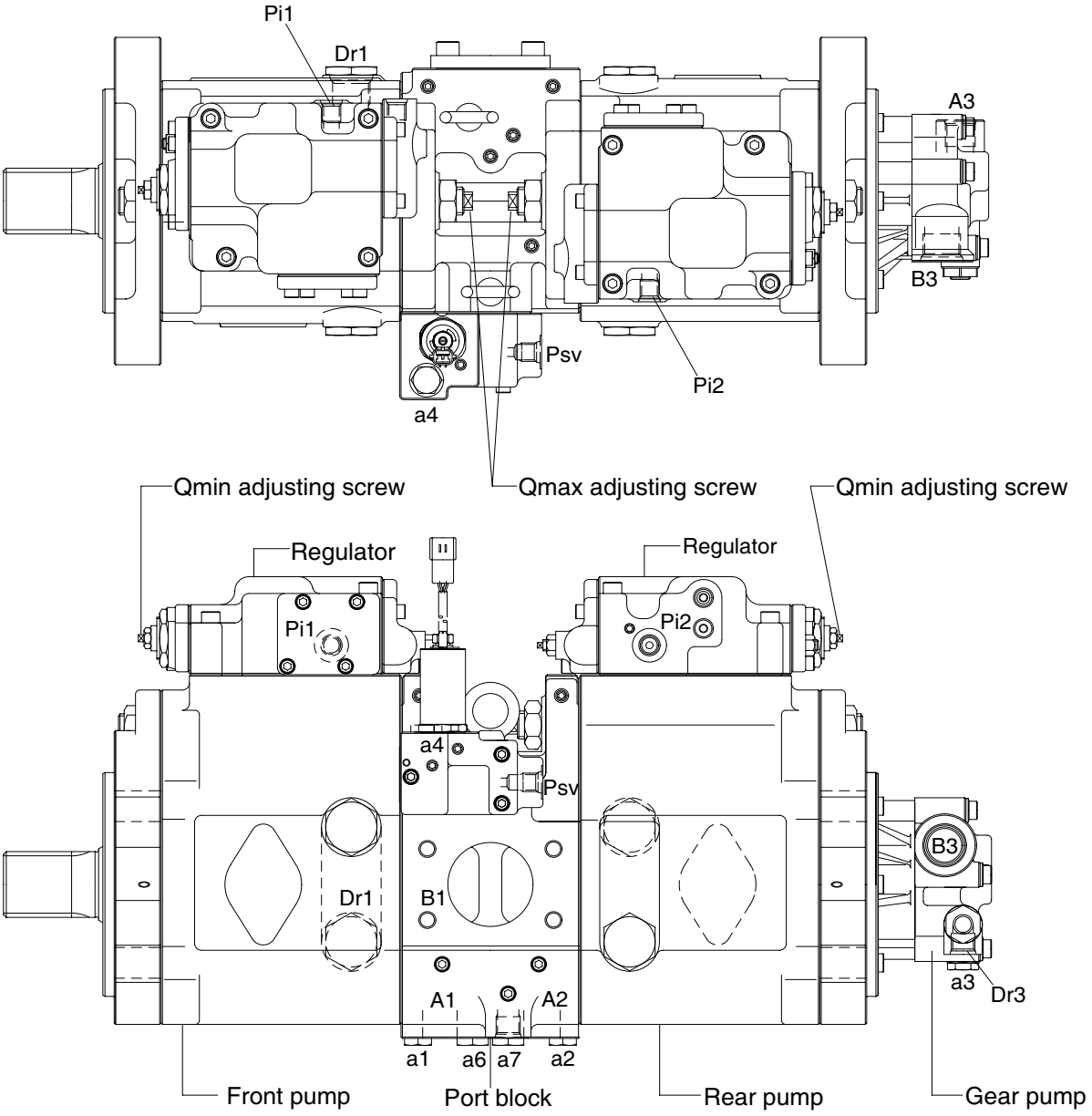
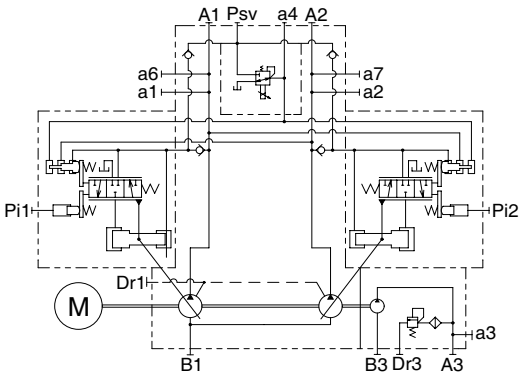
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, regulator and gear pump.

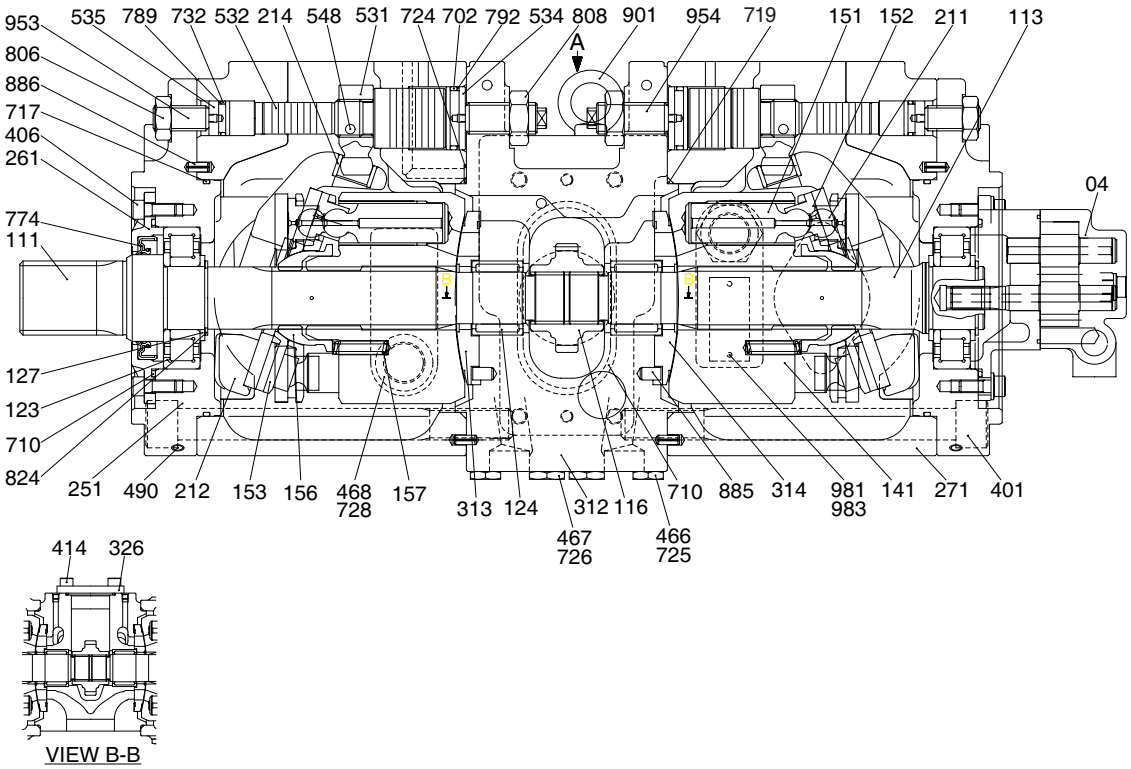




Port	Port name	Port size
A1, 2	Delivery port	SAE6000 psi 1"
B1	Suction port	SAE2500 psi 2 1/2"
Dr1	Drain port	G 3/4 - 20
Pi1, i2	Pilot port	G 1/4 - 15
Psv	Servo assist port	G 1/4 - 15
a1, 2, 4	Gauge port	G 1/4 - 15
a6, a7	Gauge port	G 3/8 - 17
a3	Gauge port	G 1/4 - 14
A3	Gear pump delivery port	G 1/2 - 19
B3	Gear pump suction port	G 3/4 - 20.5
Dr3	Gear pump drain port	G 3/8 - 15

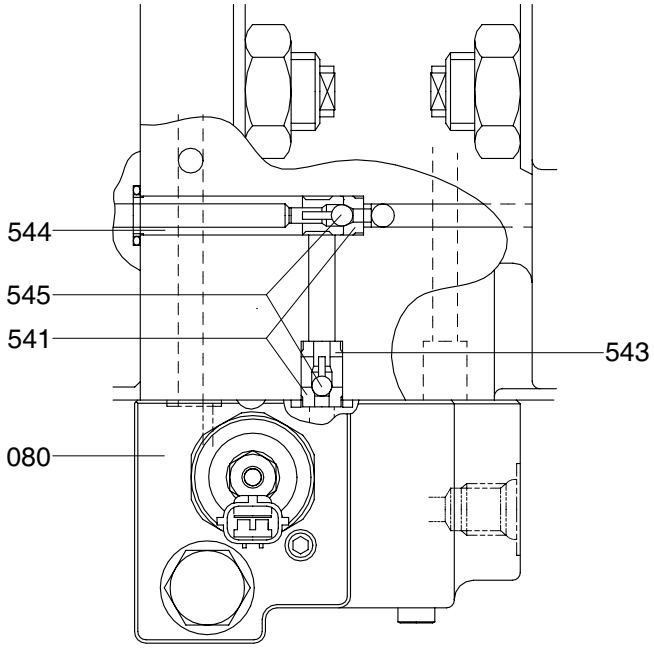
1) MAIN PUMP(1/2)

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



04	Gear pump	312	Valve block	719	O-ring
111	Drive shaft (F)	313	Drive shaft (R)	724	O-ring
113	Drive shaft (R)	314	Valve plate (L)	725	O-ring
116	Gear	326	Cover	728	O-ring
123	Roller bearing	401	Hexagon socket bolt	732	O-ring
124	Needle bearing	406	Hexagon socket bolt	774	Oil seal
127	Bearing spacer	414	Hexagon socket bolt	789	Back up ring
141	Cylinder block	466	VP plug	792	Back up ring
151	Piston	467	VP plug	806	Hexagon head nut
152	Shoe	468	VP plug	824	Snap ring
153	Set plate	490	VP plug	885	Pin
156	Bushing	531	Tilting pin	886	Spring pin
157	Cylinder spring	532	Servo piston	901	Eye bolt
211	Shoe plate	534	Stopper (L)	953	Set screw
212	Swash plate	535	Stopper (S)	954	Set screw
214	Bushing	548	Pin	981	Name plate
251	Swash plate support	702	O-ring	983	Pin
261	Seal cover (F)	710	O-ring		
271	Pump casing	717	O-ring		

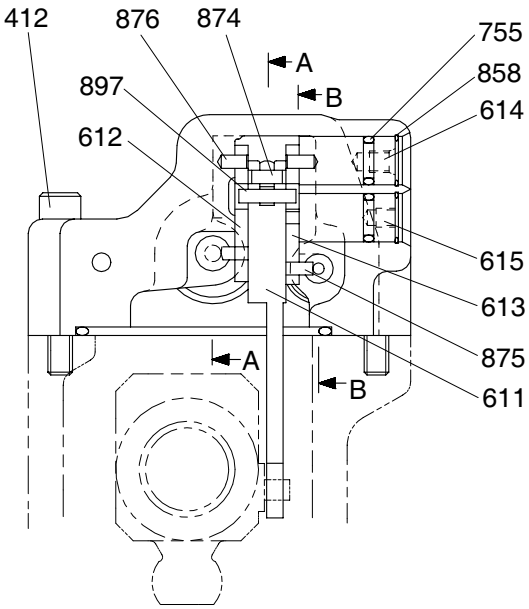
MAIN PUMP (2/2)

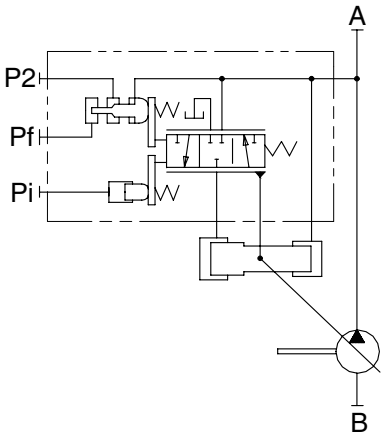


VIEW A

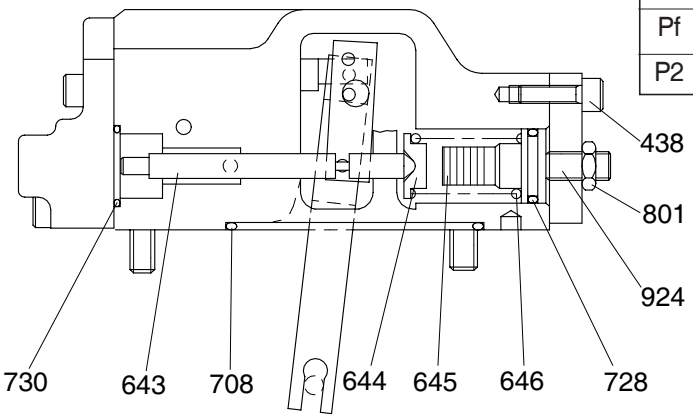
080	Proportional reducing valve	543	Stopper 1	545	Steel ball
541	Seat	544	Stopper 2		

2) REGULATOR (1/2)

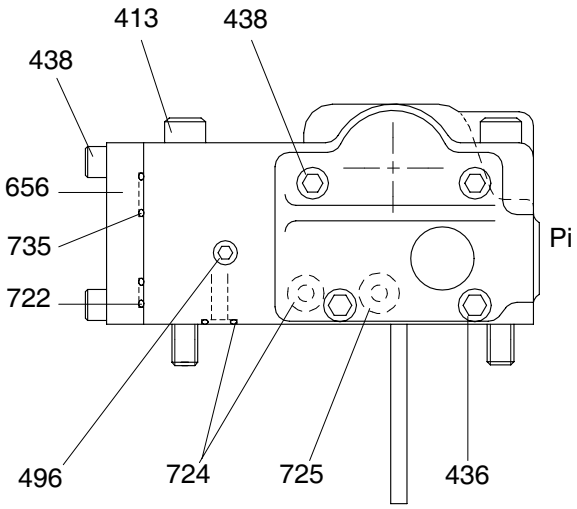




Port	Port name	Port size
A	Delivery port	1"
B	Suction port	2 1/2"
Pi	Pilot port	G 1/4-15
Pf	Power shift pressure	-
P2	Companion delivery pressure	-

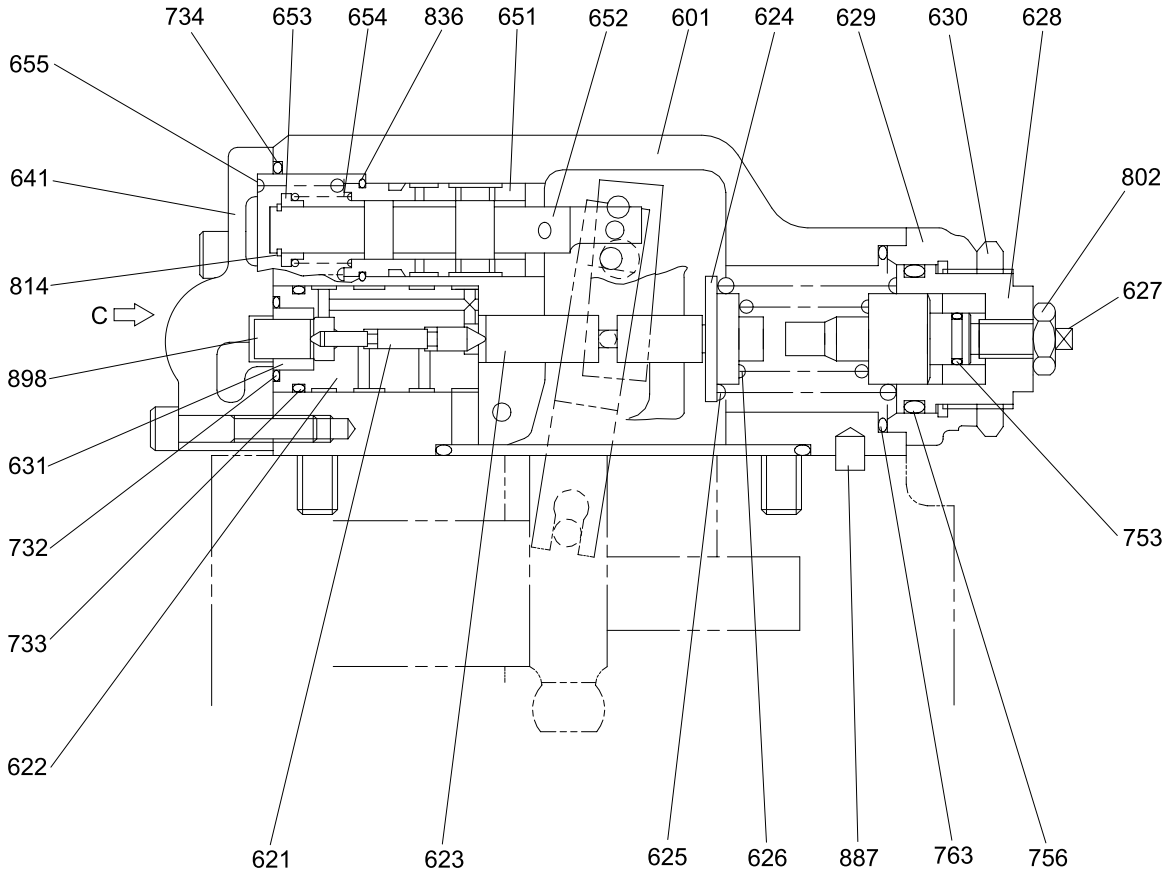


SECTION B-B



VIEW C

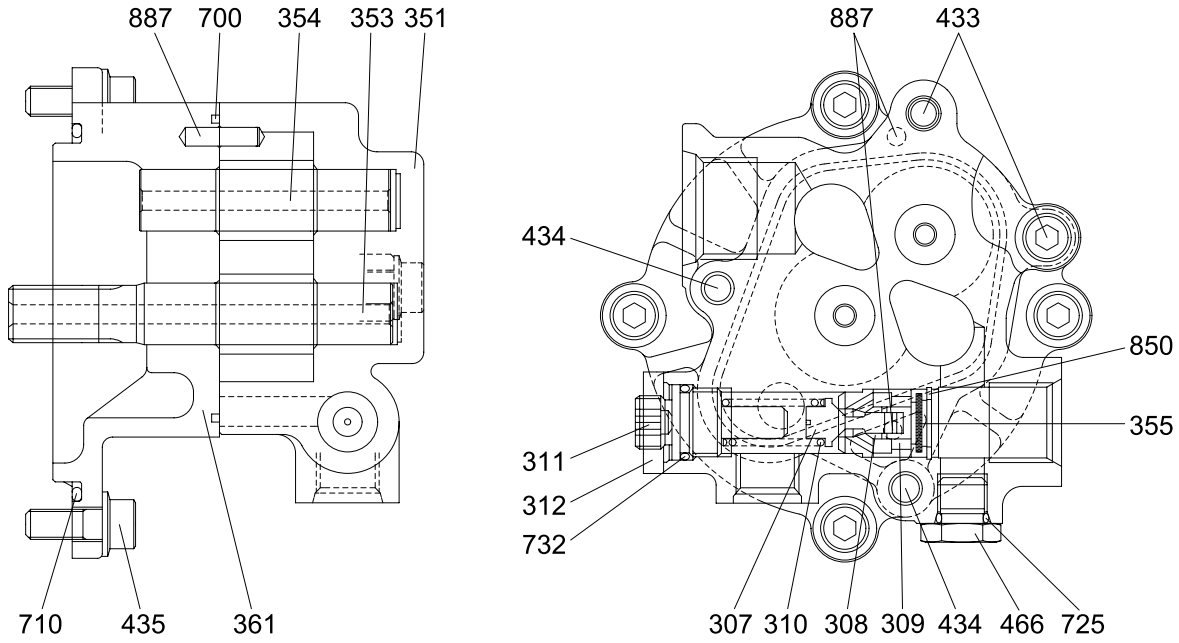
REGULATOR (2/2)



SECTION A-A

412	Hexagon socket screw	630	Lock nut	733	O-ring
413	Hexagon socket screw	631	Sleeve, pf	734	O-ring
436	Hexagon socket screw	641	Pilot cover	735	O-ring
438	Hexagon socket screw	643	Pilot piston	753	O-ring
496	Plug	644	Spring seat (Q)	755	O-ring
601	Casing	645	Adjust stem (Q)	756	O-ring
611	Feed back lever	646	Pilot spring	763	O-ring
612	Lever (1)	651	Sleeve	801	Nut
613	Lever (2)	652	Spool	802	Nut
614	Fulcrum plug	653	Spring seat	814	Snap ring
615	Adjust plug	654	Return spring	836	Snap ring
621	Compensator piston	655	Set spring	858	Snap ring
622	Piston case	656	Block cover	874	Pin
623	Compensator rod	708	O-ring	875	Pin
624	Spring seat (C)	722	O-ring	876	Pin
625	Outer spring	724	O-ring	887	Pin
626	Inner spring	725	O-ring	897	Pin
627	Adjust stem (C)	728	O-ring	898	Pin
628	Adjust screw (C)	730	O-ring	924	Set screw
629	Cover (C)	732	O-ring		

3) GEAR PUMP



307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Ring	355	Filter	710	O-ring
310	Spring	361	Front case	725	O-ring
311	Screw	433	Flange socket	732	O-ring
312	Nut	434	Flange socket	850	Snap ring
351	Gear case	435	Flange socket	887	Pin

2. FUNCTION

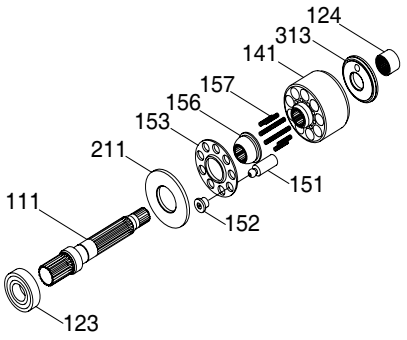
1) MAIN PUMP

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 (141), 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.

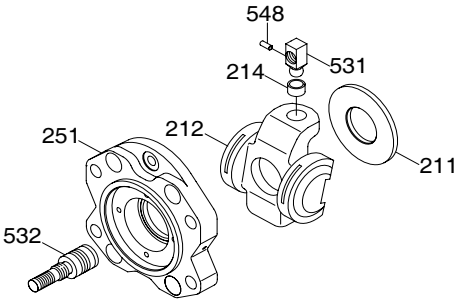


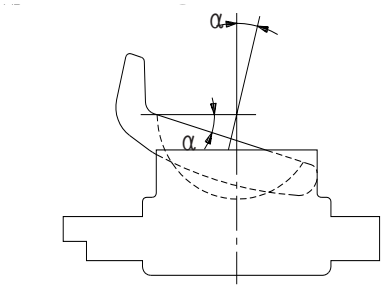
Swash plate group

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).

(2) 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)





(3) Valve block group

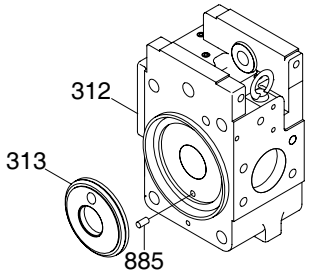
The valve block group consists of valve block (312), valve plate (313) and valve plate pin (885).

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

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

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.



2) REGULATOR

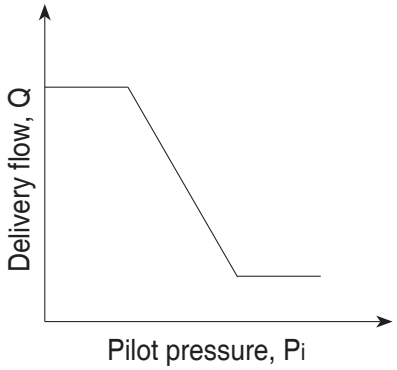
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

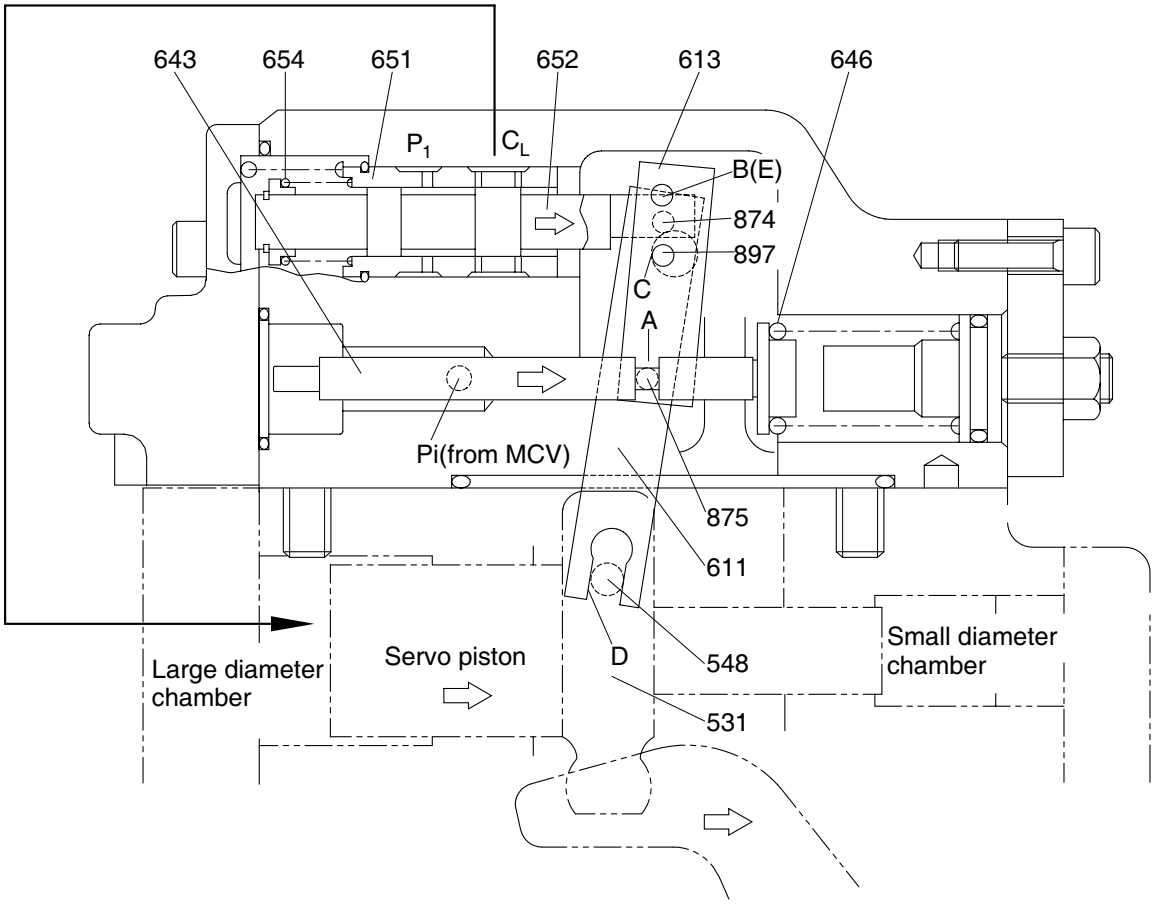
By changing the pilot pressure Pi, the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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.

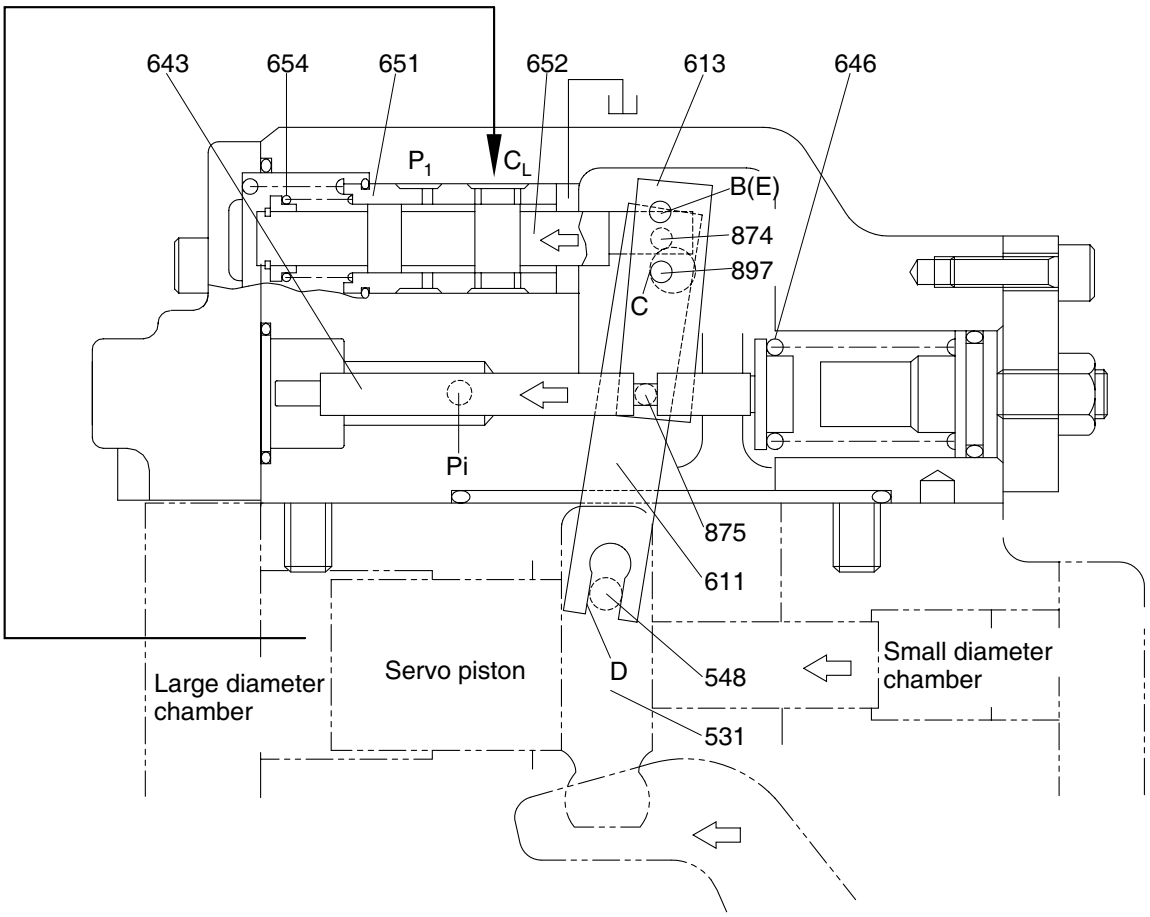
The groove (A) in the pilot piston is fitted with the pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B [Fixed by the fulcrum plug (614) and pin (875)]. Since the large hole section (C) of lever 2 contains a protruding pin (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

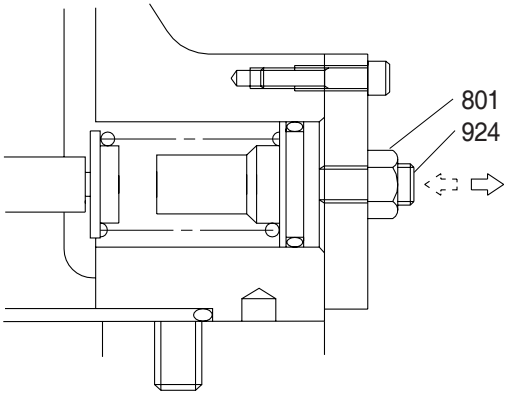


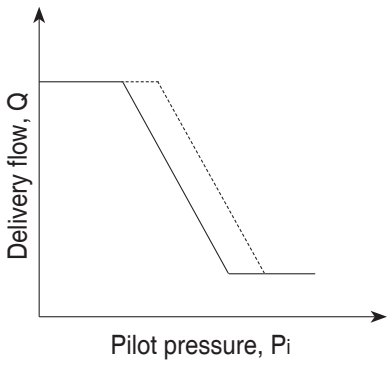
As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) 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.





※ Adjusting values are shown in table.

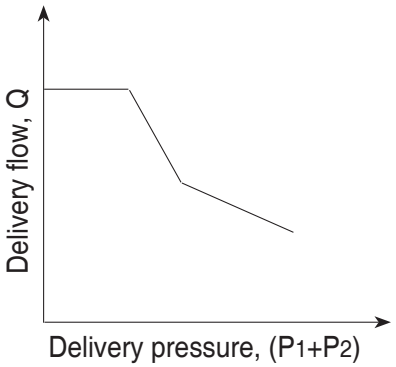
Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw (924)	Flow control starting pressure change amount	Flow change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(ℓ/min)
1800	+1/4	+1.5	+14.6

(2) Total horsepower control

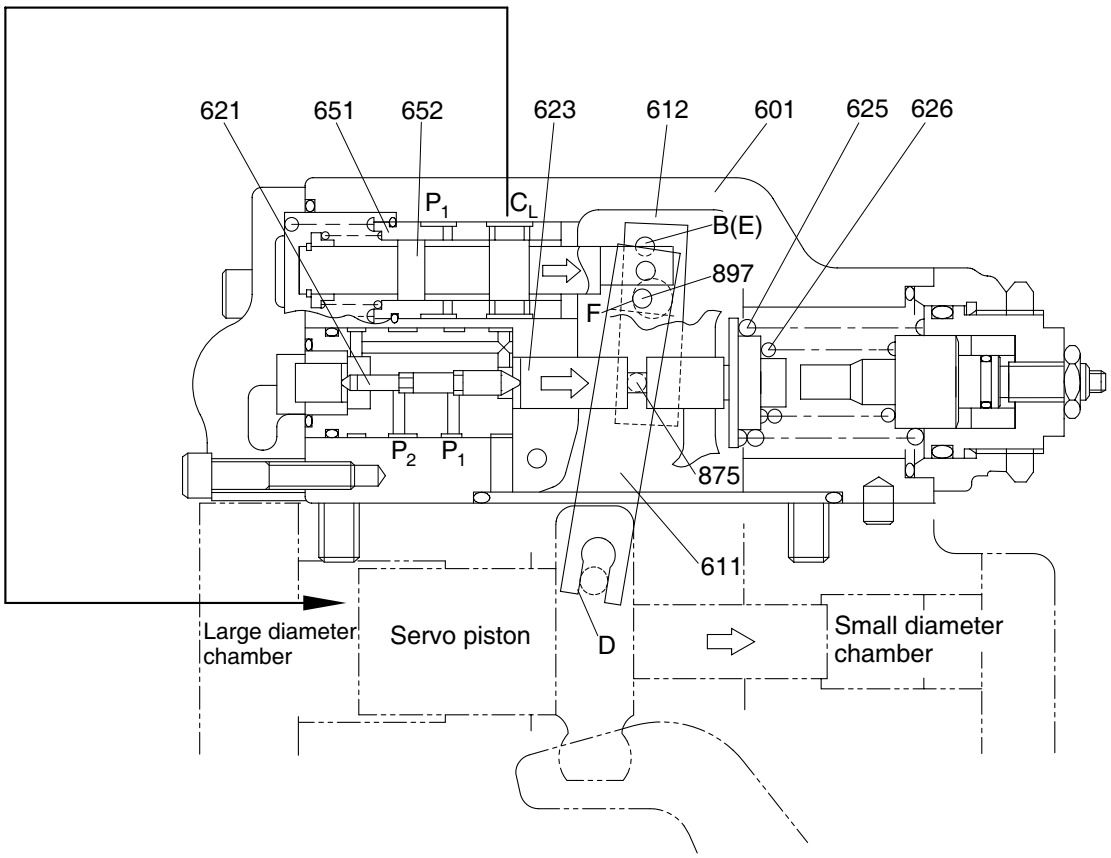
The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump.
(The input horsepower is constant when the speed is constant.)
Since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



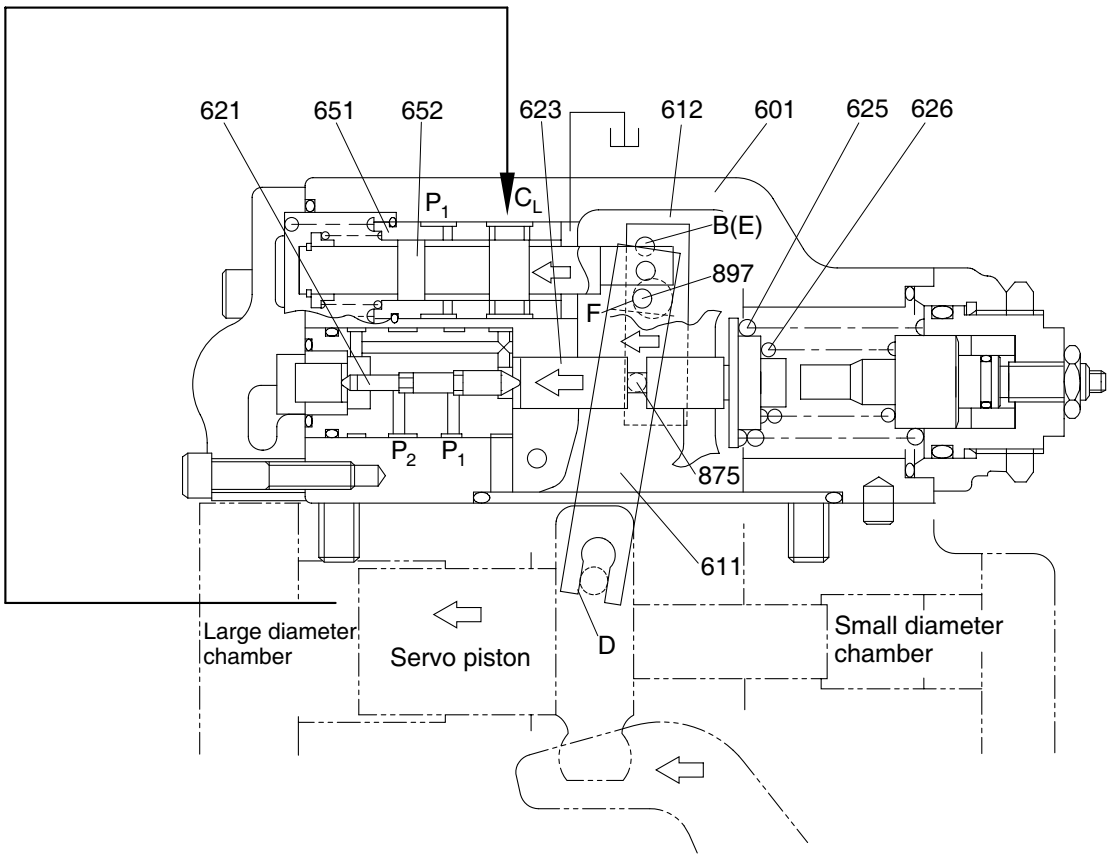
When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. 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

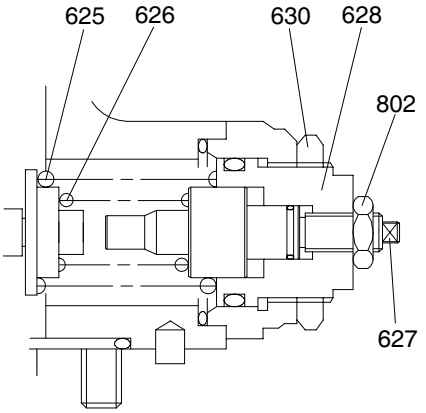
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins (∅4) protruding from the large hole (∅8), only the lever lessening the tilting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

④ Adjustment of input horsepower

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

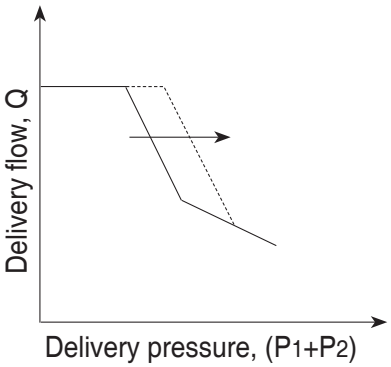
a. Adjustment of outer spring

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting screw QI (627) by N×A turns at first. (A=1.9)



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

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw (C) (628)	Compensating control starting pressure change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(kgf·m)
1800	+1/4	+19.2	+6.3



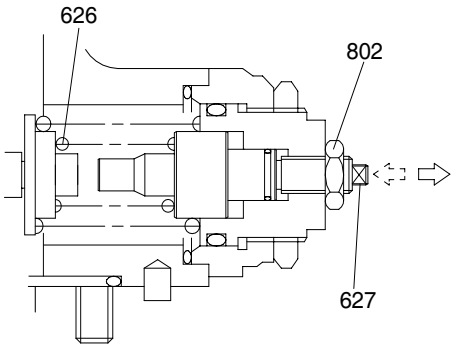
b. Adjustment of inner spring

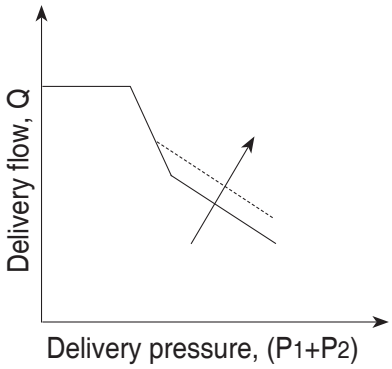
Adjust it by loosening the hexagon nut (802) and by tightening (or loosening) the adjusting screw QI (627).

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

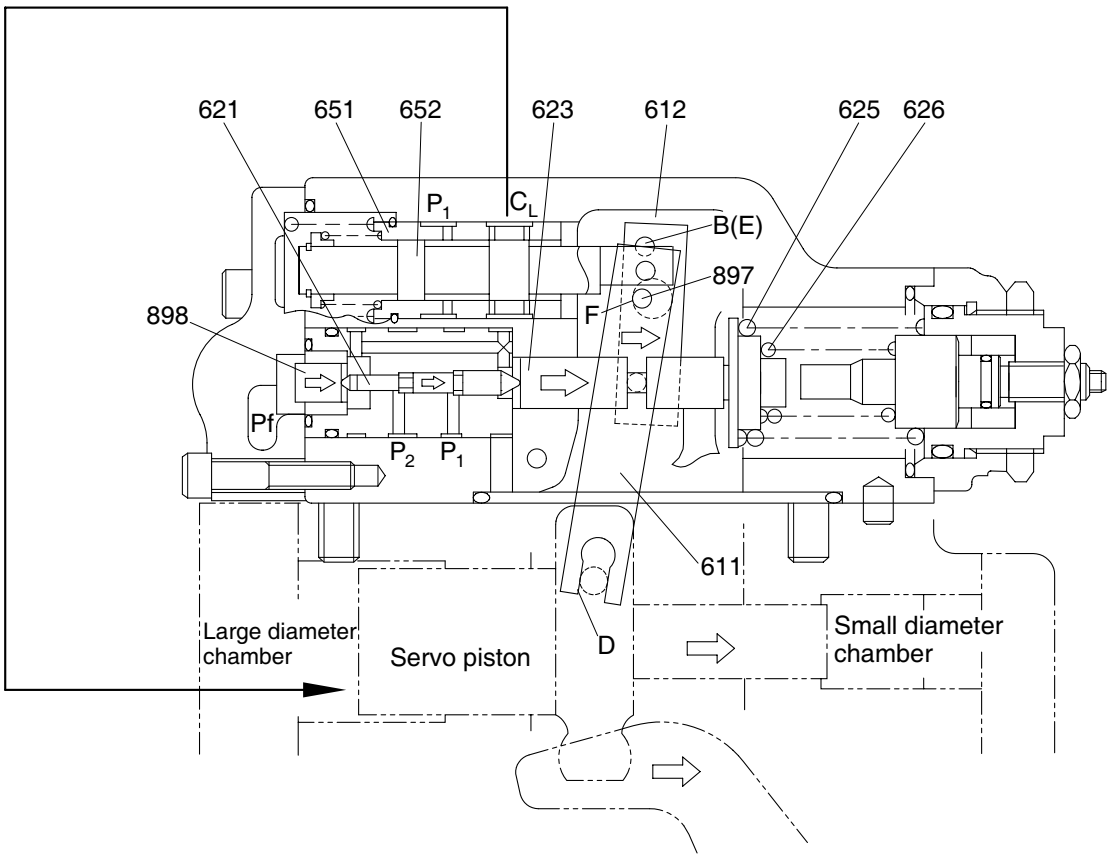
※ Adjusting valves are shown in table.

Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw (QI) (627)	Flow change amount	Input torque change amount
(min^{-1})	(Turn)	(kgf/cm^2)	(kgf·m)
1800	+1/4	+12.6	+6.4

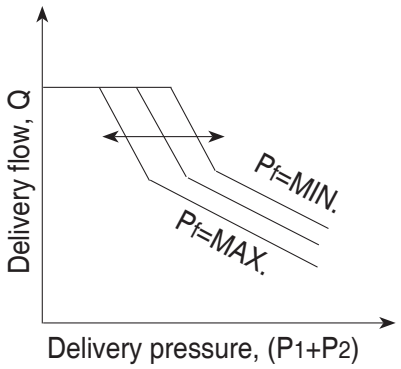




(3) Power shift control



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.



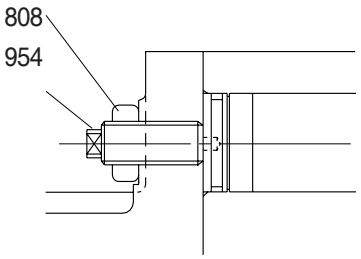
This function permits arbitrary setting of the pump output power, thereby providing the optimum power level according to the operating condition.
The power shift pressure Pf controls the set horsepower of the pump to a desired level, as shown in the figure.
As the power shift pressure Pf rises, the compensating 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

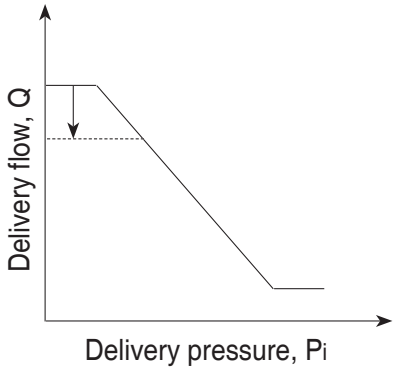
① Adjustment of maximum flow

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 (min -1)	Adjustment of max flow	
	Tightening amount of adjusting screw (954) (Turn)	Flow change amount (ℓ/min)
1800	+1/4	-5.6

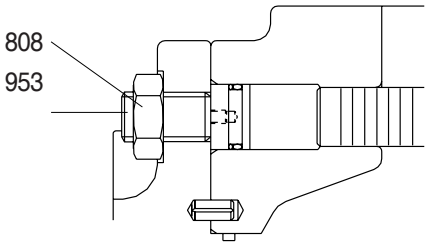


② Adjustment of minimum flow

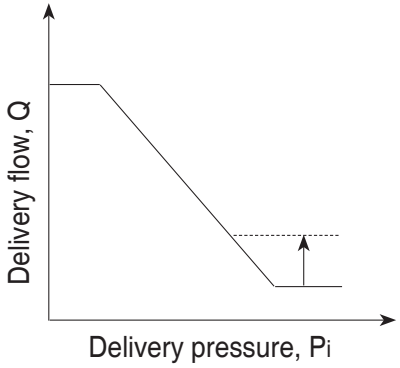
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the hexagonal socket head set screw (953).

Similarly to the adjustment of the maximum flow, other characteristics are not changed.

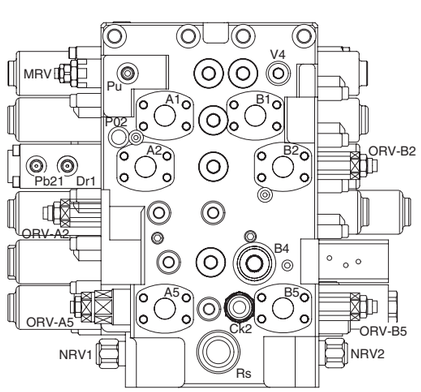
However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.



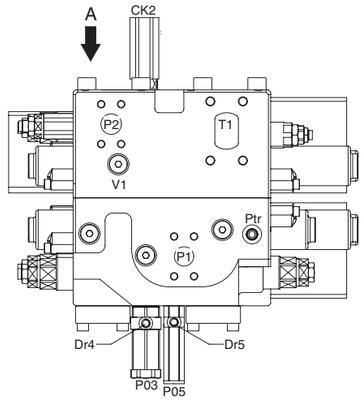
Speed (min -1)	Adjustment of min flow	
	Tightening amount of adjusting screw (953) (Turn)	Flow change amount (ℓ/min)
1800	+1/4	+4.5

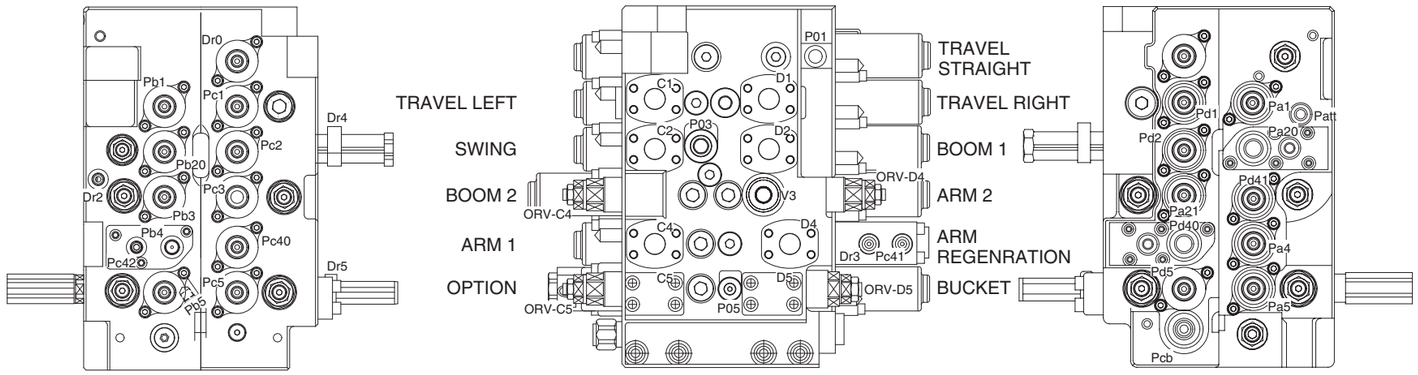


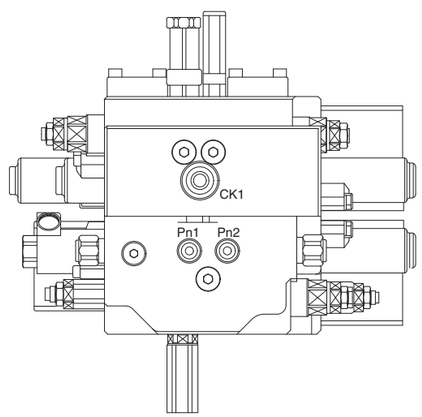
1. STRUCTURE



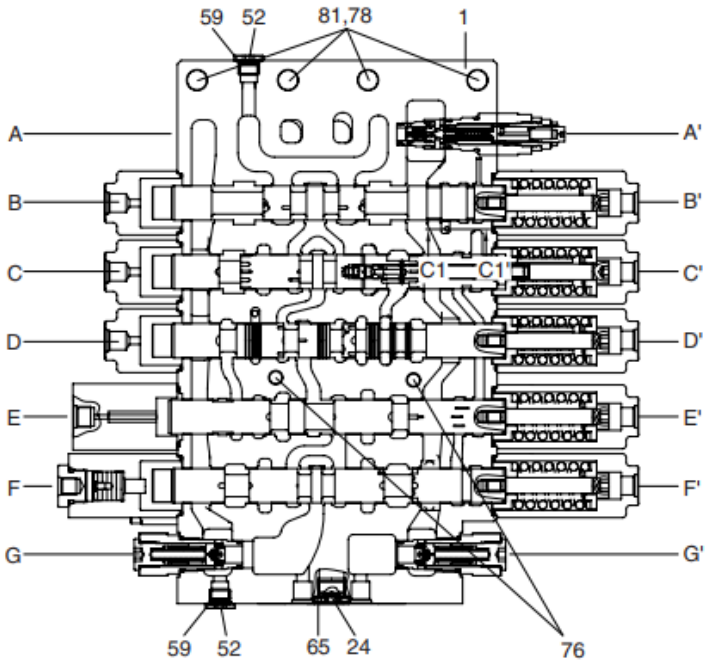
VIEW A



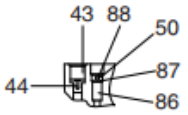




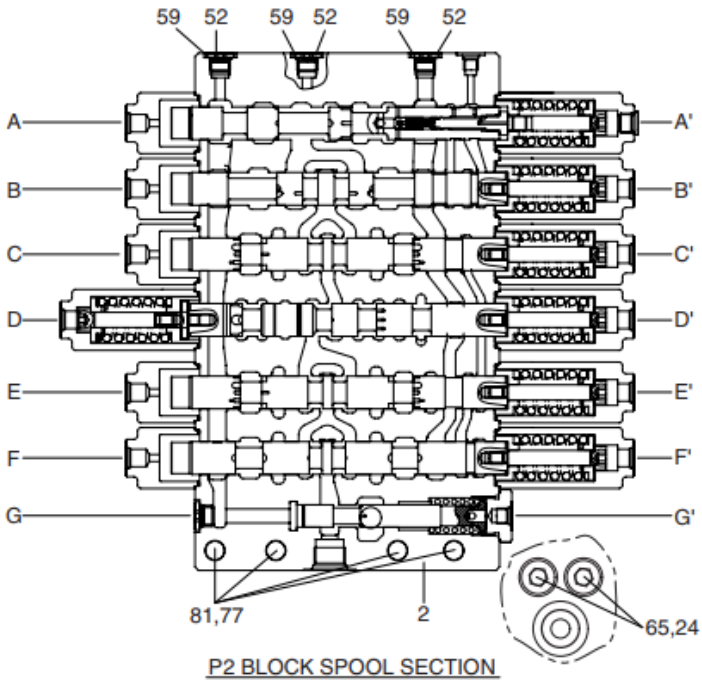
Mark	Port name	Port size	Tightening torque
Rs V3 B4	Make up for swing motor Carry-over P port Option A port (breaker)	PF1	20~25 kgf·m (145~180 lbf·ft)
Patt Pb21 Pcb P01 P02 P03 P04 P05 Pc41 Pc42 Ptr Pu Dr1 Dr2 Dr3	Auto idle signal-attachment Lock valve pilot port (boom) Bucket in confluence pilot port Pilot signal port Pilot signal port Swing logic pilot port Bucket parallel orifice pilot port Option B confluence pilot port Lock valve pilot port (arm) Arm in regen-cut signal selector port Auto idle signal-travel Power boost Drain port Drain port Drain por	PF1/4	3.5~3.9 kgf·m (25.3~28.2 lbf·ft)
Ck1 Ck2	Bucket confluence Bucket confluence	PF3/4	17~19 kgf·m (123~137.4 lbf·ft)
Pa1 Pb1 Pc1 Pd1 Pa20 Pa21 Pb20 Pc2 Pd2 Pb3 Pc3 Pa4 Pb4 Pc40 Pd40 Pd41 Pa5 Pb5 Pc5 Pd5 Dr0 Pn1 Pn2 V1 V4	ATravel pilot port-LH (FW) Travel pilot port-LH (BW) Travel pilot port-RH (BW) Travel pilot port-RH (FW) Boom up pilot port Boom up confluence pilot port Boom down pilot port Swing pilot port (LH) Swing pilot port (RH) Arm in confluence pilot port Swing priority pilot port Option A pilot port (breaker) Arm in regeneration cut port Arm in pilot port Arm out pilot port Arm out confluence pilot port Bucket in pilot port Bucket out pilot port Option B pilot port Option B pilot port Drain port Negative control signal port (A2 port side) Negative control signal port (A1 port side) Carry-over port Carry-over port	PF3/8	7~8 kgf·m (50.6~57.8 lbf·ft)
A1 B1 C1 D1 A2 B2 C2 D2 C4 D4 A5 B5 C5 D5 P1 P2	Travel motor port-LH (FW) Travel motor port-LH (BW) Travel motor port-RH (BW) Travel motor port-RH (FW) Boom up port Boom down port Swing motor port (LH) Swing motor port (RH) Arm in port Arm out port Bucket in port Bucket out port Option B port Option B port Pump port (A2 side) Pump port (A1 side)	SAE 5000 psi 1"	7.5~9.2 kgf·m (54.2~66.5 lbf·ft)
Dr4 Dr5	Drain port Drain port	PF1/8	1.5~1.9 kgf·m (10.8~13.7 lbf·ft)
T1	Return port	SAE 3000 psi 2" (M12)	6.4~8.6 kgf·m (46.2~62.2 lbf·ft)



P1 BLOCK SPOOL SECTION

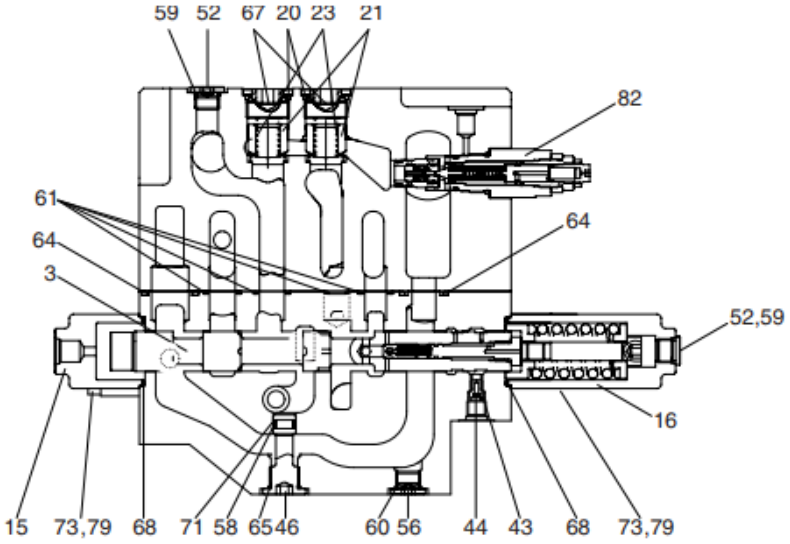


SECTION C1-C1'

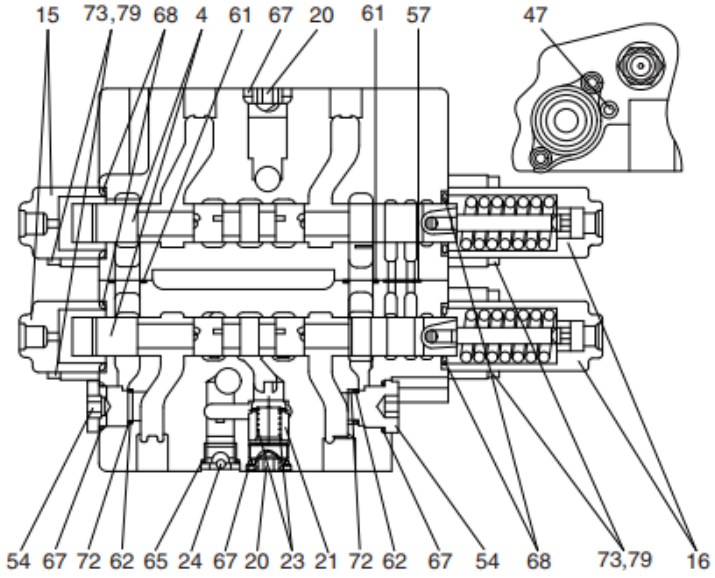


P2 BLOCK SPOOL SECTION

1	Housing (P1)
2	Housing (P2)
24	Plug
43	Orifice-signal
44	Coin type filter
50	O-ring
52	Plug
59	O-ring
65	O-ring
76	Hex socket head bolt
77	Hex socket head bolt
78	Hex socket head bolt
81	Spring washer
86	Poppet
87	Spring check
88	Plug

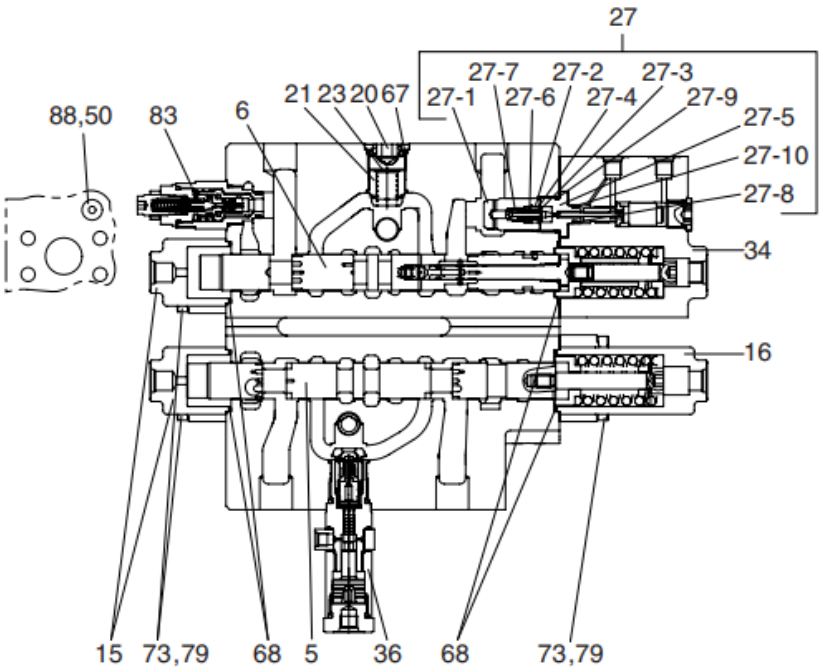


A-A' (STRAIGHT-TRAVEL & SUPPLY)

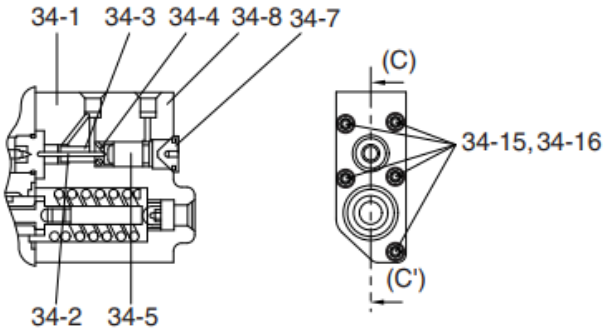


B-B' (TRAVEL RIGHT & LEFT)

3	Spool-straight
4	Spool-travel
15	Cover-pilot A
16	Cover-pilot B1
20	Plug
21	Poppet 1-check valve
23	Spring 1-check valve
24	Plug
43	Orifice-signal
44	Coin type filter
46	Plug
47	Plug
52	Plug
54	Plug
56	Plug
57	O-ring
58	O-ring
59	O-ring
60	O-ring
61	O-ring
62	O-ring
64	O-ring
65	O-ring
67	O-ring
68	O-ring
71	Back-up ring
72	Back-up ring
73	Hex socket head bolt
79	Washer
82	Main relief valve

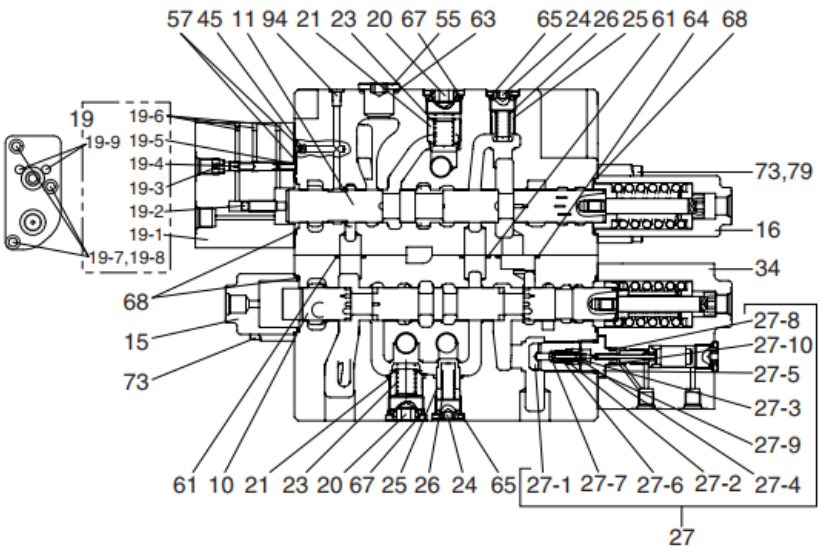


C-C' (SWING & BOOM 1)

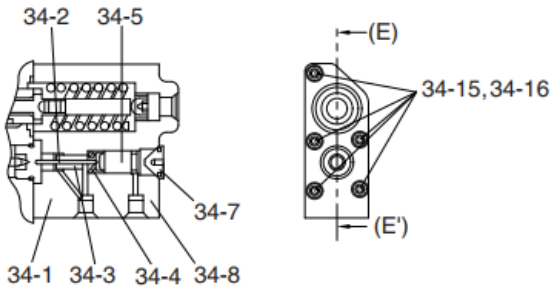


34 DETAIL (HOLDING ASSY)

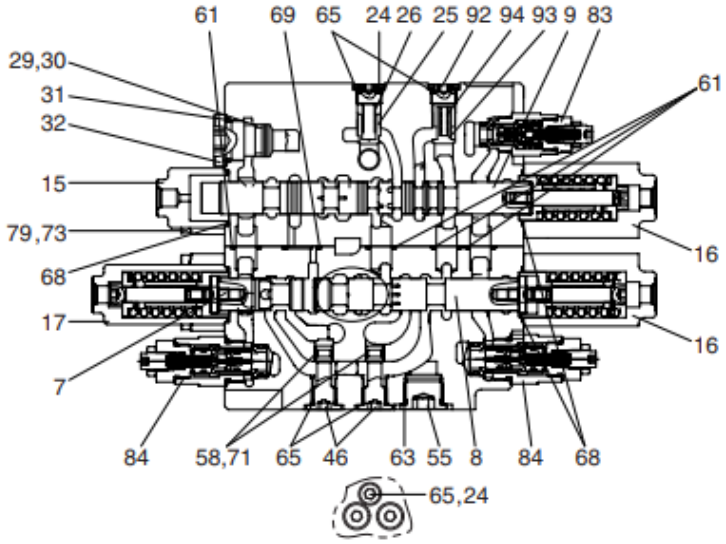
5	Spool-swing	27-7	Restrictor-lock valve	36	Logic valve
6	Spool-boom	27-8	O-ring	50	O-ring
15	Cover-pilot A	27-9	O-ring	67	O-ring
16	Cover-pilot B1	27-10	Back up ring	68	O-ring
20	Plug	34	Holding kit-A1	73	Hex socket head bolt
21	Poppet 1-check valve	34-1	Block-Holding P1	79	Washer
23	Spring 1-check valve	34-2	Piston 1-holding	83	Overload relief valve
27	Holding kit-B	34-3	Guide piston-holding	88	Plug
27-1	Poppet	34-4	Spring 1-lock valve		
27-2	Spring	34-5	Piston 2-holding		
27-3	Poppet guide	34-7	Plug		
27-4	Pilot poppet	34-8	Plug		
27-5	Poppet seat	34-15	Socket bolt		
27-6	C-ring	34-16	Spring washer		



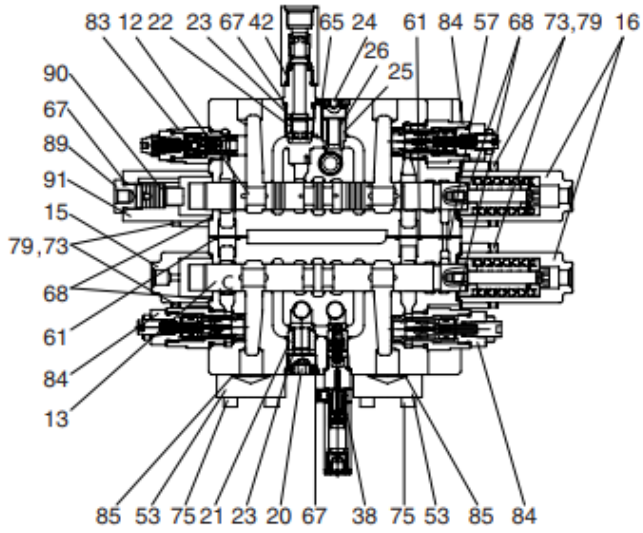
E-E' (ARM & ARM REGENRATION)



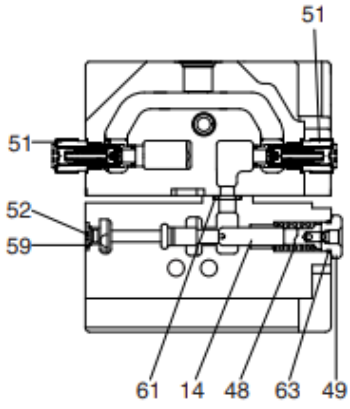
10	Spool-arm1	27	Poppet-lock valve	34-16	Spring washer
11	Spool-arm regeneration	27-1	Poppet	45	Orifice-plug
15	Cover-pilot A	27-2	Spring	55	Plug
16	Cover-pilot B1	27-3	Poppet guide	57	O-ring
19	Arm-regeneration	27-4	Pilot poppet	61	O-ring
19-1	Block-regeneration	27-5	Poppet seat	63	O-ring
19-2	Piston-cut off	27-6	C-ring	65	O-ring
19-3	Stopper-regeneration	27-7	Restrictor-lock valve	67	O-ring
19-4	Spool-regeneration	27-8	O-ring	68	O-ring
19-5	Spring-regeneration	27-9	O-ring	73	Hex socket head bolt
19-6	Plug	27-10	Back up ring	79	Washer
19-7	Socket bolt	34	Holding kit-A2	94	Plug
19-8	Spring wahser	34-1	Block-Holding P2		
19-9	Pin-regeneration	34-2	Piston 1-holding		
20	Plug	34-3	Guide piston-holding		
21	Poppet 1-check valve	34-4	Spring 1-lock valve		
23	Spring 1-check valve	34-5	Piston 2-holding		
24	Plug	34-7	Plug		
25	Poppet 2-check valve	34-8	Plug		
26	Spring 2-check valve	34-15	Socket bolt		



D-D' (SWING PRIORITY-BOOM2 & ARM2)



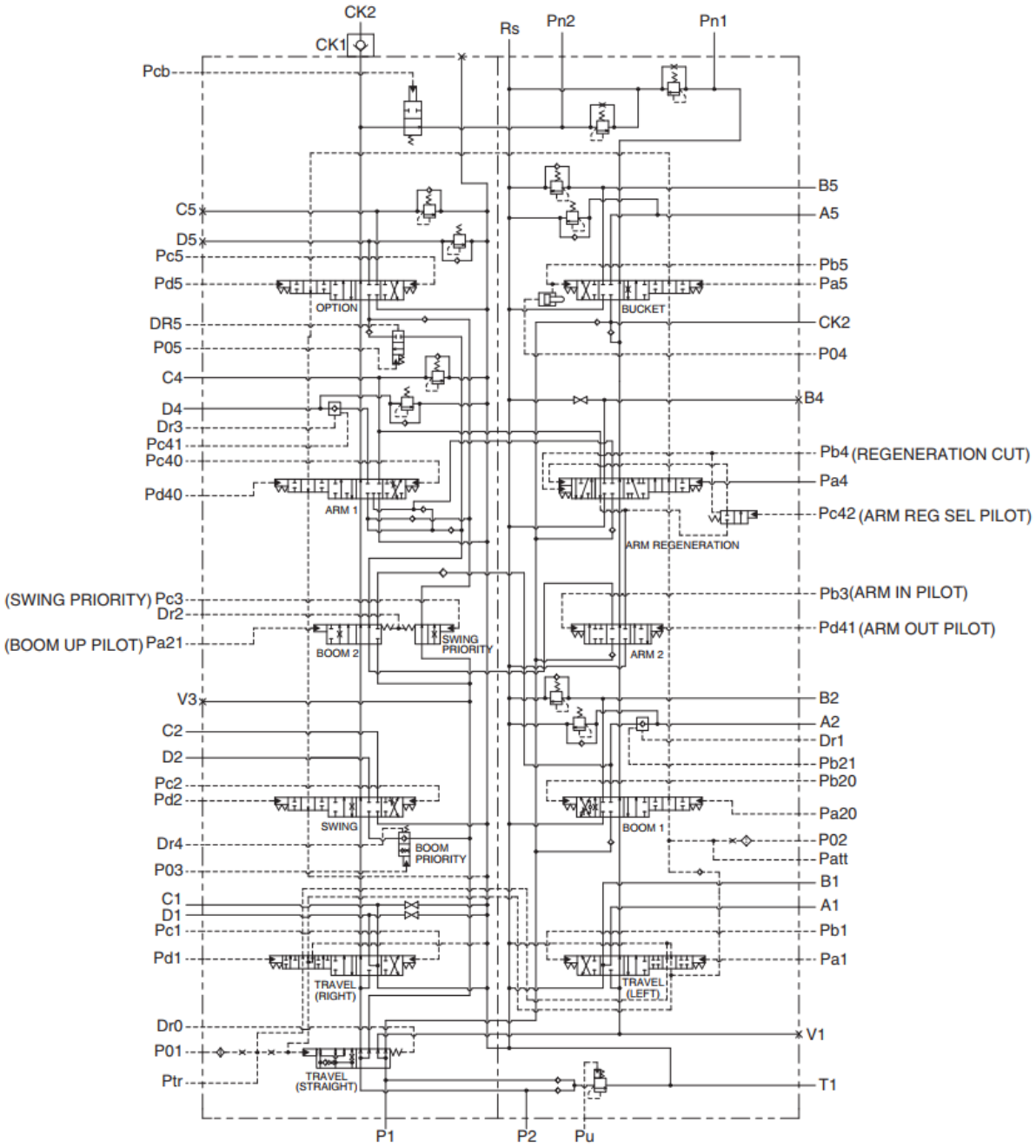
F-F' (OPTION & BUCKET)



G-G' (CENTER BYPASS CUT-OFF & NEGATIVE CONTROL)

7 Spool-swing priority
8 Spool-boom 2
9 Spool-arm 2
12 Spool-bucket
13 Spool-option
14 Bypass cut-spool
15 Cover-pilot A
16 Cover-pilot B1
17 Cover-pilot B2
20 Plug
21 Poppet 1-check valve
22 Poppet L/C-bucket
23 Spring 1-check valve
24 Plug
25 Poppet 2-check valve
26 Spring 2-check valve
29 Back up ring
30 O-ring
31 O-ring
32 Plug
38 Load check valve assy
42 Check valve
46 Plug
48 Spring-Bypass cut spool
49 Plug-Bypass cut spool
51 Negative control valve
52 Plug
53 Flange
55 Plug
57 O-ring
58 O-ring
59 O-ring
61 O-ring
63 O-ring
65 O-ring
67 O-ring
68 O-ring
69 O-ring
71 Back-up ring
73 Hex socket head bolt
75 Socket bolt
79 Washer
83 Overload relief valve
84 Overload relief valve
85 O-ring
89 Plug
90 Piston
91 Pilot cover C1
92 Plug
93 Poppet
94 Spring

2. HYDRAULIC CIRCUIT



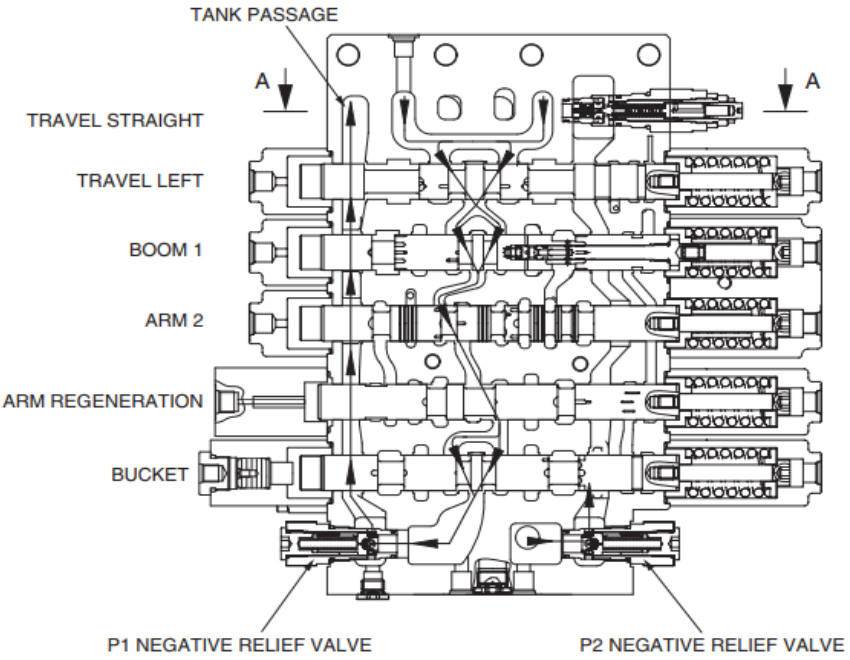
3. FUNCTION

1) CONTROL IN NEUTRAL

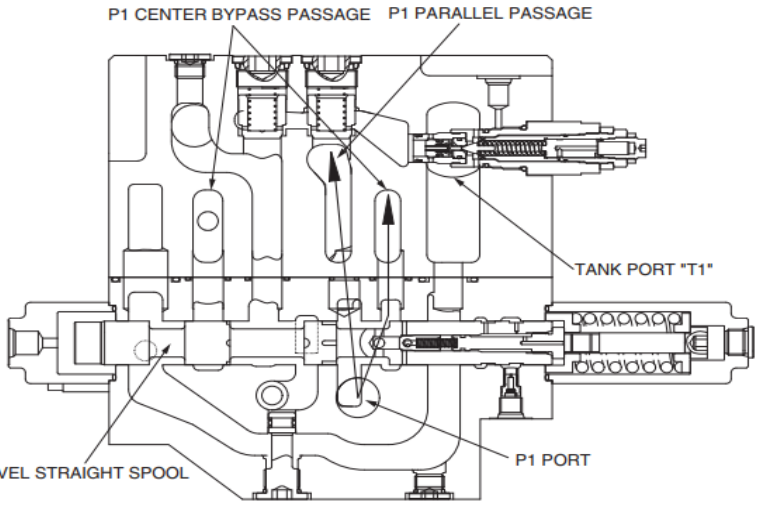
(1) P1 SIDE

The hydraulic fluid from pump flows into the main control valve through the inlet port "P1", pass the land of the travel straight spool, into the P1 bypass passage and P1parallel passage.

When the straight travel spool is in neutral position, the bypass passage is not shut off. Then the hydraulic fluid from the pump P1 is directed to the tank through the bypass passage of spools : travel right, boom 1, arm 2, arm regeneration & option A and bucket, the negative relief valve of P1, tank passage, and the tank port "T1"



P1 SPOOL SECTION

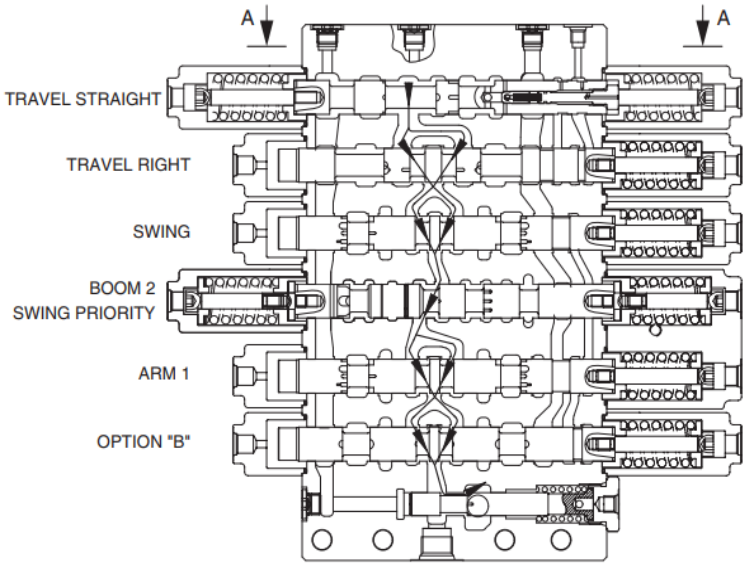


SECTION A - A

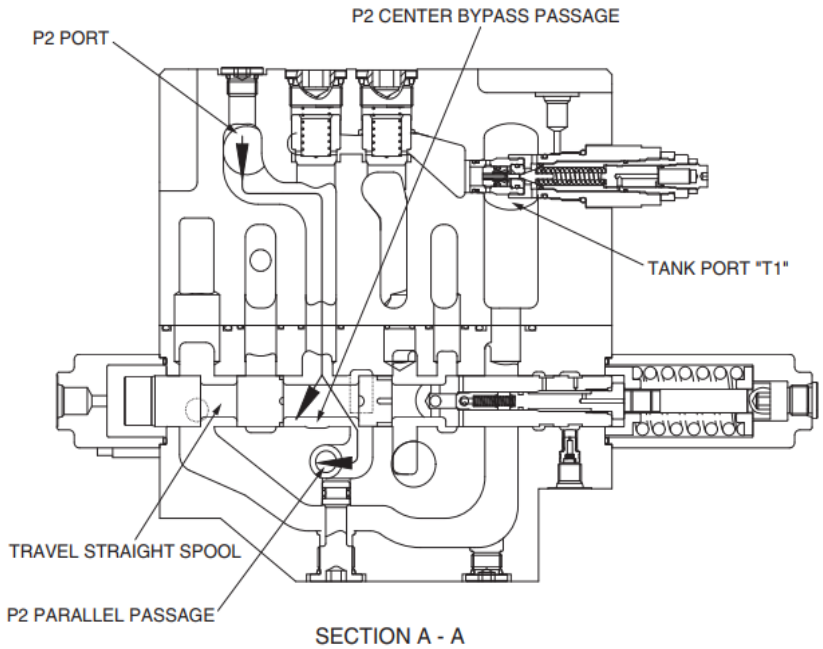
(2) P2 SIDE

The hydraulic fluid from pump flows into the main control valve through the inlet port "P2", pass the land of the straight travel spool, into the P2 bypass passage and P2 parallel passage.

When the straight travel spool is in neutral position, the bypass passage is not shut off. Then the hydraulic fluid from the pump P2 is directed to the tank through the bypass passage of spools : travel left, swing, boom 2 & swing priority, arm 1, option "B" and option "C" of bypass passage summation, and the negative relief valve of P2, the tank passage and the tank port "T1".



P2 SPOOL SECTION



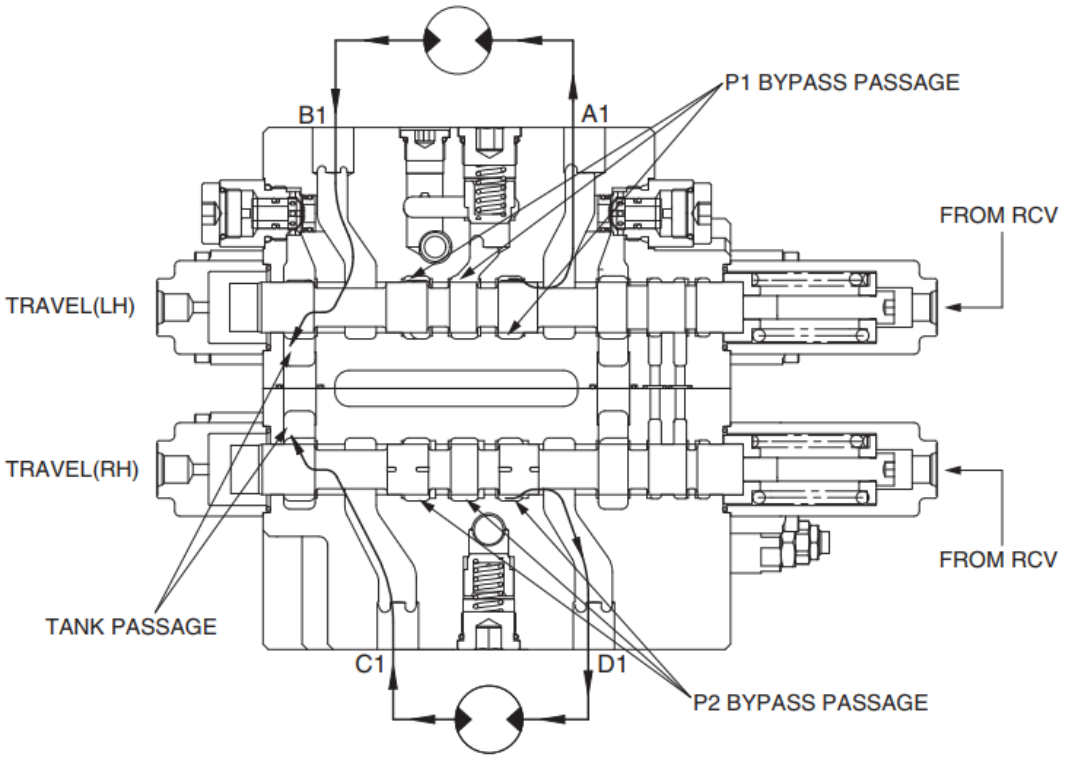
SECTION A - A

2) TRAVEL OPERATION

(1) TRAVEL FORWARD OPERATION

During the travel forward operation, the pilot pressure of RCV is supplied to the port of the spring side, and it shifts travel right and left spools in the left direction against springs. Hydraulic fluid from the pump flows into the bypass passage of travel spool through the land of the straight travel spool.

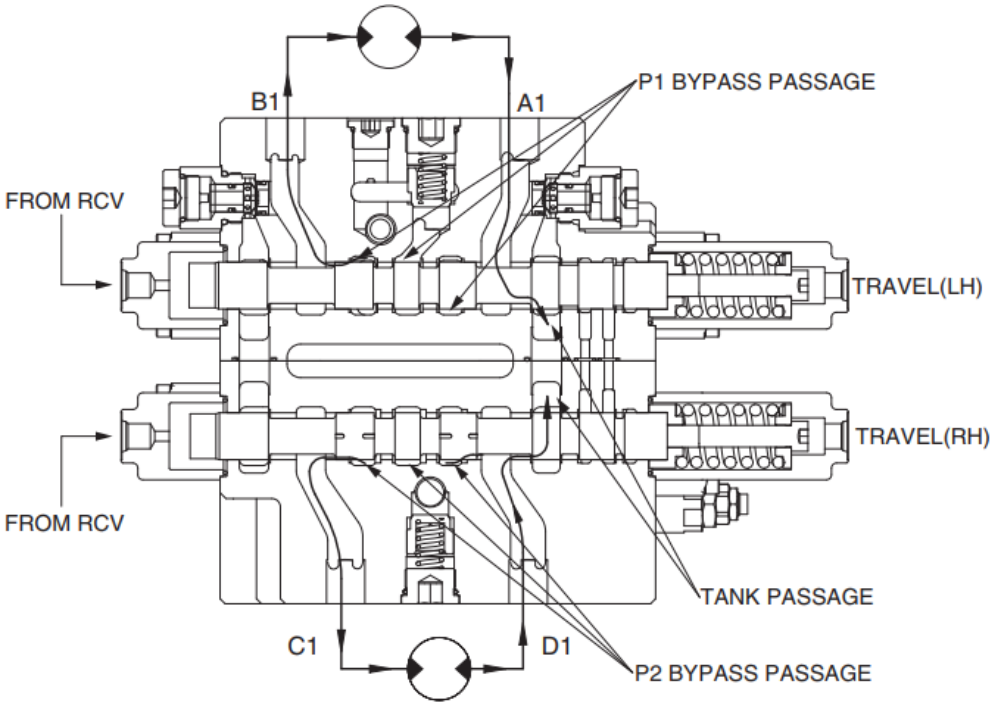
Then the bypass passage is shut off by the movement of the spool, they are directed to the each travel motor through port B1 and D1. At the same time, the hydraulic fluid from the each travel motor through port A1 and C1 returns to the tank passage through the travel spools.



(2) TRAVEL REVERSE OPERATION

During the travel reverse operation, the pilot pressure of RCV is supplied to the port of the spring opposite side, and it shifts travel right and left spools in the right direction against springs. Hydraulic fluid from the pump flows into the bypass passage of travel spool through the land of the straight travel spool.

Then the bypass passage is shut off by the movement of the spool, they are directed to the each travel motor through port A1 and C1. At the same time, the hydraulic fluid from the each travel motor through port B1 and D1 returns to the tank passage through the travel spools.



(3) TRAVEL STRAIGHT FUNCTION

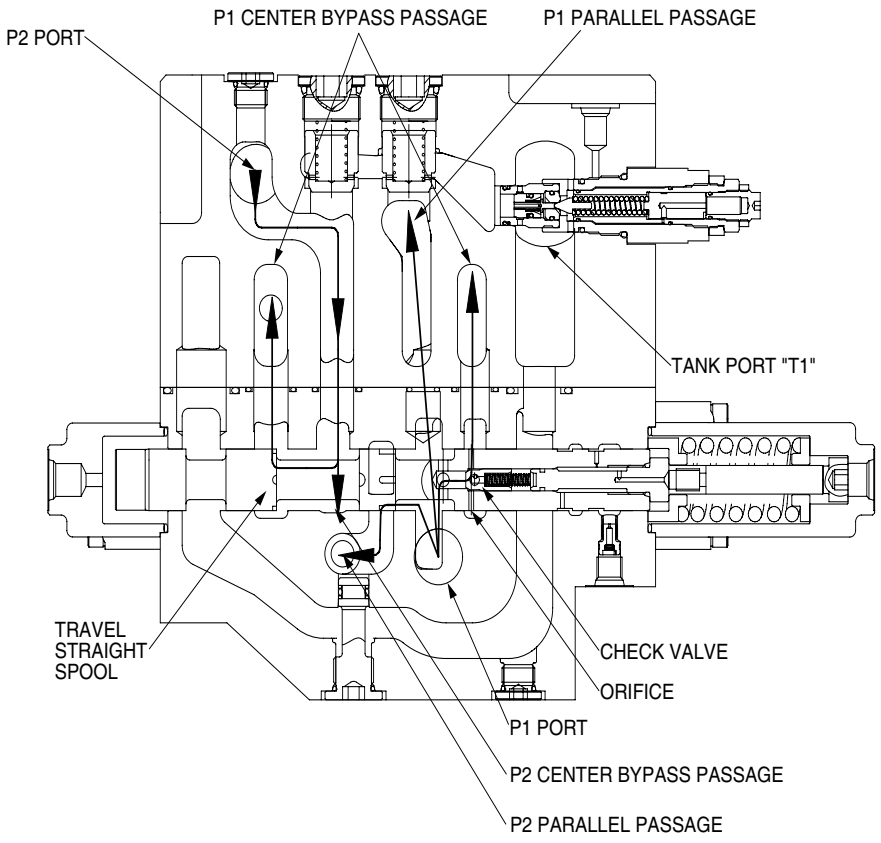
Straight travel valve is the valve for keeping traveling straight when boom, arm, bucket or swing is operated at the time of traveling. Therefore the oil from the P1 and P2 pump flows into the control valve through the each passage in neutral condition.

When the both travels and any of attachment is switched, the pilot pressure is applied the port of spring chamber and the travel straight spool is shifted.

When the straight travel spool is switched, the oil pressure from P1 is led to the each attachment switching section through the P1 and P2 parallel passage. Also some of oil id combined with bypass of P1 side by opening of check valve of spool inside through the orifice of the straight travel spool.

On the other hand, the oil from P2 is supplied to the both travel section through P1 and P2 bypass passage.

Therefore, when attachment is switched at the time of both travels, since the oil of P2 mainly flows to both travels, and the oil of P1 mainly flows to attachments, it can keep traveling straight.



3) BOOM OPERATION

(1) BOOM UP OPERATION

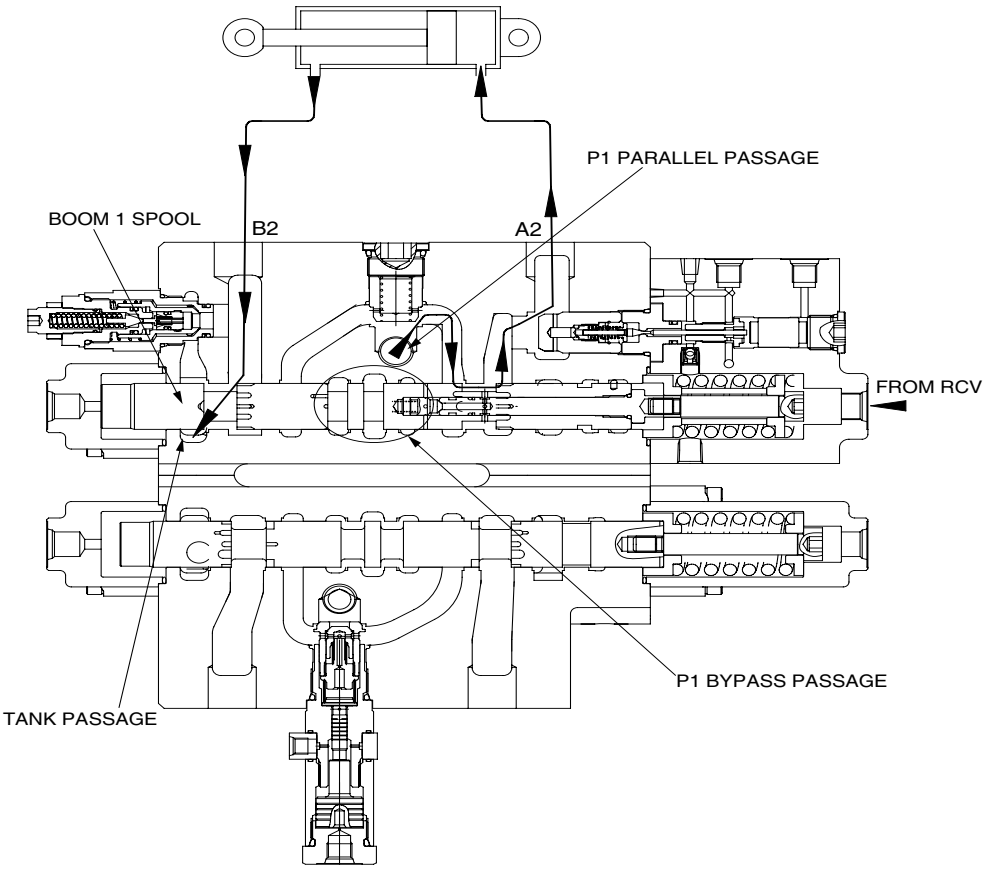
During boom up operation, the pilot secondary pressure from RCV is supplied to the port of the spring side and shifts the boom 1 spool in the left direction. The bypass passage is shut off by the movement of the spool and the hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes through the load check valve, bridge passage and boom holding valve then flows into the port A2.

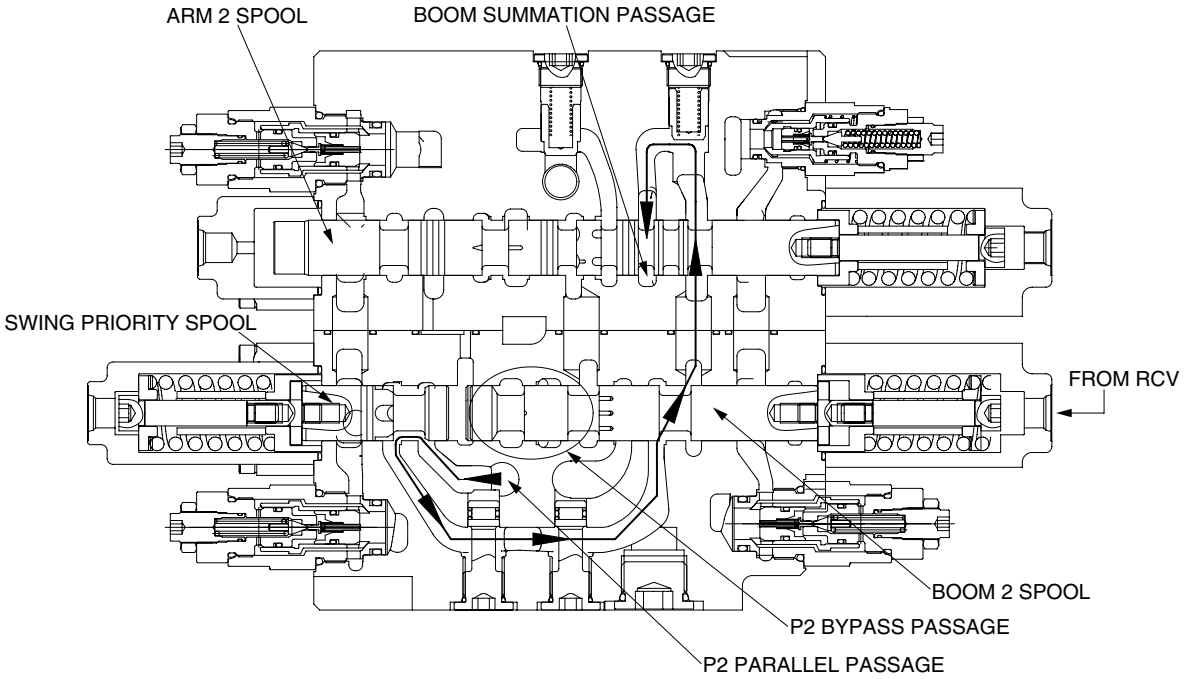
Following this it flows into the head side of the boom cylinder.

(In this case, the boom holding valve is free flow condition)

At the same time, the pilot pressure from RCV is supplied to the port of the spring side of boom 2 and shifts the boom 2 spool. The bypass passage is shut off by the movement of the spool and the hydraulic oil fluid from pump P2 entered boom summation passage via the P2 parallel passage, the land of the swing priority spool, notch of the boom 2 spool, arm 2 spool and the check. The flows combine in passage and are directed to port A2 and head side of boom cylinder.

At the same time, the flow from rod side of the boom cylinder return to the boom 1 spool through




ARM 2 SPOOL
BOOM SUMMATION PASSAGE
SWING PRIORITY SPOOL
FROM RCV
BOOM 2 SPOOL
P2 BYPASS PASSAGE
P2 PARALLEL PASSAGE

(2) BOOM DOWN OPERATION

During the boom lowing operation, the pilot pressure from RCV is supplied to the port of the spring opposite side and shifts the boom 1 spool in the right direction.

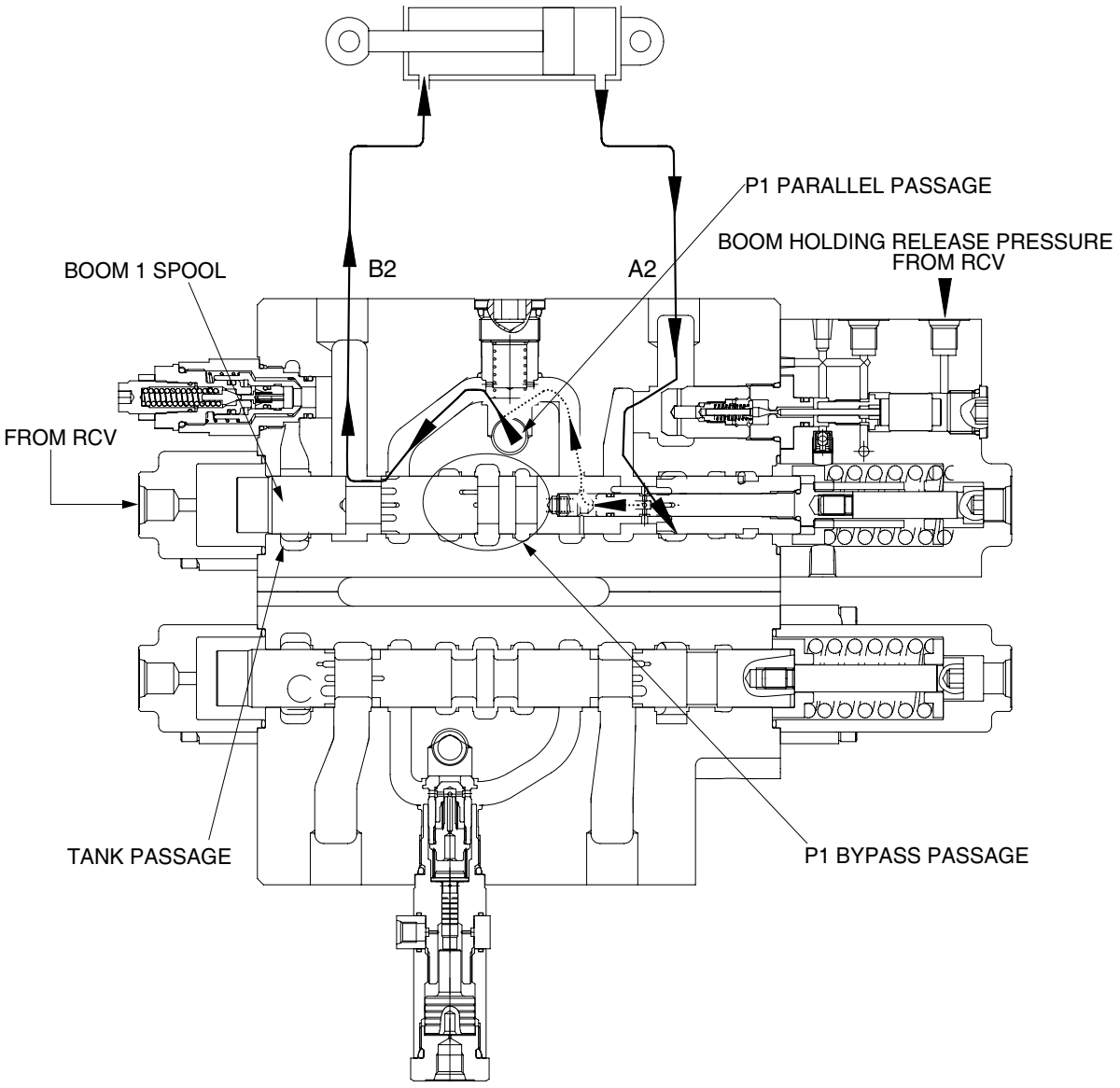
The bypass passage is shut off by the movement of the spool and the hydraulic fluid from the pump P1 enters the parallel passage and is directed to the port B2 through the load check valve. Following this, it flows into the rod side of the boom cylinder.

At the same time, the return flow from the head side of the boom cylinder returns to the port A2 and boom holding valve. And it is directed to the hydraulic oil tank through opened tank passage by movement of the boom 1 spool.

Meanwhile some of return flow is directed to P1 parallel passage through the internal passage of the boom 1 spool. (boom regeneration)

In this case, the holding valve is open condition, for details of the boom holding valve, see page following page.

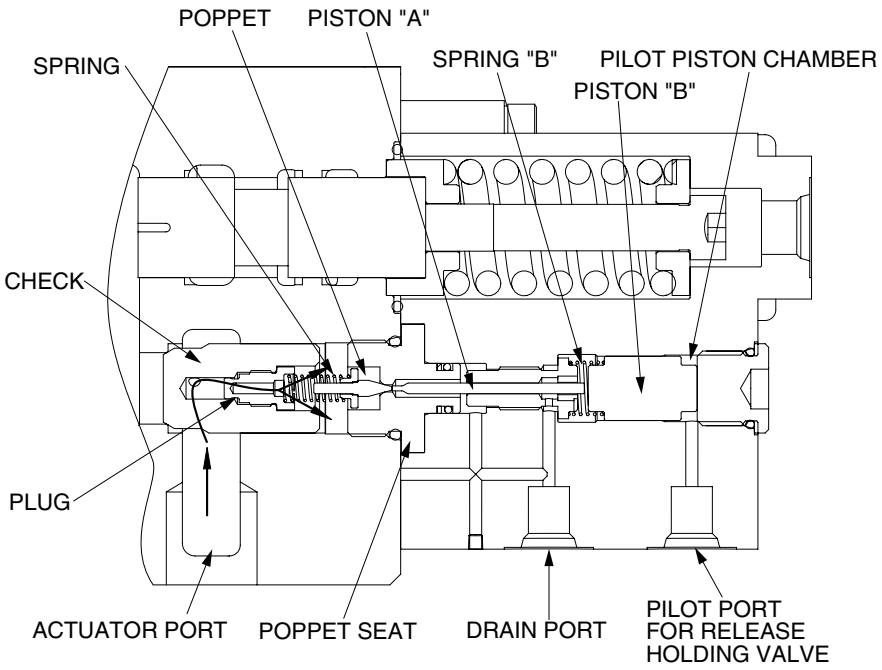
During the boom lowering operation, the fluid from P2 pump is not summation.



4) HOLDING VALVE OPERATION

(1) HOLDING OPERATION

At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.
And the piston "B" is supported with spring "B".
Also, the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug.
Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body.
So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

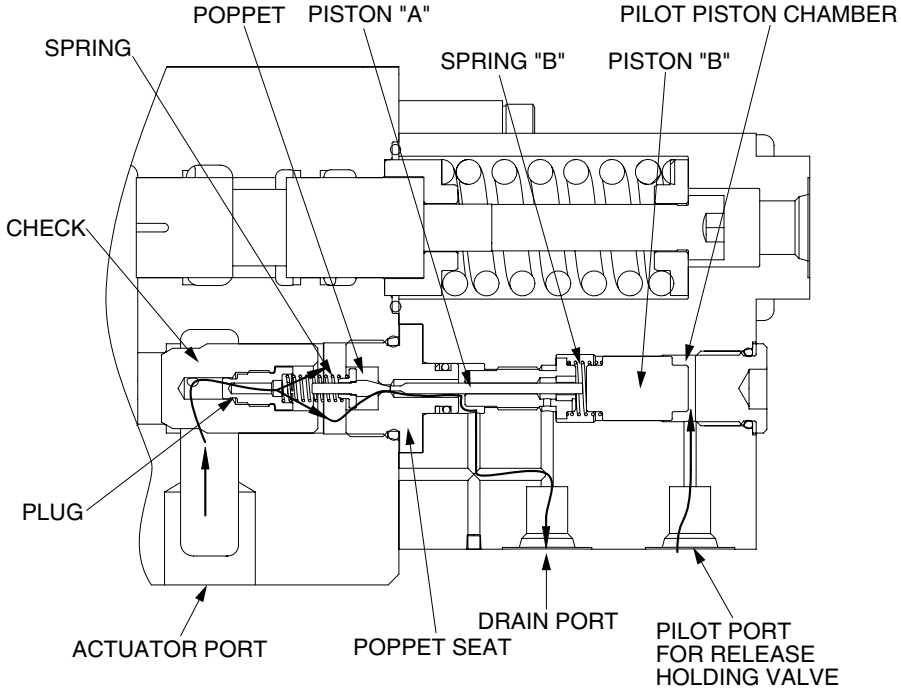


(2) RELEASE HOLDING OPERATION

The pilot pressure is supplied to the pilot port for release holding valve and shifts the piston "B" in the left direction against the spring "B", and shifts the poppet in the left direction through piston "B" and piston "A" against spring "B" and shifts the spool in the left side.

At same time, the return fluid from actuator returns to the drain port through the periphery hole of check, crevice of the check and the plug, the periphery hole of the plug, in side of holding valve, crevice of the poppet and the poppet seat, the periphery hole of the poppet seat, crevice of socket and spool and internal passage of spool.

When the poppet is opened, pressure of inside of holding valve is decreased and the return fluid from actuator returns to the tank passage through the notch of spool.



5) BUCKET OPERATION

(1) BUCKET IN OPERATION

① Bucket operation only

During the bucket in operation, the pilot secondary pressure from RCV is supplied to port of the spring side and shifts the bucket spool in the left direction.

The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port A5 through the check2.

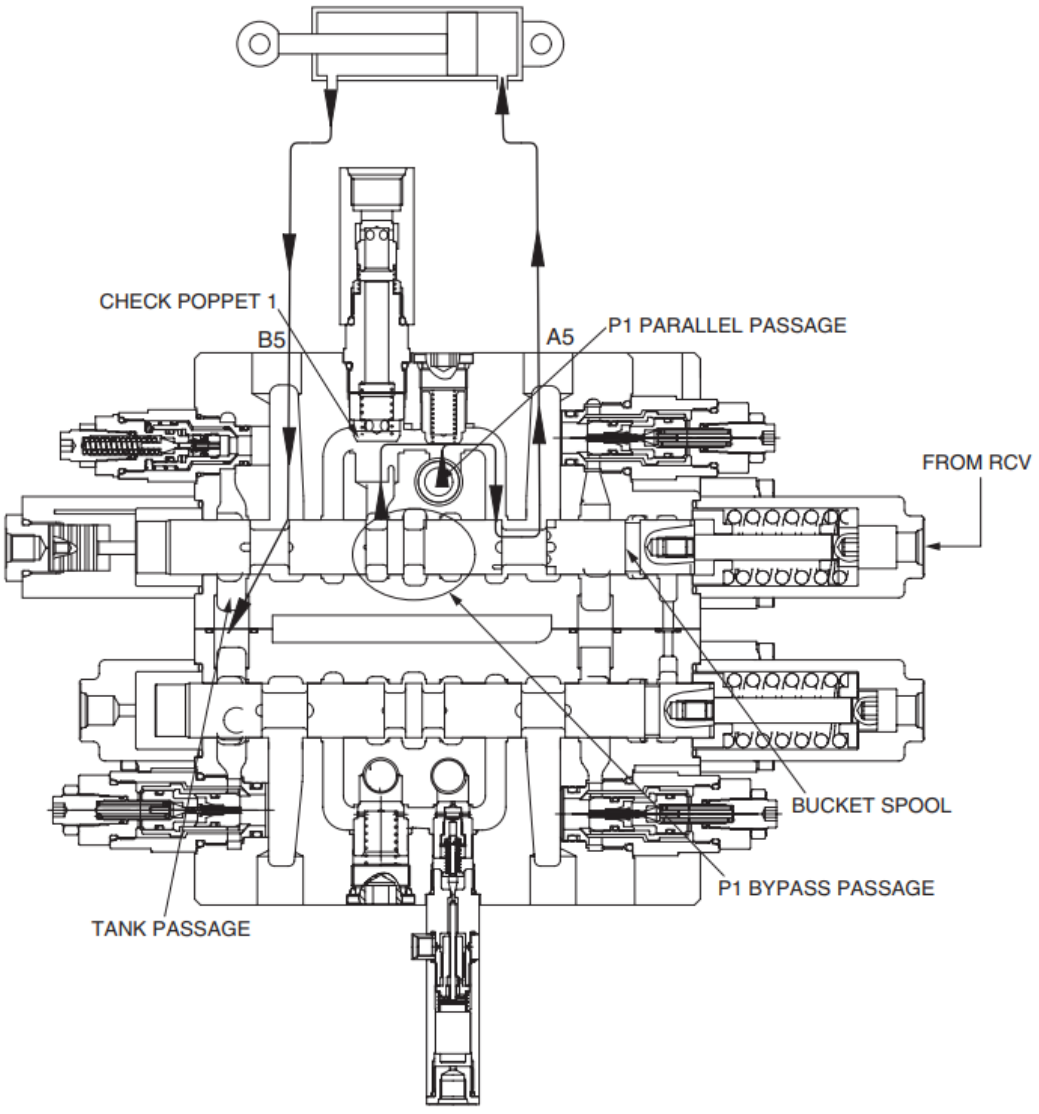
At the same time, the hydraulic fluid from P1 bypass passage is directed to the port A5 through the check1.

Following this it flows into the head side of the bucket cylinder.

The return flow from the rod side of the bucket cylinder returns to the bucket spool through the port B5. Thereafter it is directed to the hydraulic oil tank through the tank passage.

② Bucket operation with arm or boom operation

When combined operation, mostly same as above but the fluid from bypass passage is empty. So only the fluid from parallel passage is supplied to the bucket cylinder. Also, parallel passage is installed the orifice for supplying the fluid from pump to the boom or the arm operation prior to the bucket operation.



(2) BUCKET OUT OPERATION

① Bucket operation only

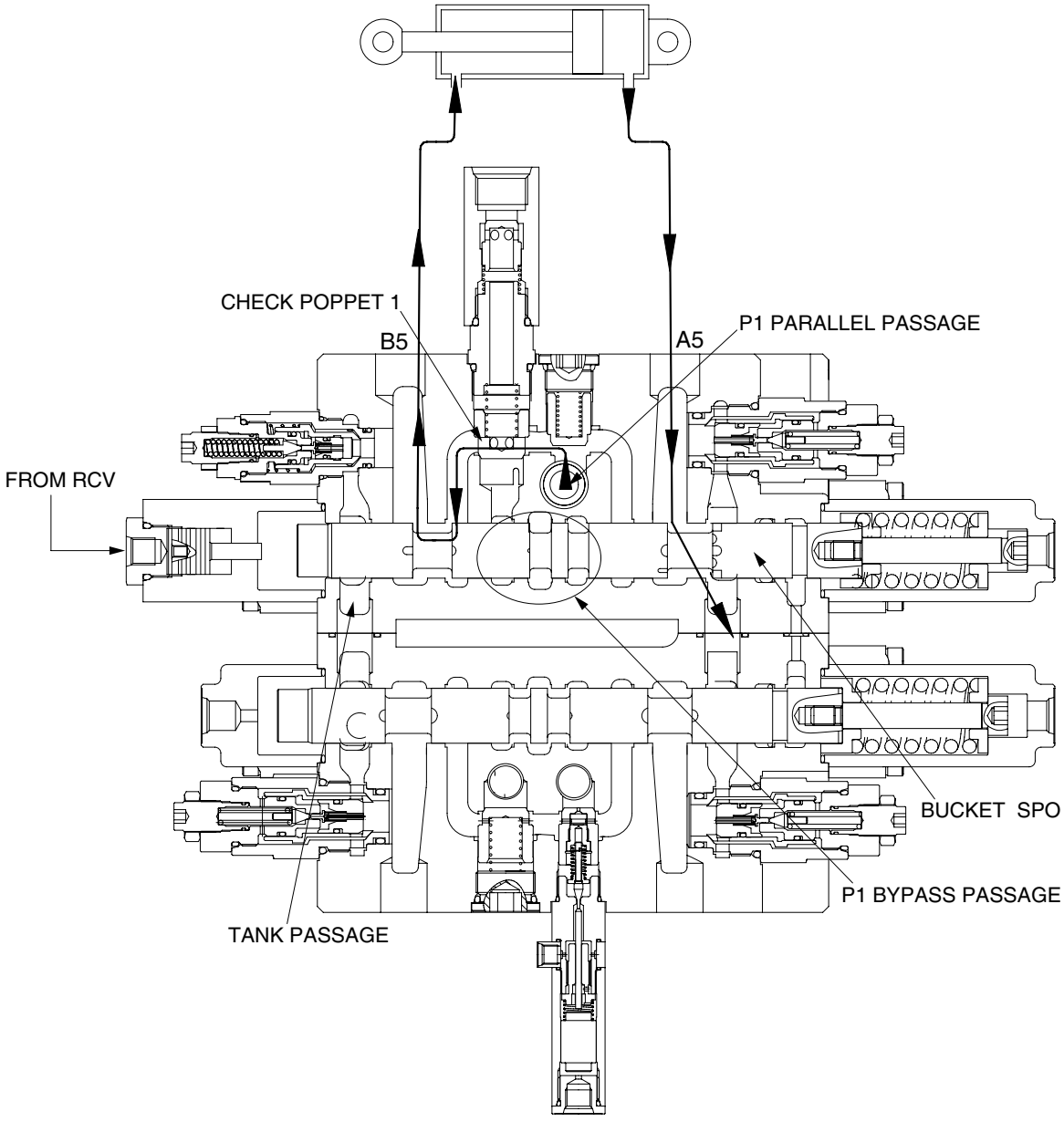
During the bucket out operation, the pilot secondary pressure from RCV is supplied to port of the spring opposite side and shifts the bucket spool in the left direction.

The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port B5 through the check1.

The return flow from the rod side of the bucket cylinder returns to the hydraulic oil tank through the tank passage and the port A5.

② Bucket operation with arm or boom operation

When combined operation, the same as above.

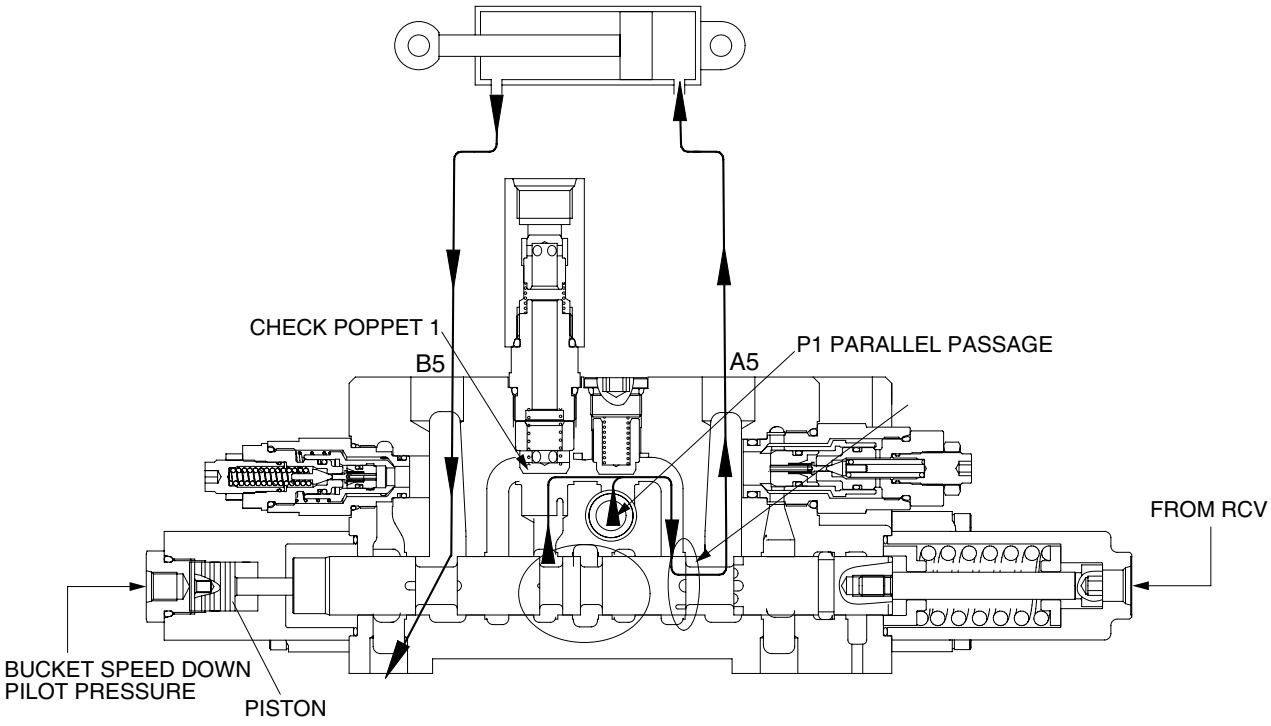


(3) BUCKET SLOW OPERATION

This function is used to speed up of the boom by reducing the bucket speed when bucket operation with boom operation simultaneously.

When the boom up operation, the boom up pilot pressure is supplied the pilot port of bucket spool stroke limit and the piston is shifted to the right and then the bucket spool stroke is limited and the open of the bucket spool is reduced.

Accordingly, the oil of the bucket spool is reduced and the boom speed up.



6) SWING OPERATION

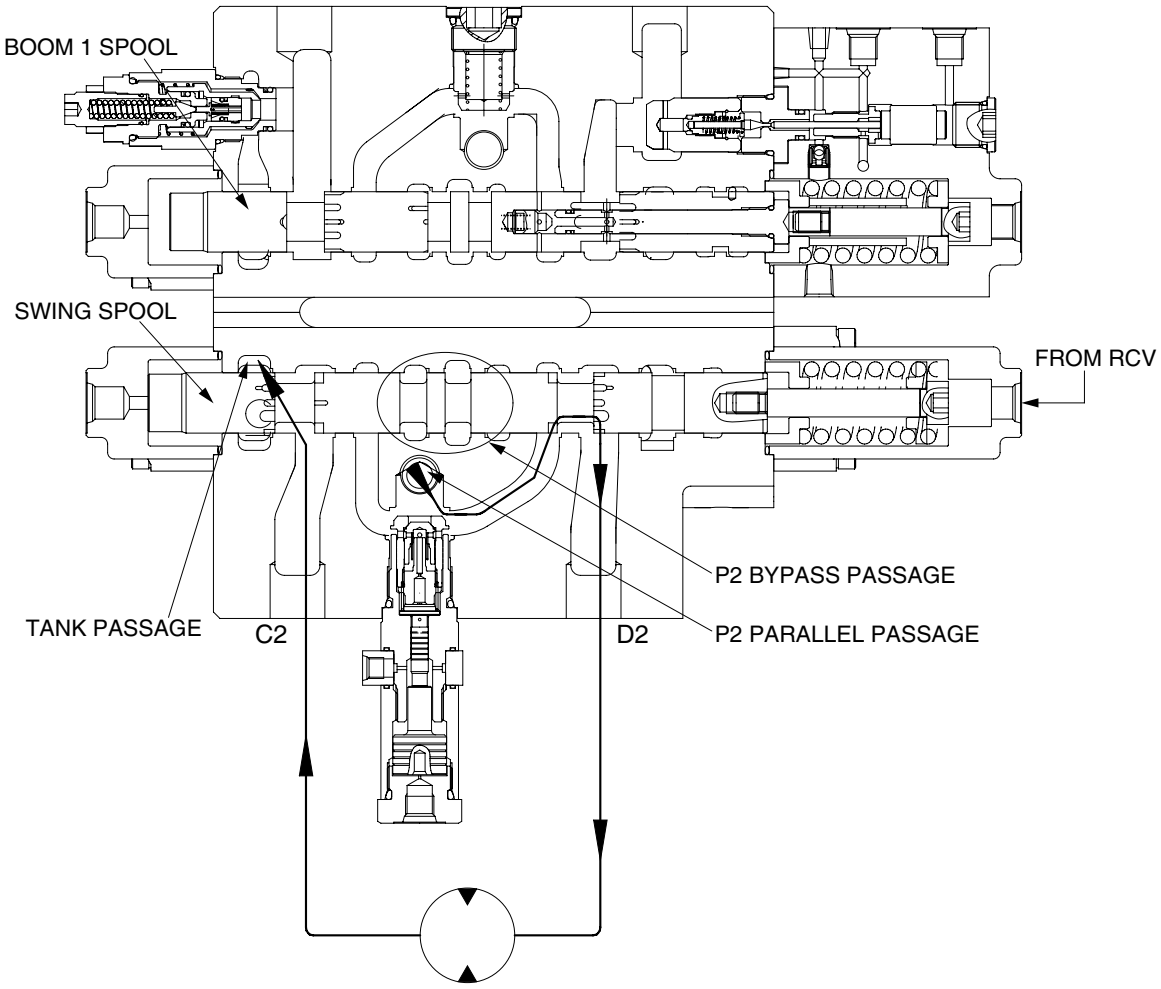
(1) SWING LEFT & RIGHT OPERATION

During the swing left operation, the pilot secondary pressure from the RCV is supplied to the port of the spring side and shift the swing spool in left direction. The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P2 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port D2.

As the result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port C2, swing spool and the tank passage.

In case of swing right operation, the operation is similar to swing left operation but the pilot secondary pressure from the RCV is supplied to the port of the spring opposite side.

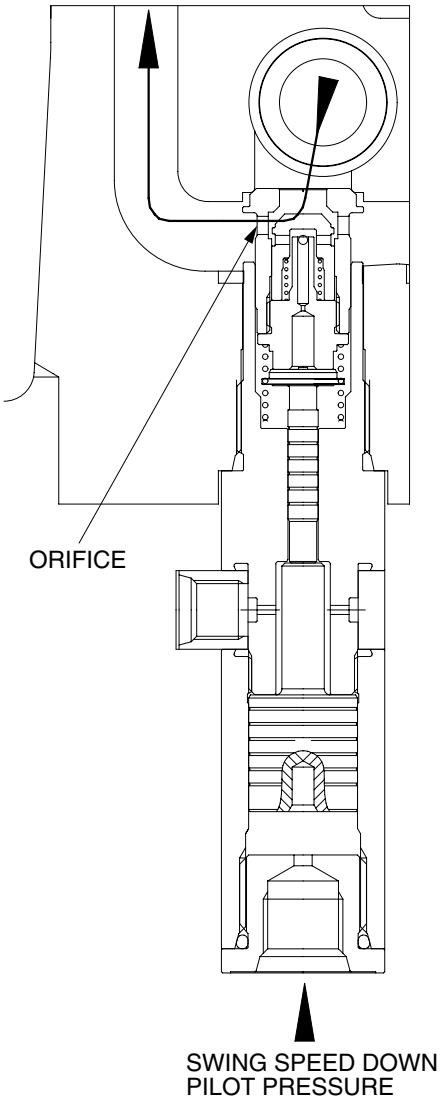
Accordingly, the hydraulic fluid from pump P2 flows into swing motor through the port C2 and returns to the hydraulic oil tank through the port D2 and the tank passage.



(2) SWING SLOW DOWN OPERATION

This operation is used to speed up the boom or arm by reducing the swing speed when swing operation with boom or arm operation.

The poppet of swing logic valve is closed by the pilot pressure of swing speed down is supplied to the port, the fluid from the port P2 is drained through orifice. Accordingly, the fluid from the port P2 is reduced and swing speed is slow down.



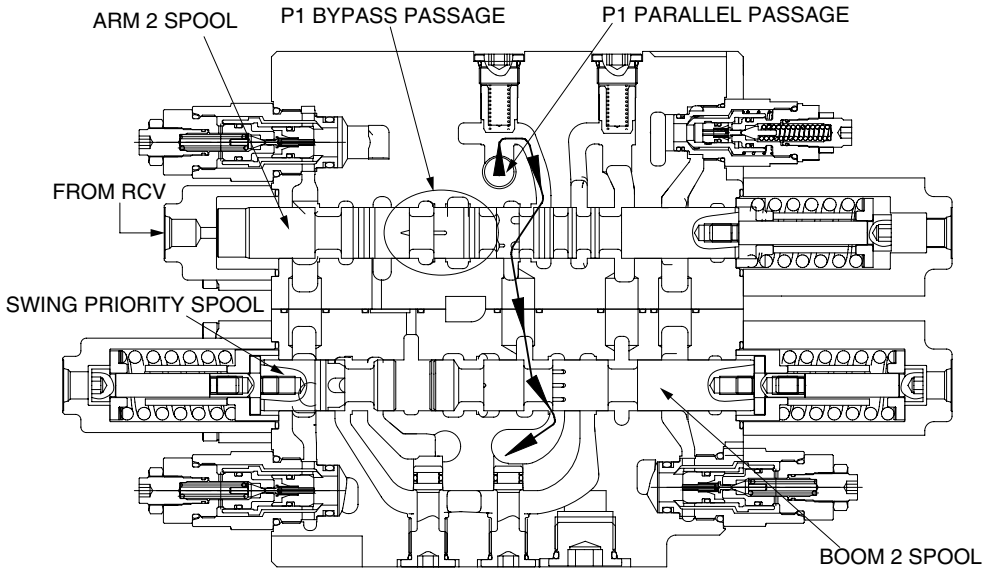
7) ARM OPERATION

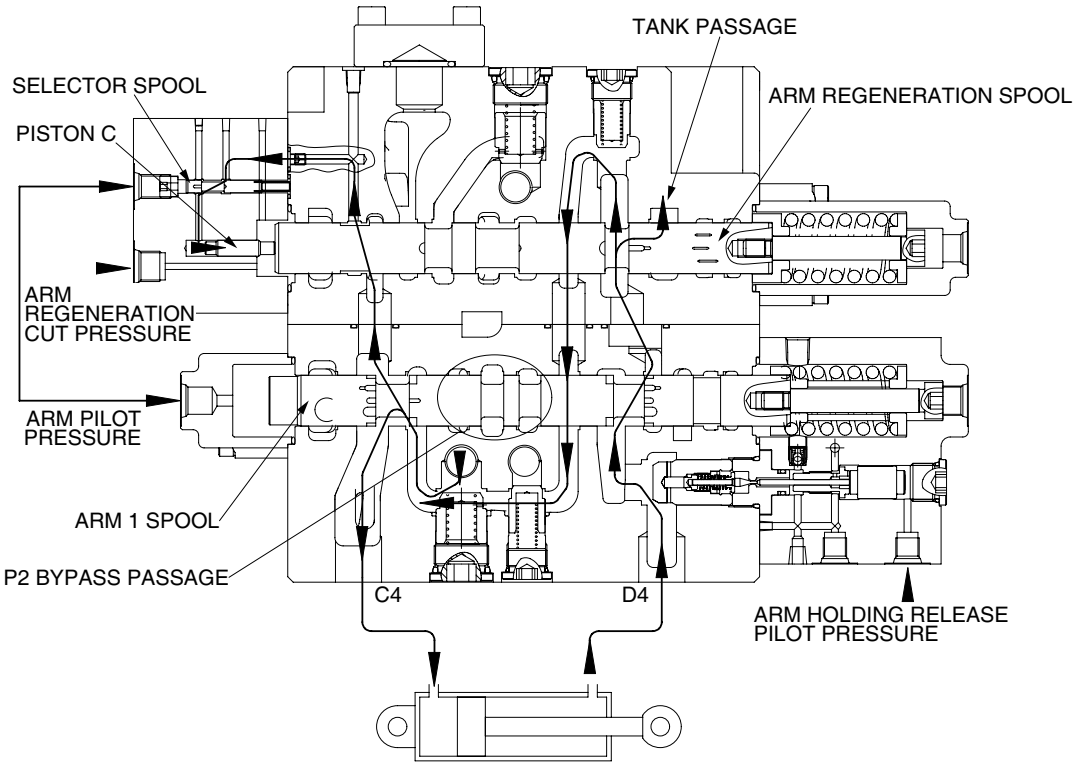
(1) ARM IN OPERATION

During arm in operation, the pilot secondary pressure from the RCV is supplied to the port of spring opposite side and shifts arm 1 spool in the right direction.

The bypass passage is shut off by the movement of the arm 1 spool and the hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve, bridge passage and the port C4.

At same time, the pilot secondary pressure from the RCV is supplied to the port of spring opposite side and shifts arm 2 spool in the right direction. The bypass passage is shut off by the movement of the spool and the hydraulic fluid from the pump P1 flows into the arm summation passage through parallel passage, the check valve, the arm 2 spool and the boom 2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm 1 spool.



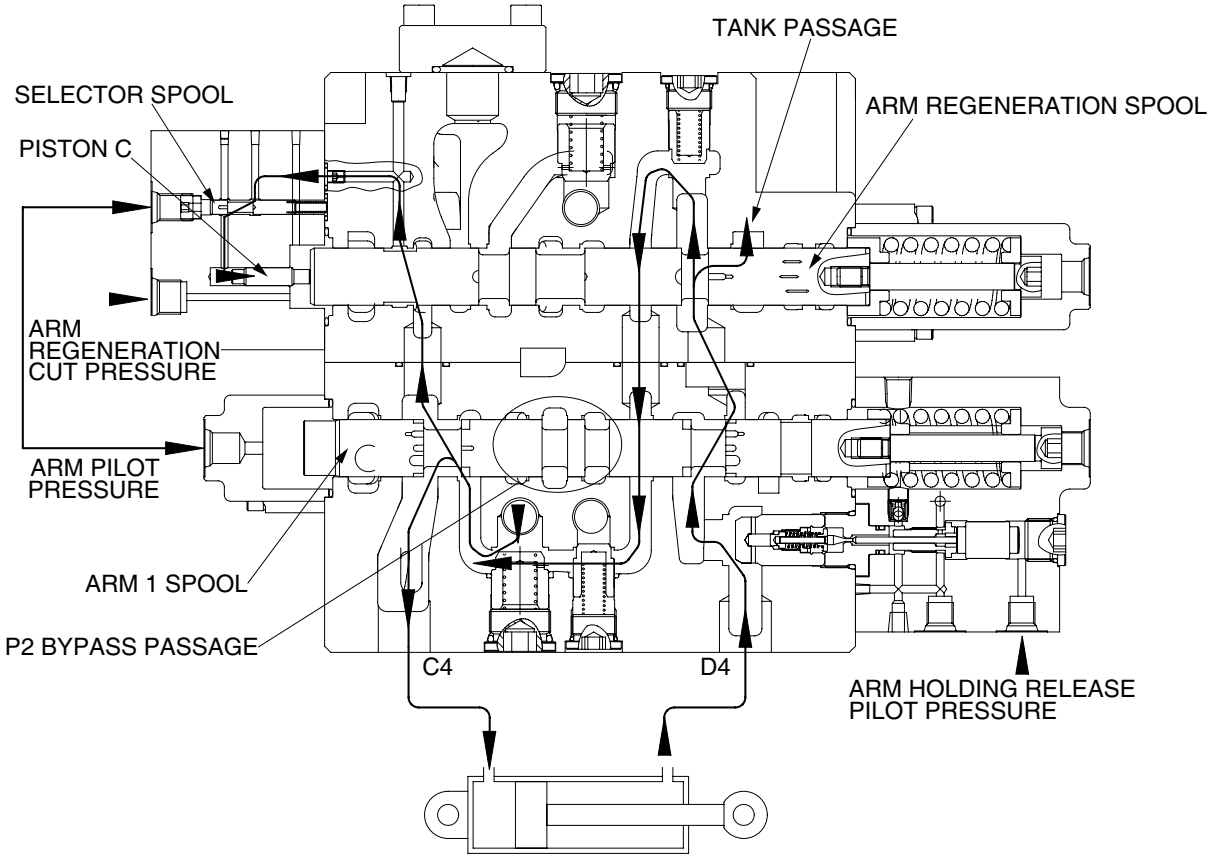


ARM REGENERATION

The return flow from the arm cylinder rod side is pressurized by self weight of arm and so, returns to port D4. The pressurized oil returning to port D4 enters the arm regeneration spool through the arm holding valve and the arm 1 spool. It is supplied the arm cylinder head through internal passage. This is called the arm regeneration function.

The amount of regeneration fluid is changed by movement of the arm regeneration spool. A few fluids after P2 parallel passage is push piston "C" through the notch of arm regeneration spool and selector spool. At this time, the selector spool is opened by pilot pressure from RCV.
Then, the arm regeneration spool shifts to right side and flow to tank pass increases and regeneration flow decreases. Therefore, pressure of arm cylinder head increases, then, arm regeneration flow decreases.

(CLUSTER TYPE 1 ONLY)
The arm regeneration cut pressure is supplied to the port of spring opposite side and arm regeneration spool is move into the right direction fully. The flow from the arm cylinder rod is returned to the hydraulic oil tank and regeneration function is not activated. (The return fluid is maximum condition)



(2) ARM OUT OPERATION

During arm out operation, the pilot secondary pressure from RCV is supplied to the port of spring side and shifts arm 1 spool in the left direction.

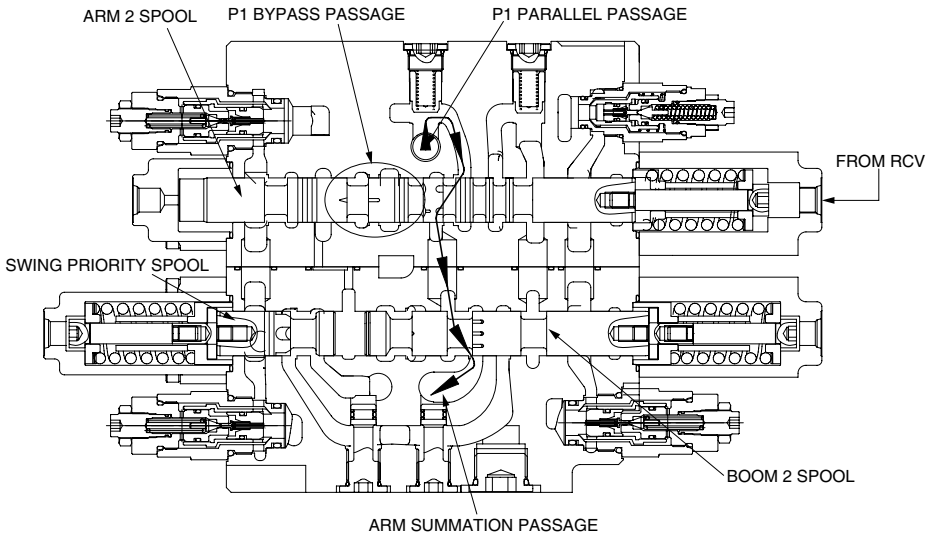
The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P2 flows into arm 1 spool through the parallel passage. Then it enters into the arm cylinder rod side through the load check valve, bridge passage, arm holding valve and the port D4.

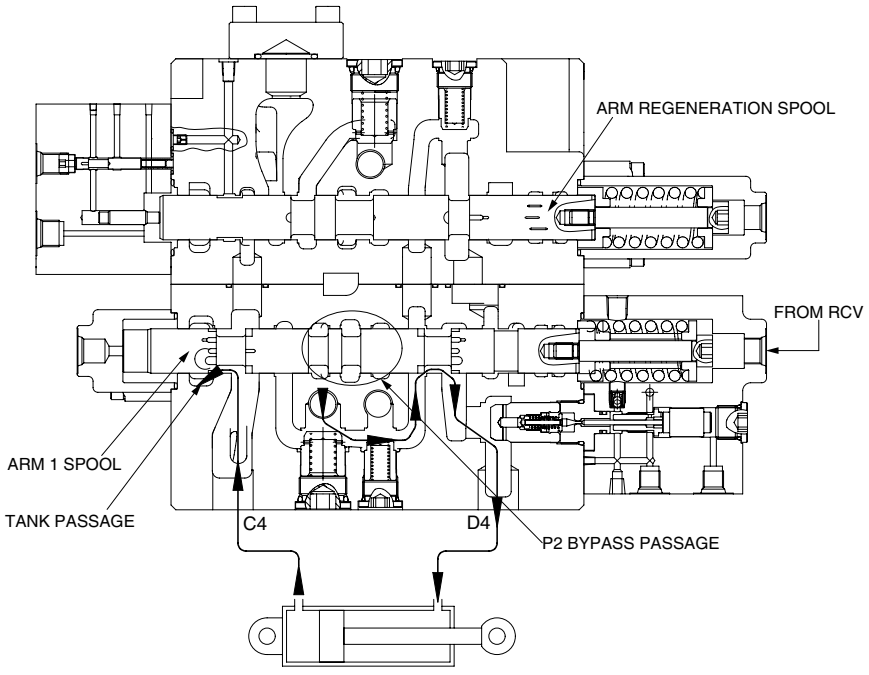
Also, the pilot secondary pressure from RCV is supplied to the port of spring side and shifts arm 2 spool in the left direction.

The bypass passage is shut off by the movement of the spool and some of the hydraulic fluid from pump P2 bypassed through bypass notch. The rest of hydraulic fluid from pump P2 flows into the arm summation passage through P1 parallel passage the check valve arm 2 spool and boom 2 spool.

Then it enters into the arm cylinder rod side with the fluid from the arm 1 spool.

The return flow from the arm cylinder head side returns to the hydraulic tank through the port C4 the arm 1 spool and tank passage.



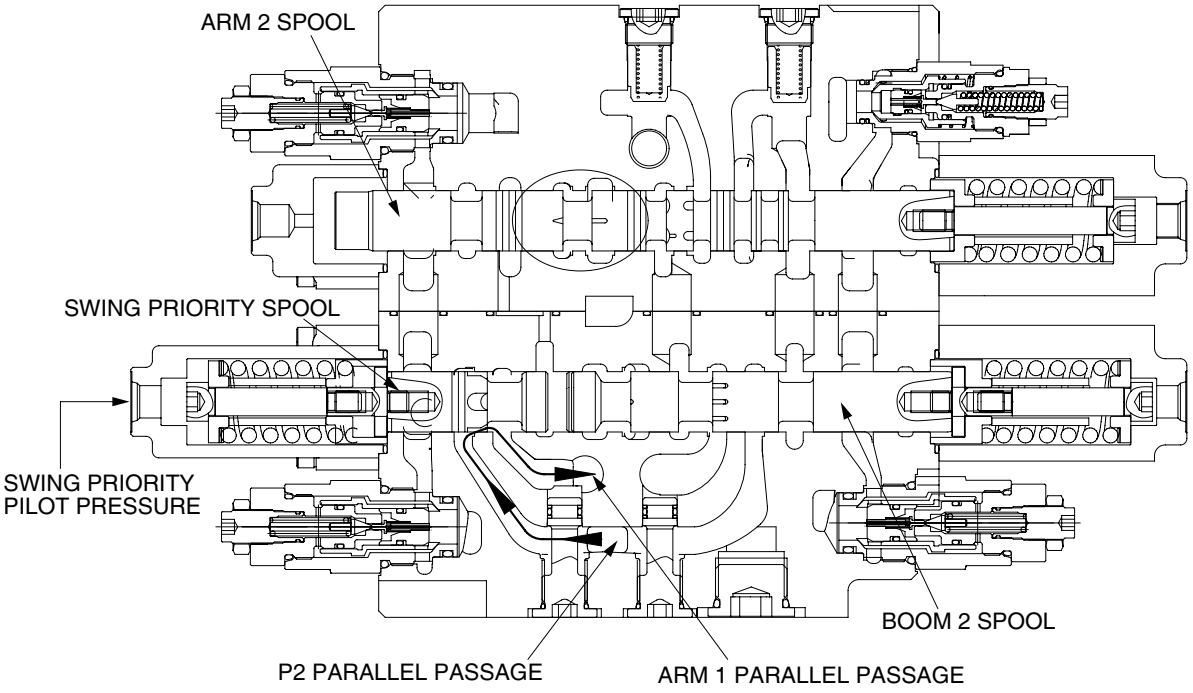


8) SWING PRIORITY FUNCTION

During swing priority operation, the pilot secondary pressure is supplied to the port of the spring side of the swing priority spool and shift swing priority spool in the right direction.

The hydraulic fluid from P2 parallel passage flows into the parallel passage of arm 1 side through swing priority spool and the passage "A" and also flows into the boom 2 spool.

When the swing priority spool is neutral condition, the passage is same as normal condition. But due to shifting of the swing priority spool, the fluid from pump P2 flows to swing side more then the boom 2, arm 1, option B and bucket summation spools to make the swing operation most preferential.



9) OPERATION OF OPTION

(1) OPERATION BY PUMP P2

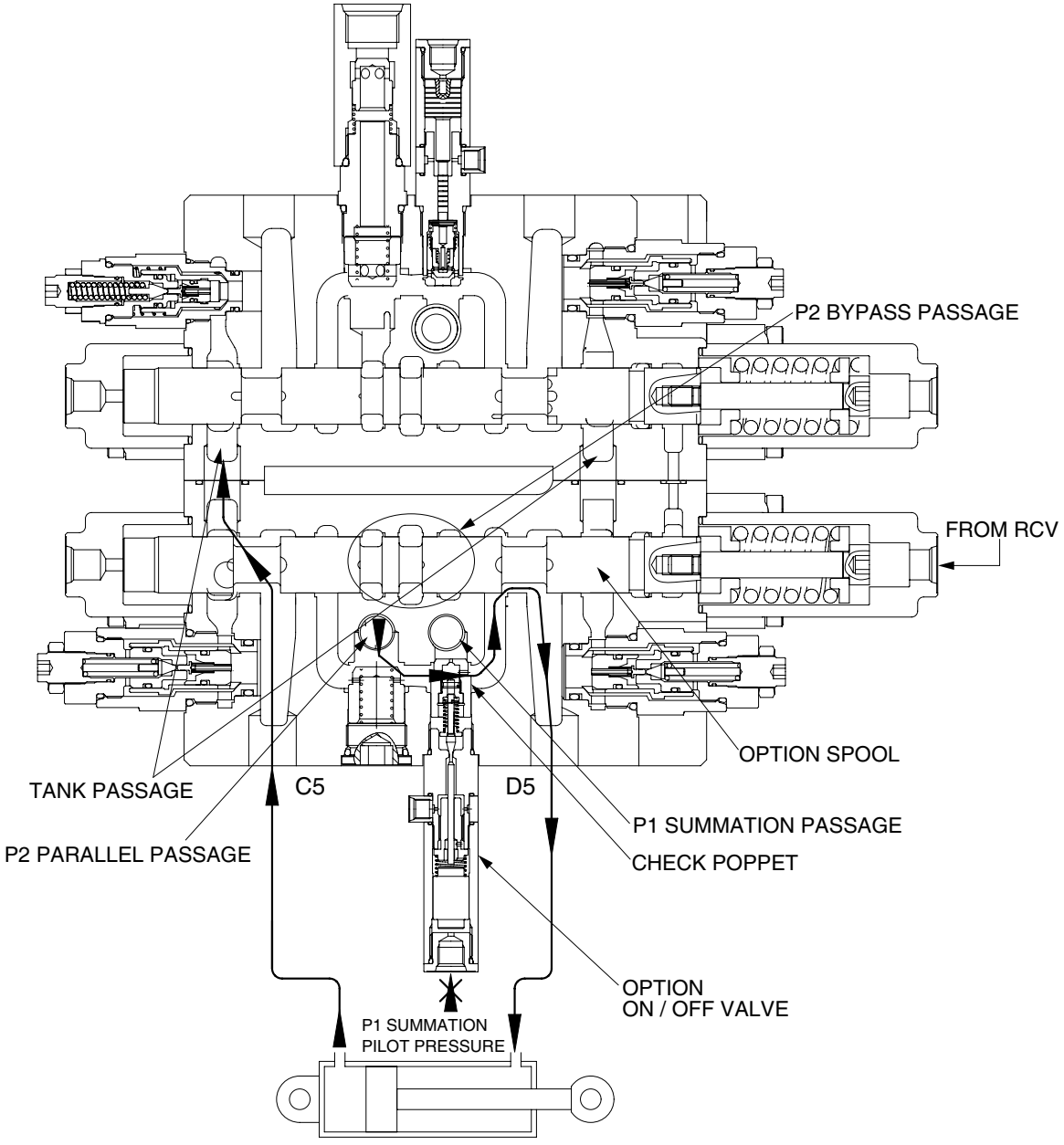
The pilot secondary pressure from RCV is supplied to the port of spring side and shifts option spool as the figure.

The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P2 flows into actuator through the load check valve, bridge passage and port D5.

If the pilot pressure is not supplied to P1 summation pilot port and is not shifts arm 2 spool. Accordingly, the pump P1 fluid connected the parallel passage is not flowing the check poppet of option ON/OFF valve and the fluid from pump is not joined the fluid from P2.

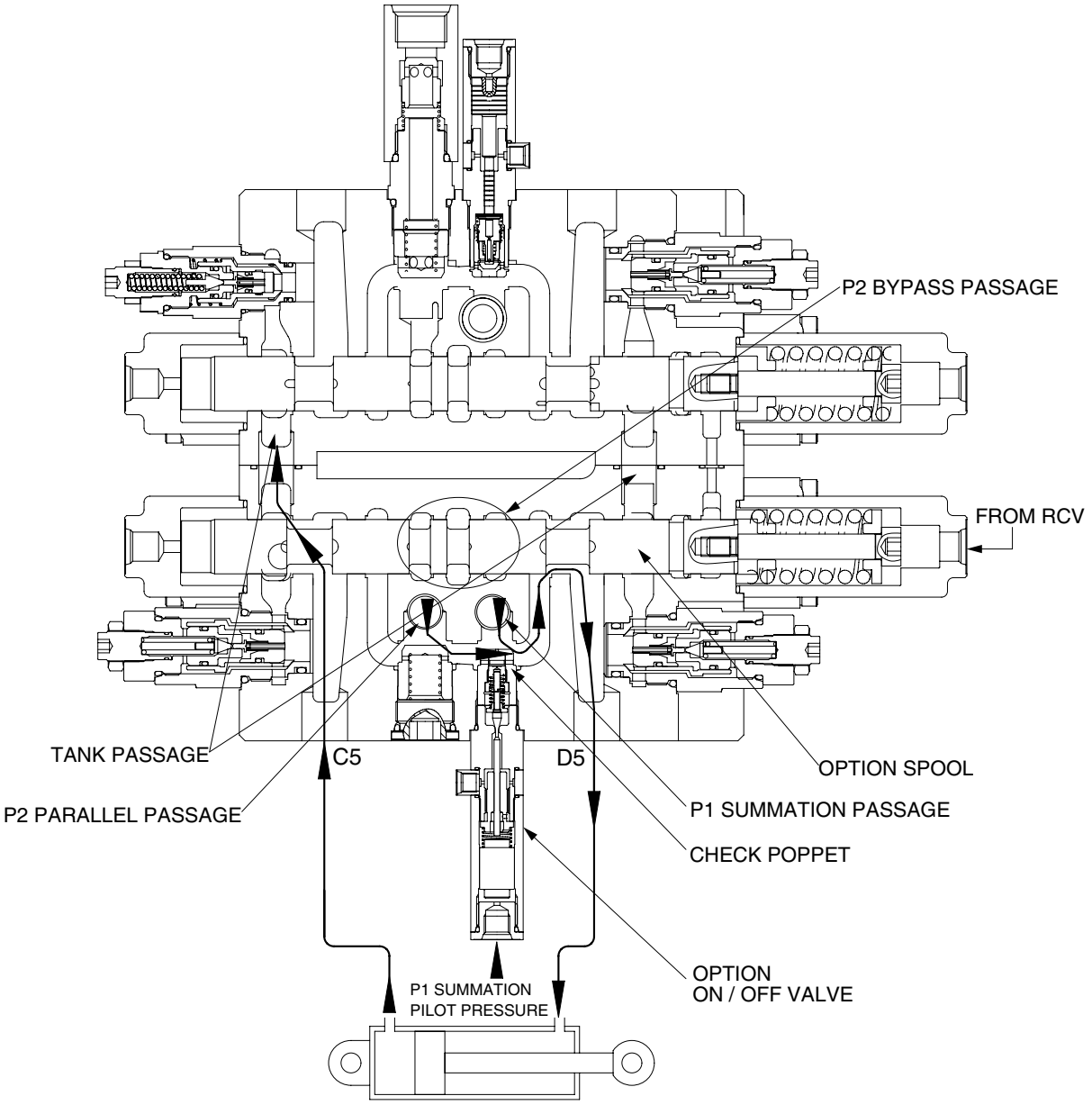
At the same time, the fluid from actuator returns to the tank passage through port C5 and notch of the option spool.

In case of reverse operation, the operating principle is same as above.



10) SUMMATION OPERATION WITH PUMP P1 (CLUSTER TYPE 1)

The pilot pressure from RCV is supplied to option pilot port and one of arm 2 pilot port at the same time, the fluid for the arm summation is build up. This fluid flows into the arm 1 spool priority but the arm is not operated, the fluid flows into P1 summation passage. Now the pilot pressure of RCV is supplied to the P1 summation pilot port of option ON/OFF valve, the fluid from pump P1 opens the load check valve and flows into port D5 with the fluid of pump P2.



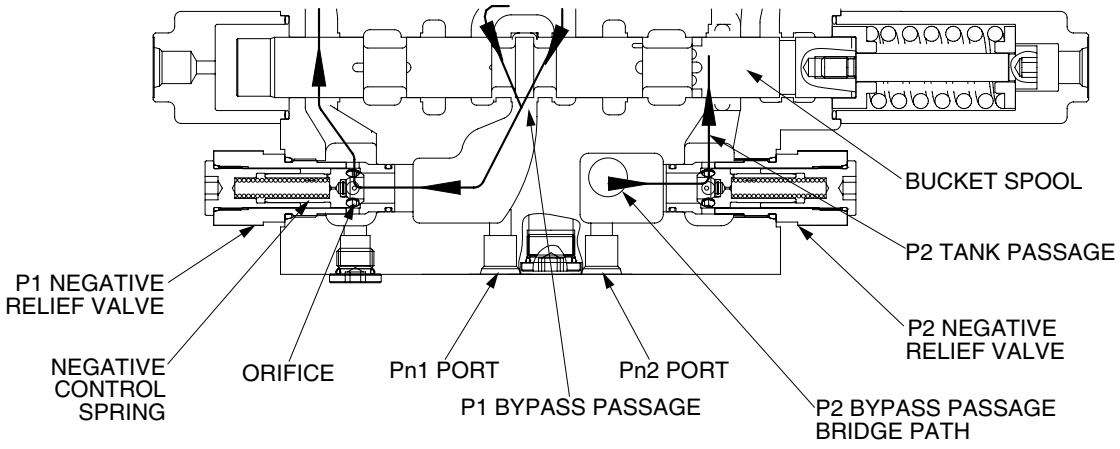
11) NEGATIVE RELIEF VALVE OPERATION

When no function is being actuated on P1 side, the hydraulic fluid from the pump P1, flows into the tank passage through the bypass passage and orifice. The restriction caused by this orifice thereby pressurizes. This pressure is transferred as the negative control signal pressure Pn1 to the pump P1 regulator. It controls the pump regulator so as to minimize the discharge of the pump P1.

The bypass passage is shut off when the shifting of one or more spools and the flow through bypass passage became zero. The pressure of negative control signal becomes zero and the discharge of the pump P1 becomes maximum.

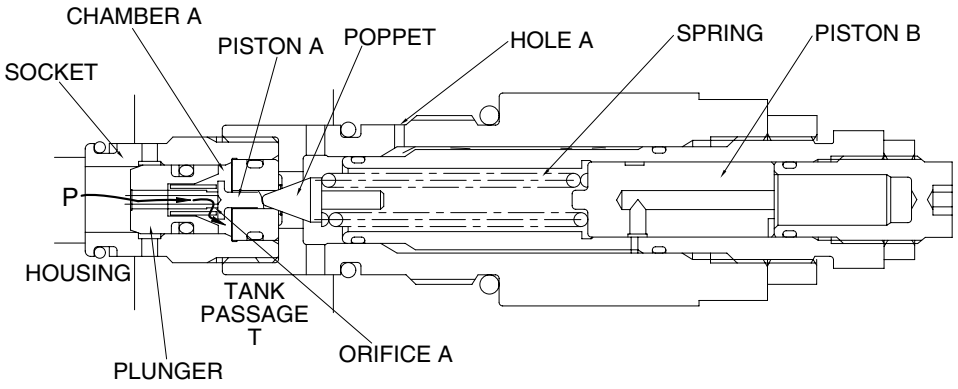
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump P2 the same negative control principle.

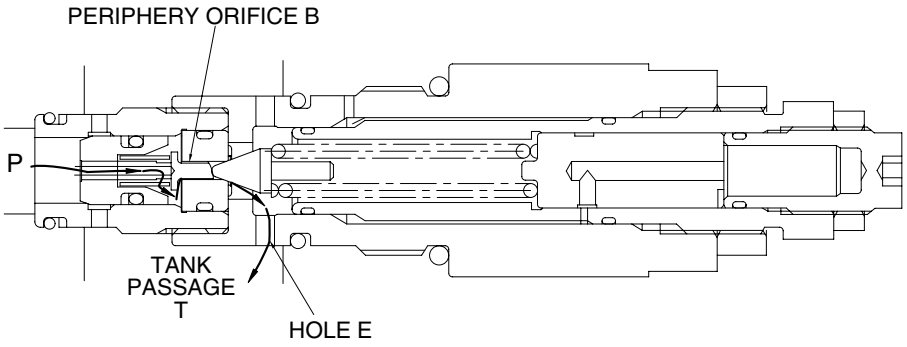


12) OPERATION OF MAIN RELIEF VALVE

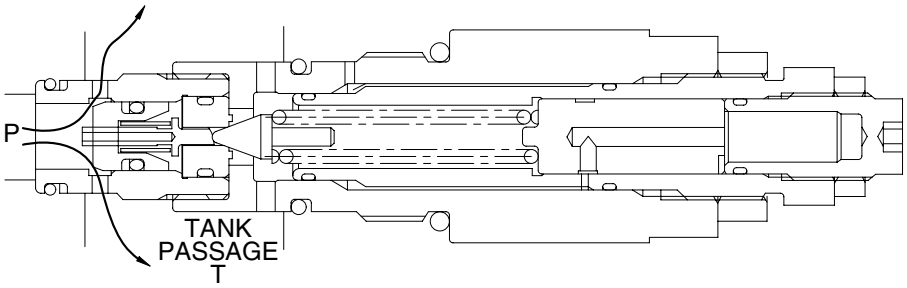
(1) The pressurized oil passes through the orifice (A) of the plunger is filled up in chamber A of the inside space, and seats the plunger against the housing securely.



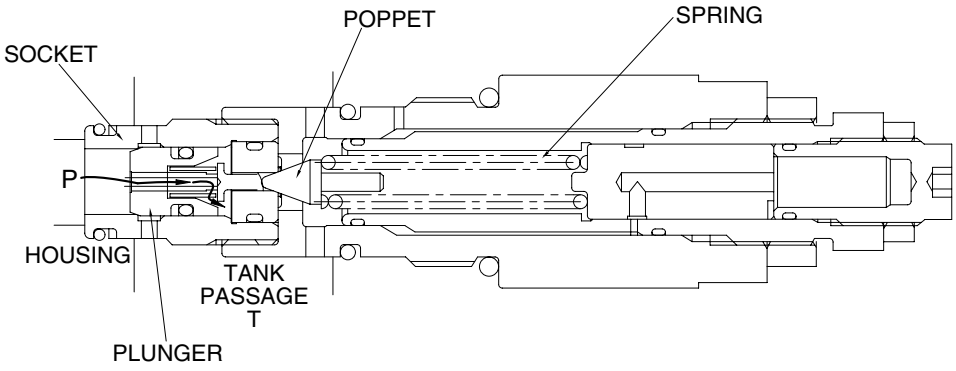
(2) When the pressure at (P) becomes equal to the set pressure of the spring the hydraulic oil passes through the piston (A) pushes open the poppet and flows to tank passage (T) through the plunger internal passage, periphery orifice A, chamber A, periphery orifice B and the hole (E).



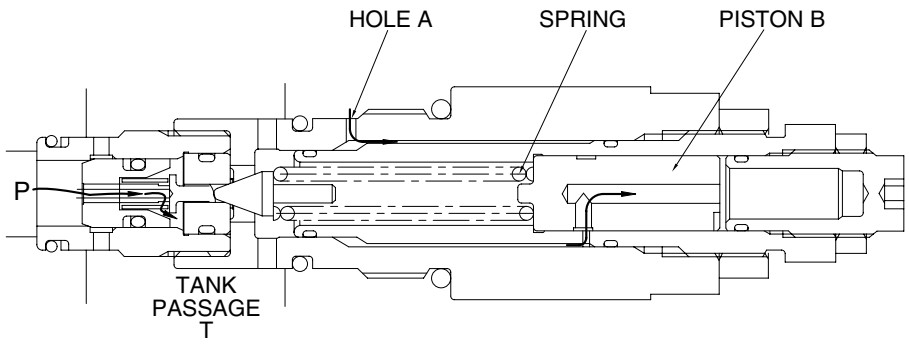
(3) Opening the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



(4) The pressure at port P becomes lower than set pressure of the spring, the poppet is seated by spring force. Then the pressure at port P becomes equal to set pressure of the spring and the plunger is seated to the socket.



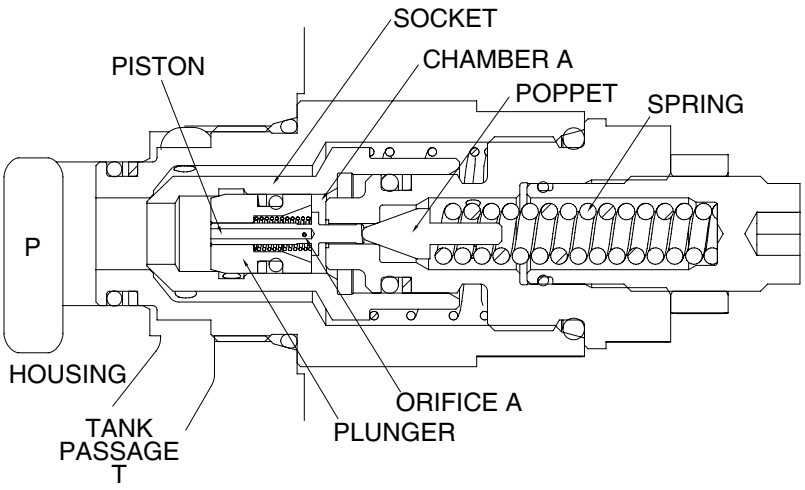
(5) When the power boost switch is ON, the pilot pressure enters through hole A.
It pushes the piston (B) in the left direction to increase the force of the spring and change the relief set pressure to the high pressure.



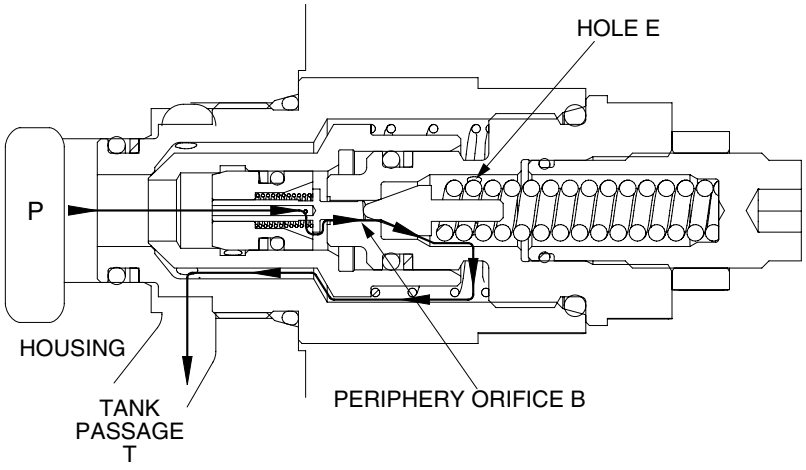
13) OPERATION OF OVERLOAD RELIEF VALVE

FUNCTION AS RELIEF VALVE

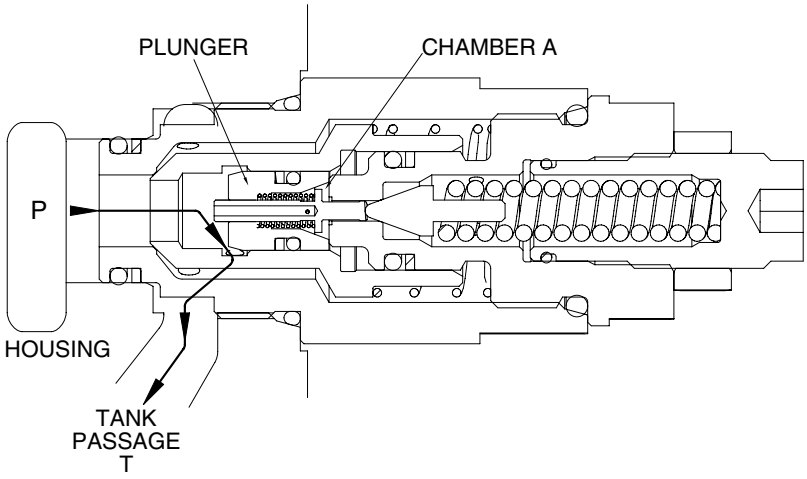
(1) The pressurized oil passes through the piston and orifice A is filled up in chamber A of the inside space and seat the plunger against the socket and the socket against the housing securely.



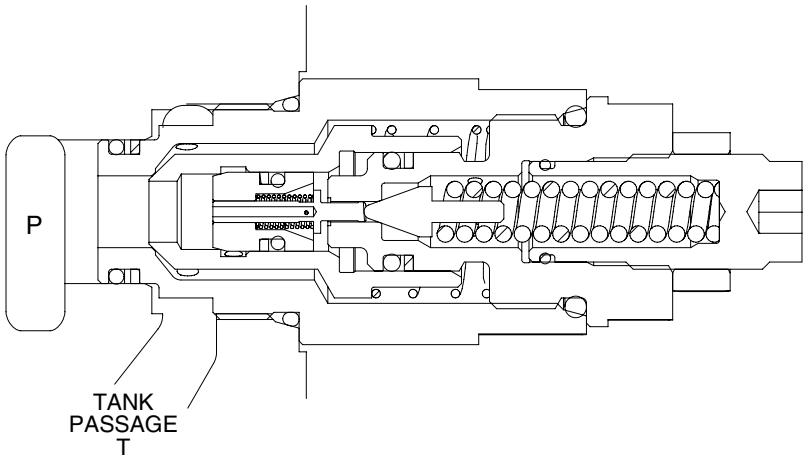
(2) When the pressure at port P becomes equal to the set pressure of the spring, the pressurized oil pushes open the poppet and flows to tank passage (T) through the plunger internal passage, orifice A, chamber A, periphery orifice B and hole E.



(3) Opening of the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).

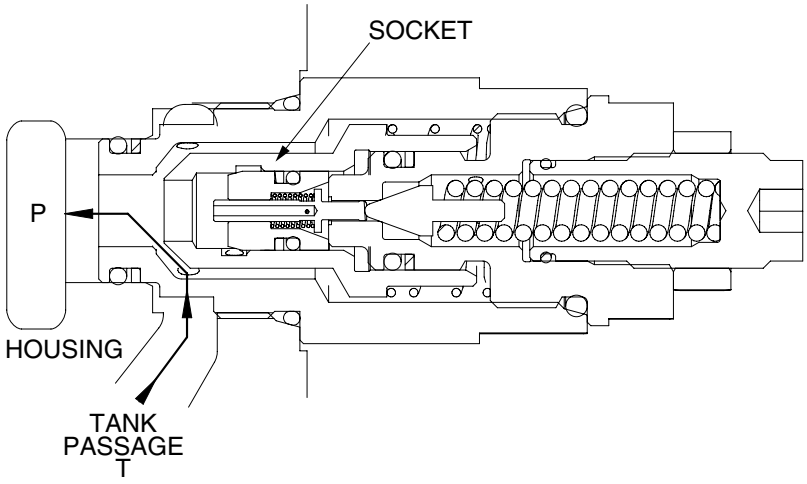


(4) The pressure at port P becomes lower than set pressure of the spring, the poppet is seated by spring force. Then the pressure at port P becomes equal to set pressure of the spring and the plunger is seated t o the socket.



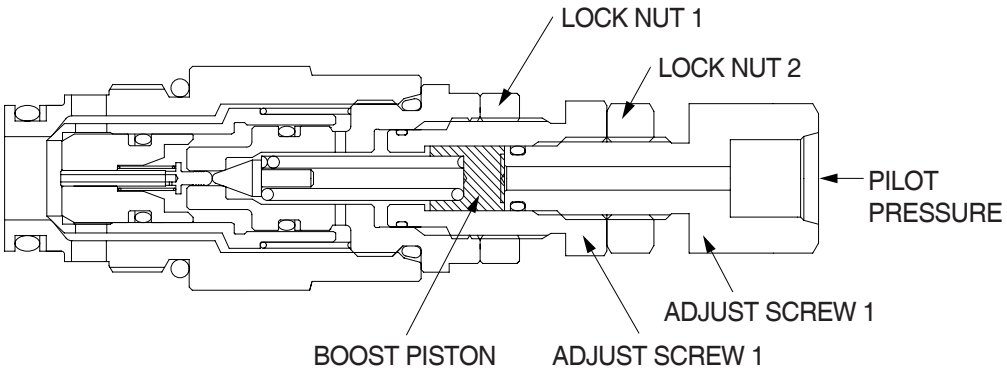
MAKE-UP FUNCTION

(5) When negative pressure exists at port P, the oil is supplied through tank passage (T). When the pressure at tank passage (T) becomes higher than that of at port P, the socket moves in the right direction. Then, sufficient oil passes around the socket from tank passage (T) to port P and fills up the space.



14) BREAKER OVERLOAD RELIEF VALVE FUNCTION

(1) The structure and function of 2 stage relief valve is similar with the overload relief but it can set the higher pressure by pilot pressure.



Boost function

(1) When the pilot pressure is supplied, the spring is a little compressure by moving of the boost piston and the set pressure is higher as length of spring compressed.

Pressure set method

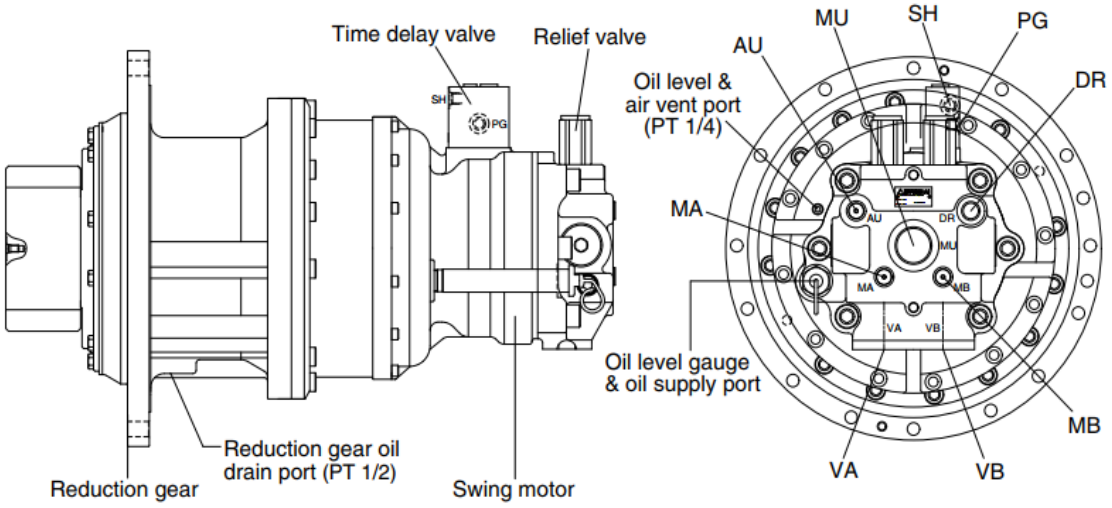
(2) Loosen lock nut 1 and 2 and then full tighten adjust screw 2.
(3) Set the high pressure by adjusting the adjust screw 1 and 2 and then fix it by the lock nut 1.
Keep the adjust screw 1 do not move when fixing the lock nut 1.
(4) Set the low pressure by adjusting the adjust screw 2 and then fix it by the lock nut 2.
Keep the adjust screw 2 do not move when fixing the lock nut 2.

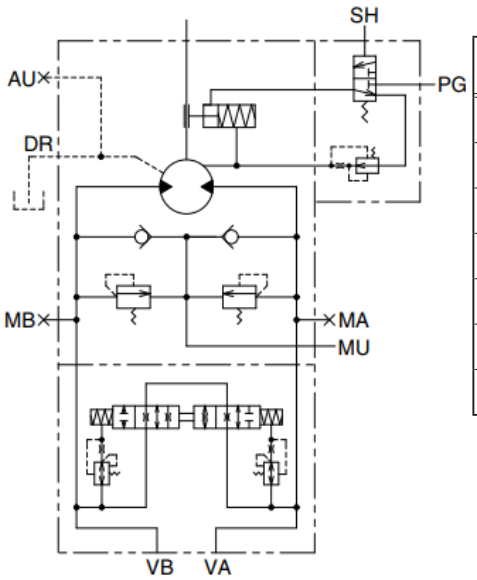
GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

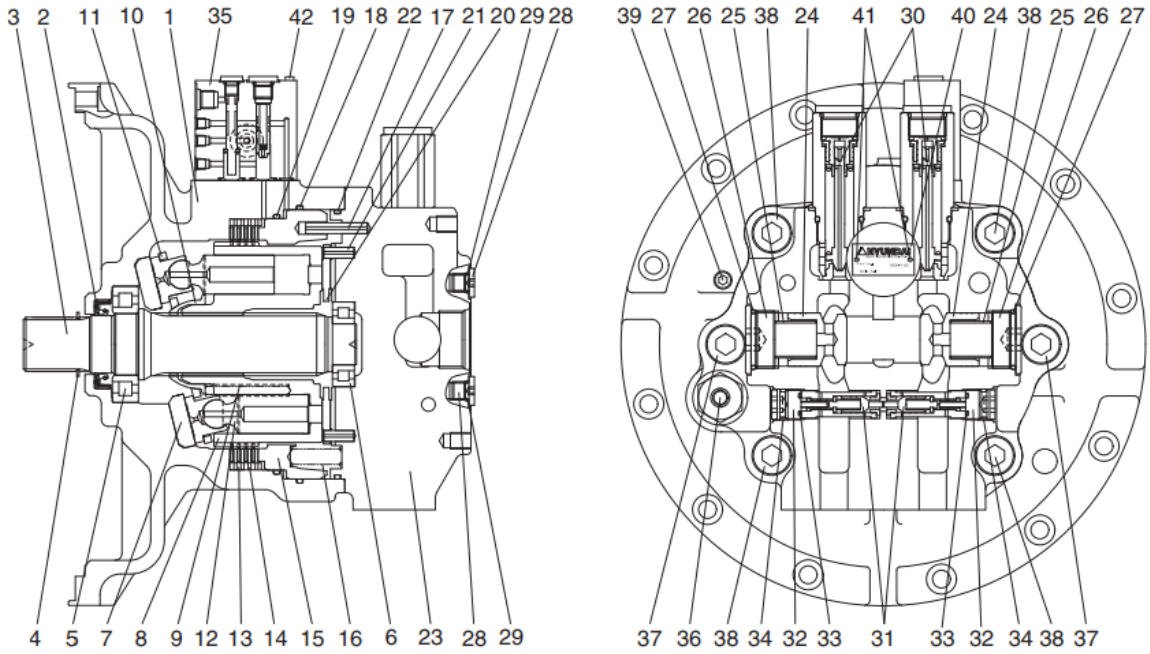
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.





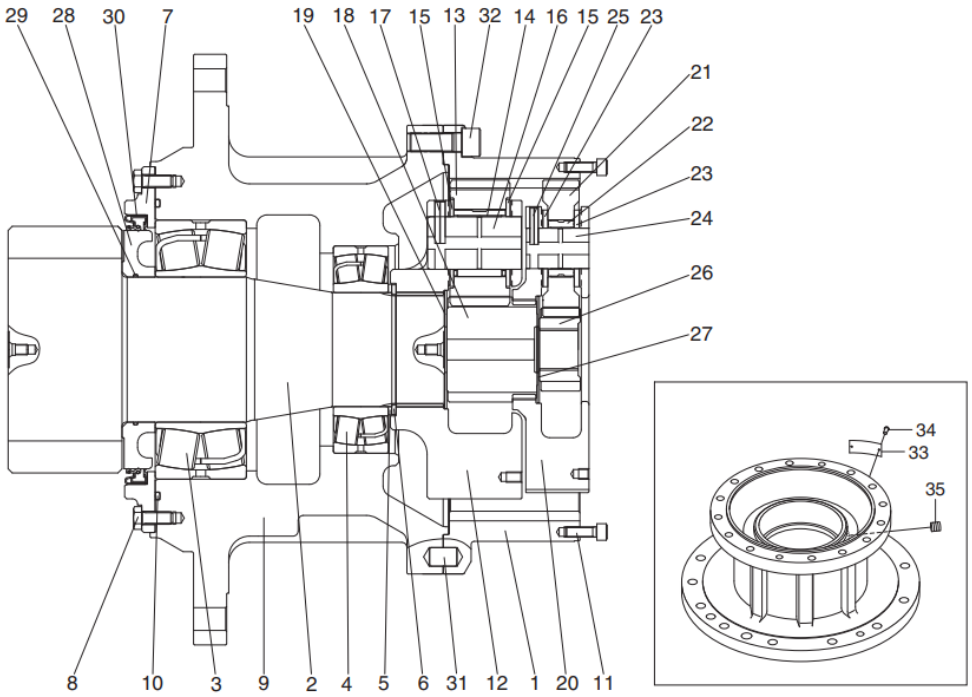
Port	Port name	Port size
A, B	Main port	∅20
DR	Drain port	PF 1/2
Mu	Make up port	PF 1 1/4
MA, MB	Gauge port	PF 1/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
AU	Air vent port	PF 1/4

1) SWING MOTOR



1	Casing	18	O-ring	35	Time delay valve assy
2	Oil seal	19	O-ring	36	Level gauge
3	Shaft	20	Valve plate	37	Socket bolt
4	Snap ring	21	Spring pin	38	Socket bolt
5	Roller bearing	22	O-ring	39	Plug
6	Needle bearing	23	Valve casing	40	Name plate
7	Swash plate	24	Check valve	41	Rivet
8	Cylinder block	25	Spring	42	Socket bolt
9	Spring	26	Plug		
10	Ball guide	27	O-ring		
11	Retainer plate	28	Plug		
12	Piston assy	29	O-ring		
13	Friction plate	30	Relief valve assy		
14	Separate plate	31	Reactionless valve assy		
15	Parking piston	32	Plug		
16	Brake spring	33	O-ring		
17	Spring pin	34	O-ring		

2) REDUCTION GEAR



1	Ring gear	13	Planetary gear 2	25	Spring pin 1
2	Drive shaft	14	Needle bearing 2	26	Sun gear 1
3	Bearing	15	Thrust washer 2	27	Thrust plate 1
4	Bearing	16	Carrier pin 2	28	Sleeve
5	Thrust plate	17	Spring pin 2	29	O-ring
6	Snap ring	18	Sun gear 2	30	Oil seal
7	Cover	19	Thrust plate 2	31	Parallel pin
8	Hex head bolt	20	Carrier 1	32	Hex socket head bolt
9	Casing	21	Planetary gear 1	33	Name plate
10	O-ring	22	Needle bearing 1	34	Rivet
11	Hex socket head bolt	23	Thrust washer 1	35	Plug
12	Carrier 2	24	Carrier pin 1		

2. PRINCIPLE OF DRIVING

1) Generating the turning force

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

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

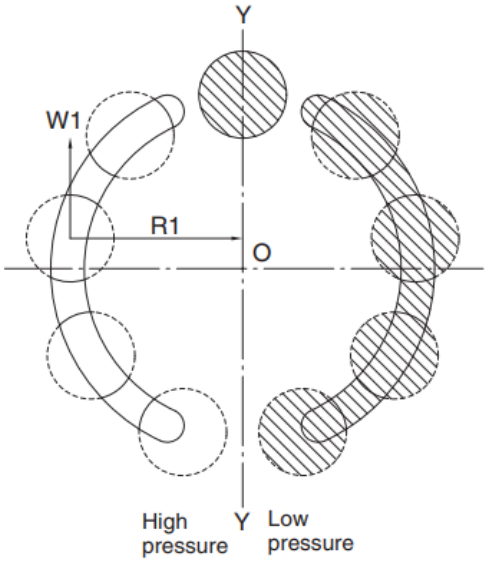
The high hydraulic can generate the force, F1=P×A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

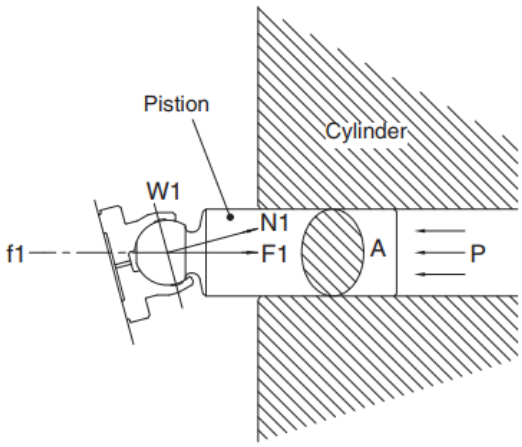
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle.

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 (W1×R1), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

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





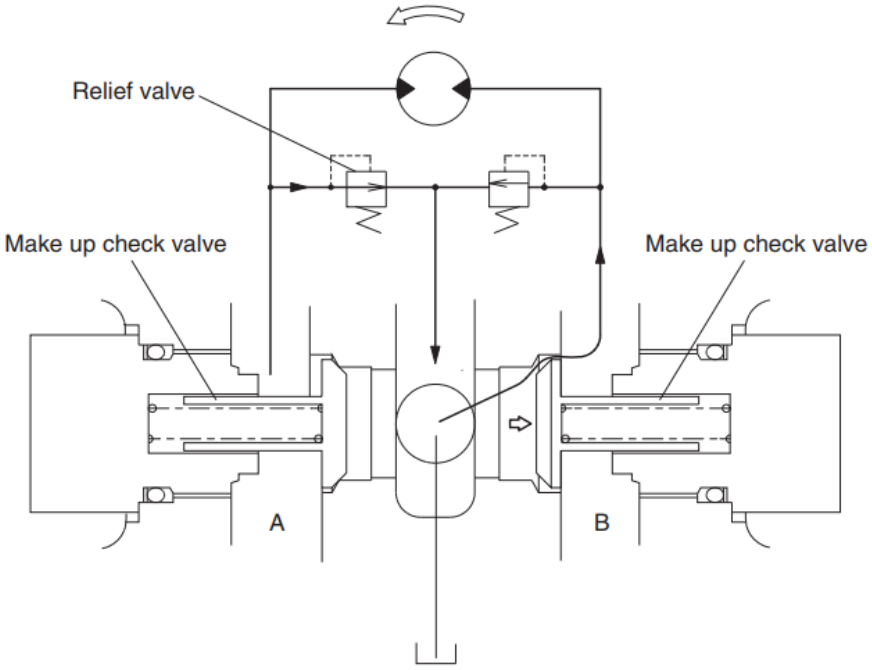
2) MAKE UP VALVE

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

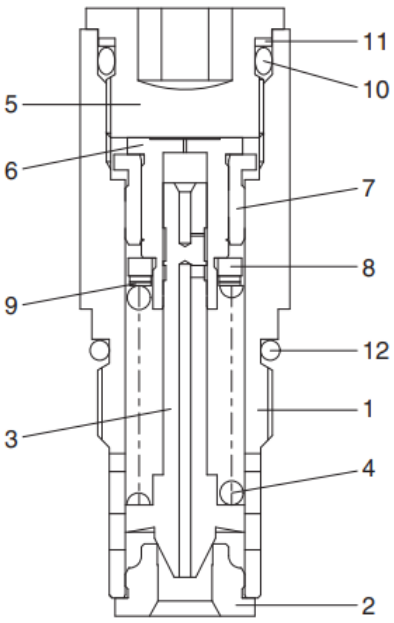
A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

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

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



3) RELIEF VALVE



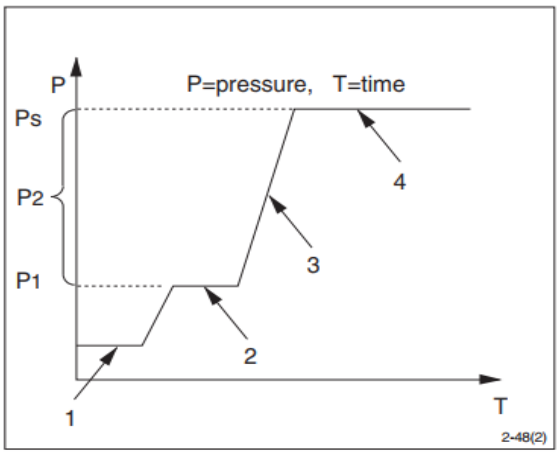
1 Body
2 Seat
3 Plunger
4 Spring
5 Adjusting screw
6 Piston
7 Bushing
8 Spring seat
9 Shim
10 O-ring
11 Back up ring
12 O-ring

(1) Construction of relief valve

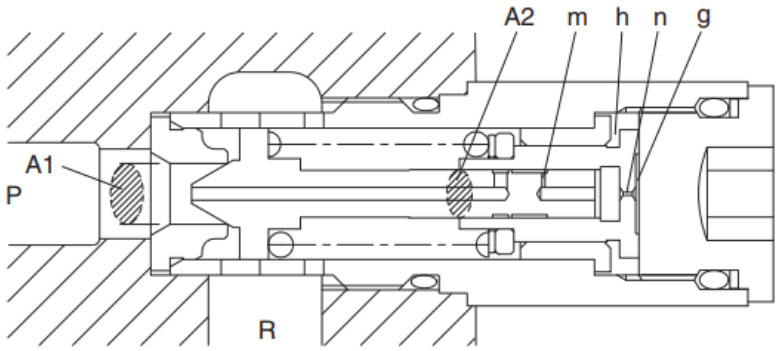
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(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



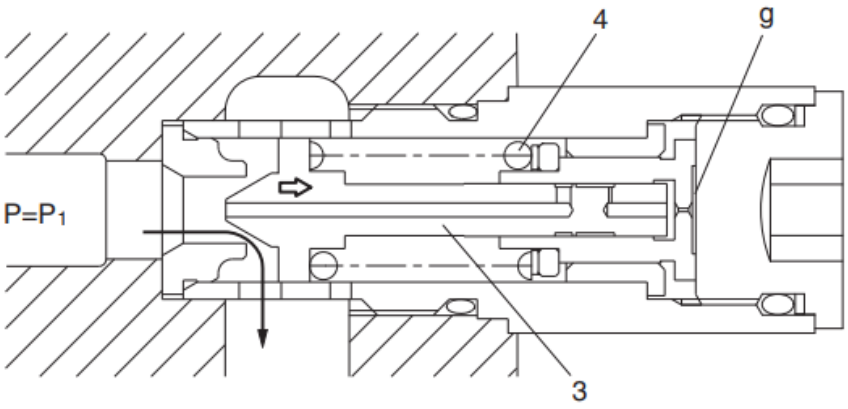
① **Ports (P,R) at tank pressure**



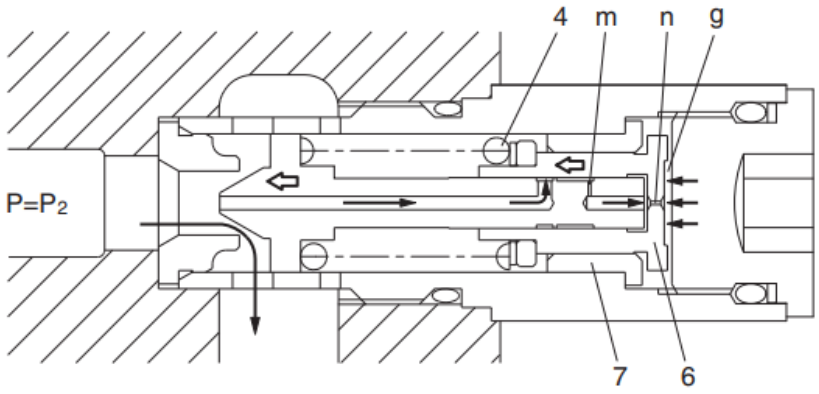
② When hydraulic oil pressure (P×A1) reaches the preset force (FSP) of spring (4), the plunger (3) moves to the right as shown.

$$P1 \times A1 = Fsp + Pg \times A2$$

$$P1 = \frac{Fsp + Pg \times A2}{A1}$$



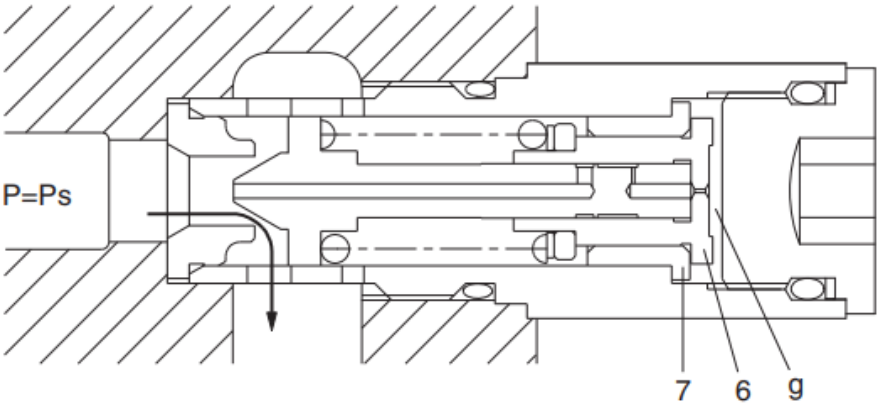
③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (FSP) of spring (4), the piston (6) moves left and stop the piston (6) hits the bottom of bushing (7)



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

$$Ps \times A1 = Fsp + Ps \times A2$$

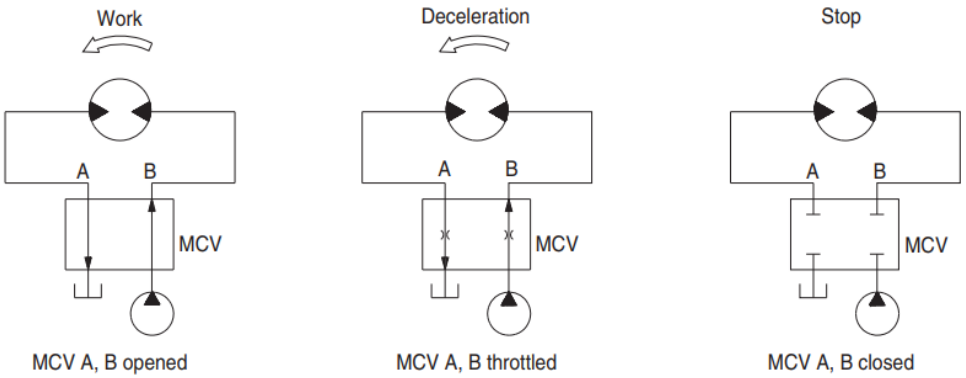
$$P1 = \frac{Fsp + Pg \times A2}{A1 - A2}$$



3) BRAKE SYSTEM

(1) Control valve swing brake system

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

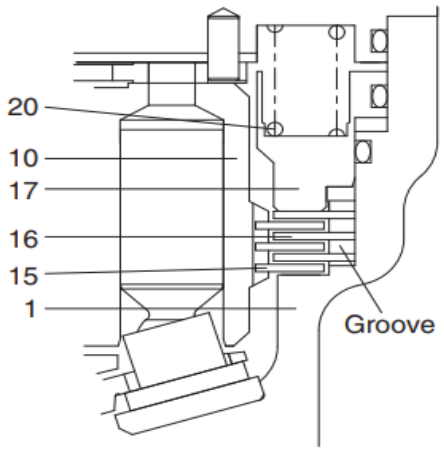


(2) Mechanical swing parking brake system

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

① Brake assembly

Circumferential rotation of separate plate (16) is constrained by the groove located at housing (1). When housing is pressed down by brake spring (20) through friction plate (15), separate plate (16) and brake piston (17), friction force occurs there.
Cylinder block (10) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.
Thus, it swings as the bypass orifice and the path are blocked up.

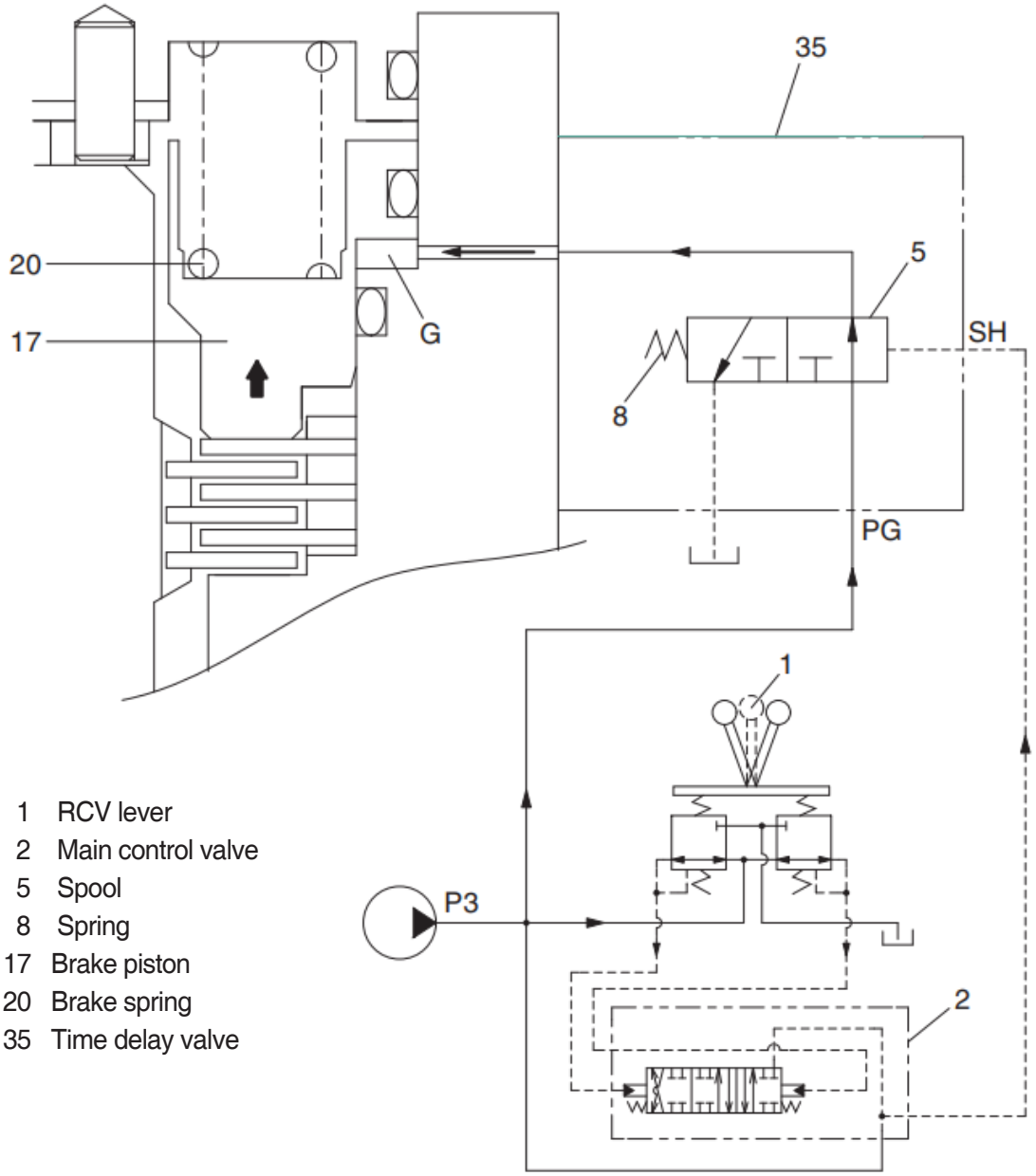


1	Housing	16	Separate plate
10	Cylinder block	17	Brake piston
15	Friction plate	20	Spring

① **Operating principle**

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 (35). 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 (17) to the upward against the force of the spring (20). Thus, it releases the brake force.



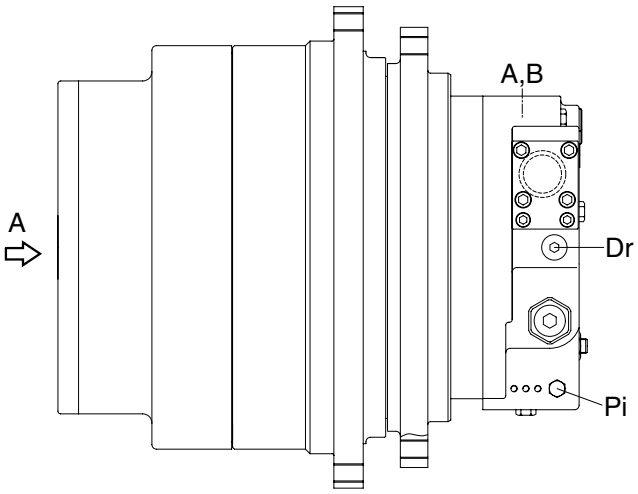
1 RCV lever
2 Main control valve
5 Spool
8 Spring
17 Brake piston
20 Brake spring
35 Time delay valve

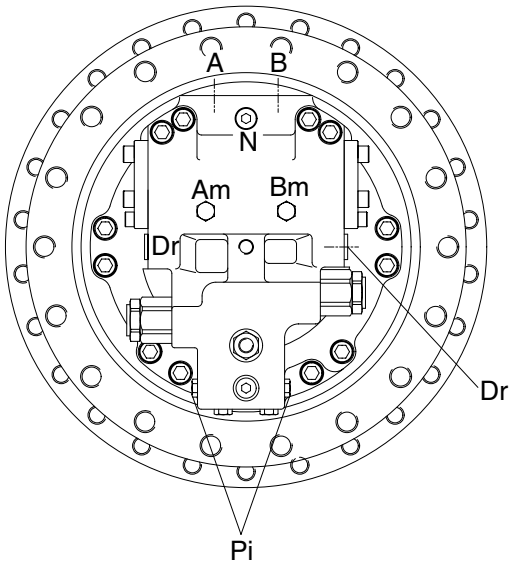
GROUP 4 TRAVEL DEVICE

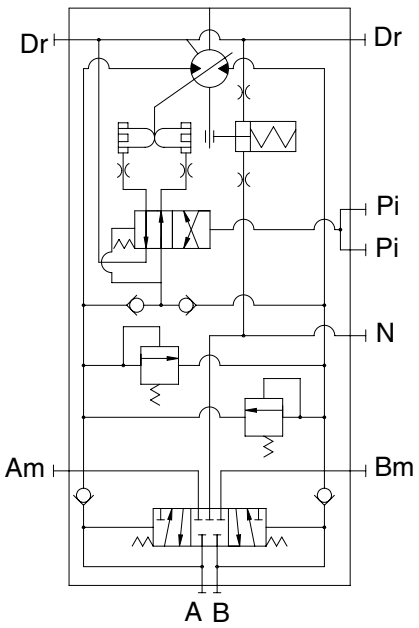
1. CONSTRUCTION

Travel device consists travel motor and gear box.

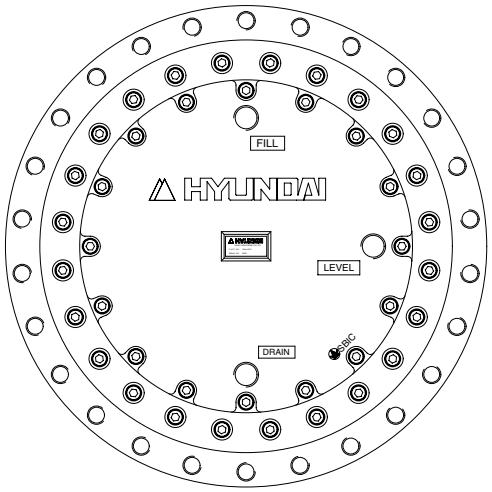
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.







Hydraulic circuit

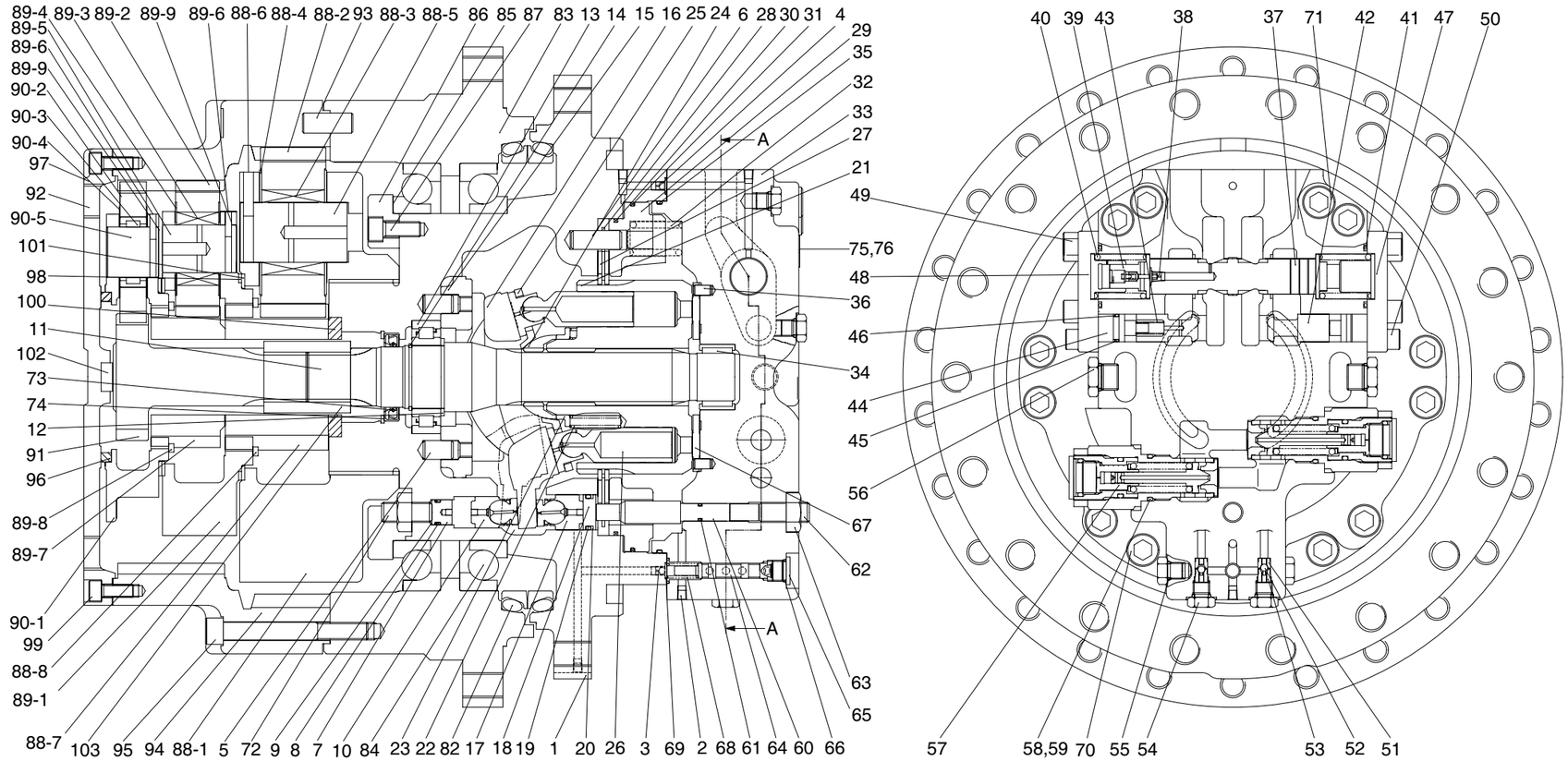


VIEW A

Port	Port name	Port size
A, B	Valve port	PF 1
Pi	Pilot port	PF 1/4
Dr	Drain port	PF 1/2
Am, Bm	Gage port	PF 1/4
N	Parking release port	PF 1/4

2. SPECIFICATION

1) TRAVEL MOTOR



SECTION A-A

1	Casing	16	Plate	31	Ring	46	Back up ring	61	O-ring	83	Housing	89-1	Carrier No.2	91	Sun gear No.1
2	Plug	17	Piston	32	Spring	47	Cap	62	Lock screw	84	Bearing	89-2	Planetary gear No.2	92	Plug
3	Screw	18	Stopper	33	Valve casing	48	Cap	63	Nut	85	Shim	89-3	Needle No.2	93	Lock pin
4	Screw	19	O-ring	34	Needle bearing	49	Bolt	64	Spool	86	Retainer	89-4	Thrust washer No.2	94	Ring gear
5	Pin	20	Back up ring	35	O-ring	50	Socket bolt	65	Plug	87	Bolt	89-5	Pin No.2	95	Bolt
6	Pin	21	Cylinder block	36	Pin	51	Seat	66	O-ring	88	Carrier No.3	89-6	Spring pin No.2	96	Thrust ring No.1
7	Stopper	22	Cylinder spring	37	Spool	52	Steel ball	67	Valve plate	88-1	Carrier No.3	89-7	Sun gear No.2	97	Cover
8	O-ring	23	Spacer	38	Screw	53	Stopper	68	Spring	88-2	Planetary gear No.3	89-8	Snap ring No.2	98	Thrust ring No.2
9	Back up ring	24	Guide	39	Damping check	54	Plug	69	O-ring	88-3	Needle No.3	89-9	Spring pin No.2	99	Bolt
10	Piston	25	Plate	40	Spring	55	O-ring	70	Socket bolt	88-4	Thrust washer No.3	90	Carrier No.1	100	Motor ring
11	Shaft	26	Piston & Shoe assy	41	O-ring	56	Plug	71	Socket bolt	88-5	Pin No.3	90-1	Carrier No.1	101	Thrust ring No.3
12	Spacer	27	Plate	42	Plunger	57	Relief valve	72	Lock screw	88-6	Spring pin No.3	90-2	Planetary gear No.1	102	Pad
13	Roller bearing	28	Plate	43	Spring	58	O-ring	73	Oil seal	88-7	Sun gear No.3	90-3	Needle bearing No.1	103	Coupling
14	Stop ring	29	Brake	44	Stopper	59	Back up ring	74	Lock ring	88-8	Snap ring No.3	90-4	Thrust washer No.1		
15	Support	30	Ring	45	O-ring	60	Rod	82	Floating Seal	89	Carrier No.2	90-5	Pin No.1		

3. PRINCIPLE OF DRIVING

1) WORKING OF ROTARY GROUP

The high pressurized hydraulic oil which is supplied from a hydraulic pump is flows into a cylinder (21) through the valve casing (33) of motor, and valve plate (67).

The rotary group has a construction that the above high pressurized hydraulic oil is flow only one side of the line Y-Y which connect the upper and lower dead point of the piston (26).

This high pressurized hydraulic oil works on the piston and generating the force F1, F1 = P * A (P : supplied pressure, A : pressure receving area), like following pictures.

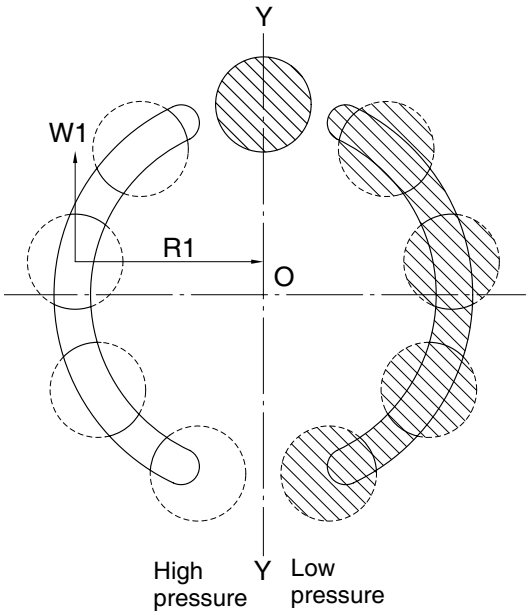
This force, F1, is devided by the swash plate (16) having a tilting angle into the thrust component N1 and radial component W1.

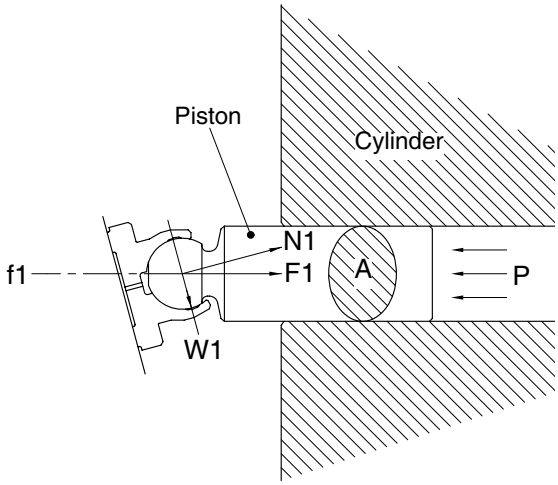
The W1 generates torque, T = W1 * R1, in respect to the line Y-Y.

This torque generated by each piston on the high pressurized hydraulic oil side is summed up onto a resultant torque (W1 * R1), which prodeces torque for rotation.

This torque transfers the rotation force to the cylinder (21) through the pistons.

Since the cylinder block is spline-coupled with the shaft, the rotation force is transmitted to the shaft accordingly.





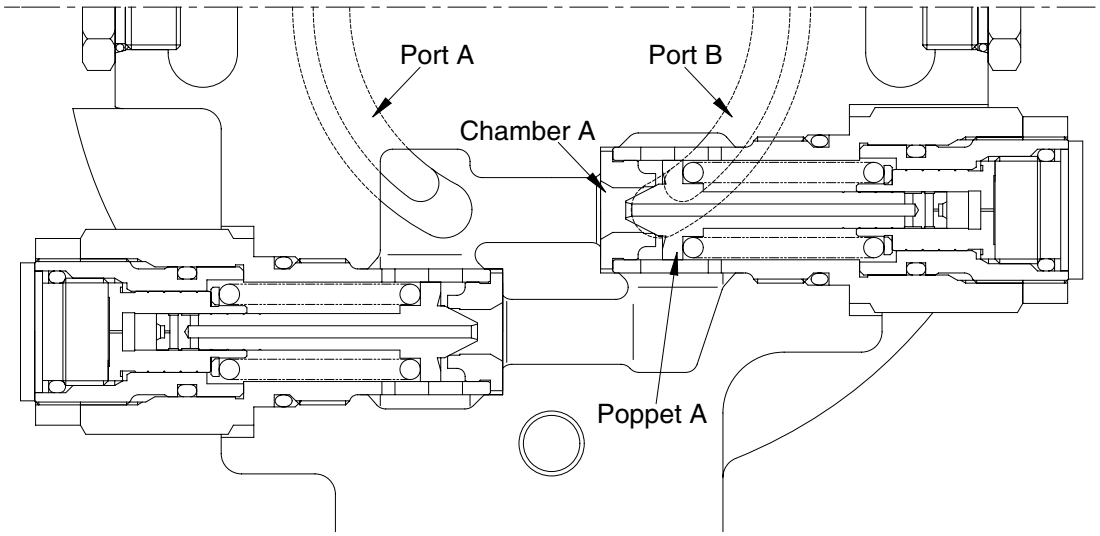
2) WORKING OF RELIEF VALVE

Relief valve carries on two function of following.

(1) Relief valve is to keep the starting pressure of the hydraulic motor at a constant value and bypass to the return line excessive oil generated at the motor inlet depending upon the acceleration speed of the inertia object.

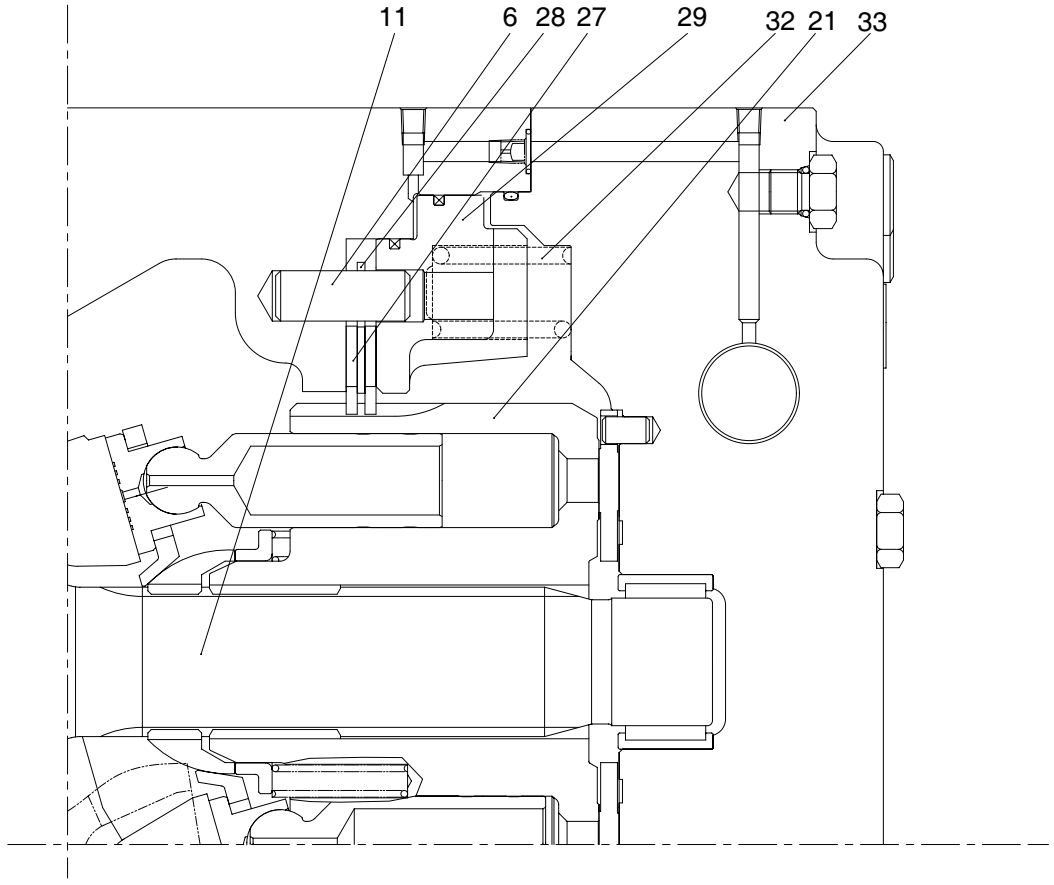
(2) In case of an inertia object stopped, relief valve is generating a break pressure at the outlet and stop it forcedly.

The chamber A is always connect with port A of a motor. When the pressure at port A increase and the force pushing poppet A is higher than the pressure of the spring, then poppet A is pushed up from the contact surface of seat A, and oil flows from chamber A to port B.



3) WORKING OF NEGATIVE BRAKE

The negative brake is released applying to the brake piston (29) the pressure led through built in the valve casing (33) spool. With no pressure working, the brake force is always ensured.
The brake force is generated by the frictional force among a plate (28) fixed by pin (6) and shaft casing, brake piston (29) and a frictional plate (27) connected through spline outside the cylinder block (21). Without pressure being applied to the brake piston, the brake piston is pushed by ten brake springs (32) and the friction plate and separator plate are held between the brake piston and casing. This friction force restrains the shaft (11) spline-coupled with the cylinder block, and thus functions the brake.



4) COUNTERBALANCE VALVE

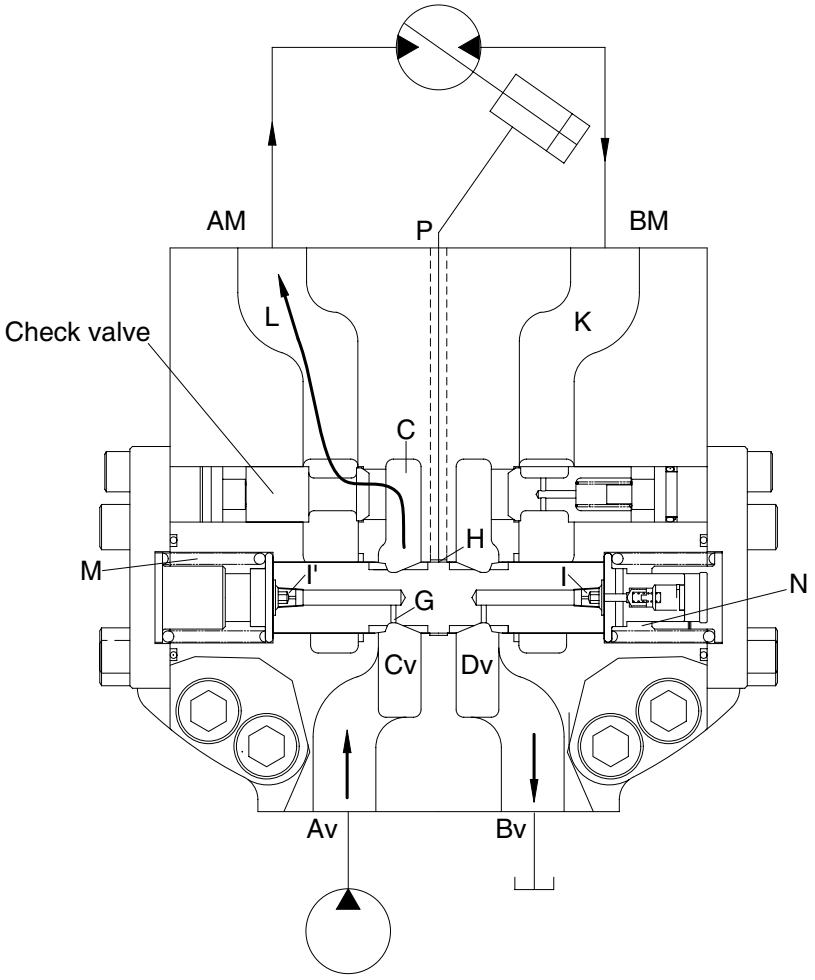
Av port is connected to a hydraulic pump : Bv port is connected to a tank.

The oil supplied from the hydraulic pump passed through Av → Cv → C sequence, pushed up the poppet of the check valve, passed through L to port AM, and is supplied to the hydraulic motor to turn it. But the brake is operated. Therefore, the pump discharge oil pressure is increases. And the pressure is led via passage G to spring room M. When the pressure in room M exceed the value equivalent to the force of the spring which holds the spool at its neutral position, the spool begins to move right.

The oil in room N is sent to room Dv by orifice I and discharged from Bv port to a tank. So spool moves to the right. The oil flows as the way of K → Dv → Bv sequence. Also according to the oil path as composed way Cv → H → P sequence, the pressure of Av pump is provided to the port P. An working oil in room N is discharged through orifice and a gap. Therefore the switching operation of spool is driving slowly.

When the pump discharge pressure fall, spool moves to the left side by a spring at the side of room N. Also spool moves to the left, the hydraulic oil in room M is sent to Cv room through orifice I' and discharged to the Av port.

When the pressure at port Av fall down to the tank pressure, the pressure of room M is as the same as that the tank pressure and becomes equal to that in room N, and so the spool returns to its neutral position.

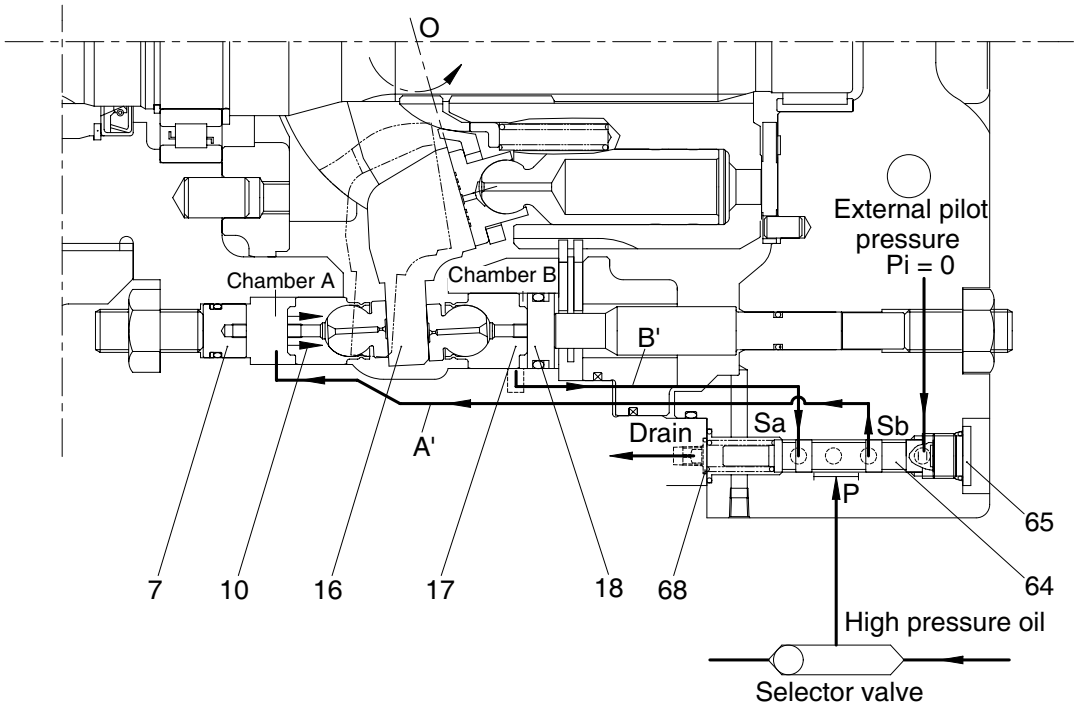


5) WORKING OF DISPLACEMENT CHANGEOVER

The capacity of the travel motor is changed by changing the tilting angle of this swash plate (16). The tilting angle changes by displacement changeover valve.

(1) External pilot pressure : Pi = 0 (large displacement)

By means of the built-in high pressure selector mechanism in the valve casing (33), the high pressure oil working on the motor function to port P of the displacement-changeover valve.
A the spool (64) assembled in the displacement changeover valve is pressed to plug (65) by the spring (68), the high pressure oil at port P flows to port Sb.
This high pressure oil flows through oil passage (passage A') of valve casing (33) and shaft casing works to chamber A.
This oil in chamber B flows through passage B' and port Sa into the drain line. The displacement changeover piston (17) is pushed right and the swash plate (16) moves in the arrowed direction around rotation center 'O'. The swash plate moves until it touched stopper (18), and then is fixed there.



(2) External pilot pressure : Pi ≥ 20kgf/cm² (small displacement)

If the force operating on spool (64) of the displacement changeover valve is stronger than the spring (68), and the spool moves to the left side.

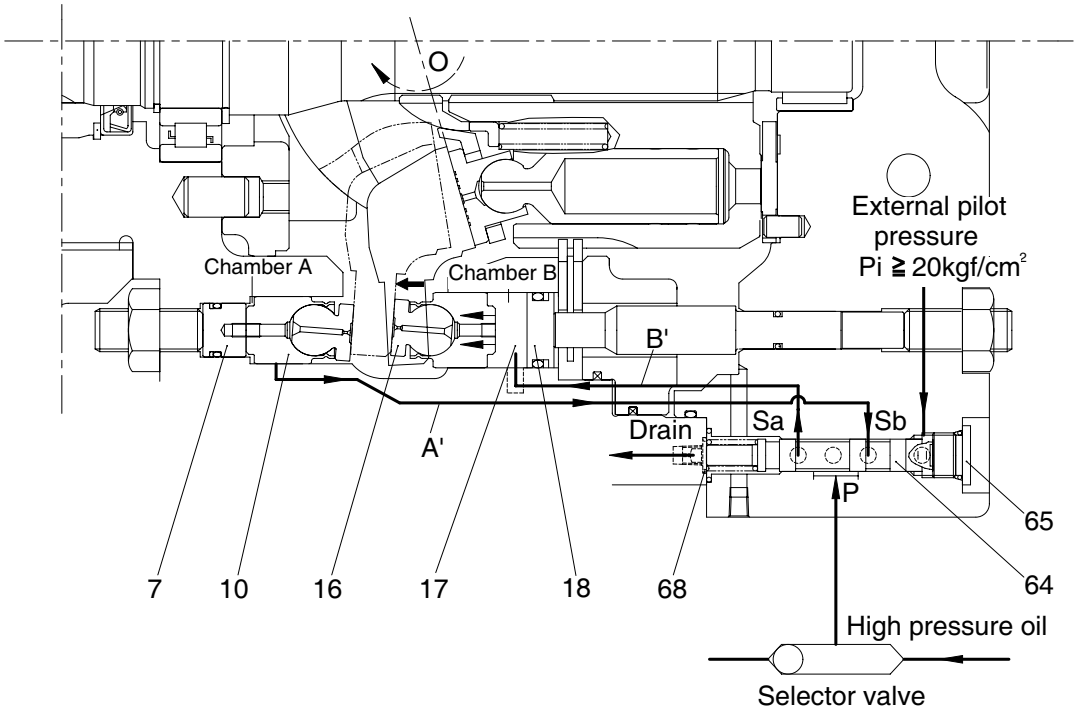
The high pressure oil is works on room B through passage Sa → B' from port P.

The oil in chamber A flows into the drain line through the passage A' → Sb.

The displacement changeover piston (17) is pushed left and the swash plate (16) moves in the arrowed direction around rotation center 'O'. The swash plate moves until it touches stopper (7), and then is fixed there.

If the load increase while the motor is working with its small displacement (Pi ≥ 20kgf/cm², 2nd speed) until the motor inlet port pressure reaches the preset value, the motor increase its displacement in response to the load, while maintaining the pressure at the preset value (automatic 2 -speed function). As motor inlet port pressure reaches the preset value and then spool (64) moves right side, inlet pressure oil flows into chamber A through port Sb and the swash plate moves until it touches stopper (17). If the load further increase until the displacement of the motor reaches the maximum value, the inlet port pressure increase further.

If the load decreases under this condition, the motor continues reducing its displacement in the reverse sequence. As the load and inlet port pressure decreases and reaches the preset value, spool (64) moves left side by the pilot pressure (Pi). Therefore inlet port pressure flow into chamber B through port Sa and the swash plate moves until it touches stopper (10).



6) REDUCTION GEAR

(1) Planetary gear mechanism

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

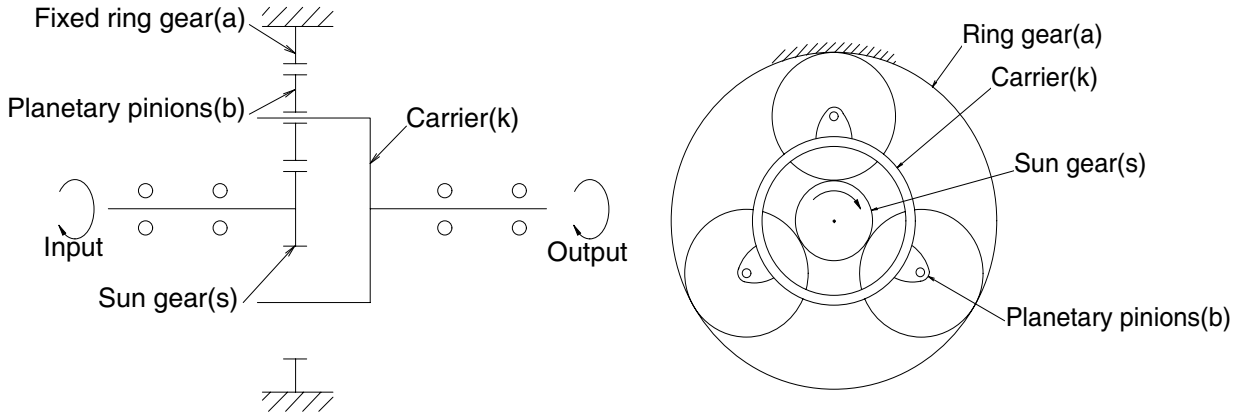
This reduction unit utilizes two stages, planetary reduction system.

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

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

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

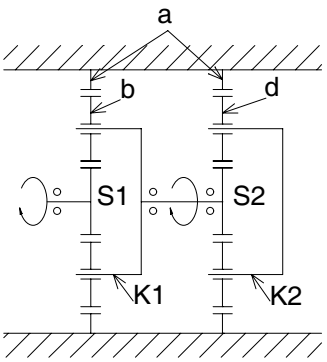
This mechanism is called planetary gear mechanism.



(2) Two stages reduction gear

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

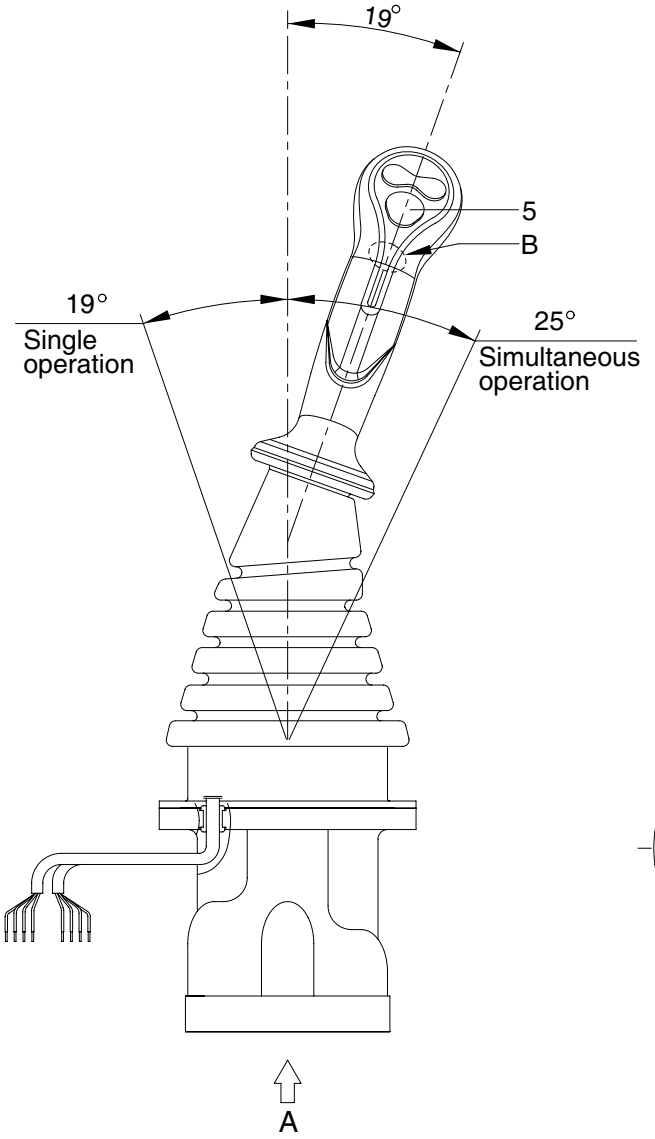
This time, because carrier K2 is fixed to frame, gear d drives ring gear a and then ring gear a rotates to drive sprocket.



GROUP 5 RCV LEVER

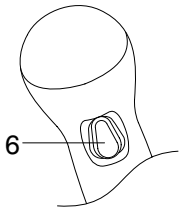
1. STRUCTURE

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

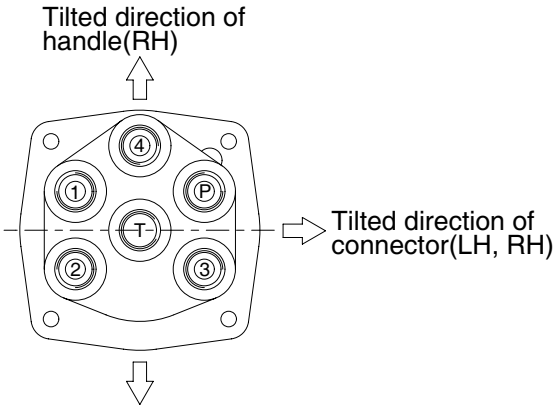


Switches

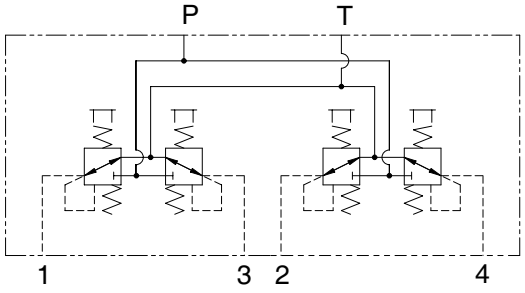
No.	LH	RH
5	One touch decel	Horn
6	Power boost	Breaker



DETAIL B



VIEW A



Hydraulic circuit

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

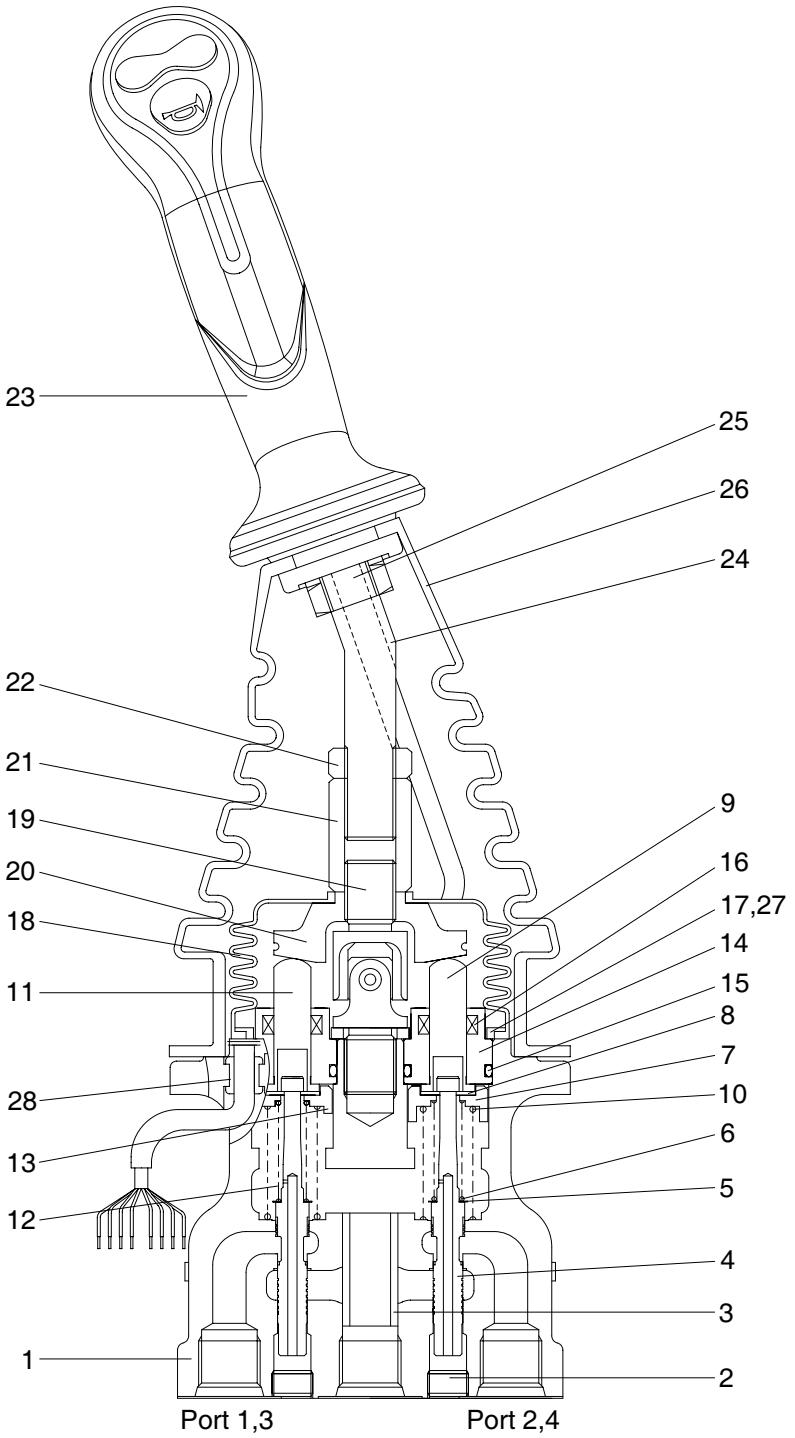
CROSS SECTION

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

The pressure reducing section is composed of the spool (4), spring (6) for setting secondary pressure, return spring (10), stopper (8), spring seat (7, 13) and shim (5). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm^2 (depending on the type). The spool is pushed against the push rod (9, 11) by the return spring.

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

CROSS SECTION



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

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

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

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

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

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

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

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

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

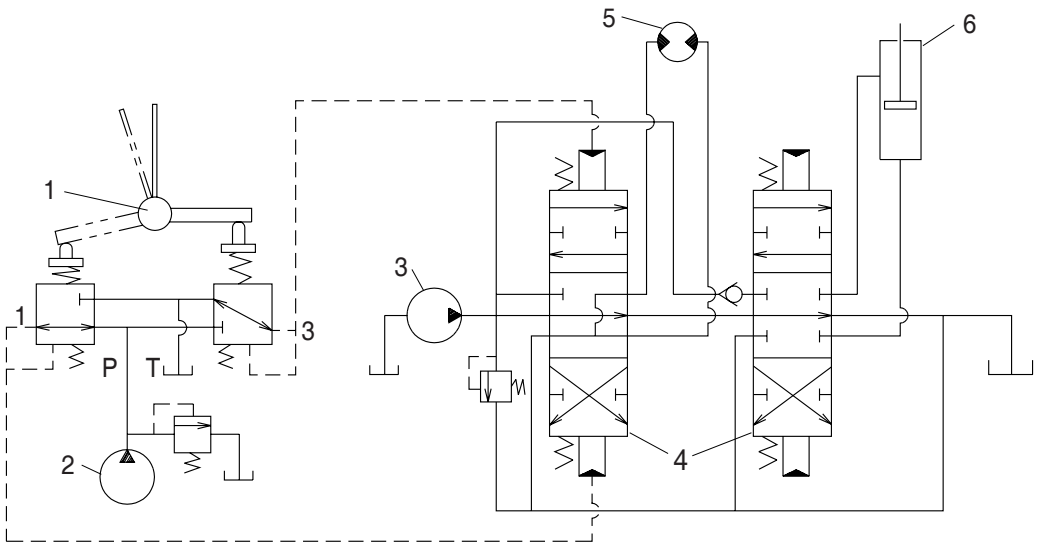
The spring (10) works on the case (1) and spring seat (7, 13) and tries to return the push rod (9,11) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

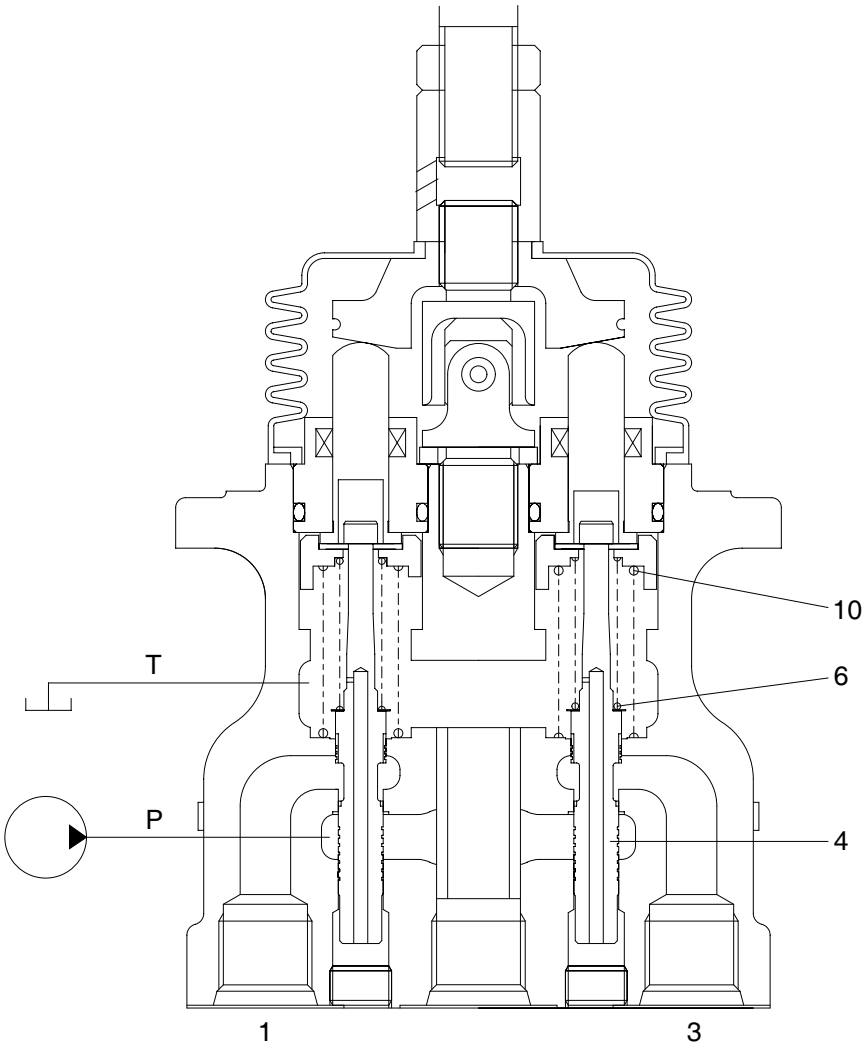
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

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



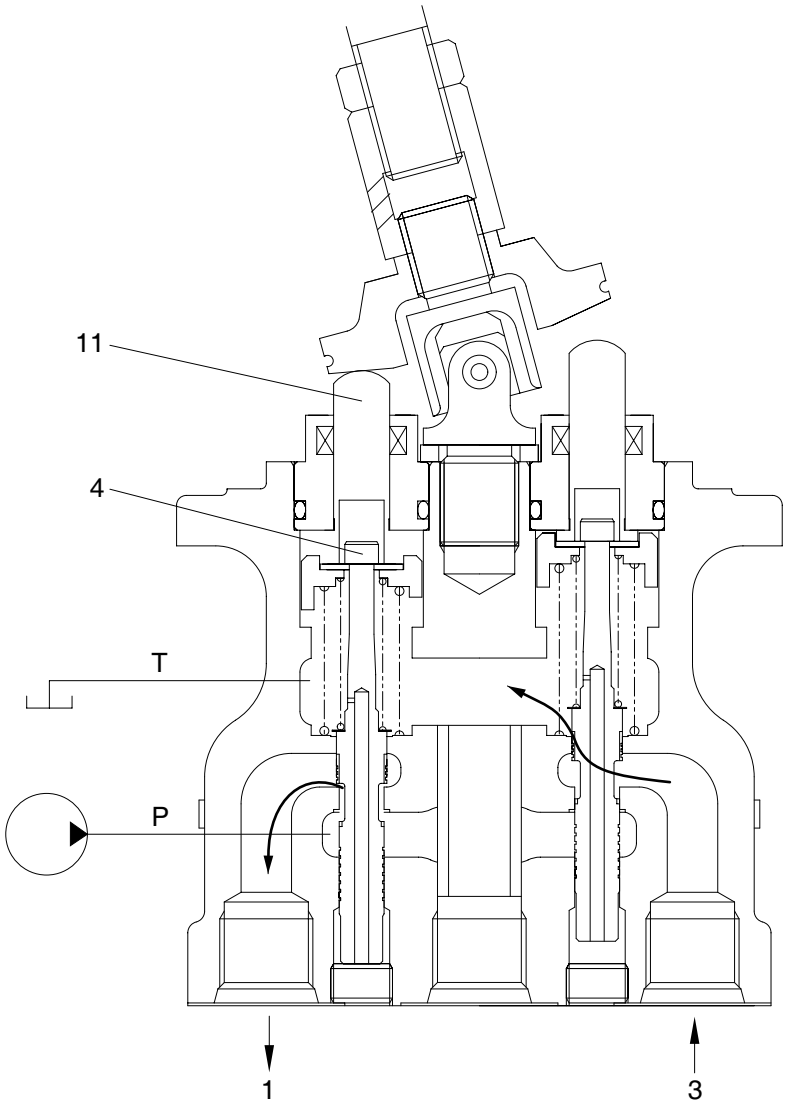
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where handle is in neutral position



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

(2) Case where handle is tilted

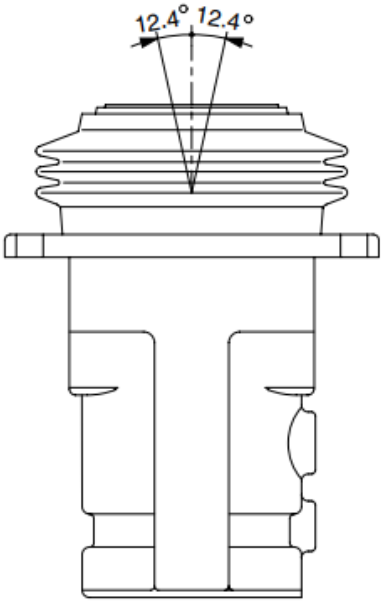


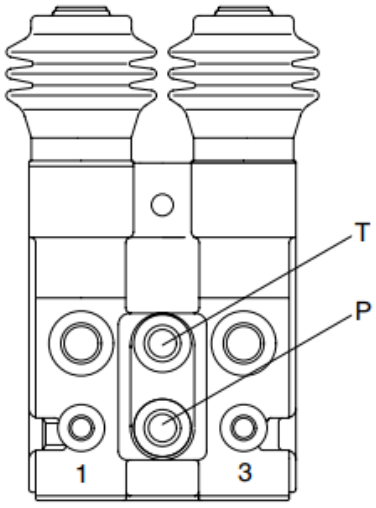
When the push rod (11) is stroked, the spool (4) moves downwards.
Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.
When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

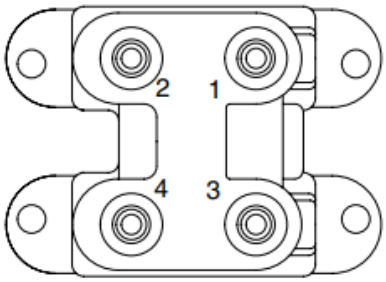
GROUP 6 RCV PEDAL

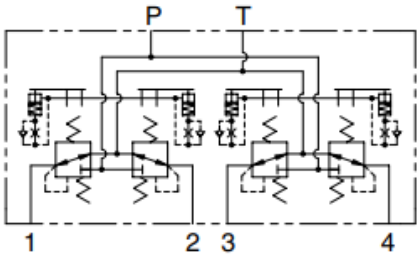
1. STRUCTURE

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









Hydraulic circuit

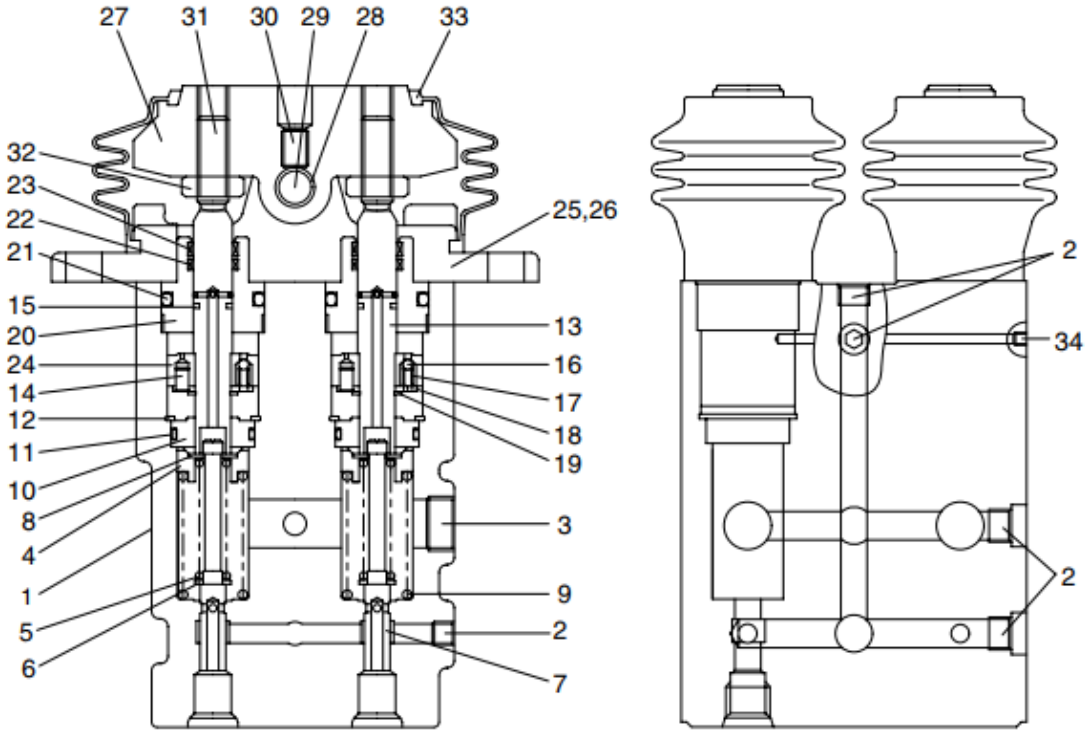
Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel (LH, Forward)	
2	Travel (LH, Backward)	
3	Travel (RH, Forward)	
4	Travel (RH, Backward)	

CROSS SECTION

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

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

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



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

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.

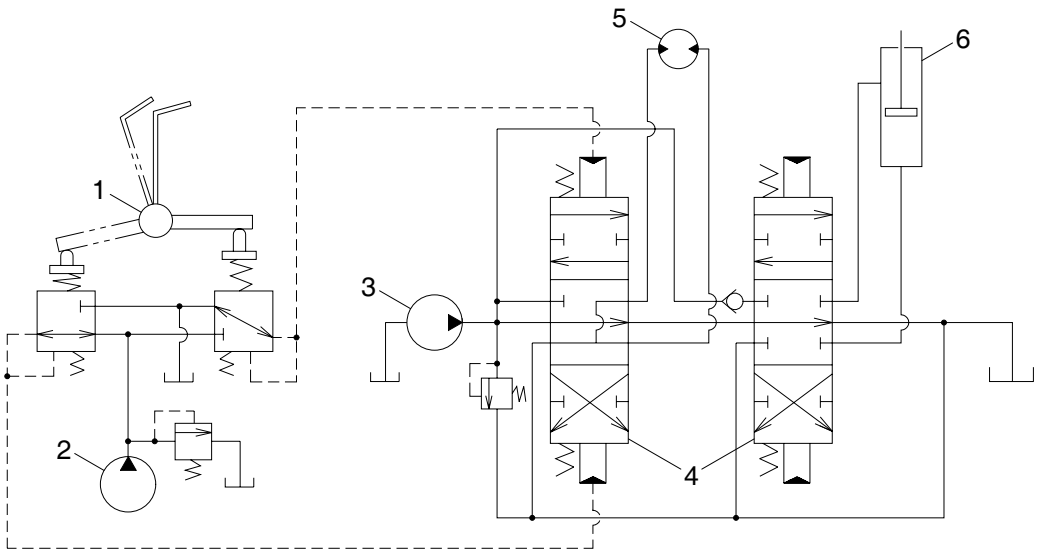
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

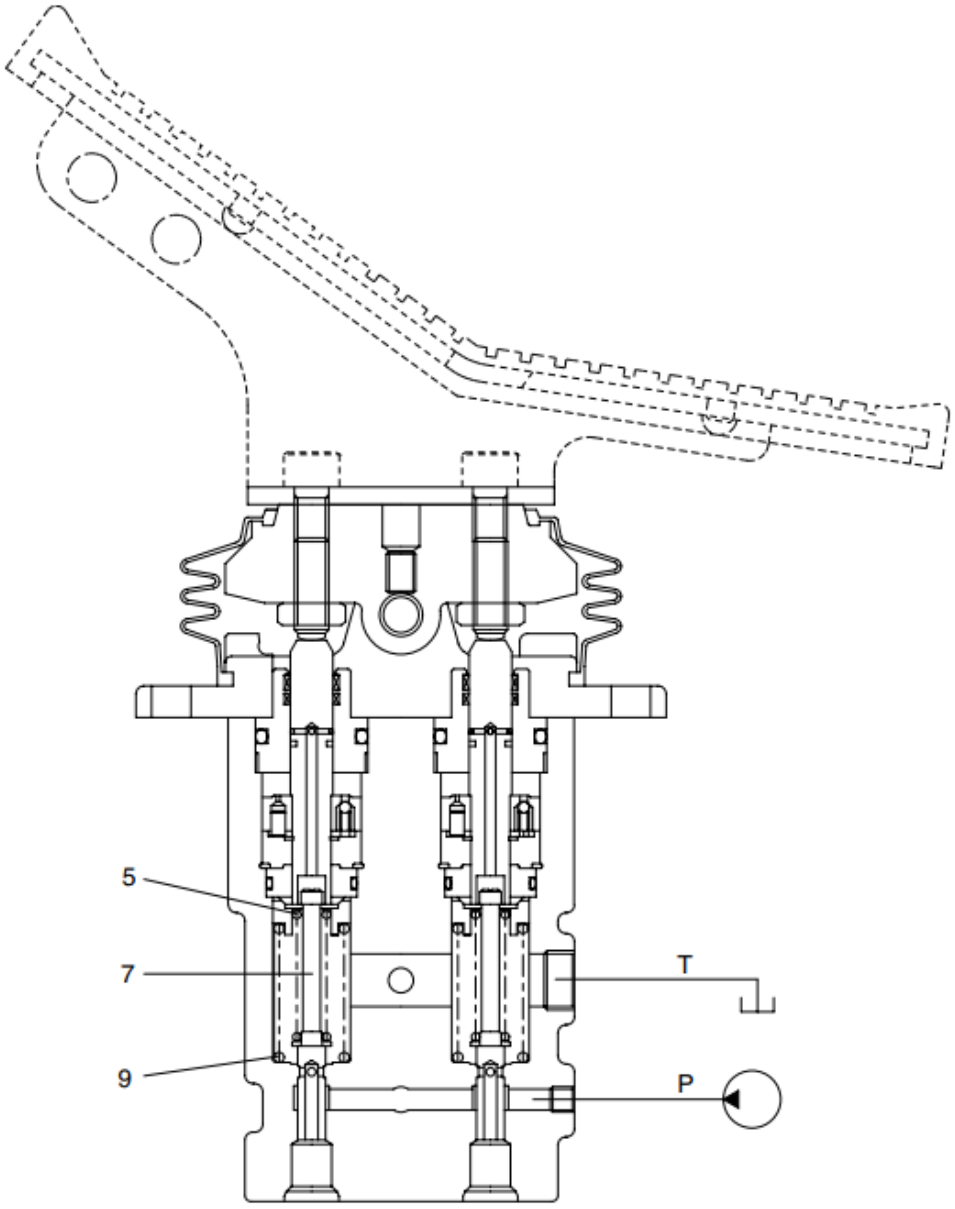
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below ant the attached operation explanation drawing.

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



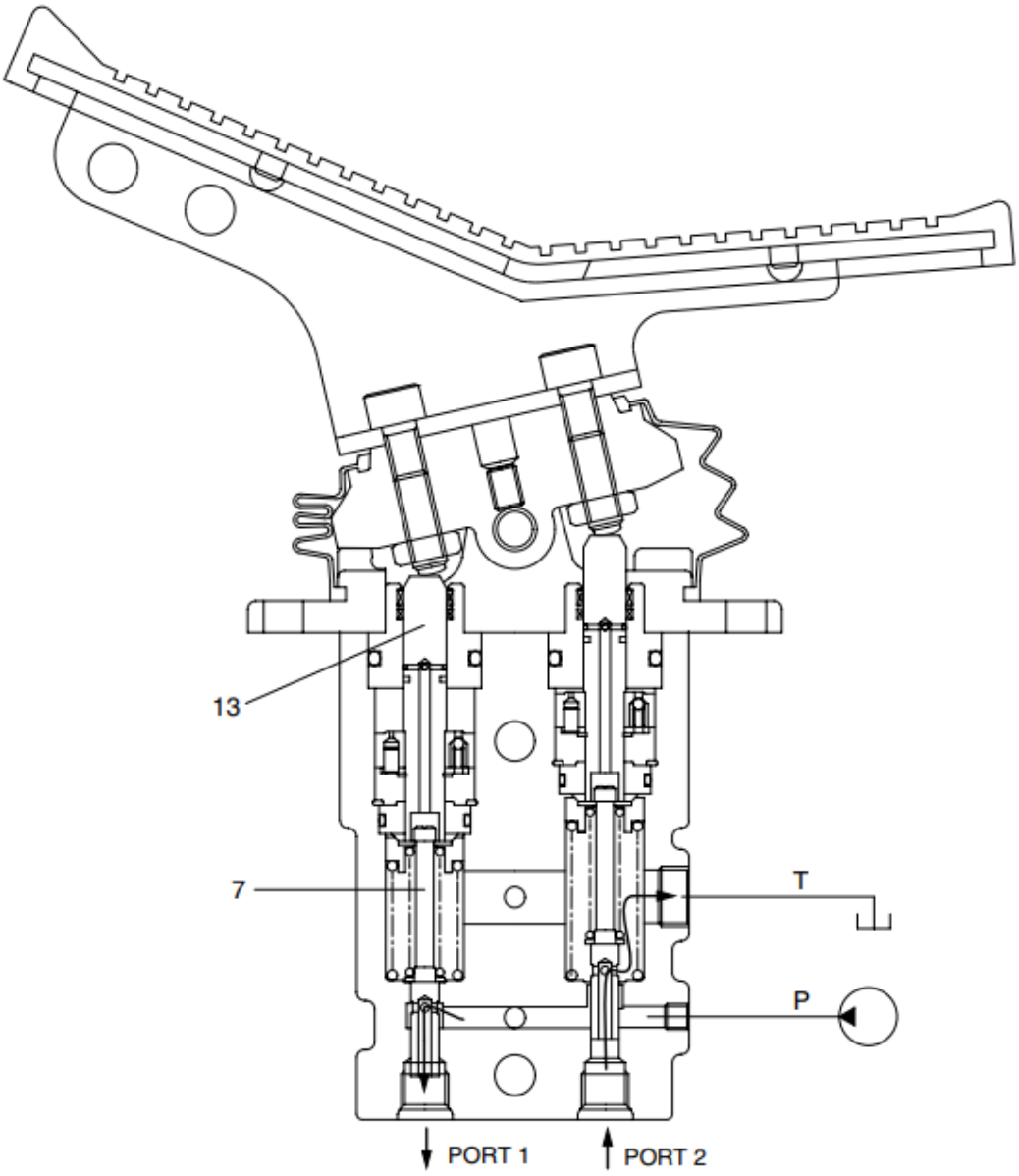
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where pedal is in neutral position



The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (7). Therefore, the spool is pushed up by the spring (9) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted



When the push rod (13) is stroked, the spool (7) 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.