

SECTION 2 STRUCTURE AND FUNCTION

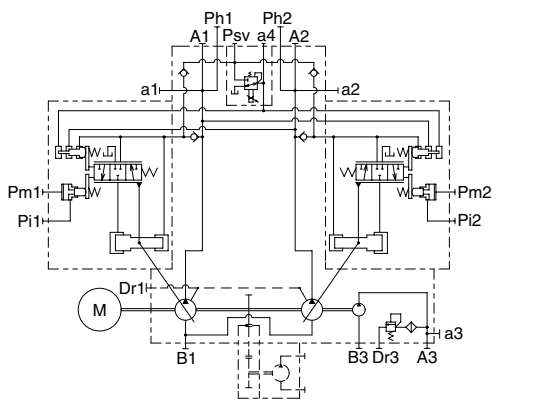
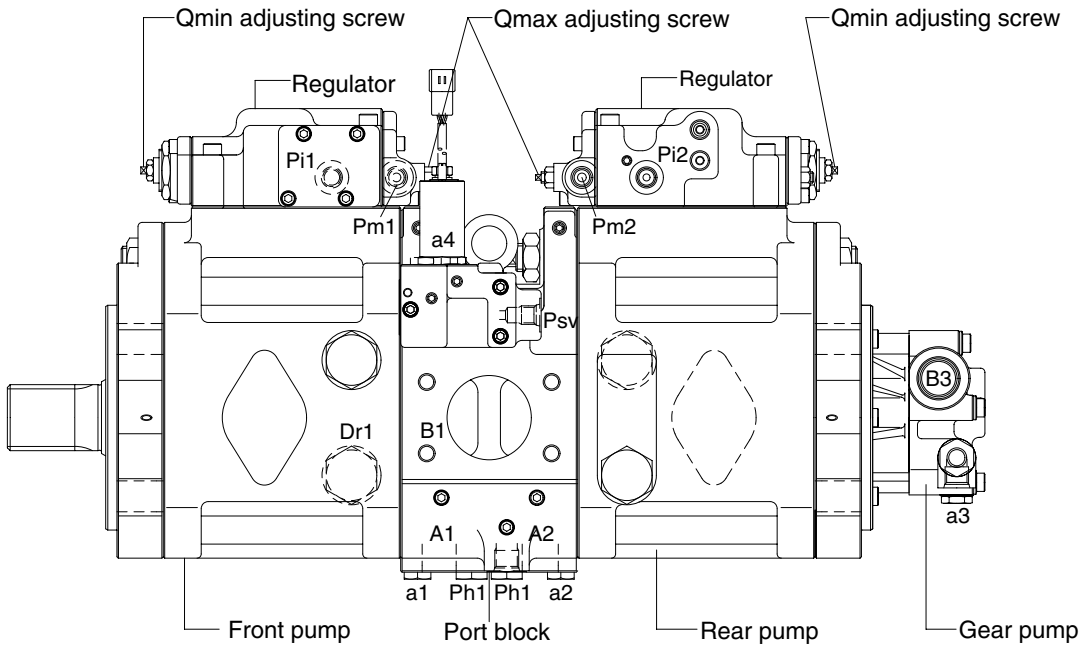
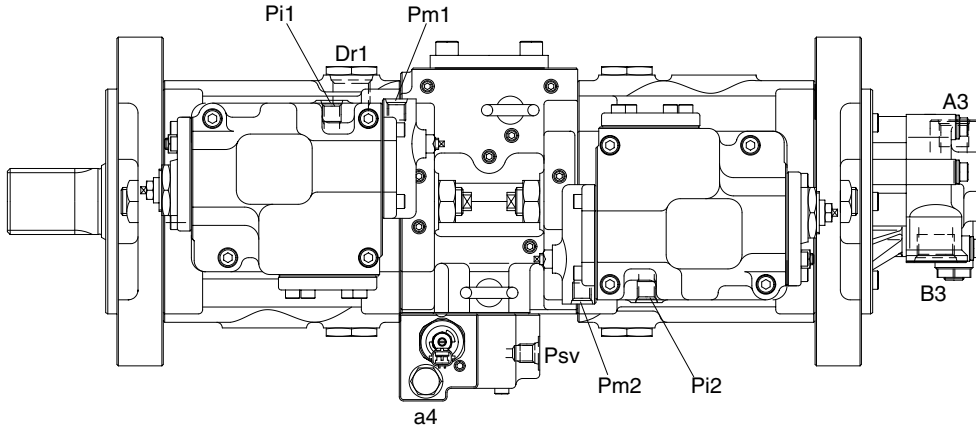
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SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

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

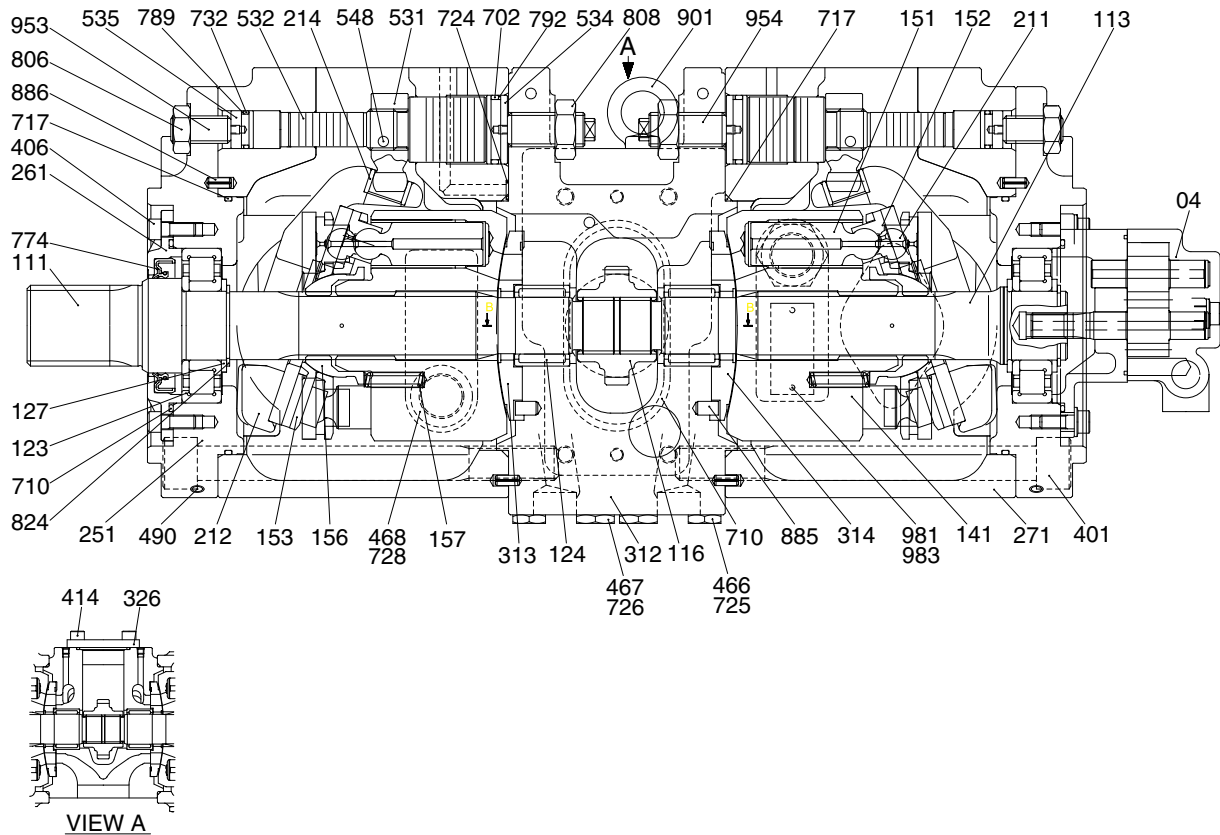


2907A2MP01

Port	Port name	Port size
A1, 2	Delivery port	SAE6000psi 1"
B1	Suction port	SAE2500psi 2 1/2"
Dr1	Drain port	PF 3/4 - 20
Ph1, h2	Pressure sensor port	PF 3/8 - 17
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
Dr3	Gear pump drain port	PF 3/8 - 15

1) MAIN PUMP(1/2)

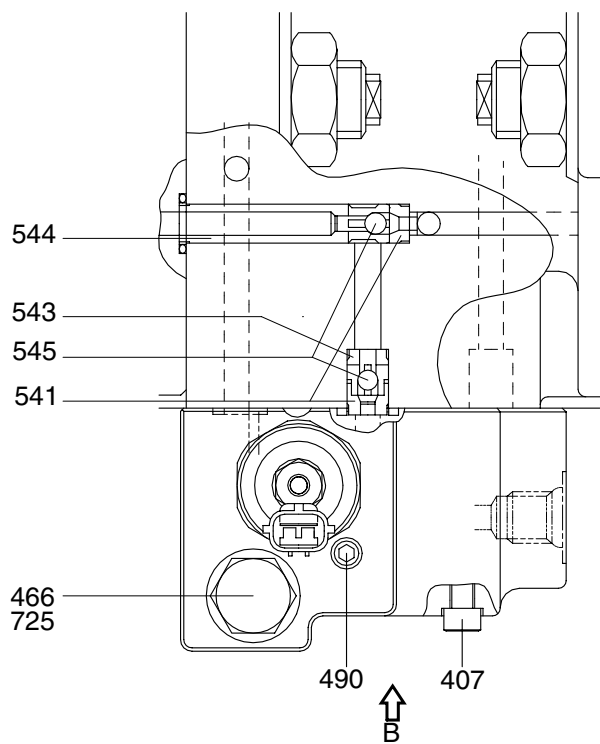
The main pump consists of two piston pumps(front & rear) and valve block.



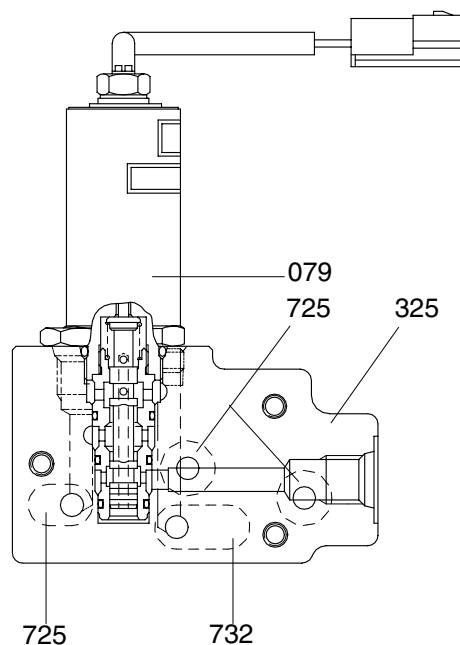
2907A2MP02

04	Gear pump	271	Pump casing	710	O-ring
111	Drive shaft(F)	312	Valve block	717	O-ring
113	Drive shaft(R)	313	Valve plate(R)	724	O-ring
114	Spline coupling	314	Valve plate(L)	725	O-ring
123	Roller bearing	326	Cover	728	O-ring
124	Needle bearing	401	Hexagon socket bolt	732	O-ring
127	Bearing spacer	406	Hexagon socket bolt	774	Oil seal
141	Cylinder block	414	Hexagon socket bolt	789	Back up ring
151	Piston	466	VP plug	792	Back up ring
152	Shoe	467	VP plug	806	Hexagon head nut
153	Set plate	468	VP plug	808	Hexagon head nut
156	Bushing	490	VP plug	824	Snap ring
157	Cylinder spring	531	Tilting pin	885	Pin
211	Shoe plate	532	Servo piston	886	Spring pin
212	Swash plate	534	Stopper(L)	901	Eye bolt
214	Bushing	535	Stopper(S)	953	Set screw
251	Swash plate support	548	Pin	954	Set screw
261	Seal cover(F)	702	O-ring		

MAIN PUMP(2/2)



VIEW A

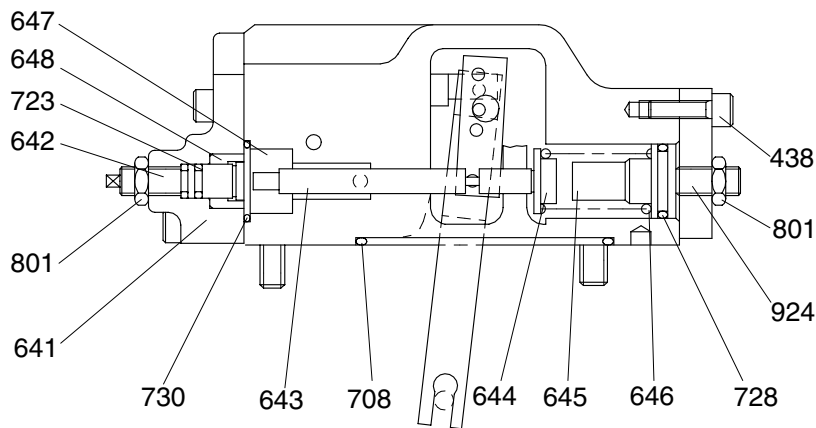
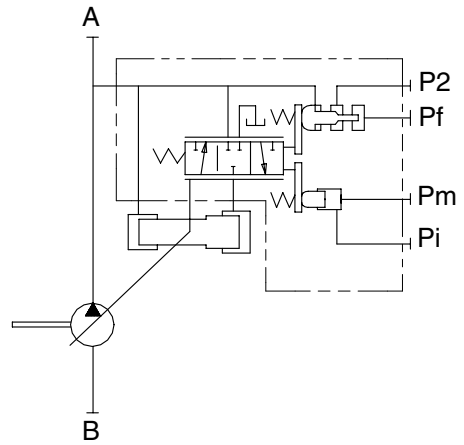
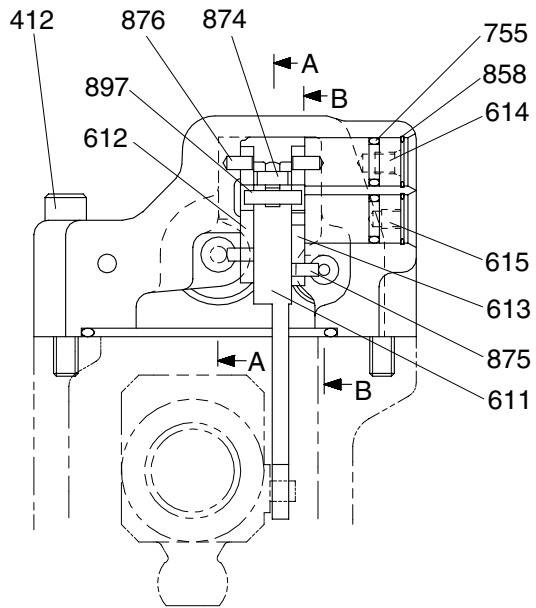


VIEW B

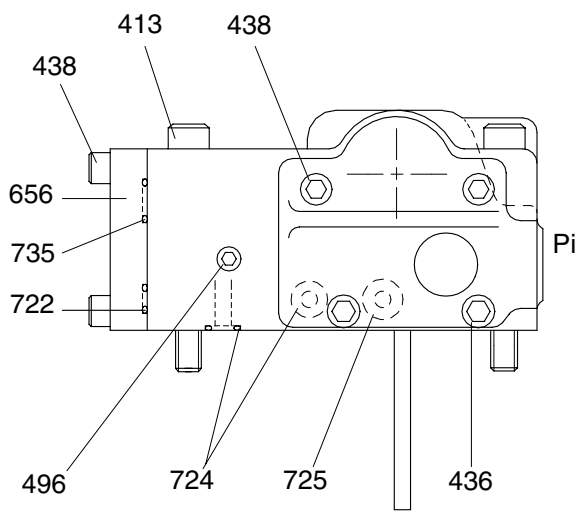
29072MP02

079	Proportional reducing valve	490	Plug	545	Steel ball
325	Casing assy	541	Seat	725	O-ring
407	Hexagon screw	543	Stopper 1	732	O-ring
466	Plug	544	Stopper 2		

2) REGULATOR(1/2)



SECTION B-B

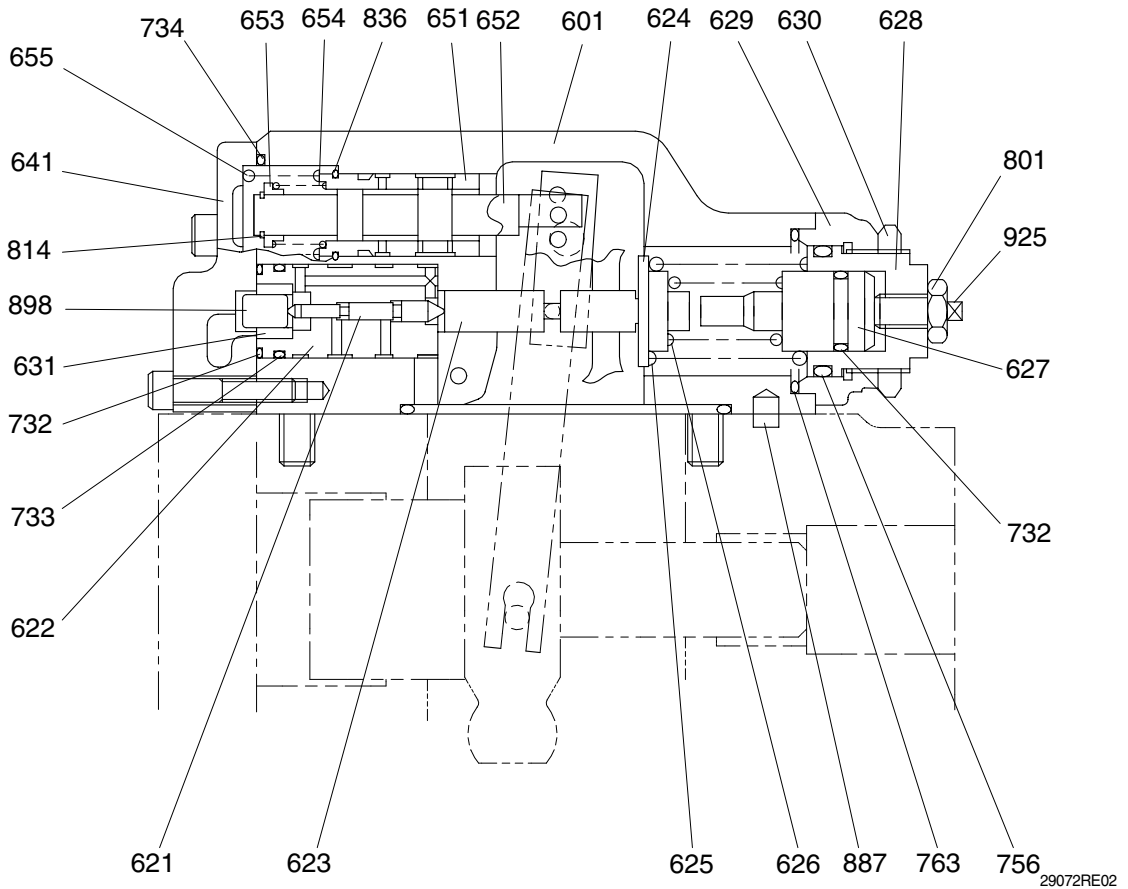


VIEW C

2907A2RE01

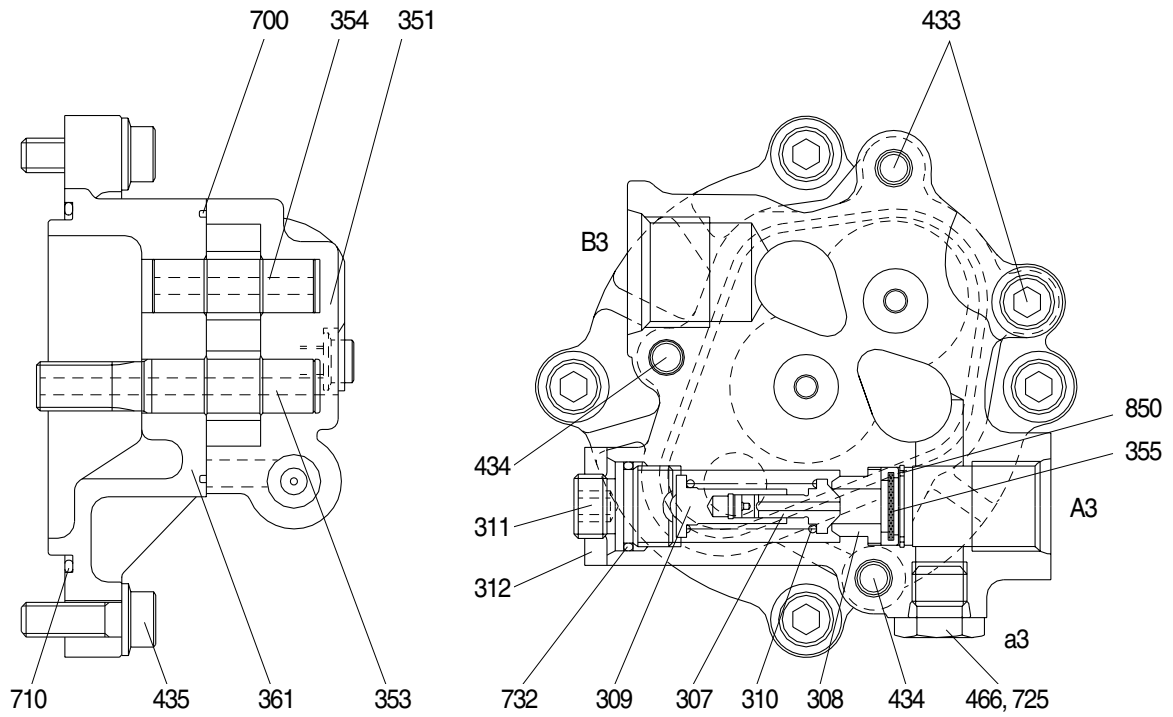
Port	Port name	Port size
A	Delivery port	1"
B	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
Pm	Qmax cut port	PF 1/4-15

REGULATOR(2/2)



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 screw(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	876 Pin
625 Outer spring	708 O-ring	887 Pin
626 Inner spring	722 O-ring	897 Pin
627 Adjust stem(C)	723 O-ring	898 Pin
628 Adjust screw(C)	724 O-ring	924 Set screw
629 Cover(C)	725 O-ring	925 Adjust screw(QI)
630 Lock nut	728 O-ring	

3) GEAR PUMP



2-6

- 307 Poppet
- 308 Seat
- 309 Ring
- 310 Spring
- 311 Screw
- 312 Nut
- 351 Gear case

- 353 Drive gear
- 354 Driven gear
- 355 Filter
- 361 Front case
- 433 Flange socket
- 434 Flange socket
- 435 Flange socket

- 466 Plug
- 700 Ring
- 710 O-ring
- 725 O-ring
- 732 O-ring
- 850 Snap ring

2. FUNCTION

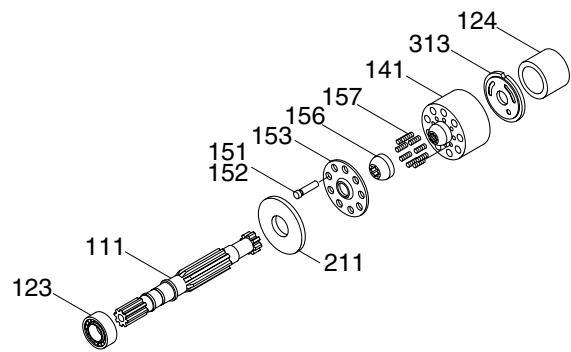
1) MAIN PUMP

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

(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block(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 form a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and to take hydraulic balance so that it slides lightly over the shoe plate(211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush. Similarly, the cylinder block is pressed against valve plate(313) by the action of the cylinder spring.



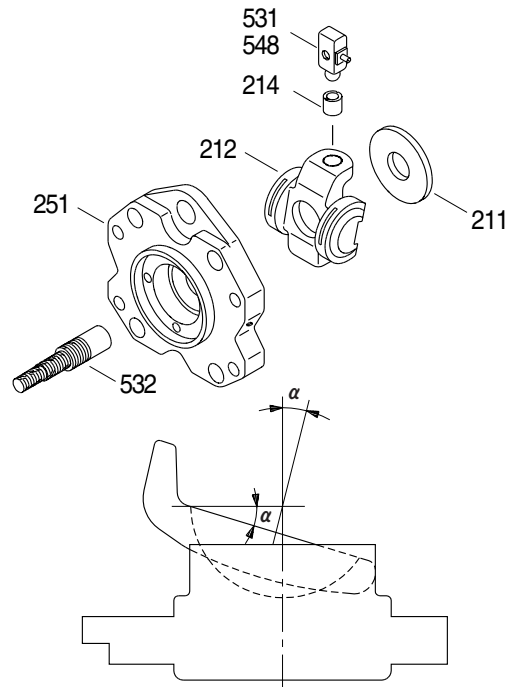
2907A2MP03

(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

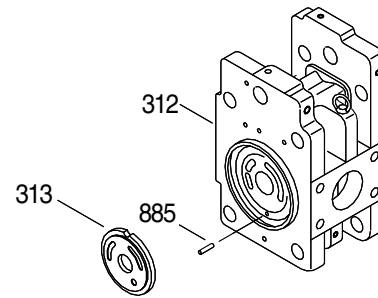
The valve block group consists of valve block(312), valve plate(313) and valve plate pin(885).

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) REGULATOR

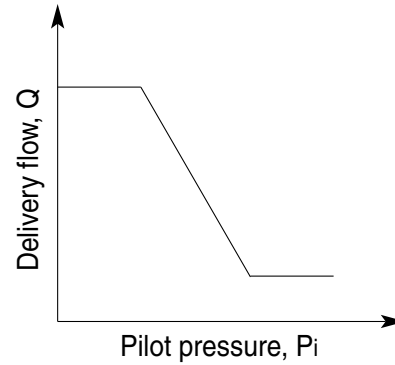
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

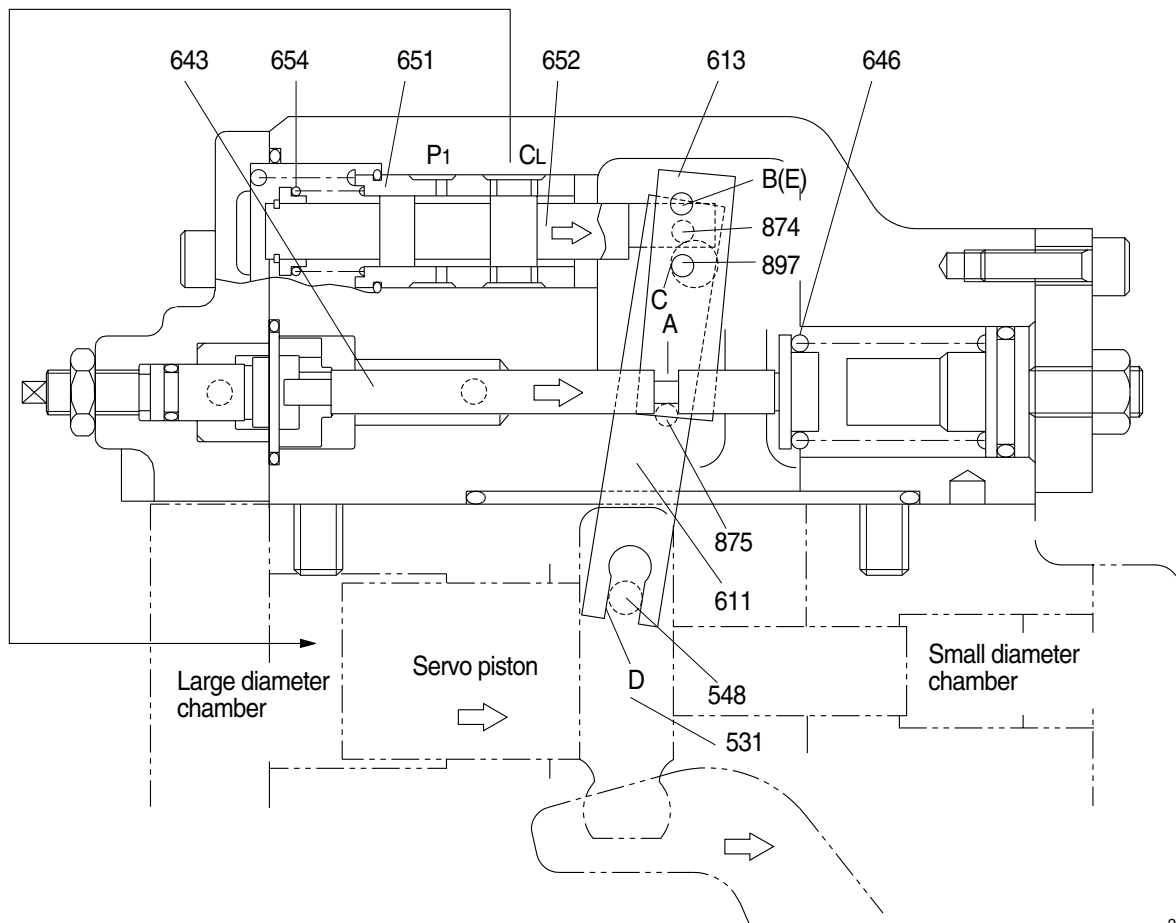
By changing the pilot pressure P_i , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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

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



① Flow reducing function



2-10

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

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

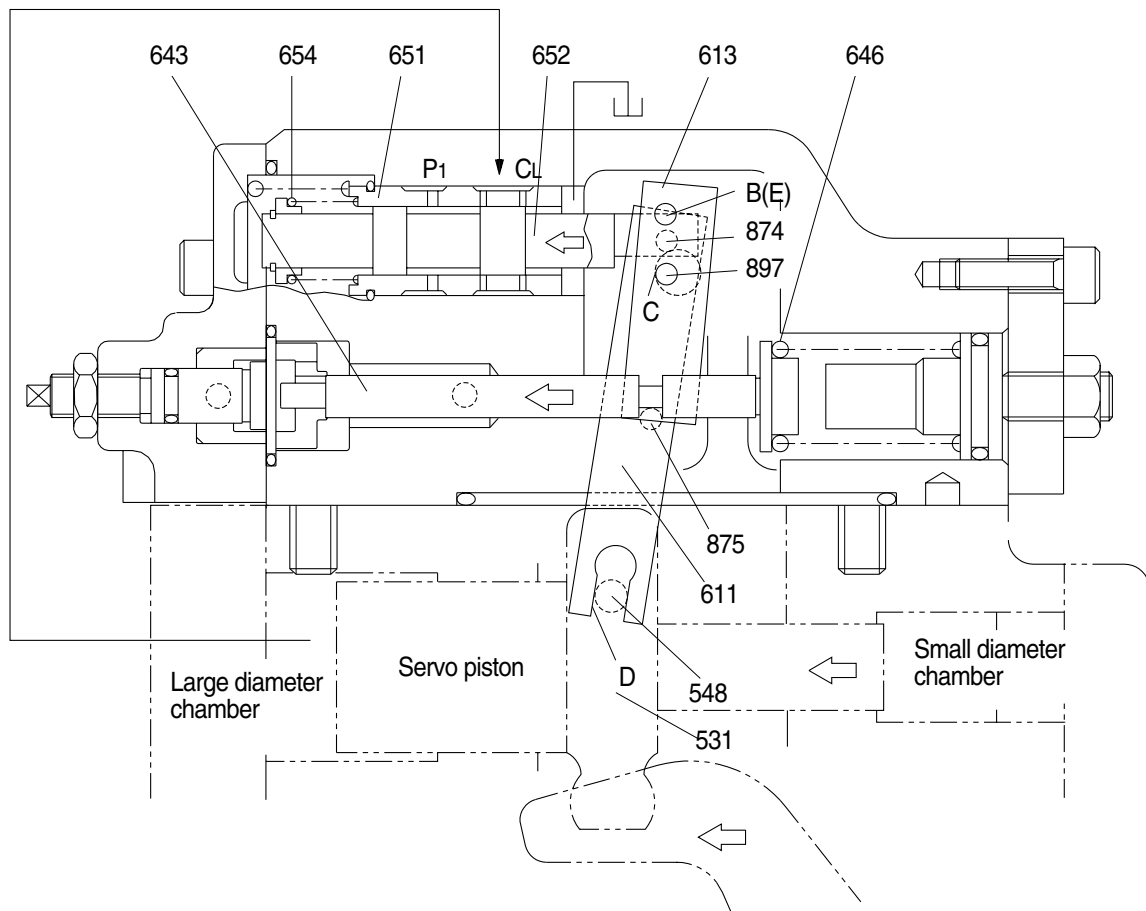
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

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

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

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

② Flow increasing function



2-11

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

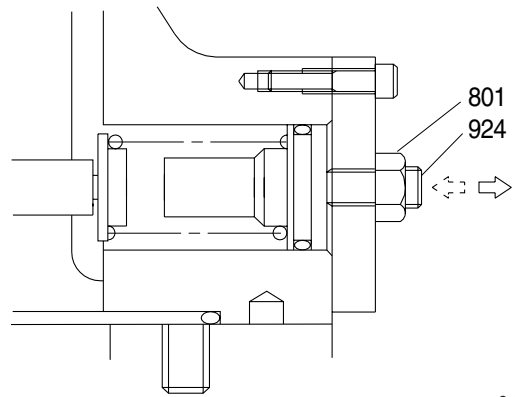
As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

③ **Adjustment of flow control characteristic**

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

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

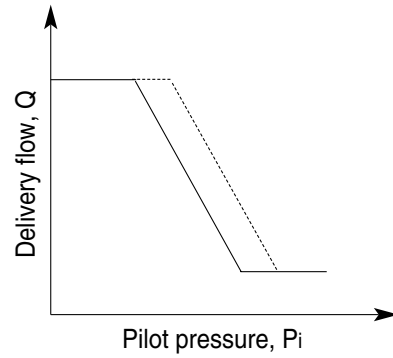
Tightening the screw shifts the control chart to the right as shown in the figure.



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

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

2-12



(2) Total horsepower control

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

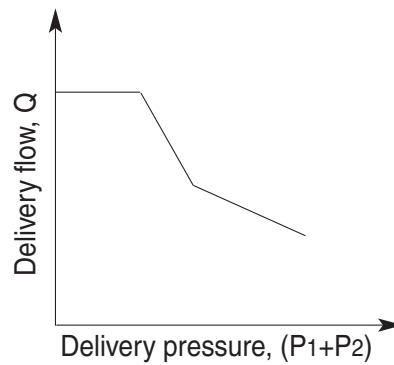
(The input horsepower is constant when the speed is constant.)

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

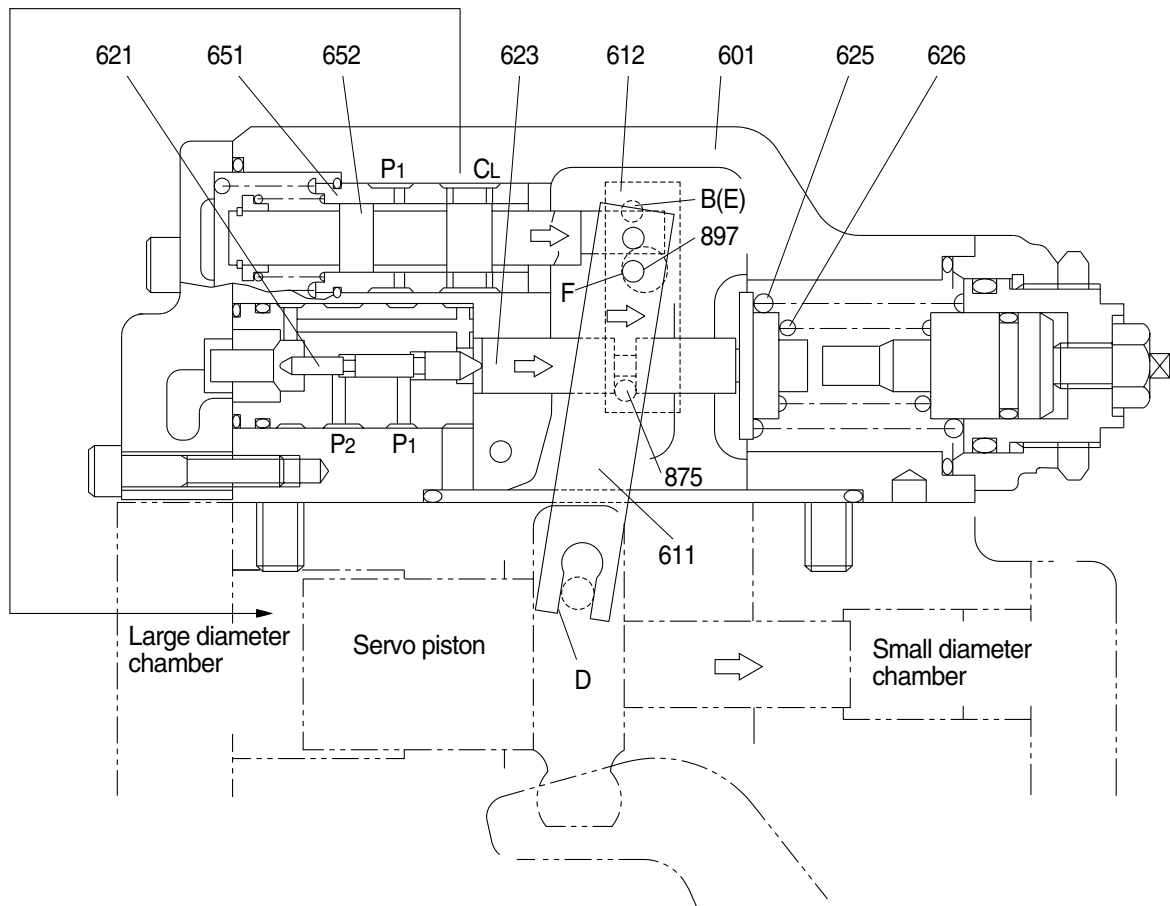
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles(displacement volumes) of the two pumps to the same value as represented by the following equation :

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

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



① Overload preventive function



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.

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

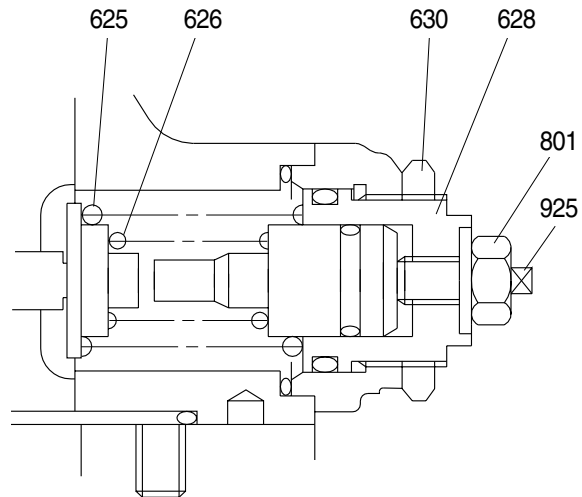
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections(C & F) of levers 1 and 2. However, since sections C and F have the pins($\phi 4$) protruding from the large hole($\phi 8$), only the lever lessening the tilting angle contacts the pin(897); the hole($\phi 8$) 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.

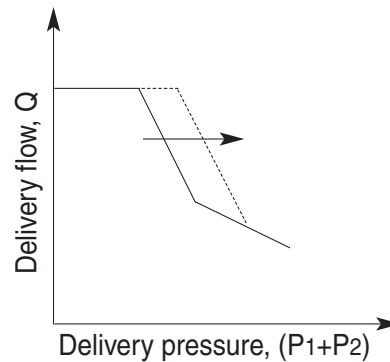
a. **Adjustment of outer spring**

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 $N \times A$ turns at first. ($A=1.9$)



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

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw(C) (925)	Compensating control starting pressure change amount	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(kgf · m)
1800	+1/4	+19.2	+6.3



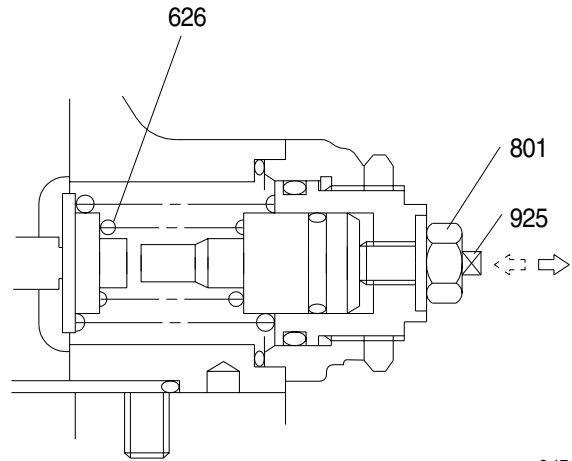
2-16

b. Adjustment of inner spring

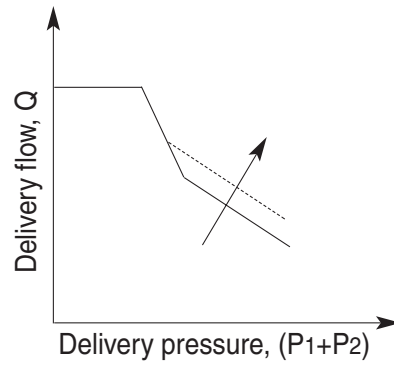
Adjust it by loosening the hexagon nut (801) and by tightening(or loosening) the adjusting screw QI(925). Tightening the screw increases the flow and then the input horsepower as shown in the figure.

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

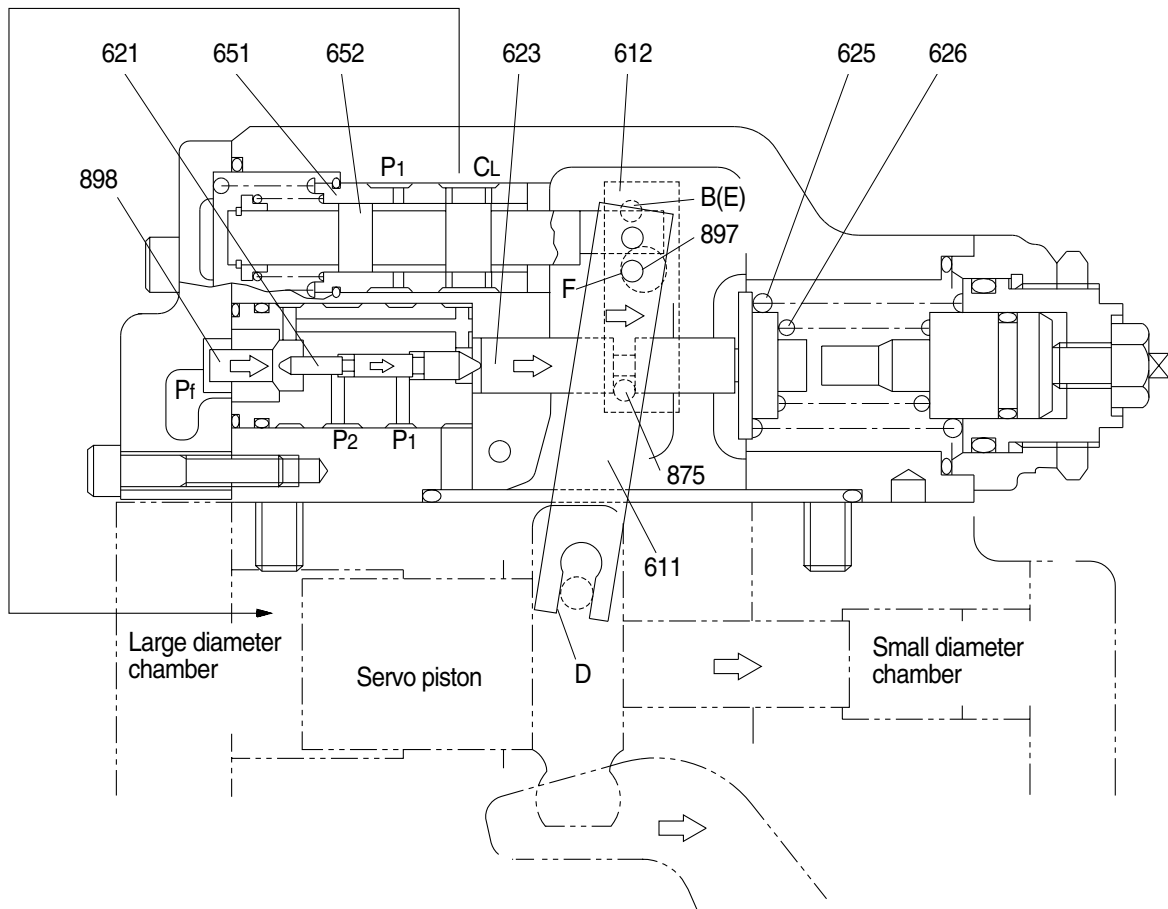
Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw(QI) (925)	Flow change amount	Input torque change amount
(min ⁻¹)	(Turn)	(l /min)	(kgf · m)
1800	+1/4	+10.4	+5.3



2-17

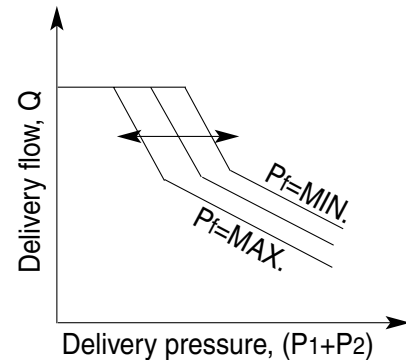


(3) Power shift control



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 P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.



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

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

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

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

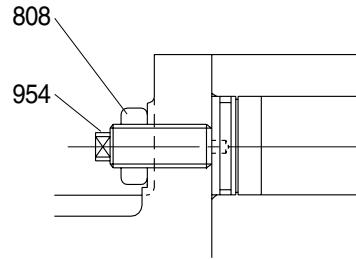
(4) Adjustment of maximum and minimum flows

① Adjustment of maximum flow

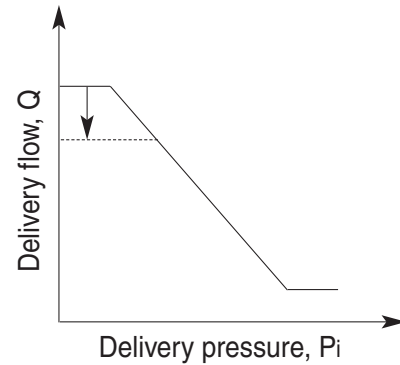
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the set screw(954).

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

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



2-19(1)

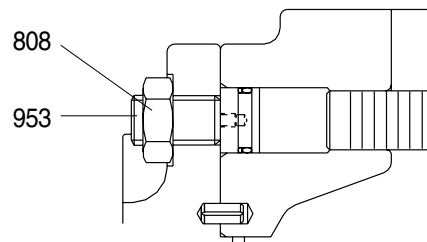


② Adjustment of minimum flow

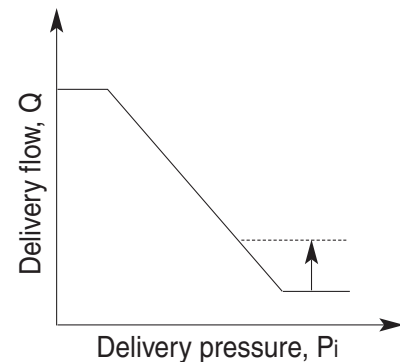
Adjust it by loosening the hexagon nut(808) and by tightening(or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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)
1800	+1/4	+4.5

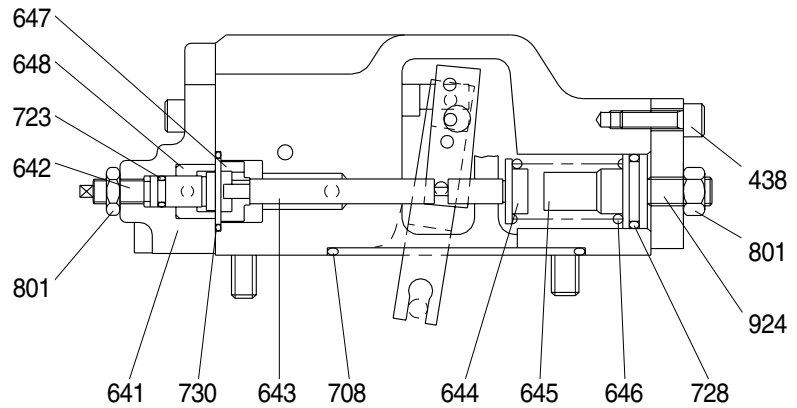


2-19(2)



(5) Qmax cut control

The regulator regulates the maximum delivery flow by inputting the pilot pressure P_m . 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 P_m . (The maximum control flow cannot be controlled in intermediate level.)



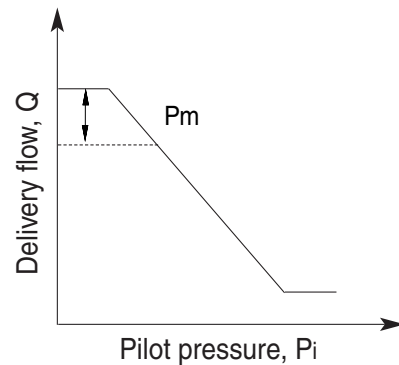
2-4

① Functional explanation

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

When the pilot pressure P_m 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.

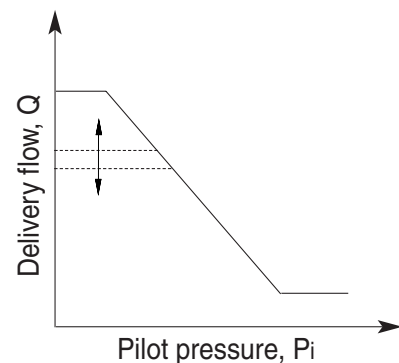
Since the adjusting screw QMC(642) is provided with a flange, the piston QMC stops upon contact with the flange, and the position of the pilot piston at this time determines the maximum flow of the pump.



② Adjustment of Qmax cut flow

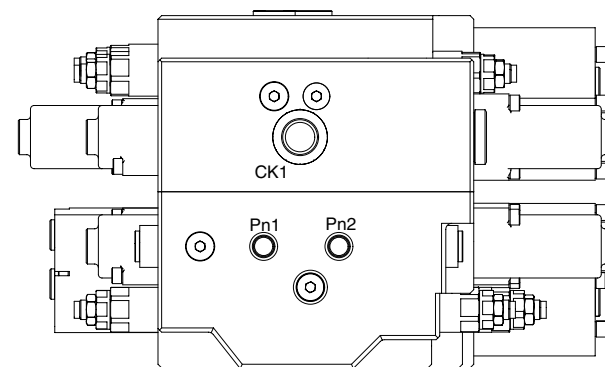
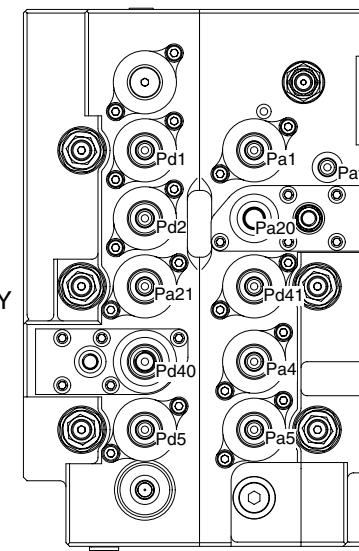
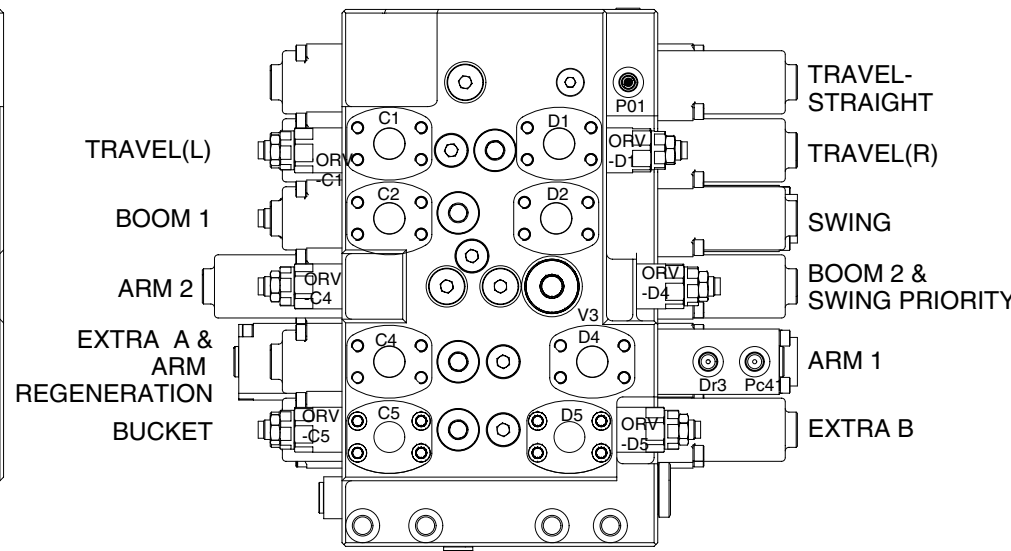
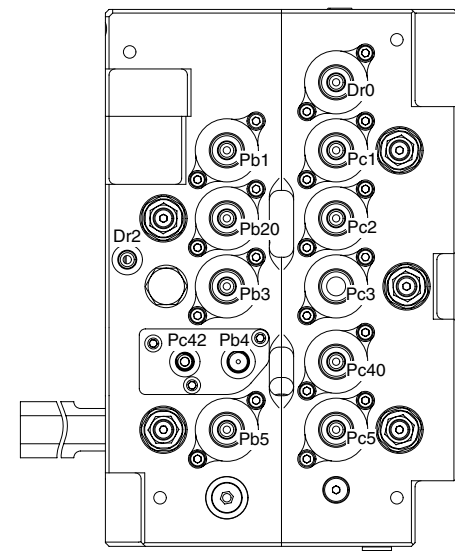
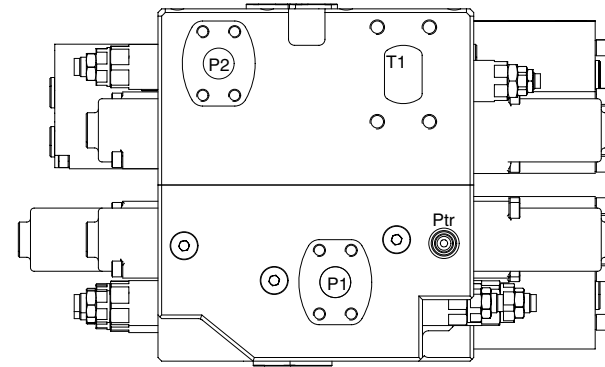
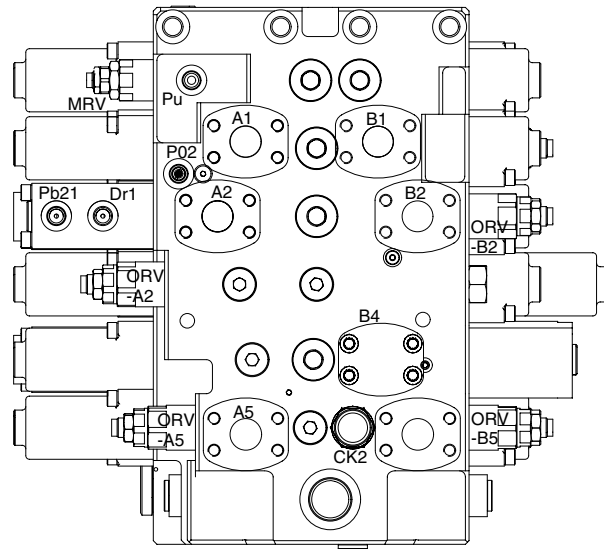
Adjust it by loosening the hexagon nut(801) and by tightening(or loosening) the adjusting screw QMC(642).

Tightening the screw decreases the Q_{max} cut flow as shown in the figure.



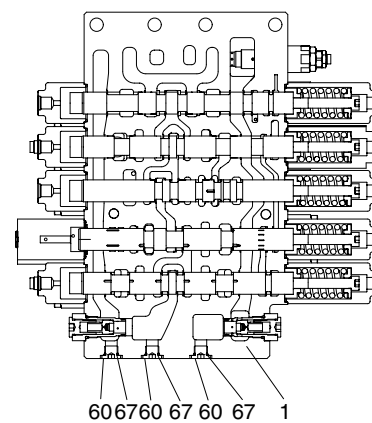
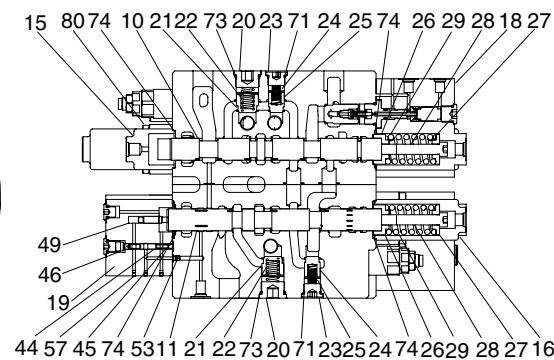
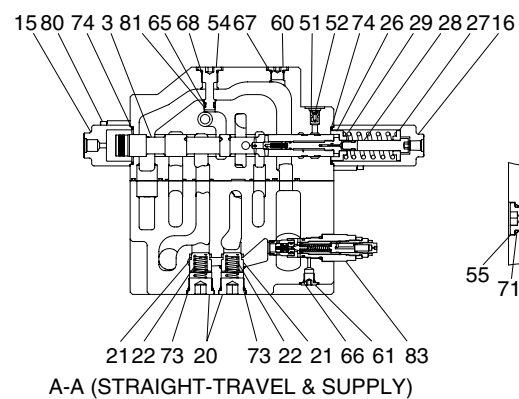
GROUP 2 MAIN CONTROL VALVE

1. STRUCTURE

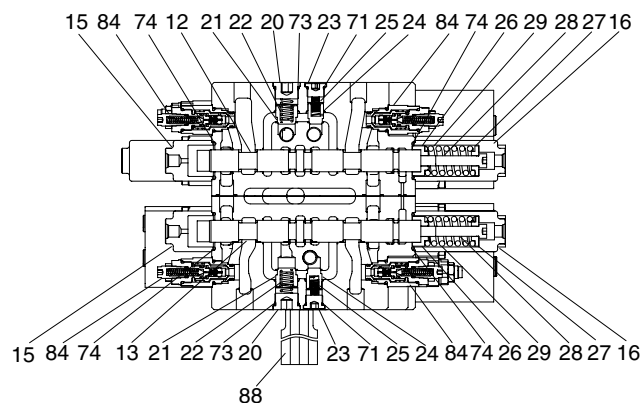
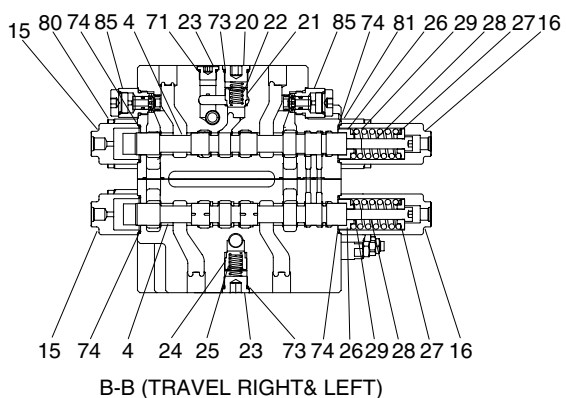


Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	G1	20~25kgf · m (145~180lbf · ft)
Patt Pb21 Pcb Pd40 Pd41 Po1 Po2 Ptr Dr1 Dr2 Dr3	Auto idle-attachment Lock valve pilot port(Boom) Bucket in confluence port Arm out pilot port Arm out confluence pilot port Pilot pressure Pilot pressure Auto idle-travel Drain port Drain port Drain port	G1/4	3.5~3.9kgf · m (25.3~28.2lbf · ft)
Ck1 Ck2	Bucket confluence Bucket confluence	G3/4	17~19kgf · m (123~137.4lbf · ft)
Pa1 Pb1 Pc1 Pd1 Pa20 Pa21 Pb20 Pc2 Pd2 Pb3 Pc3 Pa4 Pb4 Pc40 Pc41 Pc42 Pa5 Pb5 Pc5 Pd5 Po Pu Dr0 Pn1 Pn2	Travel pilot port-LH(FW) Travel pilot port-LH(BW) Travel pilot port-RH(BW) Travel pilot port-RH(FW) Boom up pilot port Boom up confluence pilot port Boom down pilot port Swing pilot port(LH) Swing pilot port(RH) Arm in confluence pilot port Swing priority pilot port Option A pilot port(Breaker) Arm in regeneration cut port Arm in pilot port Lock valve pilot port(Arm) Arm in regen-cut signal selector port Bucket in pilot port Bucket out pilot port Option B pilot port Option B pilot port Pilot pressure port Main relief pressure up port Drain port Negative control signal port(P1 port side) Negative control signal port(P2 port side)	G3/8	7~8kgf · m (50.6~57.8lbf · 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(P1 side) Pump port(P2 side)	SAE 5000, 1	7.5~9.2kgf · m (54.2~66.5lbf · ft)
T1	Return port	SAE 3000, 2 (M12)	6.4~8.6kgf · m (46.2~62.2lbf · ft)

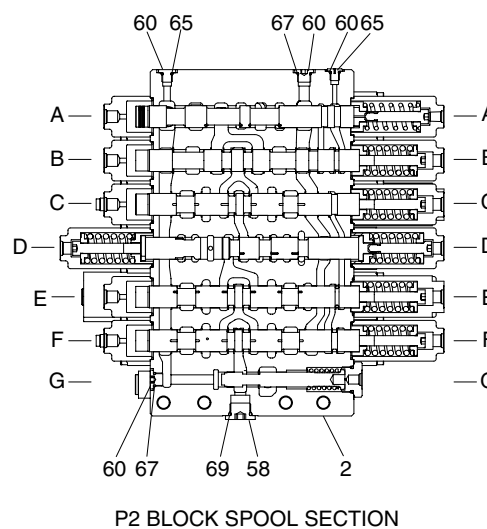
29072MC50



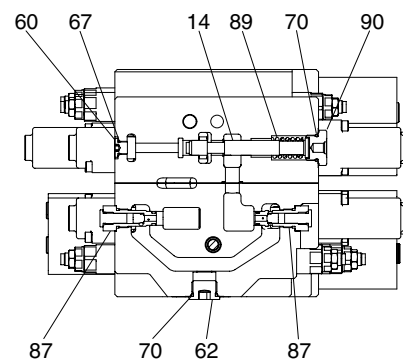
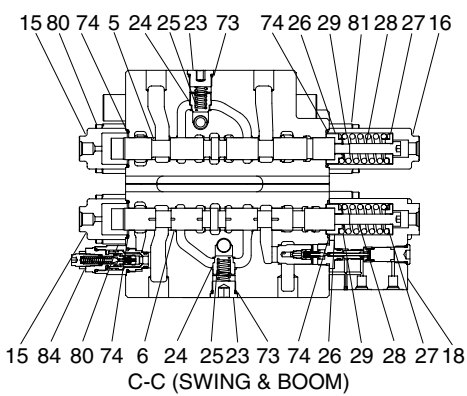
P1 BLOCK SPOOL SECTION



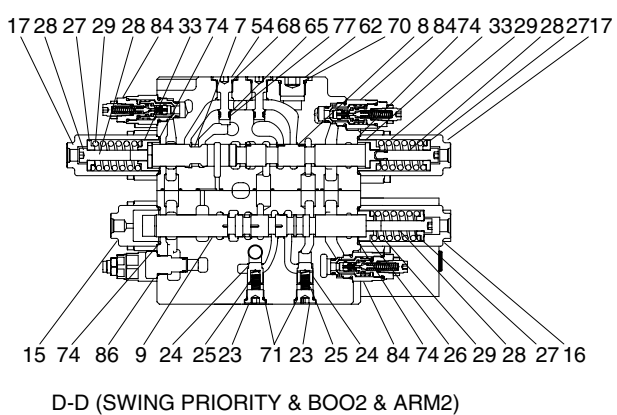
F-F (OPTION & BUCKET)



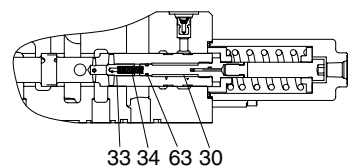
P2 BLOCK SPOOL SECTION



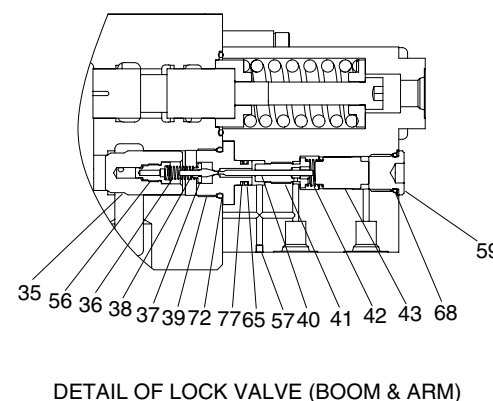
G-G (CENTER BYPASS CUT-OFF & NEGATIVE CONTROL)



D-D (SWING PRIORITY & BOO2 & ARM2)



STRAIGHT-TRAVEL SPOOL DETAIL

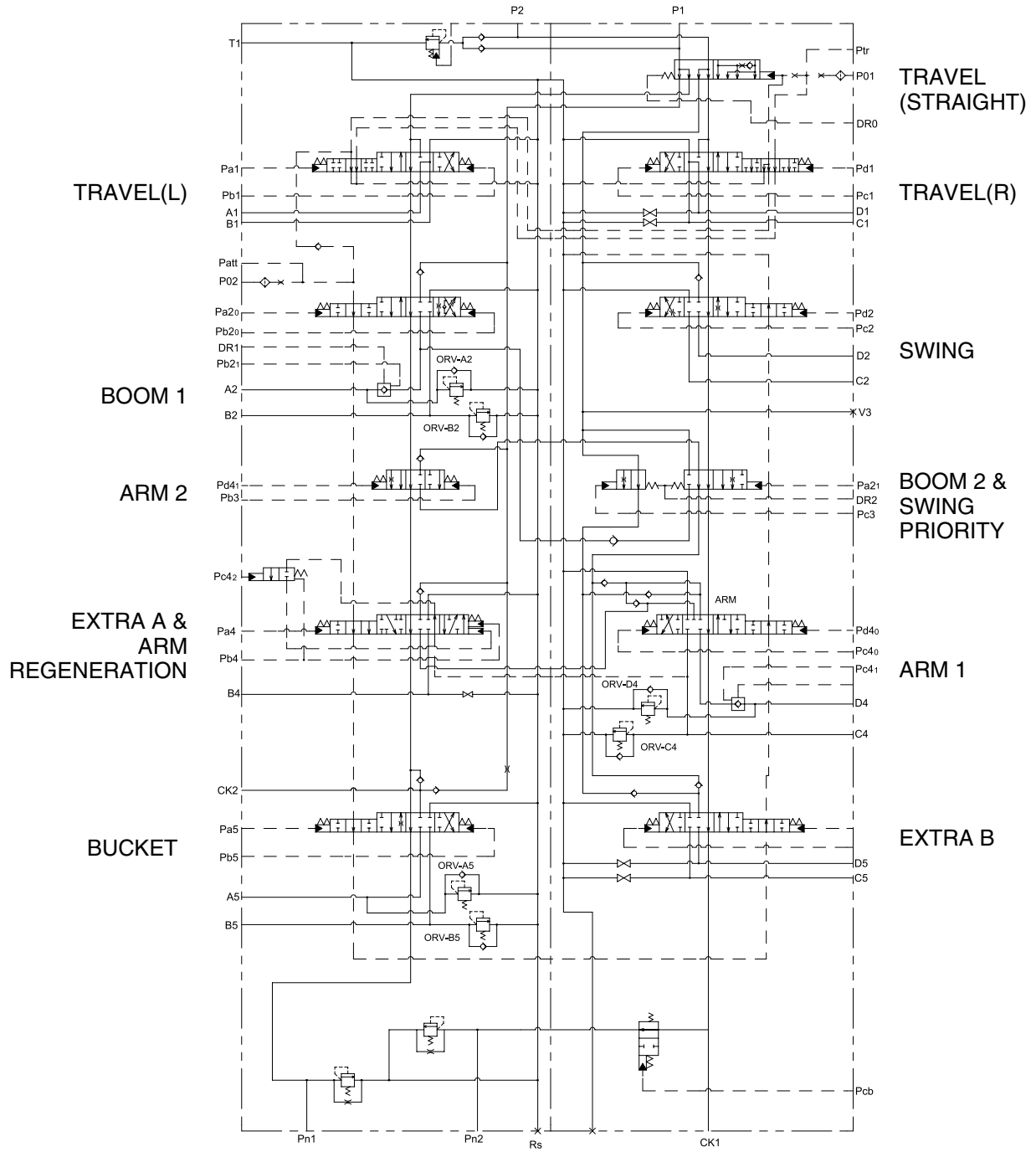


DETAIL OF LOCK VALVE (BOOM & ARM)

- | | |
|----------------------------|---------------------------------|
| 1 Body(P1) | 47 Piston-cut off |
| 2 Body(P2) | 48 Poppet-signal |
| 3 Spool-travel straight | 49 Spring-signal |
| 4 Spool-travel | 50 Plug |
| 5 Spool-swing | 51 Orifice-signal |
| 6 Spool-boom | 52 Coin type filter |
| 7 Spool-swing priority | 53 Orifice-plug |
| 8 Spool-boom 2 | 54 Plug |
| 9 Spool-arm 2 | 55 Plug |
| 10 Spool-arm | 56 Restrictor-lock valve |
| 11 Spool-arm regeneration | 57 Plug |
| 12 Spool-bucket | 58 Plug |
| 13 Spool-option | 59 Plug |
| 14 Spool-bypass cut | 60 Plug |
| 15 Cover-pilot A | 61 Plug |
| 16 Cover-pilot B1 | 62 Plug |
| 17 Cover-pilot B2 | 63 O-ring |
| 18 Block-holding | 64 O-ring |
| 19 Block-regeneration | 65 O-ring |
| 20 Plug | 66 O-ring |
| 21 Poppet 1-check valve | 67 O-ring |
| 22 Spring-check valve | 68 O-ring |
| 23 Plug | 69 O-ring |
| 24 Poppet 2-check valve | 70 O-ring |
| 25 Spring-check valve | 71 O-ring |
| 26 Spring seat 1 | 72 O-ring |
| 27 Spring seat 2 | 73 O-ring |
| 28 Spacer bolt | 74 O-ring |
| 29 Spring-return(L) | 75 Back-up ring |
| 30 Stopper 1-TS | 76 Back-up ring |
| 31 Stopper 2-priority | 77 Back-up ring |
| 32 Spring seat 3 | 78 Socket head bolt with washer |
| 33 Poppet-check valve TS | 79 Socket head bolt with washer |
| 34 Spring-check valve TS | 80 Socket head bolt with washer |
| 35 Poppet-lock valve | 81 Main relief valve |
| 36 Spring-lock valve pilot | 82 Overload relief valve |
| 37 Guide poppet | 83 Plug-relief valve |
| 38 Poppet-pilot | 84 Plug-relief valve |
| 39 Seat-poppet | 85 Negative control valve |
| 40 Piston 1 | 86 Socket head bolt with washer |
| 41 Guide-piston | 87 Socket head bolt with washer |
| 42 Spring 1-lock valve | 88 Nipple-check valve |
| 43 Piston 2 | 89 Spring-bypass cut spool |
| 44 Spool-regen selector | 90 Plug-bypass cut spool |
| 45 Spring-regeneration | 91 Backup ring |
| 46 Stopper-regeneration | |

300072MCV02

2. HYDRAULIC CIRCUIT

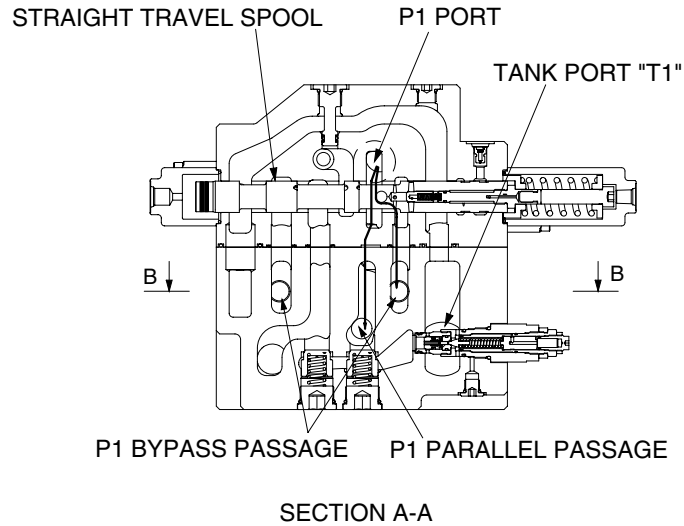


29072MC51

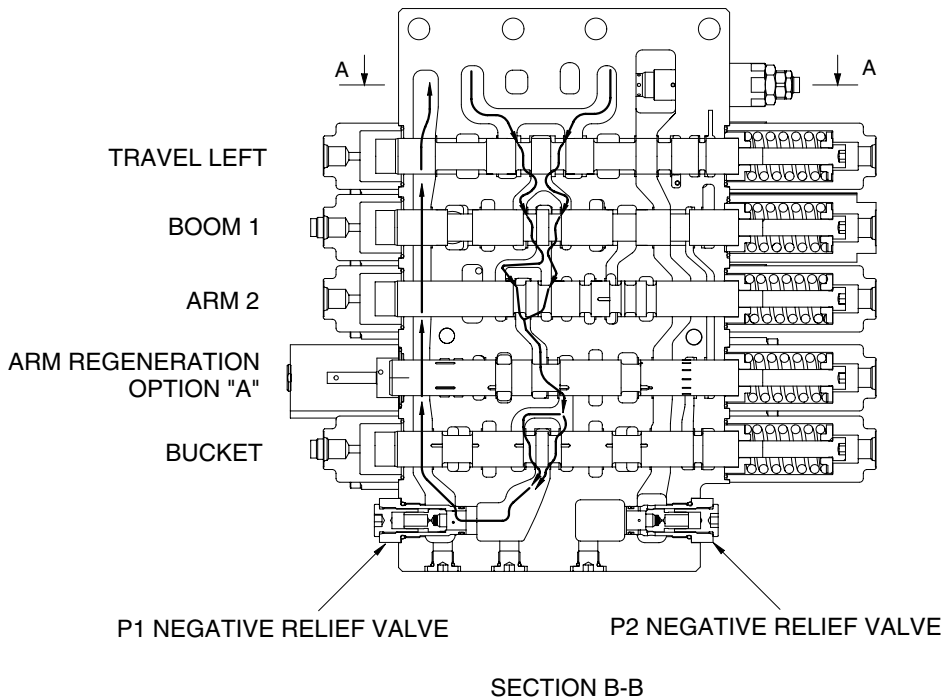
3. FUNCTION

1) CONTROL IN NEUTRAL FUNCTION

(1) P1 SIDE



29072MC53

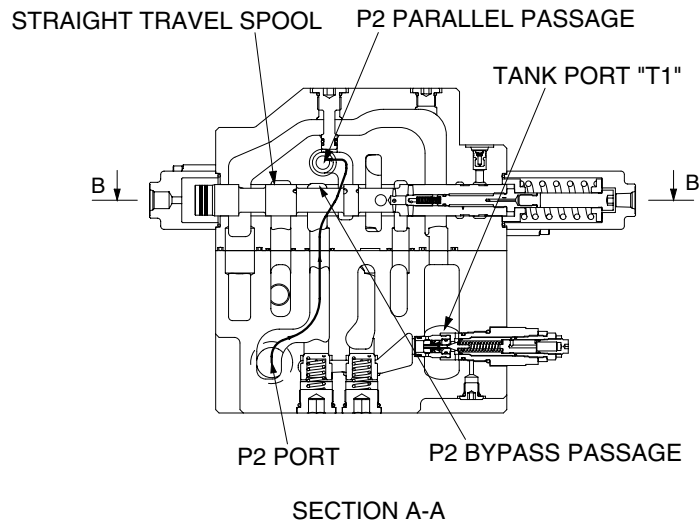


29072MC52

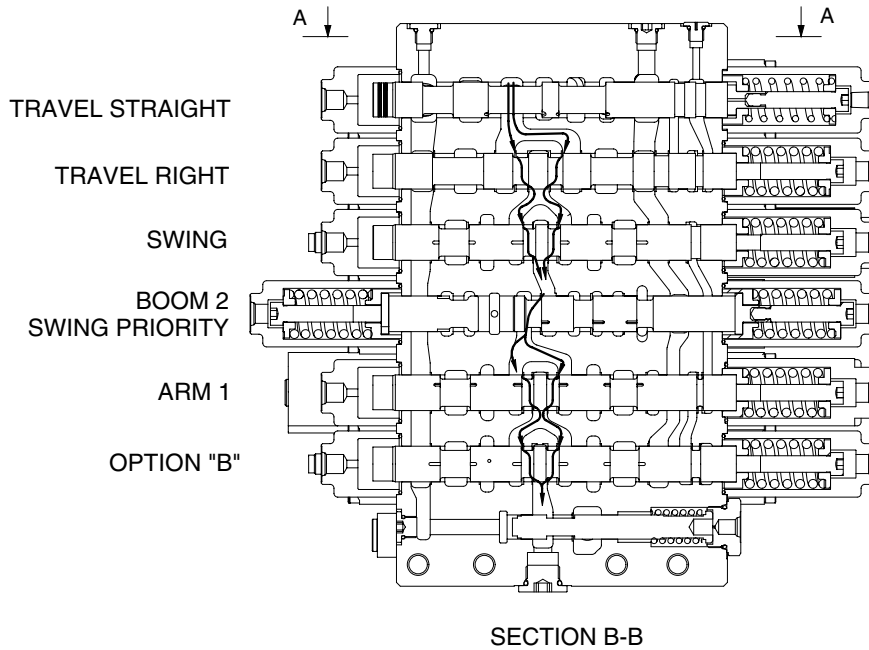
The hydraulic fluid from pump P1 flows into the main control valve through the inlet port "P1", pass the travel straight spool, into the P1 bypass passage and P1 parallel passage.

The hydraulic fluid from the pump P1 is directed to the tank through the bypass passage of spools : travel left, boom1, arm2, arm regeneration & option A and bucket, the negative relief valve, tank passage, and the tank port "T1"

(2) P2 SIDE



29072MC54



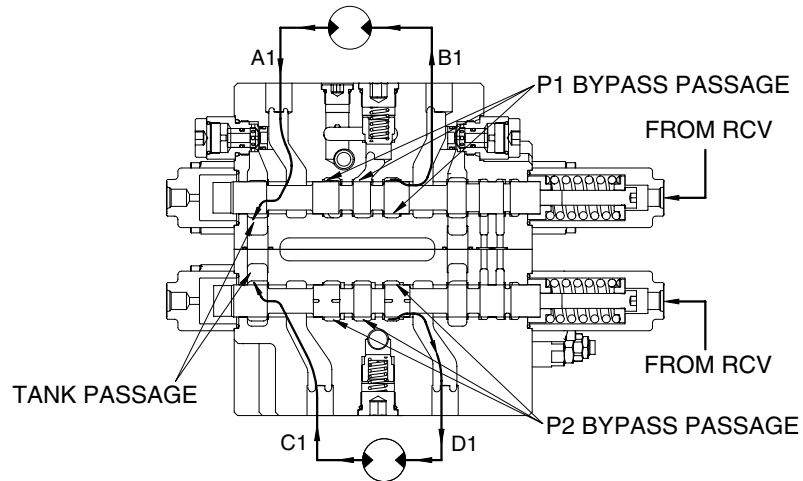
29072MC55

The hydraulic fluid from pump P2 flows into the main control valve through the inlet port "P2", pass the straight travel spool, into the P2 bypass passage and P2 parallel passage.
The hydraulic fluid from the pump P2 is directed to the tank through the bypass passage of spools : travel right, swing, boom2 & swing priority, arm1, option "B" and bypass passage of bucket summation, and the negative relief valve with the tank passage.

2) EACH SPOOL OPERATION

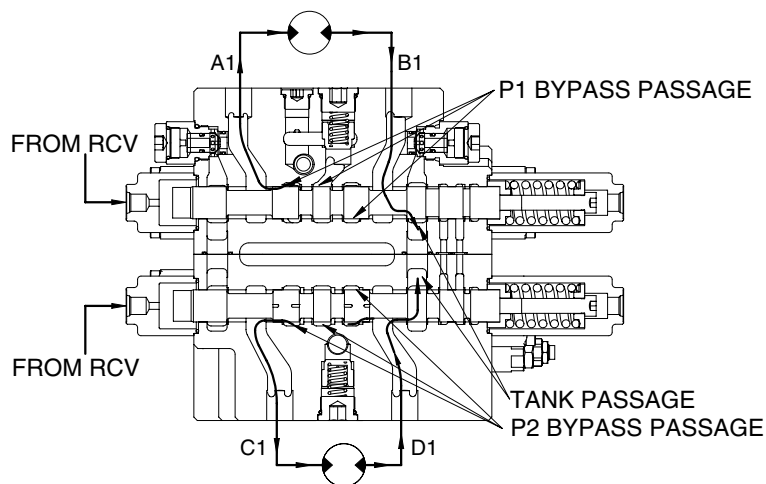
(1) TRAVEL OPERATION

① Travel forward operation



29072MC56

② Travel backward operation



29072MC57

During the travel operation, the hydraulic fluid of the pump P1 is supplied to the travel motor and the hydraulic fluid of the pump P2 is supplied to the other travel motor.

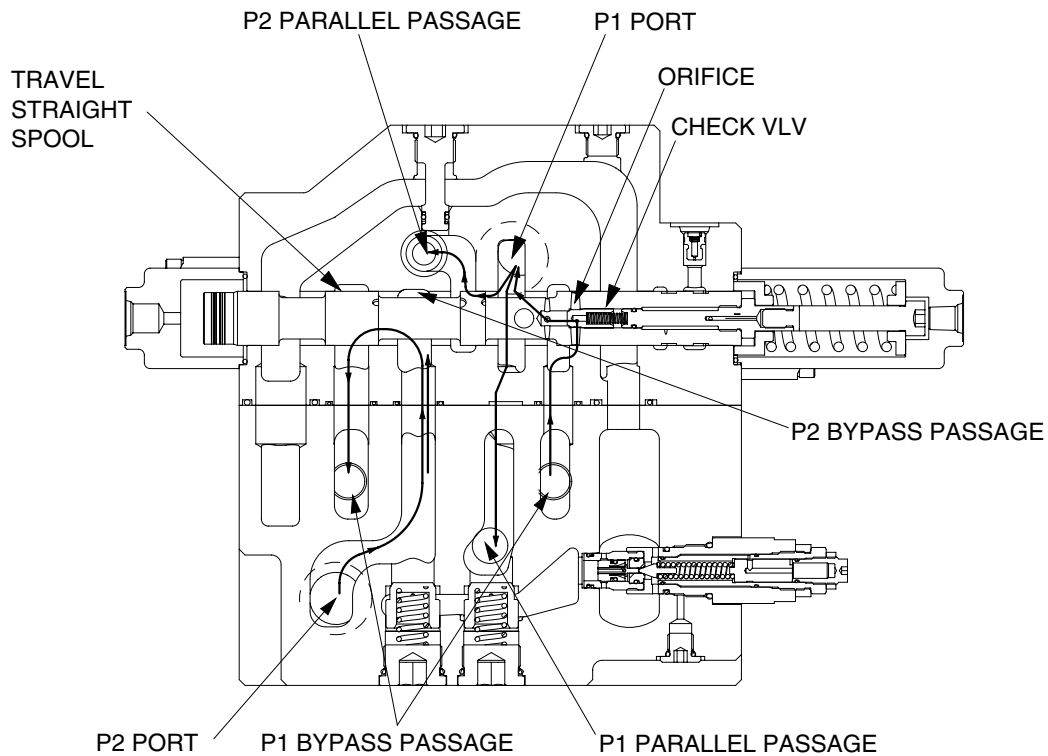
The pilot pressure from the pilot control valve is supplied to the spring side of pilot port (pa1, pd1).

And it shifts travel right and left spools in the left direction against springs. Hydraulic fluid from the pump P1 flow into the travel left spool through the bypass passage and hydraulic fluid from the pump P2 flow into the travel right spool through the bypass passage.

Then they are directed to the each travel motor through port A1 and D1. As a result, the travel motors turn and hydraulic fluid returns to the tank passage through the travel spools.

In case of the opposite operation, the operation is similar.

(2) TRAVEL STRAIGHT FUNCTION



29072MC58

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 travel motor and the pump P2 is supplied to the other 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.

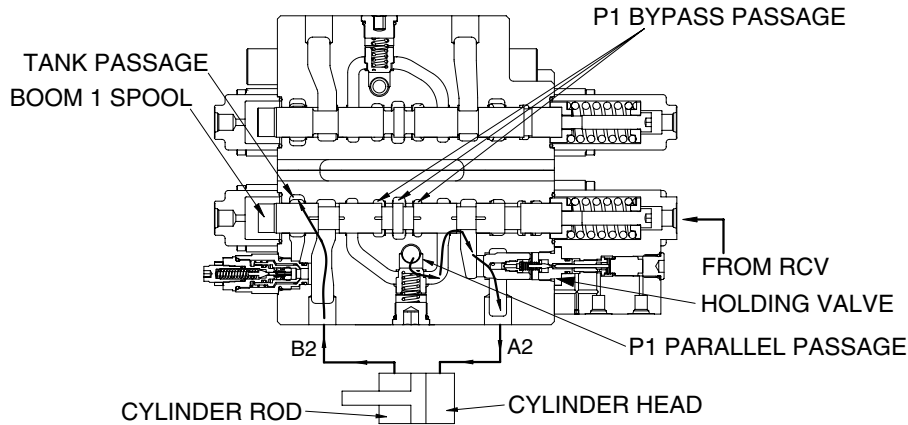
The hydraulic oil fluid from pump P2 is supplied to travel motors (left/right).

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).

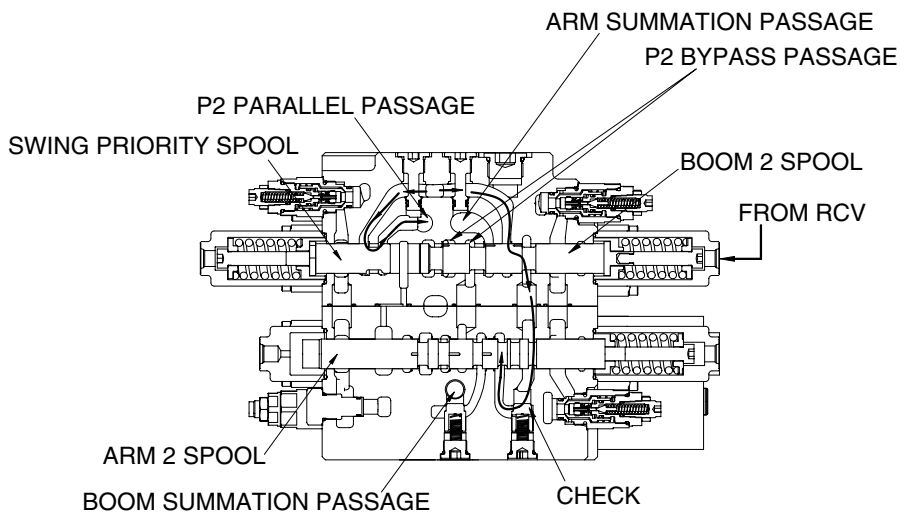
Then the machine keeps straight travel.

(3) BOOM OPERATION

① Boom up operation



29072MC59



29072MC60

During boom up operation, the pilot pressure from RCV is supplied into the port Pa20 and shift the boom1 spool in the left direction. The hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes through the load check valve and boom holding valve then flows into the port A2.

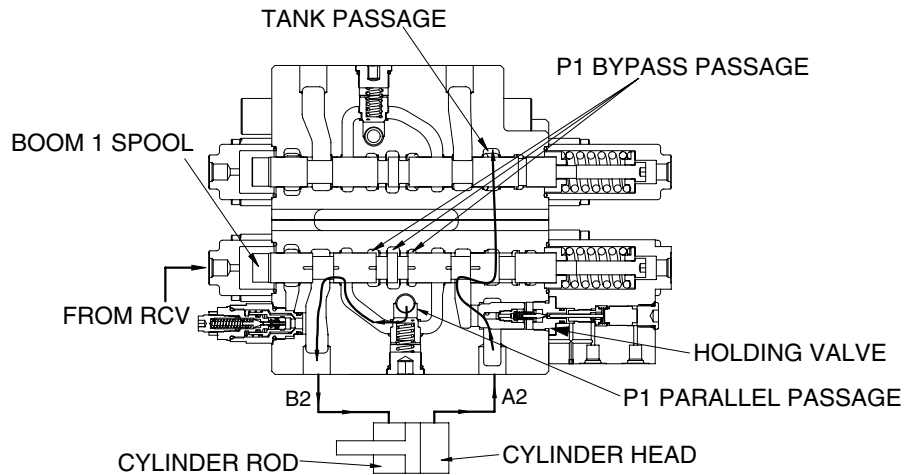
Following this it flows into the head side of the boom cylinder.

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

At the same time the pilot pressure through the port Pa21 shifts the boom2 spool. The hydraulic oil fluid from pump P2 entered boom summation passage via the P2 parallel passage, the swing priority spool, the boom2 spool, arm1 spool and the check. The flows combine in passage and are directed to port A2 and head side of boom cylinder.

The flow from rod side of the boom cylinder return to the boom1 spool through the port B2. There after it is directed to the hydraulic oil tank through the tank passage.

② Boom down operation



29072MC61

During the boom lowering operation, the pilot pressure from RCV is supplied to the port Pb20 and shift the boom1 spool in the right direction.

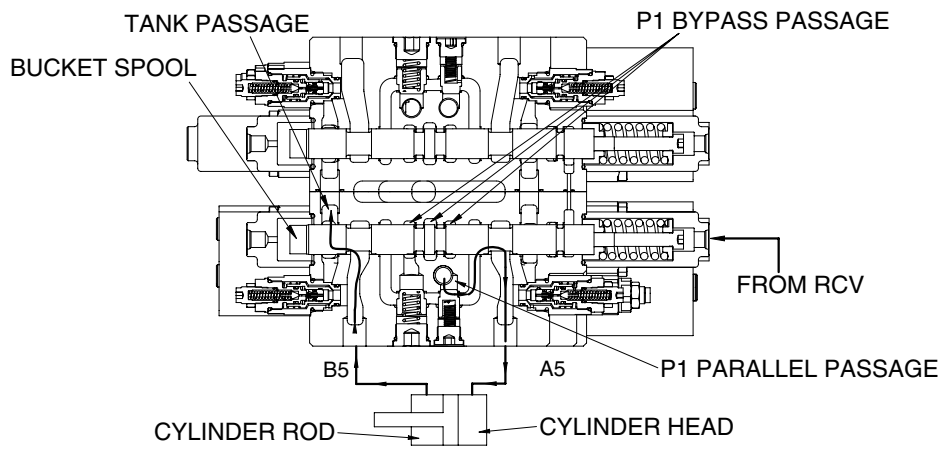
The hydraulic fluid from the pump P1 enters the parallel passage and is directed to the port B2 through the load check valve. Following this, it flows into the rod side of the boom cylinder.

The return flow from the head side of the boom cylinder returns to the boom1 spool through the port A2 and boom holding valve. Thereafter it is directed to the hydraulic oil tank through tank passage.

For details of the boom holding valve, see page 2-46-17.

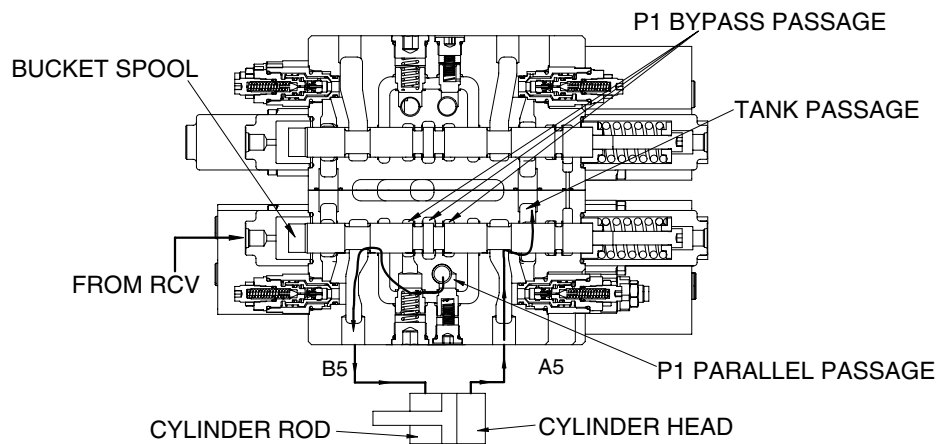
(4) BUCKET OPERATION

① Bucket roll in operation



29072MC62

② Bucket roll out operation



29072MC63

① Bucket roll in operation

During the bucket roll in operation, the pilot pressure from RCV is supplied to port Pa5 and shift the bucket spool in the left direction.

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 roll out operation

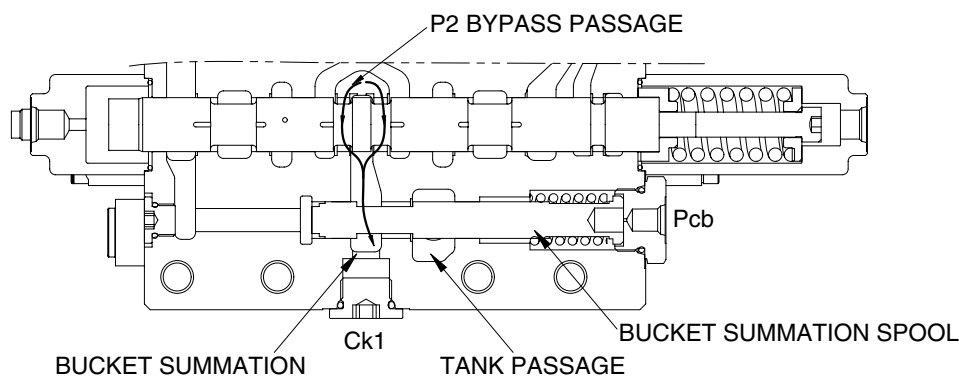
In case of the bucket roll out operation, the operation is similar

③ 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.

④ Bucket summation



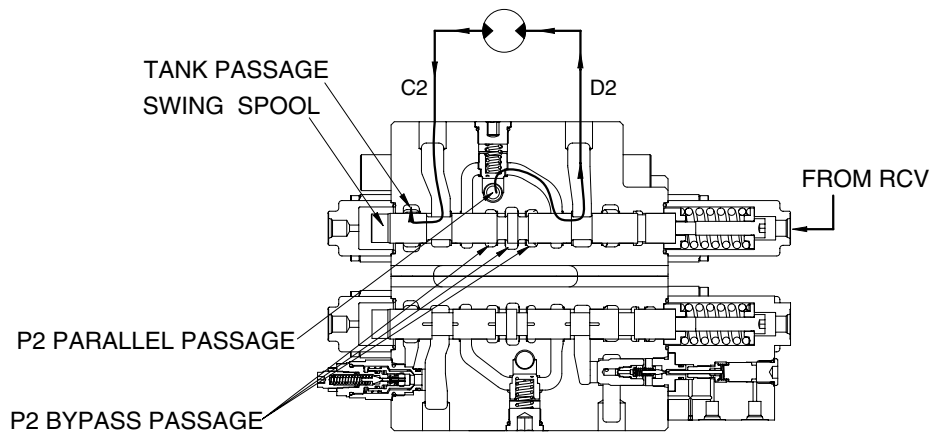
29072MC64

When bucket single operation, the pilot pressure from RCV is supplied to spring side port(pcb) of bucket summation spool and then bucket summation spool shift left direction. So the tank passage is blocked, and the hydraulic fluid from P2 by pass passage is joined with the hydraulic fluid of P1 via the check CK1 and external piping.

(Refer to hydraulic circuit page 3-1)

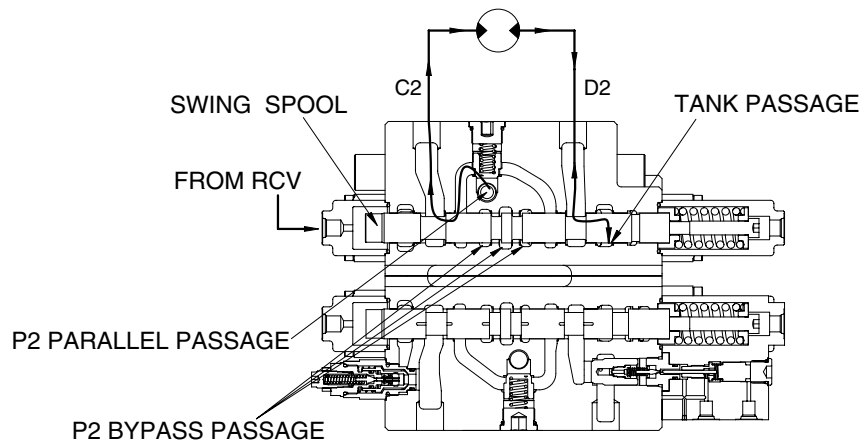
(5) SWING OPERATION

① Swing left operation



29072MC65

② Swing right operation

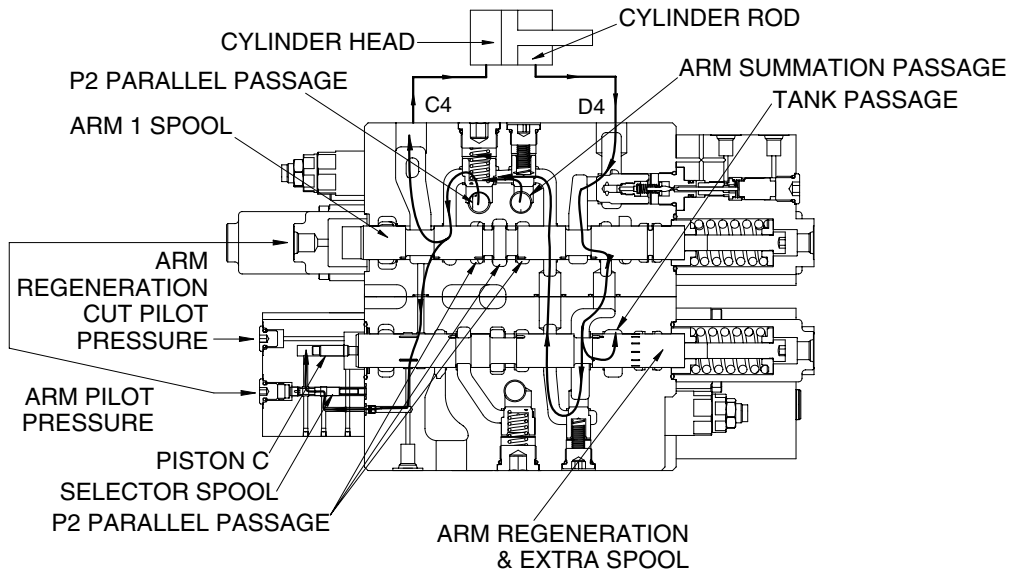


29072MC66

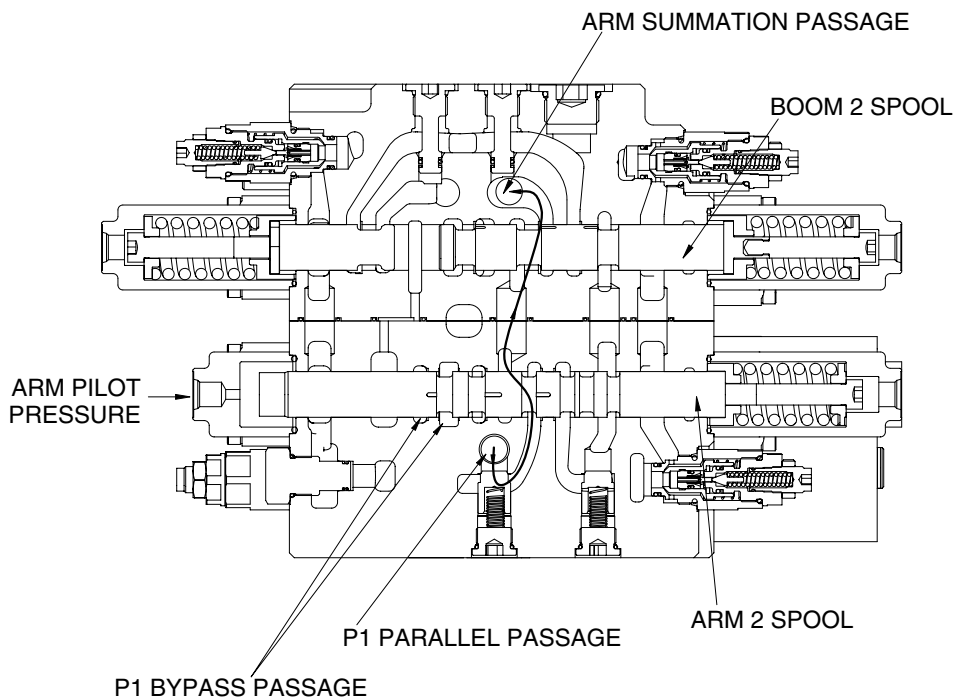
The pilot pressure from the RCV is supplied to the Pd2 and shift the swing spool in left direction. The hydraulic fluid from pump P2 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port D2. As the result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port C2, swing spool and the tank passage . In case of swing right operation, the operation is similar.

(6) ARM OPERATION

① Arm roll in operation



29072MC67



29072MC68

• Arm roll in operation :

During arm roll in operation the pilot pressure from the RCV is supplied to the port Pc40 and Pb3 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve and the port C4.

At same time, the hydraulic fluid from the pump P1 flows into the arm summation passage through parallel passage, the check valve, the arm2 spool and the boom2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm1 spool.

• **Arm regeneration :**

The return flow from the arm cylinder rod side is pressurized by self weight of arm and so, returns to port D4. The pressurized oil returning to port D4 enters the arm regeneration & breaker spool through the arm holding valve and the arm1 spool. It is supplied the arm cylinder head through internal passage. This is called the arm regeneration function.

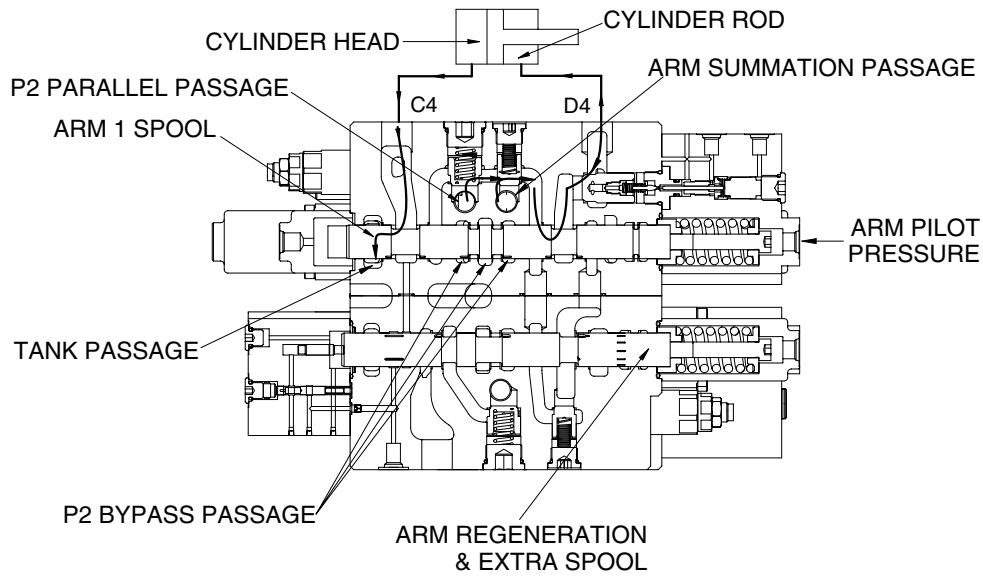
The amount of regeneration fluid are changed by movement of the arm regeneration & breaker spool.

A few fluid 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.

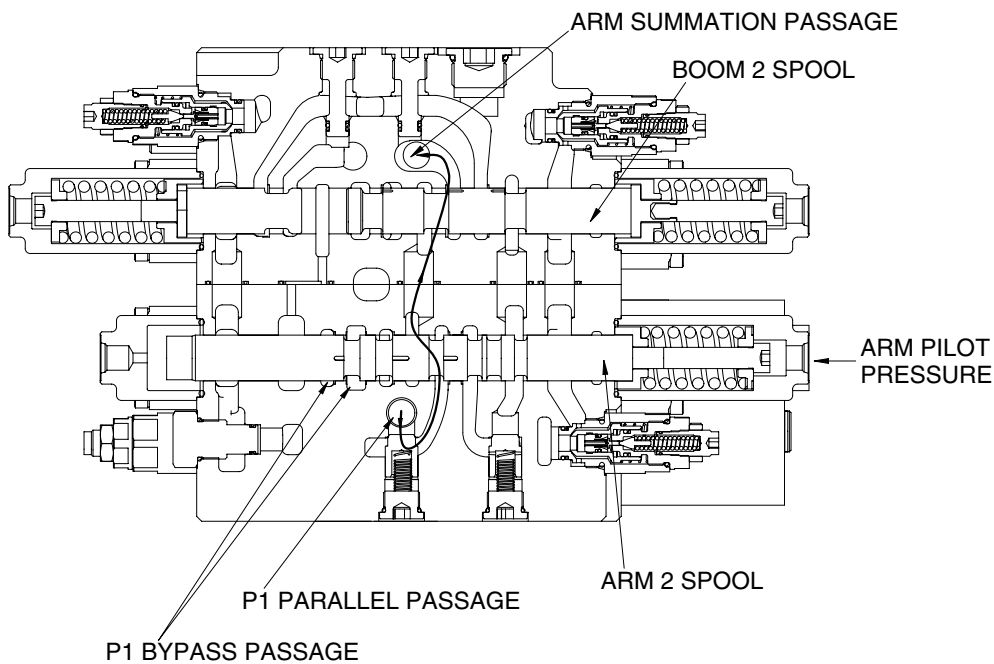
Then, the arm regeneration spool shift to right side and flow to tank pass increases and regeneration flow decreases. Therefore, pressure of arm cylinder head increases, then, arm regeneration flow decreases.

Furthermore, the arm regeneration cut pressure is supplied to port 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.

② Arm roll out operation



29072MC69



29072MC70

During arm roll out operation the pilot pressure from RCV is supplied to the port Pd40 and the Pd41 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic fluid from pump P2 flows into arm1 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.

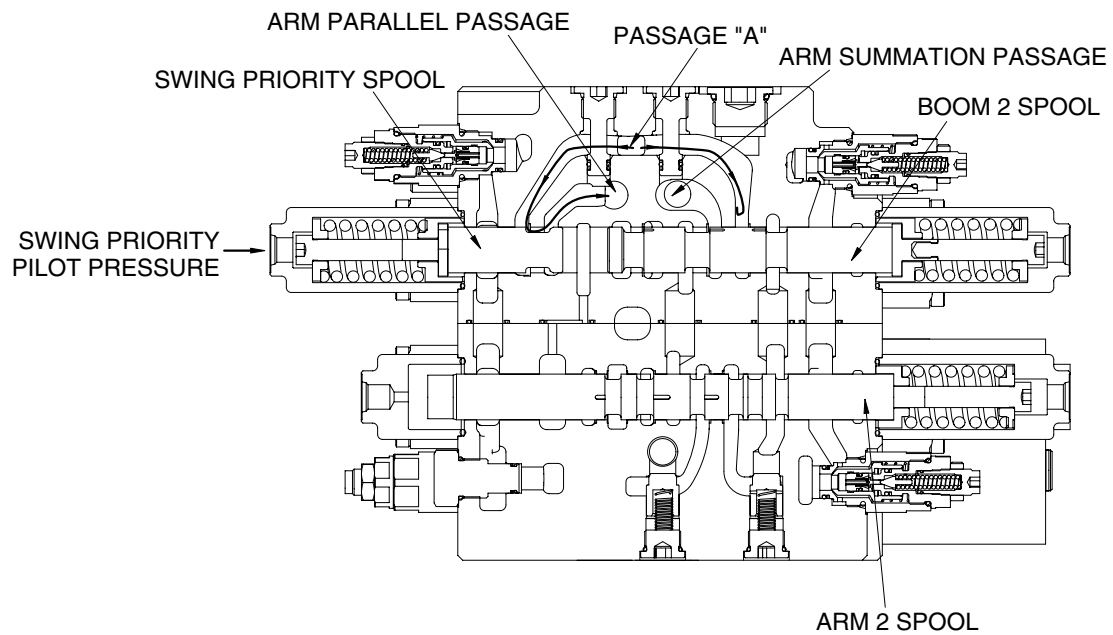
Some of the hydraulic fluid from pump P2 bypassed through bypass notch.

The rest of hydraulic fluid from pump P2 flows into the arm summation passage through P1 parallel passage the check valve arm2 spool and boom2 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 arm1 spool and tank passage.

(7) SWING PRIORITY FUNCTION



29072MC71

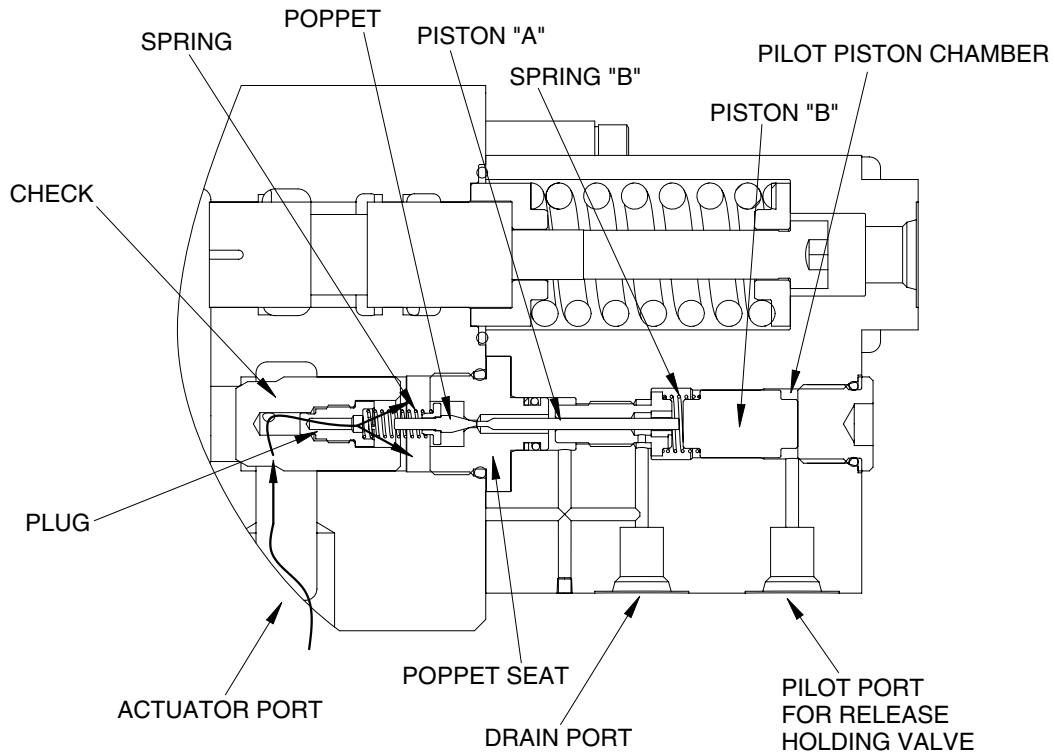
During swing priority operation, the pilot pressure is supplied to the port Pc3 and shift swing priority spool in the right direction.

The hydraulic fluid from P2 parallel passage flows into the parallel passage of arm1 side through swing priority spool and the passage "A" and also flows into the boom2 spool.

Due to shifting of the swing priority spool, the fluid from pump P2 flows to swing side more then next spools to make the swing operation most preferential.

(8) HOLDING VALVE OPERATION

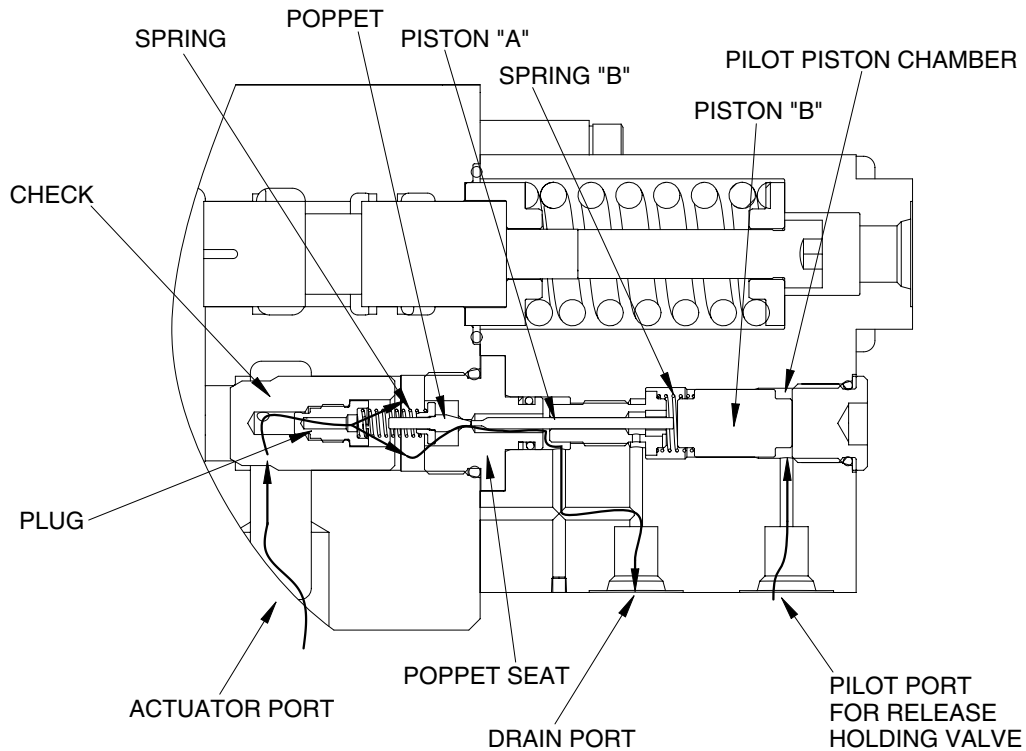
① Holding operation



29072MC72

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" and the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug. Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body. So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

② Release holding operation



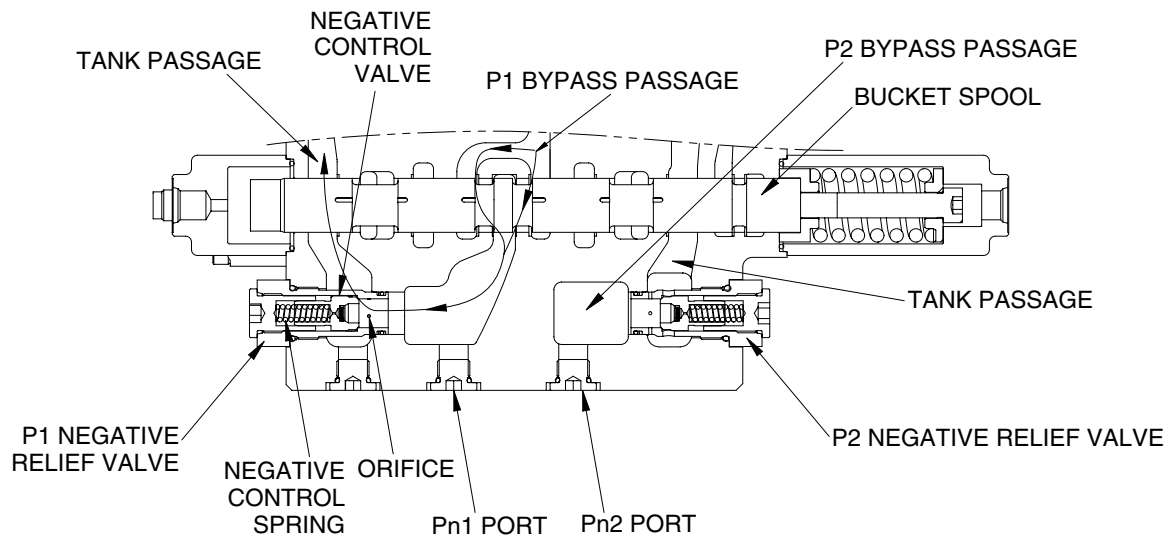
29072MC73

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.

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

(9) NEGATIVE CONTROL



29072MC74

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 become zero and the discharge of the pump P1 become maximum.

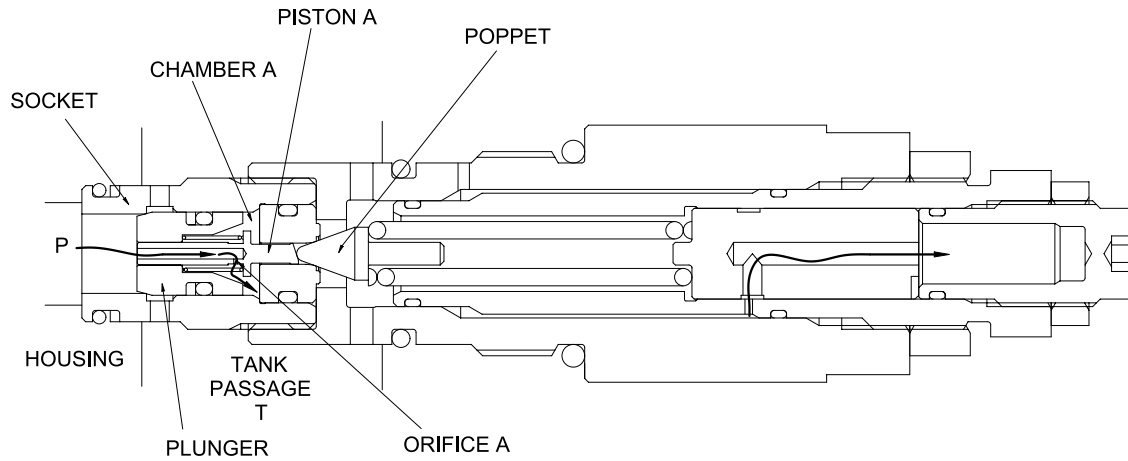
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump P2 the same negative control principle.

(10) OPERATION OF MAIN RELIEF VALVE

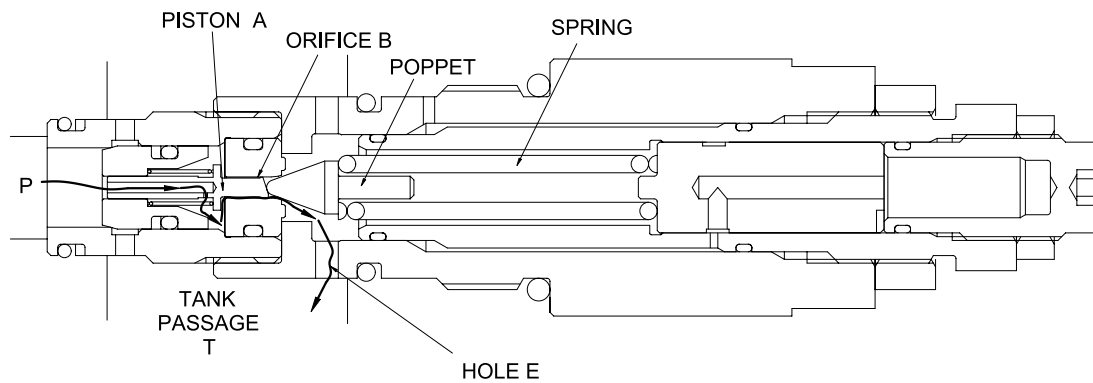
The main relief valve is fitted to the straight travel valve block and functions as follows :

- 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.



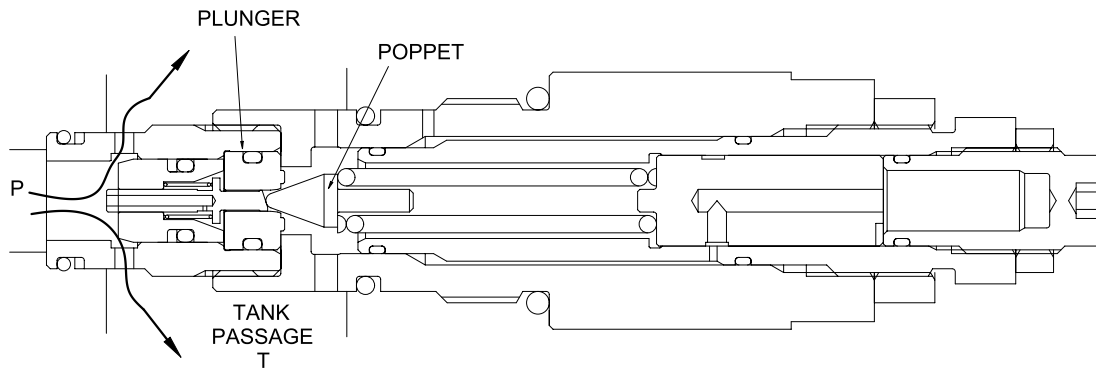
14072SF36

- 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 hole (E).



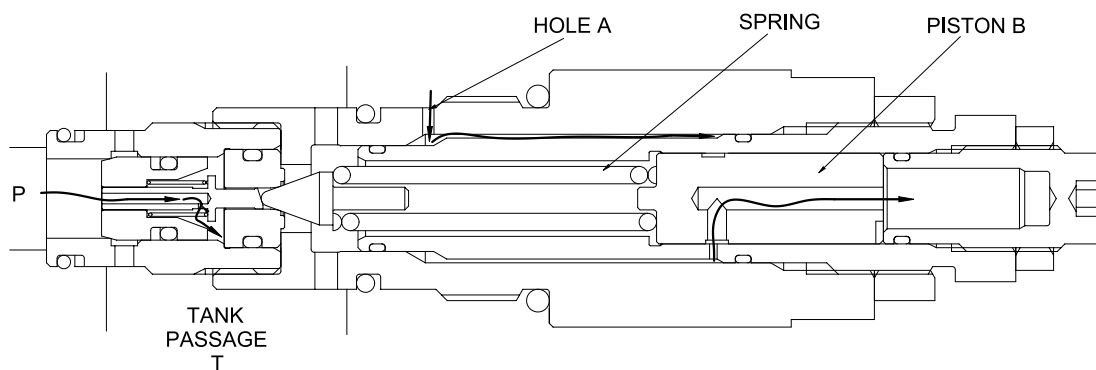
14072SF37

- 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)



14072SF38

- ④ High pressure setting pilot signal(Pu) : ON
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.

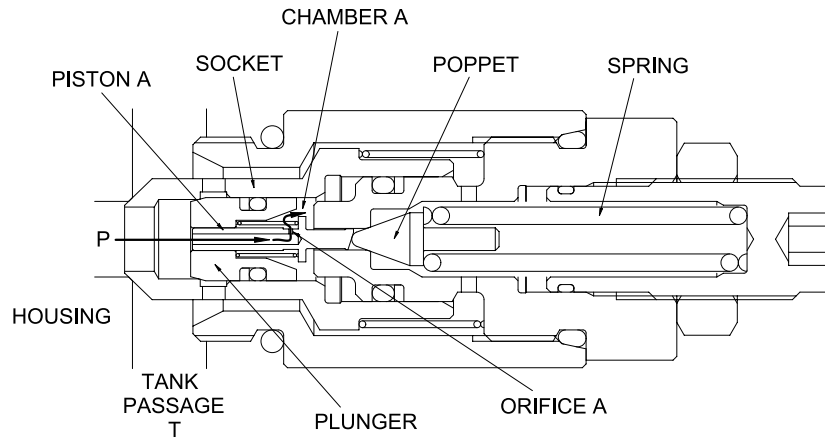


14072SF36

(11) OPERATION OF PORT RELIEF VALVE

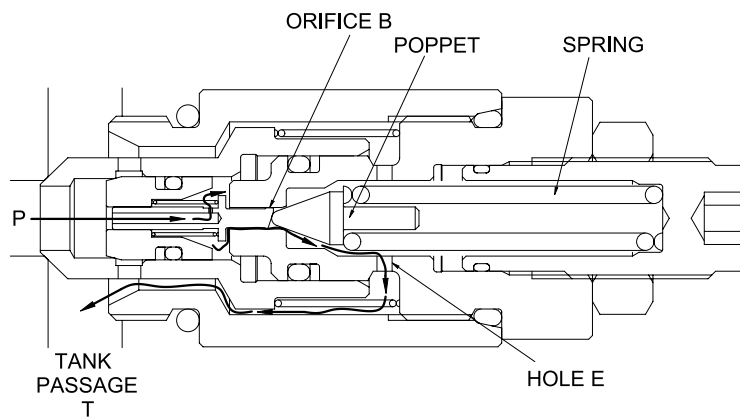
① Function as relief valve

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



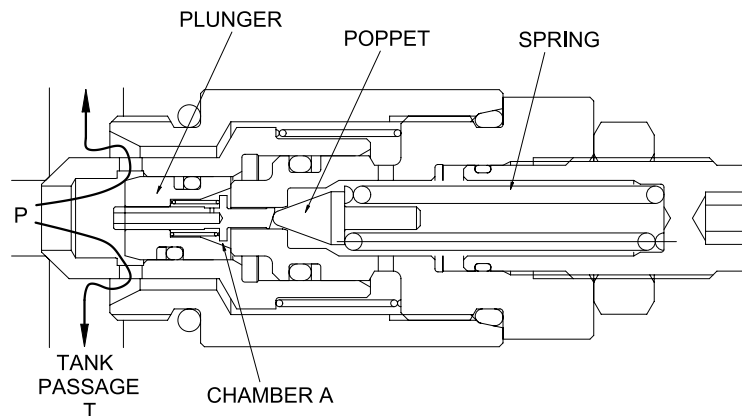
14072SF39

- ② When the pressure at port P becomes equal to the set pressure of the spring, the pressurized oil pushes open the poppet flows to tank passage (T) through hole E.



14072SF40

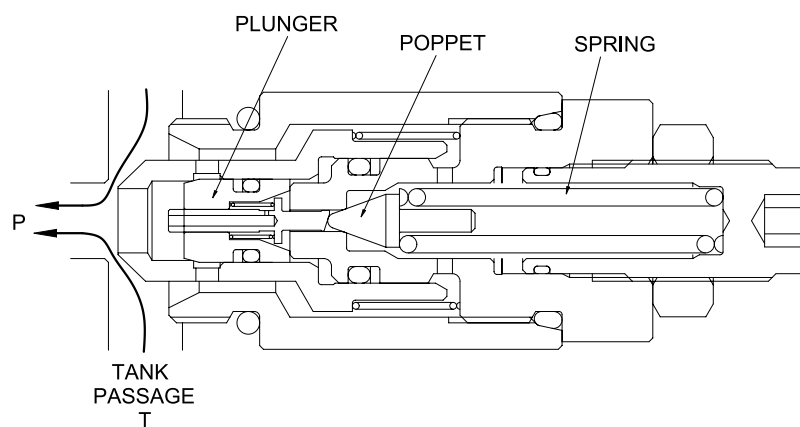
- © Opening of the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



14072SF41

② Make-up function

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 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.



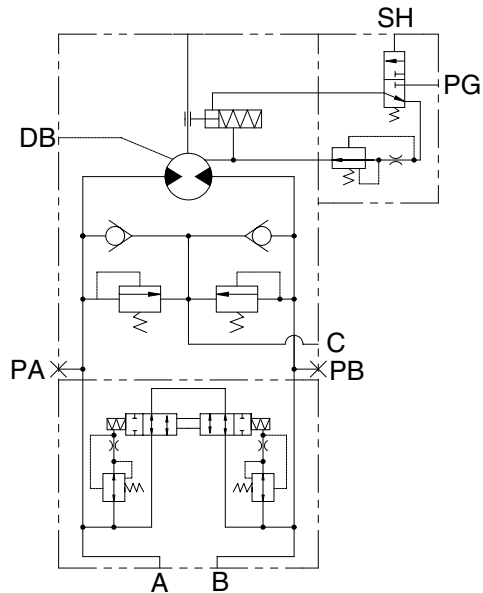
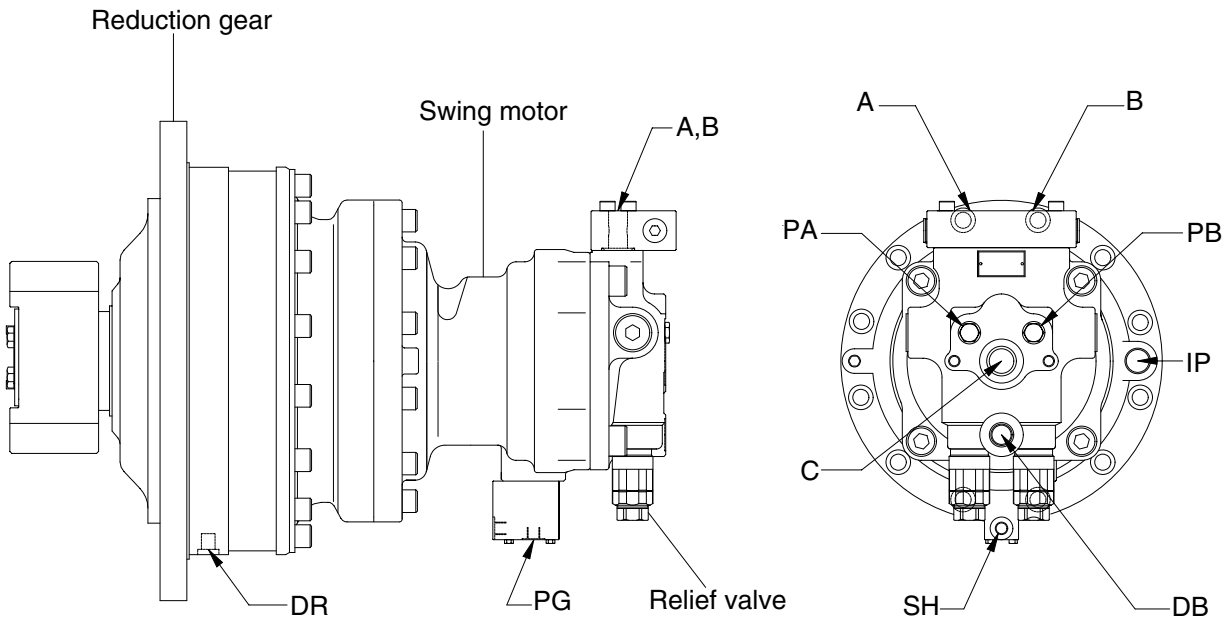
14072SF42

GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

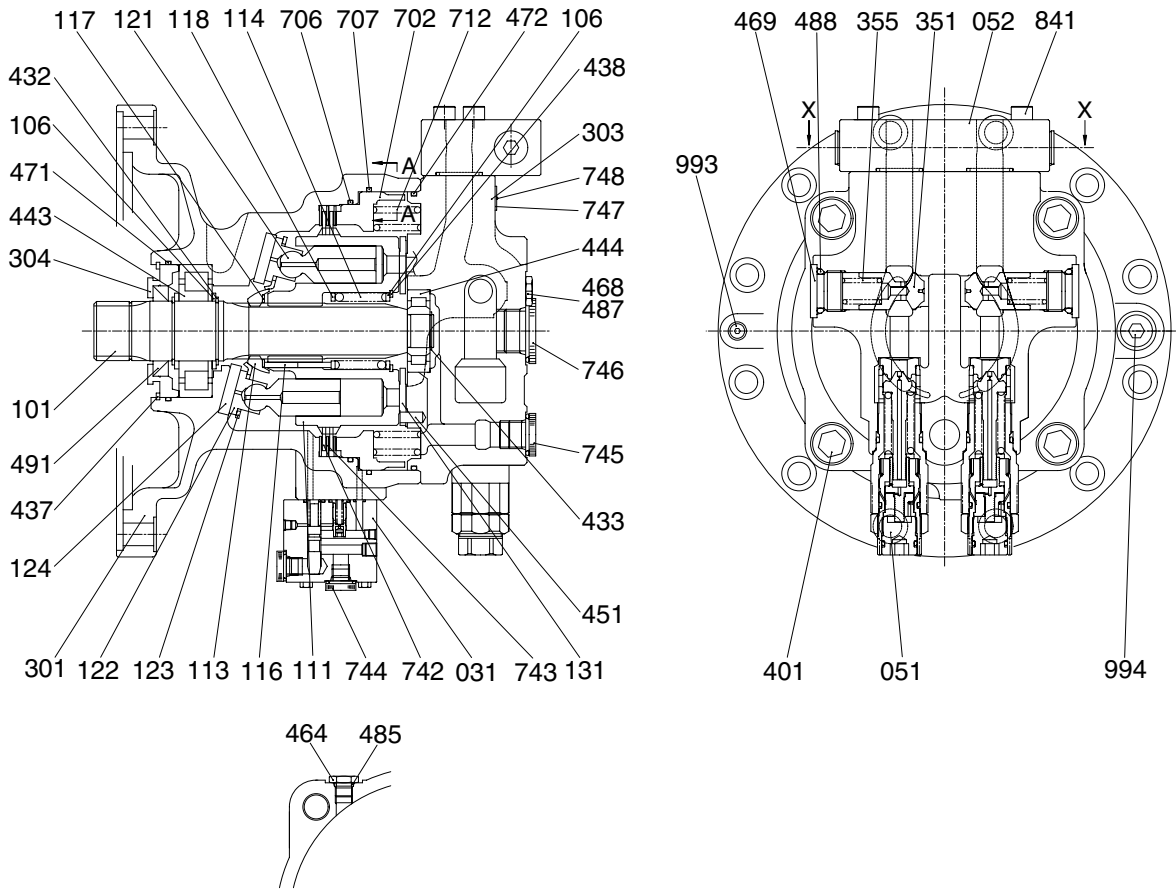
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



Port	Port name	Port size
A, B	Main port	∅ 20
DB	Drain port	PF 1/2-19
C	Make up port	PF 1-24
PA, PB	Gauge port	PF 1/4-15
PG	Brake release port	PF 1/4-12
SH	Brake pilot port	PF 1/4-12
IP	Gear oil inlet port	PT 3/4-19
DR	Gear oil drain port	PT 1/2

30572SM01

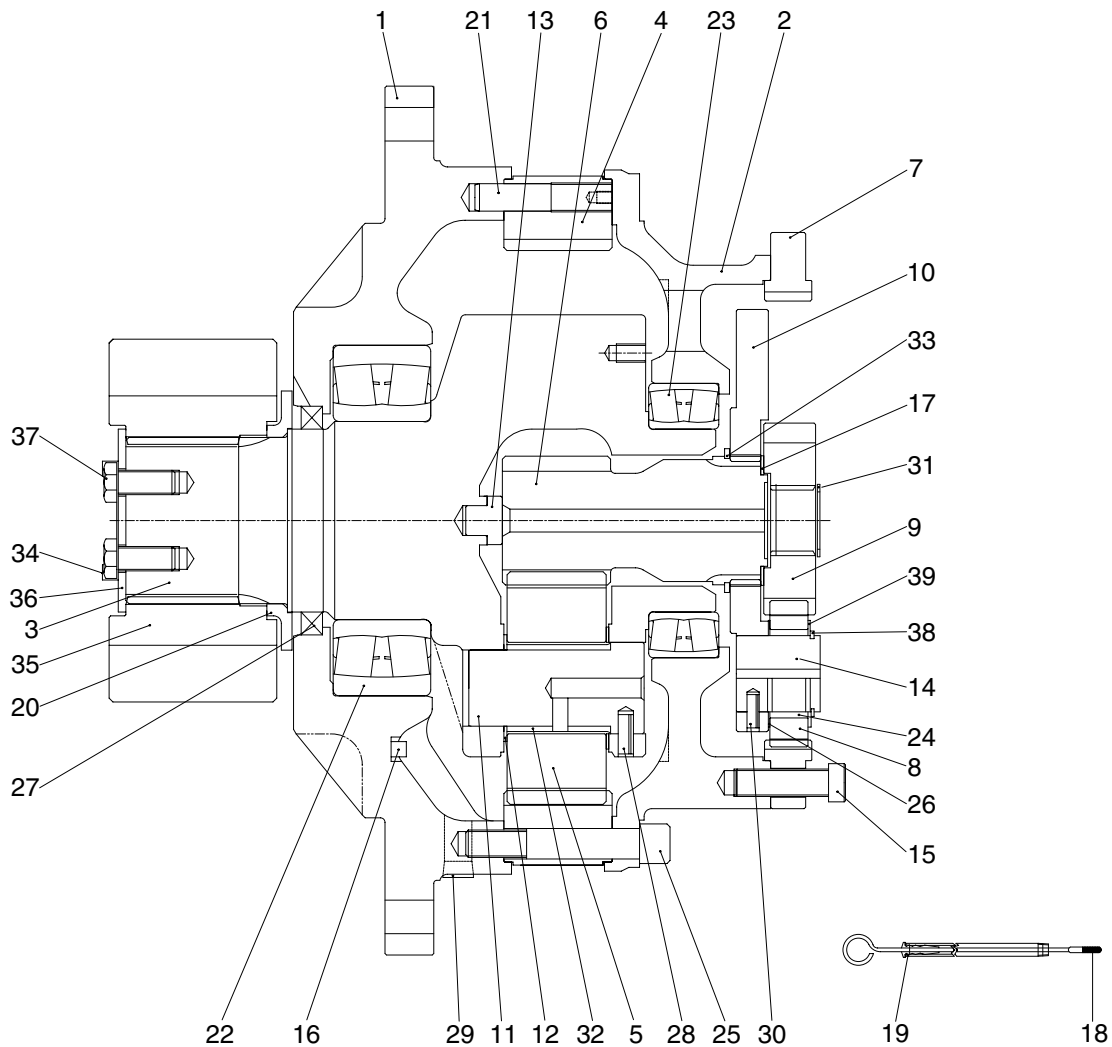
1) SWING MOTOR



30572SM02

031	Brake valve	304	Front cover	488	O-ring
051	Relief valve	351	Plunger	491	Oil seal
052	Valve assy	355	Spring	702	Piston
101	Drive shaft	401	Socket bolt	706	O-ring
106	Spacer	432	Snap ring	707	O-ring
111	Cylinder block	433	Snap ring	712	Brake spring
113	Bushing	437	Snap ring	742	Lining plate
114	Spring	438	Snap ring	743	Separate plate
116	Push rod	443	Roller bearing	744	Plug
117	Spacer	444	Roller bearing	745	Plug
118	Spacer	451	Spring pin	746	Plug
121	Piston	464	Plug	747	Name plate
122	Shoe	468	Plug	748	Rivet screw
123	Retainer	469	Plug	841	Socket bolt
124	Shoe plate	471	O-ring	993	Plug
131	Valve plate	472	O-ring	994	Plug
301	Casing	485	O-ring		
303	Casing	487	O-ring		

2) REDUCTION GEAR



30572SR01

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

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(131), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(121) upon the return plate(123) which acts upon the swash plate(124) via an hydrostatic bearing. Force F1 perpendicular to swash plate(124) and force F2 perpendicular to cylinder center. Being transferred to the cylinder block(111) through piston, force F2 causes rotational moment at surroundings of cylinder.

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

$$T = \frac{p \times q}{2\pi}, q = Z \cdot A \cdot \text{PCD} \cdot \tan\theta, F_1 = \frac{F}{\cos\theta}, F_2 = F \tan\theta, S = \text{PCD} \times \tan\theta$$

Where p : Effective difference of pressure(kgf/cm²)

q : Displacement(cc/rev)

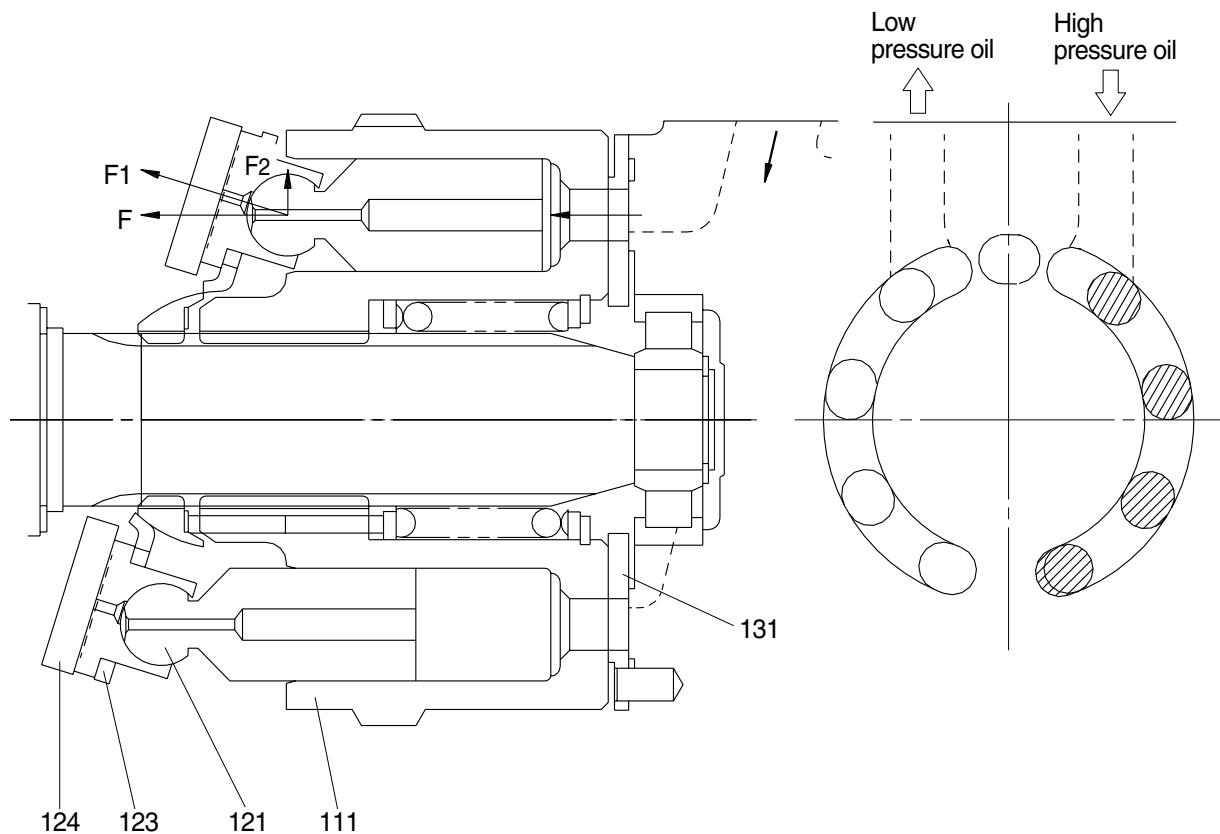
T : Output torque(kgf · cm)

Z : Piston number(9EA)

A : Piston area(cm²)

θ : Tilting angle of swash plate(degree)

S : Piston stroke(cm)



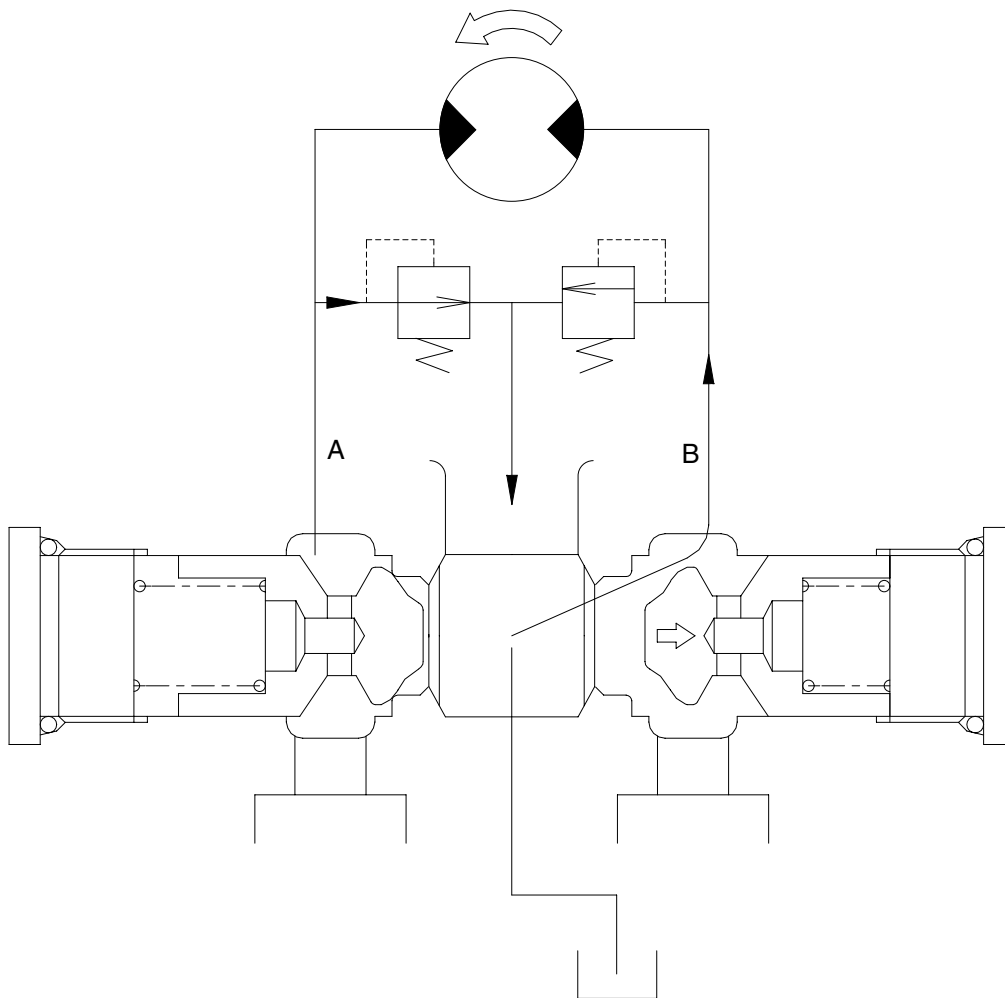
2) MAKE UP VALVE

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.

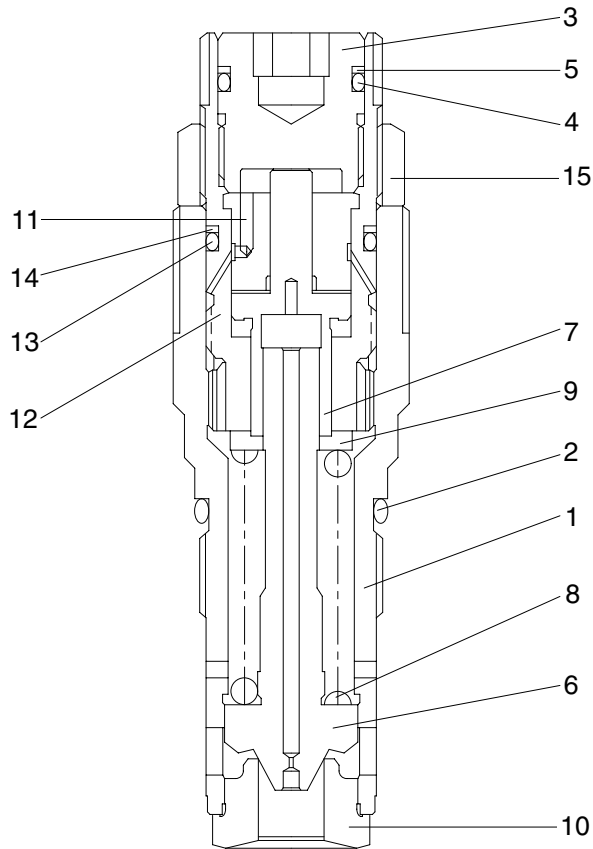
Pressurized oil into the port B, the motor rotate counterclockwise.

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.



29072SM09

3) RELIEF VALVE



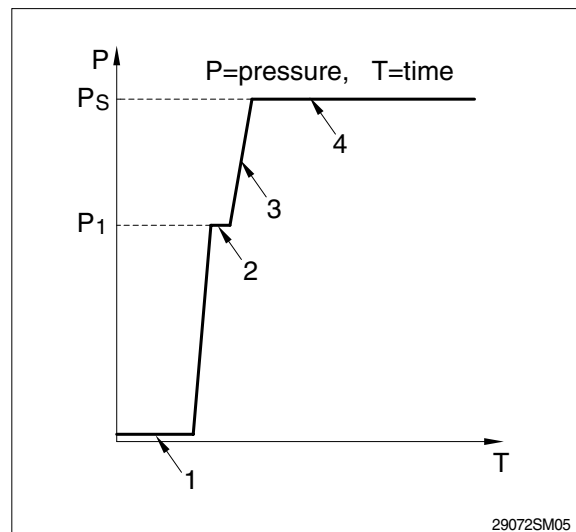
- 1 Body
- 2 O-ring
- 3 Plug
- 4 O-ring
- 5 Back up ring
- 6 Plunger
- 7 Piston
- 8 Spring
- 9 Seat spring
- 10 Seat
- 11 Sleeve
- 12 Adjust plug
- 13 O-ring
- 14 Back up ring
- 15 Nut

(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.

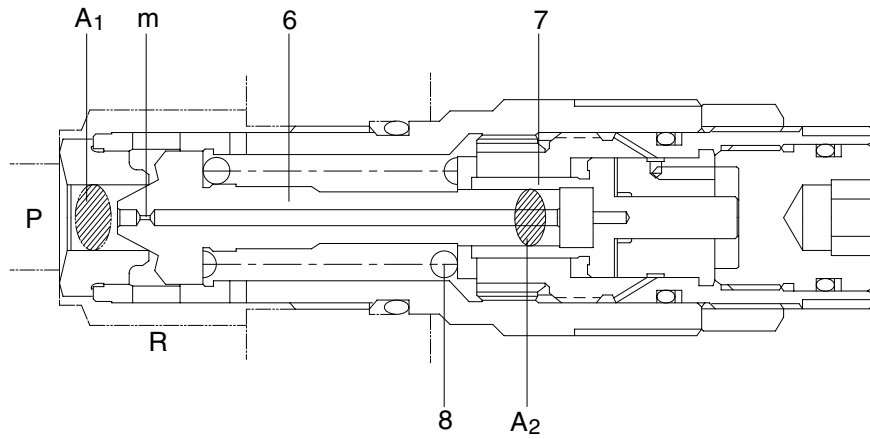
(2) Function of relief valve

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.



29072SM05

① Ports (P,R) at tank pressure.

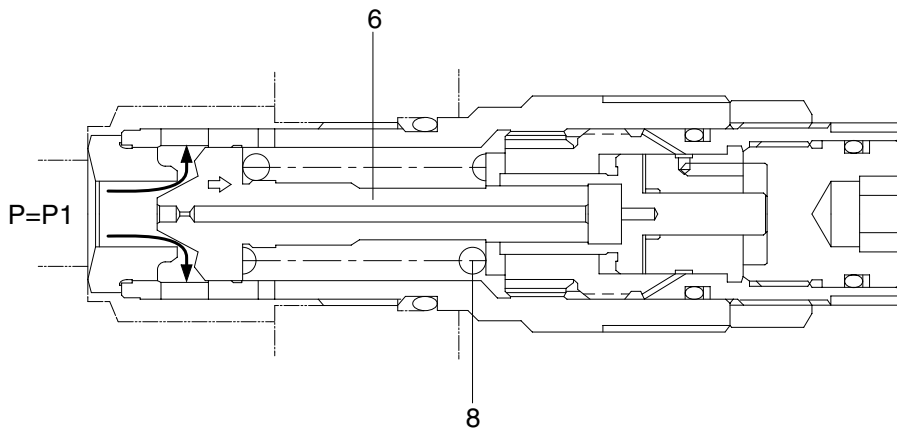


29072SM04

② When hydraulic oil pressure($P \times A_1$) reaches the preset force(F_{SP}) of spring(8), the plunger (6) moves to the right as shown.

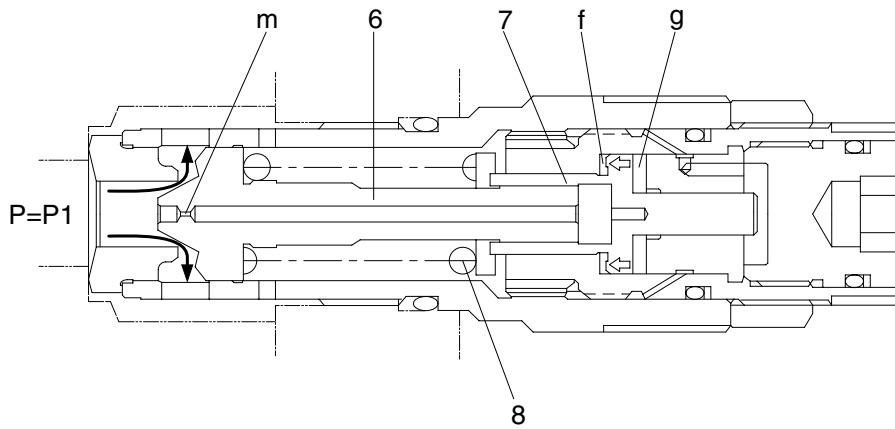
$$P_1 \times A_1 = F_{sp} + P_1 \times A_2$$

$$P_1 = \frac{F_{sp}}{A_1 - A_2}$$



29072SM06

- ③ When the pressure of chamber g reaches the preset force(F_{sp}) of spring(8), the piston(7) moves right and stop the piston(7) hits the end of body.

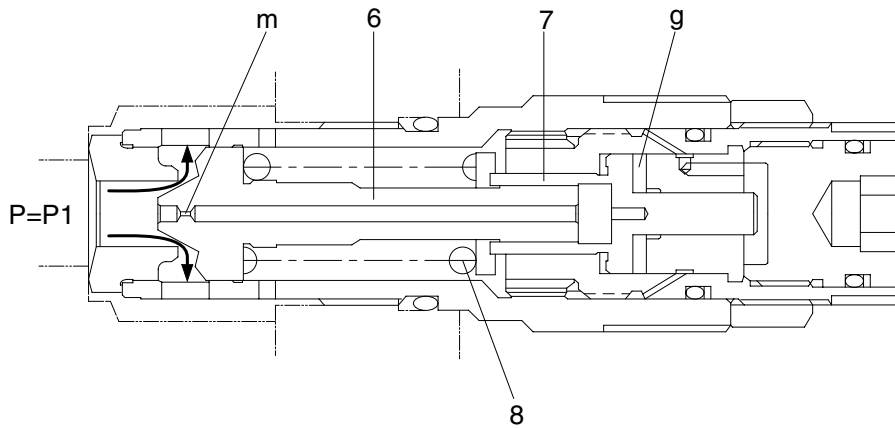


29072SM07

- ④ When piston(7) hits the end of body, it stops moving to the right any further. As the result, the pressure in chamber(g) equals(P_s).

$$P_s \times A_1 = F_{sp} + P_s \times A_3$$

$$P_s = \frac{F_{sp}}{A_1 - A_3}$$



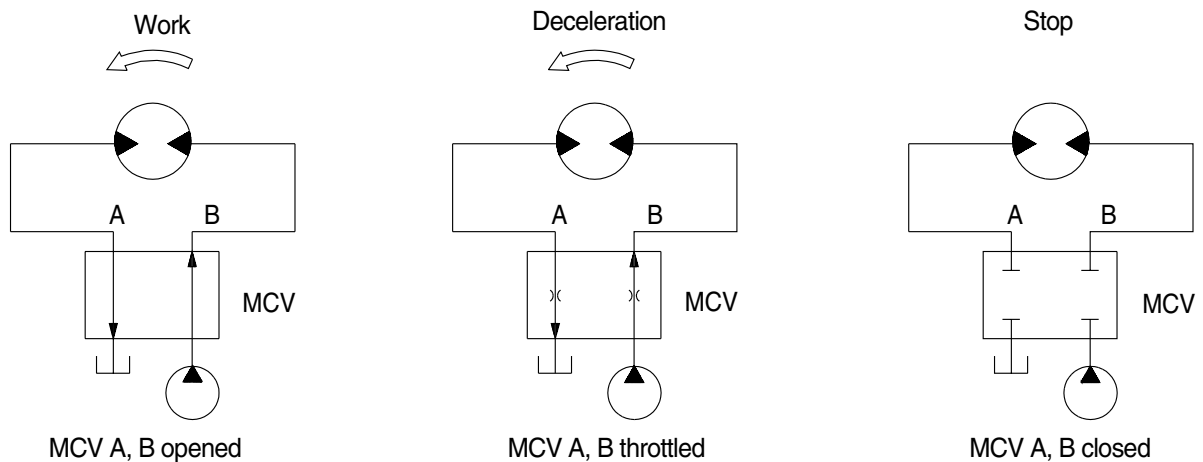
29072SM08

4) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



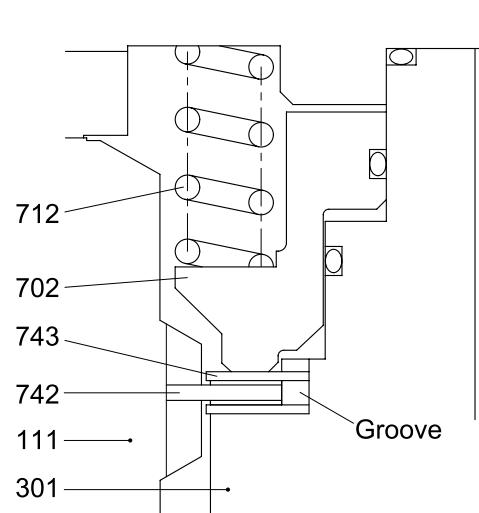
(2) Mechanical swing parking brake system

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

① Brake assembly

Circumferential rotation of separate plate(743) is constrained by the groove located at casing(301). When housing is pressed down by brake spring(712) through lining plate(742), separate plate(743) and brake piston(702), friction force occurs there.

Cylinder(111) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



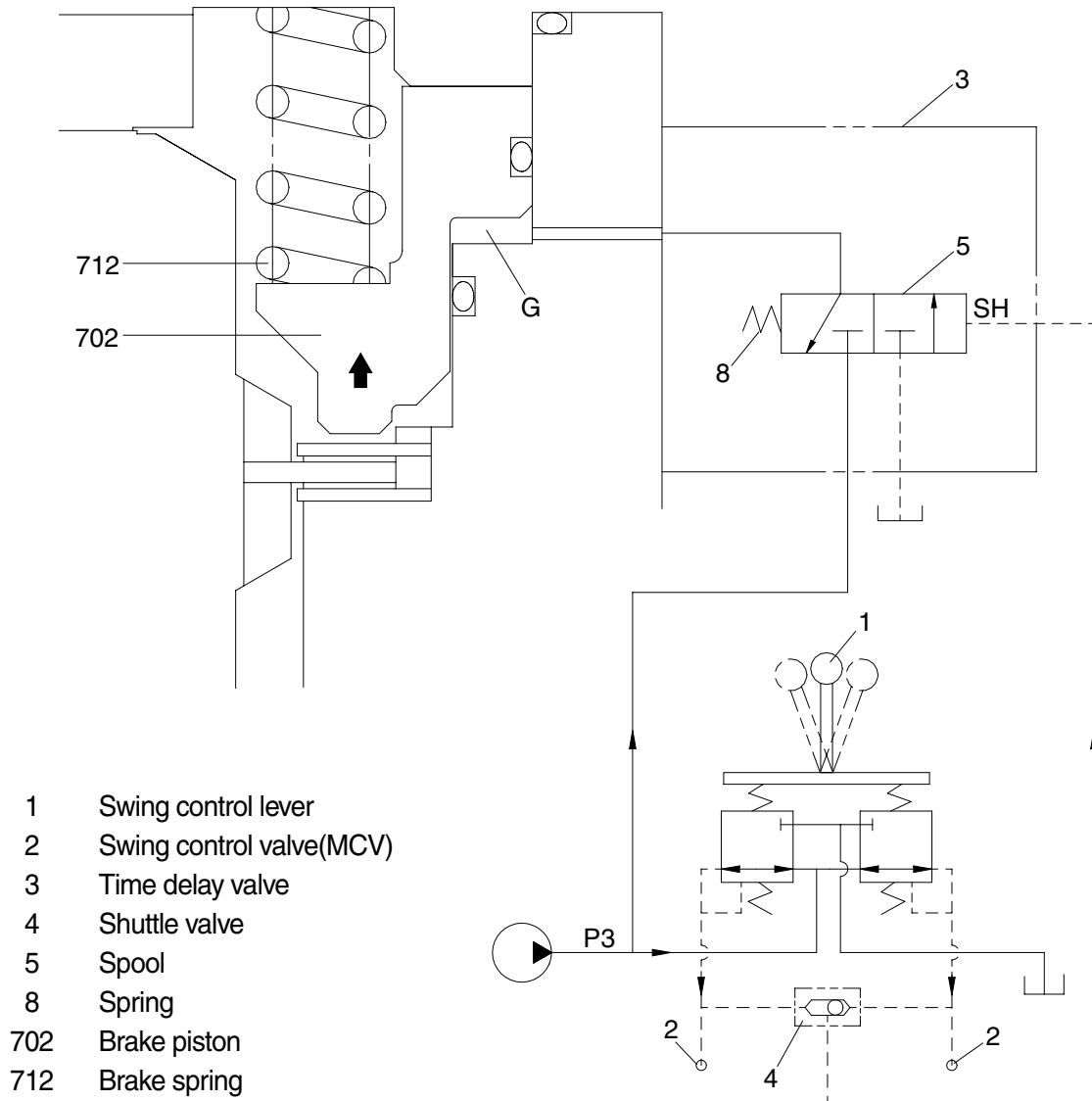
30572SM03

111	Cylinder	712	Brake spring
301	Casing	742	Lining plate
702	Brake piston	743	Separate plate

② **Operating principle**

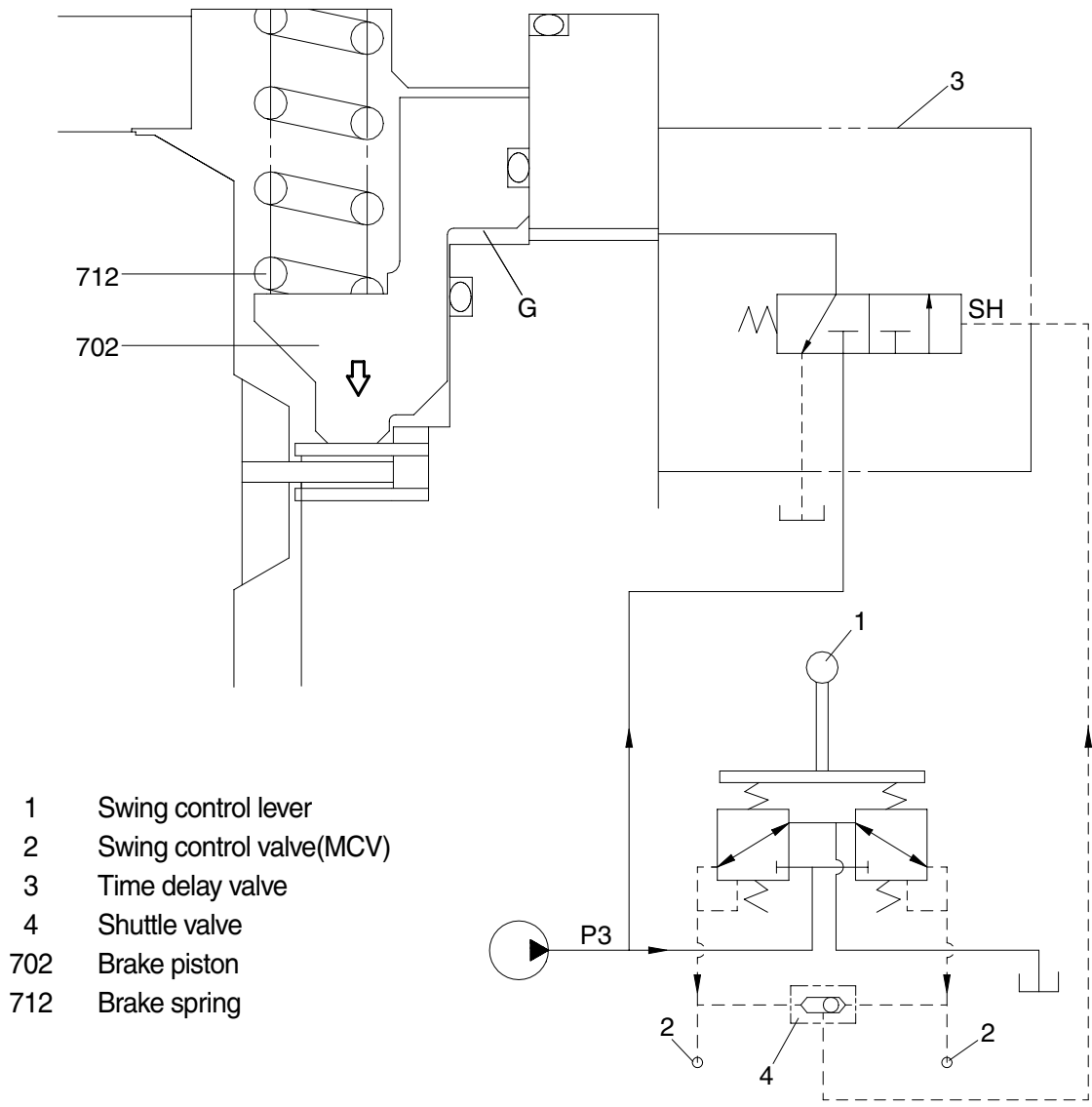
a. When the swing control lever(1) is set to the swing position, the pilot oil go to the swing control valve(2) and to SH of the time delay valve(3) via the shuttle valve(4), this pressure move spool(5) to the leftward against the force of the spring(8), so pilot pump charged oil(P3) goes to the chamber G.

This pressure is applied to move the piston(702) to the upward against the force of the spring(712). Thus, it releases the brake force.



30572SM04

- b. When the swing control lever(1) is set the neutral position, the time delay valve(3) shifts the neutral position and the pilot oil blocked chamber G.
- Then, the piston(702) is moved lower by spring(712) force and the return oil from the chamber G is drain.



- 1 Swing control lever
- 2 Swing control valve(MCV)
- 3 Time delay valve
- 4 Shuttle valve
- 702 Brake piston
- 712 Brake spring

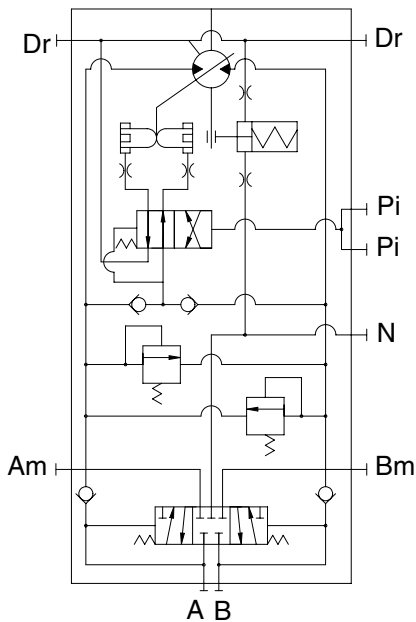
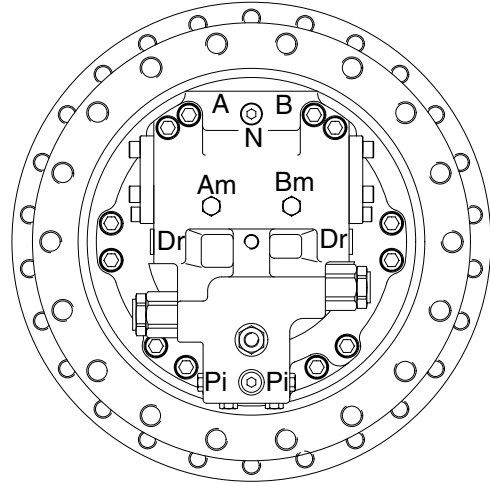
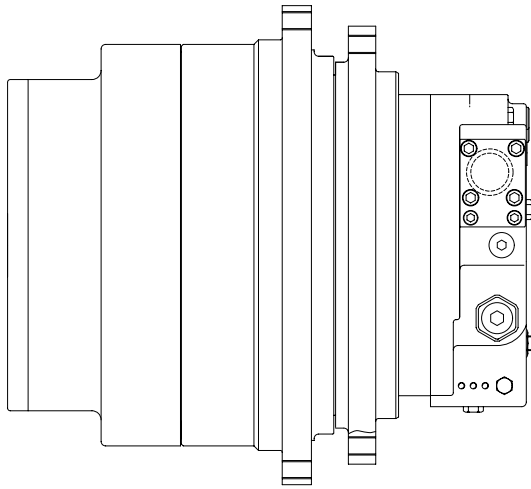
30572SM05

GROUP 4 TRAVEL DEVICE

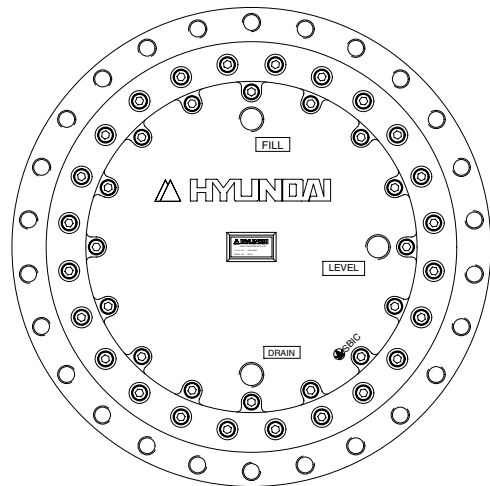
1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



CIRCUIT DIAGRAM

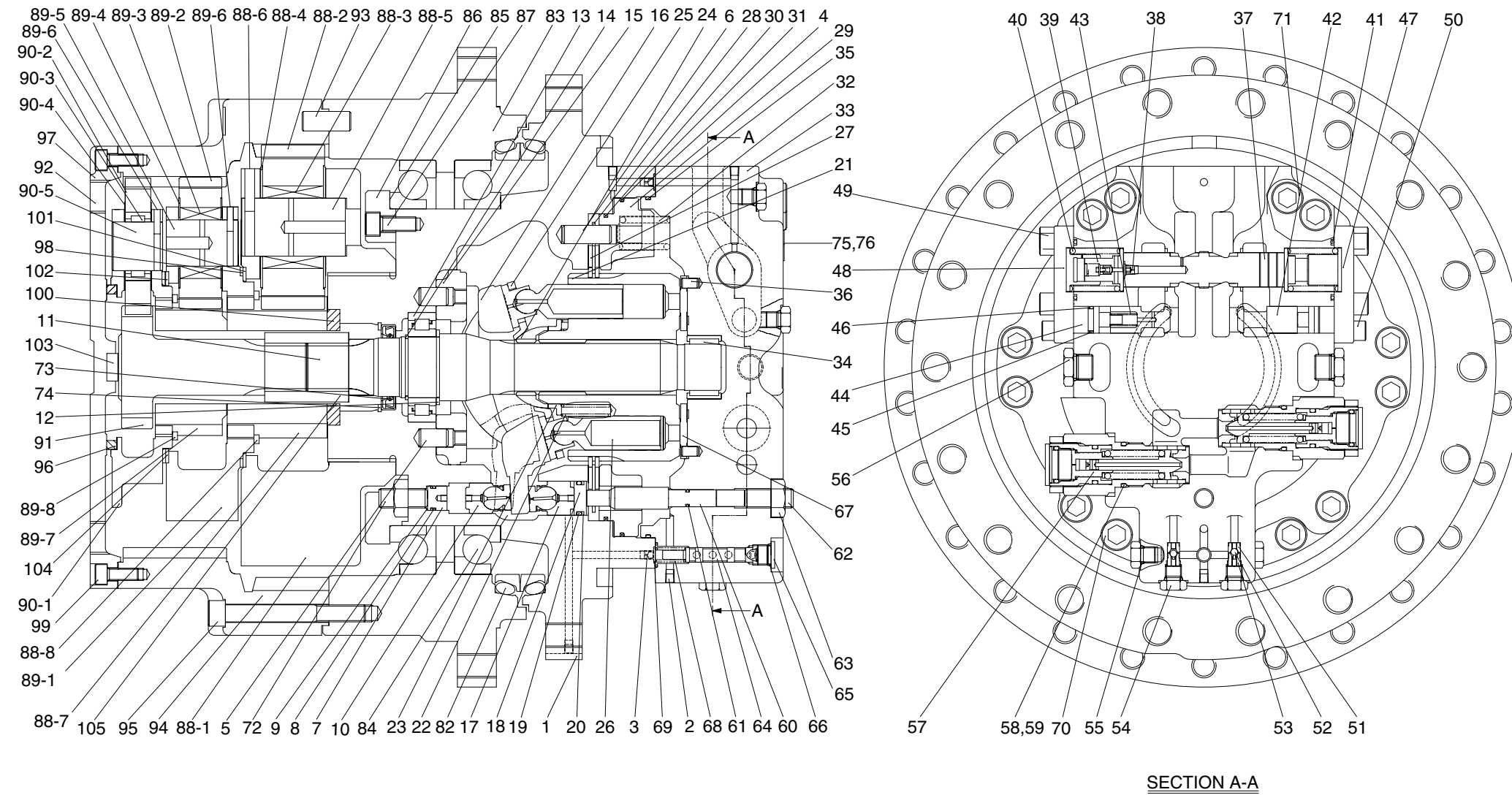


300072TM01A

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

2. SPECIFICATION

1) TRAVEL MOTOR



SECTION A-A

2907A2TM01

1 Casing	16 Plate	31 Ring	46 Back up ring	61 O-ring	83 Housing	89-1 Carrier No.2	92 Plug
2 Plug	17 Piston	32 Spring	47 Cap	62 Lock screw	84 Bearing	89-2 Planetary gear No.2	93 Lock pin
3 Screw	18 Stopper	33 Valve casing	48 Cap	63 Nut	85 Shim	89-3 Needle No.2	94 Ring gear
4 Screw	19 O-ring	34 Needle bearing	49 Bolt	64 Spool	86 Retainer	89-4 Thrust washer No.2	95 Bolt
5 Pin	20 Back up ring	35 O-ring	50 Socket bolt	65 Plug	87 Bolt	89-5 Pin No.2	96 Thrust ring No.1
6 Pin	21 Cylinder block	36 Pin	51 Seat	66 O-ring	88 Carrier No.3	89-6 Spring pin No.2	97 Cover
7 Stopper	22 Cylinder spring	37 Spool	52 Steel ball	67 Valve plate	88-1 Carrier No.3	89-7 Sun gear No.2	98 Thrust ring No.2
8 O-ring	23 Spacer	38 Screw	53 Stopper	68 Spring	88-2 Planetary gear No.3	89-8 Snap ring No.2	99 Bolt
9 Back up ring	24 Guide	39 Damping check	54 Plug	69 O-ring	88-3 Needle No.3	90 Carrier No.1	100 Motor ring
10 Piston	25 Plate	40 Spring	55 O-ring	70 Socket bolt	88-4 Thrust washer No.3	90-1 Carrier No.1	101 Thrust ring No.3
11 Shaft	26 Piston & Shoe assy	41 O-ring	56 Plug	71 Socket bolt	88-5 Pin No.3	90-2 Planetary gear No.1	102 Thrust ring No.1
12 Spacer	27 Plate	42 Plunger	57 Relief valve	72 Lock screw	88-6 Spring pin No.3	90-3 Needle bearing No.1	103 Pad
13 Roller bearing	28 Plate	43 Spring	58 O-ring	73 Oil seal	88-7 Sun gear No.3	90-4 Thrust washer No.1	104 Thrust ring No.2
14 Stop ring	29 Brake	44 Stopper	59 Back up ring	74 Lock ring	88-8 Snap ring No.3	90-5 Pin No.1	105 Coupling
15 Support	30 Ring	45 O-ring	60 Rod	82 Floating Seal	89 Carrier No.2	91 Sun gear No.1	

3. PRINCIPLE OF DRIVING

1) WORKING OF ROTARY GROUP

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

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

This high pressurized hydraulic oil works on the piston and generating the force F_1 , $F_1 = P * A$ (P : supplied pressure, A : pressure receiving area), like following pictures.

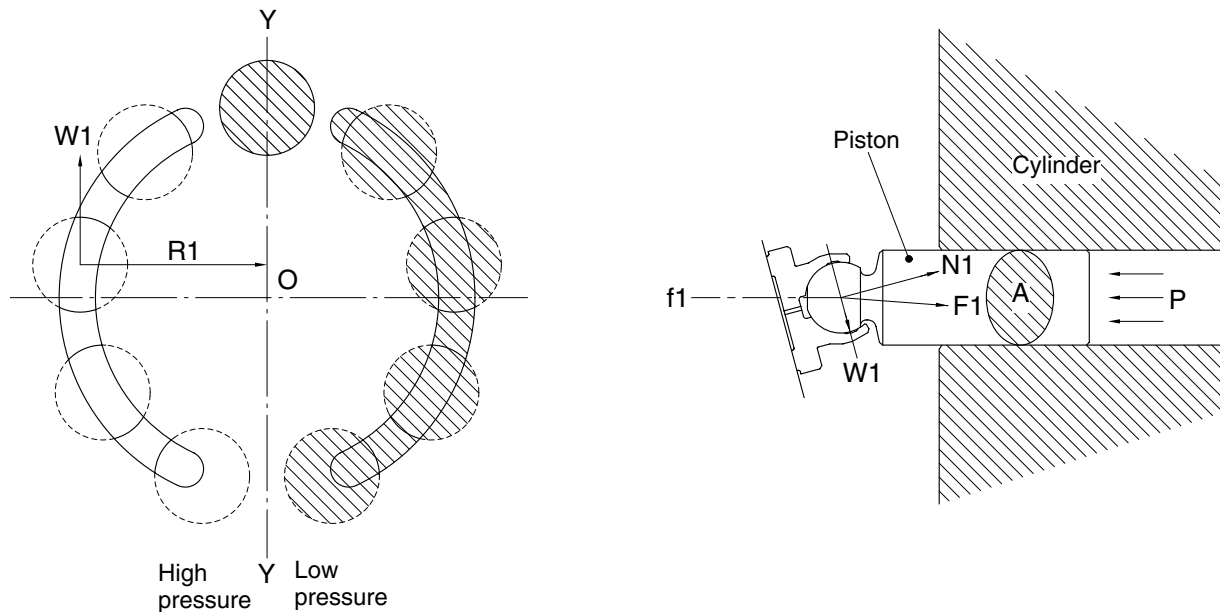
This force, F_1 , is divided by the swash plate(16) having a tilting angle α into the thrust component N_1 and radial component W_1 .

The W_1 generates torque, $T = W_1 * R_1$, in respect to the line Y-Y.

This torque generated by each piston on the high pressurized hydraulic oil side is summed up onto a resultant torque $\Sigma(W_1 * R_1)$, which prodeces torque for rotation.

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

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



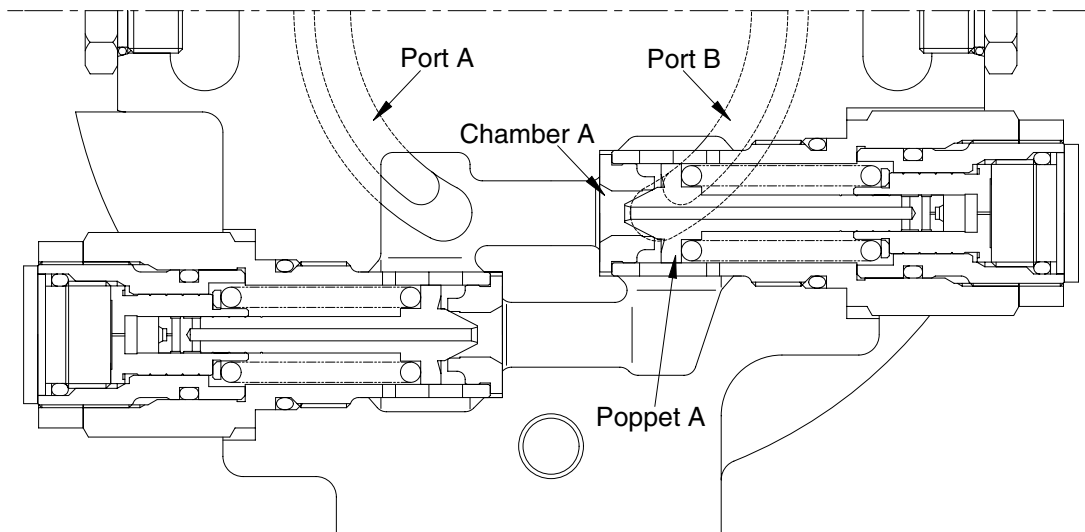
2907A2TM07

2) WORKING OF RELIEF VALVE

Relief valve carries on two function of following.

- (1) Relief valve is to keep the starting pressure of the hydraulic motor at a constant value and bypass to the return line excessive oil generated at the motor inlet depending upon the acceleration speed of the inertia object.
- (2) In case of an inertia object stopped, relief valve is generating a break pressure at the outlet and stop it forcedly.

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



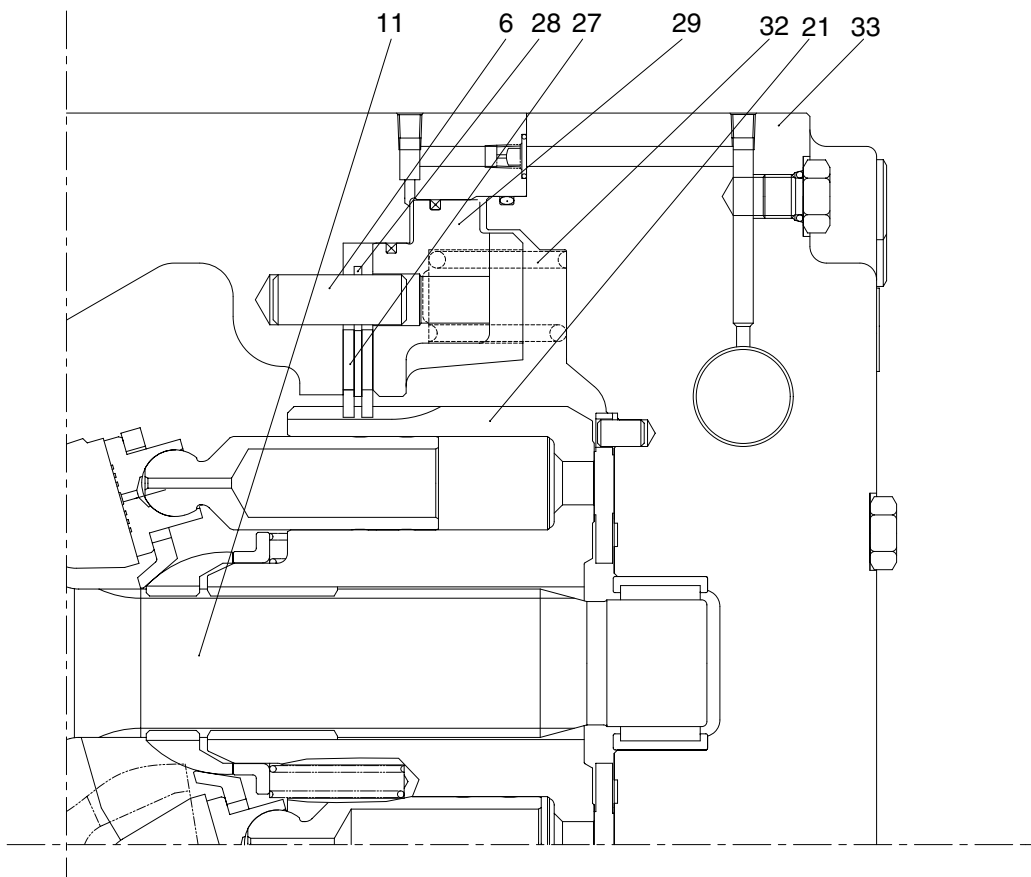
2907A2TM04

3) WORKING OF NEGATIVE BRAKE

The negative brake is released applying to the brake piston(29) the pressure led through built in the valve casing(33) spool. With no pressure working, the brake force is always ensured.

The brake force is generated by the frictional force among a plate(28) fixed by pin(6) and shaft casing, brake piston(29) and a frictional plate(27) connected through spline outside the cylinder block(21).

Without pressure being applied to the brake piston, the brake piston is pushed by ten brake springs(32) and the friction plate and separator plate are held between the brake piston and casing. This friction force restrains the shaft(11) spline-coupled with the cylinder block, and thus functions the brake.



300075TM05

4) COUNTERBALANCE VALVE

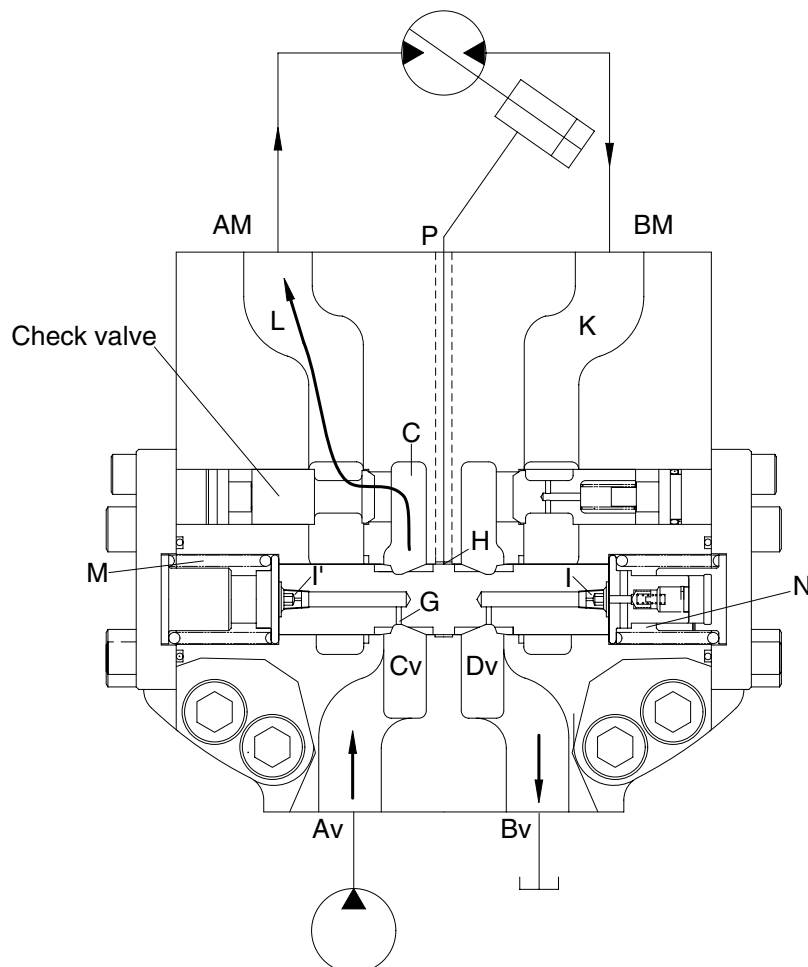
Av port is connected to a hydraulic pump : Bv port is connected to a tank.

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

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

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

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



300072TM06

5) WORKING OF DISPLACEMENT CHANGEOVER

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

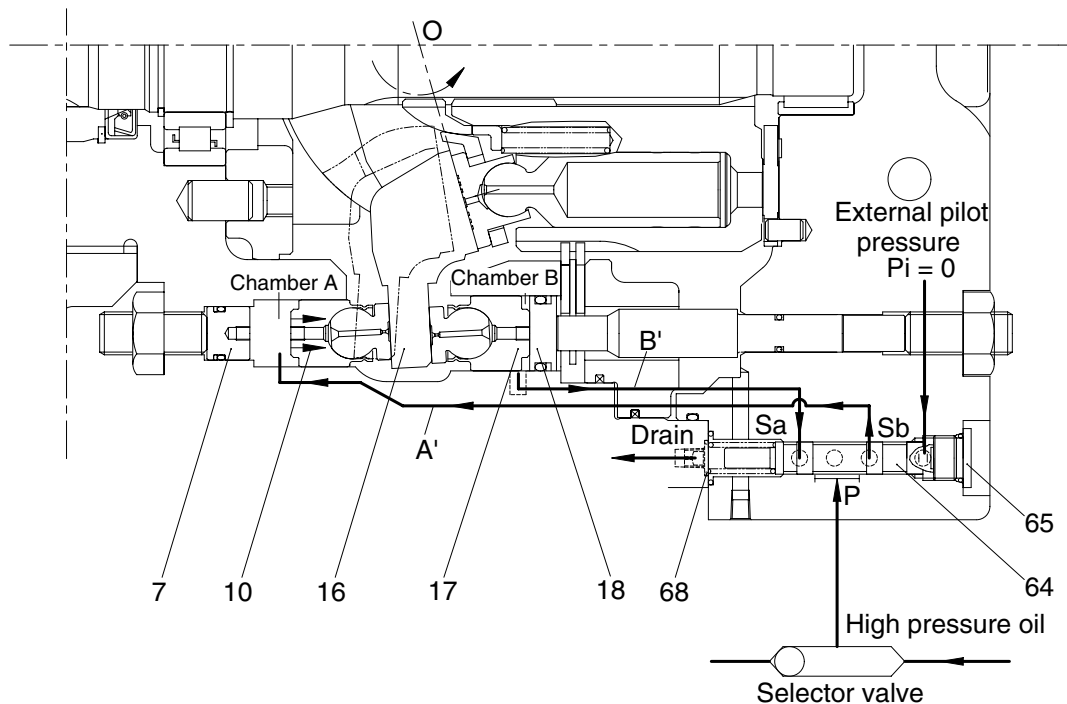
(1) External pilot pressure : $P_i = 0$ (Large displacement)

By means of the built-in high pressure selector mechanism in the valve casing(33), the high pressure oil working on the motor function to port P of the displacement-changeover valve.

A the spool(64) assembled in the displacement changeover valve is pressed to plug(65) by the spring(68), the high pressure oil at port P flows to port Sb.

This high pressure oil flows through oil passage(passage A') of valve casing(33) and shaft casing works to chamber A.

This oil in chamber B flows through passage B' and port Sa into the drain line. The displacement changeover piston(17) is pushed right and the swash plate(16) moves in the arrowed direction around rotation center 'O'. The swash plate moves until it touched stopper(18), and then is fixed there.



2907A2TM05

(2) External pilot pressure : $P_i \geq 20\text{kgf/cm}^2$ (small displacement)

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

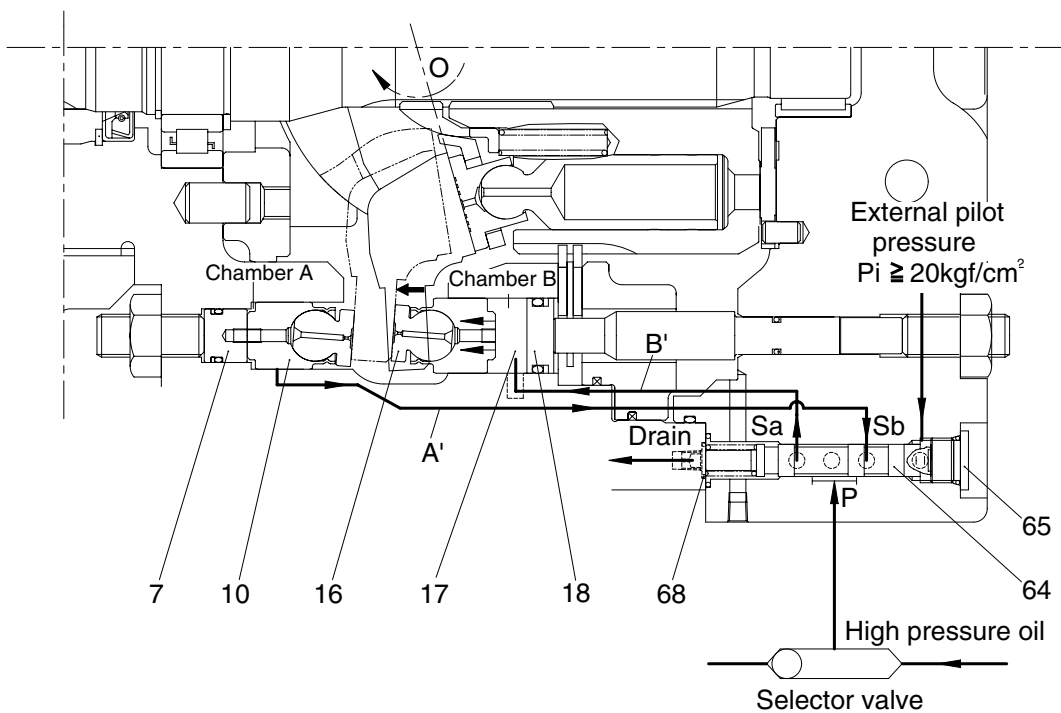
The high pressure oil works on room B through passage Sa → B' from port P.

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

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

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

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



2907A2TM06

6) REDUCTION GEAR

(1) Planetary gear mechanism

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

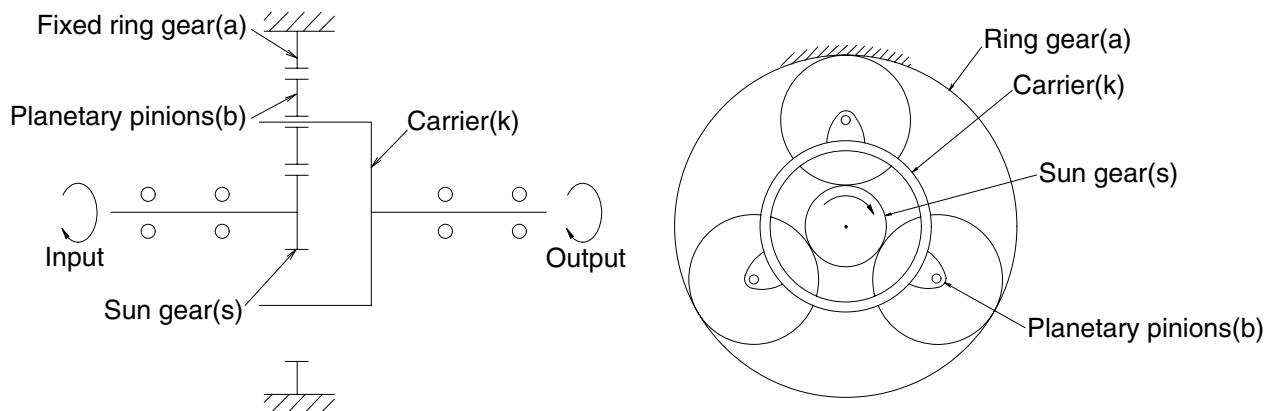
This reduction unit utilizes two stages, planetary reduction system.

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

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

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

This mechanism is called planetary gear mechanism.



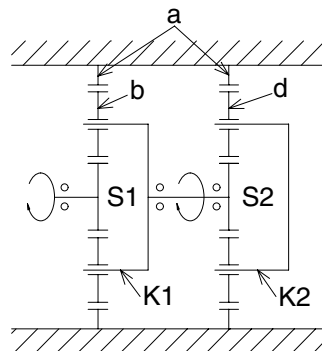
29072TM10

29072TM11

(2) Two stages reduction gear

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

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

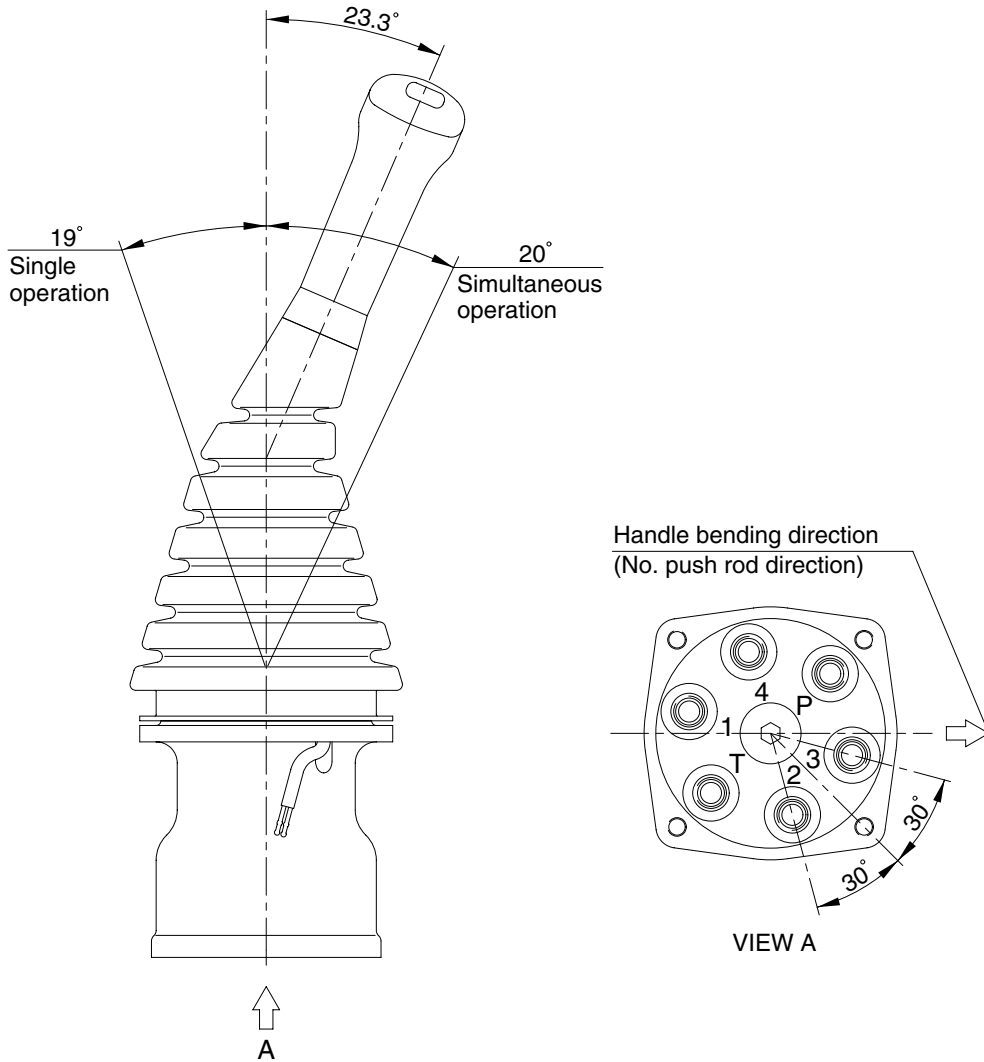


29072TM12

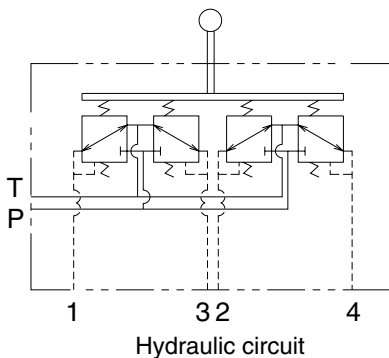
GROUP 5 RCV LEVER

1. STRUCTURE

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



25032RL01



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

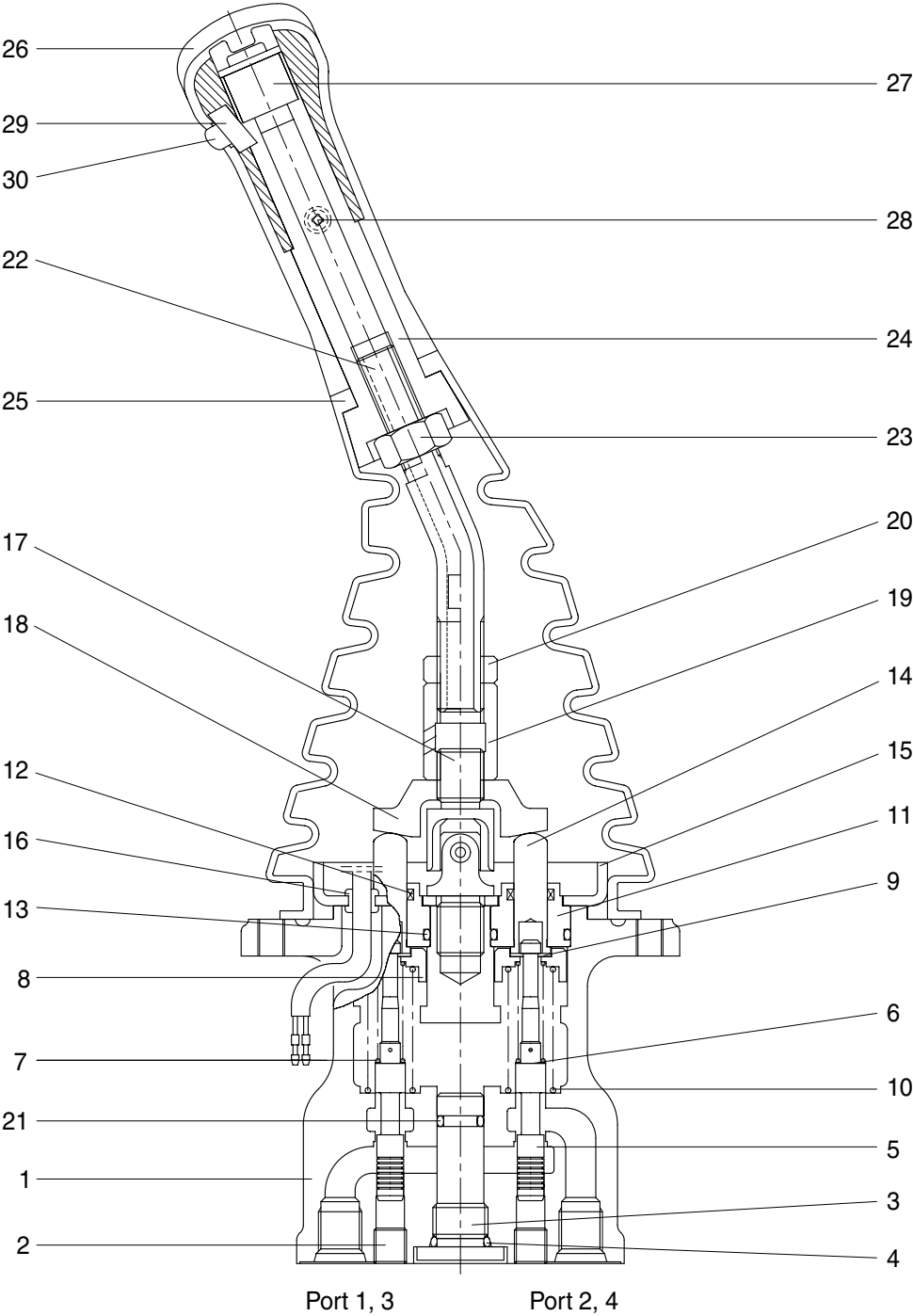
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

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/cm²(Depending on the type). The spool is pushed against the push rod(14) by the return spring.

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

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

CROSS SECTION



21072SF06

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.

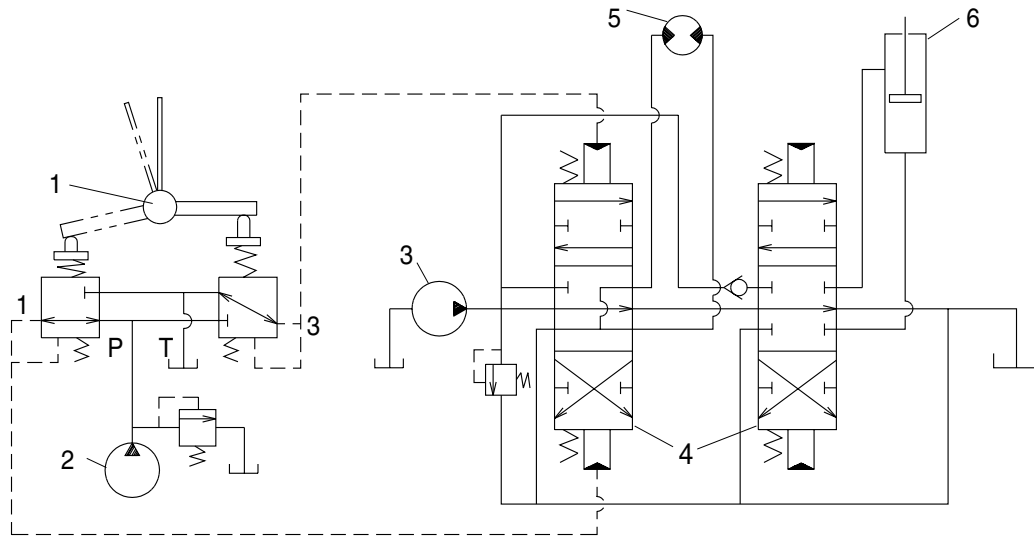
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



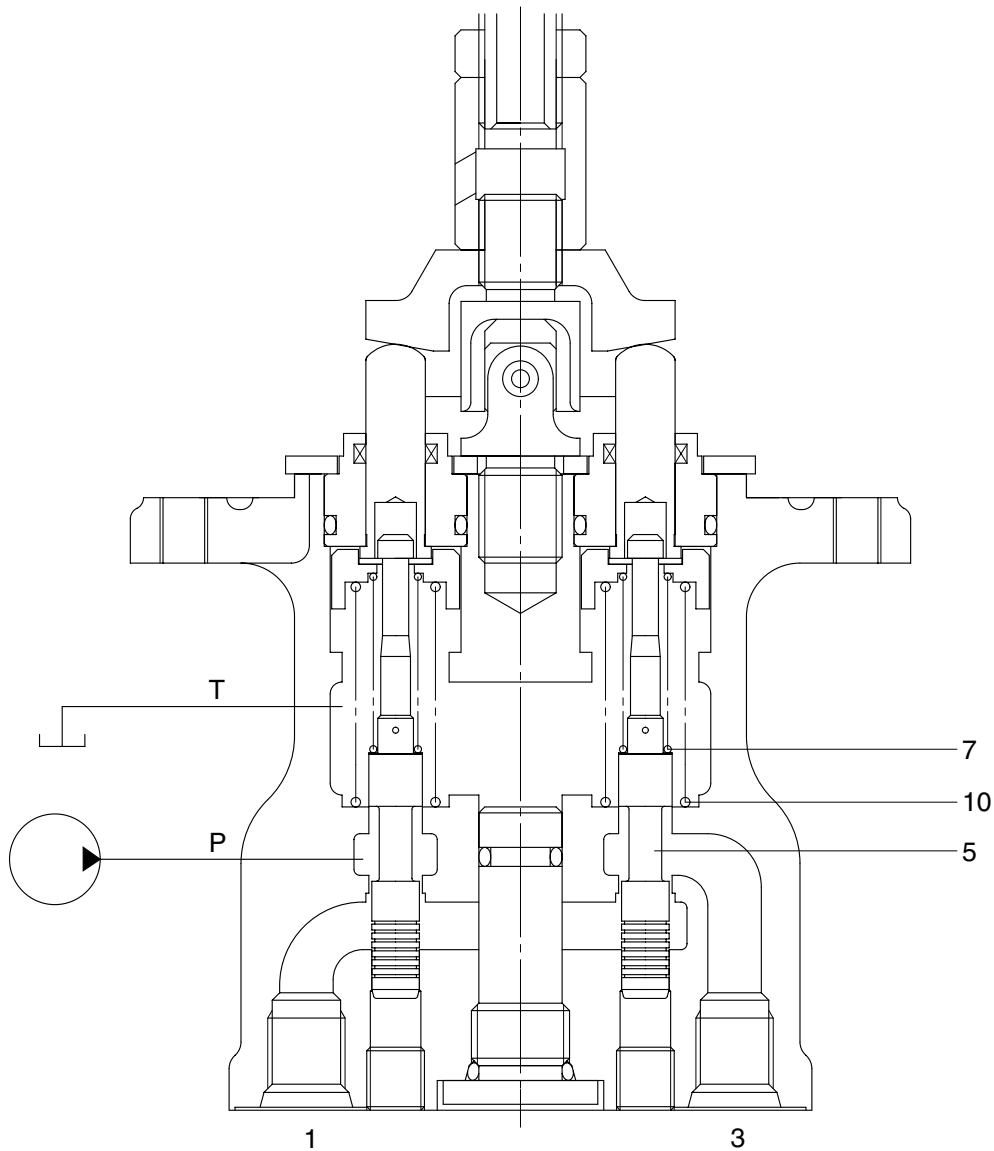
2-70

- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

- 5 Hydraulic motor
- 6 Hydraulic cylinder

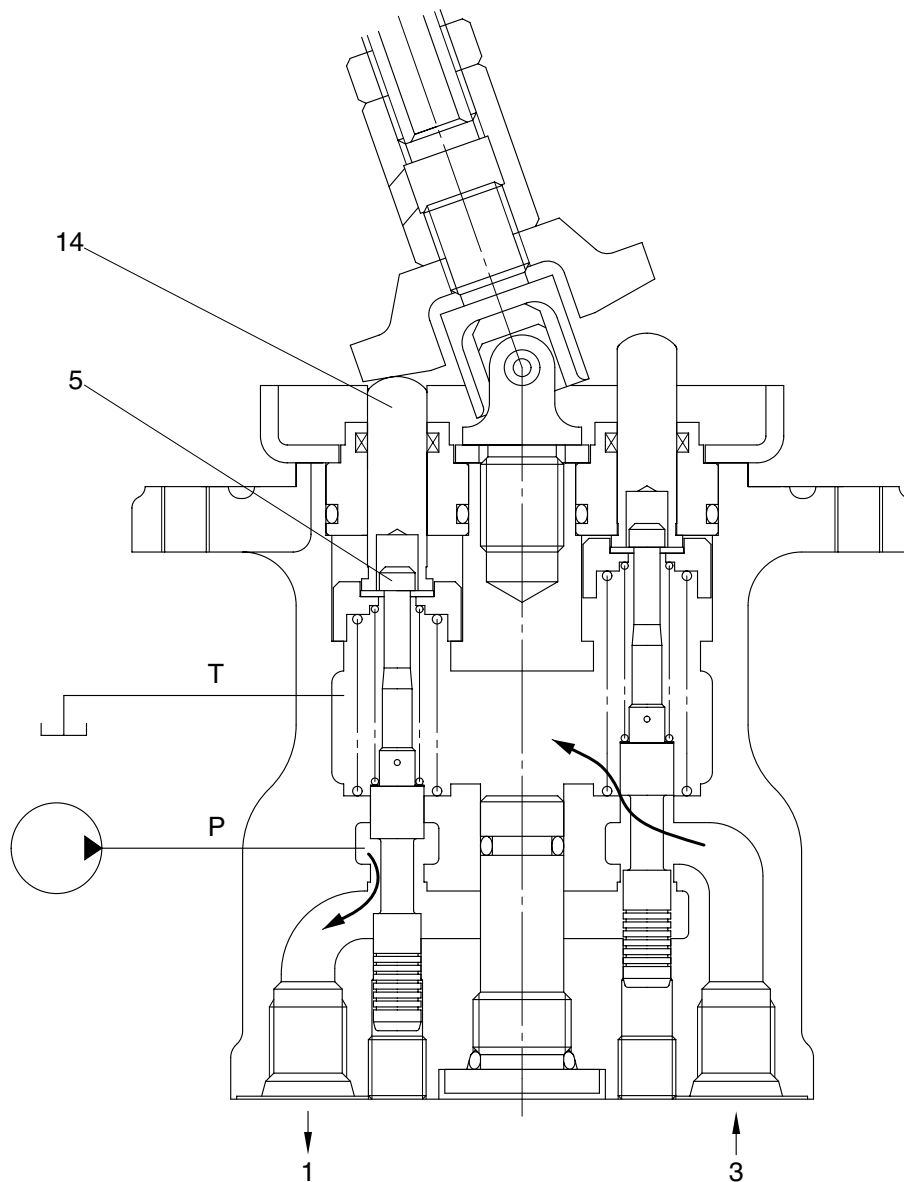
(1) Case where handle is in neutral position



25032RL03

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



29072RL04

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.

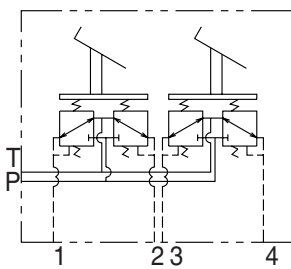
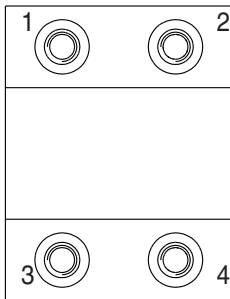
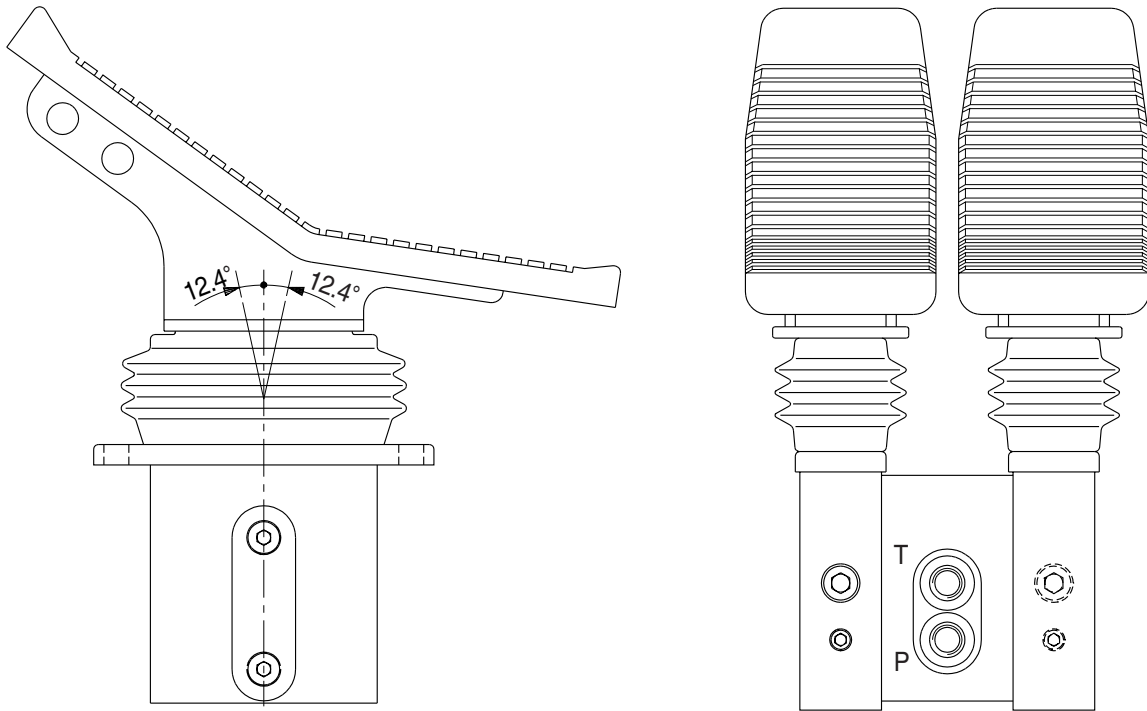
In this manner the secondary pressure is kept at the constant value.

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

2-73

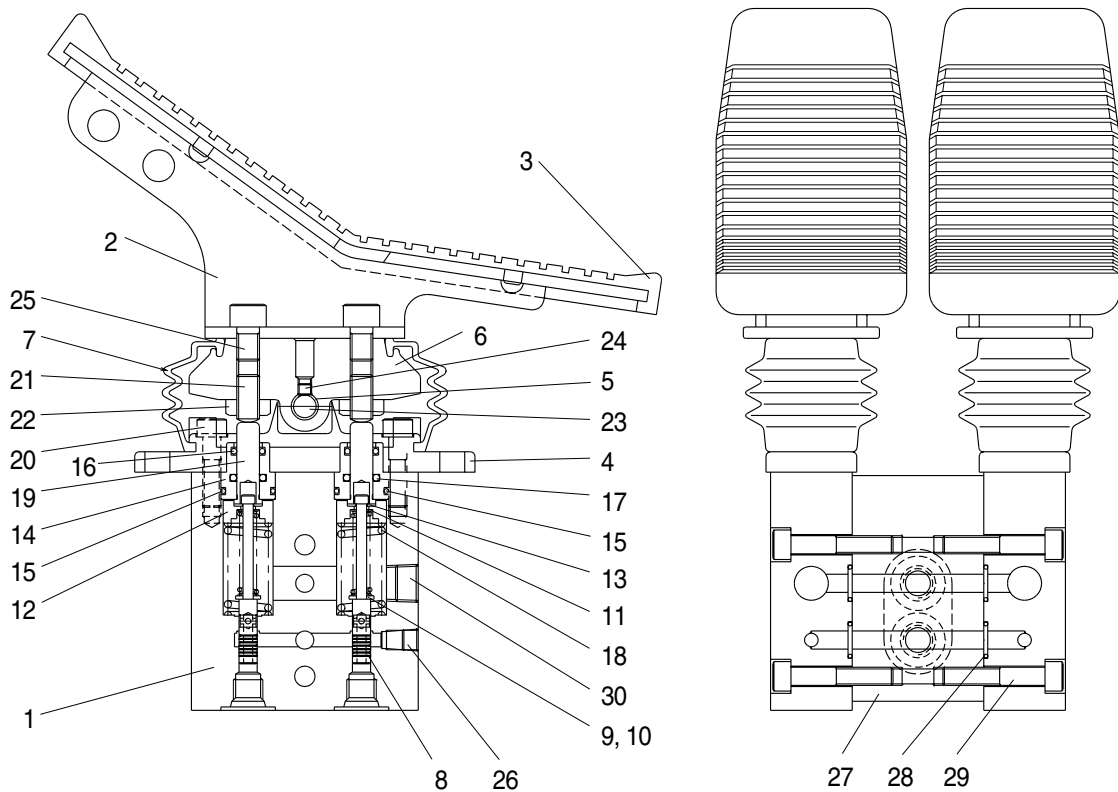
Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel(LH, Forward)	
2	Travel(LH, Backward)	
3	Travel(RH, Forward)	
4	Travel(RH, Backward)	

CROSS SECTION

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

The pressure reducing section is composed of the spool(8), spring(11) for setting secondary pressure, return spring(18), stopper(13), spring seat(12) and shim(9). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm² (depending on the type). The spool is pushed against the push rod(19) 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	Casing	11	Spring	21	Set screw
2	Pedal	12	Spring seat	22	Nut
3	Pedal cover	13	Stopper	23	Cam shaft
4	Cover	14	Plug	24	Set screw
5	Bushing	15	O-ring	25	Hexagon socket bolt
6	Cam	16	Dust seal	26	Plug
7	Bellows	17	Rod seal	27	Spacer
8	Spool	18	Spring	28	O-ring
9	Shim	19	Push rod	29	Hexagon socket bolt
10	Spring seat	20	Hexagon socket bolt	30	Plug

2-74

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(11) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod(19) is inserted and can slide in the plug(14).

For the purpose of changing th displacement of the push rod through the cam(6) and adjusting nut(22) are provided the pedal(2) that can be tilted in any direction around the fulcrum of the cam(6) center.

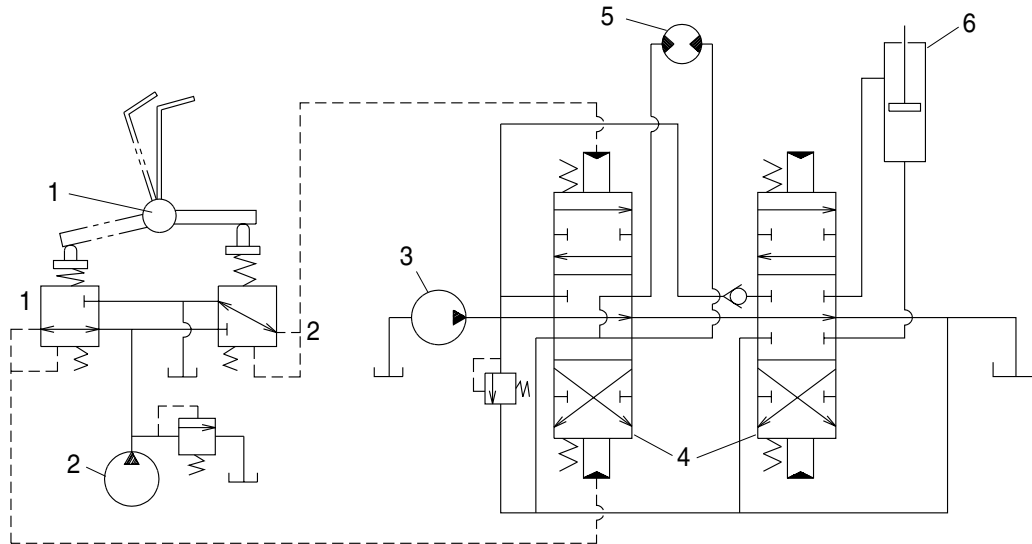
The spring(18) works on the casing(1) and spring seat(12) and tries to return the push rod(19) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

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



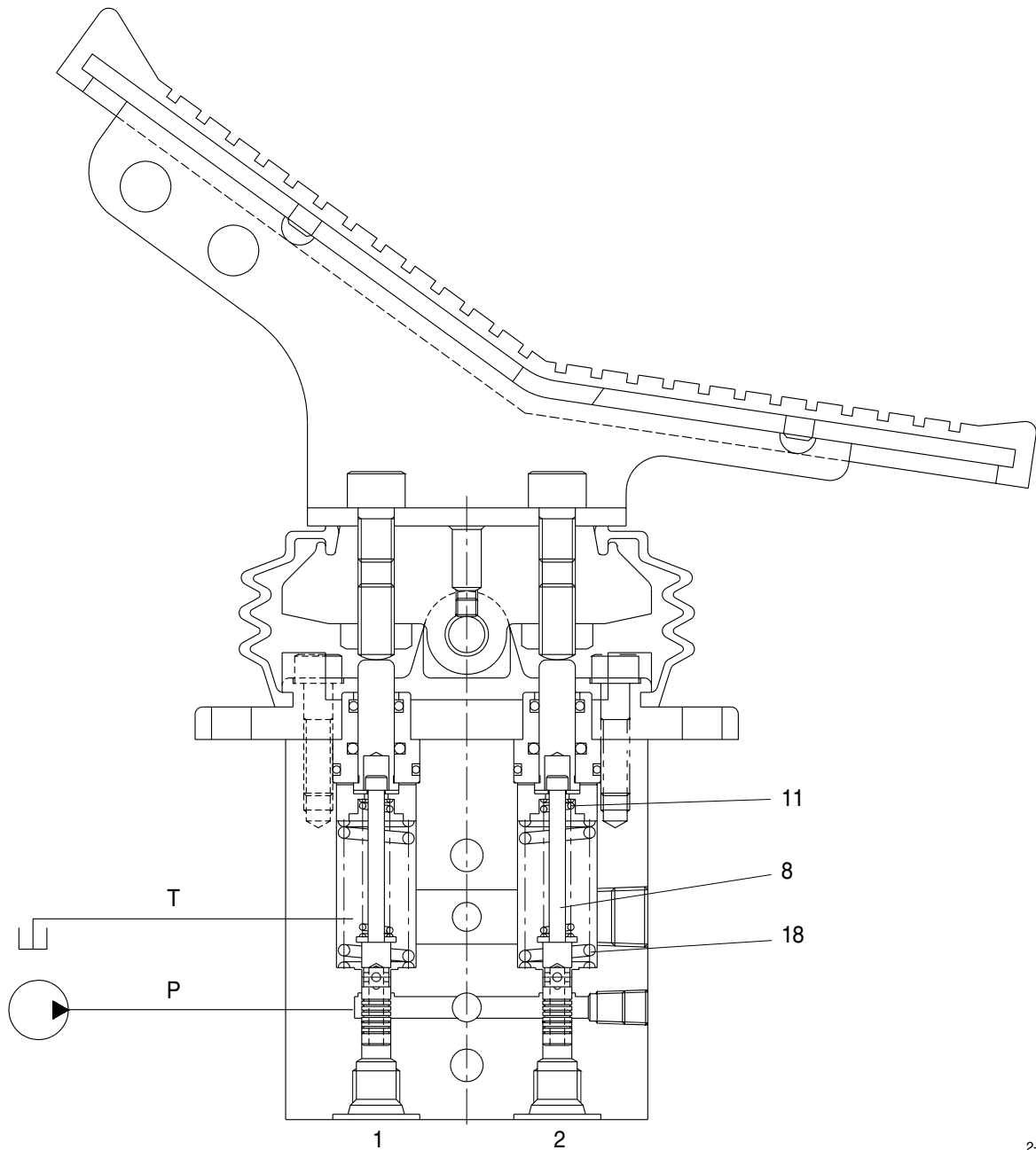
2-76

1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

5 Hydraulic motor
6 Hydraulic cylinder

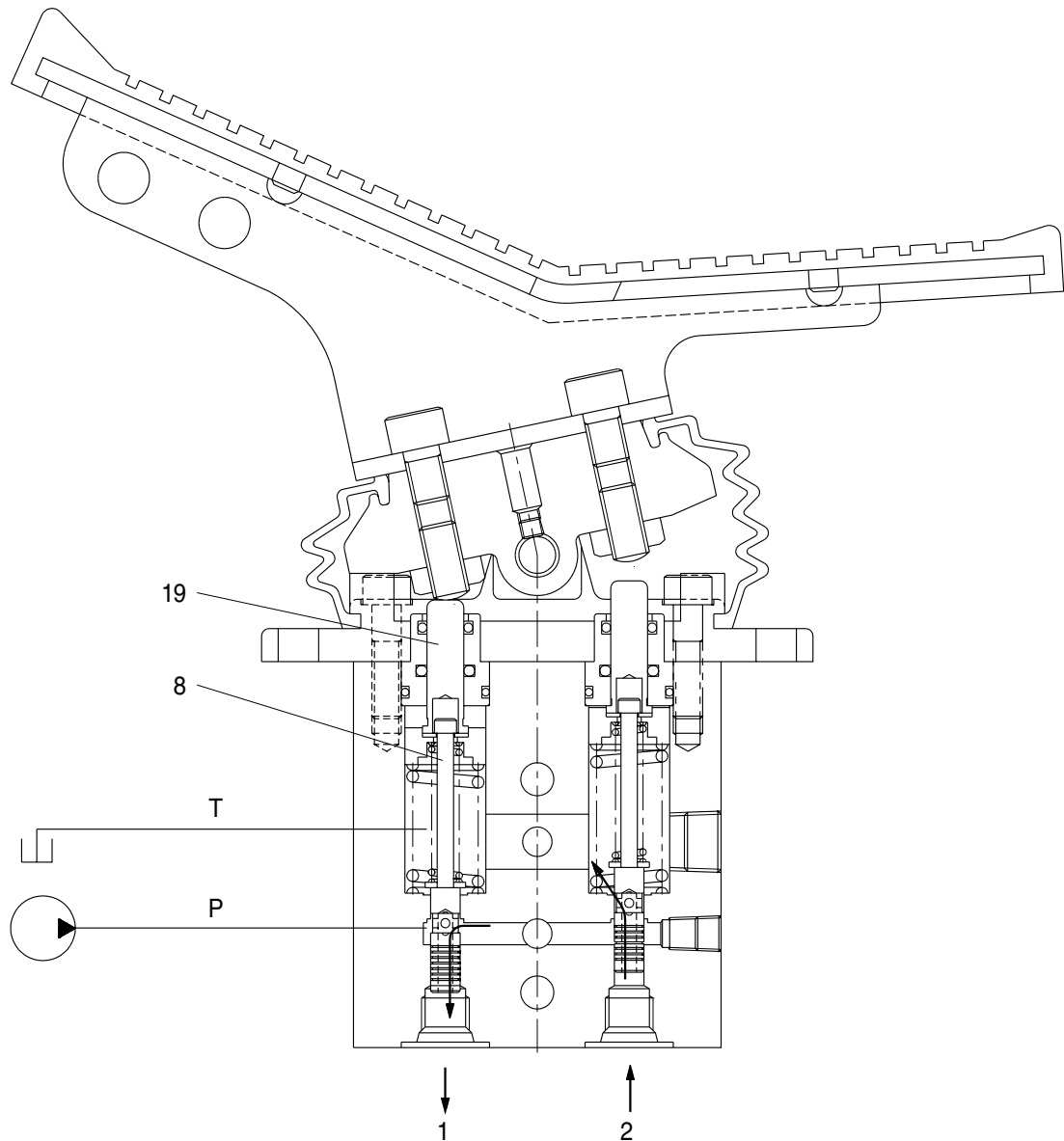
(1) Case where pedal is in neutral position



2-77

The force of the spring(11) 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(18) 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



2-78

When the push rod(19) 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.