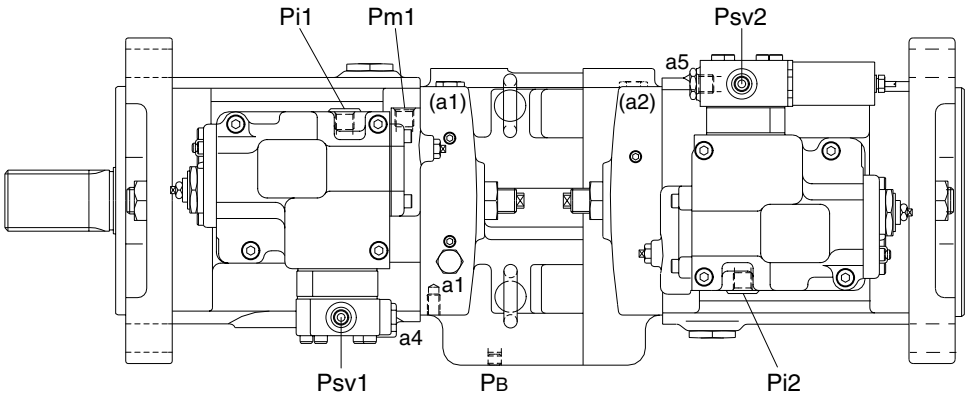
SECTION 2 STRUCTURE AND FUNCTION

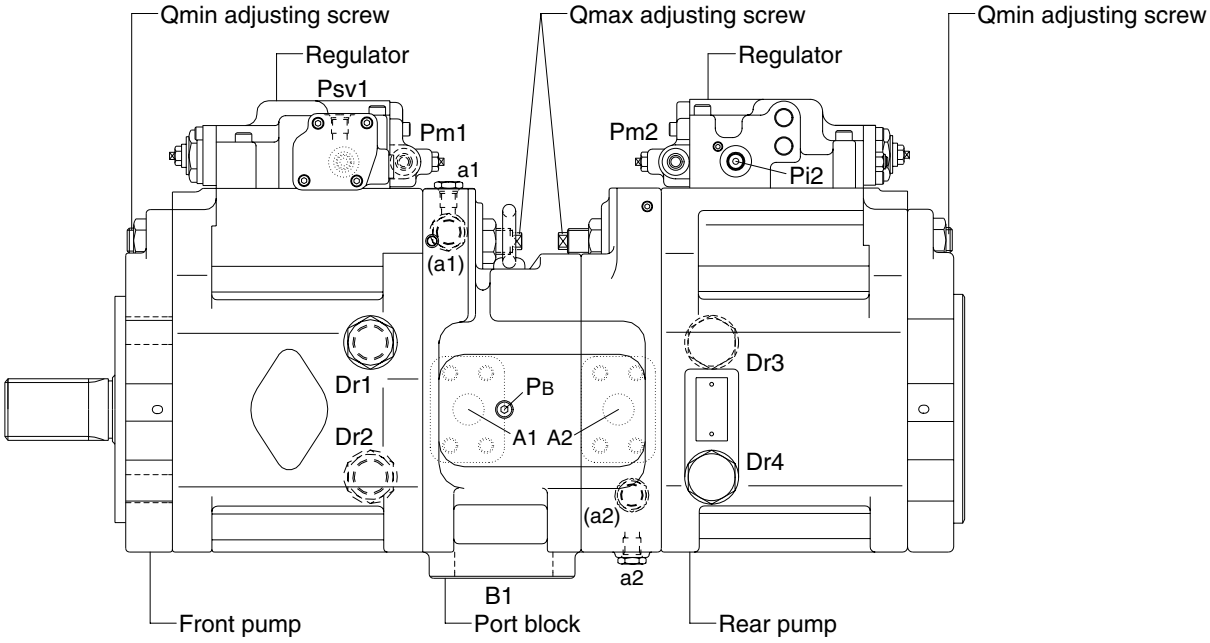
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

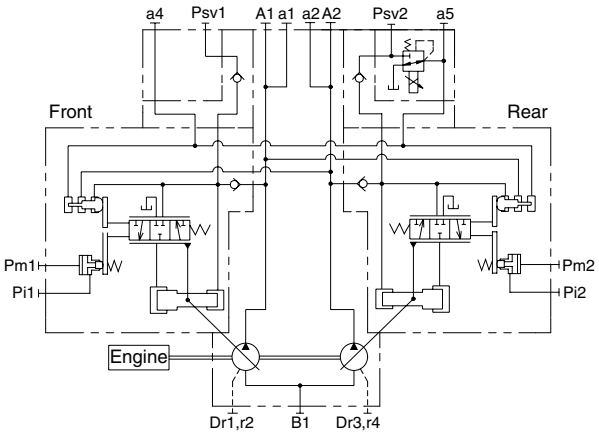
1. STRUCTURE

The pump device consists of main pump, regulator.





470072MP01

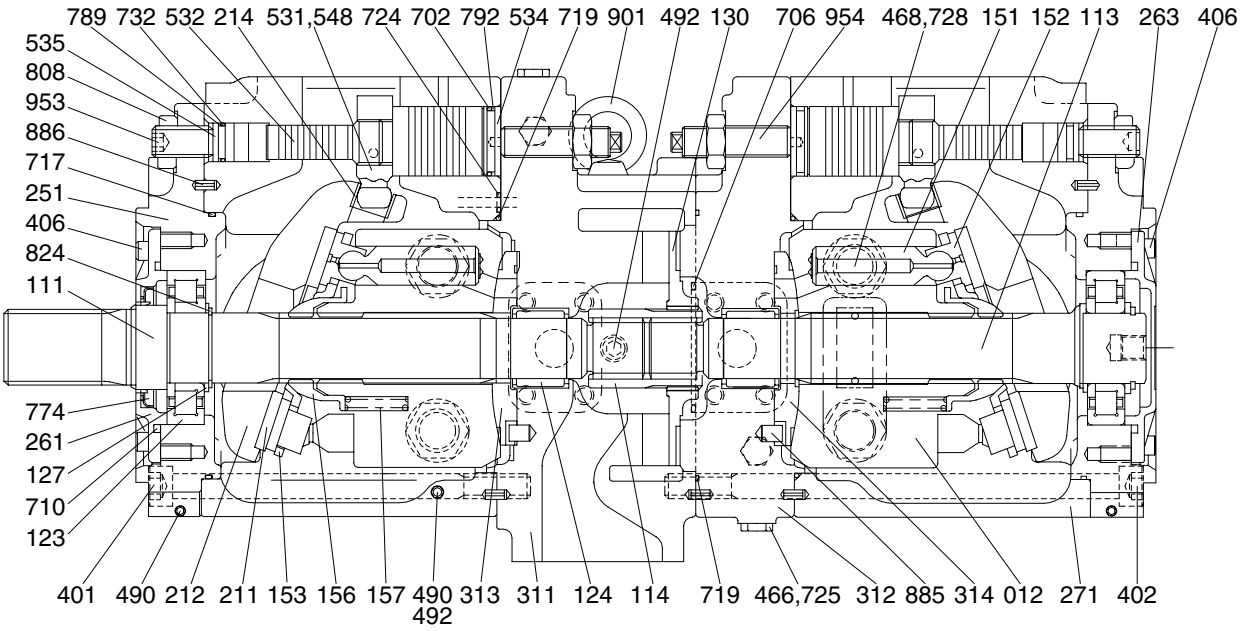


Hydraulic circuit

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
Pm1,Pm2	Qmax cut port	PF 1/4 - 15
Psv1, Psv2	Servo assist port	PF 1/4 - 15
a1, a2, a4, a5	Gauge port	PF 1/4 - 15
Pb	Gauge port	RC 1/8

1) MAIN PUMP(1/2)

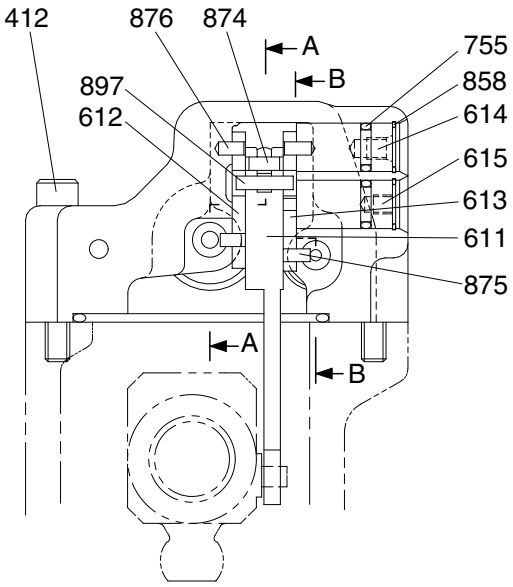
The main pump consists of two piston pumps(front & rear) and valve block.

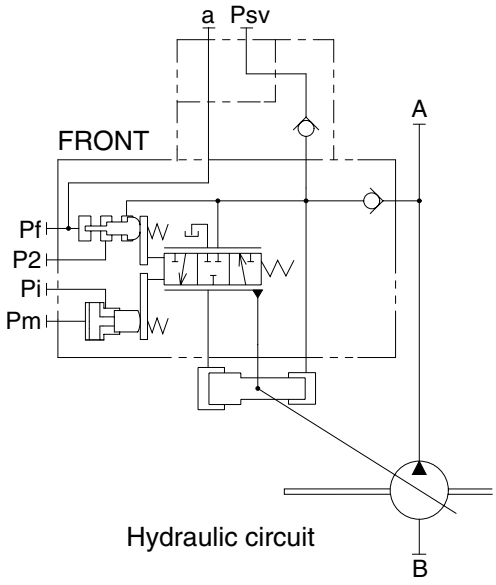


470072MP02

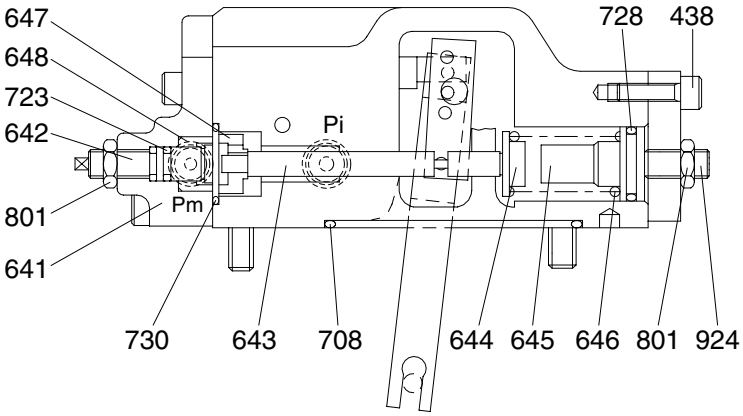
012	Cylinder block	271	Pump casing	710	O-ring
111	Drive shaft(F)	311	Valve cover(F)	717	O-ring
113	Driven shaft(R)	312	Valve cover(R)	719	O-ring
114	Coupling	313	Valve plate(R)	724	O-ring
123	Roller bearing	314	Valve plate(L)	725	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Spacer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

2) FRONT REGULATOR(1/2)

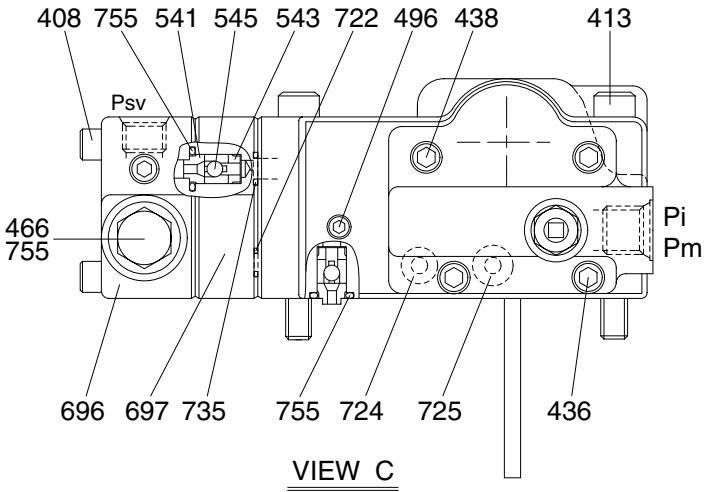




Hydraulic circuit



SECTION B-B

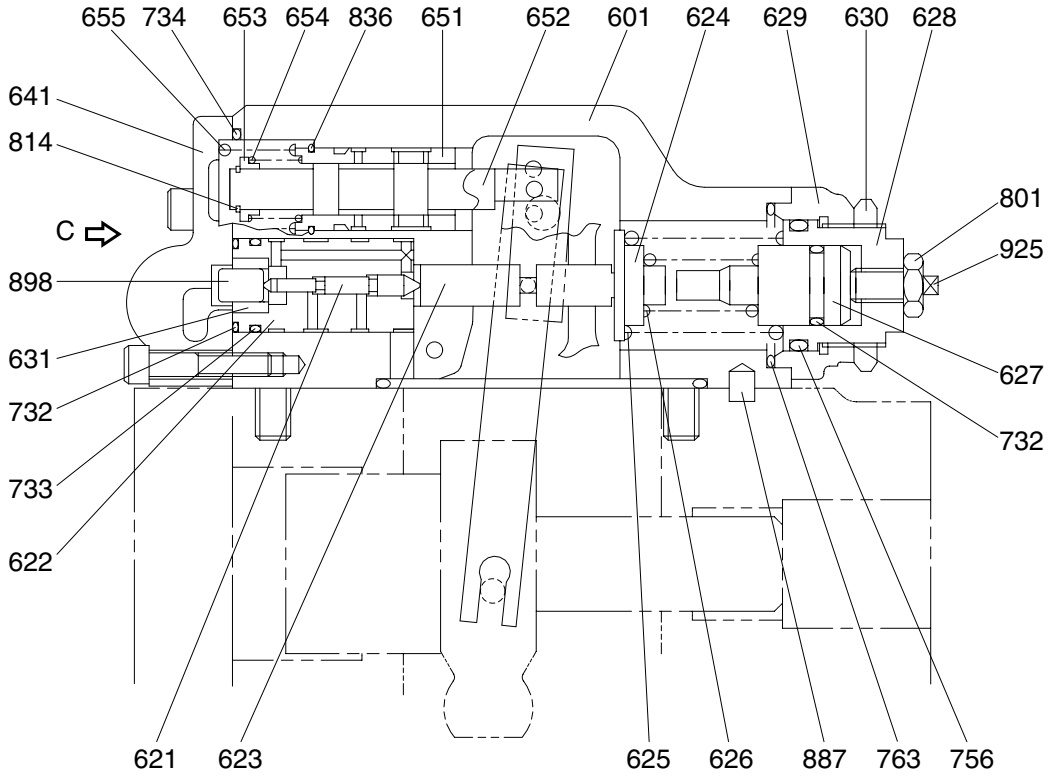


VIEW C

470072RG01

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	-
a	Gauge port	PF 1/4 - 15

FRONT REGULATOR(2/2)

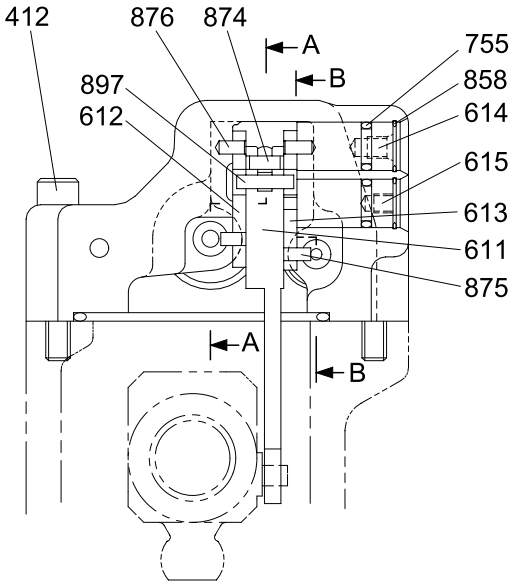


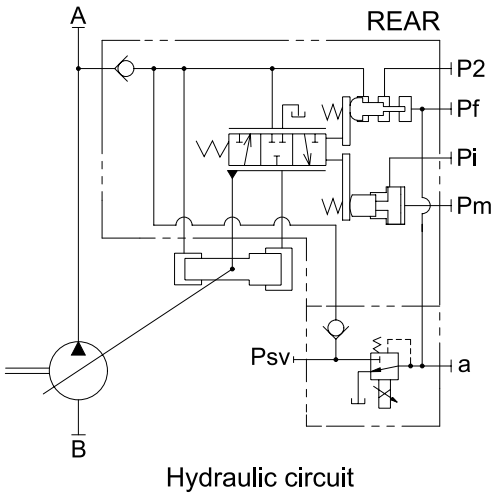
SECTION A-A

470072RG02

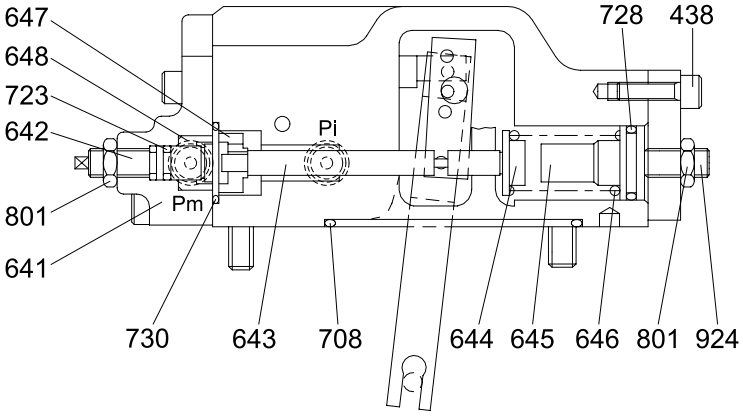
408	Hexagon socket screw	628	Adjust screw(C)	725	O-ring
412	Hexagon socket screw	629	Cover(C)	728	O-ring
413	Hexagon socket screw	630	Lock nut	730	O-ring
436	Hexagon socket screw	631	Sleeve, pf	732	O-ring
438	Hexagon socket screw	641	Pilot cover	733	O-ring
466	Plug	642	Adjust screw(QMC)	734	O-ring
496	Plug	643	Pilot piston	735	O-ring
541	Seat	644	Spring seat(Q)	755	O-ring
543	Stopper	645	Adjust stem(Q)	756	O-ring
545	Steel ball	646	Pilot spring	763	O-ring
601	Casing	647	Stopper	801	Nut
611	Feed back lever	648	Piston(QMC)	814	Snap ring
612	Lever(1)	651	Sleeve	836	Snap ring
613	Lever(2)	652	Spool(A)	858	Snap ring
614	Center plug	653	Spring seat	874	Spring pin
615	Adjust plug	654	Return spring	875	Pin
621	Compensator piston	655	Set spring	876	Pin
622	Piston case	696	Port cover	878	Pin
623	Compensator rod	697	Check valve plate	887	Pin
624	Spring seat(C)	708	O-ring	897	Pin
625	Outer spring	722	O-ring	898	Pin
626	Inner spring	723	O-ring	924	Set screw
627	Adjust stem(C)	724	O-ring	925	Adjust screw(QI)

3) REAR REGULATOR(1/2)

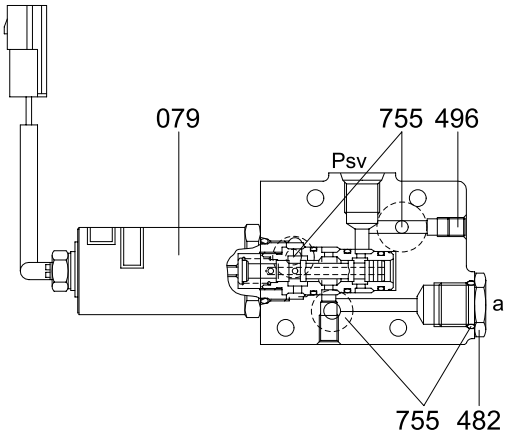




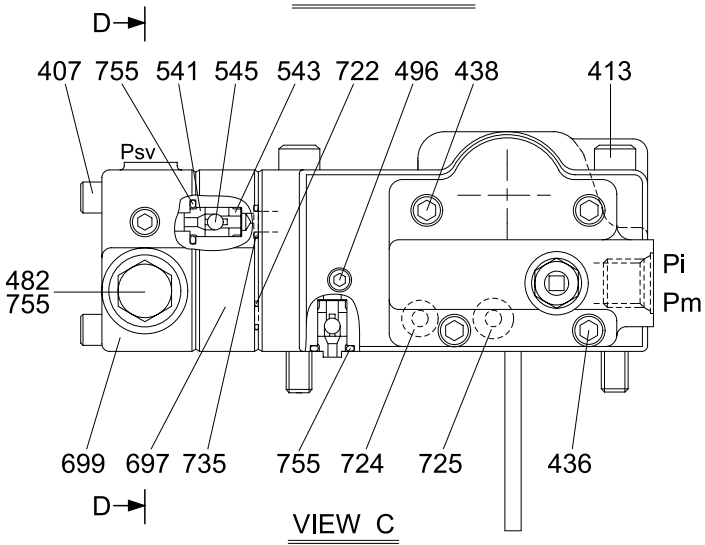
Hydraulic circuit



SECTION B-B



SECTION D-D

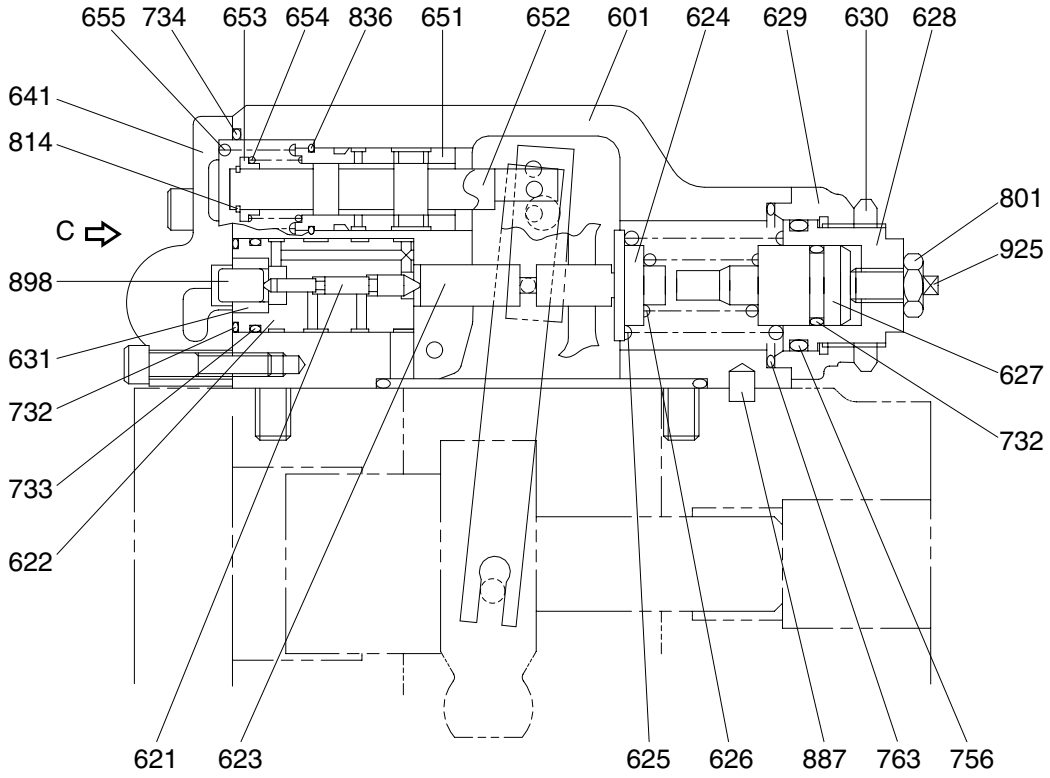


VIEW C

470072RG03

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	-
a	Gauge port	PF 1/4 - 15

REAR REGULATOR(2/2)

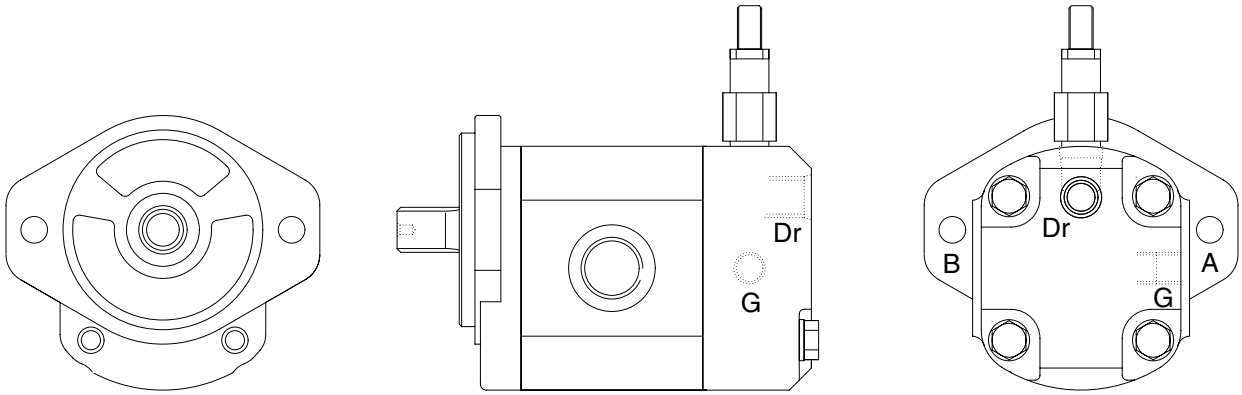


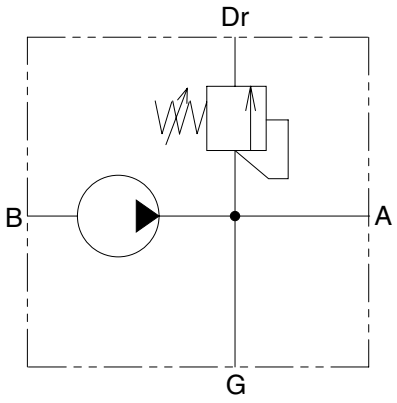
SECTION A-A

470072RG02

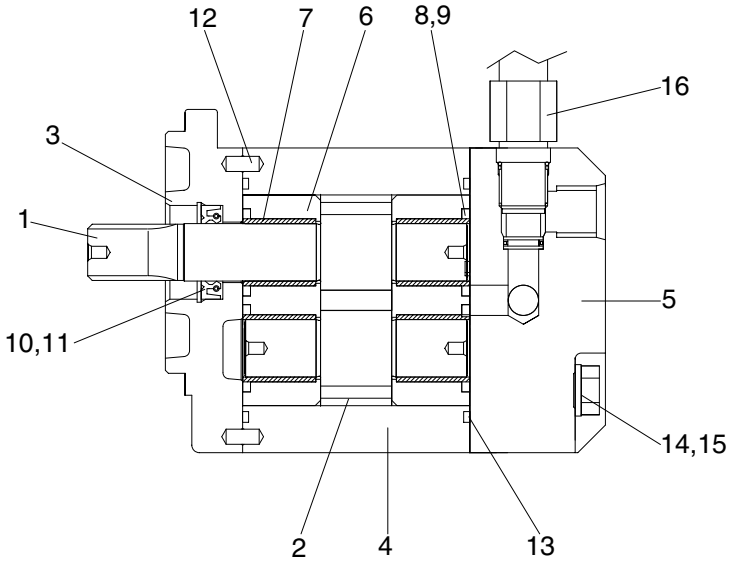
079	EPPR valve	627	Adjust stem(C)	724	O-ring
407	Hexagon socket screw	628	Adjust screw(C)	725	O-ring
412	Hexagon socket screw	629	Cover(C)	728	O-ring
413	Hexagon socket screw	630	Lock nut	730	O-ring
436	Hexagon socket screw	631	Sleeve, pf	732	O-ring
438	Hexagon socket screw	641	Pilot cover	733	O-ring
482	Plug	642	Adjust screw(QMC)	734	O-ring
496	Plug	643	Pilot piston	735	O-ring
541	Seat	644	Spring seat(Q)	755	O-ring
543	Stopper	645	Adjust stem(Q)	756	O-ring
545	Steel ball	646	Pilot spring	763	O-ring
601	Casing	647	Stopper	801	Nut
611	Feed back lever	648	Piston(QMC)	814	Snap ring
612	Lever(1)	651	Sleeve	836	Snap ring
613	Lever(2)	652	Spool(A)	858	Snap ring
614	Center plug	653	Spring seat	874	Spring pin
615	Adjust plug	654	Return spring	875	Pin
621	Compensator piston	655	Set spring	876	Pin
622	Piston case	697	Check valve plate	887	Pin
623	Compensator rod	699	Port cover	897	Pin
624	Spring seat(C)	708	O-ring	898	Pin
625	Outer spring	722	O-ring	924	Set screw
626	Inner spring	723	O-ring	925	Adjust screw(QI)

4) GEAR PUMP





Hydraulic circuit



470072GP01

Port	Port name	Port size
A	Delivery port	PF 1/2
B	Suction port	PF 1
G	Gauge port	PF 1/4
Dr	Drain port	PF 3/8

1	Gear shaft	9	Back up seal
2	Drive gear	10	Retainer seal
3	Cover(F)	11	Snap ring
4	Gear housing	12	Dowel pin
5	Cover(R)	13	O-ring
6	Block	14	Hexagon bolt
7	Bushing	15	Washer
8	Seal	16	Relief valve

2. FUNCTION

1) MAIN PUMP

The pumps may 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.

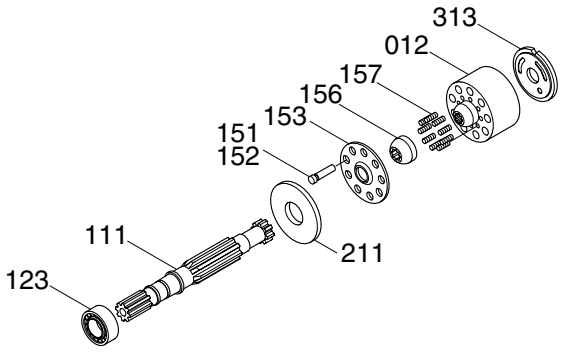
(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block(012), piston shoes(151,152), set plate(153), spherical 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 from a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and the 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.



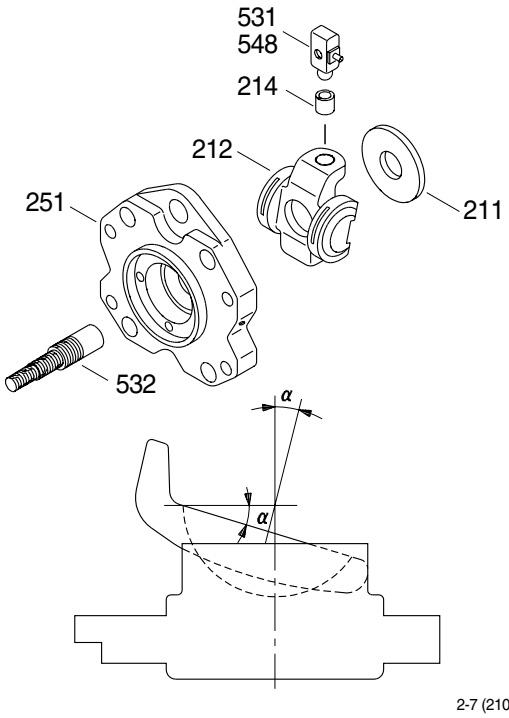
50072MP01

(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 cover group

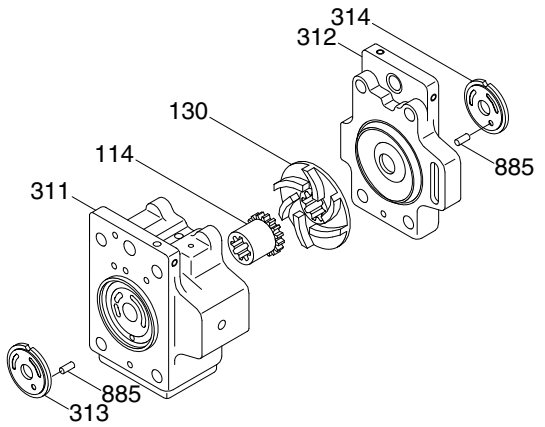
The valve cover group consists of valve cover(F, 311), valve cover(R, 312), valve plate(313, 314), spline coupling(114), booster(130) and valve plate pin(885).

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

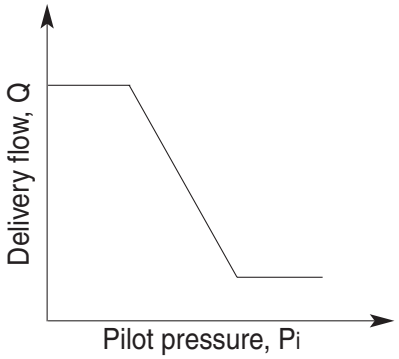
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

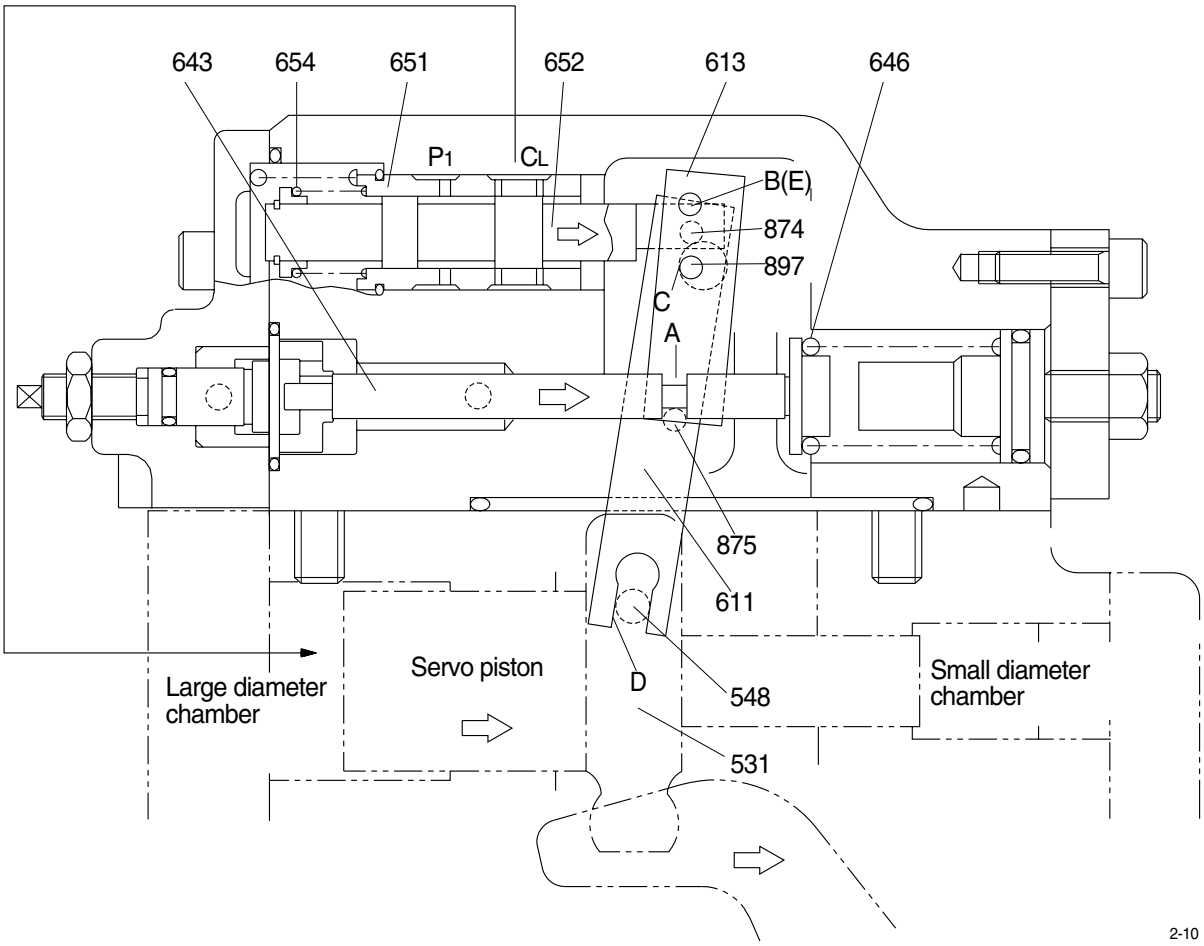
By changing the pilot pressure Pi, the pump tilting angle(delivery flow) is regulated arbitrarily, as shown in the figure.

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



As the pilot pressure Pi 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.

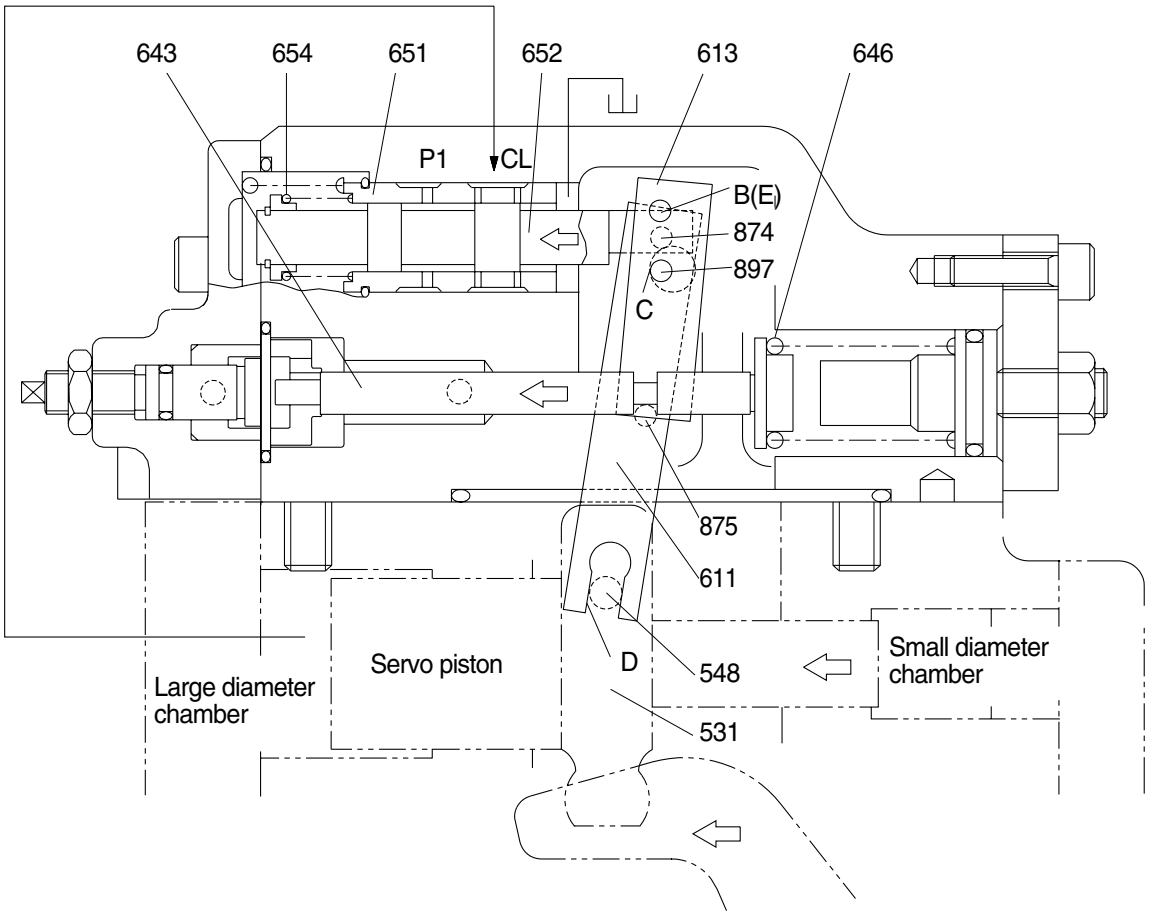
The groove(A) in the pilot piston is fitted with the pin(875) that is fixed to lever 2(613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B [Fixed by the fulcrum plug(614) and pin(875)]. Since the large hole section(C) of lever 2 contains a protruding pin(897) fixed 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 P1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P1 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



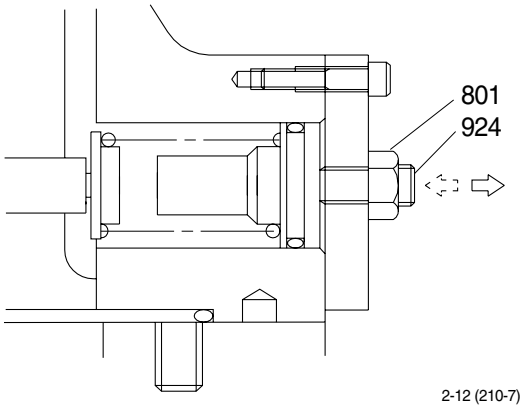
2-11

As the pilot pressure Pi 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 P1 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

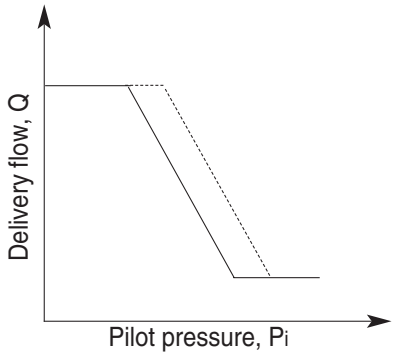
The flow control characteristic can be adjusted with the adjusting screw.
Adjust it by loosening the hexagon nut (801) and by tightening(or loosening) the hexagonal socket head screw(924).
Tightening the screw shifts the control chart to the right as shown in the figure.



2-12 (210-7)

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

Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw(924)	Flow control starting pressure change amount	Flow change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(ℓ /min)
1900	+1/4	+1.63	+22.2



(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.

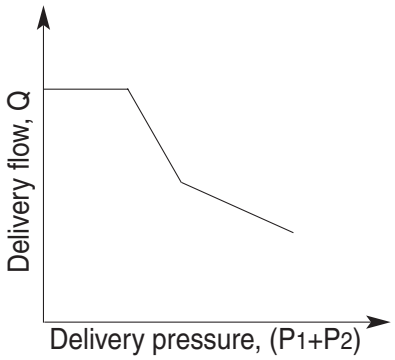
(The input horsepower is constant when the speed is constant.)

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.

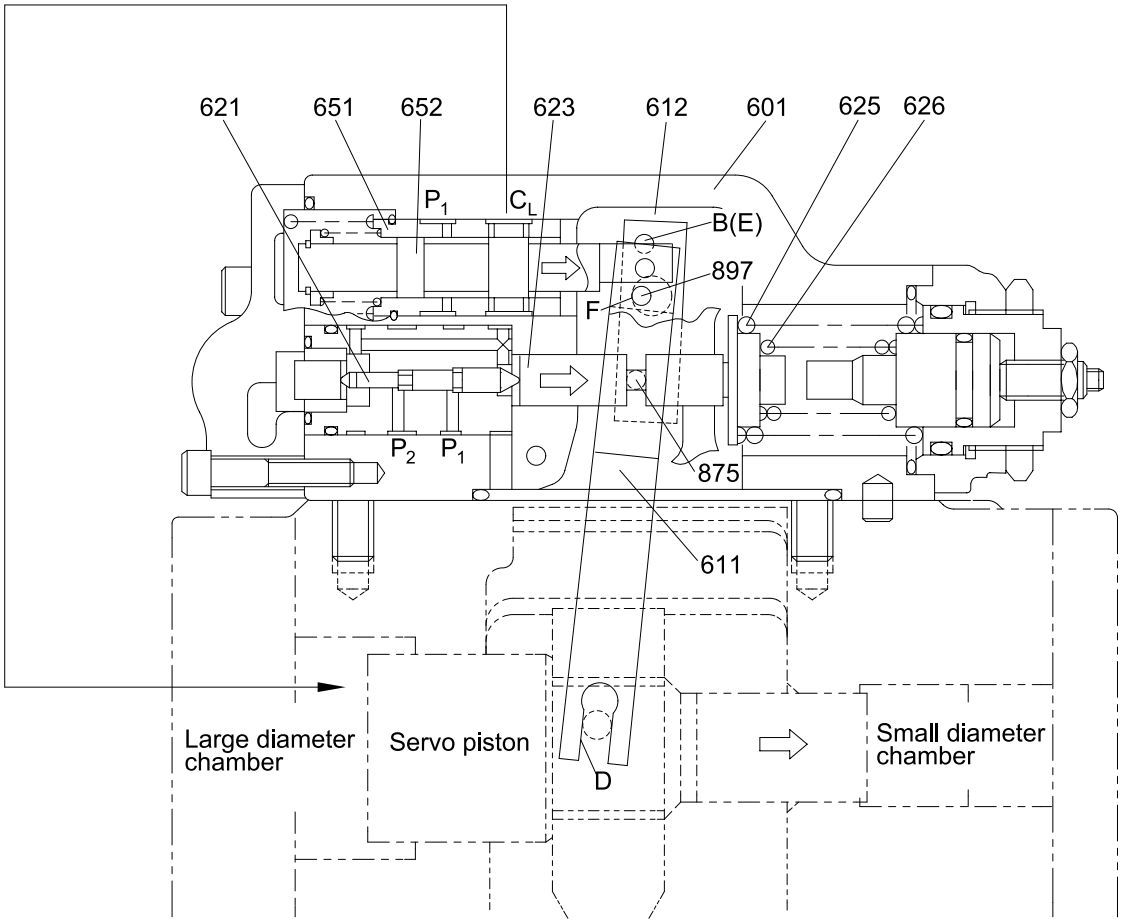
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles(displacement volumes) of the two pumps to the same value as represented by the following equation :

$$Tin = P1 \times q/2\pi + P2 \times q/2\pi$$
$$= (P1+P2) \times q/2\pi$$

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).



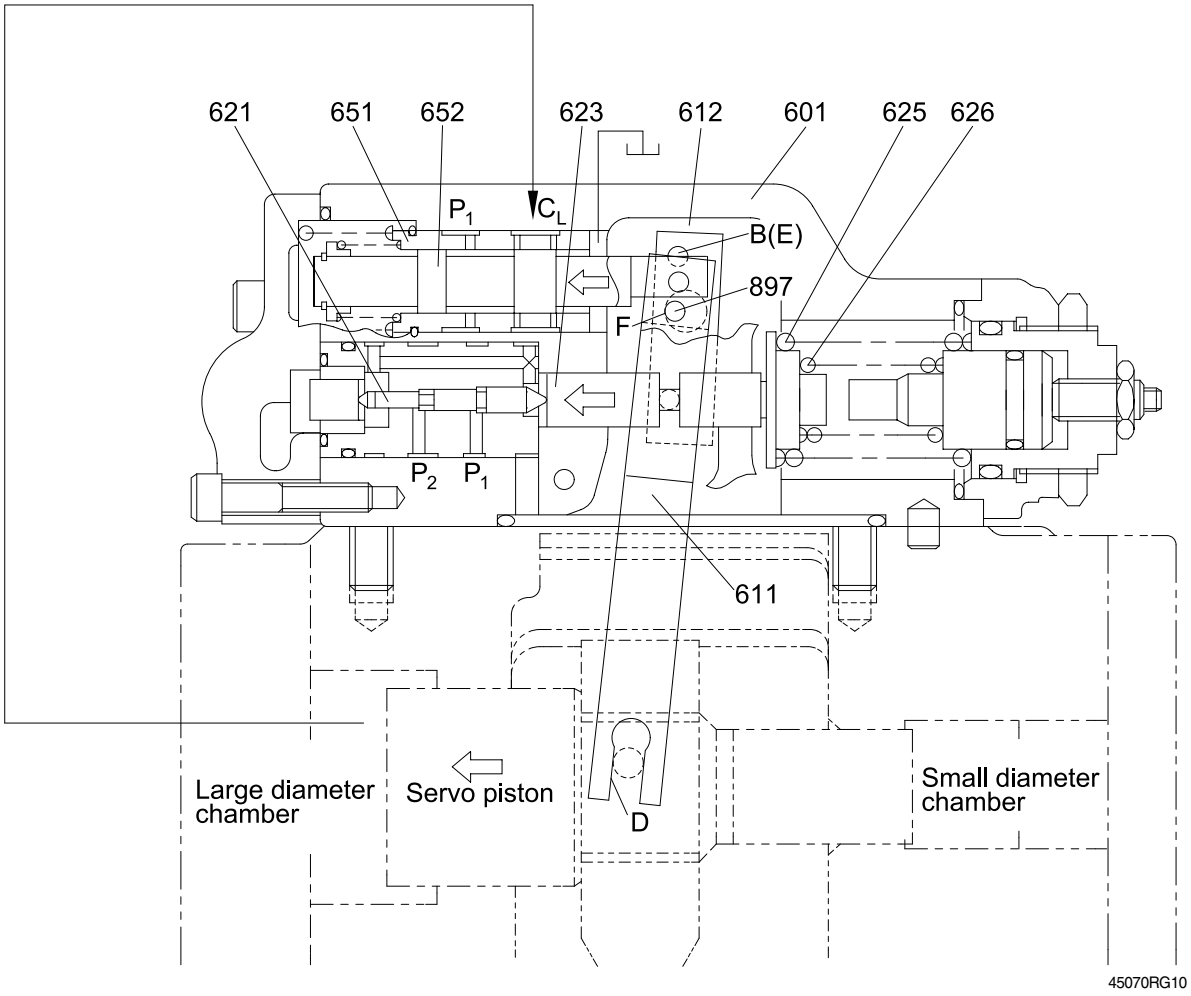
① Overload preventive function



45070RG09

When the self pump delivery pressure P1 or the companion pump delivery pressure P2 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 P1 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**



As the self pump delivery pressure P1 or the companion pump delivery pressure P2 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(ø 4) protruding from the large hole(ø 8), only the lever lessening the tilting angle contacts the pin(897) ; the hole(ø 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**

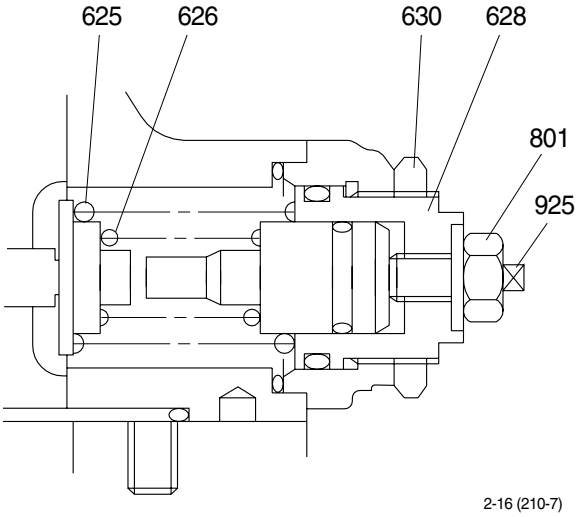
Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one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

a. Adjustment of outer spring

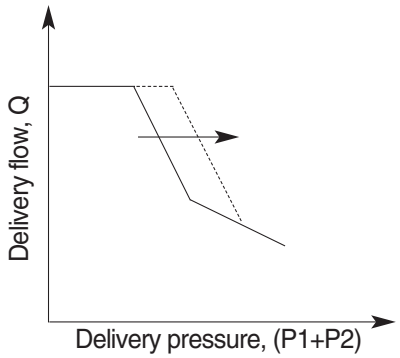
Adjust it by loosening the hexagon nut(630) and by tightening(or loosening) the adjusting screw C(628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring(626), return the adjusting screw CI(925) by N × A turns at first.(A=1.54)

※ **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)
1900	+1/4	+17.85	+9.7



2-16 (210-7)



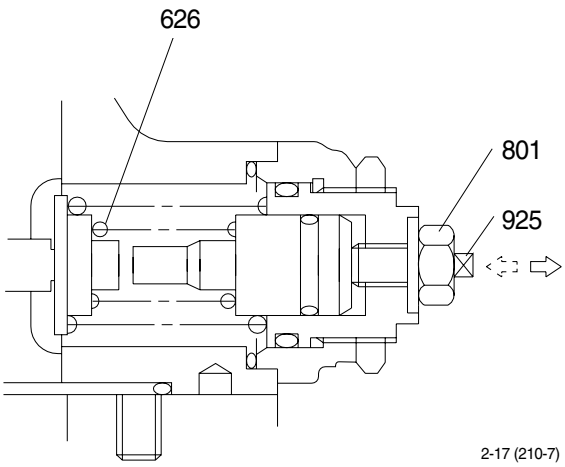
b. Adjustment of inner spring

Adjust it by loosening the hexagon nut (801) and by tightening(or loosening) the adjusting screw QI(925).

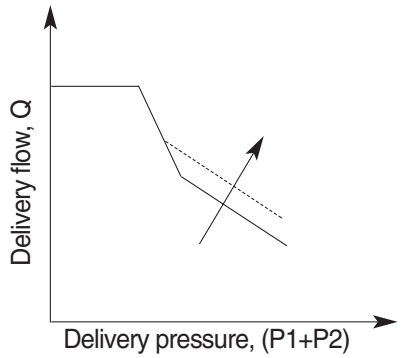
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table.

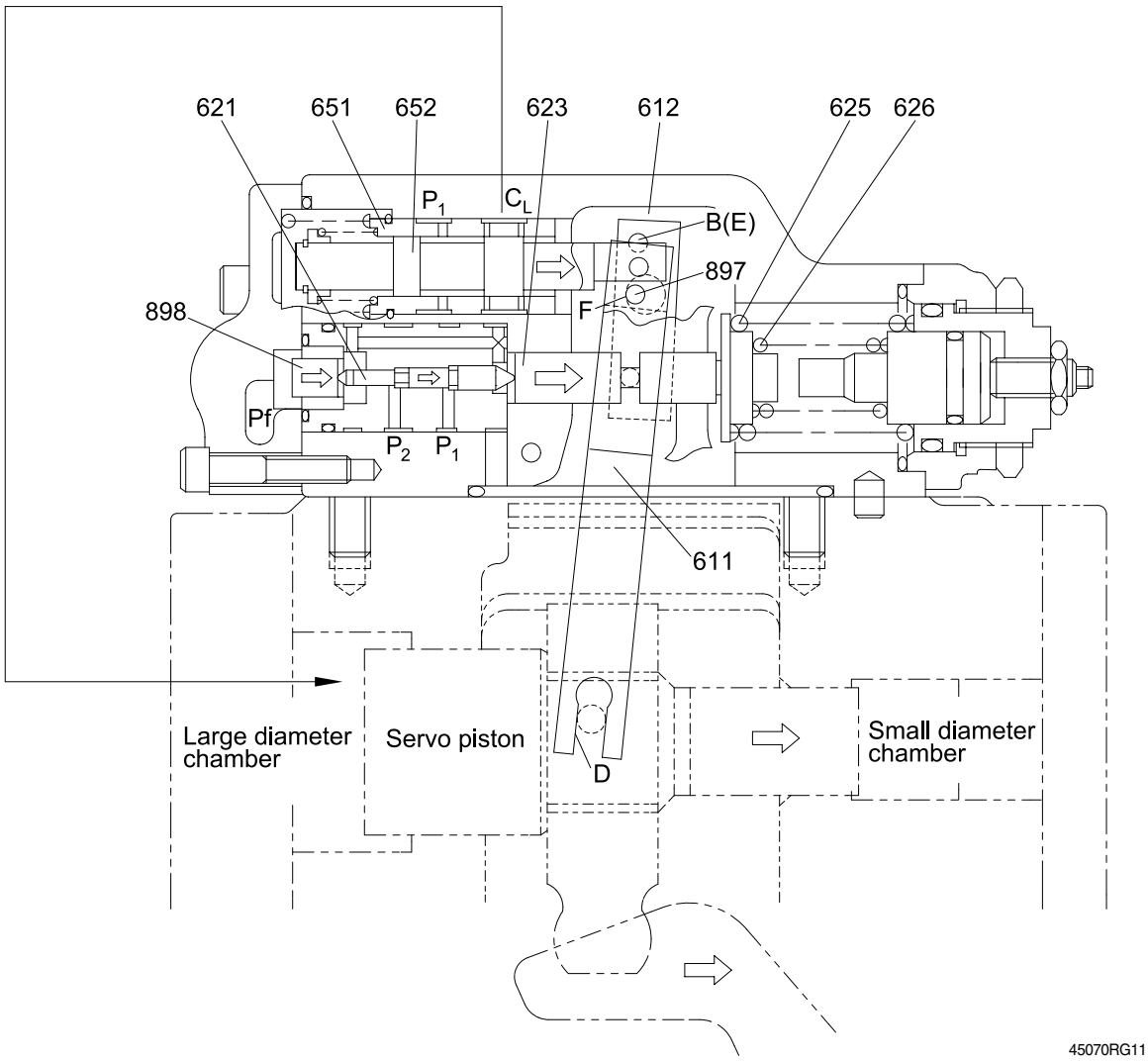
Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw(QI) (925)	Flow change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(lpm)	(kgf · m)
1900	+1/4	+19.6	+10.4



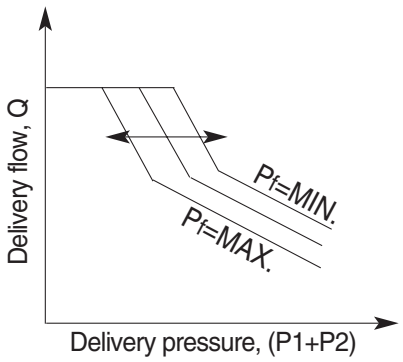
2-17 (210-7)



(3) Power shift control



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 Pf (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 Pf controls the set horsepower of the pump to a desired level, as shown in the figure.
As the power shift pressure Pf 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 Pf falls.

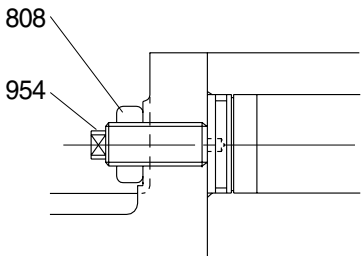
(4) Adjustment of maximum and minimum flows

① Adjustment of maximum flow

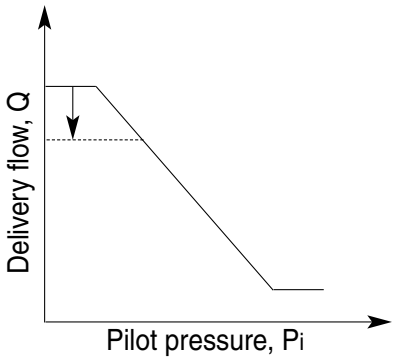
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the set screw(954).

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

Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min^{-1})	(Turn)	(ℓ /min)
1900	+1/4	-7.3



2-19(1)

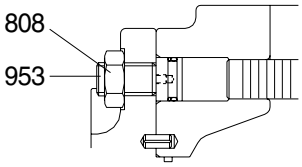


② Adjustment of minimum flow

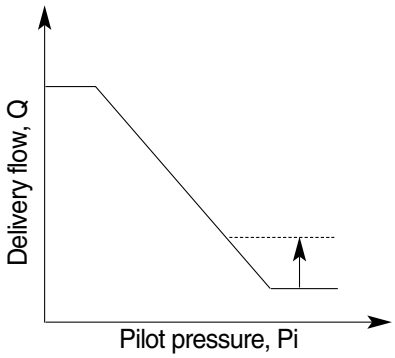
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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	
	Tightening amount of adjusting screw (953)	Flow change amount
(min^{-1})	(Turn)	(ℓ /min)
1900	+1/4	+7.3

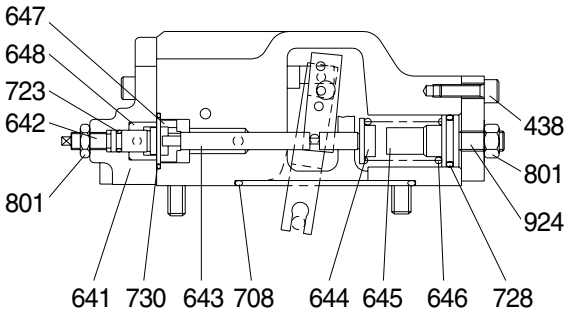


2-19(2)



(5) Qmax cut control

The regulator regulates the maximum delivery flow by inputting the pilot pressure Pm. Since this is a 2-position control method, the maximum delivery flow may be switched in two steps by turning on/off the pilot pressure Pm.(The maximum control flow cannot be controlled in intermediate level.)



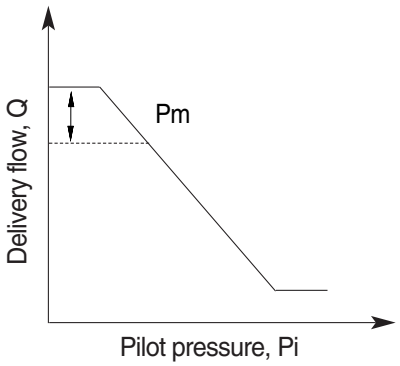
2-4

① Functional explanation

As shown in the figure, the pilot pressure Pm switches the maximum flow in two steps.

When the pilot pressure Pm is given, it is admitted to the lefthand side of the piston QMC(648). The piston QMC moves the stopper(647) and pilot piston(643) to the right, overcoming the force of the pilot spring(646), thereby reducing the delivery flow of the pump.

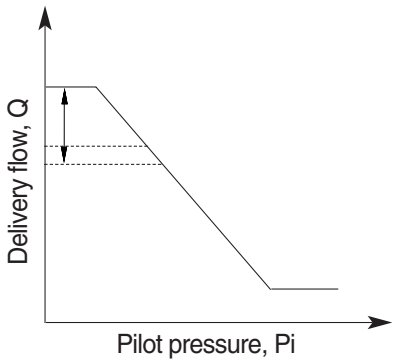
Since the adjusting screw QMC(642) is provided with a flange, the piston QMC stops upon contact with the flange, and the position of the pilot piston at this time determines the maximum flow of the pump.



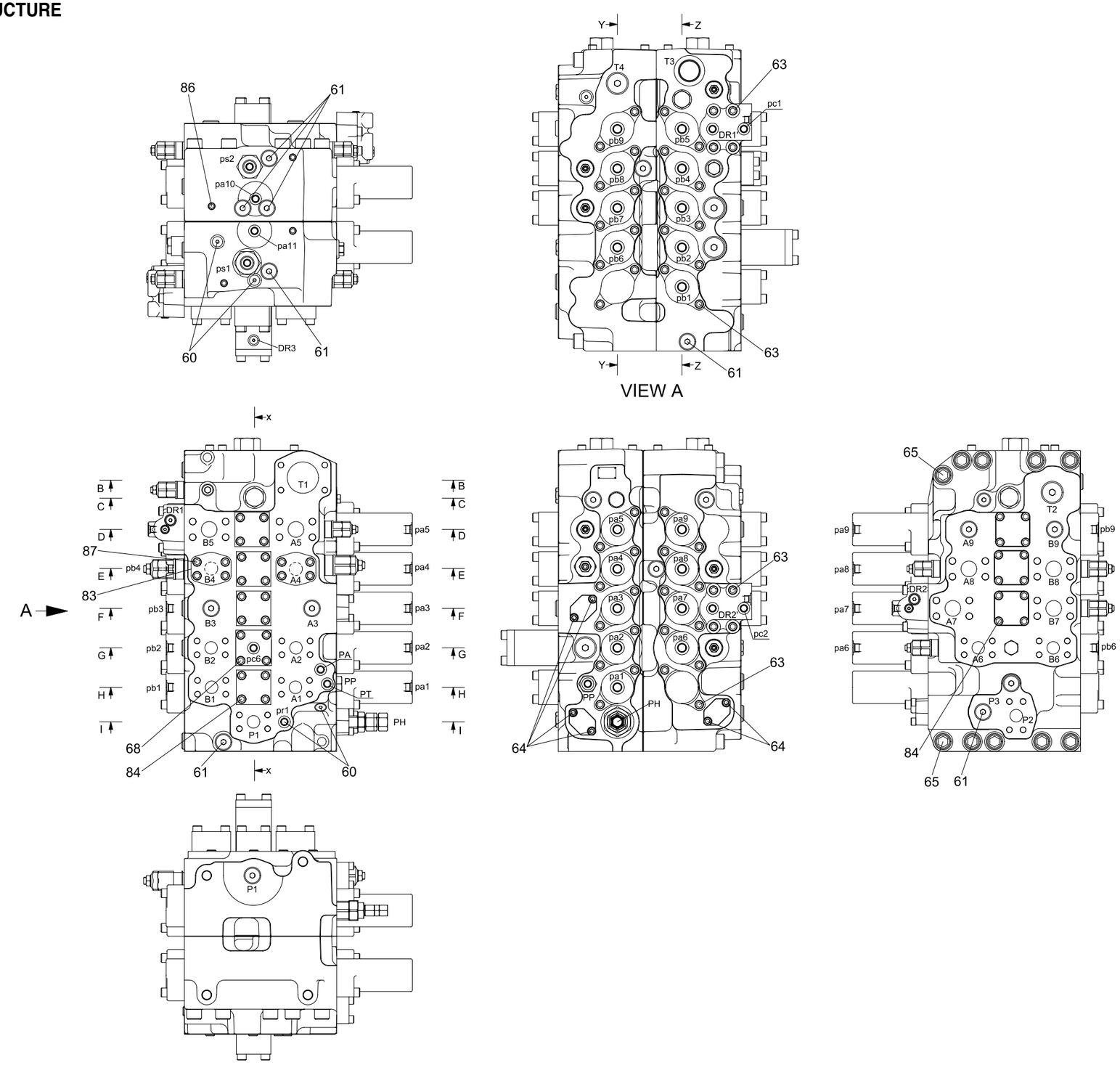
② Adjustment of Qmax cut flow

Adjust it by loosening the hexagon nut(801) and by tightening(or loosening) the adjusting screw QMC(642).

Tightening the screw decreases the Qmax cut flow as shown in the figure.



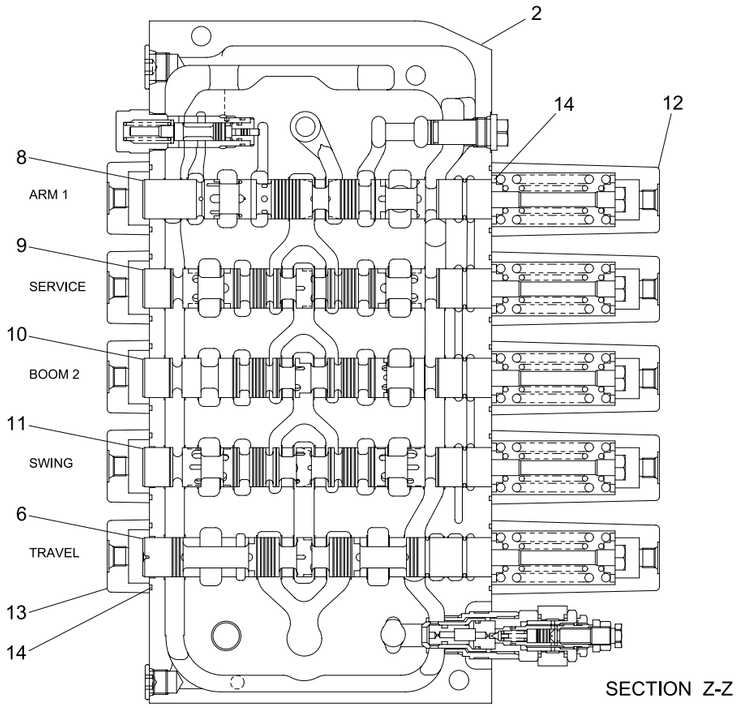
1. STRUCTURE



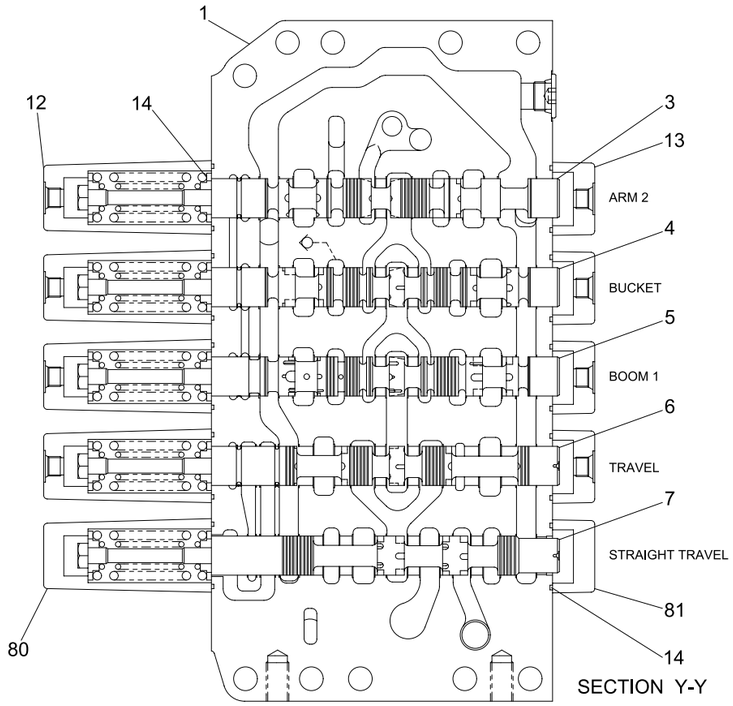
Mark	Port size	Thread depth (mm)
DR1, DR2, DR3, DR1', DR2', pr1, ps1, ps2, pc1, pc2, pc6, pa10, pa11, PA, PP, PH	PF 1/4	12
pa1~pa9, pb1~pb9	PF 3/8	14
A3, A9, B3, B9, P1, P3	PF 1/2	16
T3, T4	PF 3/4	17
T2	PF 1	21

1	Valve housing	41	Back up ring
2	Valve housing	42	Body
3	Spool assy(AM2)	43	Piston
4	Spool assy(BKT)	44	Flange
5	Spool assy(BM1)	45	O-ring
6	Spool assy(TR)	46	Poppet
7	Spool assy(S/TR)	47	Body assy
8	Spool assy(AM1)	48	Relief valve kit
9	Spool assy(SER)	49	Relief valve kit
10	Spool assy(BM2)	50	Relief valve assy
11	Spool assy(SW)	51	Plug assy
12	Cap	52	Poppet
13	Cap	53	Spring
14	O-ring	54	Plug
15	Poppet	55	O-ring
16	Spring	56	Flange
17	Spacer	57	O-ring
18	O-ring	59	Plug assy
19	Back up ring	60	Plug assy
20	Spool assy	61	Plug assy
21	Spring seat(A)	62	Plug assy
22	Spring	63	Socket head bolt
23	Plug	64	Socket head bolt
24	Spool assy	65	Socket head bolt
25	Spring	68	Socket head bolt
26	O-ring	69	Poppet
27	Plug	72	Relief valve kit
28	Poppet	76	O-ring
29	Spring	77	O-ring
30	Poppet	78	O-ring
31	Poppet	79	O-ring
32	Poppet	80	Cap
33	Spring	81	Cap
34	Flange	82	Steel ball
35	O-ring	83	Flange
36	Poppet assy	84	Socket head bolt
37	Spring	85	O-ring
38	Sleeve	86	Socket head bolt
39	Piston	87	Socket head bolt
40	O-ring		

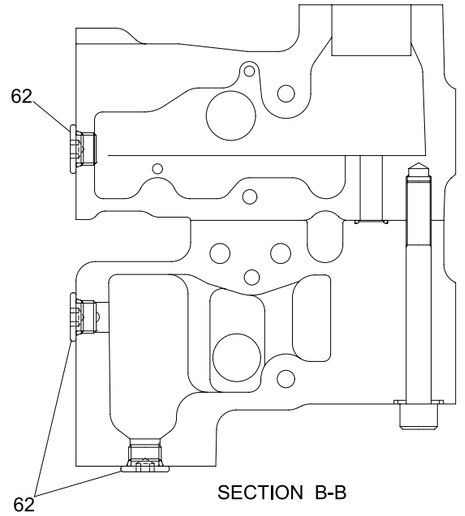
45071MC21



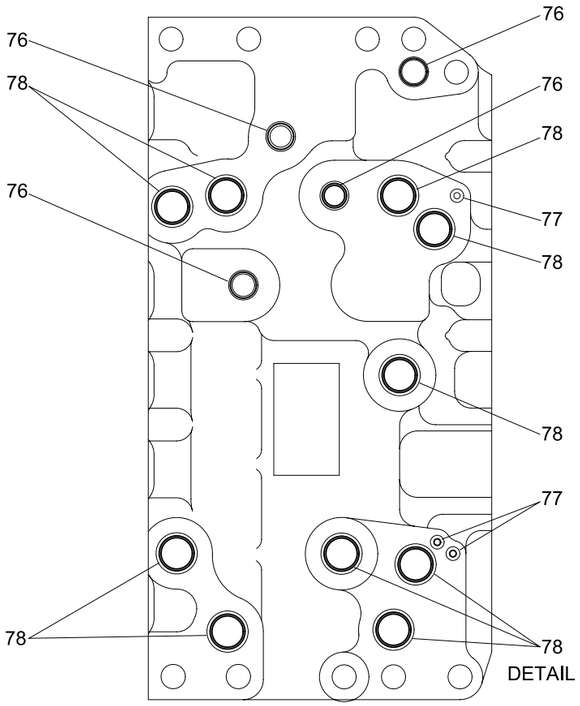
SECTION Z-Z



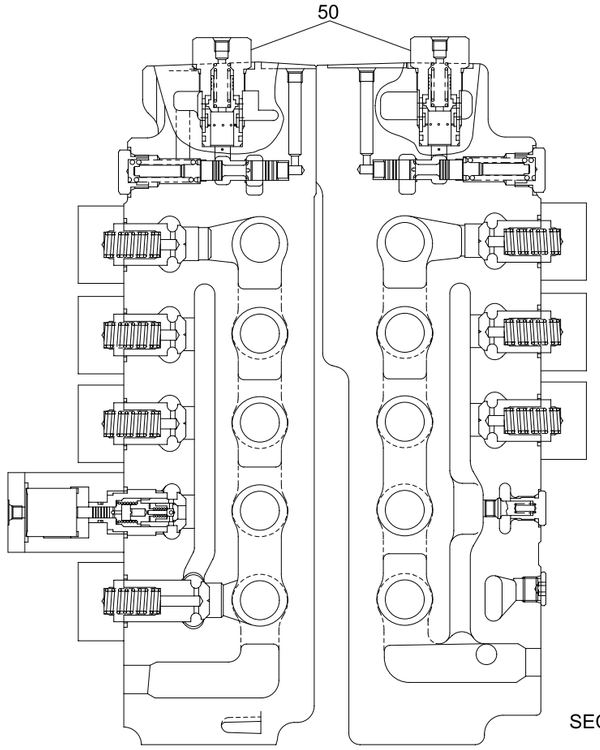
SECTION Y-Y



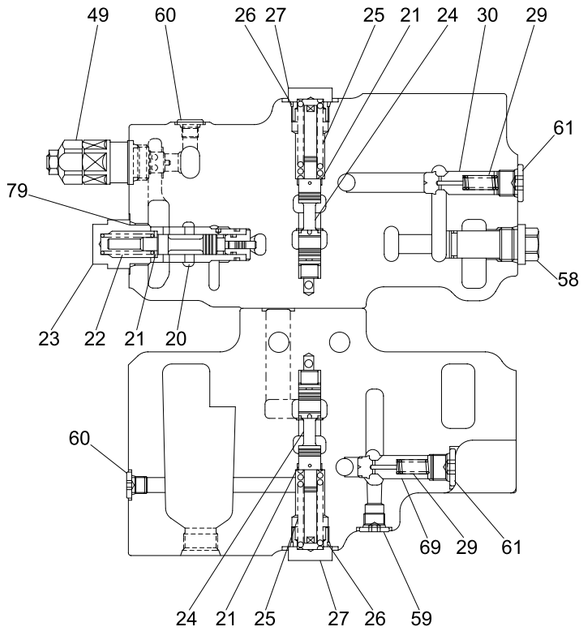
SECTION B-B



DETAIL OF COMBINED PLANE

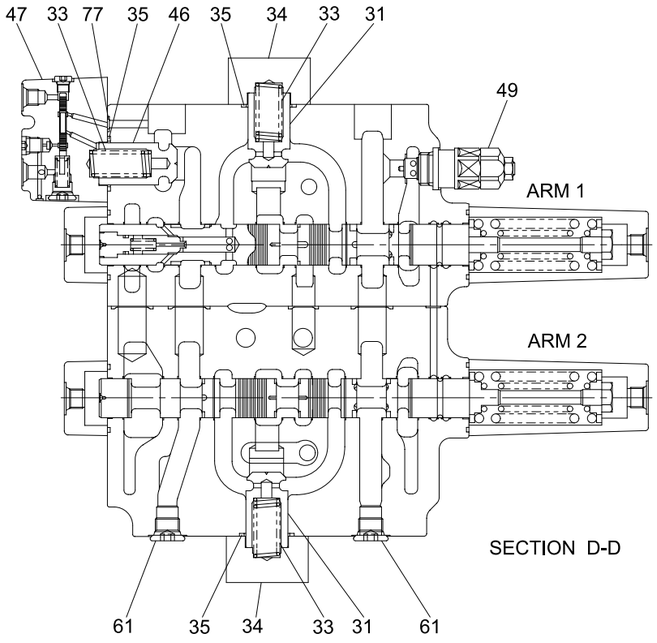


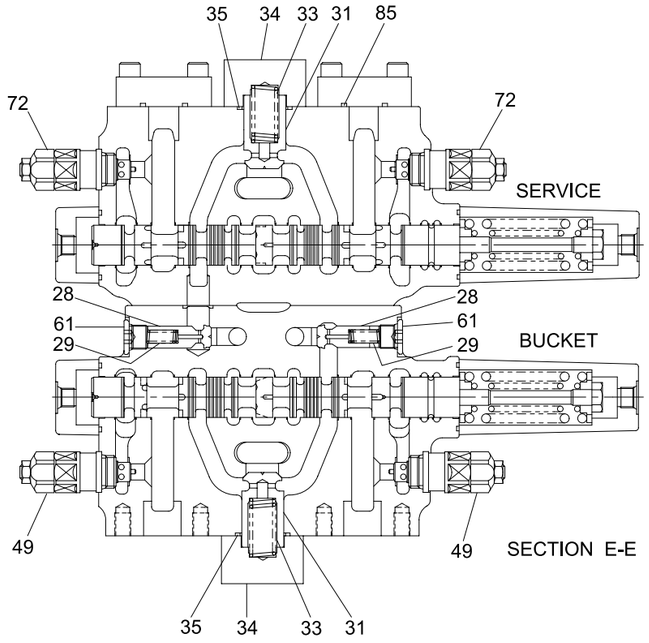
SECTION X-X

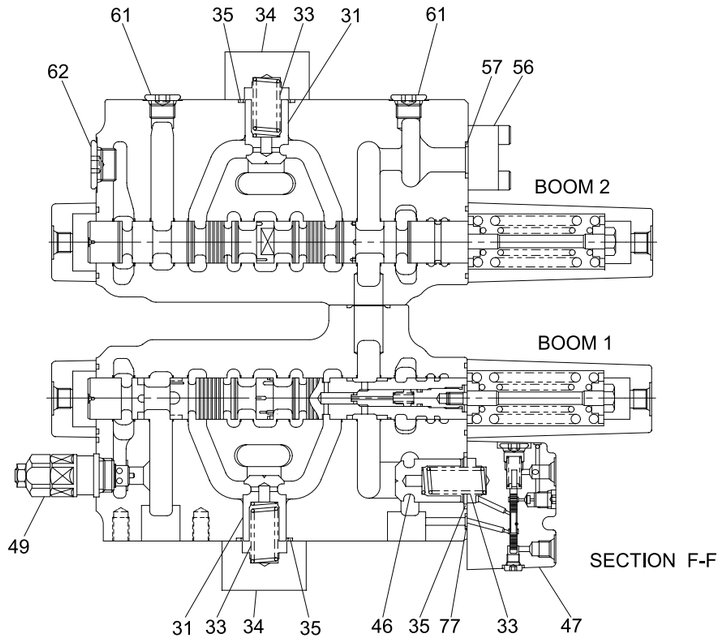


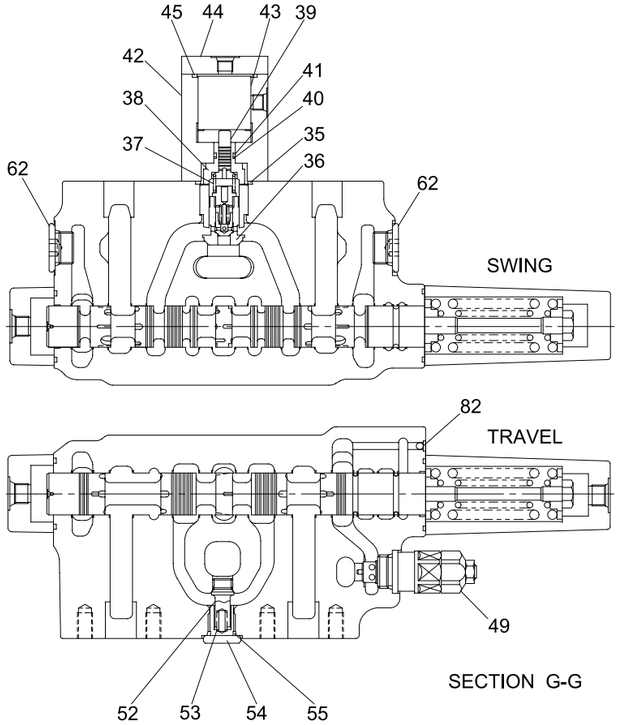
SECTION C-C

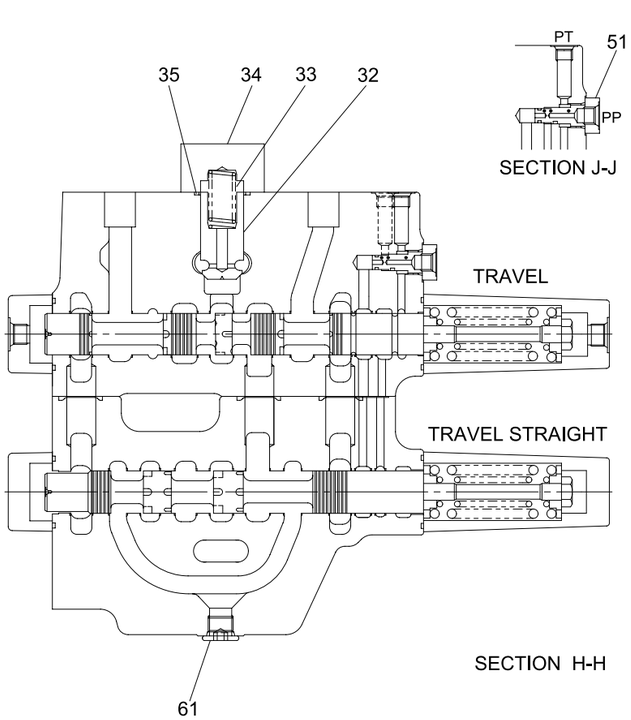
45071MC22

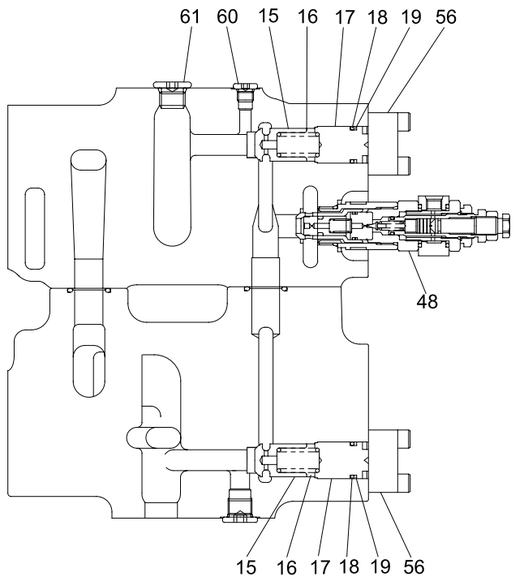

47 33 77 35 46 35 34 33 31
49
ARM 1
ARM 2
SECTION D-D
61 35 34 33 31 61


35 34 33 31 85
72
72
SERVICE
28
28
61
61
BUCKET
29
29
49
49
SECTION E-E
35 34 33 31


61 35 34 33 31 61
62
57 56
BOOM 2
BOOM 1
49
SECTION F-F
31 33 34 35 46 35 77 33 47

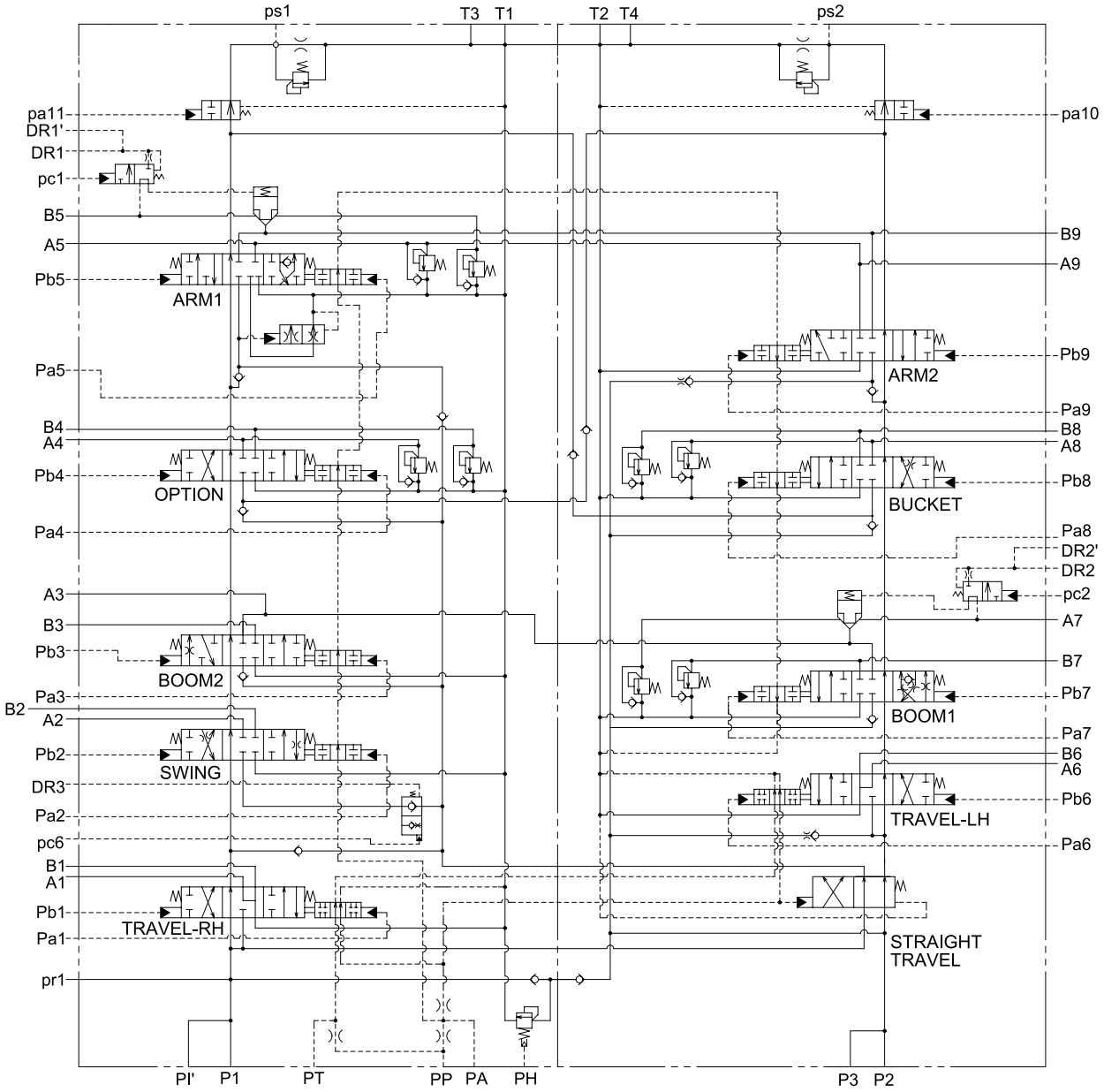

45 44 43 39
42
41
38
40
37
35
36
62
62
SWING
82
TRAVEL
49
SECTION G-G
52 53 54 55


PT
51
PP
SECTION J-J
35 34 33 32
TRAVEL
TRAVEL STRAIGHT
SECTION H-H
61


61 60 15 16 17 18 19 56
48
15 16 17 18 19 56
SECTION I-I

45071MC23

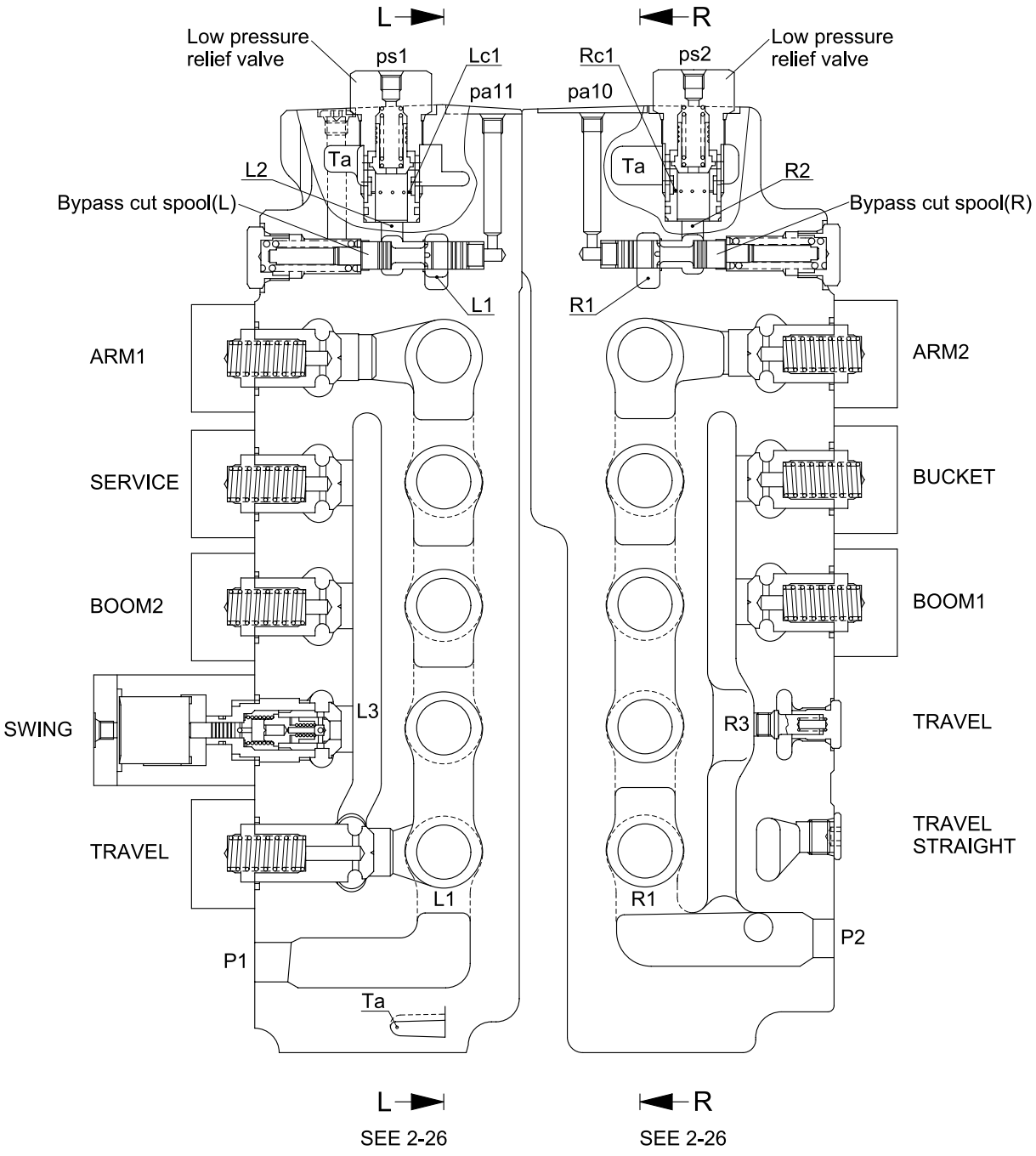
2. HYDRAULIC CIRCUIT



45071MC20

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.

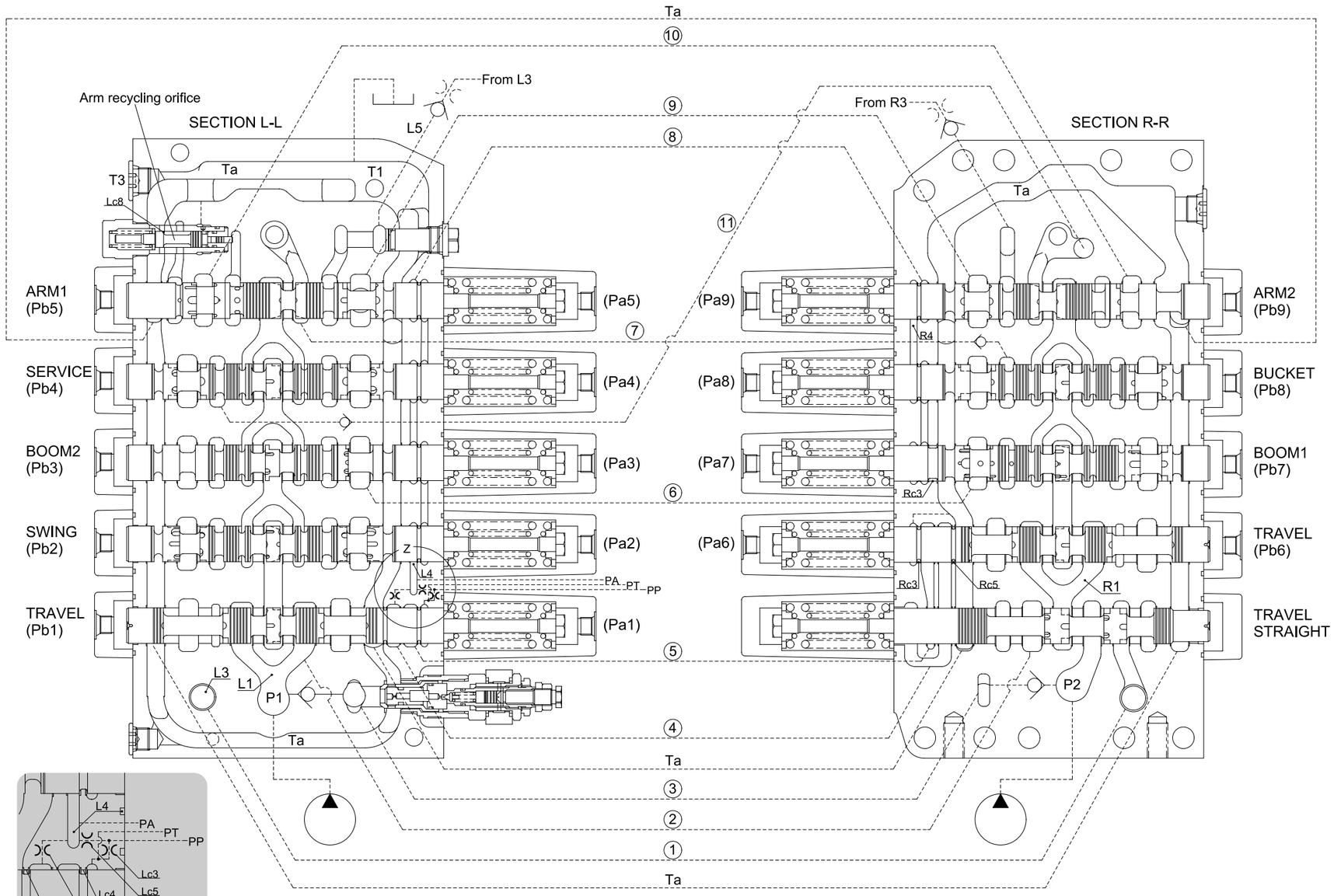
④ When a large amount of oil flows the neutral passage, the low pressure relief valves is operated. As a result, the shock pressure of port ps1, ps2 is prevented.

(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.



DETAIL Z

45071MC02

2) SINGLE OPERATION

(1) Travel spool

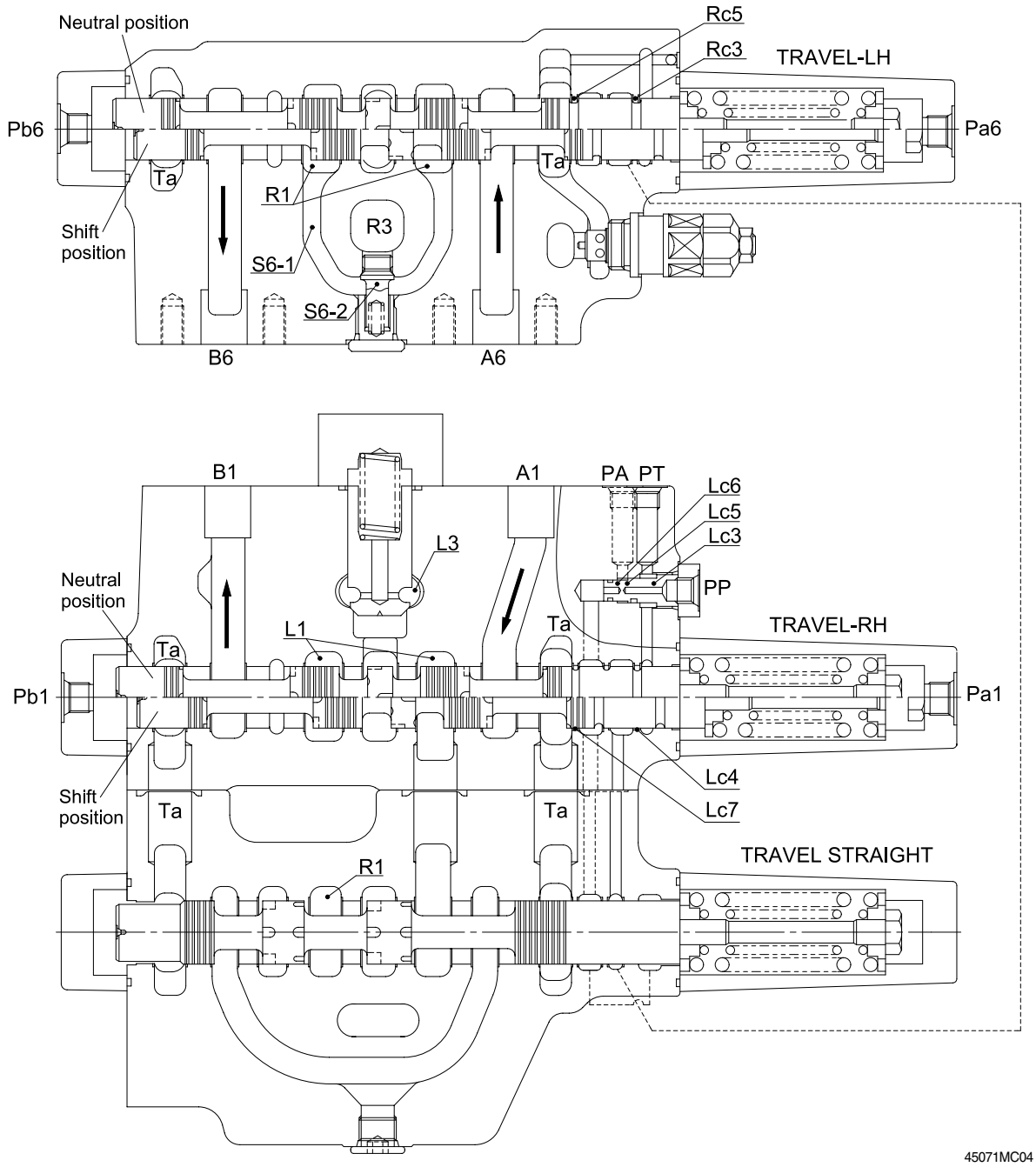
When the RH travel spool is pushed to right by the pilot pressure of port Pb1 the oil discharged from P1 port flows from the neutral passage(L1) to B1 port.

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

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

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

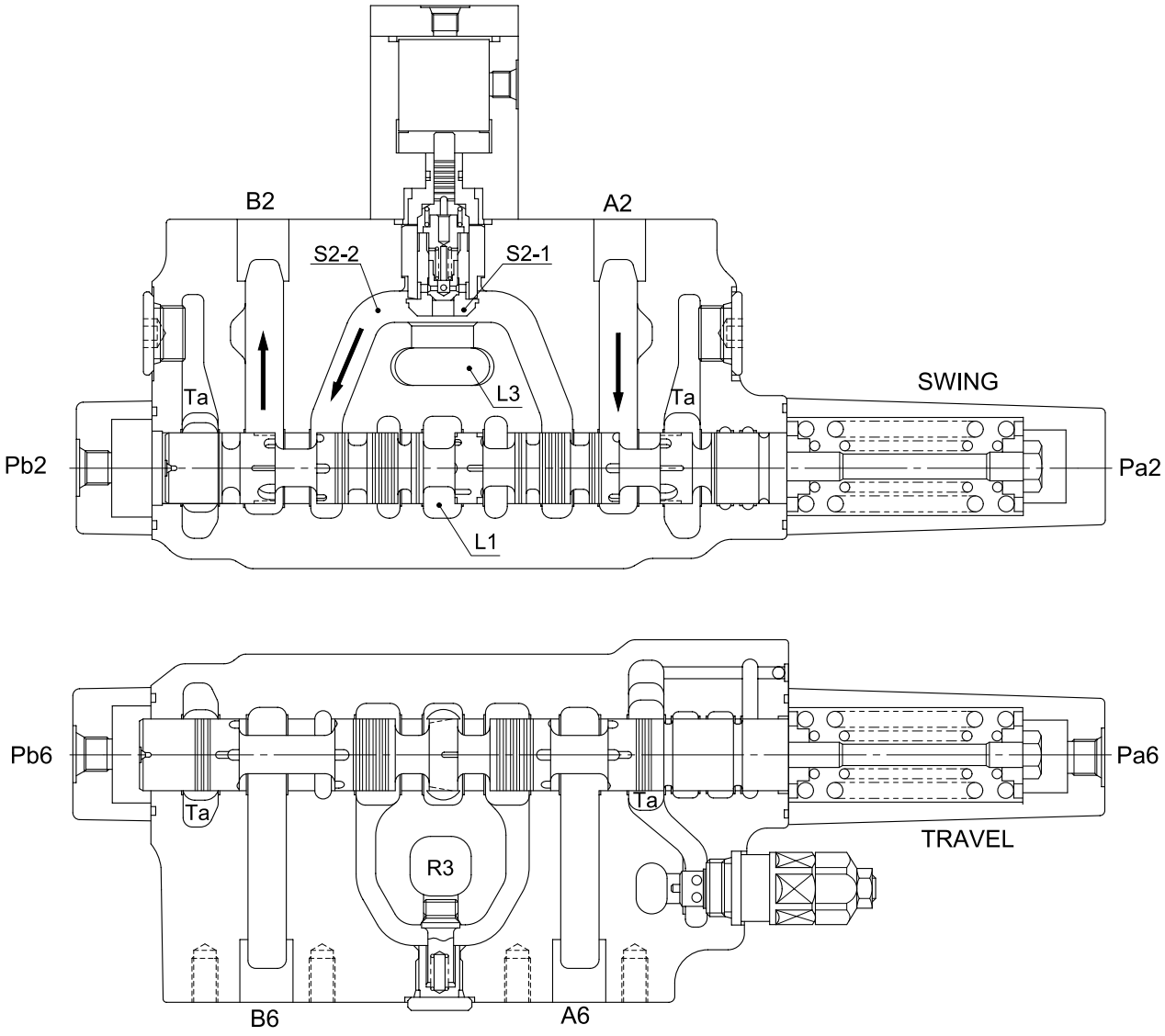
When the travel spool is pushed to the right by the pilot pressure, the land(Lc4, Rc3) is closed and the tank passage of the oil discharged from port PP is closed, and then the pressure of PT port is increased.



(2) Swing spool

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

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

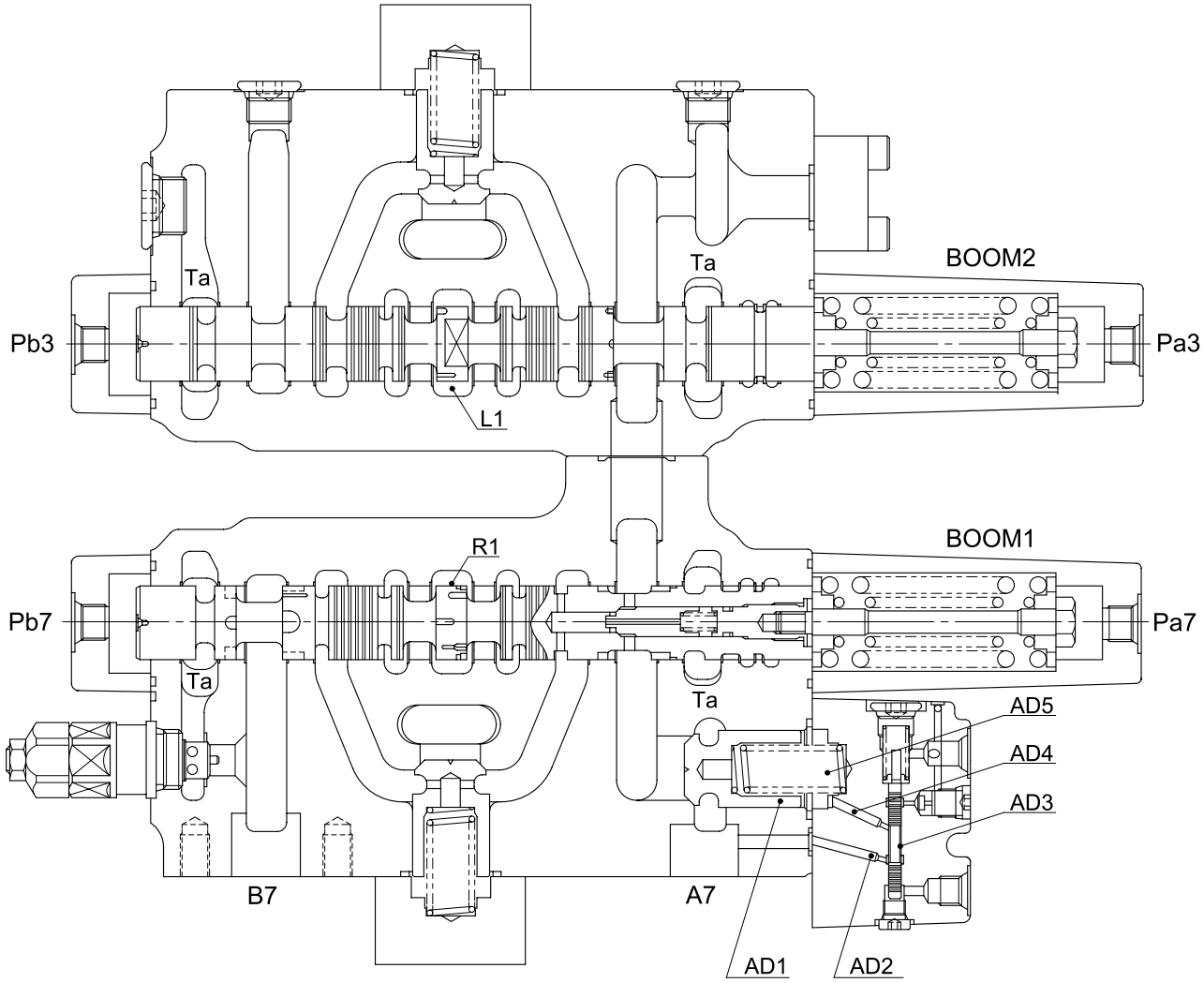


45071MC05

3) BOOM SPOOL

(1) Neutral

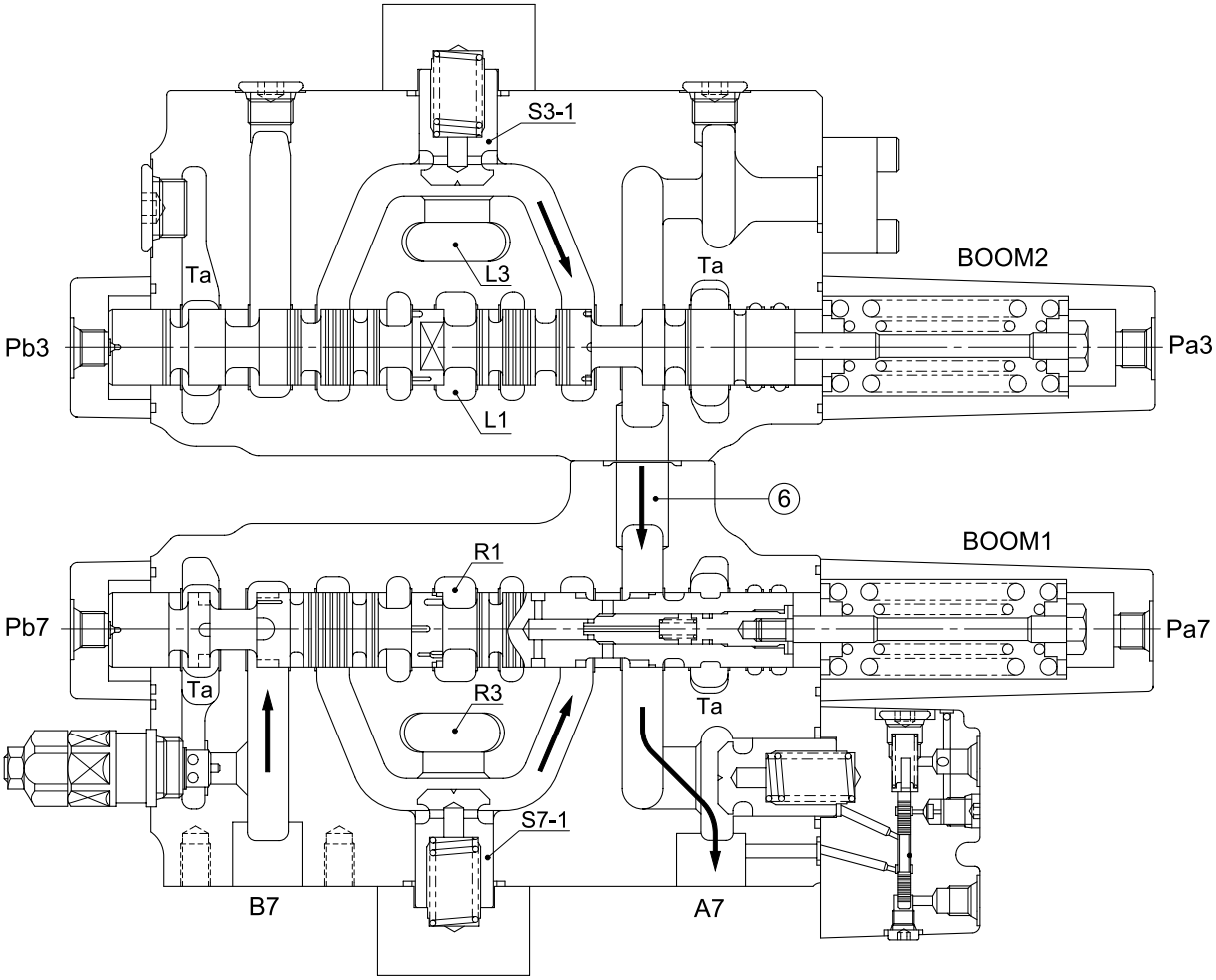
This valve is providing the anti-drift valve on the cylinder bottom side of boom 1 section. In neutral, the poppet(AD1) is seated by the pressure of spring chamber(AD5) because the oil from the port A7 is connection with spring chamber(AD5) via passage(AD2), spool(AD3) and passage(AD4).



(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).

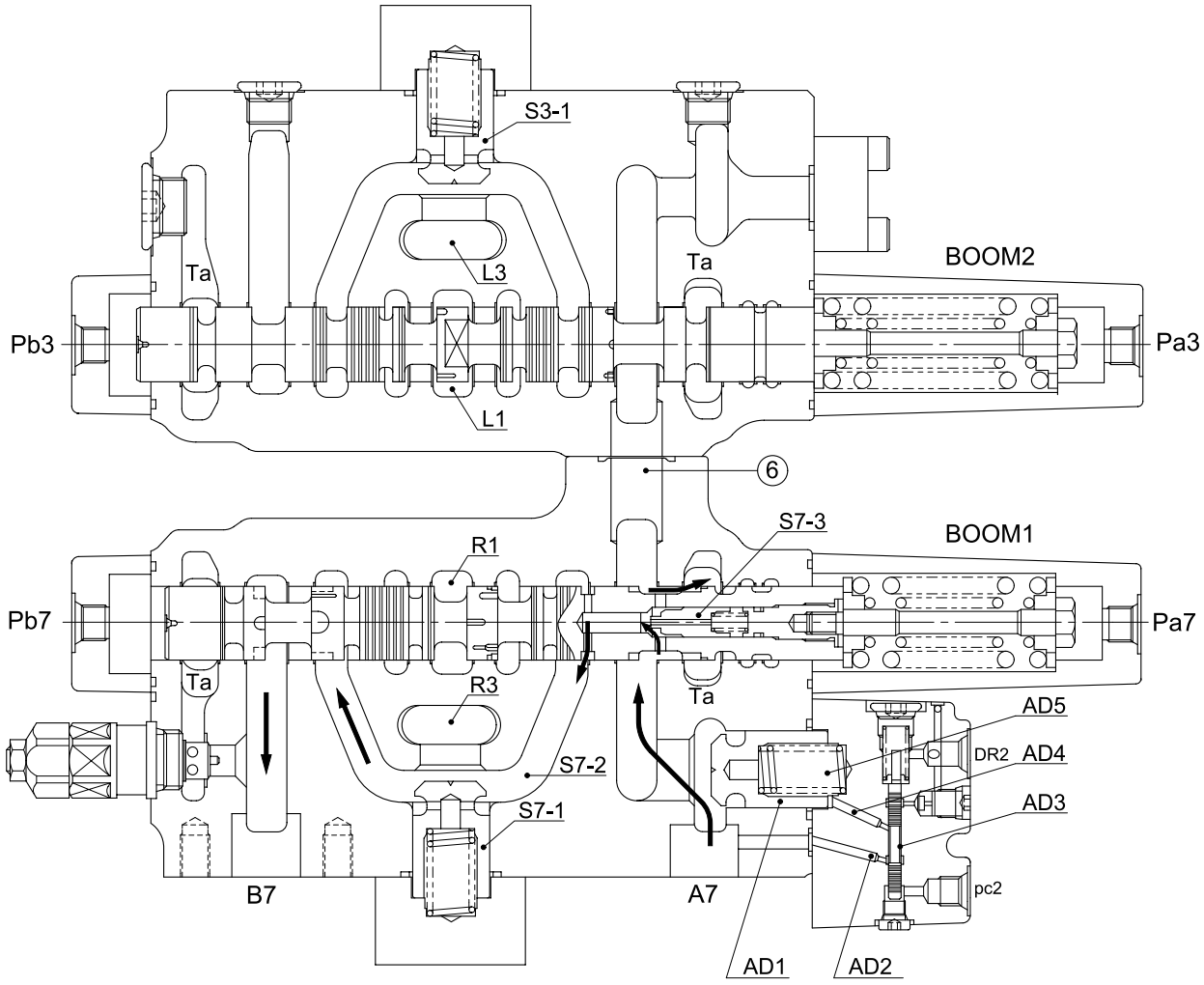


45071MC07

(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).

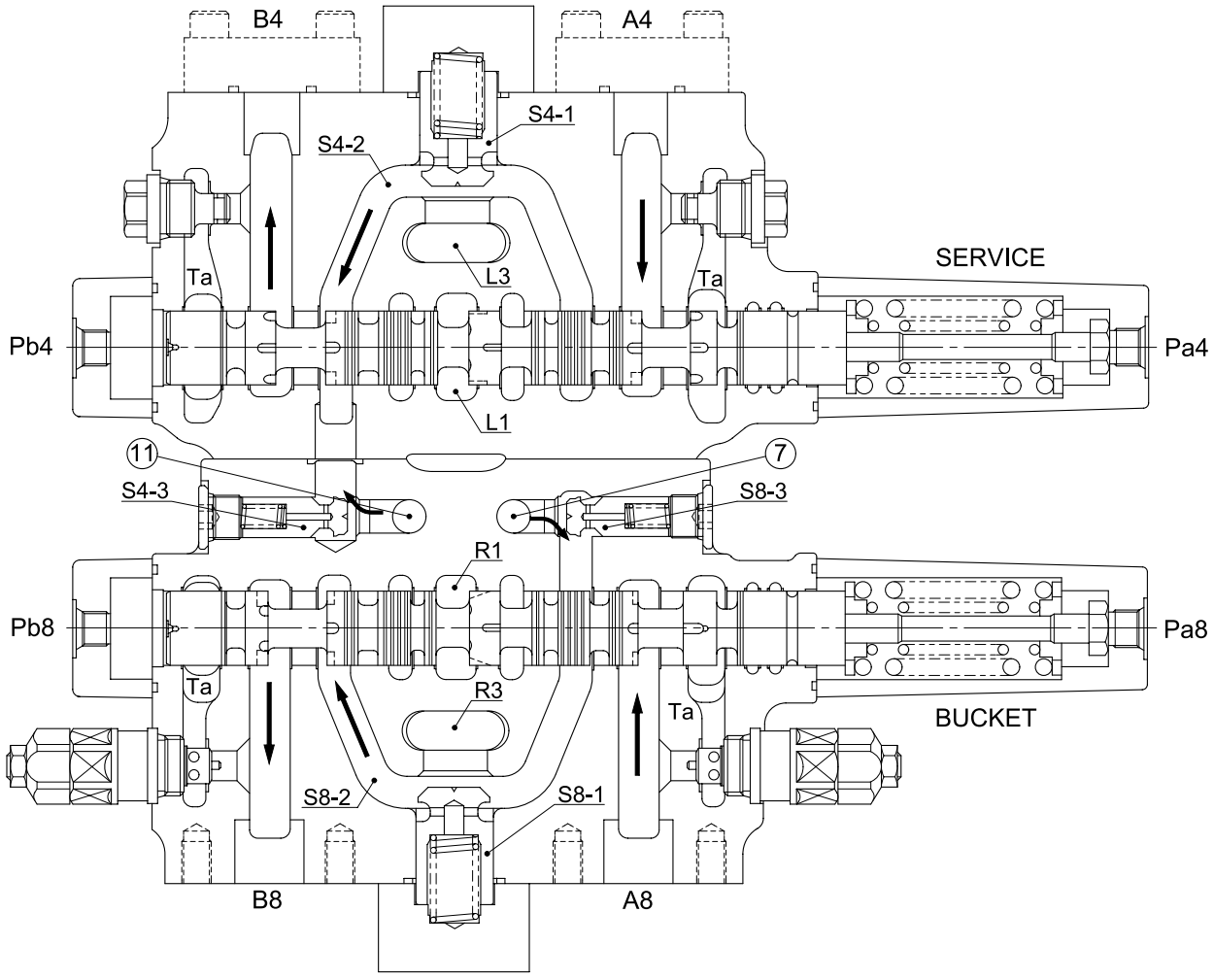
At the same time, as the port pa10(see 2-25 page) is pressurizing and the bypass cut spool(R) is pushed, the oil discharged from pump P2 flows together into the port B7 via passage(11), poppet(S4-3). The oil returned from port A4 flows into the tank via the tank passage(Ta).

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

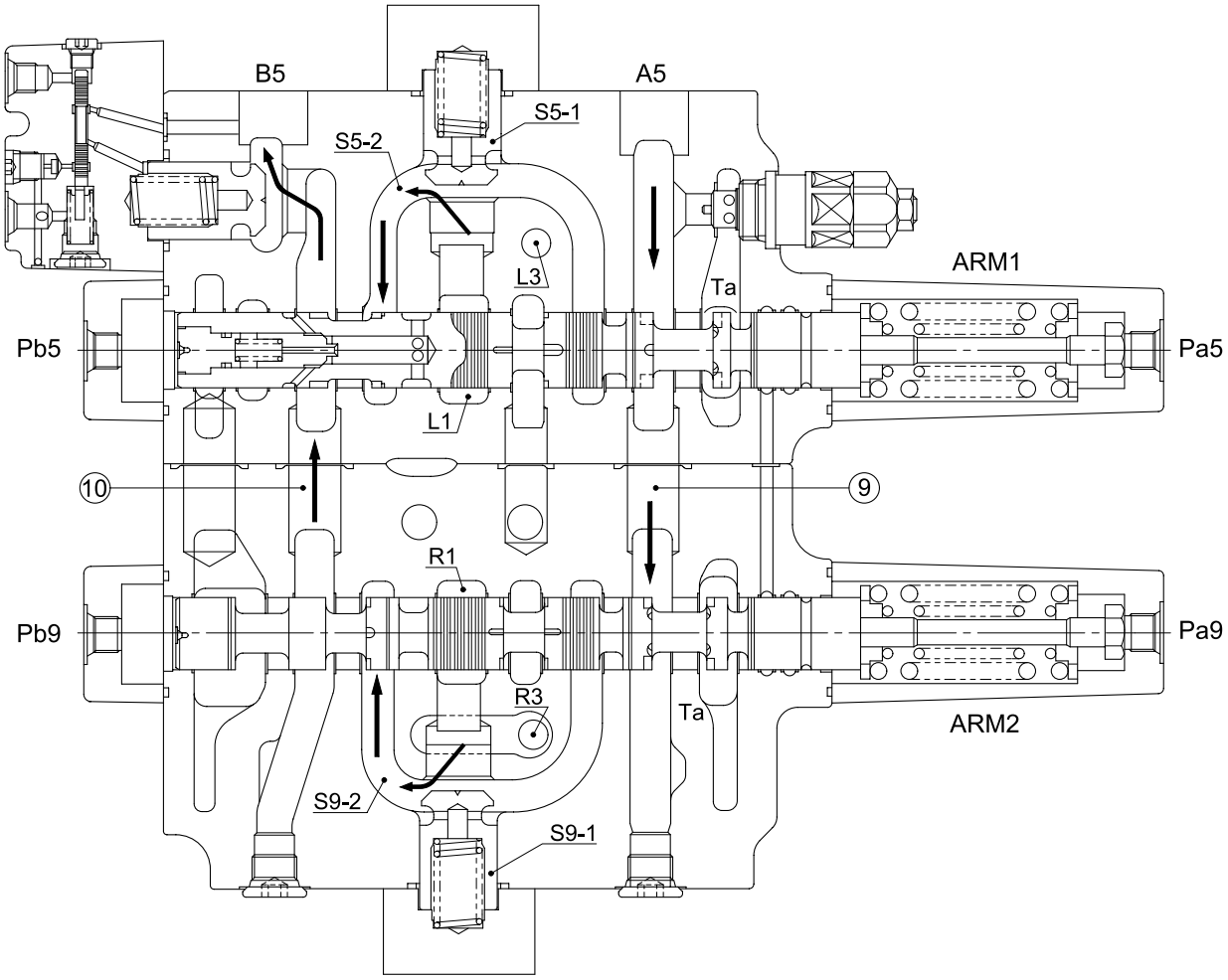
6) ARM SPOOL

(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).



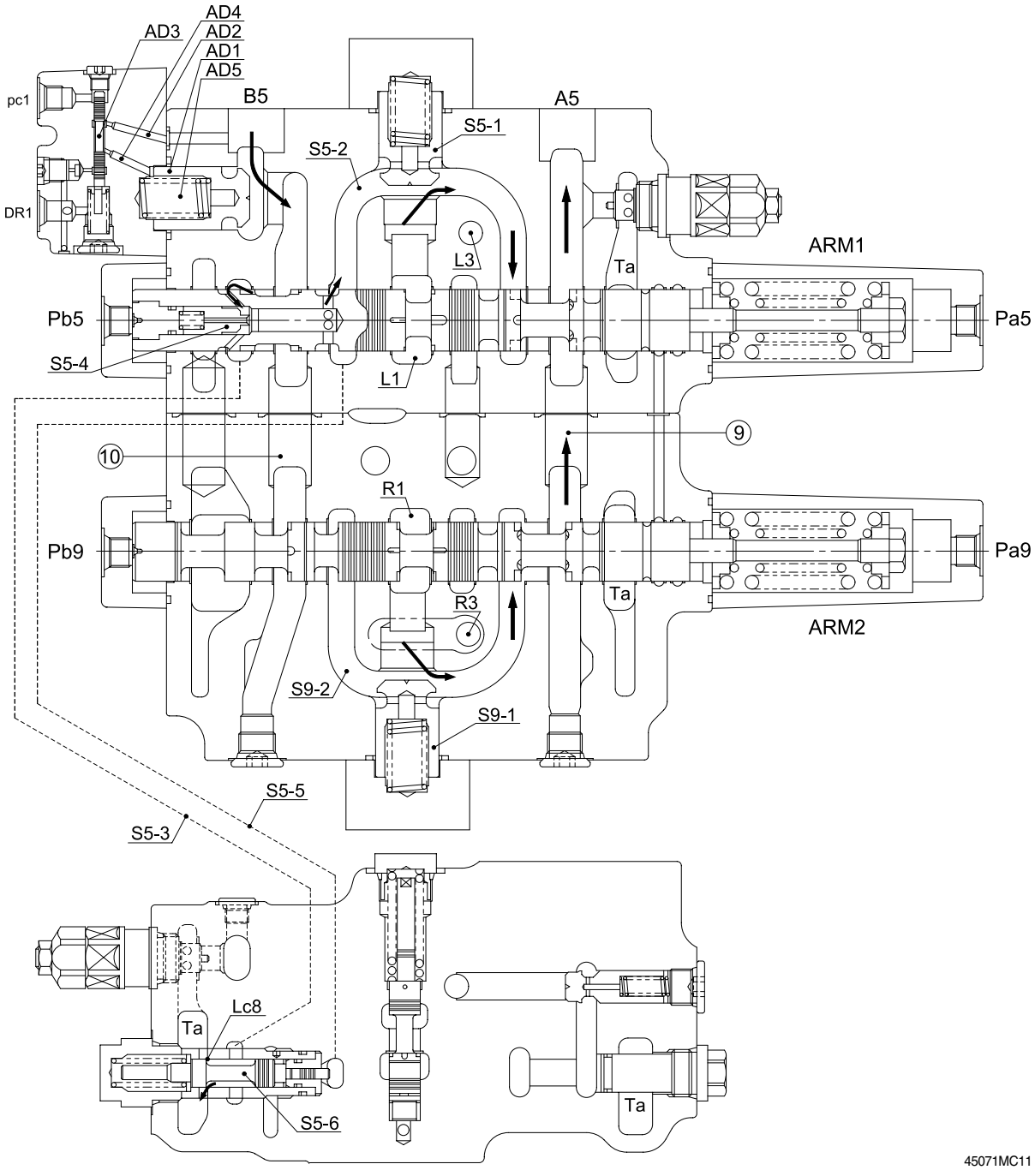
45071MC10

(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 is prevents the cavitation of bottom side.

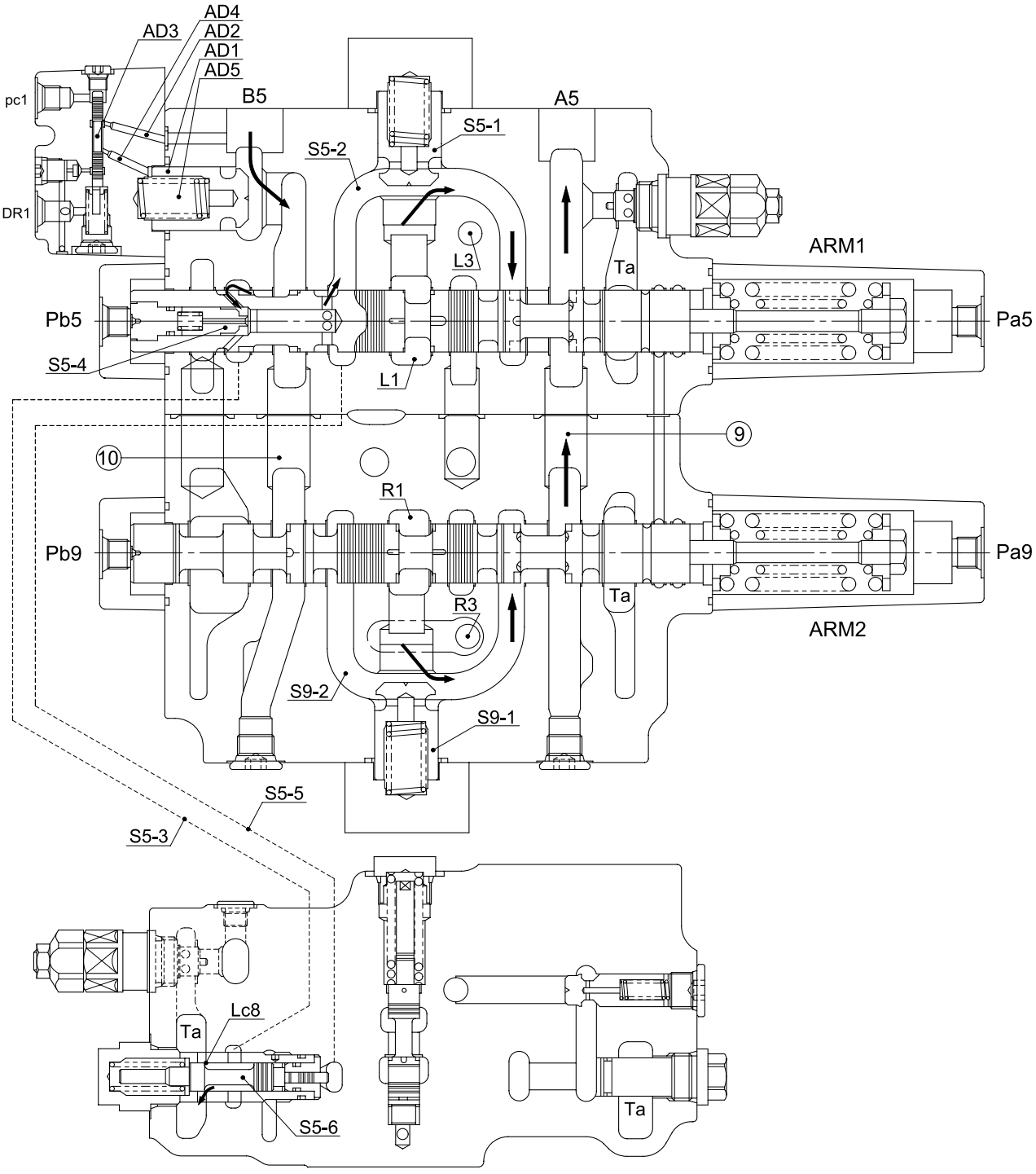


(3) Arm recycling (arm in)

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.



45071MC11

7) BYPASS CUT SPOOL

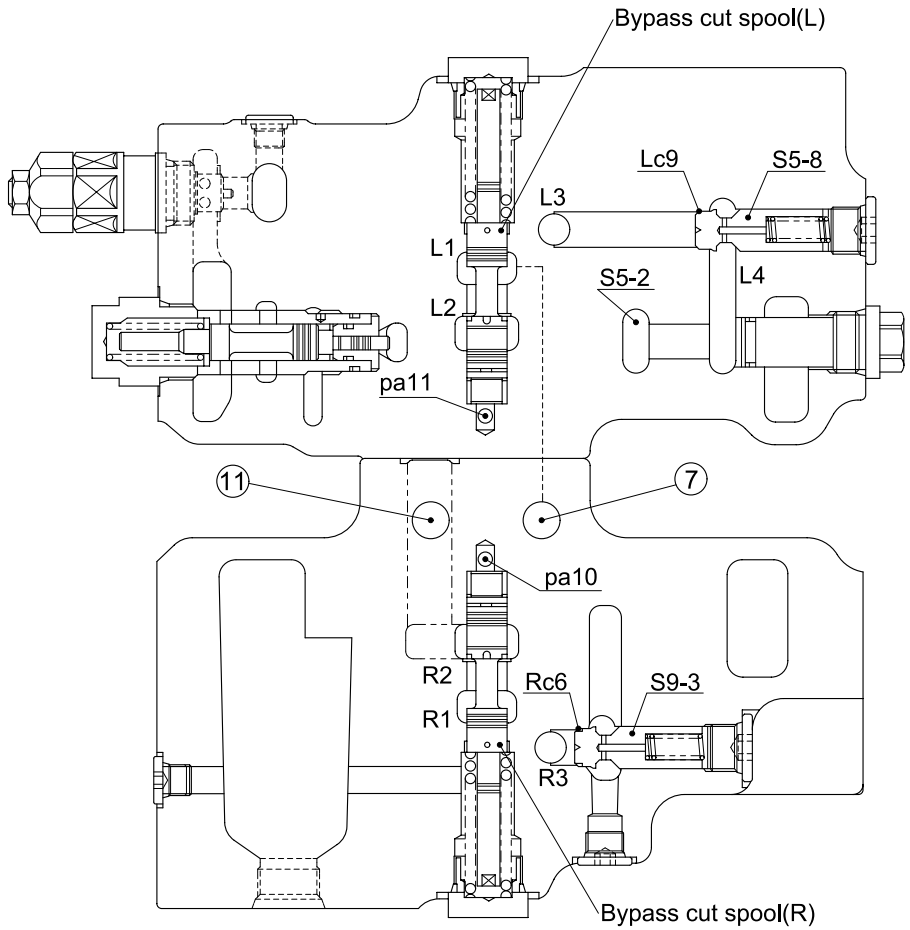
This valve is providing the bypass cut spool at the lowest stream of (upper stream of the low pressure relief valve) the neutral passage(L1, R1).

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

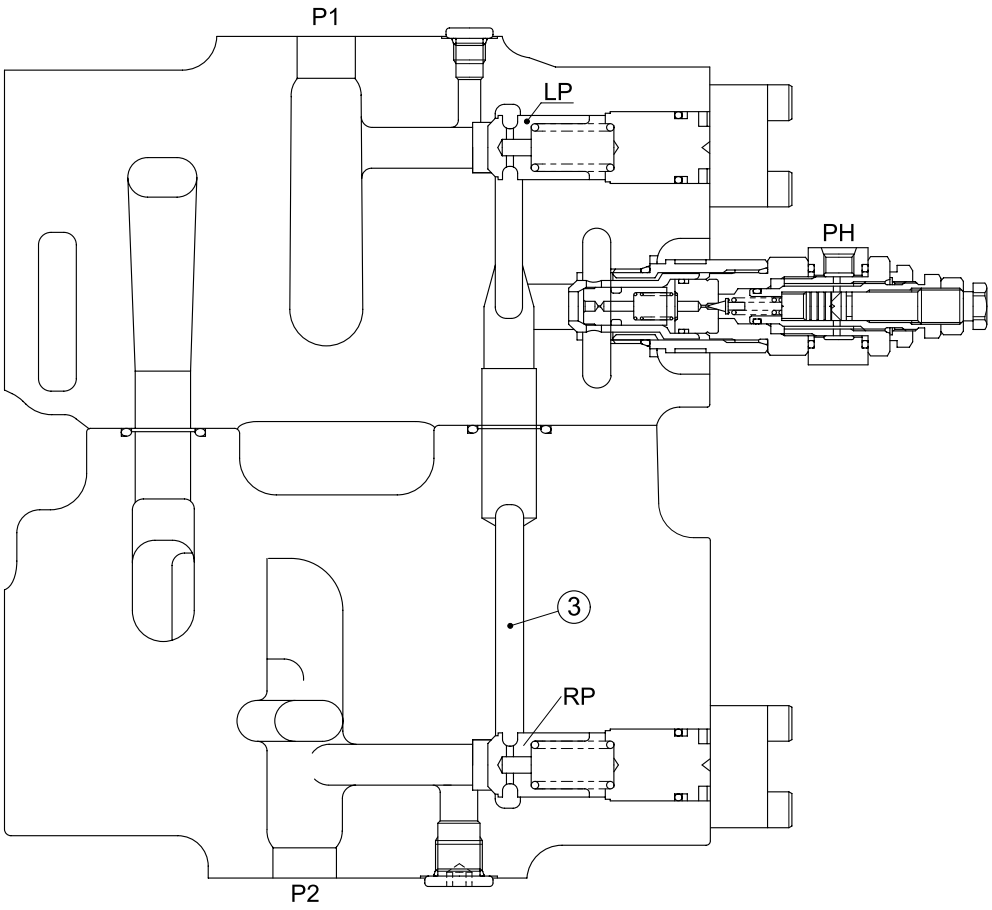
The oil discharged from P1 port via the poppet(LP) and the oil discharged from P2 port via the poppet(RP) flow into the main relief valve through the passage(3).

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 prevents 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.

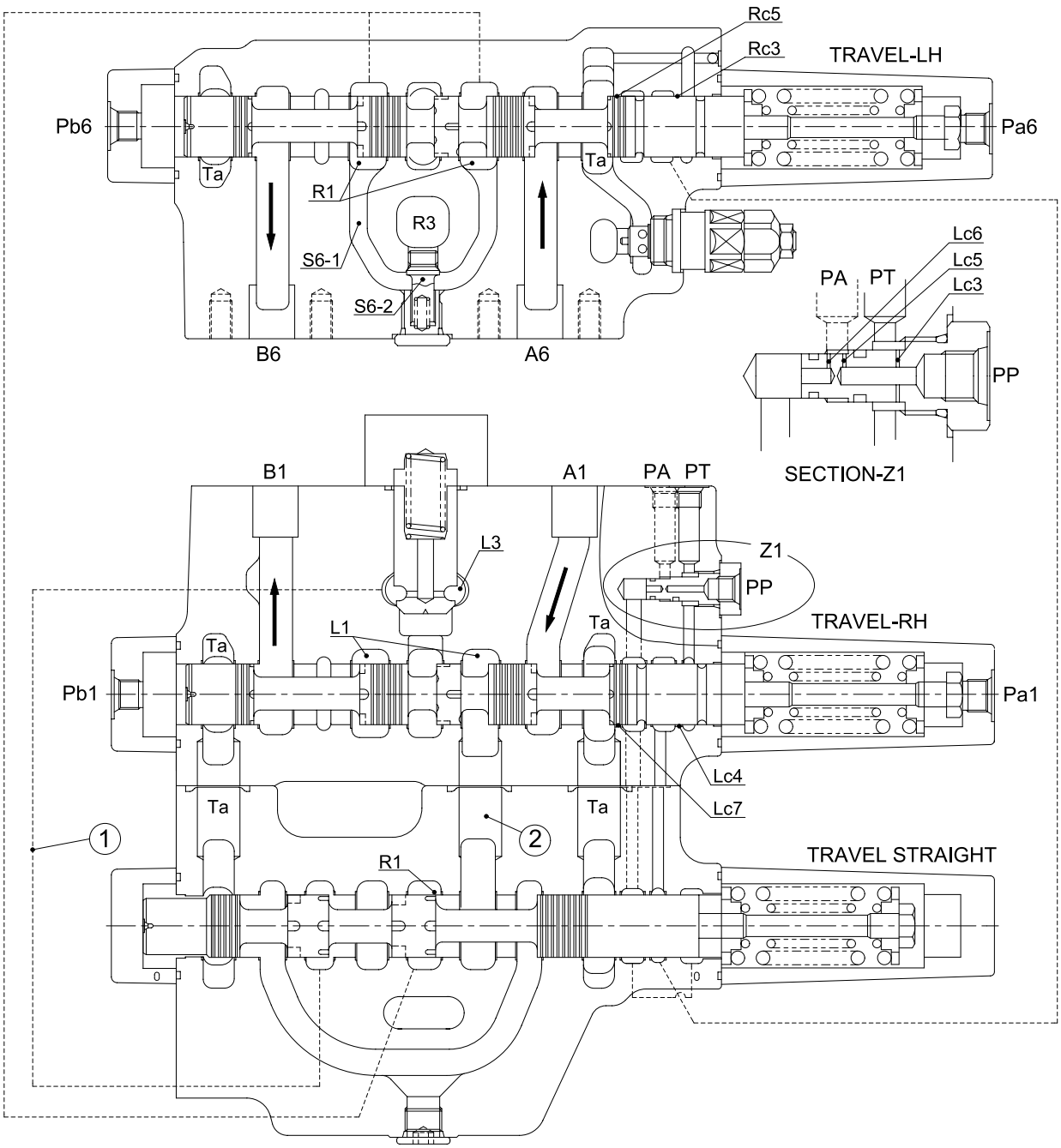


45071MC13

4. COMBINED OPERATION

1) TRAVEL COMBINED OPERATION

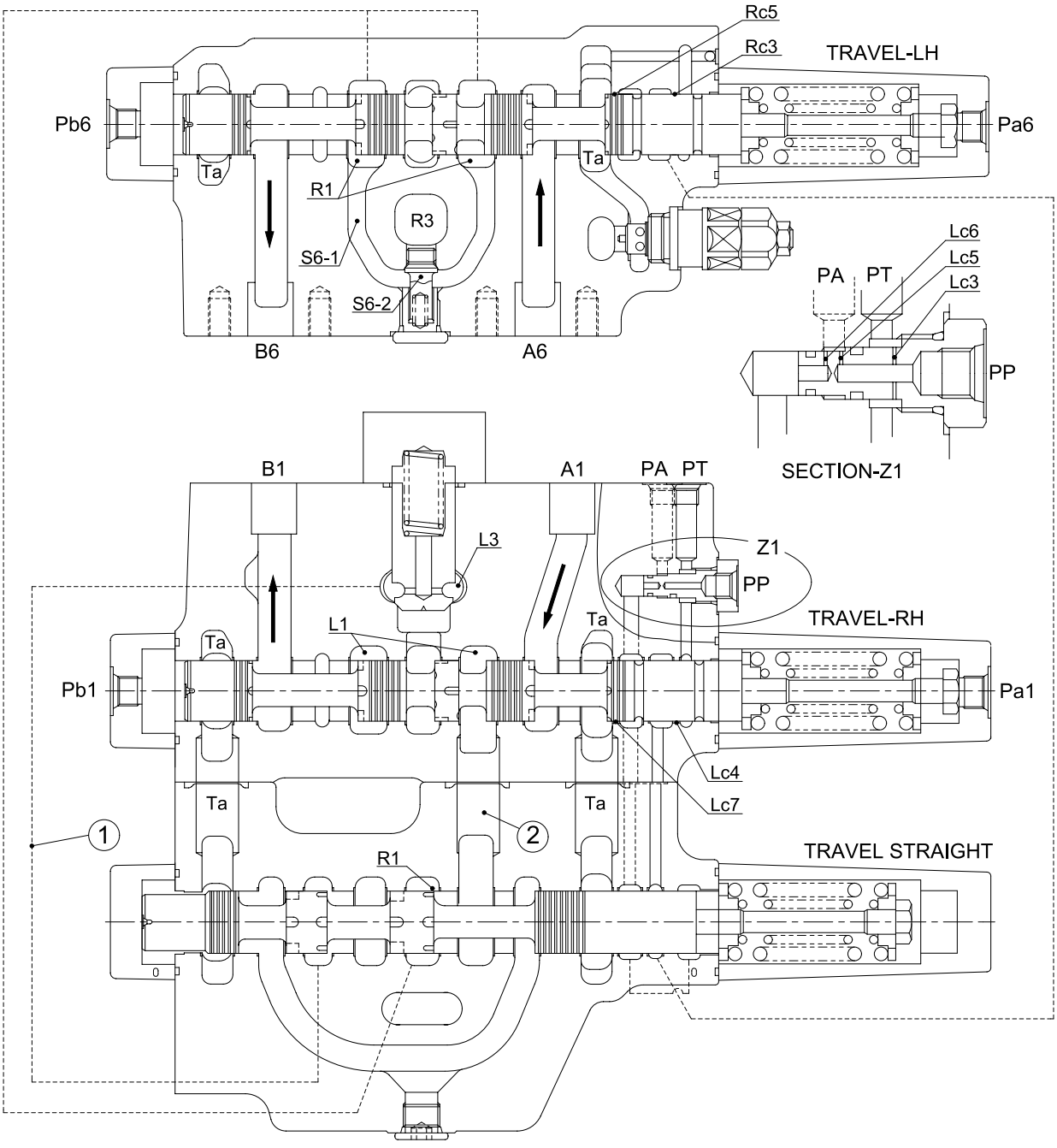
① While travel(forward, reverse and pivot turn) and front attachment(except travel section) functions are operated, the oil discharged from port PP is cut via land(Lc4, Lc7, Rc3, Rc5) and blocked from signal land except travel section to tank passage(Ta), the pressure of signal passage rises to the relief 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.



45071MC14

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.

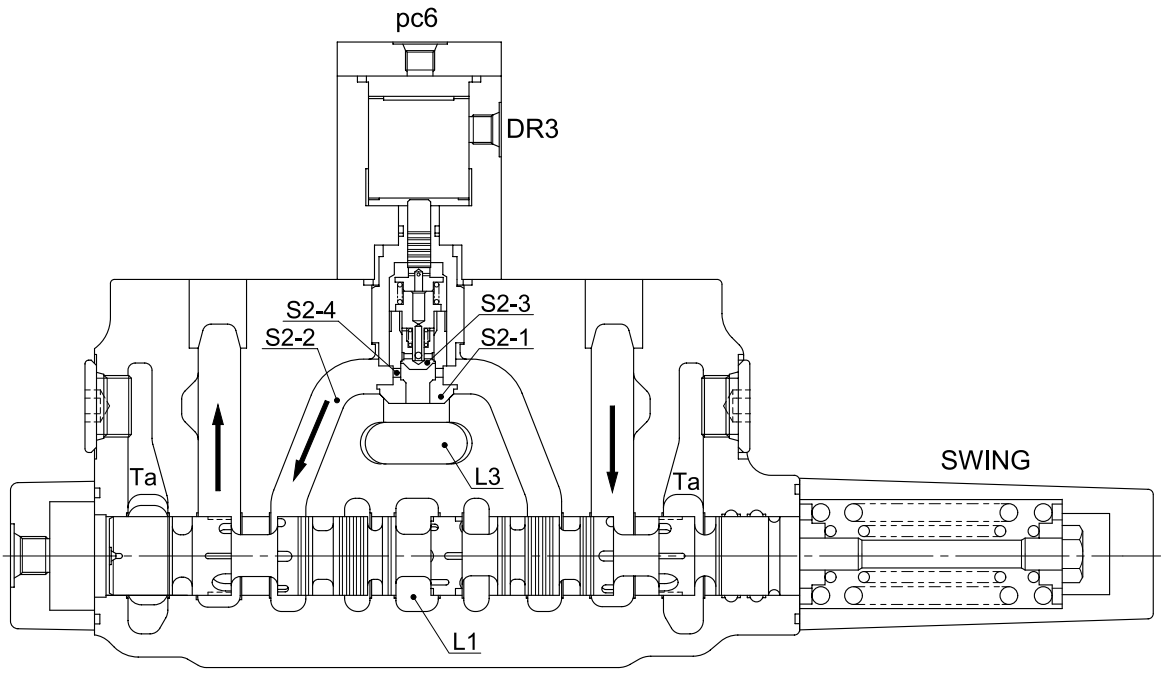


45071MC14

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

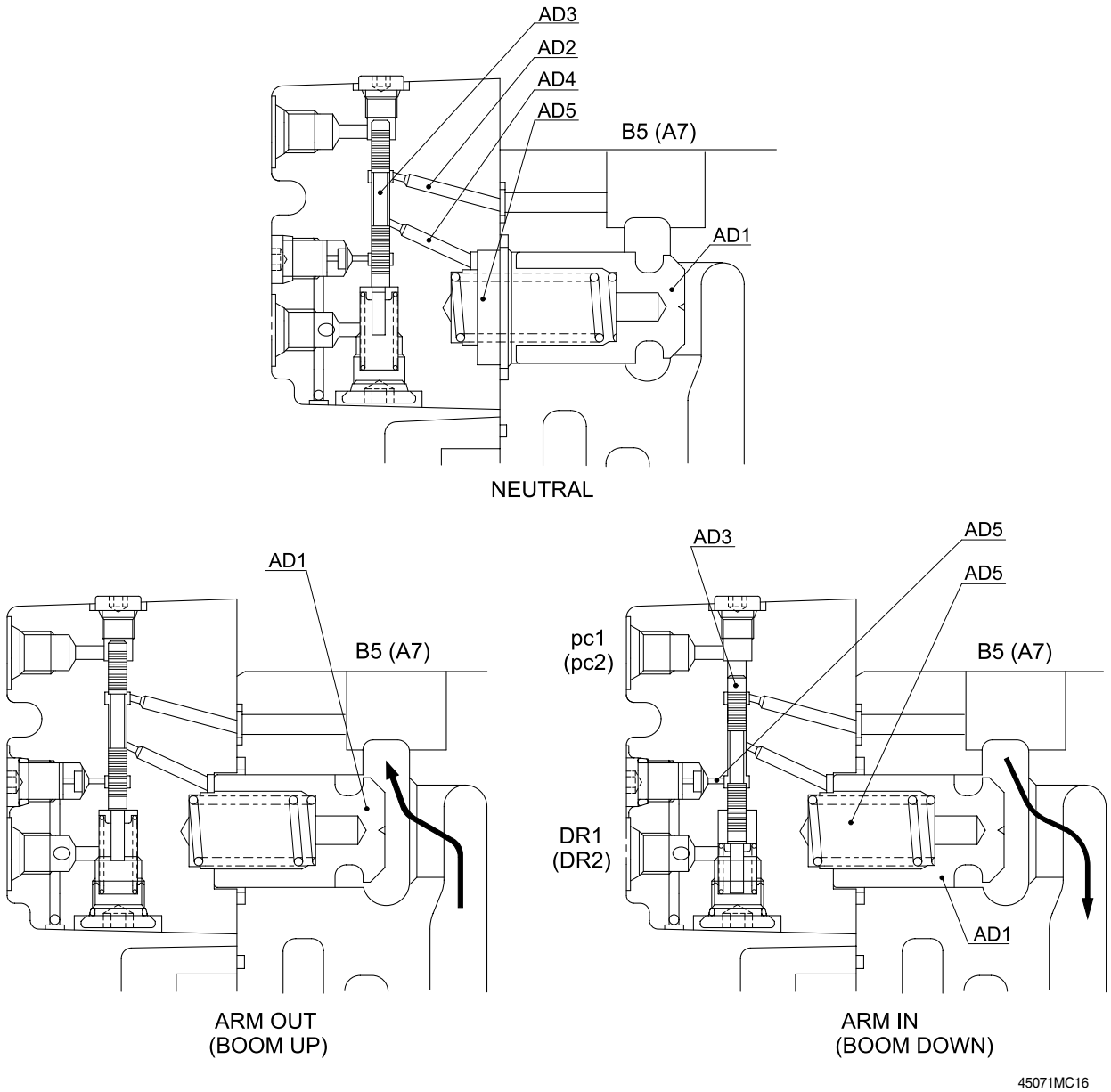
The oil from pump flows into cylinder by pushes open the poppet(AD1).

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).

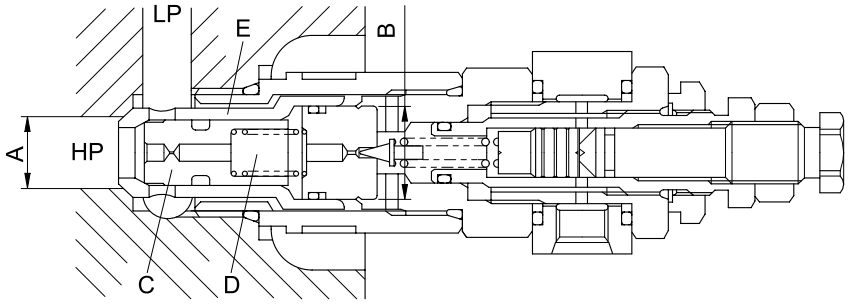


45071MC16

6. RELIEF VALVE OPERATION

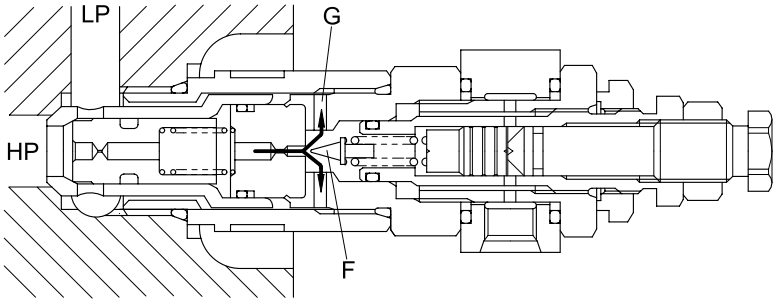
1) MAIN RELIEF VALVE

(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 an B.



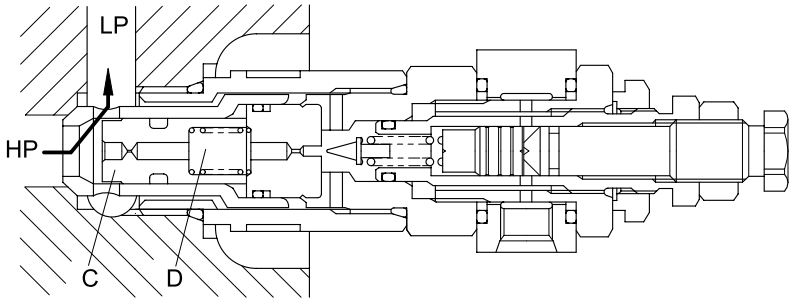
45071MC17

(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).



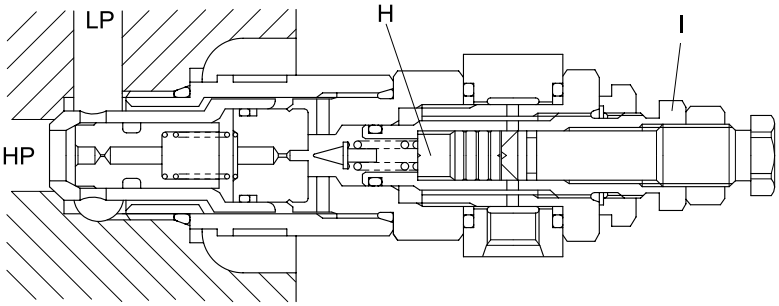
45071MC17-1

(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

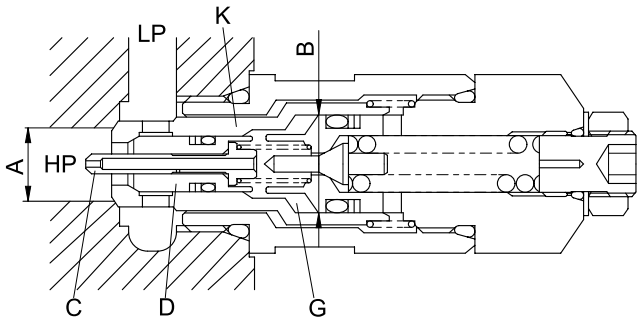
(4) High pressure setting pilot signal(Pi) : ON
The piston(H) moves to left by pilot pressure(Pi); set pressure of spring rises, making high pressure setting.



45071MC17-3

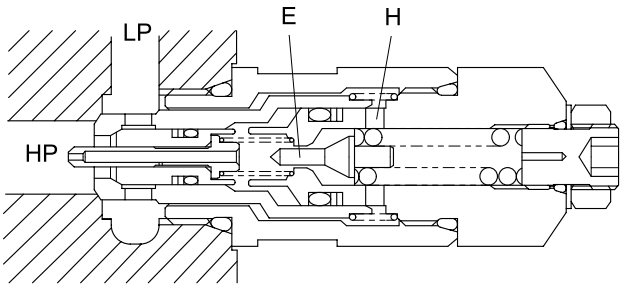
2) OVERLOAD RELIEF VALVE

(1) This relief valve is built-in the cylinder port(HP) and the low pressure(LP), and the pressure oil fills up camber(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.



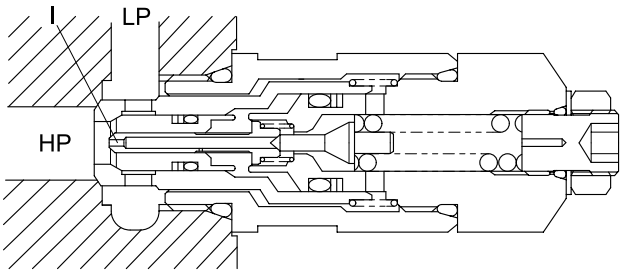
45071MC18

(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).



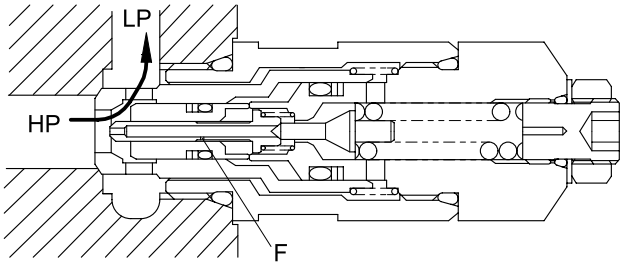
45071MC18-1

(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).

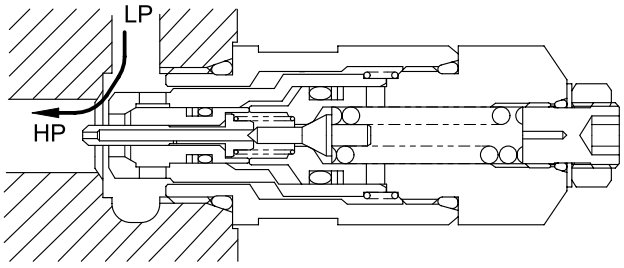


45071MC18-3

(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 camber(G) inside via hole of piston(C).

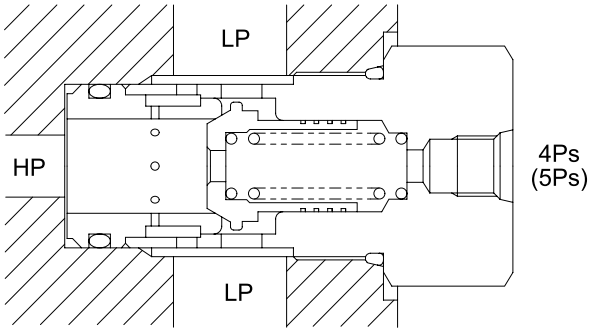
Thus the sleeve(K) and the main poppet(D) are securely seated by difference area of A and B.



45071MC18-4

3) LOW PRESSURE RELIEF VALVE

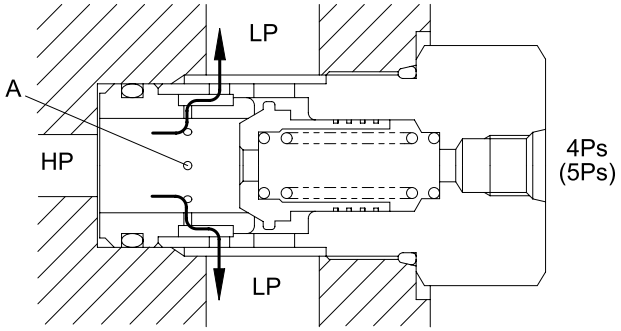
(1) When pump does not operational



45071MC19

(2) When spool neutral

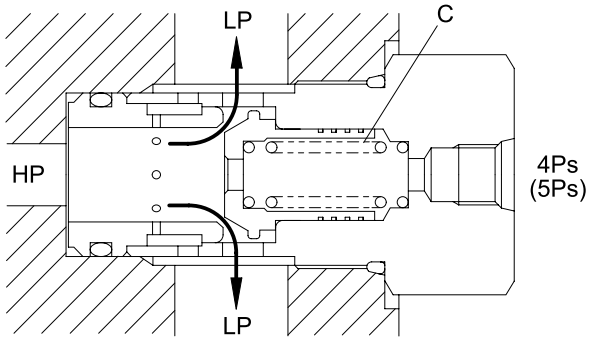
The neutral passage(HP) oil flows into the low pressure passage(LP) via signal orifice(S).
The signal port 4Ps(5Ps) pressure is raise by negative control orifice(A).



45071MC19-1

(3) Operation of low pressure relief

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



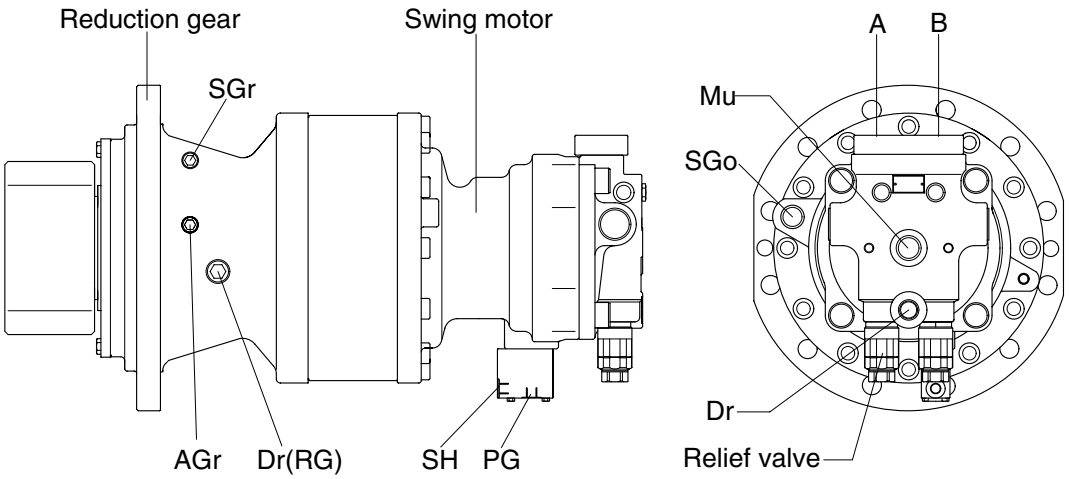
45071MC19-2

GROUP 3 SWING DEVICE (TYPE 1)

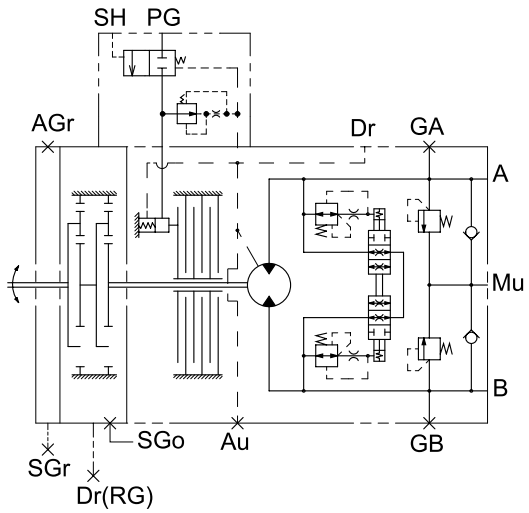
1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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

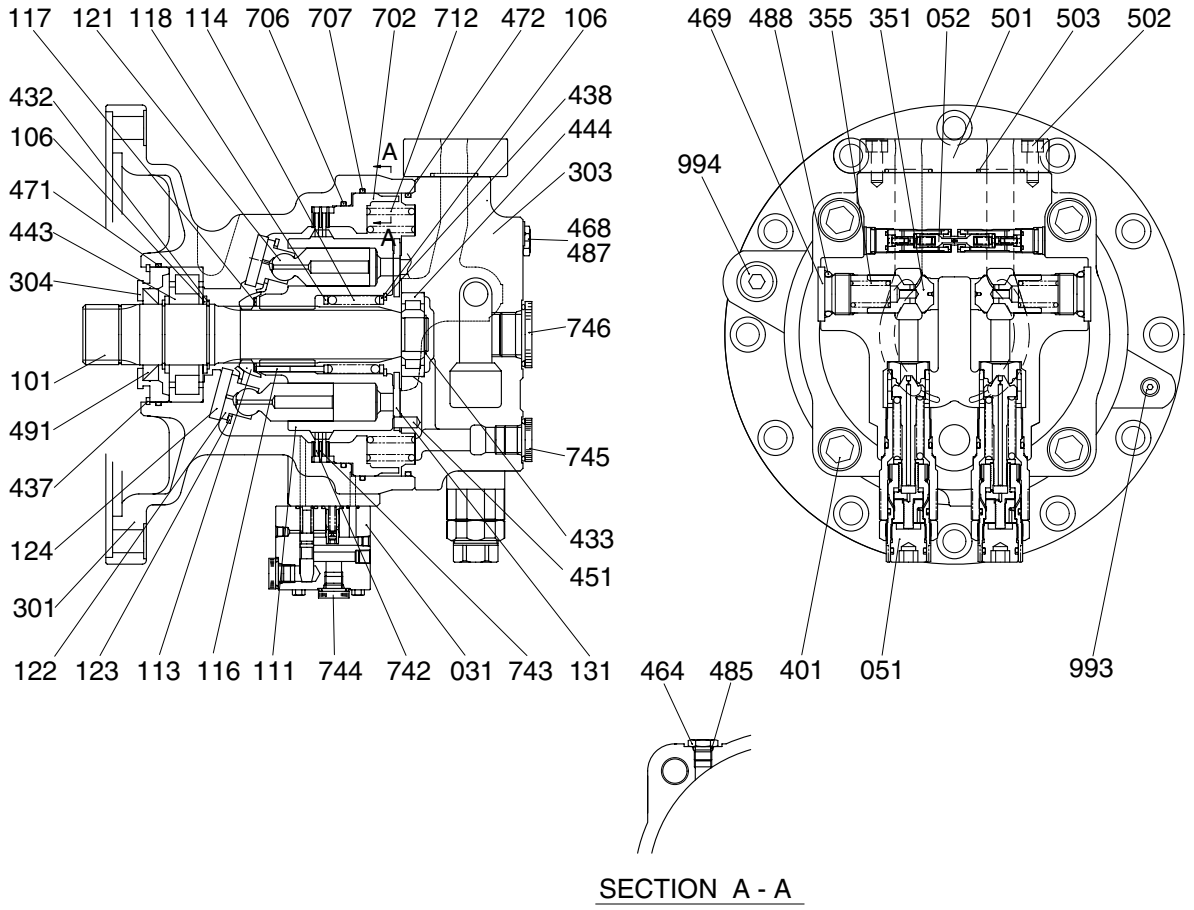


50072SM01



Port	Port name	Port size
A, B	Main port	PF 3/4
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1
GA,GB	Gauge port	PF 1/4
Au	Air vent port	PF 1/4
SGo	Reduction gear oil fill port	PT 3/4
SGr	Reduction gear grease fill port	PT 1/4
AGr	Reduction gear air vent port	PT 1/4
Dr(RG)	Reduction gear drain port	PT 1/2
PG	Brake release port	PF 1/4
SH	Brake pilot port	PF 1/4

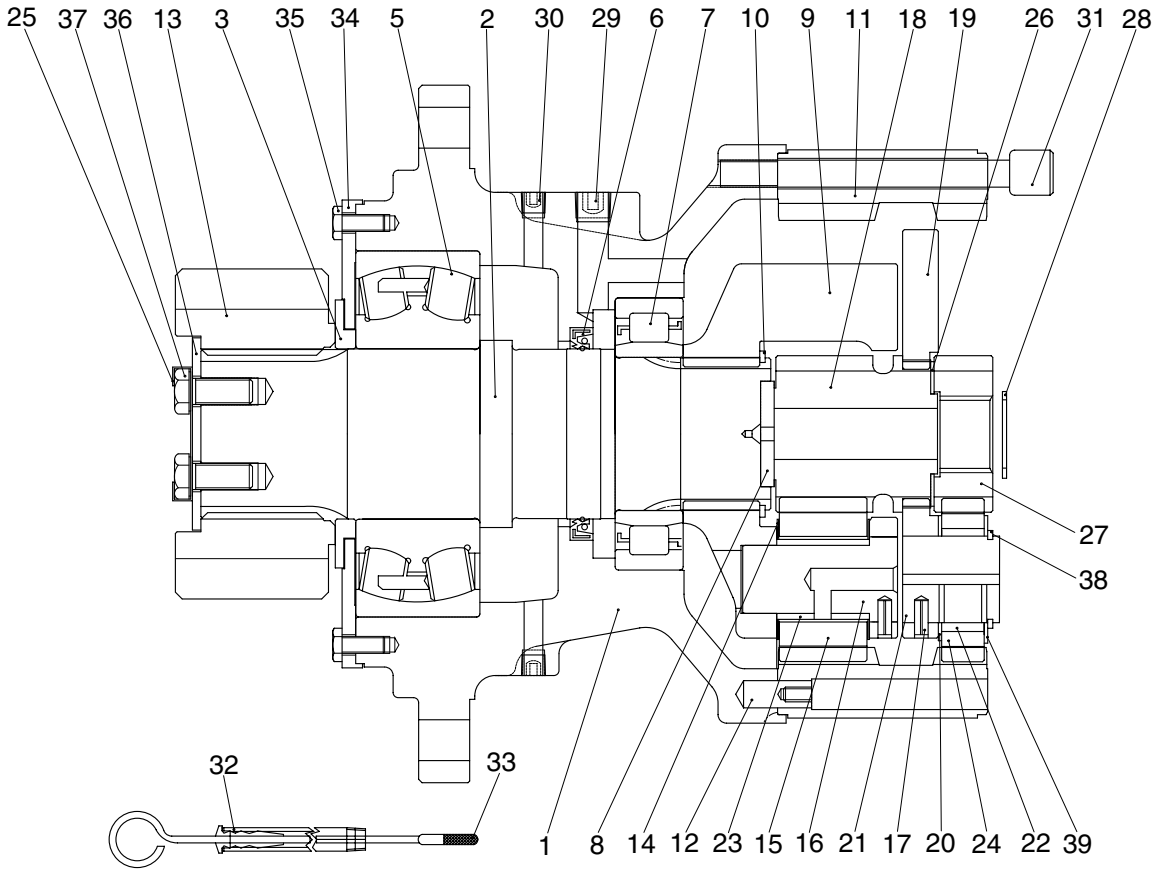
1) SWING MOTOR



50072SM02

031	Brake valve	303	Valve casing(K)	485	O-ring
051	Relief valve	304	Front cover	487	O-ring
052	Reactionless valve assy	351	Plunger(K)	488	O-ring
101	Drive shaft	355	Spring	491	Oil seal
106	Spacer	401	Socket bolt	501	Adapter
111	Cylinder block	432	Snap ring	502	Socket bolt
113	Spherical busing	433	Snap ring	503	O-ring
114	Cylinder spring	437	Snap ring	702	Brake piston
116	Push rod	438	Snap ring	706	O-ring
117	Spacer(F)	443	Roller bearing	707	O-ring
118	Spacer(R)	444	Roller bearing	712	Brake spring
121	Piston	451	Spring pin	742	Friction plate
122	Shoe plate	464	VP Plug	744	Dust plug
123	Retainer	468	VP Plug	745	Dust plug
124	Shoe	469	RO Plug	746	Dust plug
131	Valve plate	471	O-ring	993	PT Plug
301	Casing(F)	472	O-ring	994	PT Plug

2) REDUCTION GEAR



50072SM03

1	Casing	15	Planet gear 2	28	Stop ring
2	Drive shaft	16	Pin 2	29	Plug
3	Spacer	17	Spring pin	30	Plug
5	Roller bearing	18	Sun gear 2	31	Socket bolt
6	Oil seal	19	Carrier 1	32	Gage pipe
7	Roller bearing	20	Side plate 1	33	Gage bar
8	Thrust plate	21	Pin 1	34	Cover plate
9	Carrier 2	22	Needle cage	35	Hex bolt
10	Stop ring	23	Bushing 2	36	Lock plate
11	Ring gear	24	Planet gear 1	37	Hex bolt
12	Knock pin	25	Lock washer	38	Stop ring
13	Pinion gear	26	Side plate 3	39	Side plate 2
14	Thrust washer	27	Sun gear 1		

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(1), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(2) upon the return plate(3) which acts upon the swash plate(4) via an hydrostatic bearing. Force F1 perpendicular to swash plate(4) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(5) through piston, force F2 causes rotational moment at surroundings of cylinder.

Since cylinder block has 9 equidistantly arrayed pistons, rotational torque is transmitted to cylinder shaft in order by several pistons connected to the inlet port of high pressurized oil. When the direction of oil flow is reversed, rotational direction of cylinder is also reversed. Output torque is given by the equation.

$$T = \frac{p \times q}{2\pi}, \quad q = Z \cdot A \cdot PCD \cdot \tan\theta, \quad F1 = \frac{F}{\cos\theta}, \quad F_2 = F \tan\theta, \quad S = PCD \times \tan\theta$$

Where p : Effective difference of pressure(kgf/cm^2)

q : Displacement(cc/rev)

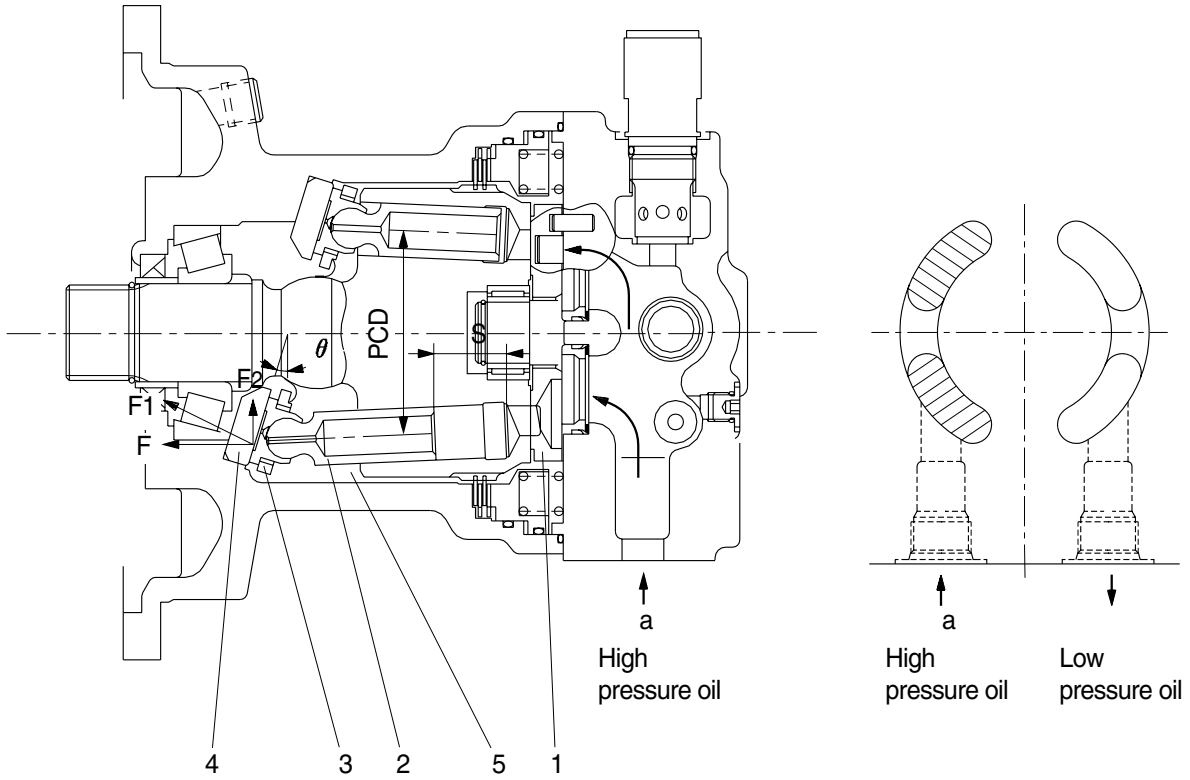
T : Output torque(kgf · cm)

Z : Piston number(9EA)

A : Piston area(cm^2)

θ : Tilting angle of swash plate(degree)

S : Piston stroke(cm)



2-52 (210-7)

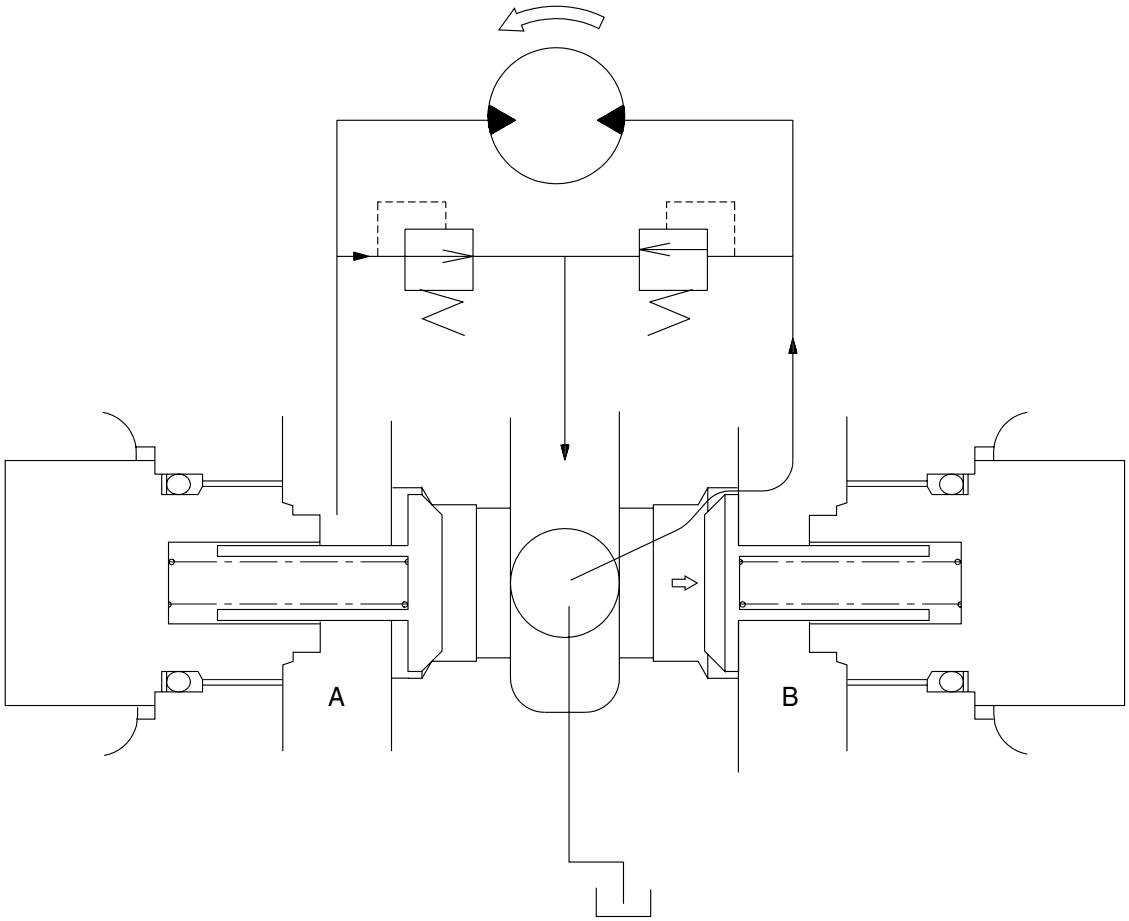
2) MAKE UP VALVE

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.

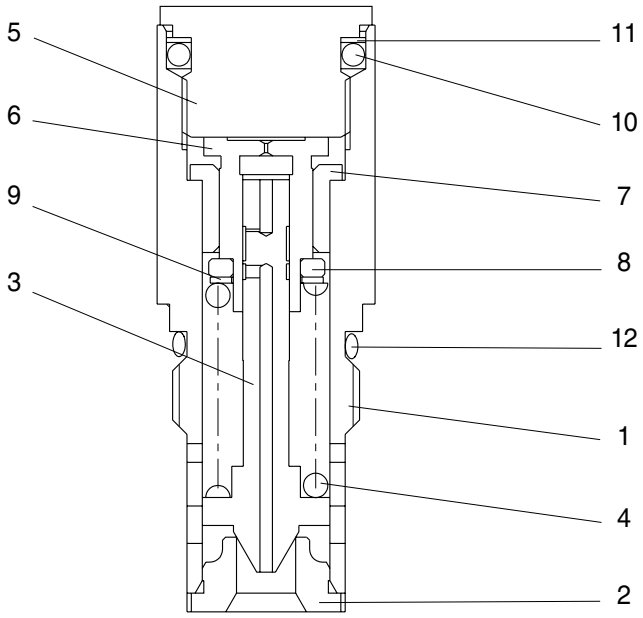
Pressurized oil into the port B, the motor rotate counterclockwise.

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.



R130SM03

3) RELIEF VALVE



R130SM05

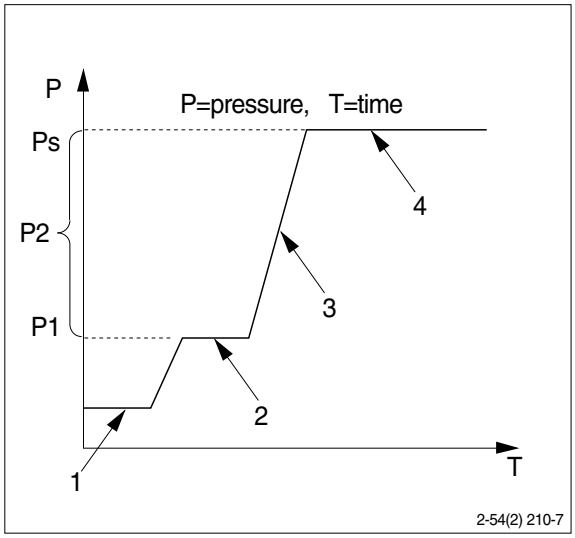
1 Body
2 Seat
3 Plunger
4 Spring
5 Adjusting screw
6 Piston
7 Bushing
8 Spring seat
9 Shim
10 O-ring
11 Back up ring
12 O-ring

(1) Construction of relief valve

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

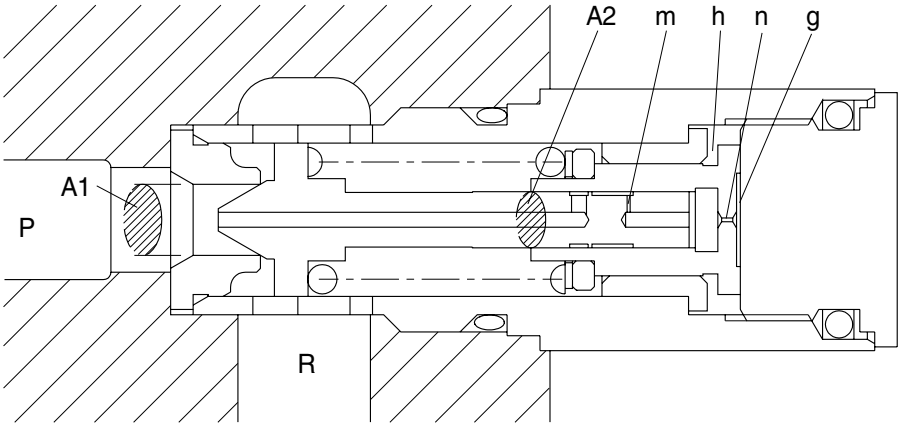
(2) Function of relief valve

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



2-54(2) 210-7

① Ports (P,R) at tank pressure.

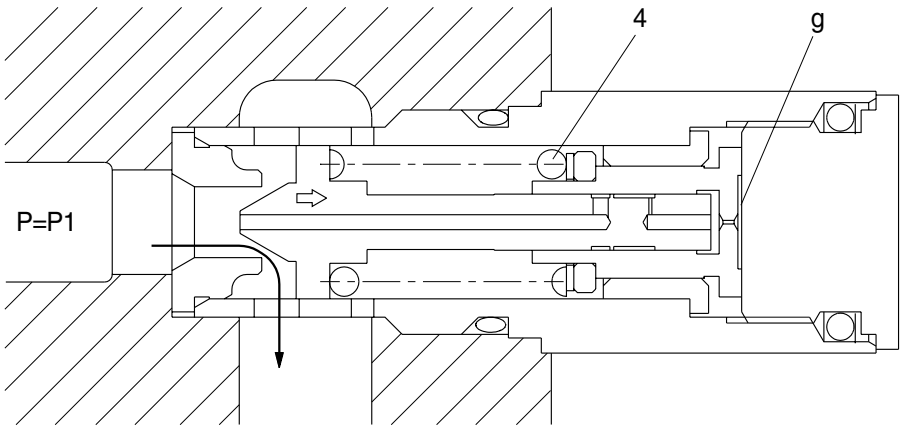


R130SM04

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.

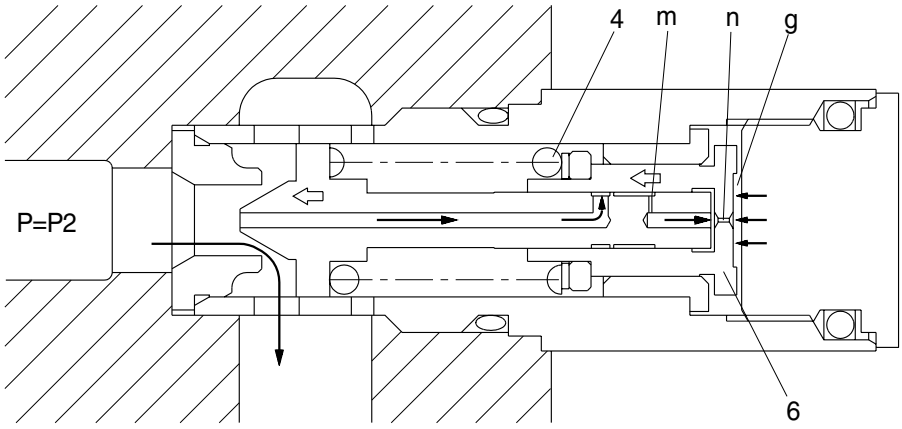
$P_1 \times A_1 = Fsp + Pg \times A_2$

$$P_1 = \frac{Fsp + Pg \times A_2}{A_1}$$



R130SM04

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).

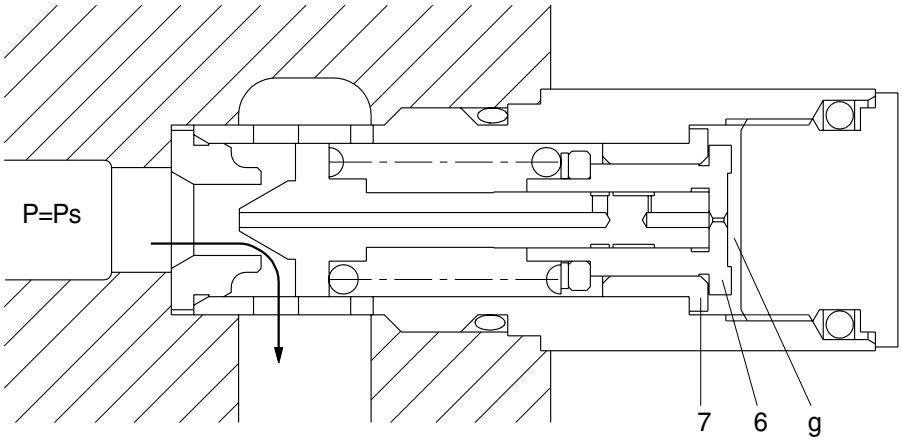


R130SM04

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(Ps).

$Ps \times A_1 = Fsp + Ps \times A_2$

$$Ps = \frac{Fsp}{A_1 - A_2}$$



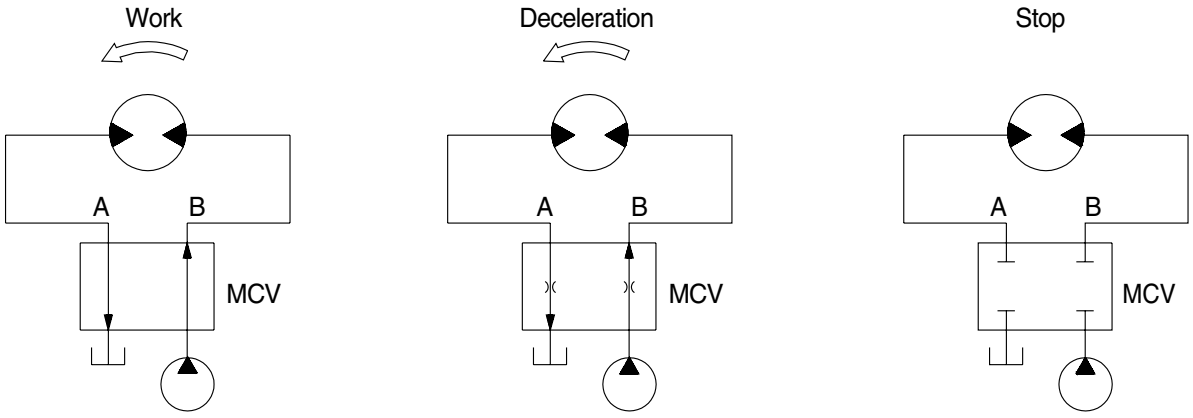
R130SM04

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.



MCV A, B opened | MCV A, B throttled | MCV A, B closed

R130SM05

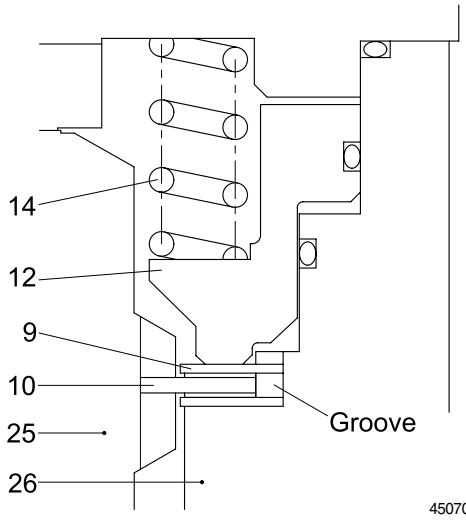
(2) Mechanical swing parking brake system

The mechanical swing parking brake system is installed to prevent the upper structure from swinging downhill because of its own weight when the excavator is parked on a slope since it completely eliminates the hydraulic drift of swing motion while the excavator is on a slop, work can be done more easily and safely.

① Brake assembly

Circumferential rotation of separate plate(9) is constrained by the groove located at housing(26). When housing is pressed down by brake spring(14) through lining plate(10), separate plate(9) and brake piston(12), friction force occurs there.

Cylinder(25) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

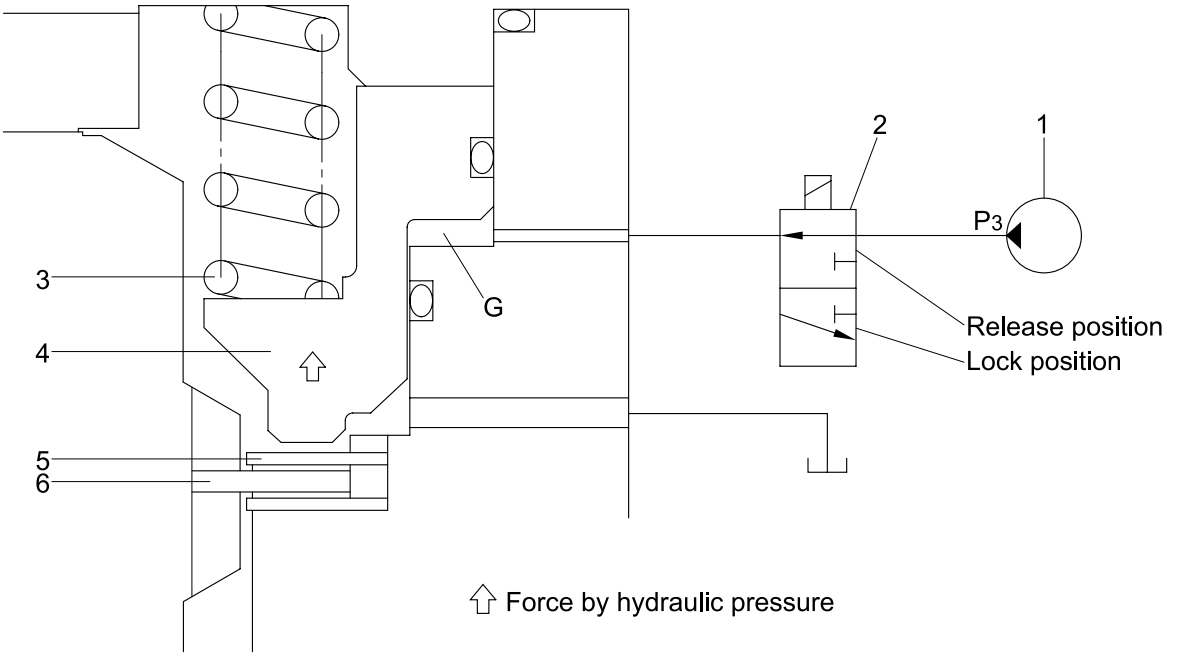


45070SM05

9	Separate plate	14	Spring
10	Lining plate	25	Cylinder
12	Brake piston	26	Housing

② **Operating principle**

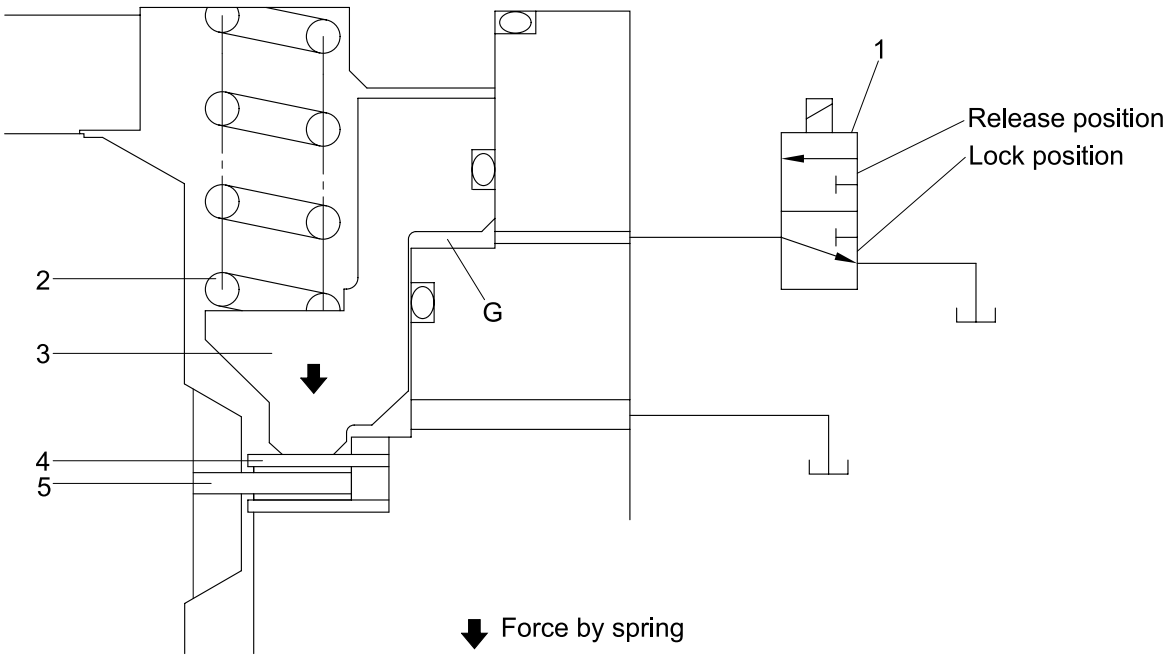
a. When the swing control lever is operated, the swing lock solenoid valve is excited, so the pilot pump discharged oil(P3) goes to the chamber G.
This pressure is applied to move the piston(6) to the upward against the force of the spring(9). Thus, it releases the brake force.



45070SM03

1 Pilot pump
2 Swing lock solenoid valve
3 Spring
4 Brake piston
5 Separate plate
6 Lining plate

b. When the swing control lever gets back to neutral position, the swing lock solenoid valve is deactivated, so the pilot pump discharged oil(P_3) is not applied to the chamber G.
Thus, the brake is actuated by spring force.



45070SM04

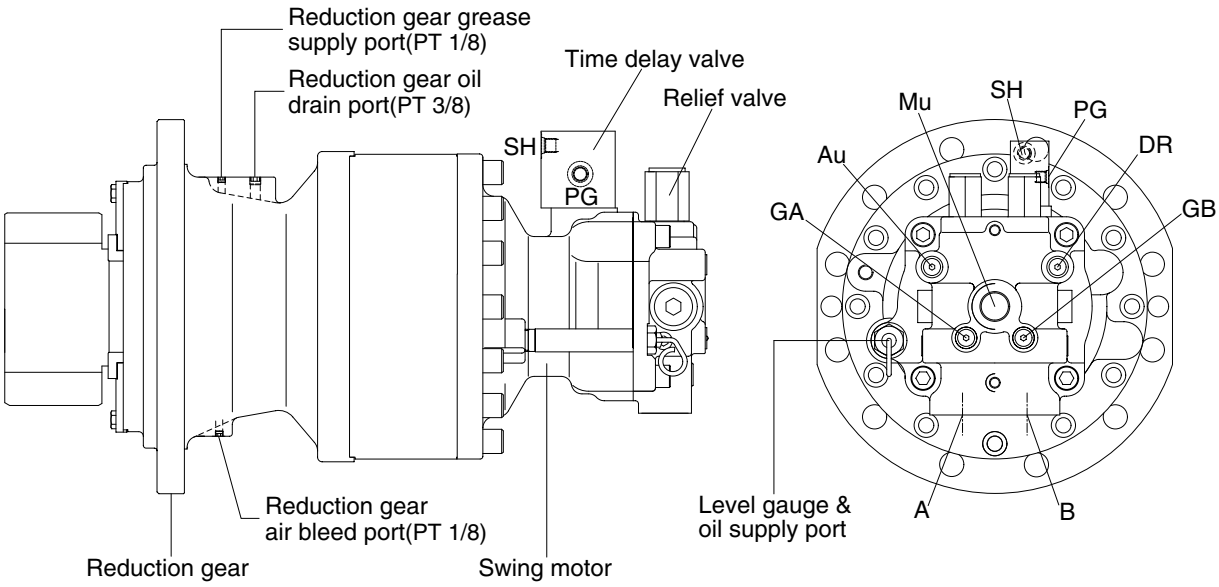
1 Swing lock solenoid valve
2 Spring
3 Brake piston
4 Separate plate
5 Lining plate

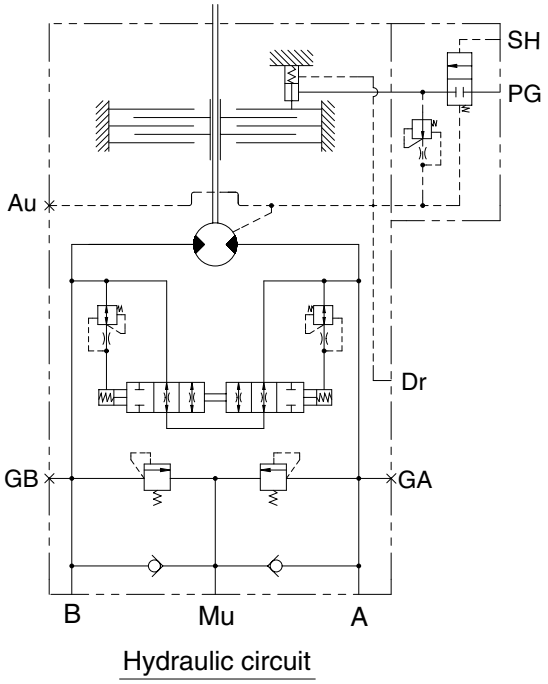
GROUP 3 SWING DEVICE (TYPE 2)

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.



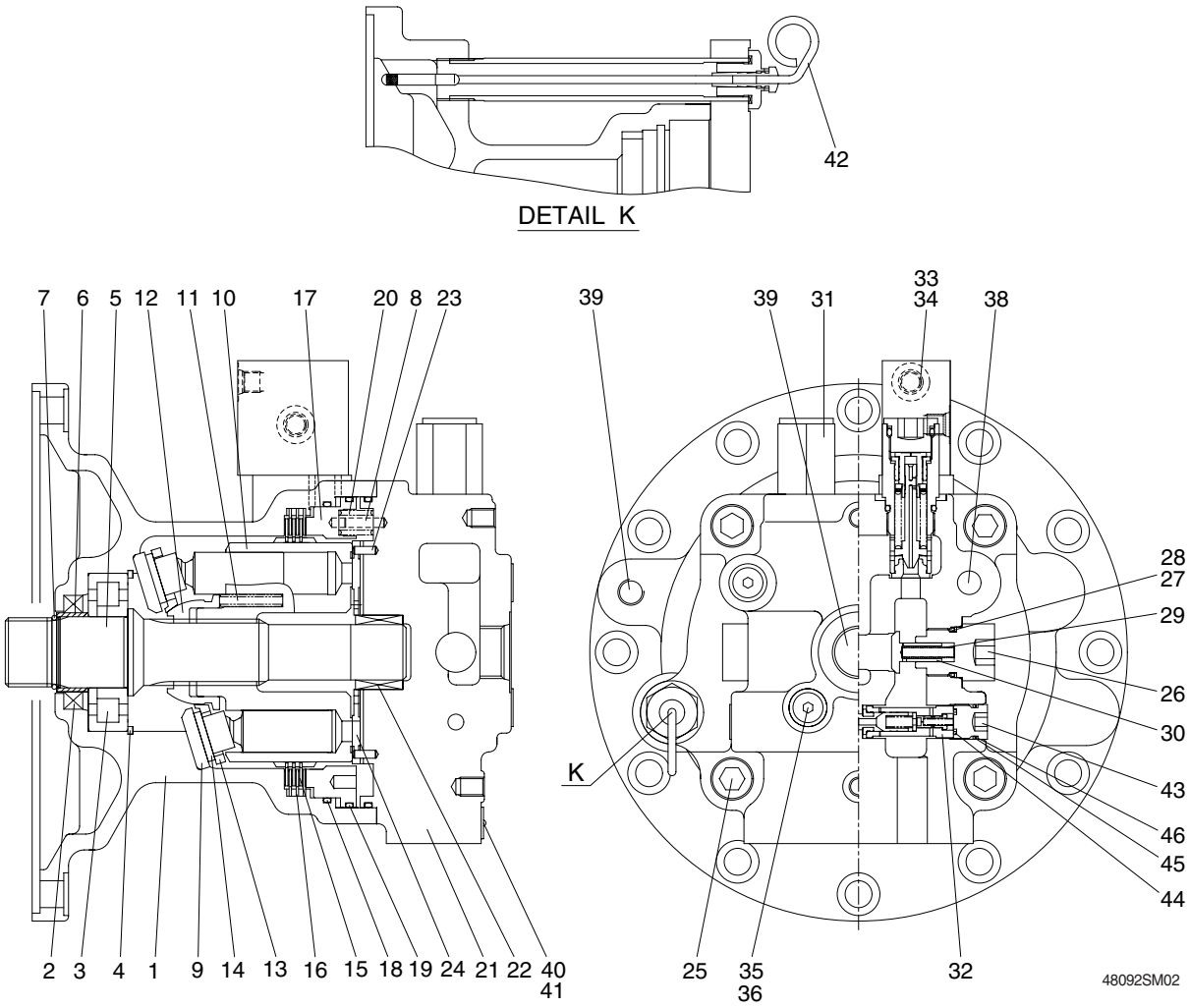


Hydraulic circuit

48092SM01

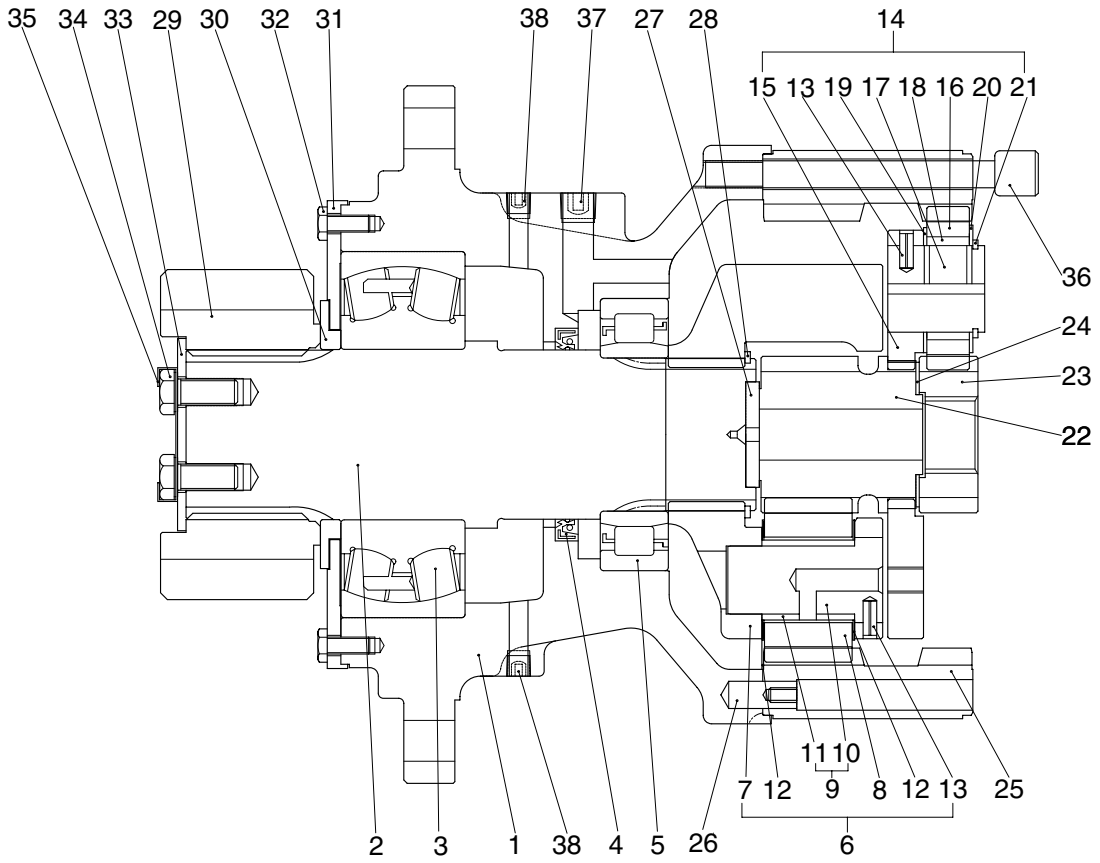
Port	Port name	Port size
A, B	Main port	ø 20
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1
GA,GB	Gauge port	PF 1/4
Au	Air vent port	PF 1/4
PG	Brake release port	PF 1/4
SH	Brake pilot port	PF 1/4

1) SWING MOTOR



1	Body	17	Brake piston	33	Time delay valve
2	Oil seal	18	O-ring	34	Wrench bolt
3	Roller bearing	19	O-ring	35	Plug
4	Snap ring	20	Spring	36	O-ring
5	Shaft	21	Rear cover	37	Plug
6	Bushing	22	Needle bearing	38	Plug
7	Stop ring	23	Pin	39	Plug
8	Pin	24	Valve plate	40	Name plate
9	Shoe plate	25	Wrench bolt	41	Rivet
10	Cylinder block	26	Plug	42	Level gauge
11	Spring	27	Back up ring	43	Plug
12	Ball guide	28	O-ring	44	O-ring
13	Set plate	29	Spring	45	O-ring
14	Piston assy	30	Check	46	Back up ring
15	Friction plate	31	Relief valve		
16	Plate	32	Anti-inversion valve		

2) REDUCTION GEAR



48092SM03

1	Casing	14	Carrier assy 1	27	Thrust plate 3
2	Drive shaft	15	Carrier 1	28	Stop ring
3	Roller bearing	16	Planet gear 1	29	Pinion gear
4	Oil seal	17	Pin 1	30	Spacer
5	Roller bearing	18	Needle cage	31	Cover plate
6	Carrier assy 2	19	Side plate 1	32	Hexagon bolt
7	Carrier 2	20	Side plate 2	33	Lock plate
8	Planet gear 2	21	Stop ring	34	Hexagon bolt
9	Pin assy 2	22	Sun gear 2	35	Lock washer
10	Pin 2	23	Sun gear 1	36	Socket bolt
11	Bush 2	24	Side plate 3	37	Plug
12	Thrust washer	25	Ring gear	38	Plug
13	Spring pin	26	Knock pin		

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder (10) through valve casing of motor (21), and valve plate (24).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (14).

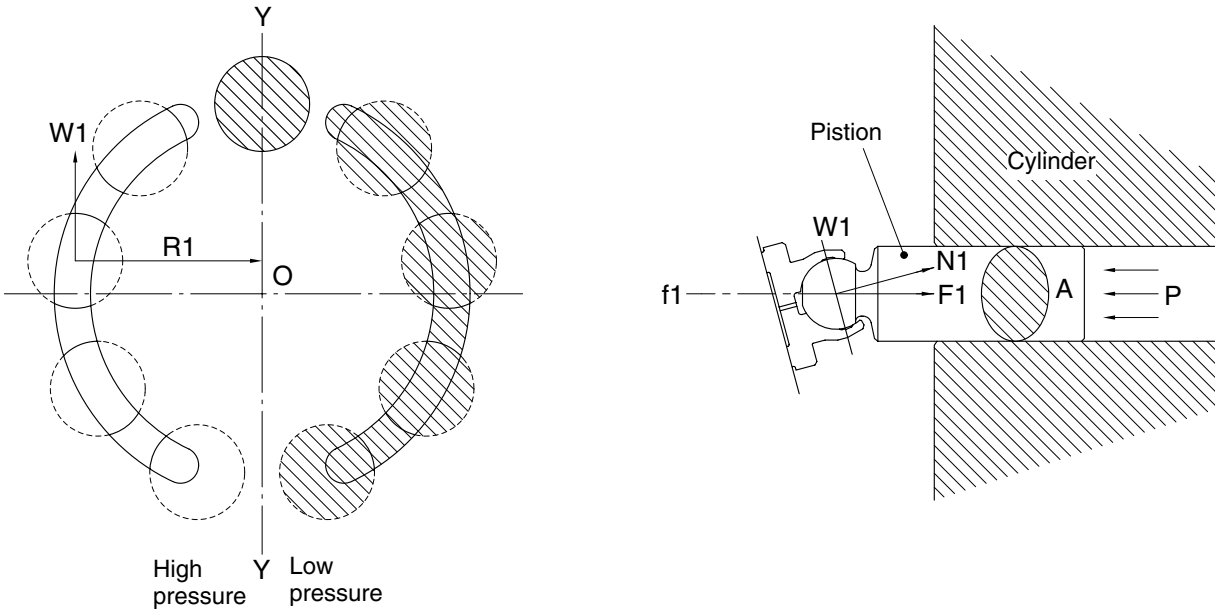
The high hydraulic can generate the force, F1=P × A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

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+R1, for Y-Y line connected by the upper and lower sides of the piston as following pictures.

The sum of torque (ΣW1 × 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 (10) 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

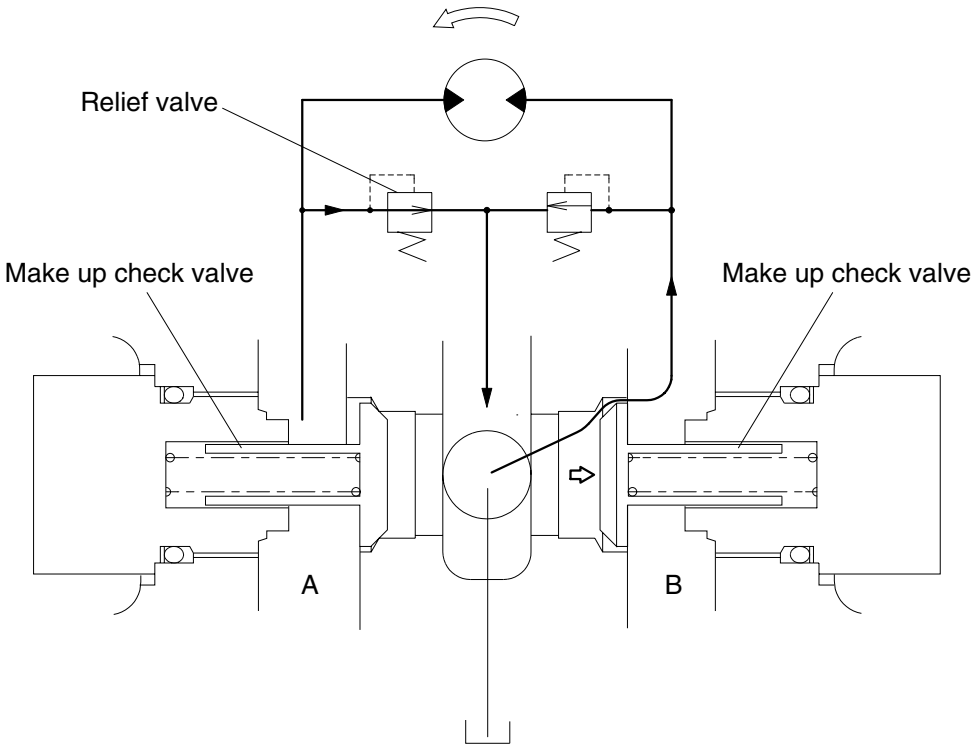
2) MAKE UP VALVE

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.

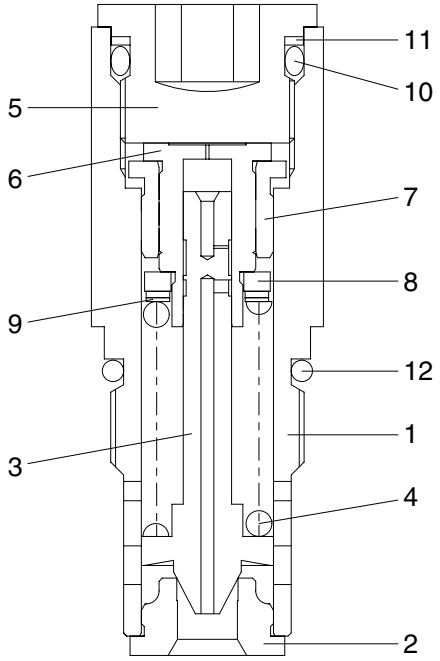
Pressurized oil into the port B, the motor rotate counterclockwise.

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



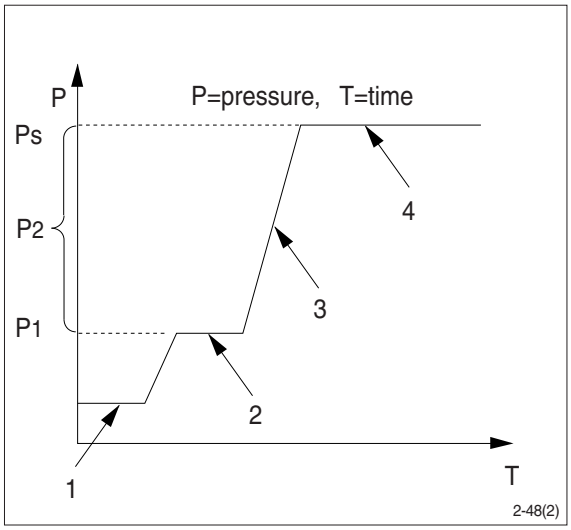
1	Body
2	Seat
3	Plunger
4	Spring
5	Adjusting screw
6	Piston
7	Bushing
8	Spring seat
9	Shim
10	O-ring
11	Back up ring
12	O-ring

(1) Construction of relief valve

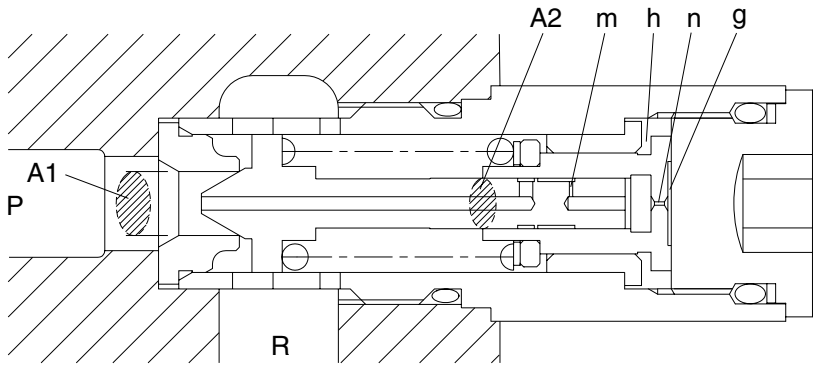
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

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



① Ports (P,R) at tank pressure.

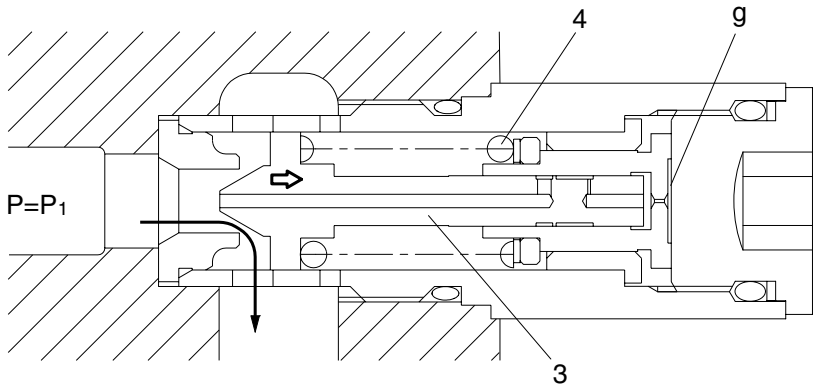


14007A2SM06

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.

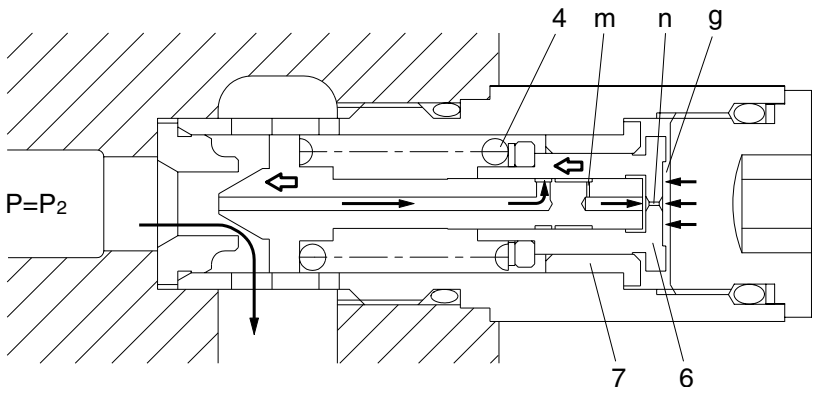
$P_1 \times A_1 = Fsp + Pg \times A_2$

$$P_1 = \frac{Fsp + Pg \times A_2}{A_1}$$



14007A2SM07

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).

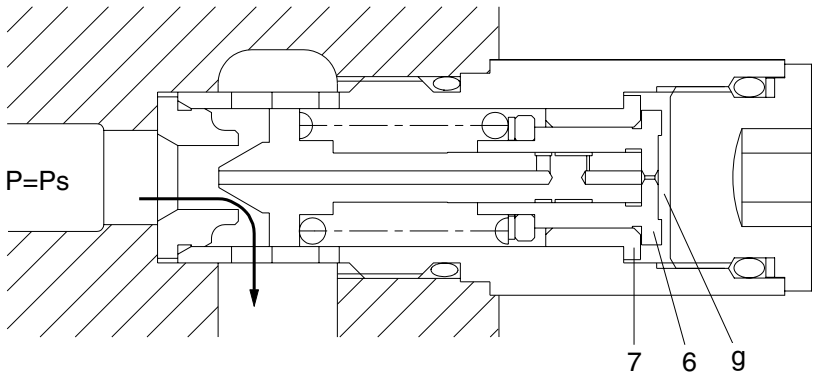


14007A2SM08

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 (Ps).

$Ps \times A_1 = Fsp + Ps \times A_2$

$$Ps = \frac{Fsp}{A_1 - A_2}$$



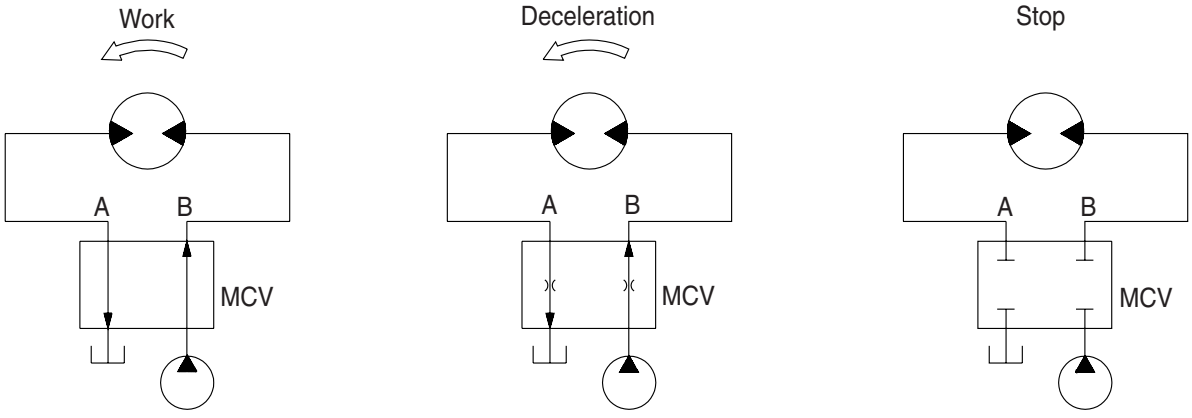
14007A2SM09

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.



MCV A, B opened | MCV A, B throttled | MCV A, B closed

2-48(1)

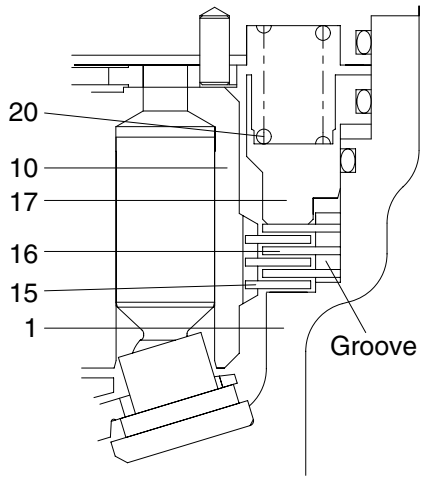
(2) Mechanical swing parking brake system

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.

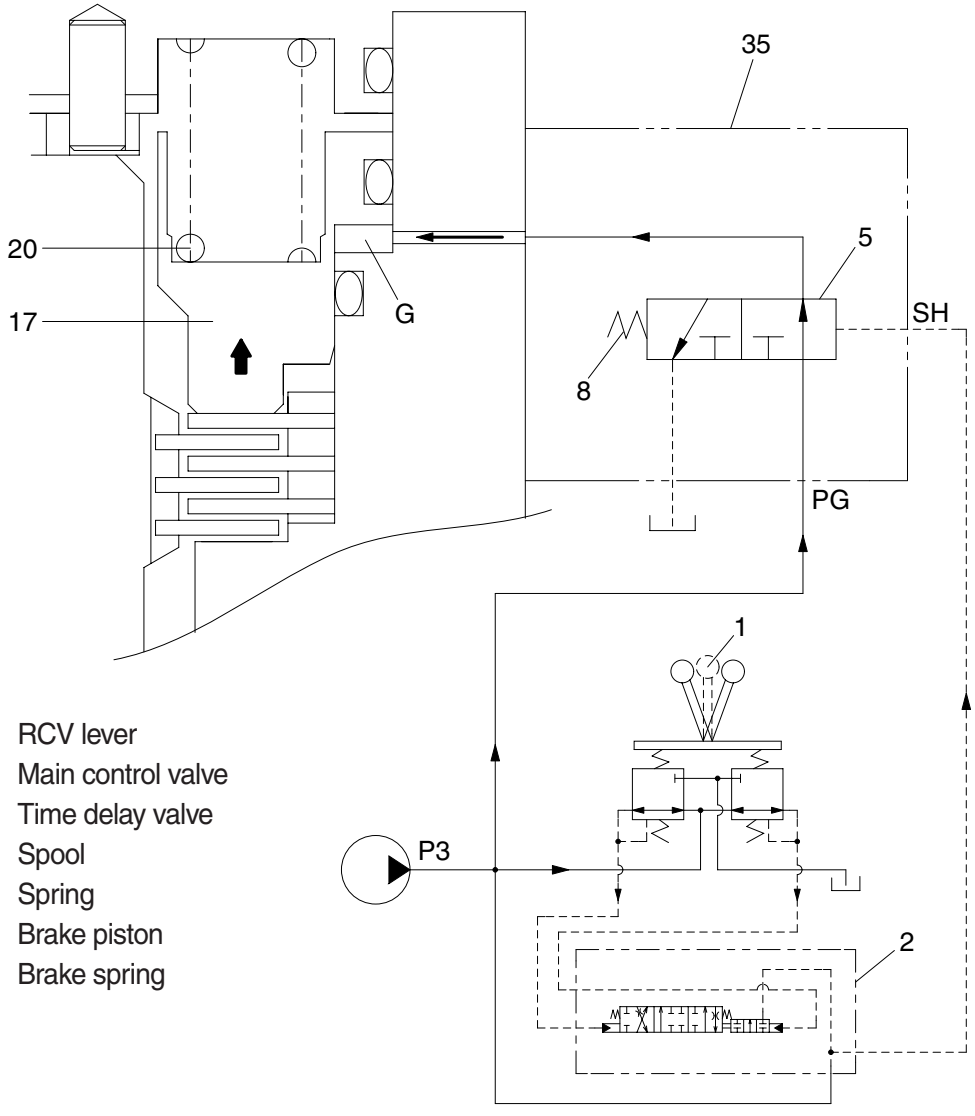


21092SM15

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

② **Operating principle**

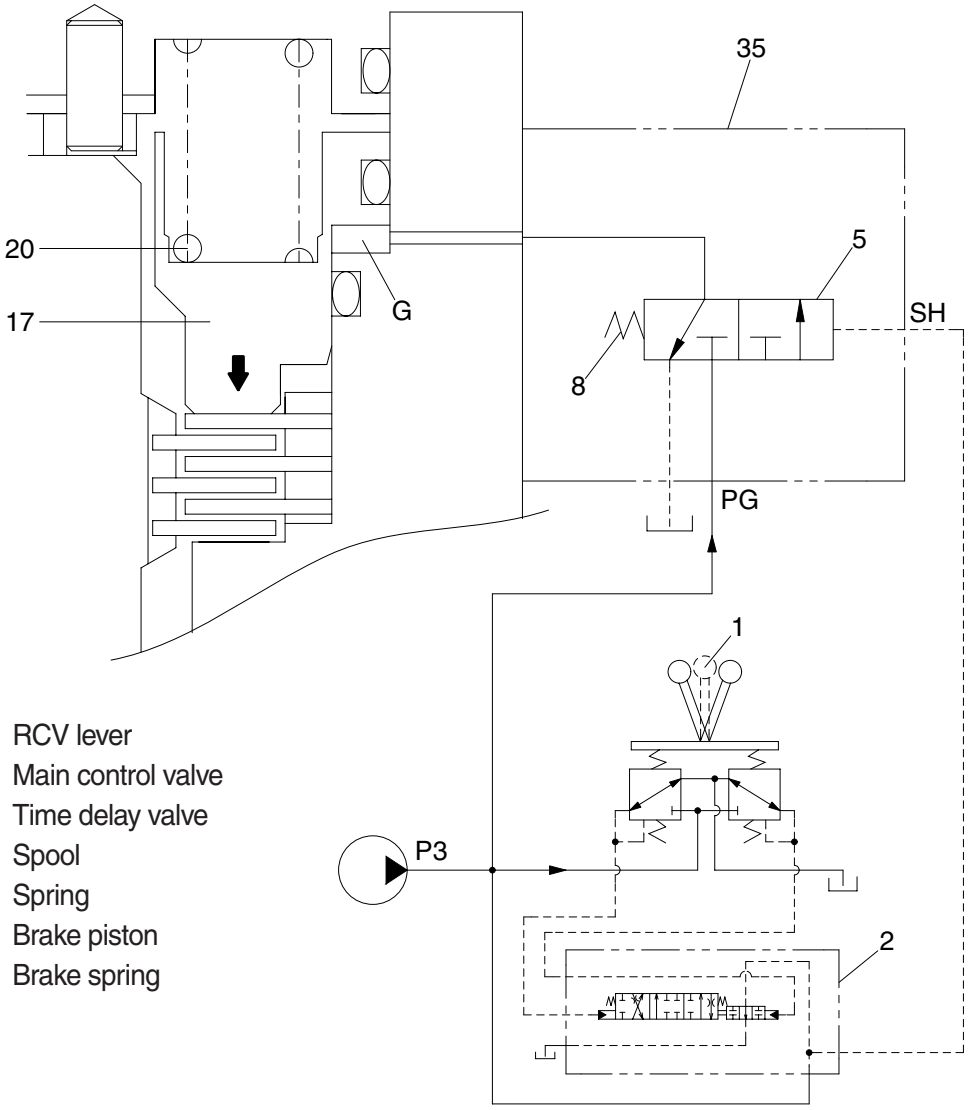
a. When one of the RCV lever (1) is set to the operation position, the each spool is shifted to left or right and the pilot oil flow is blocked. Then the pilot oil go to SH of the time delay valve (3).
This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged 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.



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

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.



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

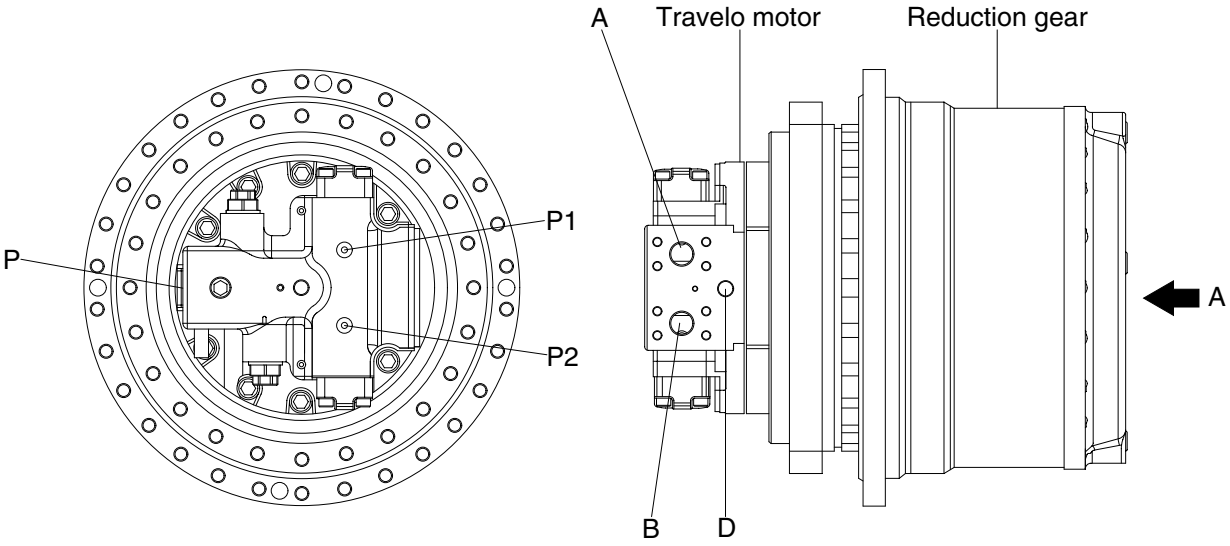
48092SM05

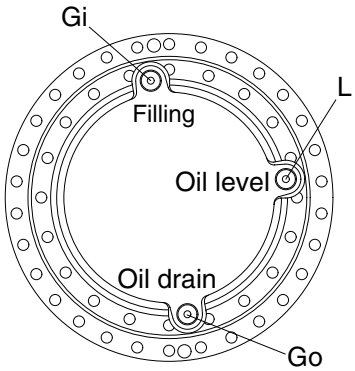
GROUP 4 TRAVEL DEVICE

1. CONSTRUCTION

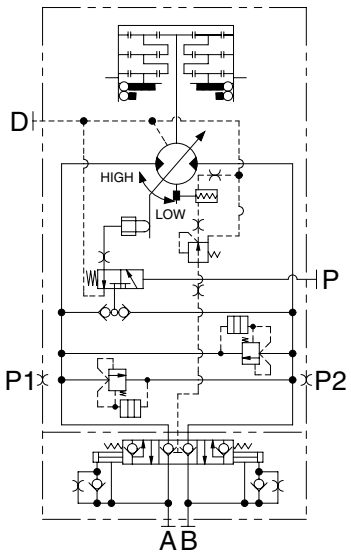
Travel device consists travel motor and gear box.

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





VIEW A



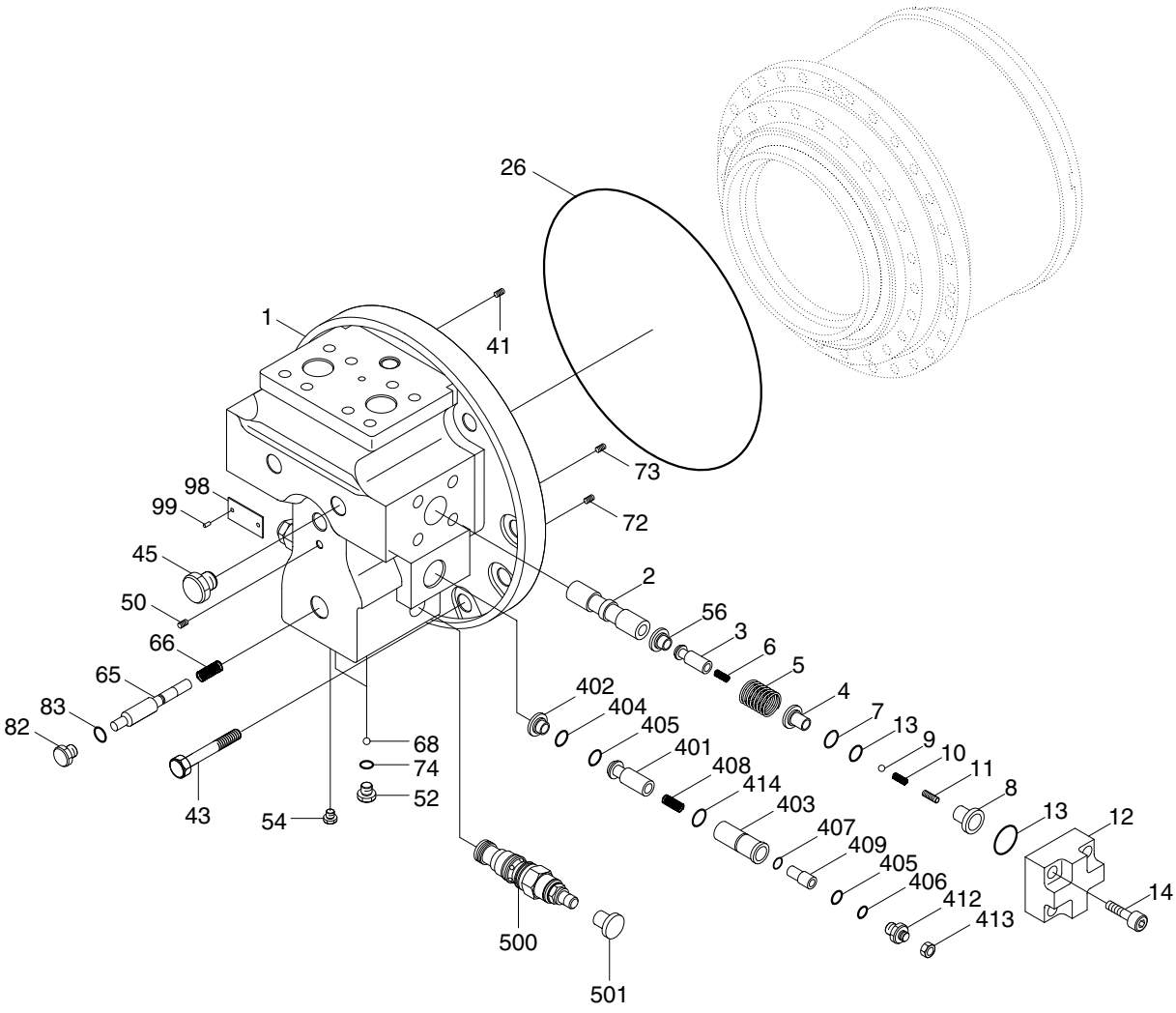
HYDRAULIC CIRCUIT

4809S2TM01

Port	Port name	Port size
A, B	Main port	SAE 5000 psi 1 1/4"
P1, P2	Pressure gauge port	PF 1/4
P	Pilot port	PF 1/4
D	Drain port	PF 1/2
L	Level gauge	PF 1/2
Gi	Gear oil filling port	PF 1/2
Go	Gear oil drain port	PF 1/2

2. STRUCTURE

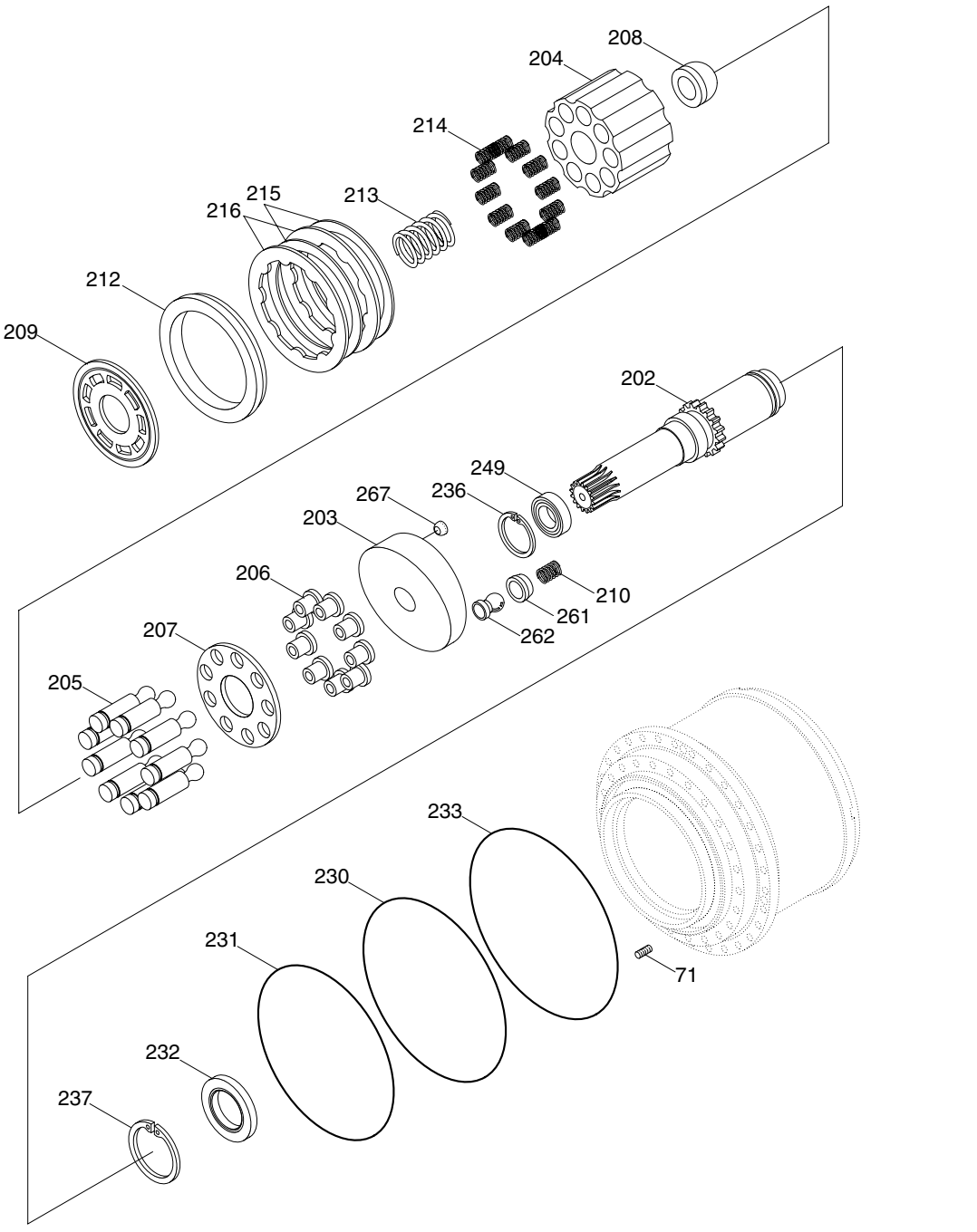
1) TRAVEL MOTOR (1/2)



4809S2TM02

1	Rear flange	43	Socket bolt	401	Plunger
2	Spool	45	PT Plug	402	Seat
3	Poppet	50	Needle bearing	403	Body
4	Plug	52	RO Plug	404	Back up ring
5	Check spring	54	Plug	405	O-ring
6	Main spring	56	Plug	406	O-ring
7	Washer	65	Spool	407	Retainer
8	Seat	66	Spring	408	Spring
9	Steel ball	68	Steel ball	409	Piston
10	Spring	72	Orifice	412	Adjust plug
11	Screw	73	Orifice	413	Lock nut
12	Cover	74	O-ring	414	Shim
13	O-ring	82	Plug	500	Reducing valve
14	Socket bolt	83	O-ring	501	Cover
26	O-ring	98	Name plate		
41	Valve plate pin	99	Rivet screw		

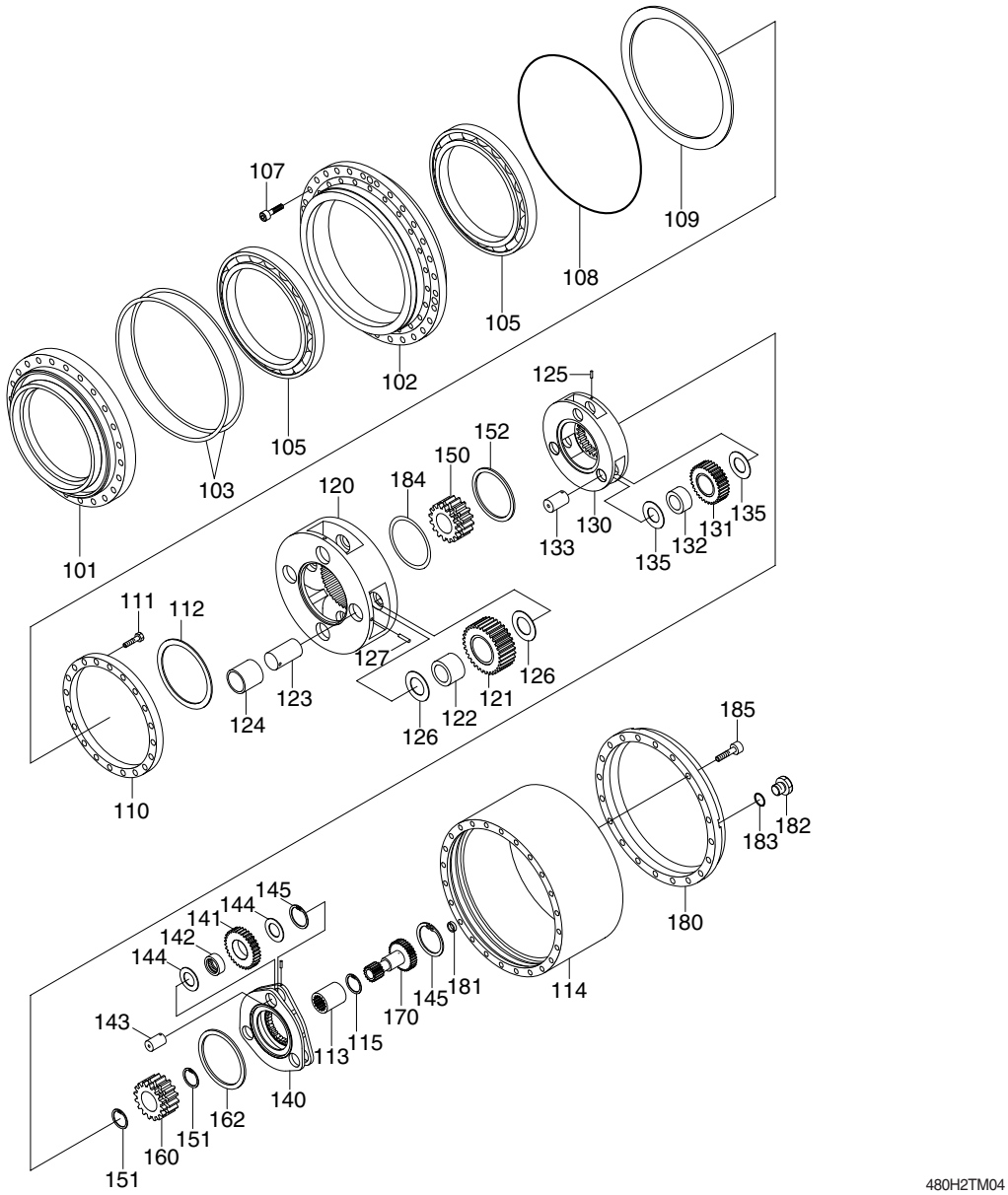
TRAVEL MOTOR (2/2)



480H2TM03

71	Orifice	209	Timing plate	231	O-ring
202	Drive shaft	210	Spring	232	Oil seal
203	Swash plate	212	Piston	233	O-ring
204	Cylinder block	213	Spring	236	Snap ring
205	Piston	214	Spring	237	Snap ring
206	Shoe	215	Friction plate	249	Roller bearing
207	Retainer plate	216	Mating plate	267	Pivot
208	Thrust ball	230	O-ring		

2) REDUCTION GEAR



480H2TM04

101	Spindle	122	Needle bearing	144	Plate
102	Hub	123	Bushing	145	Snap ring
103	Seat	124	Shaft No. 3	150	Sun gear No.3
105	Angular bearing	125	Spring pin	151	Thrust ring
107	Socket bolt	126	Thrust washer	152	Clip
108	O-ring	127	Spring pin	160	Sun gear No.2
109	Piece	130	Carrier No. 2	162	Clip
110	Coupling	131	Planetary gear No.2	170	Drive gear
111	Socket bolt	132	Needle bearing	180	Cover
112	Thrust plate	133	Shaft No.2	181	Thrust washer
113	Coupling	135	Thrust washer	182	Plug
114	Ring gear	140	Carrier No.1	183	O-ring
115	Snap ring	141	Planetary gear No.1	184	Thrust ring
120	Carrier No. 3	142	Needle bearing	185	Socket bolt
121	Planetary gear No. 3	143	Ring		

3. FUNCTION OF HYDRAULIC MOTOR

1) TURNING FORCE GENERATION

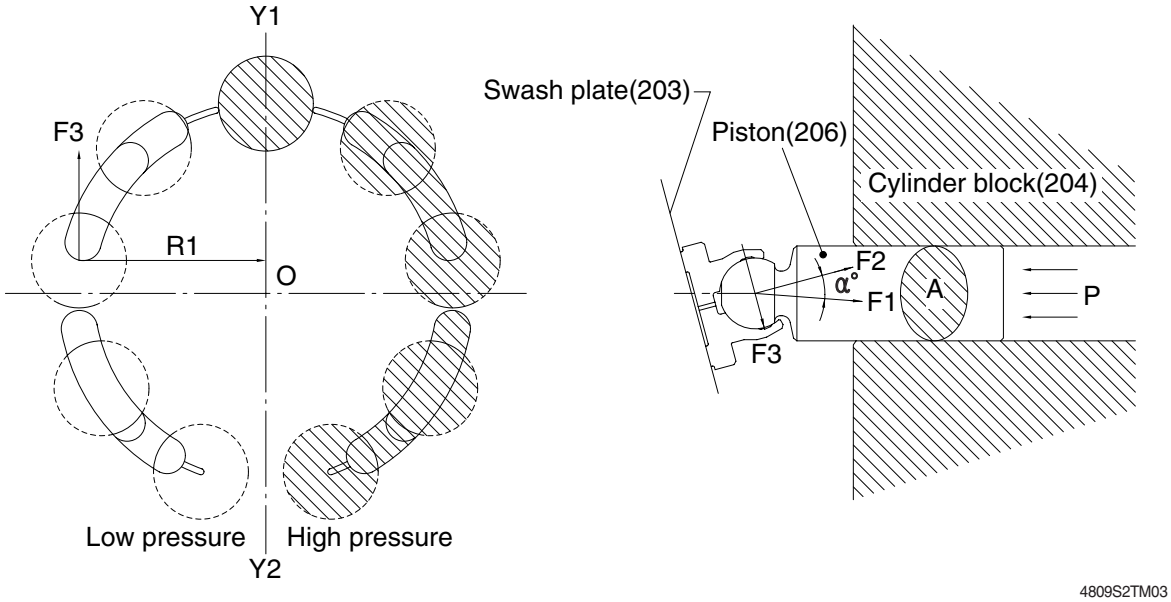
The pressure oil delivered from the hydraulic pump flows to rear flange of the motor, passes through the brake valve mechanism, and is introduced into cylinder block (204) via timing plate (209).

This oil constructively introduced only to one side of Y1-Y2 connecting the upper and lower dead points of stroke of piston (205). The pressurized oil fed to one side in cylinder block (204) pushes each piston (205) (four or five) and generates a force F(kgf) = P(kgf/cm^2) × A (cm^2).

This force acts on swash plate (203), and is resolves into components (F2 and F3) because swash plate (203) is fixed at an angle (α°) with the axis of drive shaft (202).

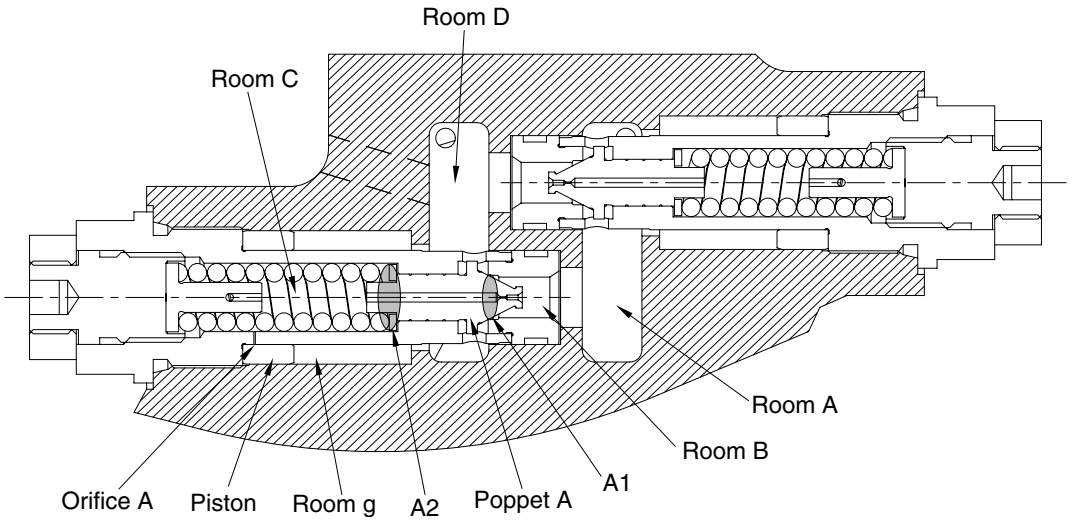
Radial component (F3) generates respective torques (T=F3 × Rl) for (Y1)-(Y2). This residual of torque (T = S (F3 × Rl)) rotates cylinder block (204) via piston (205). Cylinder block (204) is spline coupled with drive shaft (202).

So the drive shaft (202) rotates and the torque is transmitted.



4809S2TM03

2) FUNCTION OF RELIEF VALVE

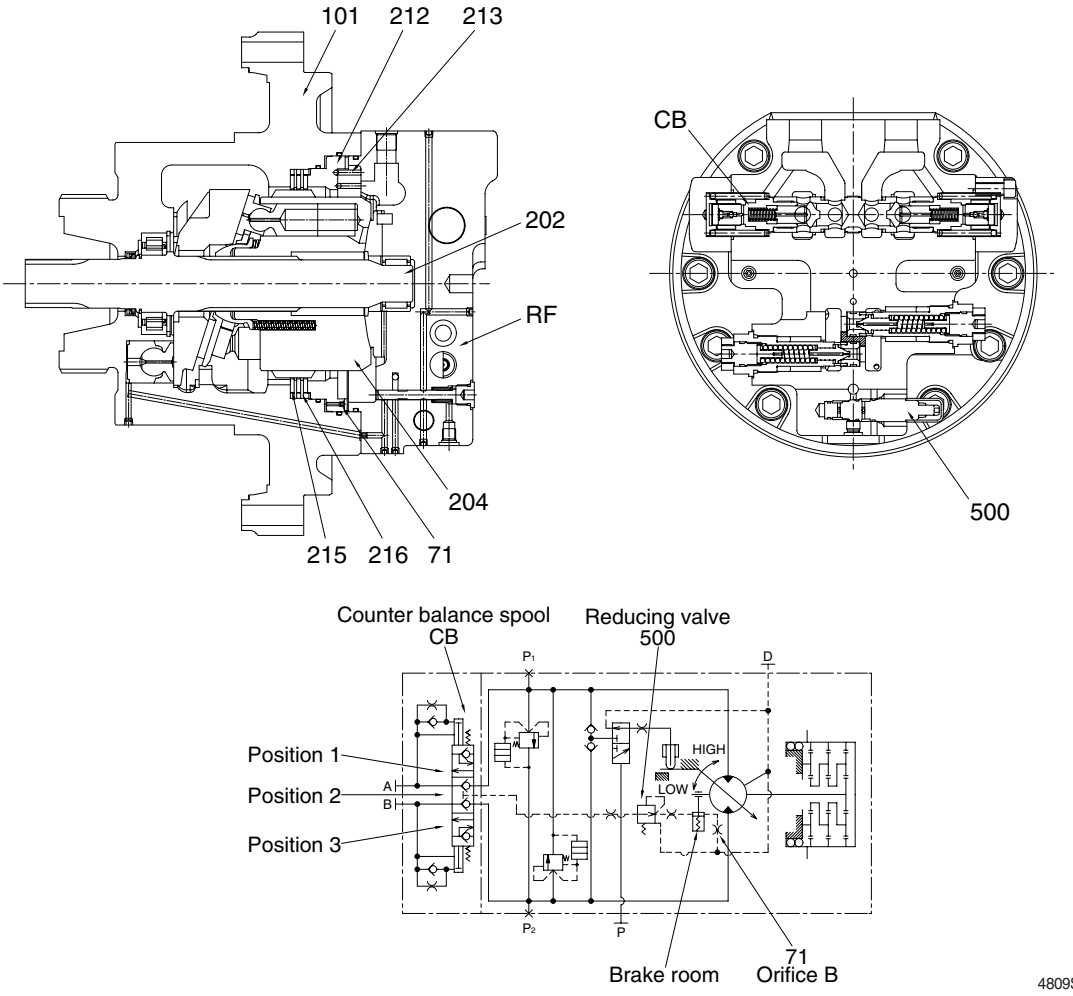


4809S2TM04

(1) The pressured oil that flowed in A room by the neutral position of counter balance spool is applied to the seat's room B at once. The poppet A is pushed on the left side by being that the room's pressured oil is forced as much as F1=A1 × P1 on section A1.
At the moment, the pressured oil goes through the orifice of poppet A.
This oil goes into the room C and goes into the room g through the orifice A then the piston is moved on the right side. The piston is reached to the stroke end, the oil has no way to go therefore.
A resultant force on force (F2=A2 × P2) pushing section A2 by the pressured oil and spring force is more than the force (F1=A1 × P1) working on section A1 of the poppet A.
During the piston is moved on the right side, the pressure of oil is kept uniformly.

(2) When the pressure of oil in the room B is higher then [F2 + spring force] the poppet opens and the pressured oil goes into the room D as a relief function.
In this way, by controlling the pressure in room A, B in two steps, the hydraulic motor is smoothly braked and to a stop.

3) FUNCTION BRAKE



The brake is released by applying to the brake piston the pressure led through the built in counterbalance spool subassembly. With no pressure working , the brake force is always ensured.
Brake force is generated from friction plate (215) which is combined with cylinder block (204) as spline, separate plate (216) which is embedded in spindle (101), spindle (101), parking piston (212).
Without pressure being applied to the brake piston, the brake piston is pushed by fourteen brake spring (213), and the friction plate and separation plate are held between the brake and spindle.
This holding force functions as the friction force. This friction force restrains the shaft (202) spline coupled with the cylinder block, and this function is the brake.

Normal travelling (at position 1 or 3)
During normal travelling, the pressured oil coming through the counter balance spool is applied to the brake room to release brake, after was decompressed at a reducing valve. At this time, the slight hydraulic oil is drained through the orifice B (71), but the pressure at brake room releases the braking by overcoming the spring force. Cause the pressure at brake room is always applied from the counter balance valve.

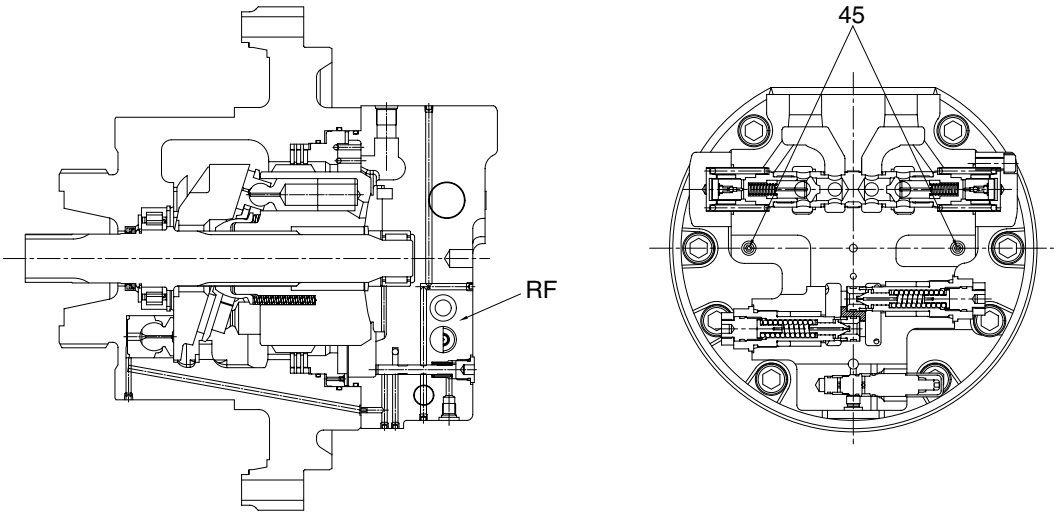
Neutral (at position 2)
The brake room's pressure is decreased by the blocked oil-passage, and the brake is generated by being that the brake spring force is much than the brake room's pressure. At this time, the hydraulic oil in the brake room is drained through the orifice B (71), then the spool returns to the neutral position. When the condition changes from travelling to stop, the brake runs in order of precedence after stopping motor, so it is preventing the damage of friction plate.

4) RELEASING METHOD OF BRAKE

In releasing the brake without applying the brake releasing pressure, follow the procedures shown below.

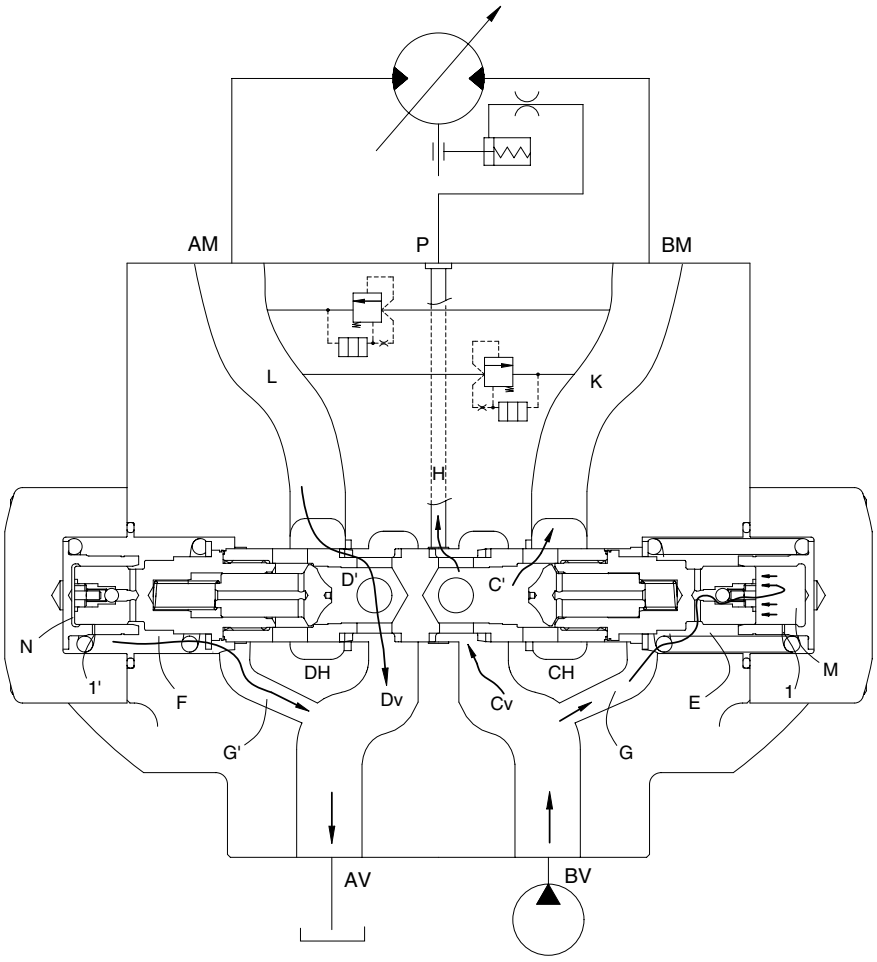
Details of work	Tools
Remove two plugs (45) from the rear flange (RF). (For their position, see the attached installation dimension.) Insert in there, tighten an M10 screw of 135 mm in length into a tapped hole of the brake piston. Then the condition having the brake released pressure is attained and the brake release pressure is attained and the brake is released.	Socket Wrench 6 mm 8 mm

※ **Even with the negative brake released, the hydraulic motor will not run.**
When it is difficult to generate the working pressure due to failure of the pump or so, and the whole machine is to be pulled for transportation without removing the hydraulic motor, connect pressure measurement ports Am, Bm with a short hose or something.
Then the machine can be pulled slowly.



4809S2TM08

5) FUNCTION OF COUNTER BALANCE VALVE



480H2TM05

Suppose port Bv is connected to the hydraulic pump and port Av, to the tank.
The oil supplied from the hydraulic pump passes through Bv, Cv and C in sequence, pushes up the poppet of the check valve, passes through K to port Bm, and is supplied to the hydraulic motor to turn it.
Therefore, the pump discharge oil pressure incerases, and the pressure is led via passage G to spring room E and via the ball check valve to dumping room M. When the pressure in rooms E and M exceeds the value equivalent to the force of the spring which holds the spool at its neutral position, the spool begins to move left. Since the working oil in room N flows into room F via throuttle 1 or clearance 2 and that in room F is discharged via passage G through port Av to the tank, the spool moves left to have passage L-Dm-D-Dv composed. In addition, passage Cv-H-P is also composed, and the pump discharge pressure in port Bv is led to port P.
Because of the throttle or clearance provided for the working oil flow from room N, this changeover motion of the spool is comparatively slow. When the pump discharge pressure is higher, the spool movement is larger and above opening area of the spool is larger.

When the pump discharge pressure falls, pressures in rooms E and M fall and the spool will move right due to the spring on the room F side.
Since working oil in room M flows to room E via throttle 1 and that in room E, to port Bv via passage G, the spool moves right.
When the presssure at port Bv, falls down to eh tank pressure, the pressure in room E also falls to the tank pressure and becomes equal to that in room F, and so the spool returns to neutral position.

6) FUNCTION OF HIGH/LOW SPEED CHANGEOVER

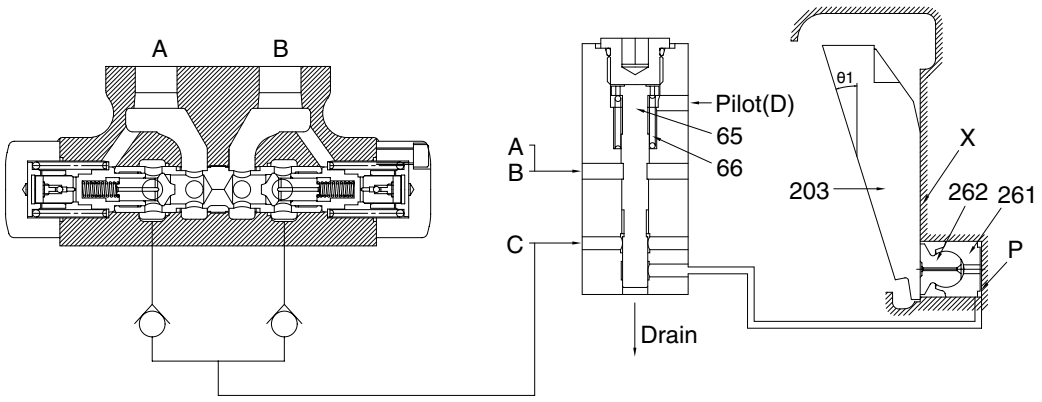
As a supporting mechanism for the swash plate (203) on which the shoe (262) slide, the pillar system is adopted to support the load with semi-cylindrical sliding bearings provided at both end of the mechanism. The capacity is changed by changing the tilting angle of this swash plate.

This is a mechanism that swash plate was pushed by tilting piston, and the tilting angle of the swash plate is decided in two positions ("large" and "small") by controlling has the flows to and from these piston rooms with the displacement changeover valve section.

(1) Low speed - at pilot pressure of less than 20 kgf/cm²

When no pilot pressure is supplied from (D) (at a pressure of 20 kgf/cm² or less), valve (65) is pressed toward the top by the force of spring (66) and (A) port or (B) port, the pressurized oil supply port (C) is shut off, and oil in chamber (P) is released into the motor case via valve (65).

Consequently, swash plate (203) is tilted at a maximum angle (Θ1) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed rotation.



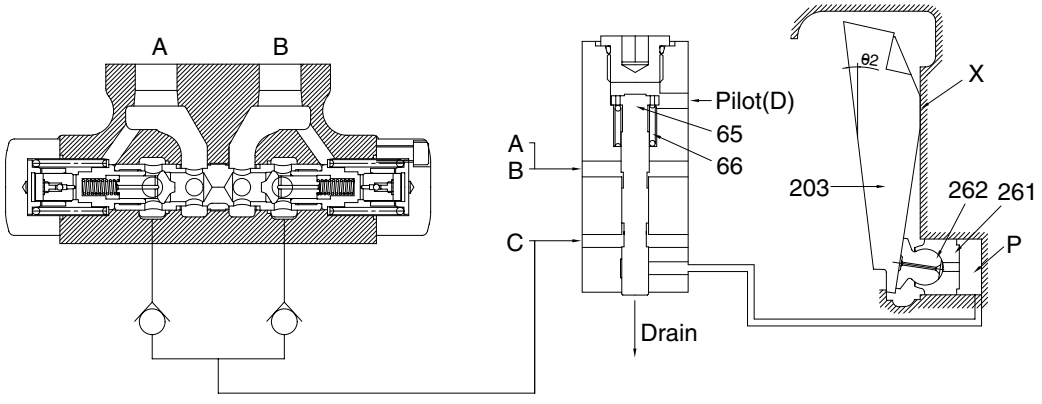
4809S2TM06

(2) High speed - at pilot pressure of 20 kgf/cm² or more.

When a pilot pressure is supplied from port (D) (at a pressure of 20 kgf/cm² or more), the pressure overcomes the force of spring (66) and (A) port or (B) port of 2 speed spool (65) is pressed toward the down.

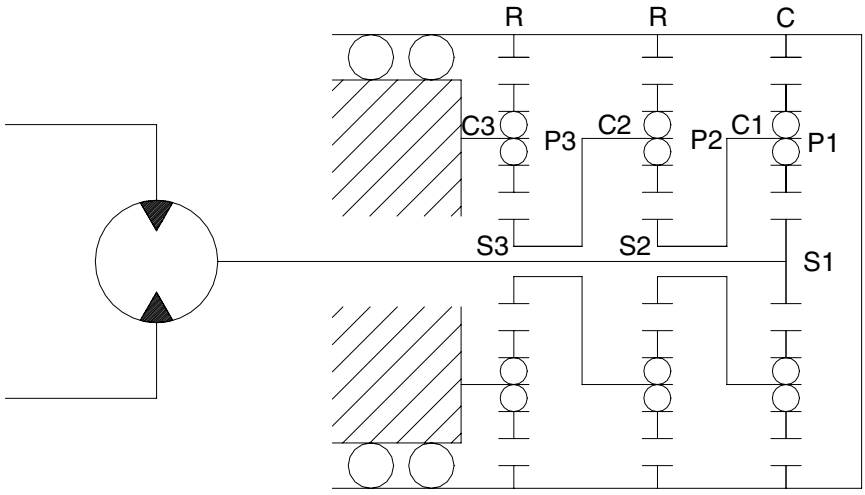
The pressurized oil at supoly port (C) is then introduced into chamber (P) via 2 speed spool (65). Piston (261) pushed up swash plate (203) until it touches side X of the spindle.

At this time, swash plate (203) is tilted at a minimum angle (Θ2) and the piston displacement of hydraulic motor becomes minimum, thus leading to high-speed rotation.



4809S2TM07

7) WORKING PRINCIPLE OF REDUCTION GEAR



4809S2TM09

The reduction gear is composed of a three-stage planetary gear mechanism shown in the following figure. Since the sun gear is designed to have a floating mechanism, errors of the gears and carrier pin hole pitches will not affect the gear's lives heavily.

The input rotation of the hydraulic motor is transmitted to the drive gear (D) and this drives the No. 1 planetary gears (P1). This No.1 planetary gears (P1) drives the cover gear (C) with the same force as the meshing tangential force with the drive gear (D), and also the No.1 carrier (C1) with the same force as the meshing reaction force.

In other words, the No.1 planetary gears (P1) revole rotating. This rotation of the No.1 carrier (C1) becomes the output of the 1st stage, and is transmitted directly to No.2 sun gear (S2). (No.1 carrier is spline-coupled with No.2 sun gear.)

Similarly the revolution of the No.2 planetary gears (P2) are transmitted via No.2 carrier (C2) to the No.3 sun gear (S3). Since the No.3 carrier (C3) supporting the No.3 planetary gears (P3) are fixed, the No.3 planetary gears (P3) do not revolve, but rotates to drive ring gear (R).

Therefore, the rotating case is driven by the overall driving torque of the cover and ring gear.

This reduction ratio is expressed as shown below :

$$I = \frac{(Z_D + Z_C)(Z_{S2} + Z_R)(Z_{S3} + Z_R)}{Z_D \times Z_{S2} \times Z_{S3}} \text{ -1}$$

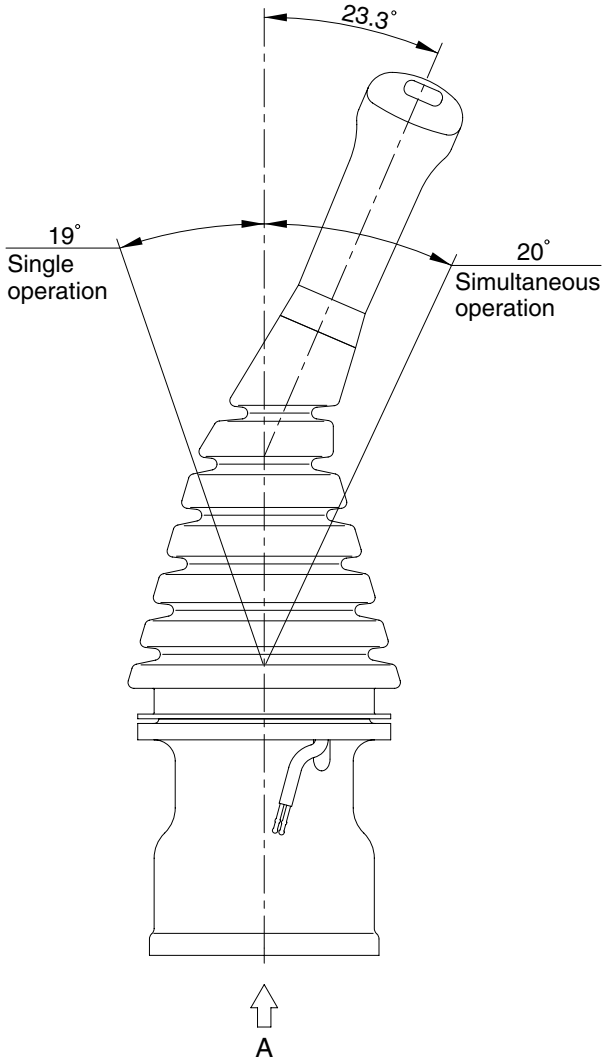
Z_D : Teeth of the drive gear
Z_C : Teeth of the cover gear
Z_{S2} : Teeth of the No.2 sun gear
Z_{S3} : Teeth of the No.3 sun gear
Z_R : Teeth of the ring gear

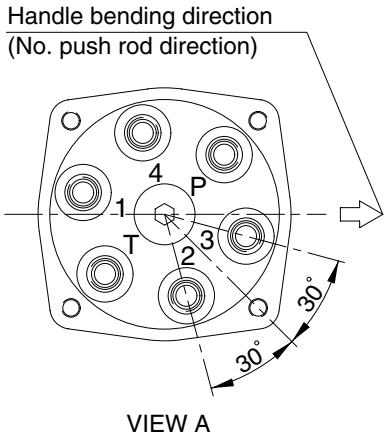
The direction of rotation is reverse to that of the input shaft.

GROUP 5 RCV LEVER

1. STRUCTURE

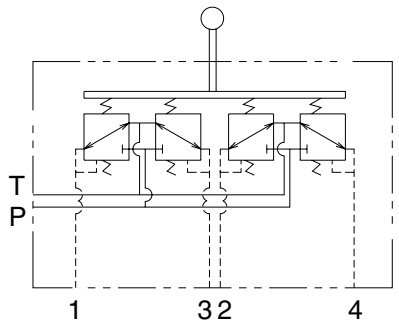
The casing has the oil inlet port P(Primary pressure) and the oil outlet port T(Tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.





VIEW A

25032RL01



Hydraulic circuit

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

CROSS SECTION

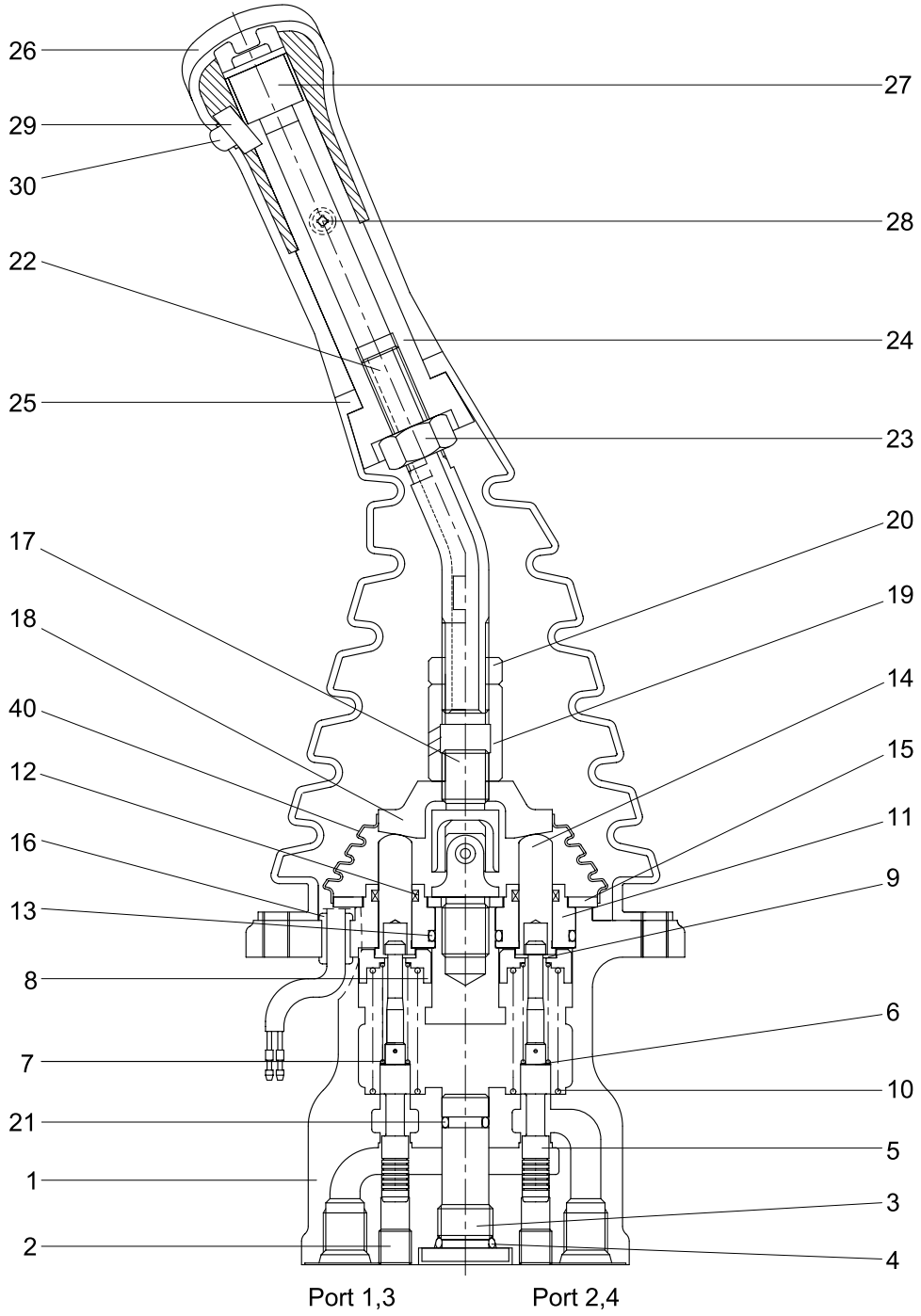
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool(5), spring(7) for setting secondary pressure, return spring(10), stopper(9), spring seat(8) and shim(6). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5kgf/cm^2(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 the handle, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.

1	Case	11	Plug	21	O-ring
2	Plug	12	Rod seal	22	Handle connector
3	Plug	13	O-ring	23	Nut
4	O-ring	14	Push rod	24	Insert
5	Spool	15	Plate	25	Boot
6	Shim	16	Bushing	26	Handle
7	Spring	17	Joint assembly	27	Switch assembly
8	Spring seat	18	Swash plate	28	Screw
9	Stopper	19	Adjusting nut	29	Switch assembly
10	Spring	20	Lock nut	30	Switch cover
				40	Boot

CROSS SECTION



14072SF80

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

(1) Inlet port(P) where oil is supplied from hydraulic pump.

(2) Output ports(1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.

(3) Tank port(T) necessary to control the above output pressure.

(4) Spool to connect output port to inlet port or tank port.

(5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool(5) 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(7) 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(11).

For the purpose of changing the displacement of the push rod through the switch plate(19) and adjusting nut(20) are provided the handle(27) that can be tilted in any direction around the fulcrum of the universal joint(18) center.

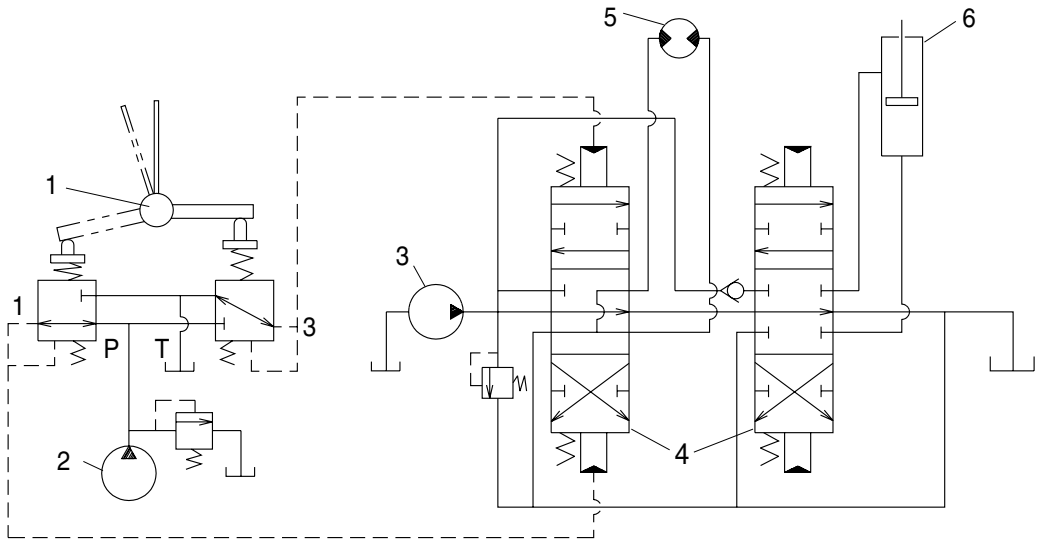
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

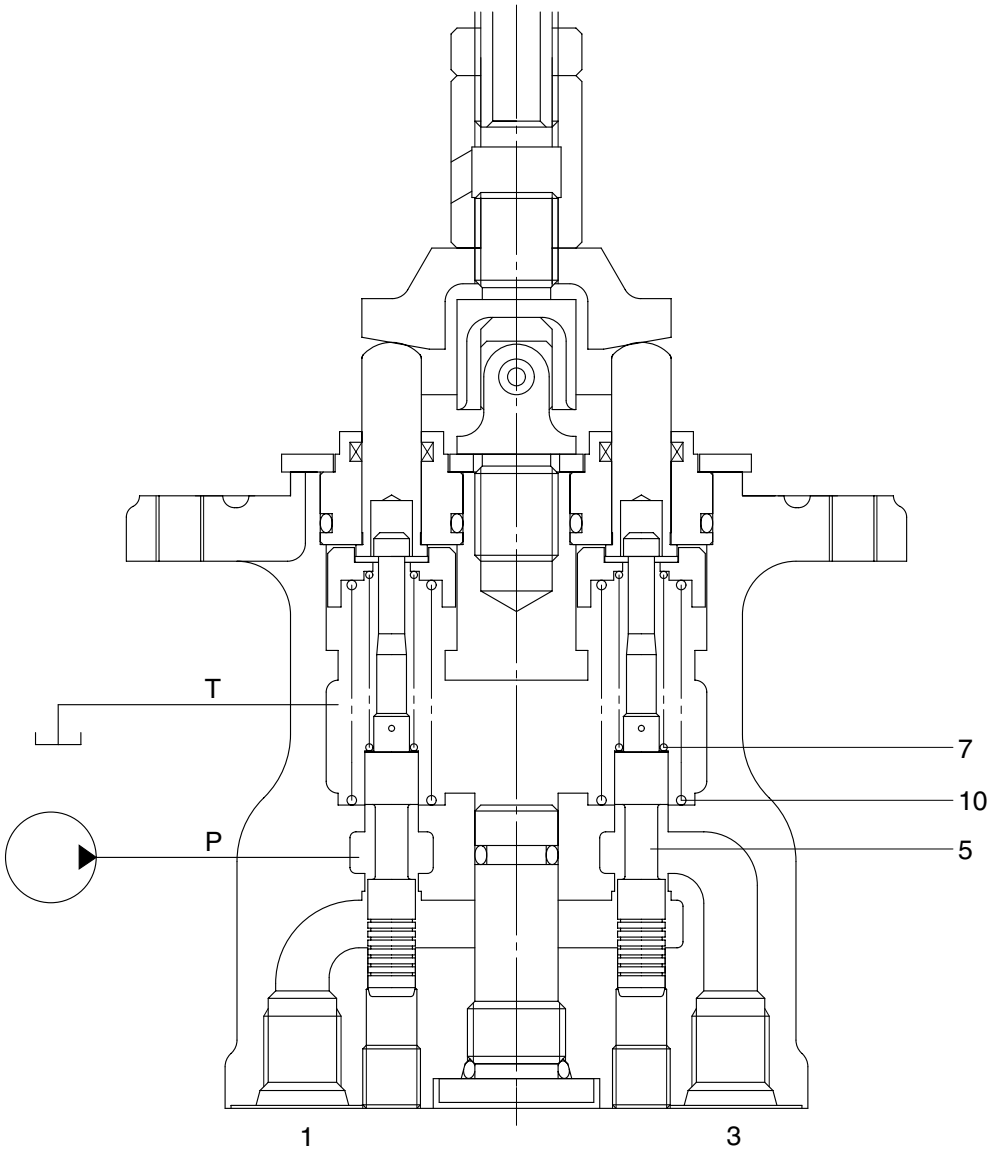
The diagram shown below is the typical application example of the pilot valve.



36072RL01

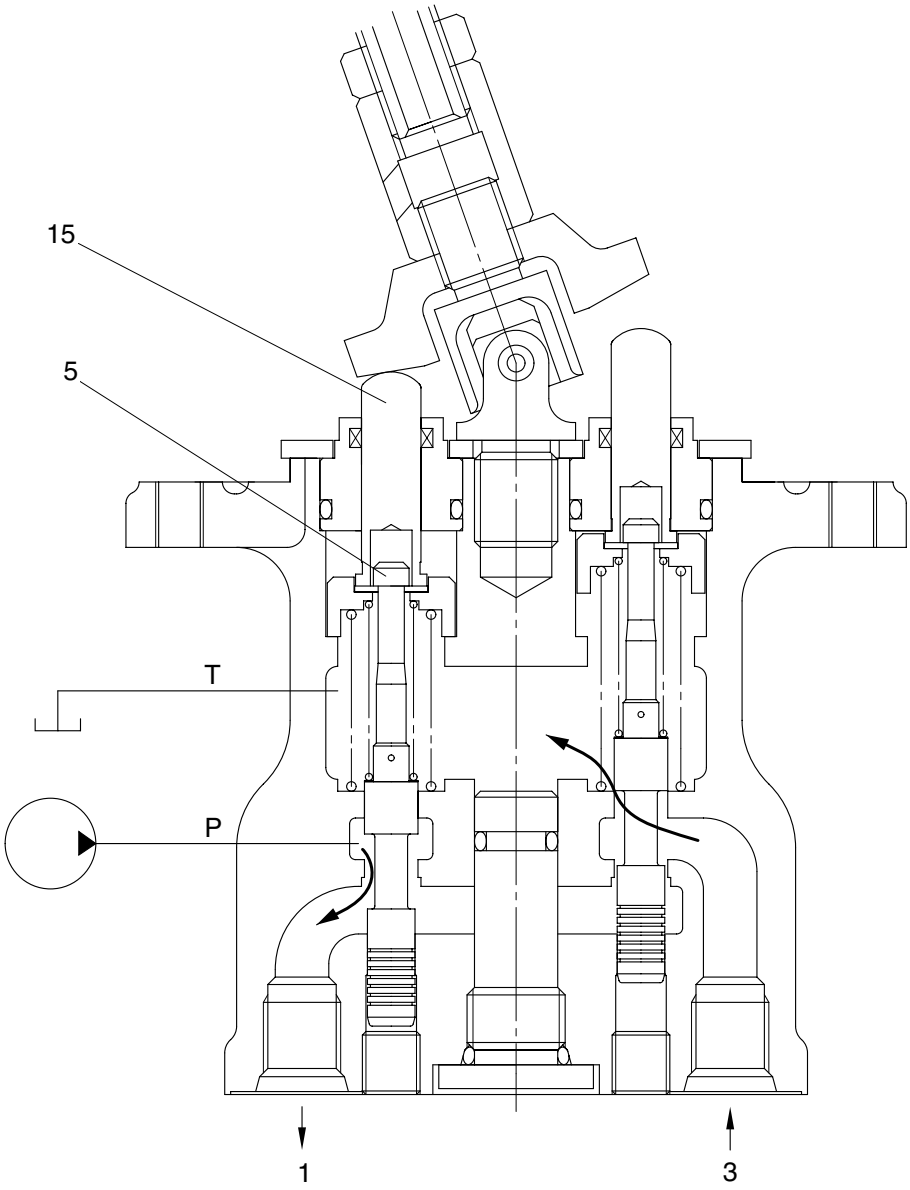
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where handle is in neutral position



The force of the spring(7) that determines the output pressure of the pilot valve is not applied to the spool(5). Therefore, the spool is pushed up by the spring(10) to the position of port(1, 3) in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where handle is tilted

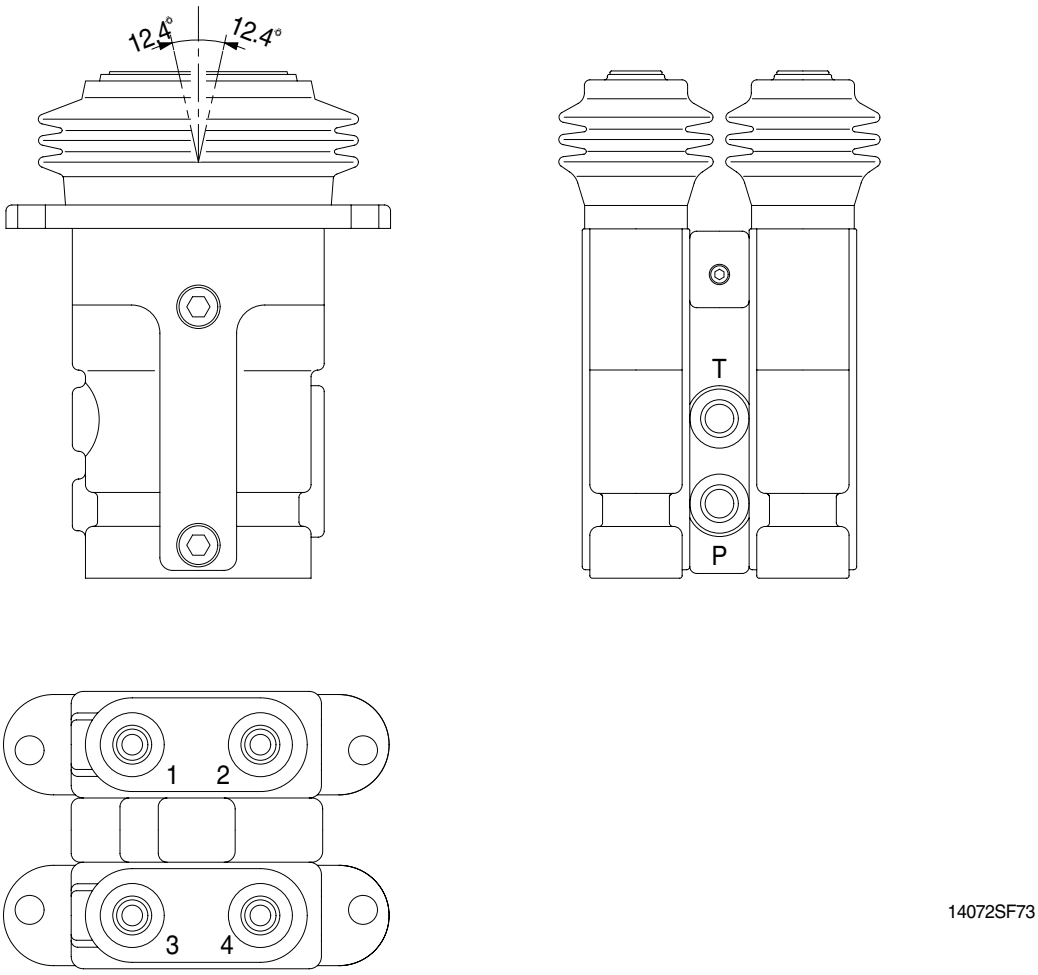


When the push rod(14) is stroked, the spool(5) moves downwards.
Then port P is connected with port(1) and the oil supplied from the pilot pump flows through port(1) to generate the pressure.
When the pressure at port(1) increases to the value corresponding to the spring force set by tilting the handle, 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.

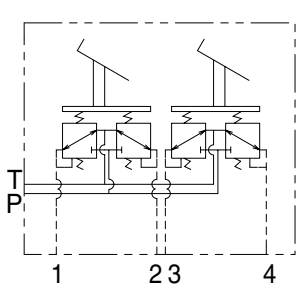
GROUP 6 RCV PEDAL

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.



14072SF73



Hydraulic circuit

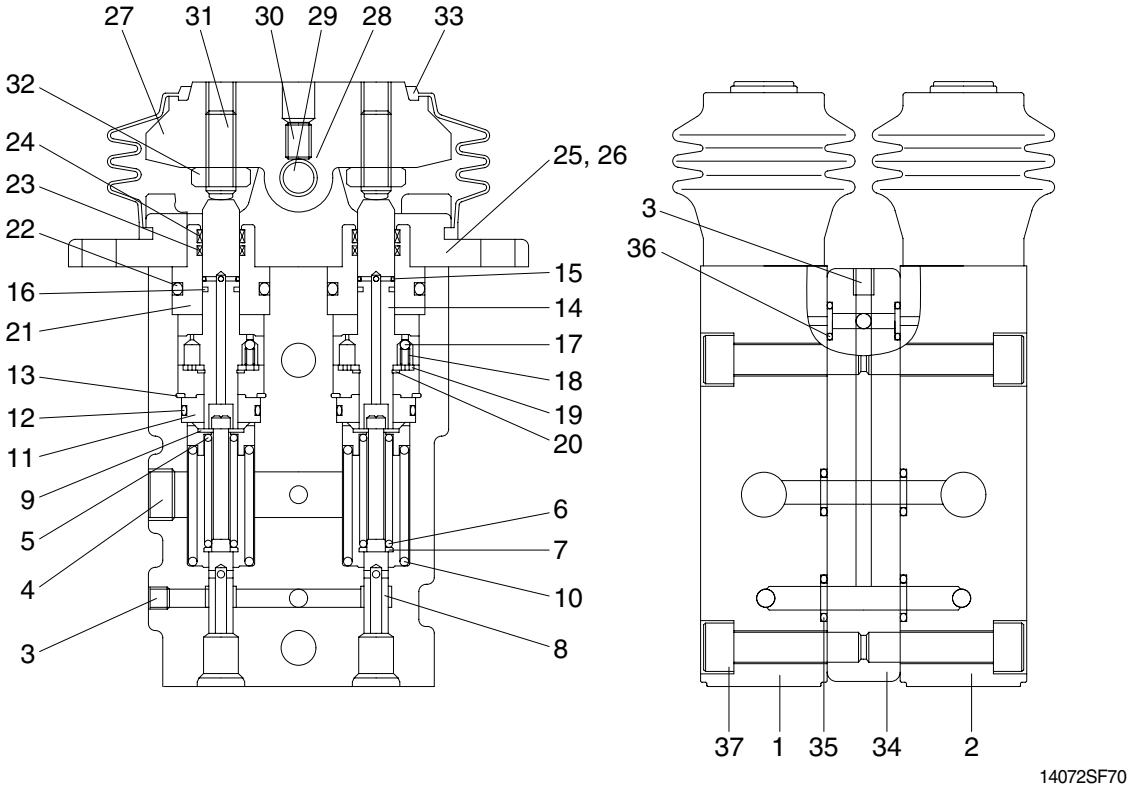
Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel(LH, Forward)	
2	Travel(LH, Backward)	
3	Travel(RH, Forward)	
4	Travel(RH, Backward)	

CROSS SECTION

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

The pressure reducing section is composed of the spool(8), spring(6) for setting secondary pressure, return spring(10), stopper(9), and spring seat(7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm^2 (depending on the type). The spool is pushed against the push rod(14) by the return spring.

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



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

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

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

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

(1) Inlet port(P) where oil is supplied from hydraulic pump.

(2) Output port(1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.

(3) Tank port(T) necessary to control the above output pressure.

(4) Spool to connect output port to inlet port tank port.

(5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

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

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

The change the deflection of this spring, the push rod(14) is inserted and can slide in the plug(21).

For the purpose of changing th displacement of the push rod through the cam(27) and adjusting nut(32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam(27) center.

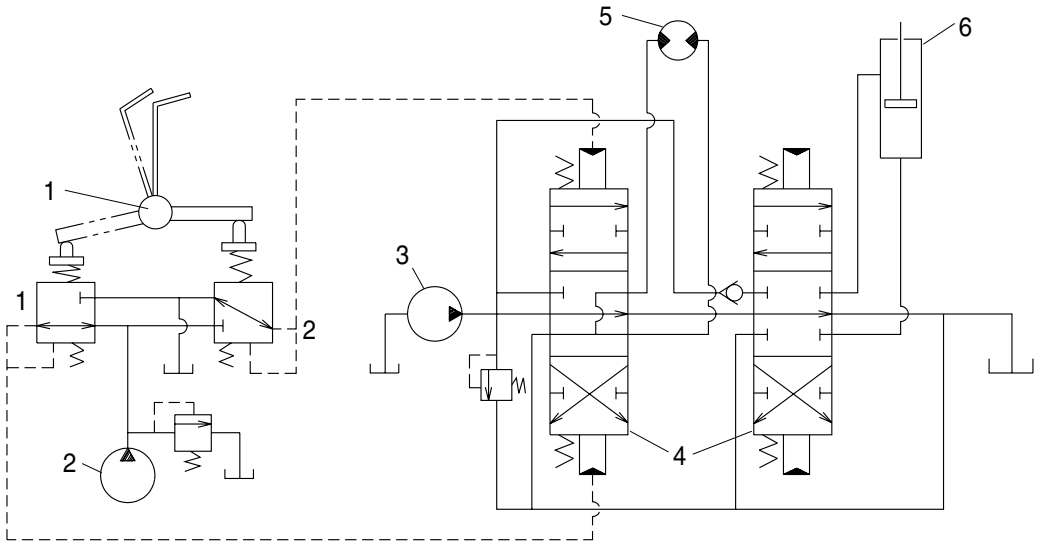
The spring(10) works on the casing(1) and spring seat(7) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

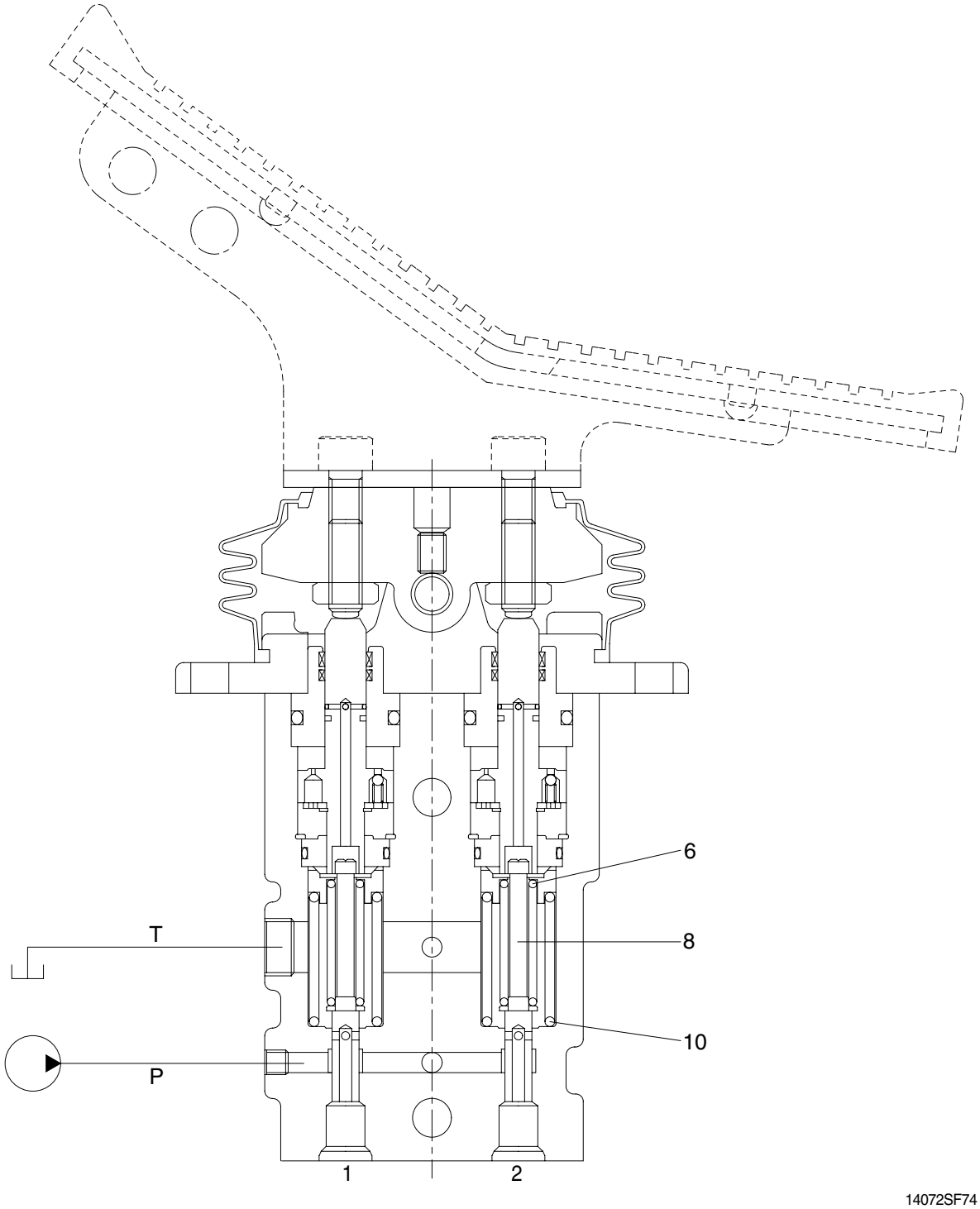
The diagram shown below is the typical application example of the pilot valve.



2-76 (140-7)

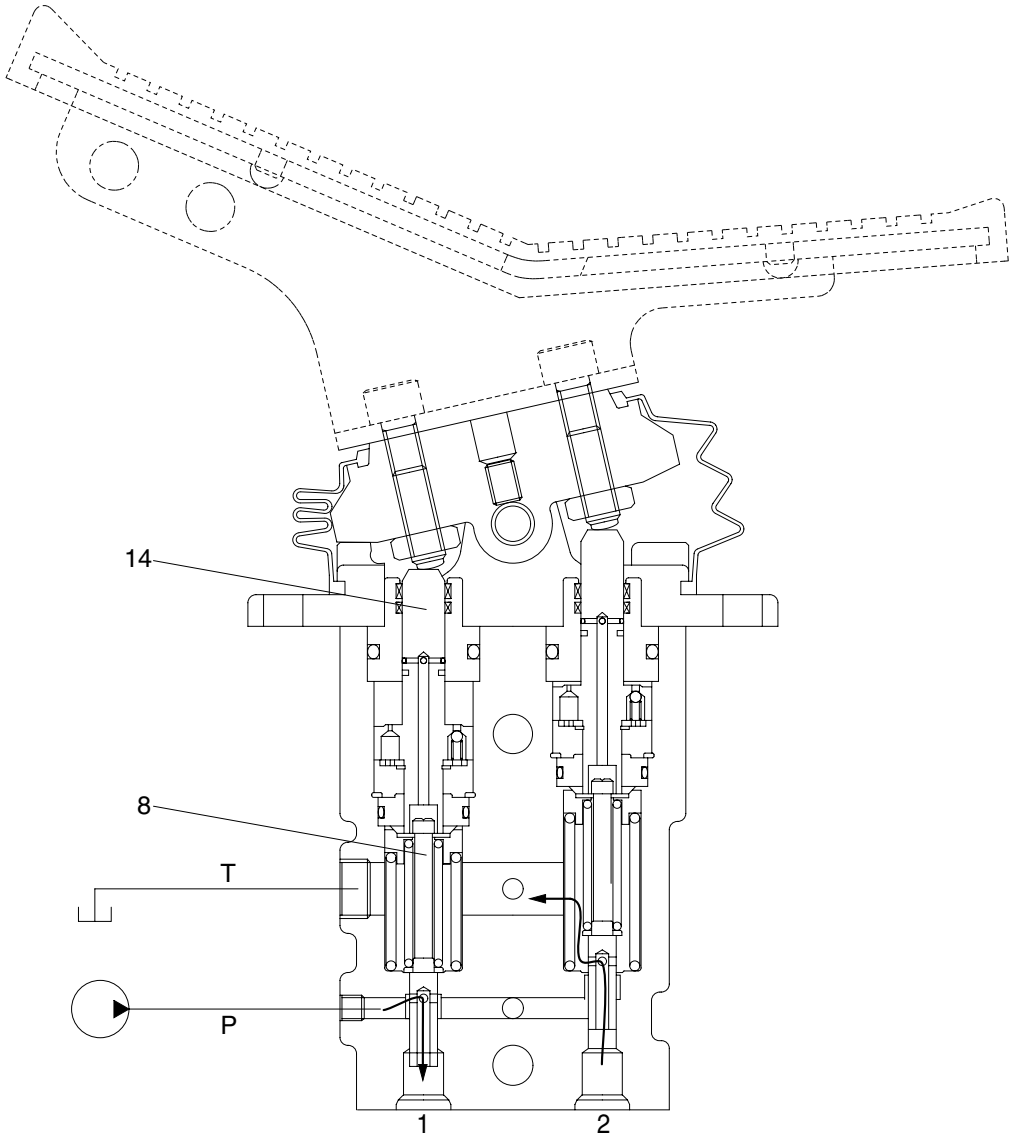
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where pedal is in neutral position



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

(2) Case where pedal is tilted



14072SF75

When the push rod(14) is stroked, the spool(8) moves downwards.
Then port P is connected with port 1, and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.