

SECTION 2 STRUCTURE AND FUNCTION

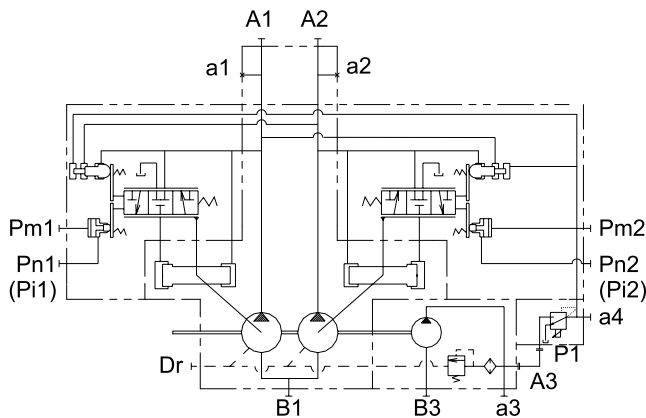
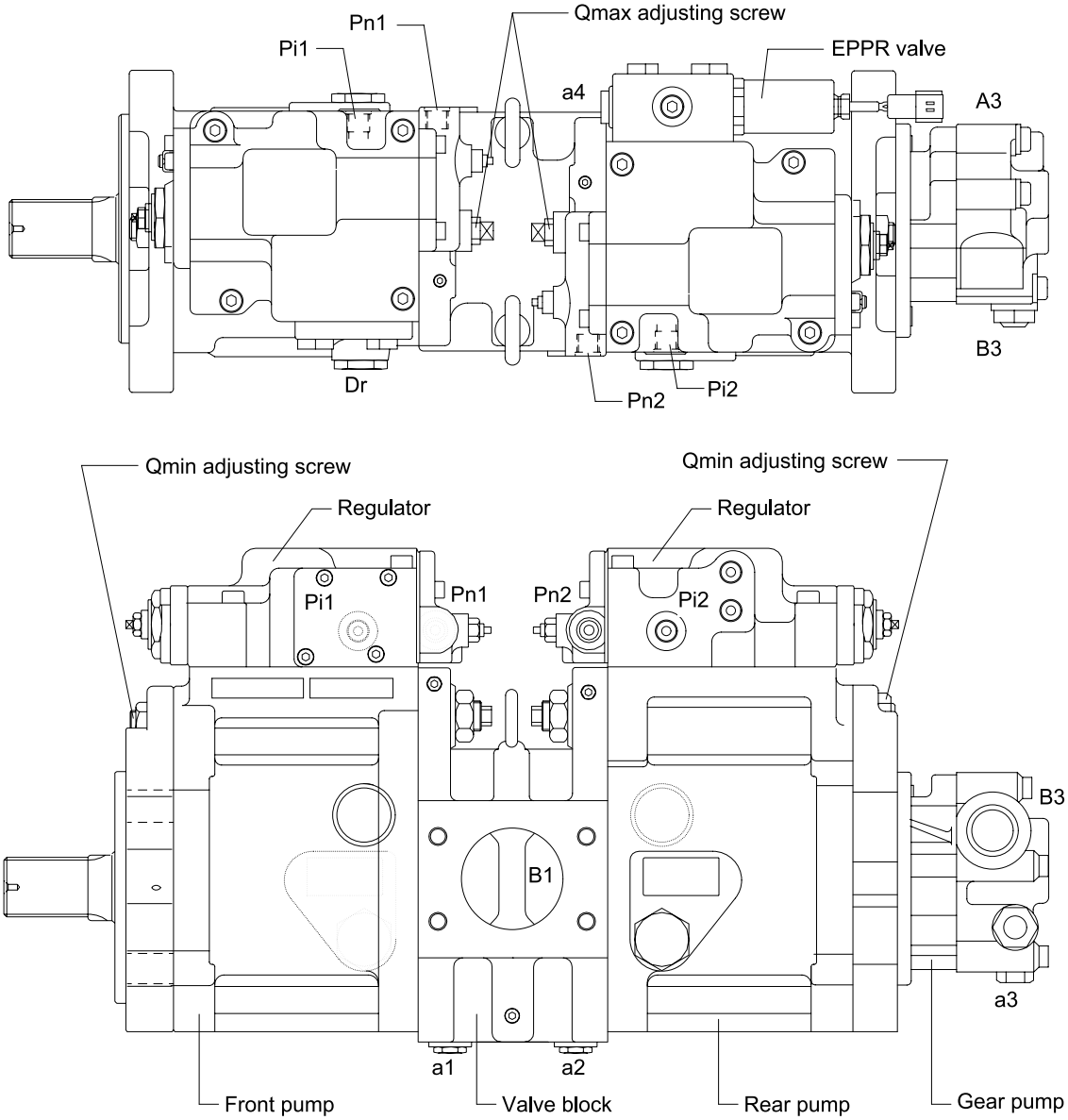
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SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

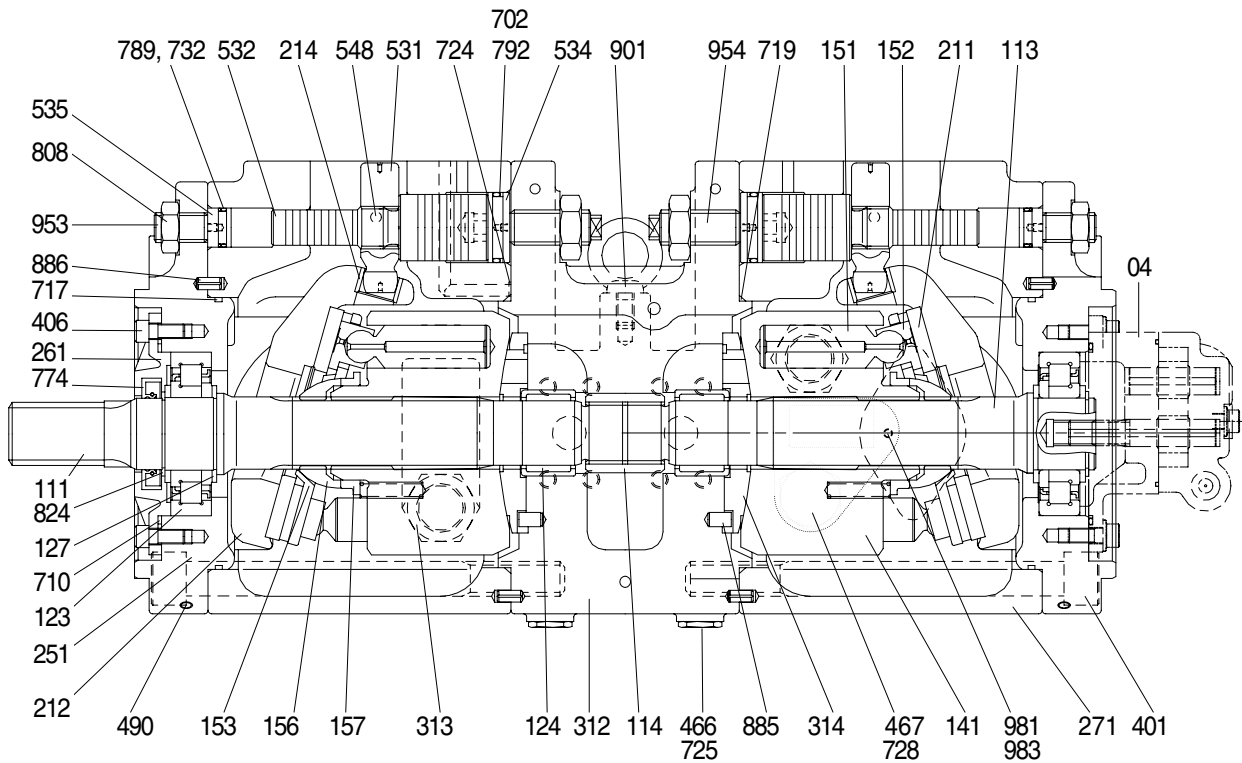
The pump device consists of main pump, regulator and gear pump.



Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 3/4"
B1	Suction port	SAE2500psi 2 1/2"
Dr	Drain port	PF 1/2 - 19
Pn1,n2	Pilot port	PF 1/4 - 15
Pm1,Pm2	Qmax cut port	PF 1/4 - 15
P1	EPPR port	PF 1/4 - 13
a1,2	Gauge port	PF 1/4 - 15
a3	Gauge port	PF 1/4 - 14
a4	Gauge port	PF 1/4 - 13
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20

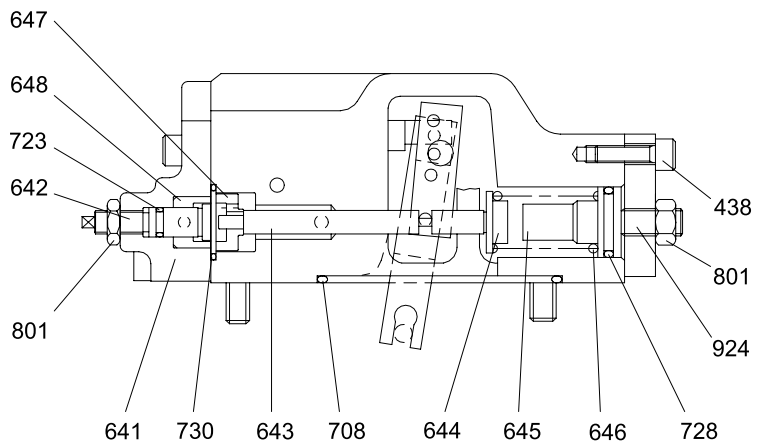
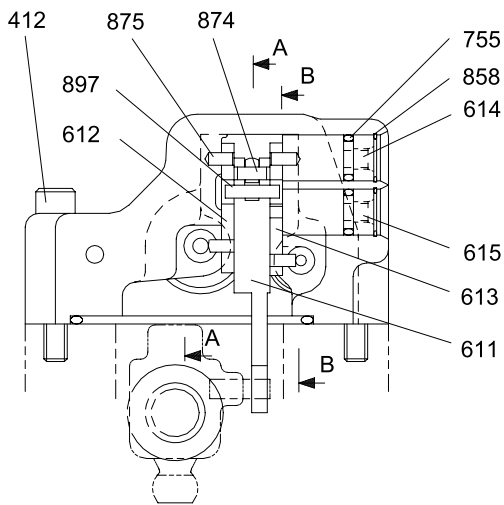
1) MAIN PUMP(1/2)

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

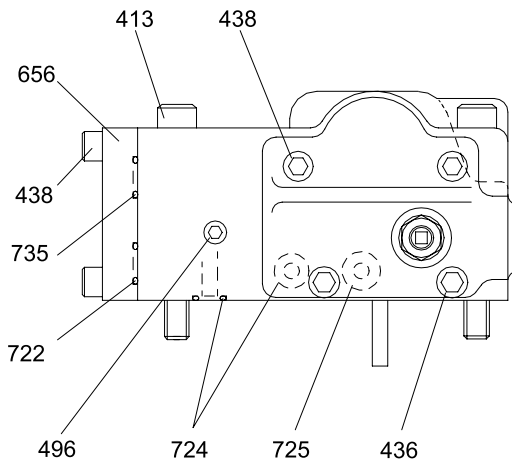


04	Gear pump	261	Seal cover(F)	717	O-ring
111	Drive shaft(F)	271	Pump casing	719	O-ring
113	Drive shaft(R)	312	Valve block	724	O-ring
114	Spline coupling	313	Valve plate(R)	725	O-ring
123	Roller bearing	314	Valve plate(L)	728	O-ring
124	Needle bearing	401	Hexagon socket bolt	732	O-ring
127	Bearing spacer	406	Hexagon socket bolt	774	Oil seal
141	Cylinder block	466	VP Plug	789	Back up ring
151	Piston	467	VP Plug	792	Back up ring
152	Shoe	490	Plug	808	Hexagon head nut
153	Set plate	531	tilting pin	824	Snap ring
156	Bushing	532	Servo piston	885	Pin
157	Cylinder spring	534	Stopper(L)	886	Spring pin
211	Shoe plate	535	Stopper(S)	901	Eye bolt
212	Swash plate	548	Pin	953	Set screw
214	Bushing	702	O-ring	981	Plate
251	Support	710	O-ring	983	Pin

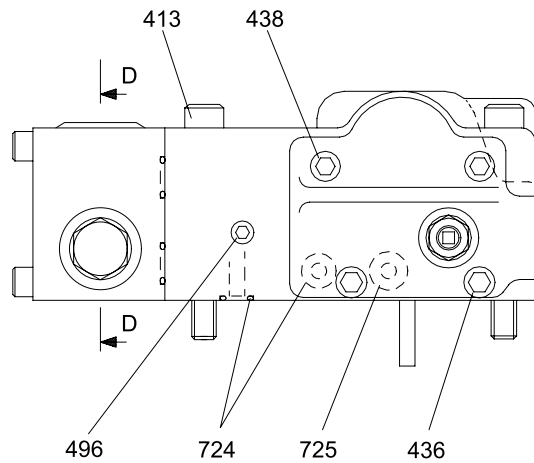
2) REGULATOR(1/2)



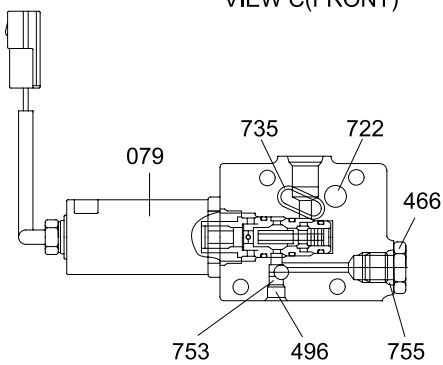
SECTION B-B



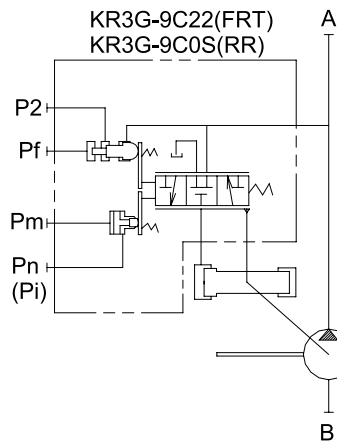
VIEW C(FRONT)



VIEW C(REAR)

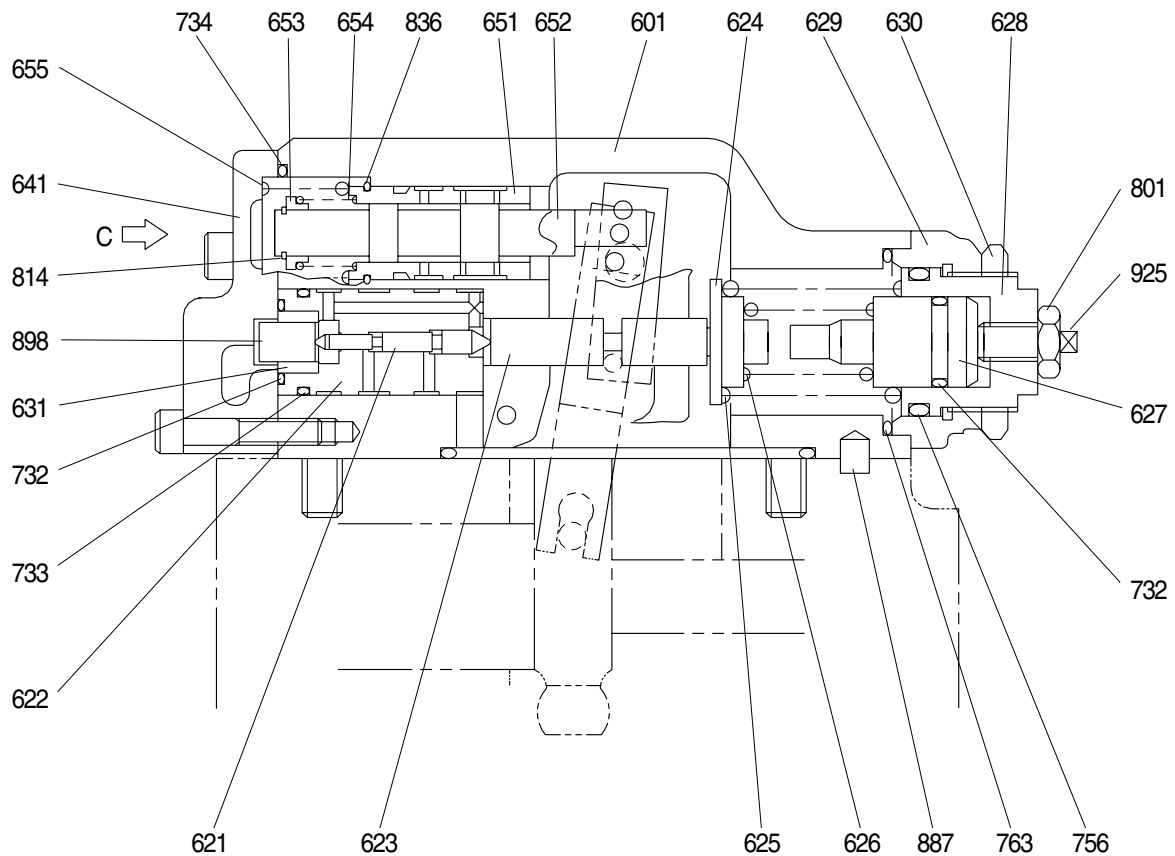


SECTION D-D



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

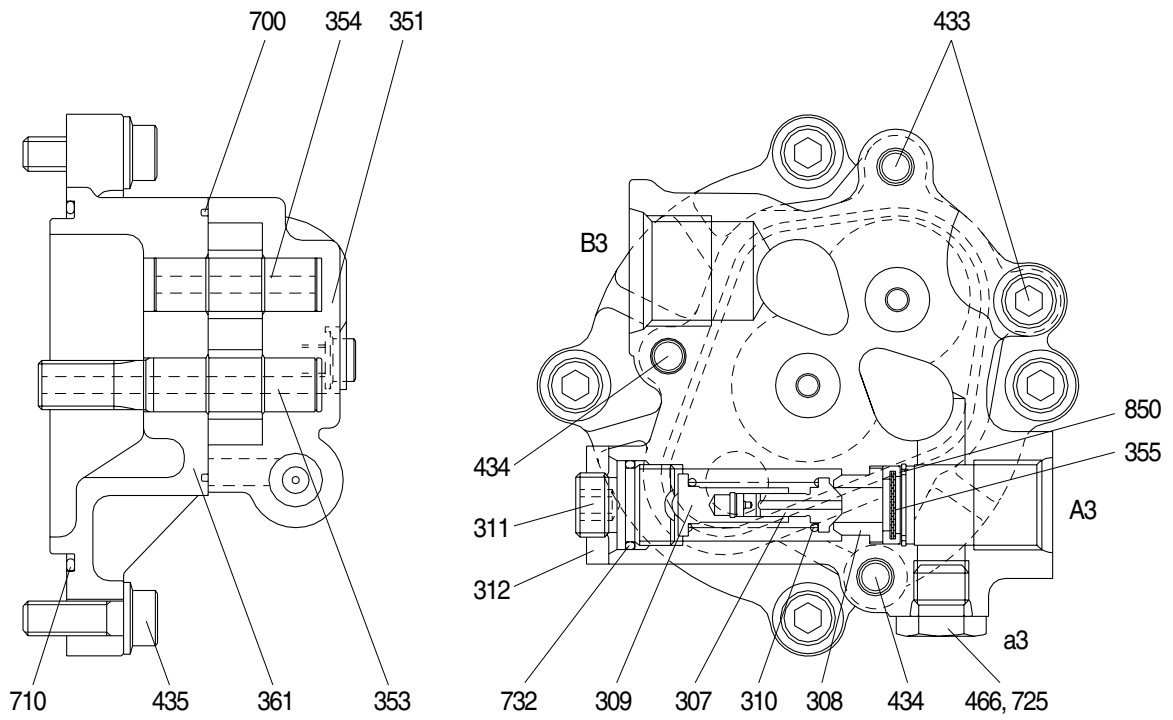
REGULATOR(2/2)



SECTION A-A

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

3) GEAR PUMP



- 307 Poppet
- 308 Seat
- 309 Spring seat
- 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.

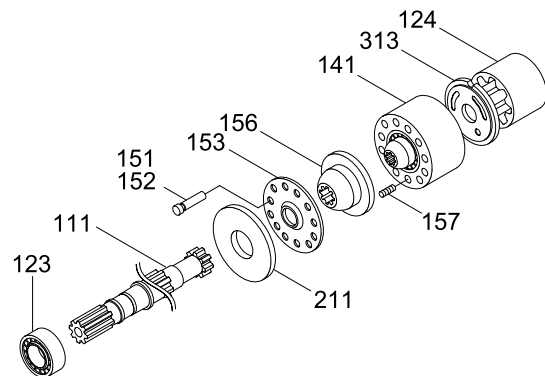
(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block(141), piston shoes(151,152), set plate(153), spherical 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.

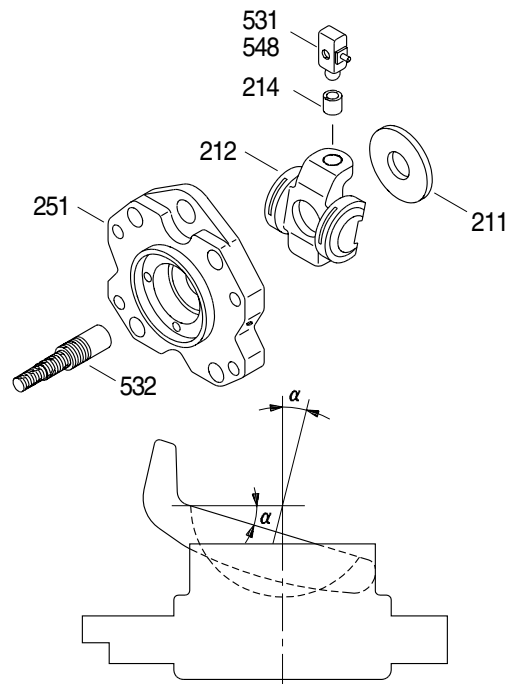


(2) Swash plate group

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)



(3) Valve block group

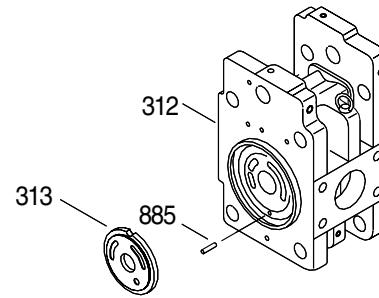
The valve block group consists of valve block(312), valve plate(313) and valve plate pin(885).

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.



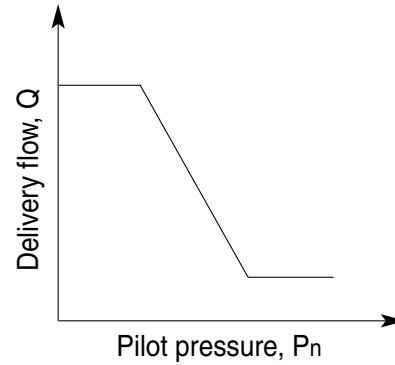
2) REGULATOR

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

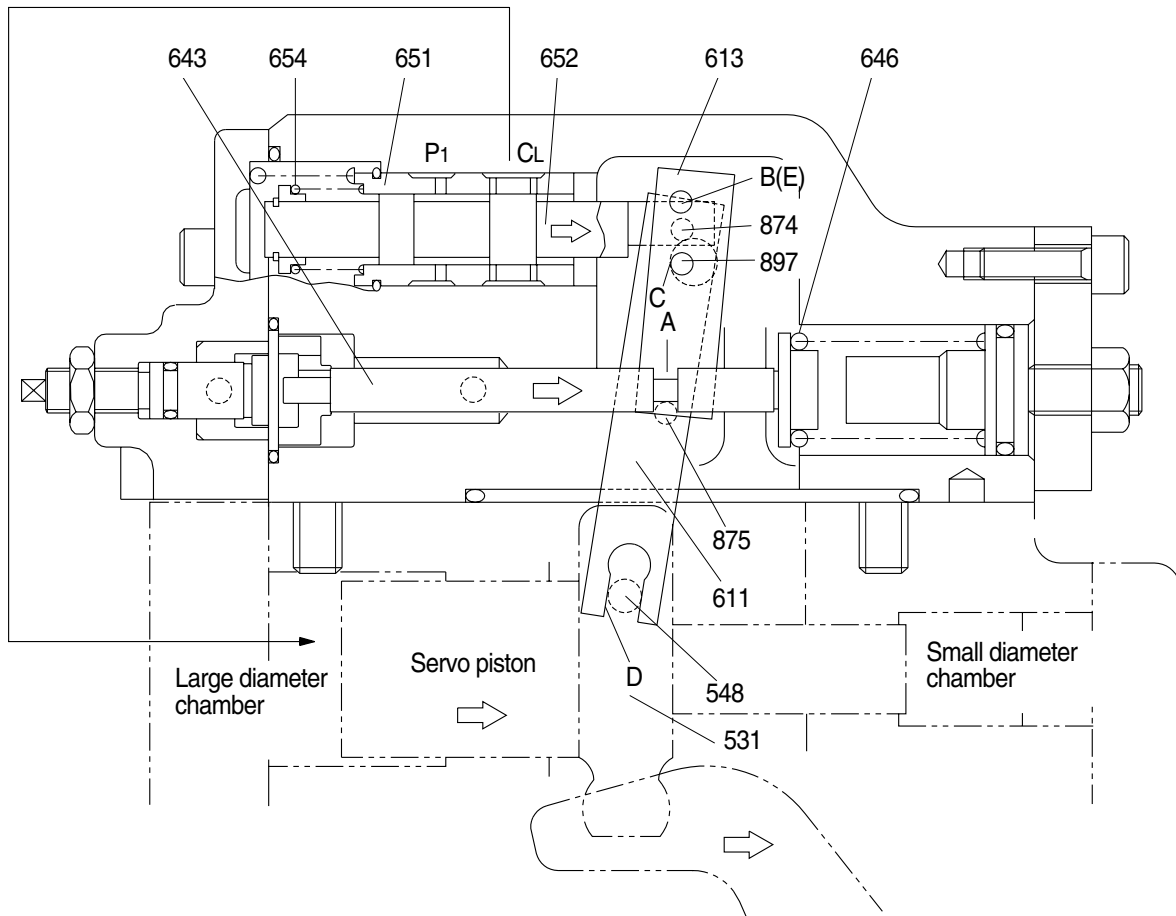
(1) Negative flow control

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



① Flow reducing function



As the pilot pressure P_n 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.

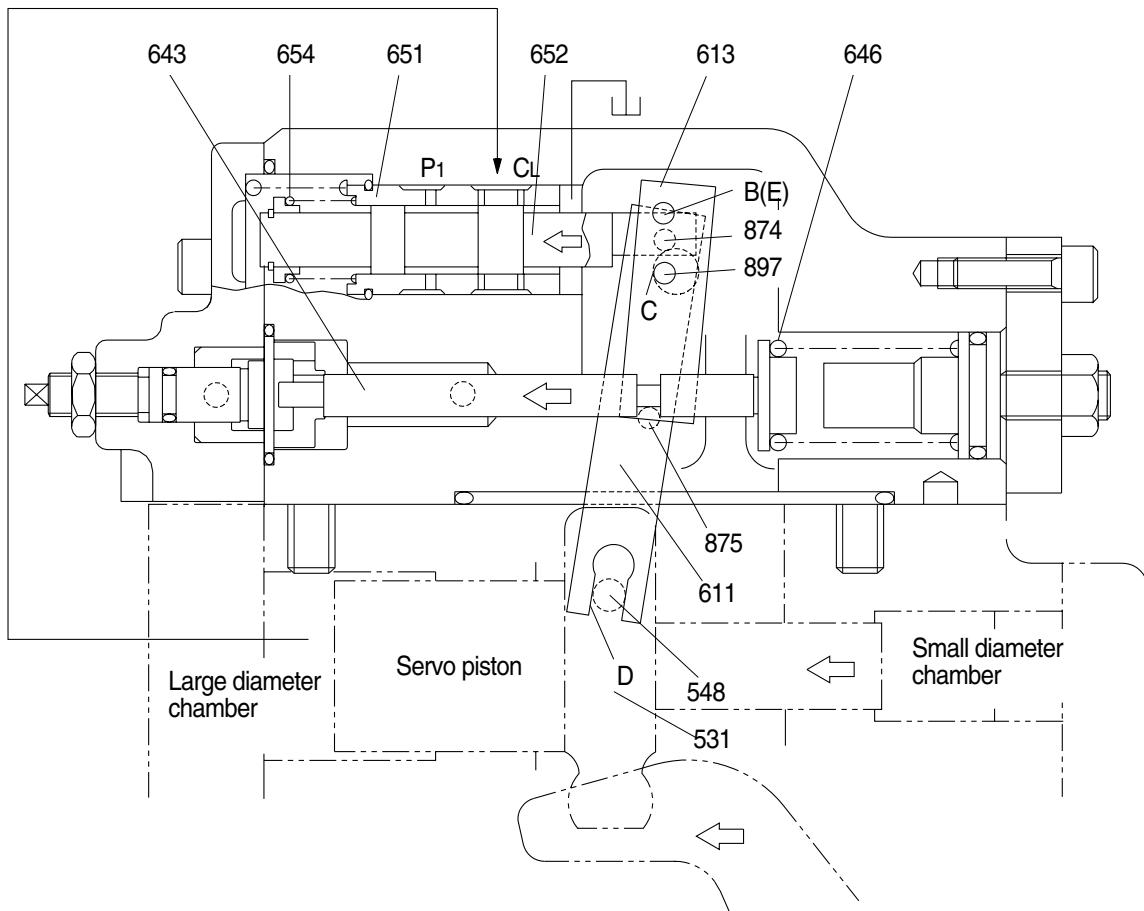
Since the feedback lever is connected with the spool(652) via the pin(874), the spool moves to the right.

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



As the pilot pressure P_n 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.

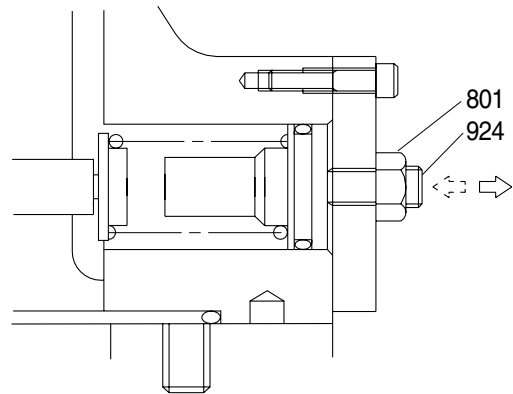
③ Adjustment of flow control characteristic

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

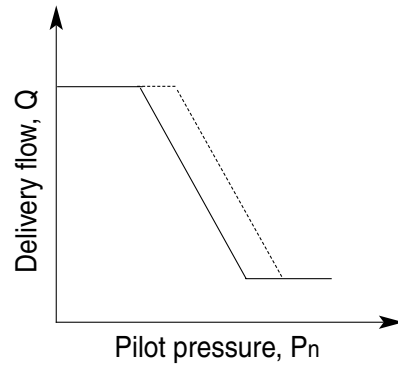
Adjust it by loosening the hexagon nut(801) and by tightening(or loosening) the hexagonal socket head screw(924).

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)
2100	+1/4	+1.5	+7.9



(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 P_1 of the self pump and the delivery pressure P_2 of the companion pump.

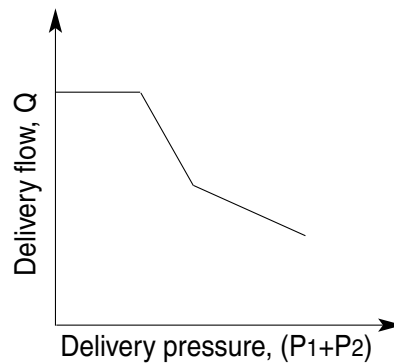
(The input horsepower is constant when the speed is constant.)

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.

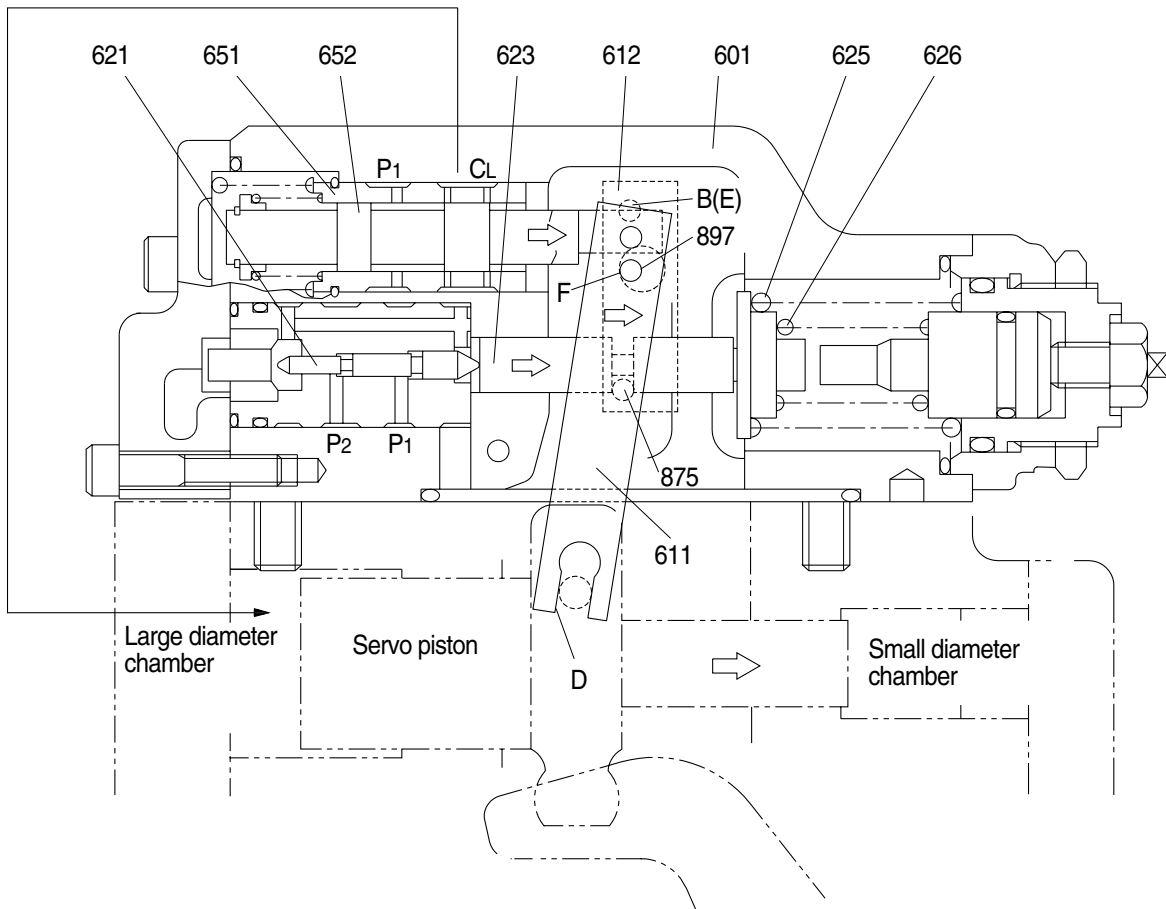
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation :

$$\begin{aligned} T_{in} &= P_1 \times q/2 \text{ JI} + P_2 \times q/2 \text{ JI} \\ &= (P_1 + P_2) \times q/2 \text{ JI} \end{aligned}$$

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).

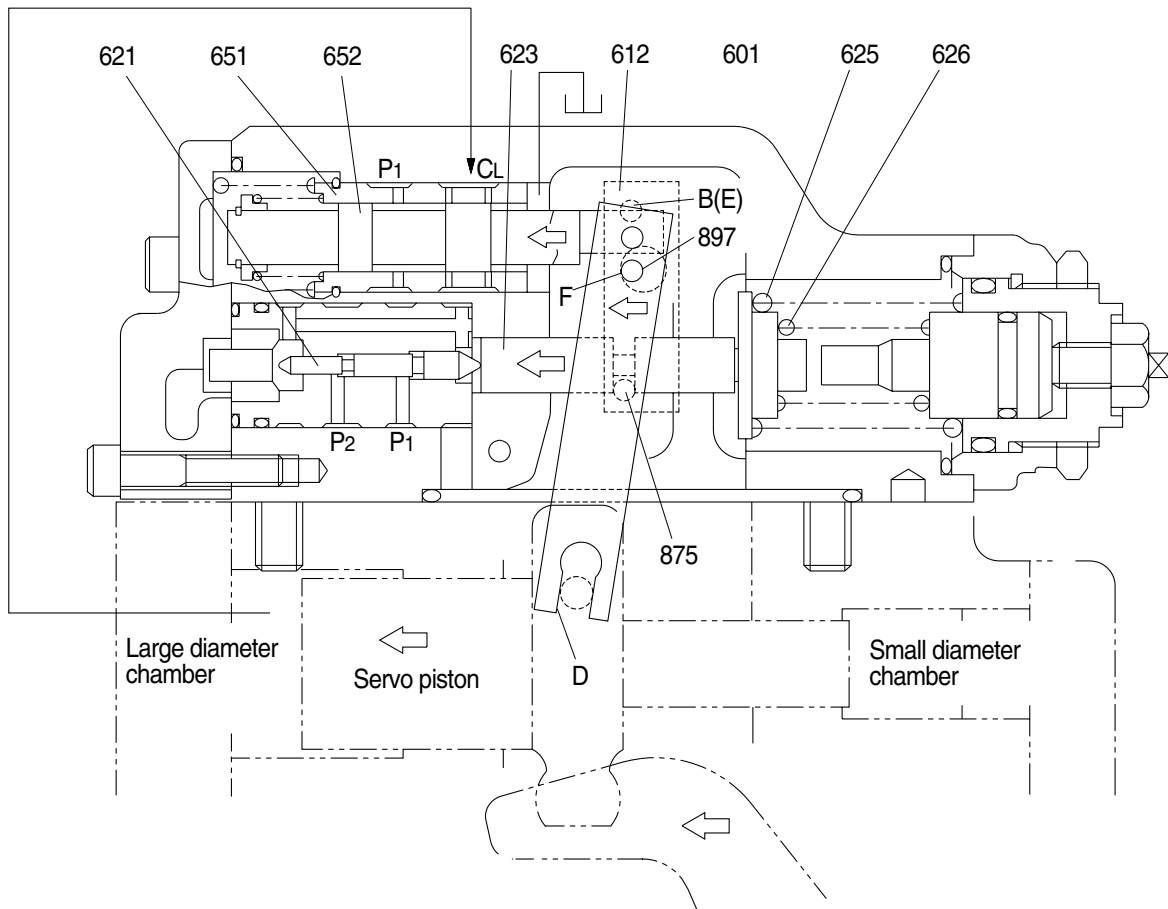


① Overload preventive function



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

② Flow reset function



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

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

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

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

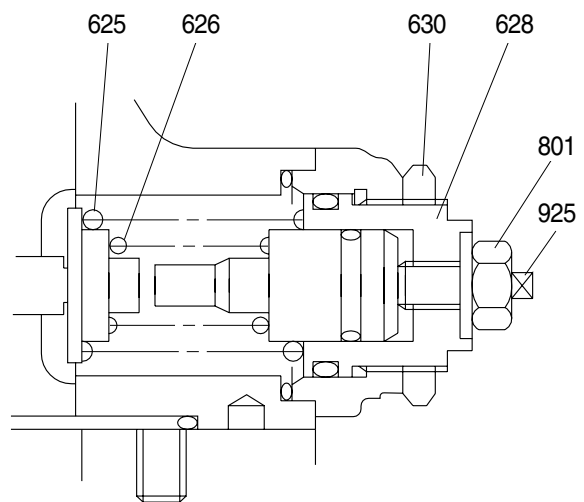
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections(C & F) of levers 1 and 2. However, since sections C and F have the pins($\varnothing 4$) protruding from the large hole($\varnothing 8$), only the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

④ **Adjustment of input horsepower**

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

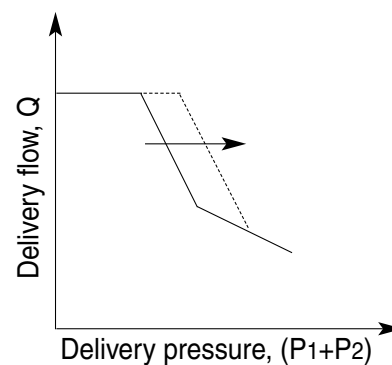
a. **Adjustment of outer spring**

Adjust it by loosening the hexagon nut(630) and by tightening(or loosening) the adjusting screw C(628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring(626), return the adjusting screw QI(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) (924)	Compensating control starting pressure change amount	Input torque change amount
(min^{-1})	(Turn)	(kgf/cm^2)	($\text{kgf} \cdot \text{m}$)
2100	+1/4	+19.2	+2.9



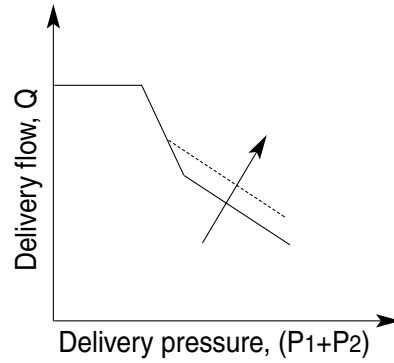
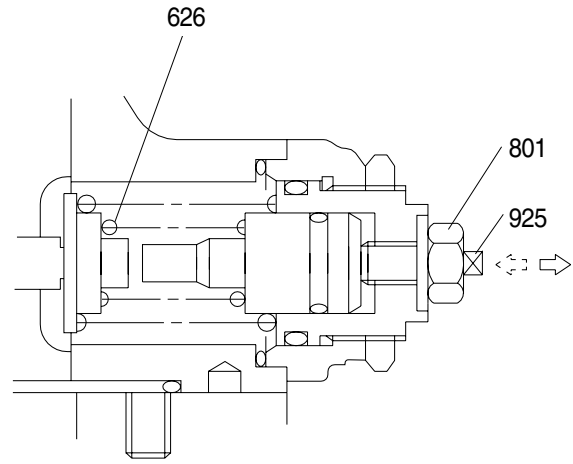
b. Adjustment of inner spring

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

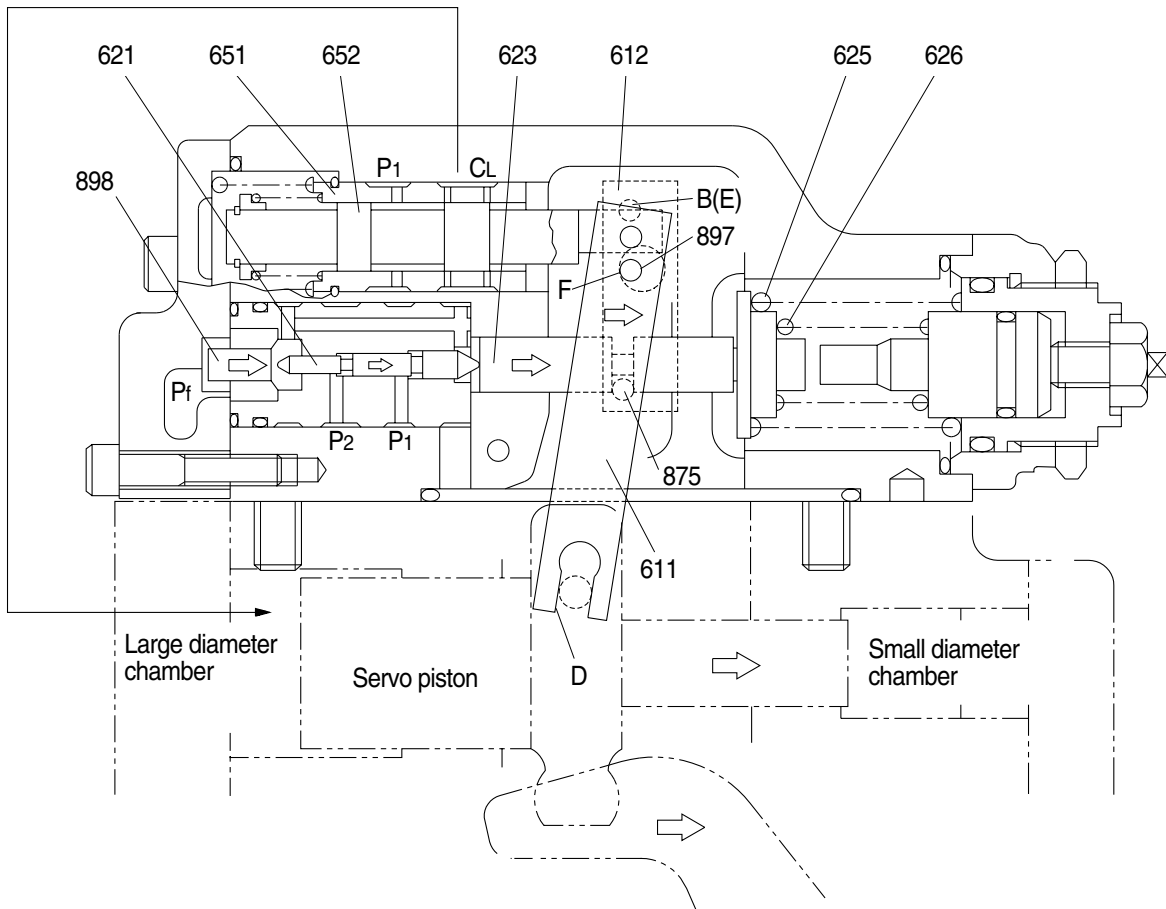
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ **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)
2100	+1/4	+5.6	+2.4



(3) Power shift control



The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.

Only one proportional pressure reducing valve is provided.

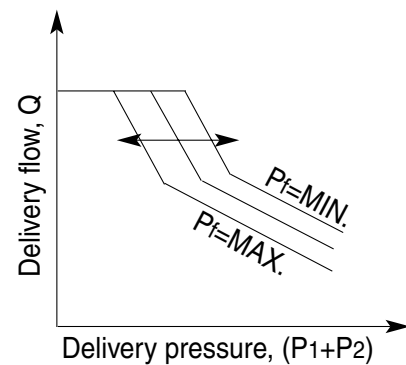
However, the secondary pressure P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.

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.

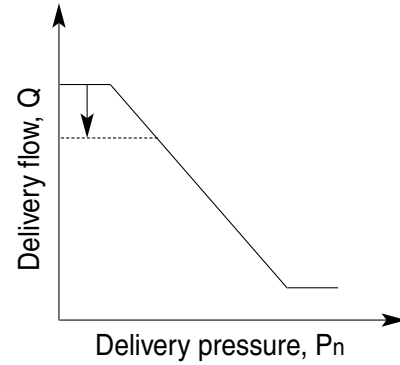
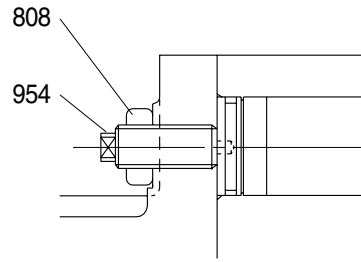


(4) Adjustment of maximum and minimum

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

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

Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min ⁻¹)	(Turn)	(l/min)
2100	+1/4	-3.4

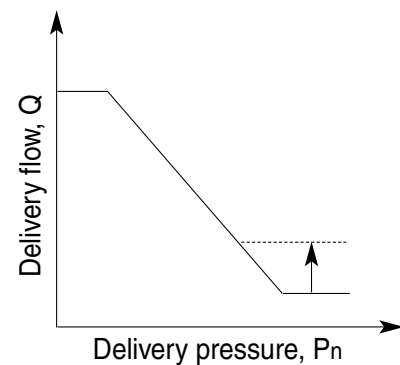
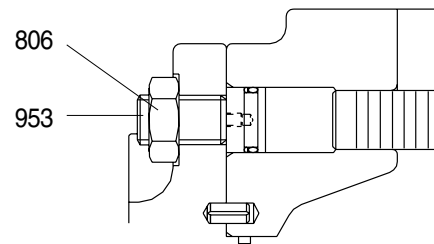


② Adjustment of minimum flow

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.

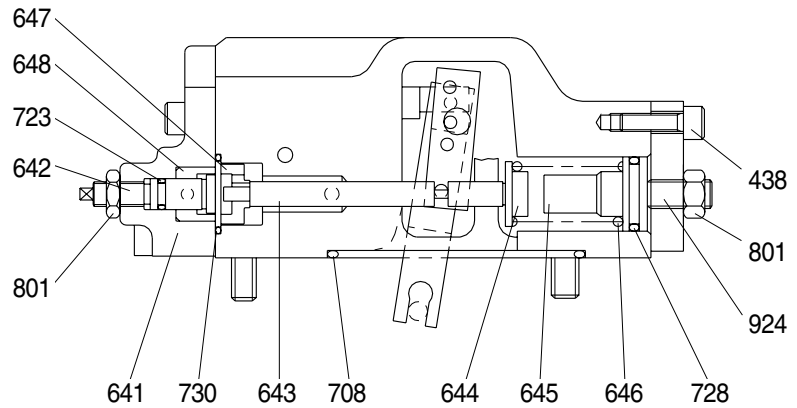
However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure(or during relieving) may increase.

Speed	Adjustment of min flow	
	Tightening amount of adjusting screw (953)	Flow change amount
(min ⁻¹)	(Turn)	(l/min)
2100	+1/4	+3.4



(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.)

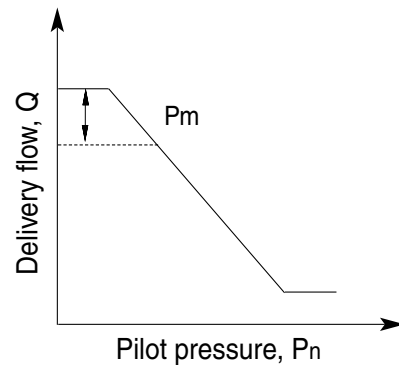


① Functional explanation

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.

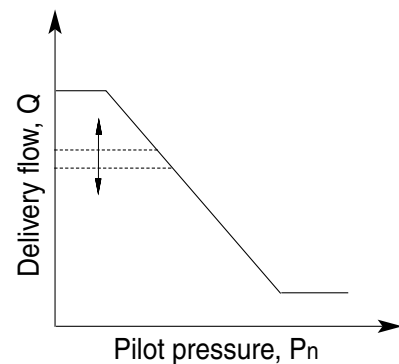
Since the adjusting screw QMC (642) is provided with a flange, the piston QMC stops upon contact with the flange, and the position of the pilot piston at this time determines the maximum flow of the pump.



② Adjustment of Qmax cut flow

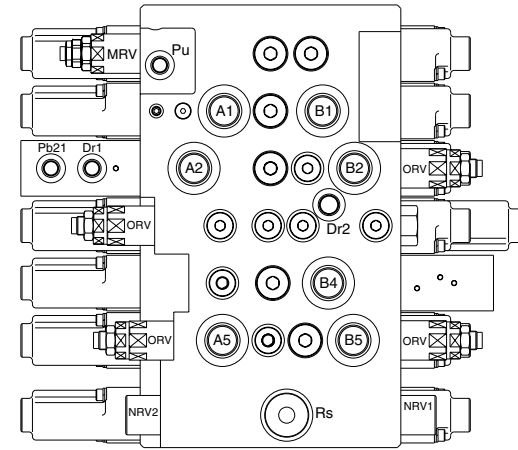
Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the adjusting screw QMC (642).

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

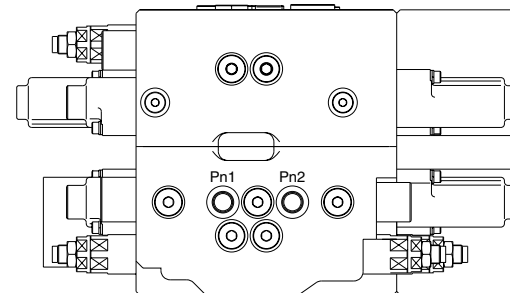
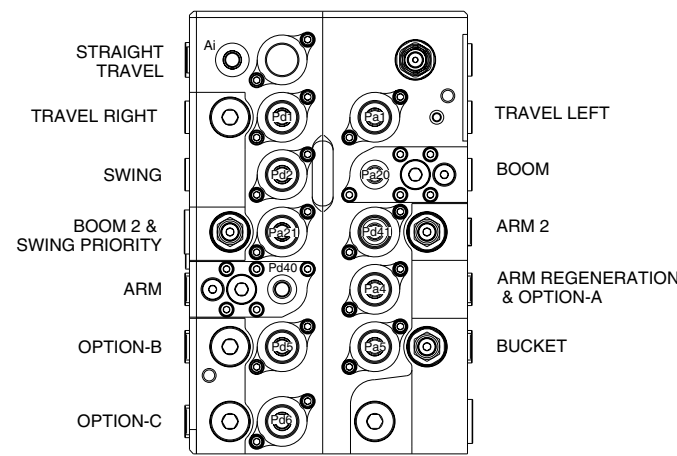
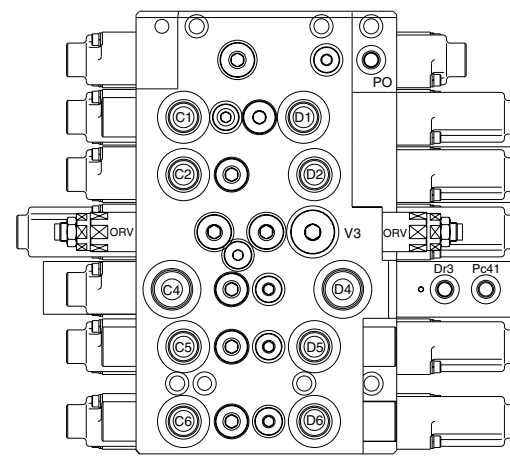
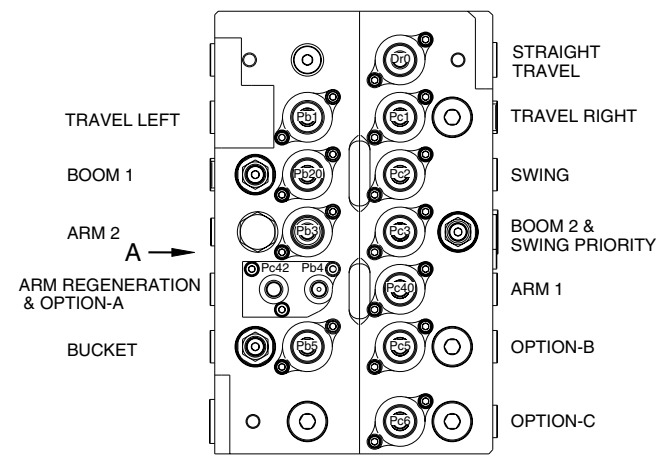
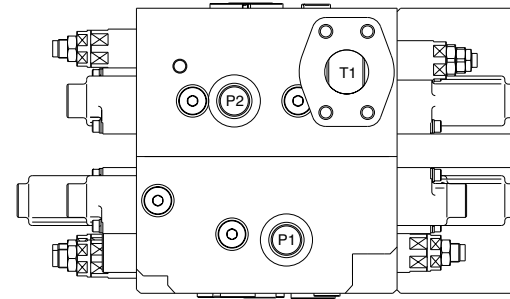


GROUP 2 MAIN CONTROL VALVE

1. STRUCTURE

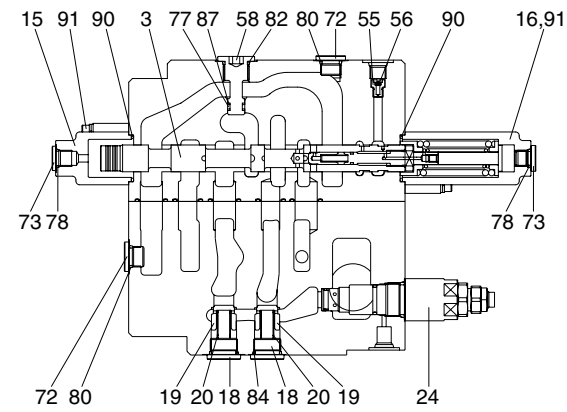


VIEW A

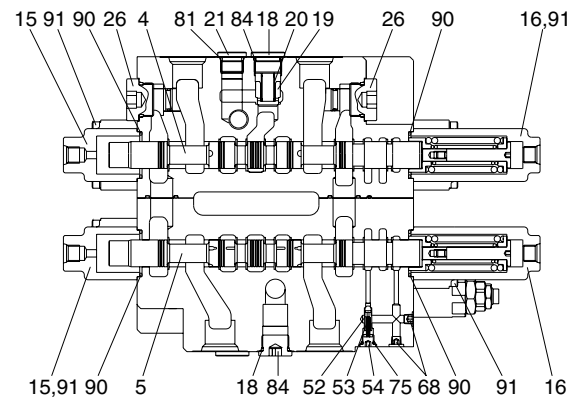


Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor		
Pa1	Travel left pilot port(FW)		
Pb1	Travel left pilot port(BW)		
Pc1	Travel right pilot port(BW)		
Pd1	Travel right pilot port(FW)		
Pa20	Boom up pilot port		
Pa21	Boom up confluence pilot port		
Pb20	Boom down pilot port		
Pb21	Lock valve pilot port(Boom)		
Pc2	Swing pilot port(RH)		
Pd2	Swing pilot port(LH)		
Pb3	Arm in confluence pilot port		
Pc3	Swing priority pilot port		
Pa4	Option A pilot port(Breaker)		
Pb4	Arm in regeneration cut port		
Pc40	Arm in pilot port		
Pc41	Lock valve pilot port(Arm)		
Pc42	Arm in regen-cut signal selector port		
Pd40	Arm out pilot port		
Pd41	Arm out confluence pilot port		
Pa5	Bucket in pilot port		
Pb5	Bucket out pilot port		
Pc5	Option B pilot port		
Pd5	Option B pilot port		
Pc6	Option C pilot port		
Pd6	Option C pilot port		
PO	Pilot pressure port		
Pu	Main relief pressure up pilot port		
Ai	Auto idle signal port		
Dr0	Drain port(Travel straight)		
Dr1	Drain port(Boom holding valve)		
Dr2	Drain port(Boom2 & swing priority)		
Dr3	Drain port(Arm holding valve)		
Pn1	Negative control signal port(P1 port side)		
Pn2	Negative control signal port(P2 port side)		
A1	Travel motor left side port(FW)		
B1	Travel motor left side port(BW)		
C1	Travel motor right side port(BW)		
D1	Travel motor right side port(FW)		
B2	Boom rod side port		
C2	Swing motor port(LH)		
D2	Swing motor port(RH)		
B4	Option A port(Breaker)		
A5	Bucket head side port		
B5	Bucket rod side port		
C5	Option B port		
D5	Option B port		
C6	Option C port		
D6	Option C port		
P1	Pump port(P1 side)		
P2	Pump port(P2 side)		
A2	Boom head side port		
C4	Arm head side port		
D4	Arm rod side port		
T1	Return port		

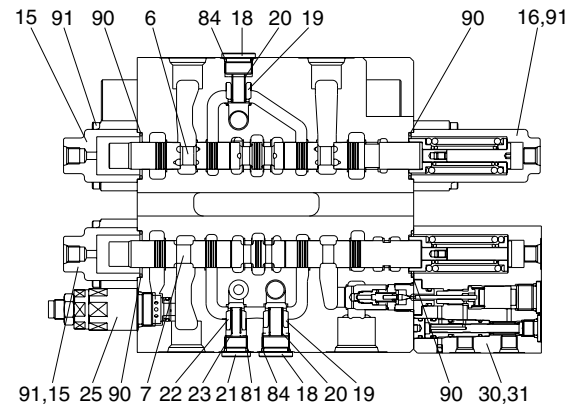
1407A2MC01A



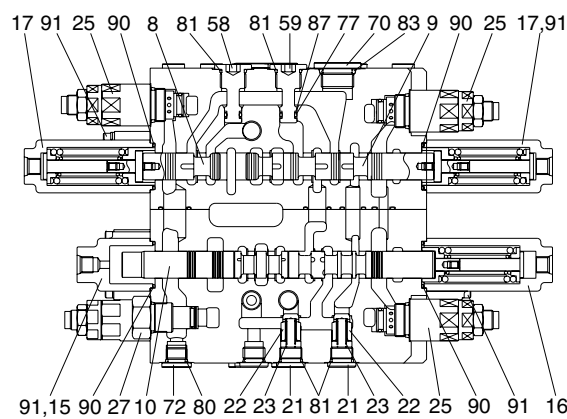
A - A (STRAIGHT-TRAVEL & SUPPLY)



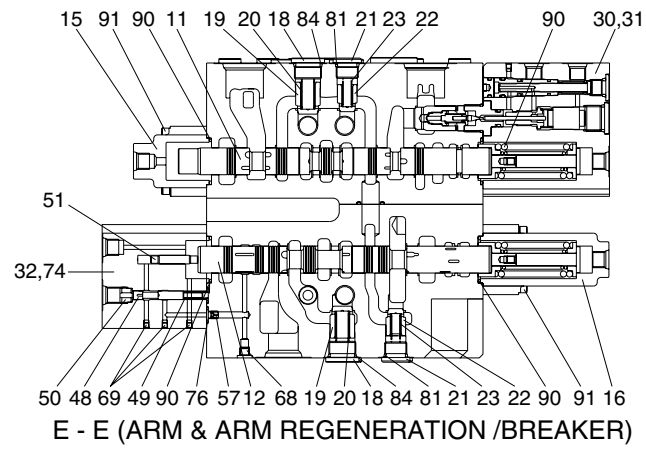
B - B (TRAVEL RIGHT & LEFT)



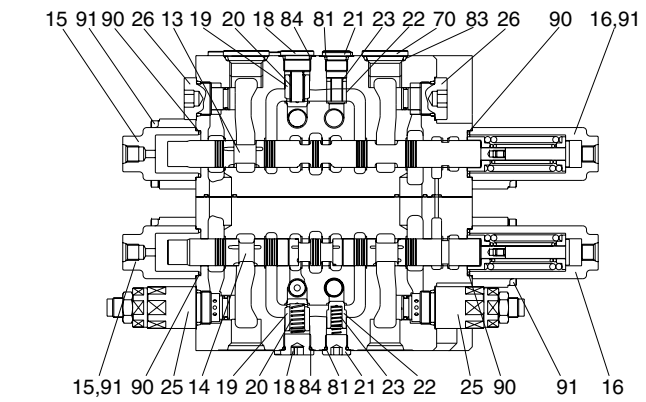
C - C (SWING & BOOM1)



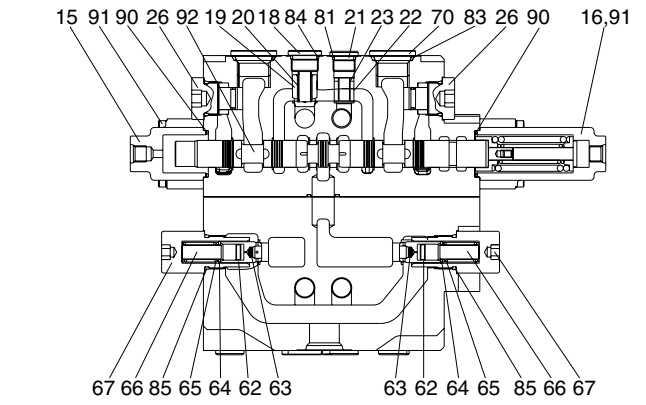
D - D (SWING PRIORITY & BOOM2 & ARM)



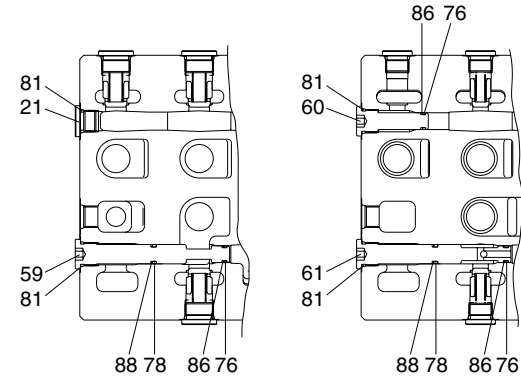
E - E (ARM & ARM REGENERATION /BREAKER)



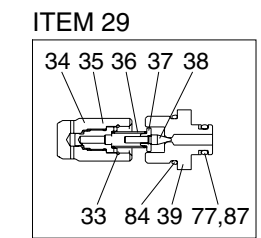
F - F (OPTION & BUCKET)



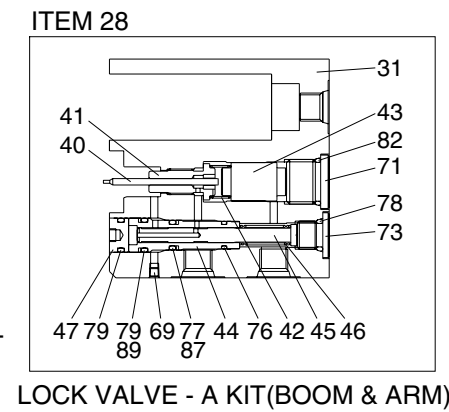
G - G (OPTION & NEGATIVE CONTROL)



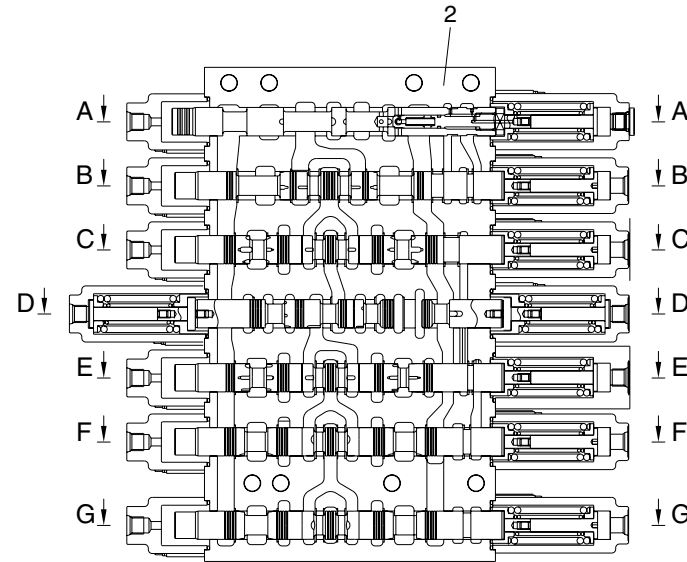
LOCK VALVE - B KIT (BOOM & ARM)



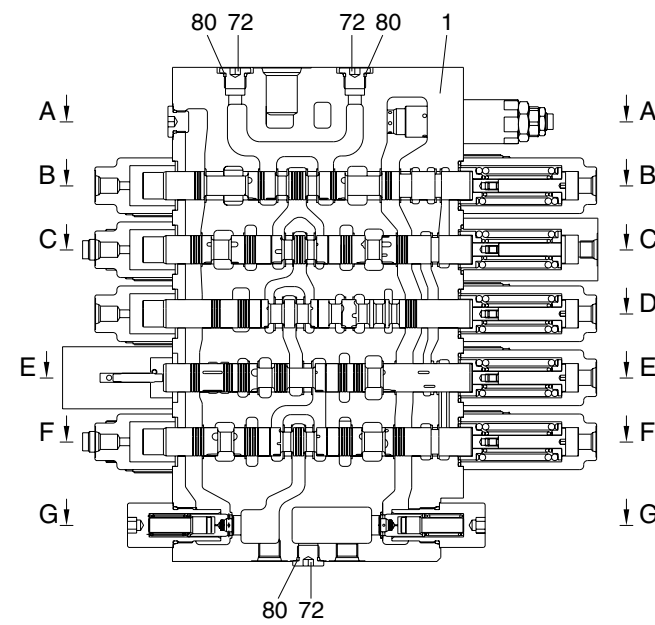
LOCK VALVE - A KIT (BOOM & ARM)



LOCK VALVE - A KIT (BOOM & ARM)



HOUSING P1 SIDE

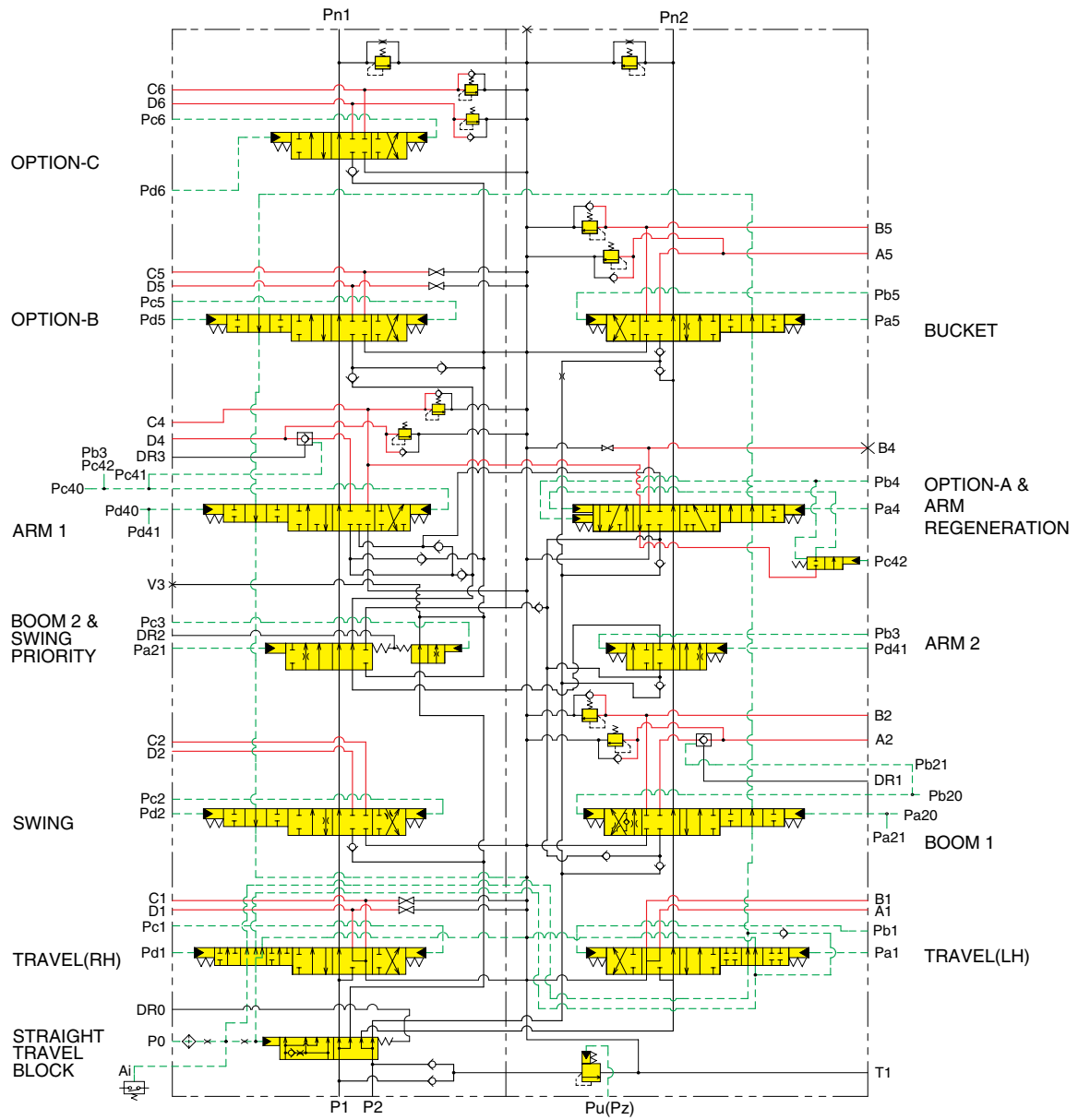


HOUSING P2 SIDE

- | | |
|-------------------------------------|----------------------------|
| 1 Housing-P2 | 47 Stopper-lock valve |
| 2 Housing-P1 | 48 Spool-regen selector |
| 3 Spool-straight travel | 49 Spring-regeneration |
| 4 Spool-travel 1-RH | 50 Stopper-regeneration |
| 5 Spool-travel 2-LH | 51 Piston-cut off |
| 6 Spool-swing | 52 Poppet-signal |
| 7 Spool-boom1 | 53 Spring-signal |
| 8 Spool-swing priority | 54 Plug |
| 9 Spool-boom2 | 55 Orifice-signal |
| 10 Spool-arm 2 | 56 Coin type filter |
| 11 Spool-arm 1 | 57 Orifice-plug |
| 12 Spool-arm regeneration & breaker | 58 Plug |
| 13 Spool-option | 59 Plug |
| 14 Spool-bucket | 60 Plug |
| 15 Cover-pilot A | 61 Plug-orifice |
| 16 Cover-pilot B1 | 62 Poppet-negative control |
| 17 Cover-Pilot B2 | 63 Coin type filter |
| 18 Plug | 64 Spring seat |
| 19 Poppet1-check valve | 65 Spring-negative control |
| 20 Spring-check valve | 66 Piston-negative control |
| 21 Plug | 67 Socket-negative control |
| 22 Poppet2-check valve | 68 Plug |
| 23 Spring-check valve | 69 Plug |
| 24 Main relief valve | 70 Plug |
| 25 Over load relief valve | 71 Plug |
| 26 Plug | 72 Plug |
| 27 Plug | 73 Plug |
| 28 Lock valve kit A | 74 Socket head bolt |
| 29 Lock valve kit B | 75 O-ring |
| 30 Socket-head bolt | 76 O-ring |
| 31 Block-holding | 77 O-ring |
| 32 Block-regeneration | 78 O-ring |
| 33 O-ring | 79 O-ring |
| 34 Poppet-lock valve | 80 O-ring |
| 35 Restrictor-lock valve | 81 O-ring |
| 36 Spring-lock valve pilot | 82 O-ring |
| 37 Guide-poppet | 83 O-ring |
| 38 Poppet pilot | 84 O-ring |
| 39 Seat poppet | 85 O-ring |
| 40 Piston 1 | 86 Back-up ring |
| 41 Guide-piston | 87 Back-up ring |
| 42 Spring 1-lock valve | 88 Back-up ring |
| 43 Piston 2 | 89 Back-up ring |
| 44 Sleeve | 90 O-ring |
| 45 Spool-lock valve | 91 Bolt with washer |
| 46 Spring-lock valve | 92 Socket head bolt |

1407A2MC02A

2. HYDRAULIC CIRCUIT

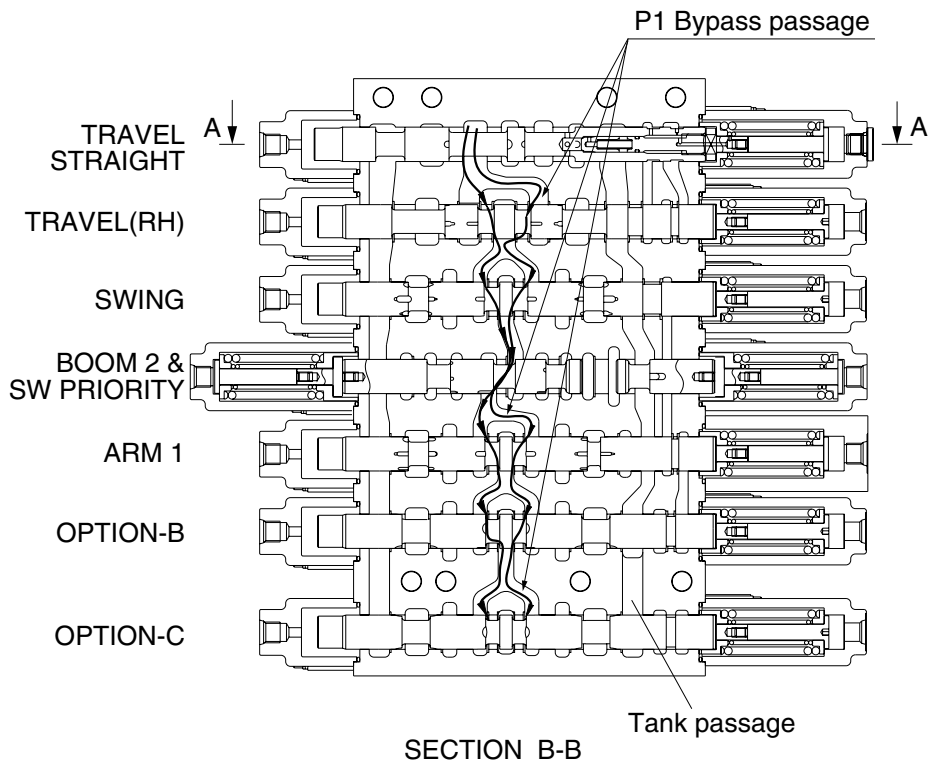
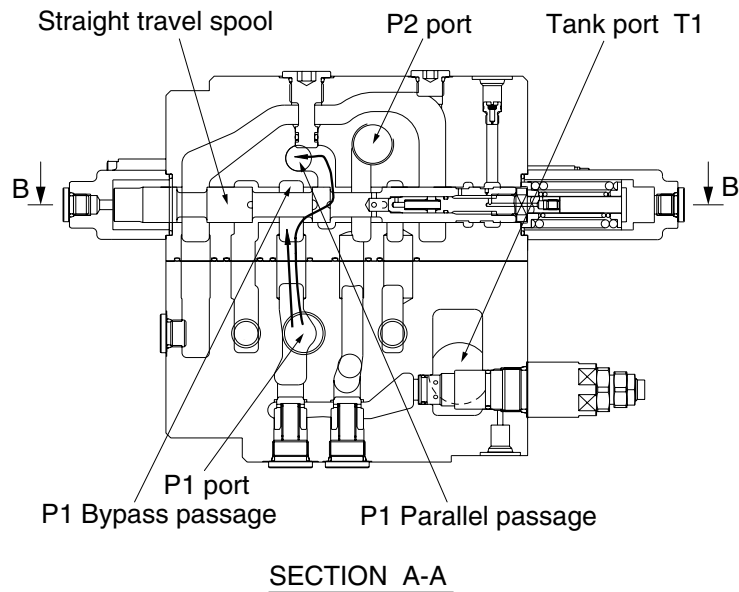


140V92MC04

3. FUNCTION

1) CONTROL IN NEUTRAL FUNCTION

(1) P1 SIDE

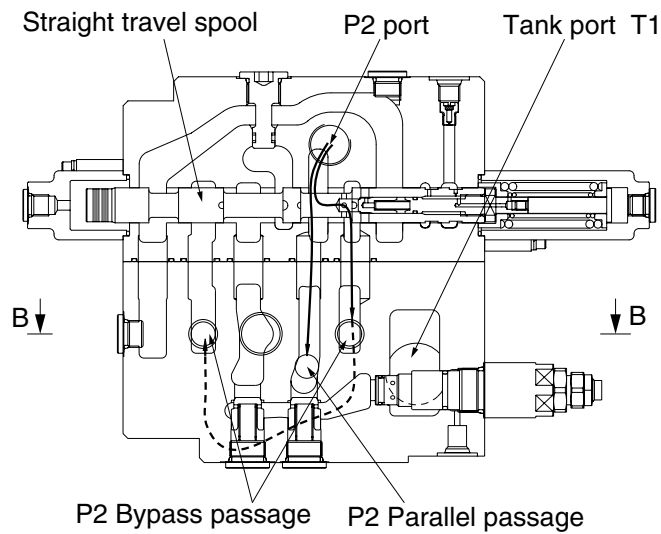


1607A2MC12A

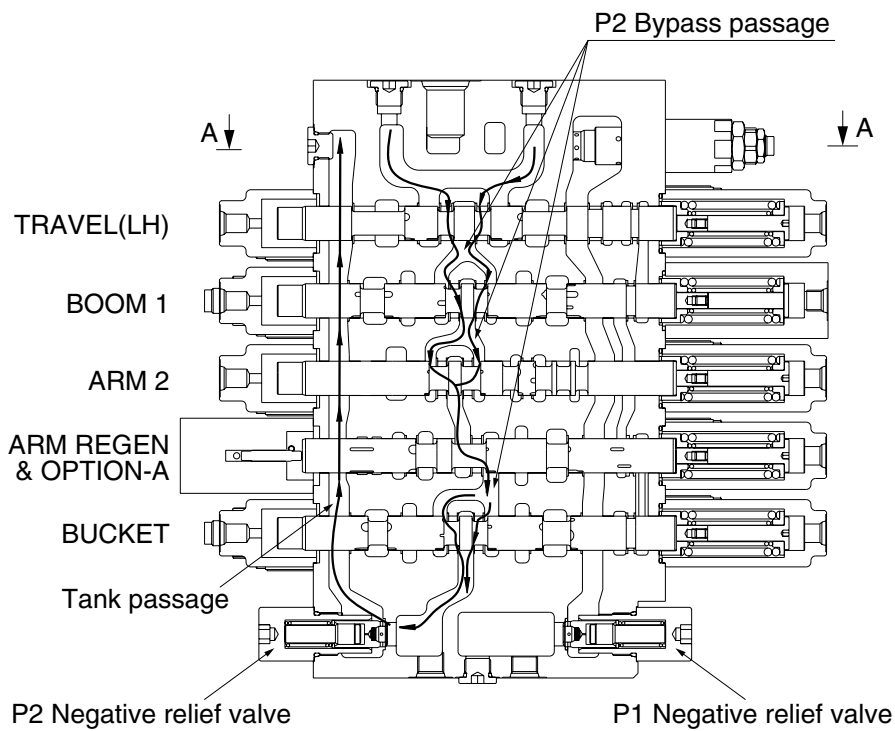
The hydraulic fluid from pump A1 flows into the main control valve through the inlet port "P1", pass the straight travel spool, into the P1 bypass passage and P1 parallel passage.

The hydraulic fluid from the pump A1 is directed to the tank through the bypass passage of spools : travel right, swing, boom 2 & swing priority, arm 1, option "B" and option "C", and the negative relief valve with the tank passage.

(2) P2 SIDE



SECTION A-A



SECTION B-B

1607A2MC11

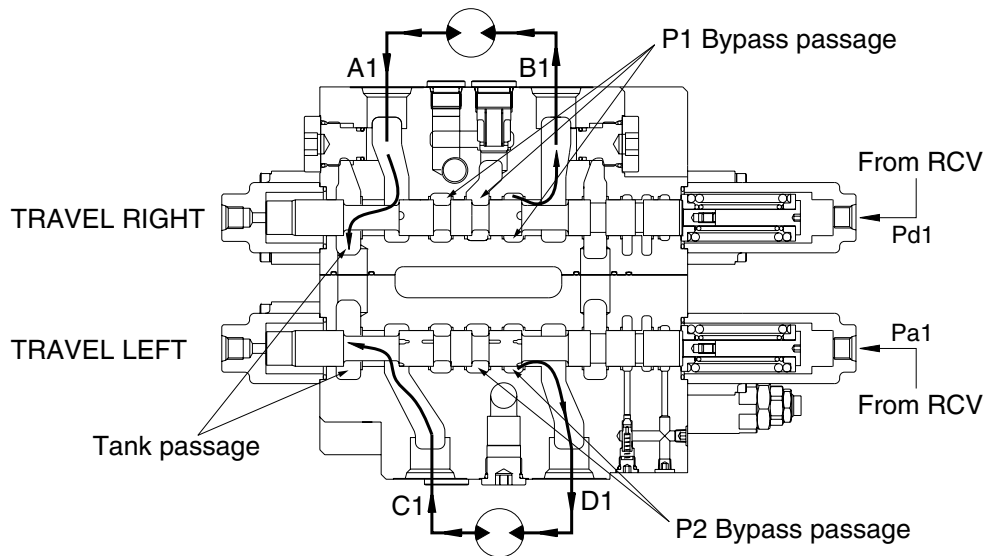
The hydraulic fluid from pump A2 flows into the main control valve through the inlet port "P2", pass the travel straight spool, into the P2 bypass passage and P2 parallel passage.

The hydraulic fluid from the pump A2 is directed to the tank through the bypass passage of spools : travel left, boom 1, arm 2, arm regeneration & option A and bucket, the negative relief valve, tank passage, and the tank port "T1"

2) EACH SPOOL OPERATION

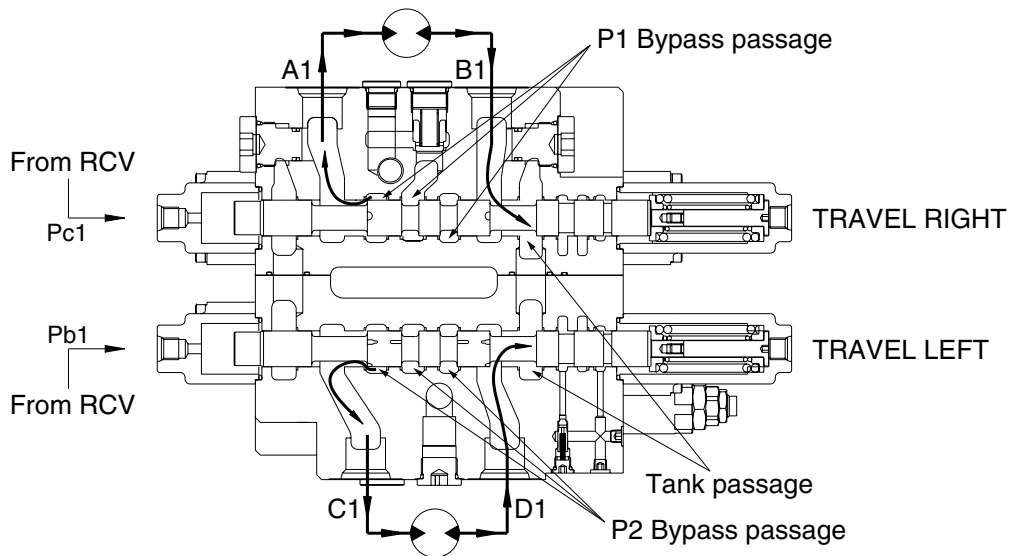
(1) TRAVEL OPERATION

① Travel forward operation



1607A2MC17A

② Travel backward operation



1607A2MC18A

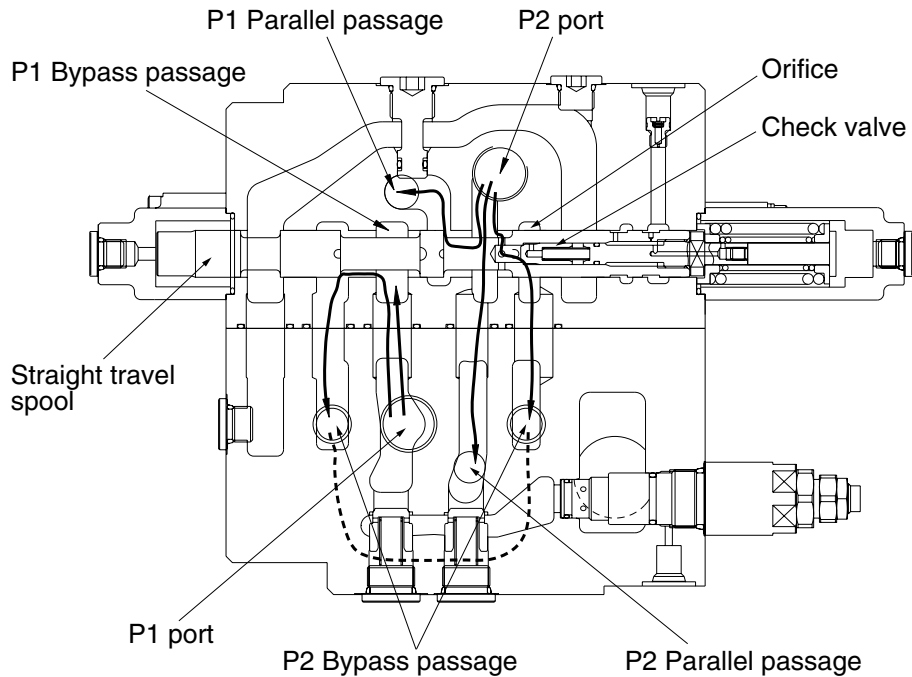
During the travel operation, the hydraulic fluid of the pump A2 is supplied to the travel motor and the hydraulic fluid of the pump A1 is supplied to the other travel motor.

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 A1 flow into the travel right spool through the bypass passage and hydraulic fluid from the pump A2 flow into the travel left 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



1607A2MC19A

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 A2 is supplied to the travel motor and the pump A1 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 A2 is supplied actuator through P2 and P1 parallel pass and travel motors through orifice at side of straight travel spool.

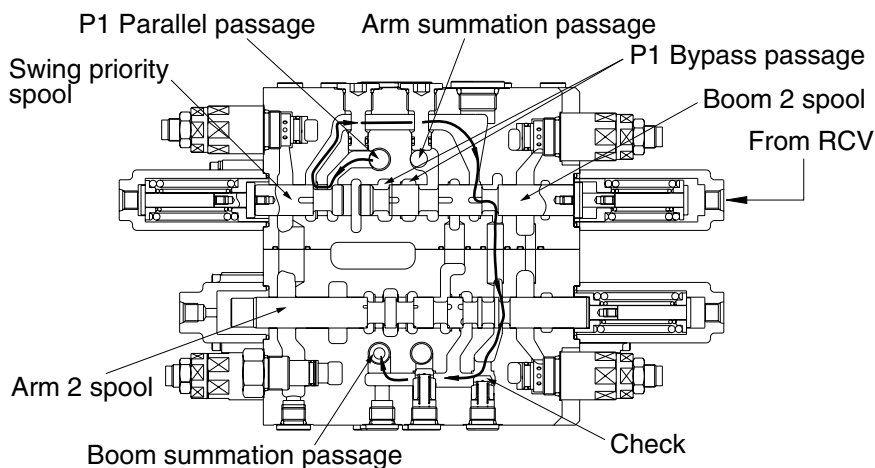
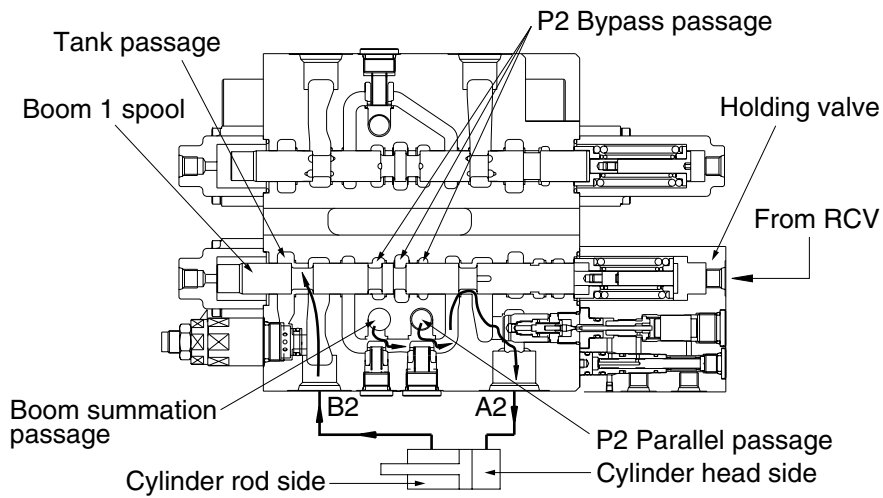
The hydraulic oil fluid from pump A1 is supplied to travel motors (left/right).

Therefore, the other actuator operation with straight travel operation, hydraulic oil fluid from pump A2 is mainly supplied to actuator, and the hydraulic oil fluid form pump A1 is mainly supplied to travel motors (left/right).

Then the machine keeps straight travel.

(3) BOOM OPERATION

① Boom up operation



1607A2MC24A

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 A2 is entered P2 parallel passage and then passes through the load check valve and boom holding valve then flows into the port A2.

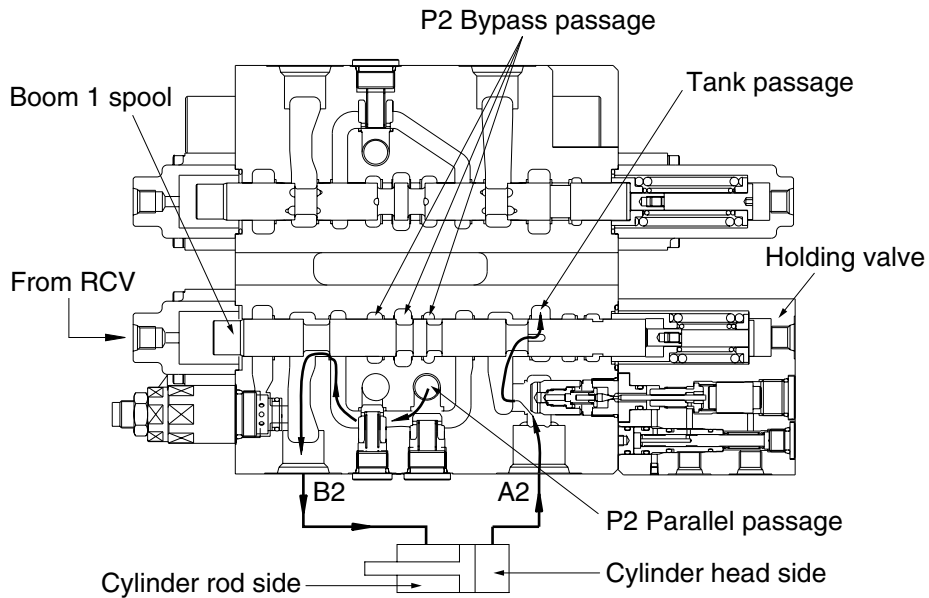
Following this it flows into the head side of the boom cylinder.

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

At the same time the pilot pressure through the port Pa21 shifts the boom 2 spool. The hydraulic oil fluid from pump A1 entered boom summation passage via the P1 parallel passage, the swing priority spool, the boom 2 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 boom 1 spool through the port B2. There after it is directed to the hydraulic oil tank through the tank passage.

② Boom down operation



1607A2MC26

During the boom lowering operation, the pilot pressure from RCV is supplied to the port Pb20 and shift the boom 1 spool in the right direction.

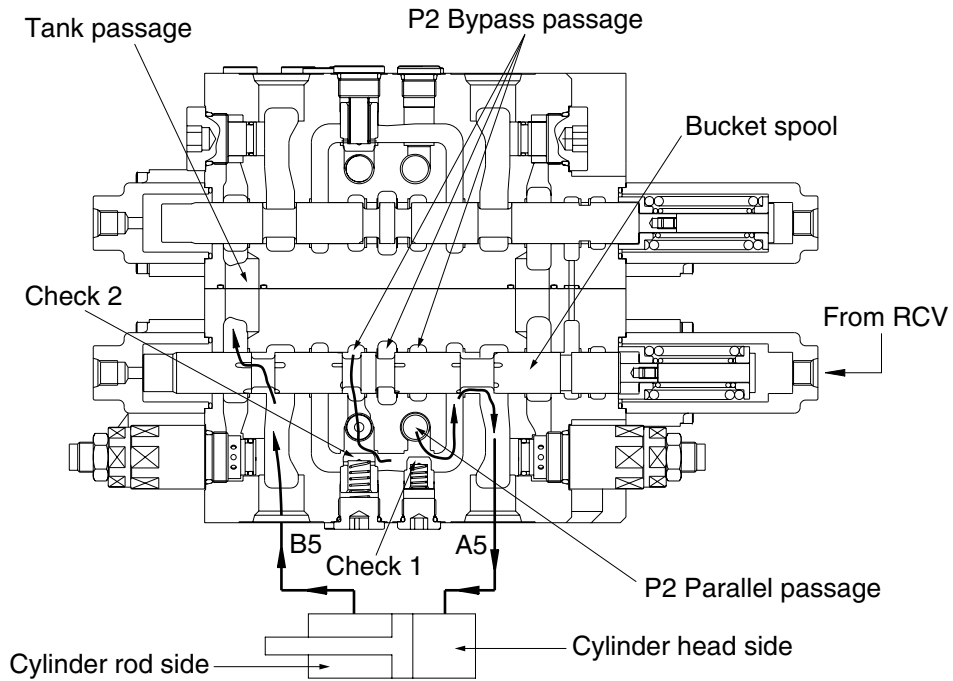
The hydraulic fluid from the pump A2 enters the parallel passage and is directed to the port B2 through the load check valve. Following this, it flows into the rod side of the boom cylinder.

The return flow from the head side of the boom cylinder returns to the boom 1 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 2-36.

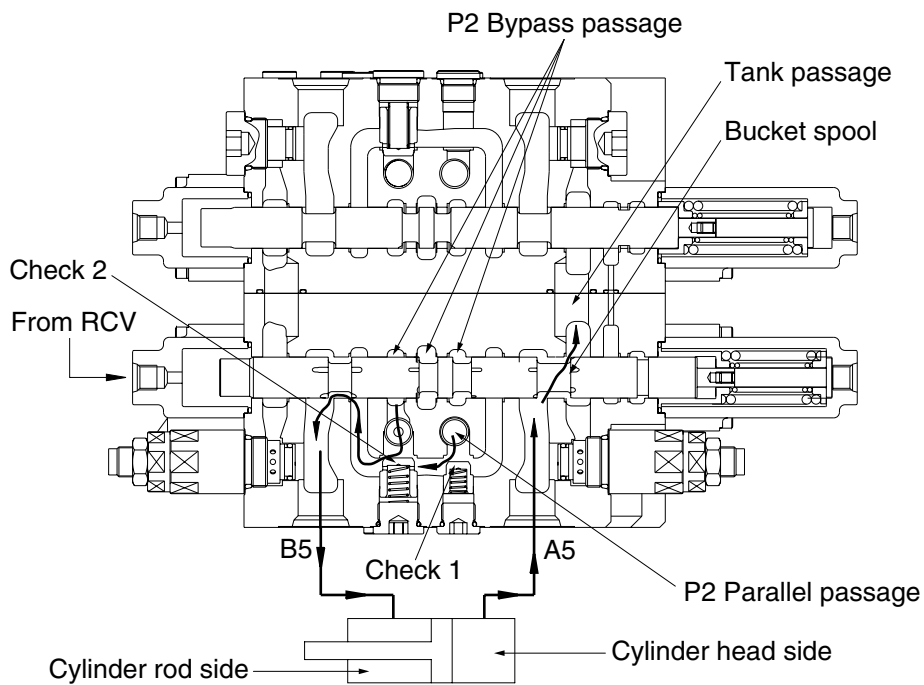
(4) BUCKET OPERATION

① Bucket roll in operation



1607A2MC34A

② Bucket roll out operation



1607A2MC35

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 A2 entered P2 parallel passage and is directed to the port A5 through the check 1.

At the same time, the hydraulic fluid from P2 bypass passage is directed to the port A5 through the check 2.

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

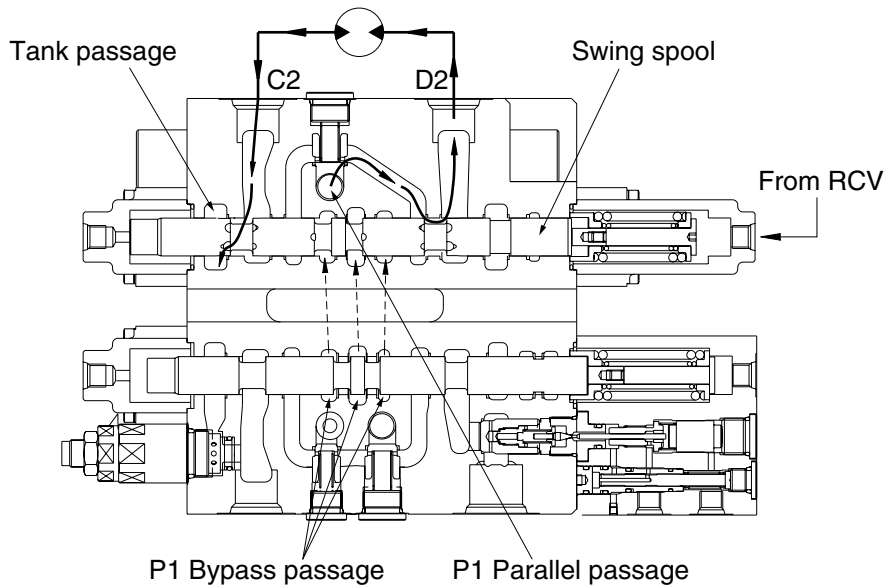
③ **Bucket operation with arm or boom operation**

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.

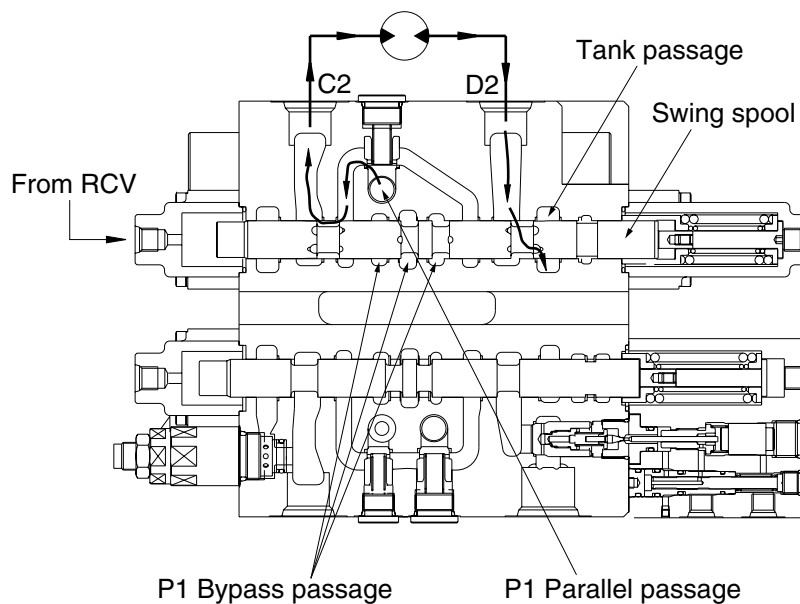
(5) SWING OPERATION

① Swing left operation



1607A2MC32

② Swing right operation

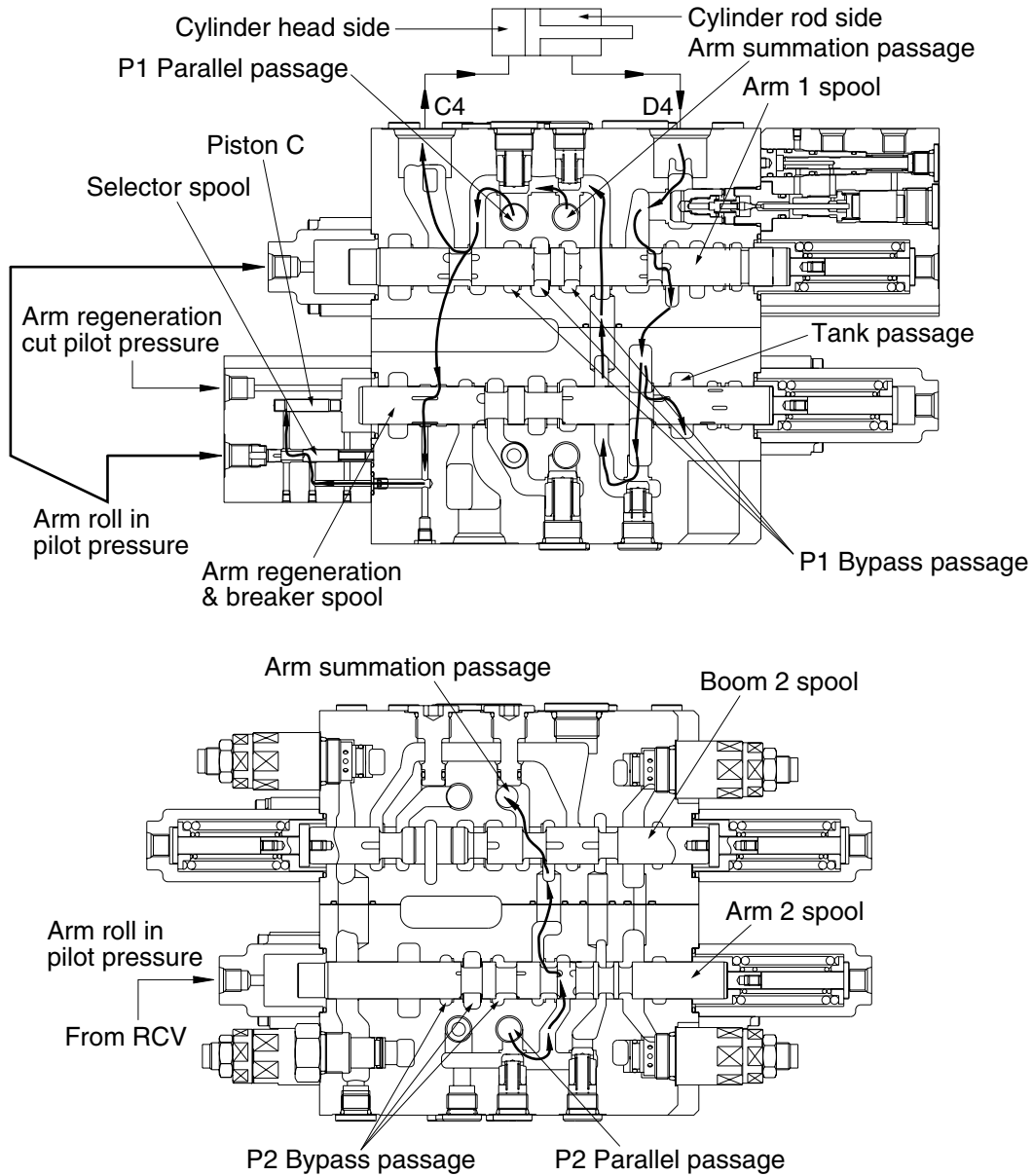


1607A2MC33

The pilot pressure from the RCV is supplied to the Pd2 and shift the swing spool in left direction. The hydraulic fluid from pump A1 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



1607A2MC21

· 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 arm 1 spool and arm 2 spool in the right direction.

The hydraulic oil from the pump A1 flows into the arm cylinder head side through P1 parallel passage, the load check valve and the port C4.

At same time, the hydraulic fluid from the pump A2 flows into the arm summation passage through parallel passage, the check valve, the arm 2 spool and the boom 2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm 1 spool.

- Arm regeneration :

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

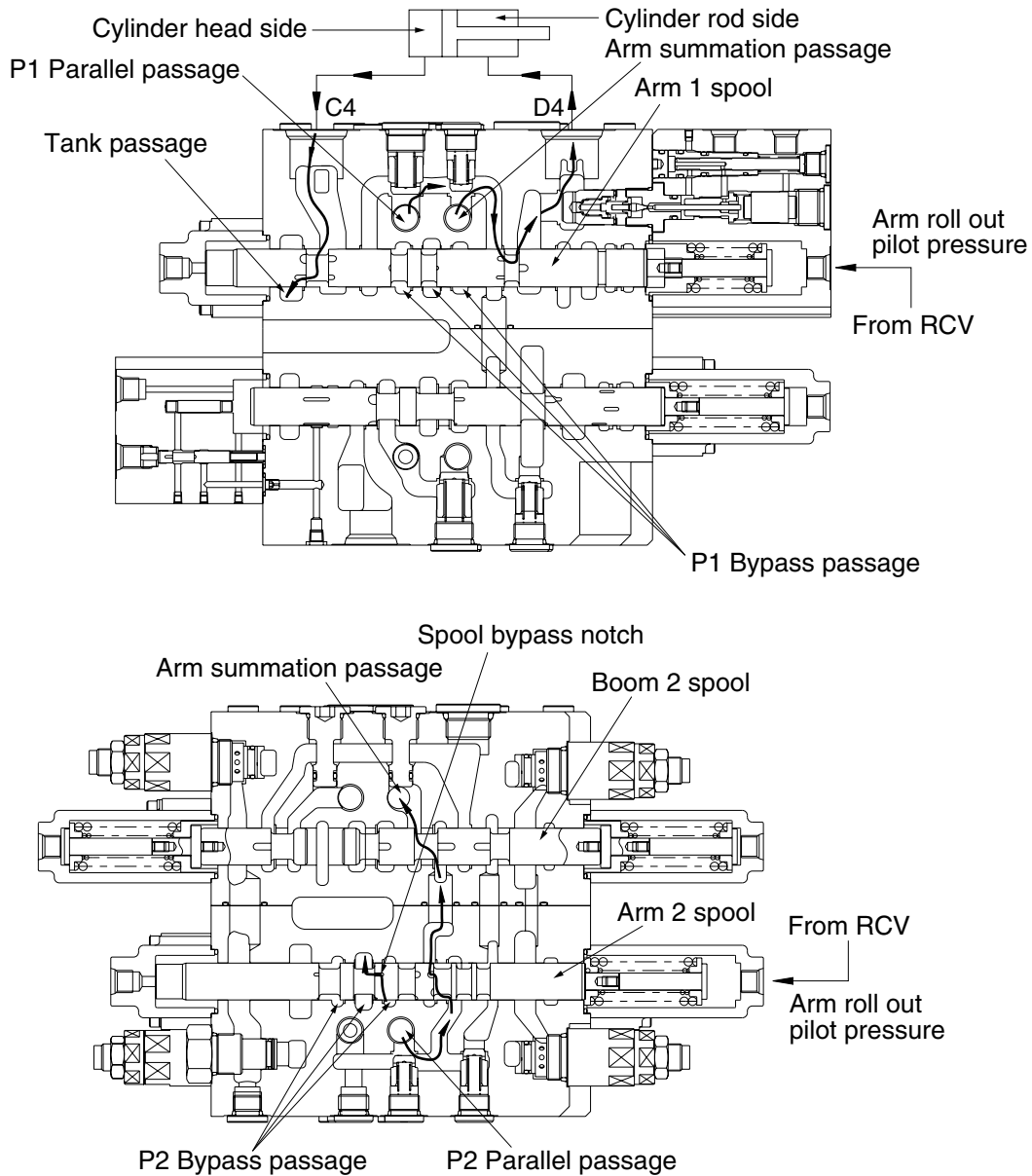
The amount of regeneration fluid are changed by movement of the arm regeneration & breaker spool.

A few fluid after P1 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



1607A2MC23

During arm roll out operation the pilot pressure from RCV is supplied to the port Pd40 and the Pd41 and shifts arm 1 spool and arm 2 spool in the right direction.

The hydraulic fluid from pump A1 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.

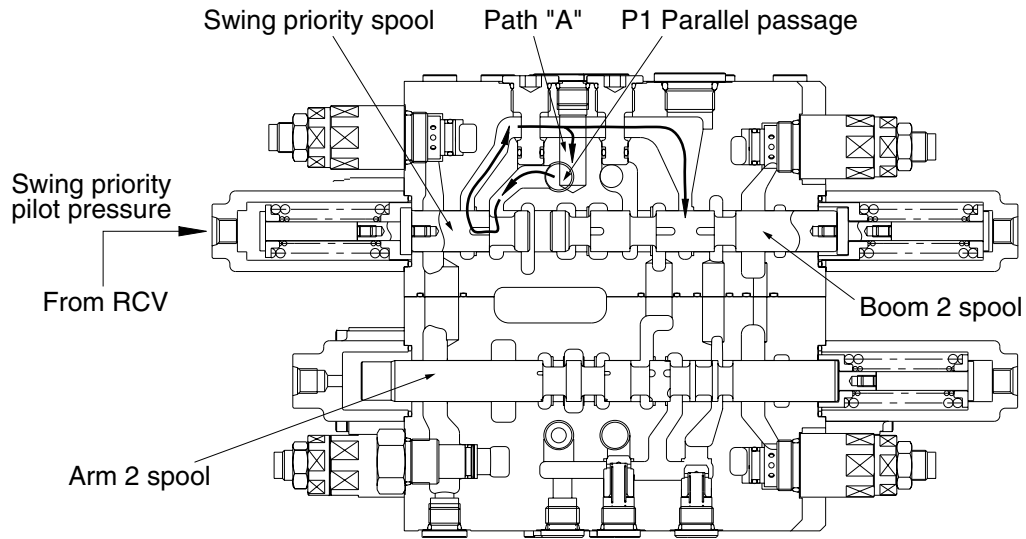
Some of the hydraulic fluid from pump A1 bypassed through bypass notch.

The rest of hydraulic fluid from pump A2 flows into the arm summation passage through P2 parallel passage the check valve arm 2 spool and boom 2 spool.

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

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

(7) SWING PRIORITY FUNCTION



1607A2MC27

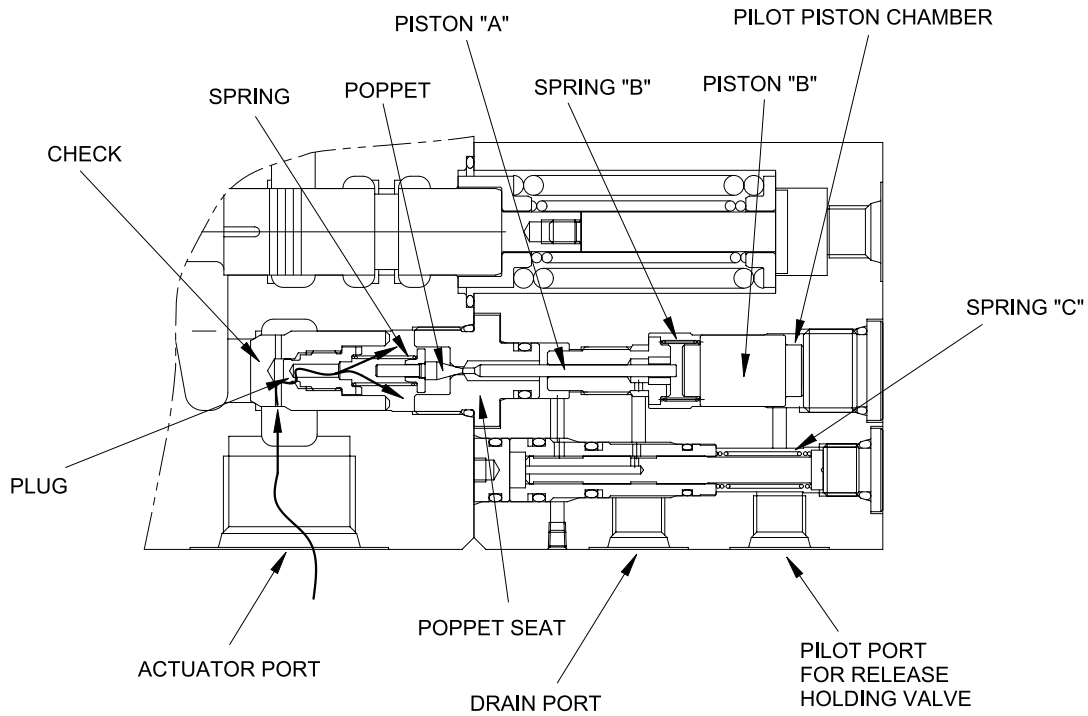
During swing priority operation, the pilot pressure is supplied to the port Pc3 and shift swing priority spool in the right direction.

The hydraulic fluid from P1 parallel passage flows into the parallel passage of arm 1 side through swing priority spool and the passage "A" and also flows into the boom 2 spool.

Due to shifting of the swing priority spool, the fluid from pump A1 flows to swing side more then next spools to make the swing operation most preferential.

(8) HOLDING VALVE OPERATION

① Holding operation



14072SF30

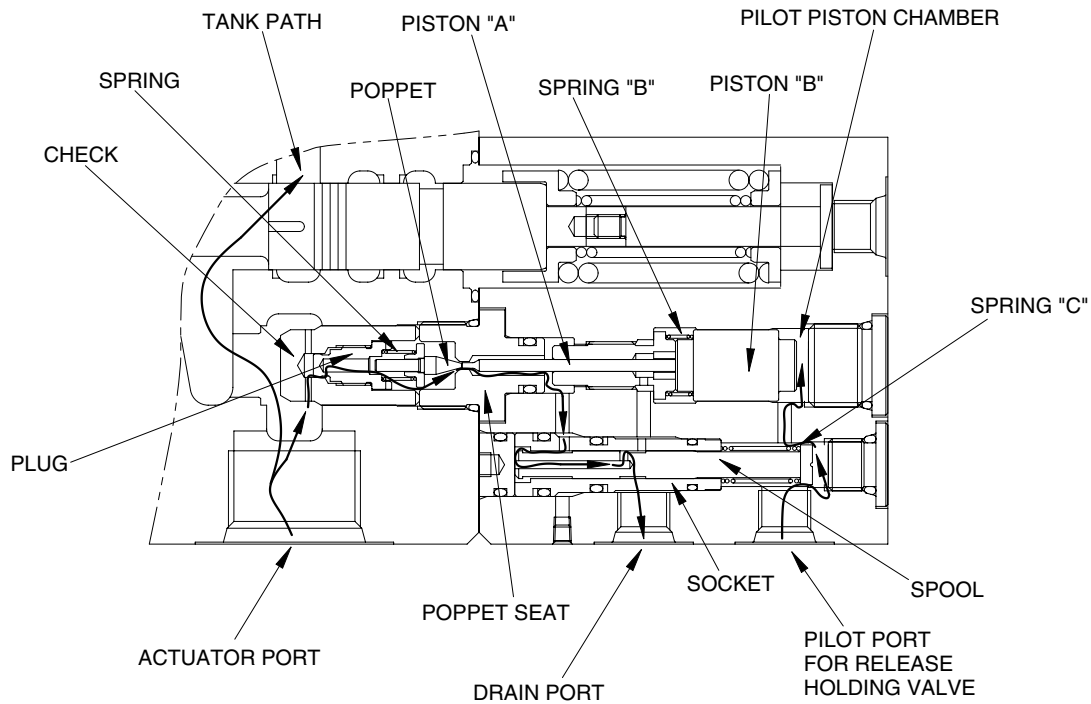
At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.

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



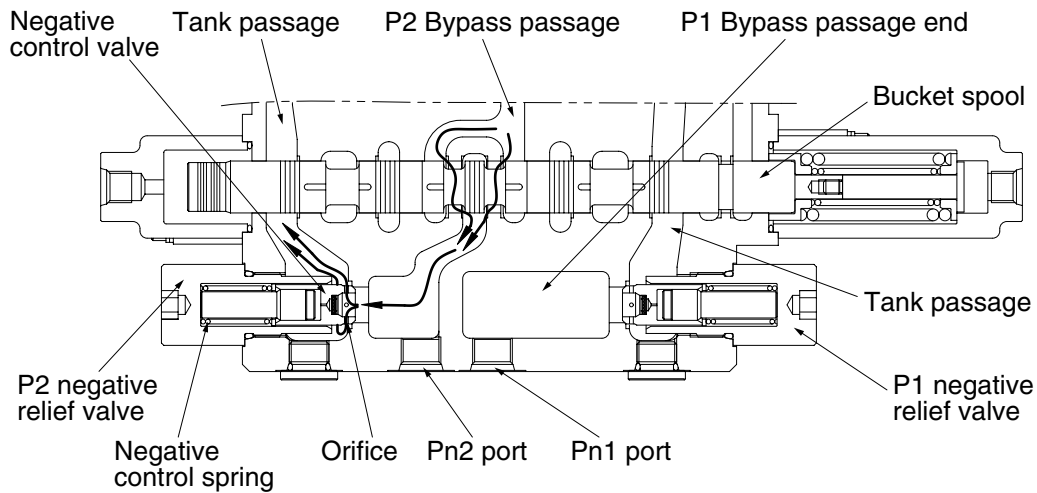
14072SF31

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

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

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

(9) NEGATIVE RELIEF VALVE CONTROL



1607A2MC28

When no function is being actuated on P2 side, the hydraulic fluid from the pump A2, 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 Pn2 to the pump A2 regulator.

It controls the pump regulator so as to minimize the discharge of the pump A2.

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 A2 become maximum.

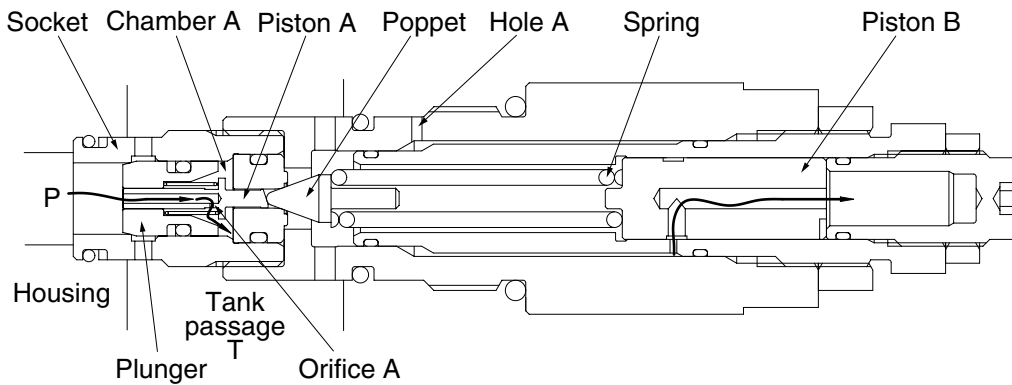
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump A1 the same negative control principle.

(10) OPERATION OF MAIN RELIEF VALVE

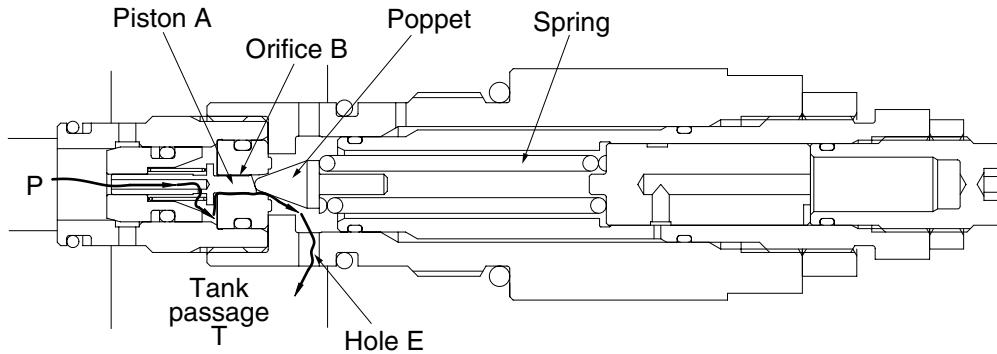
The main relief valve is fitted to the straight travel valve block and functions as follows :

- 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.



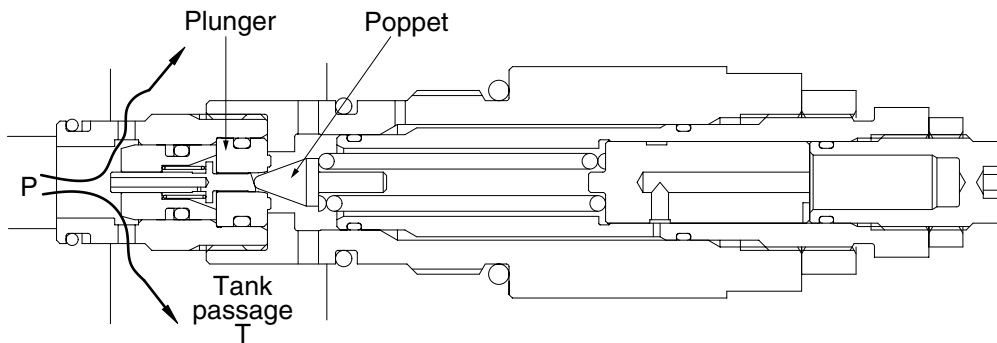
1607A2MC36

- 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).



1607A2MC37

- 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).

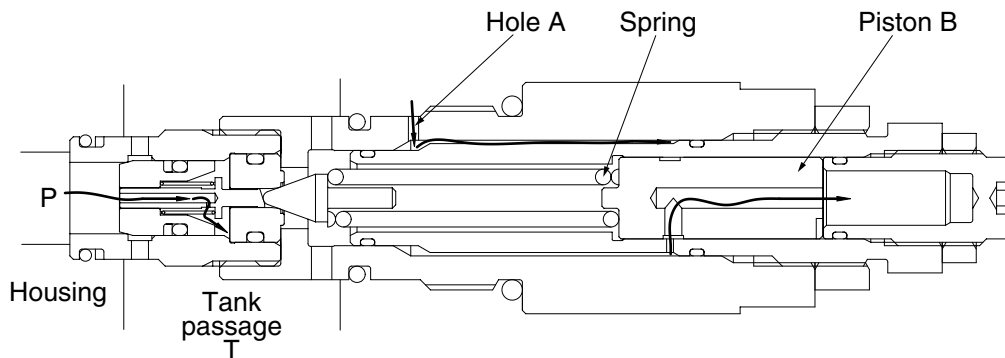


1607A2MC38

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.

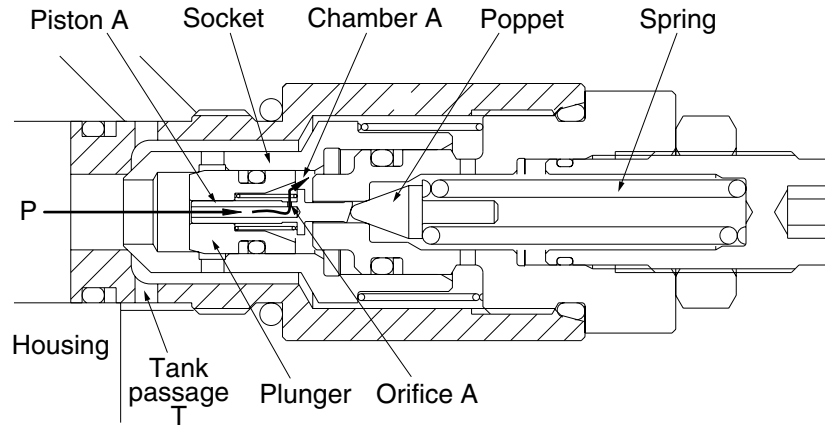


1607A2MC36A

(11) OPERATION OF PORT RELIEF VALVE

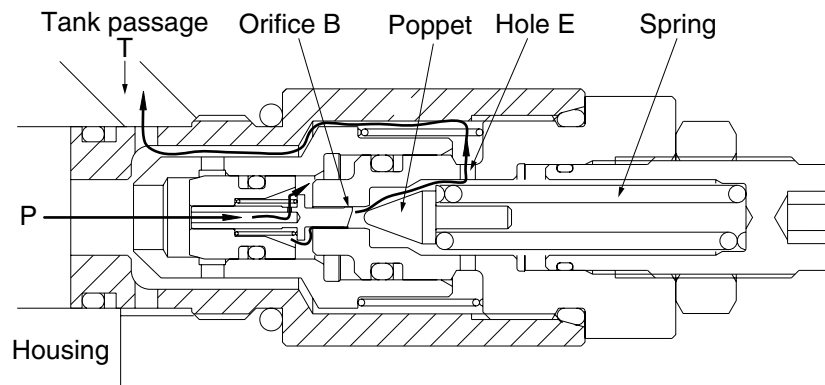
① Function as relief valve

- 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 the housing securely.



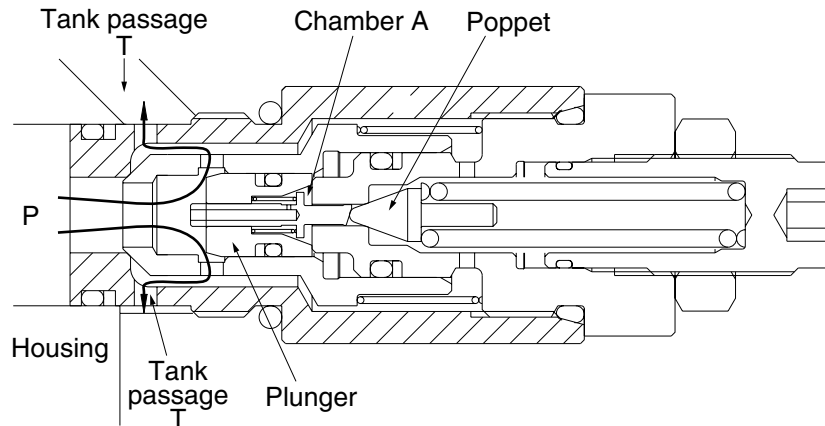
1607A2MC39

- 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.



1607A2MC40

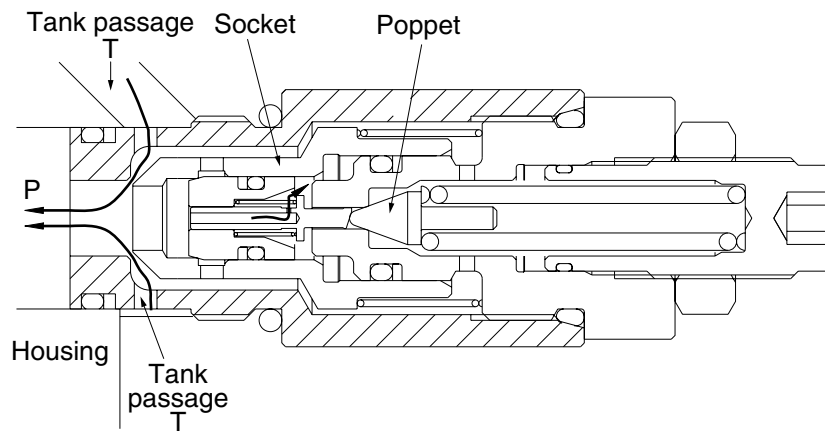
- © Opening of the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



1607A2MC41

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.



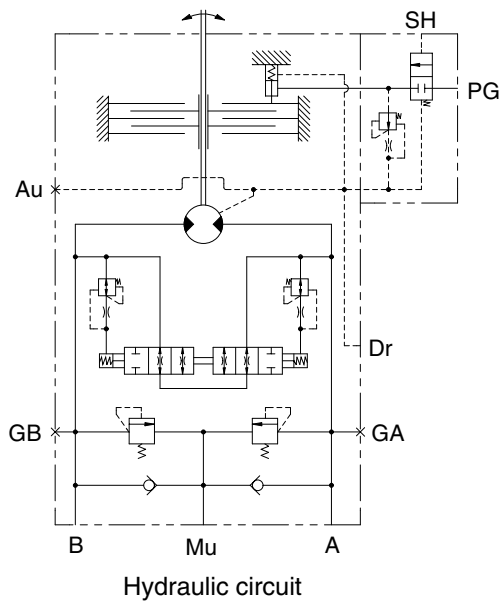
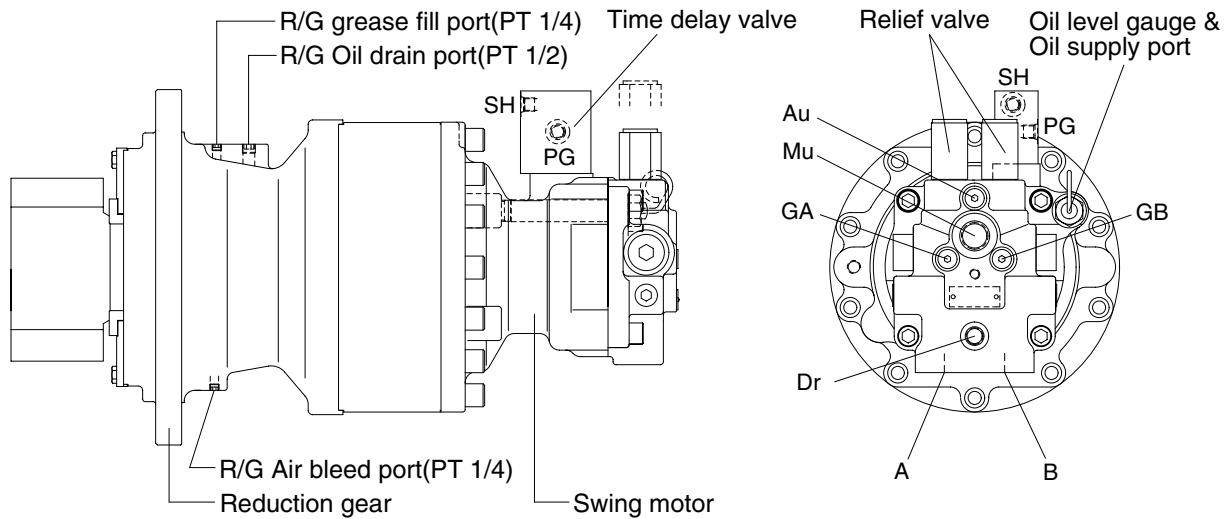
1607A2MC42

GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

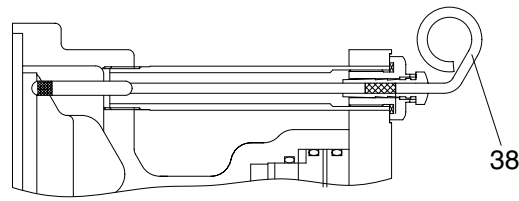
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



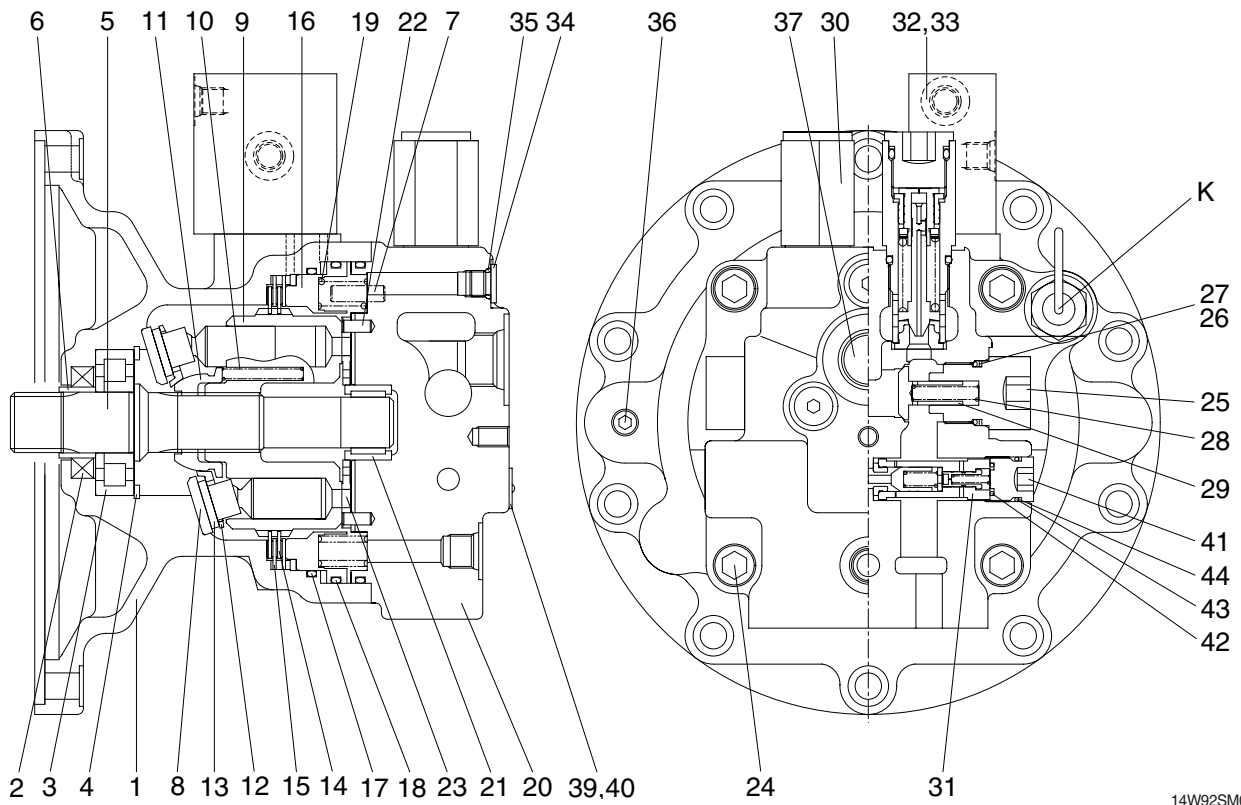
14W92SM01

Port	Port name	Port size
A	Main port	ø 13
B	Main port	ø 13
Dr	Drain port	PF 3/8
Mu	Make up port	PF 3/4
SH	Brake release port	PF 1/4
PG	Stand by port	PF 1/4
GA, GB	Gage port	PF 1/4
Au	Air vent port	PF 1/4

1) SWING MOTOR



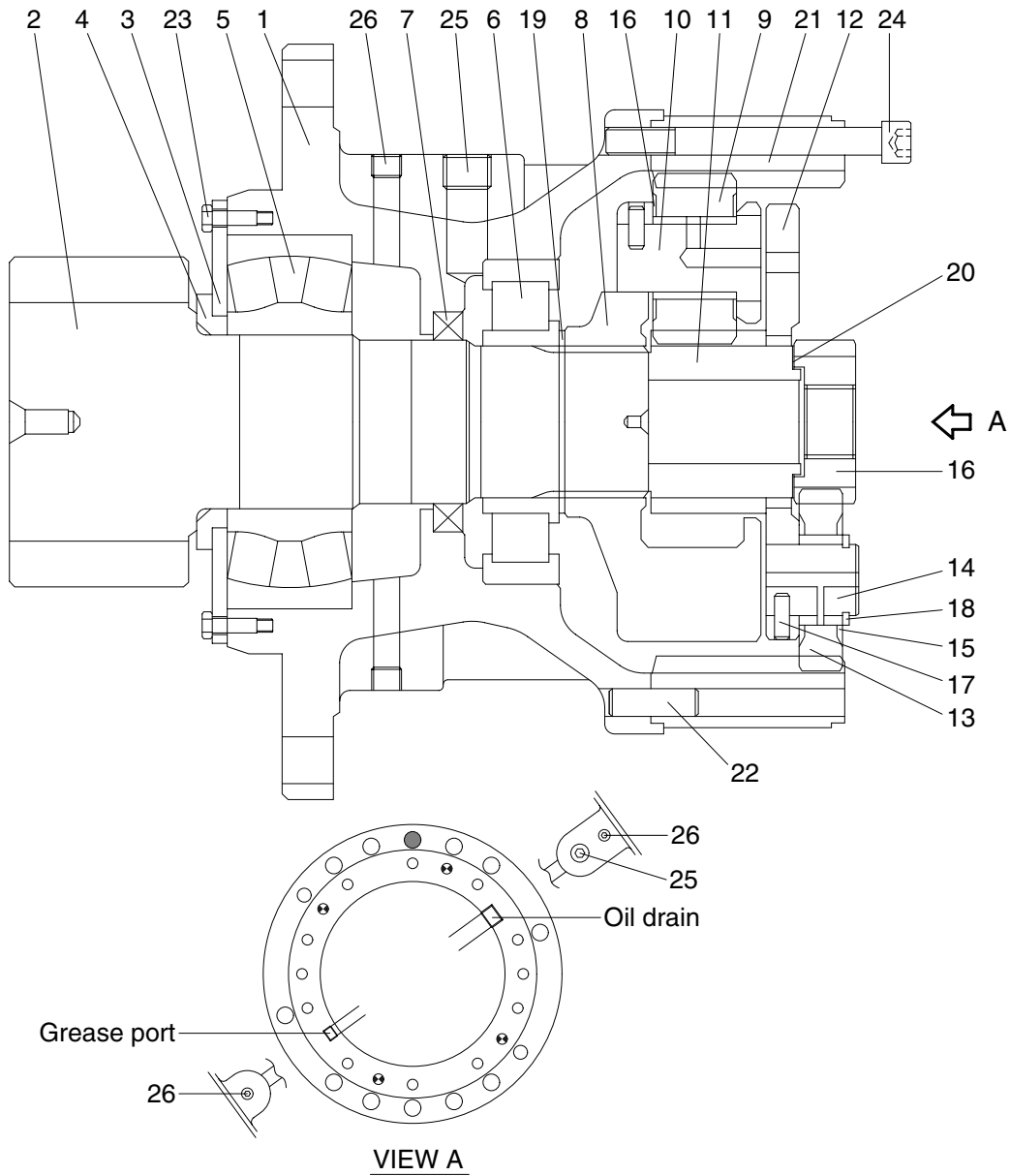
DETAIL K



14W92SM02

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

2) REDUCTION GEAR



1	Casing	10	Pin No.2 assembly	19	Stop ring
2	Drive shaft	11	Sun gear No. 2	20	Side plate No. 1
3	Cover plate	12	Carrier No. 1	21	Ring gear
4	Spacer	13	Planet gear No. 1	22	Knock pin
5	Roller bearing	14	Pin No.1	23	Hexagonal bolt
6	Roller bearing	15	Thrust washer (B)	24	Socket head bolt
7	Oil seal	16	Sun gear No. 1	25	Plug
8	Carrier No. 2	17	Spring pin	26	Plug
9	Planet gear No. 2	18	Stop ring		

14W92SM03

2. PRINCIPLE OF DRIVING

1) GENERATING THE TURNING FORCE

The high hydraulic supplied from a hydraulic pump flows into a cylinder (9) through valve cover of motor (20), and valve plate (23).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (13).

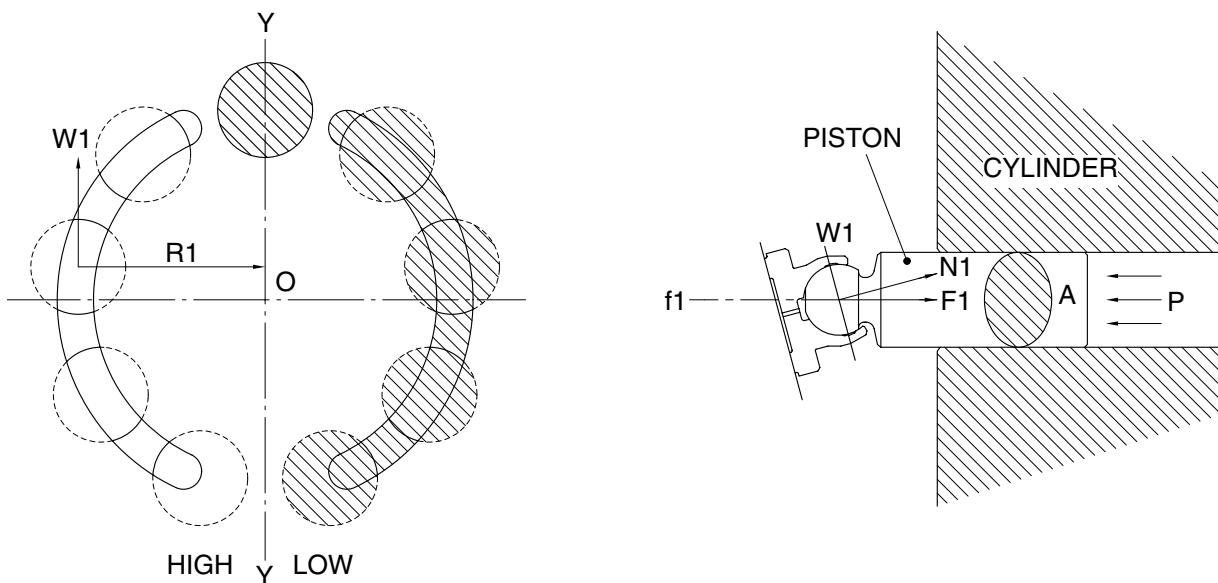
The high hydraulic can generate the force, $F1 = P \times A$ (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

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

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

The sum of torque ($\sum W1 \times R1$), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (9) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



14072NEWSM03

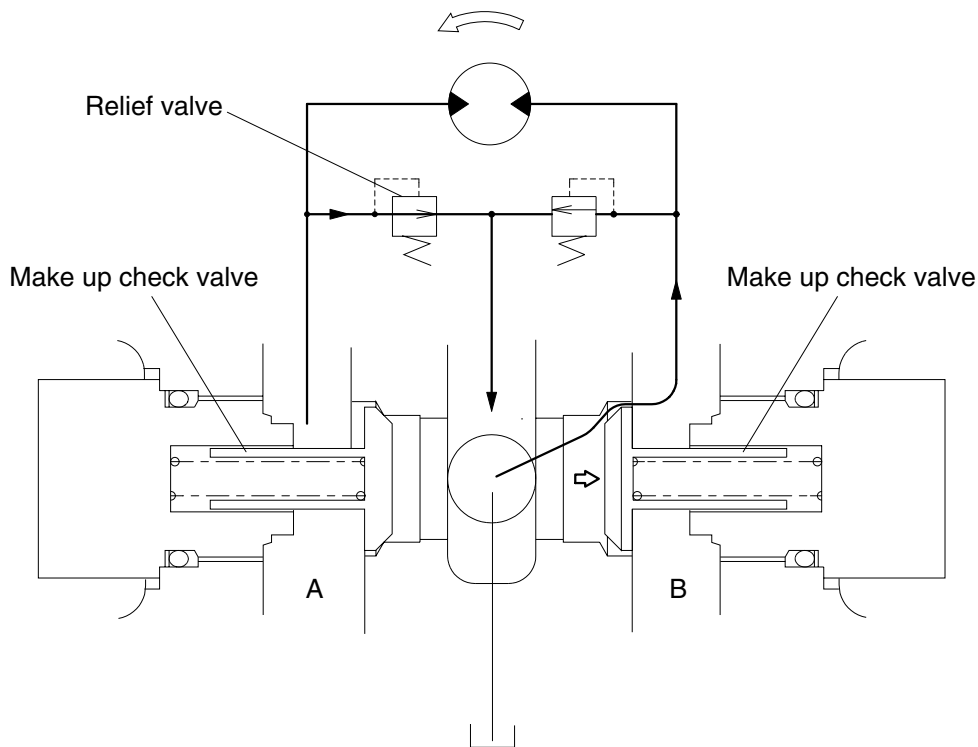
2) MAKE UP VALVE

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

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

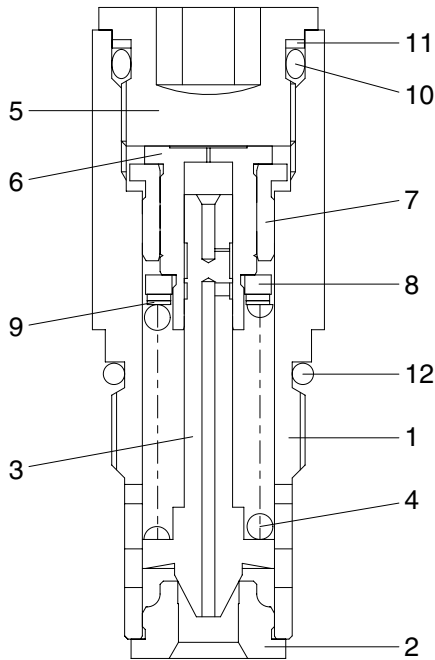
Pressurized oil into the port B, the motor rotate counterclockwise.

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



21092SM04

3) RELIEF VALVE



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

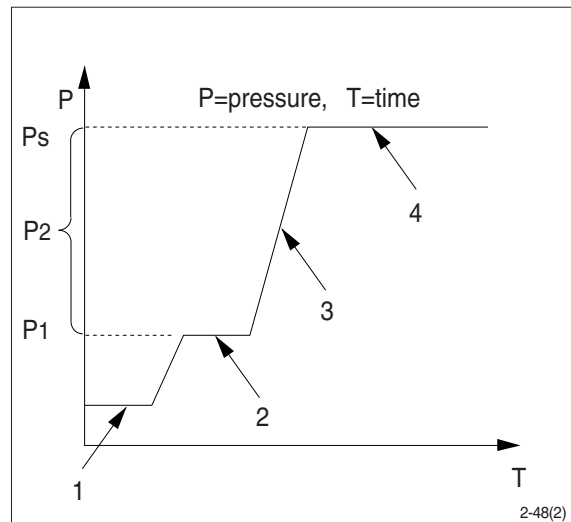
14007A2SM05

(1) Construction of relief valve

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

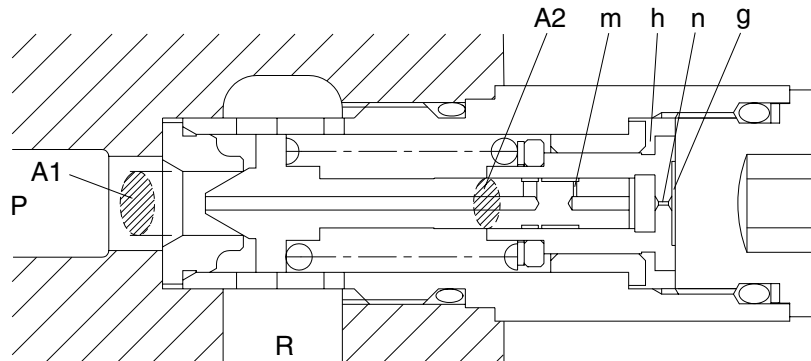
(2) Function of relief valve

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



2-48(2)

① Ports (P,R) at tank pressure.

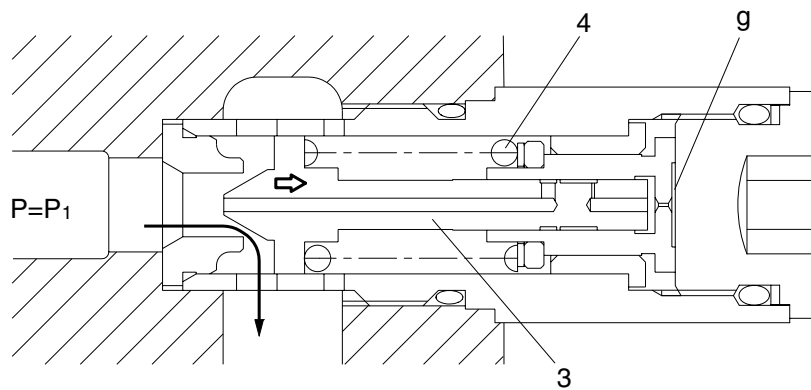


14007A2SM06

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

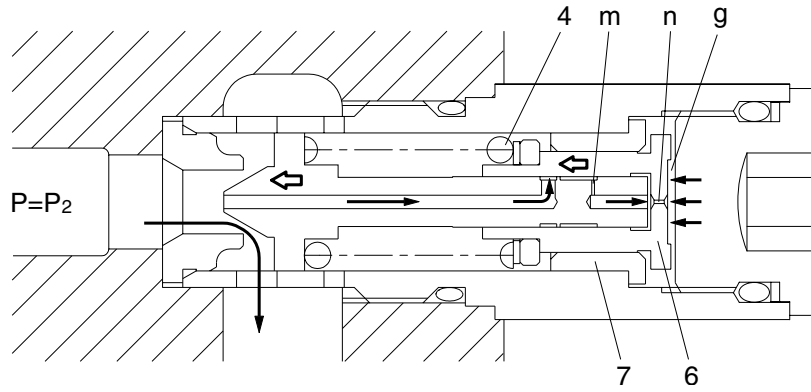
$$P_1 \times A_1 = F_{SP} + P_g \times A_2$$

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



14007A2SM07

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

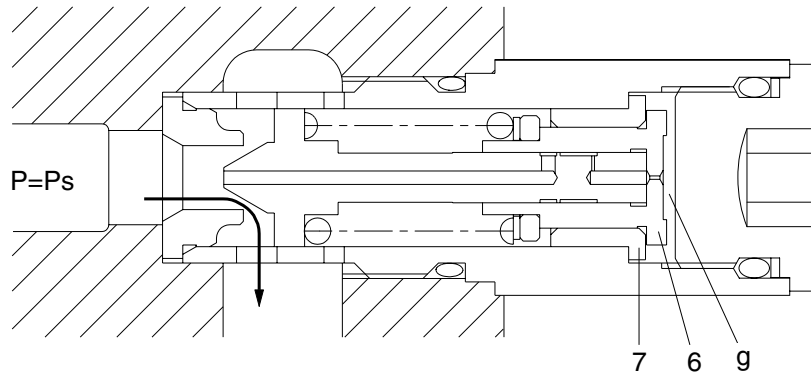


14007A2SM08

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

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

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



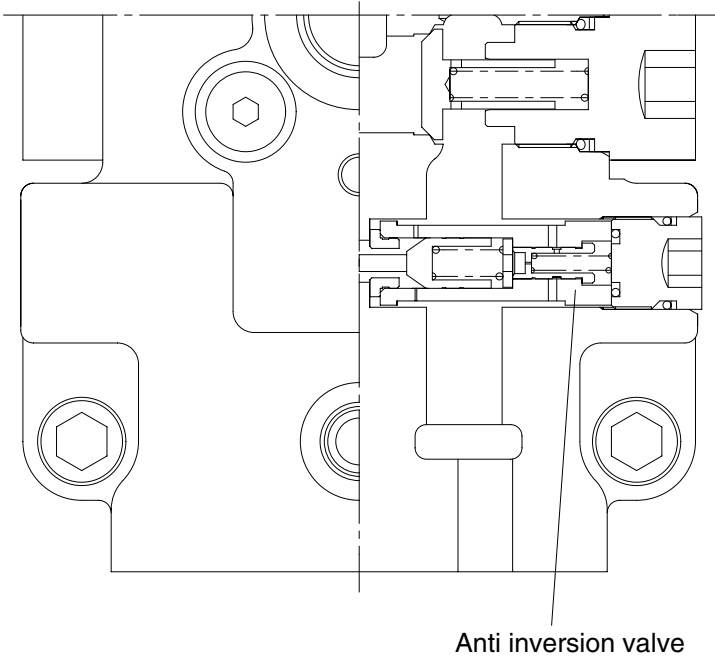
14007A2SM09

4) ANTI-INVERSION VALVE

In the event of swing motor operates switch part to drive and stop the swing part. By the action of pump on motor, there is brake on both-side of port because of the block on both sides.

Swing part is stopped by pressure of brake (in order words, 4-5 times of inversion)

Under the operating condition, the side of anti-inversion blocks off both ports but bypassing compressed oil which is blocked in processing of anti-inversion fixed time and amount to inverse port, prevent increasing pressure of motor and decrease inversing action.



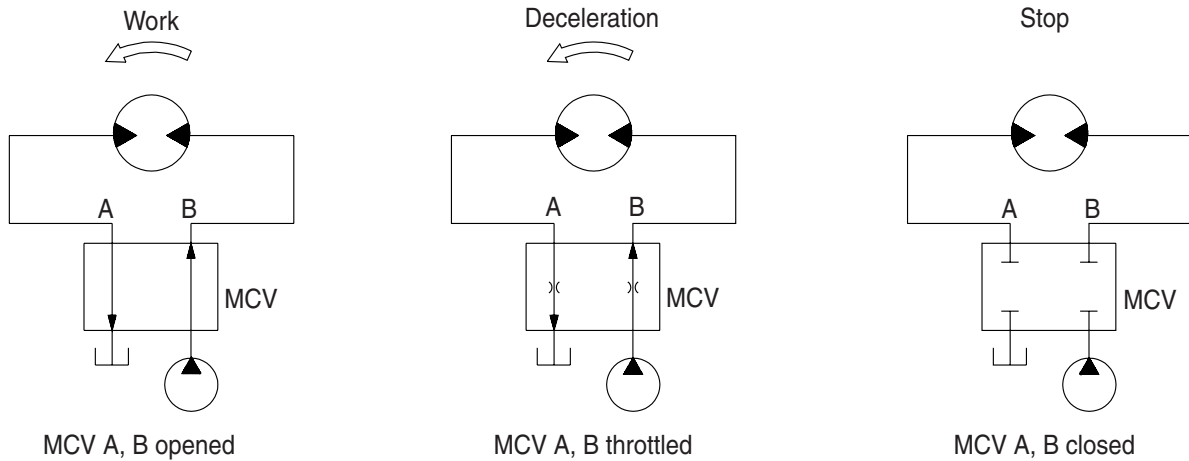
14W92SM10

5) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



2-48(1)

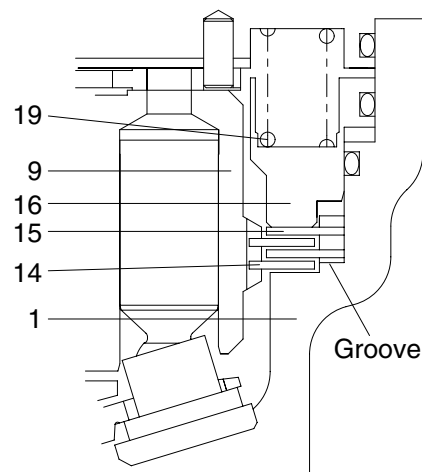
(2) Mechanical swing parking brake system

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

① Brake assembly

Circumferential rotation of separate plate (15) is constrained by the groove located at housing (1). When housing is pressed down by brake spring (19) through friction plate (14), separate plate (15) and brake piston (16), friction force occurs there.

Cylinder block (9) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

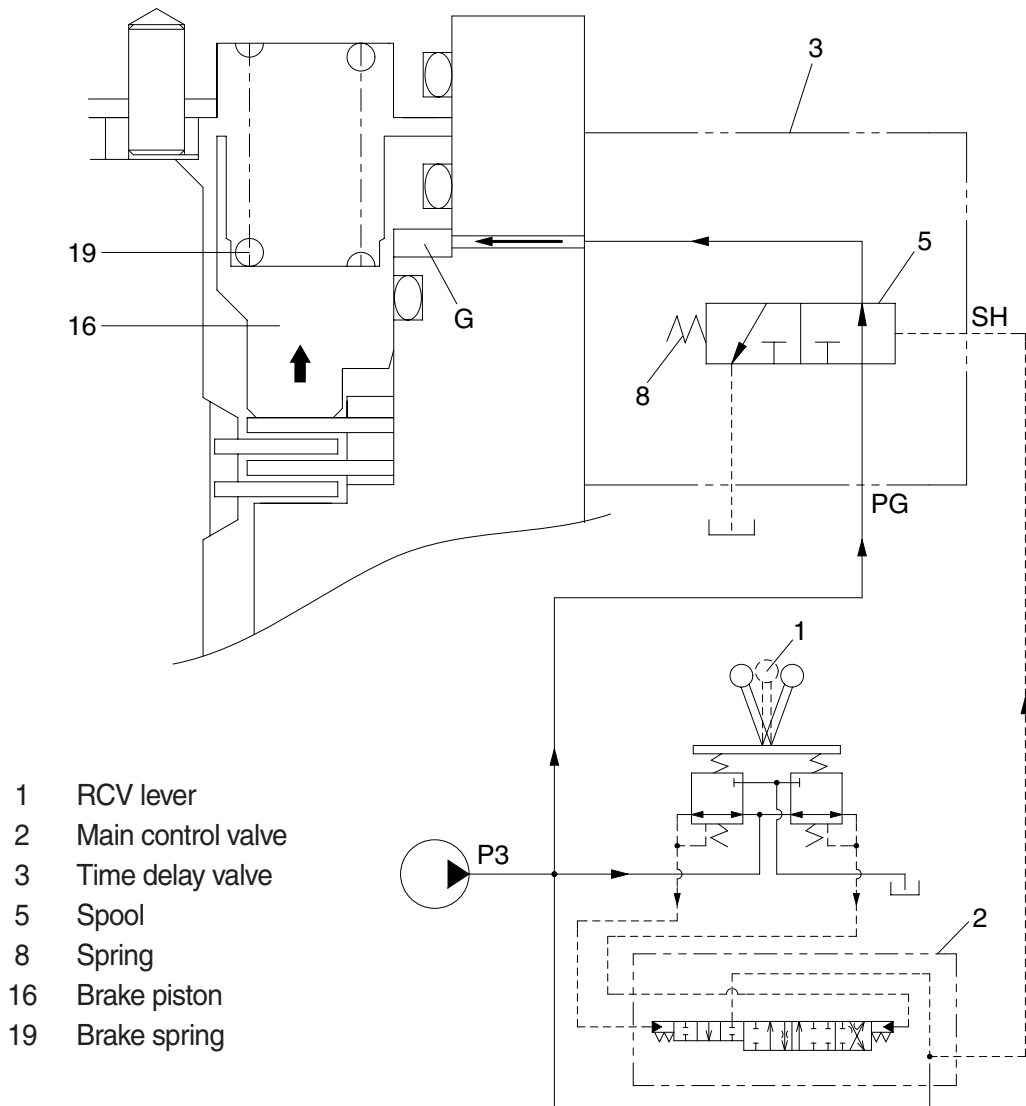


14W92SM15

1	Housing	15	Separate plate
9	Cylinder block	16	Brake piston
14	Friction plate	19	Spring

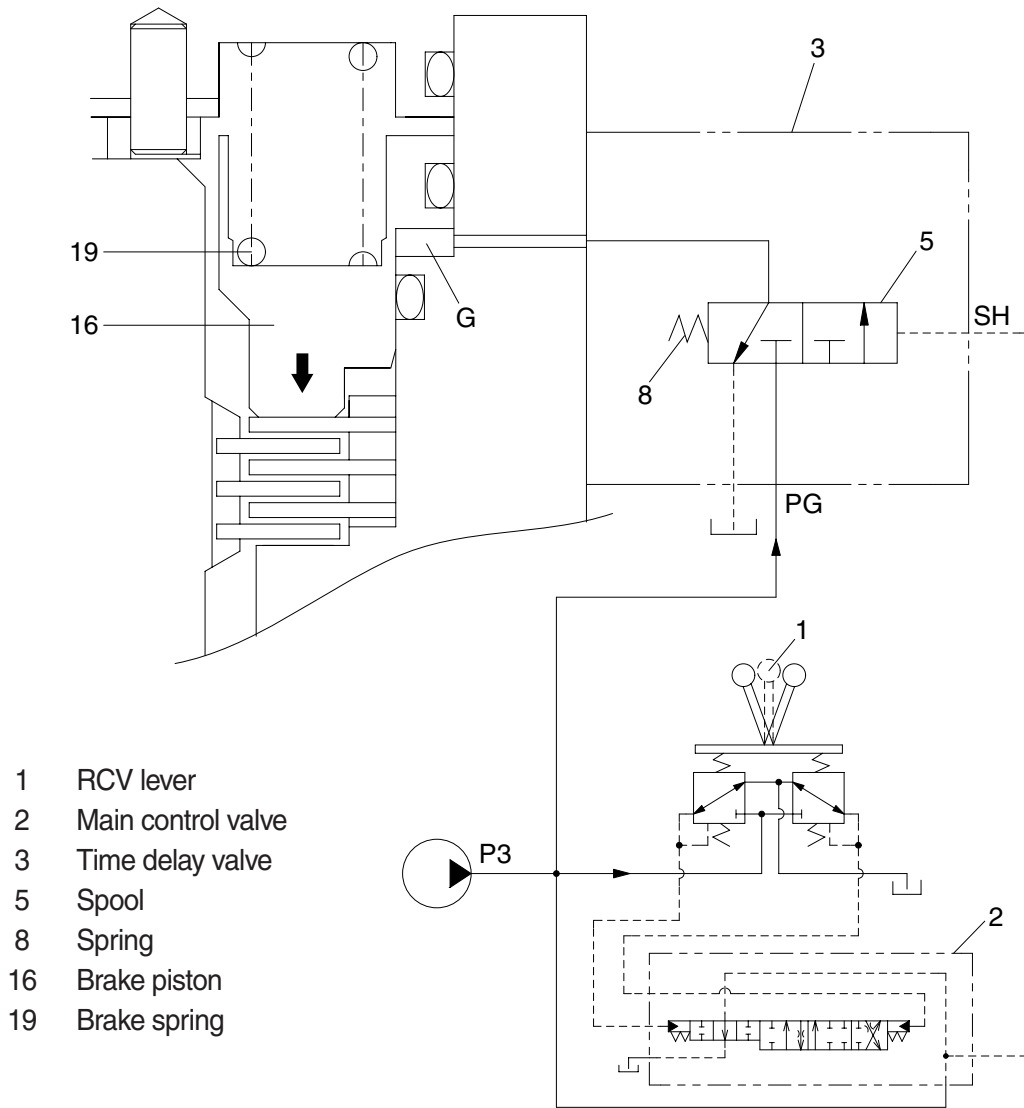
② **Operating principle**

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



14W92SM16

- b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to right. Then, the piston (16) is moved lower by spring force and the return oil from the chamber G flows back to tank port. At this time, the brake works.



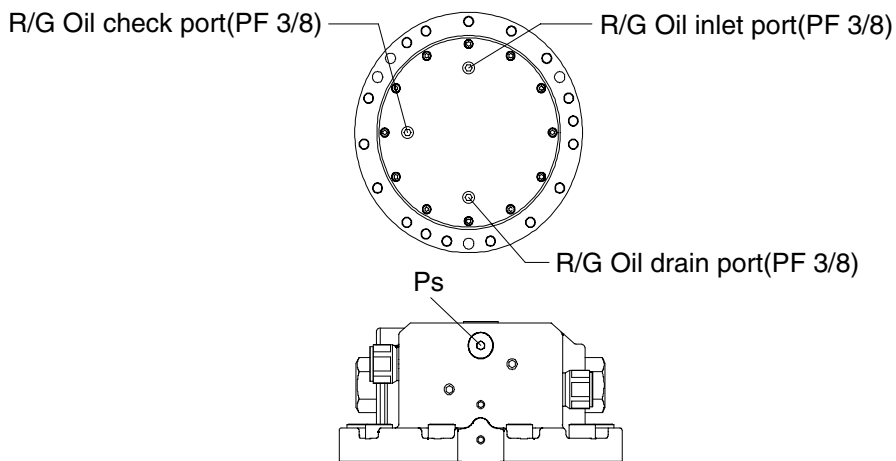
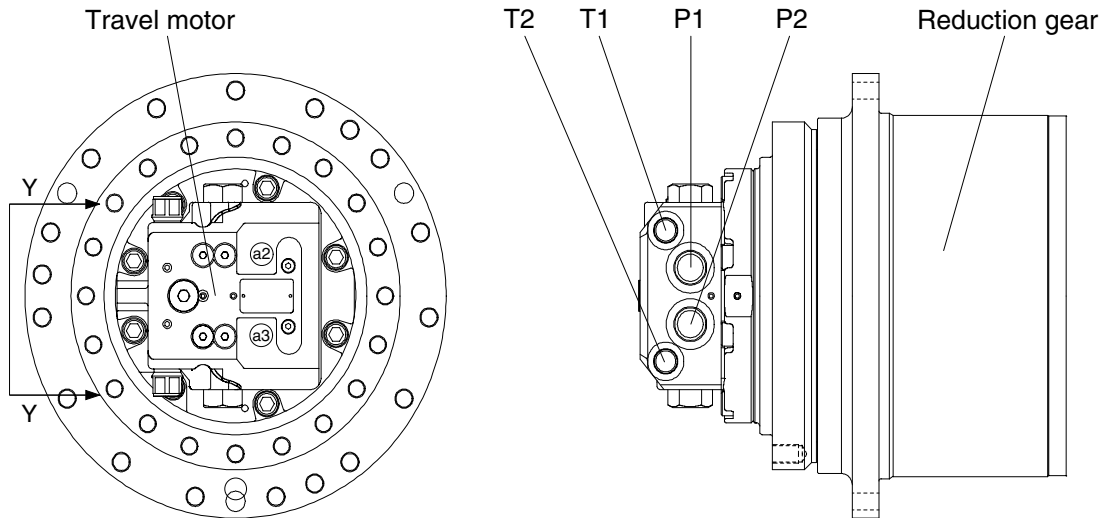
14W92SM17

GROUP 4 TRAVEL DEVICE (TYPE1)

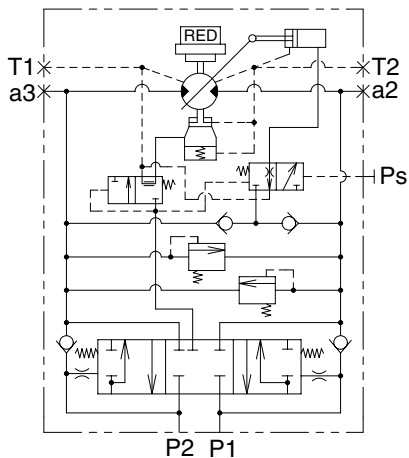
1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



VIEW Y

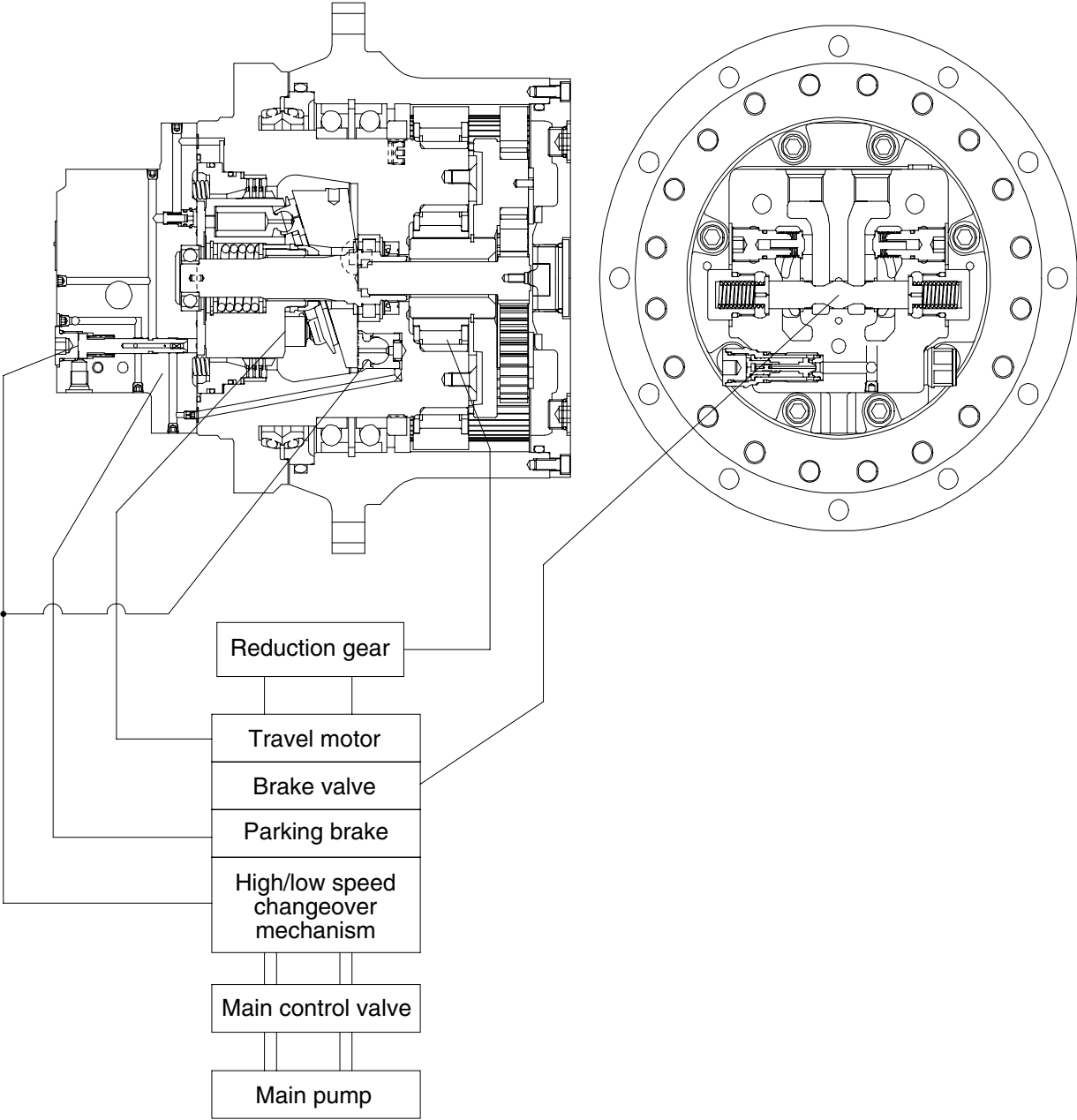


Hydraulic circuit

14092TM01A

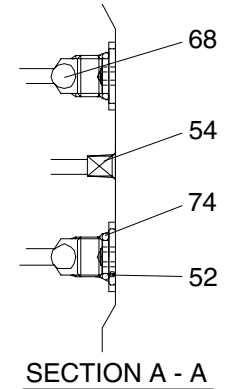
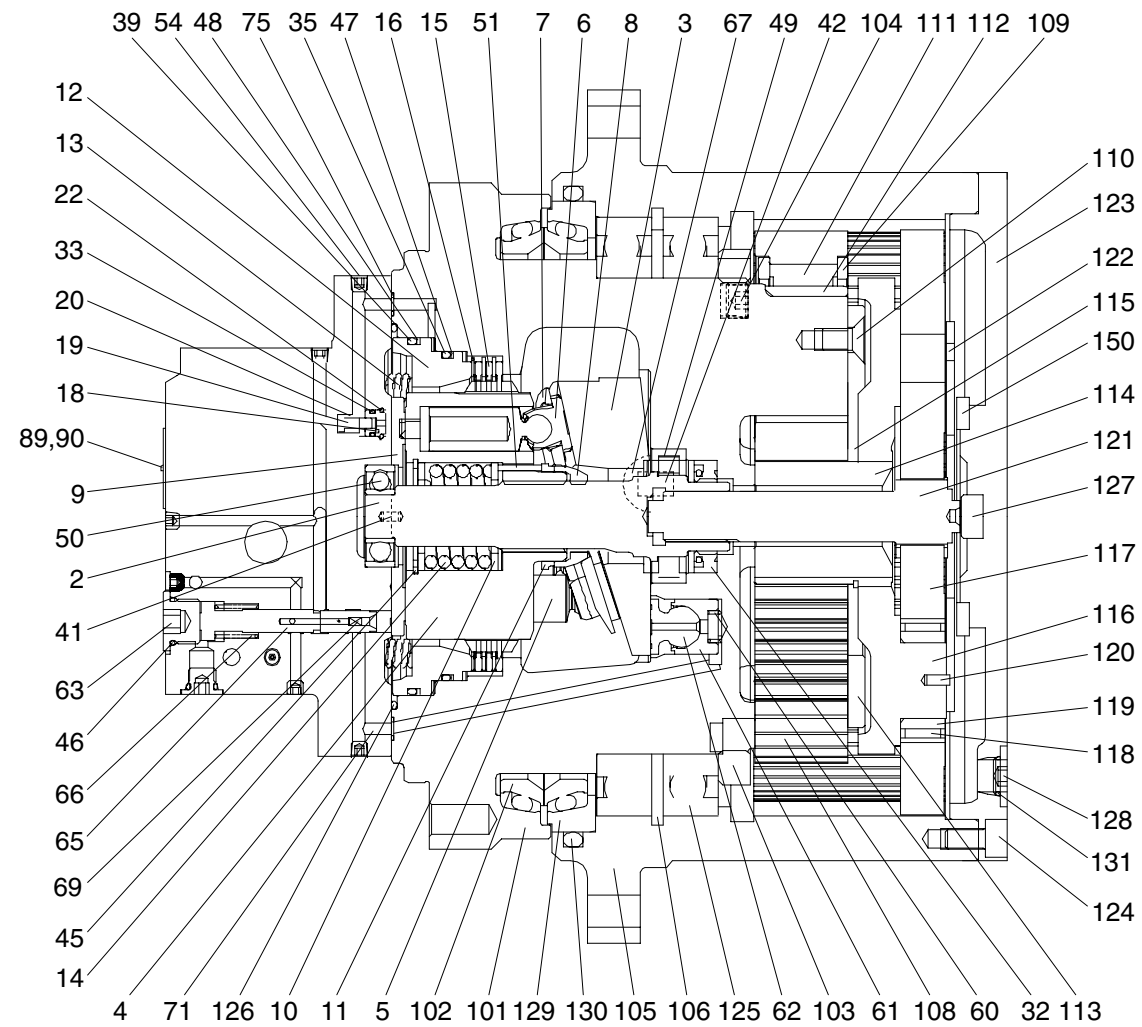
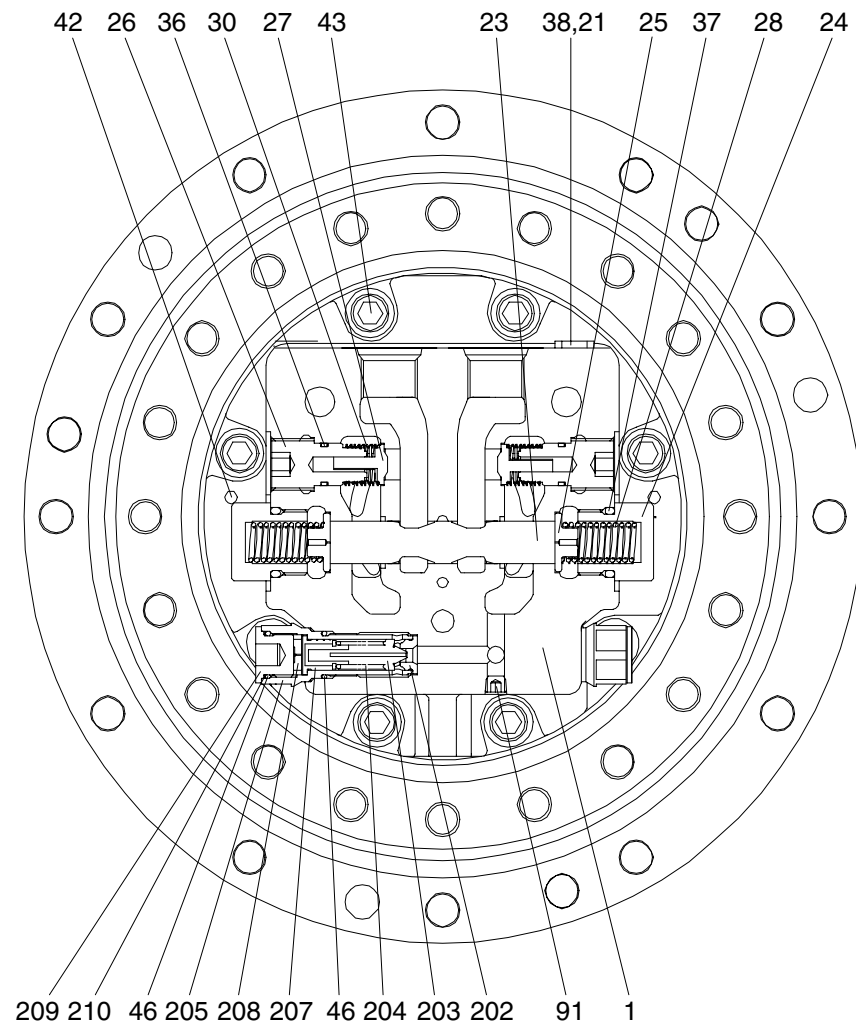
Port	Port name	Port size
P1	Main port	PF 3/4
P2	Main port	PF 3/4
a2, a3	Gauge port	PF 1/4
T1, T2	Drain port	PF 1/2
Ps	Parking brake release port	PF 1/4

1) BASIC STRUCTURE



14092TM02

2) STRUCTURE



- | | | | | | | | | | | | |
|----|----------------|----|-----------------|----|----------------|-----|----------------|-----|----------------|-----|-----------------|
| 1 | Rear flange | 19 | Valve | 39 | O-ring | 65 | 2 Speed spool | 108 | Planetary gear | 125 | Angular bearing |
| 2 | Shaft | 20 | Spring | 41 | Parallel pin | 66 | 2 Speed spring | 109 | Thrust washer | 126 | O-ring |
| 3 | Swash plate | 21 | Plug | 42 | Parallel pin | 67 | Pivot | 110 | Screw | 127 | Thrust washer |
| 4 | Cylinder block | 22 | Ring | 43 | Socket bolt | 68 | Steel ball | 111 | Needle bearing | 128 | Plug |
| 5 | Piston | 23 | Main spool | 45 | Snap ring | 69 | Set screw | 112 | Collar | 129 | Seal ring |
| 6 | Shoe | 24 | Main plug | 46 | O-ring | 71 | Orifice | 113 | Thrust plate | 130 | O-ring |
| 7 | Retainer plate | 25 | Retainer spring | 47 | Back up-ring | 74 | O-ring | 114 | Sun gear | 131 | O-ring |
| 8 | Thrust ball | 26 | Check plug | 48 | Back up-ring | 75 | O-ring | 115 | Snap ring | 150 | Thrust plate |
| 9 | Timing plate | 27 | Check valve | 49 | Roller bearing | 89 | Name plate | 116 | Holder | 205 | Body |
| 10 | Washer | 28 | Main spring | 50 | Ball bearing | 90 | Set screw | 117 | Planetary gear | 206 | Shim |
| 11 | Washer-collar | 30 | Check spring | 51 | Roller | 91 | Plug | 118 | Needle bearing | 207 | Piston |
| 12 | Piston-parking | 32 | Oil seal | 52 | Plug | 101 | Spindle | 119 | Inner race | 208 | Rod |
| 13 | Spring | 33 | O-ring | 54 | Plug | 102 | Floating seal | 120 | Spring pin | 209 | Plug |
| 14 | Spring | 35 | O-ring | 60 | Spring | 103 | Nut ring | 121 | Drive gear | 210 | Back up-ring |
| 15 | Friction plate | 36 | O-ring | 61 | Piston | 104 | Plug | 122 | Thrust plate | | |
| 16 | Mating plate | 37 | O-ring | 62 | Shoe | 105 | Hub | 123 | Cover | | |
| 18 | Seat valve | 38 | O-ring | 63 | Plug | 106 | Snap ring | 124 | Socket bolt | | |

14092TM03

2. HYDRAULIC MOTOR ASSEMBLY

With brake valve, parking brake and high/low speed changeover mechanism.

1) FUNCTION

(1) Hydraulic motor

This hydraulic motor is a swash plate type piston motor and converts the force of pressurized oil delivered from the pump into a rotational movement.

(2) Brake valve

This brake valve is incorporated in the hydraulic motor assembly and has the following four functions.

- ① Smoothly brakes and stops the motor by controlling inertial rotation of the motor due to inertia of the main body.
- ② Check valve function to prevent cavitation of the hydraulic motor.
- ③ Relief valve function to control the brake pressure of hydraulic motor and anti-cavitation valve function to prevent cavitation.
- ④ Opens a port which releases the parking brake force upon running of the motor and closes the upon stopping.

(3) Parking brake

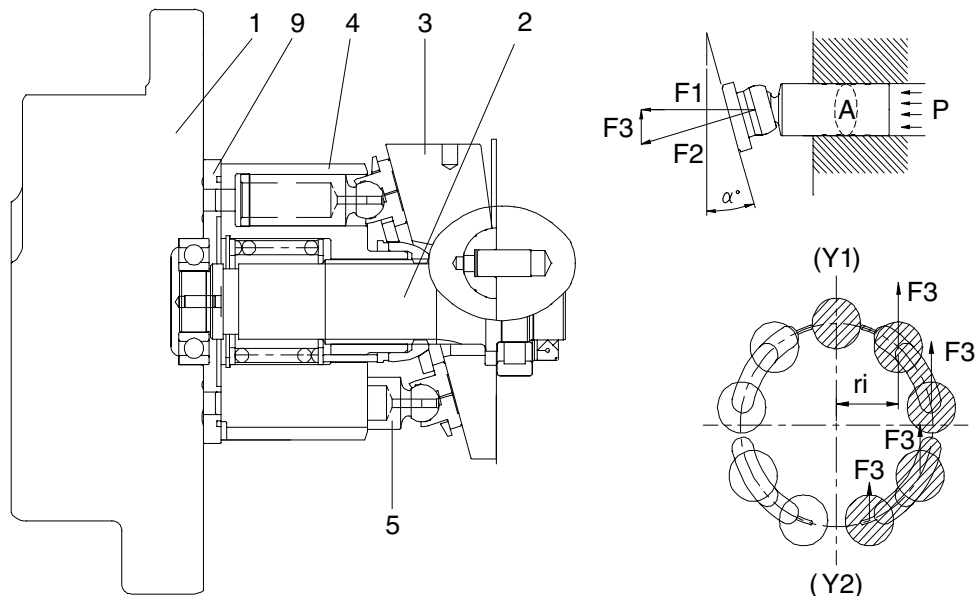
The parking brake prevents overrunning or slippage upon parking or stopping the machine on a slope with friction plate type brake mechanism, and combined with the hydraulic motor assembly into an integral structure.

(4) High/low speed changeover mechanism

This mechanism changes over the tilt angle of swash plate between high-speed/low-torque rotation and low-speed/high-torque rotation with the changeover valve and control piston.

2) OPERATING PRINCIPLE

(1) Hydraulic motor



14092TM05

The pressurized oil delivered from the hydraulic pump flows to rear flange (1) of the motor, passes through the brake valve mechanism and is introduced into cylinder block (4) via timing plate (9). This oil constructively introduced only to one side of (Y1) - (Y2) connecting the upper and lower dead points of stroke of piston (5). The pressurized oil fed to one side in cylinder block (4) pushes each piston (5) (four or five) and generates a force ($F \text{ kgf} = P \text{ kgf/cm}^2 \times A \text{ cm}^2$). This force acts on swash plate (3) and is resolved into components (F2 and F3) because swash plate (3) is fixed at an angle (α°) with the axis of drive shaft (2). Radial component (F3) generates respective torques ($T = F3 \times r_i$) for (Y1) - (Y2). This residual of torque ($T = S (F3 \times r_i)$) rotates cylinder block (4) via piston (5). Cylinder block (4) is spline coupled with drive shaft (2). So the drive shaft (2) rotates and the torque is transmitted.

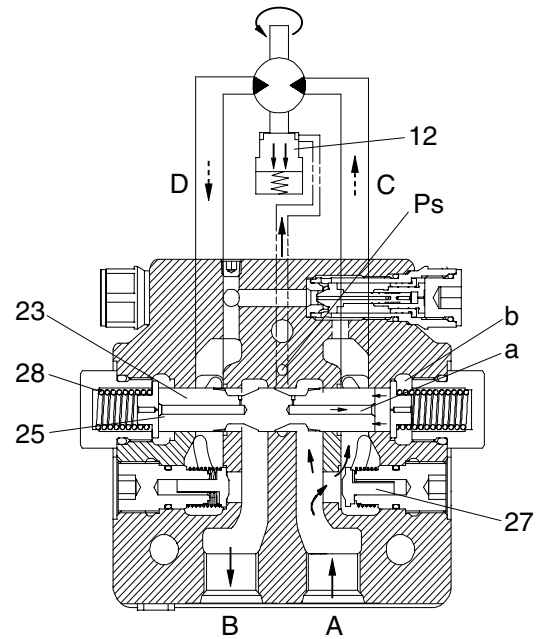
(2) Brake valve

① Brake released

When the pressurized oil supplied from port (A), the oil opens valve (27) and flows into port (C) at the suction side of hydraulic motor to rotate motor.

At the same time, the pressurized oil passes through pipe line (a) from a small hole in spool (23) and flow into chamber (b). The oil acts on the end face of spool (23) which is put in neutral position by the force of spring (28), thus causing spool (23) to slide to the left. When spool (23) slides, port (D) on the passage return side of hydraulic motor, which is closed by the spool groove during stoppage, communicates with port (B) at the tank side and the return oil from the hydraulic motor runs into the tank. In consequence, the hydraulic motor rotates.

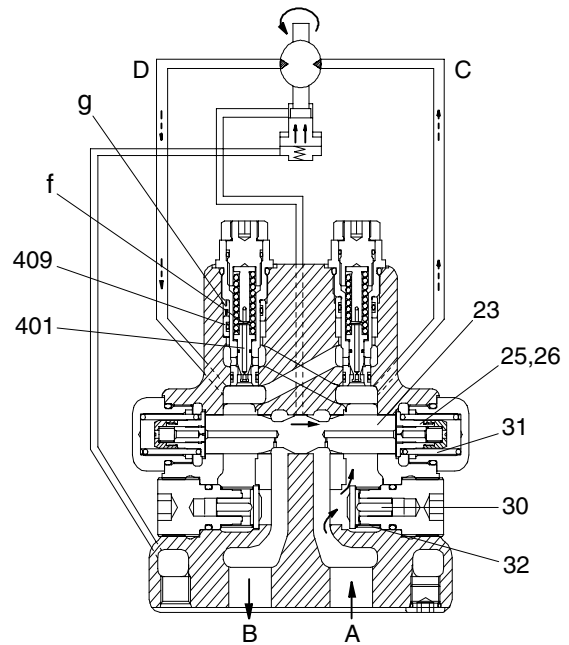
Moreover, sliding of spool (23) causes the pressurized oil to flow into ports (P) and (S). The pressurized oil admitted into port (P) activates piston (12) of the parking brake to release the parking brake force. (For details, refer to description of the parking brake.) When the pressurized oil is supplied from port (B), spool (23) and valve (27) move reversely and the hydraulic motor also rotates reversely.



14092TM06

② Stopping and stalling (brake applied)

When the pressurized oil supplied from port (A) is stopped during traveling, no hydraulic pressure is applied and spool (23) which has slid to the left will return on the right (neutral) via stopper (25, 26) by the force of spring (31). At the same time, the hydraulic motor will rotate by the inertia even if the pressurized oil stopped, so the port (D) of the motor will become high pressure. This pressurized oil goes from chamber (f) to chamber (g) through the left-hand valve (401). When the oil enters chamber (g), the piston (409) slides to the right so as not to rise the pressure, as shown in the figure. Meanwhile, the left-hand valve (401) is pushed open by the pressurized oil in port (D). Therefore, the pressurized oil in port (D) flows to port (C) at a relatively low pressure, controlling the pressure in port (D) and preventing cavitation in port (C). When the piston (409) reaches the stroke end, the pressure in chamber (g) and (f) increase and the left-hand valve (401) closes again, allowing the oil pressure in port (D) to increase further. Then, the right-hand valve opens port (C) with pressure higher than that machine relief set pressure. In this way, by controlling the pressure in port (D) in two steps, the hydraulic motor is smoothly braked and to a stop.

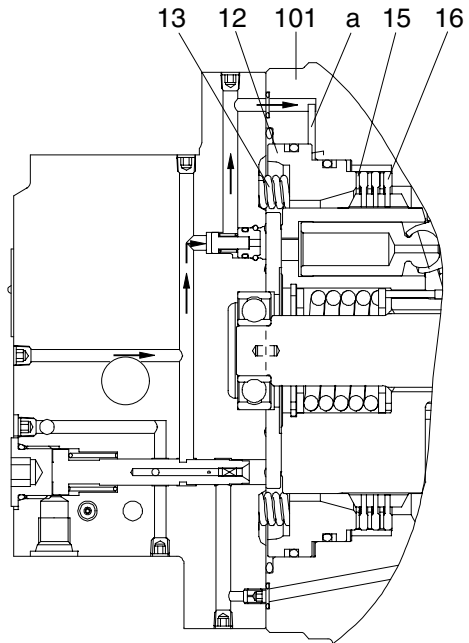


25092TM07

(3) Parking brake

① Running

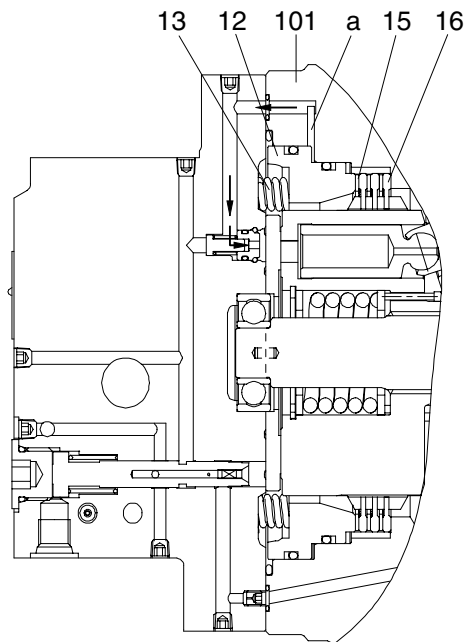
When the pressurized oil is supplied from the valve, the spool of brake valve in the hydraulic motor assembly actuates to open the passage to the parking brake and the pressurized oil is introduced into cylinder chamber (a) which is composed of the spindle of reduction gear assembly and piston (12). When the hydraulic pressure reaches 9.5 kgf/cm^2 or more, it overcomes the force of spring (13) and shifts piston (12). With shift of piston (12), no pressing force is applied to mating plate (16) and friction plate (15) and movement of friction plate (15) becomes free. Whereby the brake force to the cylinder in the hydraulic motor assembly is released.



14092TM08

② Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber (a) drops 9.5 kgf/cm^2 or less, piston (12) will return by the force of spring (13). Piston (12) is pushed by this force of spring (13), and mating plate (16) and friction plate (15) in free condition are pressed against the spindle of reduction gear assembly. The friction force produced by this pressing stops rotation of the cylinder and gives a braking torque $19.7 \text{ kgf} \cdot \text{m}$ to the hydraulic motor shaft. Note that oil control through a proper oil passage ensures smooth operation.

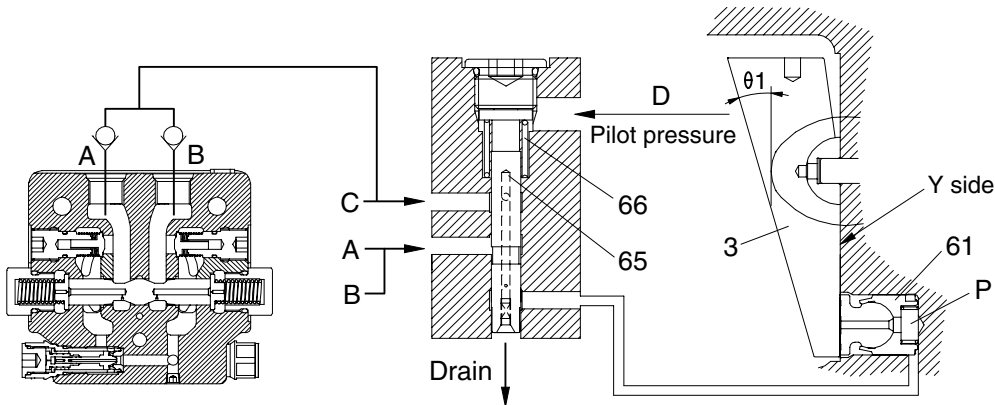


14092TM09

(4) High/low speed changeover mechanism

① At low speed - pilot pressure of less than 10 kgf/cm²

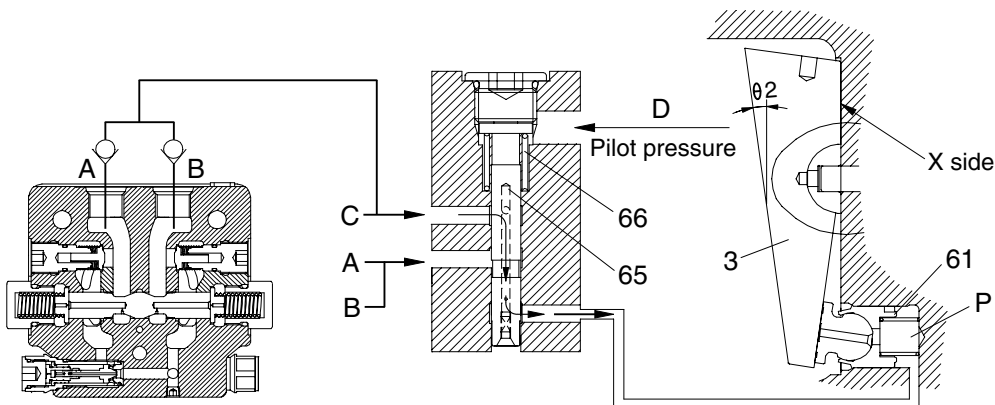
When no pilot pressure is supplied from (D) (at a pressure of 10 kgf/cm² or less), valve (65) is pressed toward the top by the force of spring (66) and (A) port or (B) port, the pressurized oil supply port (C) is shut off, and oil in chamber (P) is released into the motor case via valve (65). Consequently, swash plate (3) is tilted at a maximum angle ($\theta 1$) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed rotation.



14092TM10

② At high speed - pilot pressure of 10 kgf/cm² or more

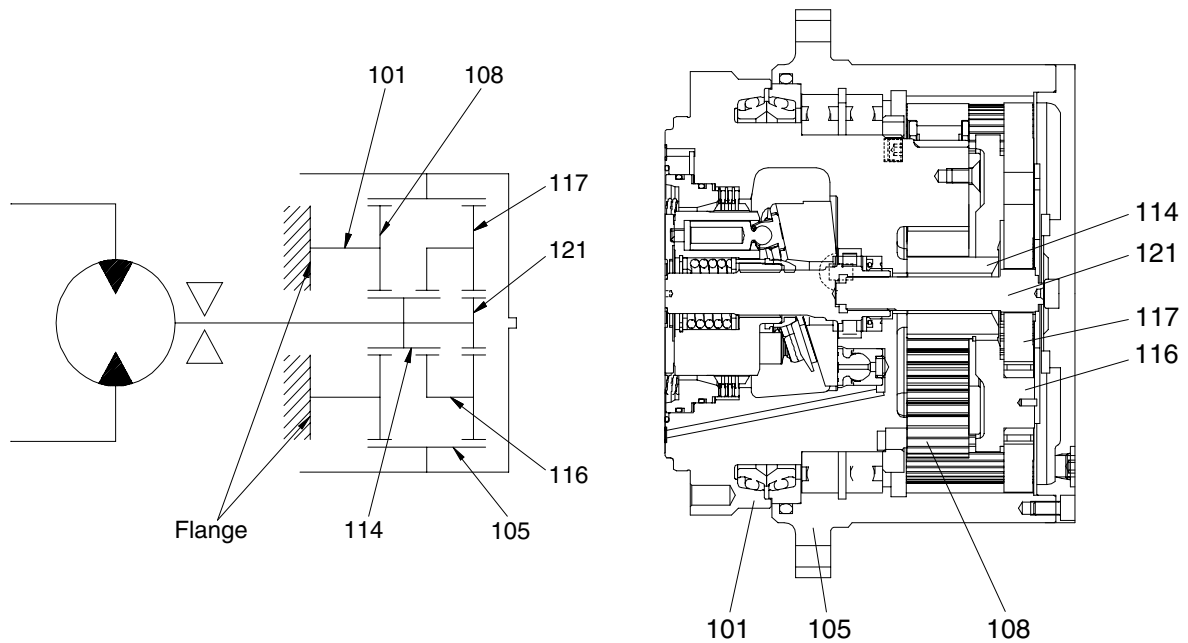
When a pilot pressure is supplied from port (D) (at a pressure of 20 kgf/cm² or more), the pressure overcomes the force of spring (66) and (A) port or (B) port of valve (65) is pressed toward the down. The pressurized oil at supply port (C) is then introduced into chamber (P) via valve (65). Piston (61) pushes up swash plate (3) until it touches side X of the spindle. At this time, swash plate (3) is tilted at a minimum angle ($\theta 2$) and the piston displacement of hydraulic motor becomes minimum, thus leading to high-speed rotation.



14092TM11

3. REDUCTION GEAR

1) The reduction gear is composed of a two-stage planetary gear mechanism shown in the following figure.



2) The rotating motion of the hydraulic motor is transmitted to drive gear (121) of 1st stage, and the drive gear rotate planetary gears (R, 117). Then planetary gears (R, 117) revolves inside fixed hub (105). This rotation becomes the output of 1st stage and is transmitted to carrier No.1 and sun gear (114). Similarly the revolution of planetary gears (F, 108) are transmitted to spindle (101). Then planetary gears (F, 108) do not revolve, but rotate to hub (105). Therefore, the rotating case is driven by the overall driving torque of hub (105).

This reduction ratio is expressed as shown below :

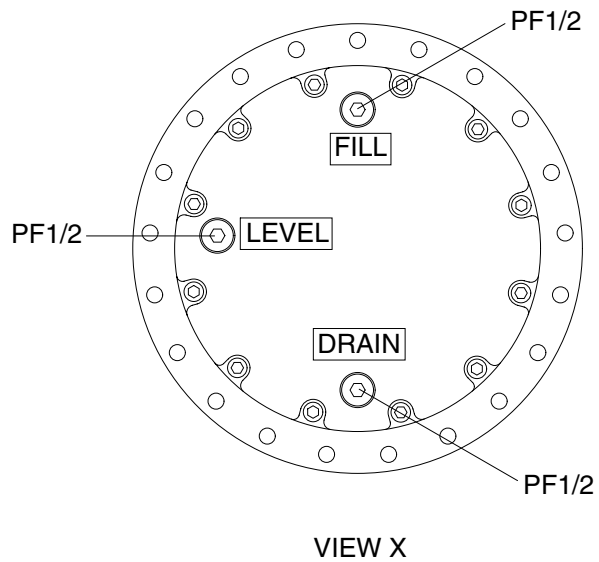
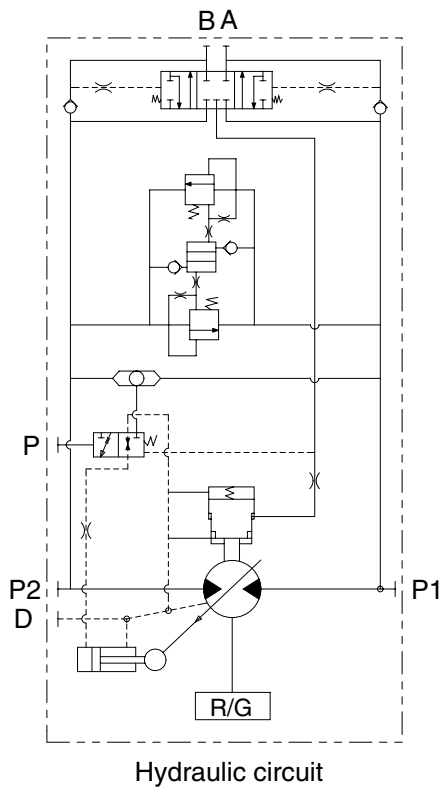
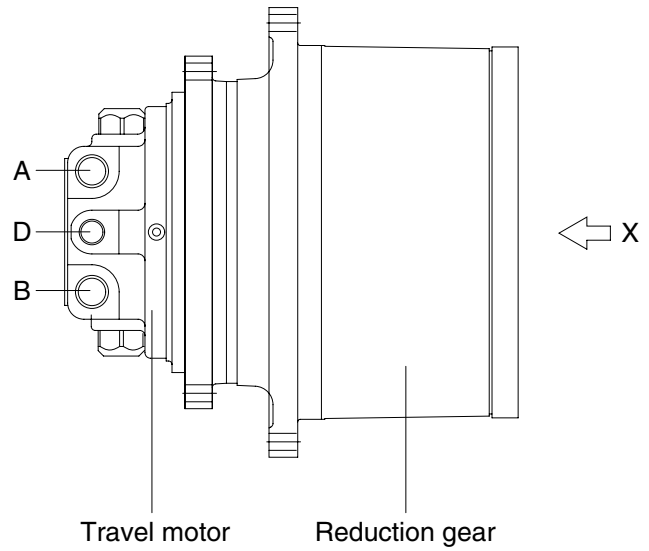
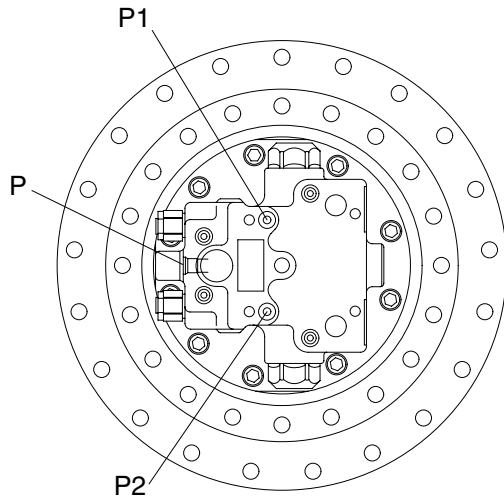
$$\cdot \text{Reduction ratio (I)} = (\text{Hub teeth} / \text{Drive gear teeth} + 1) \times (\text{Hub teeth} / \text{Sun gear teeth} + 1) - 1$$

■ TRAVEL MOTOR (TYPE 2)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

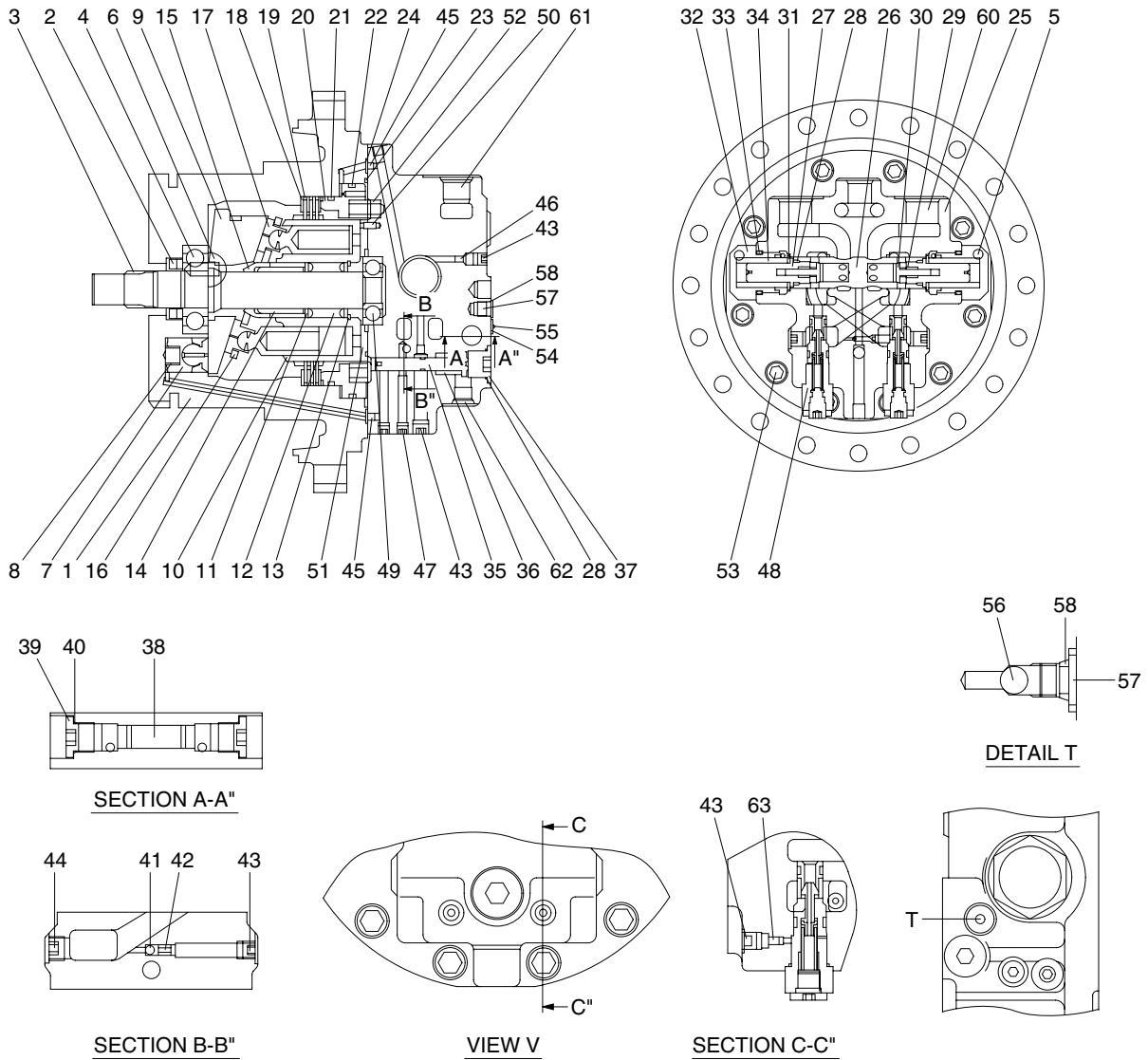
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.



145Z9A2TM01

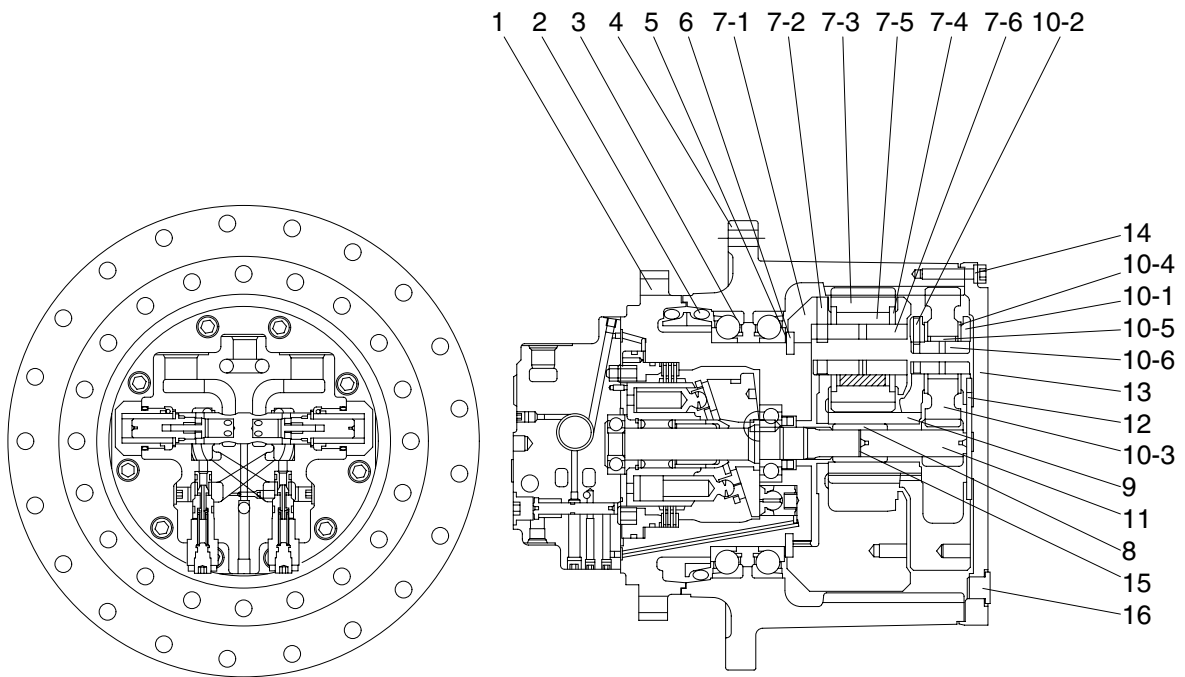
Port	Port name	Port size
A, B	Main port	PF 3/4
P	Two speed control port	PF 1/4
D	Drain port	PF 1/2
P1, P2	Gage port	PF 1/8

1) STRUCTURE



145Z9A2TM02

1	Shaft casing	17	Piston assy	33	O-ring	49	Bearing
2	Oil seal	18	Steel plate	34	Spring	50	Pin
3	Shaft	19	Friction plate	35	Spool	51	Valve plate
4	Bearing	20	Brake piston	36	Spring	52	Spring
5	Pin	21	Ring	37	Plug	53	Wrench bolt
6	Swash ball	22	Ring	38	Piston	54	Name plate
7	Swash piston	23	O-ring	39	Plug	55	Rivet
8	Spring	24	O-ring	40	O-ring	56	Steel ball
9	Swash plate	25	Valve casing	41	Steel ball	57	Plug
10	Cylinder block	26	Main spool	42	Orifice	58	O-ring
11	Spring seat	27	Plug	43	Plug	60	Plastic plug
12	Spring	28	O-ring	44	Plug	61	Plastic plug
13	Snap ring	29	Spring	45	Orifice	62	Plastic plug
14	Pin	30	Check	46	Orifice	63	Orifice
15	Ball guide	31	Plate	47	Plug		
16	Set plate	32	Plug	48	Relief valve assy		



145Z9A2TM02A

- | | | |
|----------------------|-----------------------|----------------|
| 1 Spindle | 7-4 Washer 2 | 10-5 Bearing 1 |
| 2 Floating sesal | 7-5 Bearing 2 | 10-6 Pin 1 |
| 3 Ball bearing | 7-6 Pin 2 | 11 Sun gear 1 |
| 4 Housing | 8 Coupling | 12 Plate 1 |
| 5 Shim | 9 Sun gear 2 | 13 Cover |
| 6 Shim | 10 Carrier assy 1 | 14 Bolt |
| 7 Carrier assy 2 | 10-1 Carrier 1 | 15 Snap ring |
| 7-1 Carrier 2 | 10-2 Spring pin 1 | 16 Plug |
| 7-2 Spring pin 2 | 10-3 Planetary gear 1 | |
| 7-3 Planetary gear 2 | 10-4 Washer 1 | |

3. PRINCIPLE OF DRIVING

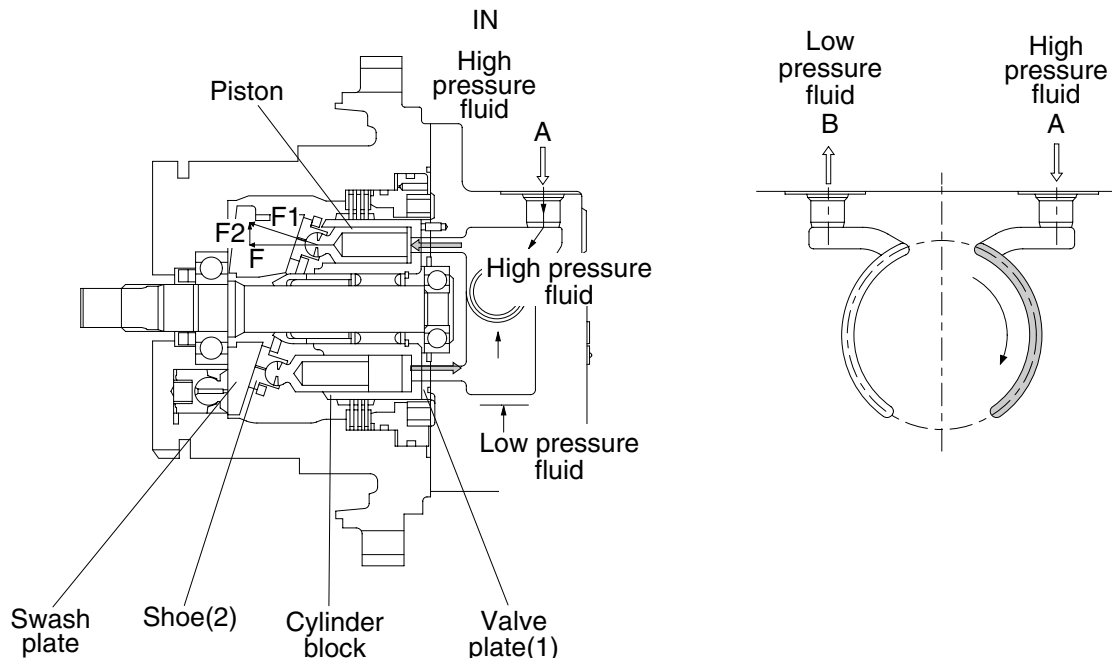
Travel motor comprises with rotary, relief valve, parking brake, counterbalance valve and 2-speed control.

1) WORKING OF ROTARY PART

In the figure below, axis directional force F_1 occurs when the high pressure oil flows into the cylinder block through to the valve plate (1) port, and the piston moves to the left hand side.

This force F_1 , which takes shoe (3) as a medium, split into axial force F which is parallel with a shaft, and radial force F_2 which is perpendicular to the shaft. By the reaction force F_2 , cylinder block rotate with piston and shoe, while shoe (2) moves on the shoe plate with piston.

There are 9 pistons inserted into the cylinder block and they rotate with the cylinder block by taking high pressure oil in order at the entrance. When the oil flow is reversed, piston and cylinder block rotate in the opposite direction.



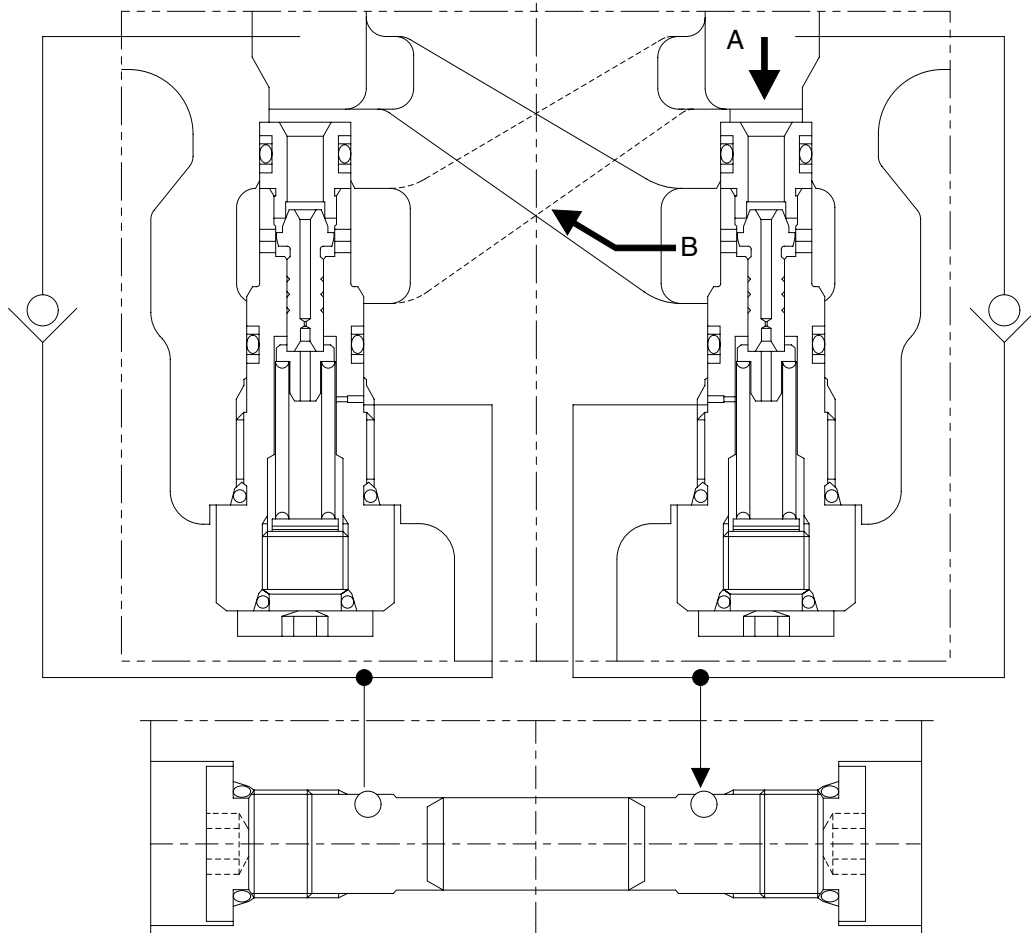
145Z9A2TM03

2) WORKING OF RELIEF VALVE

When the control valve spool is returned to neutral, the circuit between control valve and motor is blocked, and traveling movement stops.

However, motor continues rotating because of the traveling inertia of the excavator's heavy weight. Then the motor will act as a pump, and oil blocked between control valve and motor will be pressured sharply and the increased oil pressure will damage internal parts.

To prevent this damage, relief valve discharge the high pressure oil from A to B which has lower pressure.



145Z9A2TM04

- Setting pressure : 350 kgf/cm²
- Back pressure : 5 kgf/cm²
- Cracking pressure : 315 kgf/cm² over

- AT THE BEGINNING OF TRAVELING

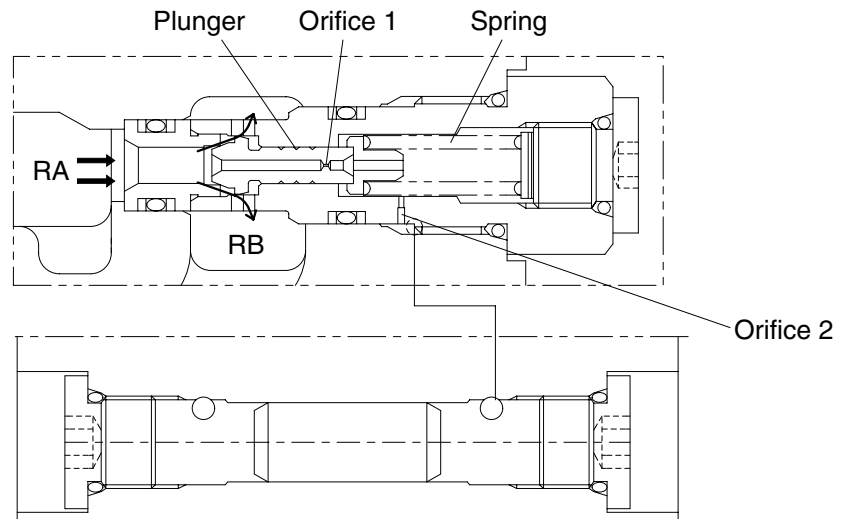
RELIEF VALVE A

When travel control lever moves, high pressure oil works to rise the pressure of RA port up. This pressurized oil press plunger to the right, and then sustain the power of the spring, the plunger moves to the right and release the pressure oil of RA port to RB port (Stage 1)

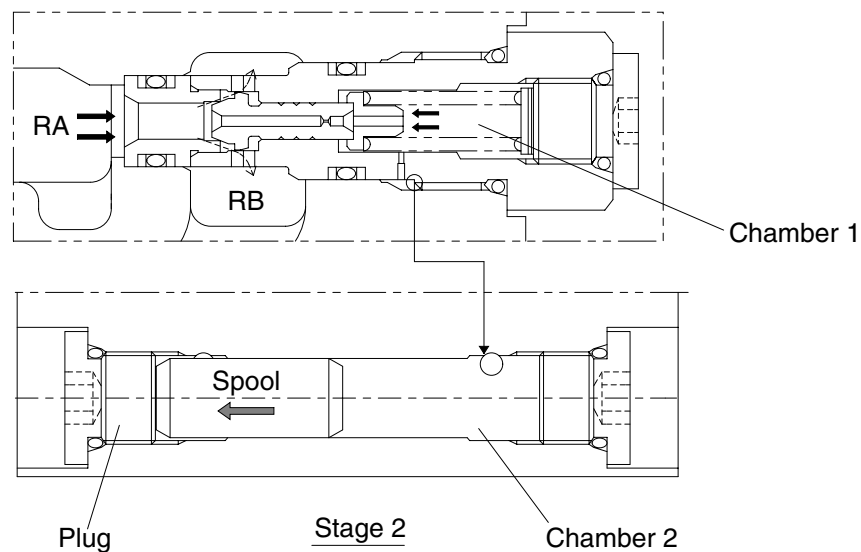
The plunger moves slowly by the pressure oil which flows into chamber 1 through orifice 1. The pressure oil flowed into chamber 1 flows into chamber 2 through orifice 2, and at this point, the plunger moves to the left again, when the spring is compressed by the flowed pressure oil which press the spool to the left. (Stage 2)

When the RA port pressure goes up much more and the set pressure overcome the power of the compressed spring again, the plunger moves to the right and the pressure has of RA port is released to RB port.

Thus, at the early stage of the relief valve operation, it works primarily at lower pressure, after then, shock is reduced during rotating at the set pressure as the secondary operation.



Stage 1



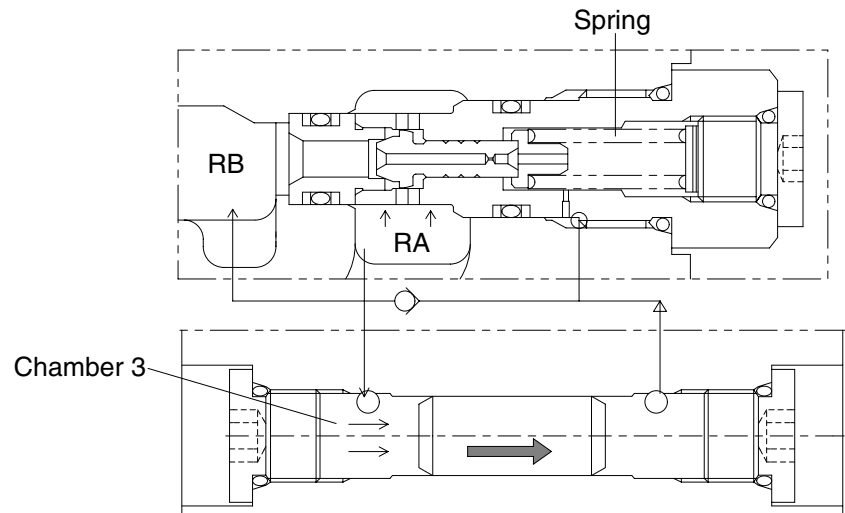
RELIEF VALVE A

145Z9A2TM05

- DURING TRAVELING OPERATION

RELIEF VALVE B

During traveling operation, RA port pressure goes up and RB port pressure goes down. Thus RA port pressure oil flows into chamber 3, and pushes plunger to the left with a high pressure and the power of the spring.



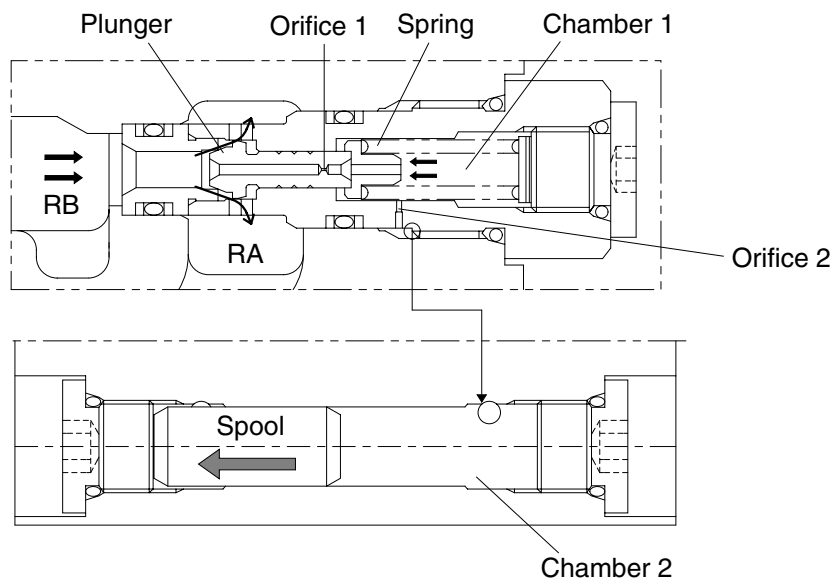
RELIEF VALVE B

145Z9A2TM06

- WHEN IT STOP

RELIEF VALVE B

When it stops or operates reversely, RA port pressure is decreased and RB port pressure suddenly goes up by the inertia of the machine heavy structure. Relief valve B operates as the same order as relief valve A, and maintains the set pressure by releasing the high pressure of RB port to RA port.



RELIEF VALVE B

145Z9A2TM07

3) WORKING OF PARKING BRAKE

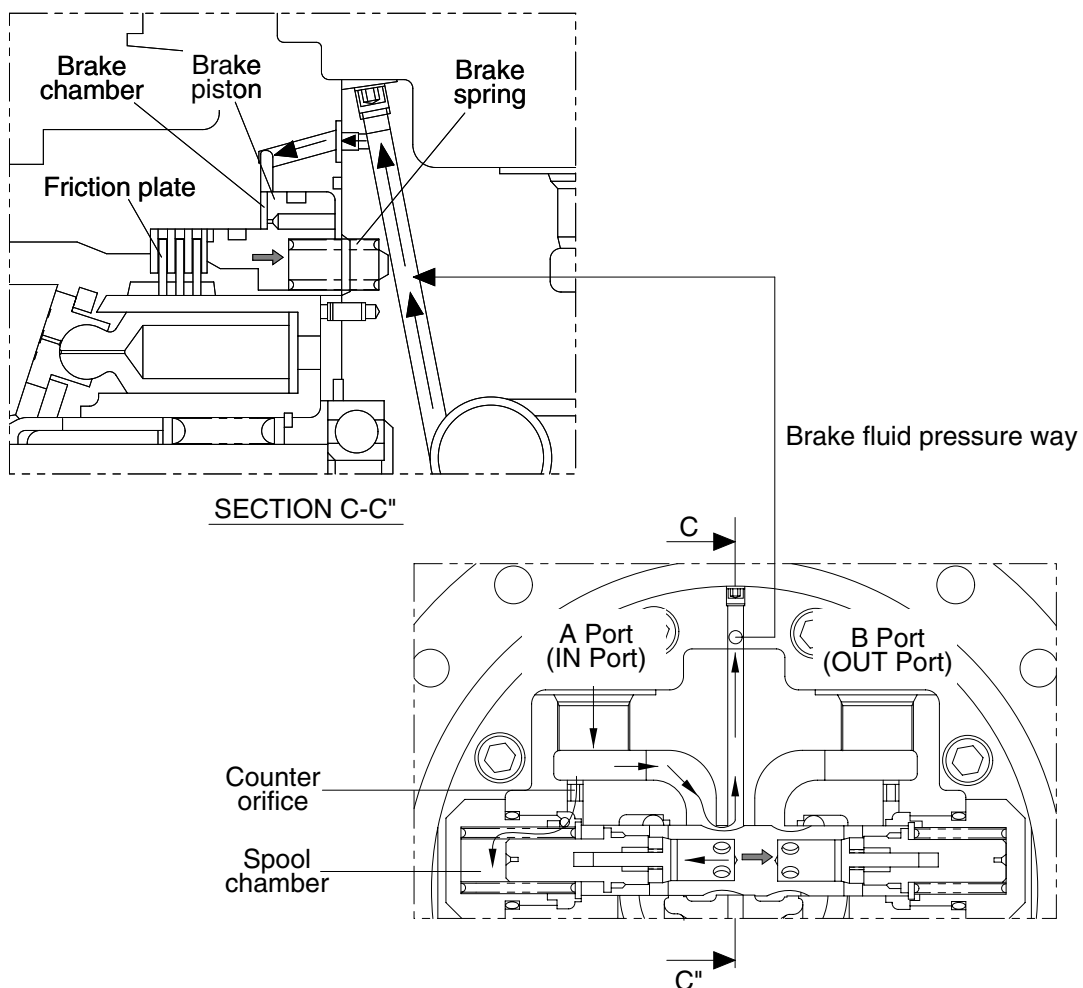
Parking brake system consists of a brake piston, springs, friction plates and separating plates, and some orifices to control responsibility of the brake piston. The brake is usually held with the force of compressed spring, and it is released automatically by traveling oil pressure coming from inlet A, or B when the motor starts to run.

- **Parking brake OFF**

When operator moves the traveling control lever, traveling working pressurized oil into IN PORT flows from spool chamber through counter orifice.

Pressurized oil pushes counter balance spool to right.

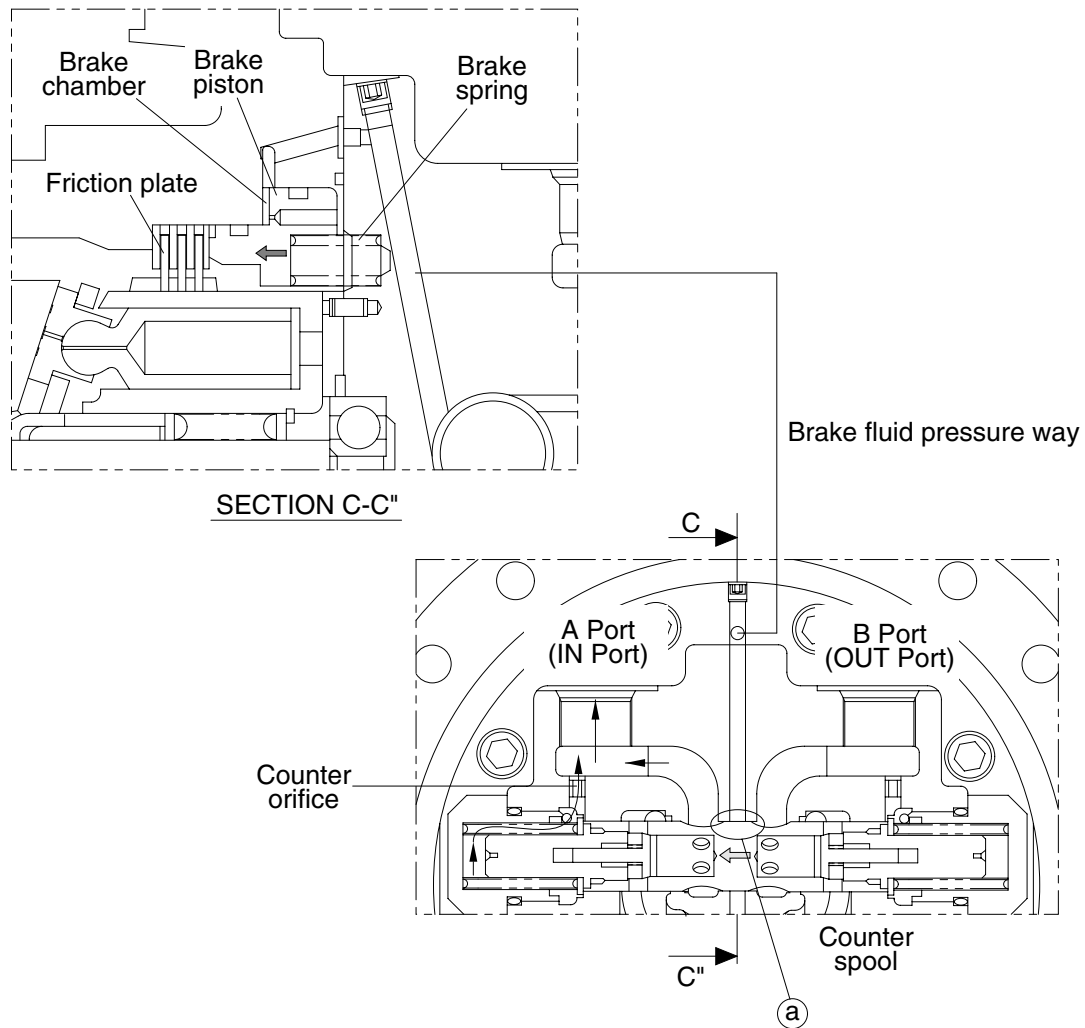
Then notch of spool opens the brake line. At the same time, pressurized oil flows to the brake chamber of motor through a brake passage, and makes brake piston move against brake spring force to allow clearance between friction plates and separate plates thereby releasing the brake.



145Z9A2TM08

- **Parking brake ON**

When the control lever is returned to neutral position, the circuit between control valve and motor is blocked. As oil pressure in spool chamber drops to zero and the counter balance spool returns to neutral position. At the spool neutral position, notch ① is disconnected from oil supply port A, instead, brake chamber oil is drained to tank through brake orifice which is center opened.



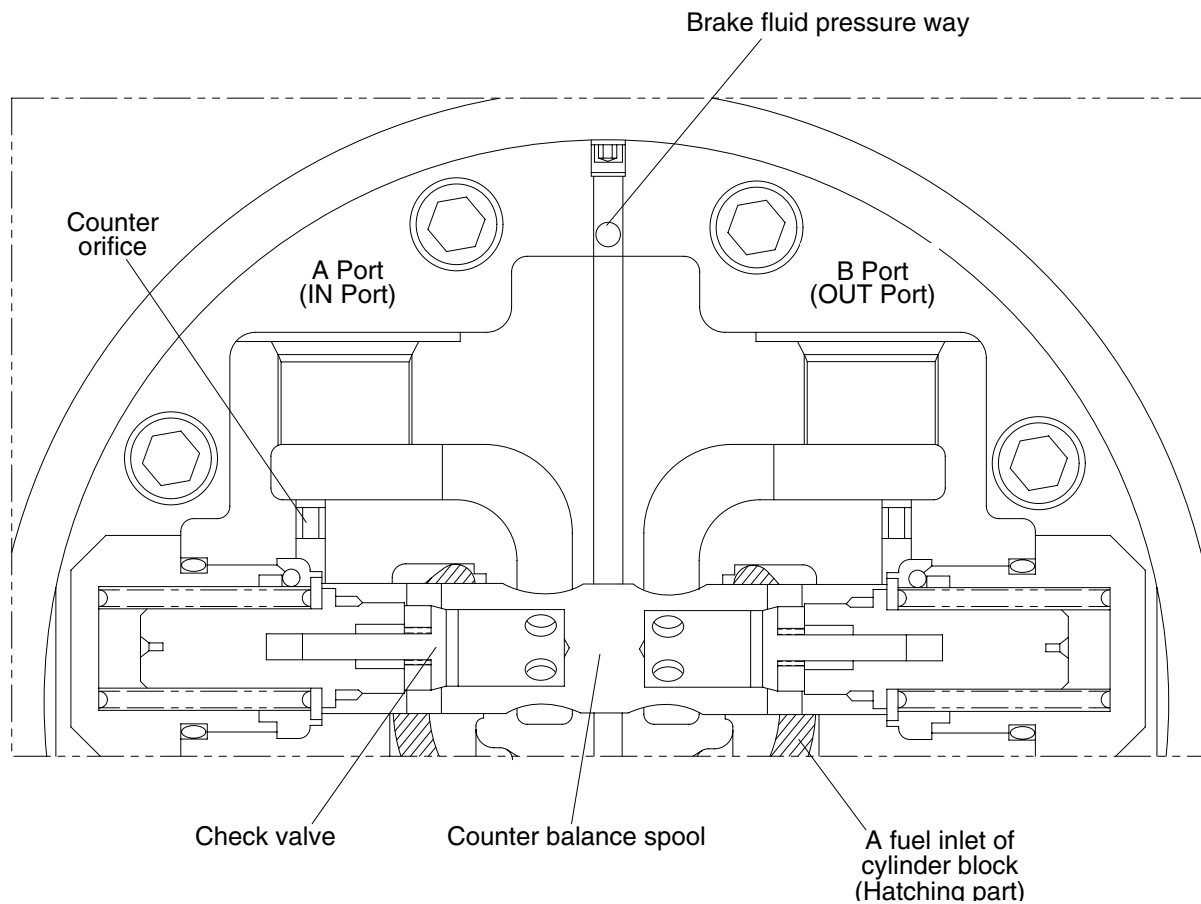
145Z9A2TM09

4) COUNTERBALANCE VALVE

(1) Function

- ① Control oil flow in the action of mechanical parking brake operation.
- ② Prevent overrun while traveling on down slope.
- ③ Work as a hydraulic brake when motor stops, and prevent motor not to slip on slope.

(2) NEUTRAL

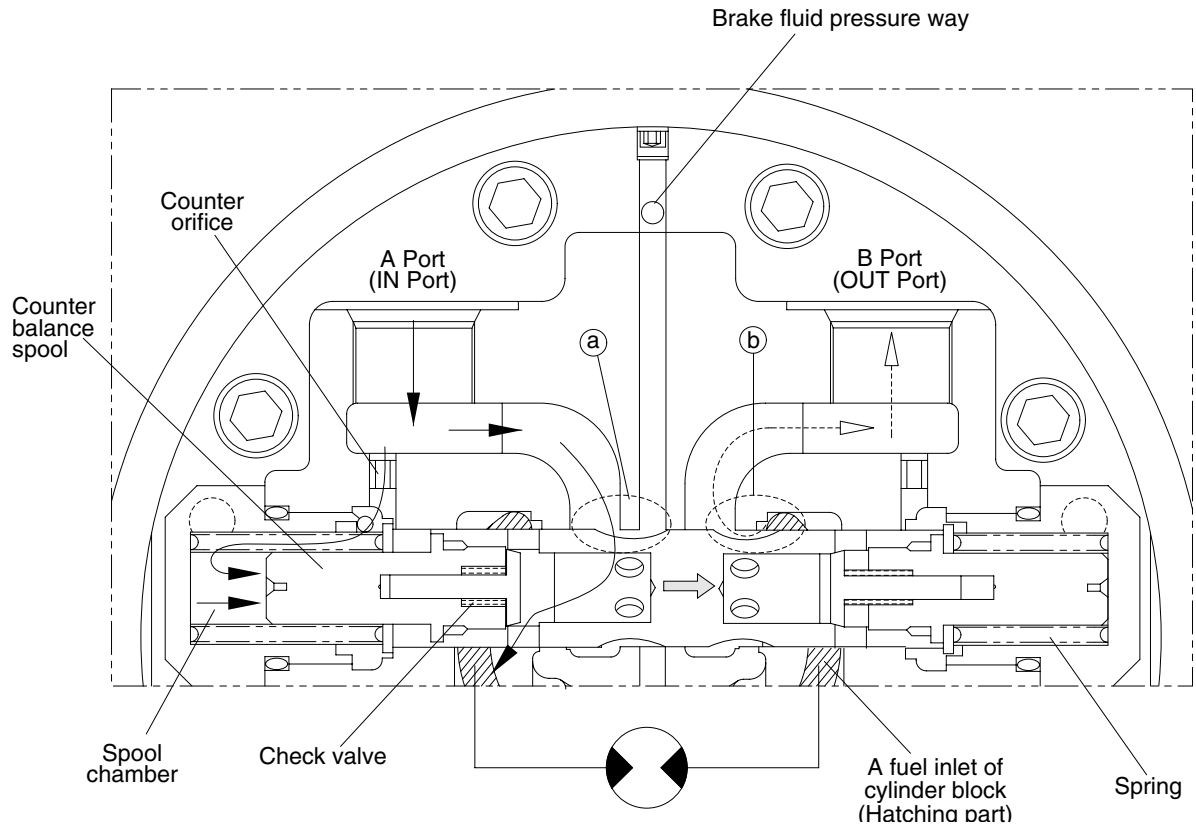


145Z9A2TM10

(3) How to work

① When motor travel

When operator moves a traveling control lever, pressurized oil flows from pump to motor inlet A, and passes into spool chamber through counter orifice, and hydraulic force moves counter balance spool to the right, it makes pump oil flow into cylinder block through check poppet and kidney port. At that time spool notch is opened and pump oil also go through line ㉑ and passes into parking brake chamber, and it releases parking brake. At the same time, return oil from cylinder block flows to outlet B through the line ㉒.

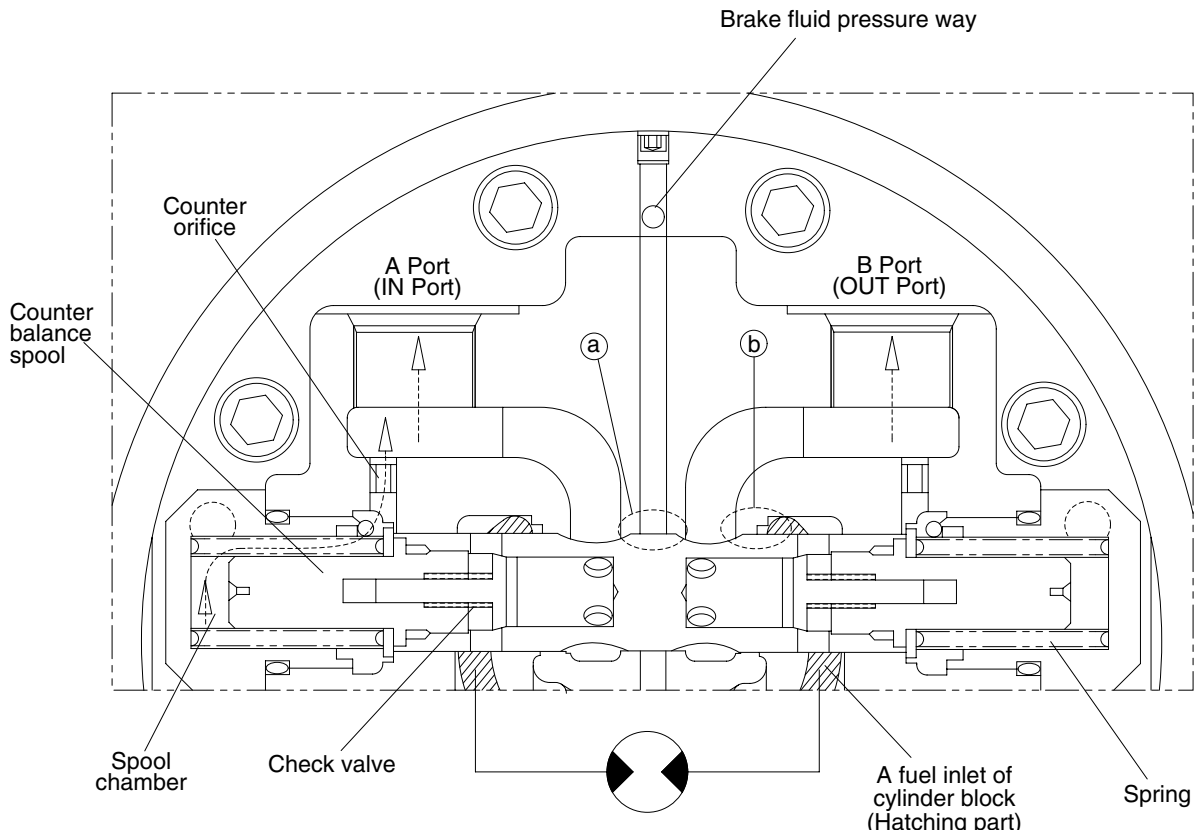


145Z9A2TM11

② **When motor stop**

When operator moves a travel control lever to neutral position, pump oil flow is blocked. It reduce oil pressure of supply line down to zero, and oil in the spool chamber moves back to oil tank through counter orifice by the return force of spring in opposite side, and then counter balance spool returns to neutral position.

As the counter balance spool moves to left, line ① is blocked, parking brake line is connected to drain passage designed in the center of counter balance spool, and oil in the parking brake chamber return to tank, finally brake piston return to parking ON position.



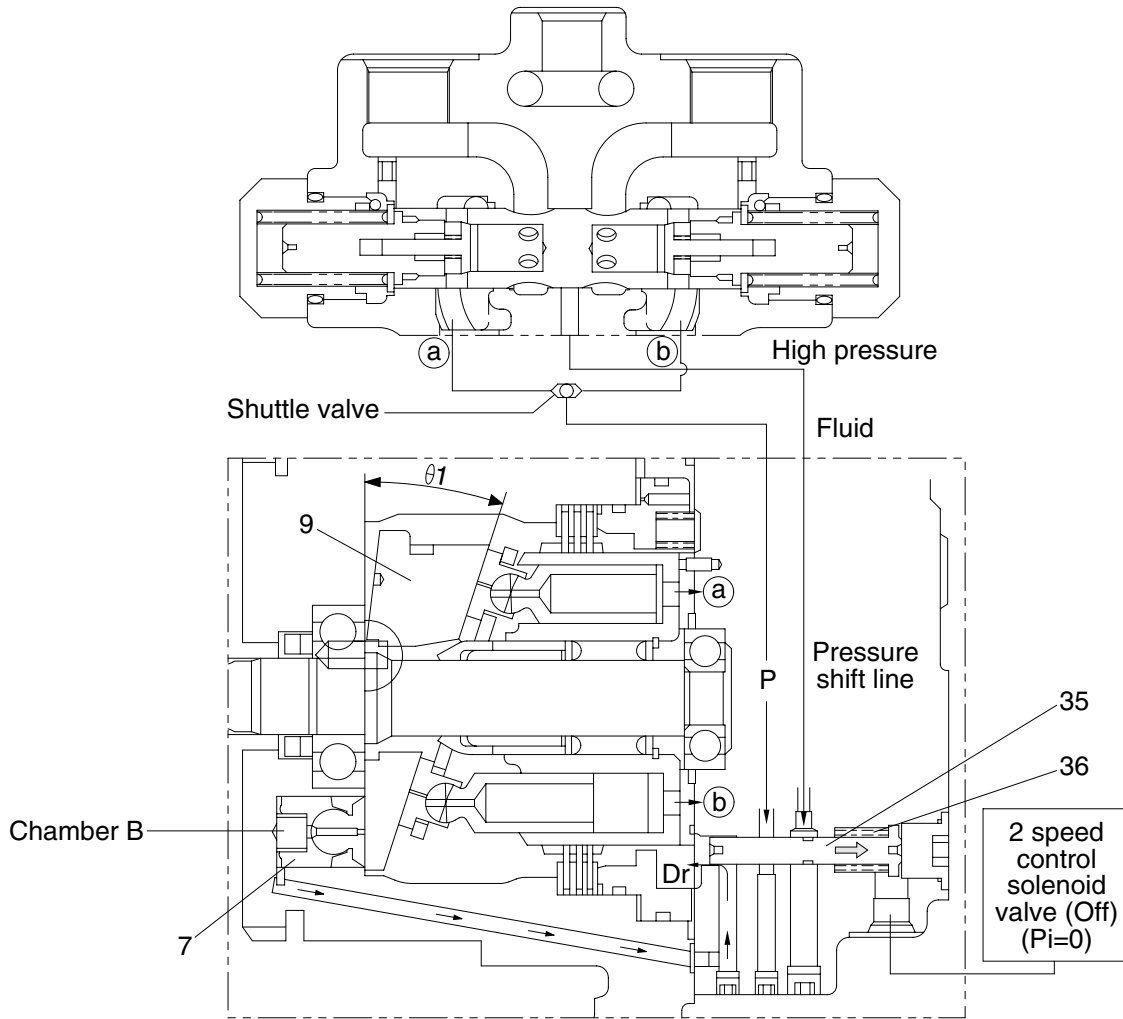
145Z9A2TM12

5) TWO SPEED (LOW SPEED - HIGH SPEED) CHANGEOVER EQUIPMENT

Rotating speed of the motor depends on slope angle of swash plate (9). Motor rotates slow when the angle is large, and rotates fast when the angle is small.

- **Low speed**

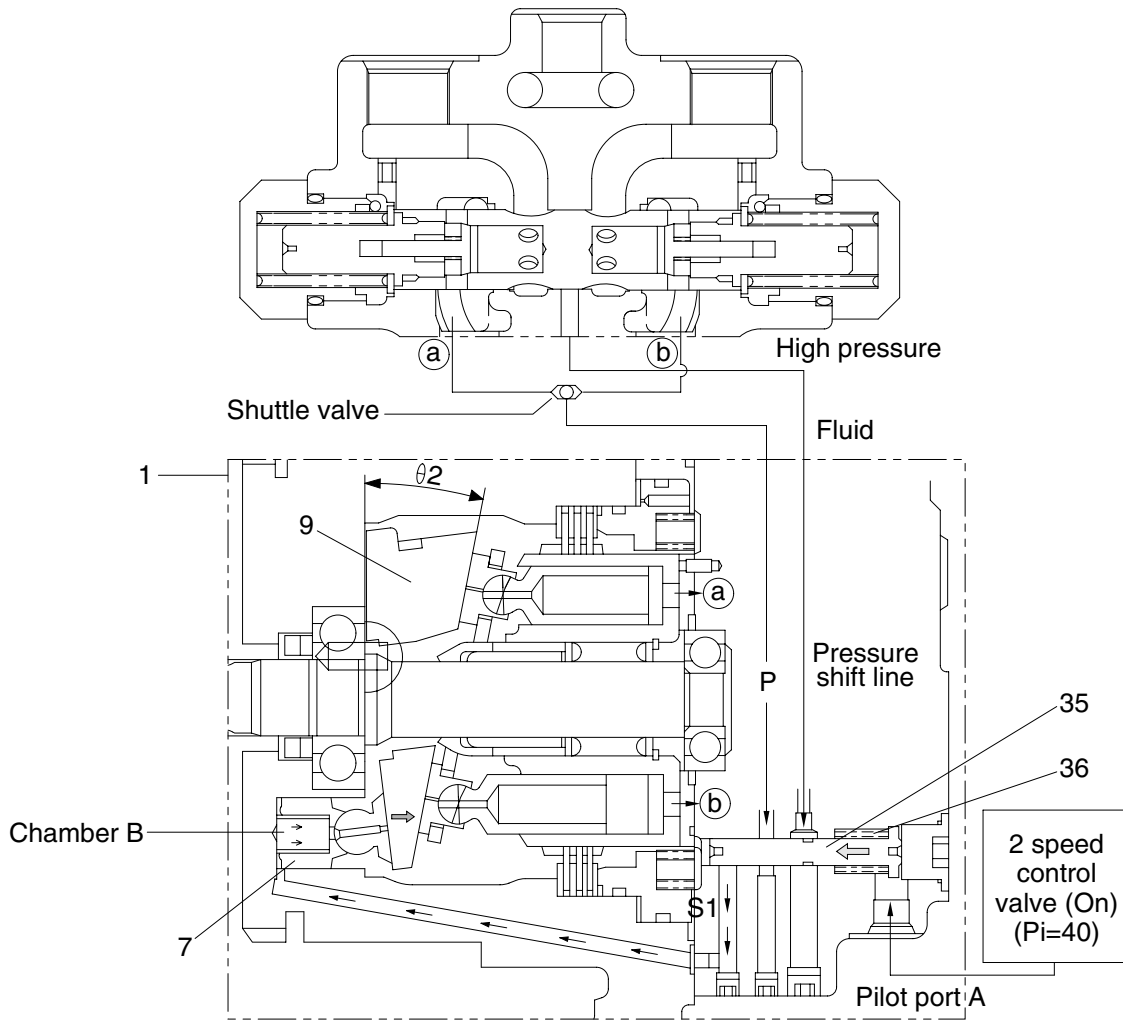
When pilot pressure signal $P_i=0$, spool (35) is located at right side by the spring (36) force and chamber A is connected to casing drain through hole S1. At this spool position, swash plate (9) sustain large angle, and motor rotate at low speed.



145Z9A2TM13

- **High speed**

When pilot pressure signal P_i is activated on spool (31), the spool moves to left hand end, and high pressure oil from Port (a) or (b) is transferred to S1 which is connected to chamber A. The high pressure transferred to chamber A lift the piston (5) up, then the swash plate (12) tilts to smaller angle, and the motor rotates higher speed.



145Z9A2TM14

4. REDUCTION GEAR

1) PLANETARY GEAR MECHANISM

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

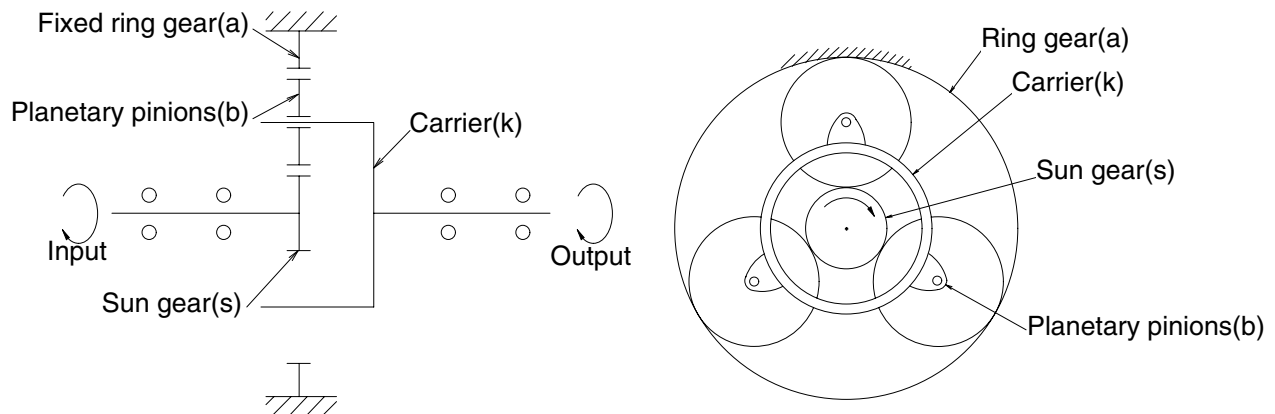
This reduction unit utilizes two stages, planetary reduction system.

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.



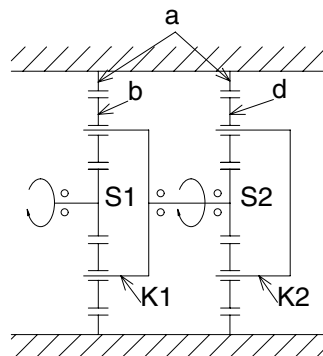
29072TM10

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.



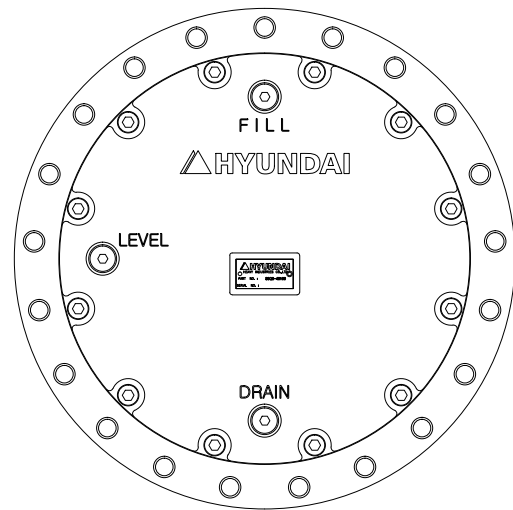
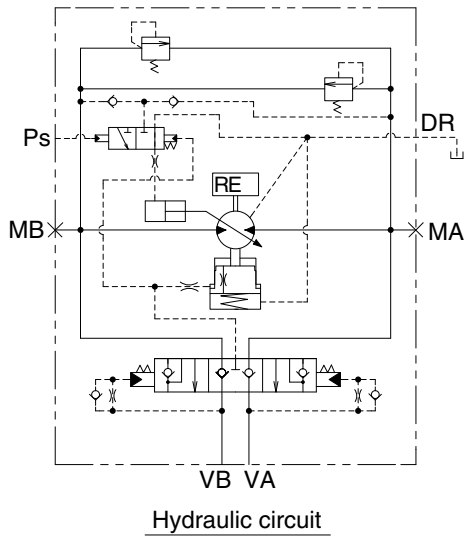
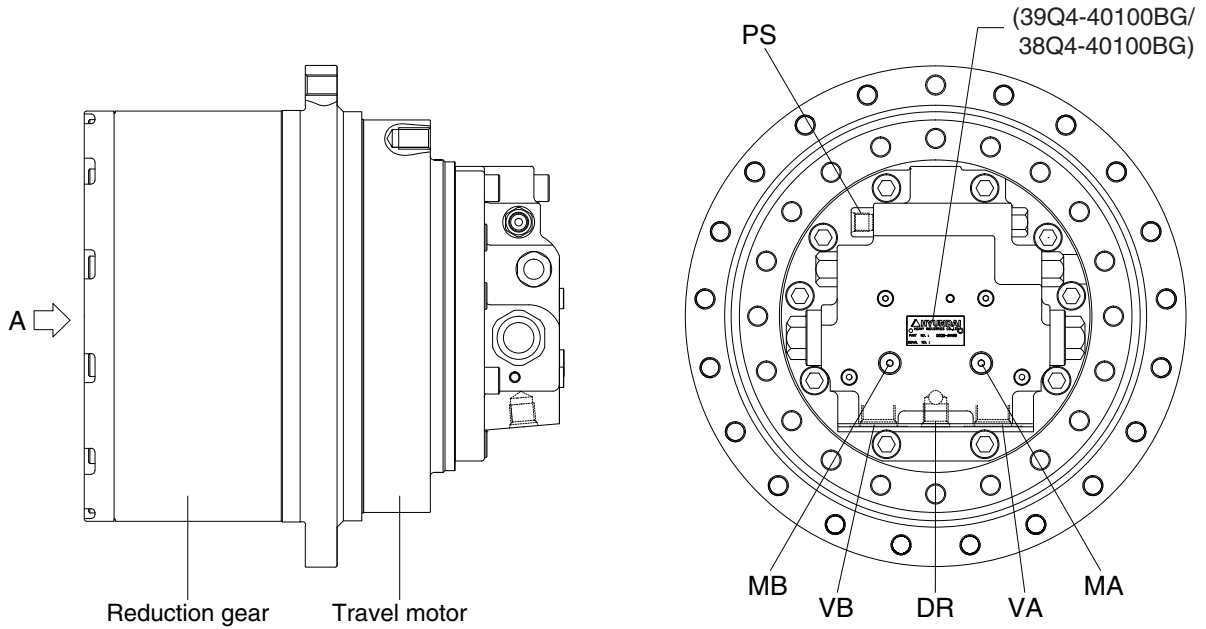
29072TM12

■ TRAVEL MOTOR (TYPE 3, 4)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

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

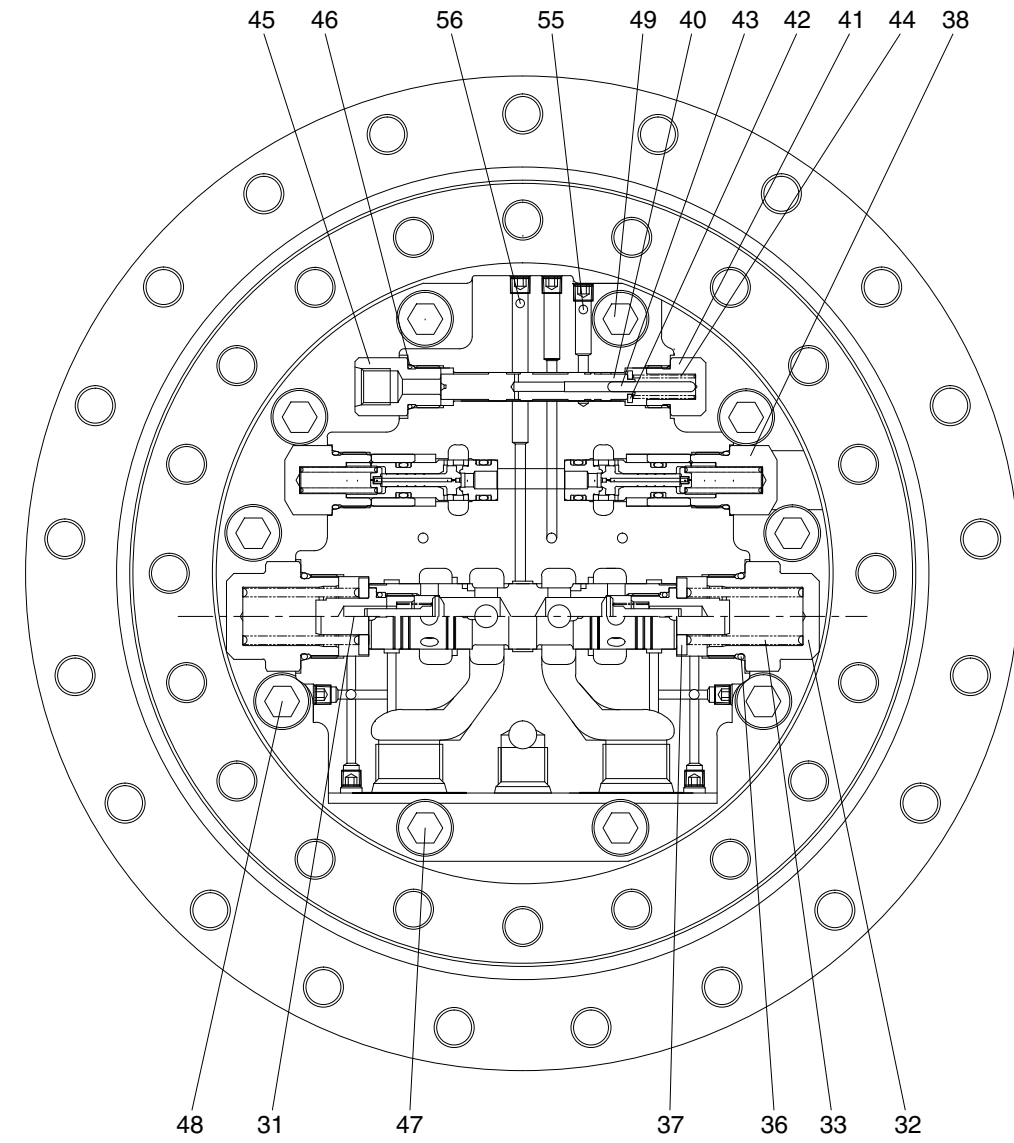
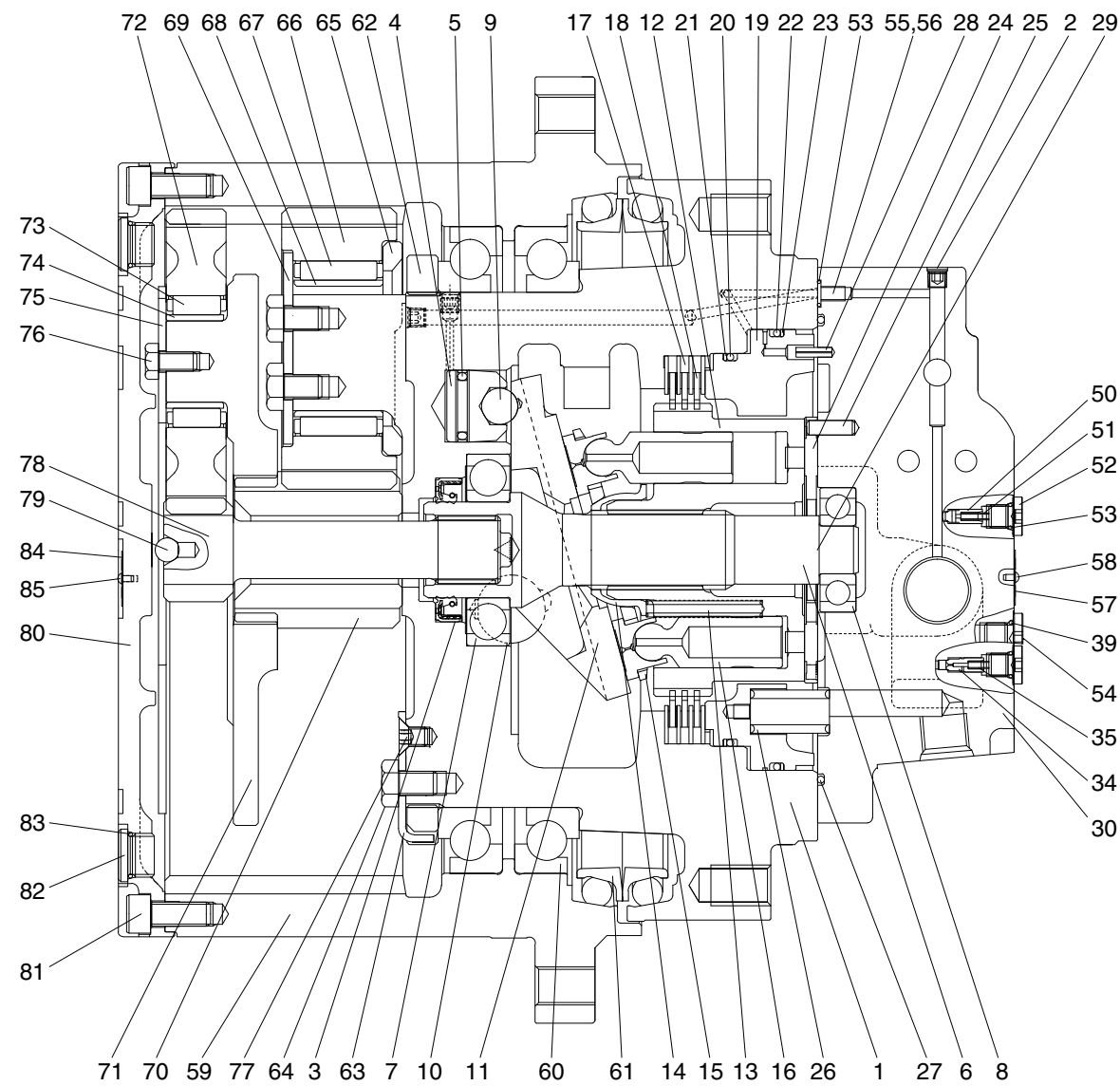


VIEW A

145LCR2TM20

Port	Port name	Port size
VA, VB	Valve port	PF 3/4
Ps	Pilot port	PF 1/4
DR	Drain port	PF 1/2
MA, MB	Gauge port	PF 1/4

2. STRUCTURE



- | | | | | |
|----------------------|--------------------|-----------------------------|------------------------|---------------------------|
| 1 Casing | 18 Separated plate | 35 Spring | 52 Plug | 69 Thrust washer No. 2 |
| 2 Plug | 19 Parking piston | 36 O-ring | 53 O-ring | 70 Sun gear No.2 |
| 3 Oil seal | 20 O-ring | 37 Spring seat | 54 Plug | 71 Carrier No.1 |
| 4 Piston | 21 Back up ring | 38 Relief valve assy | 55 Restrictor | 72 Planetary gear No.1 |
| 5 Piston seal | 22 O-ring | 39 O-ring | 56 Restrictor | 73 Needle bearing No.1 |
| 6 Shaft | 23 Back up ring | 40 Spool | 57 Name plate | 74 Inner race No. 1 |
| 7 Front ball bearing | 24 Valve plate | 41 Plug | 58 Rivet | 75 Thrust plate No. 1 |
| 8 Rear ball bearing | 25 Spring pin | 42 Spring seat | 59 Ring gear | 76 Hexagon head bolt |
| 9 Steel ball | 26 Spring | 43 Parallel pin | 60 Bearing | 77 Countersunk head screw |
| 10 Steel ball | 27 O-ring | 44 Spring | 61 Floating seal assy | 78 Sun gear No.1 |
| 11 Swash plate | 28 Spring pin | 45 Connector | 62 Nut ring | 79 Steel ball |
| 12 Cylinder block | 29 Parallel pin | 46 O-ring | 63 Lock plate | 80 Cover |
| 13 Spring | 30 Rear cover | 47 Hexagon socket head bolt | 64 Hexagon head bolt | 81 Hex socket head bolt |
| 14 Ball guide | 31 Main spool assy | 48 Hexagon socket head bolt | 65 Thrust plate No. 2 | 82 Plug |
| 15 Retainer plate | 32 Cover | 49 Hexagon socket head bolt | 66 Planetary gear No.2 | 83 O-ring |
| 16 Piston assy | 33 Spring | 50 Check valve | 67 Needle bearing No.2 | 84 Name plate |
| 17 Friction plate | 34 Restrictor | 51 Spring | 68 Inner race No. 2 | 85 Rivet |

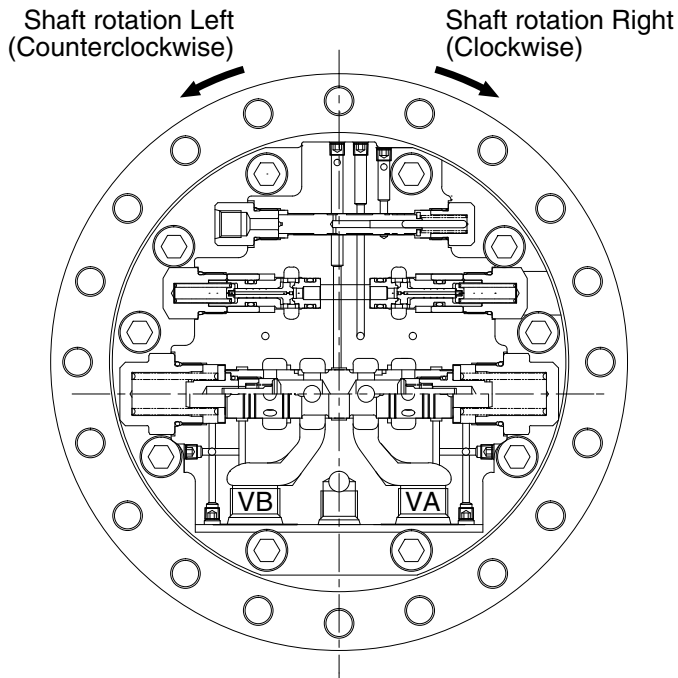
125LCR2TM21

3. OPERATION

1) MOTOR

High pressure oil delivered from hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (30) and valve plate (24), led to cylinder block (12).

The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclock wise)

125LCR2TM23

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

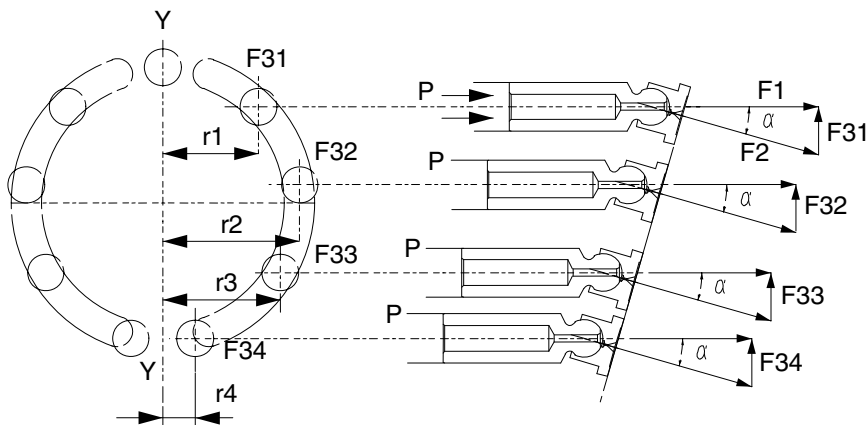
$$F1 = P \times A \quad (P : \text{pressure}, A : \text{area of piston section})$$

The swash plate (11) with inclined angle of α divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$$

This drive torque is transmitted via cylinder block (12) to driving shaft (6).



29092TM07

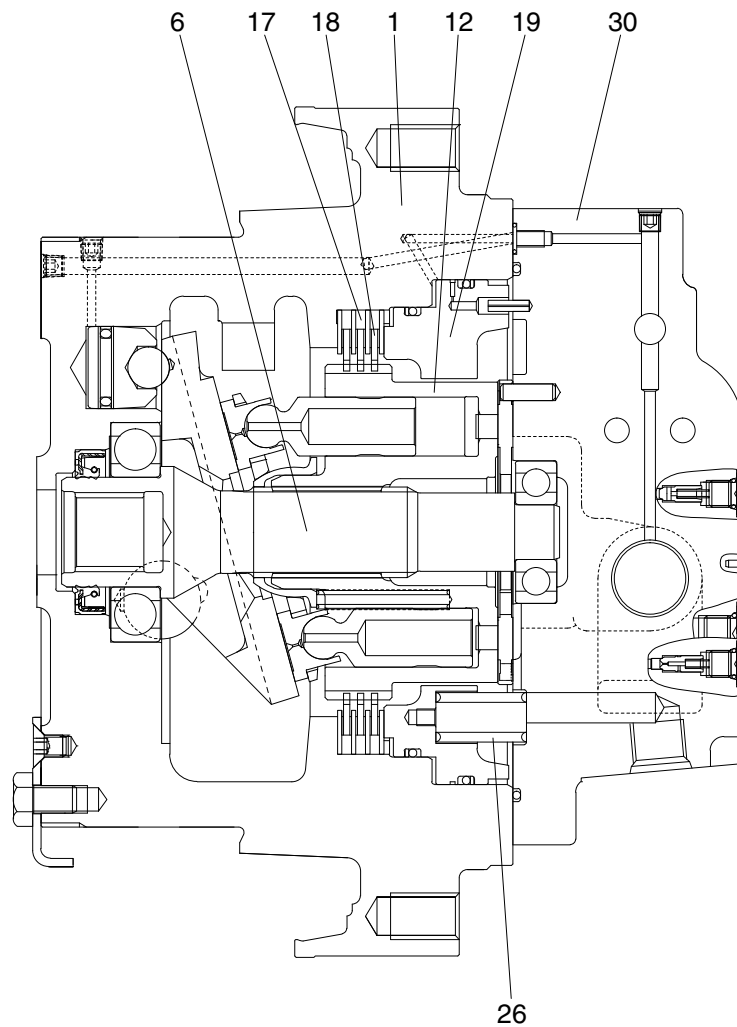
2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (30), is applied to the parking piston (19).

Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separated plates (18), inserted into the casing (1), and friction plates (17), coupled to cylinder block (12) by the outer splines.

When no pressure is activated on the parking piston (19), it is pushed by the brake springs (26) and it pushes friction plates (17) and separated plates (18) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (12) and hence the shaft (6).



125LCR2TM24

3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure P_A that overcome the spring (44), the spring (44) is compressed and spool (40) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (50) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (4). As a result, swash plate (11) turns around the line L which connect the two steel balls (10) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (11) keeps the position.

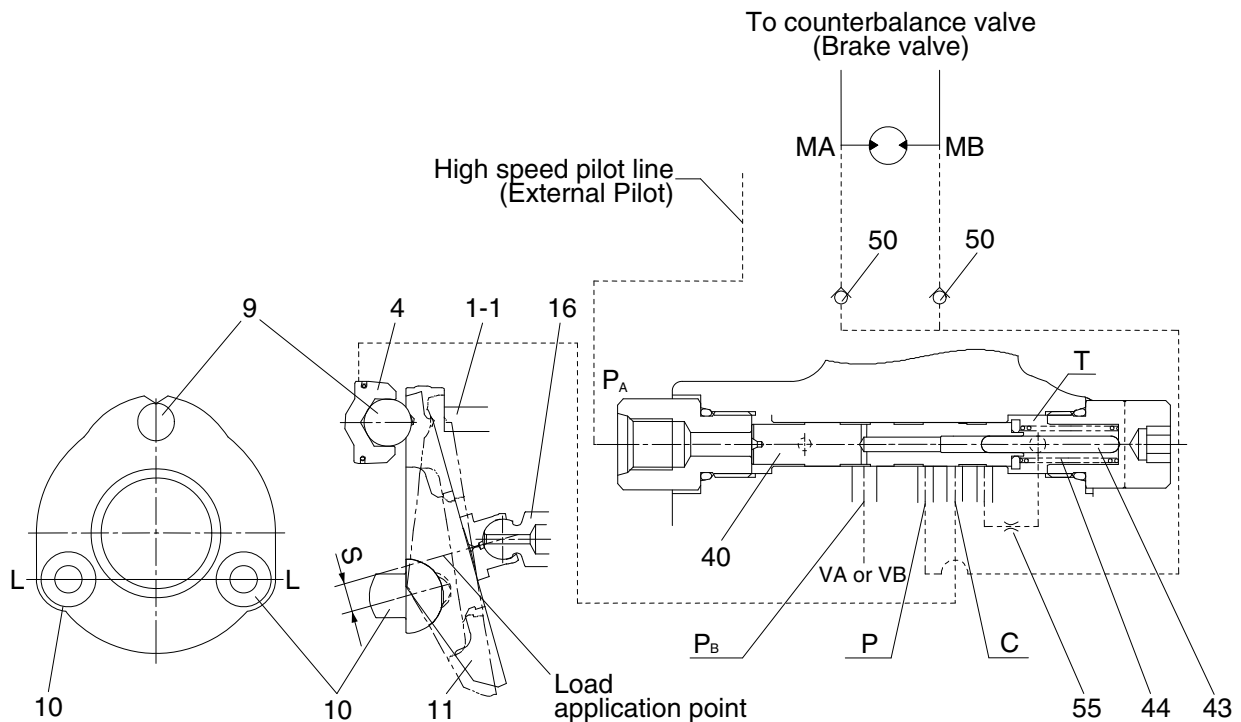
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

When no pressure is in the high speed pilot line P_A , spool (40) is pushed back by the spring (44) and pressure that pressed the shifter piston (4) is released to the hydraulic tank through restrictor (55).

Here, nine pistons are there and they equally spaced on the swash plate (11). The force that summed up those of pistons comes to almost the center of the swash plate (11) as shown. Since the steel balls (10) are off-set by S from the center, the rotating force of product S and the force moves swash plate (11) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port P_B and this pressure activate on pin (43). When the pressure at P_B exceeds predetermined value, spool (40) returns to the left by the counter-pressure against pin (43) and the pressure on the shifter piston (4) through port C is released to the tank and the motor comes to low speed.

When P_B goes down, the spool (40) moves to the right and the speed become high.

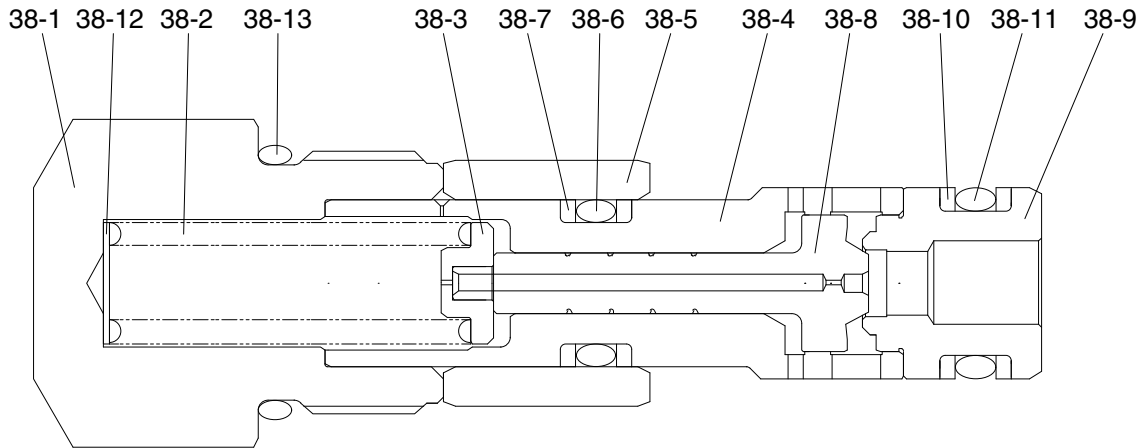


125LCR2TM19

4) OVERLOAD RELIEF VALVE

(1) Structure

This valve is screwed in the motor rear cover (30) and consists of : plug (38-1) that is screwed and fixed in the rear cover (30), poppet (38-8) and supports the poppet seat (38-9), spring (38-2) that is operating relief valve setting pressure and supports the spring seat (38-3), that is inserted in the sleeve (38-4), piston (38-5) that reduce the shock.



125LCR2TM25

38-1 Plug	38-6 O-ring	38-11 O-ring
38-2 Spring	38-7 Back-up ring	38-12 Ring
38-3 Spring seat	38-8 Poppet	38-13 O-ring
38-4 Sleeve	38-9 Poppet seat	
38-5 Piston	38-10 Back-up ring	

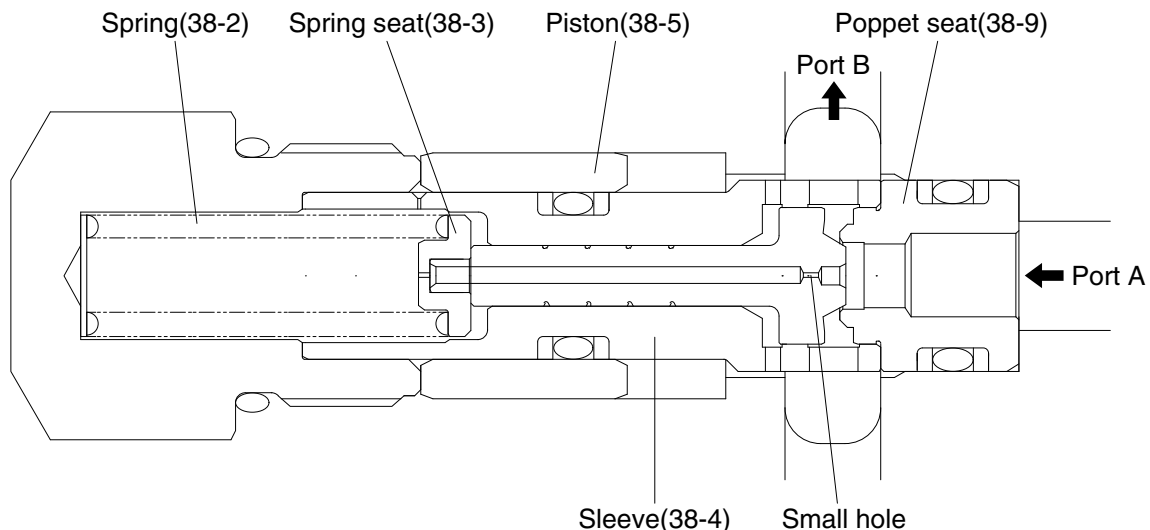
(2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions :

- ① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
- ② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
- ③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of poppet (38-8) which seats on the poppet seat (38-9) and, at the same time, is delivered, via small hole, to the spring seat (38-3) located inside the sleeve (38-4) and the seat bore pressure increases up to "A" port pressure. The poppet (38-8) opposes to spring (38-2) by the force of the pressure exerted on the area difference between poppet seat's effective diameter and spring seat bore and keep the predetermined pressure.

When hydraulically braking, the piston (38-5) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (38-5) through the small hole in the poppet (38-8), sleeve (38-4) and piston (38-5) moves rightward until it touches the stopper in rear cover. In this while, the poppet (38-8) maintains "A" port pressure at comparatively low against the spring (38-2) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



125LCR2TM27

5) BRAKE VALVE

(1) Structure

The brake valve portion mainly consists of the following parts:

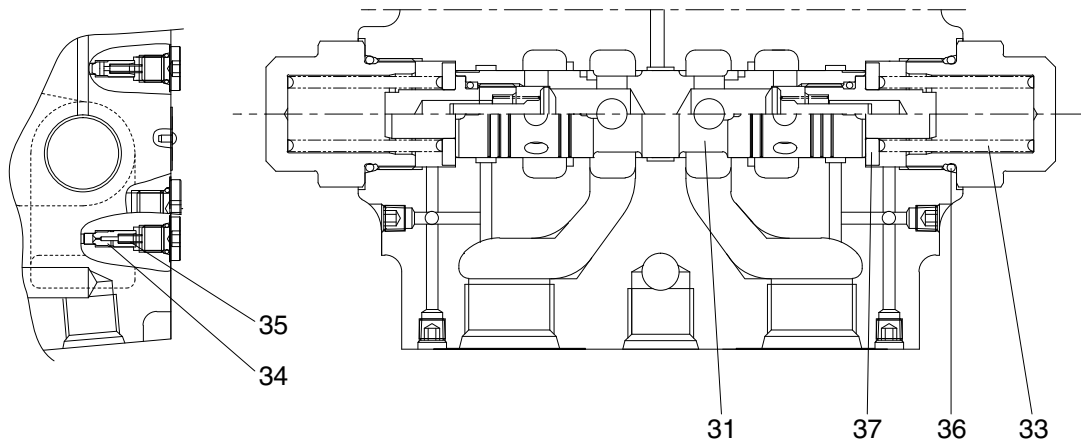
① Spool

By shifting the spool (31), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-66, (2) Operation)

② Check valve (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



125LCR2TM28

31 Main spool
33 Spring

34 Restrictor
35 Restrictor spring

36 O-ring
37 Spring seat

(2) Operation

① Holding operation

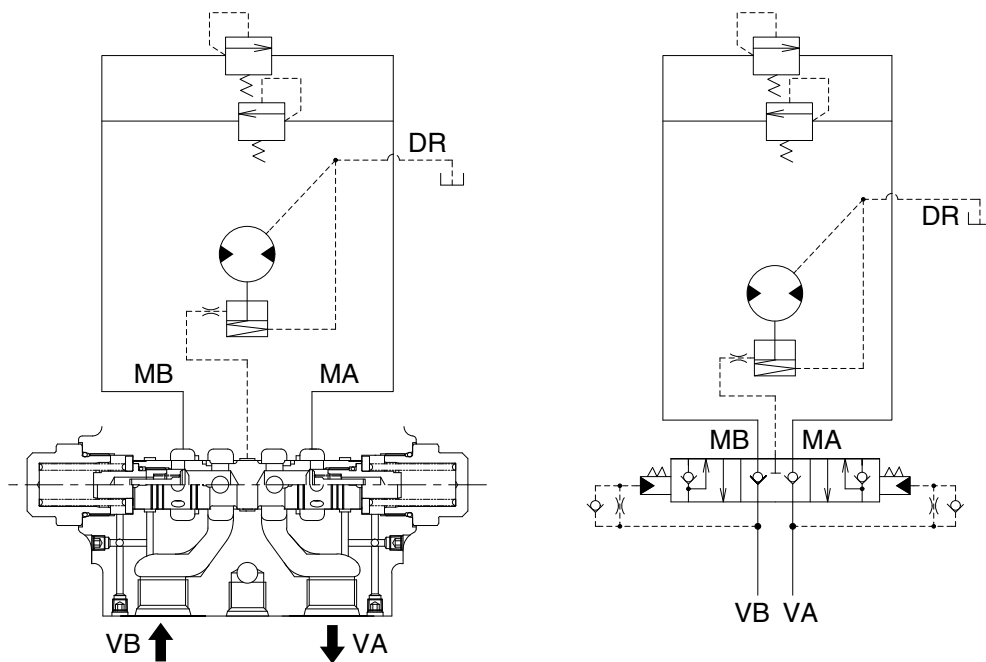
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (33) located on both spool ends holds the spool (31) at central position.

Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.

If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (31), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.



125LCR2TM29

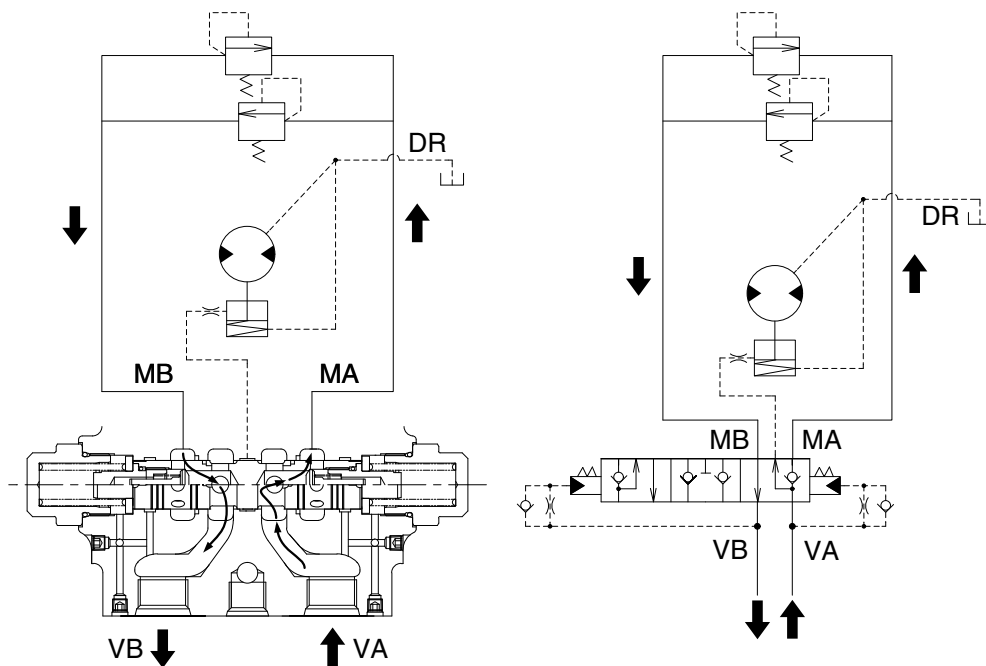
② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (31), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (31) leftwards, overcoming the spring (33) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed.

As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.



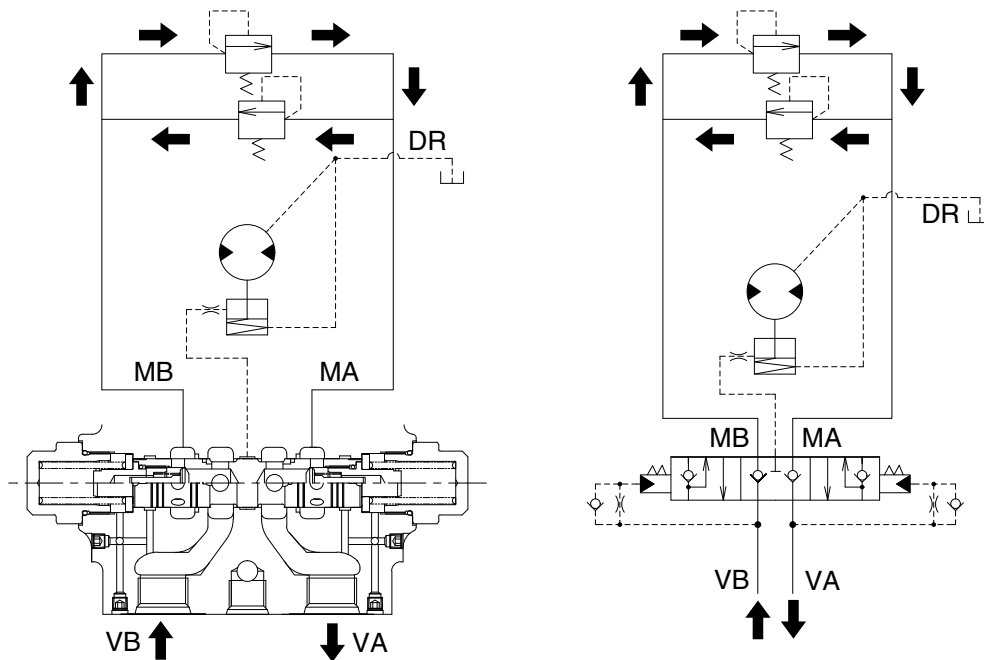
125LCR2TM30

③ Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (31) returns to the neutral position by spring (33) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



125LCR2TM31

④ Counterbalance operation

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.

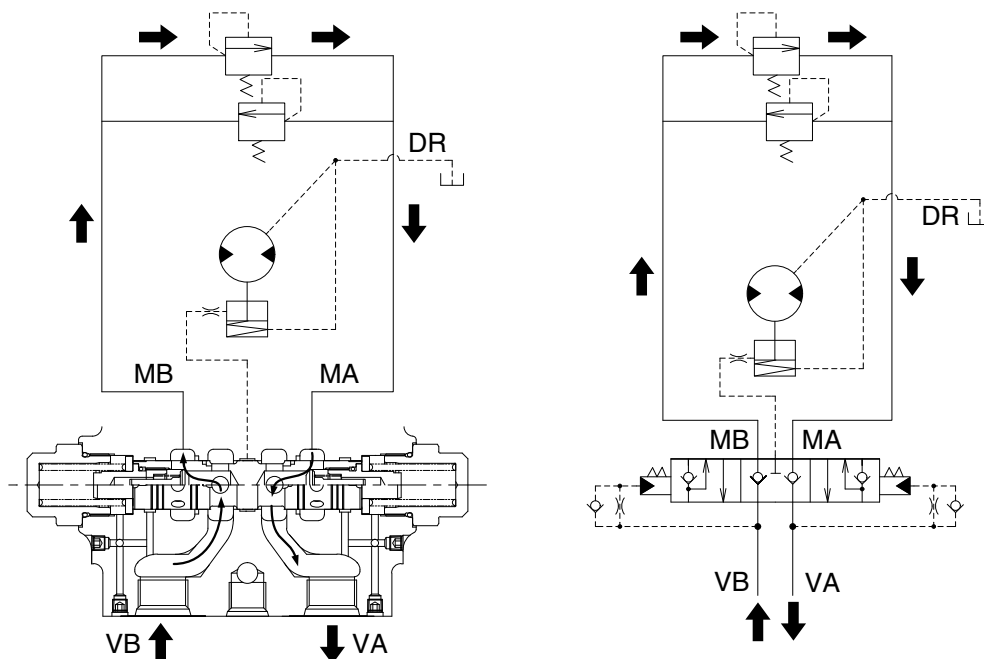
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (33) force moves the spool (31) leftwards towards neutral position.

Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (31) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.

In order to give stable counterbalance operation, the restrictors (34) are set in the pilot chamber to damp the spool (31) movement.

The parking brake is released during pressure adjusting action of the spool (31).



125LCR2TM32

6) REDUCTION GEAR

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

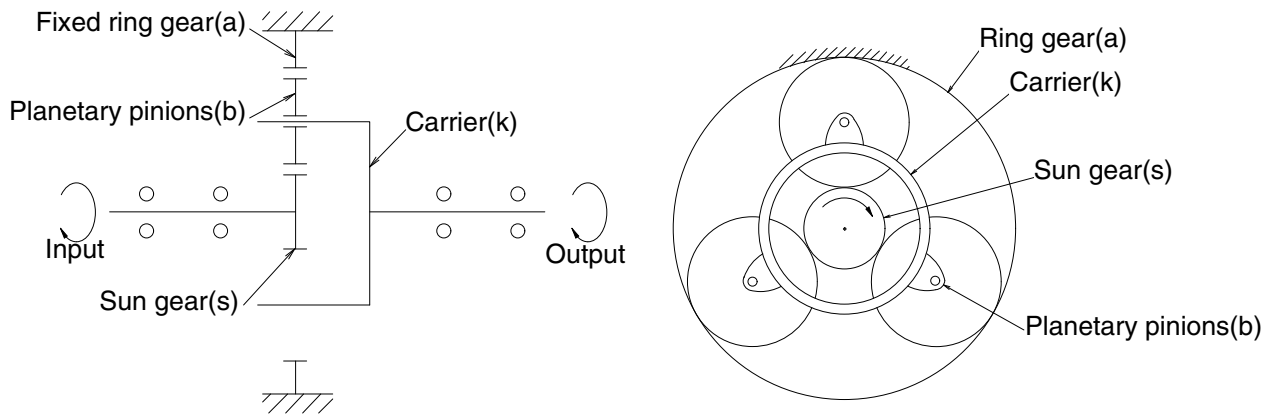
This reduction unit utilizes two stages, planetary reduction system.

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

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

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

This mechanism is called planetary gear mechanism.

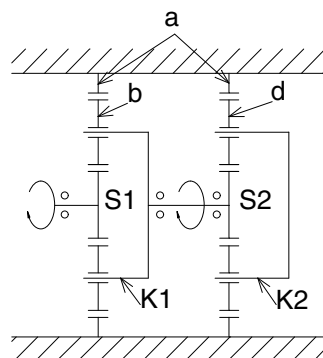


29072TM10

29072TM11

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

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

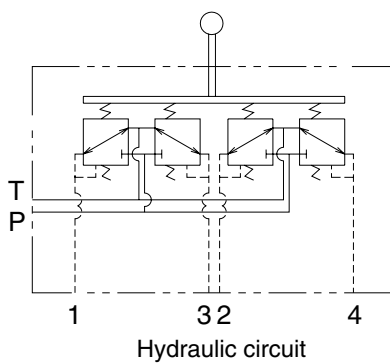
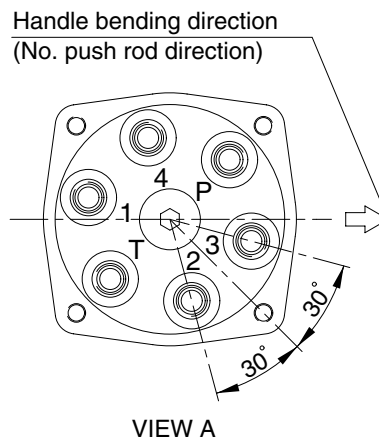
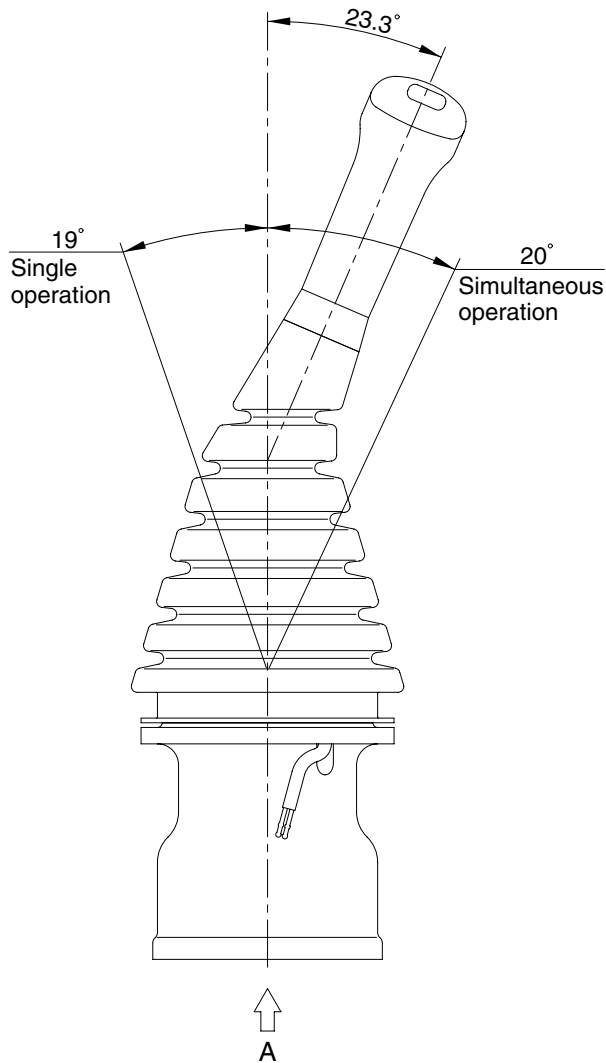


29072TM12

GROUP 5 RCV LEVER

1. STRUCTURE

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



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

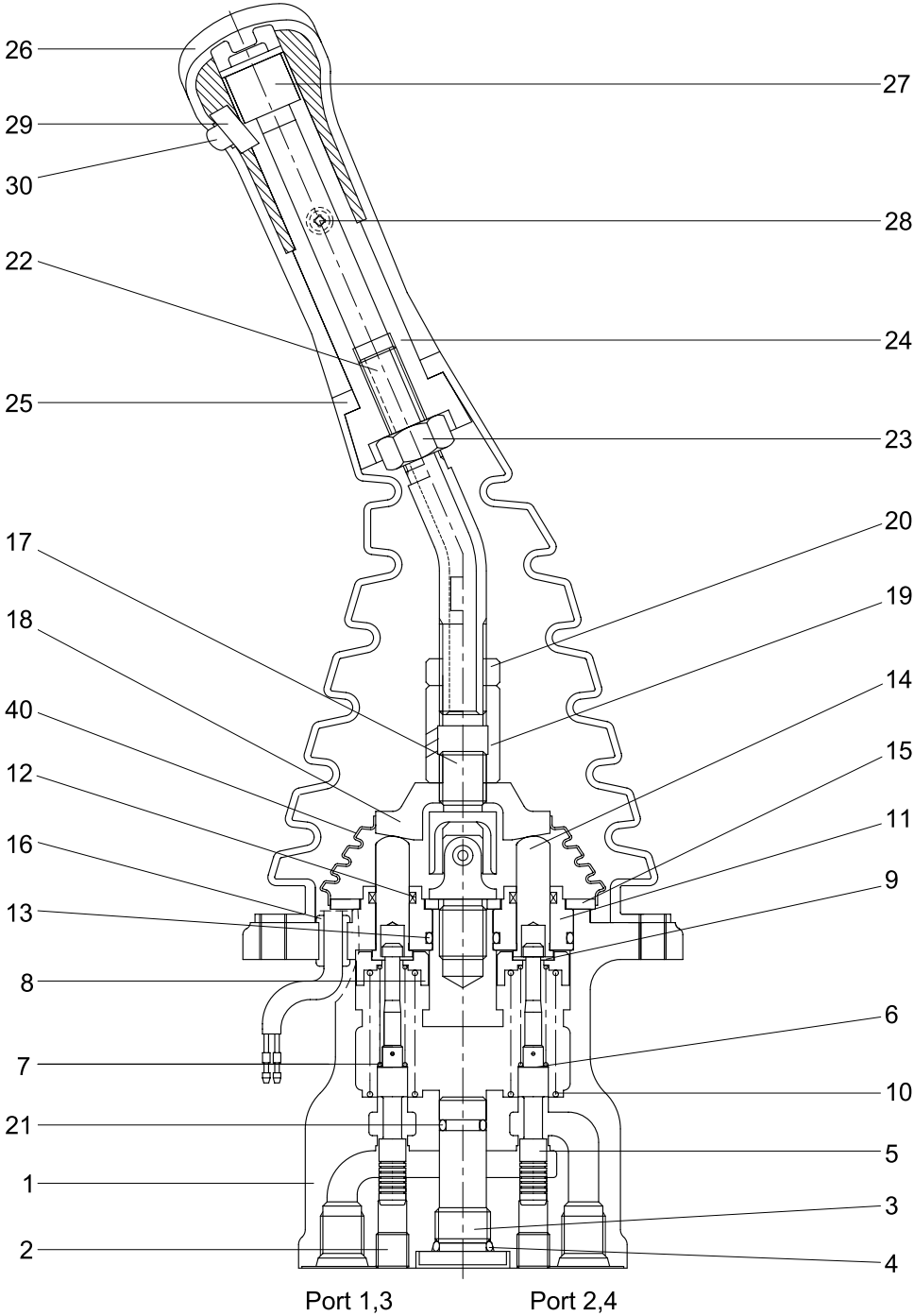
The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

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
				40	Boot

CROSS SECTION



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.

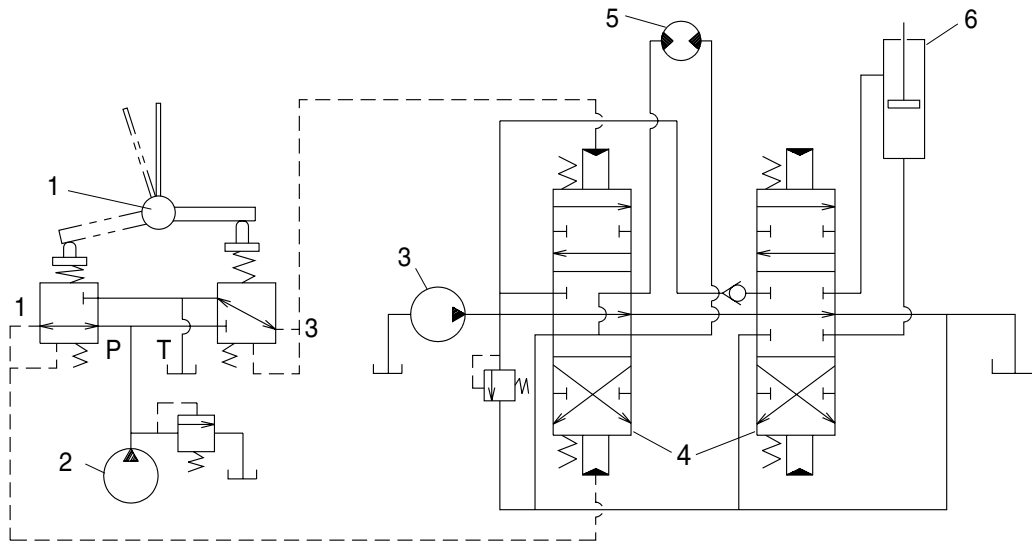
The spring(10) works on the case(1) and spring seat(8) and tries to return the push rod(14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

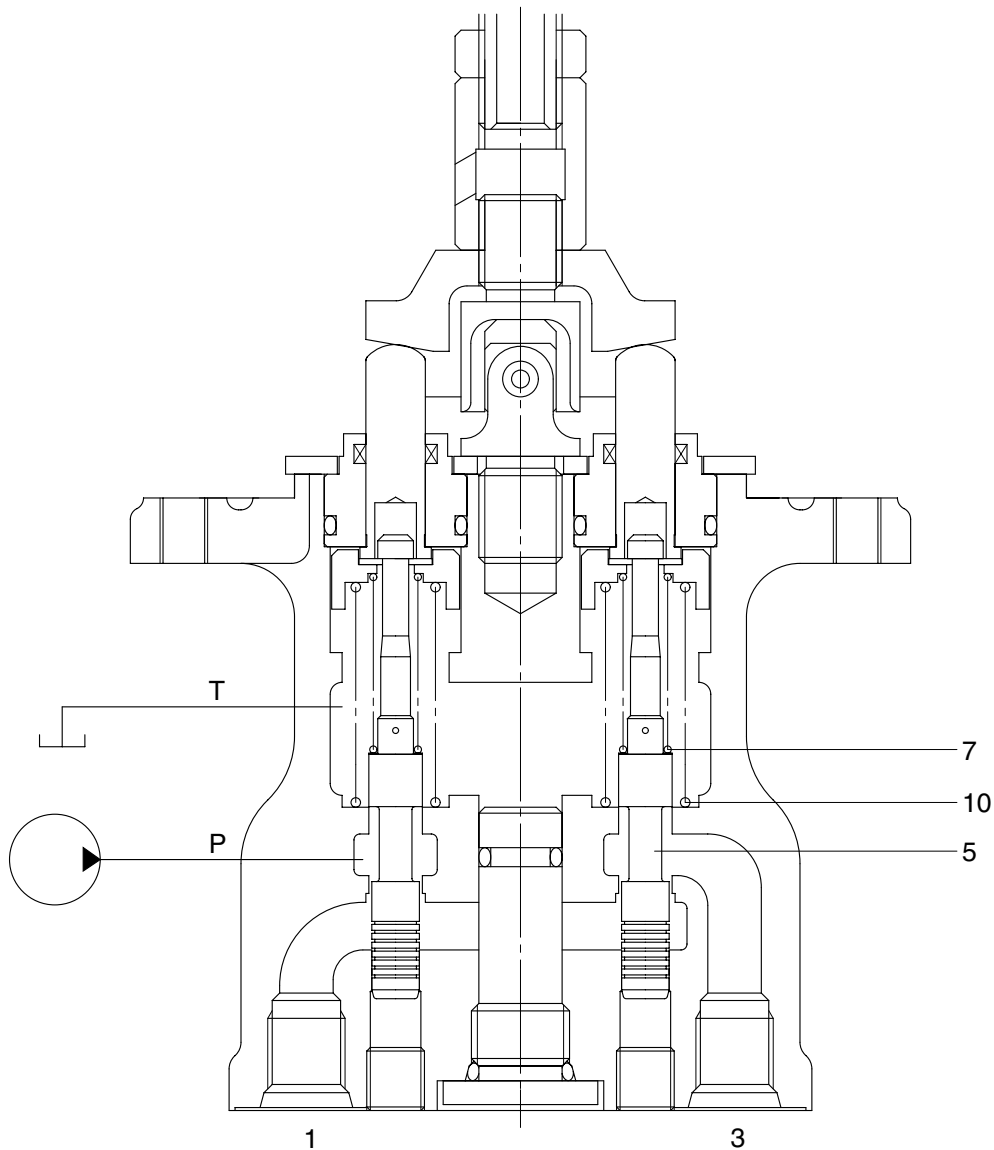


- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

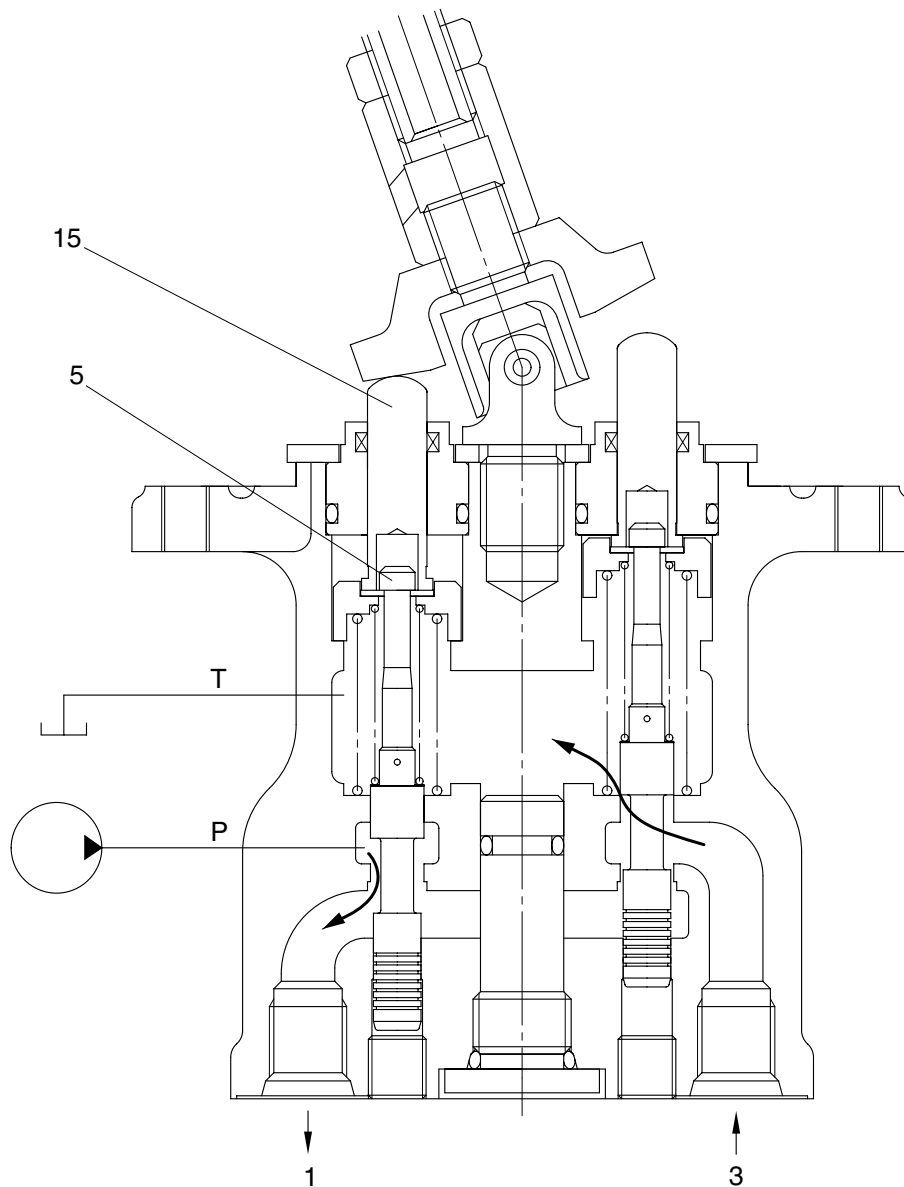
- 5 Hydraulic motor
- 6 Hydraulic cylinder

(1) Case where handle is in neutral position



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

(2) Case where handle is tilted



When the push rod(14) is stroked, the spool(5) moves downwards.

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

When the pressure at port(1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port(1) increases higher than the set pressure, port P is disconnected from port(1) and port T is connected with port(1). If it decreases lower than the set pressure, port P is connected with port(1) and port T is disconnected from port 1.

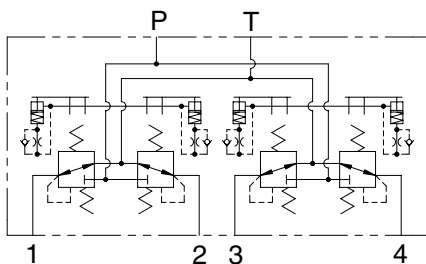
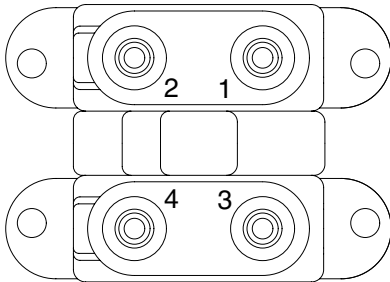
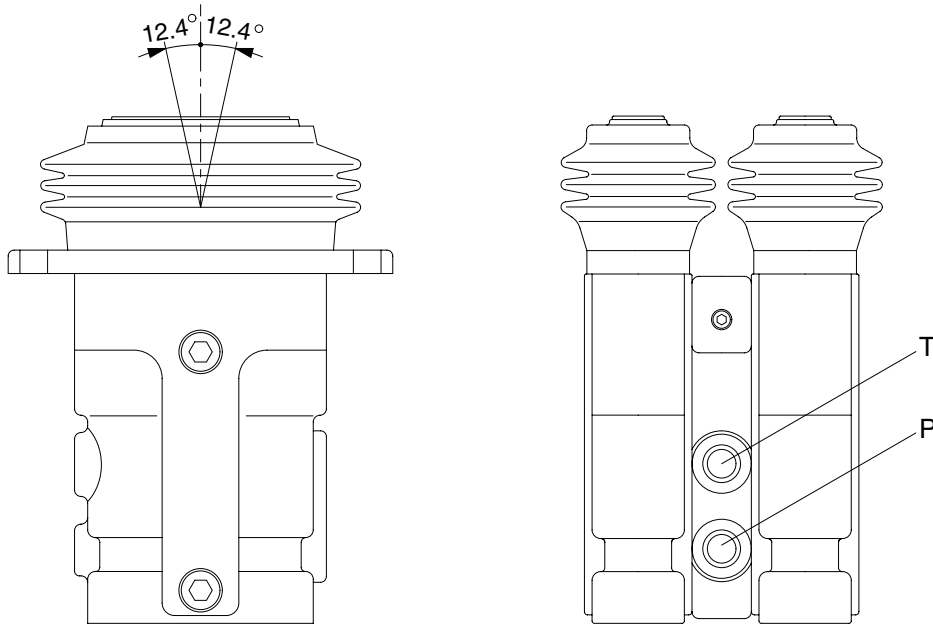
In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

GROUP 6 RCV PEDAL

1. STRUCTURE

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



Hydraulic circuit

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

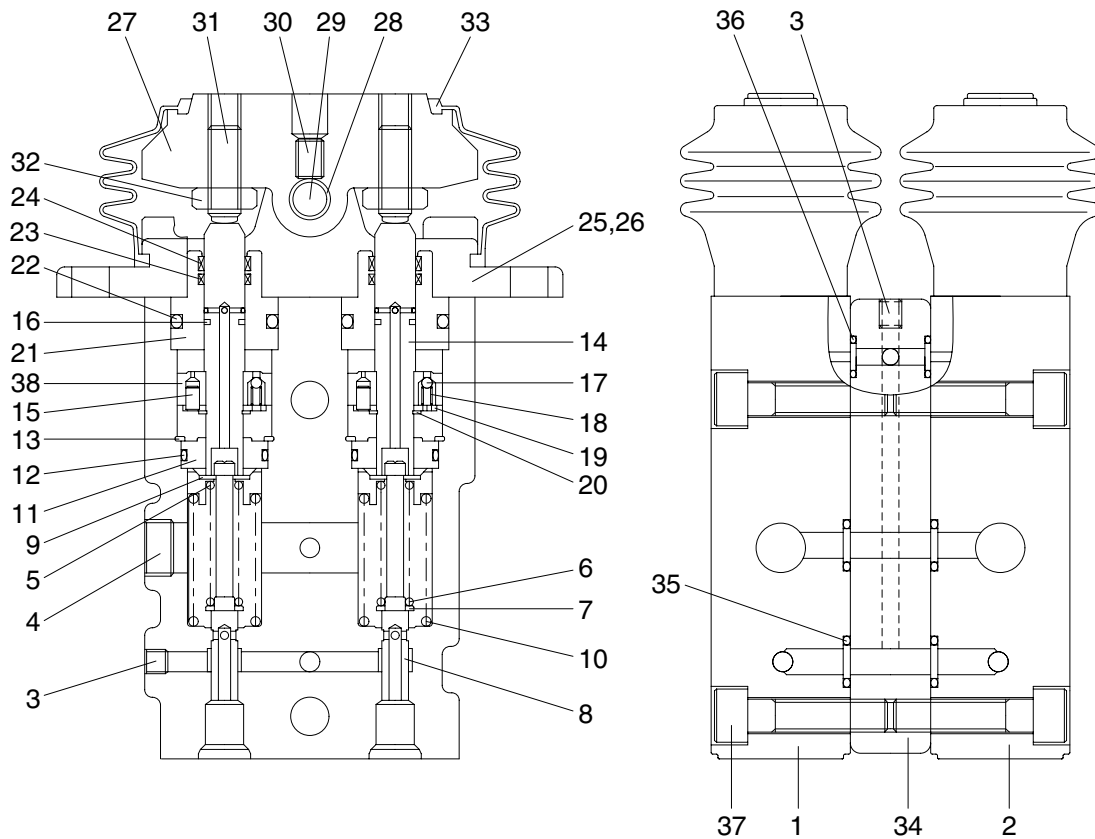
21092RP01

CROSS SECTION

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

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

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



21092RP02

1	Body(1)	14	Push rod	27	Cam
2	Body(2)	15	Spring pin	28	Bushing
3	Plug	16	Seal	29	Cam shaft
4	Plug	17	Steel ball	30	Set screw
5	Spring seat	18	Spring	31	Set screw
6	Spring	19	Plate	32	Nut
7	Spring seat	20	Snap ring	33	Bellows
8	Spool	21	Plug	34	Space
9	Stopper	22	O-ring	35	O-ring
10	Spring	23	Rod seal	36	O-ring
11	Rod guide	24	Dust seal	37	Socket bolt
12	O-ring	25	Cover	38	Piston
13	Snap ring	26	Socket bolt		

2. FUNCTION

1) FUNDAMENTAL FUNCTIONS

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

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

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output port (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

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

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

The change the deflection of this spring, the push rod (14) is inserted and can slide in the plug (21). For the purpose of changing th displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

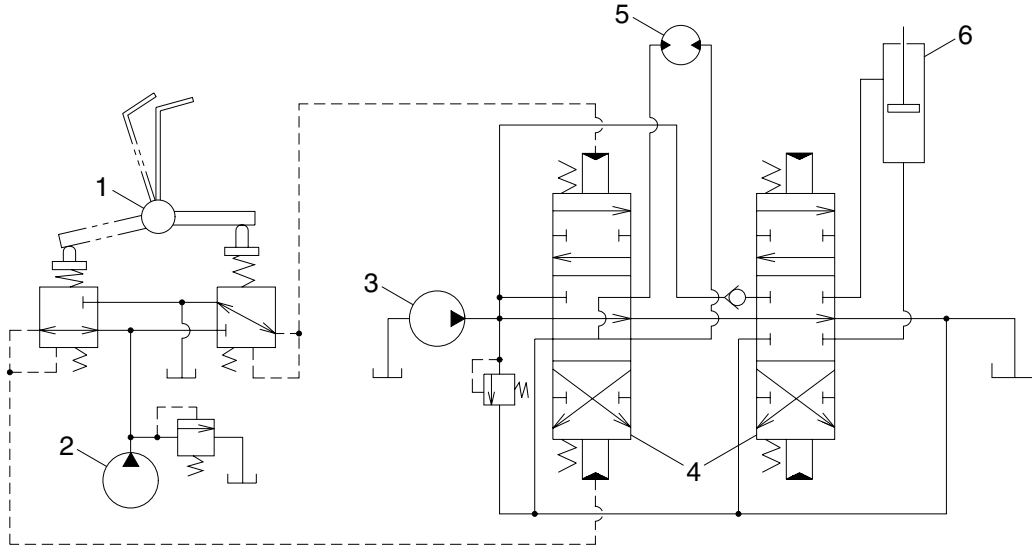
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

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



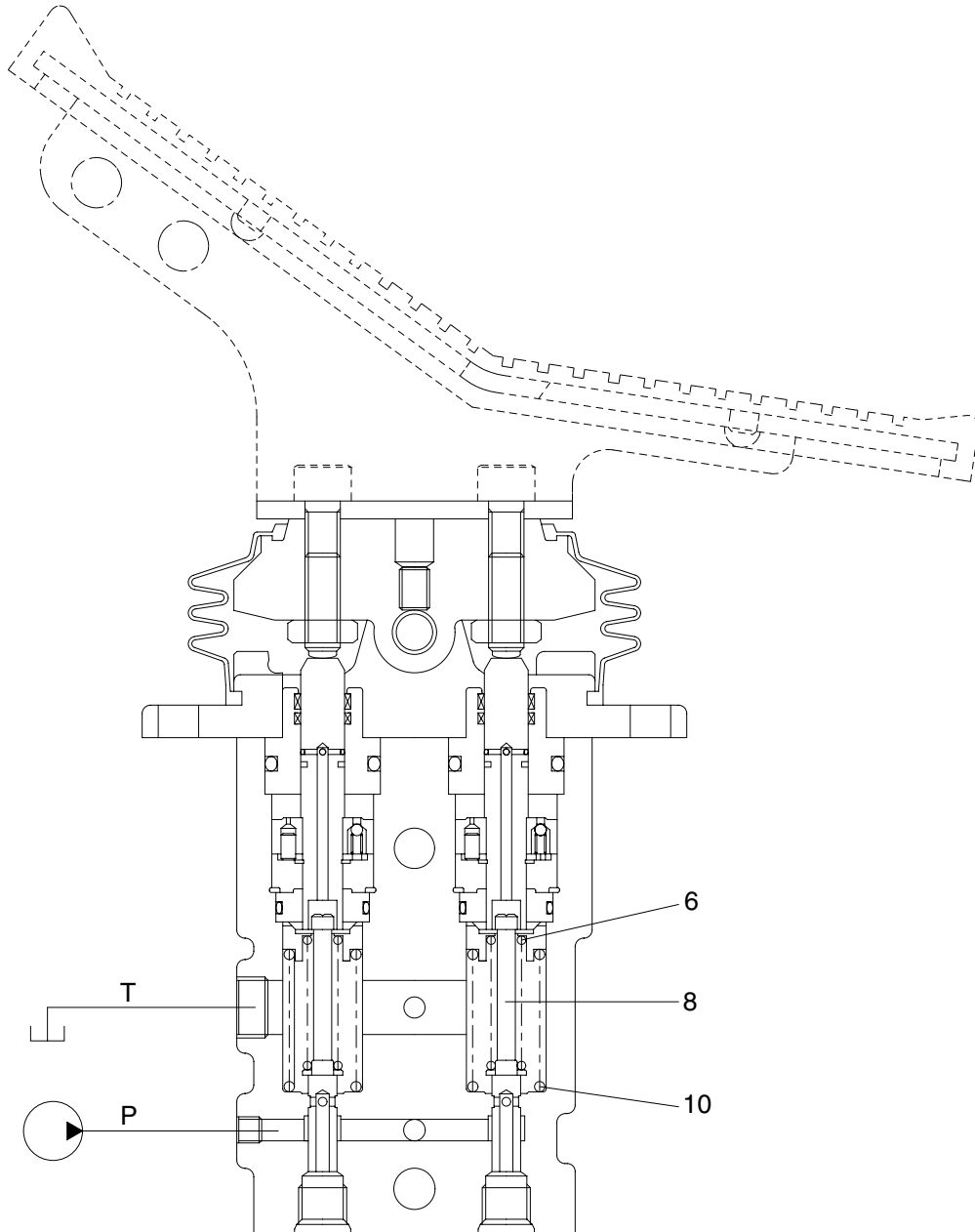
36072SF01

1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

5 Hydraulic motor
6 Hydraulic cylinder

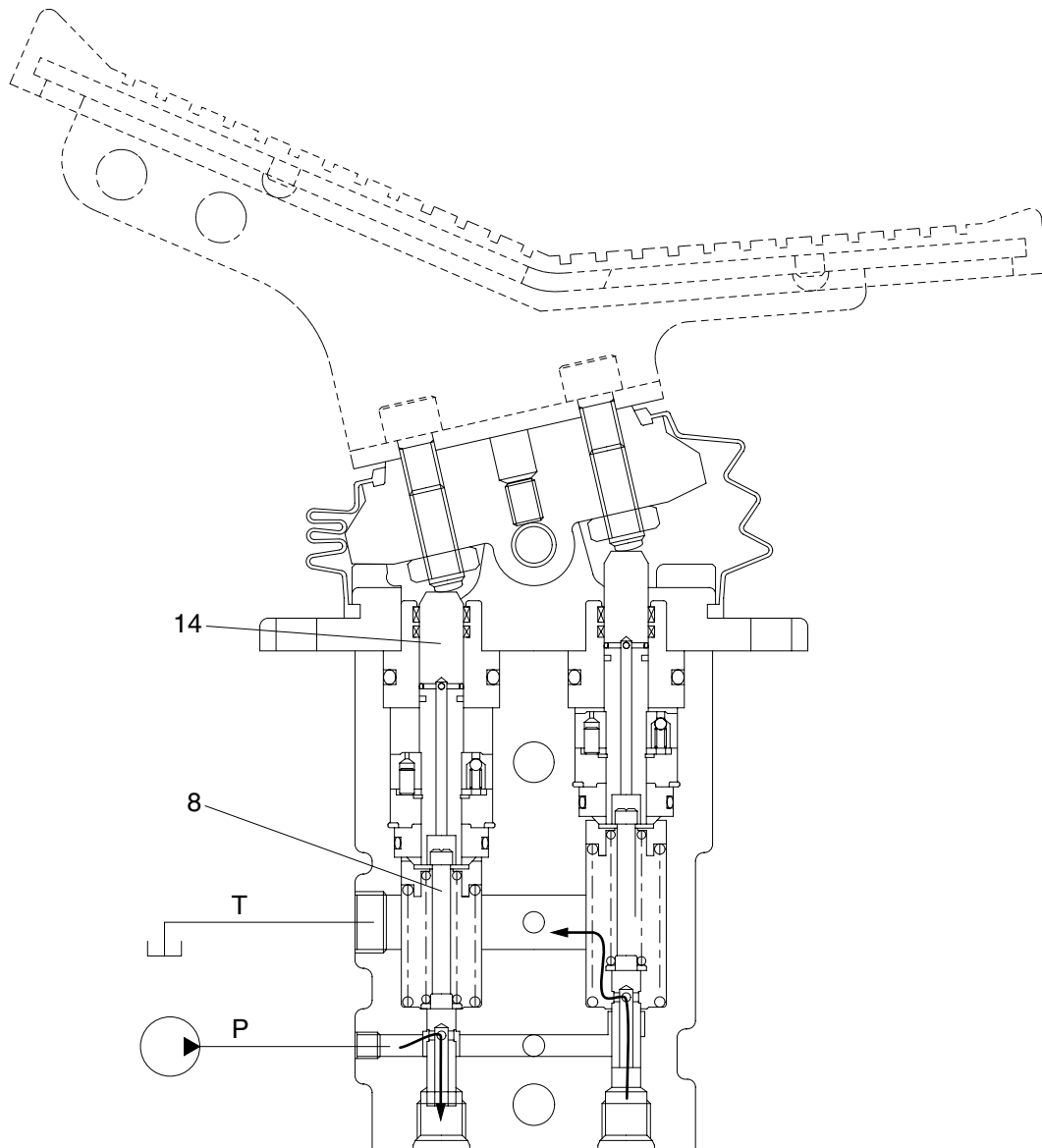
(1) Case where pedal is in neutral position



21092RP03

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

(2) Case where pedal is tilted



21092RP04

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

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

When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.

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

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.