

SECTION 2 STRUCTURE AND FUNCTION

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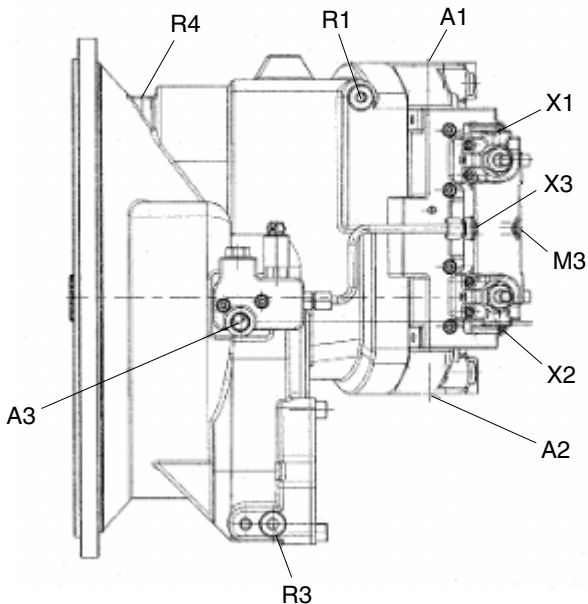
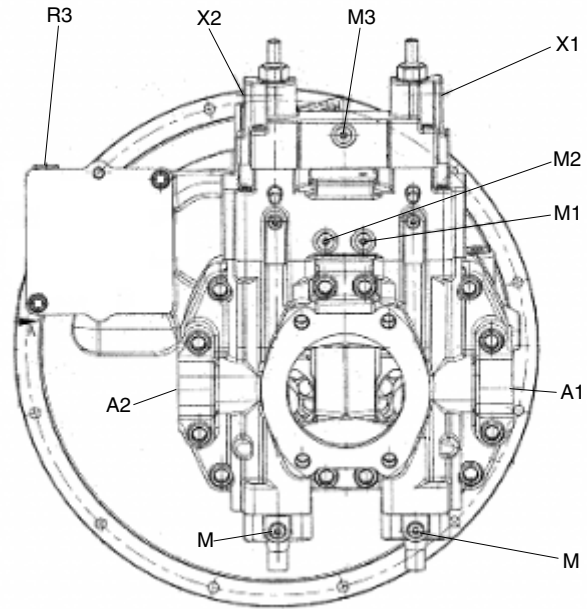
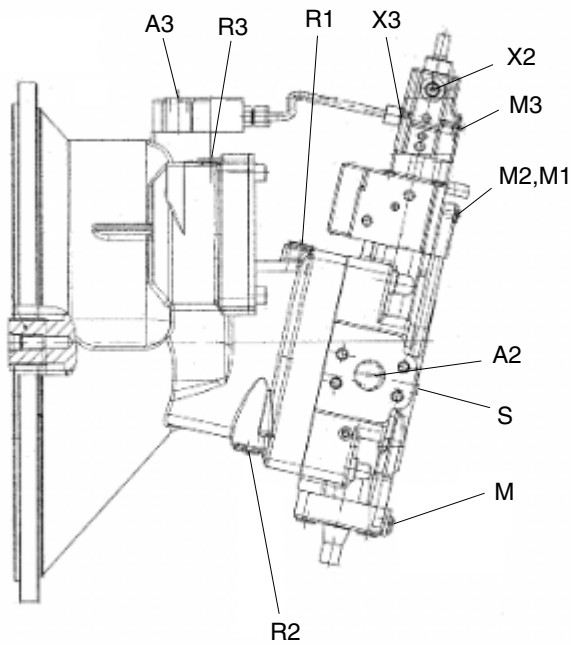
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

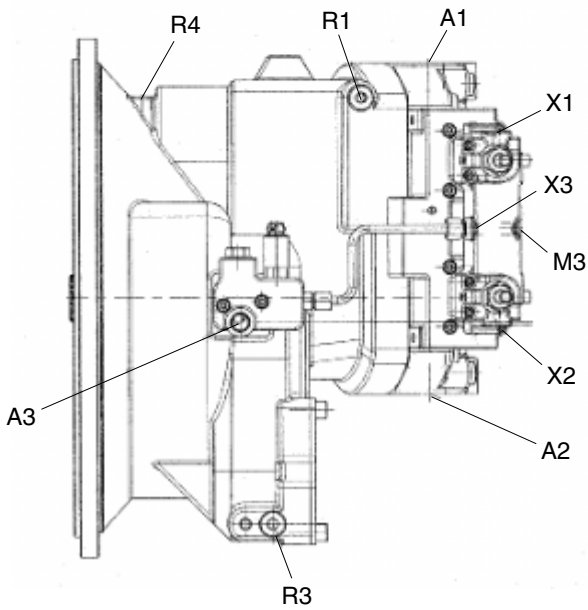
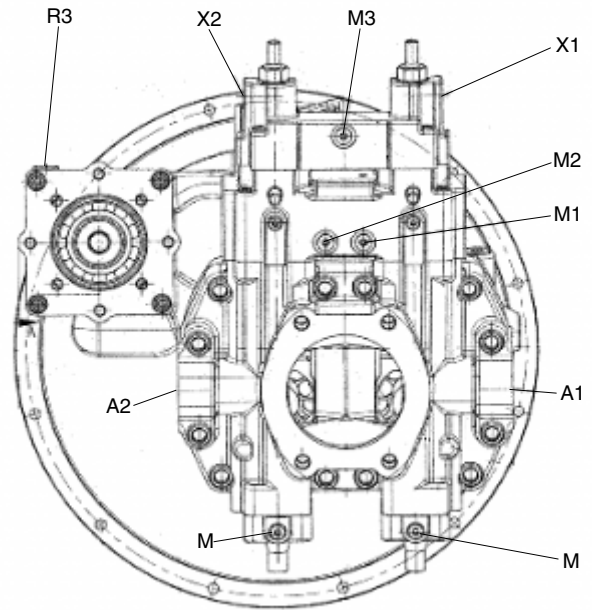
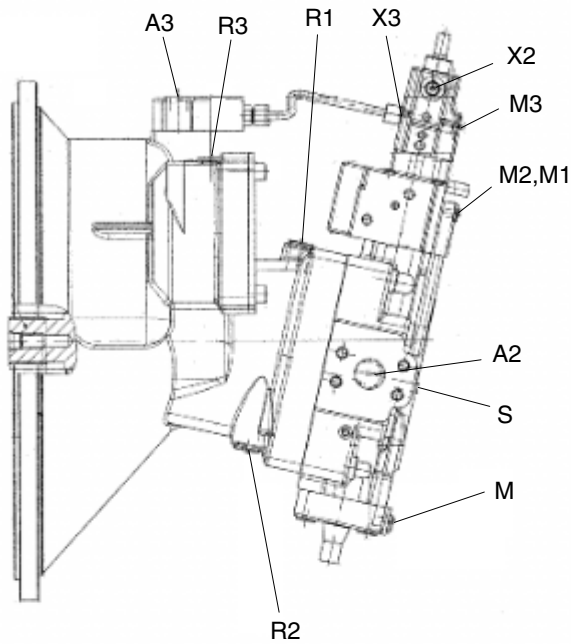
The pump device consists of main pump, regulator.

· STANDARD



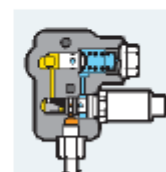
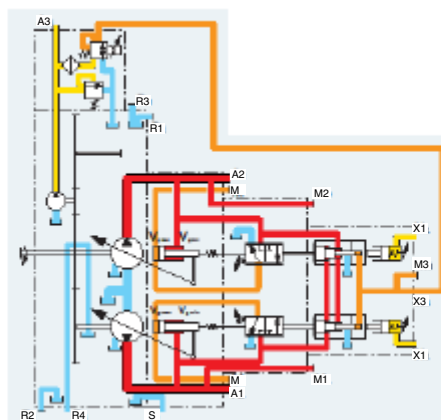
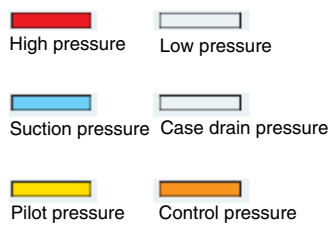
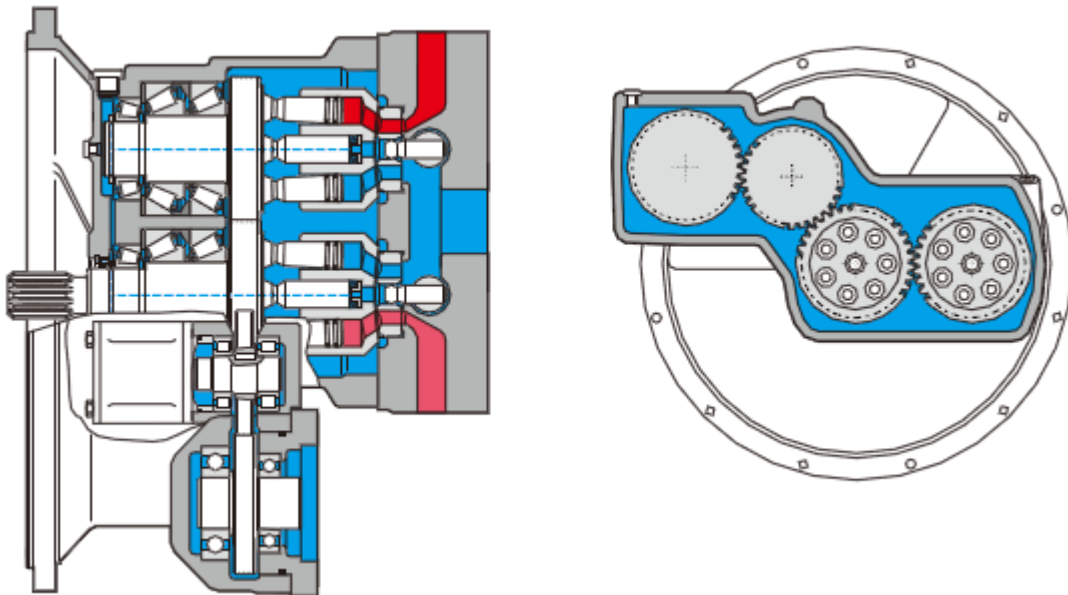
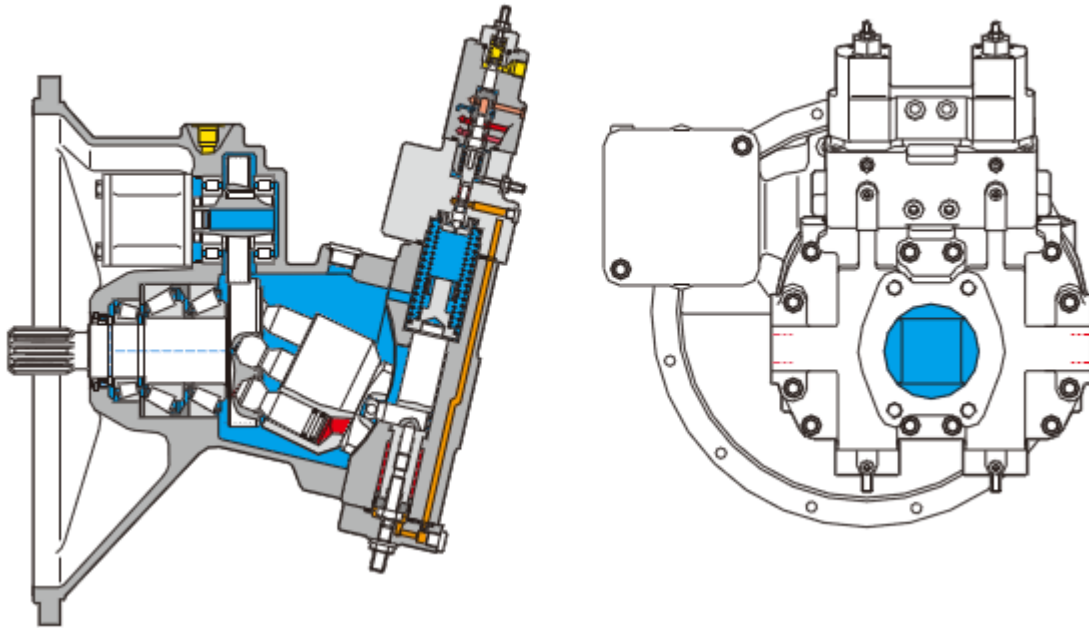
Port	Port name	Port size
A1,A2	Service port	1 1/4"
S	Suction port	5"
A3	Auxiliary pump service port	3/4-16UNF
R1	Bleed port	M22x1.5
R2	Oil drain port	M22x1.5
R3	Bleed port	M22x1.5
R4	Flushing port	3/4-16UNF
X1	Control pressure ports for negative control	9/16-18UNF
X2	Control pressure ports for negative control	9/16-18UNF
X3	Control pressure ports for power override	M14x1.5
M	Measurement port	M12x1.5
M1	Measurement port A1	9/16-18UNF
M2	Measurement port A2	9/16-16UNF
M3	Measurement port for power override	9/16-16UNF

· OPTION-ROTATING WITH PROPORTIONAL

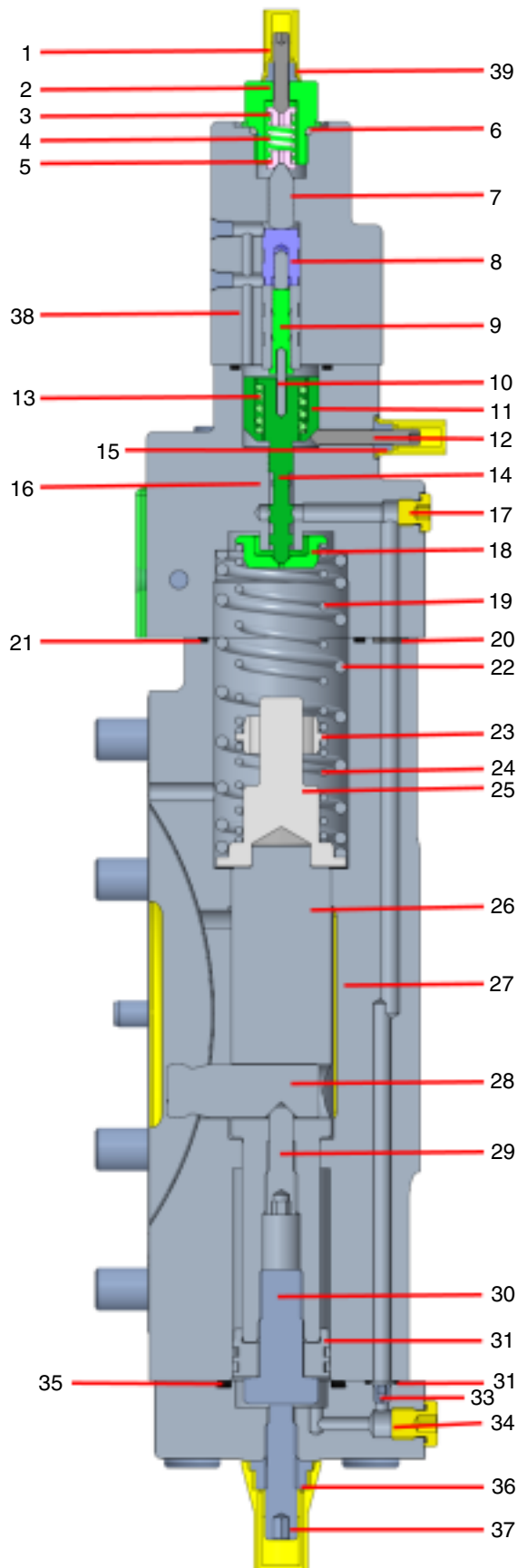


Port	Port name	Port size
A1,A2	Service port	1 1/4"
S	Suction port1	5"
A3	Auxiliary pump service port	3/4-16UNF
R1	Bleed pory	M22x1.5
R2	Oil drain port	M22x1.5
R3	Bleed port	M22x1.5
R4	Flushing port	3/4-16UNF
X1	Control pressure ports for negative control	9/16-18UNF
X2	Control pressure ports for negative control	9/16-18UNF
X3	Control pressure ports for power override	M14x1.5
M	Measurement port	M12x1.5
M1	Measurement port A1	9/16-18UNF
M2	Measurement port A2	9/16-16UNF
M3	Measurement port for power override	9/16-16UNF

2. SCHEMATIC



3. PART LIST (1/3)

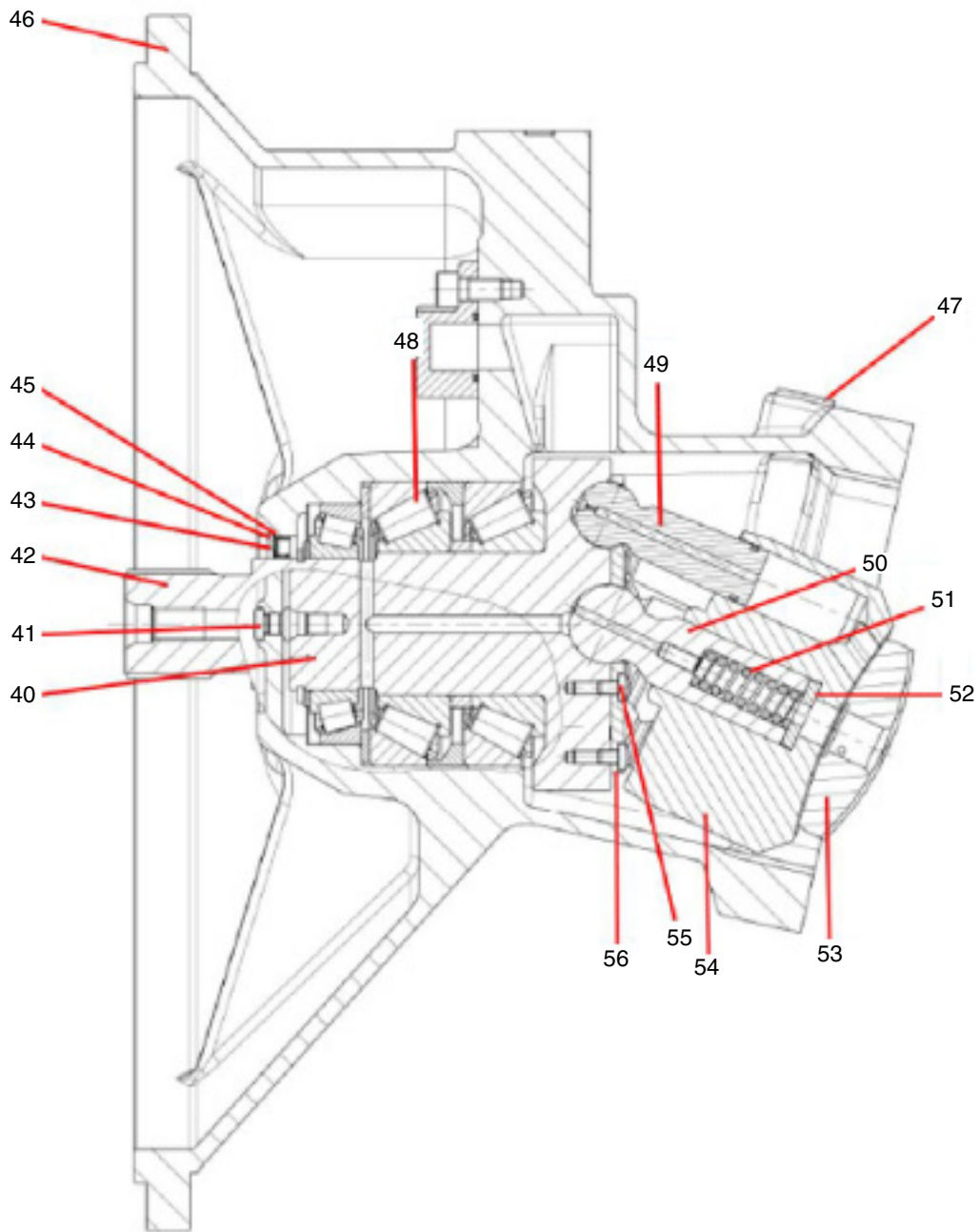


- 1 Setting screw
- 2 Screw plug
- 3 Spring cup
- 4 Spring
- 5 Spring cup
- 6 O-ring
- 7 HNC control piston
- 8 Control bushing
- 9 LLC control piston
- 10 Pin
- 11 Spring bushing
- 12 Adjustment screw
- 13 Setting screw
- 14 Control piston for stroking
- 15 Sealing screw
- 16 HNC controller housing
- 17 Sealing screw
- 18 Spring cup
- 19 Spring
- 20 O-ring
- 21 O-ring
- 22 Spring
- 23 Double spring collar
- 24 Spring
- 25 Spring collar
- 26 Stroke piston
- 27 Port plate
- 28 Setting pin
- 29 Locating screws
- 30 Bolt
- 31 Piston with steel rings
- 32 O-ring
- 33 Orifice
- 34 Sealing screw
- 35 O-ring
- 36 Sealing screw
- 37 Setting screw
- 38 Stroke controller housing
- 39 Sealing screw

※ HNC : Hydraulic Negative Control

※ LCC : Load Limiting Control

PART LIST (2/3)

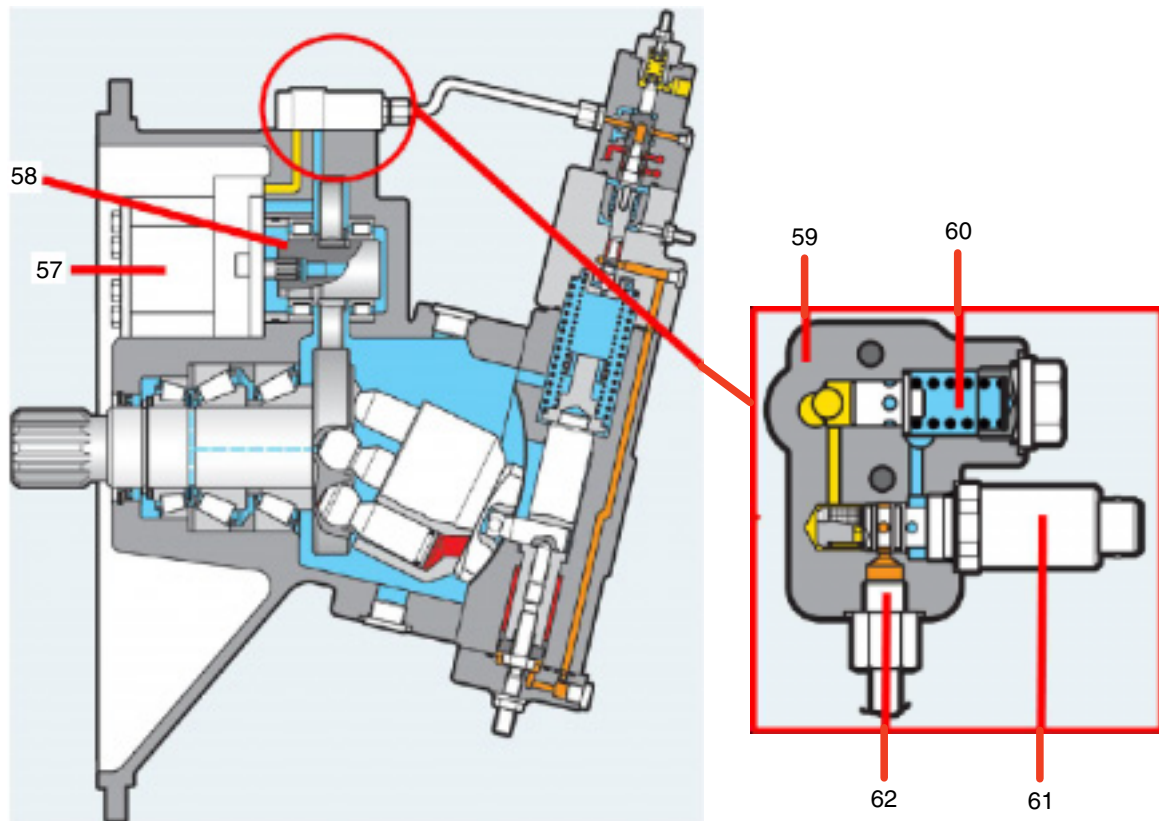


40 Rotary group
 41 Sealing screw
 42 Rotary group
 43 Snap ring
 44 Shim
 45 Shaft seal ring

46 Pump housing
 47 Sealing screw
 48 Bearings
 49 Piston with steal rings
 50 Center pin
 51 Spring

52 Shim
 53 Control lense
 54 Cylinder
 55 Bolt
 56 Retreat plate

PART LIST (3/3)



57 Gear pump
58 Gear wheel

59 Valve plate
60 Pressure relieve valve

61 EPPR valve
62 Hydraulic pipe

4. FUNCTIONAL EXPLANATIONS OF THE CONTROLLERS

Basically, we can say that there is a priority between the individual controllers. The lowest priority has the flow control (H1). This is directly influenced by the negative control pressure from the MCV.

Second priority has the torque control (K). An internal bore in the housing allows a high-pressure signal from each rotary group to be applied to both power controllers. Each individual rotary group considers the high pressure on the regulator individually. If the total power of both rotary groups exceeds the total max. set power, then both rotary groups reduce the flow by swiveling back.

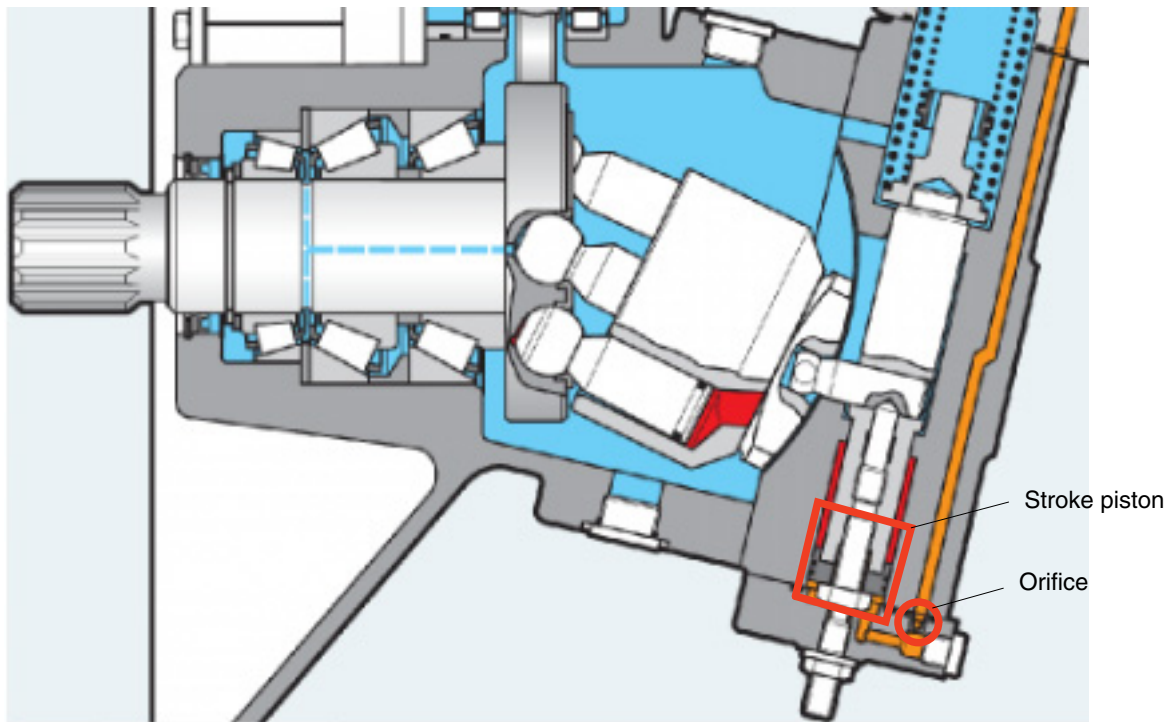
The controller with the highest priority is the power override control (LA1). This protects the diesel engine from overloading. When the diesel engine is over-loaded, it causes the engine speed to decrease and, in the worst case, the diesel engine is being stalled. We counteract the fact, that active the diesel speed is observed. When the diesel speed is too far away from the target speed, e.g. 50 rpm lower. The ECM detects this engine speed drop and provides the pump an electric signal to swivel the pump back, till the engine is recovering to the target speed. This ensures that both rotary groups are reducing their swing angle so far that the speed is recovered back to its target speed.

1) BASIC FUNCTION

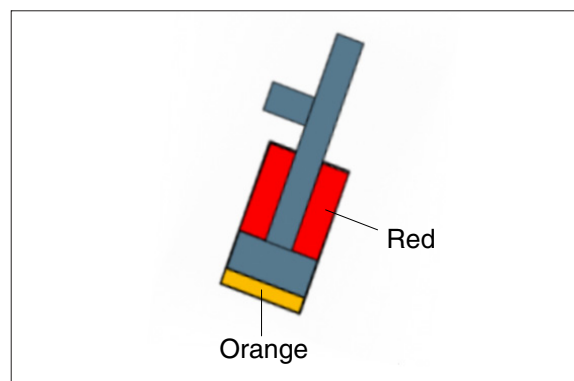
The pump is an axial piston pump in bent axis design.

The basic function of each rotary group is as follows.

The high pressure (red) serves for the rotary group as a signal pressure. This causes the rotary group to swivel to V_{gmax} (large swivel angle). The rotary group remains in this position until it gets a stroke pressure from the regulator. This is ensured by the larger piston area for the stroke pressure, inside the stroke piston we have area ratio of (3 : 1). If the forces of the stroke side are bigger than those of the high pressure side, then the unit swivel from V_{gmax} (large swivel angle) → V_{gmin} (small swivel angle). The swivel time can additionally be influenced by the orifice in picture below.



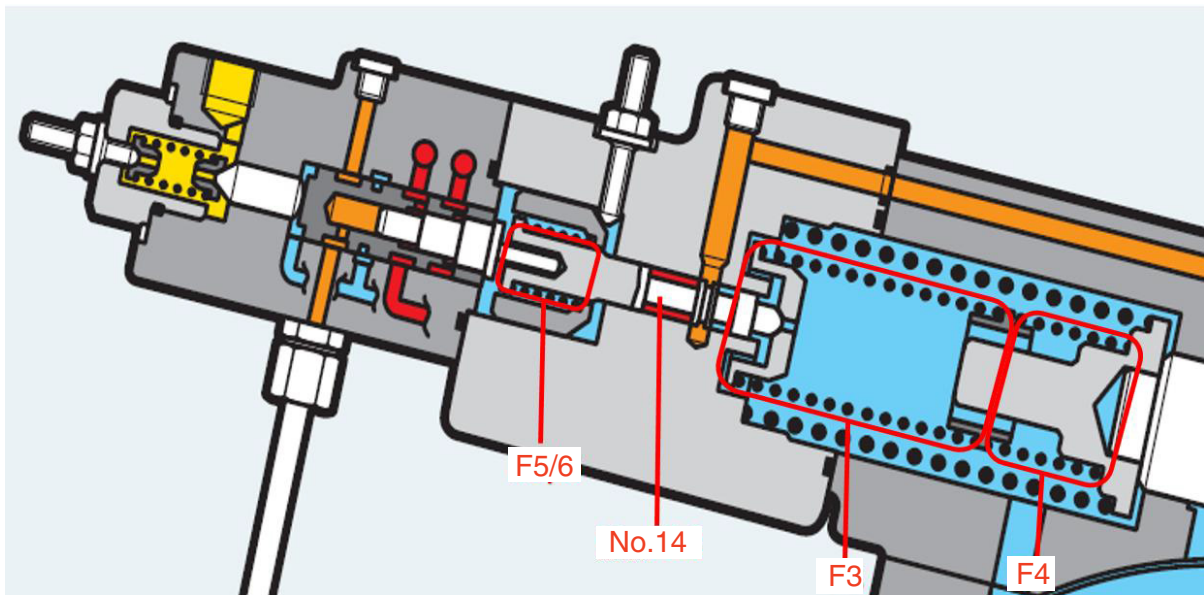
The stroke piston and the piston with steel rings (31) have an area ratio of 3 (orange) and 1 (red).



The basic function of the controller is as follows shown in picture above. If the control piston (14) opens the connection area from high pressure to the orange stroke pressure, then the unit swivel from V_{gmax} to V_{gmin} . We can say that first the spring force (F5/6) has to be overcome.

When the unit swivels, the spring F3 is compressed until it is limited by the spring cup. Then the spring F4 is compressed. If the flow is interrupted by the connection area, the unit stops at this swivel angle and is holding its position.

These two springs (F3 and F4) compression characteristic leads to the typical two spring control behavior.

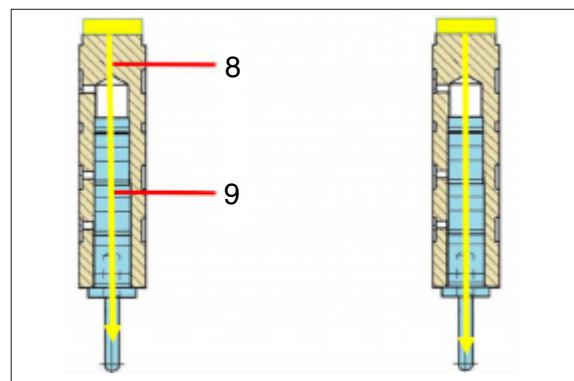


There are three ways how the control piston (14) can be pushed for connecting the high pressure with stroke pressure area.

(1) Negative control H1

Movement of control bushing (8), via the negative control pressure from main control valve.

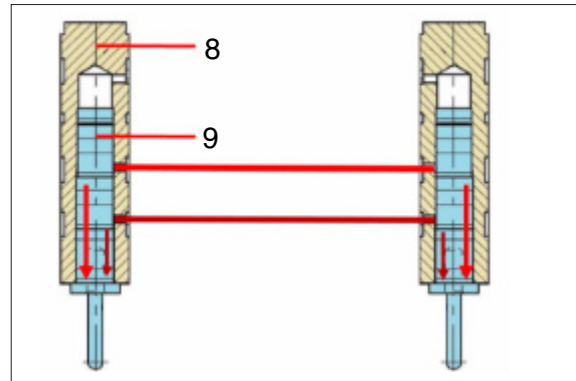
The yellow marked control bushing (8) can be operated, until enough power is available. i.e. power control (hydraulic coupling) or LLC (load limiting control) is not active. In this case the blue control piston (9) is pressed down by the control bushing (8).



(2) Hydraulic coupling for power control K

Movement of control piston (9) inside the upper control housing, via high pressure from own rotary group, or hydraulic coupling, via the other rotary group.

In case the load pressure of consumer is increasing, pressure is given to both control pistons (9) (A1 and A2). The rotary group with higher flow demand (swivel angle) is starting to swivel back at first. Until both rotary groups have the same power demand. up from this point, both rotary groups are swiveling in parallel.

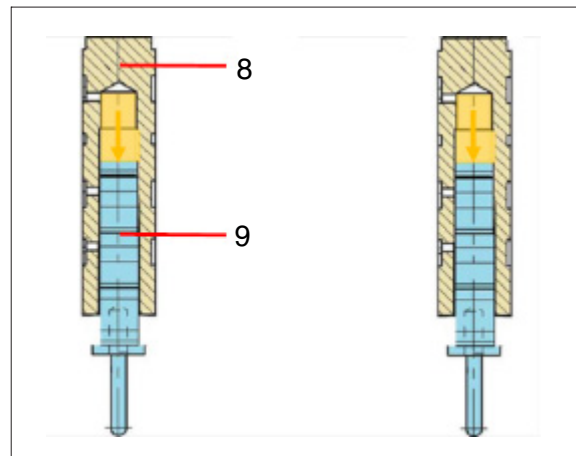


(3) Power override LA1

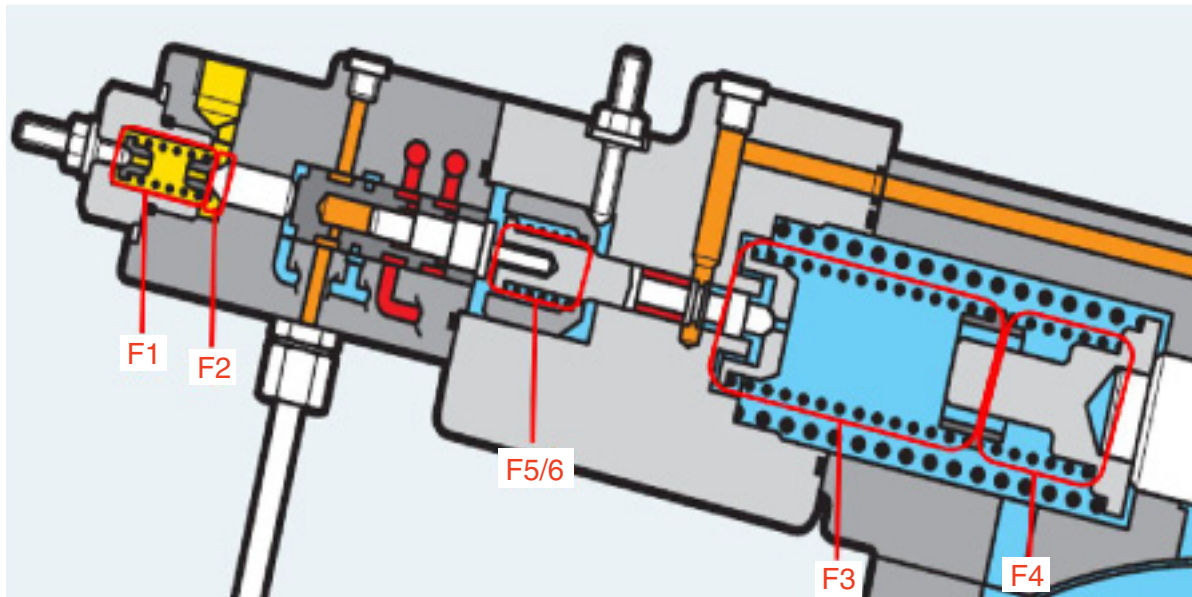
Movement of control piston (9) inside the upper control housing, via the pilot pressure from the electric proportional pressure-reducing valve, for power control.

In case the engine power is overloaded, the blue marked control piston is moving down, independent from the negative control pressure (control bushing (8)).

In case the high pressure is increasing over the available set power on one or the other rotary group, control piston (9) is also moving downwards and providing stroke pressure for swiveling back the pump.



2) FLOW CONTROL



The flow controller is the regulator with the lowest priority. This becomes dependent on an external control pressure. This control pressure is generated as follows.

The MCV inside the open center system is getting closed, when the operator doesn't move the joystick. The remaining flow rate of the pump is sent via a metering orifice. This creates a control pressure, e.g. 25 bar.

This ensures that the unit is swiveling to V_{gmin} . If the operator now requires more volume flow. Then the control pressure is reduced, the unit continues to swivel out to V_{gmax} .

There are two forces in the marked control chamber.

F1 = spring force

F2 = control pressure multiplied with the area of the control piston

These forces work against the spring forces of the power controller F3 and F4. The important factor is the control pressure.

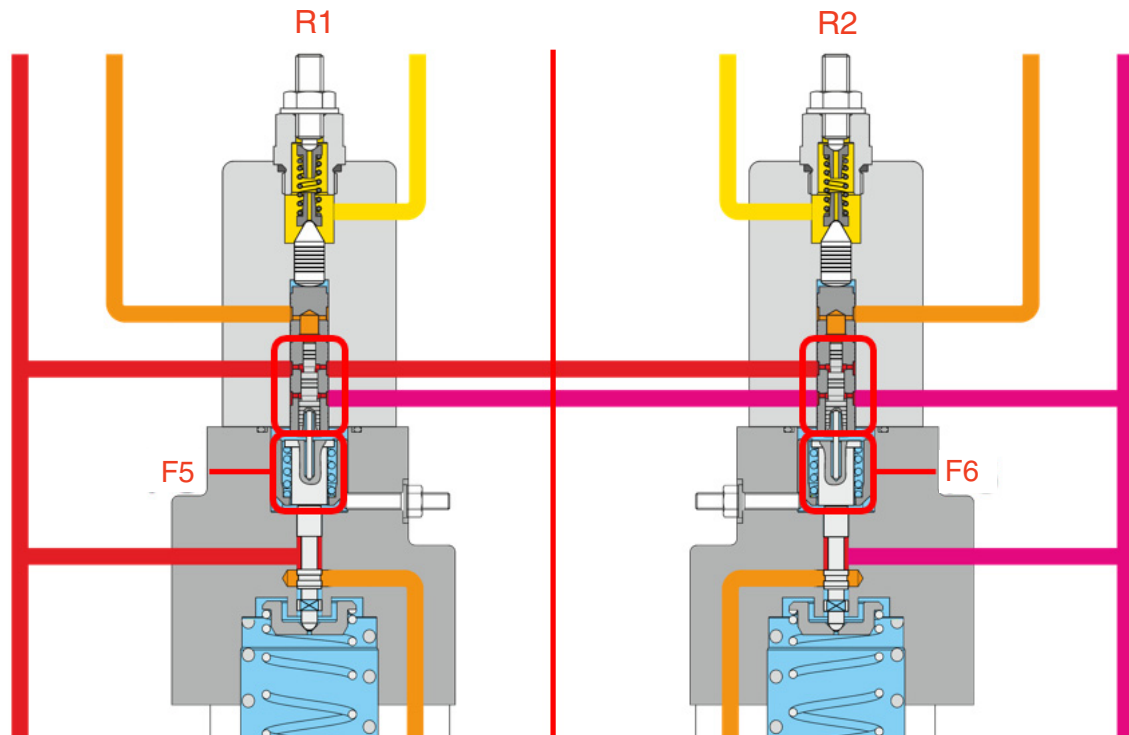
If the control pressure is increasing, the force of F2 increase too and ensures that the control piston (14) opens the channel between the high pressure and the stroke pressure. Due to that a feedback comes up, that the unit generates too much volume flow. The unit swivel to a smaller swivel angle.

The two compression springs allow us to set up a fine control range. This is realized by installing two differently strong compression springs. The softer compression spring (F4) is compressed until it is limited by the double spring collar (23). At this point, the harder spring (F3) takes over.

3) POWER CONTROL

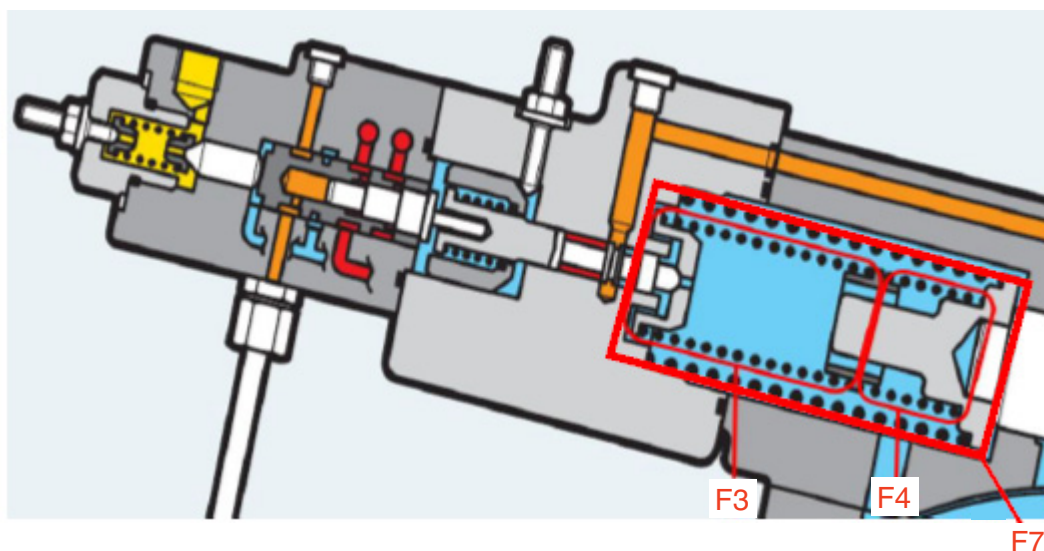
Next we take a look at the power controller. The basic understanding is that we have two rotary groups and two independent controllers. The power controller for the rotary group A1 and A2. We connect both power controllers to each other via the hydraulic coupling. In each case, the high pressure of the rotary group A1 and A2 acts on the controller. We look at the picture below. The red line (P1) and the pink line (P2) set the high pressure of the respective rotary group.

Both high pressures are applied to the control piston. Over the surfaces, these pressures generate a force which works against the adjusted spring force (F5/F6). If the force is bigger than the spring force (F5), the control edge opens and the pump swivels back.



Here it is important that the rotary group swivels according to the characteristics of the spring force F3 and F4.

The spring force F7 is pushing every rotary group to maximum swivel angle without high pressure, e.g. engine stopped.

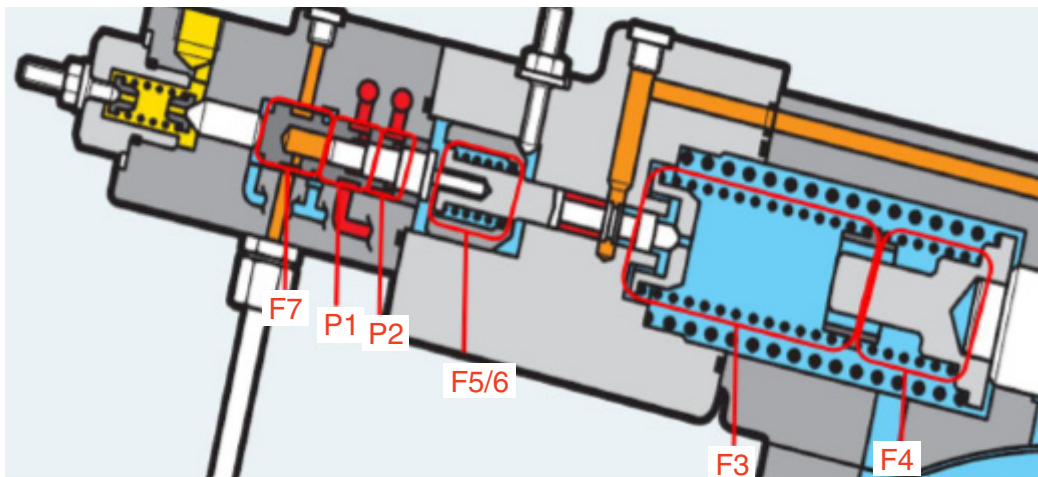


4) ANTI STALL CONTROL OR POWER SHIFTING FUNCTION

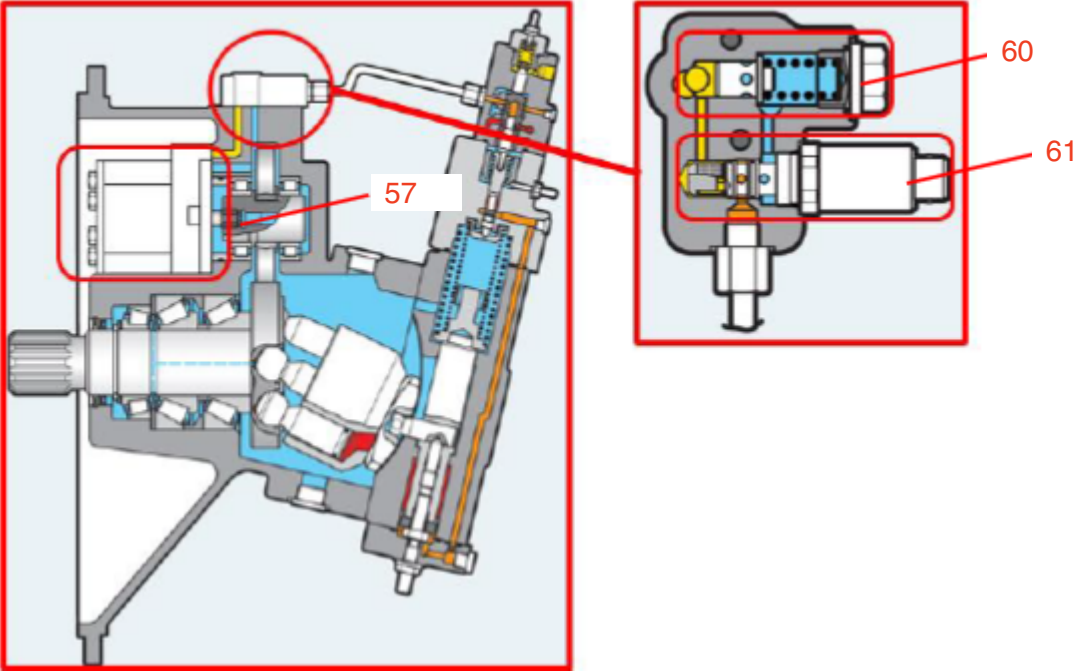
First, let's take a look at the anti-stall function. In this case, the power override is integrated into the pump control. Externally, the diesel engine speed is monitored via the ECM. If the engine is overloaded, e.g. more than 50 rpm and thereby reduces the diesel speed. Then the LLC (load limiting control) activates the anti-stall function of the pump. In this case, an external control pressure is applied to the control piston (9). This force (F7) stand over all other functions and swivel back the unit until the diesel speed recovers.

So second, let's look at the power shifting function. Here it is possible to approach different driving modes.

It can be seen very well in the picture No. 10, that the external control pressure (F7) and the two high pressures (P1/P2) of the hydraulic coupling work together against the springs (F5/6, F3 and F4). If we now increase the external control pressure (F7), less pressure is needed to open the spring F5/6. This gives us a new power setting.



The external control pressure is generated as follows. A gear pump (57) is integrated in the main pump fly wheel housing. The pressure of the gear pump flow is limited by a pressure relief valve (60), this setting is made via shims. This pressure can be used external via A3 port or is used via the electric proportional pressure reducing valve (61), which can be controlled in the two ways mentioned above: 1. LLC (load limiting control) or 2. Power mode controller.



5. ADJUSTMENT OF THE CONTROLLERS

For the adjustment of the controller, you need a power diagram. Please get in touch with your Hyundai dealer.

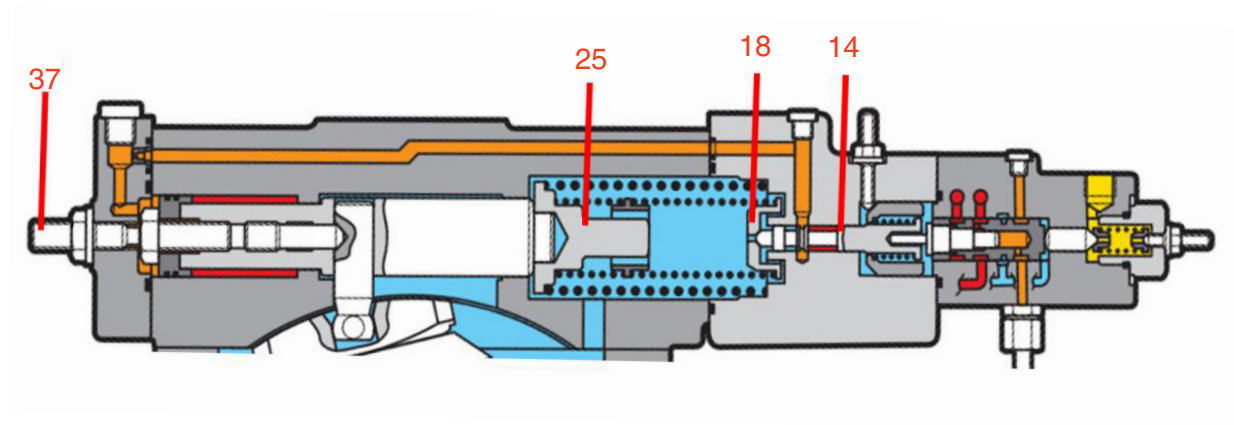
1) FLOW

(1) Maximum flow (mechanical)

The limitation for the maximum flow is done via the setting screw (37)

(2) Minimum flow (hydraulic)

The limitation over the minimum volumetric flow (residual flow) results from the spring collar (25). The spring collar (25) is pressing against the spring cup (18)/control piston (14).

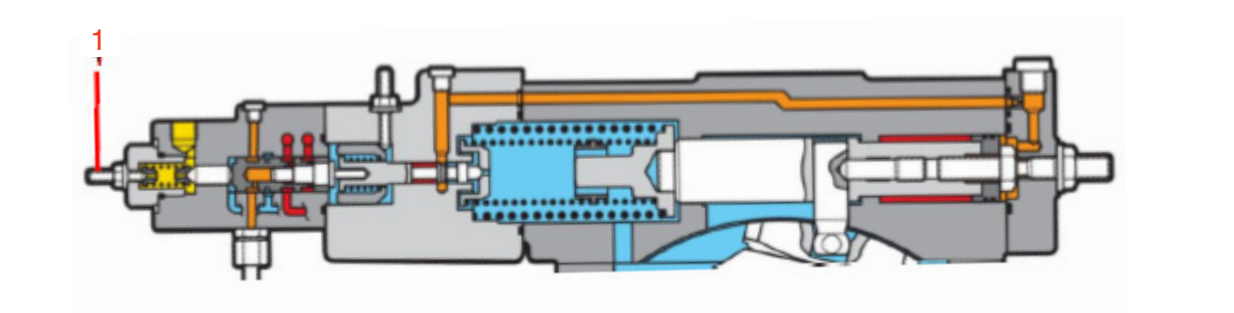


(3) Flow controller

When you turn the setting screw (1) inside you move the px1 downstairs. When you turn the setting screw (1) out than move the px1 upstairs.

※ Adjustment M6x1 : 1 turn = 1 mm = +11 bar (counter-clockwise)

※ Adjustment area piQ : 10~5.1 bar (delta 4.9 bar)



2) POWER CONTROL SETTING

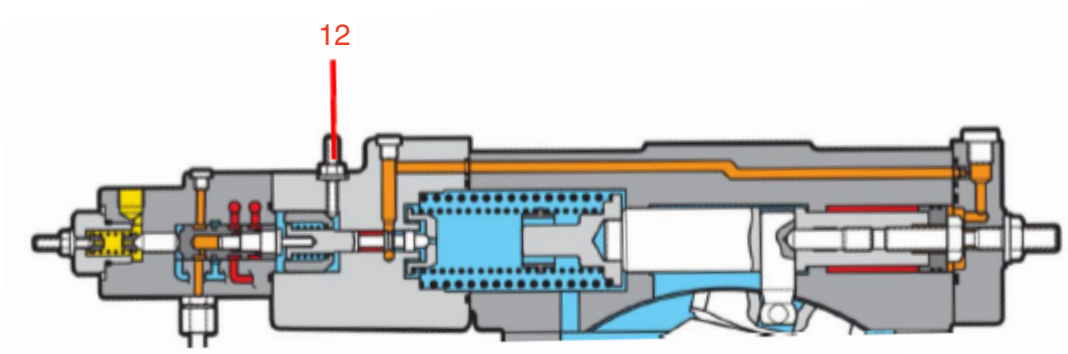
With the volumetric flow controller, fully control the A1 rotary group. Then increase the high pressure to the control point of the power controller. You realize that the power regulator is engaged when the speed of the movement slows down. Use the adjustment screw (12).

Turn the screw inside for a higher power setting, turn it out for a lower power setting.

Then repeat the same procedure for the A2 rotary group.

Afterwards, control both rotary group together and check if the hydraulic coupling works.

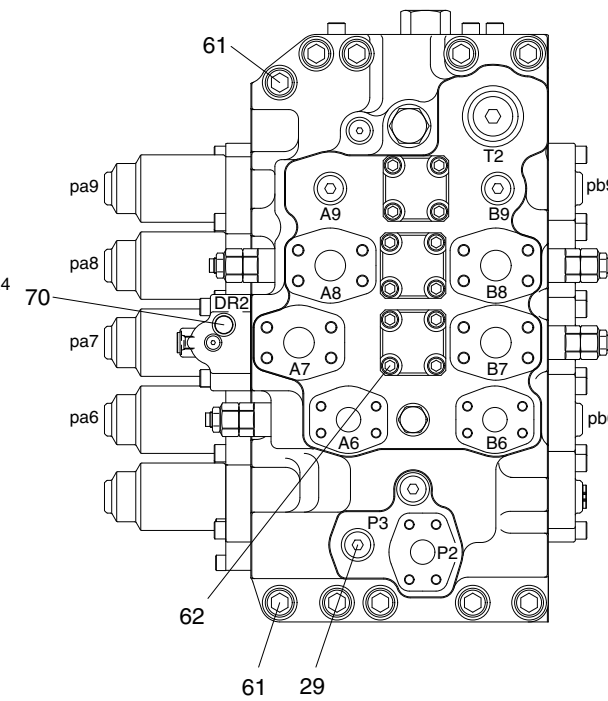
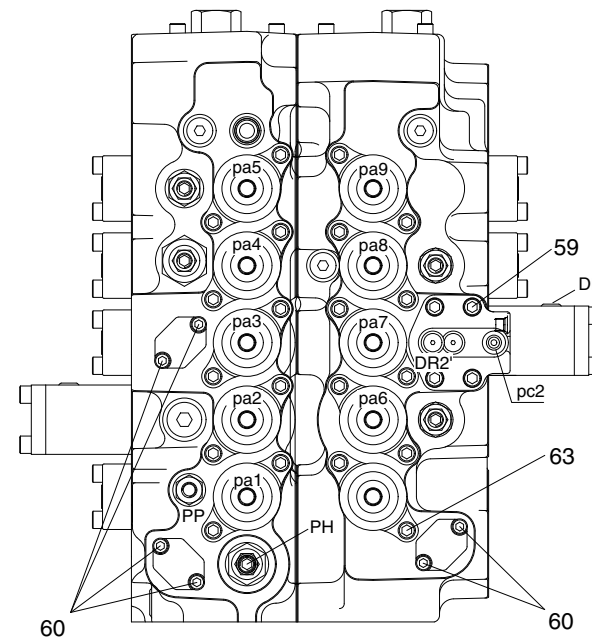
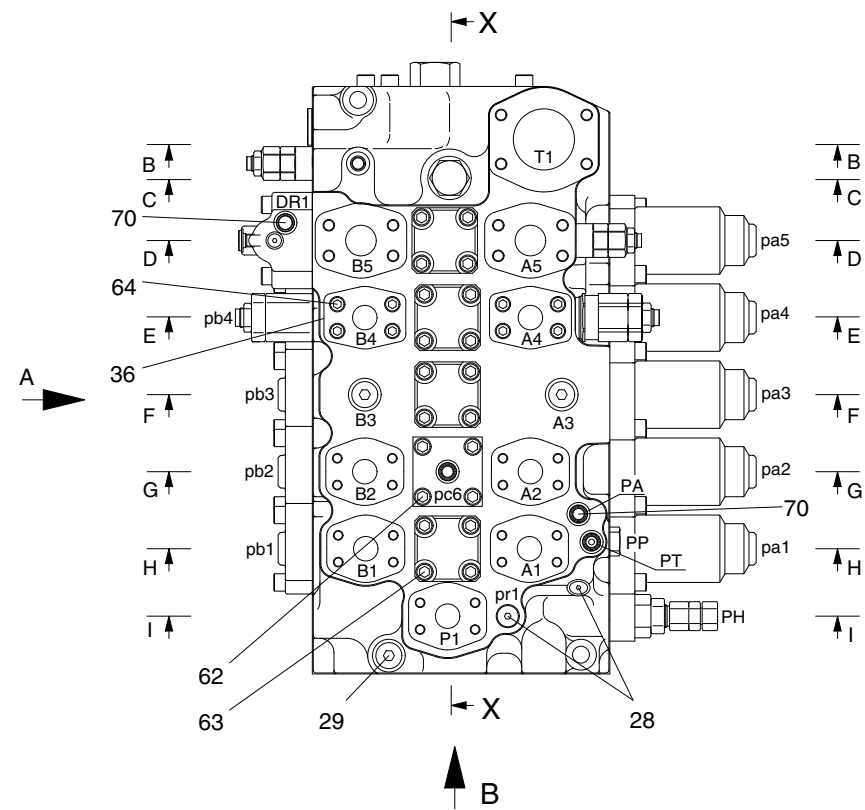
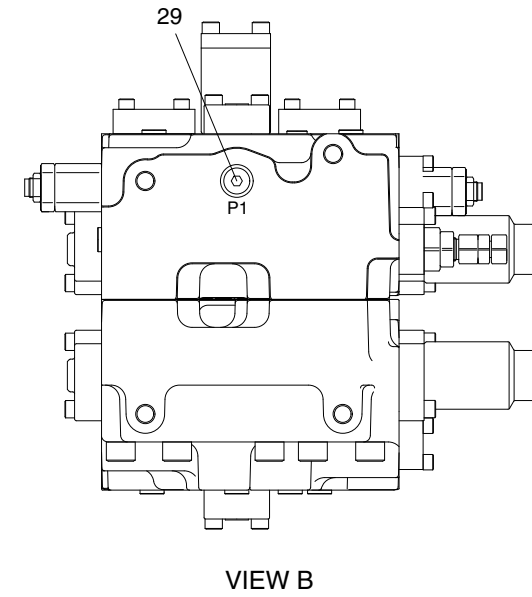
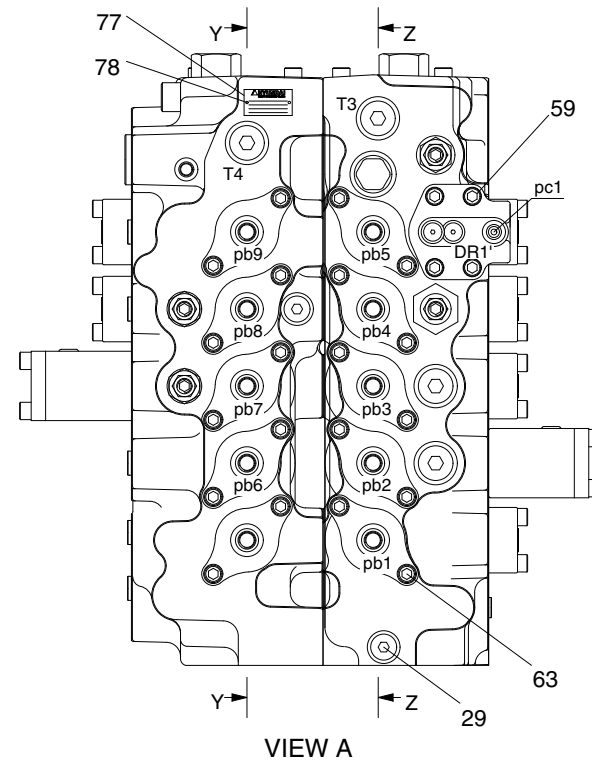
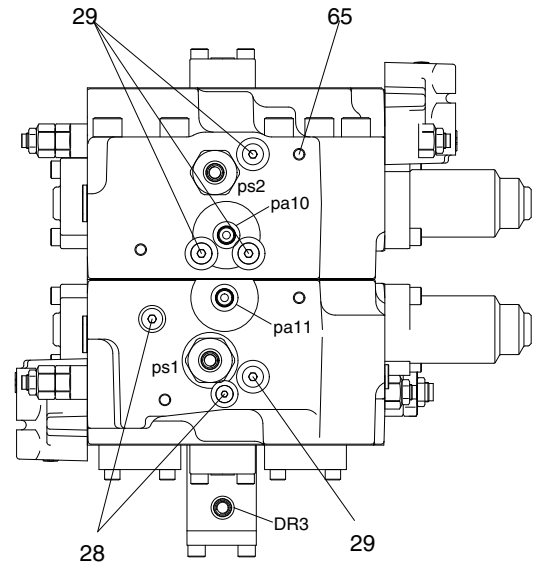
1. rotary group A1: 100% volume flow (speed), high pressure 300 bar
2. rotary group A2: 100% volume flow (speed), high pressure 300 bar
3. rotary group A1 and A2: 100% volume flow (speed), high pressure 150 bar



- ※ Adjustment M6x1 : 1 turn = 1 mm = +85.8 bar
(clockwise adjustment range of pQ: 150 ~ 300 bar (delta 150 bar)
(max. input torque 1.788 Nm of pump to be considered,
i.e. Vgmax and delta p = 250 bar, both rotary groups)

GROUP 2 MAIN CONTROL VALVE

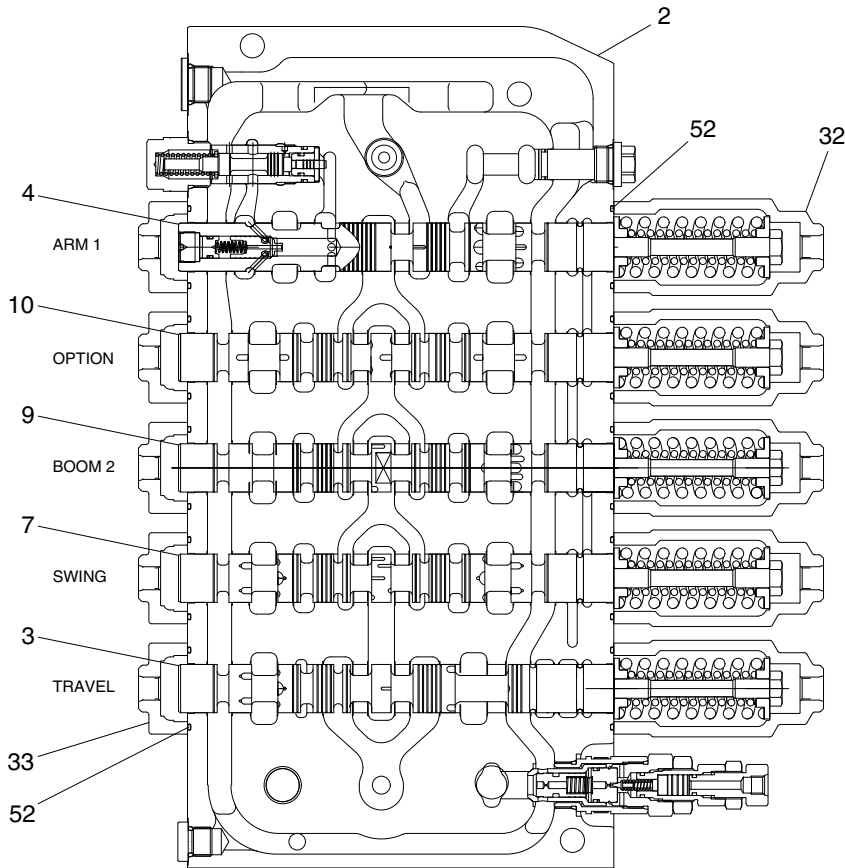
1. STRUCTURE



Port name	Port size	Thread depth (mm)
DR1, DR2, DR3, DR4, DR1', DR2', pr1, ps1, ps2, pc1, pc2, pc6, pc7, pa10, pa11, PA, PP, PH, PT	PF 1/4	12
pa1~pa9, pb1~pb9	PF 3/8	14
A3, A9, B3, B9, P1, P3	PF 1/2	16
T3, T4	PF 3/4	17
T2	PF 1	21

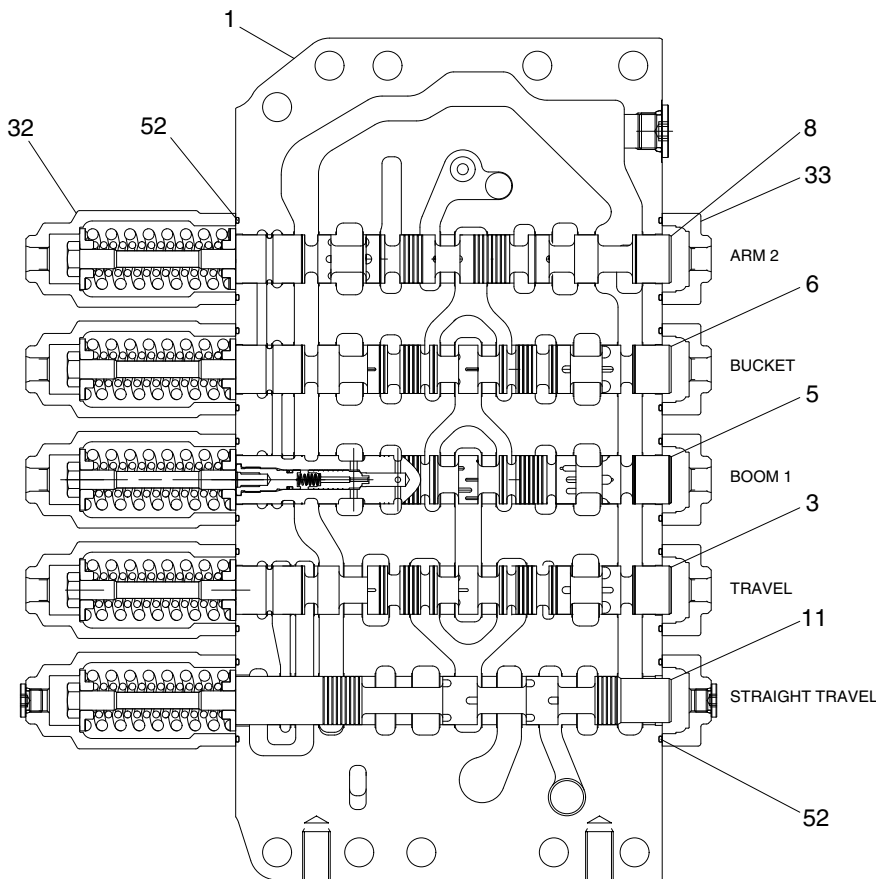
- 28 Plug assy
- 29 Plug assy
- 36 Flange
- 59 Socket head bolt
- 60 Socket head bolt
- 61 Socket head bolt
- 62 Socket head bolt
- 63 Socket head bolt
- 64 Socket head bolt
- 65 Socket head bolt
- 70 Dust cap
- 77 Name plate
- 78 Rivet

STRUCTURE (2/7)



SECTION Z-Z

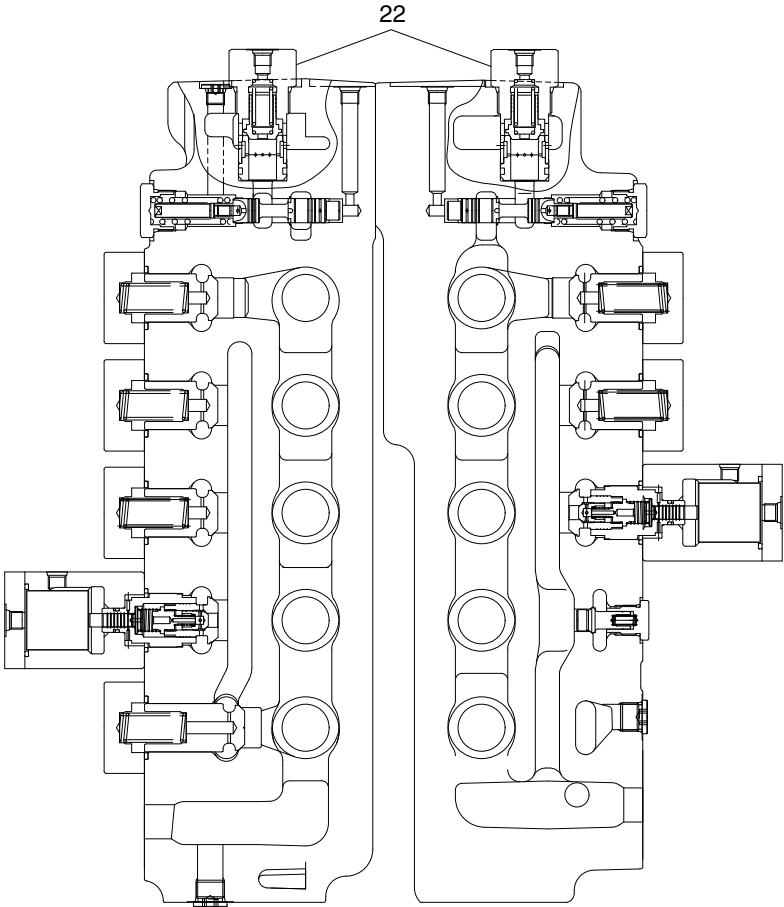
- 2 Housing P2
- 3 Travel spool kit
- 4 Arm 1 spool kit
- 7 Swing spool kit
- 9 Boom 2 spool kit
- 10 Option spool kit
- 32 Spool cap (L)
- 33 Spool cap (S)
- 52 O-ring



SECTION Y-Y

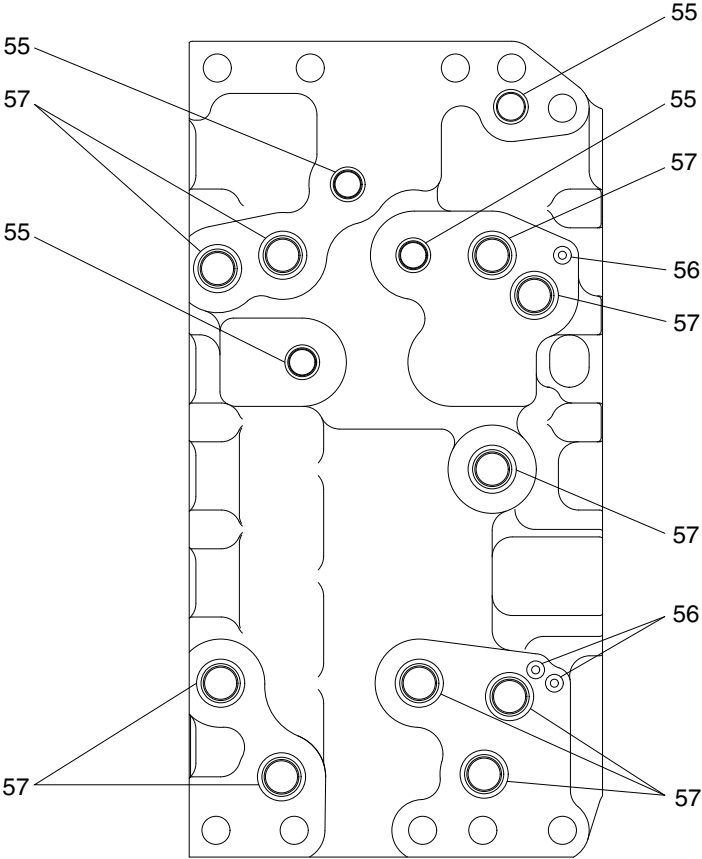
- 1 Housing P1
- 3 Travel spool kit
- 5 Boom 1 spool kit
- 6 Bucket spool kit
- 8 Arm 2 spool kit
- 11 Straight travel spool kit
- 32 Spool cap (L)
- 33 Spool cap (S)
- 52 O-ring

STRUCTURE (3/7)



22 Negacon valve assy

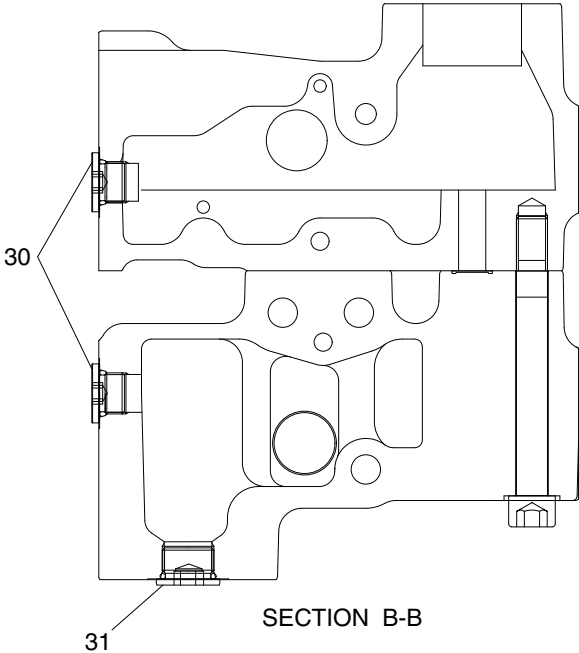
SECTION X-X



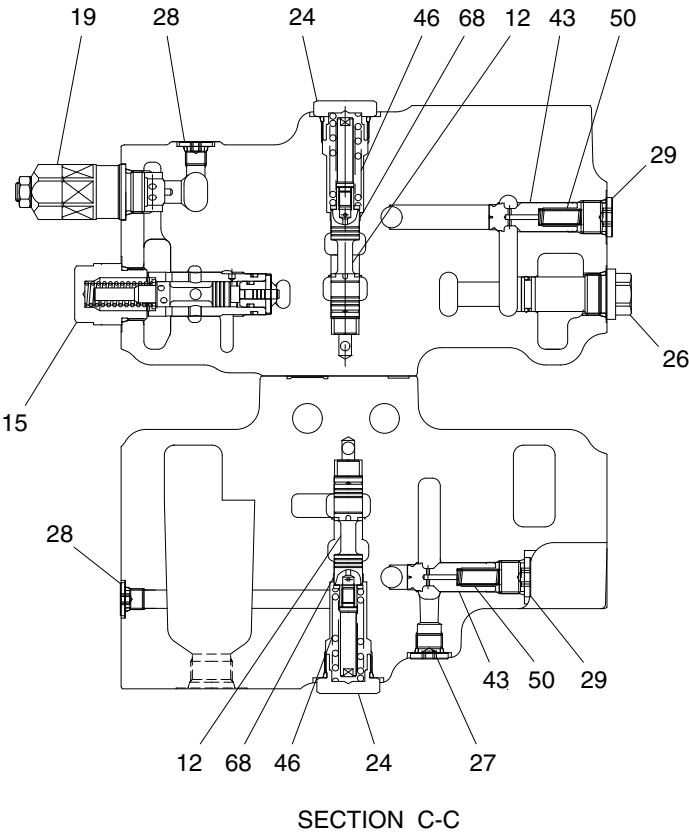
55 O-ring
56 O-ring
57 O-ring

DETAIL OF COMBINED PLANE

STRUCTURE (4/7)

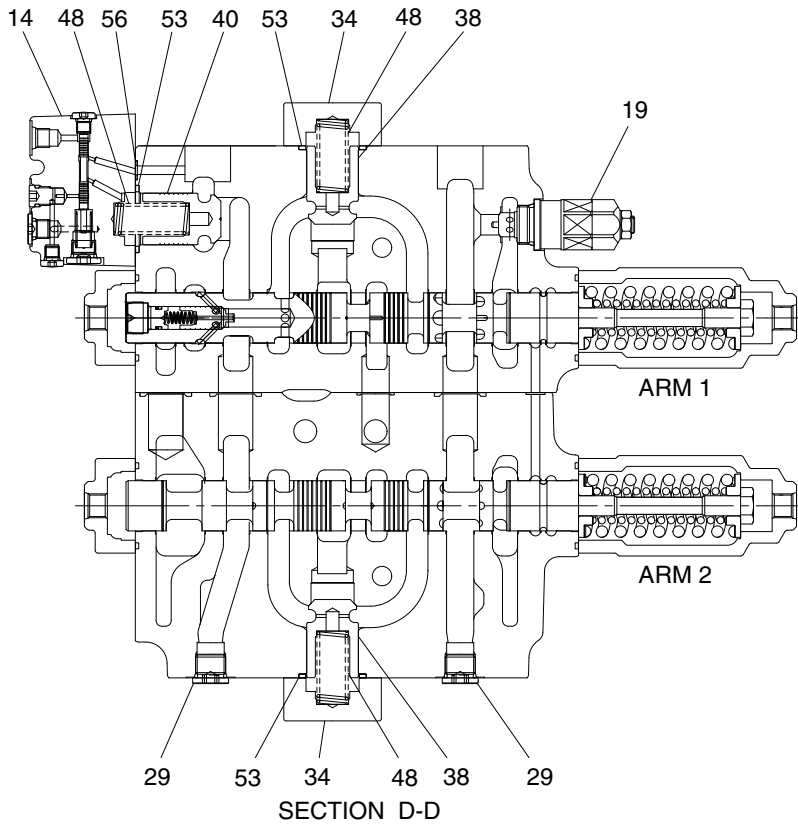


- 30 Plug assy
- 31 Plug assy
- 66 Socket head bolt

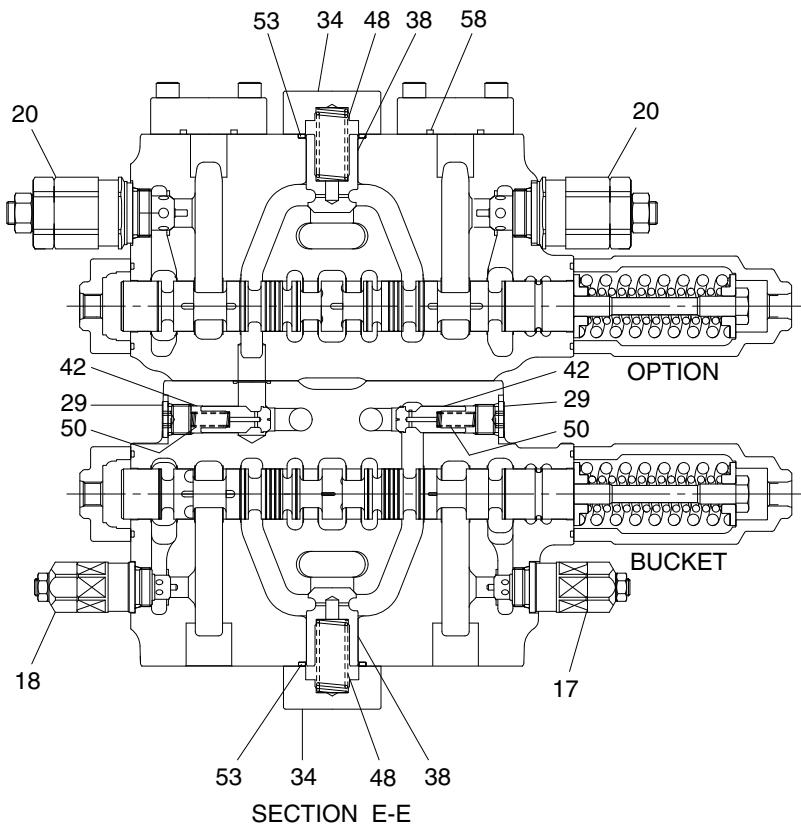


- 12 Spool kit-BC
- 15 Arm regen cut valve
- 19 Overload relief valve assy
- 24 Plug assy-BC
- 26 Plug assy
- 27 Plug assy
- 28 Plug assy
- 29 Plug assy
- 43 Poppet
- 46 Spring-BC
- 50 Spring
- 68 Spring seat-BC

STRUCTURE (5/7)

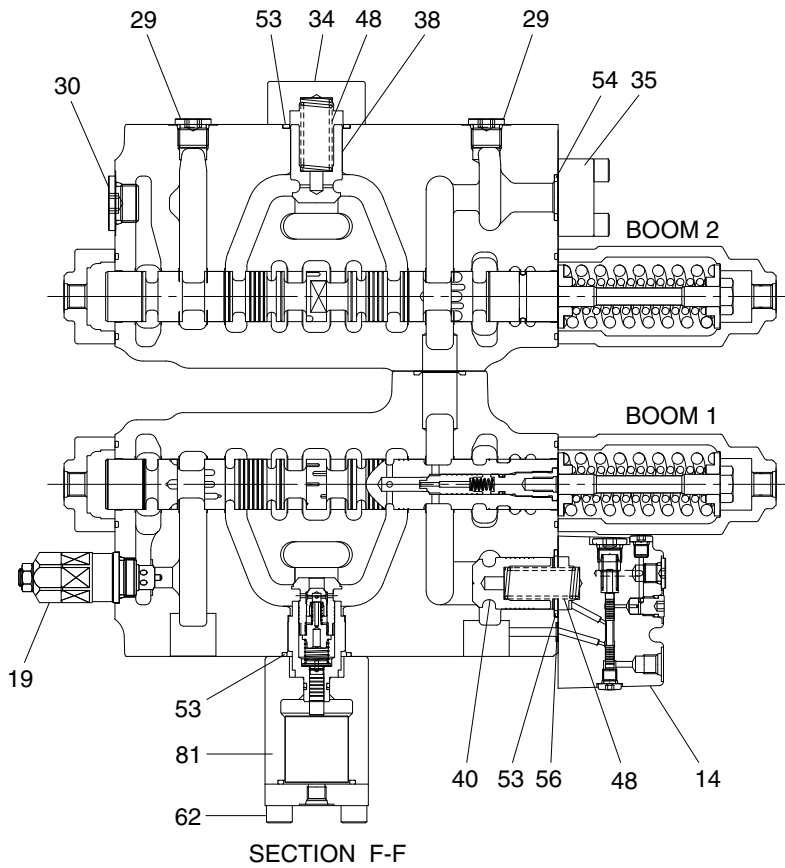


- 14 Holding valve assy
- 19 Overload relief valve assy
- 29 Plug assy
- 34 Flange-LC
- 38 Poppet
- 40 Poppet
- 48 Spring
- 53 O-ring
- 56 O-ring
- 66 Socket head bolt

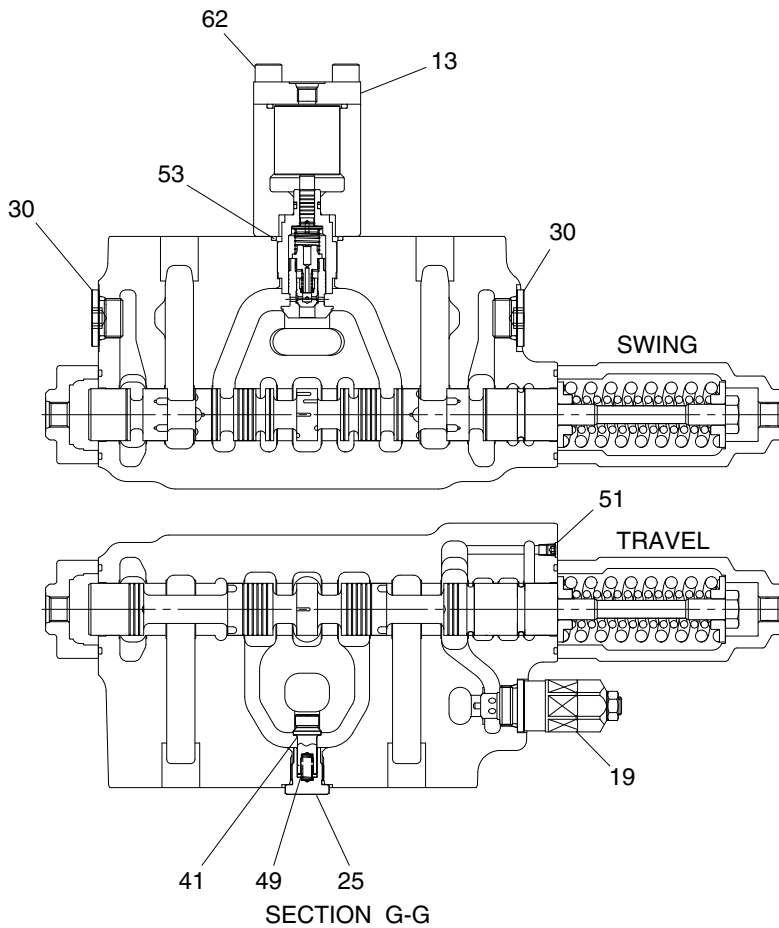


- 17 Overload relief valve assy
- 18 Overload relief valve assy
- 20 Overload relief valve assy
- 29 Plug assy
- 34 Flange-LC
- 38 Poppet
- 42 Poppet
- 48 Spring
- 50 Spring
- 53 O-ring
- 58 O-ring

STRUCTURE (6/7)

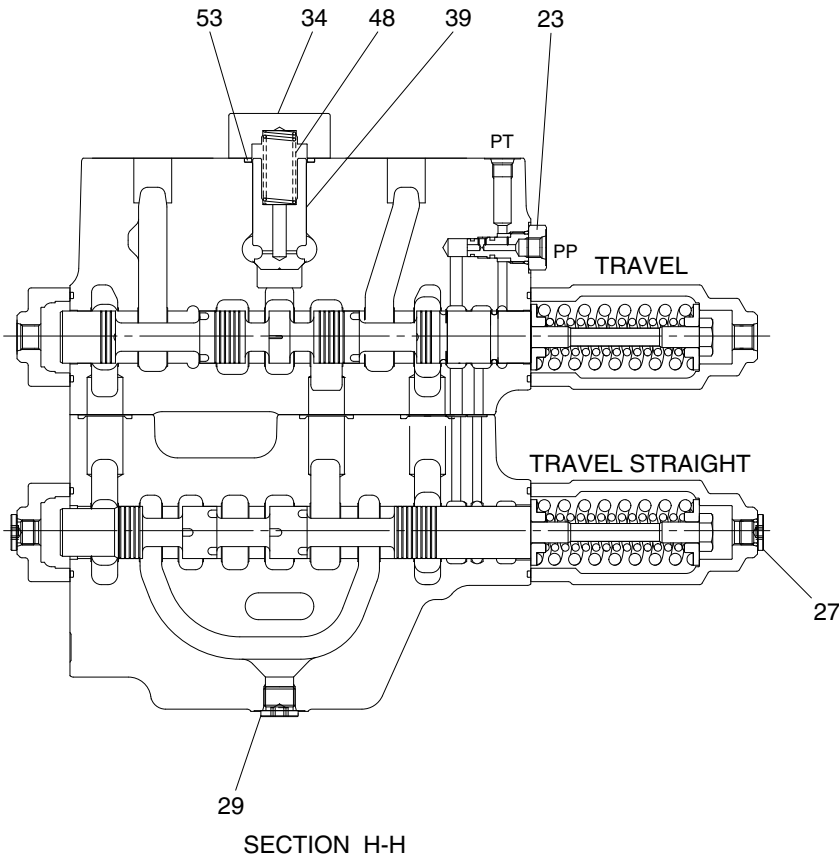


- 14 Holding valve assy
- 19 Overload relief valve assy
- 29 Plug assy
- 30 Plug assy
- 34 Spool cap
- 35 Flange-MR
- 38 Poppet
- 40 Poppet
- 48 Spring
- 53 O-ring
- 54 O-ring
- 56 O-ring
- 62 Socket head bolt
- 81 Boom logic valve assy

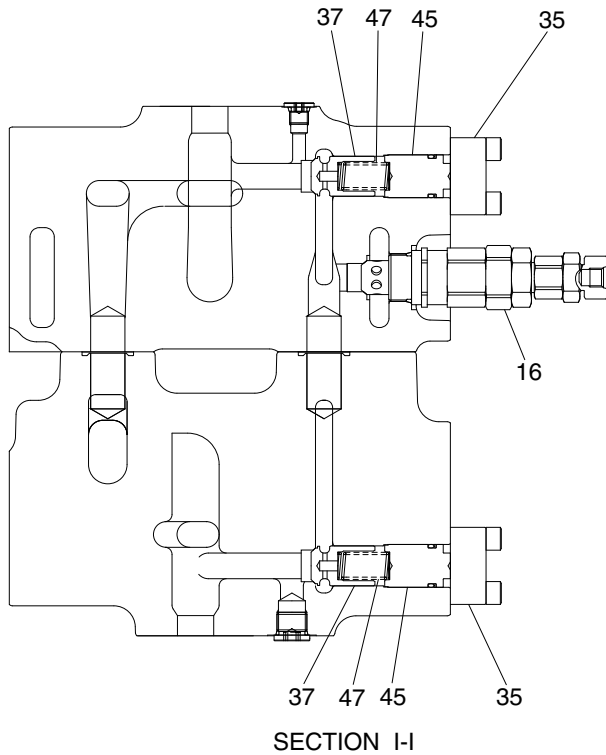


- 13 Swing logic valve assy
- 19 Overload relief assy
- 25 Plug assy
- 30 Plug assy
- 41 Poppet
- 49 Spring
- 51 O-ring
- 53 O-ring
- 62 Socket head bolt

STRUCTURE (7/7)

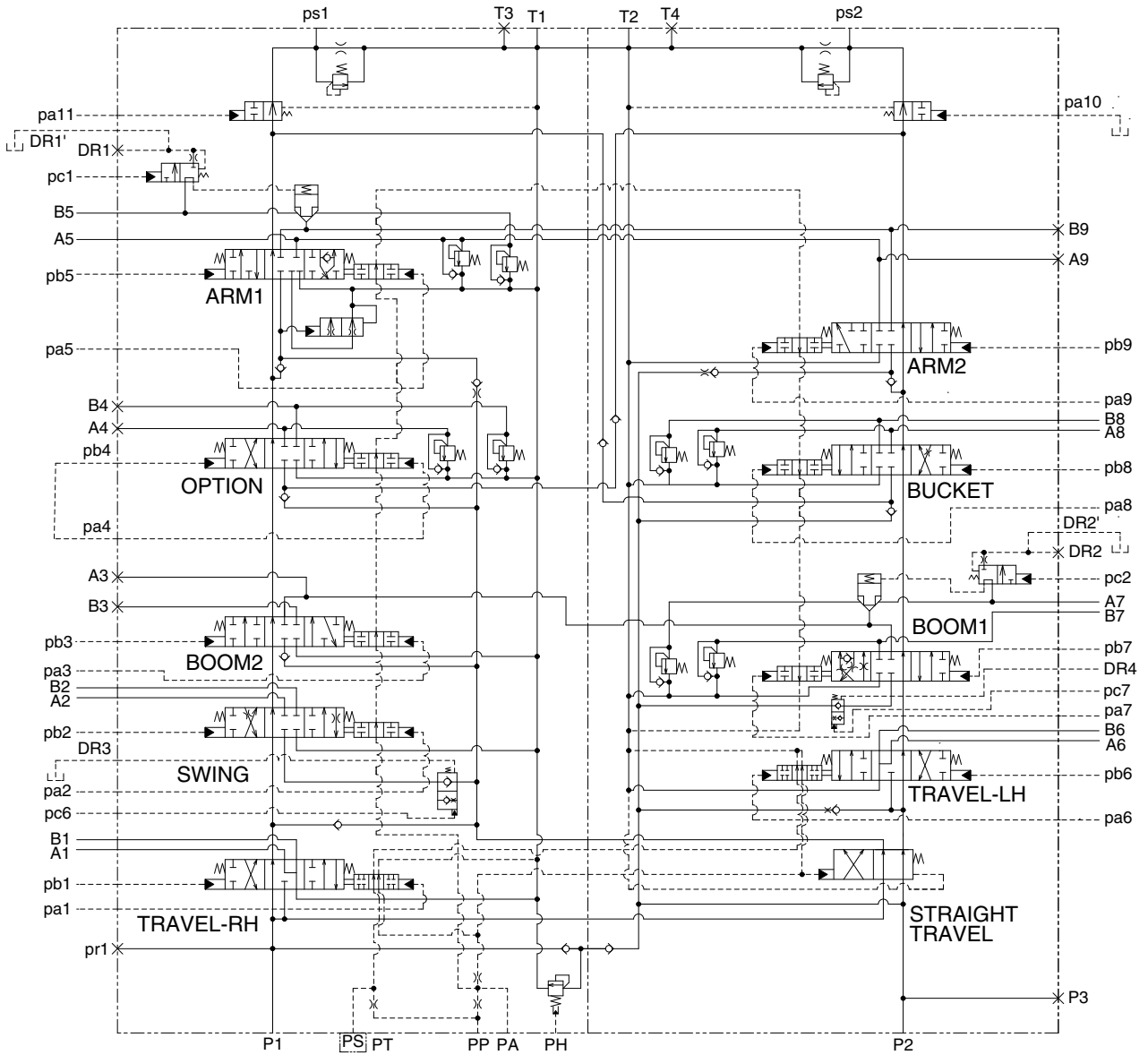


- 23 Signal plug assy
- 27 Plug assy
- 29 Plug assy
- 34 Flange-LC
- 39 Poppet
- 48 Spring
- 53 O-ring



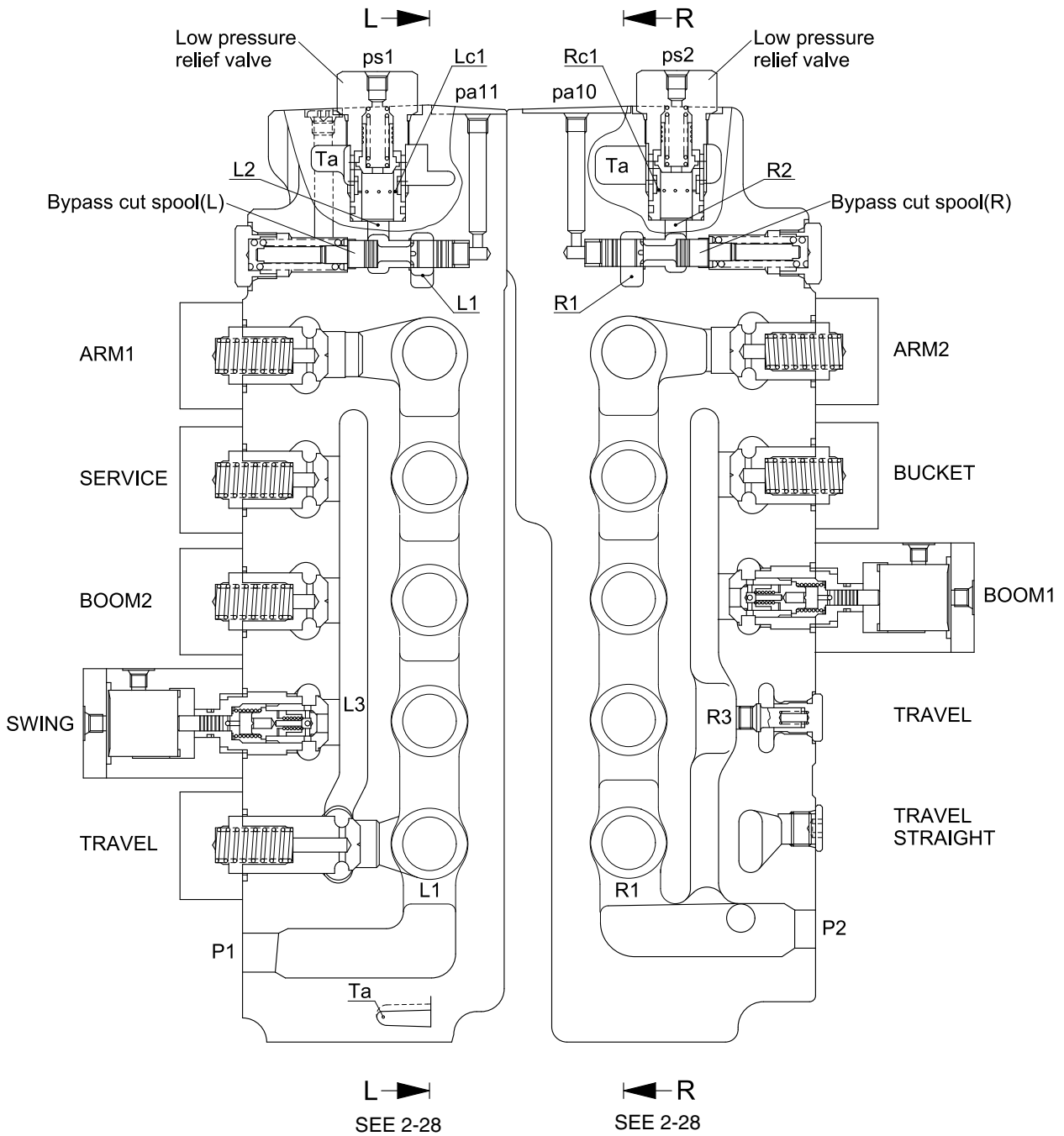
- 16 Main relief valve assy
- 35 Flange-MR
- 37 Poppet
- 45 Spacer assy-MR
- 47 Spring

2. HYDRAULIC CIRCUIT



3. OPERATION

1) ALL SPOOL NEUTRAL



2) SINGLE OPERATION

(1) Travel spool

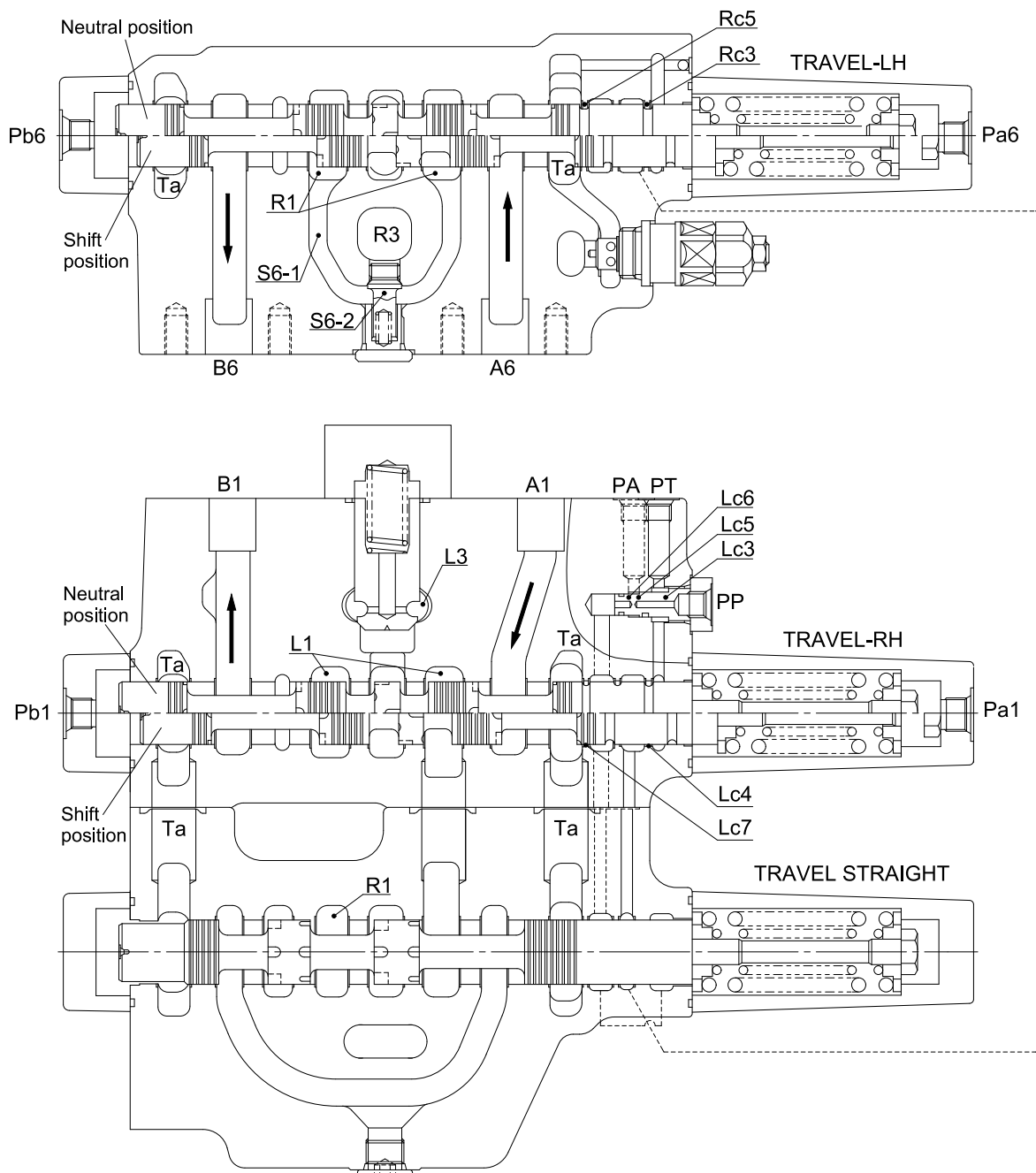
When the RH travel spool is pushed to right by the pilot pressure of port Pb1 the oil discharged from P1 port flows from the neutral passage (L1) to B1 port.

The oil from port A1 return to the tank via the tank passage (Ta).

When the LH travel spool is pushed to right by the pilot pressure of port Pb6 the oil discharged from P2 port flows from the neutral passage (R1) to B6 port through the passage S6-1.

At this time, the parallel passage (R3) and passage (S6-1) are to be maintained as same pressure as poppet (S6-2) is closed. The oil from A6 returns to the tank via the tank passage (Ta).

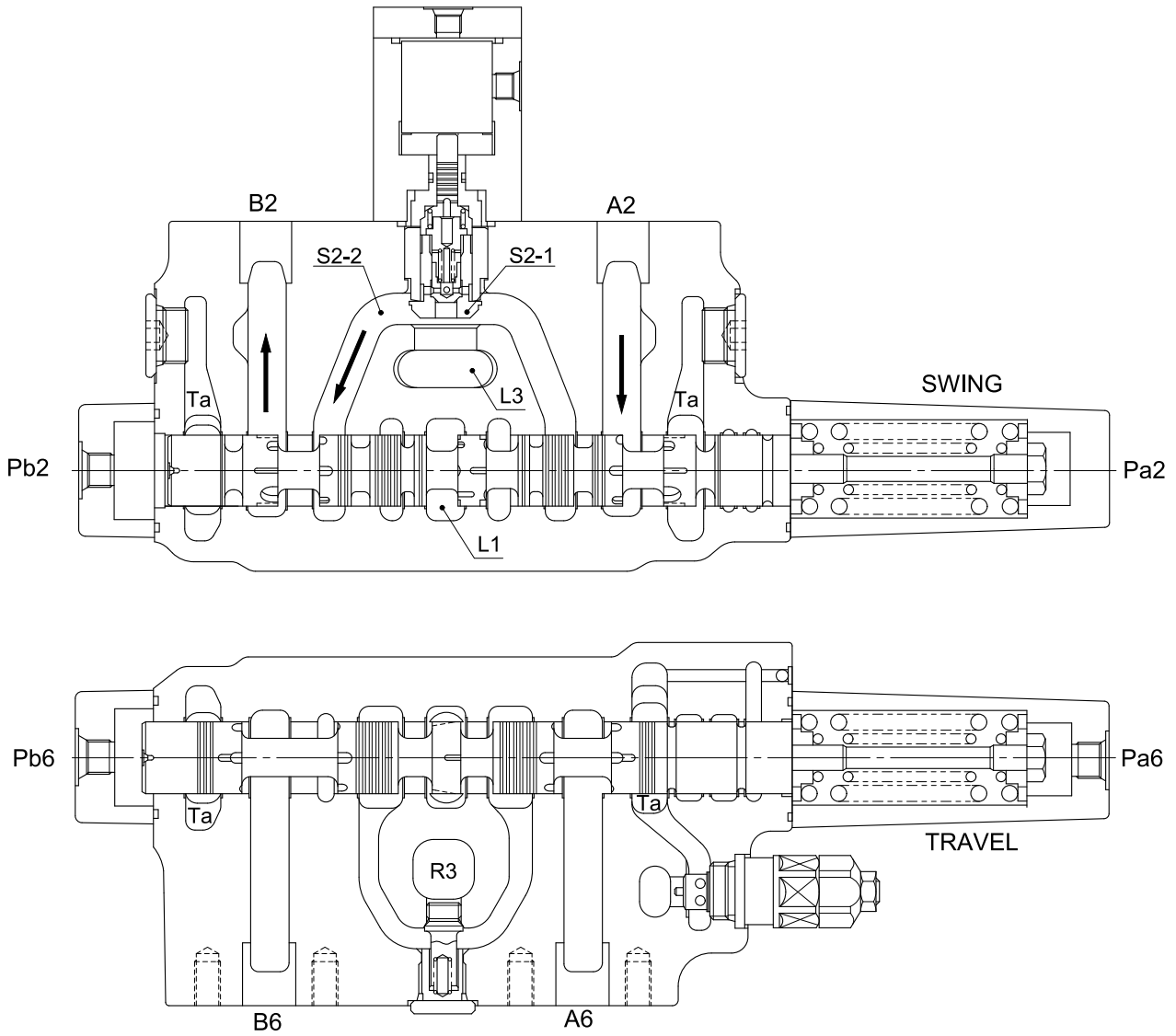
When the travel spool is pushed to the right by the pilot pressure, the land (Lc4, Rc3) is closed and the tank passage of the oil discharged from port PP is closed, and then the pressure of PT port is increased.



(2) Swing spool

When the swing spool is pushed to the right by the pilot pressure of port Pb2, the neutral passage (L1) is closed, the oil discharged from pump P1 pushes up the load check valve (S2-1), passage (S2-2) via parallel passage (L3) and then flows into port B2.

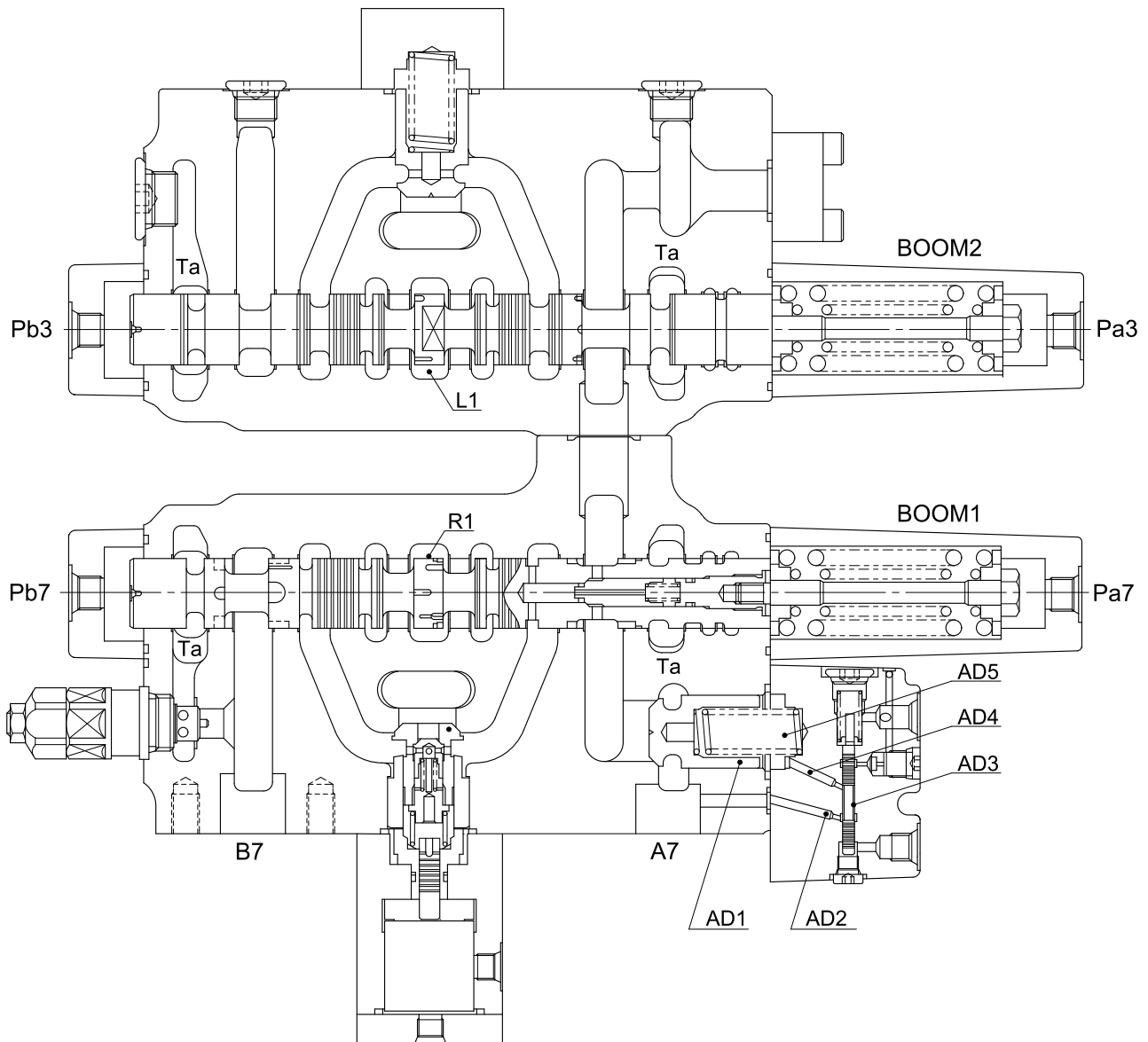
The oil from port A2 return to the tank via the tank passage (Ta).



3) BOOM SPOOL

(1) Neutral

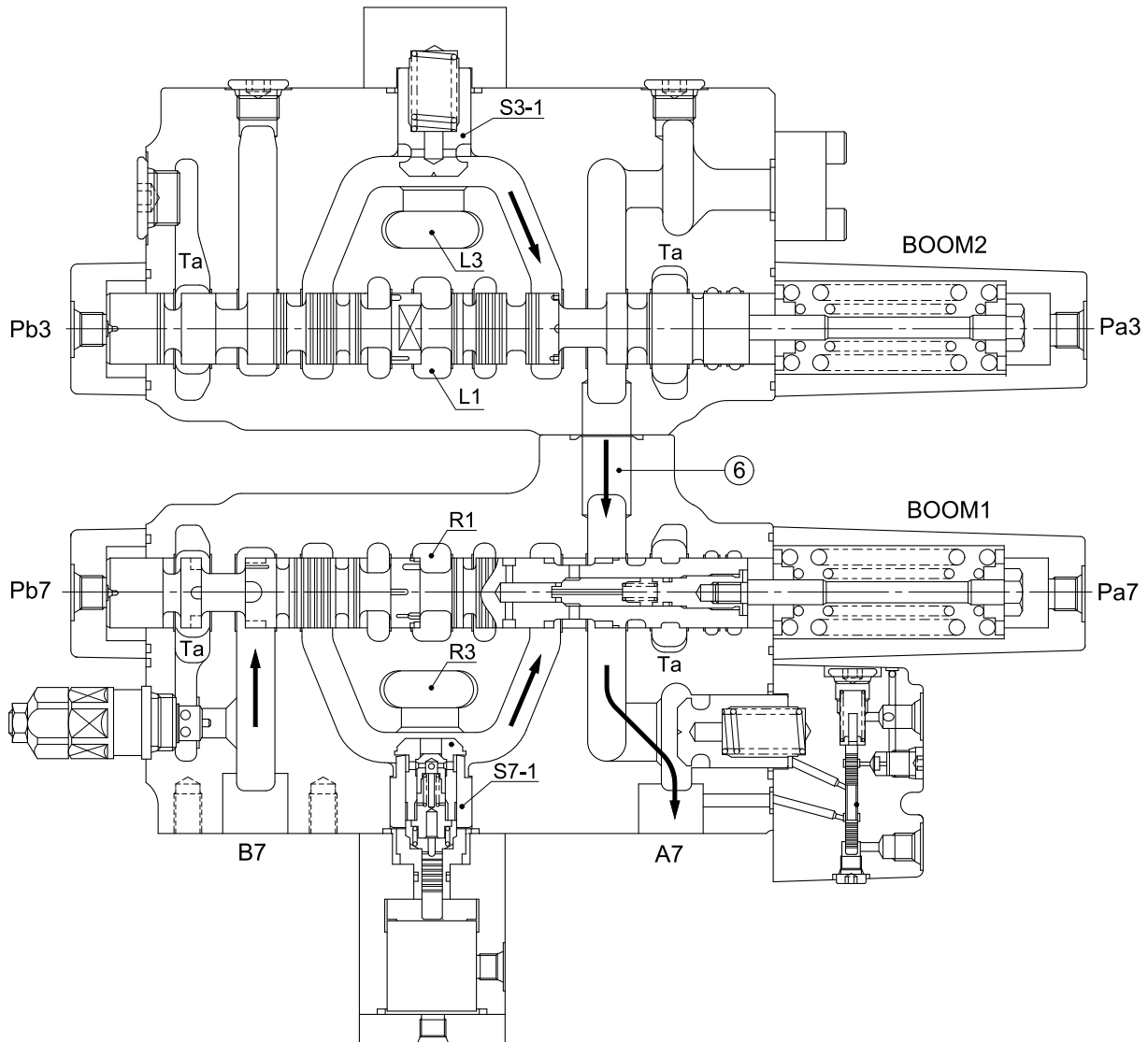
This valve is providing the anti-drift valve on the cylinder bottom side of boom 1 section. In neutral, the poppet (AD1) is seated by the pressure of spring chamber (AD5) because the oil from the port A7 is connection with spring chamber (AD5) via passage (AD2), spool (AD3) and passage (AD4).



(2) Boom up (flow summation)

When the boom 1 spool is pushed to the left by the pilot pressure of port Pa7, the neutral passage (R1) is closed, the oil discharged from pump P2 flows into the port A7 via parallel passage (R3), the load check valve (S7-1). At the same time, the boom 2 spool is pushed to the left by the pilot pressure of port Pa3, the neutral passage (L1) is closed, the oil discharged from pump P1 flows into the port A7 via parallel passage (L3), the load check valve (S3-1) and then joins to the passage (6).

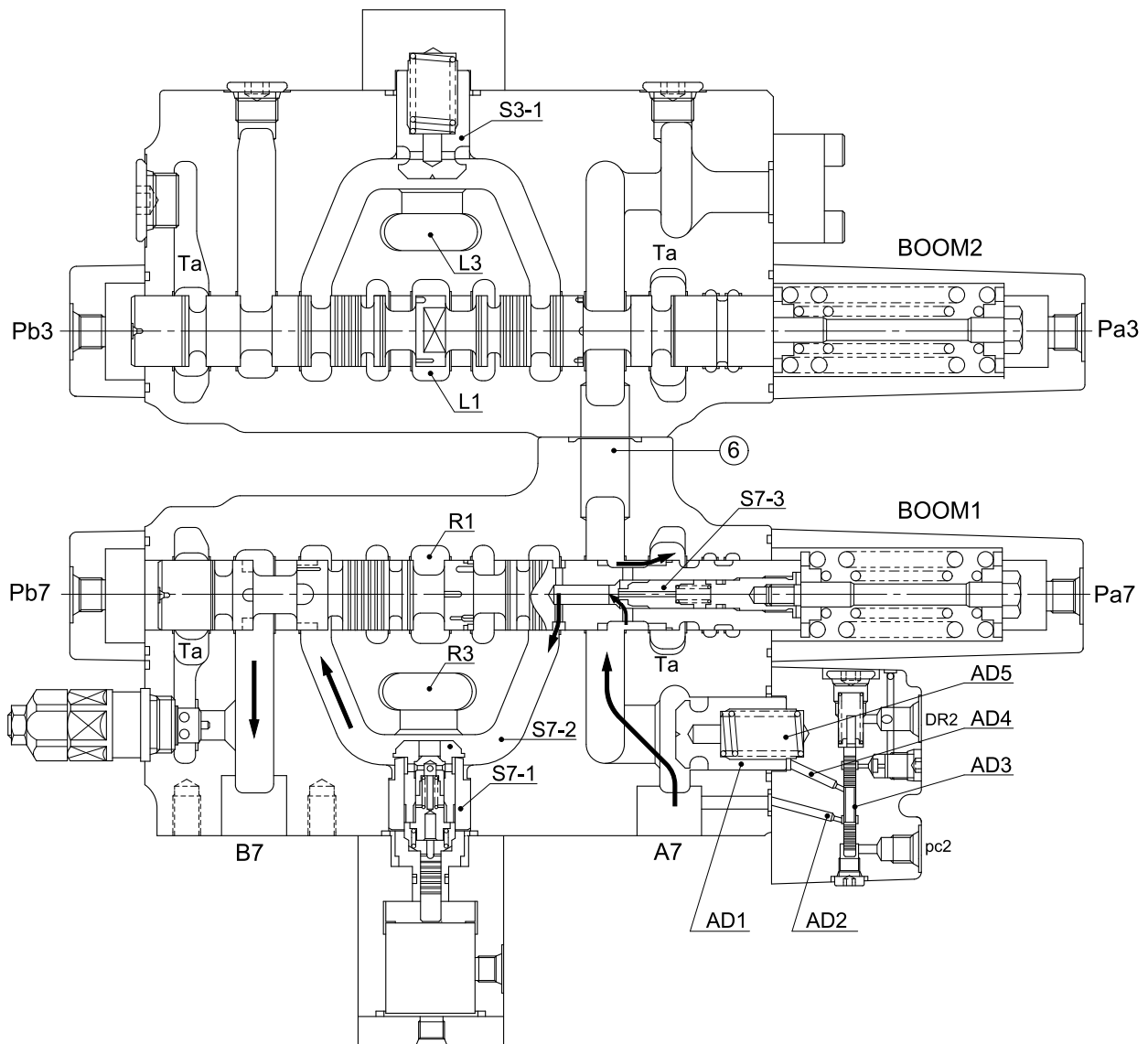
The return oil from port B7 flows into the tank via the tank passage (Ta).



(3) Boom down (recycling)

When the boom 1 spool is pushed to the right by the pilot pressure of port Pb7, the neutral passage (R1) is closed, the oil discharged from pump P2 flows into the port B7 via parallel passage (R3) and the load check valve (S7-1). At the same time, as the port pc2 is pressurizing, the spool (AD3) of anti-drift valve is pushed up, the pressure of spring chamber (AD5) is released and the poppet (AD1) is opened and then the oil from port A7 flows into the tank passage (Ta). Some of returned oil makes the poppet (S7-3) inside boom 1 spool to open and is connected to the passage (S7-2) and flows together into the port B7.

This prevents the cavitation of cylinder rod side.



4) SERVICE SPOOL

When the service spool is pushed to the left by the pilot pressure of port Pb4, the neutral passage (L1) is closed, the oil discharged from pump P1 flows into the port B4 via parallel passage (L3), the load check valve (S4-1) and passage (S4-2).

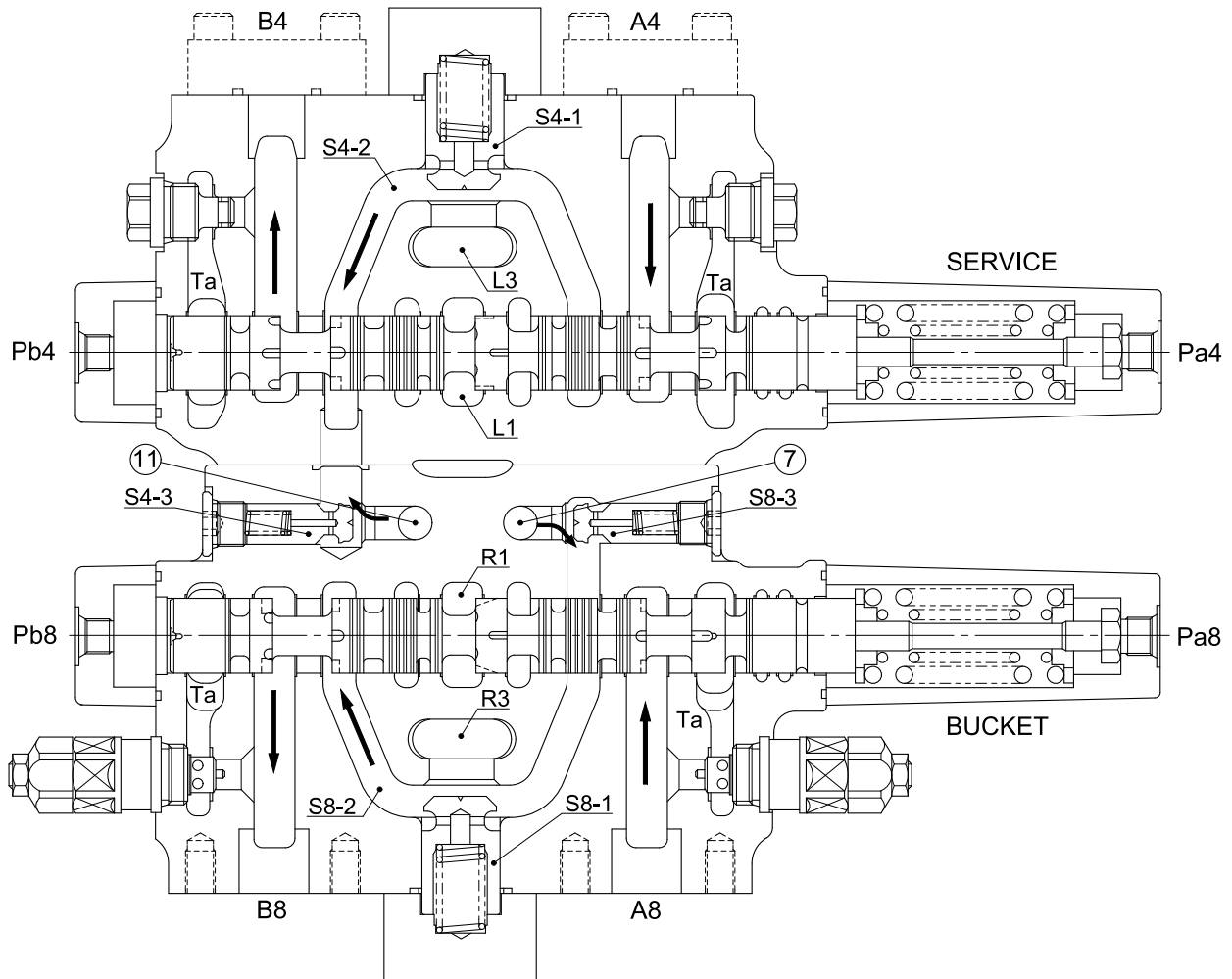
At the same time, as the port pa10 (see 2-24 page) is pressurizing and the bypass cut spool (R) is pushed, the oil discharged from pump P2 flows together into the port B7 via passage (11), poppet (S4-3). The oil returned from port A4 flows into the tank via the tank passage (Ta).

5) BUCKET SPOOL

When the bucket spool is pushed to the left by the pilot pressure of port Pb8, the neutral passage (R1) is closed, the oil discharged from pump P2 flows into the port B8 via parallel passage (R3), the load check valve (S8-1) and passage (S8-2).

At the same time, as the port pa11 is pressurizing and the bypass cut spool (R) is pushed, the oil discharged from pump P1 flows together the passage (S8-2) via passage (7), poppet (S8-3).

The return oil from port A8 flows into the tank via the tank passage (Ta).



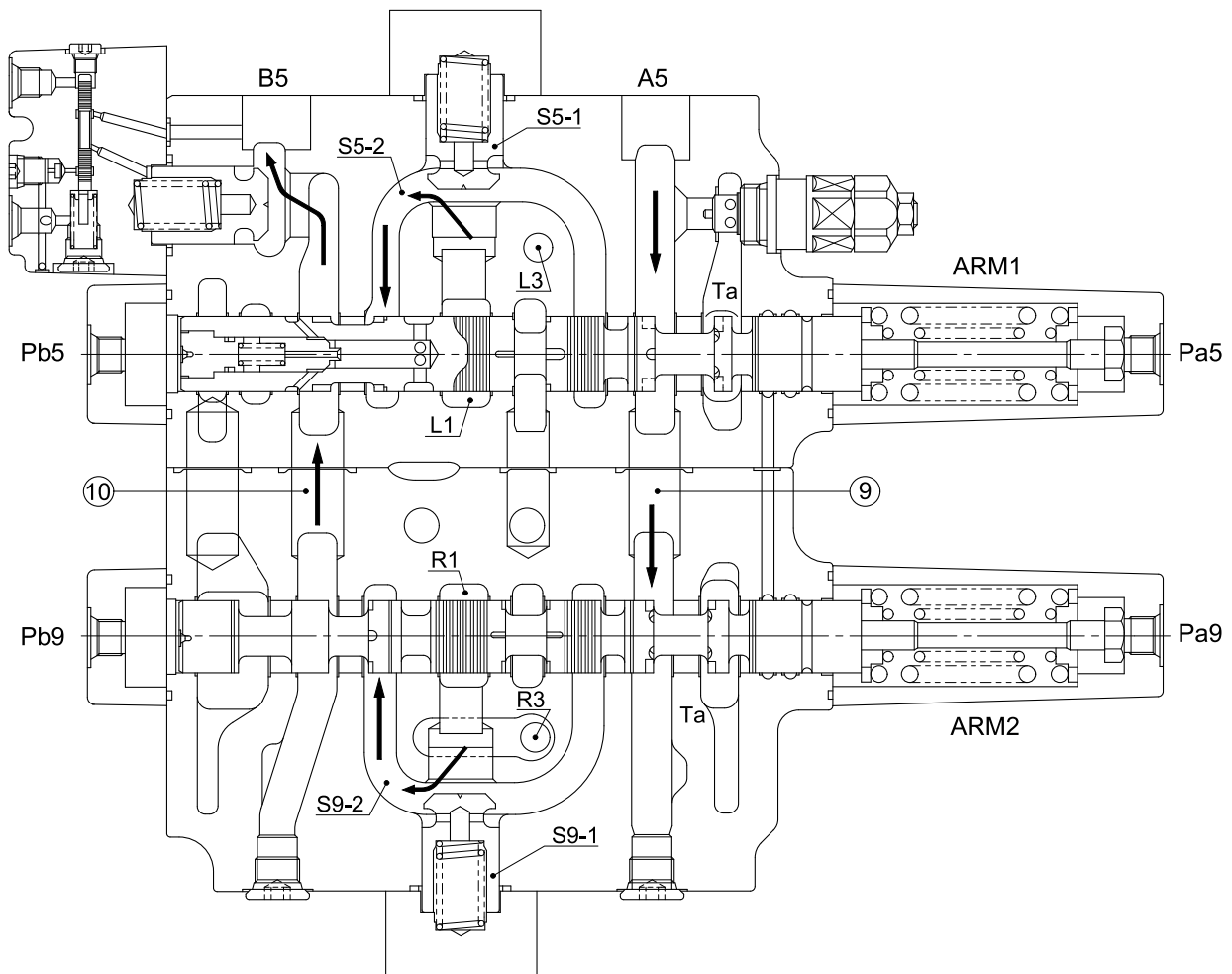
6) ARM SPOOL

(1) Arm out (flow summation)

When the arm 1 spool is pushed to the right by the pilot pressure of port Pb5, the oil discharged from pump P1 flows into the port B5 via neutral passage (L1), the load check valve (S5-1) and passage (S5-2).

When the arm 2 spool is pushed to the right by the pilot pressure of port Pb9, the oil discharged from pump P2 flows together the port B5 the passage (10) via the neutral passage (R1), the load check valve (S9-1) and passage (S9-2).

The return oil from port A5 flows into the tank via the tank passage (Ta).

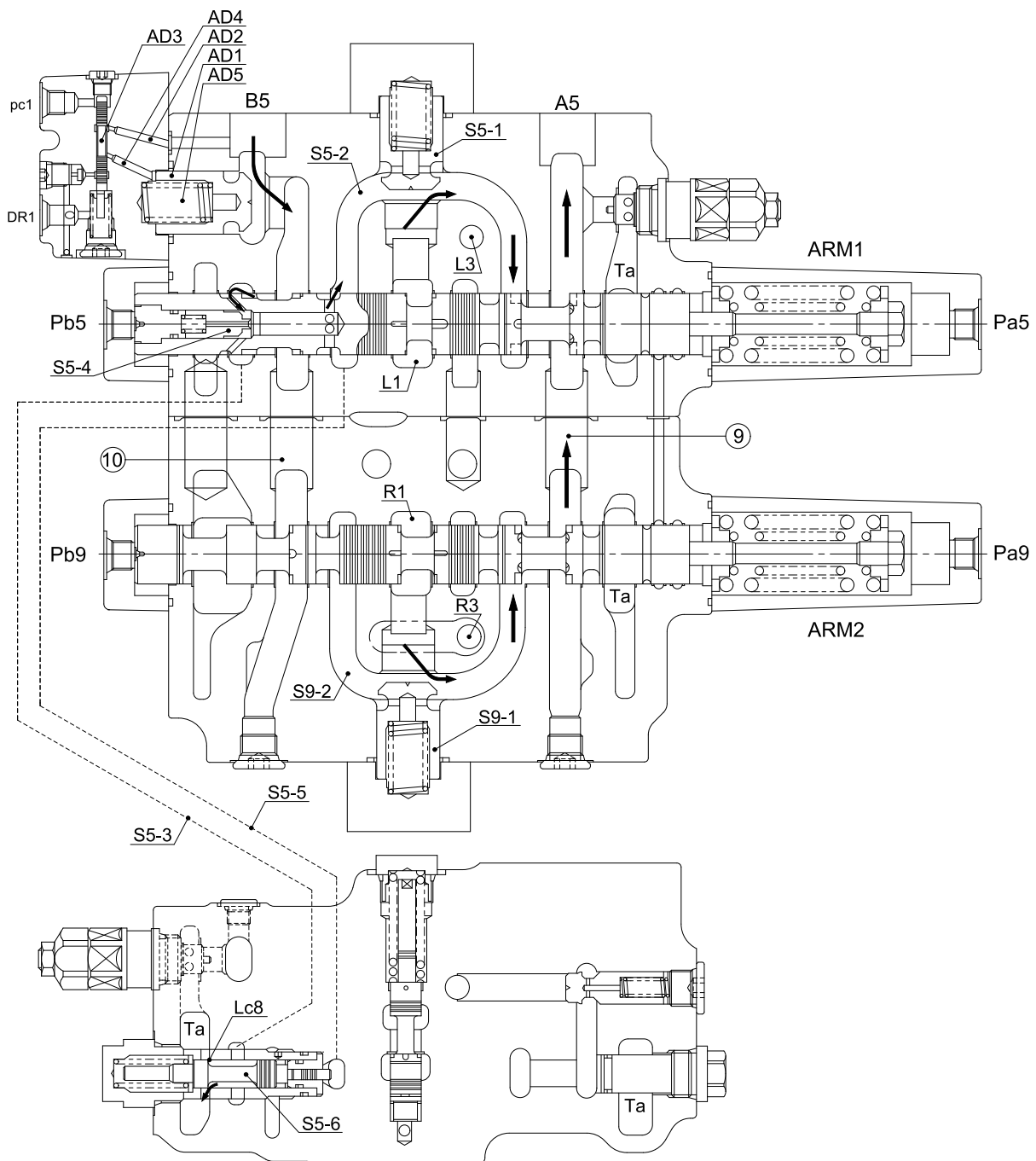


(2) Arm in (flow summation)

When the arm 1 spool is pushed to the left by the pilot pressure of port Pa5, the oil discharged from pump P1 flow into the port A5 via neutral passage (L1), the load check valve (S5-1) and passage (S5-2).

When the arm 2 spool is pushed to the left by the pilot pressure of port Pa9, the oil discharged from pump P2 flows together into the port A5 via neutral passage (R1), the load check valve (S9-1) and passage (S9-2).

At the same time, as the port pc1 is pressurizing and the spool (AD3) of anti-drift valve is pushed down, the pressure of spring chamber (AD5) is released and the poppet (AD1) is opened and then the oil returned from port B5 flows into the tank passage (Ta) through the passage (S5-4) inside arm 1 spool to open and is connected to the passage (S5-2) and flows together into the port A5, the cylinder speed is raised and also prevents the cavitation of bottom side.

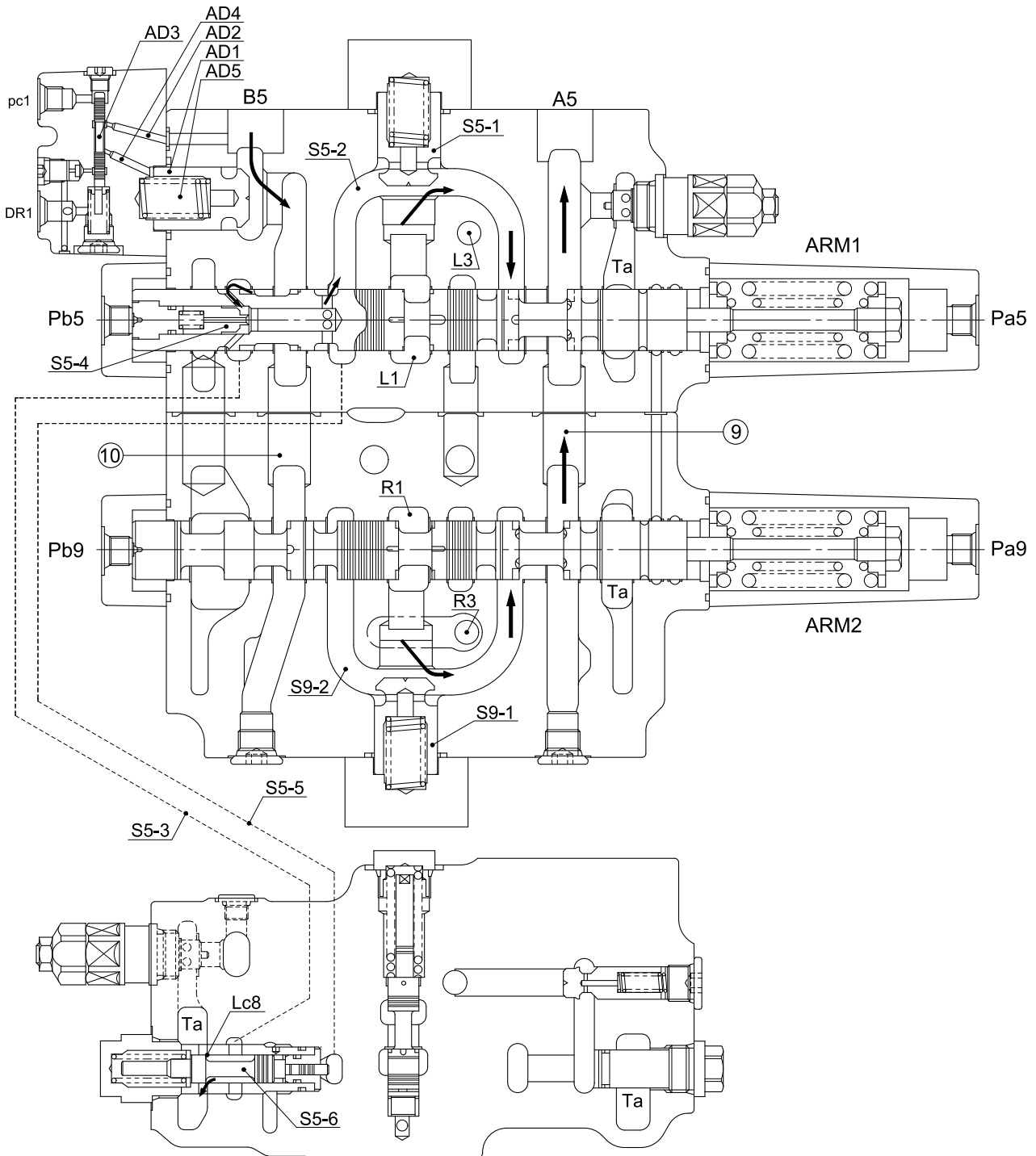


(3) Arm recycling (arm in)

When the arm is at in position, the spool (S5-6) stroke against the passage (S5-2) pressure guided from the passage (S5-5) is changed according to the opening angle of arm recycling orifice (Lc8).

When the pressure of the passage (S5-2) is high and this stroke is increased, the opening angle of orifice (Lc8) become large. On the contrary, when the pressure of passage (S5-2) is low, this stroke is decreased, the opening angle of orifice (Lc8) become small.

Therefore, the flow rate for arm recycling is changed by the pressure in bottom side of arm cylinder.



7) BYPASS CUT SPOOL

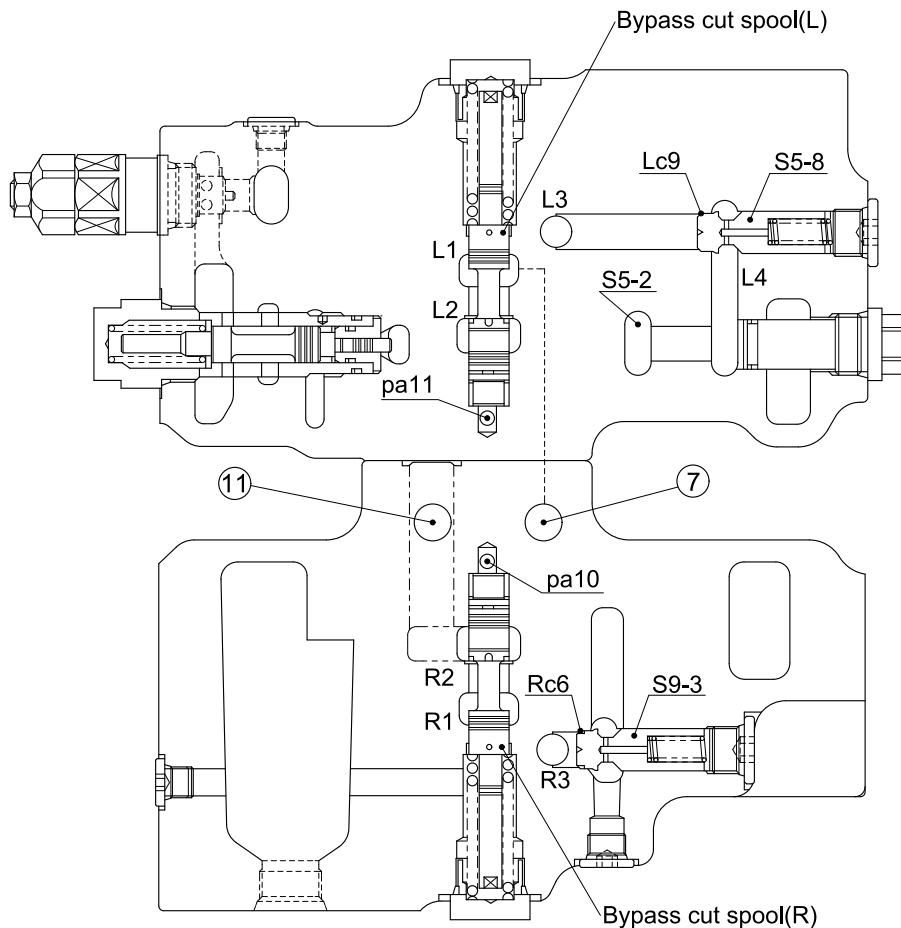
This valve is providing the bypass cut spool at the lowest stream of (upper stream of the low pressure relief valve) the neutral passage (L1, R1).

As the port pa10 (pa11) is pressurizing and the bypass cut spool (L, R) is pushed, the neutral passage (L1, R1) is closed. The oil discharged from port P1 flows together into the passage (S8-2, see 2-32 page) of bucket section via passage (⑦), poppet (S8-3) and the oil discharged from P2 port flows together into the passage (S4-2) of service section via the passage (⑪) and poppet (S4-3, see 2-32 page).

8) PARALLEL ORIFICE FOR ARM

The arm 1 and arm 2 section of this valve has orifices in the parallel circuit for arm. These orifices controls the speed of arm at combined operation.

The parallel circuit of arm 2 section is connected to the passage (S9-2, see 2-34) through orifice (Rc6) in the edge of the poppet (S9-3) from the parallel passage (R3), the parallel circuit of arm 1 section is connected to the passage (S5-2, see 2-34) through orifice (Lc9) in the edge of the poppet (S5-8) from the parallel passage (L3).



9) RELIEF VALVE

(1) Main relief valve

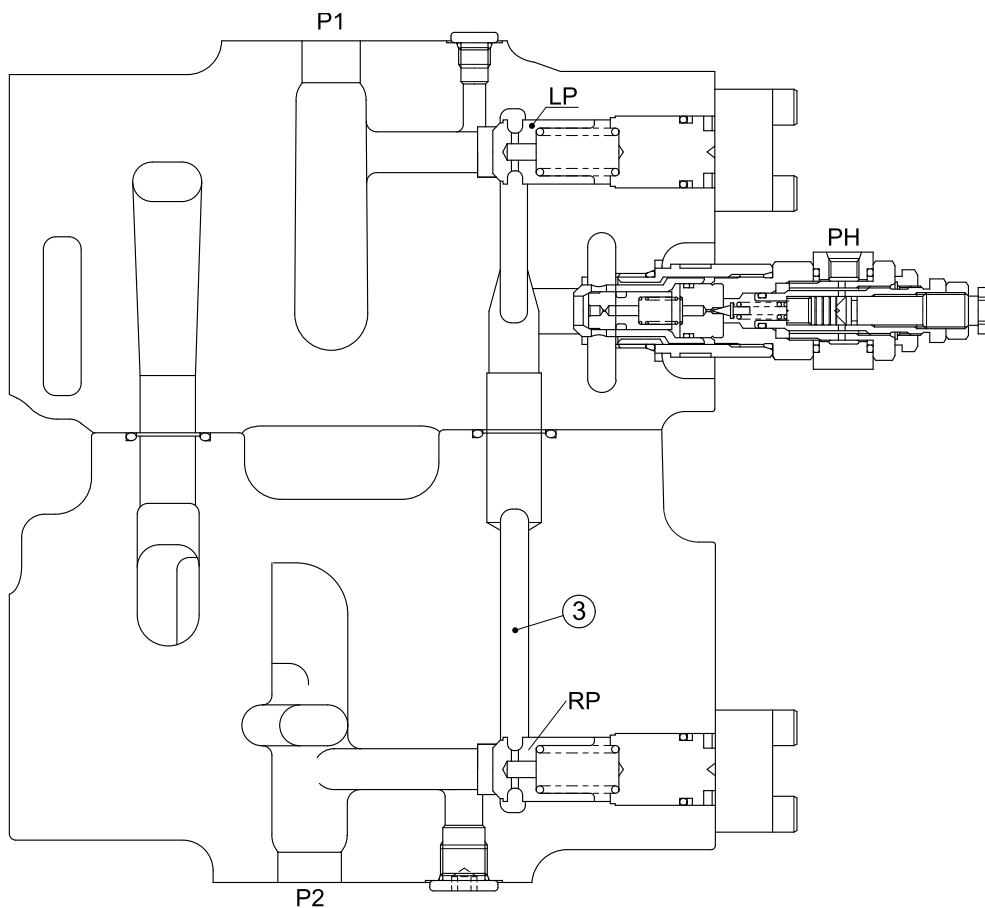
The oil discharged from P1 port via the poppet (LP) and the oil discharged from P2 port via the poppet (RP) flow into the main relief valve through the passage (3).

When the main relief valve is operating, the maximum pressure of pump P1, P2 is controlled.

(2) Overload relief valve

Overload relief valves are provided each cylinder ports of boom1, arm1 and bucket. These prevent the abnormal high pressure of actuators by external force.

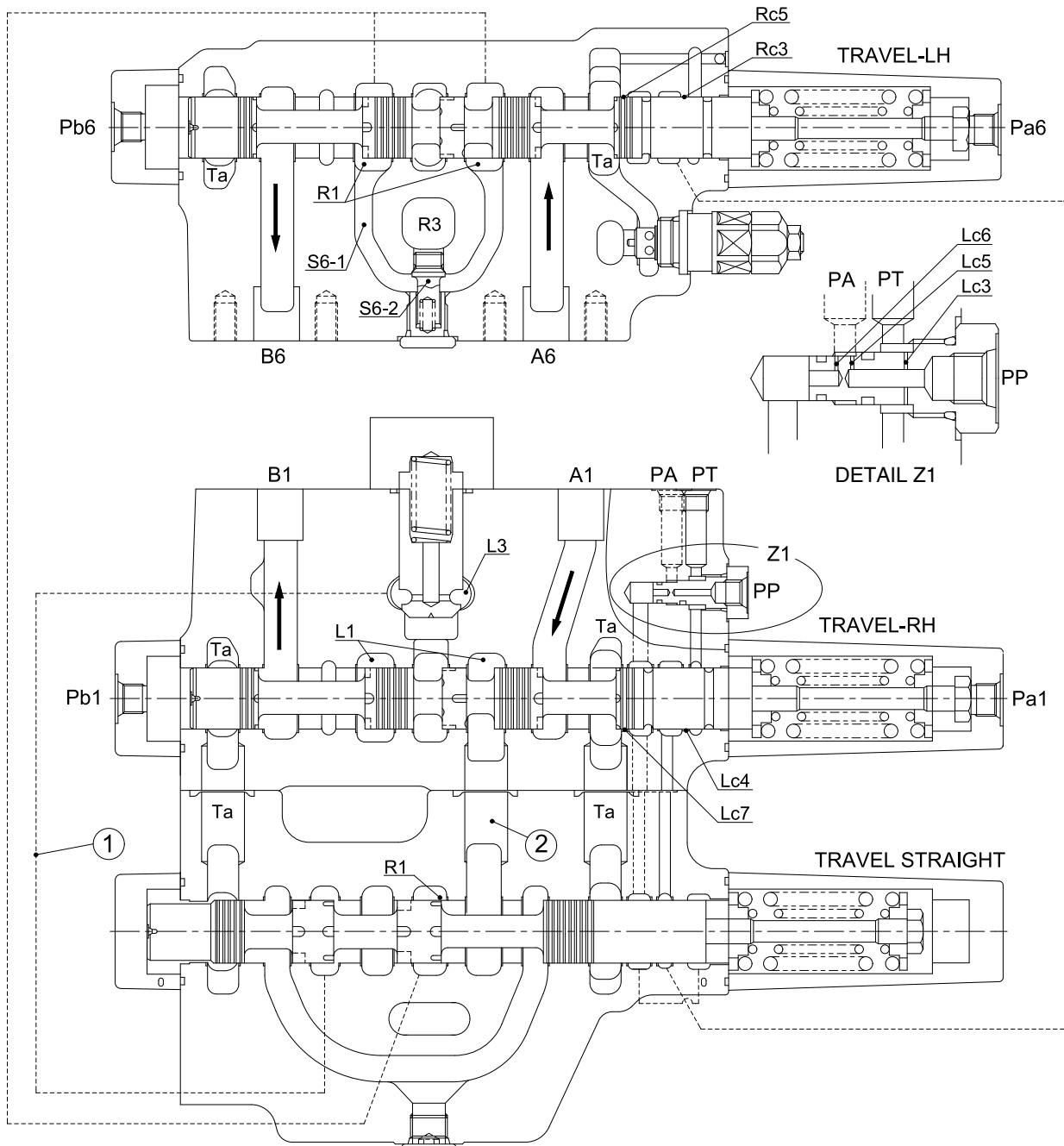
Also, when the pressure of cylinder ports create back pressure, this valve opens allowing oil from tank to cylinder port; and then prevents cavitation.



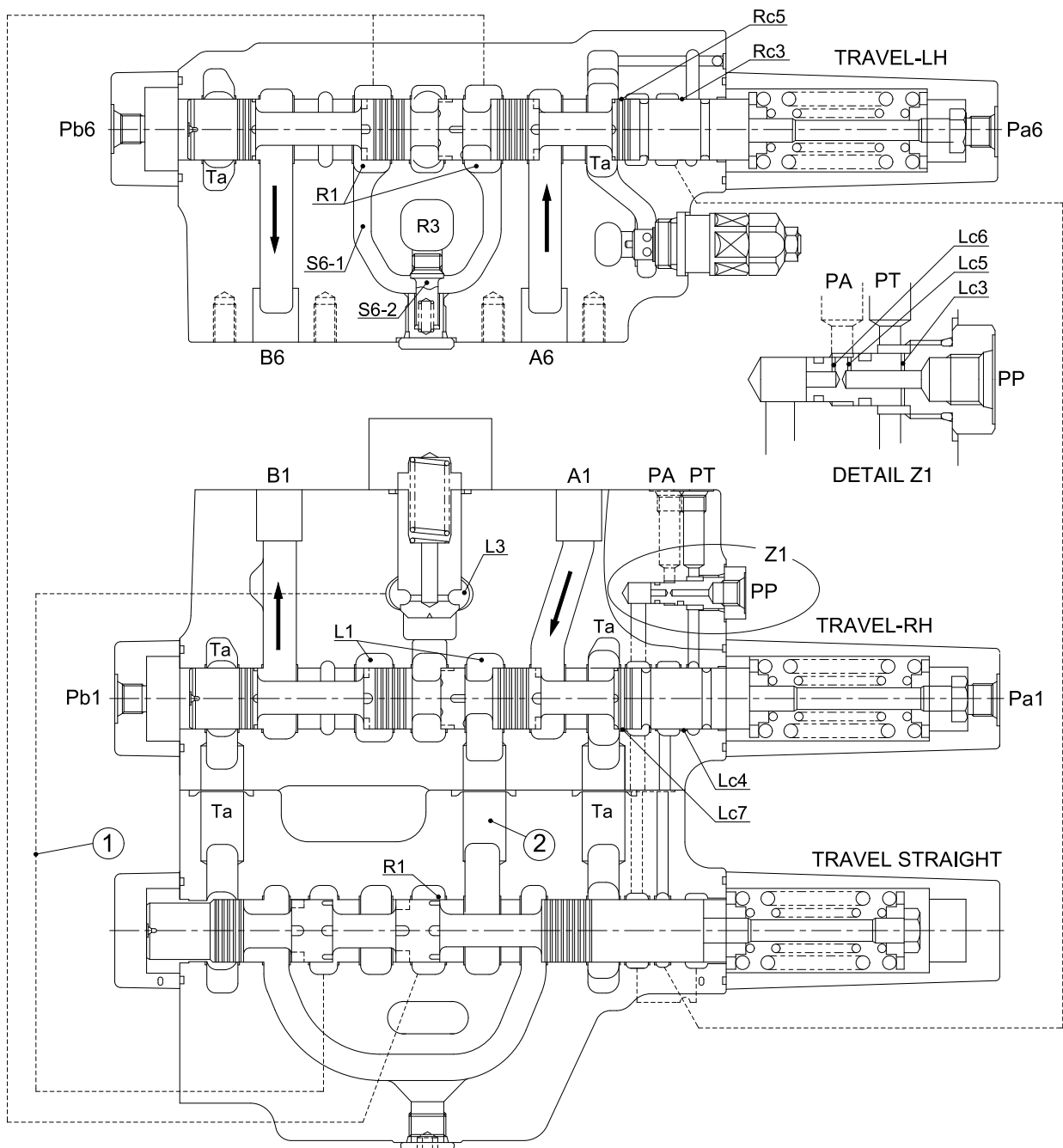
4. COMBINED OPERATION

1) TRAVEL COMBINED OPERATION

- ① While travel (forward, reverse and pivot turn) and front attachment (except travel section) functions are operated, the oil discharged from port PP is cut via land (Lc4, Lc7, Rc3, Rc5) and blocked from signal land except travel section to tank passage (Ta), the pressure of signal passage rises to the relief setting pressure of pilot pump and the straight travel spool is pushed to the left by raising of signal pressure and also, the pressure of port PT, PA port rises.



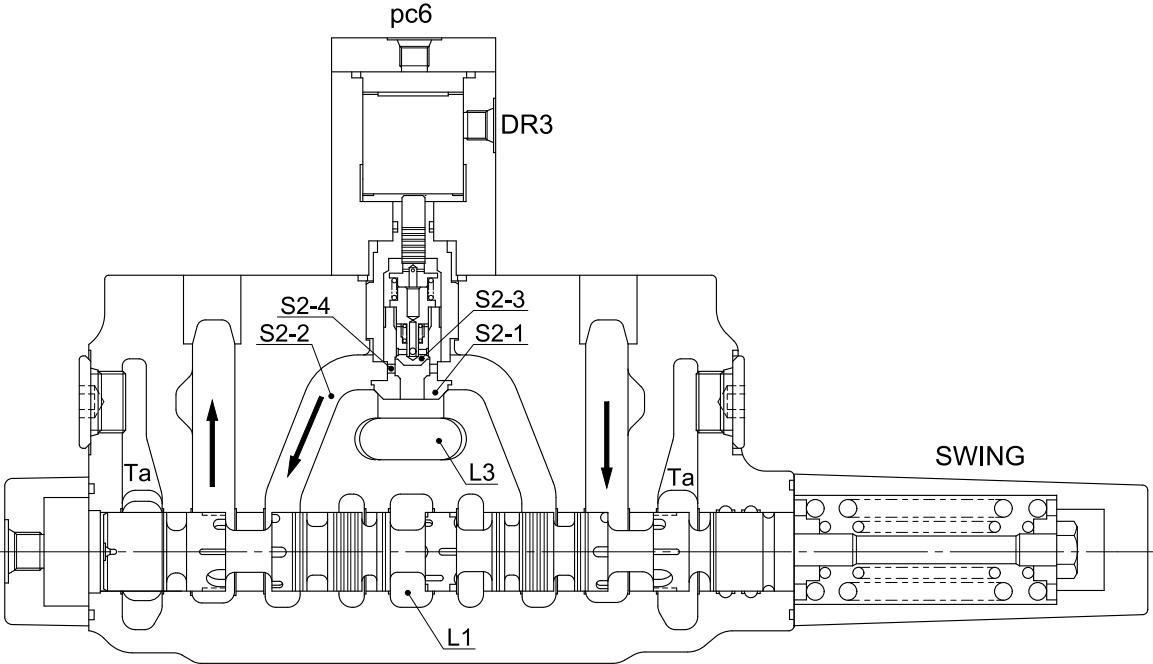
- ② When the straight travel spool is operated, the oil discharged from port P1 flows into RH travel section through the neutral passage (L1) and also flows into LH travel section via the neutral passage (R1) and passage (②). The oil discharged from port P2 flows into the parallel passage (L3) via passage (①).
- ③ In case the load pressure of the section except travel is higher than that of the RH travel section, the partial oil of discharged from port P2 pushes open the poppet (S6-2) and flows together into the passage (S6-1) through the orifice at the edge of poppet. The travel (LH, RH) is operated by the discharged oil from port P1 and the other actuators are operated by the discharged oil from port P2. Thus, when travel and front attachment functions are operated simultaneously, keeps the straight travel.



2) SWING COMBINED OPERATION

When swing and boom up functions are operated, the poppet (S2-1) is seated by pressure of port pc6 and the poppet (S2-3) only opened and the supply pressure of the parallel passage (L3) is rises by orifice (S2-4).

As a result, boom and swing simultaneous operation is ensured even if lower load of swing section.



5. ANTI-DRIFT VALVE

The anti-drift valve is provided the boom bottom and arm rod side of cylinder port for prevention of self drifting by boom weight or bucket loads.

1) WHEN NEUTRAL

The oil from cylinder port flows into spring chamber (AD5) via passage (AD2), the around of spool (AD3) and passage (AD4).

Because of the difference of poppet area and spring force, the poppet (AD1) is seated certainly.

2) WHEN BOOM UP OR ARM OUT

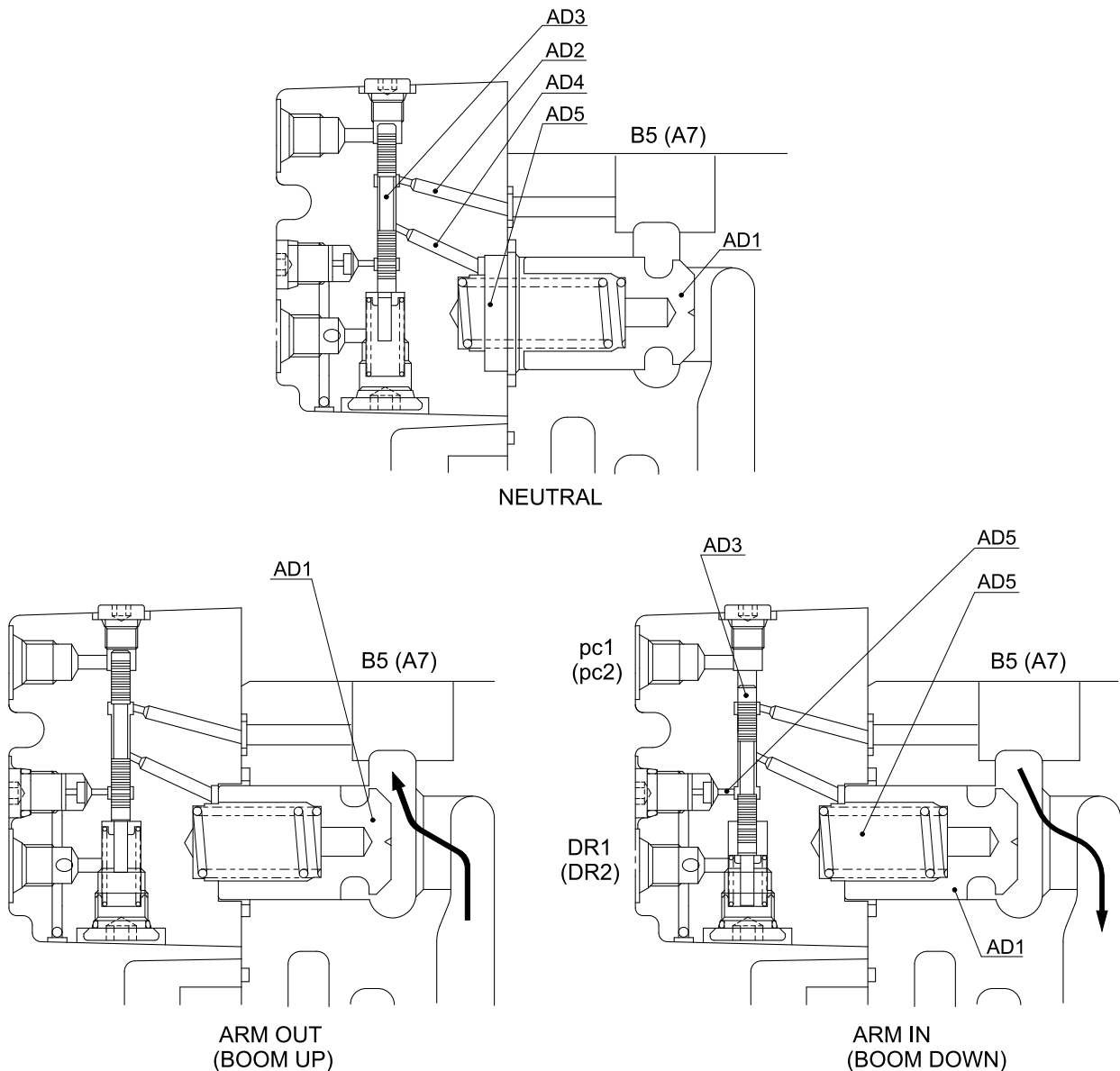
The oil from pump flows into cylinder by pushes open the poppet (AD1).

3) WHEN BOOM DOWN OR ARM IN

The spool (AD3) is pushed down by the pressure of pc1 (pc2).

Then the oil of spring chamber (AD5) flows into the drain port DR1 (DR2) and pushes open the poppet (AD1).

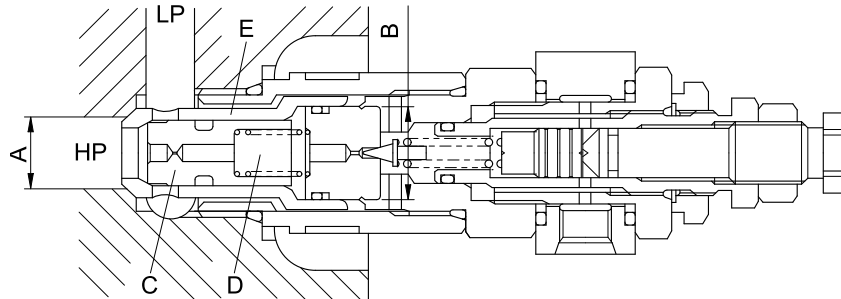
As a result, the oil from the cylinder port returns to tank passage (Ta).



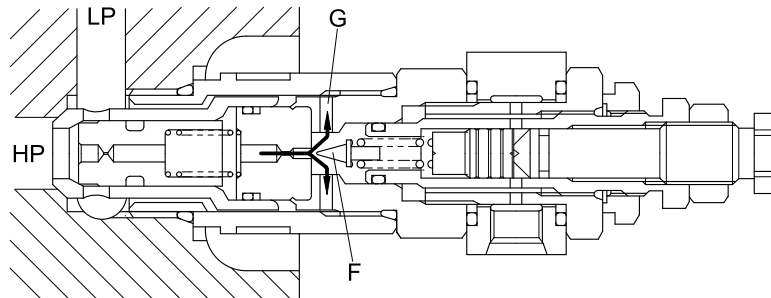
6. RELIEF VALVE OPERATION

1) MAIN RELIEF VALVE

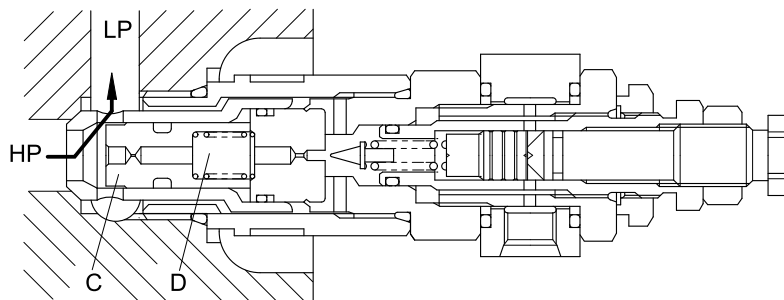
- (1) This relief valve is built-in between the neutral passage (HP) and low pressure passage (LP), and the pressure oil fills up chamber (D) inside via orifice of main poppet (C). Thus the sleeve (E) and the main poppet (C) are securely seated by difference area of A and B.



- (2) When the pressure in neutral passage (HP) reaches the setting force of spring, pilot poppet (F) is opened. The oil flows around poppet and into the low pressure passage (LP) via hole (G).

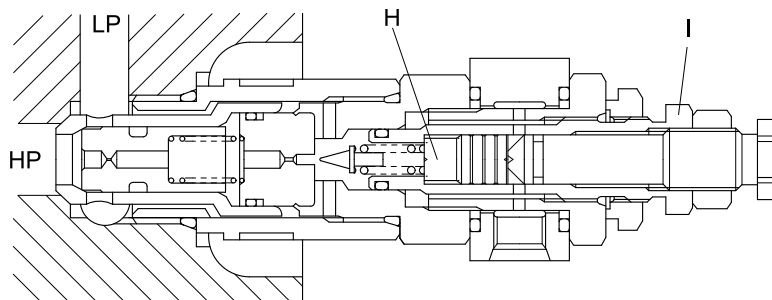


- (3) When above flow is formed, the pilot poppet is opened; the pressure of chamber (D) drops, the main poppet (C) is opened and then the oil directly flows into the low pressure passage (LP).



- (4) High pressure setting pilot signal (Pi) : ON

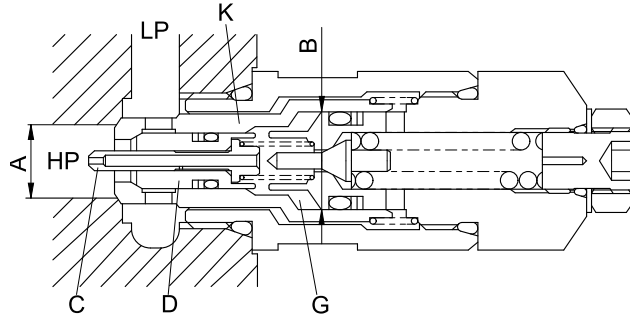
The piston (H) moves to left by pilot pressure (Pi); set pressure of spring rises, making high pressure setting.



2) OVERLOAD RELIEF VALVE

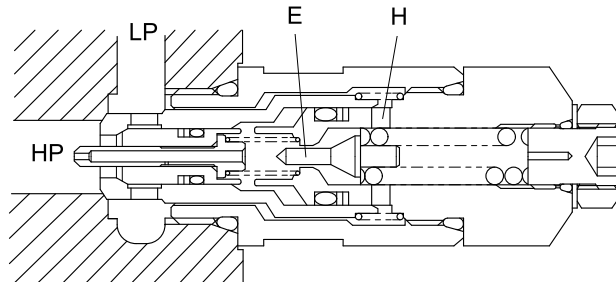
(1) This relief valve is built-in the cylinder port (HP) and the low pressure (LP), and the pressure oil fills up chamber (G) inside via hole of piston (C).

Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.



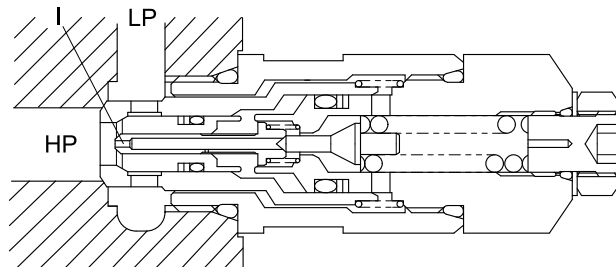
(2) When the pressure in cylinder port (HP) reaches the setting force of spring, the pilot poppet (E) is opened.

The oil flows around poppet and into the low pressure passage (LP) via hole (H).

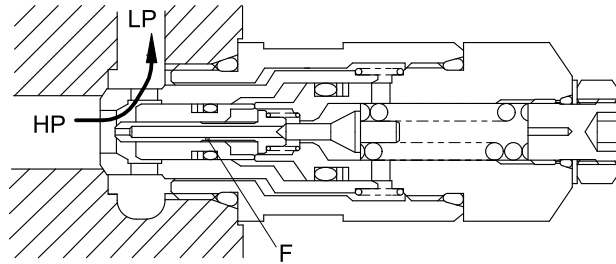


(3) When above flow is formed, the pilot poppet (E) is opened.

The pressure drops before and behind orifice (I); piston (C) moves to right and the piston (C) is seated at the tip of poppet (E).



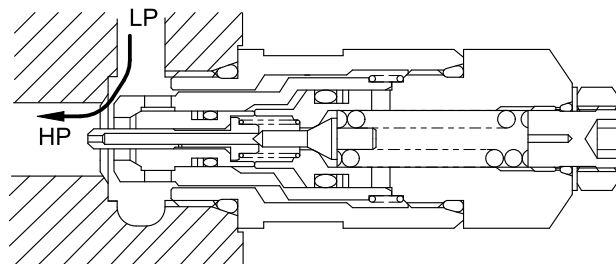
- (4) The oil flow from the high pressure passage (HP) to the poppet (D) behind is only around poppet and orifice (F); then the high pressure passage (HP) is higher than the poppet (D) behind pressure.
Thus the poppet (D) is pushed open and the oil directly flows into low pressure passage (LP).



(5) Make up operation

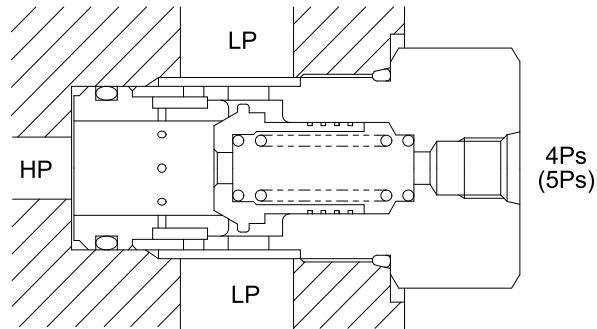
This relief valve is built-in the cylinder port (HP) and the low pressure passage (LP), and the pressure oil fills up chamber (G) inside via hole of piston (C).

Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.



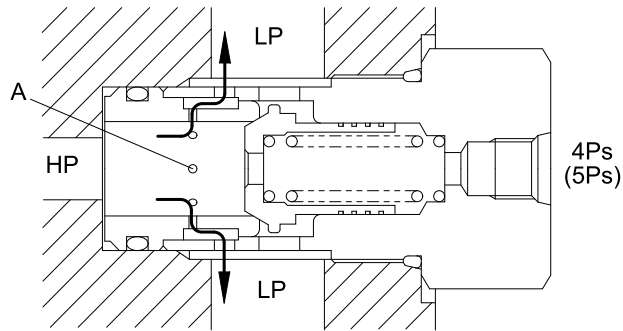
3) LOW PRESSURE RELIEF VALVE

(1) When pump does not operational



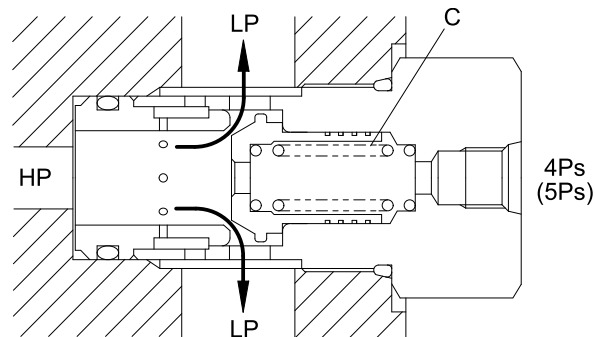
(2) When spool neutral

The neutral passage (HP) oil flows into the low pressure passage (LP) via signal orifice (S). The signal port 4Ps (5Ps) pressure is raised by negative control orifice (A).



(3) Operation of low pressure relief

When the oil pressure neutral passage (HP) reaches the setting force of spring, the poppet is pushed open; the oil directly flows through passage (HP) to passage (LP) in order to prevent abnormal pressure.

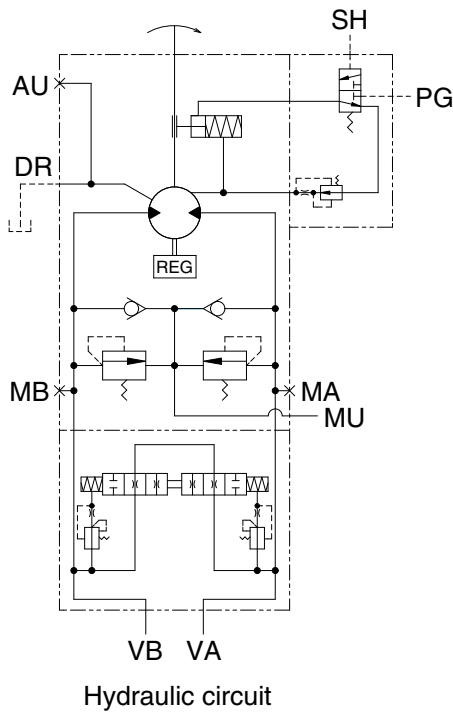
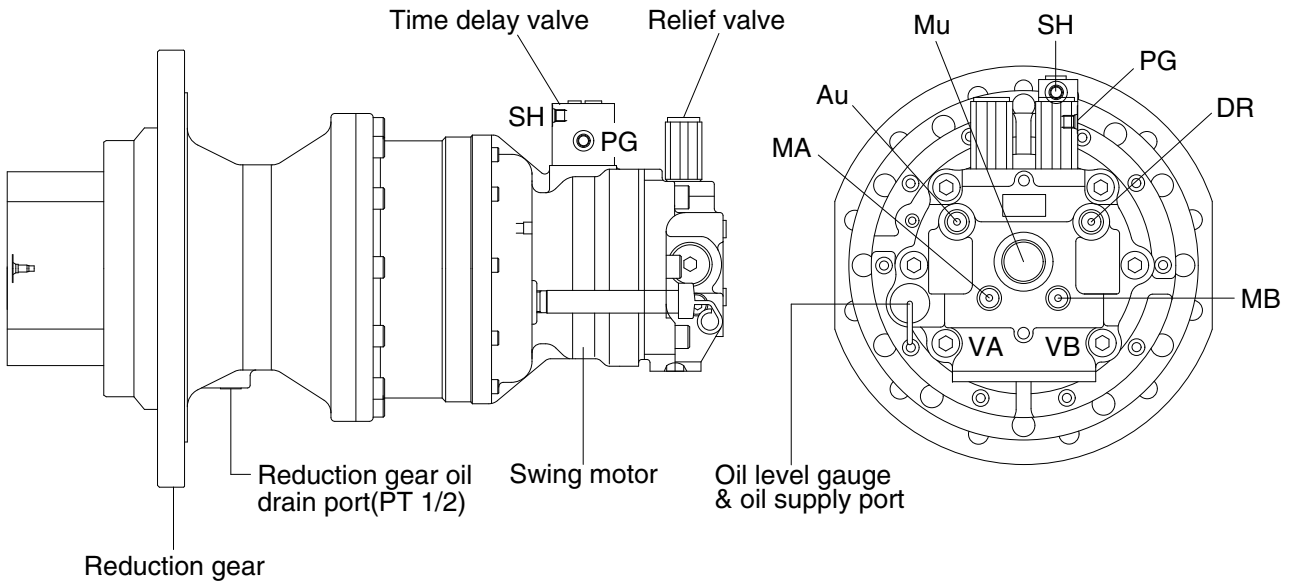


GROUP 3 SWING DEVICE

1. STRUCTURE

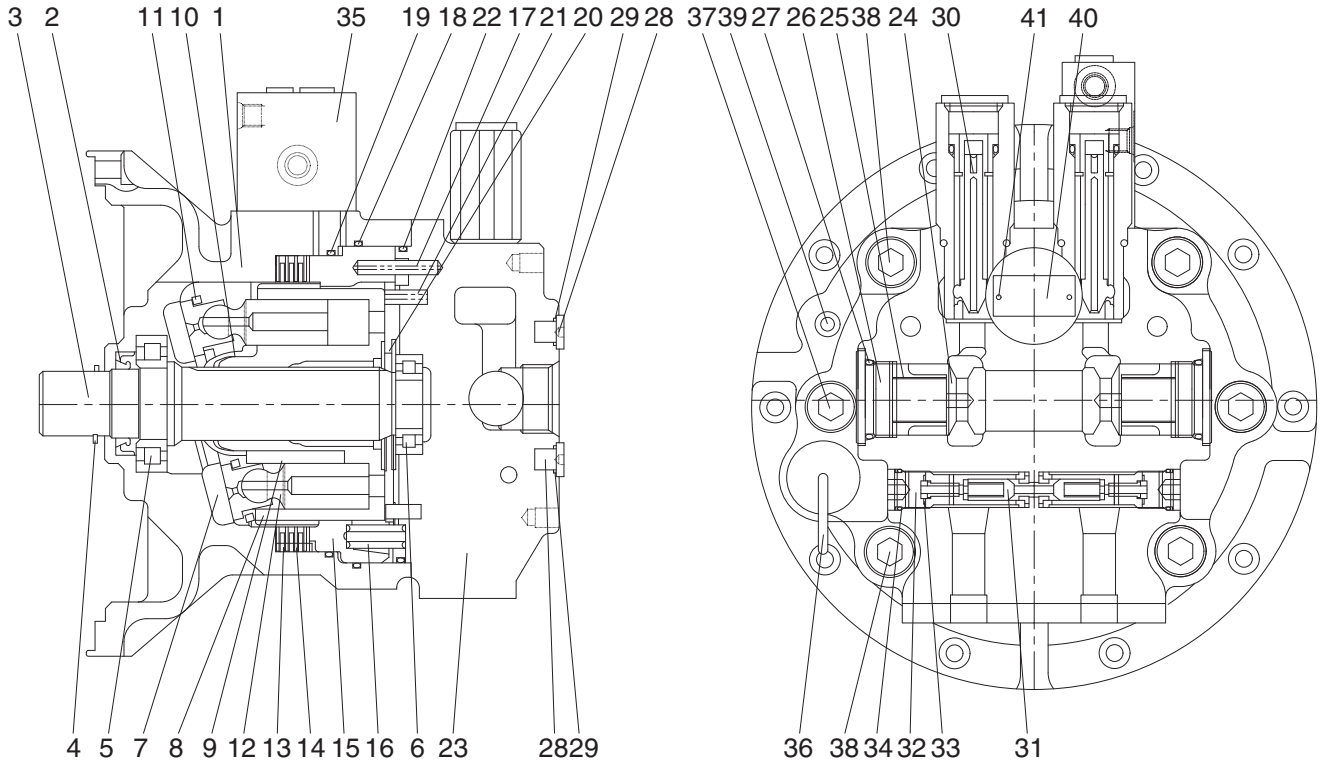
Swing device consists swing motor, swing reduction gear.

Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



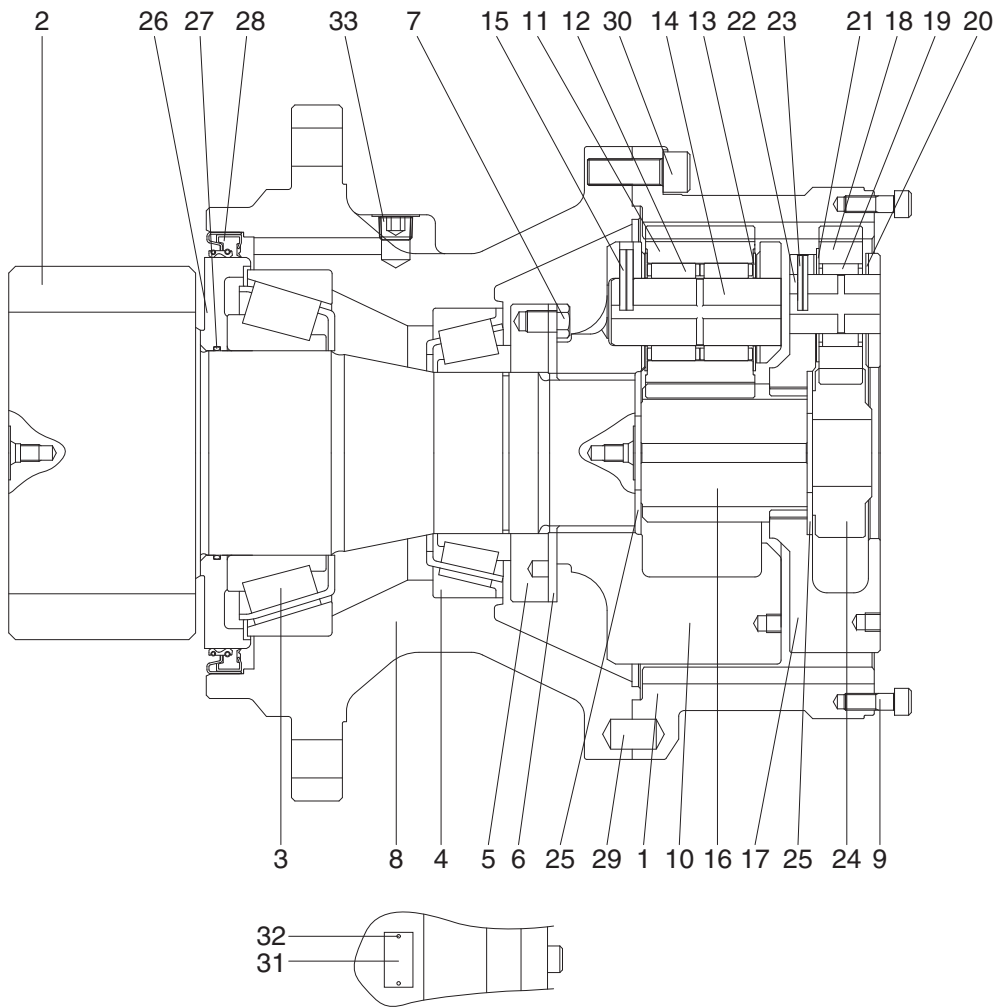
Port	Port name	Port size
VA, VB	Main port	∅ 20
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1 1/4
MA, MB	Gauge port	PF 1/4
Au	Air vent port	PF 1/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4

1) SWING MOTOR



- | | | | | | |
|----|-------------------------|----|----------------|----|--------------------------|
| 1 | Casing | 15 | Parking piston | 29 | O-ring |
| 2 | Oil seal | 16 | Spring | 30 | Relief valve assy |
| 3 | Shaft | 17 | Spring pin | 31 | Anti-rotating valve assy |
| 4 | Snap ring | 18 | O-ring | 32 | Plug |
| 5 | Cylinder roller bearing | 19 | O-ring | 33 | O-ring |
| 6 | Cylinder roller bearing | 20 | Valve plate | 34 | O-ring |
| 7 | Swash plate | 21 | Spring pin | 35 | Time delay valve assy |
| 8 | Cylinder block | 22 | O-ring | 36 | Level gauge assy |
| 9 | Spring | 23 | Valve casing | 37 | Hexagon socket head bolt |
| 10 | Ball guide | 24 | Check valve | 38 | Hexagon socket head bolt |
| 11 | Retainer plate | 25 | Spring | 39 | Plug |
| 12 | Piston assy | 26 | Plug | 40 | Name plate |
| 13 | Friction plate | 27 | O-ring | 41 | Rivet |
| 14 | Separate plate | 28 | Plug | | |

2) REDUCTION GEAR



- | | | | | | |
|----|--------------------------|----|---------------------------|----|--------------------------|
| 1 | Ring gear | 12 | Needle bearing No. 2 | 23 | Spring pin No. 1 |
| 2 | Drive shaft | 13 | Thrust washer No. 2 | 24 | Sun gear No. 1 |
| 3 | Taper bearing | 14 | Carrier pin No. 2 | 25 | Thrust plate |
| 4 | Taper bearing | 15 | Spring pin No. 2 | 26 | Sleeve |
| 5 | Ring nut | 16 | Sun gear No. 2 | 27 | O-ring |
| 6 | Lock plate | 17 | Carrier No. 1 | 28 | Oil seal |
| 7 | Hexagon head bolt | 18 | Planetary gear No. 1 | 29 | Parallel pin |
| 8 | Casing | 19 | Needle bearing No. 1 | 30 | Hexagon socket head bolt |
| 9 | Hexagon socket head bolt | 20 | Thrust washer No. 1-upper | 31 | Name plate |
| 10 | Carrier No. 2 | 21 | Thrust washer No. 1-lower | 32 | Rivet |
| 11 | Planetary gear No. 2 | 22 | Carrier pin No. 1 | 33 | Plug |

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder block (8) through valve casing of motor (1), and valve plate (20).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (12).

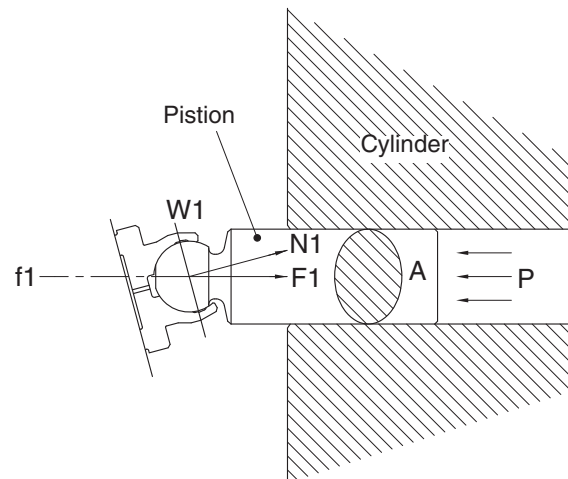
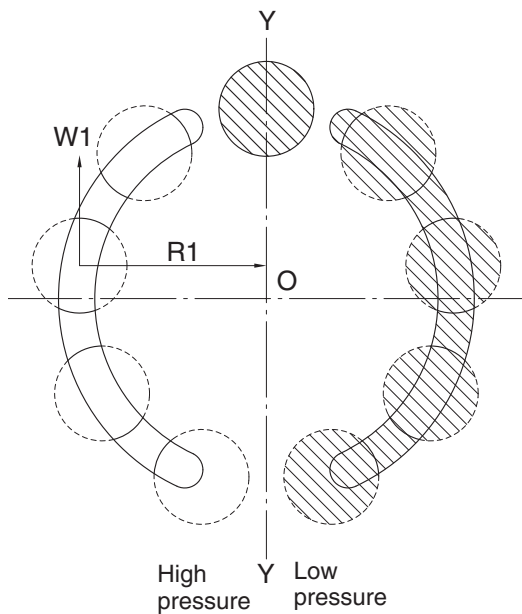
The high hydraulic can generate the force, $F1 = P \times A$ (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

This force, $F1$, is divided as $N1$ thrust partial pressure and $W1$ radial partial pressure, in case of the plate of a tilt angle, α .

$W1$ generates torque, $T = W1 \times R1$, for Y-Y line connected by the upper and lower sides of the piston as following pictures.

The sum of torque ($\sum W1 \times R1$), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (8) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



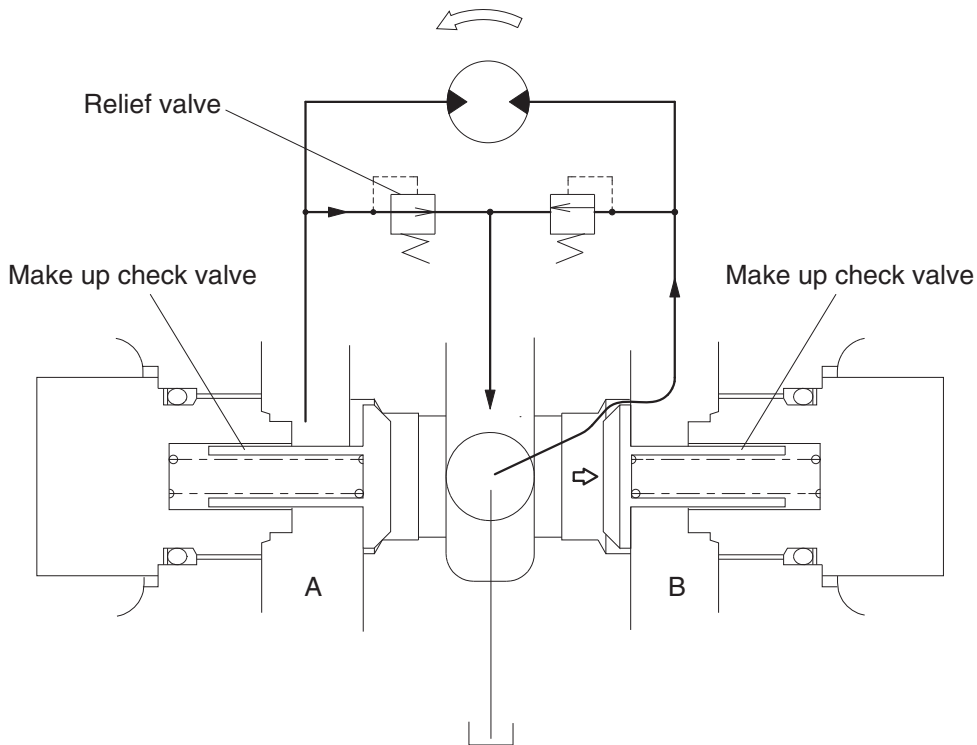
2) MAKE UP VALVE

In the system using this type of motor, there is no counter balance functioning valve and there happens the case of revolution exceeding hydraulic supply of motor. To prevent the cavitation caused by insufficient oil flow there is a make up valve to fill up the oil insufficiency.

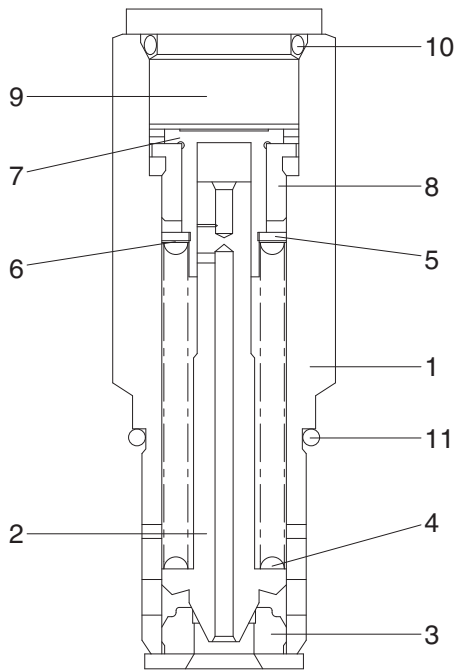
A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

Pressurized oil into the port B, the motor rotate counterclockwise.

If the plunger of MCV moves neutral position, the oil in the motor is drain via left relief valve, the drain oil run into motor via right make up valve, which prevent the cavitation of motor.



3) RELIEF VALVE



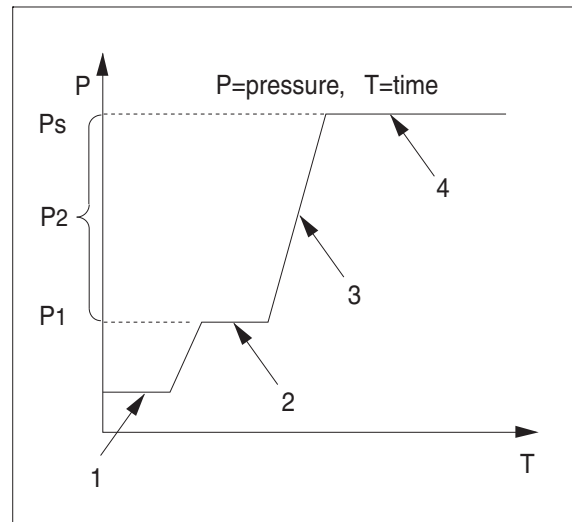
- 1 Sleeve
- 2 Poppet
- 3 Poppet seat
- 4 Spring
- 5 Spring seat
- 6 Shim
- 7 Piston
- 8 Stopper
- 9 Plug
- 10 O-ring
- 11 O-ring

(1) Construction of relief valve

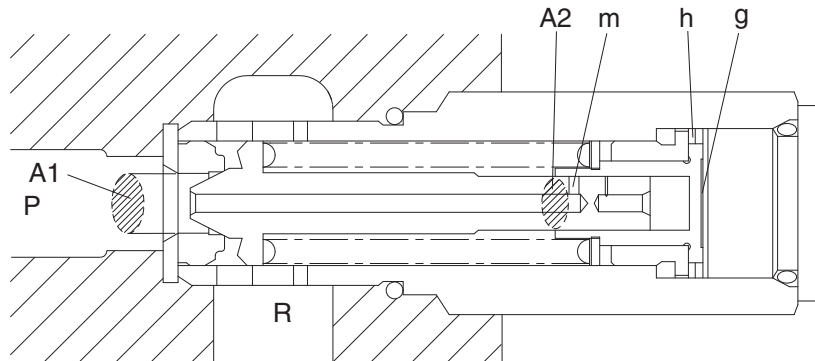
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

Figure illustrates how the pressure acting on the relief valve is related to its rising process. Here is given the function, referring to the figure following page.



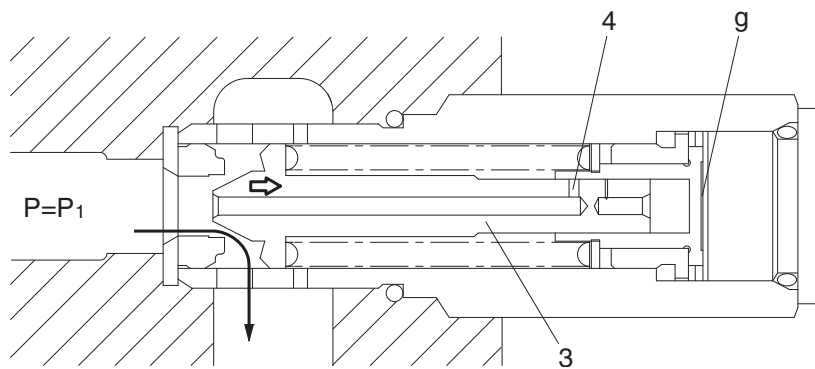
① Ports (P,R) at tank pressure.



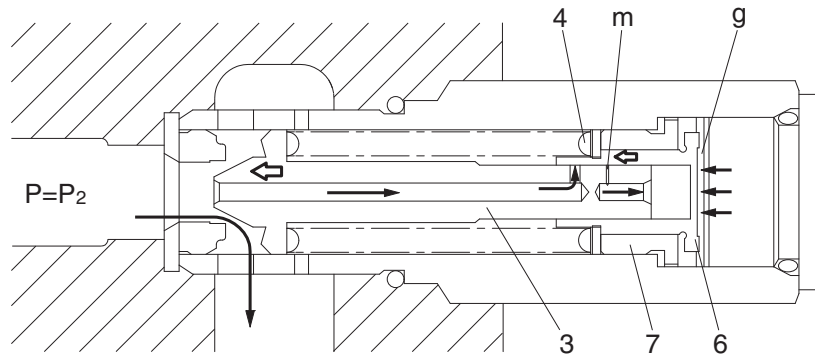
② When hydraulic oil pressure ($P \times A_1$) reaches the preset force (F_{sp}) of spring (4), the plunger (3) moves to the right as shown.

$$P_1 \times A_1 = F_{sp} + P_g \times A_2$$

$$P_1 = \frac{F_{sp} + P_g \times A_2}{A_1}$$



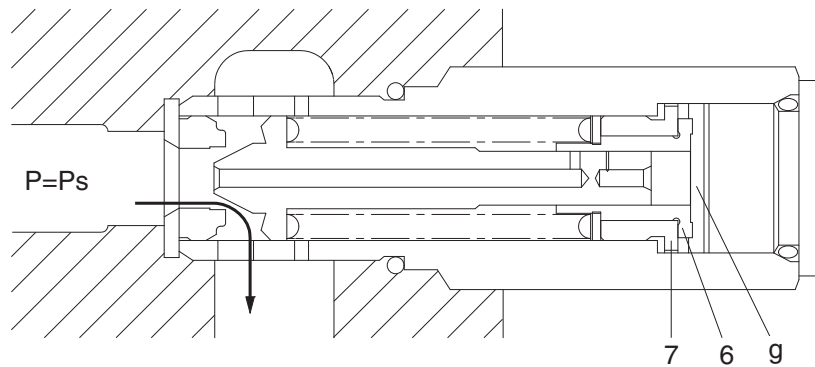
- ③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F_{sp}) of spring (4), the piston (6) moves left and stop the piston (6) hits the bottom of bushing (7).



- ④ When piston (6) hits the bottom of bushing (7), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (P_s).

$$P_s \times A_1 = F_{sp} + P_s \times A_2$$

$$P_s = \frac{F_{sp}}{A_1 - A_2}$$

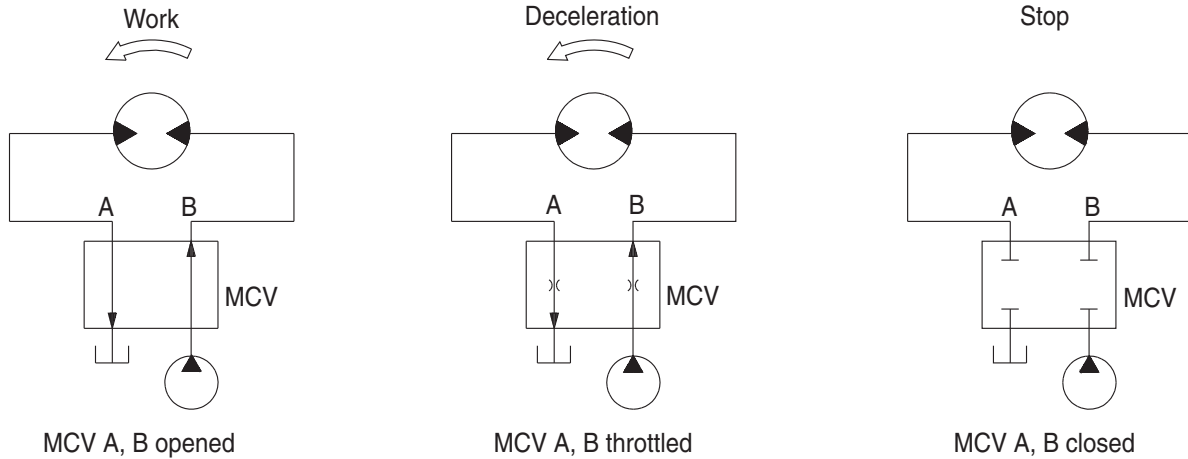


4) BRAKE SYSTEM

(1) Control valve swing brake system

This is the brake system to stop the swing motion of the excavator during operation.

In this system, the hydraulic circuit is throttled by the swing control valve, and the resistance created by this throttling works as a brake force to slow down the swing motion.



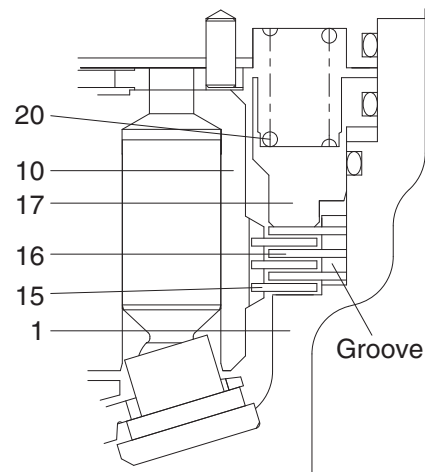
(2) Mechanical swing parking brake system

This is function as a parking brake only when all of the RCV lever (except travel pedal) are not operated.

① Brake assembly

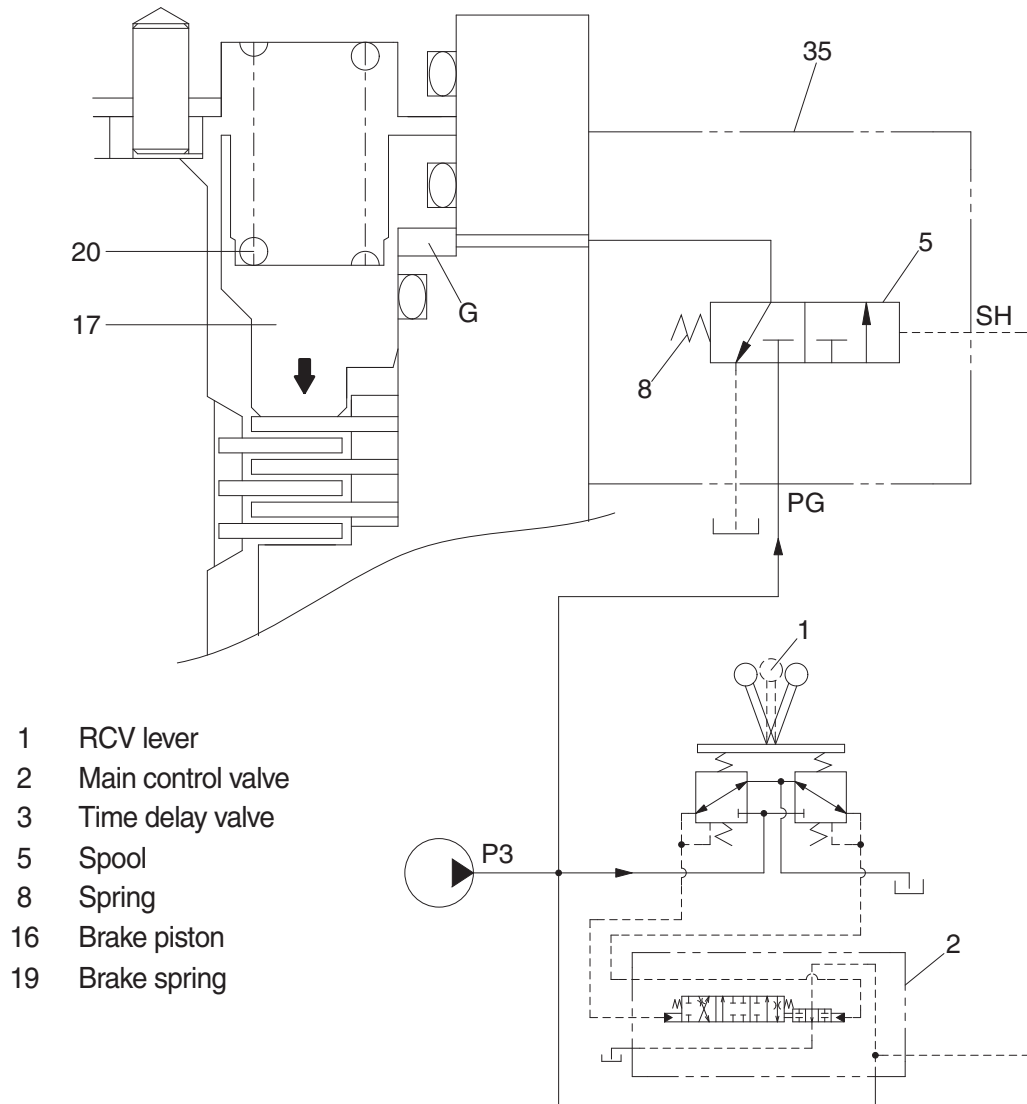
Circumferential rotation of separate plate (16) is constrained by the groove located at housing (1). When housing is pressed down by brake spring (20) through friction plate (15), separate plate (16) and brake piston (17), friction force occurs there.

Cylinder block (10) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



1	Housing	16	Separate plate
10	Cylinder block	17	Brake piston
15	Friction plate	20	Spring

- b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to right. Then, the piston (16) is moved lower by spring force and the return oil from the chamber G flows back to tank port. At this time, the brake works.



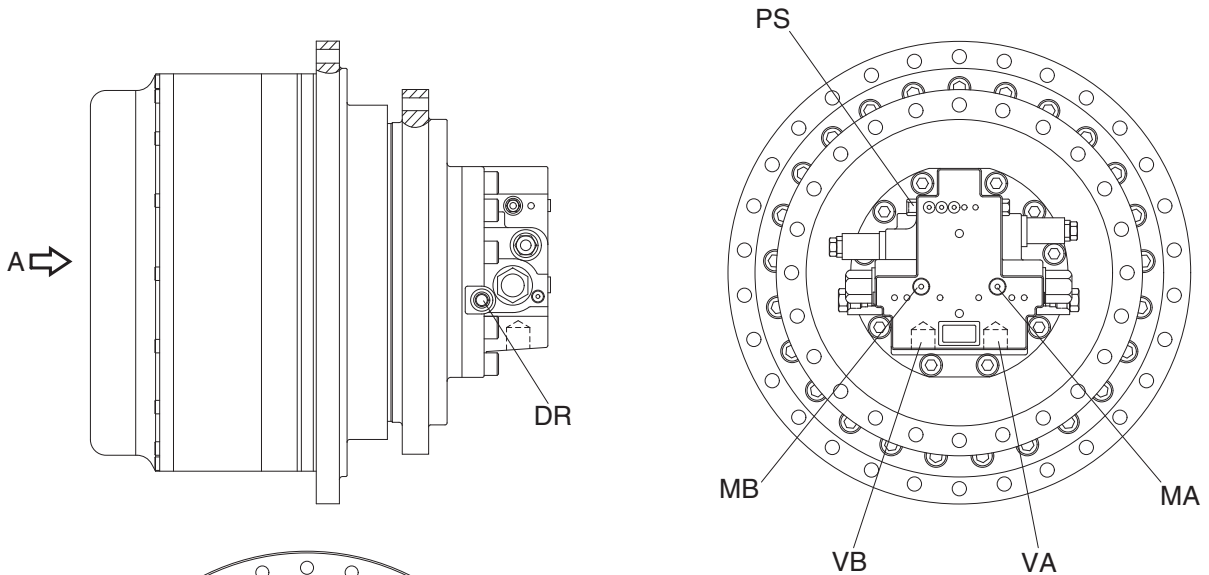
- 1 RCV lever
- 2 Main control valve
- 3 Time delay valve
- 5 Spool
- 8 Spring
- 16 Brake piston
- 19 Brake spring

GROUP 4 TRAVEL DEVICE

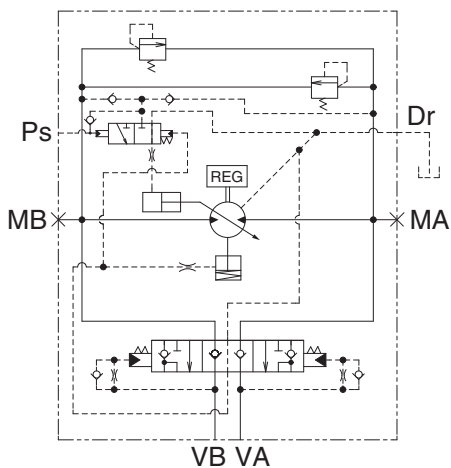
1. CONSTRUCTION

Travel device consists travel motor and gear box.

Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.



VIEW A

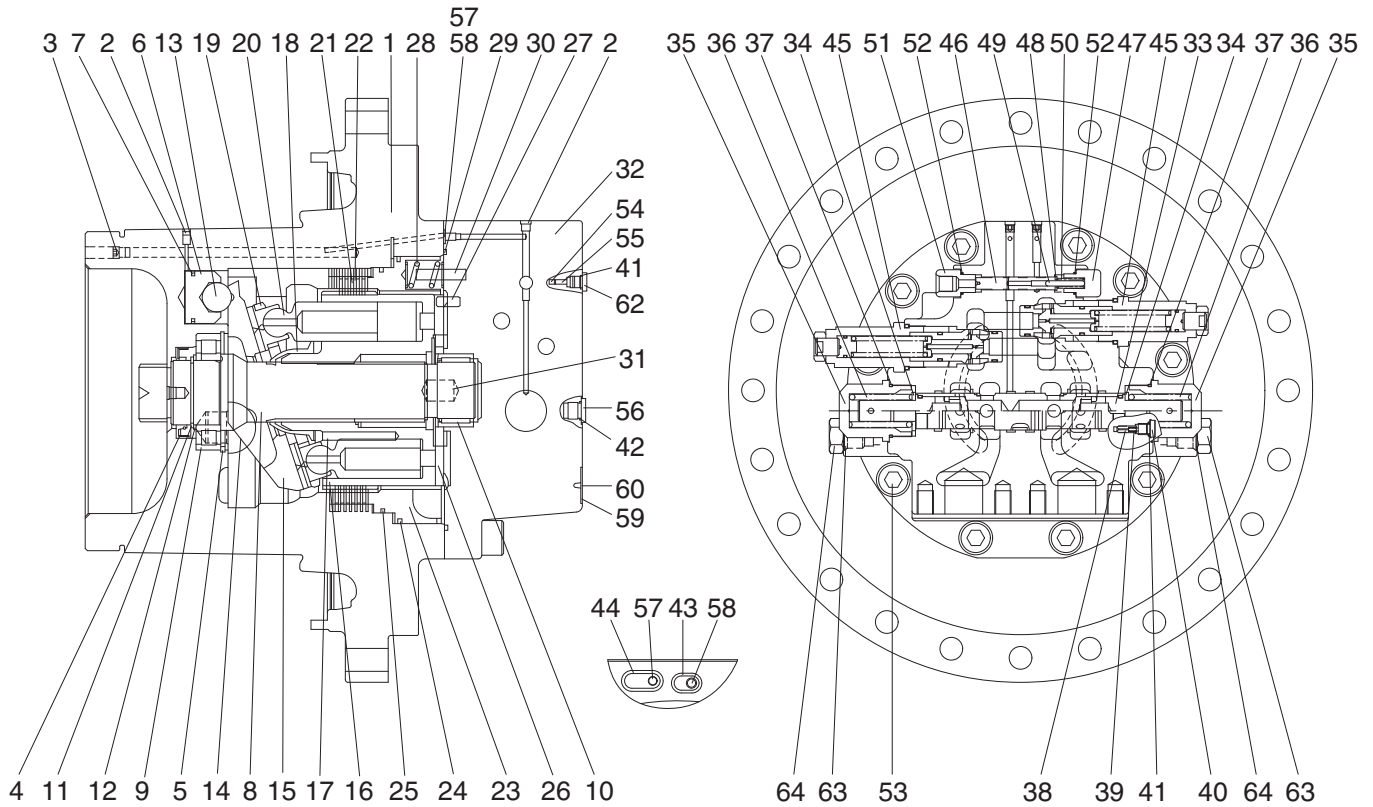


HYDRAULIC CIRCUIT

Port	Port name	Port size
VA, VB	Main port	PF1
MA, MB	Pressure gauge port	PF 1/4
PS	Pilot port	PF 1/4
DR	Drain port	PF 1/2
L	Level gauge	PF 3/4

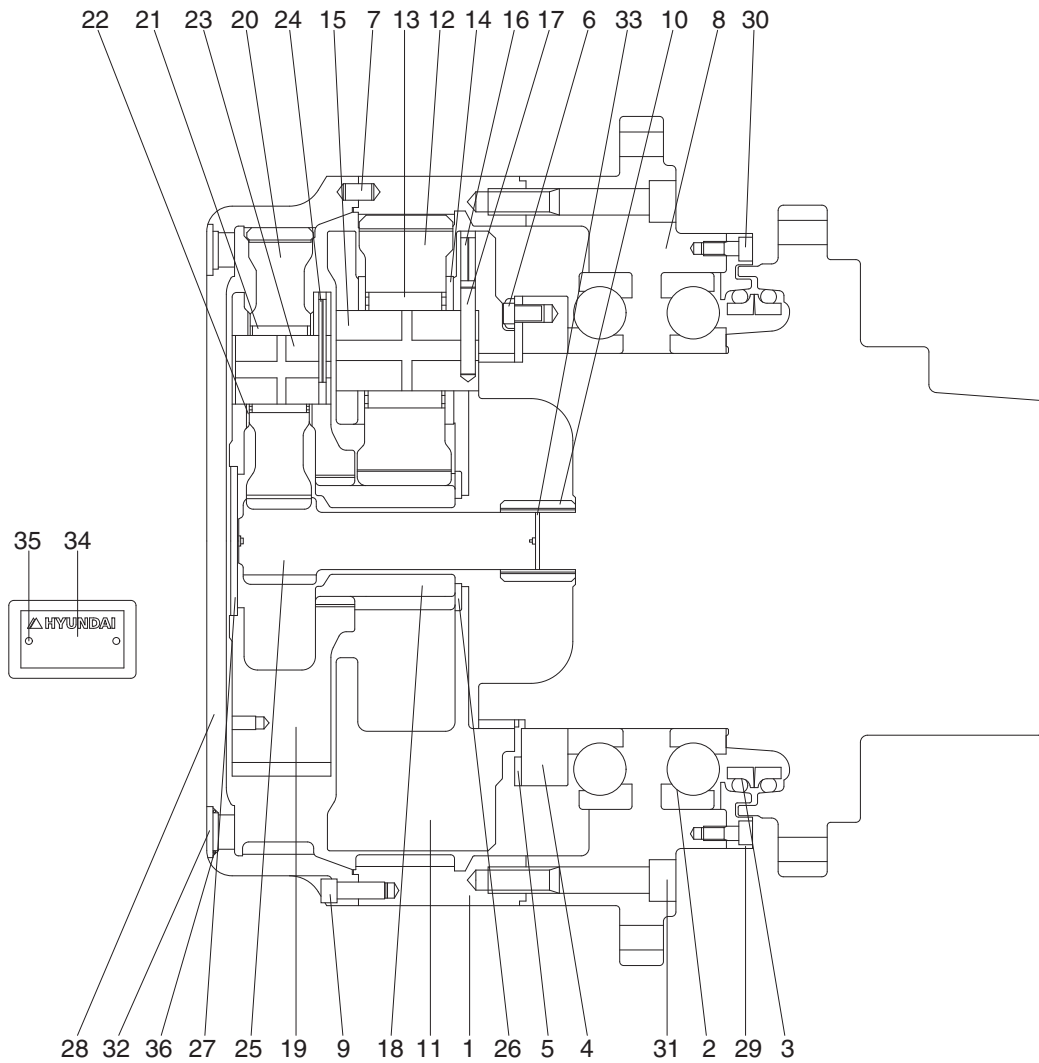
2. STRUCTURE

1) TRAVEL MOTOR



1	Casing	22	Separate plate	43	O-ring
2	Plug	23	Parking piston	44	O-ring
3	Plug	24	D-ring	45	Relief valve assy
4	Oil seal	25	D-ring	46	Spool
5	Snap ring	26	Valve plate	47	Plug
6	Piston	27	Parallel pin	48	Spring seat
7	Piston seal	28	Spring	49	Parallel pin
8	Shaft	29	O-ring	50	Spring
9	Cylinder roller bearing	30	Spring pin	51	Connector
10	Needle bearing	31	Parallel pin	52	O-ring
11	Snap ring	32	Rear cover	53	Hex socket head bolt
12	Thrust plate	33	Main spool assy	54	Check valve
13	Steel ball	34	Spring seat	55	Spring
14	Pivot	35	Plug	56	Plug
15	Swash plate	36	Spring	57	Restrictor
16	Cylinder block	37	O-ring	58	Restrictor
17	Spring	38	Restrictor	59	Name plate
18	Guide ball	39	Spring	60	Rivet
19	Retainer plate	40	Plug	62	Plug
20	Piston assy	41	O-ring	63	Plug
21	Friction plate	42	O-ring	64	O-ring

2) REDUCTION GEAR

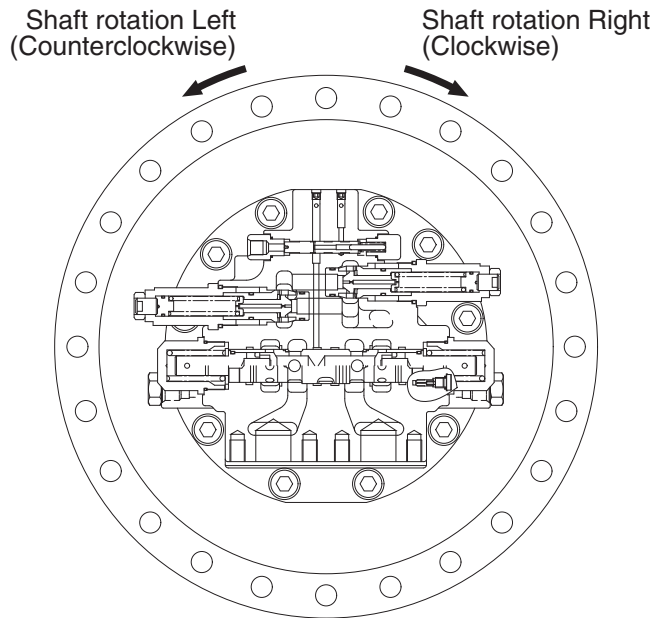


- | | | | | | |
|----|--------------------------|----|----------------------|----|----------------------|
| 1 | Ring gear | 13 | Needle bearing No. 2 | 25 | Sun gear No. 1 |
| 2 | Ball bearing | 14 | Thrust washer No. 2 | 26 | Thrust plate |
| 3 | Floating seal assy | 15 | Carrier pin No. 2 | 27 | Thrust plate |
| 4 | Ring nut | 16 | Spring pin No. 2 | 28 | Cover |
| 5 | Lock plate | 17 | Solid pin No. 2 | 29 | Cover seal |
| 6 | Hexagon head bolt | 18 | Sun gear No. 2 | 30 | Hex socket head bolt |
| 7 | Parallel pin | 19 | Carrier No. 1 | 31 | Hex socket head bolt |
| 8 | Housing | 20 | Planetary gear No. 1 | 32 | Plug |
| 9 | Hexagon socket head bolt | 21 | Needle bearing No. 1 | 33 | Snap ring |
| 10 | Coupling | 22 | Thrust washer No. 2 | 34 | Name plate |
| 11 | Carrier No. 2 | 23 | Carrier pin No. 1 | 35 | Rivet |
| 12 | Planetary gear No. 2 | 24 | Spring pin No. 1 | 36 | O-ring |

3. OPERATION

1) MOTOR

High pressure oil delivered from hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (32) and valve plate (26), led to cylinder block (16). The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclockwise)

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

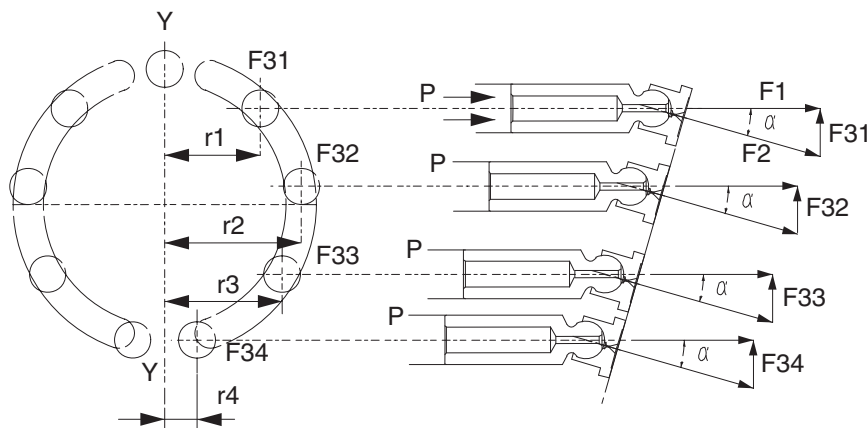
$$F1 = P \times A \quad (P : \text{pressure, } A : \text{area of piston section})$$

The swash plate (15) with inclined angle of α divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$$

This drive torque is transmitted via cylinder block (18) to driving shaft (9).



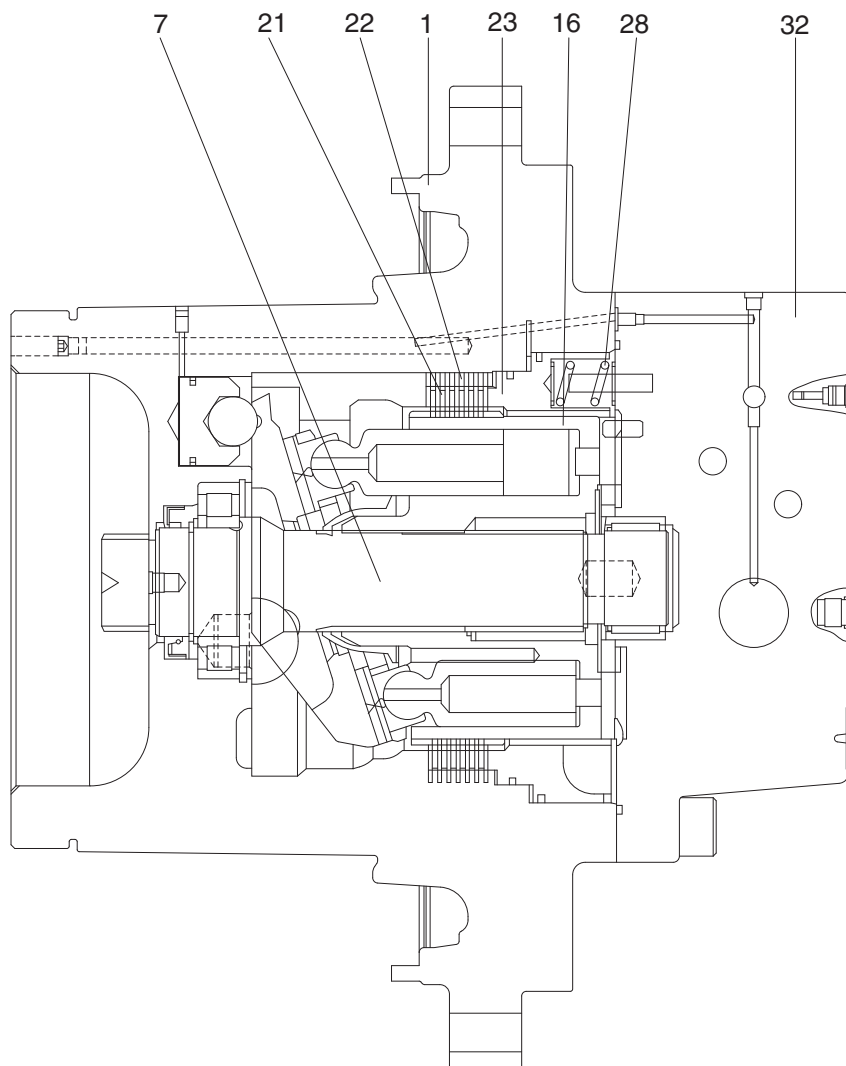
2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (32), is applied to the parking piston (23).

Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separated plates (22), inserted into the casing (1), and friction plates (21), coupled to cylinder block (16) by the outer splines.

When no pressure is activated on the parking piston (23), it is pushed by the brake springs (28) and it pushes friction plates (21) and separated plates (22) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (16) and hence the shaft (7).



3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure P_A that overcome the spring (50), the spring (50) is compressed and spool (46) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (54) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (6). As a result, swash plate (15) turns around the line L which connect the two pivots (14) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (15) keeps the position.

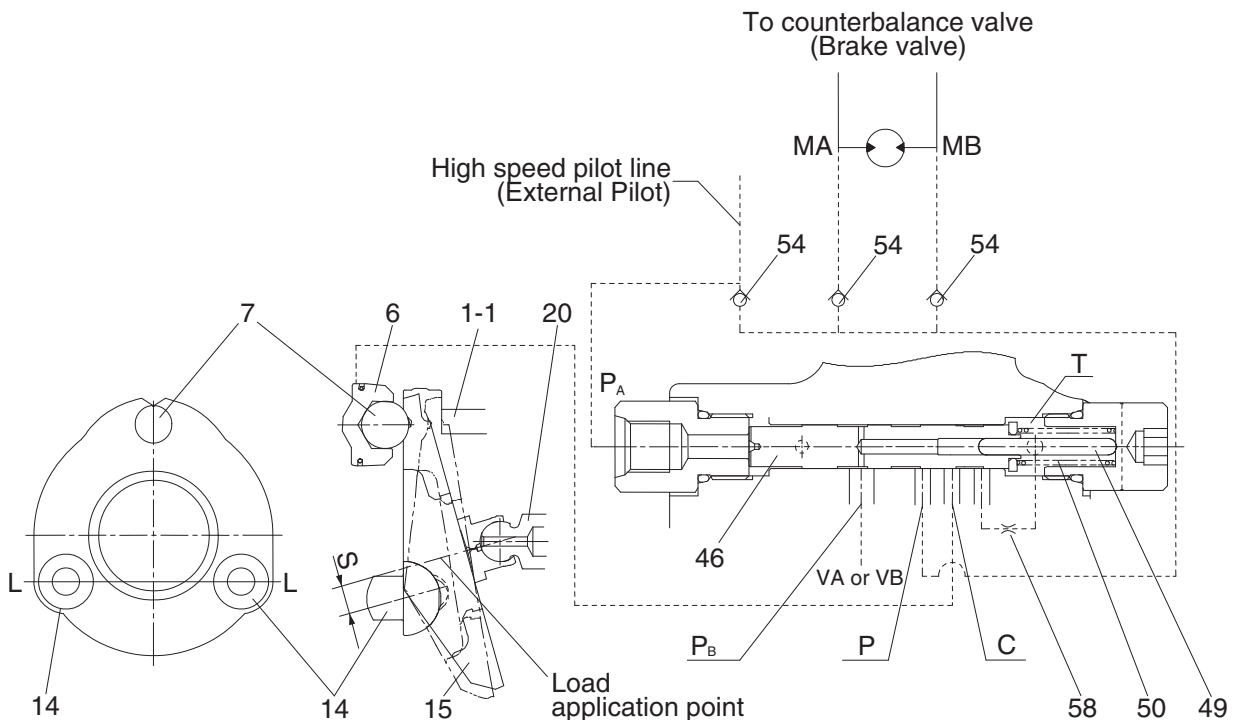
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

When no pressure is in the high speed pilot line P_A , spool (33) is pushed back by the spring (50) and pressure that pressed the shifter piston (6) is released to the hydraulic tank through restrictor (58).

Here, nine pistons are there and they equally spaced on the swash plate (15). The force that summed up those of pistons comes to almost the center of the swash plate (15) as shown. Since the pivots (14) are off-set by S from the center, the rotating force of product S and the force moves swash plate (15) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port P_B and this pressure activate on pin (49). When the pressure at P_B exceeds predetermined value, spool (46) returns to the left by the counter-pressure against pin (49) and the pressure on the shifter piston (5) through port C is released to the tank and the motor comes to low speed.

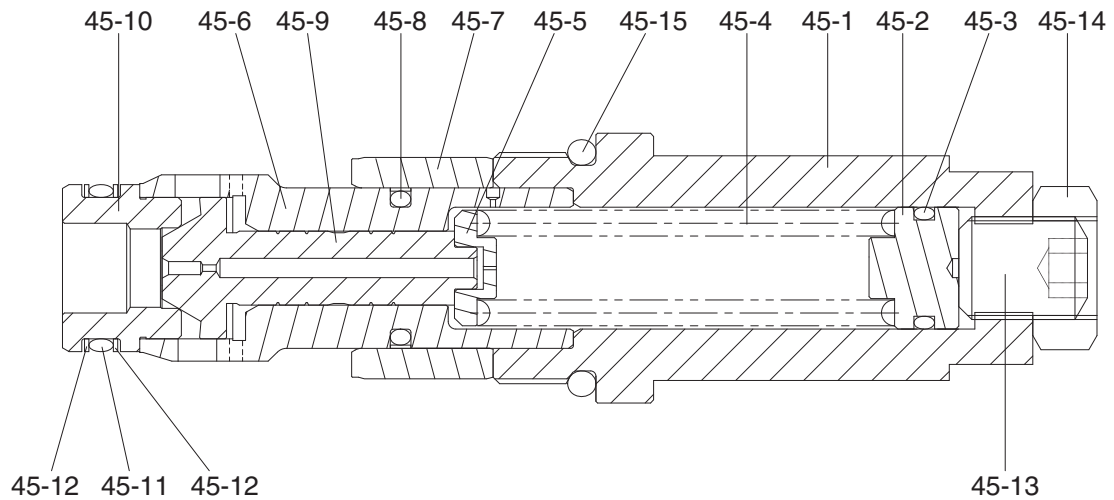
When P_B goes down, the spool (46) moves to the right and the speed become high.



4) OVERLOAD RELIEF VALVE

(1) Structure

This valve is screwed in the motor rear cover (32) and consists of : plug (45-1) that is screwed and fixed in the rear cover (32), poppet (45-9) and supports the poppet seat (45-10), spring (45-4) that is operating relief valve setting pressure and supports the spring seat (45-5), that is inserted in the sleeve (45-6), screw (45-13) that is adjust the spring force, nut (45-14) that fix screw (45-13), piston (45-7) that reduce the shock.



45-1 Plug
 45-2 Guide
 45-3 O-ring
 45-4 Spring
 45-5 Spring seat

45-6 Sleeve
 45-7 Piston
 45-8 Seal
 45-9 Poppet
 45-10 Poppet seat

45-11 O-ring
 45-12 Back-up ring
 45-13 Socket screw
 45-14 Hexagon nut
 45-15 O-ring

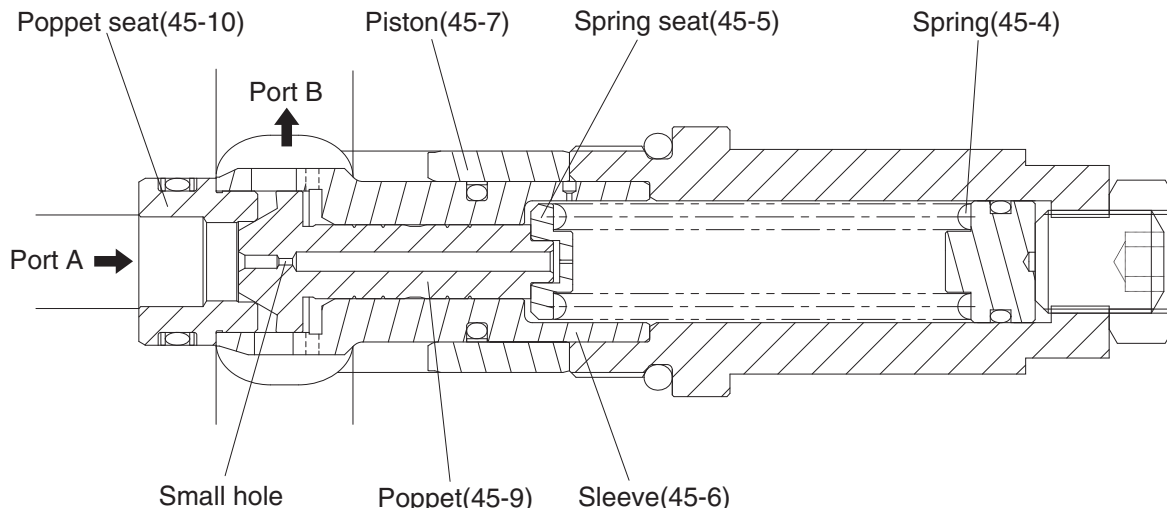
(2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions:

- ① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
- ② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
- ③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of poppet (45-9) which seats on the poppet seat (45-10) and, at the same time, is delivered, via small hole, to the spring seat (45-5) located inside the sleeve (45-6) and the seat bore pressure increases up to "A" port pressure. The poppet (45-9) opposes to spring (45-4) by the force of the pressure exerted on the area difference between poppet seat's effective diameter and spring seat bore and keep the predetermined pressure.

When hydraulically braking, the piston (45-7) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (45-7) through the small hole in the poppet (45-9) and piston (45-7) moves rightward until it touches the stopper in rear cover. In this while, the poppet (45-9) maintains "A" port pressure at comparatively low against the spring (45-4) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



5) BRAKE VALVE

(1) Structure

The brake valve portion mainly consists of the following parts:

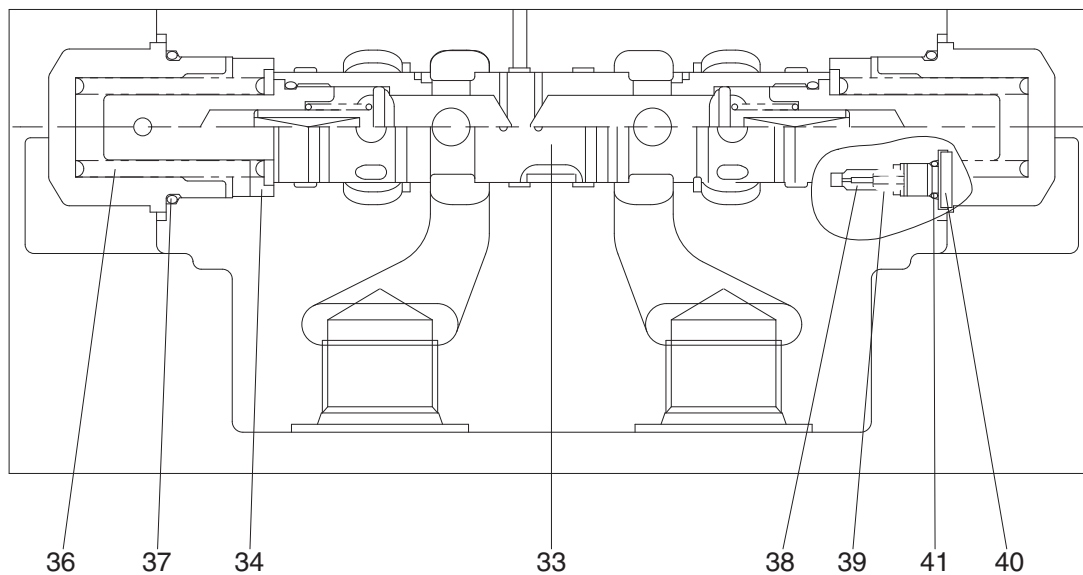
① Spool

By shifting the spool (33), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-74, (2) Operation)

② Check valve (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



33 Main spool
34 Spring seat
36 Spring

37 O-ring
38 Restrictor
39 Restrictor spring

40 Plug
41 O-ring

(2) Operation

① Holding operation

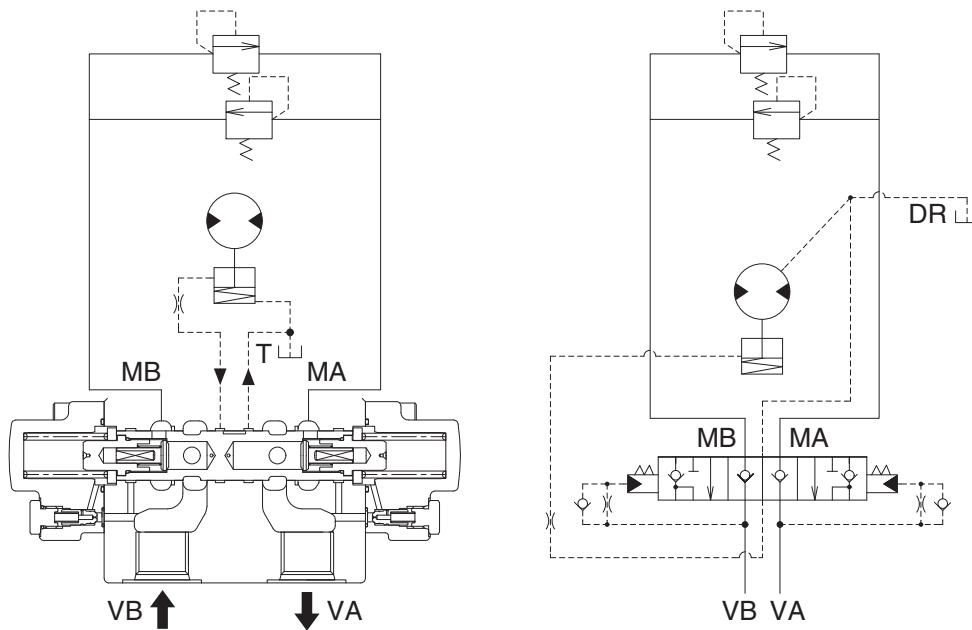
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (36) located on both spool ends holds the spool (33) at central position.

Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.

If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (33), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.



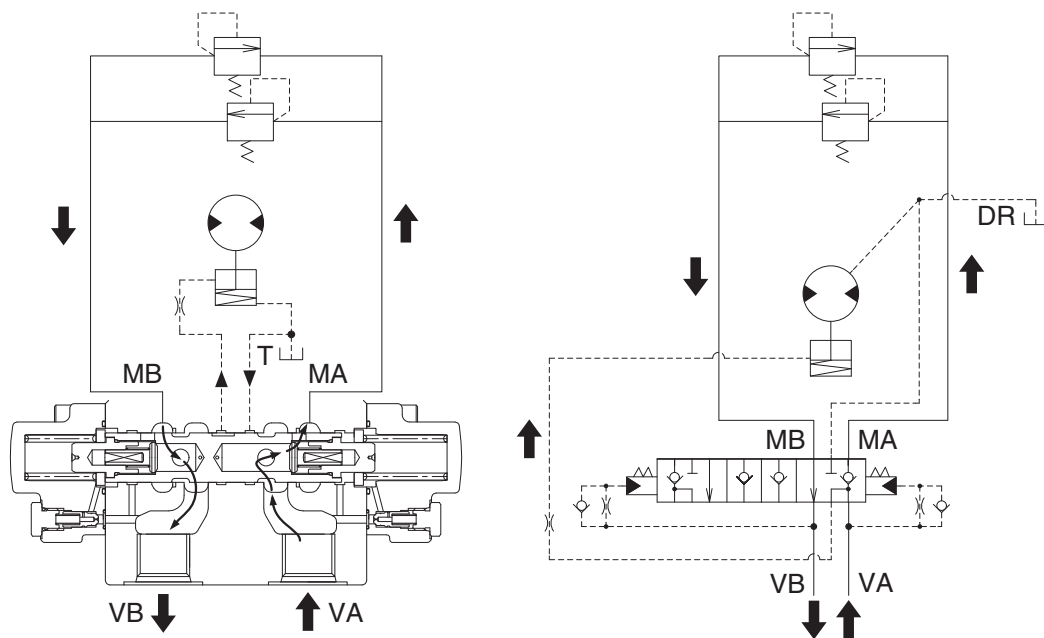
② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (33), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (33) leftwards, overcoming the spring (36) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed.

As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.

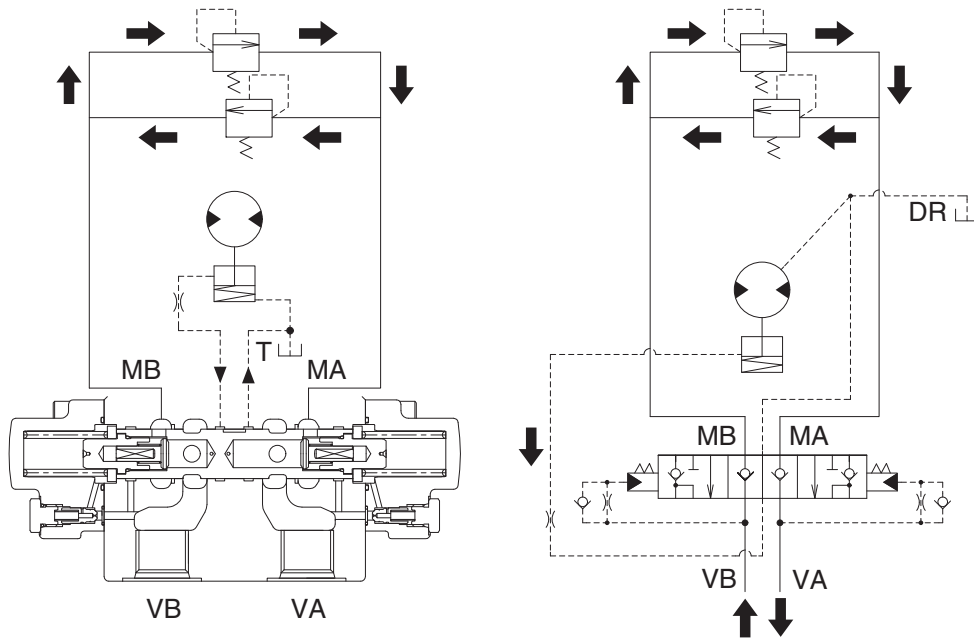


③ Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (33) returns to the neutral position by spring (36) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



④ Counterbalance operation

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.

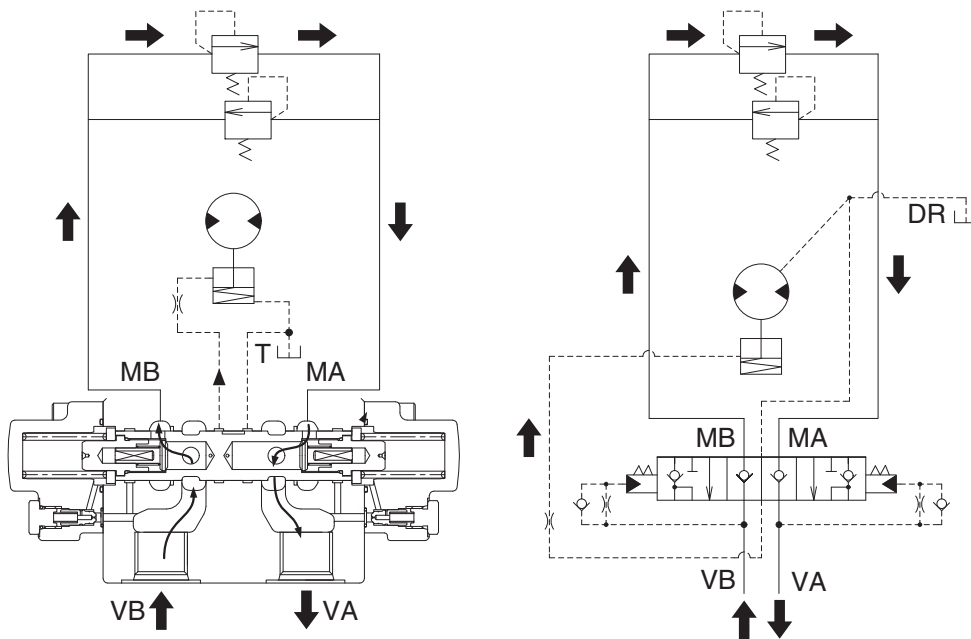
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (38) force moves the spool (33) leftwards towards neutral position.

Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (33) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.

In order to give stable counterbalance operation, the restrictors (38) are set in the pilot chamber to damp the spool (33) movement.

The parking brake is released during pressure adjusting action of the spool (33).



6) REDUCTION GEAR

Reduction unit slows down the rotating speed of motor and converts motor torque to strong rotating force.

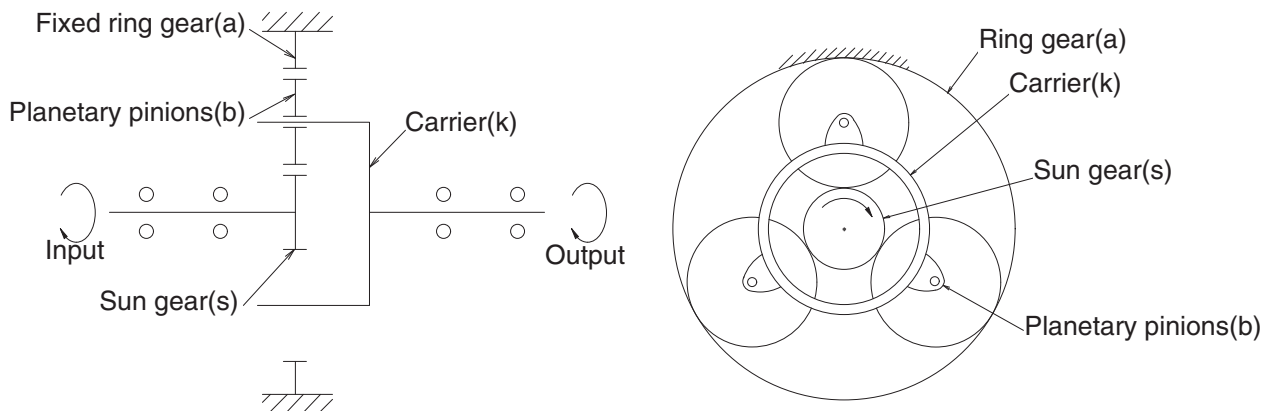
This reduction unit utilizes two stages, planetary reduction system.

Planetary reduction system consists of sun gear, planetary gears, (planetary) carriers, and ring gear.

When the sun gear (s) is driven through input shaft, planetary pinions (b), rotating on their center, also move, meshing with fixed ring gear (a), around sun gear (s).

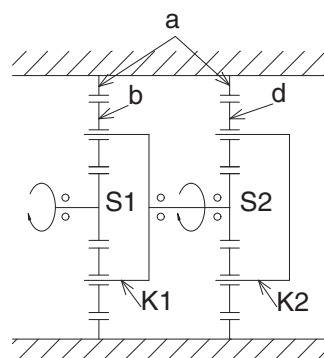
This movement is transferred to carrier (k) and deliver the torque.

This mechanism is called planetary gear mechanism.



When the sun gear **S1** is driven by input shaft, planetary action occurs among gears **S1**, **a** and **b** and revolution of gear **b** transfers the rotation of carrier **K1** to second sun gear **S2**, and also evokes planetary action between gear **S2**, **a** and **d**.

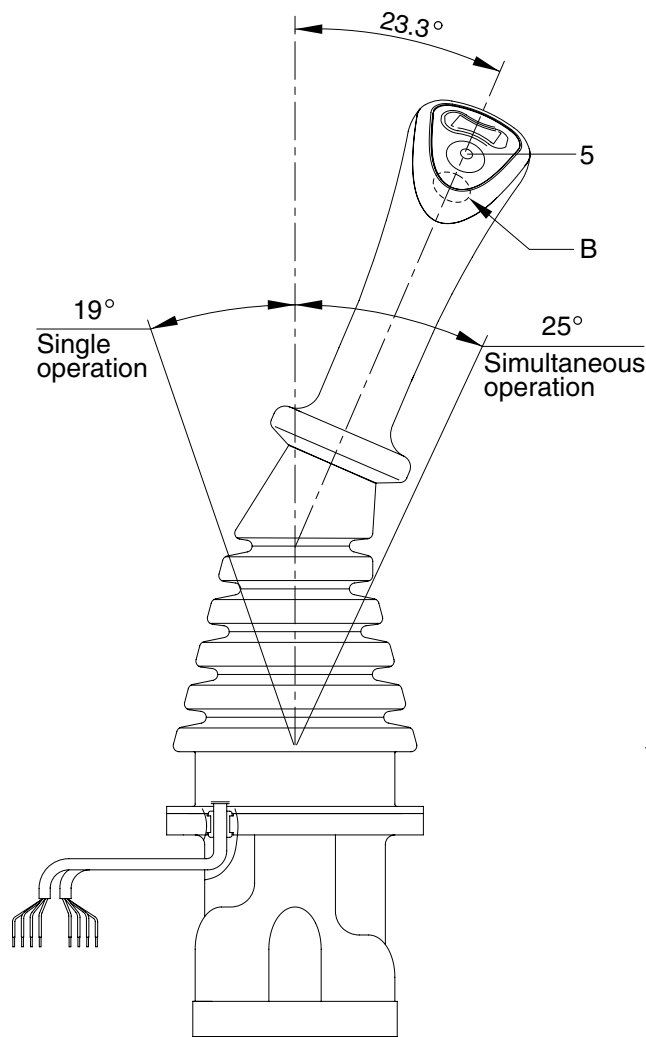
This time, because carrier **K2** is fixed to frame, gear **d** drives ring gear **a** and then ring gear **a** rotates to drive sprocket.



GROUP 5 RCV LEVER

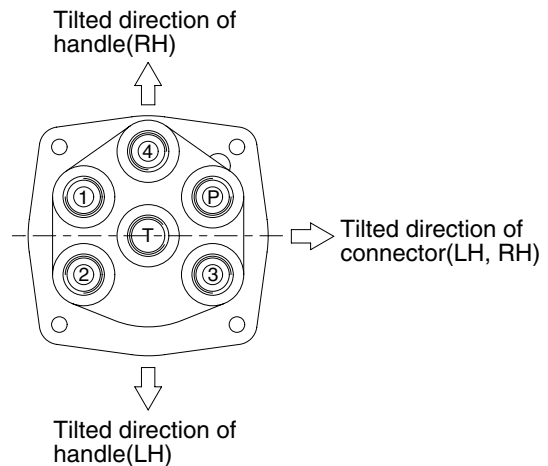
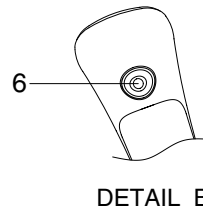
1. STRUCTURE

The casing has the oil inlet port P (primary pressure) and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.

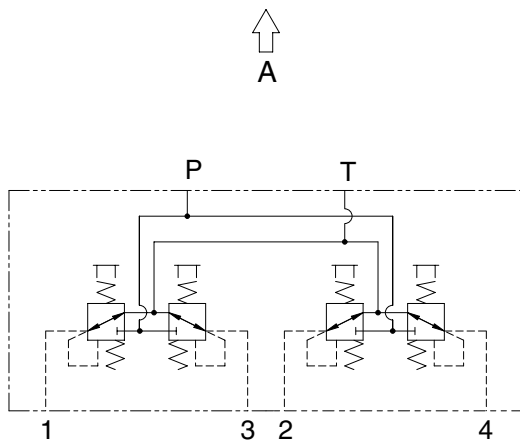


Switches

No.	LH	RH
5	One touch decel	Horn
6	Power boost	Breaker



VIEW A



Hydraulic circuit

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm in port	Boom down port	
3	Right swing port	Bucket in port	
4	Arm out port	Boom up port	

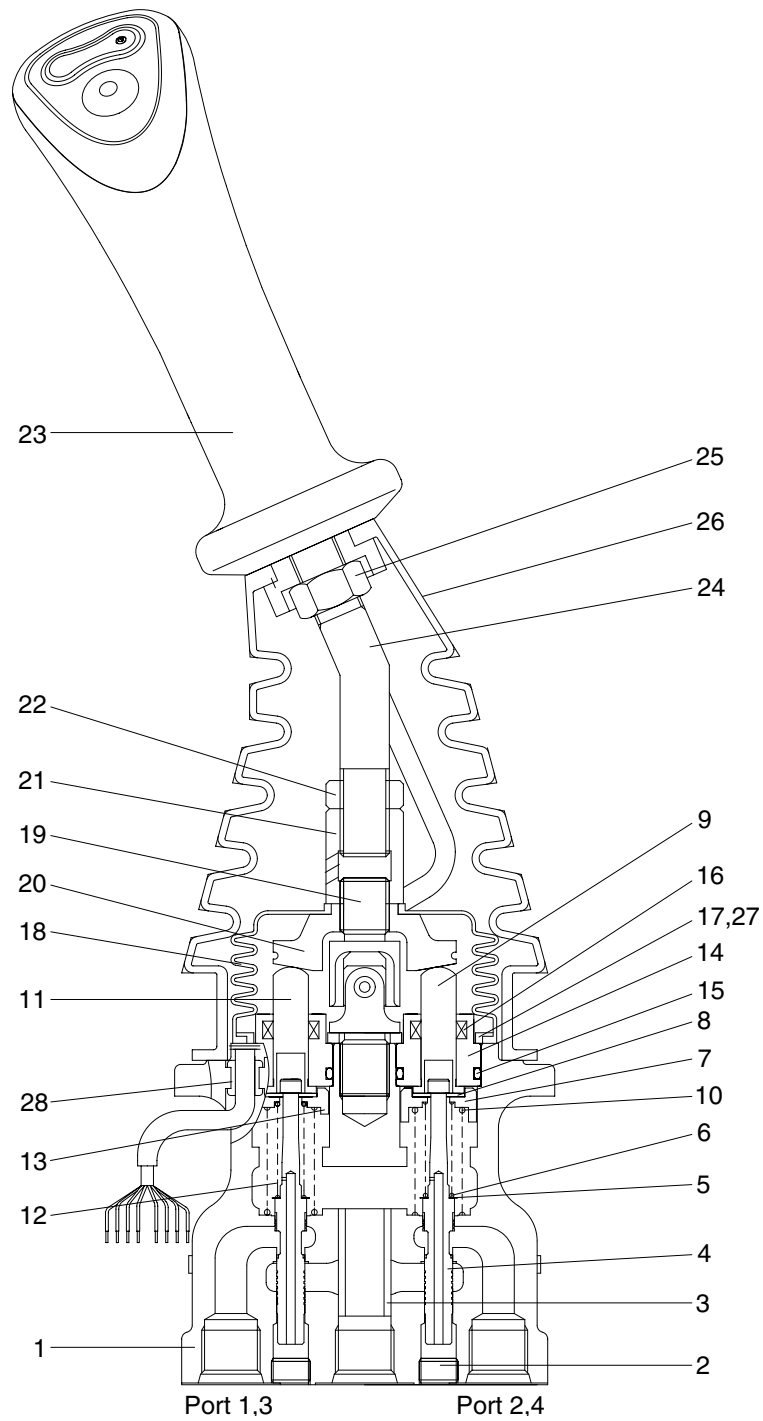
CROSS SECTION

The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (4), spring (6) for setting secondary pressure, return spring (10), stopper (8), spring seat (7, 13) and shim (5). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm² (depending on the type). The spool is pushed against the push rod (9, 11) by the return spring.

When the push rod is pushed down by tilting the handle, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.

CROSS SECTION



1	Case	8	Stopper	15	O-ring	22	Lock nut
2	Plug	9	Push rod	16	Rod seal	23	Handle assembly
3	Bushing	10	Spring	17	Plate	24	Handle bar
4	Spool	11	Push rod	18	Boot	25	Nut
5	Shim	12	Spring	19	Joint assembly	26	Boot
6	Spring	13	Spring seat	20	Swash plate	27	Spring pin
7	Spring seat	14	Plug	21	Adjusting nut	28	Bushing

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output ports (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port or tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (4) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output port pressure oil to tank port T.

The spring (6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (9,11) is inserted and can slide in the plug (14).

For the purpose of changing the displacement of the push rod through the swash plate (20) and adjusting nut (21) are provided the handle (23) that can be tilted in any direction around the fulcrum of the universal joint (19) center.

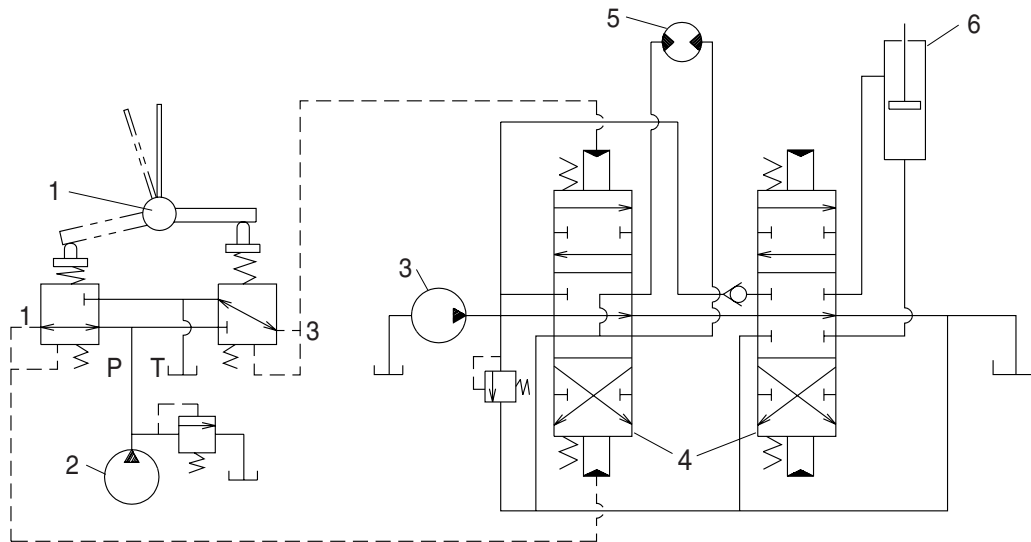
The spring (10) works on the case (1) and spring seat (7, 13) and tries to return the push rod (9,11) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

The diagram shown below is the typical application example of the pilot valve.

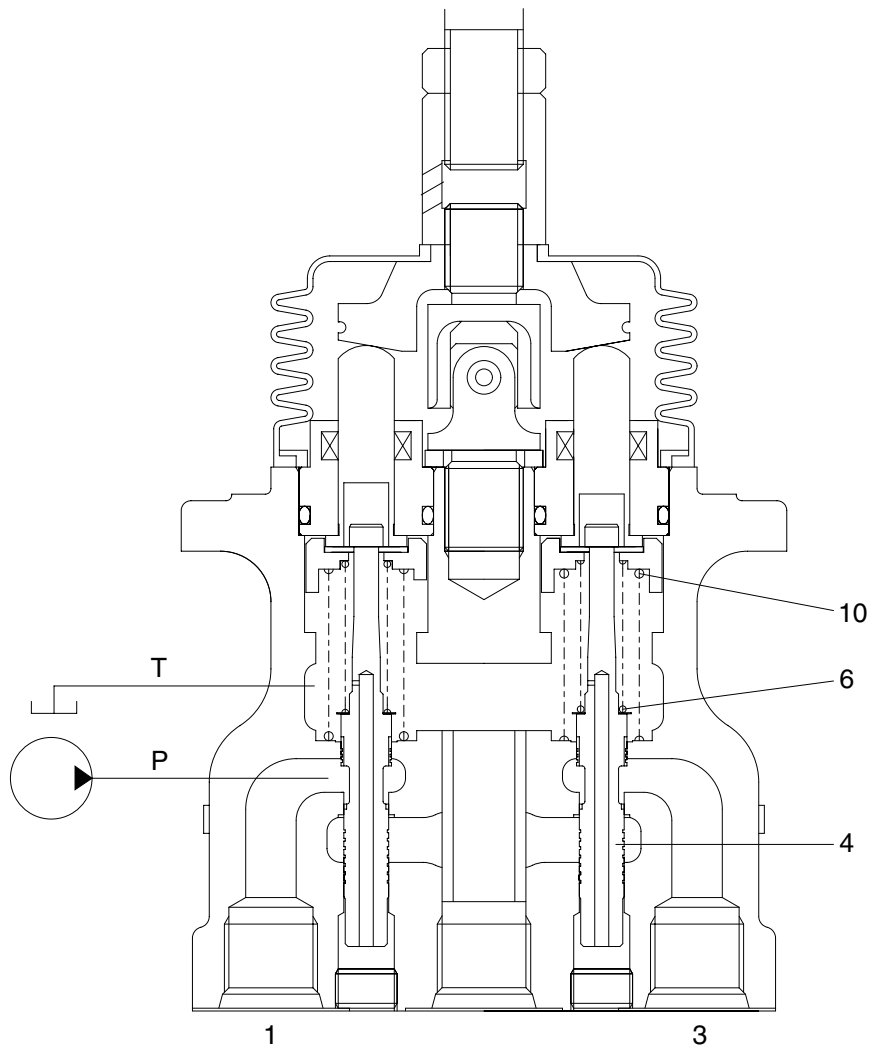


- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

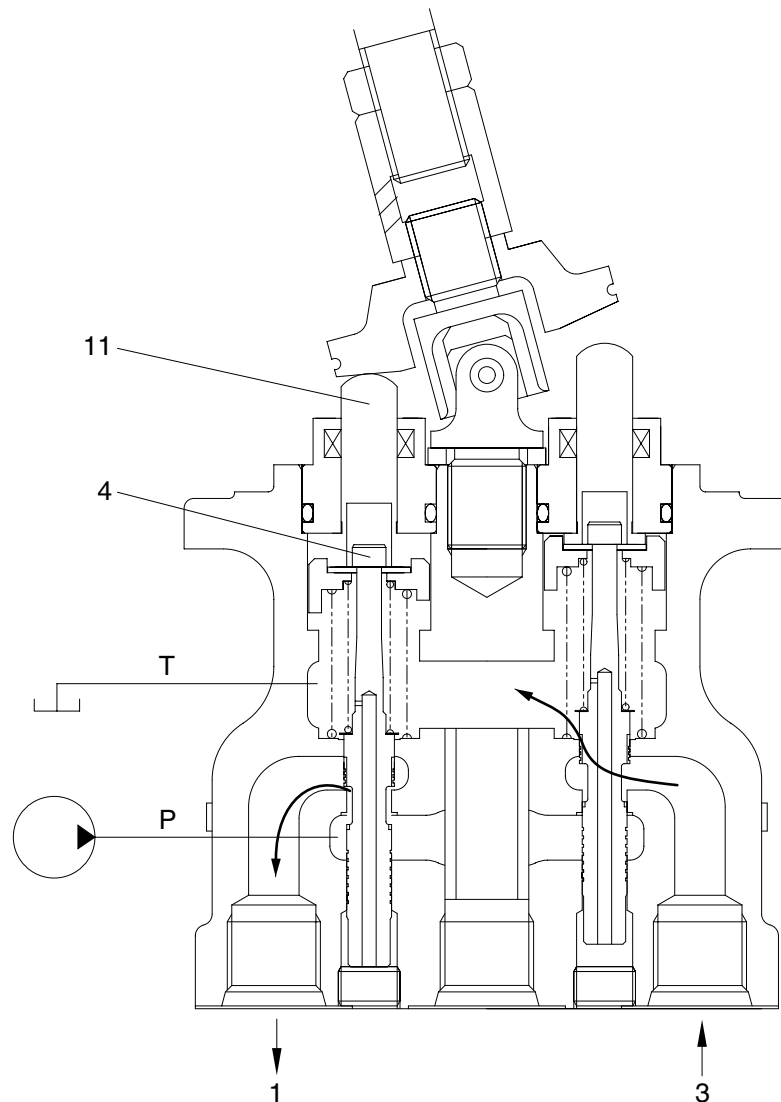
- 5 Hydraulic motor
- 6 Hydraulic cylinder

(1) Case where handle is in neutral position



The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (4). Therefore, the spool is pushed up by the spring (10) to the position of port (1, 3) in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where handle is tilted



When the push rod (11) is stroked, the spool (4) moves downwards.

Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.

When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.

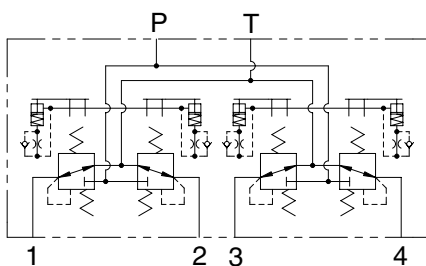
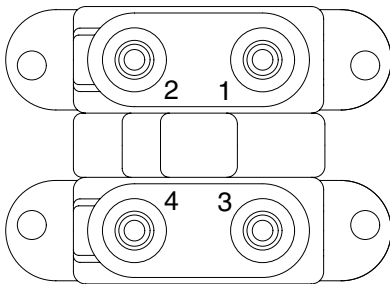
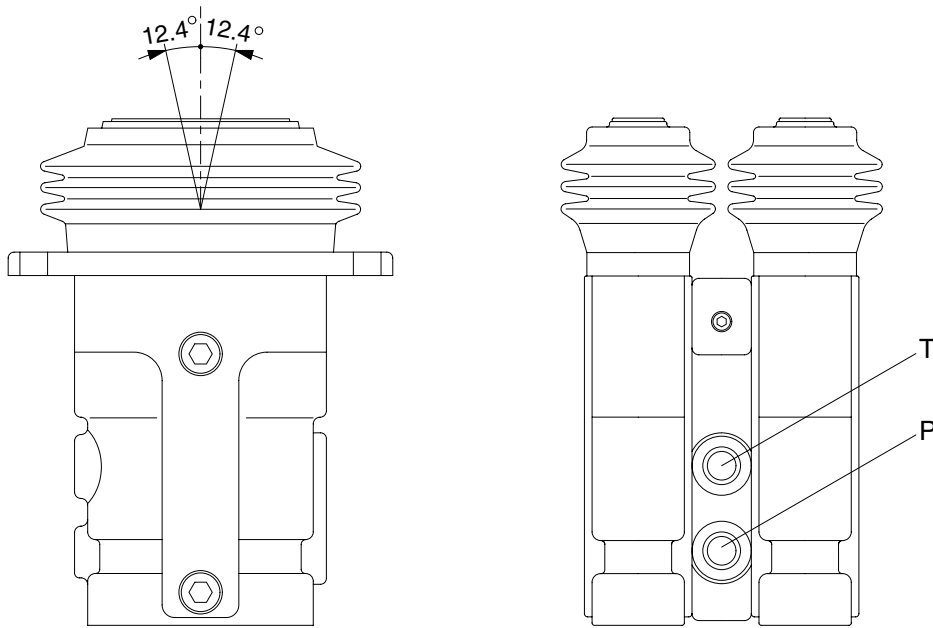
In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

GROUP 6 RCV PEDAL

1. STRUCTURE

The casing (spacer) has the oil inlet port P (primary pressure), and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1,2,3 and 4 provided at the bottom face.



Hydraulic circuit

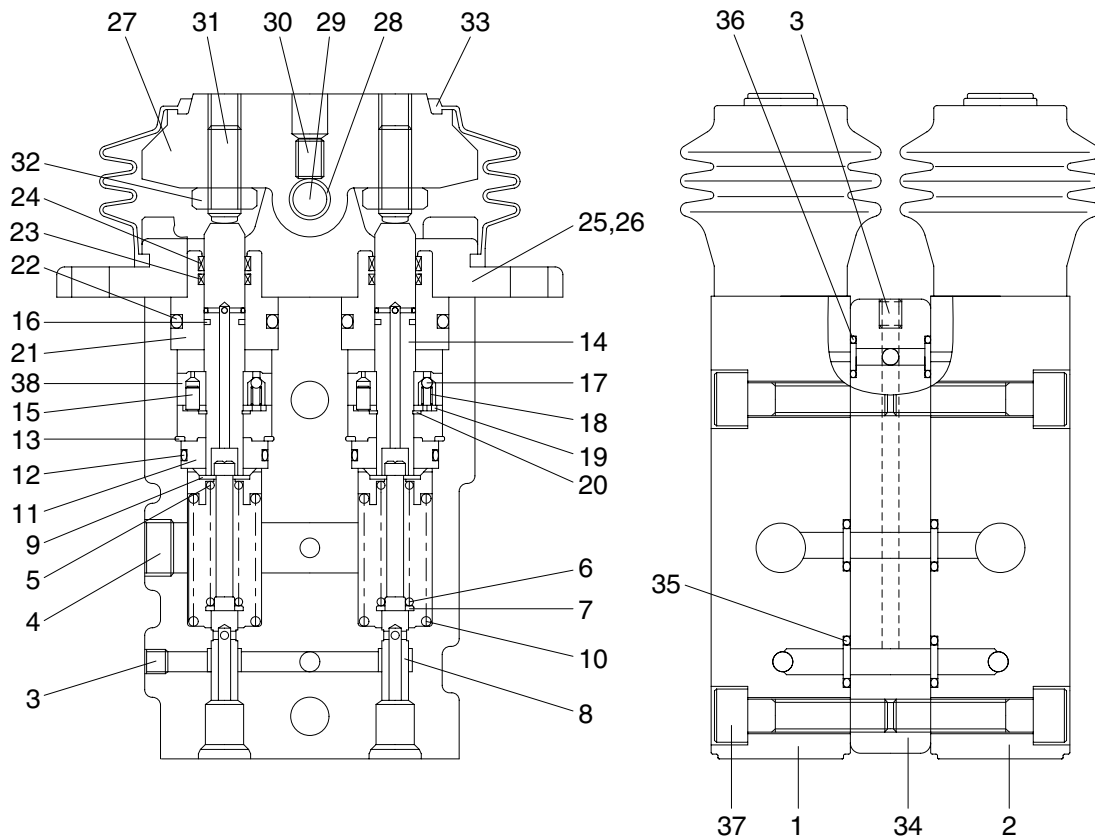
Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel (LH, forward)	
2	Travel (LH, backward)	
3	Travel (RH, forward)	
4	Travel (RH, backward)	

CROSS SECTION

The construction of the RCV pedal is shown in the below drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (8), spring (6) for setting secondary pressure, return spring (10), stopper (9), and spring seat (7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm² (depending on the type). The spool is pushed against the push rod (14) by the return spring.

When the push rod is pushed down by tilting pedal, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.



1	Body(1)	14	Push rod	27	Cam
2	Body(2)	15	Spring pin	28	Bushing
3	Plug	16	Seal	29	Cam shaft
4	Plug	17	Steel ball	30	Set screw
5	Spring seat	18	Spring	31	Set screw
6	Spring	19	Plate	32	Nut
7	Spring seat	20	Snap ring	33	Bellows
8	Spool	21	Plug	34	Space
9	Stopper	22	O-ring	35	O-ring
10	Spring	23	Rod seal	36	O-ring
11	Rod guide	24	Dust seal	37	Socket bolt
12	O-ring	25	Cover	38	Piston
13	Snap ring	26	Socket bolt		

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output port (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (8) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output spool to determine the output pressure.

The spring (6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (14) is inserted and can slide in the plug (21). For the purpose of changing th displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

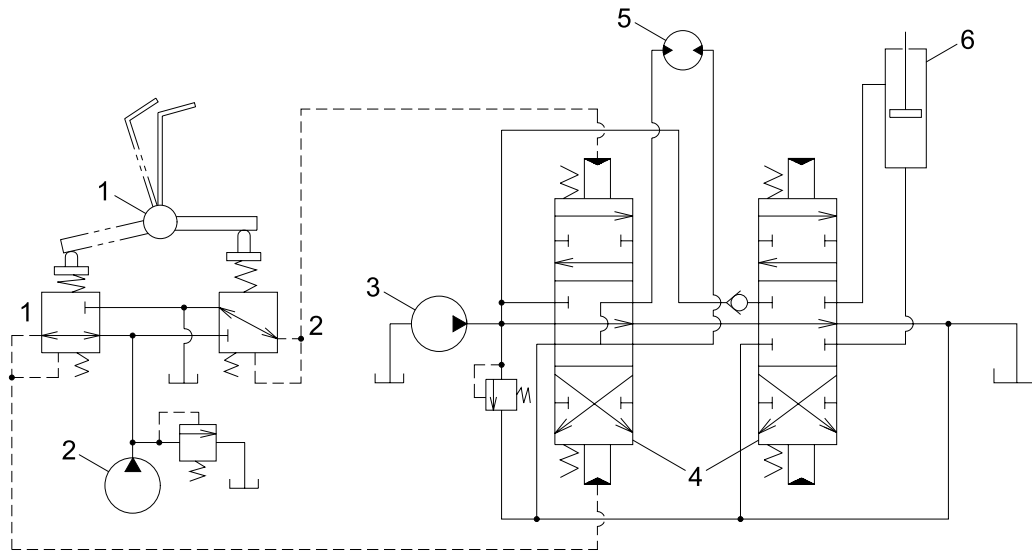
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

The diagram shown below is the typical application example of the pilot valve.

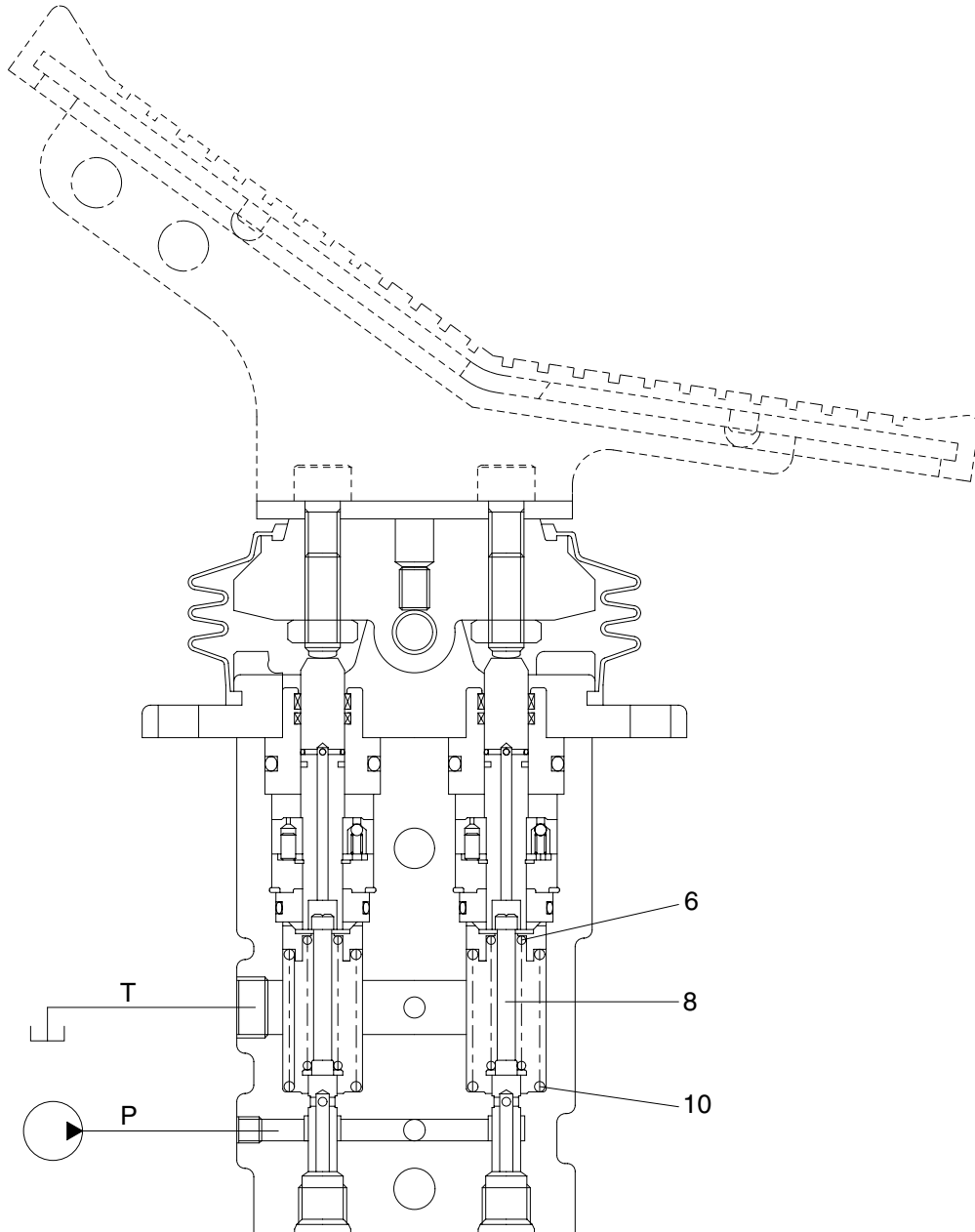


1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

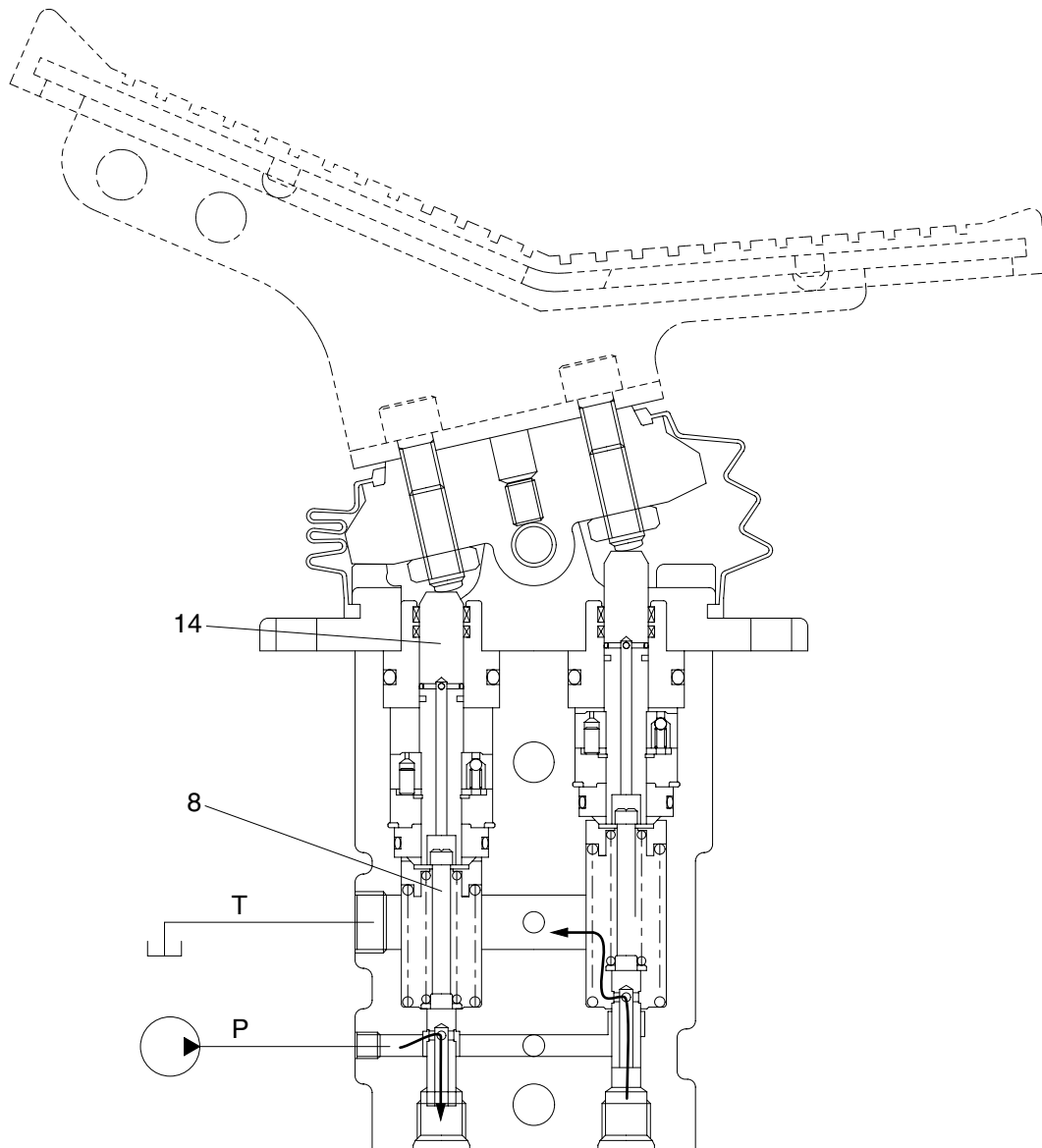
5 Hydraulic motor
6 Hydraulic cylinder

(1) Case where pedal is in neutral position



The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (8). Therefore, the spool is pushed up by the spring (10) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted



When the push rod (14) is stroked, the spool (8) moves downwards.

Then port P is connected with port 1, and the oil supplied from the pilot pump flows through port 1 to generate the pressure.

When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.

In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.