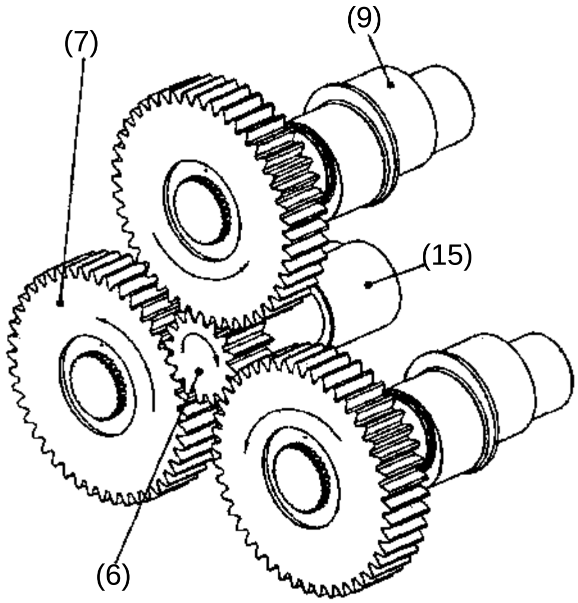
d. Function

1. Reduction gears

1) Function

The speed reducer consists of two sections: first reduction section with spur gears and second reduction section with pericycloid-toothed differential gears. The high speed of the hydraulic motor is reduced for low-speed, large-torque rotation.

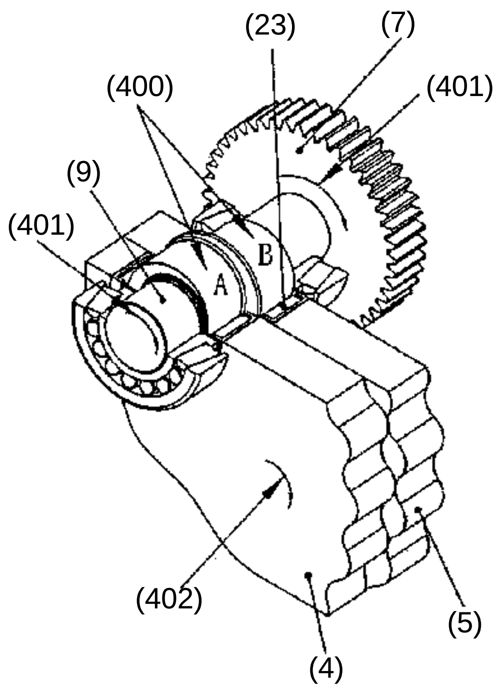
2) Behavior



2.1 First reduction section

1) The hydraulic motor's rotary motion is transmitted through the shaft (102) to the input gear (6) that is coupled with the shaft G (15). The input gear (6) is in mesh with three spur gears (7).
The spur gears (7) reduce the speed and rotate in the opposite direction. The first reduction section is composed of these input gear (6) and spur gears (7).
The reduction ratio of this section is calculated as follows.
$i1 = - Zi / Zs$
where, $i1$: First reduction section's reduction ratio
Zi: Number of teeth of input gear
Zs: Number of teeth of spur gear

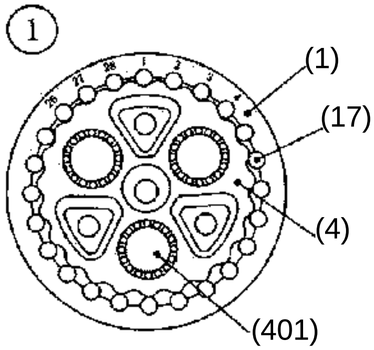
(6) Input gear
(7) Spur gear
(9) Crankshaft
(15) Shaft

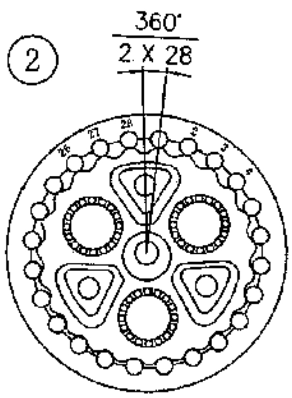


2.2 Second reduction section

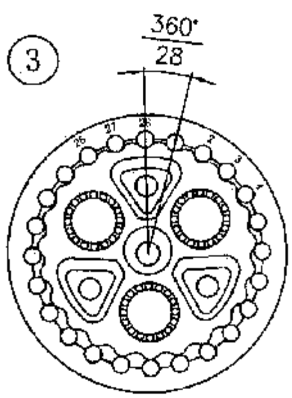
1) Each of the three spur gears (7) is coupled with its crankshaft (9). As the spur gear (7) turns, the crankshaft (9) turns at the same rpm in the same direction. The eccentric elements A and B on the crankshaft (9) produce an eccentric movement (orbital motion), which is transmitted through the needle bearings (23) to the RV gears A (4) and B (5).
In this way, the RV gears A (4) and B (5) provide for an eccentric movement in the same direction and speed as the spur gear and crankshaft.

(4) RV gear A
(5) RV gear B
(7) Spur gear
(9) Crankshaft
(23) Needle bearing
(400) Eccentric elements
(401) Rotating
(402) Eccentric movement





Movement at half-turn (180°)



Movement at full turn

2) The tooth faces of RV gears A (4) and B (5) are in constant mesh with the pins (17) (number of pins: Zp). During the eccentric movement by the RV gears A and B, their contact points shift sequentially rolling over the faces.
In one eccentric motion, the pins (17) move together with the hub (1) by the number of pins that is the difference Zp-Zr , where Zr represents the number of teeth of RV gears A and B and Zp the number of pins. The hub (1) turns in the same direction as the eccentric motion of the RV gears. The rotation of this hub (1) gives out an output.
In the second reduction section, the speed is reduced with the crankshaft, RV gears, pins and hub.
The reduction ratio of this section is calculated as follows.
i2 = (Zp-Zr) / Zp
where,i2: Second reduction section's reduction ratio
Zr: Number of teeth of RV gears A and B
Zp: Number of pins

(1) Hub
(17)Pin
(4) RV gear A or B
(403)Eccentric element on crankshaft

2.3 Entire reduction gears

The entire reduction gears behave as the multiplication of the first and second reduction sections. Accordingly, the output rpm (reduction ratio i) of the entire reduction gears, which is generated by one turn of the hydraulic motor shaft, is calculated as follows.

i = i1 x i2
= - Zi / Zs x (Zp-Zr) / Zp
where,i1: First reduction section's reduction ratio
i2: Second reduction section's reduction ratio

2. Hydraulic drive

This chapter describes the hydraulic motor, brake valve, parking brake and the hydraulic motor's two-speed select mechanism, which are all used in the hydraulic drive.

1) Functions

1-1 Hydraulic motor

The hydraulic motor is of swash-plate axial piston type. The force of pressure oil coming from the pump is converted to rotational movement.

1-2 Brake valve

(1) Inertial force is controlled in stopping the hydraulic motor. This helps bring the motor to a smooth halt.
(2) When the hydraulic motor is activated by an external force, this valve keeps the motor from running out of control. In other words, hydraulic cavitation can be avoided.
(3) The valve also keeps off an excessive pressure that would occur in case of a sudden hydraulic motor halt.

1-3 Relief valve

(1) The hydraulic motor gives out some jerk when it gets started and stopped. This valve is intended to ease such shock as well as to avoid cavitation due to the relief action (lower braking noise).
(2) The relief valve suppresses a sudden pressure upon the hydraulic motor below its preset pressure level. In this way, the hydraulic motor is protected against damages.

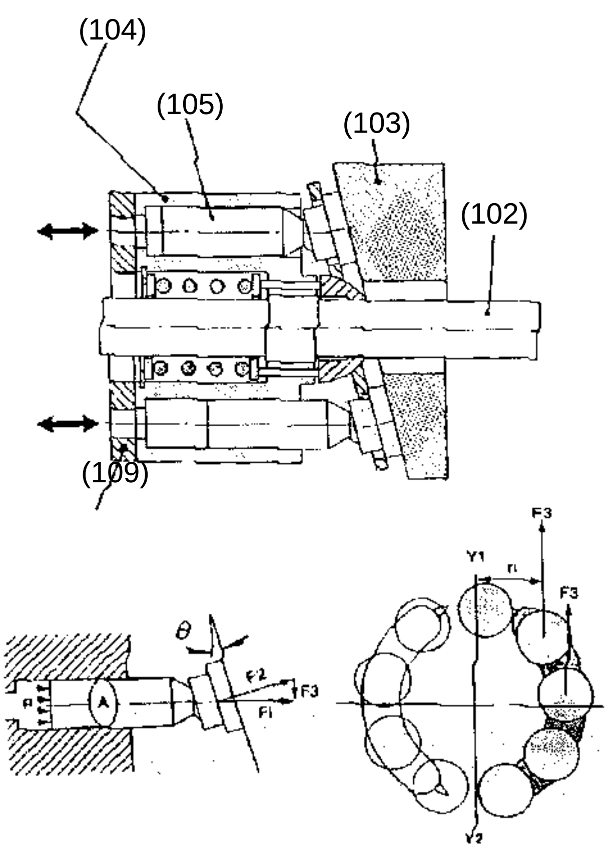
1-4 Two-speed select mechanism

The mechanism is designed to select the hydraulic motor output in two stages: high-speed, low-torque output, and low-speed, high-torque output.

1-5 Parking brake

The parking brake keeps the at-rest hydraulic motor from starting by an external force. This friction disc type brake is integrated with the hydraulic motor.

2) Principle and behavior



2-1 Hydraulic motor

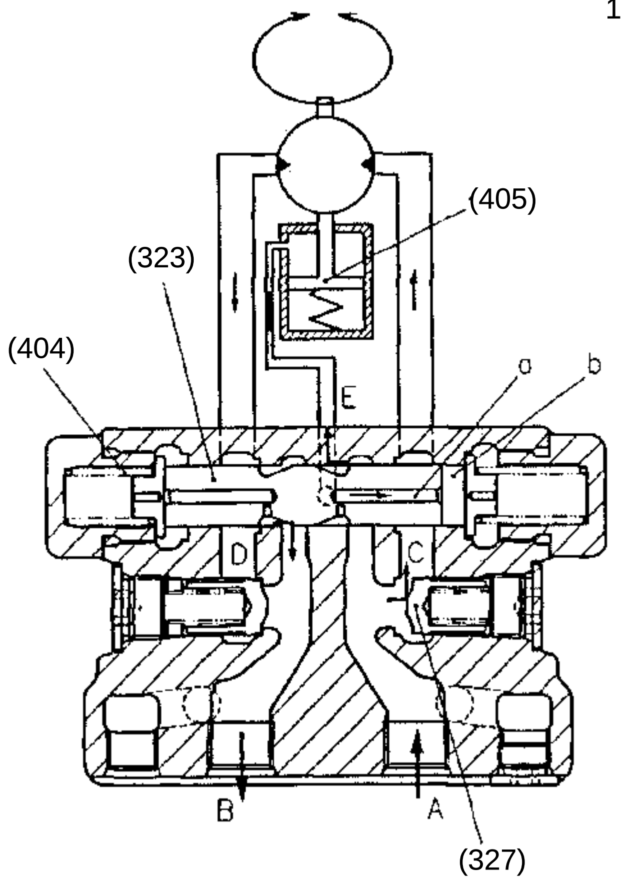
Pressure oil from the hydraulic pump flows into the rear flange (301) of the GM motor. The pressure oil is then introduced through the brake valve and timing plate (109) into the cylinder block (104).
The pressure oil is let into only one side of the Y1-Y2 line that is drawn from the top dead center to the bottom dead center of the stroke of piston (105).
The pressure oil pushes the piston (105) in question, which generates the force F (= P x A). This force then acts on the slant face of swash-plate (103). By the slanting angle θ, the force F is divided into component forces F2 and F3. Among them, the radial component force F3 generates a torque (= F3 x ri). The resultant force T (= Σ (F3 x ri)) of the torque of each piston (105) becomes the turning force of the hydraulic motor. The latter force is transmitted through the piston (105) to drive the cylinder block (104) and shaft (102).

(102) Shaft
(103) Swash-plate
(104) Cylinder block
(105) Piston
(109) Timing plate

2-2 Brake valve

The ports A and B serve to let in and out hydraulic oil. Discussed here is how the hydraulic oil (pressure oil) is supplied to the port A.

The oil through the port B flows in the opposite direction. The hydraulic motor also runs in the opposite direction.



1. Steady running

   When the pressure oil flows from the pump to the port A, the hydraulic motor gets started. Here are the details.

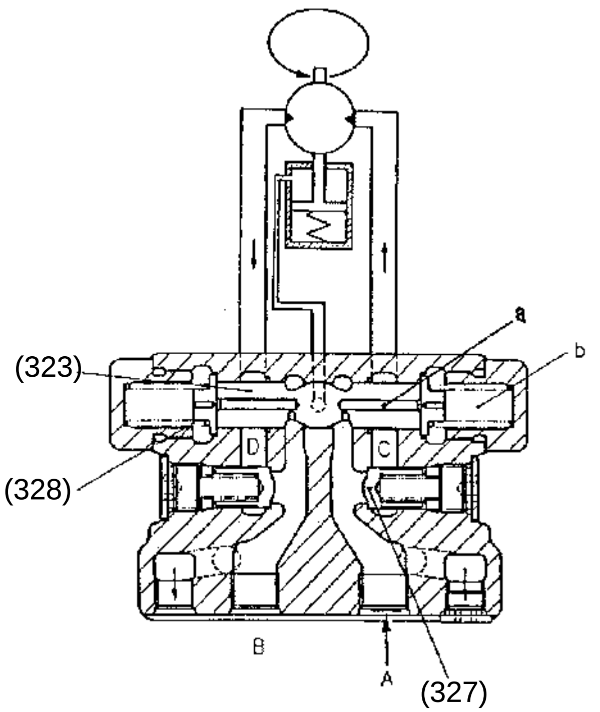
   The pressure oil from the pump flows first through the port A, which opens the valve (327). Passing through this valve, the oil flows then through the port C into the hydraulic motor, which is given a rotational force.

   The pressure oil through the port A also flows through the small opening of spool (323) and the passage a into the chamber b . By the hydraulic force in the chamber b , the spool (323) slides from the neutral position to the left. The groove in the spool (323) forms a passage for the oil to flow between the ports D and B.

   The hydraulic oil out of the hydraulic motor flows through the port D first and then B. In this way, the hydraulic motor starts running and the hydraulic oil returns into the oil tank.

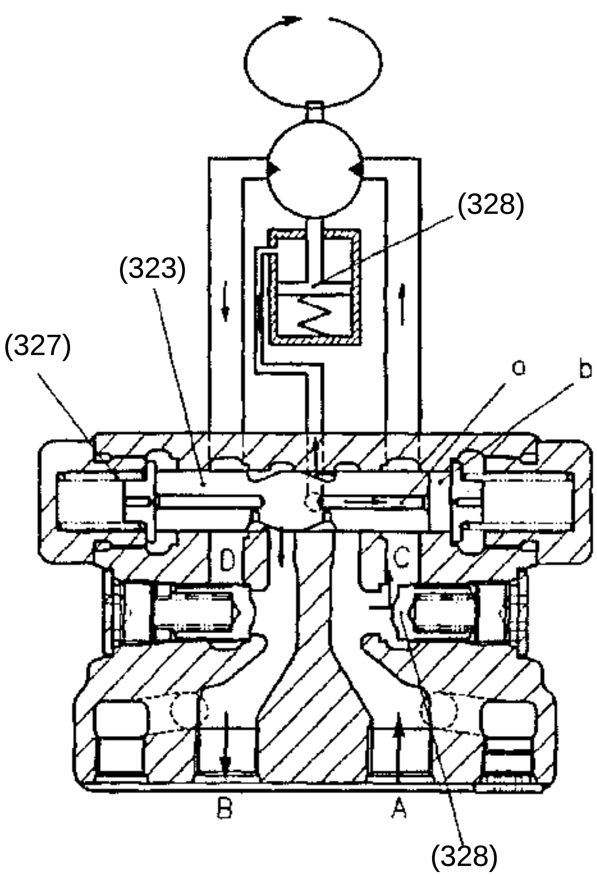
   When the spool (323) slides to the left, on the other hand, the pressure oil flows through the port E. From here, the oil goes to the parking brake and the two-speed selector valve.

   (323)Spool
   (327)Valve
   (404)Spring
   (405)Parking brake



(323)Spool
(327)Valve
(328)Spring

2. Stopping (braking)
   When the pressure oil is interrupted, the hydraulic motor gets stopped. Here are the details.
   When the pressure oil to the port A is blocked, the pressure at the port A and in the chamber b drops. Accordingly the spool (323) starts sliding from left to the neutral position by the force of spring (328). Then the oil in the chamber b is expected to flow through the passage a of spool (323) toward the port A. The throttling effect of passage a , however, produces a back pressure and controls the return speed of spool (323).
   The hydraulic motor, even after the block of the pressure oil at port A, is expected to keep running by its inertial force. The hydraulic oil from the hydraulic motor is thus expected to pass through the port D, the spool's groove, the rear flange (301) back to the port B.
   When the spool (323) has returned exactly to the neutral position, the return passage of the hydraulic motor is completely blocked and the hydraulic motor stops itself.
   In doing so, the brake valve narrows down the return passage of the hydraulic motor under the sliding speed control of spool (323) as well as by the spool groove's shape. The resulting back pressure brings the hydraulic motor, still under its inertial force, to a smooth halt.
   The valve (327) gets activated by a very small negative pressure. The oil passage between the circuit of port A and the motor's suction port C gets open, which prevents cavitation in the hydraulic motor.



3. Runaway prevention function
   If an external force affects the hydraulic motor during its steady run, a runaway trouble may occur. This may happen on the travel motor of a power shovel, for example, which is running down a steep slope. Here is the mechanism to prevent such trouble.
   Let's suppose an external force applies upon the steady-running hydraulic motor. The hydraulic oil (supplied at port A or B) drops in pressure. Before the pressure nears a runaway level, the spool (323) starts sliding to the neutral (center) position. According to the spool's shift, the hydraulic oil passage from the hydraulic motor's outlet port D to the port B becomes narrower. The hydraulic oil flow rate from port D to B is thus limited. At the same time, the back pressure at port D rises.
   In this manner, the flow rate and pressure at the hydraulic motor's outlet port are controlled, preventing the runaway problem.

(323)Spool
(327)Valve
(328)Spring
(405)Parking brake

2-3 Relief mechanism behavior

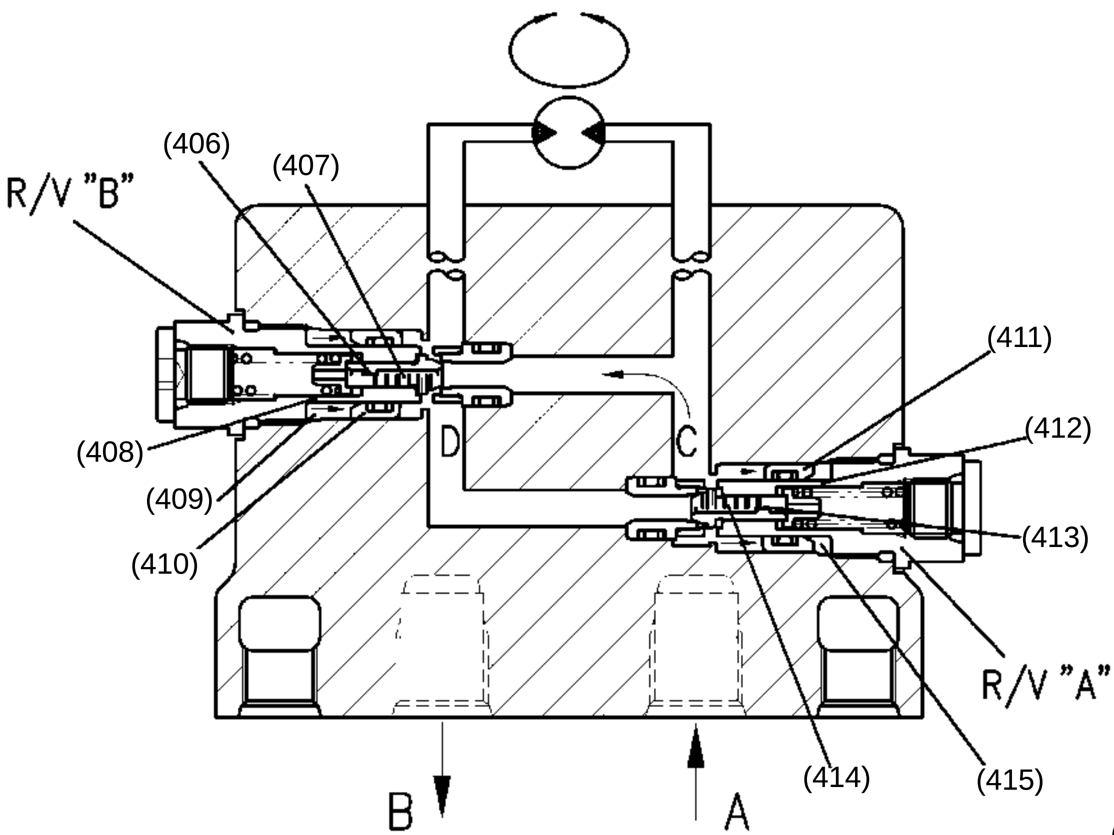
1. Starting

The pressure oil from the pump is introduced from the port A to C. The oil through the port C, connected with the hydraulic motor, gives a rotational force to the motor.

At the relief valve A , the valve a does not open by the pressure oil. The piston d is affected by the pressure oil to move in the direction of arrow to its stroke end. During this shift, the oil in the chamber x flows through the orifices c and b to the port D.

At the relief valve B , on the other hand, the pressure oil from the port C opens the valve e at over a preset pressure level, and flows to the port D. This oil passes through the orifices f and g into the chamber y . Now the piston h is activated by the oil to move in the direction of arrow to its stroke end. With the piston h at the stroke end, the pressure between the orifices f and g rises. The opening pressure of relief valve B thus becomes higher than the shovel s system pressure, which closes the valve e .

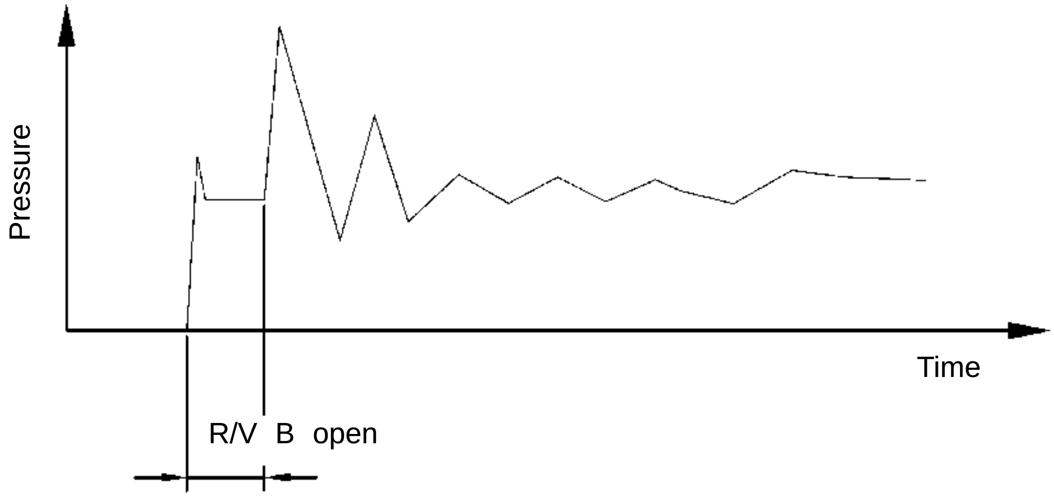
The relief valves A and B behave in this way to raise the pressure at the port C and boosts the motor.



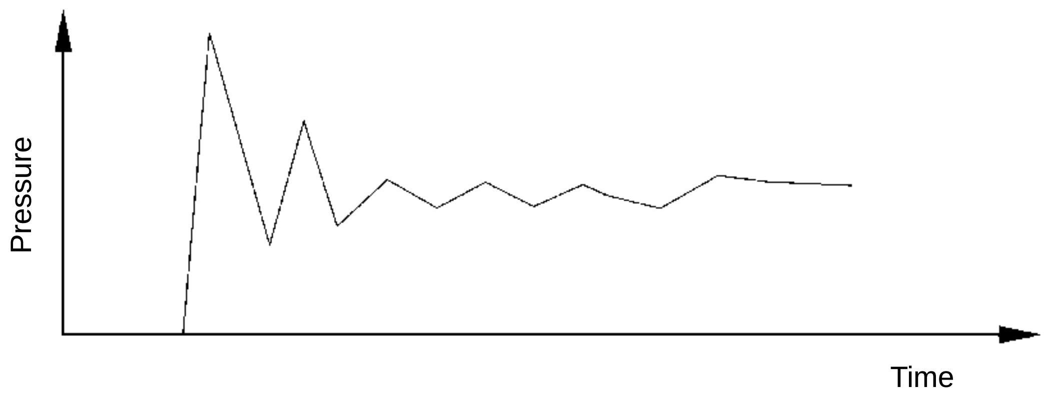
Pressure oil flow from port A

(406)Orifice f
(407)Valve e
(408)Orifice g
(409)Chamber y
(410)Piston h
(411)Piston d
(412)Orifice c
(413)Orifice b
(414)Valve a
(415)Chamber x

Pressure at port C in the above behavior



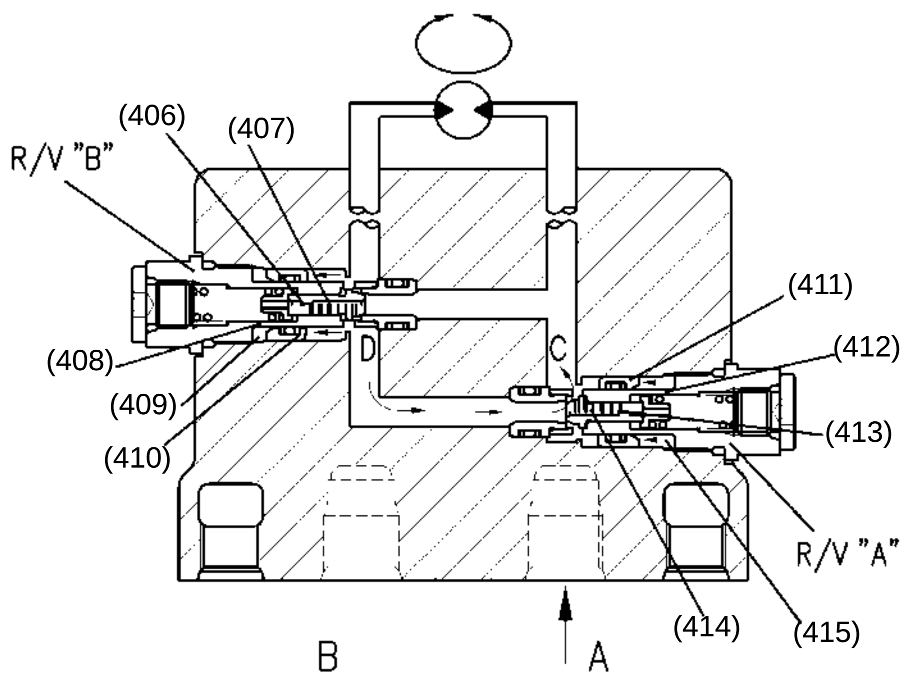
Let s suppose, however, that the piston h is already at its stroke end depending on how the machine stopped immediately before. In such case, the valve e of relief valve B does not open. The pressure at the port C is thus as shown in the chart below.



As discussed above, the startup pressure at the port C depends on the position of piston h .

* When the pressure oil from the pump flows from the port B to D, the relief valves A and B exchange their behaviors according to the above principle.

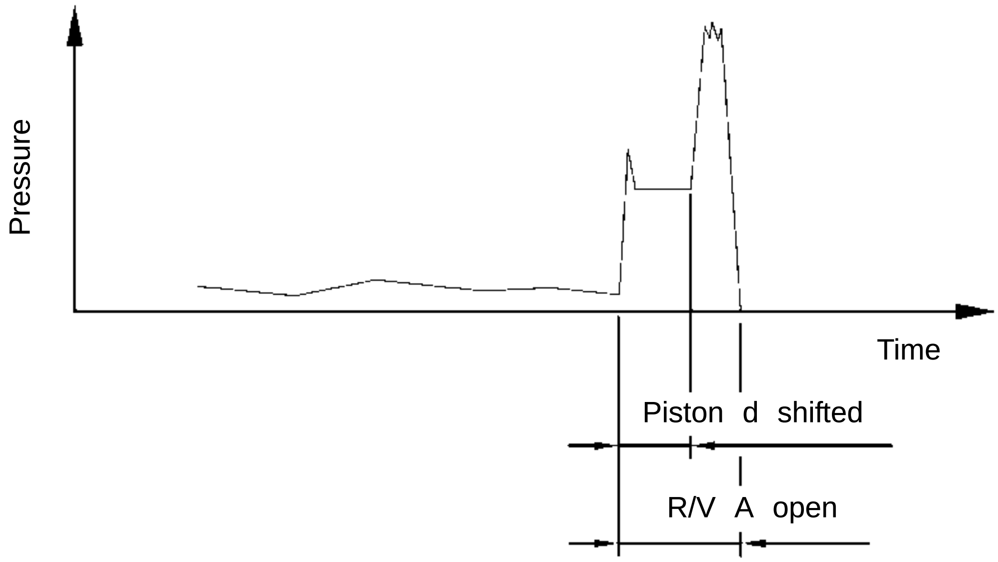
2. Stopping
   The hydraulic motor runs by the supply of pressure oil from the port A to C. When no pressure oil comes from the port A, the counterbalance valve returns to the neutral position.
   With the counterbalance valve in neutral, the outlet port D is blocked and the hydraulic motor keeps running by its inertial force alone. This applies a pressure at the port D. At the relief valve A , the pressure oil out of the port D flows through the orifices b and c in the valve a into the chamber x . The pressure oil in the chamber x then moves the piston d to its stroke end. During this shift, the pressure in the chamber x does not rise. So the valve a of relief valve A is pushed open by the pressure oil at port D. The pressure oil at port D then flows toward the low-pressure port C.
   When the relief valve A is activated, the pressure at port D is controlled and the oil is supplied to the port C, which prevents cavitation.
   When the piston d has reached its stroke end, the pressure in the chamber x and that between the orifices b and c rise, getting the valve a closed. If the shovel's system pressure is exceeded in this case, the relief valve A gets activated to stop the hydraulic motor.
   On the other hand, the piston h of relief valve B moves in the direction of arrow by the pressure oil at port D. The oil in the chamber y goes through the orifices g and f into the port C.



Pressure oil flow blocked from port A

(406)Orifice f
(407)Valve e
(408)Orifice g
(409)Chamber y
(410)Piston h
(411)Piston d
(412)Orifice c
(413)Orifice b
(414)Valve a
(415)Chamber x

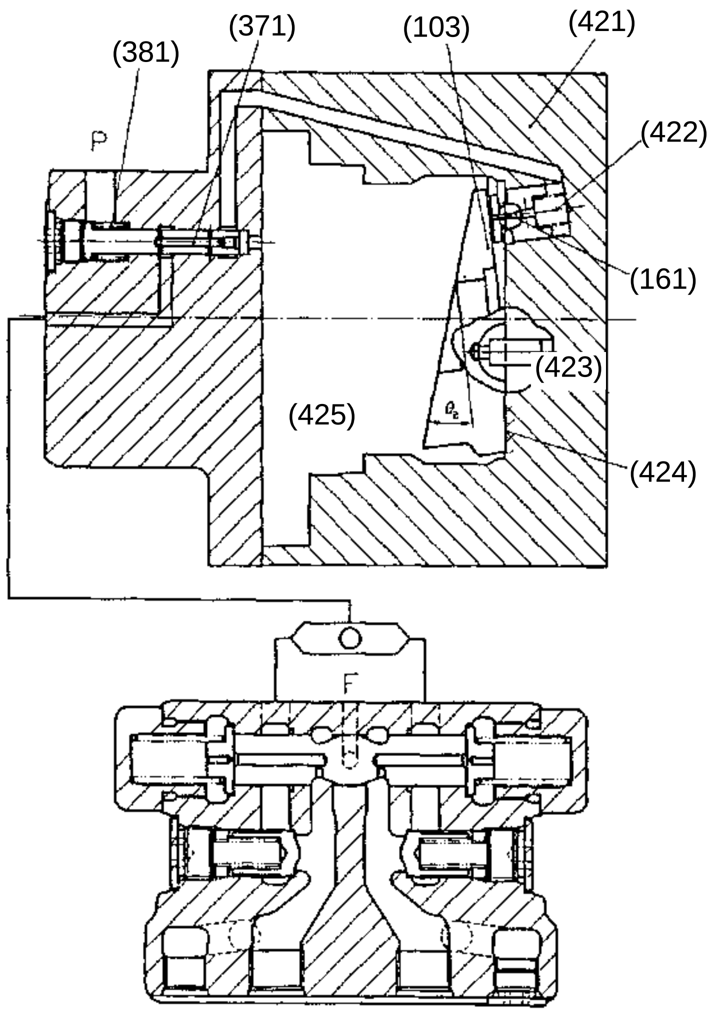
Pressure at the hydraulic motor (port D) with the pressure oil flow blocked



The pressure with the piston d being shifted is commonly called the primary relief pressure (low).
The pressure with the piston d already shifted is commonly called the secondary relief pressure (high).

2-4 Two-seed select mechanism (manual two-speed selection)

1. Low-speed stage
   At the low-speed stage, the pilot pressure is not supplied from the port P. In such state, the spool (371) is pushed to the left by the force of spring (381). The pressure oil at the port F stays blocked.
   The hydraulic oil in the chamber S is let out to the drain (motor case) through the spool (371). The thrust of piston (161) remains low. The swash-plate (103) is positioned along the face Y at the maximum tilt angle of $\theta 1$.
   In other words, the hydraulic motor reaches its maximum cylinder capacity and runs at the low speed.



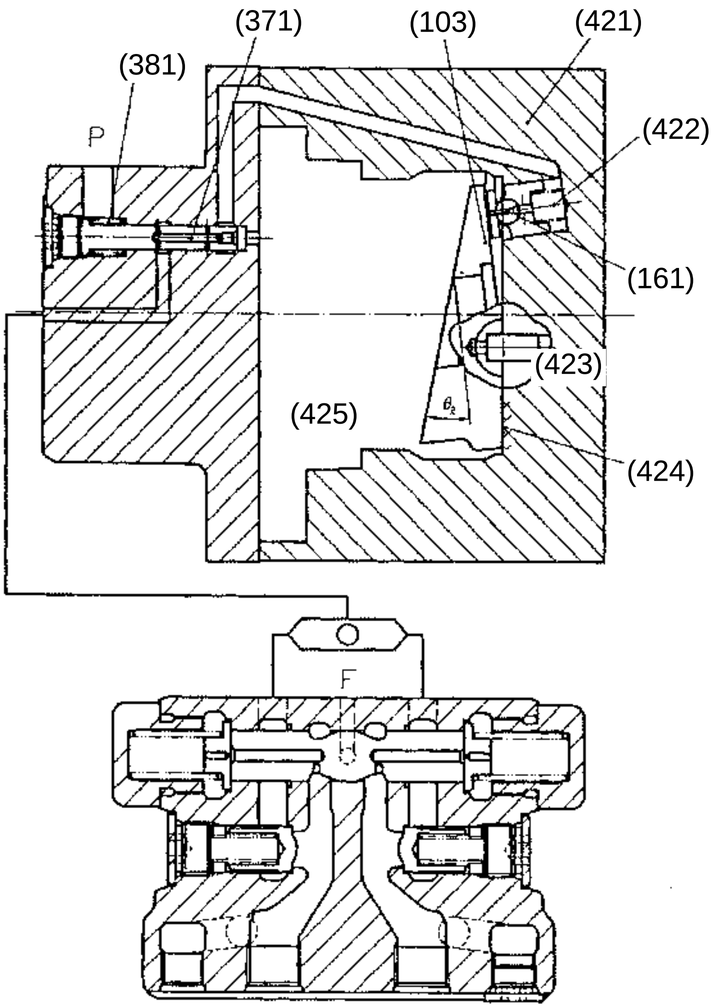
(103)Swash plate
(161)Piston
(371)Spool
(381)Spring
(421)Spindle
(422)Chamber S
(423)Support
(424)Face X
(425)Motor case

2. High-speed stage

   At the high-speed stage, the pilot pressure of over 1.96 MPs (20 kgf/cm^2) is supplied from the port P. In such state, the spool (371) surpasses the force of spring (381) and is pushed to the right. The pressure oil at port F is then introduced through the spool (371) into the chamber S.

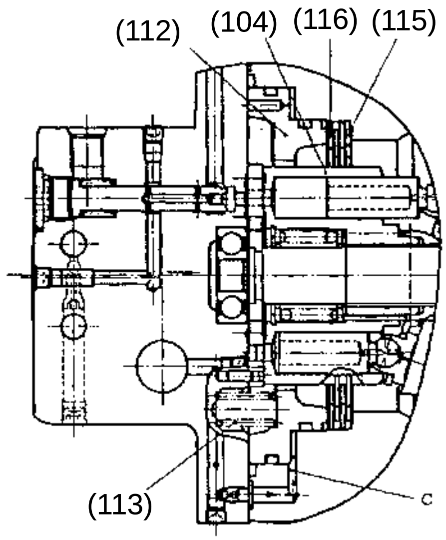
   The pressure oil in the chamber S makes the thrust of piston (161) high. The piston (161) pushes up the swash-plate (103) until it comes into contact with the face X. The swash-plate (103) stays in this position at the maximum tilt angle of $\theta 2$.

   In other words, the hydraulic motor comes to its minimum cylinder capacity and runs at the high speed.



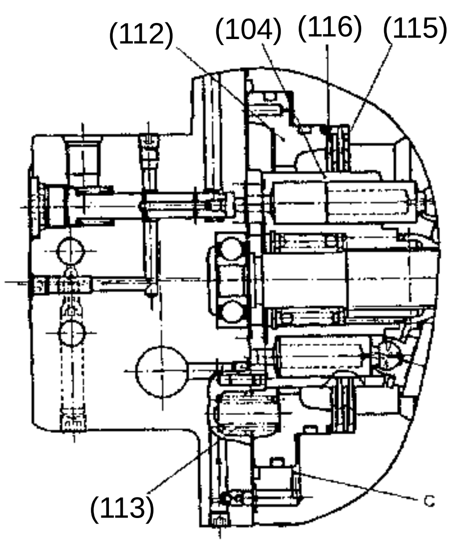
(103)Swash plate
(161)Piston
(371)Spool
(381)Spring
(421)Spindle
(422)Chamber S
(423)Support
(424)Face X
(425)Motor case

2-5 Parking brake



1. Running
   The pressure oil is supplied from the pump to the port A or B. The spool (323) of brake valve shifts to the left or right, which opens the port E. Now the pressure oil flows through the port E into the cylinder c . When the hydraulic pressure has risen above 0.47 MPs (4.8 kgf/cm^2), the thrust of piston (112) becomes greater than the force of spring (113). The piston (112) shifts toward the rear flange (301) and frees the mating plate (116) and friction plate (115). The friction plate (115) is now in free rotation.
   The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. Accordingly, the cylinder block (104) gets free from the braking force and the hydraulic motor is equally in free run.

   (104)Cylinder block
   (112)Piston
   (113)Spring
   (115)Friction plate
   (116)Mating plate



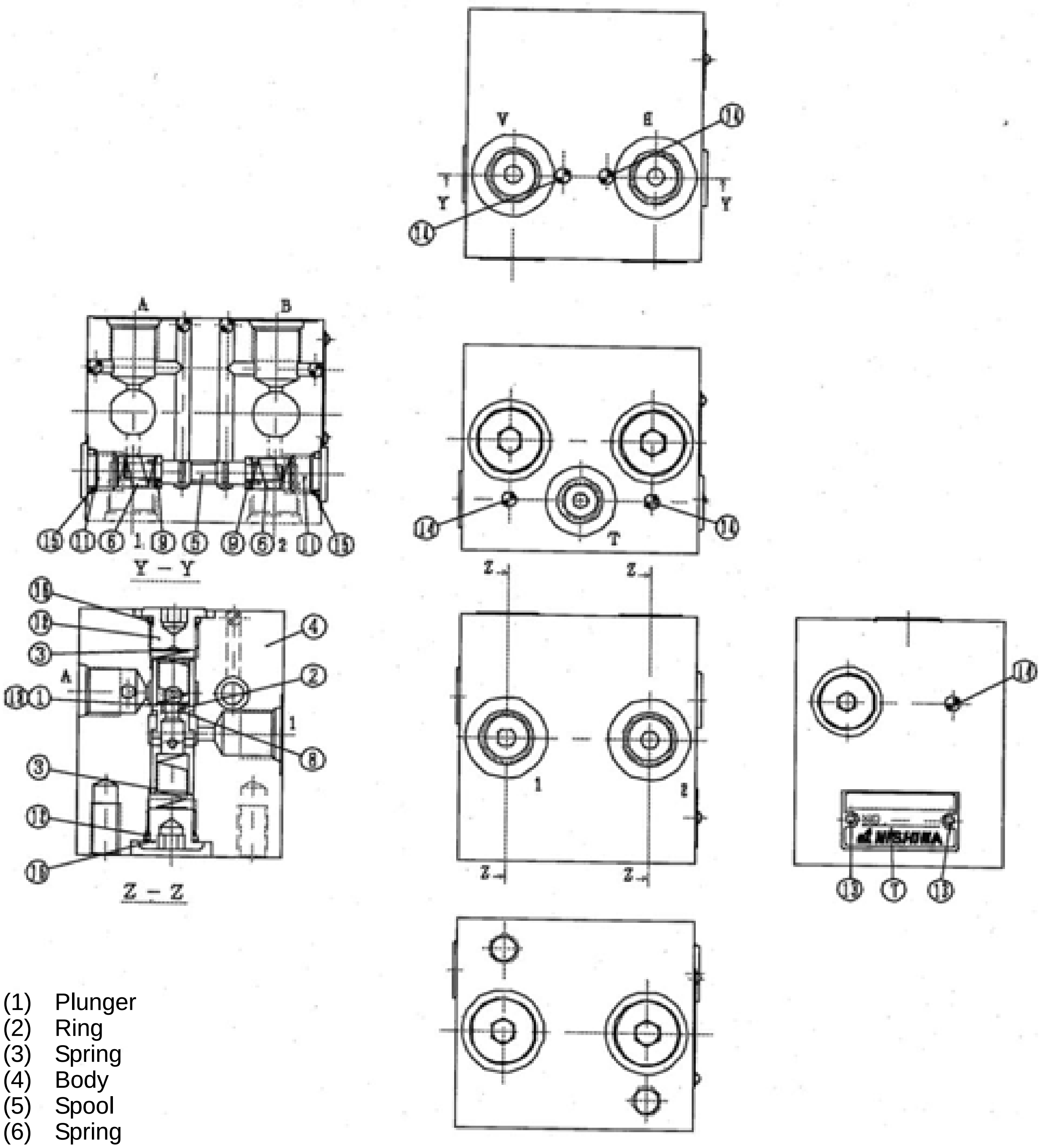
2. Braking
   The pressure oil is not supplied to the port A or B. The spool (323) of brake valve shifts to the neutral position, which closes the port E. Now the pressure in the cylinder c drops. When this pressure has dropped below 0.47 MPs (4.8 kgf/cm^2), the hydraulic pressure of piston (112) becomes less than the force of spring (113). The force of spring (113) activates the piston (112) to press the mating plate (116) and friction plate (115) together. This pressing force turns in the friction force for braking.
   The friction plate (115) is also engaged with the cylinder block (104) of hydraulic motor. The cylinder block (104) is equally coupled with the shaft (102) of hydraulic motor.
   In this way, the hydraulic motor is given a braking torque.

   (104)Cylinder block
   (112)Piston
   (113)Spring
   (115)Friction plate
   (116)Mating plate

H.Cylinder

a. Shockless valve of Boom cylinder pilot line

(1) Structure



(1) Plunger
(2) Ring
(3) Spring
(4) Body
(5) Spool
(6) Spring
(8) Orifice
(9) Retainer
(11) Collared plug
(12) Collared plug
(14) Steel ball
(15) O ring
(16) O ring

Fig. 1.

(2) Function

(Let s discuss the ports A and 1 here. The same is true of the ports B and 2.)

Port A to Port 1: Flow control See Fig. 2.

The pressure oil out of port A flows this way: through the hole (b) of plunger (1), orifice (8), the lateral hole (a) of plunger (1) and into the port 1.

The resistance in passing through the orifice (8) makes the pressure of chamber (i) higher than that of chamber (ii).

This pressure difference moves the plunger (1) downward.

When the plunger (1) has reached down, the hole (a) gets closed and the pressure of chamber (ii) rises.

When the pressure of chamber (i) and that of chamber (ii) become the same level, the plunger (1) is brought back to the neutral position by the spring force (3).

These steps are repeated. Finally the plunger (1) reaches the position at which the force of spring (3) and the passing resistance of orifice (8) get balanced each other. This is expressed in the following equation. (The more flow through orifice (8), the higher the resistance at the orifice. The hole (a) gets then closed.)

FS = FA x FB (FA = P1 x a P2 x b = FB)

Where, FS: Force of spring (3)
FA: Downward force upon plunger (1)
FB: Upward force upon plunger (1)
P1: Pressure in chamber (i)
P2: Pressure in chamber (ii)
a, b: Pressure receiving area on plunger (1) (a = b)

Accordingly, the flow of pressure oil through the orifice (8) is kept at a level that is required to produce the passing resistance proportional to the force of spring (3). This takes place regardless of the pressure at port A. In this way, the flow rate from port A to port 1 can be controlled at a constant level.

A: Boom C/V section pilot chamber
1: Boom down pilot line to return

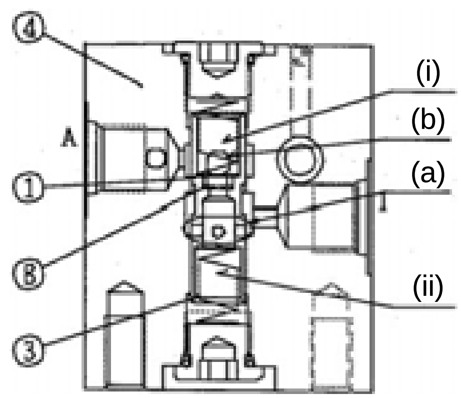


Fig. 2.

Port 1 to Port A: Free flow See Fig. 3.

The pressure oil supplied out of port 1 flows through the hole (a) and orifice first and then through the hole (b) up to the port A.
The resistance in passing through the orifice makes the pressure of chamber (i) lower than that of chamber (ii), which moves the plunger upward.
When the plunger has reached up, the hole (c) gets open and the entire pressure oil flows out to port A.
With no pressure oil flow, the plunger is brought back to the neutral position by the spring force.

A: Boom C/V section pilot chamber
1 : Boom down pilot line to return

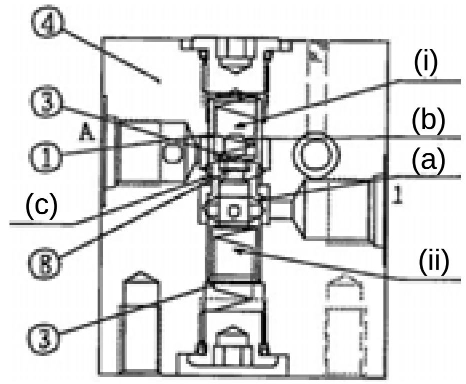


Fig. 3.

Port A to Port 1: Flow control released See Fig. 4.

Usually the spool (5) is held at the neutral position by the left and right springs (6). The pressure oil from the port A is therefore cut from the port T with the hole (d) in between. As discussed in Fig. 2, the flow through the port A is controlled. (Left layout in Fig. 4)
When the pressure at port 2 rises above the force of spring (6), the spool moves and allows the ports A and T to connect each other. The pressure oil through the port A therefore flows down directly into the tank, which releases the flow control at port A.

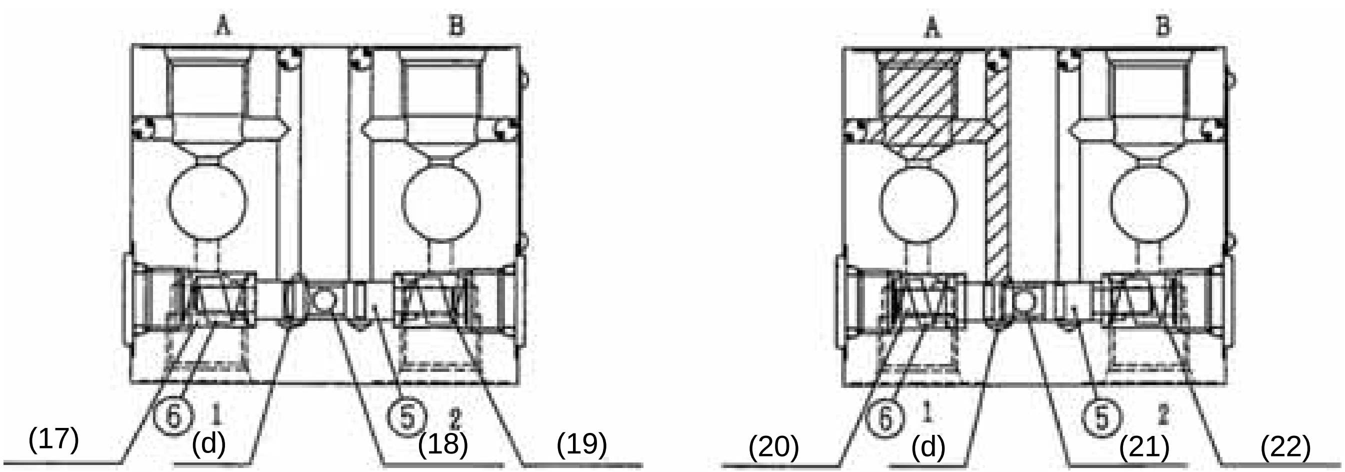


Fig. 4.

(17) Port 1 passable
(18) Port T passable
(19) Port 2 passable
(20) Port 1 passable
(21) Port T passable
(22) Port 2 passable

A: Boom C/V section rod side pilot chamber
B: Boom C/V section bottom side pilot chamber
①: Pilot valve port, boom down
②: Pilot valve port, boom up

I. Boom cylinder holding valve

a. Outline

The holding valve has been developed for hydraulic shovels. This control valve prevents the cylinder against gravity fall in the non-operating status and against sudden fall in case of hose burst.

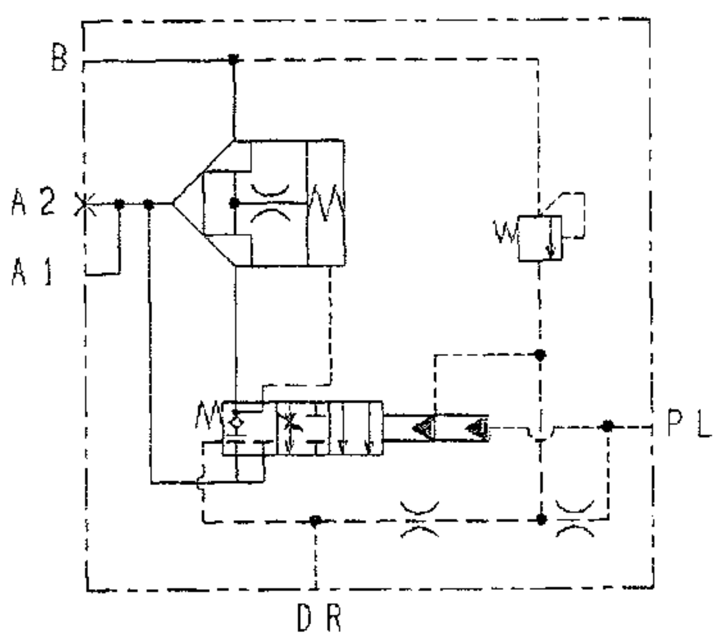
H			-	0	-	3.	0	/	3 0
(1)	(2)	(3)		(4)		(5)	(6)		(7)

(1) Holding valve
(2) Nominal diameter (size)
(3) B-port configuration (G: Threaded port)
(4) Rotation number
(5) Circuit code
(6) Major revision code
(7) Relief set pressure

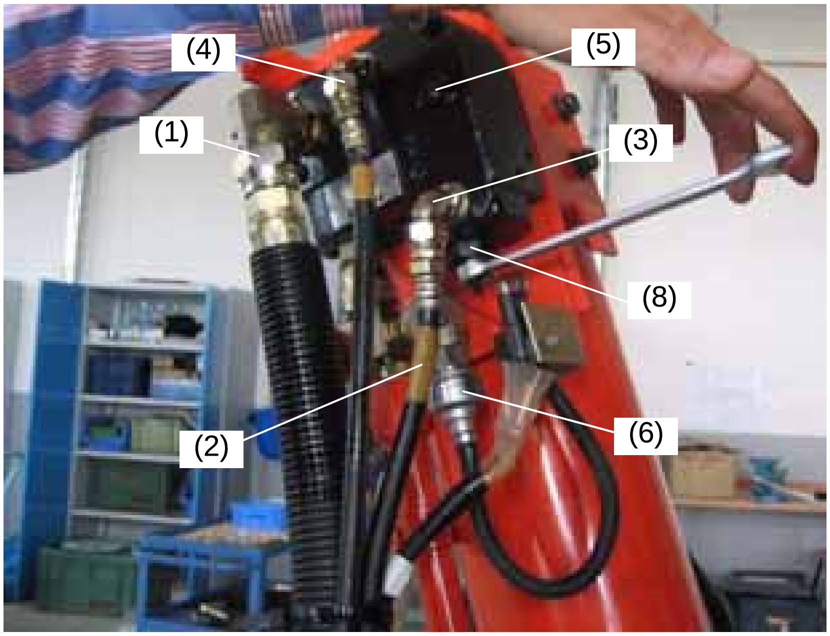
b. Specifications

Maximum operating pressure		31.4 MPa, 320 kgf/cm^2 4551 psi
Maximum allowable flow rate (P-port) A → B		150 L/min, 39.63 GPM
Cracking pressure	B-port pressurized	PB = 30.4 0.5 MPa, 310 5 kgf/cm^2, 4409 71 psi
	A-port pressurized	PA = 0.2 MPa, 2 kgf/cm^2 28 psi
	PL-port pressurized	PPL= 0.5 $^{+0.05}_{-0.10}$ MPa, 5$^{+0.5}_{-1.0}$ kgf/cm^2 71$^{+7.0}_{-14.2}$ psi
Leakage	Holding valve internal	0.8 cc/min at B port, 8.3MPa (85 kgf/cm^2)
Hydraulic oil used Allowable hydraulic oil contamination		Mineral hydraulic oil ISO VG3 or VG46 or equivalent Below Class NAS10
Operating temperature range		-20 +95°C

c. Circuit diagram



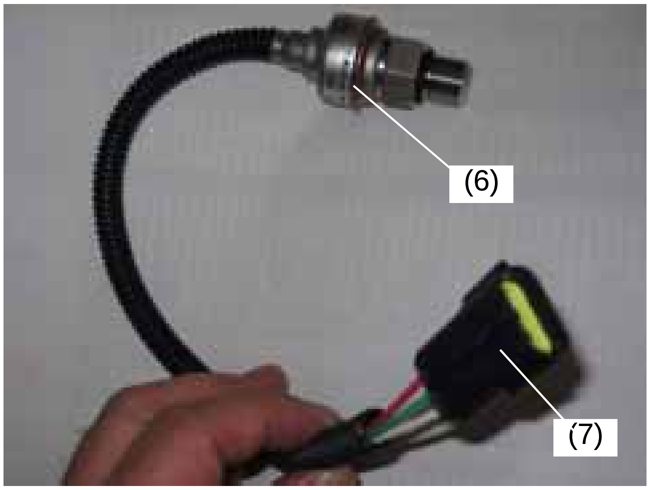
d. Holding valve installation



1. Main parts

(1) Main control valve to the holding valve
(2) Holding valve to boom cylinder bottom side
(3) Pilot secondary line
(4) Drain line
(5) Overload relief valve
(6) Load pressure switch
(8) Manual device for boom down

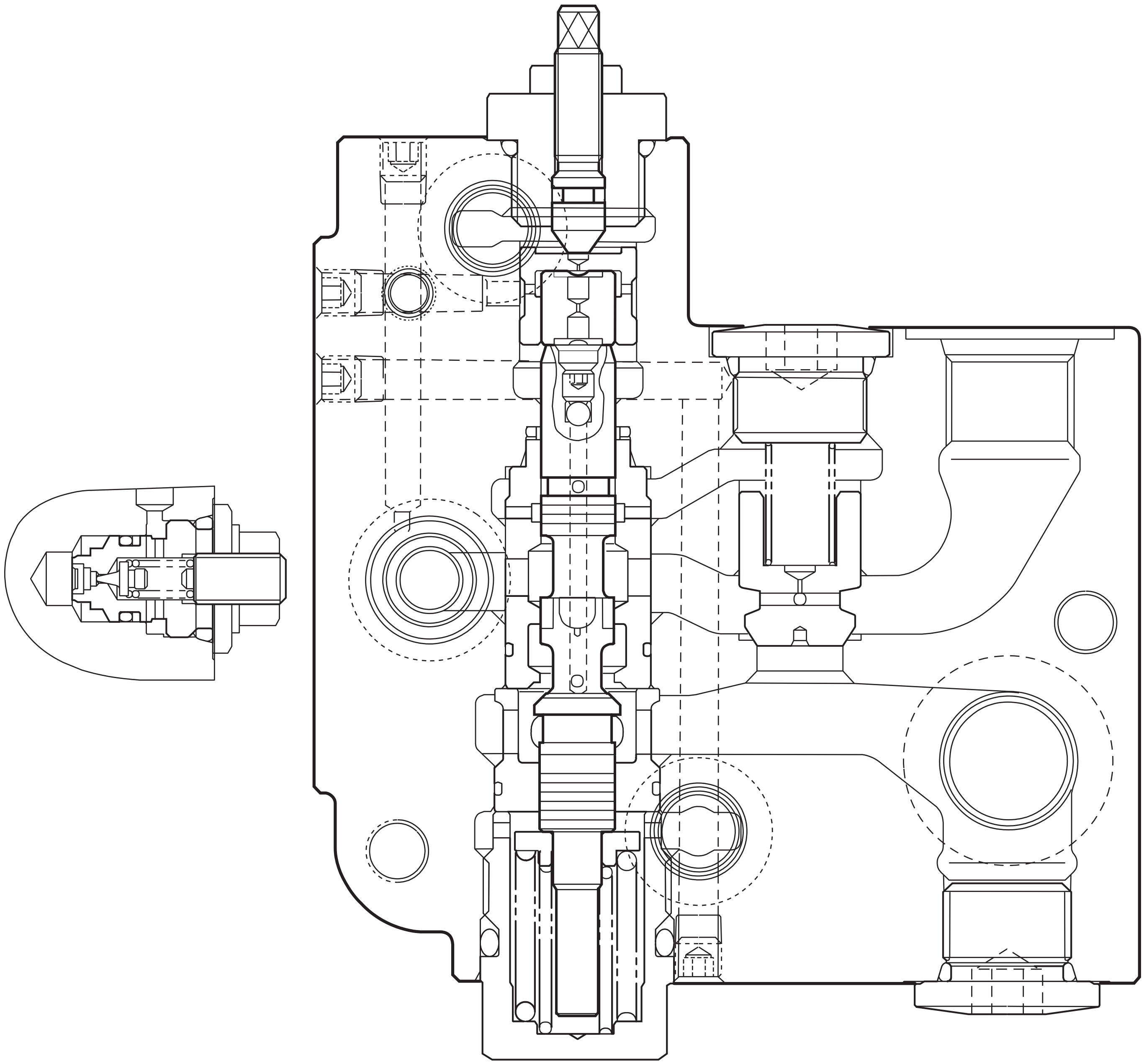
2. In order to get the boom down ;
   Disconnect the main hose to drain out the oil



(6) Load pressure switch
(7) Coupler

e. Main parts function

Holding valve (manual open type)



Main part's function

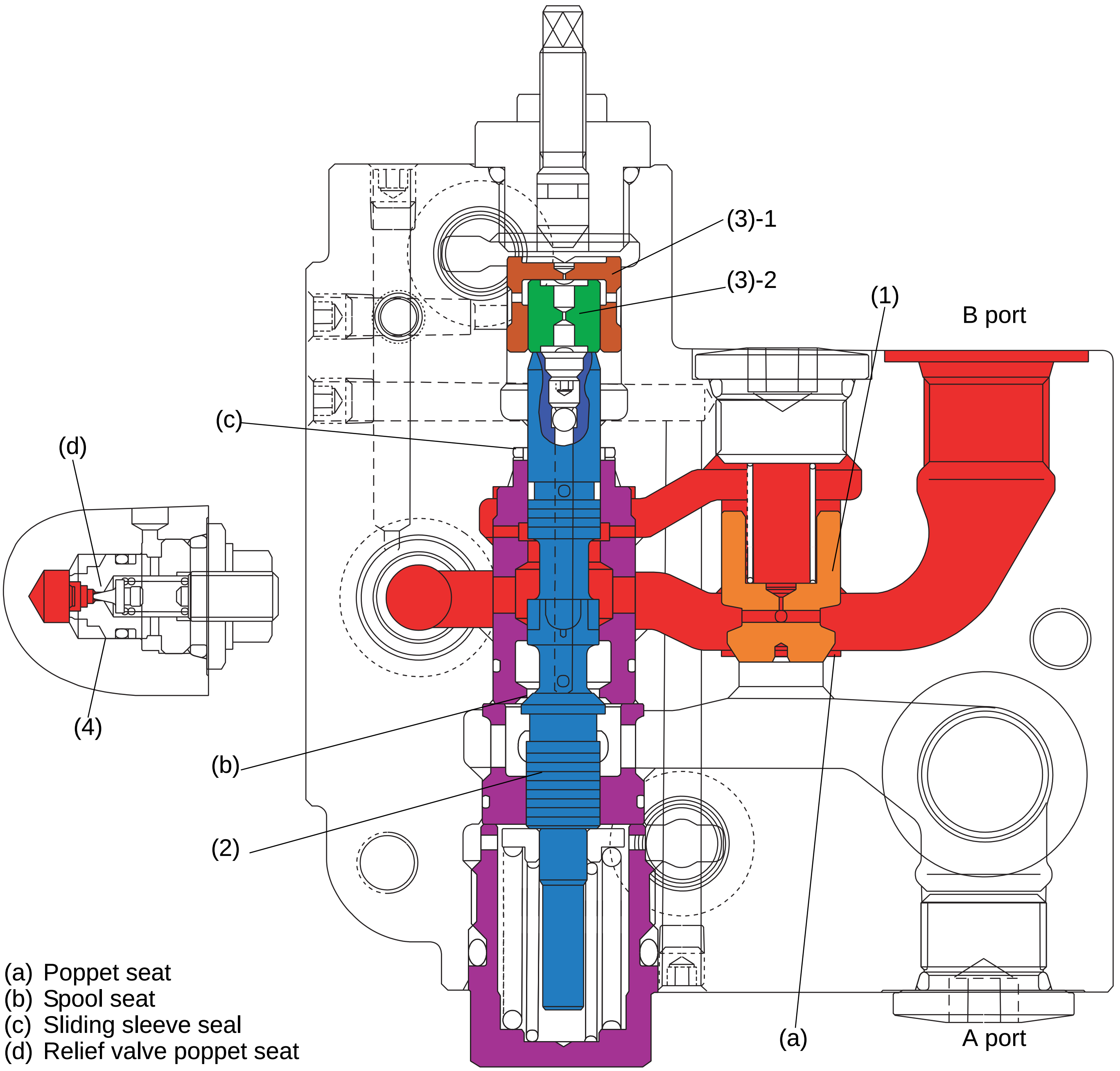
No.	Name	Function
(1)	Poppet	To stop a leak between main relief valve and cylinder. Equipped with load check function.
(2)	Spool	Activated over the stroke by the cylinder-actuated pilot pressure to control the flow rate from cylinder to main relief valve. To control the poppet openness when the pilot pressure rises too high.
(3)	Piston (1), Piston (2)	To receive the pilot pressure and to activate the spool over the stroke. Spool to be activated over the stroke by piston (1) for relief purpose.
(4)	Relief valve	To regulate maximum pressure at the cylinder port.

A port : From control valve
B port : To boom cylinder bottom side

f. Circuit function

1. Newtral position

When the spool stays neutral (with no pilot pressure applied), the poppet seat (a), spool seat (b), sliding spool seal (c) and relief valve poppet seat (d) all serve to stop a leak from the cylinder. In this way, the cylinder is prevented against gravity fall.

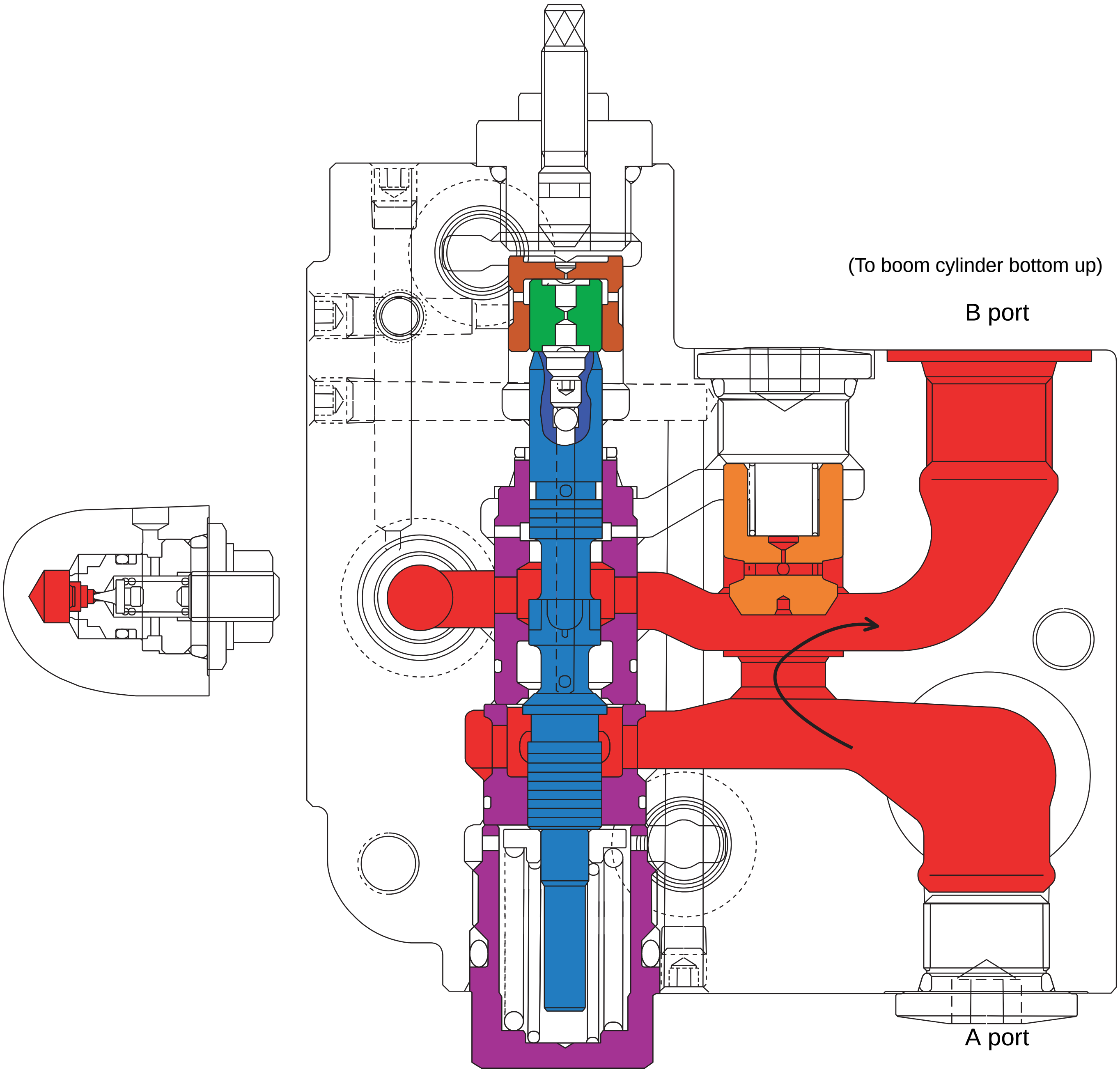


(a) Poppet seat
(b) Spool seat
(c) Sliding sleeve seal
(d) Relief valve poppet seat

Fig. 1 Spool at neutral position

2. With oil flowing from A-port to B-port (from main control valve to cylinder)

The oil from A-port flows against the cylinder pressure and the poppet s return spring force. It then gets the poppet open and flows on to B-port.



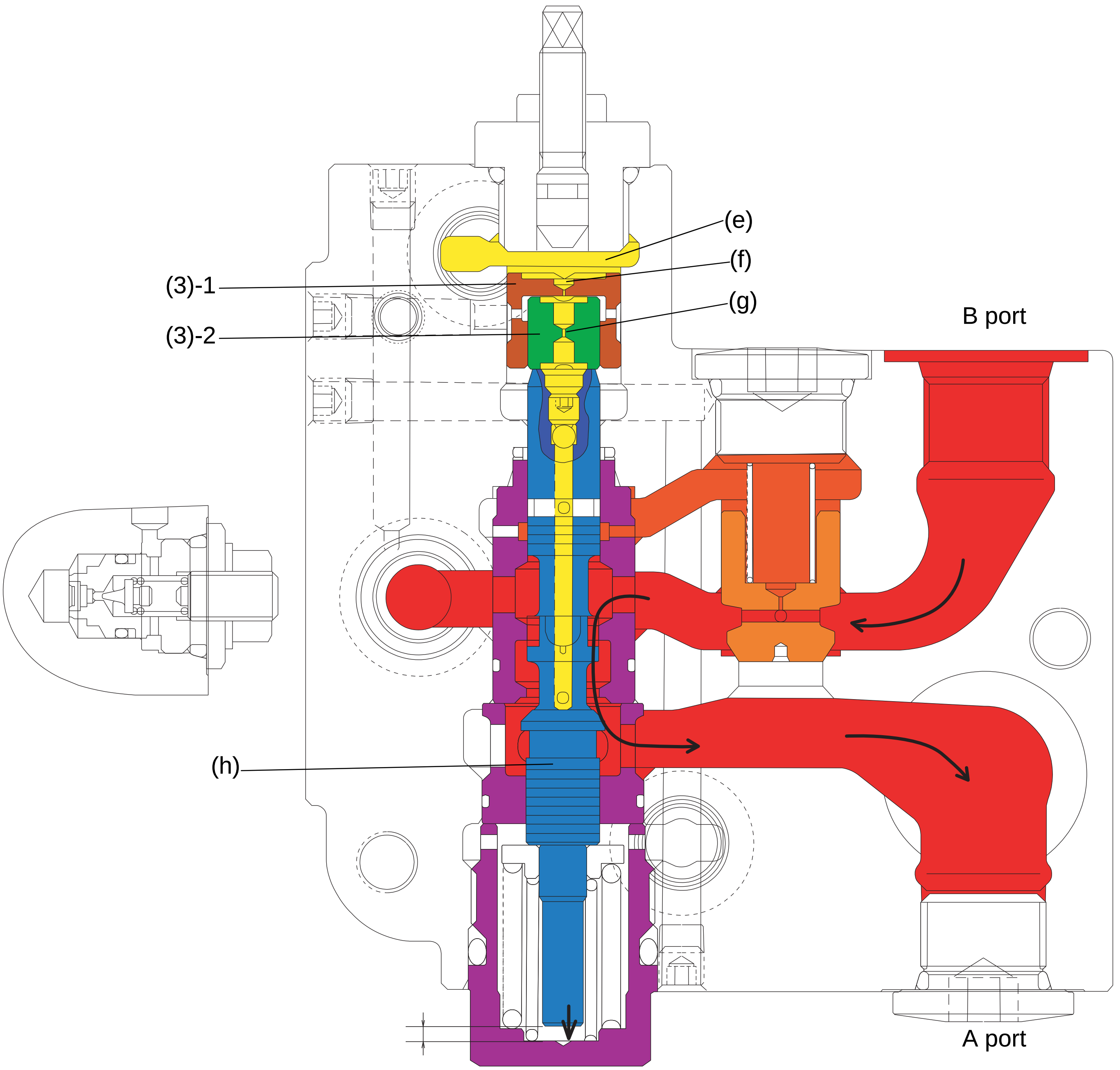
(a) Poppet seat
(b) Spool seat
(c) Sliding sleeve seal
(d) Relief valve poppet seat

Fig. 2 With oil flowing from A-port to B-port

3. With oil flowing from B-port to A-port (from cylinder bottom side to main control valve)

(1) When the pilot pressure is applied, the pressure in the pilot chamber (e) rises. The oil from the pilot chamber flows along the pilot line and through the orifices (f) and (g) into the drain port. Now the air in the pilot pipe is let out automatically.

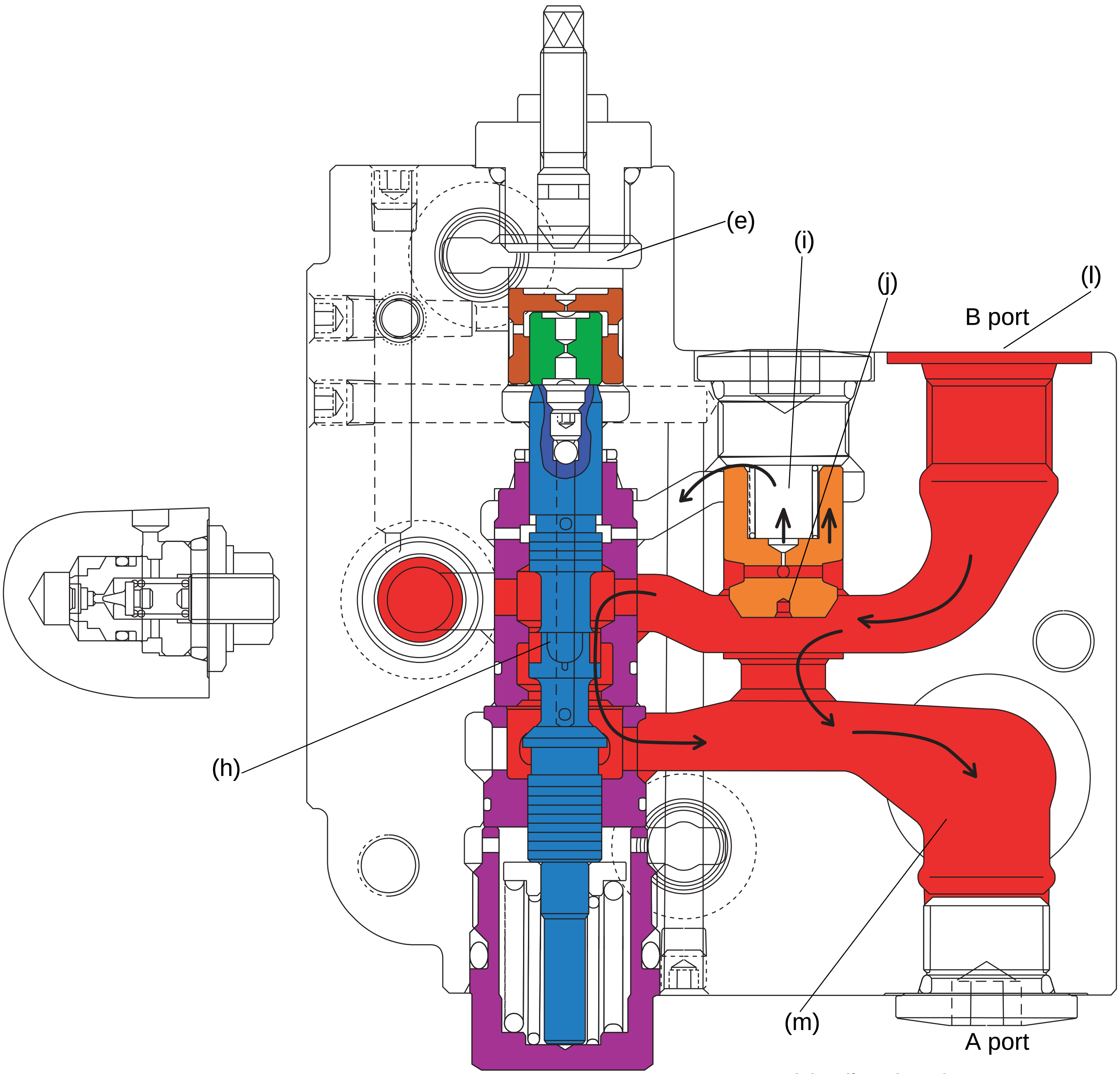
(2) Because of the pilot pressure, the pistons (3)-1 and (3)-2 as well as the spool are activated against the spool s return spring force. The return oil from the actuator flows from B-port (cylinder) through the spool control (h) into A-port (main control valve).



(e) Pilot chamber
(f) Orifice
(g) Orifice
(h) Control spool

Fig. 3 With oil flowing from B-port to A-port (at low pilot pressure)

(3) When the pilot pressure rises higher, the poppet spring chamber (i) gets connected to the A-port side with the spool internal passage in between. The poppet s orifice (j) then causes a pressure difference between B-port and poppet spring chamber, which gets the poppet open.



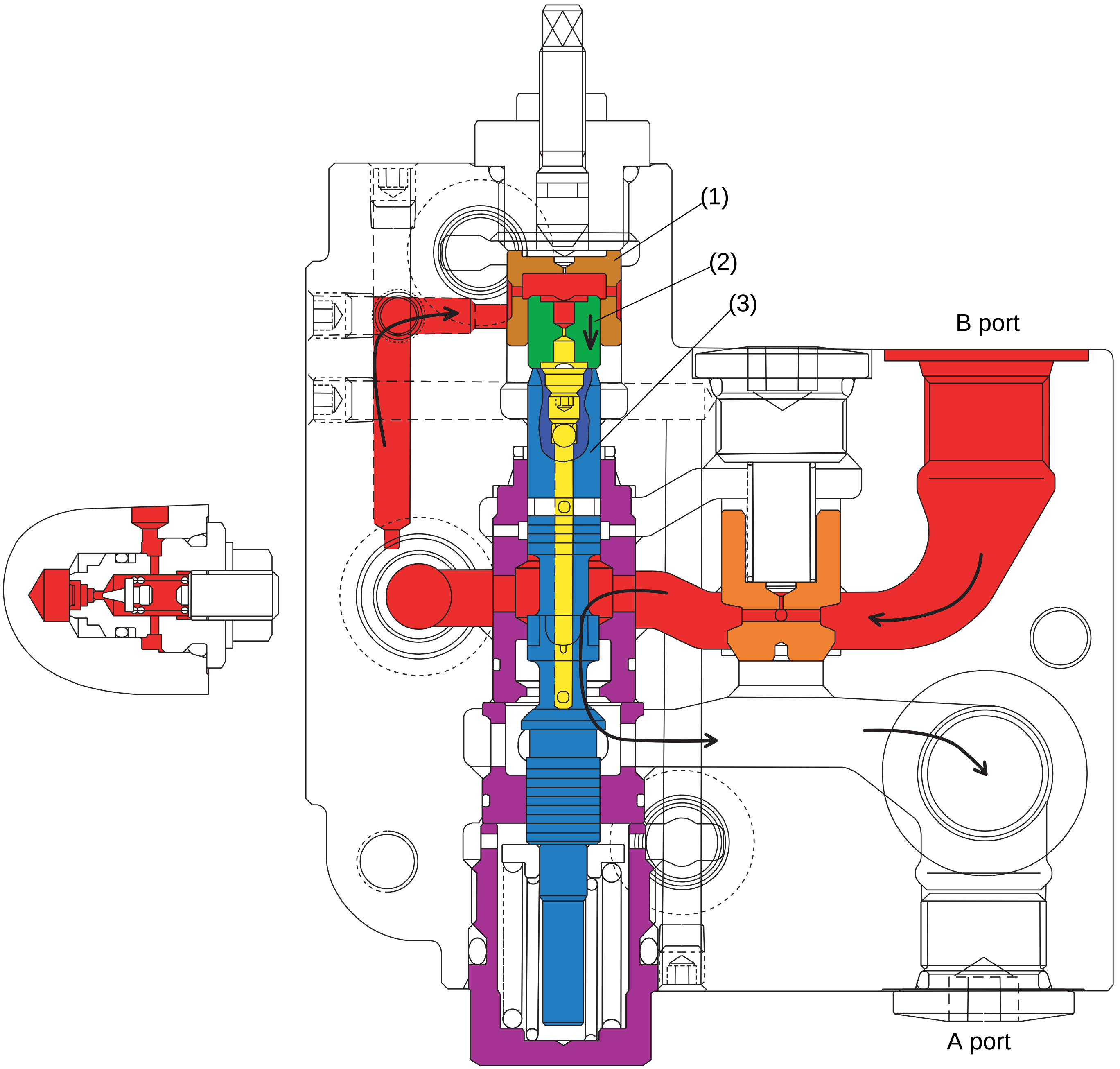
(e) Pilot chamber
(h) Control
(i) Poppet spring chamber
(e) Pilot chamber
(i) Poppet spring chamber
(j) Orifice
(l)From boom cylinder bottom
(m) To main control valve

Fig. 4 With oil flowing from B-pot to A-port (at high pilot pressure)

4. Over-pressure in the cylinder (relief valve activated)

(1) If the cylinder pressure rises above the relief valve s pressure setting, the relief valve opens itself to generate a pressure in the chamber (k).

(2) The pressure in the chamber (k) moves the piston (1) toward the plug and the piston (2) toward the spool. The piston (2) then pushes the spool against the spool s return spring force. Now the spool goes over the stroke to open the passage from B-port to A-port, which lets the oil flow from the cylinder to the main relief valve.



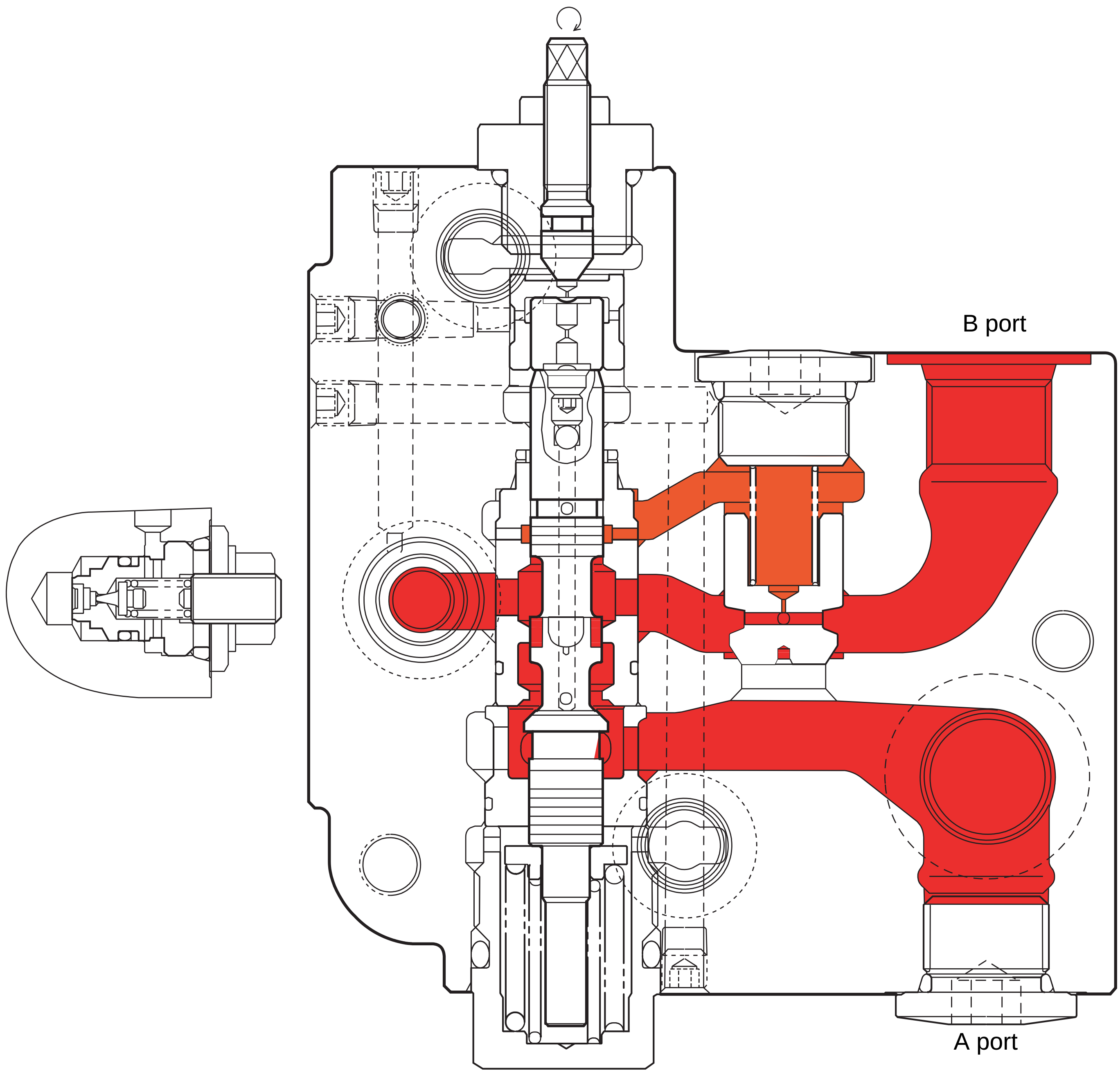
(h) Control
(k) Pilot chamber

Fig. 5

(1) Piston 1
(2) Piston 2
(3) Spool

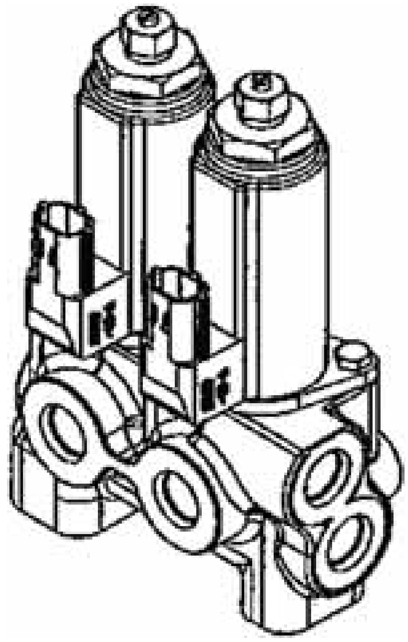
5. Manual release of cylinder bottom oil

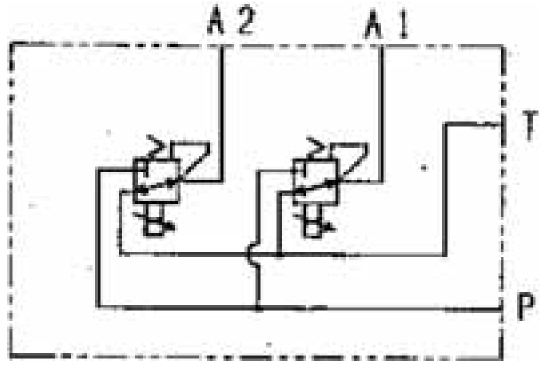
When the boom cylinder is required to get down, screw in the screw plug, which pushes the piston (1) and (2) and results in opening the oil passage of control spool.
As the main cotrol valve is at its neutral position, the hydraulic hose from A port to the main control valve should be removed to drain the oil.



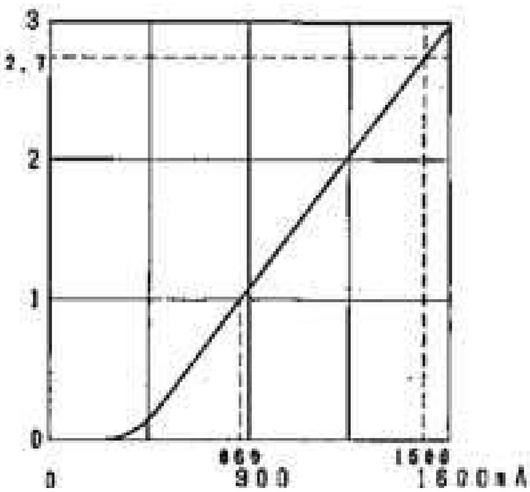
J. Solenoid valve

a. Solenoid proportional control valve



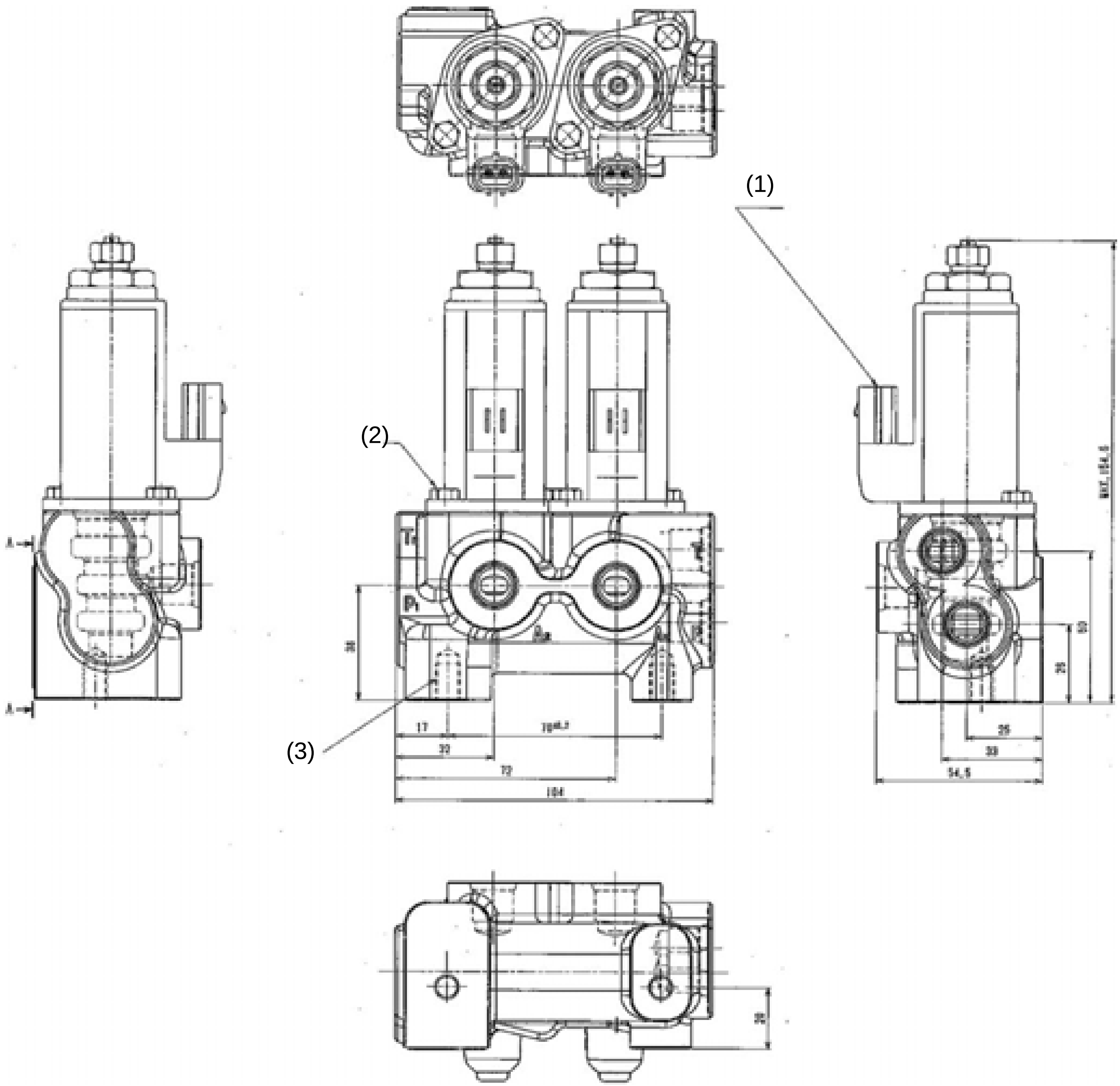


Hydraulic symbol

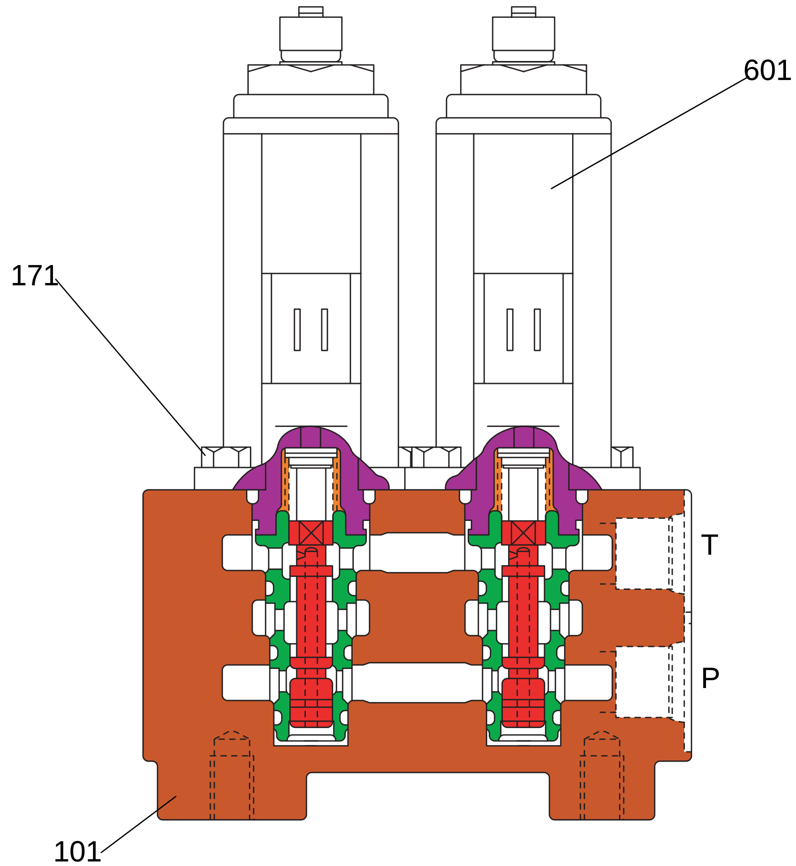


ontrol iagram

Max. working pressure. (Press. in port P)	7 MPa
Allowable back pressure. (Press. in port T)	1.0 MPa and below
Max flow proportional valve	10 L/min (1 spool)
Flow in drain line at solenoid/off	400 cm^3/min and below (AT 20 cST, P port press = 4.9 MPa)
Water resistance	According to JIS D 203 S
Vibration proof	JIS D 1601 b 7
Hydraulic oil	Accroding to ISO VG 32 68
Oil temp. range	-20 90°C
Allowable contanination	NAS grade 10 and below
Electrical specifications	Rated current : 1600 mA Coil resistance : 3.2 0.50 (at 20°C) Power source voltage : 12 V
Propotional valve, secondary press.setting range	0 2.7 MPa Current pressure profile : 38100 3408



(1) Type of connection : equivalent to amp econoseal J senies connectors mark II (+) gap hausing
(Gap housing : 174354 -2, Terminal : 173706 - 1)
(2) Tightening torque : 7 1 N m
(3) 2 - M8 screw depth 12 : Tightening torque



101	Casing	Al alloy	
171	Rexabox head bolts	M5 x 0.8 7.0	1
601	Proportional reducing valve		
901	Name plate		

I Hydraulic system

Ser ice Section

A.Troubleshooting

a. Case - Study : Abnormal speed

	Problems	Probable causes	Remedies	Ref.Fig.
1	The speed of all actuators is low.	1) The engine rpm is low.	1) Adjust the accelerator cable or link. 2) Check the engine systems (fuel system, compression system).	
		2) The quantity of working fluid in the hydraulic oil tank is too small. The oil quality is poor.	1) Replenish or replace the working fluid.	
		3) The suction line (suction filter) is clogged.	1) Check the suction line. Replace the suction filter.	
		4) The control differential pressure of the LS regulator is too low. The locknut of the differential pressure control spring in the LS regulator is loosened or maladjusted. (If the speed of all actuators is too high, suspect that the control differential pressure is too high.)	1) Actually measure the front unit or the swivel speed and make an adjustment so as to bring the setting of the spring within specifications. In the figure, tightening the setscrew increases the actuator speed and loosening the setscrew decreases the speed.	Fig.15
		5) Gear pump volumetric efficiency is too low, so that LS control pressure difference is not enough.	1) Check gear pump delivery pressure and volumetric efficiency. Renew gear pump.	
		6) Leak from the PLS signal circuit (abnormal conditions of the PLS signal circuit in the control valve)	1) Check the hose connections for leak. Disassemble and check the PLS signal circuit in the control valve.	
		7) Insufficient pressure due to defects in the unload valve seat	1) Measure the unload pressure. Disassemble and clean the unload valve seat.	Fig.2
		8) Insufficient pressure due to defects in the main relief valve seat	1) Measure and readjust the main relief pressure. Disassemble and clean the relief valve seat.	Fig.1
		9) Shut-off valve of inlet section is loosened, so that main pump pressure got down to tank.	1) Check shut-off valve and retighten.	
		10) Defects or wear in the pump-mounting coupling	1) Repair or replace the pump coupling.	
		11) Breakage or wear in the pump drive shaft	1) Replace the shaft.	
		12) Seizure, breakage or wear in the pump internal parts	1) Repair or replace the pump.	
2	The speed of all the actuators in the hydraulic pilot system is too low.	1) The pilot filter is clogged.	1) Clean the pilot filter. Replace the filter if necessary.	Fig.6
		2) Dust caught in the changeover valve or wear has caused the pilot primary pressure to drop.	1) Disassemble and clean the changeover valve and adjust the pilot relief pressure.	Fig.7
		3) Pilot primary relief valve is misadjusted.	1) Check the pressure and readjust it with shim.	
		4) Insufficient discharge quantity of the pilot pump	1) Test the pilot pump performance. Replace the pump if it is defective.	
3	All the speeds on the R or L side in the pilot manipulation system are too low or the manipulation is poor.	1) The screen built in the pilot valve on the R or L side is clogged.	1) Disassemble and clean the screen.	
		2) The pilot primary line on the R or L side is defective or the pilot valve is defective.	1) Check the defective pilot valve primary line. Replace the pilot valve assembly if necessary.	Fig.8, 9
4	The speed of a certain hydraulic pilot section is too low.	1) The control spool has got stuck in the neutral position.	1) Disassemble and service the pilot valve. Eliminate the cause of the stick. Replace the assembly if necessary.	Fig.10
		2) The relevant spool of the pilot valve has got stuck. (In both the A and B ports, a stick is rare.)	1) Measure the pilot secondary pressure. Adjust the pressure using a shim.	Fig.8, 9
		3) The pilot secondary pressure is too low.	1) Check the pilot spool for abnormal wear. Replace the valve assembly if necessary.	

Fig.1 Main relief valve

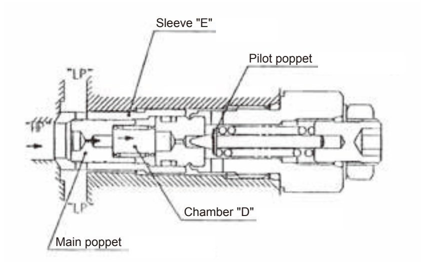
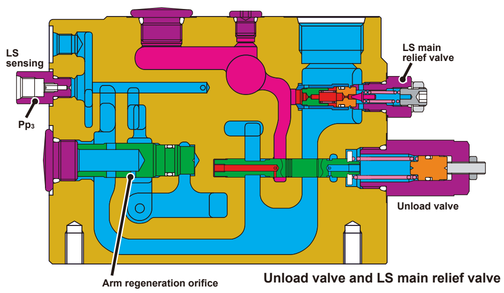
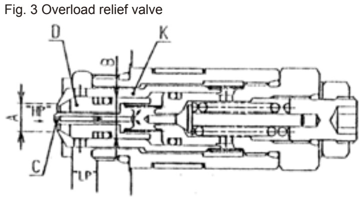


Fig. 2 Unload valve



Unload valve and LS main relief valve

Fig. 3 Overload relief valve



a. Case - Study : Abnormal speed

	Problems	Probable causes	Remedies	Ref.Fig.
5	The speed of a certain actuator is too low.	1) Swing: The swing pilot valve malfunctions.	1) Check the function of pilot valve.	
		2) Dozer: The dozer pilot valve malfunctions.	1) Check the function of pilot valve.	
		3) Service port: The service port solenoid valve malfunctions.	1) Check the solenoid valve.	
		4) Hydraulic pilot system: Poor operation of the relevant pilot valve	1) Measure the pilot secondary pressure. Disassemble and check the pilot valve.	
		5) Actuator in the cylinder system: An internal leak is increased due to breakage in the cylinder packing.	1) Disassemble the cylinder and replace the seal.	
		6) Poor operation of the spool in the control valve section	1) Disassemble and check the control valve.	
		7) A leak from the overload relief valve or improper pressure	1) Disassemble, clean and adjust the relief valve or replace it.	Fig.3
		8) Misassembling of the main C/V spool The max speed of the actuator depends on the machined opening in the spool. If the spool is misassembled, therefore, the max speed may not be achieved.	1) If the spool or the spring is misassembled, replace it with a normal part.	
		9) Misassembling of the compensation spool		Fig.1
		10) Misassembling of the high pressure selector valve.		Fig.1
		11) Compensation spool stick If the compensation spool does not open, the required quantity of fluid does not flow to the actuator and the necessary speed is not achieved.	1) Eliminate the cause of the stick completely or replace the entire assembly.	Fig.1
		12) High pressure selector valve is sticking. All of downstream sections pressure became low.	1) Check the corresponding high pressure selector valve.	
6	The speed of the arm crowd and boom lowering section is too low.	This problem arises when the pilot valve types are confused.	1) Replace it with a normal pilot valve.	Fig.12
7	The speed of a certain C/V section and its downstream actuator is too low.	1) The high pressure selector valve has got stuck. A high pressure selector valve stick causes a leak of high pressure and the PLS pressure does not increase. As a result, the pump swash plate does not tilt correctly.	1) Eliminate the cause of the stick completely or replace the valve assembly if necessary.	
8	The traveling speed only is too low.	1) Improper setting of the horsepower control valve 2) Travel independence valve spool sticks.	1) Readjust the horsepower control valve. At a low temperature, the effect of pressure loss increases, causing the traveling second gear to slow down occasionally. Warm up the traveling motor up to 50°C or so and make a retest.	Fig.14
9	The speed on the arm or bucket crowd side decreases occasionally. (Especially, in the engine's low-range or midrange)	1) Stick of the pump LS regulator spool The PLS pressure is low when the load pressure on the crowd side is low. The force that pushes the LS regulator spool is therefore weak, so that the tilting of the pump swash plate delays momentarily. However, the PLS is sufficiently high at high load pressure and the spool shifts normally.	1) Disassemble and clean the spool to eliminate the cause of the hitch. Replace the regulator valve assembly if necessary.	Fig.13
10	The traveling speed decreases when the front system is relieved during traveling.	When the load pressure increases, the system enters the horsepower control area, causing the pump discharge quantity to decrease. In the relief mode, the pump discharge quantity decreases to approximately 40 liters/min.	1) This action is normal, since the horsepower control is exercised.	
11	The port A or B speed in a certain hydraulic pilot section is too low.	1) The control spool has got stuck on one side.	1) Disassemble and service the control valve. Eliminate the cause of the stick. Replace the valve assembly if necessary.	Fig.10
		2) The relevant spool of the pilot valve has got stuck.	1) Disassemble and service the pilot valve. Eliminate the cause of the stick. Replace the assembly if necessary.	Fig.8, 9

Fig. 4 Relief valve layout

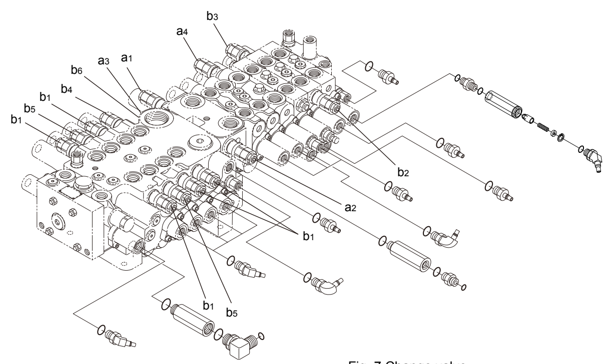


Fig. 6 Pilot filter

Fig. 7 Change valve

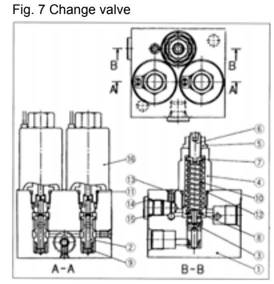
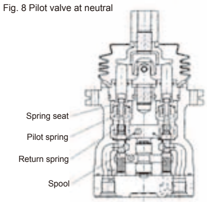


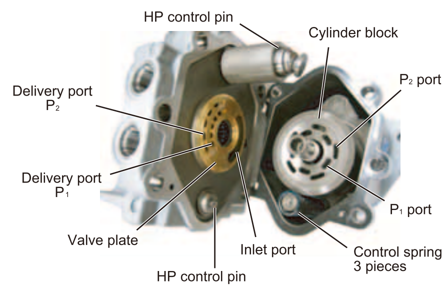
Fig. 8 Pilot valve at neutral



b. Case - Study : The power is weak.

	Problems	Probable causes	Remedies	Ref.Fig.
1	The entire actuator power is weak.	1) Poor operation or maladjustment of the main relief valve	1) Disassemble, clean and reset the main relief valve.	Fig.1
		2) The unload relief valve is defective. A leak is increased.	1) Disassemble, clean and reset the unload valve.	Fig.2
		3) Decrease in the regulator control differential pressure. Loose setscrew.	1) Readjust the LS control differential pressure.	Fig.3
		4) Leak of pressure from the high pressure relief valve.	1) Measure the pressure. Disassemble and clean or replace the assembly.	
2	The power of a certain actuator is weak.	1) For the actuator with an overload relief valve, the relief valve operation is poor or maladjusted.	1) Disassemble, clean and reset the overload relief valve.	
		2) A leak from the inside of the cylinder is increased. (An increased leak causes work to slow down.)	1) Disassemble and clean the cylinder. Replace the seal.	
		3) The high pressure relief valve has got stuck.	1) Disassemble and clean the control valve. Replace the assembly if necessary.	
3	The swivel actions in the right and left directions are different from each other and the swivel power is weak.	1) The pressure of the swivel motor relief valve is low.	1) Measure the swivel relief valve pressure. Readjust the relief pressure.	
		2) The swivel pilot pressure on one side is low.	1) Interchange the right and left pilot hoses to make a check.	
		3) The stroke of the control spool is insufficient. It has got stuck on one side.	1) Check the sliding of the control spool.	Fig.1
4	The traveling power is weak	1) Poor operation or maladjustment of the main relief valve	1) Disassemble, clean and reset.	Fig.2
		2) Poor operation or maladjustment of the unload valve	1) Disassemble, clean and reset.	
		3) Decrease in the regulator control differential pressure. Loose setscrew	1) Measure the pressure. Disassemble and clean. Replace the assembly if necessary.	
		4) Pressure leak from the shigh pressure relief valve.	1)Disassemble, clean and reset.	
		5) The traveling lever does not full-stroke shift.	1) Check the travel pilot valve.	
		6) Pump volumetric efficiency decreased.	1) Test pump efficiency and replace if needed.	

Fig. 13 Pump control



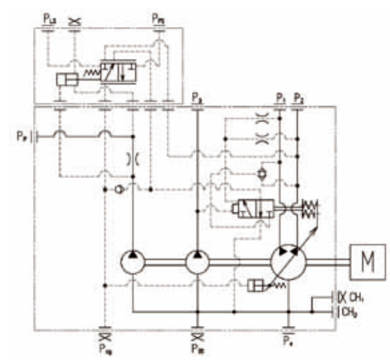
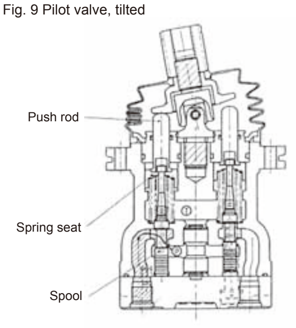
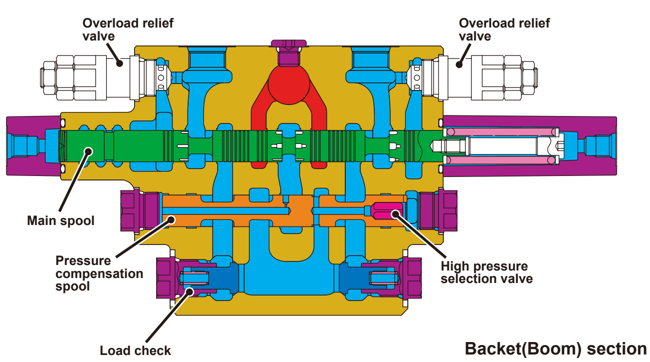


Fig. 10 Control valve

Fig. 11 Pressure compensation spool

Fig. 9 Pilot valve, tilted

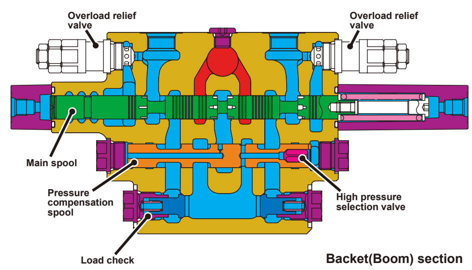


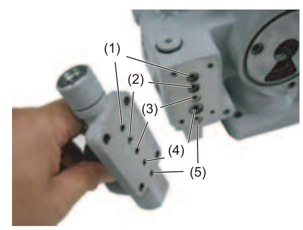


c. Case - Study : Poor Manipulation and Abnormal Operation

	Problems	Probable causes	Remedies	Ref.Fig.
1	The engine stalls at the rated rpm when a load (traveling, etc.) is imposed.	1) The control pin has got stuck.	1) Eliminate the cause of the stick completely or replace the pin assembly.	Fig.13
		2) There is a control pressure leak due to wear in the control pin (large diameter pin).	2) If the control pressure leak is caused by wear, replace the pump assembly.	
		3) The control spool of the horsepower control valve has got stuck.	3) If the horsepower control valve is set improperly, reset it.	
		4) The horsepower control valve is set improperly.	For the resetting of the horsepower control valve, refer to the P-Q characteristic diagram.	Fig.14
2	The response of the work machine is abnormally slow. (Especially, at low temperatures)	1) The orifice in the pump is clogged with dirt.	1) Disassemble and clean.	
		2) The unload valve orifice is clogged with dirt.	1) Disassemble and clean.	
		3) The PLS line orifice is clogged with dirt.	1) Disassemble and clean.	
3	An abnormal sound is heard from the pump.	1) Air bleeding hose is kept open.	1) Bleed the air from the pump and plug the hose.	
		2) The quantity of working fluid is smaller than the required quantity.	1) Check the quantity of working fluid and replenish.	
		3) The working fluid viscosity is improper.	1) Use the recommended working fluid.	
		4) Air is sucked through the suction hose or pipes.	1) Check and retighten the hose and pipe. Bleed them.	
		5) There are contaminants or pieces of metal.	1) Overhaul and clean the pump. Replace the pump assembly if necessary.	
4	Loud noise is heard from around the control unit.	1) The delivery hose touches something and rattles.	1) Reinstall the hose. Prevent the hose from touching.	
		2) The relief valve makes squeaking noises.	1) Check the relief pressure. Disassemble and clean the relief valve. Replace the relief valve assembly if necessary.	
5	The boom is not raised when horizontal work is done through simultaneous manipulation of the boom and the arm at idle or low rpm.	There is a possibility that the arm compensation spool has got stuck on the open side. (Principle) When the boom is manipulated, the arm compensation spool works in the direction where it is closed, since the operating pressure for raising the boom is high. However, the pressure compensation is not made due to a stick and the pump flow is directed to the arm crowd side under light load. As a result, the pressure for raising the boom is not built up.	1) Eliminate the cause of a compensation spool stick completely. 2) Replace the arm section assembly of the control valve.	Fig.11
6	The spontaneous boom fall amount is large.	1) Failure of the seal in the cylinder	1) Replace the seal.	
		2) Failure of the boom overload relief valve	1) Disassemble and clean the relief valve.	
		3) Failure of the load check valve	1) Check the load check valve.	
		4) Failure of the holding valve seat	1) Disassemble and clean the fall prevention valve.	
7	The swivel does not stop.	The makeup poppet has got stuck. It is clogged with dirt.	Disassemble and clean the poppet.	
		The swivel main spool has got stuck.	Disassemble and clean the control valve swivel portion.	
		The relief valve of the swivel motor is clogged with dirt.	Disassemble and clean the relief valve.	

Fig. 12 High pressure selection valve





(1) Pump pressure sensing line
(2) HPC pilot line
(3) HPC pilot line
(4) Pilot pump pressur after the fixed orifice
(5) Pilot pump pressur before the fixed orifice

Fig. 14 Horse power control setting

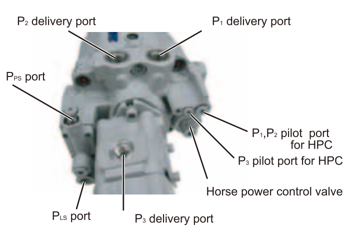
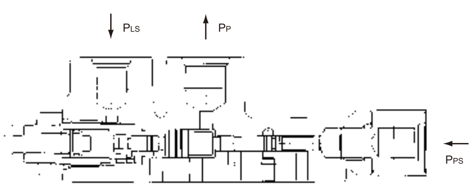


Fig. 15 LS control valve



c. Case - Study : Poor Manipulation and Abnormal Operation

	Problems	Probable causes	Remedies	Ref.Fig.
8	Swivel stop can't be not locked.	The swivel slow return check-valve is clogged with dirt.	Disassemble and clean the check-valve.	
		The swivel motor relief valve is clogged with dirt.	Disassemble and clean the relief valve.	
		The swivel motor relief pressure is too low.	Measure and readjust the swivel relief pressure.	
9	An abnormal sound is heard when the swivel is stopped.	1) The swivel makeup filter is clogged.	1) Clean the filter.	
		2) Failure of swivel negative brake release	1) Check the brake release pressure (pilot primary pressure).	
		3) Pressure escape due to brake seal failure	1) Check the brake seal. Replace it if necessary.	
		4) Damage to the friction plate	1) Overhaul the brake unit.	
10	When the machine is jacked up, the R and L revolutions differ from each other during idle traveling. (The machine travels straight on a level ground.)	This phenomenon, which is caused by a difference in the piping pressure loss, is normal.	Normal	
11	Traveling does not stop even when the lever is returned to the neutral position on a downward slope. (Poor travel block performance)	1) Dirt has caused the travel counterbalance spool to get stuck.	1) Disassemble, clean and correct the counterbalance spool.	
12	When making a travel turn, the travel section on the stop side turns together and the machine goes straight.	1) Dirt has caused the travel counterbalance spool to get stuck.	1) Disassemble, clean and correct the counterbalance spool.	
		2) A heat shock has caused the travel counterbalance spool to get stuck.	1) Lift the body and warm up the travel motor.	
		3) Travel lever return failure	1) Check the travel lever link.	
		4) The control valve spool has got stuck.	1) Disassemble and correct the spool in the control section.	
13	The traveling speed decreases to about one half when the dozer UP is relieved.	1) The set pressure of the relief valve for dozer UP (rod side) is too high.	1) Measure and readjust the relief pressure on the dozer UP side.	

d. LS control system troubleshooting

(1) General

The core of the hydraulic system corprated in KX080-3 is a combination of horsepower control and LS control.
Trouble with the hydraulic system is therefore attributed chiefly to hydraulic equipment such as pumps and control valves.
There may be cases where the hydraulic pilot system that controls the stroke of a control valve spool is secondarily involved in trouble.
Of course, individual actuators may have trouble.
Troubleshooting is therefore performed in the following four portions to determine the causes of trouble with the hydraulic system.

- 1) Pilot control system
  - Pilot pump
  - Change valve(Unload valve)
  - Pilot valve, L&R
  - Pilot filter
- 2) Control valve
  - High pressure selector popet
  - Compensation spool
  - Relief valve(Main, overload)
  - Unload valve
- 3) Pump
  - LS regurator
  - Horse power control pin, spool
  - Control pin
- 4)Actuators
  - Cylinders
  - Swivel motor
  - Travel motor(Rotary joint)

(2) Procedures for Hydraulic Pilot System Troubleshooting

- 1) All the hydraulic pilot sections are inoperative.
  - Change valve(Unload valve)
  - Pilot filter
- 2) All the right or left pilot sections are inoperative.
  - Pilot valve
- 3) Any one hydraulic pilot system is inoperative. (Both A and B ports)
  - Stick of the control spool in the neutral position
  - Stick of the relevant spool of the pilot valve (The case where both A and B are abnormal is rare.)
- 4) Either A or B in any one hydraulic pilot section is inoperative.
  - Stick of the relevant spool of the pilot valve
  - Stick of the control valve spool on one side

(3) Procedures for LS Control Valve Troubleshooting

In the event of hydraulic trouble with the LS controller for KX080-3, complete the following basic check items and check the manipulation of the hydraulic pilot system.

(1) Basic check items: Quantity of oil, quality of oil, filter clogging, oil leak, air suction, engine conditions and the method of manipulating this machine

(2) Trouble with the hydraulic pilot system?
   1) All the hydraulic pilot systems?
   2) Certain hydraulic pilot system?

(3) Trouble with the actuator side?

If the check above detects no trouble, suspect the control valve or the pump.
With the following five items related to the control valve in mind, manipulate this machine or measure the pressure to pinpoint defective portions.
The use of the five check items makes it relatively easy to pinpoint trouble in detail. Get to work on the control valve first.

Basically, the control valve consists of the following parts. Trouble phenomena occur as shown below. It is preferable that the following steps be performed to determine the cause of trouble.

1) Unload valve

Make a check if the unload pressure is not built up at the maximum rpm under no load with the valve placed in the neutral position.

KX080-3: Max. engine KPM=27 kgf/cm^2 (2.65 MPa, 384 psi)
Idle RPM=23 kgf/cm^2, 2.25 MPa, 327 psi
(Check the pump discharge quantity.)

2) Main relief valve

Make a check if the main relief pressure is not built up.

KX080-3: 285 kgf/cm^2, 27.9 MPa, 4047 psi
If any one actuator is relieved, the main relief pressure is built up.
(For the dozer UP only, however, there is a 135 k overload relief valve.)

3) Spool in the valve section

1. The spool must work at a full stroke under the secondary pressure of the pilot valve.
2. If the spool does not work at a full stroke even when the secondary pressure is the specified pressure, suspect that the spool has got stuck.
3. If the cylinder speed does not increase even when the spool works at a full stroke, suspect that the spool is misassembled.

4) High pressure selector valve

1. If the high pressure selector valve does not move normally due to a stick, its own high pressure leaks from the valve, causing the PLS pressure to the compensation spool and the PLS pressure to the LS regulator to decrease, respectively. As a result, tilting takes place so as to reduce the pump discharge quantity, so that the actuator speed decreases.
2. Similar phenomena occur in the sections downstream from the section of the defective high pressure selector valve.
3. The sections upstream from the section of the defective high pressure selector valve work normally.
4. If the section of the defective high pressure selector valve and the sections upstream from it are manipulated at the same time, the PLS pressure to the pump acts on the upstream sections and the pump is normally LS-controlled.
5. If the high pressure selector valve gets stuck, the same phenomena occur in both the A and B ports.

5) Compensation spool

1. The compensation spool moves based on a balance between the PC pressure and the load pressure. However, the symptom depends on the position in which a stick occurs.
2. If a stick occurs in the stroke-0 position, i.e. in a state of the so-called under lap, the cylinder speed decreases, since the opening in the spool is small. The speed is almost the same as that obtained when other sections are relieved and manipulated simultaneously.
   (The simultaneous manipulation must be in the horsepower control area.)
3. If the compensation spool gets stuck in the full open position during the simultaneous manipulation under light and heavy loads, the pump flow is apt to be directed to the light load side when the compensation spool on the light load side gets stuck in the full open position, making it difficult to control the heavy load side.
4. If a stick occurs in the intermediate stroke position, it is difficult to control the heavy load side up to the stick position of the compensation spool.
   In the operation conditions beyond the stick position, the cylinder speed is lower than normal.
5. What will happen if the compensation spool is misassembled?
   In a state of the under lap, compare the cylinder speed with a normal machine.
   The cylinder speed decreases with decreasing under lap opening area.
6. If the compensation spool gets stuck as shown above, disassemble and clean the spool. Eliminate the cause of trouble completely and reassemble the spool. Replace parts if necessary. In some cases, replace the section assembly.

(4) Procedures for LS control Pump Troubleshooting

1) General

The pump mainly exercises the following two types of control.

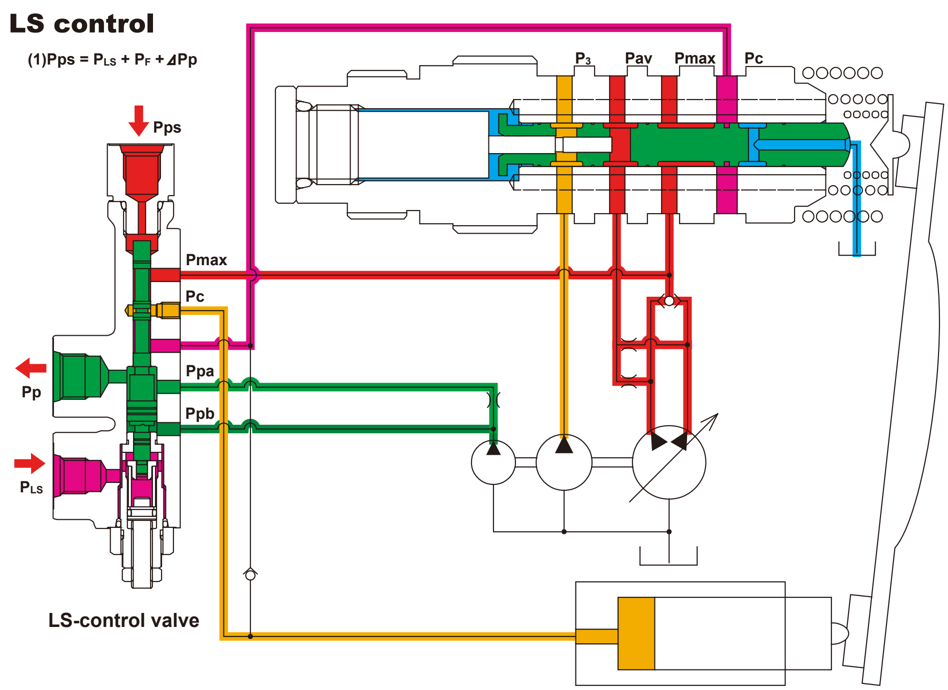
1. Exercises horse power control over the hydraulic system to prevent the maximum horsepower of the engine from being exceeded. That is, prevention of engine stall.
2. Exercises load sensing control (i.e. "Load sensing") to allow the pump to discharge the flow required on the load side.

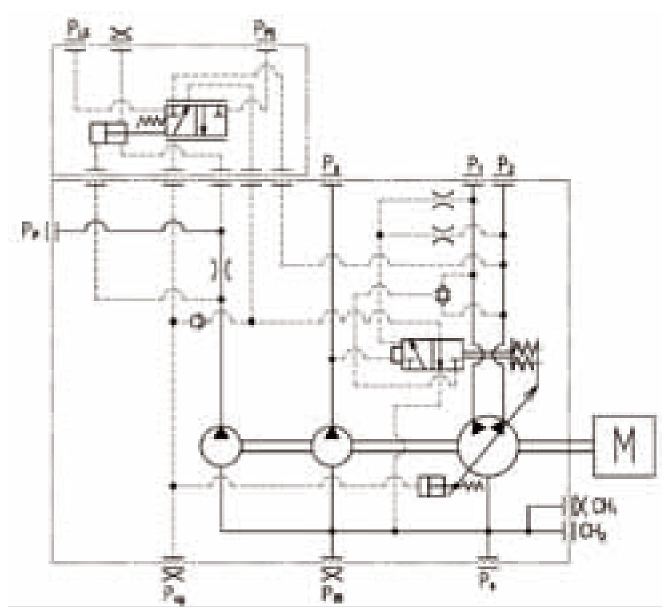
In addition, the pump is set at the minimum tilting angle, so that the pump discharges the standby flow before the LS control. Stand-by flew: 22.0 LPM (5.94 GPM)

Therefore, the pump failure symptoms are broadly classified into the following two types.

1. The speed of the work machine is low, since the required flow is not discharged from the pump.
   → Failure of LS control
2. The engine stalls in certain conditions. → Failure of horsepower control

These problems are basically attributed to the failure of pump swash plate control. The provable causes of this failure are malfunctions such as a stick of each control portion due to contamination. The fundamentals of LS pump troubleshooting are shown on the next page using the figure below.





2) Fundamentals of LS Pump Troubleshooting (Defective Portions and Symptoms)

<table>
<tr><th colspan="2">Failure symtom</th><th colspan="2">Pump performance</th></tr>
<tr><td colspan="2">Portion contributable to the failure of pump swash plate control</td><td>The speed of the work machines is low, since the required flow is not discharged from the pump.
(LS control failure)</td><td>The engine stalls in certain conditions. (Horsepower control failure)</td></tr>
<tr><td colspan="2">1. Increased pressure leak due to wear in the control pin A (small diameter pin)</td><td>The swash plate tilting power is weak and the required flow is not discharged, since the pressure that acts on the control pin A (small diameter pin) leaks. (The speed decreases especially in the arm rake-up mode at low rpm.)</td><td>The engine does not stall.</td></tr>
<tr><td colspan="2">2. Increased pressure leak due to wear in the control pin B (large diameter pin)</td><td>The LS control is disturbed, since the power to return the swash plate to a small tilting angle is weak.
The pump discharge quantity is slightly larger than usual.</td><td>The engine is apt to stall, since the control power to move the swash plate to a small tilting angle is weak even when the load pressure is increased.
The horsepower control is disturbed.</td></tr>
<tr><td colspan="2">3. Stick of the horsepower control feedback pin</td><td>A pin stick causes the control spring to push in the control spool all the time, to lead the pressure of the control pin B to the tank.
When PPS < PLS + FLS, the tilting angle of the pump swash plate is maximized.
When PPS > PLS + FLS, the LS flow control is exercised up to the pin stick position.</td><td>The engine stalls when a load that decreases the swash plate tilting beyond the pin stick position is imposed, since the horsepower control is disabled.</td></tr>
<tr><td rowspan="2">4. Stick of the control spool of the horsepower control valve</td><td>The passage Pc pressure always gets stuck on the tank side.</td><td>In the area of PPS < PLS + FLS, the pump swash plate is always forced to be held at the maximum tilting angle. It looks like a fixed capacity pump of approx. 72LPM
In the area of PPS > PLS + FLS, the flow is LS-controlled.</td><td>The engine stalls if the load pressure increases in excess of the control horsepower.
In the LS control area, the flow is controlled with the LS regulator and the normal flow is obtained.</td></tr>
<tr><td>Stick in the position where the passage Pc pressure is always open to the P pressure.</td><td>The high pressure that has acted on the control pin is not released, since the control pressure of the control pin is not linked to the tank in the control spool section. As a result, the pump swash plate tilts in the direction that decreases the discharge quantity. The work speed decreases. Running in the standby flow state. It works like a fixed capacity pump in the standby state.</td><td>The engine does not stall, since it is fixed in the standby flow position when the PPS pressure from the LS spool acts on the control pin. It goes into the standby state.</td></tr>
<tr><td rowspan="2">5. Stick of the LS regulator spool</td><td>Stick in the position where the Pc passage is dumped.</td><td>The tilting angle of the pump swash plate is maximized and the pump works like a conventional variable capacity pump.
The extra flows through the unload valve.
The LS regulator-based LS control is disabled.</td><td>The pump works like a conventional variable capacity pump and the engine does not stall.</td></tr>
<tr><td>Stick in the position where the passage Pc is blocked.</td><td>All the work speed decreases, since the swash plate is held in the standby flow position. The LS control is disabled.</td><td>The engine does not stall, since the pump swash plate is always controlled to a small tilting angle.</td></tr>
</table>

e. Pump component trouble causes and remedy

(1) General precaution

The pump works normally for a long period of time as far as it is operated under appropriate condition. If it will not work as planned, it is necessary first to check to see if the cause of trouble is derived from either the pump itself or other equipment.
Although it is not easy to clarify the cause of trouble with hydraulic system, it is important to check and investigate the following points and identify the location of abnormality.

1. Checking of filter
   Check the filter element periodically. Check whether or not abnormal impurities are generated in large amount. The cause of trouble may be predicted depending on the type of impurity.
2. Checking of drain oil
   Check drain oil coming from the pump, motor etc. The cause of trouble can be predicted from drain flowrate and type of impurity contained in drain oil.
3. Checking for abnormal noise and vibration.
   Check various equipment for any abnormal noise and vibration.
   Discovery of the source of abnormal noise and vibration leads to the clue of clarification of cause of trouble.
4. Checking of pressure at various parts
   Do not disassemble and check irrelevant equipment unnecessarily, but check the pressure by means of pressure gauge and investigate the cause of trouble.

(2) Trouble shooting

Failure symptom	Suspected causes	Remedy
1. Pump will not discharge oil.	1. Oil in the tank is decreased to such extent that the end of the suction pipe emerges above the oil level in the tank.	Replenish the tank. Raise the oil level or immerse the end of the pipe in oil.
	2. Pump case is not filled with hydraulic oil.	Fill the pump case with hydraulic oil.
	3. Strainer of suction pipe is closed, or clogged.	Clean the strainer. Open the suction pipe.
	4. Damage of pump key part(s). Trouble with input shaft and coupling.	Disassemble the pump and replace damaged part(s). Clean all the parts completely before re-assembling.
2. Pump discharge amount is small. Circuit pressure will not be raised.	1. Pressure is not raised or oil flowrate does not reach the specified level due to trouble with other hydraulic equipment than the pump, such as hydraulic motor and various control valves.	Replace, repair or check faulty hydraulic equipment.
	2. Large amount of high-pressure oil leaks due to abrasion of pump sliding parts.	Disassemble the pump. If sliding surfaces are roughened, repair them by re-polishing or lapping. Pay particular attention to damage to the valve plate. If damage is irreparable, replace part(s) and clean all the parts completely before re-assembling.
	3. Air is sucked in through suction side of the pump.	Check or replace the suction pipe and packings, or check tightened parts for any looseness and re-tighten, if any.
	4. Strainer is clogged, or air is sucked in due to lowering of oil level.	Clean or replace the strainer.

Failure symptom	Suspected causes	Remedy
	5. Suction resistance develops excessively, resulting in generation of cavitation due to abnormal oil temperature, abnormal hydraulic oil viscosity and other causes.	Reduce suction resistance.
3. Pump generates abnormal noise.	1. Air is sucked in due to lowering of oil level in the tank.	Supply oil and eliminate air under no-load operation.
	2. Suction hose and pipe are inappropriate, resulting in increase of suction resistance of the pump.	Reduce suction resistance.
	3. Cavitation is generated by clogged strainer.	Clean the strainer. If clogging of strainer is severe, flush the circuit and replace hydraulic oil.
	4. Inadequate capacity of the strainer	Select a strainer having the capacity 2 to 3 times larger than the maximum discharge amount.
	5. Cavitation generated due to too low oil temperature or too high viscosity.	Carry out warming up operation. Select oil and set the oil temperature according to the instruction manual.
	6. Defective coupling	Check it for any deviation.
	7. Pump vibrates with other equipment.	Check the set bolts for any looseness.
4. Overload to engine (Extreme lowering of engine rotating speed or engine stall)	1. Horse-power control torque is set too high.	Re-adjust it by setscrew.
	2. Clogging of internal pilot oil passage and orifice, or seizure or scuffing of parts.	If the condition remains unchanged even after re-adjustment by setscrew, disassemble and check the pump.
	4. Seizure or abrasion of pump internal parts	Repair the pump.
5. Oil leaks.	1. Drain oil flowrate increases to boost the pressure in the pump case until oil seal is broken, thus resulting in oil leakage. (Oil seal withstand pressure: 0.3 Mpa (3 kgf/cm^2, 43 psi)	Repair the pump.

f. Control valve component troubleshooting

--Control valve in general--

Failure symptom	Suspected causes	Remady
1. Spool will not stroke. (Machine will not pick up speed.)	1. Oil temperature is raised abnormally.	Remove something which hampers oil flow in the piping system.
	2. Contamination of hydraulic oil.	Replace hydraulic oil, and clean the circuit at the same time.
	3. Over-tightening of the piping port joint.	Check the tightening torque.
	4. Valve housing is distorted after mounting.	Loosen the set bolt and check the housing for distortion.
	5. Pressure is too high.	Set a pressure gauge between the pump port and the cylinder port, and check the pressure.
	6. Spool is bent.	Replace the valve assembly.
	7. Return spring is damaged.	Replace the damaged spring.
	8. Spring or cap is displaced.	Loosen the cap to make centering and then tighten.
	9. Temperature distribution in the valve is not uniform.	Warm up the whole circuit.
	10. Valve is clogged with dust.	Remove (Brush off) dust.
	11. Pilot pressure is insufficient.	Check the pressure of the pilot valve and pilot relief valve.
	12. Compensation spool is seized.	Replace the compensation spool or section assembly.
2. Load cannot be held.	1. Oil leaks from the cylinder.	Check the cylinder seal.
	2. Oil bypasses from the spool.	Check the spool for any defect.
	3. Oil leaks from the overload relief valve.	Clean the valve housing seat and relief valve seat.
	4. Oil leaks from the holding valve.	Disassemble the anti-drift valve, and clean the seats of parts. If seat is damaged, replace the poppet, or lap the poppet and seat. If any abnormality exists at the spool of holding valve, replace both the spool and sleeve, which are fitted in mutually.
3. Load drops when the spool is switched from neutral to high position.	1. Load check valve is clogged with dust.	Disassemble the check valve and clean it.
	2. Poppet or seat of the check valve is damaged.	Replace the poppet, or lap the poppet and seat.

--Relief valve, unload valve and high pressure selector valve --

Trouble	Possible cause	Remady
1. Pressure will not be raised at all.	1. Main poppet, sleeve or pilot poppet is seized and kept open, or dust exists at the valve seat.	Replace the relief valve.
2. Relief pressure is unstable.	1. Seat of the pilot poppet is damaged.	
	2. Piston or main poppet is seized.	
3. Relief pressure is out of the preset range.	1. Abrasion of seat by dust.	
	2. Lock nut and adjuster are loosened.	Re-set the pressure and tighten the lock nut with specified torque.
	3. Pressure regulating nut of the unload valve is loosened.	Re-set the pressure and tighten the lock nut with specified torque.
	4. Spool of the unload valve is seized and kept open, or dust exist at the spool of the unload valve.	Replace either of the spool of the unload valve or the inlet housing, or replace both.
	5. High pressure selector valve is damaged. 6. High pressure selector valve plate is seized.	Replace the High pressure selector valve plate or the section assembly.
4. Oil leaks.	1. Relief valve seat is damaged.	Replace the relief valve.
	2. Parts are seized by dust.	
	3. Abrasion of O-ring.	Replace the adjuster or O-ring of valve mounting part.

--General hydraulic system --

Trouble	Possible cause	Remady
1. Hydraulic system malfunctions or does not function at all.	1. Trouble with pump	Check oil pressure, or replace the pump.
	2. Trouble with relief valve	Replace the relief valve.
	3. Trouble with cylinders	Repair or replace.
	4. Pump load pressure is too high.	Check the pressure in the circuit.
	5. Valve is cracked.	Replace the valve in assembly.
	6. Spool does not stroke.	Check the spool motion.
	7. Oil level in the oil tank is too low.	Add hydraulic oil.
	8. Filter in the circuit is clogged.	Clean or replace the filter.
	9. Pipes in the circuit are choked.	Check pipes.

g. Travel motor component troubleshooting

In case of any trouble arising during running, investigate the cause and take an appropriate remedial measure by referring to the Table of Troubleshooting shown below.

(1) Main function

Trouble	Possible Cause	Remedy
1. Motor will not rotate.	Any other equipment than motor, counter-balance valve and reduction gear malfunctions	Check to see if specified pressure of hydraulic oil reaches the motor inlet side, and then check and repair the relevant equipments.
	Hydraulic pressure is relieved due to abnormal abrasion of the motor sliding part.	Replace abnormally worn part(s). Eliminate flaws and burrs on the surface and clean all the parts before re-assembling.
	Malfunction due to damaged major part(s) of the motor	Disassemble the motor and replace the damaged part(s). After cleaning all the parts, re-assemble them, using care not to allow entry of foreign matter.
2. Motor rotating speed is slow.	Due to any trouble with the hydraulic pump and pressure control valve, oil is not fed at specified flowrate, thus lowering the motor rotating speed.	Check to see if oil flows to the motor inlet side at specified flowrate, and then check and repair the relevant equipments.
	Due to lowering of volumetric efficiency, specified motor rotating speed cannot be attained.	After disassembling the motor, check the sliding parts for any abnormal abrasion. If any, repair or replace worn part(s).
3. Motor rotating speed fluctuates considerably.	Due to abrasion of motor sliding parts, a large amount of high-pressure oil leaks and flows out of the drain port, thus lowering and fluctuating the motor rotating speed considerably. Abrasion of bearing causes also fluctuation of motor rotating speed.	Disassemble the motor and replace worn parts if any. After cleaning all the parts, re-assemble them, using care not to allow entry of foreign matter.
4. Oil leak	Oil leaks due to damaged oil seal(s) or O-ring(s).	Replace damaged oil seal(s) or O-ring(s) with new one(s). At this time, use due care not to damage the oil seal lip. Apply grease slightly to O-ring before re-assembling.
5. Machine travels obliquely	1.Excessive different track tension. 2.Different pump delivery 3.Different motor drain 4.Oil leak in swivel joint 5.Motor relief valve opens one side. 6.Counterbalance spool sticks in one side.	1.Check the track sag distance 2.Swap the pump delivery hoses and check 3.Swap the motor hoses and check 4.Check the motor (track) speed 5.Check the motor operating pressure and think 6.Check the drain amount and think

(2)Counterbalance valve function

Trouble	Possible Cause	Remedy
1. Motor will not rotate or rotates but slow.	Plunger does not switch.	
	1) Hydraulic pressure is not generated.	Check whether piping is damaged or not.
	2) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	3) Orifice is clogged.	Clean it with washing oil and re-assemble.
2. Motor will not stop or stops but slow.	Plunger does not return to neutral.	
	1) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is not set properly.	Set the spring at proper position.
	3) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	4) Orifice is clogged.	Clean it with washing oil and re-assemble.
3. Machine is shocked severely when traveling is stopped.	Plunger returns too quickly.	Orifice plug came off
	Spring seat is not set properly.	Set the spring seat at proper position.
4. Abnormal noise is heard.	Plunger notch restricts oil flow.	
	1) Foreign matter exists between the plunger and the base plate.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	3) Orifice is clogged.	Clean it with washing oil and re-assemble.

(3) Hi-Low speed function

Trouble	Possible Cause	Remedy
Machine turns during traveling.	Spool does not switch.	
	1)Foreign matter exists between the spool and the valve body.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	2) Spring is not set properly.	Set the spring at proper position.
	3) Spring is damaged or broken.	Replace the spring. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	Hydraulic oil leaks due to abnormal abrasion of the 2-stage speed control piston.	Replace the 2-stage speed control piston. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	2-stage speed control piston is not set properly.	Set the 2-stage speed control piston at proper position.
	Foreign matter existing between the 2-stage speed control piston at the right side and the valve body blocks motion of the piston.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Abnormal abrasion of steel ball.	Replace the steel ball. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
Piston speed will not switch between two stages.	Foreign matter existing between the 2-stage speed control spool and the valve body blocks motion of the spool.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Foreign matter existing between the 2-stage speed control piston and the valve body blocks motion of the piston.	Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning. If the damage and leakage are severe, replace the part.
	Hydraulic oil leaks due to abnormal abrasion of the 2-stage speed control piston.	Replace the 2-stage speed control piston. Remove foreign matter completely. Repair damaged part and re-assemble it after cleaning.
	Orifice of the 2-stage speed control signal passage is clogged.	Remove foreign matter completely.

B.Specifications

a.Specifications of pump

		Unit	KX080-3	Remarks
Manufacturer			KYB Co.,Ltd.	
Model			PSVL2-36C-4	
Kubota part No.			RD809-6111-0	
Rated pump rpm		rpm	2000	
Rated load pressure	Main relief pressure a1/a2	MPa kgf/cm2 psi	29.4 300 4267	
	Main relief pressure a4	MPa kgf/cm2 psi	20.6 210 2987	
	Pilot primary pressure a6	MPa kgf/cm2 psi	3.92 40 569	
Theoretical discharge capacity	Main pump P1/P2	cc/rev cu.in./rev	36.0/36.0 2.20/2.20	Sprit flow of variable displacement piston pump
	Main pump P3	cc/rev cu.in./rev	33.0 2.01	Gear pump
	Pilot pump Pp	cc/rev cu.in./rev	8.1 0.49	Gear pump
Theoretical discharge capacity	Main pump P1/P2	L/min USGPM	72.0/72.0 19.02/19.02	
	Main pump P3	L/min USGPM	67.0 17.70	
	Pilot pump Pp	L/min USGPM	16.0 4.23	
Differential pressure	LS control valve	MPa kgf/cm2 psi	1.5 15.3 218	Engine rpm propotional control with P4, Idling /Rated = about 60 - 70%
Standby flow rate		L/min USGPM	22.0 5.81	
Horsepower control			PC horsepower control valve : With P3 horsepower shift Swash plate control aided by self-tilting moment(Small piston deleted.) P1 + P2 pressure : Average pressure by orifice	
Structure			Bearing : Cradle Shoe plate : Spherical Large-diameter piston (with shoe)	

b.Relief Valve pressure setting

(1)Main relief valve(bench data)

No.	Valve location	Operating work	Unit	KX080-3	Remarks
1	Travel main relief valve a1		MPa kgf/cm^2 psi	29.4±0.3 300±3 4264±44	KX080-3: at 43 L/min (11.36 USGPM)
2	Travel main relief valve a2		MPa kgf/cm^2 psi	29.4±0.3 300±3 4264±44	KX080-3: at 43 L/min (11.36 USGPM)
3	Main relief valve a4		MPa kgf/cm^2 psi	20.6±0.3 210±3 2988±44	KX080-3: at 66 L/min (17.44 USGPM)
4	LS unload relief valve b6		MPa kgf/cm^2 psi	1.96±0.1 20±1 284±15	KX080-3: at 26 L/min (6.87 USGPM)
5	LS main relief a3		MPa kgf/cm^2 psi	27.4±0.3 279±3 3974±44	KX080-3: at 48 L/min (12.68 USGPM)

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

No.	Valve location	Operating work	Unit	KX080-3		Remarks
1	Travel main relief valve a1		MPa kgf/cm^2 psi	30.4 310 4409	+1.0 -1.0 +10 -10 +145 -145	
2	Travel main relief valve a2		MPa kgf/cm^2 psi	30.4 310 4409	+1.0 -1.0 +10 -10 +145 -145	
3	Main relief valve a4		MPa kgf/cm^2 psi	21.6 220 3133	+1.0 -1.0 +10 -10 +145 -145	
4	LS unload relief valve b6		MPa kgf/cm^2 psi	2.65 27 384	+0.5 -0.5 +5 -5 +73 -73	Idle:23 k
5	LS main relief a3	LS regurator	MPa kgf/cm^2 psi	27.9 285 4047	+1.0 -1.0 +10 -10 +145 -145	

(3) Overload relief valve (bench data)

No.	valve location	Operating work	Unit	KX080-3		Remarks
6 7 8	Control valve	Boom up/down Bucket dump/crowd Arm dump	MPa kgf/cm^2 psi	31.4 320 4554	±0.3 ±3 ±44	at 5 L/min (4.76 USGPM)
9	Control valve	Arm crowd	MPa kgf/cm^2 psi	30.4 310 4409	±0.3 ±3 ±44	
10	Control valve	Auxiliary port 1 delivery/return	MPa kgf/cm^2 psi	20.6 210 2988	±0.3 ±3 ±44	
11	Control valve	Blade down	MPa kgf/cm^2 psi	27.4 279 3974	±0.3 ±3 ±44	
12	Control valve	Blade up	MPa kgf/cm^2 psi	11.8 120 1711	±0.3 ±3 ±44	
13	Swivel motor	Swivel, R&L	MPa kgf/cm^2 psi	21.6 220 3129	±0.3 ±3 ±44	KX080-3: at 66 L/min (17.44 USGPM)
14	Travel motor	Travel, R&L	MPa kgf/cm^2 psi	29.4 300 4267	±0.3 ±3 ±44	

(4) verload relief valve (at the measurement port on the machine

No.	valve location	Operating work	Unit	KX080-3		Remarks
6			MPa	31.5	+1.0 -1.0	
7	Control valve	Boom up/down Bucket dump/crowd Arm dump	kgf/cm^2	321	+10 -10	at 1500 rpm
8			psi	4569	+145 -145	
9	Control valve	Arm crowd	MPa	30.5	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	311	+10 -10	
			psi	4424	+145 -145	
10	Control valve	Auxiliary port 1 delivery/return	MPa	22.1	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	225	+10 -10	
			psi	3205	+145 -145	
11	Control valve	Blade down	MPa	27.4	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	279	+10 -10	
			psi	3974	+145 -145	
12	Control valve	Blade up	MPa	13.2	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	135	+10 -10	
			psi	1915	+145 -145	
13	Swivel motor	Swivel, R&L	MPa	21.6	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	220	+10 -10	
			psi	3133	+145 -145	
14	Travel motor	Travel, R&L	MPa	35.0	+1.0 -1.0	at 1500 rpm
			kgf/cm^2	357	+10 -10	
			psi	5076	+145 -145	

Note
1.Main relief valae adjusting angle : 60 kgf/cm^2 per 90degrees.
2.As for a_1 relief valve, several hoses are required to disconnect for adjusting this main relief valve.

(5) Pilot system pressure

No.	valve location	Operating work	Unit	KX080-3		Remarks
1	Primary pilot pressure	At bench	MPa	3.9	+0.2 -0.0	
			kgf/cm^2	40	+2 -0	
			psi	569	+29 -0	
2	Primary pilot pressure at machine	All pilot lines at machine port	MPa	4.1	+0.5 -0.5	
			kgf/cm^2	42	+5 -5	
			psi	598	+73 -73	
3	Secondary pilot pressure	At bench	MPa	2.7	+0.3 -0.0	
			kgf/cm^2	27	+3 -0	
			psi	384	+44 -0	
4	Secondary pilot pressure at machine	All pilot lines at C/V port	MPa	2.8	+0.5 -0.5	
			kgf/cm^2	29	+5 -5	
			psi	406	+73 -73	

c.Swivel performance

	Unit	KX080-3	Remarks
Manufacturer		Kubota Seiki	
Model		RD118-6170-0	
Kubota part No.		RD118-6170-0	
Motor Displacement	cc/rev cu.in/rev	44.1 2.69	
Reduction ratio		20.615	
Total Displacement	cc/rev cu.in/rev	909 55.48	
Max.oil flow	L/min USGPM	66 17.44	Rated flow rate
Motor speed	rpm	72.6	KX080-3: at 66 L/min (17.44 USGPM)
Relief valve pressure (at bench)	MPa kgf/cm^2 psi	21.6 220 3129	KX080-3: at 66 L/min (17.44 USGPM)
Theoretical output torque	N.m kgf.m ft.lbs	950 96.9 701	KX080-3 : at 21.6MPa(220kgf/cm2, 3129psi)
Drain amount at lock	L/min cu.in/min	4.00 ≧ 1.06 ≧	New machine
Drain amount while roating	L/min cu.in/min	0.50 ≧ 0.13 ≧	New machine
Max. drain pressure	MPa kgf/cm^2 psi	0.3 3 43	
Swivel speed	rpm	9.5	pinion / swivel teeth KX080-3 : 13/100
3 times rotation swivel time	sec.	18.9	
Swivel block performance at engine stop	deg.	0	
Swivel block performance at engine running	deg.	0 ≧	Bucket empty
Capable swivel rotation angle	deg.	17	Bucket crowded,Arm extended
Play at the tip of bucket	mm	≧	Reference value
	in.	≧	
Brake release pressure	MPa kgf/cm^2 psi	1.5 15 213	

d.Traveling performance

		Unit	KX080-3		Remarks
Manufacturer			Nabtesco Corp.		
Model			GM09VN-B-21/36-3		
Kubota part No.			RD809-6129-0		
Capacity	1st	cc/rev	21.3		
		cu.in./rev	1.30		
	2nd	cc/rev	36.3		
		cu.in./rev	2.22		
Reduction ratio			1/61.6		
Total displacement	1st	cc/rev	1312.1		
		cu.in./rev	80.07		
	2nd	cc/rev	2236.1		
		cu.in./rev	136.46		
Rated oil flow		L/min	72		
		USGPM	19.02		
Theoretical torque	1st	N.m	9000		KX080-3: at 24.5MPa (300kgf/cm2, 4267 psi)
		kgf.m	917.7		
		ft.lbf	6637.9		
	2nd	N.m	5160		
		kgf.m	526.2		
		ft.lbf	3805.8		
Theoretical speed	1F	rpm	31.6		KX080-3 : at 72 L/min (19.02 USGPM)
	2F	rpm	52.7		
Relief valve pressure		MPa	29.4		
		kgf/cm^2	300		
		psi	4267		
Climbing ability		deg.	30		
Max. traction force	1F	kN	55.2		Slip 70% theoretical torque Oil temp.:50±5°C(122±9°F)
		kgf	5633		
		lbf	12420.8		
	2F	kN	34.3		Relief 60% theoretical torque
		kgf	3500		
		lbf	7717.5		
Traveling block performance		mm/10min	0,300 ≧		10 min engine stop Testing slope angle: 20 deg.
		in./10min	0.00,11.81 ≧		
Traveling speed (Rubber/Steel)	1st	km/h	3.1		
		mph	1.93		
	2nd	km/h	4.6		
		mph	2.86		
10m(32.8ft) traveling time (Rubber crawler)	1F	sec./10m (32.8ft)			
	2F				
Straight travel performance	1F/2F	mm/10min	600 ≧		
		in./32.8ft	23.62 ≧		
Drain amount at lock	1F/2F	L/min	4.00 ≧		On new machine
		US gal/ min	1.06 ≧		

		Unit	KX080-3		Remarks
Drain amount while rotating	1F	L/min	0.50 ≧		On new machine
		US gal/ min	0.13 ≧		
	2F	L/min	1.00 ≧		On new machine
		US gal/ min	0.26 ≧		
Hi-speed change pressure Min./Max		MPa	2.0	6.9	
		kgf/cm^2	20.0	70.0	
		psi	284	996	
Parking brake ; Braking torque		N.m	97		
		kgf.m	9.9		
		ft.lbf	71.6		
Parking brake ; Release pressure		N.m	0.47		
		kgf.m	4.8		
		ft.lbf	68		

e.Cylinder

(1) Speed

Unit				KX080-3 (A)	KX080-3 (B)	Remarks
Boom cylinder	Up	Canopy	sec.	-		GL to Max. height (exclude cushion time)
		Cabin	sec.	3.1 to 3.7	4.4	
	Down	Canopy	sec.	-		Max. height to GL
		Cabin	sec.	3.1 to 3.7	4.4	
	cushion		sec.	0.4 to 1.3	1.6	
Arm cylinder	Crowd		sec.	3.4 to 4.0	4.8	Cylinder full stroke
	Dump		sec.	3.2 to 3.8	4.6	
Bucket cylinder	Crowd		sec.	3.2 to 3.8	4.6	Cylinder full stroke
	Dump		sec.	1.9 to 2.5	3.0	
Swing cylinder	Left	Canopy	sec.	-		Cylinder full stroke
		Cabin	sec.	6.6 to 7.2	8.6	
	Right	Canopy	sec.	-		
		Cabin	sec.	7.8 to 8.4	10.1	
Blade cylinder	Up		sec.	1.9 to 2.5	3.0	Cylinder full stroke
	Down		sec.	2.6 to 3.2	3.8	

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

(2) Natural falll

Unit		KX080-3 (A)	KX080-3 (B)	Remarks
Load weight	kg	0.414		includ bucket weight
	lbs	0.91		
Boom cylinder	mm	20	100	Boom raise, Arm extend, Bucket crowd, Bucket load : heaped capacity 10 min Engine stop
	in.	0.79	3.94	
Arm cylinder	mm	11	55	
	in.	0.43	2.17	
Bucket cylinder	mm	10	50	
	in.	0.39	1.97	
Blade cylinder	mm	20	100	Arm vertical
	in.	0.79	3.94	

Oil temp. : 50 ± 5 °C (122 ± 9 °F), 10 minutes

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

(3) Specifications and dimensions

1)Cylinder specifications

		Unit	KX080-3	Remarks
Boom	Tube I.D.xRod O.D.	mm in.	ø115xø65 ø4.53xø2.56	
	Stroke	mm in.	878 34.57	
	Min. retraction length	mm in.	1369 53.90	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6750-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		
Arm	Tube I.D.xRod O.D.	mm in.	ø100xø60 ø3.94xø2.36	
	Stroke	mm in.	912 35.91	
	Min. retraction length	mm in.	1378 54.25	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6760-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		

		Unit	KX080-3	Remarks
Bucket	Tube I.D. x Rod O.D.	mm in.	ø90xø55 ø3.54xø2.17	
	Stroke	mm in.	747 29.41	
	Min. retraction length	mm in.	1138 44.80	
	Manufacturer		KYB Co.,Ltd.	
	Parts No.		RD809-6780-0	
	Seal kit No.		RD809-	
	Piston tightening torque	N.m kgf.m ft.lbf		
	Piston screw size	mm		
	Width for tightening by spanner	mm		
Swing	Tube I.D.xRod O.D.	mm in.	ø110xø60 ø4.33xø2.36	
	Stroke	mm in.	715 28.15	
	Min. retraction length	mm in.	1165 45.87	
	Manufacturer		Koretsune Seiko Ltd.	
	Parts No.		RD809-6740-0	
	Seal kit No.		RD809-7238-0	
	Piston tightening torque	N.m kgf.m ft.lbf	2800 285.5 2065.0	
	Piston screw size	mm	M45x2	
	Width for tightening by spanner	mm	-	
Blade	Tube I.D.xRod O.D.	mm in.	ø125xø65 ø4.92xø2.56	
	Stroke	mm in.	250 9.84	
	Min. retraction length	mm in.	689 27.13	
	Manufacturer		Koretsune Seiko Ltd.	
	Parts No.		RD809-7510-0	
	Seal kit No.		RD809-7245-0	
	Piston tightening torque	N.m kgf.m ft.lbf	4000 407.9 2950.2	
	Piston screw size	mm	M52x2	
	Width for tightening by spanner	mm		

2)Cylinder dimensions

KX080-3

	Unit	A	B	C	D	E	F	G	H	J	Port screw size	Remarks
Boom	mm	70	70	90	90	65	115	134	57	70	G 1/2"	KYB Co.,Ltd.
	in.	2.76	2.76	3.54	3.54	2.56	4.53	5.28	2.24	2.76		
Arm	mm	60	60	85	85	60	100	118	55	58	G 1/2"	KYB Co.,Ltd.
	in.	2.36	2.36	3.35	3.35	2.36	3.94	4.65	2.17	2.28		
Bucket	mm	60	60	75	75	55	90	112	60	55	G 1/2"	KYB Co.,Ltd.
	in.	2.36	2.36	2.95	2.95	2.17	3.54	4.41	2.36	2.17		
Swing	mm	70	70	80	80	60	110	131	65	58	G 1/2"	Koretsune Seiko Ltd.
	in.	2.76	2.76	3.15	3.15	2.36	4.33	5.16	2.56	2.28		
Blade	mm	70	70	75	75	65	125	146	65	65	G 1/2"	Koretsune Seiko Ltd.
	in.	2.76	2.76	2.95	2.95	2.56	4.92	5.75	2.56	2.56		

3)Tightening torque

(1) Boom cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m	350-400		
	kgf·m	35.7-40.8		
	ft·lbs	258.1-295.0		
Piston	N·m	600±120		
	kgf·m	61.2±12.2		
	ft·lbs	442.5±88.5		
Set screw	N·m	20	M8x1.25	
	kg·m	2.0		
	ft·lbs	14.8		

(2) Arm cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m	350-400		
	kgf·m	35.7-40.8		
	ft·lbs	258.1-295.0		
Piston	N·m	600±120		
	kgf·m	61.2±12.2		
	ft·lbs	442.5±88.5		
Set screw	N·m	20	M8x1.25	
	kg·m	2.0		
	ft·lbs	14.8		

(3) Bucket cylinder

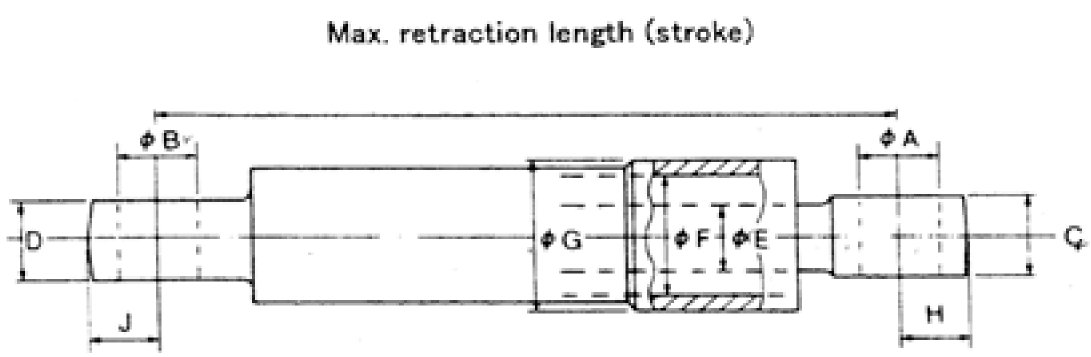
	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m	300-350		
	kgf·m	30.6-35.7		
	ft·lbs	221.3-258.1		
Piston	N·m	600±120		
	kgf·m	61.2±12.2		
	ft·lbs	442.5±88.5		
Set screw	N·m	20		
	kg·m	2.0		
	ft·lbs	14.8		

(4) Swing cylinder

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m	650	-	
	kgf 疥	66.3		
	ft·lbs	479.5		
Piston	N·m	2800	M48x2	
	kgf 疥	285.5		
	ft·lbs	2065.0		
Set screw	N·m	-	-	
	kg·m	-		
	ft·lbs	-		

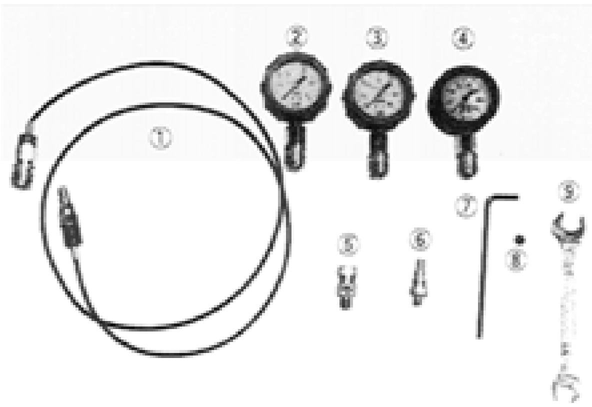
(5) Blade cylinde

	Unit	Tightening torque	Thread size	Adhesive
		KX080-3	KX080-3	
Cylinder head	N·m	1200	-	
	kgf·m	122.4		
	ft·lbs	885.3		
Piston	N·m	4000	M52x2	
	kgf·m	407.9		
	ft·lbs	2950.3		
Set screw	N·m	-	-	
	kg·m	-		
	ft·lbs	-		



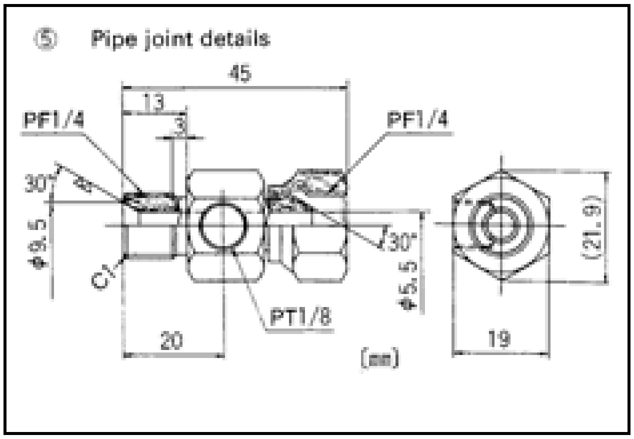
C.Testing

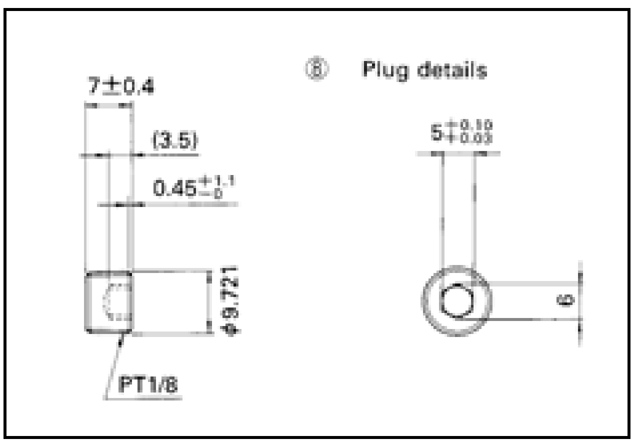
a. Testing Instruments & special tools

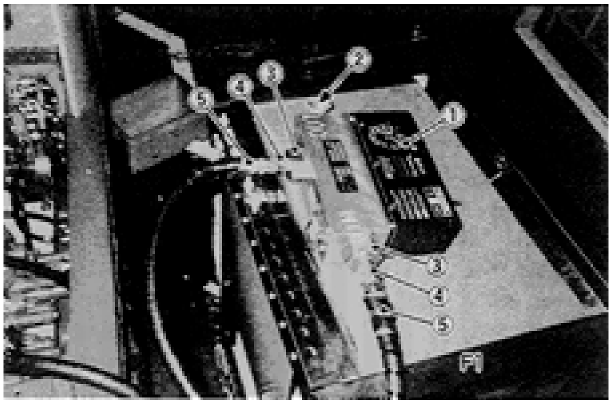


(1) Gauges and special tools for pressure testing

1. Pressure hose
2. Pressure gauge; 2.94 MPa, 30kgf/cm^2, 427 psi
   For Secondary pilot pressure test.
3. Pressure gauge; 5.88 MPa, 60kgf/cm^2, 853psi
   For primary pilot pressure test.
4. Pressure gauge; 39.2 MPa, 400kgf/cm^2, 5689psi
   For main relief pressure and overload relief pressure test.
5. Pipe joint (S, F2 - F2)
   code No.: 69181-63191
6. Pressure test plug; PT 1/8
7. Allen wrench; M5
8. Plug; PT 1/8 Code No.: 68311-13381
9. Wrench; Size 17 - 19 mm

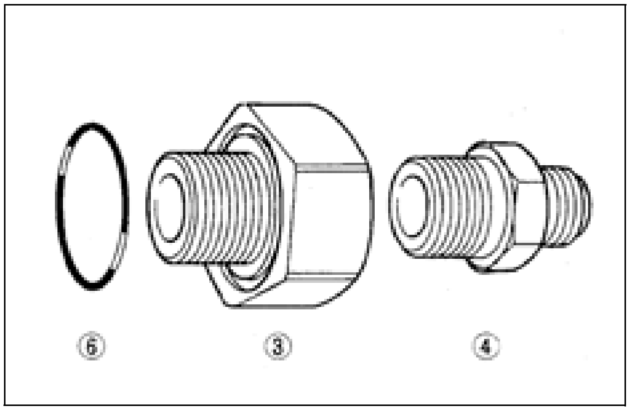


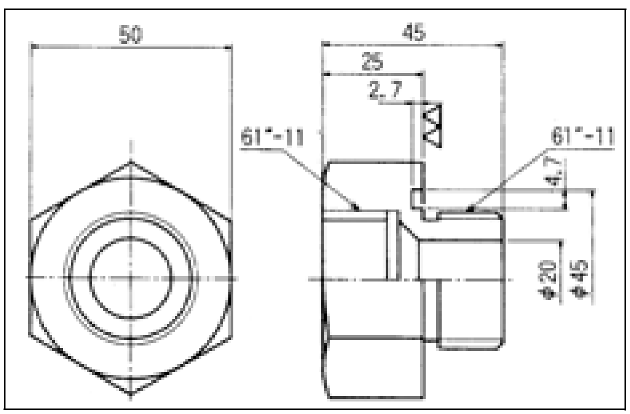




(2) Flow meter and special tools for flow testing

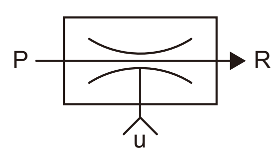
1. Flow meter; Flowtech Inc. make
2. Loading handle
3. Male-female joint 1” × 1”
4. joint 1” × 1/2”
5. Hose 1/2”
6. O-ring





Drawing of (3) Male - female joint 1” × 1”

Vacuum pump
FESTO VAD-1/4 9334



b. Precautions in handling the pump

(1) Points to remember when replacing the pump or using a vacuum pump

(Without taking the following steps, unusual noise may be heard and what's worse, the pump may get damaged.)

Take the following procedure after replacing the pump but before starting the engine.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull put the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Wait for 30 seconds or so in this state.
4) Insert the hex plug. (Make sure it is deep enough in place.)

Note:

Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

5) Reclamp the air bleeder hose back into posotion.
6) Start the engine at the idling speed.
7) Try to raise the dozer at ths speed. If it is not lifted, stop the engine, remove the plug again, and bleed air.
8) Still at the idling speed, move the lever to the neutral position. Wait until there is no cavitation noise heard.
9) Finally increase the engine speed by about 500 rpm step by step up to the maximum speed. Make sure no cavitation noise is heard. Return the engine speed back to the idling rpm. Move the arm and bucket untill there is no cavitation noise heard. Now again increase the engine speed by about 500 rpm, and move the arm and bucket. Repeat this up to the maximum engine speed and make sure no cavitation noise is heard.

(2) Air bleeding method in case the hydraulic oil in the tank looks cloudy with air bubbled

(Without taking the following steps, unusual noise may heard and what's worse, the pump may get damaged.)

Be sure to keep the engine running at the idling speed in the following procedure.

1) Unclamp the air bleeder hose that comes out from the top of the pump, and pull it toward yourself. Press in the hex plug and the black lock as well. Then hold the black lock and pull out the hex plug.
2) With the hex plug out, reclamp the hose back into position.
3) Start the engine at the idling speed. Move the lever to the neutral position and keep running the engine for 10 seconds or so. Stop this engine and wait for 10 seconds. With the lever still at the neutral position, run the engine again for 10 seconds. Repeat this step about 20 times (until the hydraulic oil does not look cloudy any longer).

* The pump's centrifugal force is utilized for this step. The hydraulic oil is forced to flow along the inner wall of the pump, whereas air bubbles are collected toward the center of the pump. Each time the engine is stopped, collected air bubbles go out through the bleeder hose atop the pump. The engine is thus atarted and stopped repeatedly to allow such collection and dischrging of air bubbles.

Note:

Be sure to run the engine at the idling speed. If higher than this, air is sucked into the bleeder hose.

4) Finaly insert the hex plug. (Make sure it is deep enough in place.) Be careful never to raise the engine rpm without the hex plug in place. Air may sucked in, getting the pump damaged.

c. Pilot pressure
(1) Primary pressure

1. Remove the side cover of the tank.
2. Set a pressure gauge to the measuring port.
3. Start the engine and run it at the maximum speed. Take 2 or 3 measurements to have an exact reading.
4. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.

Reference valve : See specifications
1)Primary pressure test port

CAUTION
Relieve the pilot line pressure bofore removing the pressure port.
Otherwise, oil will splash out by accumulated pressure.

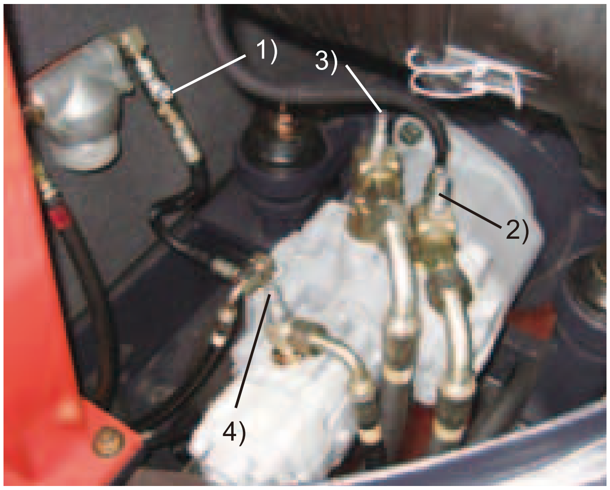
(2) Secondary pressure

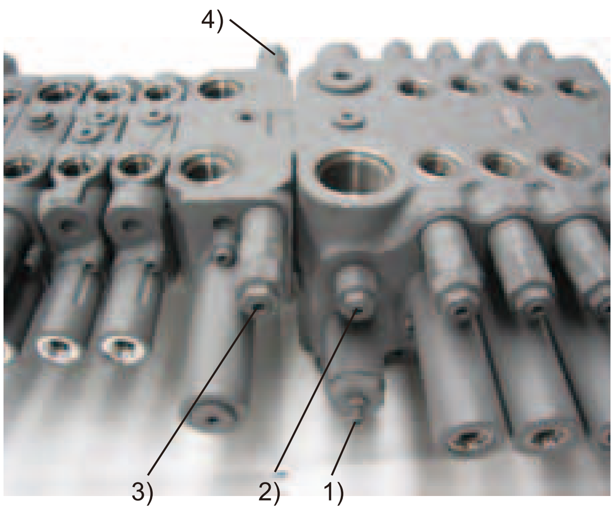
[Ex: Measurement with the arm crowd]
1. Remove the side cover of the tank.
2. Connect a T joint to the arrow-marked point and set the pressure gauge there.
3. Start the engine and run it at the maximum speed. Take 2 or 3 measurements to have an exact reading.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference value : See specifications

1) Measurement port of secondary pilot pressure.

d. Main relief valve : LS system





(Measurement methed)

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Start the engine and run it at the maximum speed. Get the following main relief valves activated.
3. Take 2 or 3 measurements to have their respective exact readings.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference value : See specifications

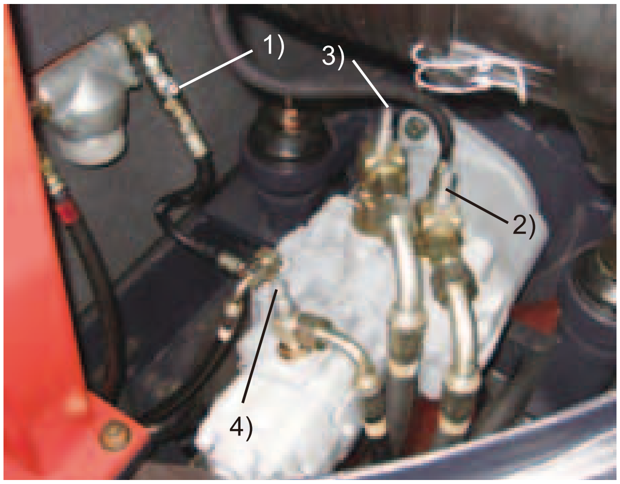
1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

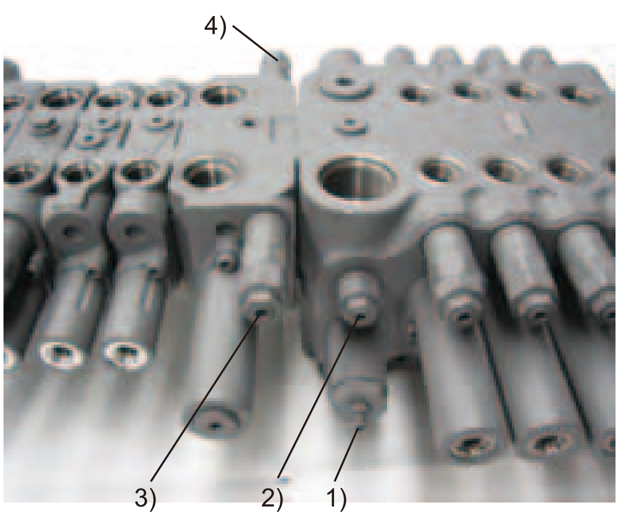
1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve

(Adjustment of the relief valve)

1. Loosen the lock nut of the relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut. Clockwise turn raises the pressure, and counterclockwise turn lowers it.
2. Run the engine at the maximum speed. Move the levers and make sure the pressure setting.

e. Main relief valve : Travel system





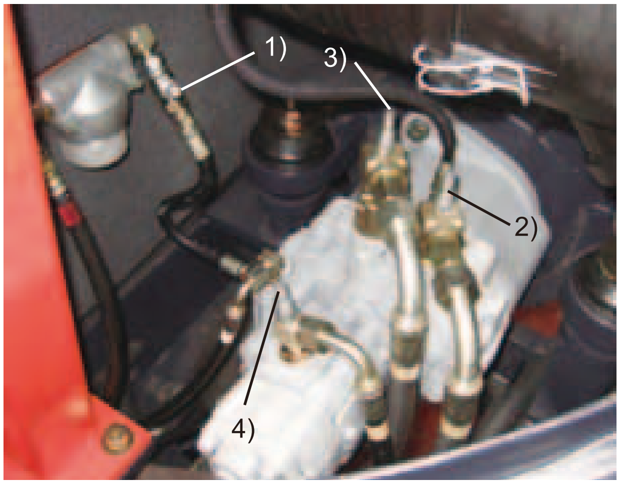
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Lock the both tracks.
3. Start the engine and run it at the maximum speed. Get the following main relief valves activated.
4. Take 2 or 3 measurements to have their respective exact readings.
5. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

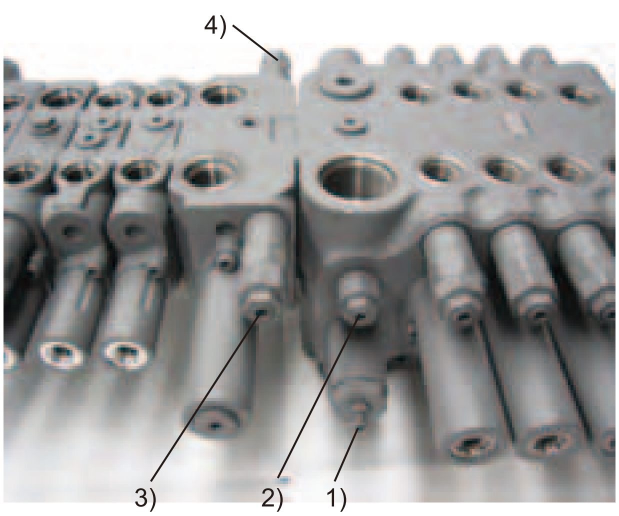
Reference value : See specifications

1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve

f. Unload valve





(Measurement method)

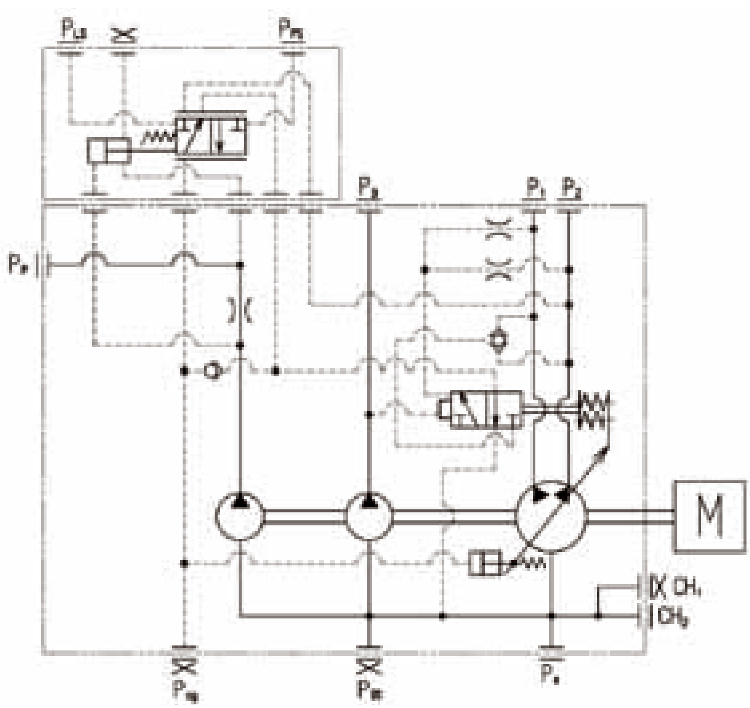
1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Start the engine and run it at the maximun speed.
3. Measure the unload valve pressure. At this measurement, all control levers should be at neutral position.
4. Take 2 or 3 measurements to have their respection exact readings.
5. Hydraulic oil and temperature are as follows.
   oil :ISO VG46
   Temp. :50 ± 5 °C, 122 ± 9°F

- Adjustment
  If the measured pressure is lower than specification, screw in the set screw.
  And vice-versa.

Reference value : See Specifications

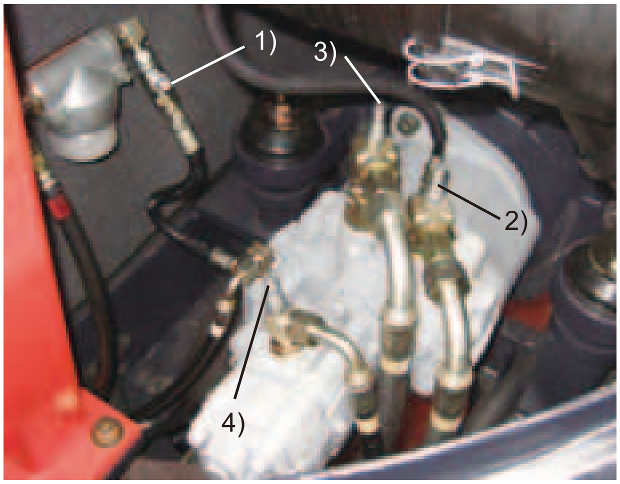
1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

1) LS unload valve
2) LS main relief valve
3) 4) Travel main relief valve



g. Overload relief valve

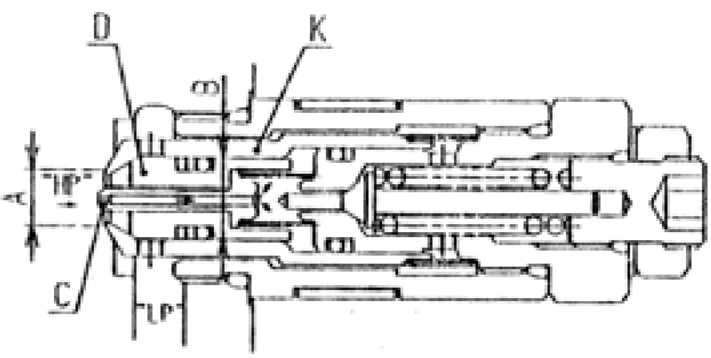
- Measurement method



1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Raise the pressure setting of the main relief valve about 0.98 MPa (10 kgf/cm^2, 142 psi) over that of the overload relief valve.
3. Run the engine at 1500 rpm. Move the levers to get the overload relief valve activated. Measure the pressure setting.
4. Take 2 or 3 measurements to have the exact reading.

Reference value : See Specifications

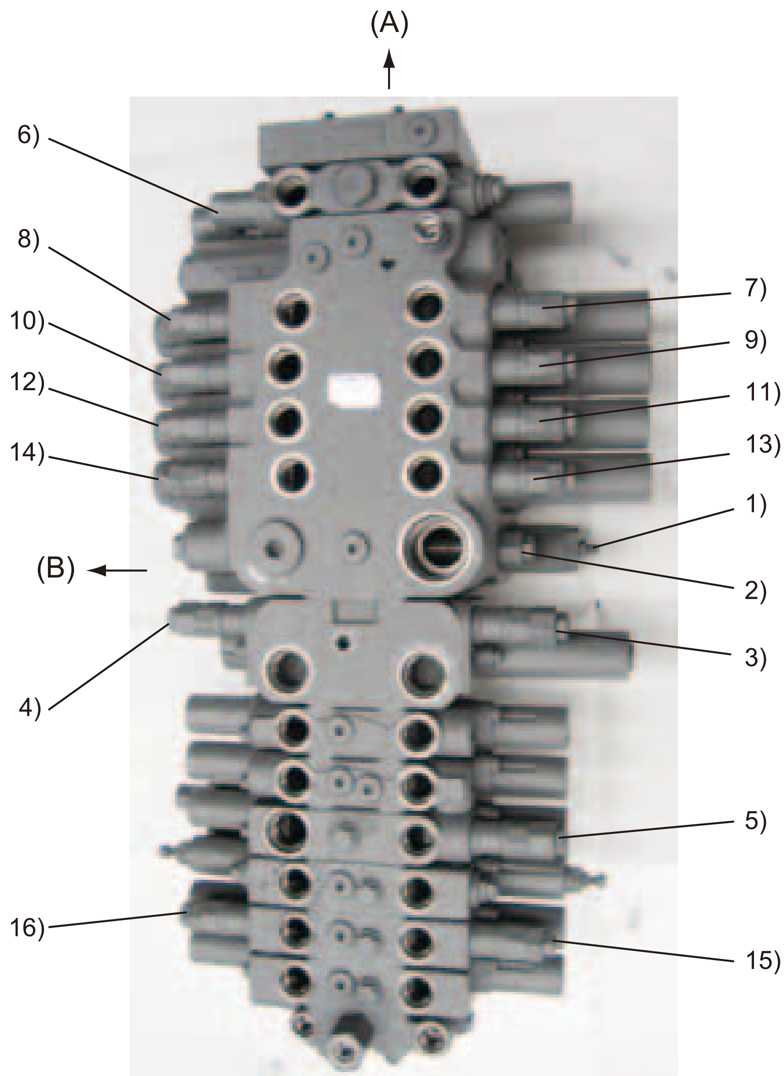
1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port



(Adjustment of the overload relief valve)

1. Loosen the lock nut of the overload relief valve. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
2. Run the engine at the 1500rpm speed. Move the levers and make sure the pressure setting.

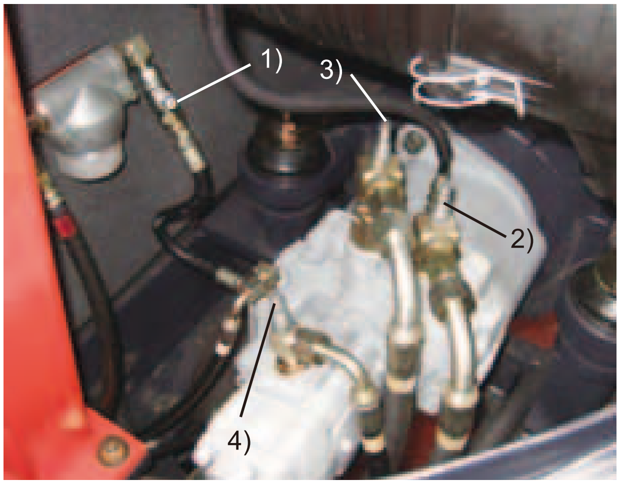
- Location of the relief valve

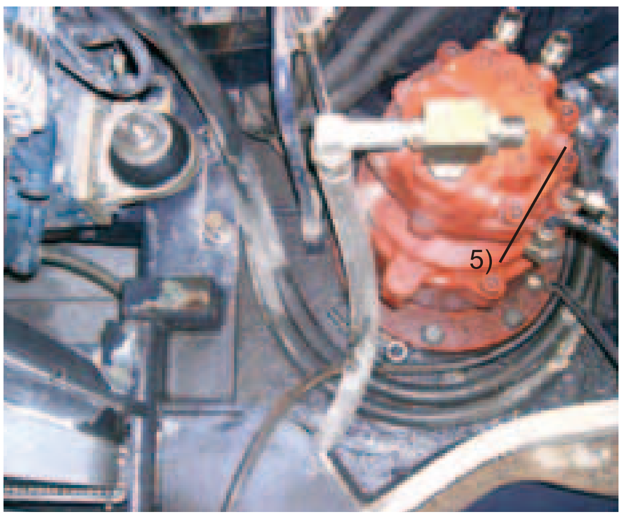


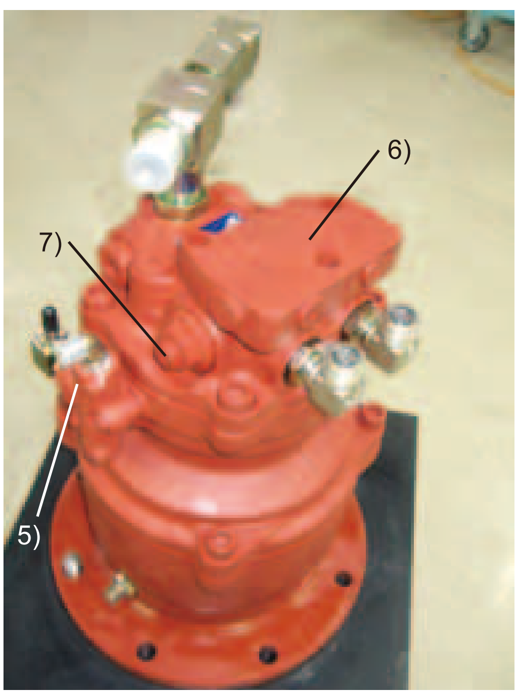
(A) Machine front
(B) Cab side
ORV : Overload Relief valve

1) LS unload valve (b6)
2) LS main relief valve (a2)
3) Travel main relief valve (a1)
4) Travel main relief valve (a2)
5) Pump 3 main relief valve (a4)
6) Swing rod, anti-void valve
7) Boom rod, ORV (b1)
8) Boom bottom, ORV (b1)
9) Service port 1, ORV (b5)
10) Service port 1, ORV (b5)
11) Bucket bottom, ORV (b1)
12) Bucket rod, ORV (b1)
13) Arm bottom, ORV (b4)
14) Arm rod, ORV (b1)
15) Dozer bottom, ORV (b3)
16) Dozer rod, ORV (b2)

h. Swivel brake valve pressure







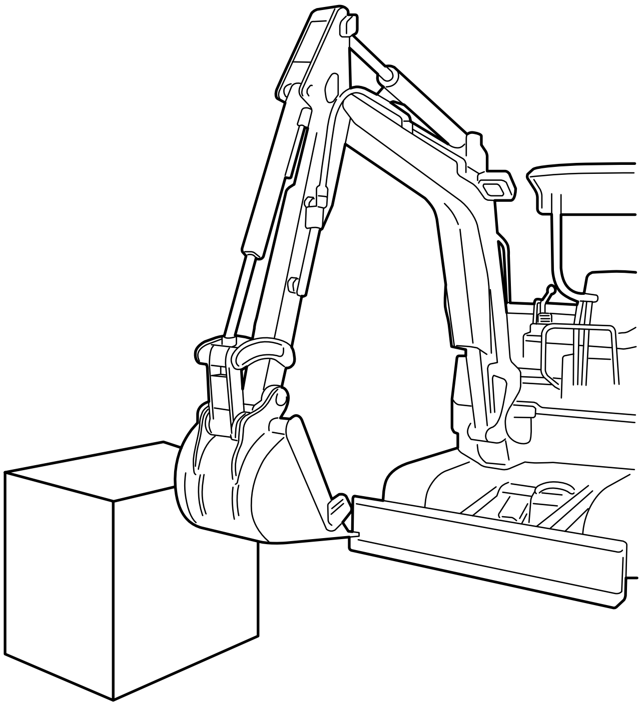
(Measurement method)

1. Set the pressure gauge to the coupler at the main pump discharge side. Or remove the plug off the main pump discharge side and set the pressure gauge there.
2. Bring the bucket in contact with a solid block. Slowly move the bucket toward the block. With the engine at 1500 rpm, measure the relief pressure.
3. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

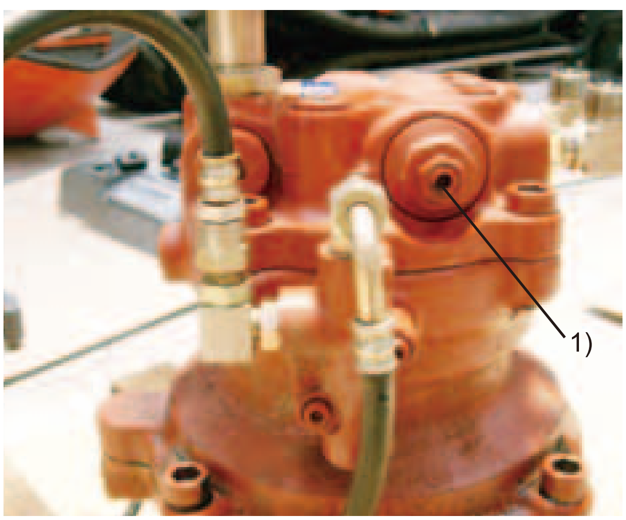
Reference valve : See Specifications

1) Primary pilot pressure port
2) Pump 1 pressure port
3) Pump 2 pressure port
4) Pump 3 pressure port

5) Swivel motor, ORV
6) Anti-swivel back valve
7) Negative brake timer



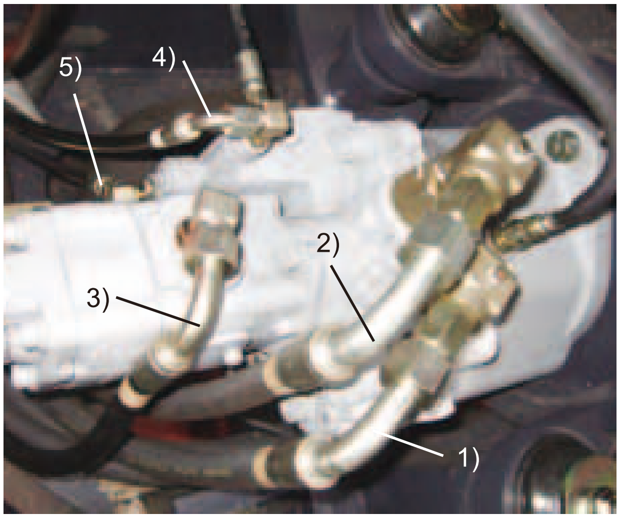
- Adjustment of the brake



1. Loosen the lock nut of the relief valve.
2. Using a hex wrench, turn the adjusting screw to reach the specified setting. Then tighten up the lock nut.
3. Run the engine at 1500 rpm. Move the levers and feel the pressure setting.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9 °F.

1) Swivel motor, ORV

i. Measuring the main pump Max. flow rate



[Precautions]
1. Park the machine on a flat, solid ground.
2. Connect a vacuum pump.
3. Disconnect the hose from port P (delivery).
4. Connect joint A and measuring hose to pipe joint T of the pump (port P). Connect the other end of the hose to the IN socket of a flowmeter.
5. Connect joint B and measuring hose to the hose at port P (delivery). Connect the other end of the hose to the OUT socket the flowmeter.
6. **Disconnect hose Pps and attach plug (1/4) to this hose's end. Keep joint Pps (at the pump) intact. (Place an oil pan to receive out-coming oil.)**

* **This is because the pump's swash plate is fixed at its maximum tilt angle.**

7. Detach plug (1/4) at port P and hook up a pressure gauge(at point A).

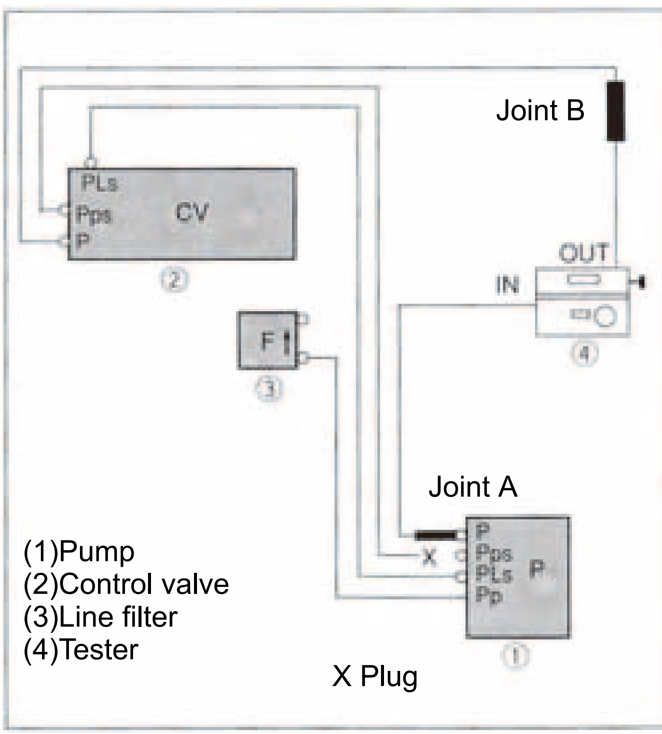
* This is because the flowmeter's readings fluctuate depending on the size of a measuring hose.

8. Disconnectthe vacuum pump.
9. Air-bleed the pump according to the air bleeding procedure.
10. Fully open the flowmeter's loading valve and start the engine. Finally make sure there is no oil leak at the pressure gauge connection.

1) Pump 1 delivery hose
2) Pump 2 delivery hose
3) Pump 3 delivery hose
4) P_{PS} sensing line hose
5) P_{LS} sensing line hose

[Measurement]
1. Raise the engine speed to the maximum rpm.
2. Gradually close the flowmeter’s loading valve and measure the flowrate and engine rpm at each pressure point in the P-Q curve.
3. Take the measurements 3 times.
   Determin the averages and take them as the final ones.

* Keep the oil temperature at 50 ± 5 °C(122 ± 9°F) for the measurements.



j. Measuring the main pump's stand-by flow rate

Preparations are almost same as in pump's Max. flow rate.

1 ~ 5. Same as in pump's Max. flowrate.

6. Disconnect hose PLs and attach plug (1/4) to this hose's end. Keep joint PLs (at the pump) intact. (Place an oil pan to receive out-coming oil.)

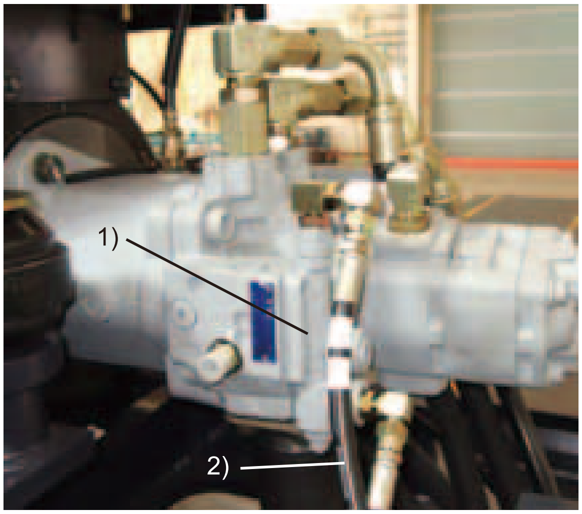
*** This is because the pump's swash plate is fixed at its minimum tilt angle.**

7 ~ 10. Same as in pump's Max. flowrate.

Reference value : See Specifications

k. LS control pressure

The actual measurement of LS control differential pressure requires special equipment such as a differential pressure instrument. General maintenance shops do not have such a expertise measuring device. This section introduces a simple method that makes use of the swivel motion or travel operation. of an actual machine.



1. Place the machine on hard ground.
2. Warm up the machine to the oil temp. of 50 ± 5 °C (122 ± 9 °F).
3. Raise up the engine speed at Max. rpm.
4. Measure the time for three turns constant swivel function

Reference value : See Specifications

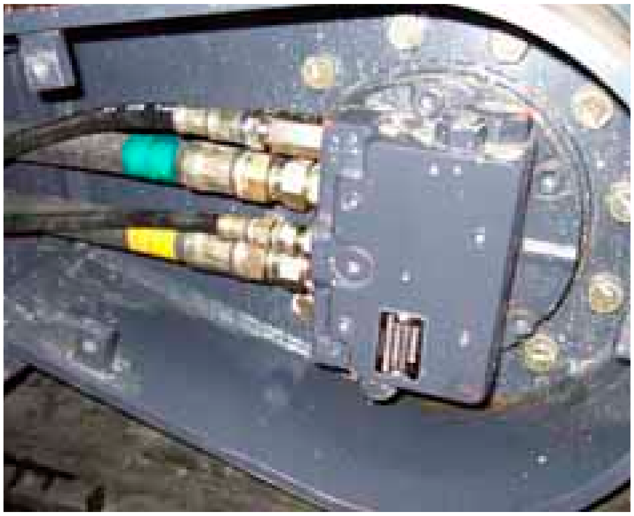
Machine condition : In case of swivel speed test
Boom raised, arm & bucket crowd
Dozer-down on ground.

5. Adjustment
   1) If actual measurement speed is slower than specification, loosen the lock nut and screw in the set screw.
   2) If actual measurement speed is faster than specification, loosen the lock nut and screw back the set screw.

   Note: Before loosening the nut, put alignment mark on body, lock nut and set screw.

1) LS control valve
2) Set screw

I. Traveling motor drain amount



1. Disconnect the drain hose from the travel motor and connect another hose (the pressure gauge hose will do) where the drain hose was disconnected.
2. Float the crawlers as shown as below.
3. Run the engine one minute at max. rpm with the lever in the forward position and measure the amount of hydraulic oil in the pan.
4. If the measurement exceeds the specification, determine the cause and replace the assembly.
5. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

Reference value : See Specifications

Never place your body under the crawler.

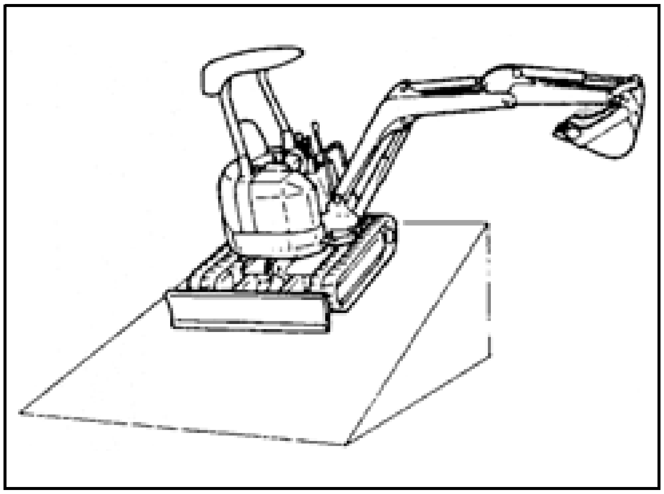
m.Swivel motor drain amount

1. Remove right side cover.
2. Locate front attachment to traveling position. Bucket should be located 1 m above from ground.
3. Remove drain hose of the swivel motor and recieve drain oil in a suitable reservoir.
4. Swivel the machine one minute at max. engine rpm and measure amount of hydraulic oil in the reservoir.

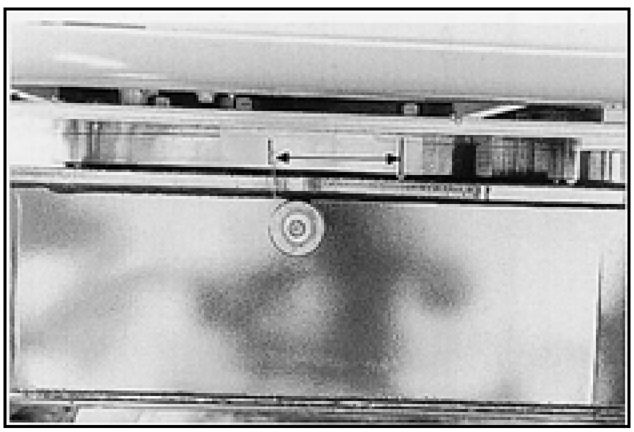
Make sure nobody is around swivel radius area.

Reference value : See Specifications

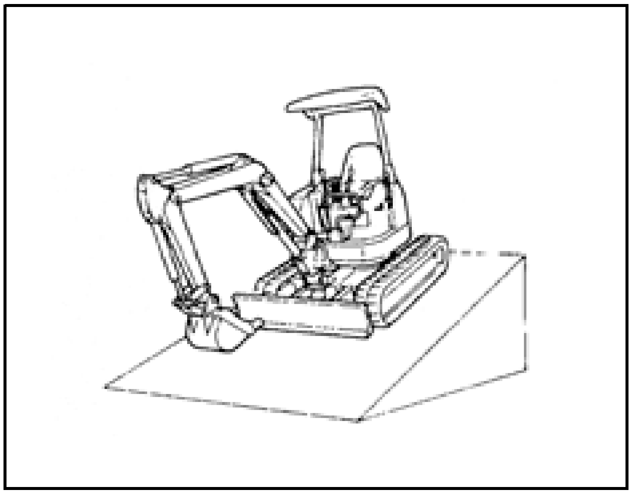
n. Swivel motor block performance

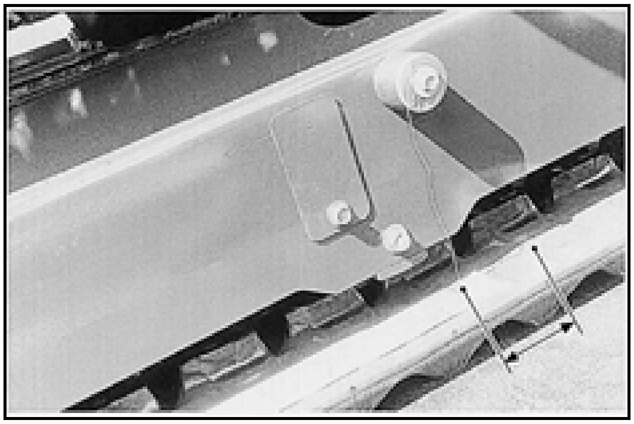


1. Locate the machine on the 20 deg. slope.
2. The front position is of arm dump and bucket crowd. Keep the boom so that the boom end pin is alignedwith the bucket pin.
3. Mark the outer ring of swivel bearing and truck frame.
4. Unlock the safety lock lever, and measure the one minute shifting distance between them with engine idling rpm.
5. Load on the bucket should be as follows.
6. Hydraulic oil temperature must be 50 ± 5°C, 122 ± 9°F.



o. Traveling motor block performance





1. Park the machine on a 20deg. slope. Keep front at traveling position.
2. Put marks on the truck frame and the crawler.
3. Measure 10 minutes slip-distance without engine running.
4. Hydraulic oil tempreture must be 50 ± 5°C, 122 ± 9°F.

p. Operating speed

(1) Checking each operating speed.

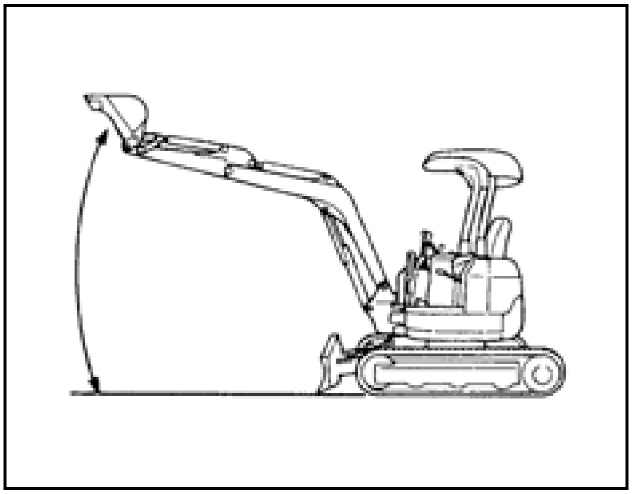
[Important points]

1. Measure full stroke operating time with no load on the standard bucket.
2. Make several mesurement and use average time for judgement.
3. Two different measurements are expected for the forward and backward movements as well as the right and left swivelings.
   Obtain their respective measurements. Do not calculate for their average.
4. Before operation, make sure nobody is around the machine.

[Measurement conditions]

1. Engine rpm is max..
2. Hydraulic temperature is 50 ± 5°C, 122 ± 9°F.
3. Ground is flat.
4. Measure time after several pre-operation.

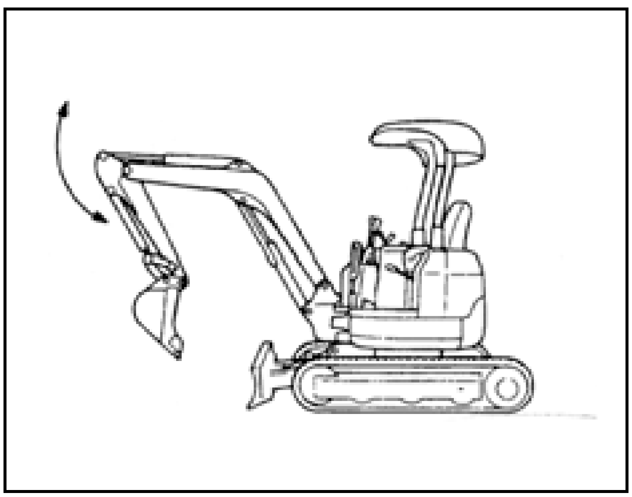
(2) Boom cylinder



1. Arm and bucket cylinder shouls be most shorted position.
2. Measure the time from the bucket is on the ground to the boom highest position, and from the boom highest position to the ground.

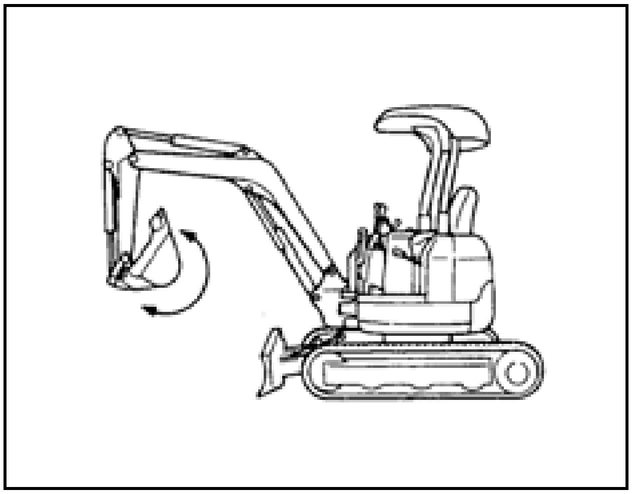
Note:The cushioning time is not included.

(3) Arm cylinder



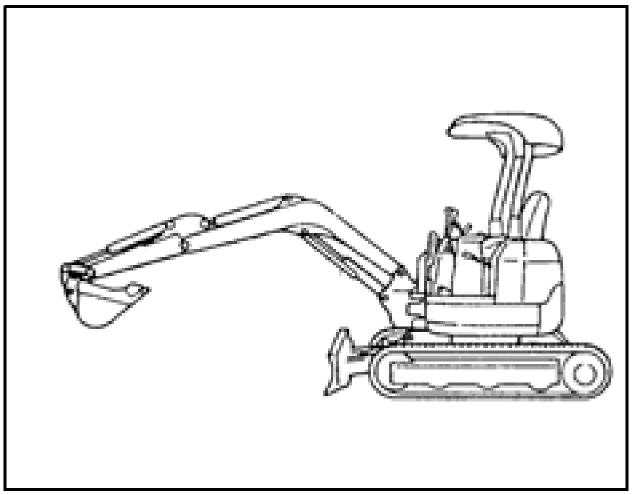
1. Position the boom and arm as showm at left.
2. Measure the arm cylinder full stroke operating time.

(4) Bucket cylinder



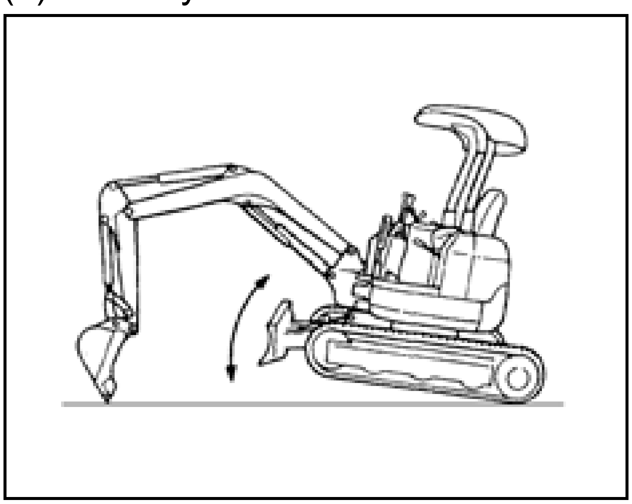
1. Position the boom and arm as showm at left.
2. Measure the bucket cylinder full stroke operating time.

(5) Swing cylinder



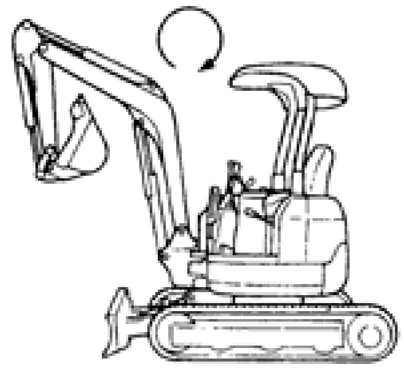
1. Position the boom, arm and bucket as showm at left. (with the bottom of the bucket about 1 m (33 ft) above from the ground.)
2. Measure the swing cylinder full stroke operating time. (right to left and left to right)

(6) Dozer cylinder



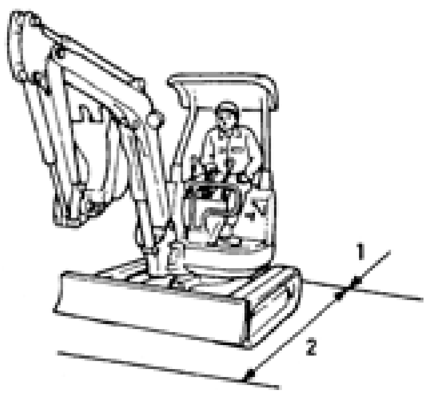
1. Place the bucket on the ground. Position the machine as shown at left for the dozer to make a full stroke.
2. Measure the dozer cylinder full stroke operating time.

(7) Swivel speed



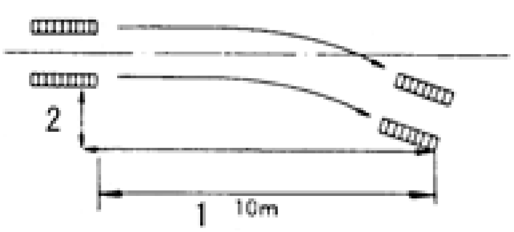
1. Position the boom, arm and bucket as showm at left.
2. Measure three times rotation time.

(8) Traveling speed



1. Travel the machine untill getting max. speed.
2. After getting max. speed, measure the 10 mm (33 ft) traveling time.

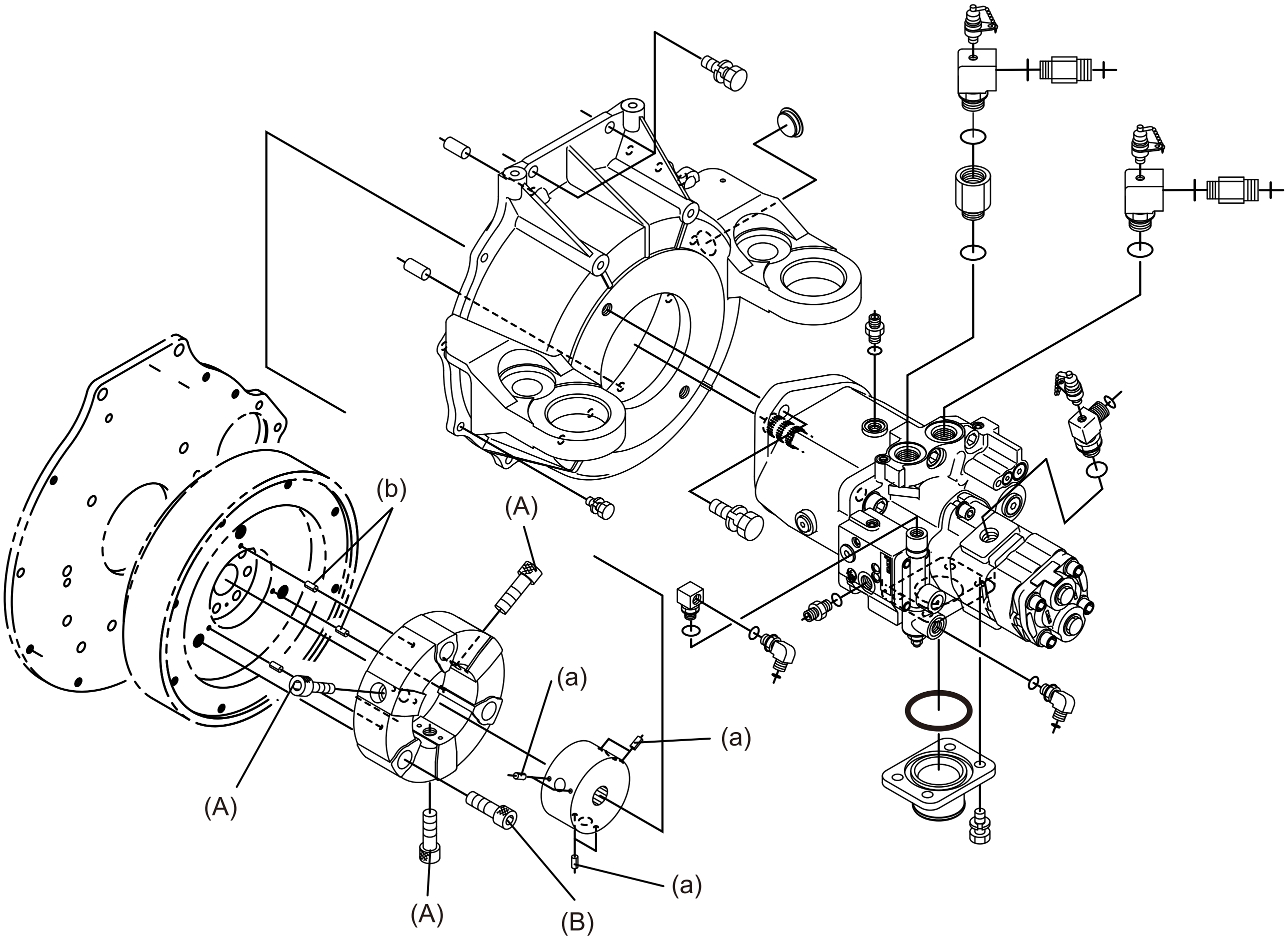
p. Straight travel performance



1. Travel the machine untill getting max. speed.
2. Measure the vertical distance from the traveling line.

D.Disassembling and Reassembling

a. Coupling flange

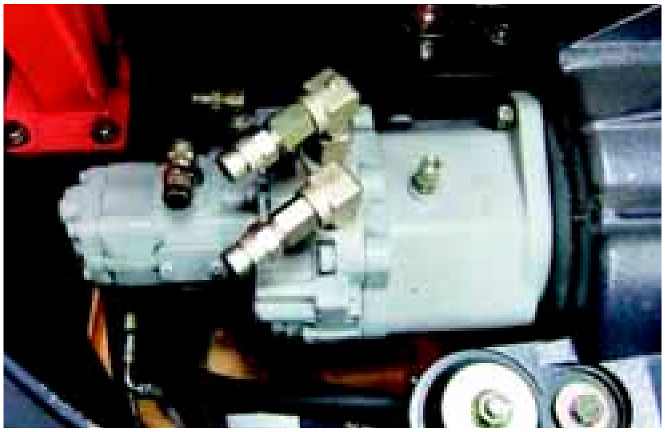


1. Apply a proper amount of grease on the splines.
   • Otherwise the splines may get burnt, making it difficult to remove the pump.
2. Keep the rubber free from grease. Immediately wipe it clean if stained with grease.
   • Otherwise the rubber may get deteriorated by the grease.
3. Fitting the coupling.
4. Tightening torque of the coupling mounting bolt: 210~230N·m, 21.4~23.5 kgf·m, 155~170 ft·lbf
   • Do not apply any adhesive.

Be sure to use a torque wrench to tighten up the bolts. Do not employ an impact wrench, because otherwise the coupling may be damaged.

A **Assembly procedure of coupling flange**

A) First tighten this bolts, aligning the spring pin (a).
B) Second tighten this bolts, aligning the spring pin (b).



b.Pump

1. Pump assy dismount

1. Disconnect the delivery hoses
2. Plug the joints.

3. Remove the section hose below the pump.

4. Wound the nylon sling around the pump and remove the mounting bolts.

5. Lift up the pump assy.

6. View after pump discounting.

2.Adaptor and joint

1)Fitting the adaptor

Position the adaptor in position as shown at left.

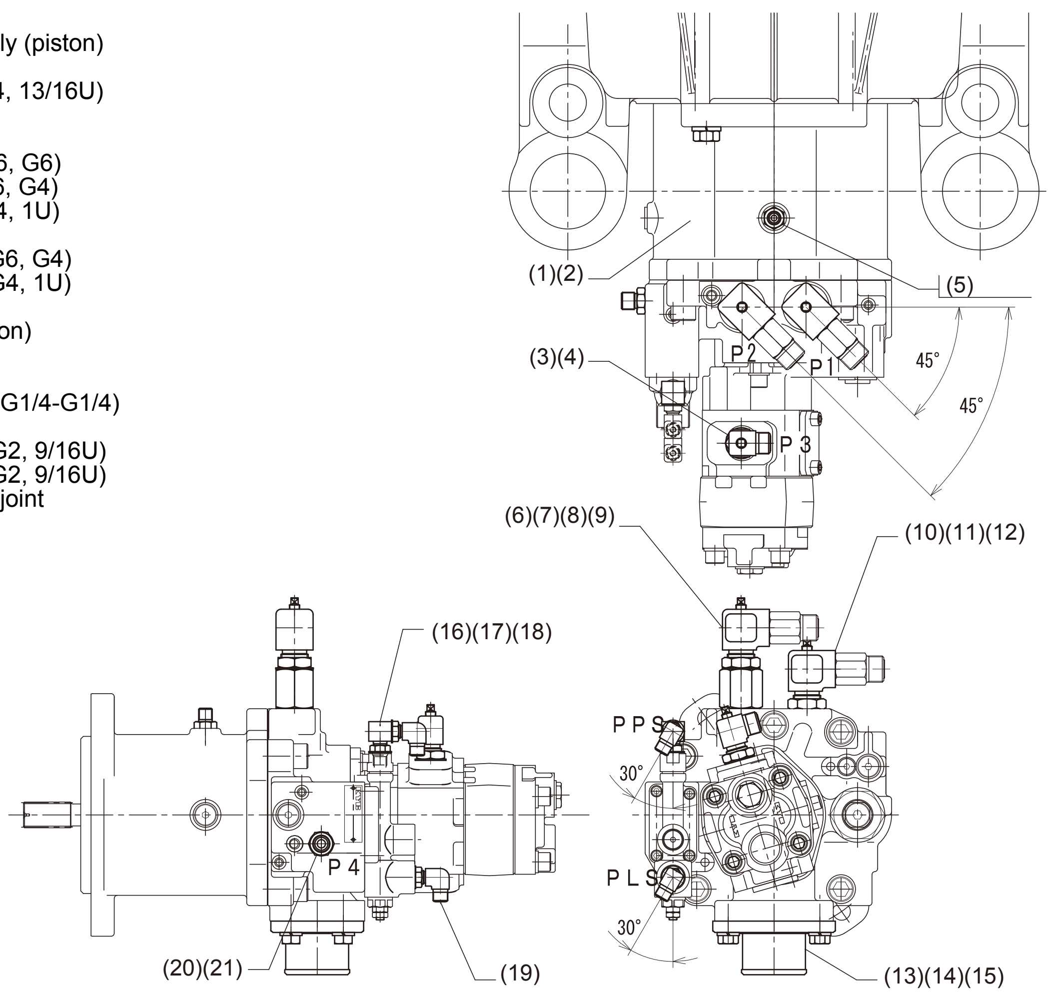
2)Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lb

3)Bolt tightening torque

196.1~225.6N.m(20.0~23.0kgf.m)144.6~166.4 ft.lbs

(1)Pump assembly (piston)
(2)Bolt
(3)Pipe joint (LG4, 13/16U)
(4)Plug
(5)Adaptor
(6)Pipe joint (SG6, G6)
(7)Pipe joint (LG6, G4)
(8)Pipe joint (SG4, 1U)
(9)Plug
(10)Pipe joint (LG6, G4)
(11)Pipe joint (SG4, 1U)
(12)Plug
(13)Flange (suction)
(14)O ring
(15)Bolt
(16)Pipe joint (L, G1/4-G1/4)
(17)O ring
(18)Pipe joint (SG2, 9/16U)
(19)Pipe joint (SG2, 9/16U)
(20)Straight pipe joint
(21)O ring



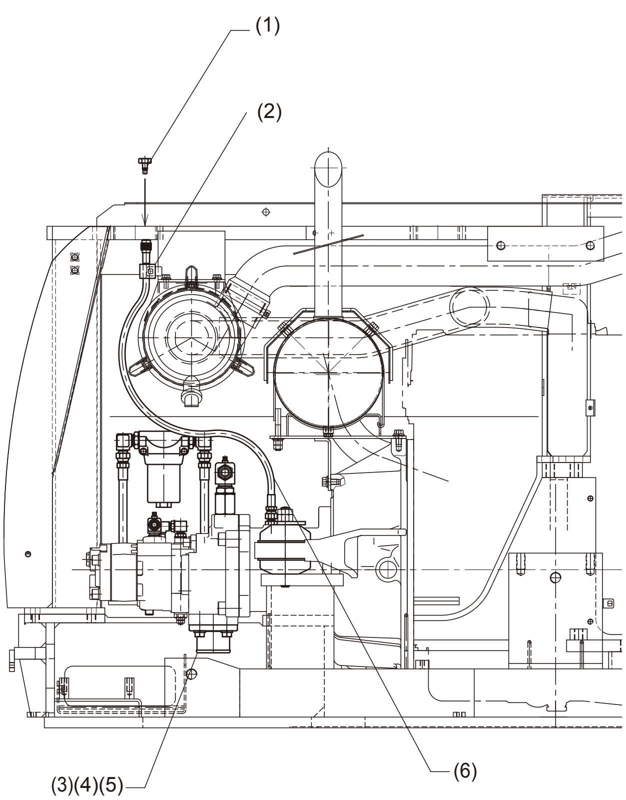
4)Fitting the flange (Suction)
Be careful to install the O ring in position.

5)Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs

6)Fitting the hydraulic hose (3/16)
Lay the hose in the route as shown at left.
Make sure the hose is tightly hooked. Press-fit the hose until it clicks. (If not, reconnect it.)
Finally gently pull the hose to make sure it does not come off.

7)Fitting the plug (Easy Touch)
Fit the plug tight enough.

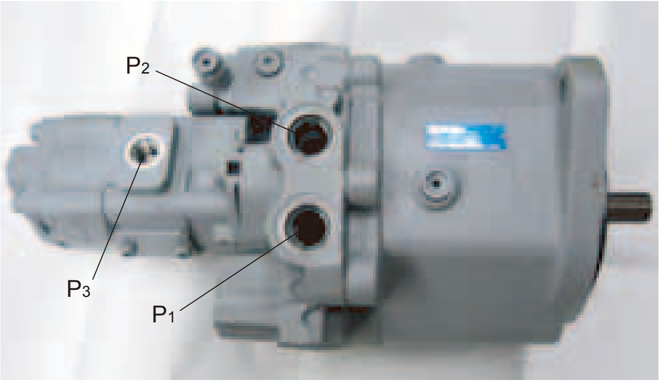
Notes:
1. To pour hydraulic oil, remove the plug (Easy Touch). After adding the oil, be sure to attach the plug (Easy Touch). Then get the engine started.
2. With the plug (Easy Touch) in place, pull it gently to make sure it does not come off.



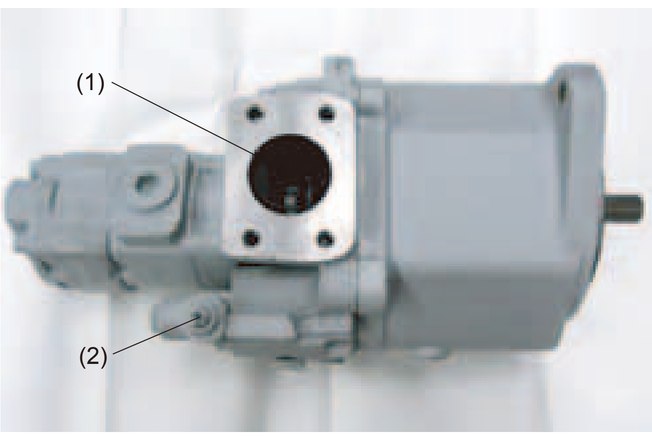
(1)Plug (Easy Touch)
(2)Insert the clamp through the member welded on the arch.
(3)Flange (suction)
(4)O ring
(5)Bolt
(6)Hydraulic hose (3/16)

3.Disassembly and reassembly

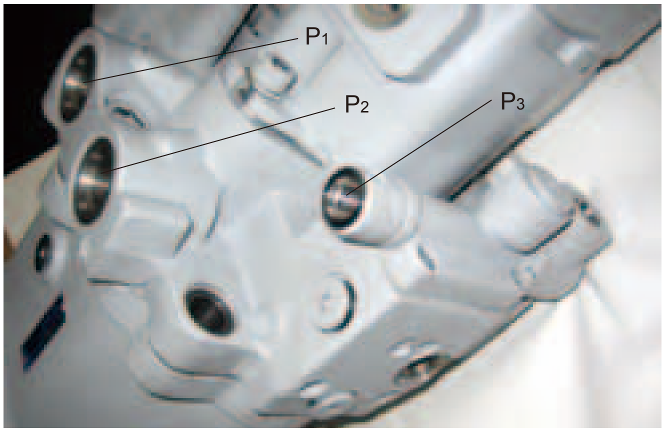
1)Outer view



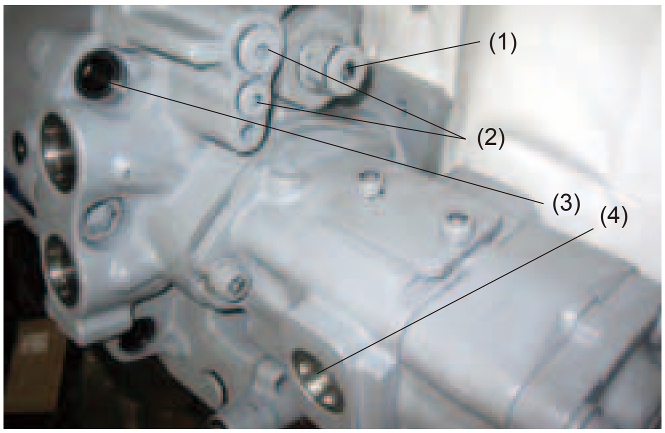
Delivery port.
P_1
P_2
P_3



(1)Inlet port.
(2)LS control valve.



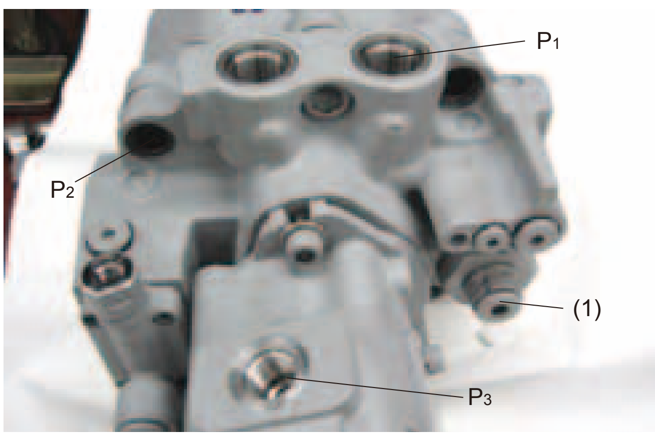
P_1
P_2
P_{LS}



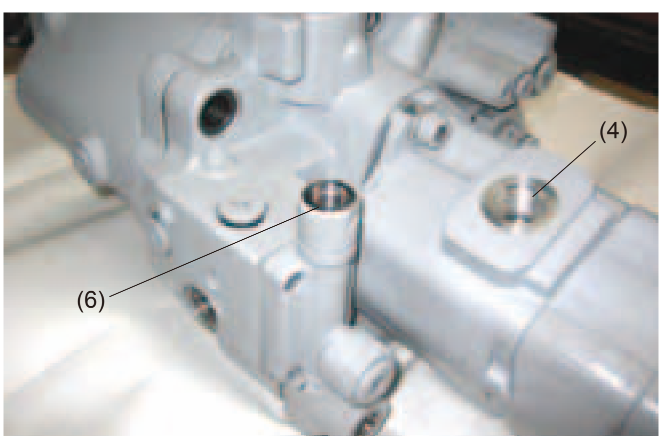
(1)Horse power control valve.
(2)Horse power sensing spools.

(3) $\dfrac{P_1+P_2}{2}$

(4)P3



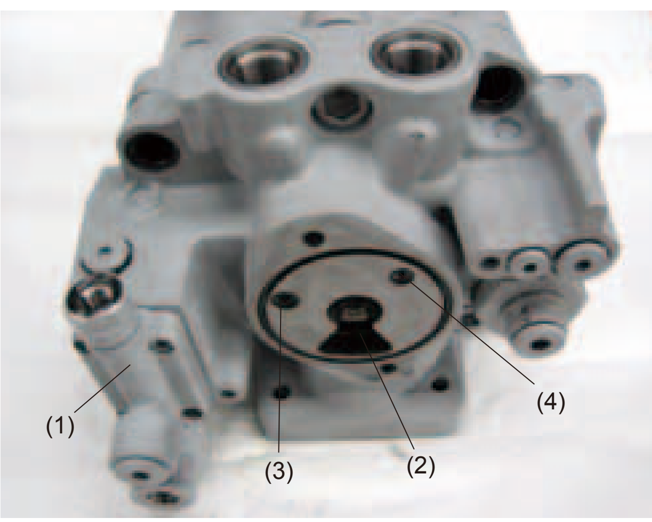
Delivery port
P_1
P_2
P_3
(1)Horse power control valve



(4) P_3 delivery port
(5) P_{LS} port
(6) P_{PS} port

4.Remove gear pump.

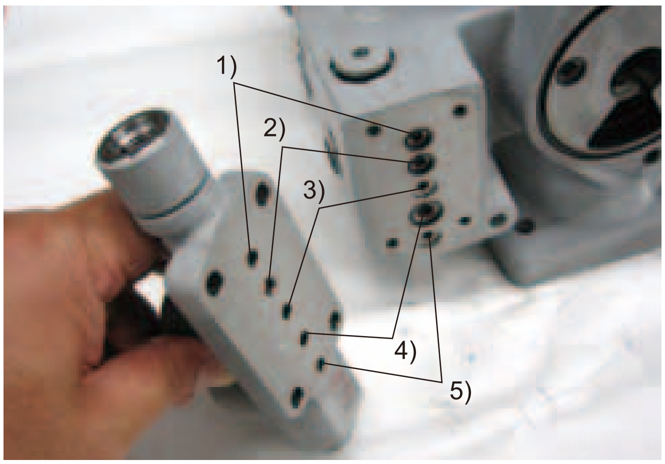
Bolt size :
Wrench :
Tightening torque :



(1)LS control valve.
(2)Section port for P_3, P_p
(3)Delivery port of P_3
(4)Horsepower sensing line of P_3

5. Remove LS control valve

1) Remove the mounting bolts.
   Bolt size :
   Wrench :



2) LS control valve.
   5 ports
   1) Pump pressure sensing line
   2) HPC pilot line
   3) HPC pilot line
   4) Pilot pump pressure after the fixd orifice
   5) Pilot pump pressure before the fixed orifice
   6) Pps port

3) Inner parts.

6. Remove horsepower control valve

1) Horsepower control valve punch the mating mark before disassembling.

2) Take out the valve assy.

3) Inner parts.

4) Average pressure sensing puppet.

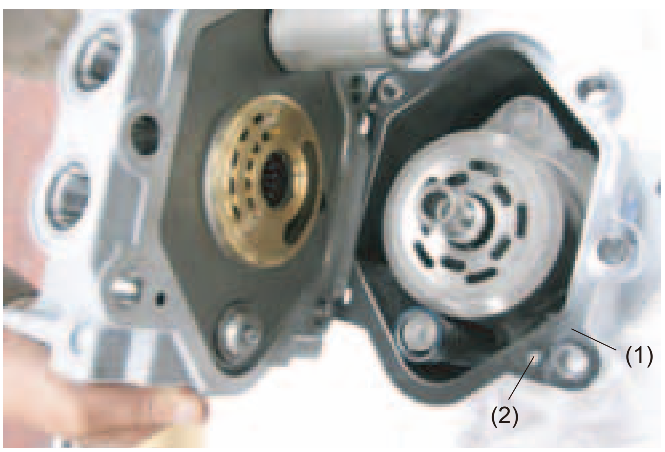
5) Max pump pressure selection check valve.

6) Check valve for Pc bypass.

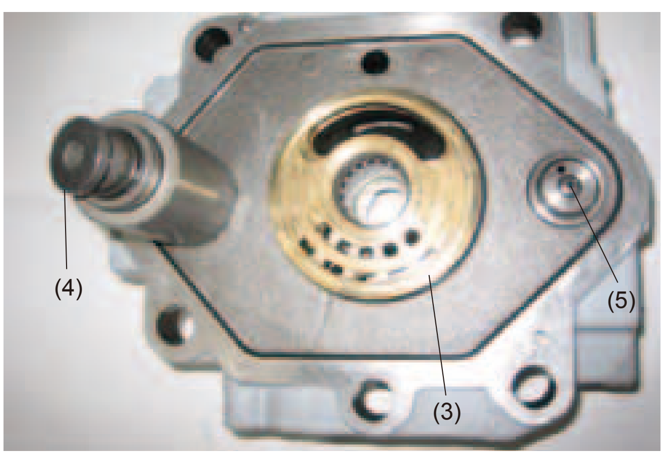
7. Remove the valve block assy

1) Remove the mounting bolts.
   Bolt size :
   Wrench :
   Tightening torque :

2) Rear view of the valve block.



3) Separate the valve block.
   (1)Gasket
   (2)Knock pins



4) View from above.
   (3)Valve plate
   (4)Control plate
   (5)Horsepower control pin

5) Control pin.

6) Control pin body.

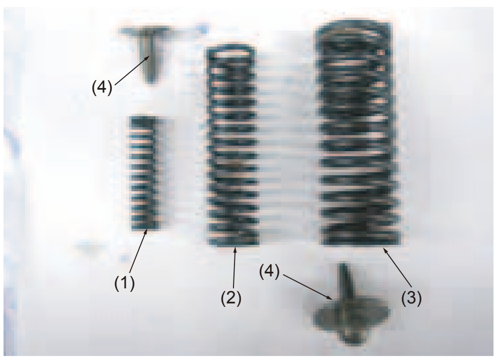
7) Take out the valve plate.

8) Take out the spacer ring.

8. Remove the cylinder block assy

1) Take out the gasket.

2) Take out the control spring assy.



3) Springs

(1)Inner control spring
(2)Outer control spring
(3)Assist spring
(4)Spring seat

4) Take out the cylinder block assy.

5) Swash plate and cylinder block.

6) Inner parts of the cylinder block

(1)Pistons
(2)Cylinder
(3)Cone
(4)Springs

7) Springs

8) Piston

9) Spring seat

9. Remove the main shaft

1) Remove the mounting bolts.
   Bolt size :
   Wrench :
   Tightening torque :

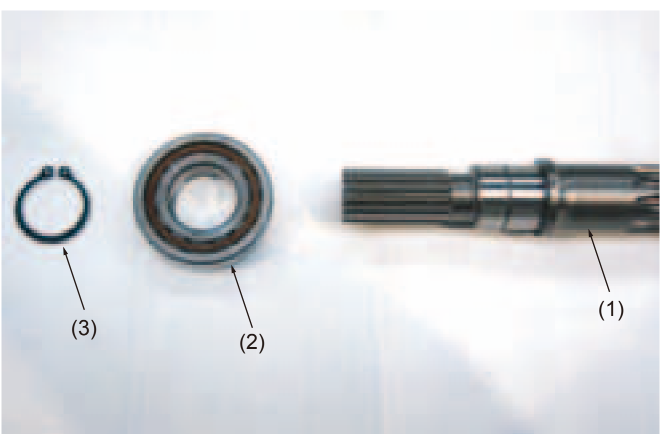
2) Punch out the main shaft.

3) Take out the shaft and the flange.

4) Take out the shaft.

5) Remove the snap ring.

6) Punch out the bearing.



7) Disassembled parts.

(1)Main shaft
(2)Bearing
(3)Snap ring

10. When reassembling

1) Install the snap ring

2) Install the flange

(1)Knock pin

3) Tighten the flange bolt

4) Assemble the pistons and springs.
In principle, each piston should be in the original cylinder barrel.
As a mark, one piston and one spring should be remained for remembrance.

5) Assemble and inner parts and gasket.
Subsequent reassembly procedure is just the reverse to the disassembly.

c.Gear pump (P_3, P_p)

Disassemble and reassemble

1. Outer view
   1) Output shaft
   2) P_3 delivery port

   3) P_p delivery port

2. Remove mounting bolts
   L-wrench=M10
   Tightening torque:

3. Mounting bolts
   M12 x 152

4. Remove the end cover.

5. Remove the casing of the pump 3.

6. Take out the gears and the plates.
   1) P_3 pears 12T x 43.55
   2) Plates

7. Remove the snap ring.

8. Separate the front flange and pilot pump housing
   1) Front flange
   2) Output shelf
   3) Pilot pump gear, T12 x 10.60
   4) Plates

9. Inner parts

   1) Pressure side (delivery)
   2) Suction side

10. Remove the side cover. Take out the yoke gear.

11. When reassembling Securely check the direction and face of the plate.
    1) Delivery side
    2) Suction side

12. Oil passage
    1) Pump 3 sensing line

13. Oil passage
    2) Pilot pump delivery port

14. Oil passage
    1) Pump 3 sensing line
    2) Pilot pump delivery port

15. When reassembly:
    Insert the drive and driven gears of P3.

16. Securely check the direction and face of side plate.

17. Check the seal; rings and knock pin.

d.Control valve

1.Adaptor and joint

1)Fitting the valve assembly (control), bracket (1, valve), bracket (2, valve) and bracket (3, valve) Set them up in the following steps.

a)Fit the three brackets (1, valve) (2, valve) and (3, valve) onto the valve assembly (control). Temporarily tighten the bolts.

b)Place the valve assembly (control) on the base (valve).

c)Tighten up the bolts (1) specified in the figure to fix the bracket (3, valve) onto the base (valve).

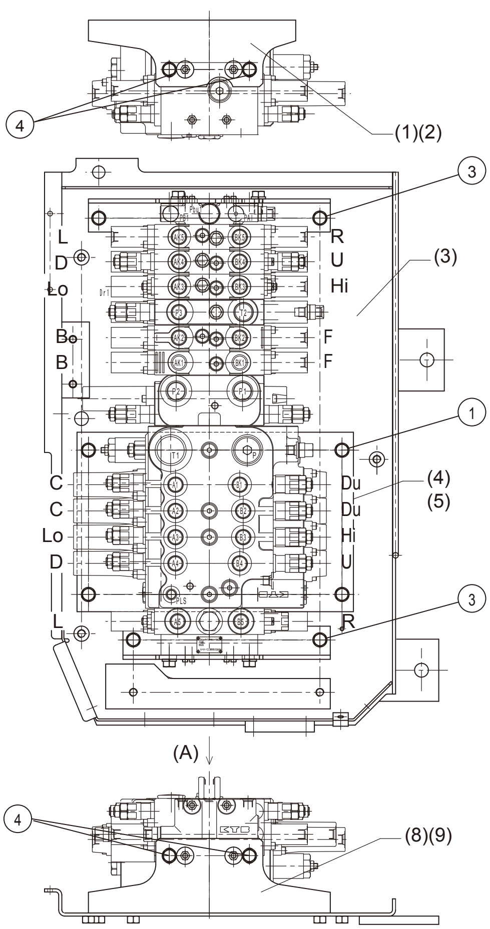
d)Tighten up the bolts (2) specified in the figure to fix the valve assembly (control) to the bracket (3, valve).

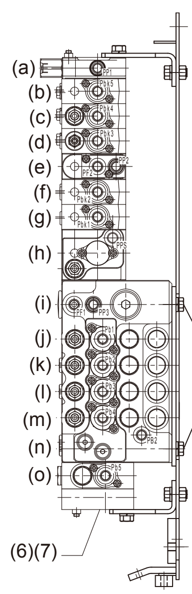
e)Tighten up the bolts (3) specified in the figure to fix the brackets (1, valve) and (2, valve) onto the base (valve).

f)Finally tighten up the bolts (4) as shown at left to fix the valve assembly (control).

2)Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs

3)Fitting the adaptor
Fit the adaptor referring to the instructions on the next page.t





(A)(Machine front)

L:(Left)
R:(Right)

D:(Down)
Lo:(LOW)
B:(Backward)
C:(Crowded)
U:(Up)
Hi:(HIGH)
F:(Forward)
Du:(Dump)

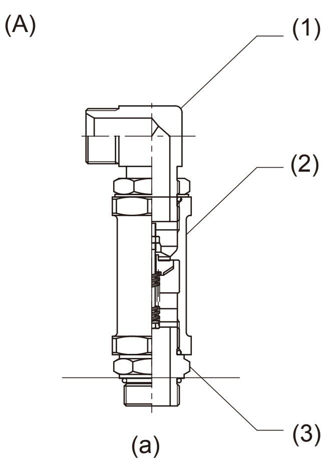
(1)Bracket (1, valve)
(2)Bolt
(3)Base (valve)
(4)Bracket (3, valve)
(5)Bolt
(6)Valve assembly (control)
(7)Bolt
(8)Bracket (2, valve)
(9)Bol

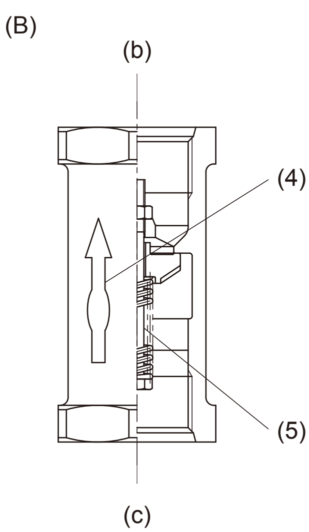
(a)(P3 confluence)
(b)(Swivel)
(c)(Dozer)
(d)(SP2)
(e)(P3, T2)
(f)(Travel left)
(g)(Travel right)
(h)(P1, P2)
(i)(T1)
(j)(Arm)
(k)(Bucket)
(l)(SP1)
(m)(Boom)
(n)(PLS)
(o)(Swing)

4)Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m86.7~94.0ft.lbs
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
7/8-14UNF size
55.9~60.8N.m(5.7~6.2kgf.m)41.2~44.8ft.lbs

5)Tightening torque of the adaptor of port T1 Pipe joint (SG12, G12) Valve assembly (return) Pipe joint (LG12, G12)
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
G1-1/4 size
85.0~100.0N.m(8.7~10.2kgf.m)62.7~73.8ft.lbs
G1-1/4 size
85.0~100.0N.m(8.7~10.2kgf.m)62.7~73.8ft.lbs

6)Fitting direction of the valve assembly (return) (RD809-6351∆)
Fit the assembly in position as shown at left.





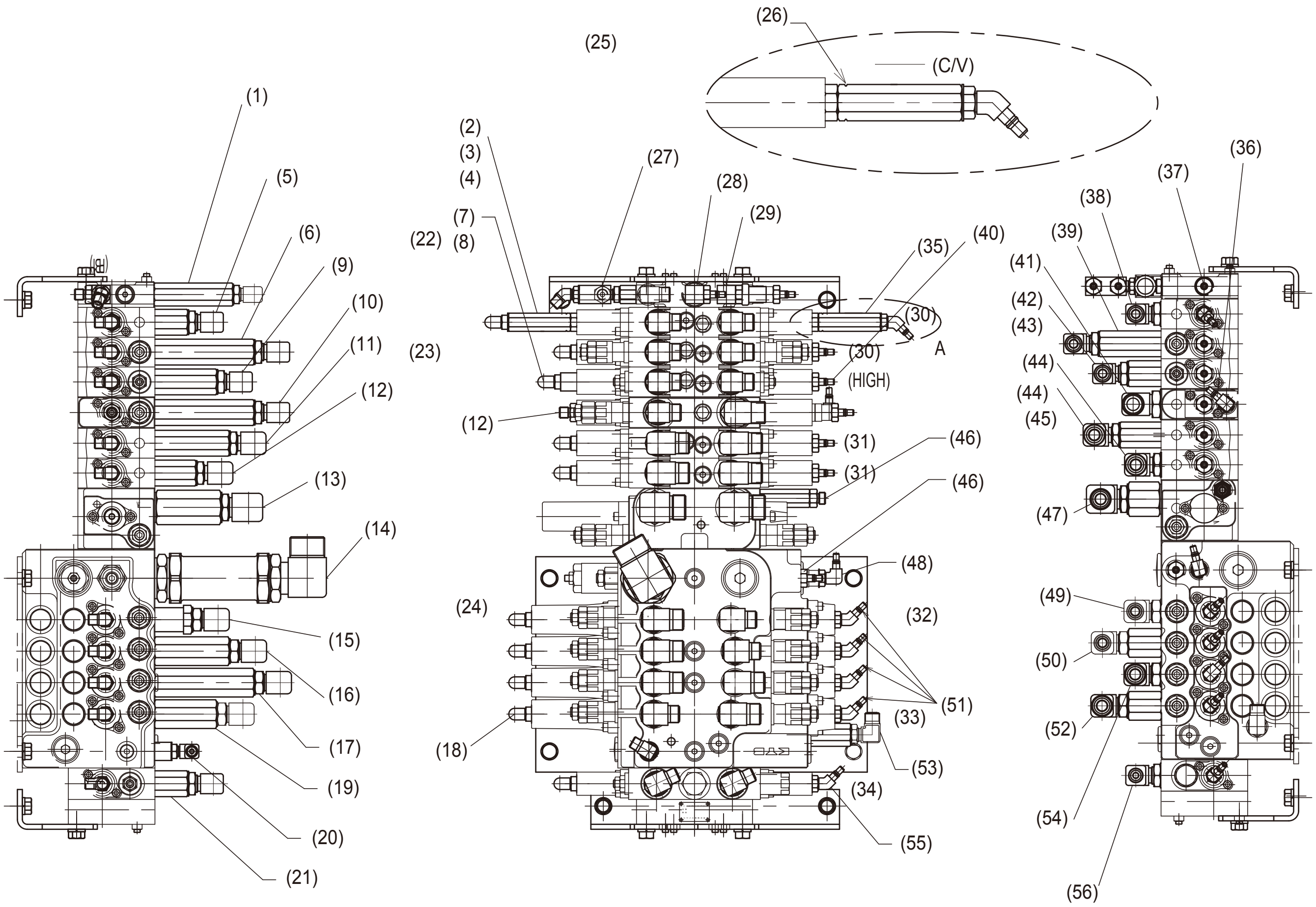
(A)Adaptor at port T1
(B)Fitting direction of the valve assembly (return)

(a)(Control valve side)
(b)(Return pipe side)
(c)(Control valve side)

(1)Pipe joint (LG12, G12)
(Tightening torque)
85.0~100.0N.m
(8.7~10.2kgf.m)62.7~73.8ft.lbs
(2)Valve assembly (return)
(Tightening torque)
85.0~100.0N.m
(8.7~10.2kgf.m)62.7~73.8ft.lbs
(3)Pipe joint (SG12, G12)
(Tightening torque)
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs
(4)Set up the assembly with the outer arrow mark pointing upward.
(5)Look into the inside and make sure the nut head faces toward the control valve.

1.Fitting the valve assembly

Fit the assembly in position as shown at left.
Tightening torque
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

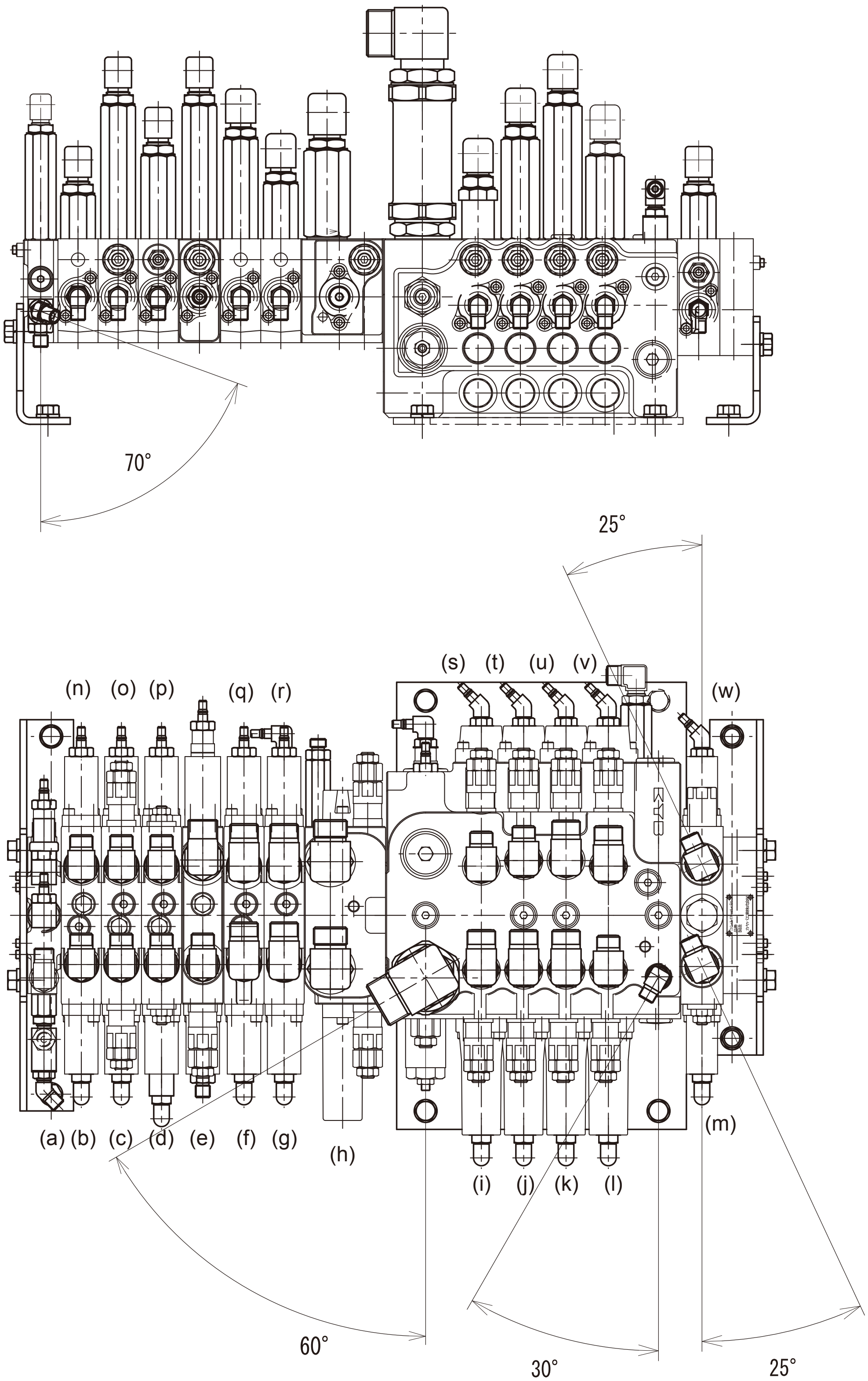


(1)Pipe joint
(2)Pipe joint
(3)O ring
(4)Valve assembly (check)
Pipe joint
(5)Pipe joint
Pipe joint
O ring
(6)Pipe joint
Pipe joint
(7)Pipe joint
Pipe joint
(8)O ring
(9)Pipe joint
Pipe joint
(10)Pipe joint
Pipe joint
(11)Pipe joint
Pipe joint
(12)Pipe joint
Pipe joint
O ring
Adaptor
O ring
(13)Pipe joint
Pipe joint
(14)Pipe joint
Valve assembly (return)
Pipe joint

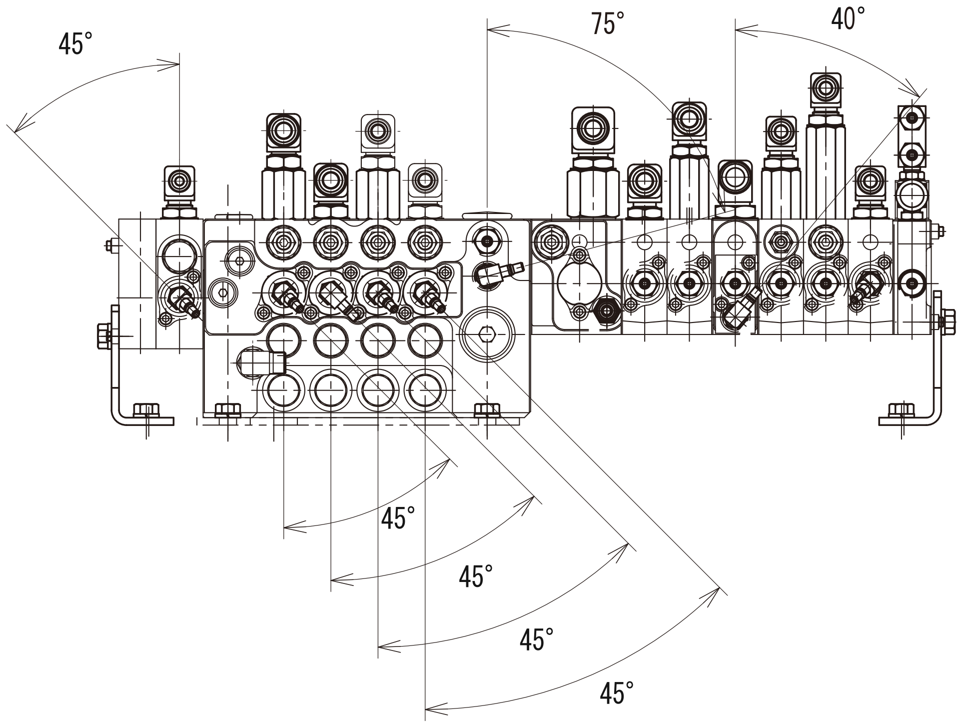
(15)Pipe joint
Pipe joint
(16)Pipe joint
Pipe joint
(17)Pipe joint
Pipe joint
(18)Pipe joint
(19)Pipe joint
Pipe joint
(20)Pipe joint
(21)Pipe joint
Pipe joint
O ring
(22)[PS bypass]
(23)[Swivel] (left)
[Dozer] (bottom)
[S/P2] (low)
[Confluence valve]
[Travel] (left backward)
[Travel] (right backward)
[Travel independent valve
(24)[Arm] (bottom)
[Bucket] (bottom)
[S/P] (low)
[Boom] (rod)
[Swing] (left)
(25)Set up the assembly with the groove toward the C/V as shown at left.

(26)Groove
(27)Pipe joint
O ring
Pipe joint
Adaptor
O ring
Pipe joint
O ring
(28)Pipe joint
Pipe joint
(29)Pipe joint
O ring
Switch
O ring
(30)(Right)
(Rod)
(31)(Left forward)
(Right forward)
(32)(Rod)
(Rod)
(33)(Bottom)
(34)(Right)
(35)Pipe joint
O ring
Valve assembly (check)
Pipe joint
(36)Pipe joint
(37)Pipe joint
(38)Pipe joint

(39)Pipe joint
Pipe join
(40)Pipe joint
(41)Elbow pipe joint
(42)Pipe joint
Pipe joint
(43)O ring
(44)Pipe joint
Pipe joint
Pipe joint
(45)O ring
(46)Pipe joint
Pipe joint
Pipe joint
(47)Pipe joint
Pipe joint
(48)Pipe joint
(49)Pipe joint
(50)Pipe joint
Pipe joint
(51)Pipe joint
(52)Pipe joint
Pipe joint
(53)Pipe joint
Pipe joint
(54)Pipe joint
(55)Pipe joint
(56)Pipe joint



(a)[PS bypass]
(b)[Swivel] (left)
(c)[Dozer] (bottom)
(d)[S/P2] (low)
(e)[Confluence valve]
(f)[Travel] (left backward)
(g)[Travel] (right backward)
(h)[Travel independent valve]
(i)[Arm] (bottom)
(j)[Bucket] (bottom)
(k)[S/P] (low)
(l)[Boom] (rod)
(m)[Swing] (left)
(n)(Right)
(o)(Rod)
(p)(HIGH)
(q)(Left forward)
(r)(Right forward)
(s)(Rod)
(t)(Rod)
(u)(HIGH)
(v)(Bottom)
(w)(Right)


45°
75°
40°
45°
45°
45°
45°

2.Disassembly and reassembly

(a)Valve assy disassembly

1. Lift down the control valve any by using the crane.

2. Lifting eye-bolt
   M10x1.5

3. View from above.

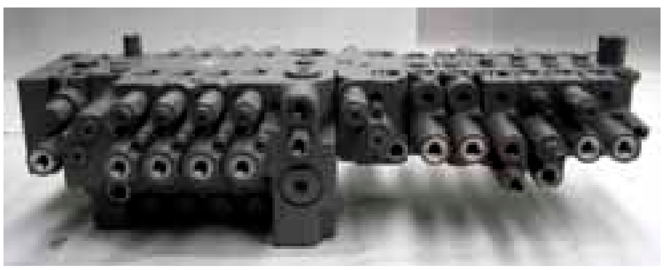
4. View from side.

5. Swing shut valve portion.

6. Unload valve area.

7. Dozer, swivel section area.

8. Side view.



9. Side view, pilot port.

10. Side view, mono block pilot port.

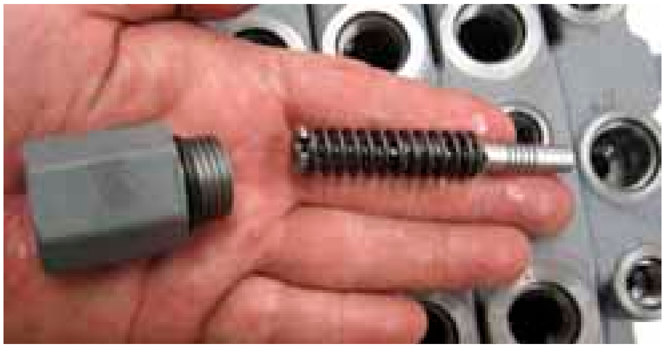
11. Side view
    Pilot port and S/P2 section.

12. P_3 confluence section.

13. Screen and orifice (P_{P1})

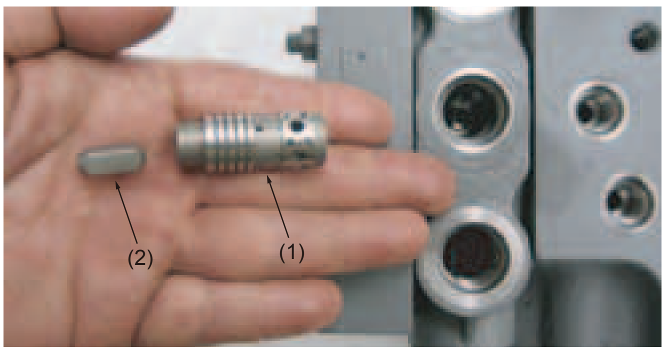
14. Screen and orifice (P_{P2})

15. LS main relief valve inside.



16. P3 bypass spool

17. Plug with orifice (P_{Ls})



18. Compensation spool in the swing section.

(1)Compenstaion spool
(2)High pressure selection poppet

19. Load check poppet and spring.

20. Swing section and end port plate.

21.Swing section and boom section (Mono-block)

22.Am section (Mono-block) and inlet section (Travel independent valve)

23.Inlet section (Travel independent valve) and travel R section.

24.Travel R and travel L section.

25.Travel L and P_3 inlet section.

26. P_3 inlet section and SP2 section.

27. SP2 section and dozer section.

28. Dozer section and swivel section.

29. Swivel section and P3 confluence section.

(b)Each section and inner parts

1.Inlet section (P1,P2) (Travel independent valve)

1) Outer view

2) Other side

3) Inner parts

2. Travel R section

1) Outer view

2) Other side

3) Inner parts

4) Spiral notch-type drain groove of the spool

3. Travel L section

1) Outer view

2) Other side

3) Inner parts

4. P_3 inlet section

1) Outer view

2) Other side

3) Inner parts

4) P_3 confluence spool

5) Pilot port

6) Pilot pressure passage

7) Orifice (P_{P2})

8) Screen (P_{P2})

9) P3 confluence section and spool.

5. S_{P2} valve section

1) Outer view

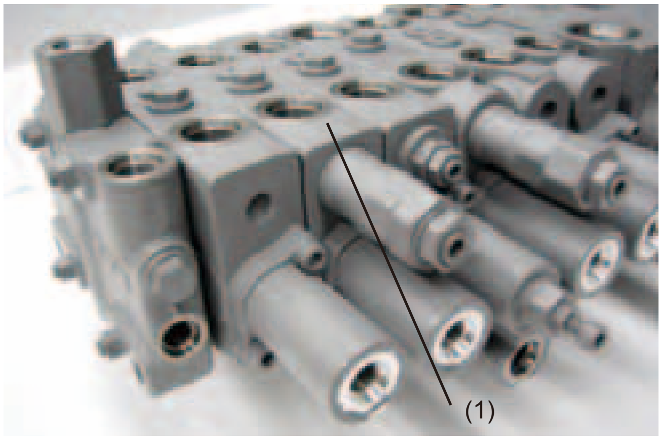
2) Other side

3) Adjusting bolt of SP2 spool.

4) Inner parts

6. Dozer section

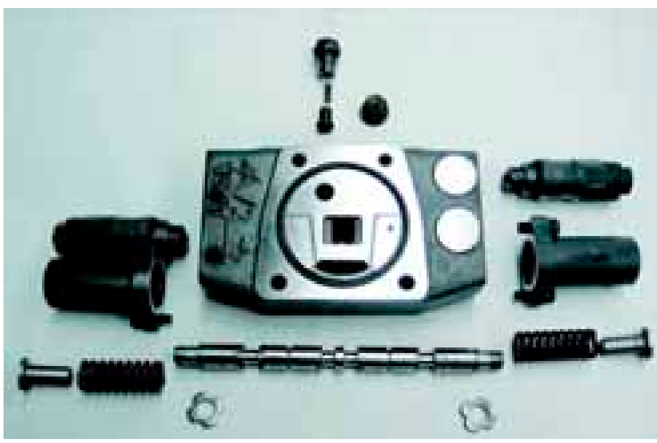
1) Outer view



(1) Dozer section

2) Other side

3) Inner parts



7. Swivel section

1) Outer view

2) Other side

3) Inner parts

8. P_3 confluence valve

1) Outer view

2) Other side

3) Inner parts

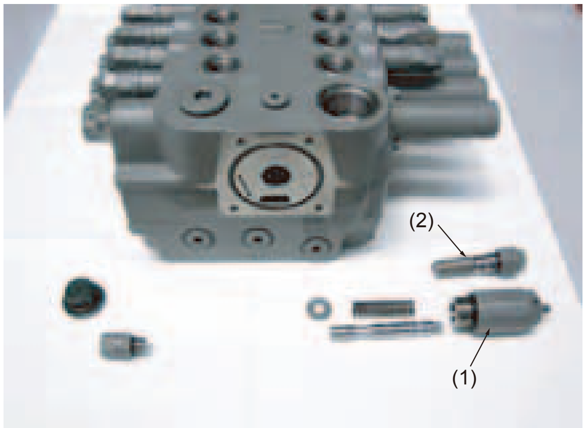
9. Mono-block valve assy

1) Outer view

2) Other side
LS main relief valve Unload valve

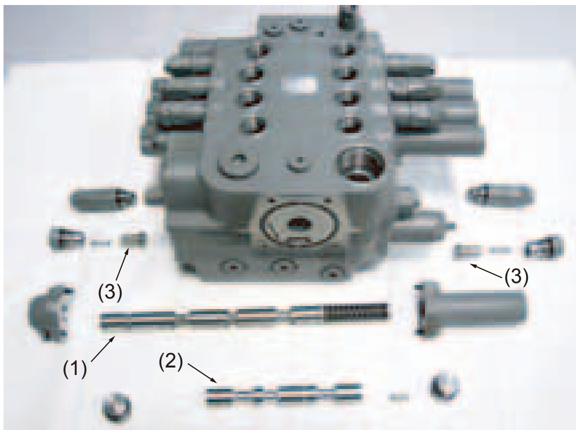
3) Boom valve section.

4) Arm valve section



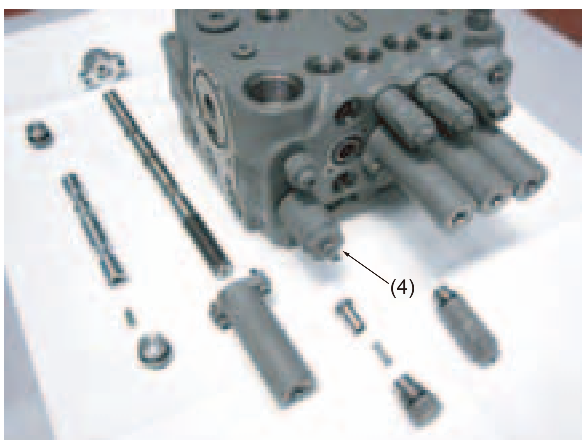
5) Inner parts

(1)LS main relief valve
(2)Unload valve



6) Inner parts Arm section

(1)Main spool
(2)Pressure compensation spool
(3)check valve



7) Side view

(4)Unload valve

8) Side view, P_{P3}

10. Swing valve section

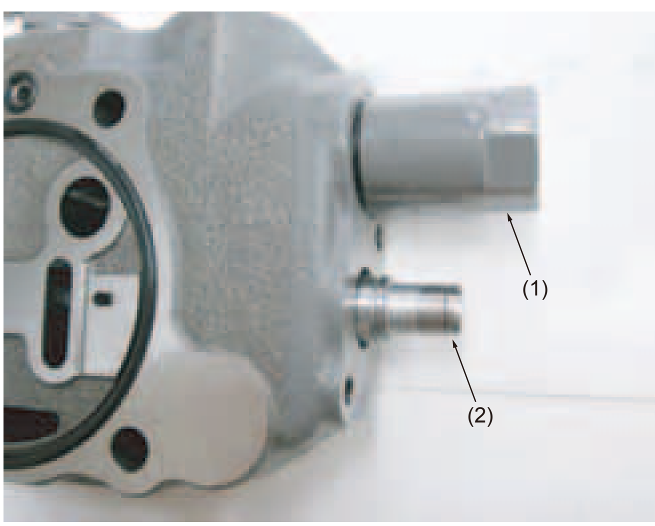
1) Outer view

2) Other side

3) Inner parts

4) Anti-void valve

(2)Spool ID mark



11. End plate

1) Tie rod

2) Tightening method of tie rod.

e. pilot valve

1.Fitting the adaptor

Port P
Filter
Pipe joint
Ports T, 1, 2, 3 and 4
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve

Position the valve with port (2) facing the machine front.

4.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

5.Fitting the thermal insulation (21, cooler) and valve assembly (pilot, R)

Tightening torque
12.3~14.2N.m(1.3~1.5kgf.m)9.1~10.5ft.lbs

6.Fitting the plate (1, partition) and plate (2, partition)

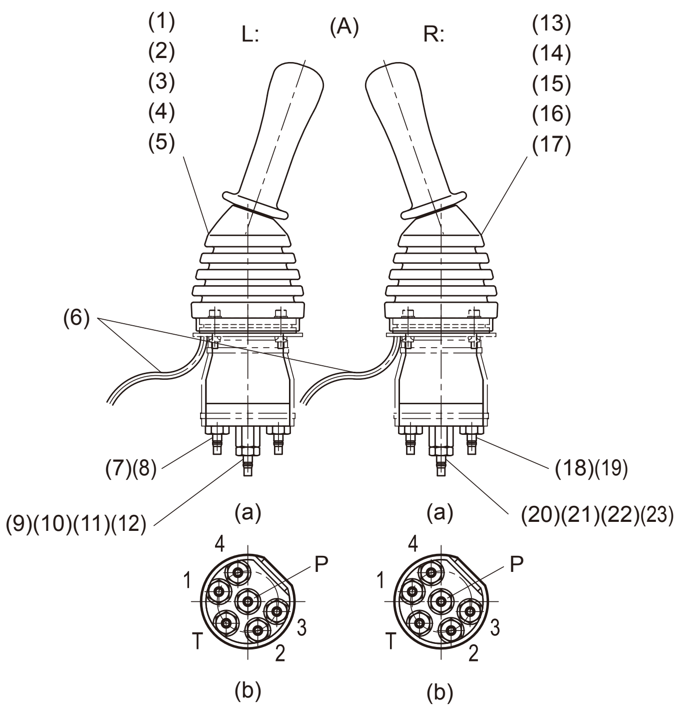
When winding the thermal insulation around the valve, be careful not to wrap the wire harness together.

Left P/V

	Location	Hose tape color
1	Swivel left	Gray
2	Arm dump	Yellowish green
3	Swivel right	Sky-blue
4	Arm crowded	Blue
P	Port P	White
T	Port T	None

Right P/V

	Location	Hose tape color
1	Bucket crowded	Orange
2	Boom down	Yellow
3	Bucket dump	Red
4	Boom up	Green
P	Port P	White
T	Port T	None

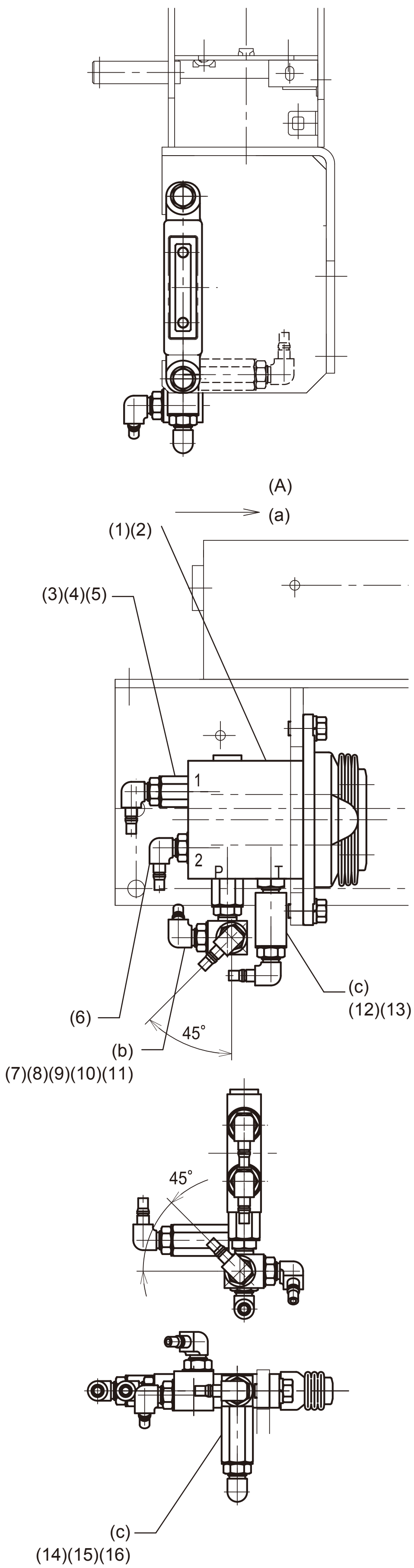


((A)(Viewed from the operator's seat)

L:Left P/V
R:Right P/V

(a)(Back)
(b)(Front)

1)Valve assembly (pilot, L)
(2)Thermal insulation (21, cooler)
(3)Inlet pipe band
(4)Lock socket bolt
(5)Spring washer
(6)Wire harness
(7)Other than port P
(8)Pipe joint (S, G1/4-8.4)
(9)Port P
(10)Filter
(11)O ring
(12)Pipe joint (S, G1/4-8.4)
(13)Valve assembly (pilot, R)
(14)Thermal insulation (21, cooler)
(15)Inlet pipe band
(16)Lock socket bolt
(17)Spring washer
(18)Other than port P
(19)Pipe joint (S, G1/4-8.4)
(20)Port P
(21)Filter
(22)O ring
(23)Pipe joint (S, G1/4-8.4)



f.Dozer pilot valve

1. Adapter and joint

1)Fitting the adaptor
Port P
Filter
Pipe joint
Pipe joint
Ports T, 1 and 2
Fit the adaptor in position as shown at left.

2)Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7t.lbs

3)Fitting direction of the valve
Position the valve with ports P and T facing the machine bottom.

4)Quick-coupling adaptor
Pipe joint
Make sure the hose connection is free from detrimental

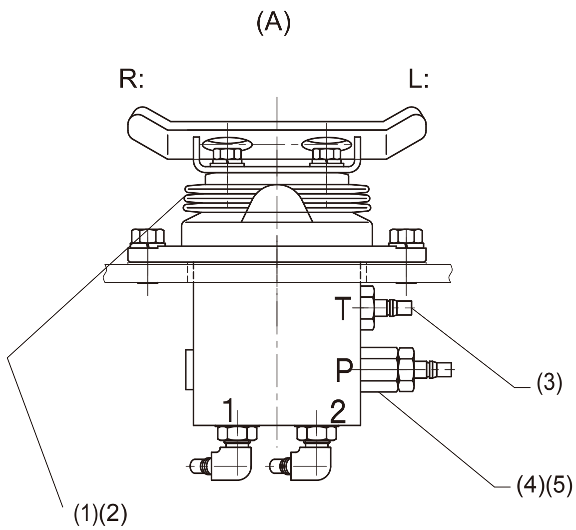
5)Fitting the valve assembly (pilot OFF)
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2t.lbs

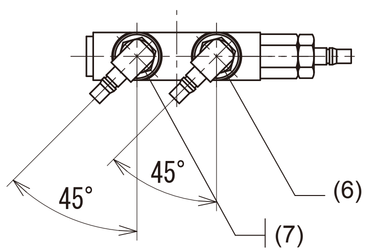
Dozer P/V

	Location	Hose tape color
1	Dozer (down)	Brown
2	Dozer (up)	Pink
P	Port P	White
T	Port T	None

(A)(Viewed from the machine center)
(a)Machine fron
(b)(Port P)
(c)(Port T)

(1)Valve assembly (pilot OFF)
(2)Bolt
(3)Pipe joint (bushing G1/4)
(4)O ring
(5)Pipe joint (QL, G1/4-8.4)
(6)Pipe joint (QL, G1/4-8.4)
(7)Filter
(8)O ring
(9)Pipe joint (L, G1/4-G1/4)
(10)O ring
(11)Pipe joint (QL, G1/4-8.4)
(12)Pipe joint (T, G2-G2-G2)
(13)Pipe joint (QL, G1/4-8.4)
(14)Pipe joint (bushing G1/4)
(15)O ring
(16)Pipe joint (QL, G1/4-8.4)





g.Swing pilot valve

1.Fitting the adaptor

Port P
Filter
Pipe joint
Port T
Pipe joint
Ports 1 and 2
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve

Position the valve with ports P and T facing the machine left side.

4.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

5.Fitting the valve assembly (pilot OFF) (RD809-6551∆)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

Swing P/V

	Location	Hose tape color
1	Swing (right)	Yellowish green, double
2	Swing (left)	Orange, double
P	Port P	White
T	Port T	None

(A)(Viewed from the machine front)

R:(Right swing)
L:(Left swing)

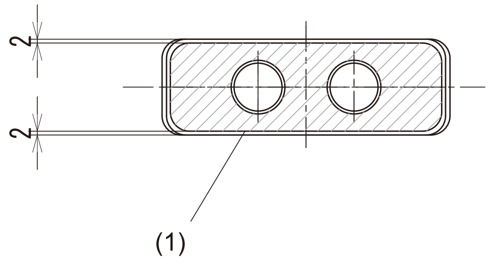
(1)Valve assembly (pilot OFF)
(2)Bolt
(3)Pipe joint (S, G1/4-8.4)
(4)Filter
(5)Pipe joint (S, G1/4-8.4)
(6)Pipe joint (QL, G1/4-8.4)
(7)Pipe joint (QL, G1/4-8.4)

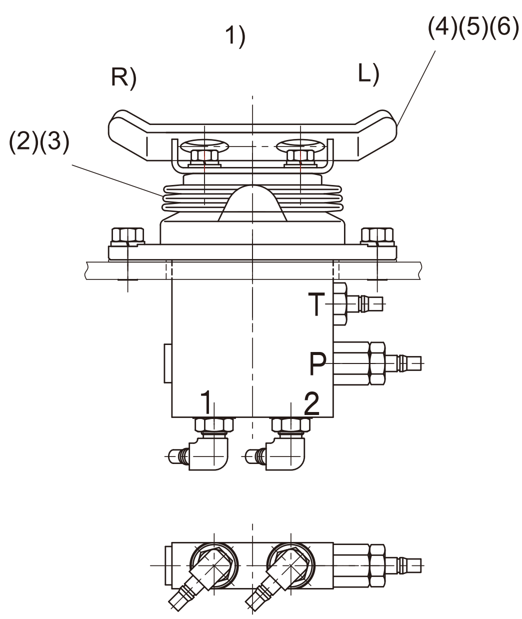
6.Fitting the valve assembly (pilot OFF)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

7.Applying the non-slip sheet (swing pedal)

Apply the sheet as shown at left.





(1)Non-slip sheet (swing pedal)
(2)Valve assembly (pilot OFF)
(3)Bolt
(4)Pedal (swing)
(5)Bolt
(6)Non-slip sheet (swing pedal)

1)View from machine front
R)Right swing
L)Left swing

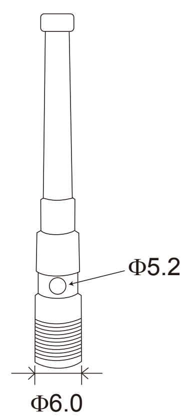
7. Pilot valve disassemble (Dozer, swing)

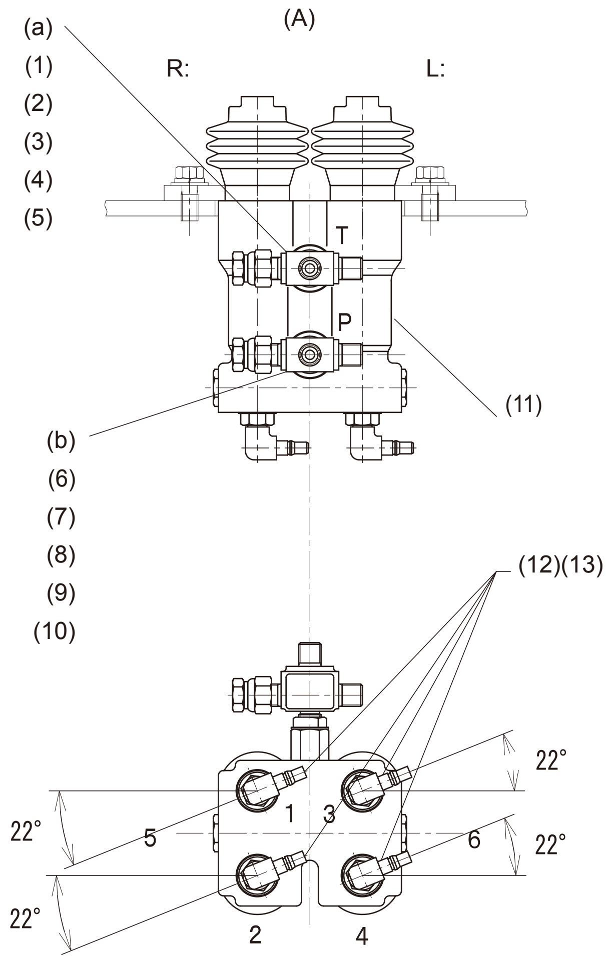
1. Overall structure
   1)
   2)
   3)
   4)

2. Remove the rubber boot and pivot link.

3. Inner parts of push rod and spool

Shims : t=1.0 and 0.5mm





Note: Set up with the hose fixtures out of contact with each other.

(A)(Viewed from the machine back)

R:(Right)
L:(Left)

(a)(Port P)
(b)(Port T)

(1)Pipe joint (bushing G1/4)
(2)O ring
(3)Pipe joint (cross, G1/4)
(4)O ring
(5)Plug
(6)Pipe joint (bushing G1/4)
(7)O ring
(8)Pipe joint (cross, G1/4)
(9)O ring
(10)Plug
(11)Valve assembly (PV, travel)
(12)Pipe joint (QL, G1/4-8.4)
(13)O ring

h.Travel pilot valve

1.Fitting the adaptor

Ports P and T
Pipe joint (bushing G1/4)
Pipe joint (cross, G1/4)
Plug
Ports 1, 2, 3 and 4
Pipe joint

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Plug tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4.Fitting direction of the valve

Pipe joint
Position the valve with port (2) facing the machine front.

5.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

6.Fitting the valve assembly (PV, travel)

Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2ft.lbs

Travel P/V

	Location	Hose tape color
1	Travel (left) backward	Blue, double
2	Travel (left) forward	Red, double
3	Travel (right) backward	Green, double
4	Travel (right) forward	Yellow, double
P	Port P	White
T	Port T	None

7.Troubleshooting and corrective measures

Troubleshooting is not easy. Some assumed causes are listed in the table below. Since repair is difficult, refer to the assumed causes and corrective measures in the table.
Symptoms, assumed causes, and corrective measures in general are listed in the table below. In most cases, a trouble isnot caused bya failureonlywitha singlepart, but caused bya failure involving more than one part.
For this reason, be aware of the fact that corrections may also be necessary other than listed.
Also, the table below does not cover al l the assumed causes and corrective measures.
The persons in charge of repair must further investigate problems and causes as necessary.

Symptom	Cause	Correction
Secondary pressure does not rise.	[1] Insufficient primary pressure [2] The secondary-pressure-setting spring (324) no longer has enough elasticity. [3] The gap between the spool and the casing is too wide. [4] The operating section is not fixed firmly.	[1] Secure primary pressure. [2] Replacewith a new one. [3] Replace the spool and casing assembly. [4] Disassemble, reassemble and replace the operat-ing section component part.
Secondary pressure is unstable.	[1] Sticking portion in siiding part [2] Fluctuations in tank line pressure [3] Air trapped in thepipe	[1] Correct the sticking portion. [2] Returntheoil intotheoil tank directly. [3] Bleed the pipe several times.
Secondary pressure is too high.	[1] Tank line pressure is high. [2] Stickingportion in siidingpart	[1] Return to the oil into the oil tank directly. [2] Correct the sticking portion.
Damping function does not work.	[1] Air is trapped inside the piston chamber. [2] Sticking portion in siiding part [3] The damping springs (336, 337) no longer have enough elasticity. [4] The gap between the dampingpiston (224) and the casing is too wide. [5] Malfunction of the check valve [6] The orifice of the damping piston is too large.	[1] Bleed the air several times. [2] Correct the sticking portion. [3] Replace with a new one. [4] Replace the damping piston and casing assembly. [5] Disassemble and investigate the check valve por-tion. [6] Replace the damping piston.
Damping torque is large.	[1] Stickingportion in siiding part [2] Clogging of the orifice in the damping piston.	[1] Correct the sticking portion. [2] Correct or replace the damping piston.
Shuttle valve does not work. (RCVD8CC only)	Malfunction of the shuttle valve	Disassemble and investigate the shuttle valve portion.

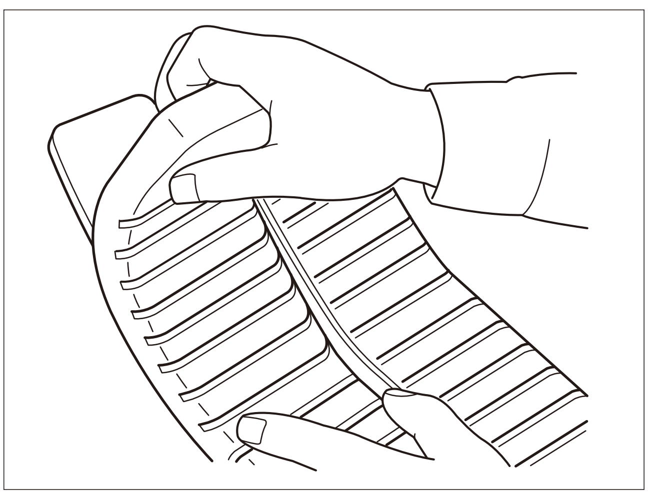
8. Disassembling procedures

1) Operational precautions in general

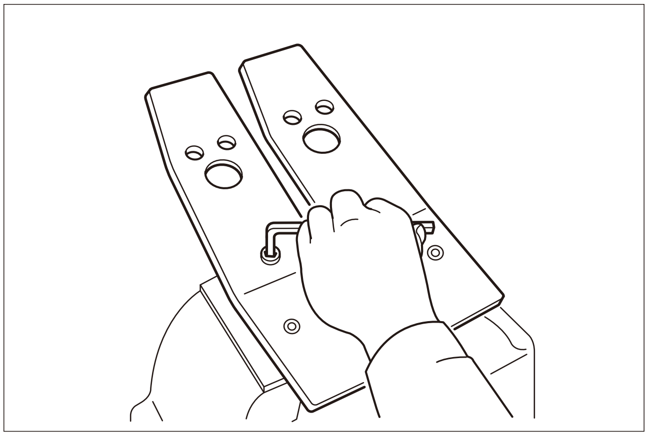
1. Prepare a solid and rattle-free working bench that is wide enough to place parts on and that does not allow the parts to drop or move.
2. Prepare tools and materials.
3. Sinee the parts are very precise, handle themwith much care not to bump them each other or drop them.
4. Do not hit or wrench the parts even when they are hardly moved. Otherwise, burrs may be generated or the parts may be damaged, causing an oil leakage or degradation in performance. Always work with patience with much care.
5. Leaving the parts disassembled may cause them to rust as a result of humidity or contamination. If it is absolutely necessary to stopworking before reassembling, pay attention to prevent rust and dust.

2) Disassembling procedures

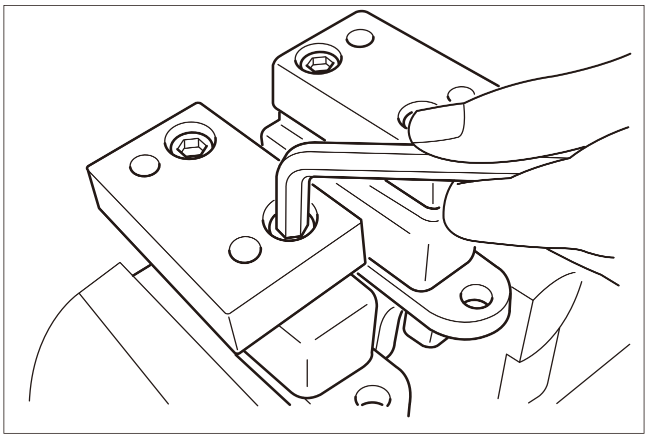
1.Clean the pilot valve with kerosene.
Close each port with a blind plug.



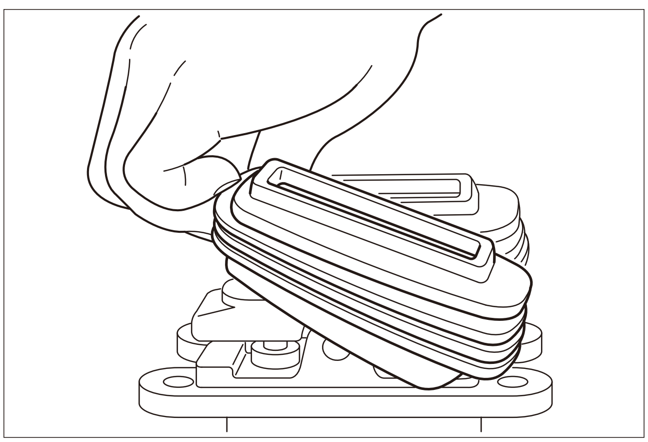
2.Fix the pilot valve on a vice using cushion sheets.
Remove the pedal cover (521) from the pedal (520)



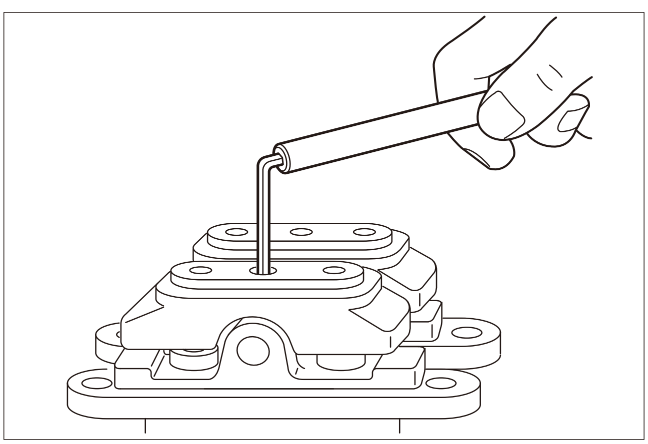
3.Unscrew the Allen screw (522) with an Allen wrench. Remove the pedal (520).



4.Unscrew the Allen screw (473) with an Allen wrench. Remove the block (431).

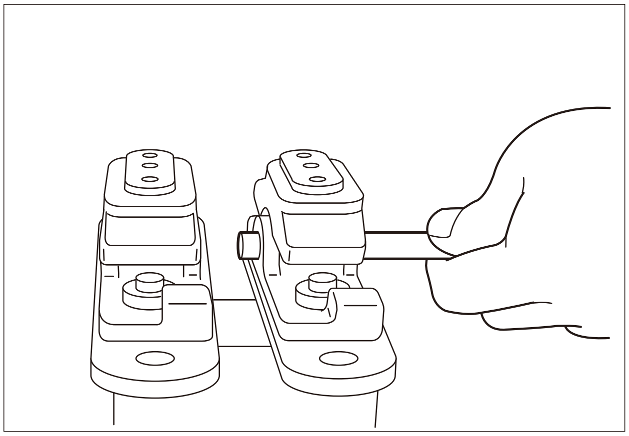


5.Remove the bellows (501) from the cover (201) by pulling the bellows upward.

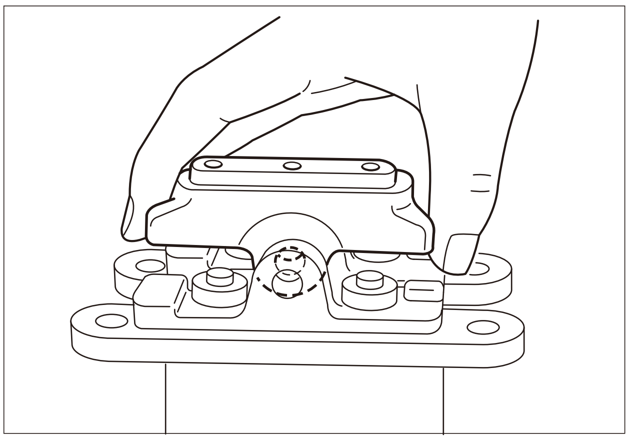


6.Loosen the setscrew (423) with an Allen wrench.

Be careful because Loctite #241 is applied to the setscrew and the tightening torque is large.



7.Putting a round bar (<|)8 or less) on one end of the cam axis (413), tap the bar gently with a hammer to pull out the axis.

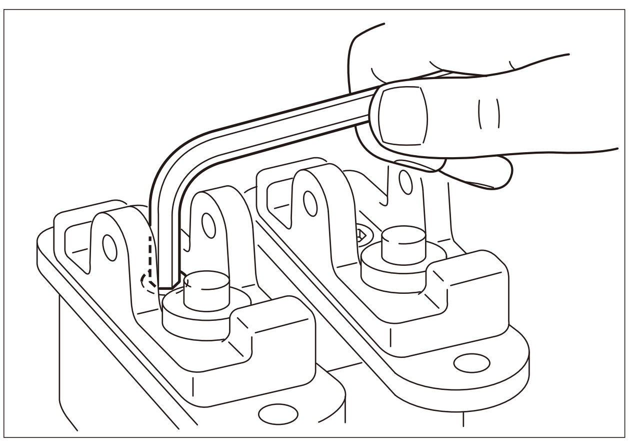


8.Remove the cam (420) as an assemblywith the setscrew (471) and lock nut (472) attached.

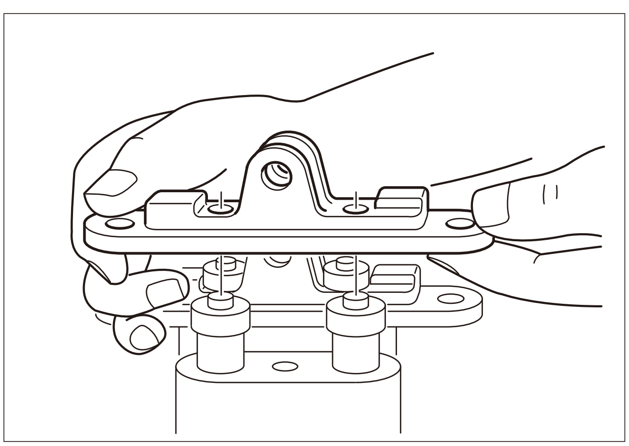
Note down the positional relationship between the cam and the cover (201).

Be careful because the push rod (214) may push out while the cam is removed.

Caution



9.Unscrew the Allen screw (271) with an Allen wrench.

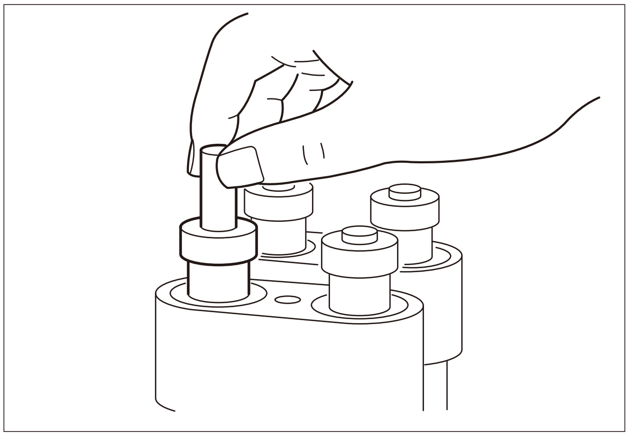


10.Remove the cover (201).

Note down the positional relationship between the cover and thecasing (101).

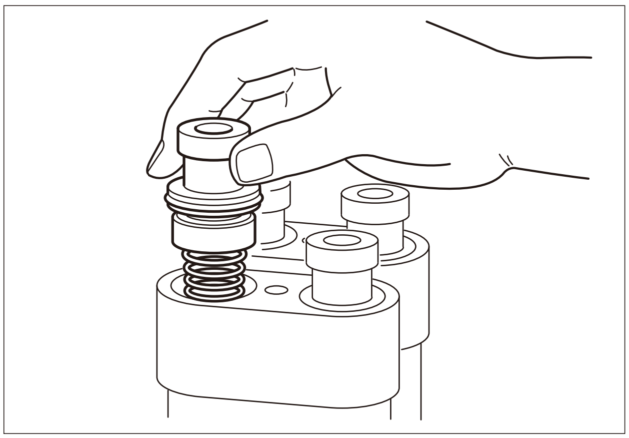
Be careful because the push rod (214) and theplug (202) maybe pushed out by the damping springs (336, 337) while the cover is removed. (The plug remains inside the casing as a result of the friction of the 0-ring (212) only.)

Caution



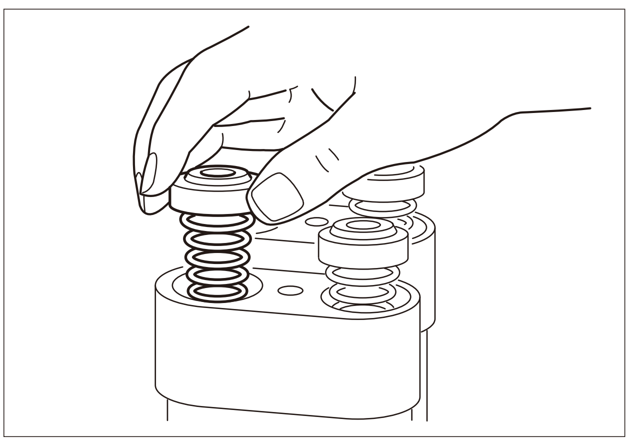
11.Pull out the push rod from the plug.
Note down the positional relationship between the plug and the push rod.
Take care not to scratch the push rod surface.
Be careful because the plug may be pushed out while the push rod is removed.

Caution

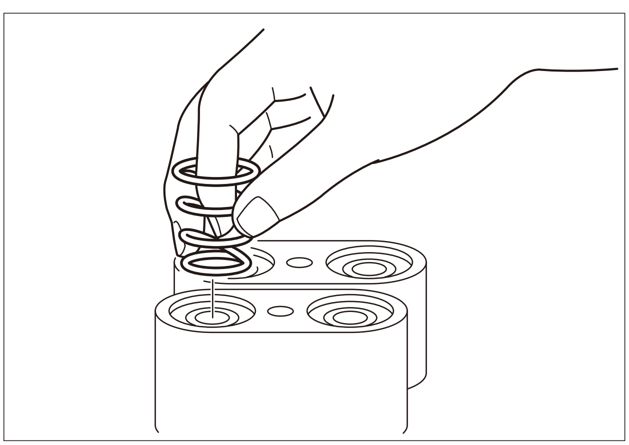


12.Remove the plugwith the grease cup (203),NHU packing (210) and O-ring (212) attached.
Note down the positional relationship between the plug and the casing.
Be careful because the piston is pushed out by the damping spring while the plug is removed.

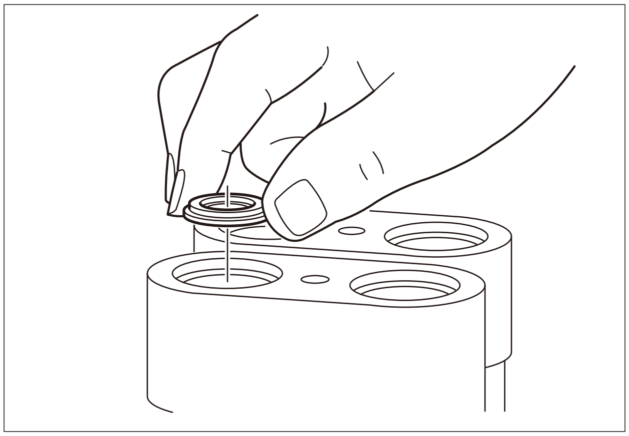
Caution



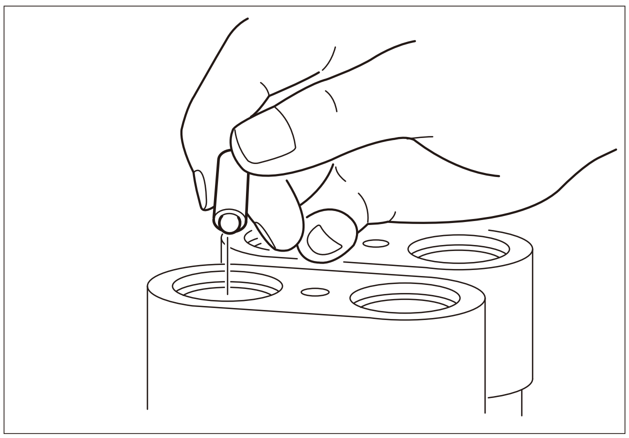
13.Remove the piston (224).
Note down the positional relationship between the piston and the hole in the casing.



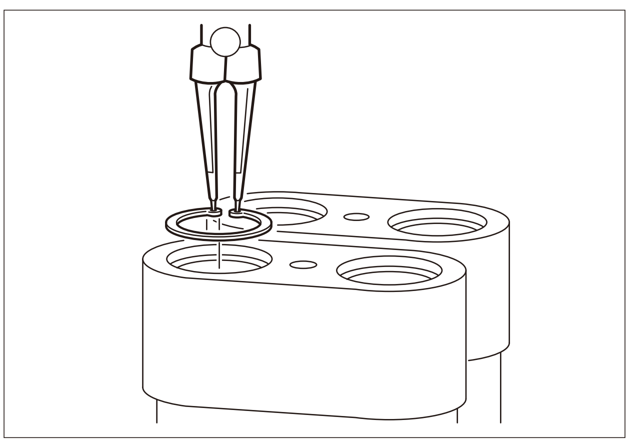
14.Remove the damping springs (336, 337) from the casing.
Note down the positional relationship between the damping spring and the hole in the casing.



15.Remove the spring seat (218) from the casing.
Note down the positional relationship between the spring seat and the hole in the casing.

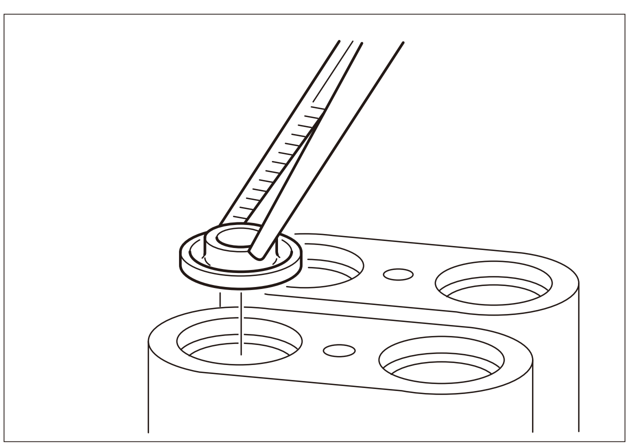


16.Remove the steel ball (225) usingadevice, such as a magnet.
Take care not to losethe steel ball.

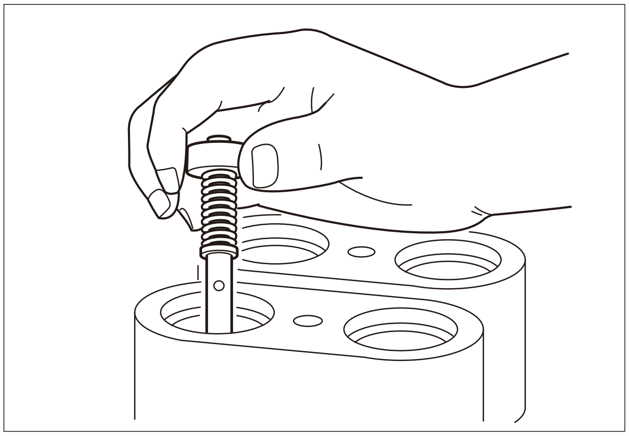


17.Remove the locking ring (221) from the casing using piiers.
Note down the positional relationship between the locking ring and the hole in the casing.
Be careful because the bush may be pushed out by the return spring (335) while the locking ring is removed.
Take care not to damage the casing inside surface.

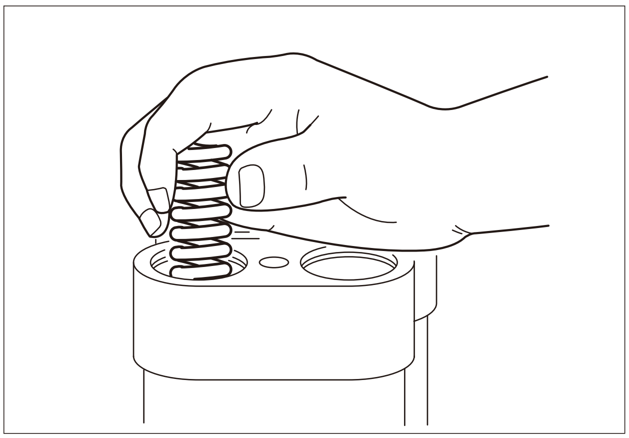
Caution

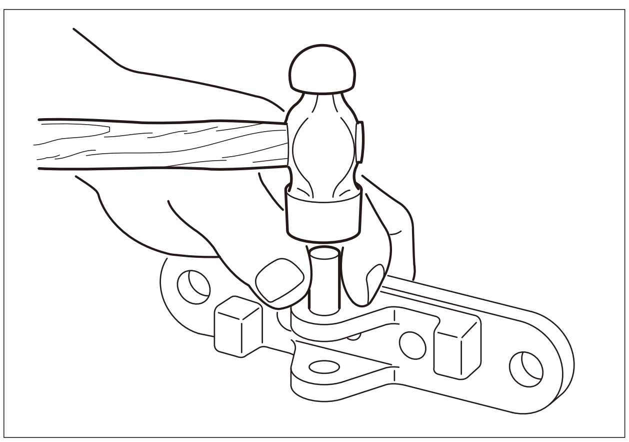


18.Takethebush (223) out of the casing using tweezers.
Note down the positional relationship between the bush and the hole in the casing.

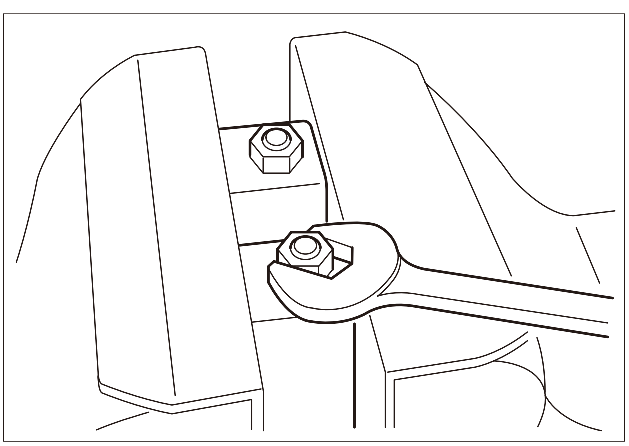


19.Remove the reducing valve section assembly and the return spring (335) from the casing.
Note down the positional relationship with the casing hole.

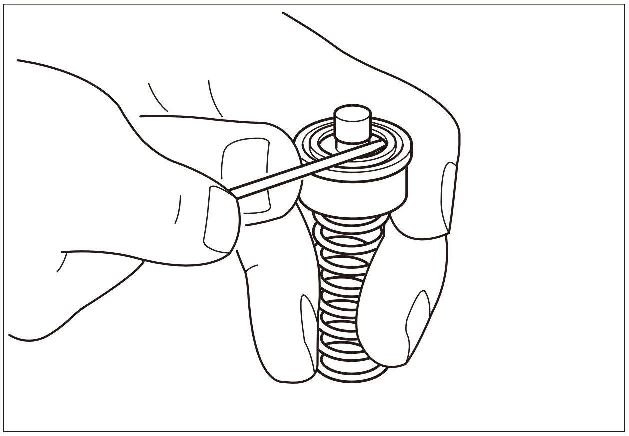




20.Place the cover (201) with its side downward on aflattable. Puttingthespecial tool 1 on thebush (412), tap the tool with a hammer to pull out the bush.



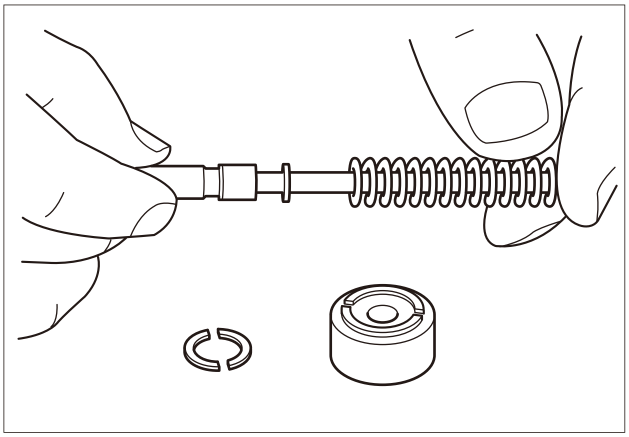
21.Fix the camassembly on avice, untighten the lock nut (472) with a spanner then remove the lock nut and setscrew (471).
If setscrew replacement is not required, handle the setscrews as part of the cam assembly thereafter since neutral position adjustment is required when setting up the cam assembly.



22.To dismantle the reducing valve section assembly, stand upright the spool (301) bottom end on a flat work bench, push down the spring seat (311) then remove 2 semicircular washers 1 (215) usinga small flat-head screwdr iver tip.

Take care not to scratch the spool surface.

Do not lower the spring seat by more than 4 mm.

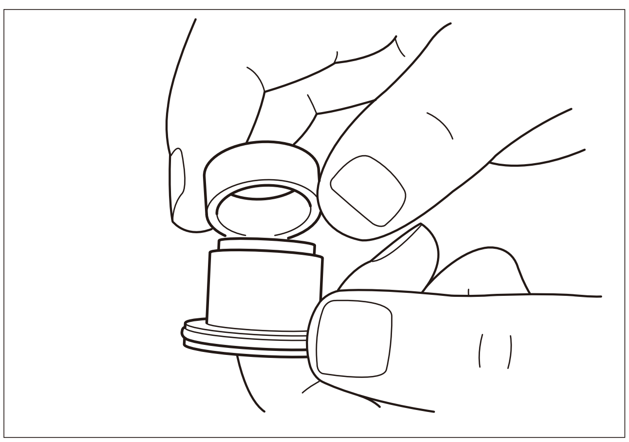


23.Remove the spool (301), spring seat (311), secondary-pressure-setting spring (324), washer 2 (217) and washer 3 (313).

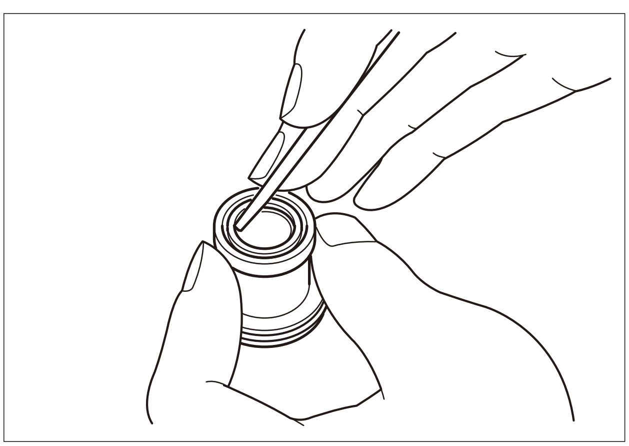
Treat the parts as an assembly until they are installed.

The washer 2, whose thickness varies dependingon the spool assembly, is for adjustment to preset the secondary-pressure-setting spr ing.

However, in some cases, the washer is not used.

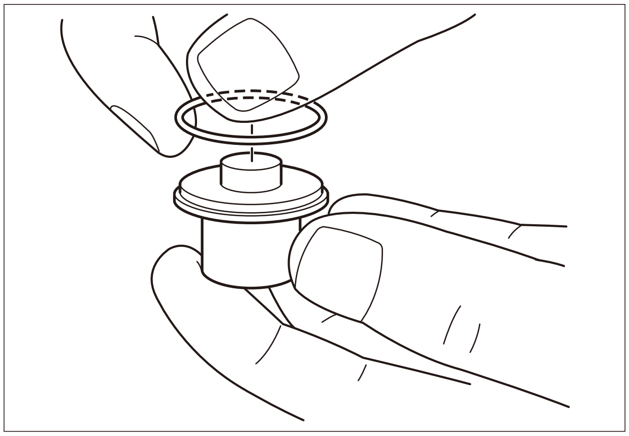


24.Remove the grease cup (203) from the plug (202).

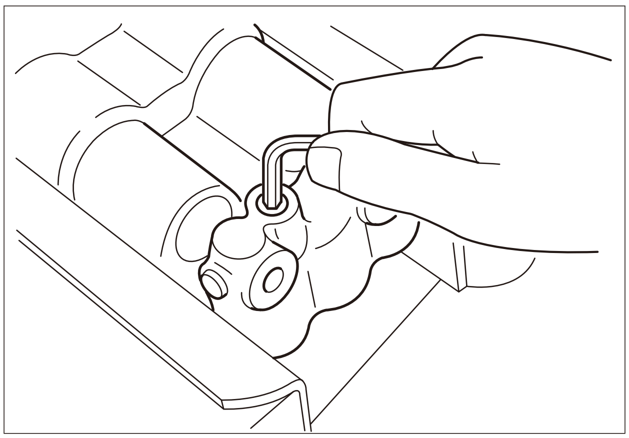


25.Remove the NHU packing (210) from the plug using a small flat-head screwdriver or the like.

Take care not to scratch the internal surface of the plug.

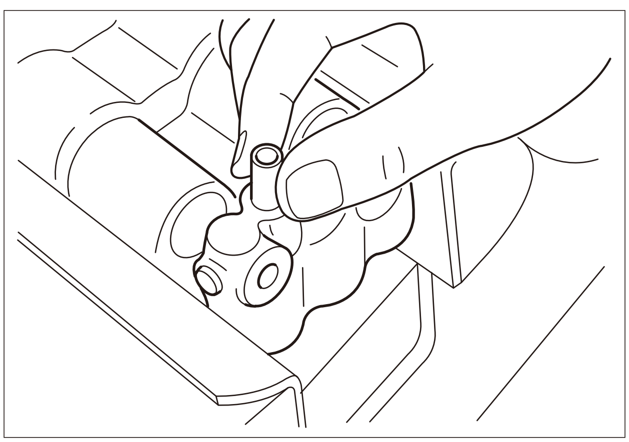


26.Remove the 0-ring (212) from the plug.



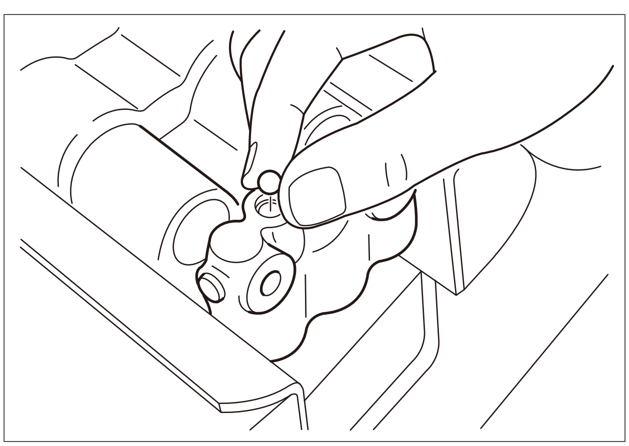
27.Fix the Casing (101) on a vice using cushion sheets. Unscrew the Plug (153) with an Allen wrench.

(RCVD8CC only)



28.Pull out the Seat (191) from the Casing (101).

(RCVD8CC only)



29.Remove the Steel ball (192) from the Casing (101).

(RCVD8CC only)

30.Cleaning the parts

1) Put the parts into the kerosene contained in a rough-cleaning container, and clean them. (Rough-cleaning)

    If the parts are washed immediately after put into the kerosene, they are easily scratched. Wait until contaminations and oily substances are detached and floated on the surface of the kerosene.

    Contaminated kerosene tends to cause the parts to be damaged, and the performance of the parts becomes degraded after they are assembled.
    Pay much attention to the degree of contamination of the kerosene.

2) Put the parts into the kerosene contained in a finish-cleaning container, and rotate them slowly until their internal surfaces can be cleaned well (Finish-cleaning).
   Wipe out the kerosene from the parts with a clean waste cloth.

    Do not dry the parts with compressed air. Otherwise, they may be scratched or rusted with the dust or moisture in the air.

31.Preventing the parts from rusting Apply a rust inhibitor to the parts.

    Leaving the parts without wiping the kerosene causes them to rust, resulting in degraded performance after assembled.

9. Assembling instructions

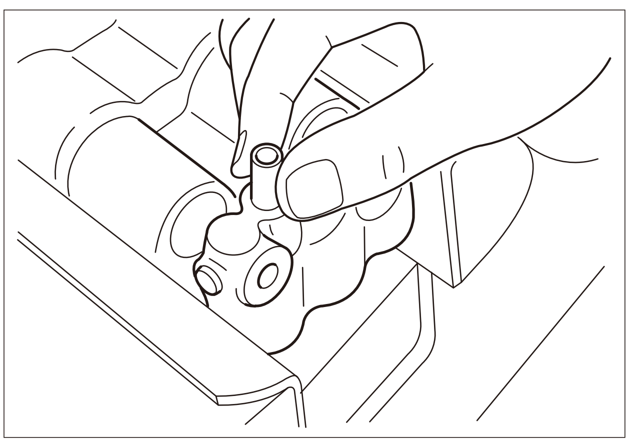
1) Operational precautions in general

(1)As done for disassembling, prepare a working bench and tools.
(2)Pay attention as done for disassembling.
(3)Before assembling, remove bits of metal or foreign material from all the parts, and also check that there is no burrs or dents on the parts. If you find burrs or dents, remove them with an oilstone.
(4)As a rule, replace all 0-rings and NHU packing with new one.
(5 Install the 0-rings and NHU packing, taking care not to damage them. (Apply a little amount of grease for smooth installation.)
(6)To prevent the parts from dropping, use grease.
(7)Tighten the bolts with the torque shown in the assembly cross-section drawing.
(8)After the assembling is completed, close all the ports with plugs to prevent dust from entering.

2) Assembling procedures

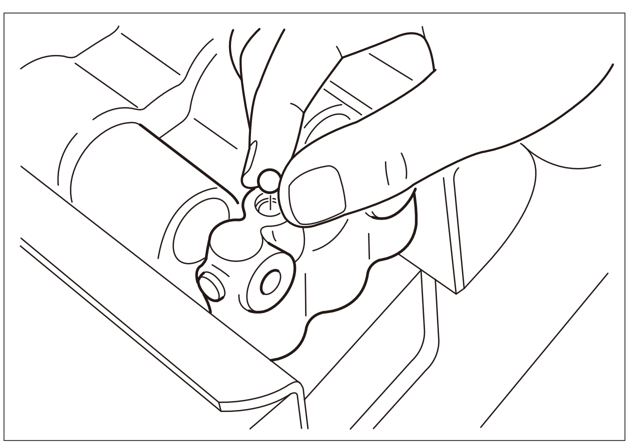
1.Fix the Casing (101) on a vice using cushion sheets. Set the steel ball (192) in the Casing (101).

(RCVD8CC only)



2.Set the Seat (191) in the Casing (101).

(RCVD8CC only)



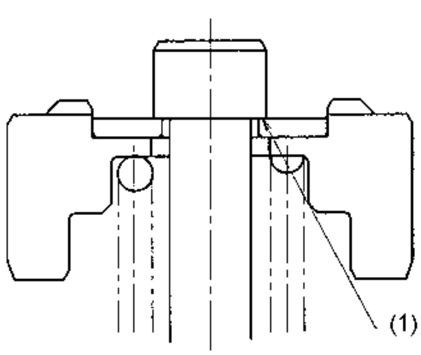
3.Tighten the Plug (153) with the torque specified.

(RCVD8CC only)

4.Attach the washer 3 (313), the washer 2 (217), the secondary-pressure-setting spring (324), and the spring seat (311) to the spool (301) in this order.

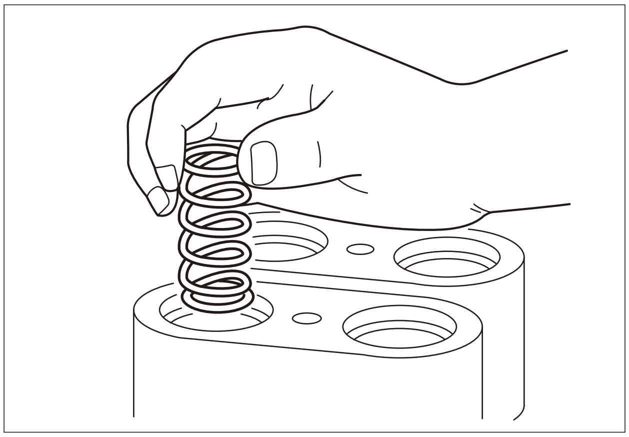
The washer 2, whose thickness varies depending on the spool assembly, is for adjustment to preset the secondary-pressure-setting spr ing. However, in some cases, the washer is not used.

5.Stand the spool (301) bottom end upright on a flat work bench, push the springseat (311) down then fit 2 semicircular washers 1 (215) to the spring seat top without overlapping the washers.

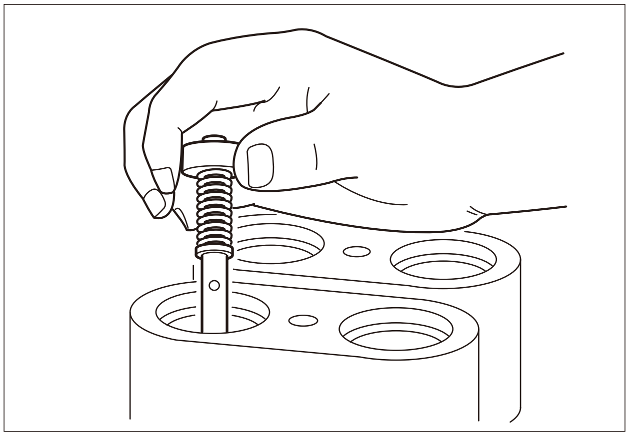


Fit washers 1 with the sharp edges turned upward and hooked on the spool head.
Do not lower the spring seat by more than 4 mm.

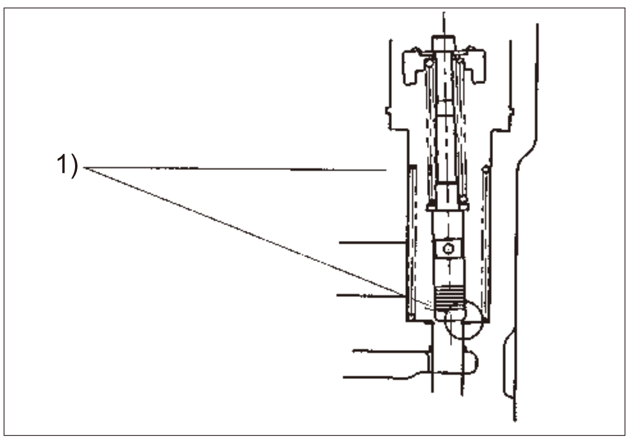
(1)Sharp edge side



6.Install the return spring (335) into the casing.
Install it at the previous position before it was disassembled.

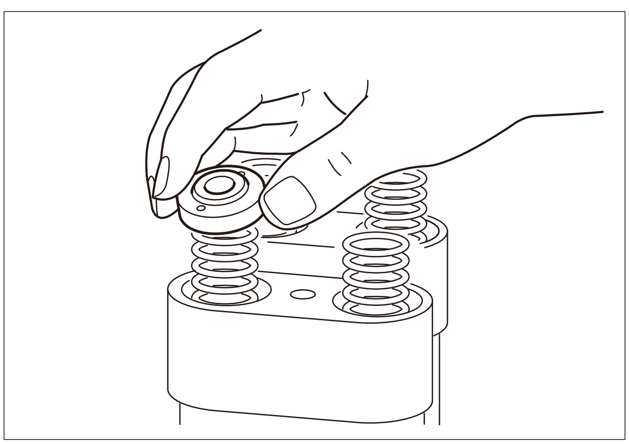


7.Install the reducing valve section subassembly, assembled in 1 and 2 above, into the casing.
Install it at the previous position before it was disassembled.

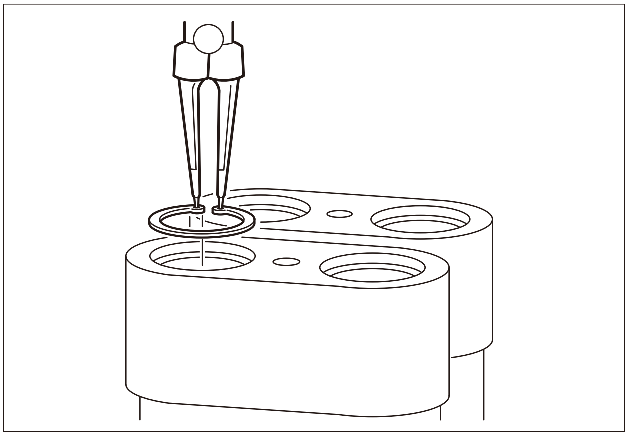


Take care not to hit the bottom of the spool strongly onto the corner of the casing while installing the reducing valve section subassembly.

1)Pay attention to the corner of the casing



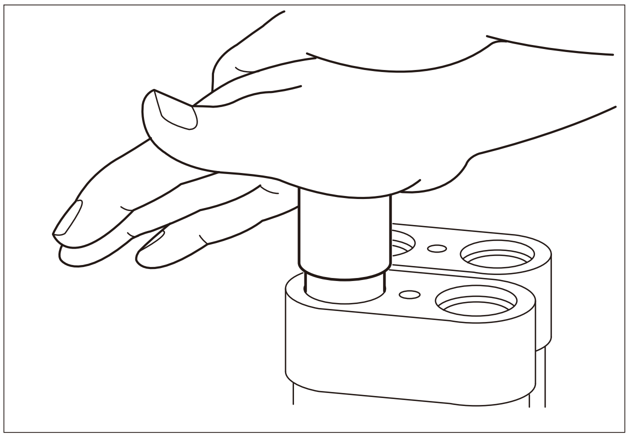
8.Install the bush (223) in the casing, and set it on the spring seat (311).
Install it at the previous position before it was disassembled.



9.Tentatively set the locking ring (221) in the casing hole using pliers.

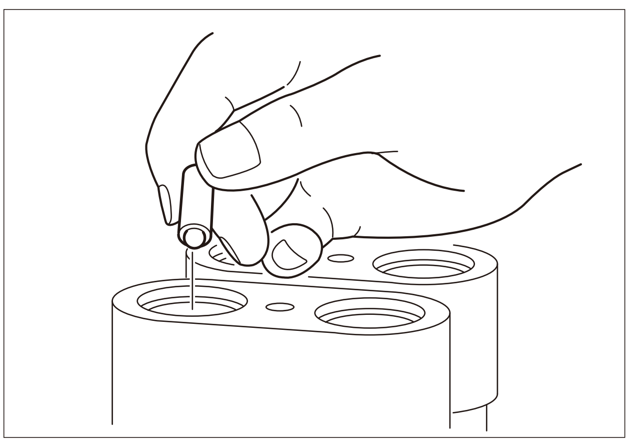
Set the locking ringwhere it was before the disassembly.
Set the locking ring horizontally.
Take care not to damage the casing inside surface.
Turn the locking ring sharp edge upward.

Caution

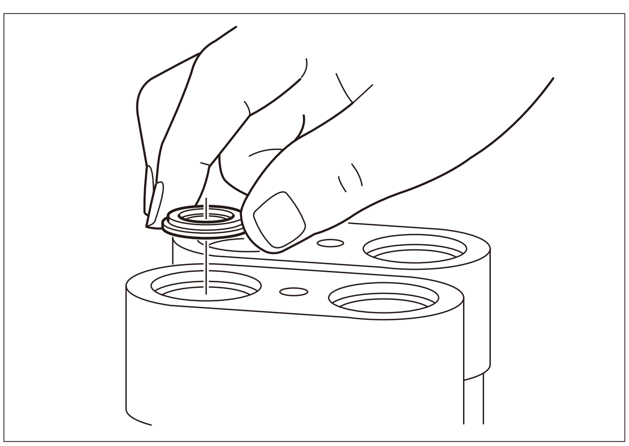


10.Set special tool 2 in thecasinghole, and push it in together with the return spring andbushuntil the lockingring is fit inthe groove with a click.

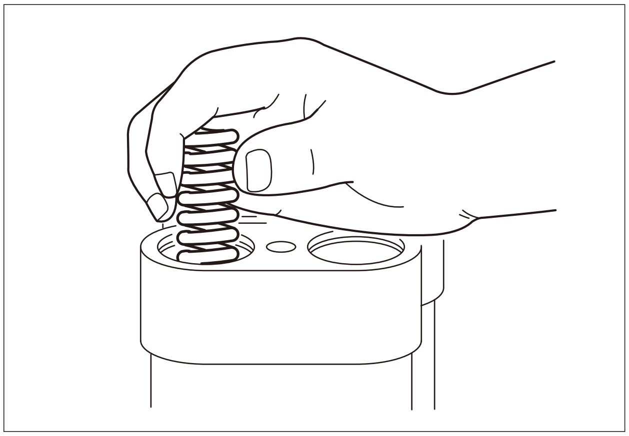
Push the tool slowly and carefully so the casing inside surface cannot be damaged.



11.Set the steel ball (225) in thebush.

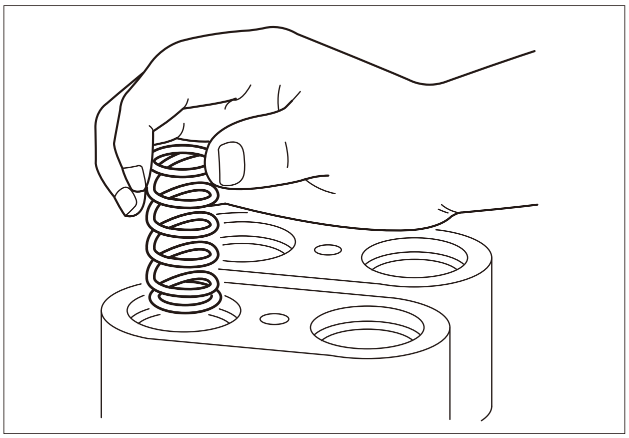


12.Set the springseat (218) inthebush.
Install it at the previous position before it was disassembled.

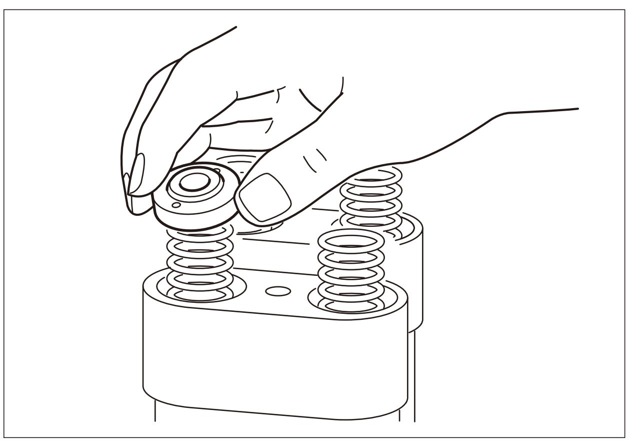


13.Install the damping spring (336) in the casing.

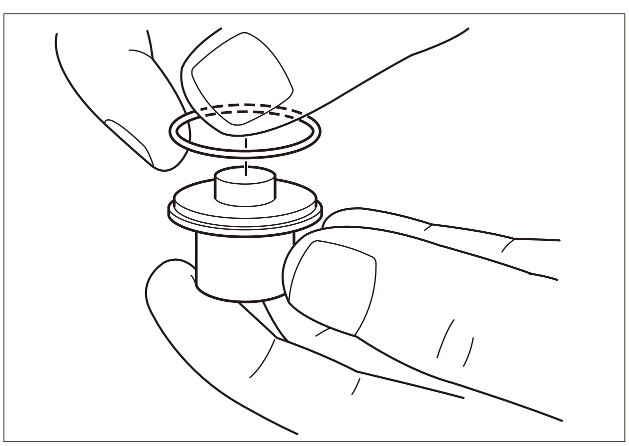
Install it at the previous position before it was disassembled.



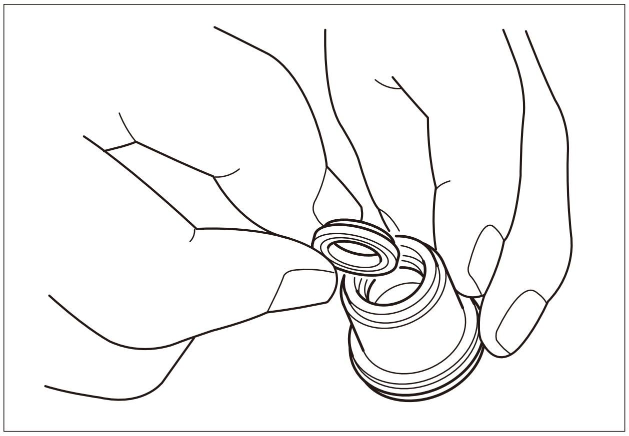
14.Install the damping spring (337) in the casing.
Install it at the previous position before it was disassembled.
Take care so the damping spring (337) does not interfere with the damping spring (336).



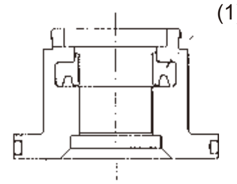
15.Install the piston (224).
Install it at the previous position before it was disassembled.



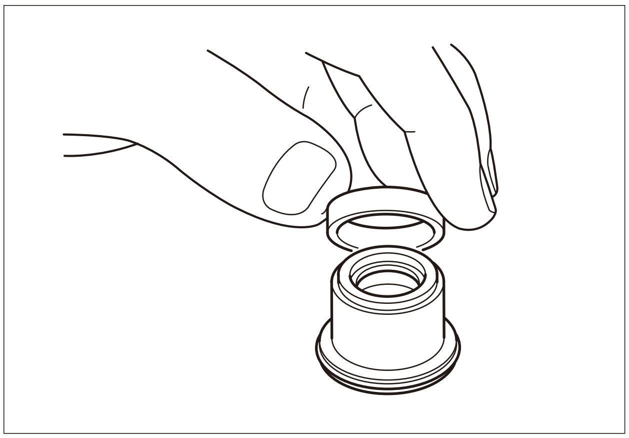
16.Install the O-ring (212) ontheplug (202).



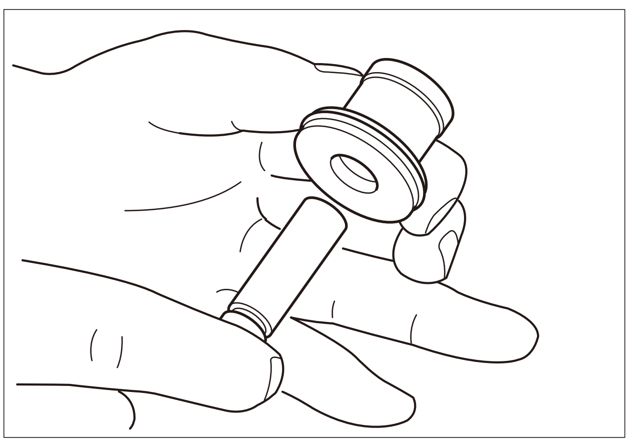
17. Install the NHU packing (210) into the plug.
    When you install the NHU packing, pay attention to its direction. (Refer to the following figure.)
    Apply a thin film of grease to the NHU packing before installing it.



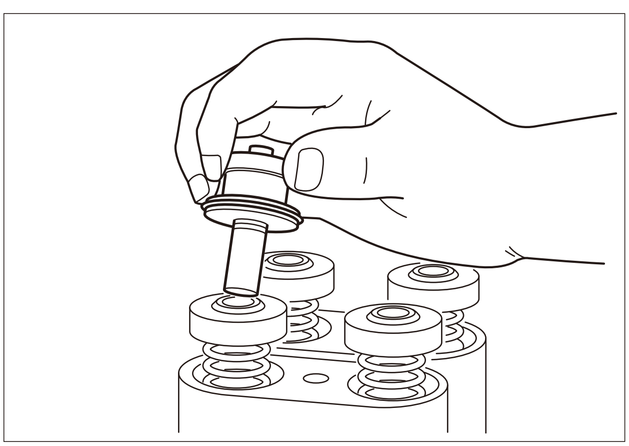
1)NHU packing



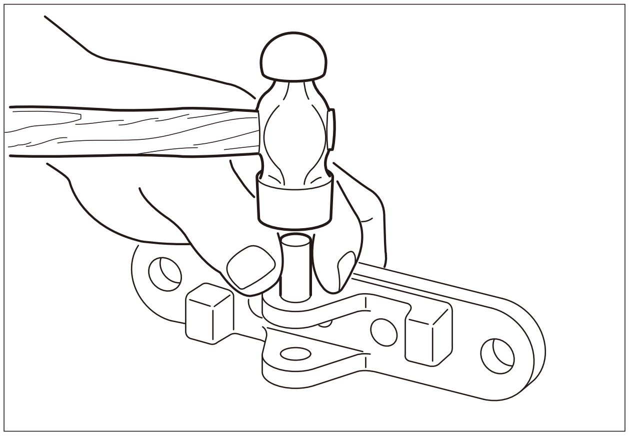
18. Install the grease cup (203) into the plug.



19. Install the push rod (214) into the plug.
    Apply the lubricating oil to the surface of the push rod before installing it.
    Do not insert the push rod with a strong force so as not to damage the lip of the NHU packing.

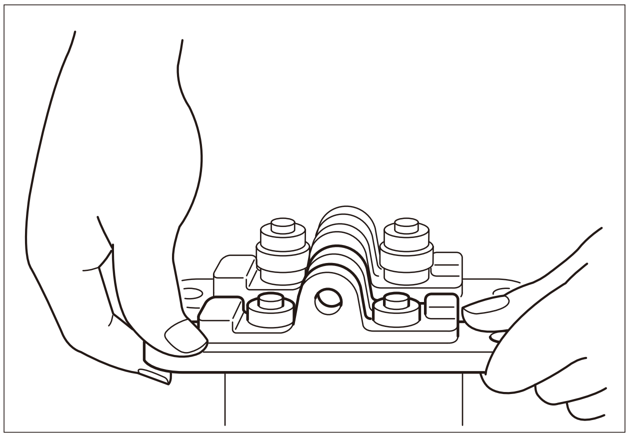


20. Install the push rod subassembly, assembled in 13-16 above, in the casing.



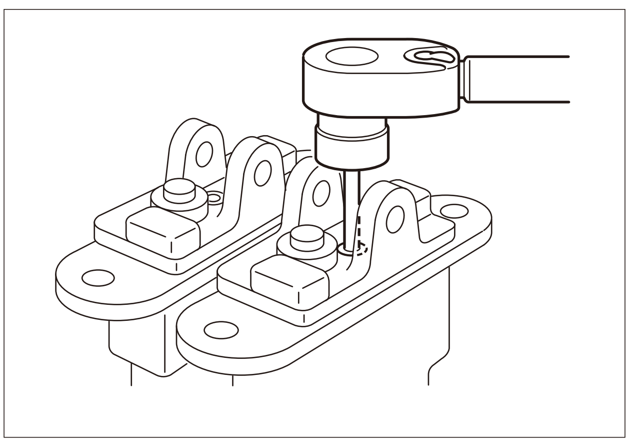
21.Press the bush (412) to the cover (201) using special tool 1 then lightly tap to press it in with a hammer.

Be careful because the end of the bush comes out of the cover.



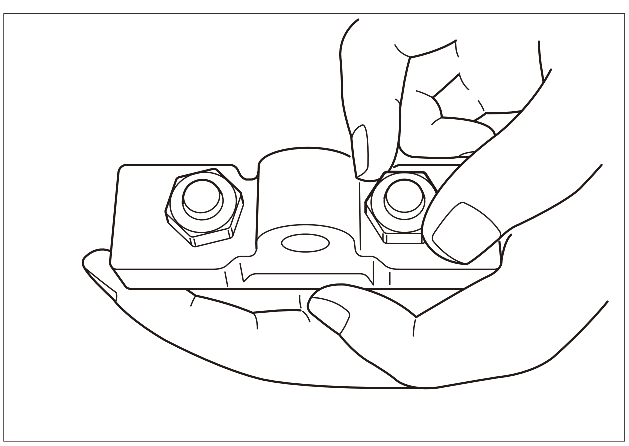
22.Install the cover into the casing.

Install it at the previous position before it was disassembled.
Be careful because the cover moves upward by the force of the damping springs (336, 337).

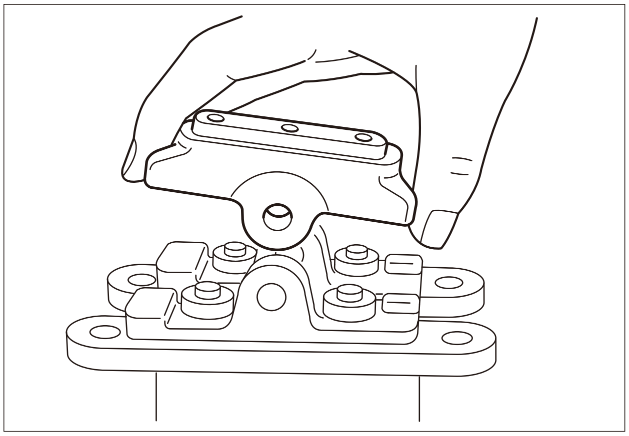


23.Tighten the Allen screw (271) with the torque specified.

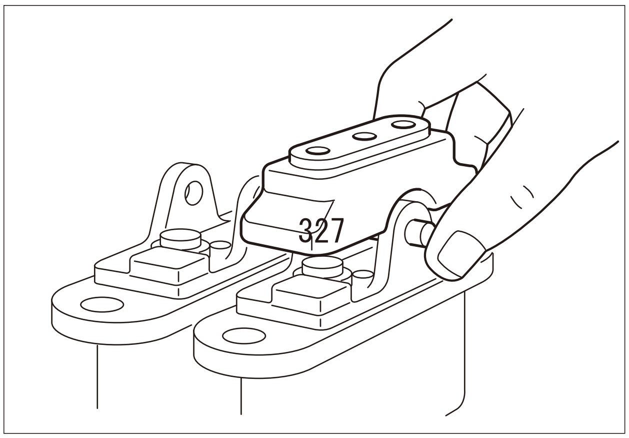
Pay attention to place the cover at horizontal position.



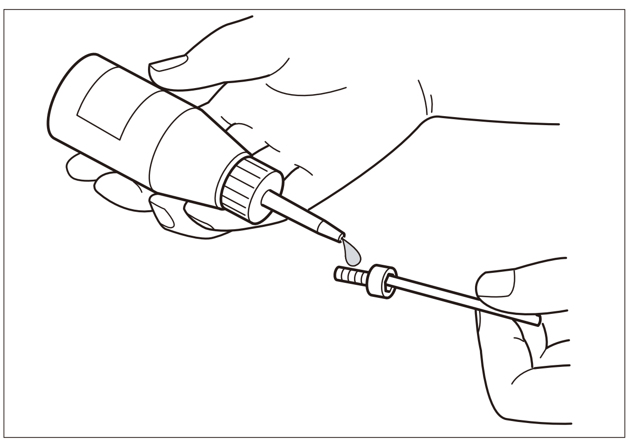
24.Tentatively set the setscrew (471) and lock nut (472) on the cam (420).



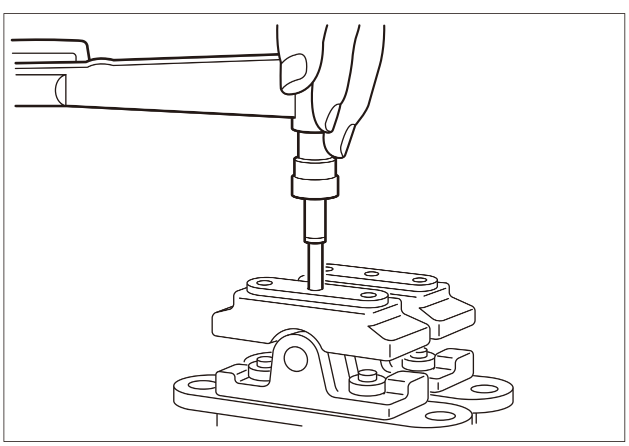
25.Install the cam (420) into the cover.
Install it at the previous position before it was disassembled.



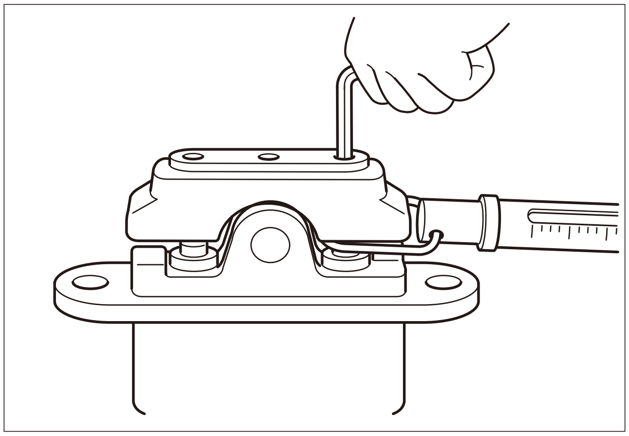
26.Holding down the cam (420), insert the cam shaft (413) from outside.



27.Apply Loctite #241 or equivalent to the surface of the setscrew (423).

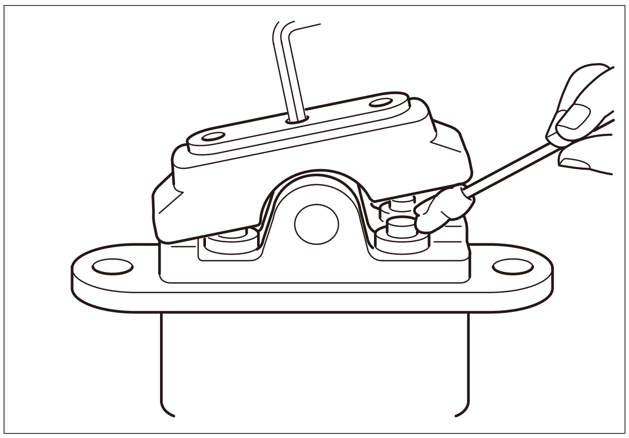


28.Tighten the setscrew (423) with the torque specified.



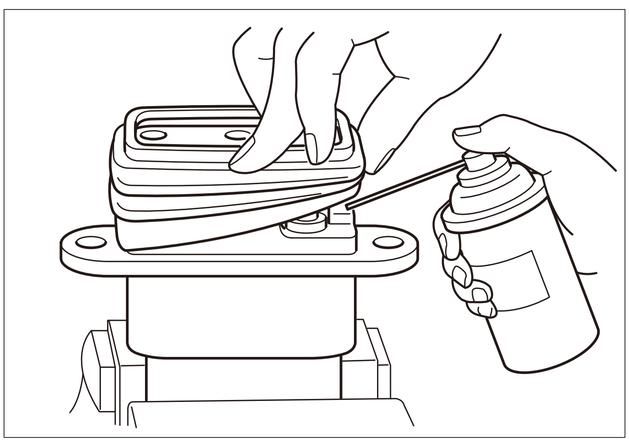
29.Adjust the setscrew (471) height so the cam (420) top surface can be parallel with the cover bottom surface, rotate the cam to the right and left to check that it can be in a neutral position without backlash, and then tighten the lock nut (472) with the specified torque.

Take care not to press the push rod (214) in too much with the setscrew. Otherwisethecam inaneutral position backlashes and may suddenly move when the engine starts or in other cases.



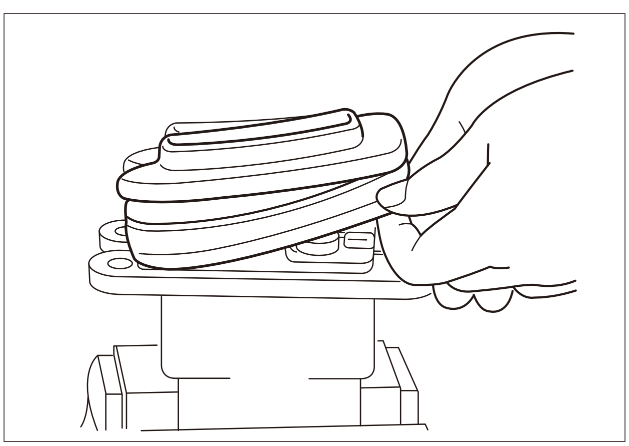
30.Tilting the cam, apply grease to the top of the push rod and also inject grease into the grease cup (203) in the plug (202).

When you apply or inject grease, use a soft spatula so as not to scratch the surfaces of the push rod and the plug.

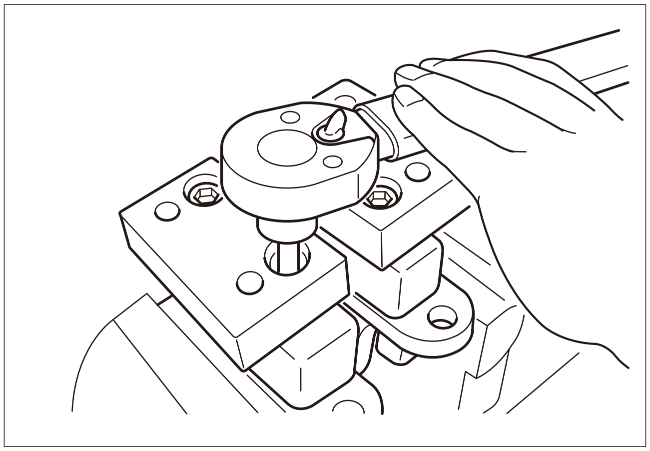


31.Engaging the upper edge of the bellows (501) with the cam, fit the lower edge of the bellows into the groove of the cover.

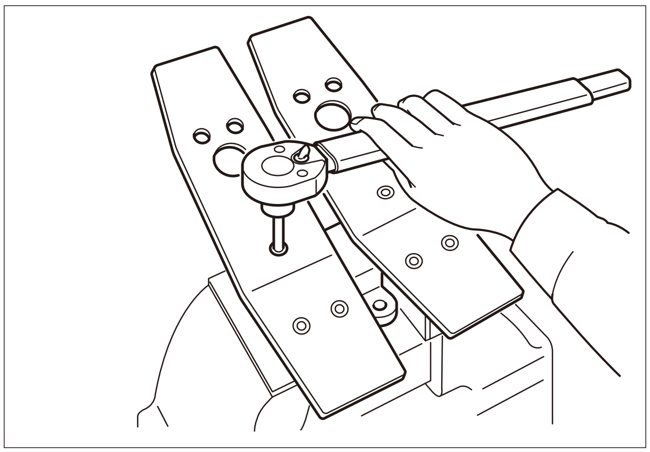
Before fitting the lower end of the bellows into the groove of the cover, spray anti-rust oil over the parts inside the bellows.



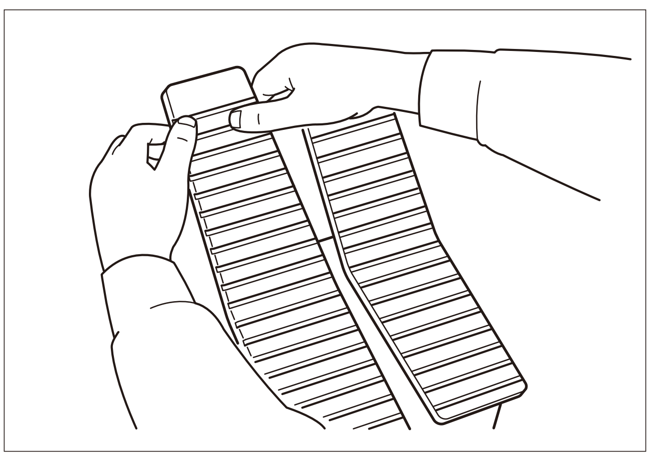
32.Be careful because anti-rust and water-proof capabi I ities are degraded if the bellows is not fixed completely or fixed bellows is twisted.



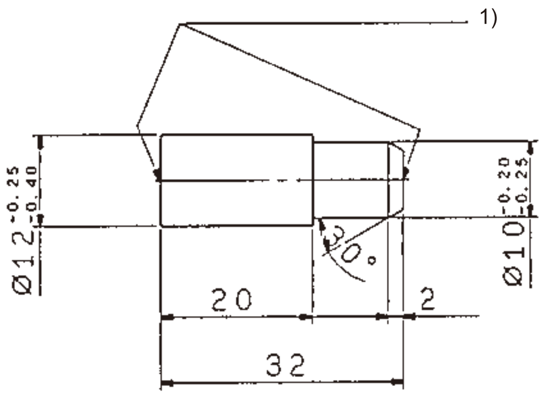
33.Install the block (431) and tighten the Al len screw (473) with the torque specified.



34.Install the pedal (520) and tighten the Al len screw (522) with the torque specified.



35.Attach the pedal cover (521)

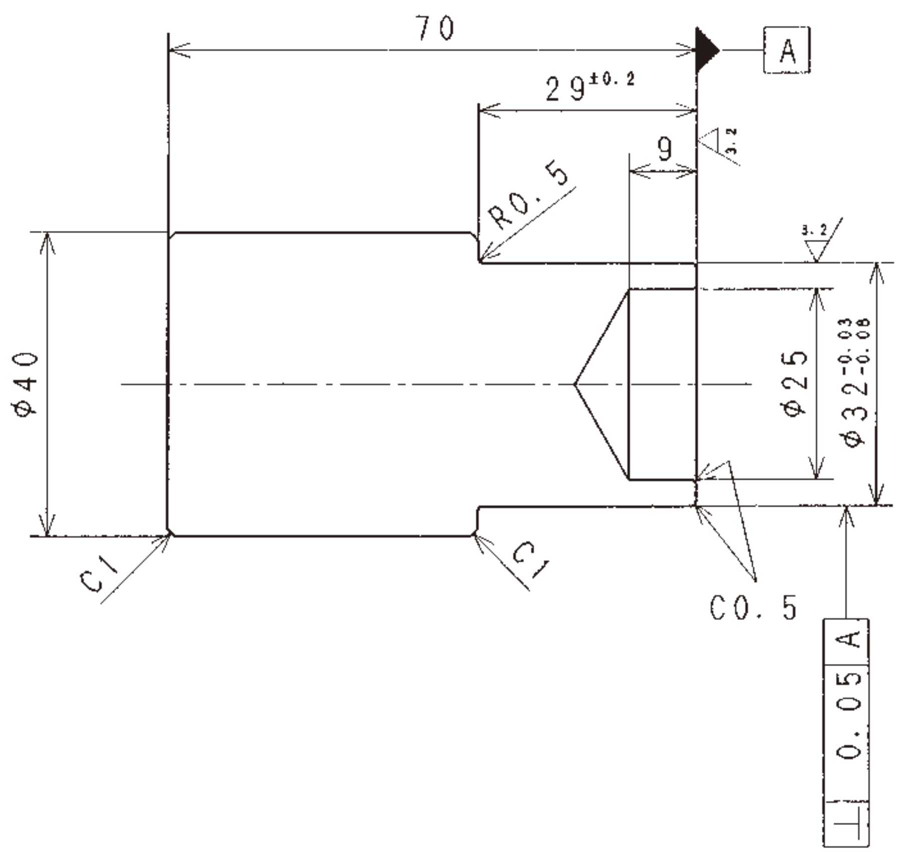


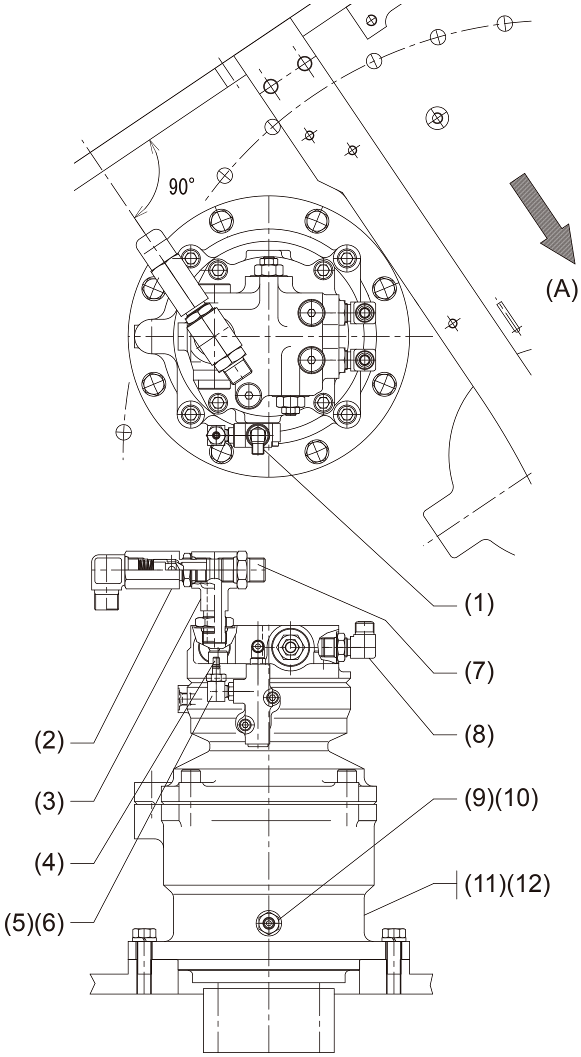
3)Special jig for disassembling/reassembling

(1) Special jig 1 (for removing and pressing the bush)

1)Center hole allowed (*2 or less)

(2) Special jig 2 (for fitting the locking ring)





i.Swive. motor

1.Fitting the adaptor

Fit the adaptor in position as shown at left.

2.Adaptor tightening torque

G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lbs

3.Fitting direction of the motor

Fit the motor in position as shown at left.

4.Quick-coupling adaptor

Pipe joint
Make sure the hose connection is free from detrimental scratches.

5.Fitting the motor assembly (swivel)

Tightening torque
259.9~304.0N.m(26.5~31.0kgf.m)191.7~224.2 ft.lbs
* Apply Loctite 271.

(A)Machine front
(1)Pipe joint (LG1/4-G1/4)
(2)Valve assembly (check, 15)
(3)Pipe joint (TG6, G6, G6)
(4)Pipe joint (S, G1/4-8.4)
(5)Pipe joint (LG1/4-G1/4)

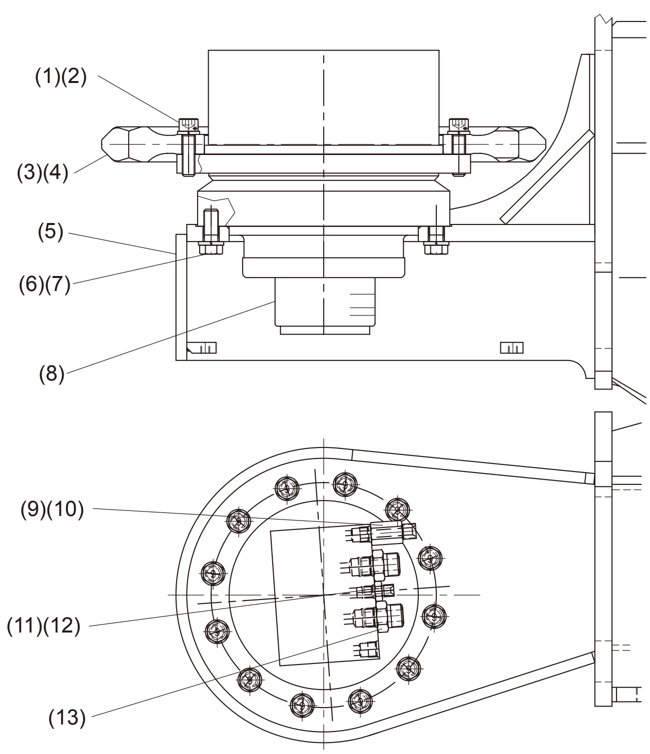
j.Travel motor (Wheel motor)

1.Adaptor and joint

1)Fitting direction of the track frame
Make sure the port side faces the machine front.

2)Tightening torque for the travel motor
Track frame sprocket
Motor mounting bolt
259.9~304.0N.m(26.5~31.0kgf.m)
191.7~224.2ft.lbs
Sprocket mounting bolt
166.7~196.1N.m(17.0~20.0kgf.m)
123.0~144.6ft.lbs
* Apply screw adhesive (Loctite 271).

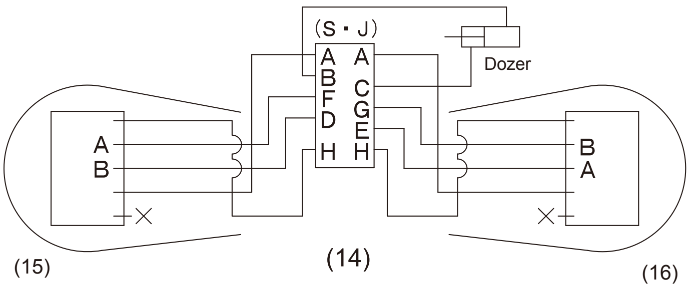
3)Connecting position of the motor drain hose
Connect the hose to the drain port located at the top. (The bottom is the plug.)



(1)Sprocket mounting bolt
(2)Hex socket bolt
(3)Spring washer
(4)Drive sprocket
(5)Frame (track)
(6)Motor mounting bolt
(7)Bolt (M16P2L40)
(8)Motor assembly (wheel)
(9)Pipe joint (S, F3/8-F3/8)
(10)O ring
(11)Adaptor
(12)O ring
(13)Pipe joint (SG4, 1U)

2.Hose routing

See (2/2).
As shown in Fig. 2, keep the hoses free from too tight contact, such as twist or crossing, inside the track frame.



(14)Fig. 2 Hose route
(15)Left foot
(16)Right foot

S/J side	Travel motor sylinder side
A Bi-speed pilot	Left/right travel bi-speed
B Dozer down	Cylinder, bottom
C Dozer up	Cylinder, rod
D Left forward	Left B
E Right forward	Right A
F Left backward	Left B
G Right forward	Right B
H Drain	Left/right drain port(top)

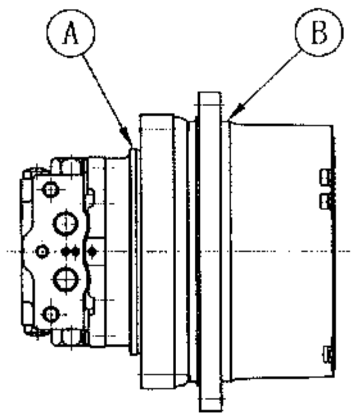
Route	Part name	Tape color	Length mm(inch)
S/J(E)-Motor right bottom (A)	Hydraulic hose (5/8)	Yellow W (right front)	1355(53.3)
S/J(G)-Motor right top (B)	Hydraulic hose (5/8)	Green W (right back)	1355(53.3)
S/J(D)-Motor left top (A)	Hydraulic hose (5/8)	Red W (left front)	1355(53.3)
S/J(F)-Motor left bottom (B)	Hydraulic hose (5/8)	Blue W (left back)	1355(53.3)
S/J(A)-Motor left/right bi-speed	Hydraulic hose (1/4)		1385(54.5)
S/J(H)-Motor left/right drain	Hydraulic hose (3/8)		1310(51.6)
S/J(C)-Dozer relay	Hydraulic hose (1/2)	Pink	430(16.9)
S/J(B)-Dozer relay	Hydraulic hose (1/2)	Brown	430(16.9)
Dozer relay-Dozer cylinder (rod)	Hydraulic hose (1/2)	Pink	790(31.1)
Dozer relay – Dozer cylinder (bottom)	Hydraulic hose (1/2)	Brown	790(31.1)

Travel motor servicing (GM090N, Nabtesco make)

a. Handling precautions

1. Positioning

(Refer to the Dimensional Outline Drawing.)
Before setting up the motor, remove the oil level check port plug and make sure the reduction gears lube oil (gear oil) is up to the check port level.



CAUTION

If the GM motor is hoisted for moving or setting up, never step in below the suspended motor. You may get injured.

A: Main body (fixed section) fixture
B: Drive (rotary section) fixture

*In setting up the GM motor, do not hit it with a hammer or the like.

NOTE
Use lock bolts with the JIS Strength Class 10.9 or higher.

*Fit the above sections A and B in place and tighten up the lock bolts.

Lock bolt tightening torque

	Q'ty	Thread size	Tightening torque	Bolt strength class
Main body lock bolt	14	M16 (P2.0)	252±39N.m (25.7±4.0kgf.m) 186±29ft.lbs	Higher than 10.9 as per JIB B1051 requirement
Drive section lock bolt	11	M14 (P2.0)	163±25N.m (16.6±2.5kgf.m) 120±18ft.lbs	

2. Piping

*The GM motor has been delivered with covers or plugs at the pipe ports. This is to keep out dust, weld scale and other foreign substances. Remove such covers or plugs before connecting the pipes.

CAUTION

Before connecting the pipes, make sure the GM motor turning direction and the pipe port locations are as specified (referring to the Dimensional Outline Drawing). If in the wrong turning direction, you may get injured.

NOTE
Before getting the motor started, be sure to fill the motor casing with hydraulic oil.
Oil amount required in the casing: 0.5 liters (0.13 US gal.)
Otherwise the hydraulic motor may reach its service life earlier than expected.

3. Selecting the right hydraulic oil

1.Types and recommended brands of hydraulic oil

(1)Use ISO VG32 or VG46 antiwear hydraulic oil.

(2)Keep the hydraulic oil cleanliness better than the NASA9 level.

(3)Keep the hydraulic oil operating temperature range and viscosity range with the following ones.
Operating temperature range: -10 to +80°C (-50 to +176°F)
Practical viscosity range: 15 to 500 cst

(4)If using any other hydraulic oil than listed below, contact us.

Grade	Viscosity (40°C)	32cst	46cst	56cst
	JIS-equivalent	VG32	VG46	#VG56
Company name	Showa Shell Oil	Tellus Oil 32	Tellus Oil 46	Tellus Oil 56
	Idemitsu Kosan	Super Hydraulic Fluid 32	Super Hydraulic Fluid 46	Super Hydraulic Fluid 56
	Cosmo Oil	Cosmo Hydro AW32	Cosmo Hydro AW46	Cosmo Hydro AW56
	Nippon Oil	Nisseki Super Hiland Oil 32	Nisseki Super Hiland Oil 46	Nisseki Super Hiland Oil 56
	Mobil Oil	DTE Oil 24	DTE Oil 25	
	General Oil	Panol P32	Panol P46	Panol P56
	Japan Energy	Hydlux 32	Hydlux 46	Hydlux 56

(in random order)

b. Maintenance and inspection

1. Daily inspection

Before running the GM motor, check the following points daily.

CAUTION

Be sure to turn off the motor before checking the following points, except checking for unusual operating noise. Otherwise, you may get injured or burnt. When checking for unusual operating noise, keep yourself at a safe distance. Do not touch nor come too close to the running motor to avoid injury and burn.

1. Oil leak (hydraulic oil and gear oil)
2. Loose bolt
3. Unusual operating noise
4. Overheated casing
   (Usual casing outer surface temperature during continuous run: Max. 80°C)

CAUTION

Immediately after a run, the casing is still hot. Measure the casing temperature with a temperature gauge. Do not touch it with your hands to avoid burn.

2. Changing the hydraulic oil

*Change the hydraulic oil every 1000 operating hours under normal operating conditions.
*If the hydraulic oil gets degraded earlier, change it referring to the requirements below.

Test item	Criteria
Viscosity change (40°C)	±10%
Total oxidation (mgKOH/g)	Type of additive is different from manufacturer to manufacturer. Contact them.
Water content (%)	0.1%
mpurities	10mg/100m
Insoluble content (%)	0.05%

3. Changing the lube oil

The reduction gears have been delivered filled with lube oil (gear oil).

1. Types and recommended brands of gear oil

(1)Use SAE#90 or equivalent gear oil (API classification, Class GL-4 or higher) with extreme-pressure additive.
(2)The following brands are for your reference.

Company name	Product name
Idemitsu Kosan	Apolloil HE 90 S
Esso Oil	Esso Gear Oil GP 90
Showa Shell Oil	Spirax EP 90
Cosmo Oil	Cosmo Gear GL-4 90
Nippon Oil	Nisseki Hypoid Gear 90
Mobil Oil	Mobilube HD 90

(in random order)

2. Gear oil changing intervals

(1)First interval (first change after running-in): After 50 operating hours.
(2)Intervals thereafter: Every 500 operating hours Avoid mixing different types of lube oil. Before pouring another type of lube oil, get the reduction gears flushed.

3. Gear oil quantity: 1.3 liters

4. Gear oil changing procedure

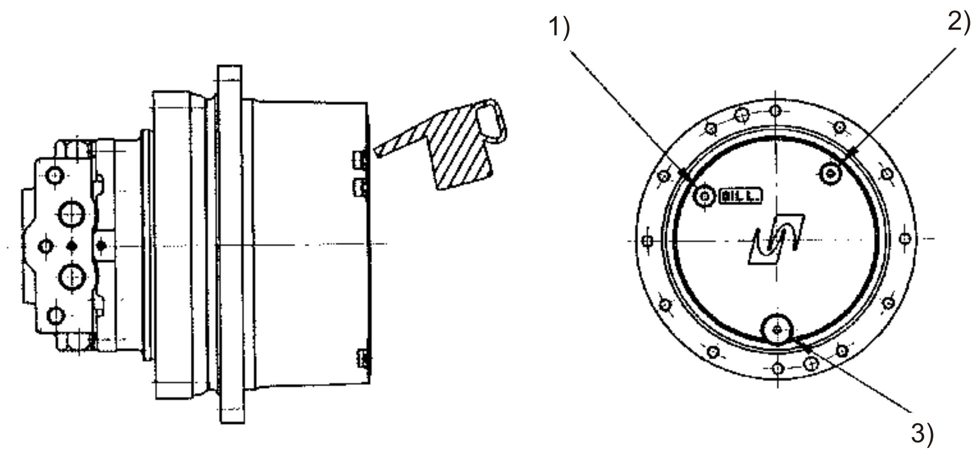
CAUTION

Immediately after a run, the casing is still hot. Do not touch it with your hands to avoid burn. Do not remove any port plug while still hot, either. Hot gear oil may gush out because of the pressure relief of the reduction gears, which may get you scaled. Wait long enough until the casing cools down.

NOTE
If the gear oil runs short unexpectedly, pinpoint and remove the cause. Then replenish gear oil.

NOTE
When letting out the gear oil, be sure to receive it in a pan, not on the ground. Handle waste oil according to your local waste disposal rules and regulations.

NOTE
Oil may gush out when removing the plugs. Turn them slowly to relieve the internal pressure.



1)Oil level check port (PF 3/8)
2)Oil filler port (PF 3/8)
3)Oil drain port (PF 3/8)

(1)Stop the GM motor so that the oil level check port comes to the top and the oil drain port to the bottom. (See the above figure.)

(2)Place an oil pan below the GM motor.

(3)To change the gear oil, remove all the three port plugs and let out the oil. Just for adding oil, keep the oil drain port plug intact.

(4)To add oil, remove the oil filler port and oil level check port plugs. If the oil has been let out, tighten the oil drain port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

(5)Pour gear oil through the oil filler port. Stop pouring just before the gear oil overflows the oil level check port.

(6)Tighten the oil level check port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

(7)Finally tighten the oil filler port plug.
Tightening torque:
58.8±9.8N-m (6.0±1.0kgf.m) 43.4±7.2 ft.lbs

c. Troubleshooting

Phenomenon 1	Phenomenon 2	Possible cause	Correction
Failure to run	No pressure rise	Relief pressure setting too low	Make correct setting.
		Pump defective	Repair.
		Directional control valve defective	Repair.
	Proper pressure rise	Brake valve defective	Replace or repair the brake valve.
		Hydraulic motor defective	Repair.
		Reduction gears damaged	Replace the GM motor.
		Overloaded	Remove the cause of overload.
Oil leak	Leak at mating surfaces	Mating surface scratched	Smooth the surface with whetstone, sand-paper or the like.
		Loose bolt	Retighten up.
	Leak at casing	Loose plug	Retighten up.
		Broken by stone or the like	Replace the GM motor.
	Leak at floating seal	Sliding face worn out	Replace the GM motor.
		O-ring crept	Replace the GM motor.
	Leak at hydraulic motor	Loose bolt	Retighten up.
		O-ring damaged	Replace the O-ring
		Sealing surface scratched	Smooth the surface with whetstone, sand-paper or the like.
Load-caused run in operation	More hydraulic oil leak	Hydraulic motor volumetric efficiency drop	Replace the GM motor.
		Brake valve internally leaky	Replace or repair the brake valve.
	Parking brake not working	Spring damaged	Replace the spring.
		Friction disc worn out	Replace the friction and mating discs.
Reduction gears casing surface temperature too high		Gear oil short	Add oil up to the proper level.
		Pitching at bearing	Replace the GM motor.
		Hydraulic oil into the casing	Replace the oil seal.
Zigzag travel (when used as travel motor)	At low pressure	Left and right discharge rates not equal	Repair the pump.
		Left and right hydraulic motor drain amounts not equal	Replace the GM motor.
	At high pressure	Left and right discharge rates not equal	Repair the pump or control valve.
		Left and right hydraulic motor drain amounts not equal	Replace the GM motor.
		Left and right brake valve actions not equal	Replace the brake valve.
		Relief pressure drop at left or right control valve	Make correct pressure setting. Replace the relief valve.
No speed-up	Pump discharge rate short	Pump malfunctioning	Repair or replace the pump.
		Too much leak out of pump	Repair or replace the pump.
		Too much leak out of hydraulic motor	Replace the GM motor.
Unusual operating noise	At GM motor	Hydraulic motor or reduction gears dam-aged	Replace the GM motor.
	At piping	Piping vibrated	Clamp the piping.
Two-speed selection impossible	Failure to switch from low to high speed	High-pressure check valve malfunctioning	Repair or replace.
		Selector valve malfunctioning	Repair or replace.
		Pilot pressure too low	Set to the specified pressure.
		Two-speed selector piston malfunctioning	Repair or replace.
	Failure to switch from high to low speed	Selector valve malfunctioning	Repair or replace.
		Two-speed selector piston malfunctioning	Repair or replace.

1. SERVICE OUTLINE
1-1. Tools
1-1.1. Standard tools

Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
284	Torquewrench	Dial type, approx. 45N	JIS B 4650	1
33, 121, 126, 143, 144, 152, 154		Dialtype, approx. 180N	JIS B 4650	1
19, 124		Dialtype, approx. 560N	JIS B 4650	1
284	Hexagon wrench	Nominal5mm	JIS B 4648	1
33, 34, 221		Nominal8mm	JIS B 4648	1
126		Nominal 10mm	JIS B 4648	1
154	Hexagon socket Insert angle 12.7mm	Nominal 4		1
284		Nominal 5		1
33, 34, 221		Nominal 8		1
245, 282		Nominal 10		1
289	Socket Insertangle 12.7mm	Nominal 22		1
19,224		Nominal36		1
19	Extension bar	Nominal200 Insert angle 19mm		1
19,124	Adapter	Insert angle 12.7X19		1
1,21,132,	Hand hammer	Nominal 12mm	JISB4613	1
8, 102,	Plastic hammer	ABT. 300mm		1
24, 25	Snap ring pliers	For shafts		1
20, 145		For holes		1
1	Centerpunch	ø9.5X100		1
21	Pin punch	ø3X150		1
For washing	Washing brush			1
For washing	Wire washing brush			1
Match marking	Paint marker	Paint maker: white		1
For oil draining and holding balls	Receptacles	Volume: W450XD300XH120		3
17	Metal-net basket			2
149	Leather gloves			1pair
21	Vinyl sheets	500X500X1.0		1
For oil filling	Oil pot with handle			2
21	Gear puller			1set

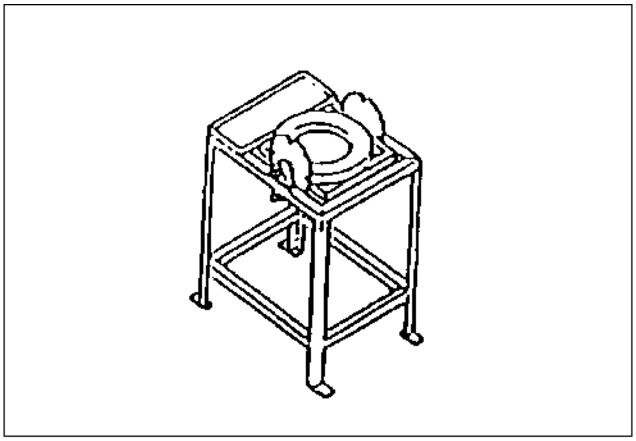
1-1.2. Equipment and materials

Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
For disassembling And reassembling works	General work stand			1
Forwashing GMY motor and parts	Washing sink	One for drain One for rinsing		2
104, 149	Press	Press capacity: 1960 N (200 kgf) 441lbs		1
149	Heating vessel	Volume: 1960 N (200 kgf) 441lbs Heating capacity: Over 100 °C 212 °F		1
1	Electricdrill	Portable drill diameter: 10 mm (0.39 in)	JIS C 9605	1
1	Drill	Diameter: 2 mm (0.08 in)		1
GM motor, 1, 2	Crane			1
3	Lathe			1
	Grinder			1
For drying washed parts	Compressed air supply	Pressure: 0.29 - 0.49 Mpa (3 - 5 kgf/cm2) 43~71 psi		1

1-1.3. Measuring devices

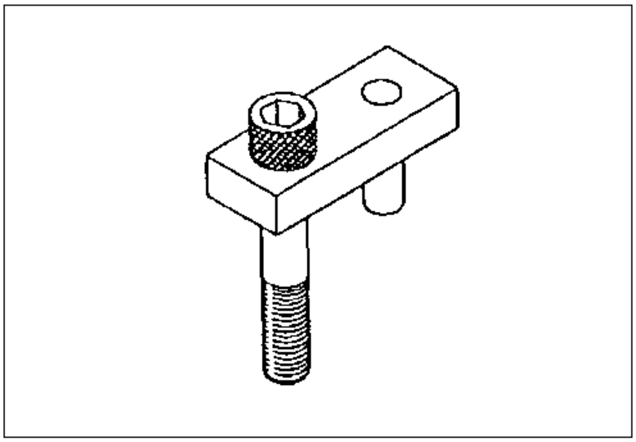
Applicable parts (Usage method or parts No.)	Name	Description	Remarks	Q'ty
For adjusting thickness of snap ring [20]	Thickness gauge	Measurement: 0.04-0.3 mm(0.002~0.01 in.)		2
	External micrometer	Measurement range: 0-25mm (0~0.98 in.) Min. graduation: 0.01 mm (0.0004 in.)		1
For pre-load adjustment of ball bearing [21]	Depth micrometer	Measurement range: 0-25mm (0~0.98 in.) Min. graduation: 0.01 mm (0.0004 in.)		1

1-1.4. Manufacturing tools



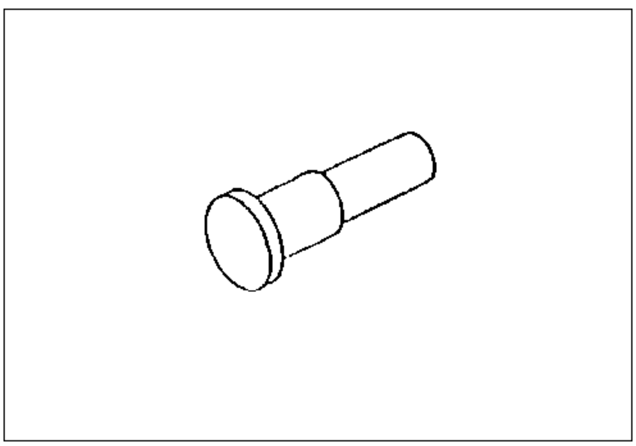
Tool name : Work stand

To be used for safe and easy disassembly and reassembly of GM motor.



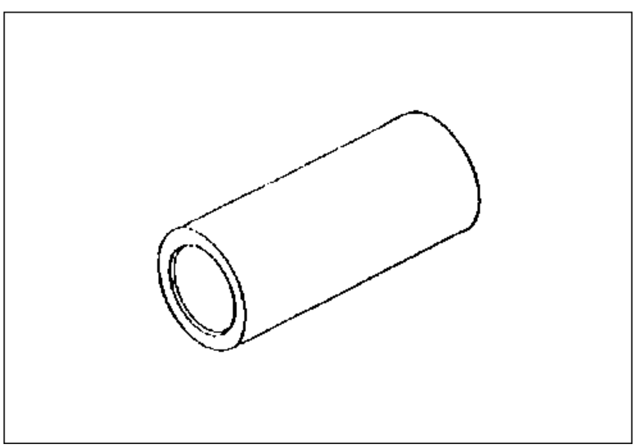
Tool name : Fixture

To be used for holding together hub [1] and spindle [2] when disassembly and reassembly.



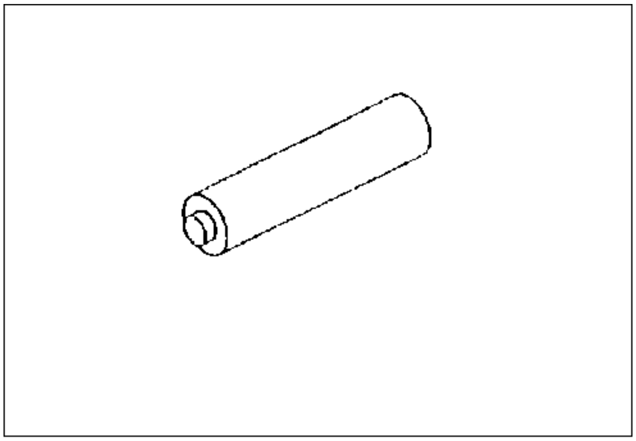
Tool name : retainer (1)

To be used for inserting coil spring [114], washers [110] and snap ring [145] into cylinder block [104].
To be used for removing coil spring [114] from cylinder block [104].



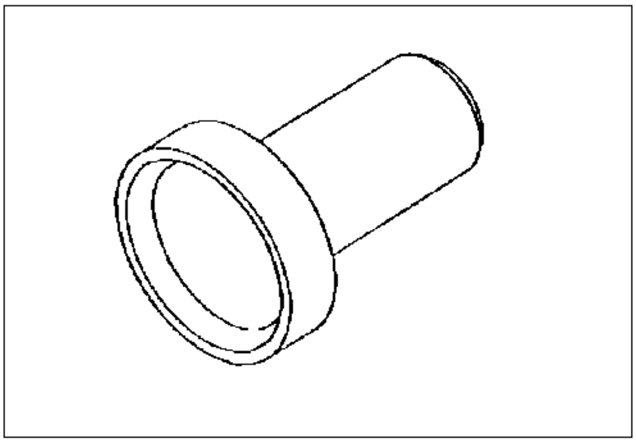
Tool name : retainer (2)

To be used for applying push to bearing when removing ball bearing [149] from shaft [102].



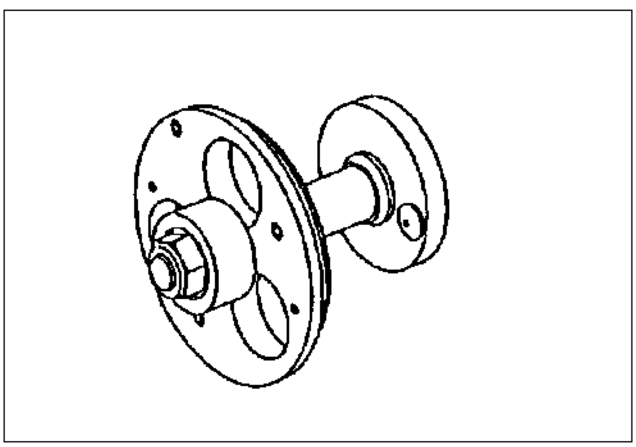
Tool name : Retainer (3)

To be used for pushing oil seal [132] when installing it in spindle [2].



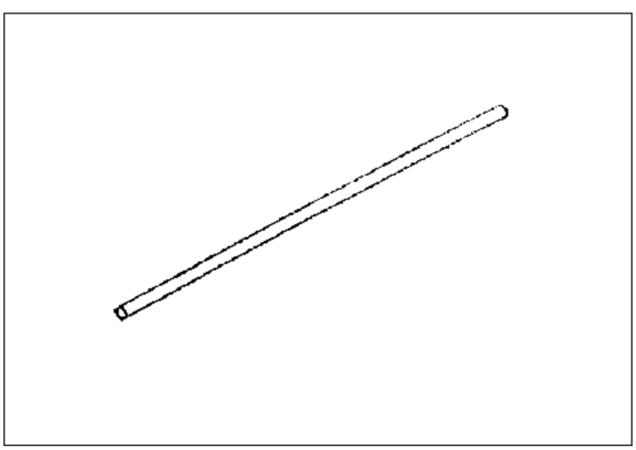
Tool name : Retainer (4)

To be used for installing RV gear sub-assembly on spindle [2].



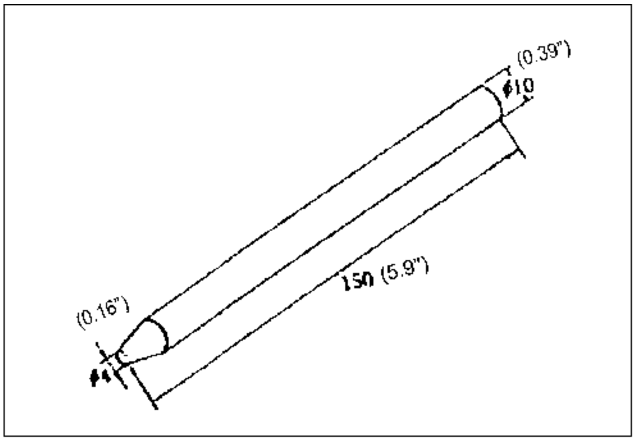
Tool name : Bearing pre-load adjuster

To be used for pushing ball bearing [21] when installing it in hub [1].
To be used for measuring axial clearance between hold flange [3] and ball bearings [21].



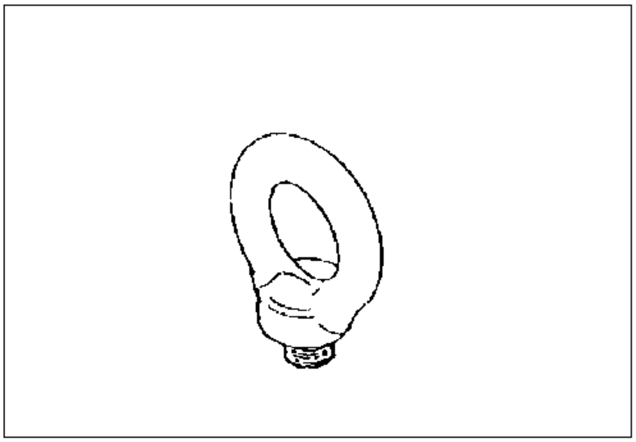
Tool name : Steel rod

To be used for removing ring [18] for hub [1]



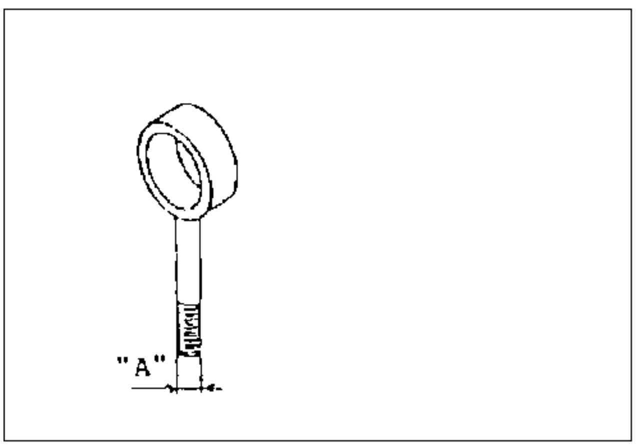
Tool name : Aluminum rod

To be used for removing oil seal [132] and collar [11] from spindle [2].
To be used for removing ball bearing [21] from hub [1].



Tool name : PF eye bolt

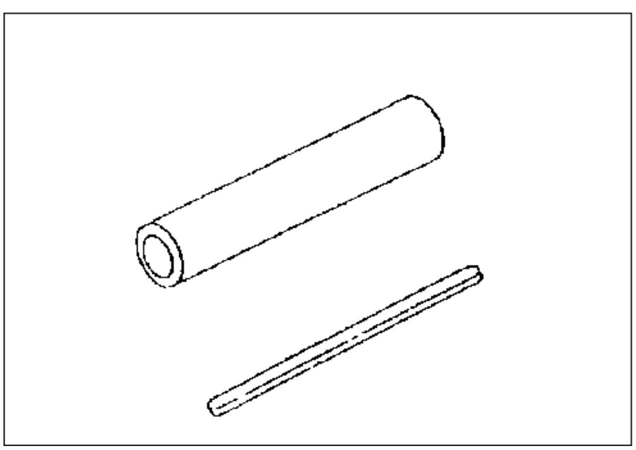
To be used for lifting cover [8] off hub [1] with a crane and wire rope.



Tool name : Long eye bolt

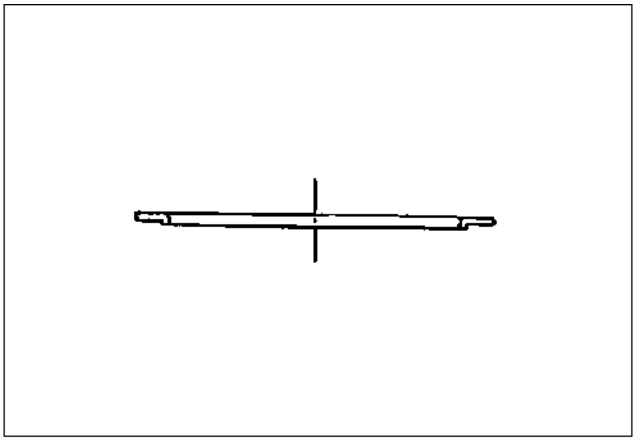
To be used for lifting GM motor, spindle [2] and hub [1].

	"A"
Hub	M14
Spindle	M16
GM motor	M16



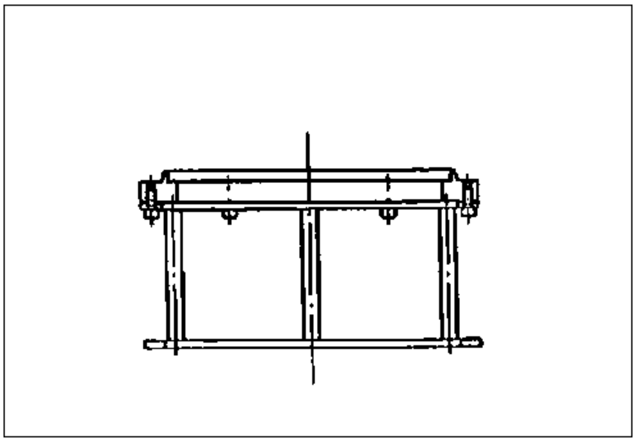
Tool name : Flat barand steel pipe

To be used for removing ball bearing [21] from spindle [2].
To be used for removing timing plate [109] from rear flange [101].
To be used for fixed hub [1] and work stand.



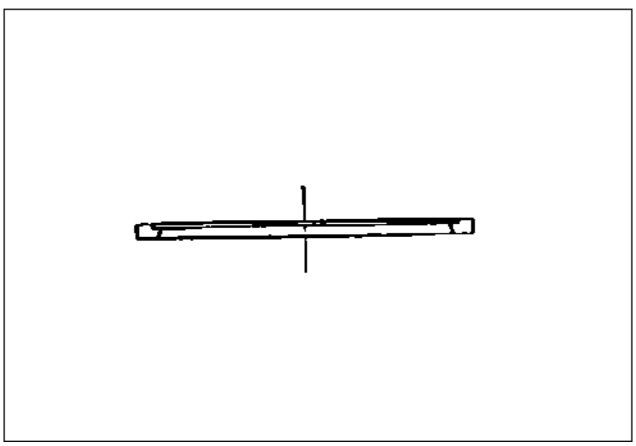
Tool name : F/S installationtool (1)

To be used for installing floating seal on hub [1]



Tool name : F/S installation tool (2)

To be used for installing floating seal on hub [1] and spindle [2]



Tool name : F/S installation tool (3)

To be used for installing floating seal on spindle [2]

1-2. Tightening torque

Applicable parts (Structural drawing)	Bolt/Nut Used		Hexagonal 2 surface width mm	Q'ty	Tightening Torque N.m (kgf.m)
	Name	Nominal Designation			
19	Reamerbolt	M24 X2.0	36mm	3	794 ± 49.0 N.m (81 ± 5 kgf.m) 580 ± 36 ft.lbs
33	Hexagon socket plug	PF3/8	8mm	3	58.8 ± 9.81 N.m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
245	Hexagon socket bolt	M12X1.75	10mm	4	102 ± 15.7 N.m (10.4 ± 1.6 kgf.m) 75.2 ± 11.6 ft.lbs
34	Hexagon socket plug	PF3/8	8mm	1	58.8 ± 9.81 N.m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
224	Plug	M30X1.5	36mm	2	353 ± 39.2 N.m (36 ± 4 kgf.m) 260 ± 29 ft.lbs
289	Plug	PF1/2	22mm	2	98.1 ± 19.6 N.m (10 ± 2.0 kgf.m) 72.3 ± 14.5 f.lbs
221	Hexagon socket plug	PF3/8	8mm	3	58.8 ± 9.81 N. m (6 ± 1.0 kgf.m) 43.4 ± 7.2 ft.lbs
282	Hexagon socket plug	PF1/2	10mm	2	98.1 ± 19.6 N.m (10 ± 2.0 kgf.m) 72.3 ± 14.5 ft.lbs
284	Hexagon socket plug	PF1/8	5mm4		12.3 ± 2.45 N.m (1.25 ± 0.25 kgf.m) 9.04 ± 1.81 ft.lbs

1-3. Weight table

Applicable parts (Structural drawing)	Component	Weight : N (kg)
GM motor	Travel motor assembly	Approx.794N (81kg) 179 lbs
[1]	Hub	Approx.186N (19 kg) 42 lbs
[2]	Spindle	Approx.265 N (27 kg) 60 lbs
[101] Other	Rear flange assembly	Approx.95N (9.7 kg) 21 lbs

2. DISASSEMBLY

2-1. Preparation

Perform the following preparations before disassembling.

2-1.1. Workbench preparations

Provide a travel motorworkbench.

Provide a sturdy workbench with which the internal parts of the travel motor can be disassembled or assembled, is wide enough to place parts so they do not move or fall off the bench while working.

Spread a rubberor vinyl sheet on the workbench.

2-1.2. Preparation of tools and materials

Provide the tools and materials listed in 1-1.

2-2. General suggestionswhen working

Caution

Internal parts are coated with hydraulic fluid during disassembly and are slippery If a parts slips out of your hand and falls, it could result in bodily injury or could damage the parts. Be very careful when handling.

Caution

Combustibles such as white kerosene are used forwashing parts. These combustibles are easily ignited, and could result in fire of injury. Be very careful when handling.

(1) Before disassembling, perform inspections and clearly determine the nature of any abnormalities which might be occurring, and work according to the disassembly procedure.
(2) Each parts is manufactured to extreme precision. Handle with care and be sure not to hit the parts together or drop them.
(3) When working, do not attempt to forcefully beat or wrench tightly fitting parts. Doing so could produce burrs or damage the parts so they can't be mounted or may reduce their performance. You should exercise patience when working.
(4) If you leave parts disassembled or partially disassembled, rust could develop on the parts due to moisture or dirt. If you have to interrupt work before completion, be careful to take measures to protect against rust or dust.
(5) Place a counter mark on mating faces of parts when disassembling.
(6) Arrange removed parts neatly when disassembling so as not to damage or lose the parts while working.
(7) As a rule, once any type of seal is disassembled it should be replaced with a new one even if it shows no signs of damage. You should have a new ready when disassembling.
(8) The photographs and drawings contained in the manual are of representative models. Disassembly procedure is however not affected even if the product you are using differs in part.

2-3.Disassembly procedure

(1) Washing the travel motor

1) Fasten the eyebolts in the screw holes for mounting the spindle [2].

Note : Fasten the 2 eye bolts in the screw holes for mounting the spindle [2] so they are positioned symmetrically.

2) Hook the wire in the eye bolts, hoist the travel motor with a crane and carry to the washing tank.

3) Wash each part of the travel motor with a car wash brush.

Note : Earth and sand get in the clearance between the hub [1] and spindle [2] (floating seal mounting section). Be sure to wash this part with special care.

(2) Travel motor installation

1) Set the travel motor on a workbench

Note : While matching the hub bolts of the hub [1] and screw holes of the workbench, carefully place the travel motor in the mounting holes of the workbench.

2) Mount the travel motor on the workbench and tighten hexagon nuts to the hub bolts.

Caution

Tighten the hexagon nuts securely. Failure to do so could result in injury cased by the travel motor falling when it is inverted.

(3) Lubricating oil drain

Note : If disassembling the rear flange only, proceed to below 1) of item (7).

1) Invert the travel motor.

2) Loosen and remove the hexagon socket plug [33] (1 plugs), [34] (2 plugs).

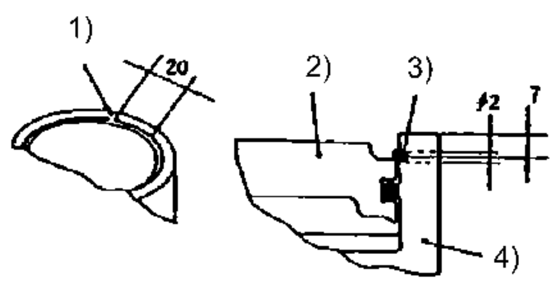
Note : When draining the lubricating oil, place a container below the workbench.

3) Slowly invert the travel motor and drain the lubricating oil.

(4) Cover removal

1) Scribe match marks across the joint seam between hub [1] and cover [8] by using a paint marker.

2) Look into the seam to locate the gap of ring [18]. Make a punch mark on the hub [1] at a point about 20mm (0.79 in.) from the ring [18] end in circular direction and 7mm (0.28 in.) from the end face of hub [1].



1)(Gap of ring}
2)Cover
3)Ring
4)Hub

3) Using an electric drill, make a 2mm (0.08 in.) diameter hole at the punch mark.

Note : Be sure to centerthe drill on the punch mark, and keep drilling until the ring starts rising. After drilling clear through the wall of hub [1], be sure to wipe off the chippings completely.

4) Insert the steel rod into the drilled hole and push it into makethe ring [18] comeout.

Note : In this case, the advanced of ring come out.

5) Pickthe end portion of ring [18] and pull it out to remove the ring [18] off the groove.

6) Fasten the PF eye bolts in the screw holes for fastening the hexagon socket plugs [33] of the cover [8] (2 places).

7) Hookthe hook and wire in the PT eyebolts, hoist with a crane and remove the cover [8].

Note : If the cover [8] is difficult to remove due to resistance of the O-ring [29], hoist while tapping the outer edges of the cover equally with a plastic hammer.

8)Remove the O-ring [29] from the cover [8].

Note : Do not reuse the O-ring [29] which has been removed.

(5) Input gear removal

1) Removethe snap ring [24] from the shaft [15].

2) Remove the input gear [6], from the shaft [15].

3) Remove the steel ball [36] from shaft [15].

4) Removethe shaft [15] from the spindle [2]

(6) Spur gears removal

1) Remove snap rings [25] (3 rings) from crankshaft [9].

Caution

Take notice when taking off the snap ring by the top with a plierthe snap ring will spring out of the snap rings hole.

2)Remove spur gears [7] from each crankshaft [9].

(7) Remove the rear flange

1)Invert the travel motor.

Note : The following task is carried out to facilitate plug removal if disassembling the rear flange [201] inside. Plugs must be loosened to the degree where they can be removed by hand. If not disassembling the rear flange [201] inside, do not loosen the plugs.

2)Loosen the plugs [282] (2 plugs).

3)Loosen the plugs [289] (2 plugs).

4)Loosen the plugs [224] (2 plugs).

5)Loosen the plugs [282] (2 plugs)

6)Remove the hexagon socket bolts [245] (6 bolts).

7)Remove the rear flange [201] from the spindle [2].

Note : Grip the rear flange [201] with both hands and remove by carefully straight upward. If removed by forcefully wrenching or beating, the timing plate [109] could fall and become damaged.

8) Remove the springs [113] (8 springs).

9) Remove the parallel pins [43] from the spindle [2].

10)Remove the O-rings [28], [30] from the spindle [2].

Note : Do not reuse the O-rings [28], [30] which have been removed.

(8) Disassembly of rear flange mounted parts

1) Place the rear flange [201] on the workbench in position where its mating face with the spinclle [2] faces upward.

2) Remove the timing plate [109] from the rear flange [201].

Note : The mating face with the rear flange [201] may be difficult to remove due to adherence of oil. It will come off if you insert a knife in the casting groove of the mating face of the rear flange [201] side and gently lift the timing plate [109]. Inserting sharp tools such as a screwdriver in the mating face will damage the mating face and cause oil leakage. Do not use sharp tools such as a screwdriver.

3) Remove the parallel pins [242] from the rear flange [201].

4) Remove the ball bearing [150] from the rear flange [201].

(9) Disassembly of plugs inside rear flange

1) Remove the plugs [224] (2 plugs) from rear flange [201].

2) Remove the O-ring [236] from the plug [224].

Note : Do not reuse the O-ring [236] which has been removed.

3) Remove the spool [223] from the rear flange [201].

Note : The spool [223] will slip out and fall if you tilt the rear flange [201] so that one of the plug ports is facing downward. Grip the ends and remove.

4) Remove the plugs [282] (2 plugs) from rear flange [201].

5) Remove the O-ring [238] from the plug [282].

Note : Do not reuse the O-ring [238] which has been removed.

6) Remove the spring [230] (2 springs), valve [227] (2 valves) from the rear flange [201].

(10) Disassembly of SRV mounted into the rear flange

1) Loosen and remove the plug [282] (2 plugs) from the rear flange [201].
2) Remove the O-ring [238] from the plug [282],

Note : Do not reusethe O-ring [238] which has been removed.

3) Remove the piston [286] from the rear flange [201].

Note : The rear flange [201] and the piston [286] are watched as a set. keep them so you will know the combination.

Note : If the piston [286] is difficult to remove, screw the bolt of M3 to the screw hole for the disassembly of the piston [286]. Be careful not to do damaged the piston hole.

4) Loosen and remove the plugs [289] (2 plugs) from the rear flange [201].

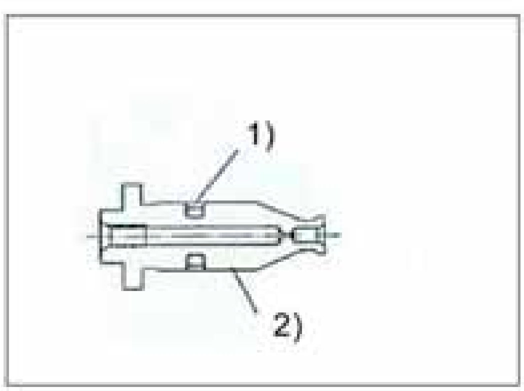
5) Remove the O-ring [238] from the plug [289].

Note : Do not reuse the O-ring [238] which has been removed.

6) Remove the spring [290], valve [287], sleeve [288] from the rear flange [201].

7) Remove the O-ring [292], backup ring [294] from the sleeve [288].

Note : Do not reuse the O-ring [292], backup ring [294] which has been removed.



8) Remove the piston seal [293] from the valve [287].

Note : Do not reuse the piston seal [293], which has been removed.

1) Piston seal
2) Valve

9) Remove the plugs [285], steel-ball [296] from the rear flange [201].

(11)Disassembly of pilot valve from the rear flange

1) Remove the plug [221], spool [271], spring [281] from the rear flange [201].

2) Remove the O-ring [292]from the plug [221].

Note : Do not reuse the O-ring[292], which has been removed.

(12) Disassembly of parking brake section

Caution

If compressed air is introduced suddenly, the piston [112] will fly off the spindle [2] and could result in injury.
A protective cover, etc., must therefore be placed over the piston [112].

1) Inject compressed air into the passage hole for parking brake of the spindle [2], and remove the piston [112] from the spindle [2].

2) Remove the O-rings [135], [141] from the piston [112].

Note : Do not reuse the O-rings [135], [141] which have been removed.

(13)Disassembly of hydraulic motor parts

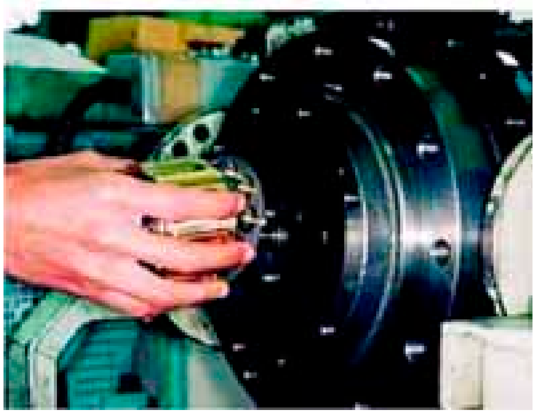
Note : Oil spills from the travel motor when faced sideways, so place a container under the travel motor.

1) Tilt the travel motor 90 degrees.

2) Extract the oil from inside the travel motor.

3) Grip the cylinder block [104] with your hands, turn alternately 2~3 times, and cut away the shoe [106] bonded to the swash plate [103].

Note : If you remove the cylinder block [104] as is, the shoe [106] remains bonded to the swash plate [103], and the parts (piston [105], shoe [106], etc.) mounted on the cylinder block [104] will come off the cylinder block [104] and fall into the spindle [2],



4) Draw out the cylinder block [104] from the shaft [102].

Note : At this time the friction plates [115] and mating plates [116] are also mounted on the cylinder block [104] and will come off.

5) Remove the friction plates [115] and mating plates [116] (2each) mounted on the removed cylinder block [1 04].

6)Remove the piston assembly (piston [105], shoe [106]) and retainer plate [107] from the cylinder block [104].

Note : When removing, grip the retainer plate [107] with both hands and remove together with the retainer plate [107]. The piston [105] and shoe [106] are squeezed into a single part at the round surface section of the piston [105]. The piston [105] and shoe [106] cannot be separated without damaging the shoe [106]. If replacement is necessary, replace the piston [105] and shoe [106] as a pair (hereinafter referred to as "piston assembly") in a 9-pair unit (hereinafter referred to as "piston kit").

7) Draw out the piston assembly [105], [106] from the retainer plate [107]. (9 pair)

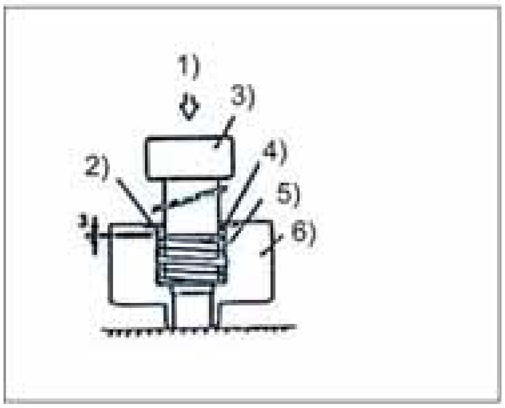
8) Remove the thrust ball [108] from the cylinder block [104].

9) Remove the needle rollers [151] (3 rollers) From the cylinder block [104].

(14)Removal of spring inside cylinder block

1) Place the cylinder block [104] on the press bench.

Note : The spring is removed only when replacing. The spring is removed by lining up the shaft centers of the retainer (1) and washer [110] in order to prevent damage to the cylinder block [104] through contact.
Cover the cylinder block [104] with a vinyl sheet to prevent the sliding surface of the cylinder block [104] from being damaged.



2) Place the retainer (1) on the washer [110], and while clamping the retainer (1) with the press, remove the THS snap ring [146] from the snap ring groove of the cylinder block [104] with a pair of snap ring pliers.

1)Press
2)Washer
3)Retalner
4)Snap ring
5)Spring
6)Cylinder brock

Caution

If the press is loosened suddenly, the spring could jump out resulting in injury. Loosen the press slowly.

3) Loosen the press slowly until the spring force is released.

4) Remove the THS snap ring [146], washer [110], spring [114], and washer [110] from the cylinder block [104].

(15)Shaft removal

1) Remove the swash plate [103] from the spindle [2].

Note : At the time of swash plate [103] removal, the pivot [176] is attached to the swash plate [103] in some cases.

2) Draw out the shaft [102] and ball bearing [149] from the spindle [2].

Note : The speed reducer side shaft can be drawn out easily after tapping the tip of the shaft gently with a plastic hammer. The shaft however may jump put if struck forcefully.

3) Remove the pivots [176], parallel pins [177] (2 each) from the spindle [2].

4) Remove the 2-speed switching piston assembly (piston [161], shoe [162]) and spring [185] from the spindle [2].

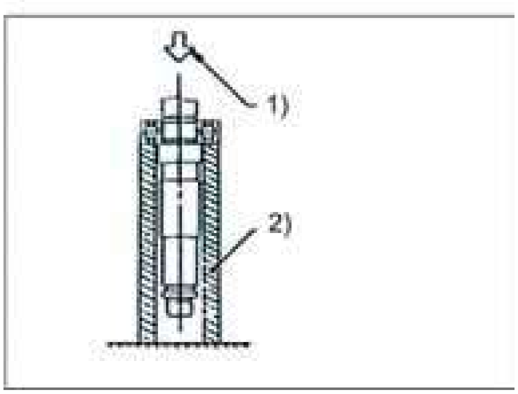
(16)Removal of ball bearing

Note : The ball bearing is removed only when replacing.

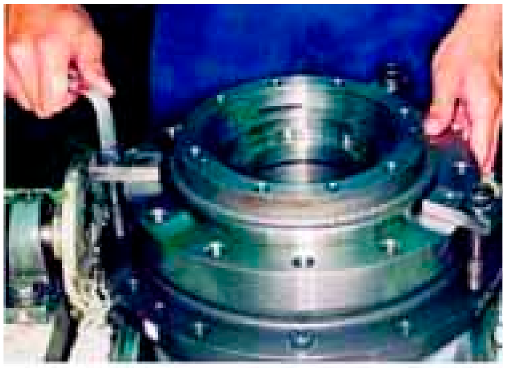
1) Place the retainer (2) on the press bench, and place the shaft [102] inside.

2) Clamp the tip of the shaft [102] with the press and remove the ball bearing [149] from the shaft [102].

Note : Do not reuse the ball bearing.



1)Press
2)Retainer(1)



(17)Removal of hold flange

1)Invert the travel motor

2)Fasten the fixtures (2 fixtures) to the hub [1] and spindle [2] and fix in place. At this time, fasten the fixtures so they are positioned symmetrically.

Note : If the hold flange [3] is removed without fastening the fixture, the hub [1] and spindle [2] become separated, and the spindle [2] will fall from the workbench. Be sure to fasten the fixture.

3)Invert the travel motor

Caution

When removing the snap ring [20], you could become injured if the tip of pliers comes out of the hole of snap ring [20], and snap ring [20] jumps out.

4)Remove the snap rings [20] (3 rings) from the hold flange [3].

5)Put a counter mark on the snap ring [20] and hold flange [3] with an oil base paint marker.

Note : This is so the parts can be assembled in the same position when reassembling.

6)Loosen the reamer bolts [19] (3 bolts).

Note : Bonding agent is used for the screw holes of reamer bolts [1 9].When loosening, disassembly may become difficult. Loosen the reamer bolts [19] as slowly as possible. If the bolts become hard to turn, do not forcefully loosen, but rather screw them in once and then loosen them again slowly. Tightening torque is 794 ± 49.0 N-m (81 ± 5 kgf-m) 586 ±36 ft-lbs, but because bonding agent is applied to the screw portion, loosening torque 794 ± 49.0 N-m (81 ± 5 kgf-m) 586 ± 36 ft-lbs, or more is required for loosening.

7) Remove the hold flange [3] from the spindle [2].

8) Write the counter mark of the hold flange [3] and spindle [2] on the hold flange [3] and spindle [2] with an oil base paint marker.

Note :This is so the hold flange [3] can be assembled in the same position as the spindle [2] before disassembly when reassembling. If replacement is necessary, replace the spindle [2] and hold flange [3] as a pair (assembly). (This assembly will hereinafter be referred to as "spindle assembly".)

(18)Fixture removal

1)Invert the travel motor.

2)Remove the fixtures (2 fixtures).

(19)Spindle removal

1) Fasten two eyebolts in the mounting holes of the spindle [2] so they are symmetrically positioned.

2) Hook the hook on the eyebolt, gently and slowly hoist with a crane, and remove the spindle [2] from the hub [1].
At this time, the floating seal [31], outer ring of the tapered roller bearing [22] and oil seal [132] come off together.

(20)Removal of ball bearing, RV gear assembly and pin

1)Remove the floating-seal [31] from the hub [1].

Note : When removing the ball bearing [21], tap the end face of the pins equally in 3-4 places around the circumference a little at a time so as not to wrench the ball bearing [21].
When the mating part of the outer ring of the ball bearing [21] is removed from the hub [1], the ball bearing [21], RV gear assembly and pin [17] will fall from the hub [1]. In order to keep the parts from being damaged, place a container underneath the workbench, and place a rubber mat over it.

2)Strike the end face of the pin [17] with a pin punch and a hammer, and remove the ball bearing [21] from the hub [1].
At this time, the RV gear assembly (RV gear A [4], RV gear B [5], crankshaft [9], tapered roller bearing [22], needle roller bearing with retainer [23], spacer [12]) and pin [17] can be taken out together.

3)Remove the ball bearing [21], RV gearassembly and pin [17] which have fallen.

Note : The tapered roller bearing [22], needle roller bearing [23], spacer [12] are not removed from the crankshaft [9] except when replacing.

(21) Ball bearing removal

Note : When removing, the ball bearing [21] falls from the hub [1]. Place a rubber mat underneath the workbench to keep the part from being damaged.

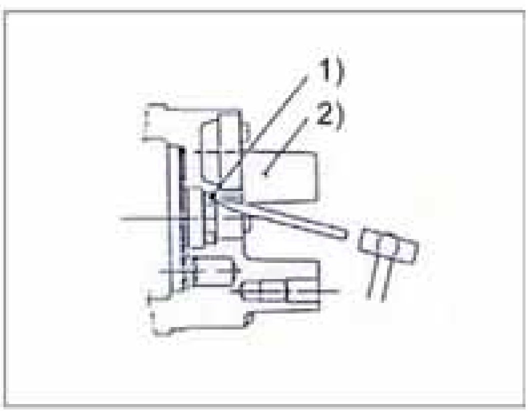
1)From the cover [8] side of the hub [1], strike the end face of the pin [17] with a pin punch and hammer, and remove the ball bearing [21] from the hub [1].

(22) Removal of spindle mounted parts

1) Takethefloating seal [31] out of the spindle [2].

2) Remove the outer rings (3 rings) of the tapered roller bearing [22] from the spindle [2].

Note : The mounting surfaces of the outer ring of the tapered roller bearing [22] and spindle [2] may adhere due to oil film of the lubricating oil. Outer ring removal may therefore be difficult. If so, if you provide a light impact to the center of the mounting hole section of the spindle [2] with an aluminum bar, the film will be broken thus facilitating removal.



3)Removal the oil seal [132]from the spindle [2].

Note : Absolutely do not reuse the oil seal [132] which has been removed.

1) Oil seal
2) Spindle

(23) Disassembly of hold flange mounted parts

1)Take the outer ring of the tapered roller bearing [22] out of the hold flange [3].

(24) Rough washing of various parts

1) Divide the hub [1], spindle [2], cover [8], rear flange [101] parts (4 parts) and other parts (hereinafter referred to as "internal parts").

2) Place the hub [1], spindle [2], cover [8] and rear flange [101] into the washing tank and wash.

Note : Earth and sand may adhere to the outer surface of the various parts. Wash well and remove the earth and sand.

Caution

White kerosene is a combustible.
Beware off ire or burns or injury due to fire.

Note : Injury may occur easily if you wash various parts which are still dirty in oil from the beginning. Let soak until the dirt and grease become loose and float up.

3)Place the internal part in a rough washing container of white kerosene and wash.

(25) Finish washing

1) Place the various parts in finish washing container of white kerosene and wash well including the inside of parts while slowly turning.

2) Wipe away the white kerosene adhering to each part with a clean waste cloth.

Note : Dry the inside surfaces of the hub [1], spindle [2] and hold flange [3] by blowing with compressed air in a place free of dust and moisture. After drying, coat each part with hydraulic fluid. Let the inside surface of the rear flange [101], hydraulic motor parts and RV gear assembly dry naturally in a place free of dust and moisture. If the pins [17] (24 pins) are treated roughly, the surfaces will become damaged from mutual contact or lost. Handle the pins with care.

3. SERVICE PREPARATIONS

Follow these standards when disassembling and inspecting the GMY motor.

Handle the various parts carefully. Be especially careful not to damage the moving and sliding parts. Seals

3-1. Once disassembled, all seals (O-rings, oil seals, floating seals) should be replaced with new ones even if no damage is observed.

3-2. Service standards for parts subject to wear

(1) Replace all parts which show striking damage.

(2) Replace if various parts have the following problem (phenomenon).

Part No.	Parts Name	Phenomenon	Reference Value (Standard Dimensions)	Tolerance Value (Criterion Value)
 (2) (3) (19) (37)	Spindle kit Spindle Hold flange Reamer bolt Expander	· Serious damage in appearance. · Abnormal wear such as scuffing.		
 (4) (5) (9) (12) (22) (23)	RV gear assembly RV gear (A) RV gear (B) Crank shaft Spacer Tapered roller bearing Needle roller bearing With retainer	· RV gear teeth surface are worn unequally. · Movement of various parts not smooth when crank shaft [9] is turned.		
20	Snap ring	· Circumferential end face has abnormal wear.		
21	Ball bearing	· Has indentation. · Exhibits flaking phenomenon. · Worn unequally.		
102	Shaft	· Working face with oil seal [132] is worn. · Spline is worn.		
104	Cylinder block	· Spline section is worn. · Inner surface of bore is worn too much. · Flaw and unequal wear on sliding plate surface with timing plate [109].		
 (105) (106)	Piston assembly Piston Shoe	· There is clearance in shaft direction of the piston [105] and shoe [106]. · Shoe [106] is abnormally worn. · Shoe [106] is unequally worn.	Clearance 0.04 mm 0.0016in.	Clearance 0.14 mm 0.0016in.
107	Retainer plate	· Circumference end face is unequally worn.		
108	Thrust ball	· Ball surface sliding part with retainer plate [107] is worn unequally.		
109	Timing plate	· Sliding surface has burning phenomenon and unequal wear.		
115 116	Friction plate Matching plate	· Both end faces are unequally worn. · Torque is not specified torque. · Has burning phenomenon.	Braking torque 97.1 N · m (9.9kgf · m) 71.6ft · lbs	Braking torque 97.1 N · m (9.9kgf · m) 71.6ft · lbs
149 150	Ball bearing Ball bearing	· Has indentation. · Exhibits flaking phenomenon. · Worn unequally.		
153	Thrust plate	· Has burning phenomenon		

4. ASSEMBLY

Assembly, as a rule, assembly is carried out by performing the procedure for disassembly inreverse.

4-1. Preparation

2.Provide a workbench, tools and materials in the same way as for disassembly of section2.

4-2. General suggestion when working

(1) Pay the same attention as for general suggestions for disassembly of section 2.

(2) When assembling, remove all foreign objects or metal fragments from parts, and make sure there are no burrs or dents, etc., on parts.
If there are burrs or dents, remove with an oil stone.

(3) Replace O-rings, oil seals and floating seals with new ones.

(4) Replace reamer bolts [19] with newones.

(5) Bonding agent is applied to the screw section of reamer bolts [19] and screw holes of reamer bolts [19] of the spindle [2] when assembling.
Degrease in order to remove grease.

(6) Be careful not to damage O-rings, oil seals and floating seals when mounting. (Apply a small amount of grease to make them slippery.)

(7) Be sure to coat the moving and sliding parts of the hydraulic motor section and valve section with clean hydraulic fluid (NAS standard class 9 or higher) and assemble.

(8) Do not use cloth gloves for assembly. (To prevent fiber pieces from causing faulty operation.)

(9) Bolts and plugs should be tightened by torque value given in 1-2. Tightening torque table.

(10) When assembly is complete, plug all ports to prevent dirt from entering.

(11) The photographs and drawing contained in the manual are of representative models.
Disassembly procedure is however not affected even if the product you are using differs inpart.

4-3. Assembly procedure

Note : If reassembling after replacing parts, pre-load adjustment of the ball bearing [21] and shaft direction clearance adjustment of the tapered roller bearing [22] are necessary.
Before assembling, therefore, make sure the following parts have been replaced.

(1) Renewal parts required for pre-load adjustment of the ball bearing [21] : Hub [1], spindle kit, collar [11], ball bearing [21].

(2) Renewal parts required for shaft direction clearance adjustment of the tapered roller bearing [22] : Spindle kit, RV gearassembly.

Note : If reassembling after replacing the parts listed above, be sure to reassemble using parts which have been adjusted.
If you reassembly with parts that have not been adjusted, it will cause the travel motor to operate poorly or break down prematurely.

(1) Hub section assembly

1) Fasten 2 eyebolts in the screw holes of the hub [1] so they are symmetrically positioned.

2) Hookthe hook and wire in the eyebolts, hoistthe hub [1] with a crane, and set the hub [1] on the workbench.

Note : While matching the hub bolts of the hub [1] and mounting holes of the workbench, place the hub [1] gently in the mounting holes of the workbench.

3) Fasten the hub [1] to the workbench and tighten the hexagon nuts are symmetrically positioned.

Caution

Tighten the hexagon nuts securely.
Failure to do so could result in injury if the travel motor is inverted and falls.

4) Press fit the ball bearing [21] in the hub [1] with an aluminum rod and hammer.

Note : When pressing ball bearing [21] , be sure to keep it true and square by shifting the aluminum rod around and pushing it in just a little at each spot.

5) Fit floating-seal [31] to hub [1], holding it by both hands and lowering it slowly into position.

(2) Spindle section assembly

1)Apply oil to the O-ring of the floating seal [31], and mount the floating seal in the floating seal groove of the spindle [2].

Note : Separate the O-ring parts of floating seal [31], and Oil it all around, and then combine itwith the seal ring part. Seat the O-ring part snugly in the groove, and after fitting the floating seal [31] in the groove, checkto be sure that it is true and square in spindle [2].

2) Mount 2 eye bolts in the spindle [2] so they are symmetrically positioned.

3) Hook the hook and wire in the eyebolts, hoist the spindle [2] with a crane, and slowly place the spindle [2] inthe hub [1].

4) Fasten the hub [1] and spindle [2] with fixtures. At this time, fasten the fixtures so they are symmetrically positioned

5) Invert the travel motor.

6) Fit the outer rings (3 rings) of the tapered roller bearing [22] into the respective outer ring fastening holes in the spindle [2].

(3) Mount the RV gear assembly.
1)I nstall RVgearA[4] inthehub [1].

2) Install the crankshaft [9] in the hub [1].

Note : Match the inner race of the tapered roller bearing [22] of the crank shaft [9] with the outer race hole of the tapered roller bearing [22] fit in the spindle [2].

3) Install RVgearB [5] inthe hub [1].

4) After applying lubricating oil to the pins [17] (24 pins), insert between the pin groove of the hub [1] and gear teeth groove.

(4) Hold flange mounting

1) Insertthe ball bearing [21] inthe hub [1].

Note : The fit of the ball bearing [21] outer diameter and hub [1] inner diameter is press fit. Press fit gradually and uniformly by tapping the pin punch.
At this time, place the ball bearing [21] securely in the hub [1].

2) Check if the hub [1], spindle kit, ball bearing [21] (2 bearings) parts haven't been replaced with new ones.

Note : If there are no renewal parts, proceed to the next step (3).
If there is even 1 renewal part, proceed to the next step Æ after carrying out "(18) Pre-load adjustment of the ball bearing".

3) Mount the outer ring of the tapered roller bearing [22] on the tapered roller bearing of the RV gear assem bly.

4) Fitthe hold flange [3] in the innerring of the ball bearing [21] in the hub [1].

Note : Match the counter marks of the spindle [2] and crank shaft [9] and fit the hold flange [3] on the ball bearing [21] so that it is in the same position as before disassembly.
If it is hard to place the hold flange [3] in the inner ring of the ball bearing [21], insert into the ball bearing [21] by tapping the hold flange [3] uniformly with a plastic hammer.

(5) Reamer bolt fastening

Note : If grease adheres to the screw section corresponding to the reamer bolt [19] of the spindle [2], degrease with degreaser and wash.

1)Apply bonding agent to screw section of the spindle [2].

Note : Tighten the 3 reamer bolts [19] equally, a little at a time.
If you tighten 1 or 2 before the other, the hold flange [3] will tilt, and you will not be able to correctly insert the ball bearing [21] in the hold flange [3].

2)Tighten the reamer bolts [19] (3 bolts) to the specified torque.
Specified torque : 794±49.0 N-m
(81.0±5.0kgf-m)
586±36 ft-lbs

3)Invert the travel motor.

4)Remove the fixtures (2 fixtures).

5)Invert the travel motor.

(6) Fitting the snap ring
1)Check if the spindle kit and RV gear assembly parts haven't been replace with new ones.

Note : If there are no renewal parts, proceed to the next step (2).
If there is even 1 renewal part, proceed to the next step (6) after carrying out "(19) Shaft direction clearance adjustment of the tapered roller bearing".

Note : f using by replacing the snap ring [20] only with a new part, select the same type of snap ring [20] as before disassembly or one which is similar from among the 15 types.

2) Mount the snap ring [20] in the snap ring groove of the hold flange [3].

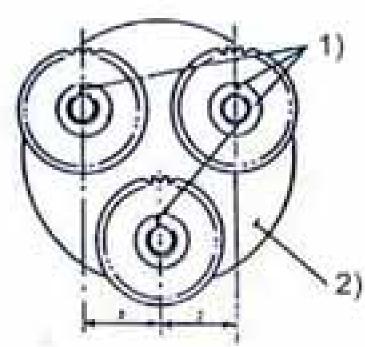
Note : Match the 3 snap rings [20] with the counter mark of the hold flange [3], and mount each in the same position as before disassembly.
If using a new snap ring [20], mount a snap ring [20] of the thickness selected in the previous step in the snap ring groove.

(7) Spur gear assembly

1) Install the snap ring [25] (3 rings) into the crankshaft [9].

2) Match the counter marks of the spur gear [7] (3 gears) and mount on the crankshaft [9].

Note : Insert the spur gear [7] (3 gears) on the crank shaft [9] by matching the counter marks (punch holes) as shown in the figure below.



1) Position matching marks (punched holes) of spur gears like this.
2) Hold flange

Caution

When mounting the snap ring [25], if the tip of the pliers slips out of the hole of the snap ring, the snap ring [25] couldjump out.

Note : Mount with the acute angle of the snap ring end face facing up.

3) Mount the snap rings for the shaft [25] (3 snap rings) in the snap ring groove of the crankshaft [9].

(8) Mounting on the spindle

Caution

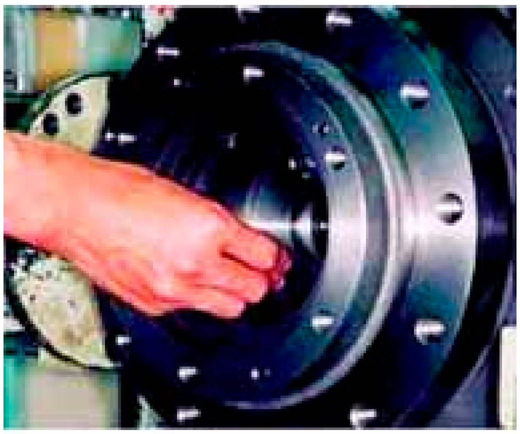
You could get burned while performing this task, so use leather gloves to perform insertion.
Be careful not to get burned.

Note : Insert until the large diameter side collarofthe inner ring of the ball bearings [149] adhere to the collar surface of the shaft [102].

1) Place ball bearings [149] in a heating tank, heat at 100±10°C for 10 minutes, and pressfiton the shaft [102].

2) Invert the travel motor

3) Apply lithium grease to the lip section of the oil seal [132], and press fit the oil seal [132] in the oil seal hole of the spindle [2] with the retainer (2) and hammer.

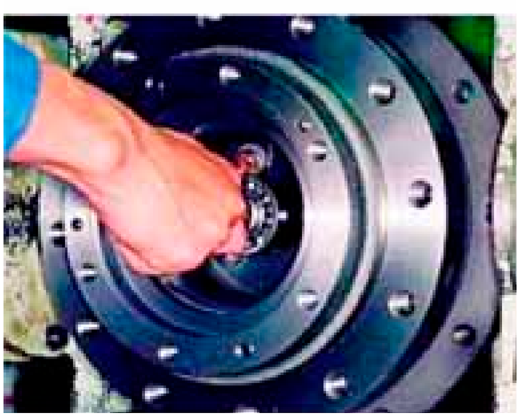


4) Mount the parallel pins [177] (2 pins) in the pin holes of the spindle [2].

5) Apply lithium grease to the hemispherical surface of the pivots [176] (2 pivots), and set in the parallel pins [177] of the spindle [2].

6) Attach to the spring [185], piston assembly (piston [161], shoe [162]).

7)Dip hydraulic fluid in the sliding parts of the piston assembly (piston [161], shoe [162]) and mount in the piston hole of the spindle [2].



8) Tilt the travel motor90 degrees.

9) Apply lithium grease to the splines of the motor shaft [102].

Note : Take care not to scratch or cut the lip portion of the oil seal [132] in place with splined foremost end of the shaft [102].

10)Fitting the motor shaft [102] slowly into the spindle [2].

11)Insert the swash plate [103] into the spindle [2].

Note : Apply lithium grease to the swash plate [103] where matching surface of spindle [2].
Make sure that the locating pivot of the spindle enters the pivot holes of the swash plate [103].

(9) Assembly of cylinder block interior

Note : Introduce the sharp side of the angled section of the THS snap ring [146] and washer [110] as shown in the figure on the left.

1) Insert parts in the cylinder block [104] in order of washer [110], spring [114], washer [110], and THS snap ring [146].

2) Place the cylinder block [104] on the press bench.

3) Place retainer (1) on the washer [110], and while clamping with the press, mount the THS snap ring [146] in the snap ring groove of the cylinder block [104] with a pairof snap ring pliers.

Note : Press force of spring [114] is 588 N (60 kgf) 132 lbs or more. Protect by covering the cylinder block [104] with a vinyl sheet so the contact surface with the timing plate of the cylinder block [104] does not become damaged.

(10) Assembly of hydraulic motor parts

1) Place the needle rollers [151] (3 rollers) in the holes of the cylinder block [104], and thrust ball [108] on the top.

2)Mount the 9 piston assemblies in the retainer plate [107].

Note : After assembling, dip the whole thing in hydraulic fluid.

3) Mount the retainer plate [107] and 9 piston assemblies in the cylinder block [104].

Note : Match the round surface sections of the retainer plate [107] and thrust ball [108].

4) Install cylinder block [104] on the motor shaft [102], matching its splines to the shaft splines.

Note : Turn the cylinder block [104] back and forth to be sure there is no play. Aplay, if any, means that the splines are worn to require replacement of the part.

(11)Assembly of parking brake section

Note : Mount the friction plate [115] after dipping in hydraulic fluid.

1) Mount the friction plate [115], mating plate [116] (2 each) alternately in the outer circumference groove of the cylinder block [104] and inner circumference groove of the spindle [2].

2) Mount the O-rings [135], [141] in the O-ring grooves of the piston [112].
At this time, apply a thin coat of grease to the O-rings [135], [141].

3) Mountthe piston [112] in the spindle [2].

Note : If it is difficult to place the piston [112] in the spindle [2] due to resistance of the O-rings [135], [141], insert by tapping the end face of the piston [112] with a plastic hammer. When mounting the piston [112], be careful not to damage the O-rings.

(12)Assembly of plugs in the rear flange
1) Insert the valve [227] into the rear flange [201].

2) Mount the O-rings [238] (2 rings) on the plugs [282] (2 plugs).

Note : Apply grease to the O-rings [282].

3) Insert the unified plugs [282] (2 plugs) in the rear flange [201] and temporarily tighten with a hexagonal wrench.

Note : Apply hydraulic fluid to the spool [223] and insert The spool [223] into the rear flange [201]
When mounting the spool [223], match the hole center of the rear flange [201] with the shaft center of the spool [223] in order to prevent damage of the rear flange [201] by contact and damage of the outer circumference surface of the spool [223].
If damage by contact is produced on the hole section of the rear flange [201] and spool [223] outer surface, after assembly, it will cause internal leaking and will cause a reduction in performance of the travel motor.
The clearance between the rear flange [201] and spool [223] in adjusted.
If replacing, replace by rear flange kit.

4) Insert the spool [223] in the rear flange [201].

5) Mount the O-rings [236] (2 rings) on the plugs [224] (2 plugs).

Note : Apply grease to the O-rings [236].

6) Screw the plugs [224] (2 plugs) in the rear flange [201] and temporarily tighten.

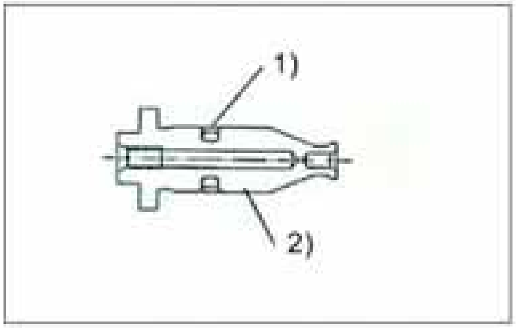
7)Insert the steel ball [296] in the mounting hole of rear flange [201].

8) Temporarily tighten the plug [284].

(13)Assembly of SRV in the rear flange
1) Mount the O-rings [291], [292], back up ring [294], [295], on the sleeve [288].

2) Mount the O-rings [238] on the plugs [289].

Note : Apply grease to the O-rings [291], [292], [238].



3) Mount the piston-seal [293] on the valve [287].

Note : The piston-seal [293] is consist of O-ring and tefron-ring.
Apply grease to the O-ring and tefron-ring.
First mount the O-ring and after mount tefron-ring.

1)Piston seal
2)Valve

4) Insert the sleeve [288], valve [287], spring [290] in the rear flange [201].

5) Temporarily tighten the plug [289].

(14) Assembly of the rear flange mounted parts
1) Apply hydraulic fluid to the outer ring of the ball bearing [150], and fit the outer ring of the ball bearing [150] in the rear flange [201].

2) Fit the parallel pins [241] (2 pins) in the pin holes of the rear flange [201].

3) Apply grease to the mating face with the rear flange [201] of the timing plate [109].

Note : Mounting of the timing plate [109] is carried out until the timing plate [109] adheres to the rear flange [201]. Adhesion prevents the timing plate [109] from falling from the rear flange [201] when mounting the rear flange [201] on the spindle [2].

4) Mount the timing plate [109] on the rear flange [201] using the parallel pin [242] as a guide.

Note : Apply a sufficient amount of grease to the spring [113], and fix so it does not fall from the rear flange [201].

5) Mount the springs [113] (8 springs) on the rear flange [201] and fix with grease.

(15) Connection of rear flange with spindle

1) Mount the O-rings [28], [30] in the O-ring groove of the spindle [2].

Note : Mount the O-ring [30] without applying grease. If reassembled with grease applied, the grease may bleed from the mating face of the rear flange [201] and spindle [2] when the travel motor is running. This maybe mistaken as an oil leak, so do not apply grease.

2) Fitthe parallel pins [43] (2 pins) in the spindle [2].

3) Put 0.5 liters of hydraulic fluid in the spindle [2].

4) Match the parallel pins [43] (2 pins) mounted in the spindle [2] with the pin holes of the rear flange [201] and mount the rear flange [201] in the spindle [2].

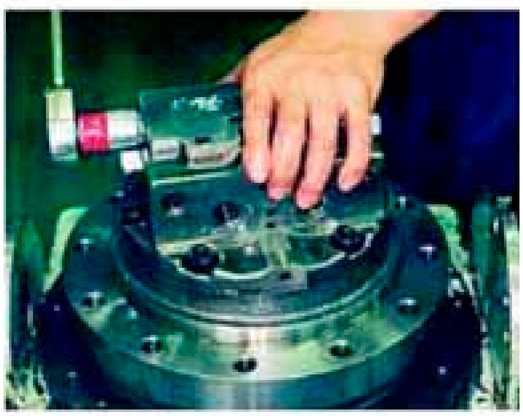
5) Tighten the hexagon socket bolts [245] (6 bolts) in the spindle [2] to the specified torque.

Tightening torque : 102± 15.7 N-m
(10.4 ±1.6kgf-m)
75.2 ±11.6 ft-lbs

6)Tighten the plugs [282] to the specified torque.
Tightening torque :98.1 ±19.6 N-m
(10 ±2.0kgf-m)
72.3±14.5 ft-lbs

7)Tighten the plugs [224] to the specified torque.
Tightening torque :353±39.2 N-m
(36±4.0kgf-m)
260 ±29 ft-lbs

8)Tighten the plugs [282] to the specified torque.
Tightening torque : 98.1±19.6 N-m
(10± 2.0kgf-m)
72.3 ±14.5 ft-lbs



9)Tighten the plugs [289] to the specified torque.
Tightening torque : 98.1± 19.6 N-m
(10 ±2.0kgf-m)
72.3 ±14.5 ft-lbs

(16)Assembly of the input gear
1)Invert the travel motor.

2)Mountthe shaft [15] on the shaft [102].

3)Mountthe input gear[6] on the shaft [15].

Note : Apply grease to the steel ball [36] so it doesn't fall out when mounting the cover [8].

4)Fit the steel ball [36] in the steel ball mounting hole of the input gear [6].

(17) Cover assembly

1) Introduce 1.3 liters of lubricating oil.

Note : Apply grease to the O-ring [29].

2) Mount the O-ring [29] in the O-ring groove of the cover [8].

3) Place the cover [8] on the hub [1], matching the marks to restore it is its original position.

Note : After positioning the cover above, force it into the hub [1] by lightly tapping with a plastic hammeron and around its rim. Avoid strong tapping or the O-ring [29] will get out of its groove to result in imperfect sealing.

4) Look the cover [8] in place by installing the ring [18].

5)Tighten plugs [33] to the specified torque.
Tightening torque : 58.8± 9.81 N-m
(6 ±1.0kgf-m) 43.4±7.2 ft-lbs

6)Mount the O-rings [35] on the plugs [34] (2plugs).
Tighten the plugs [34] to the specified tongue.
Tightening torque : 58.8±9.81 N-m
(6±1.0kgf-m) 43.4±7.2 ft-lbs

(18) Removal of travel motor

1) Invert the travel motor.

2) Removal the travel motor installation nuts from hub bolts.

3) Fasten the eyebolts (2 bolts) in the spindle [2].

Note : Fasten the 2 eye bolts in the screw holes of the spindle [2] so they are symmetrically positioned.

4) Hook the hook and wire on the eye bolts, and remove the travel motor from the workbench with a crane.

(19) Pre-load adjustment of ball bearing

Note : In order to ensure the proper life for the baa bearing [21], it is necessary to provide a certain pre-load.
Therefore, if replacing a part that influences the amount of pre-load, temporarily assemble in accordance with the following procedure, and check the amount of pre-load.

If you reassemble without checking, it could cause the GMY motor to operate poorly or break down prematurely.

Parts which influence amount of pre-load of the ball bearing Hub [1], spindle kit, collar[11], ball bearing [21]

If not replacing the parts listed above, skip this process and proceed to the process of section(3).

Pre-load check and pre-load adjustment instructions are as follows.

(1)Ball bearing pre-load adjustment procedure

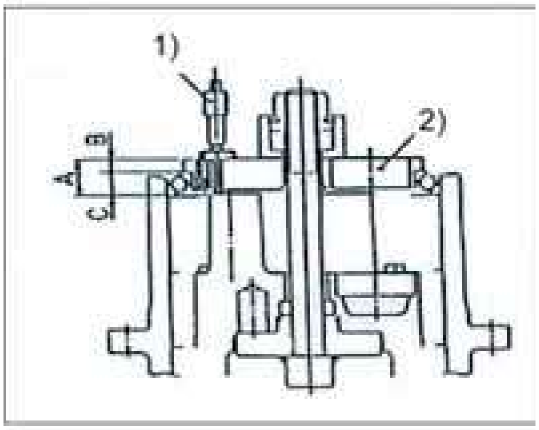
1) Mount the main Brg pre-load adjustment jig on the spindle [2], tighten the special nut, and apply pre-load to the ball bearing [21].
Special nut tightening torque : 39.2± 9.81 N-m (4±1.0kgf-m) 28.9±7.2 ft-lbs

2) Measure depth dimension "A" with a depth micrometer from the measurement hole of the main Brg pre-load adjustment jig.

3) The "B" dimension of the main Brg pre-load adjustment jig is known, so determine the clearance "C" dimension by the following formula.

"C"="A"-"B"

A : Actual measurement value
B : Jig bodydimension
C : Specified dimension

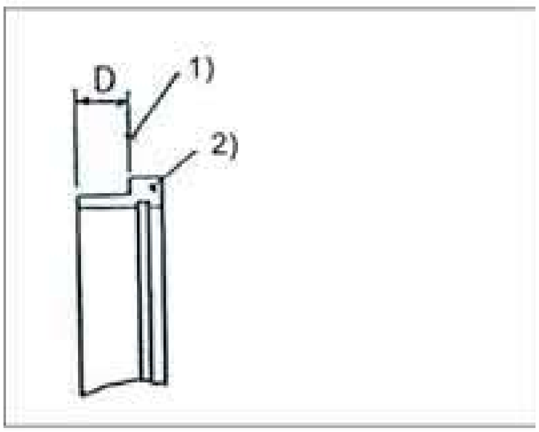


4)Next find the "D" dimension of the hold flange [3].

5)Adjust the hold flange [3] with the measurements taken in 2) ~ 4) and following procedure.
The "C" dimension is the specified dimension of the hold flanae.

1) Depth micrometer
2) Jig

I. If dimension "D" of the actual hold flange [3] 0.02 mm or smaller than specified dimension "C" : Cut the "E" surface of the hold flange [3] down to the specified dimension with a turning machine, etc..



II. If dimension "D" of the actual hold flange [3] is within tolerance * 0.02 mm (0.00079 in.) of specified dimension "C" :
Use the unmodified hold flange [3] as it is.

1) "E" inner surface
2) Hold flange

III. If dimension "D" of the actual hold flange [3] is 0.02 mm or larger than specified dimension "C" :
Replace with a new spindle assembly.
A new hold flange [3] in always provided with an arrangement allowance.

Note : The hold flange and spindle have been machined as a pair and are therefore con figured as an assembly.
The hold flange alone therefore cannot be replaced.
At this time, the spindle must be replaced together with it.
This assembly is referred to as the "spindle assembly".
If replacing by spindle assembly, perform disassembly and assembly again.

6) Remove the main Brg pre-load adjustment jig from the spindle [2].

7) After completing hold flange adjustment by the adjustments of items I , II, III, proceed to the process of (3) section (3).

(20) Shaft direction clearance adjustment of the tapered roller bearing

Note : If the following parts are replaced, the shaft direction clearance of the tapered roller bearing [22] must be adjusted to the specified value by thickness adjustment of the snap ring [20].
If you reassemble without adjusting, it could cause the GM motor to operate poorly or break down prematurely.

Spindle kit, RV gear assembly

If not replacing the parts listed above, snap ring adjustment is unnecessary, and main assembly is carried out from section (6) as is.

Shaft direction clearance adjustment method of the tapered roller bearing is as follows.

1)Tap the outer ring of the tapered roller bearing [22] attached to the crank shaft [9] with a hammer and retainer (4).

Note : This is in order to reliably insert the RV gear assembly in the spindle [2].

2) Mount the thinnest ring [20] in the snap ring groove of the hold flange [3].

3)Tap the ring [20] side with a hammer and retainer (4).

Note : Check whether the RV gear assembly has been reliably inserted in the spindle [2].

4)Place a thickness gauge between the ring [20] and tapered roller bearing [22] and measure the clearance.

5)Ring [20] thickness measurement

Set thickness (MAX.) of the ring

MAX. = Thickness of thickness gauge + Thickness of Currently mounted ring

Set thickness (MIN.) of the ring

MAX. = Thickness of thickness gauge + Thickness of Currently mounted ring - 0.002 Inch (0.05 mm)

6) After deciding thickness of the ring, select from among the 15 types and mount on the hold flange.
(See 6. CLEARANCE ADJUSTMENT PART DIMENSIONS TABLE.)

7) After mounting the ring of the set thickness, proceed to (6).

5. PERFORMANCE CONGIRMATION TEST

- After servicing the GM motor, perform the following performance tests by the following procedure.

1) Required measuring devices

Pressure gauge {for 3.43MPa 35kgf/cm^2 498psi}	2 pieces
Graduated cylinder {for 5 liter 1.32usgal.}	1 piece
Stopwatch	1 piece

2) Test procedure

1 GM motor Mounting / piping

Mount the GM motor to body (frame section) and connect piping.
The track shoe must not be attached here at this time.
[This is because for conducting the performance test (no-load operation) of the motor.]

Note :
1. When connecting, connect so that the pressure gauge (main circuit) can be mounted and drain volume of the hydraulic motor can be measured.
2. When mounting the GM motor, do not strike with a hammer, etc., but rather mount gently using the bolt holes.

↓

2 Brake-in operation Of the GM motor

GM motor r.p.m.	Pressure	Rotation direction	Running time
10 r.p.m.	No-load	Left / right	Min. 1 minute each

↓

3 GM motor performance confirmation test

1 Pre-load preparatory operation
Perform preparatory operation until approximately the following temperatures.
- Hydraulic fluid temperature : 45 ~ 55 ℃ (113~131°F)
- Speed reducer hub external temperature : 40 ~ 80 ℃ (104~176°F)

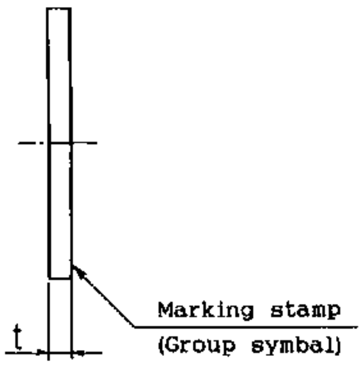
2 Confirmation test
Measure the following items to decide with the motor passes of fails the test.
Passing criteria
GM motor drive pressure : Max. 16 kgf/cm^2 (228psi) / when 10 r.p.m
Hydraulic motor drain volume : Max. 0.5 l/min. (0.13usgal) / when 10 r.p.m

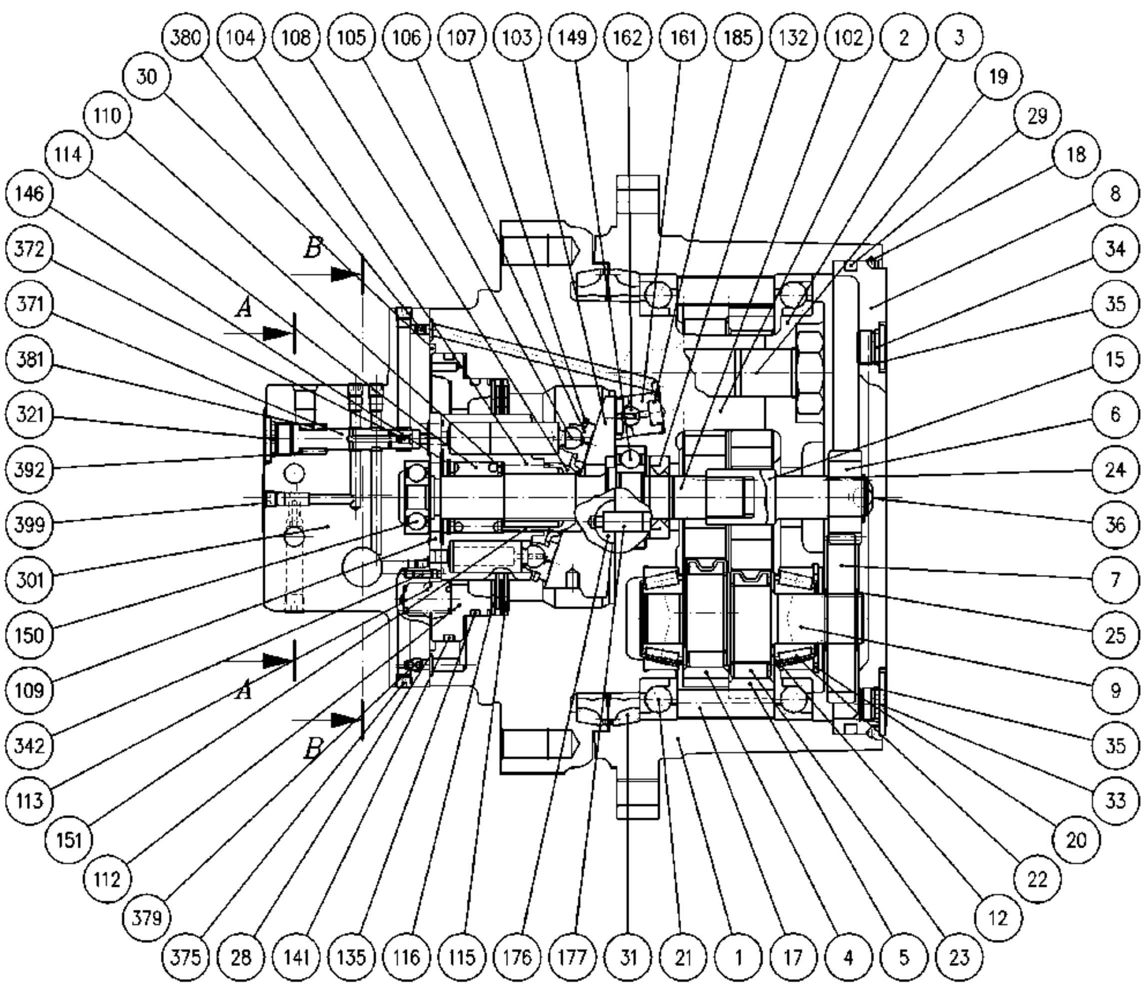
Pass → Attach the track shoe

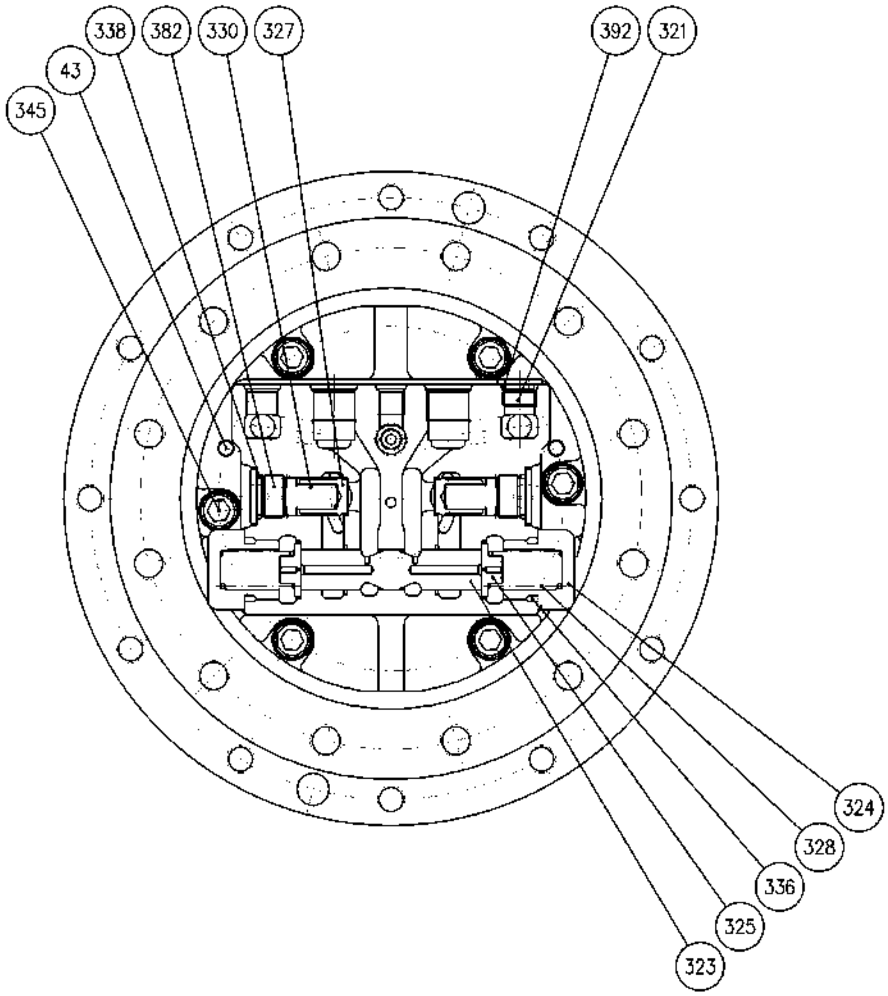
Fail → Disassemble and adjust again

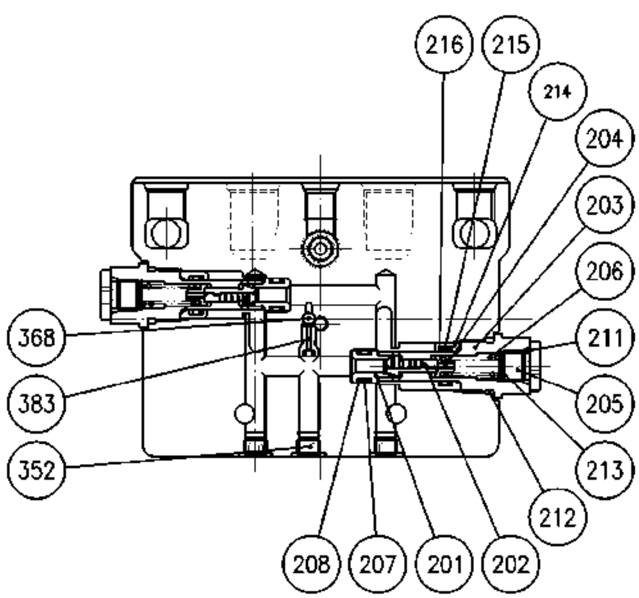
3.CLEARANCE ADJUSTMENT PARTS DIMENSIONS TABLE

Part Name	Classification symbol	Dimension(T) [Inch (mm)]
Snap ring [20]	A	$1.90 < T \leqq 1.95$
	B	$1.95 < T \leqq 2.00$
	C	$2.00 < T \leqq 2.05$
	D	$2.05 < T \leqq 2.10$
	E	$2.10 < T \leqq 2.15$
	F	$2.15 < T \leqq 2.20$
	G	$2.20 < T \leqq 2.25$
	H	$2.25 < T \leqq 2.30$
	I	$2.30 < T \leqq 2.35$
	J	$2.35 < T \leqq 2.40$
	K	$2.40 < T \leqq 2.45$
	L	$2.45 < T \leqq 2.50$
	X	$1.75 < T \leqq 1.80$
	Y	$1.80 < T \leqq 1.85$
	Z	$1.85 < T \leqq 1.90$









1) Hub
Spindle kit
*Spindle assembly
2) **Spindle
3) **Hold flange
19) *Reamer bolt
RV gear assembly
*RV gear kit
4) **RV gear A
5) **RV gear B
9) *Crank shaft
12) *Specer
22) *Tapered roller bearing
23) *Needle roller bearing
6) Input gear
Spur gear kit
7) Sper gear
F-Seal kit
31) Floating seal
8) Cover
15) Shaft (G)
17) Pin
18) Ring
20) Snap ring
21) Ball bearing
24) Snap ring
25) Snap ring
28) O-ring
29) O-ring
30) O-ring
33) Plug
34) Plug
35) O-ring
36) Steel ball
43) Parallel pin
102) Shaft
103) Swash plate
104) Cylinder block
Piston kit
*Pisdton assembly
105) **Piston
106)**Shoe
107)Retainer plate
108) Thrust ball
109) Timing plate
110) Washer
112) Piston
113) Spring
114) Sptring
115) Friction plate
116) Mating plate
132) Oil seal
135) O-ring
141) O-ring
146) Snap ring
149) Ball bearing
150) Ball bearing
151) Needle roller
Piston assembly
161) *Piston
162) *shoe
176) Pivot
177) Parallel pin
185) Spring
Rear Flange assembly
*Rear flange kit
201) **Rear flange
223) Spool
286) **piston
252) **Hex.. Socket plug
268) **Steel ball
275) **Hex.. Socket plug
279) **Filter
280) **Orifce
283) **Plug
298) **Orifce
299) **Name plate
*Sppl kit
271) **Spool
272) **Oil stopper
221) *Plug
224) *Plug
225) *Spring retainer
227) *valve
228) *Spring
230) *Spring
236) *O-ring
238) *O-ring
281) *Spring
282) *Plug
284) *Plug
285) *O-ring
287) *valve
288) *Sleeve
289) *Plug
290) *Spring
291) *O-ring
292) *O-ring
293) *Piston seal
294) *Back up ring
295) *Back up ring
296) *Steel ball
297) *Orifice
242) Parallel pin
245 Hex.. Socket bolt

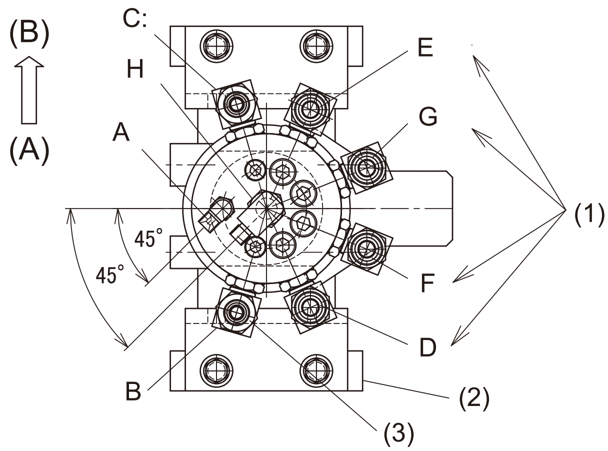
k.Rotary joint (Swivel joint)

1.Adaptor and joint

1)Fitting direction of the hydraulic adaptor
Fit the adaptor in position as shown in the figure.

2)Hydraulic adaptor tightening torque
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
37.2~42.1N.m(3.8~4.3kgf.m)27.4~31.1ft.lbs
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.1ft.lbs

3)Fitting the swivel joint assembly
(RD809-6230D) and track frame
Bolt tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs
(Apply screw adhesive (Loctite 271).)

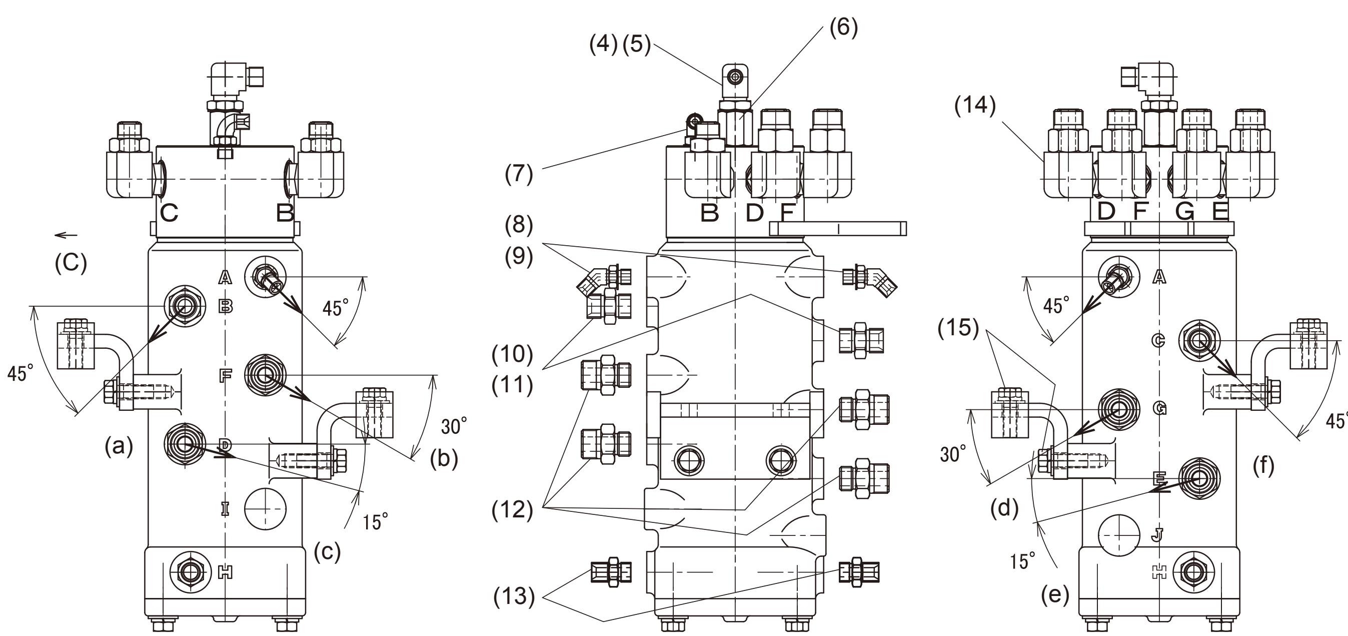


A: Bi-speed
B: Dozer down
C: Dozer up
D: Left front
E: Right front
F: Left back
G: Right back
H: Drain

(a)(Hose, crane angle)
(b)(Hose, crane angle)
(c)(Hose, crane angle)
(d)(Hose, crane angle)
(e)(Hose, crane angle)
(f)(Hose, crane angle)

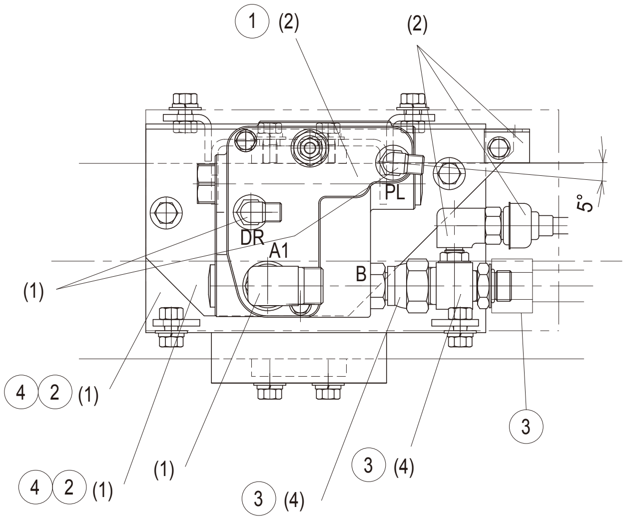
(1)Pipe joint (SG4, 1U)
(2)Bracket (swivel joint)
(3)Pipe joint (SG4, 13/16U)(Ports C and B)
(4)Washer-fitted elbow
(5)O ring
(6)Pipe joint (bushing, 1/2)
(7)Pipe joint (L, G1/4-G1/4)
(8)Pipe joint (L, G1/4-G1/4)
(9)O ring
(10)Adaptor 7
(11)O ring
(12)Pipe joint (SG4, 1U)
(13)Adaptor elbow
(14)Elbow pipe joint (G1/2-2)(Ports A thru G)
(15)Bolt

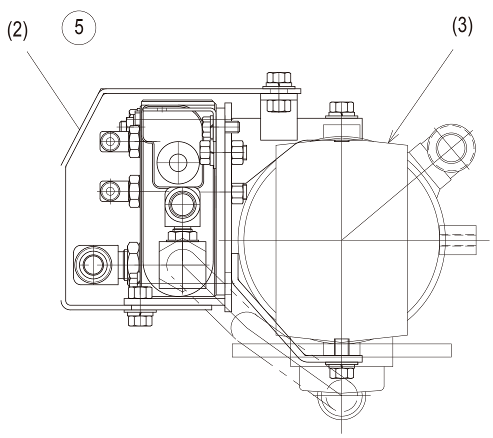
(A)Reference: Machine front
(B)(Dozer side)
(C)(Dozer side)



I. Holding valve

1) Boom cylinder
2) Holding Valve assy





1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
   G1/2 size
   58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

3. Assembling procedure
   (1)Fit the valve assembly (holding) in position.
   (2)Place the bracket (1, H/V) and bracket (2, H/V) in position, and tighten the bolts temporarily.
   (3)Connect the pipe joint (SG4, 1U), pipe joint (FG4, 1U) and the pipes.
   (4)Tighten up the bolts for the bracket (1, H/V) and bracket (2, H/V). Be careful not to get the pipes twisted.
   (5) Finally set the cover (H/V) in place.

   Bolt tightening torque
   17.7~20.6N.m(1.8~2.1kgf.m)13.0~15.2ft.lbs
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs

(1)Pipe joint (L, G1/4-G1/4)
Bracket (2, H/V)
Bolt
Bracket (1, H/V)
Bolt
Pipe joint (LG4, 1U)
(2)Valve assembly (holding)
Bolt
Pipe joint (L, G2-G3)
Switch (pressure, 35M)
Stay (wire harness clamp)
Bolt
Cover (H/V)
Bolt
(3)Hydraulic cylinder assembly (boom)
(4)Pipe joint (SG4, 1U)
O ring (1UNF)
Pipe joint (LG4, 1U)
O ring

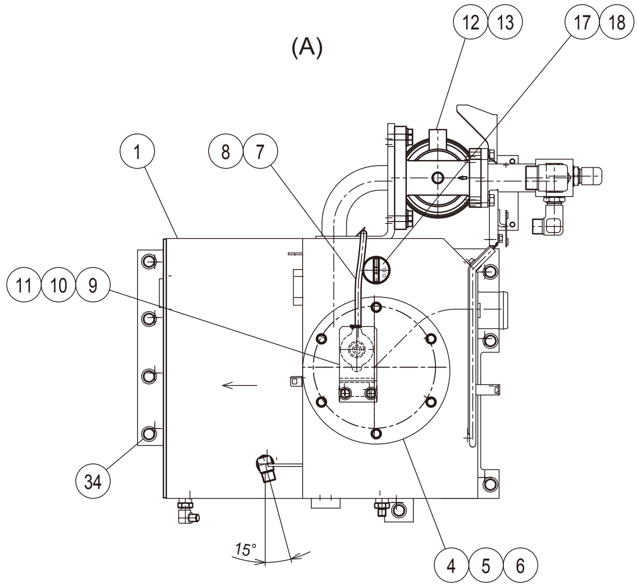
m. Hydraulic tank

(1) Tank assy

(2) Oil gauge
(3) Return filter

(4)Connector

(5) Tank cap



(34)Bolt
(33)O ring
(32)Elbow pipe joint
(31)Plug
(30)Grommet (170)
(29)Trim (390)
(28)Trim (660)
(27)Bolt
(26)Plate (2, partition)
(25)Bolt
(24)Plate (1, partition)
(23)Straight pipe joint
(22)Adaptor 7
(21)Pipe joint (L, G3/8-G3/8)
(20)O ring
(19)Pipe joint (L, F3-F2)
(18)O ring
(17)Plug (fuel filler)
(16)Thermal insulation (hydraulic tank)
(15)Gauge (oil tank)
(14)Filter assembly (suction)
(13)Bolt
(12)Filter assembly (return)
(11)Bolt
(10)Plain washer
(9)Plate (breather)
(8)Pipe clip
(7)Tube (breather)
(6)Bolt
(5)O ring
(4)Cover assembly (hydraulic tank)
(3)Rubber-fitted washer
(2)Plug
(1)Hydraulic tank

(A)Machine front

1.Tightening the filter assembly (return)
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5 ft.lbs

2.Fitting the gauge (oil tank)
Tightening torque
8.0~10.0N.m(0.82~1.0kgf.m)5.9~7.4 ft.lbs

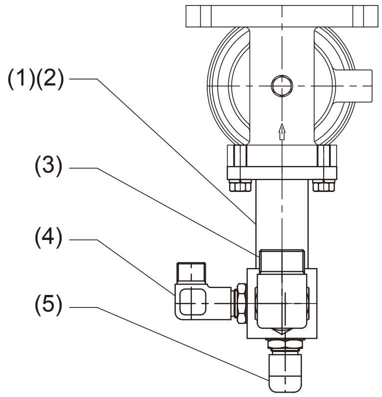
3.Fitting the cover assembly (hydraulic tank)
Tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.5~41.2 ft.lbs
Fitting direction
Place the assembly with the breather facing the machine front as shown at left.

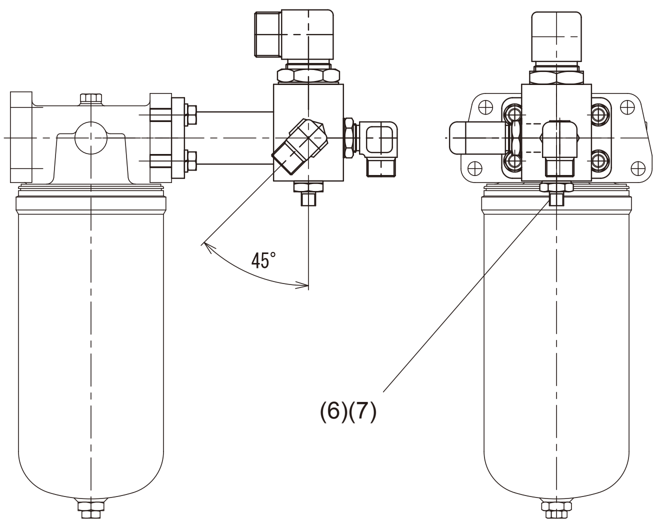
4.Fitting the adaptor
See (2/2).
Tightening torque
G3/8 size
49.1~53.9N.m(5.0~5.5kgf.m)36.2~39.8 ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

5.Fitting the hydraulic tank
Tightening torque
77.5~90.2N.m(7.9~9.2kgf.m)57.2~66.5ft.lbs
Apply screw adhesive (Loctite 271).

6.Fitting the plate(1, partition) and plate (2,partition)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.3~20.3ft.lbs

7.Filter assembly (suction)
Make sure the assembly does not stretch out of the top of the hydraulic tank. (See Fig. D on (4/4).)





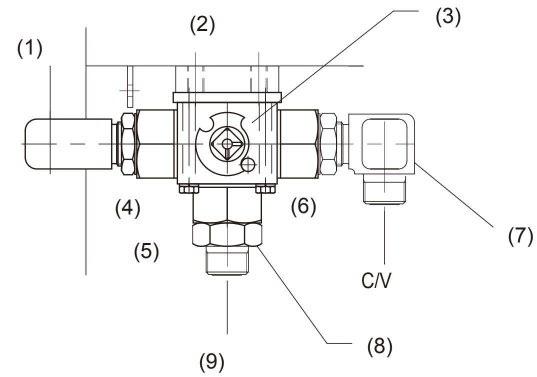
n.Filters

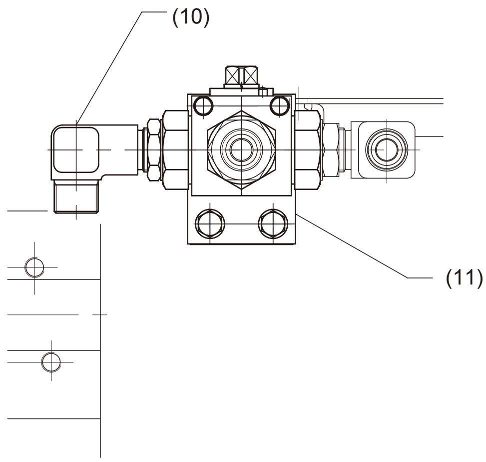
1.Fitting the adaptor
Fit the adaptor in position as shown at left.

2.Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)
96.7~94.0ft.lbs
G1-1/4 size
220.5~230.3N.m(22.5~23.5kgf.m)
162.6~169.9ft.lbs

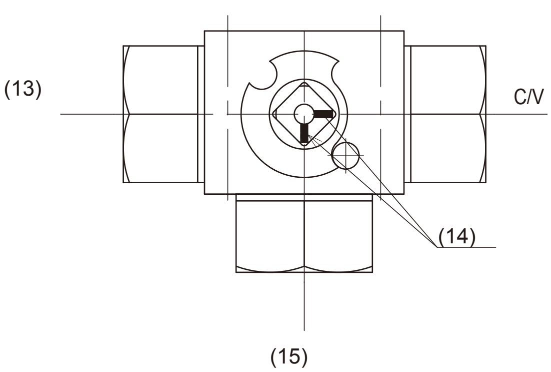
3.Fitting the pipe (return)
Tightening torque
62.8~72.6N.m(6.4~7.4kgf.m)46.3~53.5ft.lbs

(1)Pipe (return)
(2)Bolt
(3)Pipe joint (LG12, G12)
(4)Pipe joint (LG6, G6)
(5)Elbow pipe joint
(6)Adaptor
(7)O ring





(12)



o.Three way change valve

1.Fitting the valve assembly (3-way)
Fit the assembly in position as shown at left.

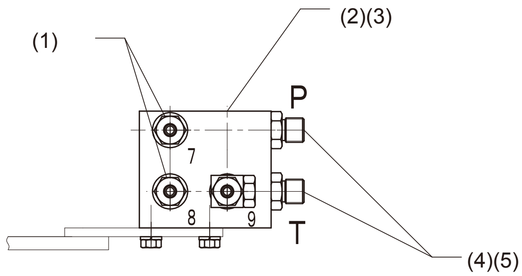
No. 1 port
Pipe joint (SG6, 1U)
(RD809-6151D)
No. 2 port
Pipe joint (LG6, G6)
(RD809-6917D)
No. 3 port
Pipe joint (LG6, G6)
(RD809-6154D)

2.Adaptor tightening torque
G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)
86.7~94.0ft.lbs

3.Factory-setting the oil flow direction
Set the oil flow direction before shipping, referring to the details given at left.
(Front pipe → C/V)

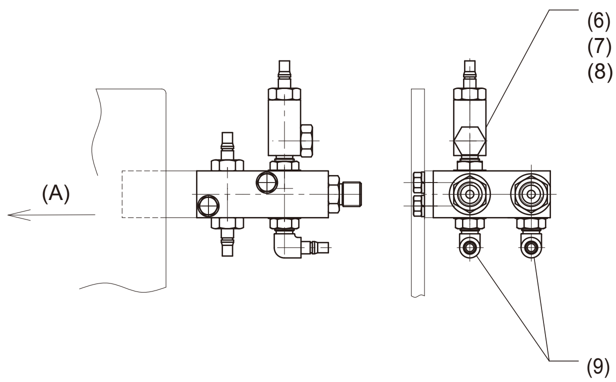
4.Fitting the bracket (selector, 3-way)
Tightening torque
48.1~55.9N.m (4.9~5.7kgf.m) 35.5~41.2ft.lbs

(1)Oil tank
(2)(Oil tank)
(3)Valve assembly (3-way)
Bolt
(4)No. 2 port
(5)No. 1 port
(6)No. 3 port
(7)Pipe joint (LG6, 1U)
(8)Pipe joint (SG6, 1U)
(9)Front pipe
(10)Pipe joint (SG6, G6)
(11)Bracket (selector, 3-way)
Bolt
(12)(Details of the selector lever)
As shown below, the lever of this valve has grooves. The oil flows along these grooves. In installing the lever, make sure the grooves are positioned as shown below.
(13)Oil tank
(14)Groove
(15)Front pipe



p.Pilot primary line and T port block

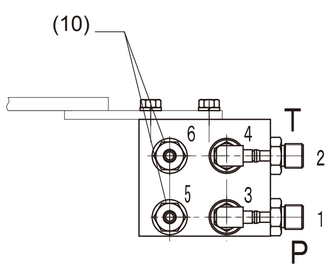
1.Fitting the adaptor
Ports 1 and 2
Straight pipe joint
Ports 3, 4, 5, 6, 7 and 8
Pipe joint
Pipe joint
Port 9
Pipe joint
Pipe joint
Plug



2.Adaptor tightening torque
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Fitting direction of the valve
Position the valve in position as shown at left.

4.Quick-coupling adaptor
Pipe joint
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental



5.Fitting the adaptor (pilot hose, 1)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs
48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

(Hose and tape color)

	Location	Hose tape color
1	Port P	White
2	Port T	None
3	Dozer P/V (P)	White
4	Dozer P/V (T)	None
5	Left control P/V (P)	White
6	Left control P/V (T)	None
7	Travel P/V (P)	White
8	Travel P/V (T)	None
9	Boom H/V (T)	None

(A)(Machine front)

(1)Pipe joint (S, G1/4-8.4)
(2)Adaptor (pilot hose, 1)
(3)Bolt
(4)Straight pipe joint
(5)O ring
(6)Pipe joint (T, G2-G2-G2)
(7)Pipe joint (S, G1/4-8.4)
(8)Plug (G1/4)
(9)Pipe joint (QL, G1/4-8.4)
(10)Pipe joint (S, G1/4-8.4)

q.Swivel shuttle valve

1.Fitting the adaptor
Position the adaptor in position as shown at left.

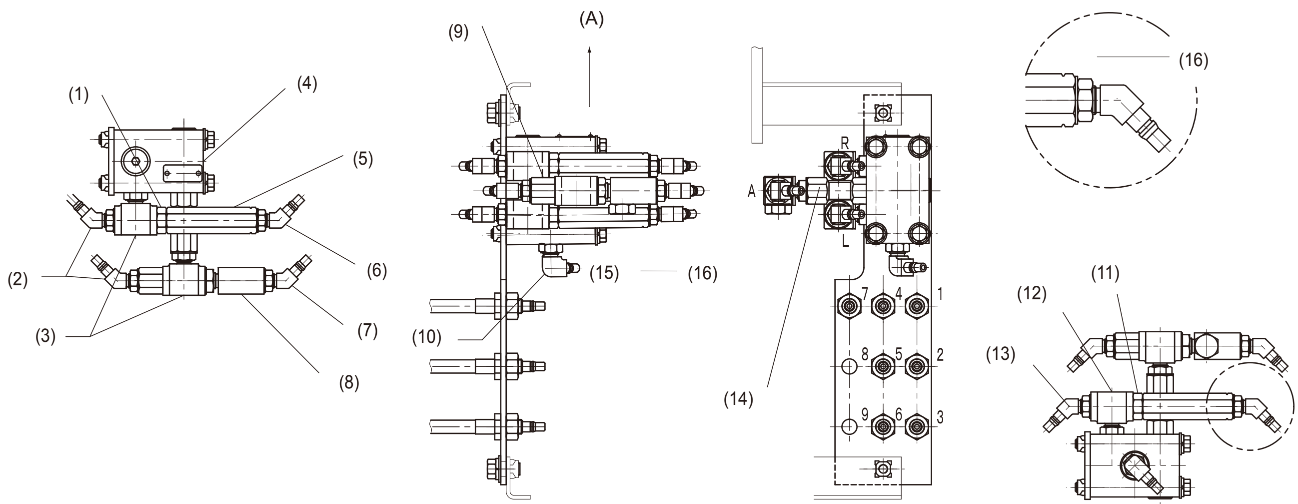
2.Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Plug tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4.Fitting direction of the valve
Position the vale with the nameplate facing the machine front.

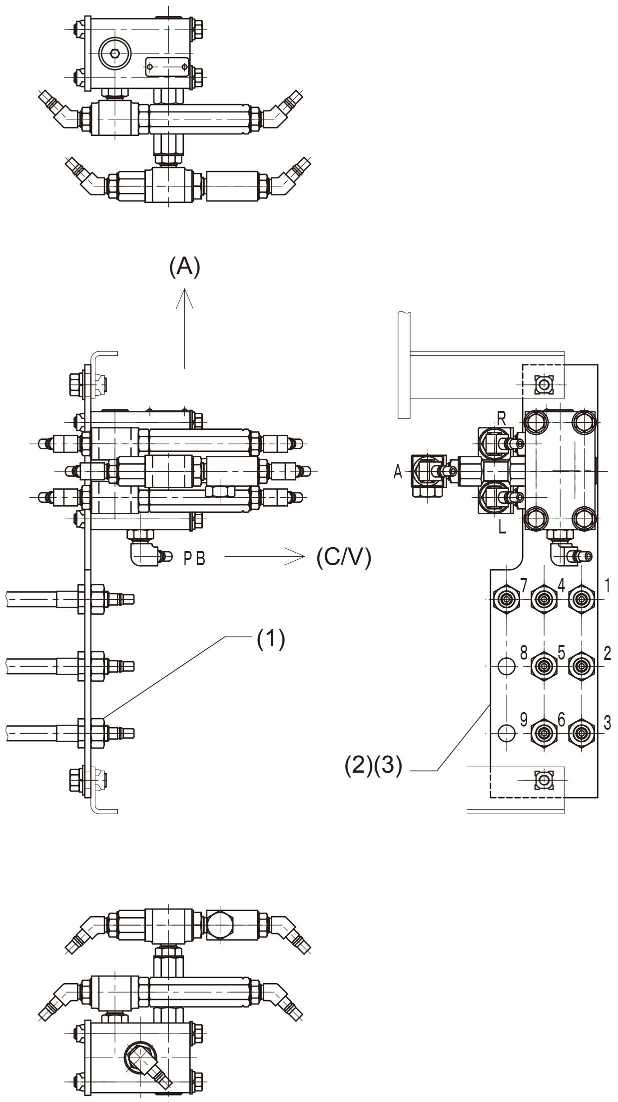
5.Quick-coupling adaptor
Pipe joint
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental scratches.

6.Fitting the valve assembly (swivel shuttle)
Tightening torque
23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs



(A)(Machine front)

(1)Pipe joint (S, G1/4-8.4)
(2)Pipe joint (to Q, G1/4-8.4)
(3)Pipe joint (T, G2, filter)
(4)Valve assembly (swivel shuttle)
(5)Pipe joint (to Q, G1/4-8.4)
(6)Pipe joint (T, G2-G2-G2)
(7)Pipe joint (bushing, G2)
(8)Plug (G1/4)
(9)Pipe joint (S, G1/4-G1/4)
(10)Pipe joint (QL, G1/4-8.4)
(11)Pipe joint (S, G1/4-8.4)
(12)Pipe joint (T, G2, filter)
(13)Pipe joint (to Q, G1/4-8.4)
(14)Pipe joint (bushing, G2)
(15)PB
(16)C/V



r.pilot hose relay plate

1.Fitting the bracket (pilot hose)
Position the bracket in position as shown at left.

2.Bolt tightening torque
48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

3.Connecting the quick-coupling hoses
Connect the hoses to the holes. Match the numbers of holes in the figure and those of the hoses in the table, as shown at left.

4.Nut tightening torque
62.8~72.6N.m(6.4~7.4kgf.m)46.3~53.5ft.lbs

5.Quick-coupling hose ends
Make sure the hose connection is free from detrimental scratches.

(Pilot hose relay plate)

	Location	Tape color
1	Boom (up)	Green
2	Bucket (dump)	Red
3	Dozer (up)	Pink
4	Boom (down)	Yellow
5	Bucket (crowded)	Orange
6	Dozer (down)	Brown
7	Arm (dump)	Yellowish green
8	Spare	None
9	Spare	None

(A)(Machine front)

(1)Nut
(2)Bracket (pilot hose)
(3)Bolt

s.Pilot hose relay adapter

1.Fitting the adaptor
Position the adaptor in position as shown at left.

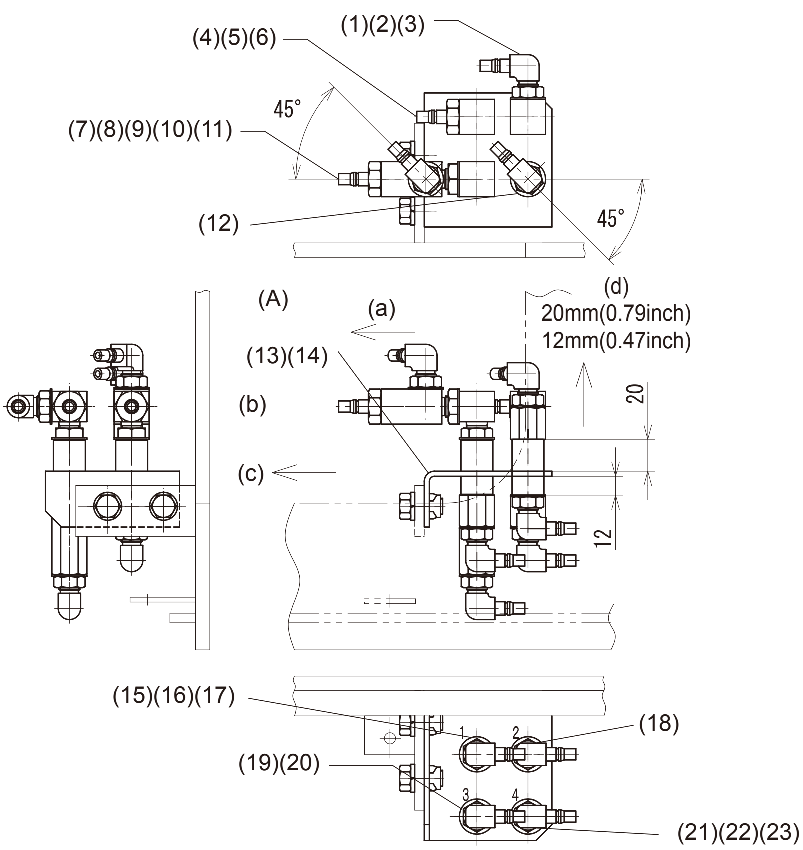
2.Adaptor tightening torque
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

3.Quick-coupling adaptor
Pipe joint
Pipe joint
Make sure the hose connection is free from detrimental scratches.

4.Fitting direction of the adaptor (pilot hose, 2)
Place the adaptor with the longer port facing the swivel center, as shown at left.

5.Fitting the adaptor (pilot hose, 2)
Tightening torque
39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbsAdaptor (pilot hose, 2)

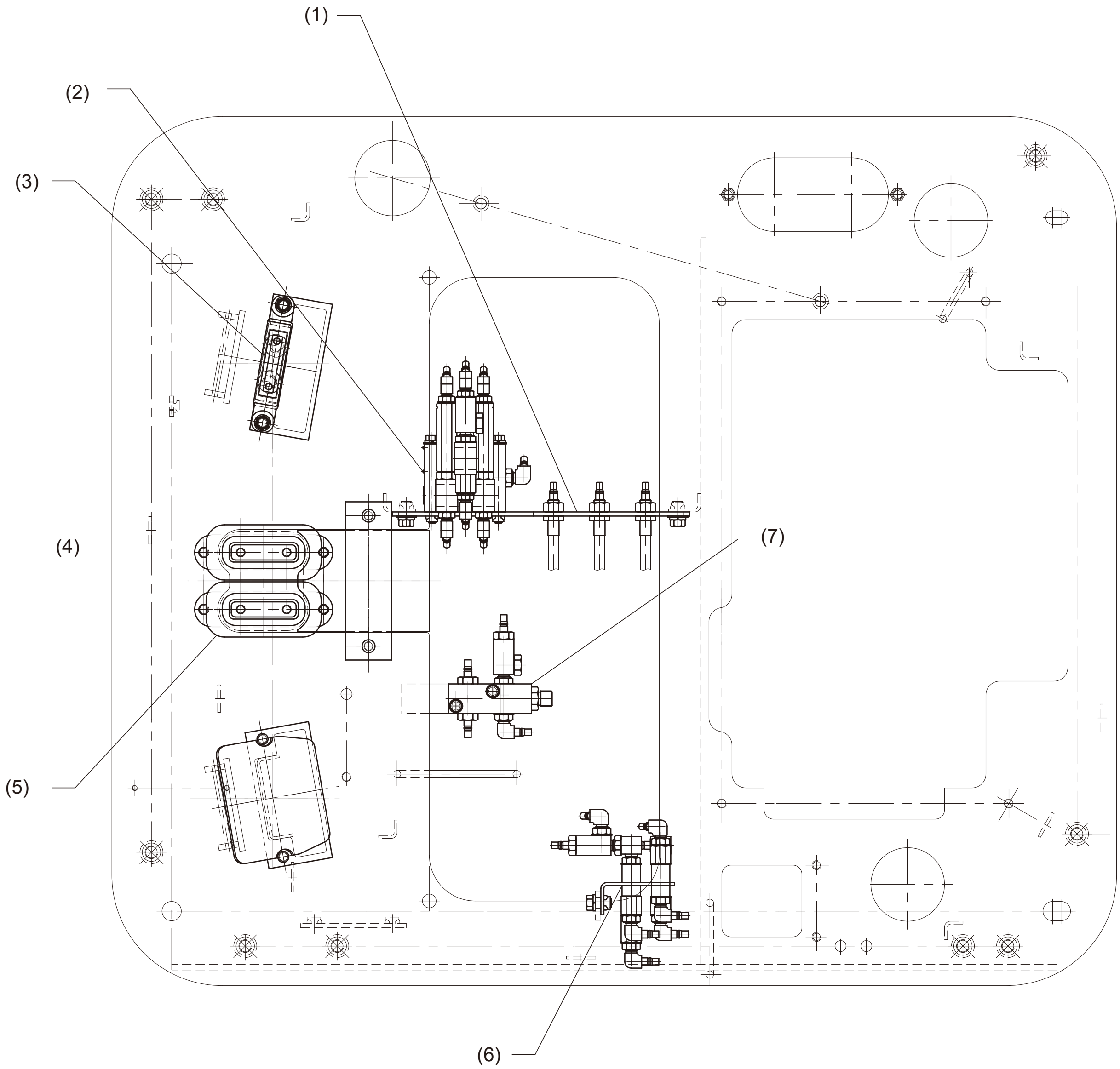
	Location	Hose tape color
1	Boom (down)	Yellow
2	Arm (dump)	Yellowish green
3	Arm (crowded)	Blue
4	Boom (up)	Green



(A)(Viewed from the machine top)

(a)(Relay plate)
(b)(To boom H/V)
(c)(Machine front)
(d)(Swivel center)

(1)Pipe joint (L, G1/4-G1/4)
(2)O ring
(3)Pipe joint (QL, G1/4-8.4)
(4)Pipe joint (L, G1/4-G1/4)
(5)O ring
(6)Pipe joint (S, G1/4-8.4)
(7)Pipe joint (L, G1/4-G1/4)
(8)O ring
(9)Pipe joint (T, G2-G2-G2)
(10)Pipe joint (S, G1/4-8.4)
(11)Pipe joint (QL, G1/4-8.4)
(12)Pipe joint (QL, G1/4-8.4)
(13)Adaptor (pilot hose, 2)
(14)Bolt
(15)Pipe joint (bushing G1/4)
(16)O ring
(17)Pipe joint (QL, G1/4-8.4)
(18)Pipe joint (QL, G1/4-8.4)
(19)Pipe joint (bushing G1/4)
(20)Pipe joint (QL, G1/4-8.4)
(21)Pipe joint (bushing G1/4)
(22)O ring
(23)Pipe joint (QL, G1/4-8.4)



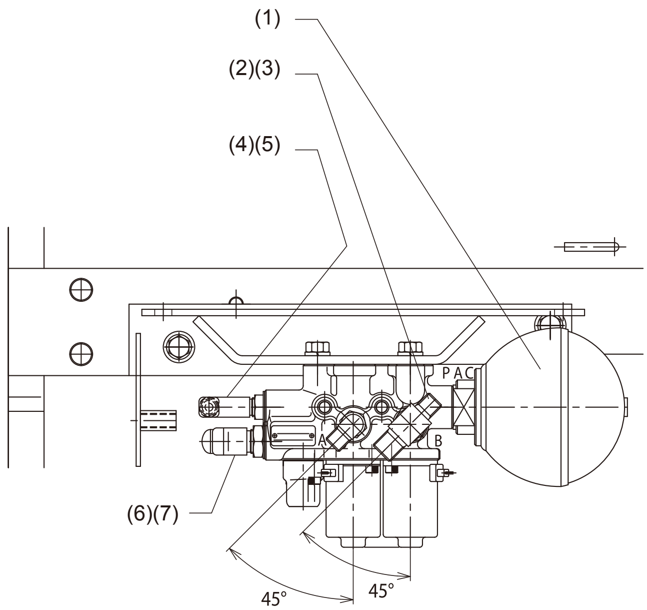
(1)Bracket (pilot hose)
(relay plate)
(2)Valve assembly (swivel shuttle)
(shuttle valve)
(3)Valve assembly (pilot, OFF)
(swing P/V)
(4)Front
(5)Valve assembly (PV, travel)
(travel P/V)
(6)Adaptor (pilot hose, 2)
(relay adaptor)
(7)Adaptor (pilot hose, 1)
(P4, T collective block)

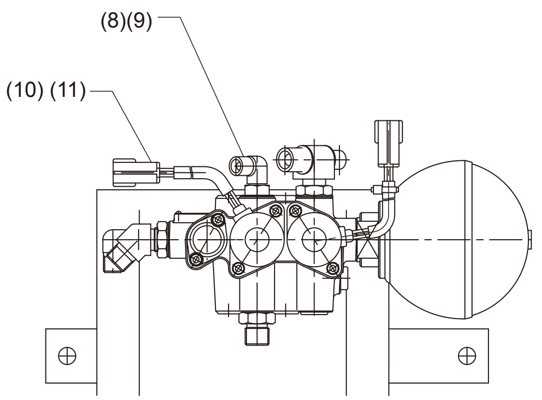
t.Unload valve

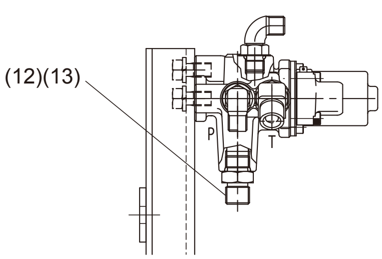
1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
   G3/8 size
   37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
   G1/2 size
   58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

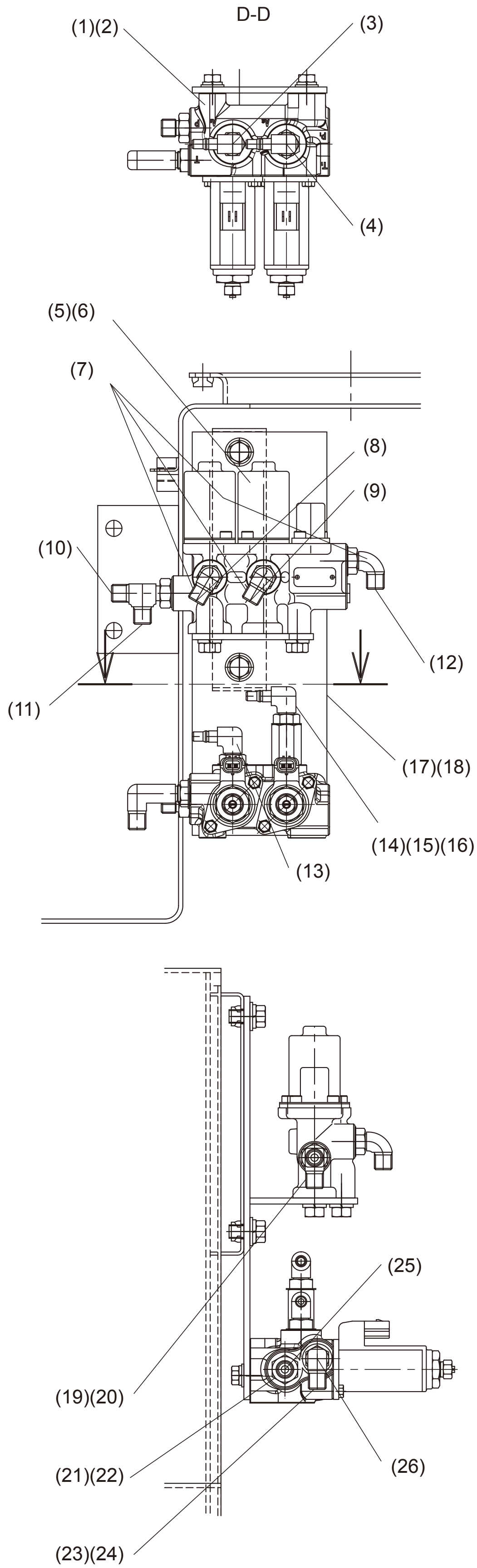
3. Fitting the valve assembly (unload)
   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs







(1)Accumulator
(2)Pipe joint (T, F2-F3)
(3)O ring
(4)Pipe joint (L, G1/4-G1/4)
(5)O ring
(6)Straight pipe joint(3-3-45)
(7)Pipe joint(L, G3/8-G1/2)
(8)Pipe joint (L, G3/8-G3/8)
(9)O ring
(10)Valve assembly (unload)
(11)Bolt
(12)Straight pipe joint
(13)O ring



u.SP1 and SP2 solenoid valve

1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

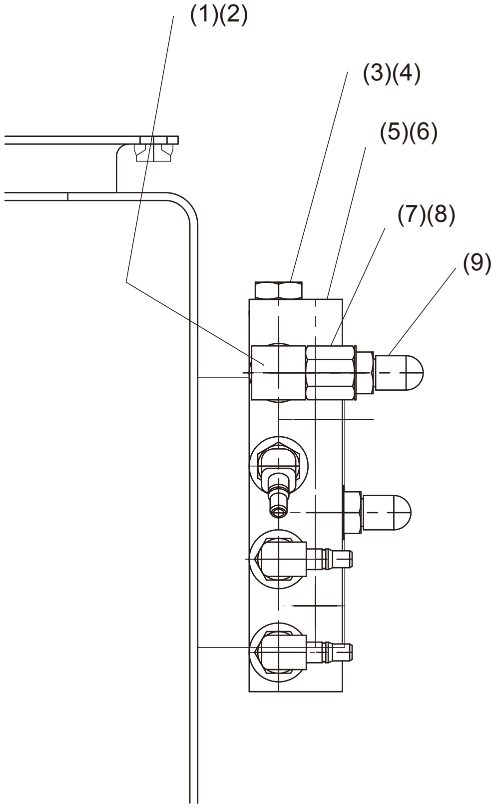
3. Quick-coupling adaptor
   Pipe joint(QL, G1/4-8,4)
   (RP812-6197D)
   Make sure the hose connection is free from detrimental scratches.

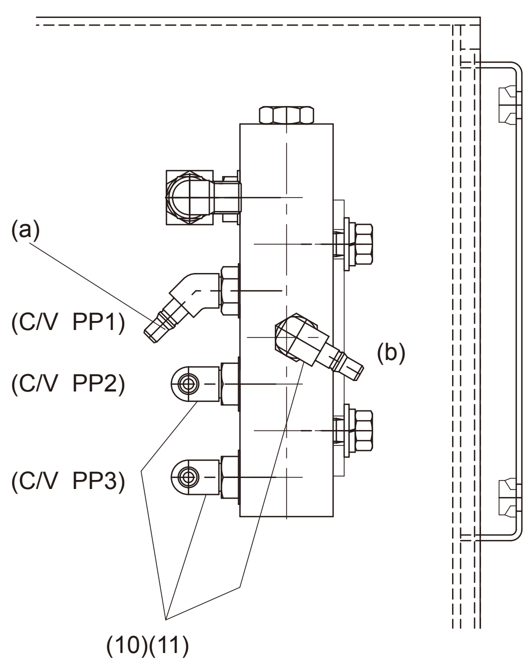
4. Fitting the bracket (valve, SP)
   Fitting the valve assembly (unload)
   Fitting the valve assembly(proportional)
   Tightening torque
   39.2~45.1N.m(4.0~4.6kgf.m)28.9~33.3ft.lbs

   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

   Tightening torque
   23.5~27.5N.m(2.4~2.8kgf.m)17.4~20.3ft.lbs

(1)Valve assembly (proportional)
(2)Bolt
(3)C/V(SP1 LOW)
(4)C/V(SP1 HIGH)
(5)Valve assembly(unload)
(6)Bolt
(7)Pipe joint (L, G1/4-G1/4)
(8)C/V(SP2 HIGH)
(9)C/V(SP2 LOW)
(10)(Unload, port B)
(11)(SP1)
(12)(Tank)
(13)Pipe joint (QL, G1/4-8.4)
(14)Pipe joint (S, G1/4-G1/4)
(15)O ring
(16)Pipe joint (QL, G1/4-8.4)
(17)Bracket (valve, SP)
(18)Bolt
(19)T pipe joint (F2)
(20)O ring
(21)Adaptor
(22)O ring
(23)Washer-fitted elbow
(24)O ring
(25)(SP2)
(26)(Tank)





v.Pilot pump relay block

1. Fitting the adaptor
   Fit the adaptor in position as shown at left.

2. Adaptor tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

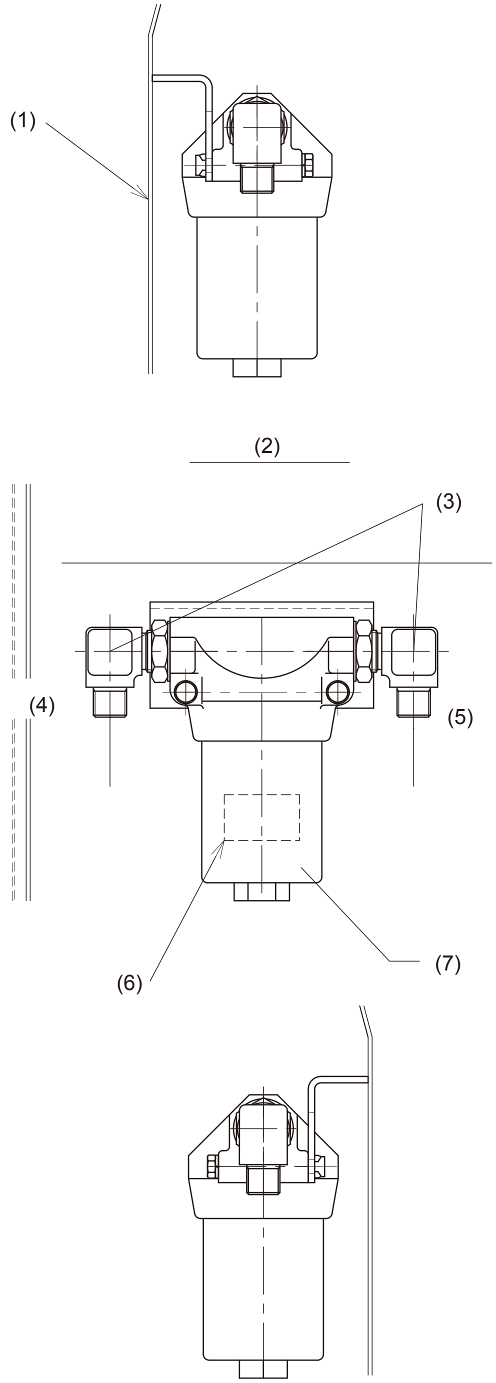
3. Plug tightening torque
   G1/4 size
   24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs

4. Quick-coupling adaptor
   Pipe joint
   Pipe joint
   Make sure the hose connection is free from detrimental scratches.

5. Fitting the joint (block, PP)
   Tightening torque
   48.1~55.9N.m(4.9~5.7kgf.m)35.4~41.2ft.lbs

(a)(Unload P)
(b)(Swivel motor PG)

(1)Pipe joint (L, G1/4-G1/4)
(2)O ring
(3)Plug (1/4)
(4)O ring
(5)Pipe joint (block, PP)
(6)Bolt
(7)Pipe joint (S, G1/4-G1/4)
(8)O ring
(9)Pipe joint(L, G1/4-G1/4)
(10)Pipe joint (to Q, G1/4-8.4)
(11)Pipe joint (QL, G1/4-8.4)



w.Pilot line filter

1.Fitting the adaptor
Fit the adaptor in position as shown at left.
Pipe joint (L, F1/2,-F3/8)
(69251-6185D)

2.Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs

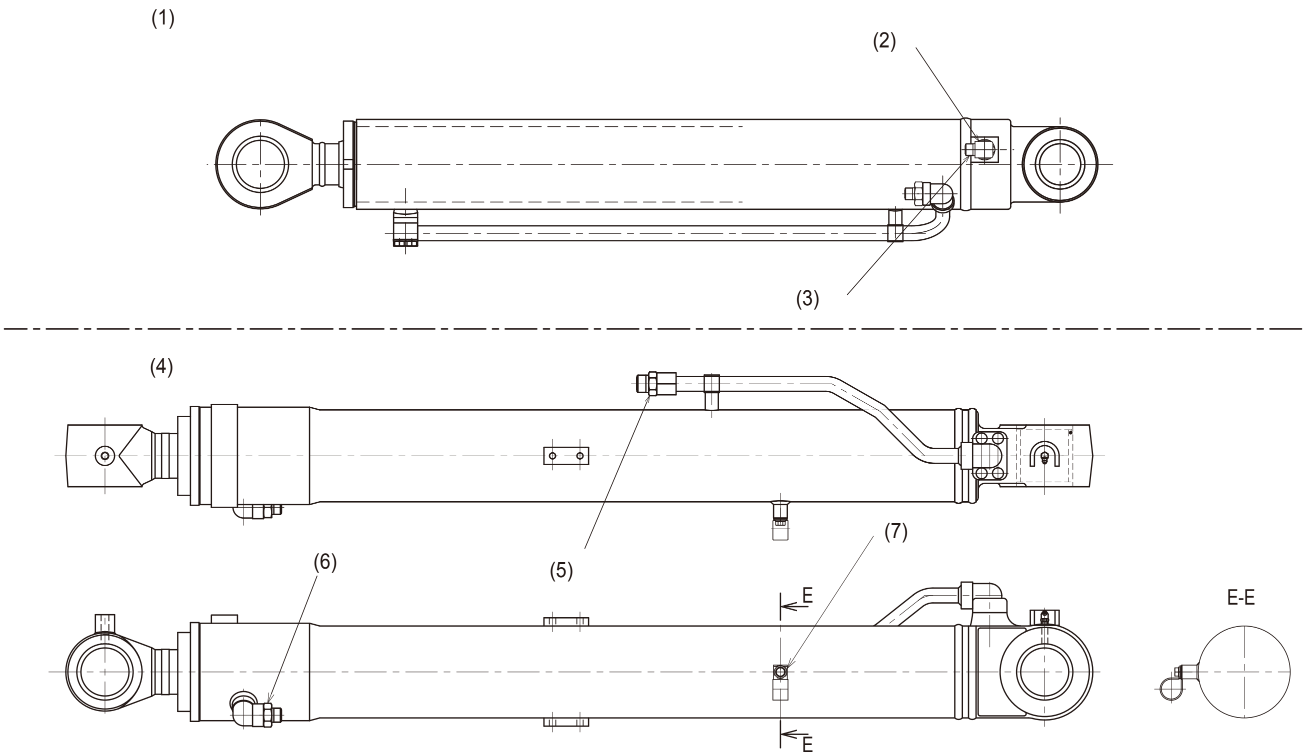
3.Fitting the filter assembly (hydraulic)
Bolt tightening torque
9.8~11.3N.m(1.0~1.15kgf.m)7.2~8.3ft.lbs
Fitting direction of the filter
Make sure the label faces toward the arch wall.

(1)Frame (arch)
(2)Oil flow direction
(3)Pipe joint (L, F1/2-F3/8)
O ring
(4)Unload valve
(5)Pump (P4)
(6)Label to face toward the arch wall
(7)Filter assembly (hydraulic)
Bolt

x.Cylinders

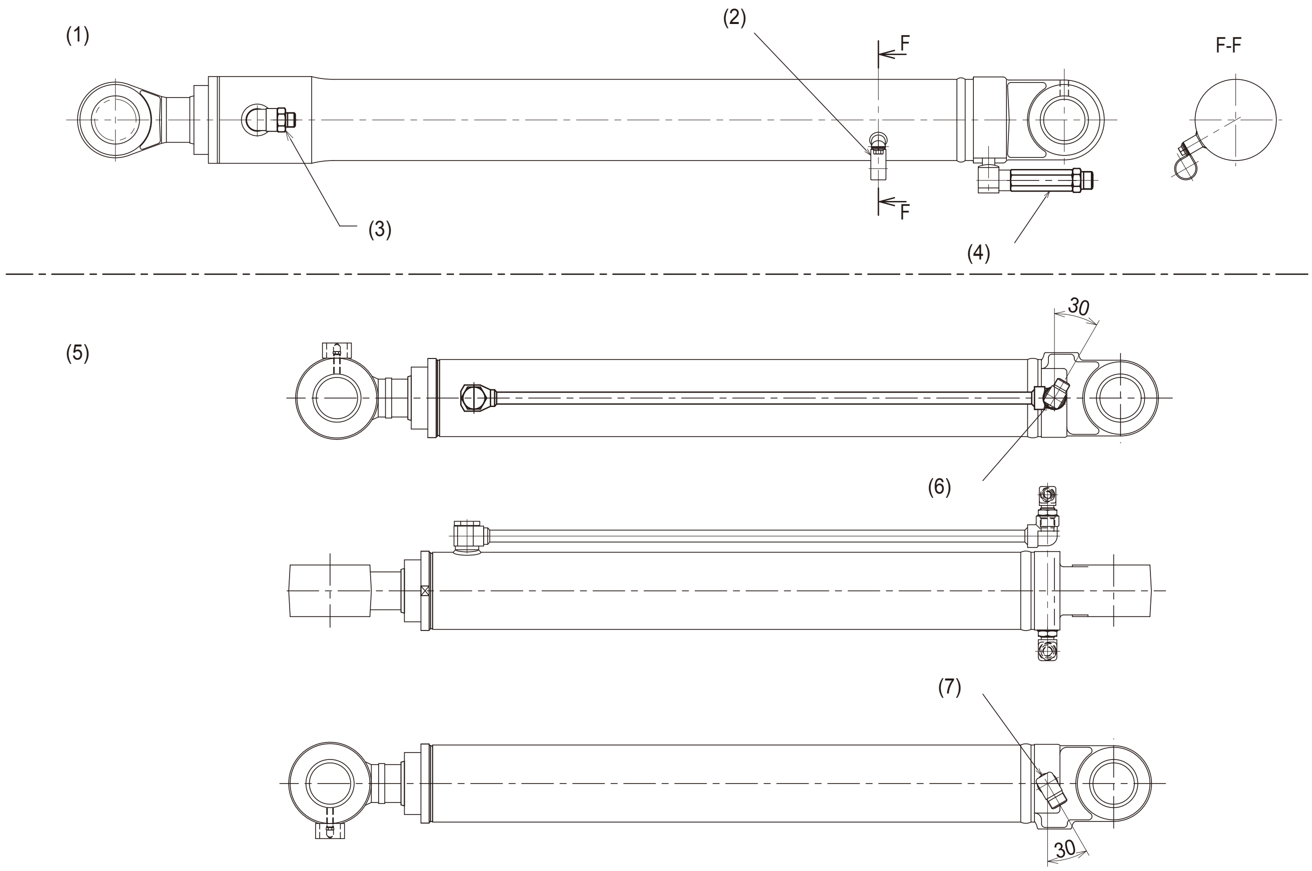
1 .Fitting the adaptor of each cylinder
Fit the adaptors at the angle specified in the figure.

2. Adaptor tightening torque
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~47.0ft.lbs



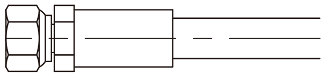
(1)(Swing cylinder)
(2)Pipe joint (LG4, 11/16U)
(3)Pipe joint (SG4, 11/16U)
(4)(Boom cylinder)
(5)Pipe joint (SG4, 1U)
(6)Pipe joint (SG4, 13/16U)
(7)Clamp

Bolt



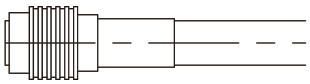
(1)(Arm cylinder)
(2)Clamp
Bolt
(3)Pipe joint (SG4, 13/16U)
(4)Pipe joint (bushing, 1/2)
Pipe joint (SG4, 1U)
(5)(Bucket cylinder)
(6)Pipe joint (LG4, 13/16U)
(7)Pipe joint (LG4, 1U)

y.Hydraulic hose



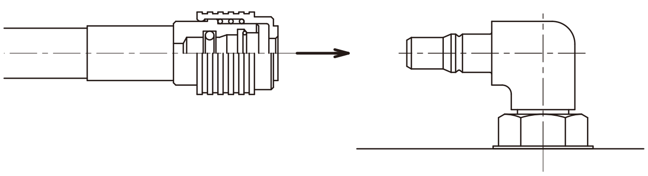
1.Metallic sealing type

Tighten to the specified torque.
G1/4 size
24.5~29.4N.m(2.5~3.0kgf.m)18.1~21.7ft.lbs
G3/8 size
37.2~42.1N.m(3.8~4.3kgf.m)27.5~31.1ft.lbs
G1/2 size
58.8~63.7N.m(6.0~6.5kgf.m)43.4~49.0ft.lbs



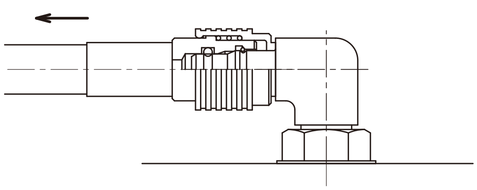
2.Quick-coupling type

G1-1/4 size
Couple the hose in position as shown at left.
Finally, make sure the hose does not come off.



3.Connecting the quick-coupling type hose

1) Couple the hose onto the joint until it clicks (in the direction of arrow).



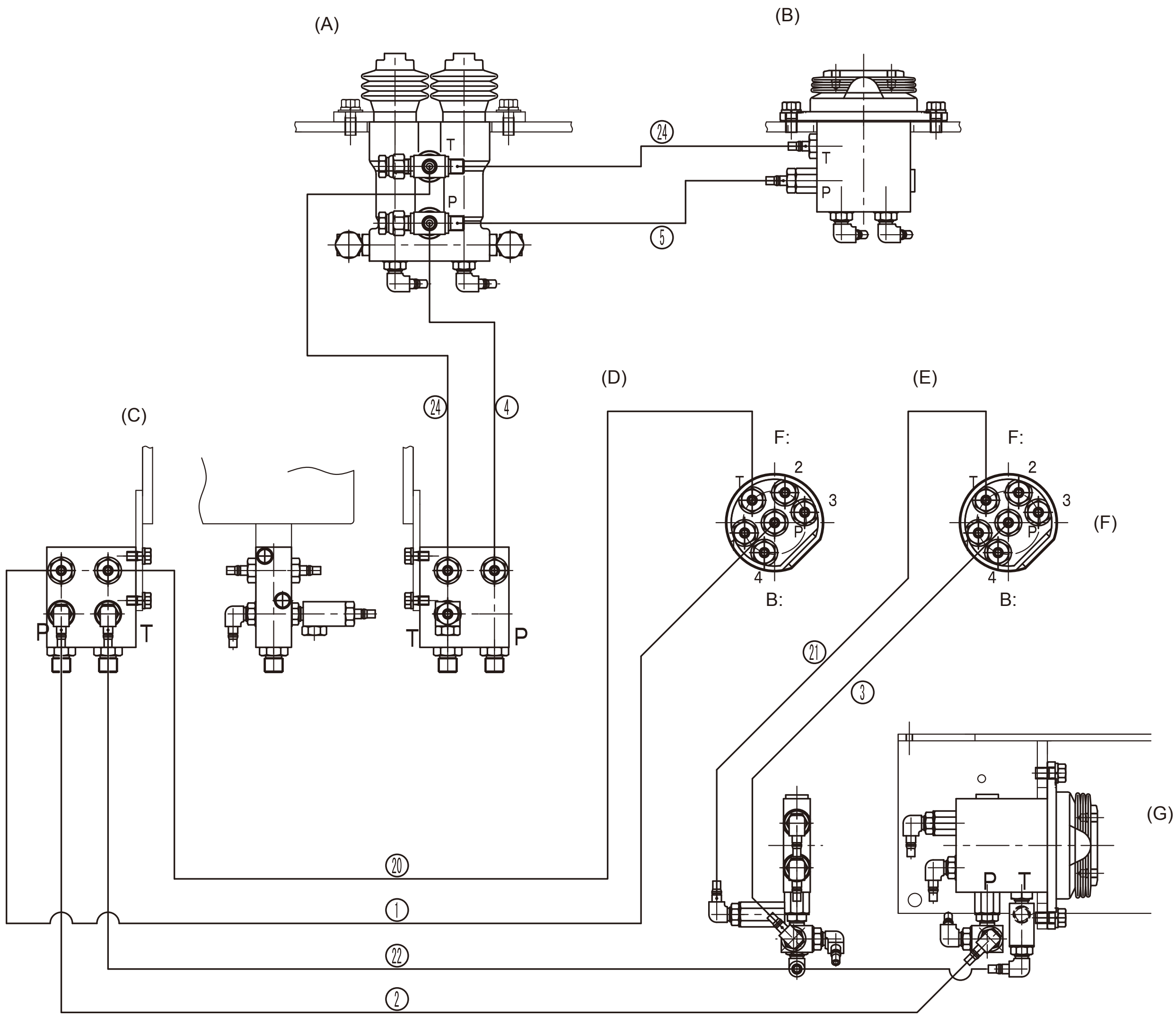
2) Pull the hose in the direction of arrow, as shown below, to make sure it does not come off the joint.

z.Hose route

1.Pilot hose 1

Pilot hoses

No.	Location		Tapecolor	Q'ty
1	(P4, T) Collective block ~ P/V (left) (P)	P/V boost	White	1
2	(P4, T) Collective block ~ Dozer P/V (P)	Dozer P/V boost	White	1
3	Dozer P/V (P) ~ P/V (right) (P)	P/V boost	White	1
4	(P4, T) Collective block ~ Travel P/V (P)	Travel P/V boost	White	1
5	Travel P/V (P) ~ Swing P/V (P)	Swing P/V boost	White	1
20	P/V (left) (T) ~ (P4, T) Collective block	Drain		1
21	P/V (right) (T) ~ Dozer P/V (T)	Drain		1
22	Dozer P/V (T) ~ (P4, T) Collective block	Drain		1
23	Swing P/V (T) ~ Travel P/V (T)	Drain		1
24	Travel P/V (T) ~ (P4, T) Collective block	Drain		1



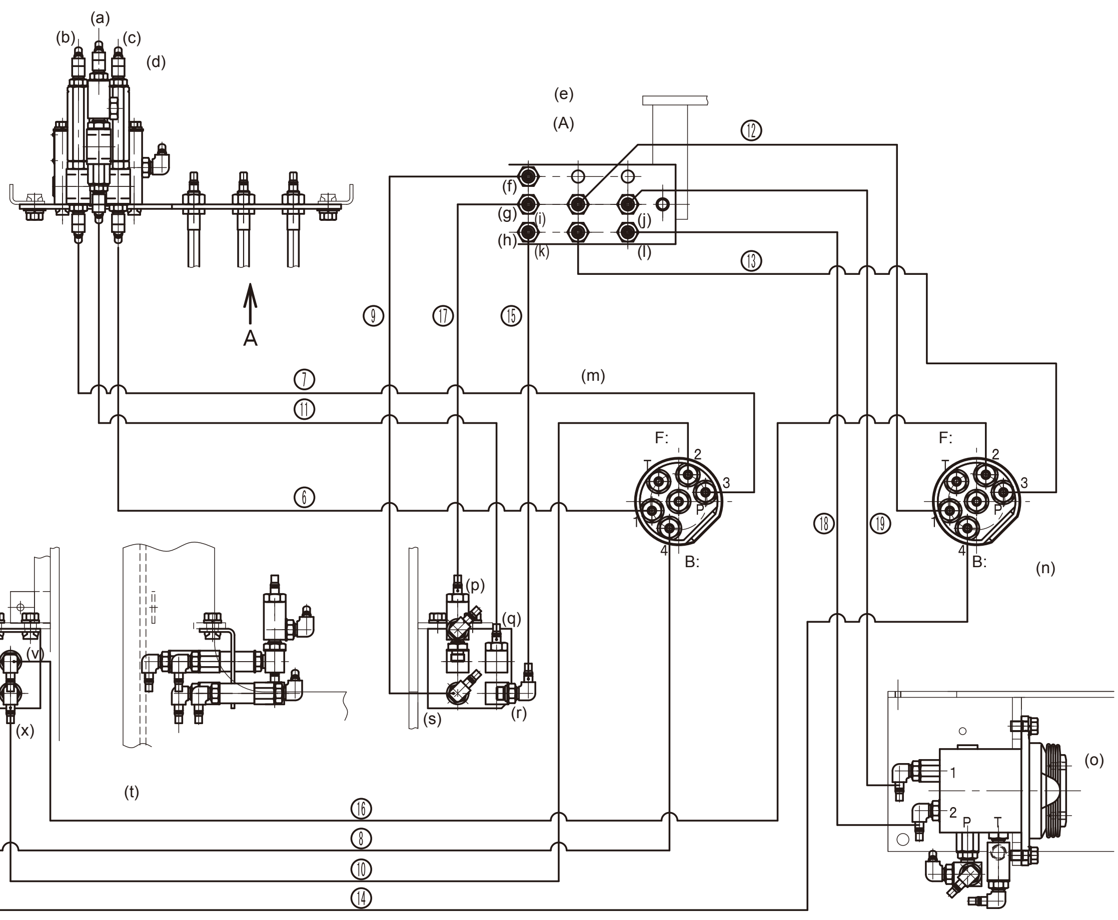
(A)Valve assembly (PV, travel)
(B)(Used for the swing pedal)Valve assembly (pilot, OFF)
(C)Adaptor (pilot hose, 1)
(D)Valve assembly (pilot, L)
(E)Valve assembly (pilot, R)
(F)(Port positions when viewed from above the valve)
(G)(Used for the dozer lever)Valve assembly (pilot, OFF)

F:(Front)
B:(Back)

2.Pilot hose 2

Pilot hoses

No.	Location		Tapecolor	Q'ty
6	P/V (swivel left) – Shuttle valve	Swivel (left)	Gray	1
7	P/V (swivel right) – Shuttle valve	Swivel (left)	Sky-blue	1
8	P/V (arm crowded) – Relay adaptor	Arm (crowded)	Blue	1
9	Relay adaptor – Relay plate (arm crowded)	Arm (crowded)	Blue	1
10	P/V (arm crowded) – Relay adaptor	Arm (dump)	Yellowish green	1
11	Relay adaptor – Shuttle valve (arm crowded)	Arm (dump)	Yellowish green	1
12	P/V (bucket crowded) – Relay plate	Bucket (crowded)	Orange	1
13	P/V (bucket dump) – Relay plate	Bucket (dump)	Red	1
14	P/V (boom up) – Relay adaptor	Boom (up)	Green	1
15	Relay adaptor – Relay plate (boom up)	Boom (up)	Green	1
16	P/V (boom down) – Relay adaptor	Boom (down)	Yellow	1
17	Relay adaptor – Relay plate (boom down)	Boom (down)	Yellow	1
18	Dozer P/V (up) – Relay plate	Dozer (up)	Pink	1
19	Dozer P/V (down) – Relay plate	Dozer (down)	Brown	1



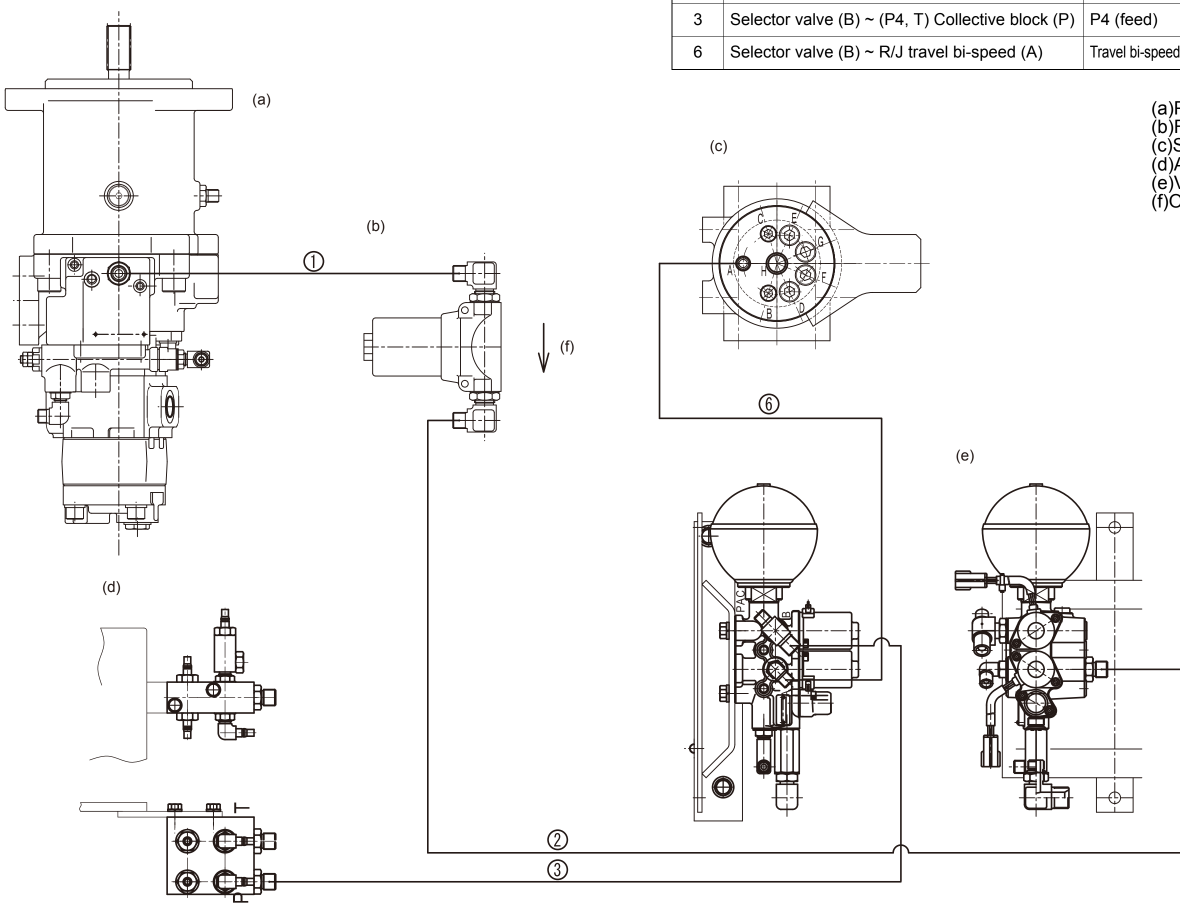
(a)Arm (crowded)
(b)Swivel (right)
(c)Swivel (left)
(d)Valve assembly (swivel shuttle)
(e)Adaptor (pilot hose, 1)
(f)Arm (dump)
(g)Boom (down)
(h)Boom (up)
(i)Bucket (crowded)
(j)Dozer (down)
(k)Bucket (dump)
(l)Dozer (up)
(m)Valve assembly (pilot, L)
(n)Valve assembly (pilot, R)
(o)(Used for the dozer lever)Valve assembly (pilot, OFF)

(p)Boom (down)
(q)Arm (crowded)
(r)Boom (up)
(s)Arm (dump)
(t)Adaptor (pilot hose, 2)
(u)Arm(crowded)
(v)Boom (down)
(w)Boom (up)
(x)Arm (dump)

(A)(View A)
F:(Front)
B:(Back)

3.Pilot hose 3

No.	Location		Tapecolor	Q'ty
1	Pump ~ Line filter	P4 (feed)		1
2	Life filter ~ Selector valve (C)	P4 (feed)	Red	1
3	Selector valve (B) ~ (P4, T) Collective block (P)	P4 (feed)	Red	1
6	Selector valve (B) ~ R/J travel bi-speed (A)	Travel bi-speed boost	Yellowish green	1



(a)Pump assembly (piston)
(b)Filter assembly (hydraulic)
(c)Swivel joint assembly
(d)Adaptor (pilot hose, 1)
(e)Valve assembly (unload)
(f)Oil flow

[redacted]

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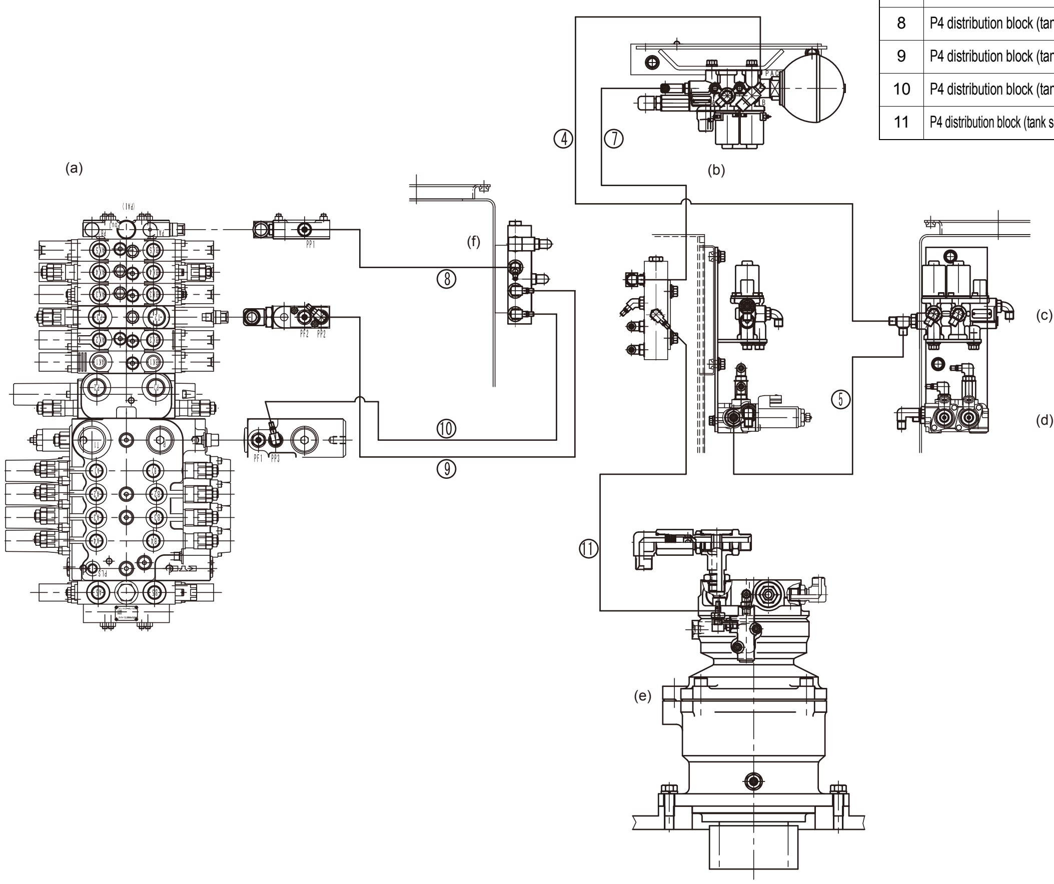
4.Pilot hose 4

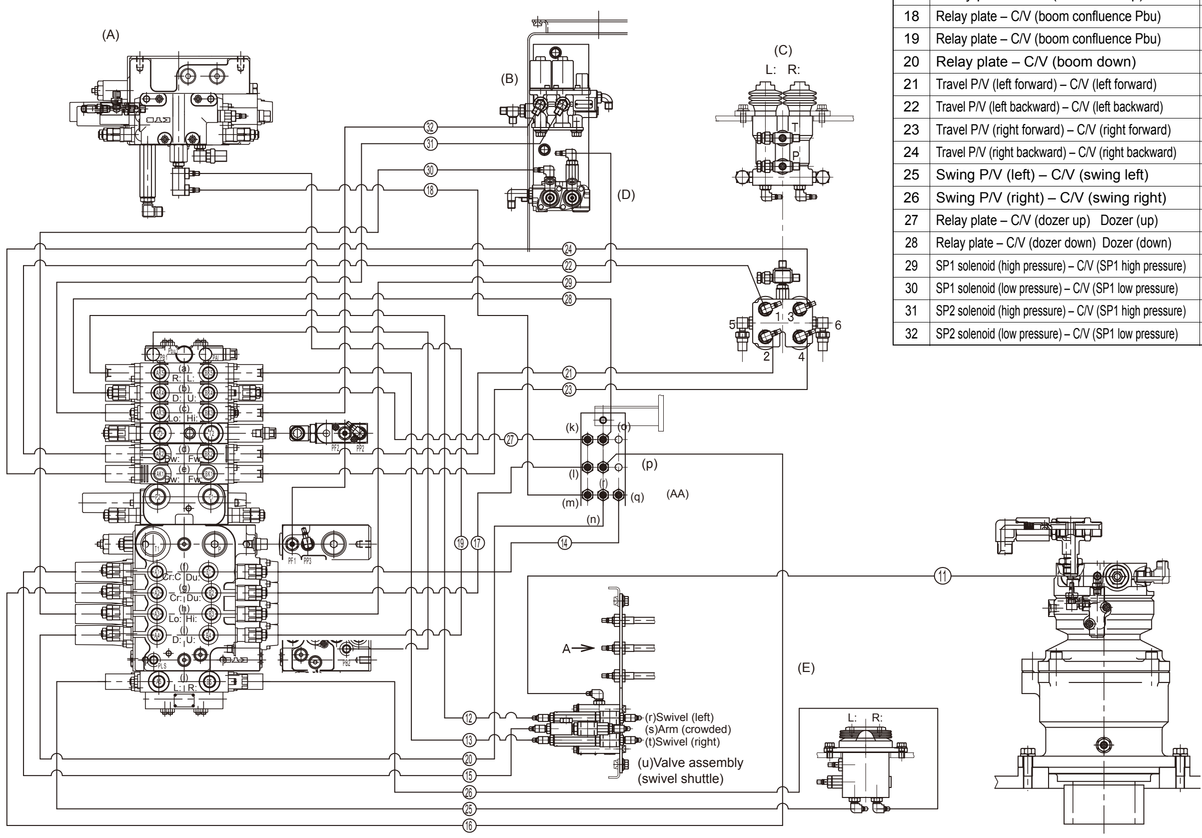
No.	Location		Tapecolor	Q'ty
4	Selector valve (B) ~ SP2 solenoid valve (P)	SP2 (feed)	Blue	1
5	SP2 solenoid valve (P) ~ SP1 solenoid valve (P)	SP1 (feed)		1
7	Selector valve (P) ~ P4 distribution block (tank side)	Distribution block (feed)	White	1
8	P4 distribution block (tank side) ~ C/V (PP1)	AI boost	Blue	1
9	P4 distribution block (tank side) ~ C/V (PP2)	P3 confluence boost	Yellow	1
10	P4 distribution block (tank side) ~ C/V (PP3)	P3 confluence boost	Green	1
11	P4 distribution block (tank side) ~ Swivel motor brake (PG)	Swivel brake release (feed)	Sky-blue	1



(a)Control valve assembly
(b)Valve assembly (unload)
(c)Valve assembly (unload)
(d)Valve assembly (proportional)
(e)Motor assembly (swivel)
(f)Joint (block, PP)

5.Pilot hose 5

No.	Location		Tapecolor	Q'ty
12	Shuttle valve – C/V (swivel left)	Swivel (right)	Sky-blue	1
13	Shuttle valve – C/V (swivel right)	Swivel (left)	Gray	1
14	Relay plate – C/V (arm dump)	Arm (dump)	Blue	1
15	Shuttle valve – C/V (arm crowded)	Arm (crowded)	Yellowish green	1
16	Relay plate – C/V (bucket crowded)	Bucket (crowded)	Orange	1
17	Relay plate – C/V (bucket dump)	Bucket (dump)	Red	1
18	Relay plate – C/V (boom confluence Pbu)	Boom (up)	Green	1
19	Relay plate – C/V (boom confluence Pbu)	Boom (confluence, up)	Green	1
20	Relay plate – C/V (boom down)	Boom (down)	Yellow	1
21	Travel P/V (left forward) – C/V (left forward)	Travel (left, forward)	Red	1
22	Travel P/V (left backward) – C/V (left backward)	Travel (left, backward)	Blue	1
23	Travel P/V (right forward) – C/V (right forward)	Travel (right, forward)	Yellow	1
24	Travel P/V (right backward) – C/V (right backward)	Travel (right, backward)	Green	1
25	Swing P/V (left) – C/V (swing left)	Swing (left)	Orange	1
26	Swing P/V (right) – C/V (swing right)	Swing (right)	Yellowish green	1
27	Relay plate – C/V (dozer up) Dozer (up)	Dozer (up)	Pink	
28	Relay plate – C/V (dozer down) Dozer (down)	Dozer (down)	Brown	
29	SP1 solenoid (high pressure) – C/V (SP1 high pressure)	SP1 (high pressure)	Pink	
30	SP1 solenoid (low pressure) – C/V (SP1 low pressure)	SP1 (low pressure)	Brown	
31	SP2 solenoid (high pressure) – C/V (SP1 high pressure)	SP2 (high pressure)	Pink	
32	SP2 solenoid (low pressure) – C/V (SP1 low pressure)	SP2 (low pressure)	Brown	



(A)Control valve assembly
(B)Valve assembly (unload)
(C)Valve assembly (PV, travel)
(D)Valve assembly (proportional)
(E)(Used for the swing pedal)
Valve assembly (pilot, OFF)

(a)Swivel
(b)Dozer
(c)SP2
(d)Travel left
(e)Travel right
(f)Arm
(g)Bucket
(h)SP1
(i)Boom
(j)Swing
(k)Dozer (up)
(l)Bucket (dump)
(m)Boom (up)
(n)Boom (down)
(o)Dozer (down)
(p)Adaptor (pilot hose, 1)
(q)Arm(dump)(r)
Bucket (crowded)

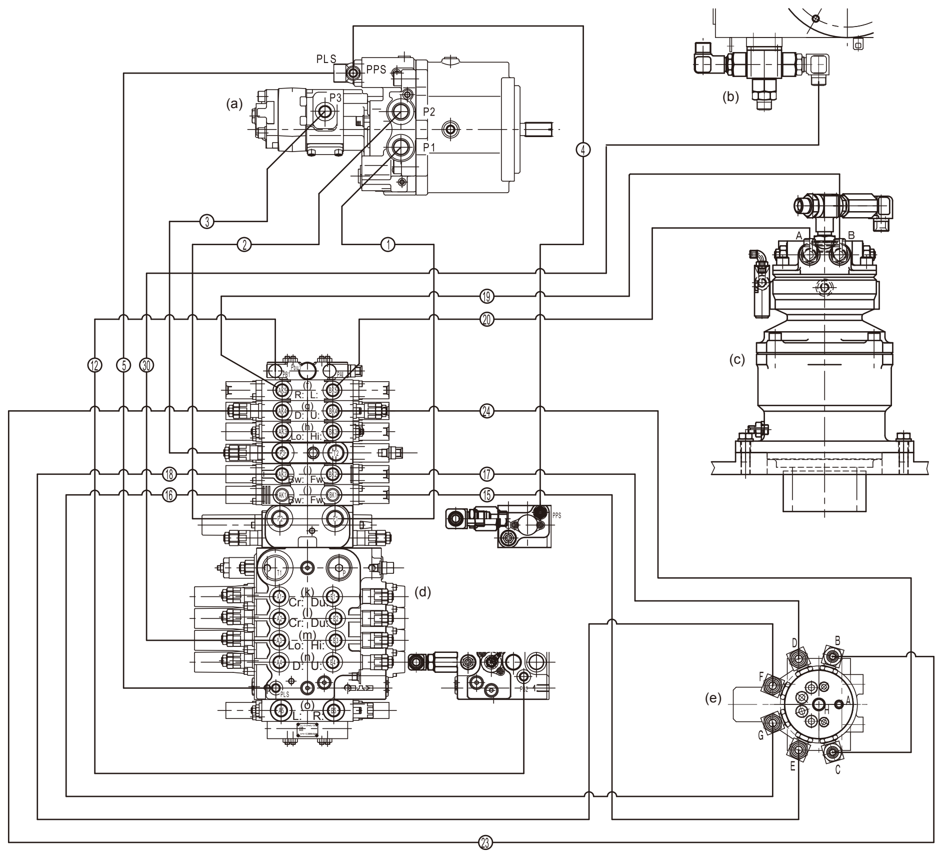
(AA)(View A)
L:(Left)
R:(Right)
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

[redacted]

[redacted]

6.High and low pressure hose 1

No.	Location		Tapecolor	Q'ty
1	Pump (P1) ~ C/V (P1)	Delivery (P1)	Red, White	1
2	Pump (P2) ~ C/V (P2)	Delivery (P2)	Red, White	1
3	Pump (P3) ~ C/V (P3)	Delivery (P3)	Red, White	1
4	Pump (PPS) ~ C/V (PPS)	LS signal	Blue	1
5	Pump (PLS) ~ C/V (PLS)	LS signal	Yellow	1
12	C/V (PB1) ~ C/V (PB2)	Boom confluence	Green	1
15	C/V (travel right forward) ~ R/J (E)	Travel (right) forward	Sky-blue	1
16	C/V (travel right backward) ~ R/J (G)	Travel (right) backward	Blue	1
17	C/V (travel left forward) ~ R/J (D)	Travel (left) forward		1
18	C/V (travel left backward) ~ R/J (F)	Travel (left) backward	White	1
19	C/V (swivel left) ~ Swivel motor (B)	Swivel (left)	Blue	1
20	C/V (swivel right) ~ Swivel motor (A)	Swivel (right)	Yellow	1
23	C/V (dozer down) ~ Dozer cylinder (bottom)	Dozer (down)	Green	1
24	C/V (dozer up) ~ Dozer cylinder (rod)	Dozer (up)	Sky-blue	1
30	3-way valve ~ C/V (SP1 low pressure)	SP1 (low pressure)	Brown	1



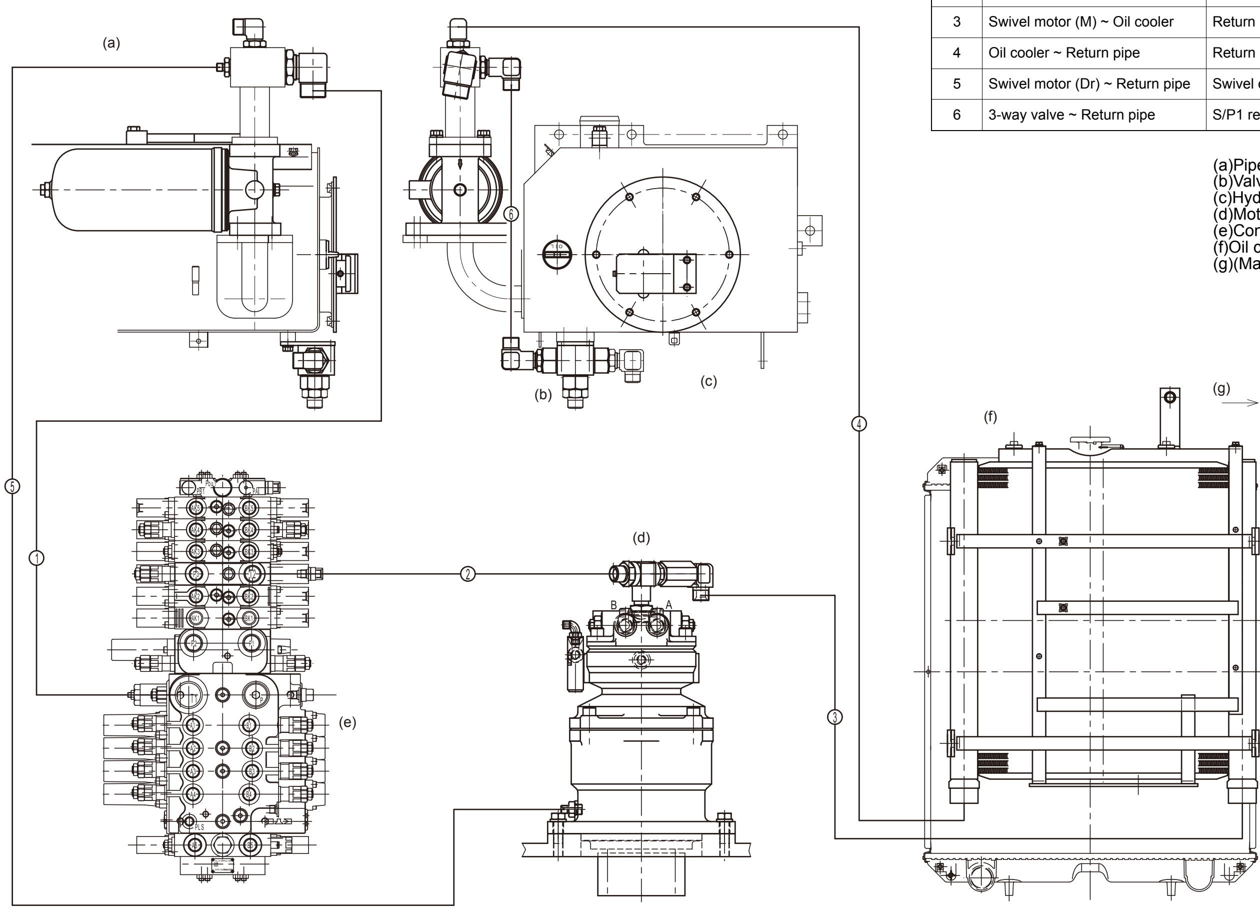
R:Right
L:Left
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

(a)Pump assembly (piston)
(b)Valve assembly(3-way)
(c)Motor assembly (swivel)
(d)Control valve assembly
(e)Swivel joint assembly
(f)Swivel
(g)Dozer
(h)SP2
(i)Travel left
(j)Travel right
(k)Arm
(l)Bucket
(m)SP1
(n)Boom
(o)Swing

R:Right
L:Left
D:Down
U:Up
Lo:Low
Hi:High
Bw:Backward
Fw:Forward
Cr:Crowded
Du:Dump

7.High and low pressure hose 2

No.	Location		Tapecolor	Q'ty
1	C/V (T1) ~ Return pipe	Return (T1)	Black	1
2	C/V (T2) ~ Swivel motor (M)	Swivel makeup		1
3	Swivel motor (M) ~ Oil cooler	Return (T2)	Black	1
4	Oil cooler ~ Return pipe	Return (T2)		1
5	Swivel motor (Dr) ~ Return pipe	Swivel drain	Pink	1
6	3-way valve ~ Return pipe	S/P1 return		1



(a)Pipe (return)
(b)Valve assembly (3-way)
(c)Hydraulic tank
(d)Motor assembly (swivel)
(e)Control valve assembly
(f)Oil cooler
(g)(Machine front)

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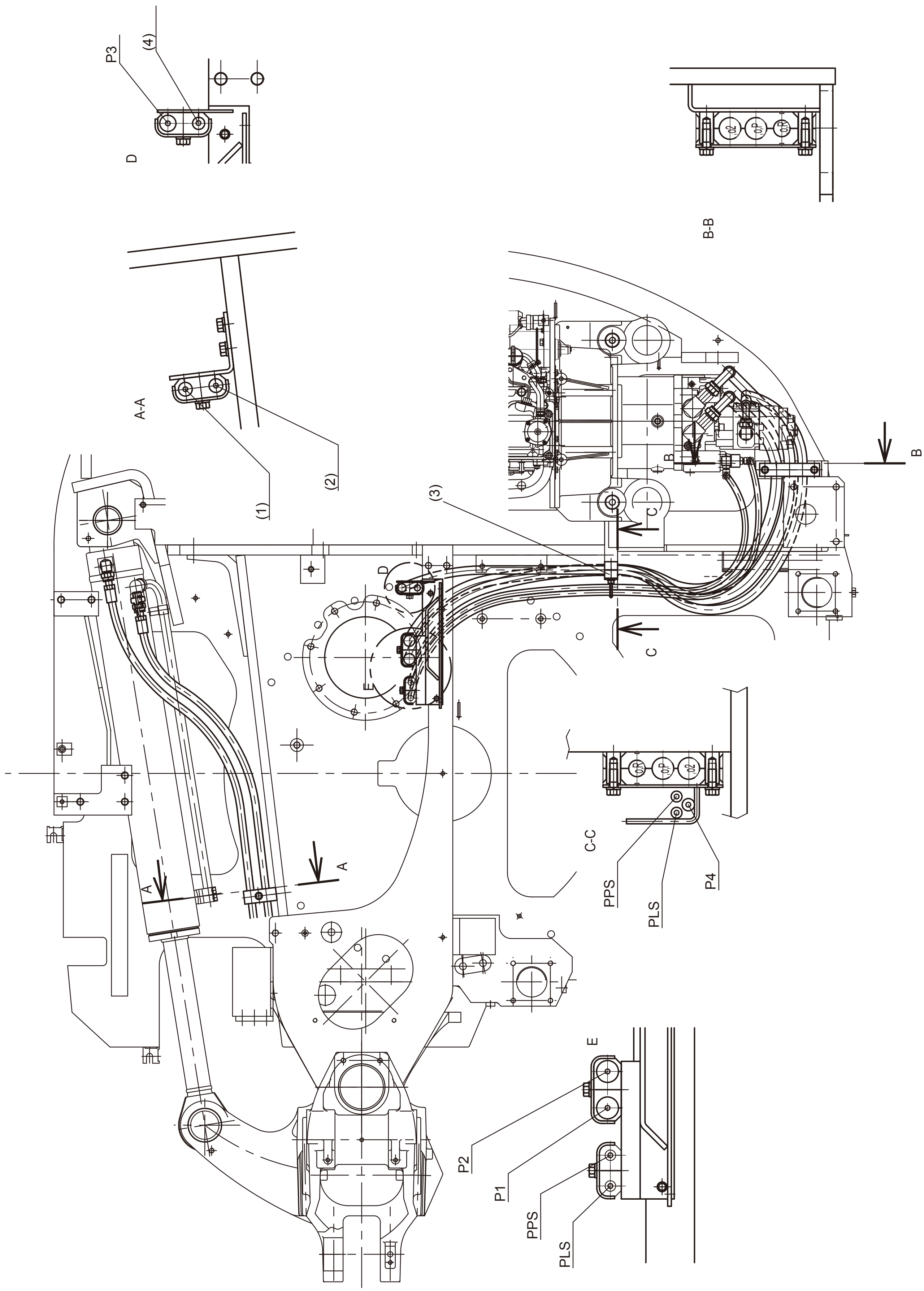
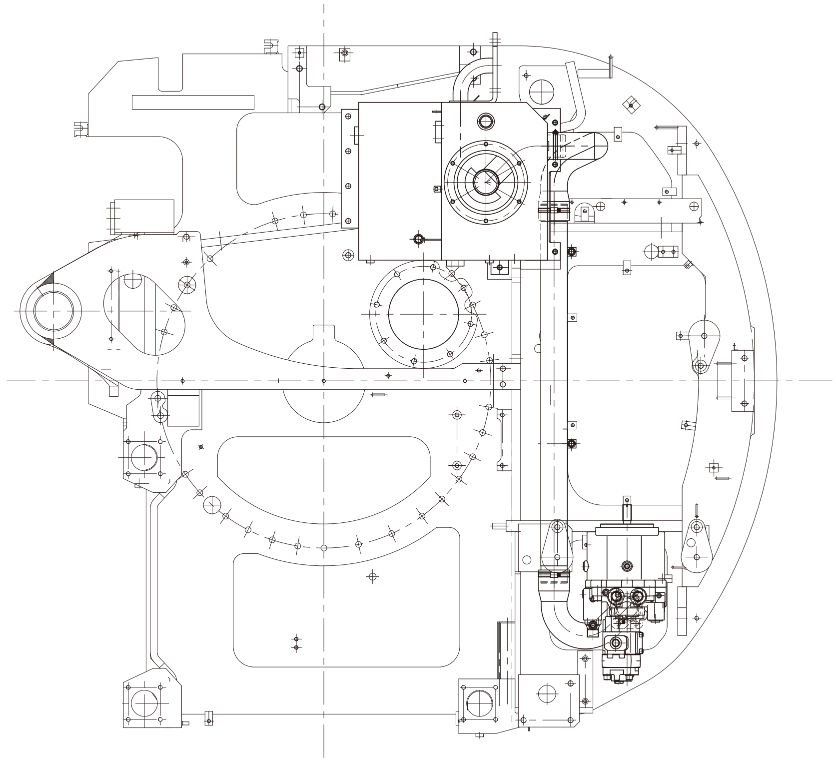
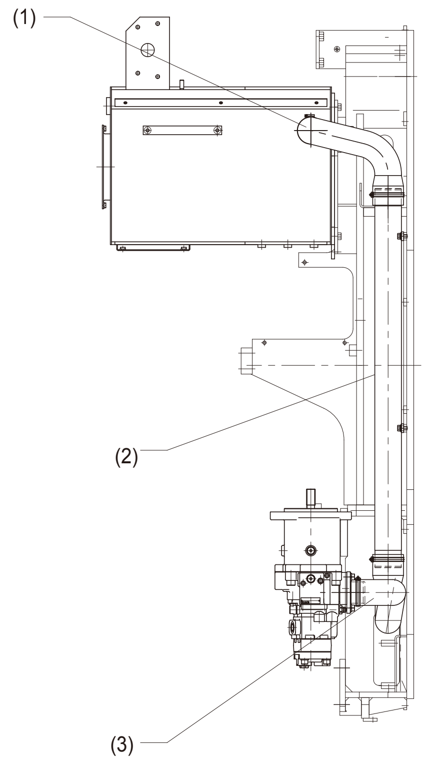
8.Pump delivery



9.Suction



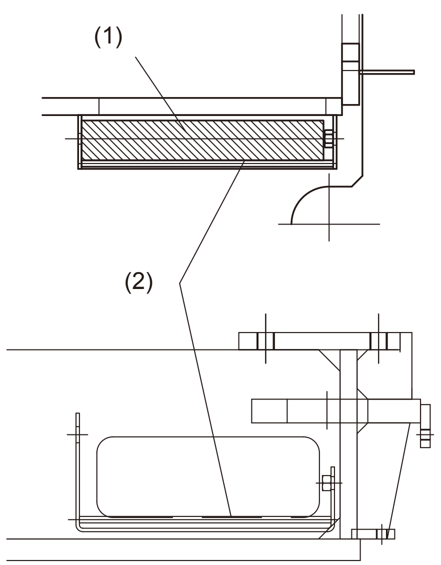


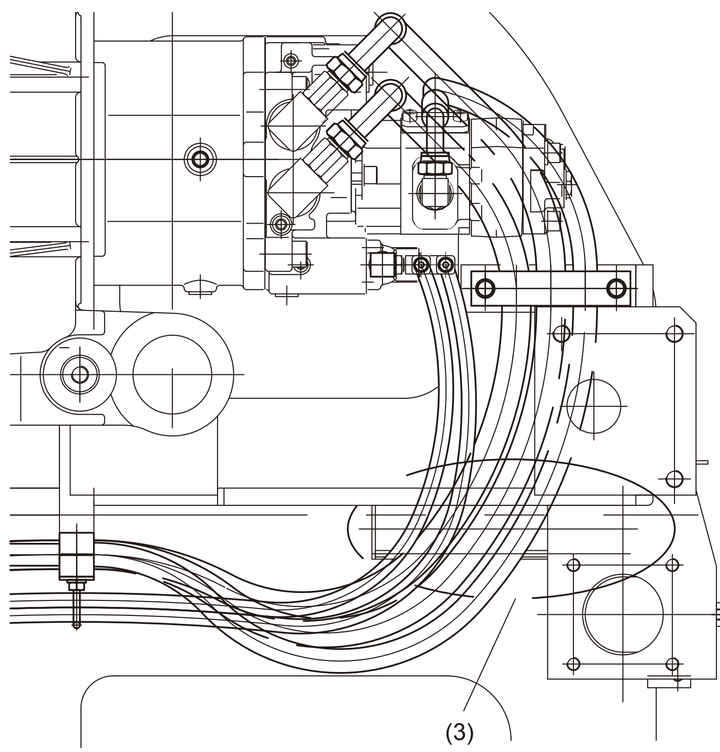
(1)Hose (1, suction)
Hose clamp (68-85)
Hose clamp (77-95)
(2)Pipe (suction)
Bolt
(3)Hose (2, suction)
Hose clamp (68-85)
Hose clamp (77-95)

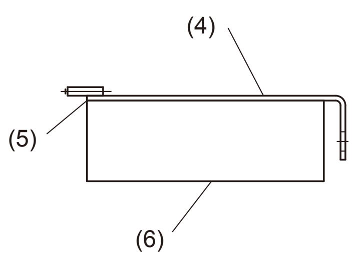
10.Swivel frame partition

1.Applying position of the cushion
(1, delivery)
Apply the cushion to the position, shown in the figure, on the swivel frame.

2.Applying position of the sticker
(2, delivery)
Apply the sticker to the position, shown in the figure, on the plate (delivery) .

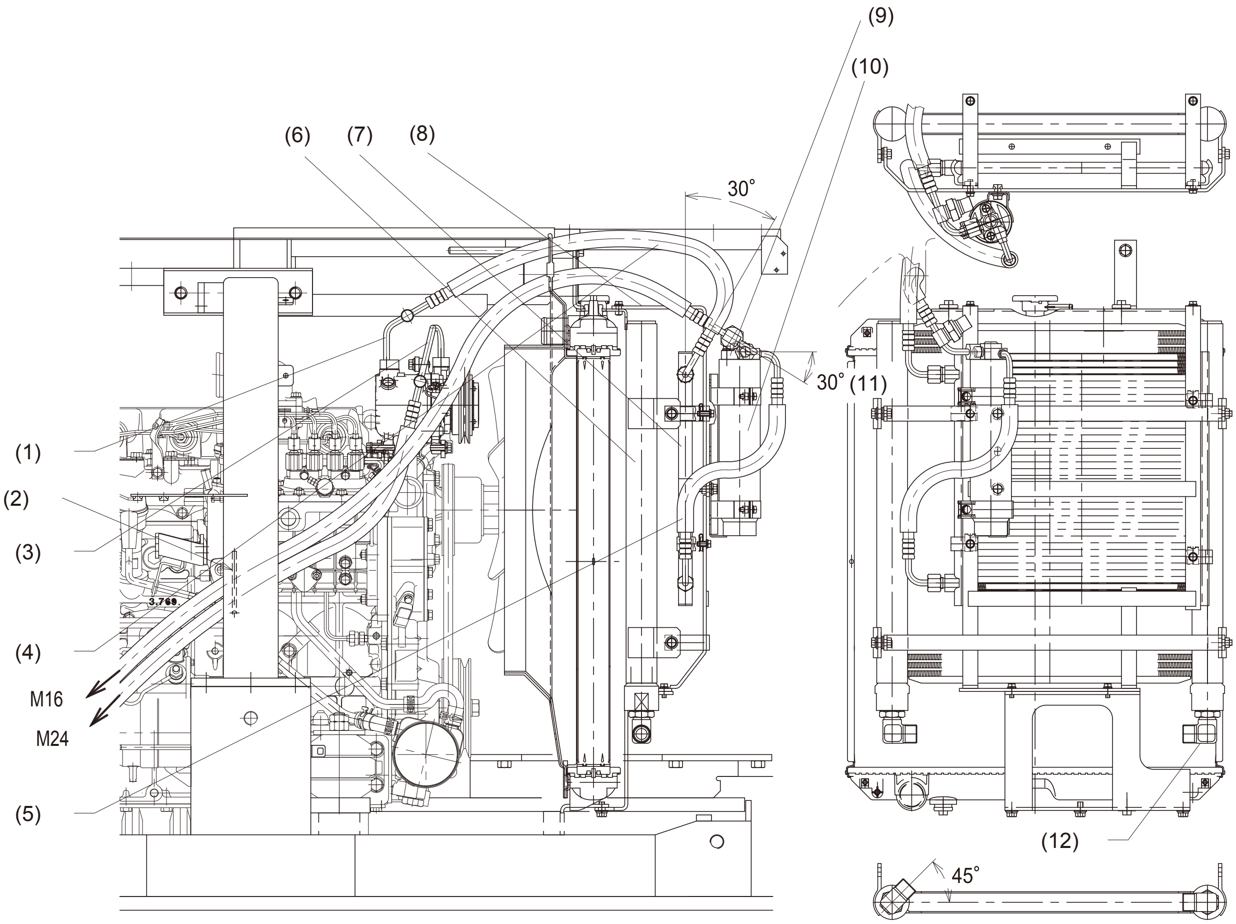






(1)Cushion (1, delivery)
(2)Apply the cushion in contact with the round bar.
(3)Finally, make sure this opening is covered as much as possible with the sealing material.
(4)Plate (delivery)
(5)End face to be aligned
(6)Sticker (2, delivery)

11.Hose route : Oil cooler



(1)Oil cooler holder (receiver)
Bolt tightening torque
17.7~20.6N.m(1.8~2.1kgf.m)13.1~15.2ft.lbs
(2)Condenser
Support (condenser)
Joint (receiver)
Bolt tightening torque
7.8~9.3N.m(0.8~0.95kgf.m)5.8~6.9ft.lbs
(3)Adaptor tightening torque
(4)G3/4 size
117.6~127.4N.m(12.0~13.0kgf.m)86.7~94.0 ft.lbs
(5)Hose (discharger)
(6)Guide bar
(7)Hose (suction)
(8)Hose (liquid, pressure)
(9)Hose (liquid)
(10)Oil cooler
Bolt
Plain washer
(11)Condenser
Nut (condenser)
Bolt
(12)Support (condenser)
Bolt
(13)Joint (receiver)
Bolt
(14)Receiver
Holder (receiver)
Bolt
(15)(Actual dimension)
(16)Elbow pipe joint

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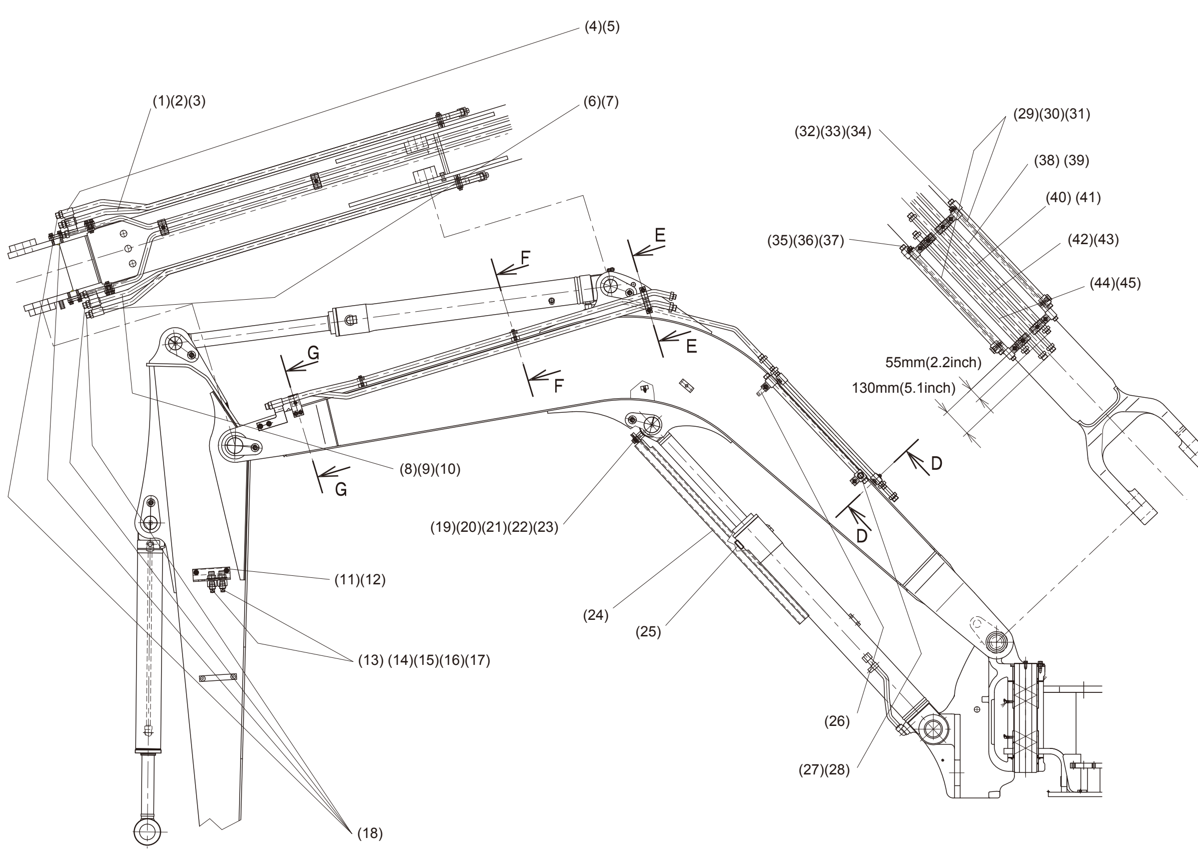
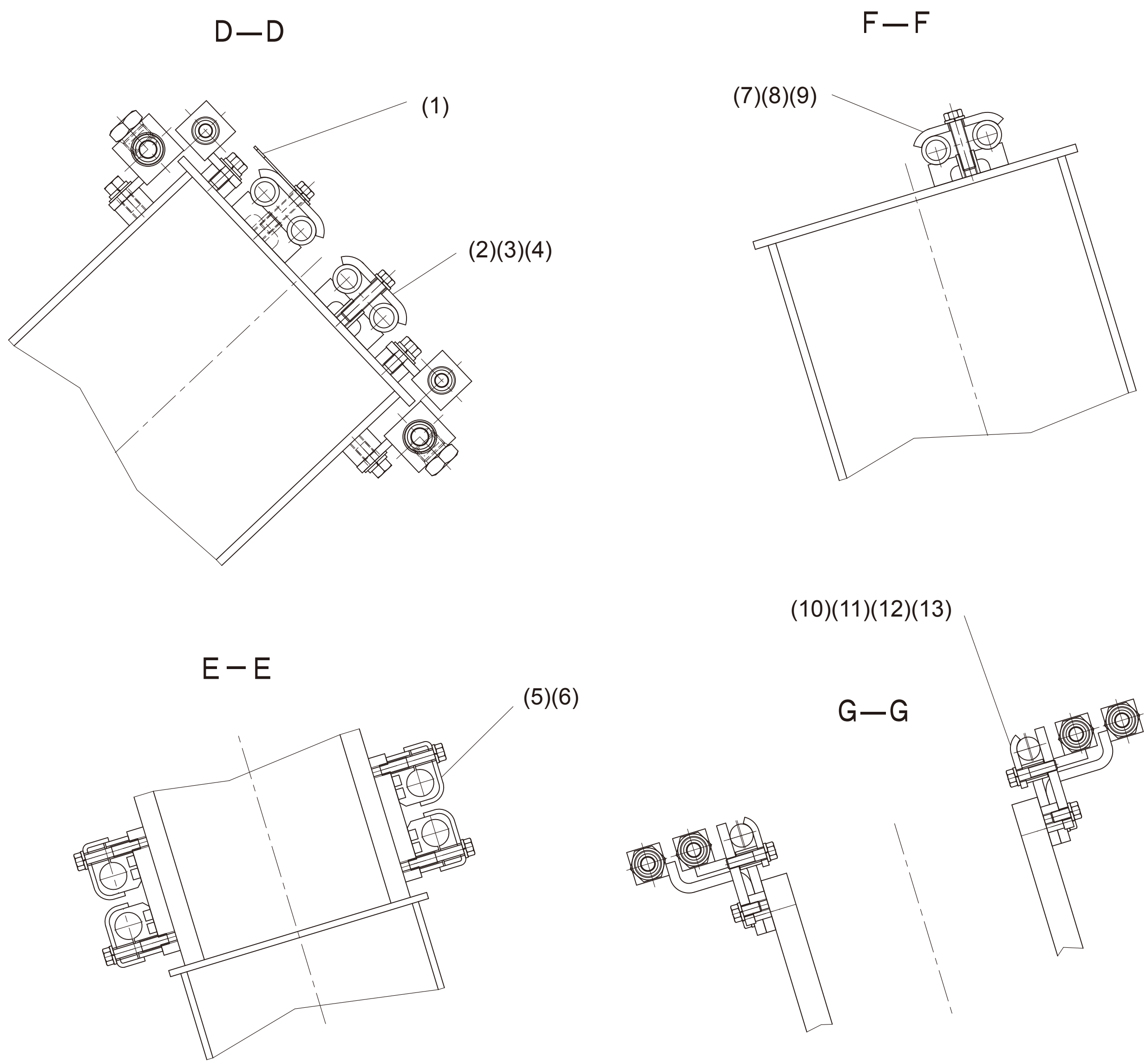
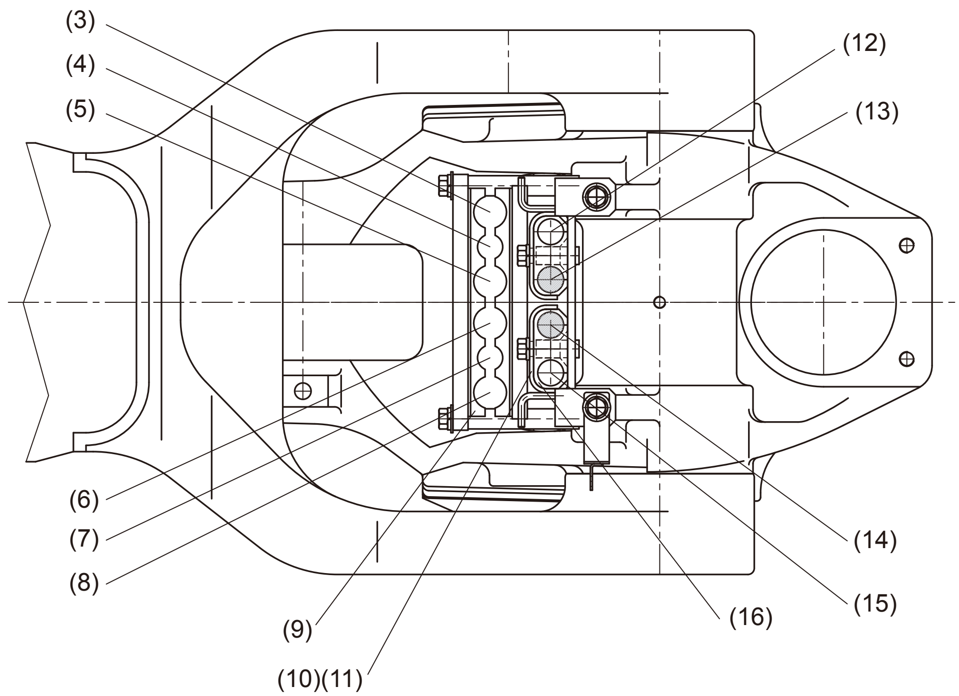
12.Front hoses and pipes

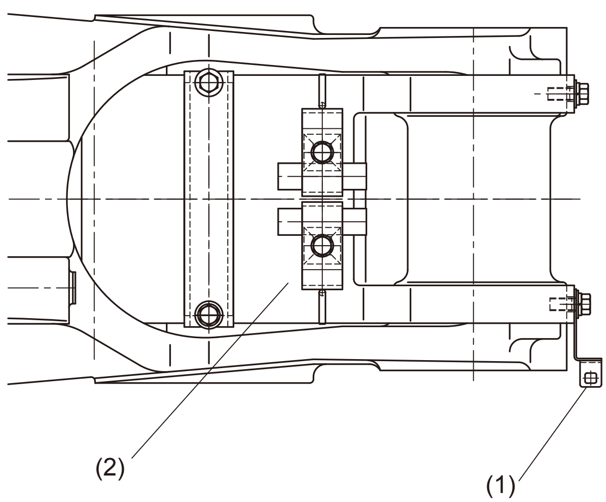


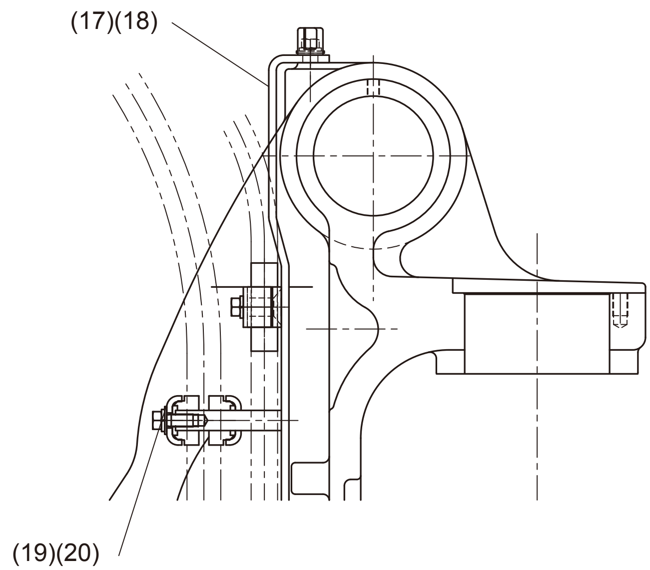
(1)Pipe (right, F, SP)
(2)O-ring (1UNF)
(3)Bolt
(4)Pipe (right, F, SP2)
(5)O-ring (13/16UNF)
(6)Pipe (left, F, SP2)
(7)O-ring (13/16UNF)
(8)Pipe (left, F, SP)
(9)ring (1UNF)
(10)Bolt
(11)Plate (SP)
(12)Bolt
(13)Adaptor (SP, 1U)
(14)O-ring (1UNF)
(15)Plain washer
(16)Nut (1UNF)
(17)Plug
(18)Pipe joint (SG4, 1U)
(19)Bolt
(20)Plain washer
(21)Collar
(22)Cushion rubber
(23)Plain washer
(24)Cover (cylinder)
(25)Cap (cylinder cover)
(26)Stay
(2, wire harness clamp)
(27)Plug
(28)O-ring
(29)Pipe (R, SP2)
(30)ring (13/16UNF)
(31)Bolt
(32)Pipe (right, R, SP)
(33)ring (1UNF)
(34)Bolt
(35)Pipe (left, R, SP)
(36)ring (1UNF)
(37)Bolt
(38)Pipe (hydraulic)
(39O-)ring (13/16UNF)
(40)Pipe (hydraulic)
(41)O-ring (1UNF)
(42)Pipe (hydraulic)
(43)O-ring (1UNF)
(44)Pipe (hydraulic)
(45)O-ring (13/16UNF)



(1)Stay (2, wire harness clamp)
(2)Clamp (4, front)
(3)Clamp (front)
(4)Bolt
(5)Clamp assembly
(6)Bolt
(7)Clamp (4, front)
(8)Clamp (front)
(9)Bolt
(10)Bracket (clamp)
(11)Clamp (pipe, front)
(12)Bolt
(13)Bolt







(1)Stay (1, wire harness clamp)
(2)Cushion (hose, dummy)
(3)S/P1
(4)Bucket (orange)
(5)Bucket (red)
(6)Arm (blue)
(7)Arm (yellowish green)
(8)S/P1
(9)Cushion
(10)Clamp (2P, front)
(11)Bolt
(12)S/P2
(13)Dummy
(14)Dummy
(15)S/P2
(16)Cushion (hose, front)
(17)Bracket (hose guide)
(18)Bolt
(19)Plate
(20)Bolt

aa.Hose route :

1.List of pilot hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	Pump ~ Line filter	Hydraulic hose (3/8)	1	360(14.2)		G 3/8 PF1406 G 3/8	
2	Life filter ~ Selector valve (accumulator)	Hydraulic hose (3/8)	1	2050(80.7)	Red	G 3/8 PF1406 G 3/8	
3	Selector valve (B) ~ (P4, T) Collective block (P)	Hydraulic hose (3/8)	1	2010(79.1)	Red	G 3/8 PLT06 G 3/8	
4	Selector valve (B) ~ SP2 solenoid valve (P)	Hydraulic hose (1/4, SP2, P)	1	340(13.4)	Blue	G 1/4 PLT04 G 1/4	
5	SP2 solenoid valve (P) ~ SP1 solenoid valve (P)	Hydraulic hose (1/4P, SP1, 2)	1	340(13.4)		G 1/4 PLT04 G 1/4	
6	Selector valve (A) ~ R/J travel bi-speed boost	Hydraulic hose (1/4, bi-speed)	1	1350(53.1)	Yellowish green	G 1/4 PLT04 G 1/4	
7	Selector valve (P) ~ P4 distribution block (tank side)	Hydraulic hose (1/4)	1	430(16.9)	White	G 1/4 PLT04 G 1/4	
8	P4 distribution block (tank side) ~ C/V (PP1)	Hydraulic hose (1/4, P4-PP1)	1	220(8.7)	Blue	Quick PLT04 Quick	
9	P4 distribution block (tank side) ~ C/V (PP2)	Hydraulic hose (1/4, P4-PP2)	1	240(9.4)	Yellow	Quick PLT04 Quick	
10	P4 distribution block (tank side) ~ C/V (PP3)	Hydraulic hose (1/4, P4-PP3)	1	400(15.7)	Green	Quick PLT04 Quick	
11	P4 distribution block (tank side) ~ Swivel motor brake (PG)	Hydraulic hose (1/4, P4-swivel M)	1	480(18.9)	Sky-blue	Quick PLT04 Quick	
12	Shuttle valve ~ C/V (swivel left)	Hydraulic hose (1/4, swivel L2)	1	1860(73.2)	Gray	G 1/4 PLT04 G 1/4	
13	Shuttle valve ~ C/V (swivel right)	Hydraulic hose (1/4, swivel R2)	1	1460(57.5)	Sky-blue	G 1/4 PLT04 Quick	
14	Shuttle valve ~ C/V (arm crowded)	Hydraulic hose (1/4, arm C3)	1	1860(73.2)	Blue	Quick PLT04 G 1/4	
15	Relay plate ~ C/V (arm dump)	Hydraulic hose (1/4, arm D3)	1	1500(59.1)	Yellowish green	Quick PLT04 Quick	
16	Relay plate ~ C/V (bucket crowded)	Hydraulic hose (1/4, bucket C2)	1	2000(78.7)	Orange	Quick PLT04 G 1/4	
17	Relay plate ~ C/V (bucket dump)	Hydraulic hose (1/4, bucket D2)	1	1470(57.9)	Red	Quick PLT04 Quick	
18	Relay plate ~ C/V (boom confluence Pbu)	Hydraulic hose (1/4, boom U3)	1	1760(69.3)	Green	Quick PLT04 Quick	
19	C/V (boom confluence Pbu) ~ C/V (boom up)	Hydraulic hose (1/4, boom confluence)	1	860(33.9)	Green	Quick PLT04 Quick	
20	Relay plate ~ C/V (boom down)	Hydraulic hose (1/4, boom D3)	1	2000(78.7)	Yellow	Quick PLT04 G 1/4	
21	Travel P/V (left forward) ~ C/V (left forward)	Hydraulic hose (1/4, travel LF)	1	1660(65.4)	Red	Quick PLT04 Quick	
22	Travel P/V (left backward) ~ C/V (left backward)	Hydraulic hose (1/4, travel LR)	1	1950(76.8)	Blue	Quick PLT04 G 1/4	
23	Travel P/V (right forward) ~ C/V (right forward)	Hydraulic hose (1/4, travel RF)	1	1550(61.0)	Yellow	Quick PLT04 Quick	
24	Travel P/V (right backward) ~ C/V (right backward)	Hydraulic hose (1/4, travel RR)	1	1840(72.4)	Green	Quick PLT04 G 1/4	
25	Swing P/V (left) ~ C/V (swing left)	Hydraulic hose (1/4, swing L)	1	1850(72.8)	Orange	Quick PLT04 G 1/4	
26	Swing P/V (right) ~ C/V (swing right)	Hydraulic hose (1/4, swing R)	1	1450(57.1)	Yellowish green	Quick PLT04 Quick	
27	Relay plate ~ C/V (dozer up)	Hydraulic hose (1/4, dozer U2)	1	1570(61.8)	Pink	Quick PLT04 Quick	
28	Relay plate ~ C/V (dozer down)	Hydraulic hose (1/4, dozer D2)	1	1900(74.8)	Brown	Quick PLT04 G 1/4	
29	SP1 solenoid (high pressure) ~ C/V (SP1 high pressure)	Hydraulic hose (1/4, SP1H)	1	790(31.1)	Pink	Quick PLT04 Quick	
30	SP1 solenoid (low pressure) ~ C/V (SP1 low pressure)	Hydraulic hose (1/4, SP1L)	1	1040(40.9)	Brown	Quick PLT04 G 1/4	
31	SP2 solenoid (high pressure) ~ C/V (SP1 high pressure)	Hydraulic hose (1/4)	1	490(19.3)	Pink	G 1/4 PLT04 Quick	
32	SP2 solenoid (low pressure) ~ C/V (SP1 low pressure)	Hydraulic hose (1/4)	1	830(32.7)	Brown	G 1/4 PLT04 G 1/4	

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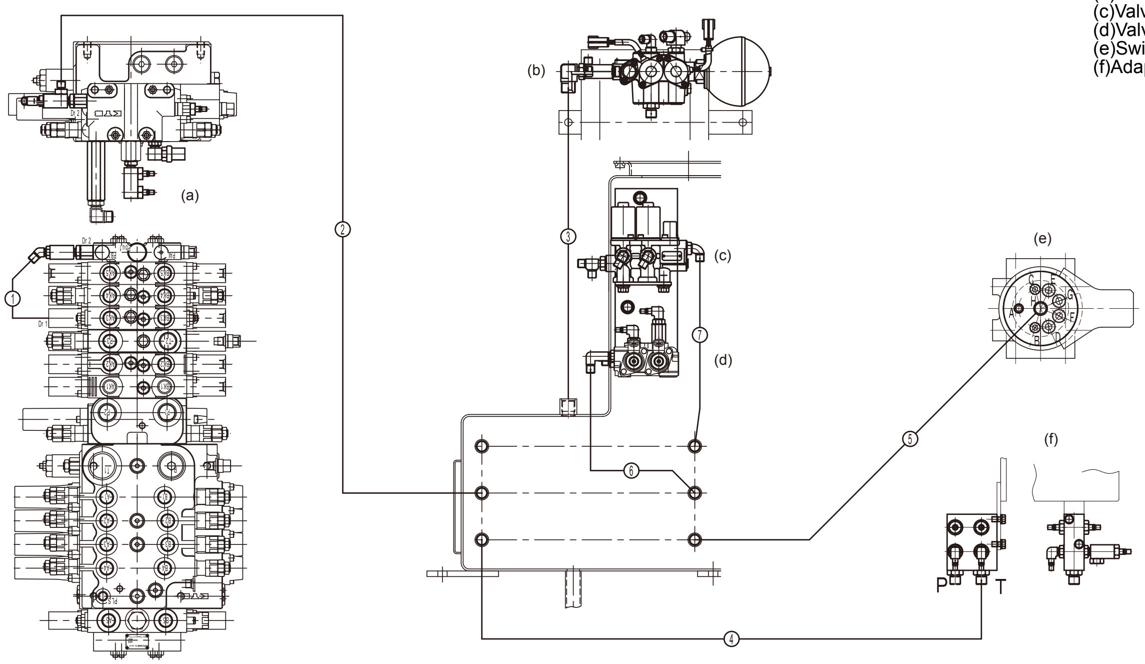
2.List of pilot hoses (drain) (upper structure) (hydraulic system)

No.	Location	Part name	Q ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	C/V (Dr1) ~ C/V (Dr2)	Hydraulic hose (1/4DR1-DR2)	1	255(10.0)		G1/4 PLT04 G1/4	
2	C/V (Dr2) ~ Tank	Hydraulic hose (1/4, P3DR)	1	610(24.0)	Sky-blue	G1/4 PLT04 G1/4	Two pieces of sky-blue tape to be wound around the center of hose
3	Selector valve (T) ~ Tank	Hydraulic hose (1/2)	1	470(18.5)	Green	G1/2 PA0308 G1/2	
4	(P4, T) Collective block ~ Tank	Hydraulic hose (3/8)	1	1670(65.7)	Gray	G3/8 PLT06 G3/8	
5	R/J (T) ~ Tank	Hydraulic hose (3/8, travel drain)	1	990(39.0)	Orange	G3/8 PLT06 G3/8	
6	SP1 solenoid (T) ~ Tank	Hydraulic hose (1/4T, SP1SV)	1	225(8.9)	Brown, Pink	G1/4 PLT04 G1/4	
7	SP2 solenoid (T) ~ Tank	Hydraulic hose (1/4T, SP2SV)	1	310(12.2)		G1/4 PLT04 G1/4	

(a)Control valve assembly
(b)Valve assembly (unload)
(c)Valve assembly (unload)
(d)Valve assembly (proportional)
(e)Swivel joint assembly
(f)Adaptor (pilot hose, 1)



3.List of pilot hoses (upper structure) (platform, control system)

No.	Location	Part name	Q'ty	Dimension mm(inch)	Tape color	Hose configuration	Remarks
1	(P4, T) Collective block ~ P/V (left) (P)	Hydraulic hose (1/4P, L-PV)	1	1390(54.7)	White	Quick PLT04 Quick	
2	(P4, T) Collective block ~ Dozer P/V (P)	Hydraulic hose (1/4P, dozer PV)	1	1190(46.9)	White	Quick PLT04 Quick	
3	Dozer P/V (P) ~ P/V (right) (P)	Hydraulic hose (1/4P, R-PV)	1	470(18.5)	White	Quick PLT04 Quick	
4	(P4, T) Collective block Travel P/V (P)	Hydraulic hose (1/4P, travel PV)	1	210(8.3)	White	Quick PLT04 G 1/4	
5	Travel P/V (P) ~ Swing P/V (P)	Hydraulic hose (1/4P, swing PV)	1	190(7.5)	White	G 1/4 PLT04 Quick	
6	P/V (swivel left) ~ Shuttle valve	Hydraulic hose (1/4, swivel L1)	1	1660(65.4)	Gray	Quick PLT04 Quick	
7	P/V (swivel right) ~ Shuttle valve	Hydraulic hose (1/4, swivel R1)	1	1660(65.4)	Sky-blue	Quick PLT04 Quick	
8	P/V (arm crowded) ~ Relay adaptor	Hydraulic hose (1/4, arm C1)	1	1080(42.5)	Blue	Quick PLT04 Quick	
9	Relay adaptor ~ Shuttle valve (arm crowded)	Hydraulic hose (1/4, arm C2)	1	490(19.3)	Blue	Quick PLT04 Quick	
10	P/V (arm dump) ~ Relay adaptor	Hydraulic hose (1/4, arm D1)	1	1070(42.1)	Yellowish green	Quick PLT04 Quick	
11	Relay adaptor ~ Relay plate (arm dump)	Hydraulic hose (1/4, arm D2)	1	530(20.9)	Yellowish green	Quick PLT04 Quick	
12	P/V (bucket crowded) ~ Relay plate	Hydraulic hose (1/4, bucket C1)	1	1590(62.6)	Orange	Quick PLT04 Quick	
13	P/V (bucket dump) ~ Relay plate	Hydraulic hose (1/4, bucket D1)	1	1610(63.4)	Red	Quick PLT04 Quick	
14	P/V (boom up) ~ Relay adaptor	Hydraulic hose (1/4, boom U1)	1	1690(66.5)	Green	Quick PLT04 Quick	
15	Relay adaptor ~ Relay plate (boom up)	Hydraulic hose (1/4, boom U2)	1	530(20.9)	Green	Quick PLT04 Quick	
16	P/V (boom down) ~ Relay adaptor	Hydraulic hose (1/4, boom D1)	1	1770(69.7)	Yellow	Quick PLT04 Quick	
17	Relay adaptor ~ Relay plate (boom down)	Hydraulic hose (1/4, boom U2)	1	470(18.5)	Yellow	Quick PLT04 Quick	
18	Dozer P/V (up) ~ Relay plate	Hydraulic hose (1/4, dozer U1)	1	1130(44.5)	Pink	Quick PLT04 Quick	
19	Dozer P/V (down) ~ Relay plate	Hydraulic hose (1/4, dozer D2)	1	1185(46.7)	Brown	Quick PLT04 Quick	

4.List of pilot hoses (drain) (upper structure) (platform, control system)

20	20 P/V (left) (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, L-PV)	1	1460(57.5)		Quick PLT04 Quick	
21	21 P/V (right) (T) ~ Dozer P/V (T)	Hydraulic hose (1/4T, R-PV)	1	420(16.5)		Quick PLT04 Quick	
22	22 Dozer P/V (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, dozer PV)	1	1205(47.4)		Quick PLT04 Quick	
23	23 Swing P/V (T) ~ Travel P/V (T)	Hydraulic hose (1/4T, swing PV)	1	210(8.3)		G 1/4 PLT04 Quick	
24	24 Travel P/V (T) ~ (P4, T) Collective block	Hydraulic hose (1/4T, travel PV)	1	210(8.3)		Quick PLT04 G 1/4	

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5.List of high-pressure hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	Pump (P1) — C/V (P1)	Hydraulic hose (5/8)	1	2890(113.8)	Red, White	1-14UNS PA2810 1-14UNS	
2	Pump (P2) — C/V (P2)	Hydraulic hose (5/8)	1	2940(115.7)	Red, White	1-14UNS PA2810 1-14UNS	
3	Pump (P3) — C/V (P3)	Hydraulic hose (5/8)	1	3170(124.8)	Red, White	13/16UN PF2108 13/16UN	
4	Pump (PPS) — C/V (PPS)	Hydraulic hose (1/4)	1	2740(107.9)	Red, White	9/16UNF PFH04 9/16UNF	
5	Pump (PLS) — C/V (PLS)	Hydraulic hose (1/4)	1	3160(124.4)	Red, White	9/16UNF PFH04 9/16UNF	
6	C/V (boom up) — Boom back (pipe)	Hydraulic hose (5/8)	1	2760(108.7)	Green	1-14UNS PA2810 1-14UNS	With corrugated tube
7	C/V (boom down) — Boom back (pipe)	Hydraulic hose (1/2)	1	3320(130.7)	Yellow	13/16UN PFH08 13/16UN	With corrugated tube
8	C/V (arm crowded) — Boom back (pipe)	Hydraulic hose (5/8)	1	3260(128.3)	Blue	1-14UNS PA2810 1-14UNS	With corrugated tube
9	C/V (arm dump) — Boom back (pipe)	Hydraulic hose (1/2)	1	3200(126.0)	Yellowish green	13/16UN PFH08 13/16UN	With corrugated tube
10	C/V (bucket crowded) — Boom back (pipe)	Hydraulic hose (5/8)	1	3320(130.7)	Red	1-14UNS PA2810 1-14UNS	With corrugated tube
11	C/V (bucket dump) — Boom back (pipe)	Hydraulic hose (1/2)	1	3260(128.3)	Orange	13/16UN PFH08 13/16UN	With corrugated tube
12	C/V (PB1) — C/V (PB2) (boom confluence)	Hydraulic hose (3/8)	1	910(35.8)	Black	11/16UN PFH06 11/16UN	
13	Boom back (pipe) (arm crowded) — Arm cylinder (bottom)	Hydraulic hose (5/8)	1	720(28.3)	Blue	1-14UNS PA2810楷 1-14UNS	Yokohama-made
14	Boom back (pipe) (arm dump) — Arm cylinder (rod)	Hydraulic hose (1/2)	1	1955(77.0)	Yellowish green	13/16UN PA2808楷 13/16UN	Yokohama-made
15	C/V (travel right forward) — R/J (E)	Hydraulic hose (5/8)	1	920(36.2)	Yellow double	1-14UNS PA2808楷 1-14UNS	Yokohama-made
16	C/V (travel right backward) — R/J (G)	Hydraulic hose (5/8)	1	1025(40.4)	Green double	1-14UNS PA2808楷 1-14UNS	Yokohama-made
17	C/V (travel left forward) — R/J (D)	Hydraulic hose (5/8)	1	950(37.4)	Red double	1-14UNS PA2808楷 1-14UNS	Yokohama-made
18	C/V (travel left backward) — R/J (F)	Hydraulic hose (5/8)	1	1065(41.9)	Yellowish green double	1-14UNS PA2808楷 1-14UNS	Yokohama-made
19	C/V (swivel left) — Swivel motor (left)	Hydraulic hose (1/2)	1	810(31.9)	Gray	13/16UN PA2808楷 13/16UN	Yokohama-made
20	C/V (swivel right) — Swivel motor (right)	Hydraulic hose (1/2)	1	670(26.4)	Sky-blue	13/16UN PA2808楷 13/16UN	Yokohama-made
21	C/V (left) — Swing cylinder (bottom)	Hydraulic hose (3/8)	1	1950(76.8)	Yellowish green	11/16UN PFH06 11/16UN	
22	C/V (right) — Swing cylinder (rod)	Hydraulic hose (3/8)	1	2020(79.5)	Orange	11/16UN PFH06 11/16UN	
23	C/V (dozer down) — R/J (B)	Hydraulic hose (1/2)	1	1175(46.3)	Brown	13/16UN PA2808楷 13/16UN	Yokohama-made
24	C/V (dozer up) — R/J (C)	Hydraulic hose (1/2)	1	2020(79.5)	Pink	13/16UN PA2808楷 13/16UN	Yokohama-made
25	Boom back (pipe) — Bucket cylinder	Hydraulic hose (5/8)	2	960(37.8)		1-14UNS PA2810 1-14UNS	Spring wound overall

6.List of high-pressure hoses (upper structure) (swivel frame, C/V side)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
26	C/V (SP1 high pressure) ~ Boom back (pipe)	Hydraulic hose (5/8)	1	3260(128.3)	Pink	1−14UNS PA2810 1−14UNS	With corrugated tube
27	3-way valve ~ Boom back (pipe)	Hydraulic hose (5/8)	1	3680(144.9)	Brown	1−14UNS PA2810 1−14UNS	With corrugated tube
28	S/P intermediate (SP1)	Hydraulic hose (5/8)	2	540(21.3)		1−14UNS PA2810 1−14UNS	Yokohama-made
29	S/P end (SP1)	Hydraulic hose (5/8)	2	960(37.8)		1−14UNS PA2810 1−14UNS	Yokohama-made, spring wound overall
30	3-way valve ~ C/V (SP1 low pressure)	Hydraulic hose (5/8)	1	460(18.1)	Brown	1−14UNS PA2810 1−14UNS	
31	C/V (SP2 high pressure) ~ Boom back (pipe)	Hydraulic hose (1/2)	1	3390(133.5)	Pink	13/16UN PA2808 13/16UN	With corrugated tube
32	C/V (SP2 low pressure) ~ Boom back (pipe)	Hydraulic hose (1/2)	1	3590(141.3)	Brown	13/16UN PA2808 13/16UN	With corrugated tube
33	S/P intermediate (SP2)	Hydraulic hose (1/2)	1	605(23.8)		13/16UN PA2808 13/16UN	Yokohama-made
34	S/P end (SP2)	Hydraulic hose (5/8)	1	960(37.8)		1−14UNS PA2810 1−14UNS	Yokohama-made, spring wound overall

7.List of low-pressure hoses (upper structure)

No.	Location	Part name	Q'ty	Dimension mm (inch)	Tape color	Hose configuration	Remarks
1	C/V (T1) ~ Return pipe	Hydraulic hose (1-1/4, return)	1	805(31.7)		G1・1/4 PA0320 G1・1/4	
2	C/V (T2) ~ Swivel motor (M)	Hydraulic hose (3/4, swivel M)	1	560(22.0)	Black	G3/4 PA0310 G3/4	
3	Swivel motor (M) ~ Oil cooler	Hydraulic hose (5/8)	1	1240(48.8)		G3/4 PA0310 G3/4	PVC tube wound
4	Oil cooler ~ Return pipe	Hydraulic hose (5/8)	1	690(27.2)	Black	G3/4 PA0310 G3/4	PVC tube wound
5	Swivel motor (Dr) ~ Return pipe	Hydraulic hose (1/4, swivel DR)	1	1430(56.3)		G1/4 PLT04 G1/4	PVC tube wound
6	3-way valve ~ Return pipe	Hydraulic hose (5/8)	1	460(18.1)	Pink	G3/4 PA0310 G3/4	

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IV-S-234

. Electrical system

Mechanism Section

A.Feature and main function

a. Development concept

1. Features of KX080-3 system

Basic electrical system structure is same as KX-3α and KX-3S series and some new values are added. Newly added features of KX080-3 electrical system are as below.

o.	Feature points	enefits
	Ser ice port ( ) eli ery flo control (S/ spee control)	Required max. flow of service port varies according to the attachments. This new S/P flow control enables operators to select optimum flow amount, thus regulate the attachment speed.
	Fuel supply pump	Fuel pump equipped as standard helps operator to supply fuel to the tank. Tank full-sensor is equipped to prevent fuel from overflowing. Four min. timer relay gets the pump function continuously for 4 minutes.
3	**Inta e air heater control**	Engine, V3800-DI, has the intake air heater which regulates the intake air temperature for proper combustion and clean exhaust gas. The electrical control system consists of micro-computer unit to work with. (Note: Repeated ON-OFF only of the main key is prohibited, may cause the heater coil damage.)
	ra el alarm system	This system warns the people working around that the machine is travelling nearby. This is the safety oriented device.
	Ser ice port ( ) is controlle by solenoi al e (- FF control).	Conventional machines are equipped with mechanical-link pedal-control service port. This one is electrical control device which is easily remote selected ON or OFF position at hand.
6	**oom o erloa sensing ith pressure s itch**	For operator’s safety, the pressure switch detects the boom cylinder’s internal pressure and alarms the operator.

2. Electrical system : Functional comparison

: 0 0-3

No.	Function	EU-version	North America Oceanea
1	KICS;Kubota Intelligent Control System, LCD(liquid crystal display) with character and illustration	Yes	Yes
2	Maintenance indication upon hour meter	Yes (delete method:manual)	Yes (delete method:auto)
3	Anti-theft system	Yes	No
4	AI(Auto idle) function	Yes	Yes
5	Engine overheat warning	Yes	No
6	Starter motor auto release function	Yes	Yes
7	Travel high-low switch at dozer lever grip	Yes	Yes
8	Fuel feed assist sound	Yes	Yes
9	Heater	Yes (cab version)	Yes (cab version)
10	Rotating lamp	Harness and switch are equipped as standard	Harness is incorporated
11	Service port (thumb) finger - control	Yes	Yes
12	Air - conditioner idling control	Yes	Yes
13	Low temp. idle up control	Yes	Yes
14	Service port (1) discharge flow control	Yes	Yes
15	Fuel supply pump	Yes	Yes
16	Intake air heater control	Yes	Yes
17	Travel alarm system	Yes (option)	Yes
18	Boom overload sensor	Yes	Yes
19	Service port (2) solenoid ON-OFF conrol	Yes	Yes

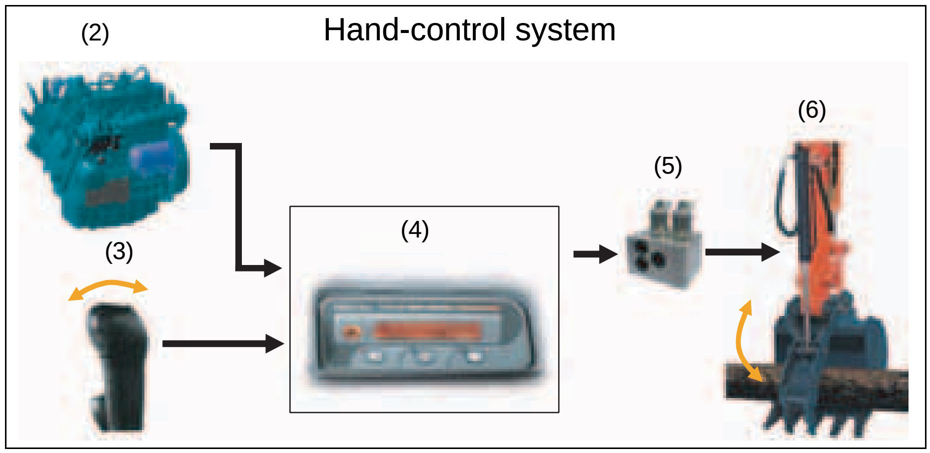
b. Service port speed limit control

1. Background and concept of R D

The hydraulic service port is provided to move an attachment that is installed on the machine. Such attachment was operated with a foot pedal on conventional machines. For finely maneuvering an attachment and saving the space around the operator s feet, the hand-control system was developed. Kubota s 3-ton and higher-capacity export machines are now standard equipped with this system.
The top-end model KX080-3 is also equipped with the speed limit function (the world s first on mini-backhoes) to differentiate this model from our competition.

Hand-control system

The hydraulic control grip has a small angle sensor built in. Signals from this sensor activate the proportional solenoid valve to control the flow rate at the hydraulic service port stepless.

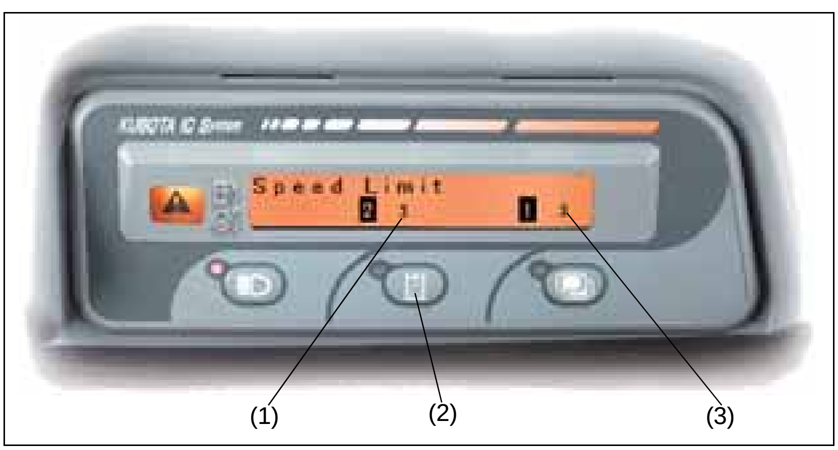


(1) Control knob (small angle sensor)
(2) Engine rpm
(3) Control angle input
(4) Electronic meter (control unit)
(5) Proportional solenoid valve
(6) Attachment

2. Outline of new function

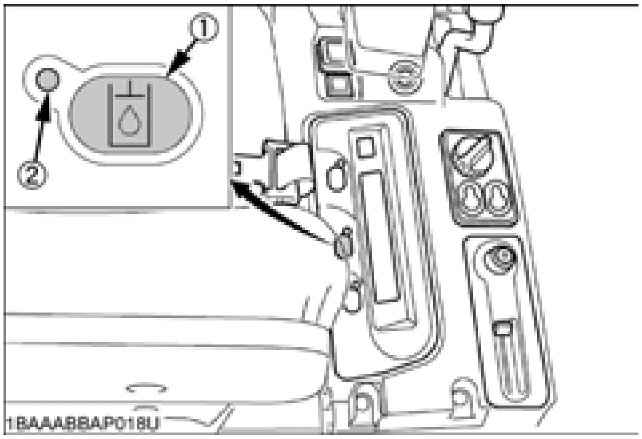
Speed limit function New Feature

According to maximum necessary flow rate of an attachment, the working speed limit can be preset in 10 steps. Just look at the electronic meter s LCD screen and press the button.
What s more, the control knob angle and the service port flow rate are in linear response to each other. The attachment can now be easily controlled by moving the control knob over its full stroke.



(1) Extend
(2) Control button
(3) Retract

3. How to operate servcie port 1



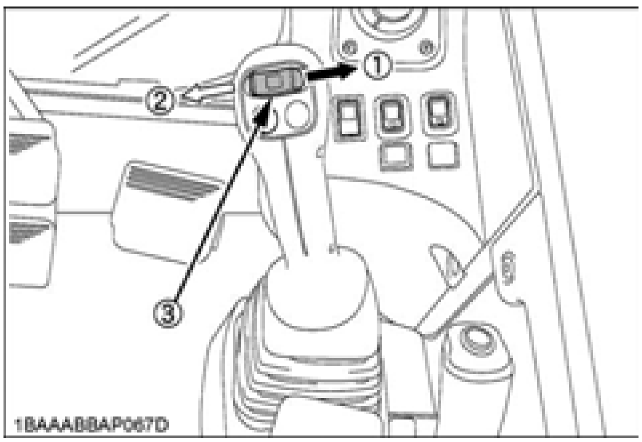
(1) Service port activation switch
(2) Indicator lamp

1. When the lock lever is raised, the service port activation switch is off.
2. Let the engine warm up after start-up for approx. 10 minutes under no load conditions.

3-1 First Service Port Operation

This switch is used to operate hydraulic attachment such as breakers.

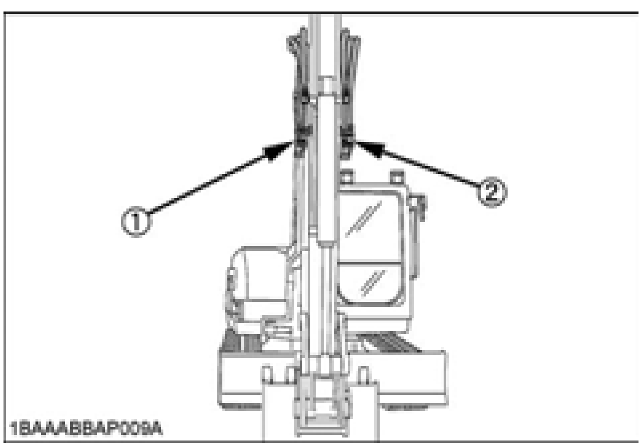
1. Turn the starter key to the RUN position.
2. Lower the lock lever.
3. Push the service port activation switch.



(3) Service port switch

4. Move the service port switch to the right (⬇) to send oil to the port (1).
5. Move the service port switch to the left (⇩) to send oil to the port (2).

- Proportional control allows for slow-to-fast movement of attachment.
  Example: If you move the knob switch half way, the attachment will move at approximately one-half speed.

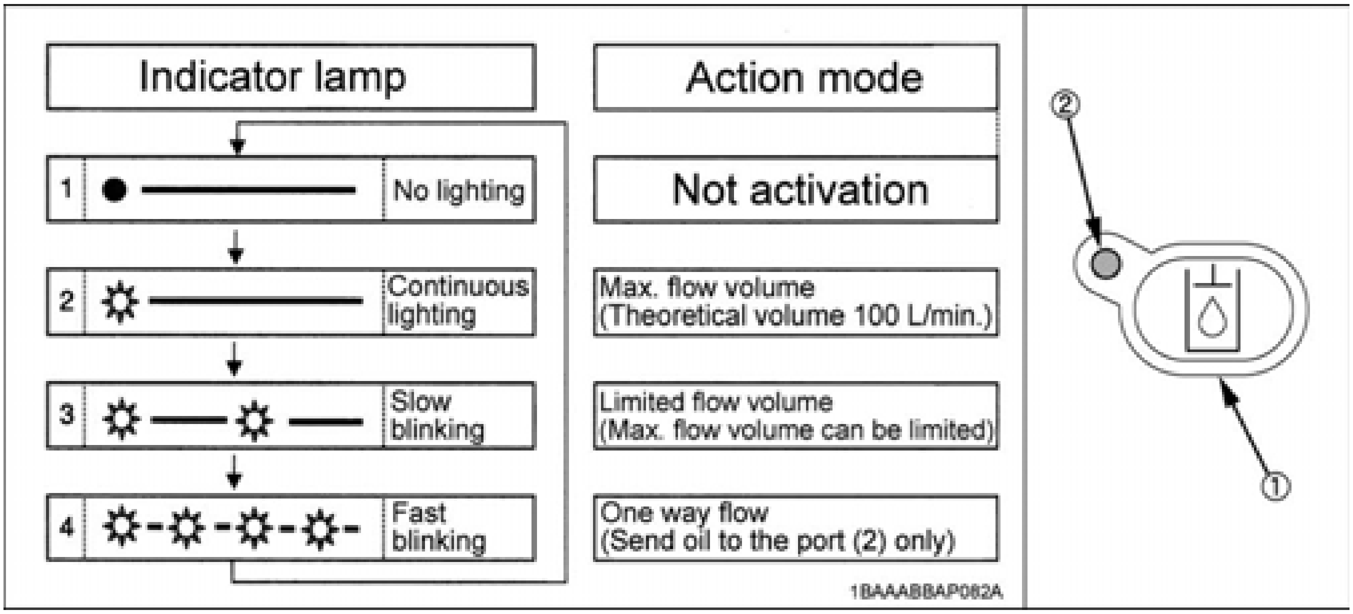


3-2 Action mode of first service port operation

It is possible to select four action mode of the first service port operation by pushing the service port activation switch.
Each time the service port activation switch is pushed, the action mode changes from 1 through 4.

NOTE:

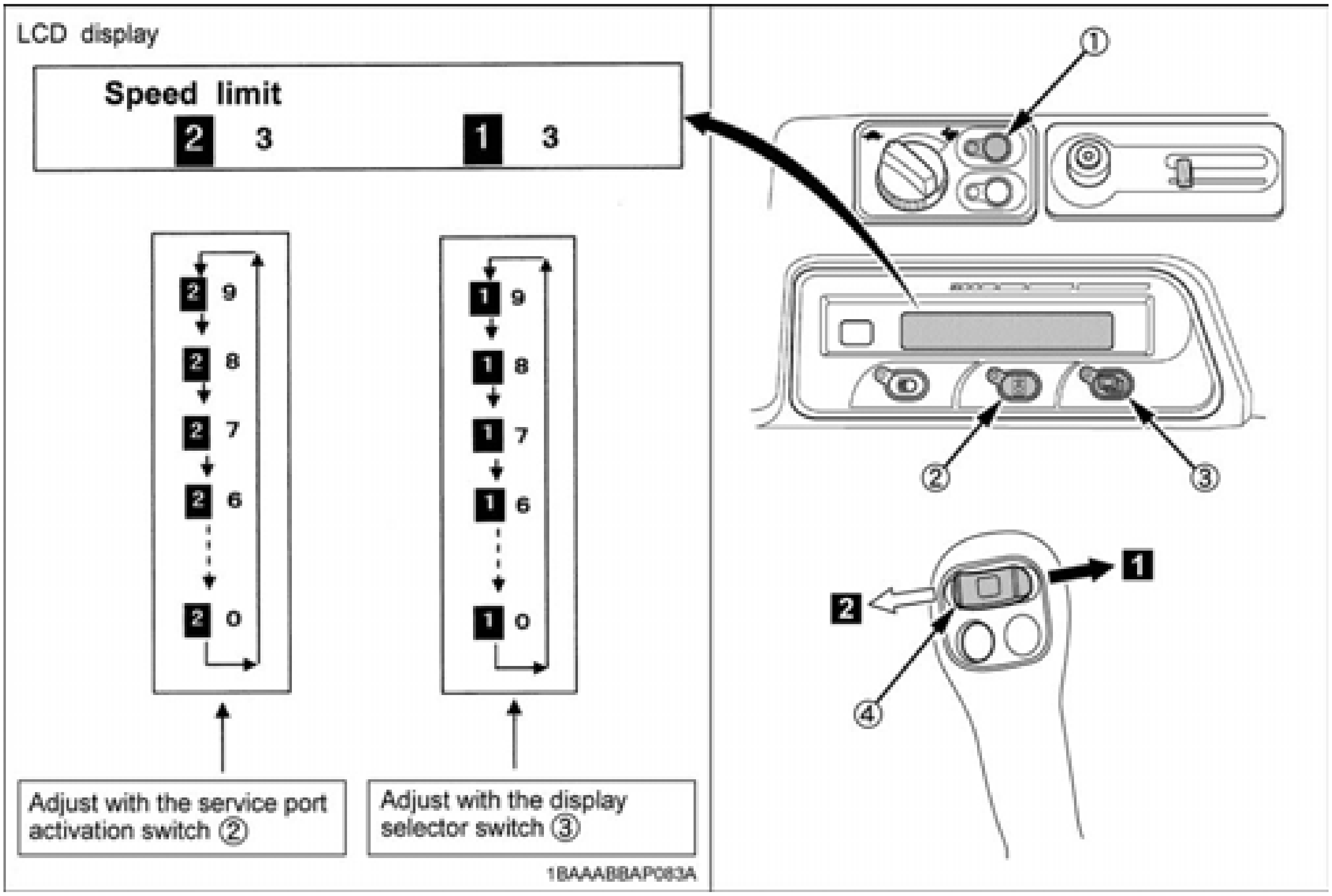
- When turning the starter key to the RUN position, the action mode will return to the last action mode used.



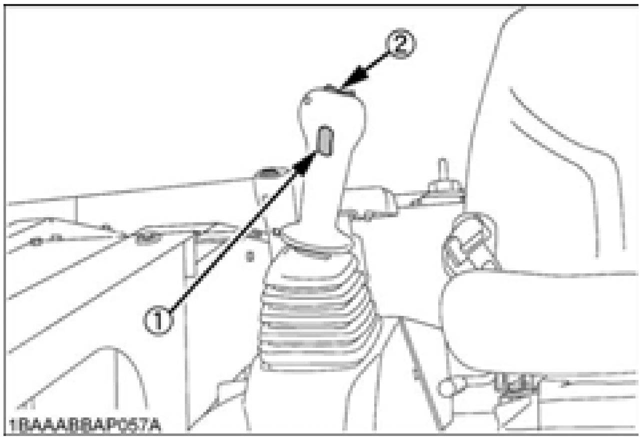
(1) Service port activation switch
(2) Indicator lamp

4. Setting of limited flow volume

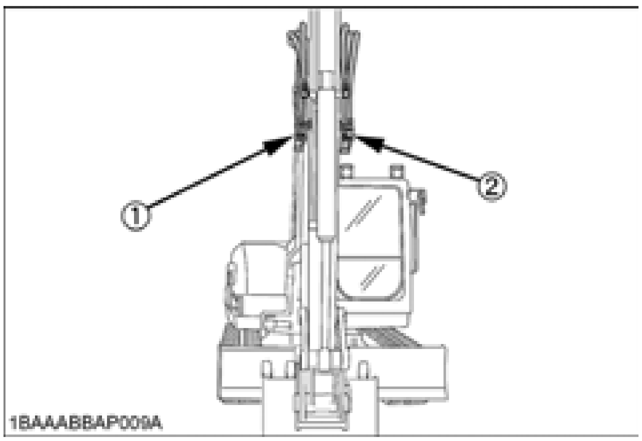
1. Turn the starter key to the RUN position while pushing the flow volume setting switch.
2. Release the hand from the switch after the engine starts.
3. Ten stages can be adjusted for Max. flow volume right (1) and left (2) independently.
4. The oil volume supplied from port (1) is adjusted with the display selector switch (3).
5. The oil volume supplied from port (2) is adjusted with the service port activation switch (2).

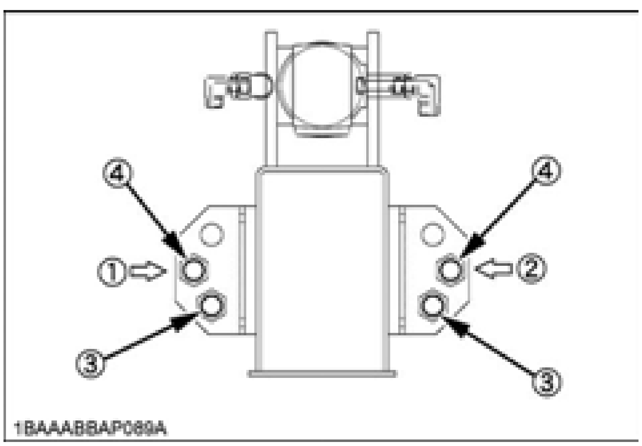


(1) Flow volume setting switch
(2) Service port activation switch
(3) Display selector switch
(4) Service port switch



(1) One way hold lock switch
(2) First service port switch

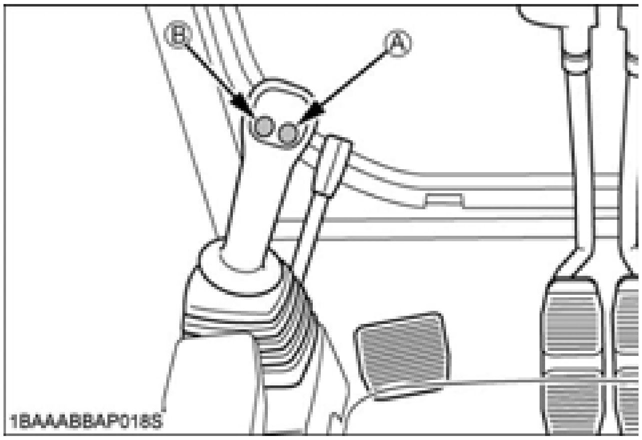




(3) First service port
(4) Second service port

5. One way flow operation

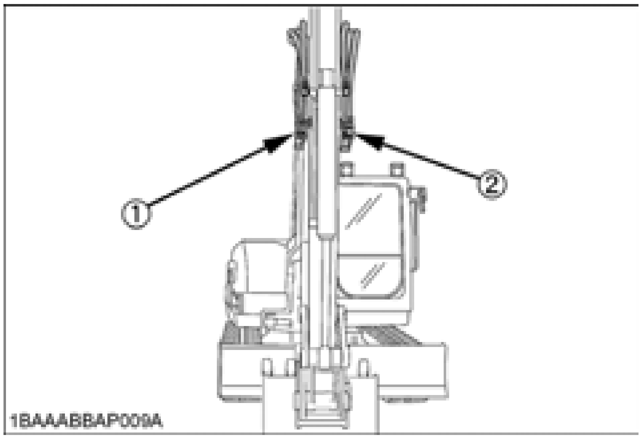
1. Push the one way hold lock switch, and oil flows into the port (2) continually. Push the switch again to stop the operation.
2. The one way flow operation stops when the first service port switch is pushed.



6. Second service port operation

1. Turn the starter key to the RUN position.
2. Lower the lock lever.
3. Press the right switch (A) to send oil to the port (1).
4. Press the left switch (B) to send oil to the port (2).

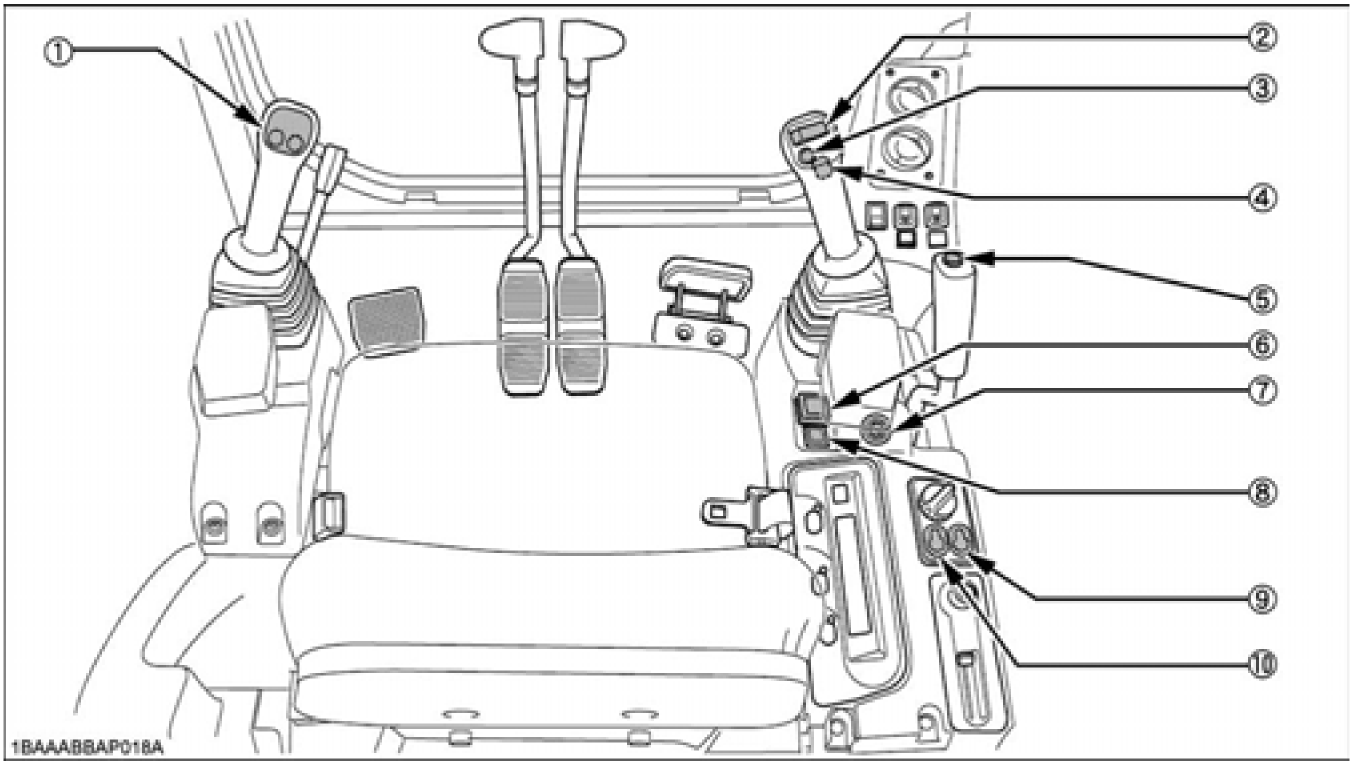
- Proportional control is not possible.

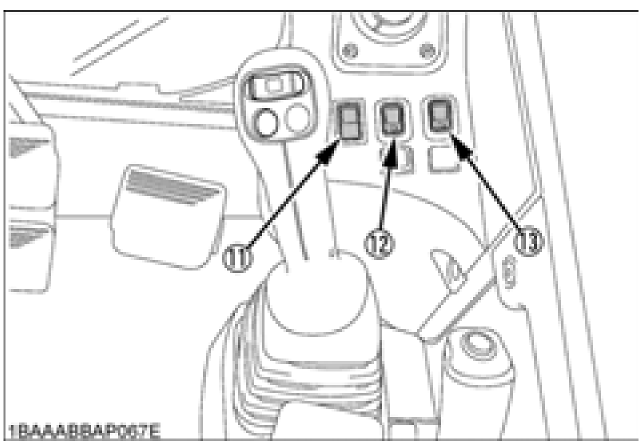


- It is possible to adjust the flow volume of the second service port. Contact your local KUBOTA dealer when necessary.

	First service port	Second service port
Max. Flow Volume Theoretical L/min.	100	67
Max. Pressure MPa (kgf/cm^2)	20.6 (210)	20.6 (210)

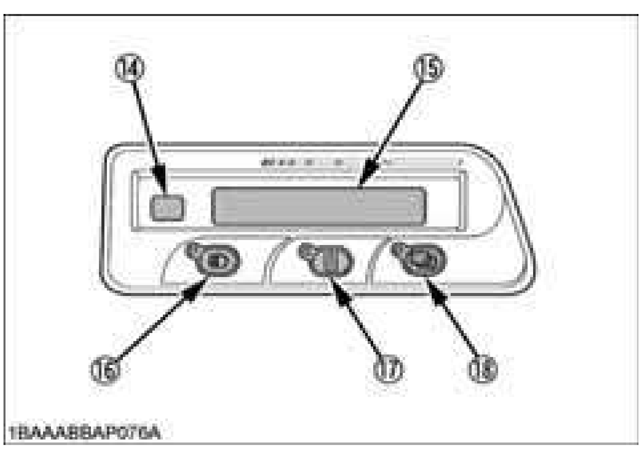
7. Instrument panel, switch





Depicted contents

(1) Second service port switch
(2) First service port switch
(3) Horn switch
(4) One way hold lock switch
(5) Two travel speed switch
(6) Beacon light switch
(7) Starter switch
(8) Two speed indicator light
(9) Flow volume setting switch



(10)Switch for Auto idle control
(11)Wiper / Washer switch
(12)Cab light switch
(13)Overload warning switch
(14)Warning lamp
(15)LCD display
(16)Working light switch
(17)Service port activation switch
(18)Display selector switch

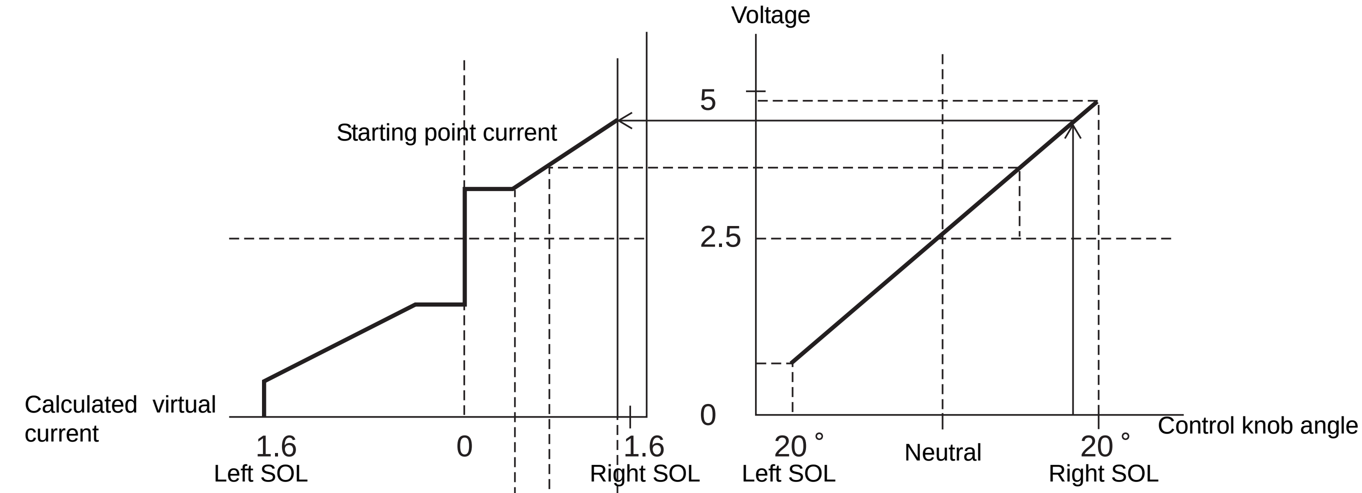
8. FYI (For Your Information)

To those who want to know more

Following charts show the theoretical approach to recognize the principle of speed limit control.

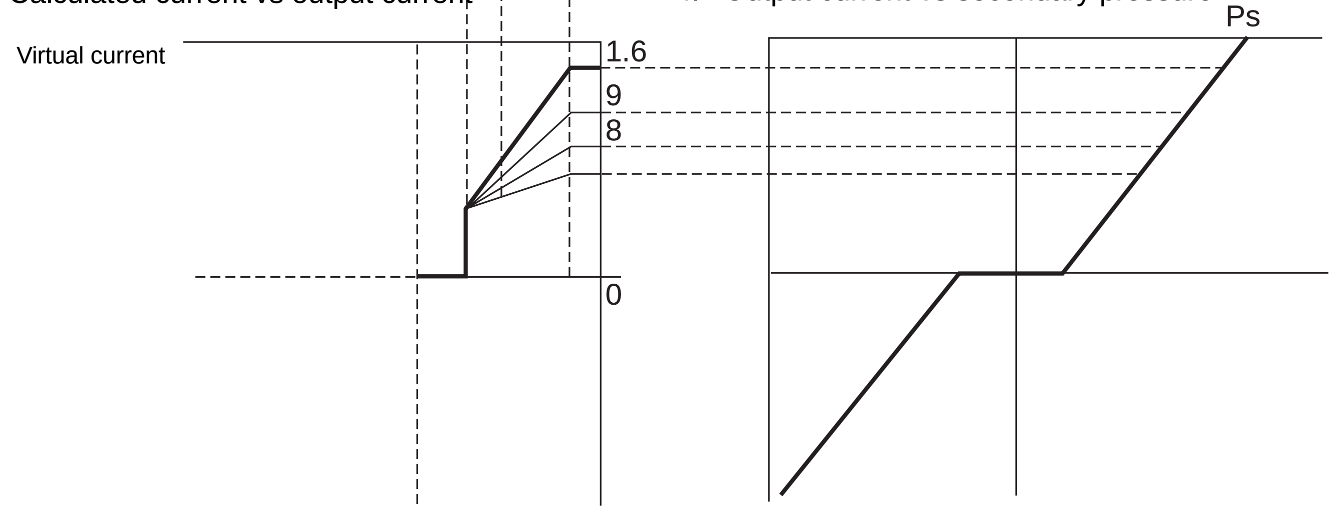
2. Output voltage vs current calculated

1. Control knob vs output voltage

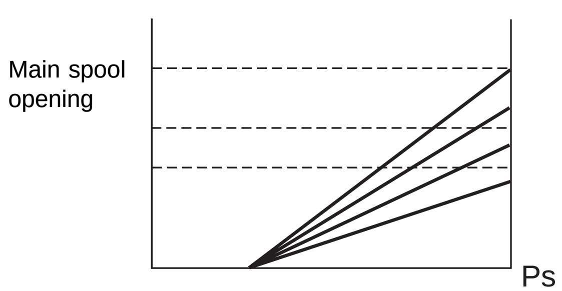


3. Calculated current vs output current

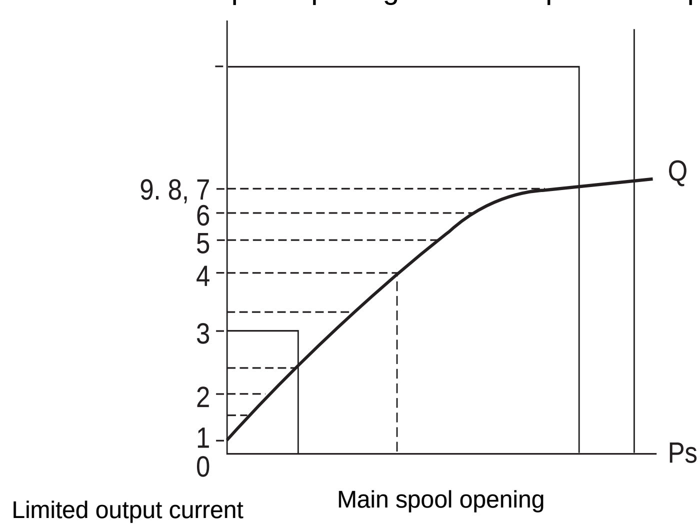
4. Output current vs secondary pressure



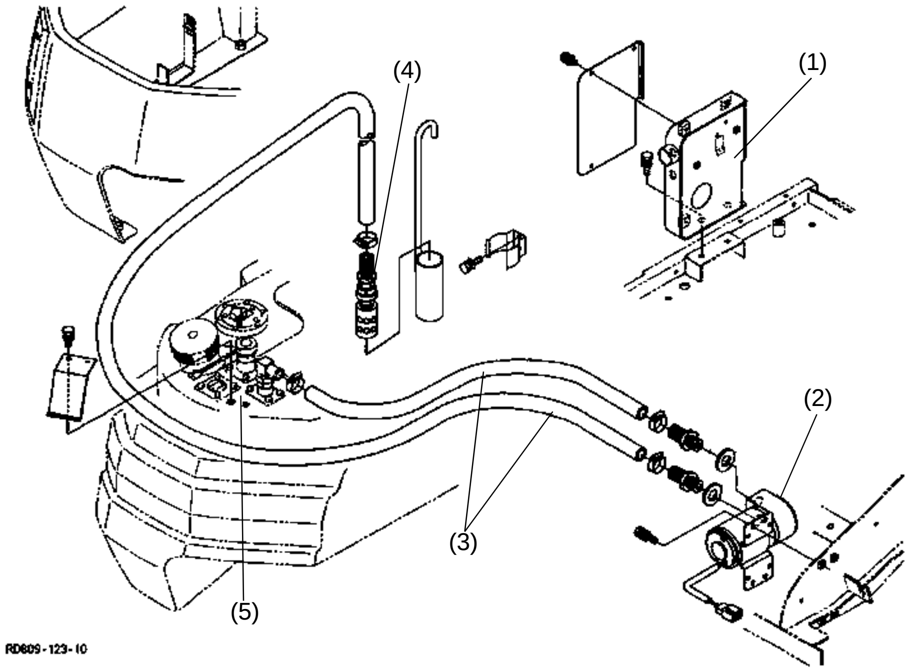
5. Pilot secondary pressure vs Main spool opening



6. Main spool opening vs service port flow input



c. Fuel supply pump



1. Main parts

(1) Control box
(2) Fuel supply pump
(3) Hoses
(4) Suction inlet and filter
(5) Fuel tank

2. How to use

E

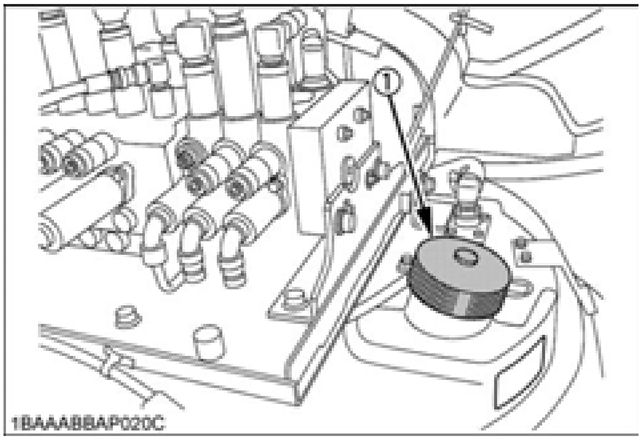
To avoid serious injury or death:

- Do not use the fuel supply pump for gasoline or hydraulic oil. Doing so could result in explosion or damage. Only use the fuel supply pump for diesel fuel.

I

To avoid personal injury:

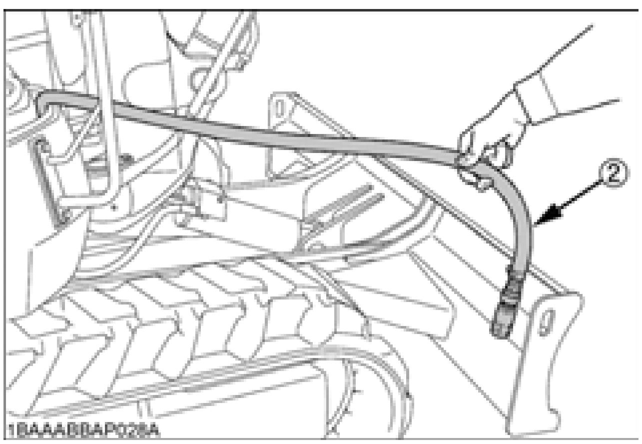
- When the fuel supply pump is used, be sure to open the fuel tank cap.



(1) Fuel tank cap

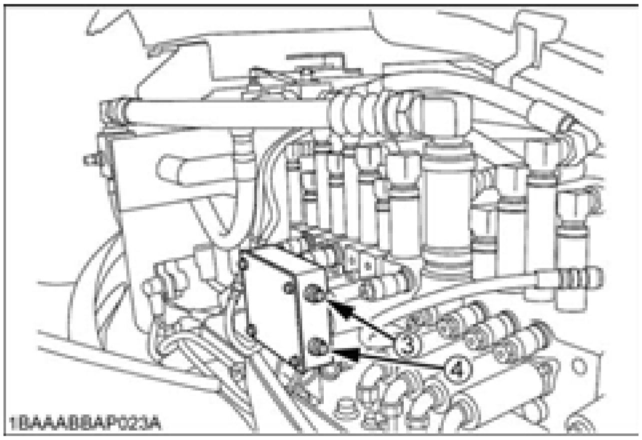
This device automatically supplies fuel to the fuel tank and stops automatically when the fuel tank is full.

1. Open the tank cover.
2. Open the fuel tank cap (1).



(2) Pump’s nozzle

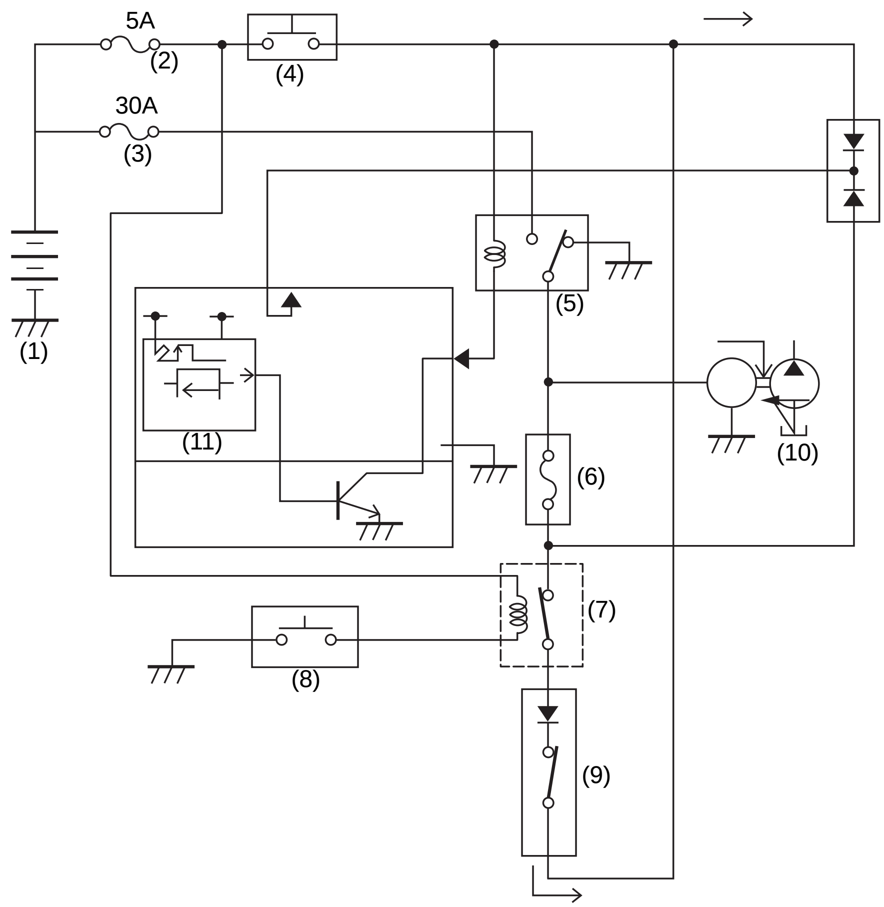
3. Insert the pump s nozzle (2) in the fuel supply tank.



(3) Switch (black button)
(4) Switch (red button)

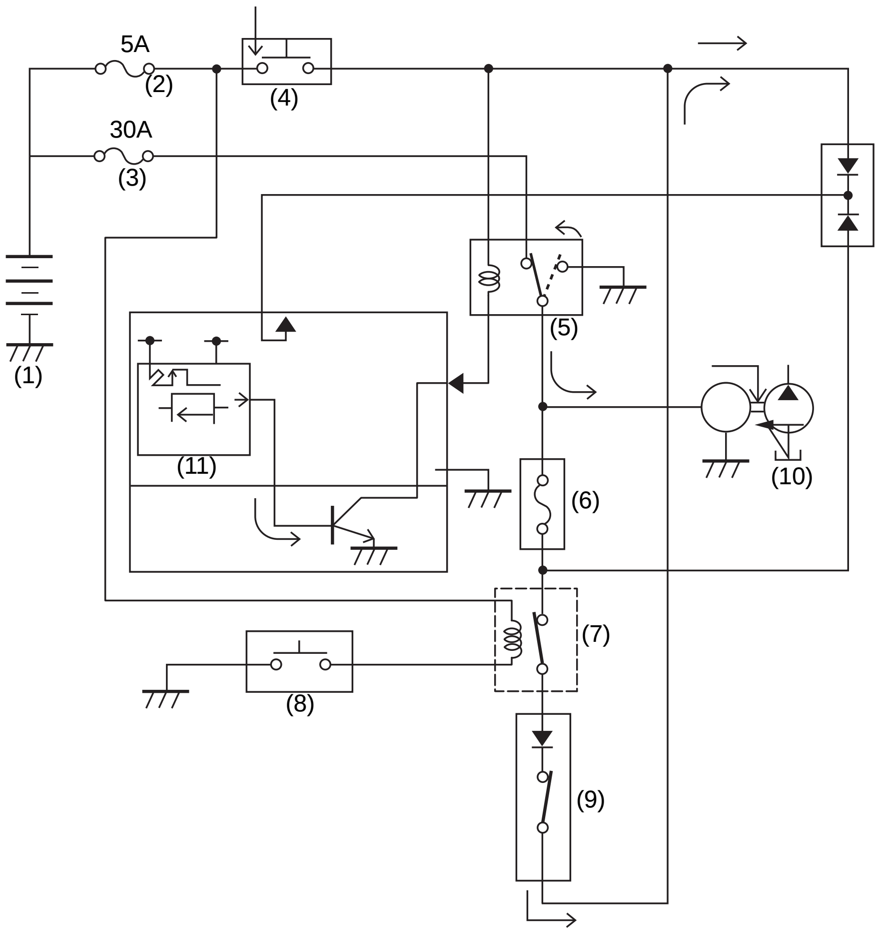
4. Push the switch (black button (3)). The pump stops automatically once the fuel tank is full. To stop the pump on the way, the switch (red button (4)) is pushed.

3. Electrical system function



3-1 Circuit diagram

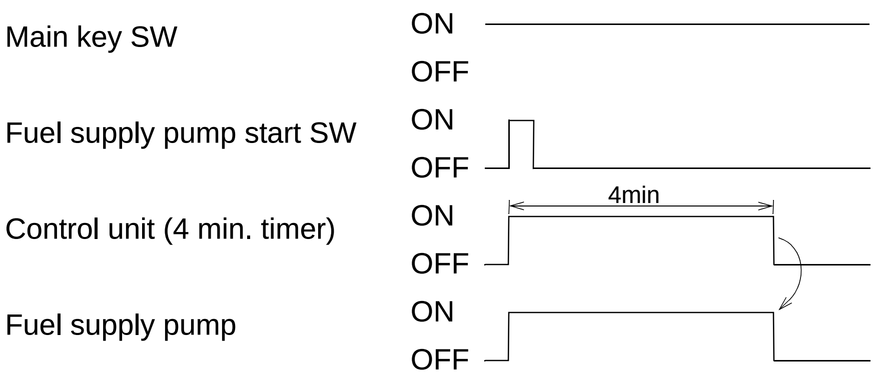
(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10) Fuel supply pump
(11) 4 min. timer relay

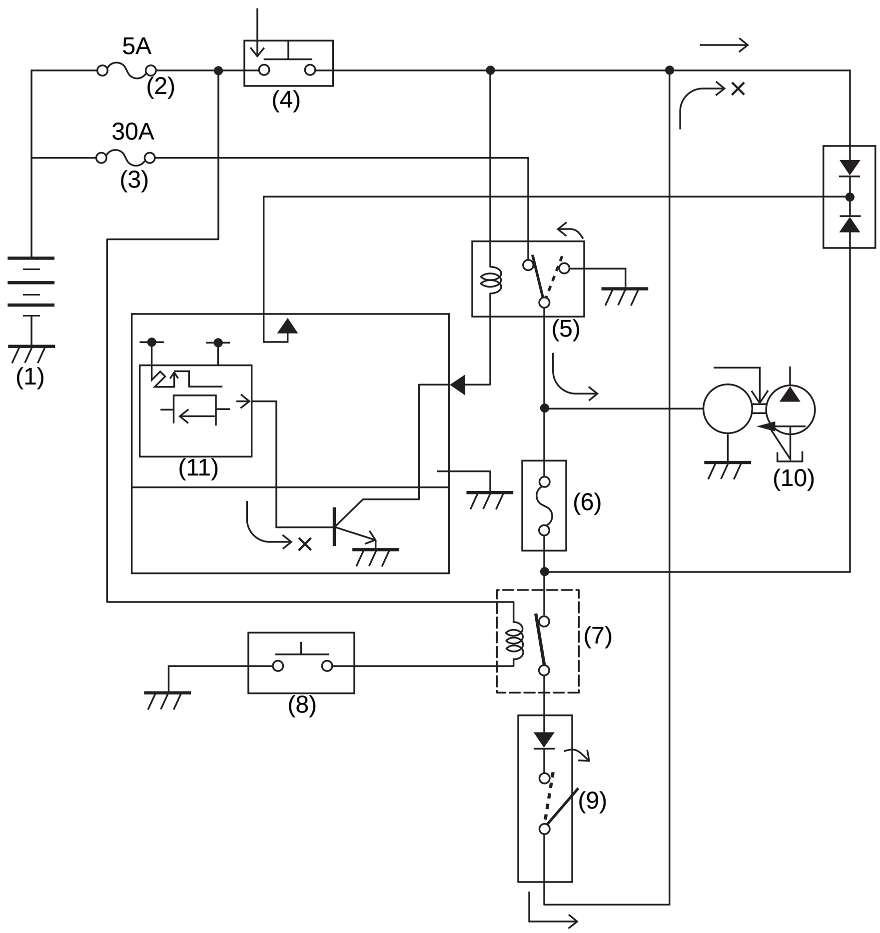


3-2 When the start switch is pushed:

(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10)Fuel supply pump

Function chart



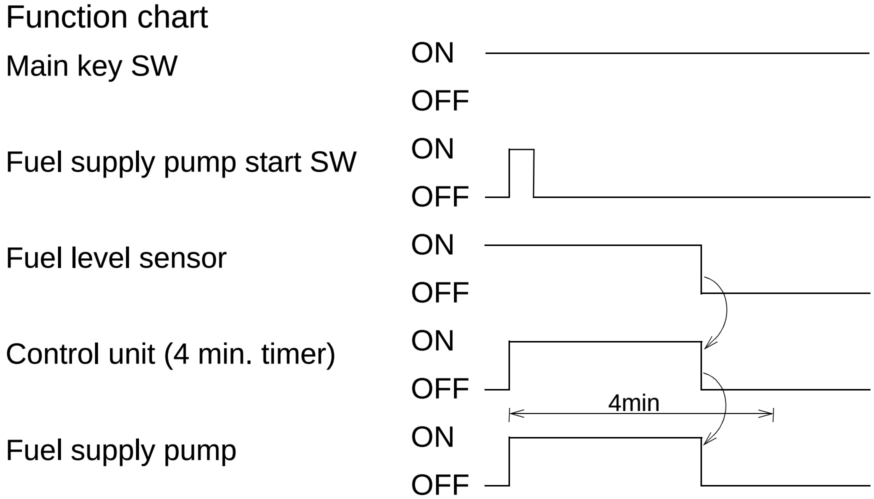


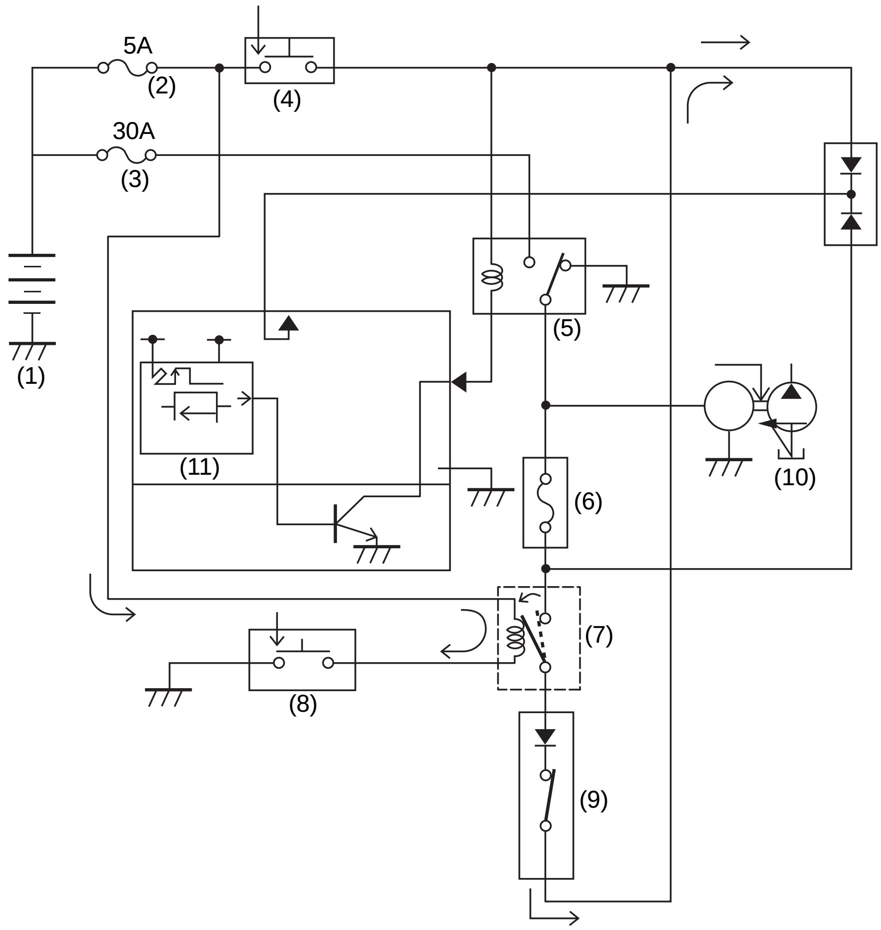
3-3 When fuel level sensor detects the full amount of fuel;

Without the battery voltage, 4 min. timer turns off condition.

(1) Battery, 12 V
(2) Mini-fuse, 5 A
(3) SBF (slow blow fuse), 30 A
(4) Start switch
(5) Relay 1
(6) Mini-fuse, 5 A
(7) Relay 2
(8) Stop switch
(9) Fuel level sensor
(10) Fuel supply pump

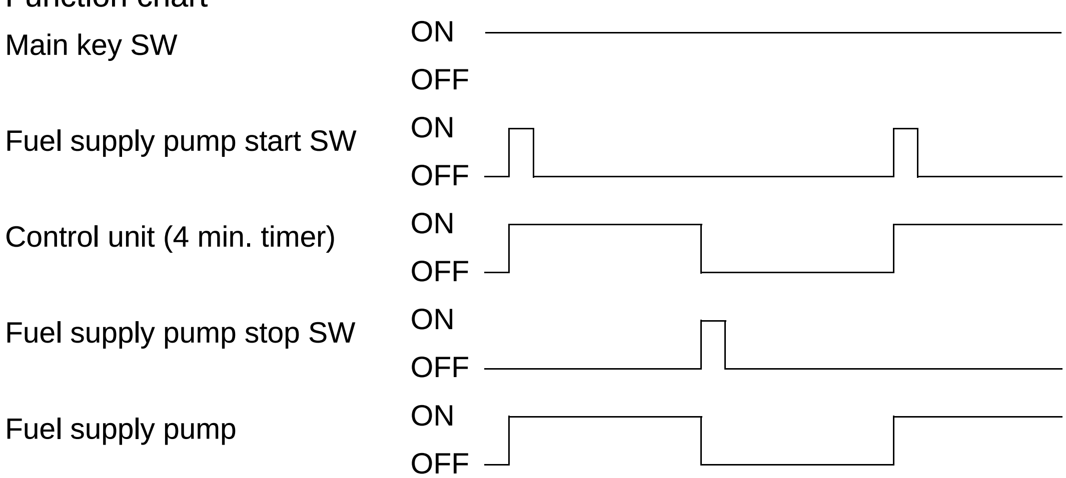
Function chart

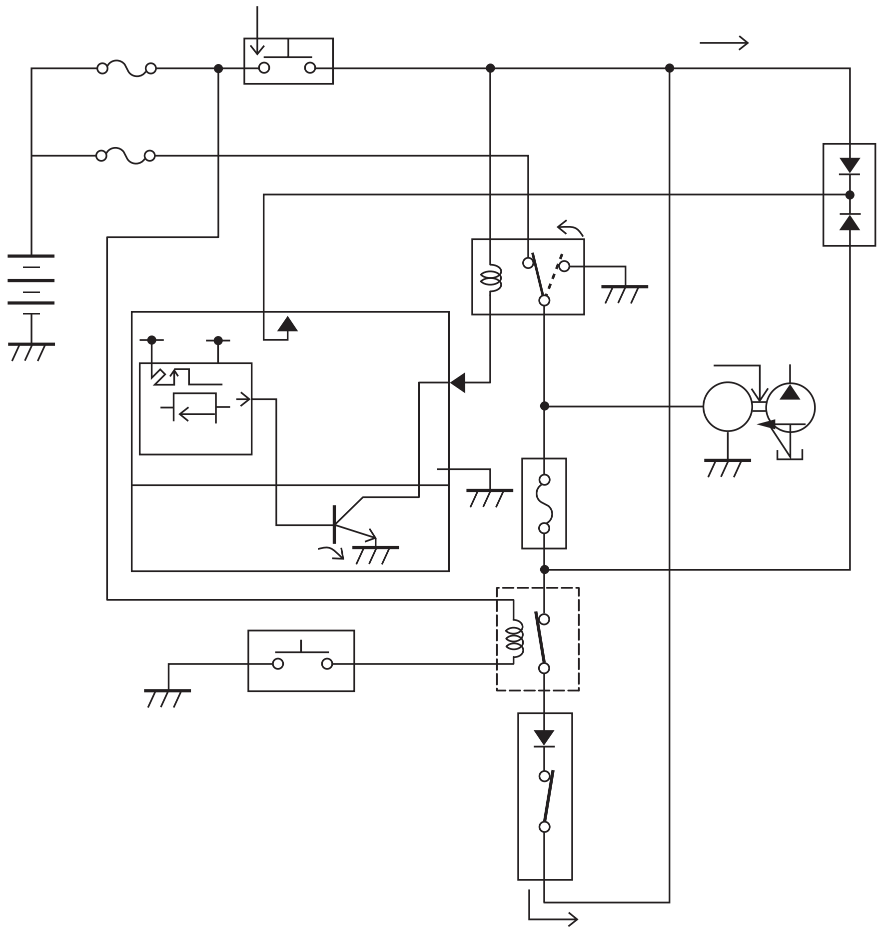




3-4 When pushing the stop switch during supplying the fuel;

Function chart

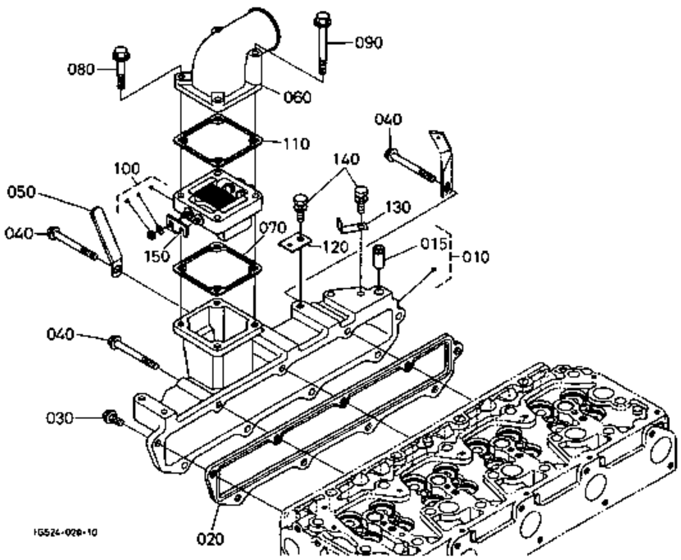




3-5 When pushing the start switch after the full fuel level;

d. Intake air heater control

1. Location of main components



2. Outline of control system

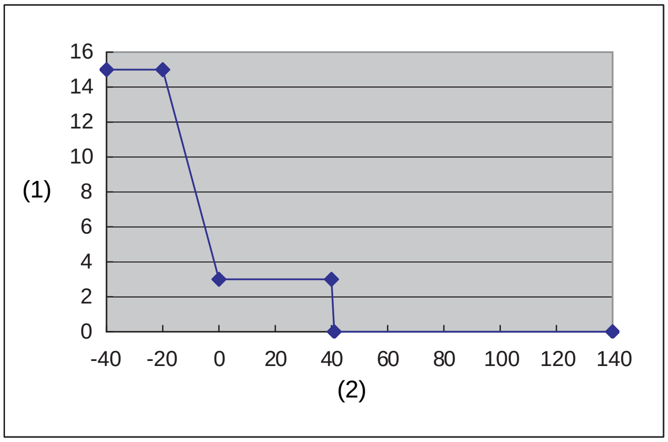
2-1. Control points

Pre-heating is automatically made according to the engine s water temperature at a cold starting. Once the engine has got started, the post-heating is also controlled to prevent bluish-white smoke.

2-2. Control system

Auto glow : Water temp. vs Glow time

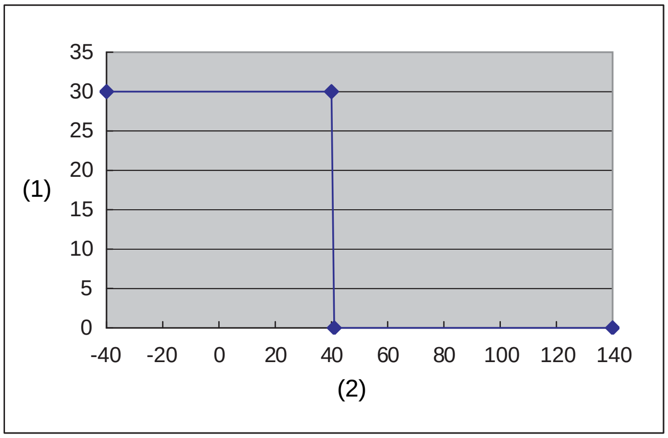
Water temp °C	Glow time s
-40	15
-20	15
0	3
40	3
41	0
140	0



(1) Water temp °C
(2) Glow time s

After glow : Water temp. vs Glow time

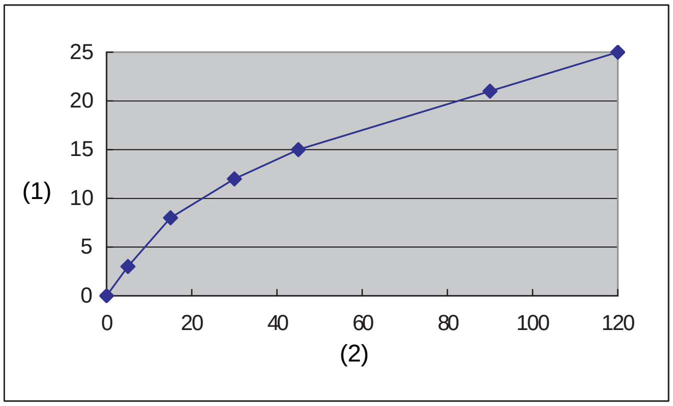
Water temp °C	Glow time s
-40	30
40	30
41	0
140	0



(1) Water temp °C
(2) Glow time s

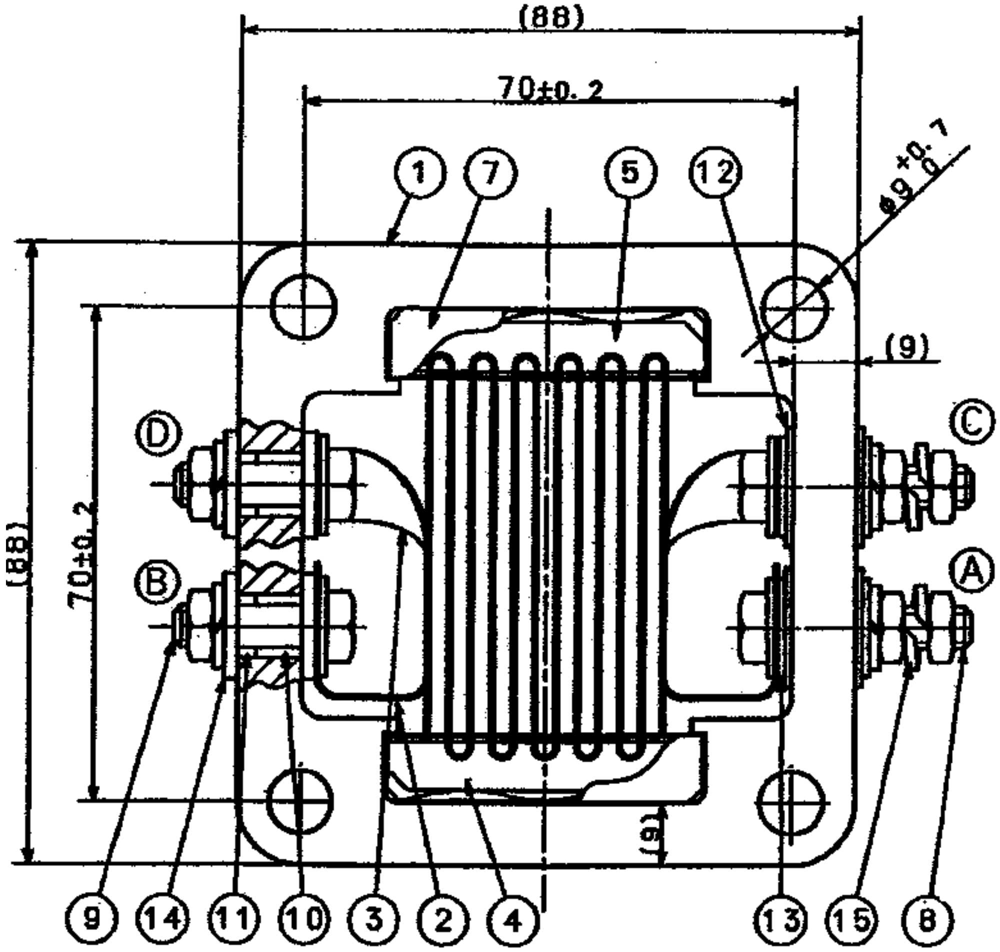
Key - off : time vs Glow time

Key - off time s	Max. Glow time s
0	0
5	3
15	8
30	12
45	15
90	21
120	25

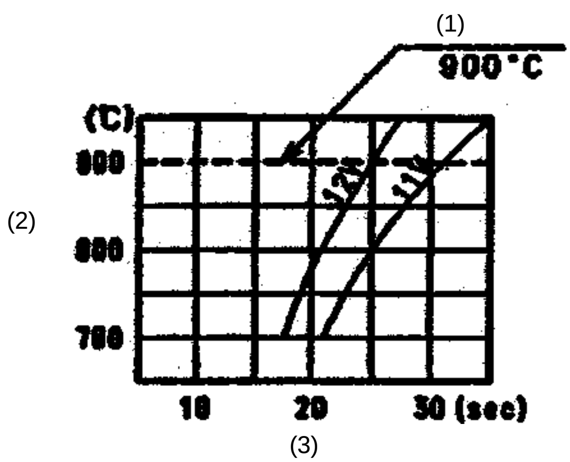


(1) Max. Glow time s
(2) Key - off time s

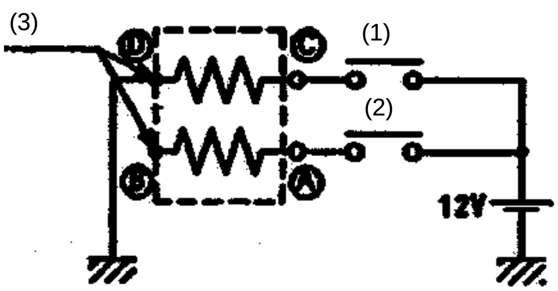
2-3. Air intake heater



(1) Heater body
(2) Heater element
(3) Heater element
(4) Heater element
(5) Insulater



(1) Max. limit temperature
(2) Heater temperature
(3) Time

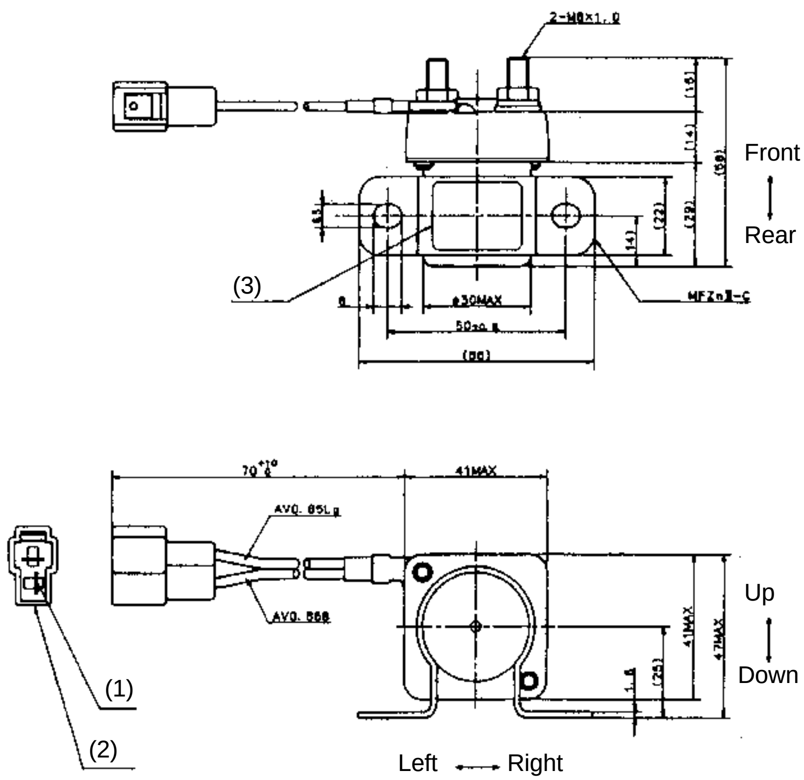


(1) Relay 1
(2) Relay 2
(3) Body earth

2-4. Air intake heater relay (Code : No. N300-75211)

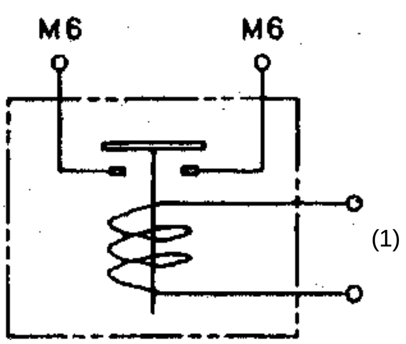
1) Outer view

2) Drawing



(1) Terminal
(2) Housing
(3) Label : Gray

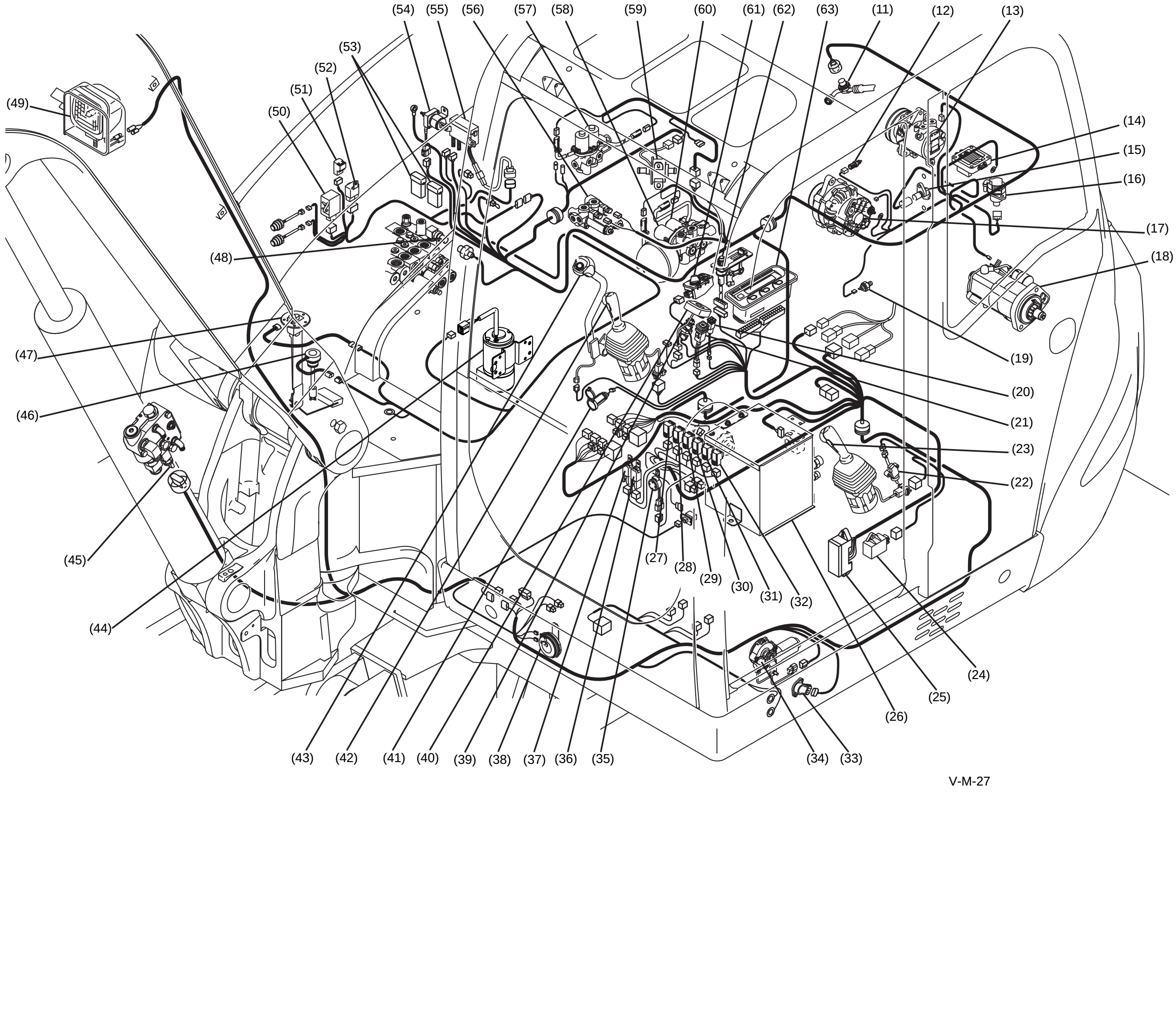
3) Diagram

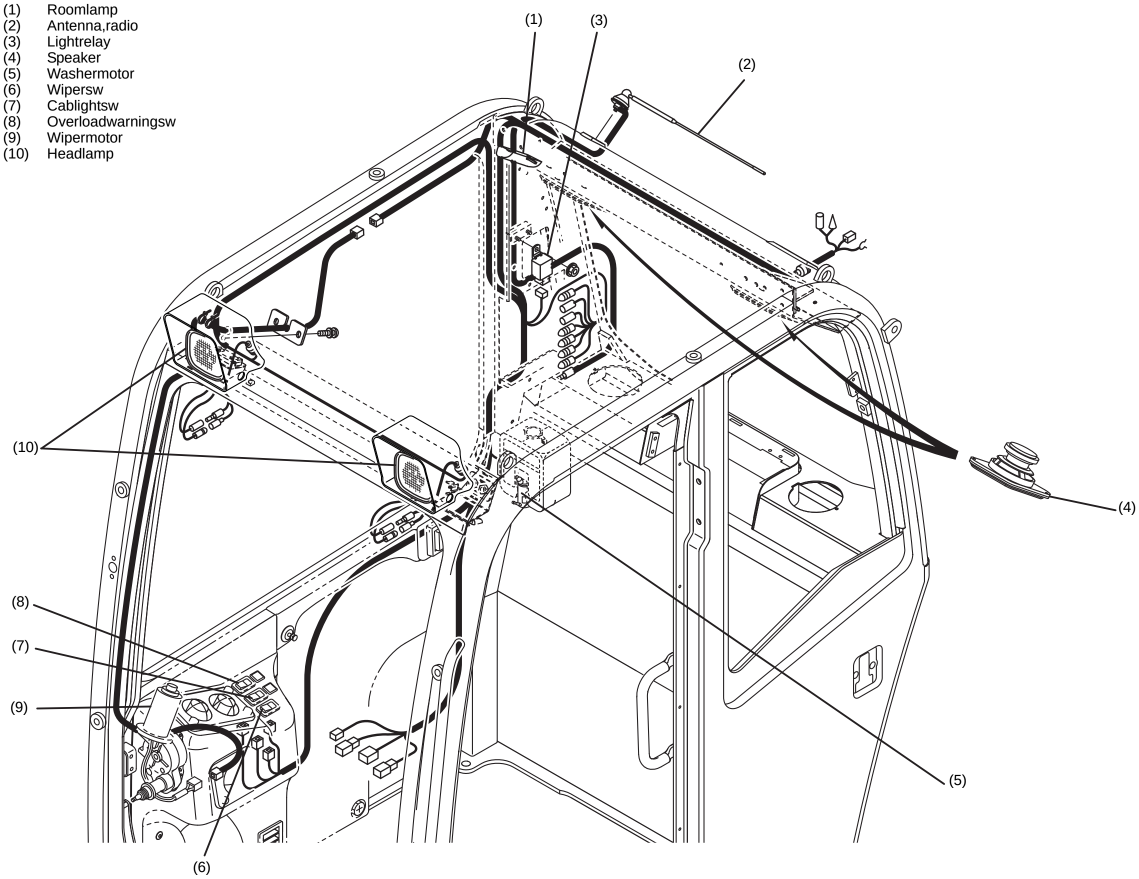


(1) Connecter

B.Electrical components and circuit diagram

a. Components layout

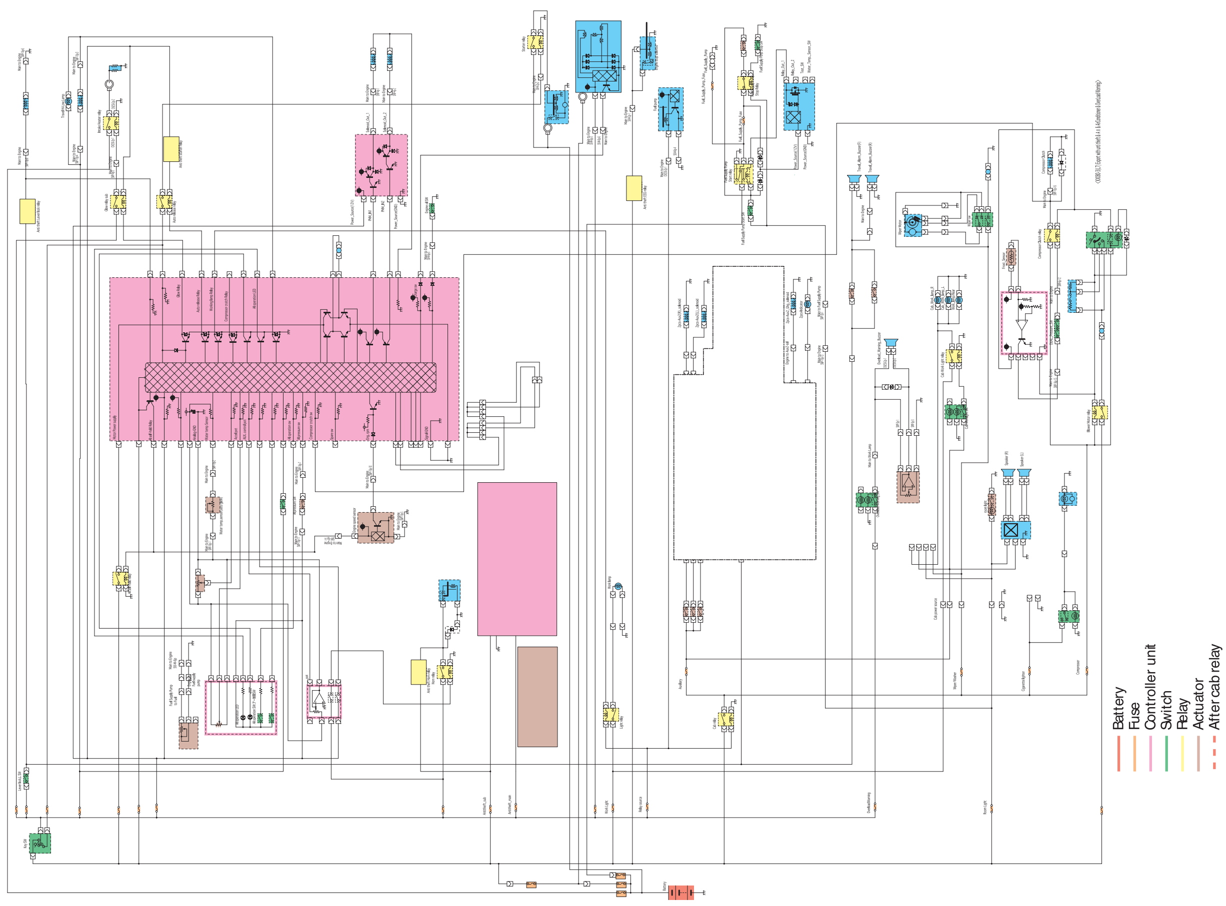




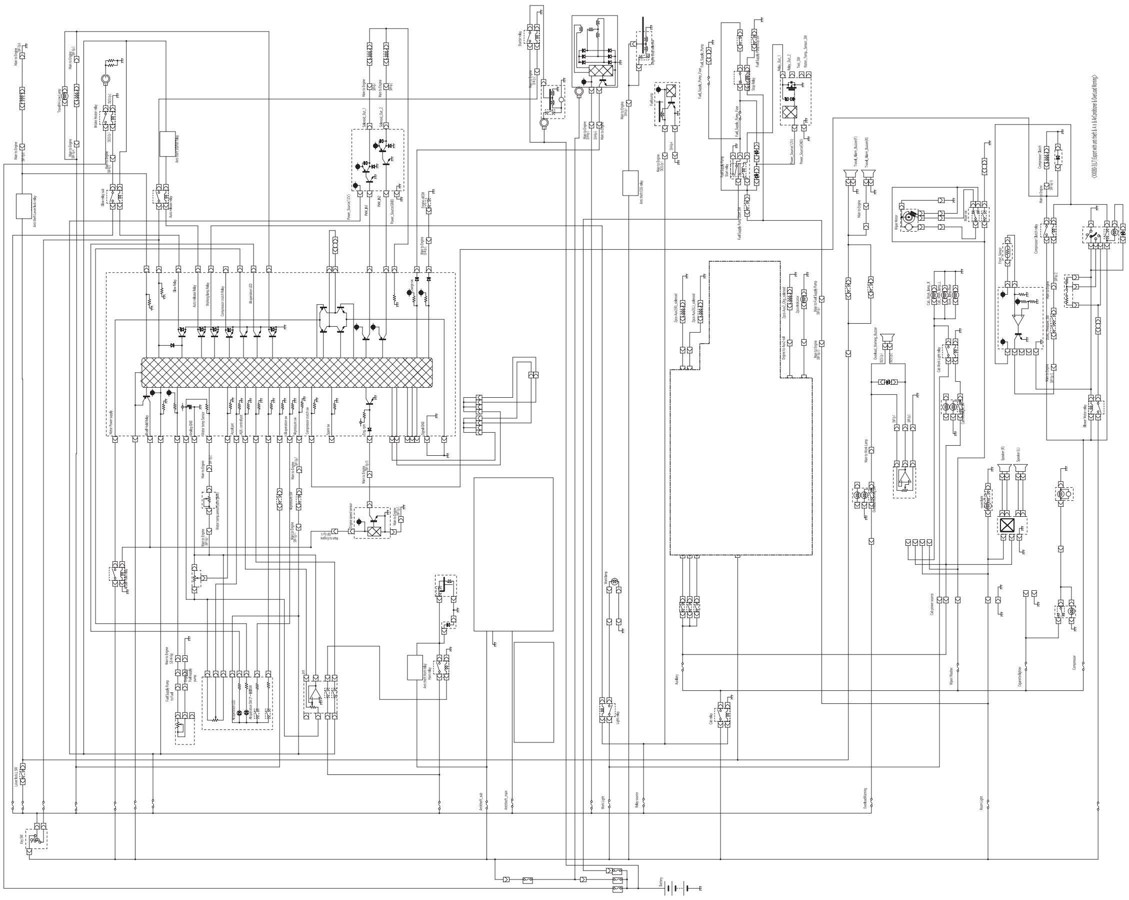
(1) Roomlamp
(2) Antenna,radio
(3) Lightrelay
(4) Speaker
(5) Washermotor
(6) Wipersw
(7) Cablightsw
(8) Overloadwarningsw
(9) Wipermotor
(10) Headlamp

(11) Dualpressuresw
(12) Watertemp.sensor
(13) Compressor,A/C
(14) Intakeairheater
(15) Enginespeedsensor
(16) Enginestopsolenoid
(17) Alternator
(18) Startermotor
(19) Engineoilsw
(20) TravelHi-Lamp
(21) Beaconlightsw
(22) Leverlocksw
(23) S/P2sw
(24) Amp.unit
(25) Fusebox
(26) A/Cunit
(27) Glowrelay
(28) Cabreley
(29) Aotoreleaserelay
(30) Hornrelay
(31) Lightrelay
(32) AIrelay
(33) Governersensor
(34) AImotor
(35) Buzzer
(36) Blowerrelay
(37) Clutchrelay
(38) Horn
(39) Mainkey
(40) Antenna(A/T)
(41) Poweroutlet
(42) S/P1controlsw
(43) TravelHi-lowsw
(44) Fuelsupplypump
(45) Overloadpressuresw
(46) Fuelresidualleadsw
(47) Fuelsensor
(48) AIpressuresw
(49) Workinglamp
(50) ECU(4min.timer)
(51) Fuelpumpstarterrelay
(52) Fuelpumpstoprelay
(53) SBF(slowblowfuse)
(54) Intakeheaterrelay
(55) Fusebox
(56) S/P1solenoid
(57) S/P2solenoid
(58) Unloadsolenoid
(59) Fuelpump
(60) Hi-Lowsolenoid
(61) Accelsensor(AIswitch)
(62) A/Cswitch
(63) Meterpanel

b. Main components diagram

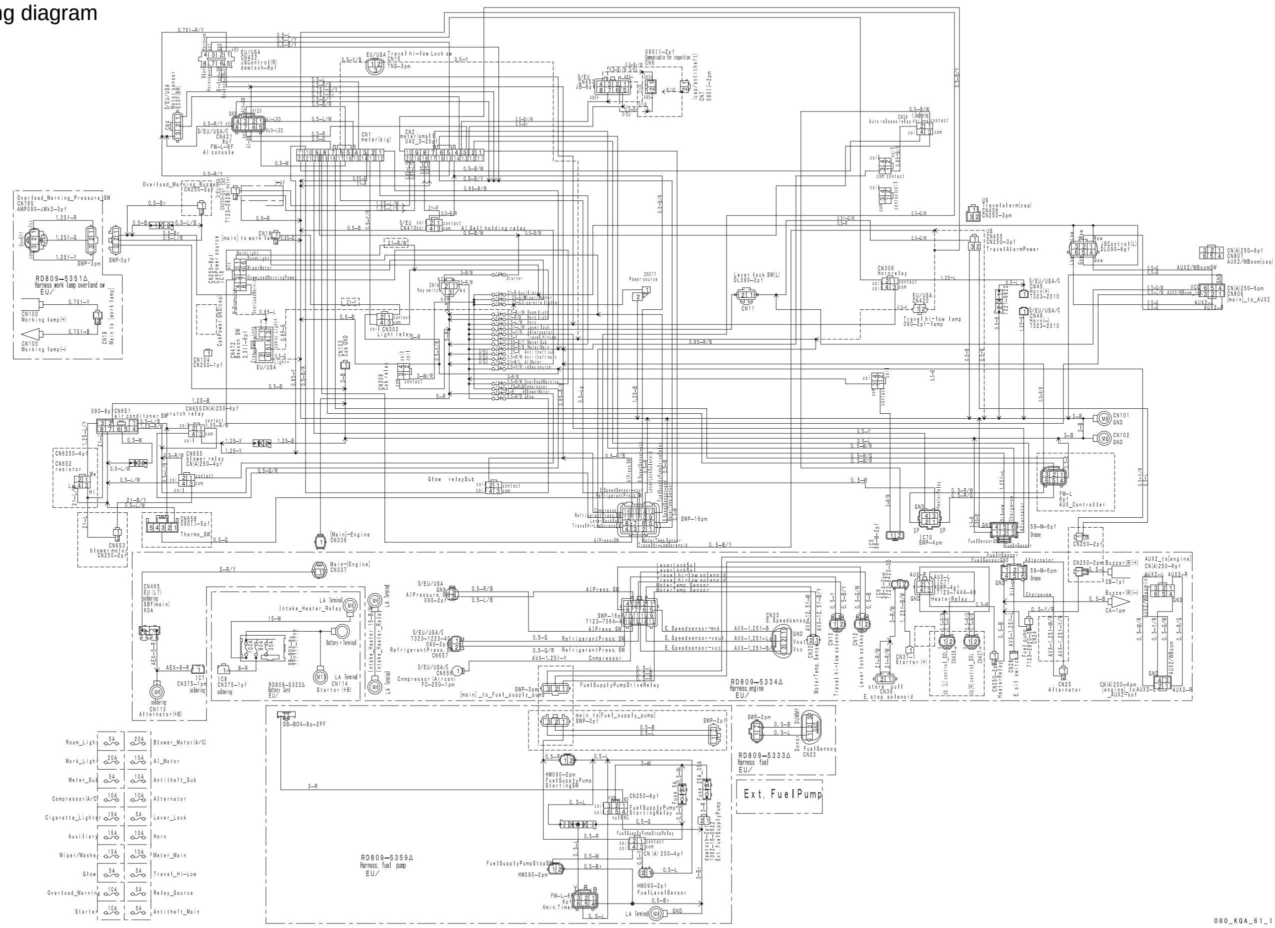


c. Electrical circuit diagram



d. Service mode flow chart

e. Electrical wiring diagram



V. Electrical system

Service Section

A. Troubleshooting

a. General guideline

(1) How to diagnose

The most important point in troubleshooting is to determine "Probable Causes". Once the probable causes are determined, parts to be checked can be limited to those associated with such probable causes. Therefore, unnecessary checks can be eliminated. The determination of the probable causes must be based on a theory and be supported by facts and must not be based on intuition only.

TROUBLESHOOTING STEPS

If an attempt is made to solve a problem without going through correct steps for troubleshooting, the problem symptoms could become more complicated, resulting in failure to determine the causes correctly and making incorrect repairs.The four steps below should be followed in troubleshooting.

1	Observation of Problem Symptoms	Observe the symptom carefully. Check if there are also other problems.
2	Determination of Probable Causes	In determining the probable causes, it is necessary to check the wiring diagram to understand the circuit as a system. Knowledge of switches, relays and other parts is necessary for accurate determination. The causes of similar problems in the past must be taken into account.
3	Checking of Parts Associated with Probable Causes and Determination of Faulty Parts.	Troubleshooting is carried out by making step by step checks until the true cause is found. Always go through the procedures considering what check is to be made where for the best results.
4	Repair and Confirmation	After the problems are corrected, be sure to check that the system operates correctly. Also check that new problems have not been caused by the repair.

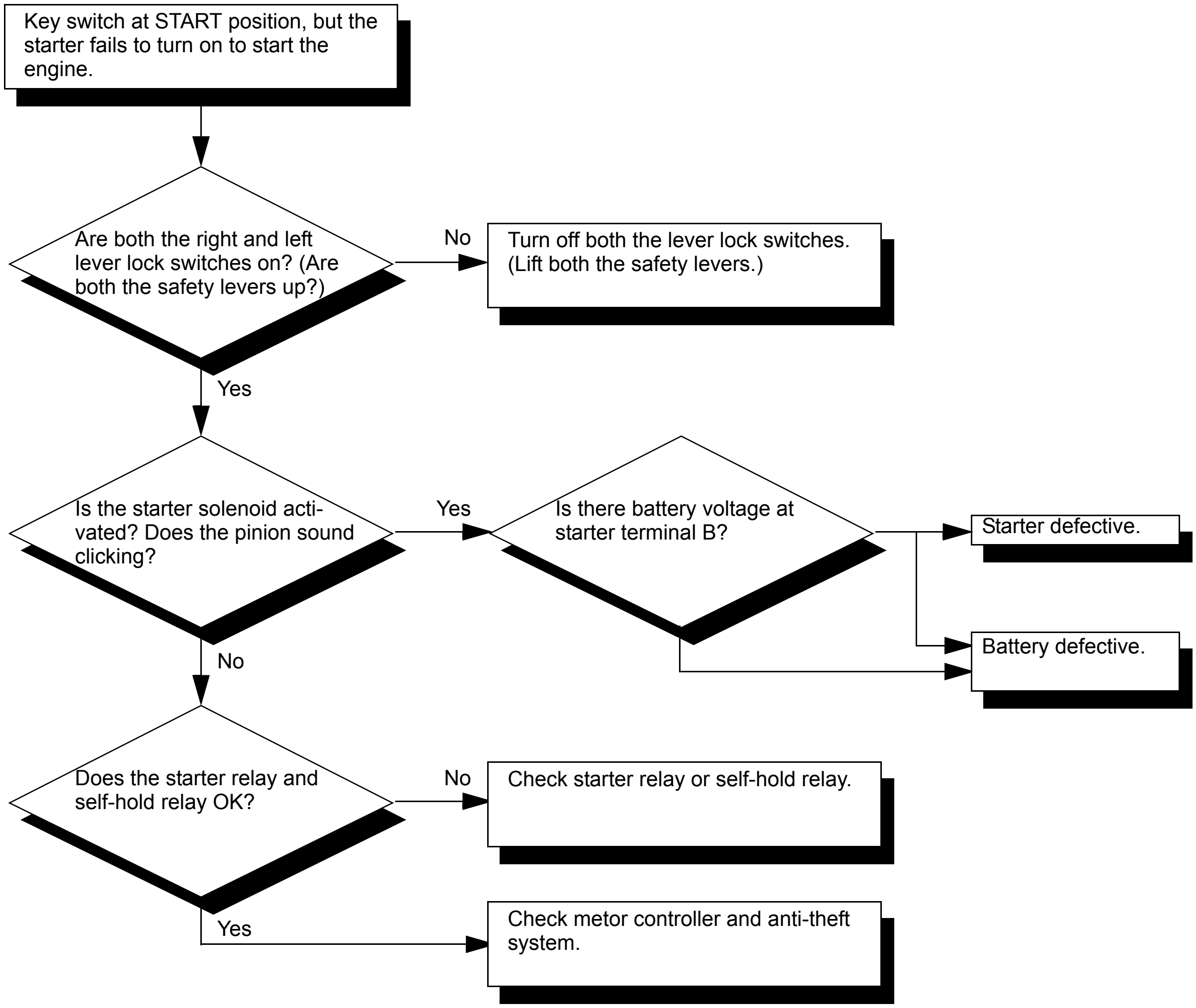
FOUR BASIC CHECKING ITEMS FOR ELECTRICAL DIAGNOSIS

This manual contains the cable diagrams as well as the individual circuit drawings, operational explanations, and troubleshooting hints for each component required to facilitate the task of troubleshooting. The information is compiled in the following manner:

1. “Power source”
   Is the supply voltage as specified? (Battery voltage at 12 V or microcomputer output at 5 V)
   → If not specified, the system fails to work.
2. “Continuity”
   Is there continuity along the specified lines and wire harnesses? Are the system’s resistance values as specified?
   → If not specified, no current flows.
3. “Earth”
   Is the system completely grounded?
   → If not grounded as specified, the electrical circuitry fails to function well.
4. “Insulation”
   Are the system’s insulation resistances as specified?
   → If an electric leak occurs, the current gets out of spec and the electrical devices malfunction.

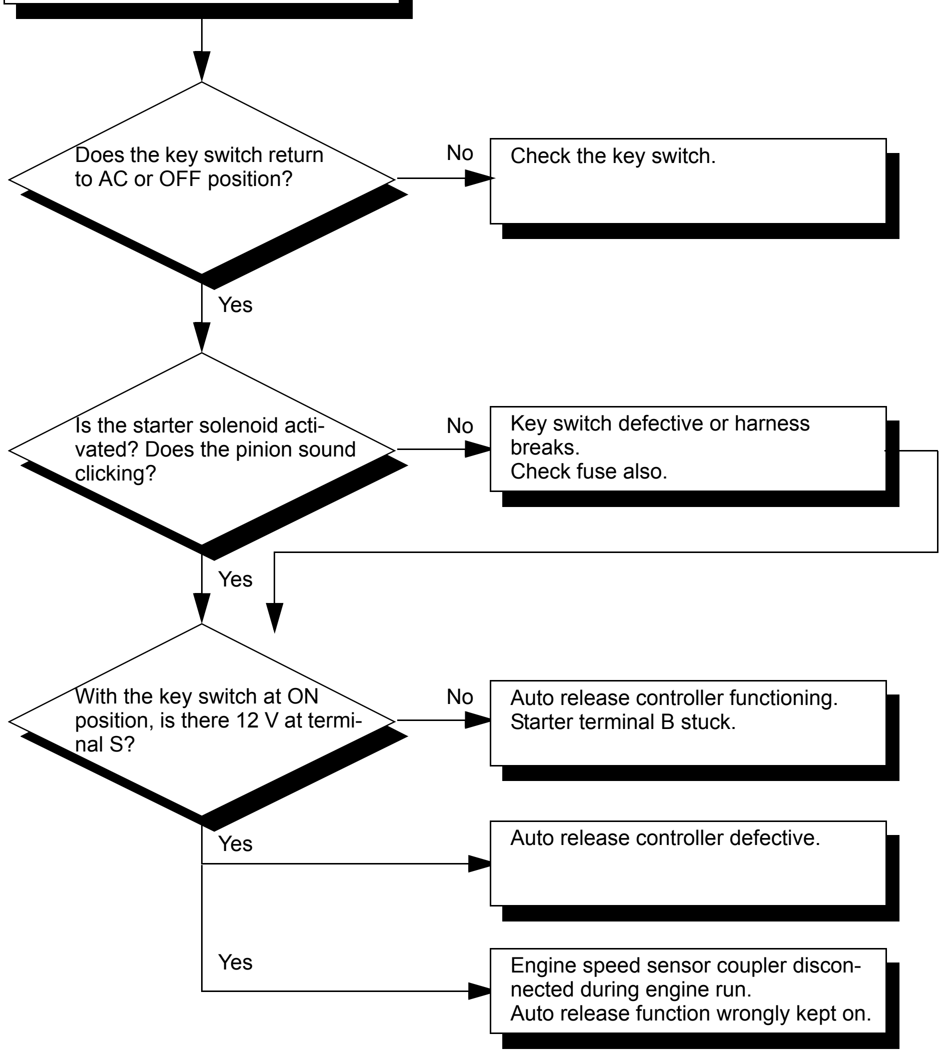
b. Troubleshooting flow chart

(1) Starter motor failure to turn on



(2) Auto release malfunction

1. Turning sensor out of contact or broken.
2. Relay.



(3) AI system failure

Auto idling malfunction.

- Control lever at NEUTRAL position, but the engine fails to reach the idling speed.
  - (1) AI switch is on?
  - (2) AI pressure sensor coupler disconnected?
  - (3) AI pressure switch circuit broken?
  - (4) Hydraulic valve pressure sensor line clogged (pressure sensor off)?
  - (5) Microcomputer power line fuse blown out?
  - (6) Accelerator sensor broken?
  - (7) Governor sensor broken?
  - (8) AI motor coupler disconnected?
  - (9) AI motor stuck?

  Take measures according to indicator lamp.

- Control lever activated, but the engine rpm does not rise.
  - (1) Pressure sensor switch kept on.
  - (2) Insufficient pressure in the hydraulic valve pressure sensor line.

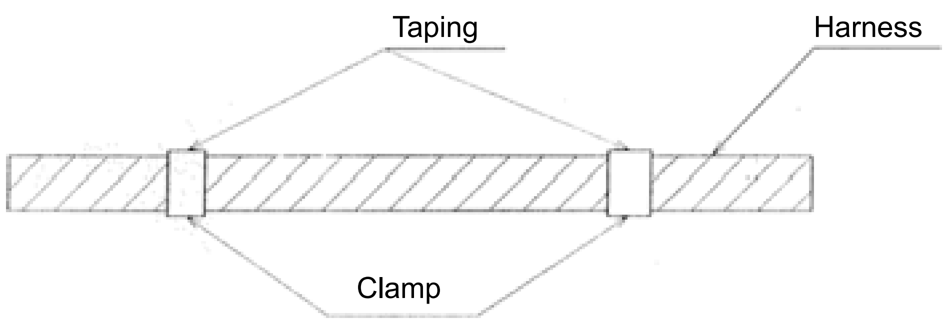
B. Wire harness installation

a. Precautions

S **(1) No contact with the peripheral parts along the route**
Unprotected members not to be in contact

S **(2) Checking the routes**
1. Fuel hose not to be clamped together
2. Couplers, terminals, etc. to be connected tight enough to withstand usual pulling force
3. Clamps to be surely folded

S **(3) Clamping the harness at the specified points**
1. White-colored tapings to be clamped
2. Clamps to be surely folded
3. Harness-fixed clamps
* Anchor-shaped clamps to be inserted deep to the stoppers
* Threaded clamps to be inserted deep enough



1) The harness tapings indicate the clamping positions. Clamp at these specified points.
2) Clamp the harness tight enough not to come off nor get loose.
3) Insert the handgrip-equipped harness deep into their mating holes.
* Do not allow the harness to come out of the corrugated slit.
* Catch the cord clamp at the corrugated winding.

b. Engine earth, starter switch

S **(1) Tightening torque of the cable fixing nut to the sel-motor terminal**

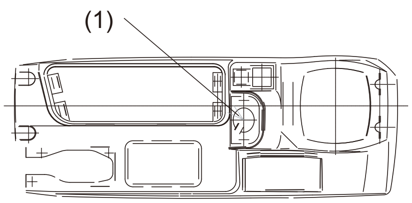
Tightening torque 5.9 ~ 11.8 N·m (0.6 ~ 1.2 kgf·m) 4.34~8.68ft.lbs

S **(2) Installation of starter switch (RC411-5346△)**

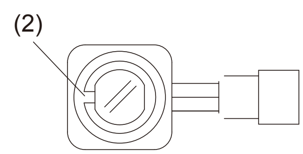
1. Starter switch groove to be fitted to the projection of the cover (top right)
2. Nut tightening torque 4.0 ~ 5.0 N·m (0.4 ~ 0.51 kgf·m) 2.89~3.69ft.lbs

S **(3) Checking the automatic starter release function**

Start the engine, place the key switch back to the start position and make sure the starter is not activated.



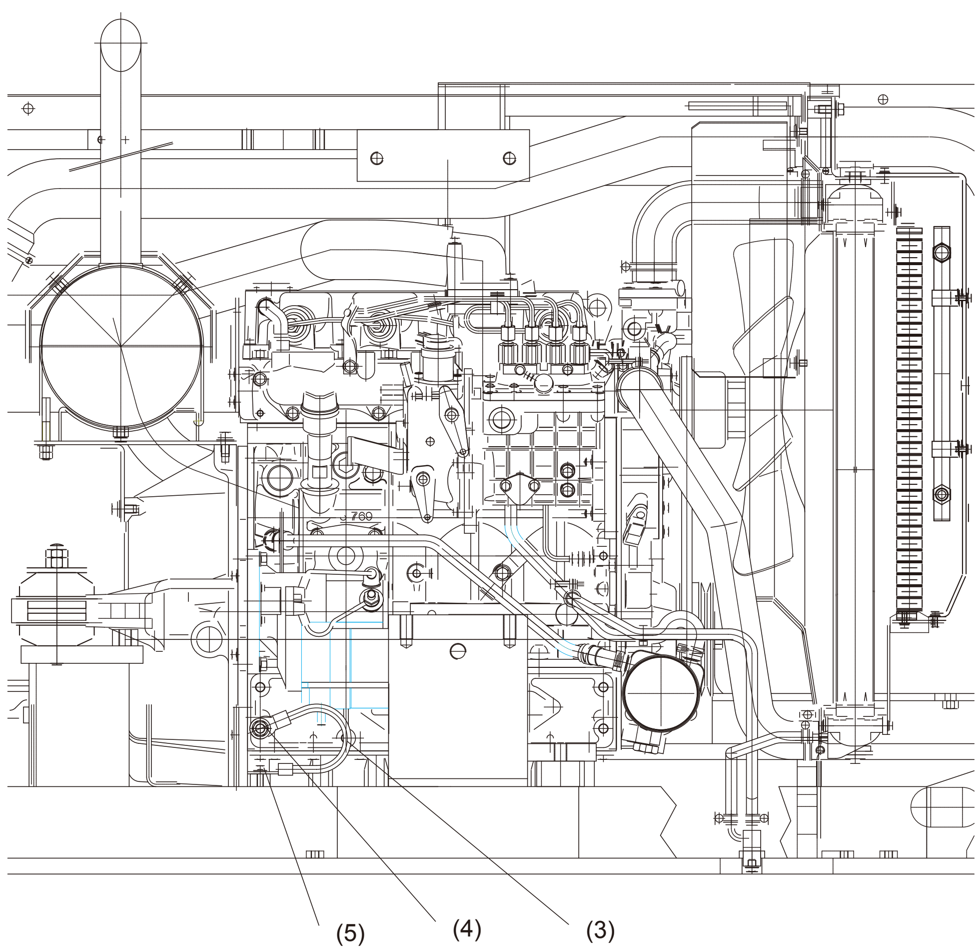
(A)

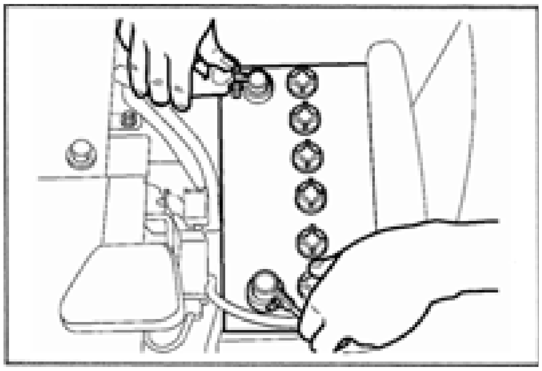


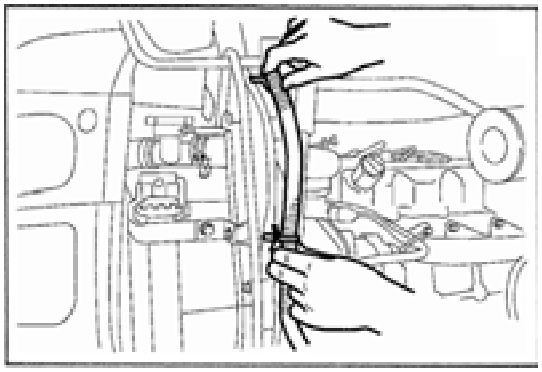
(B)

(A)Cover (right, top)
(B)Starter switch

(1)Projection (behind)
(2)Groove
(3)Cord (body ground)
(4)Bolt
(5)Bolt

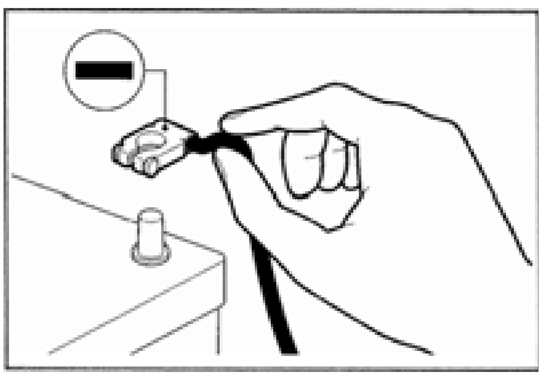






c. Checking cables, wires and battery

1) Check connections for looseness, rust and stains.
2) Check terminals and wires for corrosion by battery electrolyte, etc.
3) Check terminals and wires for open circuit or impending open circuit.
4) Check wire insulation and coating for damage, cracks and degrading.
5) Check conductive parts of terminals for contact with other metallic parts (vehicle body and other parts).
6) Check grounding parts to verify that there is complete continuity between attaching bolt(s) and vehicle body.
7) Check for incorrect wiring.
8) Check that wirings are so clamped as to prevent contact with sharp corners of the vehicle body, etc. or hot parts (exhaust manifold, pipe, etc.).
9) Check that wirings are clamped firmly to secure enough clearance from the fan pulley, fan belt and other rotating or moving parts.
10) Check that the wirings between the fixed parts such as the vehicle body and the vibrating parts such as the engine are made with adequate allowance for vibrations.



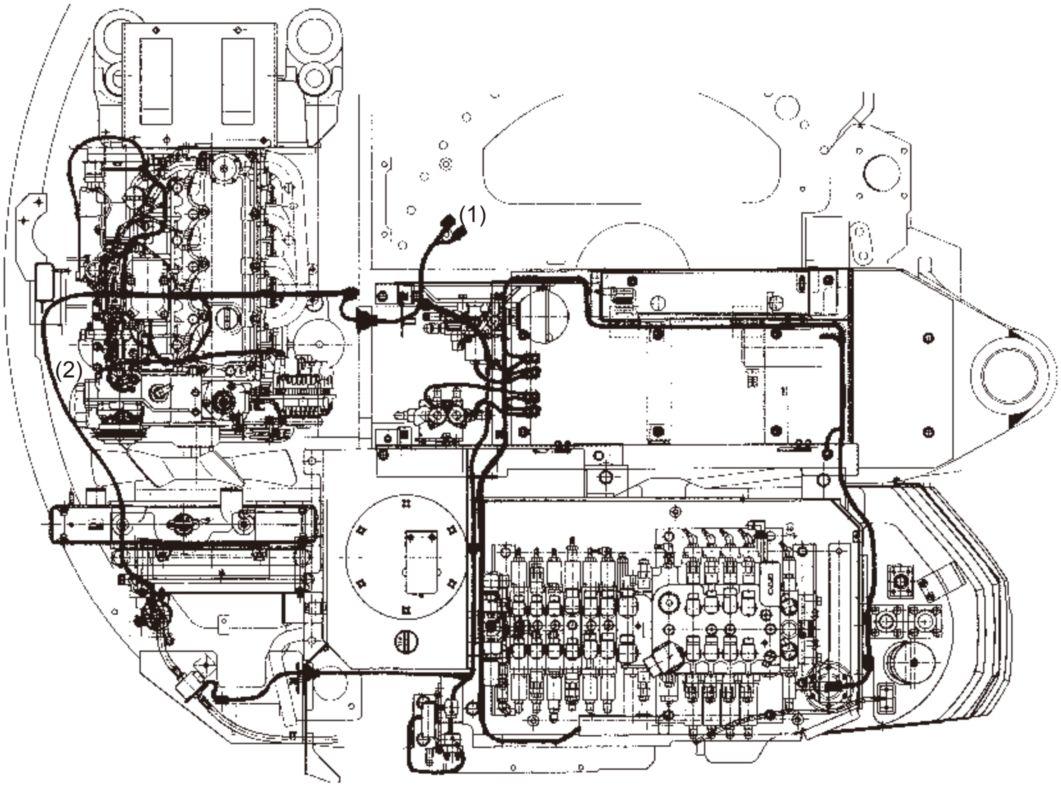
(1) HANDLING ON-VEHICLE BATTERY

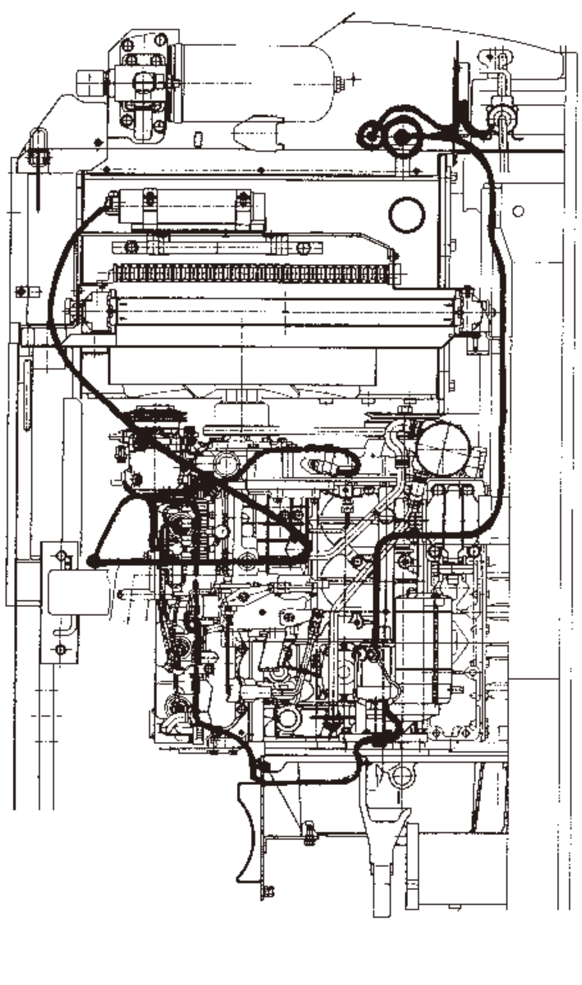
When checking or servicing does not require power from the on vehicle battery, be sure to disconnect the cable from the battery (-) terminal. This is to prevent problems that could be caused by shorting of the circuit. Disconnect the (-) terminal first and reconnect it last.

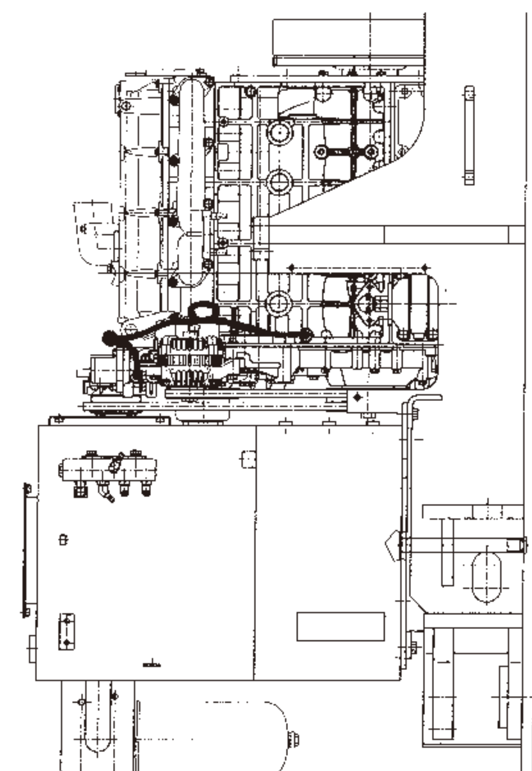
Caution

1. **Before connecting or disconnecting the negative cable, be sure to turn off the ignition switch and the lighting switch.**
   (If this is not done, there is the possibility of semiconductor parts being damaged.)

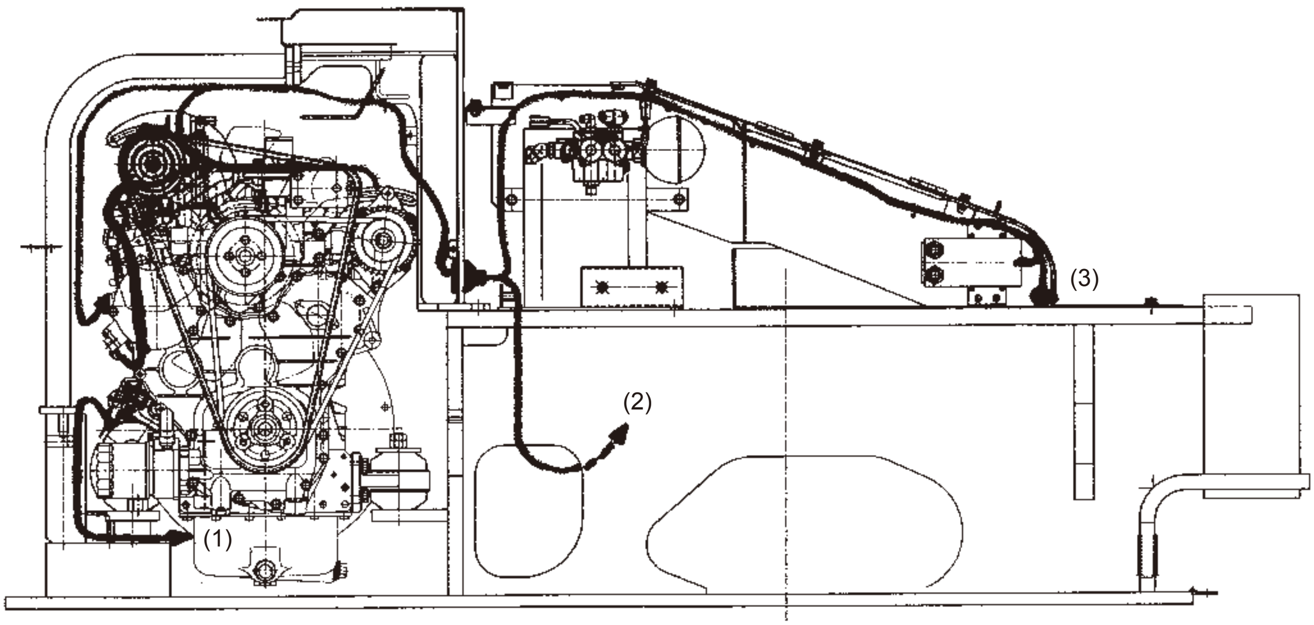
d.Wireharness route

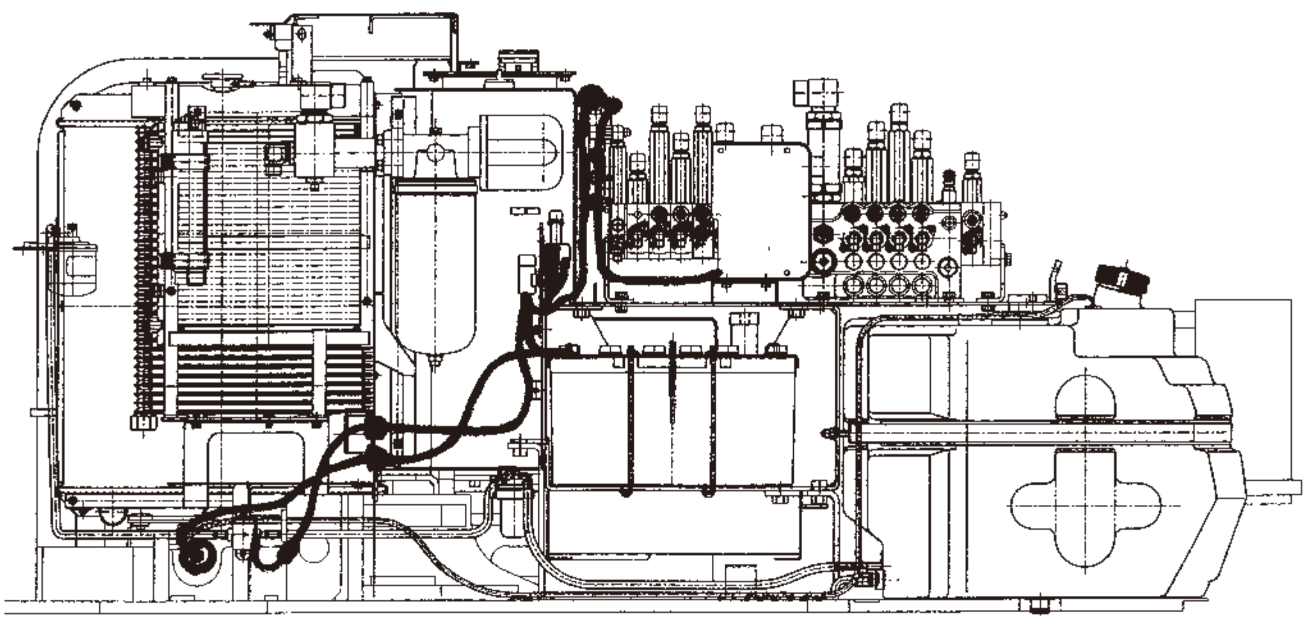




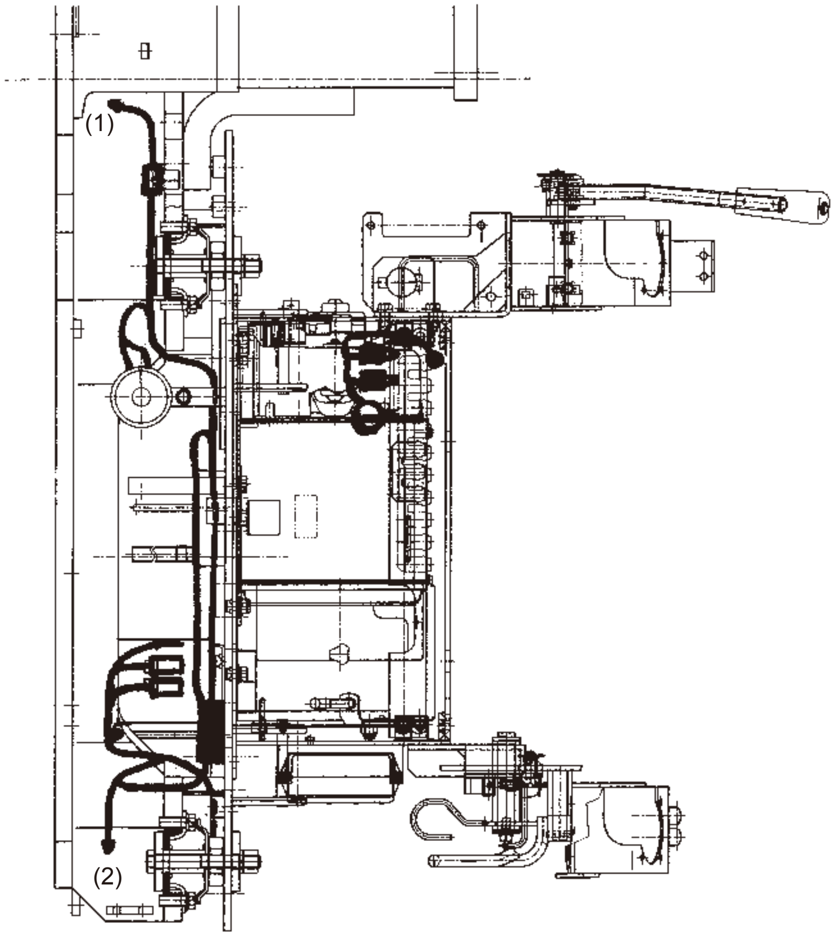


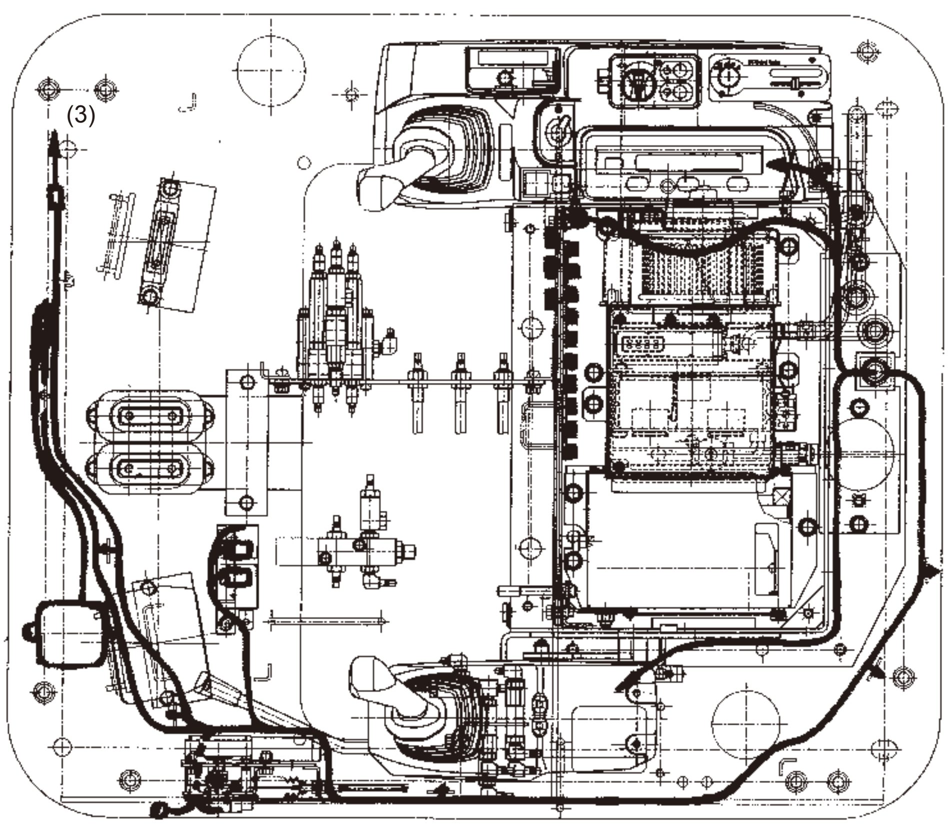
(1)To main wire harness
(2)Run sensor



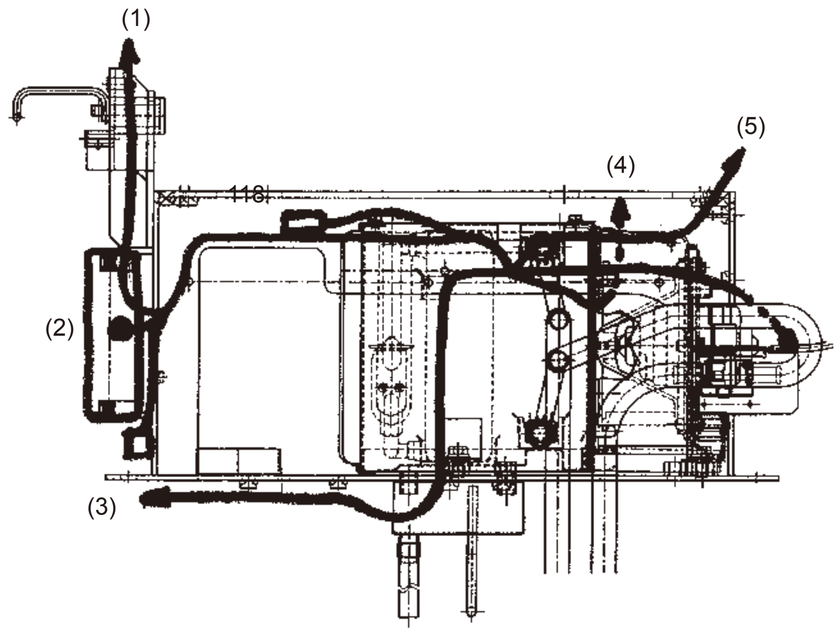


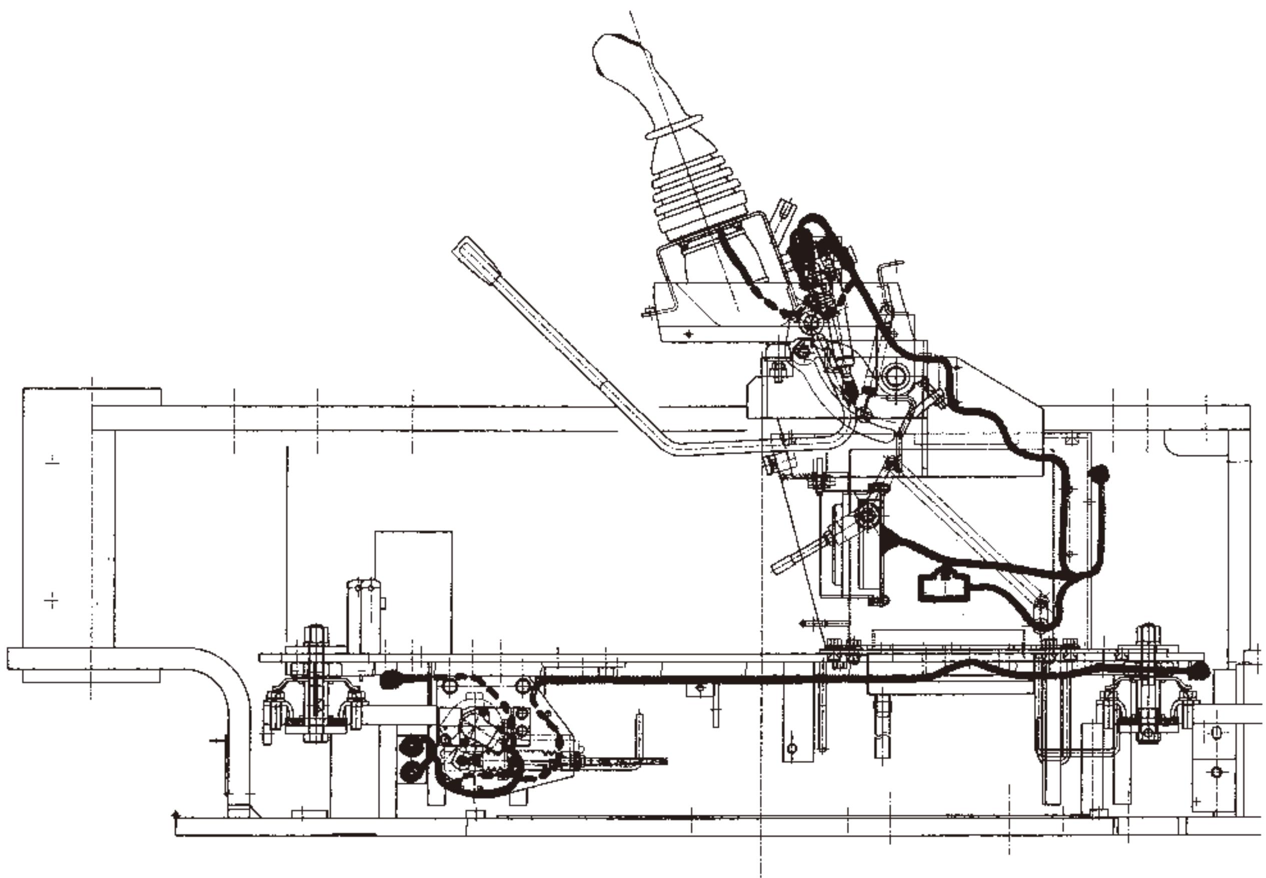
(1)Battery
(2)Main wire harness
(3)To fuel tank



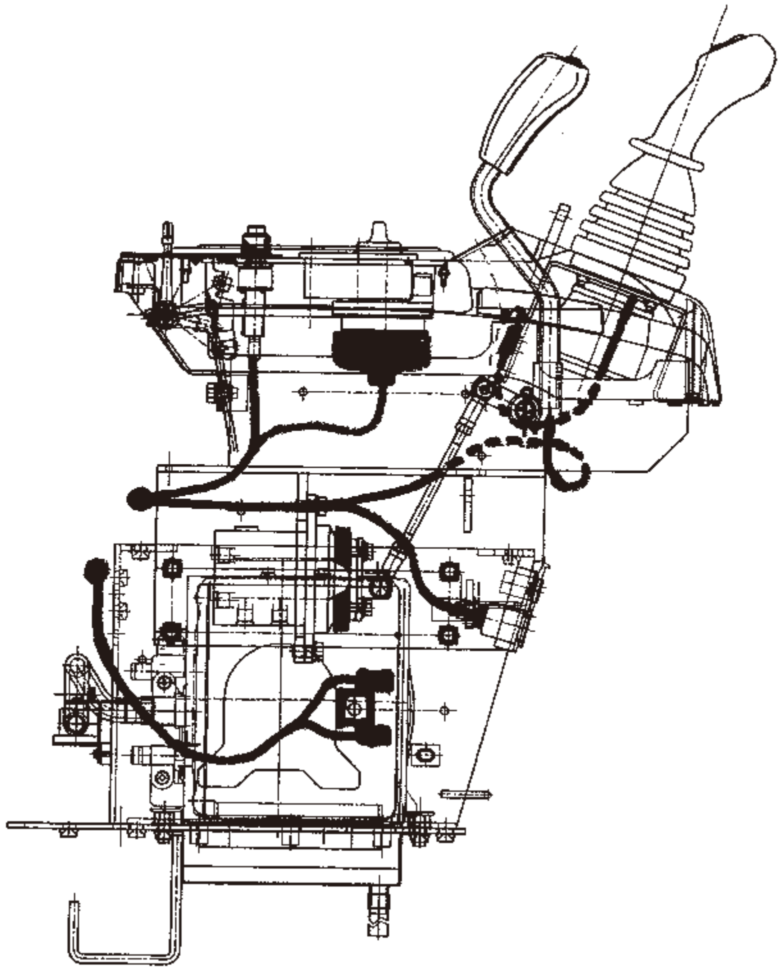


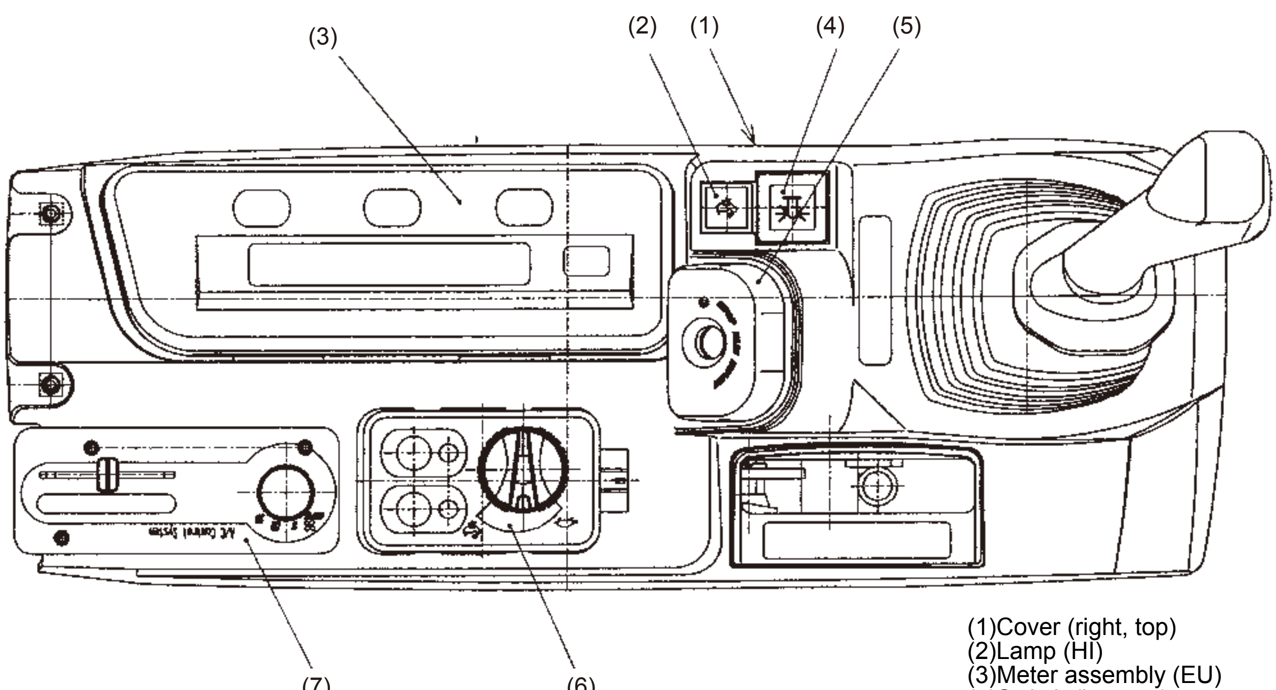
(1)To machine front
(2)AI motor
(3)To machine front



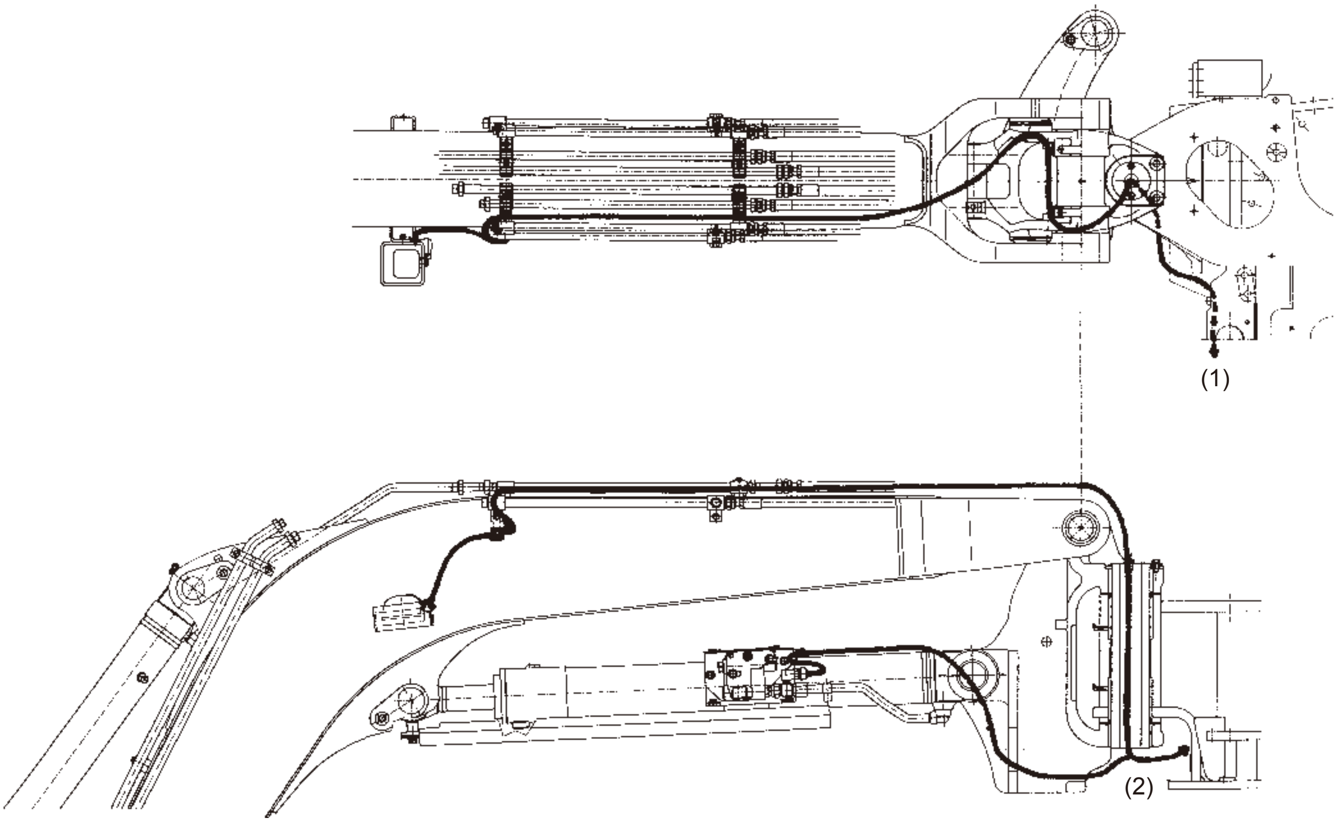


(1)To left control
(2)Fuse box
(3)Front of the step
(4)To front of the operator's seat
(5)To right control (meter)





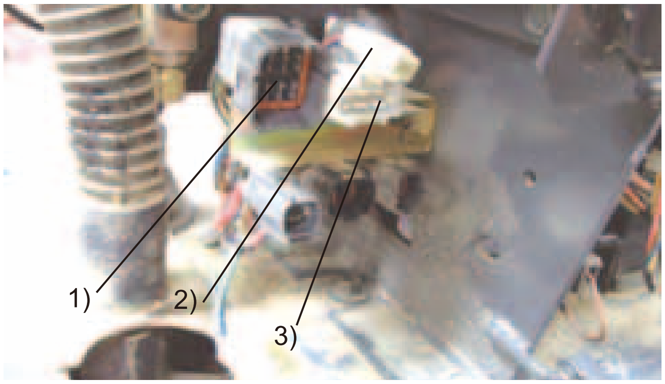
(1)Cover (right, top)
(2)Lamp (HI)
(3)Meter assembly (EU)
(4)Switch (beacon)
(5)Antenna (anti-theft)
(6)Meter assembly (AI, SC)
(7)Switch assembly (A/C)

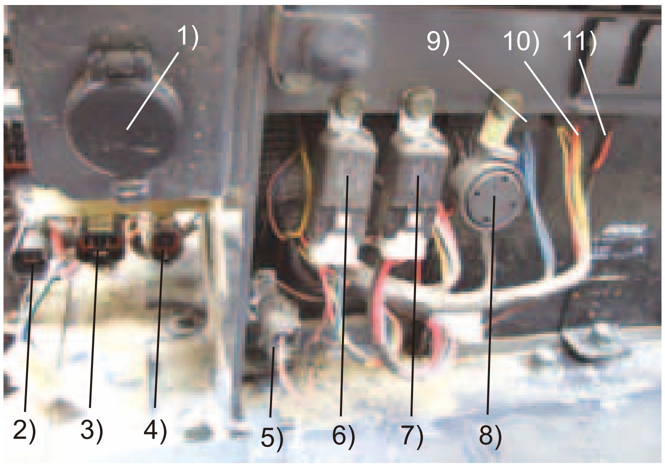


(1)To main wire harness
(2)To main wire harness

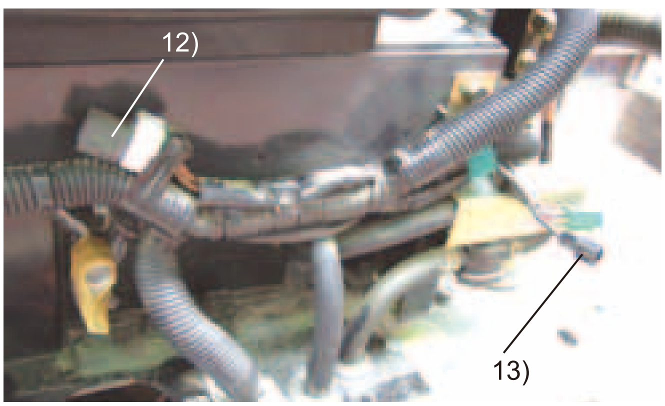
C.Installation of main parts, couplers and harnesses

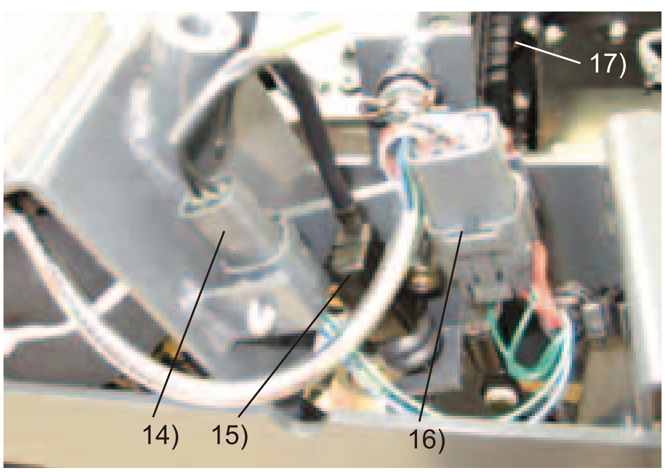
a.Around the operator's seat



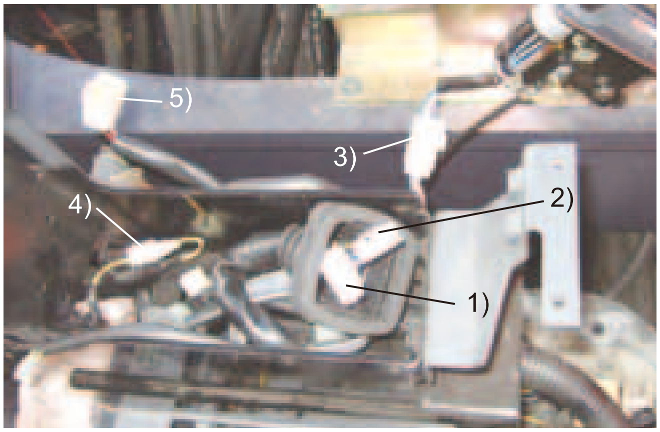


1)Power source, outlet
2)
3)
4)Coupler, to heater relay
5)
6)Compressure dutch relay
7)A/C blower relay
8)Buzzar, boom overload
9)
10)
11)

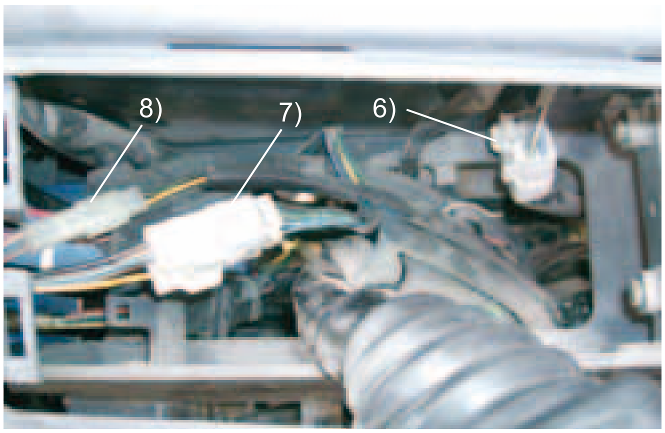




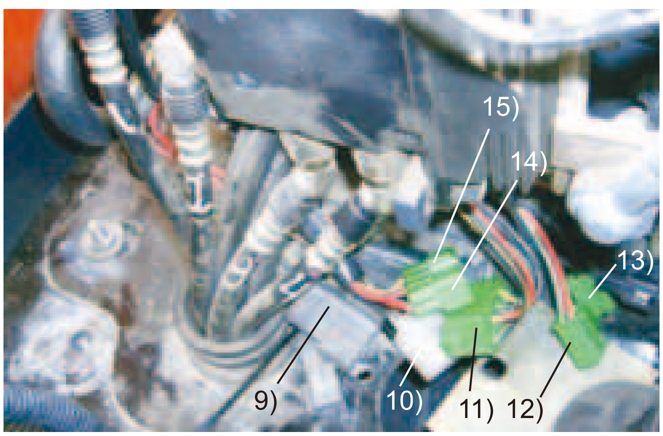
14)Coupler, unload switch
15)Switch, unload
16)Coupler, S/P 2 switch

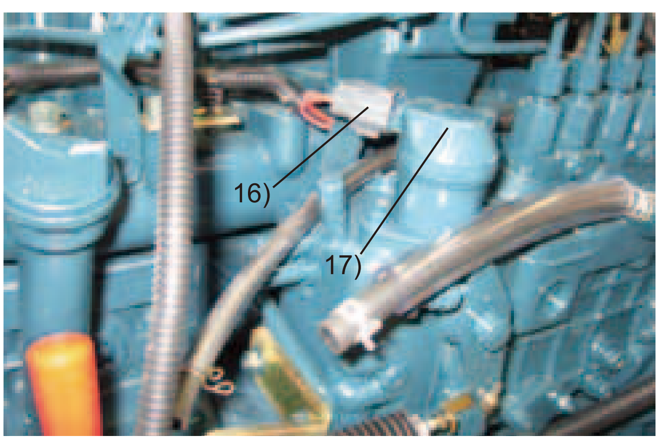


1)Meter coupler, L (22p)
2)Meter coupler, S (20p)
3)Coupler, A/C SW
4)Coupler, hi-low SW
5)Coupler, AI SW



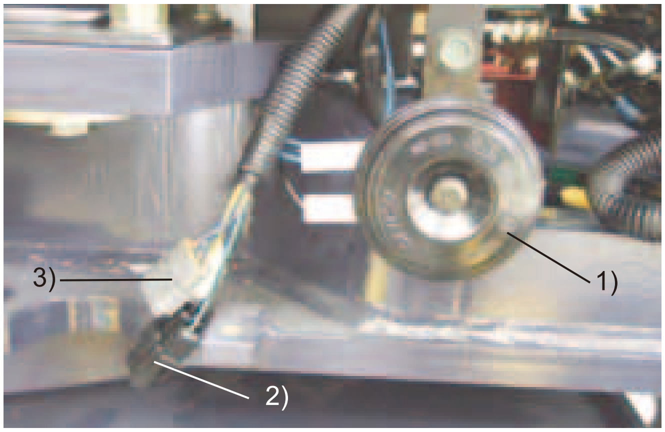
6)
7)Coupler, hbeacomSW
8)Coupler, travel high lamp



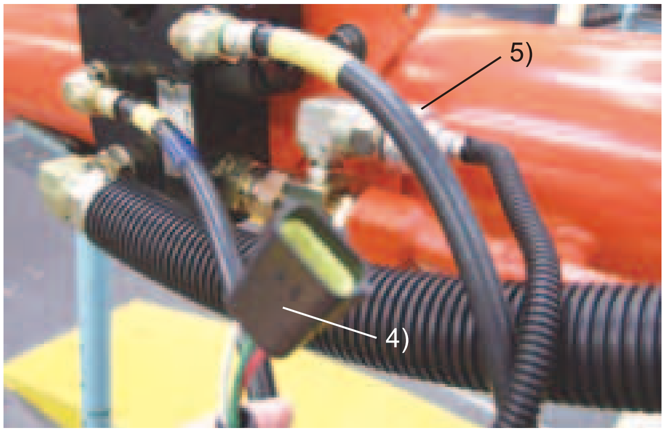


16)Coupler,
17)Engine stop solenoid

b.Front

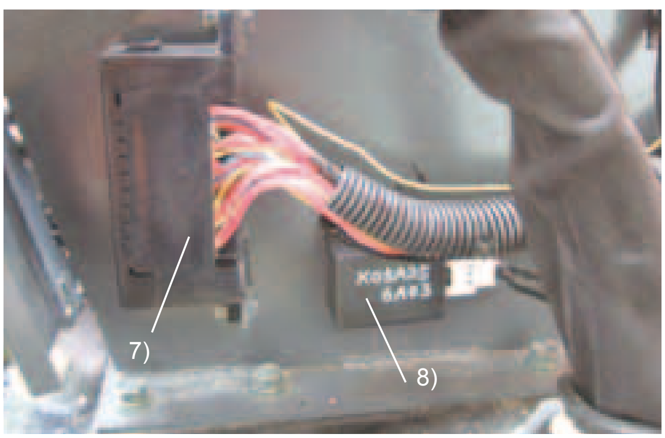


1)Horn
2)Coupler, work lamp
3)Coupler, boom overload SW



4)Coupler, boom overload SW
5)Boom overload SW

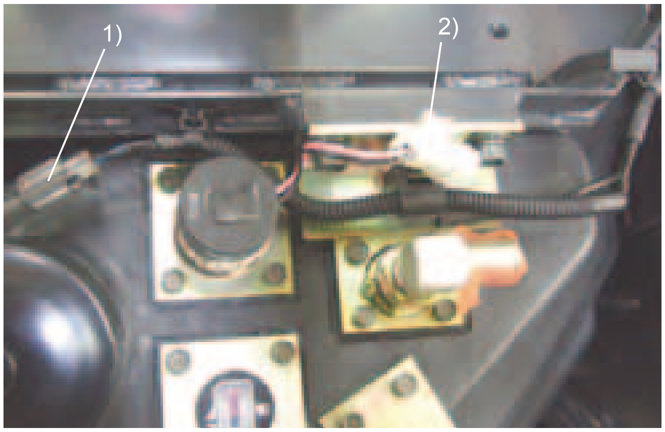
6)Coupler, S/P 1, right



7)Fuse box
8)Amp. unit

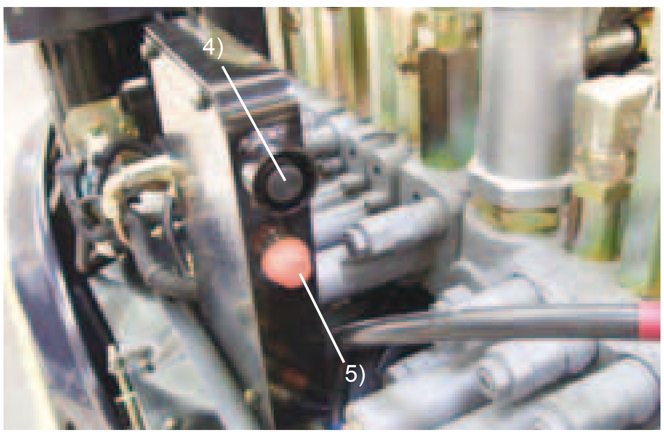
WorK lamp harness

c.Fuel tank

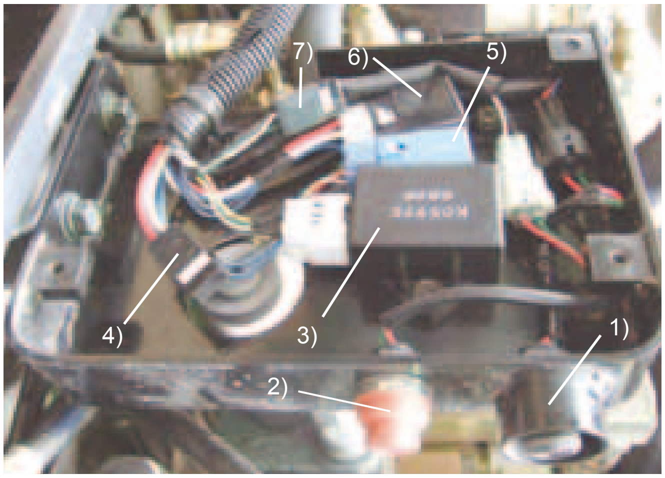


1)Fuel sensor
2)Lead SW, fuel amount

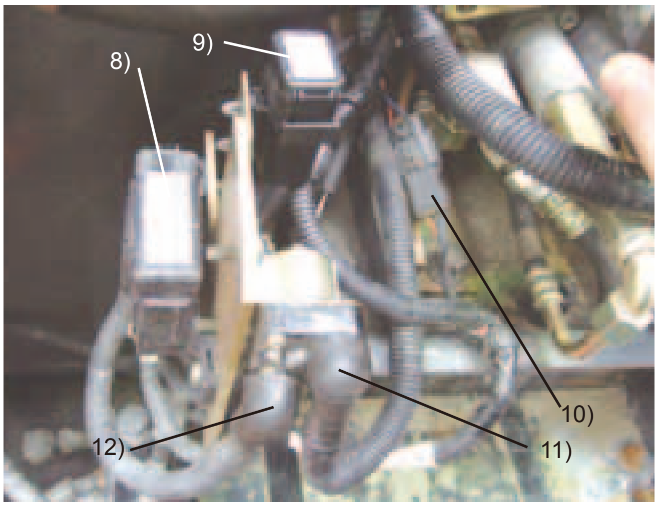
3)Fuel supply pump



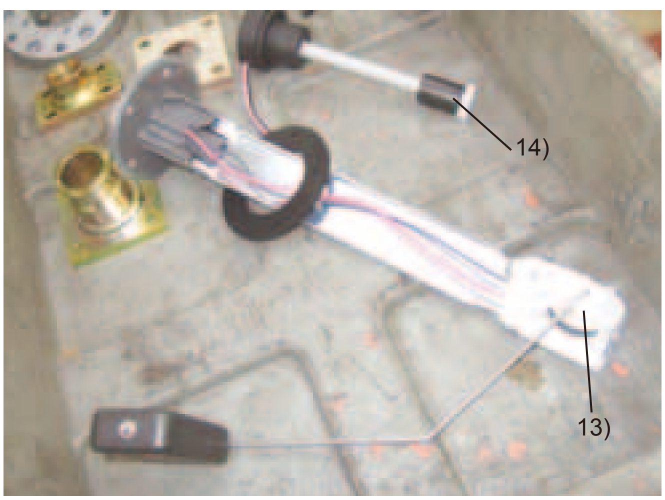
4)ON SW
5)OFF SW



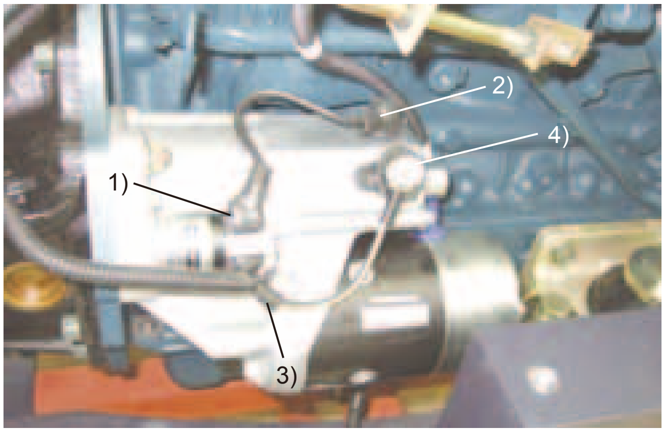
1)Switch ON
2)Switch OFF
3)4min. controller
4)Fuse A
5)Stop relay (NC, blue)
6)Stop relay (NO, NC)
7)Fuse A



8)Fuse box
9)Fuse
10)Coupler
11)
12)

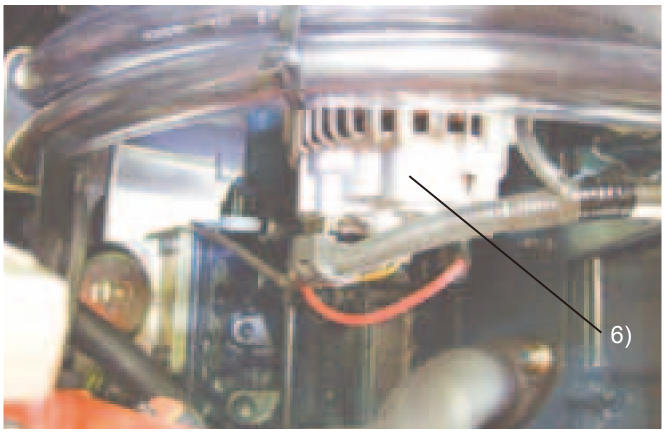


13)Fuel slide sensor
14)Lead sensor

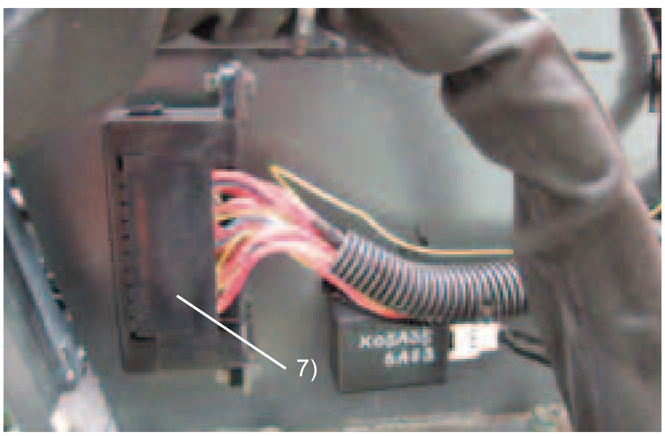


d.Starter, alternator, battery

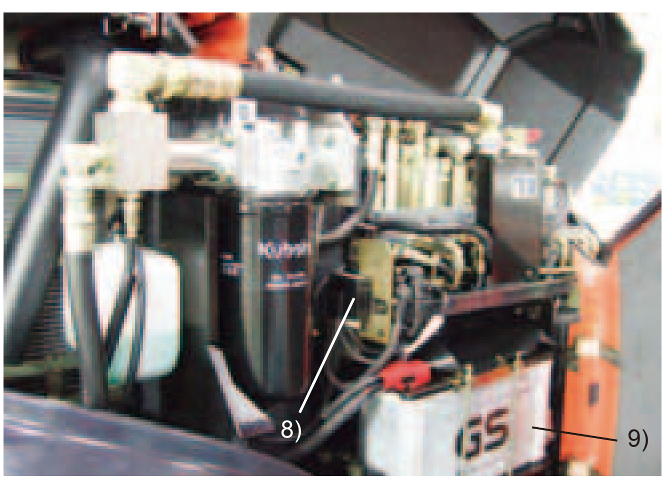
1)Relay terminal
2)
3)
4)
5)



6)Alternator



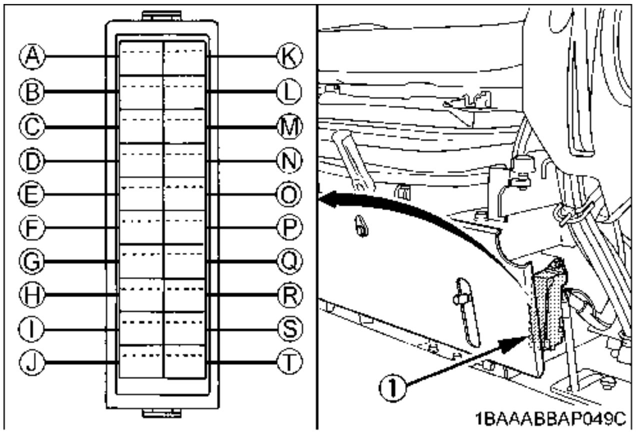
7)Fuse box



8) Fuse box(Slow blow fuse)
9) Battery

e.Fuses

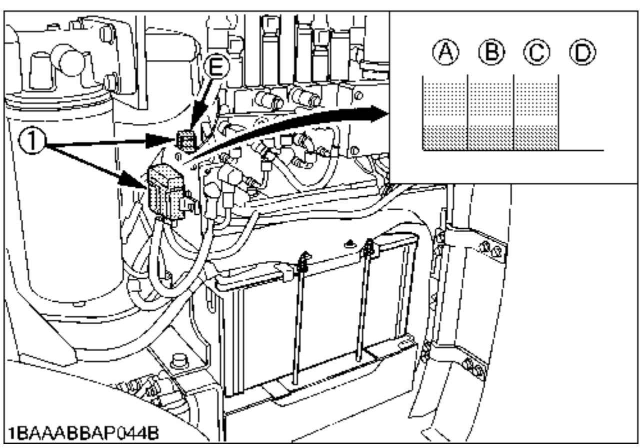
1.Fuse capacities and Circuits



(A)	5A Room Light
(B)	20A Work Light
(C)	5A Meter Sub
(D)	10A Compressor(A/C)
(E)	15A Cigarette Lighter
(F)	15A Auxiliary
(G)	15A Wiper / Washer
(H)	5A Glow
(I)	10A Overload Warning
(J)	10A Starter
(K)	20A Blower Motor (A/C)
(L)	15A AI Motor
(M)	10A Anti-theft Sub
(N)	10A Alternator
(O)	5A Lever Lock
(P)	10A Horn
(Q)	10A Meter Main
(R)	5A Travel Hi-Low
(S)	5A Relay Source
(T)	5A Anti-theft Main

(1) Slow blow fuse

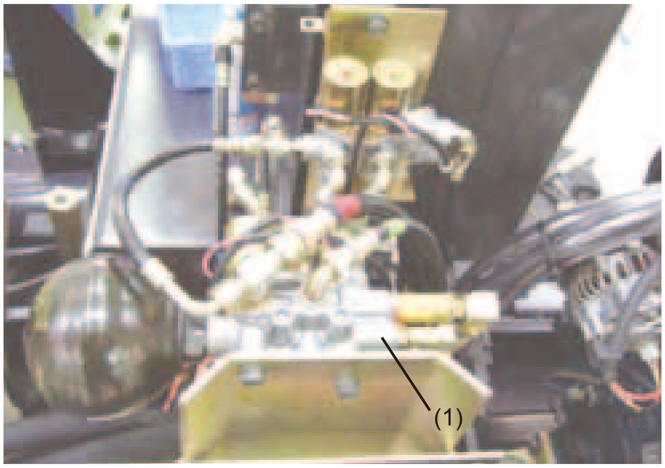
2.Slow blow fuse



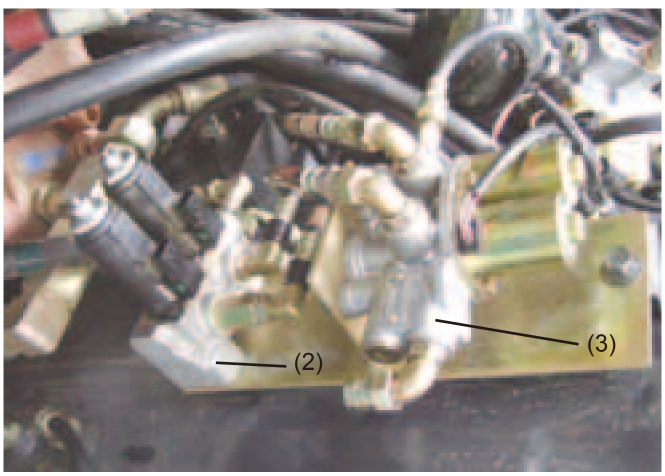
Slow blow fuse is provided to protect the electrical circuits.If the fusible link is blown, check the electrical circuits fortrouble and then replace with a new compatible slow blowfuse.

(A)	80A Alternator
(B)	100A Intake Heater
(C)	30A Fuel Supply Pump
(D)	
(E)	60A Main Power

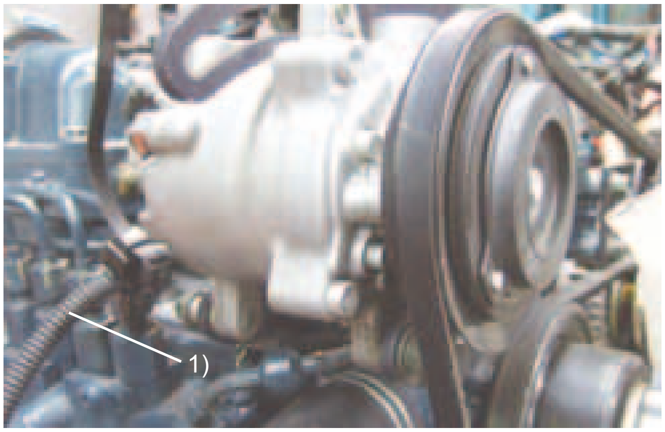
f. Solenoid valve wiring



(1) Unload solenoid valve
(Travel Hi-Low solenoid)

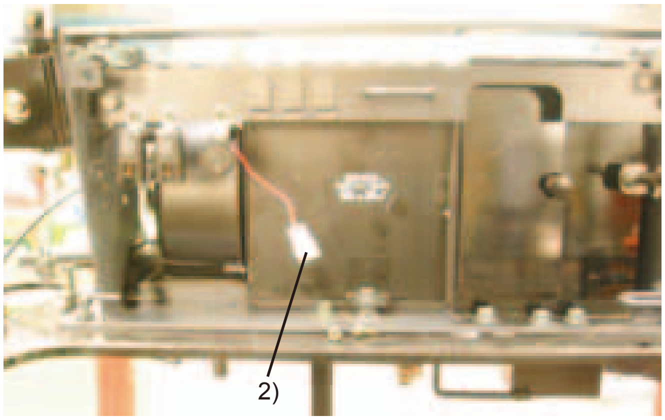


(2)Service port 1 proportional solenoid valve
(3)Service port 2 solenoid valve

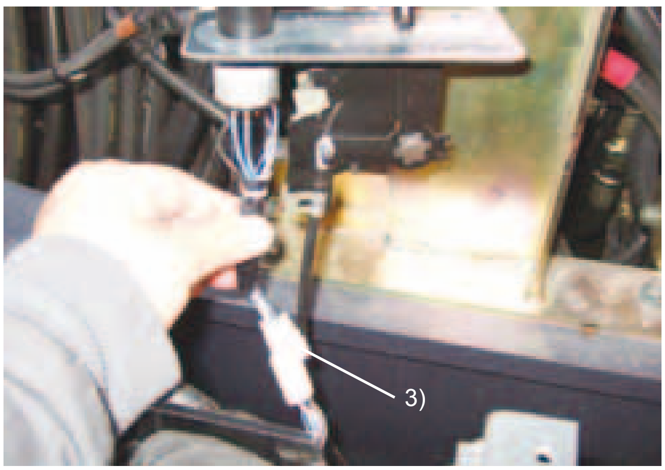


g. Air conditioner wiring

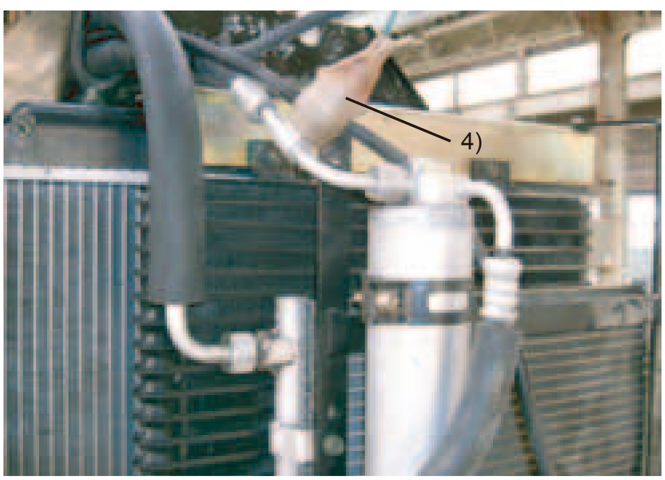
1) Compressor harness



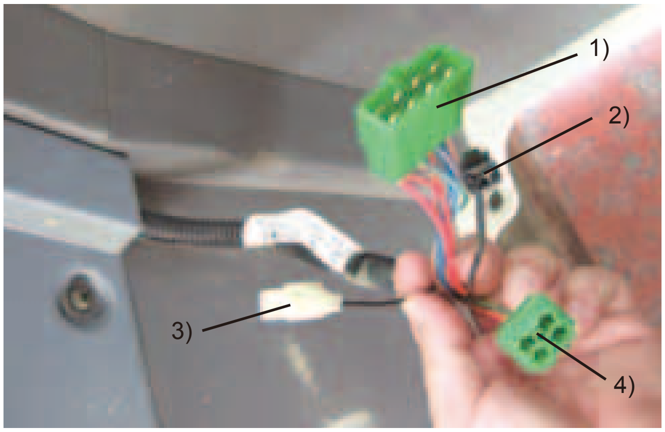
2) Blower harness coupler



3) Blower harness coupler



4) Dual pressure switch

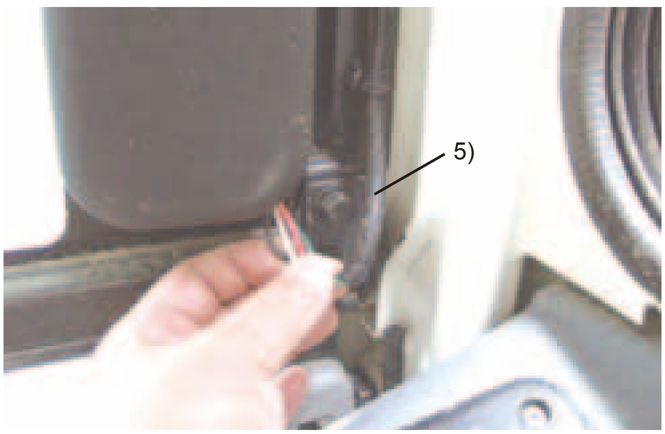


h.Cab wire harness

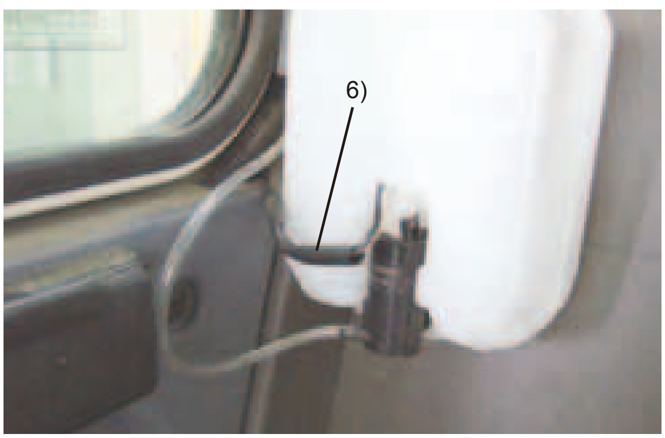
1.Couplers of cab harness

1)Main line to cab
2)GND
3)Auxiliary outlet
4)GND

2.Wire harness for woper motor

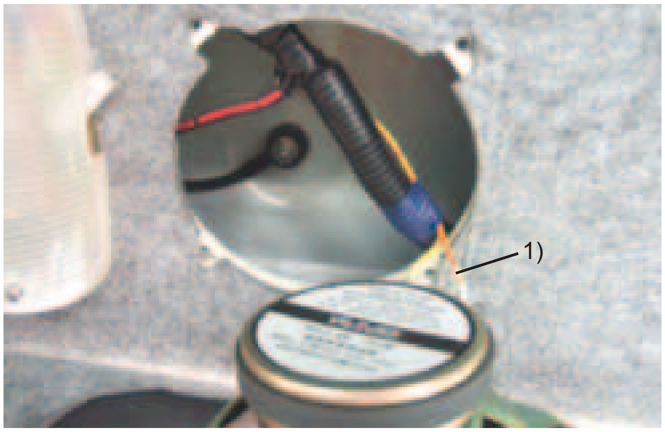


5)Wiper motor

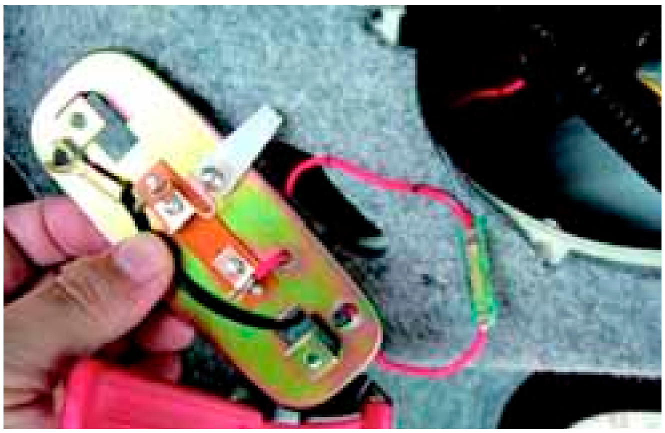


3.Wire harness for washer tank

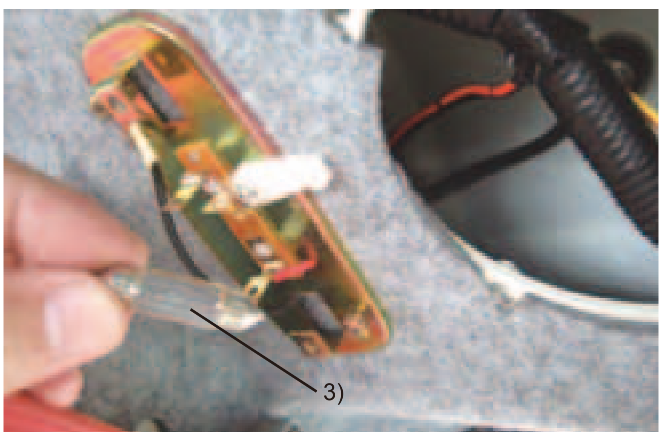
6)Washer motor



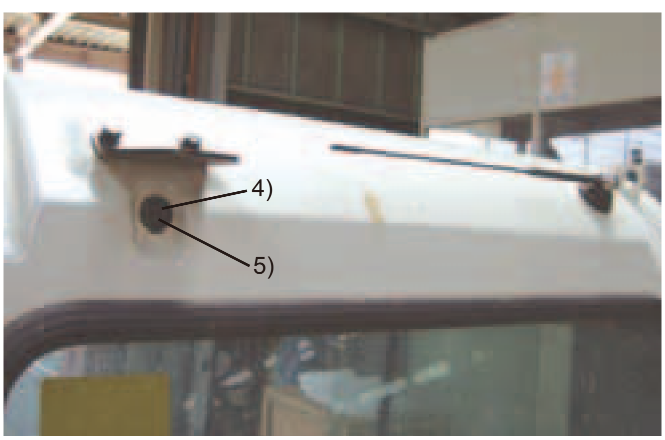
4.Wire harness for speaker and antenna



5.Wire harness for room lamp



3)Bulb of the room lamp
12V 10W

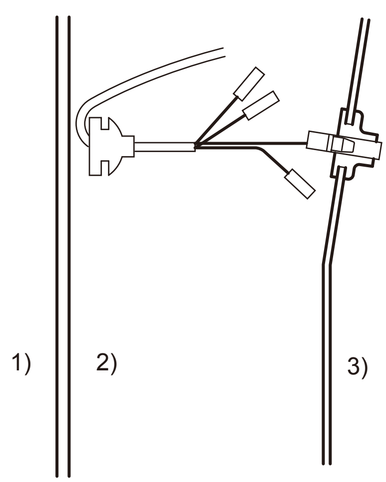


6.Auxiliary harness outlet
5)Outlet grommet

6)Pull out the grommet.

7)Remove the antenna and get the harness outside.

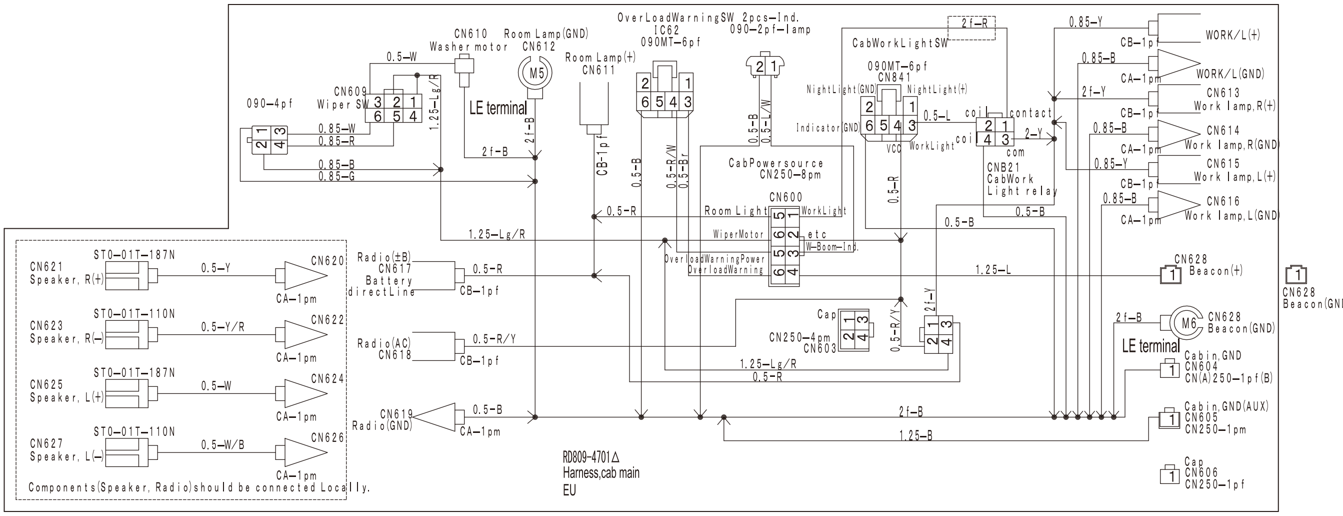
8)Auxiliary terminals for rotating lamp or rear work lamp.

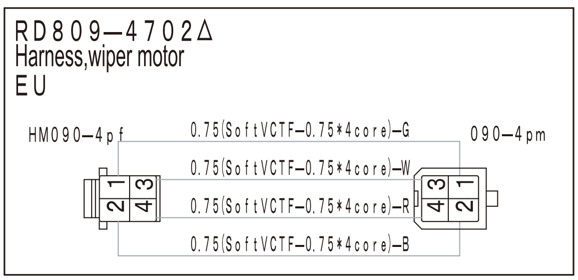


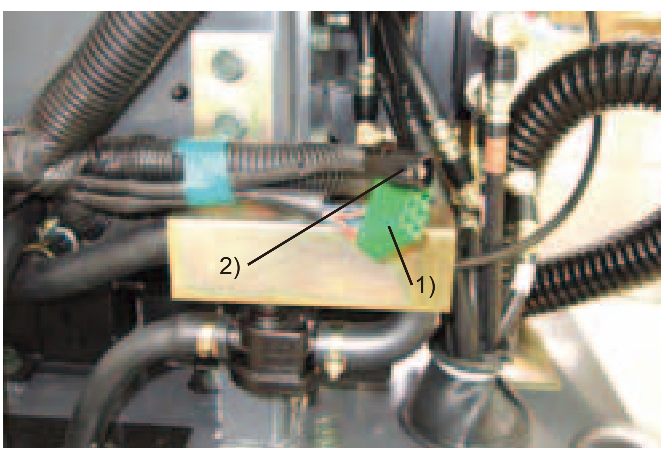
9) Wire harness storage.

1)Inside the cap
2)Between the walls
3)Outside

i.Circuit diagram of cab harness







1)Coupler, cab main
2)Coupler, earth

I. Air Conditioner (Mechanism)

Mechanism Section

A.Air conditioner system

a. Introduction of air conditioner

(1) Principle of air conditioner

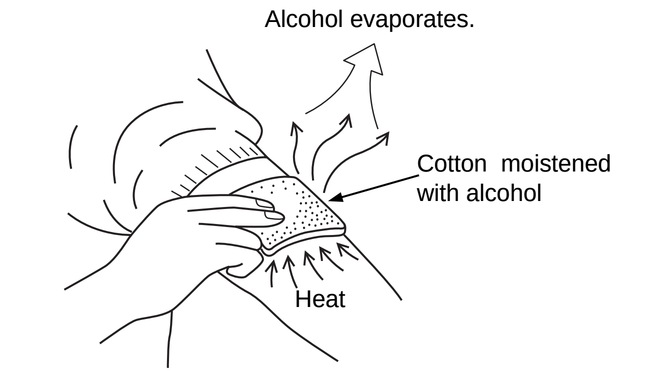
When your hand is wet and exposed to the wind or when you disinfect your hand with alcohol, you should feel your skin being cooled. This is because water or alcohol draws heat from your skin when it evaporates.

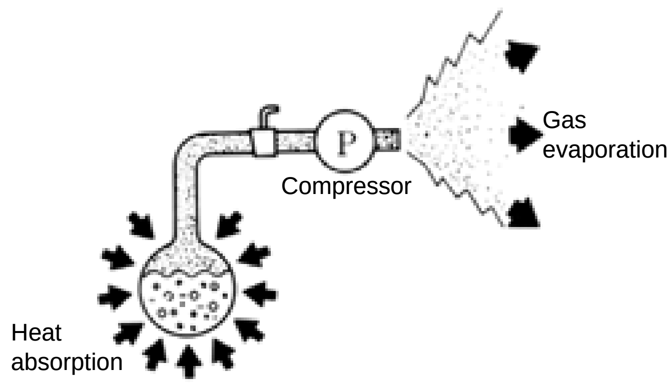
Air conditioners operate on this principle, using Freon as a refrigerant instead of water and alcohol.

To cool the cabin of a vehicle in hot summer, the air conditioner of a vehicle is a device to absorb heat in the cabin and emit it out of the vehicle. Heat will transfer from high temperatures to low temperatures. In summer, inconveniently the temperature outside the vehicle is higher than the temperature of the cabin from which heat should be transferred. If the temperature outside the vehicle is lower, just opening the windows will emit heat out of the vehicle and cool the cabin immediately.

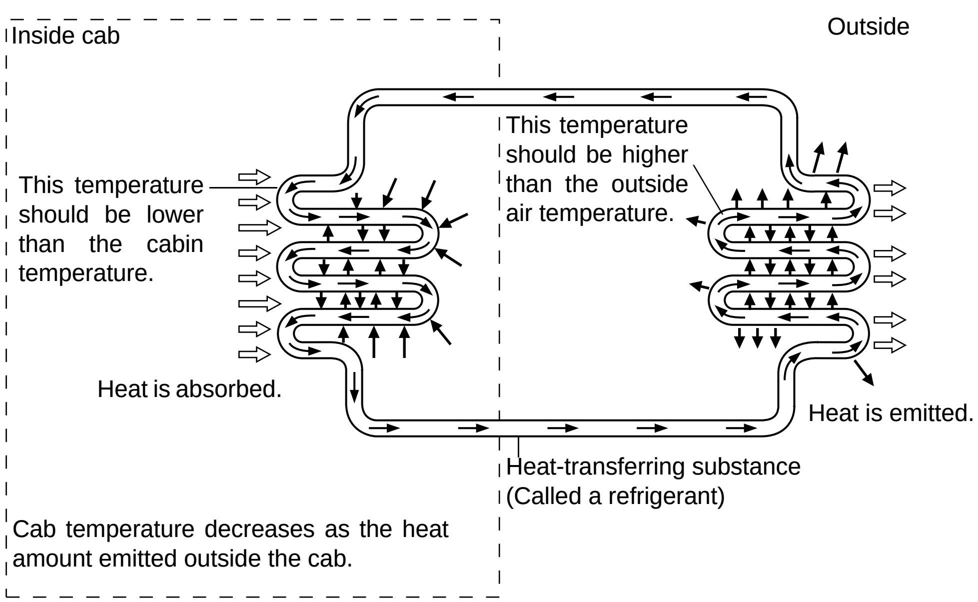
Trying to emit heat out of the vehicle in hot summer when the temperature outside the vehicle is higher than inside is to fight against the natural phenomenon. It seems that man likes to fight against nature and has been accumulating wisdom and expending enormous efforts to do so.

The air conditioner is the fruit of man s wisdom, which is a device that consumes important energy accordingly.





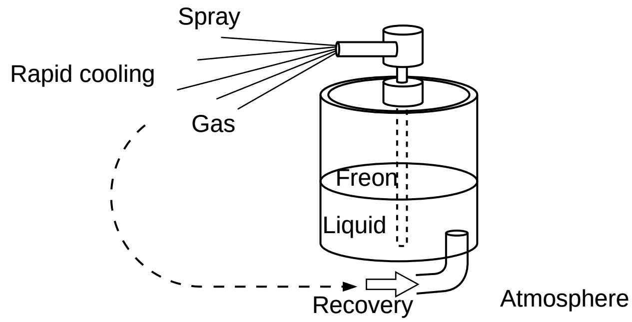
Cooling the cabin of the vehicle means emitting heat out of the vehicle. The air conditioner is a device to absorb heat in the cabin and emit it out of the vehicle.



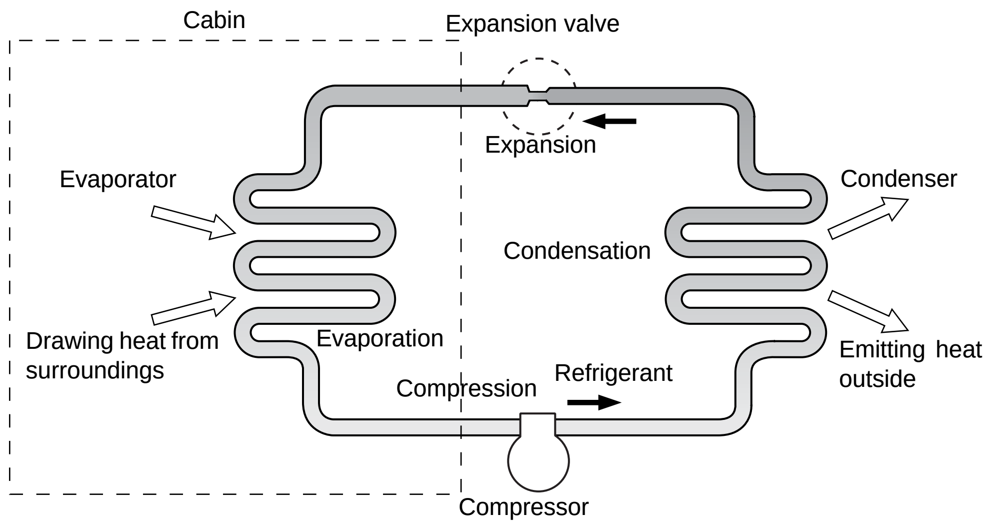
The figure in the left shows the principle of the air conditioning system to lower the temperature of the cabin by emitting heat out of the vehicle. Because heat transfers from high temperatures to low temperatures, the temperature in the piping should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle.

(2) Change of state of refrigerant

The concept of the air conditioning system is as follows. When liquid Freon is sprayed, it expands and turns into very cold gas. It is so cold that it freezes and looks snow-white (even under atmospheric pressure). If the sprayed Freon is left as it is, it will be lost. It should be therefore recovered and reused. Freon continues to carry out a cooling function while changing its state from liquid to gas and vice versa.

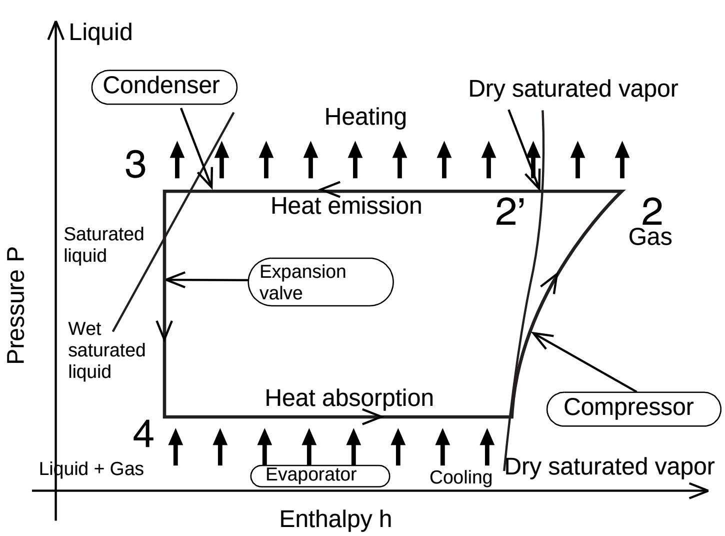


The temperature of the refrigerant should be lower than the cabin temperature inside the vehicle and higher than the atmospheric temperature outside the vehicle. As a refrigerant (heat-exchanging medium), Freon is used which makes it possible to provide such temperature changes relatively easily.



The principle of the air conditioner is as follows. By means of the expansion valve, the refrigerant in liquid form is rapidly expanded and turned into low-temperature gas. This low-temperature gas is passed through the evaporator, which is so designed that heat in the cabin can be absorbed effectively, and the cabin is cooled. Then the refrigerant in gaseous form, which has absorbed heat in the cabin and increased its temperature a little, is compressed by the compressor and becomes high-pressure and high-temperature gas. By means of the condenser, this high-pressure and high-temperature gas is air-cooled and turned back into liquid. At this time, the refrigerant emits into the atmosphere the heat absorbed from the cabin. This circulating system is called Refrigerant Cycle .

The following p-H diagram describes each state of refrigerant.



1: Dry vapor
   1→2: Adiabatic compression by means of compressor
2: Superheated vapor
   2→2'→3: Isobaric change by means of condenser (condensation through heat emission)
3: Saturated liquid
   3→4: Isoentropic change by means of expansion valve (restriction phenomenon)
4: Wet vapor
   4→1: Isobaric and isothermal change by means of evaporator (evaporation through heat absorption)

The cycle is thus completed.

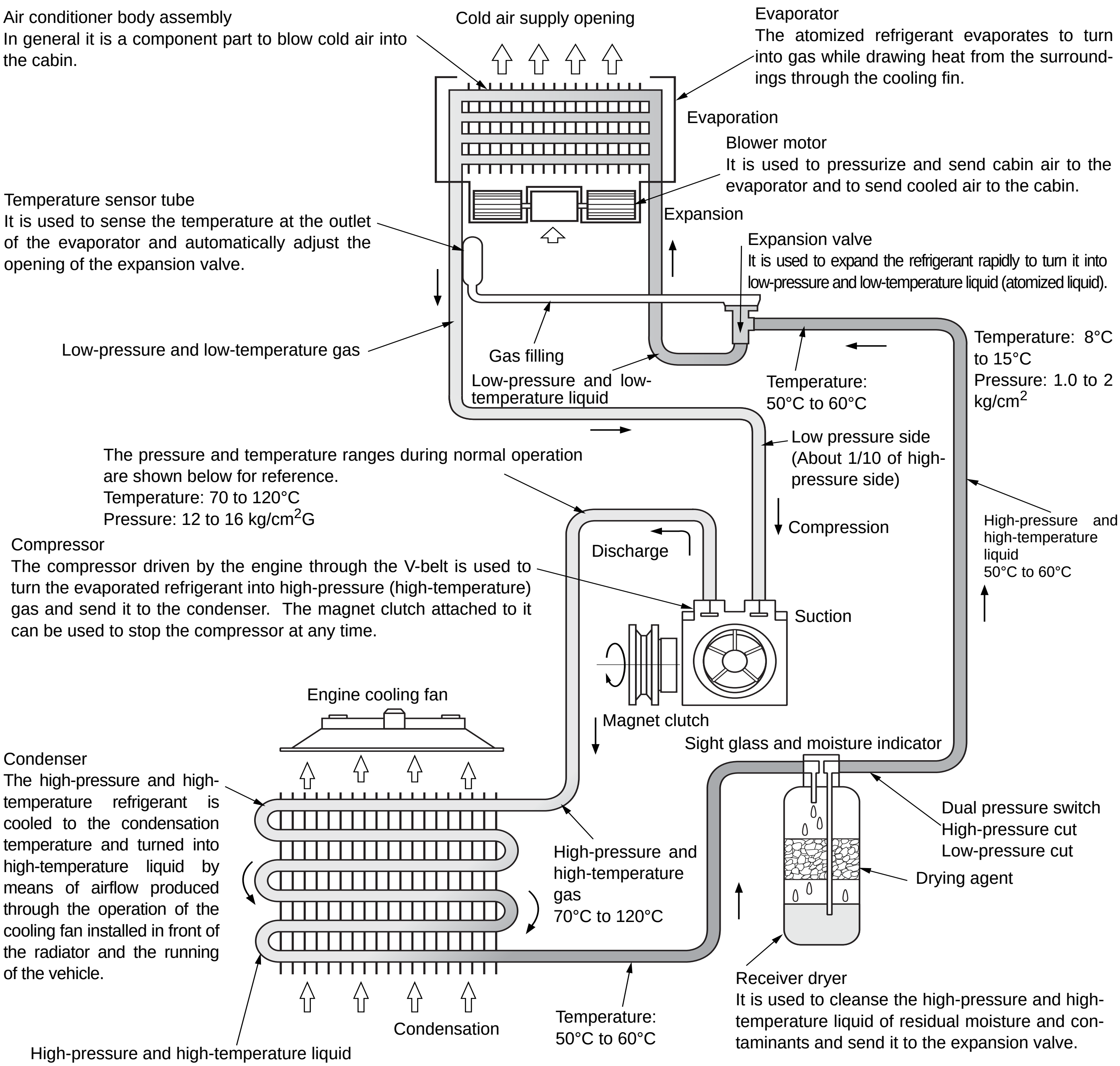
Function of expansion valve

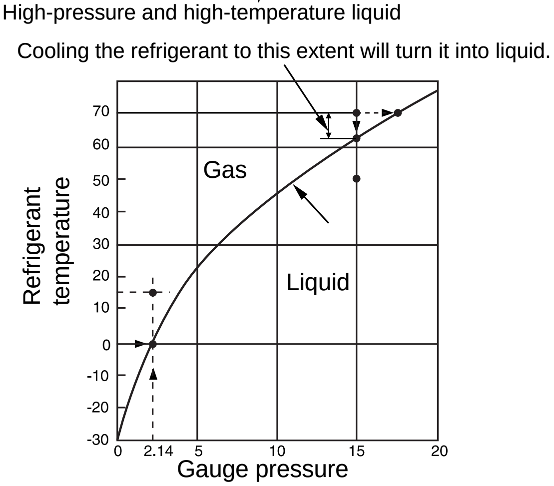
Sending a proper amount of refrigerant in liquid form from the high-pressure condenser side to the low-pressure evaporator side (flow control)

Turning high-pressure refrigerant into low-temperature and low-pressure wet vapor

(3) Function and construction

ote : alues of temperature an pressure in belo Fig. are not specifications but ust sample ata.



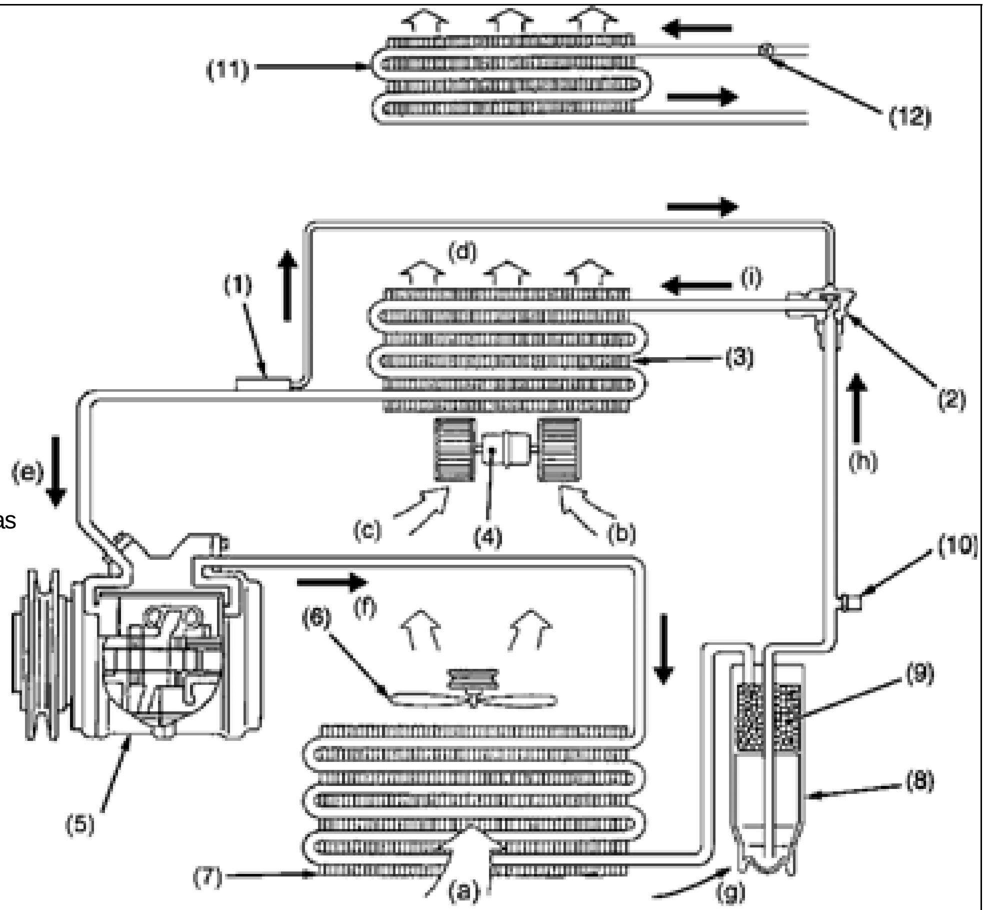


The characteristics of the refrigerant used so far are as follows. When the gasified refrigerant is compressed to 15 kg/cm^2 , its temperature becomes 70 C. Then, when the refrigerant is cooled to less than 60 C (which means the refrigerant emits 10 C or more of heat), it turns into liquid. When the pressure is reduced to less than 2.14 kg/cm^2 , it turns back into gas at 0 C.

b. Function and structure

(1) System flow

(1) Heat Sensitizing Tube
(2) Expansion Valve
(3) Evaporator
(4) Blower Motor
(5) Compressor
(6) Engine Cooling Fan
(7) Condenser
(8) Receiver
(9) Desiccant
(10) Pressure Switch(Dual type)
(11) Heater Core
(12) Water Valve
(a) Hot air
(b) Cab Interior Air
(c) Cab External Air
(d) Colded Air
(e)Low Press, low-temp. gas
(f)High Pressure, High Temperature Gas
(g)High Pressure, High temp. liquid
(h)Liquid refrigerant
(i)Low Pressure,
Low Temperature Liquid



The refrigerant cycle of air conditioning system is as follows.

1) The gaseous refrigerant evaporated through the evaporator (3) is compressed in the compressor (5) to approx. 1.47Mpa (15kgf/cm^2, 213 psi) and is also raised in temperature to approx. 70 C (158 F) and delivered to the condenser (7).
2) The gaseous refrigerant is cooled down through the condenser (7) to approx. 50 C (122 F) and delivered to the receiver (8) in the liquid state. At this time, heat removed from the cabin interior is extracted by means of the condenser (7).
3) The liquid refrigerant is collected in the receiver (8) for a certain period. At this time moisture are removed from the refrigerant by desiccant (9).
4) The liquid refrigerant after removing moisture and dust is jetted out of the small hole of the expansion valve (2) into the evaporator (3) as if it were distributed by an atomizer. Thus, the refrigerant is reduced in both pressure and temperature, and becomes easy to evaporate.
5) The refrigerant evaporates at 0 C (32 F) vigorously, taking heat from the surface of the pipes in the evaporator (3).
6) At this time, warm air in a cabin is drawn into the evaporator (3) by the blower motor and is passed over those pipes, transferring its heat to the refrigerant for evaporation. The air thus cooled is distributed to the cabin. (That is, heat in a cabin is taken by the evaporator.)

eference

Since warm air in a cabin is cooled suddenly, water in the air is liquefied and removed, which means dehumidification is also performed.

7) The gaseous refrigerant from the evaporator (3) after having performed the cooling action is returned to the compressor (5), and is compressed to liquefy it (high pressure and high temperature). This cycle is repeated.

(2) Refrigerant Cycle

1) Evaporation

The refrigerant changes from liquid (wet vapor) to gas (superheated vapor) in the evaporator. The atomized refrigerant sent to the evaporator evaporates actively. At this time, the liquid (wet vapor) keeps on evaporating while drawing heat necessary for evaporation (latent heat) from air around the cooling fin (cabin air). The air cooled as a result of losing heat is used to cool the cabin through the operation of the blower.
In the evaporator, the liquid (wet vapor) sent from the expansion valve and the evaporation gas (superheated vapor) coexist and a change of state from liquid to gas is performed. During this change of state, there is a certain relation between the pressure (evaporating pressure) and temperature (evaporating temperature); if the pressure is determined, the temperature is also determined. In other words, this relation is one between saturation pressure and saturation temperature.
In order to allow evaporation at a lower temperature in this change of state from liquid to gas, it is necessary to lower the pressure in the evaporator accordingly. The evaporation gas (superheated vapor) is therefore discharged rapidly from the evaporator with the compressor sucking it.

2) Compression

The compressor compresses the refrigerant to a state in which the refrigerant can be easily liquefied at ordinary temperature (outside air temperature).
The gas generated through evaporation in the evaporator (superheated vapor) is sucked into the compressor. This operation is intended to keep the evaporating pressure in the evaporator at a low level so that the refrigerant in liquid form can evaporate even at low temperatures around 0°C. The gas (superheated vapor) sucked into the compressor is compressed in the vane chamber and becomes such high-pressure and high-temperature gas as can be easily liquefied by being cooled with outside air at ordinary temperature.

3) Condensation

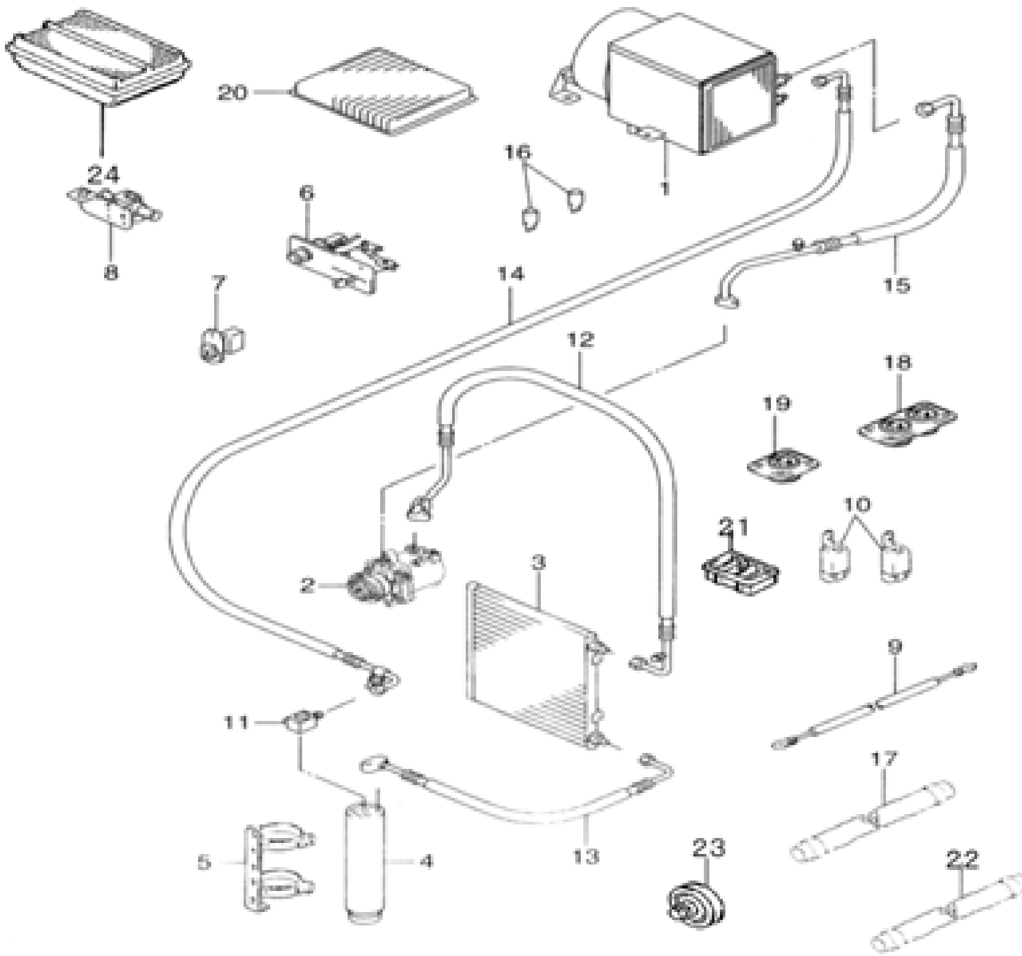
The refrigerant is cooled with outside air in the condenser and changes from gas to liquid.
The high-pressure and high-temperature gas coming out of the compressor is cooled with outside air, liquefied and stored in the receiver. The heat emitted from the high-pressure and high-temperature gas coming out of the compressor is called heat of condensation.
This heat of condensation is equal to the sum of the heat drawn from the cabin (evaporation heat) by the refrigerant in the evaporator and the energy used for compression (converted to heat quantity).
In the case of condensation, like the case of evaporation, there is a certain relation between the pressure (condensing pressure) and temperature (condensing temperature) during a state of change from gas to liquid performed with vapor and liquid coexisting. (Note that the pressure varies depending on the type of refrigerant and the condensing temperature.)

4) Expansion

The expansion valve reduces the pressure of the refrigerant in liquid form to a state in which the refrigerant can be easily evaporated.
Before the liquefied refrigerant is sent to the evaporator, its pressure is reduced to a state in which it can be easily evaporated, which is called an expansion process. The expansion valve used for this process performs flow control of the refrigerant as well as pressure reduction.
The amount of refrigerant to be evaporated in the evaporator is determined by the heat quantity to be removed (cooling load) at a given evaporating temperature (evaporating pressure). It is important to catch it correctly and feed a proper amount of refrigerant.
The refrigerant circulates through the cooling system while going through the above-mentioned four processes. As a result, it transfers heat from the cabin to the outside air, that is, from low temperatures to high temperatures.

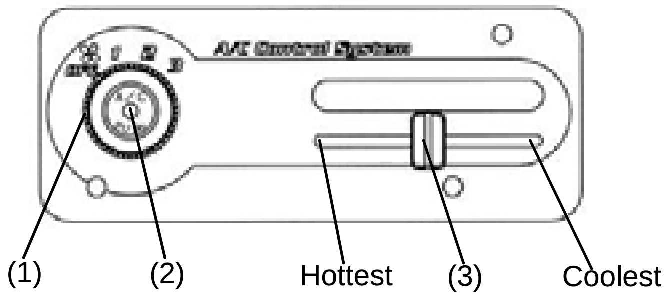
B.System components; KX080-3

a. Components and location



No.	Part name	KX121-3, KX161-3	Qty	KX080-3	Qty	Remarks
1	Unit assembly, air conditioner	RD118-53703	1	RD809-53702	1	Thermostat→ Fin thermistor
2	Compressor assembly, with clutch	T2055-72253	1	←	1	
3	Condenser	T1065-72221	1	←	1	
4	Tank, receiver	T0070-79271	1	←	1	
5	Holder, receiver	T0070-79281	1	←	1	
6	Control assembly, air conditioner	RD118-53611	1	←	1	
7	Resistor, blower	T1065-72181	1	←	1	
8	Valve assembly, water	T0270-67501	1	←	1	
9	Cable, control	RD118-47451	1	RD809-47451	1	
10	Relay assembly	T1155-72151	2	←	2	
11	Joint assembly	T0270-87171	1	←	1	
12	Hose, discharge	RD118-47511	1	RD809-47511	1	
13	Hose, liquid	RD411-47541	1	RD809-47542	1	
14	Hose accessory assembly	RD118-47531	1	RD809-47531	1	
15	Hose, suction	RD118-47622	1	RD809-47521	1	
16	Connector, drain	6A671-71691	2	←	3	
17	Hose, air	RB419-49282	1	68729-47141	1	For outside air intake
18	Grill assembly (for face)	3G710-50291	1	←	1	
19	Grill assembly (for def.)	RD118-47231	1	←	1	
20	Filter assembly	6A671-75091	1	—	0	
21	Grill assembly (for foot)	RD118-47221	1	←	2	Added for rear blow
22	Hose, air	—	0	RB419-49282	1	For rear blow
23	Pulley assembly	—	0	3C581-50091	1	
24	Filter assembly	—	0	T0270-67061	1	Common for inside and outside air

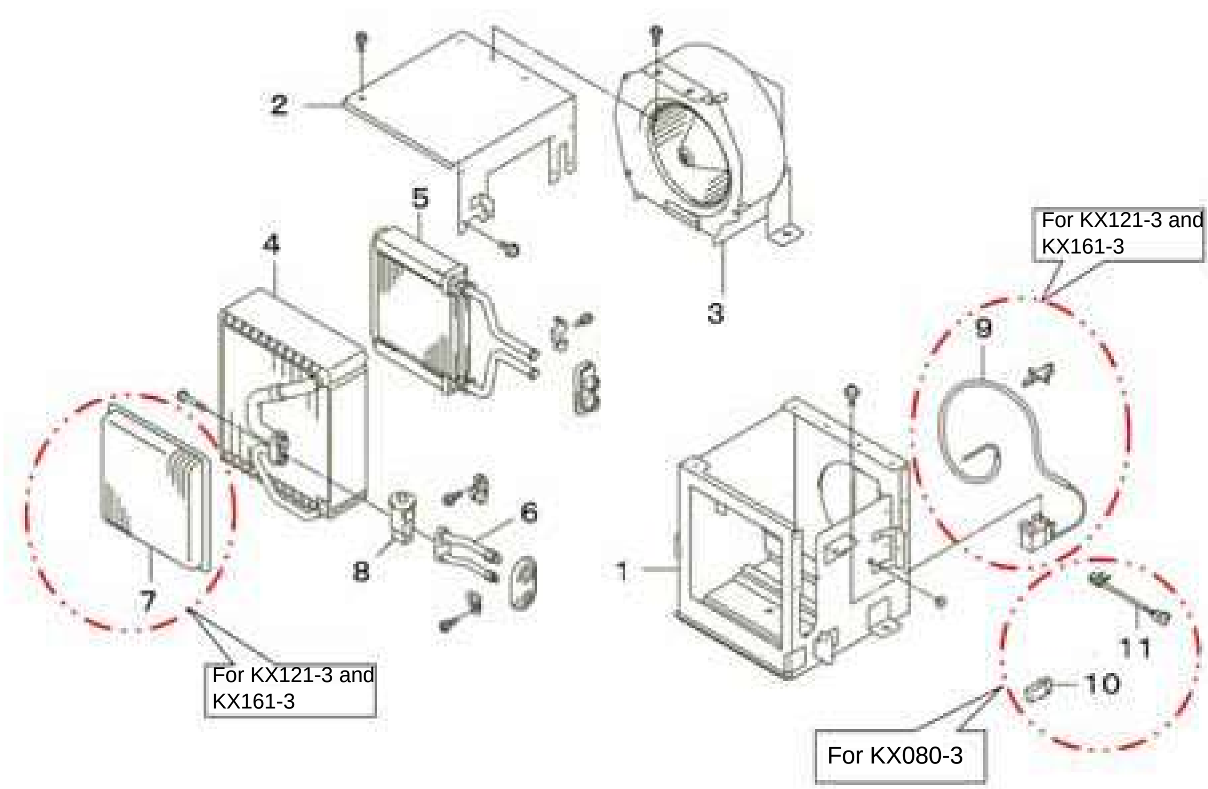
b. Control panel



Mounted on actual machine

(1) Fan switch: Used to turn on and off the fan and to select the airflow in 3 steps.
(2) Air conditioner switch: Used to turn on the compressor to start cooling.
(3) Temperature adjusting lever: Used to adjust the blow temperature by opening and closing the hot-water valve via cable.

c. Air conditioner unit



No.	Part name	Remarks
1	Case sub-assembly (bottom case)	
2	Case sub-assembly (top cover)	
3	Blower assembly	
4	Evaporator assembly	
5	Core sub-assembly, heater	
6	Tube accessory	
7	Filter, air (for inside air)	For KX121-3 and KX161-3
8	Valve, expansion	
9	Thermostat assembly	For KX121-3 and KX161-3 (for frost control)
10	Amplifier assembly (electronic thermo amp.)	For KX080-3 } (for frost control)
11	Thermistor assembly (fin thermistor)	For KX080-3

C.Main components

a. Compressor

The compressor is installed on the engine and is driven by crank pulley through a belt.
The compressor is a pump designed to raise the pressure of refrigerant. Raising the pressure means raising the temperature. High temperature refrigerant vapor will condense rapidly in the condenser by releasing heat to the surrounding.

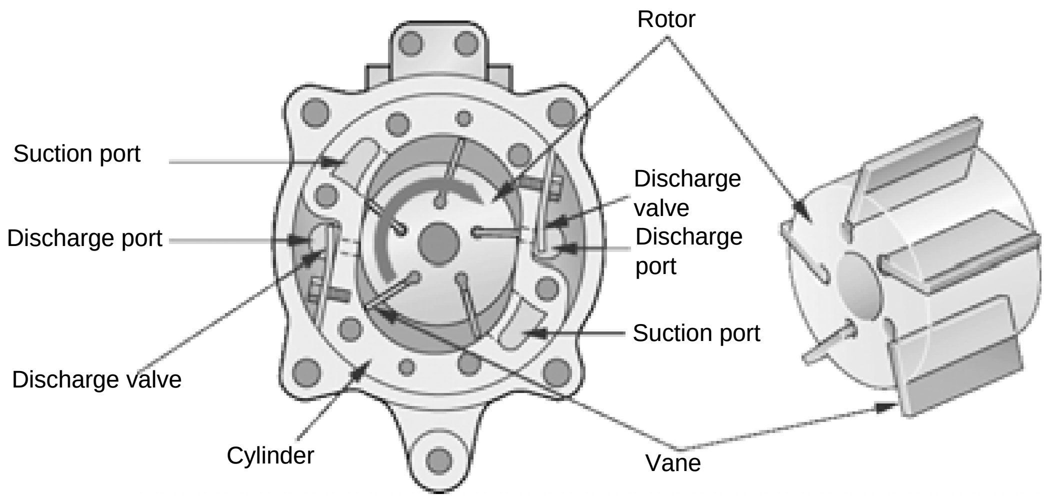
Compressors are classified as follows:

Reciprocationg type
- Swash plate type(6,10 cylinders) . . . . . . 10P,10PA type
- Wobble plate type(6 sylinders) . . . . 6C, 6CA type
- Variable capacity type . . . . 7SB16 type
- Crank shaft type(1 to 6 cylinders)

Rotary type
- Through vane type . . . . TV type
- Sliding vane type . . . . SV type
- Scroll type . . . . SC type

(1) Outline of sliding-vane type compressor (SV07 type) : 0 0-3 -3 6 -3

This compressor consists of the following main parts: rotor with built-in five vanes and cylinder, two discharge valves, side plates on the front and back. As the rotor turns, the five vanes also turn pressed into contact with the inner surface of the cylinder by the centrifugal force and the back pressure of the vanes themselves.



(2) Feature

1) The rotor, cylinder and other major parts are made of aluminum for tremendous drop in weight.
2) The vanes are used to make the compressor compact.
3) Compared to conventional swash-plate compressors, the SV07 is compact with smaller cylinder capacity. Thanks to the better volumetric efficiency, however, the SV07 proves as powerful as the 10P08.

(3) Main specifications

Type	Displacement	Max.RPM	Lib. oil	Type of magnet clutch
SV07	70cm^3	6000rpm	ND OIL8	K-20

(4) Structure   Function

The basic internal construction of sliding-vane type compressor consists of a rotor fitted with five vanes, and a cylinder.

Although its internal construction partially differs from that of the through-vane type compressor, the function is identical. Its basic operation is to effect the suction, the compression, and the discharge of refrigerant gas by rotating the rotor, pushing the vanes to the cylinder inner wall, and allowing the vanes to rotate while sliding along the cylinder wall.

Similar to the through-vane type compressor, the sliding-vane type compressor uses the ND-OIL8 for the compressor oil.

1   Construction

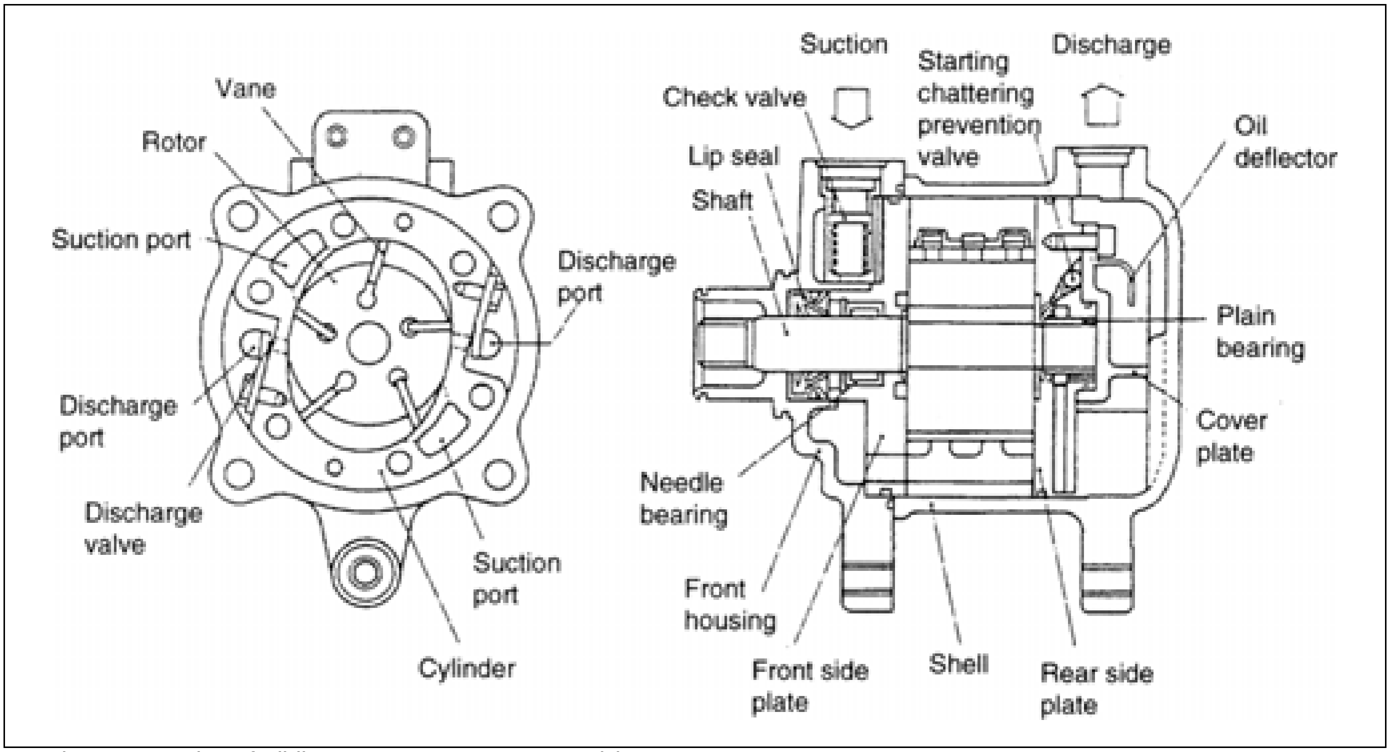


Fig. Construction of Sliding-vane Type Compressor (1)

1)   ylin er Internal   onstruction

Internally, the cylinder consists of a rotor fitted with five vanes. These vanes slide in contact with the inner cylinder wall to effect the suction, the compression, and the discharge of refrigerant gas.

2) Shaft

The shaft is integrated with the rotor. The front of the shaft is supported by the needle bearing which is fitted in the front side plate. The rear is supported by plain bearing which is fitted in the rear side bearing.

The end of the shaft is provided with splines, and the magnetic clutch (K type) that mates to the spline shaft is secured by a bolt (M6), in the same way as in the through-vane type compressor.

3)   ear Si e   late

The rear side plate is equipped with a valve that prevents the vanes from chattering during starting.

2 Operation

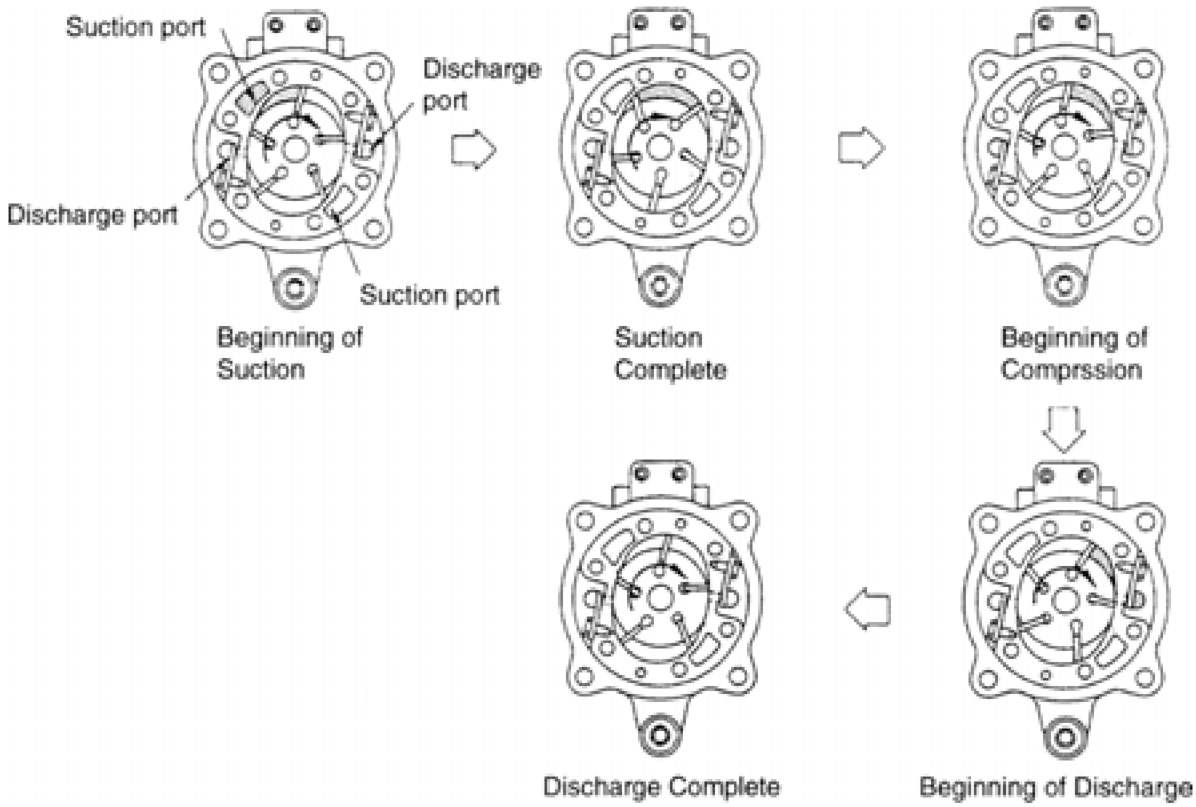


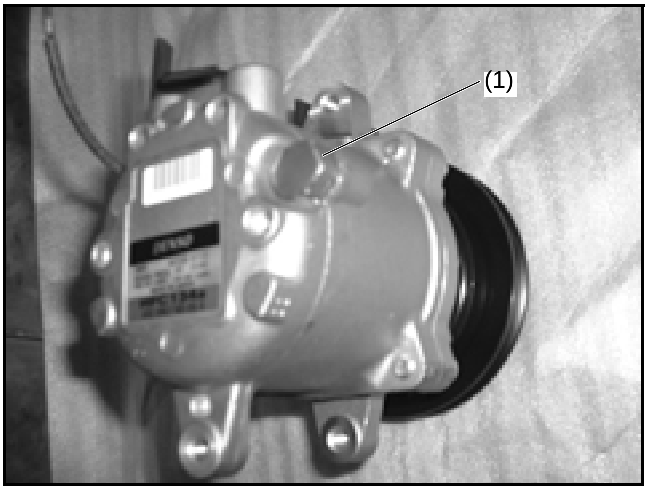
Fig. Operation of Sliding-vane Type Compressor

1) **Suction**
The refrigerant gas exits from the evaporator by the operation of the compressor, enters the compressor s low-pressure chamber. As the rotor turns together with the vanes, the refrigerant gas is drawn from the suction port into the cylinder.

2) **ompression**
After completing suction, the refrigerant gas, which is sealed by the vanes in the cylinder, becomes compressed as the vanes rotate. At this time, the sealing between the tip of the vanes and the cylinder wall is ensured by the compressor oil.

3) **ischarge**
At the compression continues and the refrigerant pressure in the cylinder increases to the point that it becomes higher than that of the high-pressure chamber, the refrigerant gas is discharged.
Even when the pressure in cylinder because the high-pressure chamber pressure maintains the discharge valve closed.
The compressor repeats the cycle described above to enable the five chambers, which are partitioned by the vanes in the cylinder, to perform suction, compression, and discharge twice for each rotation of the rotor.

b. High pressure relief valve

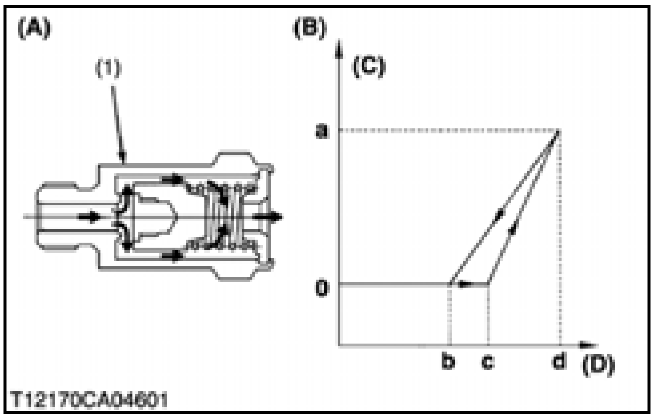


If the high pressure is abnormally high, the pressure relief valve open, and the refrigerant is released into the atmosphere, and the system is maintained. At that time, some of the refrigerant in the system is released into the atmosphere.
Even in the worst case, the outflow of refrigerant is stopped at the minimum limit.

(Reference)

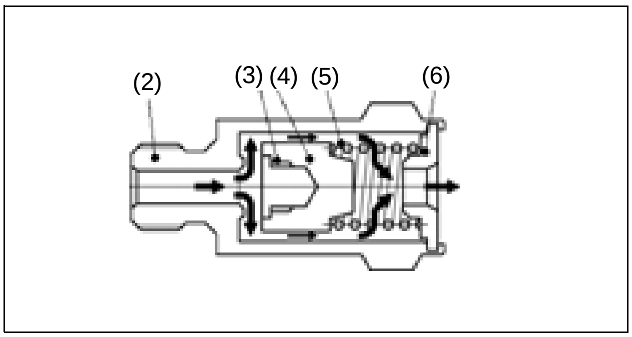
In normal operation, the high pressure switch is triggered first and the compressor stops, so the pressure relief valve is not triggered so easily.

(1) Pressure Relief Valve



(a) 113L/min., 27.2 U.S.gals./min., 24.86 Imp.gals/min.
(b) 2.75 Mpa, 28.1 kgf/cm2, 399.7 psi
(c) 3.43 Mpa, 35.0 kgf/cm2, 497.8 psi
(d) 4.14 Mpa, 42.4 kgf/cm2, 603.1 psi

(A) Gas Ejection Route When Operating
(B) Operating Characteristic
(C) Leakage Quantity
(D) Pressure



(2) Body
(3) Seal
(4) Poppet
(5) Spring
(6) Stopper

c. Magnetic clutch

A magnetic clutch is used to connect and disconnect the compressor from the engine. The main components are the stator, rotor, and pressure plate.

(1) Principle

When the current is supplied to the coil, magnetic forces are generated in the iron II and attracts the iron I.

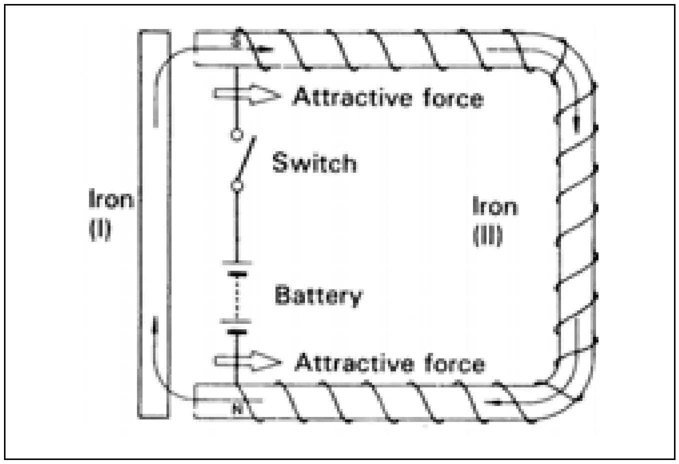
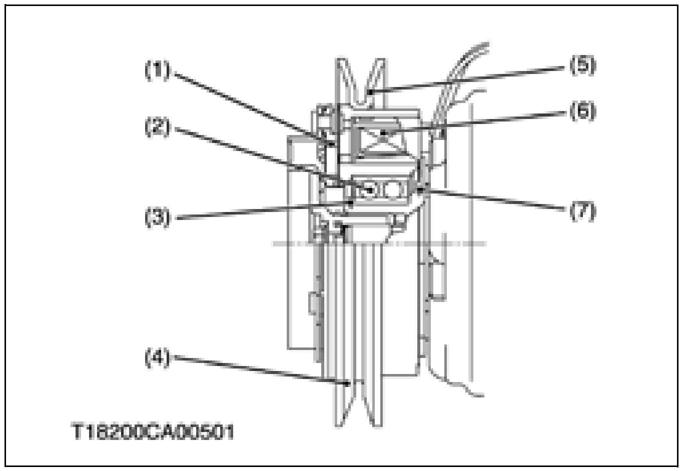


Fig. Magnetic Attractive Force

(2) Magnetic Clutch

A magnetic clutch is used to engage and disengage the compressor from the engine. Main components are stator (6) and rotor with pulley (5), and pressure plate (1) to engage the drive pulley (4) and compressor magnetically.
The stator is fixed on the compressor housing, and pressure plate is attached to the compressor shaft.
Two ball bearings are used between the inner surface of the rotor and the front housing of the compressor.

(1) Pressure Plate
(2) Ball Bearing
(3) Snap Ring
(4) Pulley
(5) Rotor with Pulley
(6) Stator
(7) Snap Ring



(3) Operation

Whenever the engine is operating, the pulley is rotating since it is connected to the crankshaft by a drive belt, but the compressor does not operate until the magnetic clutch is energized. When the air conditioning system is switched on, the system supplies current to the stator coil. Then the electromagnetic field attracts the pressure plate and pulls the plate against the friction facings on the pulley. The friction between the facings on the pulley and pressure plate causes the magnetic clutch assembly to rotate as a unit, and drive the compressor.

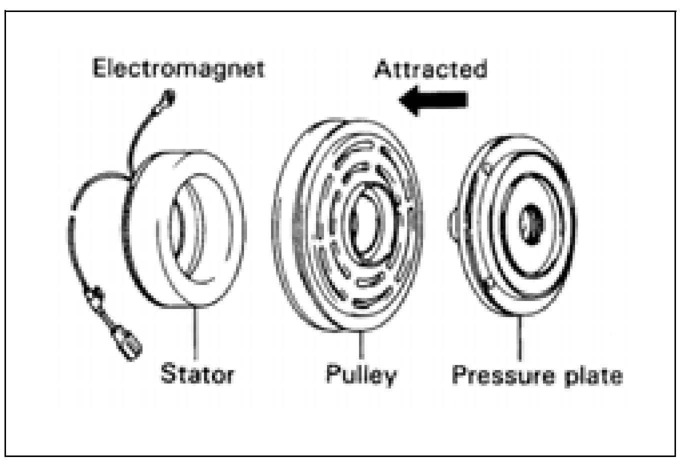


Fig. Operation

d. Condenser

(1) Description

The condenser is used to cool down the high temperature and high pressure gas refrigerant and change it to a liquid refrigerant.
The greater the amount of the heat released off into the air through the condenser, the greater will be the cooling effect obtained by the evaporator.
Therefore, the condenser is installed at the front end of the vehicle to get forcible cooling by the machine when moving.
There are some models which are equipped with a fan exclusively for the condenser.

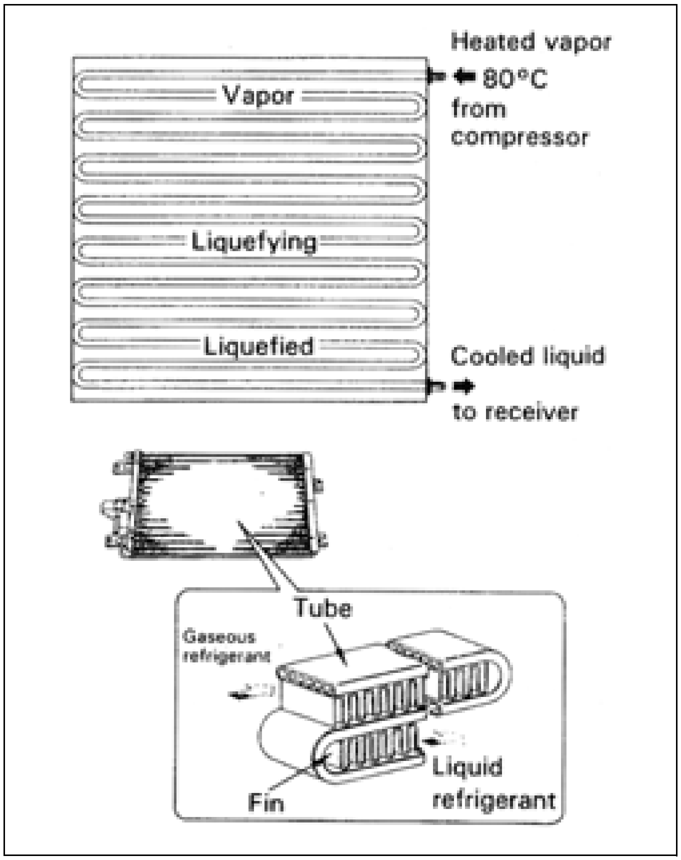


Fig. Single Pass Condenser

(2) Type of Condenser

To improve the cooling performance and decrease the weight and size of condenser, new types of condenser have been developed as follows:

1) Single Pass Type (Conventional type)
   As shown in Fig, the refrigerant gas flows only in one passage.
2) Two Pass (Passage) Type
   This condenser has the refrigerant passages in two directions to improve cooling performance.
3) Three Pass (Passage) Type
   This condenser has the refrigerant passages in three directions to improve cooling performance.
4) Multi Pass (Passage) Type
   This condenser has been developed to decrease its weight and size especially for HFC134a, new refrigeration cycle.

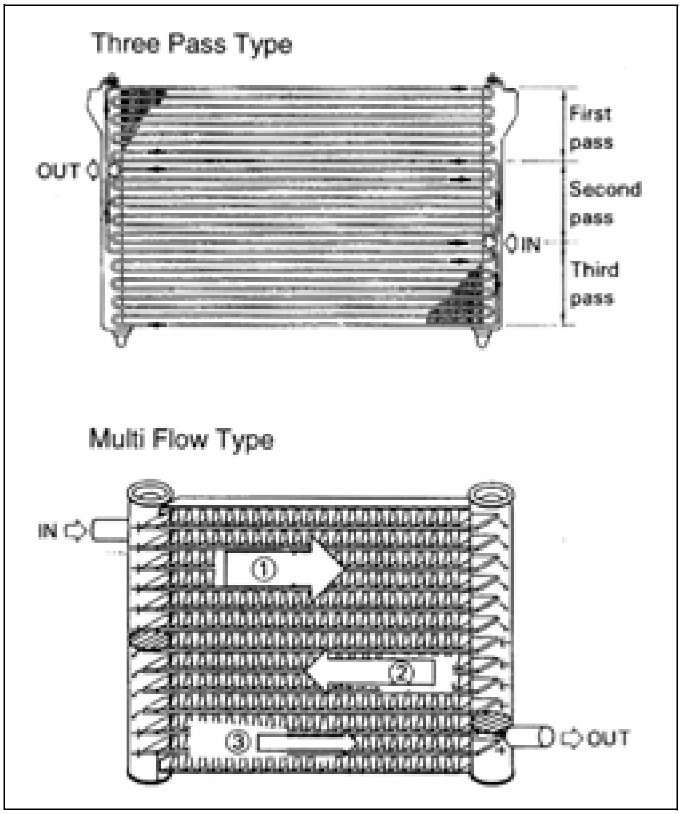
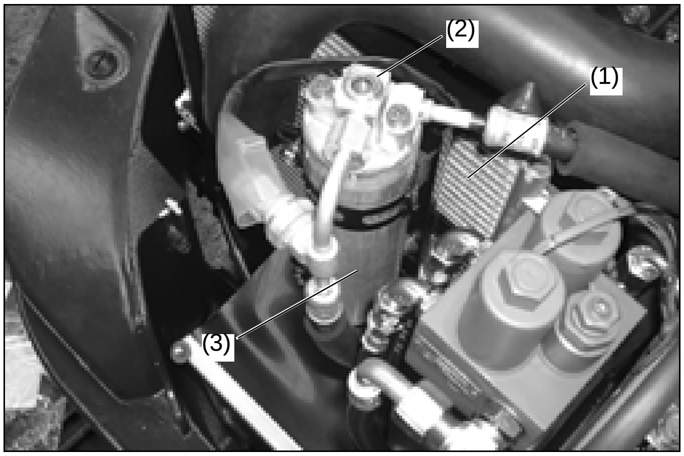
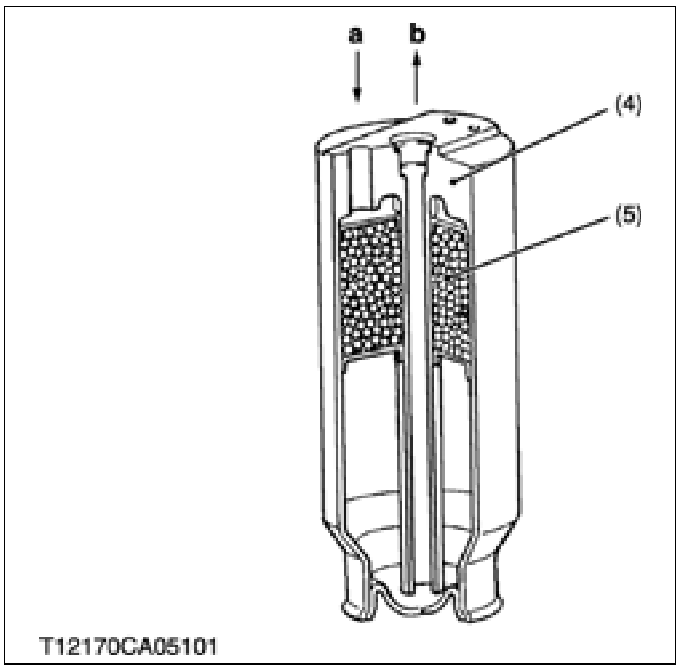


Fig. Three Pass Type and Multi Pass Type Condensers

e. Receiver





The receiver (3) serves the purpose of storing the liquid refrigerant. The amount of the liquid refrigerant flowing through the system varies with the operating condition of the air conditioner. To be accurate, the receiver stores excess amount of refrigerant when the heat load is lowered. It also releases stored refrigerant when additional cooling is needed, thus, maintaining the optimum flow of refrigerant within the system.
The receiver includes a desiccant (5). It has the job of removing moisture as the refrigerant circulates within the system.
The sight glass (2) is installed on the top of receiver. Amount of refrigerant to be charged is very important for the efficiency of air conditioner. The sight glass is used to check the amount of refrigerant. If large flow of bubbles can be seen in the sight glass, there is insufficient refrigerant charged. If so, replenish the refrigerant to the proper level.

(1) Condenser
(2) Sight Glass
(3) Receiver
(4) Receiver Body
(5) Desiccant (silicagel → zeolite)

a : IN
b : OUT

Desiccant changed from silicagel to zeolite for HFC134a type.

f. Dual pressure switch

(1) Location structure

The pressure switch is installed on the liquid tube between the receiver and the expansion valve. It detects abnormally high and low pressure of the refrigerant and switches off the magnetic clutch. Then the compressor operation is stopped, preventing potential trouble with the system.

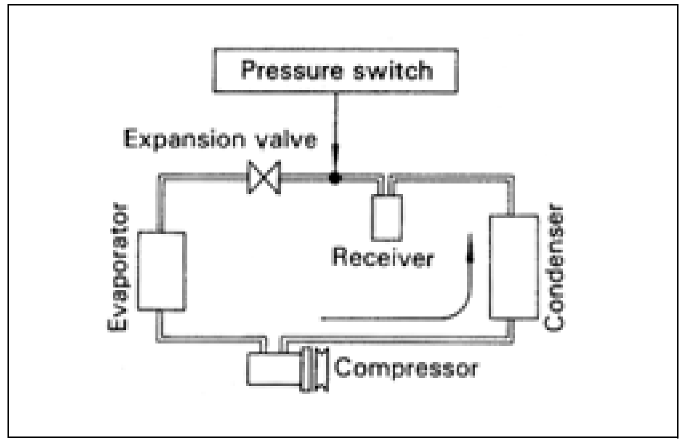


Fig. Location of Dual Pressure Switch

(1) Dual Pressure Switch

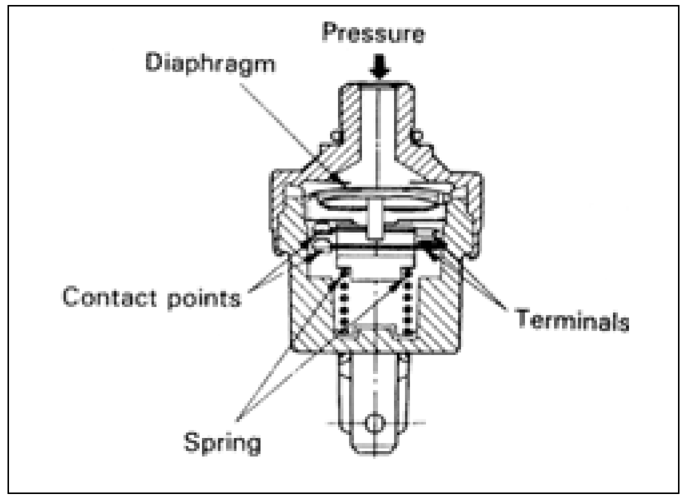


Fig. Dual Pressure Switch

(2) When the Pressure is Abnormally High

When the pressure in the refrigeration cycle becomes abnormally high, it may cause damage to various components.

When it detects abnormally high pressure, generally about 32 kg/cm^2 (3.14 MPa) the switch turns off. This turns the magnetic clutch off and stops the compressor (27 kg/cm^2 for CFC12).

(3) When the Pressure is Abnormally Low

When there is insufficient refrigerant and the pressure drops to 2.0 kg/cm^2 (0.20 MPa) or lower, the pressure switch turns off. This turns the magnetic clutch off and stops the compressor.

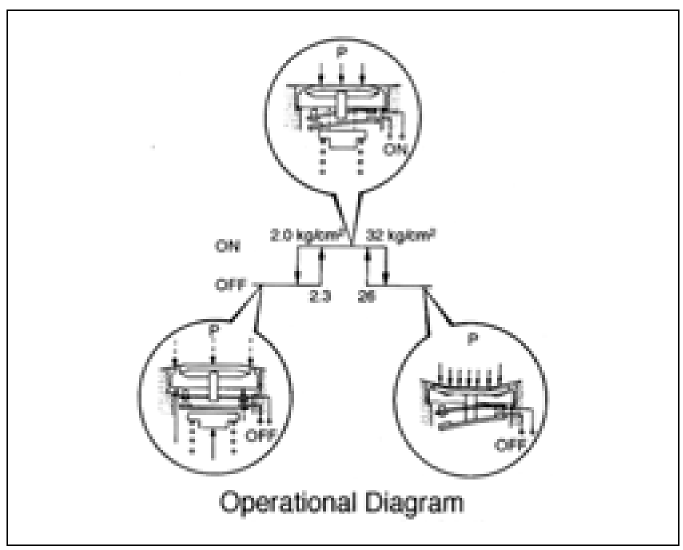
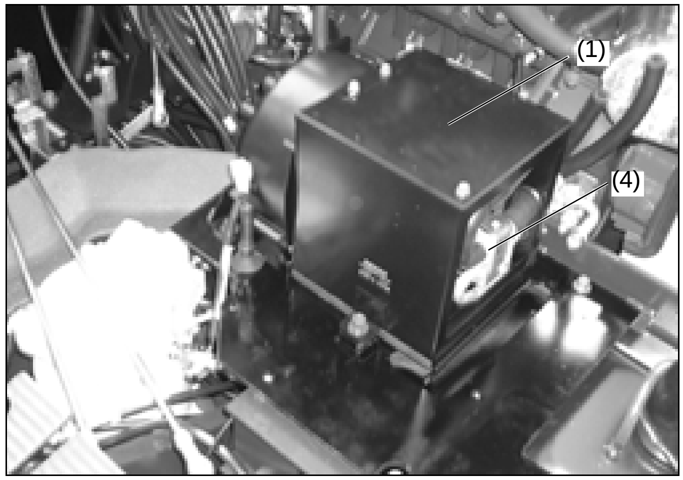


Fig. Operation of Dual Pressure Switch for HFC134a.

g. Air Conditioner Unit

Air conditioner unit (1) consists of evaporator (3), expansion valve (4), heater core (2), blower (5), etc..

(1) Air Conditioner Unit
(2) Heater Core
(3) Evaporator
(4) Expansion Valve
(5) Blower



h. Box type expansion valve

Some recent vehicle models use a box-type expansion valve. This expansion valve features an internal temperature sensing rod (equivalent to the temperature sensing bulb found in the conventional expansion valve, which makes the use of the conventional capillary tube.). This capillary tube is not necessary for the box type. In addition, the box-type construction, in which the refrigerant pressure at the evaporator outlet is applied directly to the temperature sensing rod side of the diaphragm, makes the use of the conventional equalizer pipe unnecessary.
In operation, the temperature sensing rod senses the temperature at the evaporator outlet and transmits to the diaphragm, causing the pressure of the gas that is contained in the diaphragm chamber to vary. As a result, the diaphragm moves, thereby controlling the opening and closing of the valve.

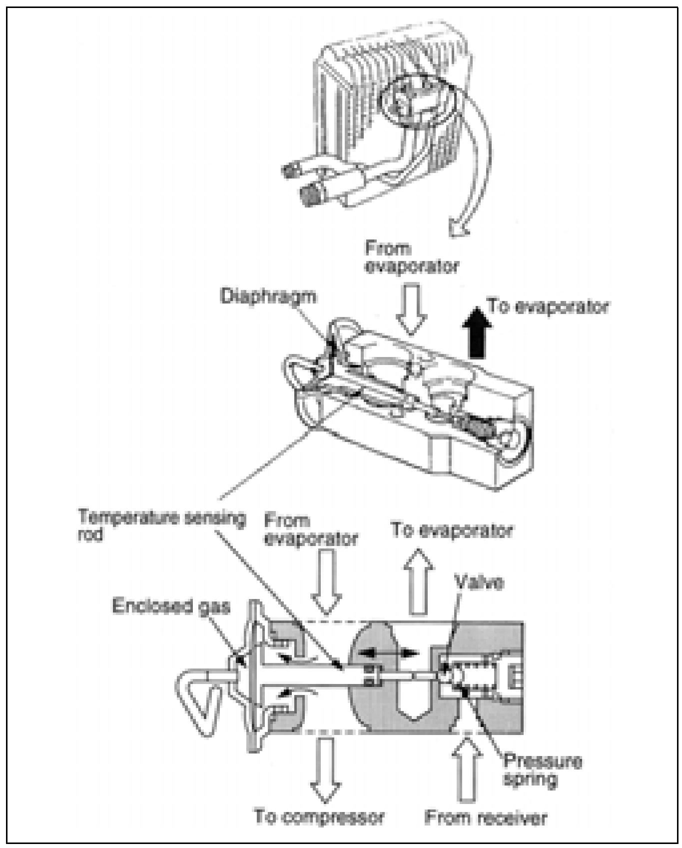


Fig. Box Type Expansion Valve

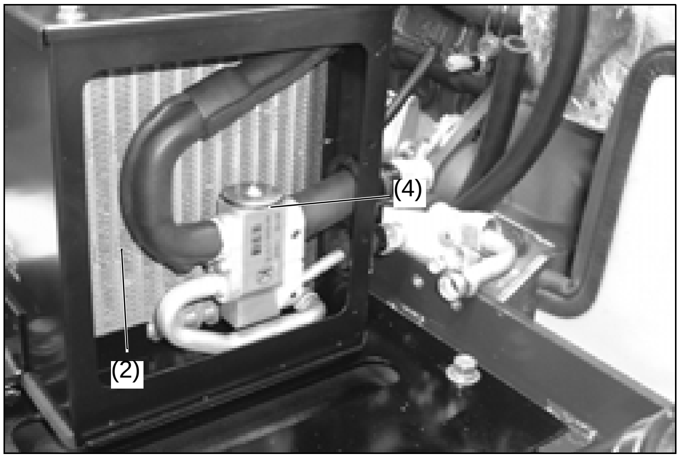
i. Evaporator

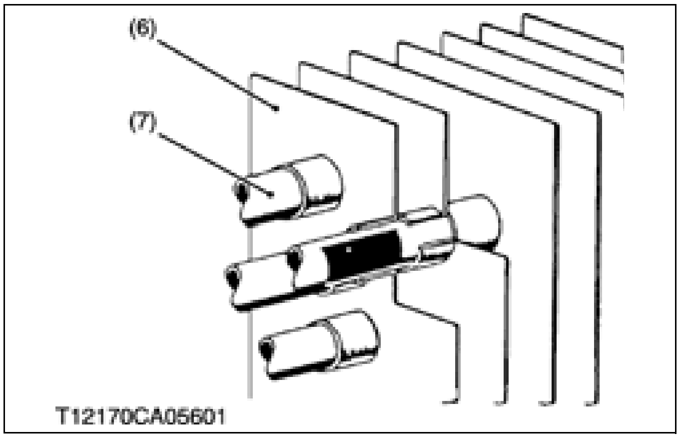
The purpose of evaporator (2) is just opposite to that of the condenser. The state of refrigerant immediately after the expansion valve (4) is 100% liquid. As soon as the liquid pressure drops, it starts to boil, and in doing so, absorbs heat. This heat is removed from the air passing over the cooling fins of the evaporator and causes the air to cool.

If too much refrigerant is sent into the evaporator, it will not boil away so easily. Also, the evaporator filled with liquid refrigerant eliminates a place for the refrigerant to properly vaporize, which is necessary in order to take on heat. A flooding condition of the evaporator will allow an excess of liquid refrigerant to leave the evaporator and may cause serious damage to the compressor.

If too little refrigerant is sent into the evaporator, again the evaporator will not cool because the refrigerant will vaporize, or boil off, long before it passes through the evaporator.

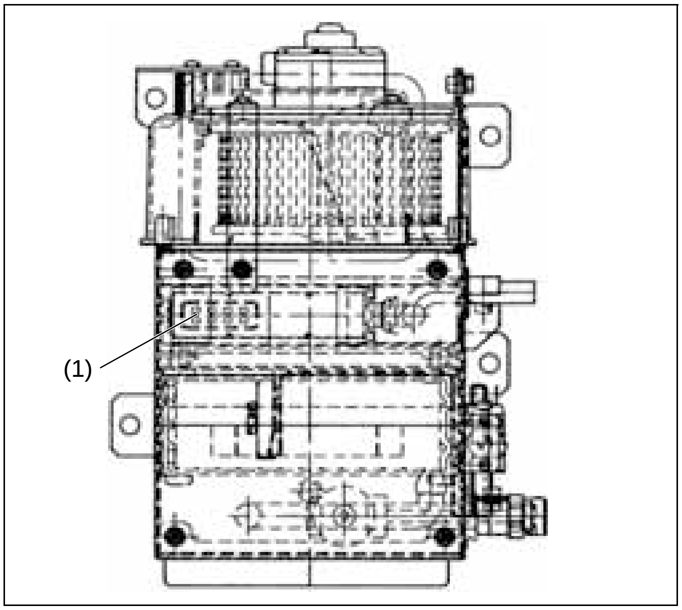
Refrigerant properly metered into the evaporator should allow for 100% liquid just after the expansion valve, and 100% gas at the outlet.





(1) Pressure Switch
(2) Evaporator
(3) Capillary Tube
(4) Expansion Valve
(5) Thermostat
(6) Fin
(7) Tube

j. Heater core



The heater-source of heater utilizes coolant which becomes high temperature by heat of engine.

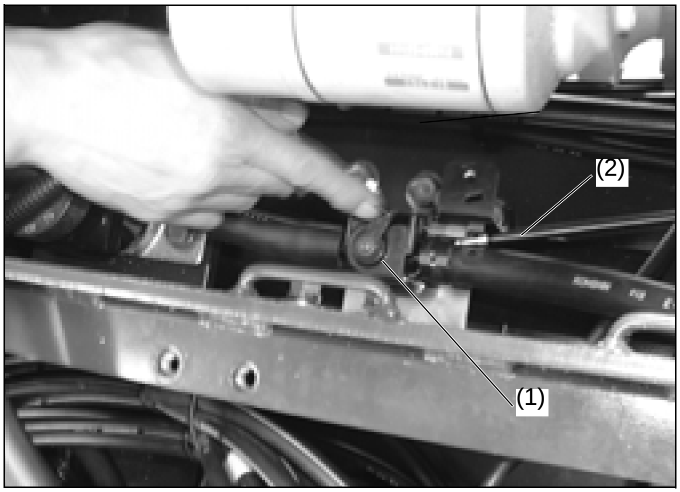
The inlet port heater core is connected to the delivery side of engine water pump by a rubber hose, and the water valve is installed on the inlet port of heater core.

Also, the outlet port of heater core is connected to the engine cylinder block.

The heater core (1) is one of the heat exchangers like evaporator or condenser, and heat is exchanged between heated coolant passing through the core and air in the cabin or fresh outdoor air. Thus, air is heated.

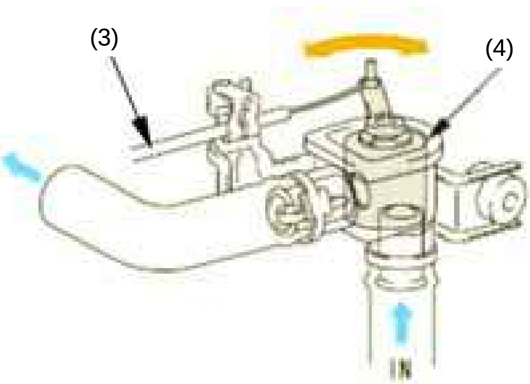
(1) Heater Core

k. Water valve



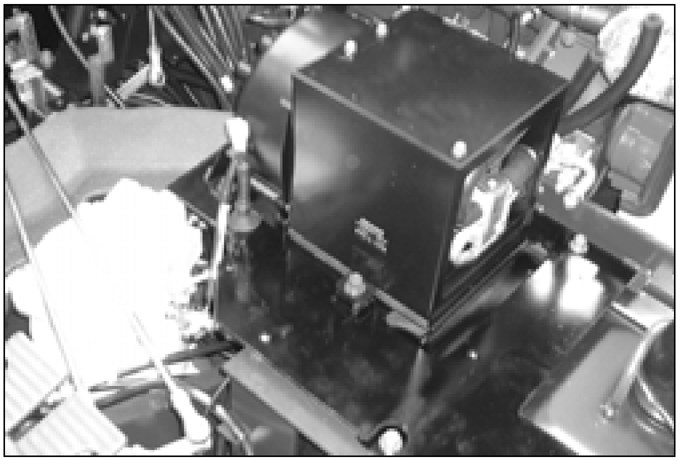
The hot water valve (1) is connected with the got water valve cable (2) and controlled with the temperature control lever on the control panel. This lever is used to adjust the flow rate of hot water going into the heater.
Set the temperature control lever to the COOL position and the hot water valve gets closed, allowing no hot water flow. The hot water valve is built in at the right-hand top of the center pillar.

(1) Hot Water Valve
(2) Hot Water Valve Cable



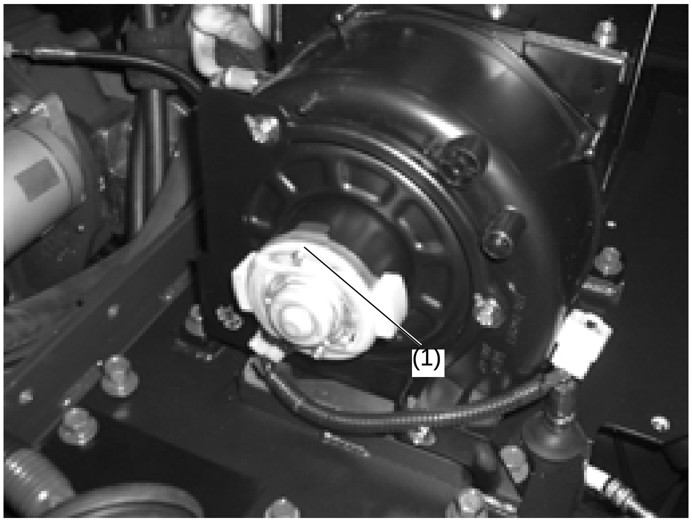
(3) Cable (control panel side)
(4) Rotary valve

I. A/C blower



The blower is incorporated in the right-hand space of the air conditioner unit. It blows cool, warm of fresh air via the front and side blow ports into the cabin.
The speed of the blower motor (1) can be adjusted in 3 steps by the resistor (2).
The blower fan (3) is centrifugal type. The air being sucked in parallel with the rotary shaft is blown in the centrifugal direction; in other words, perpendicular to the rotary shaft.

(1) Blower Motor
(2) Resistor
(3) Blower Fan



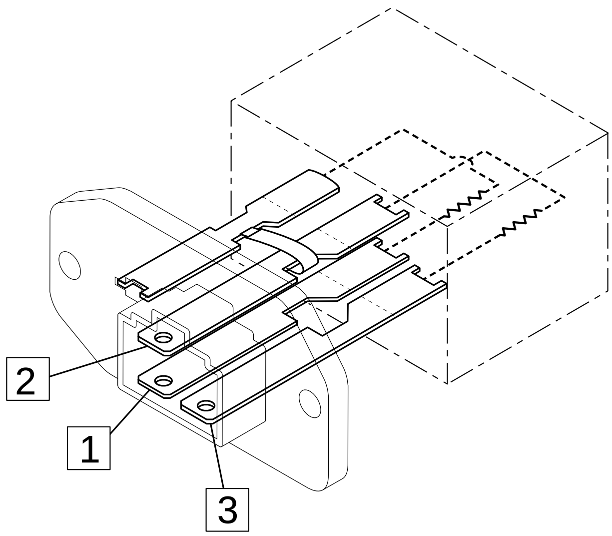
(1) Blower Motor

m.A/C blower resistor

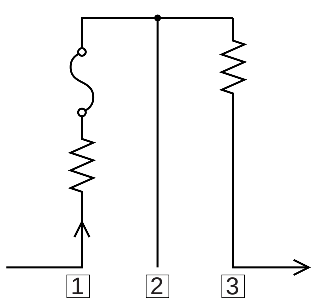
1 Main functions are ;

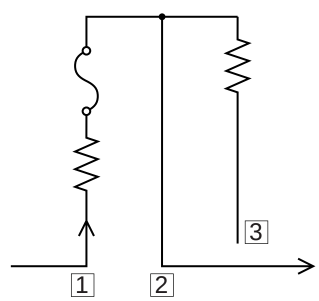
1. Two resistors regulate the blower speed according to the A/C blower switch speed range.
2. Fuse prevents the blower from burning out.

2 Structure

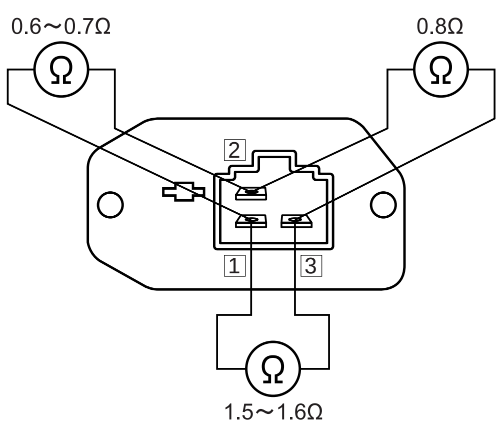


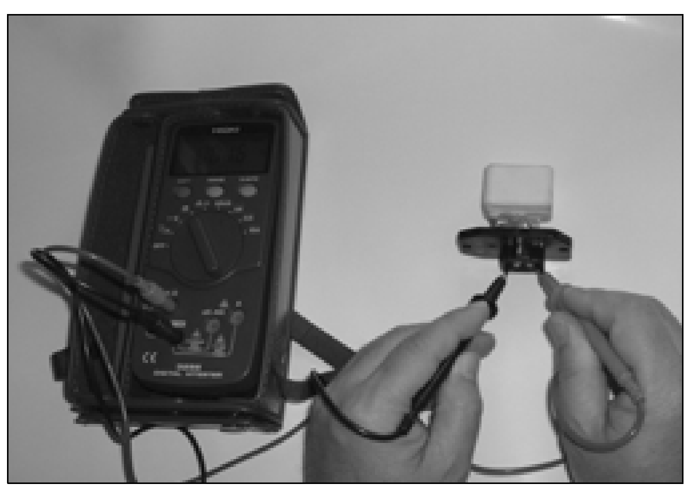
3 Current flow



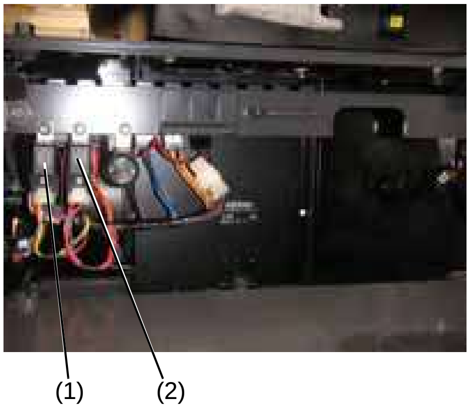


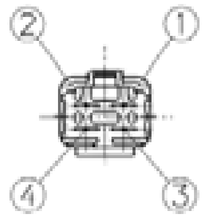
4 Testing

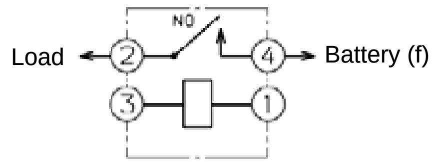




n. Relays







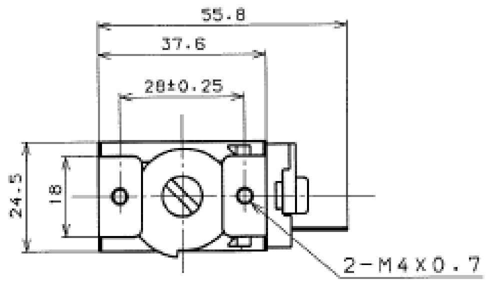
(1) Clutch relay
(2) Blower relay

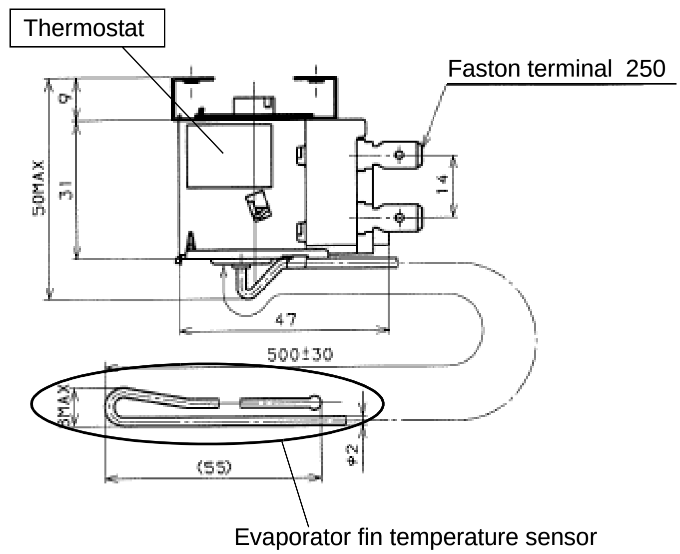
D.Frost control

Function

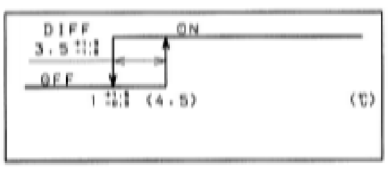
The evaporator fin temperature is sensed. If detected too low, the compressor is interrupted to prevent the evaporator from freezing.

a. KX121-3, 161-3



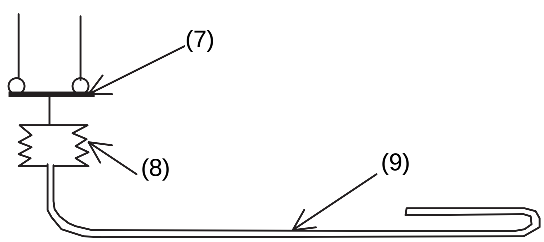


Activating temperature characteristic



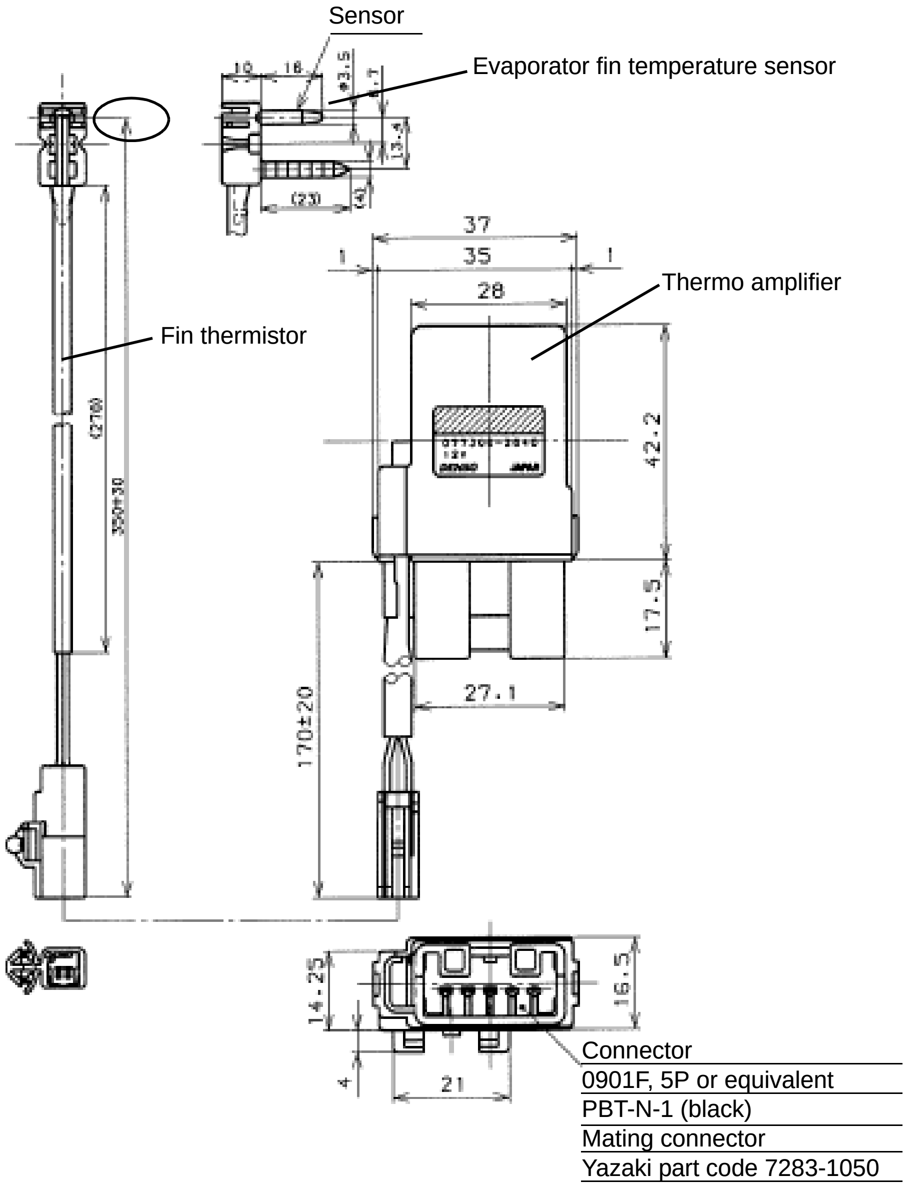
Function

The evaporator fin temperature is sensed by a refrigerant-filled capillary tube. If the temperature drops below a specified level, the pressure in the internal bellows drops too. The contact is now broken to turn off the compressor clutch power.



(7) Contact
(8) Bellows
(9) Capillary tube

b. KX080-3



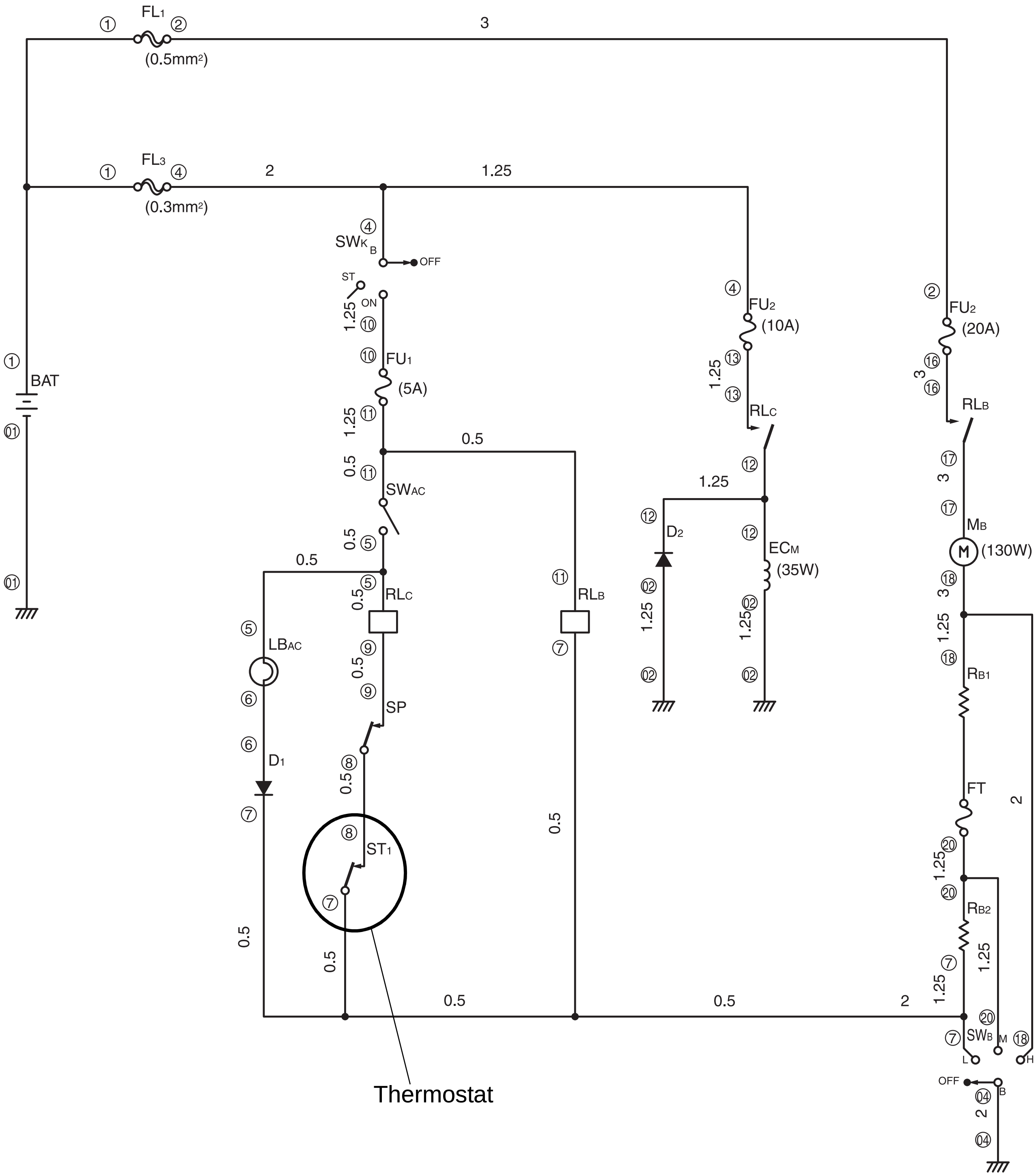
Specifications			
Rated voltage	DC12V		
Measuring conditions	DC13 0.2 V at 25 5°C		
Temperature detection (RTH) (Note 4)	OFF R1	4383 131 Ω	(2°C)
	ON R2	(4095 Ω)	(3.35°C)
	Hysteresis	215^{+145} 0 Ω	(1°C)
Operating conditions			
Operating temperature range	-30 80°C		
Operating voltage range	DC10 16V		
Activating voltage range	DC8 1GV (at 25°C)		

Function

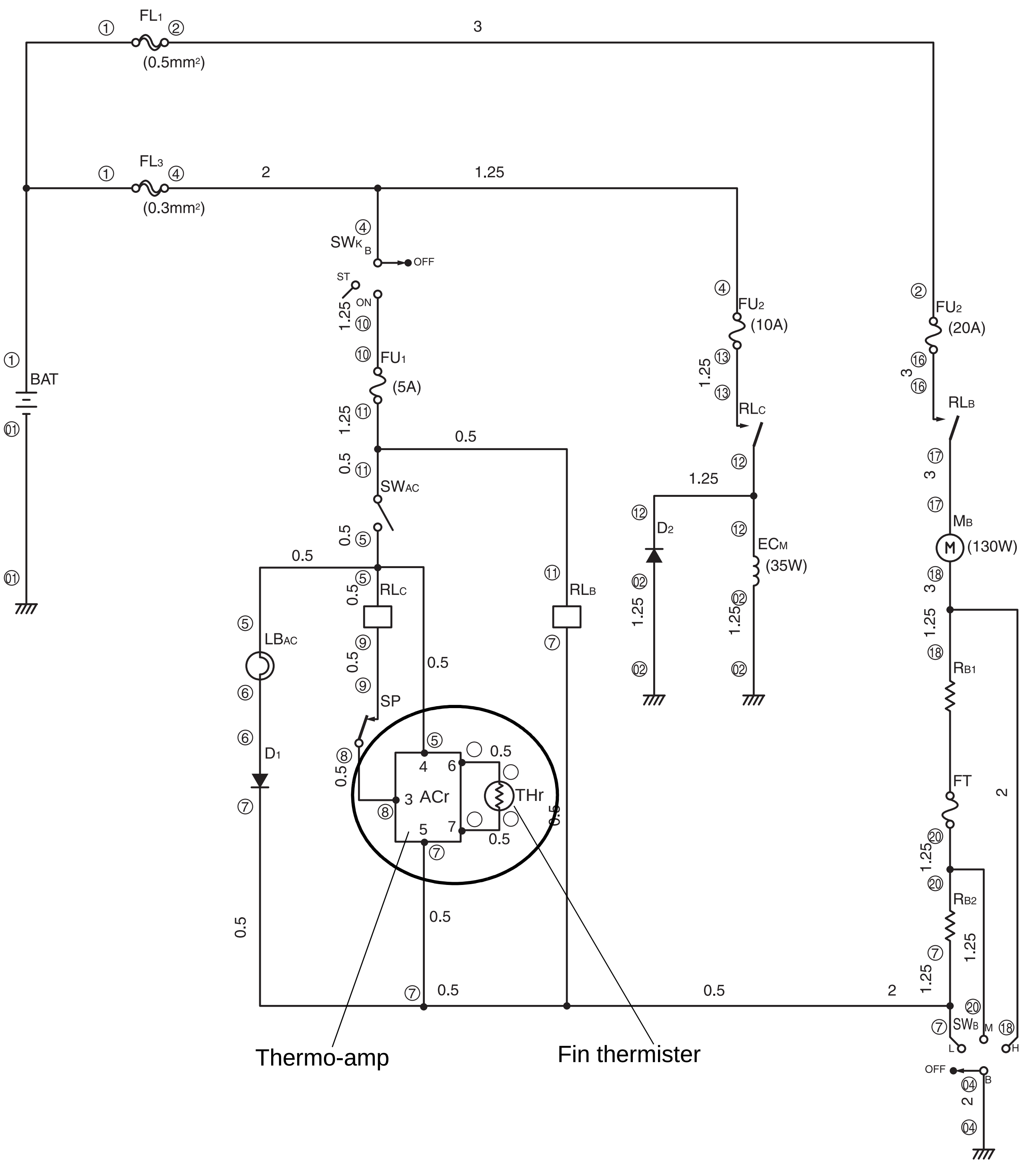
The evaporator fin temperature is sensed by the sensor of fin thermistor. If the sensor s internal resistance rises above the thermo amplifier s set resistance, the internal circuit is activated to turn off the compressor clutch power.

E.Electric circuit diagram

a. KX121-3, 161-3



b. KX080-3


FL1
(0.5mm2)
FL3
(0.3mm2)
BAT
SWKB
OFF
ST
ON
FU1
(5A)
SWAC
RLC
RLB
LBAC
D1
SP
ACr
THr
FU2
(10A)
FU2
(20A)
D2
ECM
(35W)
MB
(130W)
RB1
FT
RB2
SWB
OFF
Thermo-amp
Fin thermister

I. Air Conditioner (Service)

Ser ice Section

A.Servicing specifications

a. Specifications of A/C system and components

	Item			Specifications	Remarks
Performance	Cooler		Capacity	2.8 kW 10%	Outside air: 35 C Inside air: 27 C, 50% Rotating speed of Comp: 1800 rpm Terminal voltage of blower motor: 13.5 V Vehicle duct resistance: 310 Pa (including air supply grille)
			Airflow	280 m^3/h 10%	
			Power consumption	150 W 10%	
	Heater		Capacity	3.6 kW 10%	Difference between air and water temperatures: 65 C Hot water flow: 6 L/min Terminal voltage of blower motor: 13.5 V Vehicle duct resistance: 460 Pa (including air supply grille)
			Air flow	250 m^3/h 10%	
			Power consumption	140 W 10%	
Component	Compressor assembly	Compressor	Model	SV07E	
			Piston displacement	70 cm^3	
			Rotating speed	700 6000 rpm	
			Lubricant	ND-0il 8 140 10 cm^3	
		Magnet clutch	Model	K20	
			Drive belt	Single HM,33.5 inch	Deflection : 12 - 15 mm at 6 7 kgf
			Pulley efficacy	dia. 108	Nut tightening torque = 19.6 N·m (200 kgf·cm)
			Power consumption	35 W or less	
		Weight		2.82kg	
	Condenser	Specifications of core	Dimensions (mm)	Height 264.2 Width 325 Thickness 16.1	
			Fin type	Corrugated fin, 3.6 mm (With louver)	
		Weight		1.1 kg	
	Cooler unit	Specifications of core (cooler)	Dimensions (mm)	Height 165 Width 163.5 Thickness 58	
			Fin type Pitch	Corrugated fin, 4 mm	
		Specifications of core (heater)	Dimensions (mm)	Height 140 Width 122.5 Thickness 21	
			Fin type Pitch	Corrugated fin, 1.8 mm	
		Motor	Motor type	dia.70 ferrite motor	
			Rotating speed	3350rpm 10%	12 V
			Current	12 A or less	
		Weight		6.9 kg	
	Receiver	Actual capacity		370 cm^3	Inner gas = N_2
		Moisture absorption capacity		32 g	60 C, 90% in air (Desiccant: 290 g)

		Item	Specifications		Remarks
Component	Pressure switch	High-pressure relief	Opening pressure	3.43 4.1 MPa	Installed in the compressor
			Closing pressure	2.75 MPa or more	
		High-pressure OFF	3.14 MPa (DIFF 0.59 MPa)		High-pressure cut
		Low-pressure OFF	0.196 MPa (DIFF 0.02 MPa)		Low-pressure cut (prevention of operation without gas)
Refrigerant used			HFC134a		
Engine pulley			140		Code No. : RD411-55161
Compressor pulley			120, w =11.7, θ= 36		

b. Performance specifications

Item		Specifications	Remarks
Noise level at ear point db(A)		80, 82	
Duct sealing capacity	Air flow speed out of grille A (m/s)	17.0, 17.0	Engine : MAx., Blower : MAX. All outlet except A are closed.
Heater capacity	Air temp. out of grille A (°C)	45.0, 45.0 5 min. later	Engine : Max. Blower : Max. A/C switch : OFF, 4 outlets : Open Measuring point : 20 - 30 mm lower from grille A.
Cooler capacity	Air temp. out of grille A (°C)	10.0 at ambient temp. =35 °C within 10 min.	Engine : Max. Blower : Max. A/C switch : ON, 4 outlets : Open Measuring point : 20 - 30mm lower from grille A.
		15.0 at ambient temp. 35 °C within 10 min.	

c. Adjustment and testing

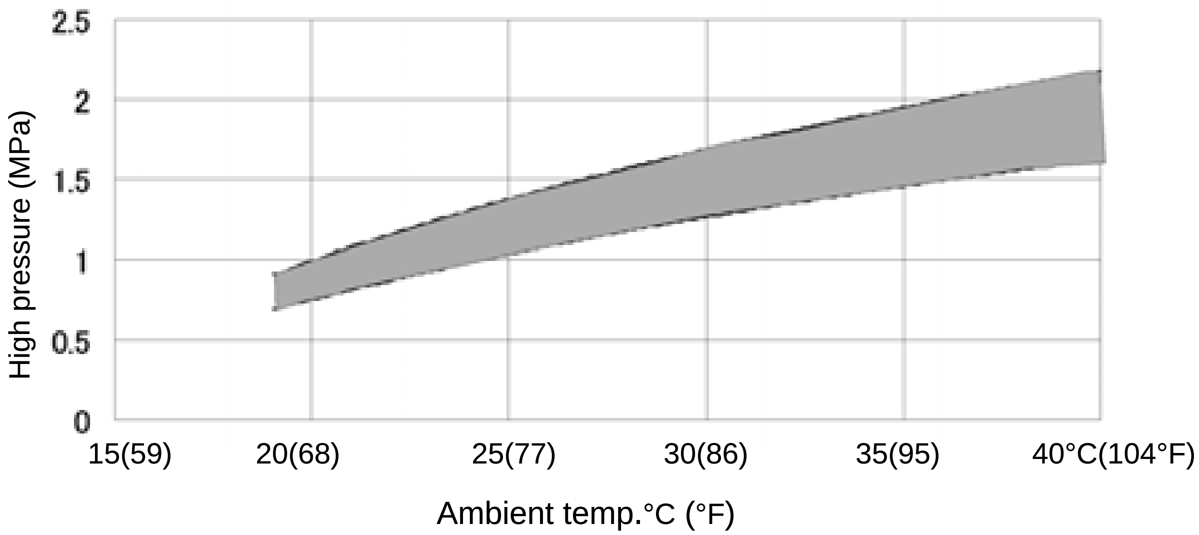
Item		Factory Specification	Allowable Limit
Refrigerant amount	Type : R134a	800 50 g 1.76 0.11 lbs	
Lub. oil amount in total system	Type : ND-Oil 8	140 10 cc 0.037 0.003 us gal	In new compressor
Air-gap of A/C Compressor Magnet Clutch	Swash Plate Type Compressor Scroll Type Compressor	0.25 to 0.50 mm 0.010 to 0.020 in. 0.35 to 0.65 mm 0.014 to 0.022 in.	
Refrigerating Cycle (Refrigerating Cycle is Normal Operating) Condition Engine Speed : Approx. 1500 min-1 (rpm) Ambient Temperature : 30 to 35 °C 86 to 95 °F Blower Switch : High position	Pressure (Pressure Side) Pressure (**HI** Pressure Side)	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi 1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi	
Pressure Switch (Dual Type) (When pressure switch is turned **FF**)	Setting Pressure (Pressure Side) Setting Pressure (**HI** Pressure Side)	Less than Approx. 0.196 MPa 2.0kgf/cm^2 28.4psi More than approx. 3.14 MPa 32 kgf/cm^2 455 psi	
Air Conditioner Drive Belt	Tension	12 to15 mm (0.47 to 0.59 in.) deflection at 58.8 68.6 N (6 7 kgf, 13.2 15.4 lbs) of force	

d. Ambient temperature vs normal high-low pressure range

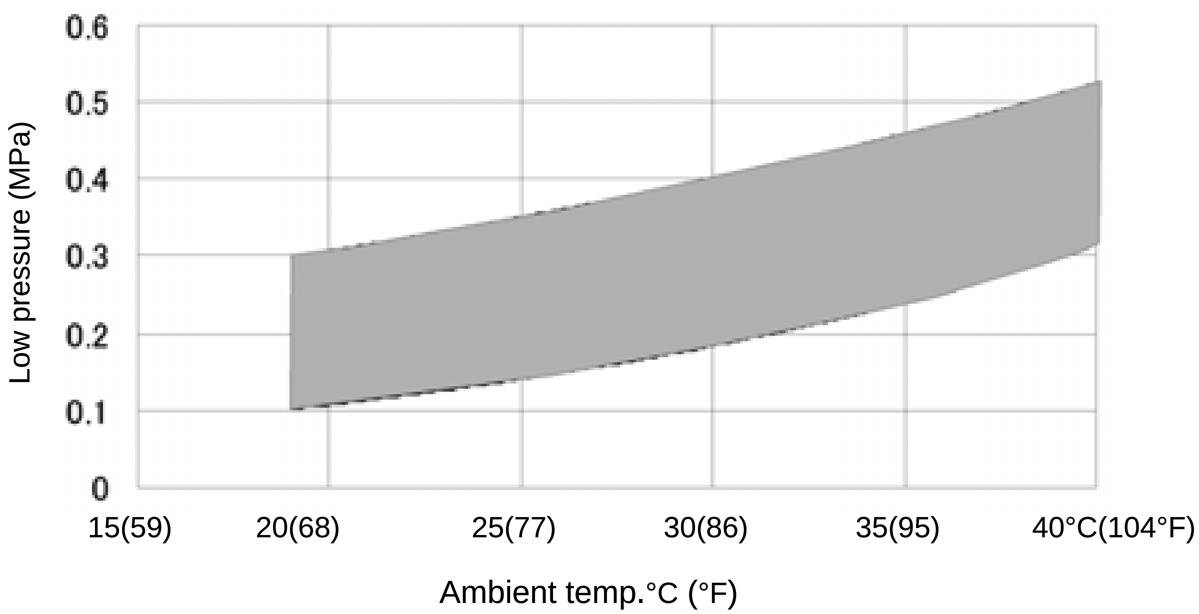
Conditions :

Door	; open
Blower	; High range
Temp. control	; Max. cool
Engine speed	; 1500 rpm

Normal high pressure range



Normal low pressure range



1 MPa = 10.2 kgf/cm^2 = 145 psi

e. Tightening torques

Tightening torques of screws, bolts and nuts on the table below are especially specified.
(For general use screws, bolts, and nuts : See page G-11.)

Item	N•m	kgf•m	ft-lbs
Cabin mounting nuts			
M14 nut	107.9 to 125.5	11.0 to 12.8	79.6 to 92.6
M16 nut	166.7 to 191.2	17.0 to 19.5	123.0 to 141.0
Compressor mounting screw, M8 bolt	16.7 to 19.9	1.7 to 2.0	12.3 to 14.5
Compressor bracket mounting screws			
Screws M12	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
Screw M8	16.7 to 19.6	1.7 to 2.0	12.3 to 14.5
Receiver mounting bolt (M6)	3.9 to 6.9	0.4 to 0.7	
Clutch mounting screw (Slide vane type compressor)	10.8 to 16.2	1.10 to 1.65	8.0 to 11.9
High pressure pipe screw and retainer nut			
between compressor and condenser (High pressure pipe 1)			
screw	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M22 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
between condenser and receiver			
screw, M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
between receiver and A/C unit (High pressure pipe 2)			
retaining nut, M16 x 1.5	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
Low pressure pipe			
between A/C unit and compressor			
screw, M6 bolt	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
retaining nut, M24 x 1.5	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
A/C unit mounting screws (M6)	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
A/C unit mounting screws (M8)	9.8 to 15.7	1.0 to 1.6	7.23 to 11.6

Reference: Lub.oil

Replacing Parts	Approx Replenish Quantity	Brand Name
Condenser	20 cc 0.021 U.S.qts. 0.018 Imp.qts.	ND-OIL 8 PAG oil
Evaporator	20 cc 0.021 U.S.qts. 0.018 Imp.qts.	
Receiver	10 cc 0.011 U.S.qts. 0.009 Imp.qts.	

PAG : Polyalkyleneglycol (Synthetic oil)

B.Regular check and service points

a. Maintenance interval ; Air conditioner

No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			50	100	150	200	250	300	350			
1	Inner air filter	clean				○				every 200 hrs	1	2
		replace								every 1000hrs	1	2
2	Outer air filter	clean				○				every 200 hrs	1	2
		replace								every 1000 hrs	1	2
3	Air conditioner condenser	clean				○				every 200 hrs	2	
4	Air conditioner drive belt	check				○				every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

No.	Items	Period	Indication on hour meter							Since then	Reference No.	
			400	450	500	550	600	650	700			
1	Inner air filter	clean	○				○			every 200 hrs	1	2
		replace								every 1000hrs	1	2
2	Outer air filter	clean	○				○			every 200 hrs	1	2
		replace								every 1000 hrs	1	2
3	Air conditioner condenser	clean	○				○			every 200 hrs	2	
4	Air conditioner drive belt	check	○				○			every 200 hrs	3	
5	Air conditioner pipes and hoses	check								every 1 year		
		replace								every 2 years		
6	Refrigerant (gas)	check								Service as required		

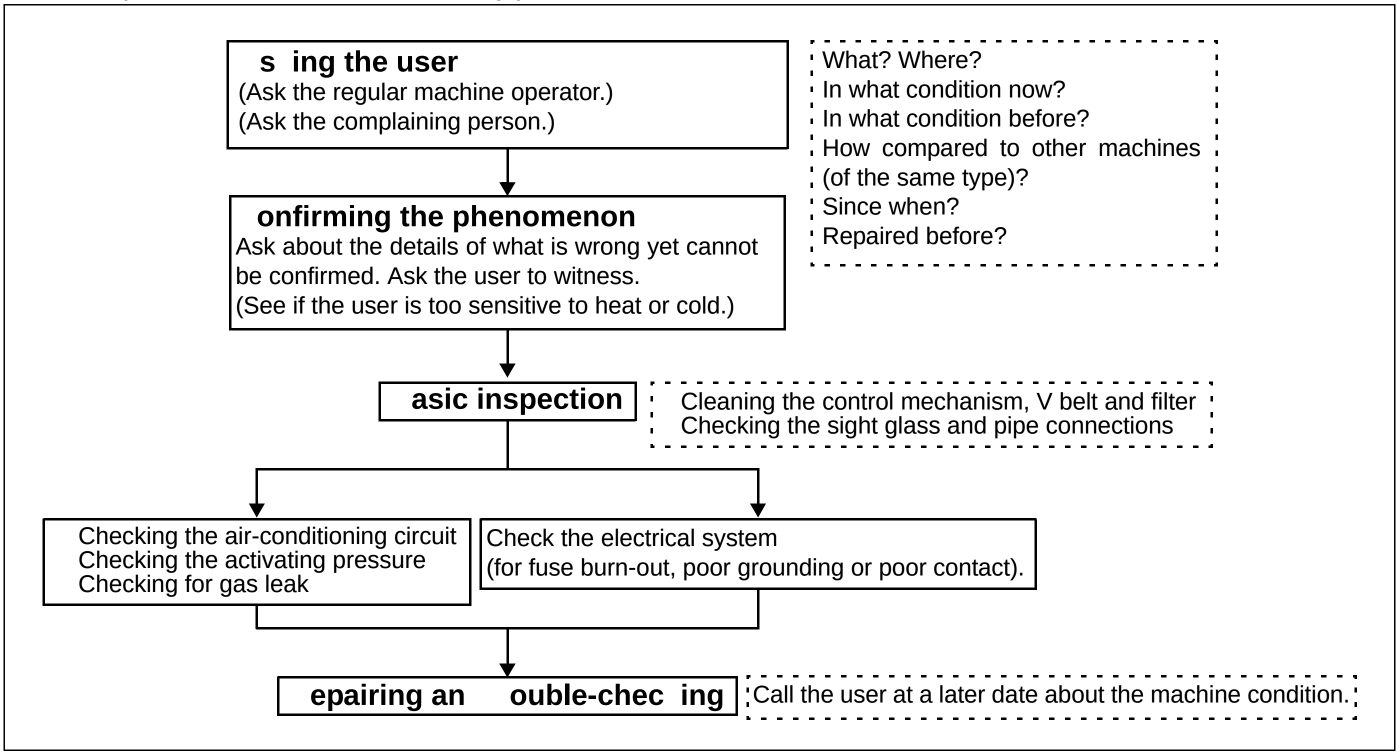
Important

2 Clean and replace the air filter more frequently if used under dusty conditions. By heavy soiling, replace the filter.

C.Troubleshooting

a. Procedure

The chart shows the basic troubleshooting procedure.
Car air conditioner troubles are roughly classified in the refrigeration cycle and electrical system. In this chapter the basic troubleshooting procedure is discussed.



b. Asking the user and confirming the phenomenon

Before troubleshooting, it is essential to fully understand what is wrong and how it happened. If a trouble occurs from time to time or if it cannot be reproduced, in particular, the first step must be to ask the machine operator about the situation of the trouble.

What to ask

What	Type of machine, model of engine, model of air conditioner
When	Date, time, how often
Where	Worksite (road) condition
Why	Running condition, weather
How	Feeling of phenomenon

c. Troubleshooting from problem symptoms (except refrigeration cycle troubles)

You will find the troubles easily using the table below. For details, refer to each troubleshooting chart.

No.	Problem	Main Inspection Areas: Fuses	Connectors	Wire harness	Body ground	1 Sensor circuit	Others	Refer to page
1	Fuse is blown out easily	○	○	○	○			
2	No blower operation	○	○	○	○		Blower motor, Blower resistor, Blower switch	
3	Blower speed does not change	○	○	○	○		Blower resistor Blower switch	
5	No compressor operation	○	○	○	○		Magnetic clutch relay Compressor A/C switch	
6	A/C lamp does not light	○	○	○	○		A/C switch	
7	A/C lamp flashes. (only for compressor with lock sensor)	○	○	○		○	Compressor, V-ribbed belt Magnetic clutch	
8	No A/C operation (No cool air comes out)	○	○	○	○			
9	Room temp. does not decrease (insufficient cooling)	○	○	○	○	○		
10	No warm air comes out						Engine coolant volume, A/C temp. control lever Heater radiator	

ote : 1 : Sensors are thermistor, pressure switch and water temp. switch.

d. Connecting the pipes

(1) Replacing the O-rings

Replace the O-rings with new ones (for R134a and R12). Use a toothpick for removing the old O-rings.
When connecting the pipes, be sure to apply compressor oil to them.
Tighten the connections to their specified torques.

Connection	Tube size or bolt size	Tightening torque
Nut	ϕ8 pipe	12 15 N m (120 150 kmf/cm^2)
	ϕ1/2 pipe	20 25 N m (200 250 kmf/cm^2)
	ϕ5/8 pipe	30 35 N m (300 350 kmf/cm^2)
Block joint	M6 bolt (4T) at receiver	4.0 7.0 N m (40 70 kmf/cm^2)
	Other M6 bolts (6T)	8.0 12.0 N m (80 120 kmf/cm^2)

Compressor oil (spray type): ND-OIL8 (995500-0300)

(2) Charging compressor oil in replacing the functional parts

	Condenser	Evaporator	Receiver	Pipes
Oil charge	40 cc	40 cc	10 cc	10 cc (scroll)
				20 cc (swash plate type)

Compressor: Charge the same amount of oil as that of the old compressor.
Compressor oil:ND-8 for the scroll (SCS) and swash plate types
ND-OIL9 for the vane (SV) type

ote : An open oil container is easy to absorb moisture from the air. Close the lid immediately after use.

e. Checking the refrigeration cycle

Troubleshooting the refrigeration cycle

hec ing the refrigeration cycle

hec ing the refrigerant amount Using a gauge manifold
Using the sight glass

hec ing the refrigerant gas pressure Using a gauge manifold

epairing efecti e spot(s)

eco ering the refrigerant

eplacing efecti e part(s)

harging the refrigerant

ouble-chec ing

erformance test

(1) Checking the refrigerant amount

1. Using a gauge manifold

1) Attach a gauge manifold in position and place the machine in the following conditions.

Item	Conditions
Door	Fully open
Air conditioner (magnetic clutch)	ON
Engine rpm	1500 rpm
Inside/outside air select damper position	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI
High-pressure side level	Below 1.86 MPa (19 kgf/cm^2)

1: If the outside air temperature is higher than 40°C, the high-pressure side level may be above 1.86 MPa (19 kgf/cm^2) in the above conditions. In such case, (1) fully close the door and set the blower speed to LO, and/or (2) park the machine in a workshop or in the shade, in order to get the level lower than 1.86 MPa (19 kgf/cm^2).

2) Check the pressure reading of the gauge manifold.

Pressures when the refrigerant gas charge is as specified

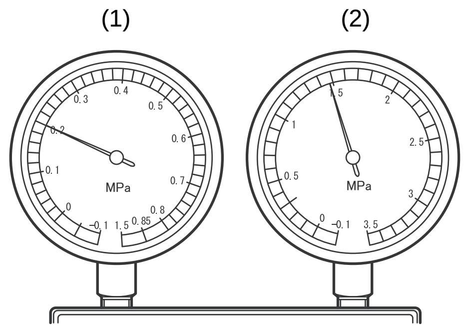
Low-pressure side level	0.15 0.25 MPa (1.5 2.5 kgf/cm^2)
High-pressure side level	1.37 1.57 MPa (14 16 kgf/cm^2)

Reference

On the EPR (Evaporator Pressure Regulator) type car air conditioner, the low-pressure side level rises and drops from the level of about 0.18 MPa (1.8 kgf/cm^2) at regular intervals, if the outside air temperature is low.

The gauge manifold may read somewhat different pressures depending on the conditions.

An overcharge of refrigerant may cause poor cooling effect, overheat or other trouble.



(1) Low-pressure side
(2) High-pressure side

2. Using the sight glass

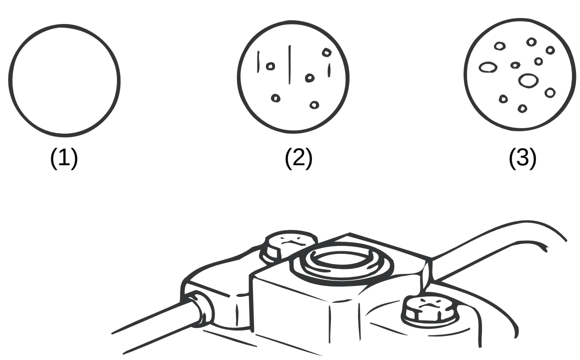
1) Place the machine in the following conditions.

Item	Conditions
Door	Fully open
Air conditioner (magnetic clutch)	ON
Engine rpm	1500 rpm
Inside/outside air select damper position	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI

2) Look at the sight glass to see how well the refrigerant flows in the air conditioner circuit.

For all the systems other than subcool condenser type

Refrigerant charge	Condition
Proper amount	No or little bubbles are contained. Gradually raise the engine speed from idling to 1500 rpm, and the bubbles disappear and the fluid becomes transparent.
Overcharge	No bubbles are contained. The pressures at both the high-pressure and low-pressure sides are too high, resulting in poor cooling effect.
Refrigerant shortage	Bubbles appear continuously.



(1) Too much
(2) Proper
(3) Too short

(2) Using a gauge manifold

1. Using a gauge manifold, measure the pressures at the low-pressure and high-pressure sides of refrigeration cycle.
2. Attach a gauge manifold in position and place the machine in the following conditions.

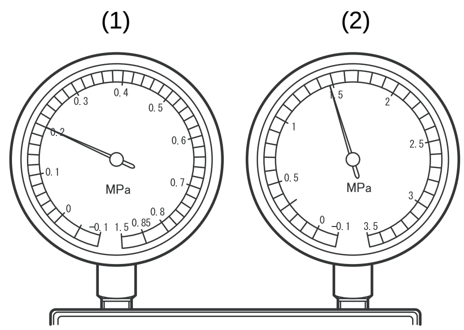
Item	Conditions
Engine	Warmed up
Door	Fully open
Air conditioner	ON
Engine rpm	1500 rpm
Inside/outside air selection	Inside air mode
Temperature setting	MAX COOL (Coolest)
Blower speed	HI
Air conditioner suction port temperature	30°C 35°C

Reference

On a machine equipped with variable displacement compressor or EPR, the suction pressure is controlled. Even if the low-pressure side level is not as specified, the gauge may fail to show such error. In such case, consider the high-pressure side level, blow-out temperature, sight-glass bubbles and other factors to make an overall judgment.
The gauge manifold may read somewhat different pressures depending on the conditions.

1) Normal condition

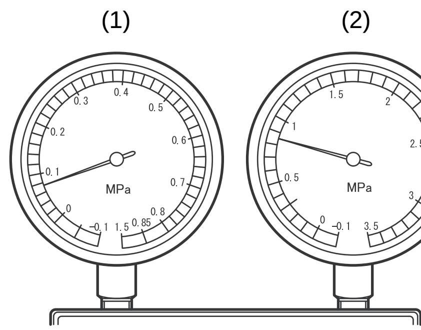
Low-pressure side level	0.15 0.25 MPa (1.5 2.5 kgf/cm^2)
High-pressure side level	1.37 1.57 MPa (14 16 kgf/cm^2)



(1) Low-pressure side
(2) High-pressure side

2) Refrigerant shortage

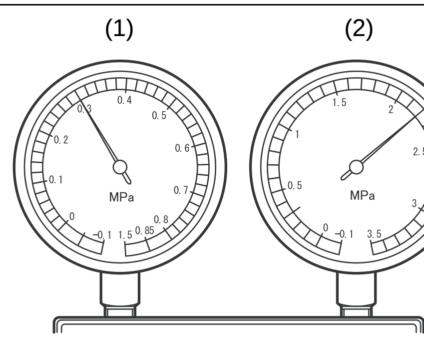
Phenomenon	Possible cause	Correction
Too low pressure at both low-pressure and high-pressure sides Bubbles flowing continuously in the sight glass Poor cooling effect	Refrigerant too short. Gas leak.	Pinpoint and repair the leaky spot. Add refrigerant.



(1) Low-pressure side
(2) High-pressure side

3) Too much refrigerant and poor condenser cooling

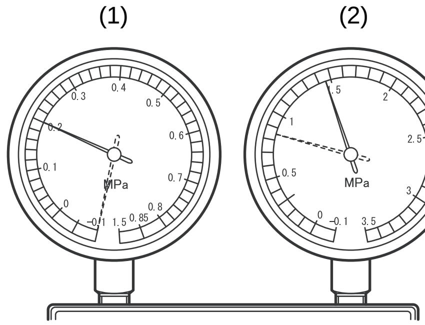
Phenomenon	Possible cause	Correction
Too high pressure at both low-pressure and high-pressure sides No bubbles appearing in the sight glass even at low rpm Poor cooling effect	Refrigerant too much Poor condenser cooling effect	Optimize the refrigerant amount. Clean the condenser fins. Check the machine s cooling system (electric fan, etc.).



(1) Low-pressure side
(2) High-pressure side

4) Water mixed in the circuit

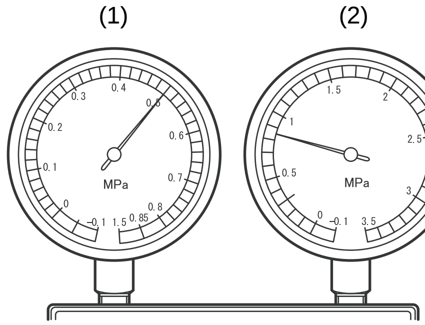
Phenomenon	Possible cause	Correction
Gradual drop to negative pressure at low-pressure side after a certain period of use	Water mixed (Water mixed in the refrigeration cycle freezes at the extension valve port, which temporarily blocks the refrigerant flow. After the ice has thawed, the normal state resumes.)	Do the complete vacuuming before charging fresh refrigerant into the receiver (dryer). This helps keep off water.



(1) Low-pressure side
(2) High-pressure side

5) Poor compressor performance

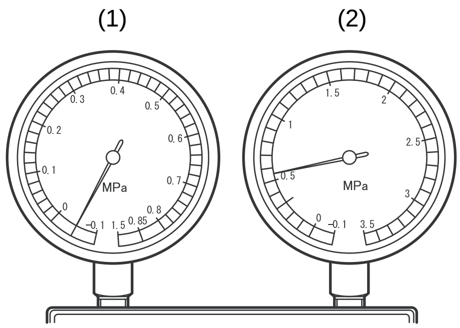
Phenomenon	Possible cause	Correction
Too high pressure at low-pressure side and too low pressure at high-pressure side Same pressure levels at high-pressure and low-pressure sides soon after the air conditioner is turned off	Compressor in trouble	Check and repair the compressor as required.



(1) Low-pressure side
(2) High-pressure side

6) No refrigerant circulation (clogged circuit)

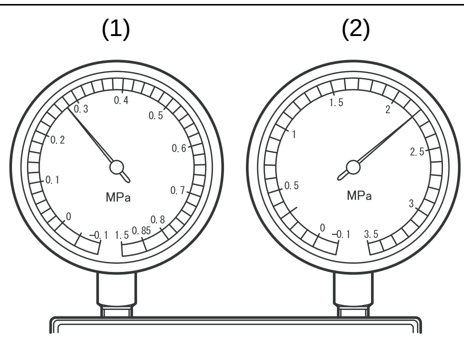
Phenomenon	Possible cause	Correction
Negative pressure immediately shown at low-pressure side if the circuit is fully clogged. Gradual drop to negative pressure at low-pressure side if the circuit is partially clogged. Temperature difference generated between before and after a clogged spot.	Dust buildup or water freezing at the small port of expansion valve or EPR, which blocks the refrigerant flow.	Replace the receiver with new one (replace the dryer and clean the strainer). Do the complete vacuuming.



(1) Low-pressure side
(2) High-pressure side

7) Air mixed in the circuit

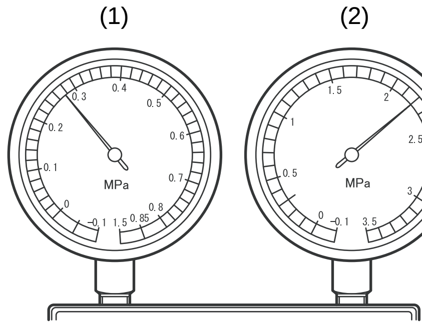
Phenomenon	Possible cause	Correction
Too high pressure at both low-pressure and high-pressure sides Nothing cold at a touch of low-pressure pipe Bubbles appearing in the sight glass	Air mixed in the refrigeration cycle	Change the refrigerant for fresh one. Do the complete vacuuming.



(1) Low-pressure side
(2) High-pressure side

8) Too open expansion valve

Phenomenon	Possible cause	Correction
Too high pressure at both low-pressure and high-pressure sides Frosty low-pressure pipe	Too much refrigerant in low-pressure pipe Expansion valve too open	Replace the expansion valve with new one.



(1) Low-pressure side
(2) High-pressure side

(3) Checking for gas leak

1. If a refrigerant leak is suspected, check for it with a gas leak detector in the following procedure.
   1) Preparatory checking: Connect a gauge manifold and check the refrigeration cycle pressure. Add refrigerant as required to raise the in-circuit pressure. This helps to improve the gas leak detection accuracy.

Read the gauge pressure with the compressor at rest. The outside air temperature must be above 15°C, however.

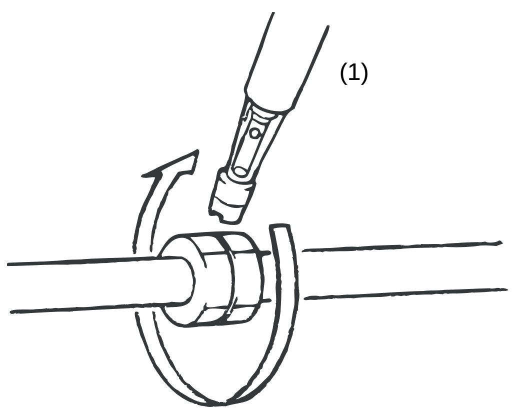
When the gauge pressure is above 0.4 MPa (4 kgf/cm^2) or so, go straight to check.

If the gauge pressure is below 0.4 MPa (4 kgf/cm^2), add refrigerant to achieve the 0.4 MPa (4 kgf/cm^2) level and then go to check.

Reference

Check for gas leak in a well-ventilated place. If the sensor of an electric gas leak detector gets exposed to gasoline, light oil or auto emission, it may wrongly react to these gases.

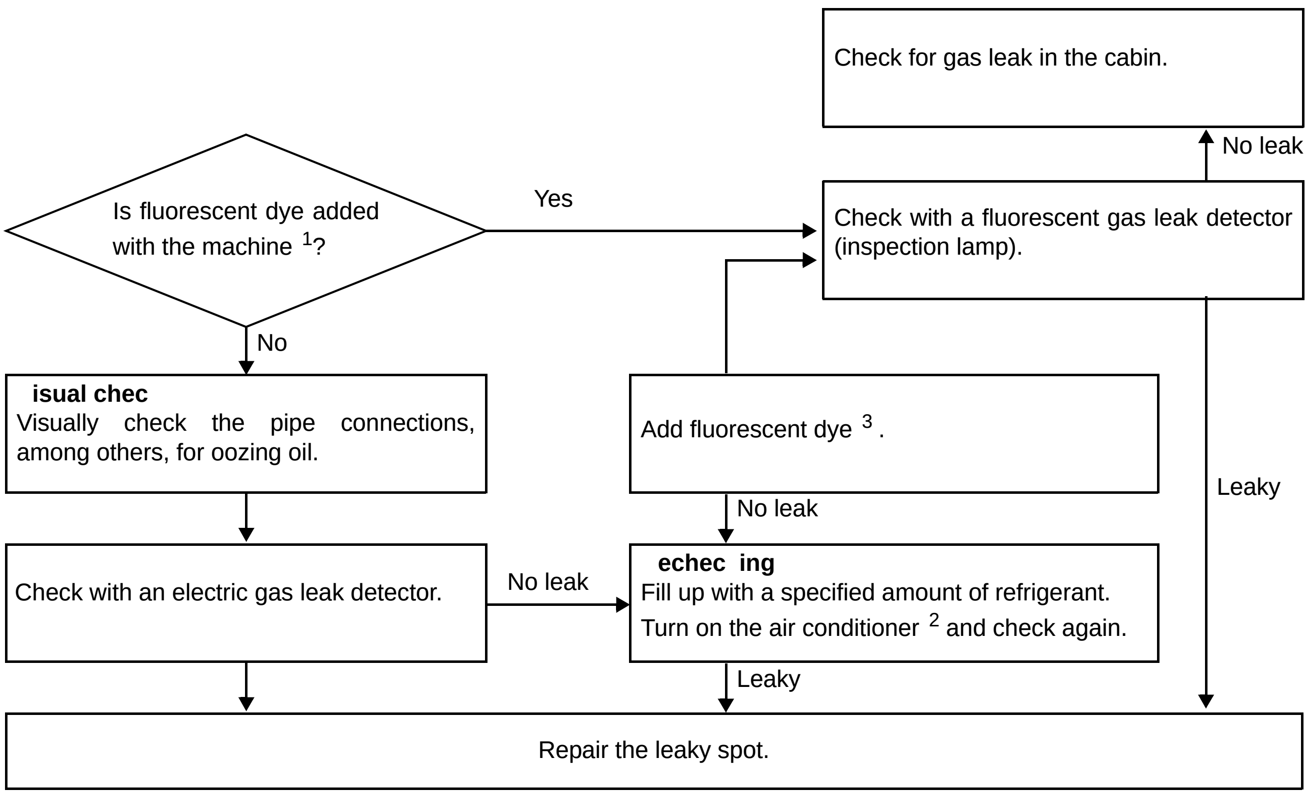
Gas leaking from a pipe connection may get blown away even by breeze. Apply the tip of the probe all around the connection, not on a single spot.



(1) Probe

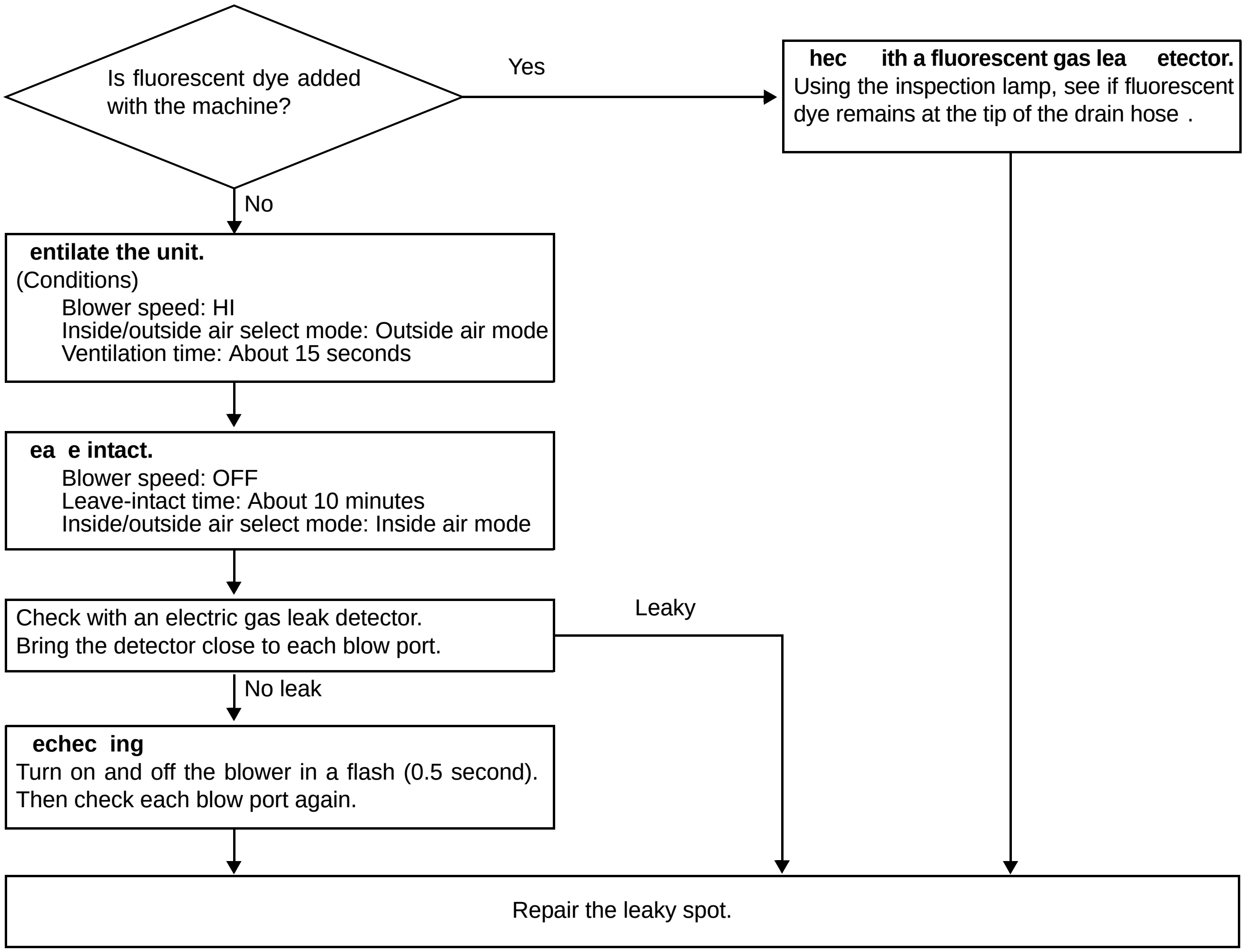
2. Checking for gas leak

1) Gas leak checking procedure in the engine room



1: Machines with fluorescent dye added are identified with a label or the like.
2: When the air conditioner runs, the engine gets vibrated and the refrigeration cycle gets under pressure for easily detecting a leak.
3: Fluorescent dye is added under the pressure of a gas container. Be careful not to apply it too much.

2) Gas leak checking procedure in the cabin (cooler unit)



: Take this action, because fluorescent dye flows away with drain if the evaporator is leaky.

3) Efficient use of a fluorescent gas leak detector

Reference

An electric gas leak detector works only when a gas leak occurs during inspection. A fluorescent gas leak detector, on the other hand, can find an occasionally leaky spot too, because it traces fluorescent dye that remains at the leaky point. If no leaky spot is found in the primary inspection with an electric gas leak detector, therefore, advisably take the secondary inspection with a fluorescent gas leak detector.

(4) Precautions ⚠

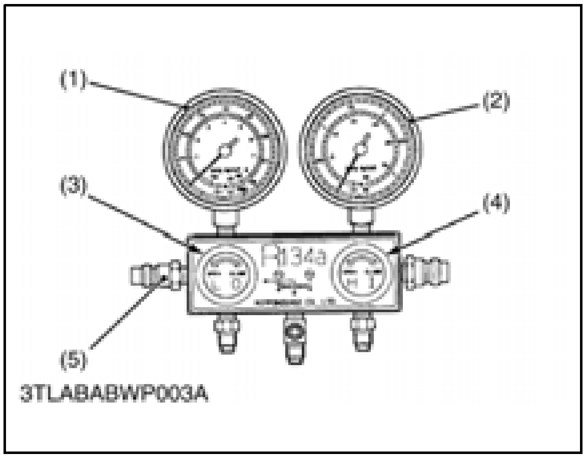
Preparations		
Gauge manifold kit	Dry-bulb thermometer	CFC gas recovery unit
Psychrometer	Thickness gauge	Circlip pliers
Circuit tester	Platform scale	

1. Precautions for training (charging refrigerant)
   1) Allow qualified personnel only to join the training.
      ⇒High-pressure gas (about 3.0 MPa) is handled. It is hazardous.
   2) Wear protective goggles during training.
      ⇒If liquid refrigerant gets in your eye, you may lose your eyesight. If your hand gets splashed with it, it may get it frostbitten.
      (Do not bend over when handling the service container and gauge manifold.)
   3) Do not return gas to the service container.
      (The service container is prohibited for reuse. The recovery unit s cylinder can be reused.)
   4) Store the service container with care.
      (Be careful not to drop and hit upon it. Apply no pressure upon it. Store it in a dark cool place without risk of get corroded.)
      ⇒Do not use any gas container deformed or with broken threads.
   5) Be sure to use specified type of gas (R134a or R12).
      ⇒The service valve diameter and shape are designed to avoid wrong type of gas.
   6) Be careful not to confuse the type of compressor oil. ND-OIL08 Denso-brand
      (ND-OIL06 only for R12)

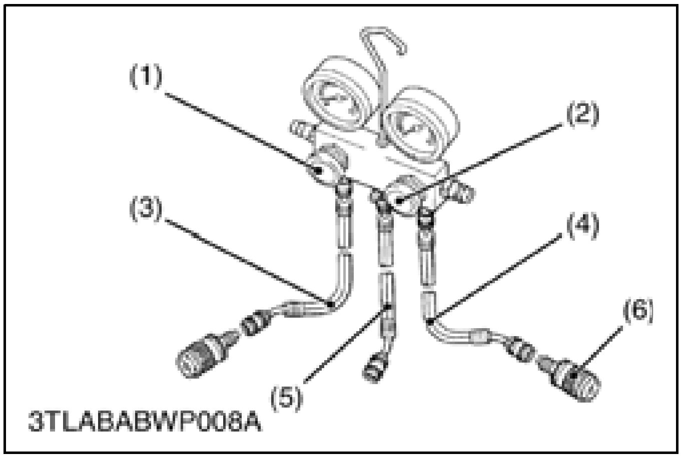
2. Precautions for checking and charging air conditioner refrigerant gas
   1) Select a well-ventilated place.
      ⇒Refrigerant gas is heavier than the air. If the room if filled with this gas, it may result in lack of oxygen.
   2) Handle the high-pressure valve with care.
      ⇒Do not open this valve while the engine (compressor) is running.
      (The fluid will flow back, possibly bursting the service container.)
   3) Remember the toxicity of refrigerant gas. The gas itself is not toxic, but if burnt, a harmful gas is emitted.
      ⇒If the gas gets exposed to a space heater or other open flame, it turns to a toxic substance.
   4) Be careful not to overcharge the gas.
      ⇒It may result in a trouble (poor cooling effect, overheat, refrigerant gas gushing from the safety valve).
   5) The service container cools down during charging. Do not get it heated.
      ⇒Keep water below around 40°C. Do not dip the connection port in warm water.
   6) Do not turn the service container upside down.
      ⇒Refrigerant will come into the circuit in a liquid form, getting the compressor in trouble.
   7) Make sure the service container packing is not clogged.
   8) After charging, immediately disconnect the hose.
   9) Be sure to do the vacuuming (below 750 mmHg).
      ⇒If water or air is left inside the pipe, it may cause poor cooling effect.
   10) If unavoidably the high-pressure and low-pressure hoses and/or the pipes are left open for a long time, be sure to cover their ends with plugs or plastic bags to keep out dust and water.

Training 1: Setting the gauge manifold

1) Close the gauge manifold s valves (for HI and LO).
2) Connect the charging hoses. (Connect the red one to HI and the blue one to LO.)
3) Slightly loosen the high-pressure and low-pressure valves to let air out of the hoses.
4) Fully close the high-pressure and low-pressure valves.



(1) LO Pressure Gauge
(2) HI Pressure Gauge
(3) LO Pressure Side Valve
(4) HI Pressure Side Valve
(5) Schrader Valve



(1) LO Pressure Side Valve
(2) HI Pressure Side Valve
(3) Blue Hose
(4) Green Hose
(5) Red Hose

(5) Check performance of air conditioning system

1) Calculate the relative humidity from the psychrometric graph by comparing the wet- and dry-bulb readings of the psychrometer at the air inlet.

HOW TO READ THE GRAPH:
After measuring the temperatures of wet- and dry-bulb thermometers at the evaporator air inlet, relative humidity (%) can be obtained.
Example: Supposing dry- and wet- bulb temperatures at the evaporator air inlet are 25°C (77°F) and 19.5°C (67°F) respectively. The point of intersection of the dotted lines in the graph is 60%.

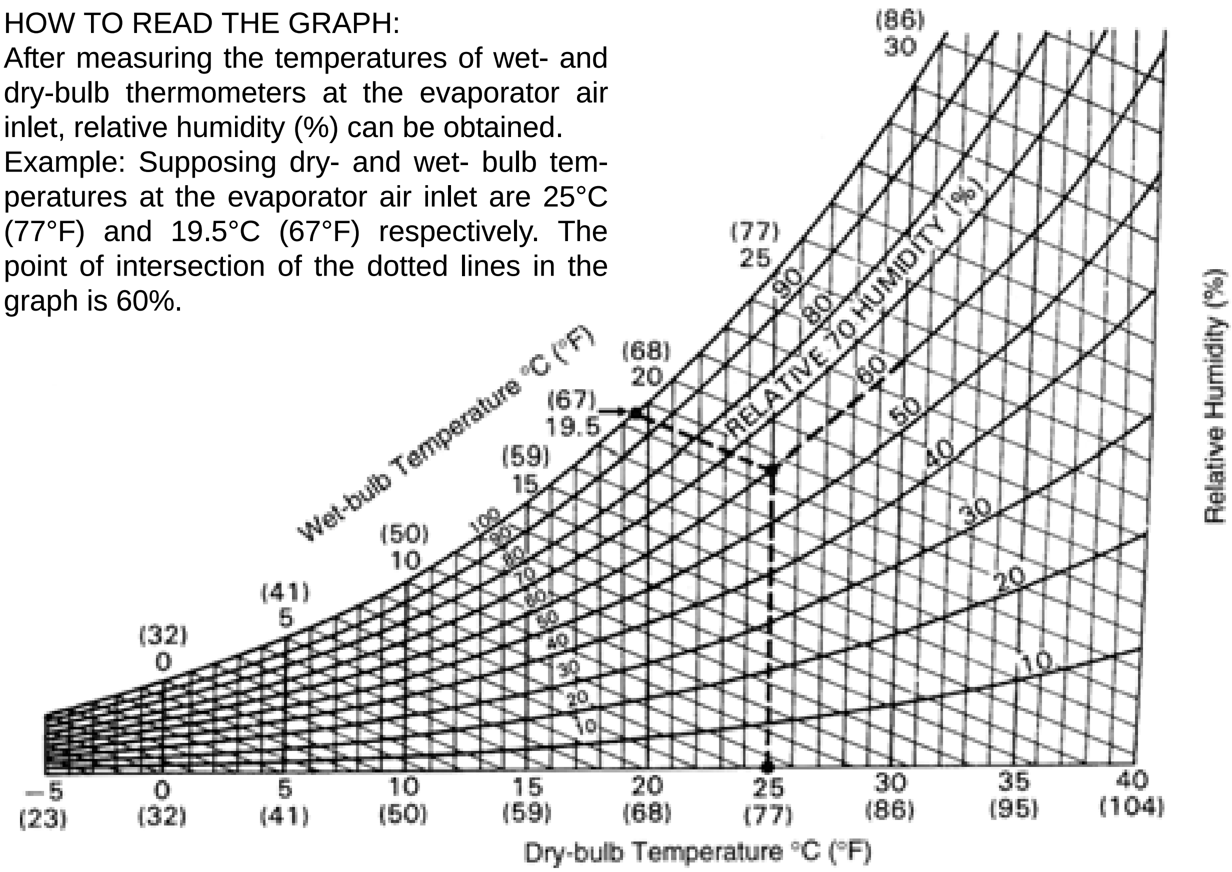


Fig. Psychrometric Graph

2) Measure the dry-bulb temperature at the cool air outlet, and calculate the difference between the inlet dry-bulb and outlet dry-bulb temperatures.
   In this case ;
   inlet dry-bulb = 25°C
   outlet dry-bulb = 8°C
   Then, temp. difference = 17°C
3) Check that the intersection of the relative humidity and temperature difference is above the line.
   If the intersection is within a line A and a line B, cooling performance is satisfactory.

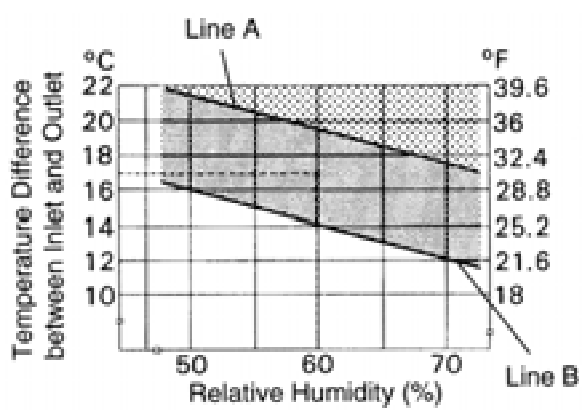


Fig. Relative Humidity Graph

Conversion Tables

Conversion Tables, *Tableaux Conversions,* Umrechnungstabelle

a. Length *Longuleur* Loenge

mm	cm	m	inch	ft	yd
1	0.1	0.001	0.03937	0.0032808	0.001094
10	1	0.01	0.39370	0.0328080	0.010940
1000	100	1	39.370	3.2808	1.0936
25.400	2.540	0.02540	1	0.083333	0.02778
304.800	30.480	0.30480	12	1	0.3333
914.4	91 44	0.9144	36	3	1

Ex. 1mm=0.03937in 120mm=120×0.03937=4.7244in 1mile = 1.609km

b. Area *Aire* Areal

cm^2	m^2	sq.in	sq.ft	sq.yd
1	0.0001	0.15500	0.0010764	0.0001196
10000	1	1550.0	10.764	1 1960
6.4516	0.00064516	1	0.006944	0.0007716
929.03	0.092903	144	1	0.11111
8361.0	0.8361	1296	9	1

Ex. 1㎡=1.1960 sq.yd 1.2㎡=1.2×1.1960=1.4352 sq.yd

c. Volume *Volume* Volume

dm^3(l)	m^3	cu.in	cu.ft	cu.yd	Imperial gal	US gal
1	0.001	61.027	0.035317	0.0013	0.21998	0.26418
1000	1	61027	35.317	1.3079	219.98	264.18
0.016387	0.00001639	1	0.578697	0.0000214	0.003605	0.00433
28.3153	0.028315	0.000464	1	0.037026	6.22786	7 4006
764.584	0.764584	46656	27	1	168.152	199.816
4.5465	0.0045465	277 4207	0.16057	0.0059	1	1.20114
3.7852	0.0037852	231.005	0.13368	0.0050	0.83254	1

Ex. 0.04㎥=0.04×1.3097=0.052316 cu.yd 1liter=1000cc=1000㎤

d. Flow amount *Decharge intemes* Entladung

L/sec	m^3/min	m^3/h	Inp.gal/min	US gal/min	cu.yd/min	L/min
1	0.060	3.6	13.197	15.8514	21 192	60
16.666	1	60.0	219.98	264.1833	35.3165	999.96
0.2778	0.016668	1	3.6658	4.4032	0.58806	16.668
0.075775	0.0045465	0.27279	1	1.2011	0.16065	4.5465
0.06309	0.0037824	0.2271	0.8325	1	0.17768	3.7854
0.47192	1.6989	0.02832	6.22787	7 4855	1	28.3152
0.016667	0.001	0.06	0.21995	0.264173	0.035317	1

Ex. 25.6l/sec=25.6×0.06=1.53㎥/min=25.6×15.8514=405.79584Usgal/min

e. Force(Weight) *Foece(Contrepoids)* Kraft(Gewicht)

N	dyn	kgf	lbw
1	1×10^5	1.01972×10^{-1}	2.24809×10^{-1}
1×10^{-5}	1	1.01972×10^{-6}	2.24809×10^{-6}
9.80665	9.80665×10^5	1	2.20462
4.44822	4.44822×10^5	4.53592×10^{-1}	1

Ex 1.2kgf=1.2×9.80665=11.76798N=11.76798×2.24809×10^{-1}=2.64555lbw

f. Stress *Emphase* **Betonen**

Pa	MPa or N/mm^2	kgf/mm^2	kgf/cm^2
1	1×10^{-6}	1.01972×10^{-7}	1.01972×10^{-5}
1×10^{6}	1	1.01972×10^{-1}	1.01972×10
9.80665×10^{6}	9.80665	1	1×10^{2}
9.80665×10^{4}	9.80665×10^{-2}	1×10^{-2}	1

Ex. 1.2kgf/㎠=1.2×9.80665×10⁻¹=0.1176798 MPa

g. Pressure *Pression* **Pruefdruck**

MPa	Pa	Bar	kgf/cm^2	atm	mmH^2O	psi(lbw/in^2)
1×10^{-6}	1	1×10^{-5}	1.01972×10^{-5}	9.86923×10^{-6}	1.01972×10^{-1}	1.45038×10^{-4}
1	1×10^{6}	10	10.1972	9.86923	1.01972×10^{5}	1.45038×10^{2}
0.0980665	9.80665×10^{4}	9.80665×10^{-1}	1	9.67841×10^{-1}	1.0×10^{4}	1.42233×10
1.01325×10^{-1}	1.01325×10^{5}	1.01325	1.03323	1	1.03324×10^{4}	1.46959×10
9.80665×10^{-6}	9.80665	9.80665×10^{-5}	1.0×10^{-4}	9.67841×10^{-5}	1	1.42233×10^{-3}
1.33322×10^{-4}	1.33322×10^{2}	1.33322×10^{-3}	1.35951×10^{-3}	1.31579×10^{-3}	1.35951×10	1.93368×10^{-2}
6.89474×10^{-3}	6.89474×10^{3}	6.89474×10^{-2}	7.03070×10^{-2}	6.80460×10^{-2}	7.03070×10^{2}	1

Ex. 120 kgf/㎠=120×9.80665×10⁴=11767980Pa=11.76798MPa 1Pa=1N/㎡ , 1MPa=1×10⁶Pa

h. Work energy amount *Equivalent travail mecanique de lachaleur* **Leistung**

J	kW.h	kgf.m	kcal	ft.lb
1	2.77778×10^{-7}	1.01972×10^{-1}	2.38889×10^{-4}	7.37555×10^{-1}
3.6×10^{6}	1	3.67098×10^{5}	8.6×10^{2}	2.65519×10^{6}
9.80665	2.72407×10^{-6}	1	2.34270×10^{-3}	7.23292
4.18605×10^{3}	1.16279×10^{-3}	4.26858×10^{2}	1	3.08743×10^{3}
1.35583	3.76621×10^{-4}	1.38257×10^{-1}	3.23899×10^{-4}	1

Ex. 12kgf.m=12×9.80665=117.6798J, 1J=1W·S, 1W·h=3600W·S, 1cal=4.1865J

i. Work efficiency *Puissance* **Wirkungsgrad**

kW	kgf.m/s	PS	HP	kcal/h
1	1.01922×10^{2}	1.35962	1.34048	8.6000×10^{2}
9.80665×10^{-3}	1	1.33333×10^{-2}	1.31456×10^{-2}	8.43371
7.355×10^{-1}	7.5×10	1	9.85925×10^{-1}	6.32529×10^{2}
7.46×10^{-1}	7.60707×10	1.01428	1	6.41564×10^{2}
1.16279×10^{-3}	1.18572×10^{-1}	1.58095×10^{-3}	1.55869×10^{-3}	1

Ex. 10.2PS=10.2×7.355×10⁻¹=7.5021kW

j. Torque *Couple* **Drehmoment**

kgf.m	ft.lbs	N.m
1	7.233	9.80665
0.1383	1	1.35582
0.1020	0.7376	1

Ex. 12kgf.m=12×9.80665=117.6798N.m

k. Velocity *Vitesse* **Geschwindigkeit**

m/sec	km/h	ft/min	mile/h
1	3.6	3.2808	2.2370
0.2778	1	54.68	0.6214
0.00508	18.288	1	11.639
0.447	1.6093	0.19398	1

l. Temperature
Temperature
Temperatur

°F	°C
0	-17.8
10	-12.2
20	-6.7
30	-1.1
32	0
40	4.4
50	10.0
60	15.6
70	21.1
80	26.7
90	32.2
100	37.8
110	43.3
120	48.9
130	54.4
140	60.0
150	65.6
160	71.1
170	76.7
180	82.2
190	87.8
200	93.3
210	98.9
212	100.0
220	104.4
230	110.0
240	115.6

$F=32+9/5\times C$
$C=5/9\times(F-32)$

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