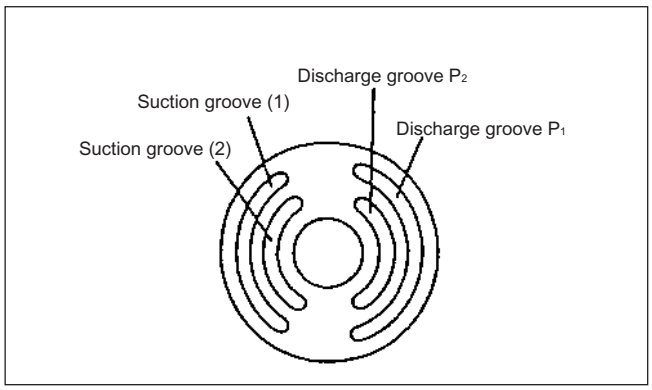
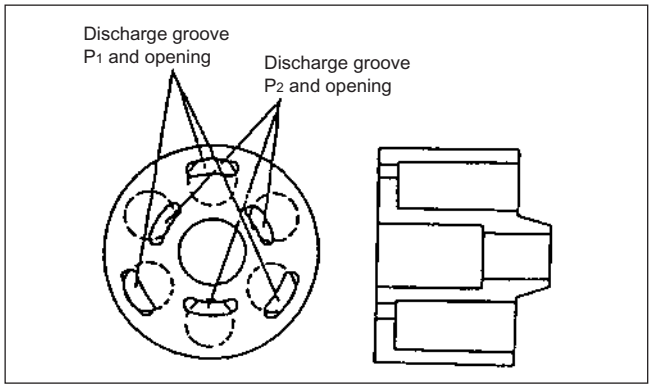
c. Operating principle

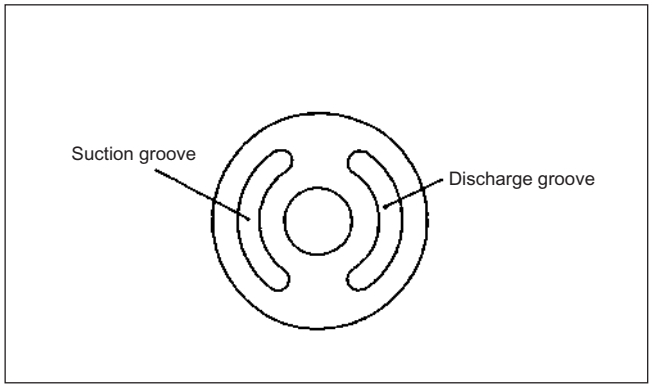


(a) Valve plate

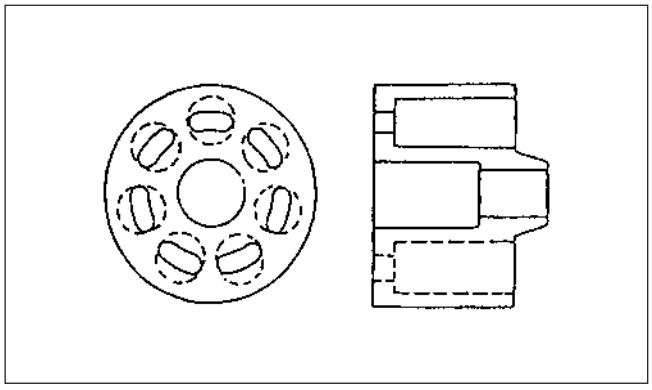


(b) Cylinder barrel

Fig. 3 Operating principle



(a) Valve plate



(b) Cylinder barrel

Fig. 4 Conventional swash plate piston pump

1) Outline

This compact, lightweight hydraulic pump has a mechanism that provides for the performance of two variable pumps. Yet it needs as small a space as for just one conventional pump. This pump is also equipped with a pilot gear pump.

The pump features a constant horsepower control function for making most of the engine power. The greater the pump load becomes, the lesser the discharge rate becomes. As a result, when the pump discharge pressures P_1 and P_2 have risen and the resultant force of the piston higher, the swash plate exceeds the spring force and tilts from the oscillating center of the oscillating pin. In this way, the discharge rate can be kept low.

2) Construction and behavior

An even number of pistons are used in this swash plate variable piston pump. This is to produce the performance of two same-capacity pumps in one pump casing.

Conventional valve plates have one suction groove and one discharge groove, as shown in Fig. 4. The new system, on the other hand, is provided with two suction grooves and two discharge grooves, as shown in Fig. 3. The discharge grooves P_1 and P_2 are located in the outer and inner sides, respectively. Every other piston chamber of cylinder barrel gets open to either of these discharge grooves in the valve plate. In other words, both the inner and outer suction grooves behave just the same way, whereas the inner and outer discharge grooves work independently from each other.

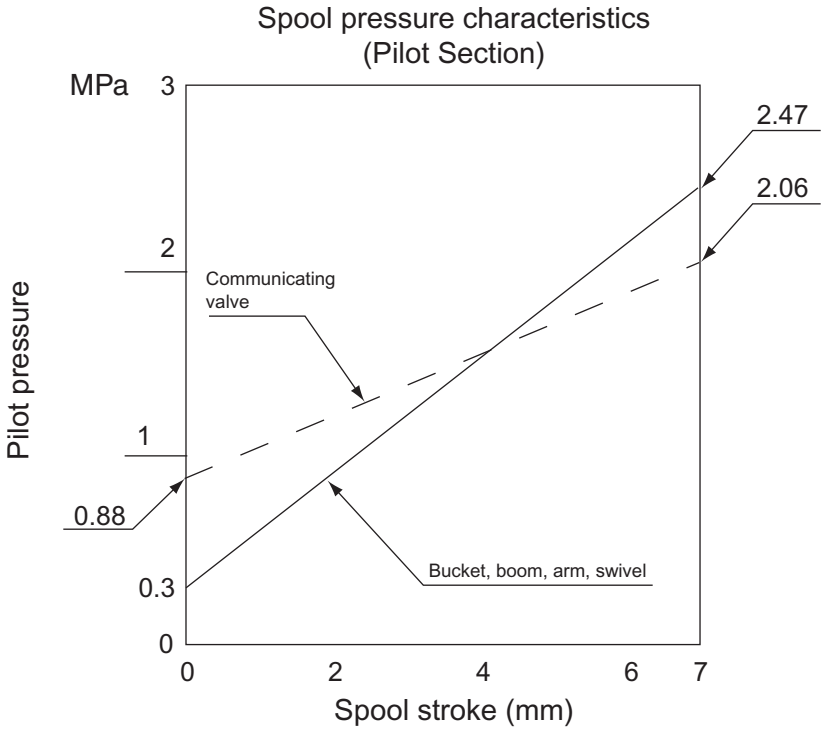
In this design with an even number of pistons, the same number of pistons gets open outward and inward of the valve plate. Because all the pistons are of the same diameter, located in a same-pitch circle and slide over the same swash plate, the discharge rates of the discharge grooves P_1 and P_2 are the same.

There is another advantage in employing just a single swash plate. Even though the swash plates tilting angle varies according to the variable control, the discharge rates of P_1 and P_2 ports change accordingly and equally.

D.Control valve

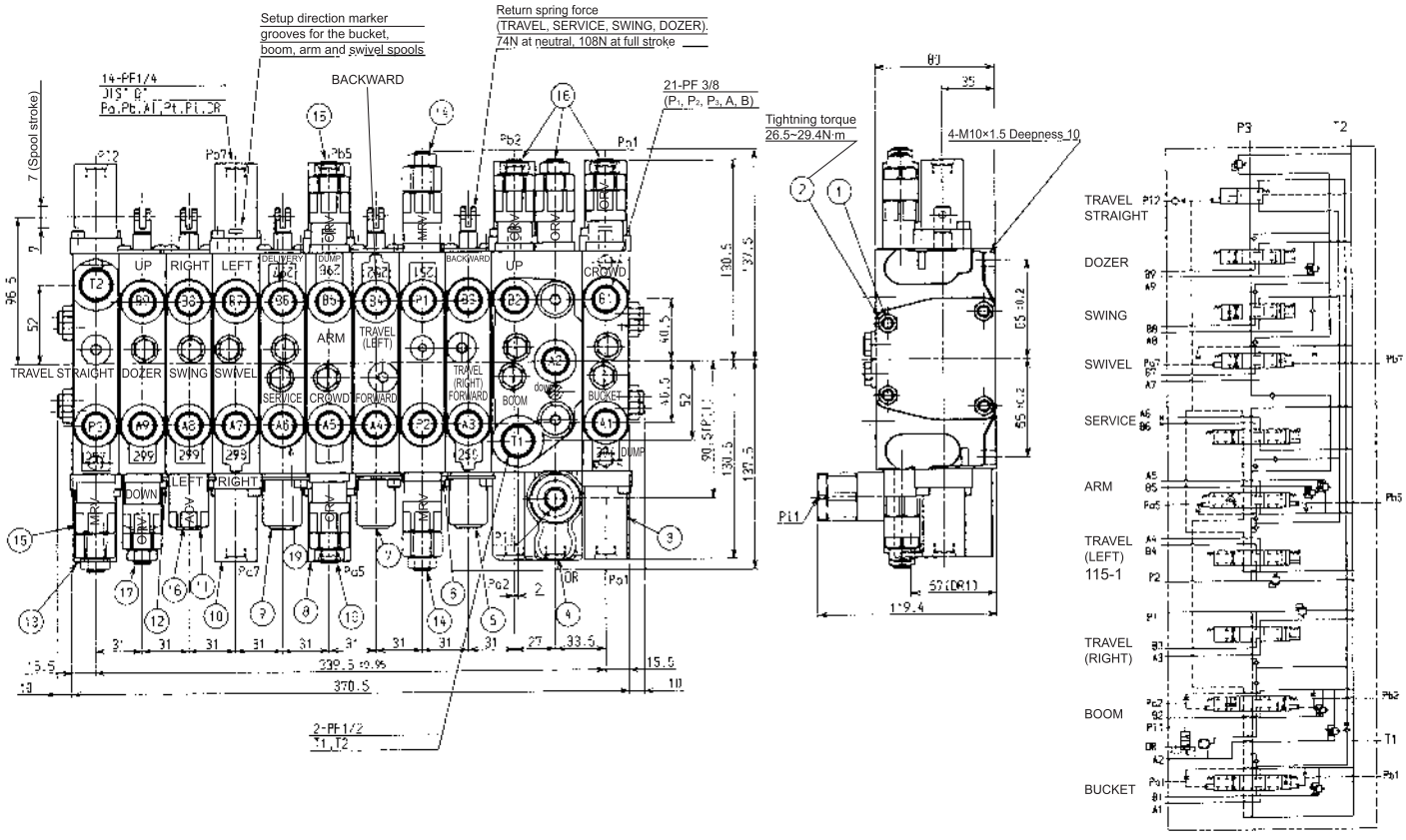
a. Specifications

Machine model			U20-3	U25-3
Type			KVSE-36-10	KVSE-36-10
Section width		mm	31.0	31.0
Total length		mm	390.5	390.5
Main spool dia		mm		
Spool stroke Pilot section		mm	7	
Mechanical section		mm	7	
Main relief valve setting pressure	P_1 P_2	MPa kg/cm^2	$21.6^{+0.3}_{-0.2}$ at 23 l/min	$21.6^{+0.3}_{-0.2}$ at 29 l/min
	P_3	MPa kg/cm^2	$20.6^{+0.3}_{-0.2}$ at 13 l/min	$17.2^{+0.3}_{-0.2}$ at 19 l/min
Overload relief valve setting pressure	Bucket Bottom Boom Rod Boom Bottom Arm Rod Arm Bottom	MPa kg/cm^2	24.0±0.3 at 29 l/min	24.0±0.3 at 29 l/min
	Dozer Bottom		24.0±0.3 at 18 l/min	24.0±0.3 at 18 l/min
Spool operating force of mechanical section Return spring at neutral		N kgf	74N	74N
at full stroke		N kgf	108N	108N
Spool operating force of pilot section		See below diagram		

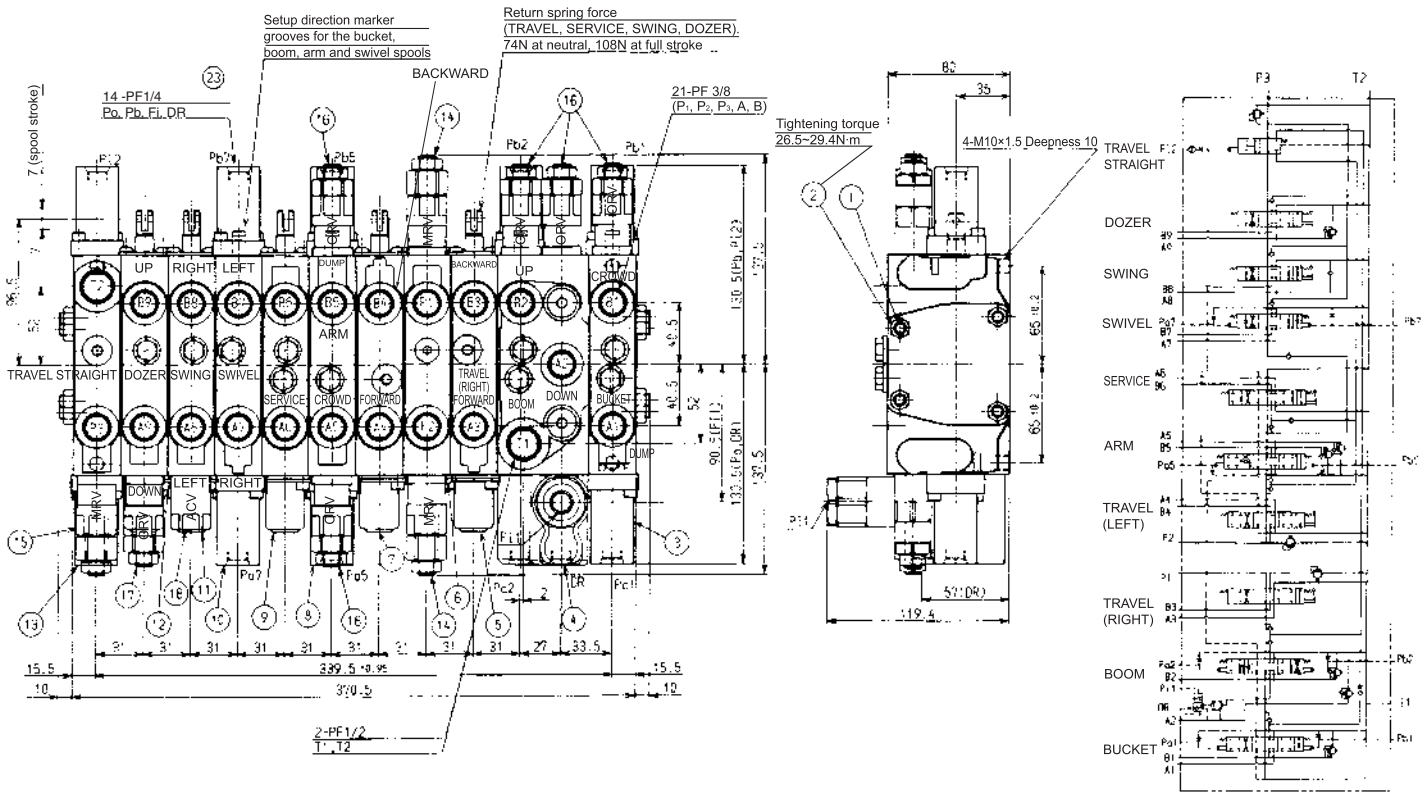


b. General view of control valve

U20-3: P/N RB411-61151

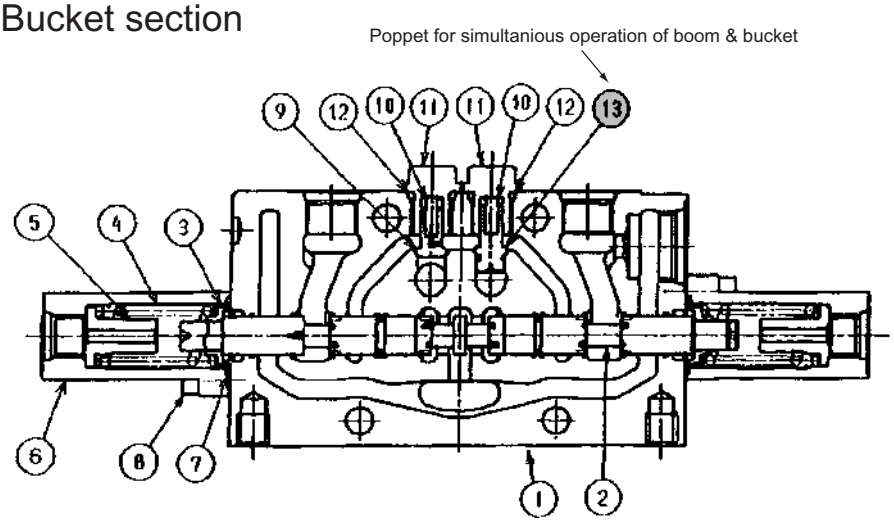


U25-3: P/N RB519-61151



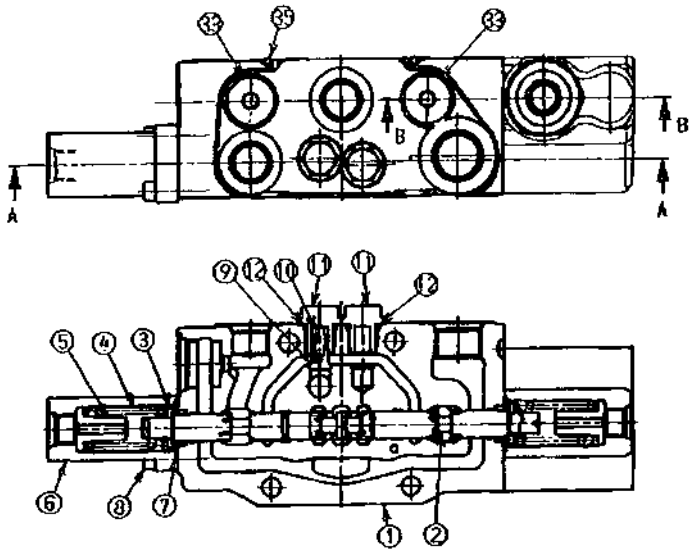
c. Sectional view

Bucket section

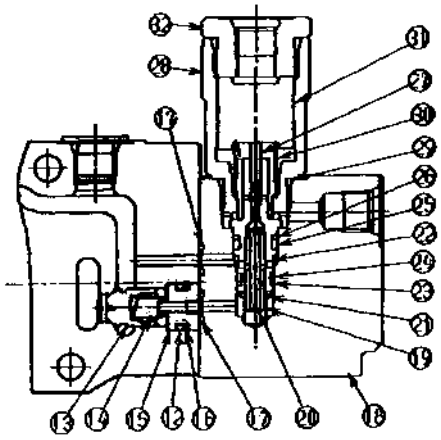


No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	SPRING SEAT	2
4	SPRING	2
5	SPRING SEAT	2
6	CAP	2
7	O RING	2
8	BOLT	4
9	POPPET	1
10	SPRING	2
11	PLUG	2
12	O RING	2
13	POPPET	1

Boom section



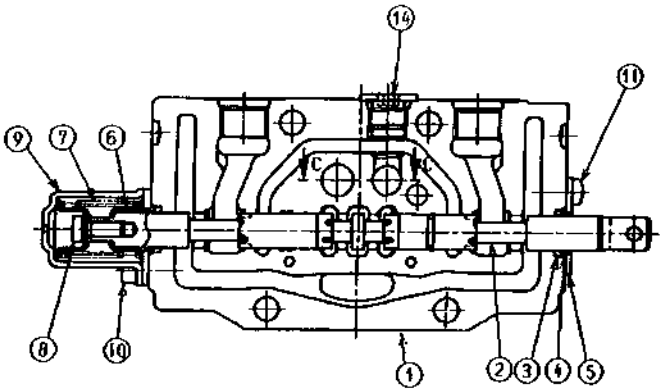
Section A-A

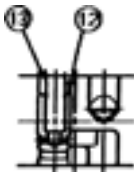


Section B-B

No.	PARTS NAME	Q'ty
1	Valve housing	1
2	Spool	1
3	Spring seat	2
4	Spring	2
5	Spring seat	2
6	Cap	1
7	O-ring	2
8	Socket head bolt	2
9	Poppet	1
10	Spring	1
11	Plug	2
12	O-ring	3
13	Poppet	1
14	Spring	1
15	Spacer	1
16	Backup ring	1
17	O-ring	2
18	Body	1
19	Spring	1
20	Poppet	1
21	Spring seat	1
22	Sleeve	1
23	Backup ring	1
24	O-ring	1
25	O-ring	1
26	Backup ring	1
27	Spool	1
28	Plug	1
29	O-ring	1
30	Spring	1
31	Piston	1
32	Plug assembly	1
33	Plug assembly	2
34	Socket head bolt	5
35	O-ring	1

Travel (right) section

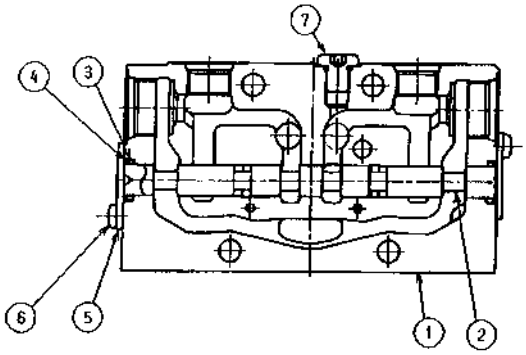




Section C-C

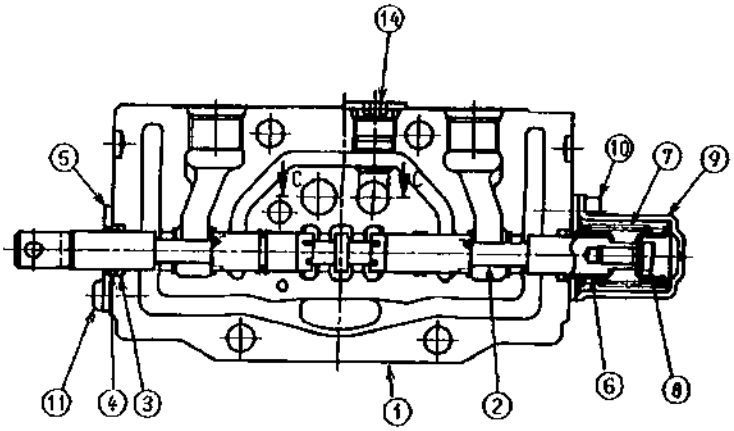
No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	WIPER	2
5	SEAL PLATE	2
6	SPRING SEAT	2
7	SPRING	1
8	CAP SCREW	1
9	CAP	1
10	BOLT	2
11	BOLT	2
12	POPPET	1
13	SPRING	1
14	PLUG	1

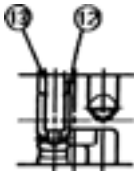
Inlet section



No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	BACKUP LING	2
5	SEAL PLATE	2
6	BOLT	4
7	PLUG	1

Travel (left) section

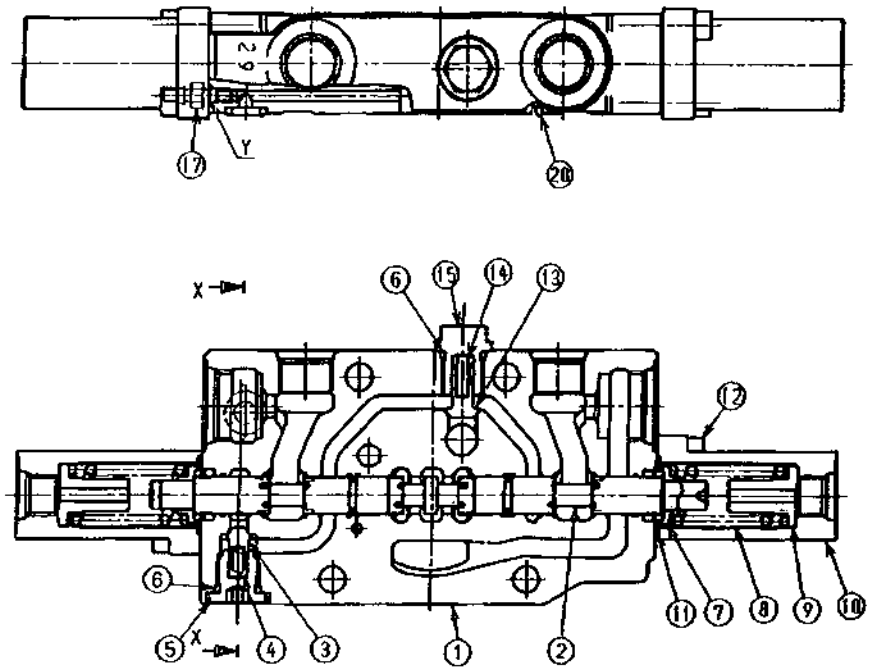




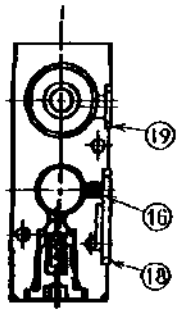
Section C-C

No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	WIPER	2
5	SEAL PLATE	2
6	SPRING SEAT	2
7	SPRING	1
8	CAP SCREW	1
9	CAP	1
10	BOLT	2
11	BOLT	2
12	POPPET	1
13	SPRING	1
14	PLUG	1

Arm section

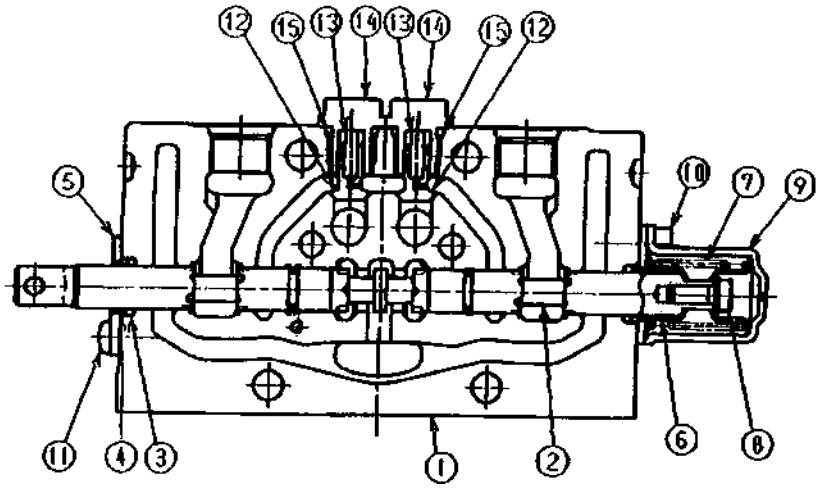


No.	PARTS NAME	Q'ty
1	Valve housing	1
2	Spool	1
3	Poppet	1
4	Spring	1
5	Plug	1
6	O-ring	2
7	Spring seat	2
8	Spring	2
9	Spring seat	2
10	Cap	2
11	O-ring	2
12	Socket head bolt	4
13	Poppet	1
14	Spring	1
15	Plug	1
16	Orifice plug	1
17	Plug	1
18	O-ring	1
19	O-ring	1
20	O-ring	1



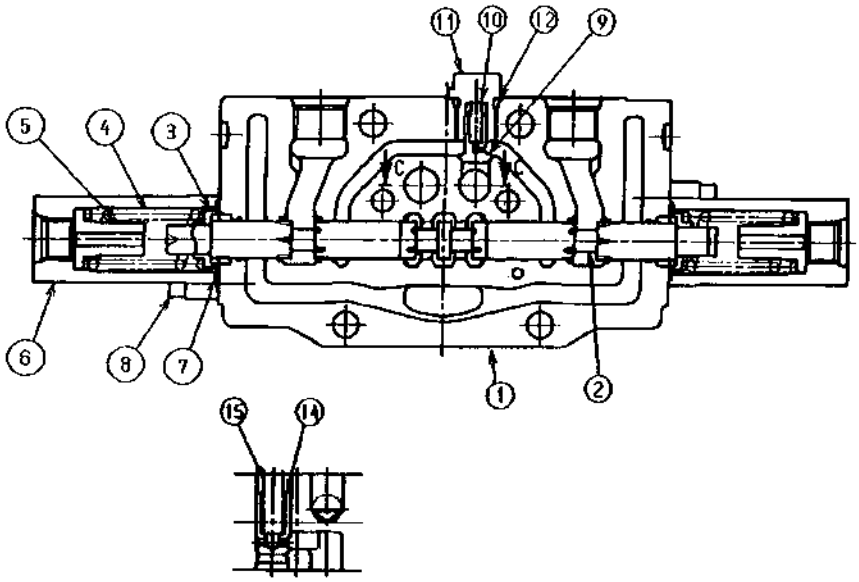
Section X-X

Service section



No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	WIPER	2
5	SEAL PLATE	2
6	SPRING SHEET	2
7	SPRING	1
8	CAP SCREW	1
9	CAP	1
10	BOLT	2
11	BOLT	2
12	POPPET	2
13	SPRING	2
14	PLUG	2
15	O RING	2

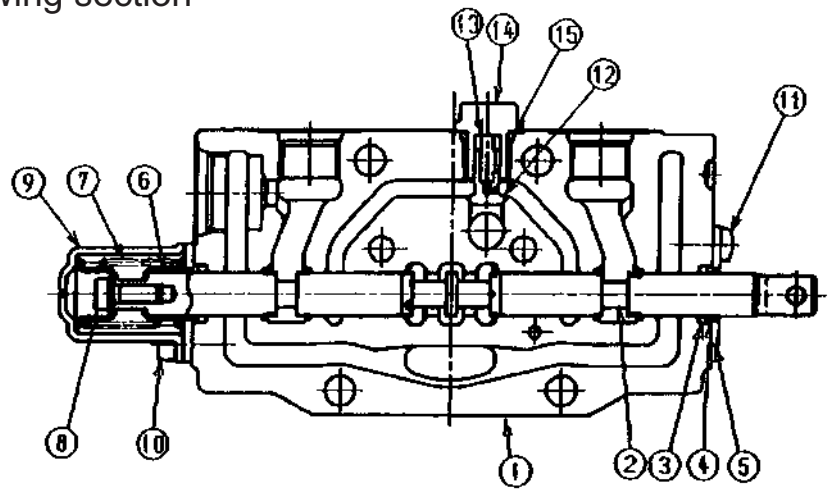
Swivel section



Section C-C

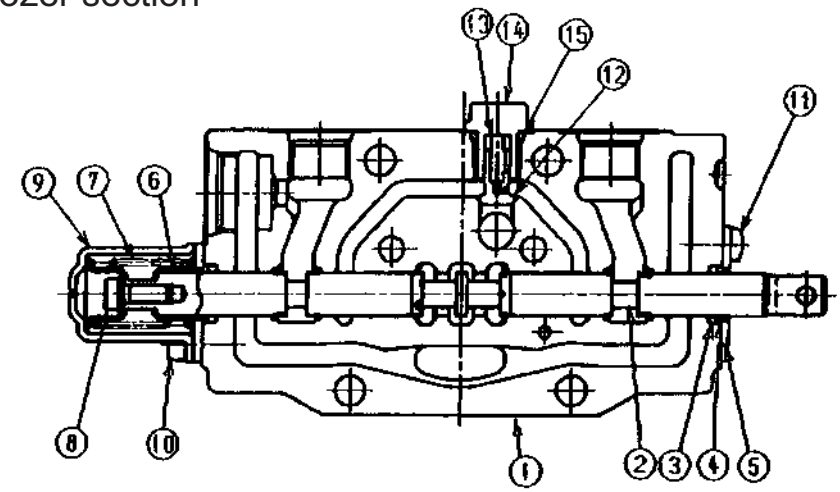
No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	SPRING SEAT	2
4	SPRING	2
5	SPRING SEAT	2
6	CAP	2
7	O RING	2
8	BOLT	4
9	POPPET	1
10	SPRING	1
11	PLUG	1
12	O RING	1
13	O RING	1
14	POPPET	1
15	SPRING	1

Swing section



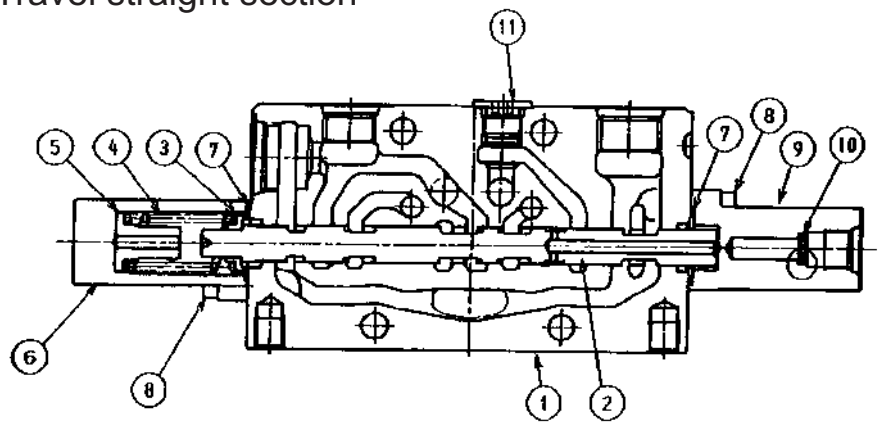
No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	WIPER	2
5	SEAL PLATE	2
6	SPRING SEAT	2
7	SPRING	1
8	CAP SCREW	1
9	CAP	1
10	BOLT	2
11	BOLT	2
12	POPPET	1
13	SPRING	1
14	PLUG	1
15	O RING	1

Dozer section



No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	O RING	2
4	WIPER	2
5	SEAL PLATE	2
6	SPRING SEAT	2
7	SPRING	1
8	CAP SCREW	1
9	CAP	1
10	BOLT	2
11	BOLT	2
12	POPPET	1
13	SPRING	1
14	PLUG	1
15	O RING	1

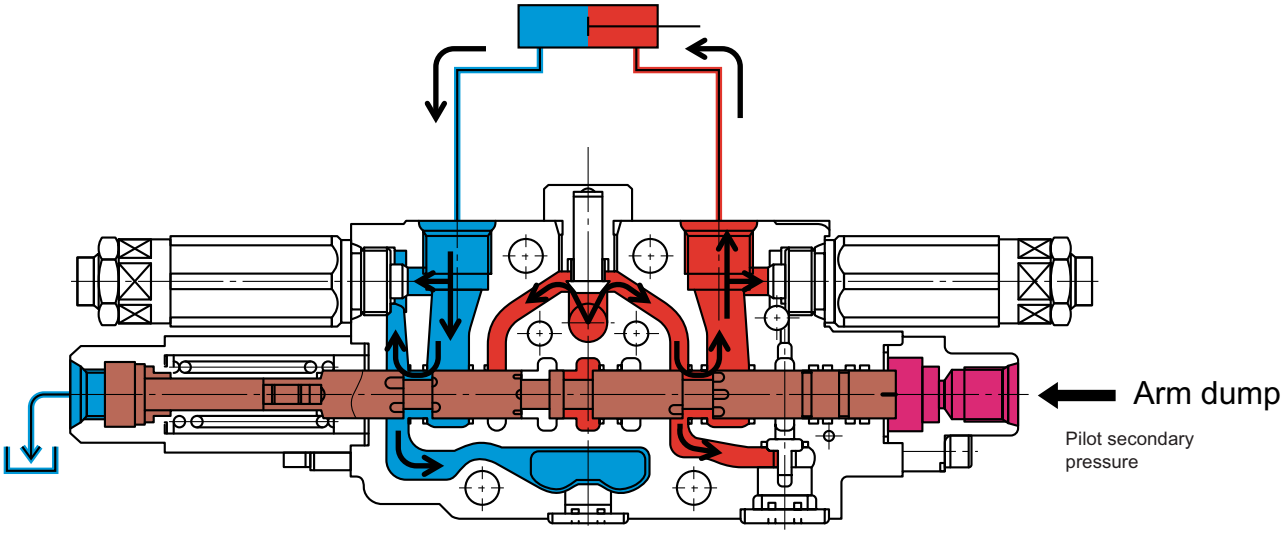
Travel straight section



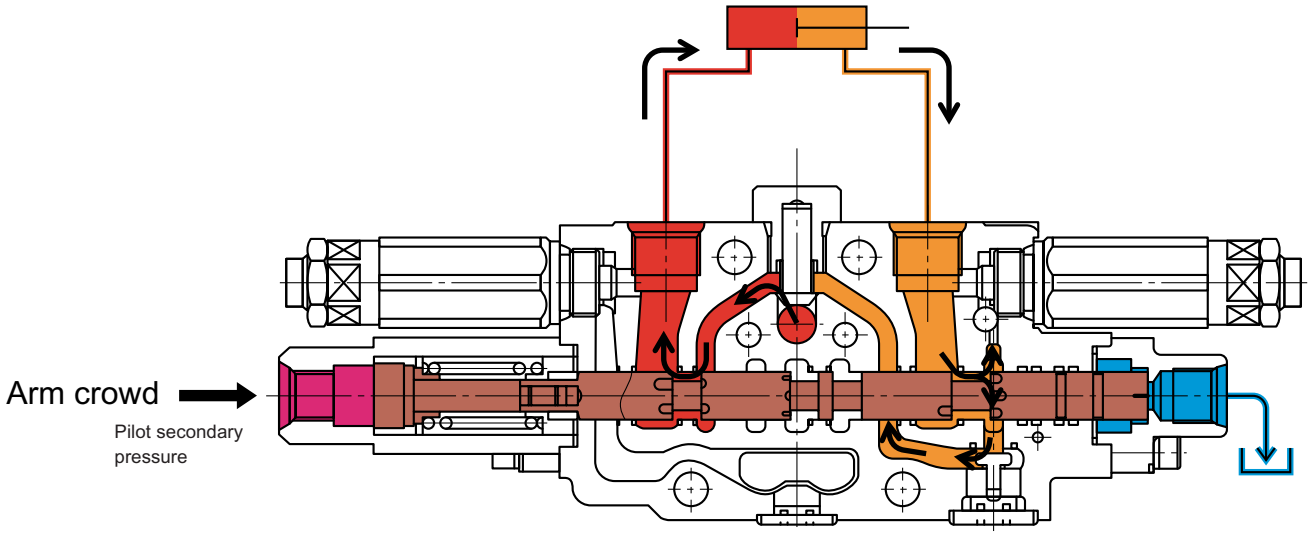
No.	PARTS NAME	Q'ty
1	HOUSING	1
2	SPOOL	1
3	SPRING SEAT	1
4	SPRING	1
5	SPRING SEAT	1
6	CAP	1
7	O RING	2
8	BOLT	4
9	CAP	1
10	FILTER	1
11	PLUG	1

d. Arm regeneration circuit

(1) Arm dump



(2) Arm crowd

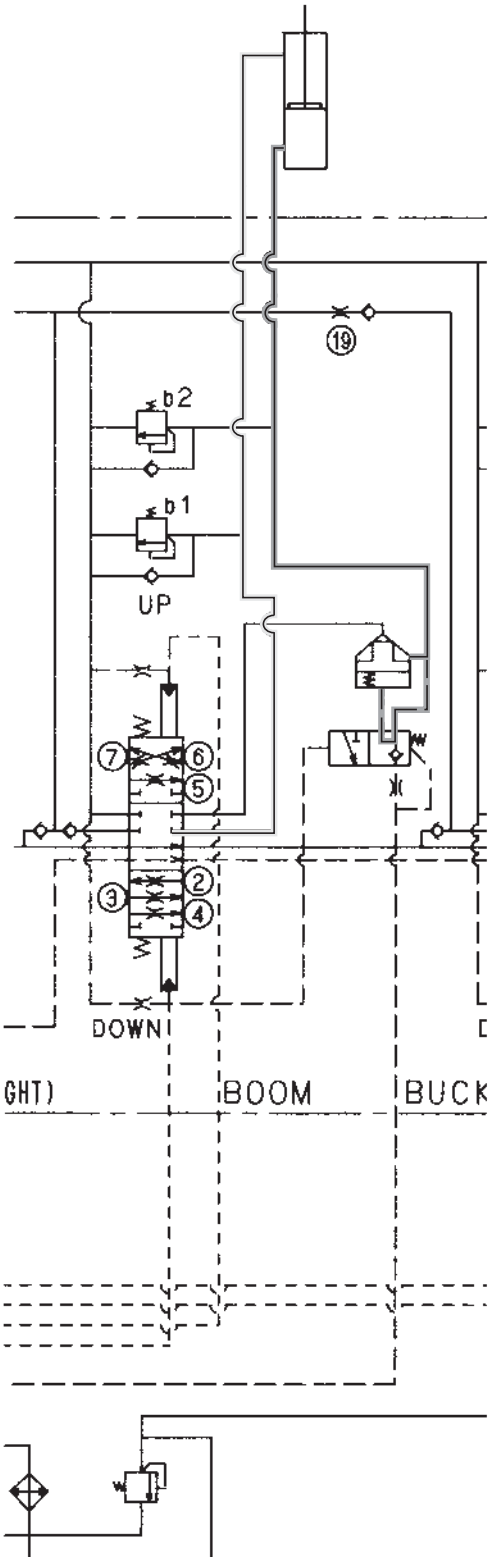


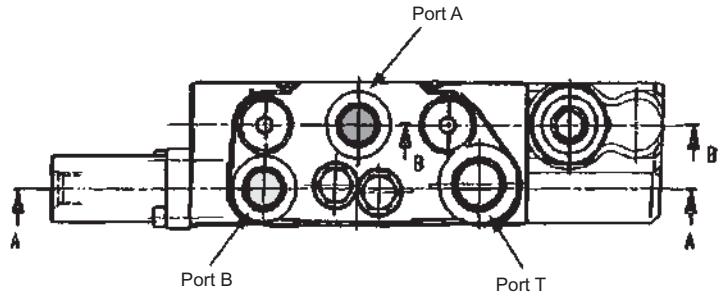
- When oil flows through the hydraulic pilot passage shown at left above, the spool shifts rightward and the neutral passage gets closed. The pressure oil goes through the parallel feeder, pushes up the load check valve and flow on to the cylinder bottom.
- Part of return oil from the cylinder bottom flows through the spool throttle first and then through the low-pressure passage, returning to the tank. The remaining oil pushes the check valve open and reaches the cylinder bottom.

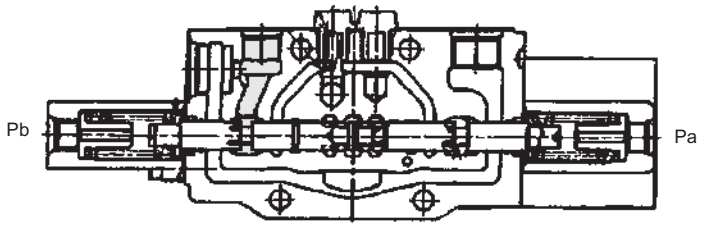
e. Boom anti-fall valve

(1) At neutral position of boom section

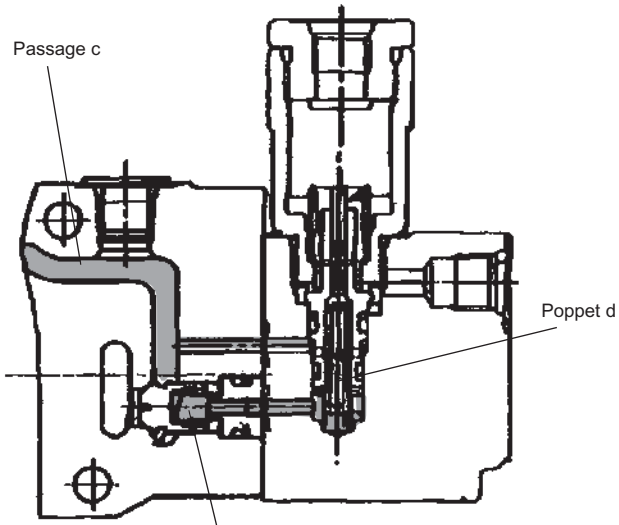
The hydraulic oil at port B (cylinder rod side) is shut off.
The hydraulic oil at port A (cylinder bottom side) flows through the passage C and poppet "d" into the chamber Z. Now the anti-drift poppet gets closed, which prevents the boom from falling.







Section A-A

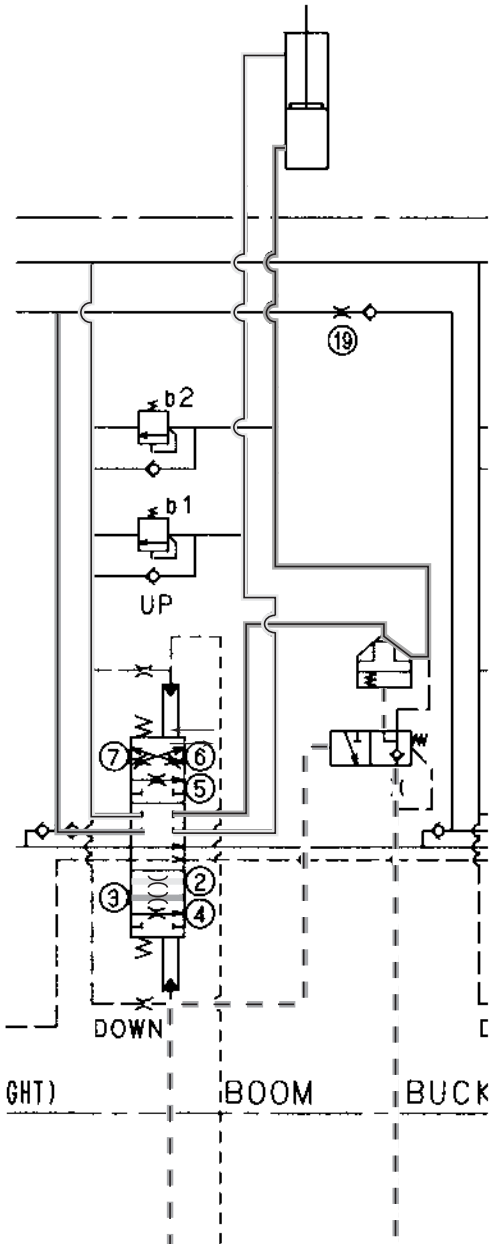


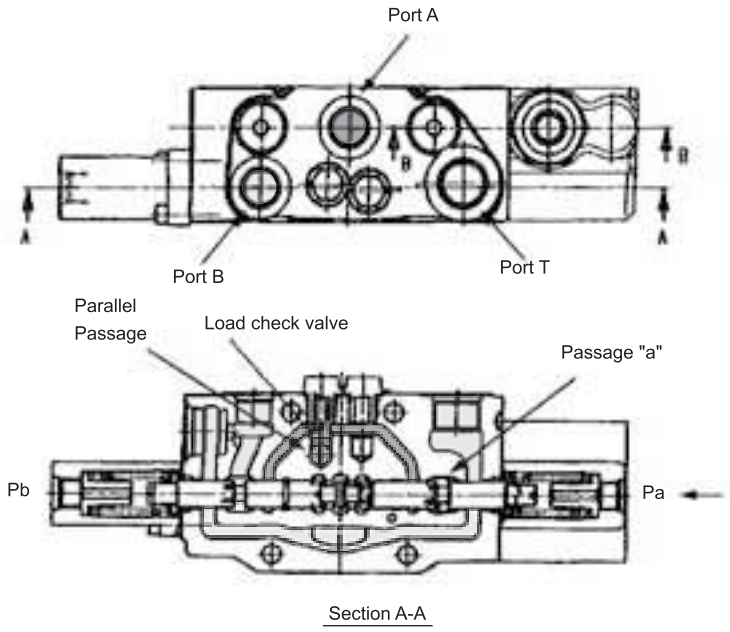
Section B-B

Chamber Z

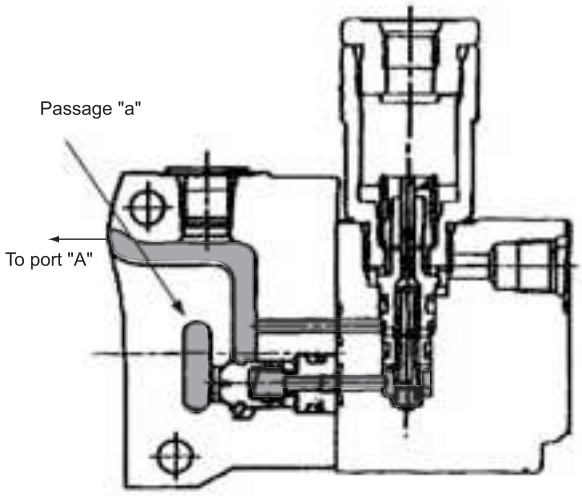
(2) Boom up (with port Pa under pressure)

When the boom is lifted, the oil from the pilot valve is introduced into the port Pa and the control valve spool is moved to the lift.
The hydraulic oil from the pump flows through parallel passage, pushing load check valve. The oil then flows through the passage "a", pushing up the anti-drift poppet. The oil further goes through the port A. The return oil from the port B comes through the throttle into the tank.



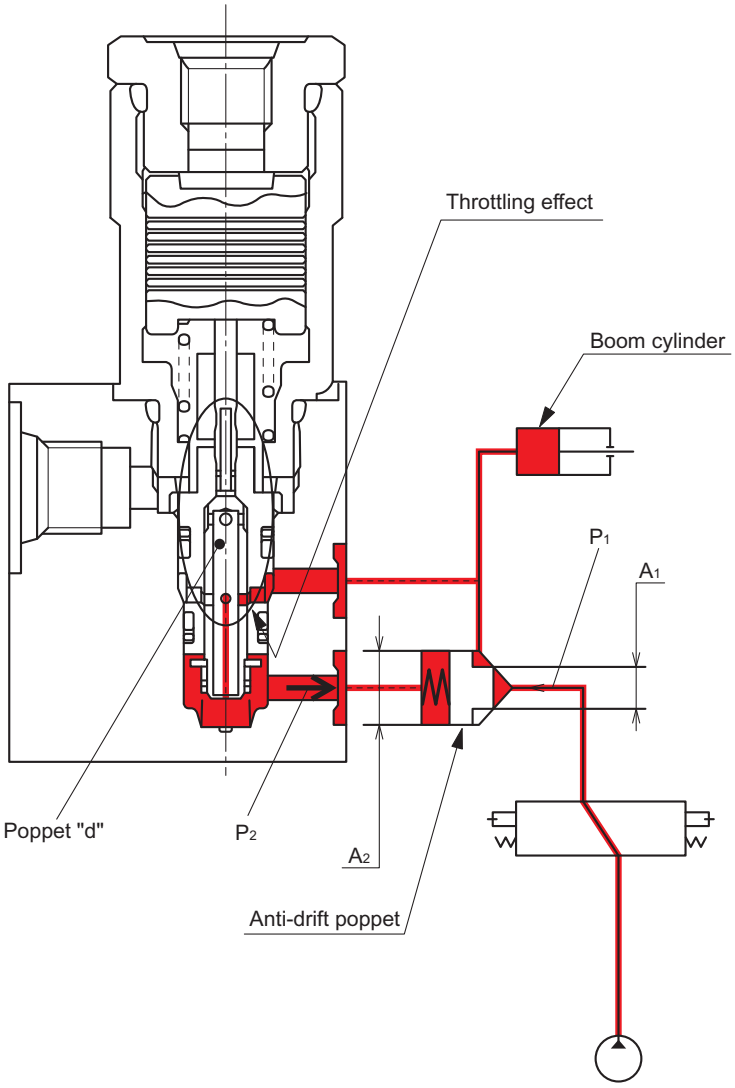


Section A-A



Section B-B

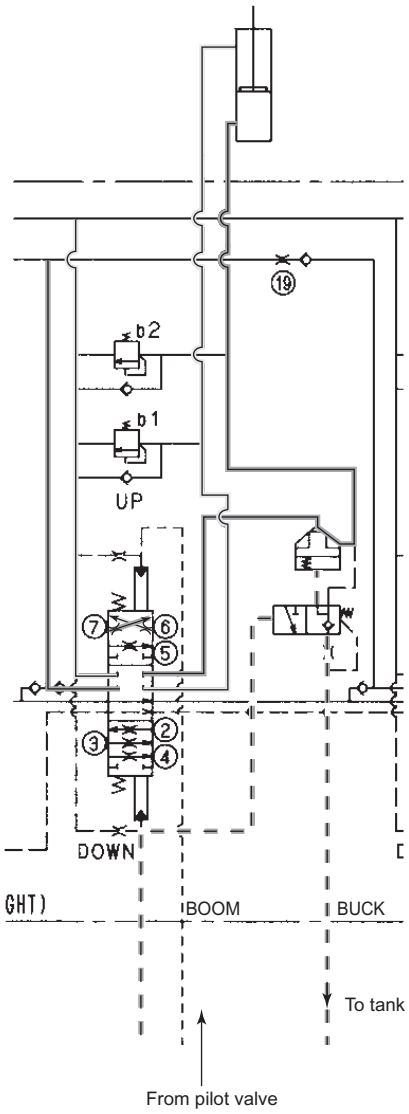
Details of the anti-drift valve operation

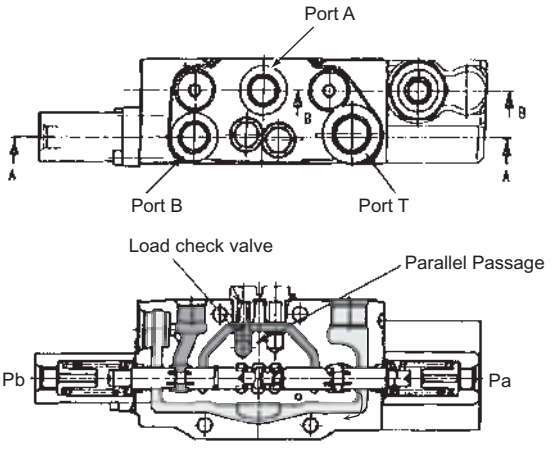


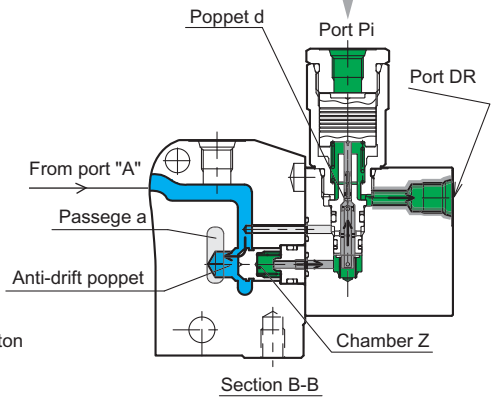
The oil from the pump comes pushing through the anti-drift poppet into the boom cylinder. The oil also passes through the poppet "d" and reaches behind the anti-drift poppet.
The power balance at this time is expresses as $P_1 \times A_1 > P_2 \times A_2$.
Where P_1: Pressure of the oil from the pump
P_2: Pressure applied behind the anti-drift poppet ($P_1 > P_2$ because of the throttling effect of poppet "d")
A_1: Area exposed to the pressure P_1
A_2: Area exposed to the pressure P_2
The anti-drift poppet shifts to the left in the above figure.
$A_1 < A_2$ but $P_1 >> P_2$, Thus we have $P_1 \times A_1 > P_2 \times A_2$.

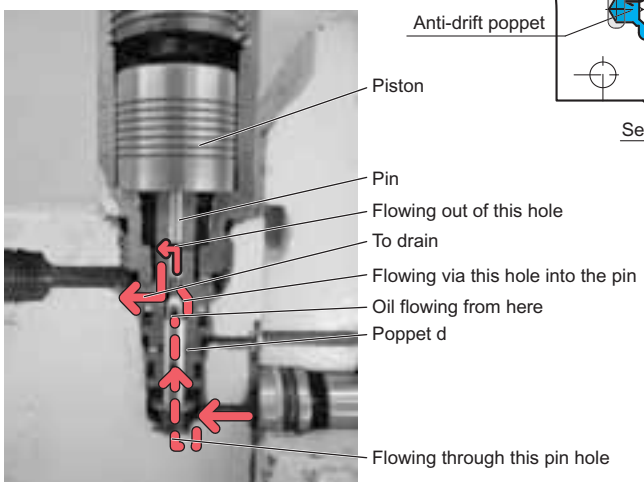
(3) Boom down (with port Pb under pressure)

When the boom is lowered, the oil from the pilot valve is introduced into the port Pb and the control valve spool is moved to the right. The hydraulic oil from the pump flows through parallel passage, pushing load check valve. The oil further goes through the port B.
The oil from the pilot valve, on the other hand, is also introduced to the port Pi, pushing down the piston, pin and poppet "d". The oil in the chamber Z flows through the poppet "d" and the pin's internal hole and then via the drain port back into the tank.
Now the pressure in the chamber Z goes down, and the return oil from the port A pushes open the anti-drift poppet. It further flows through the passage a, the spool's throttle and the tank passage back into the tank.

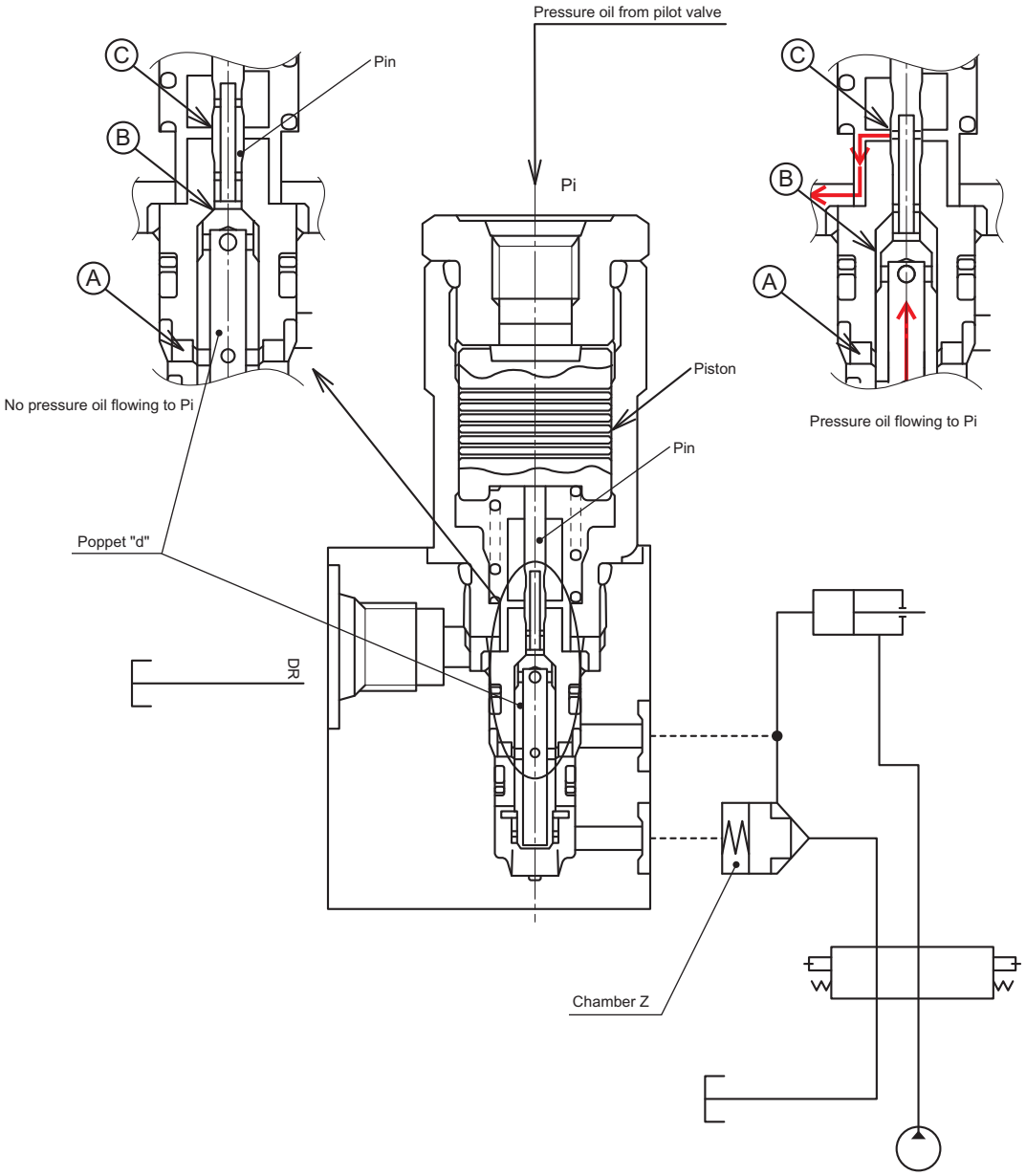


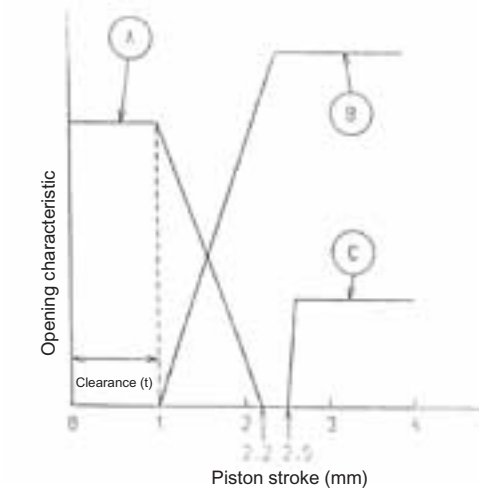






Details of the anti-drift valve operation





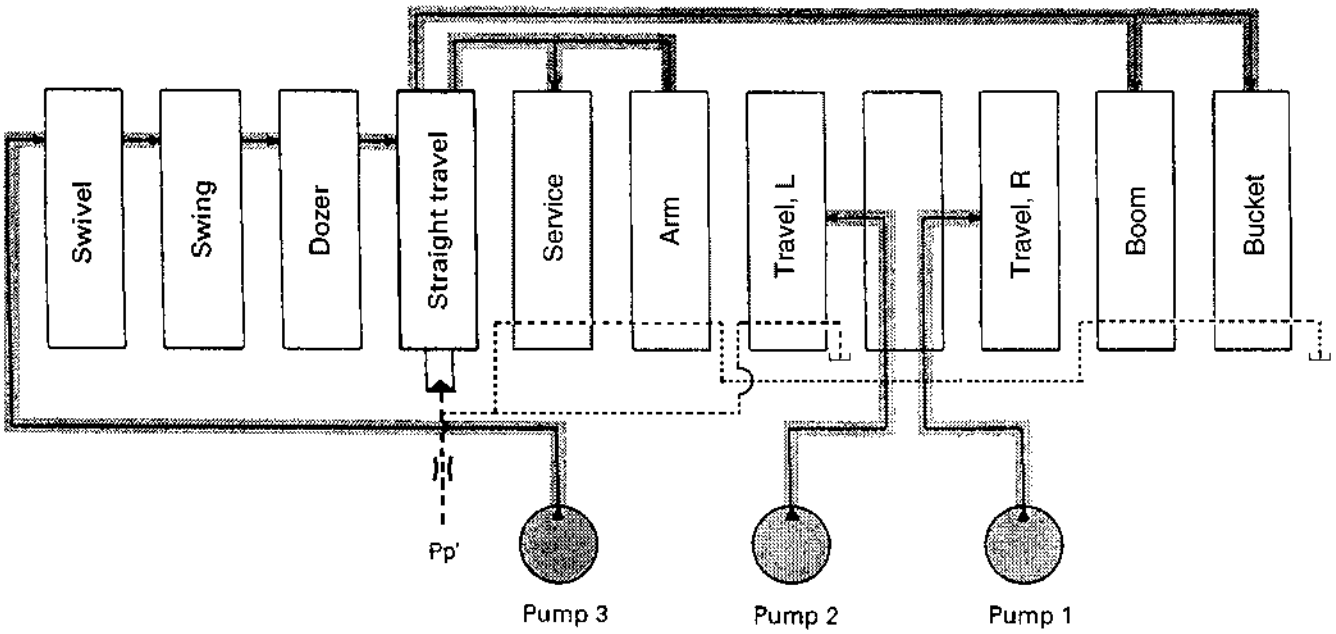
Part of the oil from the pilot valve is introduced into port Pi of the anti-drift valve, thereby pushing down the piston. Part (A) gets shut off first. Part (C) then gets open, which feeds the oil from chamber Z, through the poppet "d" and the pin, and into the tank. In this design - shutting off part (A) before opening part (C), the oil at the boom cylinder bottom is kept from flowing to the tank. Thus the anti-drift poppet can be perfectly pushed open. As a result, the oil at the boom cylinder bottom is all fed through the control valve back into the tank.

f. Straight travel circuit

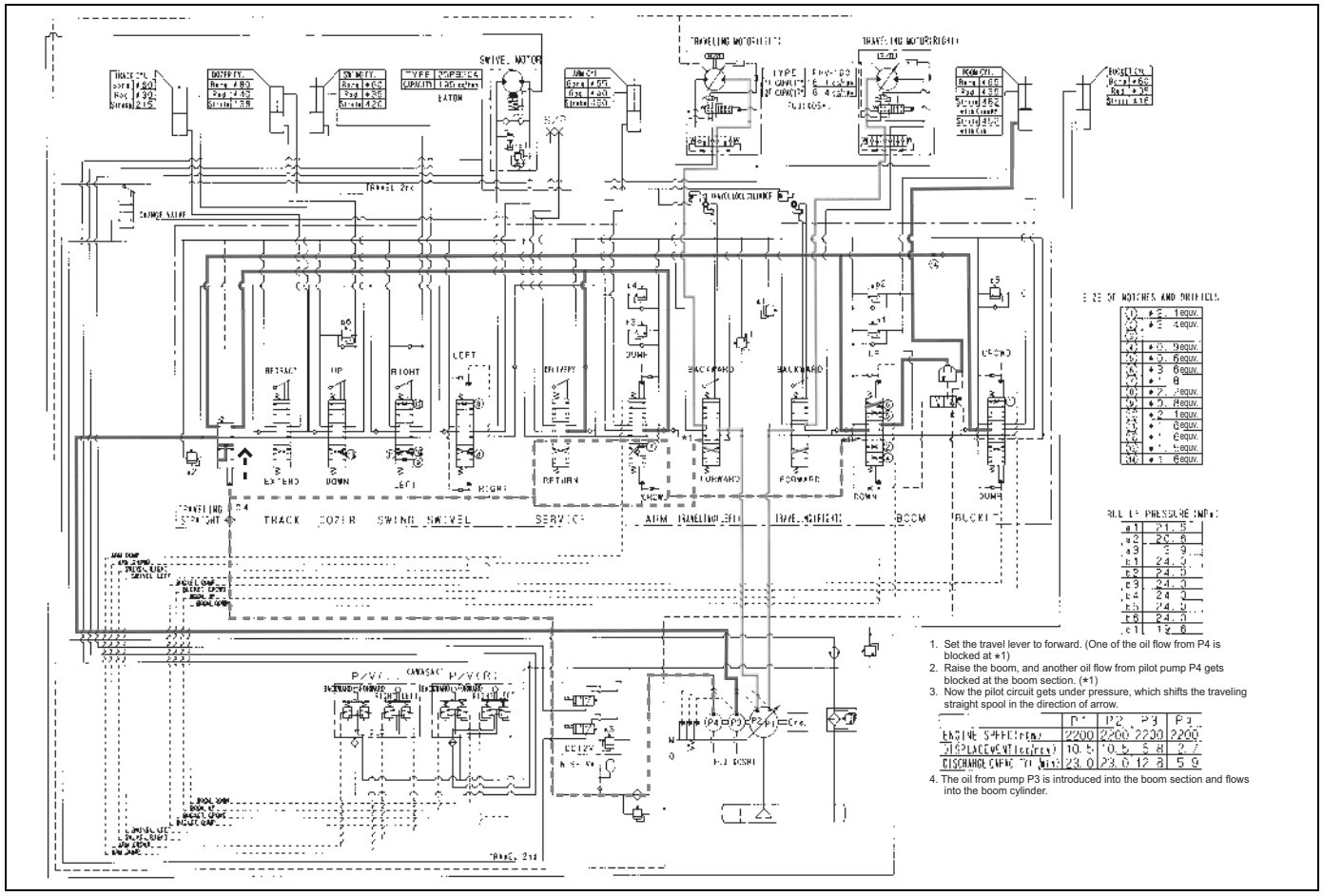
(1) Feature
The following points are ensured even when a front attachment (boom, arm, bucket, etc.) is operated while traveling.
1) The machine keeps running straight.
2) The machine keeps running at the same speed.

(2) Working effect
1) When loading and unloading the machine on and off a truck, the front attachments can be moved up and down for safe, efficient work.
2) Before lifting pipes, the front attachment can be positioned exactly to the pipes while the machine is traveling.

(3) Operating



When the boom, arm, bucket or service port is used while traveling, the signal line of the related spool is activated to shut off the passage leading to the tank. The Pp' port then gets under pressure, which switches the spool of the straight travel section.
So the oil that is supplied from the pump 3 flows to the boom, arm, bucket or service port. In this design, the machine can keep running straight.
The oil flow when the machine travels and the boom is raised is shown on the next page.



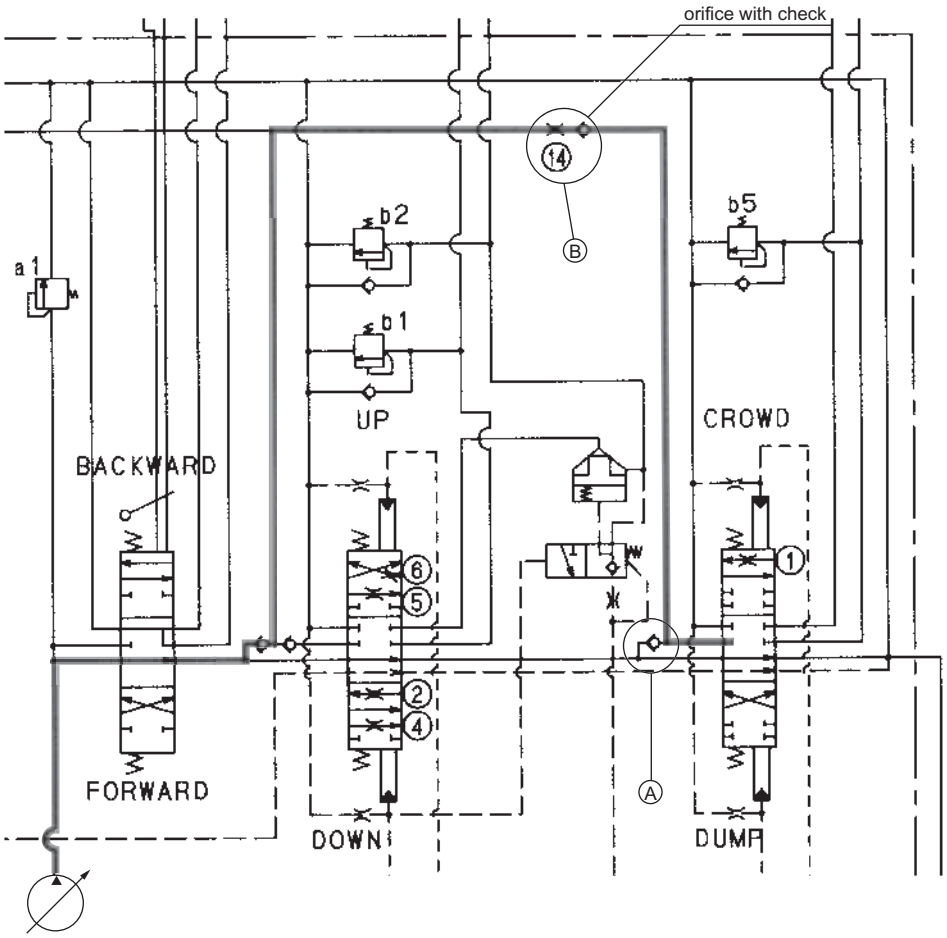
1. Set the travel lever to forward. (One of the oil flow from P4 is blocked at *1)
2. Raise the boom, and another oil flow from pilot pump P4 gets blocked at the boom section. (*1)
3. Now the pilot circuit gets under pressure, which shifts the traveling straight spool in the direction of arrow.

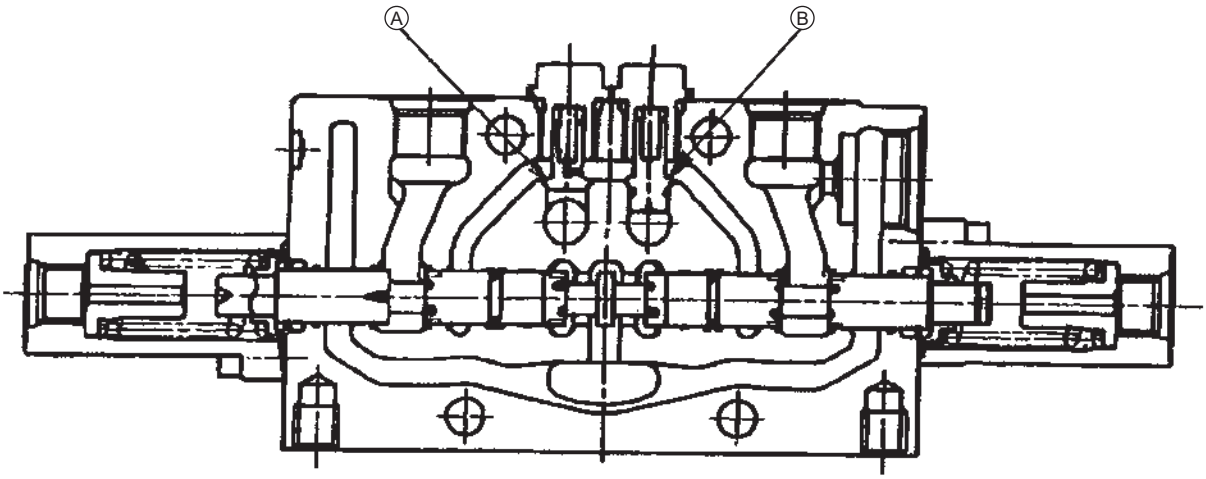
	P1	P2	P3	P4
ENGINE SPEED (rpm)	2200	2200	2200	2200
DISPLACEMENT (cc/rev)	10.5	10.5	5.8	2.7
DISCHARGE CAPACITY (l/min)	23.0	23.0	12.8	5.9

4. The oil from pump P3 is introduced into the boom section and flows into the boom cylinder.

g. Simultaneous operation of boom & bucket

While the boom and bucket are being used together, the pressure oil to the bucket switch is fed via the intermediate orifice. The orifice openness is not enough to cover the difference with respect to the attachment load, but designed to keep the best balance for simultaneous operation of the boom and bucket.





h. Relief valve/Anti-cavitation valve

Function of relief valve

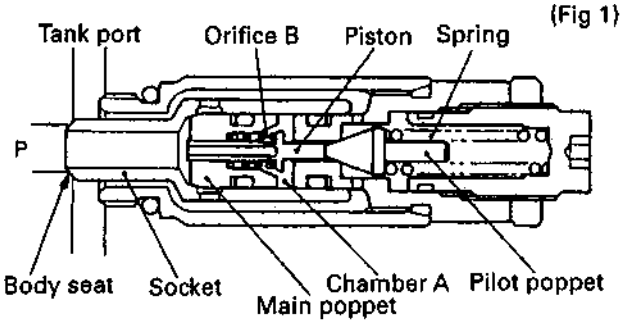
(1) The pressure oil passes first through the piston that is built in the main poppet. It then goes through the orifice B and fills the chamber A. Now the main poppet and socket are well fitted, whereas the socket and body seat are also ensured together.(Fig.1)

(2) When the pressure oil at the port P has reached the spring's set pressure, the piston is pushed, which in turn pushes the pilot poppet open.
Now the pressure, oil flows in this way: piston, orifice B, chamber A, ring orifice A, and port D. It finally passes around the socket into the tank port. (Fig.2)

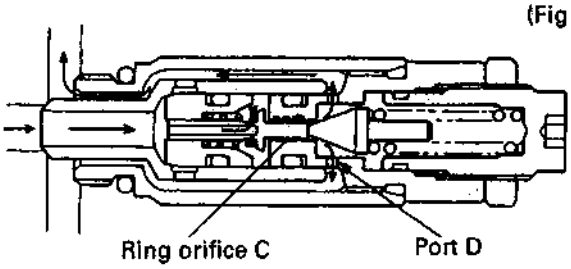
(3) With the pilot valve open, the pressure in the chamber A drops. The main poppet then opens, and the pressure oil at the port P goes through the port E and directly reaches the tank port. (Fig.3)

(4) When the pressure at the port P has dropped below the spring's set pressure, the pilot popper is pressed against the seat by the spring force and the pressure of chamber A becomes equal to that of port A. The main poppet is also pressed against the socket seat resulting in the original state(Fig.1)

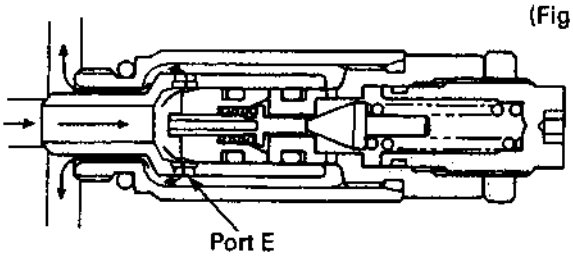
(Fig 1)



(Fig 2)



(Fig 3)

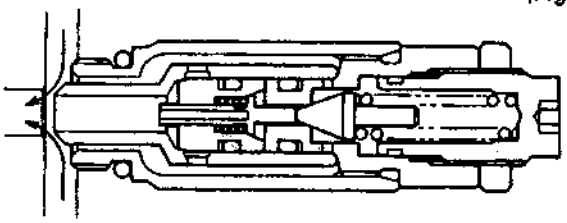


Function of anti-cavitation valve

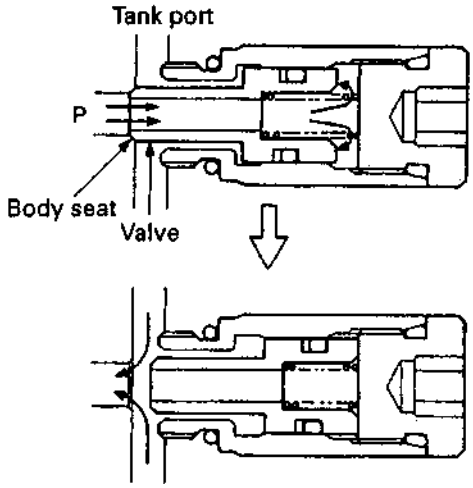
(1) This valve works to feed the oil from the tank port if a negative pressure occurs at the port P. When the pressure at tank port has risen above that at the port P, the socket is activated upward.
This upward force makes a space between the body seat and the socket. The oil now comes through the tank port into the port P and fills the space. (Fig. 4)

(2) This valve works to feed the oil from the tank port if anegative pressure occurs at the port P. When the pressure at the tank port has risen above that at the port P, the valve is activated upward.
This upward force makes a space between the body seat and the valve. The oil now comes through the tank port into the port P and fills the space. (Fig.5)

(Fig 4)



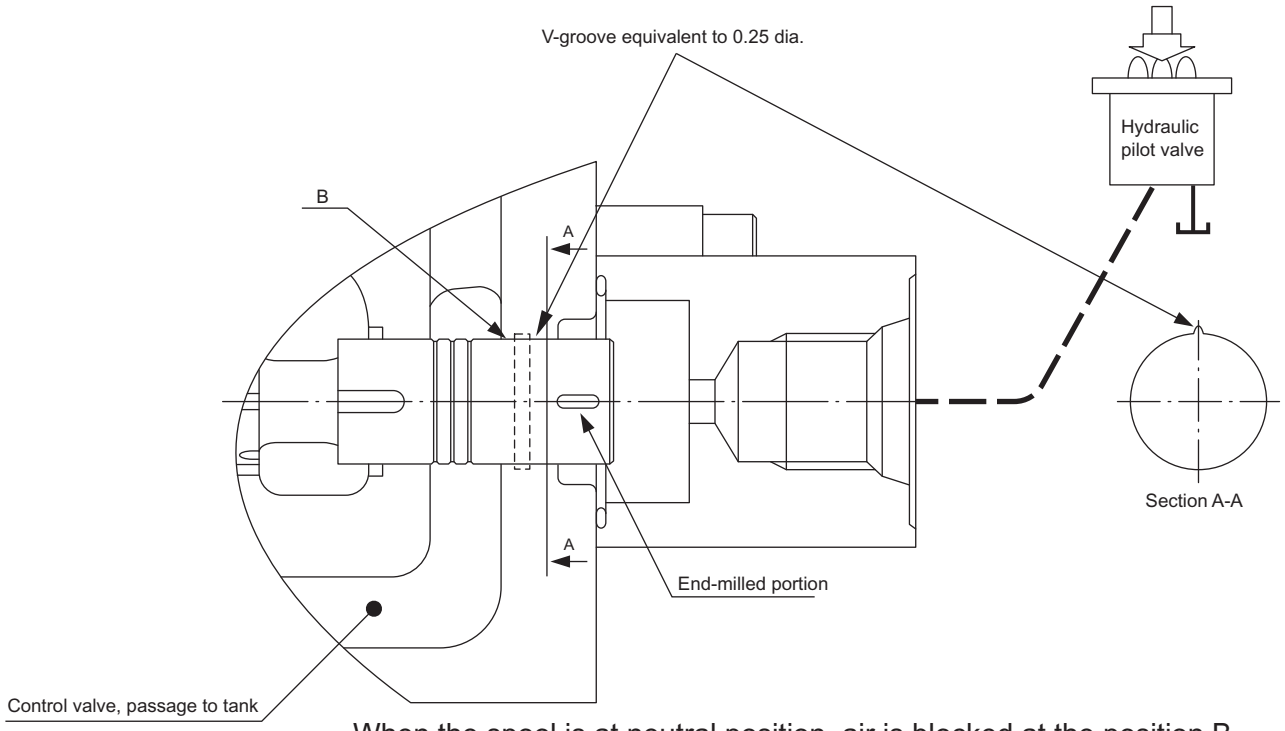
(Fig 5)



i. Automatic air bleeding in hydraulic pilot section

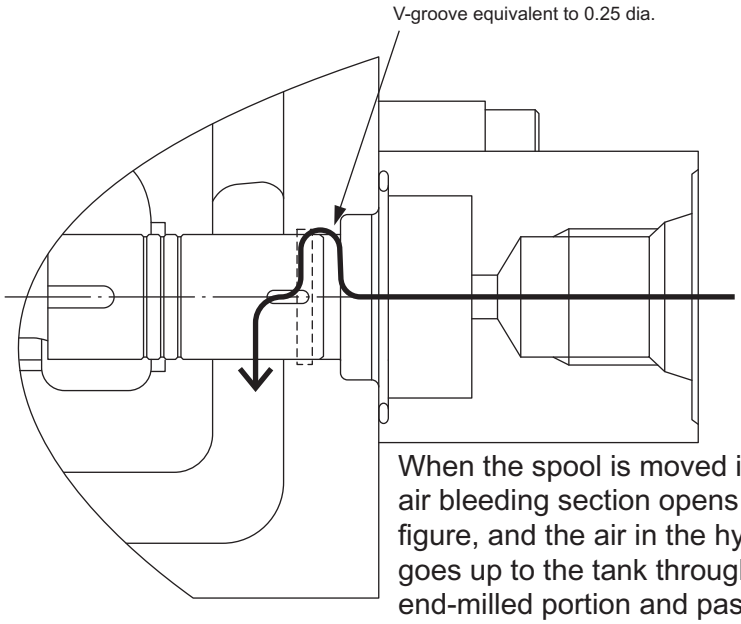
Automatic air bleeding mechanism is provided at the control valve spool which is operated by hydraulic pilot valve.

(1) When the spool of the control valve is at neutral position.



When the spool is at neutral position, air is blocked at the position B as shown in the figure above and the air in the hydraulic pilot circuit does not return to the tank.

(2) When the spool of the control pilot valve is moved in full stroke.

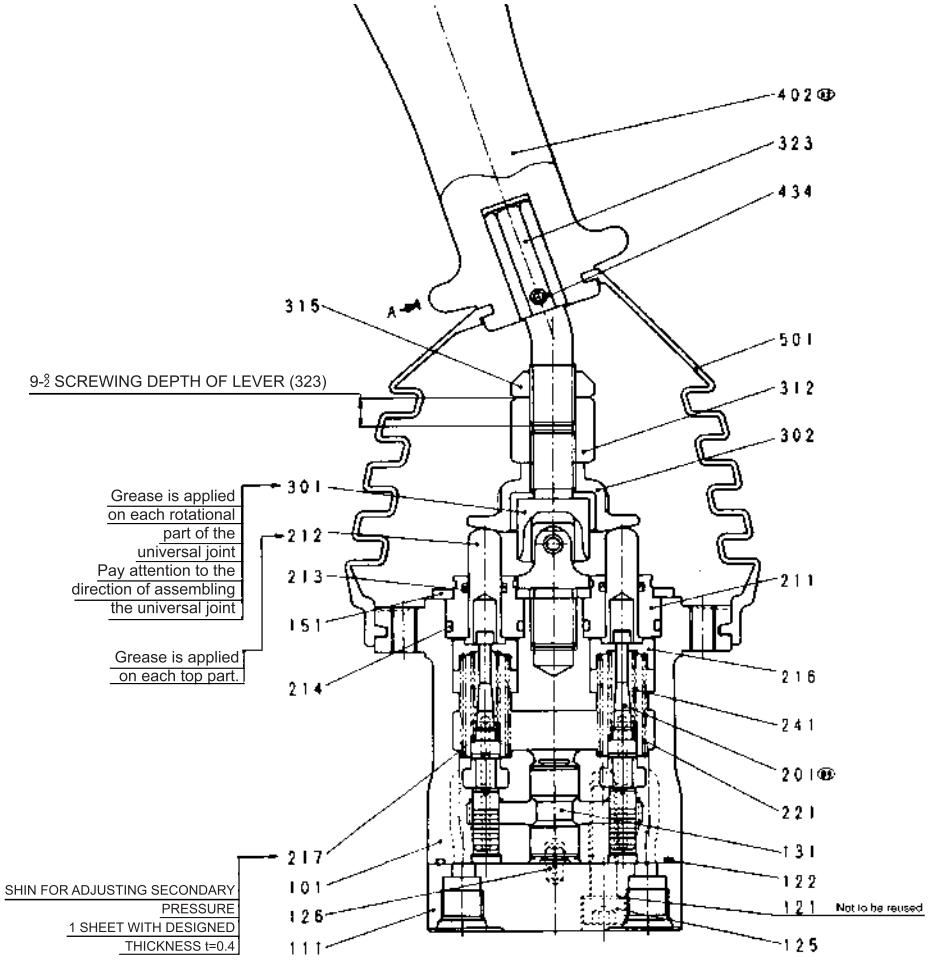


When the spool is moved in full stroke, the air bleeding section opens as shown in the figure, and the air in the hydraulic pilot circuit goes up to the tank through the V-groove, end-milled portion and passage to the tank.

E. Pilot valve

a. Structure

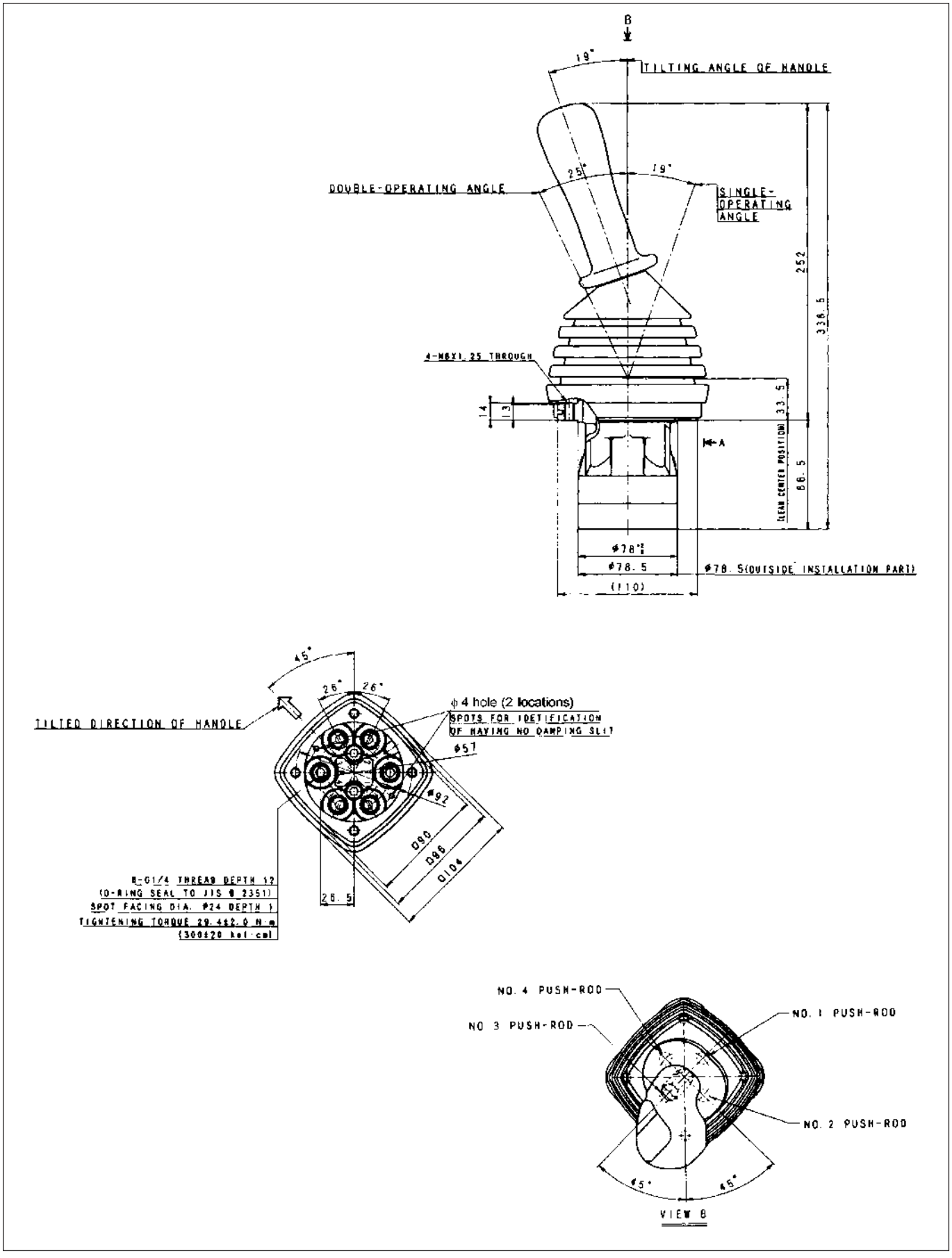
The construction of pilot valve is shown in the sectional view (page 16). The casing has a vertical hole in which a reducing valve is integrated.
The reducing valve consists of spool (201), secondary pressure setting spring (241), return spring (221), spring washer (216) and washer 2 (217). The secondary pressure setting spring (241) has been factory-adjusted to a converted secondary pressure of 0.5-1 MPa (depending on models). The spool (201) is kept against the push rod (212) by the return spring (221).
Tilt the operating lever, and the push rod (212) is pressed down and the spring seat goes down too. This affects the secondary pressure setting spring (241).
The oil inlet (primary pressure) port P and outlet (tank) port T are located at the casing (101) and port plate (111). The secondary pressure is taken out of the ports 1, 2, 3 and 4.



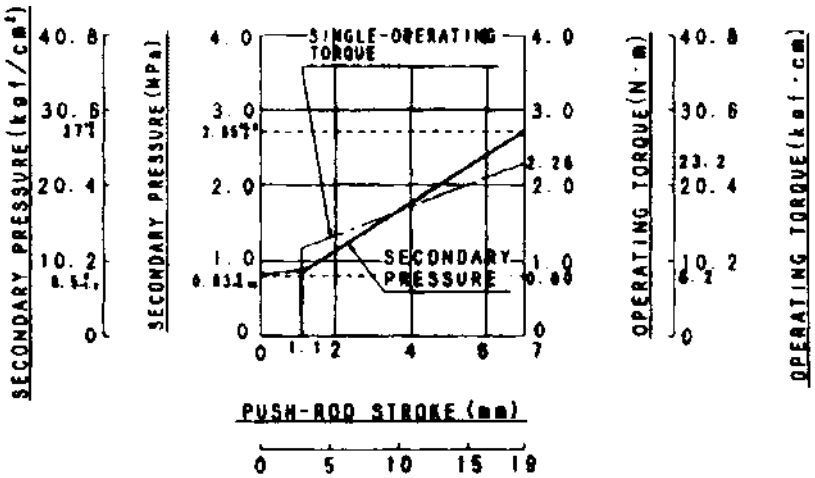
No.	PART NAME	Q'ty
101	CASING	1
111	PLATE, port	1
121	WASHER, seal	2
122	O-RING	1
125	SCREW, hex, S.M.C	2
126	PIN, spring	1
131	BUSH	1
151	PLATE	1
201	SPOOL	4
211	PLUG	4
212	ROD, push	4
213	Seal	4
214	O-RING	4
216	SEAT1, spring	4
217	WASHER 2	4
221	SPRING	4
241	SPRING	4
301	JOINT	1
302	PLATE, circular	1
312	NUT, adjusting	1
315	NUT, lock	1
323	LEVER	1
434	PIN, spring	1
501	BELLOWS	1

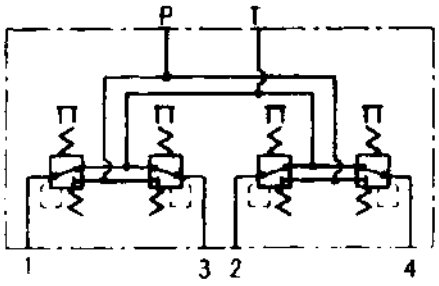
TIGHTENING TORQUE LIST

No.	SCREW SIZE	TIGHTENING TORQUE
125	M8	20.6 ± 1.5 N·m (210 ± 15 kgf·cm)
301	M14	47.1 ± 2.9 N·m (480 ± 30 kgf·cm)
302, 312	M14	68.6 ± 4.9 N·m (700 ± 50 kgf·cm)
315	M14	49 ± 3.4 N·m (500 ± 35 kgf·cm)



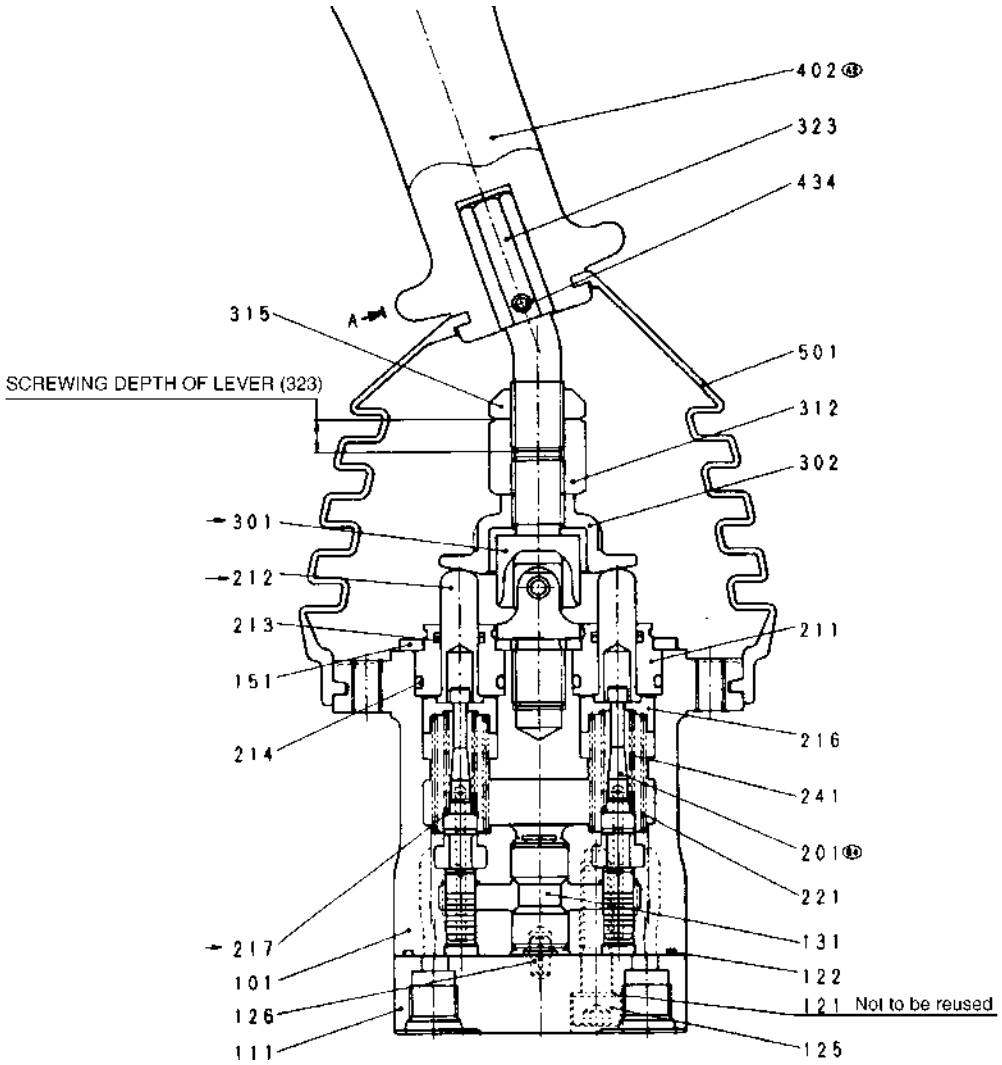
b. Pilot valve control diagram





HYDRAULIC SYMBOL

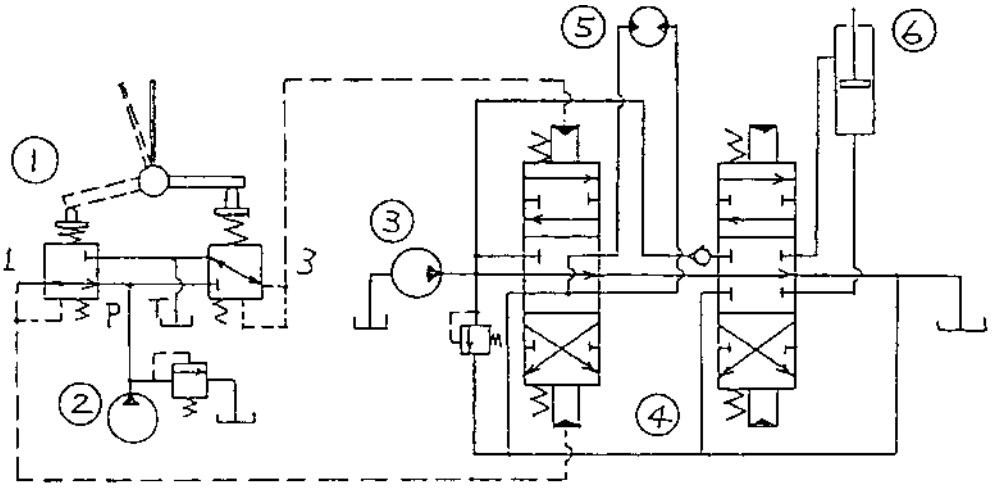
c. Function



1. Basic function
   The pilot valve is intended to control the stroke and direction of the control valve spool. To do this, the output pressure of the pilot valve is applied to the end of the control valve spool.
   To achieve this function, the pilot valve consists of the following elements.
   (1) Inlet port (P) used to supply oil from the hydraulic pump
   (2) Multiple outlet ports (1, 2, 3 and 4) used to apply the feed pressure of the inlet port to the end of the control valve spool.
   (3) Tank port (T) required to control the output pressure discussed above
   (4) Spool used to connect the output ports to the inlet port or tank port
   (5) Mechanism (including the spring for the above spool) used to control the output pressure

2. Functions of major parts
   The spool (201) is designed to switch between two oil passages: one passage is for the pressure oil from the hydraulic pump to go to the port P first and then to the output ports (1, 2, 3 and 4). The other is for the pressure oil to go from the output port to the port T. The secondary pressure setting spring (241) exerts upon this spool (201) to determine the output pressure.
   The push rod (212) is integrated in the plug (211) and ready to slide to change the deflection of the secondary pressure setting spring (241).
   The return spring (221) exerts upon the casing (101) and spring seat (216) to keep the push rod (212) free of the output pressure and pressed in the zero-displacement direction. This ensures the neutral return of the spool (201). This spring serves also as reaction spring to give the operator proper operating feel.

3. Operation
The behavior of the pilot valve is discussed, referring to the hydraulic circuit diagram (Fig. 1) and behavior diagrams (Figs. 2, 3 and 4). Fig. 1 shows a typical application of the pilot valve.



(1) Pilot valve (2) Pilot pump (3) Main pump
(4) Control valve (5) Hydraulic motor (6) Hydraulic cylinder

Fig. 1 Pilot valve application

1) With the lever at neutral (See Fig. 2.)
The secondary pressure setting spring (241), which determines the pilot valve output pressure, does not exert upon the spool (201). The spool (201) is therefore pressed down by the return spring (221) (spring seat (216)), which interconnects the output ports (2 and 4) and the port T. In this state, the output pressure is kept at the same level as the tank pressure.

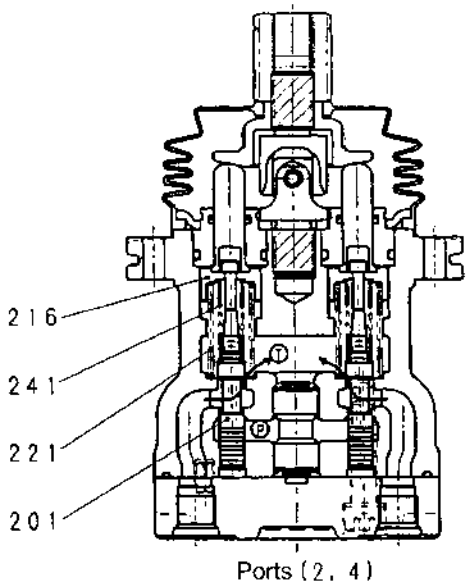


Fig. 2 With the lever at neutral

2) With the lever being tilted (See Fig. 3.)
When the lever is tilted and the push rod (212) gives a stroke, the spool (201) (spring seat (216)) lowers, which interconnects the port P and output ports (2 and 4). In this state, the oil from the pilot pump flows to the ports (2 and 4) and produces a pressure.

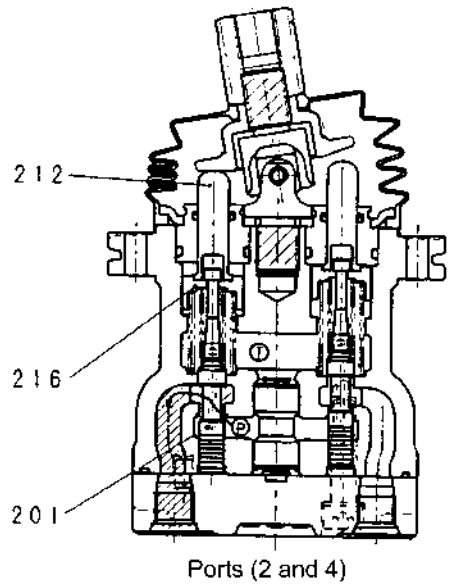


Fig. 3 With the lever being tilted

3) With the lever held tilted (See Fig. 4.)
When the pressure at the ports (2 and 4) has reached the level that corresponds to the force of the spring (241), then the oil pressure and spring force get balanced. When the pressure at the ports (2 and 4) has risen above the set level, the ports (2 and 4) and port P get closed, whereas the ports (2 and 4) and port T get open. When this pressure has dropped below the set level, the ports (2 and 4) and port P get open, whereas the ports (2 and 4) and port T get closed.

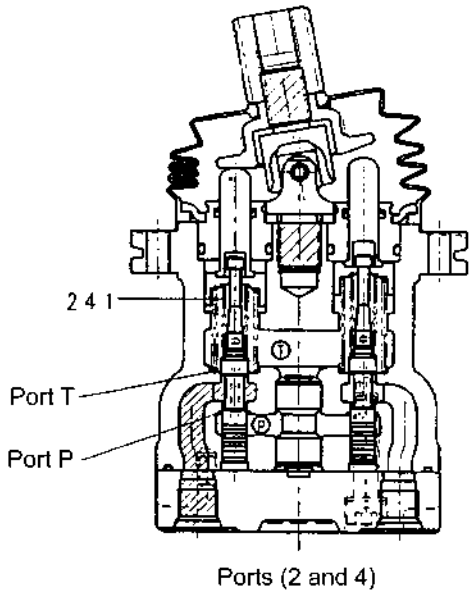
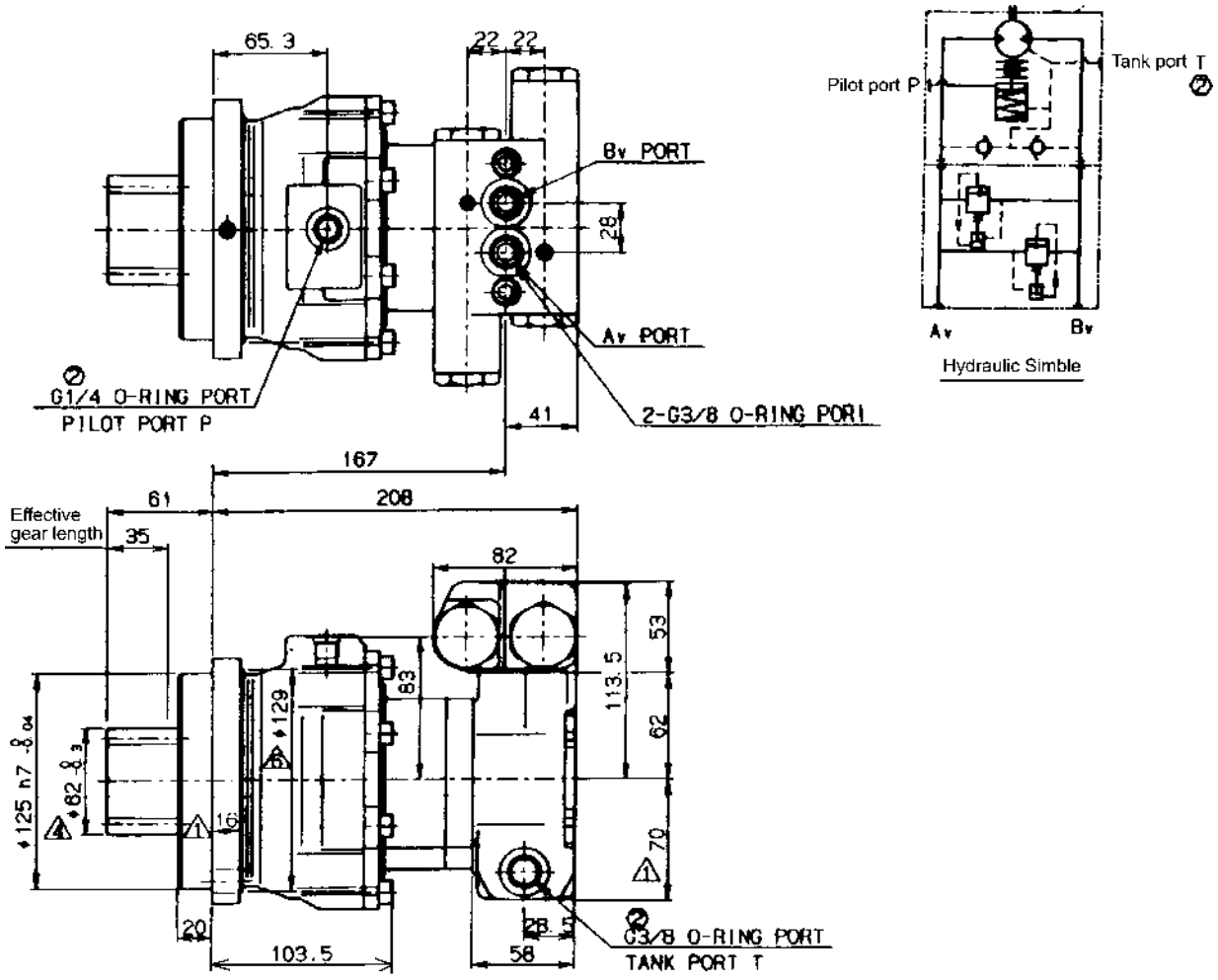


Fig. 4 With the lever held tilted
(Secondary pressure beyond the setting)

4) With the lever too tilted (depending on the model)
On some models, if the lever is tilted beyond a certain angle, the spool top end comes in contact with the push rod bottom. This means that the output pressure is being applied to the port P.
In another construction, the spring and its seat are integrated in the push rod. If the lever is tilted beyond a certain angle, the spring comes in contact with the push rod bottom. The spring force in turn affects the secondary pressure gradient. Then there will be contact between the push rod bottom and the spring seat top end, which keeps the output pressure applied to the port P.

F. Swing motor

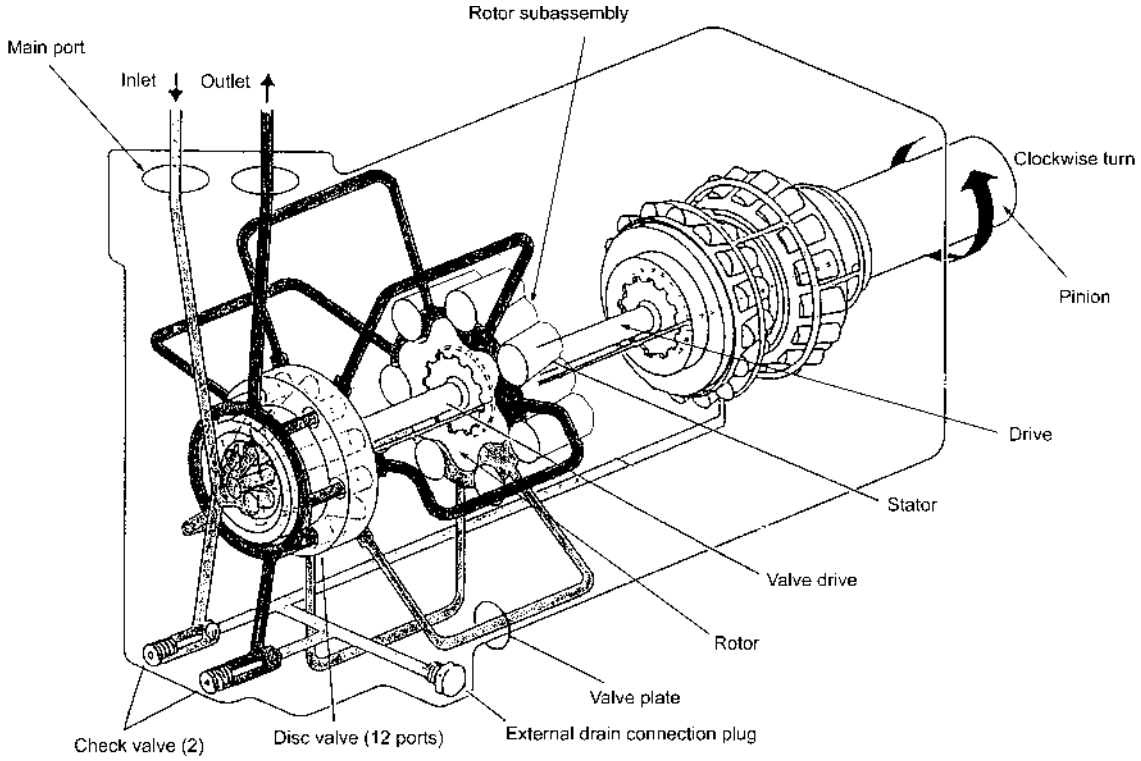
a. Structure & specifications



• Specification

		U20-3	U25-3
Type		25PB20A1124-C	25PB25A1125-C
Displacement	cc/rev	195	244
Theoretical RPM	rpm	63.4 at 12.4 L / min	75.4 at 18.4 L / min
Theoretical output torque	N·m kgf·m	609 62.1 at 19.6 MPa (200kgf / cm^2)	629 64.0 at 16.2 MPa (165 kgf / cm^2)
Theoretical brake torque	N·m kgf·m	440 43.1	440 43.1
Brake releasing pleasure	MPa kgf·m	2.0 20.2	2.0 20.2
Shockless valve type		VNS 200S 310A	VNS 165S 320A
Releaf valve pressure	MPa kgf/cm^2	19.6 200 at 10L / min	16.2 165 at 20L / min

b. Operating principle



1. High-pressure oil coming via the main port flows through the disc valve and valve plate into the rotor subassembly. The rotor subassembly consists of stator and rotor. The stator has 7 rollers inside and is fixed in the housing, whereas the inner rotor has 6 outer teeth. In the design, there are 7 compartments in the rotor subassembly. And the rotor moves in a planetary motion inside the stator.

2. The disc valve, on the other hand, has 12 oil holes. The high-pressure oil comes through 6 of the holes, and the return oil through the other 6 holes. Similarly, the valve plate has 7 oil holes. These oil holes connect with the rotor subassemblies 7 compartments. In this way, the 7 oil holes of the valve plate come in alignment with some of the 12 oil holes of the disc valve, making the rotor subassembly circuit.

3. Now under hydraulic pressure, the rotor of the rotor subassembly starts the planetary motion. The autorotation alone is taken out by the drive shaft and transmitted to the pinion.
The rotors rotation is also transmitted via the valve drive shaft to the valve.

4. As the disc valve turns, the valves oil holes shift in alignment with the valve plates other oil holes. In this way, the high-pressure oil flows from the rotor subassembly into different compartments in sequence. The motor is thus kept running nonstop.

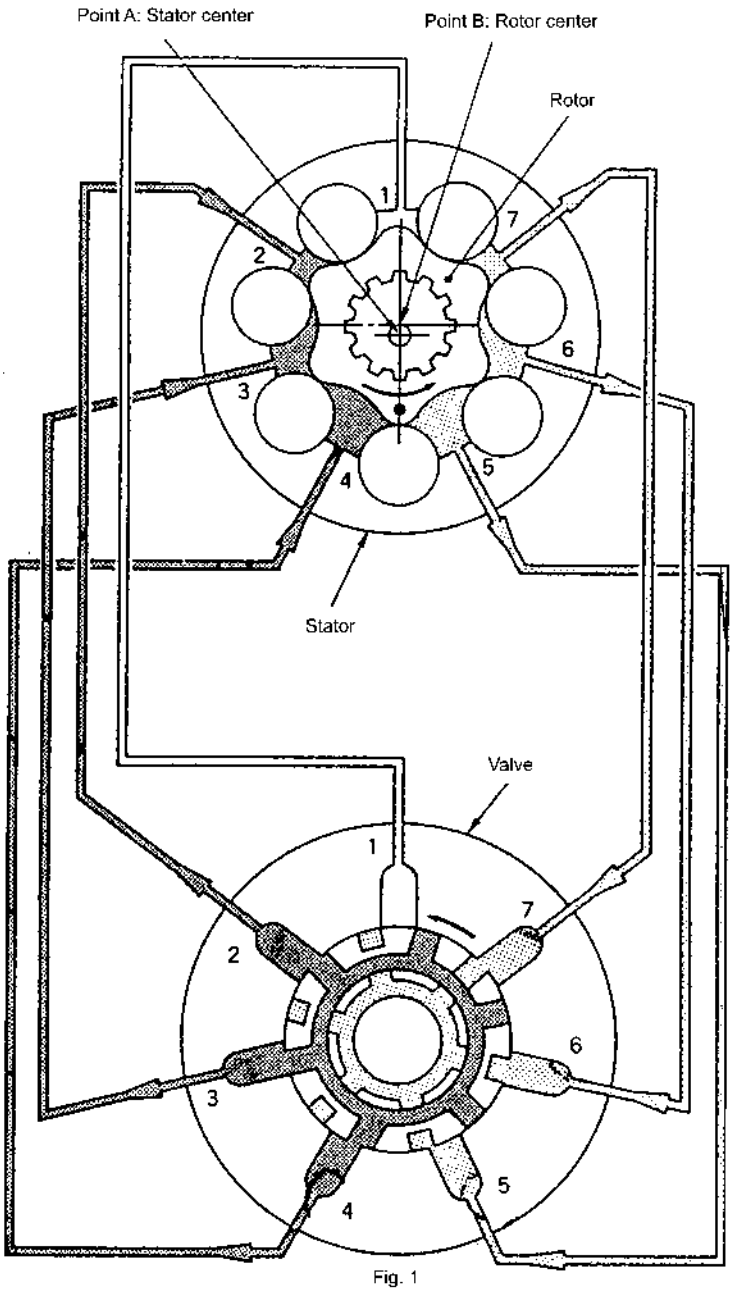


Fig. 1

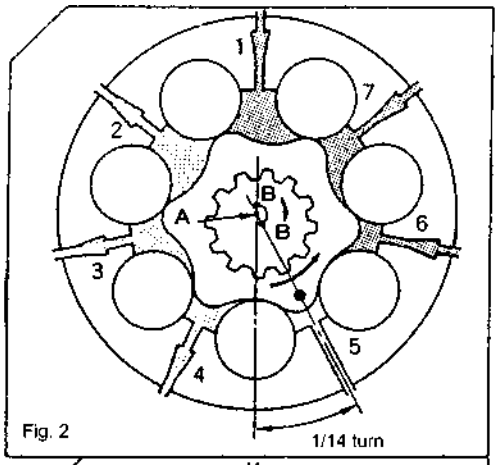


Fig. 2

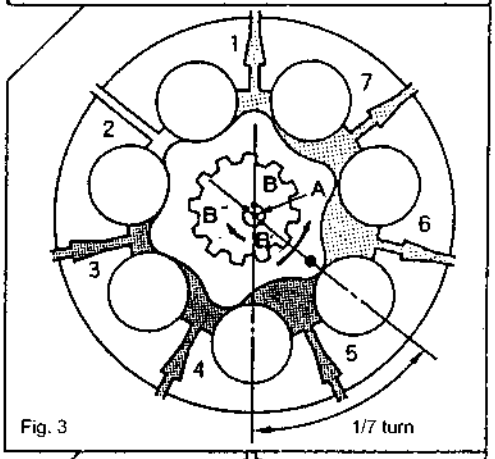


Fig. 3

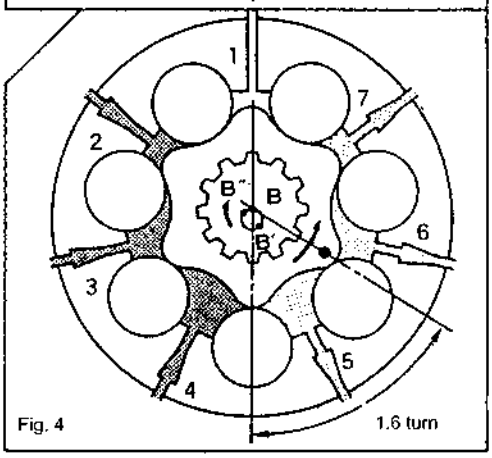


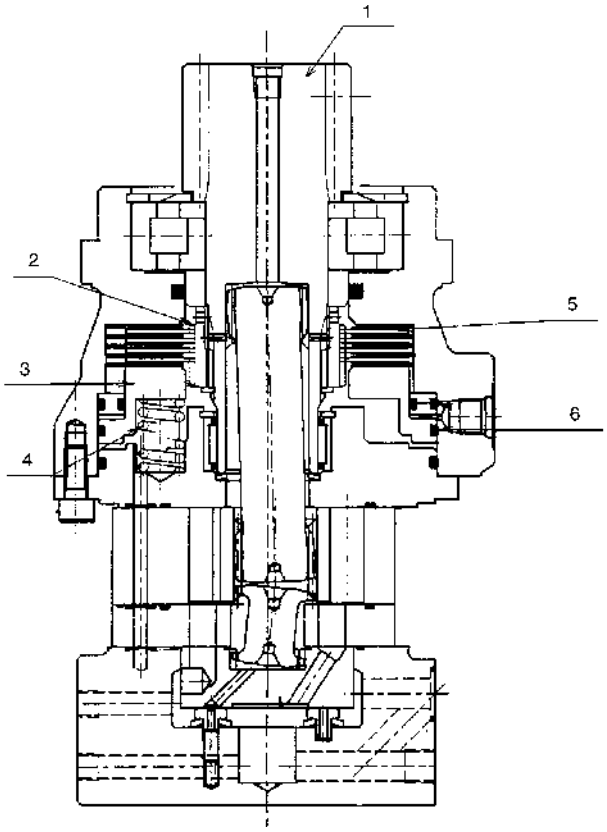
Fig. 4

When the high-pressure oil comes in the compartments 2, 3 and 4, as shown in Fig. 1, the rotor in internal contact with the stator starts turning in the direction of arrow. The valve starts turning together. The compartments receiving the high-pressure oil, however, move in the opposite direction. Fig. 2 shows that the rotor makes 1/14 turn and that the compartments 1, 7 and 6 receive the high-pressure oil. The rotors center point B moves around point A to point B'. Fig.3 illustrates that point B' has shifted up to B".

In other words, the rotors center makes 6/7 turn around point A from B thorough B' to B". In Fig. 4, point B" is back to point B, completing a cycle. At this time, the rotor moves in the opposite direction of point B, shifting the * marking by 1/6 turn.

In this manner, one turn of the output shaft produces the inflow of high-pressure oil in 42 compartments (7 compartments x 6 cycles) in total.

c. Function of negative brake



1. Piston Gear
2. Ring Gear
3. Piston
4. Spring
5. Friction Plate
6. P-port

(1) Negative brake function (Unload condition)

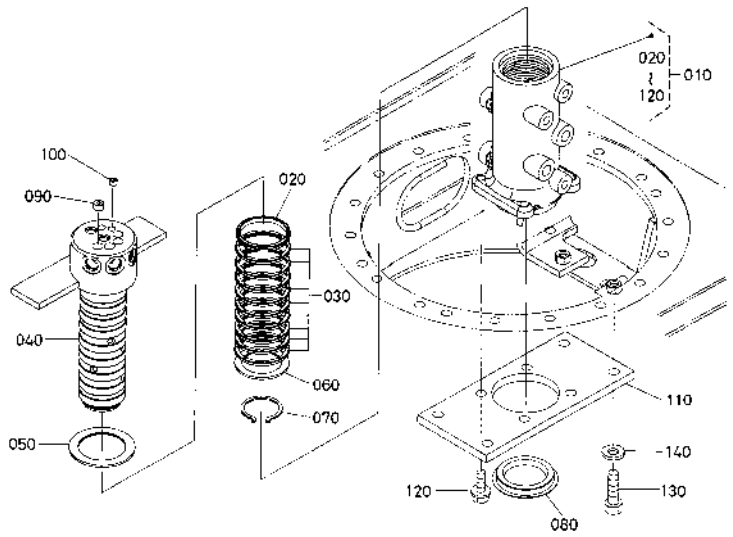
No pressure is applied at the P-port, which means there is no piston driving force.
In this state, the force of negative brake springs pushes down the negative brake piston to get the friction plate between the piston and the casing. By so doing, the friction plate is held in this poison by a friction force.
Because the pinion gear and the friction plate are spline-coupled through ring gear, the cylinder block is held and thus the motor is braked.

(2) Negative brake release (On-load condition)

A pilot pressure is applied at the P-port, generating a driving force to the negative brake piston.
In this state, the piston driving force surpasses the force of negative brake springs to push down the negative brake piston.
By so doing, the friction plate gets free from the friction force, allowing the motor to run freely.

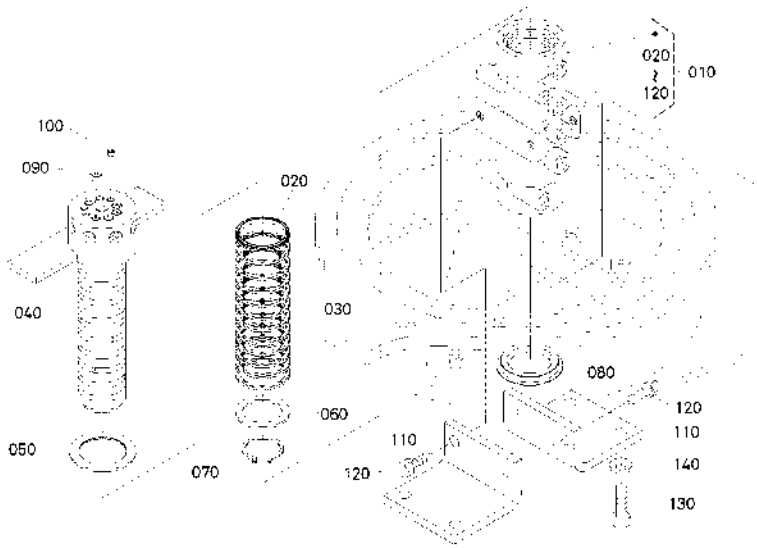
G.Rotary joint (Swivel joint)

- Fixed undercarriage (U20-3, U25-3)



No.	PARTS NAME	Q'ty
010	Rotary joint assy	1
020	Seal	1
030	Seal	9
040	Shaft	1
050	Collor	1
060	Collor	1
070	Circlip	1
080	Plug	1
090	Plug (PT1/8)	4
100	Plug (PT1/4)	2
110	Plate	1
120	Bolt	4
130	Bolt	4
140	Washer	4

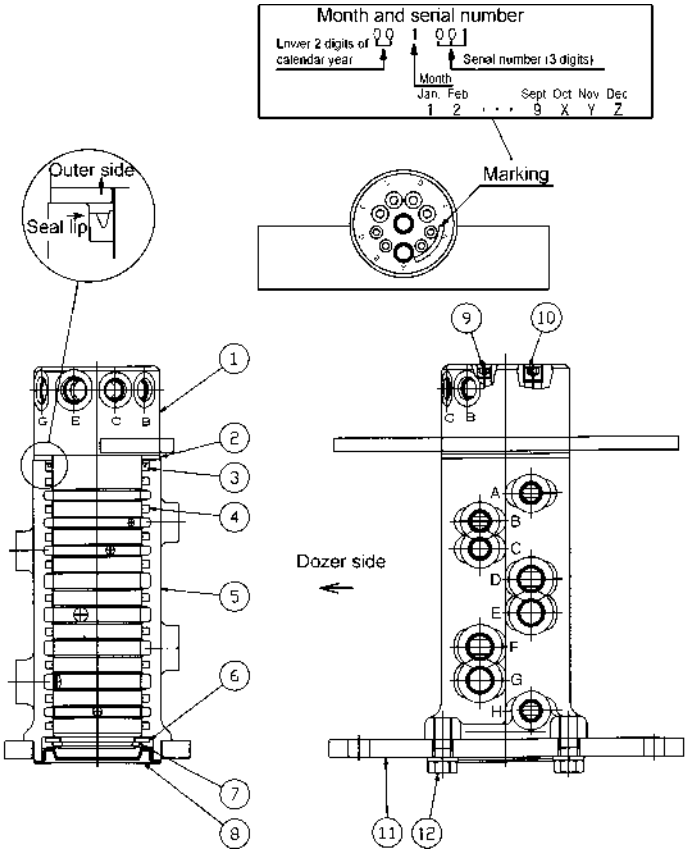
- Retractable undercarriage (U20-3)



No.	PARTS NAME	Q'ty
010	Rotary joint assy	1
020	Seal	1
030	Seal	1
040	Shaft	1
050	Collor	1
060	Collor	1
070	Circlip	1
080	Plug	1
090	Plug (PT1/8)	4
100	Plug (PT1/4)	4
110	Plate	2
120	Bolt	4
130	Bolt	4
140	Washer	4

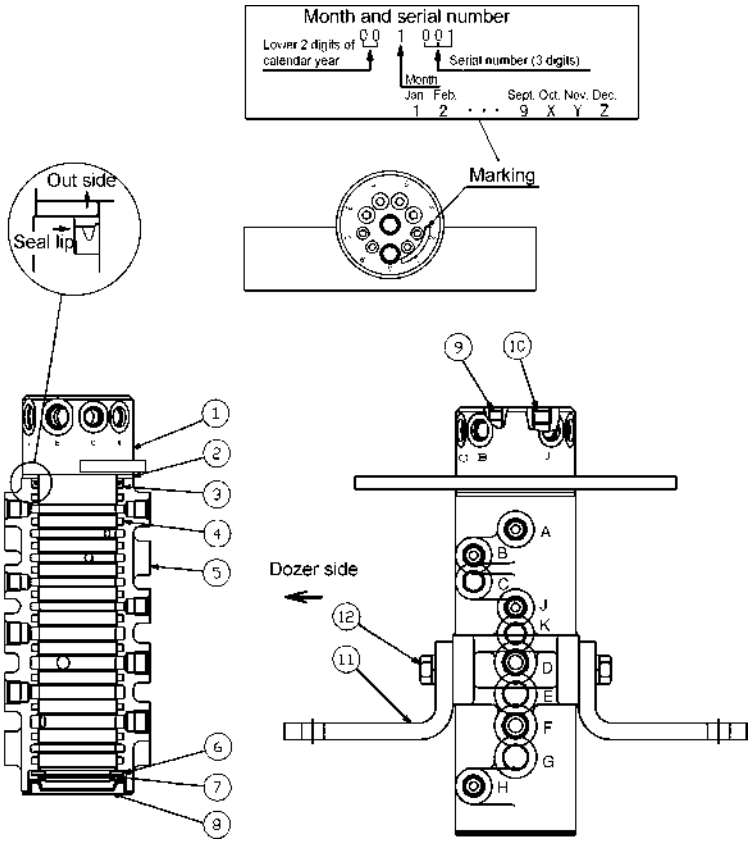
- Fixed undercarriage (U20-3, U25-3)

A: Travel (2nd)
B: Dozer, down
C: Dozer, up
D: Travel left, foreword
E: Travel right, foreword
F: Travel left, foreword
G: Travel right, foreword
H: Drain



- Retractable undercarriage (U20-3)

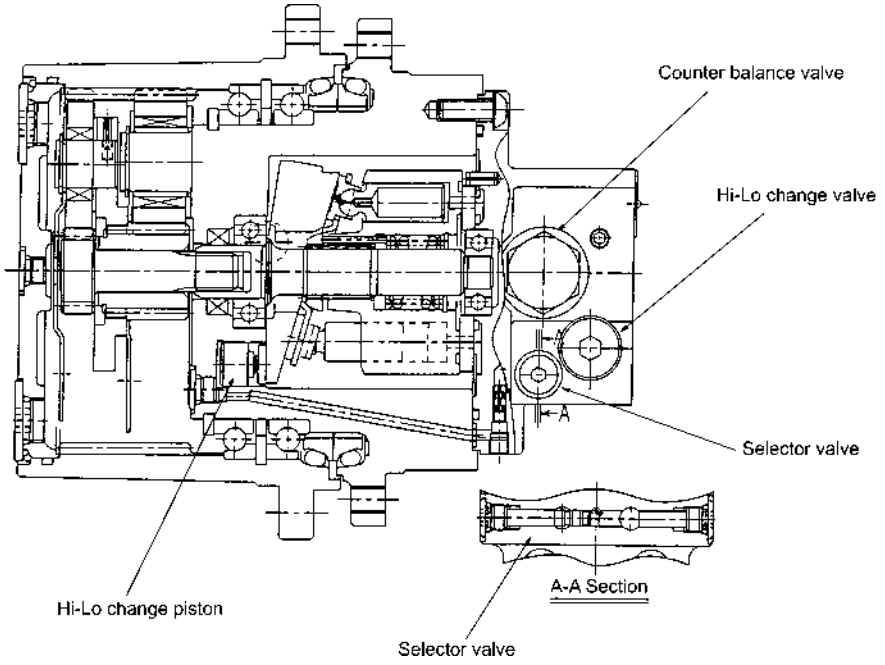
A : Travel (2nd)
B : Dozer, down
C : Dozer, up
J : Track, extend
K : Track, retract
D : Travel left, foreward
E : Travel right, foreward
F : Travel left, foreward
G : Travel right, foreward
H : Drain

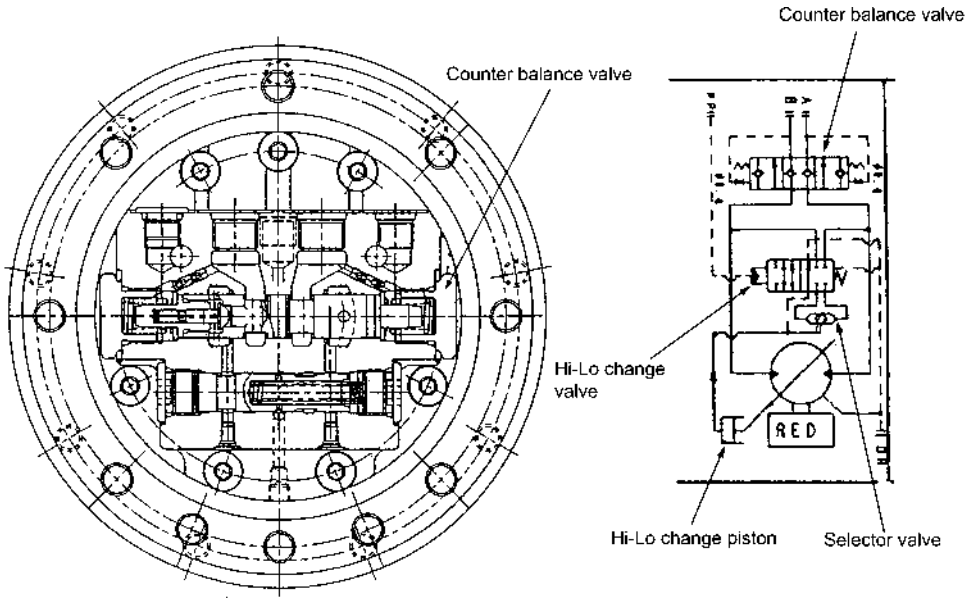


H.Travel motor

U20-3 (Fujikoshi)

a. Structure & specifications



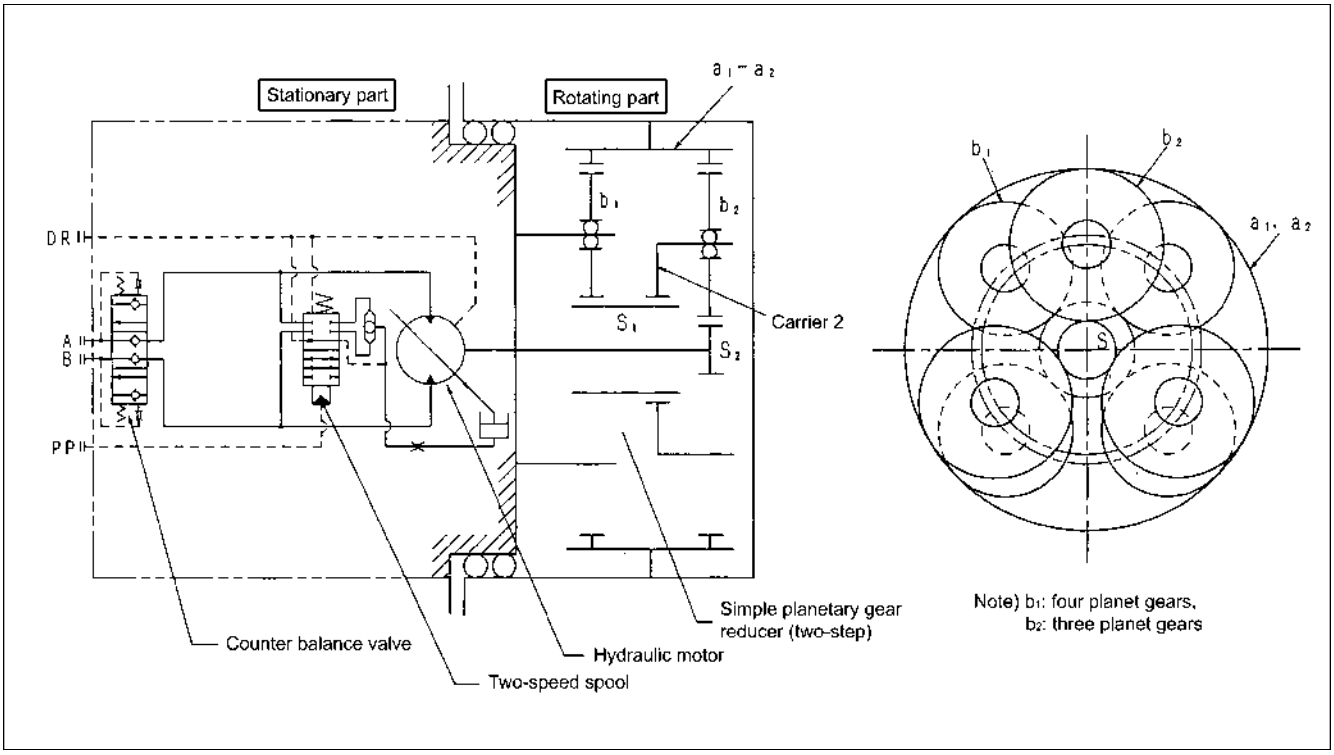


- Specifications (Theoretical numbers)

Type		
Displacements (1F/2F)	cc/rev	16.1/8.4
Realuction gear ration		1/39
Max. output torque	N·m kgf·m	2156 220
Max. output rpm (1F/2F)		36.6/70.2

b. Principle of operation

(1) Operating principle of wheel motor



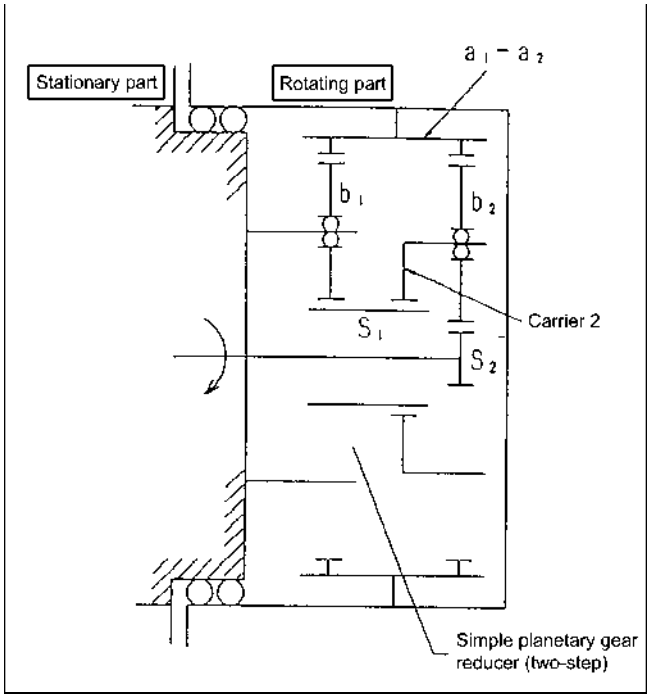
Description of operation

The PHV series travelling motor has a stationary main body composed of a hydraulic motor and hydraulic valve and a rotating main body composed of a simple planetary gear reducer.

[1] Reducer

1) Function
The PHV series travelling motor reducer, which is a simple two-step planetary gear reducer, converts the high-speed revolution of the hydraulic motor to low-speed high torque to obtain case rotation.

2) Description of operation
In the figure shown to the right, the gear S2 is spline-coupled with the hydraulic motor output shaft (or they are combined). The revolution of the gear S2 is single-reduced through the gears (S2, b2, a2). This single-reduced revolution is double-reduced through the gears (S1, b1, a1) spline-coupled with the carrier 2. The reduced revolution is transmitted to the rotating main body through the annular gears a1 and a2, providing travelling driving force. The reduction ratio of a simple two-step planetary gear reducer is generally expressed as shown below.



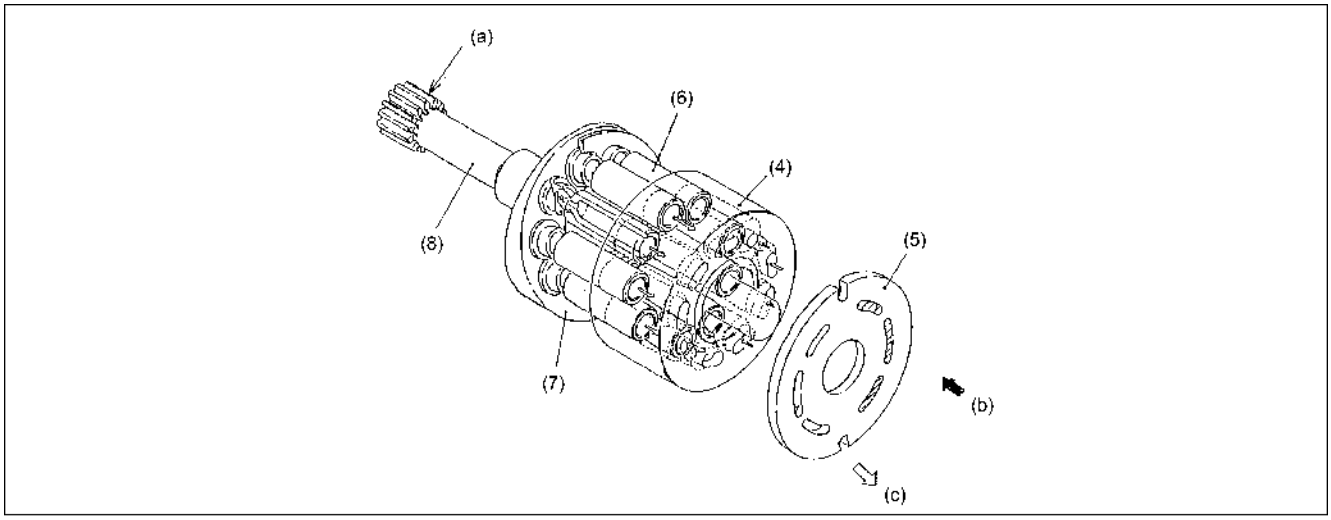
$$R = \frac{Zs1}{Zs1 + Za1} \times \frac{Zs2}{Zs2 + Za2}$$

Where
Zs1, Zs2: Number of teeth of gears s1 and s2
Za1, Za2: Number of teeth of gears a1 and a2
Because the PHV series travelling motor is of the main body rotating type, the reduction ratio is expressed as shown below.

$$R' = \frac{1}{1-1/R}$$

[2] Hydraulic motor

1) Function of motor
   The hydraulic motor, which is an axial piston motor (rotating cylinder and swash plate type), converts the hydraulic energy supplied from the pump to revolving movement.
2) Structure of motor and operating principle (See the figure below.)

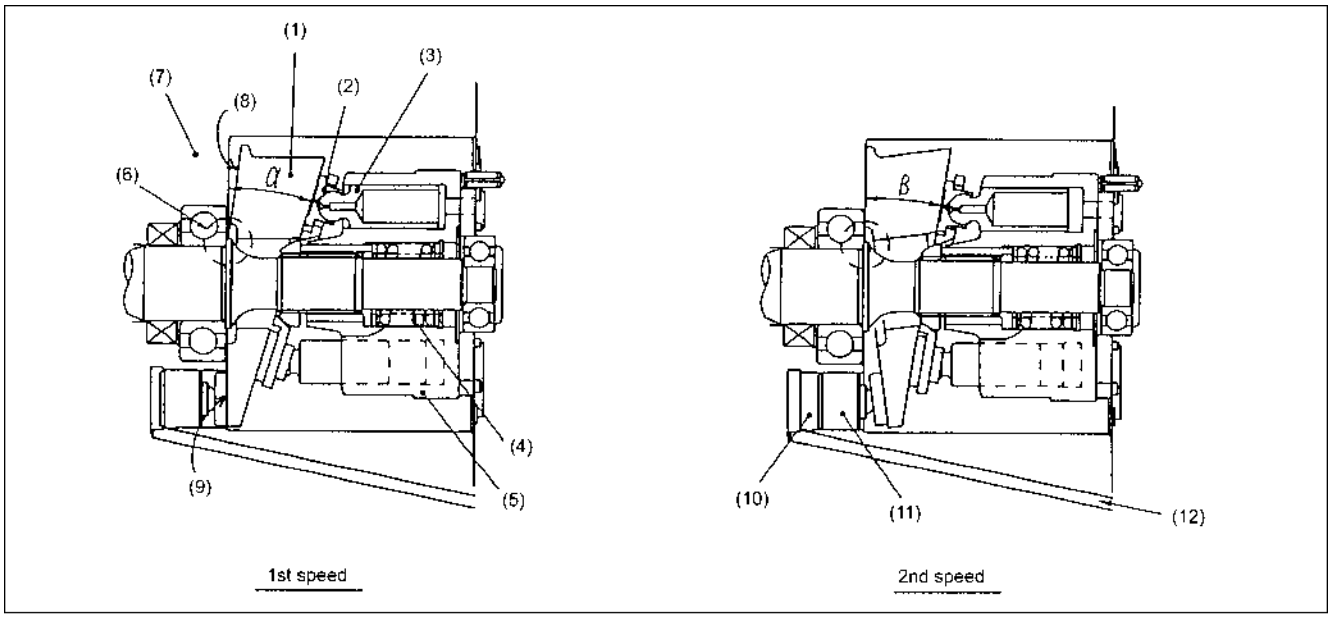


(4) Cylinder barrel
(5) Valve plate
(6) Piston
(7) Swash plate
(8) Shaft

(a) The motor shaft and gear S2 are combined or coupled through splines.
(b) Port A
(c) Port B

The pressure oil flowing in through the hydraulic valve is supplied to the valve plate (5). When the pressure oil is supplied to the port A, the oil flows into the cylinder port, which corresponds to the port A, in the cylinder barrel (4) and presses the piston (6). This pressing force is converted to turning force through the swash plate (7) and the resulting turning force is transmitted to the shaft (3) spline-coupled with the cylinder barrel (4). The return oil in the cylinder port flows out through the port B of the valve plate (5).
In the case of reverse rotation, the pressure oil flows in through the port B and flows out through the port A.

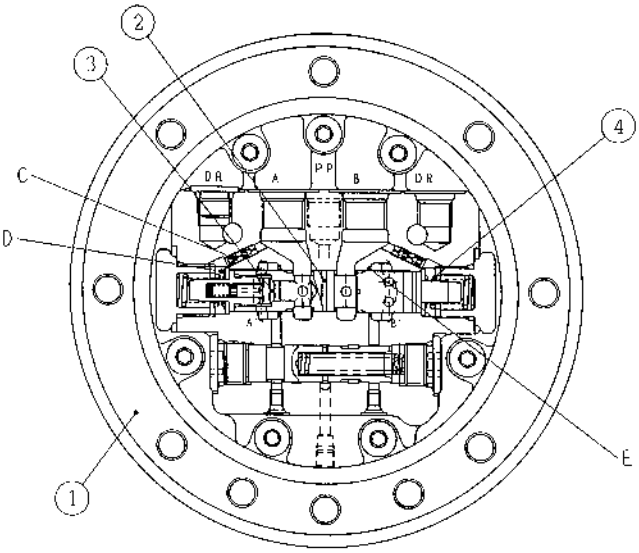
3) Operating principle of two-speed motor
The swash plate has two faces I and II on the surface opposite to the shoe-sliding surface and supported by the two balls fixed in the body 2 .
The ball is positioned eccentrically above the central axis. In the 1st speed state, therefore, the face II is pressed against the body 2 by hydraulic oil force applied to the piston and the spring force in the cylinder barrel and the swash plate angle becomes α. At this time, the motor is of large capacity.
When the speed selector lever is switched to the g2nd speed position, the operating pressure is conducted through the two-speed spool to the control room and the control piston moves until the face II of the swash plate touches the body 2, fixing the swash plate angle at β. At this time, the motor is of small capacity.
When the engine is stopped, the control room is connected to the drain port through the two-speed spool and the swash plate is returned to the 1st speed position by the spring force. At the time of starting, therefore, the motor is always in the 1st speed state.



(1) Swash plate
(2) Shoe
(3) Piston
(4) Spring
(5) Cylinder barrel
(6) Ball
(7) Body 2
(8) Face II
(9) Face I
(10) Control room
(11) Control piston
(12) Operating pressure

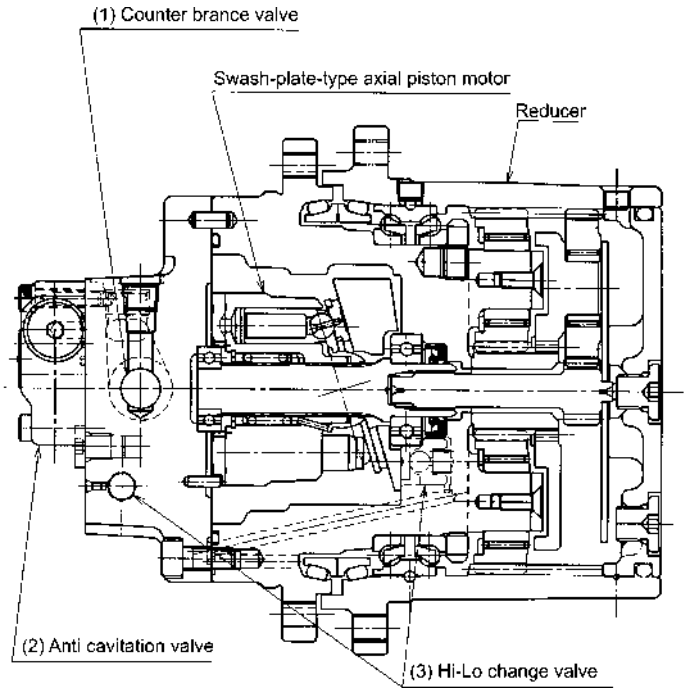
[3] Hydraulic valve (counter balance valve)

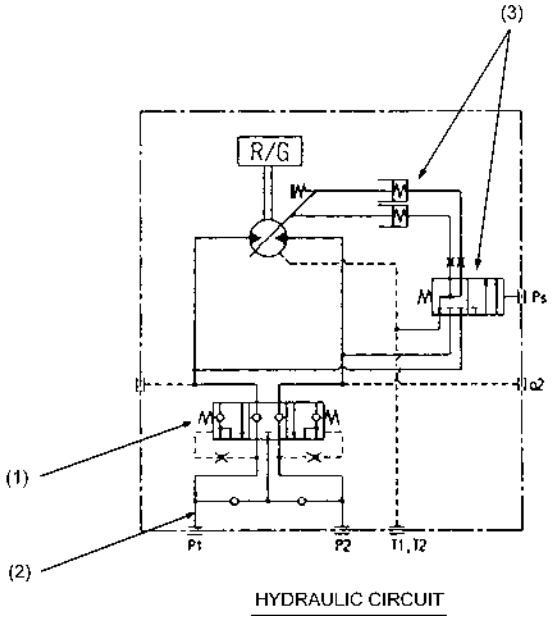
When the pressure oil is supplied through the port A, the pressure oil pushes open the check valve (3) and flows into the inlet-side port A' of the hydraulic motor. At the same time, the pressure oil flows through the choke hole C into the room D and slides the spool valve (2) to the right, overcoming the force of spring (4). As a result, the hydraulic motor return oil flows in through the port B', passes through the opening E of the main body (1) and spool valve (2) and returns to the port B. These processes make the hydraulic motor rotate. When the pressure oil is supplied through the port B, the above-mentioned processes are reversed and the hydraulic motor rotates reversely.
When the pressure oil supplied through the port A is made unpressurized, the spring force works to return the spool valve to the left. At this time, the oil in the room D controls the speed at which the spool valve returns to the left, utilizing the choking effect of the choke hole C. Even if the pressure oil supplied through the port A is made unpressurized, the hydraulic motor continues rotating using an inertial force. At this time, the return oil is gradually controlled through the sliding speed of the spool valve and the helix shape, thus stopping the hydraulic motor smoothly.



U25-3 (KAYABA)

a. Structure & specifications





HYDRAULIC CIRCUIT

• Specifications

	Model		
Axial piston motor	MAG-18V-230E-1		
Reducer	RGC-18V-43E-2		
Axial piston motor	MAG equivalent capacity cm^3/rev	1st speed	774
		2nd speed	430
	Motor displacement cm^3/rev	1st speed	18.0
		2nd speed	10.0
	Working pressure MPa		21.6
	Supply flow rate L/min		27.6
	Output torque (theoretical) KN-m	1st speed	2.66
		2nd speed	1.75
	Revolutions (theoretical) rpm	1st speed	35.6
		2nd speed	64.2
	Drain pressure MPa	Normal	0.2
		Maximum instantaneous	0.5
Counter balance valve	Spool switching pressure MPa		0.23
	Check valve cracking pressure		0.03 or less
Two-speed control valve	Switching pressure MPa		0.59 or more
Reducer	Structure		Planetary gear two-step speed reduction
	Reduction ratio MPa		1 : 42. 958

b. Operating principle of motor

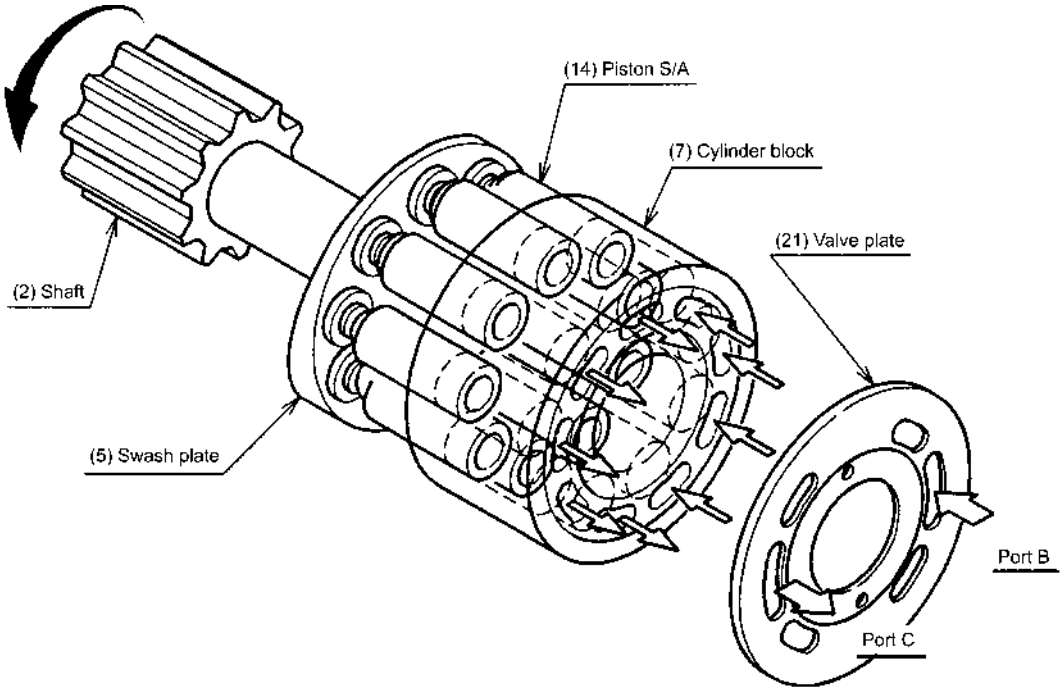


Fig. 2 Structural drawing of swash-plate-type axial piston motor

The cylinder block (7) incorporates nine piston S/As (14).
The end face of the cylinder block (7) is in contact with the valve plate (21) having two semicircular ports B and C (high-low change valve).
When the high pressure oil (pressure P) is supplied to the port B, it presses the swash plate (5) with a force of “F = P·A” (A: Pressure-applied area of piston) per piston S/A (14). The piston S/A (14) receives a reaction force against this force, which produces a turning force (Ft). The sum of the turning forces produced through the piston S/As (14) on the high pressure side makes the cylinder block (7) rotate, which torque is transmitted to the shaft (2) through the splines, making the shaft (2) rotate.
The output torque and revolution of the piston motor obtained based on the above-mentioned operating principle are determined by the supplied pressure (P) and the supply flow rate (Q) and calculated from the following expression.

$$T = \frac{P \times D \times \eta m}{2 \times \pi \times 10^2}$$

$$N = \frac{Q \times 10^3 \times \eta v}{D}$$

T : Output torque	(kgf-m)
N : Revolutions	(rpm)
P : Working pressure	(kgf/cm^2)
Q : Supply flow rate	(L / min)
D : Theoretical displacement	(cc/rev)
ηm : Mechanical efficiency	
ηv : Volumetric efficiency	

c. Operating principle of counter valance valve

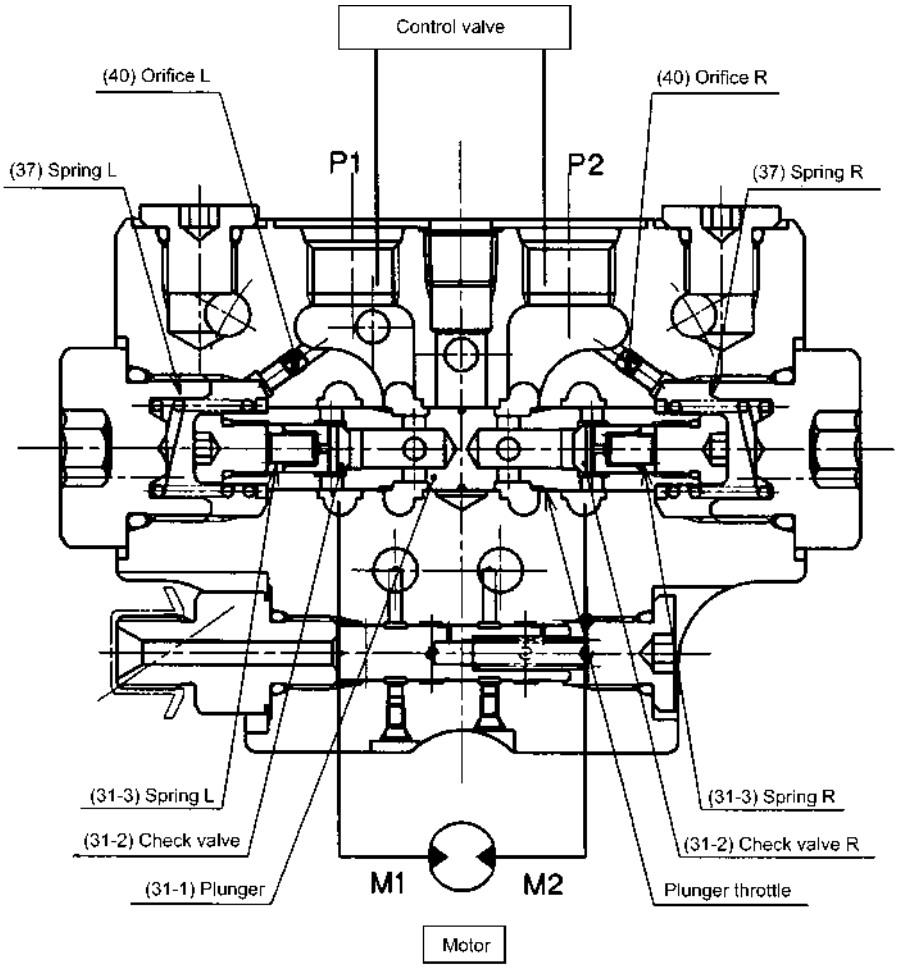


Fig. Structural drawing of counter balance valve

The counter balance valve is used to stop the axial piston motor and to prevent it from overrunning. When the control valve is in the neutral position, because no pressure is applied to the ports P1 and P2, the ports M1 and M2 (31-1) are blocked by the plunger and check valve (31-2) and therefore the motor does not rotate.

- Counter balance function

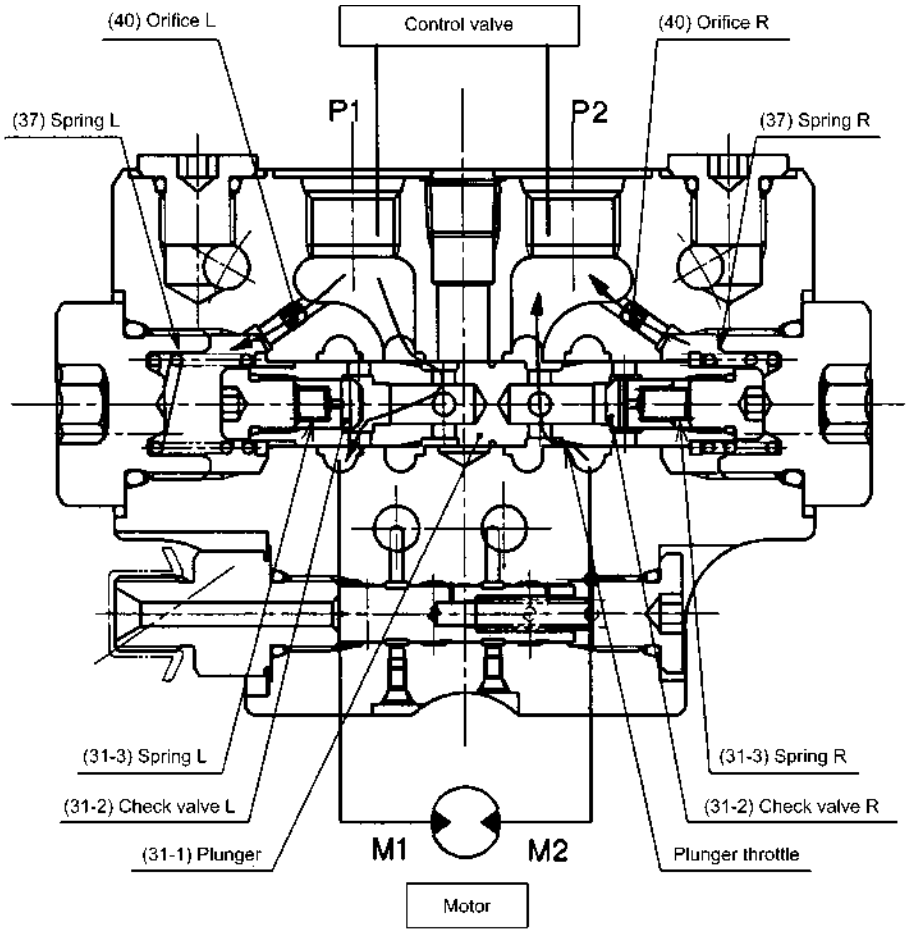


Fig. Counter valance valve (counter valance)

After the hydraulic oil discharged from the hydraulic pump is supplied to the port P1 of the counter valance valve via the control valve, the hydraulic oil passes through the check valve L (31-2) and flows through the port M1 into the piston motor, working to make the piston motor rotate.
The return oil from the piston motor flows through the port M2 into the counter valance valve, where the check valve R (31-2) stop the return oil from flowing, which causes the pump discharge pressure to rise.
On the port P1 side, the further pressurized hydraulic oil passes through the orifice L and acts on the end face of the plunger (31-1), working to move the plunger to the right with a force proportionate to the pressure against the spring R (37) on the opposite side.
When a certain pressure is reached, the plunger (31-1) starts to move to the right. As a result, the return oil passes through the plunger helix, flows into the port P2 while applying a back pressure to the port M2, and returns to the tank via the control valve. When the pump discharge pressure rises further, the opening of the plunger throttle becomes larger and the back pressure applied to the port M2 decreases.
In this manner, the opening of the plunger throttle in the return pathway is adjusted automatically so that the piston motor rotates at a speed corresponding to the port P1-side pressure, that is, the port P1-side flow rate.

- Brake function

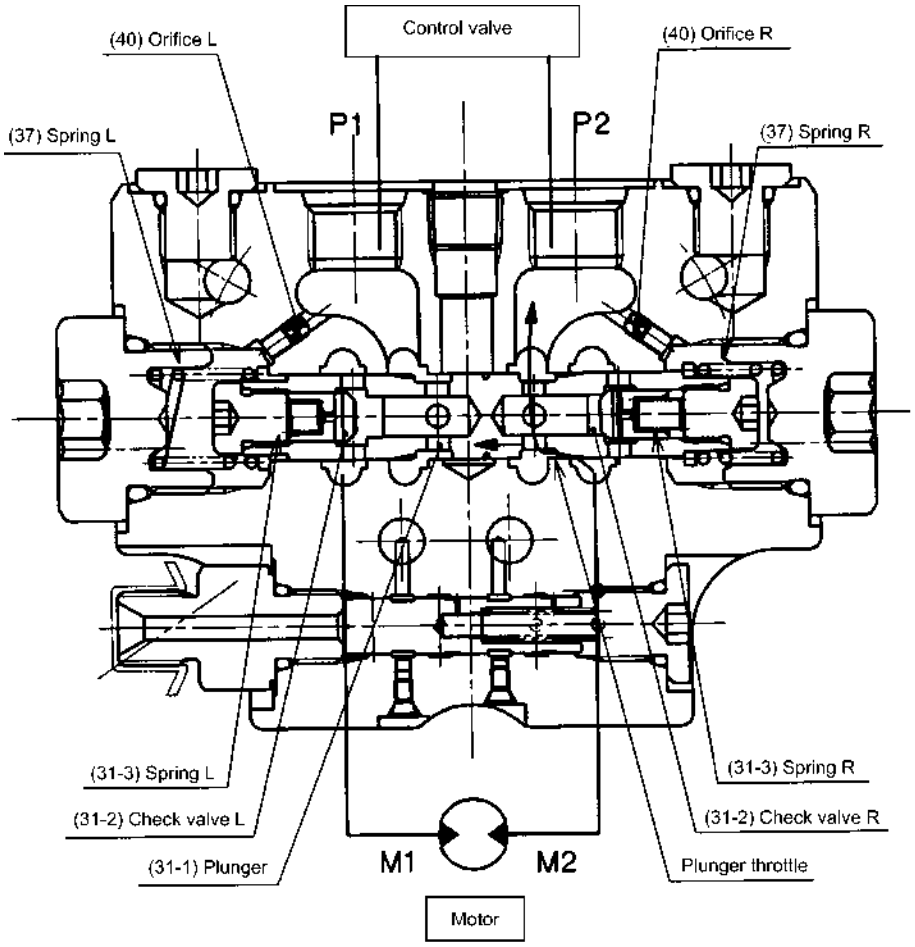
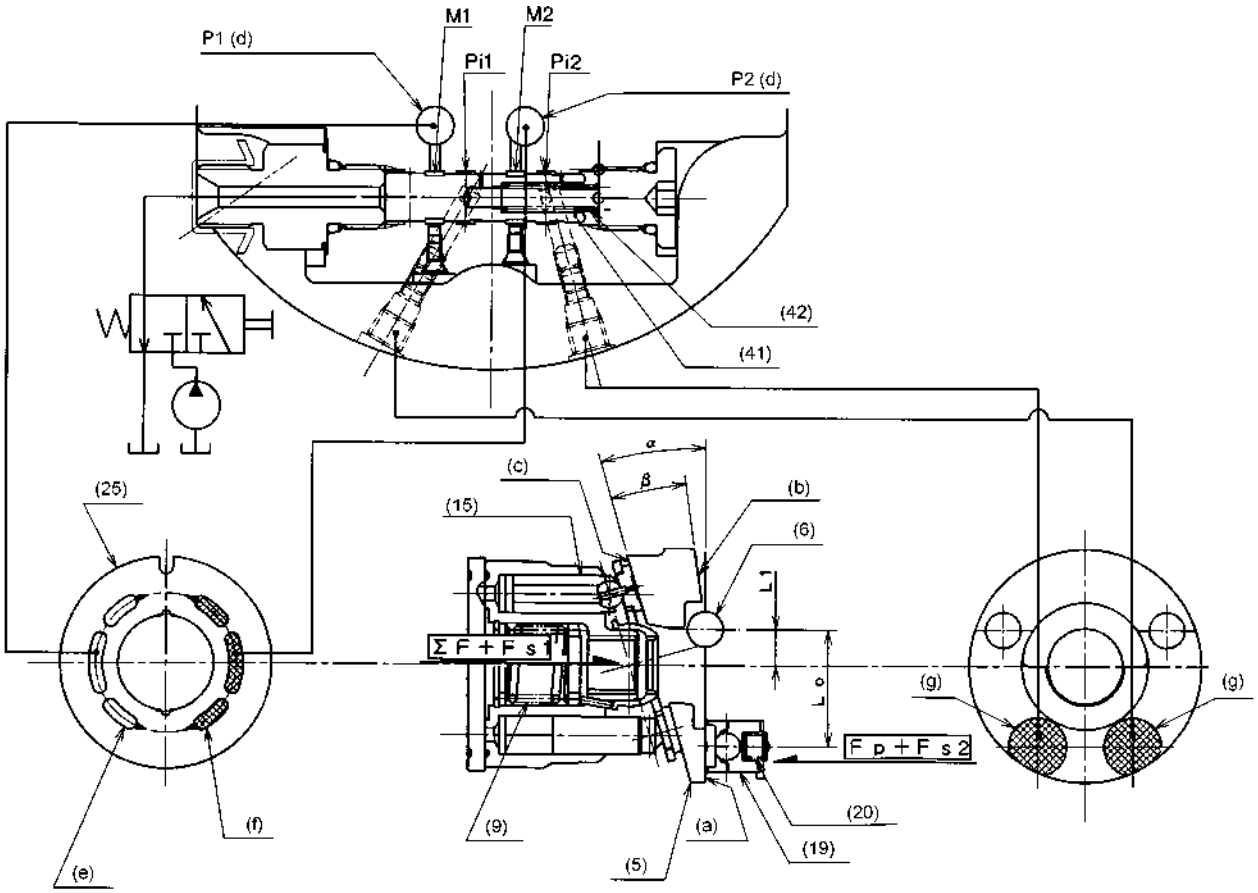


Fig. Counter balance valve (brake)

When the control valve is returned to the neutral position, the pressure oil from the pump is shut off, the pressure in the ports P1 and P2 become the same, and the spring R (37) works to return the plunger (31-1) to the neutral position. The opening of the plunger throttle becomes smaller when the plunger moves. In addition, using an inertial force, the piston motor continues rotating (pumping action of motor). As a result, the port M2-side pressure rises. When the plunger moves, the hydraulic oil in the pilot pressure room L passes through the orifice L to control the speed of the plunger. In this manner, the speed of the plunger is controlled so that the piston motor is stopped without causing cavitation, while absorbing a shock pressure resulting from the inertial energy of the motor.

d. Function of Hi-Lo change

- 1st (low) speed



(5) Swash plate
(6) Steel ball
(9) Spring
(15) Piston S/A
(19) Swash plate control piston
(20) Spring
(25) Valve plate
(41) Spool
(42) Spring
(a) Face
(b) Face
(c) Face
(d) driving pressure
(e) Port B (high pressure)
(f) Port C (low pressure)
(g) Low pressure

As shown in the figure, the swash plate (5) having three faces (a) to (c) is fitted to the flange holder through the two steel balls (6) so that it can be tilted.
When the control valve is in the 1st speed position, the spring (42) positions the spool (41) as shown in the figure to the left and the swash plate control piston (19) is connected to the port T via the ports Pi1 and Pi2. Therefore no force for pushing the swash plate (5) is applied to the swash plate control piston (19).

$Fp = (Ap \cdot P) = 0$

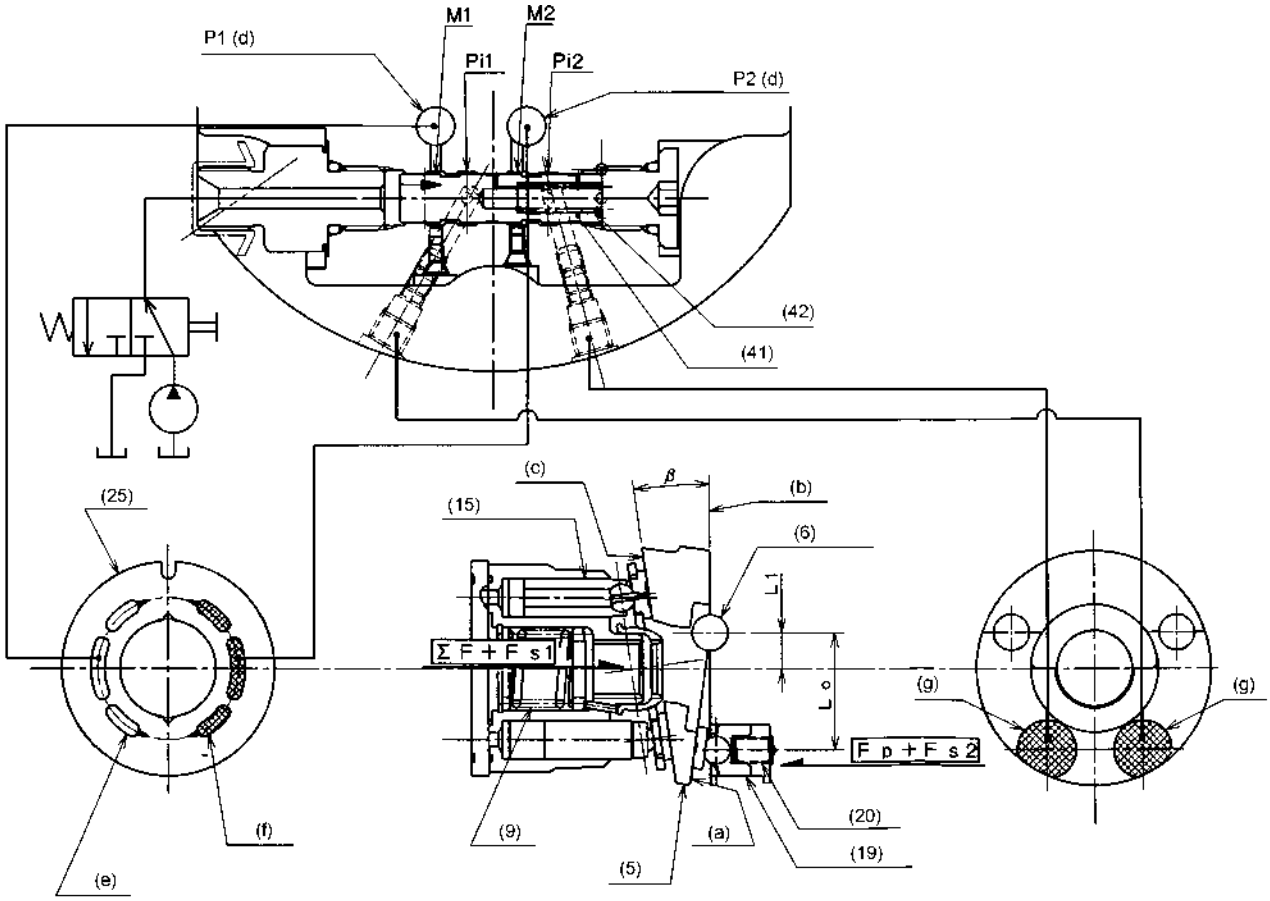
Fp : Thrust of swash plate control piston
Ap : Pressure-applied area of swash plate control piston
P : Pressure

The moment acting on the swash plate with the steel balls (6) serving as the tilting center is expressed as shown bellow: where f°F is the sum of the thrusts of the piston S/As (15) and Fs1 and Fs2 are the forces of the spring (9).

$(\Sigma F + F\ s1) \cdot L1 > (Fp + F\ s2) \cdot Lo$

The swash plate is stabilized on the face (a) and the swash plate angle becomes α, providing the revolutions for the 1st (low) speed of the motor.

- 2nd (high) speed



(5) Swash plate
(6) Steel ball
(9) Spring
(15) Piston S/A
(19) Swash plate control piston
(20) Spring

(25) Valve plate
(41) Spool
(42) Spring
(a) Face
(b) Face
(c) Face

(d) drving pressure
(e) Port B (high pressure)
(f) Port C (low pressure)
(g) Low pressure

When the control valve is switched to the 2nd speed position, the pressure oil is supplied from the pump to the spool (41) and the spool is positioned as shown in the figure to the left. The motor driving pressure (P1: High pressure, P2: Low pressure) is supplied from the ports M1 and M2 through the ports Pi1 and Pi2 to the swash plate control piston (19). Therefore a force for pushing the swash plate (5) is applied to the swash plate control piston (19).

$F_{p1} = A_p \cdot P1$ $F_{p2} = A_p \cdot P2$

The moment acting on the swash plate with the steel balls (6) serving as the tilting center is expressed as shown bellow: where Σ F is the sum of the thrusts of the piston S/As (15), Fs1 is the force of the spring (9), Fp is the pushing force of the swash plate control piston and Fs1 is the force of the spring (20)

$(\Sigma F + F_{s1}) \cdot L1 < (F_p + F_{s2}) \cdot Lo$

The swash plate is stabilized on the face (b) and the swash plate angle becomes β, providing the revolutions for the 2nd (high) speed of the motor.
When the engine is stopped, the spring (9) returns the spool (41) to the 1st speed position because no pressure oil is supplied.

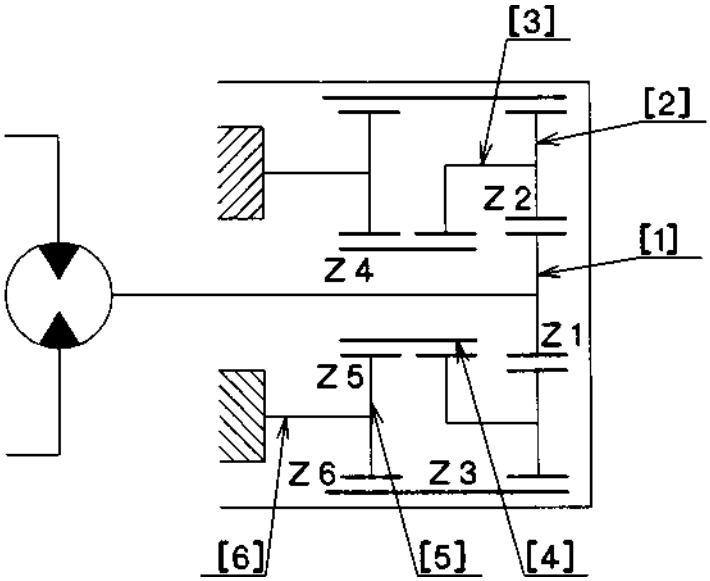
The moment acting on the swash plate with the steel balls (6) serving as the tilting center is expressed as shown bellow.

$F_s \cdot L1 > F_p \cdot Lo$

Therefore the swash plate is stabilized on the face (a) and the swash plate angle becomes α. At the time of starting, therefore, the motor is always in the 1st speed state.

e. Function of reduction gear

The reducer is composed of a two-step planetary gear mechanism.



Construction view

The drive gear [1] is engaged with the 1st planetary gear [2] and the 2nd sun gear [4] is engaged with the 2nd planetary gear [5]. The 2nd planetary carrier [6] is fixed on the body. The planetary gears [2] and [5] are engaged with the ring gear [7] (housing).
The driving force from the piston motor is transmitted to the driving gear [1] and its speed is reduced through the gears. The speed-reduced driving force is transmitted to the ring gear [7] via the planetary gear [5] of the planetary carrier [6] fixed on the body.
(The driving force is also transmitted via the 1st planetary gear [2].)
The output rotation is reverse to the input rotation.
The reduction ratio (i) is expressed as shown below: where (i1) and (i2) are the 1st-step reduction ratio and 2nd-step reduction ratio, respectively.
Reduction ratio (i)

$$i = -(i1 \times i2 - 1) = -\left(\frac{Z1 + Z3}{Z1} \times \frac{Z4 + Z6}{Z4} - 1\right)$$

Z1: Number of teeth of drive gear
Z3: Number of teeth of ring gear
Z4: Number of teeth of sun gear
Z6: Number of teeth of ring gear

⊙ Reducer output torque (T)

$$T = T_M \times i \times \eta m$$

T_M : Input torque (motor output torque)
i : Reduction ratio
ηm : Mechanical efficiency

⊙ Reducer output revolutions (N)

$$N = \frac{N_M}{i}$$

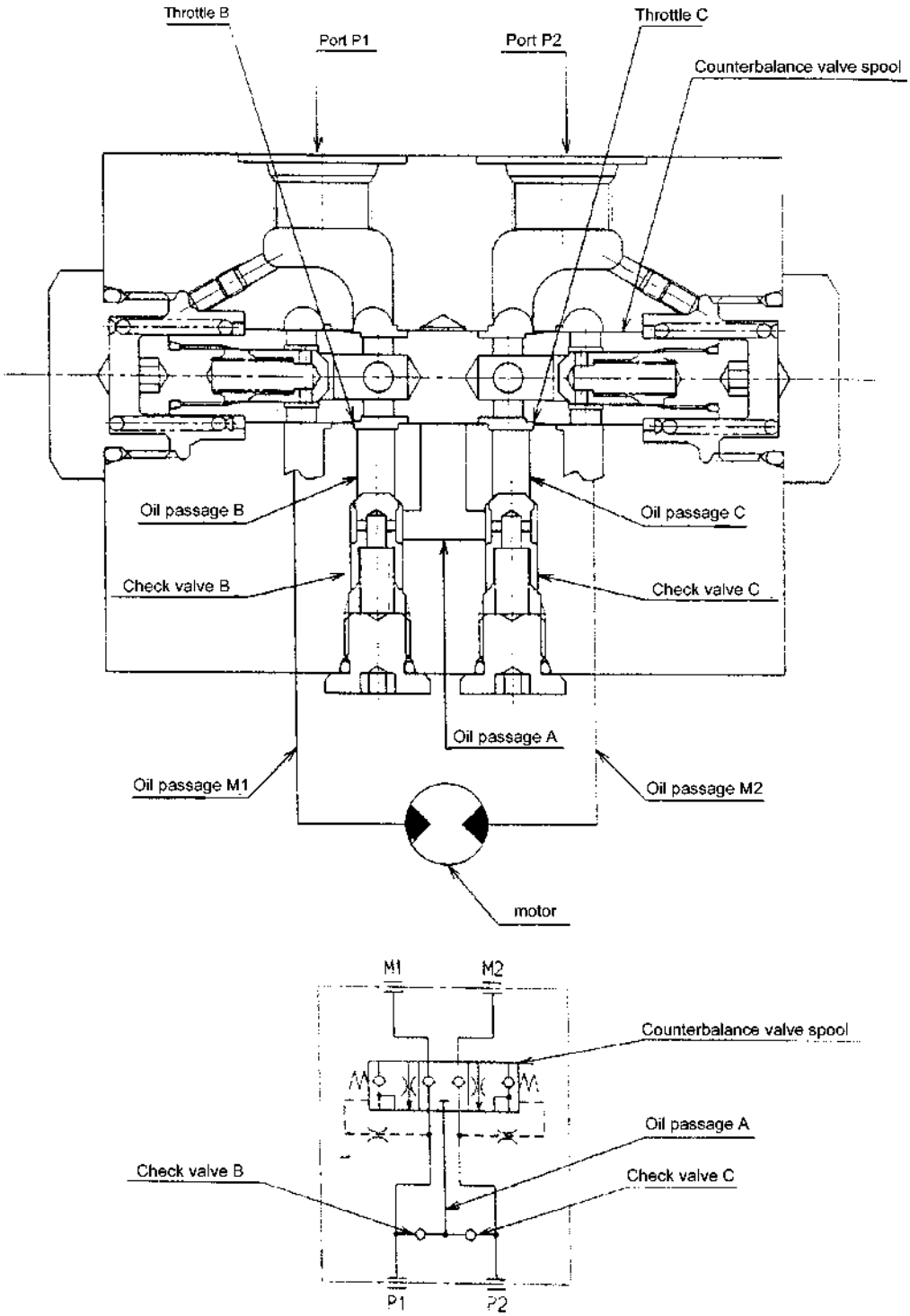
N_M: Input revolutions (motor output revolutions)

f. Function of anti-cavitation valve

(1) Construction

The anti-cavitation mechanism functions in sync with the counterbalance mechanism.
Unlike conventional types of counterbalance mechanism, the oil passages A, B and C as well as the check valves B and C are added in this circuit.

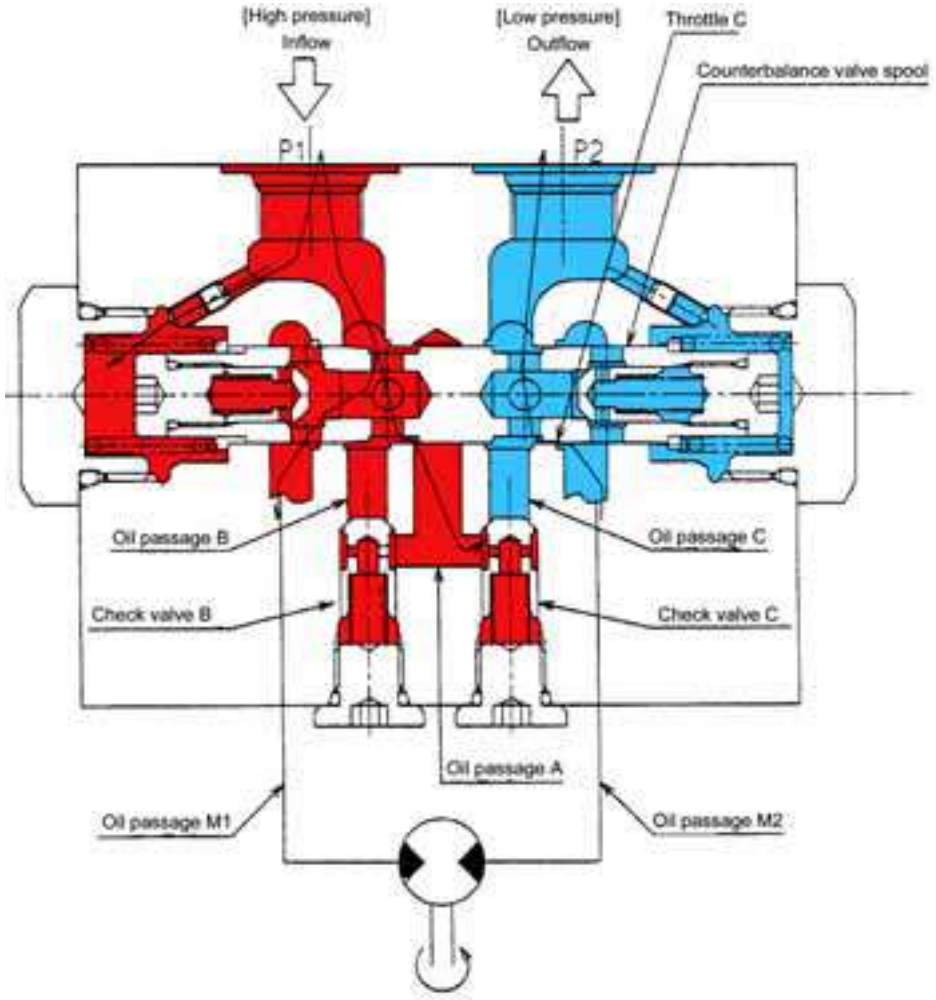
<Hydraulic circuit diagram>



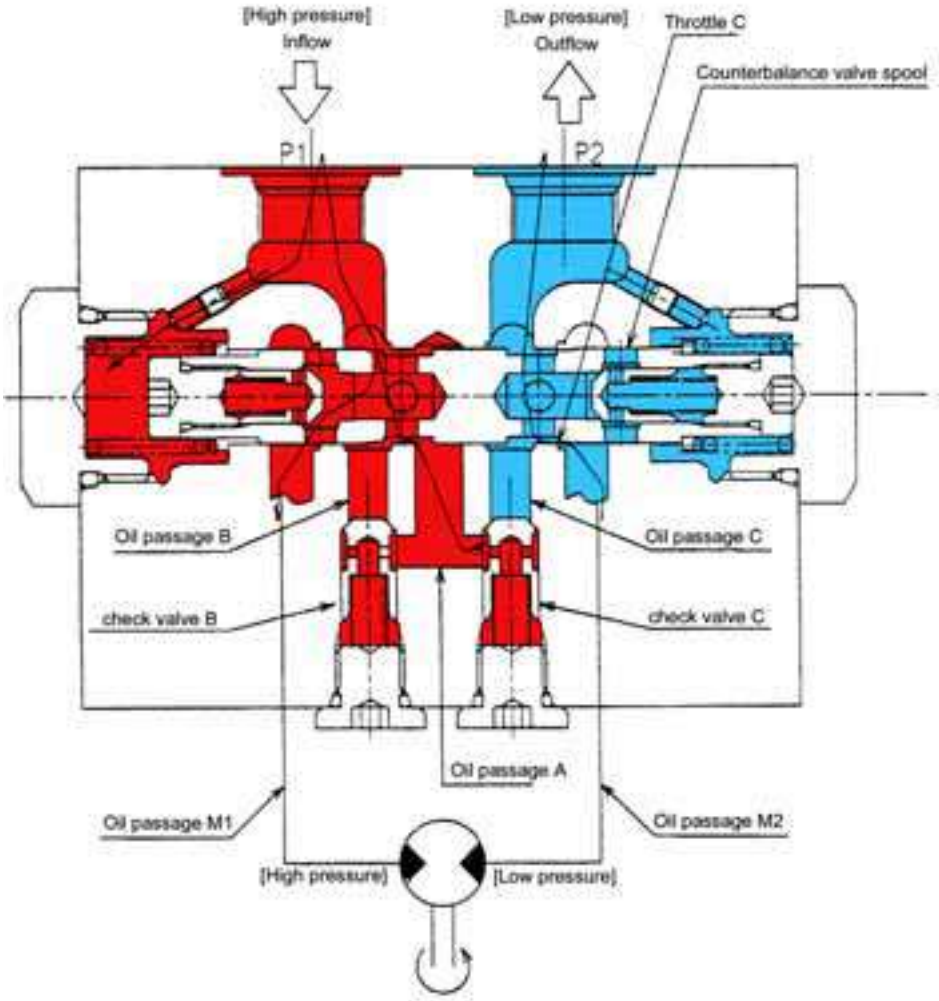
(2) Circuit behavior

1) Motor start-up

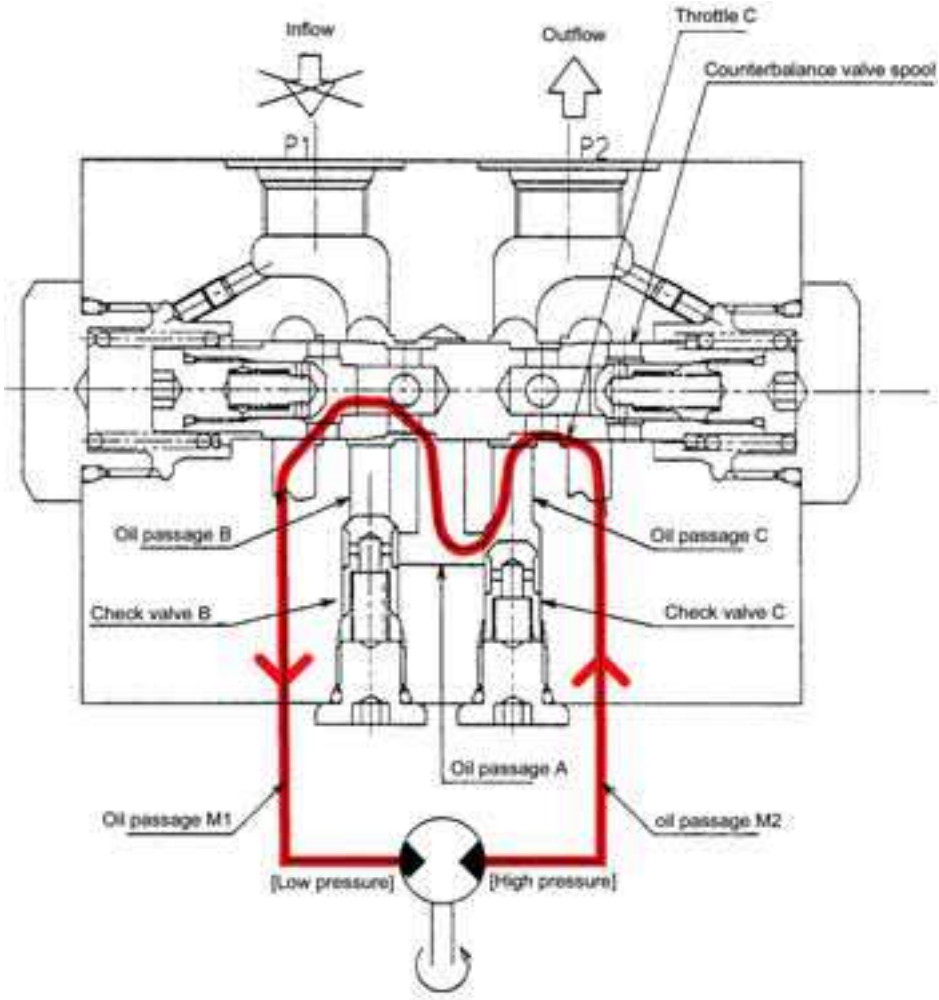
When the hydraulic pressure is applied to P1, the counterbalance valve spool overcomes the spring's counter-force and shifts to the right as shown in the figure below. In the meanwhile, the valve switches from M2 to P2, which gets the motor started. (Usual counterbalance action)
At the same time, the oil passage A goes under high pressure. Thanks to the action of the check valve C, however, the pressure oil is kept from leaking out toward the low-pressure side (oil passage C).



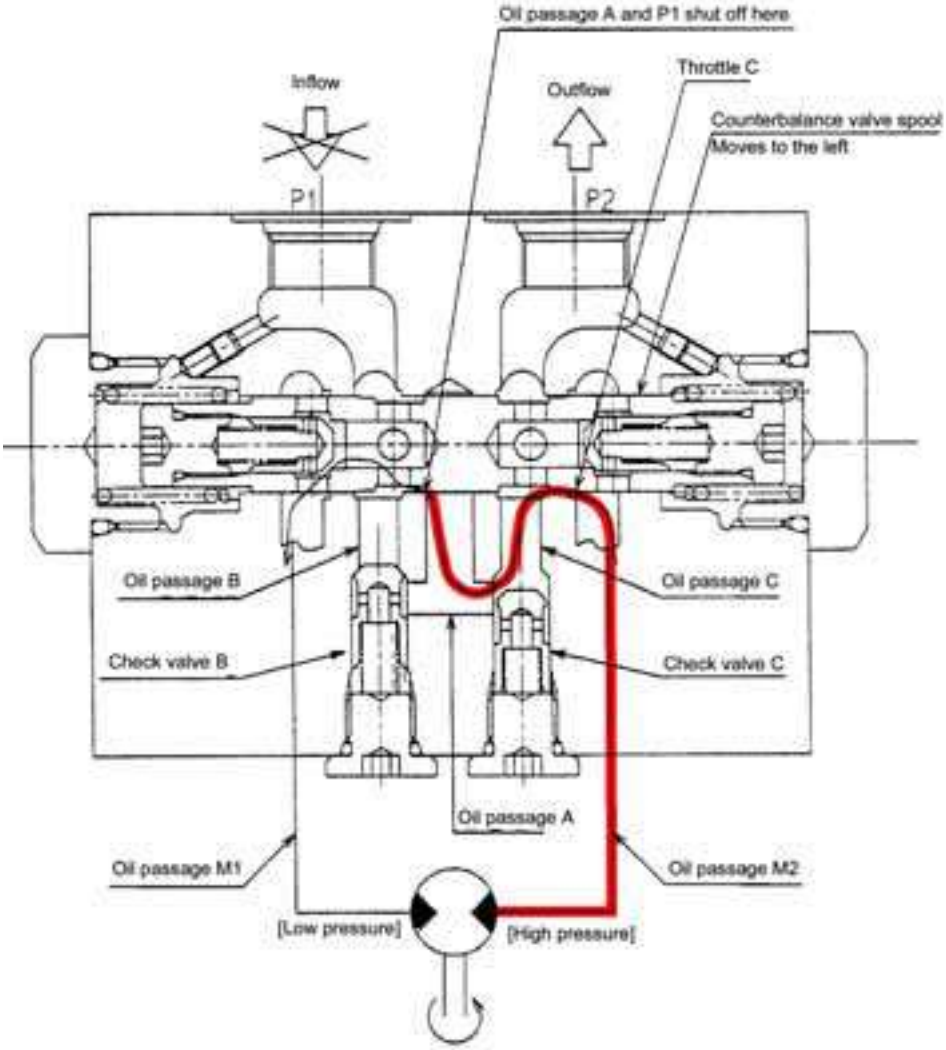
2) Motor running at constant speed
With the motor running at constant speed, the oil passage A stays under high pressure. Thanks to the action of the check valve C, however, the pressure oil is kept from leaking out toward the low-pressure side.
Thus the motor runs stably with the anti-cavitation mechanism intact.



3) Motor slowing down
When being slowed down, the motor keeps running for a while by its inertia force. While the counterbalance valve is open, however, the hydraulic oil flows through the oil passage M2 into the port P2.
Because there is no enough oil flow from P1, cavitation occurs at P1 and M1.
The anti-cavitation mechanism works to avoid this. Until the counterbalance valve returns to its original state, P1 is connected with the oil passage A. In this condition, the hydraulic oil flows in this route: oil passage M2, counterbalance throttle C, oil passage C, check valve C, oil passage A, port P1 and oil passage M1. It finally flows back to the motor. In this way, cavitation is minimized.

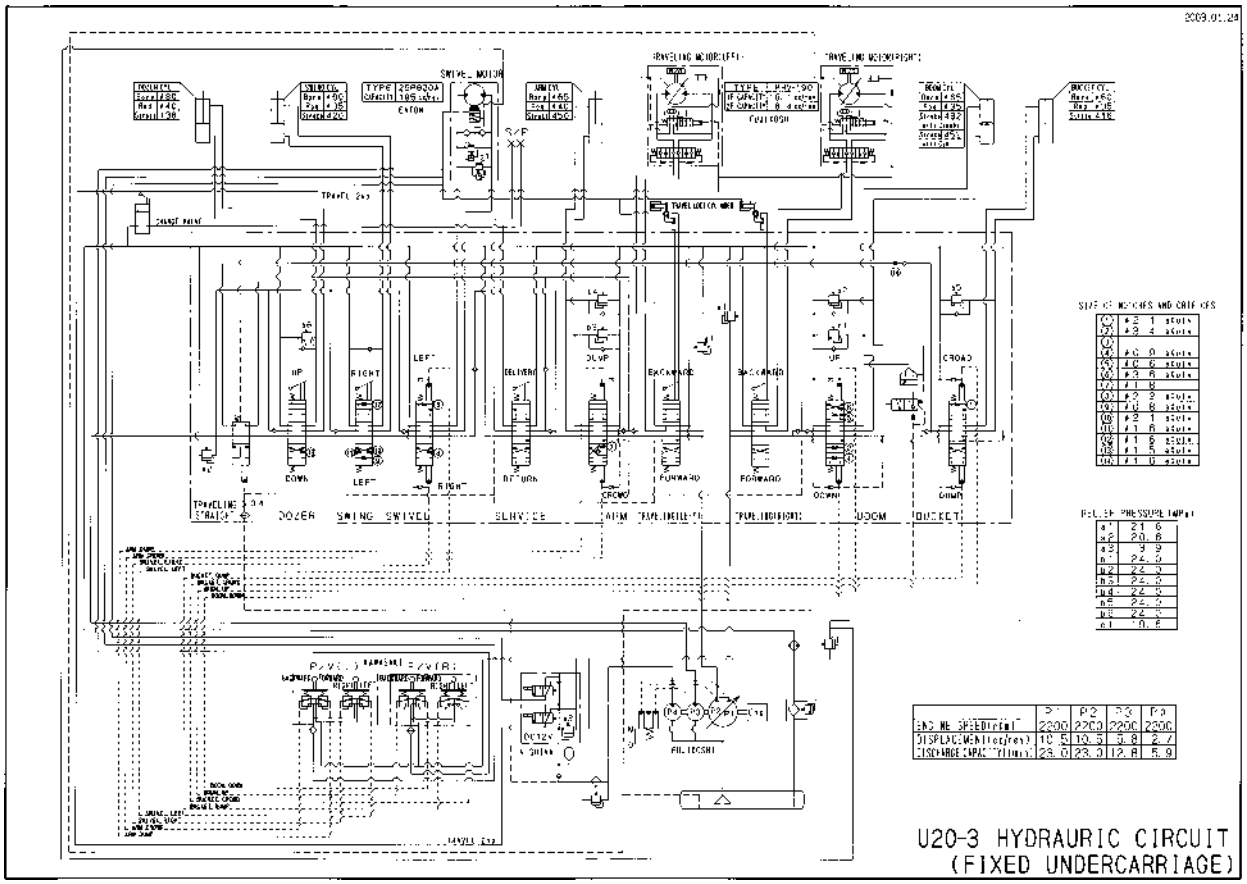


4) Motor stop
The anti-cavitation function keeps on until the oil passage A and port P1 are shut off as shown in the figure below (at the indicated positions).

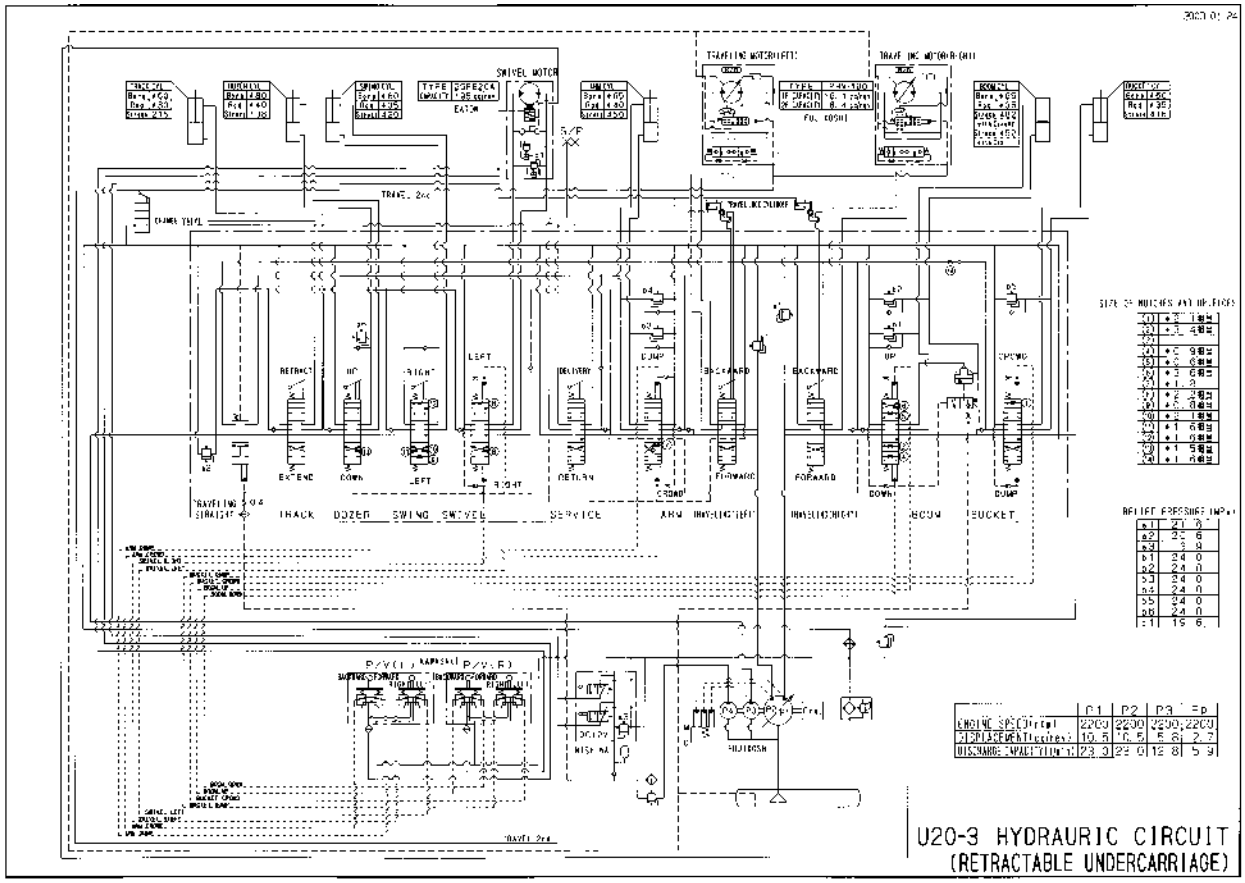


I. Hydraulic circuit diagram

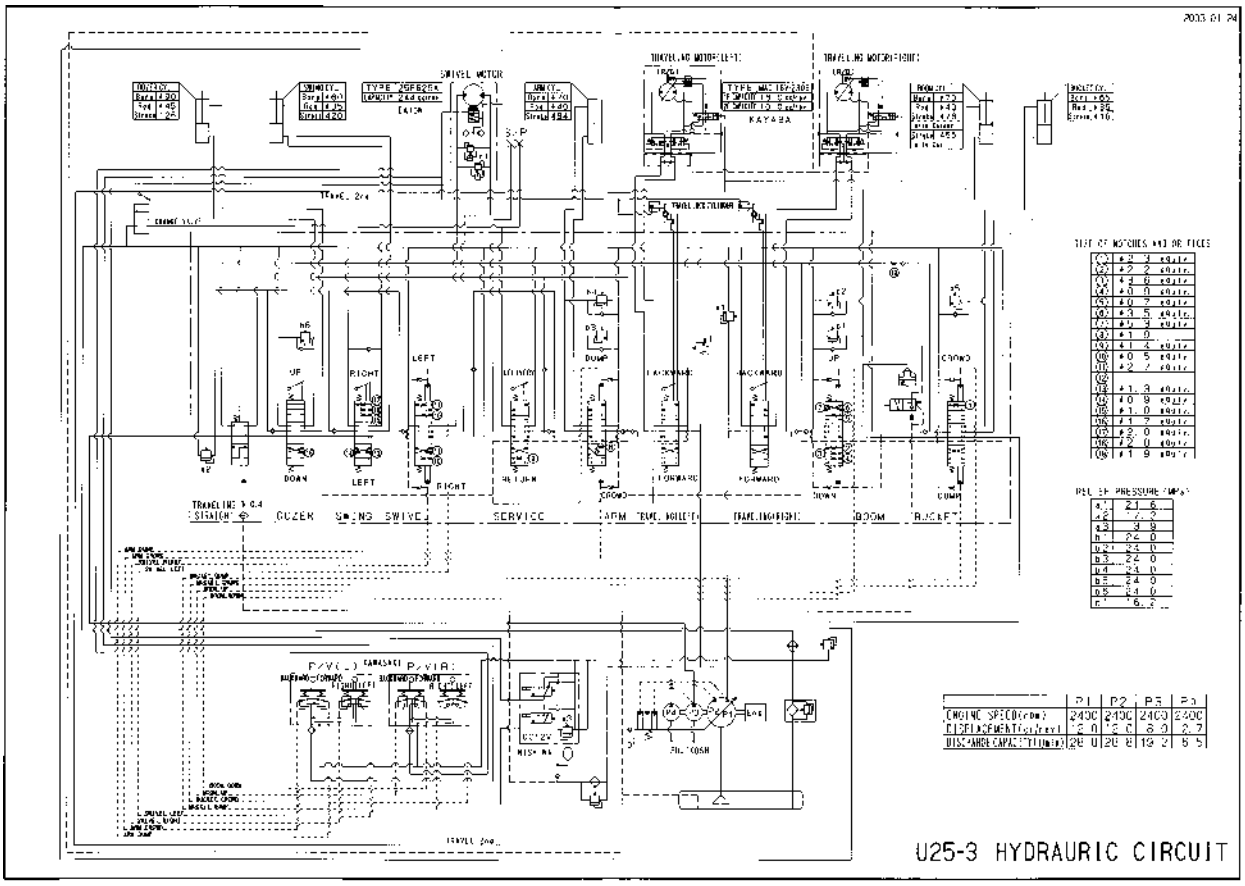
a. U20-3 Fixed undercarriage



b. U20-3 Retractable undercarriage

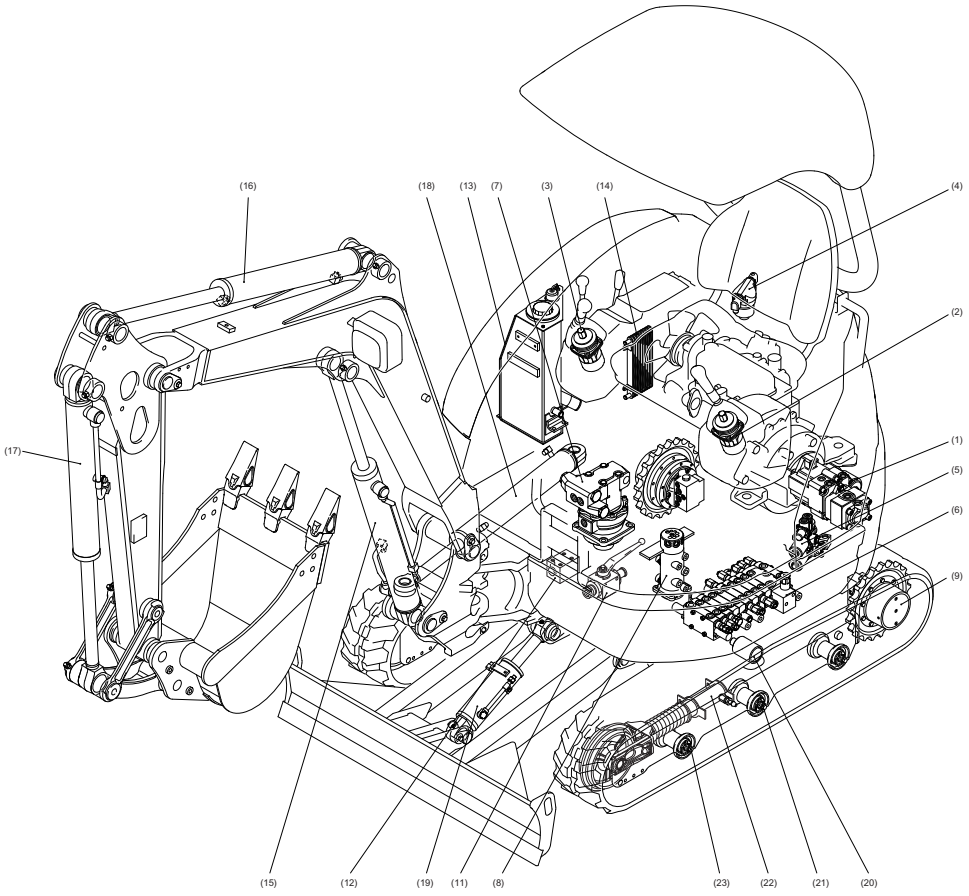


c. U25-3



d. Hydraulic components layout

U20-3, U25-3

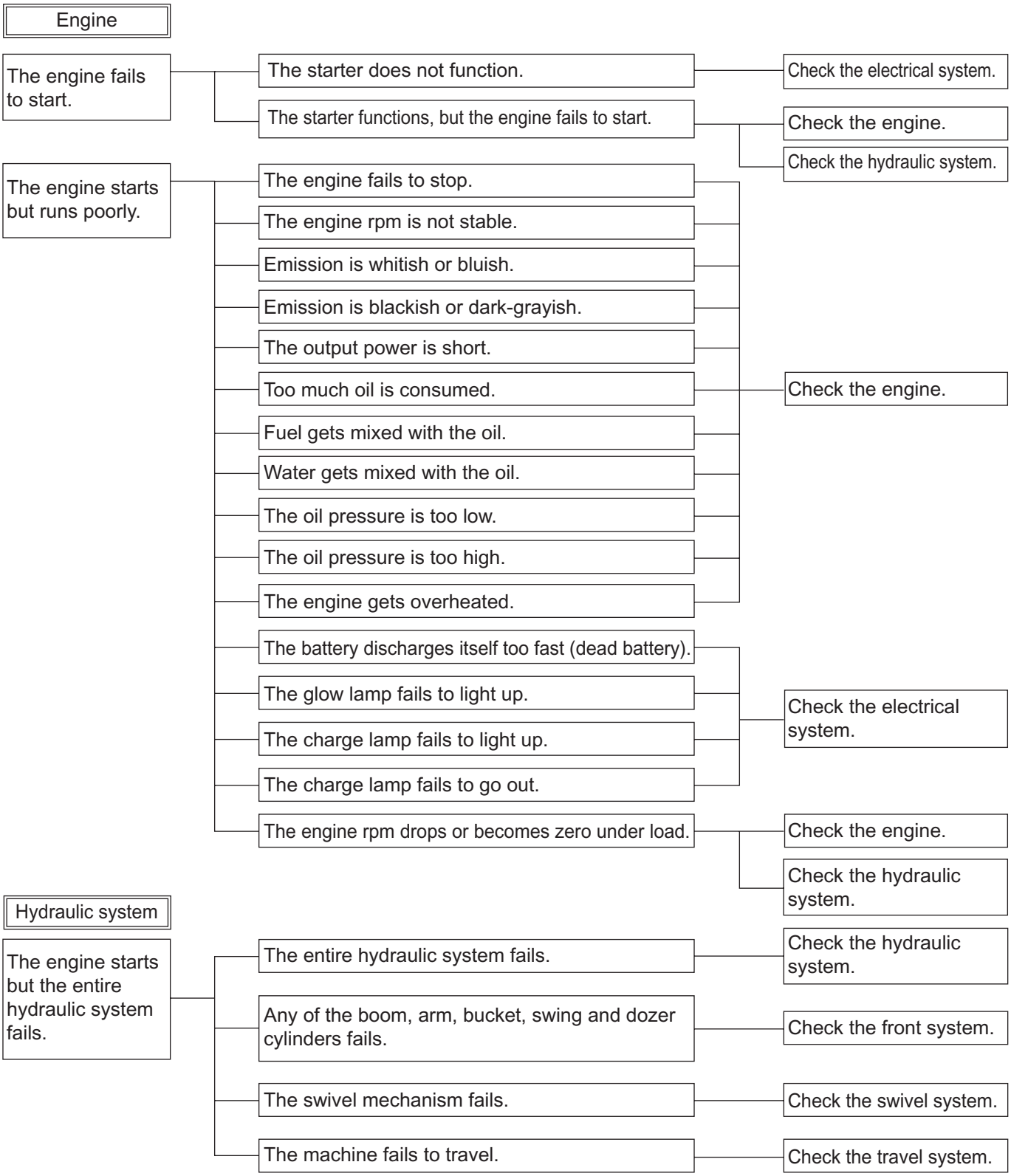


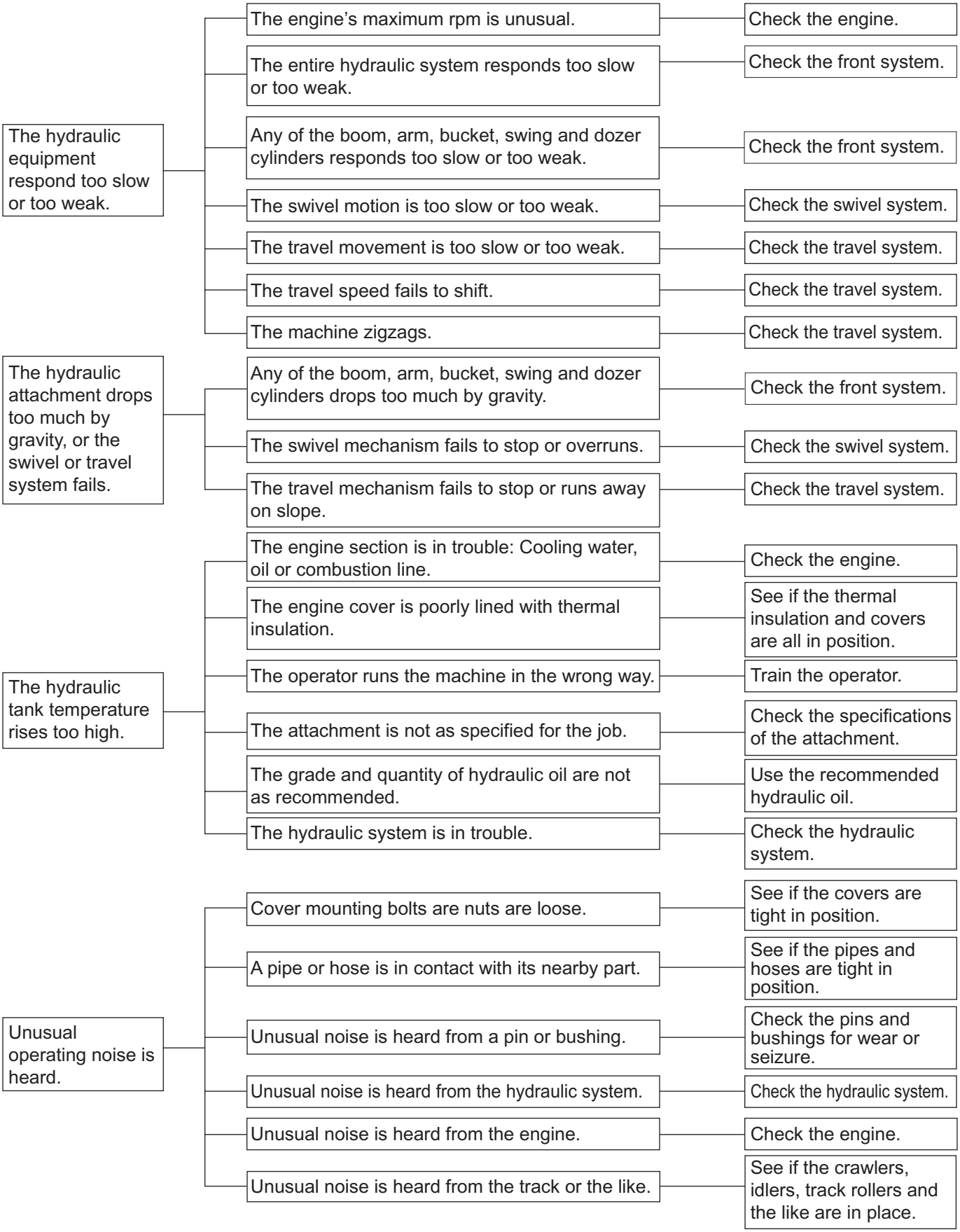
No.	PART NAME
1	Main pump
2	Pilot value, L
3	Pilot value, R
4	Pilot filter
5	Change valve
6	Control valve
7	Swivel motor
8	Rotary joint
9	Travel motor, L
10	Travel motor, R
11	Change valve for sp (1 way, 2 way)
12	Travel lock cylinder
13	Hydraulic oil tank
14	Oil cooler
15	Boom cylinder
16	Arm cylinder
17	Bullcket cylinder
18	Swing cylinder
19	Dozer cylinder
20	Upper roller
21	Track rollers
22	Grease tension cylinder
23	Idler

IV. Hydraulic system (Service section)

A. Troubleshooting

a. Common Circuit





b. Hydraulics

Problem	Cause	Correction
The entire hydraulic system fails or responds too slow or too weak.	(1) Hydraulic oil too short in the tank or oil degraded.	Add or change the hydraulic oil.
	(2) Suction line (suction filter) clogged.	Check the suction line and replace the suction filter as required.
	(3) Pump coupling defective.	Repair or replace the pump coupling.
	(4) Pump drive shaft broken.	Replace the shaft.
	(5) Pump internal parts seized or damaged.	Repair or replace the pump.
The boom, arm, bucket and swivel mechanism fail or respond too slow or too weak.	(1) Hydraulic pilot filter or hydraulic pilot line filter clogged.	Clean or replace the pilot filter.
	(2) Selector valve defective.	Overhaul or replace the selector valve.
	(3) Pilot pump internal parts seized or damaged.	Replace the pilot pump.
The boom, bucket and right-travel mechanism fail or respond too slow or too weak.	(1) Main relief valve (P1) not at specified pressure.	Check the main relief valve (P1) and readjust as required.
	(2) P1 or P2 line pump internal parts seized or damaged if the arm, service port and left-travel mechanism fail too.	Overhaul or replace the pump.
The arm, service port and left-travel mechanism fail or respond too slow or too weak.	(1) Main relief valve (P2) not at specified pressure.	Check the main relief valve (P2) and readjust as required.
	(2) P1 or P2 line pump internal parts seized or damaged if the boom, bucket and right-travel mechanism fail too.	Overhaul or replace the pump.
The swing, dozer and swivel mechanism fail or respond too slow or too weak.	(1) Main relief valve (P3) not at specified pressure.	Check the main relief valve (P3) and readjust as required.
	(2) P3 line pump internal parts seized or damaged.	Overhaul or replace the pump.
The boom alone fails or responds too slow or too weak.	(1) Boom overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve or boom section spool malfunctioning.	Check the spool and repair as required.
	(3) Pilot valve defective.	Measure the secondary pressure and check the pilot valve.
	(4) Boom cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The arm alone fails or responds too slow or too weak.	(1) Arm overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve or arm section spool malfunctioning.	Check the spool and repair as required.
	(3) Pilot valve defective.	Measure the secondary pressure and check the pilot valve.
	(4) Arm cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The bucket alone fails or responds too slow or too weak.	(1) Bucket overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve or bucket section spool malfunctioning.	Check the spool and repair as required.
	(3) Pilot valve defective.	Measure the secondary pressure and check the pilot valve.
	(4) Bucket cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.

Problem	Cause	Correction
The swing mechanism alone fails or responds too slow or too weak.	(1) Swing pedal and link maladjusted.	Check the pedal and link and readjust as required.
	(2) Control valve swing section spool malfunctioning.	Check the spool and repair as required.
	(3) Anti-void valve defective.	Check the anti-void valve and replace as required.
	(4) Swing cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The dozer alone fails or responds too slow or too weak.	(1) Dozer overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Dozer lever and cable maladjusted.	Check the lever and cable and readjust as required.
	(3) Control valve dozer section spool malfunctioning.	Check the spool and repair as required.
	(4) Dozer cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The boom cylinder allows too much gravity fall.	(1) Overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve's anti-drift valve malfunctioning.	Check the anti-drift valve and repair as required.
	(3) Control valve spool scratched or spring broken.	Check the spool and repair as required.
	(4) Boom cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The bucket cylinder and arm cylinder allow too much gravity fall.	(1) Overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve spool scratched or spring broken.	Check the spool and repair as required.
	(3) Bucket cylinder or arm cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The swing cylinder still works at neutral position.	(1) Swing pedal linkage maladjusted.	Check the linkage and readjust as required.
	(2) Anti-void valve defective.	Check the anti-void valve and repair as required.
	(3) Control valve spool stick or spring broken.	Check the spool and repair as required.
	(4) Swing cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The dozer cylinder allows too much gravity fall.	(1) Overload relief valve not at specified pressure.	Check the overload relief valve and repair as required.
	(2) Control valve spool scratched or spring broken.	Check the spool and repair as required.
	(3) Dozer cylinder rod packing broken.	Overhaul the cylinder and replace the sealing.
The hydraulic oil tank temperature is too high.	(1) Hot air backflow due to damaged partition around oil cooler.	Check the oil cooler and its surrounding.
	(2) Oil cooler clogged.	Clean the oil cooler.
	(3) Return filter clogged.	Check the return filter and replace as required.
	(4) Low-pressure line clogged with foreign matters.	Check the low-pressure line.

c. Pump

Problem	Cause	Correction
1. The engine gets overloaded.	1) Engine rpm higher than specified. 2) Pressure higher than specified. 3) Pump internal parts seized or damaged.	1) Readjust as specified. 2) Readjust as specified. 3) repair or replace the pump.
2. The pump flowrate drops extremely with too low discharge pressure.	1) Engine rpm too low. 2) Pump coupling defective. 3) Pump internal parts seized or damaged.	1) Readjust the rpm. 2) Repair or replace the pump coupling. 3) Repair or replace the pump.
3. Unusual noise or unusual vibrations occur (cavitation phenomenon).	1) Air or water mixed in hydraulic oil. 2) Suction strainer clogged. 3) Suction pipe clogged or throttled. 4) Attached pump in trouble (if provided). 5) Piston shoe poorly crimped. 6) Pump loosely mounted. 7) Coupling defective.	1) Retighten the circuit connections, the suction pipe in particular. Replace if water is mixed in. 2) Clean or replace the suction strainer. 3) Correct the suction pipe. 4) Repair or replace the attached pump. 5) Replace the piston assembly. 6) Mount correctly. 7) Replace the coupling.
4. There is oil leak.	1) O-ring or sheet packing defective. 2) Oil leak from oil seal edge.	1) Replace the O-ring or sheet packing (install as specified). 2) Replace or repair the oil seal or shaft.

d. Motor

Problem	Cause	Correction
Motor failure to run	No pressure rise or no oil flow.	Check the entire hydraulic circuit including the valves and pumps.
	Oil viscosity inappropriate.	Ensure the specified viscosity ranges.
	Dust, degraded hydraulic oil, cavitation, internal parts seized due to excessive radial load, unusual contact, bearing damaged.	Run the motor alone and get it under a pressure of 30 kgf/cm^2 (2.9 MPa) or so. If it fails to run, then some internal parts might be seized or damaged. Disassemble the motor and replace damaged parts.
Rpm not as designed	Incoming flowrate too low.	Check the pump discharge rate, the motor rpm, and the valves for oil leak.
	Low viscosity and internal leak for oil temperature or other reason.	Ensure the specified viscosity ranges.
	Internal parts worn out.	Replace worn-out parts.
Wrong turning direction	Wrong pipe connections.	Reverse the pipe connections.
	Poor valve timing due to wrong disassembling/reassembling procedures.	Disassemble and reassemble again for good valve timing.
Oil leak	Oil seal scratched or worn.	Replace the oil seal. Repair or replace if the shaft seal contact surface is scratched or worn.
	Loose bolt or plug, resulting in oil leak (at joints) from O-ring.	Tighten the bolt and plug to their specified torques. See also if the O-ring is damaged. Replace the O-ring as required.
	O-ring scratched or damaged.	Replace the O-ring.
	Dust or dent on the O-ring contact face.	Check for hit marks, burr, etc. Correct the surface with #600 or so sandpaper. Replace the O-ring. Clean up and reassemble.
	Cracked port, damaged screw. Inappropriate joint.	Replace the housing. Use an appropriate joint and tighten it to the specified torque.
Unusual noise	Shaft poorly fitted.	Center the shaft exactly.
	Air left in the circuit or motor.	Let out the air completely. Fill the motor with oil and keep it running under no load until there is no air bubbles in the tank.
	Pump's cavitation.	Unclog the suction filter.
	Air mixed in the suction pipe line.	Apply oil or grease to each connection and carefully listen to the noise there. If the noise is less, retighten the joint there.
Unusual temperature rise	Cooler in trouble.	Repair the cooler.
	Motor seized.	Repair or replacement

As listed above, there are various problems and their possible causes. The majority of troubles are, however, caused by the entry of dust. Be very attentive not to allow any dust into the system.

e. Swivel performance

First make sure the swivel mechanism alone is in trouble.

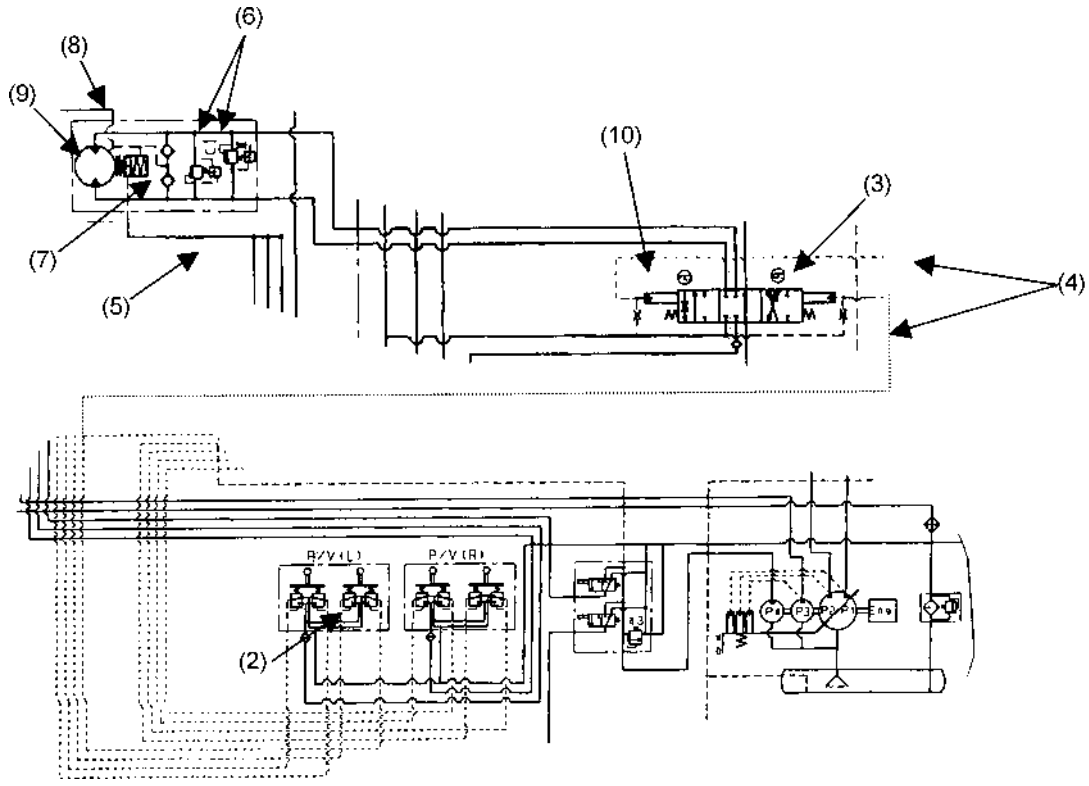
Problem		Cause		Correction
1	No swiveling in both directions	(2)	Pilot valve spool malfunctioning	Check the performance. Overhaul and clean.
		(3)	Control valve spool stick malfunctioning	Check the performance. Overhaul and clean.
		(4)	Pilot secondary pressure unspecified	Measure the pressure.
		(5)	Brake poorly unlocked	Measure the pressure.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(7)	Anti-void valve malfunctioning, valve seat defective	Overhaul and clean.
		(8)	Motor drain too much	Measure the drain amount.
		(9)	Motor internal parts damaged	Overhaul, clean and replace.
		(10)	Control valve internal parts damaged	Overhaul, clean and replace.
2	No swiveling in one direction	(2)	Pilot valve spool malfunctioning	Check the performance. Overhaul and clean.
		(3)	Control valve spool stick malfunctioning	Check the performance. Overhaul and clean.
		(4)	Pilot secondary pressure unspecified	Measure the pressure.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(7)	Anti-void valve malfunctioning, valve seat defective	Overhaul and clean.
		(8)	Motor drain too much	Measure the drain amount.
		(9)	Motor internal parts damaged	Overhaul, clean and replace.
		(10)	Control valve internal parts damaged	Overhaul, clean and replace.
3	No enough power. Too slow motion	(2)	Pilot valve spool malfunctioning	Check the performance. Overhaul and clean.
		(3)	Control valve spool stick malfunctioning	Check the performance. Overhaul and clean.
		(4)	Pilot secondary pressure unspecified	Measure the pressure.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(7)	Anti-void valve malfunctioning, valve seat defective	Overhaul and clean.
		(8)	Motor drain too much	Measure the drain amount.
		(9)	Motor internal parts damaged	Overhaul, clean and replace.
		(10)	Control valve internal parts damaged	Overhaul, clean and replace.
4	No stop even at neutral position. Overrunning	(2)	Pilot valve spool malfunctioning	Check the performance. Overhaul and clean.
		(3)	Control valve spool stick malfunctioning	Check the performance. Overhaul and clean.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(7)	Anti-void valve malfunctioning, valve seat defective	Overhaul and clean.
		(8)	Motor drain too much	Measure the drain amount.
5	Too high shock at start and stop. No inching operation	(2)	Pilot valve spool malfunctioning	Check the performance. Overhaul and clean.
		(3)	Control valve spool stick malfunctioning	Check the performance. Overhaul and clean.
		(7)	Anti-void valve malfunctioning, valve seat defective	Overhaul and clean.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(8)	Motor drain too much	Measure the drain amount.

Problem		Cause		Correction
6	Wobbling if pressed by hand	(3)	Control valve spool malfunctioning	Check the performance. Overhaul and clean.
		(7)	Anti-void valve malfunctioning, valve seat defective	Check the performance. Overhaul and clean.
		(6)	Brake valve pressure unspecified	Measure the pressure. Overhaul, clean and readjust.
		(8)	Motor drain too much	Measure the drain amount.

1) Swivel mechanism check points

1. First make sure the swivel mechanism alone is in trouble.
2. Then see if what is in trouble is in both directions or in either direction.
3. Also see if the trouble occurs all the time or from time to time and how often it happens.

The numbers given in the figure below correspond to those in the troubles at a glance.

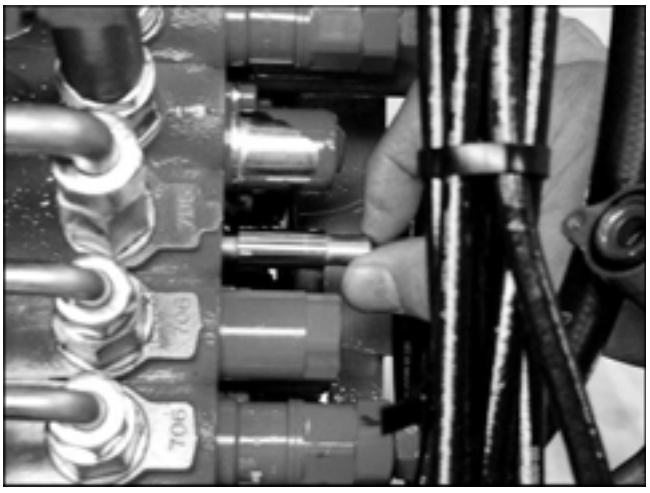


4. If the trouble is found in either direction, reverse the right and left hoses and see if the trouble occurs in the other direction.
5. If the hoses have been reversed and the trouble found in the other direction, it means that the trouble spot is upstream. If still in the same direction, the trouble spot is downstream.
6. Hose reversing points (~)
   (2) Pilot valve ~ (4) Control valve ~ (9) Swivel motor
7. Right and left parts switching
   (2) Pilot valve (6) Brake valve

2) Checking the pilot valve spool performance

1. Operate the swivel lever and see if the pilot valve spool functions well.
2. If the spool malfunctions, check for foreign matters, scratches, deformation, etc.
3. If the swivel mechanism is in trouble in either direction, reverse the two one-touch coupler hoses below the valve. See if the trouble happens in the other direction this time.

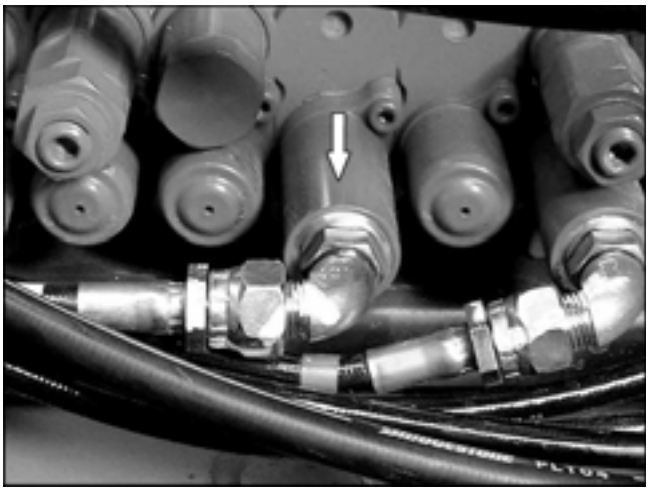
3) Checking the control valve spool stick performance



1. See if the swivel section spool moves well.
2. If the spool fails to move smoothly, check for foreign matters, scratches, deformation, etc.

For servicing, refer to page IV-S-60.

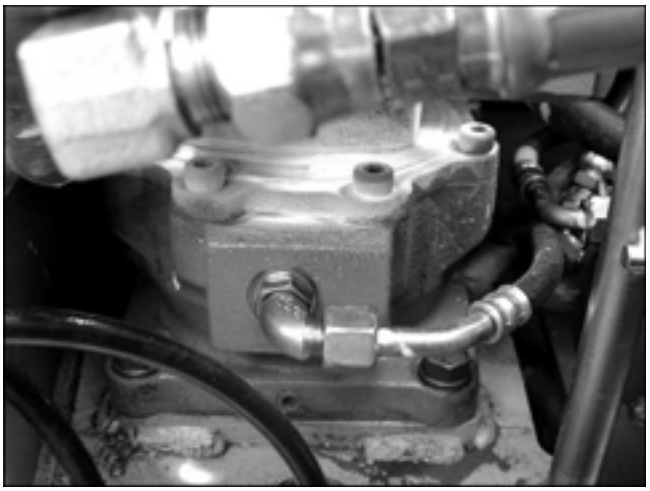
4) Measuring the pilot secondary pressure



1. Measure the secondary pressure between the pilot valve and the control valve.
2. Make sure the pressure is as specified.

For measuring, refer to page IV-S-30.

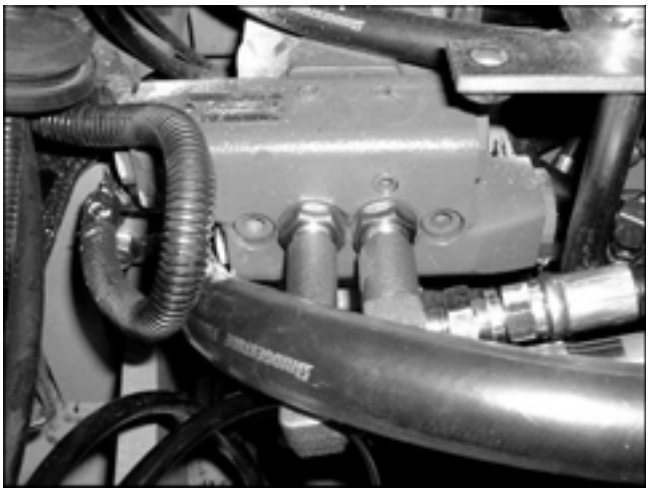
5) Checking the brake release



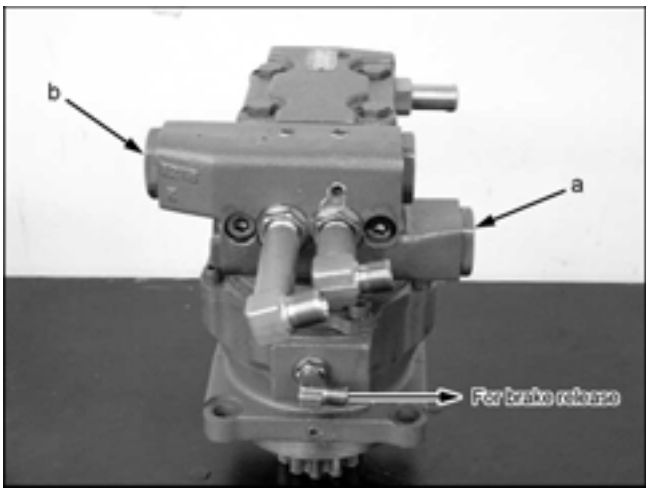
1. Measure the pressure between the solenoid valve and the swivel motor brake.
2. Make sure the pressure is as specified.
3. Start the engine and unlock the control lever. Extend the front attachment in maximum reach in the air, and move the bucket by hand (using your reaction force). Make sure the swivel mechanism starts and the brake gets applied when it gets locked.

   For measuring and servicing, refer to pages IV-S-35 and IV-S-78, respectively.

6) Checking the brake valve pressure



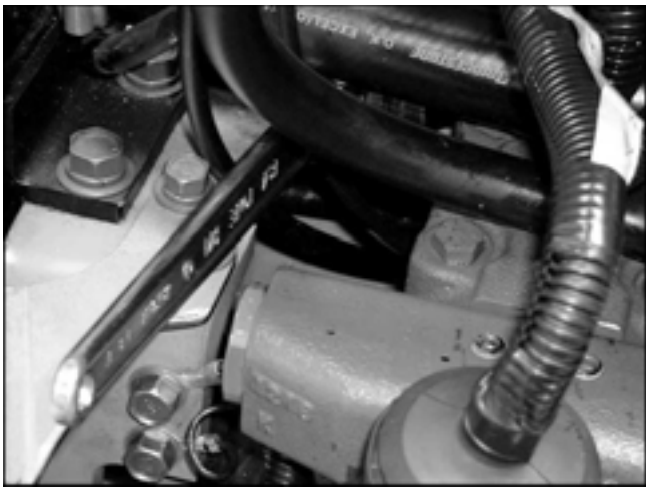
1. Measure the brake valve pressure. (Before the measurement, bring the bucket end in contact with something fixed.)
2. Make sure the pressure is as specified.



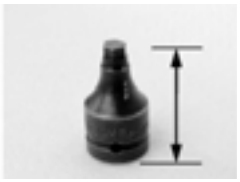
3. Readjust the relief valve, or disassemble and clean it up.
   a: For clockwise swivel
   b: For counterclockwise swivel

   For measuring and servicing, refer to pages IV-S-34 and IV-S-78, respectively.

7) Checking the anti-void valve and valve seat

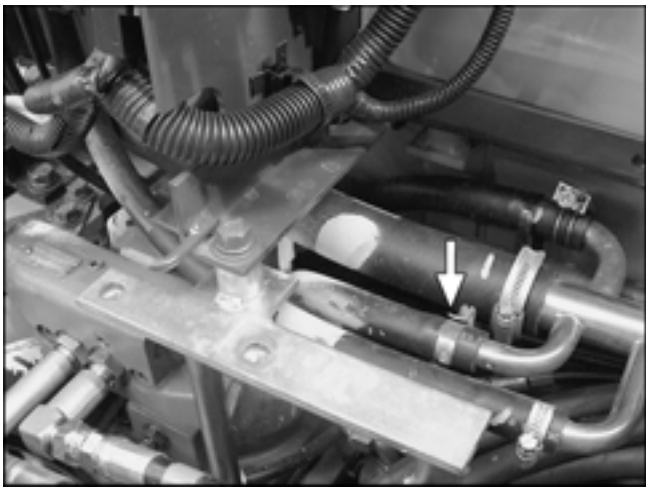


1. Check the anti-void valve for heavy movement, scratches, foreign matters, etc.
   Prepare an 8M hex hollow wrench that is 45 mm or so tall.



For servicing, refer to page IV-S-78.

8) Checking the motor drain amount



1. Remove the steps.
2. The drain hose is between the swivel motor and drain pipe. Disconnect this hose from the drain pipe alone. Plug one end of a 30 cm or so long spare hose and connect the other end to the drain pipe.
3. Do and lock the swiveling (with the bucket end in contact with something fixed), and measure their respective drain amounts.

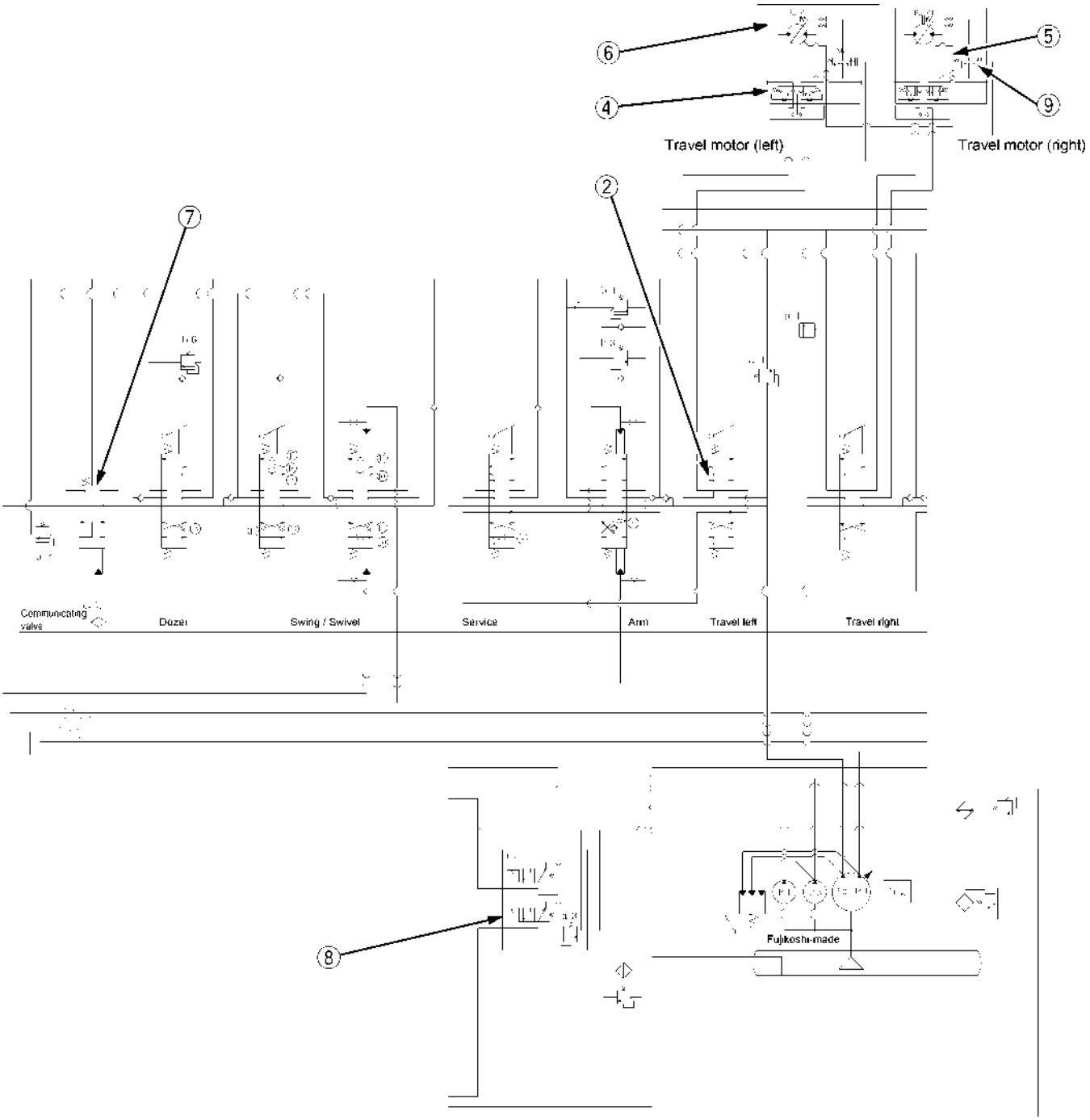
For measuring, refer to page IV-S-37.

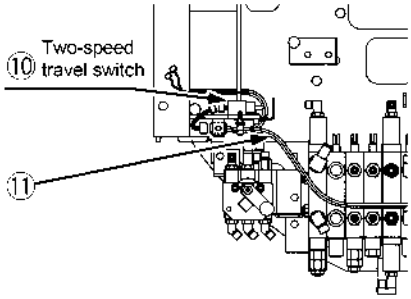
f. Traveling performance

In advance, make sure the trouble is in the travel mechanism alone.

Problem		Cause	Correction
Failure to run.	(1)	Travel lever linkage stuck or missing.	Readjust the linkage or replace as required.
	(2)	Control valve spool stuck.	Overhaul and clean the control valve. Replace as required.
	(3)	Internal leak in rotary joint.	Overhaul the rotary joint. Replace the seal.
	(4)	Counterbalance valve spool stuck.	Overhaul and clean the counterbalance valve. Replace as required.
	(5)	Too much motor drain.	Measure the drain amount. Overhaul the motor. Replace as required.
	(6)	Motor internal parts damaged.	Overhaul the motor. Replace as required.
Too slow travel speed. Too low travel force.	(1)	Travel lever linkage malfunctioning.	Readjust the linkage.
	(2)	Control valve spool stuck.	Overhaul and clean the control valve. Replace as required.
	(3)	Internal leak in rotary joint.	Overhaul the rotary joint. Replace the seal.
	(4)	Counterbalance valve spool stuck.	Overhaul and clean the counterbalance valve. Replace as required.
	(5)	Too much motor drain.	Measure the drain amount. Overhaul the motor. Replace as required.
	(6)	Motor internal parts damaged.	Overhaul the motor. Replace as required.
	(7)	Communicating valve spool stuck.	Clean the communicating valve. Replace as required. Clean the filter.
Zigzagging. (while traveling)	(1)	Right and left travel lever linkages out of alignment.	Readjust the linkage.
	(2)	Right and left control valve spools out of alignment.	Overhaul and clean the control valve. Replace as required.
	(3)	Internal leak in rotary joint on one side.	Overhaul the rotary joint. Replace the seal.
	(4)	Counterbalance valve spool stuck.	Overhaul and clean the counterbalance valve. Replace as required.
	(5)	Too much difference between right and left motor drain amounts.	Measure the drain amount. Overhaul the motor. Replace as required.
	(6)	Internal parts damaged on motor on one side.	Overhaul the motor. Replace as required.
	If there is a difference in the flowrate and pressure between the right-travel and left-travel pumps, check the delivery hoses on both sides. If one of them is in trouble, the machine travels zigzag. In this case, other operations are also affected.		
Failure to stop.	(1)	Travel lever linkage poor in return or stuck.	Readjust the linkage.
	(2)	Control valve spool poor in return or stuck.	Overhaul and clean the control valve. Replace as required.
	(4)	Counterbalance valve spool poor in return or stuck.	Overhaul and clean the counterbalance valve. Replace as required.
Failure to shift the gears.	(8)	Selector valve's two-travel-speed switching in trouble.	Overhaul and clean the selector valve. Replace as required.
	(9)	Travel motor's high/low-speed switch spool malfunctioning.	Overhaul and clean the high/low-speed selector valve control. Replace as required.
	(10)	Limit switch malfunctioning.	Check the limit switch. Replace as required.
	(11)	Solenoid and limit switch harness broken.	Check the harness. Replace as required.

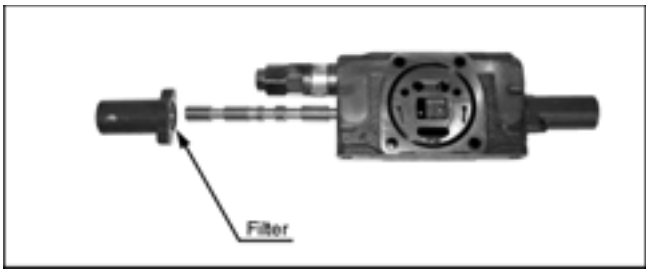
1) Travel mechanism check points





Left front of the machine

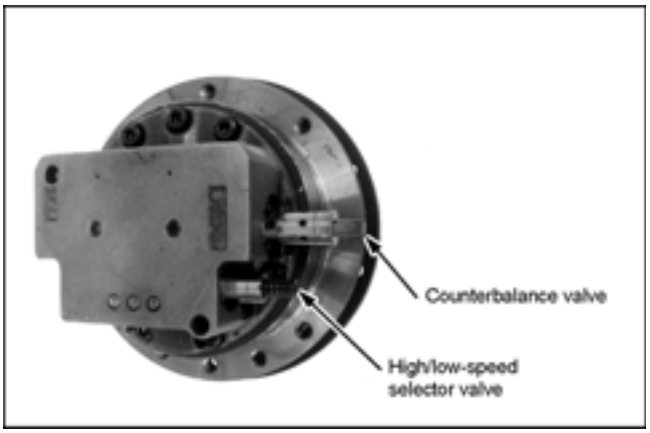
2) Checking the communicating valve



1. For disassembling and reassembling the control valve, refer to IV-S-63.
2. Remove the cap and spool. Check and clean them up.
3. Clean up the filter in the cap too.

3) Checking the counterbalance valve and high/low-speed selector valve (travel motor)

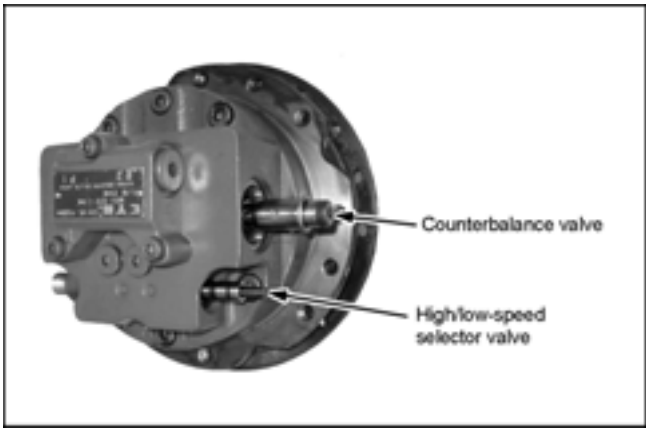
U-20-3 (Fujikoshi-made)



Checking the counterbalance valve and high/low-speed selector valve

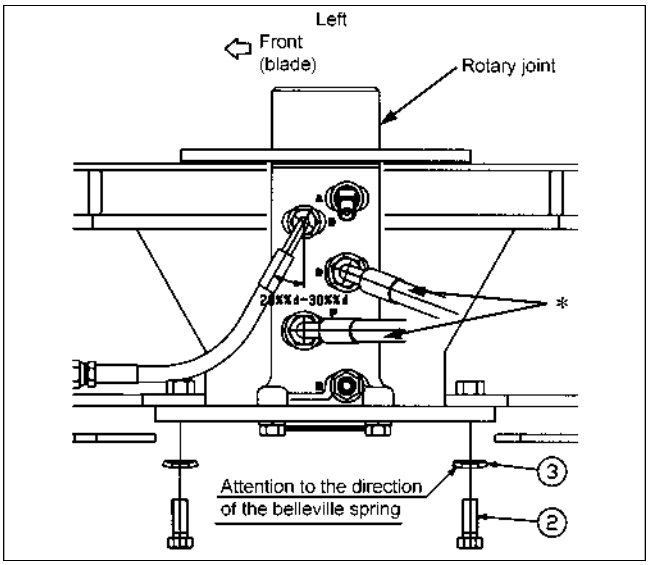
1. For disassembling and reassembling the valves, refer to IV-S-102.
2. Remove the plug and spool. Check and clean them up.

U-25 (Kayaba-made)



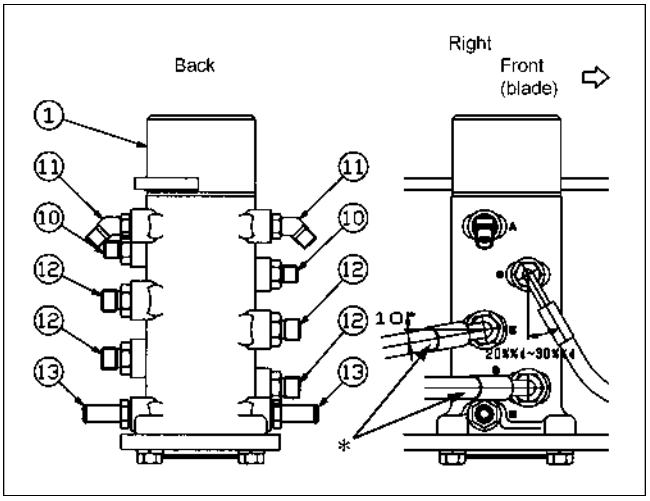
4) Checking the rotary joint for internal leak

Checking the left travel



1. Make sure there is nothing unusual between the pump and rotary joint.
2. Disconnect the *-marked hoses as shown at left. Put plugs to the openings.
3. Raise the pump pressure and make sure the main relief pressure reaches the specified level.

Checking the right travel



1. Make sure there is nothing unusual between the pump and rotary joint.
2. Disconnect the *-marked hoses as shown at left. Put plugs to the openings.
3. Raise the pump pressure and make sure the main relief pressure reaches the specified level.

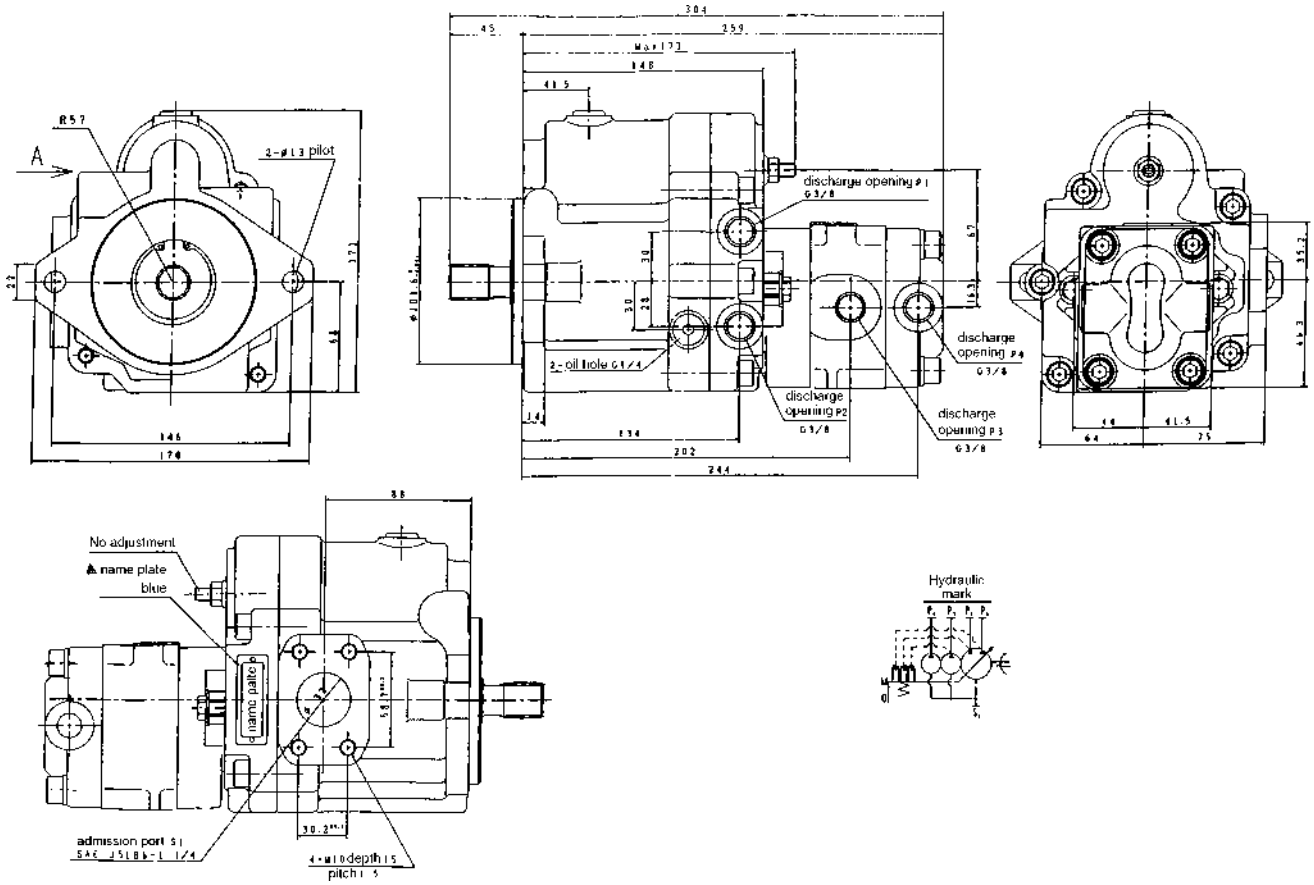
A : Two-speed
B : Dozer (lower, bottom)
C : Dozer (upper, rod)
D : Travel left (front)
E : Travel right (front)
F : Travel left (back)
G : Travel right (back)
H : Drain

B. Specifications

a. Pomp

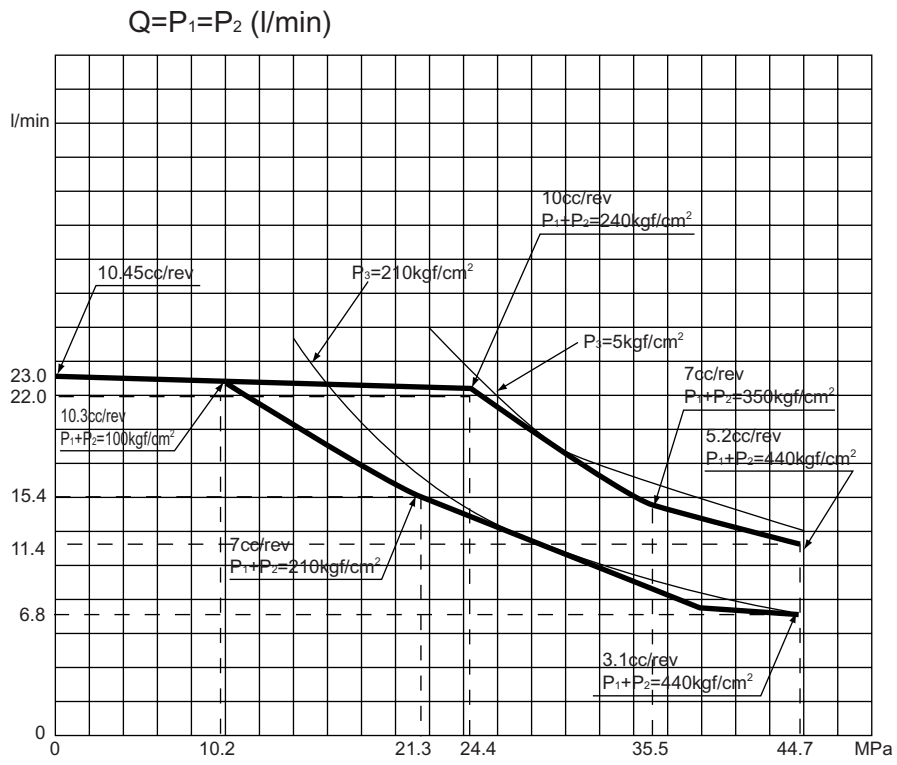
[1] Specifications

		Unit	U20-3	U25-3		Remarks
Manufactue			Industry Co.Ltd			
Model			PVD-08-24P-6G3	PVD-08-24P-8G3		
Rated pump rpm		rpm	2,200	2,400		
Rated load pressure	P1, P2 Main relief pressure	MPa kgf/cm^2	21.6 220	21.6 220		
	P3 Main relief pressure	MPa kgf/cm^2	20.6 210	17.2 175		
	Pilot primary pressure	MPa kgf/cm^2	3.9 40	3.9 40		
Theoretical discharge capacity	P1 / P2 Main pump	cc/rev	10.5/10.5	12.0/12.0		
	P3 / Pp pump	cc/rev	5.8/2.7	8.0/2.7		
Theoretical discharge capacity at rated load	P1 / P2 Main pump	L/min	21.5~24.5/ 21.5~24.5	27.5~30.5/ 27.5~30.5		
	P3 / Pp pump	L/min	12.7/5.9	19.2/6.5		



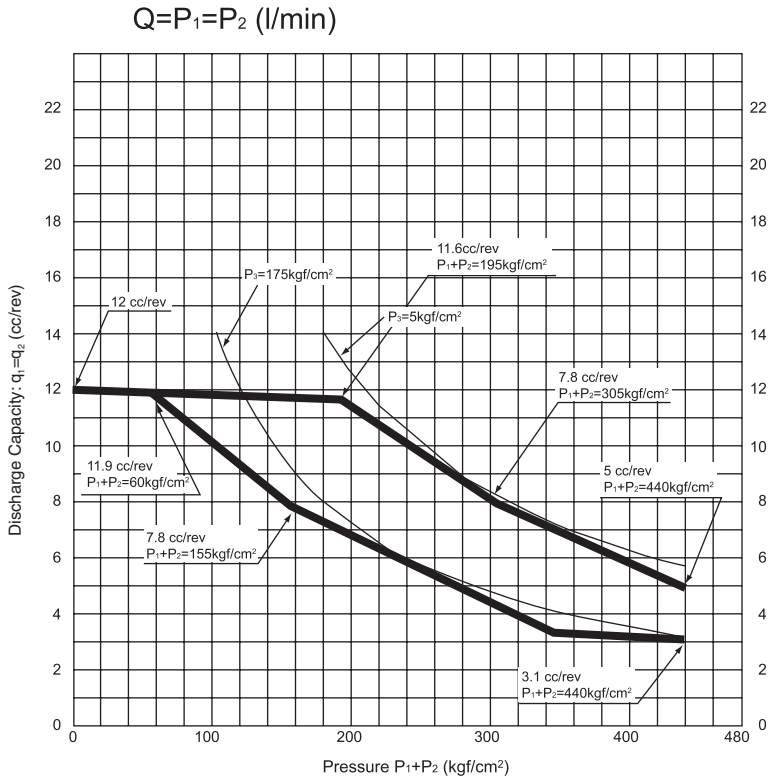
[2] Piston pump P-Q performance curve (Theoretical)

U-20-3



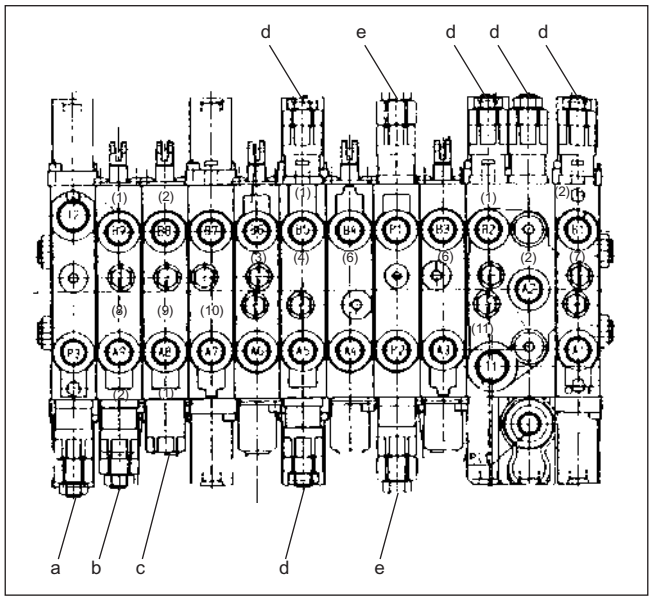
Measuring conditions	
Oil used	ISO VG46 or equivalent
Oil temperature	50±5℃
Turning speed	2,200 rpm
Turning direction	Clockwise
8_3	5.8 cc/rev
8_4	2.7 cc/rev
P_4	4.1 MPa

U25-3



Measuring conditions	
Oil used	ISO VG46 or equivalent
Oil temperature	50±5℃
Turning speed	2,400 rpm
Turning direction	Clockwise
8_3	8 cc/rev
8_4	2.7 cc/rev
P_4	4.1 MPa

b. Relief valve



No	Location
a	P3 main relief valve for
b	Dozer overload relief valve
c	Swing anti-void valve
d	Overload relief valve
e	P1-P2 main relief valve

(1) Rod
(2) Bottom
(3) Spare
(4) Arm
(5) Travel left
(6) Travel right
(7) Bucket
(8) Dozer
(9) Swing
(10) Swivel
(11) Boom

[1] Relief valve (bench data)

No.	Valve location	Operating work	Unit	U20-3	U25-3		Remarks
1	P1 Main relief valve	Bucket crowd	MPa kgf/cm^2	21.6 220	21.6 220		U20-3: at 29 L/min U25-3: at 29 L/min
2	P2 Main relief valve	Arm crowd or dump	MPa kgf/cm^2	21.6 220	21.6 220		U20-3: at 29 L/min U25-3: at 29 L/min
3	P3 Main relief valve	Swing Left or Right	MPa kgf/cm^2	20.6 210	17.2 175		U20-3: at 19 L/min
4	Pilot primary pressure	All pilot lines	MPa kgf/cm^2	3.9 40	3.9 40		

[2] Main relief valve (at the measurement port on the machine)

No.	Valve location	Operating work	Unit	U20-3	U25-3		Remarks
1	P1 Main relief valve	Bucket crowd	MPa kgf/cm^2	22.1 $^{+1.0}_{-0.5}$ 225 $^{+10}_{-5}$	22.1 $^{+1.0}_{-0.5}$ 225 $^{+10}_{-5}$		
2	P2 Main relief valve	Arm crowd or dump	MPa kgf/cm^2	22.1 225	22.1 225		
3	P3 Main relief valve	Swing Left or Right	MPa kgf/cm^2	21.1 215	17.6 180		
4	Pilot primary pressure	All pilot lines	MPa kgf/cm^2	4.1 ± 0.5 42 ± 5	4.2 ± 0.5 43 ± 5		

[3] Overload relief valve (bench data)

No.	Valve location	Operating work	Unit	U20-3	U25-3		Remarks
5	Control valve	Boom up Boom down	MPa kgf/cm^2	24 245	24 245		at 29 L/min
6	Control valve	Bucket crowd					
7	Control valve	Arm dump Arm crowd					
8	Control valve	Dozer down					
9	Control valve	Dozer up	MPa kgf/cm^2	24 245	24 245		at 18 L/min
10	Swivel motor	Swivel, R & L	MPa kgf/cm^2	19.6 200	16.2 165		

[4] Overload ralief valve (at the measurement port on the machine)

No.	Valve location	Operating work	Unit	U20-3	U-25-3		Remarks
5 6 7 8	Control valve	Boom up, down Arm dump, crowd Bucket dump, crowd Dozer down	MPa kgf/cm^2				
9	Control valve	Dozer up					
10	Swivel motor	Swivel R & L					

c. Swivel performance

		U20-3	U25-3	Remarks
Manufacturer		Eaton Fluid Power	Eaton Fluid Power	
Model		25PB2PA	25PB25A1125-C	
Displacement	cc/rev	195	244	
Max. oil flow	L/min	30	30	Rated flowrate
Motor speed	rpm	63.4	75.4	U20-3: at 12.4 L/min
				U20-3: at 18.4 L/min
Brake valve pressure	MPa kg/cm^2	19.6 200	16.2 165	
Drain amount at lock	L/min			
Drain amount while rotating	L/min			
Swivel speed	rpm	8.9	8.9	pinion/swivel teeth
3 times rotation swivel speed	sec	20.2	19.5	
Swivel block performance at engine stop	mm/min	0	0	
Swivel block performance at engine running	mm/min	130 ≧	140 ≧	Bucket empty
Capable swivel rotation angle	deg.	23.7	21.5	Bucket crowded
Play at the tip of bucket	mm	73 ≧	73 ≧	Reference value
Brake release pressure	MPa	2	2	
	kgf/cm^2	20.2	20.2	

d. Traveling performance

				U20-3	U25-3	Remarks
Manufacturer				Fujikoshi	KAYABA	
Model				PHV-190-39-1	MAG-18V-230E	
Capacity		1st/2nd	cc/rev	16.1/8.4	18.0/10.0	
Reduction ratio				1/39	1/42.96	
Total displacement			cc/rev	627.9/327.6	774/430	
Rated oil flow			L/min	23	27.6	
Theoretical torque		1F	kg·m N·m	220 2156	269.6 2,656	U25-3: at 21.6 MPa, 213 kgf/cm^2
		2F	kg·m N·m	N/A	149.8 1,476	
Theoretical speed		1F/2F	rpm	36.6/70.2	35.6/64.2	U25-3: at 27.6 L/min
Relief valve pressure			Mpa kg/cm^2	21.6 213	21.6 213	
Climbing ability			deg.	30	30	
Max. traction force		1F	KN kgf	15.5 1580	20.3 2070	Slip 70% theoretical torque Oil temp. : 50 ± 5 °C
		2F	KN kgf	8.1 826	9.7 990	Relief 60% theoretical torque
Traveling block performance			mm/10min	300 ≧	300 ≧	10 min engine stop Testing angle : 20deg
Traveling speed	Rubber/Iron	1F	km/h	2.2	2.5	
		2F	km/h	4.2	4.5	
10m traveling time		1F	sec./10m	16/	14/	R : Rubber shoe/ I : Iron shoe
		2F	sec./10m	8.6/	8.0/	
Straight travel performance		1,2F	mm/10m	600 ≧	600 ≧	
Drain amount at lock		1F	L/min			
		2F	L/min			
Drain amount while rotating		1F	L/min			
		2F	L/min			
Hi-speed change pressure 1st → 2nd			MPa kgf/cm^2	1.5 14.7	0.59 20.2	

e. Cylinder

[1] Speed

Unit				U20-3		U25-3		Remarks
				(A)	(B)	(A)	(B)	
Boom cylinder	Up	Canopy	sec.	2.5~3.1	3.7	2.1~2.7	3.2	GL to Max. height (exclude cushion time)
		Cabin	sec.	2.1~2.7	3.2	2.1~2.7	3.2	
Boom cylinder	Down	Canopy	sec.	2.6~3.2	3.8	2.4~3.0	3.6	Max. height to GL
		Cabin	sec.	2.2~2.8	3.3	2.3~2.9	3.5	
Boom cylinder	cushion		sec.	0.4~1.3	1.6	0.4~1.3	1.6	
Arm cylinder	Crowd		sec.	2.3~2.9	3.5	2.2~2.8	3.4	Cylinder full stroke
Arm cylinder	Dump		sec.	2.4~3.0	3.6	2.4~3.0	3.6	
Bucket cylinder	Crowd		sec.	2.9~3.5	4.2	2.7~3.3	4.0	Cylinder full stroke
Bucket cylinder	Dump		sec.	1.8~2.4	2.9	1.8~2.4	2.9	
Swing cylinder	Left	Canopy	sec.	4.8~5.8	7.0	4.1~5.1	6.1	Cylinder full stroke
		Cabin	sec.	4.8~5.8	7.0	4.1~5.1	6.1	
Swing cylinder	Right	Canopy	sec.	4.6~5.6	6.7	4.6~5.6	6.7	
		Cabin	sec.	4.6~5.6	6.7	4.6~5.6	6.7	
Dozer cylinder	Up		sec.	2.3~2.9	3.5	2.0~2.6	3.1	Cylinder full stroke
Dozer cylinder	Down		sec.	3.0~3.6	4.4	2.3~2.9	3.5	

(A) New machine reference value
(B) Allowable limit

[2] Natural fall

Unit		U20-3		U25-3		Remarks
		(A)	(B)	(A)	(B)	
Load weight	kg	146		167		• includ bucket weight
Boom cylinder	mm	20	100	20	100	Boom raise, Arm extend, Bucket crowd, Bucket load : heaped capacity 10 min Engine stop
Arm cylinder	mm	11	55	11	55	
Bucket cylinder	mm	10	50	10	50	
Dozer cylinder	mm	20	100	20	100	Arm vertical

Oil temp. : 50 ± 5 °C, 10 minutes

(A) New machine reference value
(B) Allowable limit

[3] Specifications and dimensions

1) Specifications and dimensions at a glance

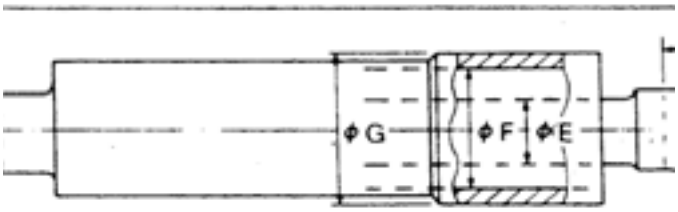
		Unit	U20-3	U25-3		Remarks
Boom	Tube I.D. × Rod O.D.	mm	65×35	70×40		
	Stroke	mm	482/452	476/455		canopy/cabin
	Max.retraction length	mm	778/778	795/795		canopy/cabin
	Seal Kit No.		RB411-71471	RB511-71471		
	Piston tightening torque	N·m kgf·m	578 59	747 76		
	Piston screw size	mm	M27	M30		
	Width for tightening by spanner	mm	41	50		
Arm	Tube I.D. × Rod O.D.	mm	65×40	70×40		
	Stroke	mm	450	484		
	Max.retraction length	mm	733	800		
	Seal Kit No.		RB411-71551	RB511-71551		
	Piston tightening torque	N·m kgf·m	644 65	747 76		
	Piston screw size	mm	M30	M30		
	Width for tightening by spanner	mm	50	50		
Bucket	Tube I.D. × Rod O.D.	mm	60×35	60×35		
	Stroke	mm	416	416		
	Max.retraction length	mm	679	741		
	Seal Kit No.		RB411-71791	RB511-71791		
	Piston tightening torque	N·m kgf·m	735 75	462 47		
	Piston screw size	mm	M27	M27		
	Width for tightening by spanner	mm	41	41		
Swing	Tube I.D. × Rod O.D.	mm	60×35	60×35		
	Stroke	mm	420	420		
	Max.retraction length	mm	686	686		
	Seal Kit No.		RB411-71871	RB411-71871		
	Piston tightening torque	N·m kgf·m	470 48	470 48		
	Piston screw size	mm	M27	M27		
	Width for tightening by spanner	mm	41	41		
Dozer	Tube I.D. × Rod O.D.	mm	80×40	90×45		
	Stroke	mm	138	126		
	Max.retraction length	mm	499	505		
	Seal Kit No.		RB411-71671	RB511-71671		
	Piston tightening torque	N·m kgf·m	795 81	855 87		
	Piston screw size	mm	M33	M36		
	Width for tightening by spanner	mm	55	55		

2) Cylinder dimensional specifications

U20-3

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm	48	48	45	50	35	65	80	39	36		
Arm	mm	48	48	40	40	40	65	80	39	36		
Bucket	mm	48	48	50	50	35	60	75	36	36		
Swing	mm	38	38	35	35	35	60	75	34	36		
Dozer	mm	45	45	50	50	40	80	96	39	39		

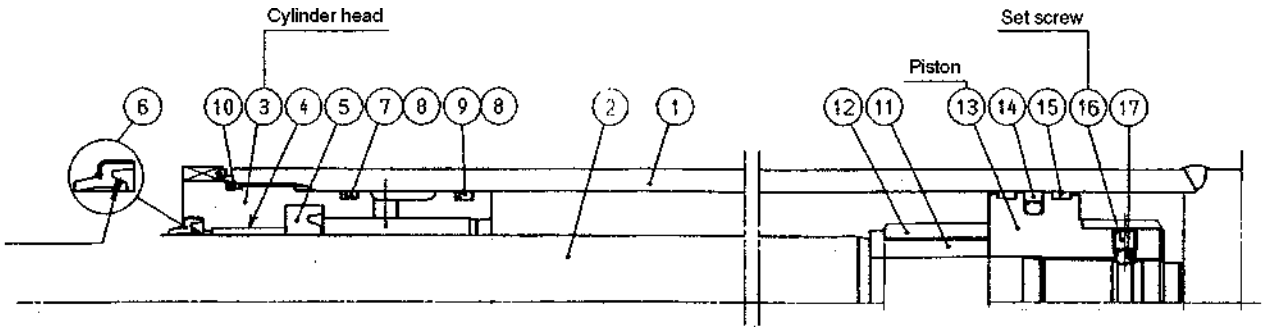
Max. retraction length (stroke)



U25-3

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm	48	48	45	50	40	70	85	39	39		
Arm	mm	48	48	40	40	40	70	85	48	48		
Bucket	mm	48	48	50	50	35	65	80	36	36		
Swing	mm	38	38	35	35	35	60	75	34	36		
Dozer	mm	45	45	50	50	45	90	108	44	42		

3) Tightening torque



1. Boom cylinder

	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	343 35.0	382 39.0	M72×2	M77×2	Three bond # 1901
Piston	578 59.0	747 76.2	M27×2	M30×2	
Set screw	6.9 0.7	16.2 1.7	M6×1	M8×1.25	

2. Arm cylinder

	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	343 35.0	382 39.0	M72×2	M77×2	Three bond # 1901
Piston	644 65.7	747 76.2	M30×2	M30×2	
Set screw	16.2 1.7	16.2 1.7	M8×1.25	M8×1.25	

3. Bucket cylinder

	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	304 31.0	343 35.0	M67×2	M72×2	Three bond # 1901
Piston	735 75.0	462 47.1	M27×2	M27×2	
Set screw	6.9 0.7	6.9 0.7	M6×1	M6×1	

4. Dozer cylinder

	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	451 46.0	530 54.1	M87×2	M97×2	Three bond # 1901
Piston	795 81.1	855 87.2	M33×2	M36×3	
Set screw	16.2 1.7	16.2 1.7	M8×1.25	M8×1.25	

5. Swing cylinder

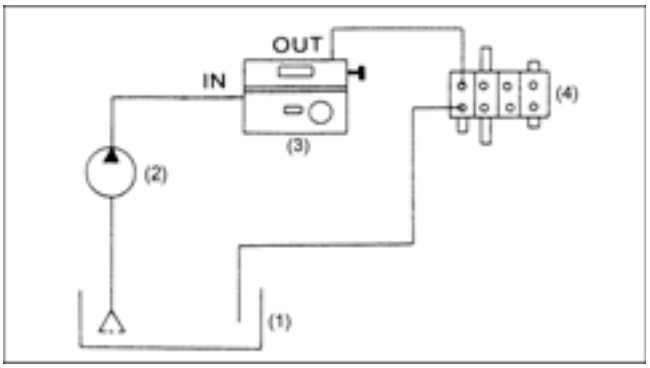
	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	304 31.0	304 31.0	M67×2	M67×2	Three bond # 1901
Piston	470 48.0	470 48.0	M27×2	M27×2	
Set screw	6.86 0.7	6.86 0.7	M6×1	M6×1	

6. Track cylinder

	Tightening torque (N·m / kgf·m)		Thread size		Adhesive
	U20-3	U25-3	U20-3	U25-3	
Cylinder head	304 31.0	—	M67×2	—	Three bond # 1901
Piston	333 34.0	—	M24×2	—	
Set screw	6.86 0.7	—	M6×1	—	

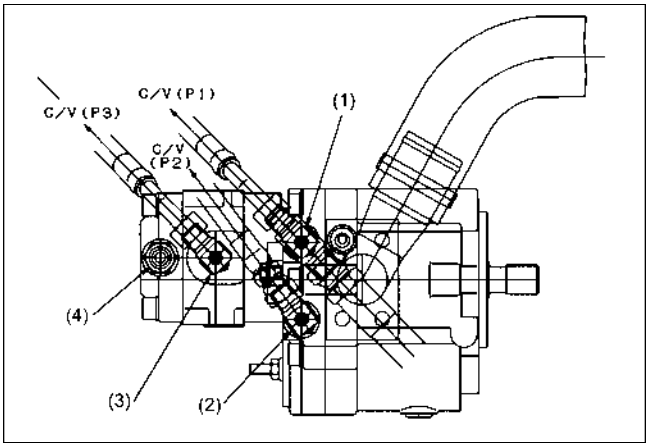
C.Testing

a. Pump flow



(1) Hydraulic oil tank (2) Pump
(3) Tester (4) Control valve

Pump discharge side



(1) To control valve (P1) (2) To control valve (P2)
(3) To control valve (P3) (4) To pilot filter

1) Measuring procedure

1. Connect the tester to the pump outlet. Be careful not to confuse the tester's pipe connections.
2. Open the tester's loading valve. Start the engine.
3. Set the engine to the maximum rpm.
4. Gradually close the loading valve. Apply the rated load pressure (test pressure) to the pump.
5. Measure the discharge flowrate and pump rpm (engine rpm).
6. Calculate the volumetric efficiency and judge the performance.

2) Checking the pump performance

To inspect the pump performance, apply the specified pressure to the pump discharge side. Measure the discharge rate at the specified rpm to check the volumetric efficiency.

$$\text{Volumetric efficiency} = \frac{\text{Discharge rate at rated load}}{\text{Theoretical discharge rate (calculated value)}} \times 100(\%)$$

Notes

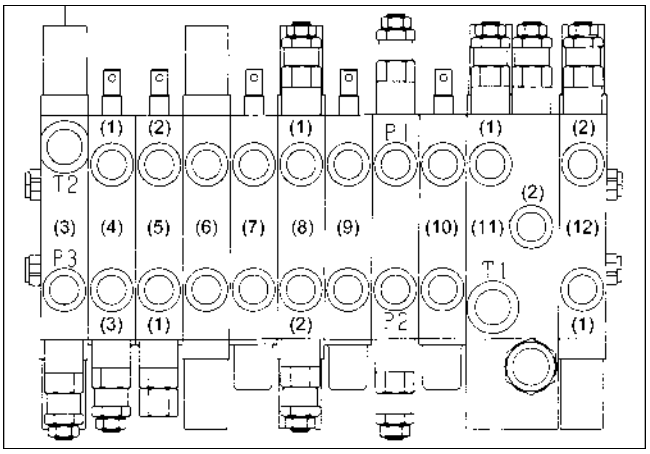
1. The pump's volumetric efficiency is proportional to the pump rpm and inversely proportional to the load pressure. During the test, keep the engine at its maximum rpm.
2. The volumetric efficiency is the ratio of the discharge rate per pump turn (cc/rev) to the theoretical discharge rate (calculated value). The main relief set pressure is used as the rated load.
3. The discharge rate under rated load must be converted to that per pump turn. This is because the pump usually runs at lower rpm.

Discharge rate under rated load

$$\text{(cc/rev)} = \frac{\text{Discharge rate at rated load (L/min)} \times 1000}{\text{Pump rpm at rated load (rpm)}}$$

4. The volumetric efficiency must be satisfied to accept the pump for its performance.
5. The hydraulic oil temperature must be 50±5°C.

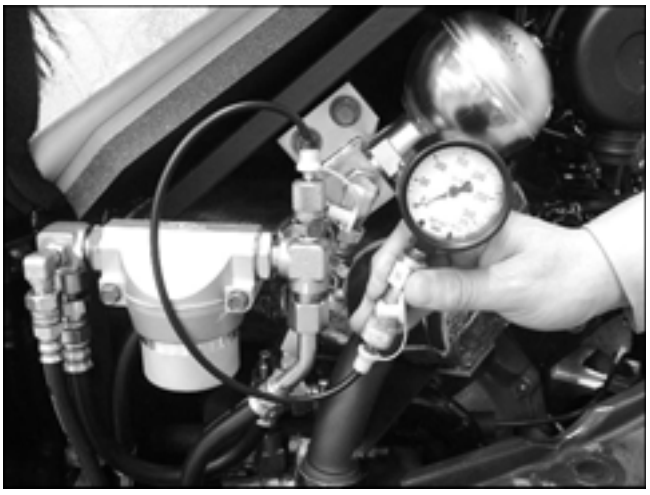
Control valve section layout



(1) Rod
(2) Bottom
(3) Communicating valve
(4) Dozer
(5) Swing
(6) Swivel
(7) Spare
(8) Arm
(9) Travel left
(10) Travel right
(11) Boom
(12) Bucket

b. Pressure measurement

[1] Pilot pressure



1) Pilot primary pressure

1. Remove the left cover of the bonnet.
2. Disconnect the plug (1/8) from the elbow pipe joint of the pilot filter. Set the pressure gauge.
3. Start the engine. Take the reading at the maximum speed. Take 3 measurements and take the average.

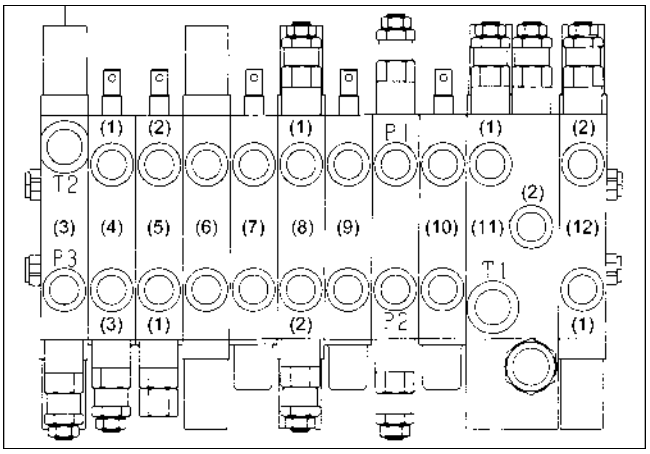
* Keep the oil temperature at 50±5°C.

2) Pilot secondary pressure(in moving up the boom)

1. Remove the steps and swivel cover.
2. There is the hose between the pilot valve and control valve. Disconnect this hose from the control valve alone.
3. Attach the T joint and set the pressure gauge.
4. Start the engine. At the maximum rpm, move up the boom and take the reading.
5. Take 3 measurements and take the average.

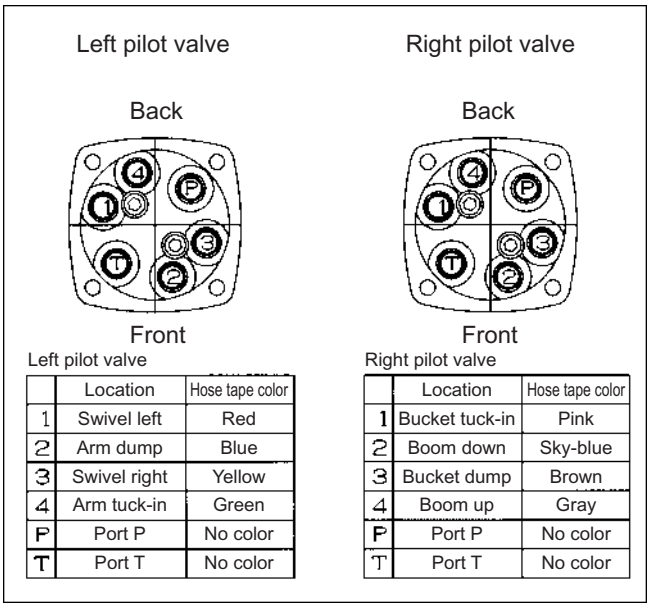
* Keep the oil temperature at 50±5°C.

Control valve section layout



(1) Rod
(2) Bottom
(3) Communicating valve
(4) Dozer
(5) Swing
(6) Swivel
(7) Spare
(8) Arm
(9) Travel left
(10) Travel right
(11) Boom
(12) Bucket

Pilot valve hose routes



Left pilot valve

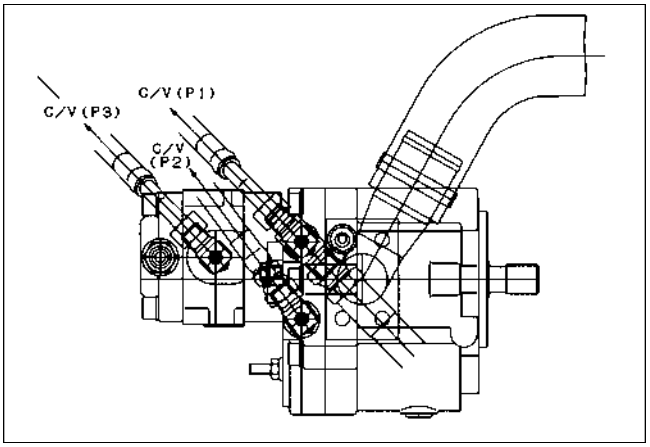
	Location	Hose tape color
1	Swivel left	Red
2	Arm dump	Blue
3	Swivel right	Yellow
4	Arm tuck-in	Green
P	Port P	No color
T	Port T	No color

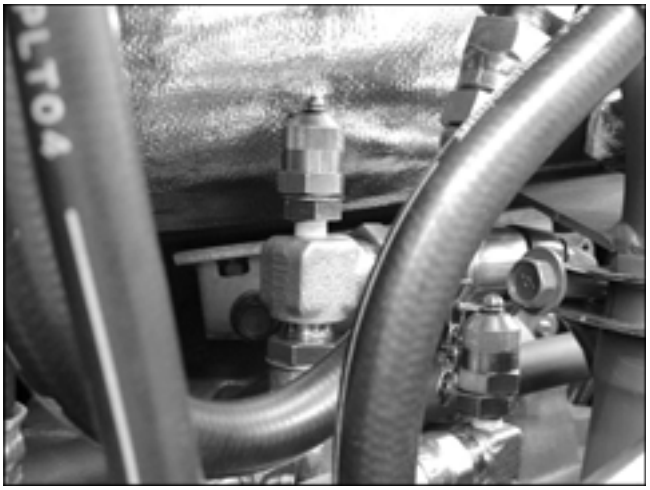
Right pilot valve

	Location	Hose tape color
1	Bucket tuck-in	Pink
2	Boom down	Sky-blue
3	Bucket dump	Brown
4	Boom up	Gray
P	Port P	No color
T	Port T	No color

[2] Main relief valve pressure

Pump discharge side

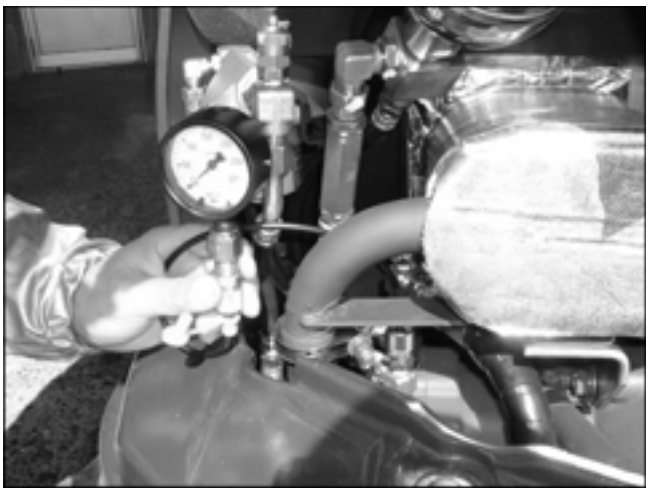




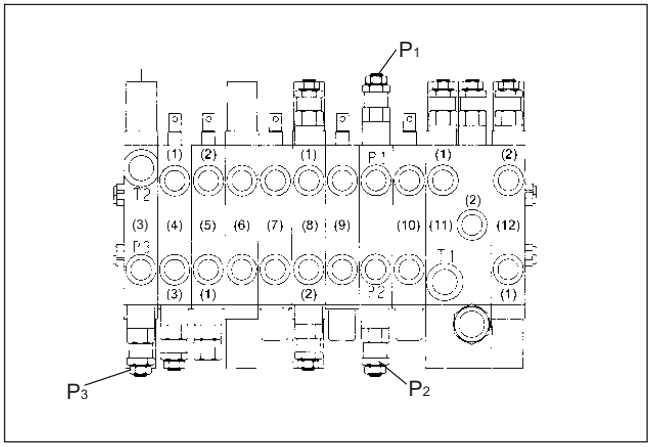
1) Measuring procedure

1. Remove the adaptor plug (1/8) of main pump discharge side and connect thereto a pressure gauge.
   { P1 Bucket, boom and travel right
   P2 Arm, service port and travel left
   P3 Swivel, swing and dozer }
2. Start the engine. Check the circuit to be measured for oil leak.
3. With the engine running at maximum rpm, operate the lever to relieve the cylinder.
4. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

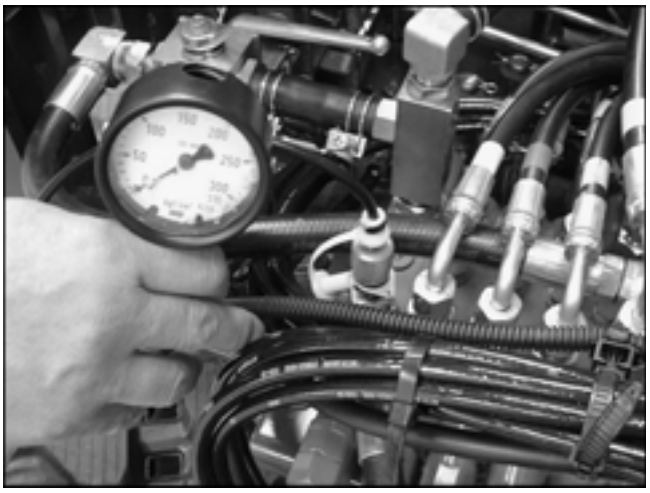
* Measure the pressure at oil temperature of 50±5°C.



Control valve section layout



(1) Rod
(2) Bottom
(3) Communicating valve
(4) Dozer
(5) Swing
(6) Swivel
(7) Spare
(8) Arm
(9) Travel left
(10) Travel right
(11) Boom
(12) Bucket



2) Adjusting procedure

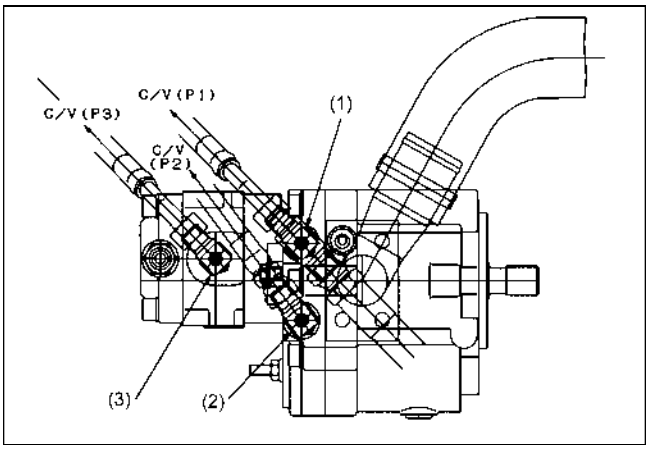
1. Loosen the lock nut of the relief valve.
2. Turn the adjusting screw with a hex wrench to set the pressure and tighten the lock nut after setting.

* Clockwise turning increases the pressure and counterclockwise turning decreases it.

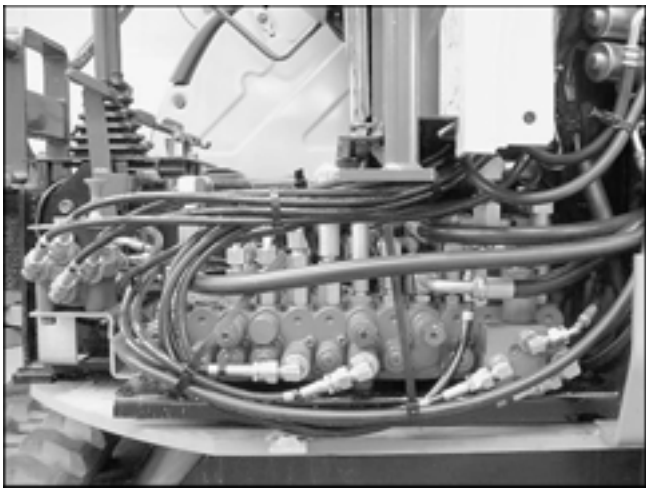
3. With the engine running at maximum rpm, operate the lever and check the set pressure.

[3] Overload relief pressure

Pump discharge side



(1)C/V(P1) (2)C/V(P2) (3)C/V(P3)

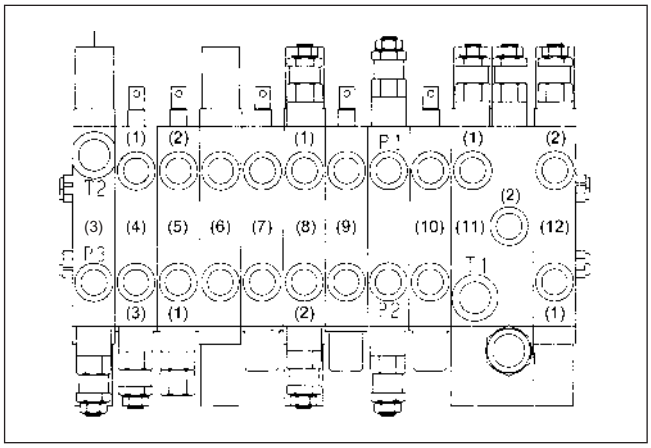


1) Measuring procedure (in tucking in the arm)

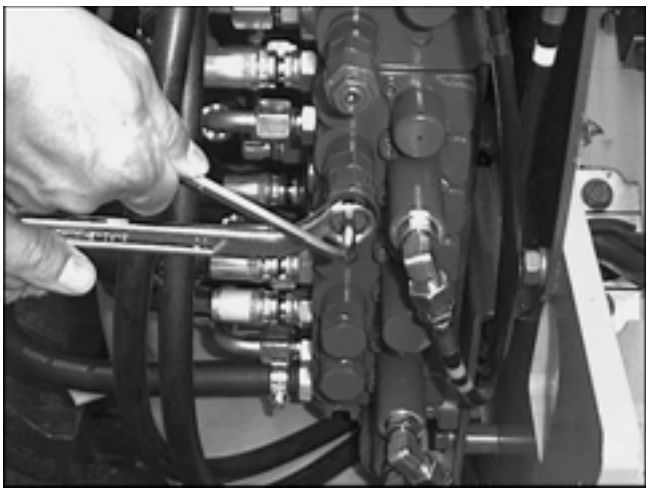
1. Remove the adaptor plug (2) (1/8) of main pump discharge side and connect thereto a pressured gauge.
2. Raise the set pressure of the main relief valve (P2) approx. 0.98 MPa (10 kgf/cm^2) higher than that of the overload relief valve.
3. With the engine running at maximum rpm, tuck in the arm, relieve the cylinder and measure the set pressure.
4. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.
5. After the measurement, return the pressure of the main relief valve to the original set value.

* Measure the pressure at oil temperature of 50±5°C.

Control valve section layout



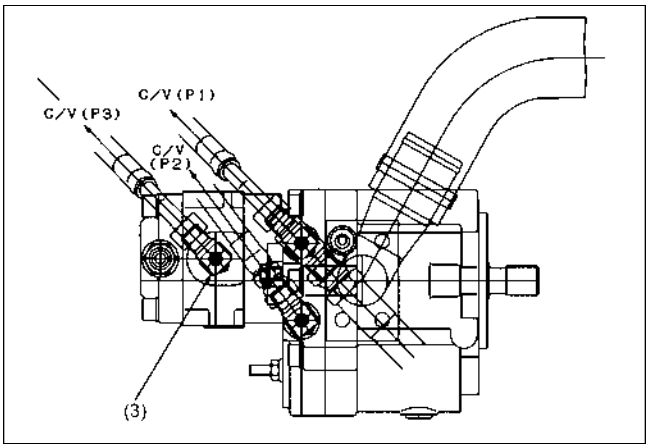
(1) Rod
(2) Bottom
(3) Communicating valve
(4) Dozer
(5) Swing
(6) Swivel
(7) Spare
(8) Arm
(9) Travel left
(10) Travel right
(11) Boom
(12) Bucket



2) Adjusting procedure

1. Loosen the lock nut of the overload relief valve, turn the adjusting screw with a hex wrench to set the pressure and tighten the lock nut after setting.
2. With the engine running at maximum rpm, operate the lever and check the set pressure.
3. After the measurement, return the pressure of the main relief valve to the original set pressure.

[4] Swivel brake pressure

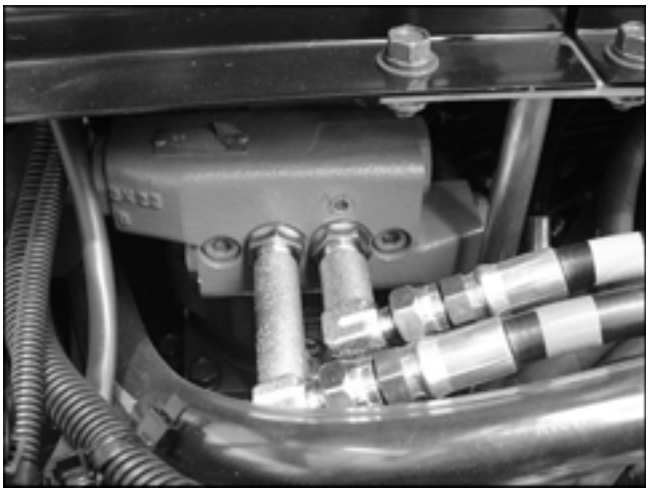


(3) P_3 discharge

1) Measuring procedure

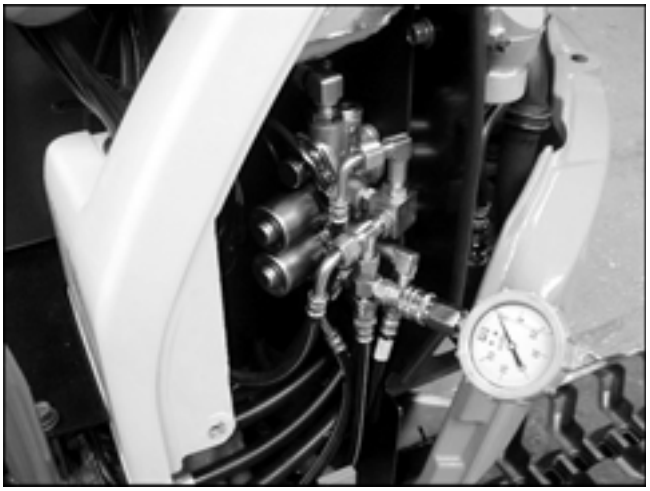
1. Remove the adaptor plug (P_3 discharge) of main pump discharge side and connect thereto a pressured gauge.
2. Support the bucket with a strongly-built stand.
3. Operate the swivel lever slowly and measure the brake valve relief pressure while operating the engine at maximum rpm.
4. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

* Measure the pressure at oil temperature of 50±5°C.



(4) Left swivel relief valve
(5) Right swivel relief valve

[5] Swivel brake release valve

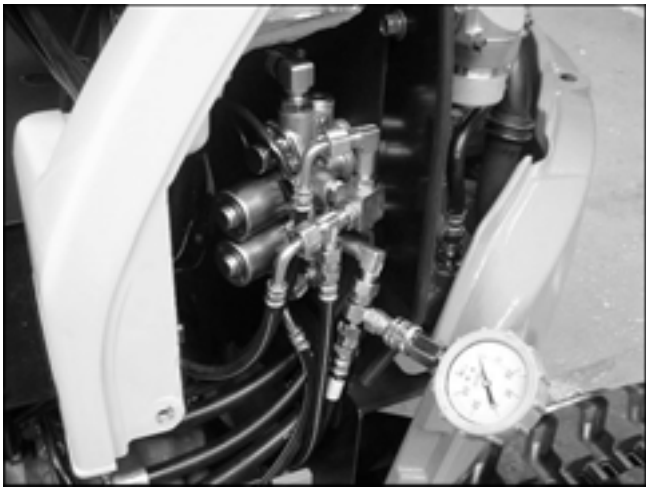


1) Measuring procedure

1. Stop the engine, disconnect the swivel brake release hose of the selector valve using a vacuum pump and set the pressure gauge.
2. With the engine running at maximum rpm, unlock the lever (to bring it to operating position) and measure the pressure.
3. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

* Measure the pressure at oil temperature of 50±5°C.

[6] Travel two-speed selector pressure



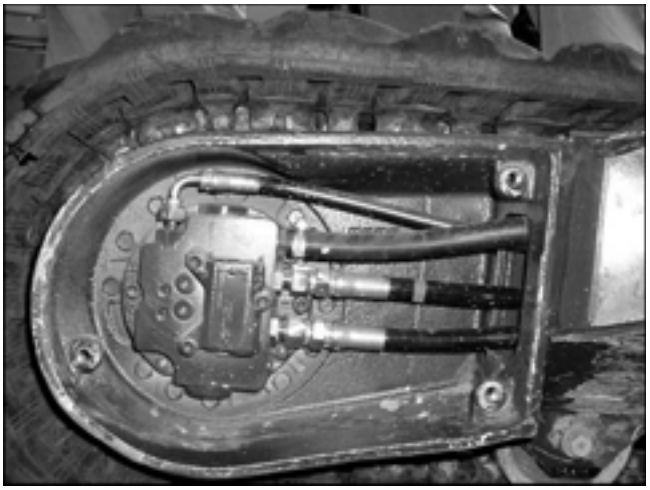
1) Measuring procedure

1. Stop the engine, disconnect the travel two-speed selector hose of the selector valve using the vacuum pump and set the pressure gauge.
2. With the engine running at maximum rpm, step on the two-speed pedal and measure the pressure.
3. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

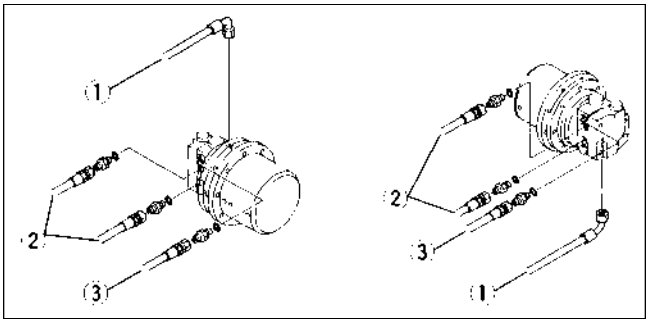
* Measure the pressure at oil temperature of 50±5°C.

c. Drain measurement

[1] Travel motor



(Travel left) (Travel right)



1) Measuring procedure

1. Disconnect the drain hose of the travel motor and plug the drain hose to prevent oil from flowing out of the tank.
2. Connect another hose (a vinyl hose for low pressure will do) to the travel motor drain port. (Photo: Left travel motor U25-3)
3. Lift up the crawler and bring it into measurable posture.
4. With the engine running at maximum rpm, rotate the crawler for 1 minute and measure the amount of hydraulic oil collected in a container
5. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

Caution:
Be very careful not to put your hands and feet under the crawler.

(1) Two-speed selector hose
(2) Travel forward/backward hose
(3) Motor drain hose

[2] Swivel motor

2) Measuring procedure

1. Disconnect the drain hose using the vacuum pump as shown in the photo.
2. Plug the tank-side hose which has been disconnected.
3. Dismount the vacuum pump.

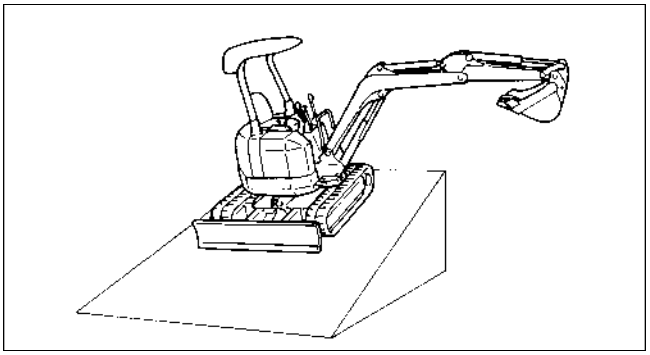
4. Bring the front attachment into travel posture and hold up the bucket 1 m above the ground.
5. With the engine running at maximum rpm, do the swiveling for 1 minute and measure the amount of oil collected in a container.
6. Repeat the pressure measurement 3 times, obtain the average and adopt it as measured value.

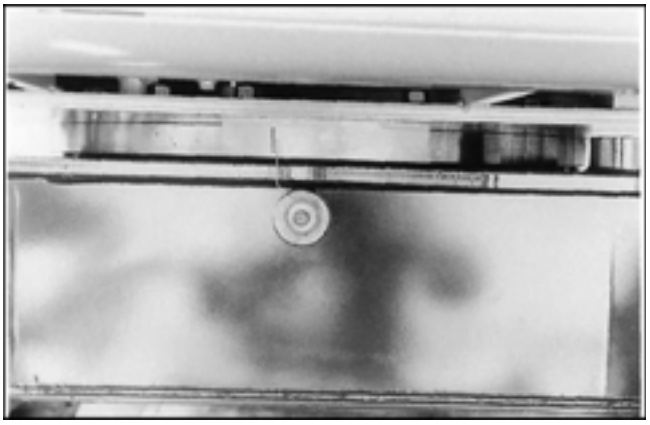
Caution:

Pay full attention to the surrounding during swiveling.

d. Measurement of block performance

[1] Swivel



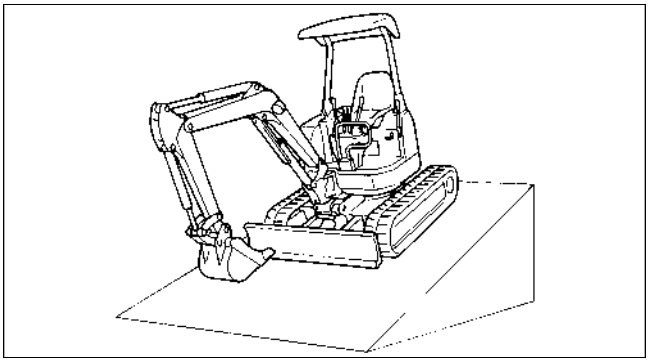


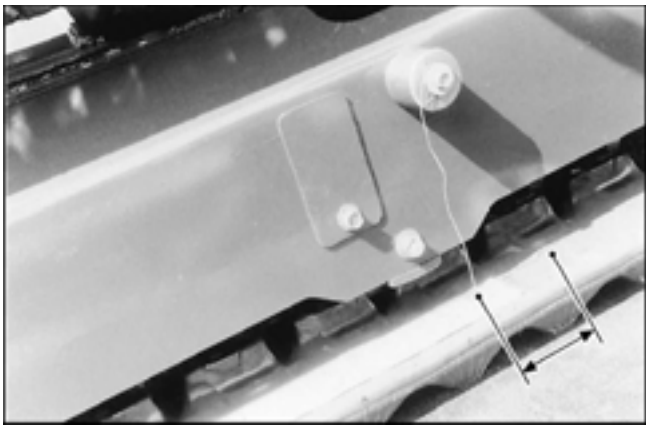
1) Measuring procedure

1. Park the machine on a 20-degree slope.
2. Bring the front attachments into such a posture that the arm is ready for dumping and the bucket is crowded, and hold the boom in line with the boom root pin and bucket pin.
3. Mark the swivel race outer ring and the lower frame and measure the displacement generated for 1 minute.
4. Start the engine, unlock the lever while idling and start the measurement.
5. A bucket load should be JIS crowded x specific gravity 1.8.
6. Conduct the measurement at hydraulic temperature of 50±5°C.
   Allowable range

On race periphery:	U20-3	131 ≧
	U25-3	140 ≧

[2] Travel





1) Measuring procedure

1. Park the machine on a 20-degree slope and bring the front attachments into traveling posture.
2. Mark the lower travel frame and the crawler and measure the displacement generated for 10 minutes.
3. Conduct the measurement at hydraulic temperature of 50±5°C.
   Allowable range

Crawler inside:	300 mm	≧

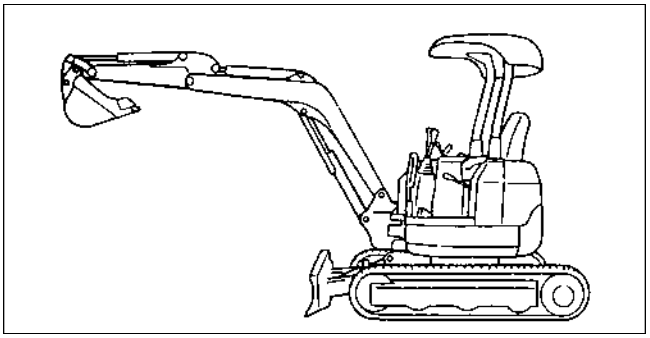
e. Operating speed

[Points]
(1) Measure the time required for full stroke with the standard front attachments without load.
(2) Repeat the measurement several times, obtain the average and adopt it as measured value.
(3) When two kinds of measured value such as for forward/backward and for right swivel/left swivel can be obtained, do not work out the average.
(4) Pay full attention to the surrounding.

[Conditions]
(1) The engine should be run at maximum rpm.
(2) The hydraulic oil temperature should be 50±5°C.
(3) Measurement should be done on a flat ground.
(4) Take the measurement after each operation has been done several times without load.

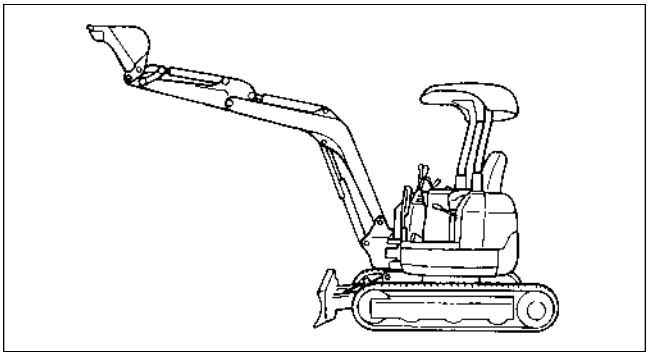
[1] Checking procedure of each speed

1) Gravity fall of cylinder



1. Place the machine on a level place. Crowd the bucket. (72 kg)
2. Fully retract the arm cylinder and fully extend the bucket cylinder.
3. Adjust the bucket bottom approx. 1 m above the ground.
4. Mark the boom, arm and bucket cylinder rods.
5. Measure the amount of gravity fall 10 minutes later, using a measuring scale.
   Hydraulic oil temp: 50±5°C

2) Boom cylinder



1. Fully retract the arm cylinder and bucket cylinder.
2. Operate the engine at maximum rpm.
3. Measure the time required for the movement from the ground to the cylinder end.
   Note: Cushion operating time is not included.

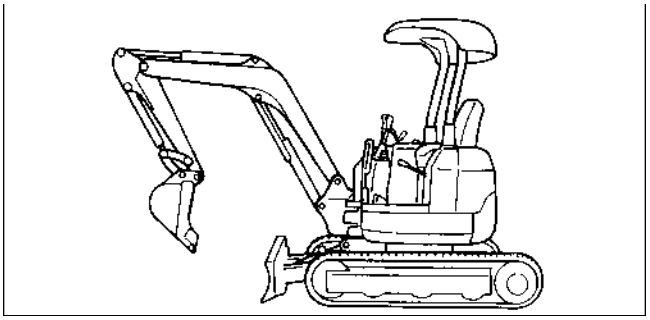
U20-3

Canopy	Extension 2.5 to 3.1 sec.	Retraction 2.6 to 3.2 sec.
Cabine	Extension 2.1 to 2.7 sec.	Retraction 2.2 to 2.8 sec.

U25-3

Canopy	Extension 2.1 to 2.7 sec.	Retraction 2.4 to 3.0 sec.
Cabine	Extension 2.1 to 2.7 sec.	Retraction 2.3 to 2.9 sec.

3) Arm cylinder



1. Bring the boom and arm into the postures as shown in the figure.
2. Operate the engine at maximum rpm.
3. Measure the time required for full stroke of the arm cylinder.

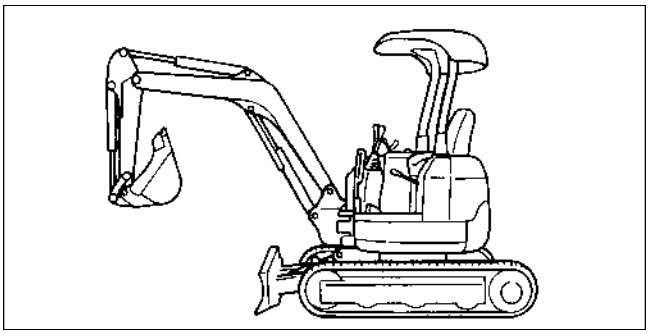
U20-3

Extension 2.3 to 2.9 sec.	Retraction 2.4 to 3.0 sec.

U25-3

Extension 2.2 to 2.8 sec.	Retraction 2.4 to 3.0 sec.

4) Bucket cylinder



1. Bring the boom and arm into the postures as shown in the figure.
2. Operate the engine at maximum rpm.
3. Measure the time required for full stroke of the bucket cylinder.

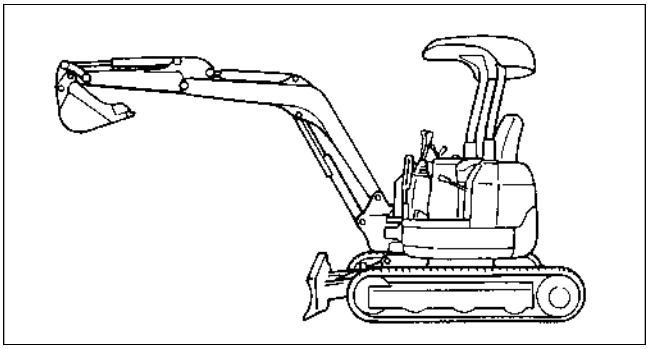
U20-3

Extension 2.9 to 3.5 sec.	Retraction 1.8 to 2.4 sec.

U25-3

Extension 2.7 to 3.3 sec.	Retraction 1.8 to 2.4 sec.

5) Swing cylinder



1. Bring the boom, arm and bucket into the postures as shown in the figure. (Keep the bucket bottom approx.1 m above the ground.)
2. Operate the engine at maximum rpm.
3. Measure the time required for full stroke of the swing cylinder (Right to left and let to right).
   Note: Cushion operating time is not included.

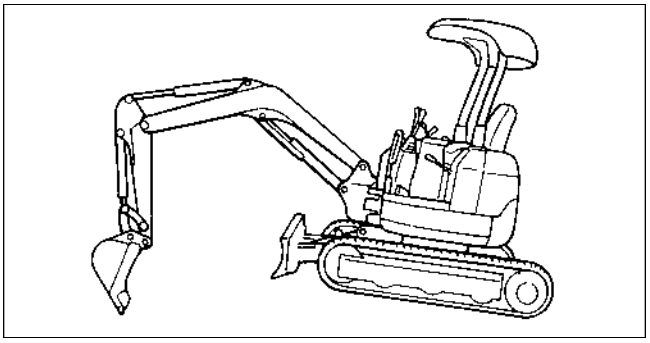
U20-3

Extension 4.8 to 5.8 sec.	Retraction 4.1 to 5.1 sec.

U25-3

Extension 4.1 to 5.1 sec.	Retraction 4.6 to 5.6 sec.

6) Dozer cylinder



1. Bring the bucket down to the ground in such a posture that the dozer can be operated at full stroke as shown in the figure.
2. Operate the engine at maximum rpm.
3. Measure the time required for full stroke of the dozer cylinder.

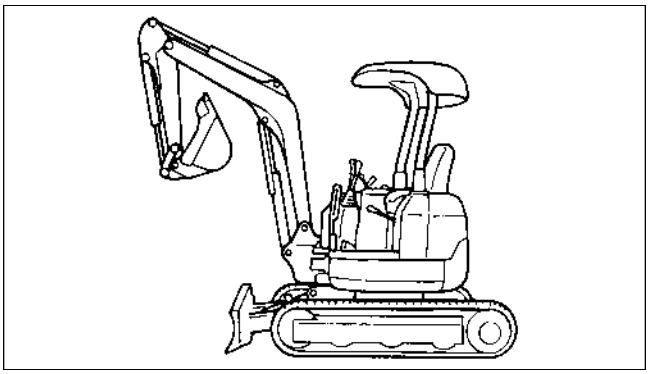
U20-3

Extension 3.0 to 3.6 sec.	Retraction 2.3 to 2.9 sec.

U25-3

Extension 2.3 to 2.9 sec.	Retraction 2.0 to 2.6 sec.

7) Swivel



1. Bring the front attachments into the posture as shown in the figure.
2. Operate the engine at maximum rpm.
3. Measure the time required for three turns.

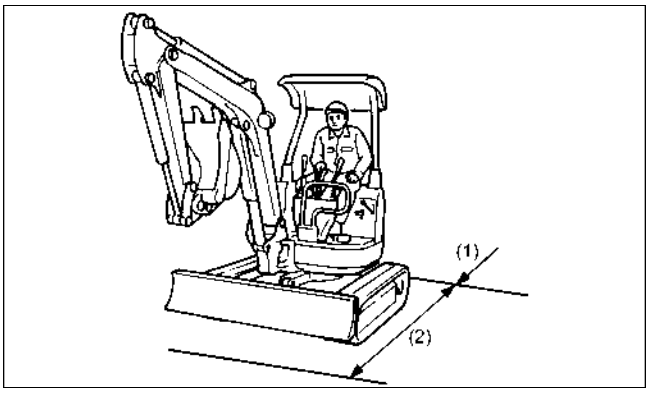
U20-3

Left/Right 18.4 to 22.5 sec.

U25-3

Left/Right 17.1 to 20.9 sec.

8) Travel



1. Bring the machine into traveling posture and run up the machine until each speed reaches the maximum.
2. Measure the time required for travel in 10 m distance.
   (1) Run-up
   (2) Distance for measurement (10 m)
   * Rubber crawler type

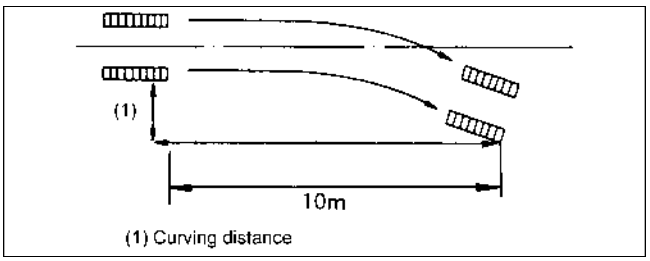
U20-3

1F	2F
15.0~18.0 sec.	7.8~9.5 sec.

U25-3

1F	2F
12.8~15.7 sec.	7.2~8.8 sec.

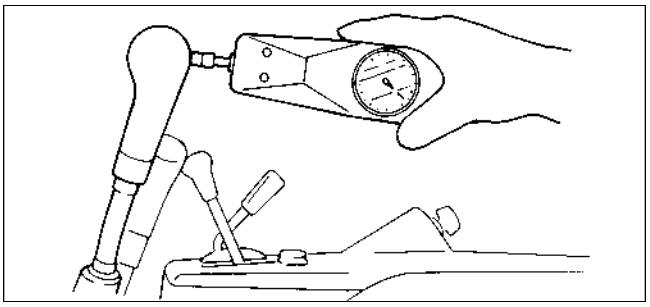
f. Straight travel performance



1. Bring the machine into traveling posture. With the engine running at maximum rpm, move the lever for full stroke to run the machine in 10 m distance.
2. Measure the error from the track as viewed above from the straight line.

600mm ≧

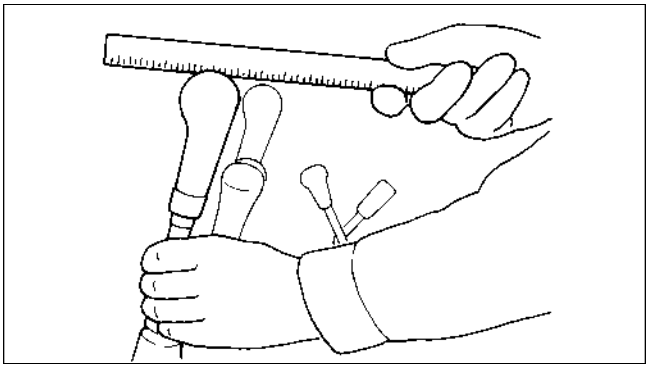
g. Control and Traveling lever operating force



1. Conduct measurement with regard to the right and left levers.
2. Start the engine, move the levers for full stroke and measure the maximum operating force in relief state.
3. Repeat the measurement 3 times, obtain the average and adopt it as measured value.

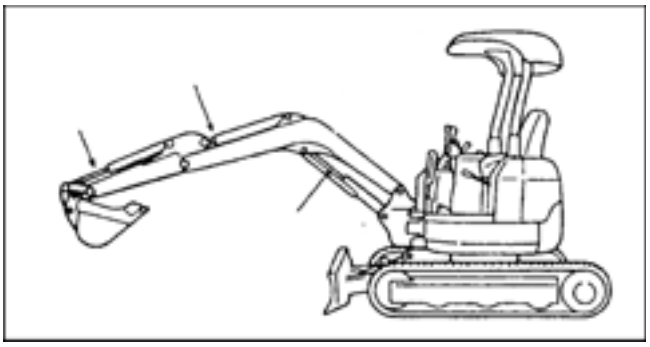
* Conduct measurement at oil temperature of 50±5°C.

h. Control and Traveling lever stroke



1. Stop the engine.
2. Move each of the travel, boom, arm, bucket and dozer control levers from neutral to full stroke end and measure their strokes at the top center of each lever grip.
3. If any of the levers is out of position, measure the stroke from its loose end.
4. Conduct the measurement along a straight line.
5. Repeat the measurement 3 times, obtain the average and adopt it as measured value.

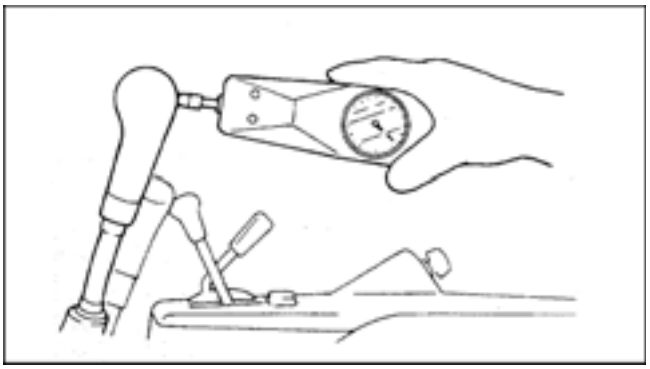
i. Cylinder natural fall amount



1. Locate the machine on the flat ground, and put the load the bucket.
   Load on the bucket should be as follows.
   U20-3: 280 kg - include bucket weight
   620 lbs - include bucket weight
   U25-3: 285 kg - include bucket weight
2. Arm cylinder must be fully retracted. Bucket cylinder must be fully extended.
3. Locate the bottom of bracket about 1 m above from the ground. Stop the engine.
4. Mark on the rod of each cylinder.
5. Measure the fall distance after 10 min.

Reference Value	See IV-S-24

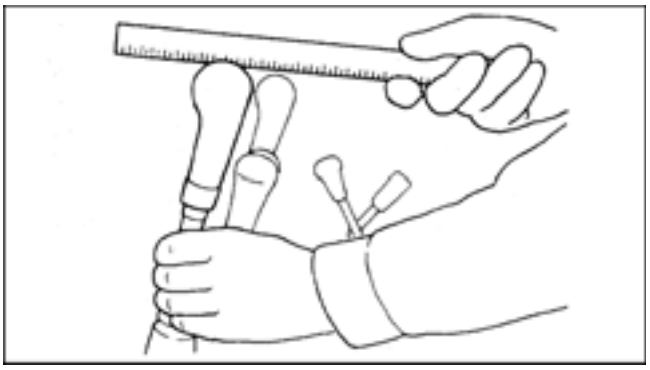
j. Control and Traveling lever operating force



1. Stop the engine.
2. Measure force of right and left control and traveling levers.
3. Start the engine, operate the control lever or traveling lever for a full stroke, and measure the max. operating force.
4. Make three measurements and take their average.
5. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference Value	See II-S-4

k. Lever stroke



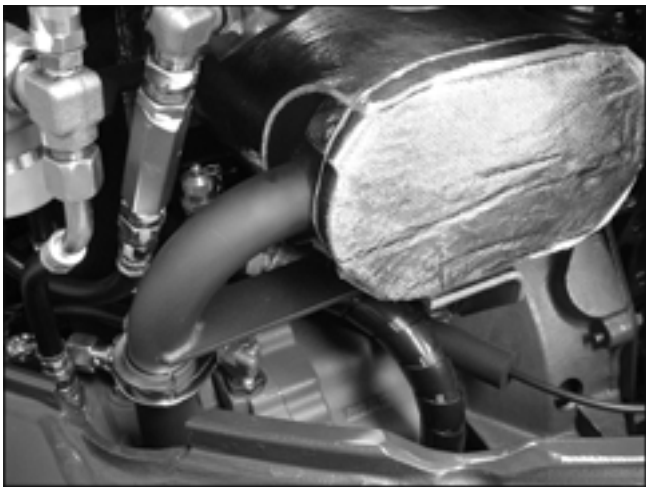
1. Stop the engine.
2. Move each lever from neutral to full stroke end, and measure each stroke with respect to the top center of the each lever grip.
3. If any lever is loose at its neutral position, measure the stroke from each loose end.
4. Make three measurements and take their average.

Reference Value	See II-S-4

D.Disassembling and Assembling

a. Pump

[1] Pump coupling



1) Disassembling the pump

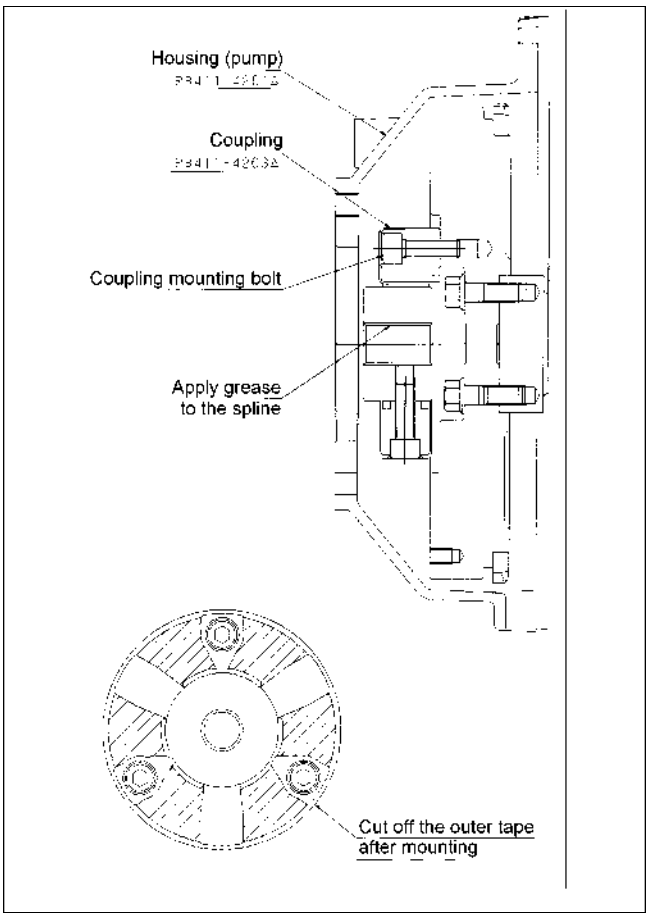
1. Bring the attachments down to the ground and stop the engine.

2. Open the bonnet, remove the bonnet left cover and dismount the muffler.

3. Mount a vacuum pump and disconnect the hydraulic hose and suction hose from the pump.

4. Remove the two pump mounting bolts.
   Tightening torque of bolt:
   77.5 ~ 90.2N·m (7.9~9.2kgf·m)

5. Pull the pump assembly toward the counterweight, separate it from the pump coupling and dismount it.



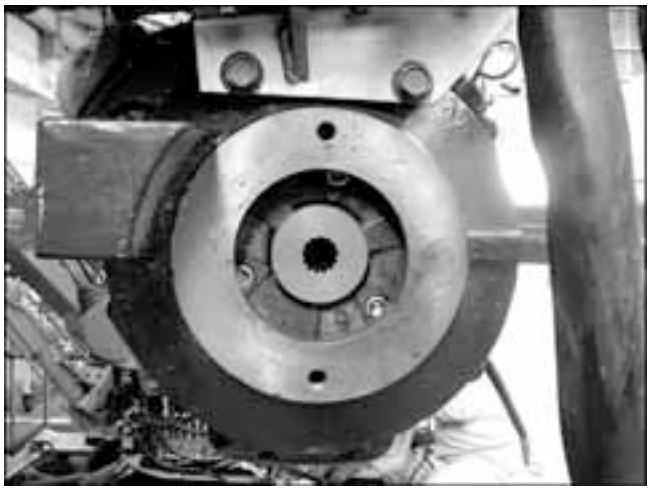
2) Reassembling procedure

1. Apply an appropriate amount of grease to the spline before mounting the pump.

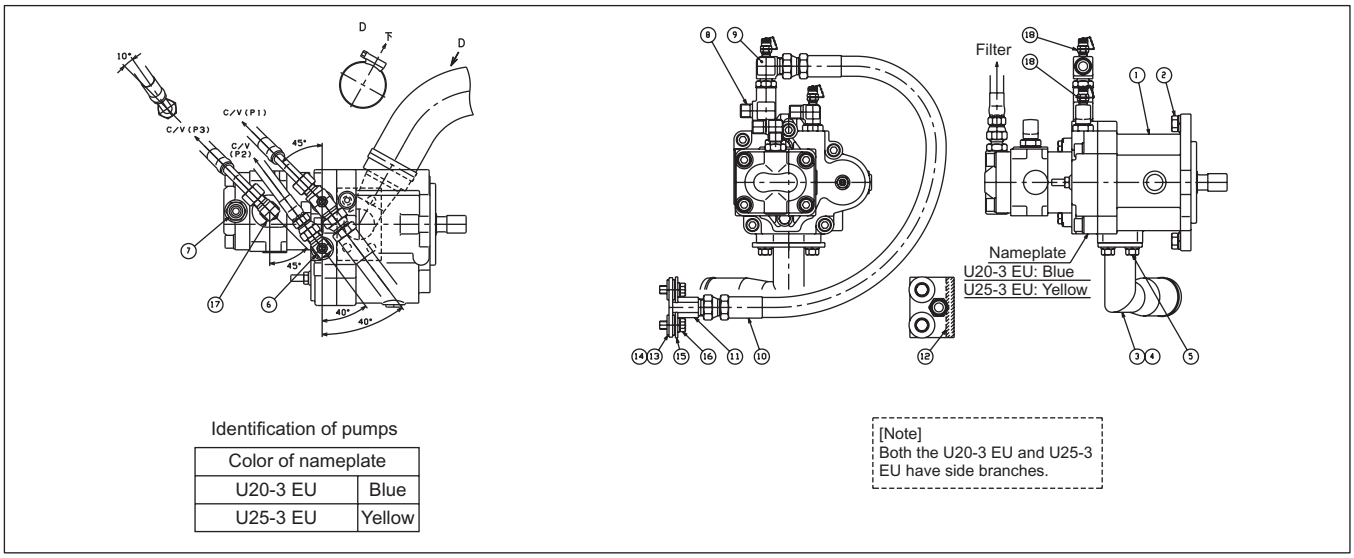
CAUTION:
Do not allow grease onto the rubber parts. Rubber may be deteriorated.

2. Tightening torque of coupling mounting bolt: 48.1-55.9N·m(4.9 ~ 5.7kgf·m)

CAUTION:
Do not apply screw LOCTITE. Rubber may be deteriorated.



[2] Mounting and dismounting the pump



Identification of pumps

Color of nameplate	
U20-3 EU	Blue
U25-3 EU	Yellow

2) Reassembling procedure

1. Hydraulic adaptor mounting direction and angle.
   Mount it as shown at left.

CAUTION:
There should be no close contact with other parts in the hose line.

2. Tightening torque of hydraulic adaptor:
   G3/8 49.0~53.9N·m(5.0~5.5kgf·m)

No.	Part No.	Part name	Q'ty	Remarks
1	RB411-6111Δ	Pump assembly	1	U20-3 EU(blue)(611)
	RB511-6111Δ	Pump assembly	1	U25-3 EU(yellow)
2	01133-61230	Bolt	2	M12×1.25 7T
3	RB411-6317Δ	Flange (suction)	1	
4	04811-10440	O-ring	1	
5	01123-61020	Bolt	4	M10×1.5 7T
6	RB201-63881	Elbow pipe joint (F3x2-T1)	1	P2
7	68311-64321	Straight pipe joint	1	P4
8	RB511-6398Δ	T pipe joint (3-3-3)	1	P1
9	RB511-6399Δ	Elbow pipe joint (3-4-25)	1	P1
10	RB511-6397Δ	Hydraulic hose (5/8)	1	
11	RB511-6396Δ	Plug (G1/2, hose)	1	
12	RB511-6394Δ	Cushion (plug)	1	
13	68551-51251	Cushion	2	
14	RB511-6395Δ	Collar	2	
15	04015-60100	Plain washer	2	
16	01133-61025	Bolt	2	
17	PR201-6181Δ	Pipe joint (L. G3/8-03/8)	1	P3
18	RG908-8644Δ	ADAPTER	2	R1/7 P1·P2
	04810-00140	O-ring		for 3/8

[3]Component parts of pump

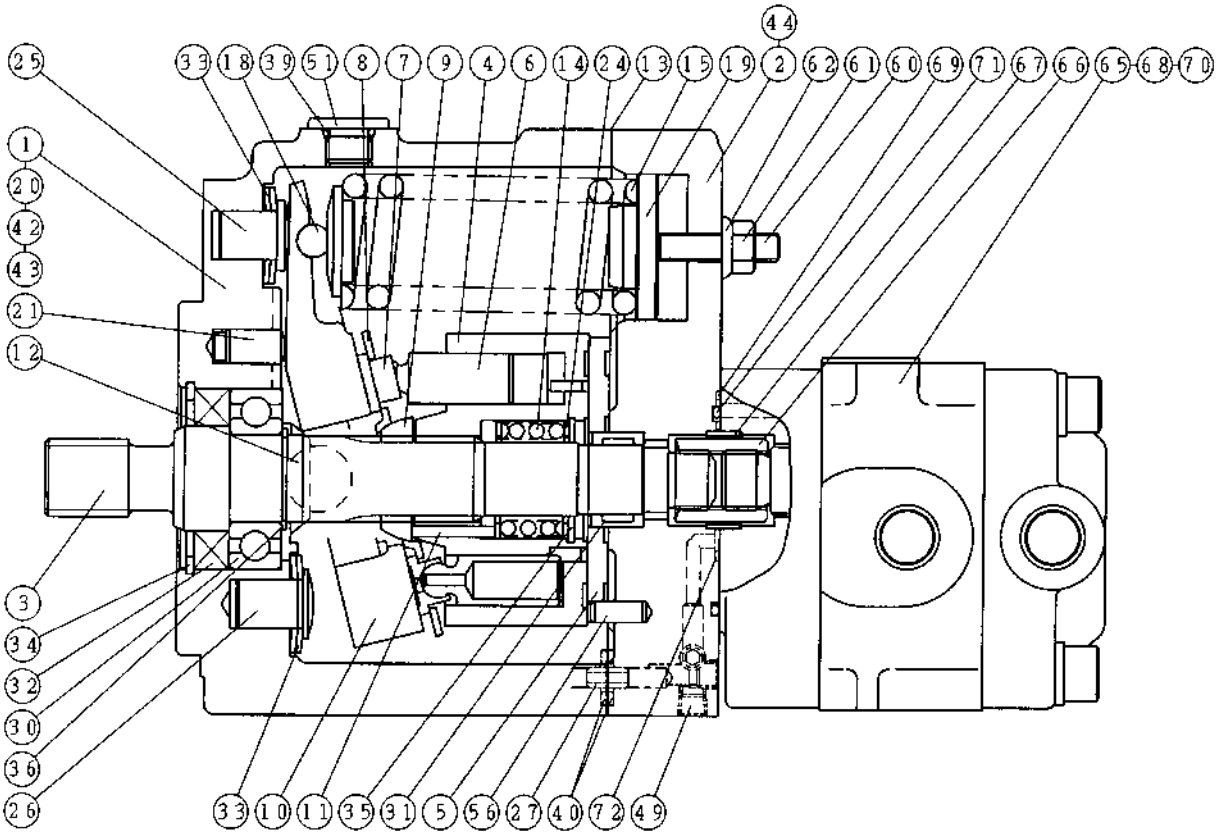


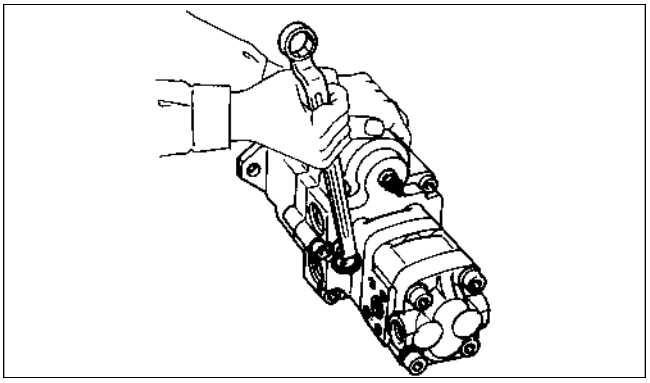
Fig. 2 Construction of Hydraulic Pump

No.	Part name	Q'ty	No.	Part name	Q'ty	No.	Part name	Q'ty	No.	Part name	Q'ty
1	Body S	1	21	Rod G	1	41	None		61	Hex nut	1
2	Body H	1	22	None		42	Plug	1	62	Sealing washer	1
3	Shaft	1	23	None		43	O-ring	1	63	None	
4	Cylinder barrel	1	24	Retainer	2	44	Hex socket bolt	5	64	None	
5	Valve plate	1	25	Stopper pin A	1	45	None		65	Gear pump	1
6	Piston	10	26	Stopper pin B	1	46	None		66	Coupling	1
7	Shoe	10	27	Pin with hole	1	47	None		67	Collar	1
8	Shoe holder	1	28	None		48	None		68	Hex bolt	2
9	Barrel holder	1	29	None		49	Hex socket plug	5	69	O-ring	1
10	Swash plate	1	30	Ball bearing	1	50	None		70	Washer	2
11	Needle	3	31	Needle bearing	1	51	Plug	1	71	O-ring	1
12	Rocking pin	2	32	Oil seal	1	52	None		72	O-ring	1
13	Packing	1	33	Plate spring	4	53	None				
14	Spring C	1	34	Snap ring	1	54	None				
15	Spring T1	1	35	Snap ring	1	55	None				
16	None		36	Snap ring	1	56	Spring pin	1			
17	None		37	None		57	None				
18	Spring holder	1	38	None		58	None				
19	Spring guide	1	39	O-ring	1	59	None				
20	Pin	1	40	O-ring	2	60	Hex socket lock screw	1			

[4]Disassembling and reassembling the pump.

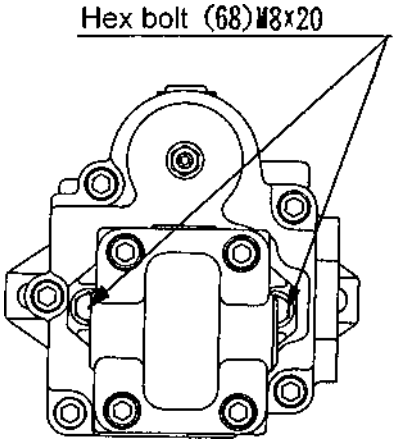
General precautions

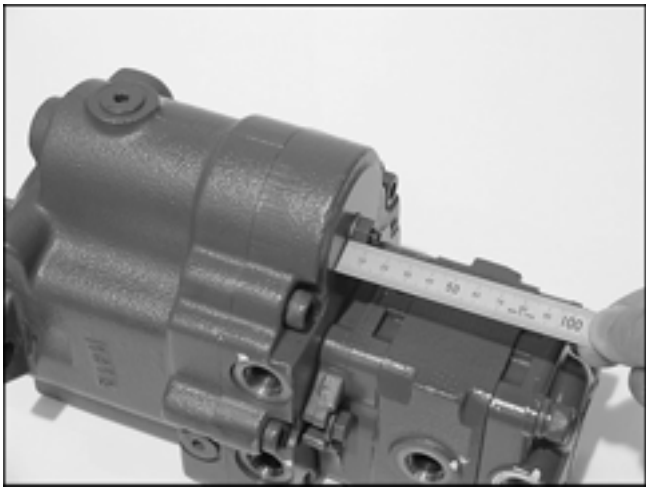
After draining the oil out of the pump, first clean up the pump. Lay clean paper, cloth or rubber sheet on the workbench and place the pump on them. Disassembly and reassemble the pump with care using necessary tools. Take proper measures against scratches, foreign matters and other troubles.



1) Disassembling

1. Dismounting the gear pump
   Remove the two M8x25 hex bolts (68).

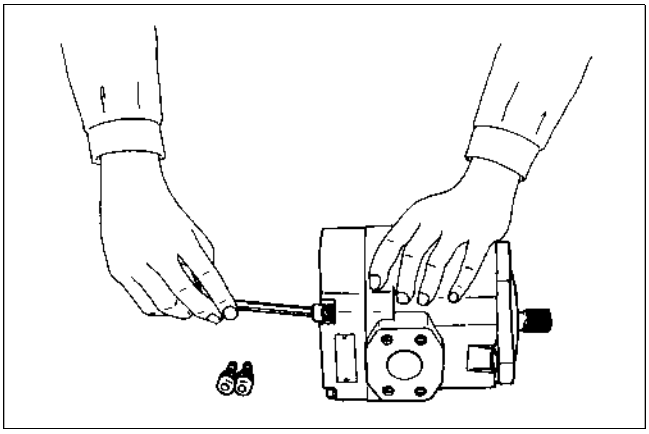




2. Removal of hex socket lock screw
   Loosen the hex nut (61) completely and remove the hex socket lock screw (60).
   Tools: Wrench 13 mm, hex wrench 4 mm

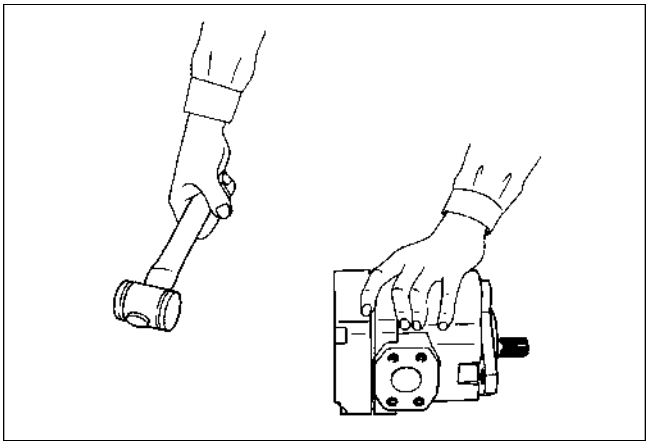
Supplement:

Preferably record the stretch-out distance of this hex socket lock screw, and it will facilitate pressure adjustment after reassembly.

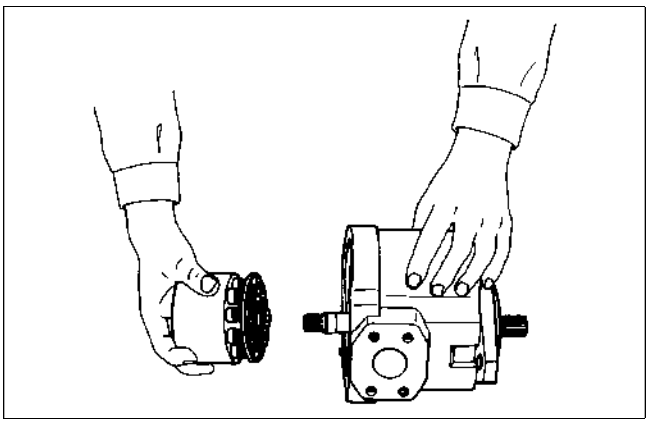


3. Separating the body S from the body H

Remove the upper two of the five M10x35 hex socket bolts (44).
Tool: Hex wrench 8 mm
Temporarily tighten the two M10x65 bolts about 10 mm deep to this position and slowly tighten the remaining three bolts.
Next, loosen the former two temporary bolts and separate the body S kit.



The body can be separated easily by tapping on the spring inserting part of the body H with a plastic or copper hammer.

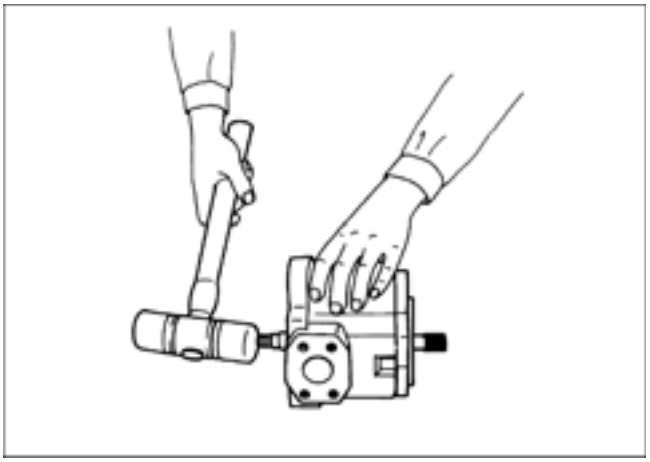


4. Disassembling the body S kit

Take the following parts out of the body S kit in this order: spring T (15), spring holder (18), cylinder barrel (4), swash plate (10), rocking pin (12), stopper pin A (25), two plain springs (33), stopper pin B (26), two plate springs (33) and rod (21).

5. Dismounting the oil seal

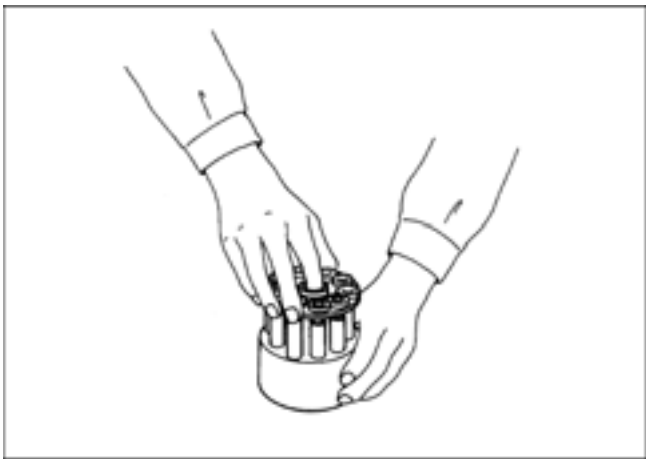
Remove the snap ring (34) provided at the drive shaft (3) from the body S.



Using a plastic hammer, tap on the opposite end of the shaft, and the oil seal (32) and the shaft (with bearing (30)) can be removed.

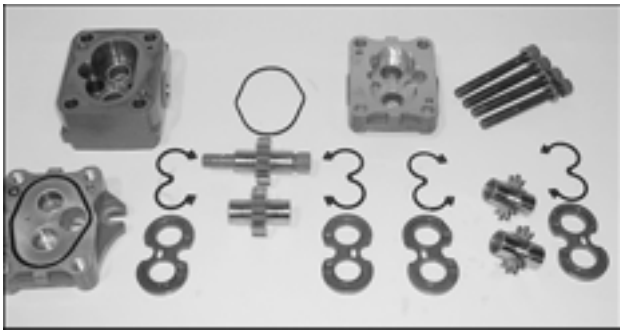
6. Disassembling the body H kit

When the hex socket lock screw (60) is screwed in the hex socket lock screw hole of the body H (2), the spring guide (19) can be taken out.



7. Disassembling the cylinder barrel kit

Remove the shoe holder (8), to which the piston shoe assemblies (6) and (7) are mounted, out of the cylinder barrel kit, and dismount the barrel holder (9) and needle valve (11) in this order.
Then, remove the snap ring (35), retainer (24), spring C (14) and retainer (24), in this order, out of the cylinder barrel (4).

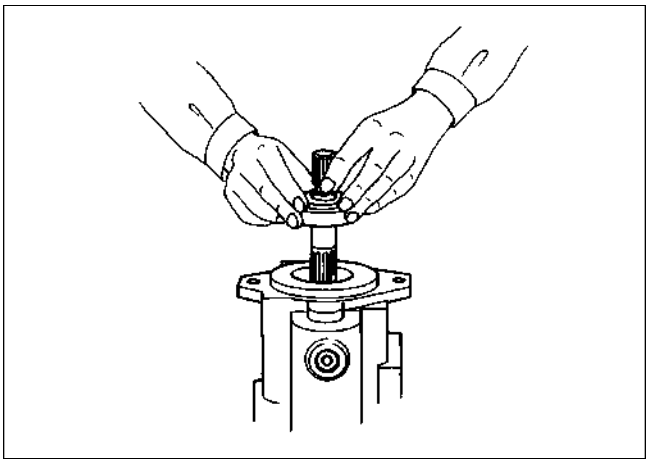


2) Reassembling

Reassembling precautions

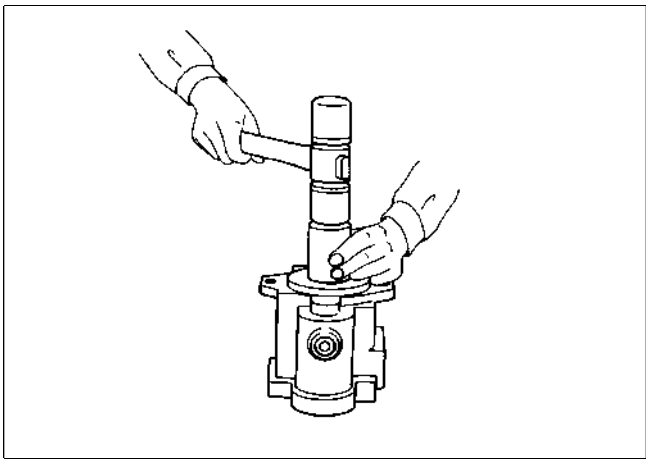
The parts are reassembled in the reverse order of being disassembled. Wash the parts with clean washing oil and handle them with due care not to allow dust deposits and foreign matters as well as not to damage the sliding faces of parts during assembly work.

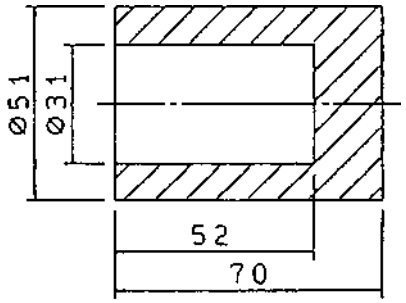
* To protect the outer surface of the O-ring to be fitted to the spigot joint, apply a small amount of grease.



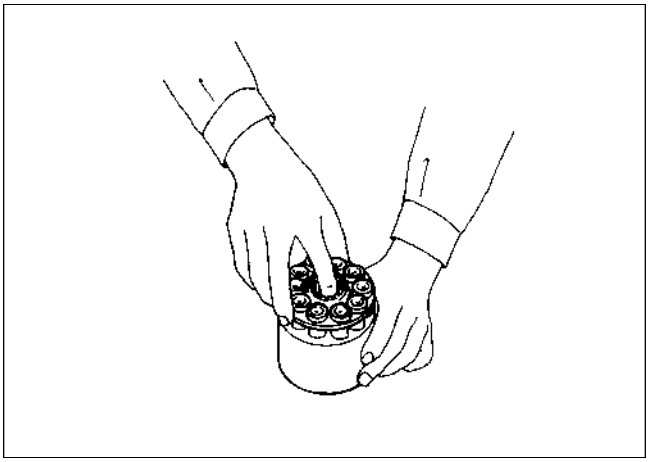
1. Assembling the oil seal

   Assemble the shaft (3) kit, oil seal (32) and snap ring (34) in this order into the body S (1). Apply a small amount of grease to the lip and outer surface of the oil seal, and mount the oil seal using a specific tool and tapping with a hammer.
   (At this time, replace the oil seal with new one.)
   Temporary mounting of the body S (1) on the body H (2) facilitates the work.



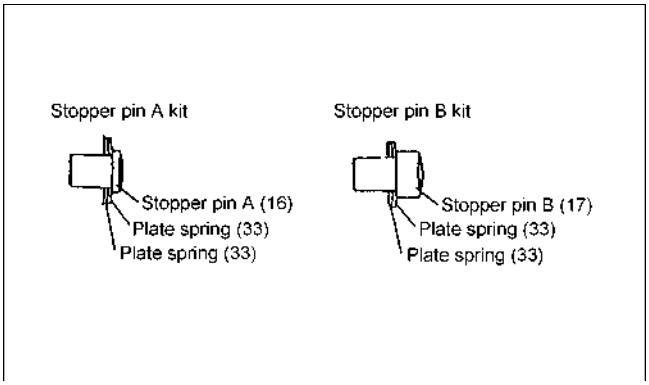


Oil seal insertion tool



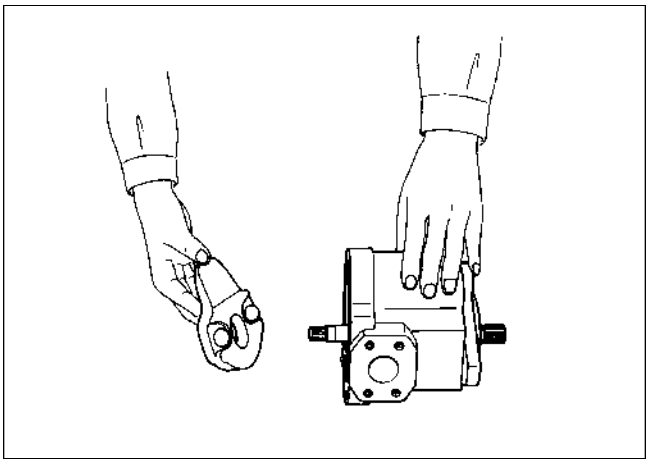
2. Assembling the cylinder barrel kit

   Assemble the retainer (24), spring C (14), retainer (24) and snap ring (33), in this order, into the shaft hole of the cylinder barrel (4), and carefully assemble the needle (11), barrel holder (9) and shoe holder (8) in which ten pistons and shoe assemblies are fitted.



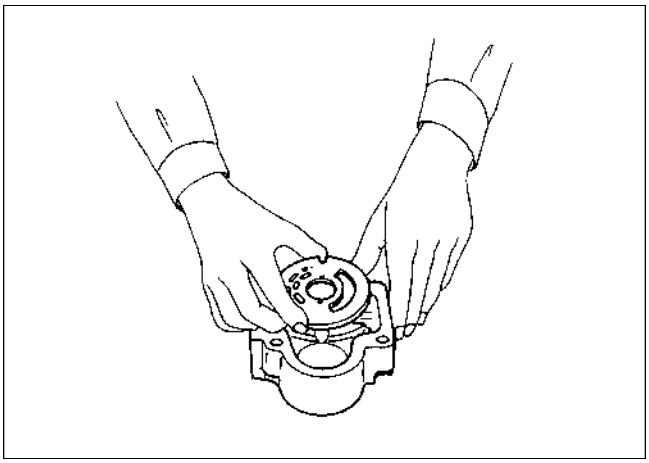
3. Assembling the stopper pin A and B kits

Assemble the two plate springs (33) to the stopper pin A (25) to form the stopper pin A kit. Similarly, assemble the two plate springs (33) to the stopper pin B (26) to form the stopper pin B kit.
At this time, use care not to confuse the plate spring mounting direction. Mount it in the manner as shown in Fig.5.



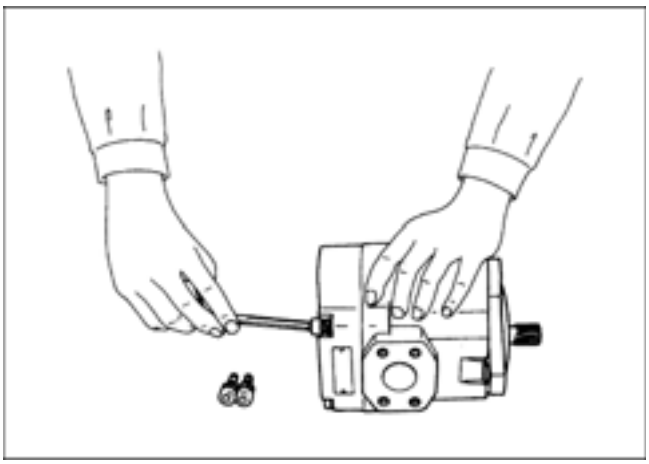
4. Assembling the body S kit (Photo 11)

Assemble the stopper pin A kit, stopper pin B kit and rod (21) to the body S, and then insert the rocking pin (12) into the hole of the swash plate (10) and mount them into the hole of the body S (1).
Next, mount one spring T (15) to the spring holder (18) and set the spherical portions of the spring holder (18) into the holes of the swash plate (10).



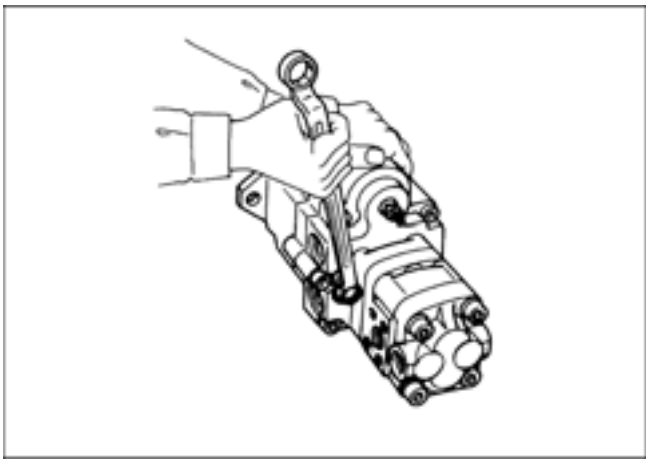
5. Assembling the body H kit (Photo 12)

Mount the spring holder (18) to the body H (2). Then, position the valve plate (5) by the spring pin (56) of the body H (2) and gently mount it in place.
The cylinder barrel (4) slides over the surface of the valve plate having fine grooves. Use care not to confuse the mounting direction.



6. Assembling the body S kit and body H kit (Photo 13)

Mount the packing (13) to the mating face of the body S (1) with use of the positioning pin (27).
At this time, replace the packing with new one.
Place the two M10x6.5 hex socket bolts for temporary mounting to the upper side and tighten them slowly.
When the clearance between the mating faces becomes 5 to 10 mm, replace with the five M10x35 hex socket bolts (44) and fix them firmly.
Tool: Hex wrench 8 mm
Tightening torque: 5.2 ~ 6.6 kgf·m



7. Mounting the hex socket lock screw
   Secure the hex socket lock screw (60) and the hex nut (61) to achieve the same length as before disassembly.
   (Wrench “13”, hex wrench “4”)

8. Mounting the gear pump
   Assemble the collar (67), coupling (66) and O-rings (71) and (72) to the gear pump joint of the piston pump kit, and mount the gear pump with the two M8x20 hex bolts (68) and the polished washer (70).
   (Closed wrench “13”)
   Tightening torque: 1.0 ~ 1.4 kgf·m

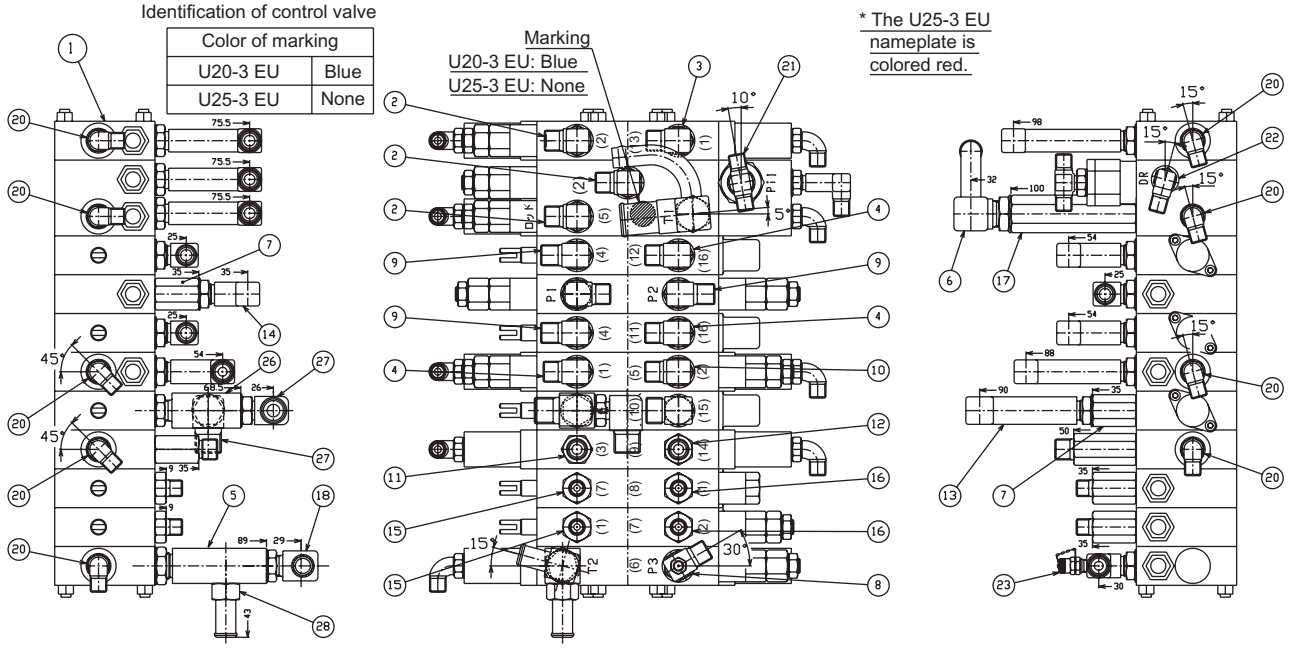
9. Checking after assembly
   The above completes the reassembly work. Turn the shaft and check to see if it turns smoothly.

[5]Troubleshooting of pump

Trouble	Cause	Remedy
1. Engine is overloaded.	(1) Engine rpm higher than specified. (2) Pressure higher than specified. (3) Pump internal parts seized or broken.	(1) Readjust as specified. (2) Readjust as specified. (3) Repair or replace the pump.
2. Pump oil amount drops extremely. Discharge pressure does not rise.	(1) Engine rpm drop. (2) Pump mounting coupling defective. (3) Pump internal parts seized or broken.	(1) Readjust the rpm. (2) Repair or replace the pump coupling. (3) Repair or replace the pump.
3. Unusual noise or vibrations (Cavitation)	(1) Air or water mixed in hydraulic oil. (2) Suction strainer clogged. (3) Suction pipe clogged or choked. (4) Attached pump in trouble (if it is attached.) (5) Caulking of piston shoe broken. (6) Pump mount loose. (7) Coupling defective.	(1) Repair the circuit. Retighten the suction pipe in particular. Replace if mixed with water. (2) Wash or replace the suction strainer. (3) Repair the suction pipe. (4) Repair or replace the attached pump. (5) Replace the piston assembly. (6) Mount the pump firmly. (7) Replace the coupling.
4. Oil leak	(1) O-ring or seat packing defective. (2) Cap ring in poor contact. (3) Oil leak from oil seal edge.	(1) Replace the O-ring or seat packing. (Fit it correctly.) (2) Retighten to the specified torque. (3) Replace or repair the oil seal and shaft.

b. Control valve

[1] Mounting and dismounting the valve



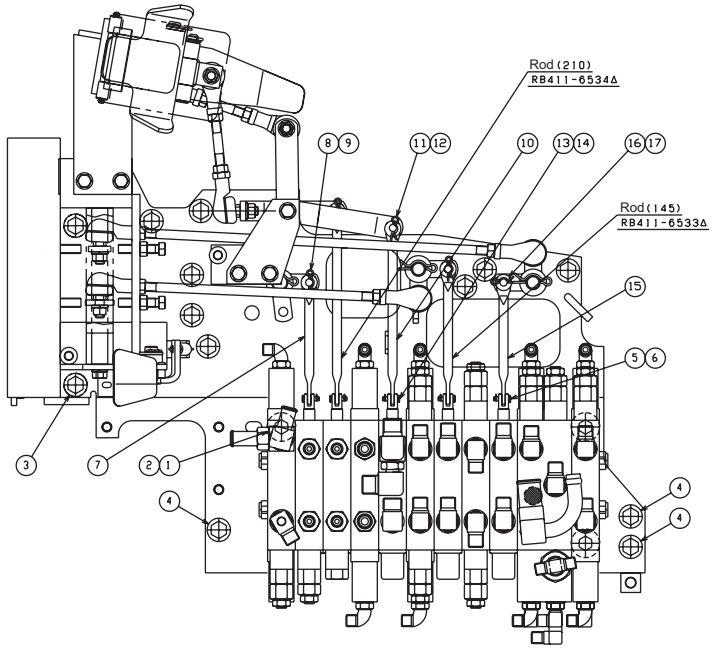
(1) Rod (2) Bottom (3) Left
(4) Back (5) Boom (6) Communicating valve
(7) Dozer (8) Swing (9) Swivel
(10) Service (11) Travel Left (12)Travel right
(13) Bucket (14) Right (15) High
(16) Front

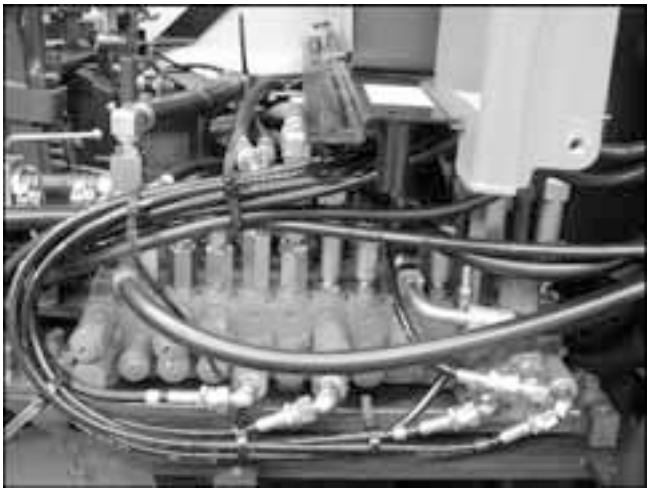
(1) Mount each rod and control valve as shown in the figure.
(2) Tightening torque of control valve mounting bolt (1):
48.1 ~ 55.9 N-m (4.9 ~ 5.7 kgf m)
(3) Tightening torque of bracket (control valve) mounting bolt (4):
77.5 ~ 90.2 N-m (7.9 ~ 9.2 kgf m)

No.	Part No.	Part name	Q'ty	Remarks	
1	RB411-6115Δ	Valve, assembly (Control)	1	U20-3 EU (Blue)	(612)
	RB519-6115Δ	**Valve, assembly (Control)**	1	**U25-3 EU (None)**	(612)
2	RB411-6401Δ	Elbow pipe joint (3-3-75)	3		(612)
3	RP301-68161	Pipe joint (L. G3/8-G3/8)	1		(612)
4	68881-34933	Flange-faced elbow	3		(612)
5	RB419-9251Δ	**Pipe joint (T. G1/2-G3/8)**	1	T2	(612)
6	RB411-6390Δ	Valve, assembly (Check)	1	T1	(612)
7	RB411-6403Δ	Straight pipe joint (3-3-35)	1	P1	(612)
8	RB419-63861	**Pipe joint (L. G3-G3-R1)**	1	P3	(612)
9	RP201-61812	Pipe joint (L. G3/8-G3/8)	3	Travel right back, P2, travel left back	(612)
10	68191-61831	Pipe joint (L. F3/8-H3/8)	1		(612)

No.	Part No.	Part name	Q'ty	Remarks	
11	RB301-63812	Pipe joint (S. G3/8-G3/8)	1	Swivel left	(612)
12	RB411-6395Δ	Straight pipe joint (3-3-65)	1	Swivel right	(612)
13	RC411-63961	Pipe joint (L. G1/2-G3/8)	1		(648)
14	RB401-64081	Pipe joint (L. G3-G3)	1	P1	(612)
15	06112-52037	Straight pipe joint	2		(612)
16	RB101-63811	Pipe joint (S. F3/8-F1/4)	2		(612)
17	RB411-6397Δ	Straight pipe joint (4-4-100)	1	T1	(612)
18	RB419-9253Δ	**Pipe joint (L. G3/8-16)**	1	T2	(612)
19	None				(612)
20	RB411-6376Δ	Pipe joint (L. G1/4-G1/4)/Pilot	9		(612)
21	RC101-63821	T-pipe joint (F2)	1	P11	(612)

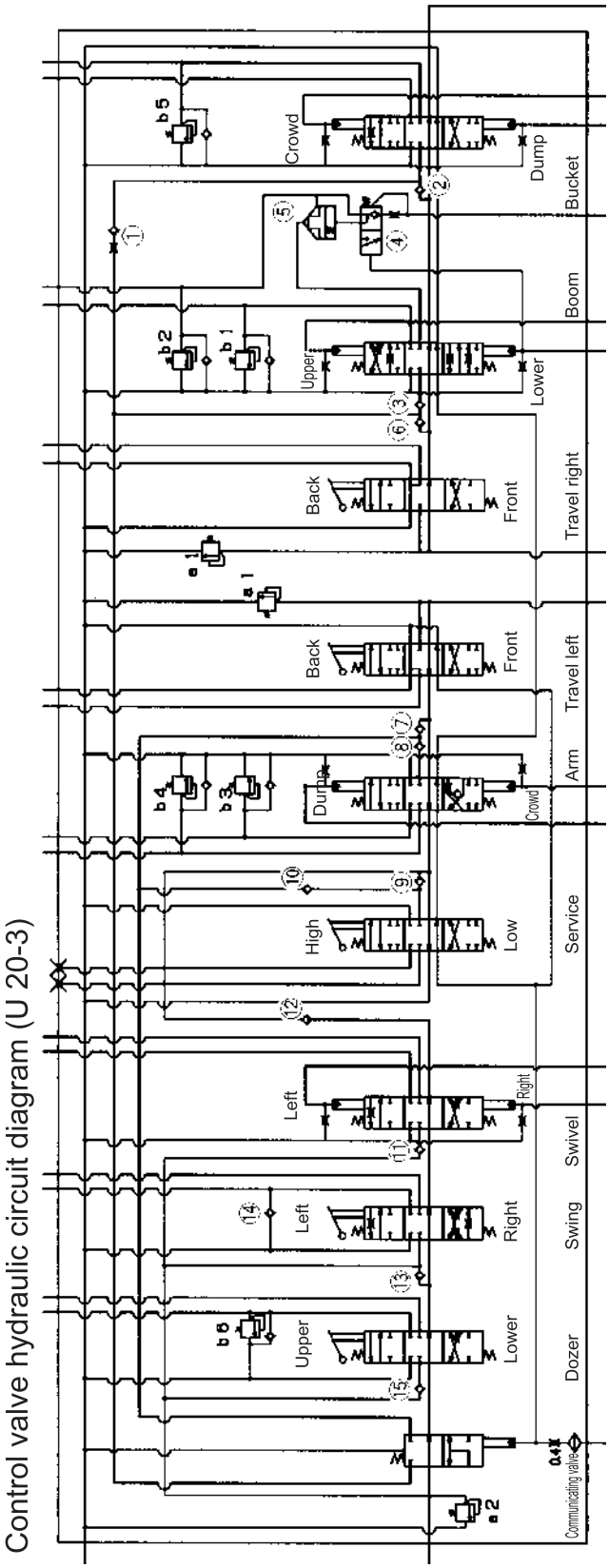
No.	Part No.	Part name	Q'ty	Remarks	
22	68591-63231	Flange-faced elbow	1	DR	(612)
23	RG908-86443	ADAPTER	1		(612)
24	None				
25	None				
26	RB419-9252Δ	**Pipe joint (T. G3/8)**	1		(648)
27	RD118-94891	**Pipe joint (L. G1/2-G3/8)**	2		(648)
28	RP401-61831	**Pipe joint (S. G3/8-16)**	1	T2	(612)





No.	Part No.	Part name	Q'ty	Remarks
1	01123-61020	Bolt	3	M10×1.5 7T
2	04015-60100	Plain washer	3	U25-3 EU (None)
3	01135-61235	Bolt	10	M12×1.25 7T
4	01135-61255	Bolt	3	M12×1.25 7T
5	68021-32792	Pin	4	
6	05525-50500	Snap pin	4	
7	RB411-6539Δ	Rod (130)	1	Dozer
8	04013-60080	Plain washer	1	
9	05525-50800	Snap pin	1	
10	RB411-6537Δ	Rod (190)	1	Service port spec.
11	04013-60080	Plain washer	1	
12	05525-50800	Snap pin	1	
13	68021-32792	Pin	1	
14	05525-50500	Snap pin	1	
15	RB411-6539Δ	Rod (130)	1	Travel (Right)
16	04013-60080	Plain washer	1	
17	05525-50800	Snap pin	1	

[2] Disassembling and reassembling the valve

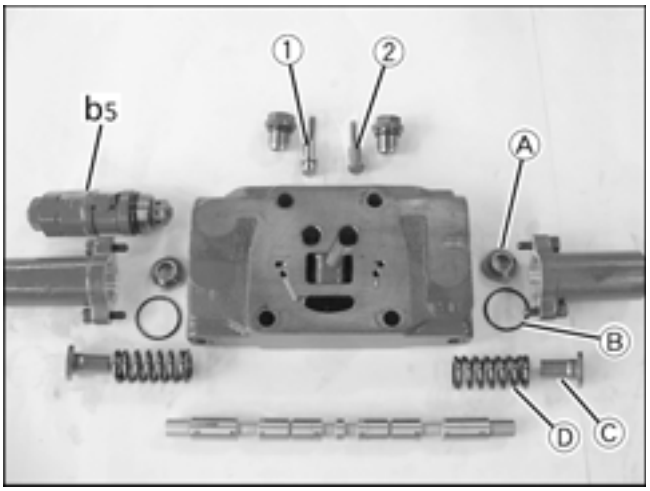


●Specification

Model	KVSE-36-10
Maker	Kayaba Industry Co., Ltd.
Weight	Approx. 31 kg
Tightening torque of tie rod	26.5 ~ 29.4 N·m

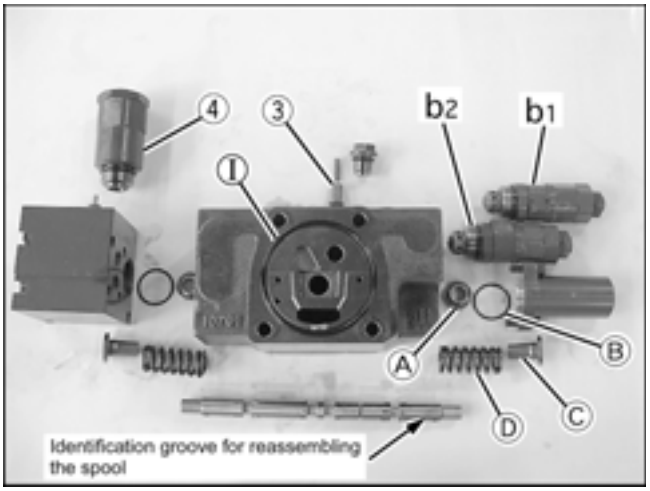
[3] Component parts of sections

1) Bucket section

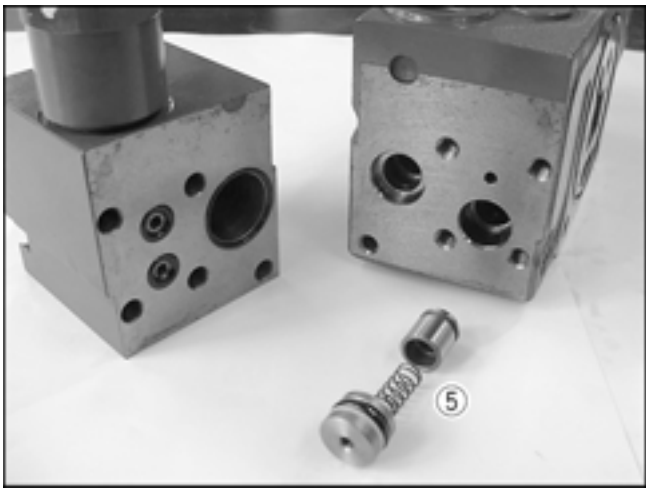


Component parts
(1) Poppet
(2) Poppet
b_5 Overload relief valve
(A) Spring seat
(B) O-ring
(C) Spring seat
(D) Spring

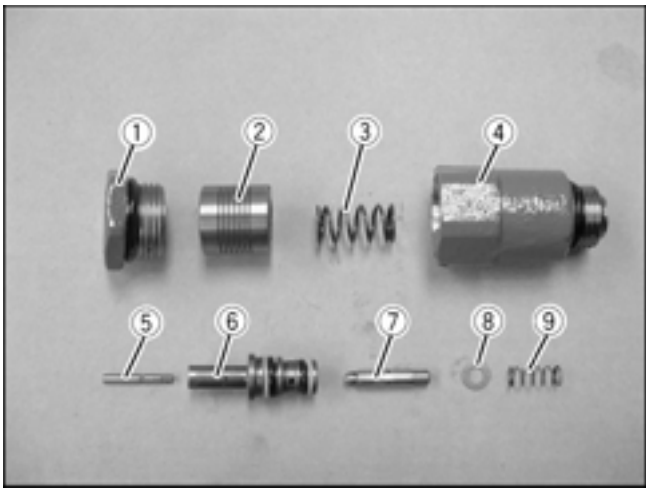
2) Boom section



Component parts
(3) Poppet
(4) Anti-drift valve
b_1 Overload relief valve
b_2 Overload relief valve
(A) Spring seat
(B) O-ring
(C) Spring seat
(D) Spring
(I) O-ring

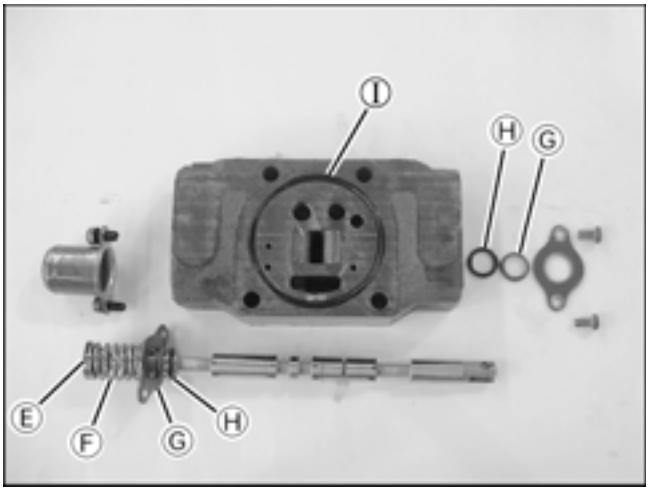


(5) Poppet
Spring
Spacer
O-ring
Backup ring

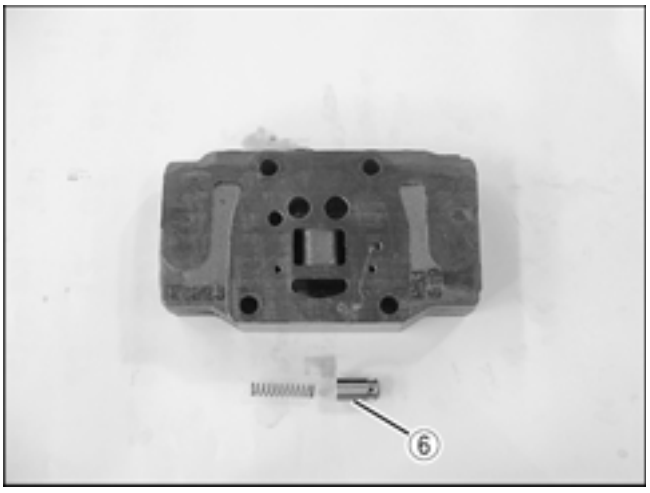


Component parts of anti-drift valve
(1) Plug assembly
(2) Piston
(3) Spring
(4) Plug
(5) Spool
(6) Sleeve
(7) Poppet
(8) Spring seat
(9) Spring
Tightening torque of plug assembly (1): 69 ~78 N·m
Reassembling precautions
The spool (5) is directional. Do not confuse its inserting direction.

3) Travel right section

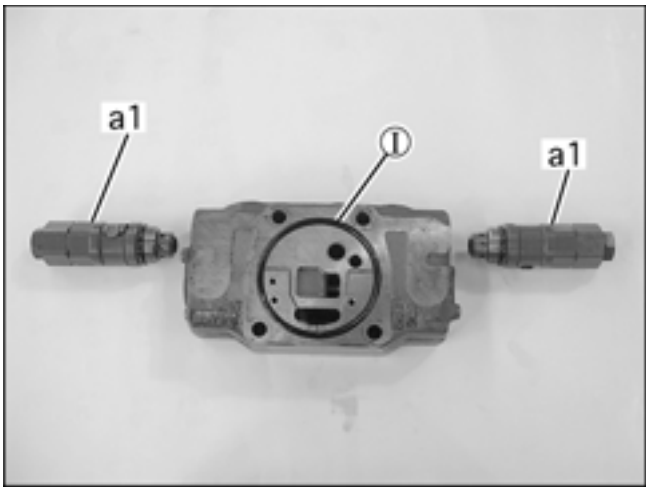


Component parts
(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring
(I) O-ring



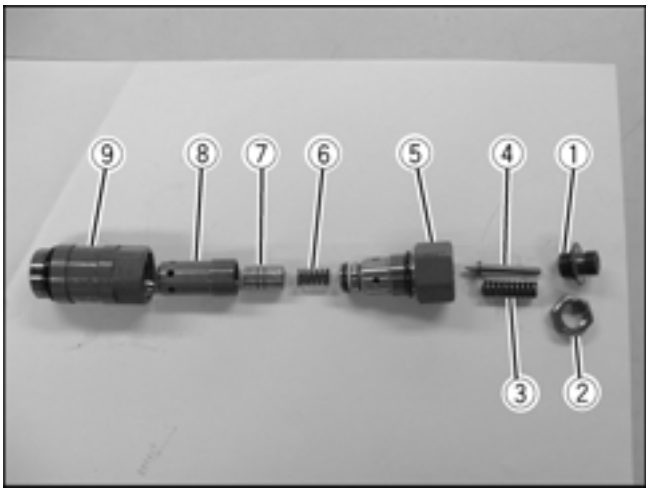
(6) Poppet, spring

4) Inlet section



Component parts

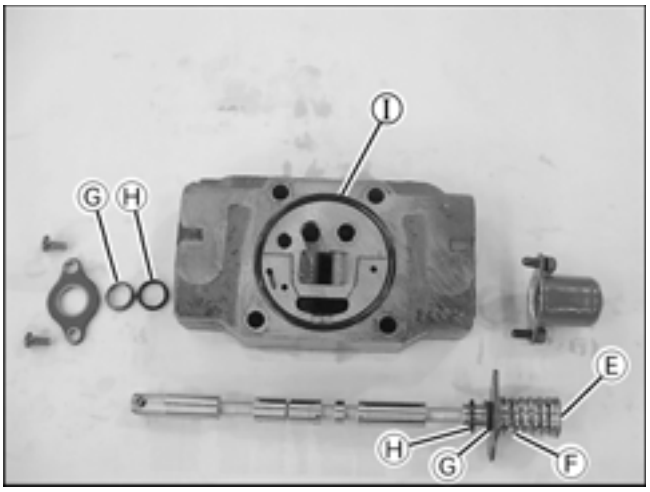
a1 Main relief valve
(1) O-ring



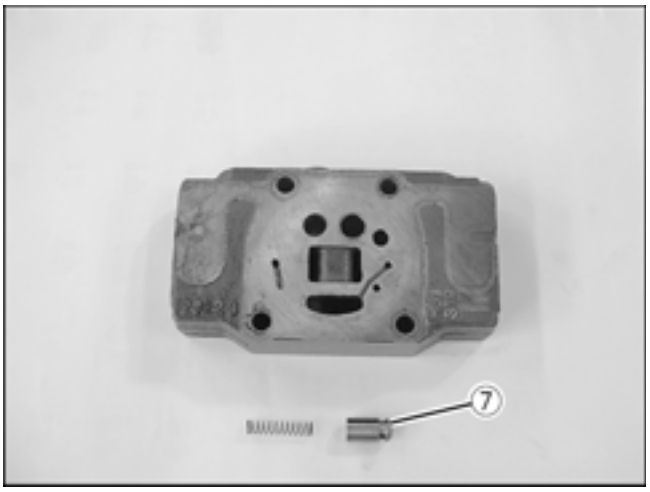
Component part of main relief valve

(1) Adjuster, washer
(2) Nut
(3) Spring
(4) Pilot poppet
(5) Plug
(6) Spring
(7) Piston
(8) Sleeve
(9) Cap

5) Travel left section

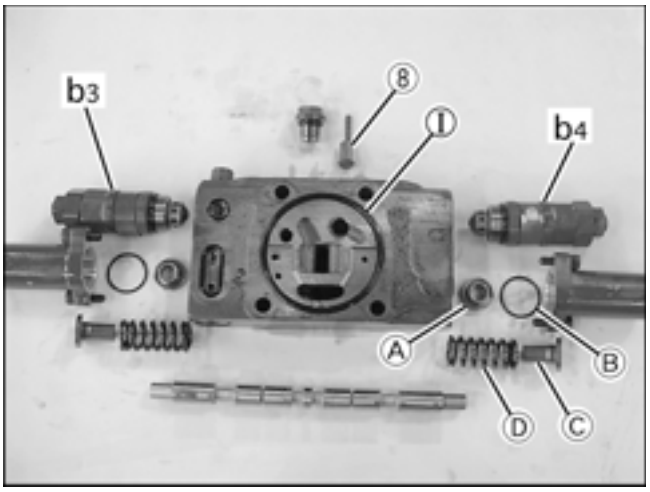


Component parts
(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring
(I) O-ring



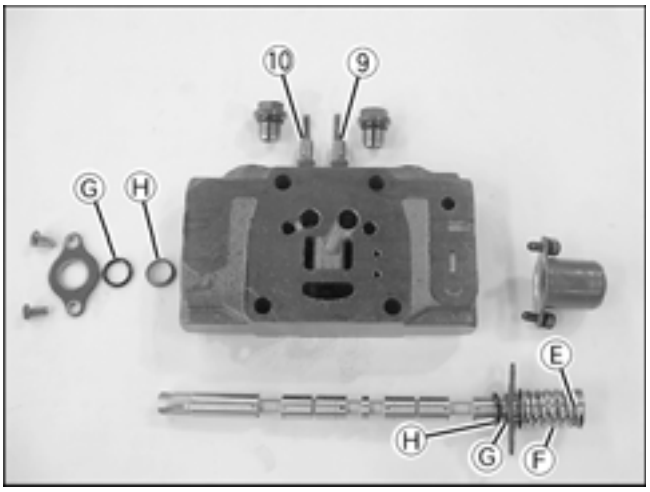
(7) Poppet, spring

6) Arm section



Component parts
(8) Poppet
b_3 Overload relief valve
b_4 Overload relief valve
(A) Spring seat
(B) O-ring
(C) Spring seat
(D) Spring
(E) O-ring

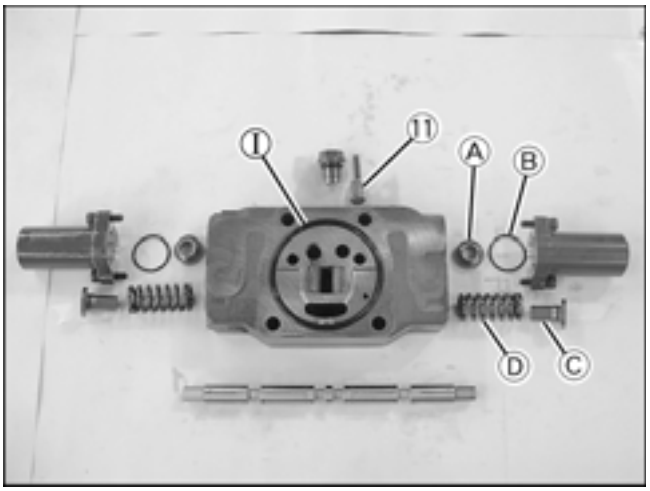
7) Service port section



Component parts
(9) Poppet
(10) Poppet

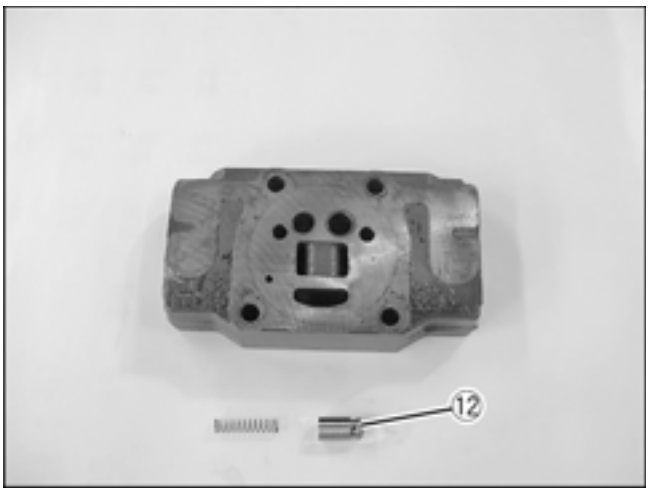
(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring

8) Swivel section



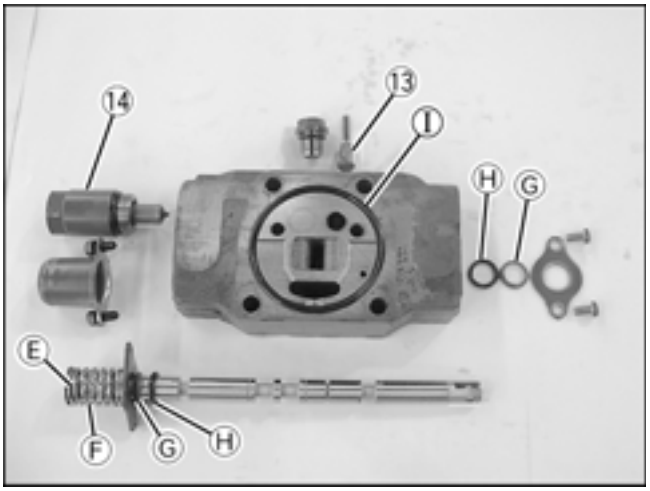
Component parts
(11) Poppet

(A) Spring seat
(B) O-ring
(C) Spring seat
(D) Spring
(I) O-ring



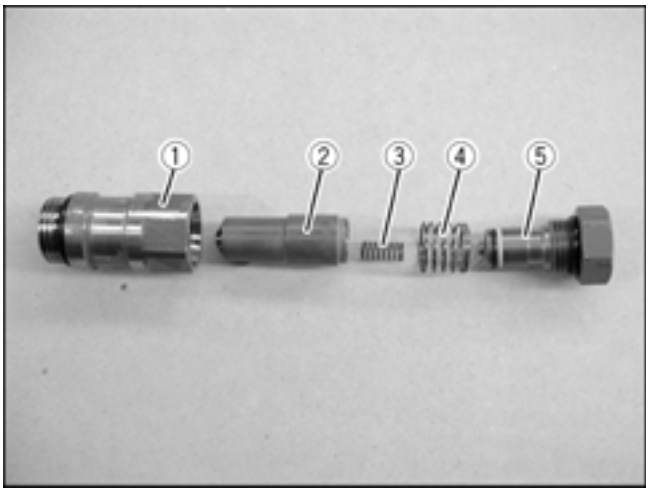
(12)Poppet, spring

9) Swing section



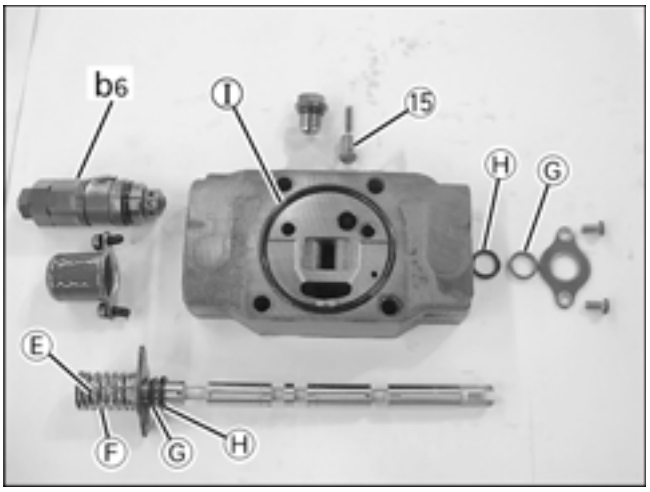
Component parts
(13)Poppet
(14)Anti-void valve

(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring
(I) O-ring



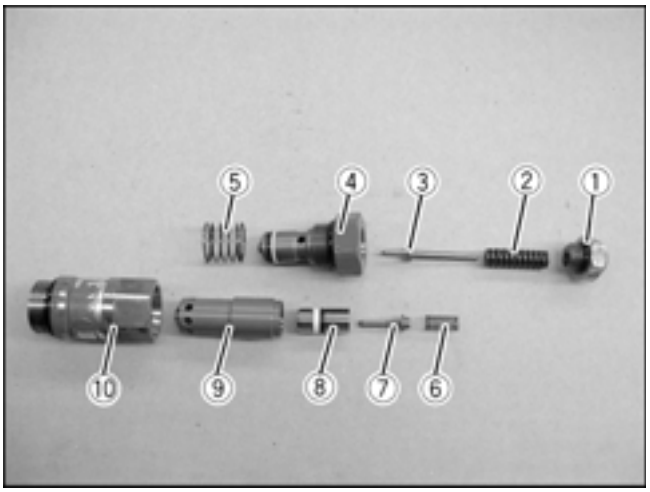
Component parts of anti-void valve
(1) Cap
(2) Sleeve
(3) Spring
(4) Spring
(5) Plug
Tightening torque of anti-void valve: 69 ~ 78 N·m

10) Dozer section



Component parts

(15)Poppet
b_6 Overload relief valve
(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring
(I) O-ring

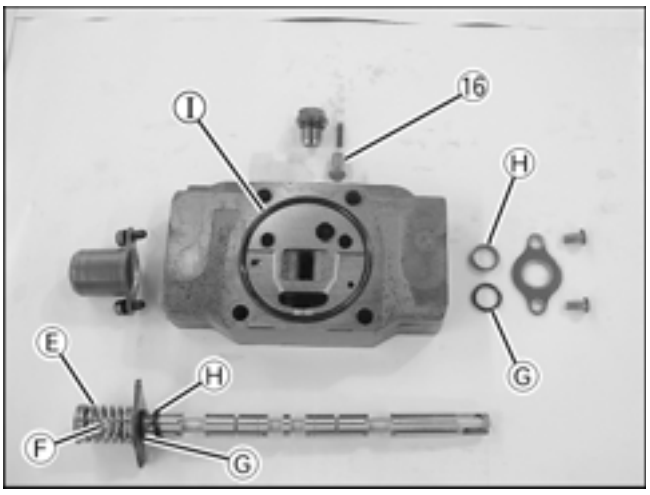


Component parts of overload relief valve

(1) Adjuster, nut, washer
(2) Spring
(3) Pilot poppet
(4) Plug
(5) Spring
(6) Spring
(7) Piston
(8) Poppet
(9) Sleeve
(10)Cap

Tightening torque of overload relief valve: 69~78 N·m
Check the seats of the poppets (3) and (8) carefully for dust deposits or metal chippings. If there is dent or scratch on the seat face, repair or replace.

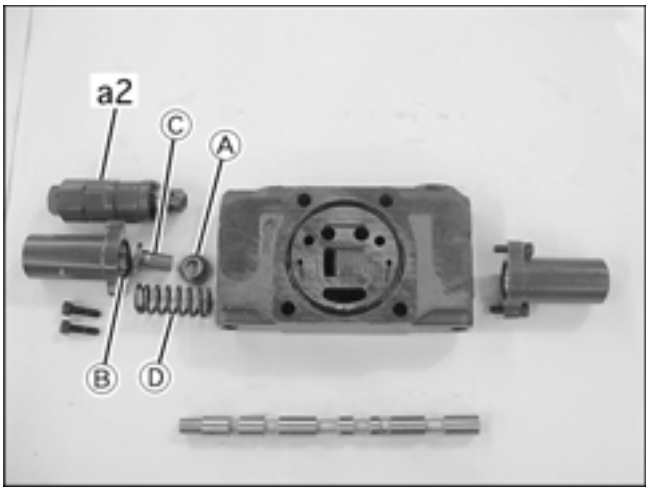
11) Track stretch section



Component parts

(16) Poppet
(E) Cap screw
(F) Spring
(G) Wiper
(H) O-ring
(I) O-ring

12) Communicating valve

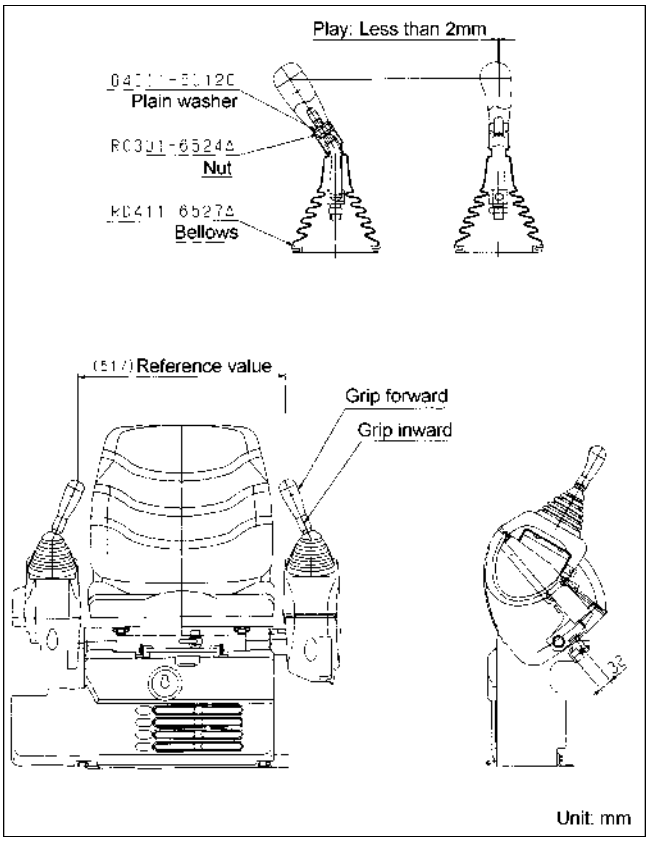


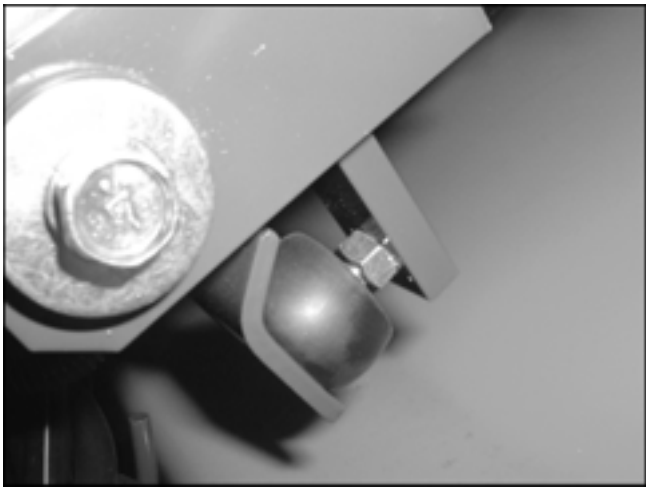
Component parts

a2 Main relief valve
(A) Spring seat
(B) O-ring
(C) Spring seat
(D) Spring

C. Pilot valve

[1] Mounting and dismounting the pilot valve

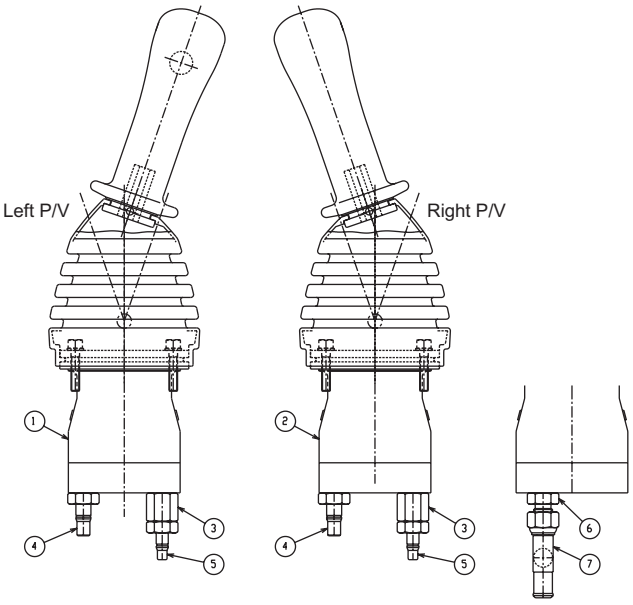


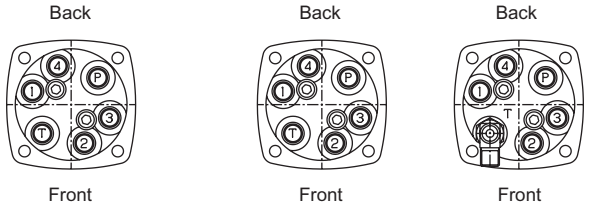


1) Reassembling procedure

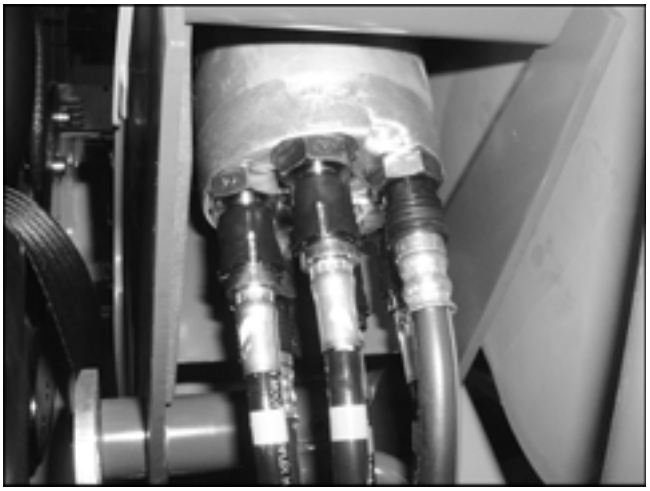
1. Tightening torque of grip lock nut: 25.0~27.0 N-m (2.5~2.8 kgf·m)
   The stepped (machined) part should be toward the lever.
   Bring the stepped part of the nut to the opposite side of the grip, and fit the projection of the rubber bellows securely to the stepped part.
2. Play of lever
   Less than 2 mm
3. Control lever mounting dimension
   Refer to the left figure. 517 mm (reference value)

(1) Tightening torque of hydraulic adaptor:
G1/4: 24.5 ~ 29.4 N·m (2.5 ~ 3.0 kgf·m)
(2) Check the fitting part of the quick adaptor coupler for any flaw.





No.	Part No.	Part name	Q'ty	Maker	Remarks
1	**RC417-61711**	**Valve, assembly (Pilot L)**	**1**	Kawasaki Heavy Ind-made.	(652)
2	**RC417-61721**	**Valve, assembly (Pilot R)**	**1**	Kawasaki Heavy Ind-made	(652)
3	68499-83741	Filter	2		R&L P/V ports
4	RB411-6386	Pipe joint (S. G1/4)	8	Nitta-made / R&L	P/V 1,2,3,4 ports
5	RD411-61761	Pipe joint (S. G1/4 ~ 8. 4)	3	B. S-made / R&L	P/V P-port, L P/V T-port
6	68728-76151	Adaptor	1		R P/V T-port
7	RP201-61872	Pipe joint	1		R P/V T-port
	04811-00110	O-ring	14		For 1/4



Right P/V

	Position for Use	Color of Hose Tape
1	Bucket crowd	Pink
2	Boom down	Sky-blue
3	Bucket dump	Brown
4	Boom up	Gray
P	P port	None
T	T port	None

Left P/V

	Position for Use	Color of Hose Tape
1	Swivel left	Red
2	Arm dump	Blue
3	Swivel right	Yellow
4	Arm tuck-in	Green
P	P port	None
T	T port	None

[2] Disassembling and reassembling the pilot valve

1) Tools and tightening torque

Tool	Size (mm)	Part No.	Part name	Screw size	Tightening torque (N·m)
Hex wrench	6	125	Hex socket bolt	M8	20.6 ± 1.5
Money wrench	22	312	Adjusting nut	M14	68.6 ± 4.9
	32	302	Disc	M14	
Special tool (Drawing on page 17)	24	301	Joint	M14	47.1 ± 2.9

Others

- Vapor phase inhibitor
- Kerosene
- Heat-resistant grease
- Sandpaper (#1000, #2000)
- Oilstone
- Vise

2) Maintenance standard

Checkpoints	Criteria	Remarks
Leak amount	Replace the pilot valve assembly with new one if the oil leak exceeds 1000 cc/min with the steering wheel at neutral or 2000 cc/min while in operation.	Conditions: Primary pressure: 2.95 MPa Oil viscosity: 23 mm^2/s
Spool	If the sliding face is worn over 10 μ more than the non-sliding one, replace the pilot valve assembly with new one.	This amount of wear corresponds to the above leak amount. The same conditions as above are expected.
Push rod	If the tip is worn 1 mm or more, replace the push rod with new one.	
Loose control elements	If the disc (302) or joint (301) is worn out and loose 2 mm or more, replace it with new one.	If the shakiness is caused by a loose fixture, tighten it up.
Stable operation	If unusual noise, hunting, primary pressure drop, etc, occurs and it cannot be corrected according to "Chapter 8 Troubleshooting", replace the pilot valve assembly with new one.	

Note 1: It is advisable to replace the O-rings and other sealing elements at every disassembly. They may be reused when they are found not damaged.

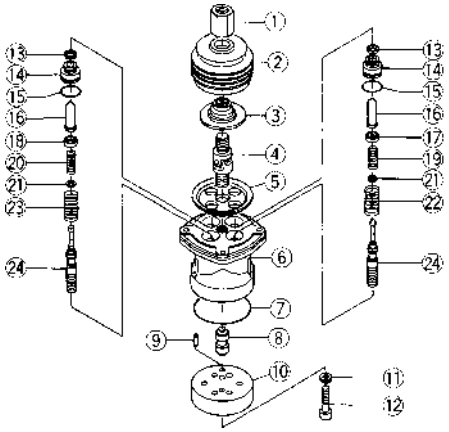
Note 2: When the hex socket bolt (125) has been loosened, be sure to replace the sealing washer (121).

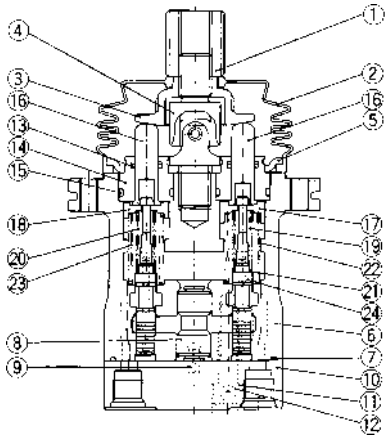
3) Disassembling

1. Preparations
   (1) Prepare a workbench that is spacious enough for the parts handled and strong and stable enough to keep the parts in place.
   (2) Also have the tools and jigs, discussed in Item 7-1, at hand.
2. General precautions
   (1) The parts are precision-machined. Handle them with enough care not to hit them against each other or drop them.
   (2) Even if any part is hard to remove, do not strike it out or pry out forcibly. Such handling may cause burrs or damages, which may invite oil leak or poor performance later. Try to do the job with patience.
   (3) Do not leave the taken-out or exposed parts unprotected. Moisture or dust may get stuck on them, causing rust. If unavoidably the job is interrupted halfway, be careful to protect such parts against rust and dust.
3. Disassembling procedure

	Procedure	Precautions
1	Clean up the pilot valve with kerosene.	* Apply blind plugs to all the open ports.
2	Fix the pilot valve on a vise using copper (or lead) sheets.	
3	Remove the bellows (501). [Photo 7-1]	* Be careful not to break the bellows (501).
4	Apply a wrench across the adjusting nut (312) and disc (302). Loosen and remove the adjusting nut and disc. [Photos 7-2, 7-3 and 7-4]	
5	With the specified jig, turn the joint (301) counterclockwise to get it loose. [Photos 7-5 and 7-6]	* Photo 7-5 shows the jig in its specified position. **CAUTION:** * When the return spring (221) is strong in force, take care in loosening and drawing out the joint (301). The plate (151), plug (211) and push rod (212) may pop out together when taking out the joint.
6	Remove the plate (151). (When the return spring (221) is strong in force) [Photo 7-7] (When the return spring (221) is weak in force) [Photo 7-8]	
7	When the return spring (221) is weak in force, the sliding resistance of the O-ring holds the plug (211) inside the casing (101). Using a bladed screwdriver, draw out the plug. [Photo 7-9]	* Using its outer groove, draw out the plug (211) with care not to get it damaged by an unbalanced load. **CAUTION:** * Keep in mind that when the plug (211) may pop out by the force of the return spring (221).
8	Pull the push rod (212), plug (211), reducing valve assembly, and return spring (221) out of the casing (101). [Photo 7-10]	* Keep record of the positional relation with the casing hole.
9	Fix the pilot valve, with its port plate (111) upward, in the vise.	
10	Using the specified hex wrench, loosen and remove the hex socket bolt (125). [Photo 7-11]	
11	Detach the port plate (111) and O-ring (122) from the casing (101). [Photos 7-12 and 7-13] Draw the bushing (131) out of the casing (101).	
12	To disassemble the reducing valve, do the following. Press in the spring seat (216) to get the secondary-pressure spring (241) warped. Then slide this spring seat sideways and pass it through the larger hole and out of the spool (201). [Photo 7-14] Next separate the following parts: spool (201), spring seat (216), secondary-pressure spring (241) and washer 2 (217). [Photo 7-15]	* Be careful not to scratch the surface of the spool (201). * Do not allow the spring seat (216) 6 mm or lower than specified. * Handle this group of parts as an assembly.

	Procedure	Precautions
13	Remove the folding-purpose spring (246) and spring seat (218) from the push rod (212). [Photo 7-16]	
14	Draw the push rod (212) out of the plug (211). [Photo 7-17]	
15	Remove the O-ring (214) and seal (213) from the plug (211). Use a small bladed screwdriver or the like to take out the seal (213). [Photos 7-18 and 7-19]	
16	Clean up the parts. 1) Put the parts one by one in a rough-washing container with kerosene. (Rough washing) 2) Put the parts one by one in a finish-washing container with kerosene. Slowly turn them and wipe them clean thoroughly inside and out. (Finish washing) Using clean waste cloth, wipe kerosene away from the parts.	* Do not wipe dirty parts in kerosene from the beginning because otherwise they might get scratched. Keep them dipped until dirt, fat and grease become loose enough off the parts. * Be attentive to keep the kerosene clean enough. Otherwise the parts may get scratched, leading to poor performance when reassembled. * Do not dry up the parts with compressed air. Dust and moisture in the air may damage the parts or get them rusty later.
17	Keep the parts against rust. Apply rust-preventive to the specified parts.	* Do not leave the parts without rust-preventive. Rust may build up, causing malfunction later.



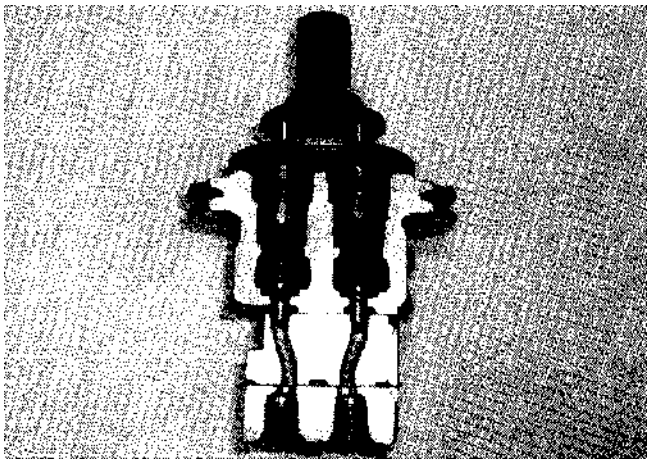


No.	Part name	No.	Part name
1	Nut (Adjusting)	13	Seal
2	Bellows	14	Plug
3	Nut (Disk)	15	O-ring
4	Joint	16	Bush rod
5	Plate	17	Seat (Spring)
6	Valve body	18	Seat (Spring)
7	O-ring	19	Spring
8	Bush	20	Spring
9	Spring pin	21	Washer 2
10	Plate (Port)	22	Spring
11	Sealing washer	23	Spring
12	Hex socket bolt	24	Spool

2. Reassembling procedure

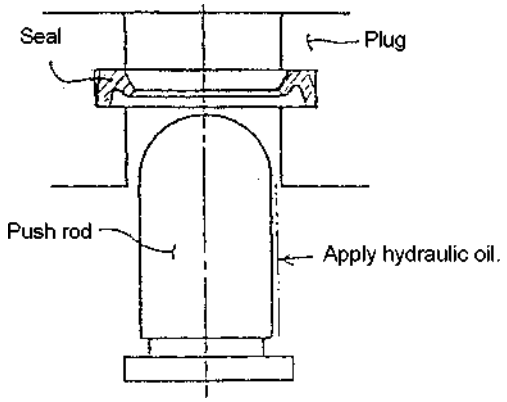
(1) Apply grease to the following parts.
- Rotating part of joint (4)
- Top of push rod (16)

(2) Cut model of pilot valve



4) Assembling

1. Preparations
   (1) As in the case of disassembling, prepare the specified workbench, tools and materials.
2. General precautions
   (1) Take the same general precautions as in disassembling.
   (2) Before reassembling, remove metal chippings and foreign matters from all the parts. Make sure the parts are free of burrs, hit marks and other problems. If a burr or hit mark is found, get rid of it with an oilstone.
   (3) In principle, replace the O-rings and backup rings with new ones.
   (4) When fitting the O-rings and backup rings, handle them with care not to damage it. (Apply a small amount of grease for smooth fitting.)
   (5) When fitting the parts in place, preferably use grease to avoid accidental drop.
   (6) Tighten the bolts and the like to the their specified torques listed in "7-1 Tightening Torque Chart". Measure the tightening torques with a torque wrench.
   (7) Finally apply blind plugs to all the open ports to avoid entry of dust.
3. Reassembling procedure

	Procedure	Precautions
1	Fit the bushing (131) and O-ring (122) to the casing (101). [Photo 7-20]	
2	Install the port plate (111), with the hex socket bolt (125) and seal washer (121) in between, on the casing (101). [Photos 7-21 and 7-22]	* Carefully position the spring pin (126) in the casing hole. * Replace the seal washer (121) with new one.
3	Tighten the hex socket bolt (125) to the specified torque. [Photo 7-23]	* Alternately tighten the two bolts.
4	Install the washer 2 (217), secondary-pressure spring (241) and spring seat (216) in this order on the spool (201). [Photo 7-24] Then press in the spring seat (216) to get the secondary-pressure spring (241) warped. Now slide this spring seat sideways and pass it through the larger hole and onto the spool (201). [Photo 7-25]	* Do not allow the spring seat (216) 6 mm or lower than specified.
5	Fit the return spring (221) in the casing (101). Also fit the reducing valve assembly to the casing (101). [Photo 7-26]	* Place these parts back in their original positions.
6	Fit the O-ring (214) to the plug (221). [Photo 7-27]	
7	Fit the seal (213) to the plug (211). [Photo 7-28]	* Place the seal (213) with its lip positioned as shown below.
8	Fit the push rod (212) into the plug (211). [Photo 7-29] Fit the folding-purpose spring (246) and spring seat (218) into the push rod (212). [Photo 7-30]	* Apply hydraulic oil over the surface of the push rod. 

	Procedure	Precautions
9	Fit the plug assembly to the casing (101). When the return spring (221) is weak in force, this assembly is kept in place by the sliding resistance of the O-ring. [Photo 7-31] When the return spring (221) is strong in force, fit all the four plugs at once using the plate (151). Apply and temporarily tighten the joint (301). [Photo 7-32]	* Be careful not to pry the spool (201) too hard. Otherwise the casing hole (101) may get damaged. **CAUTION:** * Keep in mind that the plug assembly and plate (151) may pop out.
10	Place the plate (151) in position.	
11	Using the specified jig, tighten the joint (301) to the casing (101) by the specified torque. [Photos 7-33 and 7-34]	* Photo 7-33 shows the jig in its specified position.
12	Fit the disc (302) to the joint (301). [Photo 7-35]	* Screw in the disc until it comes into even contact with the four push rods (212). **WARNING:** * Carefully adjust the final position of the disc (302). If it is screwed in too much, the secondary pressure with the lever at neutral may be wrongly applied, causing the machine to malfunction.
13	Apply the adjusting nut (312) and fix it by applying the specified wrench across the disc (302). Tighten the adjusting nut to the specified torque. [Photo 7-36]	* In tightening the nut, keep the disc (302) in position.
14	Apply grease to the turning portion of the joint (301) and the top of the push rod (212). [Photo 7-37]	
15	Fit the bellows back into position. [Photo 7-38]	* Be careful not to break the bellows (501).
16	Pour vapor phase inhibitor from the ports and apply the blind plugs.	

Photo 7-1

Photo 7-2

Photo 7-3

Photo 7-4

Photo 7-5

Photo 7-6

Photo 7-7

Photo 7-8

Photo 7-9

Photo 7-10

Photo 7-11

Photo 7-12

Photo 7-13

Photo 7-14

Photo 7-15

Photo 7-16

Photo 7-17

Photo 7-18

Photo 7-19

Photo 7-20

Photo 7-21

Photo 7-22

Photo 7-23

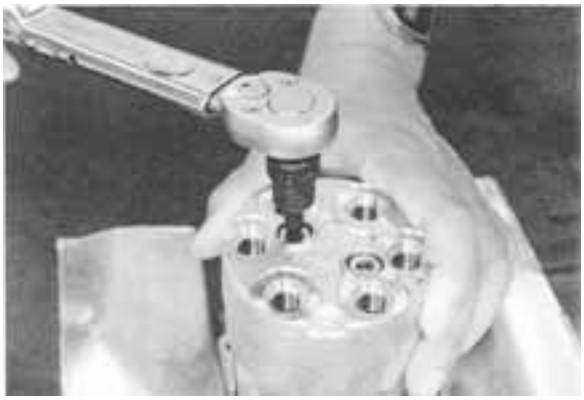


Photo 7-24

Photo 7-25

Photo 7-26

Photo 7-27

Photo 7-28

Photo 7-29

Photo 7-30

Photo 7-31

Photo 7-32

Photo 7-33

Photo 7-34

Photo 7-35

Photo 7-36

Photo 7-37

Photo 7-38

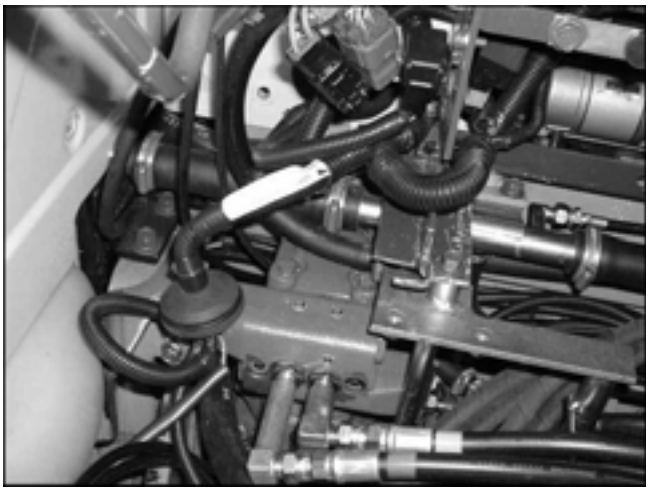
[3] Trouble shooting

It is not easy to pinpoint trouble spots. The table below lists some typical problems, their possible causes and corrections. Before starting repair jobs, refer to the table below.
A machine trouble is not necessarily caused by just one part, but by come different parts combined. It should be noted that the corrections listed below might not be enough and additional measures might be needed.
This chart does not cover all possible causes and corrections. Whenever necessary, it is therefore essential for the repair supervisor to look further into the problem and cause in question.

Problem	Causes	Corrections
Secondary pressure failure to rise	(1) Primary pressure too low. (2) Secondary-pressure spring (241) broken or worn out. (3) Too large a gap between the spool (201) and casing (101). (4) Steering wheel too loose.	(1) Ensure the specified primary pressure. (2) Replace the spring with new one. (3) Replace the remotely operated valve with new one. (4) Disassemble and reassemble the related section. Or replace the steering wheel as required.
Secondary pressure unstable	(1) Sliding parts stuck. (2) Tank line pressure fluctuating too much. (3) Air sucked in the piping.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank. (3) Operate the machine to let out the air.
Secondary pressure too high	(1) Tank line pressure too high. (2) Sliding parts stuck.	(1) Correct the stuck spot. (2) Return the oil direct to the oil tank.

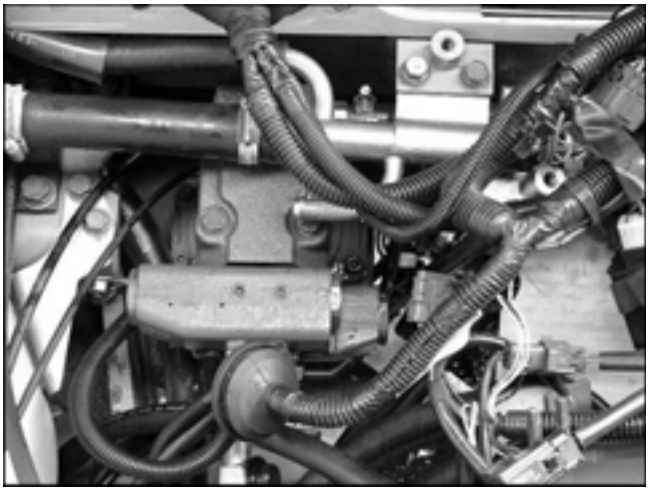
d. Swivel motor

[1] Mounting and dismounting the swivel motor

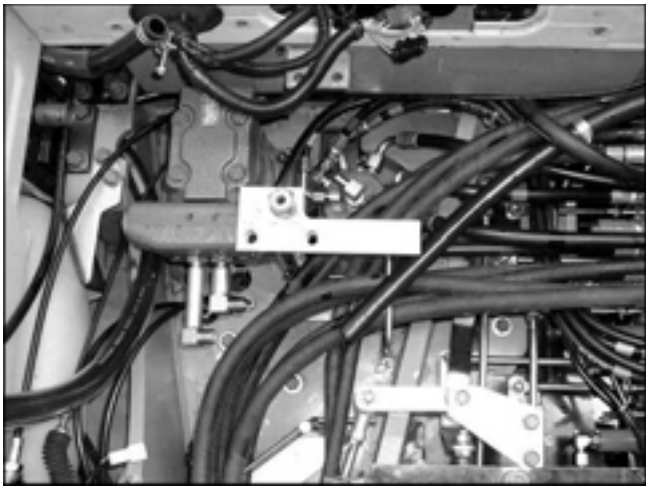


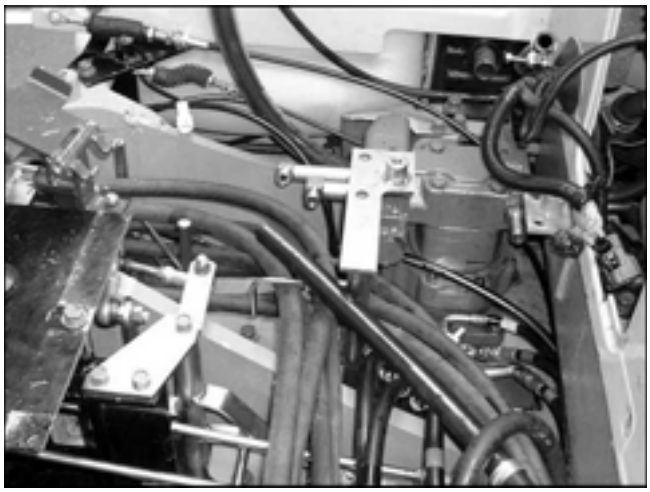
1) Dismounting the swivel motor

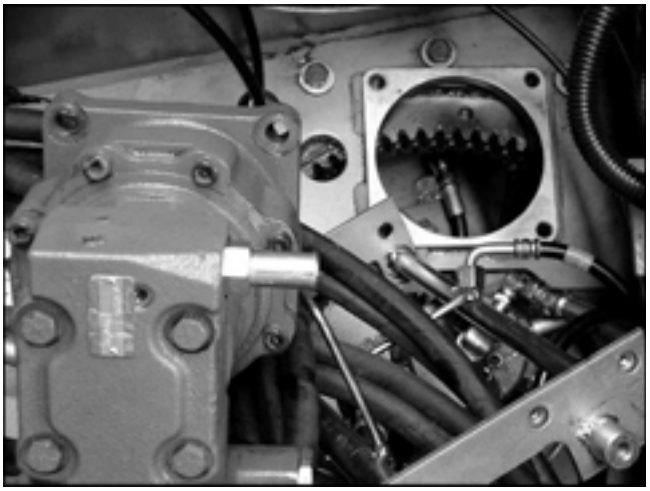
1. Let out the hydraulic oil.
2. Remove the steps.
3. Remove the related wire harnesses for dismounting the seat stand.
4. Dismount the left pilot valve from the operation panel.
5. Dismount the left operation panel together with the seat stand.
6. Be careful not to bend the pilot hose.



7. Disconnect the panel related wire harnesses and cables.
8. Remove the bolts which fix the right operation panel and seat stand. Tilt the seat stand forward, paying attention not to bend the pilot hose. Confirm the safety.
9. Dismount the seat stand.
10. Disconnect the return hose and return pipe running between the swivel and the control valve.
11. Remove the hose guide fixing bolts. (Make the guide free beforehand.)
12. Disconnect the brake release hose.

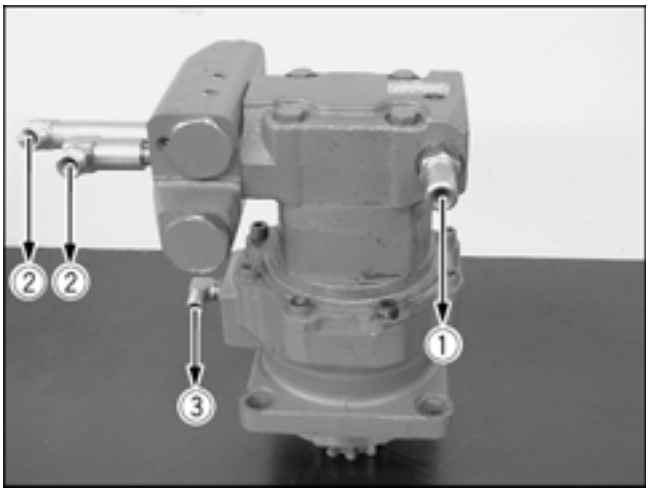






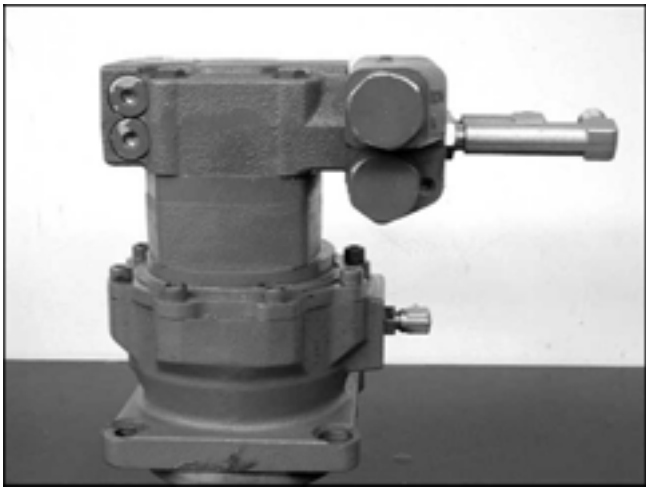
13. Remove the 4 motor mounting bolts.
    Tightening torque: 103.0 ~117.7 N·m (10.5 ~ 12.0 kgf·m)
    Apply screw loctite. (Loctite 271)
14. Dismount the motor.

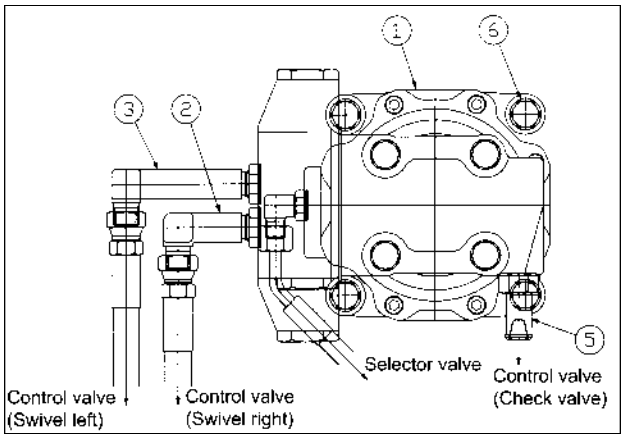
[2] Swivel motor mounting/dismounting component parts

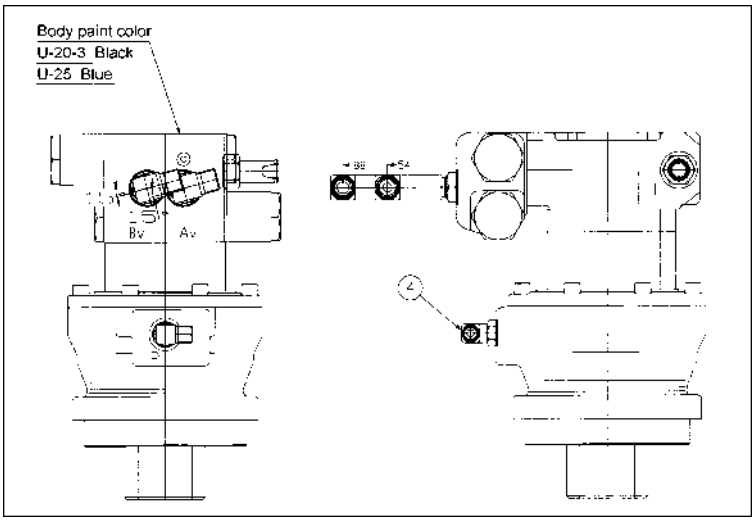


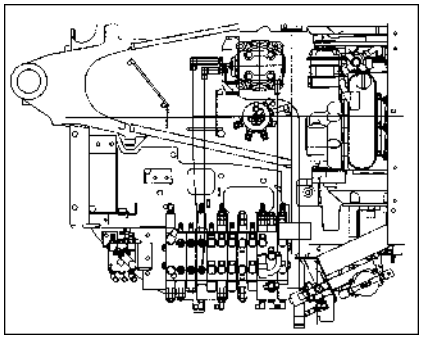
2) Reassembling procedure

(1) Drain hose (to tank)
(2) To right and left control valves
(3) For negative brake releasing (to selector valve)
(4) Brake valve
(5) Anti-void valve



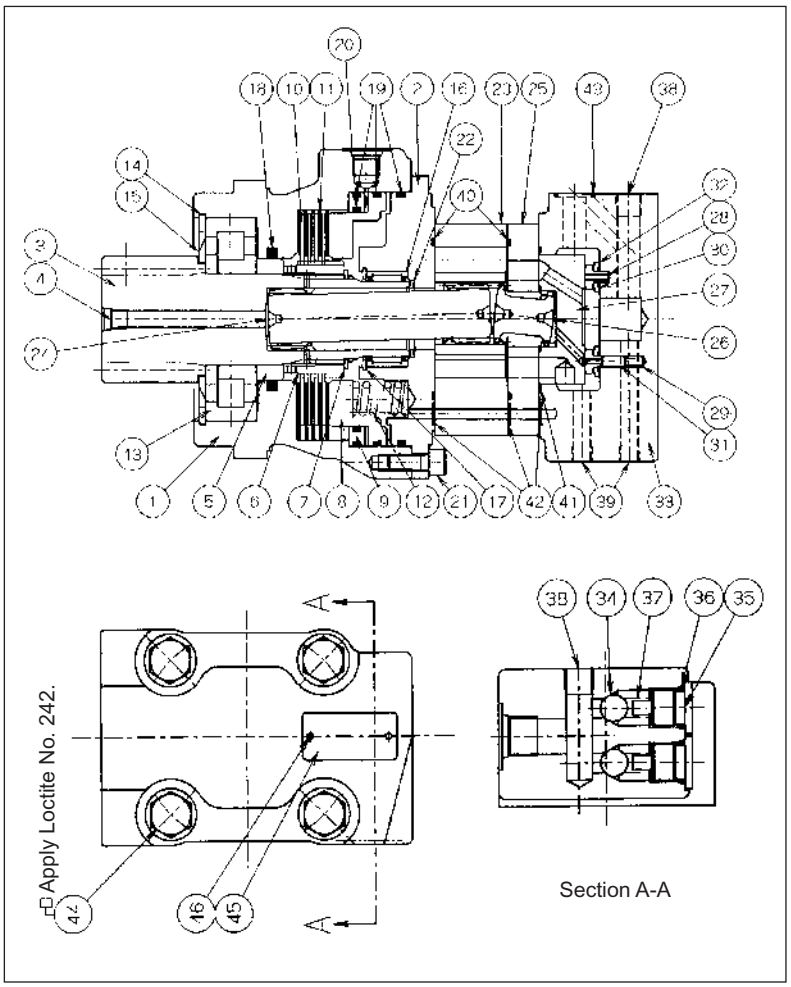




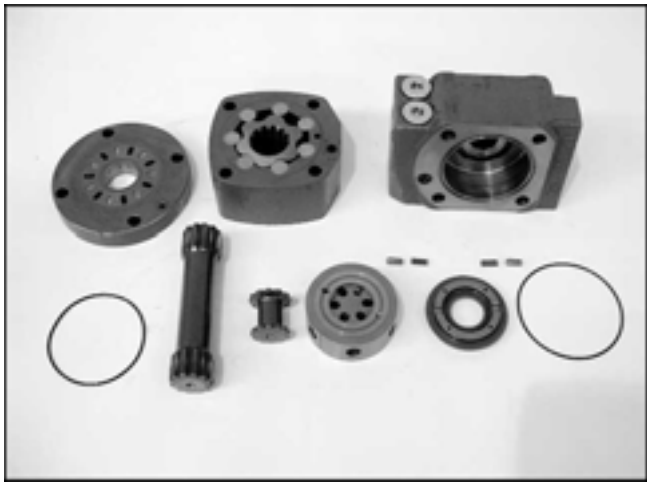


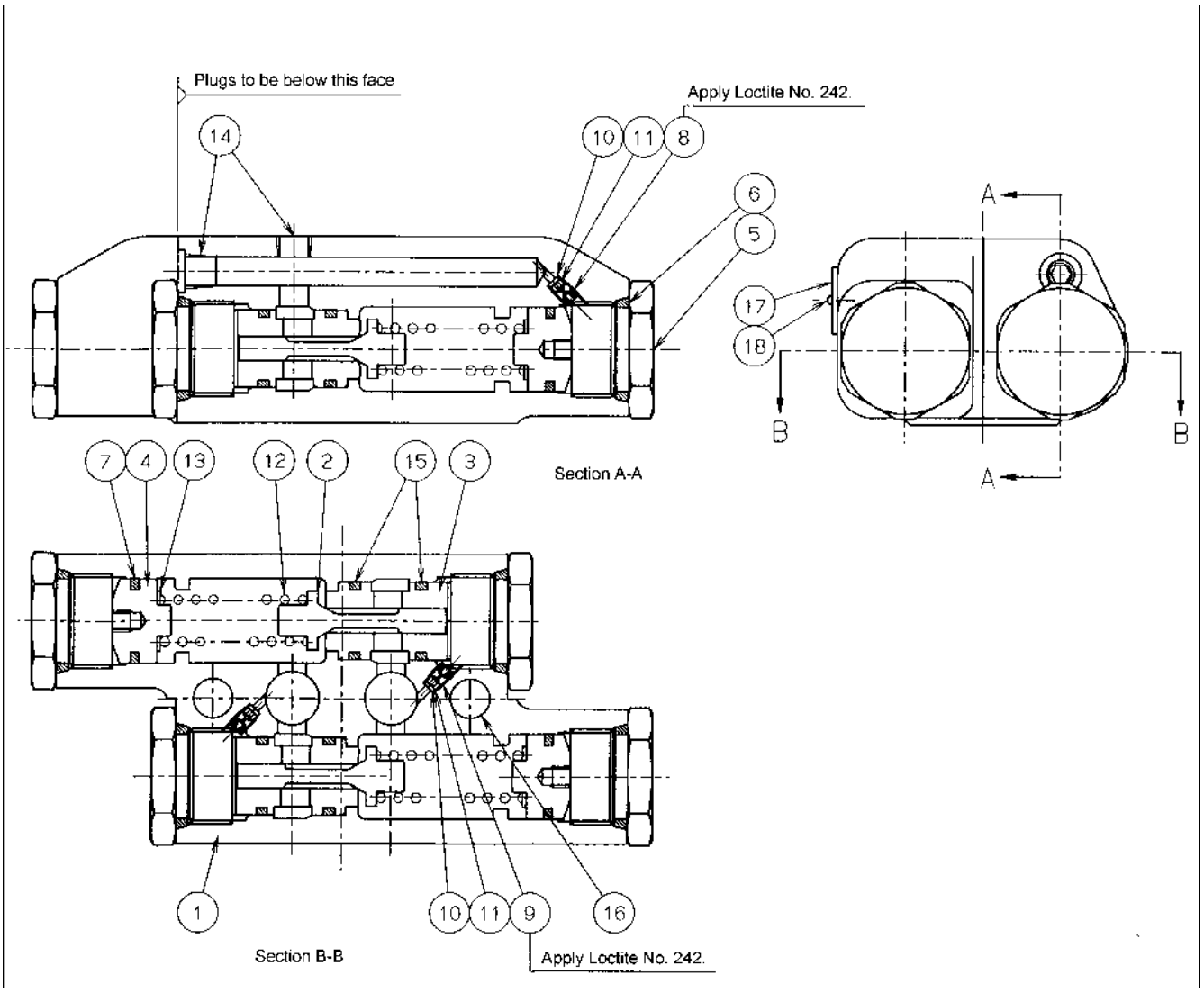
No.	Part No.	Part name	Q'ty	Remarks
(1)	RB411-6128△	Motor, assembly (Swivel)	1	U-20-3 (Black) (613)
	RB511-6128△	Motor, assembly (Swivel)	1	U-25 (Blue)
(2)	68881-34933	Flange-based elbow	2	Av
(3)	68191-61831	Pipe joint (L. F3/8-F3/8)	1	Bv
(4)	RC601-63721	Pipe joint (L. G1/4-G1/4))	1	P
(5)	RC101-63801	Pipe joint (Filter), assembly	1	T
	04810-00110	O-ring	1	For 1/4P
	04810-00140	O-ring	3	For 3/8 Av・Bv・T
(6)	01138-61240	Bolt	4	M12×1.25 9T

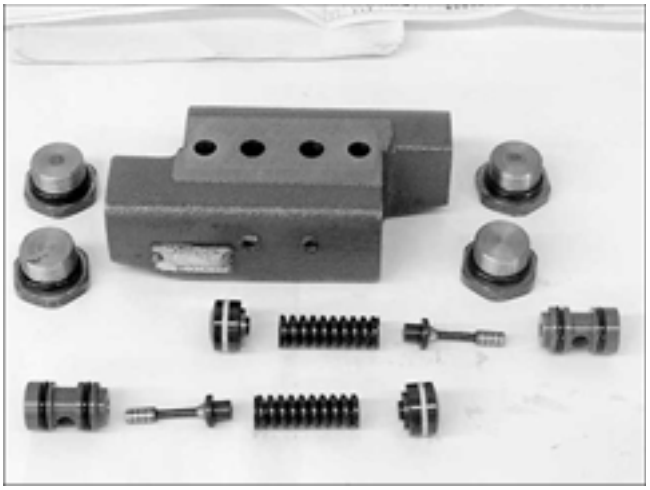
Tightening torque of hydraulic adaptor:
G1/4 24.5~29.4N・m(2.5~3.0kgf・m)
G3/8 49.0~53.9N・m(5.0~5.5kgf・m)



No.	Part name	Part No.	Q'ty	Remarks
47	Pinion gear assembly	AD1165C	1	Including 1 ~ 22
1	Bearing housing		(1)	
2	Flange mounting		(1)	
3	Pinion gear		(1)	
4	Plug		(1)	Rc1/8
5	Collar		(1)	
6	Ring gear		(1)	
7	Snap ring for shaft		(1)	ϕ42
8	Piston		(1)	
9	Ring		(1)	
10	Friction plate		(4)	
11	Mating plate		(5)	
12	Spring		(8)	
13	Front bearing		(1)	NUP309
14	Snap ring for hole		(1)	ϕ100
15	Bearing cover		(1)	
16	Rear bearing		(1)	RLM3720
17	Snap ring		(1)	IRTW-047
18	X-ring	AD1046A	(1)	ϕ60
19	O-ring	AA0014B-120	(3)	TBG120
20	O-ring	AA0014B-105	(1)	TBG105
21	Hex socket bolt		(8)	M8 × 20
22	Shaft face seal	9050	(1)	
23	Geroller	AD1160C-503	1	
24	Drive	AD1158C-005	1	
25	Valve plate	AD1135B	1	
26	Valve drive	AD1161B	1	
27	Valve	8435S-6	1	
28	Balancing ring	8915-1	1	
29	Spring	7383	2	
30	Inner face seal	9135-1	1	
31	Pin	14351	2	
32	Outer face seal	9135-2	1	
48	Valve housing assembly	AD1048A	1	Including 33 ~ 39
33	Valve housing		(1)	
34	Steel ball		(2)	7/16"
35	Plug		(2)	
36	O-ring	A40001-14	(2)	4BP14
37	Spring		(2)	
38	Plug		(2)	Rc1/4
39	Plug		(2)	Rc1/8
40	O-ring	9022S-6	2	AS568-041
41	O-ring	9022S-2	1	AS568-038
42	O-ring	9022S-12	3	AS568-011
43	O-ring	A40001-18	2	1BP18
44	Hex bolt	14313	4	3/8"UNF
45	Name plate		1	
46	Rivet		2	







No.	Part name	Q'ty	Part No.	Remarks
1	Valve body	1		
2	Plunger	2		
3	Seat	2		
4	Piston	2		
5	M27 plug	4		M27
6	O-ring	4	A40001-24	1BP24
7	Seal set	2	AH0597A	
8	Orifice plug	2		ϕ0.40
9	Orifice plug	2		ϕ0.35
10	Filter	4		100-mesh
11	Collar	4		
12	Spring	2		
13	Shim	2		
14	Plug	4	A42041	Rc1/8
15	O-ring	4	A40001-18	1BP18
16	Hex socket bolt	2	DW0024A-055	M10×L55
17	Nameplate	1		
18	Rivet	2		
0	Seal kit		AH0615A	

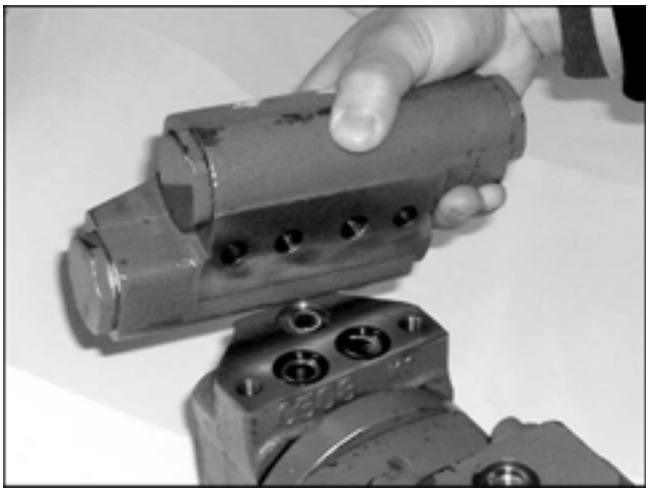
[3] Disassembling and reassembling the swivel motor

1) Disassembling/reassembling tools

Torque wrench: 9.8~98 N·m
Socket wrench: 14 mm
Hex hollow wrench: 5.8 mm
Bladed screwdriver
Plastic hammer
Snap ring removal tweezers (for hole and shaft)
Special screwdriver

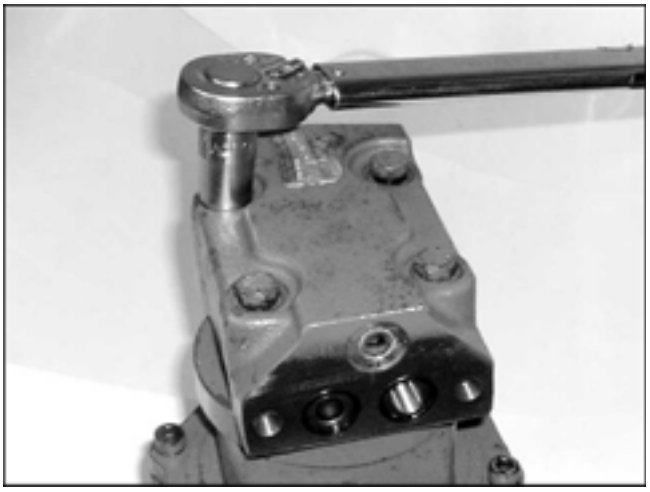
Wash the parts with clean oil and remove dust and dirt off them. Also use due care not to give damage or dent to them.
Replace the seals with new ones. Apply grease to the new seals beforehand.
When disassembling the parts, clean around the workshop and prepare plastic cases for keeping the removed parts.
Before disassembly, clean around the ports of the motor and remove paint from the connections using a wire brush.

2) Disassembling procedure

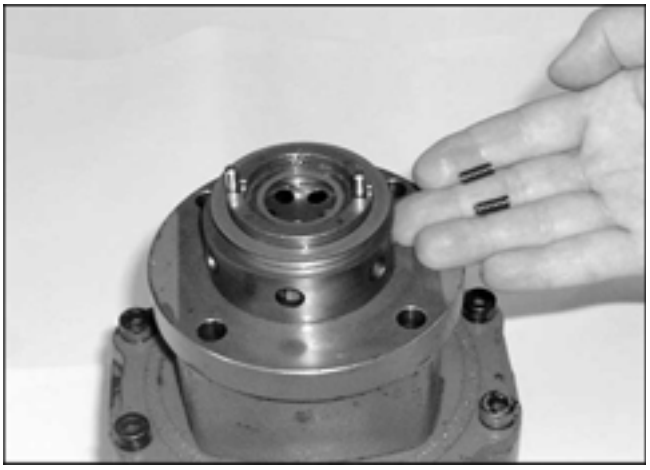


Disassembling procedure

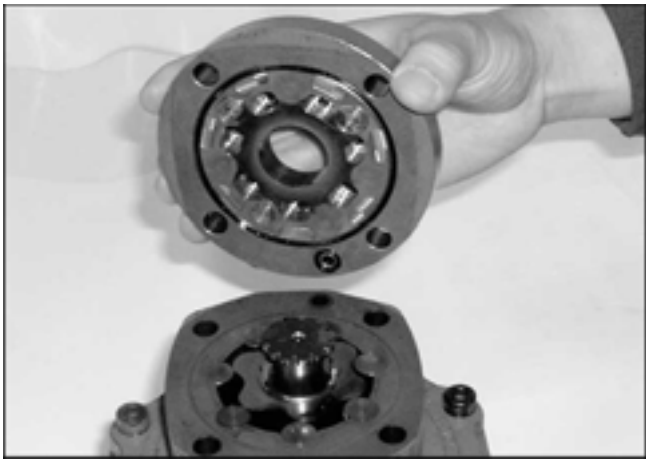
1. Dismount the shock-less valve from the motor body.
   Do not disassemble the shock-less valve unless necessary.



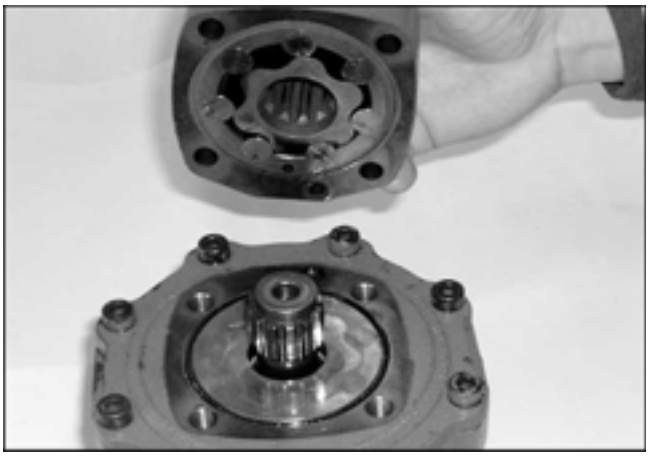
2. Fix the flange in a vise with the pinion gear facing downward.
   Remove the hex bolt.



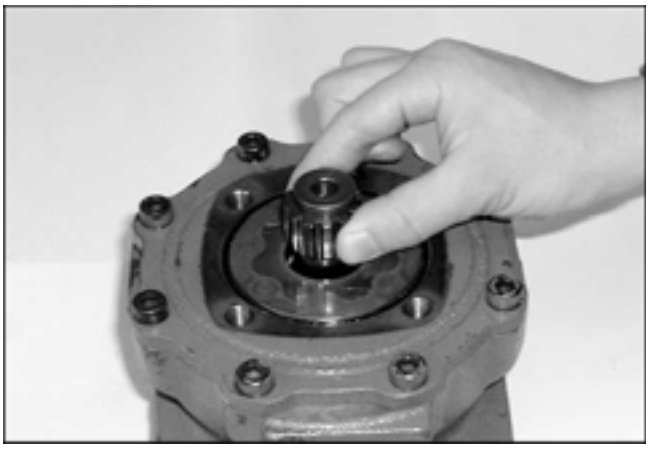
3. Dismount the valve housing. At this time, use care not to lose the spring.
   Do not disassemble the valve housing unless necessary.



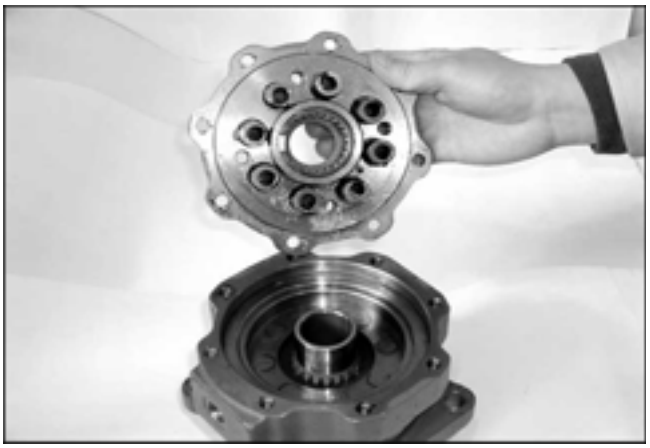
4. Remove the balancing ring, valve and valve seat.



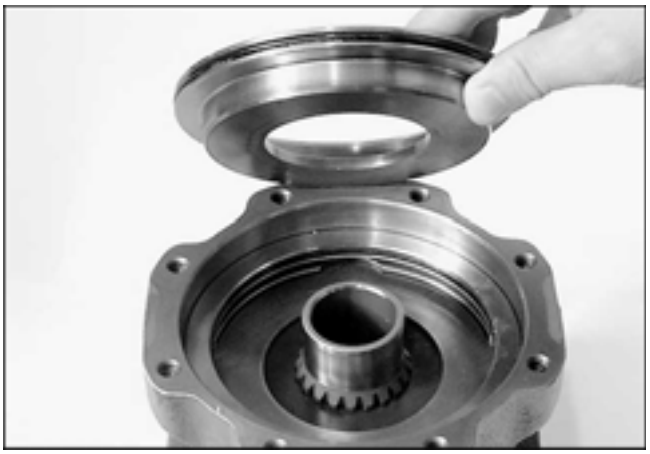
5. Remove the valve drive and geroller.



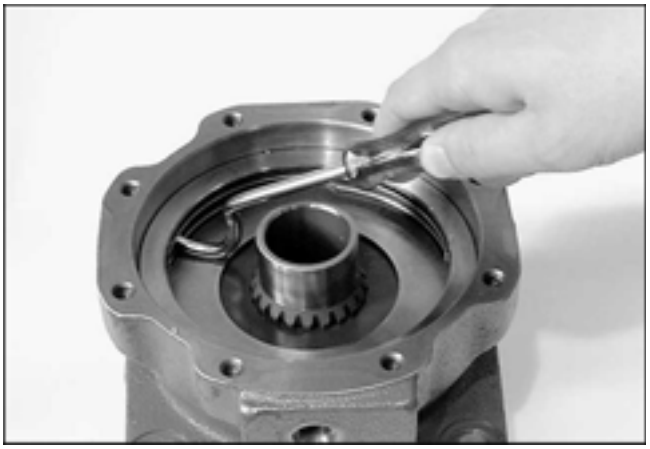
6. Dismount the drive.
   Do not disassemble the pinion gear unless necessary.



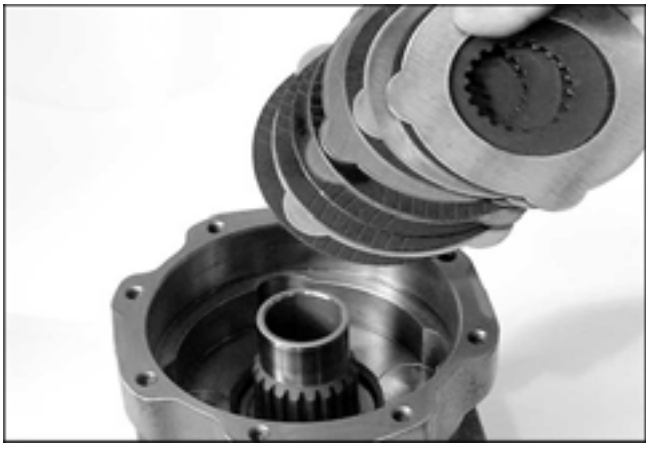
7. When the pinion gear must be disassembled, take the following.
   (1) Dismount the bearing housing.
   (2) Remove the 8 springs.



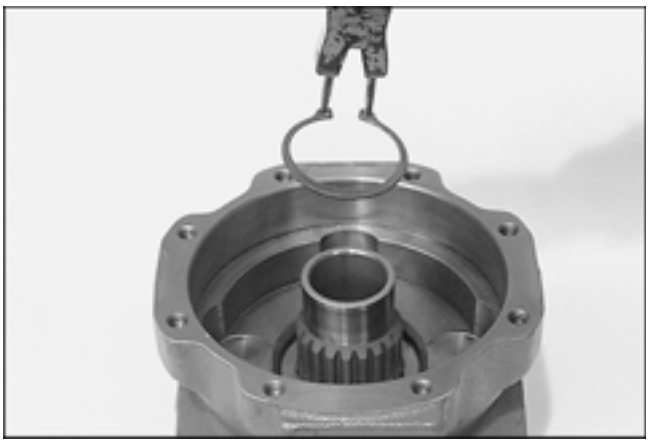
8. Remove the piston.
   The piston will be easily removed by blowing air through the brake release port. Keep in mind, however, that the piston may pop out.



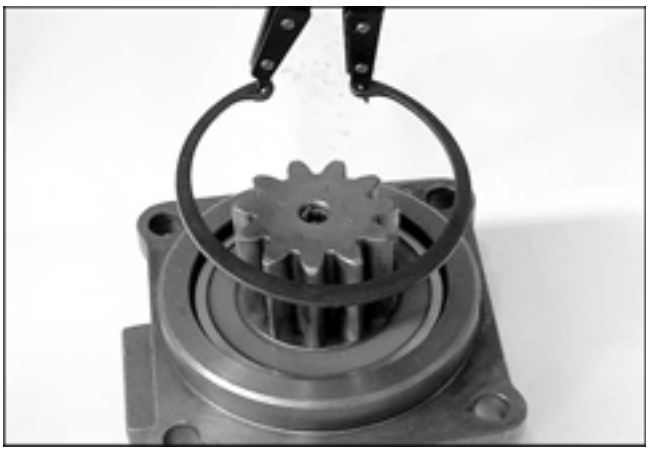
9. Remove the ring.
   Remove it with a screwdriver as shown at left. Be careful not to scratch the ring.



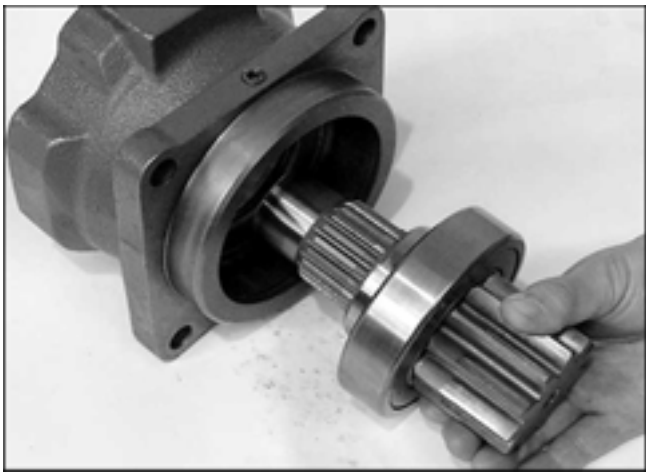
10. Remove the friction plates and mating plates.
    Remove them, paying attention to their orders and numbers.



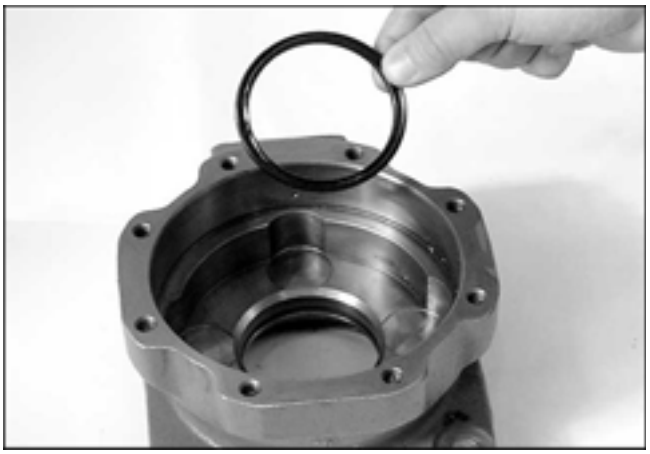
11. Remove the snap ring for shaft.
    Bear in mind that the snap ring may pop out.



12. Remove the snap ring for hole.
    Bear in mind that the snap ring may pop out.

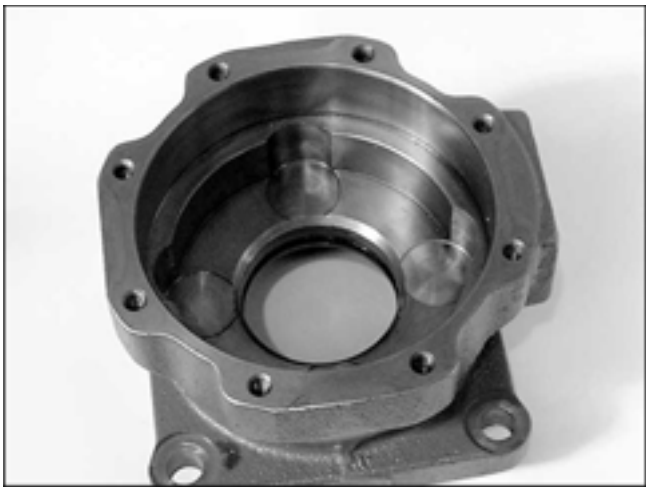


13. Strike out the pinion gear together with the bearing.



14. Remove the X-ring (60 mm dia.).

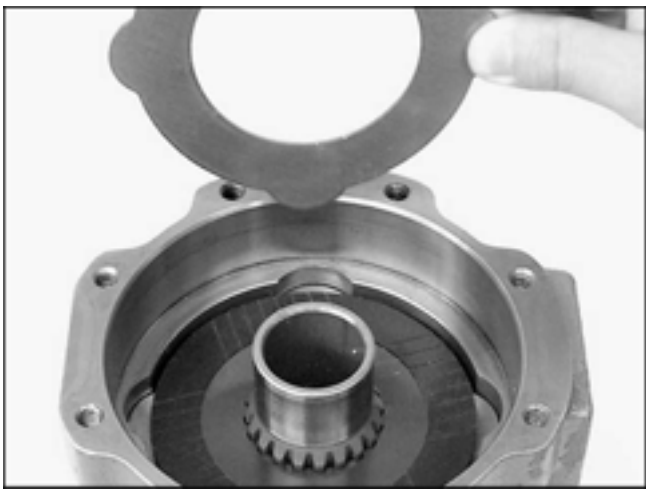
3) Reassembling procedure



Reassemble the parts after washing and checking them for any damage.

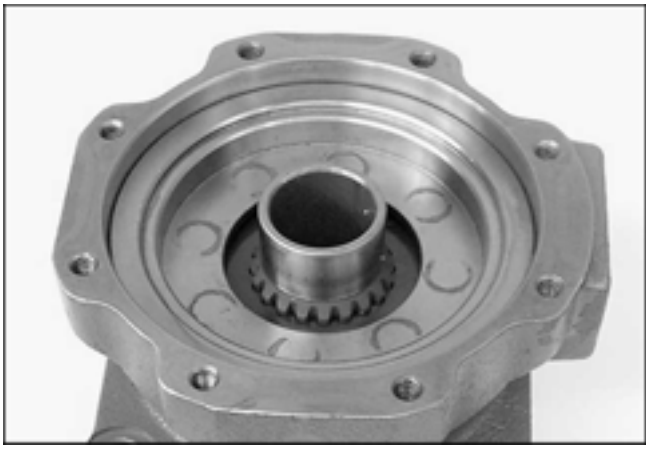
15. Apply hydraulic oil to the X-ring before mounting.

16. Mount the pinion gear and the snap rings for hole and shaft.

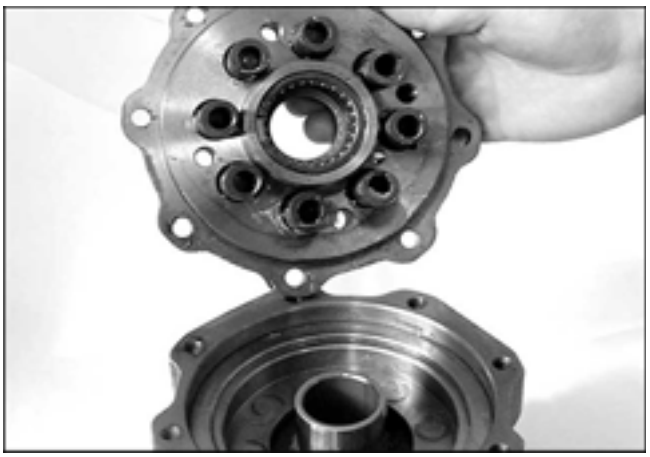


17. Check the friction plates and mating plates for scratches and dust deposits, and assemble them with care not to confuse their orders.

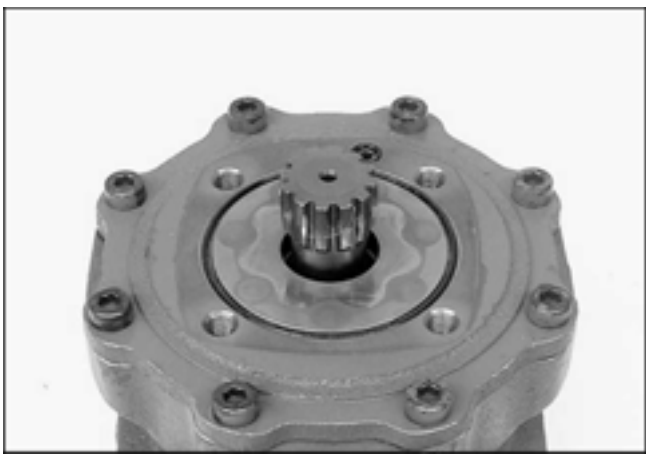
18. Check the inner and outer O-rings of the ring for scratches and distortion, and apply hydraulic oil to them before assembling.



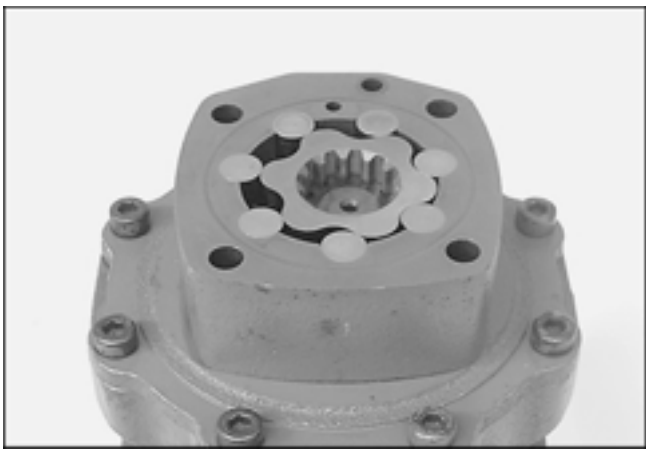
19. Check the outer O-ring of the piston for scratches and distortion, and apply hydraulic oil to it before assembling.



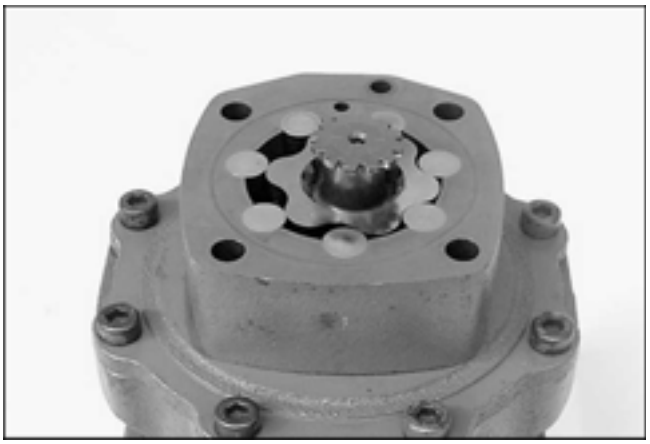
20. Apply grease to the bearing housing before assembling, paying attention not to let the spring drop.
    Tightening torque: 34.3 N·m (35 kgf·m)
    Apply LOCTITE No. 242.



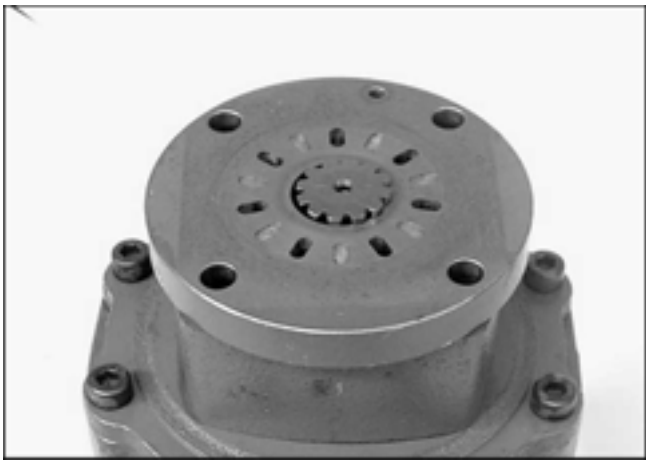
21. Fit the 2 different O-rings into the O-ring grooves of the flange mounting.
    Insert the drive.



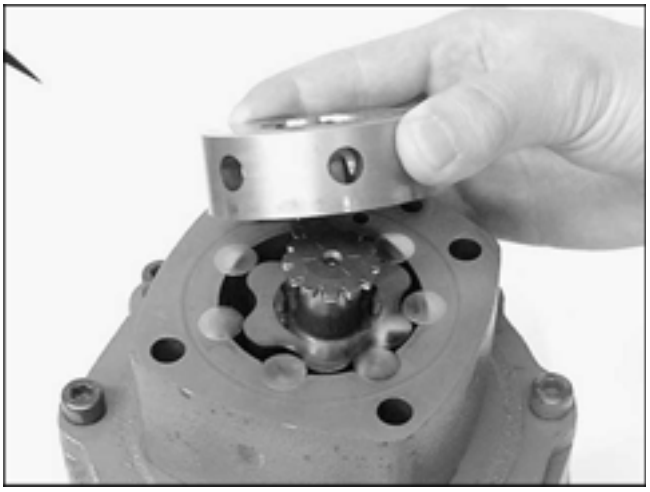
22. Mount the geroller.
    Align it with the drain hole.



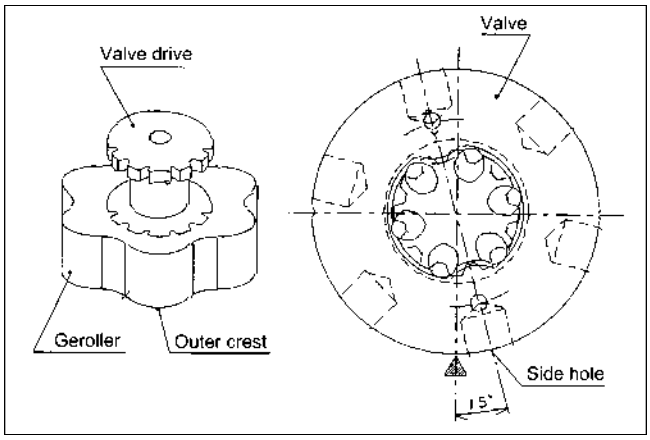
23. Insert the valve drive.

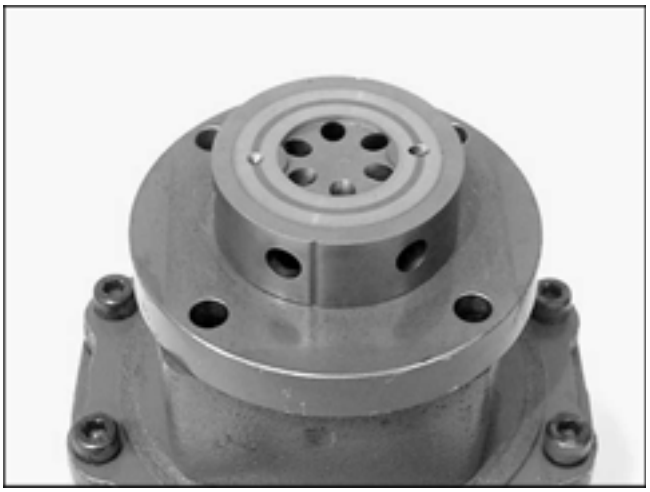


24. Fit the 2 different O-rings into the O-ring grooves of the valve plate.
    Mount the valve plate onto the geroller.
    Align it with the drain hole.



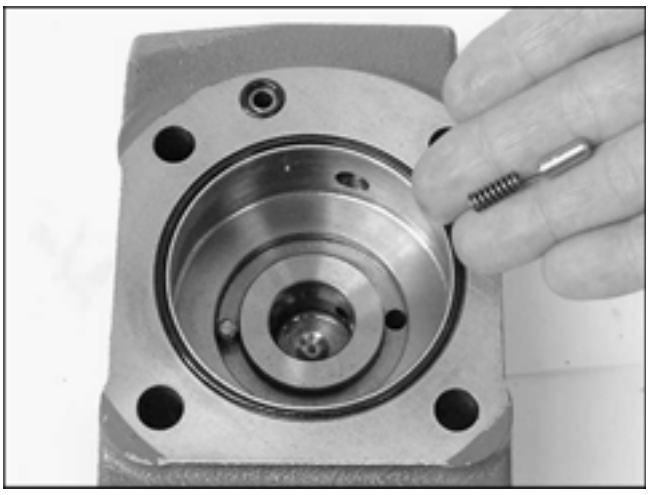
25. Mount the valve.



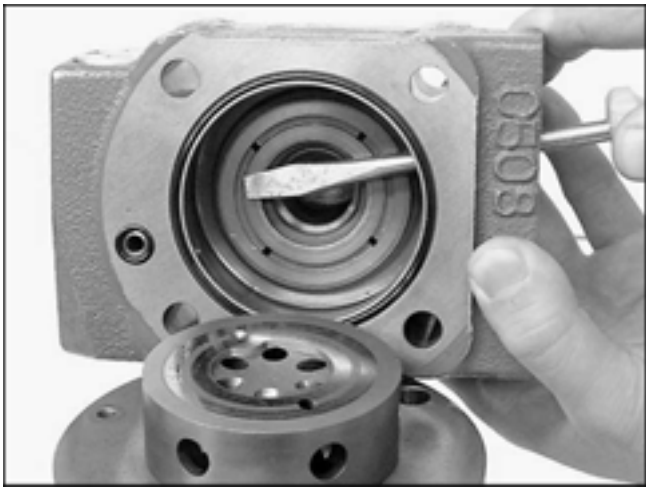


26. Mounting the valve is important for determining the motor rotating direction.
Mount it with care according to the left figure.

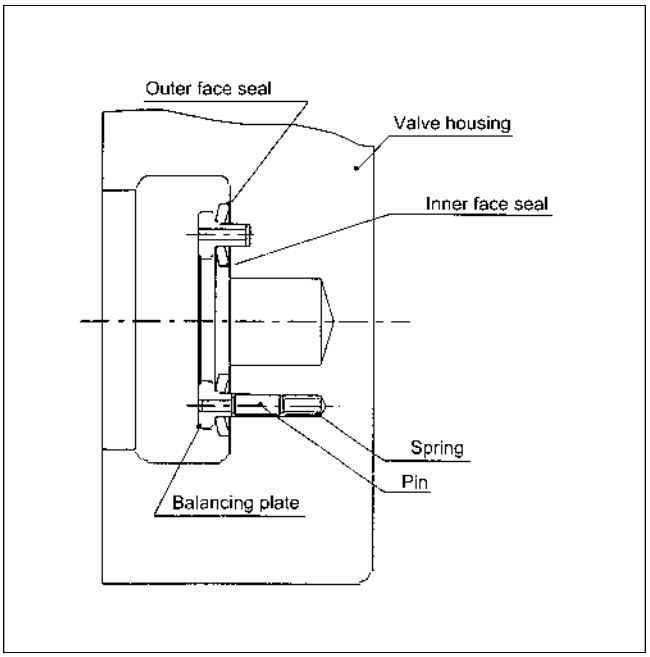
⚠ Wrong timing will rotate the motor in the wrong direction, which causes danger.

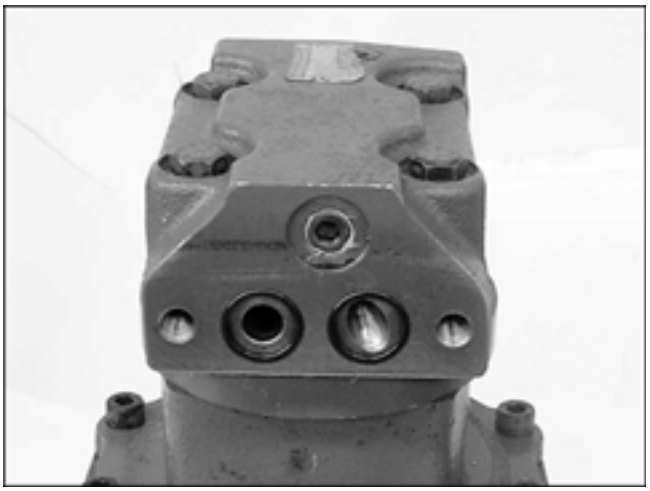


27. Fit the spring and pin to the valve housing.
Fit the outer face seal and inner face seal to the balancing ring.
Mount the balancing ring, with its notch in the pin, into the valve housing.

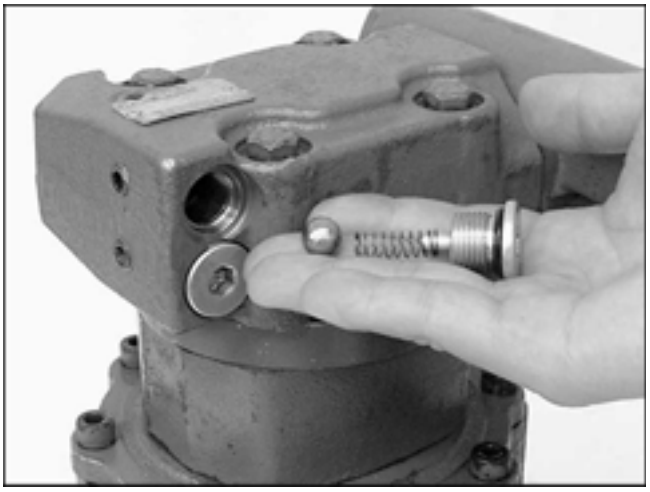


28. Fit the 2 different O-rings into the O-ring grooves of the valve housing.
    Insert a screwdriver or the like from the B port of valve housing, and mount the valve housing to the valve while holding the balancing ring in place.
    Align it with the drain hole.





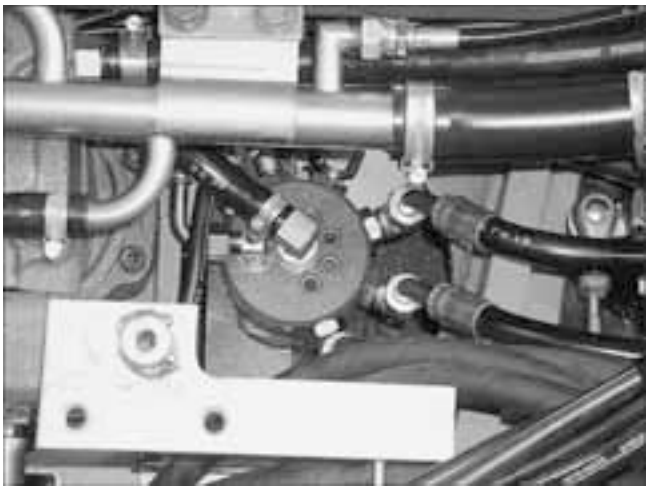
29. Tighten the hex bolt. (53 N·m)
    Tightening torque: 59 N·m (6 kgf·m)
    Apply LOCTITE No. 242.



30. Fit the steel ball, spring and check plug to the valve housing.
    Tightening torque: 59 N·m (6 kgf·m)

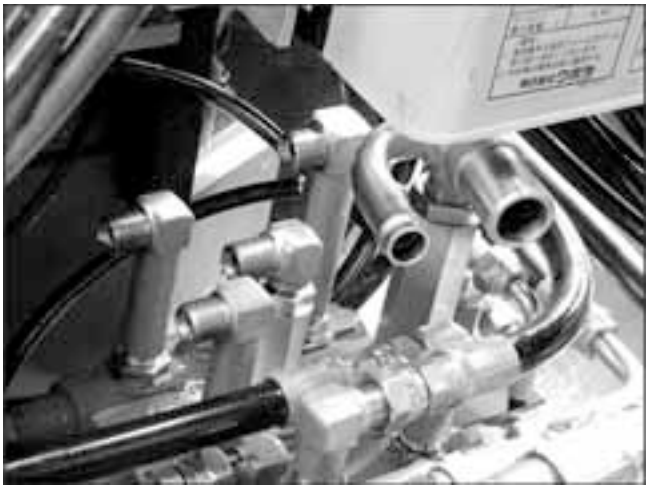
Now the swivel motor has been reassembled.
Before mounting it to the machine, check the motor rotating direction.
Rotating direction (as viewed from the pinion shaft side)
Av port pressurization: Clockwise
Bv port pressurization: Counterclockwise

e. Rotary joint (Swivel joint)

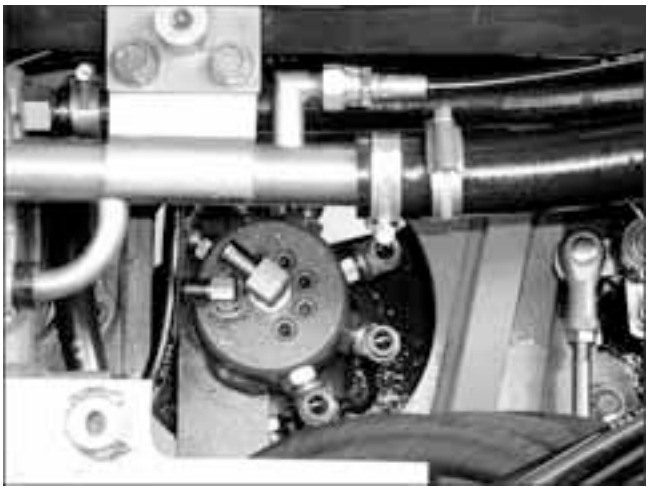


1) Mounting and dismounting procedure

1. Let out the hydraulic oil.
2. Dismount the steps.
3. Disconnect the return, bucket and boom hoses from the control valve.
4. Disconnect the travel, dozer, 2-speed select and drain hoses.
   * Disconnect them from the upper side (shaft side).

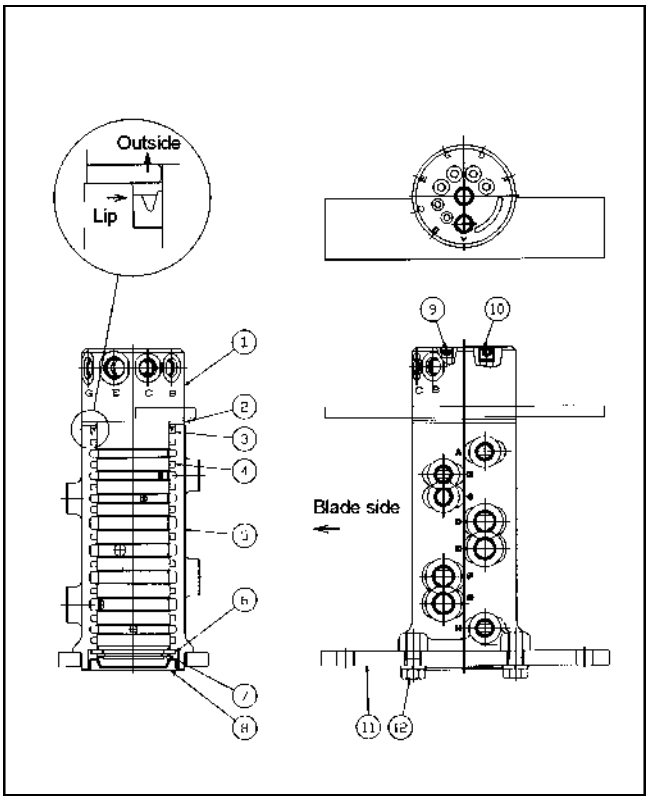


5. When disconnecting the travel motor hose from the control valve, loosen the return joint 90 degrees. It helps disconnect the hose easily.



6. Disconnect the 10 hoses, including the travel, dozer, 2-speed select and drain hoses, from the bottom.

7. Remove the 4 lock bolts.
   (Place a jack below the machine or apply ropes or the like to the machine to avoid a fall.)
   Tightening torque of swivel joint assembly and track frame:
   166.7~196.1 N·m (17.0~20.0 kgf·m)
   Apply screw LOCTITE. (LOCTITE 271)



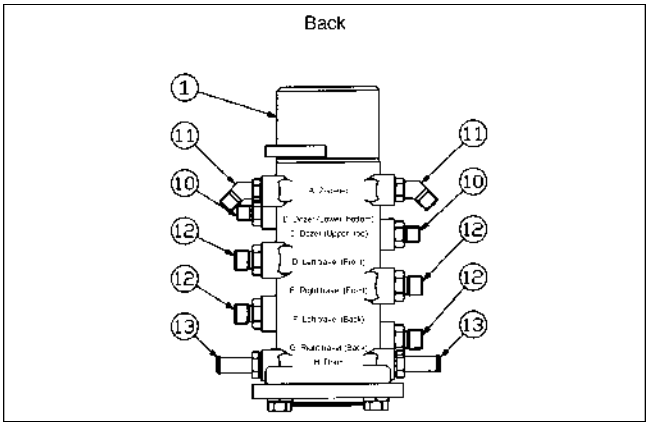
2) Reassembling procedure

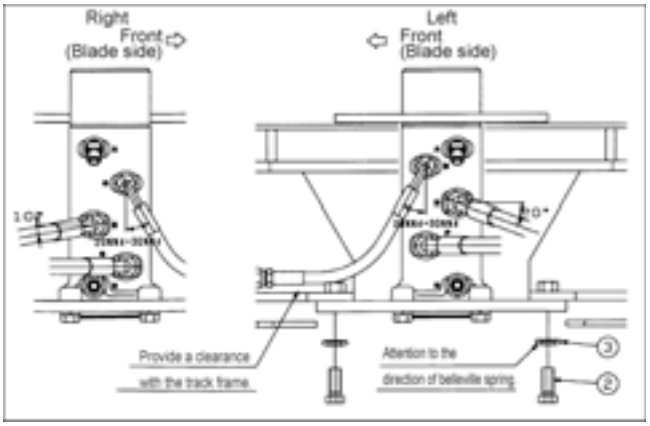
1. Check the outer casing, inner casing and seals for scratches and dust deposits before reassembling.
2. Fit the packing with its seal lip facing outward. (Apply grease to the outer and inner faces of the lip.)
3. When connecting the shaft to the body, apply grease to the outer and inner faces.
4. Tightening torque of swivel joint assembly and stay:
   77.5~90.2 N·m (7.9~9.2 kgf·m)
   Apply screw LOCTITE. (LOCTITE 271)
5. When mounting the plugs (PT1/8, PT1/4), tighten them so that they do not stretch out of the shaft end.

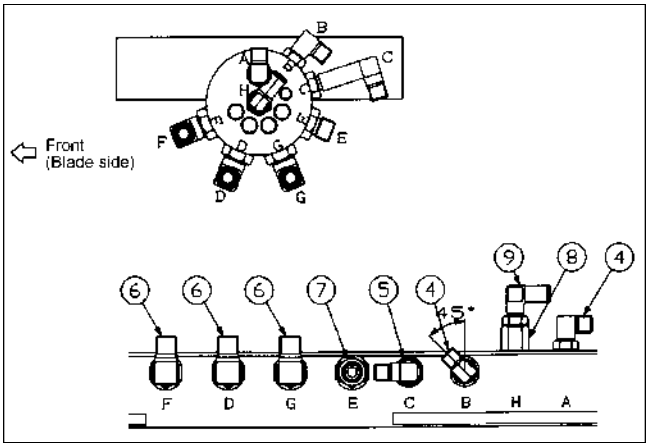
No.	Part No.	Part name	Q'ty	Remarks
1	RB411-6232Δ	Shaft (Swivel joint)	1	
2	RC411-6234Δ	Collar (Swivel joint)	1	
3	RC411-6241Δ	Packing	1	
4	RC411-6238Δ	Packing (Swivel joint)	9	
5	RB411-6231Δ	Body (Swivel joint)	1	
6	RC411-6237Δ	Collar	1	
7	04612-00500	Snap ring for shaft	1	
8	31353-4285Δ	Plug	1	
9	68311-1338Δ	Plug (PT1/8)	2	
10	68311-1335Δ	Plug (PT1/4)	4	
11	RB411-6236Δ	Stay (Swivel joint)	1	
12	01133-61230	Bolt	4	M10×1.25 7T

Insert the seal ring using a specific tool.

Seal inserting tool Tool No.: KS000-00130



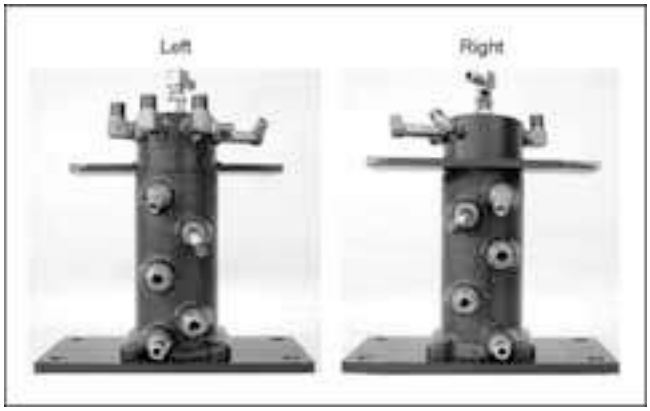


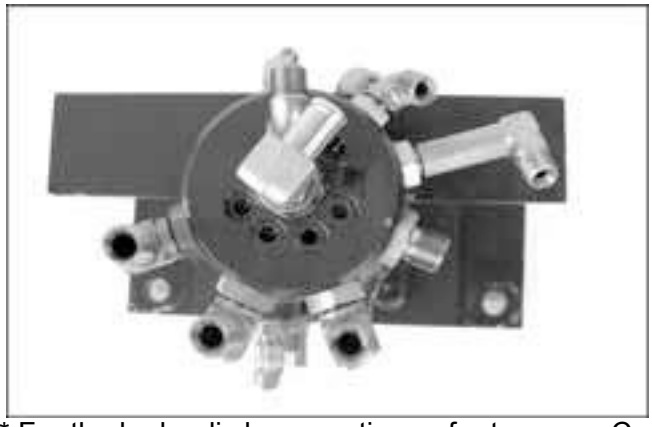


3) Mounting the adaptor

1. Mount the adaptor as shown in the figure and photo.
2. Tightening torque of hydraulic adaptor:
   G1/4 24.5 ~ 28.4 N·m (2.5~3.0 kgf·m)
   G3/8 49.0 ~ 53.9 N·m (5.0~5.5 kgf·m)
3. Parts list.

	No.	Part No.	Part name	Q'ty	Remarks
	1	RB411-6230Δ	Swivel joint, assembly	1	
	2	01176-61440	Bolt	4	M14×1.5 9T
	3	35358-27371	Plain spring	4	
Shaft side	4	RC601-63721	Pipe joint (L. G1/4~G1/4)	2	A·B
Shaft side	5	69254-78491	Pipe joint (L. G1/4~G1/4)	1	C
Shaft side	6	RP201-61812	Pipe joint (L. G3/8~G3/8)	3	D·F·G
Shaft side	7	68311-64321	Straight pipe joint	1	E
Shaft side	8	RC411-63881	Pipe joint (Bushing G1/4)	1	H
Shaft side	9	RD401-63951	Elbow pipe joint (G4 ~13)	1	H
Shaft side		04810-00110	O-ring	5	For 1/4 A·B·C·H
Shaft side		04810-00140	O-ring	4	For 3/8 A·B·C·H
Body side	10	06112-52027	Straight pipe joint	2	B·C
Body side	11	RP301-61861	Pipe joint (L. G1/4~G1/4)	2	A
Body side	12	68311-64321	Straight pipe joint	4	D·E·F·G
Body side	13	RC101-63971	Straight pipe joint (F2~13)	2	H
Body side		04810-00110	O-ring	6	For 1/4 A·B·C·H
Body side		04810-00140	O-ring	4	For 3/8 A·B·C·H





* For the hydraulic hose routing, refer to pages C-30 and 31.

f. Traveling motor

[1] Mounting and dismounting the wheel motor

1) Mounting and dismounting the wheel motor

1. Loosen the tension cylinder and remove the crawler

⚠ CAUTION:
If you work together with a person to remove the crawler, pay attention to the positions of your and the person's feet and hands.

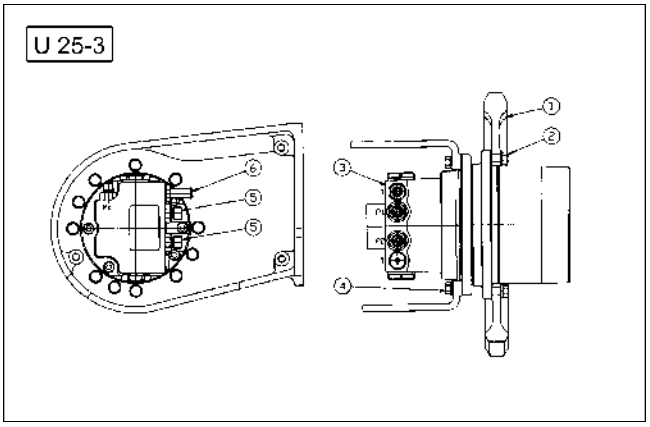
2. Remove the motor cover and then remove the high-pressure hose and drain hose, using a vacuum pump.
3. Remove the wheel motor mounting bolt and remove the wheel motor from the track frame.

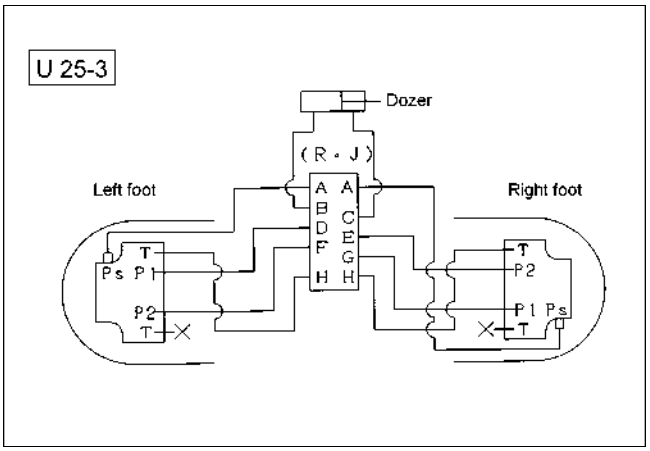
- Tightening torque of motor (track frame, sprocket):
  166.7~196.1 N·m (17.0~20.0 kgf·m)
  Apply screw LOCTITE. (LOCTITE No. 271)

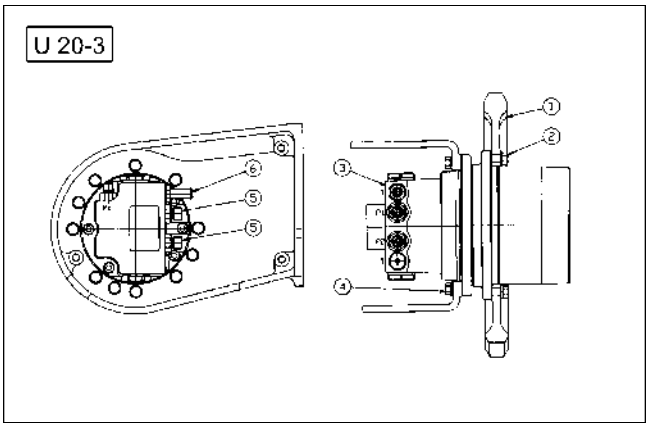
2) Reassembling procedure

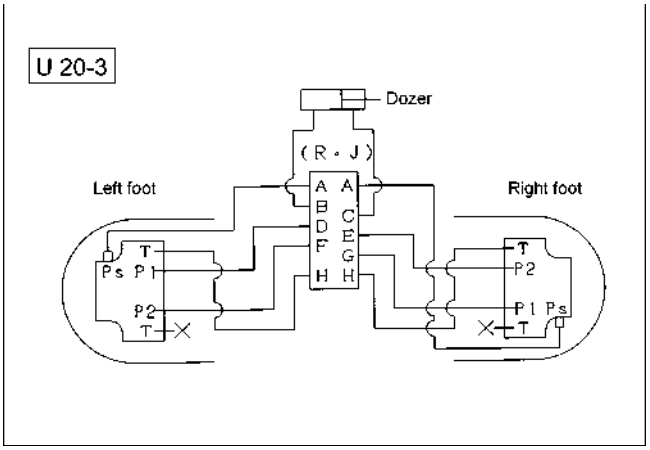
1. When installing the wheel motor on the track frame, face the port side to the front.
2. Face the motor drain hose upward and the plug downward.
3. The hoses connected between the motor and swivel joint should not be twisted or crossed unduly in the track frame.

[2] List of adapter hoses









Parts list

No.	Part No.	Part name	Q'ty	Remarks
1	RB511-1443Δ	Drive sprocket	2	(111)
2	01128-61025	Bolt	20	M10×1.5 9T
3	RB511-6129Δ	Motor assembly (wheel)	2	Kayaba-made (614)
4	01128-61025	Bolt	24	M10×1.5 9T
5	68311-6432Δ	Straight pipe joint	4	P1•P2
6	RC101-6397Δ	Straight pipe joint (F2-13)	2	T upper side
	04810-00110	O-ring	2	For 1/4 T
	04810-00140	O-ring	4	For 3/8 P1•P2

Parts list

Location	Part No.	Part name	Q'ty	Dimension (mm)	Tape color
R/J to travel M travel (upper side)	RB511-6371Δ	Hydraulic hose (travel, 3/8)	2	920	Red
R/J to travel M travel (lower side)	RB511-6375Δ	Hydraulic hose (travel, 3/8)	2	920	
R/J to travel M two-speed	RB511-6372Δ	Hydraulic hose (two-speed, 1/4)	2	1030	
R/J to connection (dozer)	RB511-6472Δ	Hydraulic hose (blade, 1/4)	2	255	
Joint to dozer cylinder	RB511-6473Δ	Hydraulic hose (blade, 1/4)	2	590	

Hose routing

S/J side	Travel motor and cylinder side
A Two-speed pilot	Right/Left travel two-speed
B Dozer down	Cylinder bottom side
C Dozer up	Cylinder rod side
D Left forward	Left P1 (upper side)
E Right forward	Right P2 (upper side)
F Left backward	Left P2 (lower side)
G Right backward	Right P1 (lower side)
H Drain	Right/Left drain port (upper side)

Parts list

No.	Part No.	Part name	Q'ty	Remarks
1	RB411-1443Δ	Drive sprocket	2	(111)
2	01128-61025	Bolt	18	M10×1.5 9T
3	RB411-6129Δ	Motor assembly (wheel)	2	Fujikoshi-made (614)
4	01128-61025	Bolt	16	M10×1.5 9T
5	RB411-6394Δ	Straight pipe joint (3-3-35)	4	A•B
6	06112-52027	Straight pipe joint	2	PP
7	RC101-6397Δ	Straight pipe joint (F2-13)	2	DP upper side
	04810-00110	O-ring	4	For 1/4 PP•DR
	04810-00140	O-ring	4	For 3/8 A•B

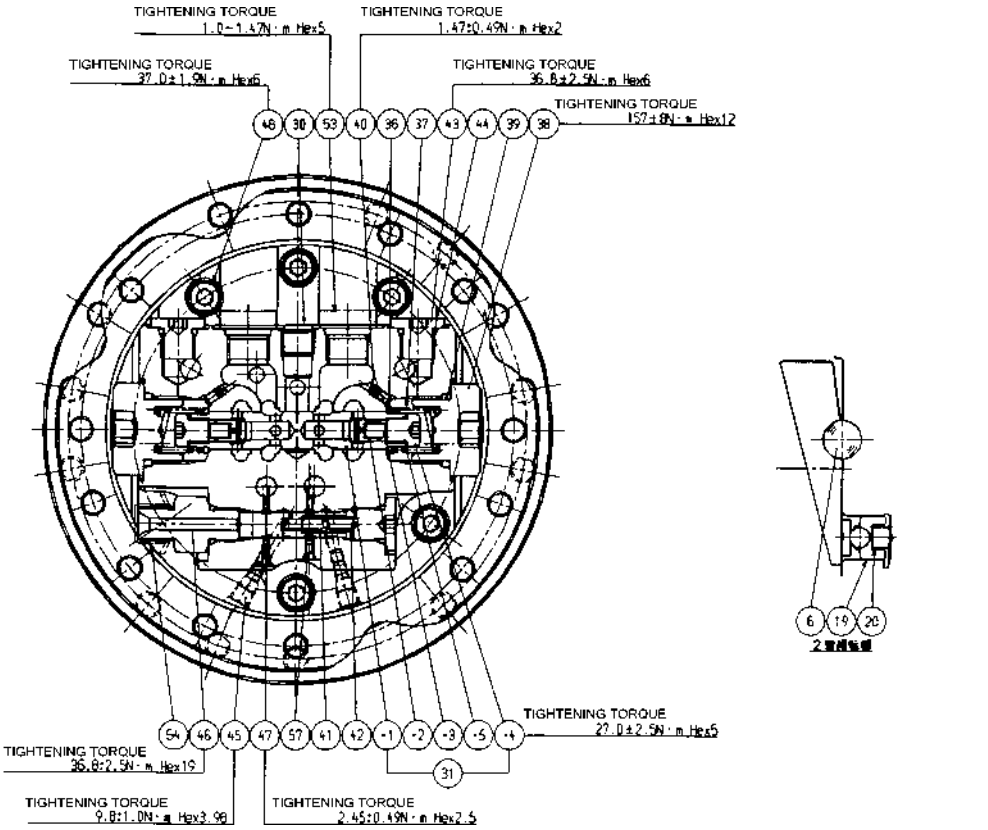
Parts list

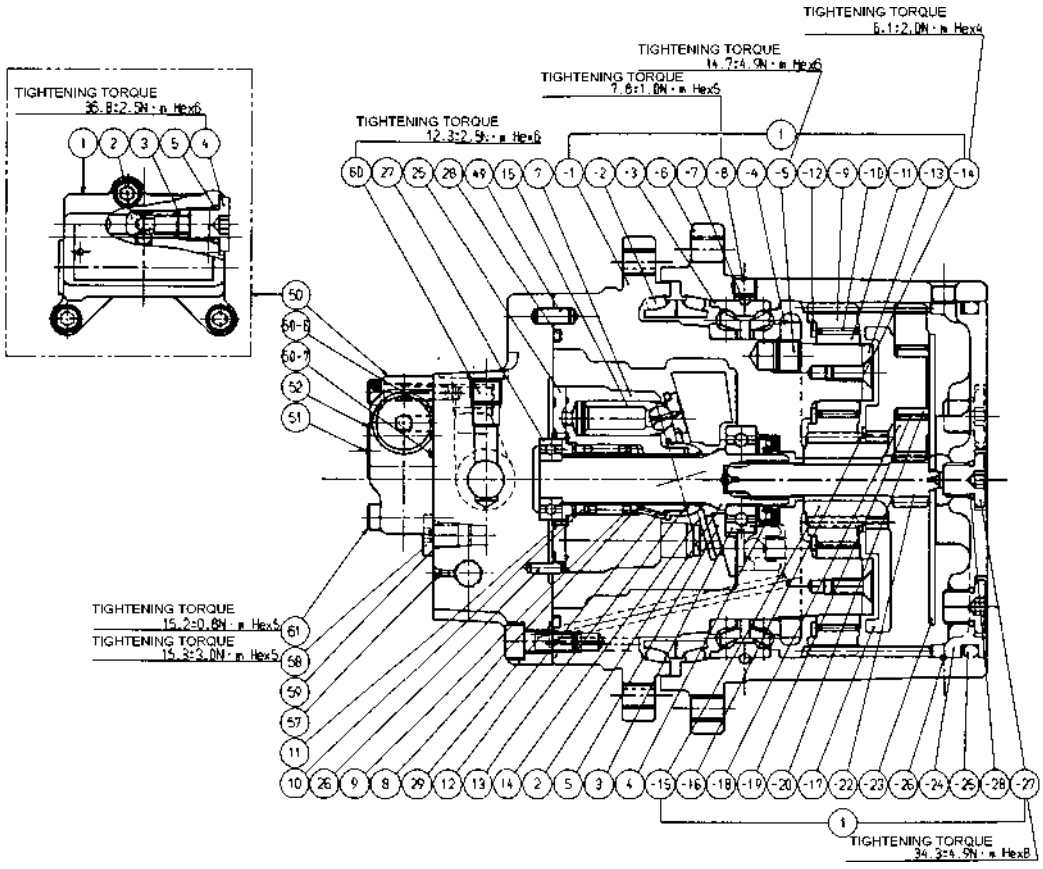
Location	Part No.	Part name	Q'ty	Dimension (mm)	Tape color
R/J to travel M travel (upper side)	RB411-6371Δ	Hydraulic hose (travel, 3/8)	2	840	Red
R/J to travel M travel (lower side)	RB411-6375Δ	Hydraulic hose (travel, 3/8)	2	840	
R/J to travel M two-speed	RB411-6372Δ	Hydraulic hose (two-speed, 1/4)	2	890	
R/J to connection (dozer)	RB411-6472Δ	Hydraulic hose (blade, 1/4)	2	240	
Joint to dozer cylinder	RB411-6473Δ	Hydraulic hose (blade, 1/4)	2	490	

Hose routing

S/J side	Travel motor and cylinder side
A Two-speed pilot	Right/Left travel two-speed
B Dozer down	Cylinder bottom side
C Dozer up	Cylinder rod side
D Left forward	Left A (upper side)
E Right forward	Right B (upper side)
F Left backward	Left B (lower side)
G Right backward	Right A (lower side)
H Drain	Right/Left drain port (upper side)

[3] Component parts of wheel motor





Parts list

Part No.	Name	Q'ty
1	Reducer	1
1-1	Flange holder	1
1-2	Floating seal	2
1-3	Angular bearing	1
1-4	Ring nut	1
1-5	Plug	2
1-6	Housing	1
1-7	Steel ball	109
1-8	Hex socket plug	2
1-9	Planetary gear B	4
1-10	Needle bearing	4
1-11	Inner race	4
1-12	Thrust washer	4
1-13	Thrust plate	1
1-14	Screw	4
1-15	Sun gear	1
1-16	Snap ring	1
1-17	Holder	1
1-18	Planetary gear A	3
1-19	Cage & Roller	3
1-20	Inner race	3
1-22	Drive gear	1
1-23	Thrust plate	1
1-23	Thrust plate	1
1-23	Thrust plate	1
1-24	Cover	1
1-25	O-ring	1
1-26	Wire	1
1-27	Plug	2
1-28	O-ring	2
2	Shaft	1
3	Ball bearing	1
4	Oil seal	1
5	Swash plate	1
6	Steel ball	2
7	Cylinder block	1
8	Spring seat	1
9	Spring	1
10	Washer	1
11	Snap ring	1
12	Pin	3
13	Retainer holder	1
14	Retainer plate	1
15	Piston assembly	9
19	Piston assembly	2

Part No.	Name	Q'ty
20	Spring	2
25	Valve plate	1
26	Pin	1
27	Ball bearing	1
28	O-ring	1
29	O-ring	3
30	Base plate	1
31	Spool assembly	1
31-1	Spool	1
31-2	Check valve	2
31-3	Spring	2
31-4	Plug	2
31-5	O-ring	2
36	Spring seat	2
37	Spring	2
38	Cap	2
39	O-ring	2
40	Orifice	2
41	Spool	1
42	Spring	1
43	Plug	3
44	O-ring	4
45	Plug	2
46	Plug	1
47	Orifice	4
48	Socket head bolt	6
49	Pin	2
50	Valve assembly	1
50-1	Valve body	1
50-2	Check valve	2
50-3	Spring	2
50-4	Plug	2
50-5	O-ring	2
50-6	O-ring	2
50-7	O-ring	1
51	Nameplate	1
52	Drive screw	2
53	Shipping plug	2
54	Shipping plug	1
57	Plug	2
58	Plug	2
59	O-ring	2
60	Plug	1
61	Socket head bolt	3

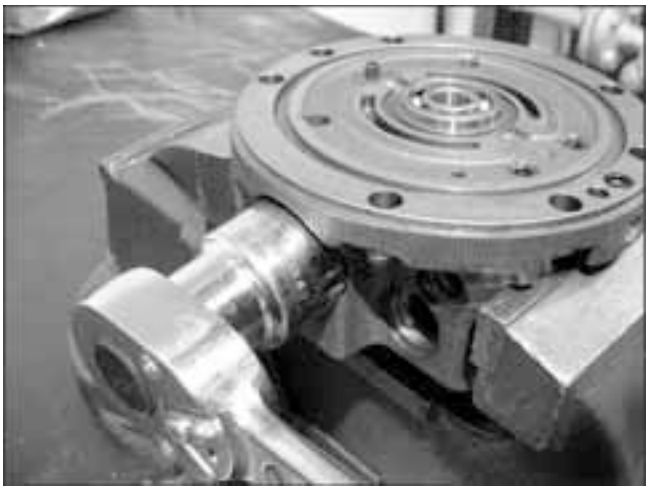
[4] Disassembling and reassembling the wheel motor

1) General cautions in disassembling/reassembling

In disassembling and reassembling, observe the following precautions.

1. Perform work in a clean place and take care not to allow dirt, dust, paint flakes, water, etc. to adhere to the motor. Have a clean container handy so that the removed parts can be put in it.
2. Before disassembling, clean dirt off the outer surface of the motor, and remove paint from the joints of each section using a wire brush or the like.
3. Put a marking on each part before disassembling so that it can be put back in place at the time of reassembling.
4. Carefully handle the removed parts so that they are not damaged.
5. Well wash the removed parts with washing oil, etc.
6. Check the removed parts for abnormal wear or seizure. Remove burrs etc., if any.
7. The seals and snap rings should be replaced with new ones.
8. Note that the parts to be press-fitted (bearing, pin, etc.) cannot be disassembled in principle.

1. Insert the spool assembly ring (both sides) and spring (both sides) into the body 1.



2. Tighten the plug (both sides) to which the O-ring is fitted.

   Tightening torque of plug: 167~196 N·m (17~20 kgf·m)

   Width across flat of hexagon: 27 mm

3. Insert the two-speed spool and spring into the body 1.

4. Tighten the plug (both sides) to which the O-ring is fitted.

   Tightening torque of plug: 46~51 N·m
   (4.7~5.3 kgf·m)

   Take care that the spool and spring are positioned and oriented properly.

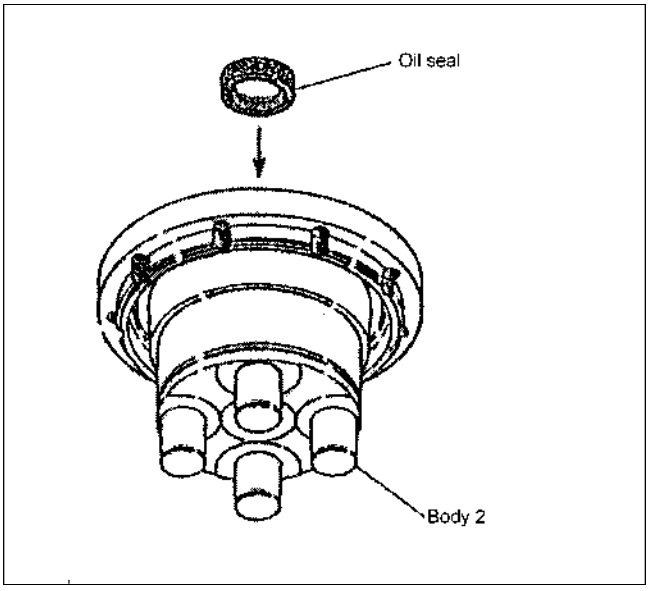
5. Insert the shuttle spool and needle (both sides) in to the body 1.

6. Tighten the plug (both sides) to which the O-ring is fitted.

   Tightening torque of plug: 12~22 N·m
   (1.2~2.3 kgf·m)

   Width across flat of hexagon: 5 mm

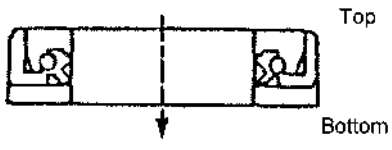
7. Press-fit the bearing and spring pin into the body 1. Then fit the O-rings (2 places).



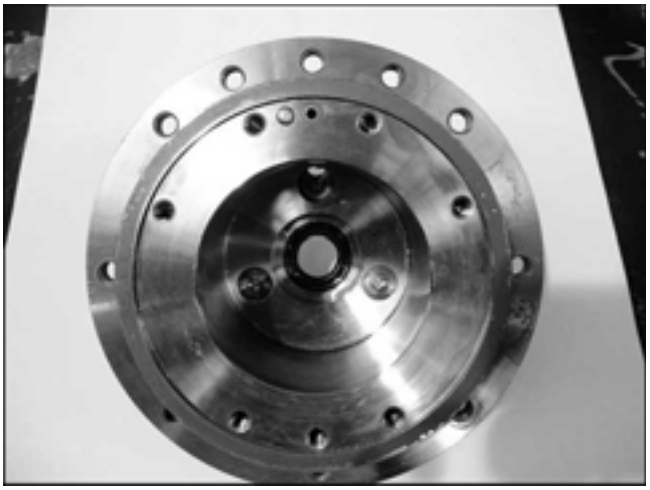
8. Press-fit the oil seal into the body 2.

⚠ CAUTION:

1. Apply grease to between the lips of the oil seal
2. Press-fit the oil seal in the direction shown in the figure below.



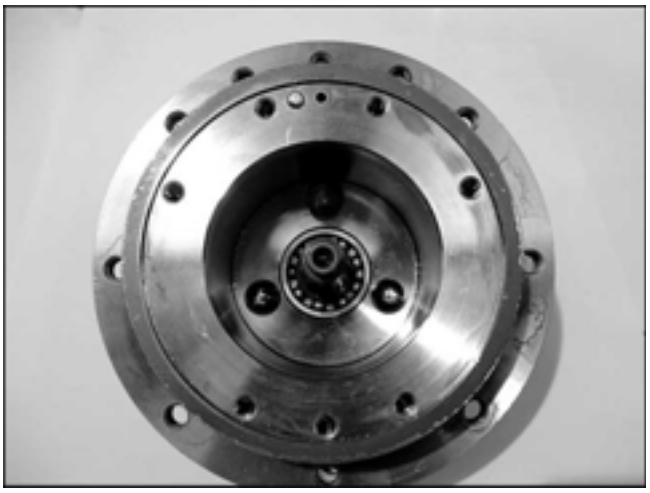
Oil seal press-fitting direction



9. Fit the parallel pin to the body 2.

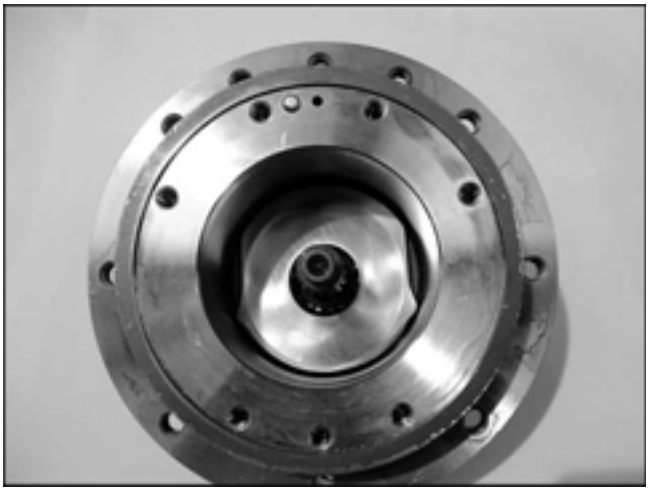
10. Press-fit the bearing onto the shaft.

⚠ CAUTION:
The bearing cannot be disassembled because it is press-fitted.

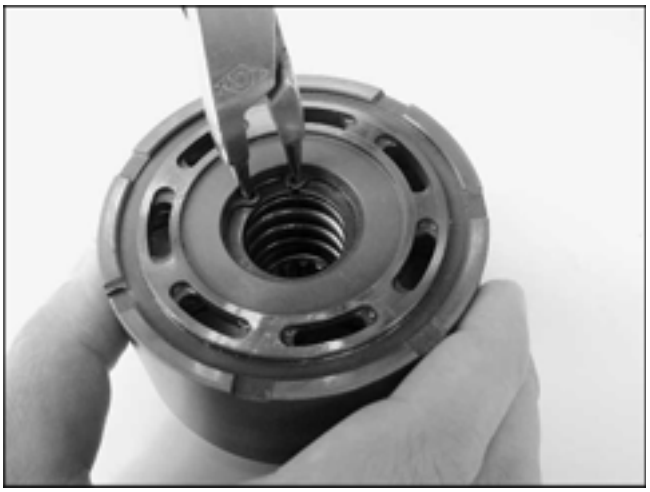


11. Fit the control piston, steel ball and shaft to the body 2.

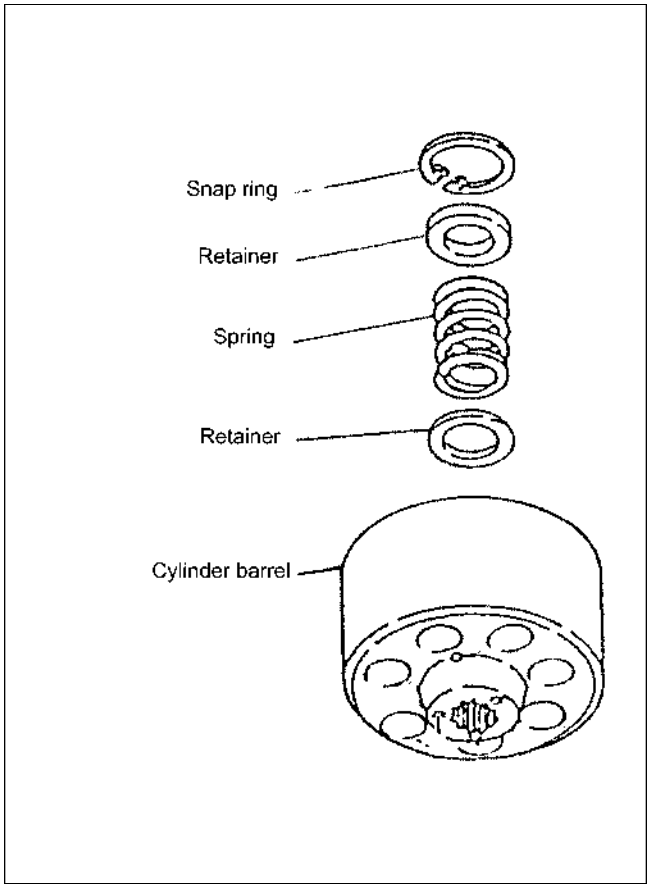
⚠ CAUTION:
Take care not to allow the shaft to damage the oil seal.

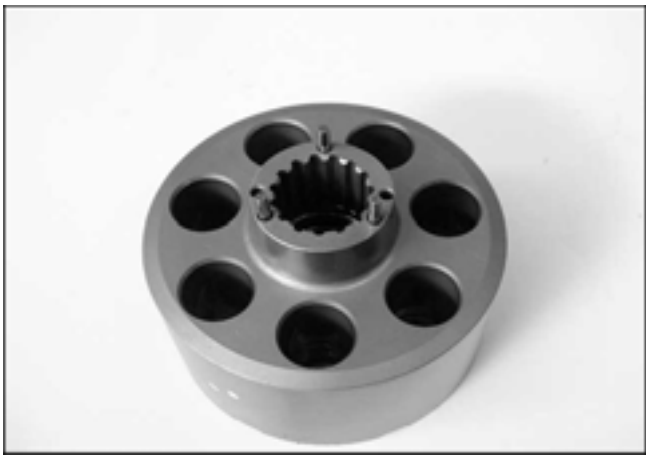


12. Fit the swash plate.



13. Fit the retainer, spring and retainer to the cylinder barrel in this order and fix them with the snap ring.





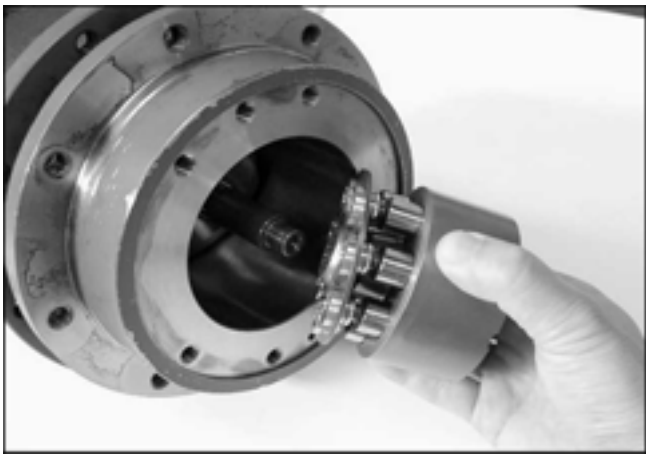
14. Insert the pins (3 pairs) into the cylinder barrel.

CAUTION:
Take care not to lose the pin at the time of disassembling/assembling.

15. Fit the retainer holder to the cylinder barrel.

16. Using the shoe holder assembly and barrel holder, assemble the cylinder barrel assembly.

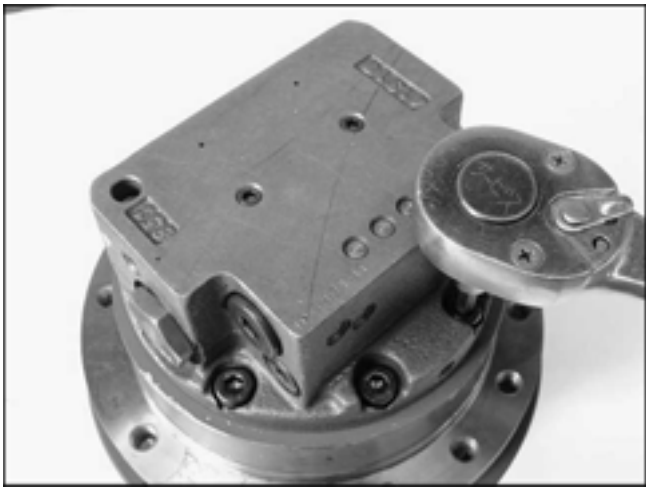
CAUTION:
Apply hydraulic oil to the seven holes in the cylinder barrel.



17. Fit the cylinder barrel assembly to the body 2 so that the shoe touches the swash plate.

18. Fit the valve plate to the body 1.
    1) Apply hydraulic oil to the sliding surface (copper surface) of the valve plate.
    2) Applying grease to the back surface (iron surface) of the valve plate will prevent it from coming off easily.

19. Combine the body 1 and body 2.



20. Tighten with the hex socket bolt.

    Tightening torque of M8 bolt:
    28.4~30.4 N·m (2.8~3.1 kgf·m)

    Width across flat of hexagon: 5 mm

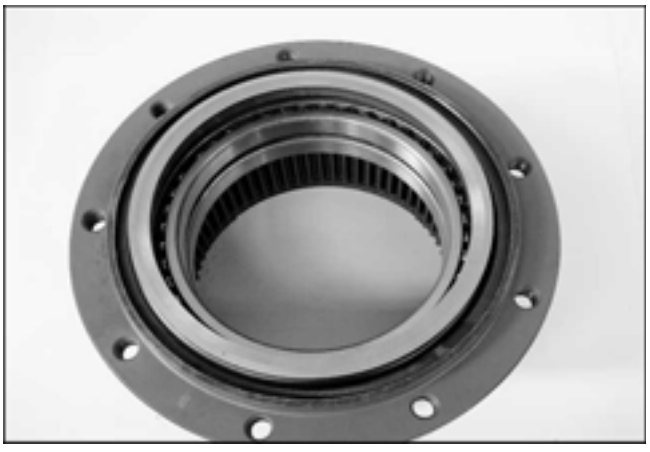
    When fixing the motor with a vise, protect the body with aluminum plates, etc.

2) Reassembling the reducer

1. Fit the bearing to the main body.

2. Fit the snap ring for hole.

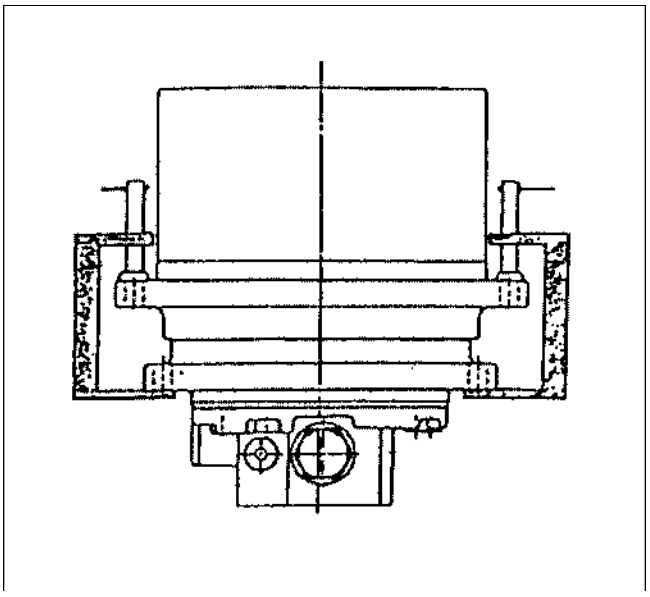
3. Fit the bearing.

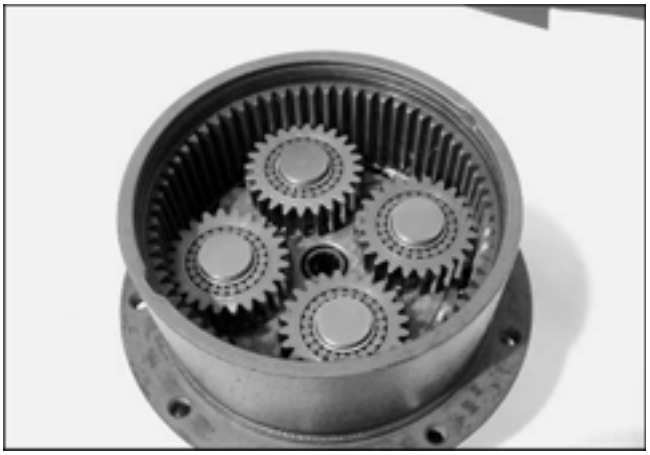


4. Fit the floating seat combined with the O-ring.
   * If it is difficult to fit it, apply grease to the O-ring.

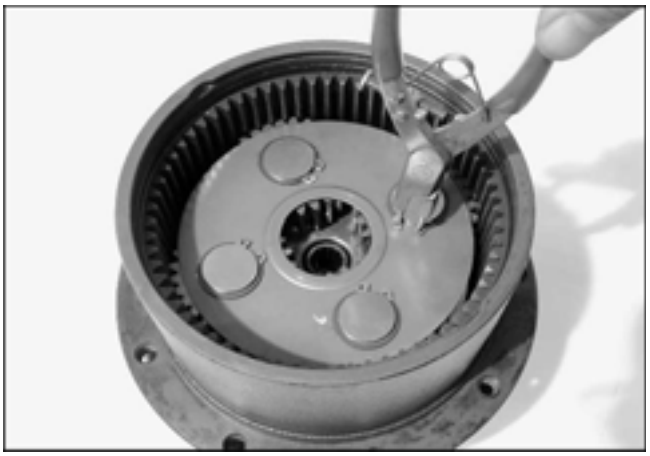
5. Fit the floating seat combined with the O-ring to the hydraulic motor.
   * If it is difficult to fit it, apply grease to the O-ring.

6. Combine the main body and the hydraulic motor and fix them with the snap ring.
   1) Degrease the seat surface of the floating seat.
   2) If it is difficult to fit the main body, evenly hit the periphery of the main body with a resin hammer to fit it.
   3) Fit the snap ring while clamping the reducer main body flange and hydraulic motor flange with a squill vise, hydraulic press, etc.
   4) Adjust the bearing preload with the thickness of the snap ring.



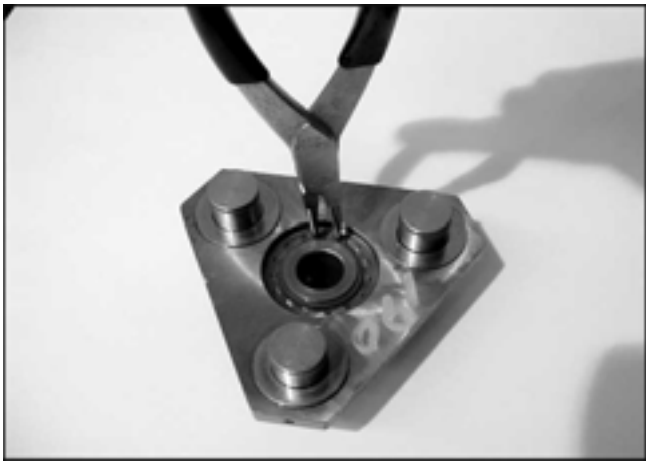


7. Fit the ring, thrust washer, gear b1 and needle to the body 2 in this order.

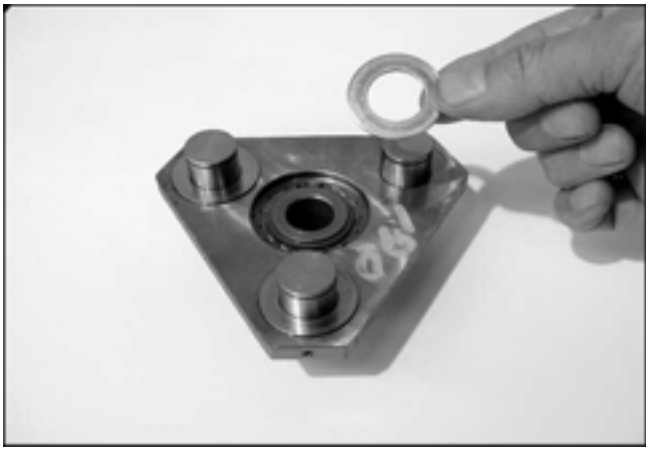


8. Fit the thrust plate 1 and fix it with the snap ring.

CAUTION:
Fit the plate with the convex surface of the inside diameter side faced upward.



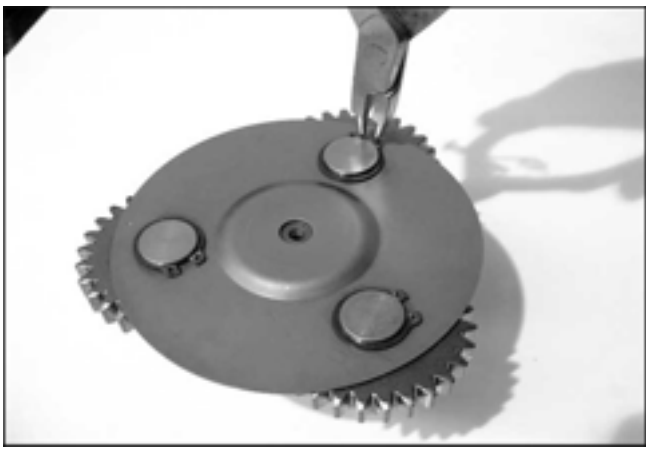
9. Fit the gear S1 to the carrier II and fix it with the snap ring.



10. Fit the thrust washer to the carrier II.

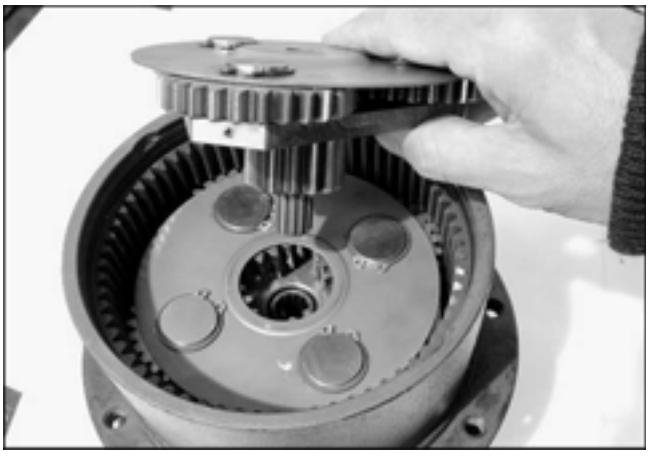
11. Fit the gear b2 and needle to the carrier II in this order.

12. Fit the gear S2.

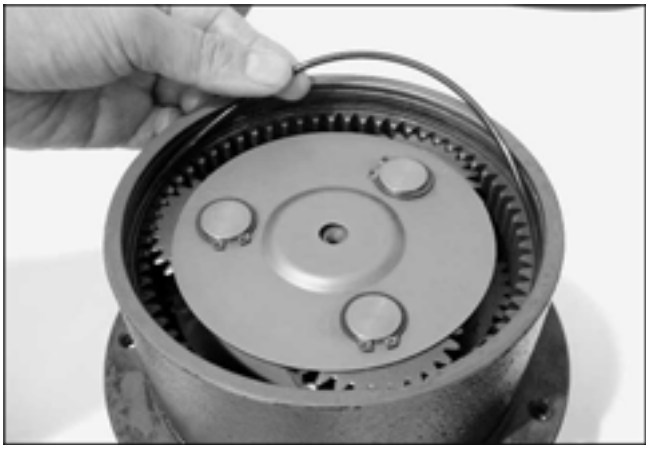


13. Fit the thrust plate II and fix it with the snap ring to assemble the carrier II assembly.

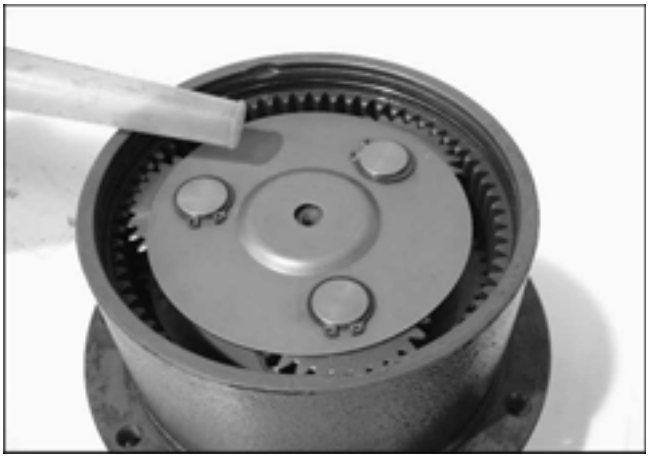
⚠ CAUTION:
Fit the plate with the convex surface faced upward.



14. Fit the carrier II assembly to the main body.

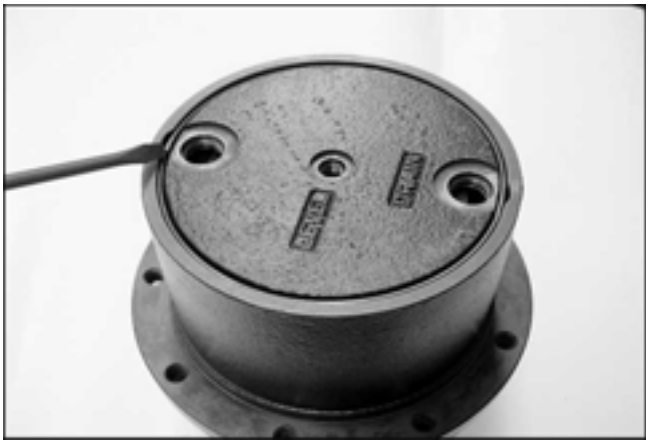


15. Fit the O-ring to the main body.



16. Inject 0.33L of lubricating oil.

17. Fit the cover to the main body.
    1) Apply grease to the O-ring and fit the cover horizontally while taking care not to damage it.
    2) Align the upper and lower tapped holes (G3/8) with the notches in the main body



18. Fit the O-snap-ring and fix the cover.
    1) Put a flatblade screwdriver on the end face of the O-snap-ring and strike it in the circumferential direction.

19. Fit the flanged plug (G3/8) to which the O-ring is fitted.

CAUTION:
1. As shown in the figure below, use the flange of the plug to prevent the cover from turning.

   Tightening torque: 46 ~ 51 N·m (4.7 ~ 5.2 kgf·m)

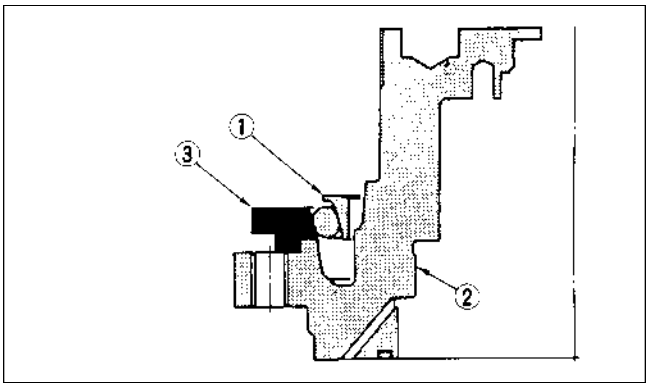
   Width across flat of hexagon: 8 mm

20. Fit the flanged plug (G1/8) to which the O-ring is fitted.

CAUTION:
1. Tightening torque: 12 ~ 22 N·m (1.2 ~ 2.3 kgf·m)

   Width across flat of hexagon: 5 mm

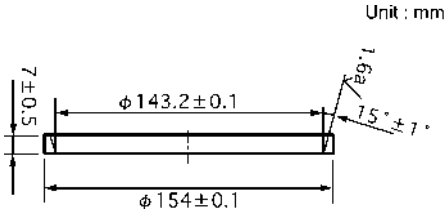
3) Reassembling the wheel motor

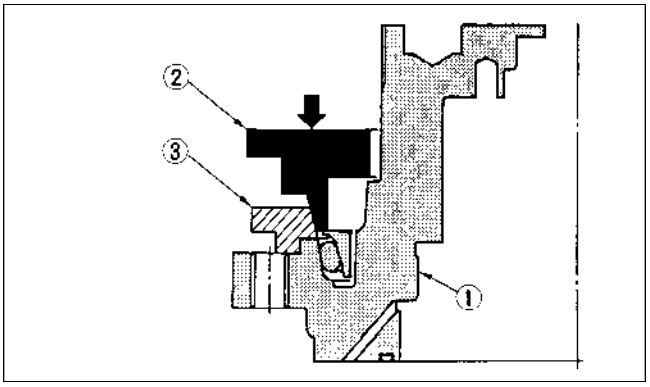


1. Fit the floating seal
   1) Temporarily set the floating seal using the guide jig (see the figure below).

(1) Floating seal
(2) Flange holder
(3) Guide jig

Unit : mm



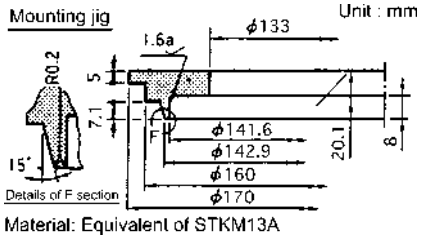


   2) Fit the floating seal using the mounting jig (see the figure below).

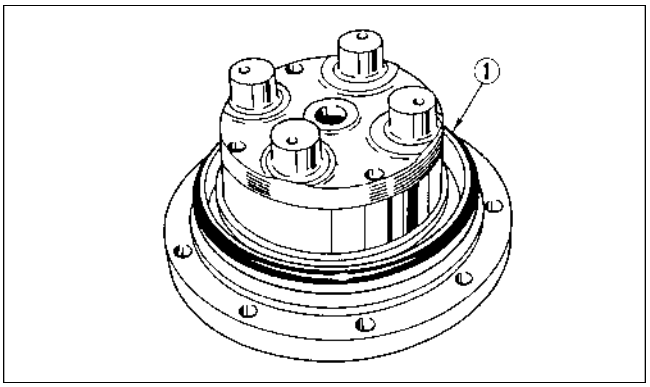
(1) Flange holder
(2) Mounting jig
(3) Guide jig

Mounting jig

Unit : mm

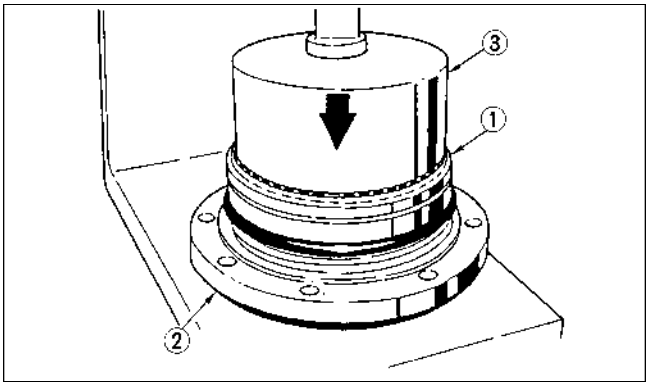


Material: Equivalent of STKM13A



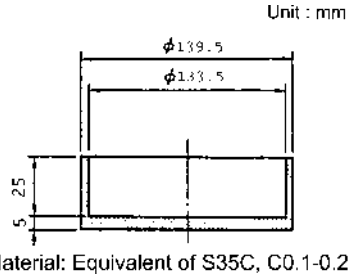
2. Place the other floating seal concentrically.

(1) Floating seal



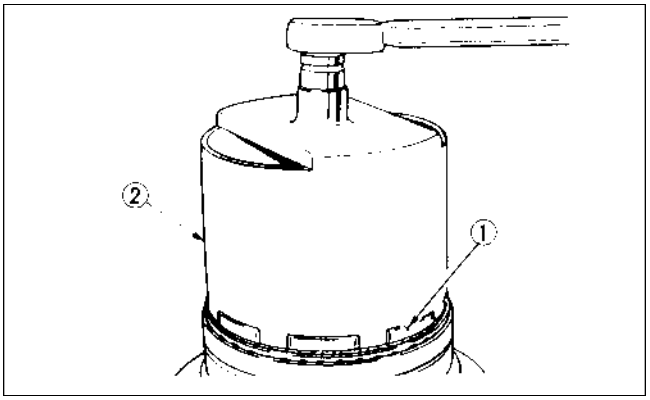
3. Press-fit the angular bearing into the flange holder using the mounting jig (see the figure below).

Unit : mm



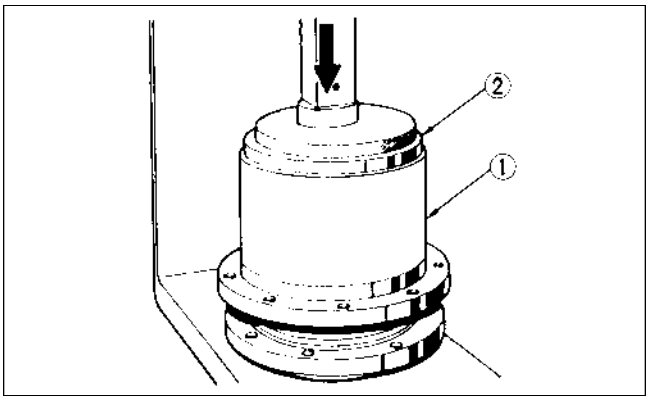
Material: Equivalent of S35C, C0.1-0.2

(1) Angular bearing
(2) Flange holder
(3) Mounting jig



4. Using the tightening jig, tighten the ring nut so as to leave no clearance between the ring nut and angular bearing.
   • For the tightening jig, refer to V17.

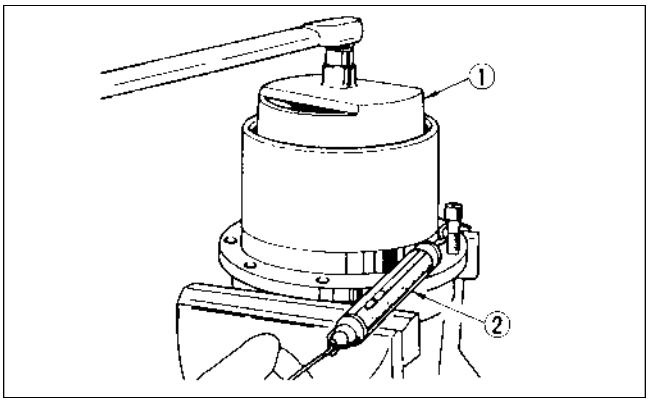
(1) Ring nut
(2) Tightening jig



5. Using the press-fitting jig (see the figure below), press-fit the housing onto the angular bearing.

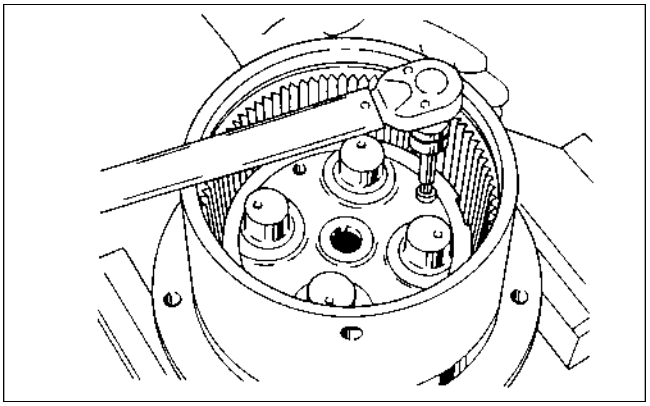
(1) Housing
(2) Press-fitting jig

Material: Equivalent of S35C, C0.1

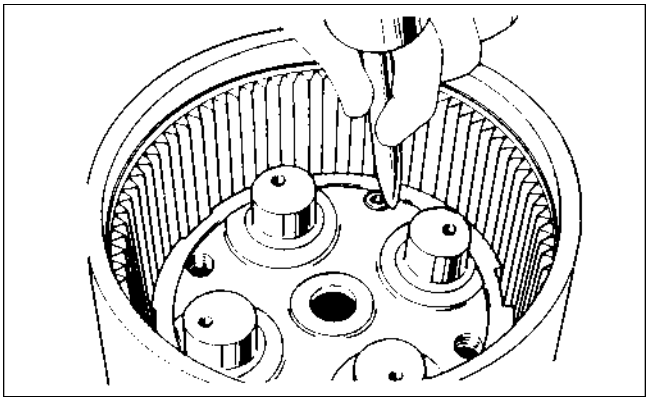


6. Tighten the ring nut using the tightening jig.
   • When the ring nut is tightened so as to leave no clearance between the ring nut and angular bearing, measure the load after turning the housing several turns. The load (starting load) measured at this time is assumed to be F kgf.
   • Tighten the ring nut so that the starting load becomes F + (1.7-2.5) kgf.

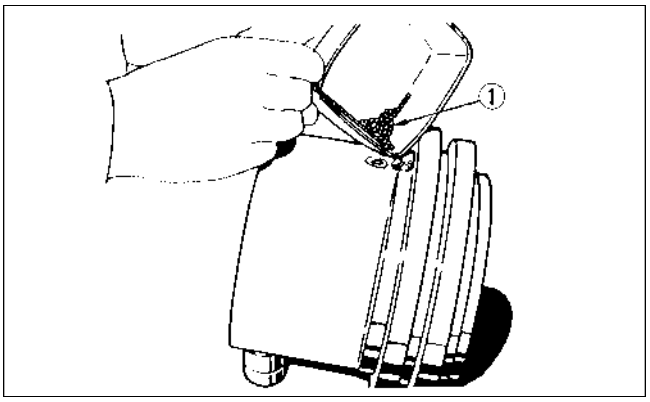
(1) Tightening jig
(2) Spring scale



7. Tighten the plug.
   • No seal tape is needed.

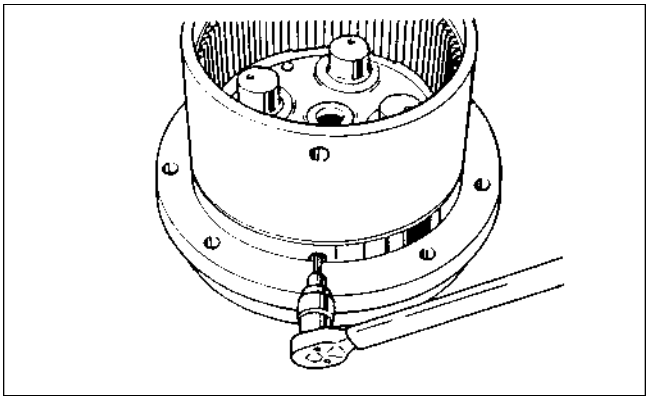


8. Using a punch, crimp the plug at two points in order to prevent it from getting loose.

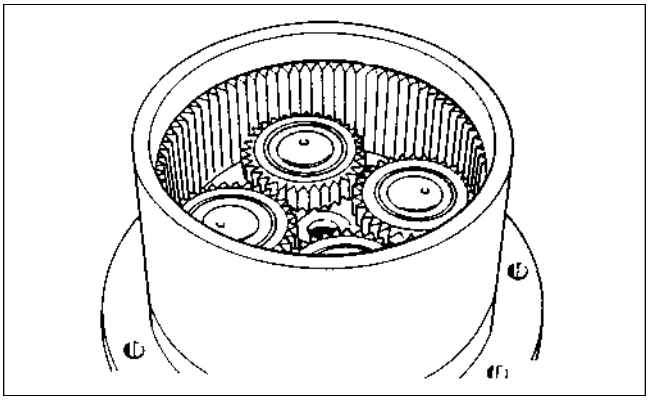


9. Put the steel balls in the unit.

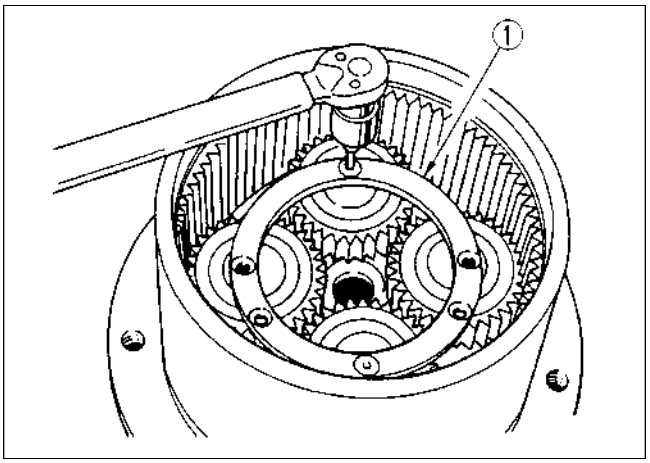
(1) Steel ball
- Number of steel balls



10. Wind seal tape around the plug and tighten it.
- Tightening torque of plug: 0.7~0.9 kgf·m

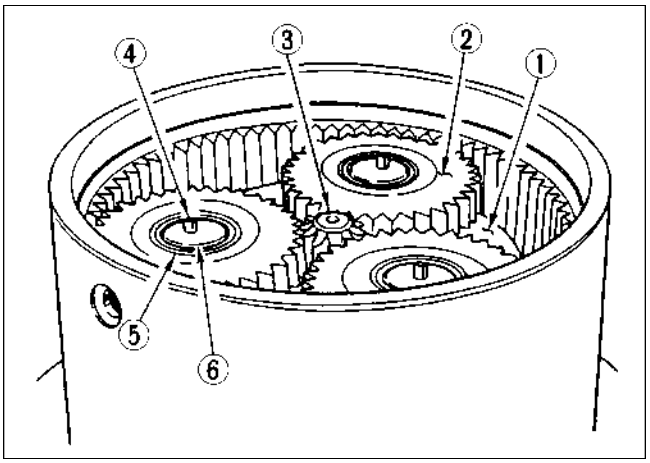


11. Fit the thrust washer, planetary gear B, bearing (roller) and collar.



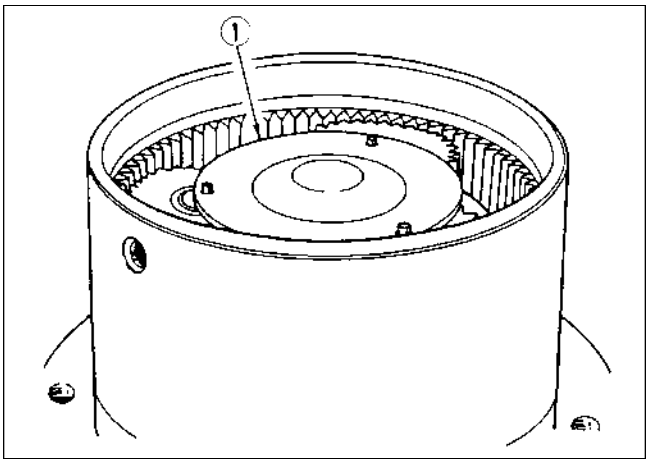
12. Attach the thrust plate, and apply loctite No. 262 to the flush screw and tighten it.
    - When applying loctite, well degrease the part and use a hardening accelerator.
    - Tightening torque of screw:
      0.41~ 0.83 kgf·m

(1) Thrust plate



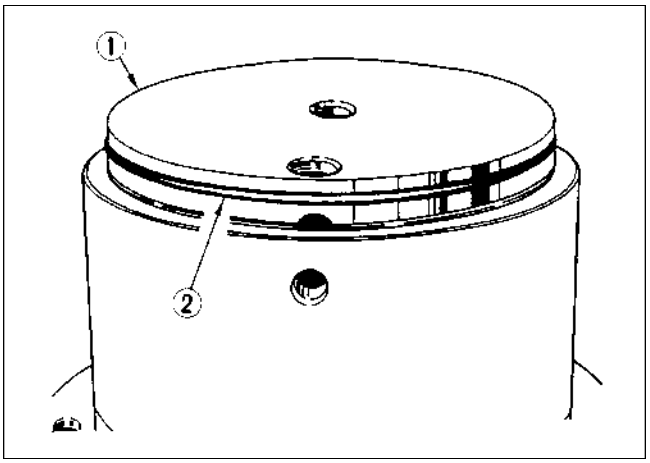
13. Attach the snap ring to the sun gear and fit the sun gear.
14. Attach the spring pin, bearing (inner), bearing (roller) and planetary gear A to the holder and fit the holder.
15. Fit the drive gear.

(1) Holder
(2) Planetary gear A
(3) Drive gear
(4) Spring pin
(5) Bearing (roller)
(6) Bearing (inner)



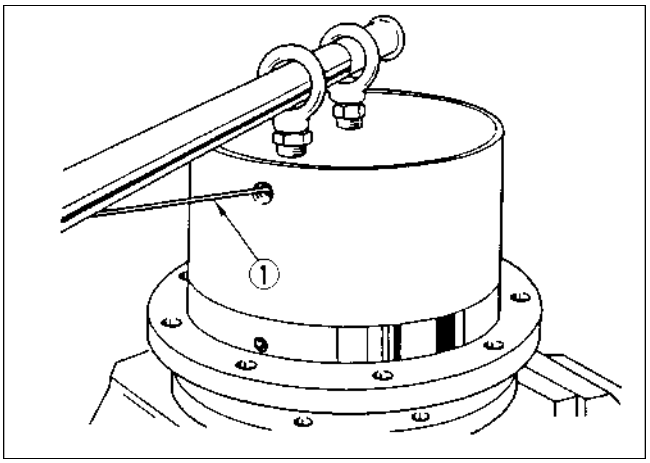
16. Fit the thrust plate.

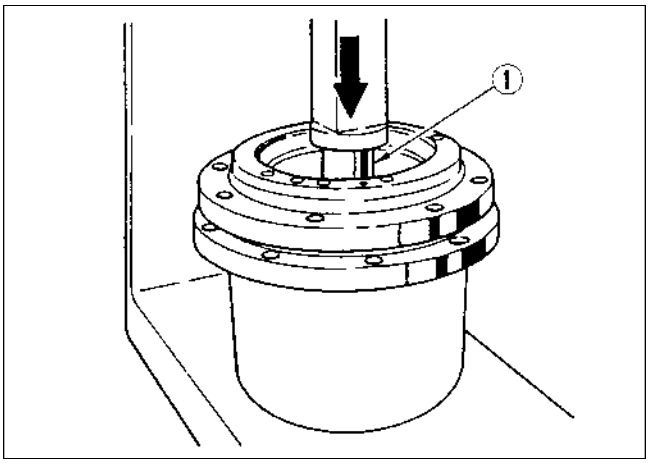
(1) Thrust plate

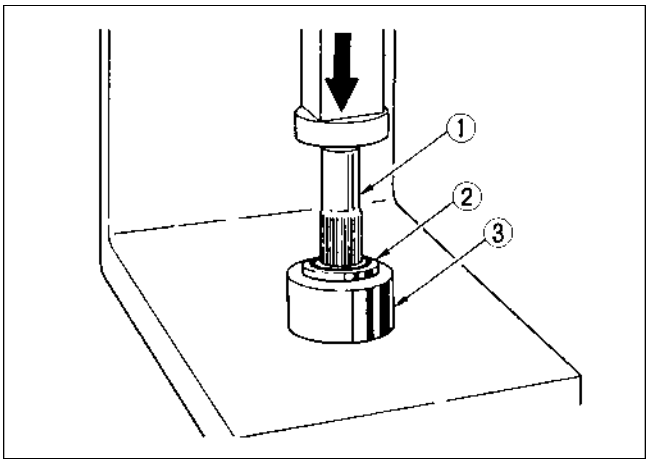


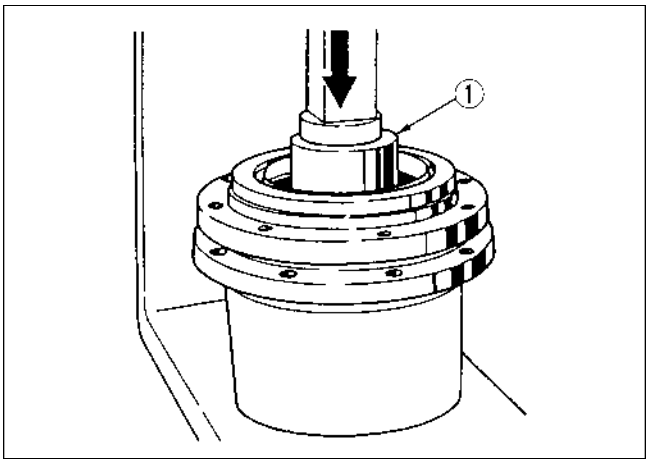
17. Apply grease to the O-ring and fit it to the cover. Fit the cover to the housing so that the U groove is aligned with the screw hole position of the plug in the housing.

(1) Cover
(2) O-ring

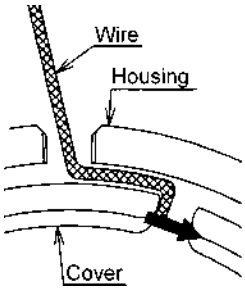






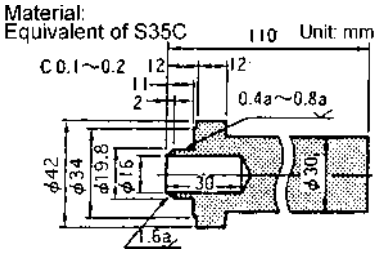


18. Bend the wire at a point about 8 mm apart from the end, insert it into the screw hole in the housing, and turn the cover to draw the wire into the housing.
(1) Wire



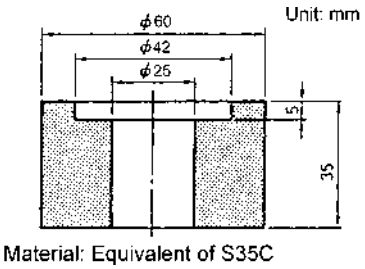
19. Wind seal tape around the plug and tighten it.
    - Tightening torque of plug: 7.8 ±1.0 N·m

20. Press-fit the oil seal into the flange holder using the mounting jig (see the figure below).



(1) Mounting jig

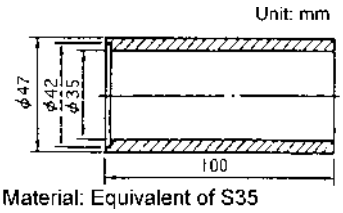
21. Press-fit the ball bearing onto the shaft using the press-fitting jig (see the figure below).



Material: Equivalent of S35C

(1) Shaft (2) Bearing (3) Press-fitting jig

22. Press-fit the shaft subassembly into the flange holder using the mounting jig (see the figure below).

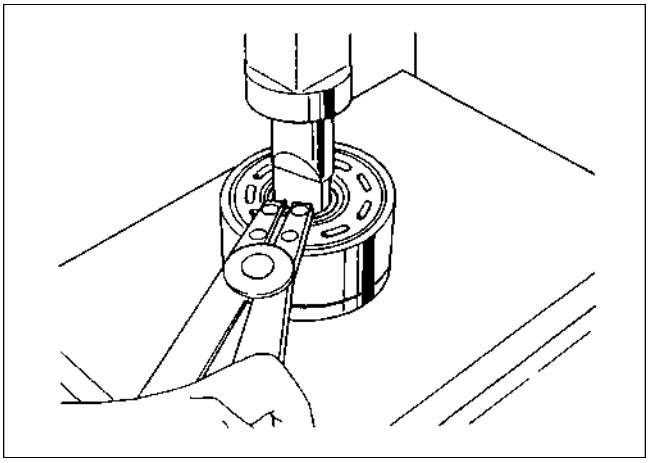


Material: Equivalent of S35

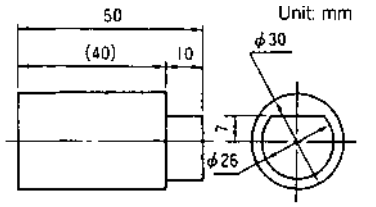
(1) Mounting jig

23. Fit the steel ball, spring, piston subassembly and swash plate to the flange holder.
    - Apply hydraulic oil to the sliding surface of the swash plate.

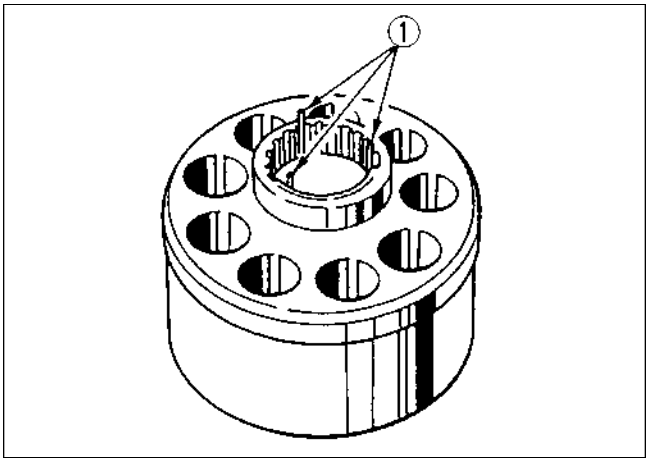
(1) Swash plate



24. Attach the collar, spring and washer to the cylinder block and fit the snap ring using the mounting jig (see the figure below).

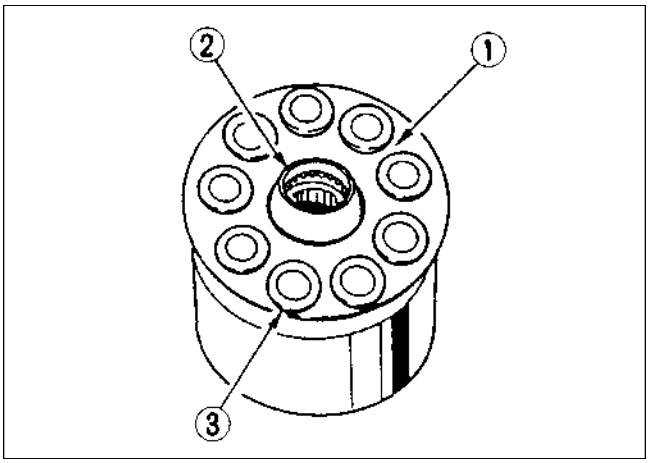


Material: Equivalent of S35C, C0.1-0.2



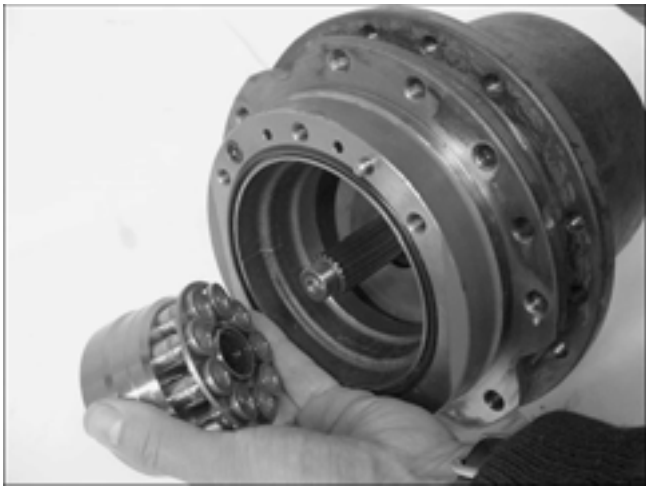
25. Apply grease to the pins and fit them into the three holes in the cylinder block.

(1) Pin

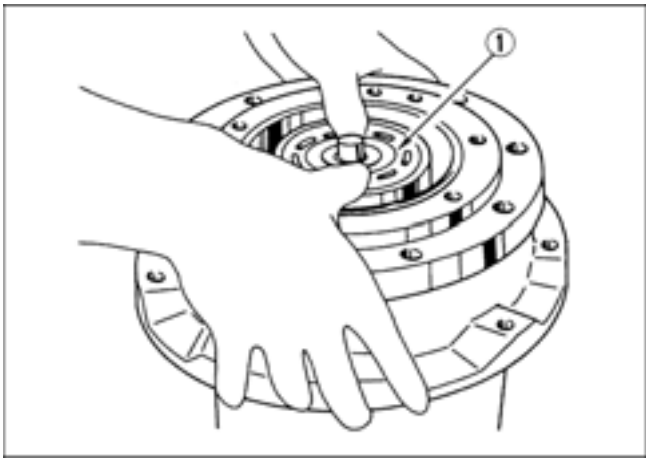


26. Fit the retainer holder, retainer plate and piston subassembly.
    - Apply hydraulic oil to the nine holes in the cylinder block.

(1) Retainer plate
(2) Retainer holder
(3) Piston assembly



27. Set the motor on its side and fit the cylinder block subassembly using the spline in the shaft as a guide.

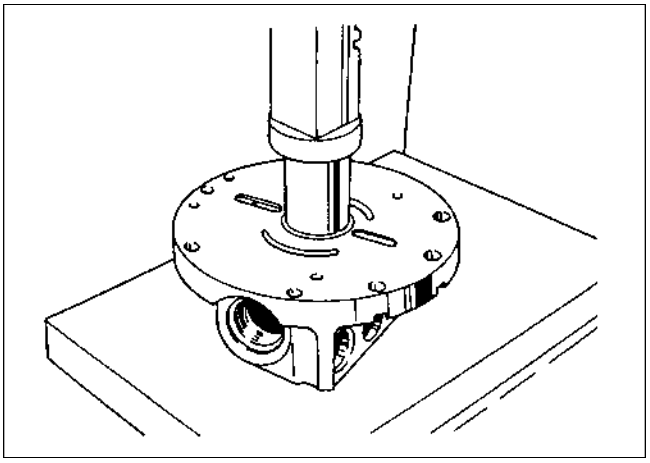


28. While pushing the cylinder block by hand, check that the spring works.
    - Apply hydraulic oil to the sliding part of the cylinder block.

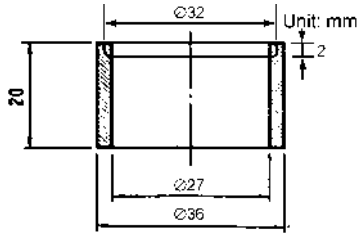
(1) Cylinder block

29. Fit the O-ring and pin to the flange holder.
    - Apply grease to the O-ring.

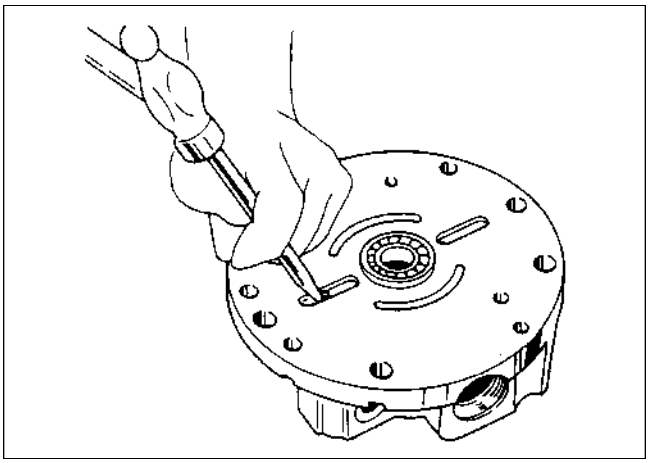
(1) O-ring
(2) Pin



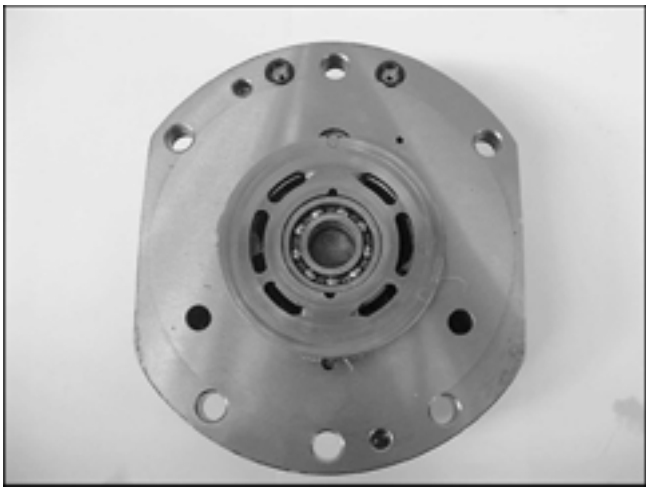
30. Press-fit the ball bearing into the base plate using the press-fitting jig (see the figure below).



Material: Equivalent of S35C, C0.1-0.2

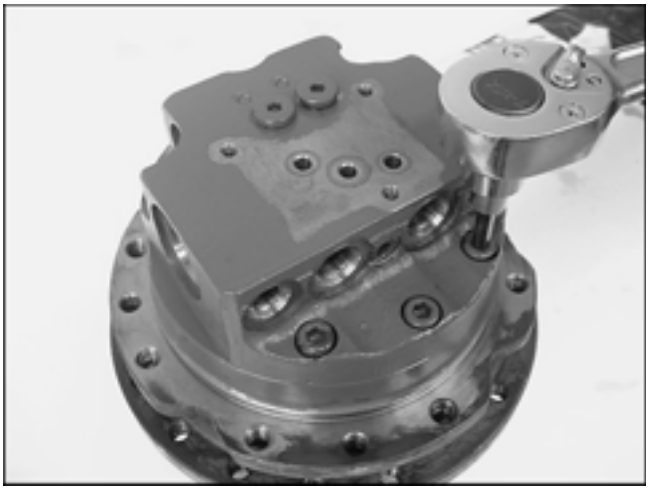


31. Fit the pin and crimp it at two at two points.

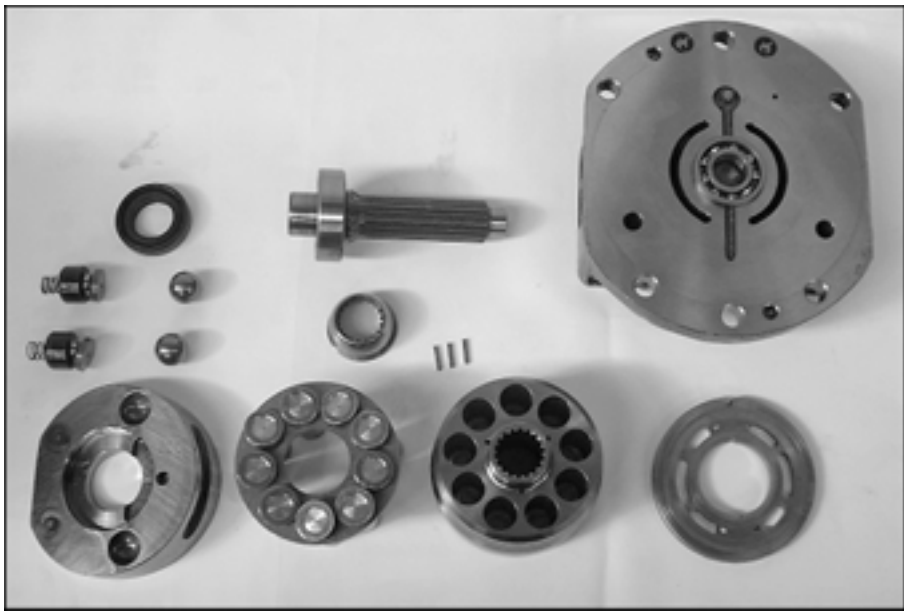


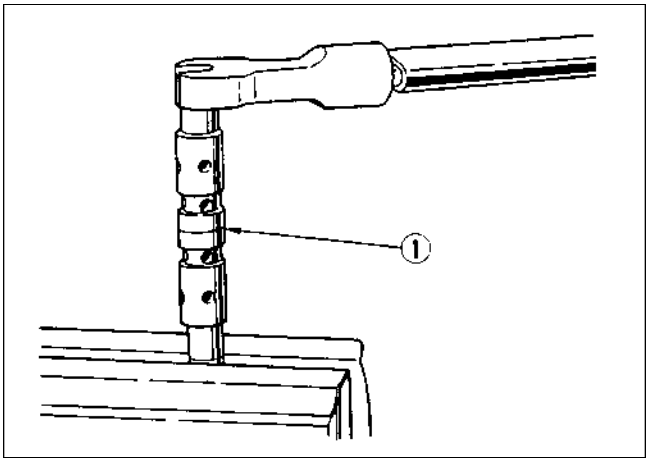
32. Apply grease to the back surface of the valve plate and fit it to the base plate.

(1) Valve plate
(2) Base plate



33. Fit the base plate and tighten the socket head bolt.
    - Tightening torque of socket head bolt: 37.0±1.9 N·m

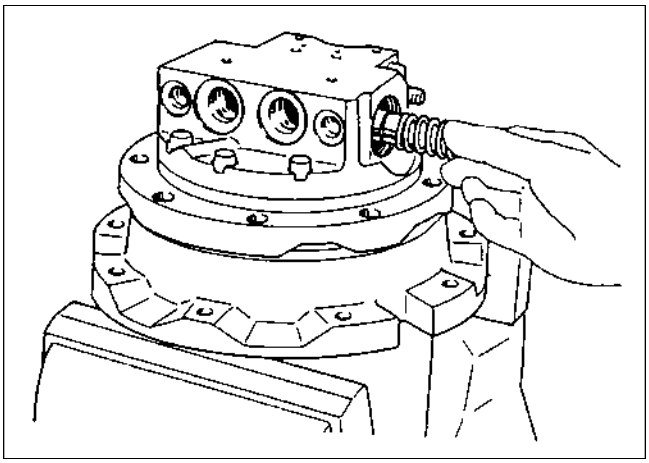




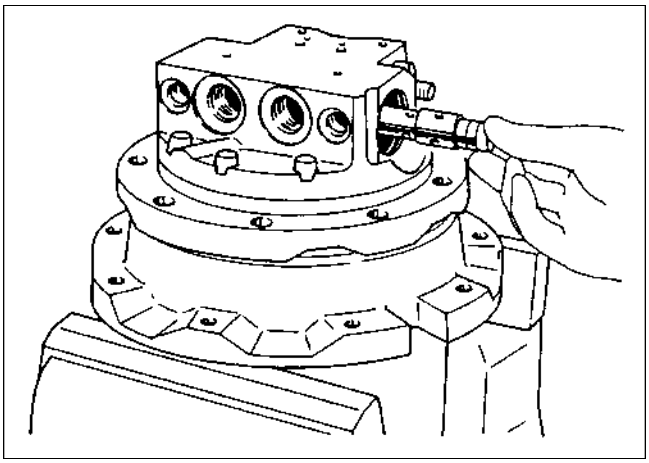
34. Fit the check valve and spring to the plunger.

35. Attach the O-ring to the plug and fit the plug to the plunger.
    - Tightening torque of plug: 27.0±2.45 N·m

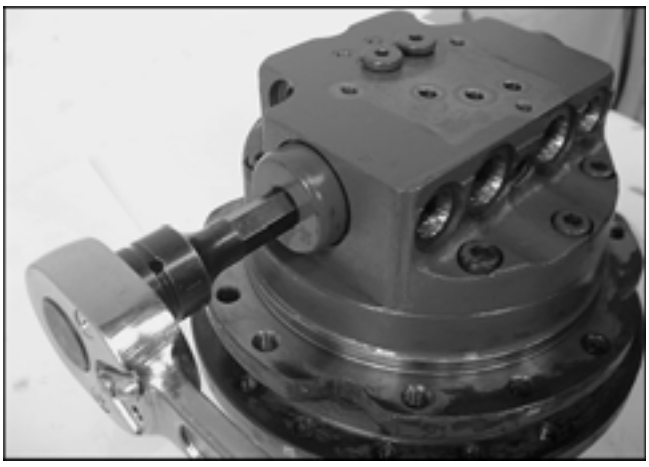
(1) Plunger assembly



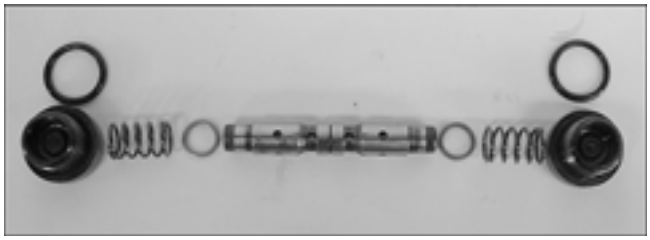
36. Fit the plunger assembly to the base plate.
    - Fit the plunger assembly while turning it so that it will not bind.
    - Apply hydraulic oil to the plunger subassembly

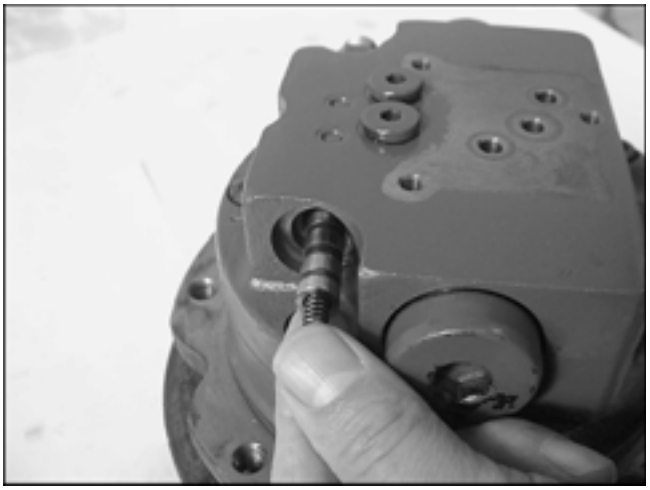


37. Fit the spring sheet and spring.

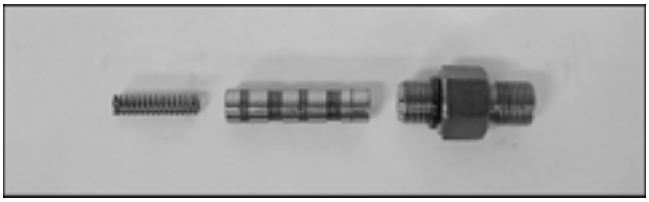


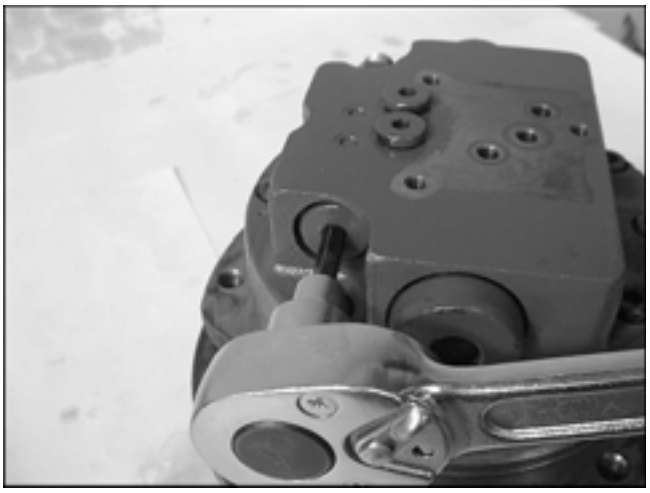
38. Attach the O-ring to the cap and fit the cap to the base plate by tightening it.
    - Apply grease to the O-ring.
    - Tightening torque: 157±8 N·m



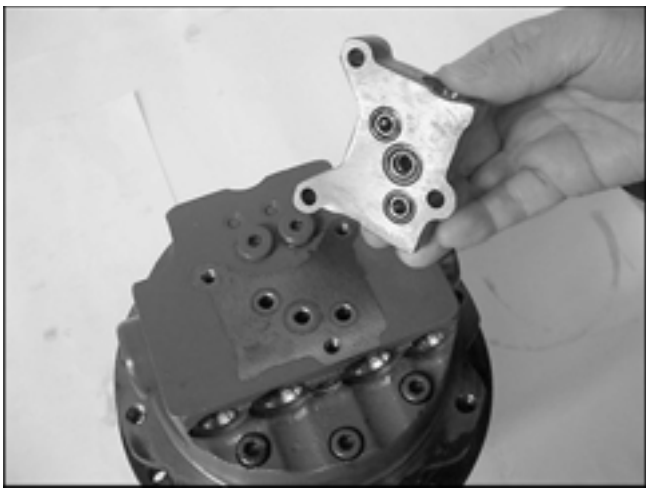


39. Attach the spring to the spool and fit the spool to the base plate.
    - Apply hydraulic oil to the spool and insert it while turning it.

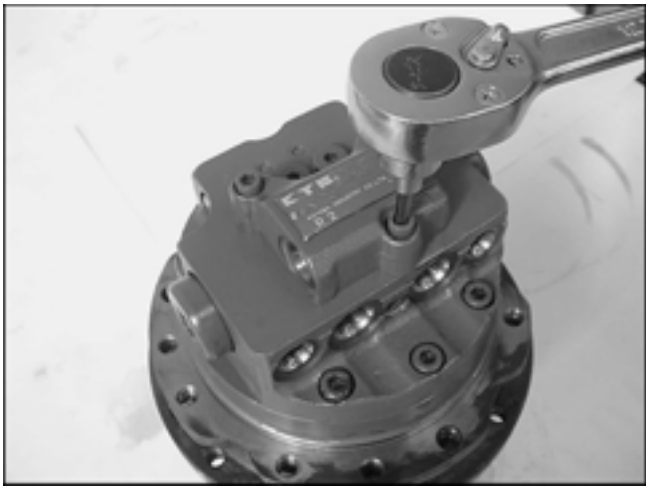




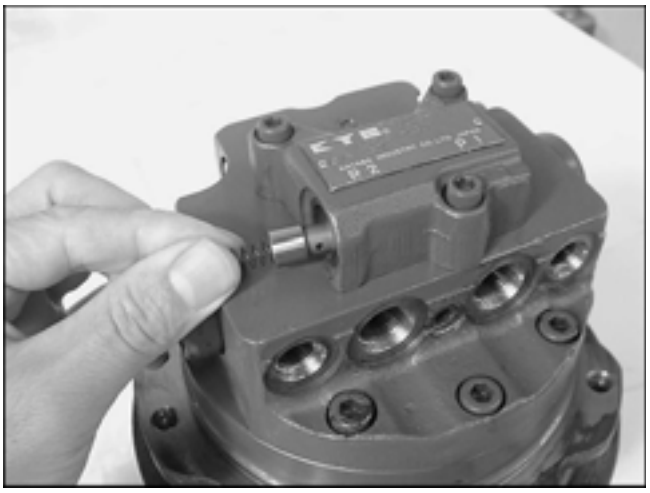
40. Attach the O-ring to the plug and fit the plug to the base plate.
    - Tightening torque of plug: 36.8±2.5 N·m



41. Fit the O-ring to the valve body.
    Apply a small amount of grease to the O-ring.

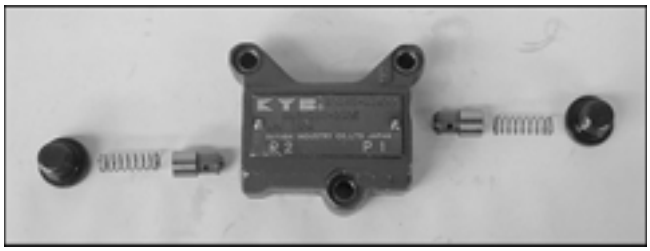


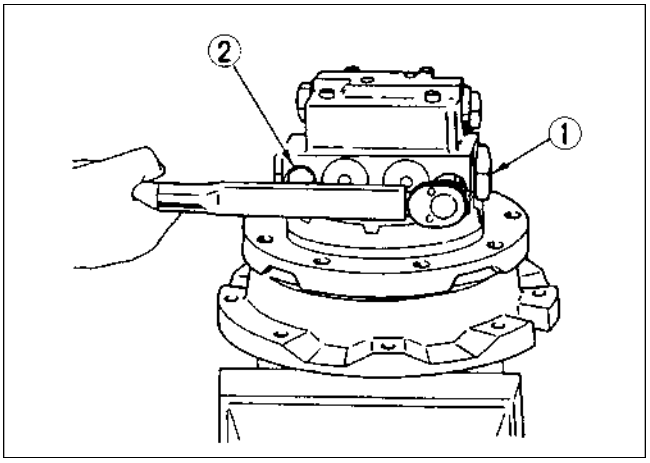
42. Fit the valve assembly to the base plate.
    - Tightening torque: 15.2±0.8 N·m



43. Fit the check valve and spring to the valve body.

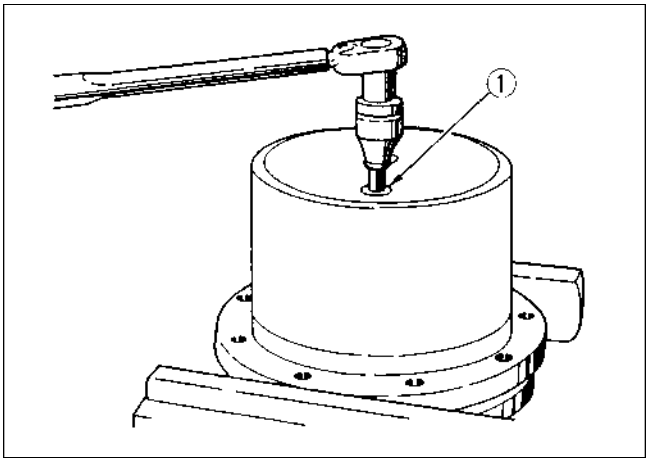
44. Tighten the plug.
    - Tightening torque of plug: 36.8±2.5 N·m





45. Attach the O-ring to the plug and fit the plug to the base plate.
    - Tightening torque of plug: 22.6±1.0 N·m

(1) Cap
(2) Plug



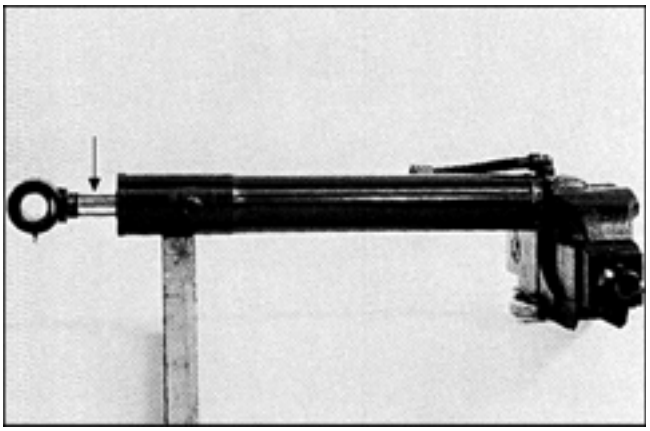
46. Inject the specified amount of gear oil (see below) through the plug screw hole and tighten the plug.
    - Wind seal tape around the plug.
    - Tightening torque of plug: 22.6±1.0 N·m

(1) Plug

Oil type	Amount
Diamond Hipoid Oil 90 (Mitsubishi)	0.35L

b. Cylinder

[1] Disassembling and reassembling the boom cylinder

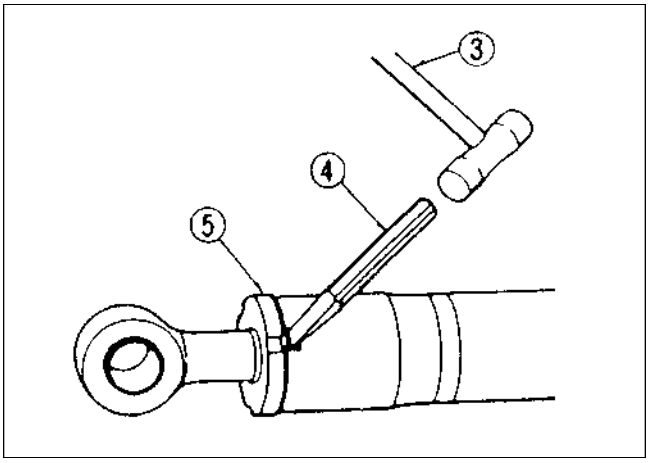


1) Drain oil from the cylinder.

2) Fix the cylinder with a vise.

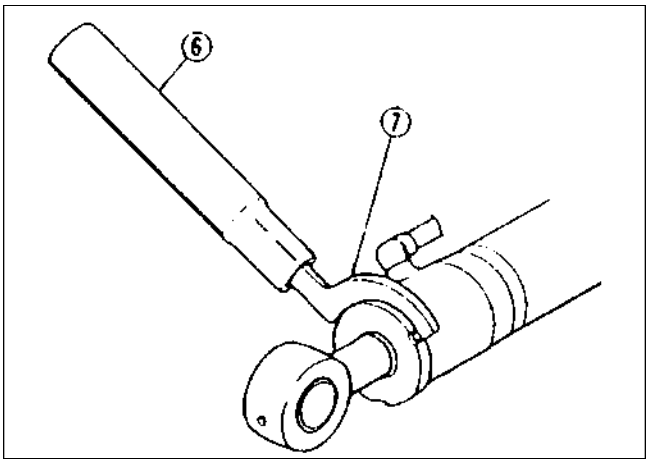
Supplement:

* Support the cylinder tube with a wooden board.



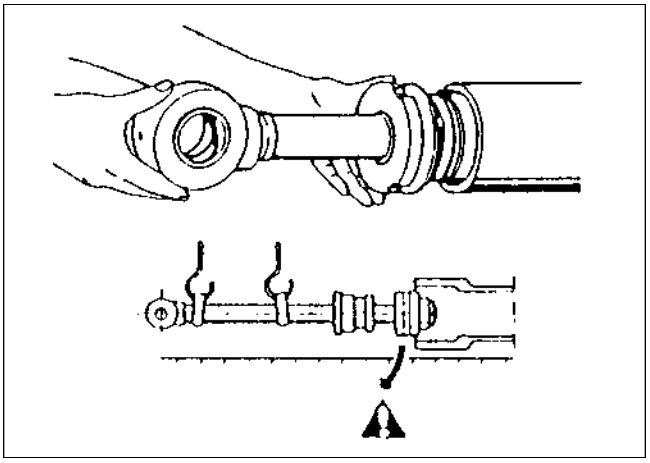
3) Straighten the lock washer.

(3) Hammer
(4) Chisel
(5) Straighten



4) Remove the cylinder head while loosening the screw on the cylinder head.

(6) Pipe
(7) Hook wrench



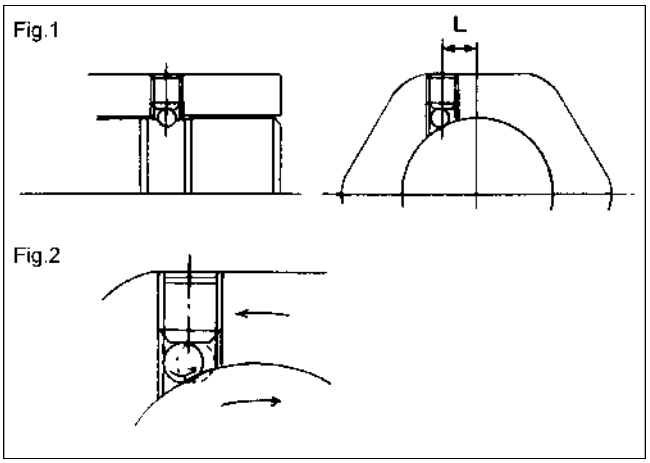
5) Pull out the piston rod together with the cylinder head.

Supplement:

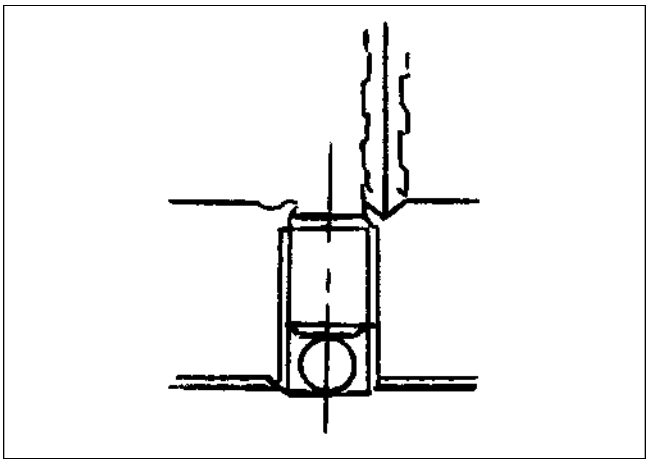
* Open the port of the pipe.

Caution:

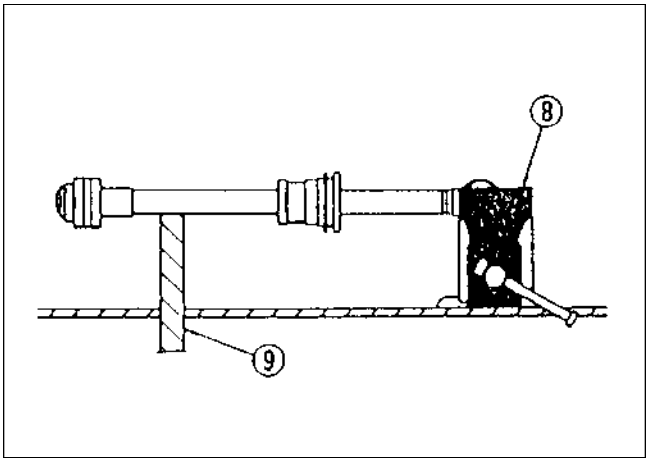
* When pulling out the piston, take care not to drop the piston end. If the piston end drops, it could injure your hand or damage the piston itself.



6) Remove the setscrew.
   - Because the setscrew is tightened and punch-crimped at two points, scrape away the punched portions with a hand drill, loosen the setscrew and remove the steel ball.



* How to use the steel ball to prevent the nut from turning
- By tightening the setscrew, fix the steel ball at a position decentered from the nut rod center line by L. (Fig.1)
- When the screw is loosened and the nut (rod) turns, the ball turns and moves to dig into the narrower side of the taper face. (Fig.2)
- The resistance of the steel ball generated at this time prevents the nut from turning

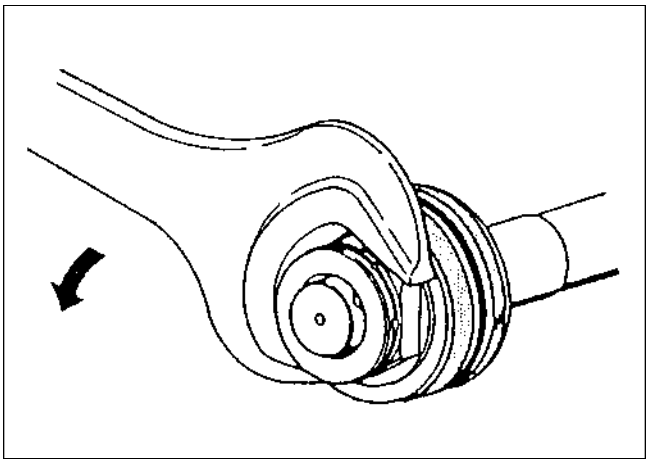


7) Fix the piston rod with a vise.

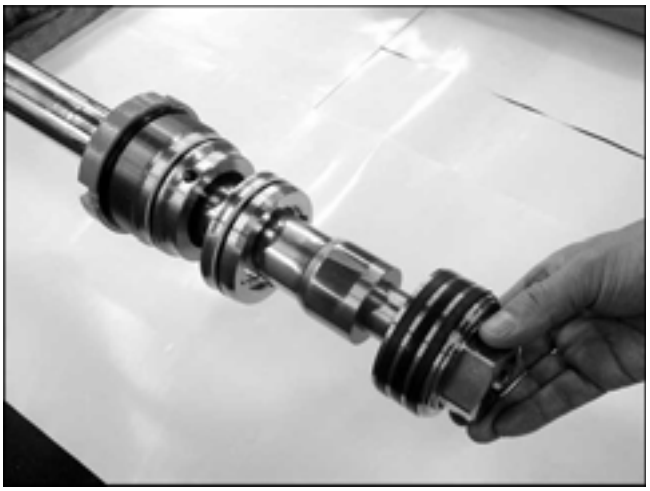
IMPORTANT

* Support the rod with a wooden board.

(8) Vise
(9) Wooden board



8) Set a spanner on the hex nut portion of the piston and loosen the piston.

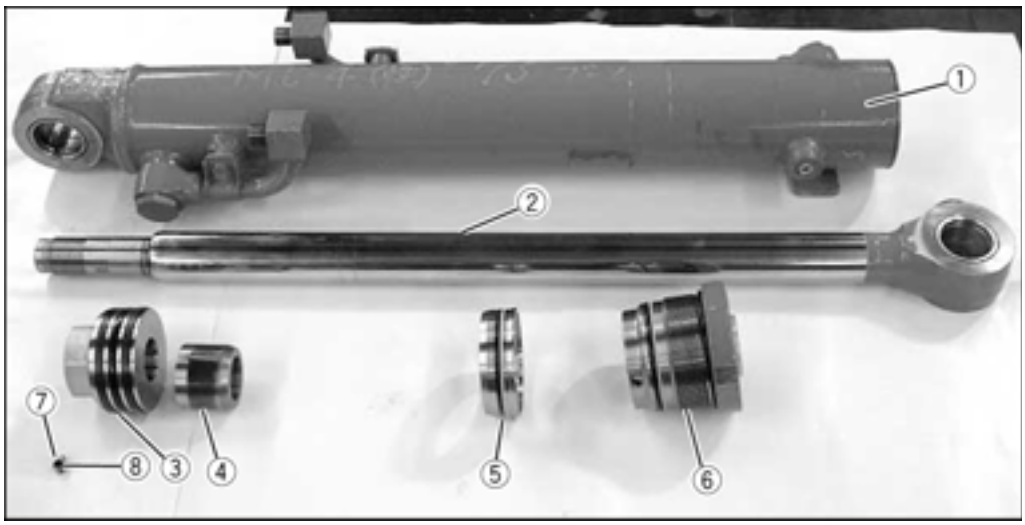


9) Remove the piston.

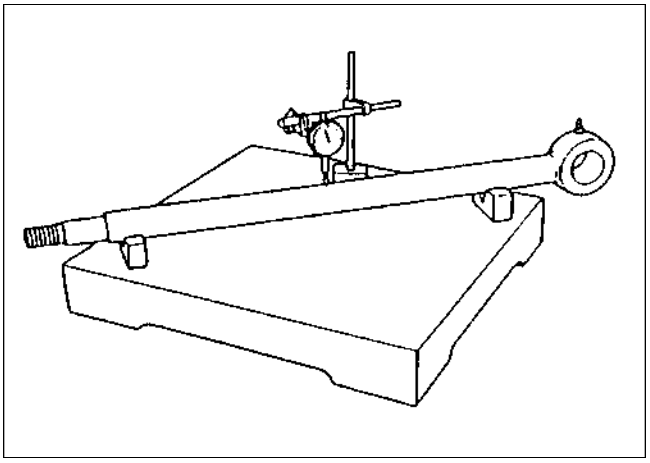
10) Remove the cushion bearing and holder.

11) Pull out the cylinder head.
Release the piston rod from the vise.

[2] Component parts of boom cylinder

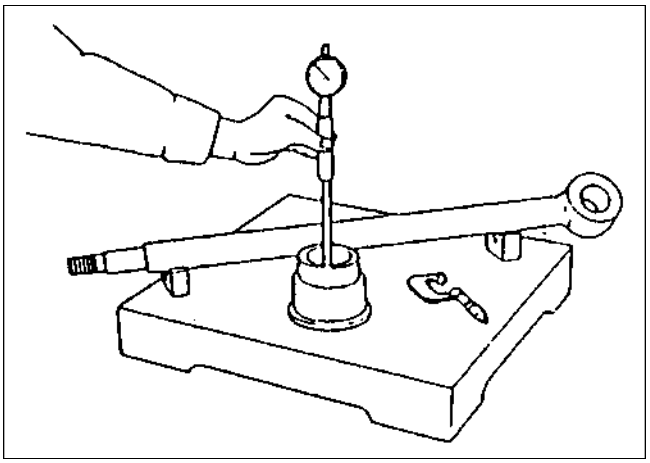


(1) Cylinder tube (2) Piston rod (3) Piston (4) Cushion bearing (5) Holder
(6) Cylinder head (7) Setscrew (8) Steel ball



[3] Measuring the bent in the piston rod

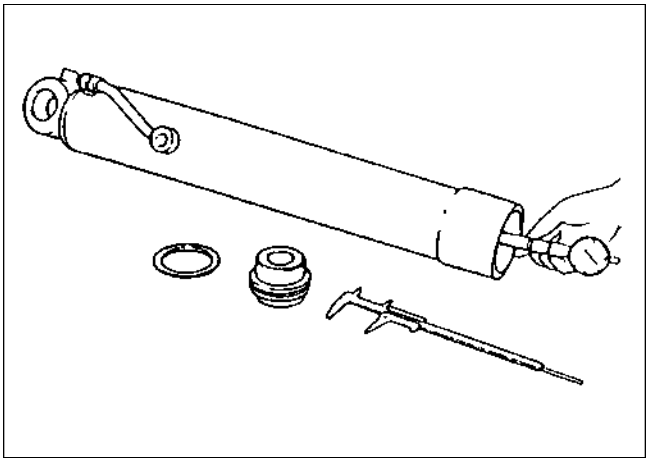
1. Place the piston rod on a V block.
2. Put a dial gauge on the center of the rod.
3. While turning the piston rod, read the value indicated by the dial gauge.
   The bend is one-half of the difference between the maximum and minimum readings.
4. If the bend exceeds the limit, replace the piston rod.
   Standard.....value Bend: 0.05 mm or less
   Limit.....Bend: 0.5 mm



[4] Measuring the wear in the rod and bush

1. Measure the outside diameter of the piston rod and the inside diameter of the bush of the cylinder head section and determine the clearance.

	Rod size	Gap
Standard value	ϕ25~40mm	0.25mm or less
	ϕ45~75mm	0.35mm or less
Limit	ϕ25~40mm	0.4mm
	ϕ45~75mm	0.5mm



[5] Measuring the wear in the tube and piston ring

1. Measure the inside diameter of the cylinder tube.
2. Measure the outside diameter of the piston ring and determine the clearance.

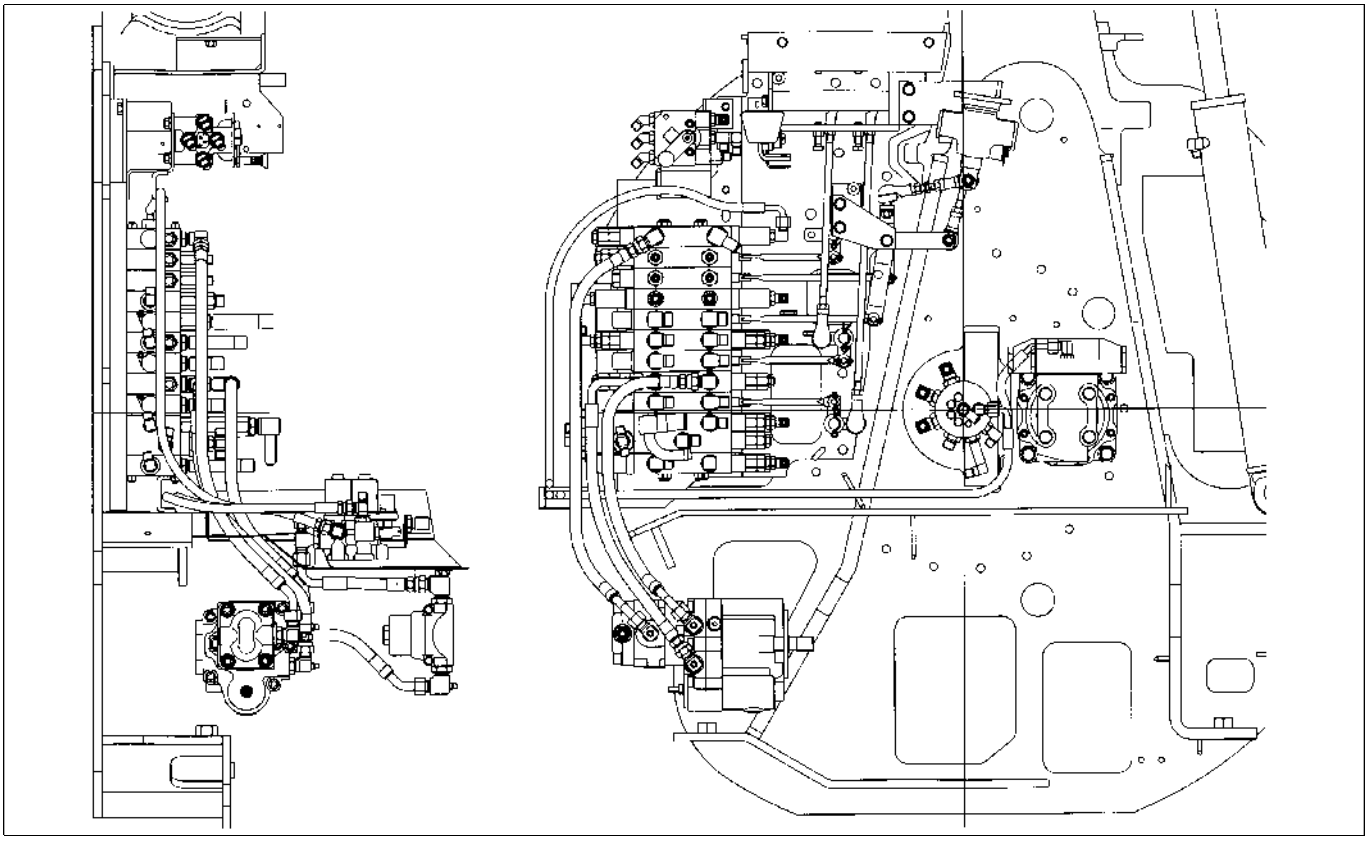
	Rod size	Gap
Standard value	ϕ60mm or less	0.05~0.30mm
	ϕ65~115mm	0.05~0.35mm
	ϕ120mm or more	0.05~0.40mm
Limit	ϕ60mm or less	0.60mm
	ϕ65~115mm	0.70mm
	ϕ120mm	0.80mm

h. Hydraulic hose

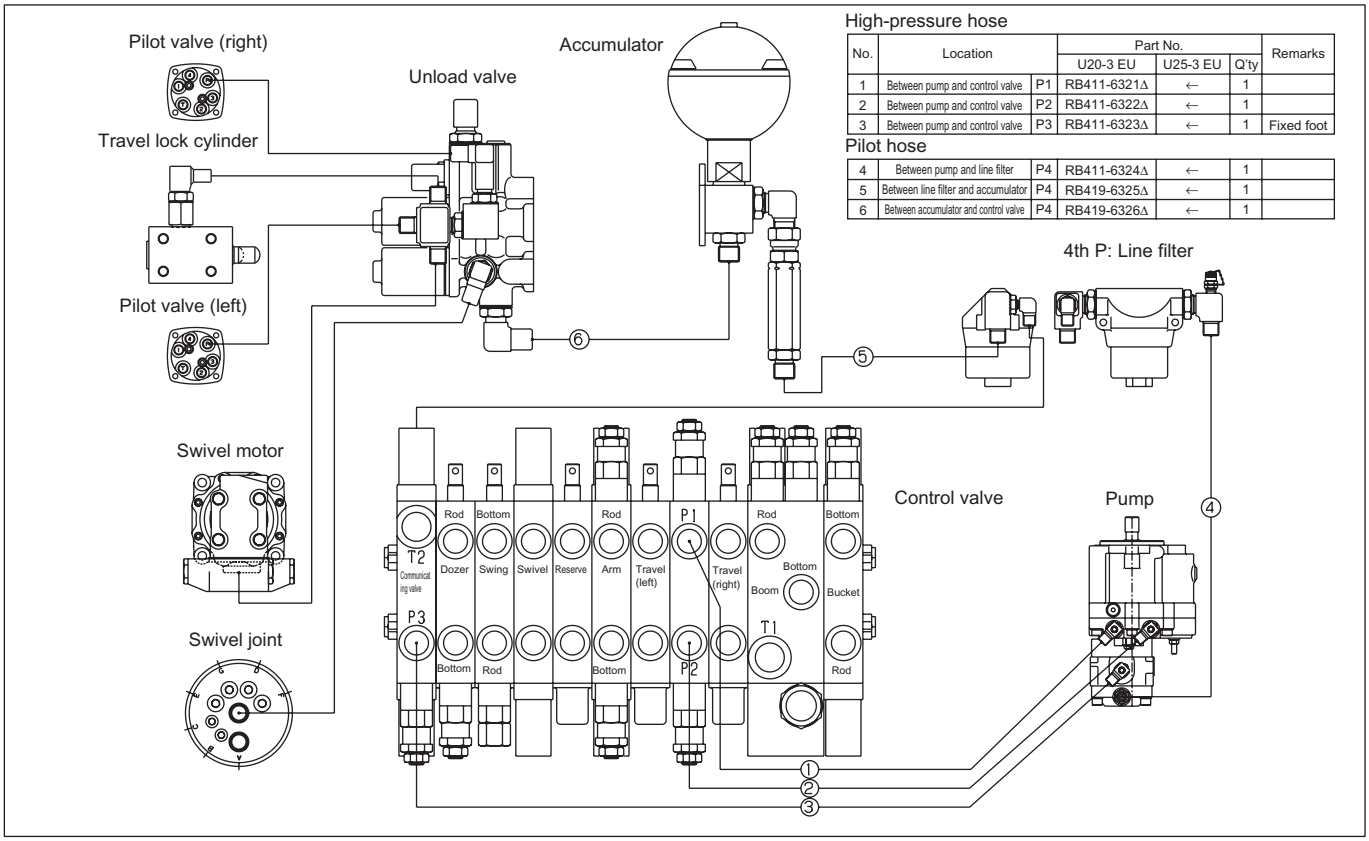
(Important)
The hydraulic hose (main pump suction/delivery) should be replaced every two years or 400 hours of operation, whichever is earlier.

[1] Delivery hose

1) Delivery hose routing



[2] Delivery hose routing



High-pressure hose

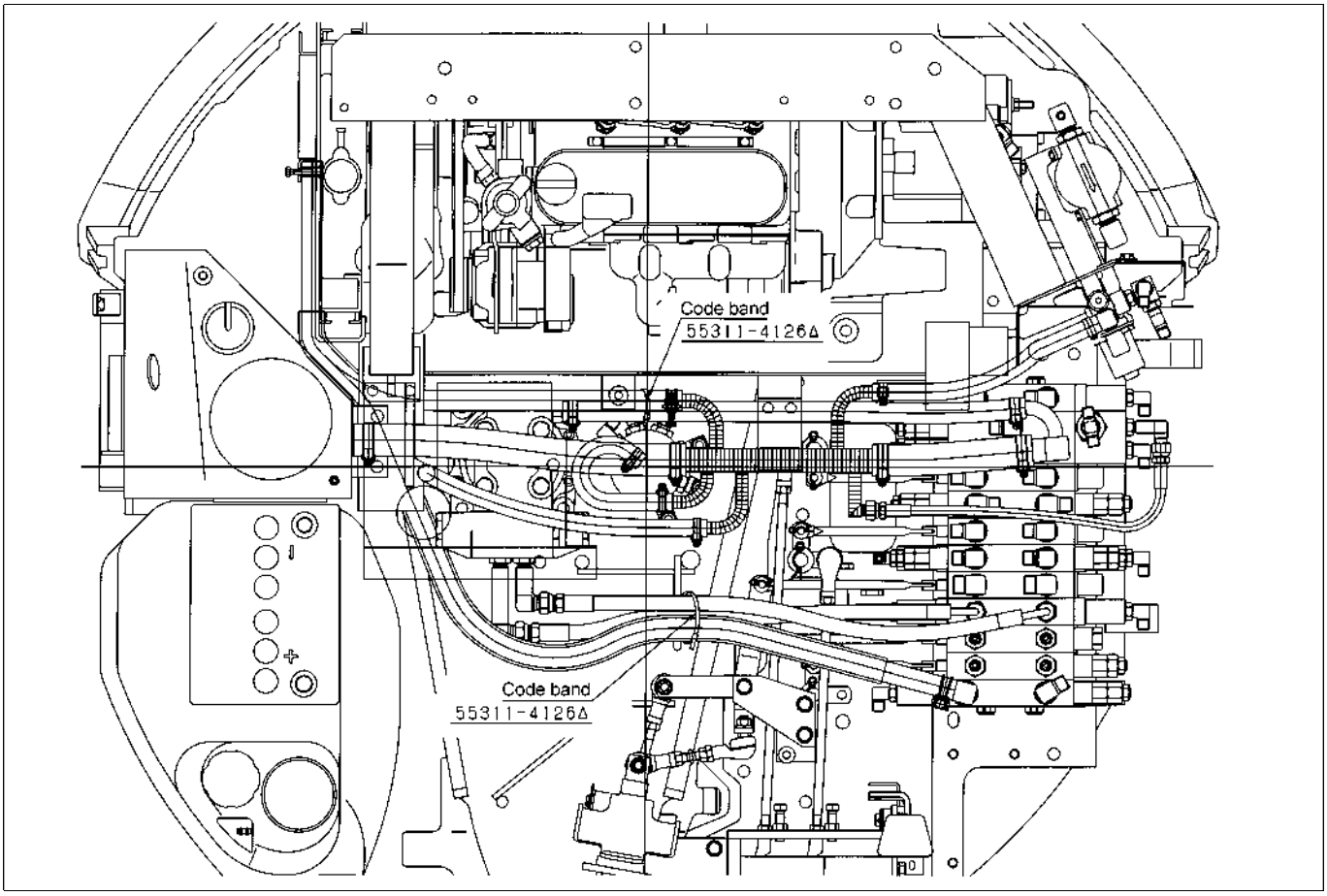
No.	Location		Part No. U20-3 EU	Part No. U25-3 EU	Q'ty	Remarks
1	Between pump and control valve	P1	RB411-6321Δ	←	1	
2	Between pump and control valve	P2	RB411-6322Δ	←	1	
3	Between pump and control valve	P3	RB411-6323Δ	←	1	Fixed foot

Pilot hose

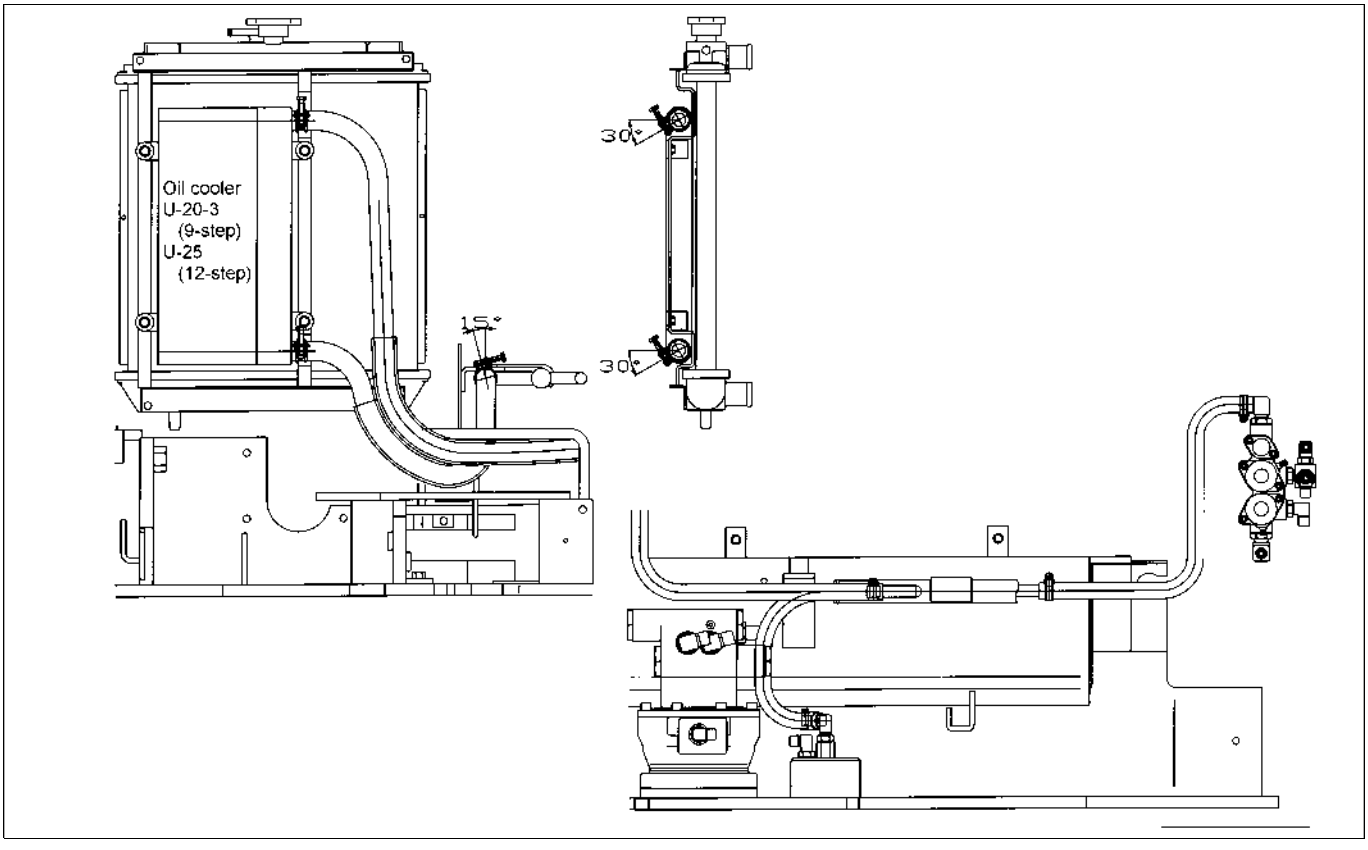
4	Between pump and line filter	P4	RB411-6324Δ	←	1	
5	Between line filter and accumulator	P4	RB419-6325Δ	←	1	
6	Between accumulator and control valve	P4	RB419-6326Δ	←	1	

[2] Return drain hose

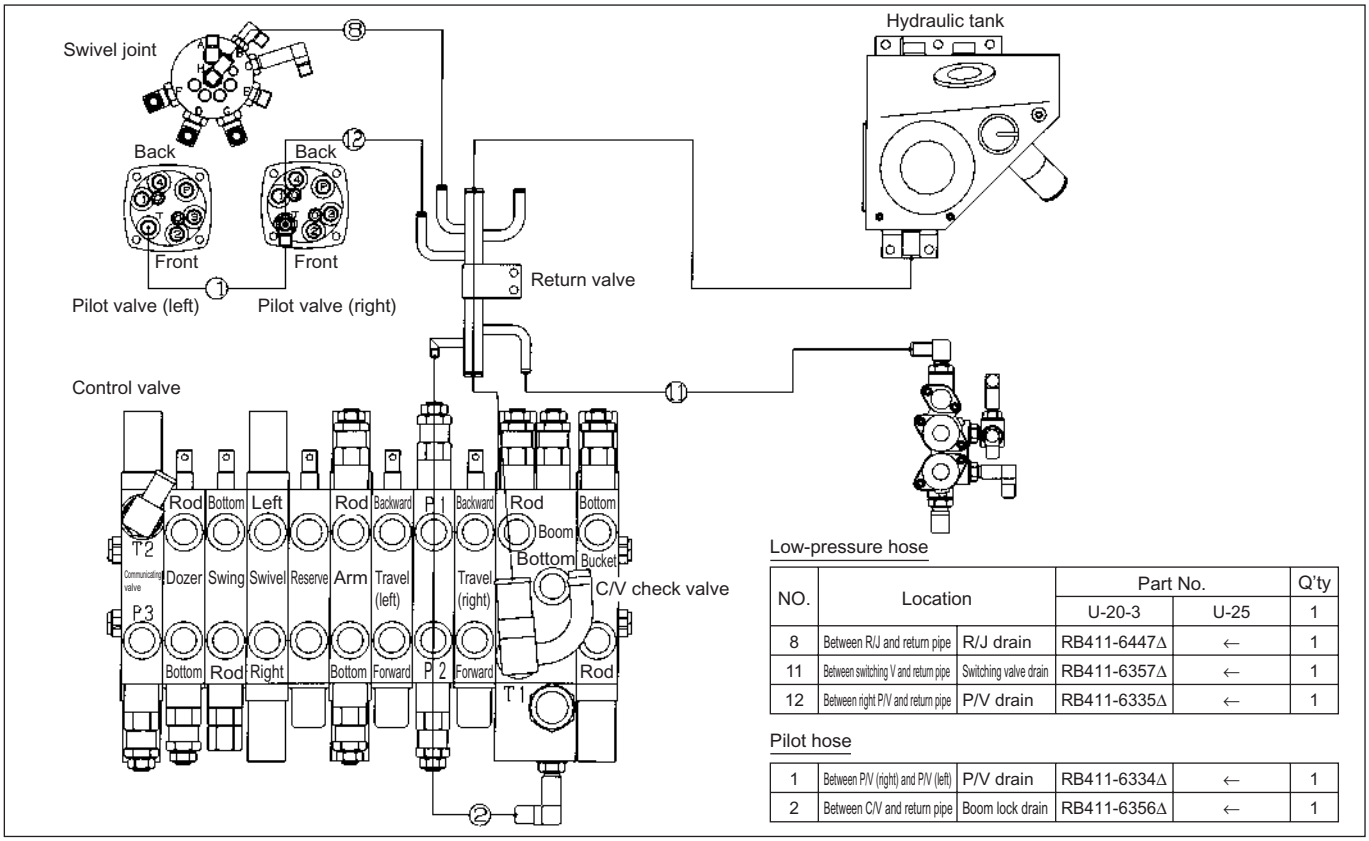
1) Return drain hose routing



2) Return drain hose routing



3) Return drain hose routing



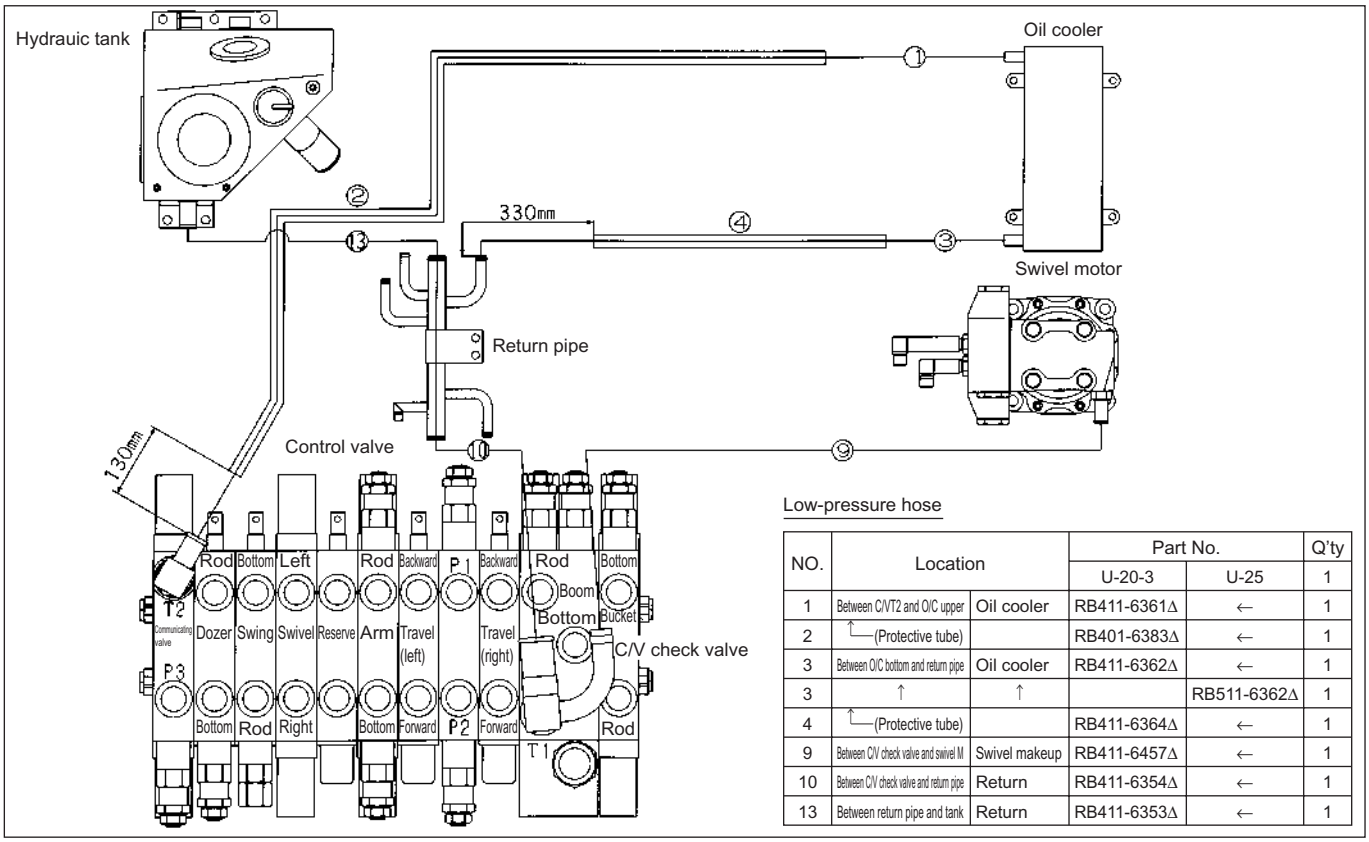
Low-pressure hose

NO.	Location		Part No. U-20-3	Part No. U-25	Q'ty
8	Between R/J and return pipe	R/J drain	RB411-6447Δ	←	1
11	Between switching V and return pipe	Switching valve drain	RB411-6357Δ	←	1
12	Between right P/V and return pipe	P/V drain	RB411-6335Δ	←	1

Pilot hose

1	Between P/V (right) and P/V (left)	P/V drain	RB411-6334Δ	←	1
2	Between C/V and return pipe	Boom lock drain	RB411-6356Δ	←	1

4) Return drain hose routing



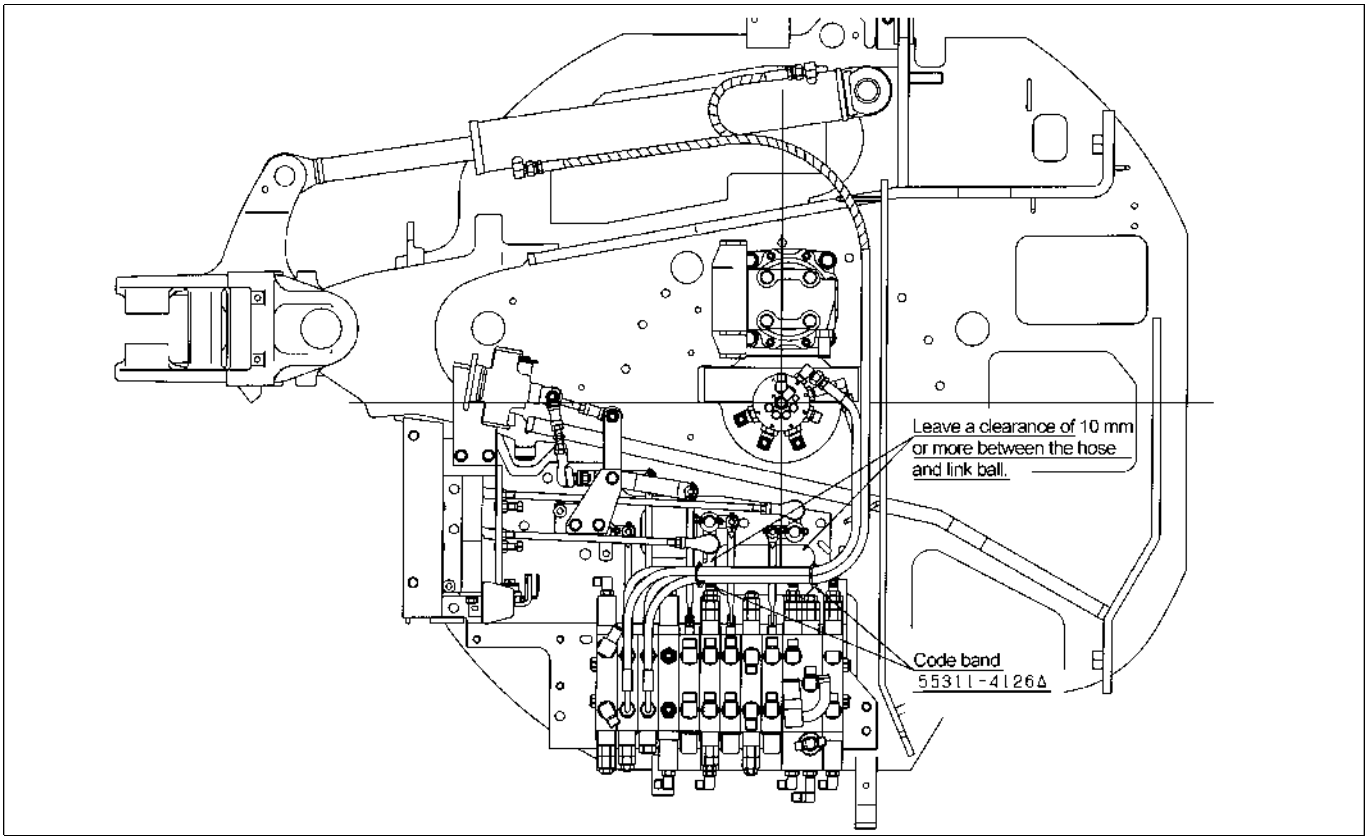
Low-pressure hose

NO.	Location		Part No. U-20-3	Part No. U-25	Q'ty
1	Between C/VT2 and O/C upper	Oil cooler	RB411-6361Δ	←	1
2	↑ (Protective tube)		RB401-6383Δ	←	1
3	Between O/C bottom and return pipe	Oil cooler	RB411-6362Δ	←	1
3	↑	↑		RB511-6362Δ	1
4	↑ (Protective tube)		RB411-6364Δ	←	1
9	Between C/V check valve and swivel M	Swivel makeup	RB411-6457Δ	←	1
10	Between C/V check valve and return pipe	Return	RB411-6354Δ	←	1
13	Between return pipe and tank	Return	RB411-6353Δ	←	1

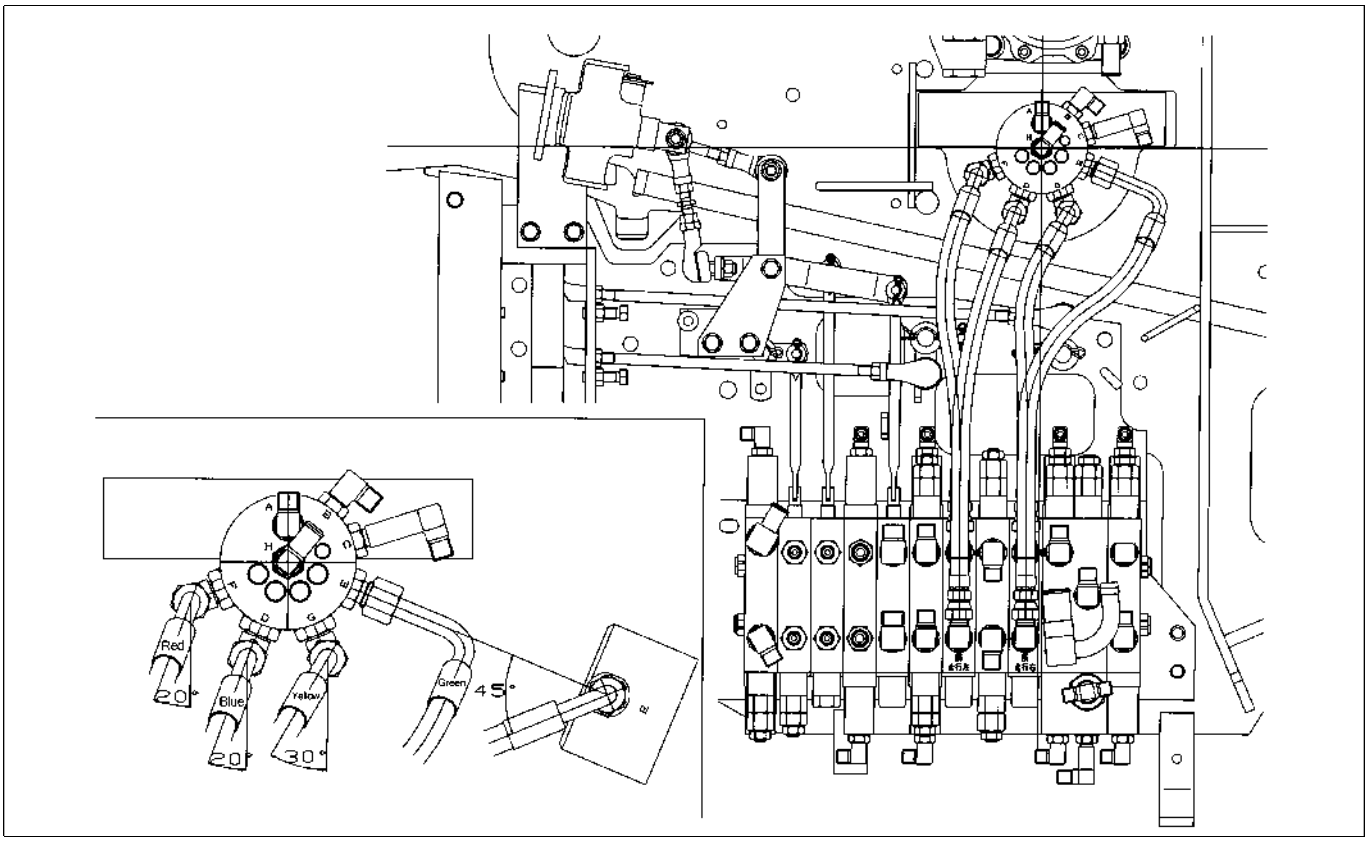
[3] Blade / travel hose

1) Blade/swing hose routing

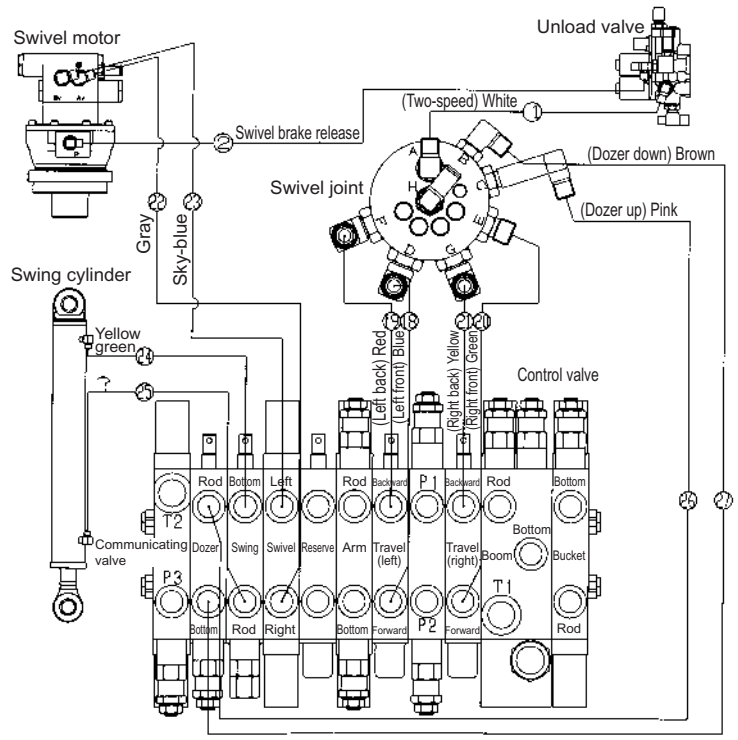
(Important)
The hydraulic hose (for blade/swing) should be replaced every two years or 400 hours of operation, whichever is earlier.



2) Travel hose routing (rotary joint upper)



3) Travel, swivel, swing and blade hose routing (rotary joint upper)

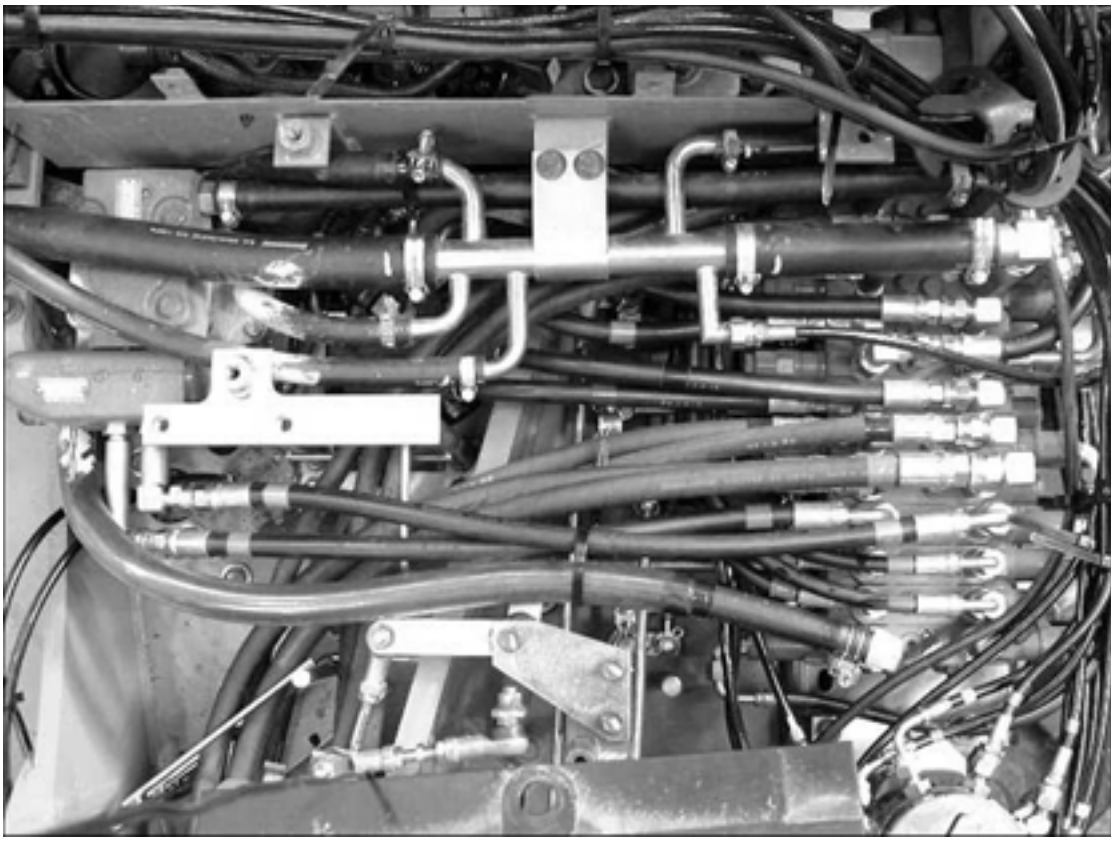


High-pressure hose

NO.	Location			Part No. U-20-3	Part No. U-25	Q'ty
18	C/V~R/J	Travel left forward	Blue	RB411-6441Δ	←	1
19	C/V~R/J	Travel left backward	Red	RB411-6442Δ	←	1
20	C/V~R/J	Travel right forward	Green	RB411-6443Δ	←	1
21	C/V~R/J	Travel right backward	Yellow	RB411-6444Δ	←	1
22	Between C/V and swivel M	Swivel left	Gray	RB411-6455Δ	←	1
23	Between C/V and swivel M	Swivel right	Sky-blue	RB411-6456Δ	←	1
24	Between C/V and swing cylinder bottom	Swing left	Yellow-green	RB411-6461Δ	←	1
25	Between C/V and swing cylinder rod	Swing right	?	RB411-6462Δ	←	1
26	C/V~R/J	Dozer up	Pink	RB411-6487Δ	←	1
27	C/V~R/J	Dozer down	Brown	RB411-6488Δ	←	1

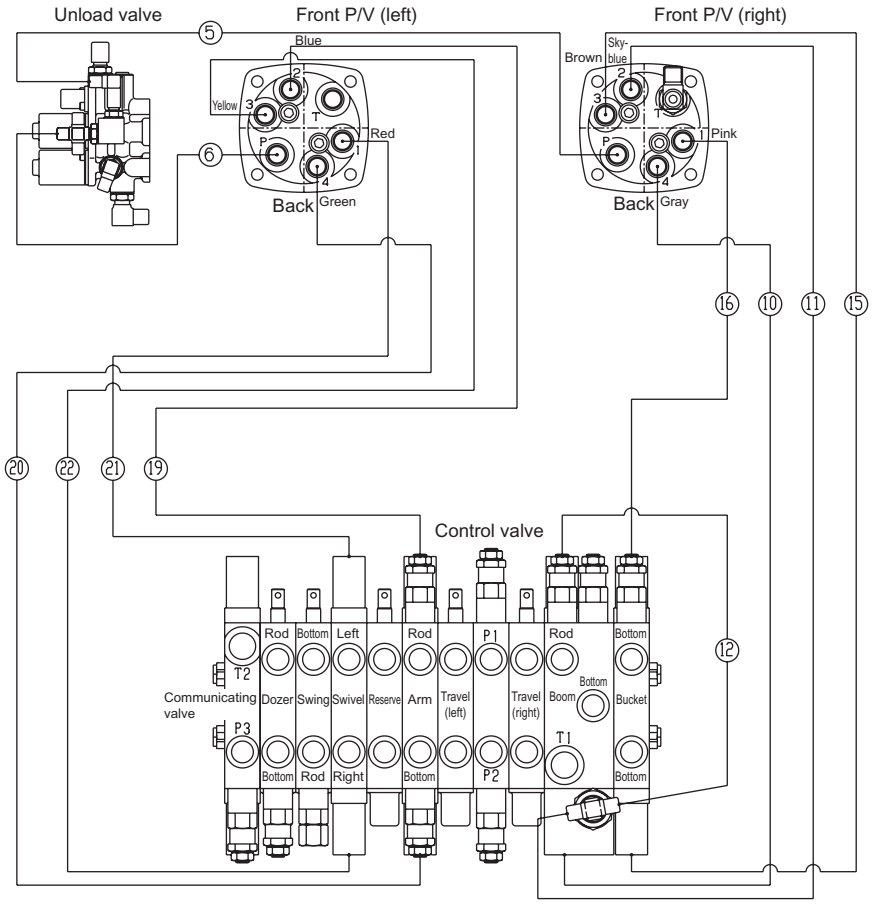
Pilot hose

1	Between selector V and R/J	Travel two-speed pressurization	White	RB411-6487Δ	←	1
2	Between selector V and R/J	Swivel brake release	——	RB411-6488Δ	←	1



[4] Pilot hose

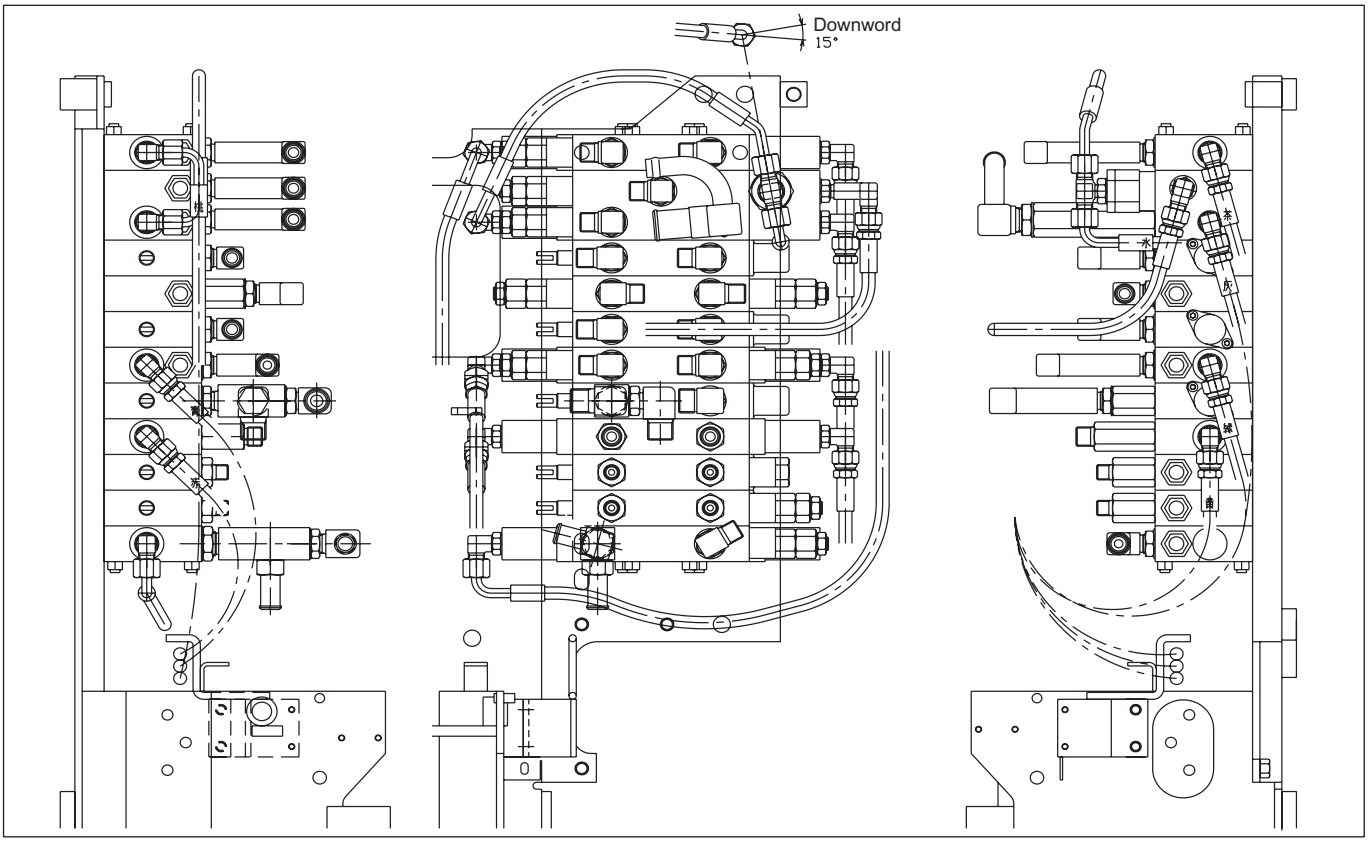
1) List of pilot hoses



List of pilot hoses

No.	Location	Part No.		Part name	Q'ty	Dimension (mm)	Tape color	Hose shape	Remarks
		U20-3 EU	U25-3 EU						
1	Between pump and line filter P4	RB411-6324Δ	←	Hydraulic hose (3/8)	1	240		G3/8 PLT06 G3/8	632-040
2	Between line filter and accumulator	RB419-6325Δ	←	Hydraulic hose (3/8, P4, 2-1)	1	300		G3/8 PLT06 G3/8	632-090
3	Between accumulator and selector valve	RB419-6326Δ	←	Hydraulic hose (3/8, P4, 2-2)	1	300		G3/8 PLT06 G3/8	632-100
4	Between line filter and CV (travel straight)	RB419-6328Δ	←	Hydraulic hose (1/4, travel straight)	1	1120		G1/4 PLT04 G1/4	632-080
5	Between selector V and Swivel M Swivel brake release	RB411-6327Δ	←	Hydraulic hose (1/4)	1	1120		G1/4 PLT04 G1/4	632-070
6	Between selector V and P/V (right) P	RB411-6331Δ	←	Hydraulic hose (1/4)	1	1360		G1/4 PLT04 Quick	633-090
7	Between selector V and P/V (left) P	RB411-6332Δ	←	Hydraulic hose (1/4)	1	710		G1/4 PLT04 Quick	633-100
8	Between P/V (right) T and PV (left) T P/V drain	RB411-6334Δ	←	Hydraulic hose (1/4)	1	1190		G1/4 PLT04 Quick	633-110
9	Between selector V and R/J Travel two-speed	RB411-6445Δ	←	Hydraulic hose (1/4)	1	970	White	G1/4 PLT04 G1/4	644-050
10	Between C/V and return pipe Boom lock drain	RB411-6356Δ	←	Hydraulic hose (1/4)	1	430		G1/4 1500-03 G1/4	Nitta-made 635-030
11	Between C/V and P/V (right) Boom up	RB411-6341Δ	←	Hydraulic hose (1/4)	1	1820	Gray	G1/4 1500-03 Quick	634-010
12	Between C/V and P/V (right) Boom down	RB411-6342Δ	←	Hydraulic hose (1/4)	1	1920	Sky-blue	G1/4 1500-03 Quick	634-020
13	Between C/V and C/V Lock valve release	RB411-6343Δ	←	Hydraulic hose (1/4)	1	320		G1/4 1500-03 G1/4	634-030
14	Between C/V and P/V (left) Arm dump	RB419-6344Δ	←	Hydraulic hose (1/4, arm D)	1	1420	Blue	G1/4 1500-03 Quick	634-040
15	Between C/V and P/V (left) Arm scoop	RB419-6345Δ	←	Hydraulic hose (1/4, arm C)	1	1210	Green	G1/4 1500-03 Quick	634-050
16	Between C/V and P/V (right) Bucket dump	RB411-6346Δ	←	Hydraulic hose (1/4)	1	1950	Brown	G1/4 1500-03 Quick	634-055
17	Between C/V and P/V (right) Bucket scoop	RB411-6347Δ	←	Hydraulic hose (1/4)	1	2020	Pink	G1/4 1500-03 Quick	634-060
18	Between C/V and P/V (left) Swivel left	RB419-6348Δ	←	Hydraulic hose (1/4, swivel L)	1	1310	Red	G1/4 1500-03 Quick	634-070
19	Between C/V and P/V (left) Swivel right	RB419-6349Δ	←	Hydraulic hose (1/4, swivel R)	1	1140	Yellow	G1/4 1500-03 Quick	634-080
20									

2) Pilot hose routing

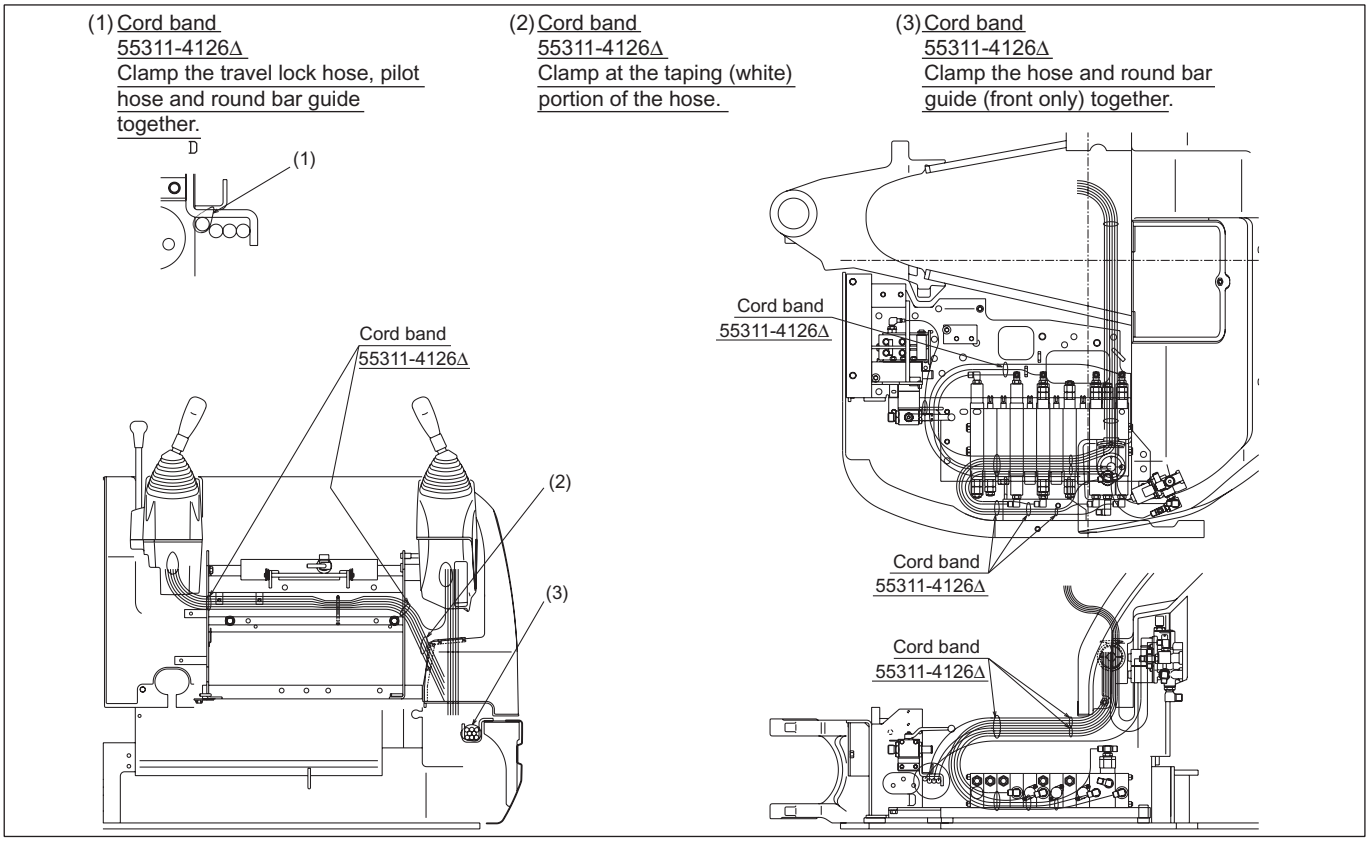


3) Assembling procedure

(1) Cord band
55311-4126Δ
Clamp the travel lock hose, pilot hose and round bar guide together.

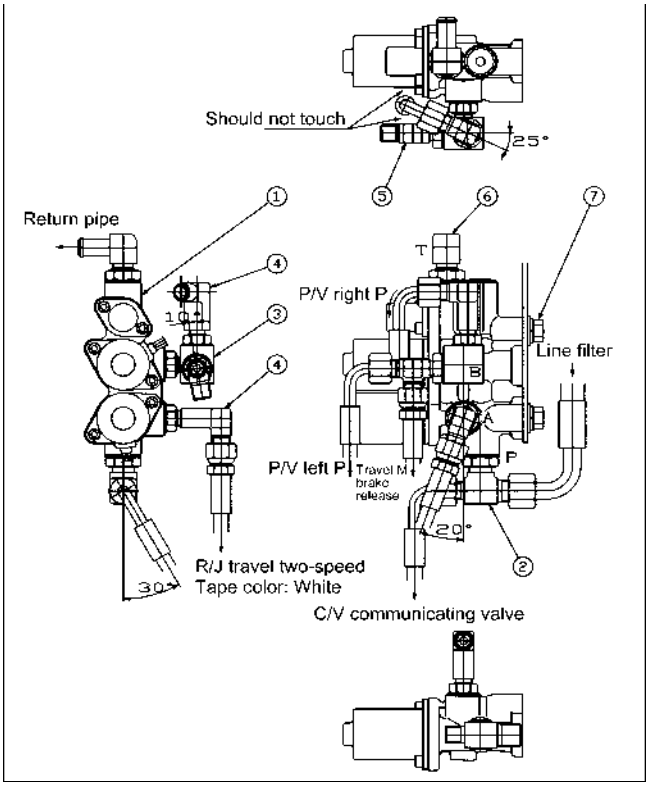
(2) Cord band
55311-4126Δ
Clamp at the taping (white) portion of the hose.

(3) Cord band
55311-4126Δ
Clamp the hose and round bar guide (front only) together.

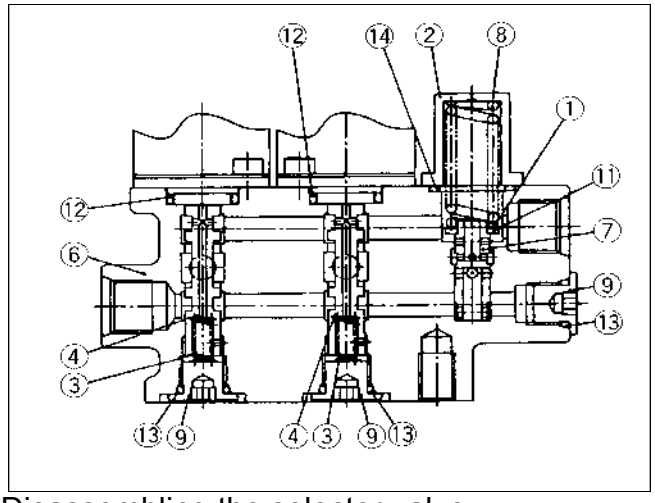


i. Other hydraulic valve

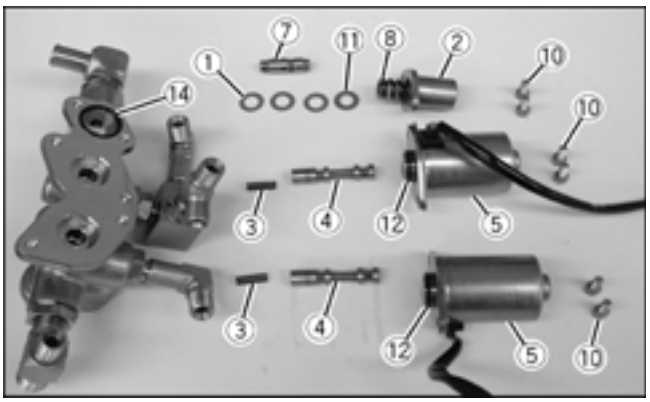
[1] Selector valve



Cross sectional view of selector valve



Disassembling the selector valve



1) Reassembling procedure:

1. Tightening torque of hydraulic adapter
   G1/4 : 24.5~29.4N·m (2.5~3.0kgf·m)
   G3/8 : 49.0~53.9N·m (5.0~5.5kgf·m)

* For the mounting direction and angle of the hydraulic adapter, refer to the figure to the left.

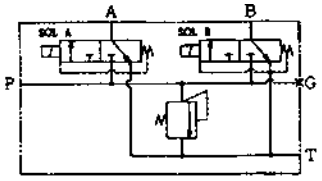
2. Tightening torque of valve assembly (selector):
   48.1~55.9 N·m (4.9~5.7 kgf·m)

Parts list

No.	Part No.	Part name	Q'ty	Remarks
1	RB411-6191Δ	Valve assembly (selector)	1	
2	RC411-63841	Pipe joint (T, F2-F3)	1	P
3	RP201-61892	Pipe joint (L, G1/4- G1/4)	1	B
4	68591-63231	Washer based elbow	2	A·B
5	RC101-63831	T pipe joint (F2)	1	B
6	RB411-6391Δ	Elbow pipe joint (G3/8-13)	1	T
	04810-00110	O-ring	4	A·B for 1/4
	04810-00140	O-ring	2	P·T for 3/8
7	01125-61020	Bolt	2	M10×1.5 7T

Tightening torque of hex socket bolt (10):
3.92 N·m (0.4 kgf·m)
Relief valve set pressure: 3.9 MPa (40 kgf/cm^2)

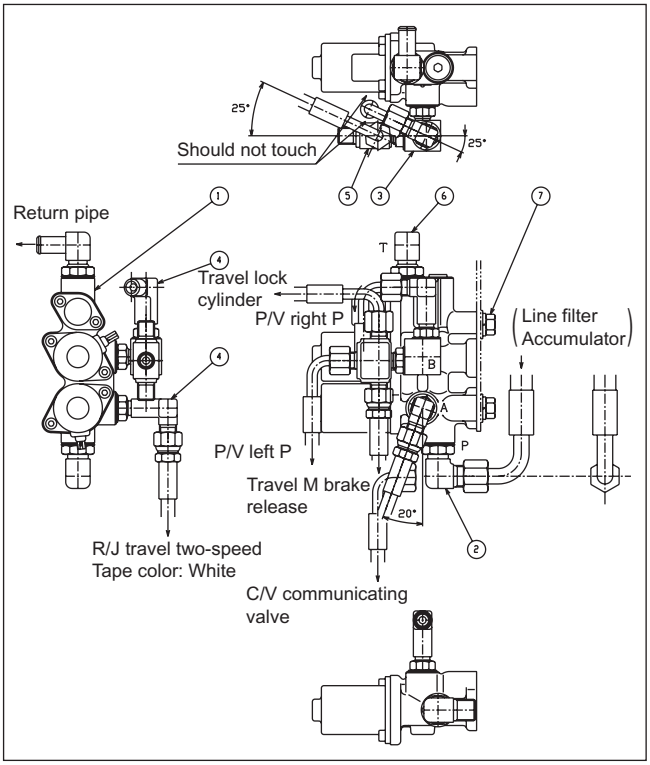
Hydraulic circuit diagram



Parts list

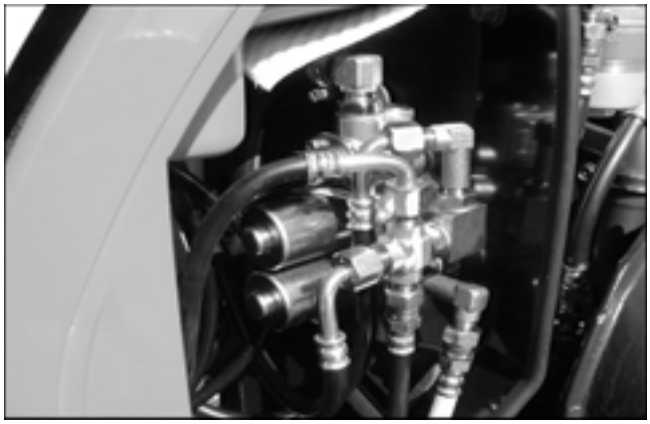
No.	Part name	Q'ty
1	Shim	3
2	Cover spring	1
3	Spring	2
4	Spool	2
5	Solenoid	2
6	Body	1
7	Plunger	1
8	Spring	1
9	Flanged plug	3
10	Hex socket bolt	6
11	Flat washer	1
12	O-ring	2
13	O-ring	3
14	O-ring	1

2) Installing the selector valve

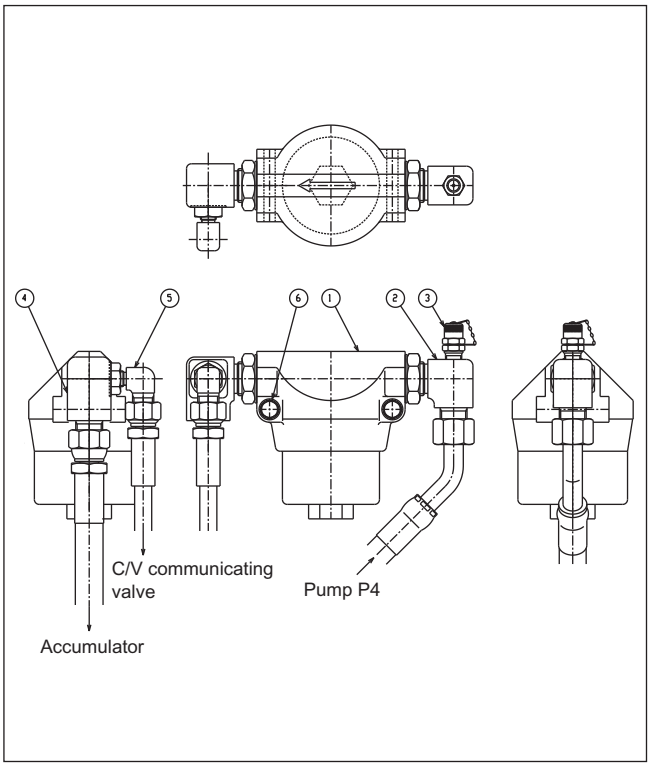


(1) Tightening torque for installation of valve
48.1~55.9 N·m (4.9~5.7 kgf·m)
(2) Tightening torque of adaptor
G3/8: 49.0~53.9 N·m (5.0~5.5 kgf·m)
G1/4: 24.5~29.4 N·m (2.5~3.0 kgf·m)

No.	Part No.	Part name	Q'ty	Remarks
1	RB411-6191Δ	Valve assembly (selector)	1	(633)
2	RP201-61812	Pipe joint (L, G3/8- G3/8)	1	P
3	RP201-61892	Pipe joint (L, G1/4- G1/4)	1	B
4	68591-63231	Washer based elbow	2	A·B
5	RP802-61931	Pipe joint (cross, G1/4)	1	B
6	RB411-6391Δ	Elbow pipe joint (G3/8-13)	1	T
7	01125-61020	Bolt	2	M10×1.5 7T
	04810-00110	O-ring		A·B for 1/4
	04810-00140	O-ring		P·T for 3/8

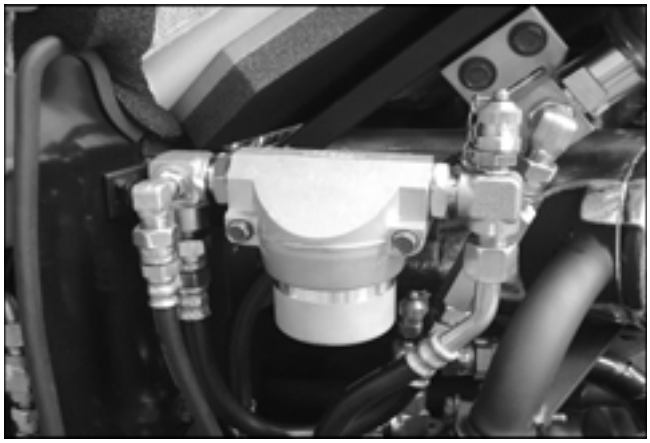


[2] Pilot filter

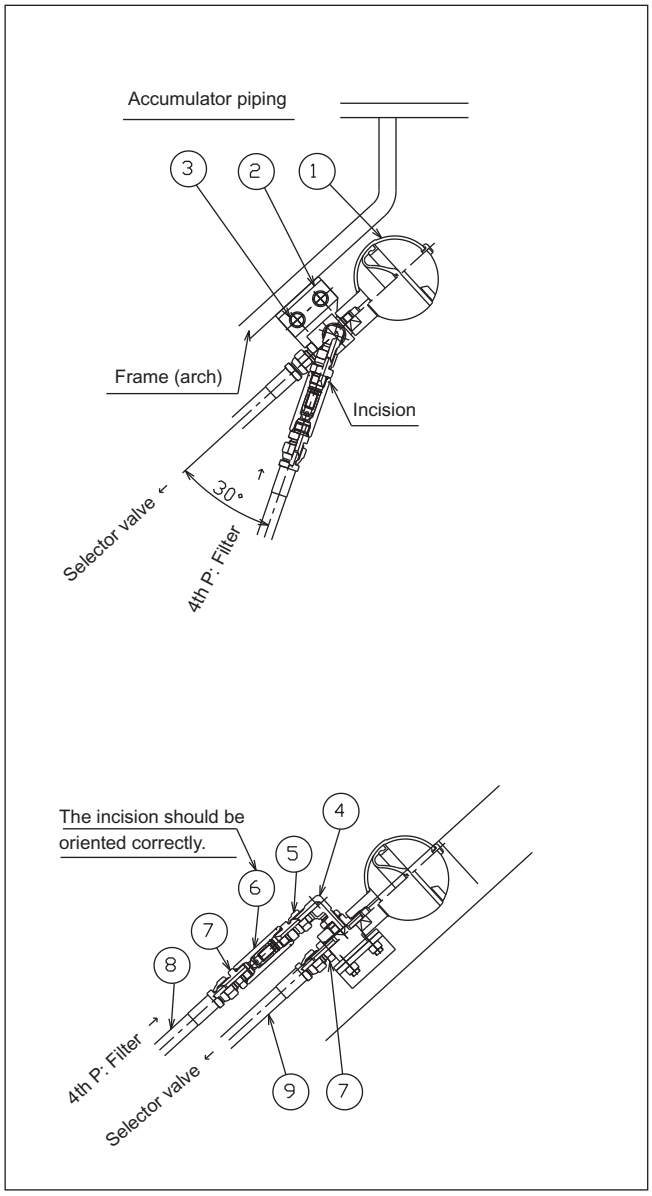


(1) Tightening torque for installation of filter:
9.8~11.3 N·m (1.0~1.15 kgf·m)
(2) Tightening torque of adaptor:
G1/2: 58.8~63.7 N·m (6.0~6.5 kgf·m)
(3) Tightening torque of hydraulic hose:
G3/8: 49.0~53.9 N·m (5.0~5.5 kgf·m)

No.	Part No.	Part name	Q'ty	Remarks
1	RD401-6126Δ	Filter assembly (pilot)	1	(624)
2	RC401-6383Δ	Elbow pipe joint (F4-F3)	1	IN
3	RG908-86443	Adapter	1	R1/8
4	RB419-6381Δ	Pipe joint (L G4-G3-G1)	1	OUT
5	RP201-6962Δ	Pipe joint (L G1/8-G1/4)	1	
6	01025-60655	Bolt	2	M6×1 7T

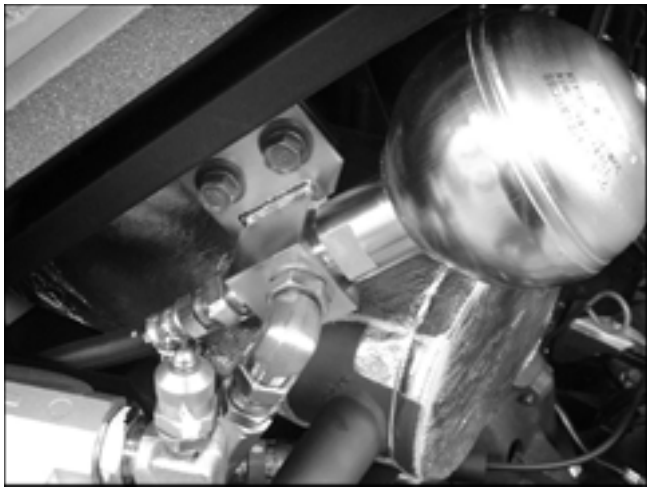


[3] Accumulator



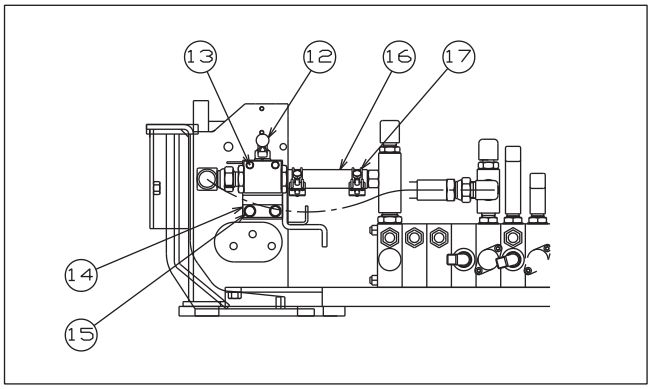
(1) Tightening torque of accumulator hydraulic adaptor:
G3/8: 49.0~53.9 N·m (5.0~5.5 kgf·m)

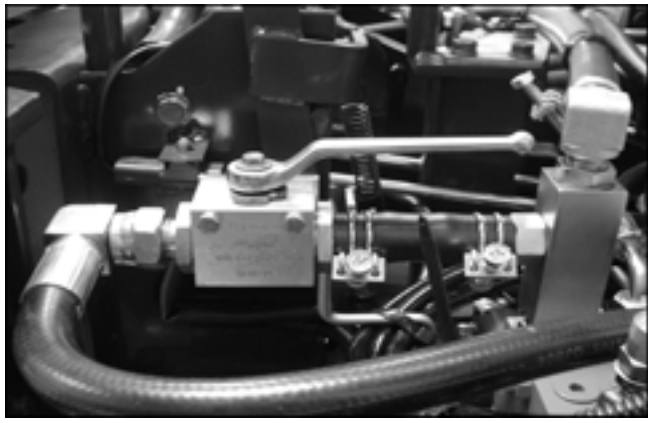
No.	Part No.	Part name	Q'ty	Remarks
1	RB419-6281Δ	Accumulator	1	
2	RB419-6385Δ	Pipe joint (accumulator)	1	
3	01133-61025	Bolt	2	
4	RP201-6181Δ	Pipe joint (L, G3/8- G3/8)	1	
5	RB419-6383Δ	Straight pipe joint (G3)	1	
6	RD119-6283Δ	Valve assembly (check)	1	
7	68311-6432Δ	Straight pipe joint	2	
8	RB419-6325Δ	Hydraulic hose (3/8, P4, 2-1)	1	
9	RB419-6326Δ	Hydraulic hose (3/8, P4, 2-2)	1	

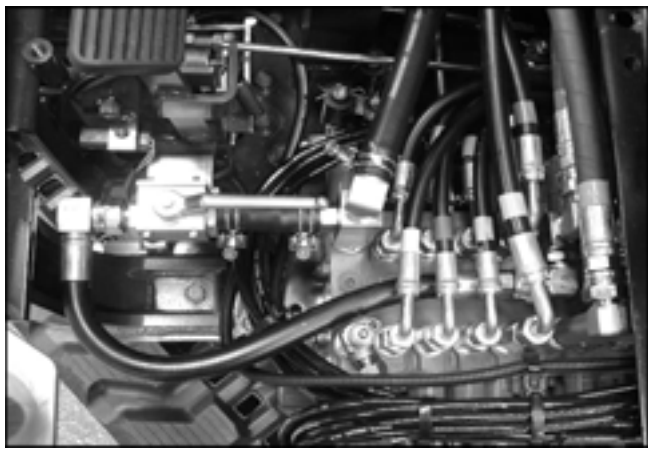


[4] Third line

No.	Part No.	Part name	Q'ty	Remarks
11	RB419-9258Δ	Hydraulic hose (1/2. third line)	1	
12	RD418-9640Δ	Valve assembly (third line)	1	
13	RD418-9642Δ	Bolt	1	
14	RB419-9255Δ	Plate (third line)	1	
15	01123-60820	Bolt	2	
16	RB419-9261Δ	Hose (5/8-100, third line)	1	Fixed foot
	RB419-9262Δ	Hose (5/8-70, third line)	1	Movable foot
17	09318-89024Δ	Hose clamp (screw type)	2	







1-way or 2-way CIRCUIT SELECTION VALVE OPERATION

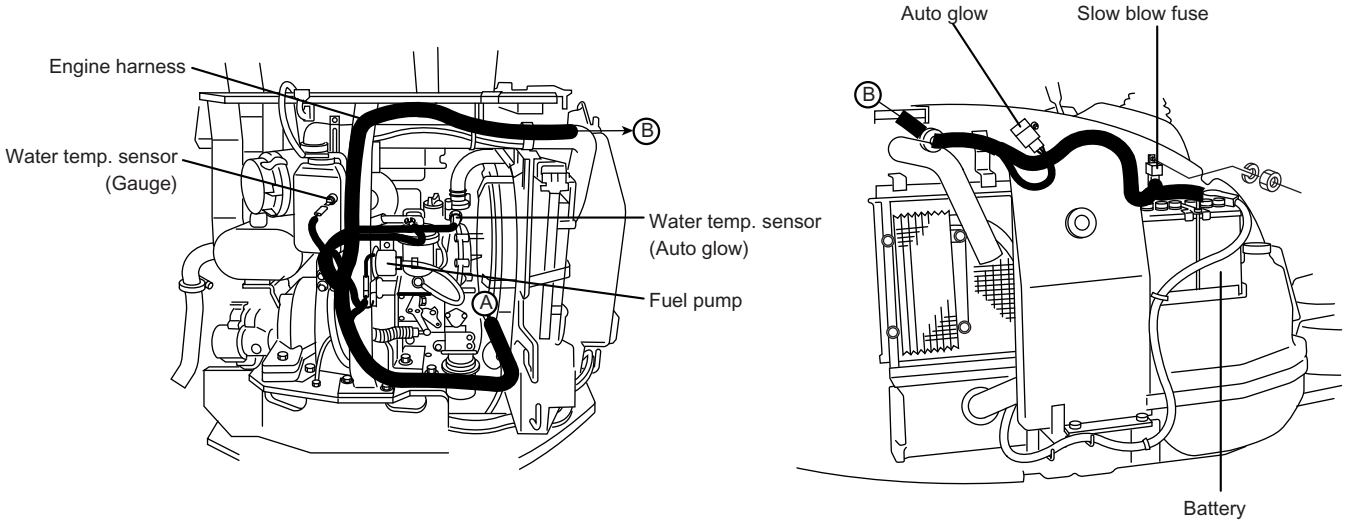
The selection valve which select 1-way or 2-way circuit of service port has been installed on the control valve.
When the breaker will be used, position the lever of selection valve to the “OPENED” position (1-way circuit) to reduce the back pressure.

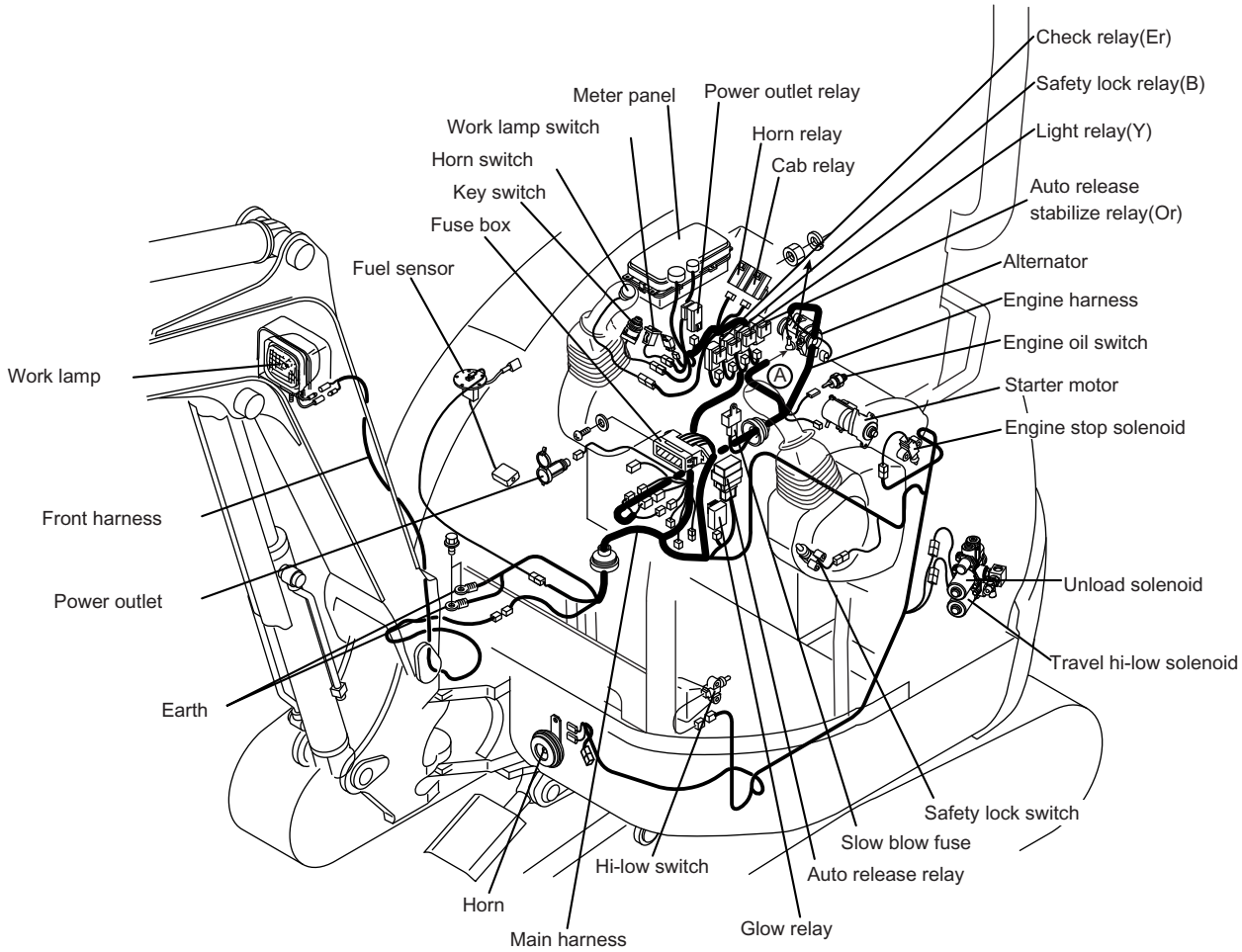
IMPORTANT:

- When the equipment (auger, crusher, telescopic arm, ...), which need 2-way circuit will be used, position the lever to the “CLOSED” position.

V. Electrical system (Mechanism section)

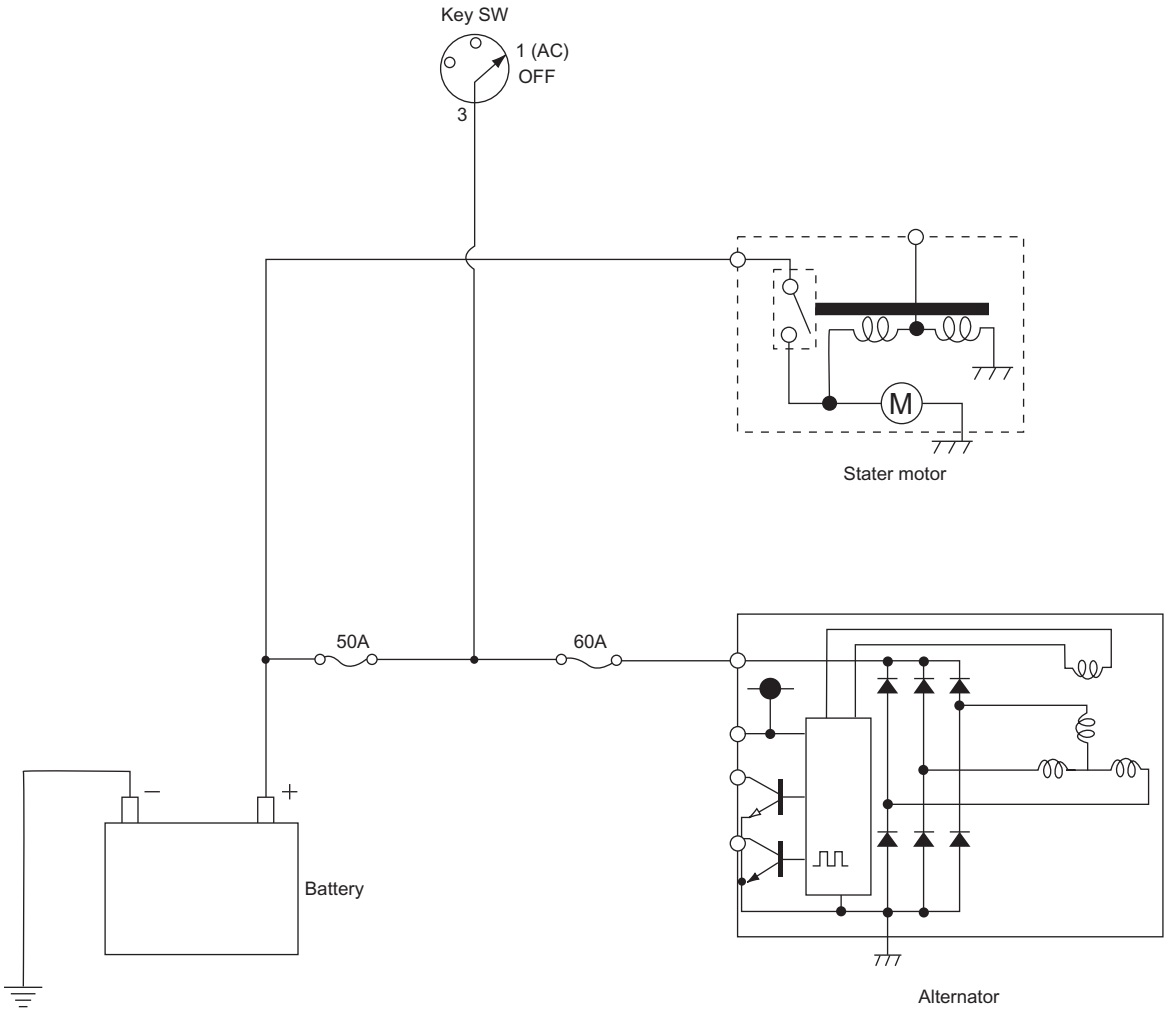
A. Components & harness layout





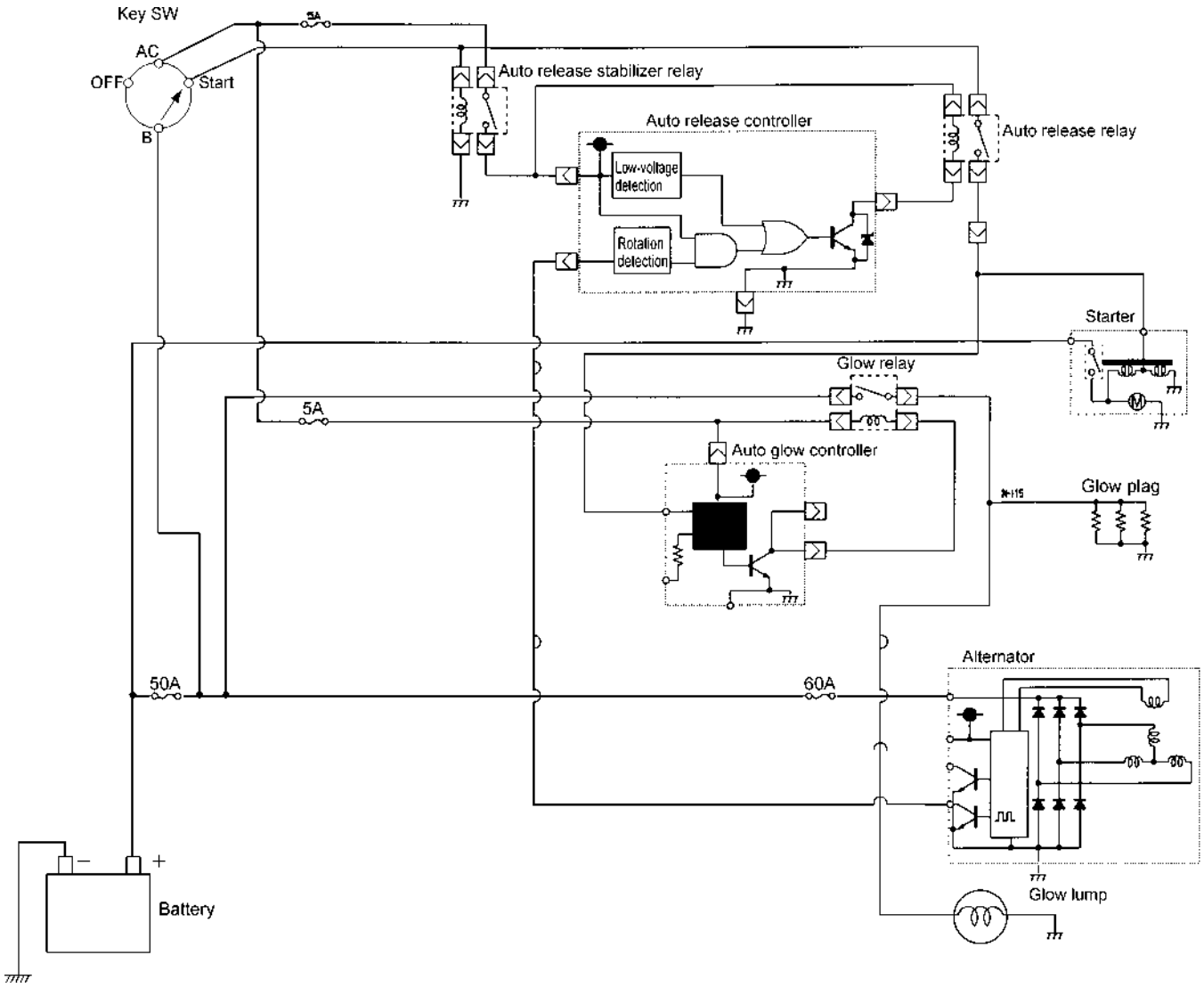
B. Function of main circuit

a. Battery circuit



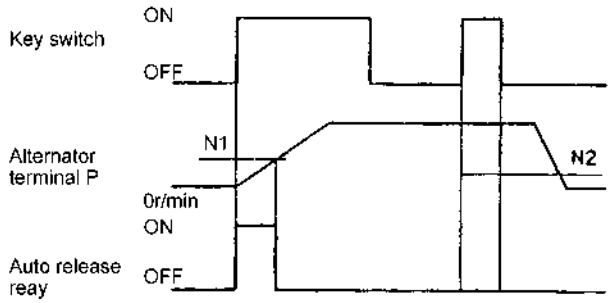
1. Keep in mind that the battery voltage is applied through the above circuit all the time.
2. A 60A fuse is added close to the alternator, because otherwise part of the harness may get short-circuited due to the alternator's current generated while the engine is running. In this way, the devices and harness can be protected against burn-out.

b. Safety Relay circuit (Automatic release function)



1. When the engine has started and the alternator has reached the specified rpm (N = 1 in the figure below), the auto release controller is activated to turn off by the auto release relay.
2. With the auto release relay off, the starter motor current is interrupted to stop the starter motor.
3. In this way, the starter motor can be protected against seizure even if the key switch fails to get back.

Operating pattern



c. Auto glow circuit

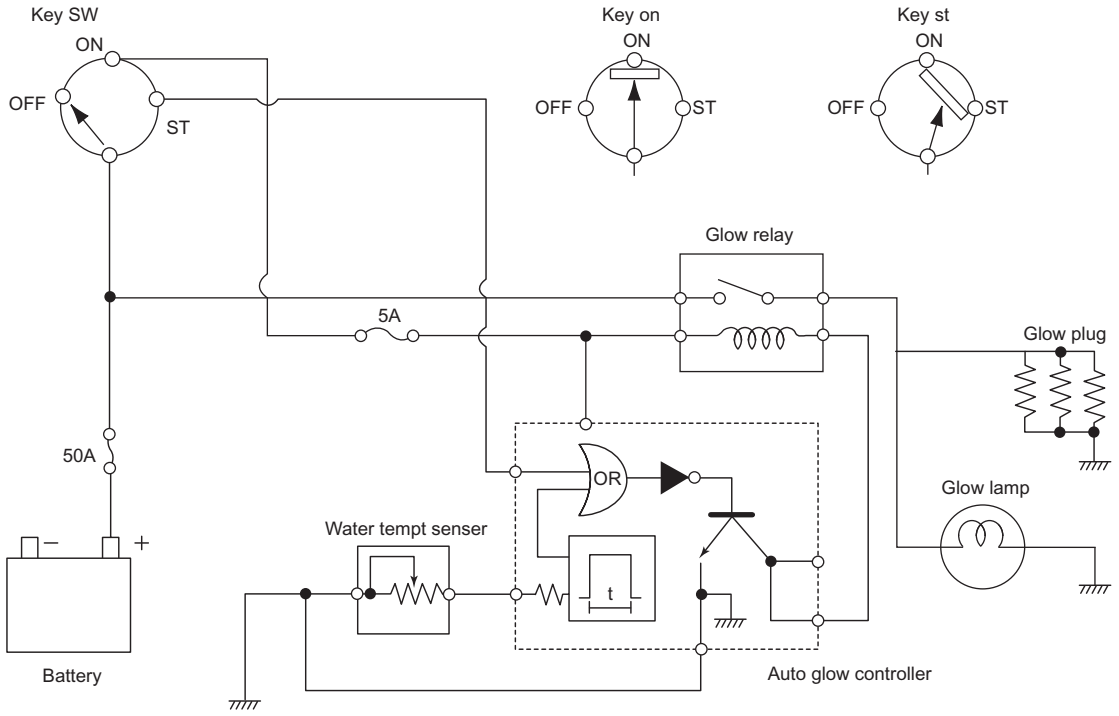


Fig 1

(1) Function

1. The glow controller receives a water temperature sensor signal or a key switch start position signal and makes the signal voltage (1) drop to the ground level. Now the current starts flowing to the relay coil. (NOR signal circuit)
2. Turn the key switch from the OFF to ON position, and the glow relay is kept on for the time "t" as shown in Fig. 2 (Function chart) to light up the glow lamp.
3. While the key switch is set at the ST position, the glow relay is turned on again to light up the glow lamp.
4. As indicated in Fig. 3 (Timer curve), the pre-glow time (glow lamp-on time) "t" is compensated depending on the water temperature.
5. Once the current flows to the relay coil, the battery voltage starts flowing to the glow plug.

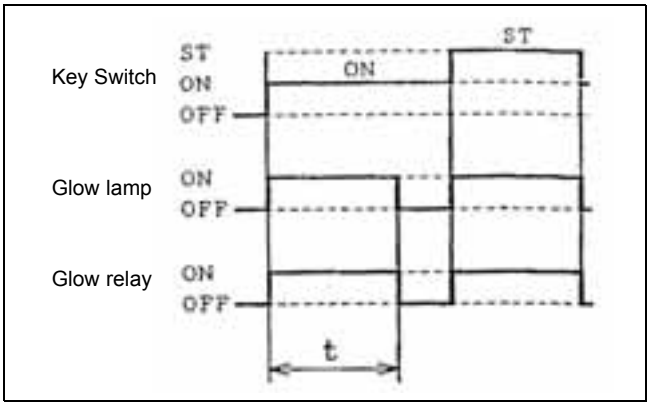
Reference: NOR logic circuit

Water temp sensor signal	Key SW ST signal	OR	
H	H	H	L
H	L	H	L
L	H	H	L
L	L	L	H

H: High level, 12V
Indicates that a signal voltage is applied.
L: Low level, 0V
Indicates that no signal voltage is applied or that the terminal is grounded.

The NOR logic circuit is a composite circuit of OR gate and NOT gate.

Fig 2. Function chart



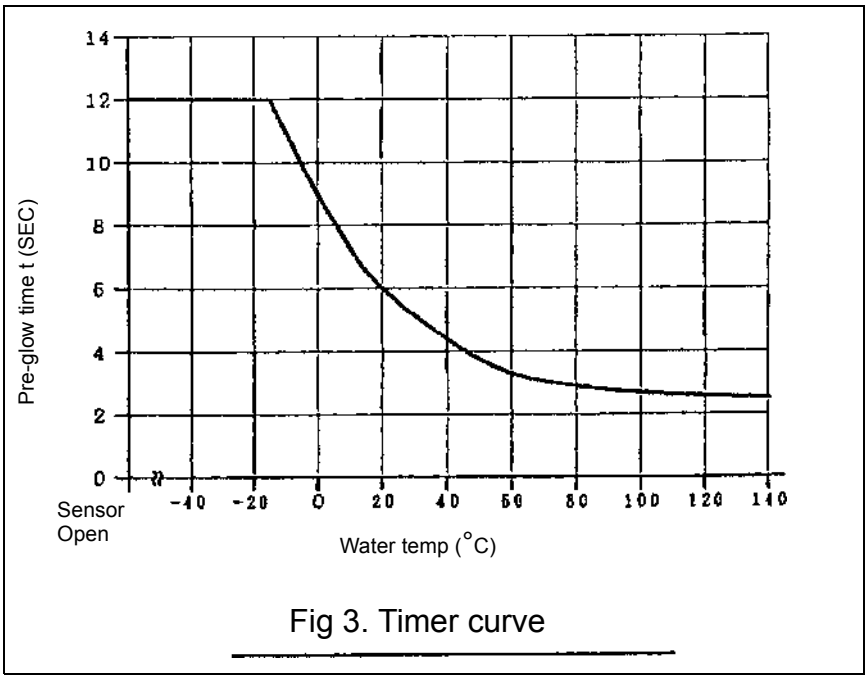


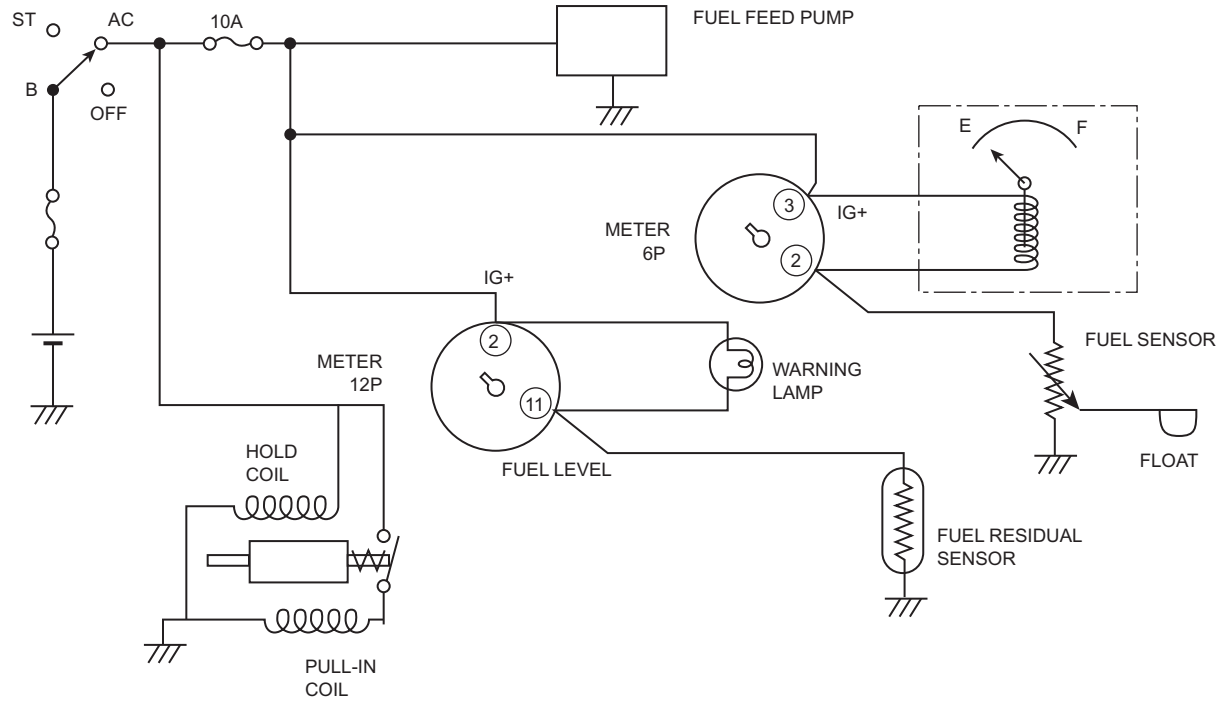
Fig 3. Timer curve

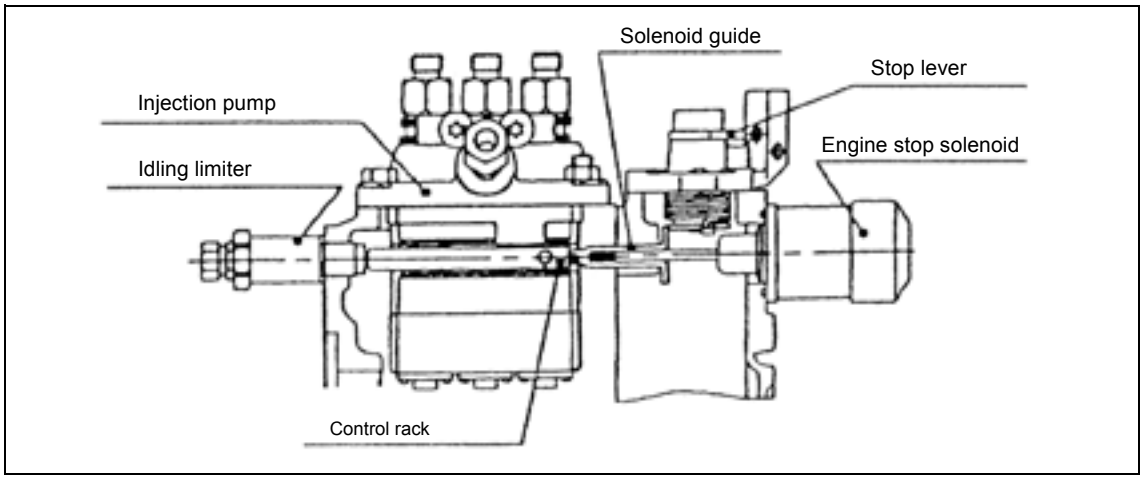
Table 1. Timer function values

Water temp (°C)	Thermistor resistance (Ω)	Pre-glow time (sec)
140	58	2.55
100	155	2.73
80	277	2.95
60	530	3.37
40	1100	4.22
20	2525	5.85
10	3997	7.12
0	6544	8.77
-10	11123	10.81
-20	19716	12.00
-30	36630	12.00
-40	71770	12.00

d. Fuel control circuit

(1) Function

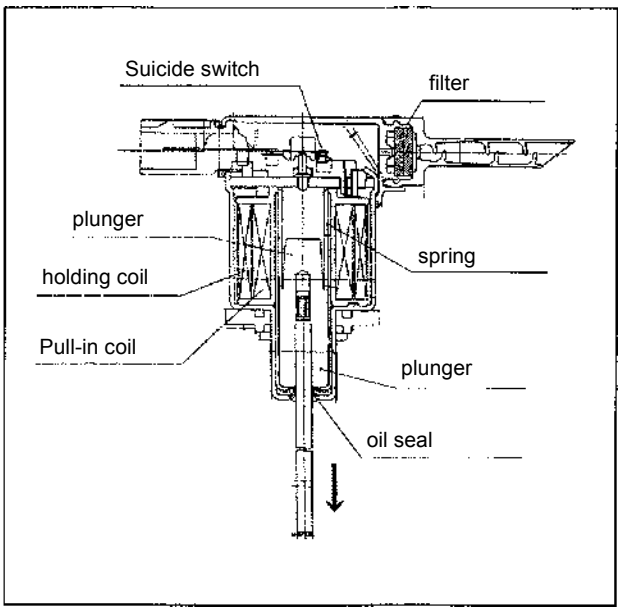




1. The fuel control circuit is mainly composed of the following devices.
   1) Fuel feed pump
   2) Engine stop solenoid
   3) Fuel gauge
   4) Fuel sensor
   5) Fuel residual sensor
2. The fuel sensor detects the position of the float and the remaining fuel amount is displayed in the fuel gauge.
3. The fuel residual sensor has a thermistor. When the sensor is well below the fuel level, the resistance value is high enough to allow no current to the warning lamp. If the fuel level has dropped below specified, however, the thermistor gets exposed to the air and becomes smaller in resistance. This allows the current to flow to the warning lamp that will light up.

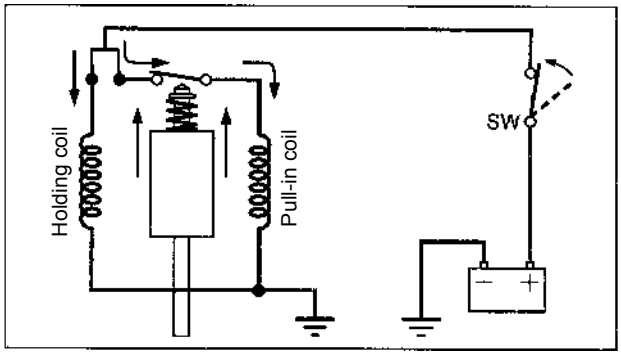
(2) Engine stop solenoid

1) Structure



Specifications

1. Rated voltage : DC12V
2. Rated ampere
   Pull-in coil : 32A / DC12V
   Hold coil : 77A / DC12V
   at 20°C
3. Resistance
   Pull-in coil : Ω
   Hold coil : Ω



2) Circuit and its function

The engine stop solenoid circuit is as shown at left.

Turn the key switch to the ON position, and the battery current flows both to the pull-in coil and the holding coil. These coils are excited to attract and lift the plunger.

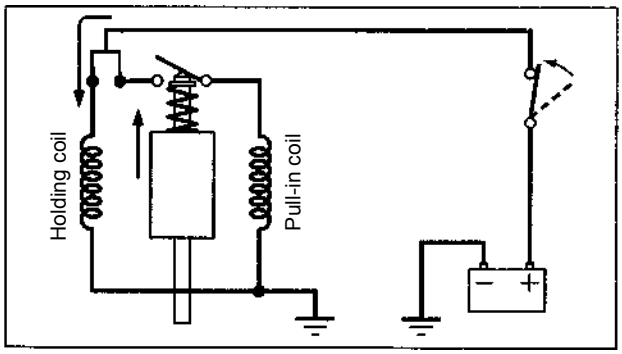
Now the fuel injection pump is ready to get the engine started.

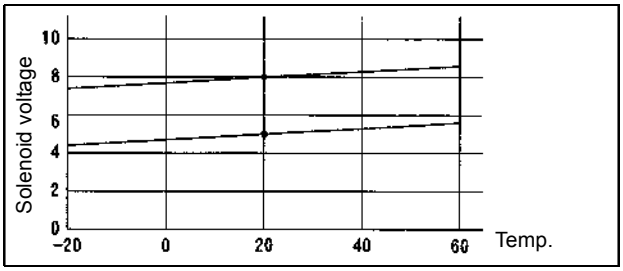
Being attracted upward, the plunger pushes and opens the contact, which discontinues the current flow to the pull-in coil.

With the current still flowing to the holding coil, the plunger stays in this position.

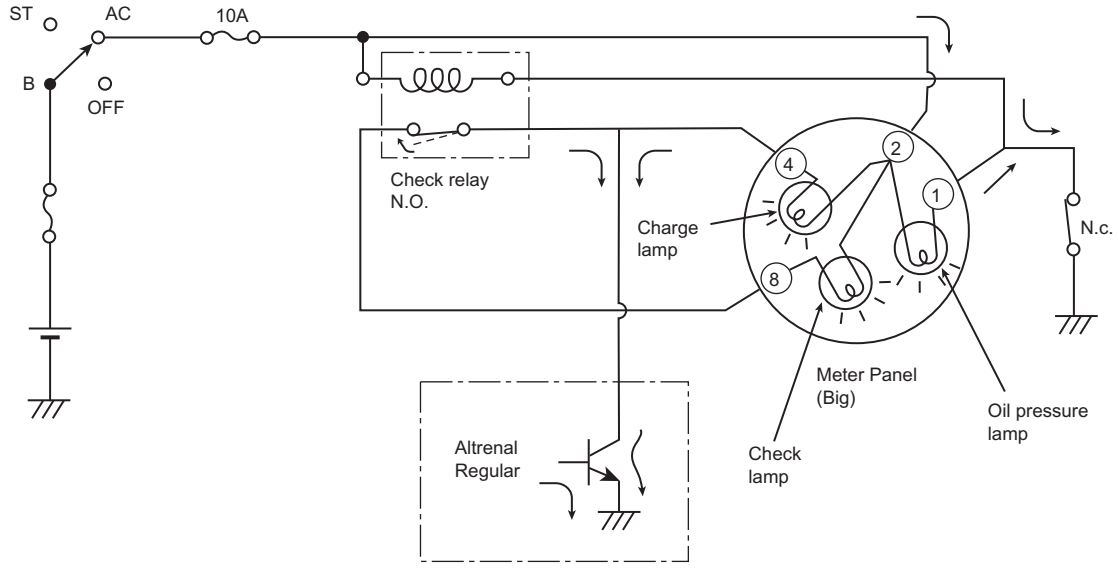
Turn the key switch to the OFF position, and the current flow to the holding coil is also interrupted.

By the force of the return spring, the plunger comes back to the original position. By so doing, the fuel injection pump will be back to the engine-off status.



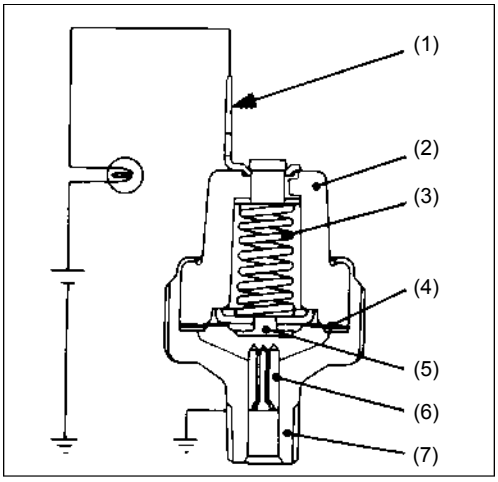


e. Engine oil pressure sensor circuit

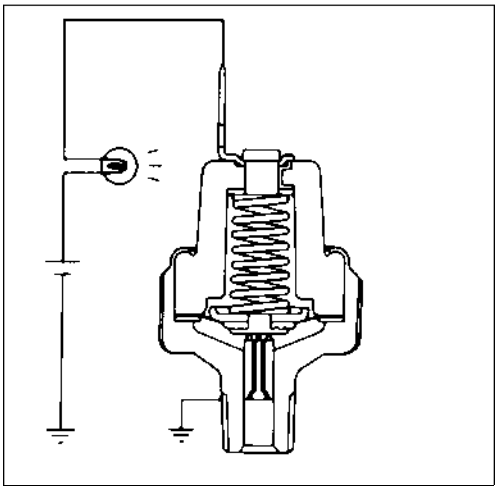


1. Engine oil pressure sensor is N.C.(Normal close) type.
2. Check relay is N.O.(Normal open) type.
3. Meter panel (Big): (1) Engine oil pressure line. (3) Charge line
   (2) Battery IG(+) (4) Check relay line

(1) In normal



(2) In trouble



Oil switch

1. Code No, :15531-39011
2. DC12V
3. Warning lamp :SW
4. Operating pressure :0.5 ± 0.1 kgf/cm^2
5. Insulation resistance :3MΩ or more

(1) In normal condition
When the engine lube oil pressure goes up, the contact of oil switch 6 opens to turn off the lamp.

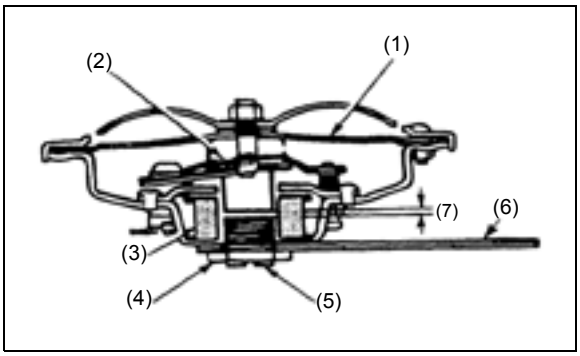
(2) In trouble
When the above pressure comes down, the contact of oil switch 6 closes to turn on the lamp.

Operating pressure of oil switch
·····Ref. value : 0.5 kgf/cm^2 , 7.1 psi, 0.05 MPa

(1) Terminal (5) Contact rivet
(2) Insulator (6) Contact
(3) Spring (7) Body
(4) Rubber

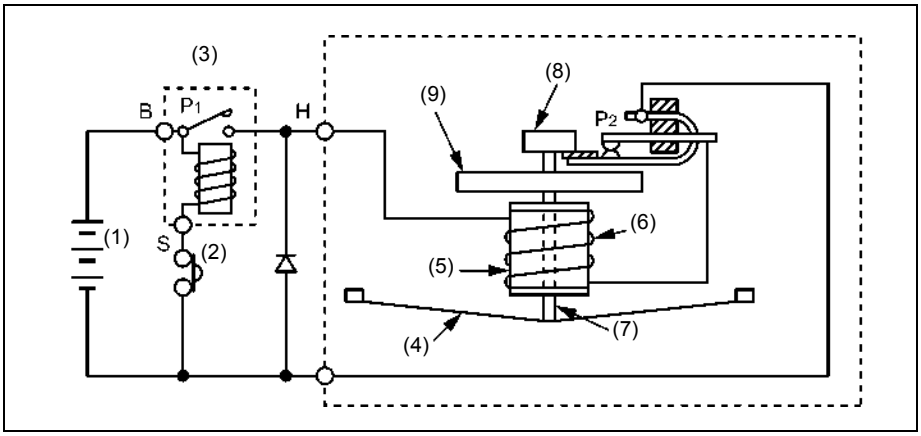
f. Horn circuit

(1) Structure



(1) Diaphragm
(2) Point
(3) Horn coil
(4) Nut
(5) Stop screw
(6) Stay
(7) Air gap

The horn consists of acoustic diaphragm, point, horn coil and other parts. It comes in spiral, flat and other types in construction.
Currently, the flat type is most widely used. A typical flat horn is shown at right.

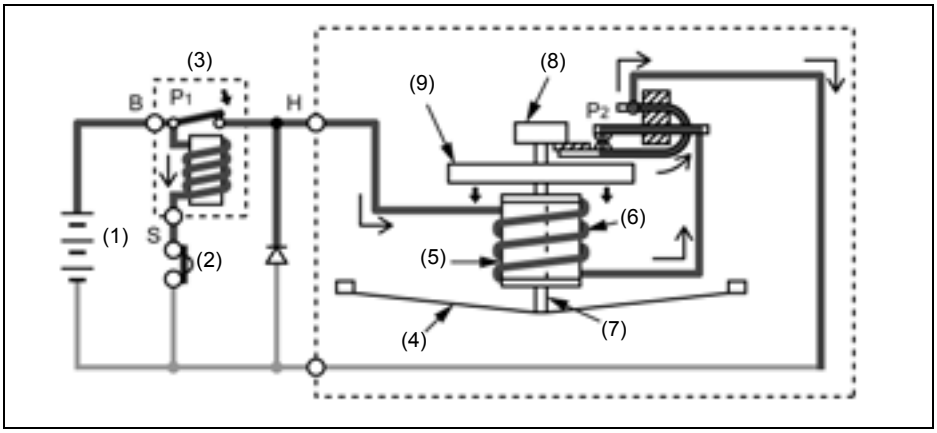


(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphragm
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate

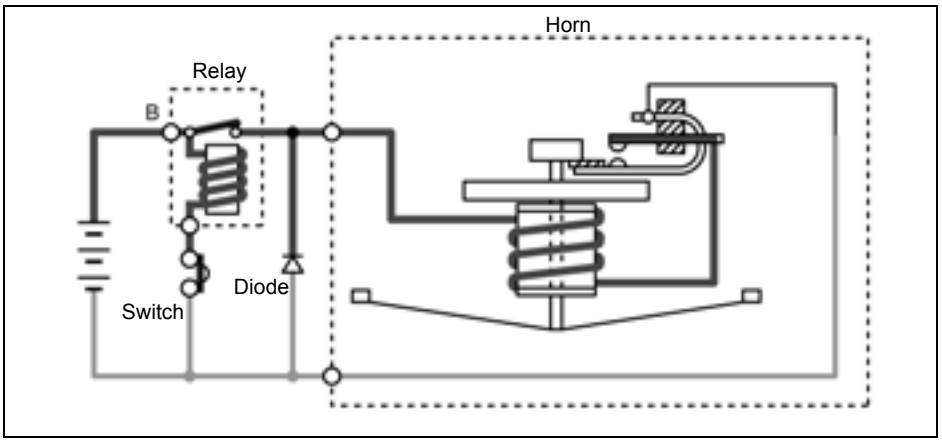
(2) Function

Shown above is the horn drive circuit. When the horn switch is pressed, current flows to the horn relay to get its contact P1 closed. The current from the battery now flows directly through the horn coil and the contact P2, which magnetizes the core and attracts the moving plate. Then the contact P2 opens itself and the current is interrupted. The magnetic force then disappears and the spring-loaded diaphragm comes back to the original position. The contact P2 closes itself, and the current flows again through the coil to attract the moving plate. The above series of actions are repeated to keep the diaphragm vibrating, producing sound.

(3) Current flow



(1) Battery
(2) Horn switch
(3) Horn relay
(4) Diaphragm
(5) Core
(6) Coil
(7) Moving bolt
(8) Adjust nut
(9) Moving plate

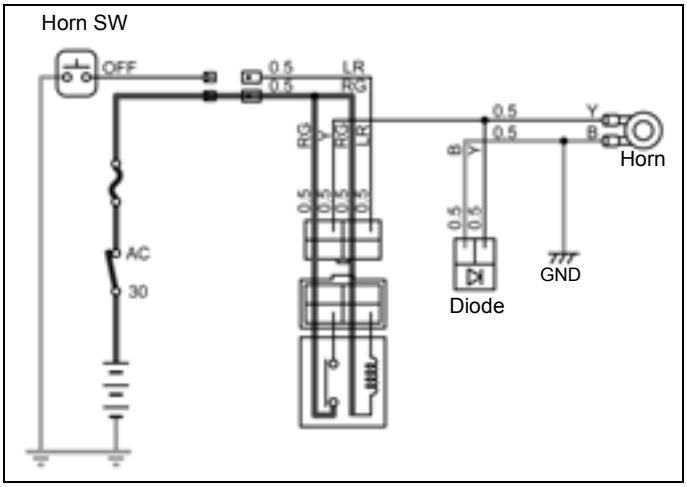


For your information

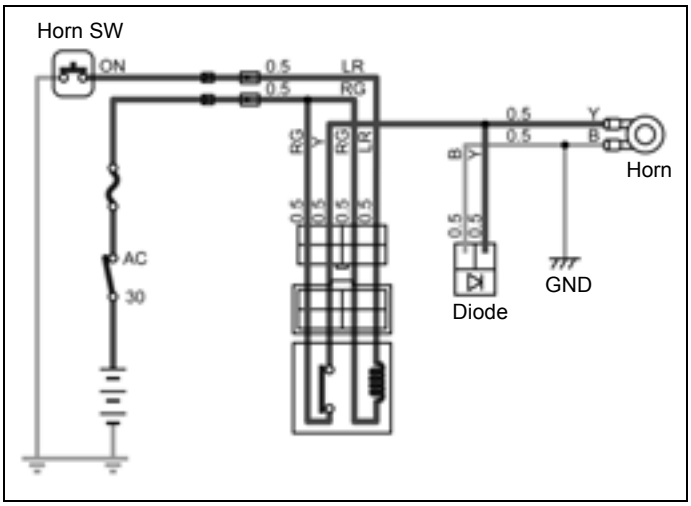
1. Function of diode: Prevention of horn switch by absorbing the surge current.
   Inductive type of load, such as solenoid valve generates arc spark at switch point.
   This diode installed parallel to solenoid valve let the surge current energy flow back to coil to consume as a joule heat.
   In this way, surge current won't flow to horn switch.

(4) Horn circuit

(Horn SW is off position)

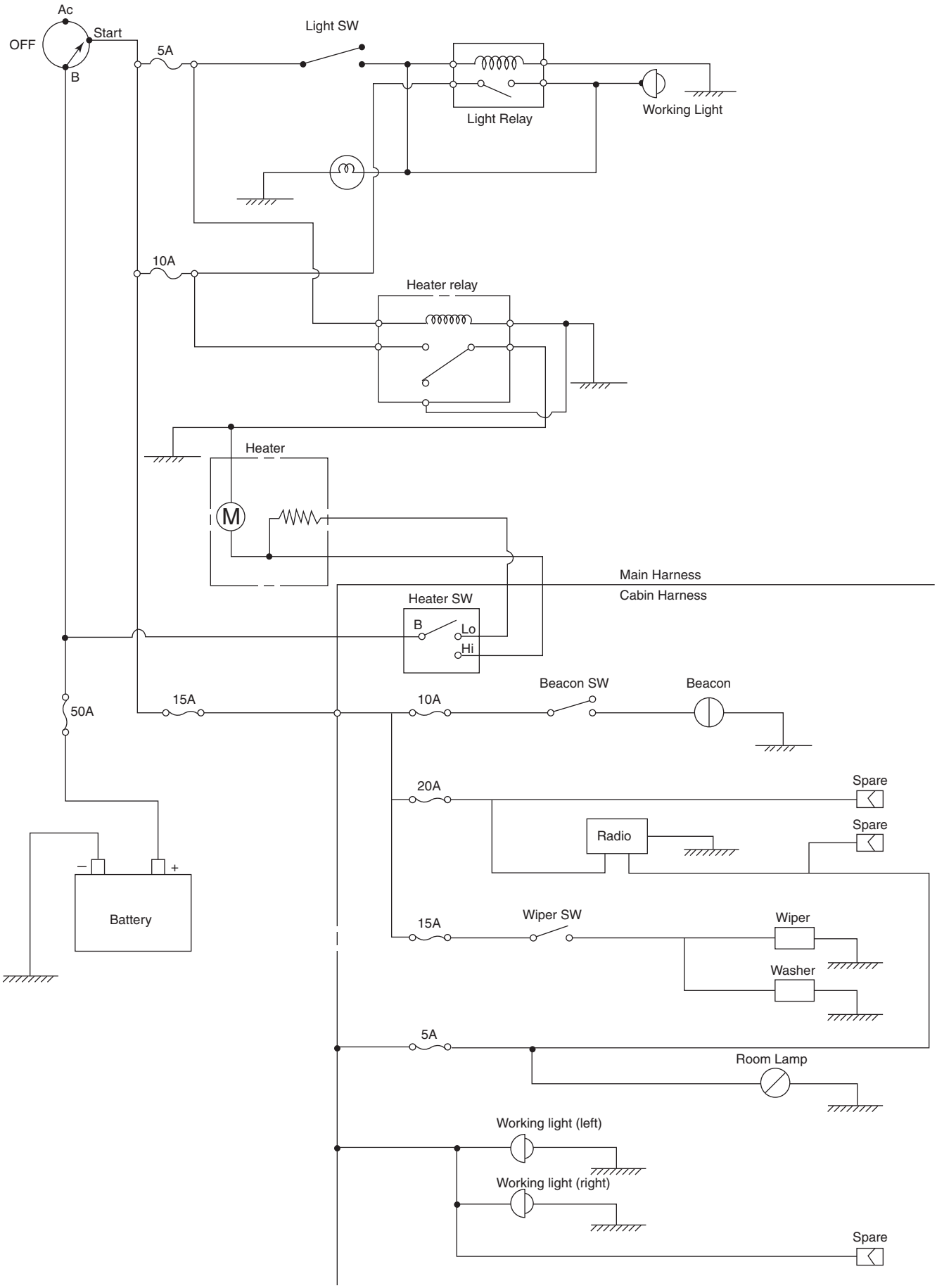


- When horn switch is off, current doesn't flow through relay.
  So relay remains off condition and horn doesn't sound.



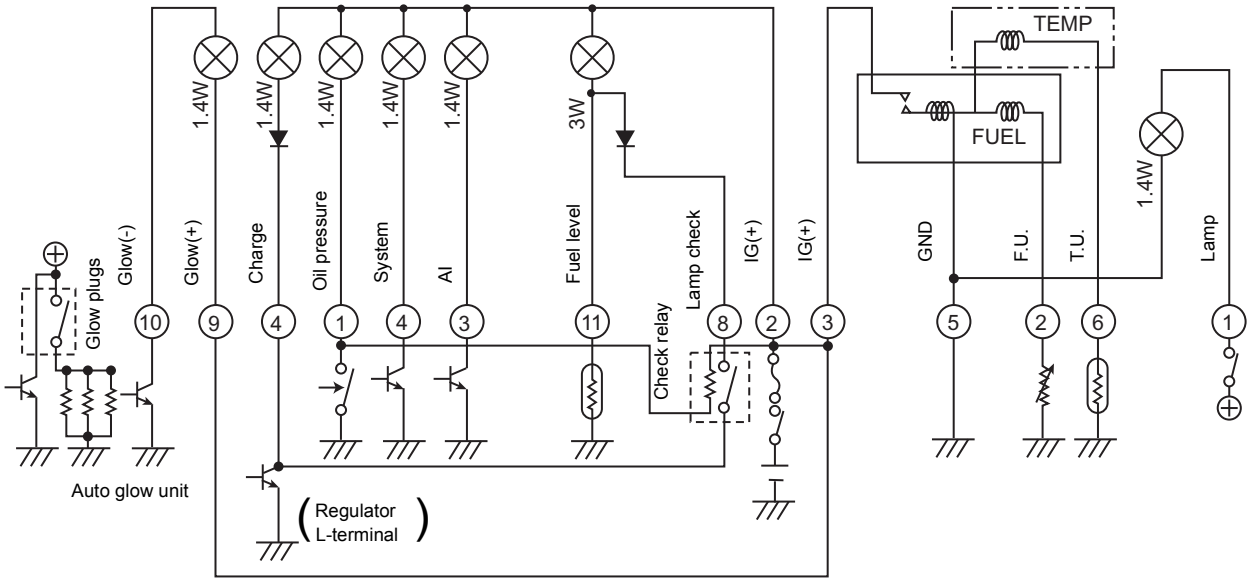
- When horn switch is on position, current flows through relay, magnetizes it and activates horn.

g. Cab & Working lamp circuit

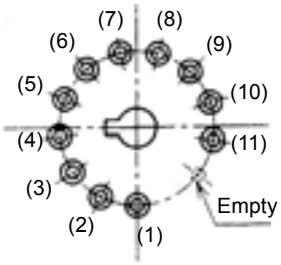


h. Meter panel

Circuit diagram

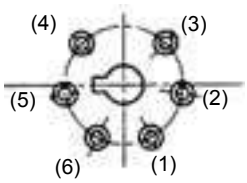


12p connector



No	Connection
1	Engine Pressure
2	IG(+)
3	-
4	Charge
5	-
6	-
7	-
8	Check SW
9	Glow (+)
10	Glow(-)
11	Fuel level

6p connector



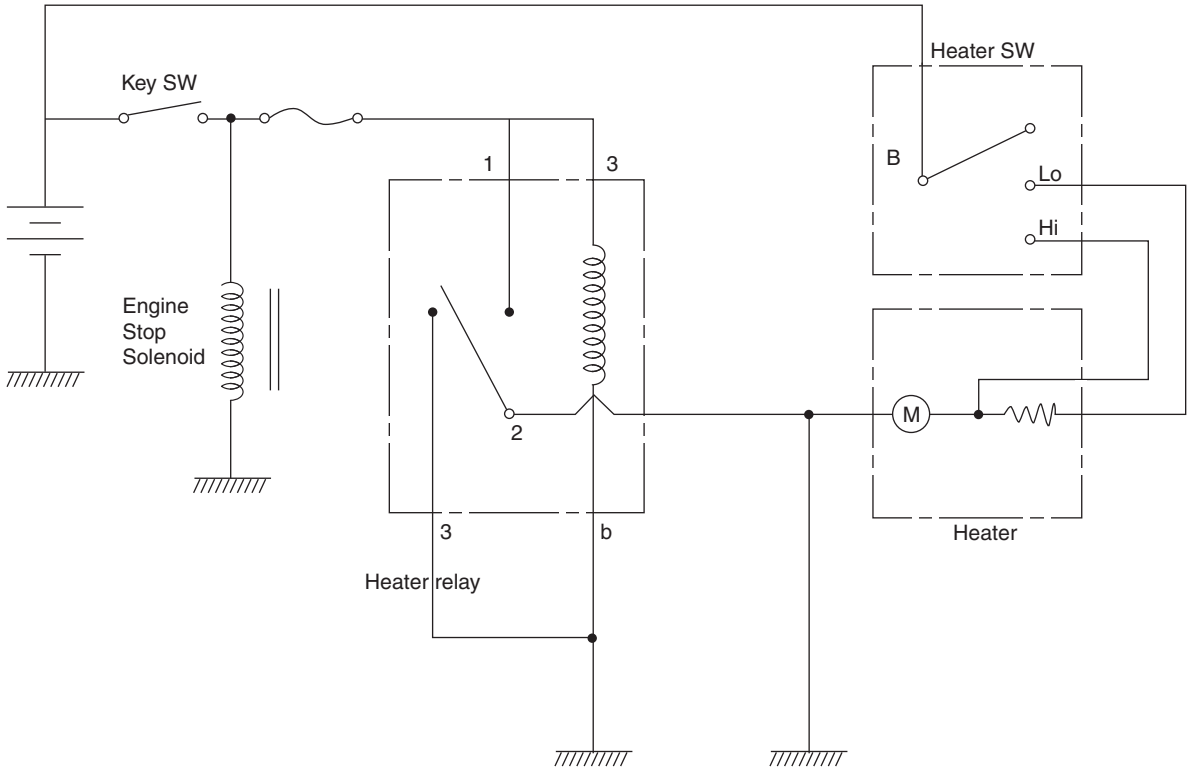
No	Connection
1	Lamp(+)
2	Fuel unit
3	IG(+)
4	System lamp
5	GND
6	Temp. unit

1. Turn the key switch to the ON position, and the battery current starts flowing as shown in the figure. Because the engine oil pressure switch is of NC type, the check relay comes on too and all the warning lamps light up.(The regulator terminal L also lights up when the key switch is turned to the ON position.)

2. When the engine has started and reached the specified speed, the engine oil pressure rises too and the switch is turned off. The charge voltage also rises, which discontinues the current flow to the terminal L. Thus the check relay turns itself off and all the warning lamps go out.

3. During usual operation, the indicator lamps are ready to light up according to their respective circuits. Let's take some examples. The glow lamp stays on while the current is flowing to the glow plug. The AI lamp is kept on during the AI function. The charge lamp lights up if the charge voltage drops below the specified level. The fuel level lamp lights up if the fuel runs short.

i. Heater circuit



(1) Current flow

1.Turn the key switch to the ON position, and the battery current starts flowing to the heater relay, making the relay contact.

2.By changing the heater switch to the High and Low position, the heater can be controlled in two steps.

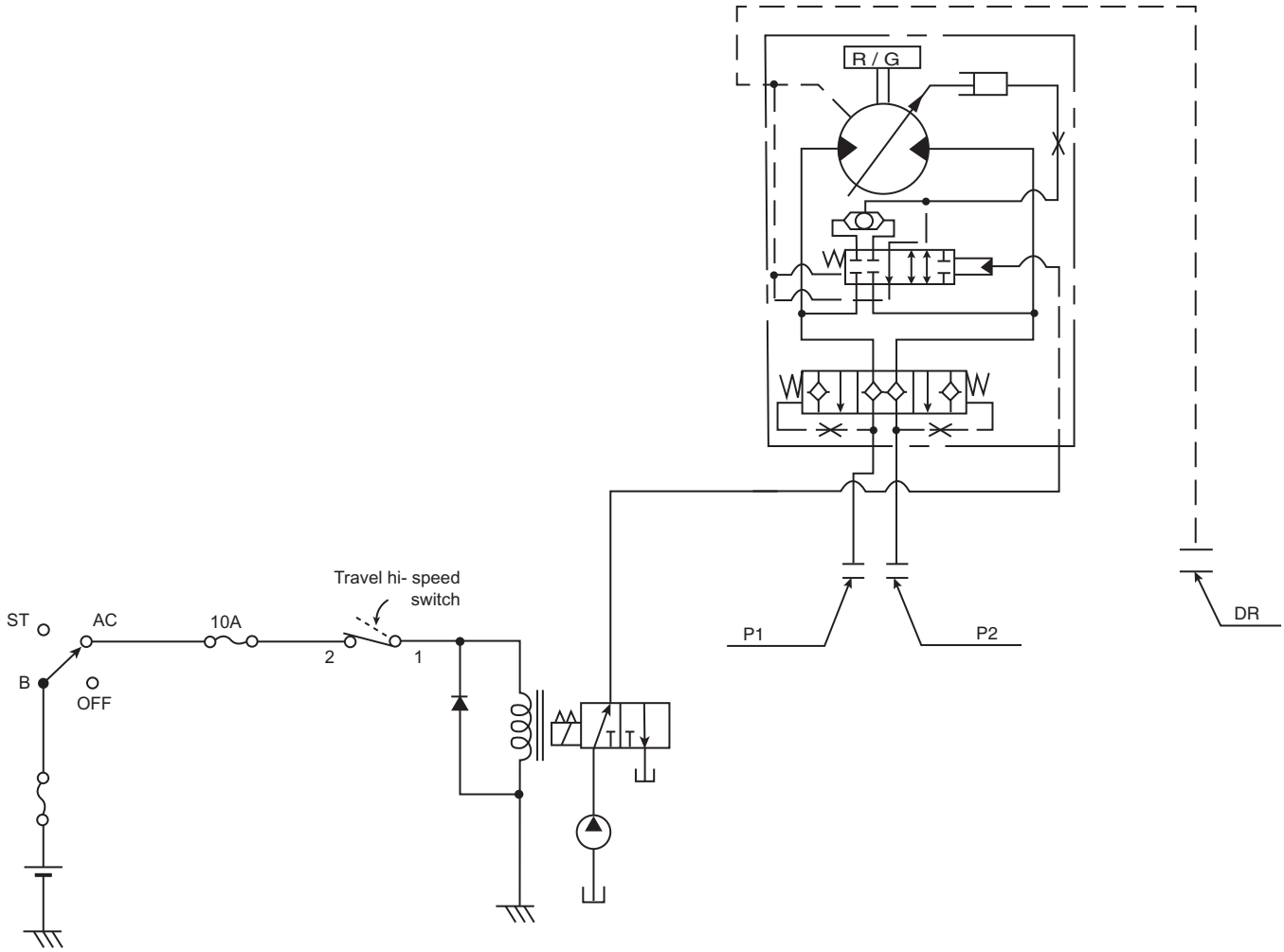
(2) Electromagnetic braking

Turn the key switch to the OFF position with the heater switch still on, and the heater motor usually keeps turning by inertial force and generates electricity. Since the relay terminal is always grounded, however, the self-generated current causes an inverse electromagnetic action, which interrupts the motor quickly. This process is called electromagnetic braking.

(3) Purpose of relay

Without the relay, the above-mentioned self-generated current at a stop of the heater motor might flow into other solenoid valves for example. The relay is thus used to prevent malfunction of other devices.

j. Travel hi-speed control circuit



Troubleshooting: Travel hi-speed malfunction

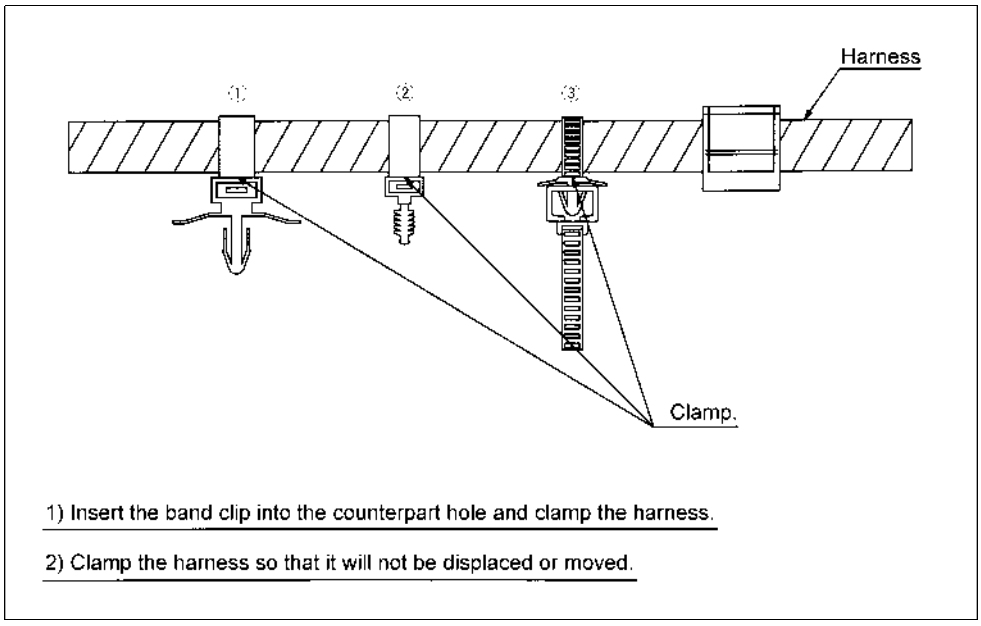
1. Turn the key switch to the ON position to see if 12 V is applied to terminal 2 of the travel hi-speed switch.
2. Press the travel hi-speed switch to see if the 12 V signal comes to terminal 1.
3. Turn on and off the travel hi-speed switch and check the continuity and discontinuity.
4. Check the continuity of the travel hi-speed solenoid coil and measure its resistance.
5. If there is no problem with the above steps, it means the electrical system functions. Now go to the hydraulic system.
6. Possible troubles with the hydraulic system include stuck solenoid spool, poorly performing pilot pump, malfunctioning primary relief valve, stuck Hi-Lo selector spool, etc.

V. Electrical system (Service section)

A Wire harness installation

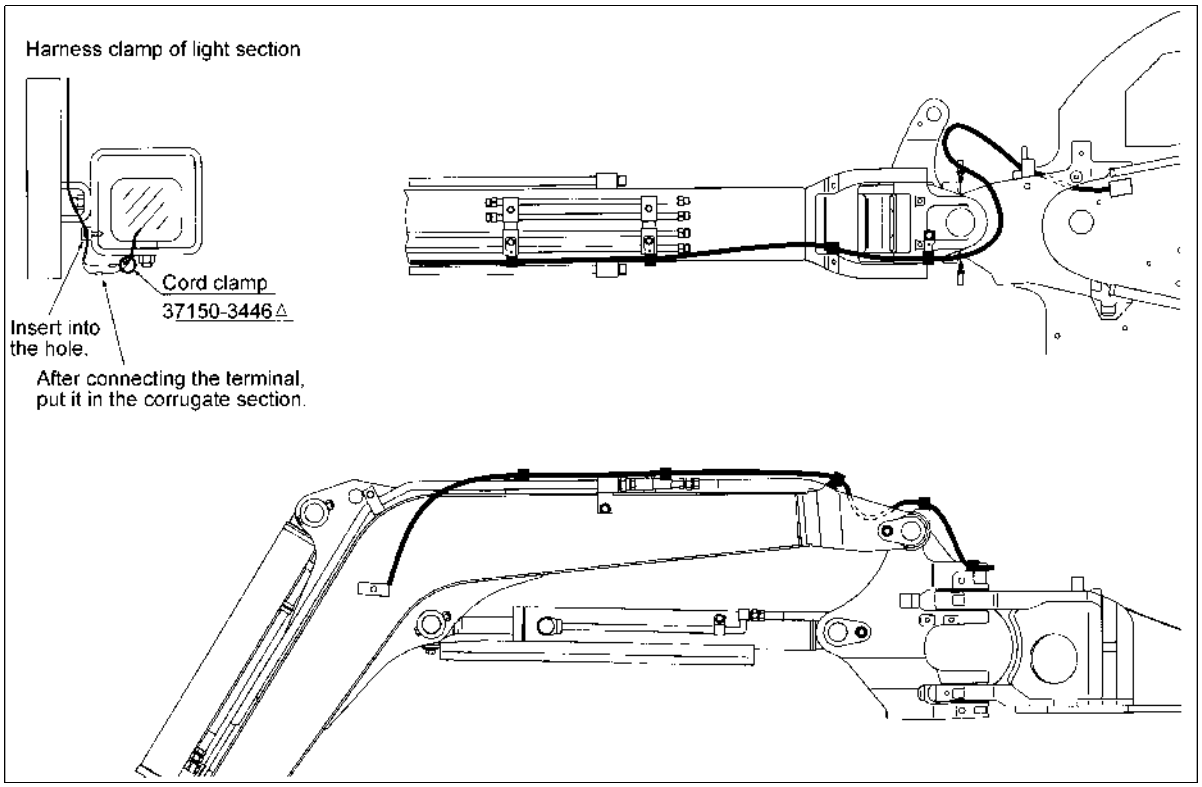
Precautions in clamping the electric wires

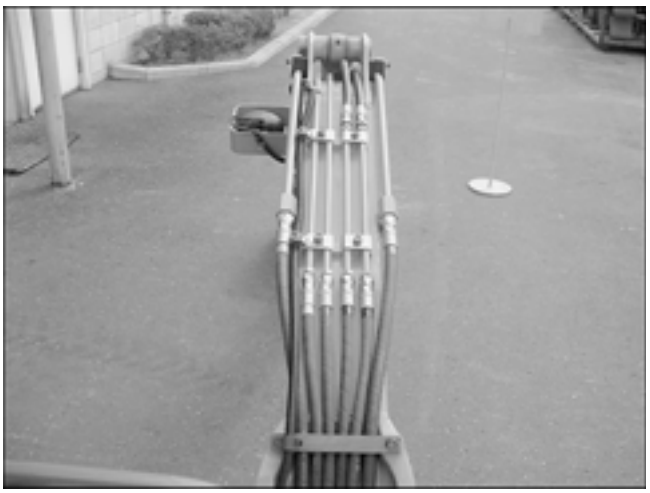
1. Do not allow the wire to touch things around the path.
   Do not touch the wire to a place where protective material is not used.
2. Do not clamp the wire together with the fuel hose.
3. Securely connect the coupler, terminal, etc. so that they will not be disconnected when pulled by some force.
4. Securely clamp the harness at the clamping position.
5. Harness-fixed clamp
   (1) Anchor type
   Insert to the engaging section.
   (2) Screw type
   Insert to the bottom of threaded portion.
   (3) Plug-in type
   Insert until locked.



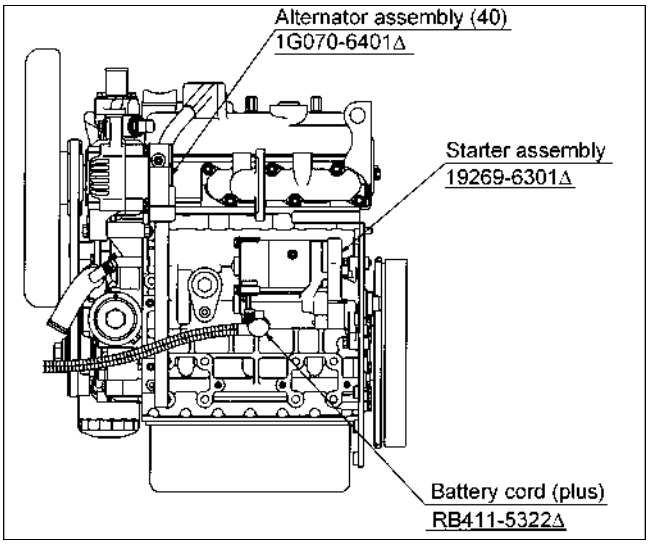
* The harness should not protrude from the corrugate slit section of the
* The cord clamp should clamp at the corrugate winding section.

a Front

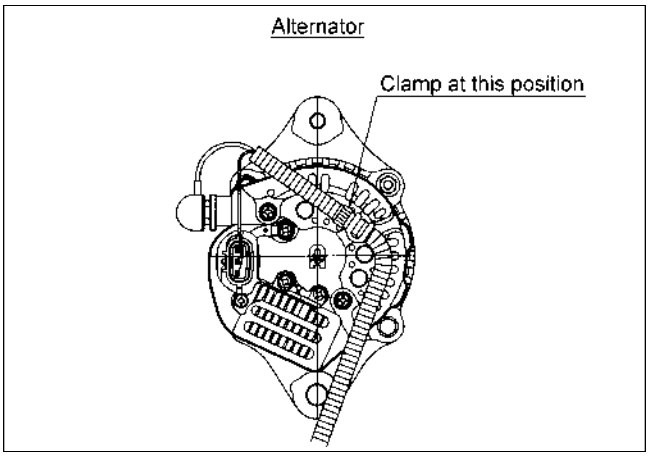


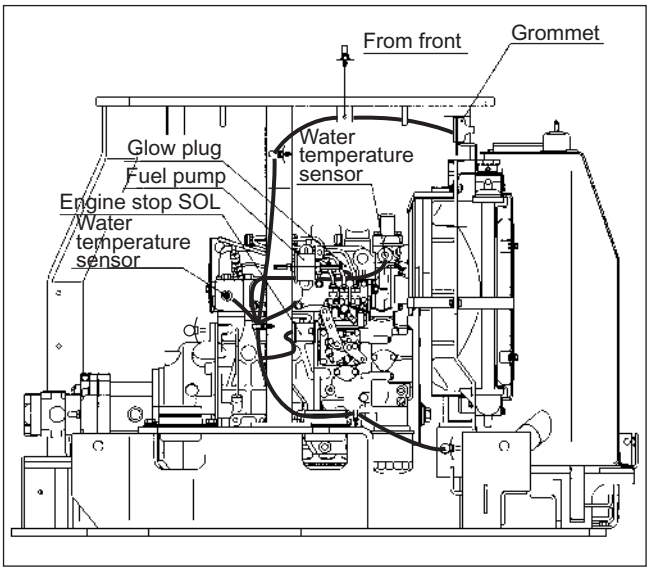


b Engine

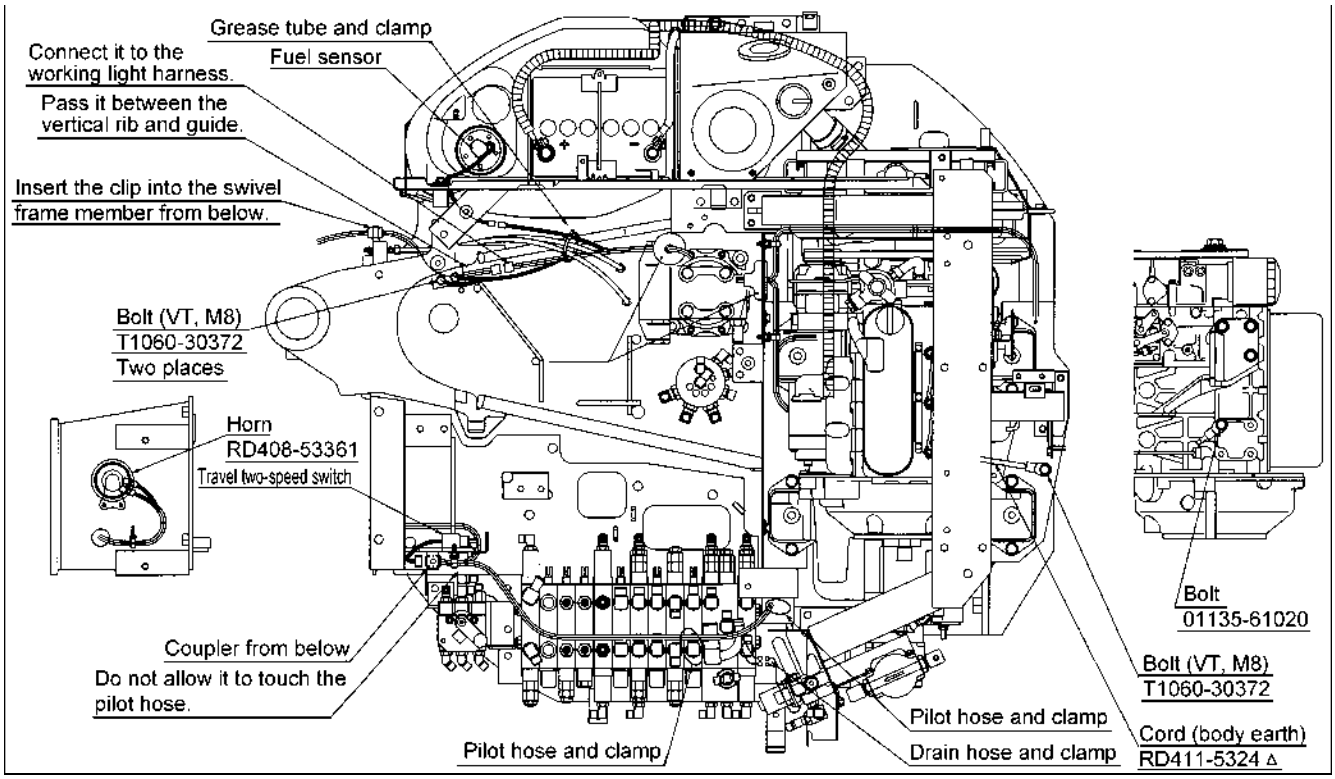


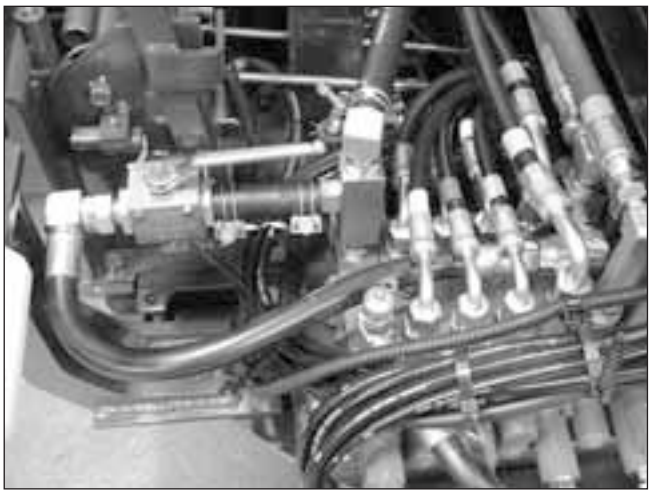
(1) Nut tightening torque for connecting cable to starter terminal
5.9~11.8N·m (0.6~1.2kgf·m)



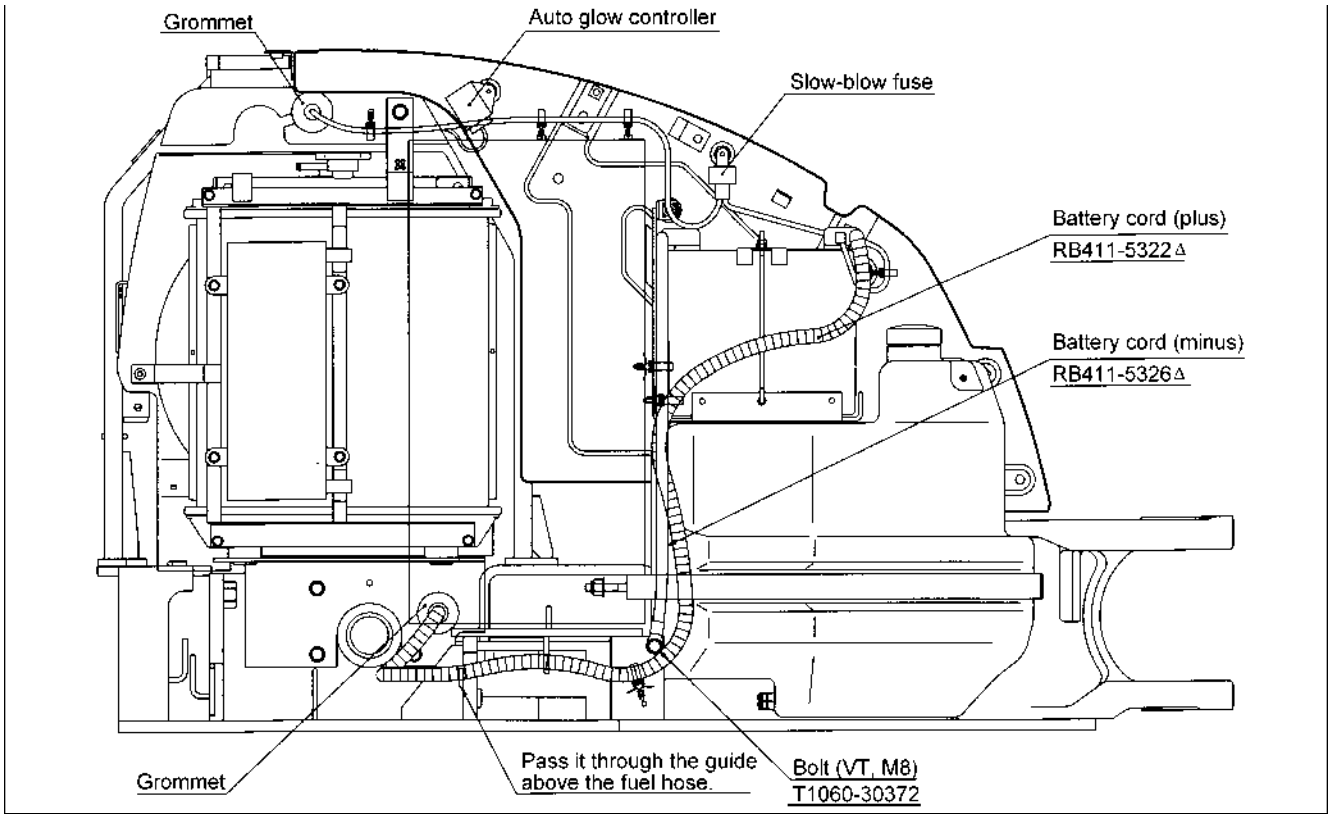


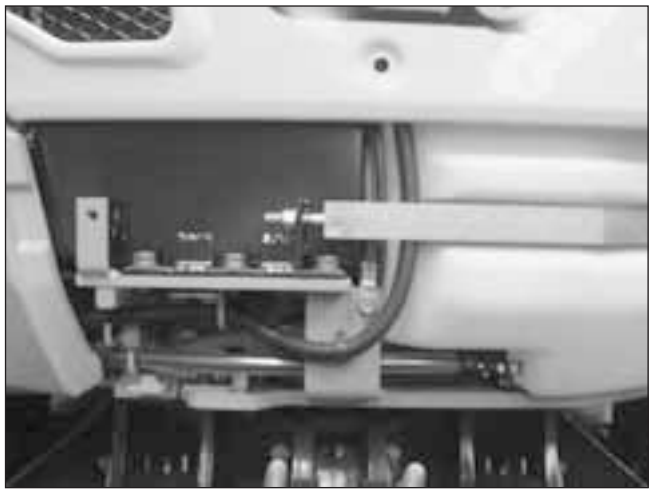
c Swivel frame





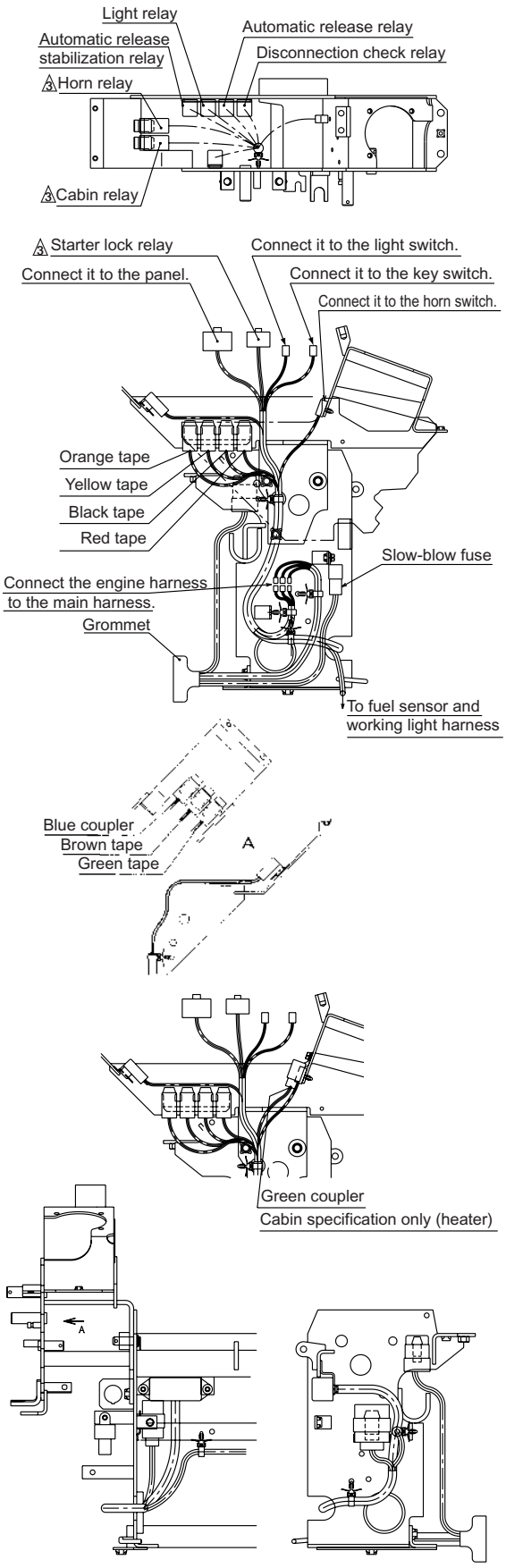
Around battery

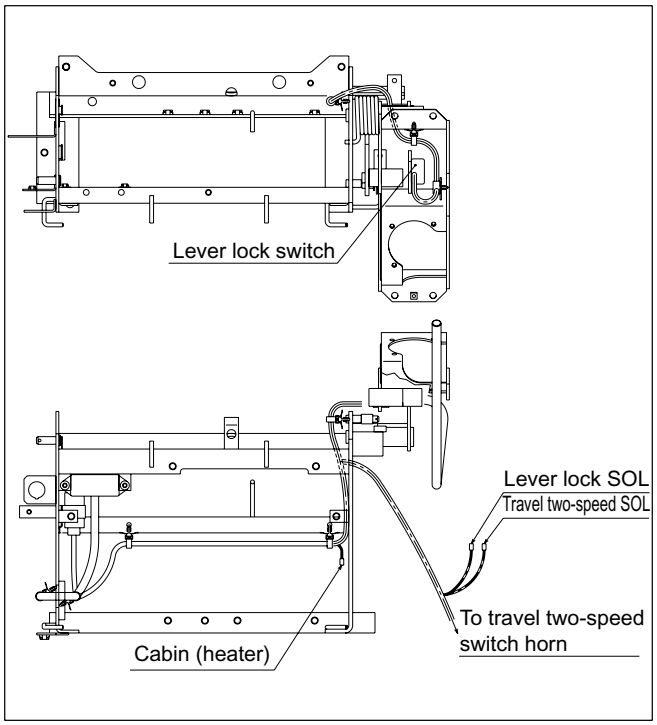


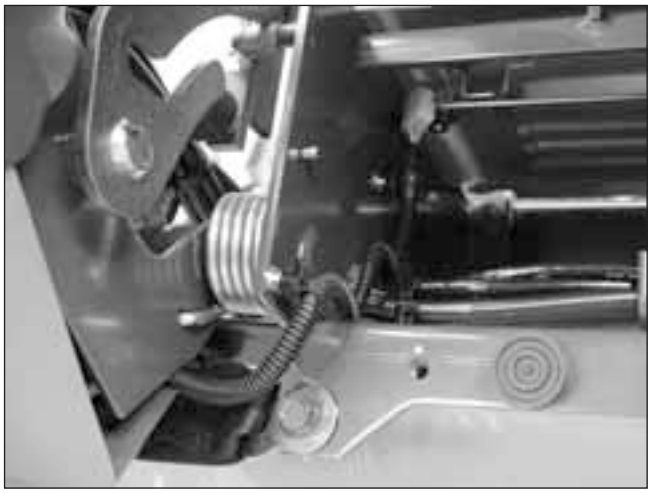


d Around seat

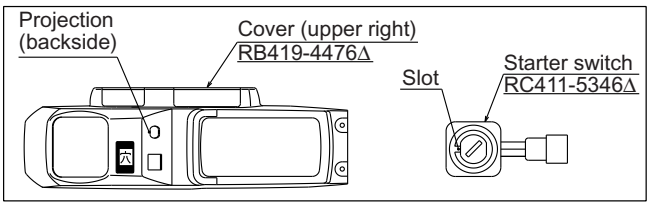
[1] Around seat





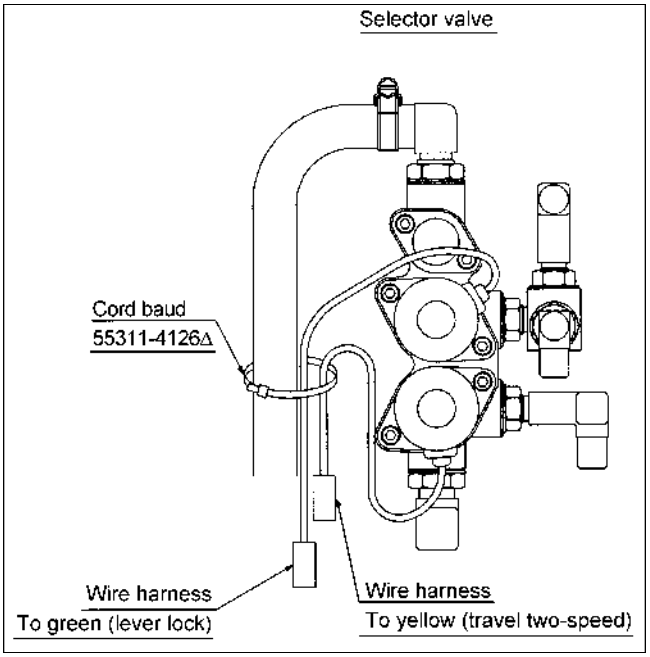


[2] Starter switch



(1) Align the slot in the starter switch with the projection on the cover (upper right).
(2) Tightening torque for installation of starter switch
4.0 ~ 5.0 N·m (0.4 ~ 0.51 kgf·m)
(3) Hold the starter switch in the starting position and check that the starter stops immediately after engine startup (automatic release).

[3] Around selector valve



B Troubleshooting

a Engine

Trouble	Check item	Remedy	Remarks
1. The starter does not run.	(1) Check the slow-blow fuse (50A) and fuse (10A) for blowouts.	Check or replace.	Fig.1, Fig.2
	(2) Check the battery terminal for looseness.	Retighten.	Fig.3
	(3) Hold the starter switch in the starting position and check if a voltage of 10.5 V or more appears between the both ends (+, –) of the battery.	Charge or replace.	Fig.3
	(4) Interchange the release relay and the light relay.	Check or replace.	Fig.4
	(5) Check if the release controller is normal.	Check or replace.	Photo.1
	(6) Check the starter M terminal for looseness.	Retighten.	Fig.6, Fig.7, Photo.2
	(7) Hold the starter switch in the starting position and check if a voltage of 9V or more is applied to the starter 50 terminal.	Repair or replace.	Fig.8
	(8) Check if the key switch is normal.	Check or replace.	
2. The starter runs but the engine does not start.	(1) Turn On the key switch and check if fuel overflows into the tank.	Check visually.	
	(2) Turn On the key switch and check by hand if the fuel pump is running.	Replace.	
	(3) Check the fuel pump fuse for blowouts.	Replace.	
	(4) Check if a voltage is applied to the Fuel pump coupler 1 and 2.	Repair or replace.	Fig.9, Fig.10
	(5) Disconnect the stop solenoid and check if the engine starts.	Repair or replace.	
	(6) Turn On the key switch and check if a voltage is applied to the engine stop solenoid coupler.	Repair or replace.	Fig.11, Fig.12
3. The cold-temperature starting property is poor.	(1) Check if the battery voltage is normal.	Charge or replace.	Fig.3
	(2) Check the glow relay fuse (5A) for blowouts.	Replace.	
	(3) Check by hand if the glow relay is running.	Replace.	Fig.13
	(4) Check if a voltage is applied to the glow relay coupler.	Repair or replace.	Fig.14
	(5) Check if a voltage is applied to the glow plug.	Repair or replace.	Fig.15
	(6) Check if the glow plug is normal.	Replace.	Fig.16
	(7) Check the glow relay.	Replace.	Fig.17

b Meter panel

Trouble	Check item	Remedy	Remarks
1. The glow lamp does not go on.	(1) Check by hand if the glow relay is running.	Replace	Fig.13
	(2) Check the meter-side coupler for disconnection.	Repair or replace	
	(3) Interchange the disconnection check relay and the light relay.	Repair or replace	Fig.4
	(4) Check if a voltage is applied to the bigger meter coupler (9).	Replace	Fig.18 Fig.19-1, 19-2
	(5) Check the lamp for blowouts.	Replace	
2. The charge lamp does not go on.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the coupler of the alternator for disconnection.	Repair or replace	Fig.20
	(3) Check the meter-side coupler for disconnection.	Repair or replace	
	(4) Check the lamp for blowouts.	Replace	
3. The oil lamp does not go on.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the coupler of the oil switch for disconnection.	Repair or replace	Fig.21
	(3) Check if a voltage is applied to the coupler of the oil switch.	Repair or replace	Fig.22, Fig.23
	(4) Disconnect and body-earth the harness terminal of the oil switch and check if the lamp goes on.		Fig.22
	(5) Measure the engine oil pressure.	Repair	Fig.24
4. The fuel remaining amount alarm lamp does not go on.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check if the charge lamp and the oil lamp are lit up. Lit up: Normal Not lit up: Abnormal	Repair or replace	
	(3) Check by hand if the disconnection check relay is running, or interchange the disconnection check relay and the light relay.	Replace	
	(4) Body-earth the harness terminal of the fuel sensor. Lit up: Normal Not lit up: Harness broken	Repair or replace	
	(5) Check the panel lamp for blowouts.	Replace	

Trouble	Check item	Remedy	Remarks
5. The charge lamp does not go off.	(1) Check the 60A fuse for blowouts.	Replace	
	(2) Check the alternator B terminal or coupler for disconnection.	Repair or replace	
	(3) Check if the alternator is normal.	Repair or replace	Fig.25-1, 25-2
6. The oil lamp does not go off.	(1) Check if the specified amount of oil is supplied.	Refill	
	(2) Check the oil switch coupler for disconnection.	Repair or replace	
	(3) Check if a voltage is applied to the oil switch coupler.	Replace	Fig.22, Fig.23
	(4) Measure the pressure of the engine oil.	Repair	Fig.24
7. The water temperature gauge does not function.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the water temperature gauge coupler for disconnection.	Repair or replace	
	(3) Check the meter-side coupler for disconnection.	Repair or replace	
	(4) Check if a voltage is applied to the water temperature gauge coupler.	Repair	Fig.26, 27
	(5) Check if the water temperature sensor is normal.	Repair	Fig.28
8. The fuel remaining amount alarm lamp does not go on.	(1) Check if fuel is supplied.		
	(2) Check if the fuel sensor is normal.	Replace	Fig.32
9. The fuel gauge does not function.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the fuel sensor coupler for disconnection.	Repair or replace	Fig.29
	(3) Check the meter-side coupler for disconnection.	Repair or replace	
	(4) Check if a voltage is applied to the fuel sensor coupler.	Replace	Fig.30, Fig.31
	(5) Check if the fuel sensor is normal.	Replace	Fig.32

c Others

Trouble	Check item	Remedy	Remarks
1. The machine does not run in spite of the machine lock lever being released.	(1) Check the fuse (5A) for blowouts.	Replace	
	(2) Check the lever lock solenoid coupler and switch coupler for disconnection.	Repair or replace	Fig.33
	(3) Interchange the lever lock solenoid coupler and 2nd-speed solenoid coupler.	Repair or replace	Fig.34
	(4) Check if a voltage is applied to the lever lock solenoid coupler and switch coupler.	Repair or replace	Fig.35, Fig.36
	(5) Check the solenoid valve.	Repair or replace	Fig.37
	(6) Check if the lever lock switch is normal.	Replace	Fig.38
2. The travel speed does not change in spite of the two-speed pedal being pressed.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the 2nd-speed solenoid coupler and switch coupler for disconnection.	Replace	Fig.33
	(3) Interchange the 2nd-speed solenoid coupler and lever lock solenoid coupler.	Repair or replace	Fig.34
	(4) Check if a voltage is applied to the 2nd-speed solenoid coupler and switch coupler.	Replace	Fig.39, Fig.40
	(5) Check the solenoid valve.	Replace	
	(6) Check if the 2nd switch is normal.	Replace	
3. The horn does not sound in spite of the horn switch being pressed.	(1) Check the fuse (10A) for blowouts.	Replace	
	(2) Check the harness from the grip (horn switch) for breaking.	Repair or replace	Fig.42
	(3) Check the horn coupler and grip (horn switch) coupler for disconnection.	Repair or replace	
	(4) Check if a voltage is applied to the horn terminal.	Replace	Fig.41, Fig.44
	(5) Check if the horn switch is normal.	Replace	Fig.42
	(6) Check if the horn is normal.	Replace	Fig.43
4. The working light does not go on in spite of the working light switch being pressed.	(1) Check the fuse (20A) for blowouts.	Replace	
	(2) Check the working light terminal and switch coupler for disconnection.	Repair or replace	
	(3) Check if a voltage is applied to the working light terminal.	Replace	Fig.45, Fig.47
	(4) Interchange the working light relay and release relay.	Replace	
	(5) Check the lamp for blowouts.		Fig.46

d Check instructions

Fig.1

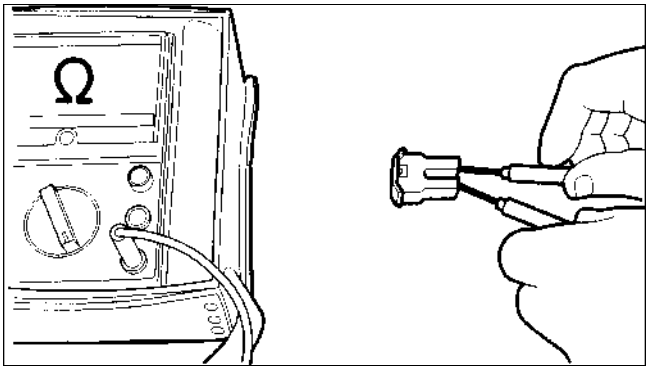
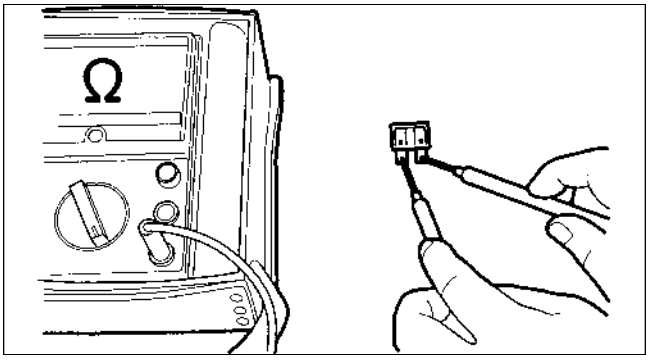
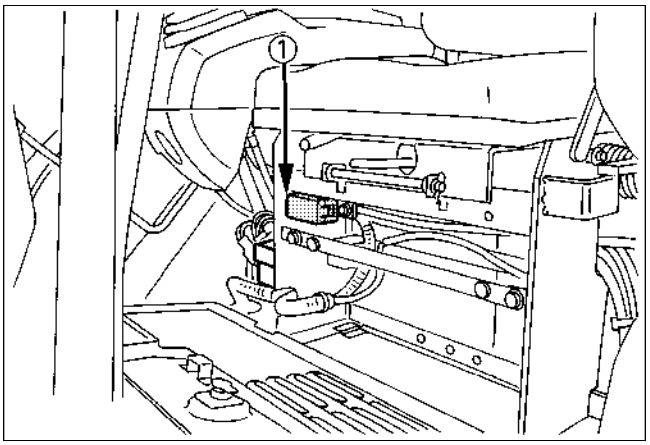
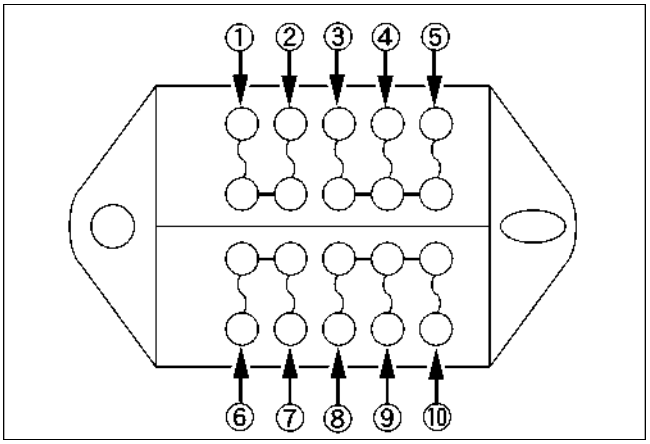


Fig.2





(1)Fuse box



[1] Fuse

1 Check the continuity of the slow-blow fuse (50A) to see if the fuse is blown. (Fig.1)

2 Check the continuity of the fuse (10A) to see if the fuse is blown. (Fig.2)

FUSES

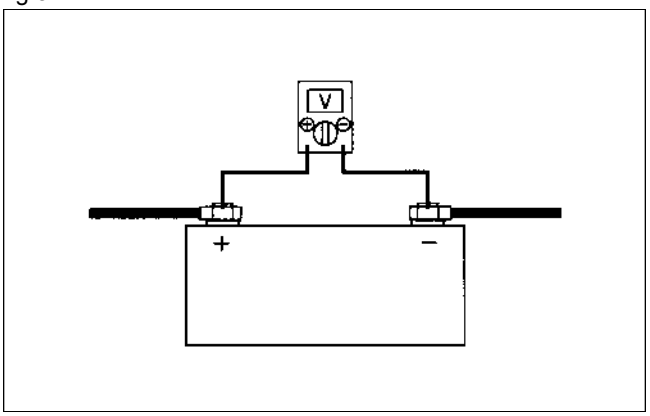
■ Replacing Fuses

1. Remove the cover of the fuse box.
2. Replace the burnt out fuse with a fuse having the same capacity.

■ Fuse Capacities and Circuits

No.	Capacity	Circuit
(1)	15A	Cabin equipment
(2)	15A	Power source
(3)	5A	Lever lock
(4)	10A	Horn
(5)	5A	Glow
(6)	10A	Heater fan
(7)	20A	Work lamp
(8)	5A	Relay
(9)	10A	High speed Alternator
(10)	5A	Auto release
	5A, 10A, 15A, 20A	Spare fuses

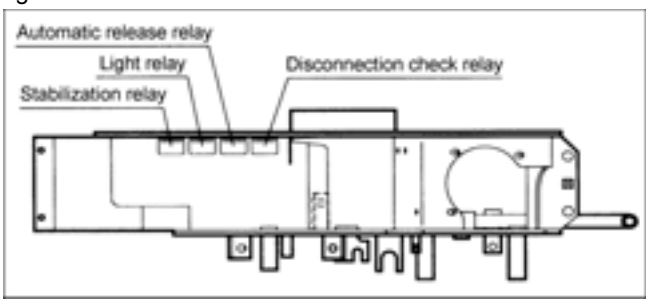
Fig.3



[2] Battery voltage

1. Start the engine.
2. Connect a circuit tester to the (+) terminal and (–) terminal of the battery and measure the voltage. (Fig.3)
   10.5 V or higher: The battery is normal.
   Lower than 10.5 V: Charge or replace the battery.

Fig.4



[3] Automatic release relay

Interchange the automatic release relay and light relay and start the engine.

Starting: The automatic release relay is faulty.

Not starting: The wire is broken, the key switch is faulty or the starter is faulty.

Fig. 5

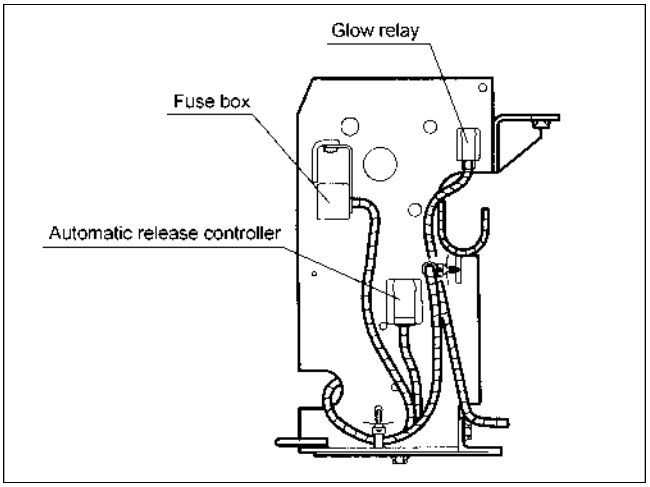


Photo 2

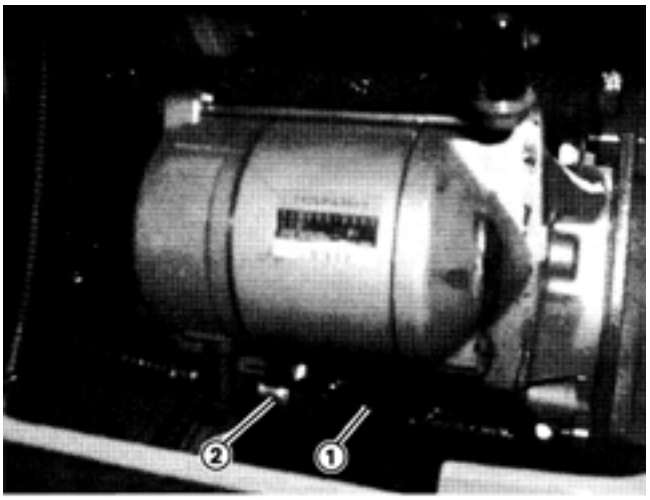
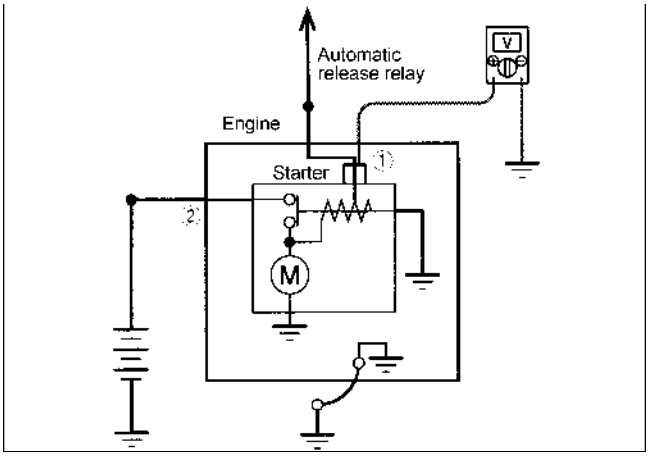


Fig. 6



[4] Release controller

1. Disconnect the coupler CN310 from the controller.

2. Body-earth the controller coupler CN310-(6), set the key switch to the starting position and check if the engine starts. (Photo 1)
   Starting : The controller is faulty.
   Not starting : The key switch is faulty or the wire is broken.

Photo 1

[5] Starter motor

1. Check the B terminal of the starter motor for looseness. Check the starter coupler CN37 for disconnection. (Photo 2 (1))

2. Voltage check (Fig.6)

   1) From the back, connect the lead of a tester to the CN37 coupler terminal (1) connected to the starter motor

   2) Set the key switch to the starting position and check if a voltage is applied to the CN37 coupler terminal (1).
      12 V : Check the continuity of the harness.
      Other than 12 V : The key switch is faulty.

⚠ Caution:
Note that the starter motor could run suddenly.

Fig.7

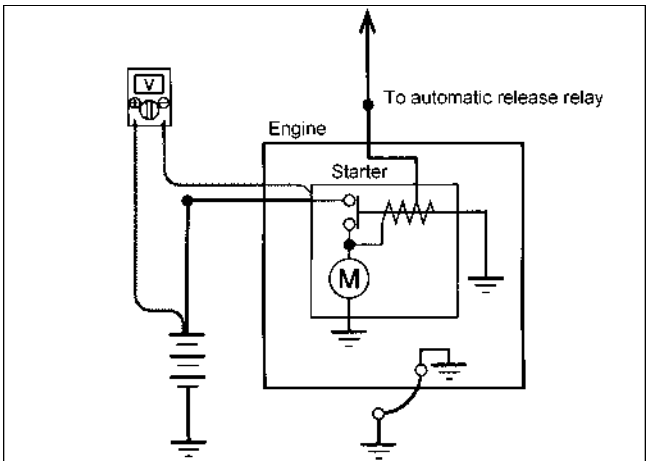


Fig.8

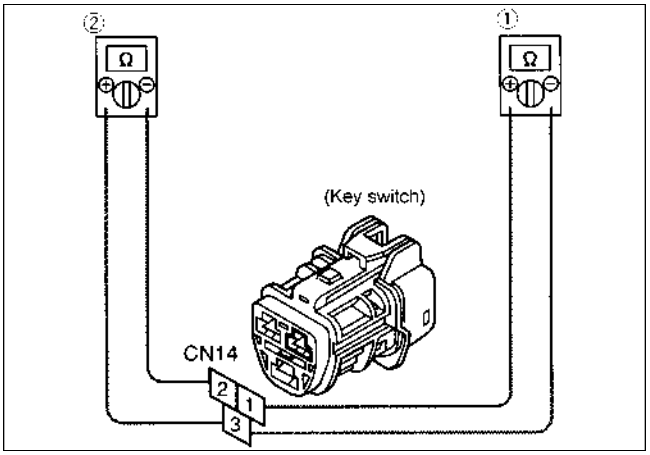


Fig.9

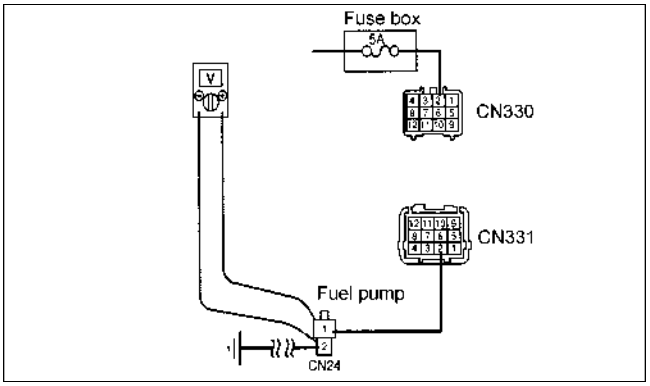
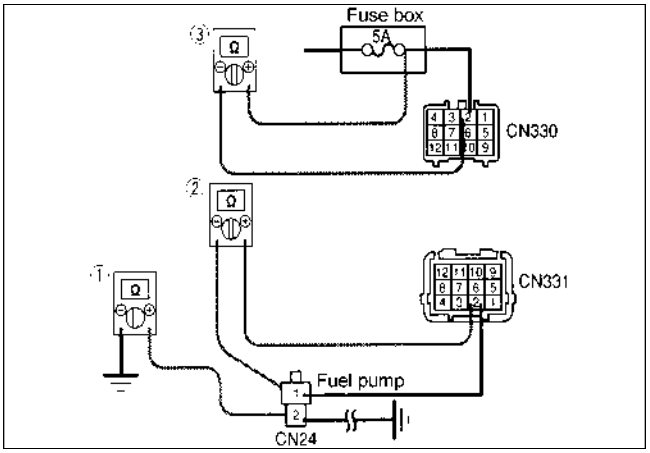


Fig.10



3. Continuity check (Fig.7)
   - Key switch: OFF
   - Check for continuity between the starter B terminal and battery (+) terminal.

[6] Key switch

- Disconnect the key switch and the key switch coupler CN14.

1. Set the key switch to the ON position (key right 1st step) and check for continuity between (1) and (3).
2. Hold the key switch in the starting position (key right 2nd step) and check for continuity between (2) and (3).
   Continuity :The key switch is normal.
   No continuity :The key switch is faulty.

[7] Fuel pump coupler

1. Measuring the voltage of the fuel pump coupler (Fig.9)
   - Disconnect the fuel pump coupler CN24.
   - Key switch: ON
   - Measure the voltage between (1) and (2) of the coupler CN24.
     12 V : The fuel pump is faulty.
     Other than 12 V: Check for continuity. (Fig.10)

2. Continuity check (Fig.10)
   - Key switch: ON
   - Disconnect the coupler.

(1) Check for continuity between the fuel sensor coupler CN24-(2) and body earth.
(2) Check for continuity between the fuel sensor coupler CN24-(1) and coupler CN24-(2).
(3) Check for continuity between the 5A fuse and coupler CN330-(2).

Fig.11

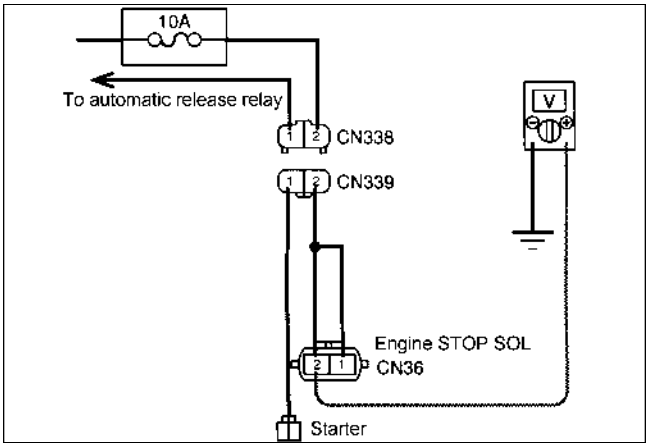


Fig.12

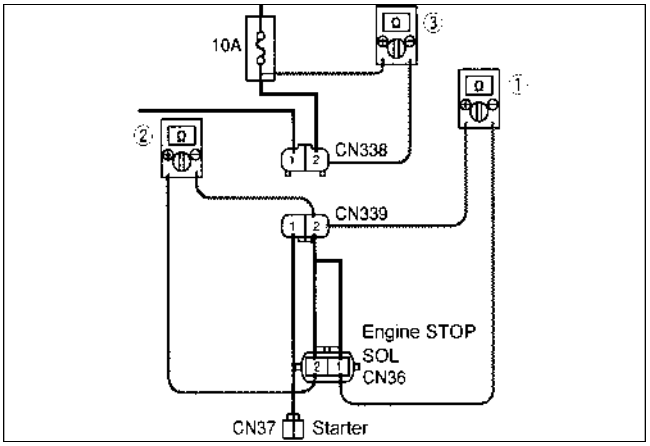


Fig.13

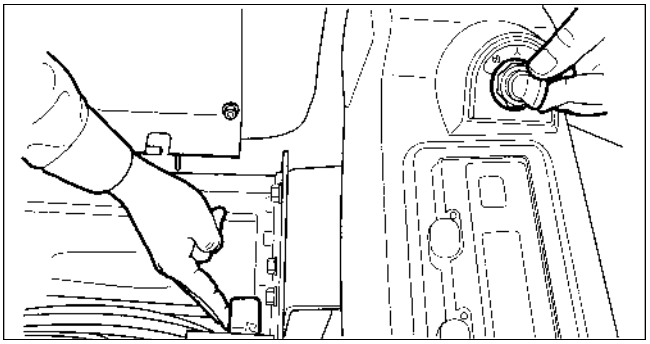
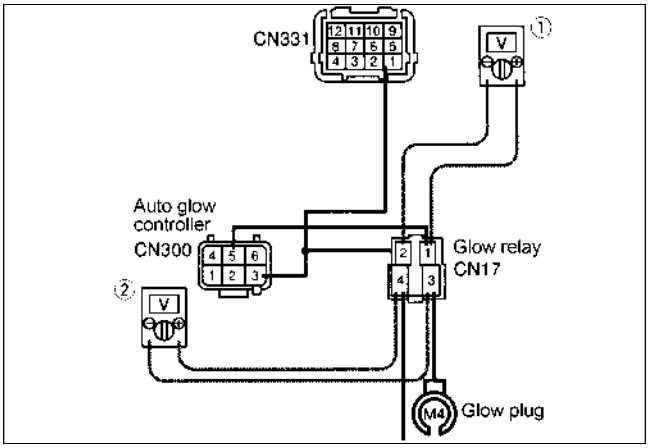


Fig.14



[8] Engine stop solenoid

1. Measuring the voltage of the engine stop solenoid (Fig.11)
   - Disconnect the engine stop solenoid coupler CN36.
   - Measure the voltage between the coupler CN36-(1) or (2) and the body earth.
     12 V : The stop solenoid is faulty.
     Other than 12 V : Check for continuity. (Fig.12)

2. Continuity check (Fig.12)
   - Key switch: OFF
   - Disconnect the coupler.

   (1) Check for continuity between the solenoid coupler CN36-(1) and relay coupler CN339-(2).
   (2) Check for continuity between the solenoid coupler CN36-(2) and relay coupler CN339-(2).
   (3) Check for continuity between the 10A fuse and relay coupler CN338-(2).

[9] Glow relay

1. Checking the operation of the glow relay (Fig.13)
   (1) Lightly touch the glow relay with your hand.
   (2) Key switch: ON
   (3) Check if the glow relay operates with a click.
   Clicking : The glow relay is normal. Check the glow plug voltage.
   Not clicking : Measure the voltage, check for continuity and inspect the glow relay (Fig.17).

2. Measuring the voltage of the glow relay coupler (Fig.14)
   - Disconnect the glow relay coupler CN17.
   - Key switch: ON
   - Measure the voltage between (1) and (2) and between (3) and (4) of the coupler CN17.
     12 V for both (1) and (2) : The glow relay is faulty.
     Other than 12 V : The harness is broken.

Fig.15

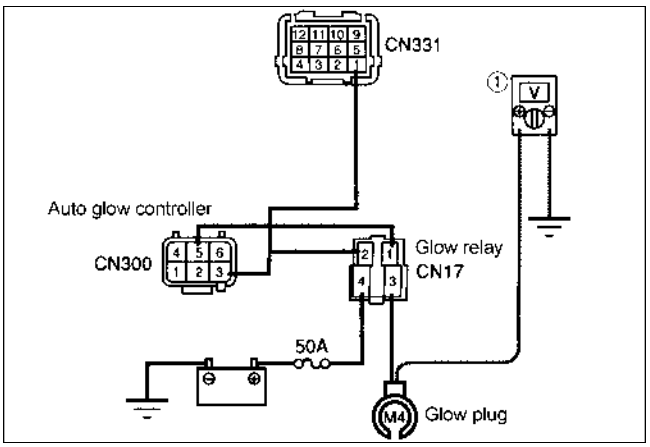


Fig.16

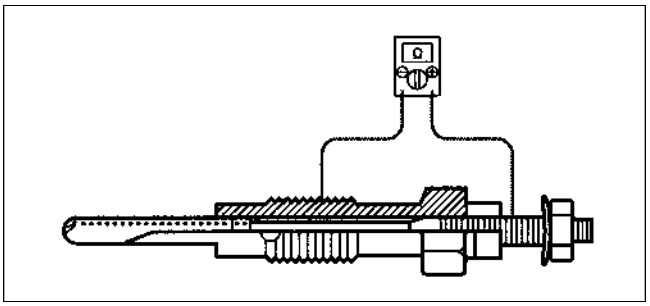


Fig.17

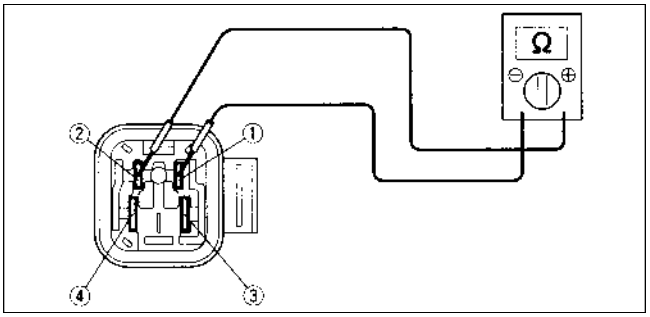
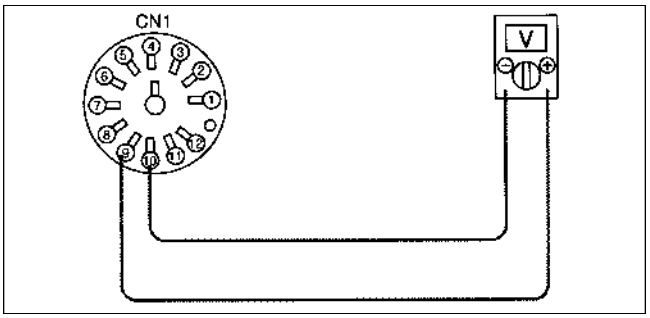


Fig.18



3. Measuring the voltage of the glow plug (Fig.15)
   - Disconnect the glow plug LE terminal.
   - Key switch: ON
   - Measure the voltage between the LE terminal and body earth.

* 12 V is indicated and then 0 V is indicated 10 seconds later.

12 V→0 V : The glow lamp is faulty.
Other than 12 V: The glow controller is faulty.
The glow relay is faulty.
The harness is broken.

4. Inspection of glow plug (Fig.16)
   - Remove the plate between the cylinders.
   - Measure the resistance of the glow plug alone.

   1Ω or less :Normal
   More than 1Ω :Faulty

5. Inspection of glow relay (Fig.17)
   (1)Measure the glow relay alone.

Standard value	52 to 80Ω
Measured value	About 78Ω

   - Apply 12 V between (1) and (2) of the glow relay and check for continuity between (3) and (4).

   Continuity :Normal
   No continuity:Faulty

6. Measuring the voltage of the meter coupler (Fig.18)
   - Disconnect the meter coupler (large).
   - Key switch: ON
   - Measure the voltage between (9) and (10) of the coupler CN1.

   12 V : The meter is faulty.
   Other than 12 V : The harness is broken.Check for continuity.

Fig.19-1

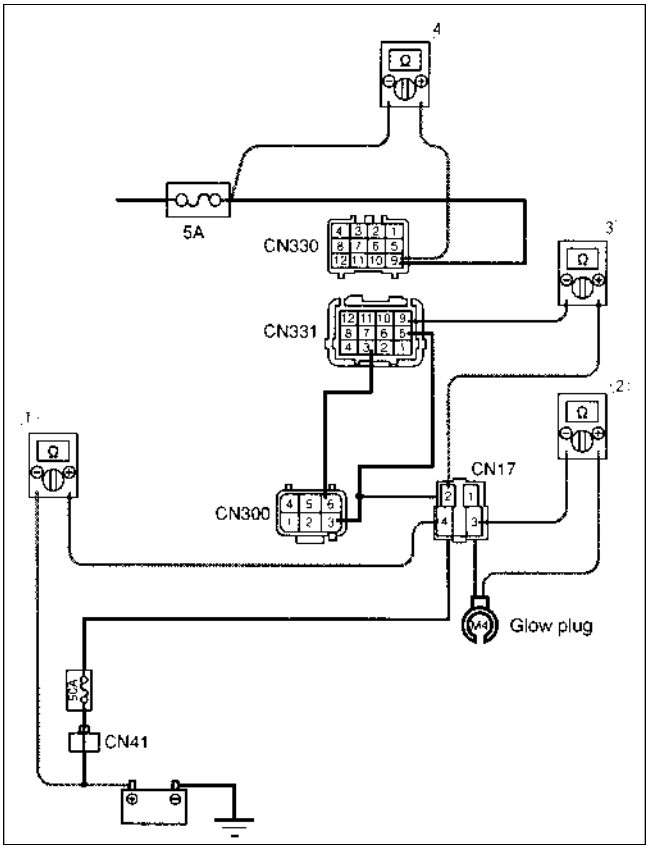
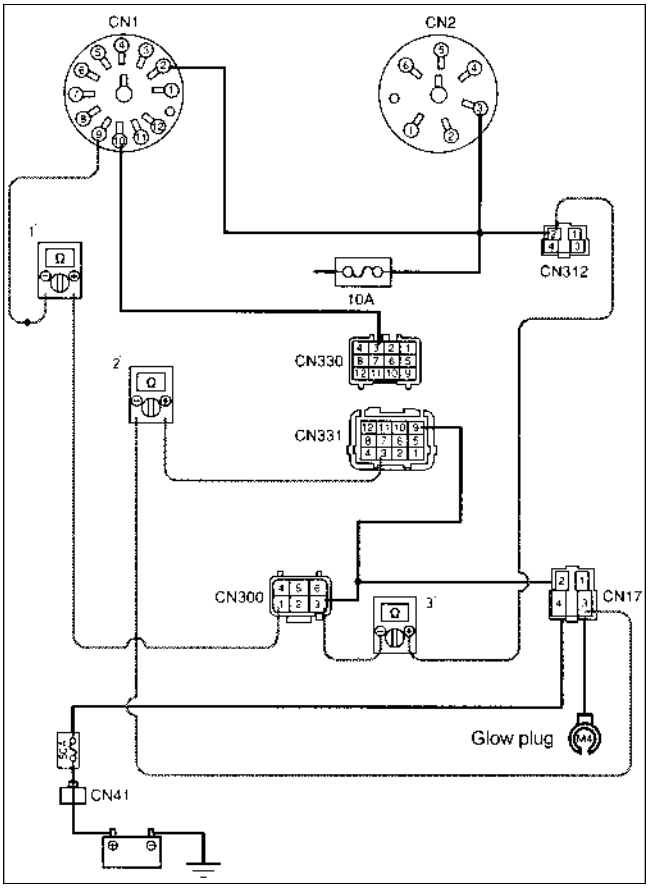


Fig.19-2



7. Continuity check
   - Key switch: OFF
   - Disconnect the coupler.

   (1) Check for continuity between the battery ({) and glow relay coupler CN17-(4).
   (2) Check for continuity between the glow plug and glow relay coupler CN17-(3).
   (3) Check for continuity between the glow relay coupler CN17-(2) and coupler CN331-(9).
   (4) Check for continuity between the 5A fuse and coupler CN330-(9).

8. Continuity check (Fig.19-2)
   - Key switch: OFF
   - Disconnect the coupler.

   (1) Check for continuity between the meter coupler CN1-(9) and glow control coupler CN300-(3).
   (2) Check for continuity between the coupler CN331-(3) and glow relay coupler CN17-(3).
   (3) Check for continuity between the disconnection check relay coupler CN312-(2) and glow control coupler CN300-(3).

Fig.20

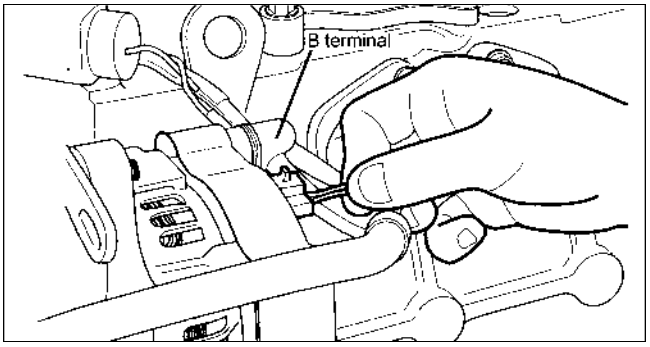


Fig.21

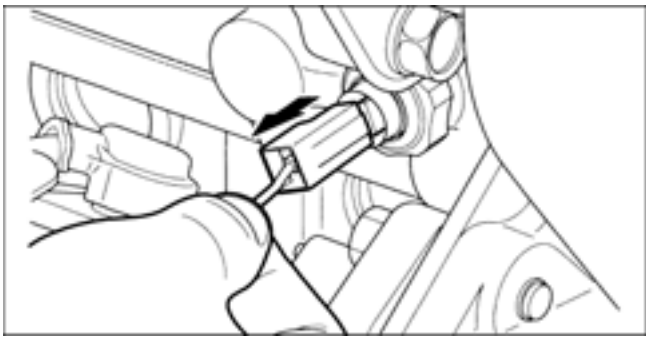


Fig.22

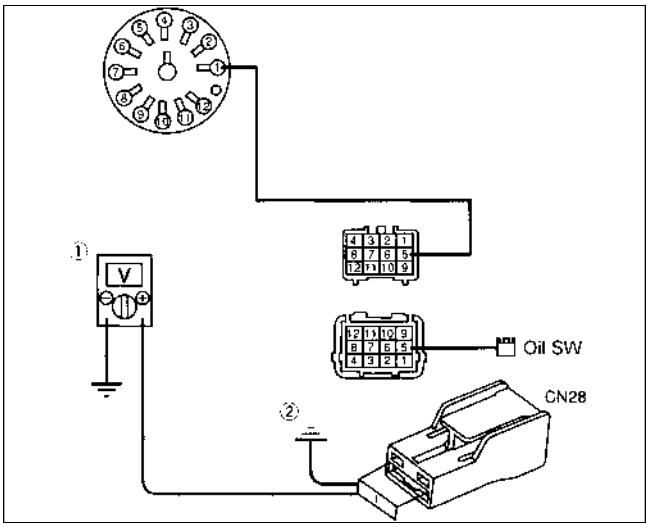
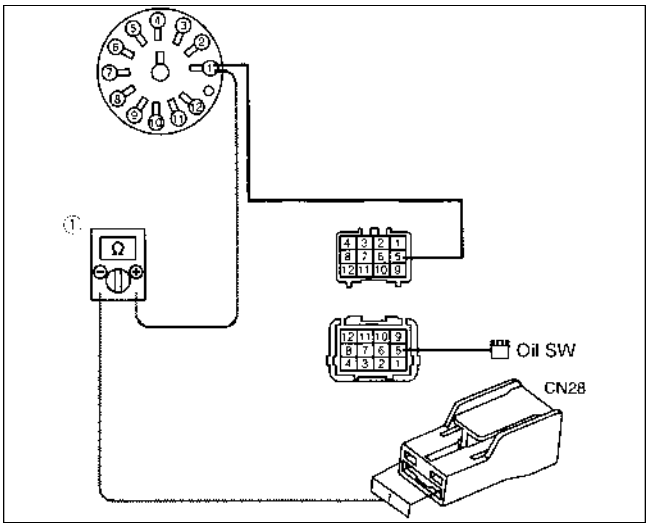


Fig.23



[10] Charge engine oil lamp

1. Check the alternator coupler and B terminal for disconnection. (Fig.20)

2. Check the oil switch coupler CN28-(1) for disconnection. (Fig.21)

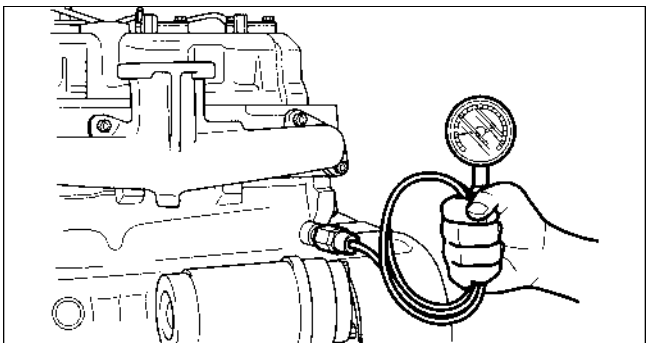
3. Measuring the voltage of the oil switch coupler CN28-(1) (Fig.22)
   - Disconnect the oil switch coupler CN28-(1).
   - Key switch: ON

   (1)Measure the voltage of the oil switch coupler CN28-(1).
   12 V : Normal. Measure the engine pressure.
   Other than 12 V : Check for continuity.
   (2)Body-earth the oil switch coupler CN28-(1).
   Oil switch lamp
   Light up :The oil switch is faulty.
   Not light up :The harness is broken. Check for continuity.

4. Continuity check (Fig.23)
   - Disconnect the meter coupler (large).
   - Key switch: OFF

   Check for continuity between the oil switch coupler CN28-(1) and meter coupler (large) (1).

Fig.24



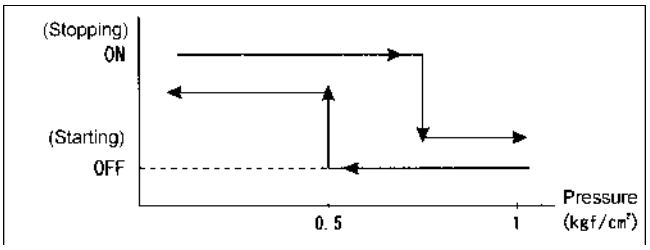


Fig.25-1

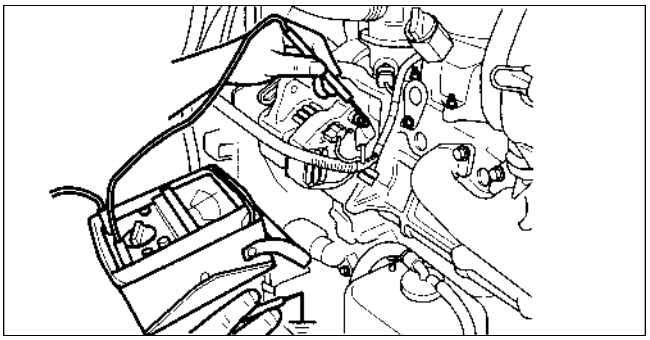
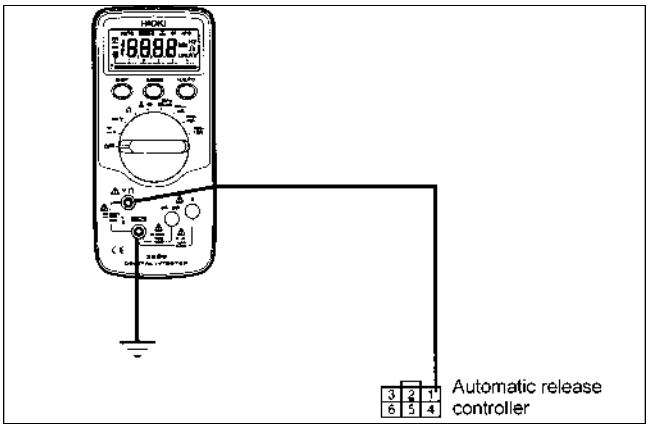


Fig.25-2



5. Measurement of engine oil pressure
Measure the engine oil pressure.

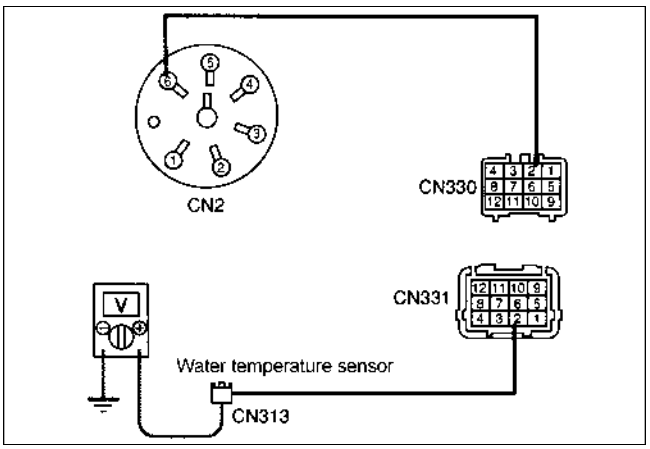
Idling	0.4MPa (4kgf / cm^2)
MAX	0.6MPa (4kgf / cm^2)

* Oil switch actuating pressure
Standard value:0.05 ± 0.01MPa
(0.5 ± 0.1kg f / cm^2)

6. Inspection of alternator (general-purpose tester) (Fig.25-1)
   (1)Measure the voltage between the B terminal of the alternator and the body earth.
   If the measured voltage is about 12 V, it is normal.
   If the measured voltage is lower, the battery capacity is insufficient or a wire connection before the alternator is loosened.
   (2)Start the engine and measure the voltage generated during the operation of the alternator.
   Measure the voltage between the B terminal of the alternator and the body earth.
   If the measured voltage is about 14 V (alternator-generated voltage), the alternator is normal.
   If the measured voltage is equal to the battery voltage (about 12 V), the alternator main body or regulator is faulty.

7. Inspection of alternator (tester with pulse count indication) (Fig.25-2)
   - Connect the (+) test lead to (1) by inserting it from the harness side of the automatic release controller.
   - Engine start
   - Pulse count
     Indicated: Idlingc230 HZ
     MAXc432 HZ
     Not indicated: The alternator is faulty.
     The harness between the alternator and automatic release controller is broken.

Fig.26

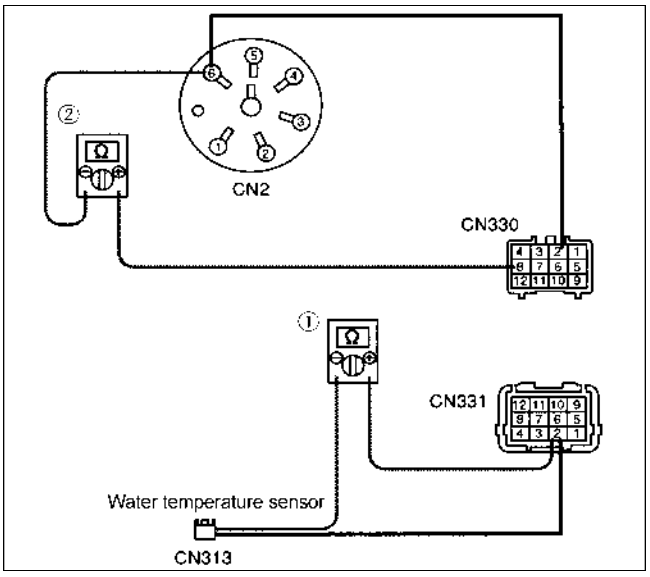


[11] Water temperature gauge

1. Disconnect the water temperature gauge coupler.(Fig.26)
   - Key switch: ON
   - Measure the voltage of the water temperature gauge coupler CN313 (1).

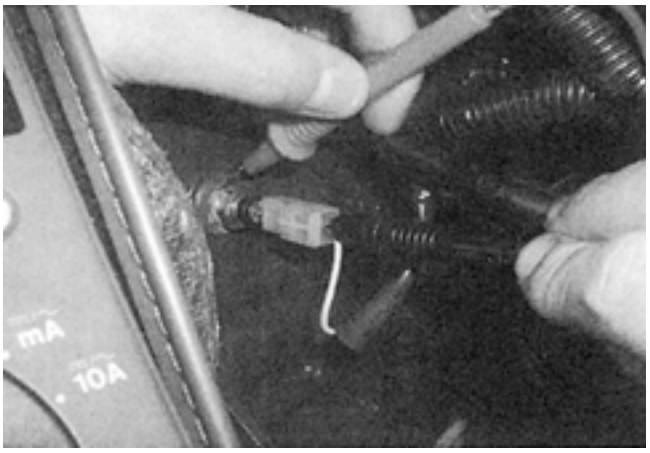
12V: Normal
Other than 12 V: Check for continuity.

Fig.27



2. Continuity check (Fig.27)
Disconnect the meter coupler.
Key switch: OFF
(1) Check for continuity between the water temperature gauge coupler CN313 (1) and relay coupler CN331 (6).
(2) Check for continuity between the meter coupler CN2 (6) and relay coupler CN330 (6).

Fig.28



3. Inspection of water temperature gauge (Fig.28)

Performance ( )Values in parentheses are for reference

Temperature	7V, 55f gauge	
	Resistance	Current
(50)°C	(153.9 $^{+25.0}_{-20.0}$ Ω)	(33.5±1.6 mA)
80°C	81.9 $^{+4.9}_{-4.4}$ Ω	(65.5 $^{+2.8}_{-2.9}$ mA)
100°C	27.4 $^{+1.9}_{-1.7}$ Ω	(85.0 $^{+1.5}_{-2.0}$ mA)
(120°C)	(161±1.2 Ω)	(98.5±1.6 mA)

* Measurement should be made with the coupler connected.

Fig.29

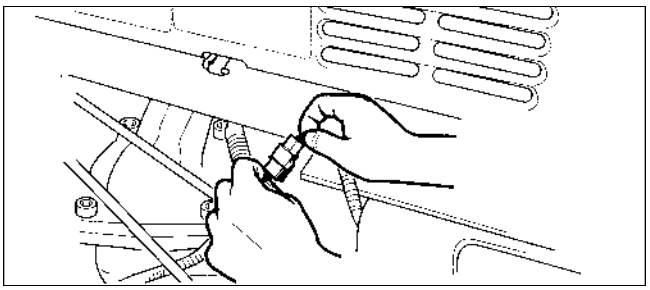


Fig.30

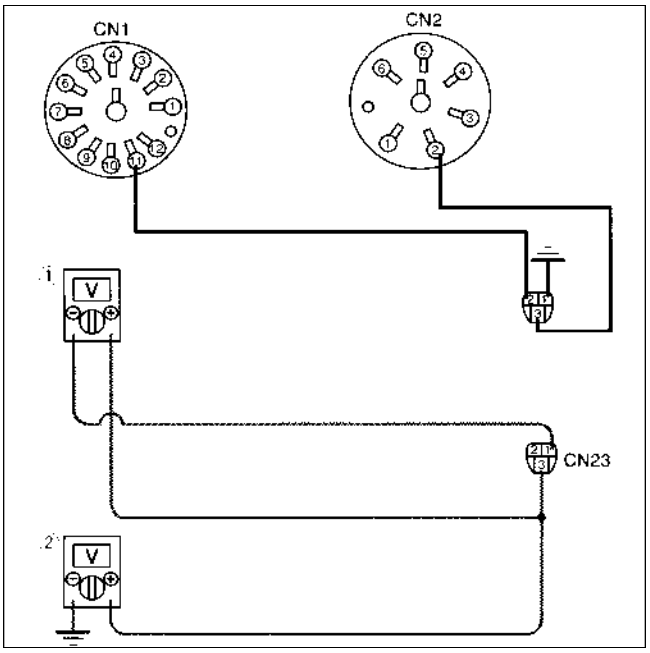
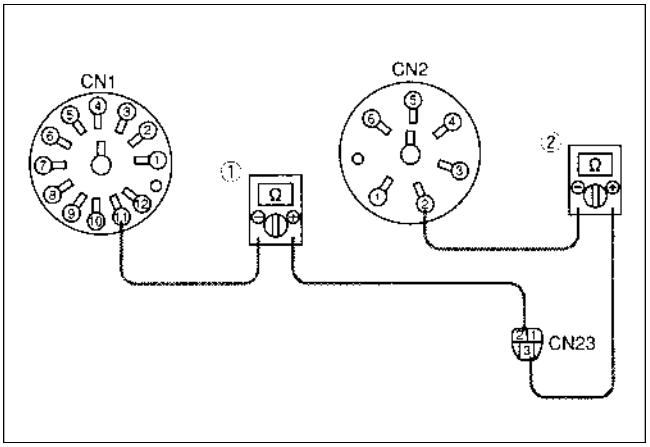


Fig.31



[12]Fuel sensor

1. Check the relay coupler CN23 of the fuel sensor for disconnection. (Fig.29)

2. Measuring the voltage of the fuel sensor coupler (Fig.30)
   - Disconnect the coupler CN23.
   - Key switch: ON

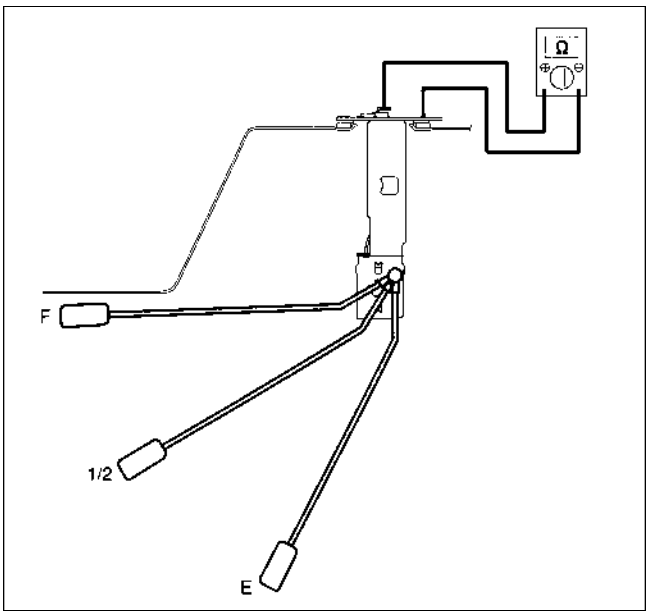
   12 V : Normal. Inspect the sensor.
   Other than 12 V : Measure the voltage of (2).

3. Continuity check
   (1) Measure the voltage between the sensor coupler CN23-(3) and CN23-(1).
   (2) Measure the voltage between the sensor coupler CN23-(3) and body earth.

4. Continuity check (Fig.31)
   Key switch: OFF
   - Disconnect the meter coupler CN1 and CN2.

   (1) Check for continuity between the sensor coupler CN23-(2) and meter coupler CN1-(11).
   (2) Check for continuity between the sensor coupler CN23-(3) and meter coupler CN2-(2).

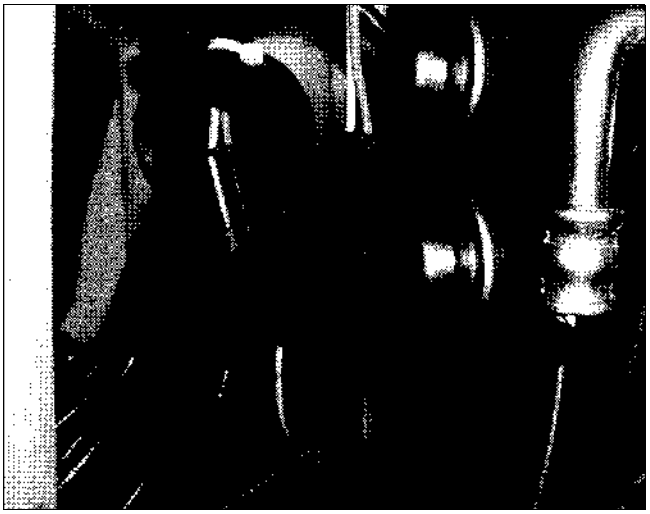
Fig.32



5. Inspection of fuel sensor (Fig.32)
   - Remove the fuel sensor from the tank and inspect it.
   - Put the (+) test lead on the coupler CN23 (3) terminal.
   - Put the (–) test lead on the plated portion and measure the resistance.
   - Standard value

Float position	F	1/2	E
Resistance(Ω)	3±2	32.5±4	110±7

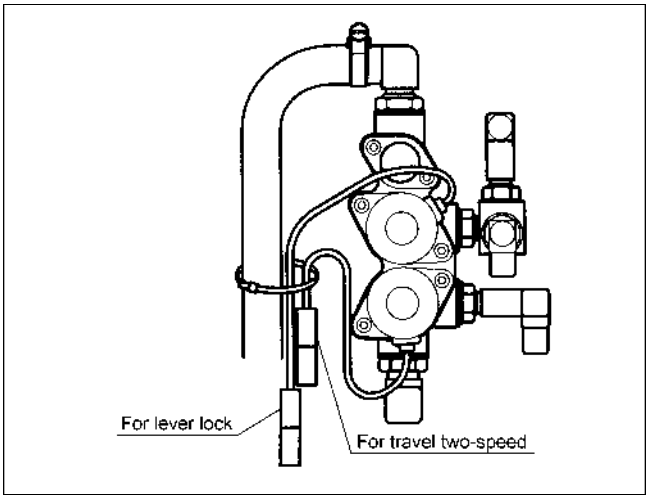
Fig.33



[13]Solenoid valve

1. Check the lever lock coupler and lever lock switch coupler for disconnection. (Fig.33)
   - Yellow for two-speed
   - Green for lever lock

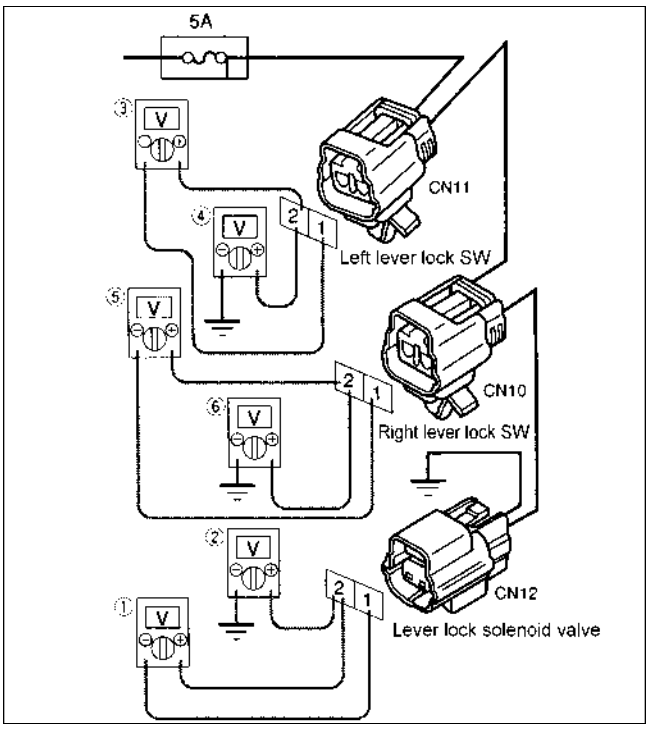
Fig.34



2. Interchanging of lever lock coupler (Fig. 34)
   - Interchange the lever lock coupler and two-speed coupler.
   - Engine start
   - While pressing the two-speed pedal, check if the machine runs.

   Running : The solenoid valve is faulty.
   The lever lock switch is faulty.
   Not running : The wire is broken.
   The lever lock switch is faulty.

Fig.35

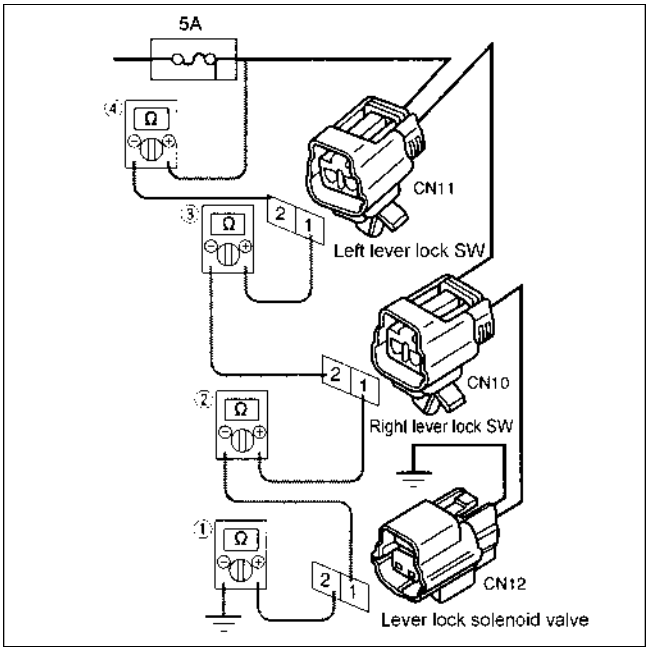


3. Check if a voltage is applied to the lever lock solenoid coupler and lever lock switch coupler.
   - Disconnect the coupler.
   - Key switch: ON

   (1) Measure the voltage between the solenoid valve coupler CN12-(1) and (2).
   (2) Measure the voltage between the solenoid valve coupler CN12-(2) and body earth.
   (3) Measure the voltage between the left lever lock coupler CN11-(1) and (2).
   (4) Measure the voltage between the left lever lock coupler CN11-(2) and body earth.
   (5) Measure the voltage between the right lever lock coupler CN10-(1) and (2).
   (6) Measure the voltage between the right lever lock coupler CN10-(2) and body earth.

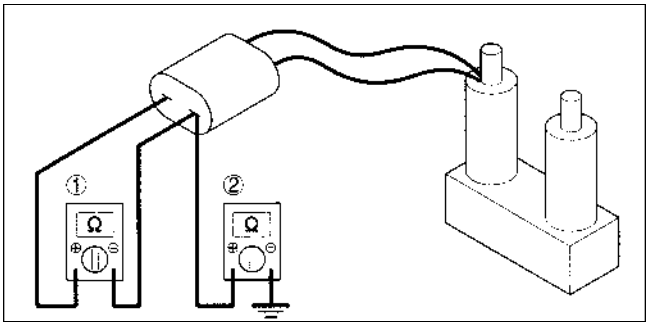
   12 V : (1), (3) and (5) are normal. Inspect the solenoid valve.
   Other than 12 V : Check for continuity ((2), (4) and (6)). Inspect the lever lock switch.

Fig.36



4. Continuity check (Fig.36)
   (1) Check for continuity between the solenoid valve coupler CN12-(2) and body earth.
   (2) Check for continuity between the solenoid valve coupler CN12-(1) and CN00-(2).
   (3) Check for continuity between the right lever lock coupler CN10-(1) and CN00-(1).
   (4) Check for continuity between the left lever lock coupler CN11-(2) and 5A fuse.

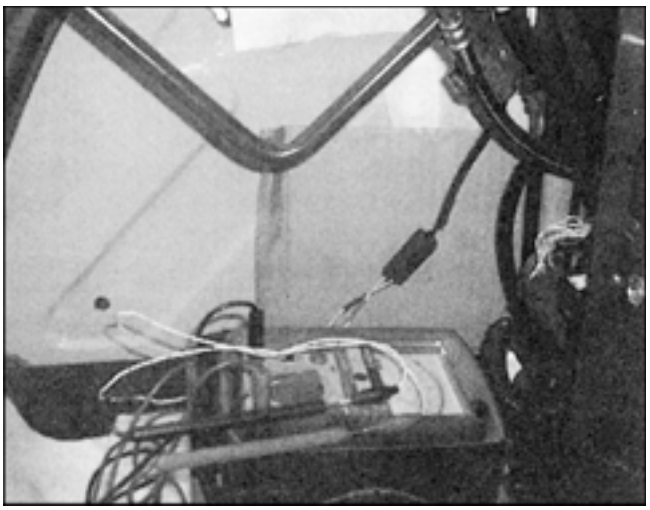
Fig.37



5. Inspection of solenoid valve (Fig.37)
   (1) Coil resistance
   Standard value: 6 to15Ω
   - A digital meter is used in the figure. (Note that the direction of (+) and (–) is reversed when a analog meter is used.)

   (2) Coil insulation
   Standard value: 1MΩor more

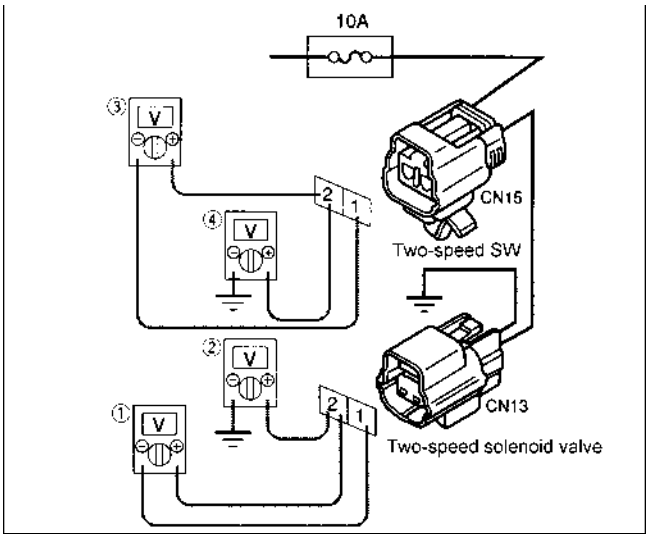
Fig.38



6. Inspection of lever lock switch (Fig.38)
   Key switch: OFF
   Turn ON/OFF the lever lock switch by moving the unload lever of the right control lever and check if the pointer of the tester shakes.
   Shaking : Normal
   Not shaking: Faulty

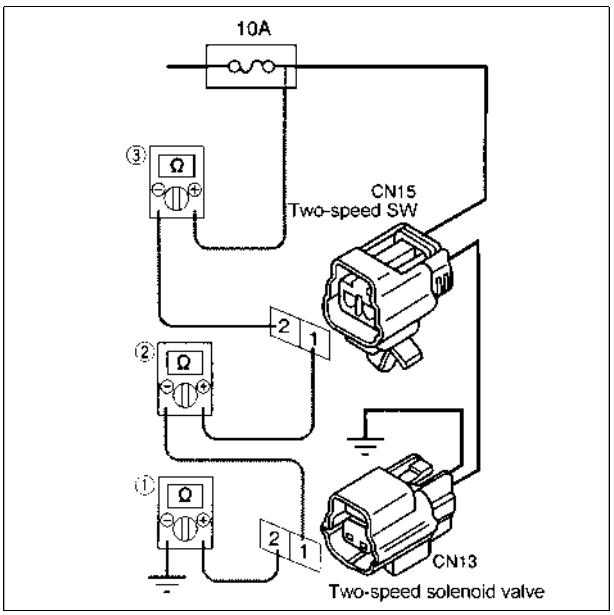
* In the case of the two-speed switch, use the speed-up pedal.

Fig.39



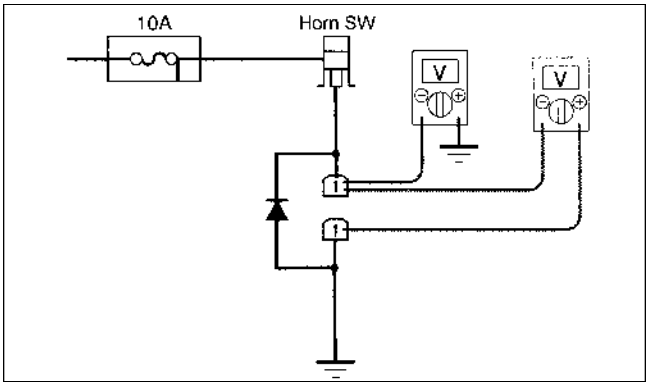
7. Check if a voltage is applied to the two-speed solenoid valve and two-speed switch coupler.
   • Disconnect the coupler.
   • Key switch: ON
   (1) Measure the voltage between the solenoid valve coupler CN13-(1) and (2).
   (2) Measure the voltage between the solenoid valve coupler CN13-(2) and body earth.
   (3) Measure the voltage between the two-speed switch coupler CN15-(1) and (2).
   (4) Measure the voltage between the solenoid valve coupler CN15-(2) and body earth.

Fig.40



8. Continuity check (Fig.40)
   Disconnect the coupler from the part.
   (1) Check for continuity between the CN13-(2) and body earth.
   (2) Check for continuity between the CN13-(1) and CN15-(2).
   (3) Check for continuity between the CN15-(2) and body earth.

Fig.41



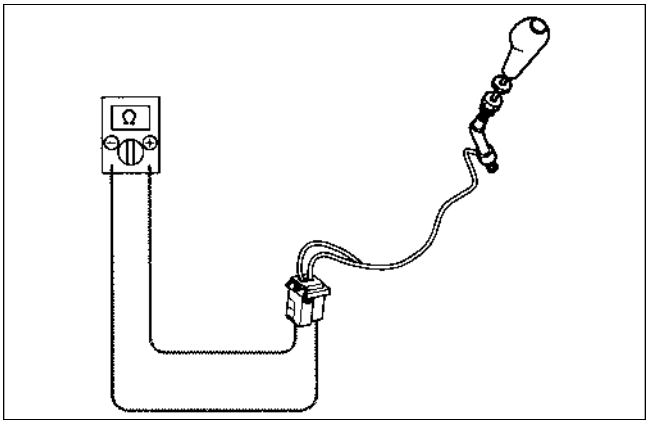
[14]Horn

1. Measuring the voltage of the horn terminal (Fig.14)
   - Key switch : ON
   - Horn switch: ON

     12 V : Normal. Inspect the horn.

     Other than 12 V : Check for continuity. Inspect the horn switch

Fig.42

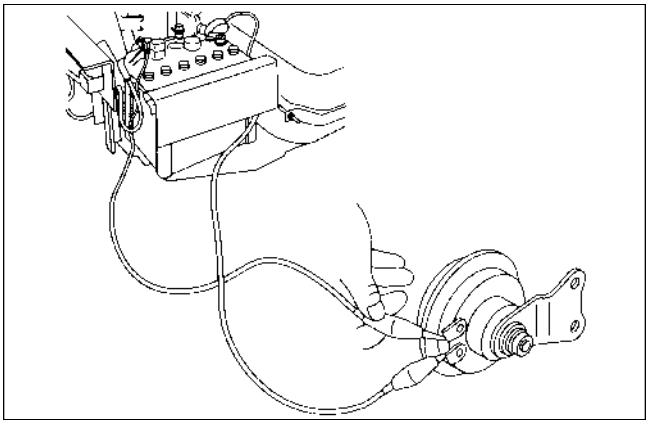


2. Inspection of horn switch (Fig.42)
   - Turn ON/OFF the horn switch and check if the pointer of the tester shakes.

     Shaking : Normal

     Not shaking : Faulty

Fig.43

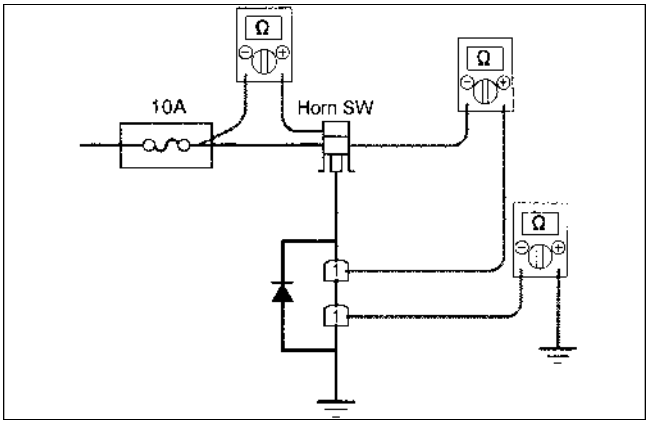


3. Inspection of horn (Fig.43)
   - Apply 12 V between the horn terminals and check if the horn sounds.

     Sounding : Normal

     Not sounding : Faulty

Fig.44



4. Continuity check (Fig.44)
   - Disconnect the coupler
   - Key switch: OFF

   (1) Check for continuity between the horn coupler (1) and body earth.

   (2) Check for continuity between the horn coupler (1) and horn switch coupler 2.

   (3) Check for continuity between the horn coupler (1) and fuse BOX10A.

Fig.45

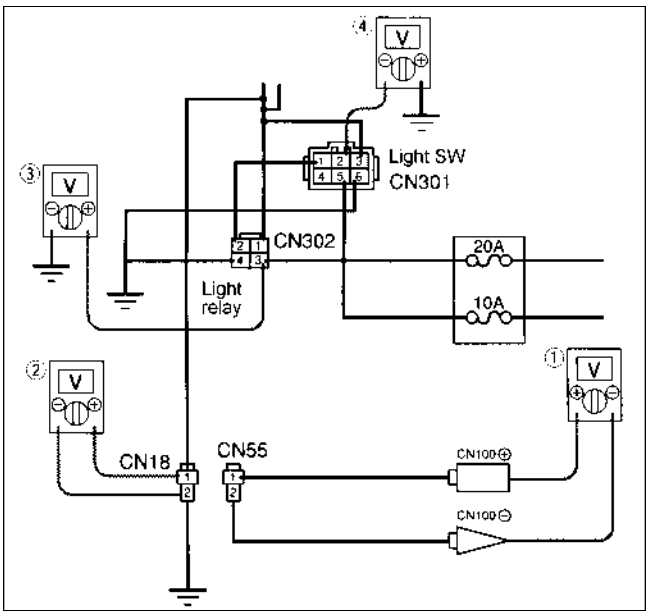


Fig.46

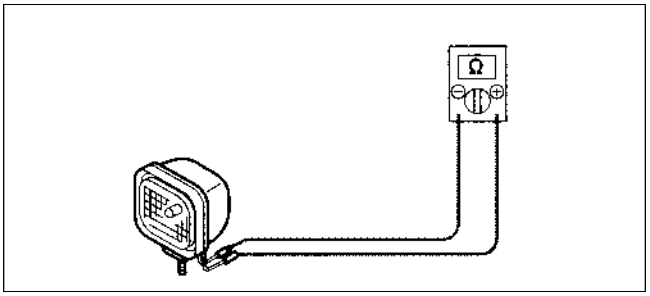
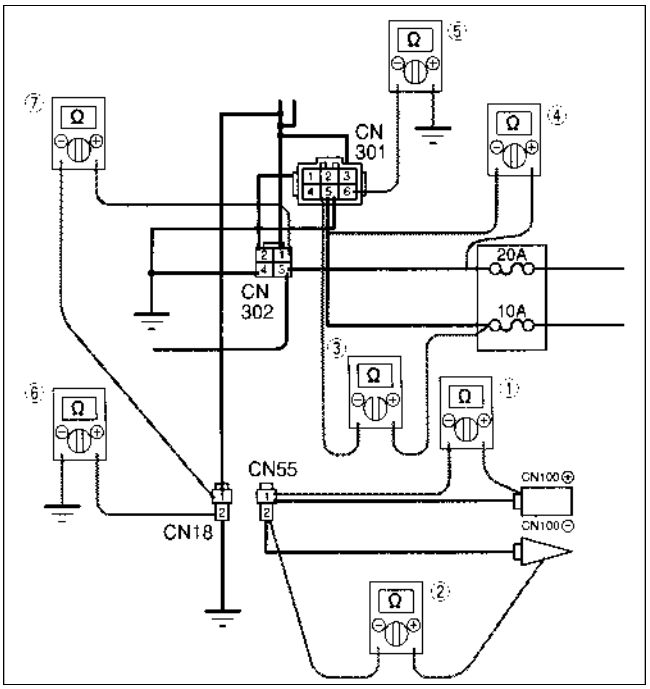


Fig.47



[15]working light

1. Measuring the voltage of the working light
   - Key switch : ON
   - Light switch : ON

     12 V : Normal. Inspect the light.

     Other than 12 V: Check for continuity.

   (1) Measure the voltage between the working light terminal CN100 (+) and CN100 (–) .
   (2) Measure the voltage between the coupler CN18-(1) and (2).
   (3) Measure the voltage between the light relay coupler CN302-(3) and body earth.
   (4) Measure the voltage between the light switch coupler CN301-(5) and body earth.

2. Continuity check
   - Disconnect the terminal.
   - Key switch: OFF

   Check for continuity between the working light terminal (1) and (2).

3. Continuity check
   - Disconnect each coupler.
   - Key switch: OFF

   (1) Check for continuity between the working light terminal CN100 (+) and CN55 coupler (1).
   (2) Check for continuity between the working light terminal CN100 (–) and CN55 coupler (2).
   (3) Check for continuity between the light switch coupler CN301-(5) and 10A fuse.
   (4) Check for continuity between the light switch coupler CN301-(5) and 20A fuse.
   (5) Check for continuity between the light switch coupler CN301-(6) and body earth.
   (6) Check for continuity between the working light coupler CN18-(2) and body earth.
   (7) Check for continuity between the working light coupler CN18-(1) and light relay coupler CN302-(1).

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