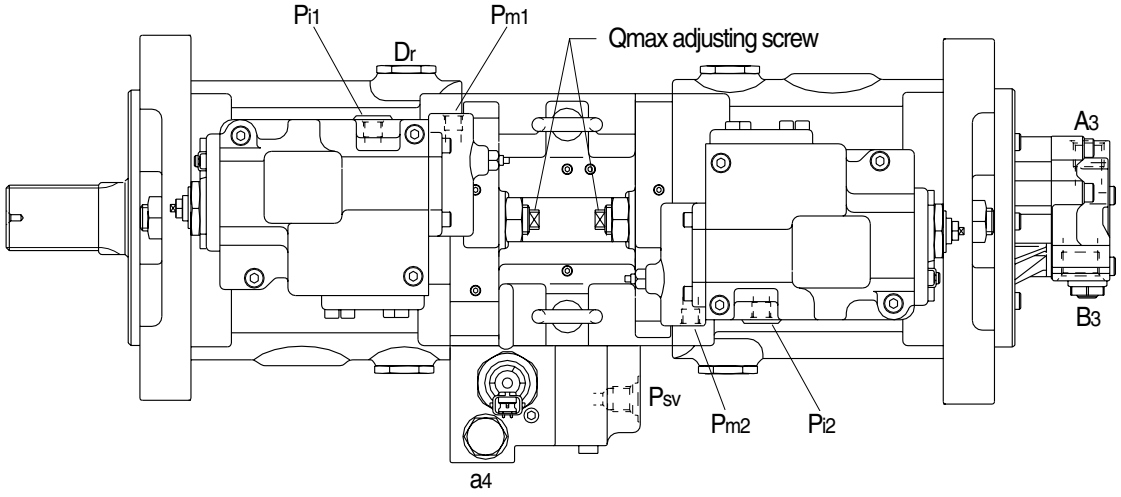
SECTION 2 STRUCTURE AND FUNCTION

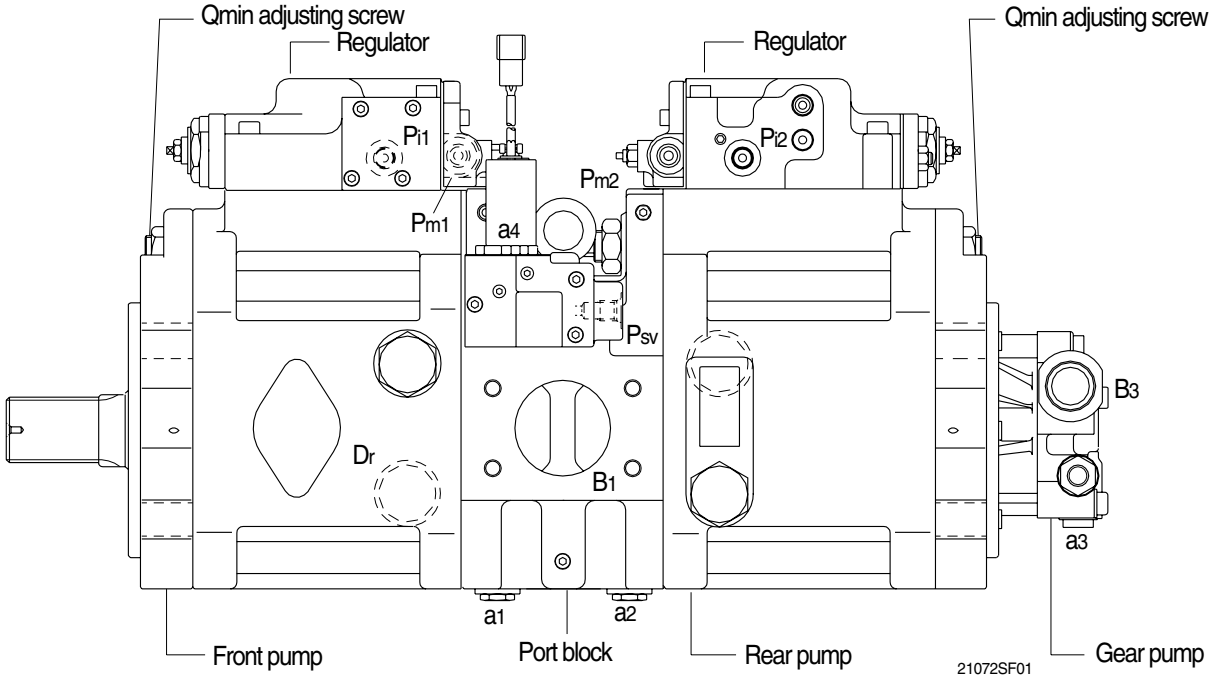
SECTION 2 STRUCTURE AND FUNCTION

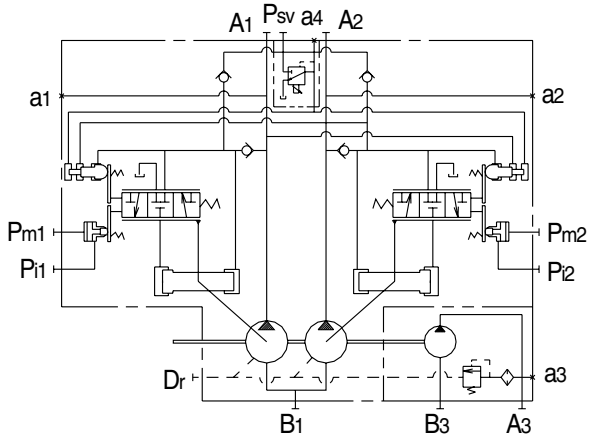
GROUP 1 PUMP DEVICE

1. STRUCTURE

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



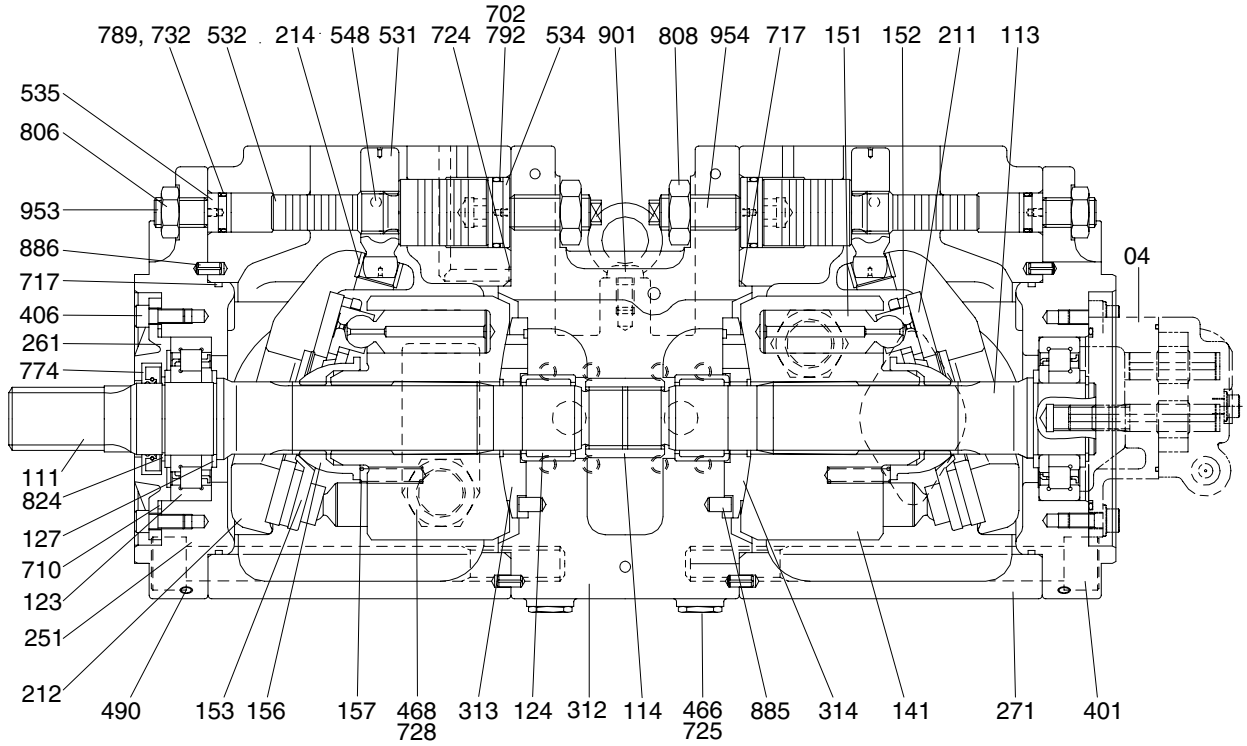




Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 3/4"
B1	Suction port	SAE2500psi 2 1/2"
Dr	Drain port	PF 3/4 - 20
Pi1,i2	Pilot port	PF 1/4 - 15
Pm1,m2	Qmax cut port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
a1,2,4	Gauge port	PF 1/4 - 15
a3	Gauge port	PF 1/4-14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

1) MAIN PUMP(1/2)

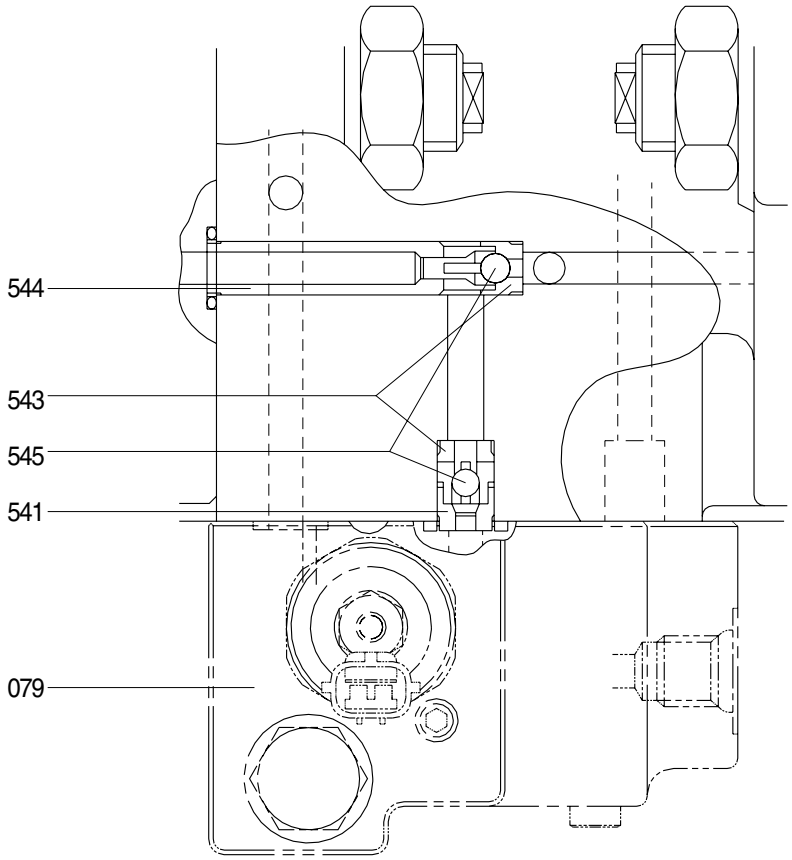
The main pump consists of two piston pumps(front & rear) and valve block.



RD21072SF02

04	Gear pump	261	Seal cover(F)	717	O-ring
111	Drive shaft(F)	271	Pump casing	724	O-ring
113	Drive shaft(R)	312	Valve block	725	O-ring
114	Spline coupling	313	Valve plate(R)	728	O-ring
123	Roller bearing	314	Valve plate(L)	732	O-ring
124	Needle bearing	401	Hexagon socket bolt	774	Oil seal
127	Bearing spacer	406	Hexagon socket bolt	789	Back up ring
141	Cylinder block	466	VP Plug	792	Back up ring
151	Piston	468	VP Plug	806	Hexagon head nut
152	Shoe	490	Plug	808	Hexagon head nut
153	Set plate	531	Tilting pin	824	Snap ring
156	Bushing	532	Servo piston	885	Pin
157	Cylinder spring	534	Stopper(L)	886	Spring pin
211	Shoe plate	535	Stopper(S)	901	Eye bolt
212	Swash plate	548	Pin	953	Set screw
214	Bushing	702	O-ring	954	Set screw
251	Support	710	O-ring		

MAIN PUMP(2/2)

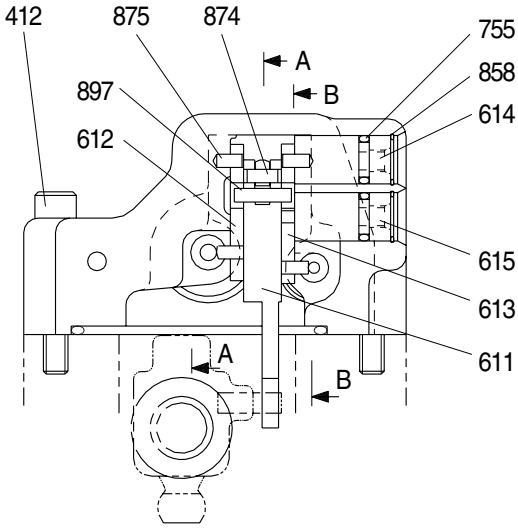


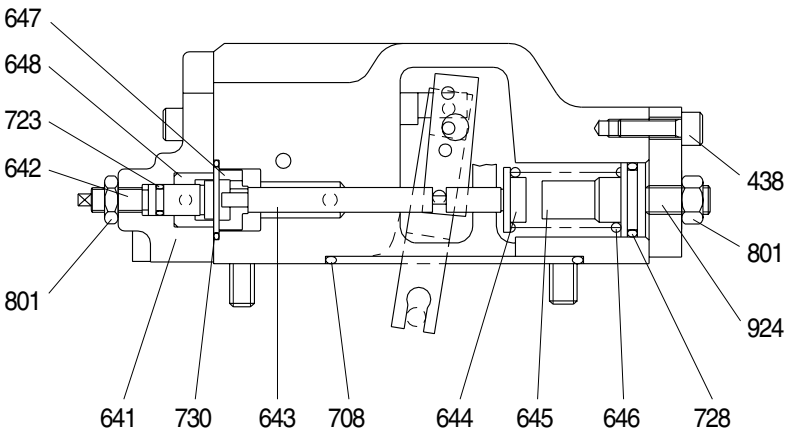
VIEW A

2-3

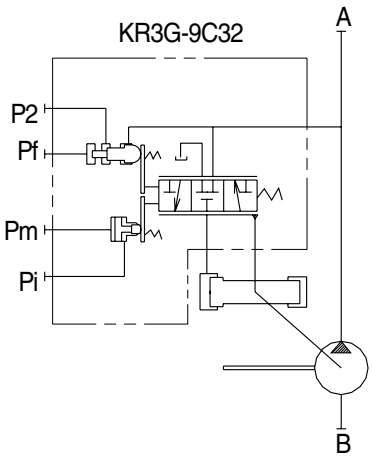
079	Proportional reducing valve	543	Stopper 1	545	Steel ball
541	Seat	544	Stopper 2		

2) REGULATOR(1/2)

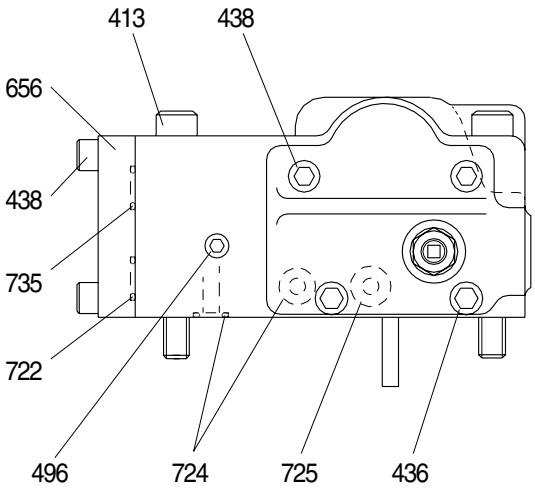




SECTION B-B



2-4

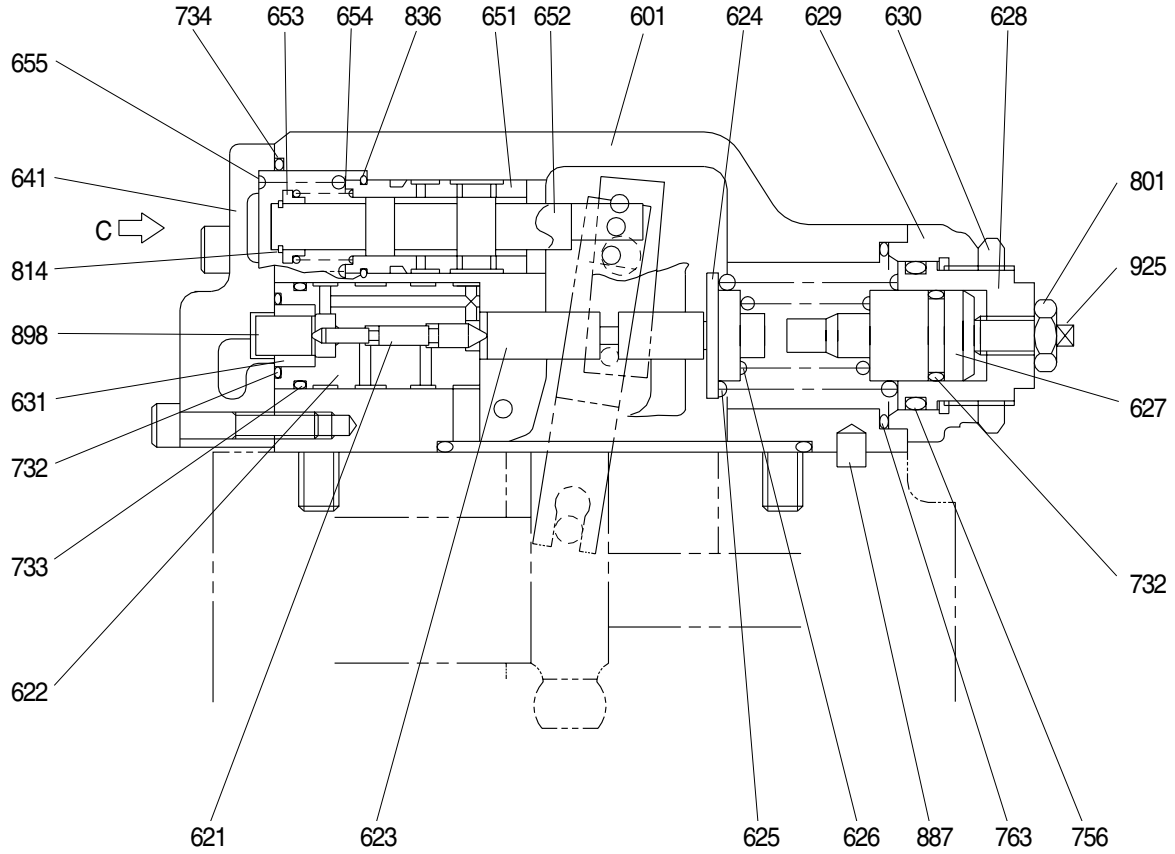


VIEW C

Port	Port name	port size
A	Delivery port	3/4"
B	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
Pm	Qmax cut port	PF 1/4-15

2-4

REGULATOR(2/2)

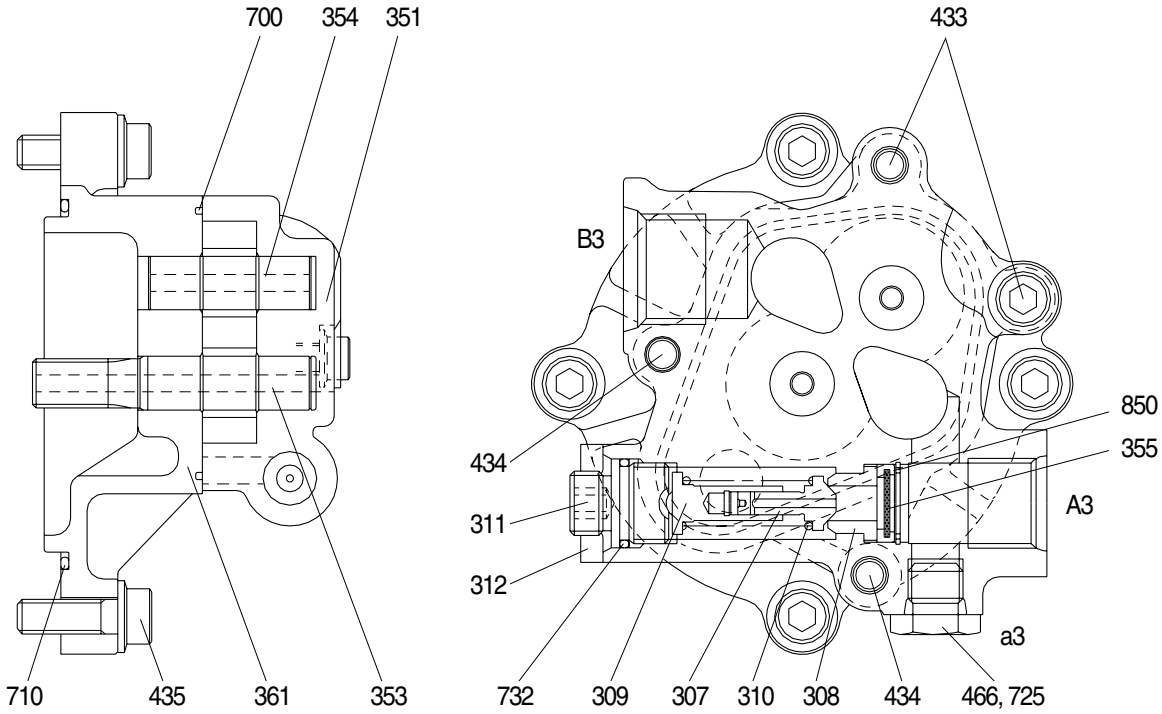


SECTION A-A

2-5

412	Hexagon socket screw	631	Sleeve, pf	730	O-ring
413	Hexagon socket screw	641	Pilot cover	732	O-ring
436	Hexagon socket screw	642	Pilot cover(QMC)	733	O-ring
438	Hexagon socket screw	643	Pilot piston	734	O-ring
496	Plug	644	Spring seat(Q)	735	O-ring
601	Casing	645	Adjust stem(Q)	755	O-ring
611	Feed back lever	646	Pilot spring	756	O-ring
612	Lever(1)	647	Stopper	763	O-ring
613	Lever(2)	648	Piston(QMC)	801	Nut
614	Fulcrum plug	651	Sleeve	814	Snap ring
615	Adjust plug	652	Spool	836	Snap ring
621	Compensator piston	653	Spring seat	858	Snap ring
622	Piston case	654	Return spring	874	Pin
623	Compensator rod	655	Set spring	875	Pin
624	Spring seat(C)	656	Block cover	887	Pin
625	Outer spring	708	O-ring	897	Pin
626	Inner spring	722	O-ring	898	Pin
627	Adjust stem(C)	723	O-ring	924	Set screw
628	Adjust screw(C)	724	O-ring	925	Adjust screw(QI)
629	Cover(C)	725	O-ring		
630	Lock nut	728	O-ring		

3) GEAR PUMP



307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Spring seat	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		

2. FUNCTION

1) MAIN PUMP

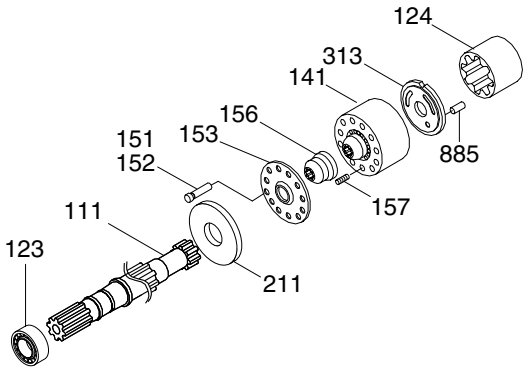
The pumps may classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

(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.



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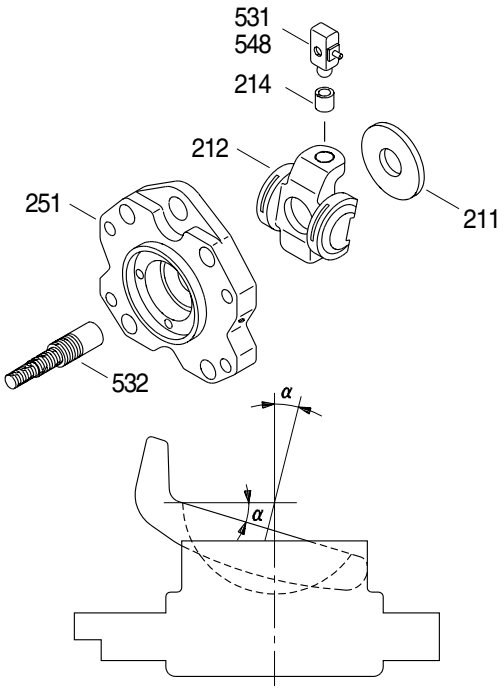
(2) Swash plate group

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

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

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



2-7

(3) Valve block group

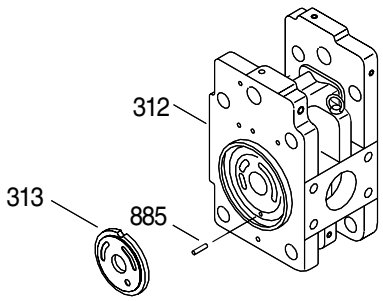
The valve block group consists of valve block(312), valve plate(313) and valve plate pin(885).

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.



2-8

2) REGULATOR

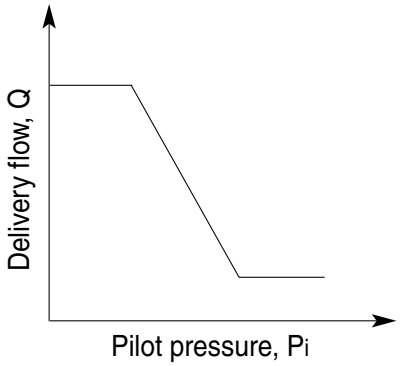
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

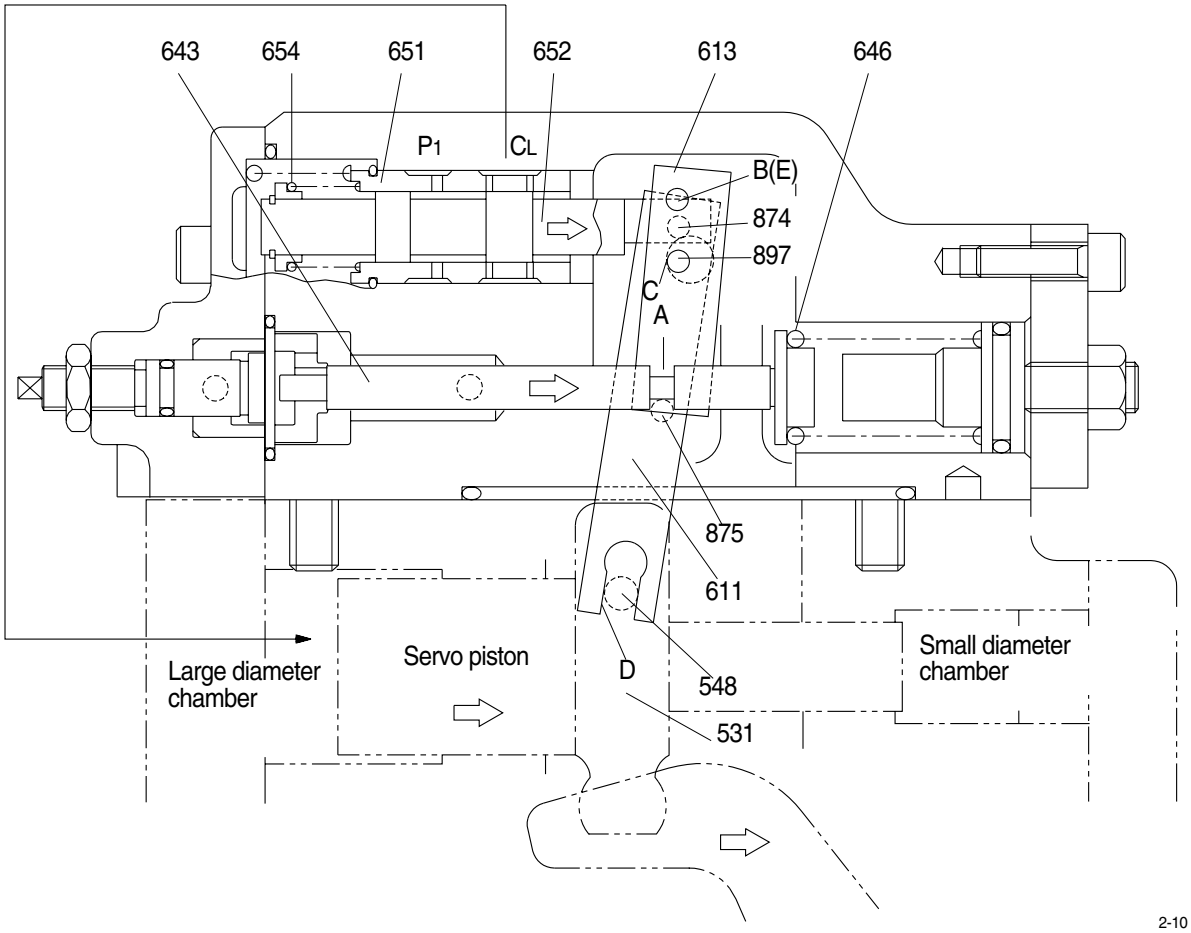
By changing the pilot pressure Pi, the pump tilting angle(delivery flow) is regulated arbitrarily, as shown in the figure.

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.

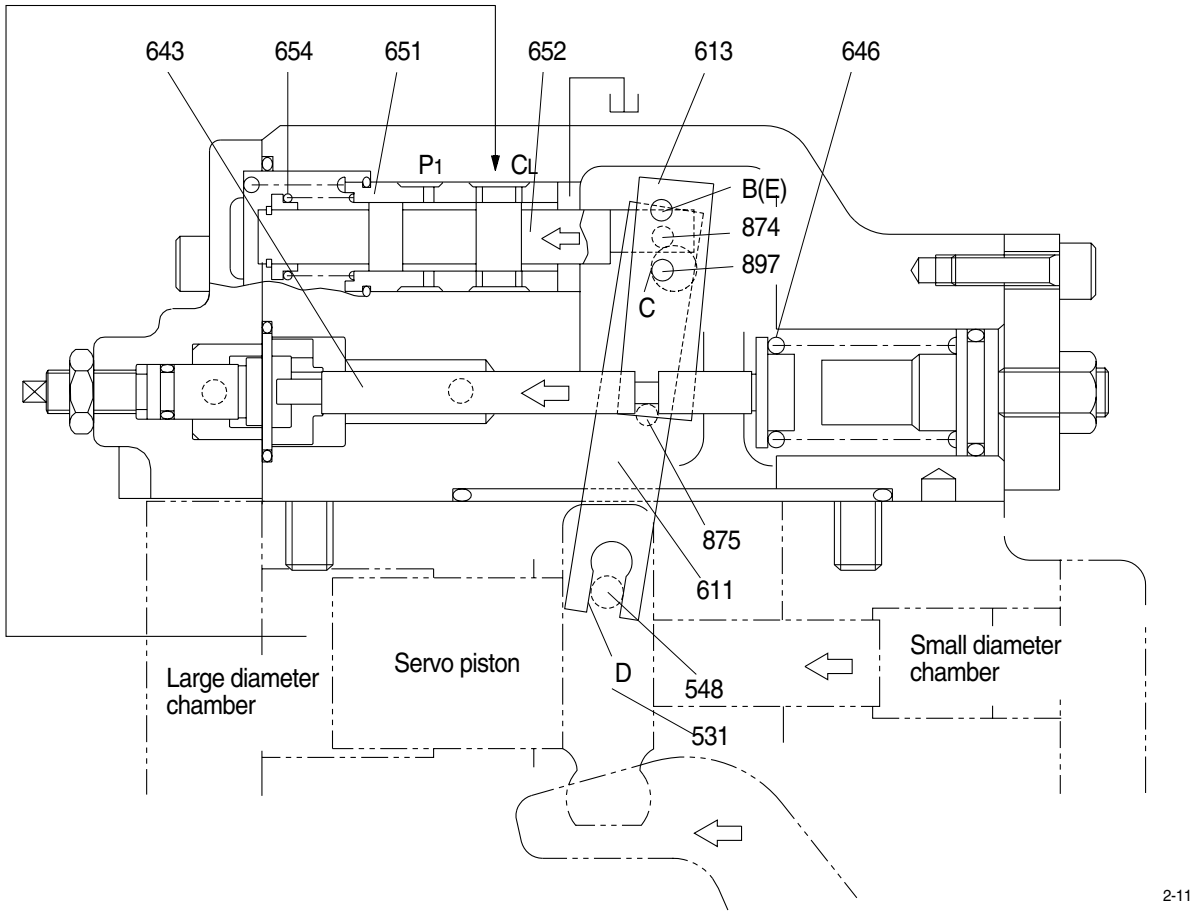
Since the feedback lever is connected with the spool(652) via the pin(874), the spool moves to the right.

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**

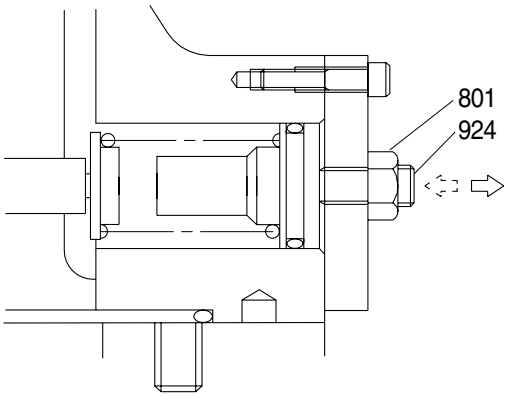


As the pilot pressure Pi decreases, the pilot piston(643) moves to the left by the action of the pilot spring(646) and causes lever 2(613) to rotate around the fulcrum of point B. Since the pin(897) is pressed against the large hole section(C) of lever 2 by the action of the return spring(654) via the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

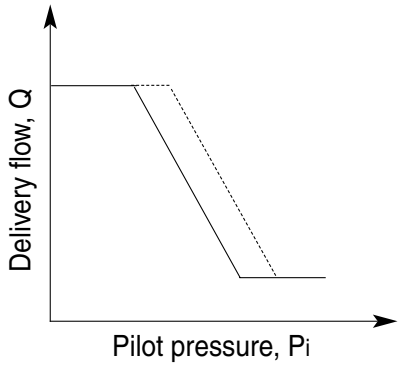
③ Adjustment of flow control characteristic

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)
1950	+1/4	+1.5	+12.7



(2) Total horsepower control

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

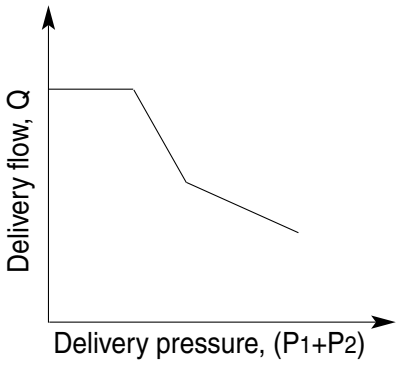
(The input horsepower is constant when the speed is constant.)

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

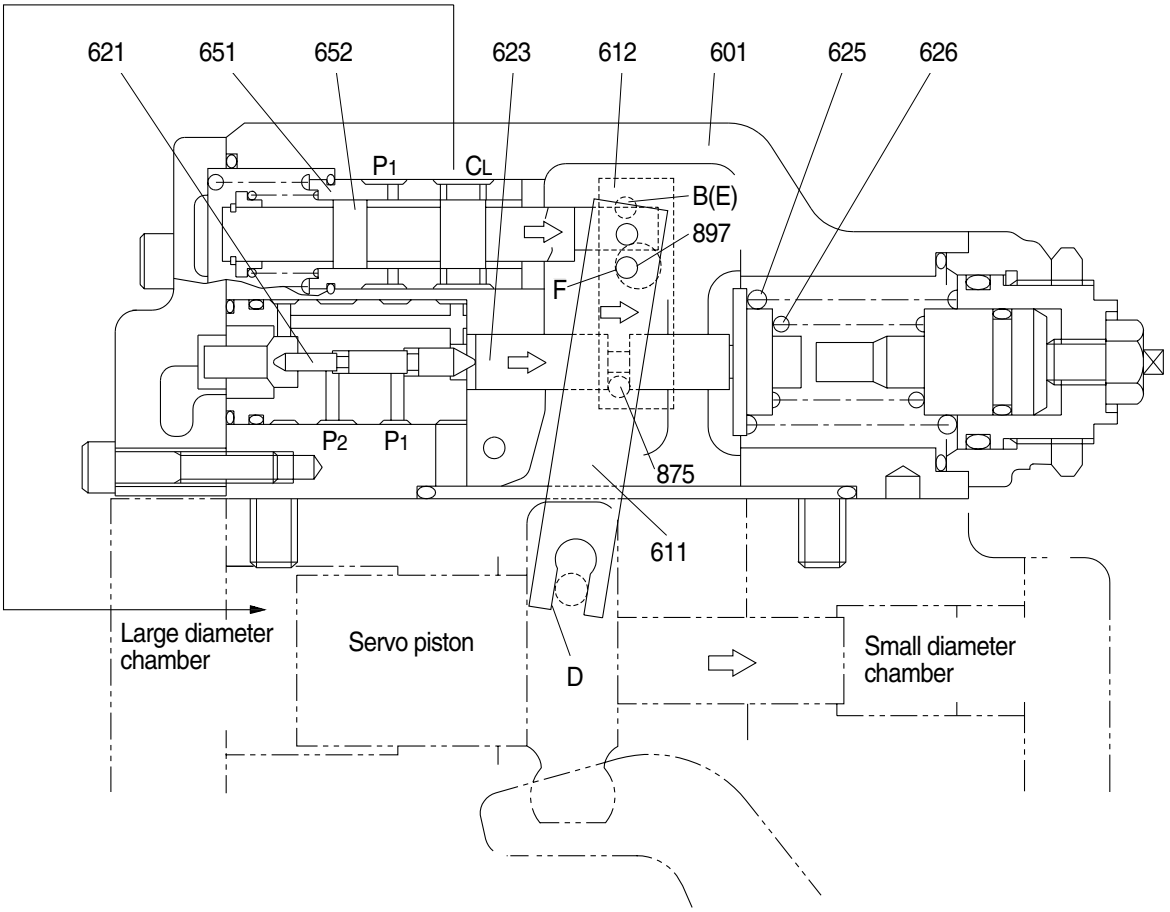
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles(displacement volumes) of the two pumps to the same value as represented by the following equation :

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

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).



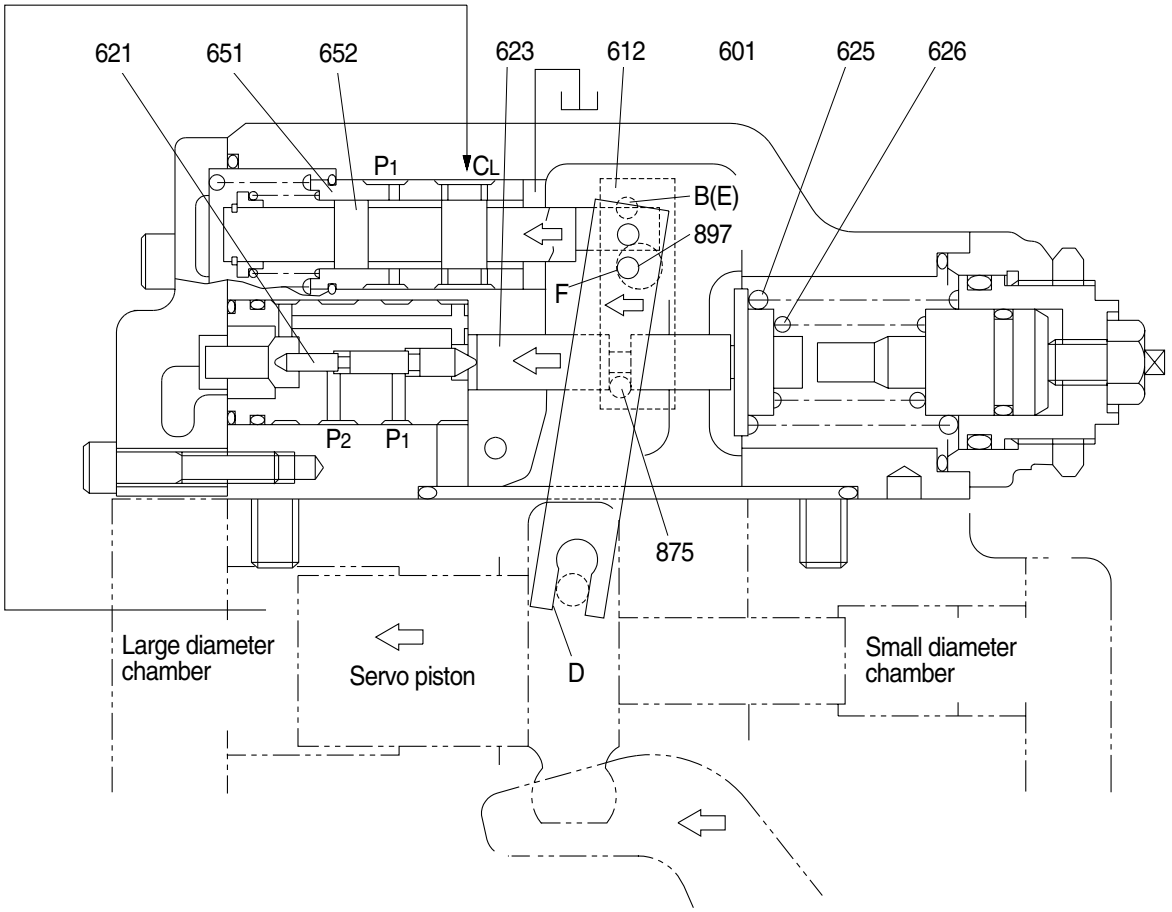
① Overload preventive function



2-14

When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston(621). It presses the compensating rod(623) to the right till the force of the outer spring(625) and inner spring(626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1(612) via pin(875).
Lever 1 rotates around the pin(875) (E) fixed to the casing(601).
Since the large hole section(F) of lever 1 contains a protruding pin(897) fixed to the feedback lever(611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool(652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded.
The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool(652) and sleeve(651) is closed.

② **Flow reset function**



As the self pump delivery pressure P1 or the companion pump delivery pressure P2 decreases, the compensating rod(623) is pushed back by the action of the springs(625 & 626) to rotate lever 1(612) around point E. Rotating of lever 1 causes the feedback lever(611) to rotate around the fulcrum of point D and then the spool(652) to move to the left. As a result, port CL opens a way to the tank port.

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

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

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

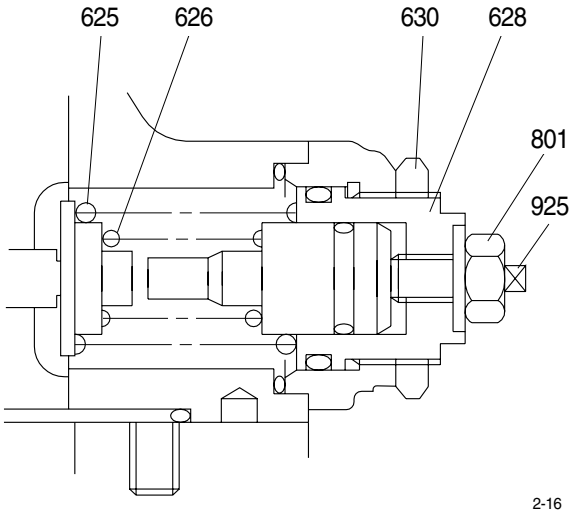
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections(C & F) of levers 1 and 2. However, since sections C and F have the pins(ø 4) protruding from the large hole(ø 8), only the lever lessening the tilting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

④ **Adjustment of input horsepower**

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

a. Adjustment of outer spring

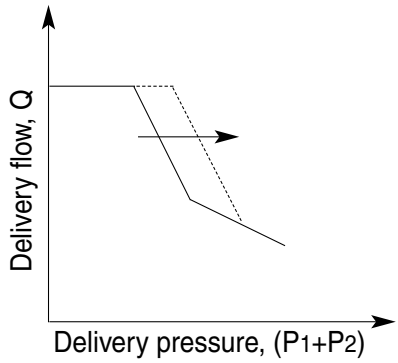
Adjust it by loosening the hexagon nut(630) and by tightening(or loosening) the adjusting screw C(628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring(626), return the adjusting screw QI(925) by N × A turns at first.(A=1.71)



2-16

※ **Adjusting values are shown in table**

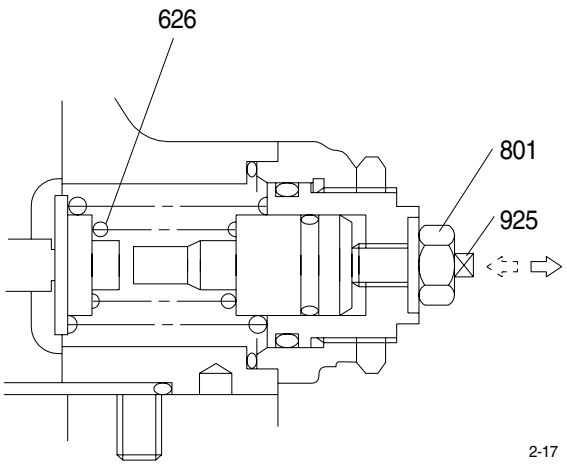
Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw(924)	Flow control starting pressure change amount	Flow change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(ℓ /min)
1950	+1/4	+15.9	+17.3



b. Adjustment of inner spring

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

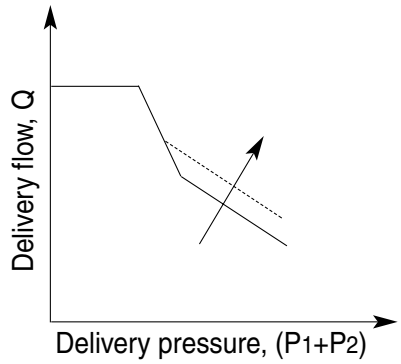
Tightening the screw increases the flow and then the input horsepower as shown in the figure.



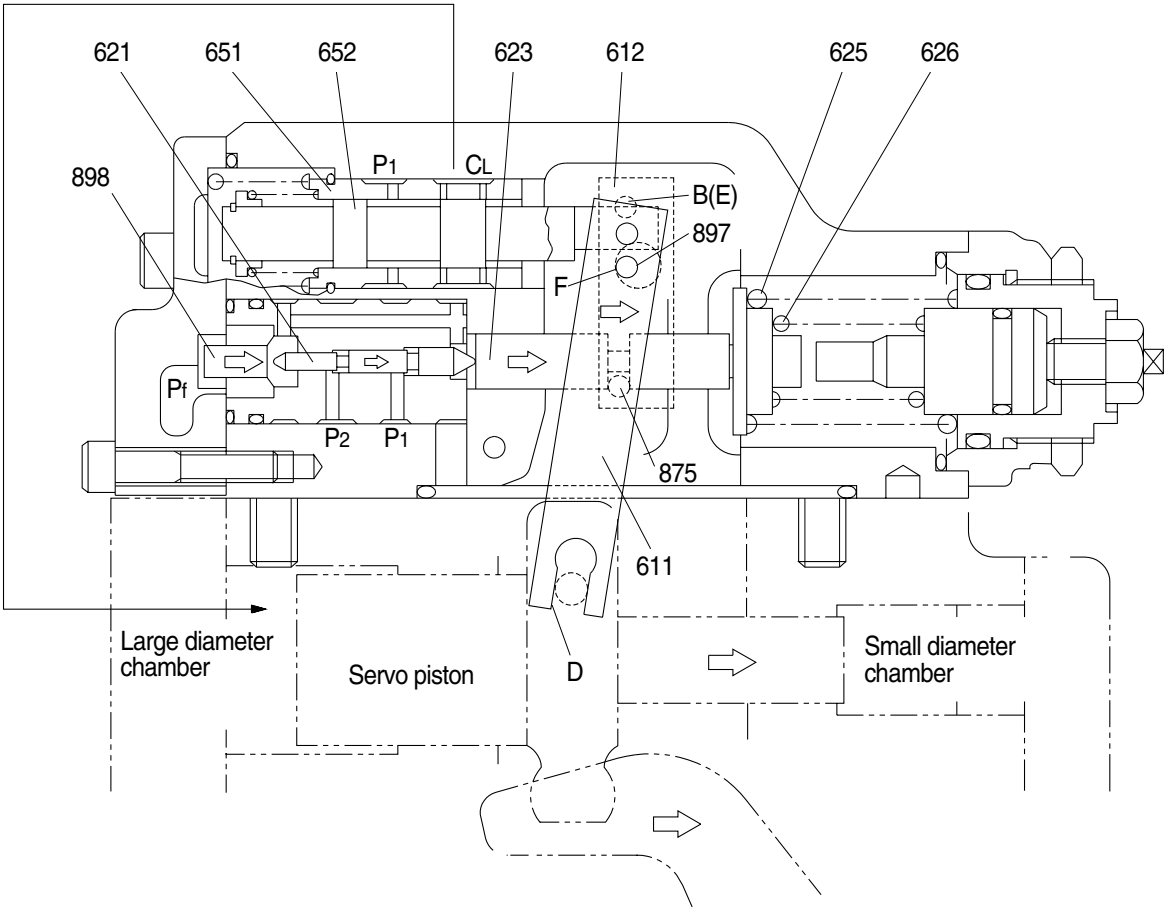
2-17

※ **Adjusting valves are shown in table**

Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw(925)	Flow change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(ℓ /min)	(kgf · m)
1950	+1/4	+10.1	+3.46



(3) Power shift control

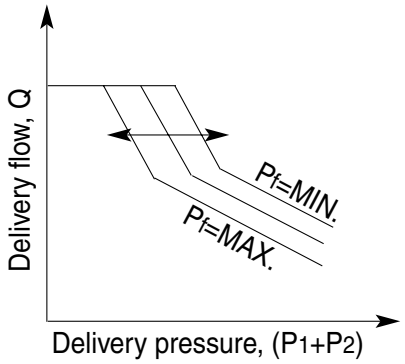


2-18

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).

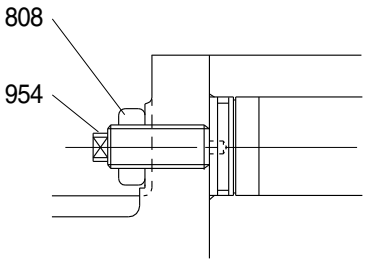
This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure Pf falls.

(4) Adjustment of maximum and minimum flows

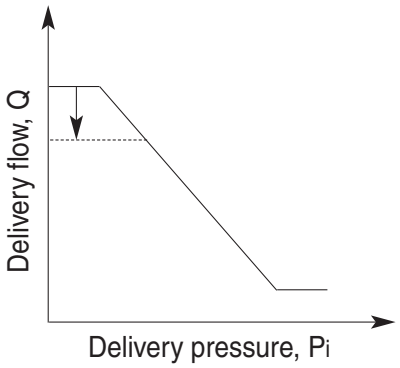
① Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the set screw(954).

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

Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min $^{-1}$)	(Turn)	(ℓ /min)
1950	+1/4	-5.6



2-19(1)

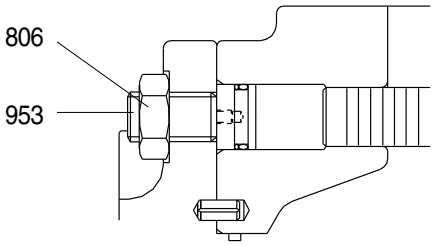


② **Adjustment of minimum flow**

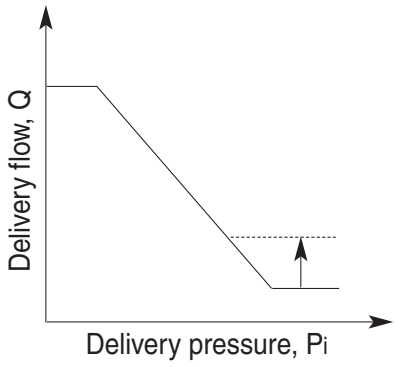
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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

Speed	Adjustment of min flow	
	Tightening amount of adjusting screw (953)	Flow change amount
(min $^{-1}$)	(Turn)	(ℓ /min)
1950	+1/4	+4.5

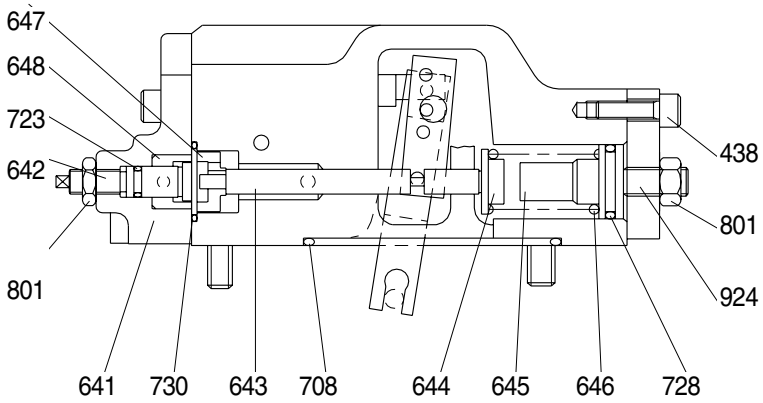


2-19(2)



(5) Qmax cut control

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



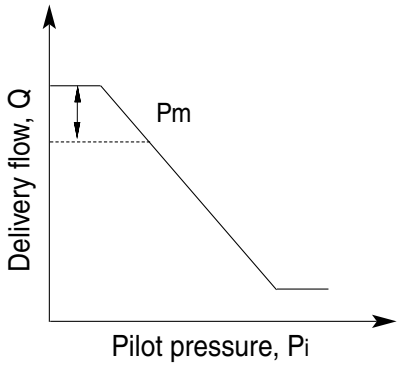
2-4

① **Functional explanation**

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

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

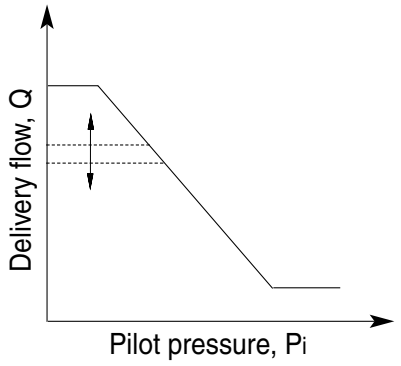
Since the adjusting screw QMC(642) is provided with a flange, the piston QMC stops upon contact with the flange, and the position of the pilot piston at this time determines the maximum flow of the pump.



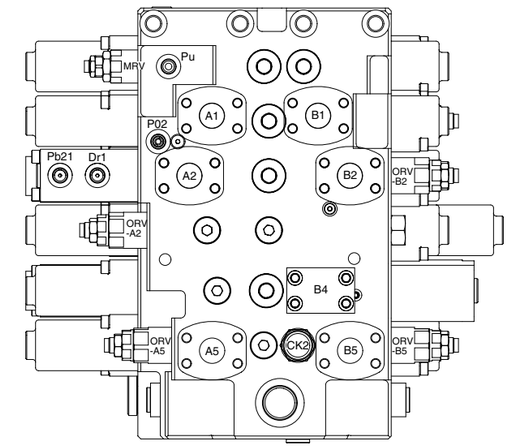
② **Adjustment of Qmax cut flow**

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

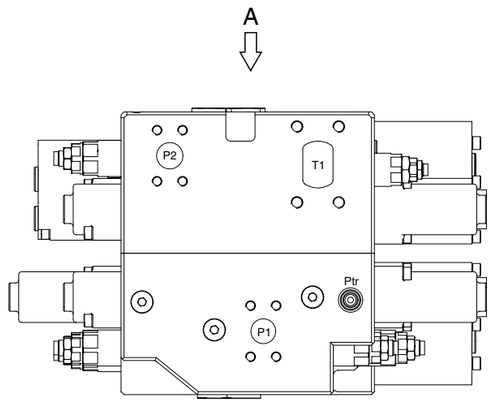
Tightening the screw decreases the Qmax cut flow as shown in the figure.

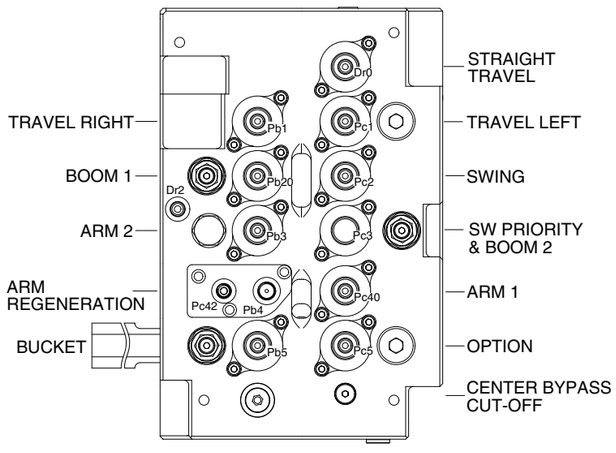


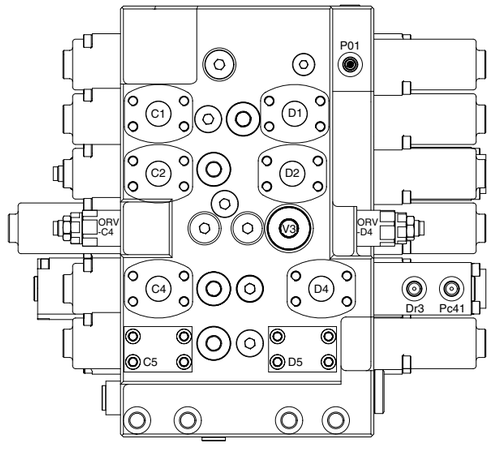
1. STRUCTURE

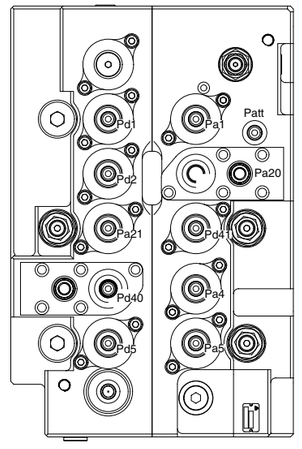


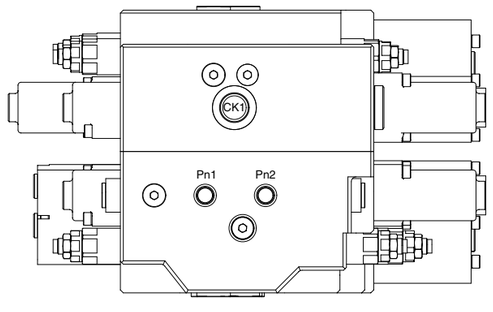
VIEW A





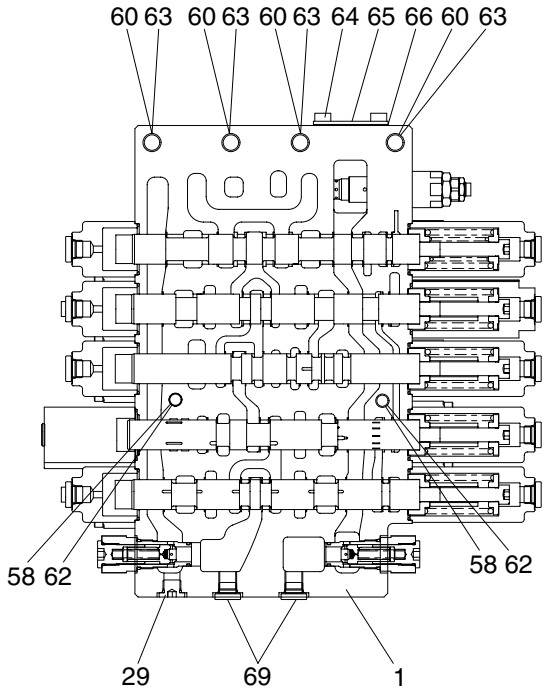




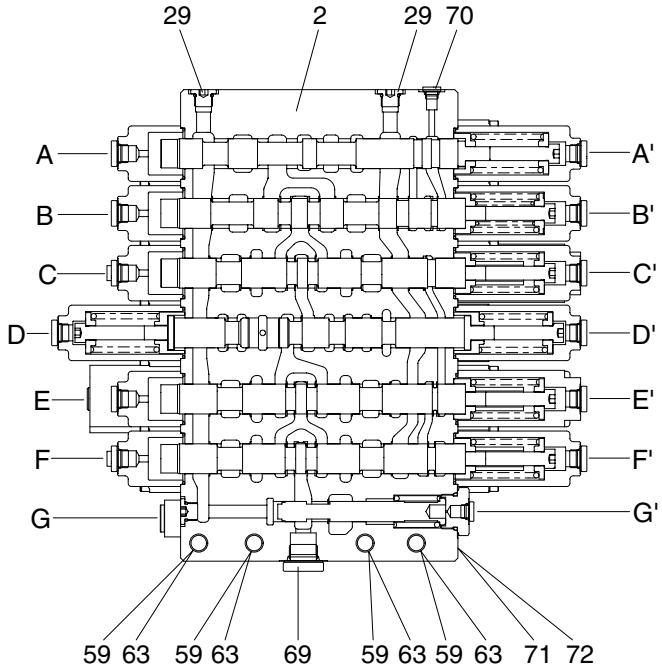


2107V2MC01

Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	G1	20~25 kgf · m (145~180 lbf · ft)
Patt Pb21 Pcb P01 P02 Pc41 Pc42 Ptr Pu Dr1 Dr2	Auto idle signal-attachment Lock valve pilot port (boom) Bucket in confluence pilot port Pilot signal port Pilot signal port Unlock signal Arm in regen-cut signal selector port Auto idle signal-travel Power boost Drain port Drain port	G1/4	3.5~3.9 kgf · m (25.3~28.2 lbf · ft)
Ck1 Ck2	Bucket confluence Bucket confluence	G3/4	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	Travel pilot port-RH (FW) Travel pilot port-RH (BW) Travel pilot port-LH (BW) Travel pilot port-LH (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)	G3/8	7~8 kgf · m (50.6~57.8 lbf · ft)
A1 B1 C1 D1 A2 B2 C2 D2 B4 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) Option A port (breaker) 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)
Dr5	Drain port	G1/8	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)



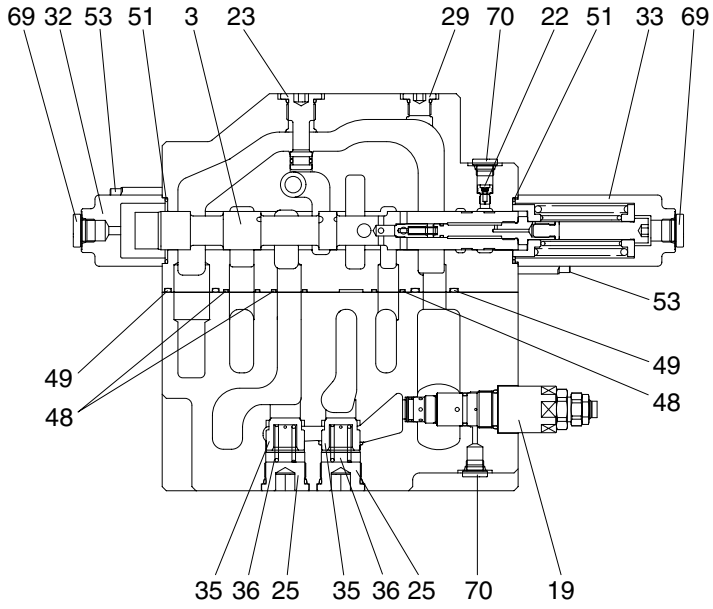
P1 BLOCK SPOOL SECTION



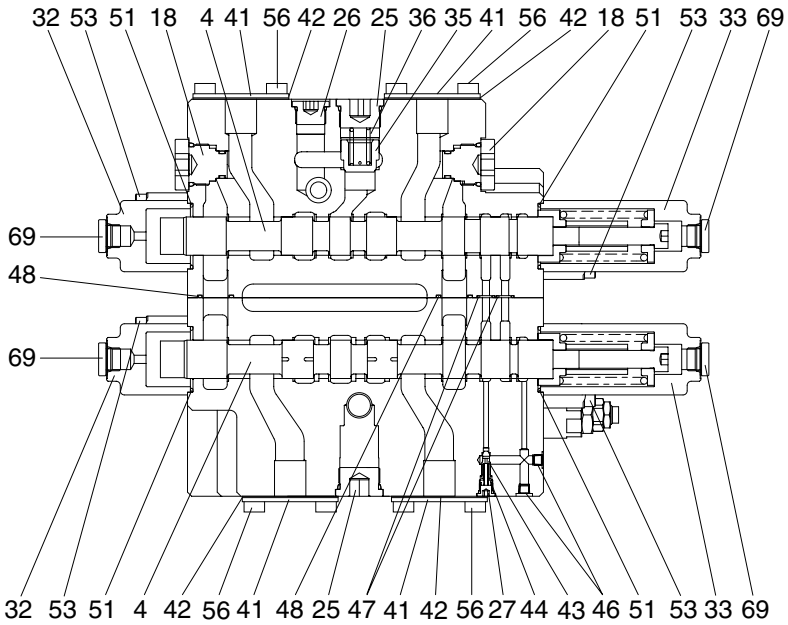
P2 BLOCK SPOOL SECTION

1	Housing P1
2	Housing P2
29	Plug kit
58	Socket bolt
59	Socket bolt
60	Socket bolt
62	Spring washer
63	Spring washer
64	Hexagon bolt
65	Cover 2
66	Gasket 2
69	Dust cap
70	Dust cap
71	Name plate
72	Rivet

2107V2MC40



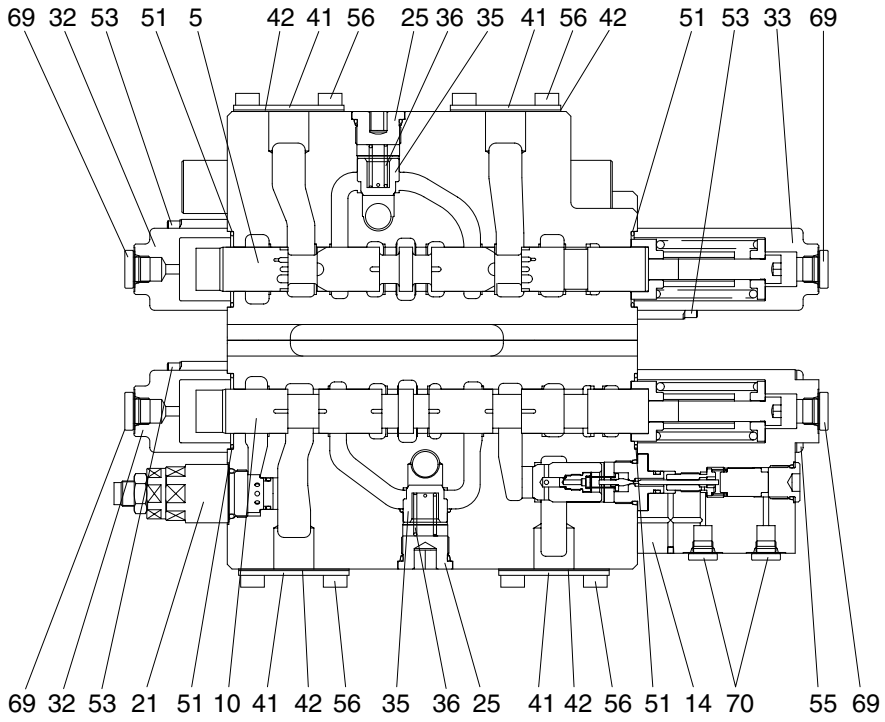
SECTION A-A ' (STRAIGHT-TRAVEL & SUPPLY)



SECTION B-B ' (TRAVEL RIGHT & LEFT)

3	Spool assy
4	Spool assy
18	Overload R/V plug assy
19	Main relief valve assy
22	Signal orifice assy
23	Parallel block plug assy
25	Load check plug kit
27	Plug kit
29	Plug kit
32	Pilot cover A
33	Pilot cover B1
35	Load check poppet 1
36	Load check spring 1
41	Cover 1
42	Gasket 1
43	Poppet signal
44	Spring signal
46	Plug
47	O-ring
48	O-ring
49	O-ring
51	O-ring
53	Socket bolt
56	Hexagon bolt
69	Dust cap
70	Dust cap

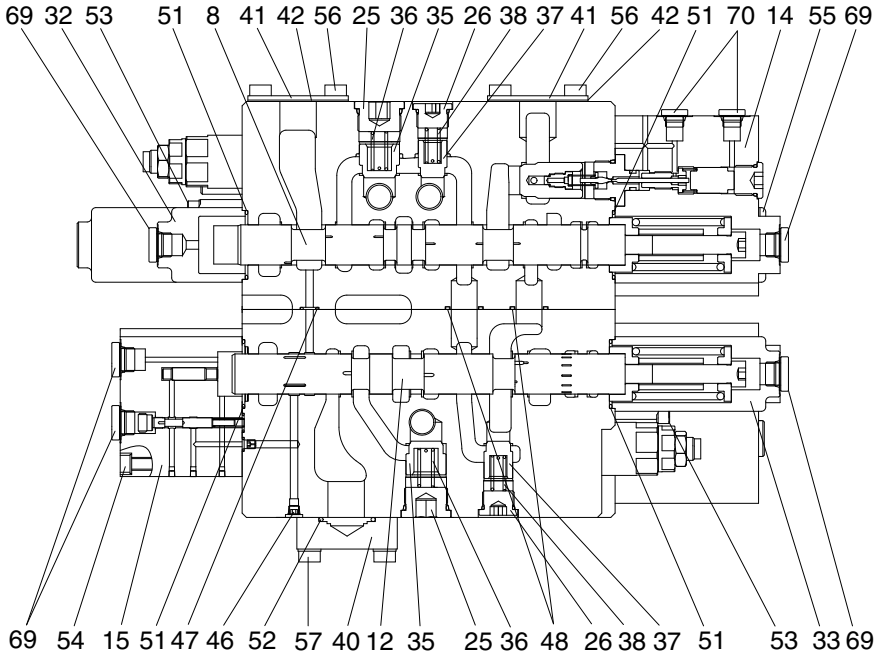
2107V2MC41



SECTION C-C ' (SWING & BOOM 1)

2107V2MC42

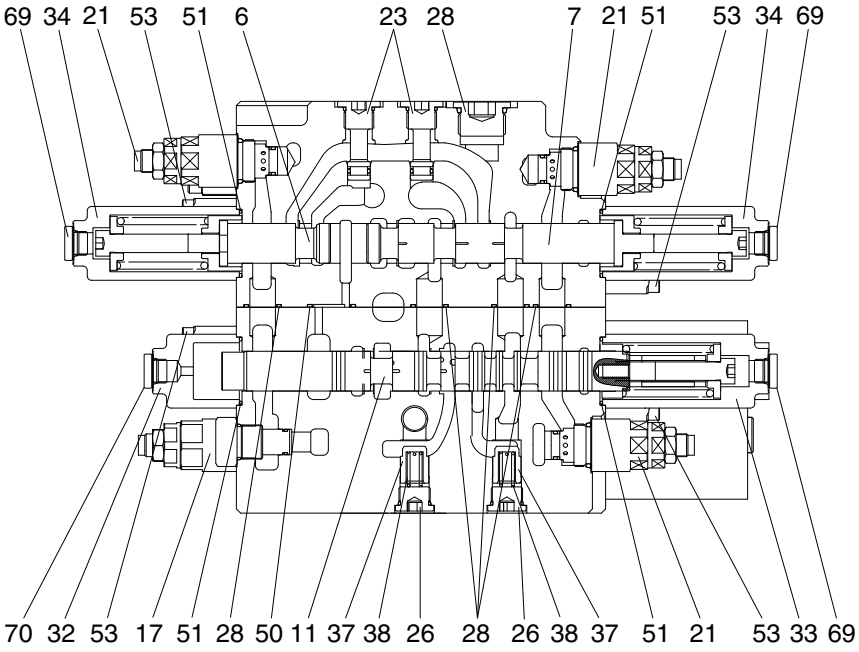
5	Swing spool assy	33	Pilot cover B1	53	Socket bolt
10	Boom 1 spool	35	Load check poppet 1	55	Socket bolt
14	Holding valve assy	36	Load check spring 1	56	Haxagon bolt
21	Overload relief assy	41	Cover 1	69	Dust cap
25	Load check plug kit	42	Gasket 1	70	Dust cap
32	Pilot cover A	51	O-ring		



SECTION E-E ' (ARM 1 & ARM REGENRATION)

2107V2MC44

8	Arm 1 spool assy	37	Load check poppet 1	53	Socket bolt
12	Arm regen spool assy	38	Load check spring 2	54	Socket bolt
14	Holding valve assy	40	Flange	55	Socket bolt
15	Regen valve assy	41	Cover 1	56	Haxagon bolt
25	Load check plug kit	42	Gasket 1	57	Socket bolt
26	Load check plug kit	46	Plug	62	Spring washer
32	Pilot cover A	47	O-ring	69	Dust cap
33	Pliot cover B1	48	O-ring	70	Dust cap
35	Load check poppet 1	51	O-ring		
36	Load check spring 1	52	O-ring		

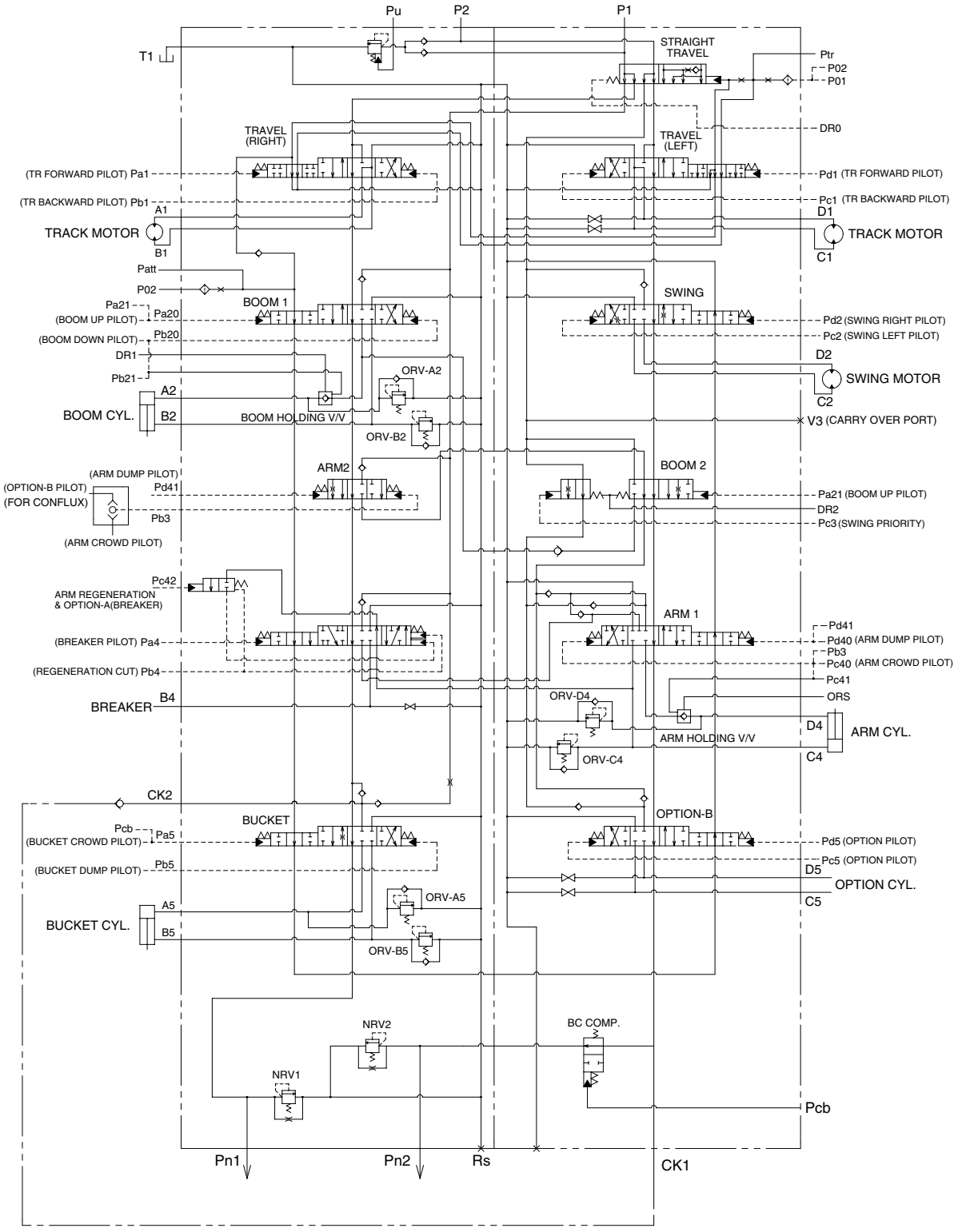


SECTION D-D ' (SWING PRIORITY & BOOM 2 & ARM 2)

D21072MC43

6	Swing priority spool assy	26	Load check plug kit	38	Load check spring 2
7	Boom 2 spool assy	28	Plug kit	50	O-ring
11	Arm 2 spool assy	32	Pilot cover A	51	O-ring
17	Overload relief plug assy	33	Pilot cover B1	53	Socket bolt
21	Overload relief assy	34	Pilot cover B2	69	Dust cap
23	Parallel block plug assy	37	Load check poppet 2		

2. HYDRAULIC CIRCUIT



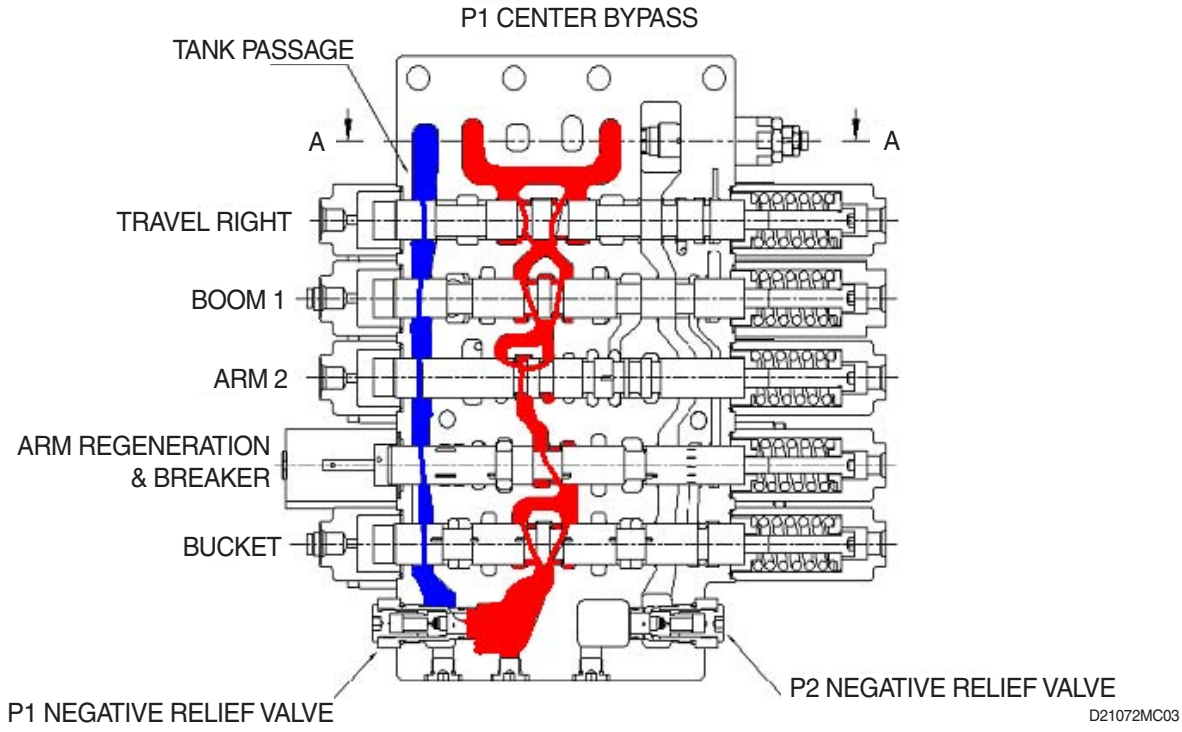
D21072MC02

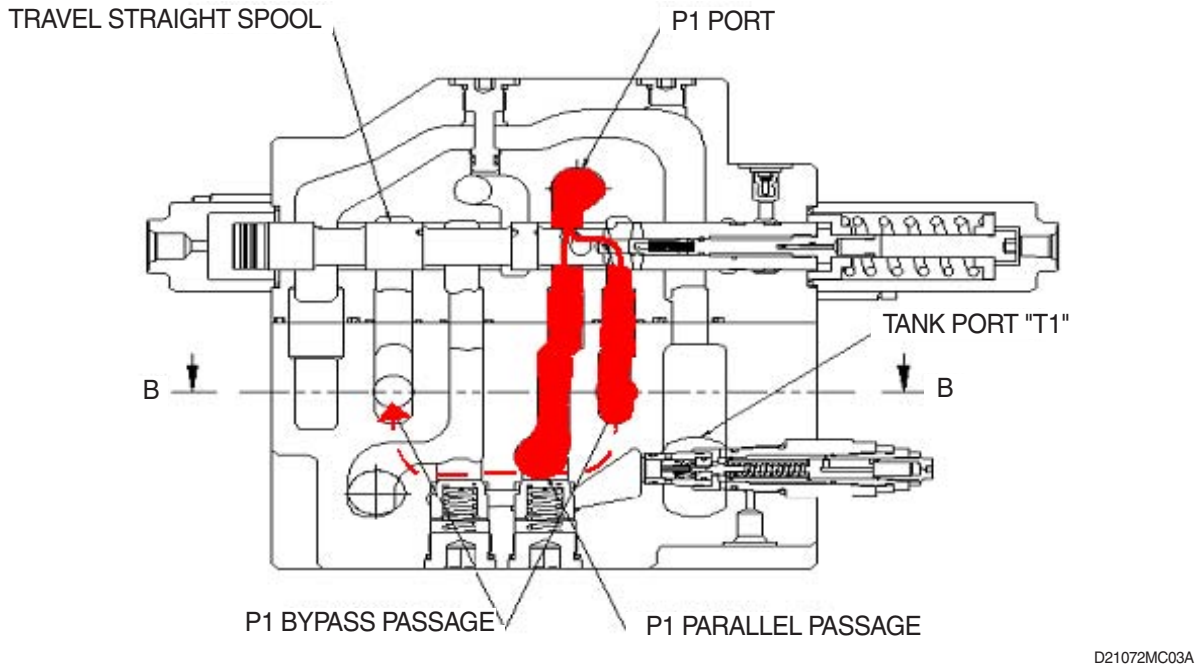
1) CONTROL IN NEUTRAL

(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 P1 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 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"

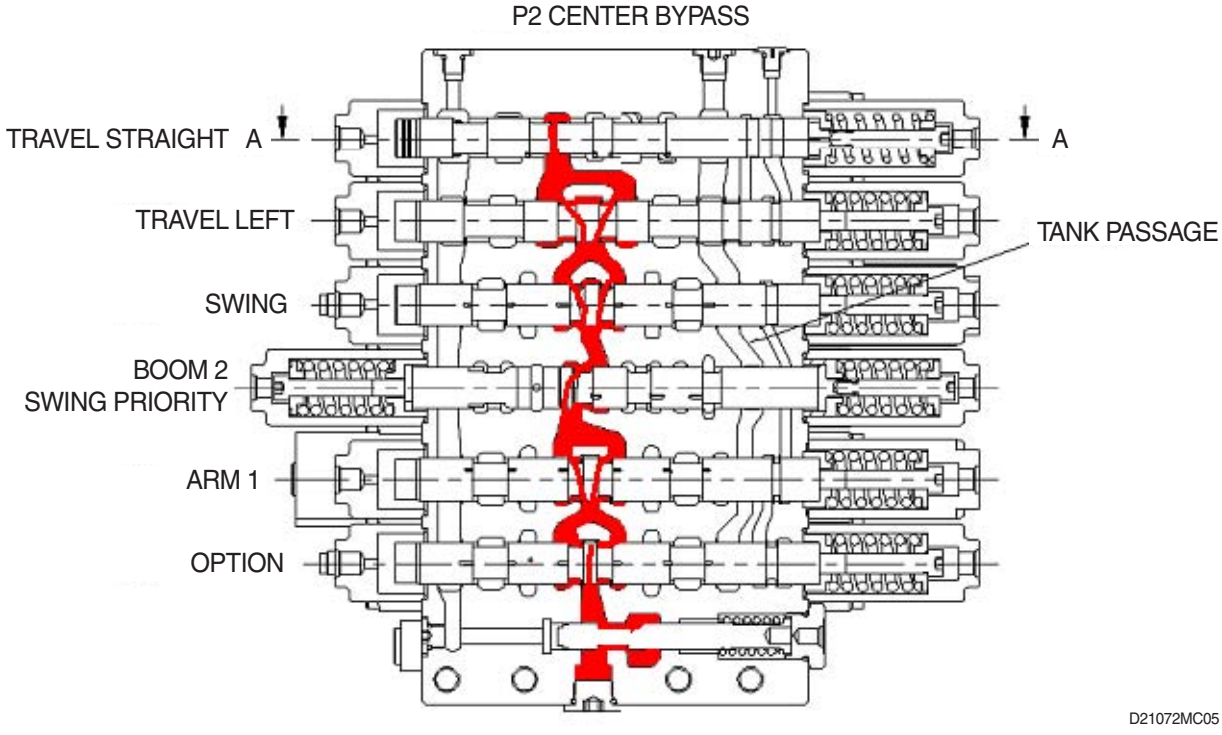


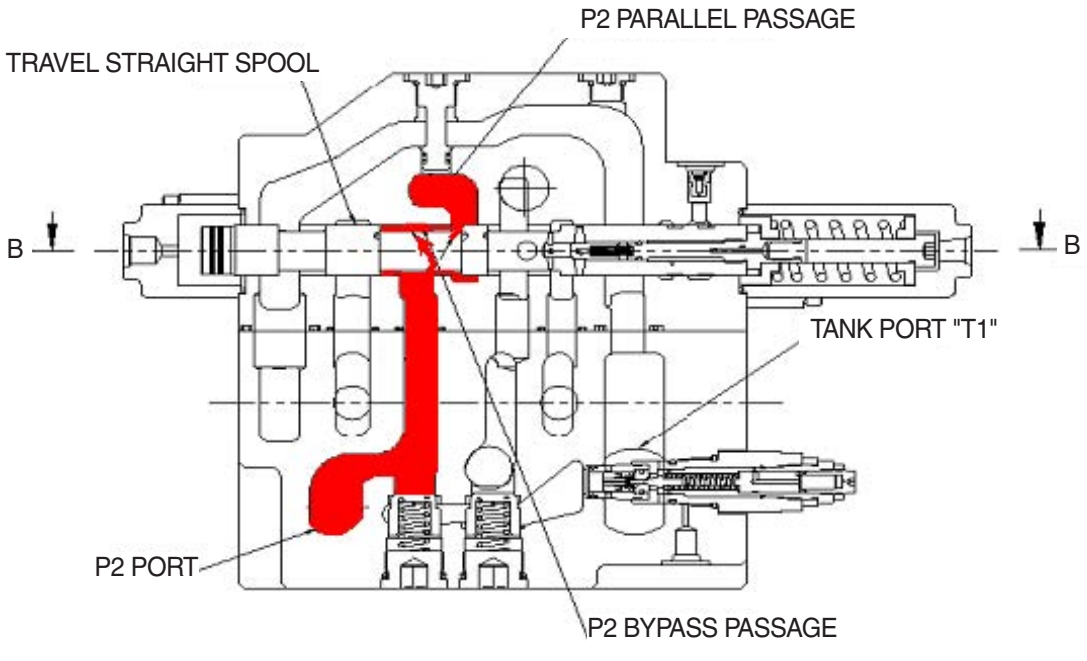


(2) P2 SIDE

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 bucket summation and the negative relief valve of P2, the tank passage and the tank port "T1".



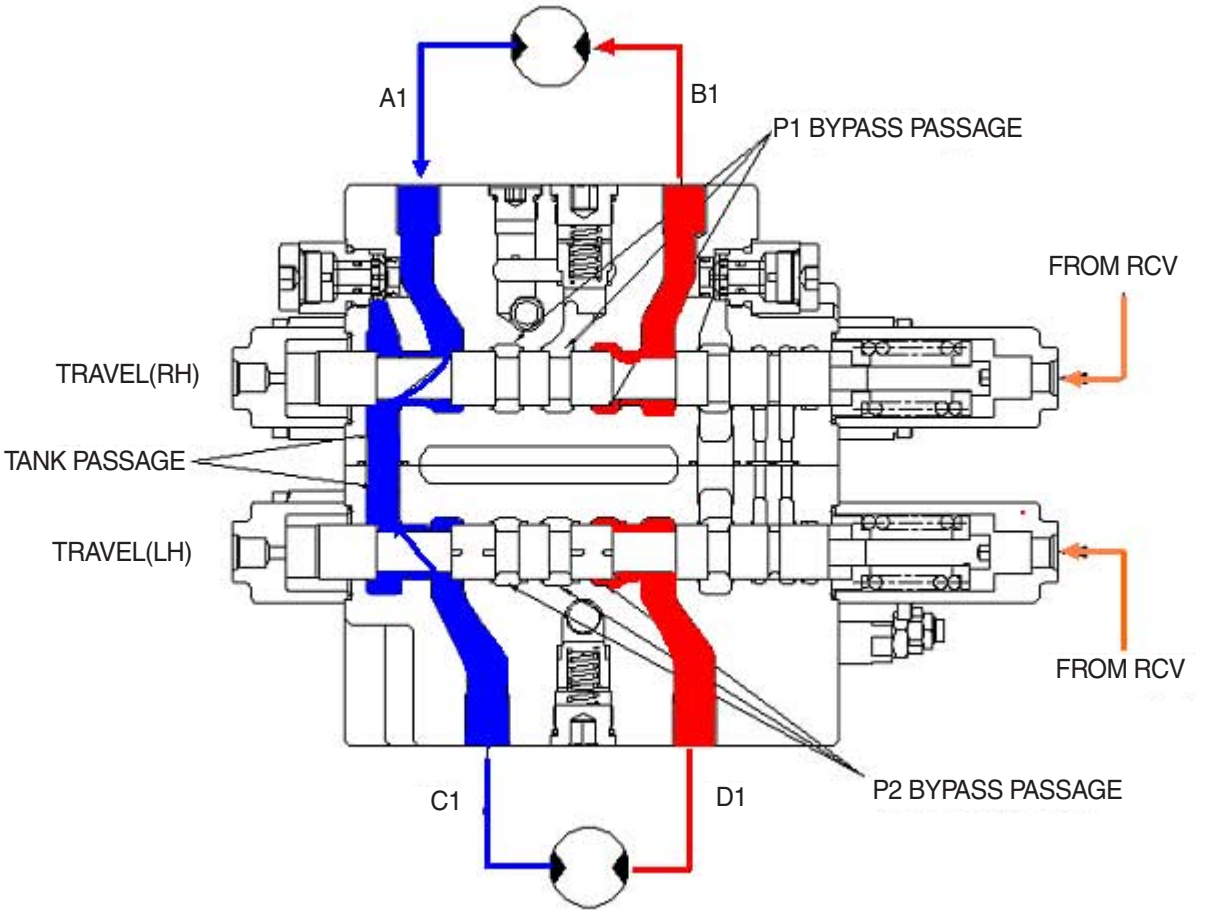


2) TRAVEL OPERATION

(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.

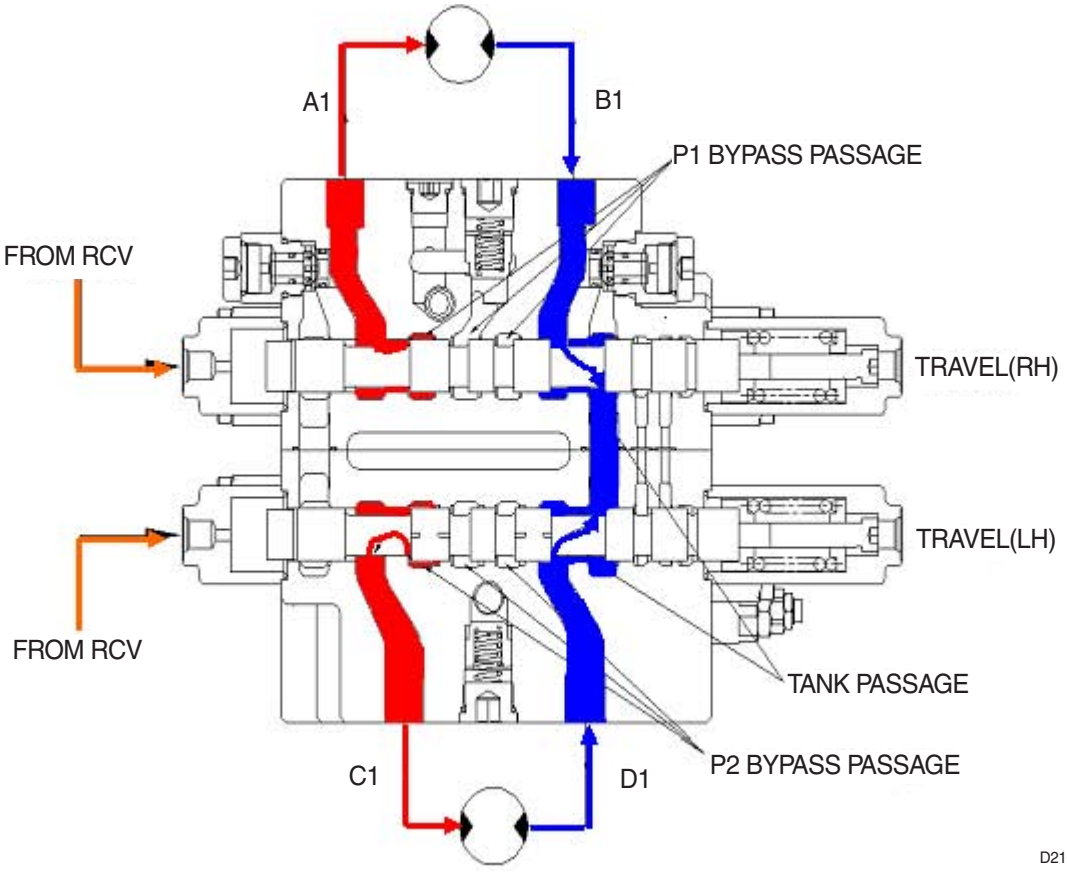
Then the bypass passage is shut off by the movement of the spool, they are directed to the each travel motor through port B1 and D1. At the same time, the hydraulic fluid from the each travel motor through port A1 and C1 returns to the tank passage through the travel spools.



(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

This function keeps straight travel in case of simultaneous operation of other actuators (boom, arm, bucket, swing) during a straight travel.

① **During travel only :**

The hydraulic fluid of the pump P1 is supplied to the RH travel motor and the pump P2 is supplied to the LH travel motor.

Thus, the machine keep travel straight.

② **The other actuator operation during straight travel operation :**

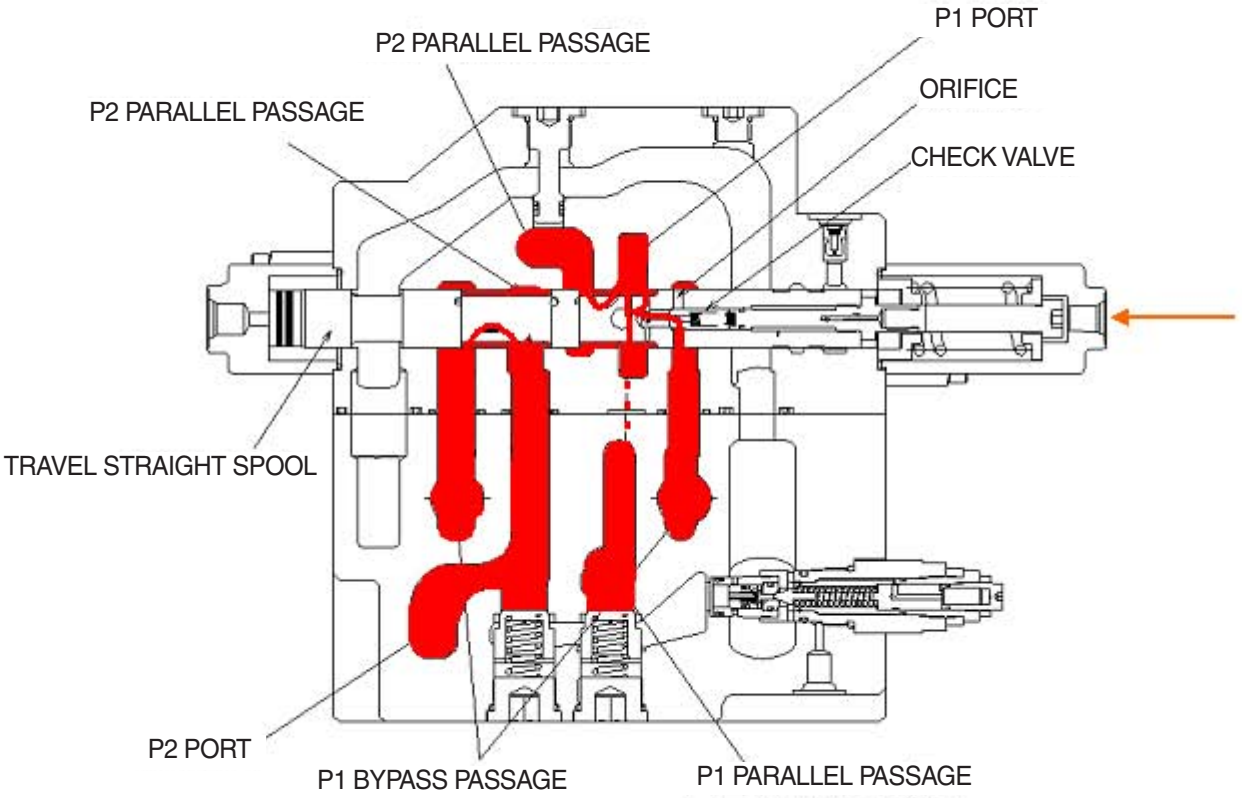
When the other actuator spool (S) is selected under straight travel operation, the straight travel spool is moved.

The hydraulic fluid from pump P1 is supplied actuator through P1 and P2 parallel pass and travel motors through orifice at side of straight travel spool.

The hydraulic oil fluid from pump P2 is supplied to travel motors (left/right).

Therefore, the other actuator operation with straight travel operation, hydraulic oil fluid from pump P1 is mainly supplied to actuator, and the hydraulic oil fluid form pump P2 is mainly supplied to travel motors (left/right).

Then the machine keeps straight travel.



D21072MC08

3) BOOM OPERATION

(1) BOOM UP OPERATION

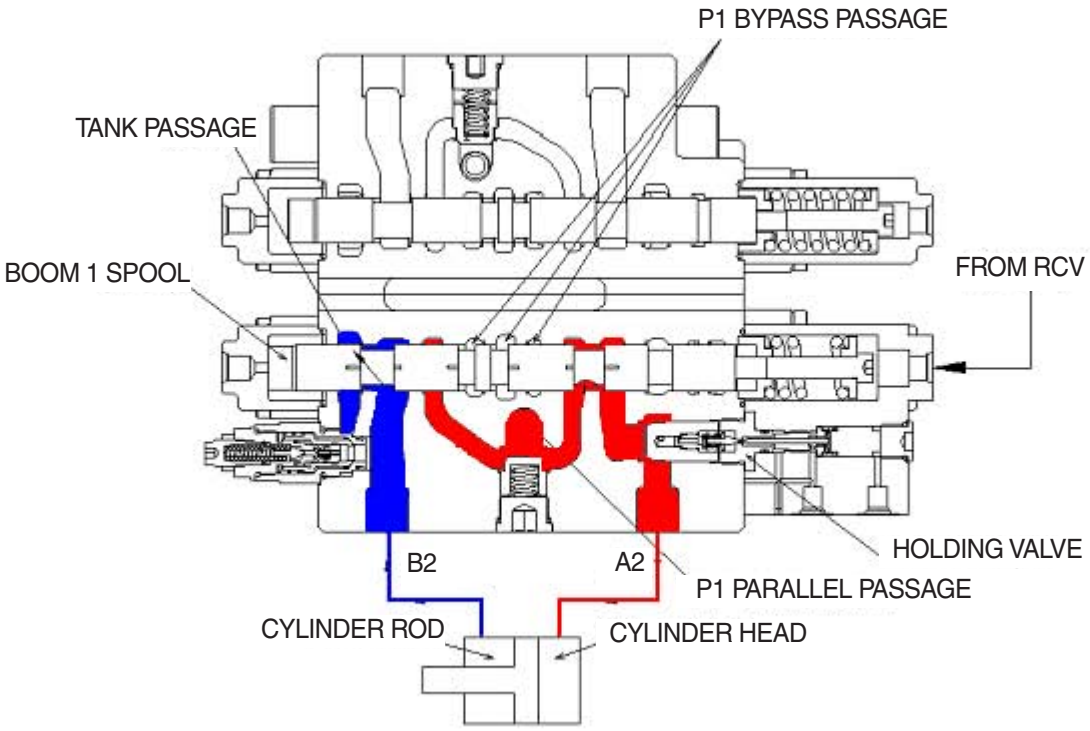
During boom up operation, the pilot secondary pressure from RCV is supplied to the port of the spring side and shifts the boom 1 spool in the left direction. The bypass passage is shut off by the movement of the spool and the hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes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

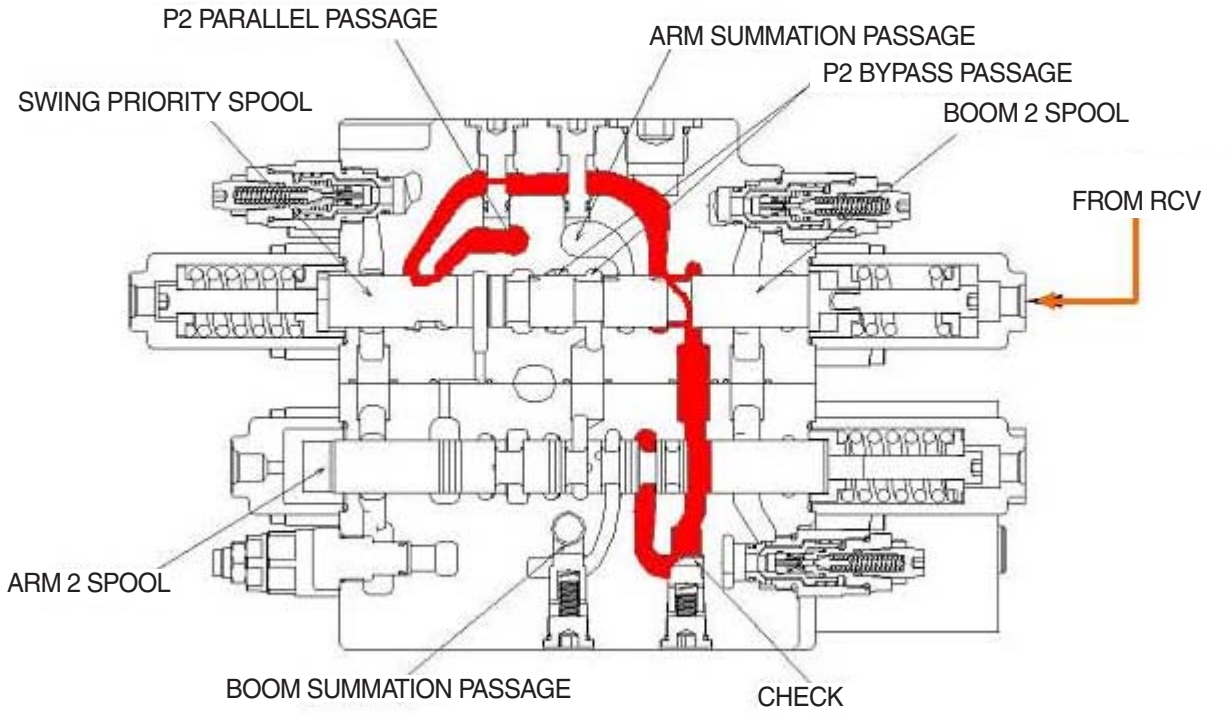
At the same time, the pilot pressure from RCV is supplied to the port of the spring side of boom 2 and shifts the boom 2 spool. The bypass passage is shut off by the movement of the spool and the hydraulic oil fluid from pump P2 entered boom summation passage via the P2 parallel passage, the land of 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 the port B2. There after it is directed to the hydraulic oil tank through the tank passage.



BOOM 1 SPOOL SIDE

D21072MC09



BOOM 2 SPOOL SIDE

D21072MC10

(2) BOOM DOWN OPERATION

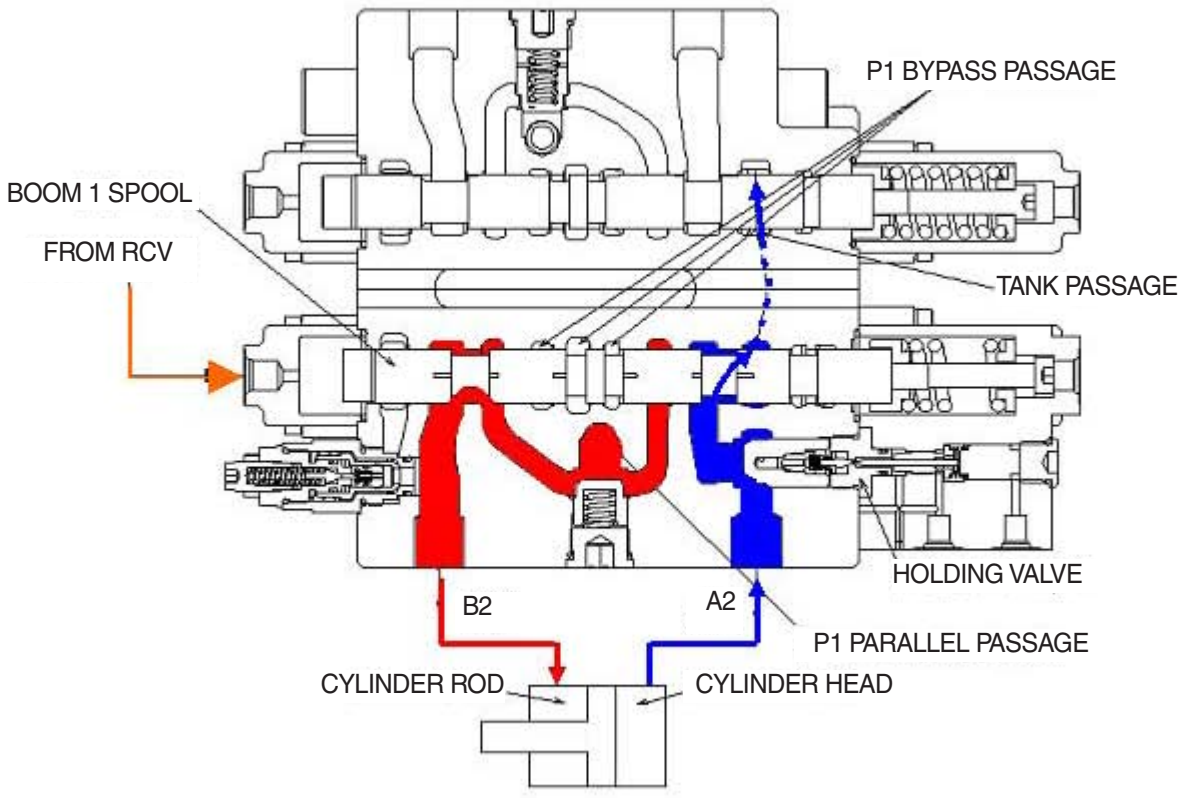
During the boom lowing operation, the pilot pressure from RCV is supplied to the port of the spring opposite side and shifts the boom 1 spool in the right direction.

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.

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.

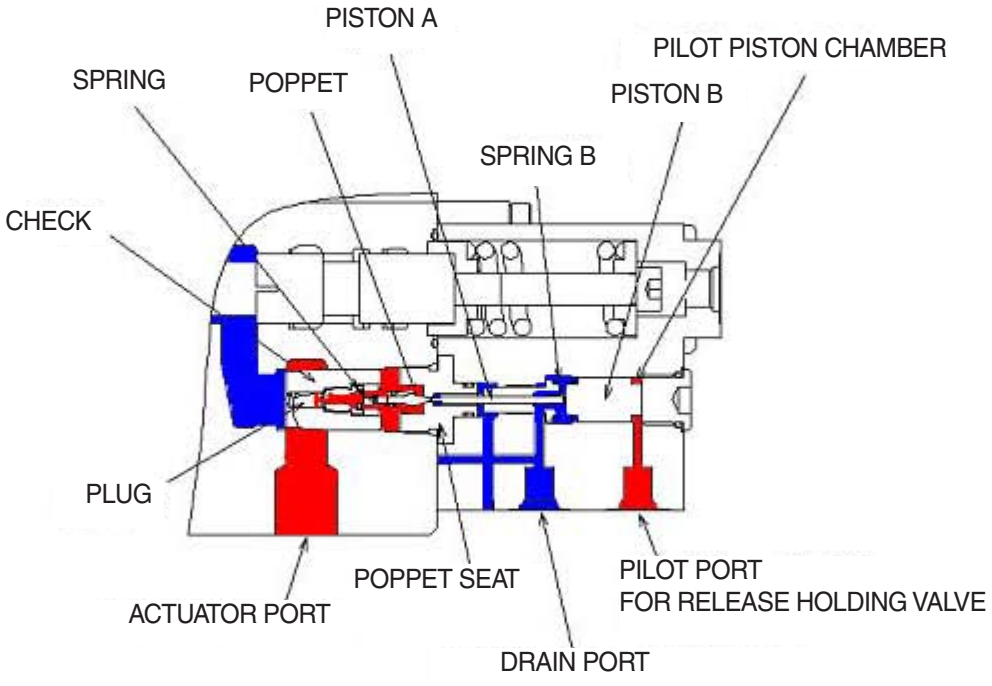


D21072MC11

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.



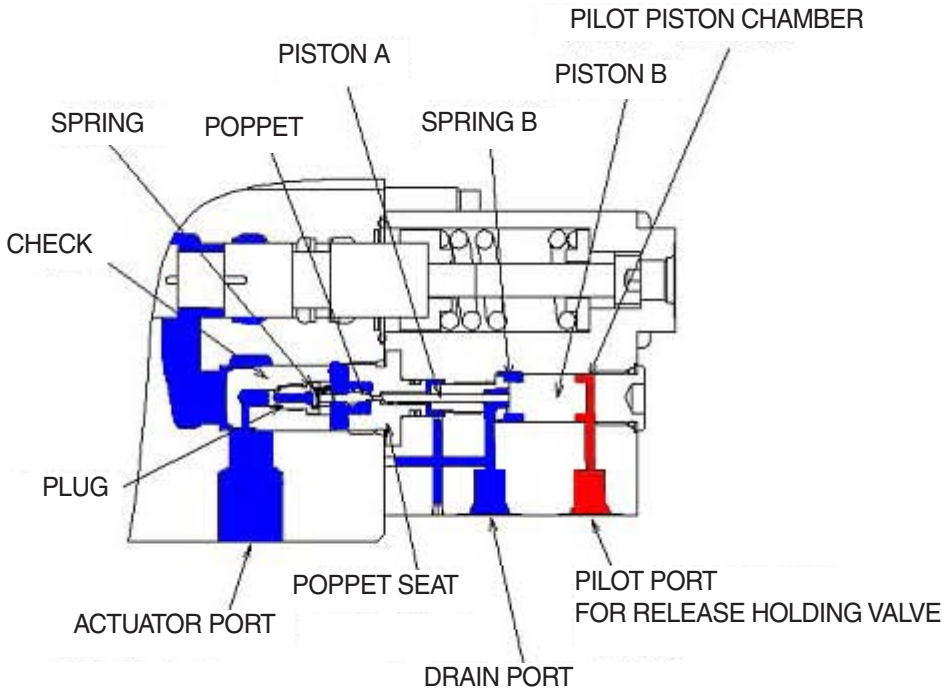
D21072MC12

(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 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 internal passage of spool.



D21072MC13

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 check1.

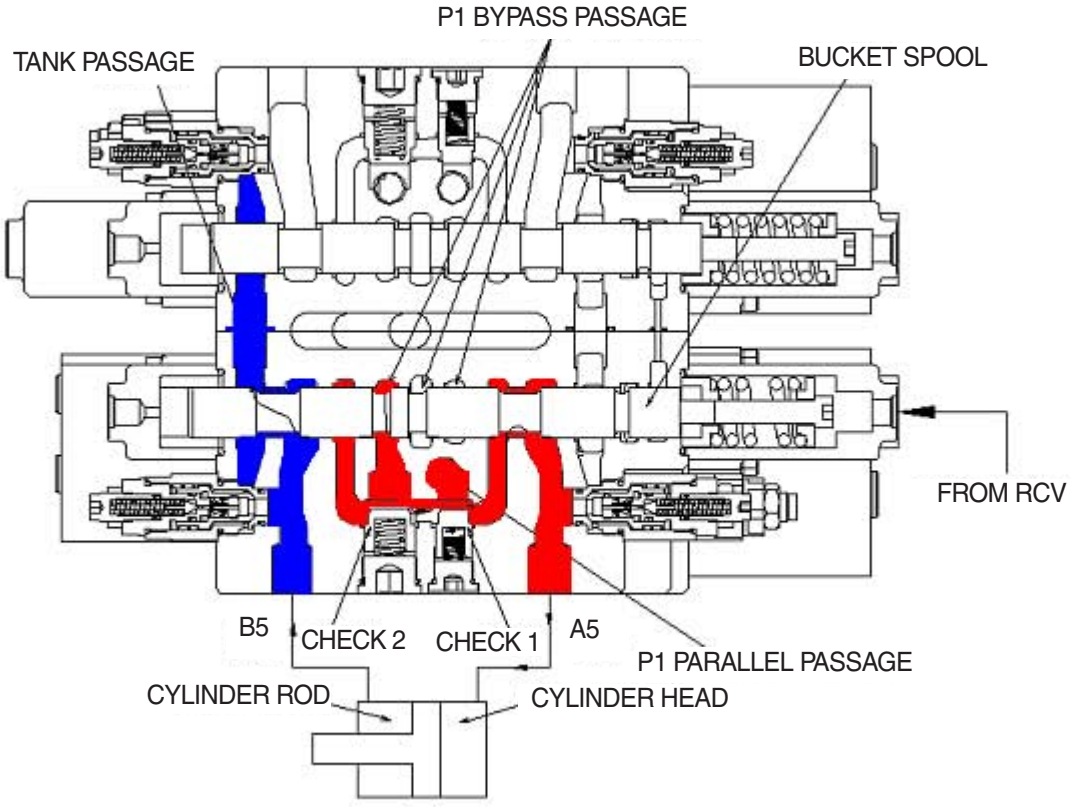
At the same time, the hydraulic fluid from P1 bypass passage is directed to the port A5 through the check2.

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.



D21072MC14

(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.

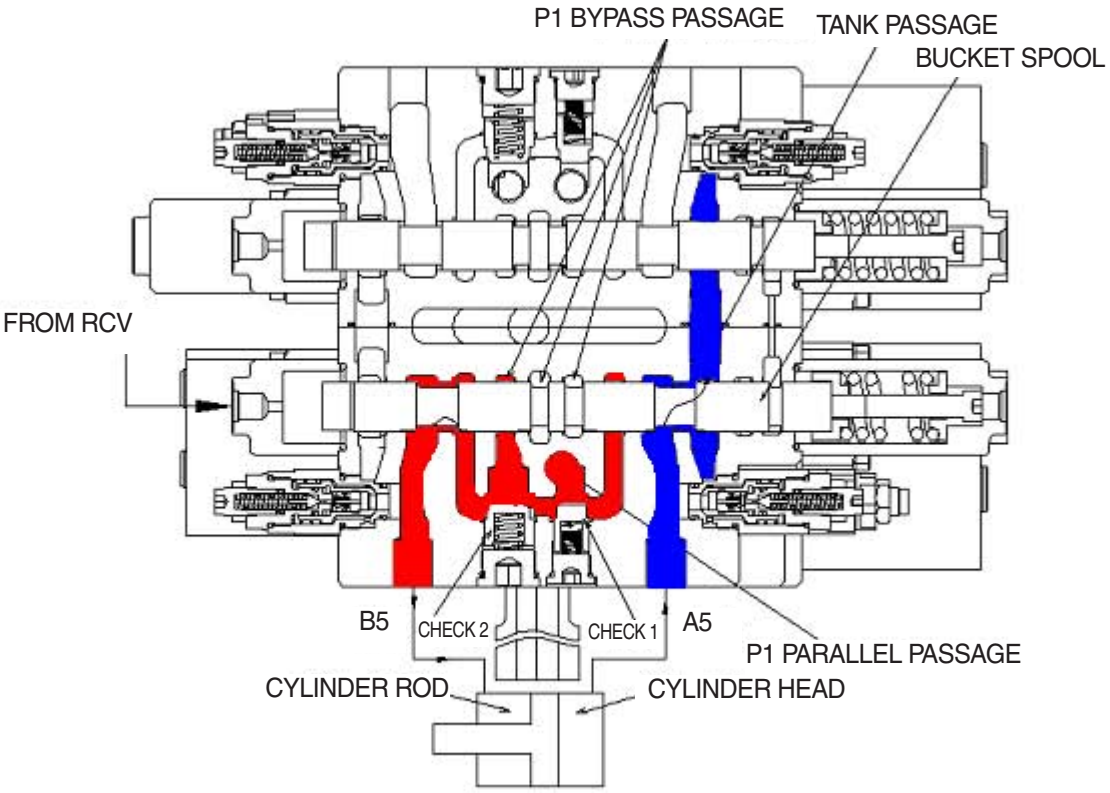
The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port B5 through the check1.

At the same time the hydraulic fluid from bypass passage is directed to the port B5 through the check 2.

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, 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.



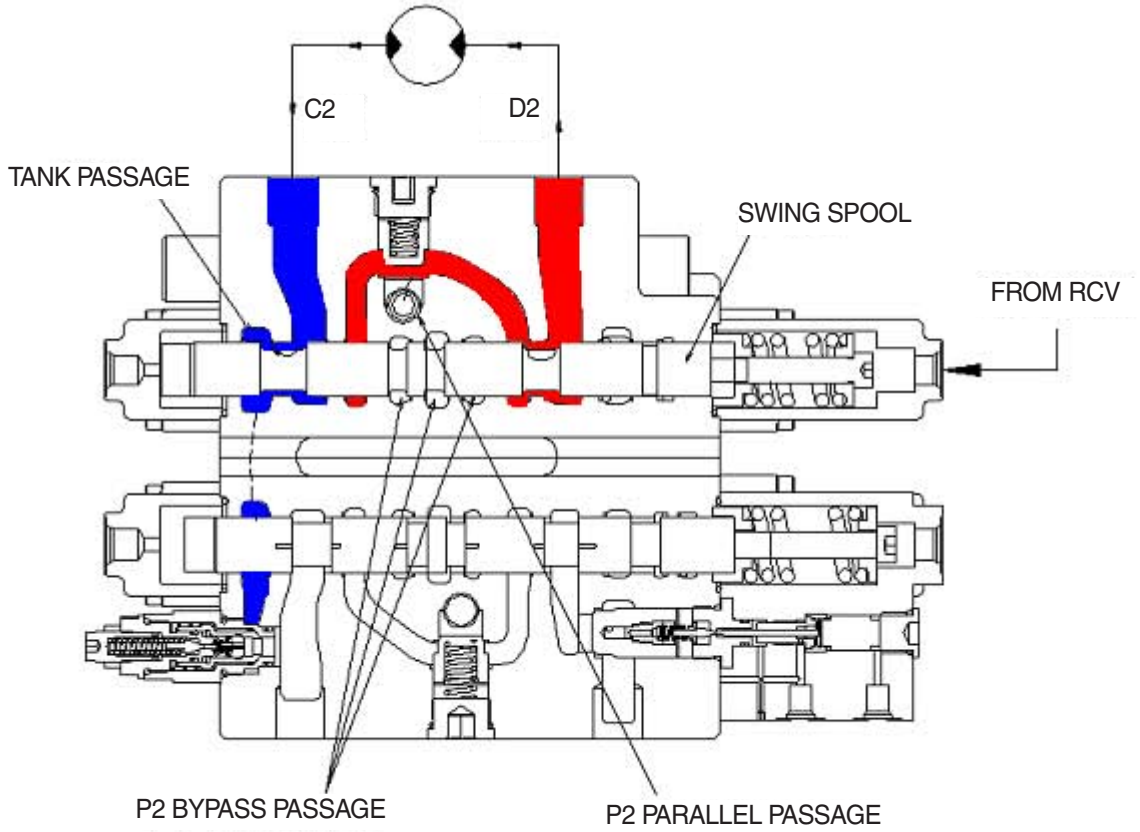
D21072MC15

6) SWING OPERATION

(1) SWING LEFT 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.

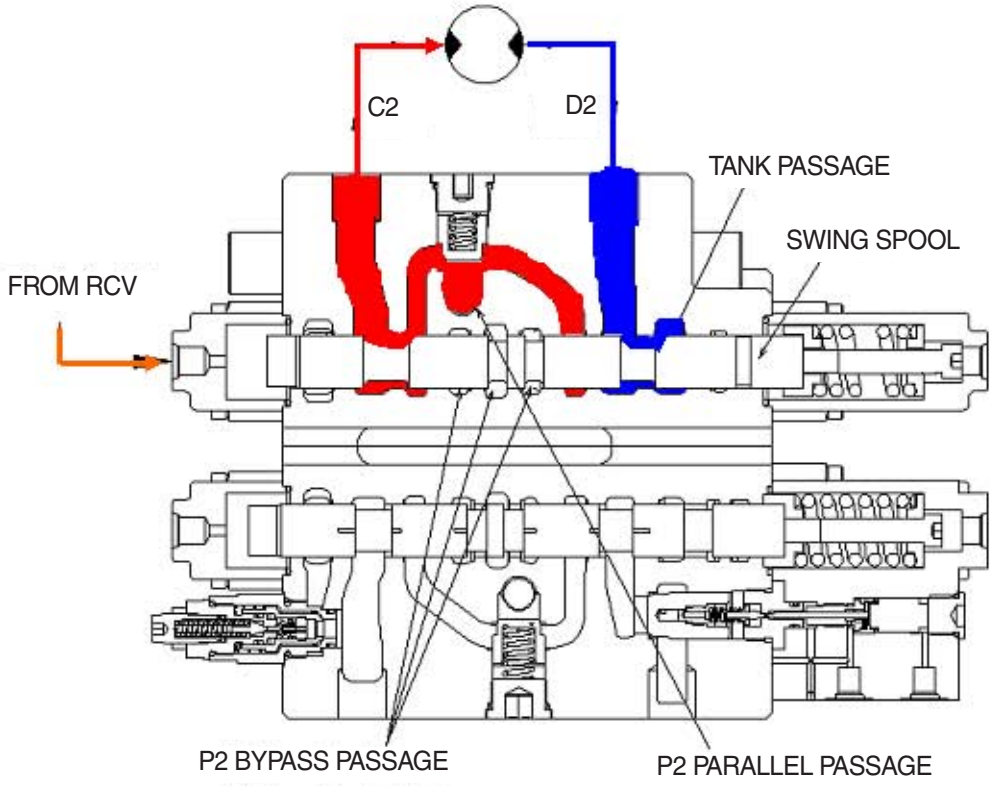


D21072MC16

(2) SWING RIGHT OPERATION

During the swing right 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 C2.

As the result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port B2, swing spool and the tank passage.



D21072MC17

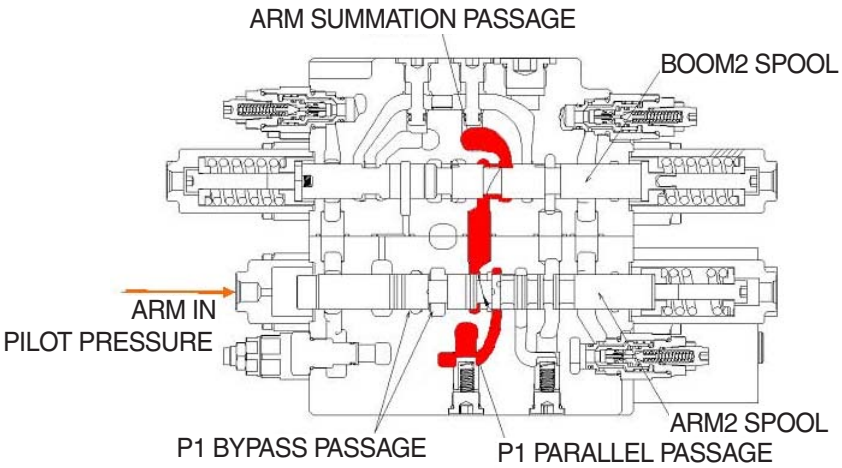
7) ARM OPERATION

(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.

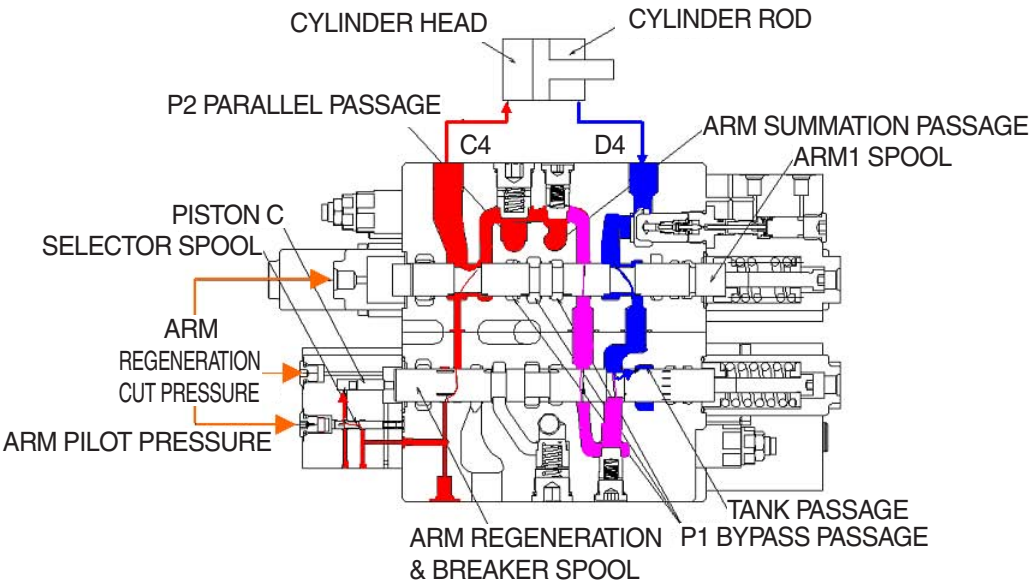
The bypass passage is shut off by the movement of the arm 1 spool and the hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve, bridge passage and the port C4.

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 2 SPOOL SIDE

D21072MC19



ARM 1 SPOOL SIDE

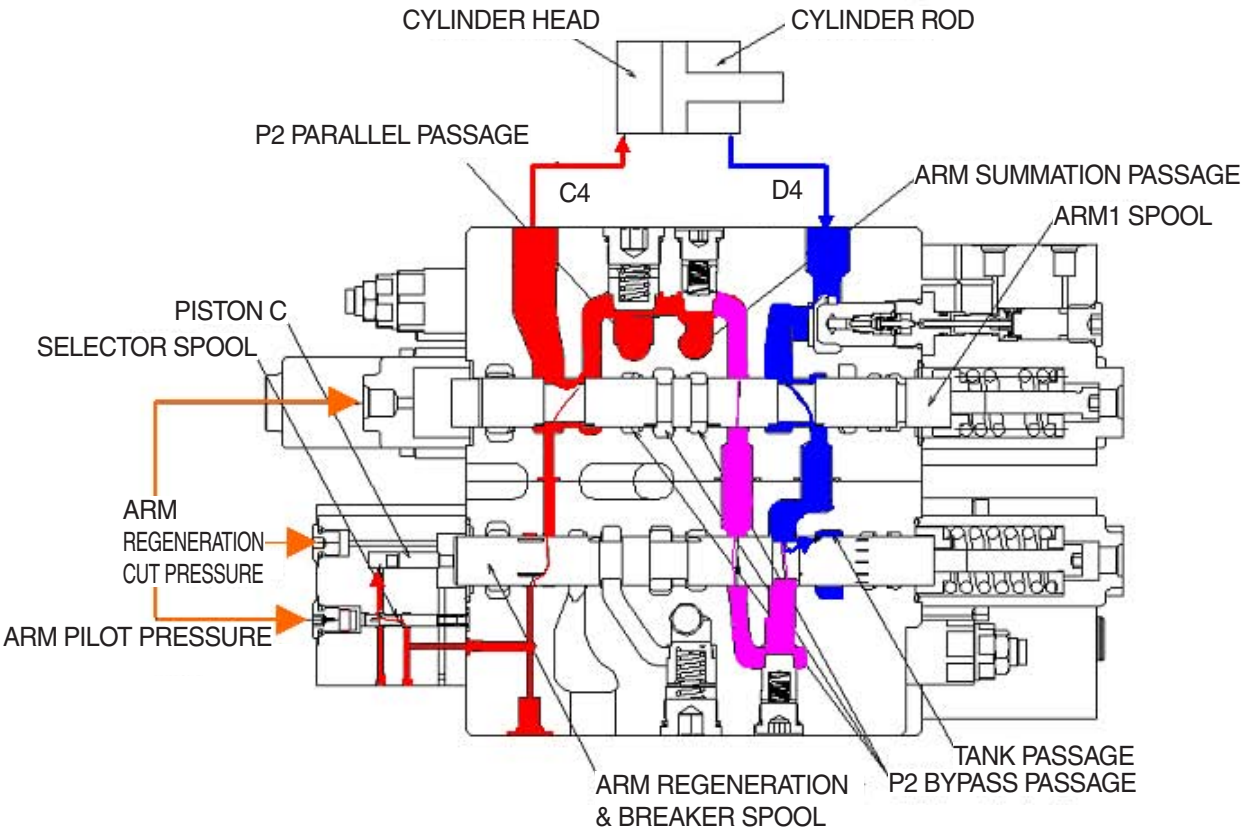
D21072MC18

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.

Furthermore, 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)



D21072MC18

(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.

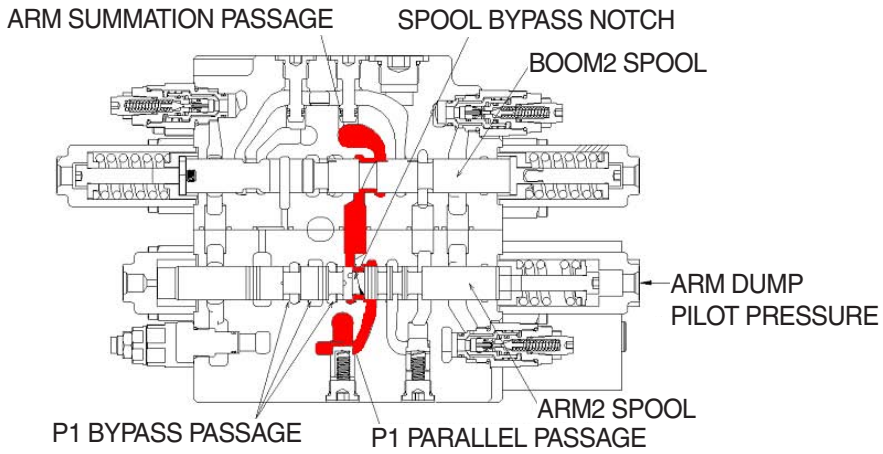
The bypass passage is shut off by the movement of the spool and the hydraulic fluid from pump P2 flows into arm 1 spool through the parallel passage. Then it enters into the arm cylinder rod side through the load check valve, bridge passage, arm holding valve and the port D4.

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.

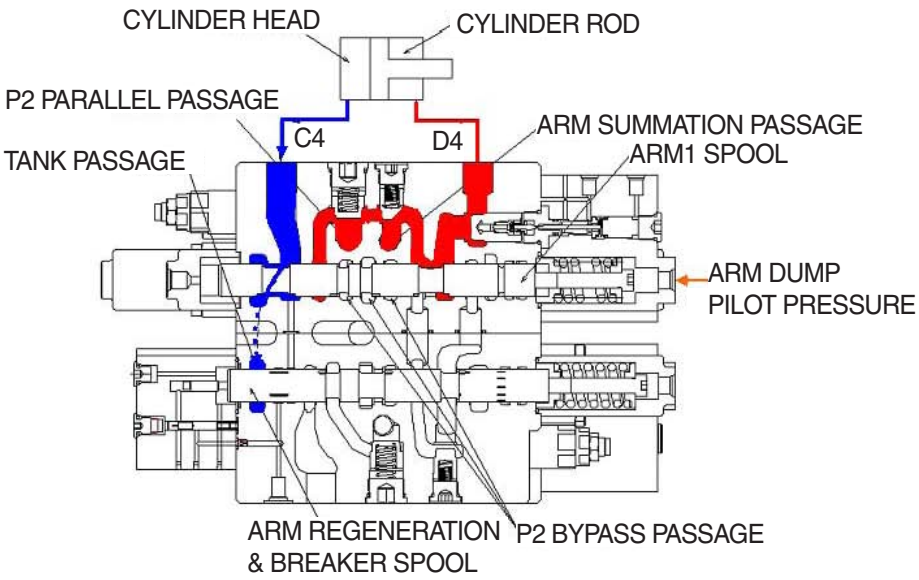
Then it enters into the arm cylinder rod side with the fluid from the arm 1 spool.

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.



ARM 2 SPOOL SIDE

D21072MC21



ARM 1 SPOOL SIDE

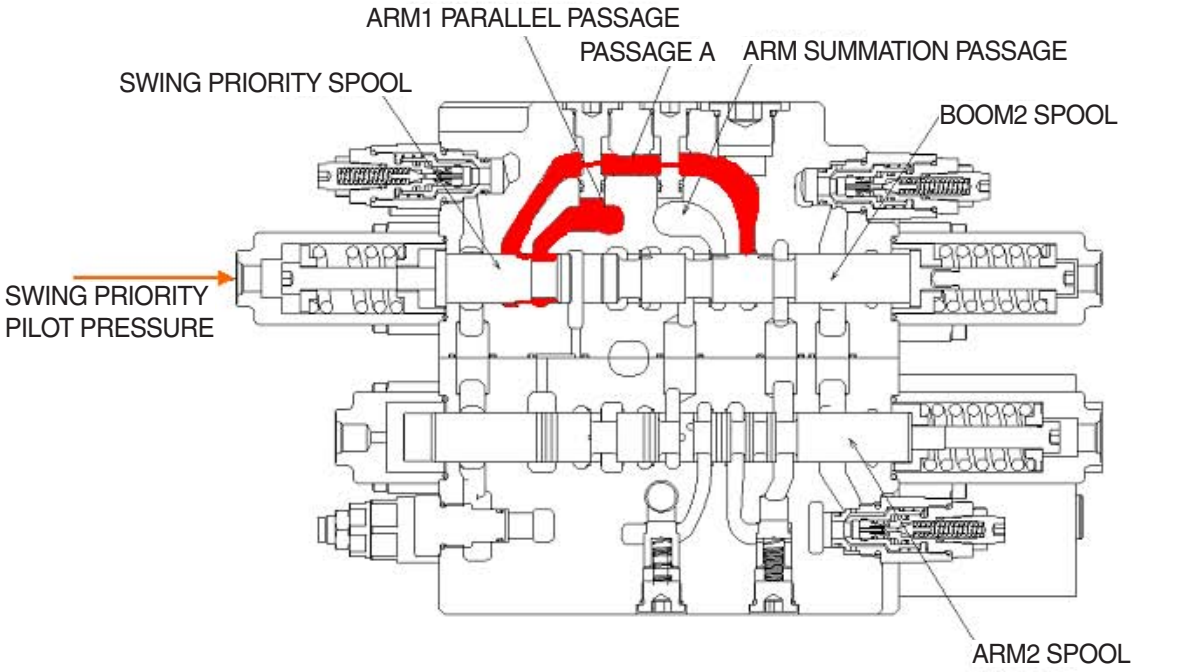
D21072MC20

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.

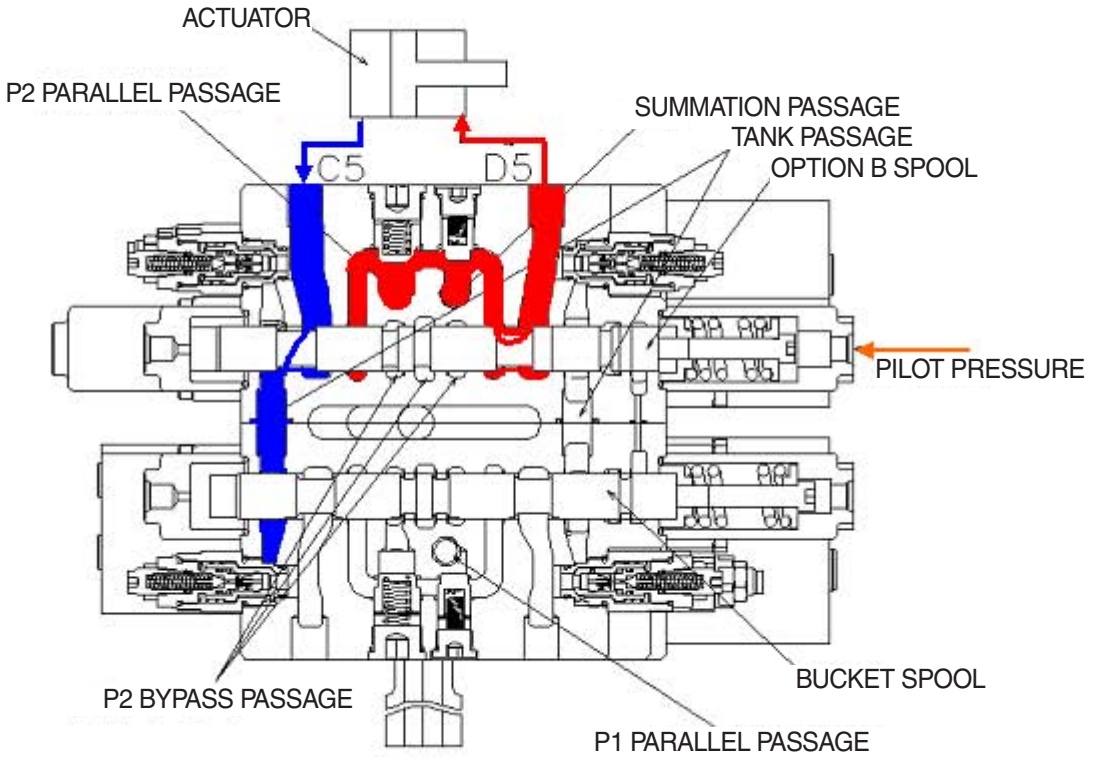


9) OPTION B OPERATION

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.

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

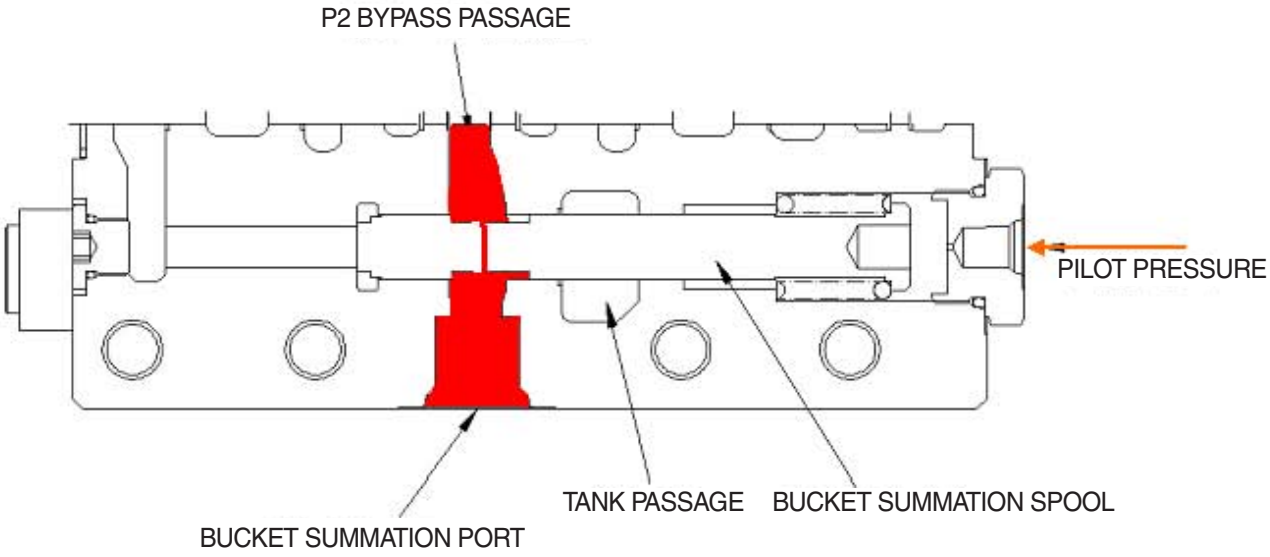
In case of reverse operation, the operating principle is same as above.



D21072MC24

10) BUCKET SUMMATION OPERATION

During bucket single operation, the bucket pilot pressure from RCV is supplied to the port of the spring side of the bucket summation spool and shift the spool in the left direction. As the spool moves, return line will be blocked and bypass pressure will open the check valve CK1 and join the parallel flow of the bucket from the P1 pump.



D21072MC25

11) NEGATIVE RELIEF VALVE OPERATION

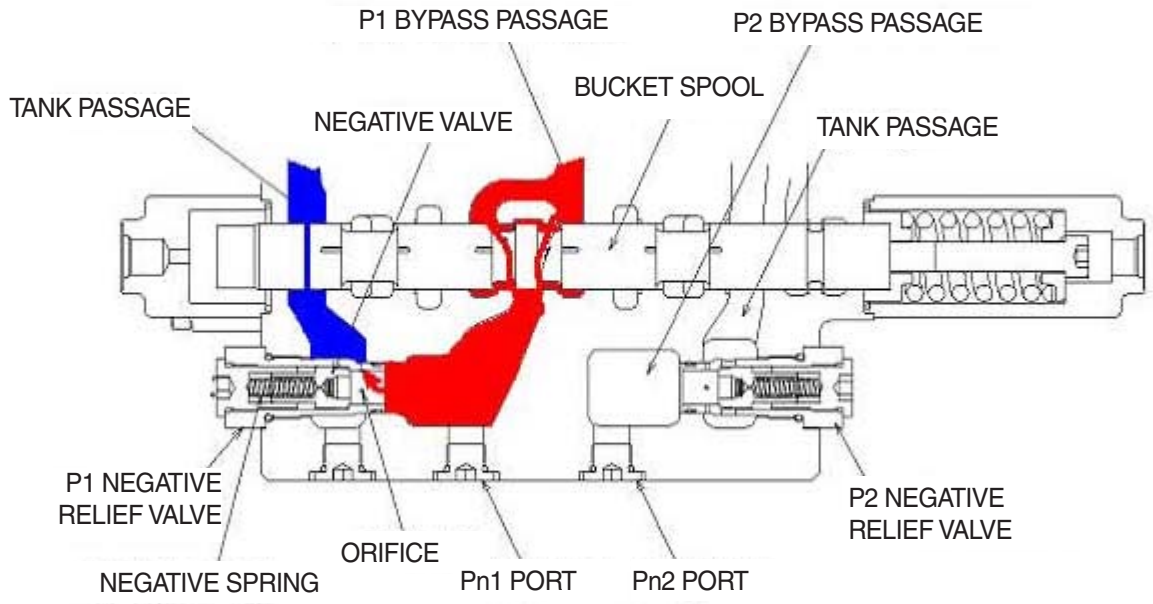
When no function is being actuated on P1 side, the hydraulic fluid from the pump P1, flows into the tank passage through the bypass passage and orifice. The restriction caused by this orifice thereby pressurizes. This pressure is transferred as the negative control signal pressure Pn1 to the pump P1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

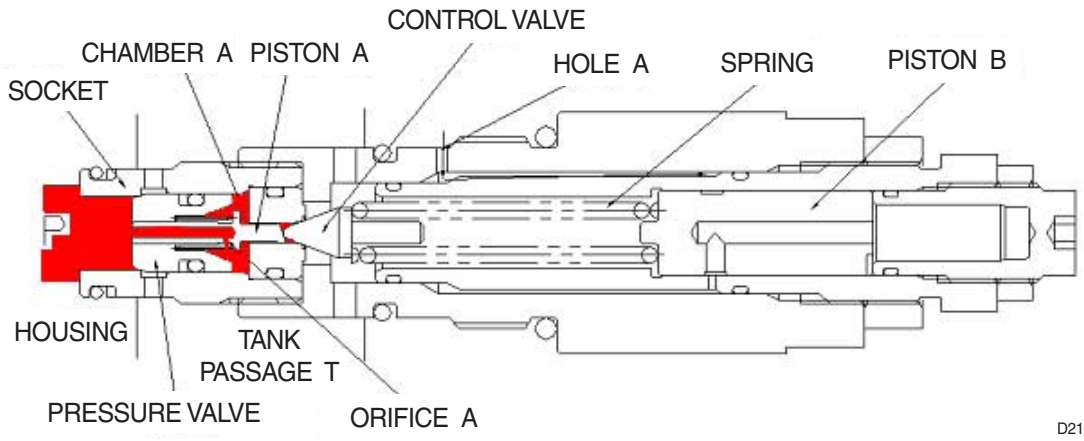
For the pump P2 the same negative control principle.



D21072MC26

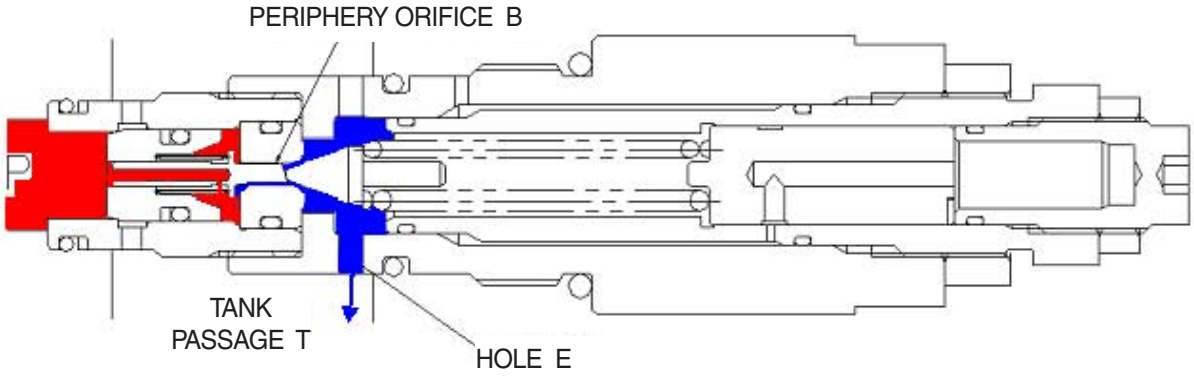
12) OPERATION OF MAIN RELIEF VALVE

(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.



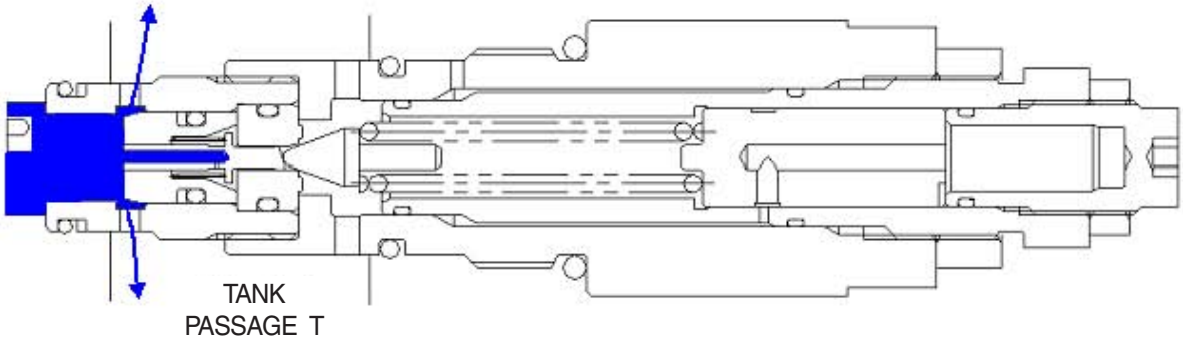
D21072MC27

(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).



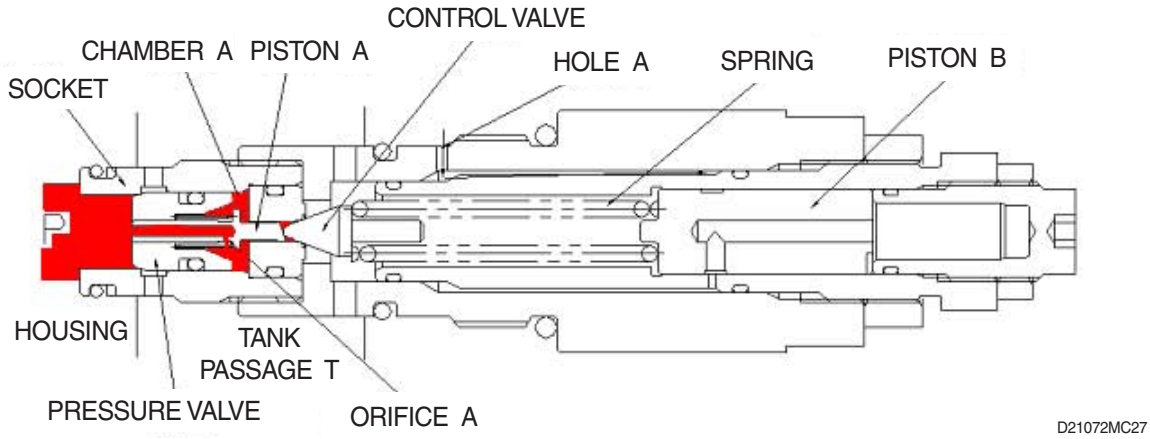
D21072MC28

(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).

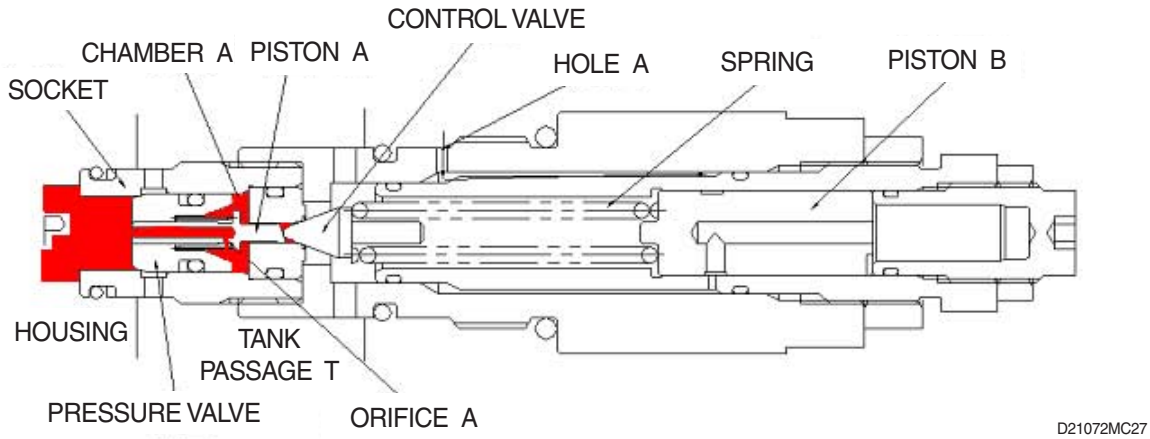


D21072MC29

(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.



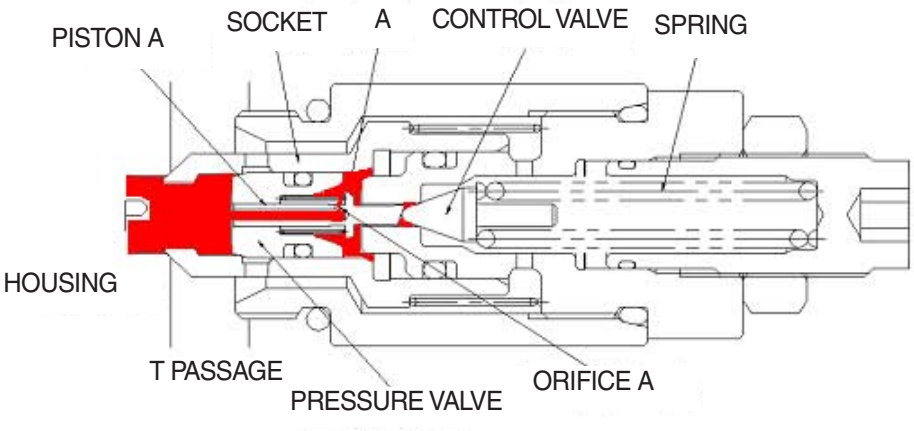
(5) When the power boost switch is ON, the pilot pressure enters through hole A.
It pushes the piston (B) in the left direction to increase the force of the spring and change the relief set pressure to the high pressure.



13) OPERATION OF OVERLOAD RELIEF VALVE

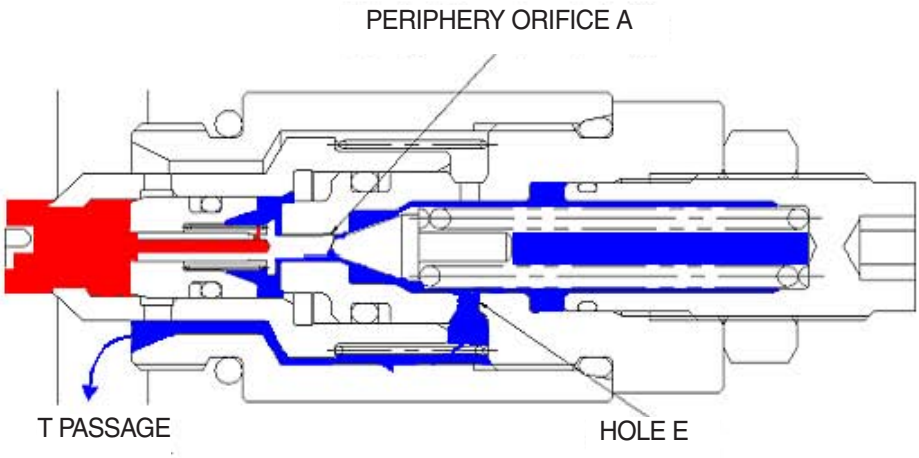
FUNCTION AS RELIEF VALVE

(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.



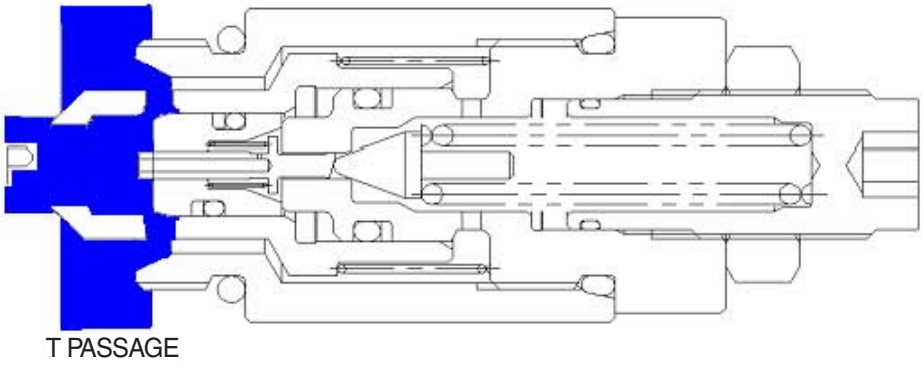
D21072MC30

(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.



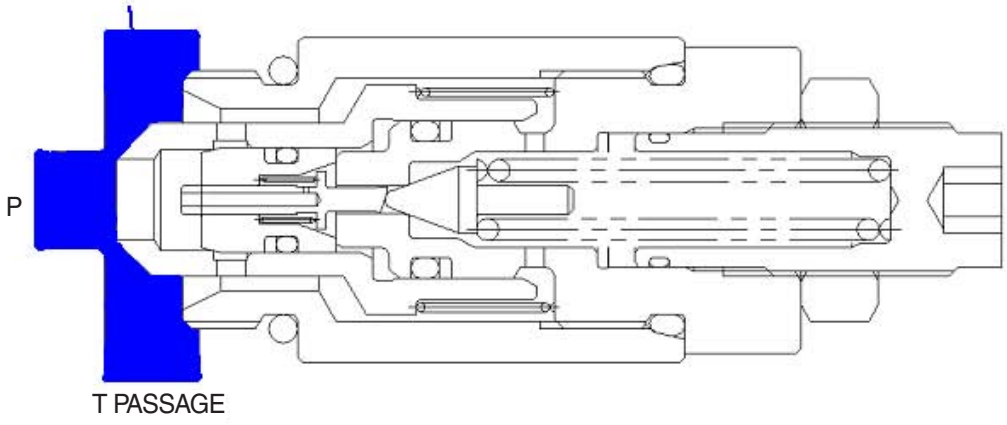
D21072MC31

(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).



D21072MC32

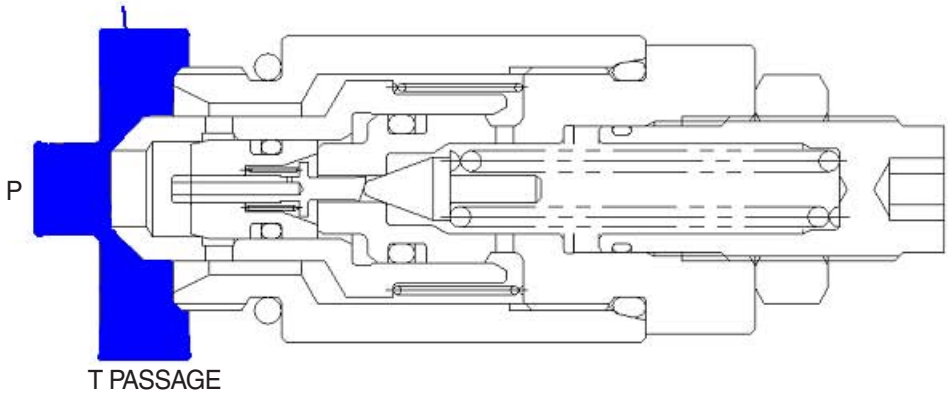
(4) The pressure at port P becomes lower than set pressure of the spring, the poppet is seated by spring force. Then the pressure at port P becomes equal to set pressure of the spring and the plunger is seated to the socket.



D21072MC33

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.



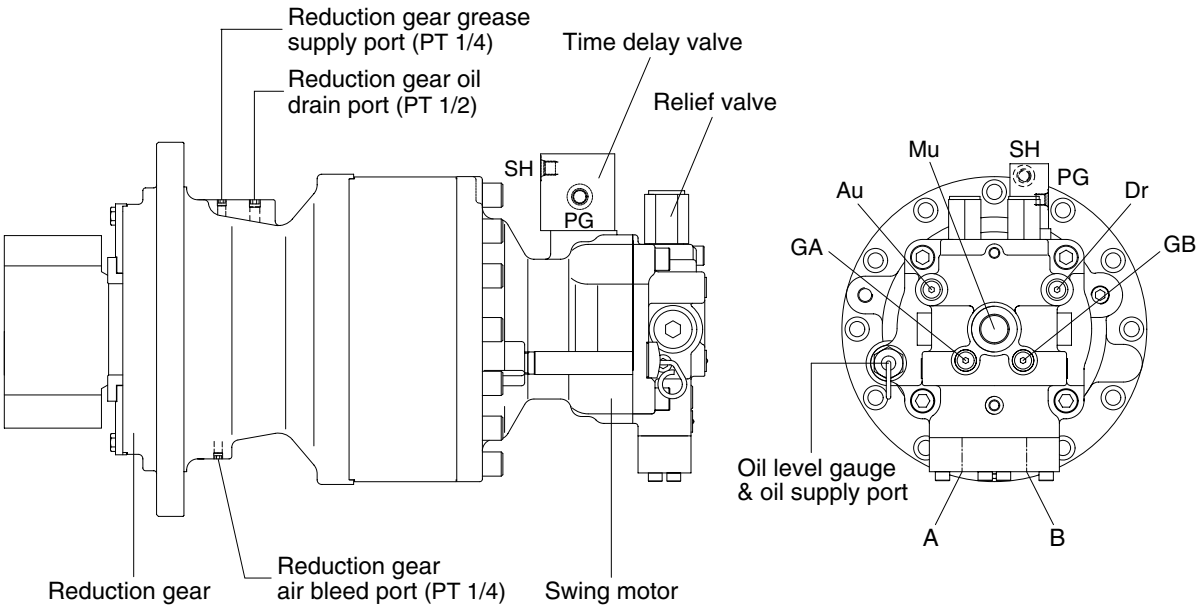
D21072MC33

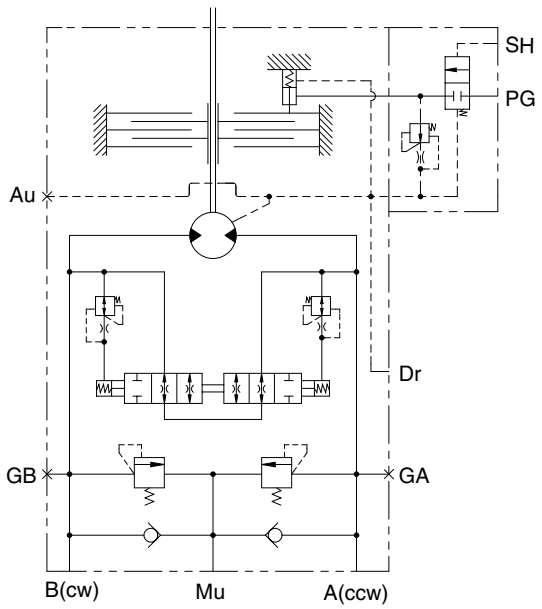
GROUP 3 SWING DEVICE (TYPE 1)

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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



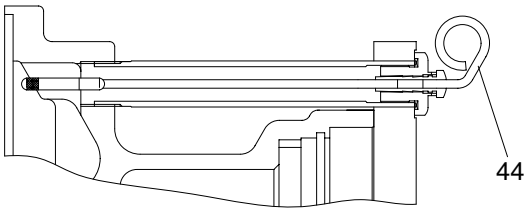


Hydraulic circuit

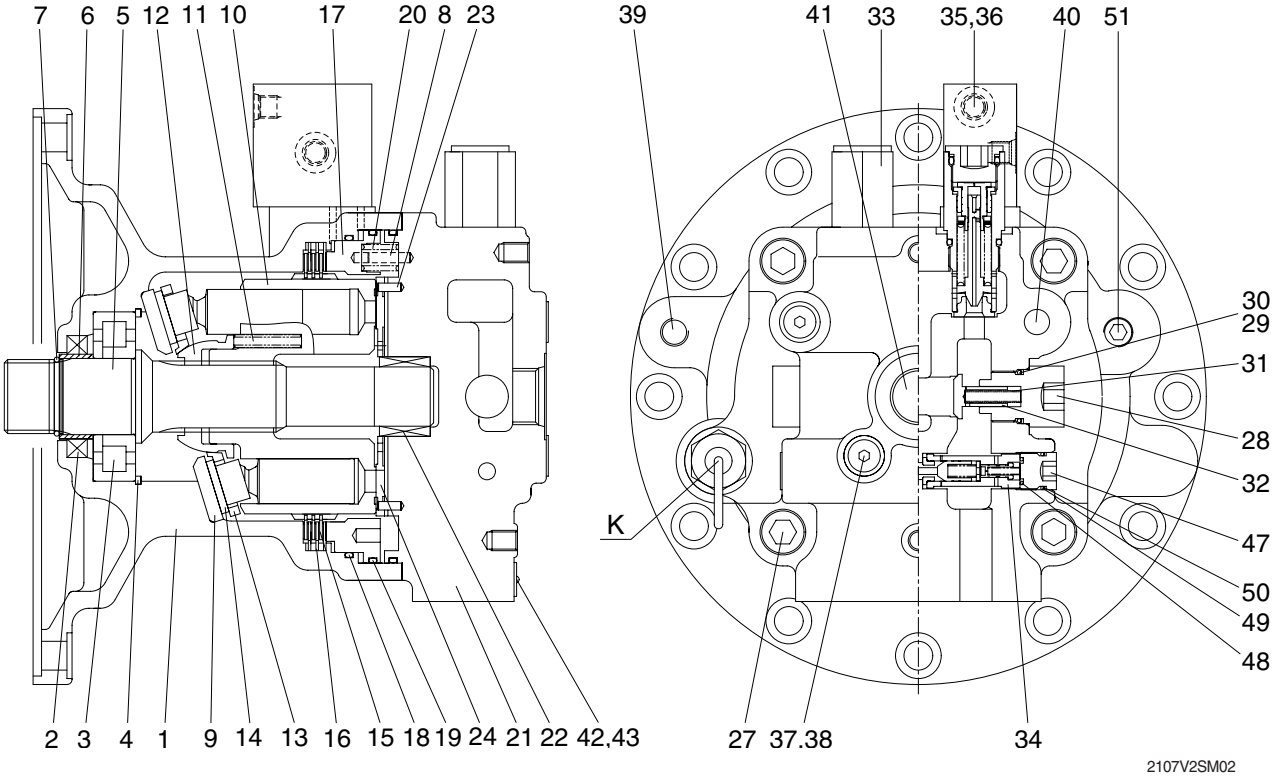
Port	Port name	Port size
A	Main port	ø 20
B	Main port	ø 20
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1
PG	Brake release port	PF 1/4
SH	Stand by port	PF 1/4
GA, GB	Gage port	PF 1/4
Au	Air vent port	PF 1/4

2107V2SM01

1) SWING MOTOR

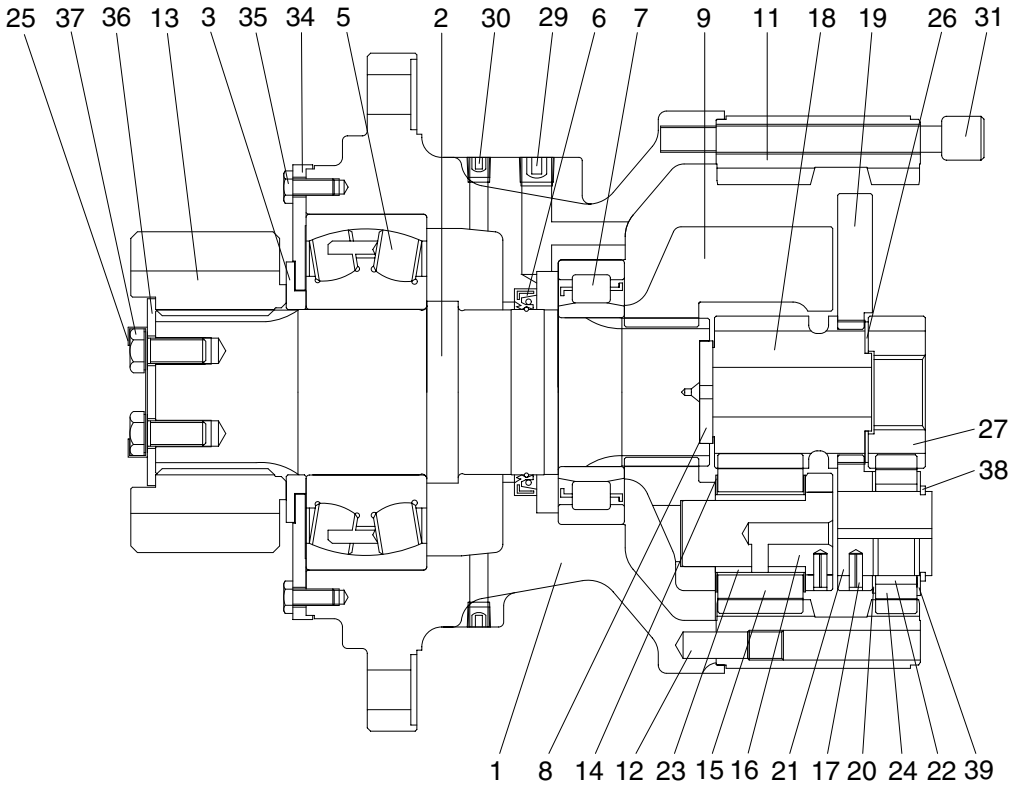


DETAIL K



1	Body	18	O-ring	37	Plug
2	Oil seal	19	O-ring	38	O-ring
3	Roller bearing	20	Brake spring	39	Plug
4	Snap ring	21	Rear cover	40	Plug
5	Shaft	22	Needle bearing	41	Plug
6	Bushing	23	Pin	42	Name plate
7	Stop ring	24	Valve plate	43	Rivet
8	Pin	27	Wrench bolt	44	Level gauge
9	Shoe plate	28	Plug	45	Flange
10	Cylinder block	29	Back up ring	46	O-ring
11	Spring	30	O-ring	47	Plug
12	Ball guide	31	Spring	48	O-ring
13	Set plate	32	Check	49	O-ring
14	Piston assy	33	Relief valve assy	50	Back up ring
15	Friction plate	34	Anti-inversion valve assy	51	Plug
16	Separate plate	35	Time delay valve assy		
17	Brake piston	36	Wrench bolt		

2) REDUCTION GEAR



2107V2SM03

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

2. PRINCIPLE OF DRIVING

1) Generating the turning force

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

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

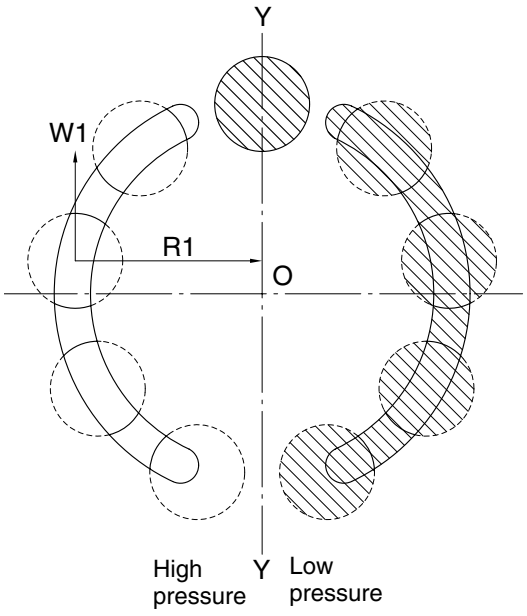
The high hydraulic can generate the force, F1=P × A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

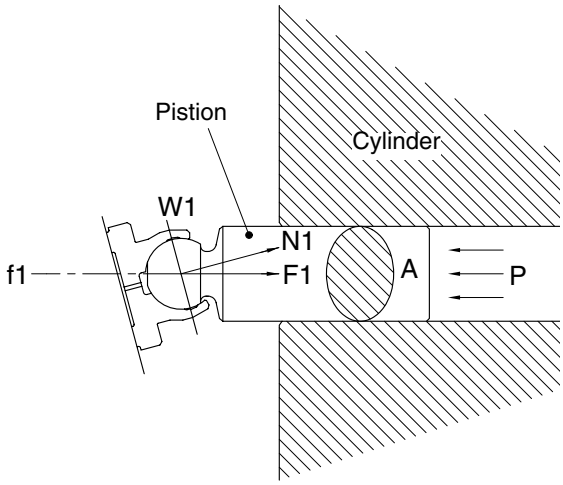
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle, α .

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

The sum of torque (ΣW1 × R1), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (10) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.





21078TM05

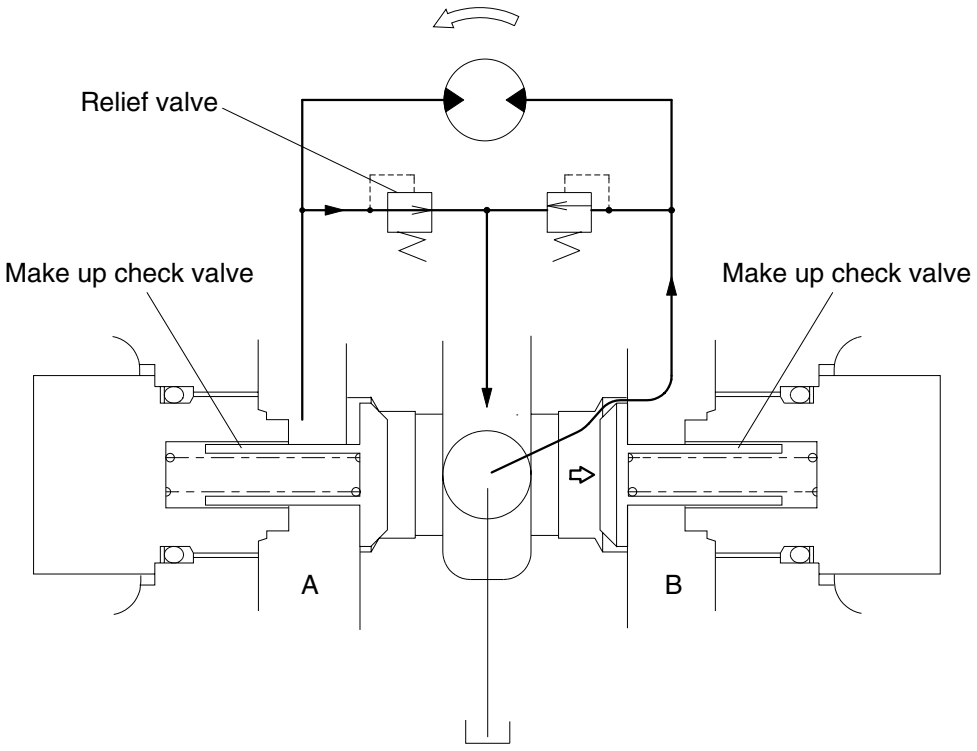
2) MAKE UP VALVE

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

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

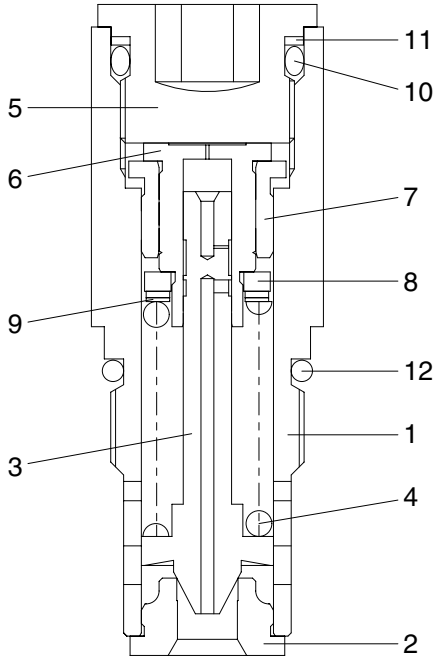
Pressurized oil into the port B, the motor rotate counterclockwise.

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



21092SM04

3) RELIEF VALVE



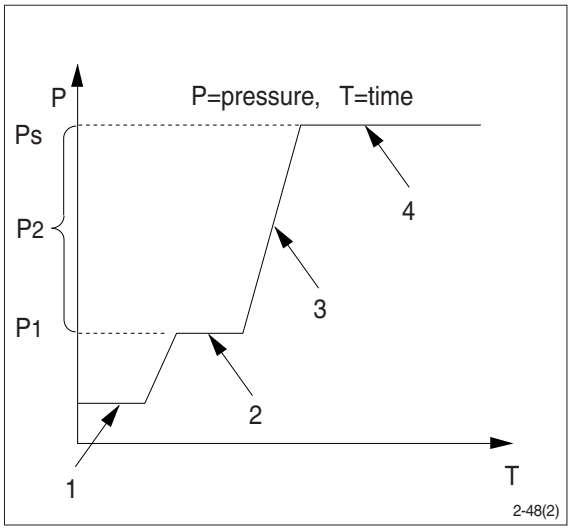
1	Body
2	Seat
3	Plunger
4	Spring
5	Adjusting screw
6	Piston
7	Bushing
8	Spring seat
9	Shim
10	O-ring
11	Back up ring
12	O-ring

(1) Construction of relief valve

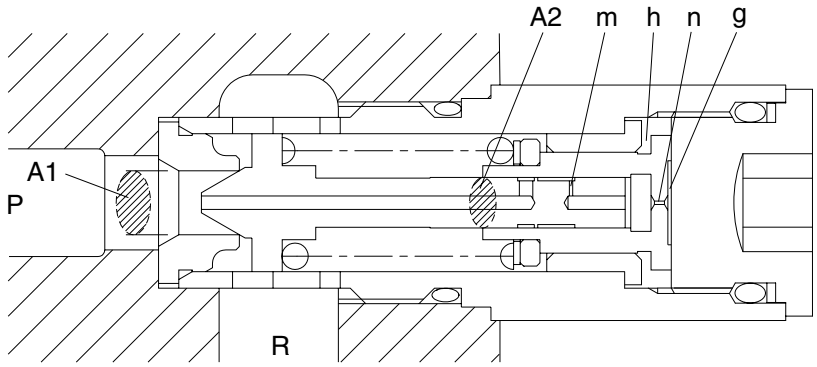
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

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



① Ports (P, R) at tank pressure.

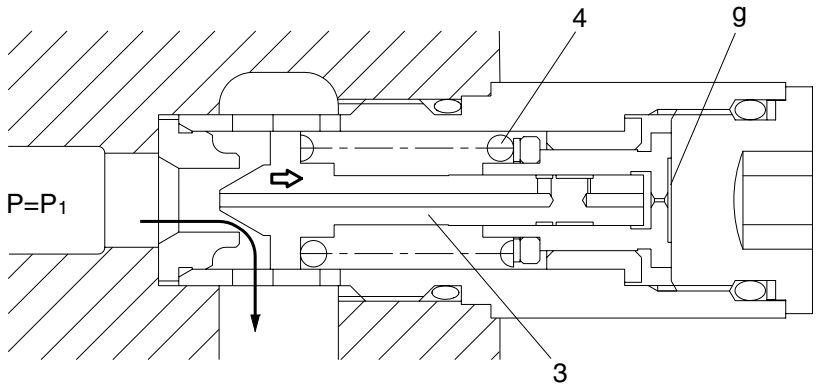


14007A2SM06

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

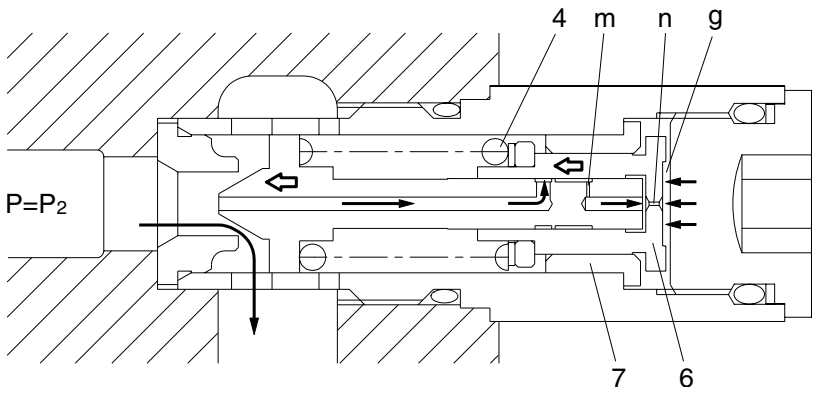
$P_1 \times A_1 = Fsp + Pg \times A_2$

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



14007A2SM07

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

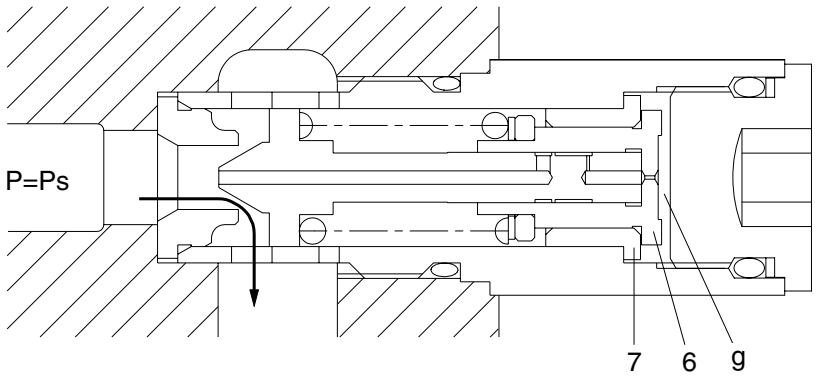


14007A2SM08

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

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

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



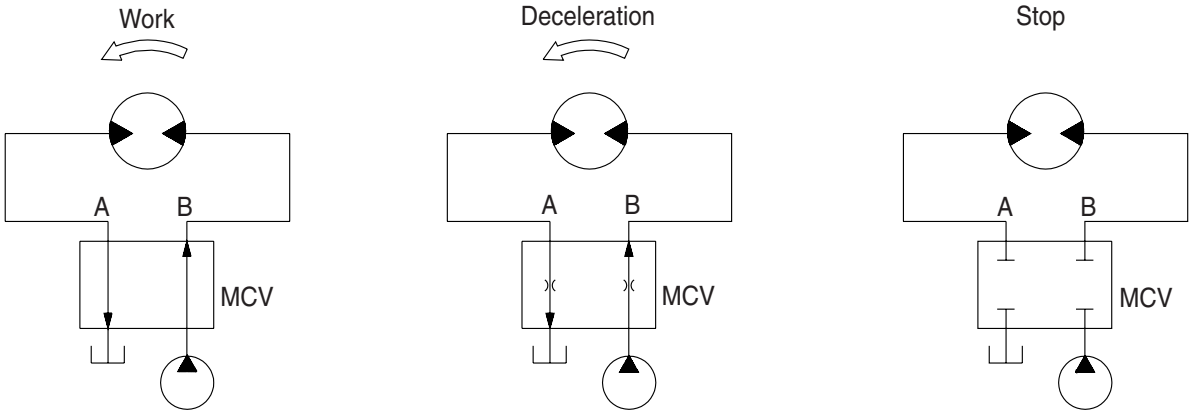
14007A2SM09

4) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



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

2-48(1)

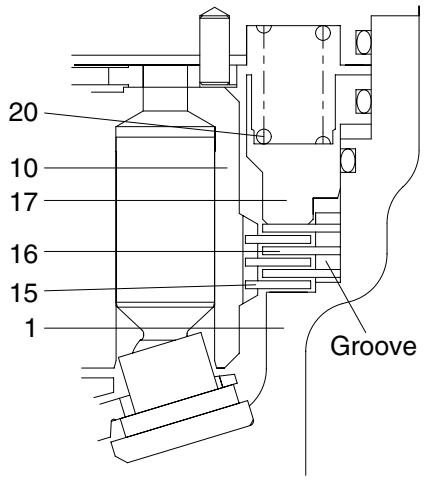
(2) Mechanical swing parking brake system

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

① Brake assembly

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

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

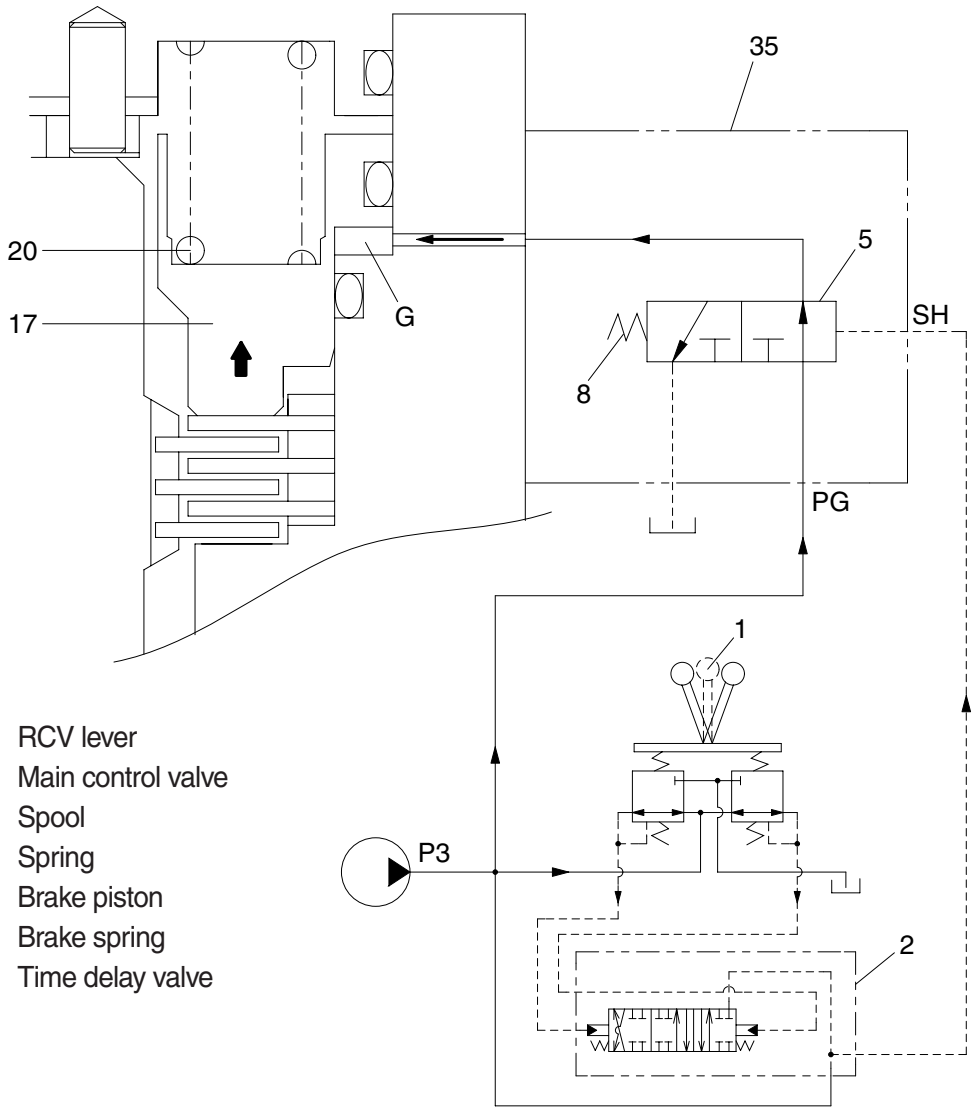


21092SM15

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

② **Operating principle**

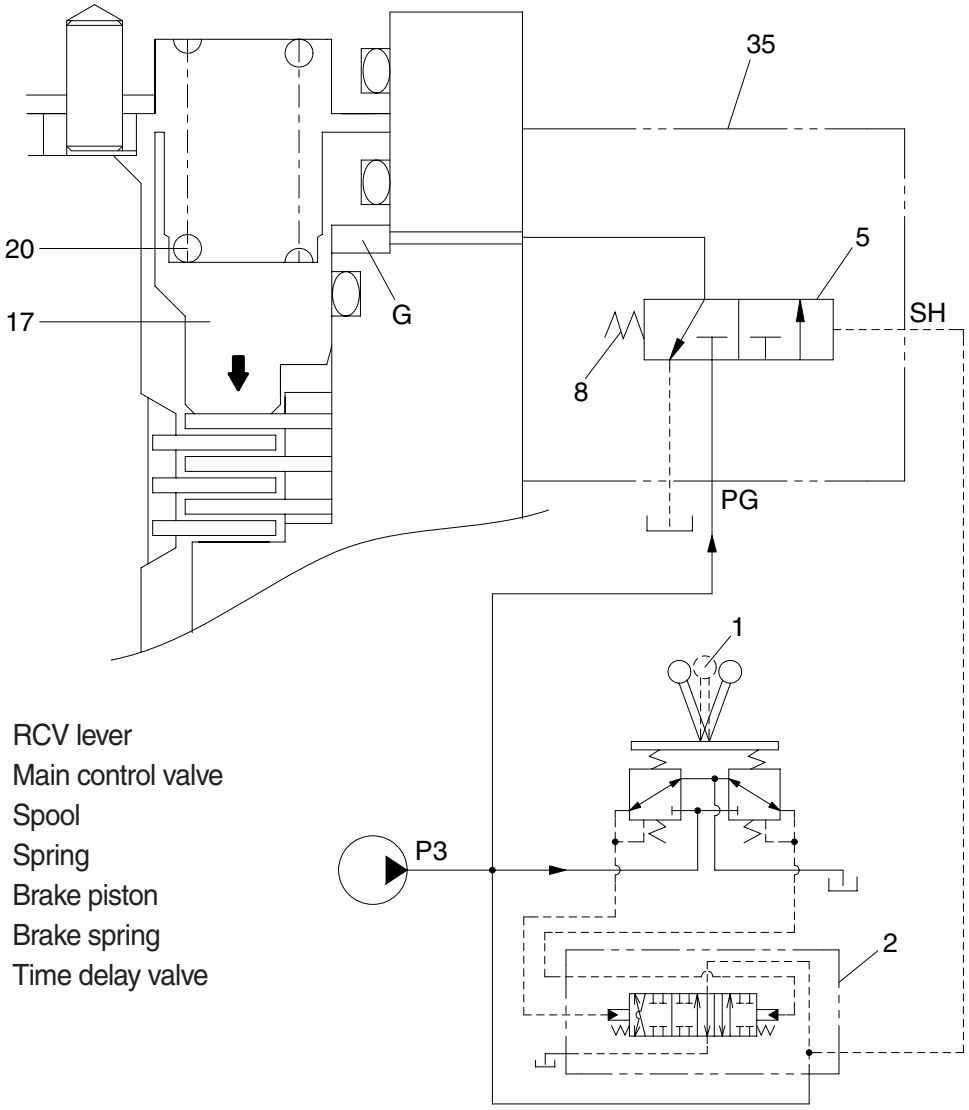
a. When one of the RCV lever (1) is set to the operation position, the each spool is shifted to left or right and the pilot oil flow is blocked. Then the pilot oil go to SH of the time delay valve (35). This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged 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

21092SM16

b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to right.
Then, the brake piston (17) is moved lower by spring force and the return oil from the chamber G flows back to tank port.
At this time, the brake works.



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

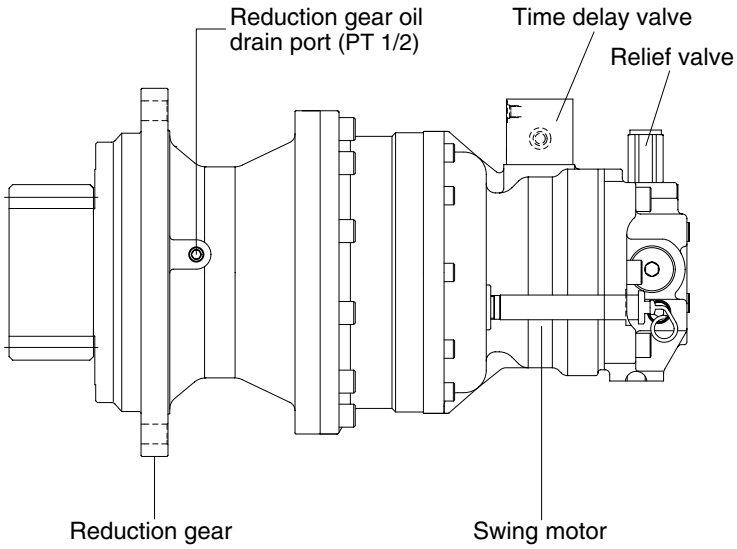
21092SM17

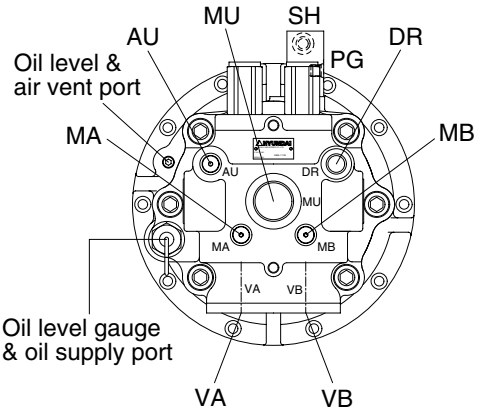
GROUP 3 SWING DEVICE (TYPE 2 & TYPE 3)

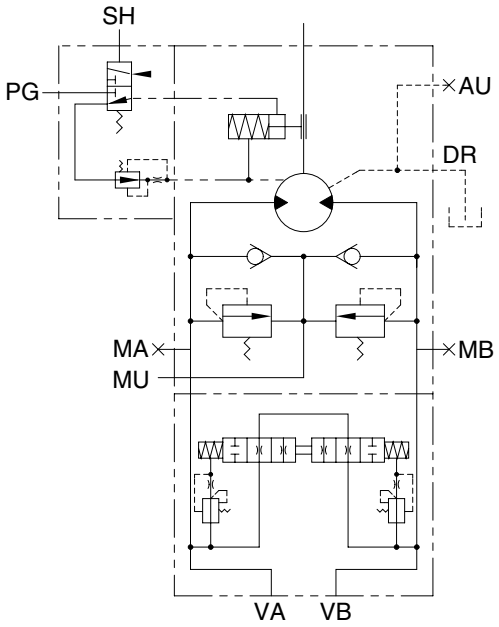
1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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





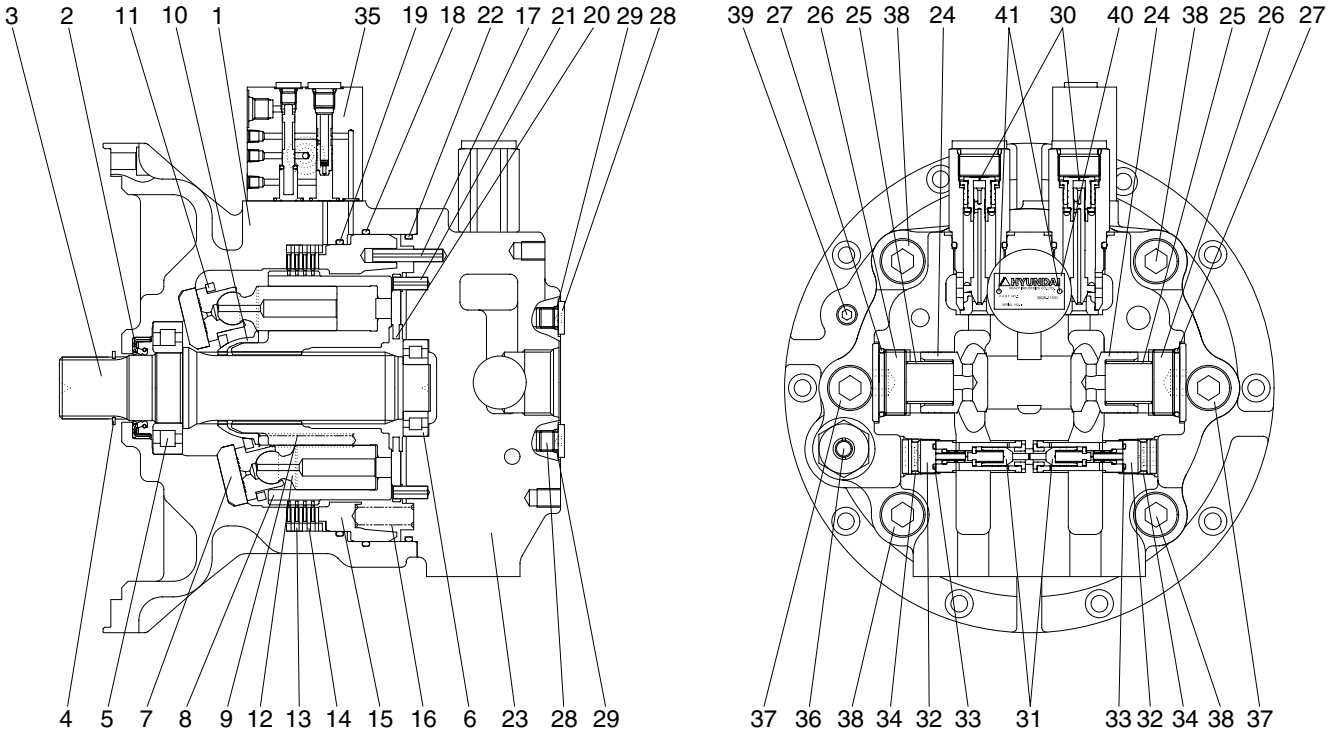


Hydraulic circuit

Port	Port name	Port size
VA	Main port	ø 20
VB	Main port	ø 20
DR	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
PG	Brake release port	PF 1/4
SH	Stand by port	PF 1/4
MA, MB	Gauge port	PF 1/4
AU	Air vent port	PF 1/4

2209A2SM21

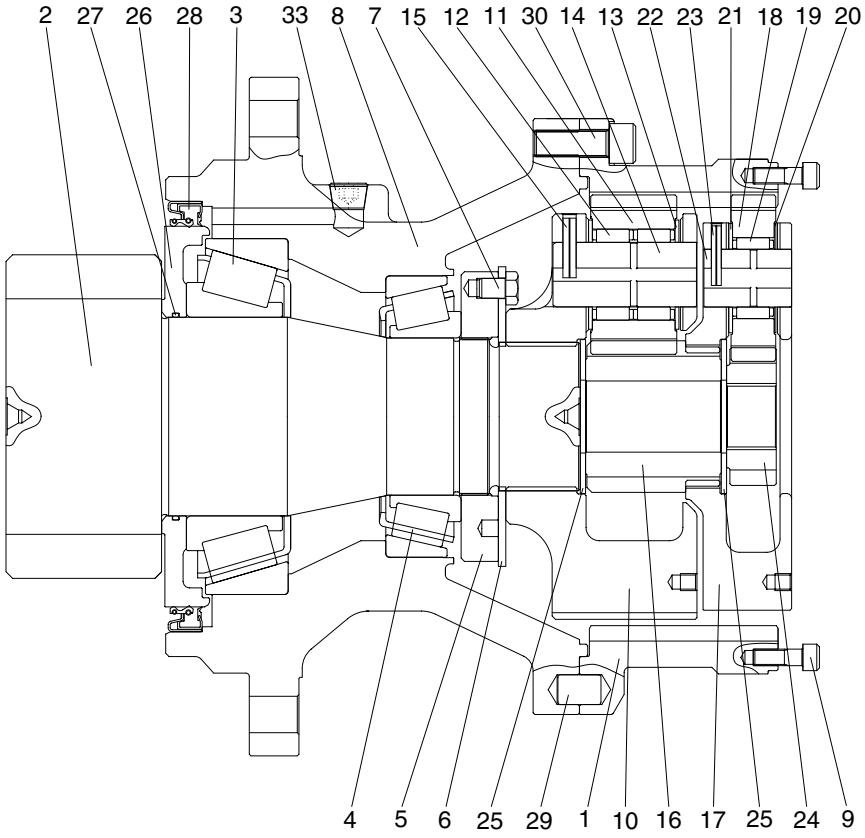
1) SWING MOTOR



2209A2SM22

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

2) REDUCTION GEAR



2209A2SM23

1	Ring gear	11	Planetary gear 2	21	Thrust washer 1
2	Drive shaft	12	Needle bearing 2	22	Carrier pin 1
3	Bearing	13	Thrust washer 2	23	Spring pin
4	Bearing	14	Carrier pin 2	24	Sun gear 1
5	Ring nut	15	Spring pin	25	Thrust plate
6	Lock plate	16	Sun gear 2	26	Sleeve
7	Hexagon bolt	17	Carrier 1	27	O-ring
8	Casing	18	Planetary gear 1	29	Parallel pin
9	Socket bolt	19	Needle bearing 1	30	Socket bolt
10	Carrier 2	20	Thrust washer 1	33	Plug

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 (23), 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).

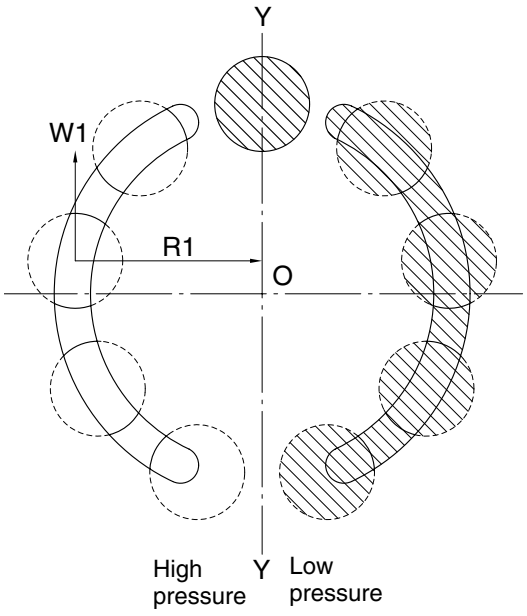
The high hydraulic can generate the force, F1=P × A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

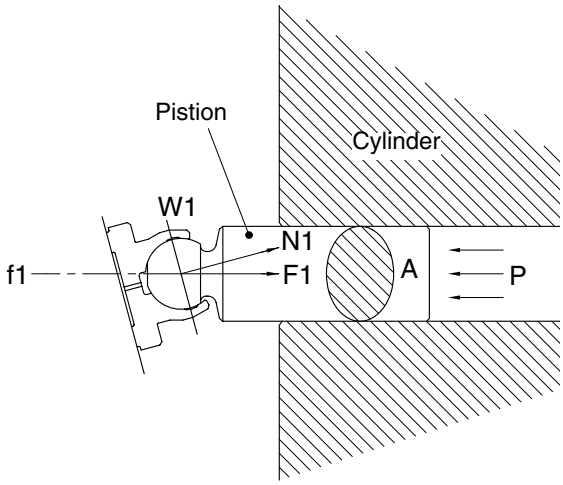
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle, α .

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

The sum of torque (ΣW1 × R1), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

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





21078TM05

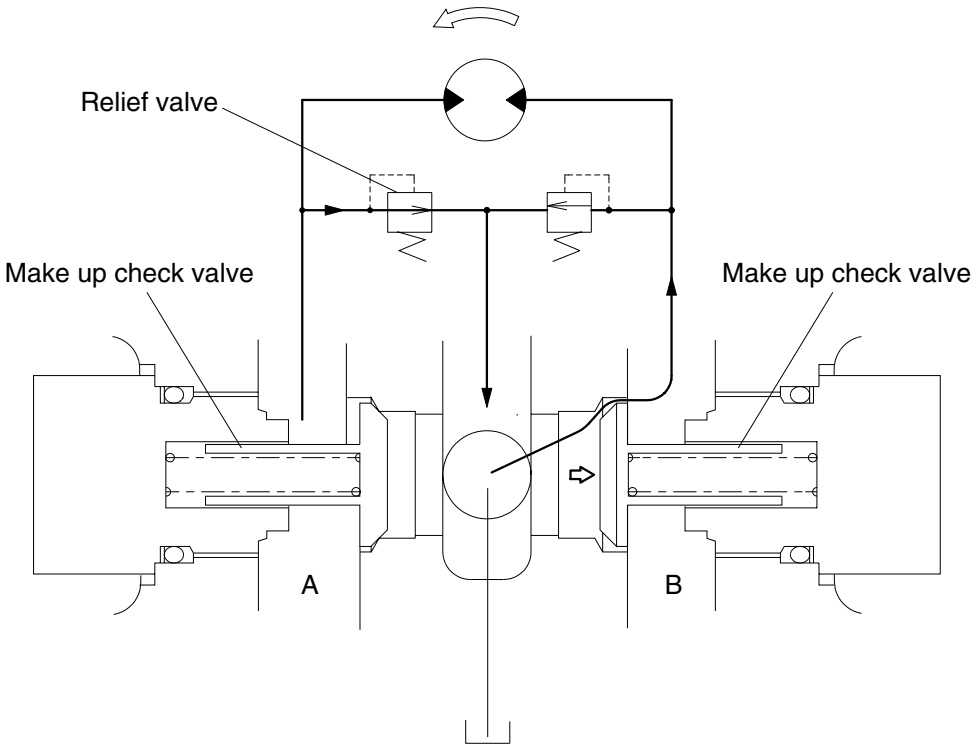
2) MAKE UP VALVE

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

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

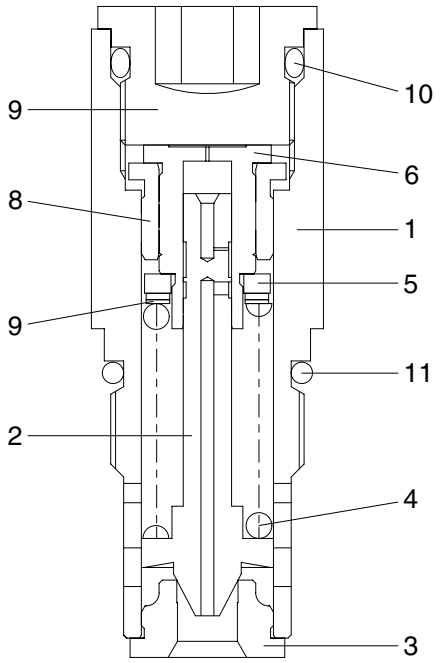
Pressurized oil into the port B, the motor rotate counterclockwise.

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



21092SM04

3) RELIEF VALVE



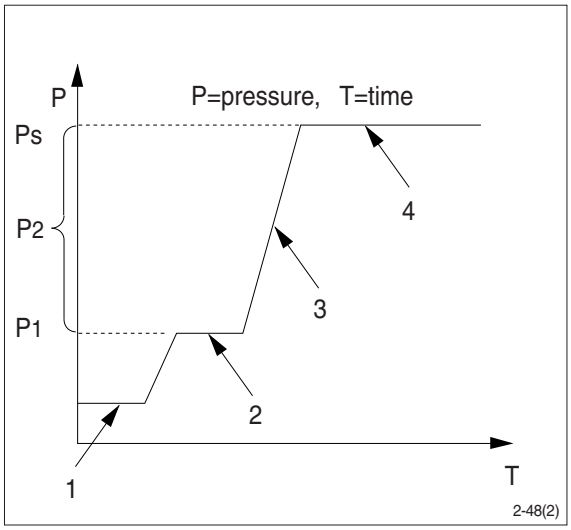
1	Sleeve
2	Poppet
3	Poppet seat
4	Spring
5	Spring seat
6	Shim
7	Piston
8	Stopper
9	Plug
10	O-ring
11	O-ring

(1) Construction of relief valve

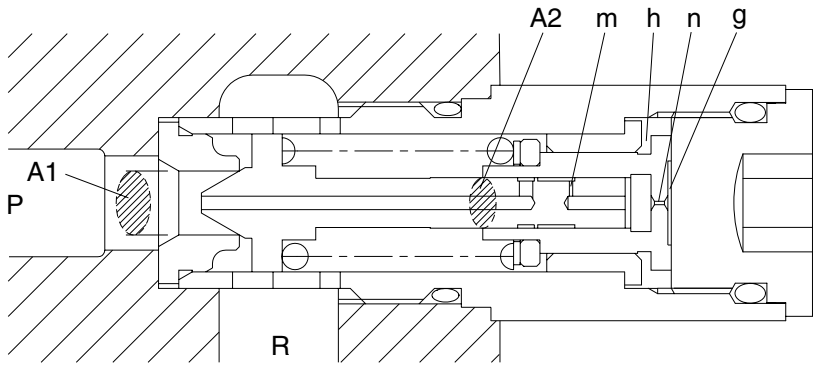
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(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.

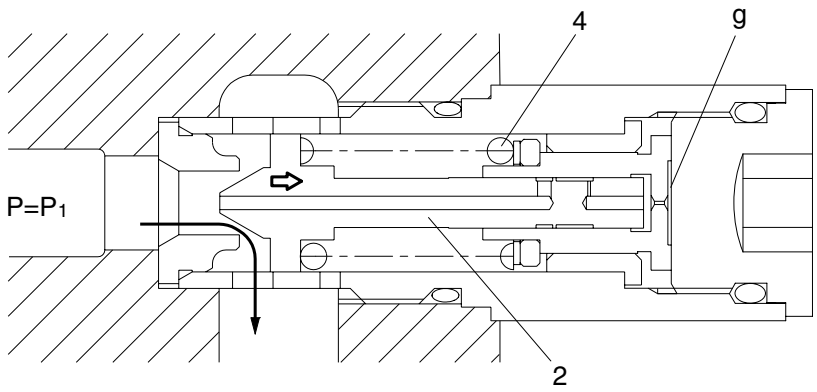


2209A2SM26

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

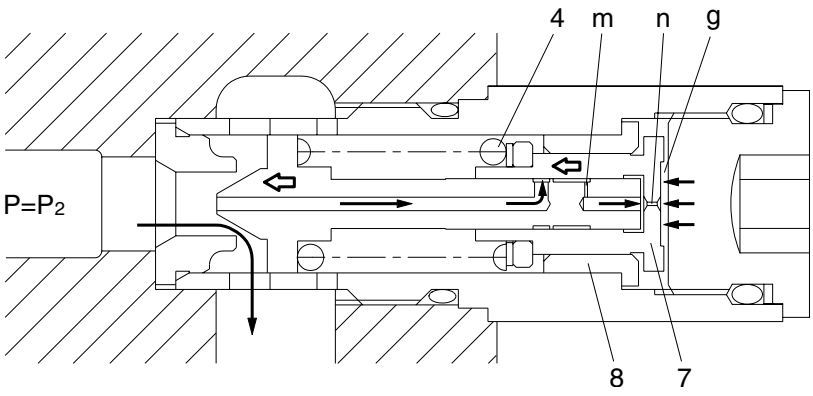
$P_1 \times A_1 = Fsp + Pg \times A_2$

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



2209A2SM27

③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F_{SP}) of spring (4), the piston (7) moves left and stop the piston (7) hits the bottom of bushing (8).

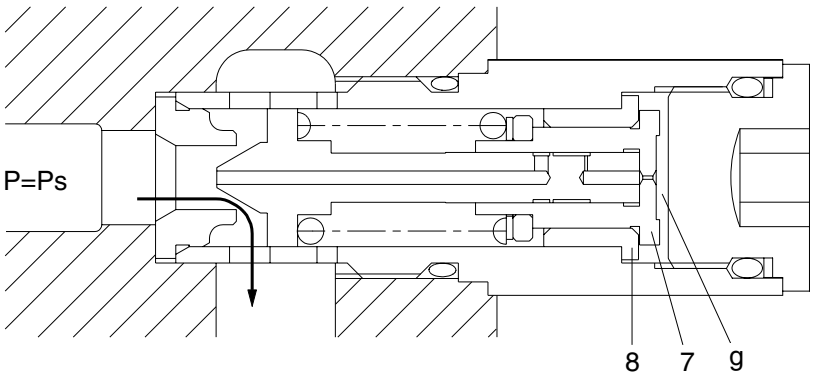


2209A2SM28

④ When piston (7) hits the bottom of bushing (8), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (Ps).

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

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



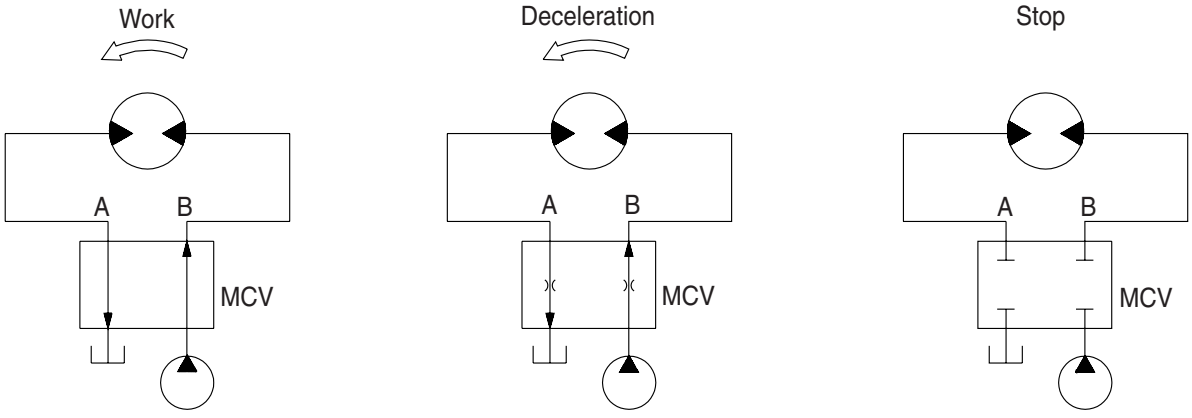
2209A2SM29

4) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



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

2-48(1)

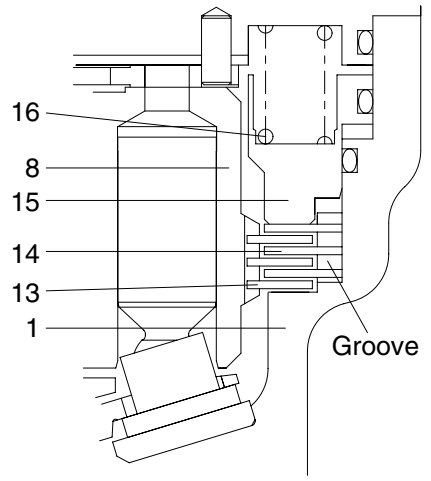
(2) Mechanical swing parking brake system

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

① Brake assembly

Circumferential rotation of separate plate (14) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (16) through friction plate (13), separate plate (14) and parking piston (15), friction force occurs there.

Cylinder block (8) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

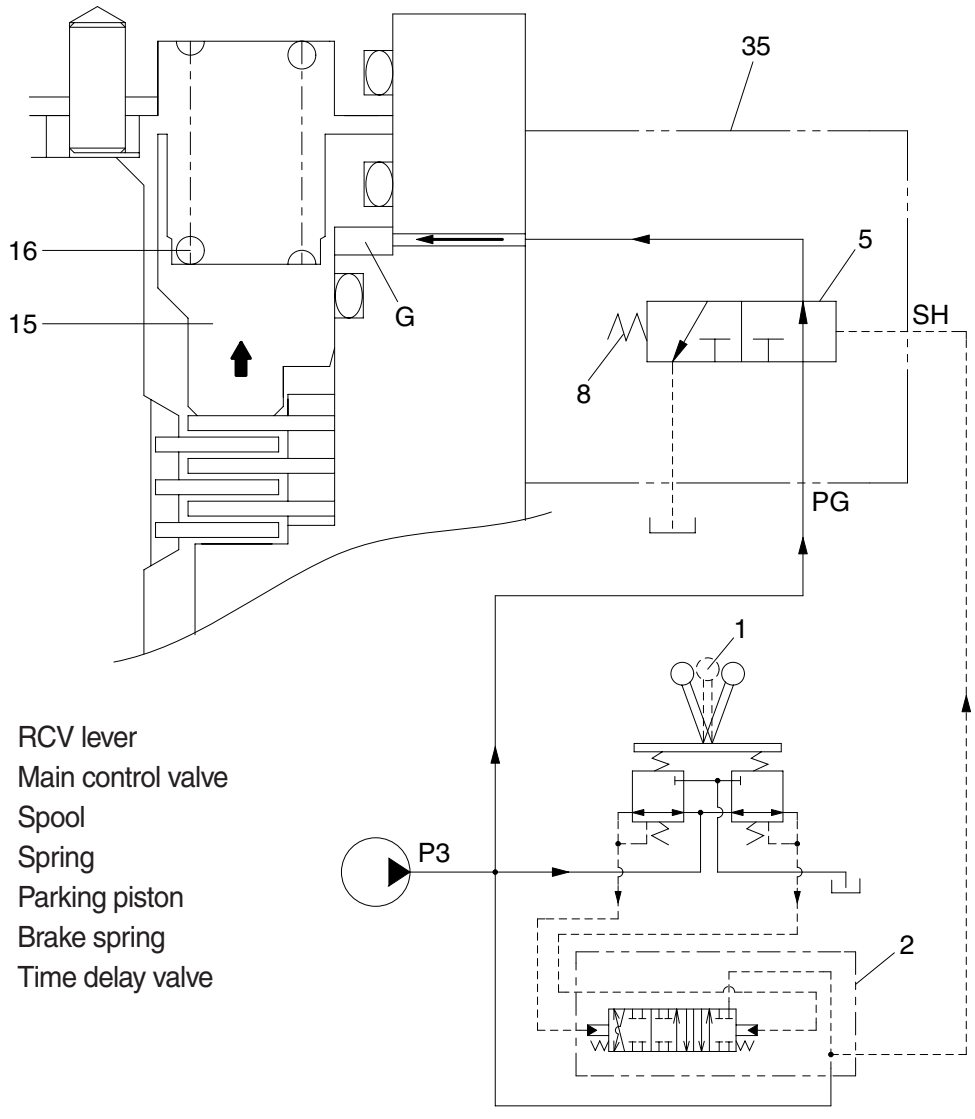


2209A2SM35

1	Casing	14	Separate plate
8	Cylinder block	15	Parking piston
13	Friction plate	16	Brake spring

② **Operating principle**

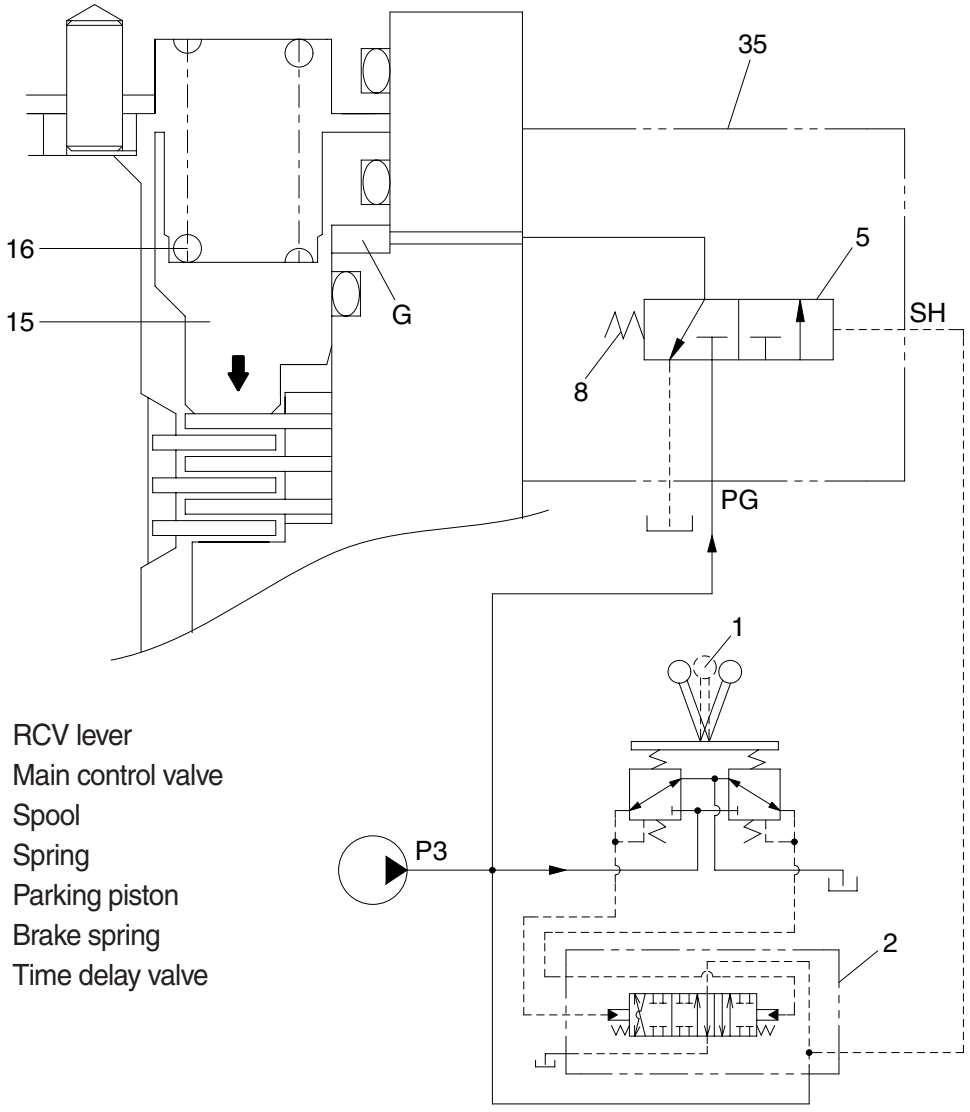
a. When one of the RCV lever (1) is set to the operation position, the each spool is shifted to left or right and the pilot oil flow is blocked. Then the pilot oil go to SH of the time delay valve (35). This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged oil (P3) goes to the chamber G through port PG.
This pressure is applied to move the parking piston (15) to the upward against the force of the brake spring (16). Thus, it releases the brake force.



1 RCV lever
2 Main control valve
5 Spool
8 Spring
15 Parking piston
16 Brake spring
35 Time delay valve

2209A2SM36

b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to right.
Then, the parking piston (15) is moved lower by spring force and the return oil from the chamber G flows back to tank port.
At this time, the brake works.



1 RCV lever
2 Main control valve
5 Spool
8 Spring
15 Parking piston
16 Brake spring
35 Time delay valve

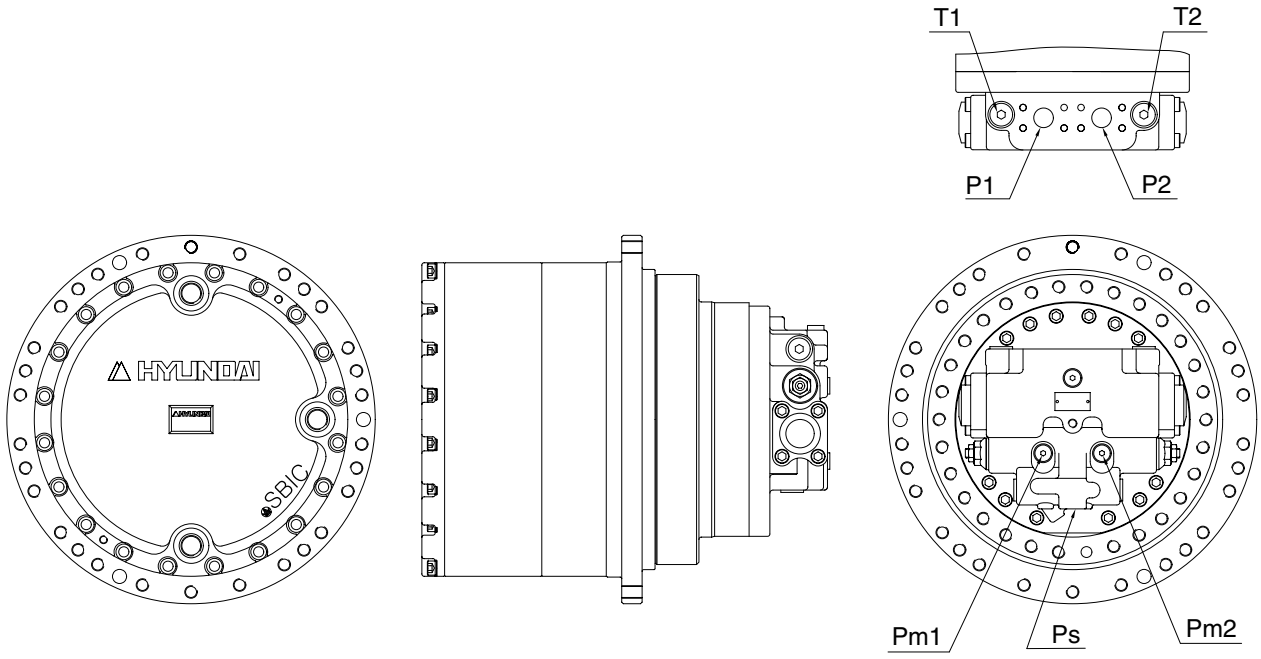
2209A2SM37

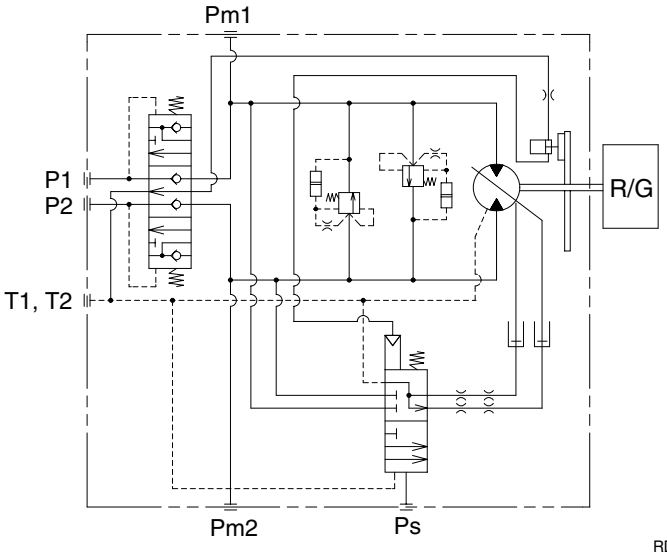
GROUP 4 TRAVEL DEVICE

1. STRUCTURE

A hydraulic motor includes followings.

- Part of rotary generating turning force
- Part of a valve of relief
- Part of Brake
- Part of a valve of counterbalance
- Part of flowing changeover
- Part of auto changeover

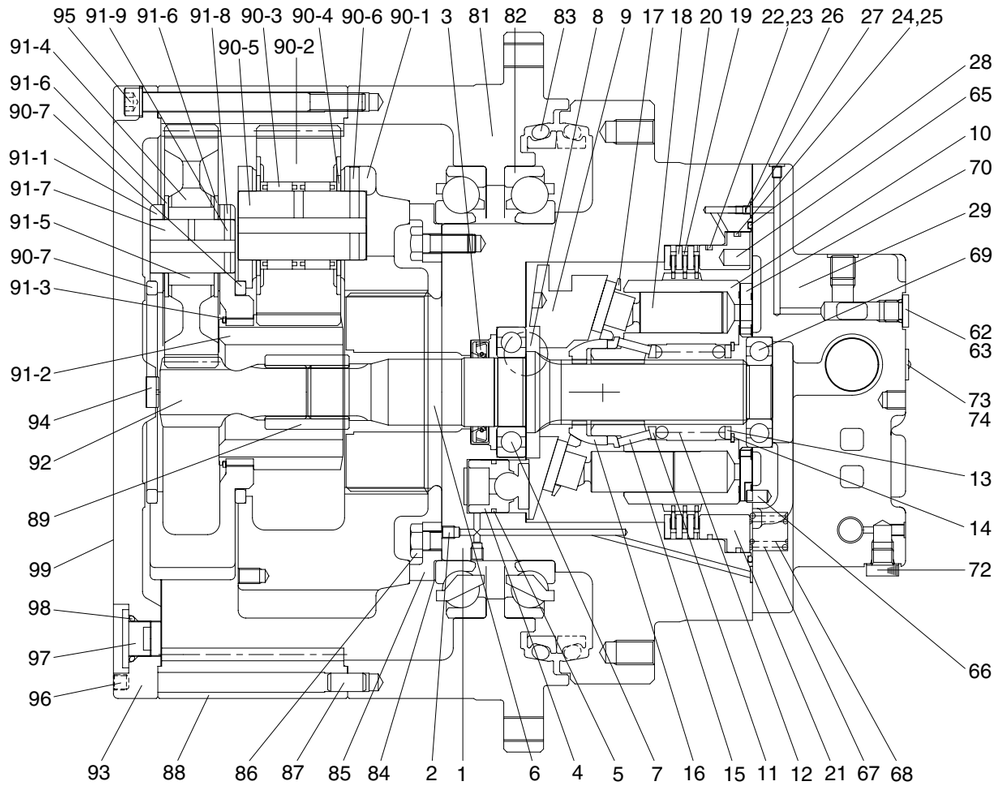


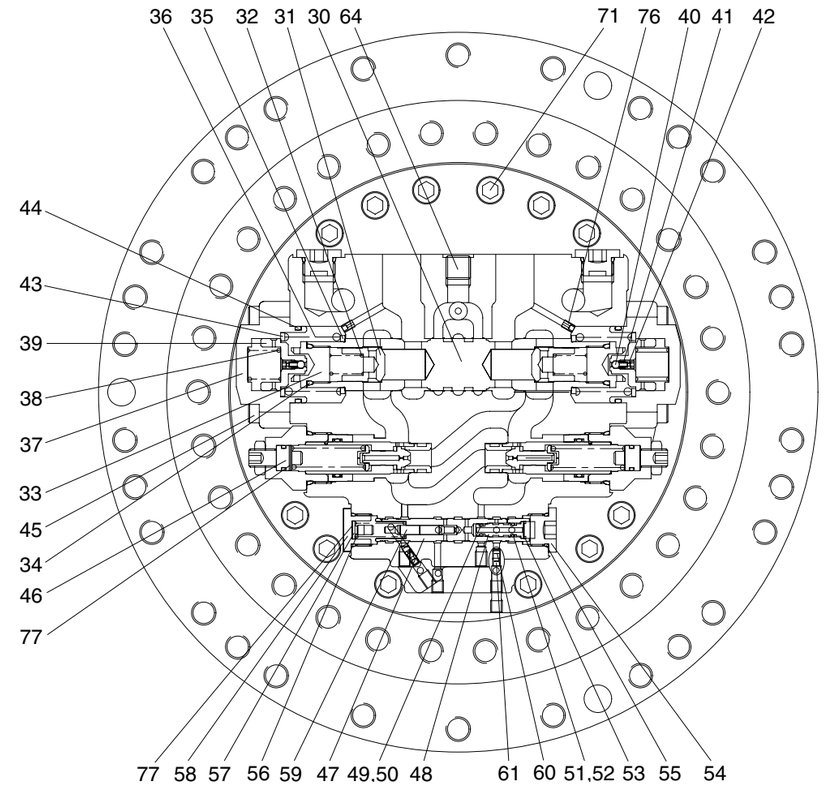


RD21072TM12

Port	Port name	Port size
P_1, P_2	Main port	SAE 1"
P_{m1}, P_{m2}	Gauge port	PF 1/4
T_1, T_2	Drain port	PF 1/2
P_s	2 speed control port	PF 1/4

1) STRUCTURE





2107V2TM02

1	Shaft casing	20	Plate	39	Spool	58	Plug
2	Plug	21	Packing piston	40	Steel ball	59	Spool
3	Oil seal	22	O-ring	41	Spring	60	Orifice
4	Swash piston	23	Back up ring	42	Plug	61	Orifice
5	Piston ring	24	O-ring	43	Spring seat	62	Plug
6	Shaft	25	Back up ring	44	O-ring	63	O-ring
7	Bearing	26	Orifice	45	Wrench bolt	64	Plug
8	Steel ball	27	O-ring	46	Relief valve assy	65	Pin
9	Swash plate	28	O-ring	47	Spool	66	Pin
10	Cylinder block	29	Rear cover	48	Guide	67	Spring
11	Spring seat	30	Spool	49	O-ring	68	Spring
12	Spring	31	Check	50	Back up ring	69	Bearing
13	End plate	32	Spring	51	O-ring	70	Valve plate
14	Snap ring	33	Plug	52	Back up ring	71	Wrench bolt
15	Pin	34	O-ring	53	Snap ring	72	Plug
16	Ball guide	35	Spring seat	54	plug	73	Name plate
17	Set plate	36	Spring	55	O-ring	74	Rivet
18	Piston assy	37	Cover	56	Spring	75	Seal kit
19	Friction plate	38	Spring	57	Spring seat	76	Orifice

77	Shim	91-1	Carrier No.1
81	Housing	91-2	Sun-gear No.2
82	Main bearing	91-3	Retaining ring
83	Floating seal	91-4	Planetary gear No.1
84	Shim	91-5	Needle bearing No.1
85	Retainer	91-6	Thrust washer
86	Hex head bolt	91-7	Pin No.1
87	Parallel pin	91-8	Spring pin
88	Ring gear	91-9	Spring pin
89	Coupling	92	Sun gear No.1
90	Carrier assy No.2	93	Cover
90-1	Carrier No.2	94	Pad
90-2	Planetary gear No.2	95	Hex socket head bolt
90-3	Needle bearing No.2	96	Hex socket Screw
90-4	Thrust washer	97	Hydraulic plug
90-5	Pin No.2	98	O-ring
90-6	Spring pin	99	Name plate
90-7	Thrust ring		
91	Carrier assy No.1		

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder(10) through valve casing of motor(29), and valve plate(77).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston(18).

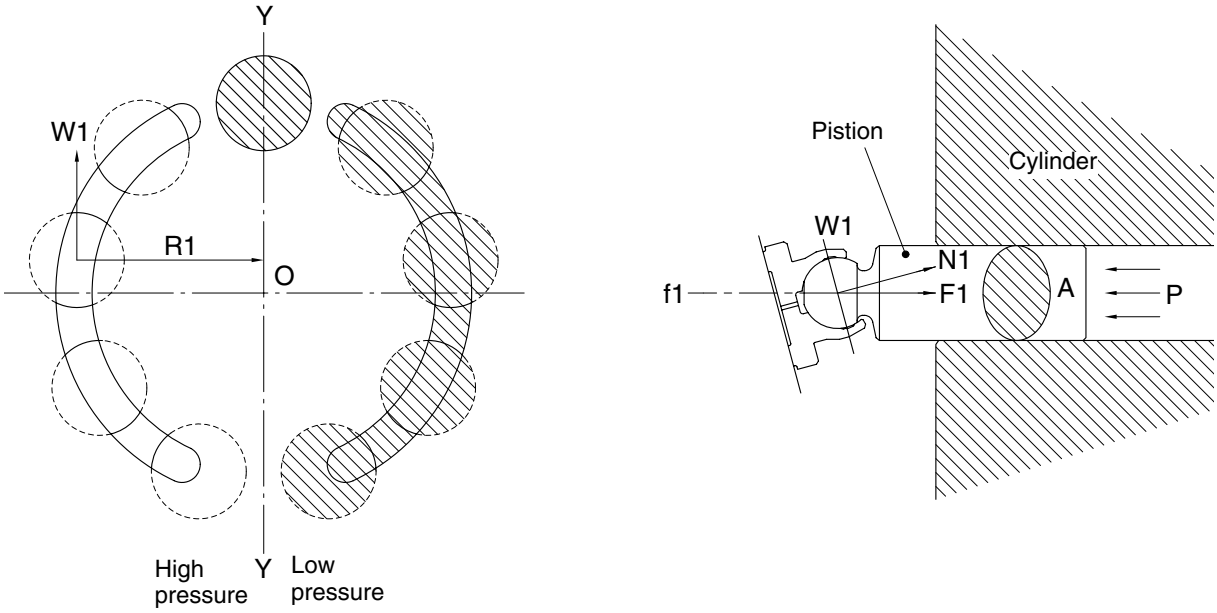
The high hydraulic can generate the force, F1 = P × A(P : Supplied pressure, A : water pressure area), like following pictures, working on a piston.

This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate(09) of a tilt angle, α.

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

The sum of torque(ΣW1 × R1), generated from each piston(4~5pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder(10) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



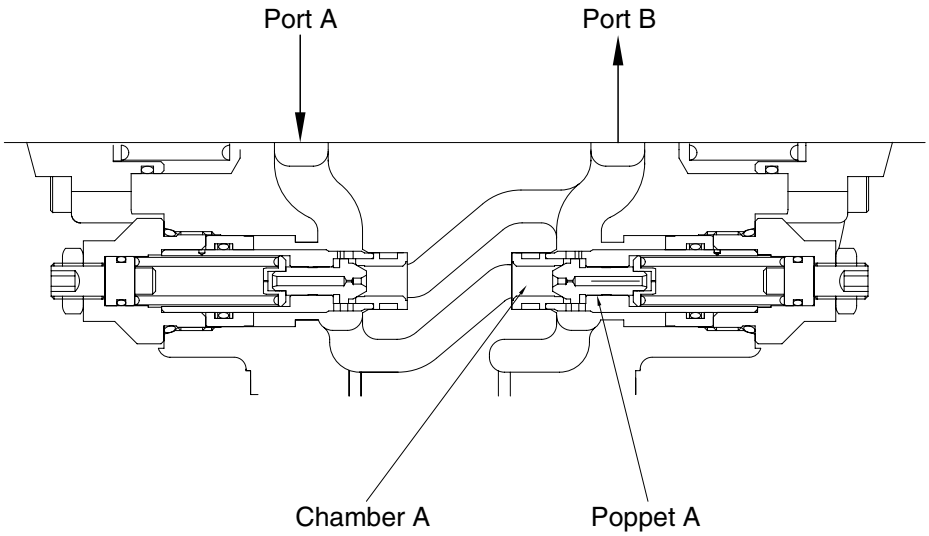
21078TM05

2.2 Working of relief valve

Relief valve carries on two functions of followings.

1) It standardizes a pressure in case of driving a hydraulic motor ; bypasses and extra oil in a motor inlet related to acceleration of an inertia to an outlet.

2) In case of an inertia stopped, it forces an equipment stopped, according to generating the pressure of a brake on the projected side.
   Room A is always connected with port A of a motor. If the pressure of port is increased, press poppet A. And if it is higher than the setting pressure of a spring, the oil of an hydraulic flows from room A to port B, because poppet A is detached from the contact surface of seat A.



21078TM06A

2.3 Working of negative brake

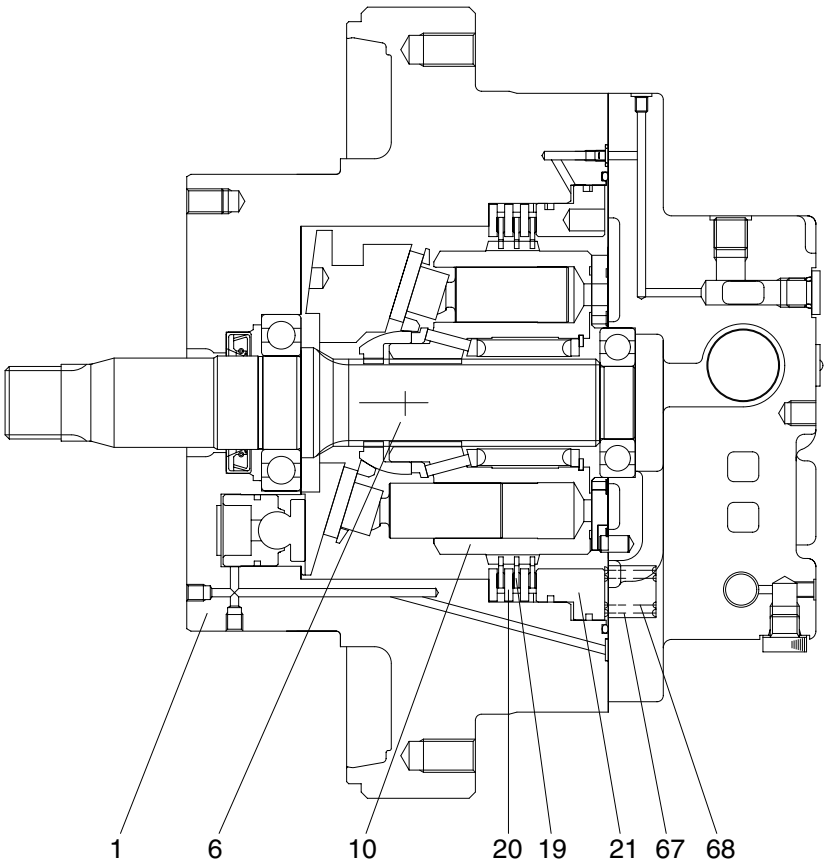
When the operating pressure is supplied to the brake piston (21) through the spool (simultaneous peripheral operation online) built in the valve casing (29), the negative brake is released.

When the pressure does not work, the brake always runs.

The force of a brake is generated by the frictional force among a separate plate (20) fixed by shaft casing, parking piston (21) and a frictional plate (19) connected through spline outside a cylinder block (10).

When a pressure does not work on the part of piston, brake spring presses brake piston; oil in a brake room flows into the drain of a motor through an orifice; in that time, brake piston compresses a frictional plate and a detached plate in the middle of shaft casing and brake piston according to the force that presses 10 pieces of brake springs (67, 68); finally, it makes a frictional force.

This frictional force helps the brake fixing a turning shaft (6) connected by a cylinder and spline operated.

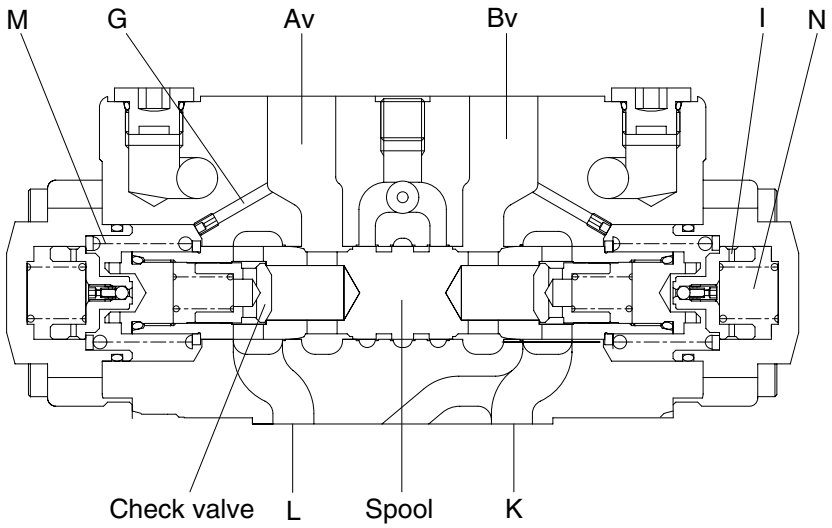


21092TM07

2.4 Counterbalance valve

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

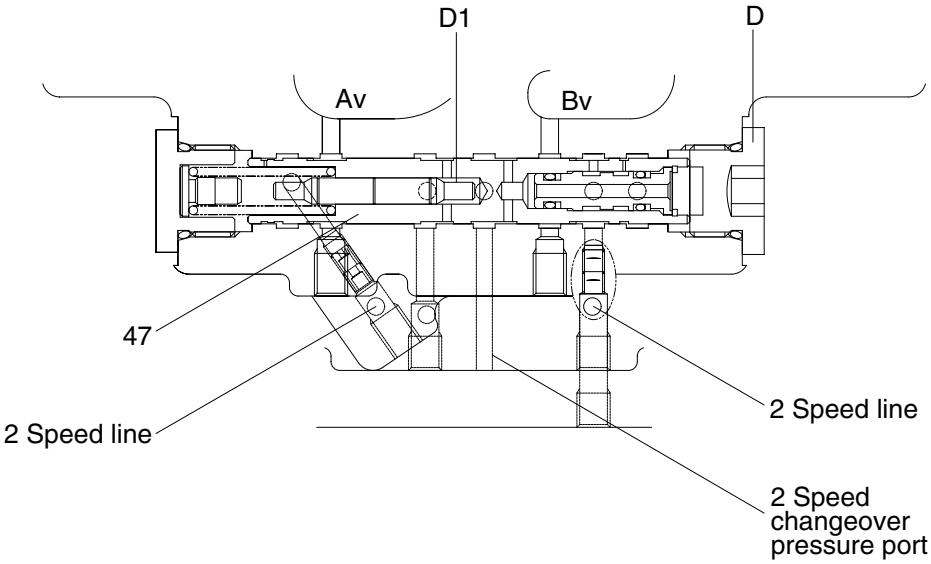
An oil supplied from a hydraulic pump presses check valve and flows into L port. It makes a hydraulic motor circulated. The oil pressure out of a pump is increased and transferred to spring room M through the path G because negative brake is working on. When the pressure of room M exceeds the force of spring that keeps spool at its neutral position, the spool begins to move the right side.
An oil in room N is sent to room M by orifice I and discharged from G line to a tank.
Then the spool moves to the right and the oil flows from K to Bv.



21078TM08

2.5 Working description of automatic switch(at normal speed)

Due to no pressure on pilot now, spool(47) is not working.



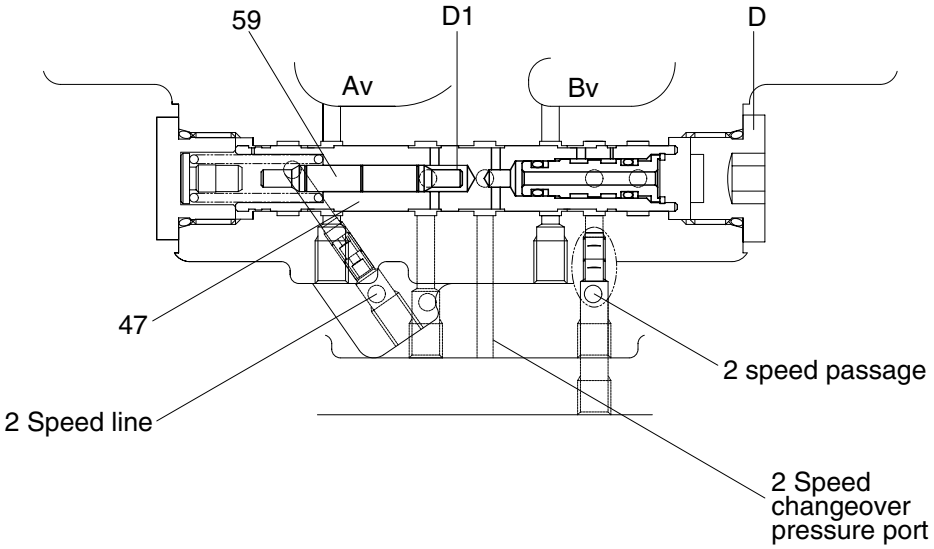
(Normal Speed)

21078TM09

2.6 Working description of automatic switch(at high speed)

At normal speed, once the hydraulic oil which is through the inner path of spool(47) flows into high speed switching pressure port(The pressure of external pilot : Pi = 35kgf/cm^2) spool(47) moves from right to left.

At high speed, turning pressure of motor(D1) is over 250kgf/cm^2, when the power forcing to spool(59) (pressure, P1) is stronger than spool(47) and spool(59) is pushed out, after then spool(47) moves from left to right. So it is switched.



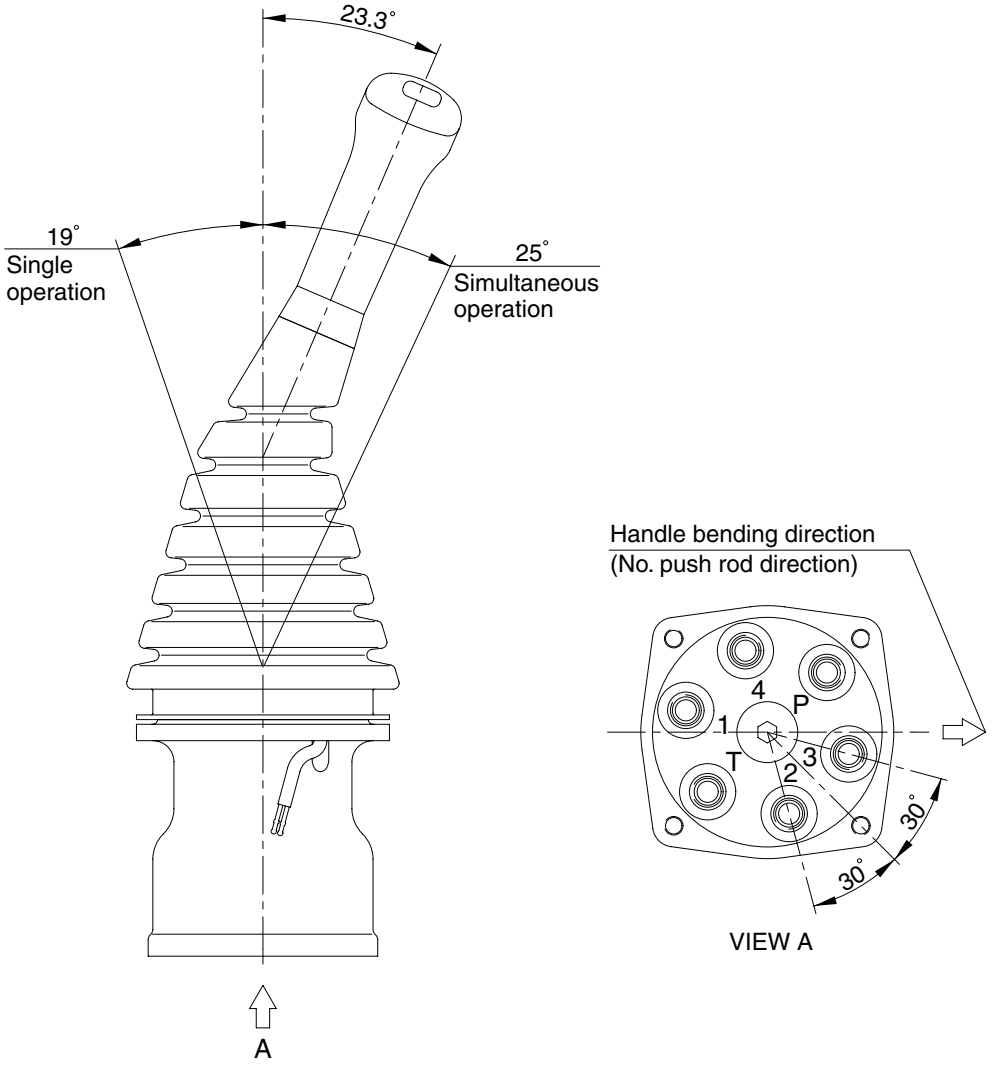
(High Speed)

21078TM10

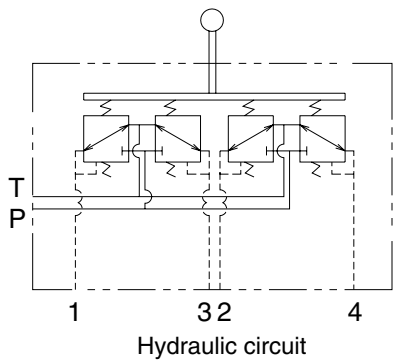
GROUP 5 RCV LEVER

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.



25032RL01A



Hydraulic circuit

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

CROSS SECTION

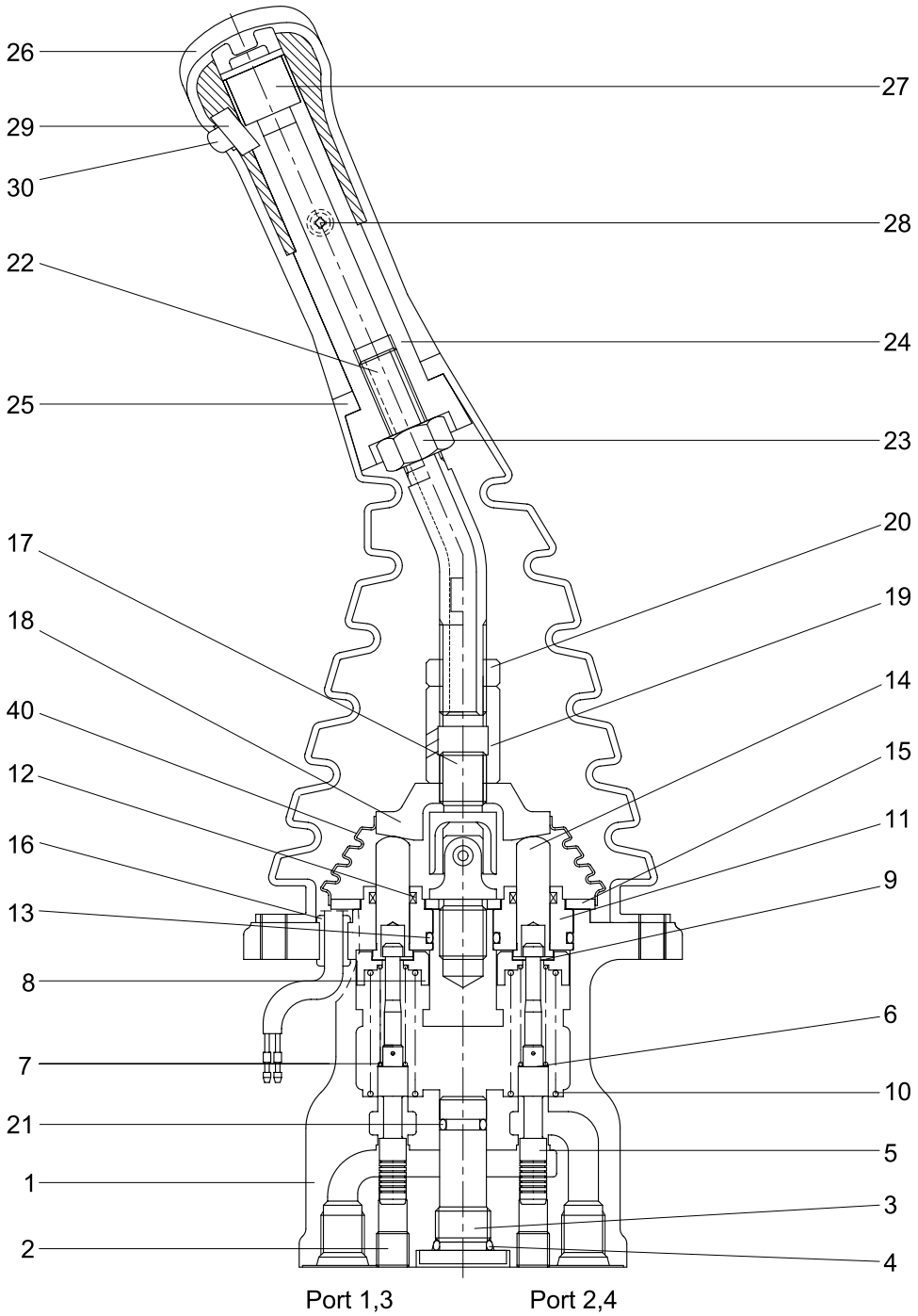
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool(5), spring(7) for setting secondary pressure, return spring(10), stopper(9), spring seat(8) and shim(6). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5kgf/cm^2(Depending on the type). The spool is pushed against the push rod(14) by the return spring.

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

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

CROSS SECTION



14072SF80

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

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

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

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool(5) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1,2,3 & 4 or the output port pressure oil to tank port T.

The spring(7) works on this spool to determine the output pressure.

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

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

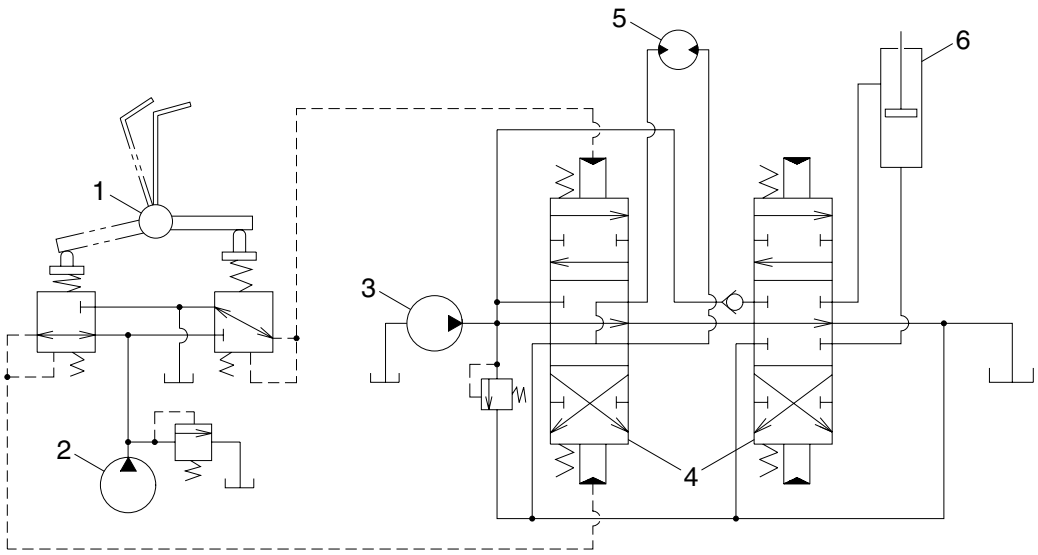
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

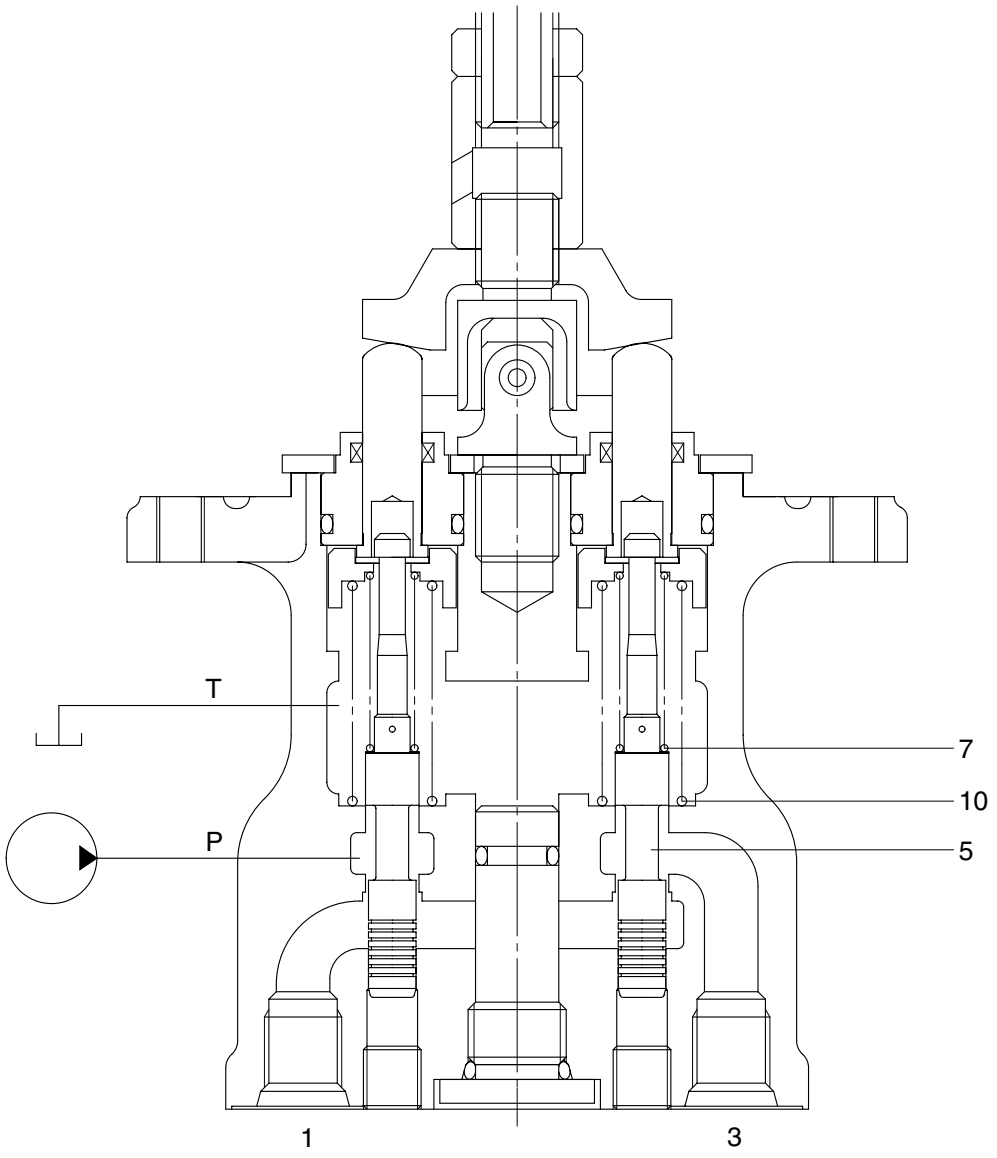
The diagram shown below is the typical application example of the pilot valve.



36072SF01

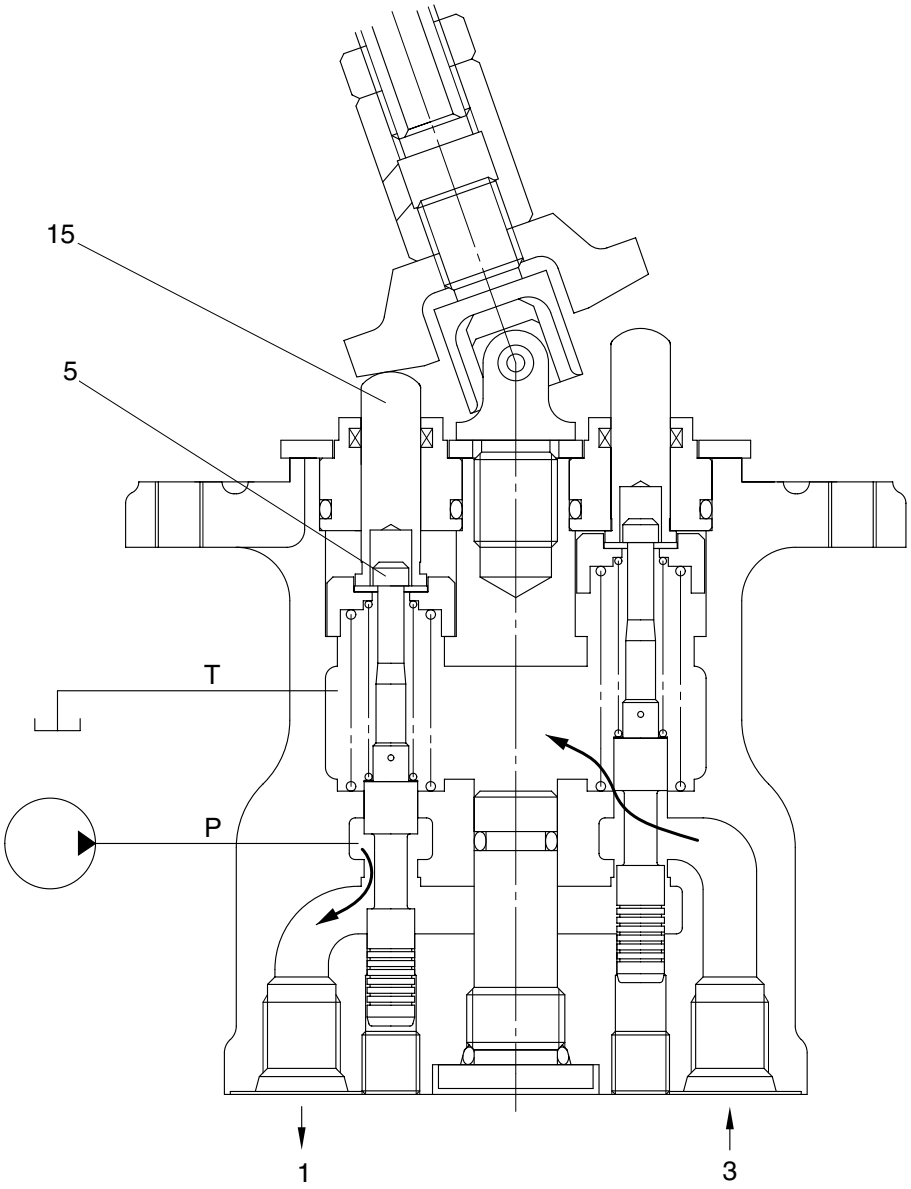
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where handle is in neutral position



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

(2) Case where handle is tilted



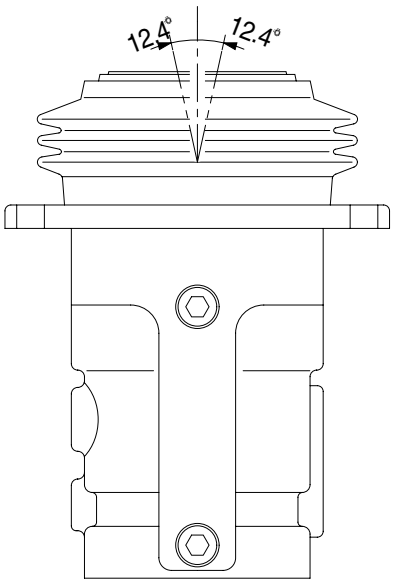
25032RL04

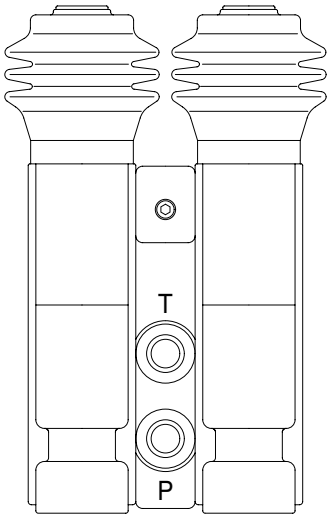
When the push rod(14) is stroked, the spool(5) moves downwards.
Then port P is connected with port(1) and the oil supplied from the pilot pump flows through port(1) to generate the pressure.
When the pressure at port(1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port(1) increases higher than the set pressure, port P is disconnected from port(1) and port T is connected with port(1). If it decreases lower than the set pressure, port P is connected with port(1) and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

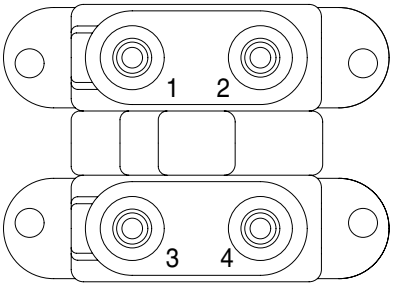
GROUP 6 RCV PEDAL

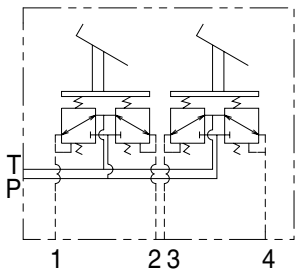
1. STRUCTURE

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









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)	

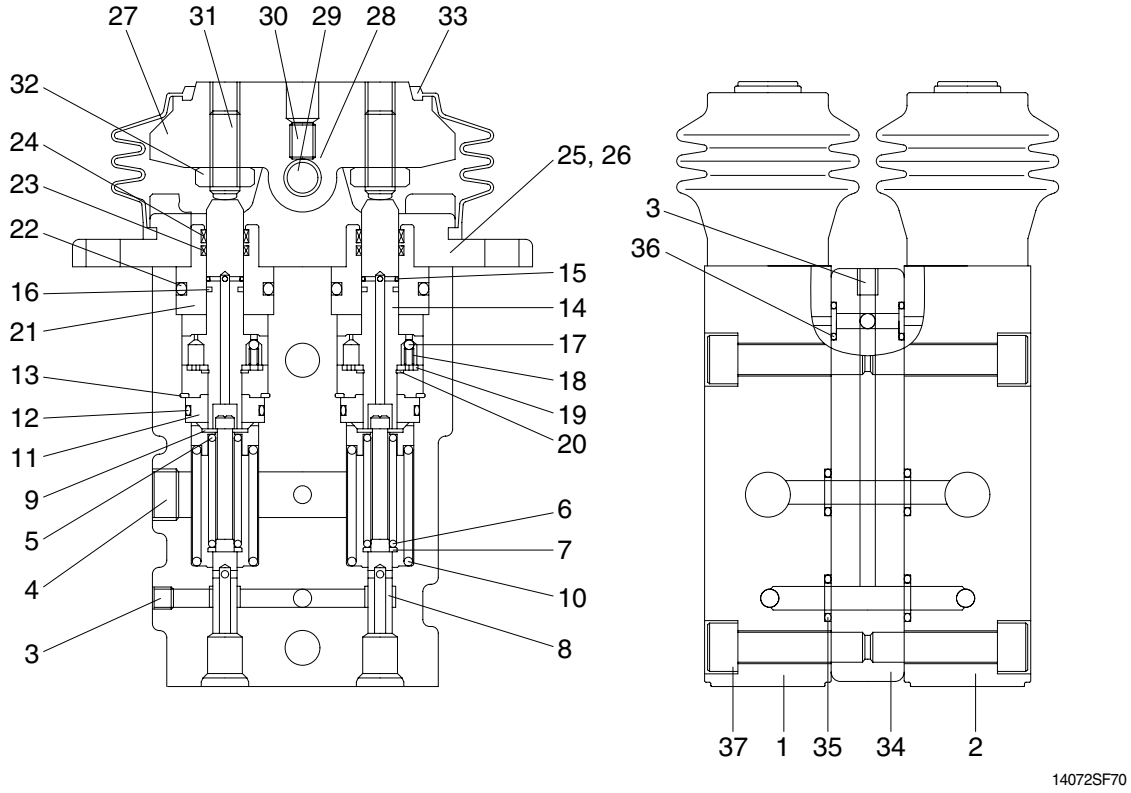
14072SF73

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 19kgf/cm^2 (depending on the type). The spool is pushed against the push rod(14) by the return spring.

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



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

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

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

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

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

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

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

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

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

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

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

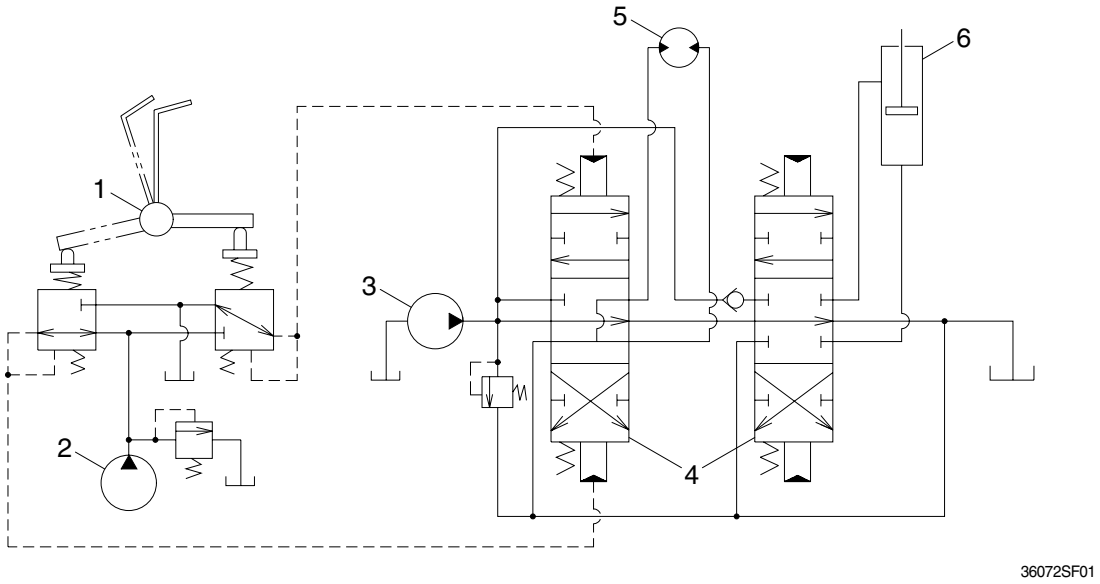
The spring(10) works on the casing(1) and spring seat(7) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

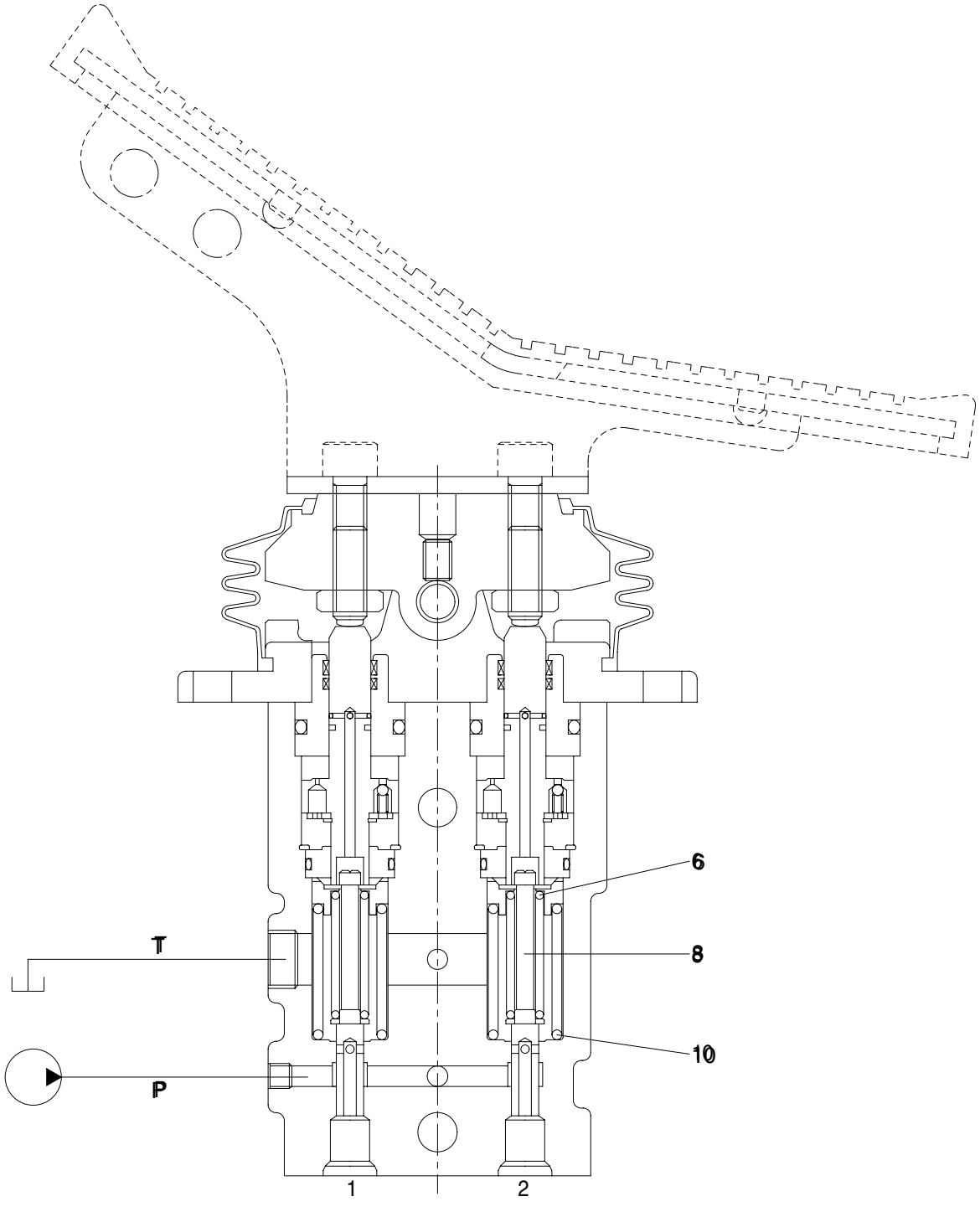
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below ant the attached operation explanation drawing.

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



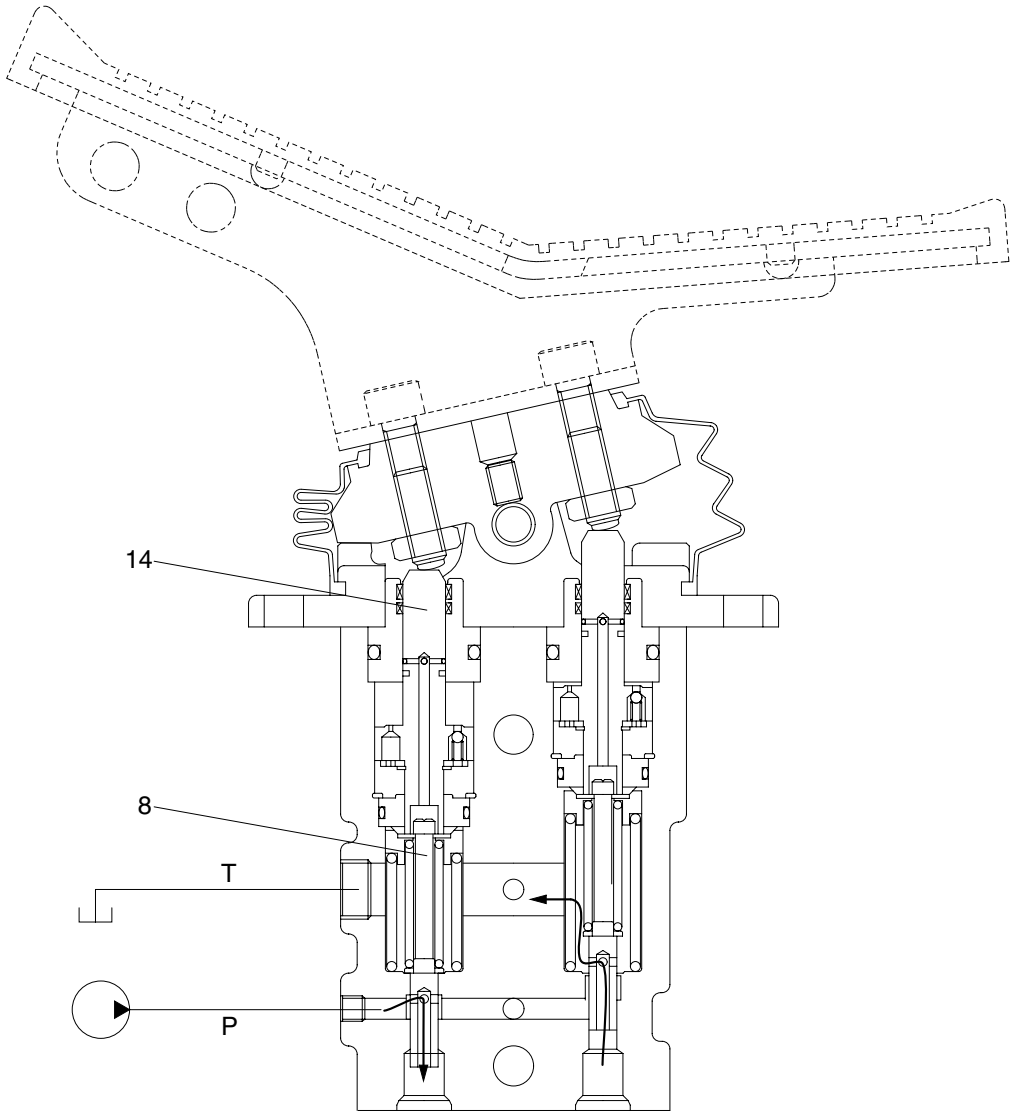
1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

(1) Case where pedal is in neutral position



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

(2) Case where pedal is tilted



14072SF75

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