

SECTION 2 STRUCTURE AND FUNCTION

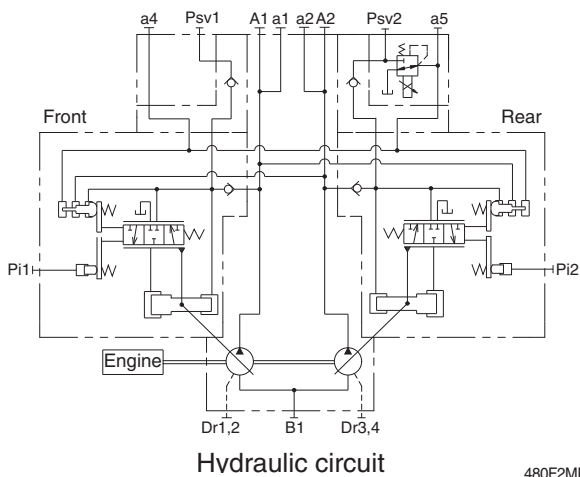
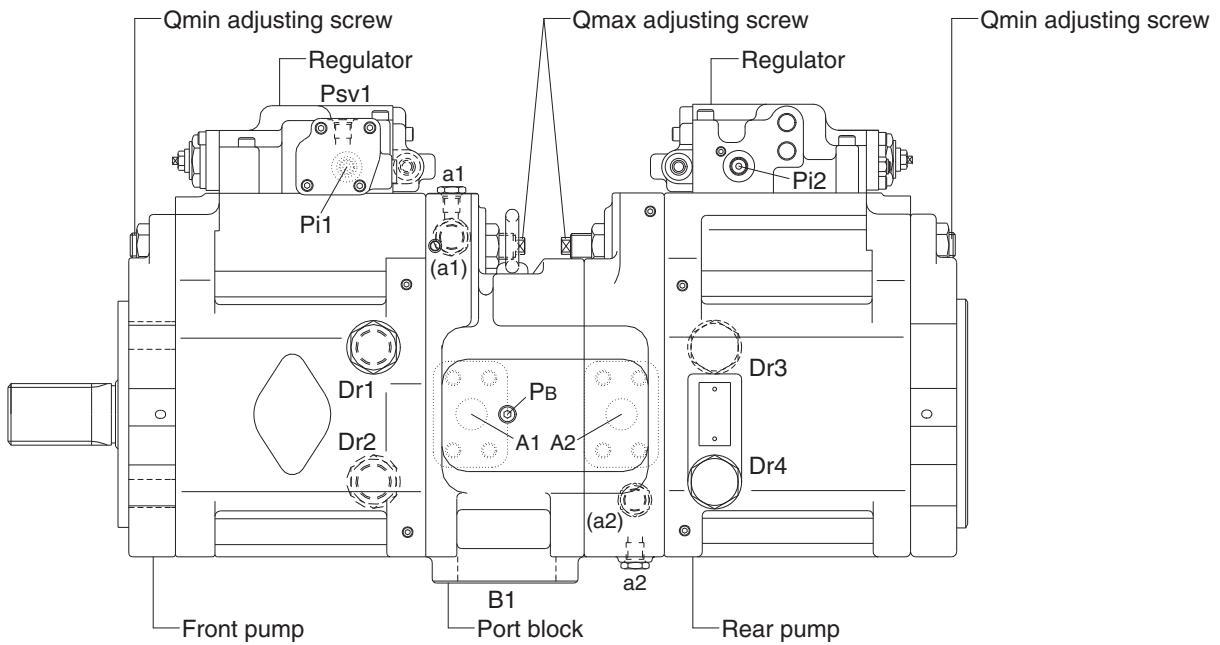
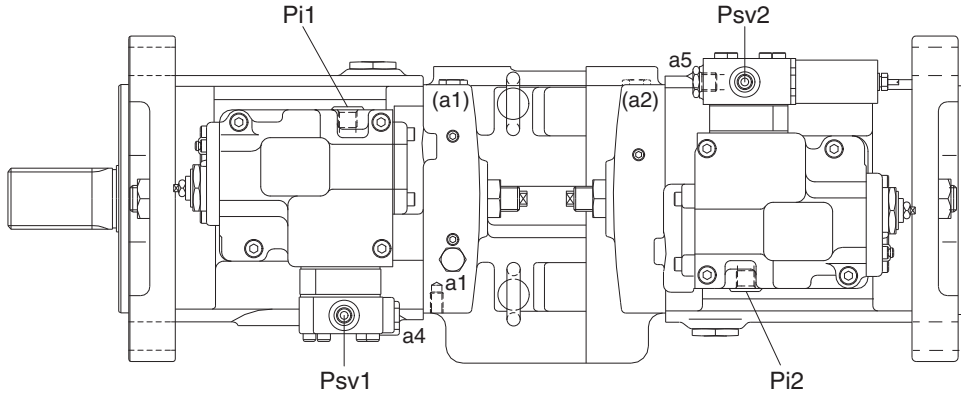
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SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, regulator.

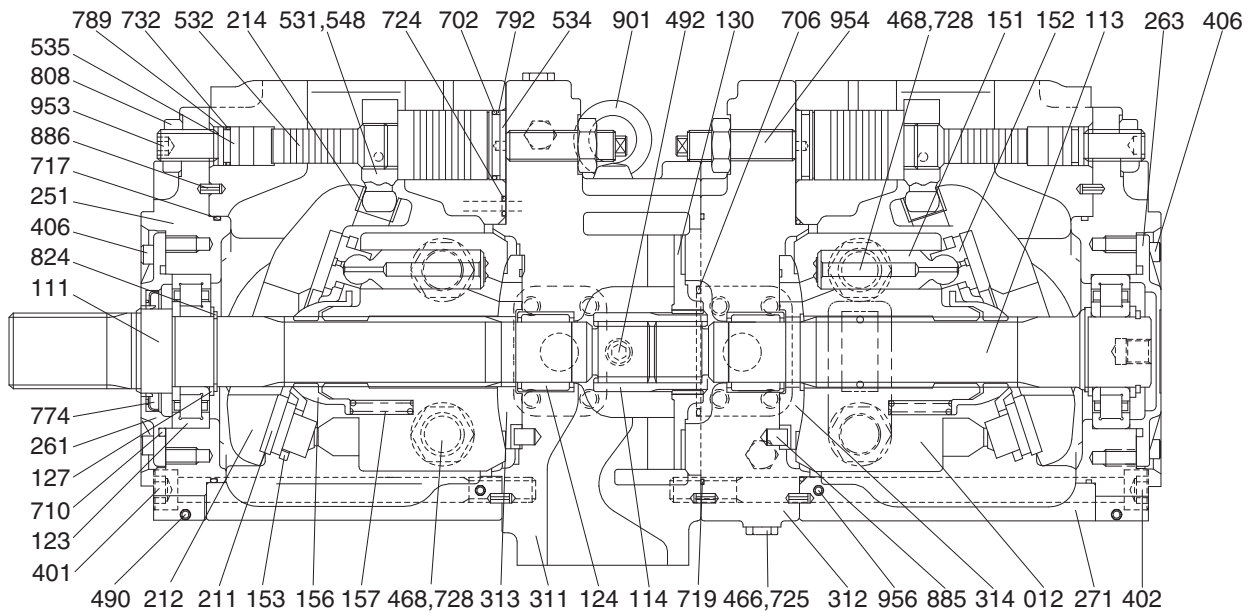


Port	Port name	Port size
A1,A2	Delivery port	SAE6000psi 1"
B1	Suction port	SAE2500psi 3"
Dr1~Dr4	Drain port	PF 3/4 - 23
Pi1,Pi2	Pilot port	PF 1/4 - 15
Psv1, Psv2	Servo assist port	PF 1/4 - 15
a1, a2, a4, a5	Gauge port	PF 1/4 - 15

480F2MP01

1) MAIN PUMP(1/2)

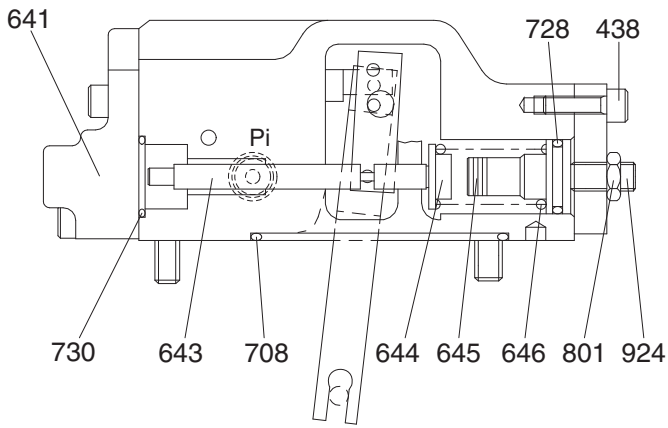
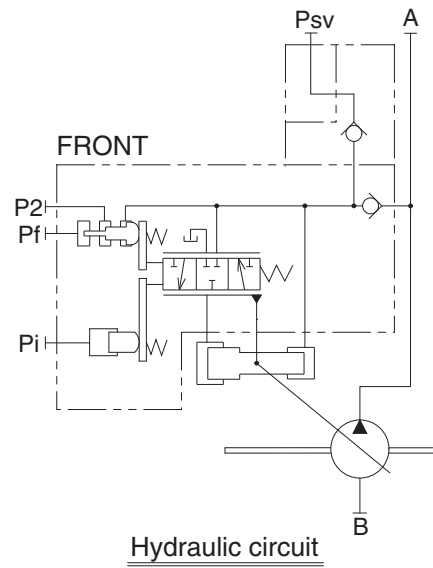
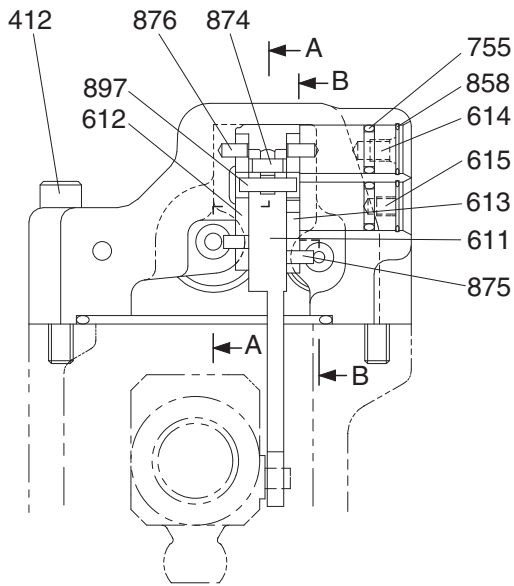
The main pump consists of two piston pumps (front & rear) and valve block.



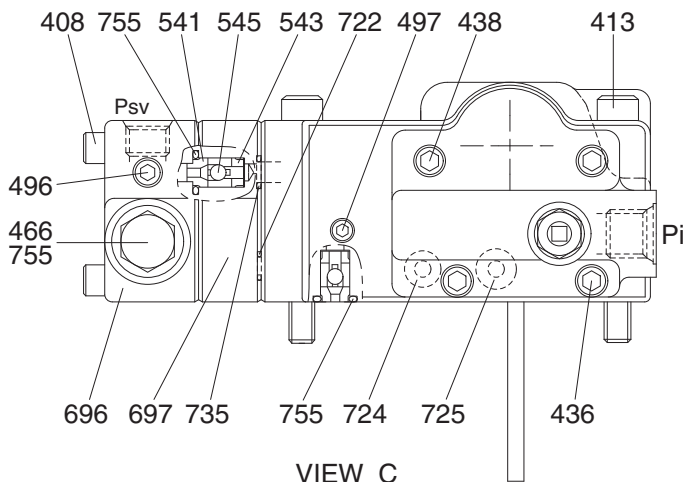
480F2MP02

012	Cylinder block	271	Pump casing	710	O-ring
111	Drive shaft (F)	311	Valve cover (F)	717	O-ring
113	Driven shaft (R)	312	Valve cover (R)	719	O-ring
114	Coupling	313	Valve plate (R)	724	Square ring
123	Roller bearing	314	Valve plate (L)	725	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Spacer	402	Hexagon socket bolt	732	O-ring
130	Booster	406	Hexagon socket bolt	774	Oil seal
151	Piston	466	VP Plug	789	Back up ring
152	Shoe	468	VP Plug	792	Back up ring
153	Set plate	490	VP Plug	808	Hexagon head nut
156	Bushing	492	VP Plug	824	Snap ring
157	Cylinder spring	531	Tilting pin	885	Valve plate pin
211	Shoe plate	532	Servo piston	886	Spring pin
212	Swash plate	534	Stopper (L)	901	Eye bolt
214	Tilting bushing	535	Stopper (S)	953	Set screw
251	Support plate	548	Feed back pin	954	Set screw
261	Seal cover (F)	702	O-ring	956	Set screw
263	Seal cover (R)	706	O-ring		

2) FRONT REGULATOR (1/2)



SECTION B-B

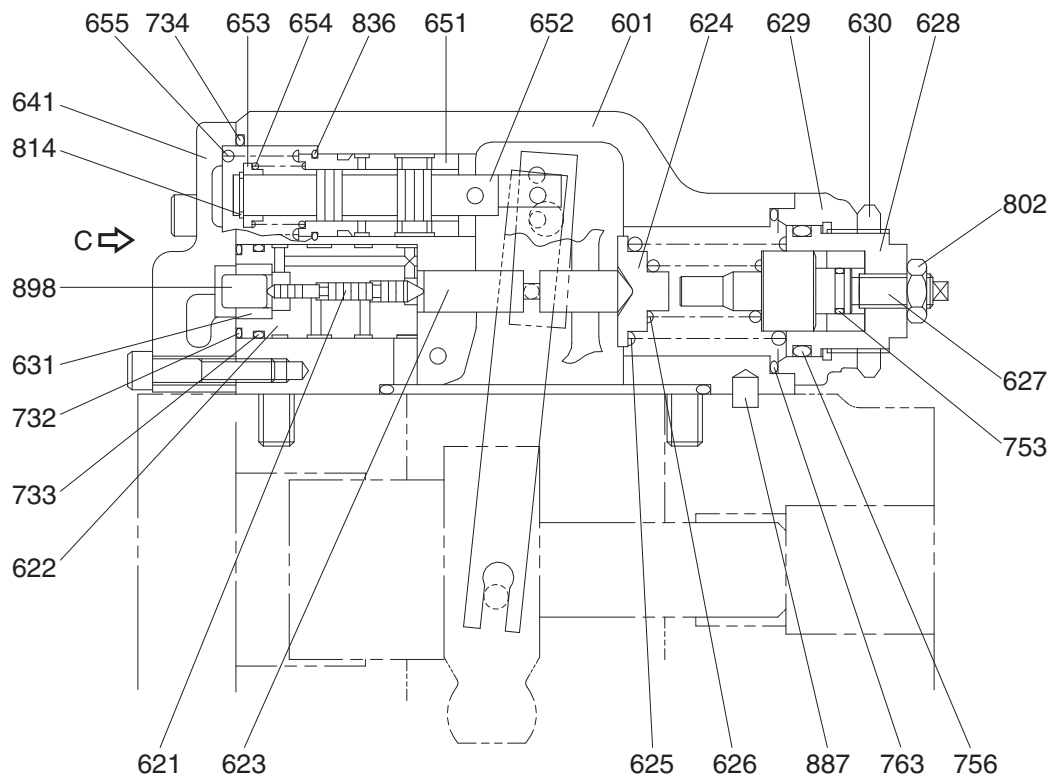


VIEW C

Port	Port name	Port size
Pi	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
P2	Companion delivery port	-
Pf	Powershift port	-

480F2RG01

FRONT REGULATOR (2/2)

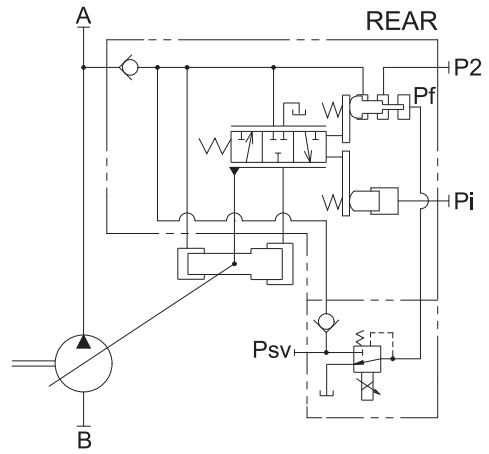
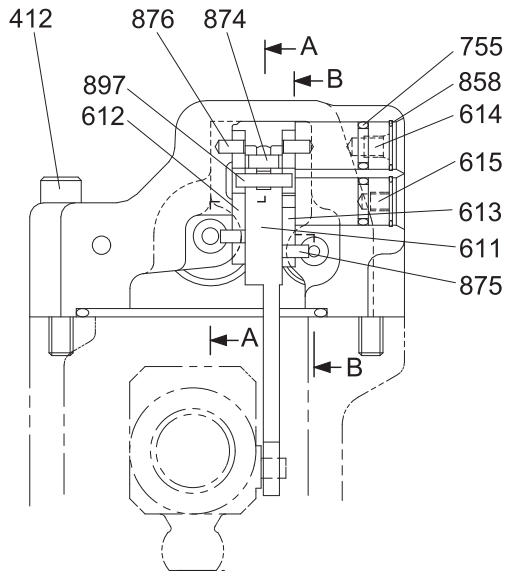


SECTION A-A

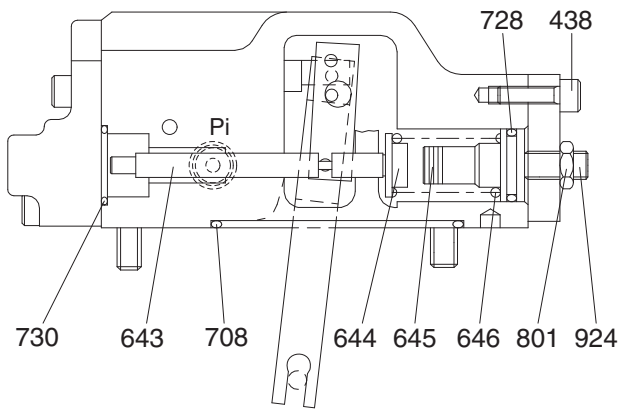
48092RG02

408 Hexagon socket screw	626 Inner spring	728 O-ring
412 Hexagon socket screw	627 Adjust stem (C)	730 O-ring
413 Hexagon socket screw	628 Adjust screw (C)	732 O-ring
436 Hexagon socket screw	629 Cover (C)	733 O-ring
438 Hexagon socket screw	630 Lock nut	734 O-ring
466 Plug	631 Sleeve, pf	735 O-ring
496 Plug	641 Pilot cover	753 O-ring
497 Plug	643 Pilot piston	755 O-ring
541 Seat	644 Spring seat (Q)	756 O-ring
543 Stopper	645 Adjust stem (Q)	763 O-ring
545 Steel ball	646 Pilot spring	801 Nut
601 Casing	651 Sleeve	802 Nut
611 Feed back lever	652 Spool	814 Snap ring
612 Lever (1)	653 Spring seat	836 Snap ring
613 Lever (2)	654 Return spring	858 Snap ring
614 Center plug	655 Set spring	874 Pin
615 Adjust plug	696 Port cover	875 Pin
621 Compensator piston	697 Check valve plate	876 Pin
622 Piston case	708 O-ring	887 Pin
623 Compensator rod	722 O-ring	897 Pin
624 Spring seat (C)	724 Square ring	898 Pin
625 Outer spring	725 O-ring	924 Set screw

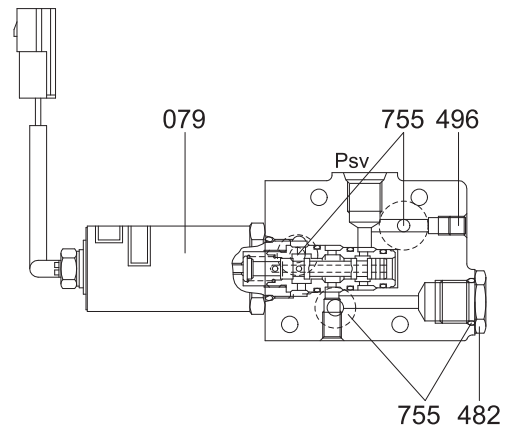
3) REAR REGULATOR (1/2)



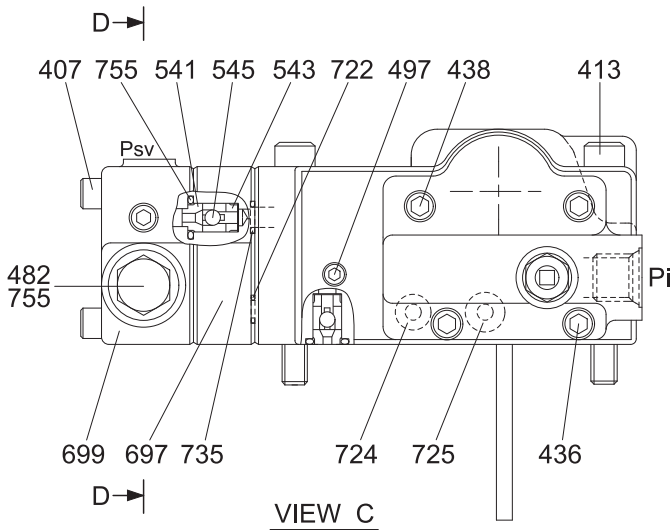
Hydraulic circuit



SECTION B-B



SECTION D-D

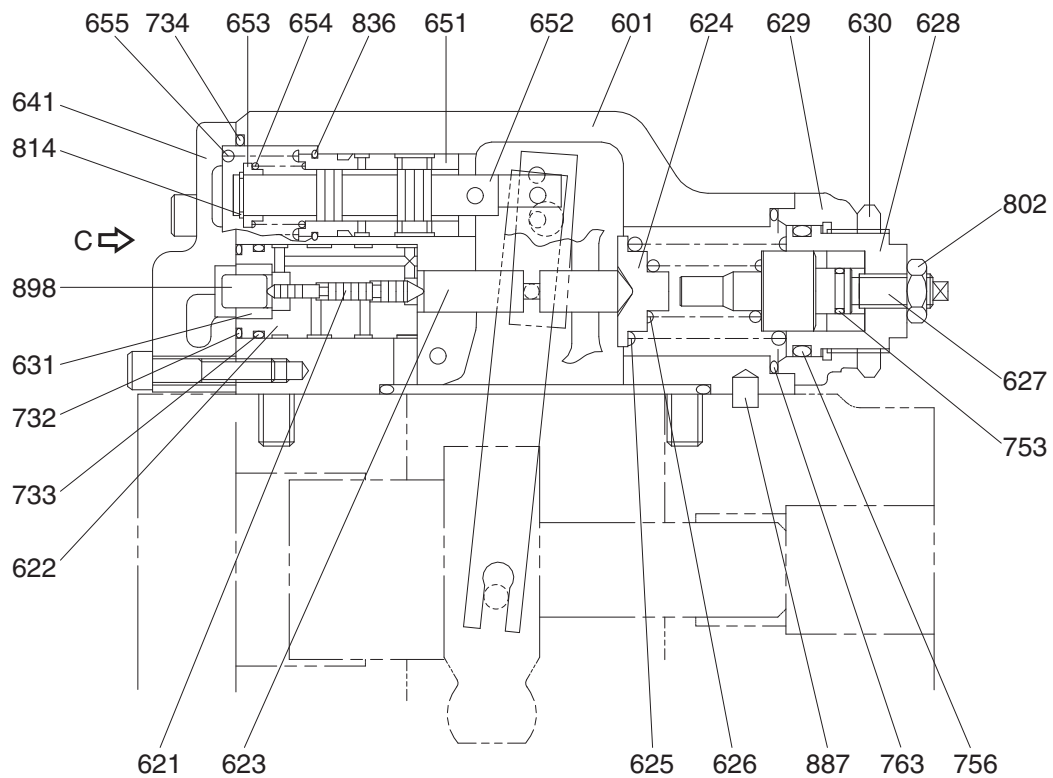


VIEW C

Port	Port name	Port size
Pi	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
P2	Companion delivery port	-
Pf	Powershift port	-

480F2RG03

REAR REGULATOR (2/2)

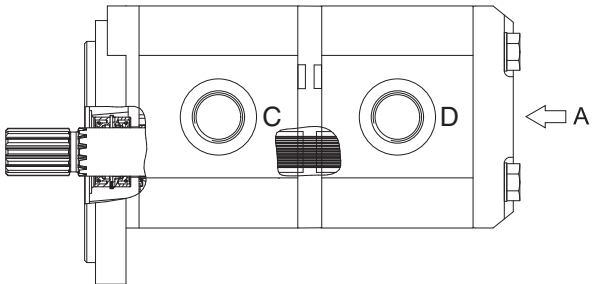
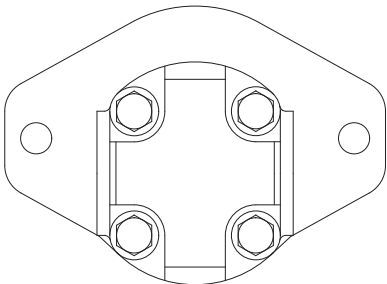
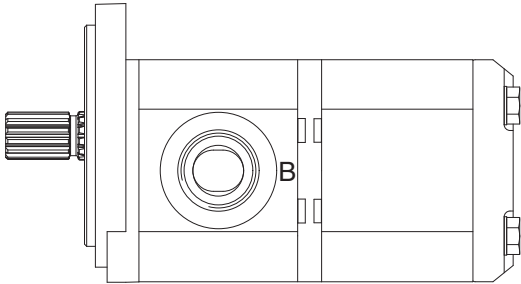
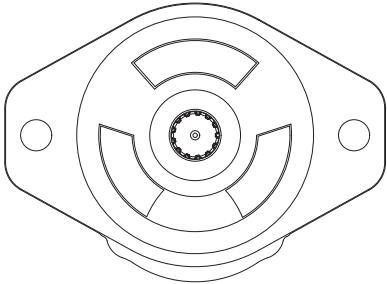


SECTION A-A

48092RG02

079 EPPR valve	626 Inner spring	728 O-ring
407 Hexagon socket screw	627 Adjust stem(C)	730 O-ring
412 Hexagon socket screw	628 Adjust screw(C)	732 O-ring
413 Hexagon socket screw	629 Cover(C)	733 O-ring
436 Hexagon socket screw	630 Lock nut	734 O-ring
438 Hexagon socket screw	631 Sleeve, pf	735 O-ring
482 Plug	641 Pilot cover	753 O-ring
496 Plug	643 Pilot piston	755 O-ring
541 Seat	644 Spring seat(Q)	756 O-ring
543 Stopper	645 Adjust stem(Q)	763 O-ring
545 Steel ball	646 Pilot spring	801 Nut
601 Casing	651 Sleeve	802 Nut
611 Feed back lever	652 Spool	814 Snap ring
612 Lever(1)	653 Spring seat	836 Snap ring
613 Lever(2)	654 Return spring	858 Snap ring
614 Center plug	655 Set spring	874 Pin
615 Adjust plug	697 Check valve plate	875 Pin
621 Compensator piston	699 Port cover	876 Pin
622 Piston case	708 O-ring	887 Pin
623 Compensator rod	722 O-ring	897 Pin
624 Spring seat(C)	724 O-ring	898 Pin
625 Outer spring	725 O-ring	924 Set screw

4) GEAR PUMP (1/2)



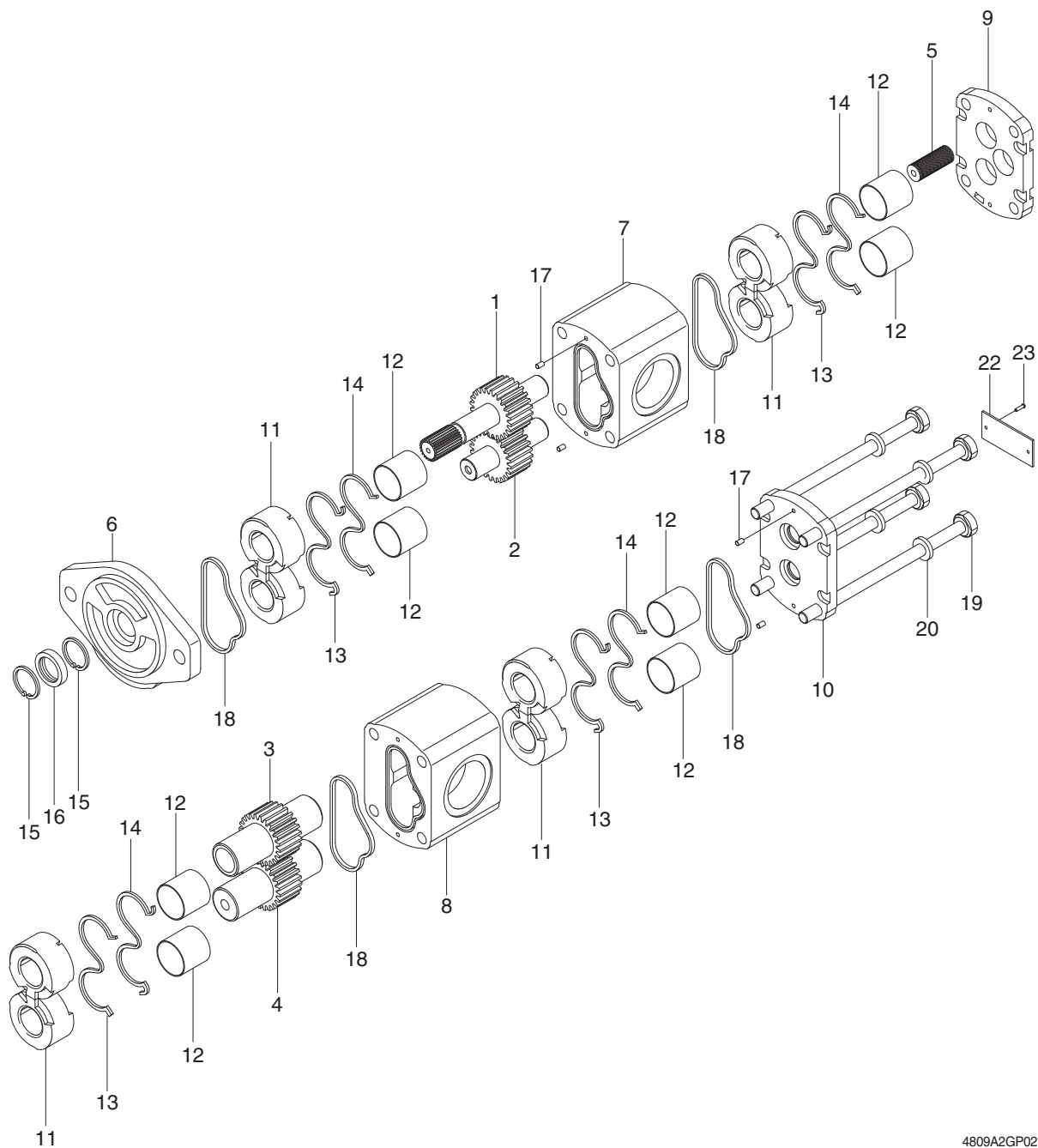
VIEW A

REAR VIEW

Port	Name	Size
B	Suction port	PF 1"
C	Delivery port (fan motor)	7/8"-14UNF
D	Delivery port (pilot line)	7/8"-14UNF

480F2GP01

GEAR PUMP (2/2)



4809A2GP02

- | | | | | | |
|---|---------------------|----|---------------|----|------------|
| 1 | Multi shaft gear 1 | 9 | Multi spacer | 17 | Dowel pin |
| 2 | Driven gear 2 | 10 | Rear cover | 18 | D-ring |
| 3 | Joint driven gear 3 | 11 | Bushing block | 19 | Bolt |
| 4 | Driven gear 4 | 12 | DU-Bushing | 20 | Washer |
| 5 | Connector | 13 | Channel seal | 21 | Name plate |
| 6 | Front cover | 14 | Back up seal | 23 | Rivet |
| 7 | Gear housing 1 | 15 | Retainer seal | | |
| 8 | Gear housing 2 | 16 | Snap ring | | |

2. FUNCTION

1) MAIN PUMP

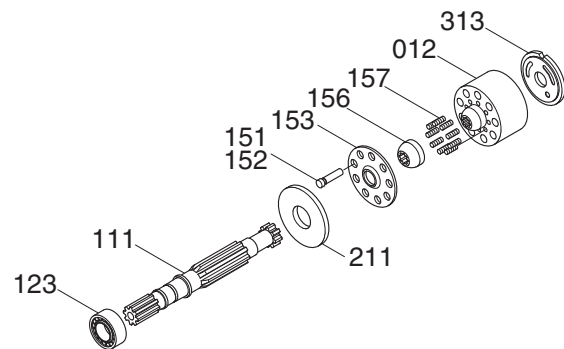
The pumps may be classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block (012), piston shoes (151,152), set plate (153), spherical shoes (151,152), set plate (153), spherical bush (156), and cylinder spring (157).

The drive shaft is supported by bearing (123,124) at its both ends.

The shoe is caulked to the piston to form a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and to take hydraulic balance so that it slides lightly over the shoe plate (211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush. Similarly, the cylinder block is pressed against valve plate (313) by the action of the cylinder spring.



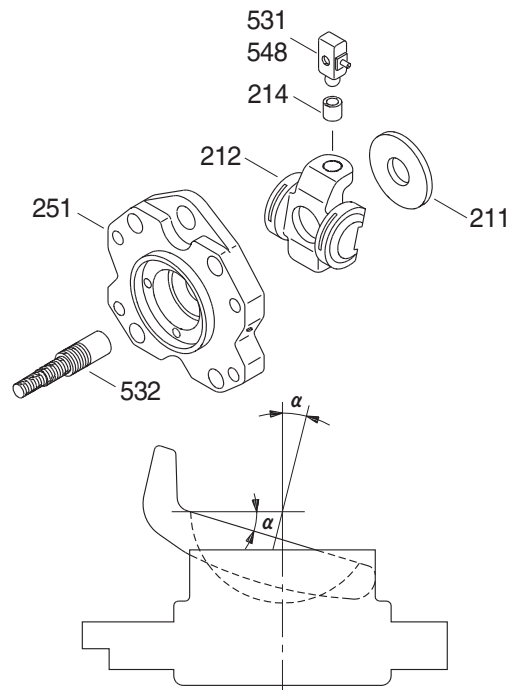
50072MP01

(2) Swash plate group

The swash plate group consists of swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and servo piston (532).

The swash plate is a cylindrical part formed on the opposite side of the sliding surface of the shoe and is supported by the swash support.

If the servo piston moves to the right and left as hydraulic force controlled by the regulator is admitted to hydraulic chamber located on both sides of the servo piston, the swash plate slides over the swash plate support via the spherical part of the tilting pin to change the tilting angle (α)



2-7 (210-7)

(3) Valve block group

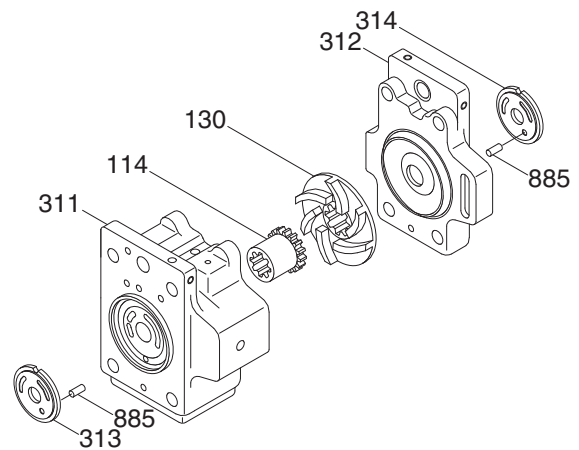
The valve cover group consists of valve cover (F, 311), valve cover (R, 312), valve plate (313, 314), spline coupling (114), booster (130) and valve plate pin (885).

The valve plate having two melon-shaped ports is fixed to the valve cover and feeds and collects oil to and from the cylinder cover.

The oil changed over by the valve plate is connected to an external pipeline by way of the valve cover.

Now, if the drive shaft is driven by a prime mover (electric motor, engine, etc), it rotates the cylinder block via a spline linkage at the same time. If the swash plate is tilted as in Fig (previous page) the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block.

If you pay attention to a single piston, it performs a motion away from the valve plate (oil sucking process) within 180 degrees, and makes a motion towards the valve plate (or oil discharging process) in the rest of 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.



36072MP03

2) REGULATOR

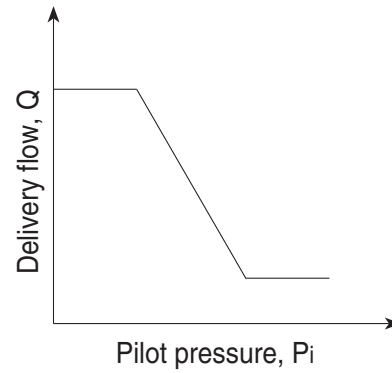
Regulator consists of the negative flow control, total horse power control and power shift control function

(1) Negative flow control

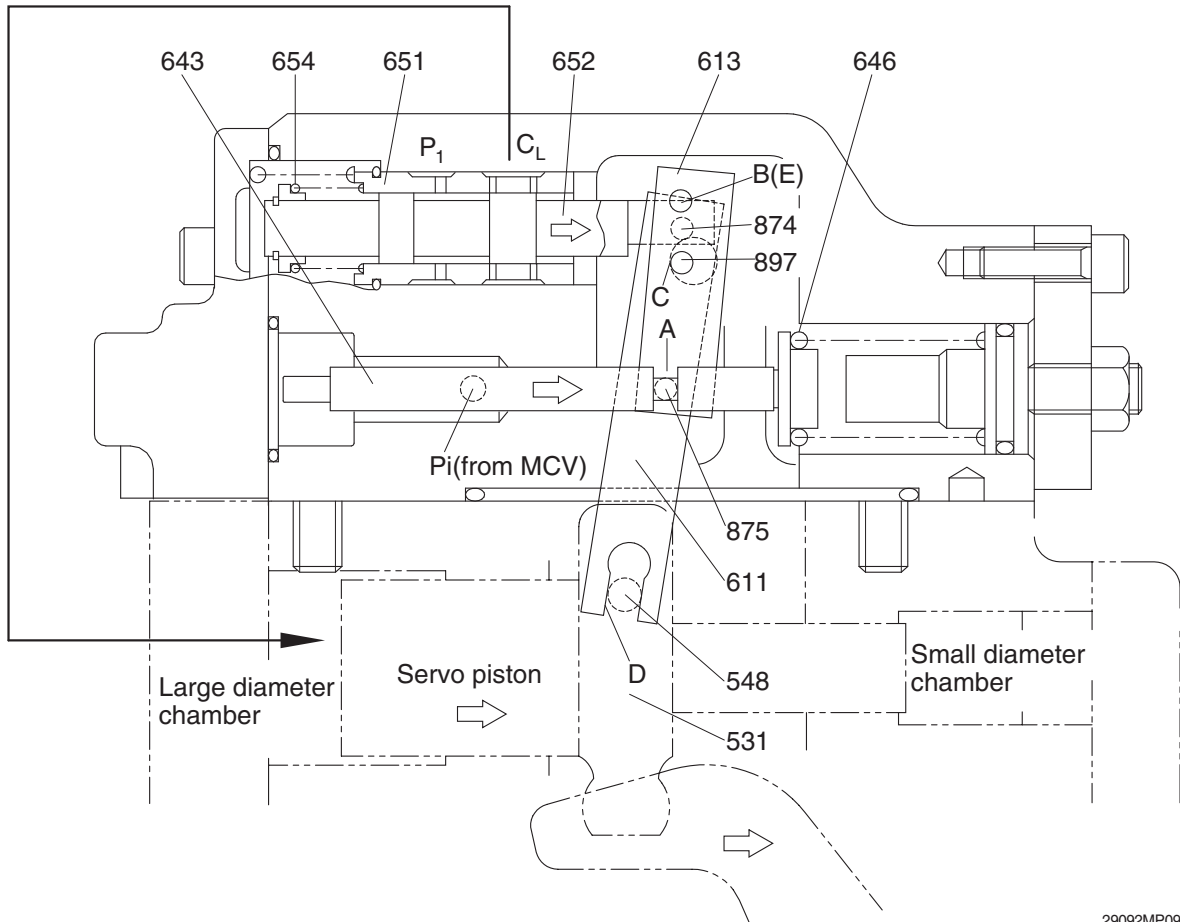
By changing the pilot pressure P_i , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

This regulator is of the negative flow control in which the delivery flow Q decreases as the pilot pressure P_i rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.



① Flow reducing function



29092MP09A

As the pilot pressure P_i rises, the pilot piston (643) moves to the right to a position where the force of the pilot spring (646) balances with the hydraulic force.

The groove (A) in the pilot piston is fitted with the pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B [Fixed by the fulcrum plug (614) and pin (875)]. Since the large hole section (C) of lever 2 contains a protruding pin (897) fixed to the feedback lever (611), the pin (897) moves to the right as lever 2 rotates. Since the opposing-flat section (D) of the feedback lever is fitted with the pin (548) fixed by the tilting pin (531) that swings the swash plate, the feedback lever rotates around the fulcrum of point D, as the pin (897) moves.

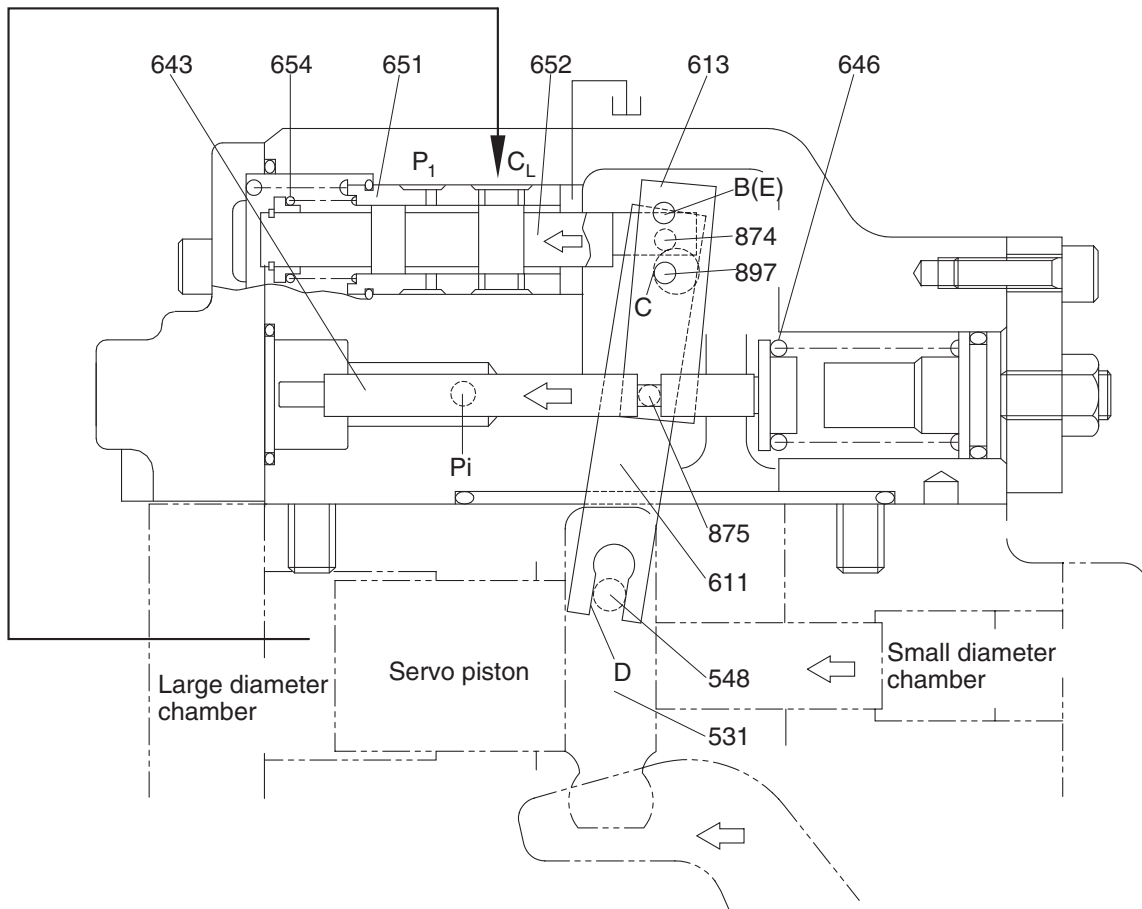
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

The movement of the spool causes the delivery pressure P_1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P_1 that is constantly admitted to the small diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring (654) and is tensioned to the left at all times, and so the pin (897) is pressed against the large hole section (C) of lever 2.

Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve (651) and spool (652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

② Flow increasing function



29092MP10

As the pilot pressure P_i decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P_1 in the small diameter section, resulting in an increase in the flow rate.

As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

③ Adjustment of flow control characteristic

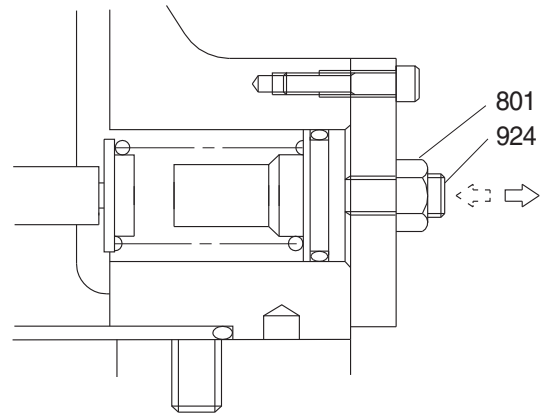
The flow control characteristic can be adjusted with the adjusting screw.

Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the hexagonal socket head screw (924).

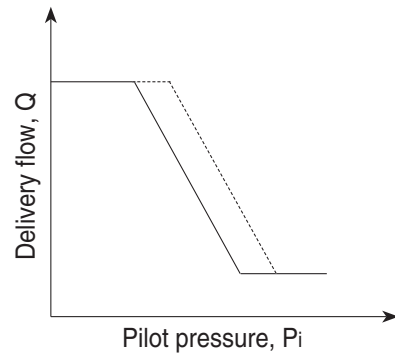
Tightening the screw shifts the control chart to the right as shown in the figure.

※ Adjusting values are shown in table.

Speed (min ⁻¹)	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw (924) (Turn)	Flow control starting pressure change amount (kgf/cm ²)	Flow change amount (l /min)
1800	+1/4	+1.02	+21



2-12 (210-7)



(2) Total horsepower control

The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump.

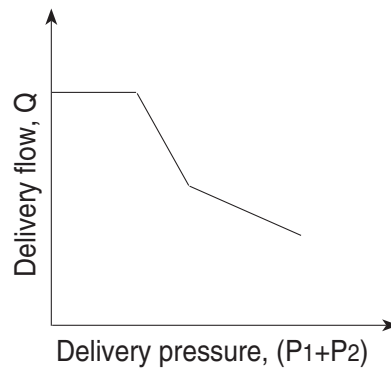
(The input horsepower is constant when the speed is constant.)

Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.

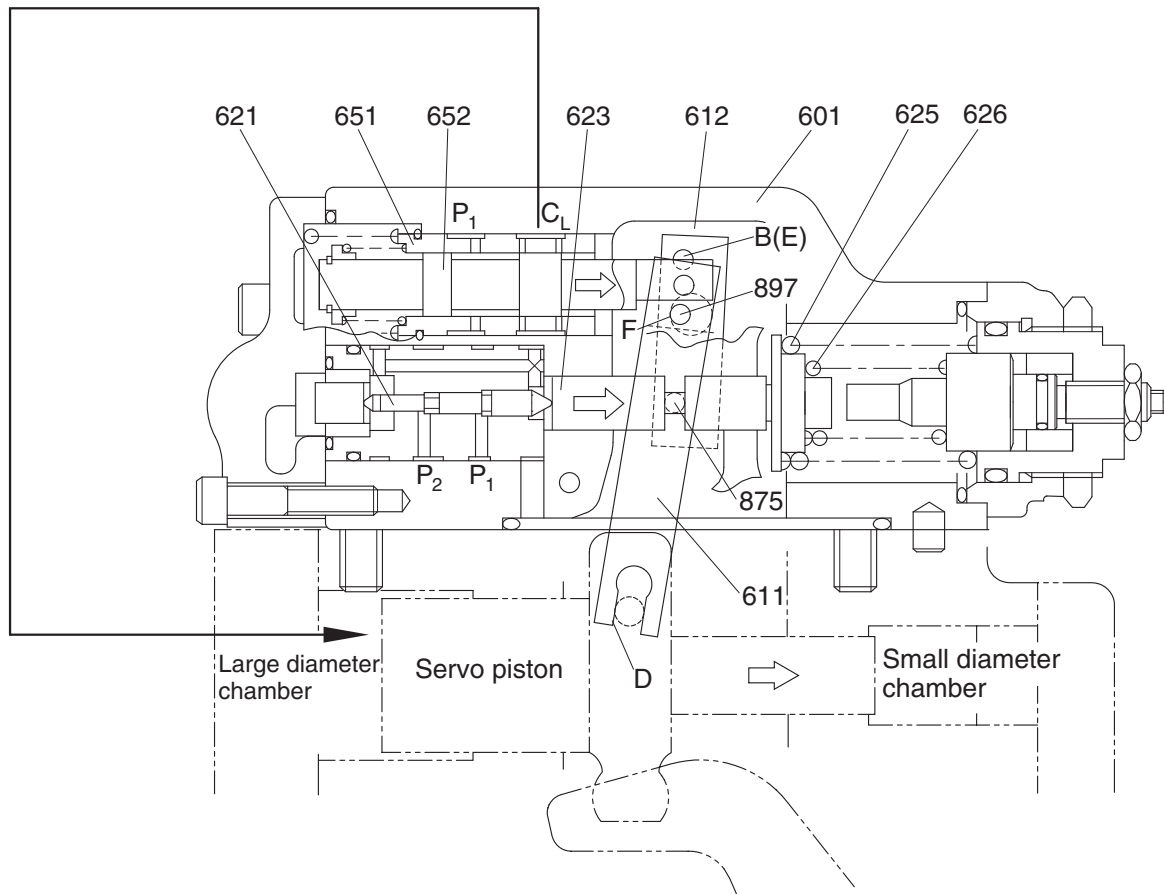
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation :

$$\begin{aligned} T_{in} &= P1 \times q / 2 \pi + P2 \times q / 2 \pi \\ &= (P1+P2) \times q / 2 \pi \end{aligned}$$

The horsepower control function is the same as the flow control function and is summarized in the following. (For detailed behaviors of respective parts, refer to the section of flow control).



① Overload preventive function



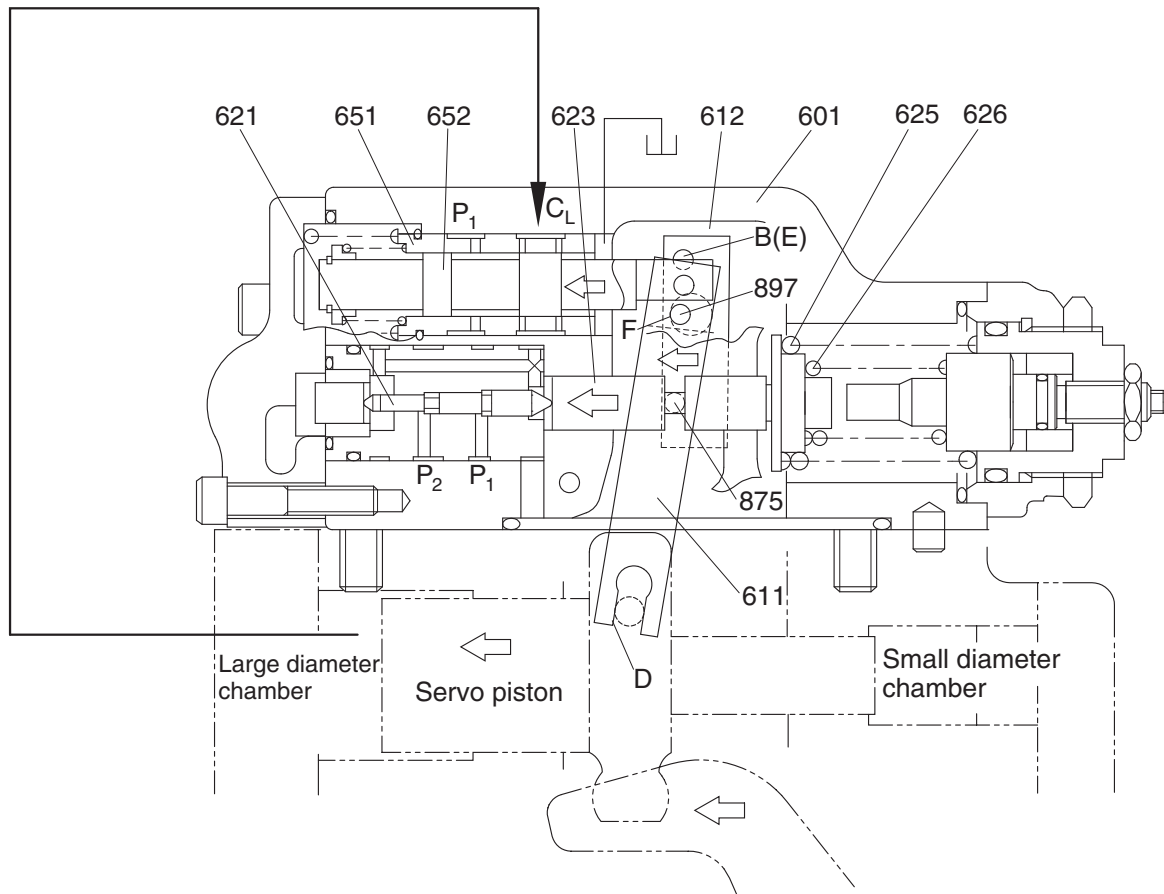
29092MP11

When the self pump delivery pressure P_1 or the companion pump delivery pressure P_2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1 (612) via pin (875).

Lever 1 rotates around the pin (875) (E) fixed to the casing (601).

Since the large hole section (F) of lever 1 contains a protruding pin (897) fixed to the feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P_1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded. The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool (652) and sleeve (651) is closed.

② Flow reset function



29092MP12

As the self pump delivery pressure P_1 or the companion pump delivery pressure P_2 decreases, the compensating rod (623) is pushed back by the action of the springs (625 & 626) to rotate lever 1 (612) around point E. Rotating of lever 1 causes the feedback lever (611) to rotate around the fulcrum of point D and then the spool (652) to move to the left. As a result, port CL opens a way to the tank port.

This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

③ **Low tilting angle (low flow) command preferential function**

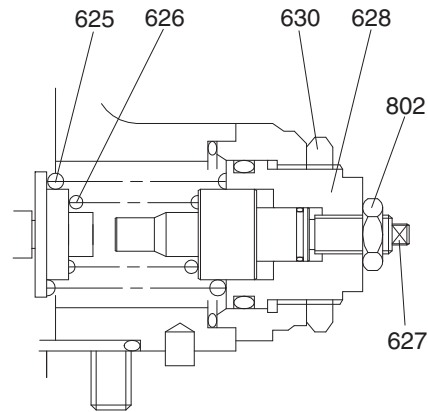
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins ($\varnothing 4$) protruding from the large hole ($\varnothing 8$), only the lever lessening the tilting angle contacts the pin (897); the hole ($\varnothing 8$) in the lever of a larger tilting angle command is freed without contacting the pin (897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

④ **Adjustment of input horsepower**

Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one pump is loaded.

a. **Adjustment of outer spring**

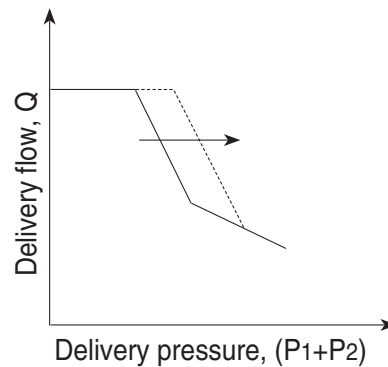
Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting screw QI (627) by $N \times A$ turns at first. ($A=1.85$)



※ **Adjusting values are shown in table.**

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw (C) (628)	Compensating control starting pressure change amount	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(kgf · m)
1800	+1/4	+17.8	+9.7

8007A2MP03



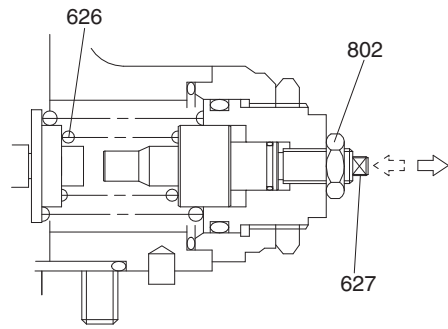
b. Adjustment of inner spring

Adjust it by loosening the hexagon nut (802) and by tightening (or loosening) the adjusting screw QI (627).

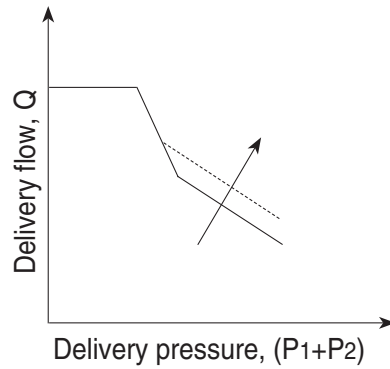
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table.

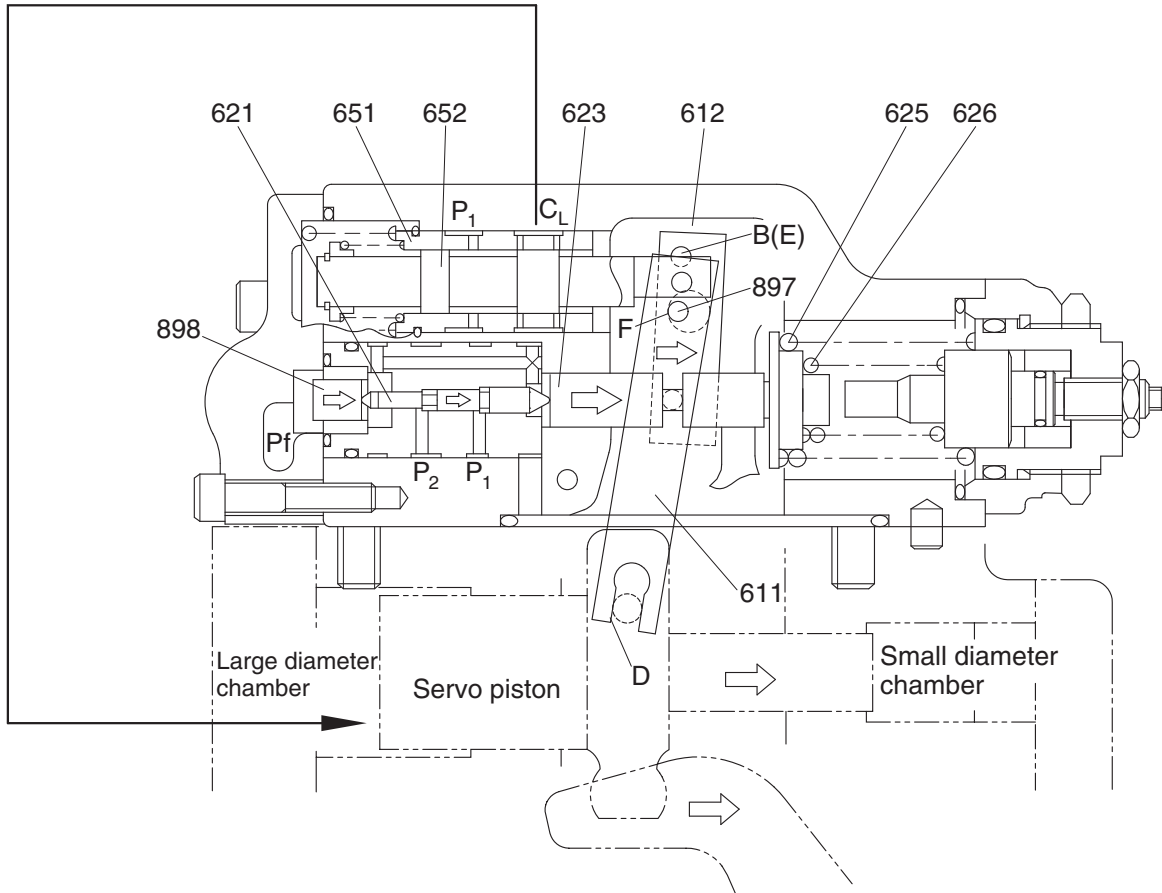
Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw (QI) (627)	Flow change amount (lpm)	Input torque change amount
(min ⁻¹)	(Turn)	(l /min)	(kgf · m)
1800	+1/4	+18.6	+10.4



8007A2MP04



(3) Power shift control



29092MP13

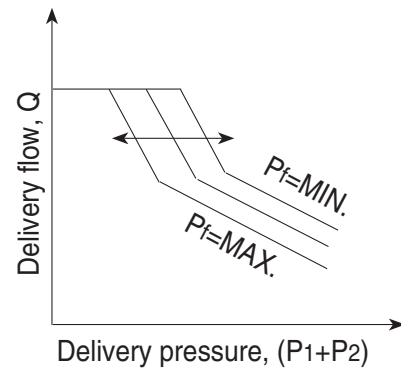
The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump. Only one proportional pressure reducing valve is provided. However, the secondary pressure P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.

This function permits arbitrary setting of the pump output power, thereby providing the optimum power level according to the operating condition.

The power shift pressure P_f controls the set horsepower of the pump to a desired level, as shown in the figure.

As the power shift pressure P_f rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621).

This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure P_f falls.



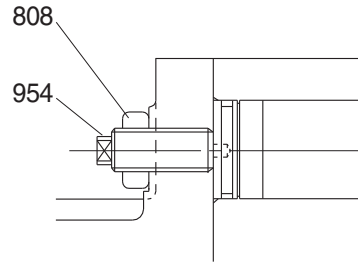
(4) Adjustment of maximum and minimum flows

① Adjustment of maximum flow

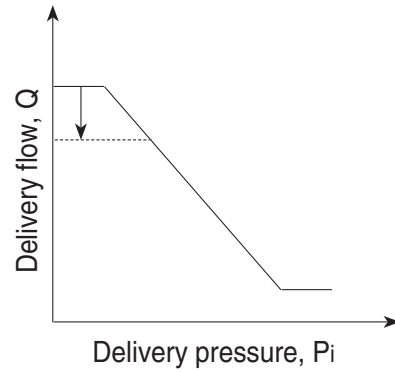
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

The maximum flow only is adjusted without changing other control characteristics.

Speed	Adjustment of max flow spring	
	Tightening amount of adjusting screw (954)	Flow change amount
(min ⁻¹)	(Turn)	(l /min)
1800	+1/4	-6.9



2-19 (1)

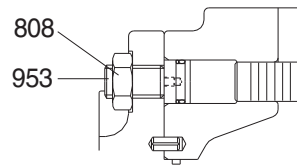


② Adjustment of minimum flow

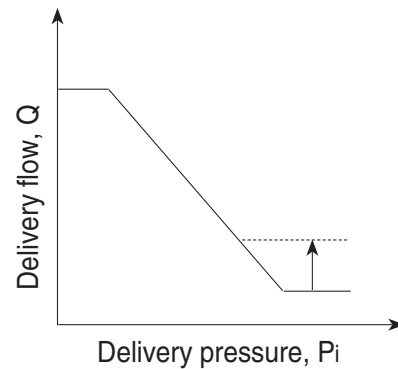
Adjust it by loosening the hexagon nut(808) and by tightening (or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.

Speed	Adjustment of min flow spring	
	Tightening amount of adjusting screw (953)	Flow change amount
(min ⁻¹)	(Turn)	(l /min)
1800	+1/4	+6.9

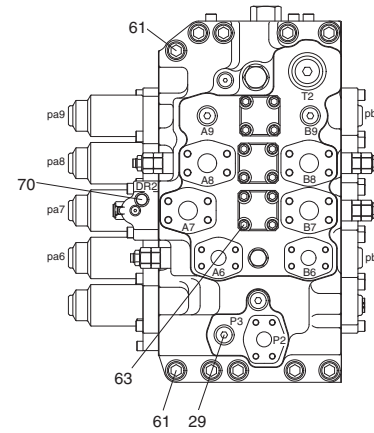
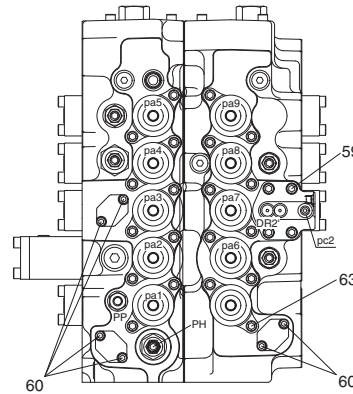
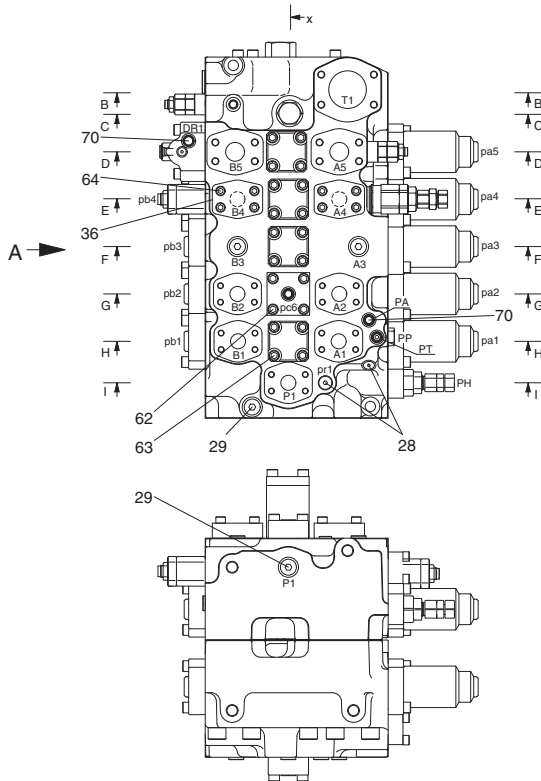
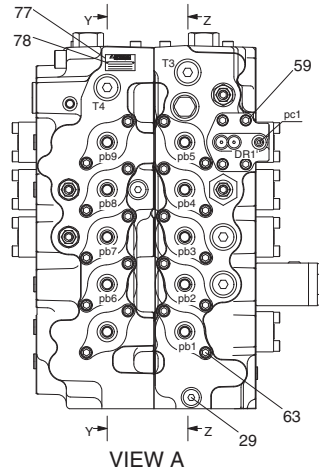
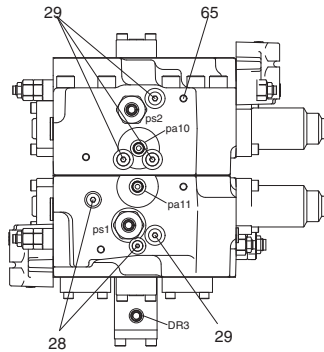


2-19 (2)



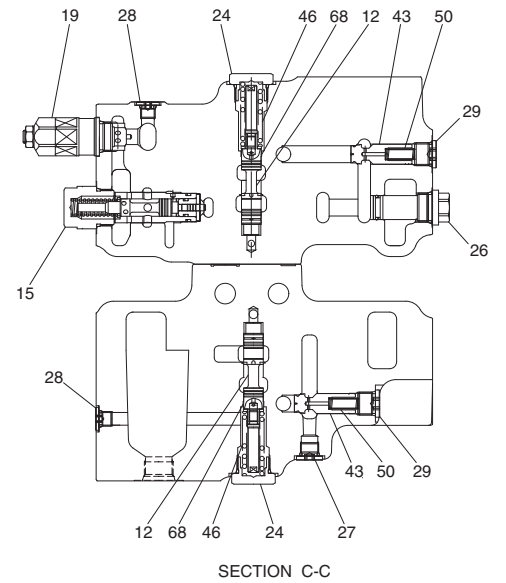
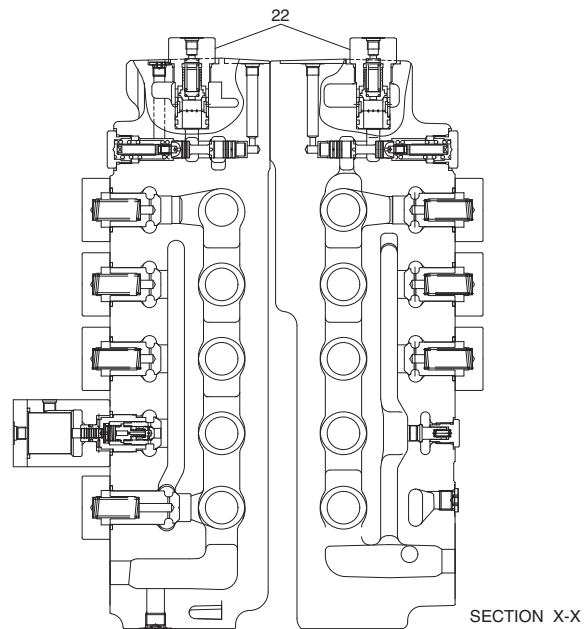
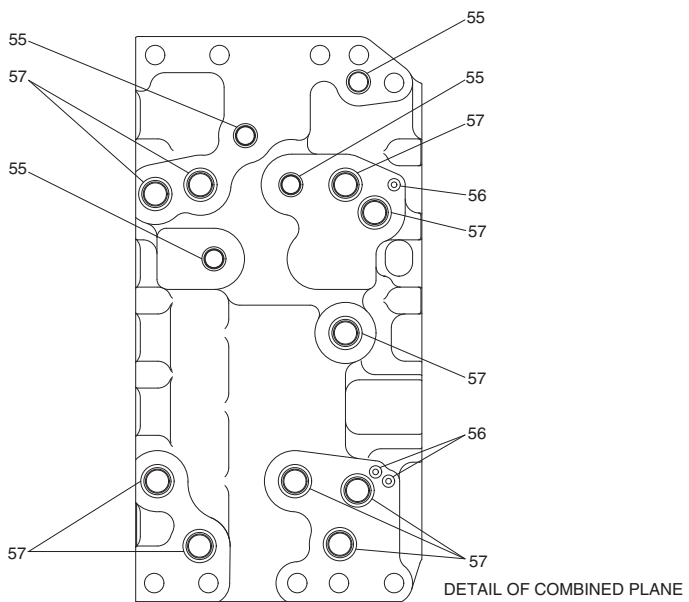
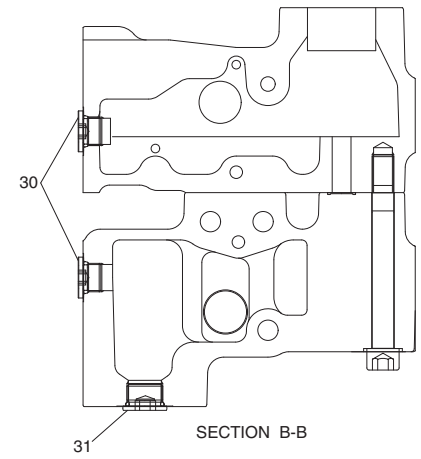
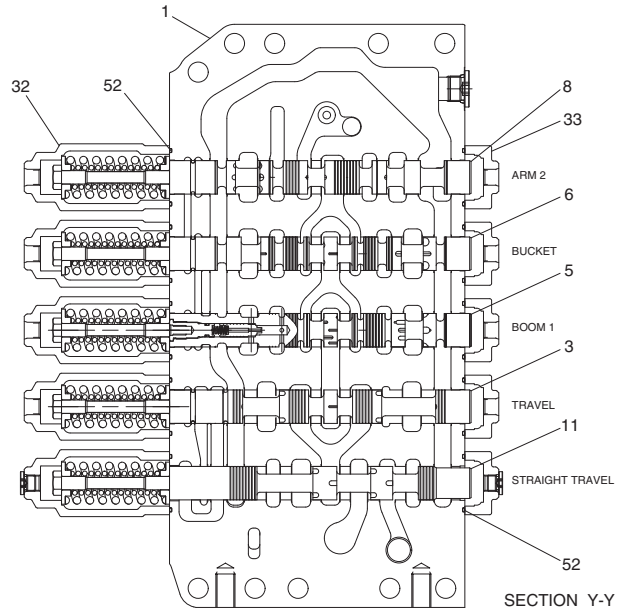
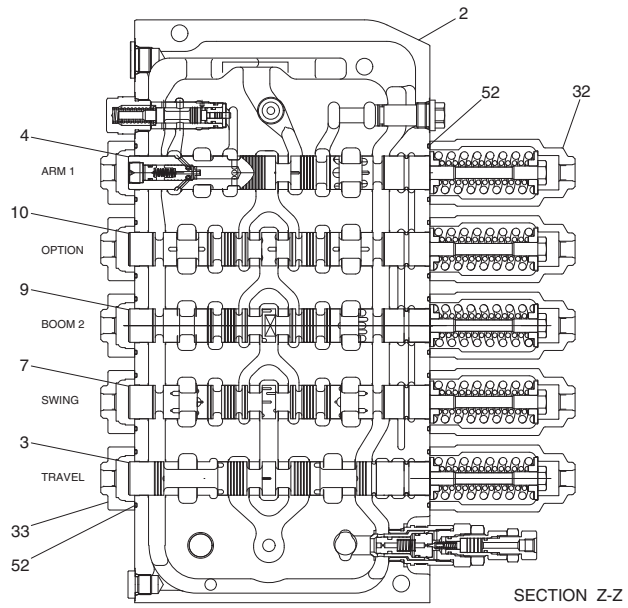
GROUP 2 MAIN CONTROL VALVE

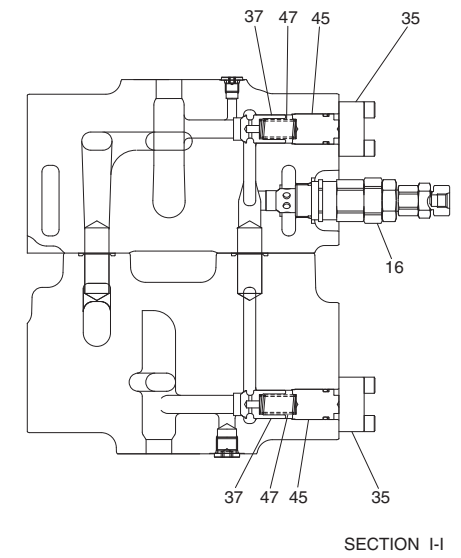
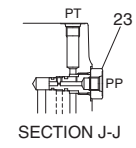
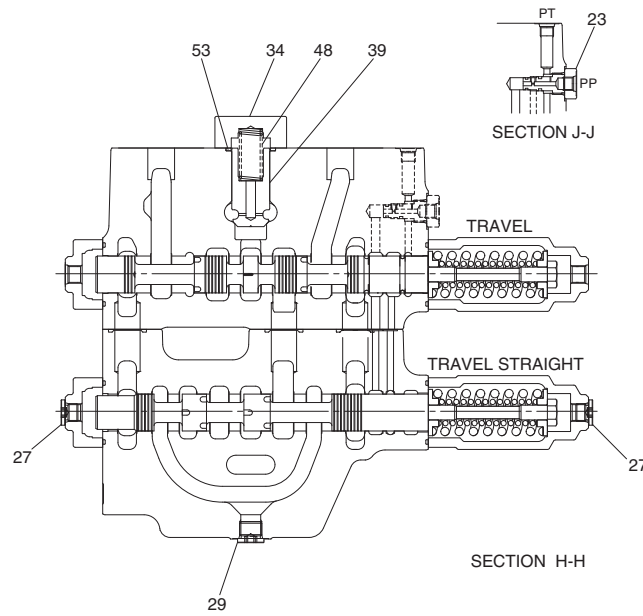
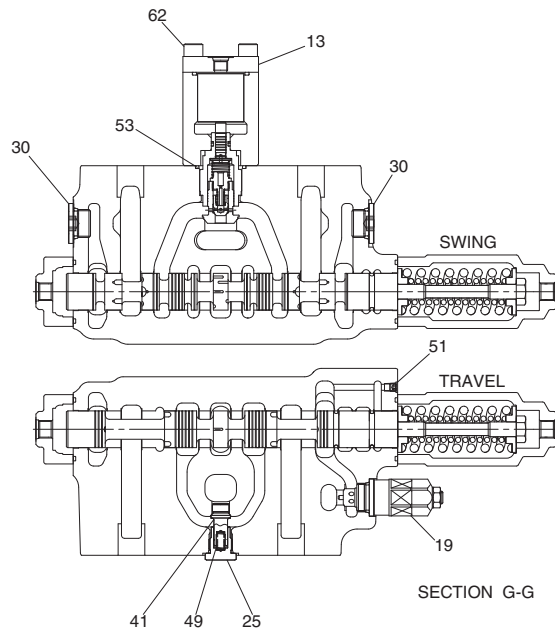
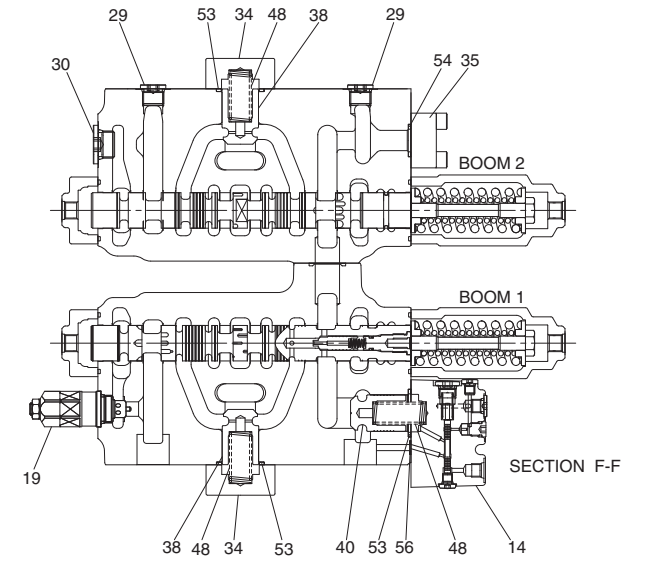
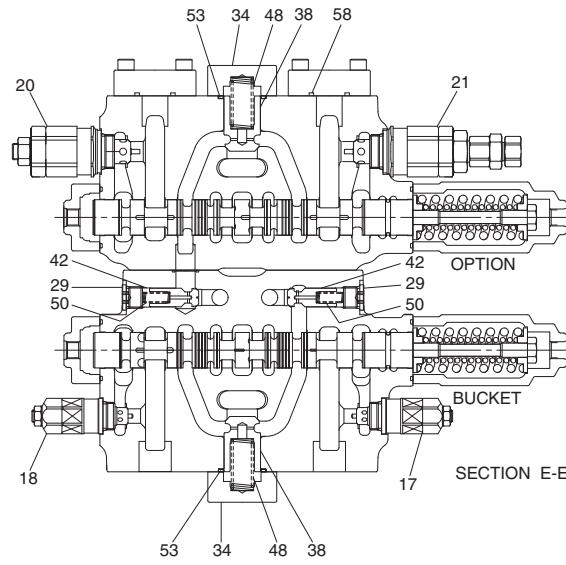
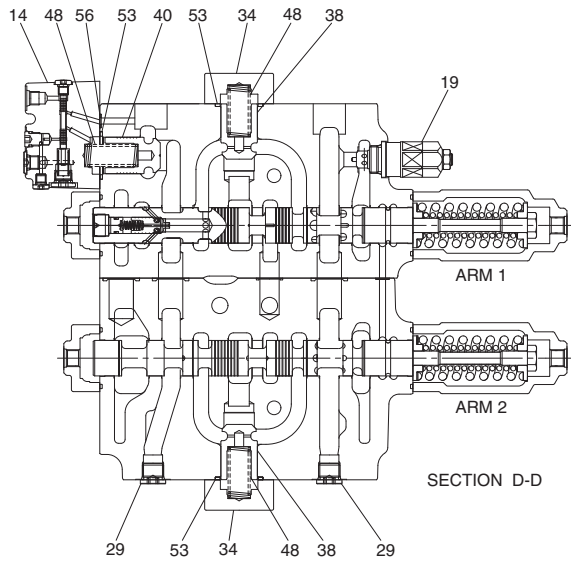
1. STRUCTURE



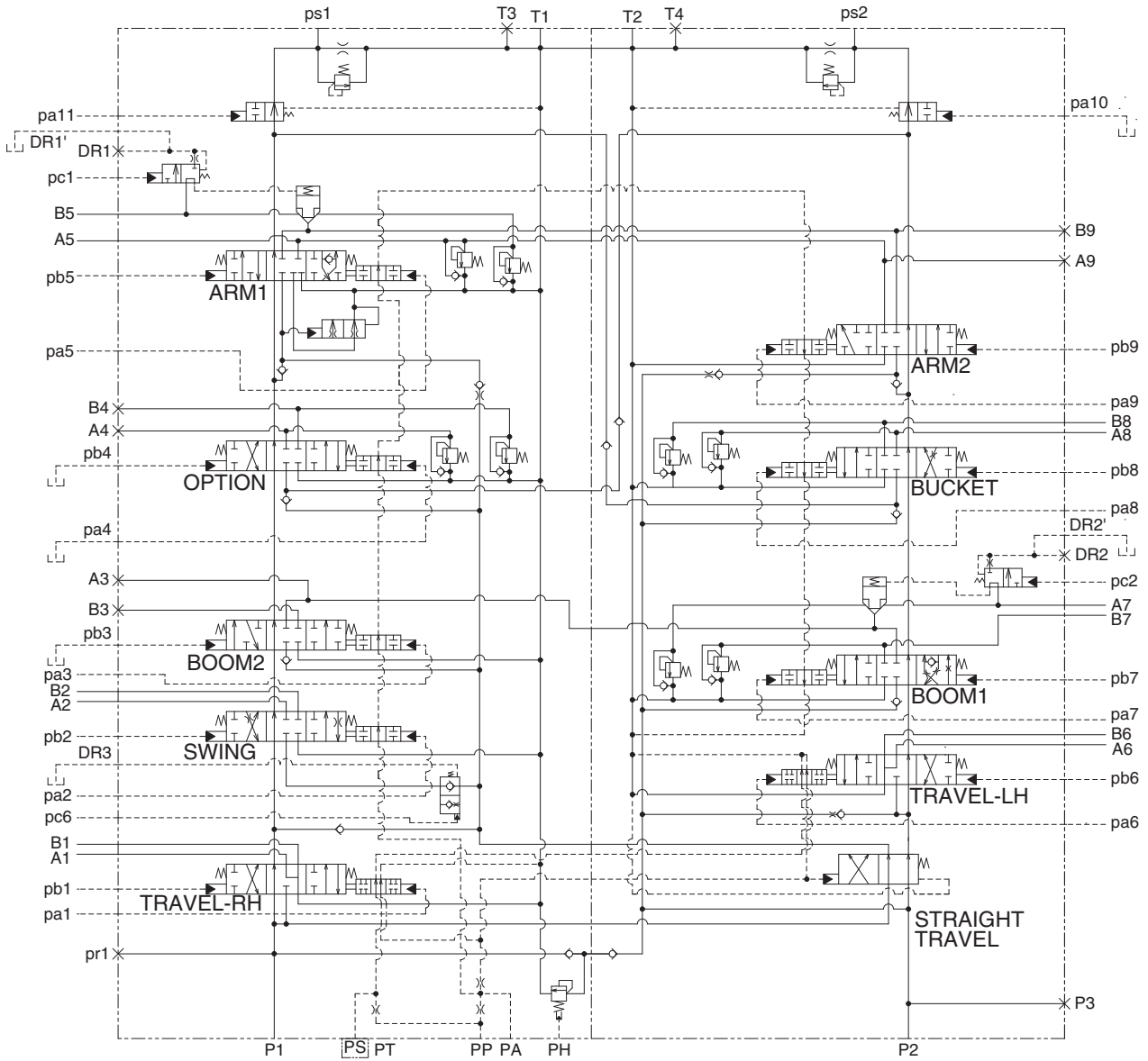
Mark	Port size	Thread depth (mm)
DR1, DR2, DR3, DR1', DR2', pr1, ps1, ps2, pc1, pc2, pc6, pa10, pa11, PA, PP, PH, PT	PF 1/4	12
pa1~pa9, pb1~pb9	PF 3/8	14
A3, A9, B3, B9, P1, P3	PF 1/2	16
T3, T4	PF 3/4	17
T2	PF 1	21

- | | | | |
|----|----------------------------|----|------------------------|
| 1 | Housing (P1) | 34 | Flange (LC) |
| 2 | Housing (P2) | 35 | Flange (MR) |
| 3 | Travel spool assy | 36 | Flange (OPT) |
| 4 | Arm 1 spool assy | 37 | Poppet |
| 5 | Boom 1 spool assy | 38 | Poppet |
| 6 | Bucket spool assy | 39 | Poppet |
| 7 | Swing spool assy | 40 | Poppet |
| 8 | Arm 2 spool assy | 41 | Poppet |
| 9 | Boom 2 spool assy | 42 | Poppet |
| 10 | Option spool assy | 43 | Poppet |
| 11 | Straight travel spool assy | 45 | MR spacer assy |
| 12 | BC spool assy | 46 | BC spring |
| 13 | Swing logic valve assy | 47 | Spring |
| 14 | Holding valve assy | 48 | Spring |
| 15 | Arm regen cut valve | 49 | Spring |
| 16 | Main relief valve assy | 50 | Spring |
| 17 | Overload relief valve assy | 51 | Plug (NPT 1/16) |
| 18 | Overload relief valve assy | 52 | O-ring (G55 18) |
| 19 | Overload relief valve assy | 53 | O-ring (G41 18) |
| 20 | Overload relief valve assy | 54 | O-ring (P26 18) |
| 21 | Overload relief valve assy | 55 | O-ring (P22 18) |
| 22 | Negacon valve assy | 56 | O-ring (P10 18) |
| 23 | Signal plug assy | 57 | O-ring (P30 18) |
| 24 | BC plug assy | 58 | O-ring (AN6227) |
| 25 | Plug assy | 59 | Socket head bolt (M12) |
| 26 | Plug assy | 60 | Socket head bolt (M10) |
| 27 | Plug assy (PF3/8) | 61 | Socket head bolt (M20) |
| 28 | Plug assy (PF1/4) | 62 | Socket head bolt (M12) |
| 29 | Plug assy (PF1/2) | 63 | Socket head bolt (M12) |
| 30 | Plug assy (PF3/4) | 64 | Socket head bolt (M10) |
| 31 | Plug assy (PF1) | 65 | Socket head bolt (M12) |
| 32 | Spool cap (L) | 68 | BC spring seat |
| 33 | Spool cap (S) | | |





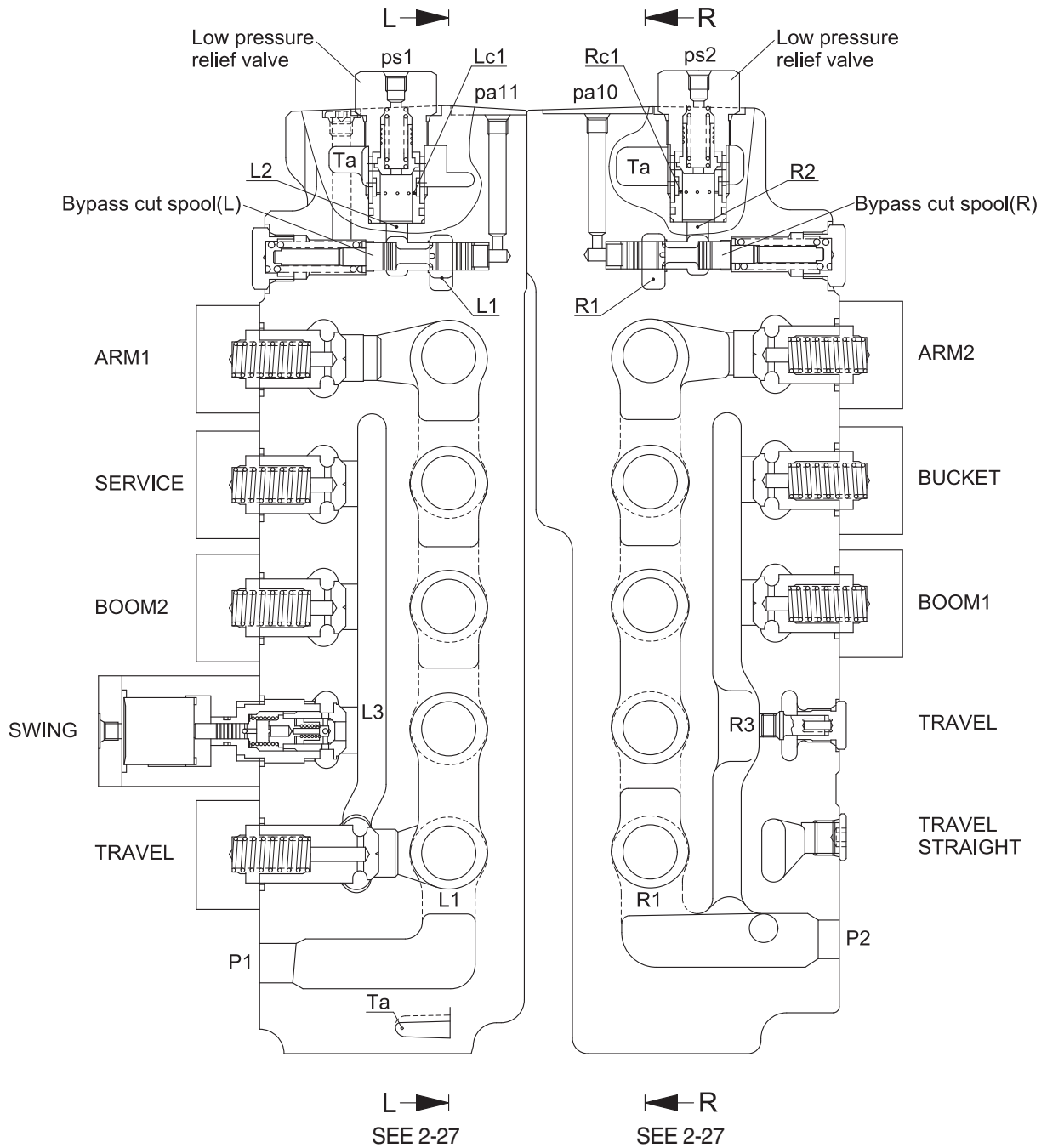
2. HYDRAULIC CIRCUIT



480F2MC05

3. OPERATION

1) ALL SPOOL NEUTRAL



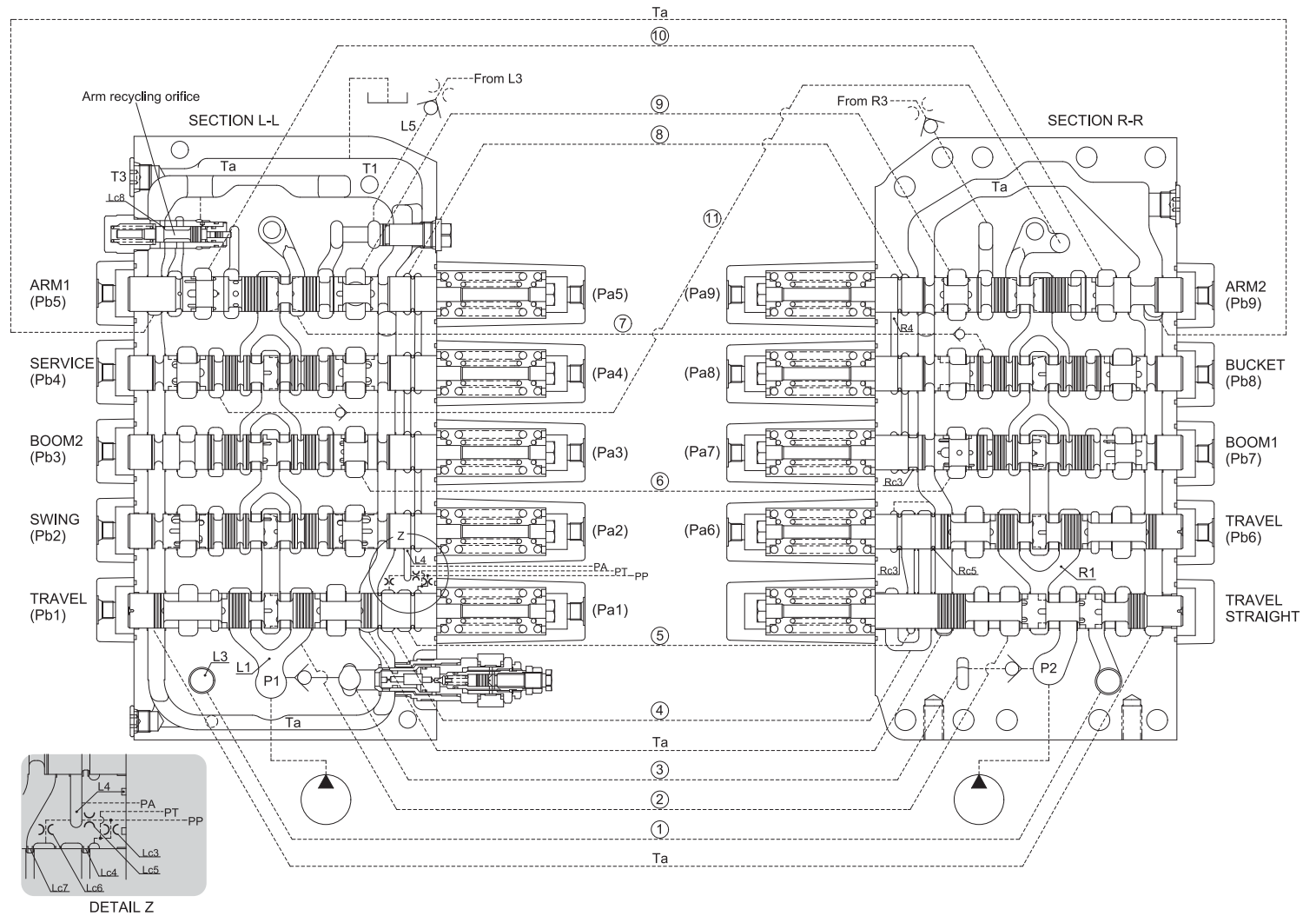
45071MC01

(1) Neutral passage

- ① Oil from pump P1 goes through neutral passage (L1) to the orifice (Lc1) of the low pressure relief valve and then oil returns to port T1 and T3 via tank passage (Ta).
- ② Oil from pump P2 goes through neutral passage (R1) to the orifice (Rc1) of the low pressure relief valve and then oil returns to port T1 and T3 via tank passage (Ta).
- ③ The pressure of upper chamber (L2), (R2) for the low pressure relief valve flow into pump through port ps1, ps2 and then controls the discharge of pump P1, P2.
- ④ When a large amount of oil flows the neutral passage, the low pressure relief valves is operated. As a result, the shock pressure of port ps1, ps2 is prevented.

(2) Signal passage

- ① Oil from port PP flows into port PT via orifice (Lc3). At the same time, after passing through passage (⑤) via land (Lc4), oil returns to the tank passage (Ta) via land (Rc3).
- ② Meanwhile, some of oil from port PP flows into port PA via orifice (Lc5) and return to the tank passage (Ta) from boom 1 spool land (Rc4) via passage (L4, ⑧, R4).
- ③ Oil via orifice (Lc6) flows into the tank passage (Ta) from land (Lc7) and return to the tank passage (Ta) via travel spool land (Rc5) through the passage ④.



2) SINGLE OPERATION

(1) Travel spool

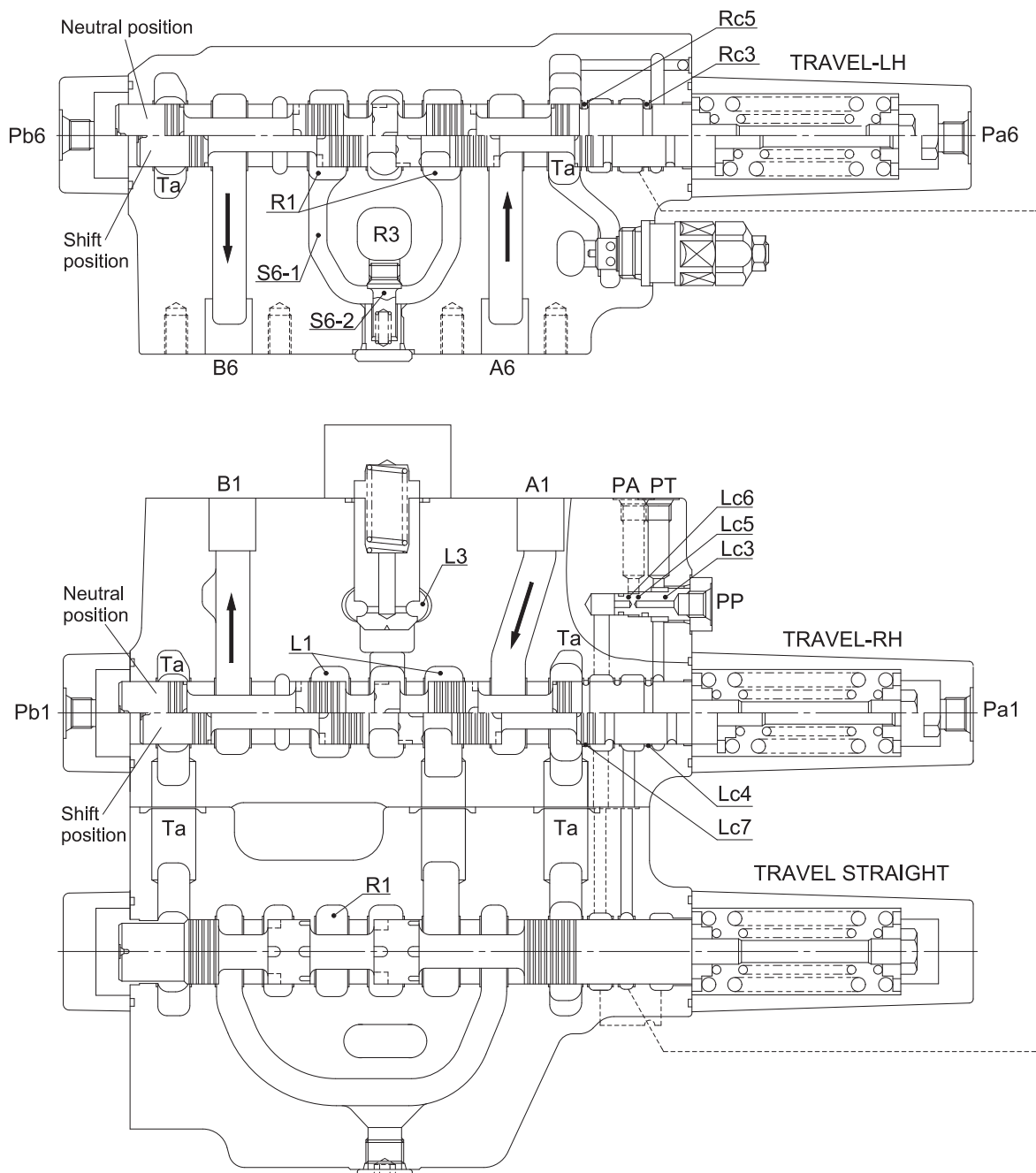
When the RH travel spool is pushed to right by the pilot pressure of port Pb1 the oil discharged from P1 port flows from the neutral passage (L1) to B1 port.

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.

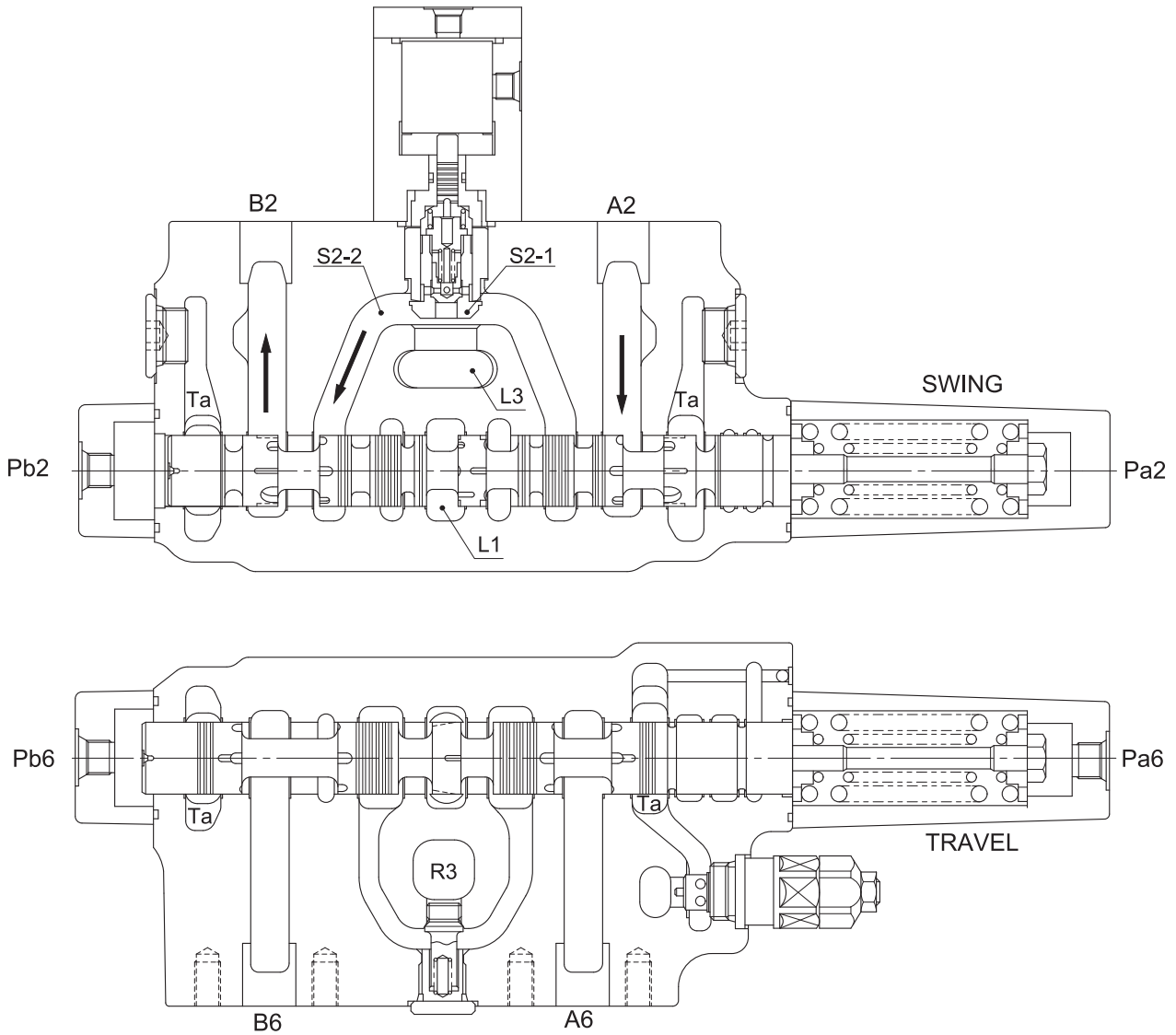


45071MC04

(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).

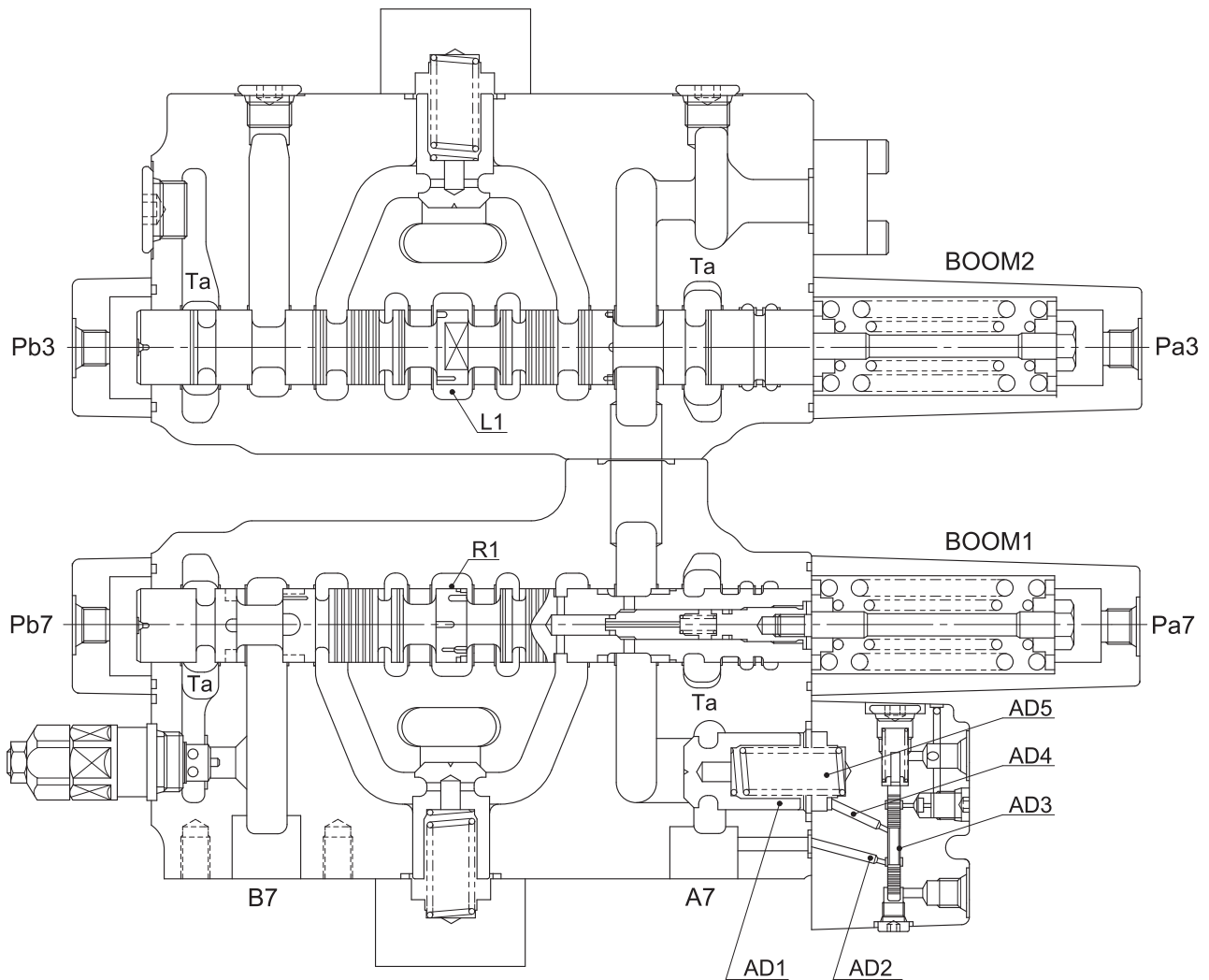


45071MC05

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).

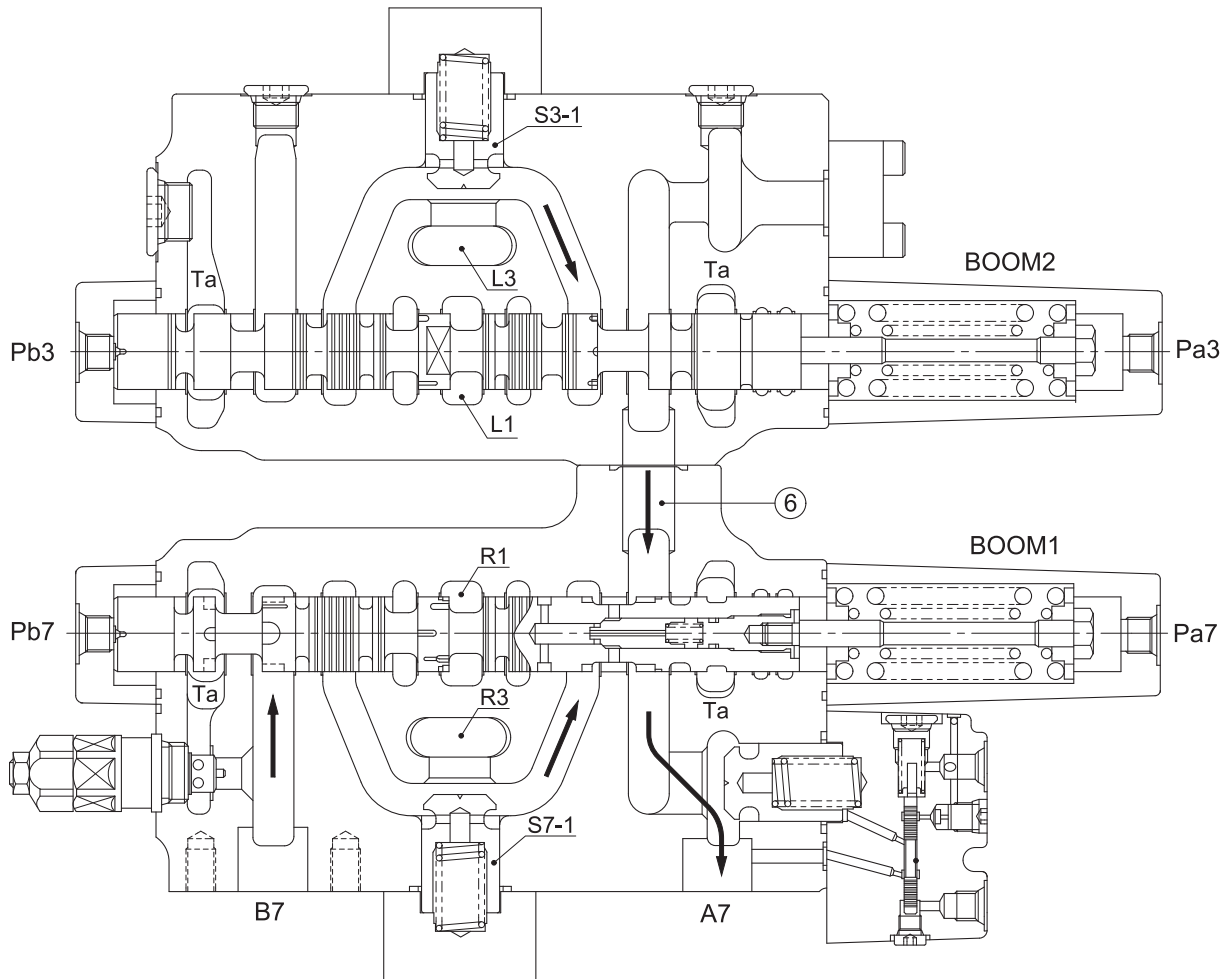


45071MC06

(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).

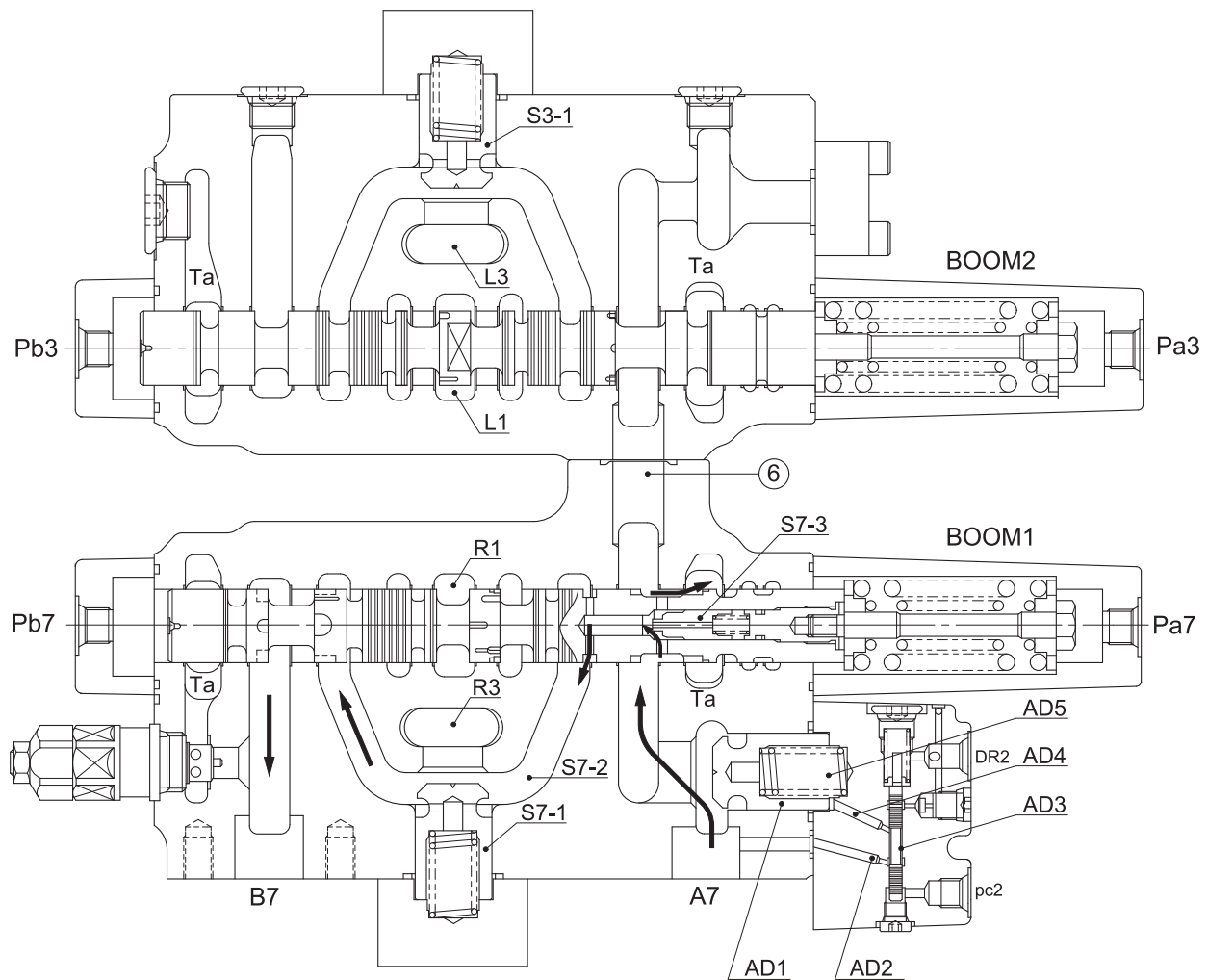


45071MC07

(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.



45071MC08

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).

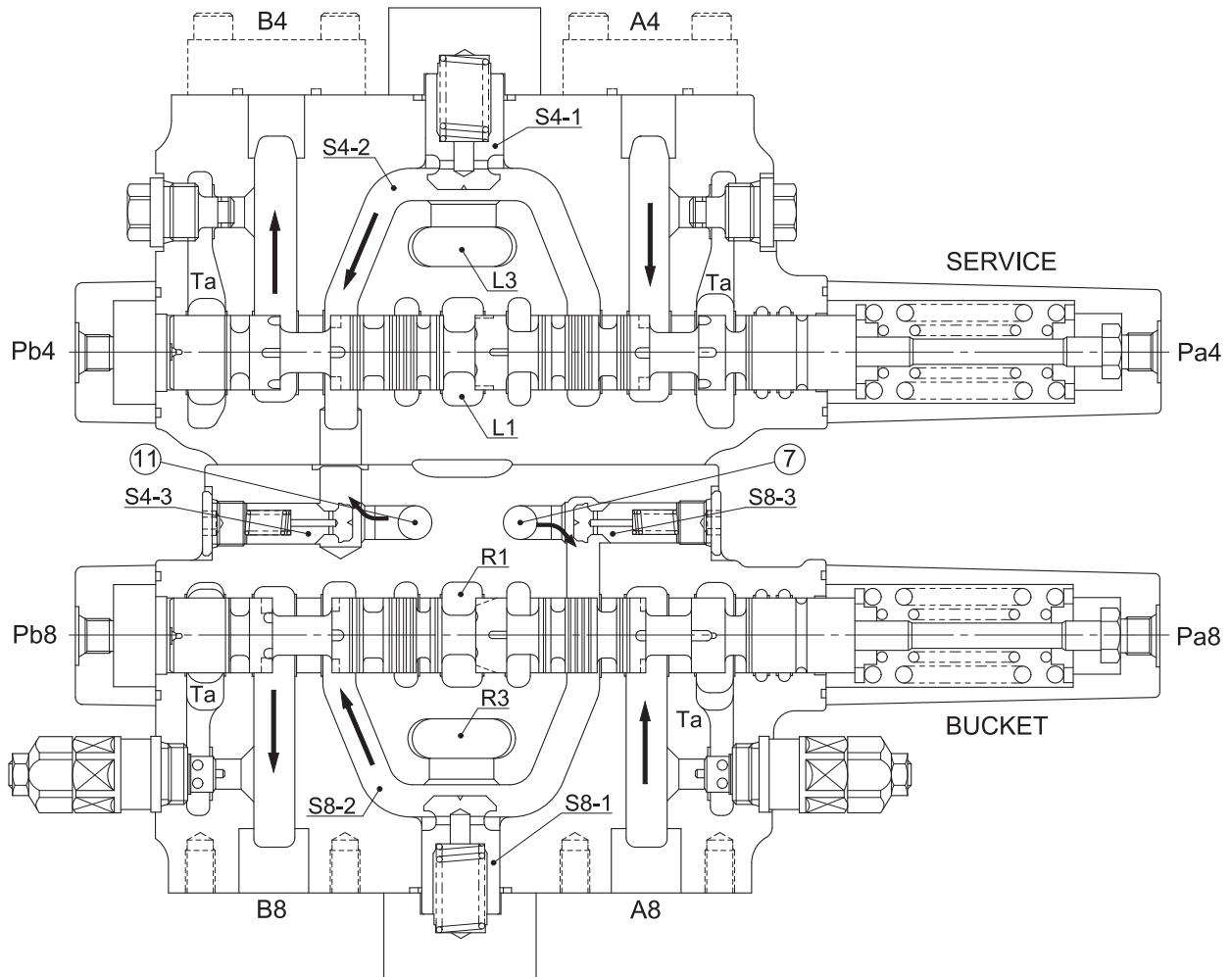
At the same time, as the port pa10 (see 2-25 page) is pressurizing and the bypass cut spool (R) is pushed, the oil discharged from pump P2 flows together into the port B7 via passage (11), poppet (S4-3). The oil returned from port A4 flows into the tank via the tank passage (Ta).

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).



45071MC09

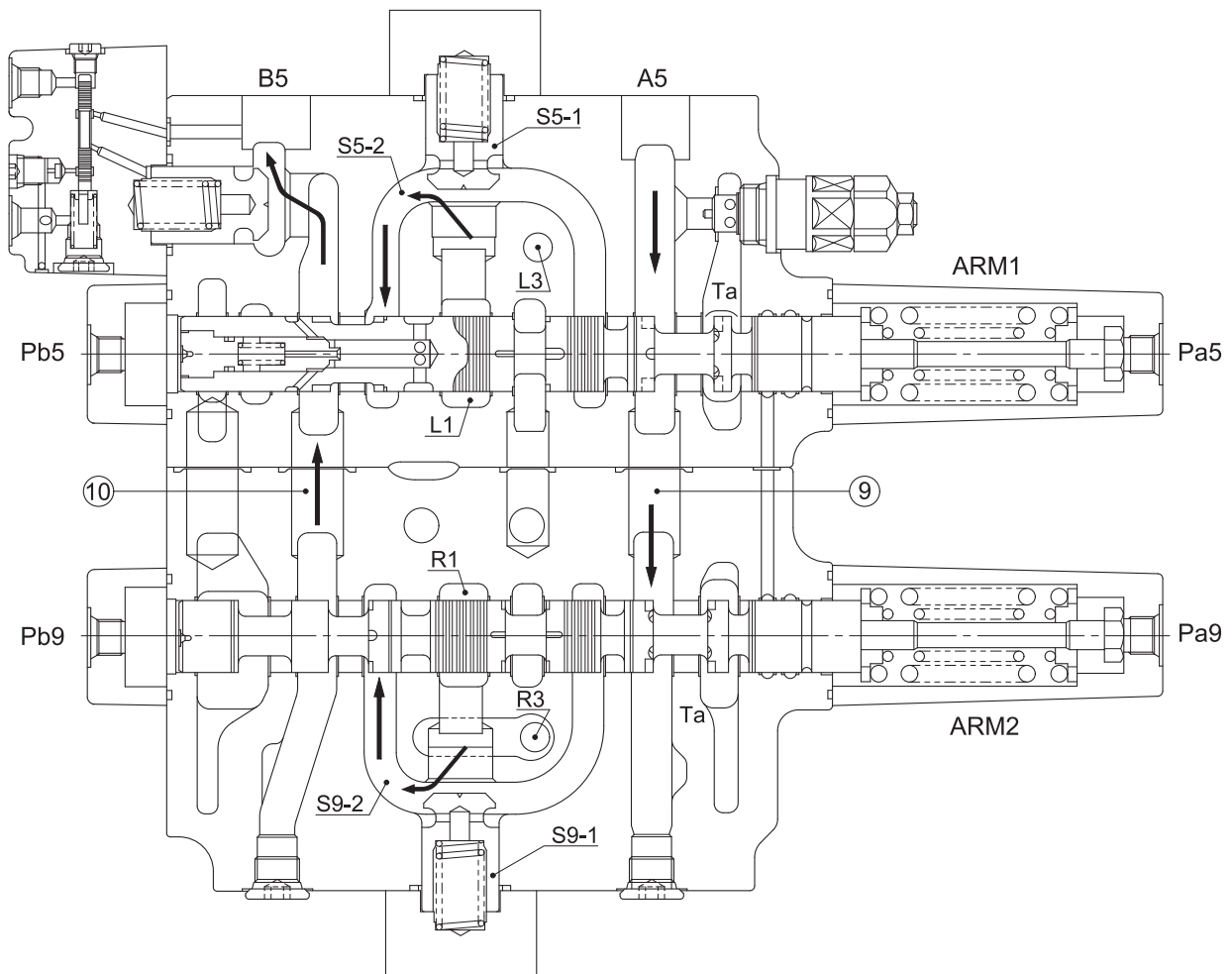
6) ARM SPOOL

(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).



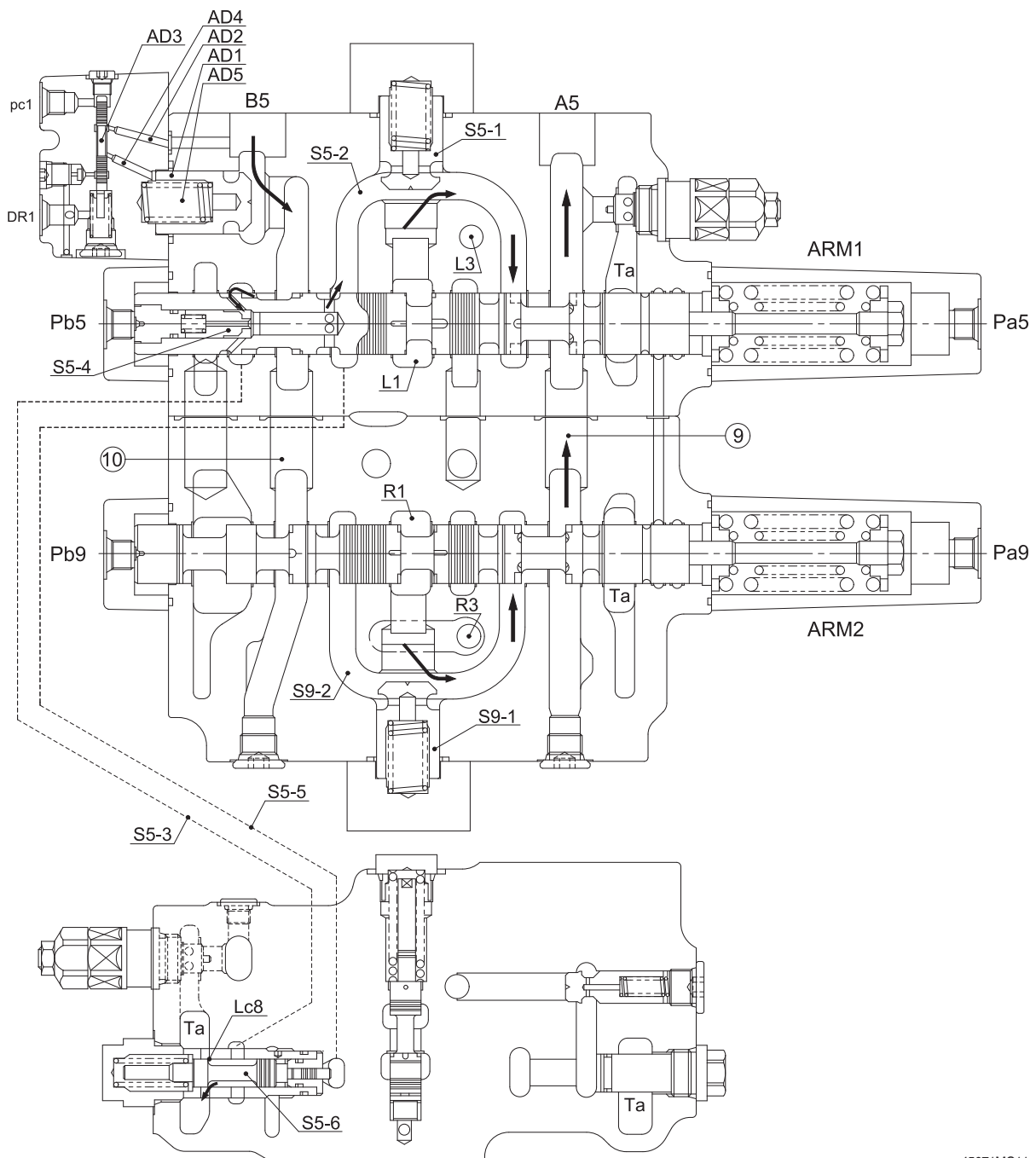
45071MC10

(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.

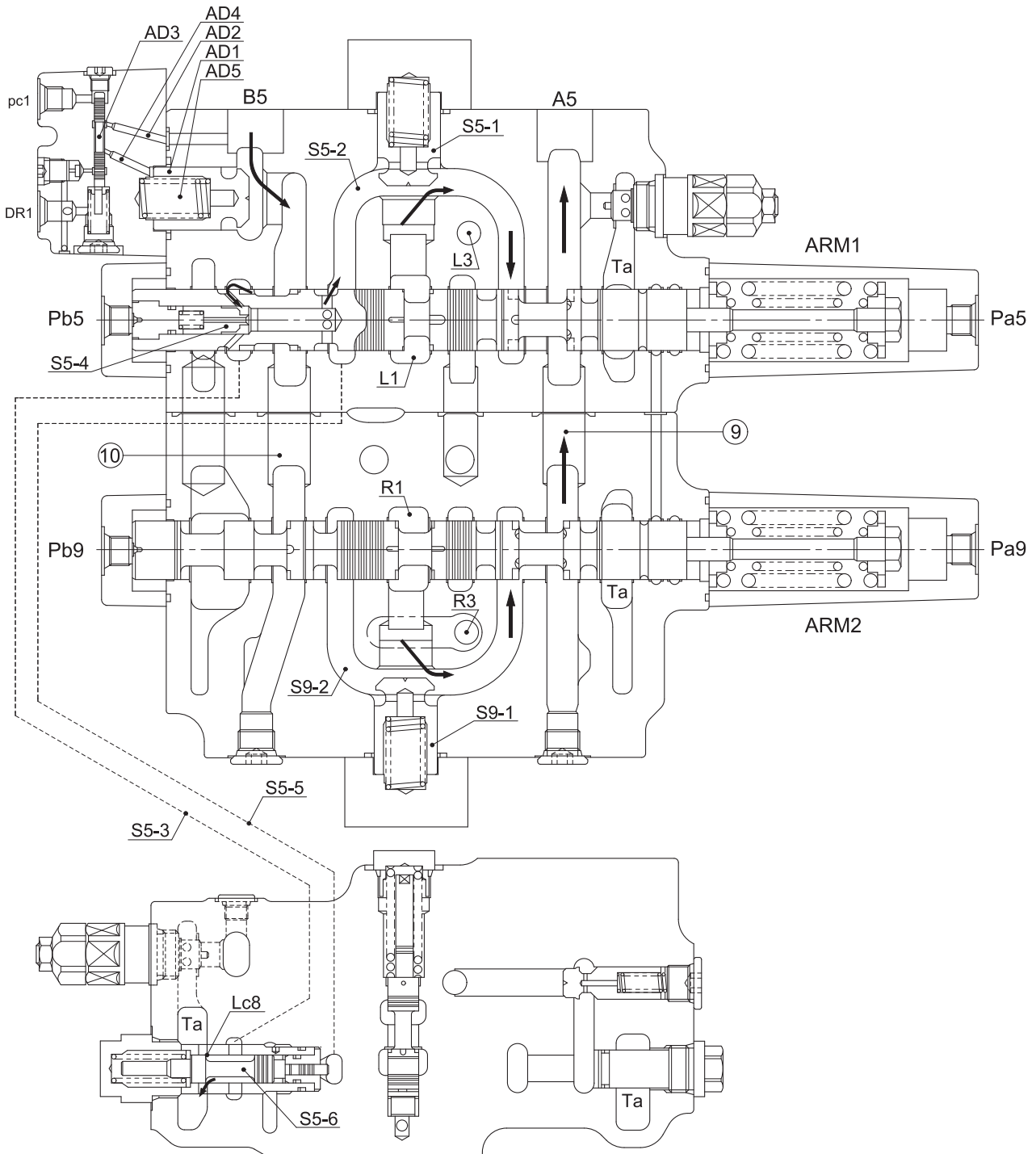


(3) Arm recycling (arm in)

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

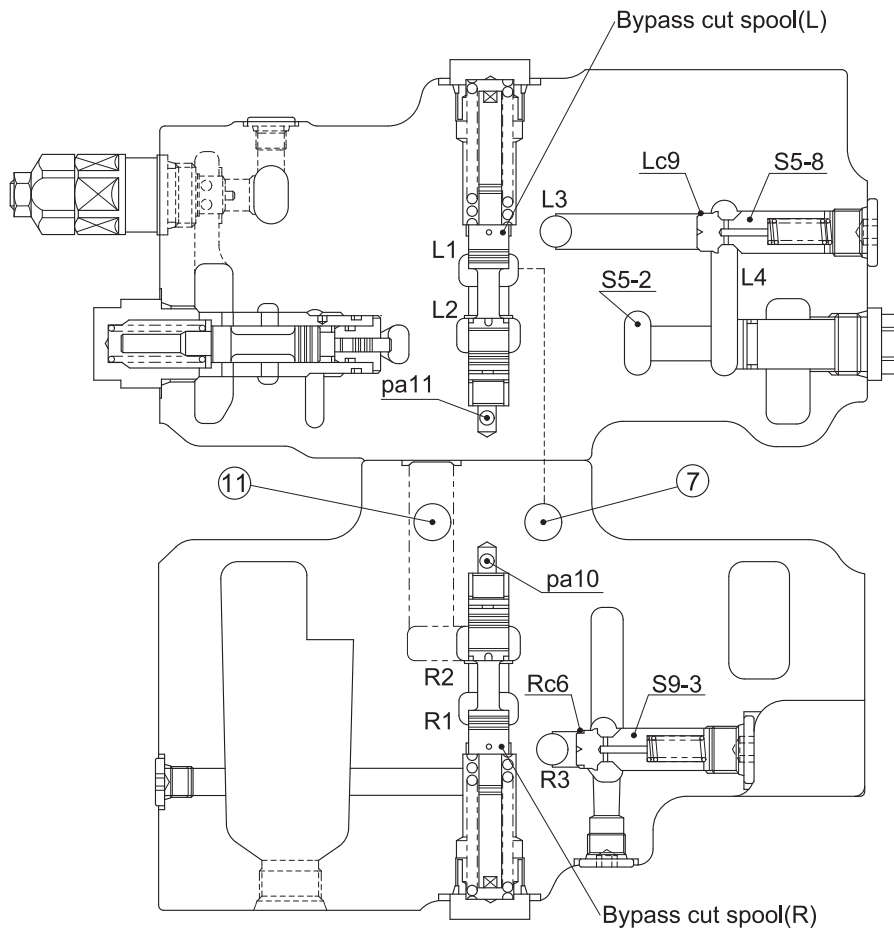
This valve is providing the bypass cut spool at the lowest stream of (upper stream of the low pressure relief valve) the neutral passage (L1, R1).

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 2-35) 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 2-35) through orifice (Lc9) in the edge of the poppet (S5-8) from the parallel passage (L3).



45071MC12

9) RELIEF VALVE

(1) Main relief valve

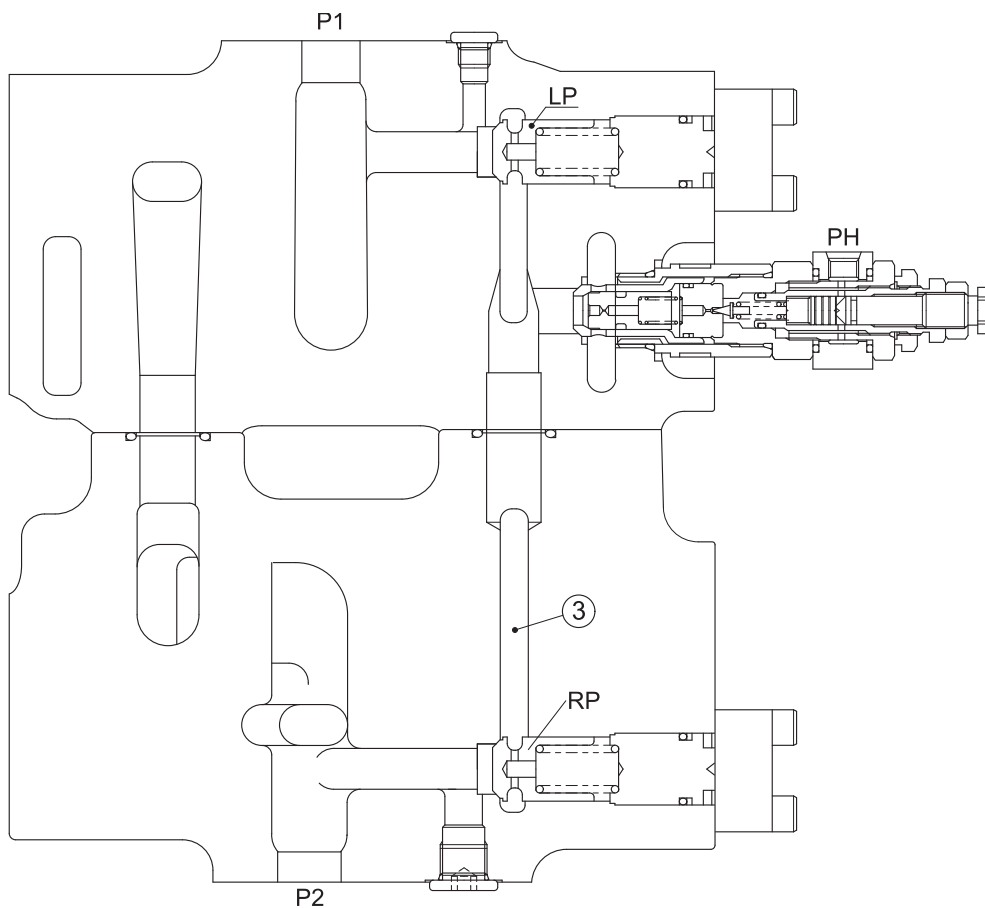
The oil discharged from P1 port via the poppet (LP) and the oil discharged from P2 port via the poppet (RP) flow into the main relief valve through the passage (3).

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.

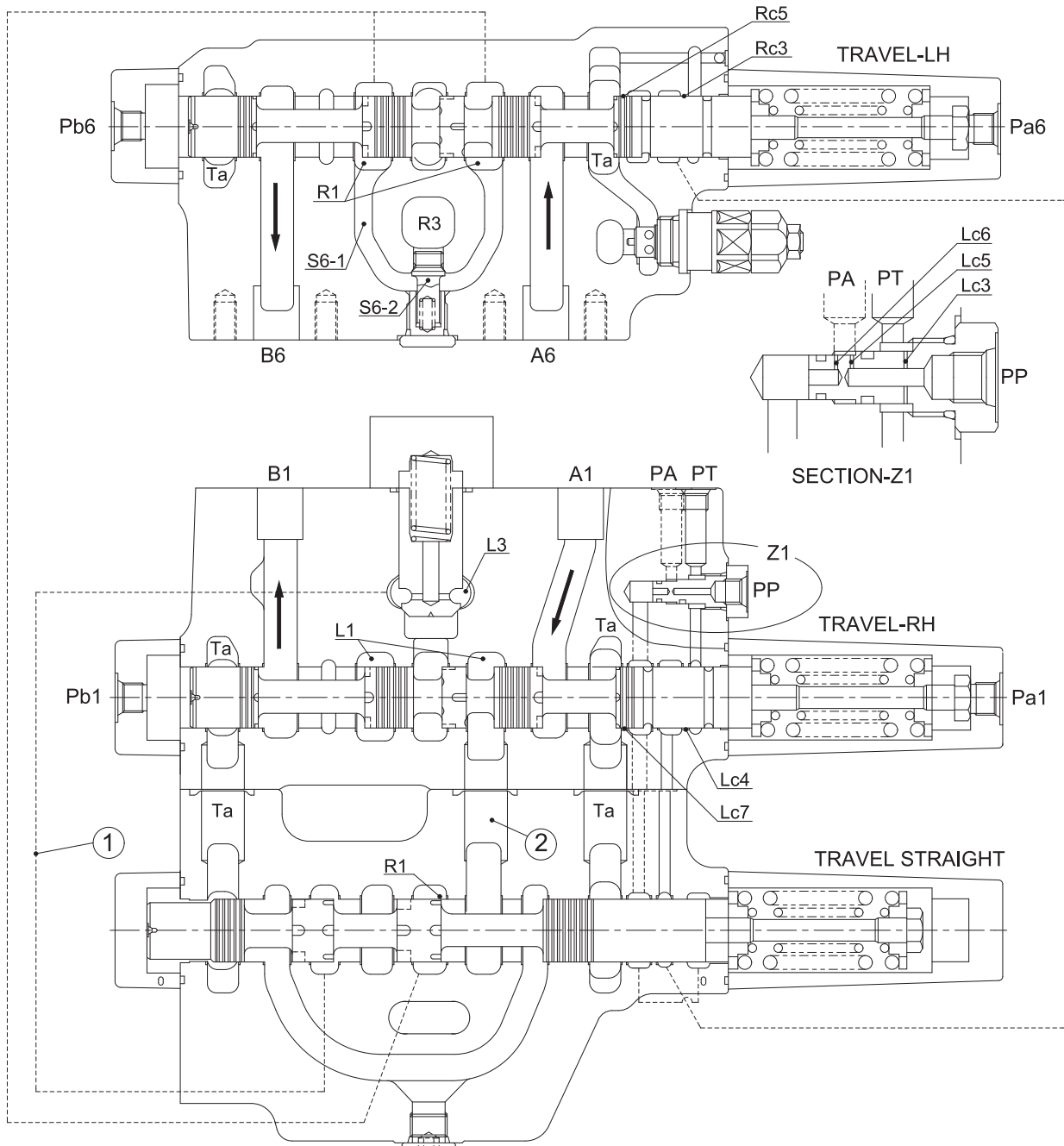


45071MC13

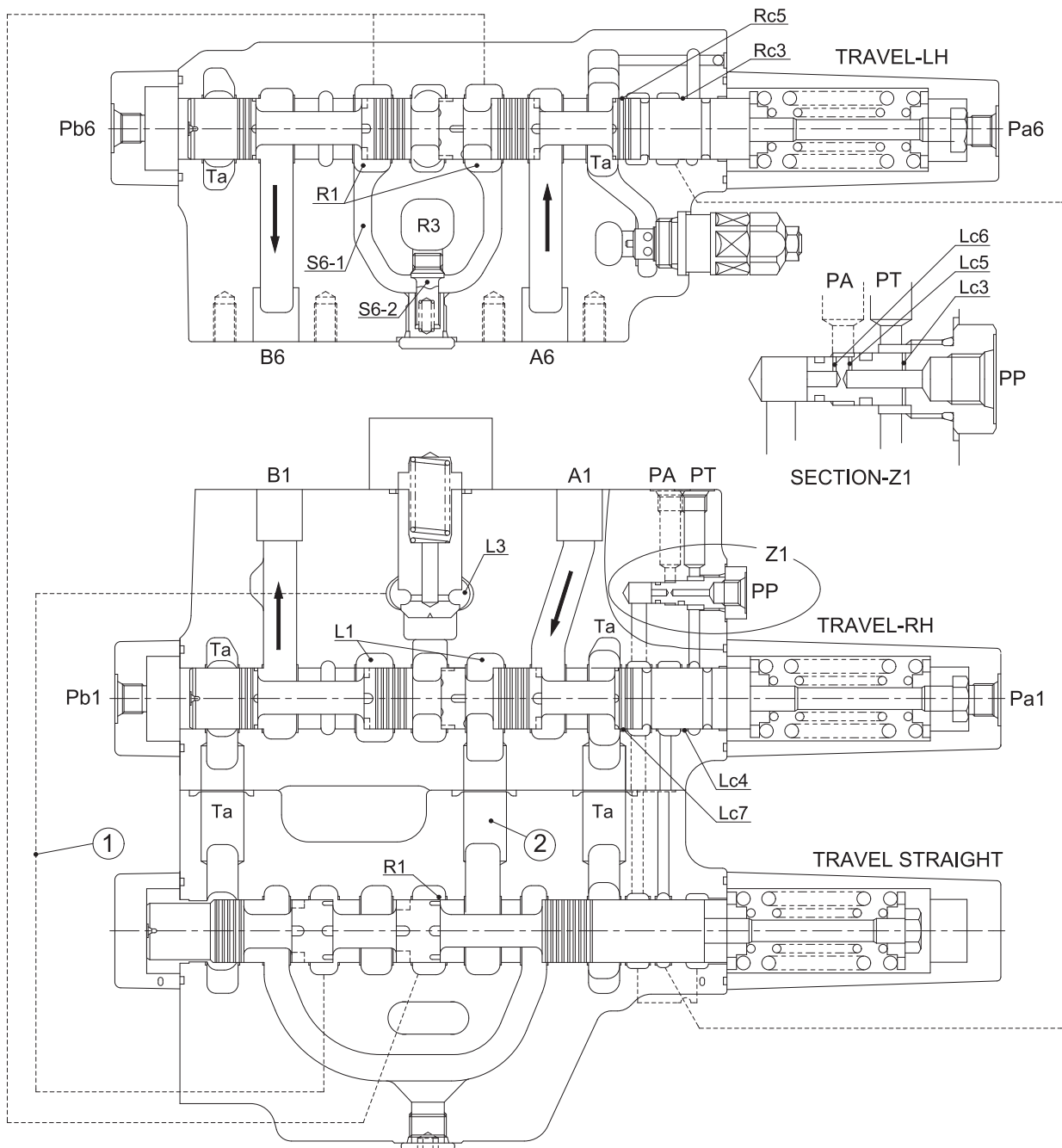
4. COMBINED OPERATION

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.



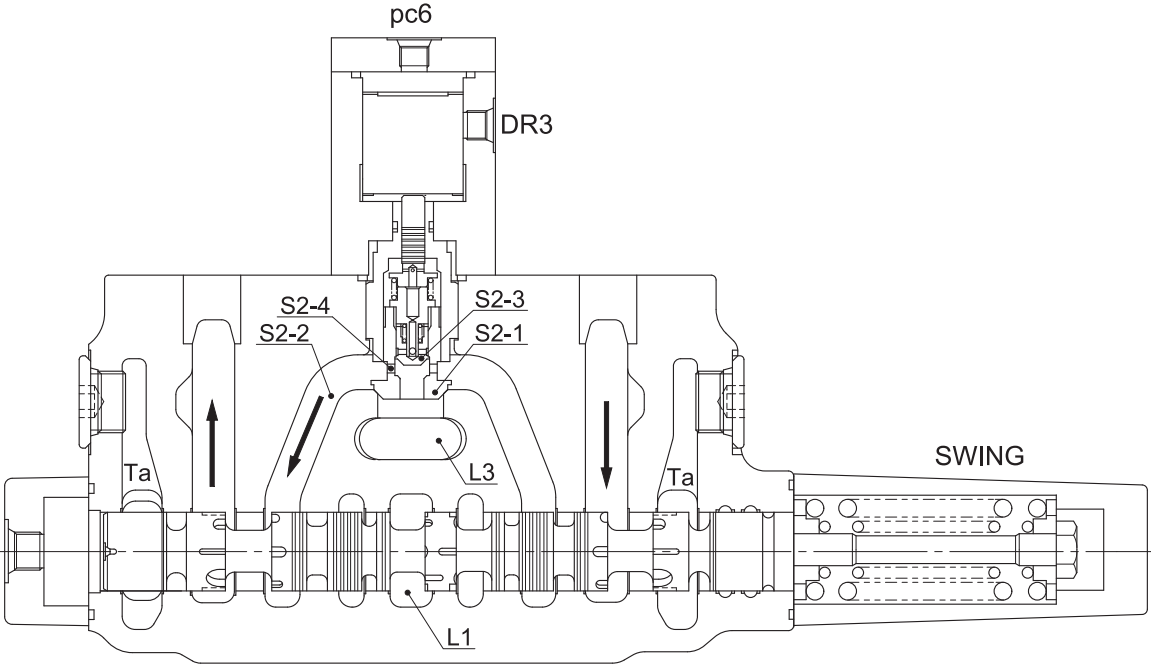
- ② When the straight travel spool is operated, the oil discharged from port P1 flows into RH travel section through the neutral passage (L1) and also flows into LH travel section via the neutral passage (R1) and passage (②). The oil discharged from port P2 flows into the parallel passage (L3) via passage (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.



45071MC15

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

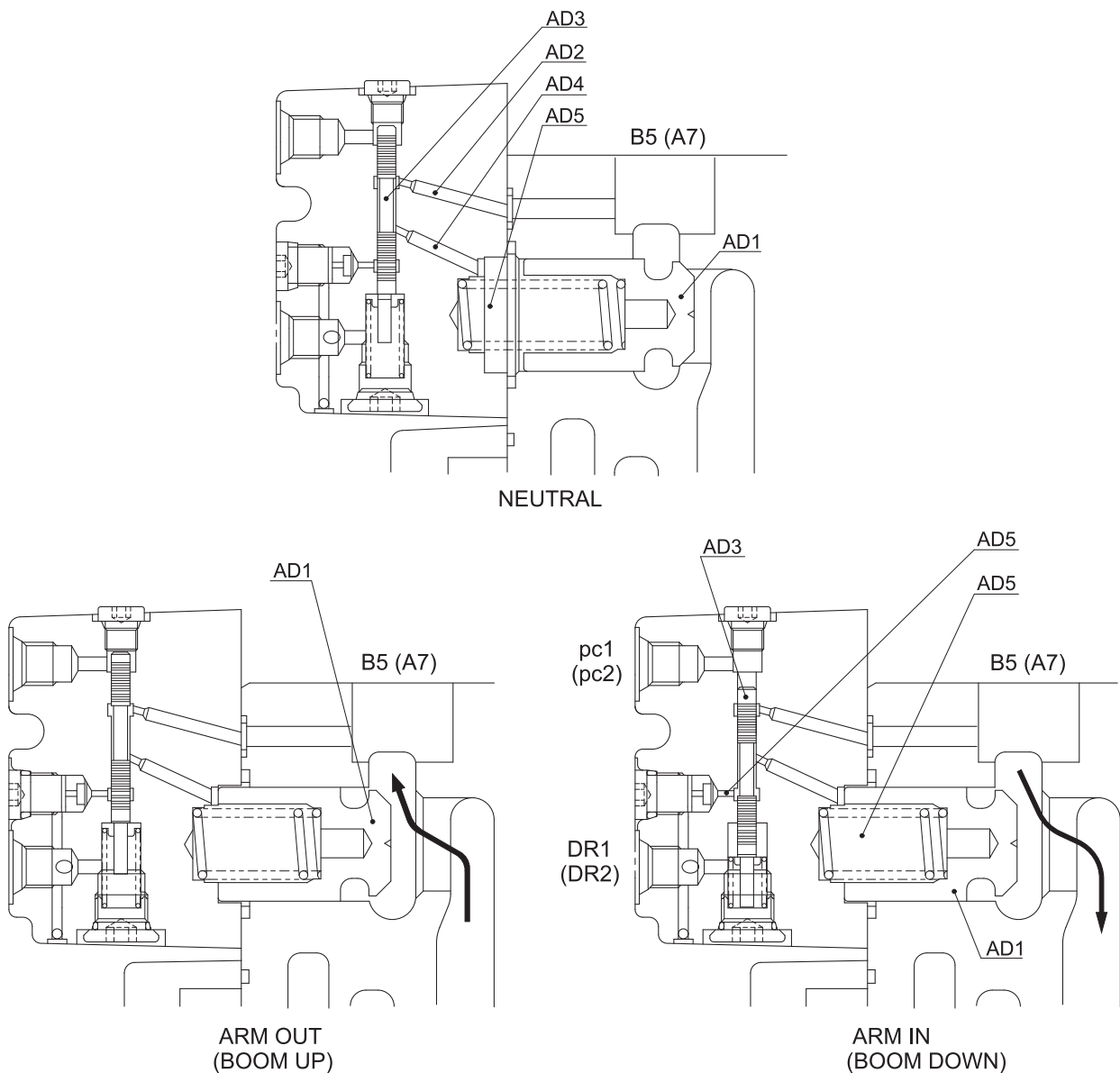
The oil from pump flows into cylinder by pushes open the poppet (AD1).

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).



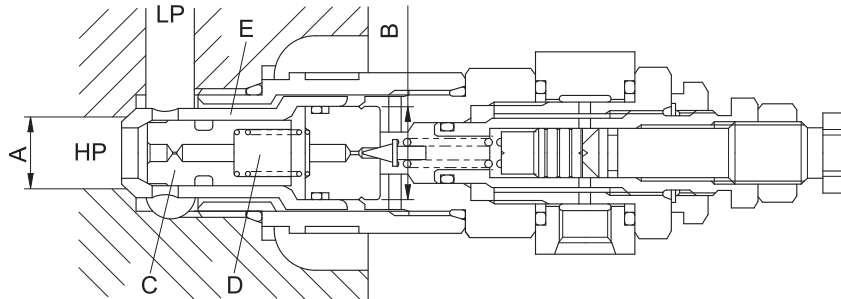
45071MC16

6. RELIEF VALVE OPERATION

1) MAIN RELIEF VALVE

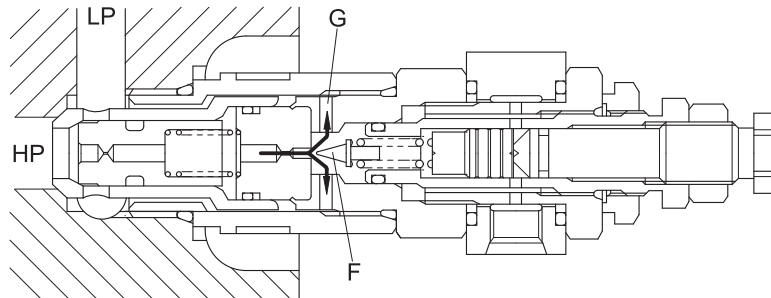
(1) This relief valve is built-in between the neutral passage (HP) and low pressure passage (LP), and the pressure oil fills up chamber (D) inside via orifice of main poppet (C).

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



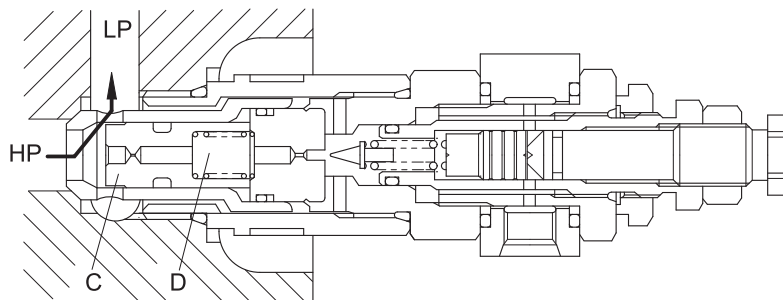
45071MC17

(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).



45071MC17-1

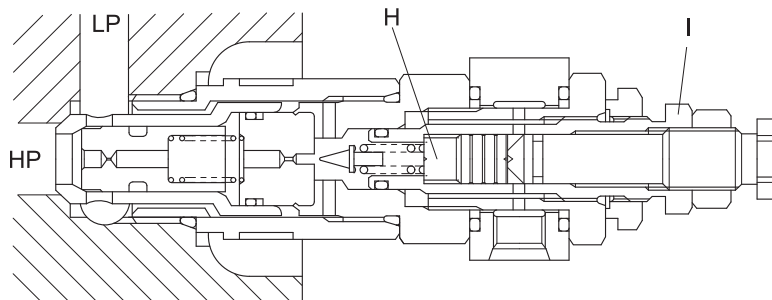
(3) When above flow is formed, the pilot poppet is opened; the pressure of chamber (D) drops, the main poppet (C) is opened and then the oil directly flows into the low pressure passage (LP).



45071MC17-2

(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.

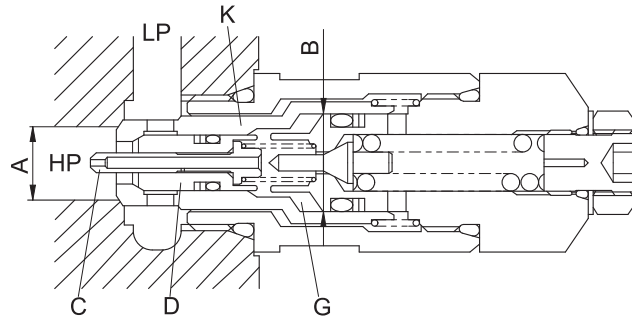


45071MC17-3

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).

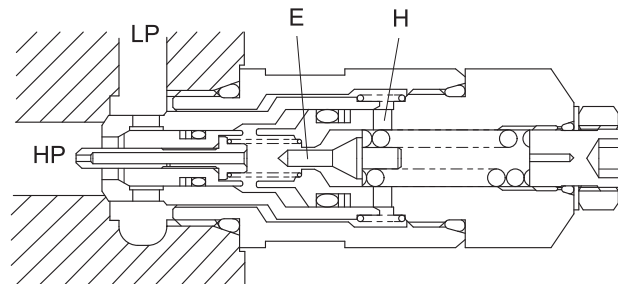
Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.



45071MC18

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

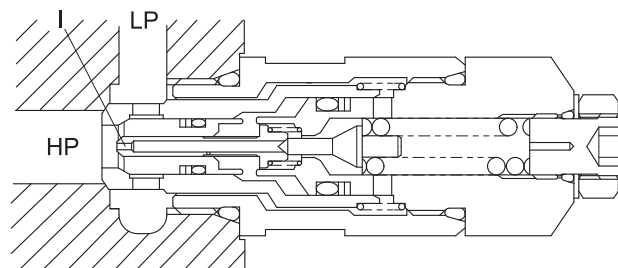
The oil flows around poppet and into the low pressure passage (LP) via hole (H).



45071MC18-1

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

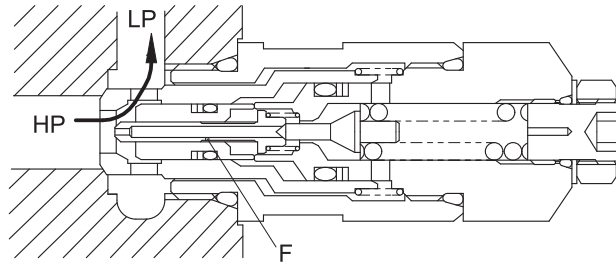
The pressure drops before and behind orifice (I); piston (C) moves to right and the piston (C) is seated at the tip of poppet (E).



45071MC18-2

(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).

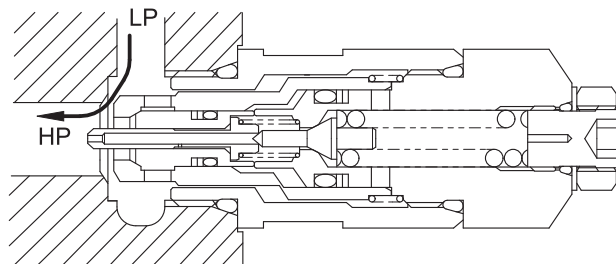


45071MC18-3

(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).

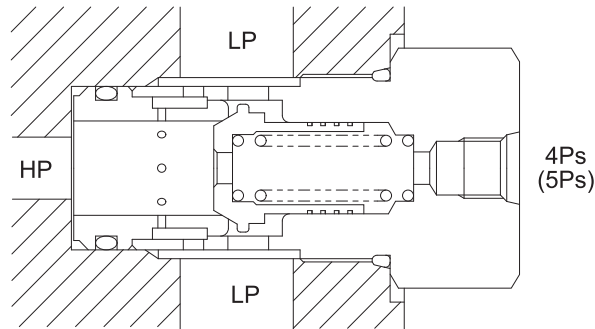
Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.



45071MC18-4

3) LOW PRESSURE RELIEF VALVE

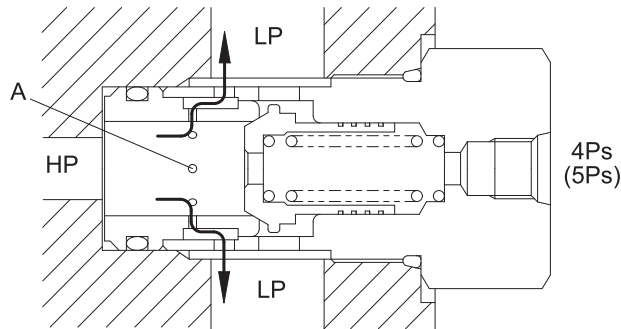
(1) When pump does not operational



45071MC19

(2) When spool neutral

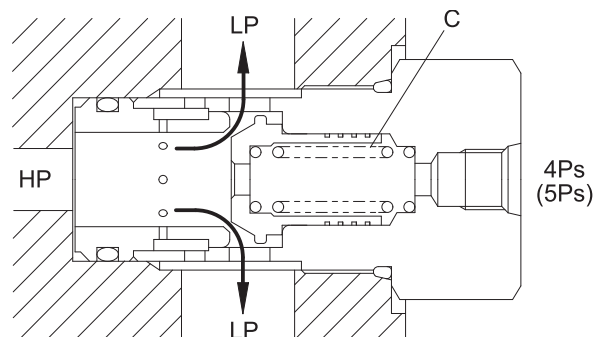
The neutral passage (HP) oil flows into the low pressure passage (LP) via signal orifice (S). The signal port 4Ps (5Ps) pressure is raised by negative control orifice (A).



45071MC19-1

(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.



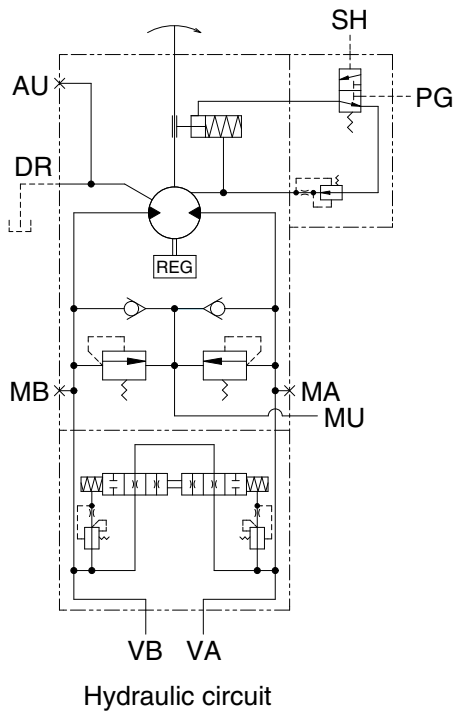
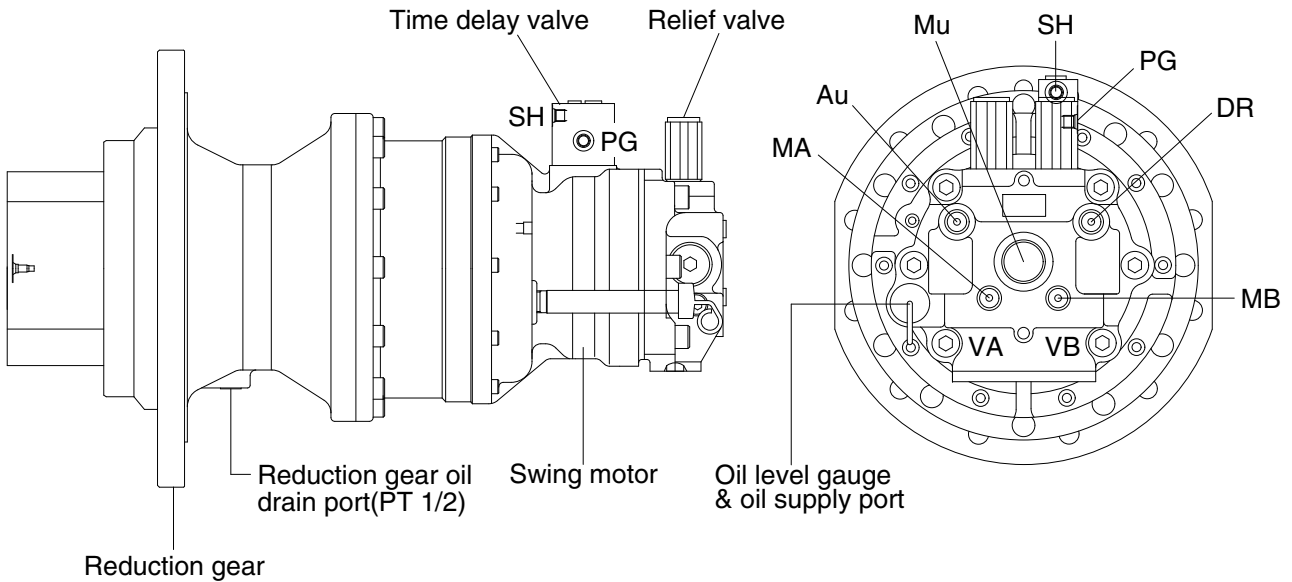
45071MC19-2

GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

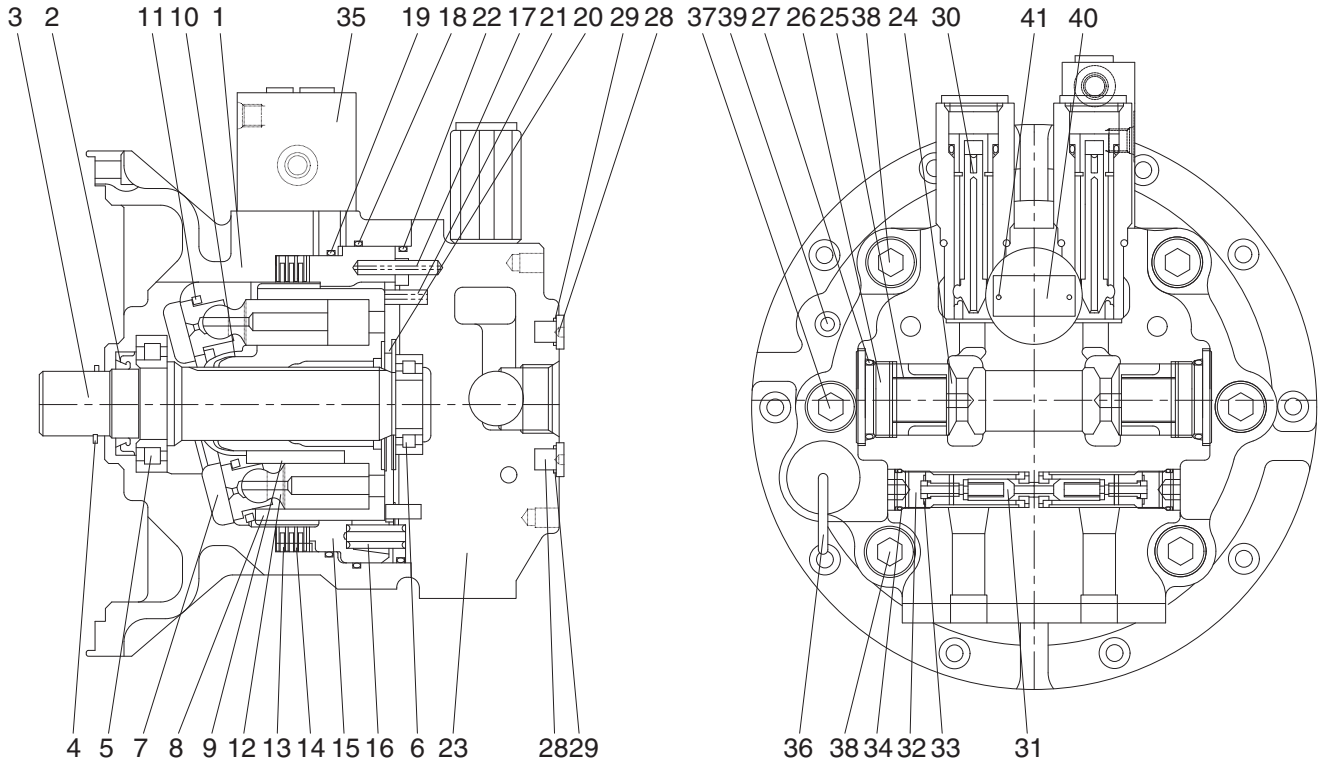
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



480F2SM01

Port	Port name	Port size
VA, VB	Main port	ø 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

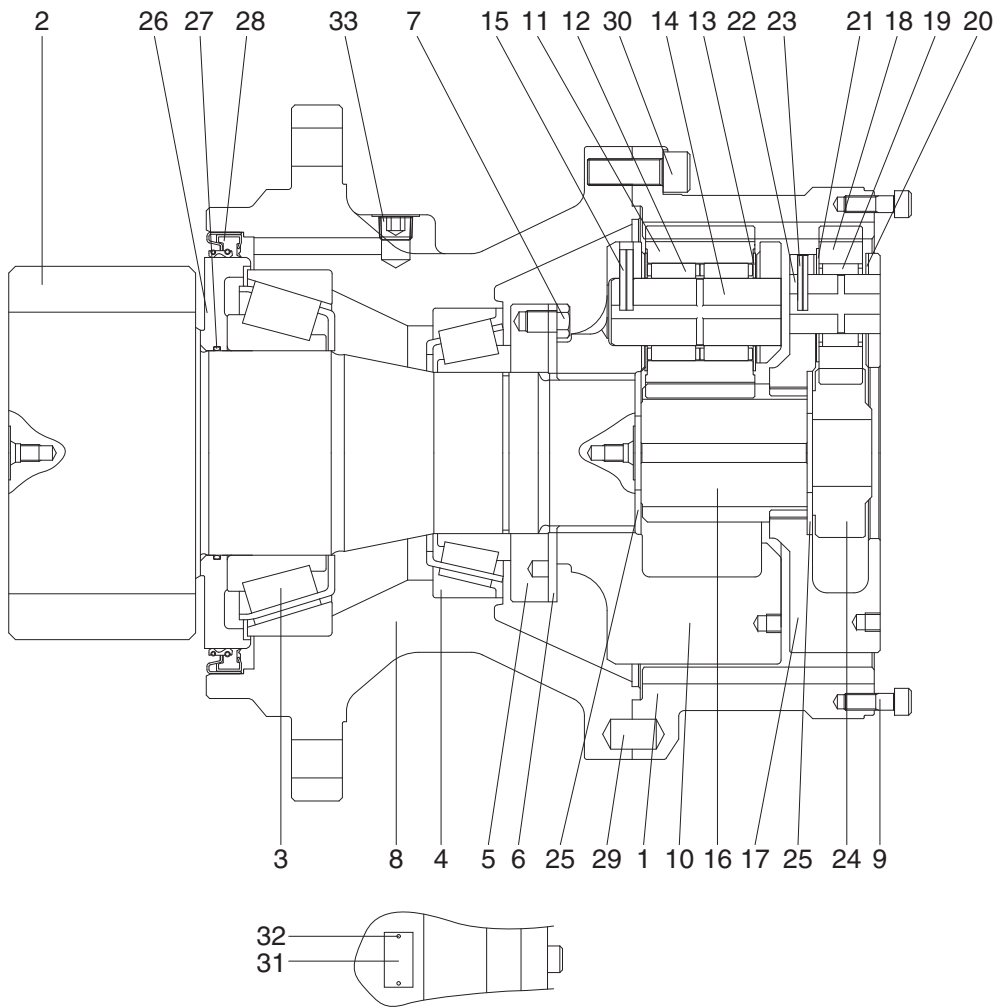
1) SWING MOTOR



480F2SM02

- | | | | | | |
|----|-------------------------|----|----------------|----|--------------------------|
| 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



480F2SM03

- | | | | | | |
|----|--------------------------|----|---------------------------|----|--------------------------|
| 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).

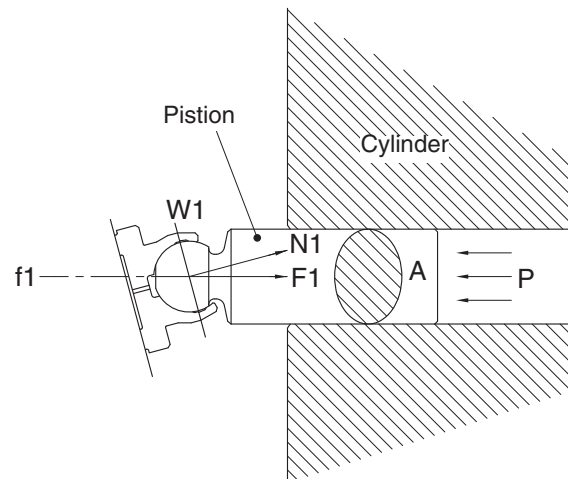
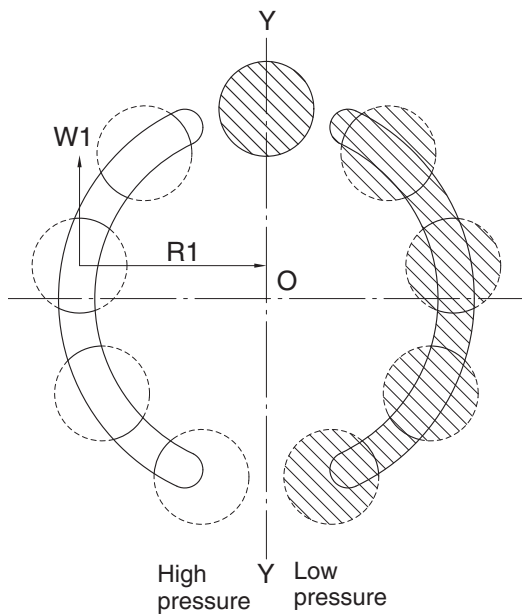
The high hydraulic can generate the force, $F1 = P \times A$ (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

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.



21078TM05

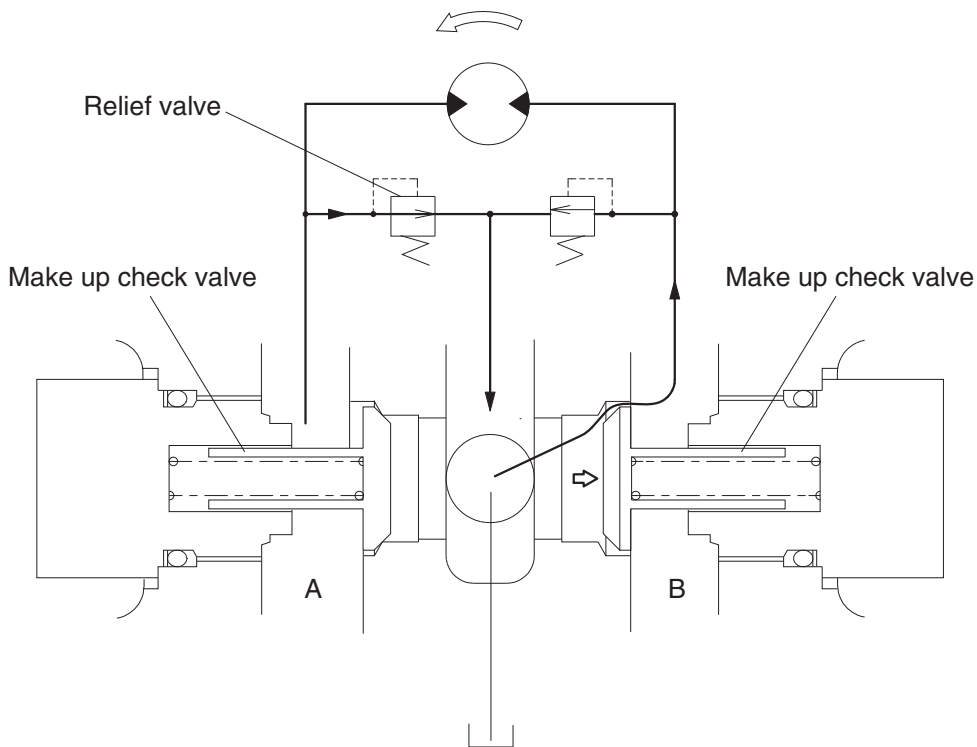
2) MAKE UP VALVE

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.

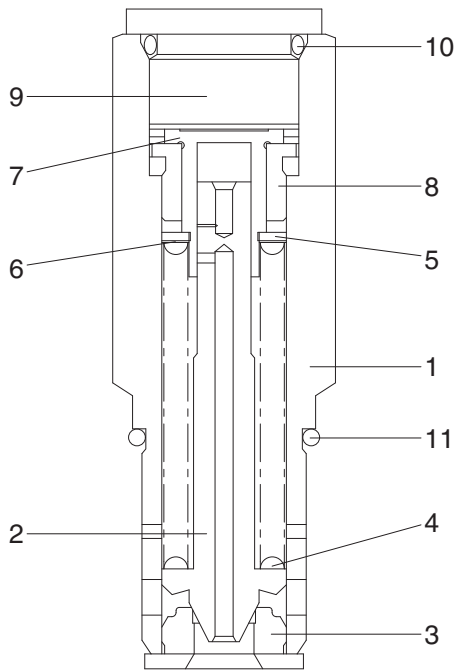
Pressurized oil into the port B, the motor rotate counterclockwise.

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.



21092SM04

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

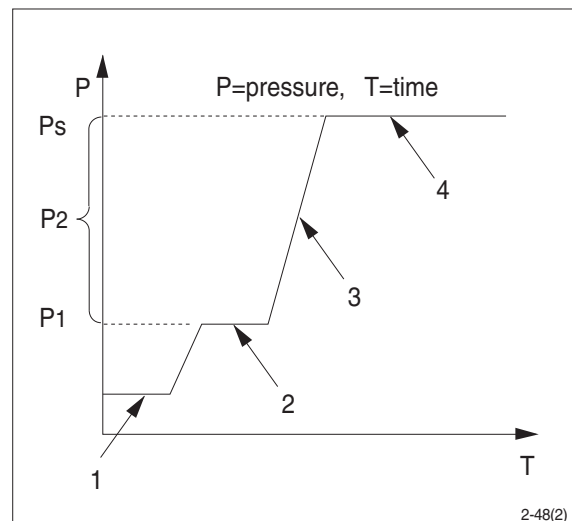
480F2SM05

(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.

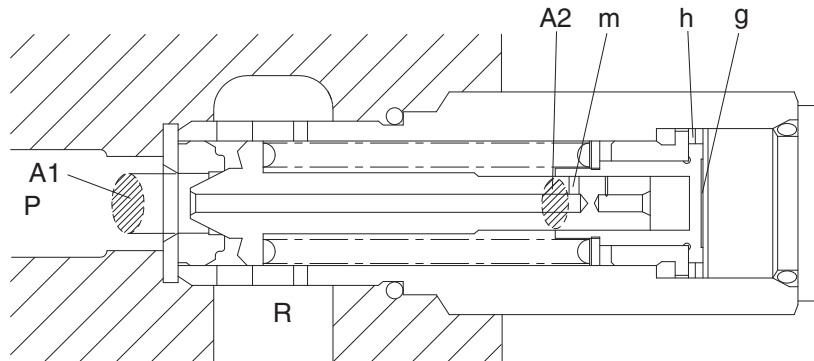
(2) Function of relief valve

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.



2-48(2)

① Ports (P,R) at tank pressure.

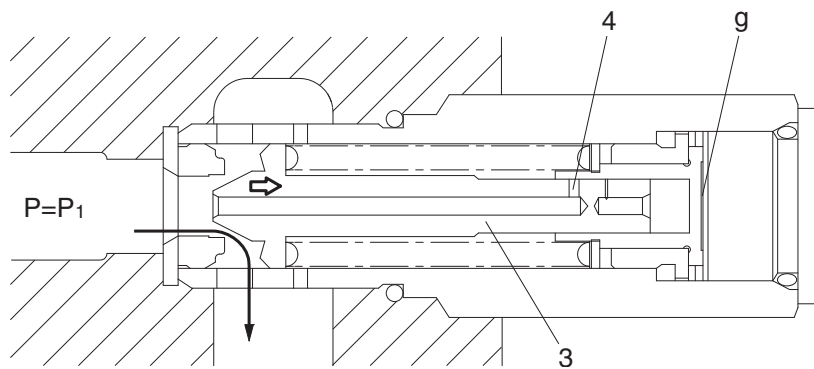


480F2SM06

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.

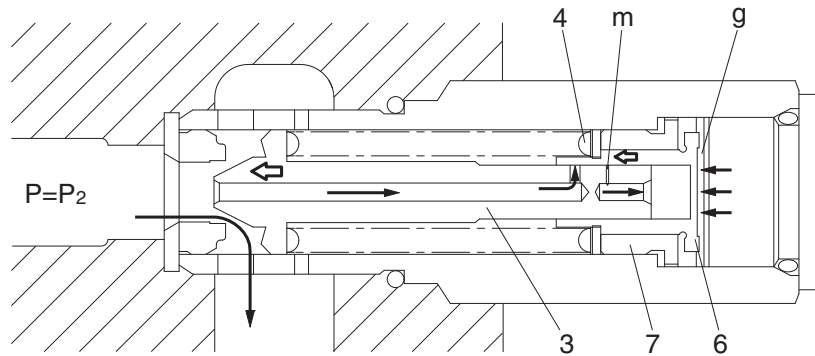
$$P_1 \times A_1 = F_{SP} + P_g \times A_2$$

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



480F2SM07

- 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).

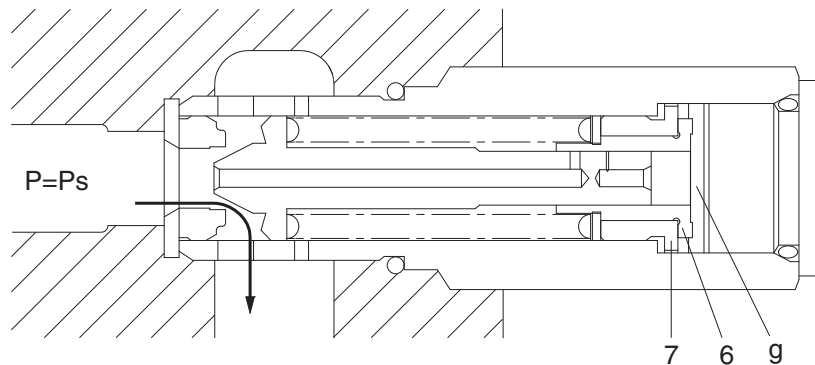


480F2SM08

- 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).

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

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



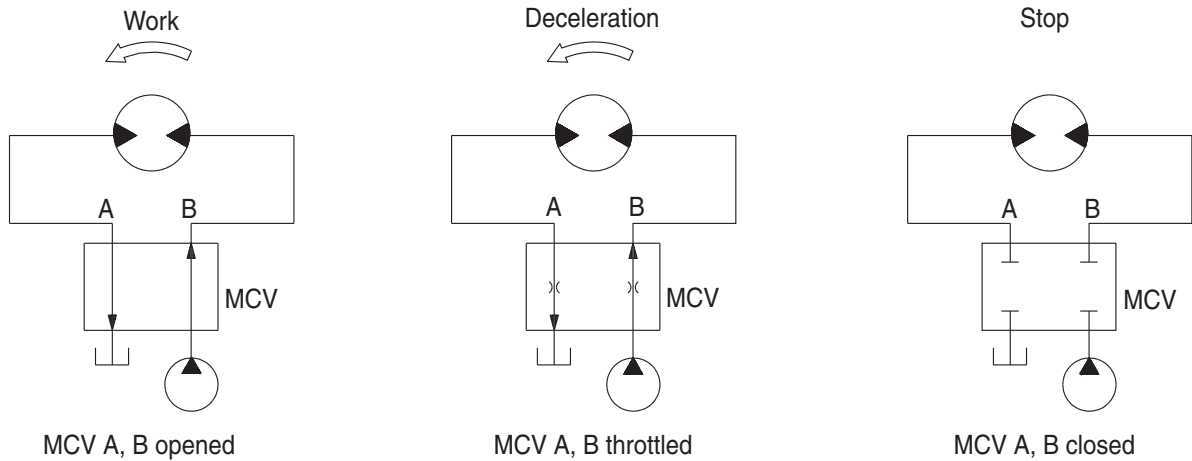
480F2SM09

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.



2-48(1)

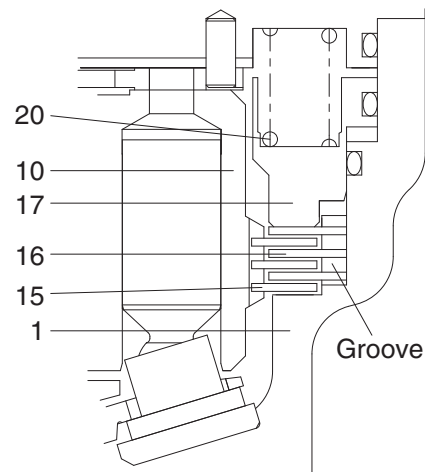
(2) Mechanical swing parking brake system

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.

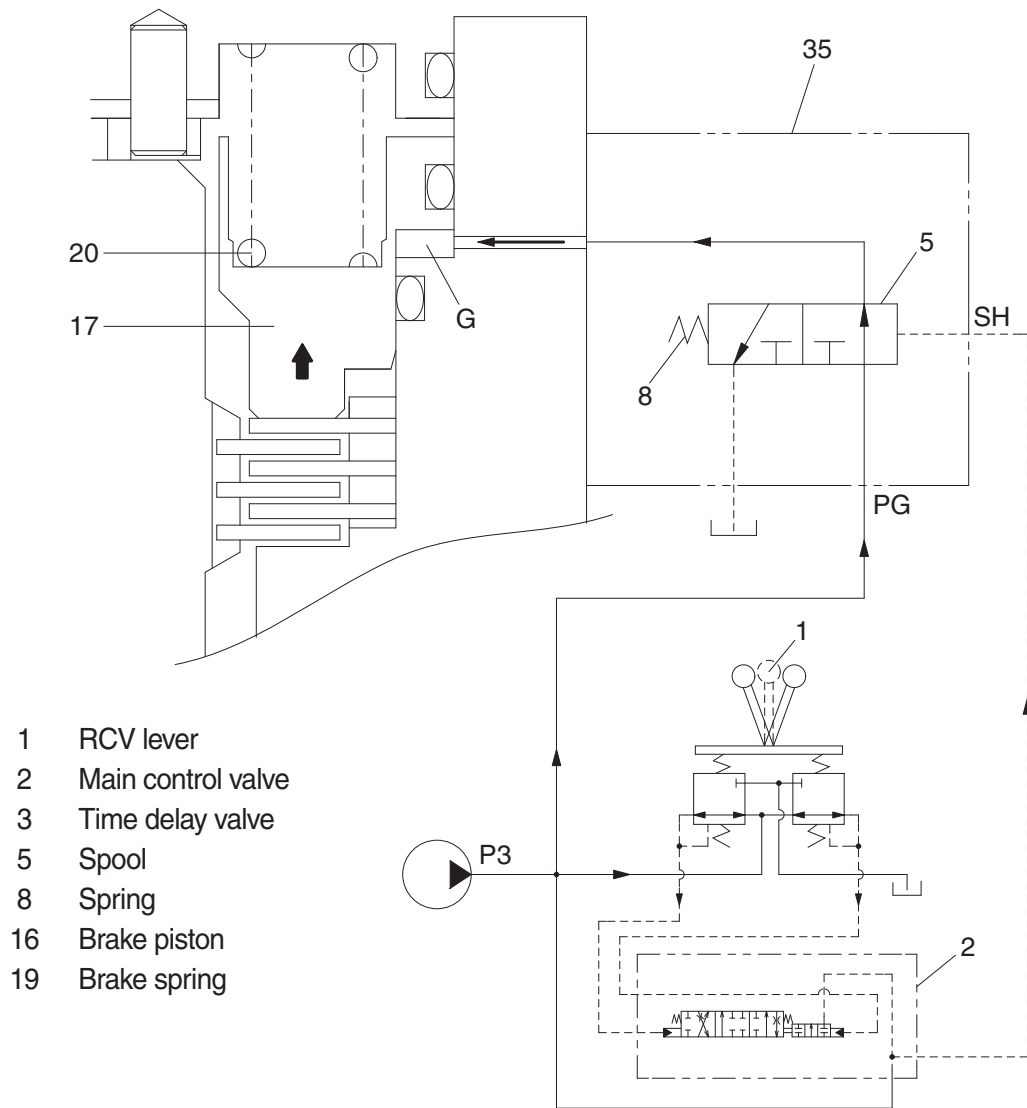


21092SM15

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

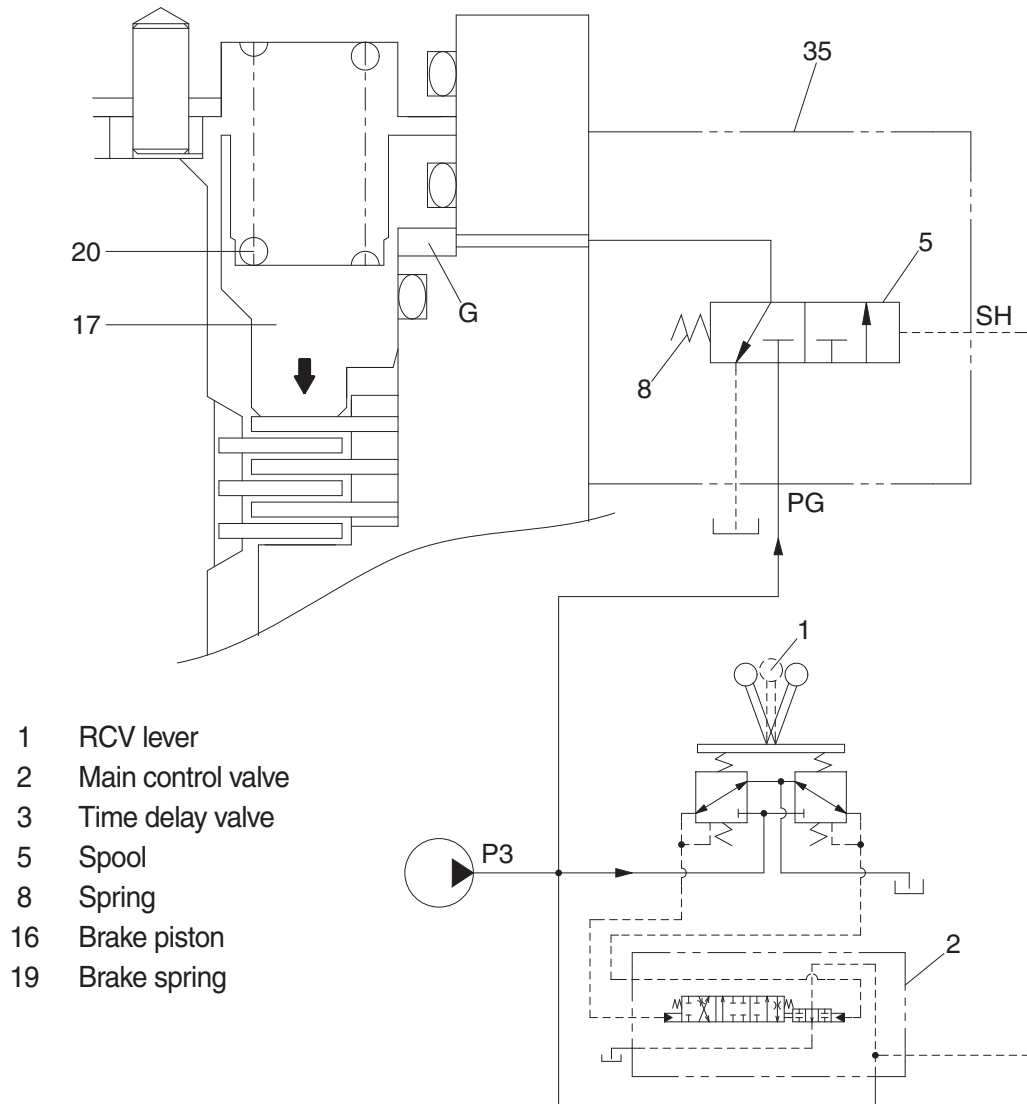
② **Operating principle**

- a. When one of the RCV lever (1) is set to the operation position, the each spool is shifted to left or right and the pilot oil flow is blocked. Then the pilot oil go to SH of the time delay valve (3). This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged oil (P3) goes to the chamber G through port PG. This pressure is applied to move the piston (16) to the upward against the force of the spring (19). Thus, it releases the brake force.



48092SM04

- 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.



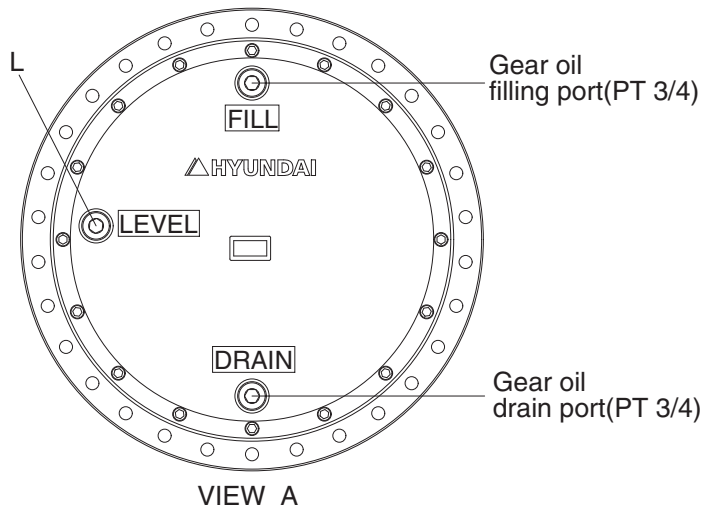
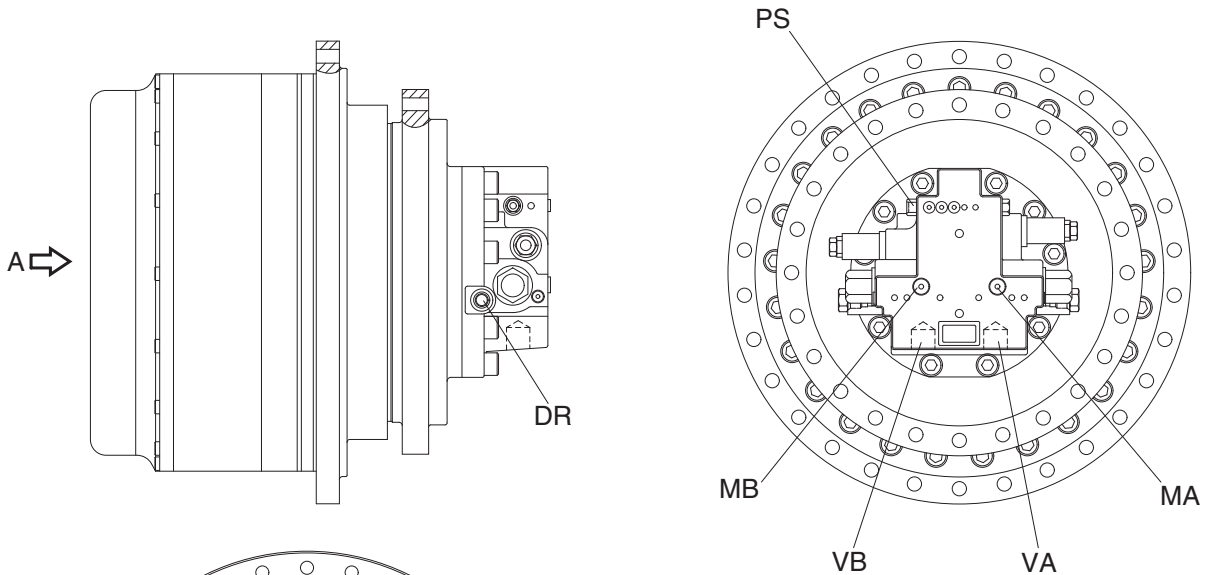
48092SM05

GROUP 4 TRAVEL DEVICE

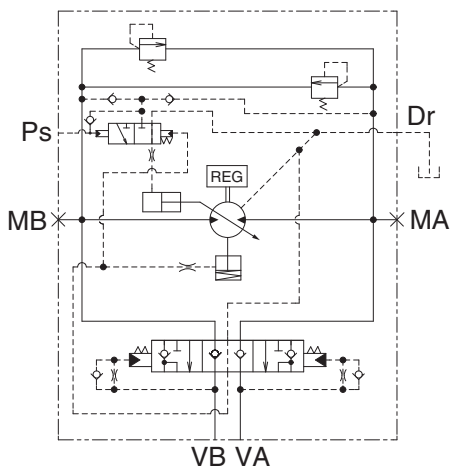
1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



480F2TM01

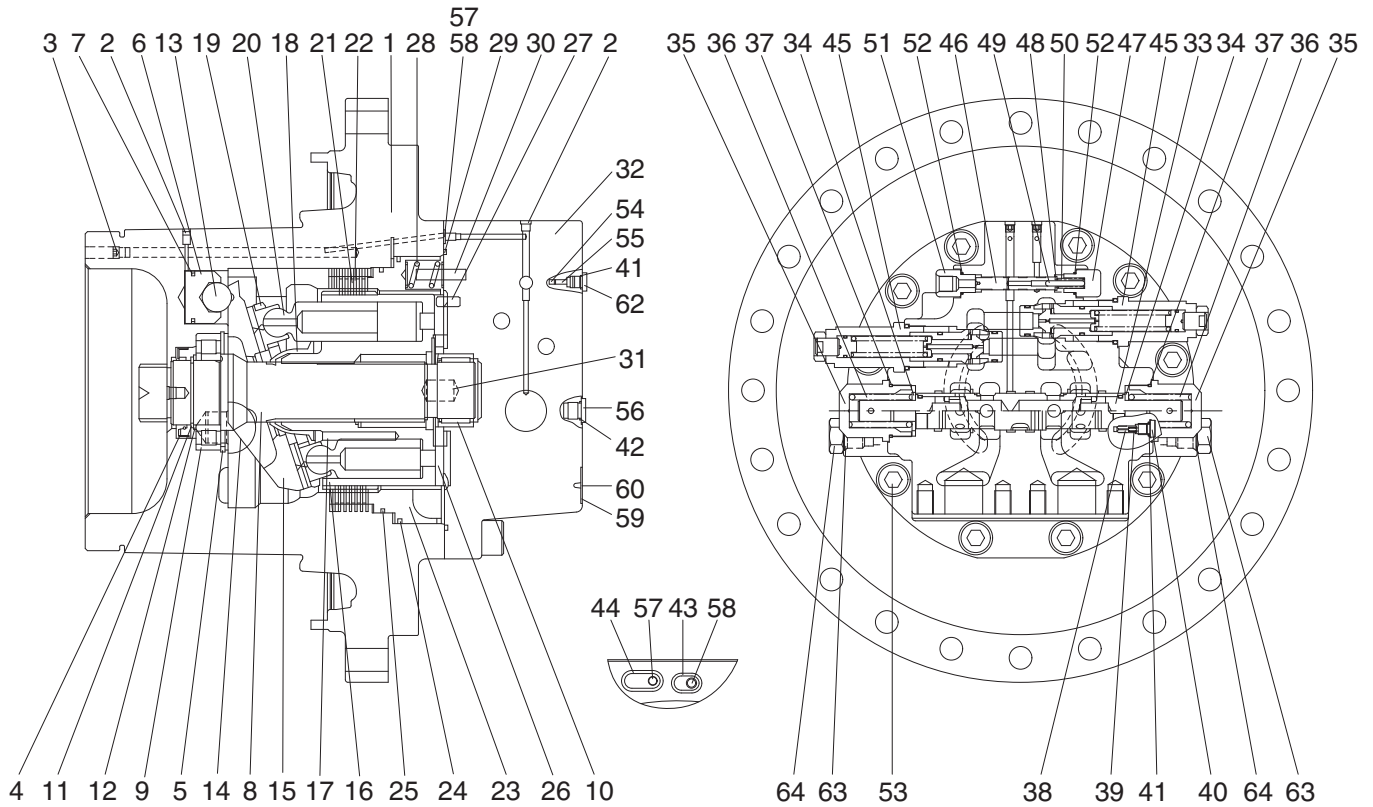


HYDRAULIC CIRCUIT

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

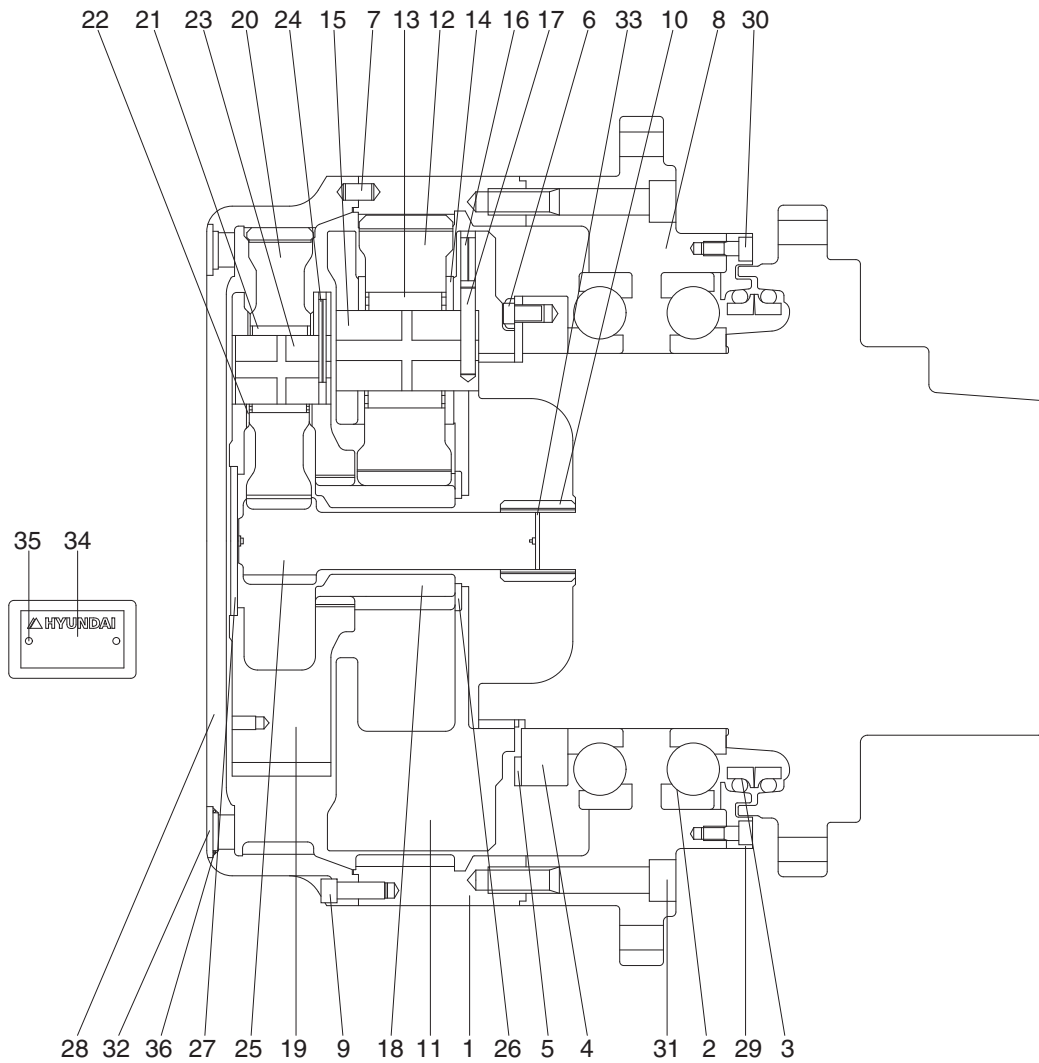
1) TRAVEL MOTOR



480F2TM02

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



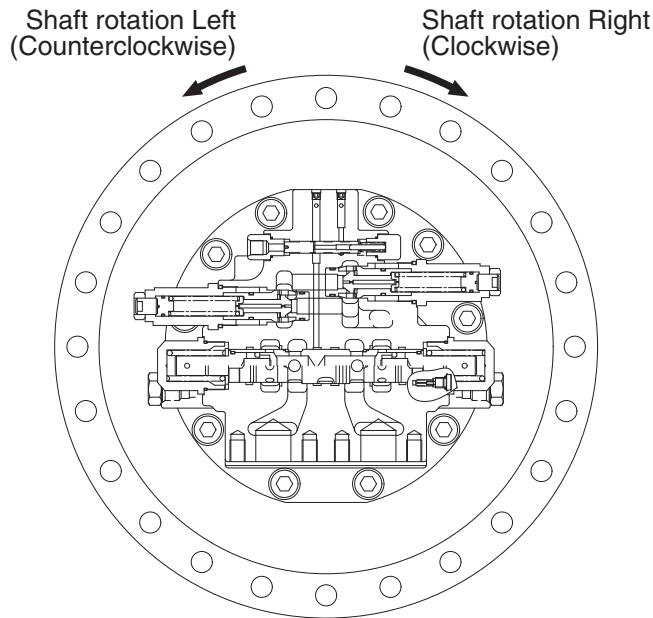
480F2TM03

- | | | | | | |
|----|--------------------------|----|----------------------|----|----------------------|
| 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)

480F2TM04

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.

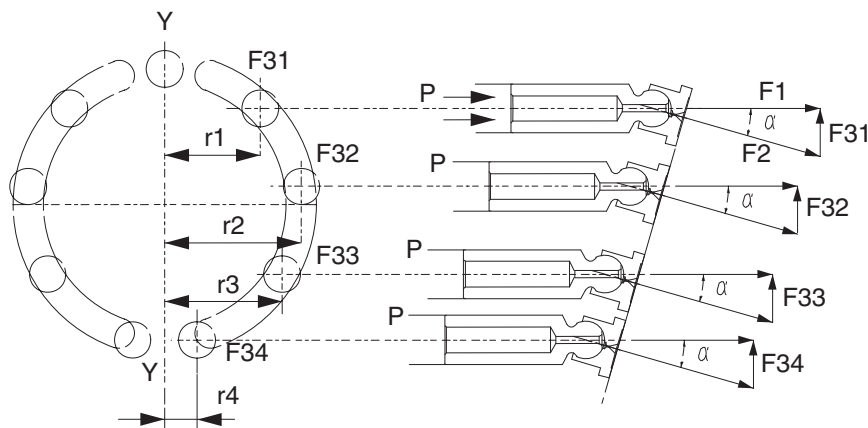
$$F1 = P \times A \quad (P : \text{pressure, } A : \text{area of piston section})$$

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).



29092TM07

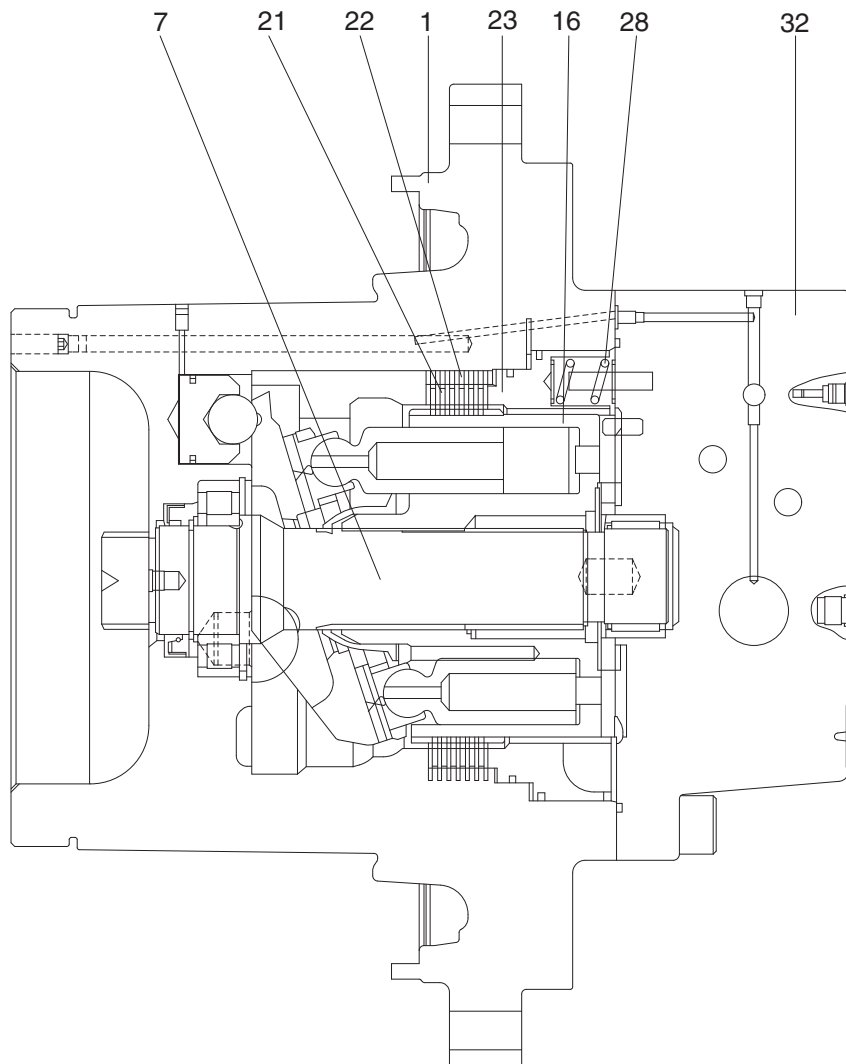
2) PARKING BRAKE

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).



480F2TM05

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.

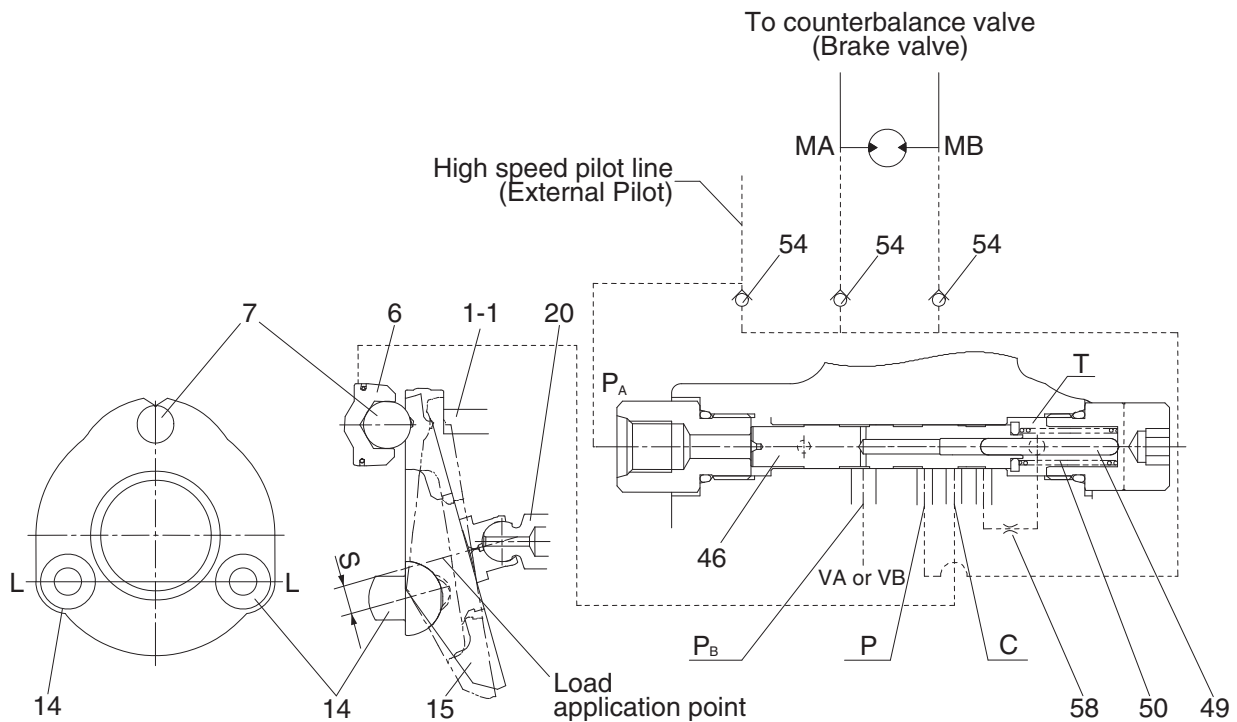
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

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.

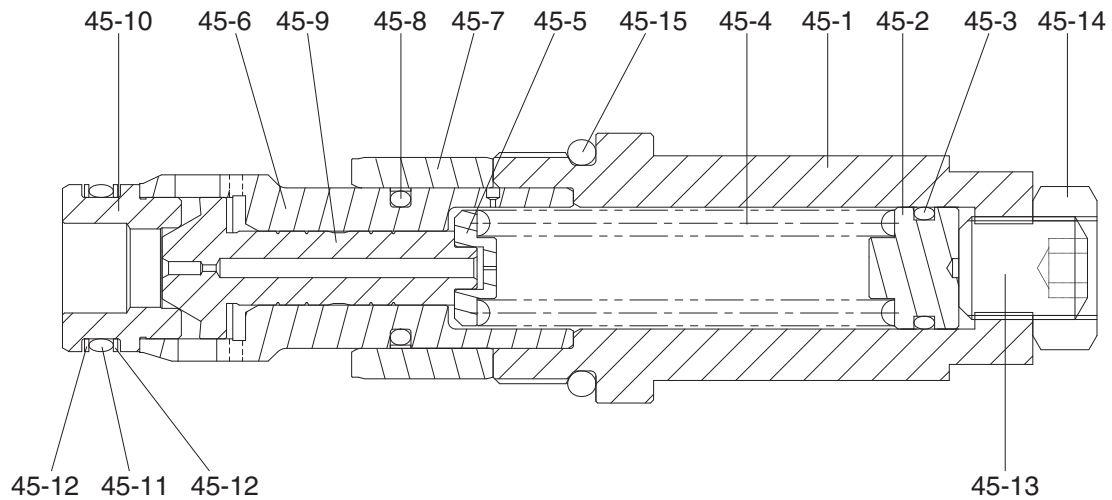


480F2TM06

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.



480F2TM07

45-1 Plug	45-6 Sleeve	45-11 O-ring
45-2 Guide	45-7 Piston	45-12 Back-up ring
45-3 O-ring	45-8 Seal	45-13 Socket screw
45-4 Spring	45-9 Poppet	45-14 Hexagon nut
45-5 Spring seat	45-10 Poppet seat	45-15 O-ring

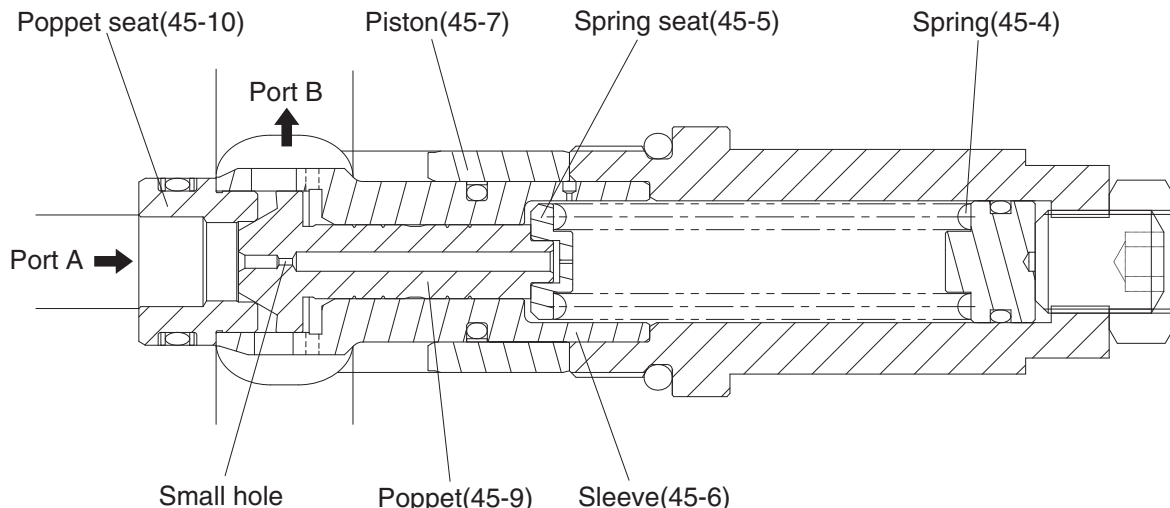
(2) Operation

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.



480F2TM08

5) BRAKE VALVE

(1) Structure

The brake valve portion mainly consists of the following parts:

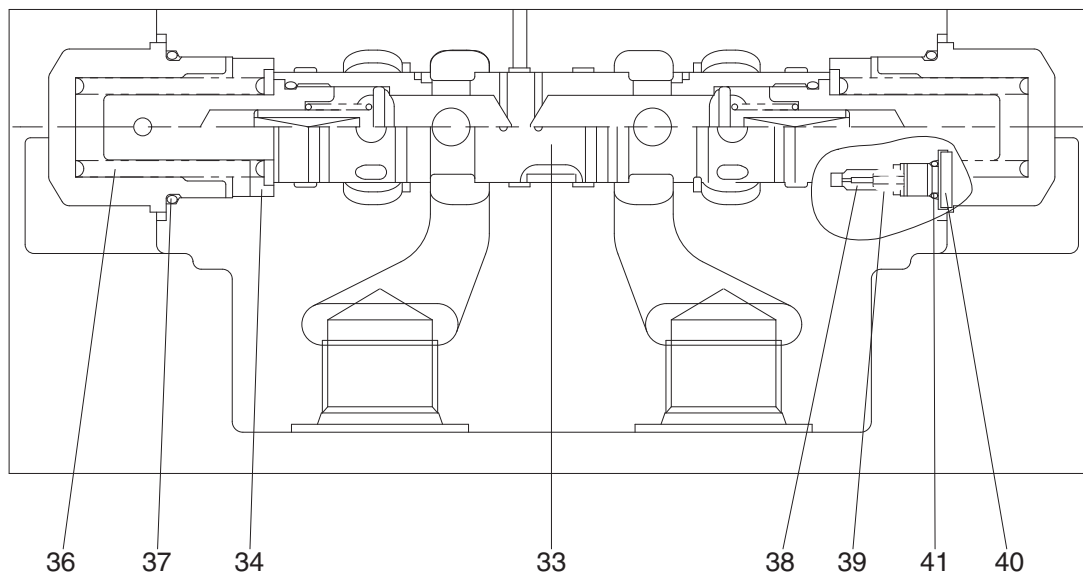
① Spool

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.



480F2TM09

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

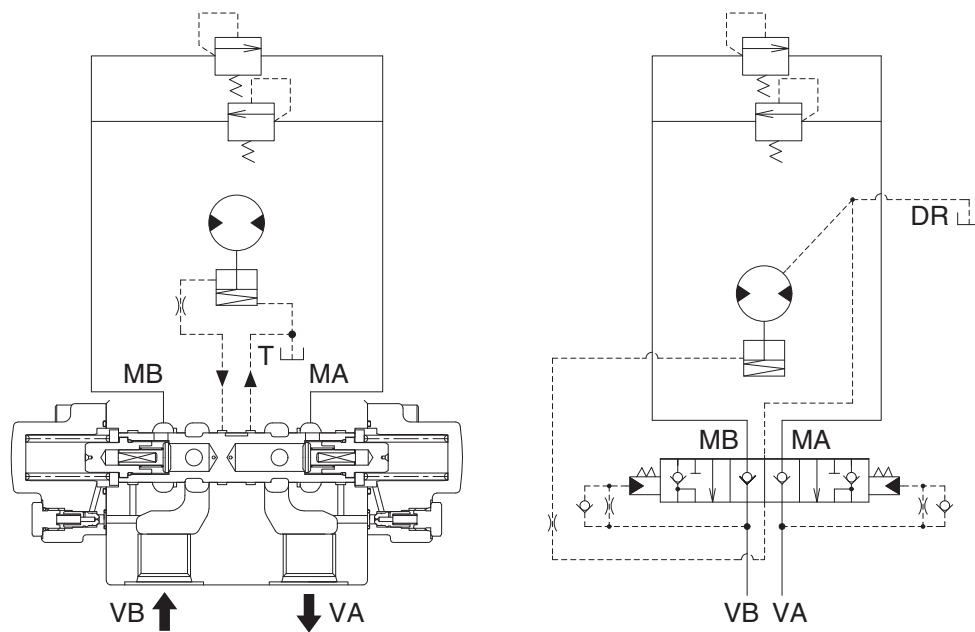
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (36) located on both spool ends holds the spool (33) at central position.

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.



25092TM29

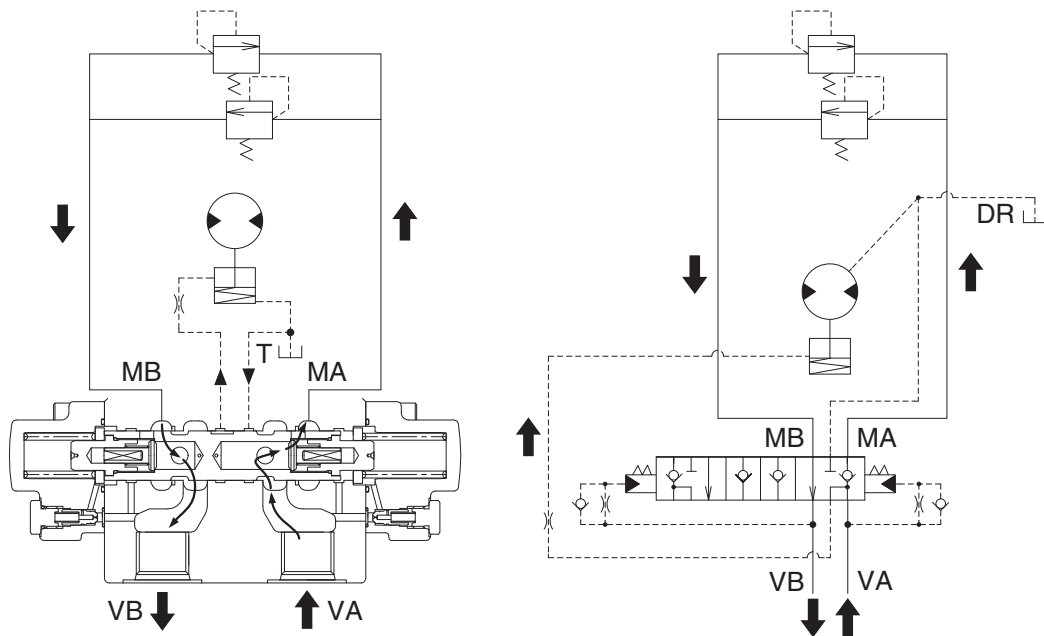
② Accelerating operation

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.



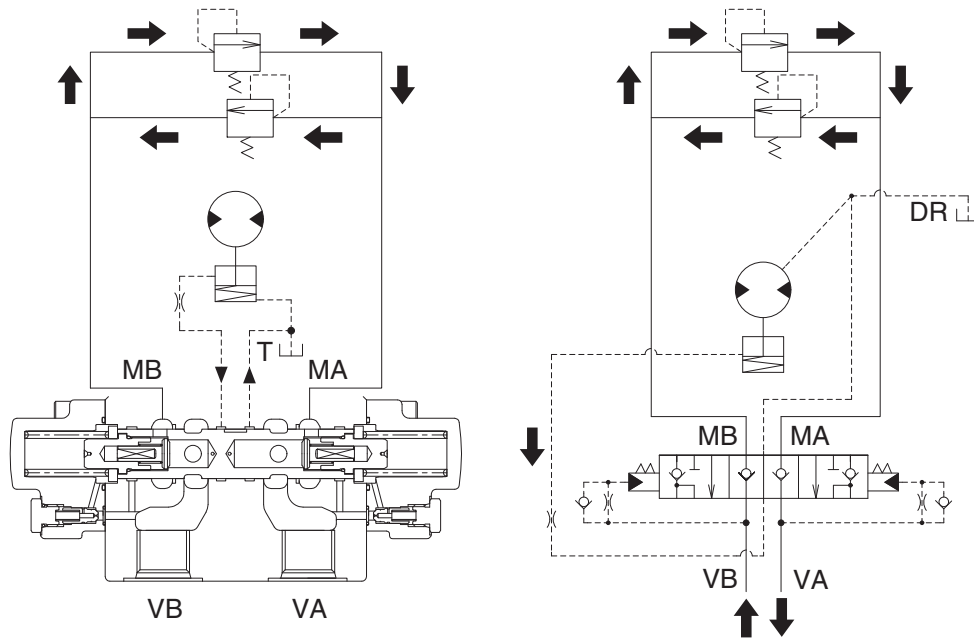
25092TM30

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.



25092TM31

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.

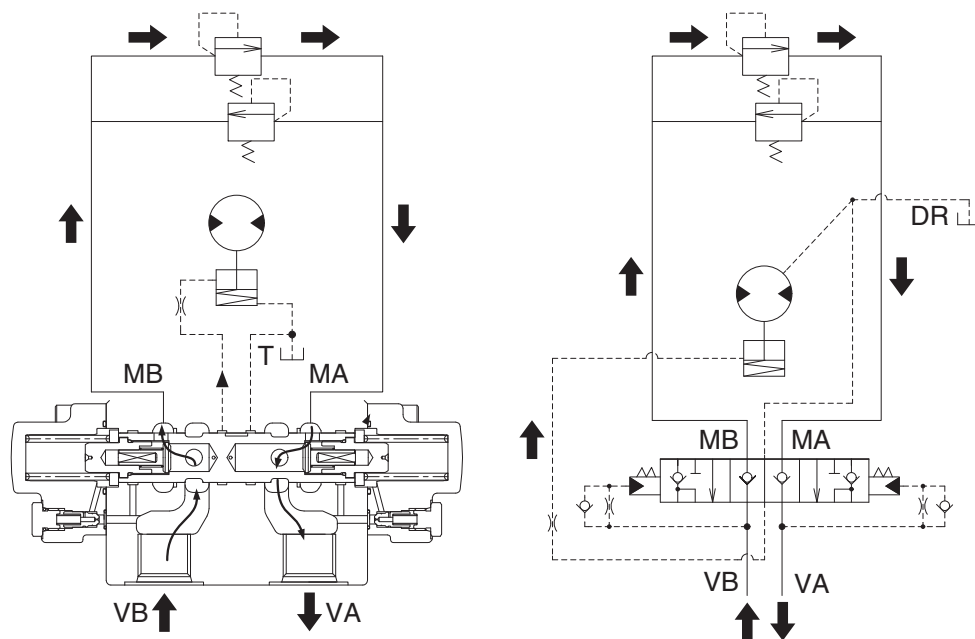
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (38) force moves the spool (33) leftwards towards neutral position.

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).



25092TM32

6) REDUCTION GEAR

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

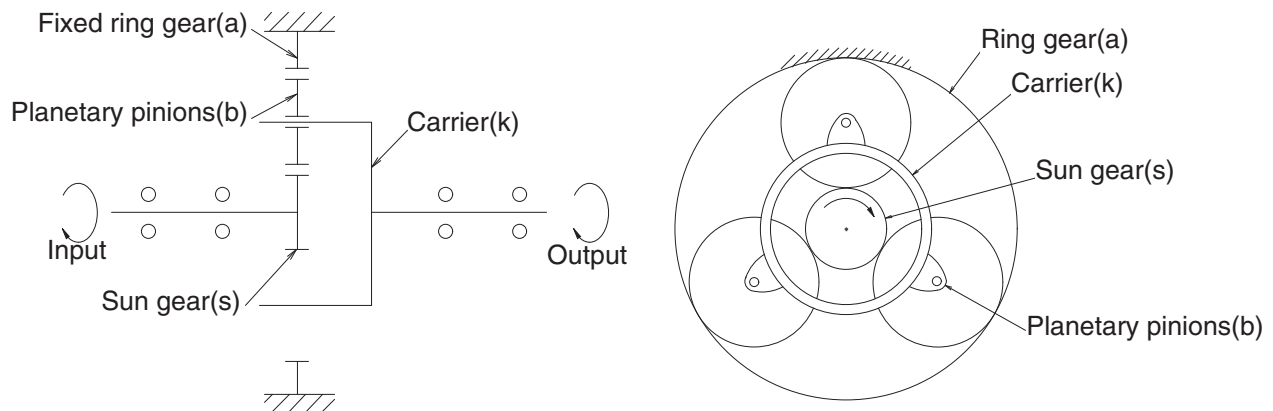
This reduction unit utilizes two stages, planetary reduction system.

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.

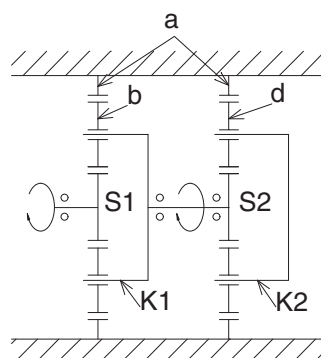


29072TM10

29072TM11

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.



29072TM12

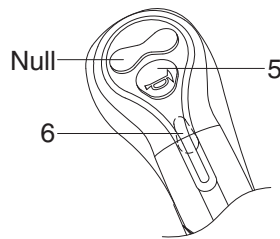
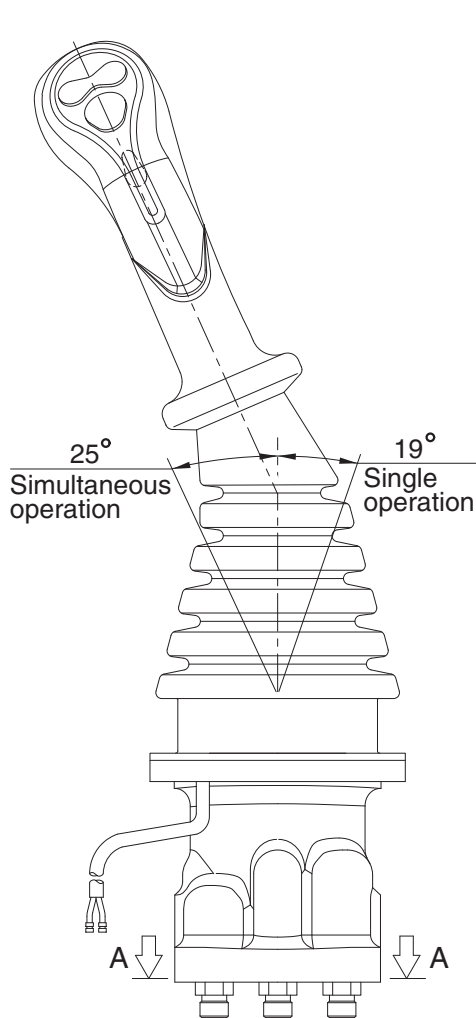
GROUP 5 RCV LEVER

1. STRUCTURE

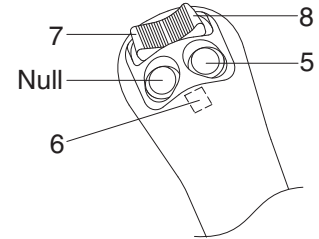
The casing has the oil inlet port P (primary pressure) and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.

※ Refer to the parts manual for the types of the RCV lever.

1) TYPE L1, L3, L5



TYPE L1, L3

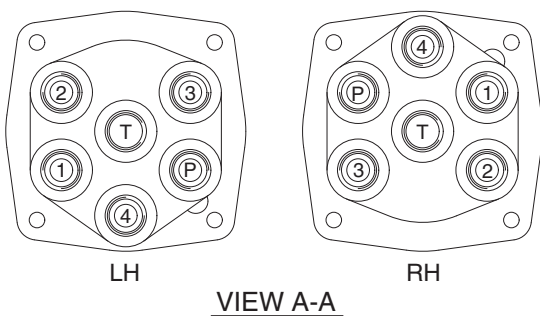
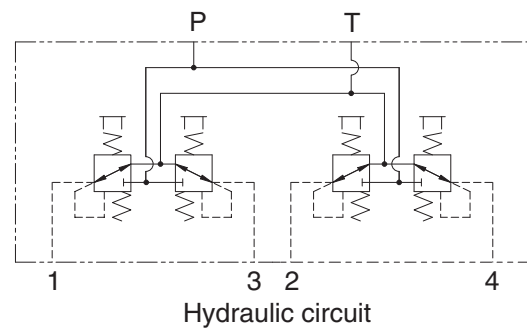


TYPE L5

Switches

Type	No.	LH	RH
L1, L3	5	One touch decel	Horn
	6	Power boost	Breaker
L5	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment

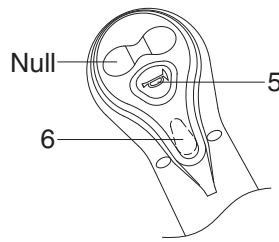
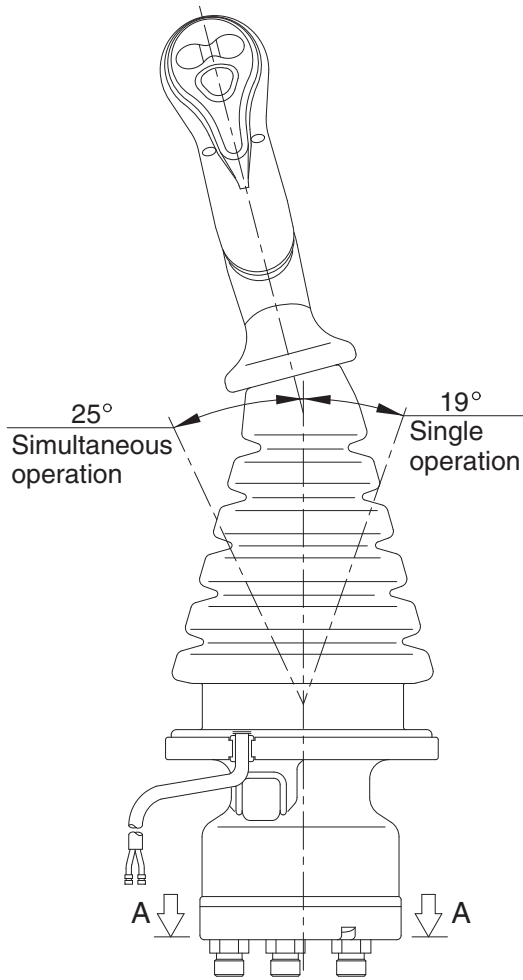


Pilot ports

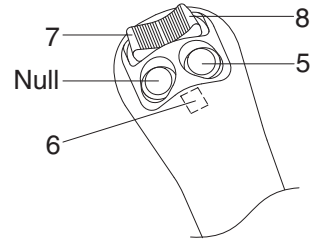
Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

300L2RL01

2) TYPE L2, L4, L6



TYPE L2, L4

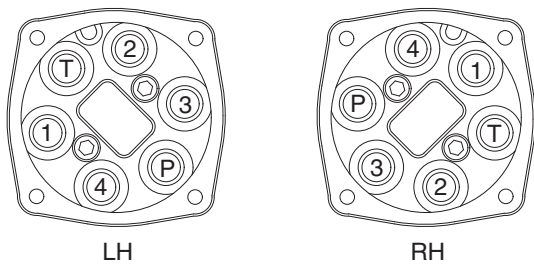
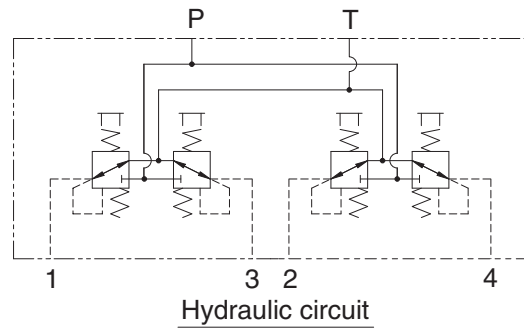


TYPE L6

Switches

Type	No.	LH	RH
L2, L4	5	One touch decel	Horn
	6	Power boost	Breaker
L6	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment



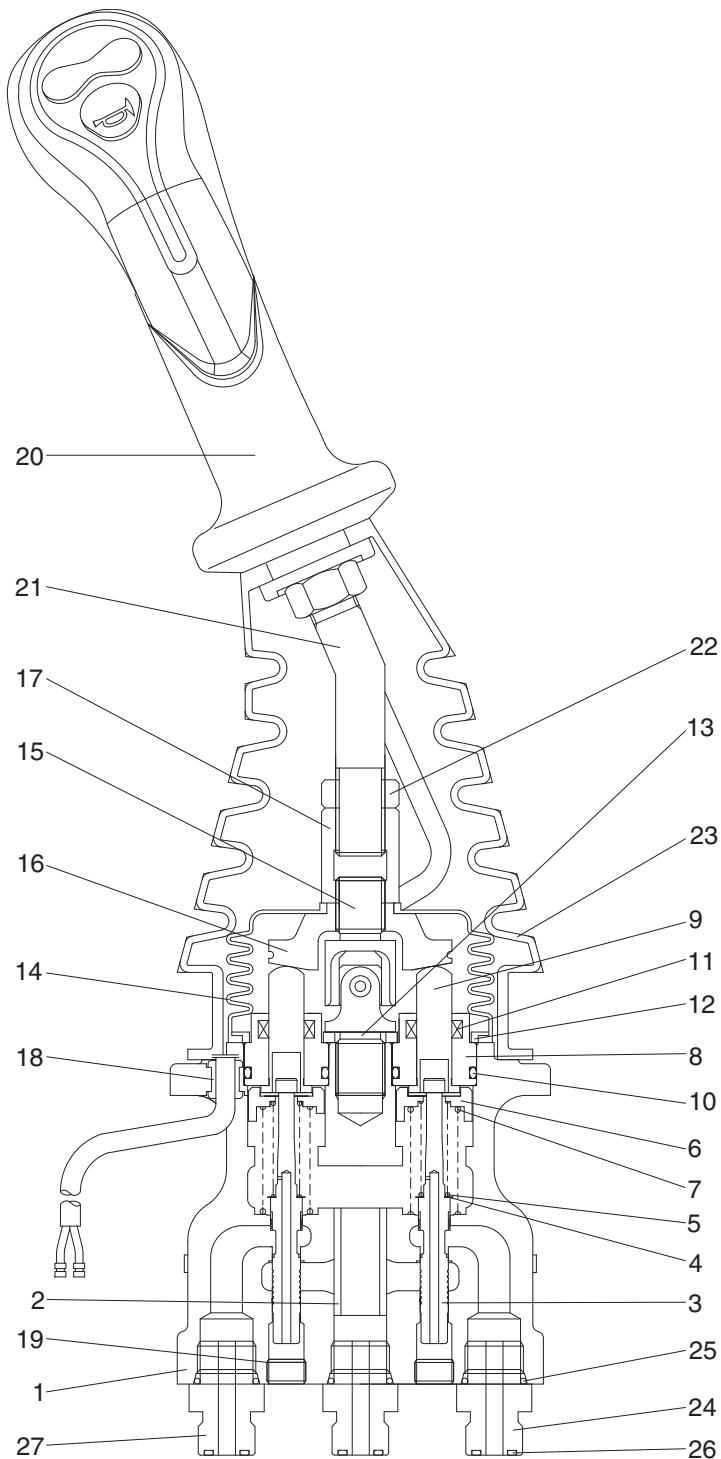
VIEW A-A

Pilot ports

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

300L2RL05

3) CROSS SECTION



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

300L2RL06

Item numbers are based on the type L1.

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 (3), spring (5) for setting secondary pressure, return spring (7), spring seat (6) and shim (4). 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) 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.

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

Item numbers are based on the type L1.

The functions of the spool (3) 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 (5) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (9) is inserted and can slide in the plug (8).

For the purpose of changing the displacement of the push rod through the swash plate (16) and adjusting nut (17) are provided the handle assy (20) that can be tilted in any direction around the fulcrum of the universal joint (15) center.

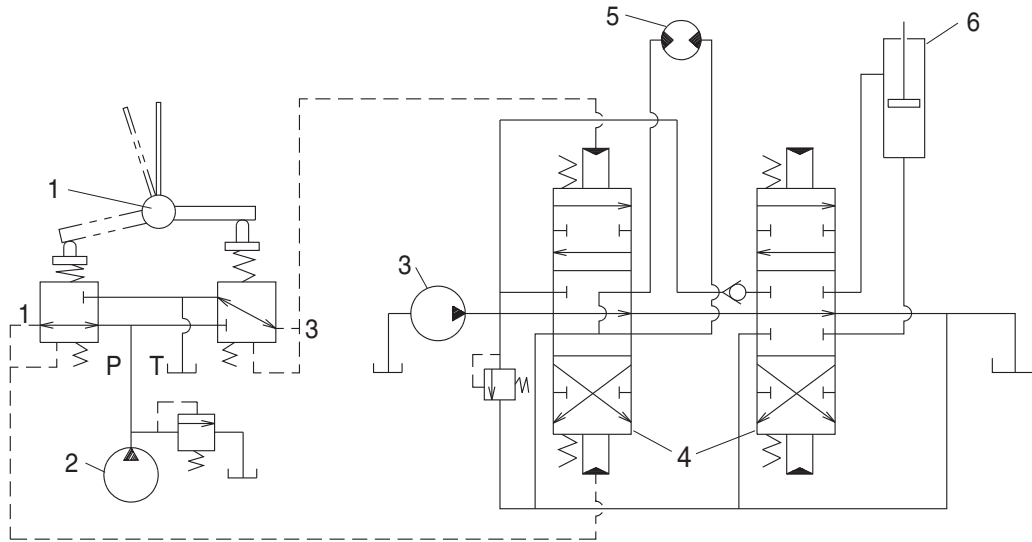
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



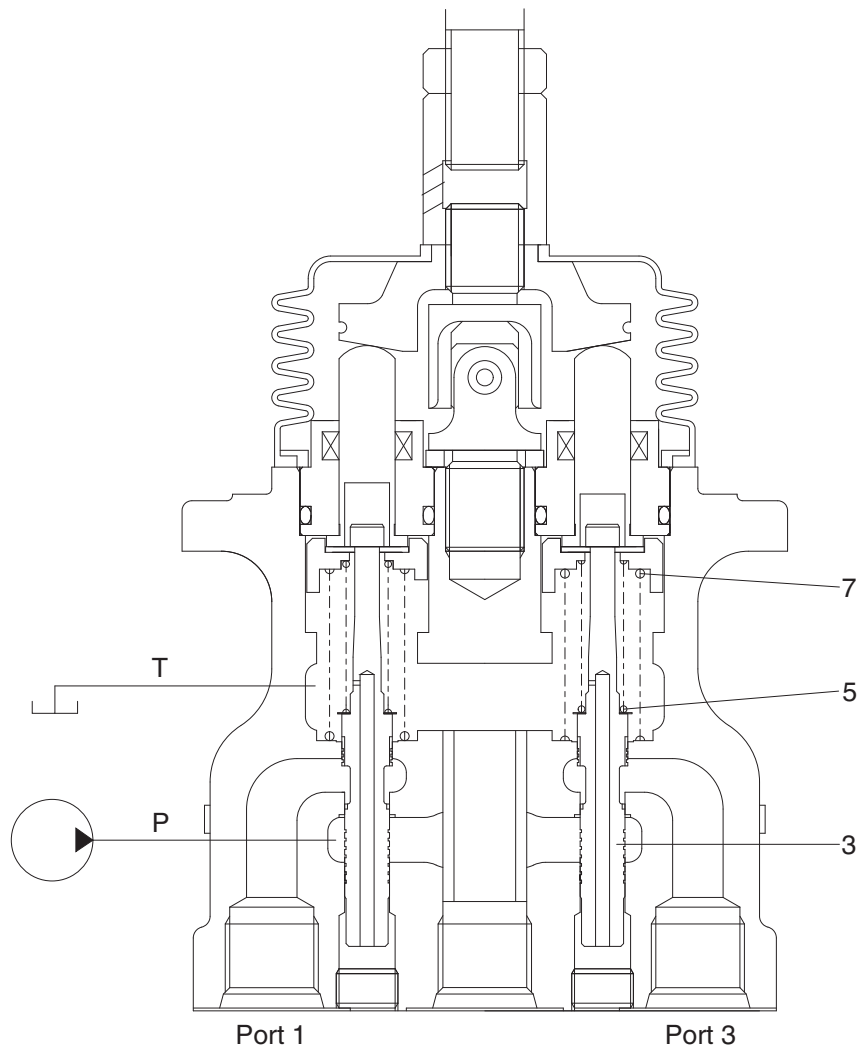
2-70

- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

- 5 Hydraulic motor
- 6 Hydraulic cylinder

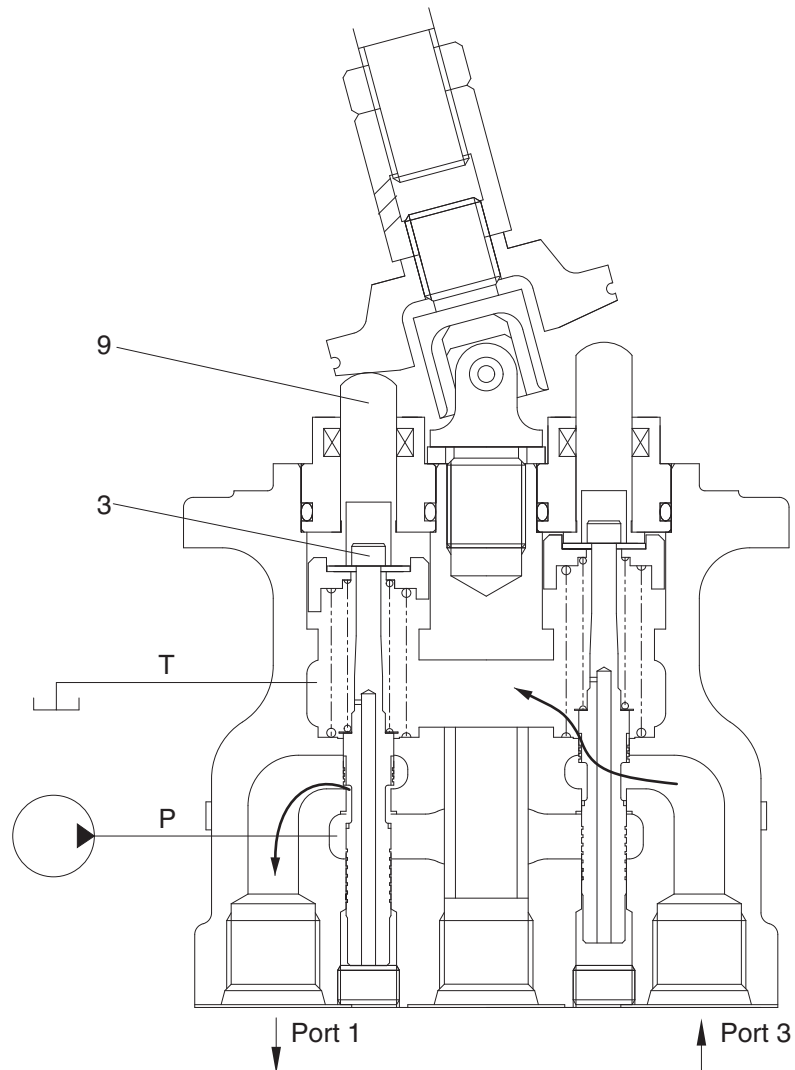
(1) Case where handle is in neutral position



300L2RL03

The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (3). Therefore, the spool is pushed up by the spring (7) 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



300L2RL04

When the push rod (9) is stroked, the spool (3) 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.

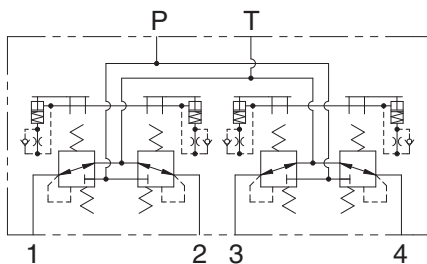
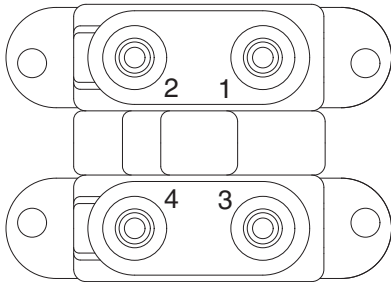
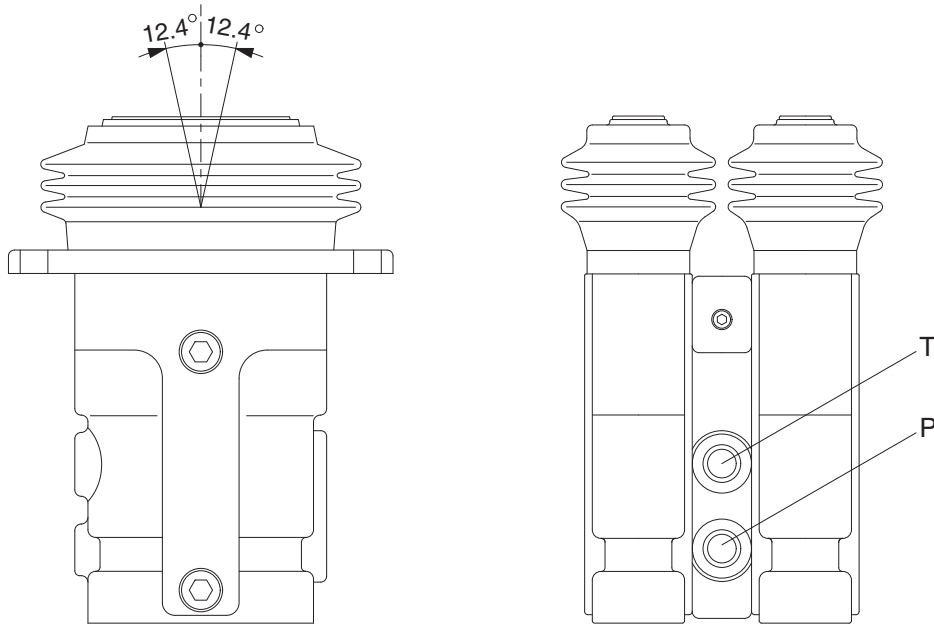
In this manner the secondary pressure is kept at the constant value.

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)	

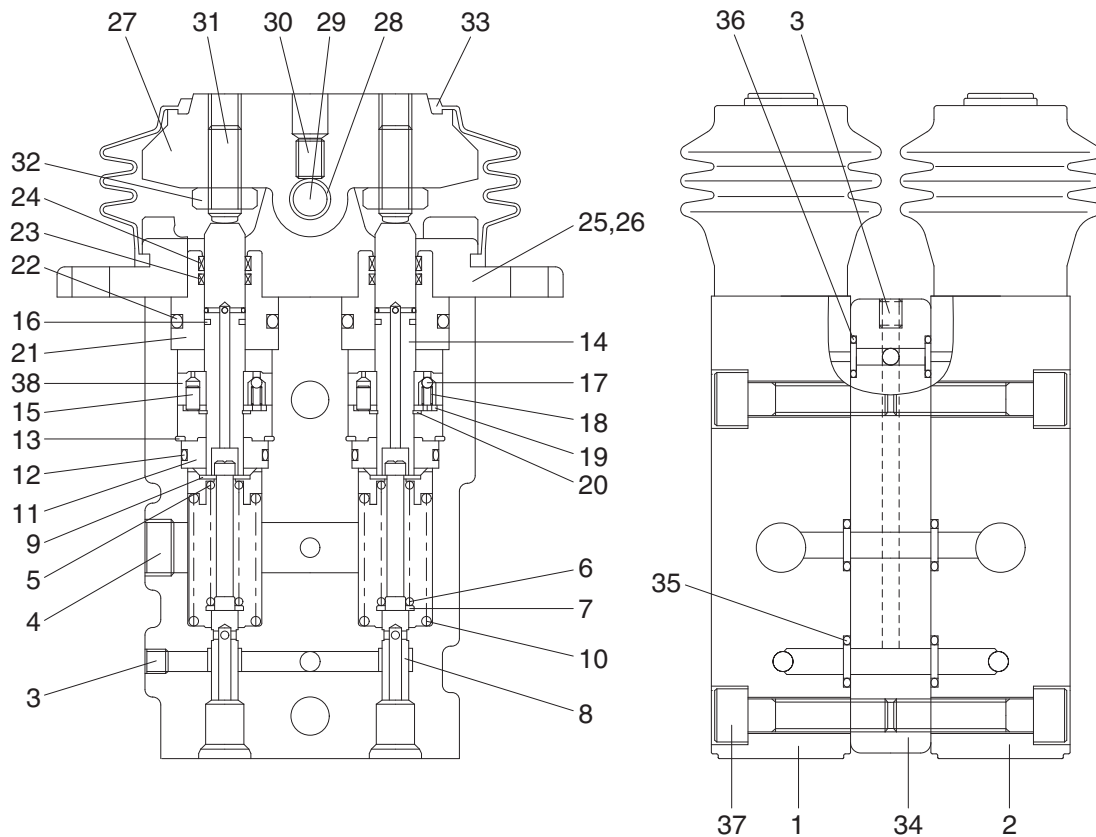
21092RP01

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.



21092RP02

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 the 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.

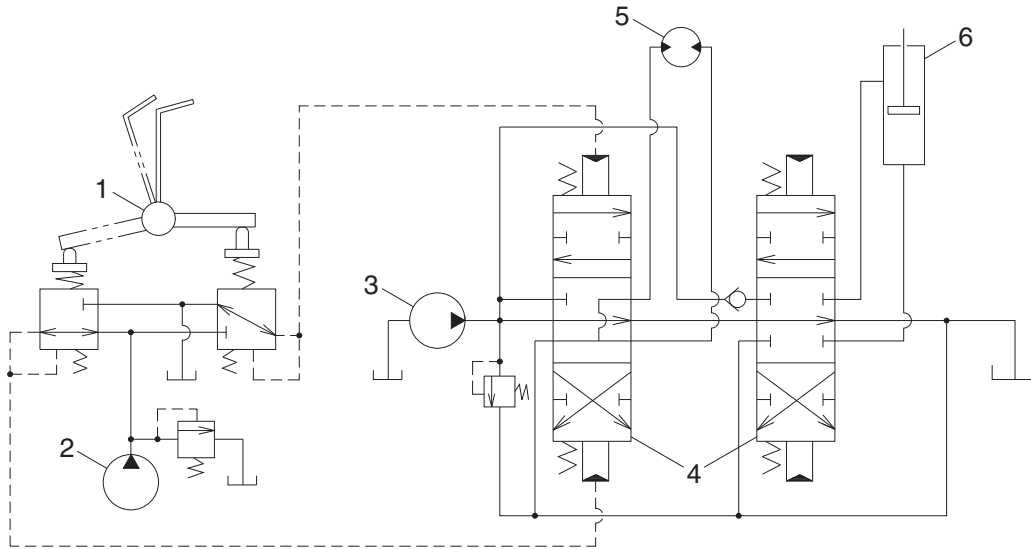
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



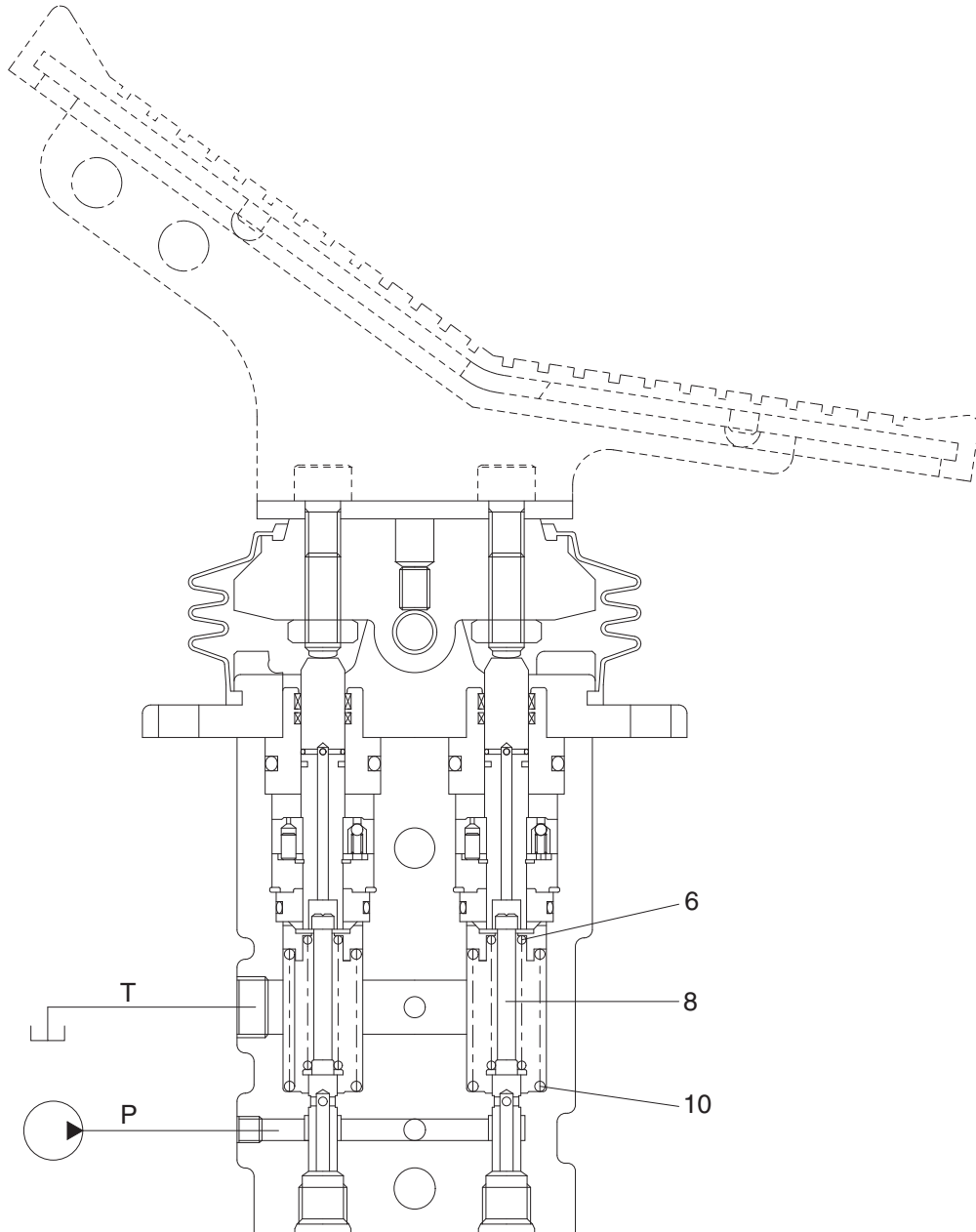
36072SF01

1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

5 Hydraulic motor
6 Hydraulic cylinder

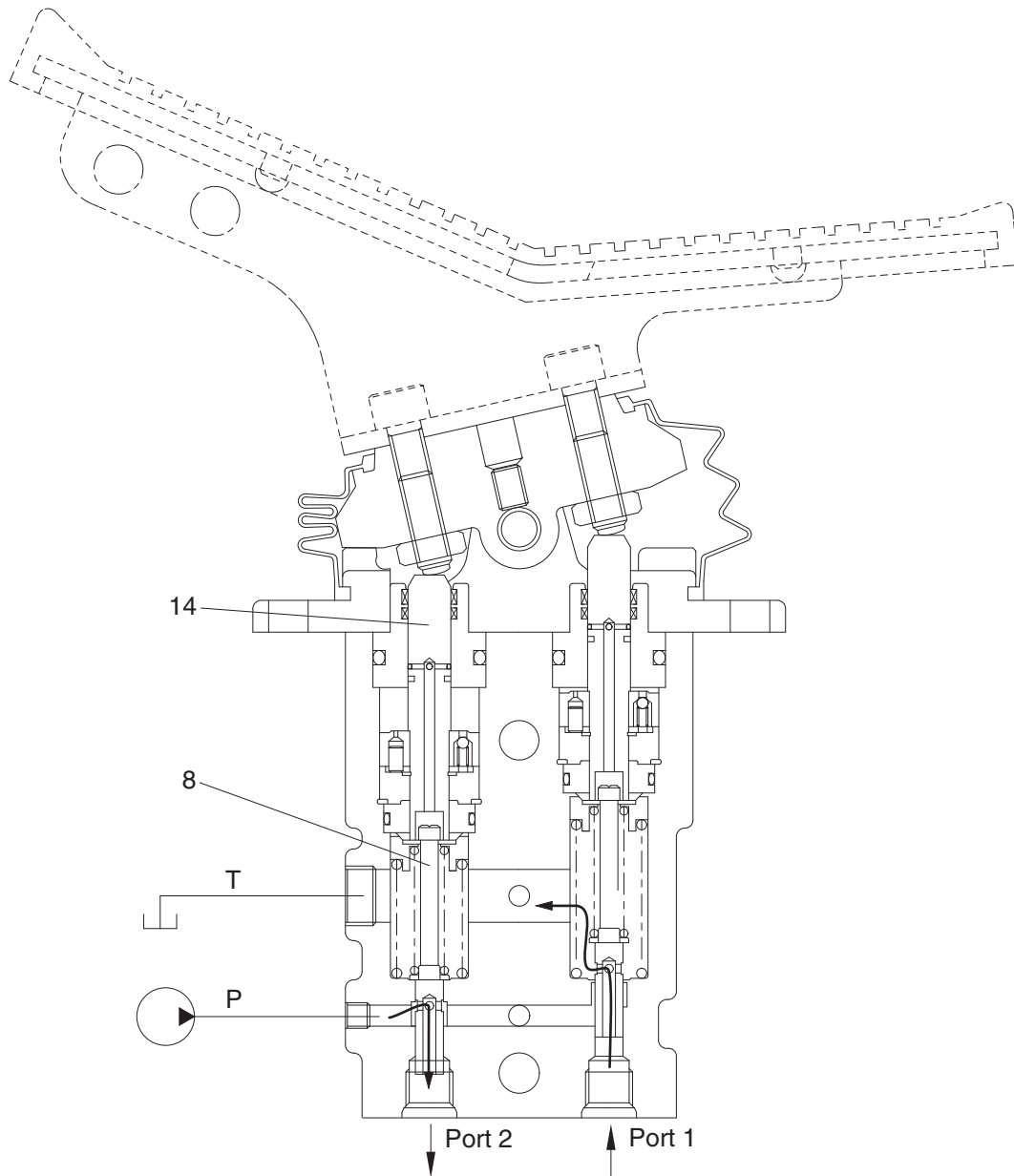
(1) Case where pedal is in neutral position



21092RP03

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



300L2RL08

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

Then port P is connected with port (2), and the oil supplied from the pilot pump flows through port 1 to generate the pressure.

When the pressure at port (2) increases to the value corresponding to the spring force set by tilting the pedal, 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 (2). If it decreases lower than the set pressure, port P is connected with port (2) and port T is disconnected from port (2).

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

Besides, in some type, when the pedal 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.