

SECTION 2 STRUCTURE AND FUNCTION

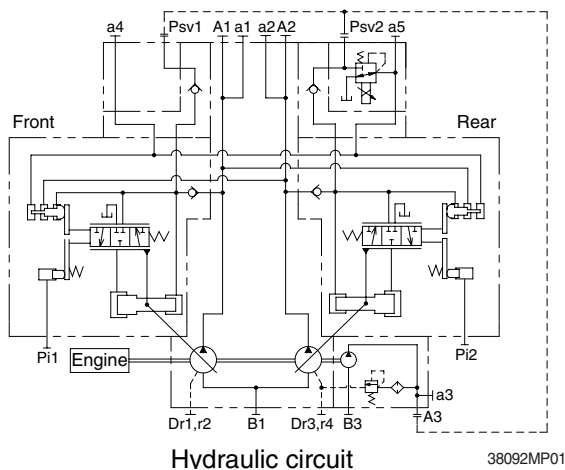
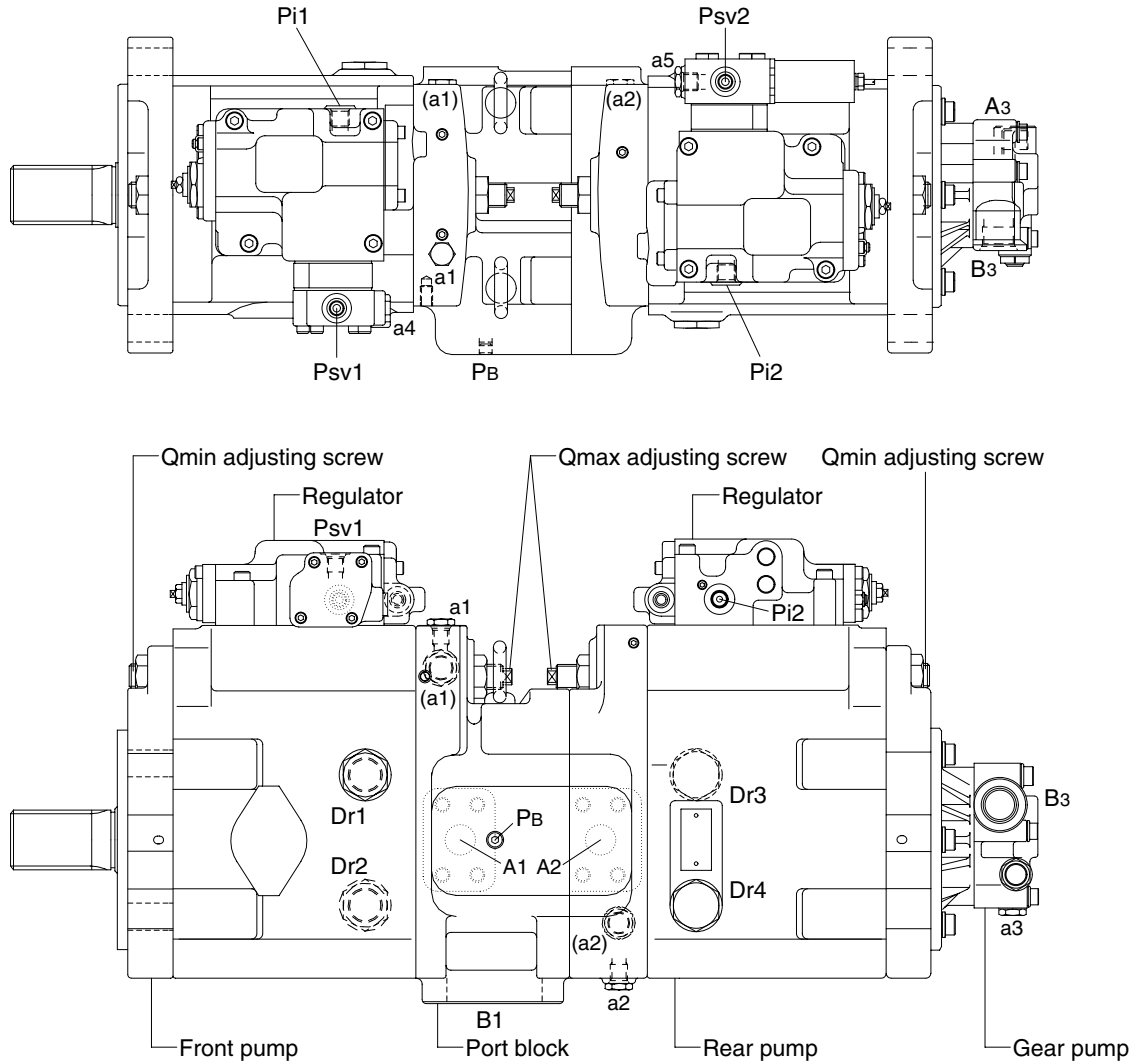
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SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

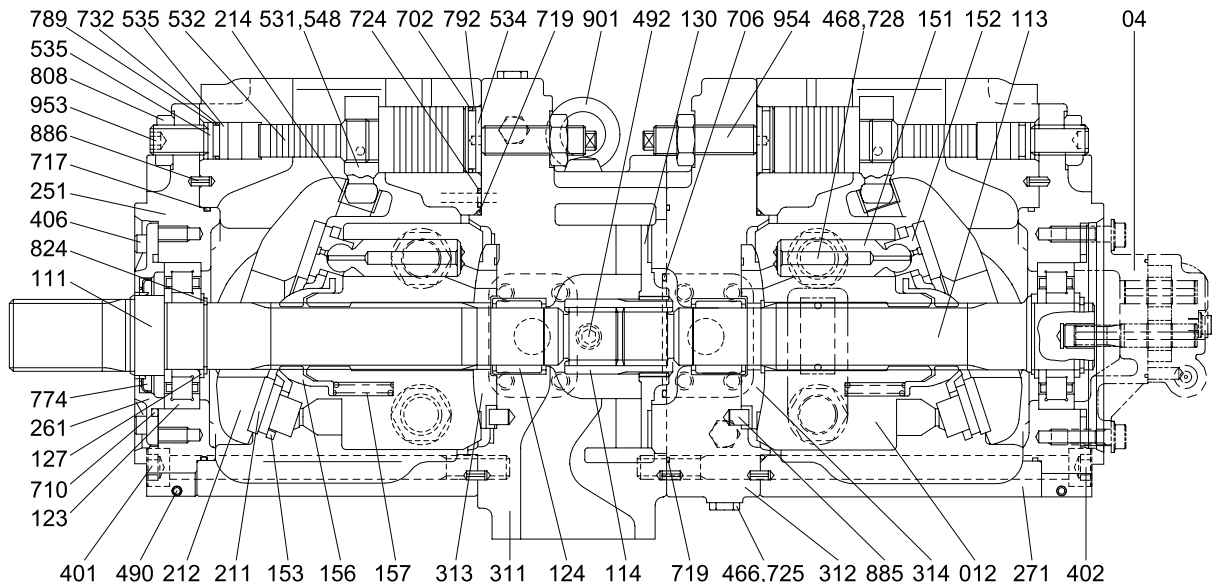
The pump device consists of main pump, regulator and gear pump.



Port	Port name	Port size
A1, 2	Delivery port	SAE6000psi 1"
B1	Suction port	SAE2000psi 3"
Dr	Drain port	PF 3/4 - 23
Pi1, i2	Pilot port	PF 1/4 - 15
Pm1, m2	Qmax cut port	PF 1/4 - 15
Psv1, sv2	Servo assist port	PF 1/4 - 15
a1, 2, 4,5	Gauge port	PF 1/4 - 15
a3	Gauge port	PF 1/4 - 14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20
PB	Gauge port	PT 1/8

1) MAIN PUMP(1/2)

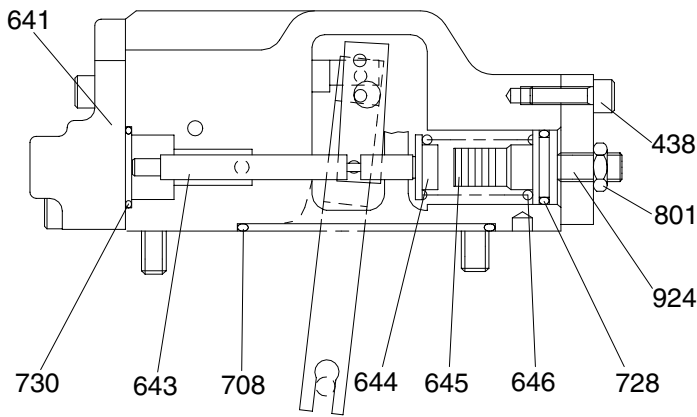
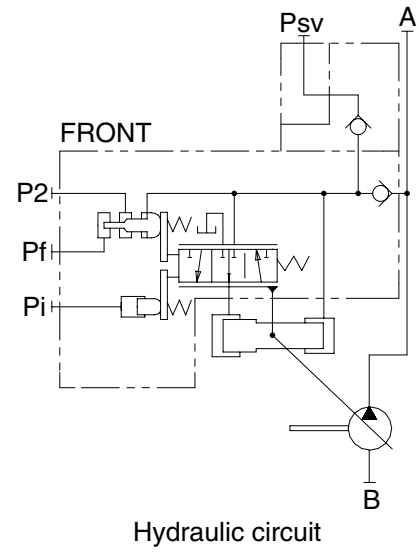
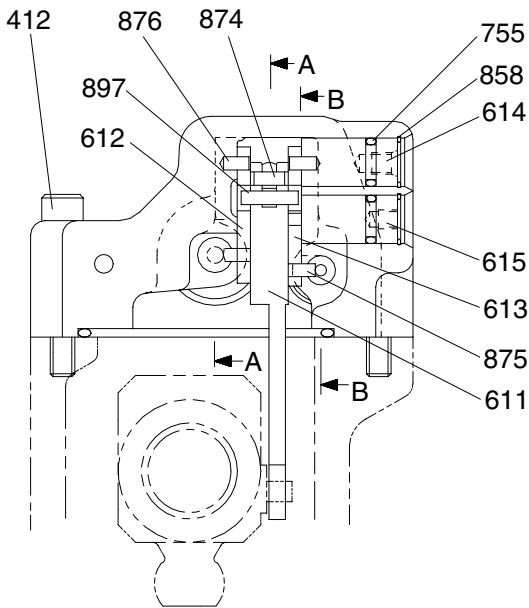
The main pump consists of two piston pumps (front & rear) and valve block.



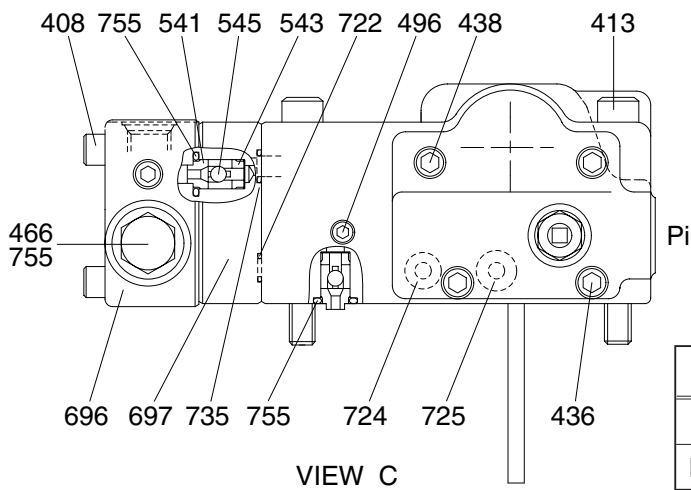
38092MP02

04	Gear pump	271	Pump casing	710	O-ring
111	Drive shaft (F)	311	Valve cover (F)	717	O-ring
113	Drive shaft (R)	312	Valve cover (R)	719	O-ring
114	Spline coupling	313	Valve plate (R)	724	O-ring
123	Roller bearing	314	Valve plate (L)	725	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Bearing spacer	402	Hexagon socket bolt	732	O-ring
130	Booster	406	Hexagon socket bolt	774	Oil seal
012	Cylinder block	466	VP Plug	789	Back up ring
151	Piston	468	VP Plug	792	Back up ring
152	Shoe	490	Plug	808	Hexagon head nut
153	Set plate	492	Plug	824	Snap ring
156	Bushing	531	Tilting pin	885	Pin
157	Cylinder spring	532	Servo piston	886	Spring pin
211	Shoe plate	534	Stopper (L)	901	Eye bolt
212	Swash plate	535	Stopper (S)	953	Set screw
214	Bushing	548	Feedback pin	954	Adjust screw
251	Support plate	702	O-ring		
261	Seal cover (F)	706	O-ring		

2) FRONT REGULATOR (1/2)



SECTION B-B

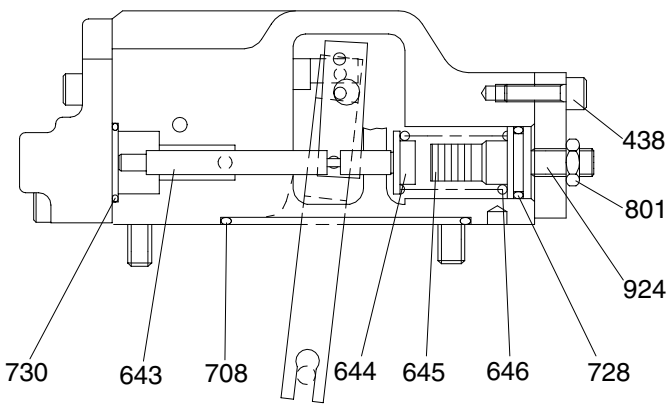
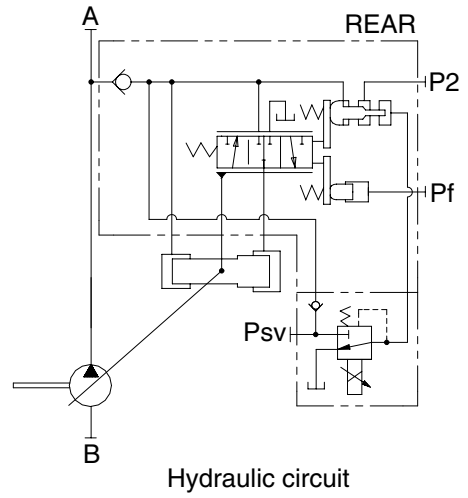
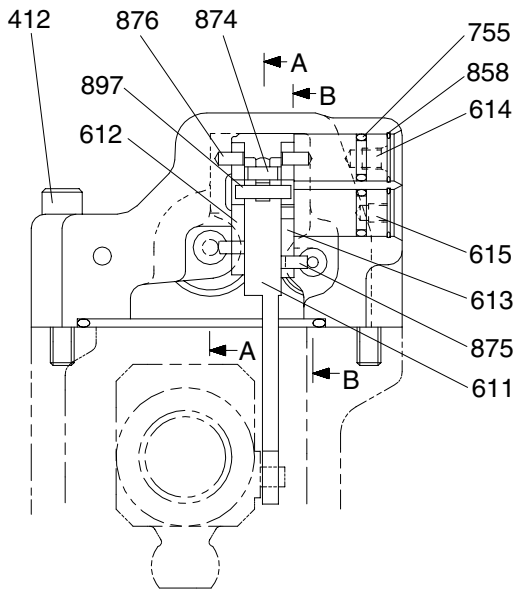


VIEW C

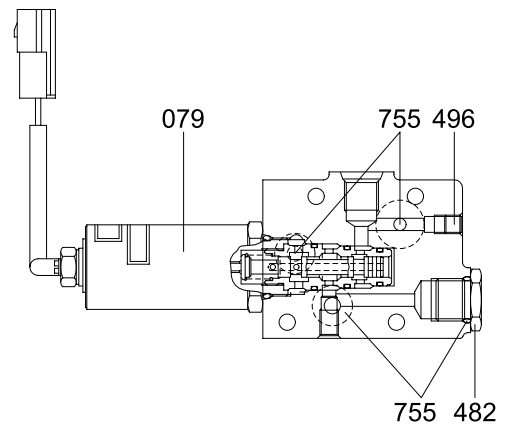
Port	Port name	Port size
Pi1, Pi2	Pilot port	PF 1/4-15
Psv1, Psv2	Servo assist port	PF 1/4-15

38092RG01

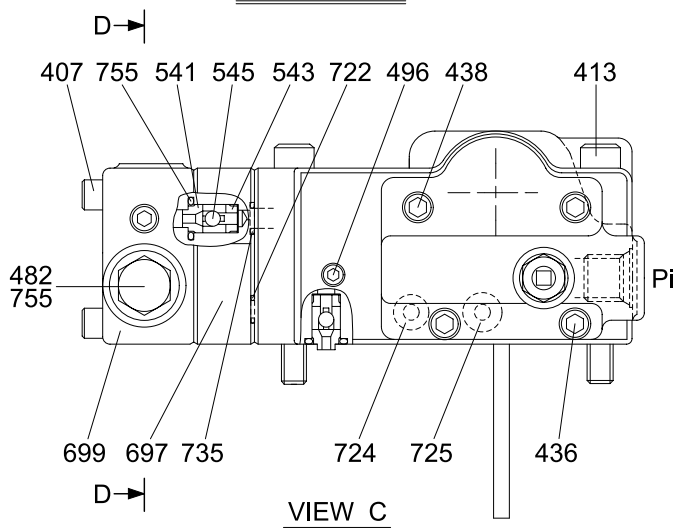
3) REAR REGULATOR (1/2)



SECTION B-B



SECTION D-D

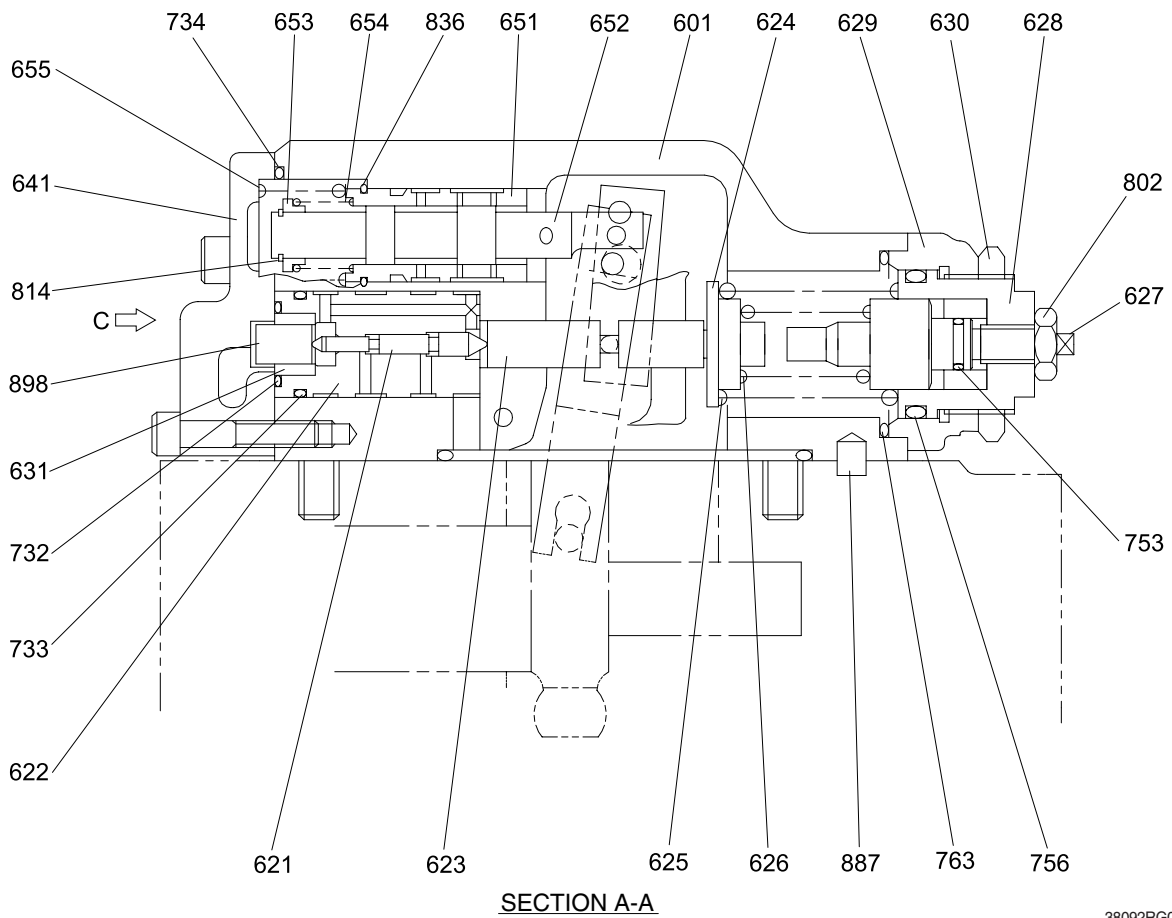


VIEW C

Port	Port name	Port size
Pi1, Pi2	Pilot port	PF 1/4-15
Psv1, Psv2	Servo assist port	PF 1/4-15

38092RG02

REGULATOR (2/2)

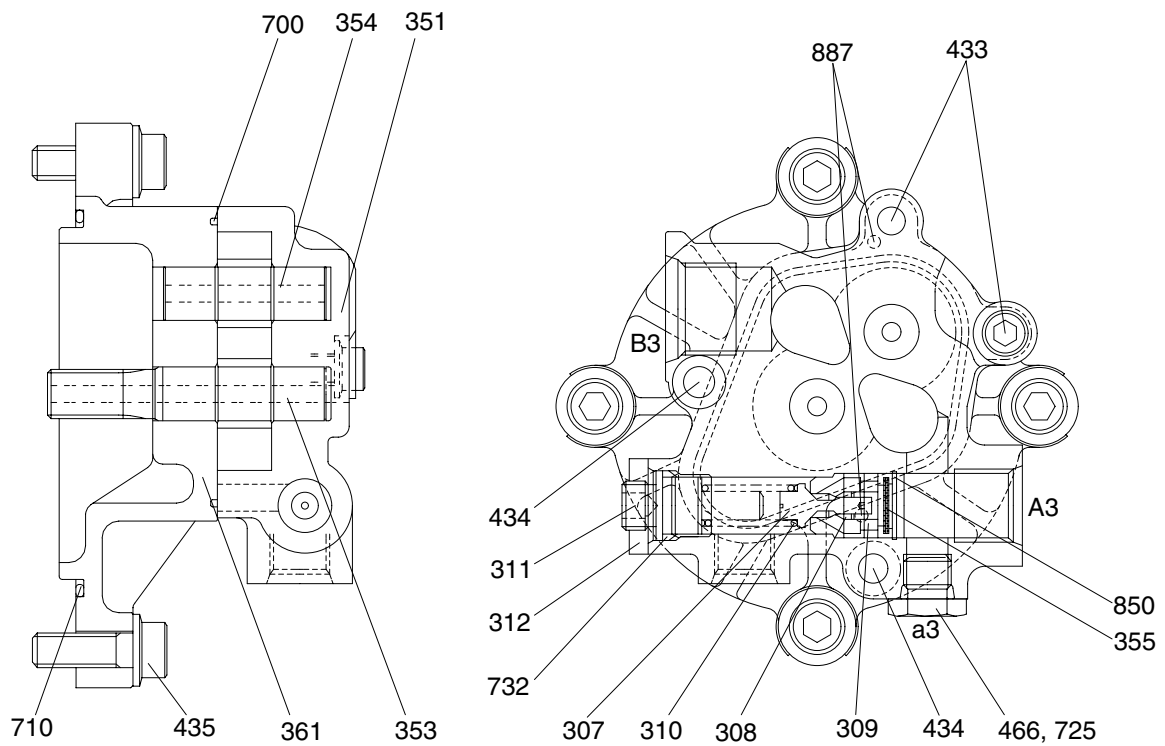


SECTION A-A

38092RG03

408 Hexagon socket bolt	627 Adjust stem (C)	730 O-ring
412 Hexagon socket bolt	628 Adjust screw (C)	732 O-ring
413 Hexagon socket bolt	629 Cover (C)	733 O-ring
436 Hexagon socket bolt	630 Lock nut	734 O-ring
438 Hexagon socket bolt	631 Sleeve, pf	735 O-ring
466 Plug	641 Pilot cover	753 O-ring
496 Plug	643 Pilot piston	755 O-ring
541 Seat	644 Spring seat (Q)	756 O-ring
543 Stopper	645 Adjust stem (Q)	763 O-ring
545 Steel ball	646 Pilot spring	801 Hexagon nut
601 Casing	651 Sleeve	814 Snap ring
611 Feedback lever	652 Spool	836 Stop ring
612 Lever(1)	653 Spring seat	858 Snap ring
613 Lever(2)	654 Return spring	874 Pin
614 Center plug	655 Set spring	875 Pin
615 Adjust plug	696 Port cover	876 Pin
621 Compensator piston	697 Check valve plate	887 Pin
622 Piston case	708 O-ring	897 Pin
623 Compensator rod	722 O-ring	898 Pin
624 Spring seat (C)	724 O-ring	924 Set screw
625 Outer spring	725 O-ring	
626 Inner spring	728 O-ring	

4) GEAR PUMP



29092MP05

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

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

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

2. FUNCTION

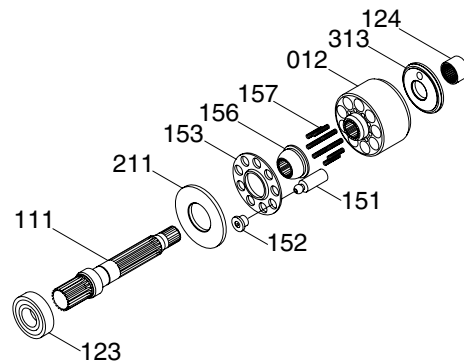
1) MAIN PUMP

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 (012), piston shoes (151,152), set plate (153), spherical bush (156) and cylinder spring (157). The drive shaft is supported by bearing (123,124) at its both ends.

The shoe is caulked to the piston to 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.



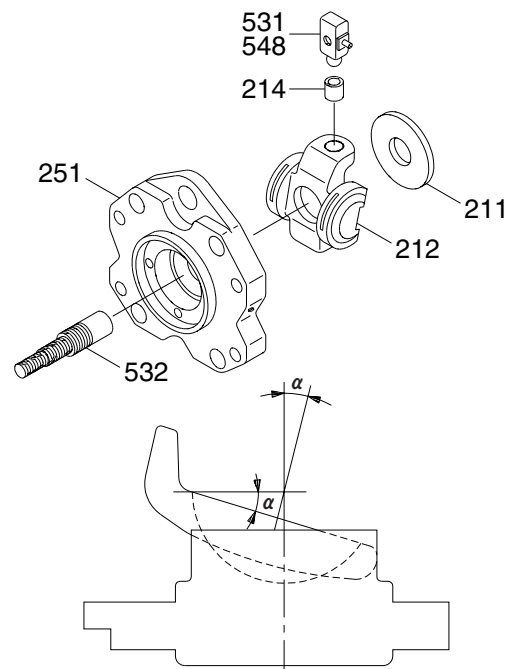
32092MP03

(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)



3607A2MP10

(3) Valve block group

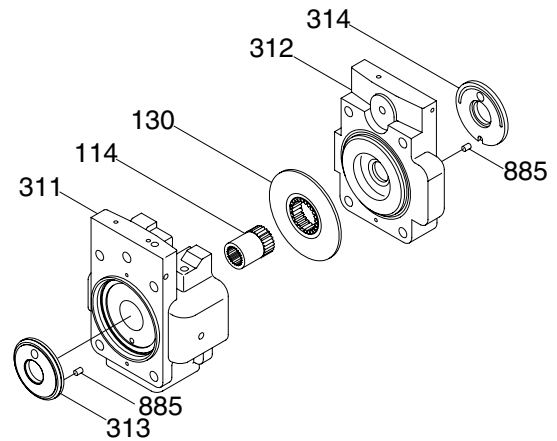
The valve block group consists of valve cover (F, 311), valve cover (F, 312), valve plate (313, 314), spline coupling (114), booster (130) and valve plate pin (885).

The valve plate having two melon-shaped ports is fixed to the valve 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.



38092MP04

2) REGULATOR

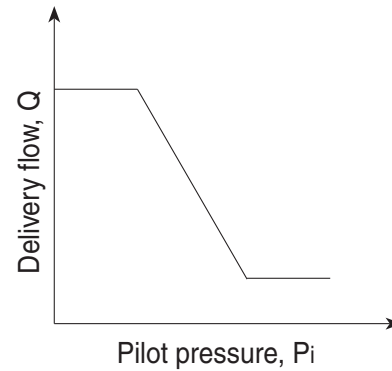
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

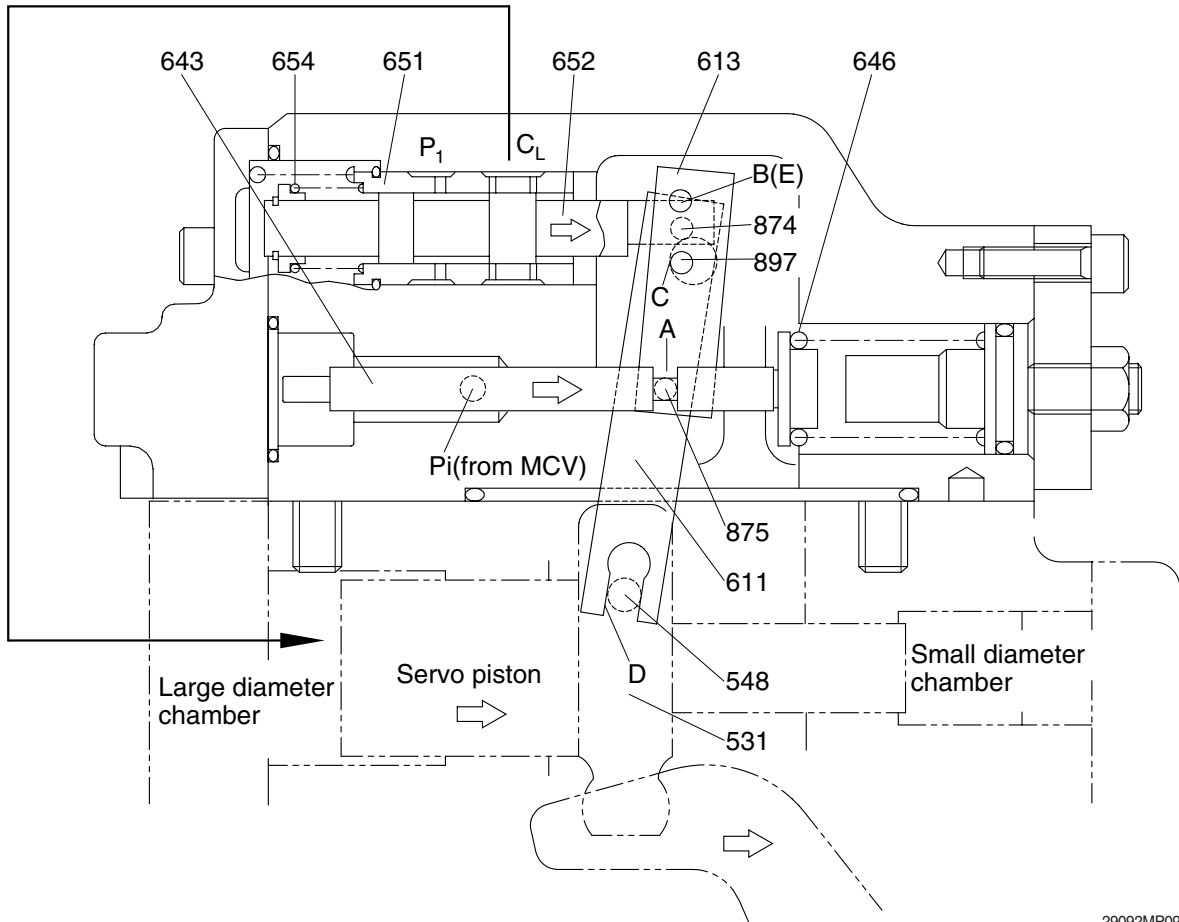
By changing the pilot pressure P_i , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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

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



① Flow reducing function



29092MP09A

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

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

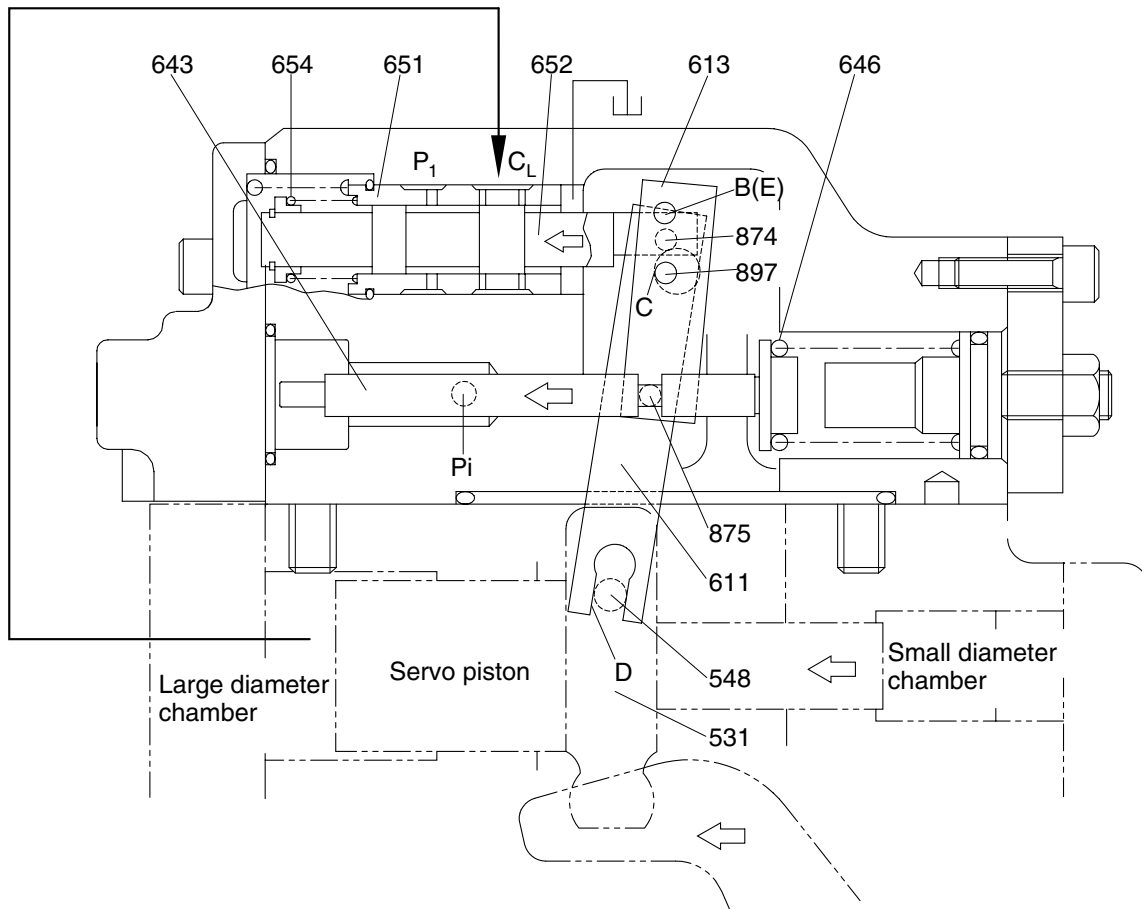
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

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

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

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

② Flow increasing function



29092MP10

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

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

③ Adjustment of flow control characteristic

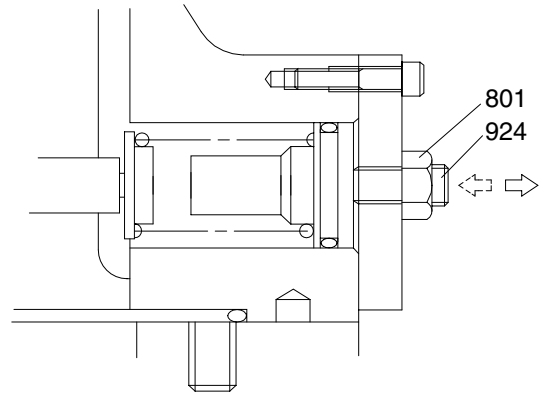
The flow control characteristic can be adjusted with the adjusting screw.

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

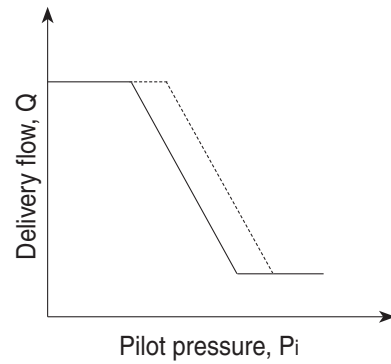
Tightening the screw shifts the control chart to the right as shown in the figure.

※ Adjusting values are shown in table.

Speed (min ⁻¹)	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw (924) (Turn)	Flow control starting pressure change amount (kgf/cm ²)	Flow change amount (l /min)
1750	+1/4	+1.6	+18.3



R290RE08(1)



(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.

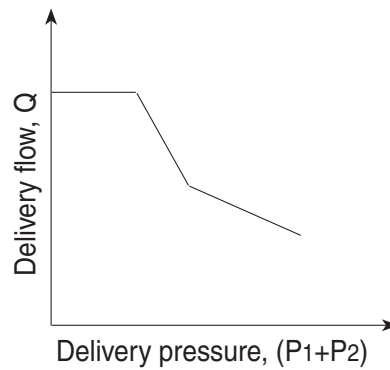
(The input horsepower is constant when the speed is constant.)

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.

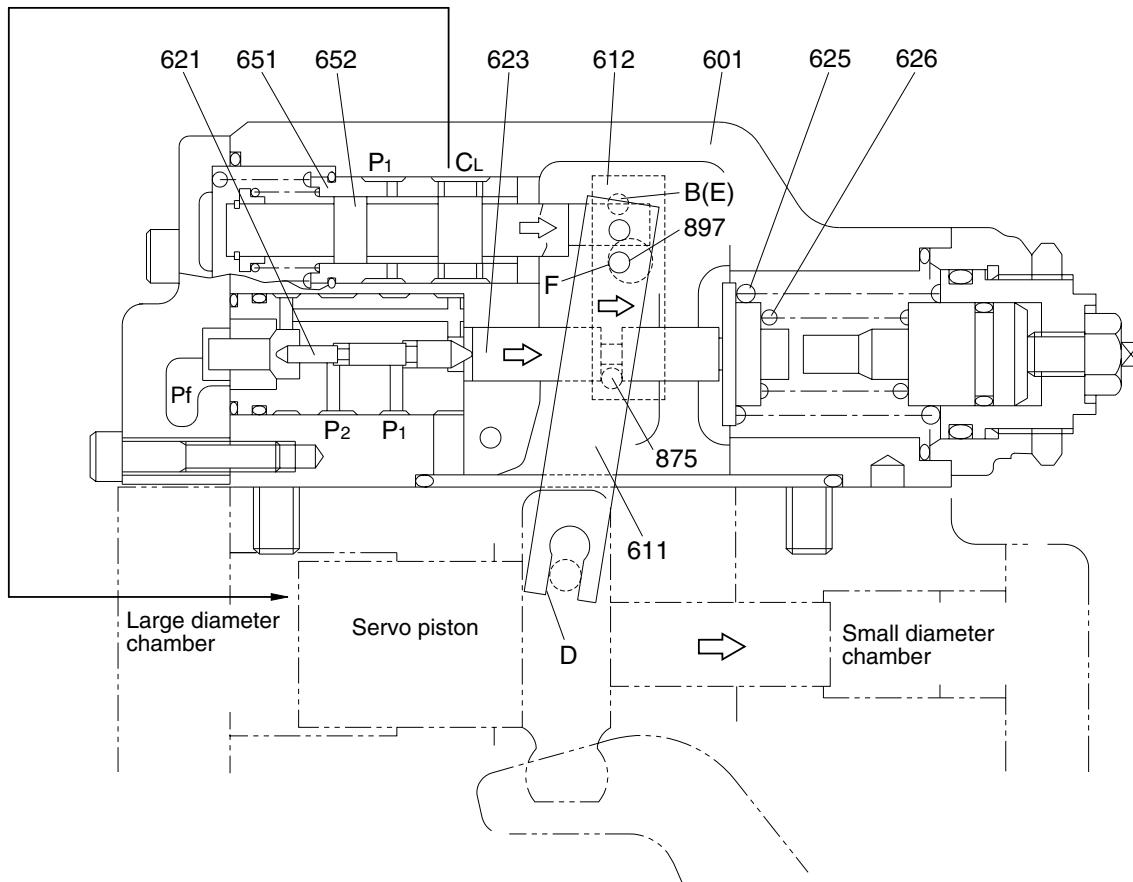
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation :

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

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



① Overload preventive function

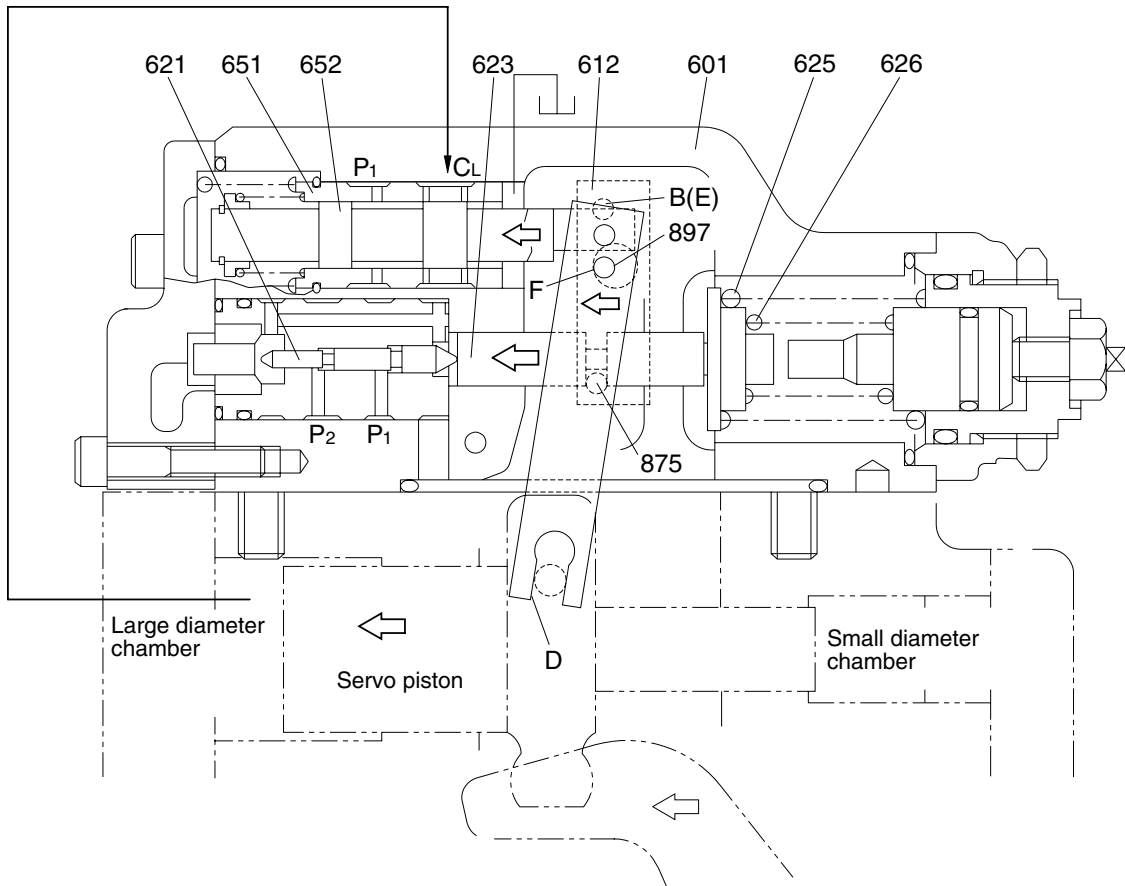


R130RE01

When the self pump delivery pressure P_1 or the companion pump delivery pressure P_2 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 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 P_1 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



R130RE11

As the self pump delivery pressure P_1 or the companion pump delivery pressure P_2 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**

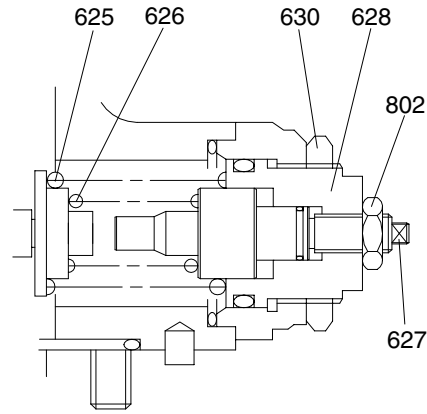
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins ($\varnothing 4$) protruding from the large hole ($\varnothing 8$), only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

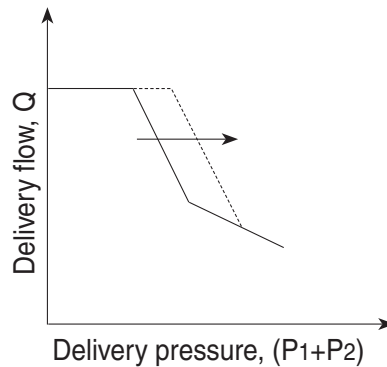
Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting screw QI (627) by $N \times A$ turns at first. ($A=1.85$)



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

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw (C) (628)	Compensating control starting pressure change amount	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(kgf · m)
1750	+1/4	+17.7	+8.5

8007A2MP03



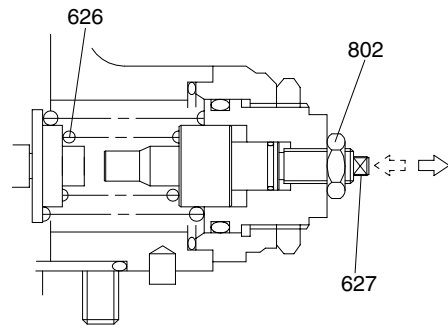
b. Adjustment of inner spring

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

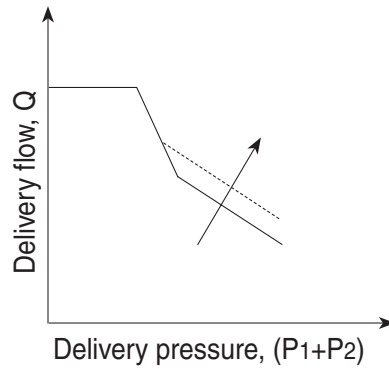
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table.

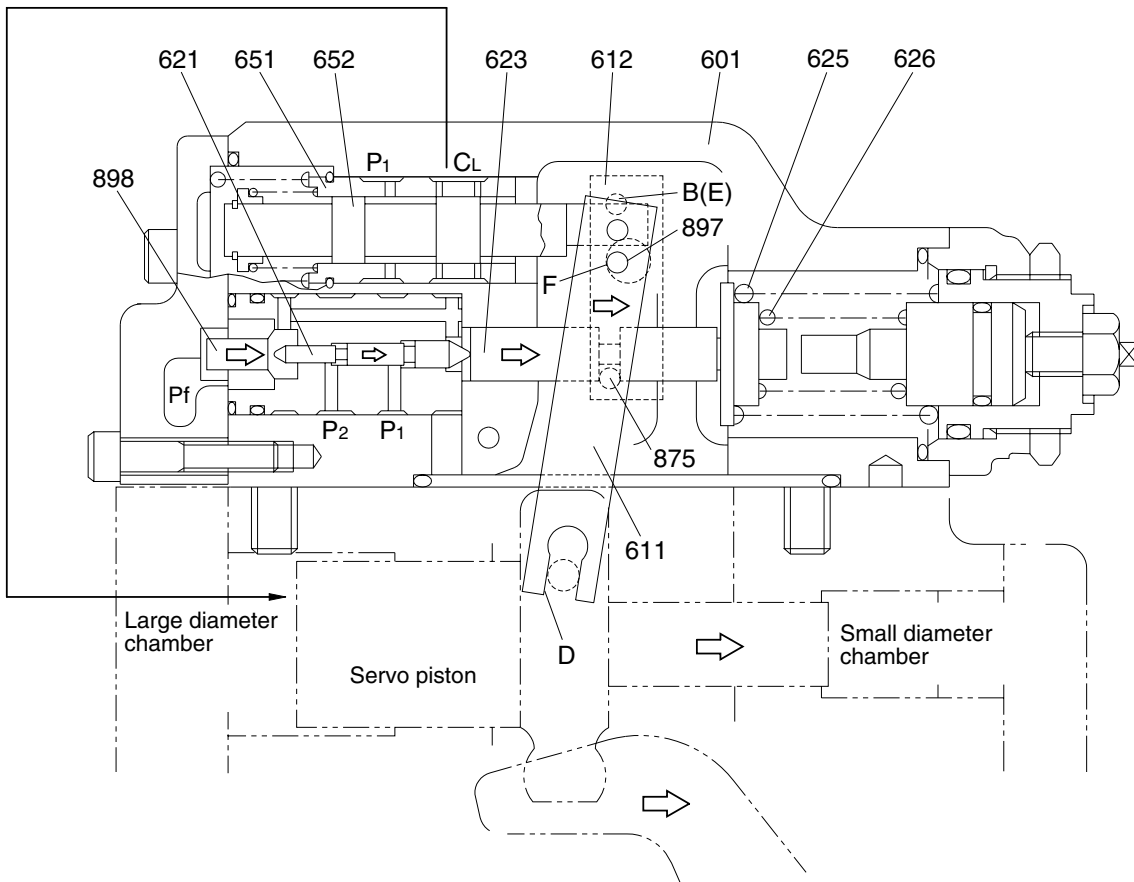
Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw (QI) (627)	Flow change amount (lpm)	Input torque change amount
(min ⁻¹)	(Turn)	(kgf/cm ²)	(kgf · m)
1750	+1/4	+16.7	+9.2



8007A2MP04



(3) Power shift control



R130RE13

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

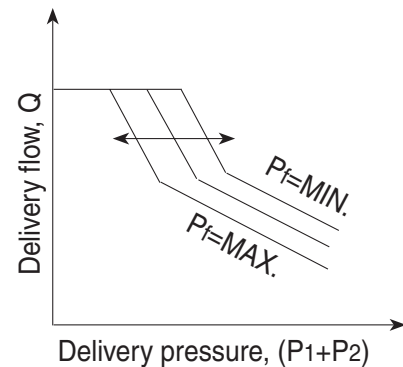
However, the secondary pressure P_f (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.

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

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

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

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



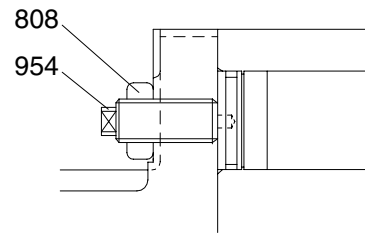
(4) Adjustment of maximum and minimum flows

① Adjustment of maximum flow

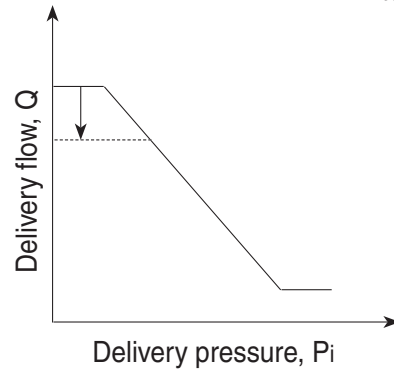
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

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

Speed	Adjustment of max flow spring	
	Tightening amount of adjusting screw (954)	Flow change amount
(min ⁻¹)	(Turn)	(l/min)
1750	+1/4	-6.7



R290RE08(5)

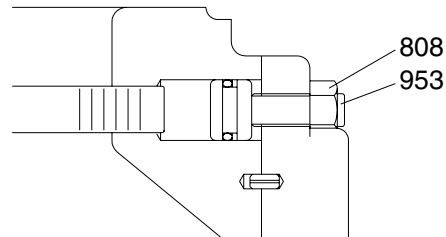


② Adjustment of minimum flow

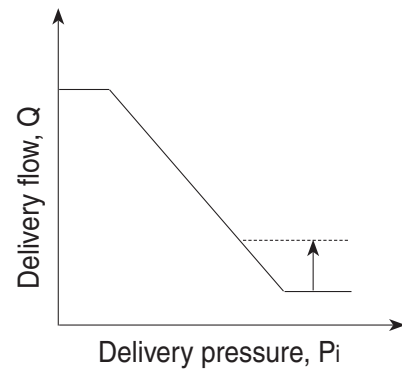
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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 spring	
	Tightening amount of adjusting screw (953)	Flow change amount
(min ⁻¹)	(Turn)	(l/min)
1750	+1/4	+6.7

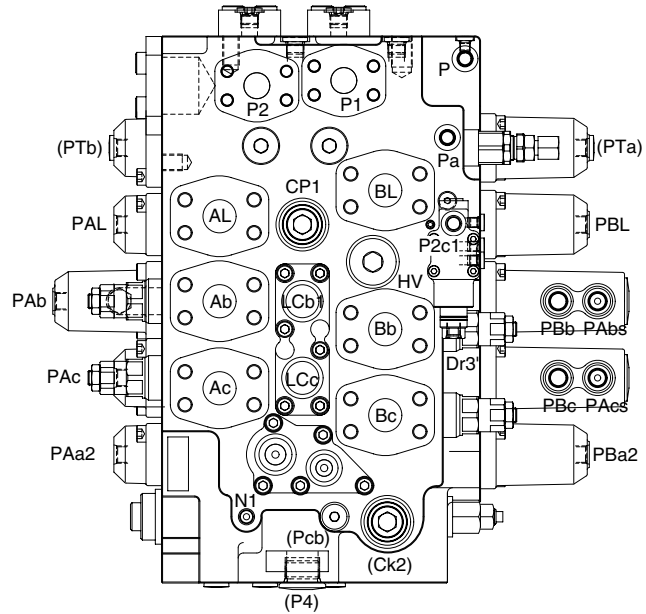
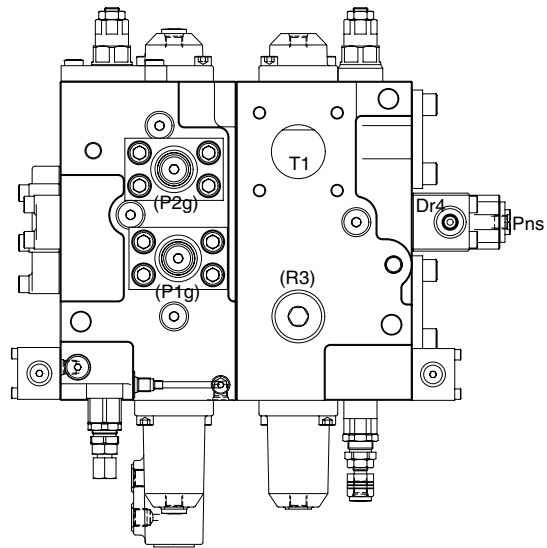


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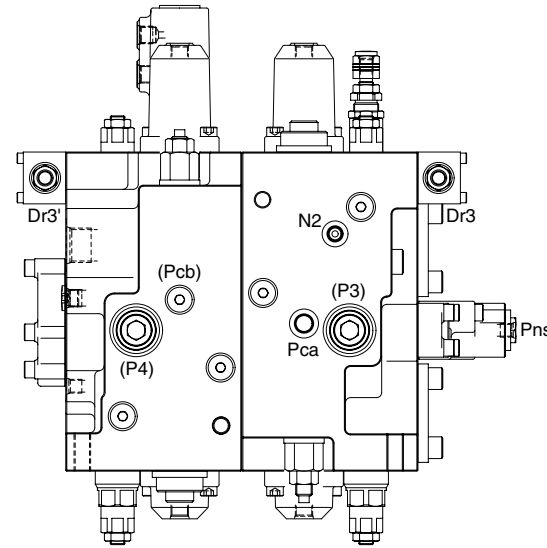


GROUP 2 MAIN CONTROL VALVE

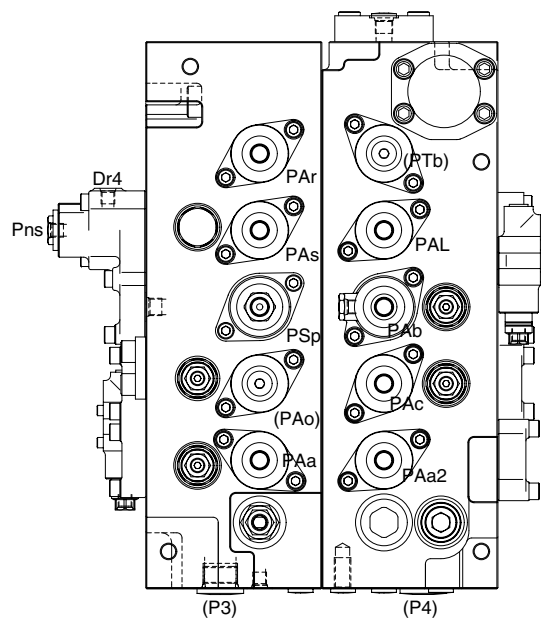
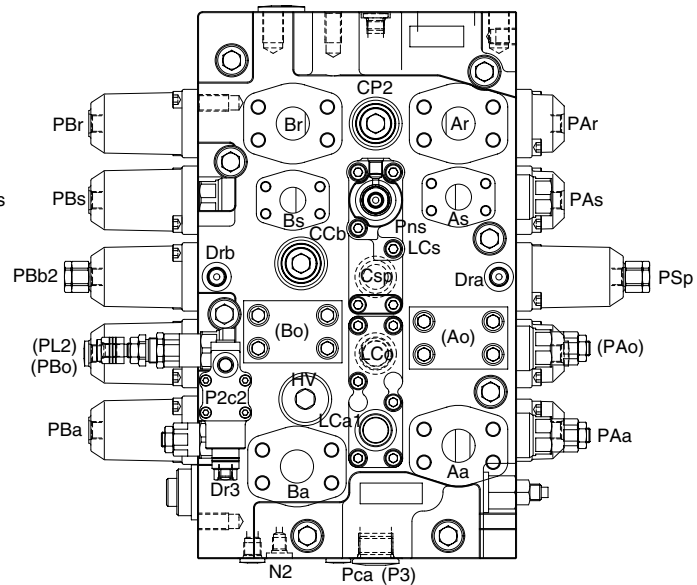
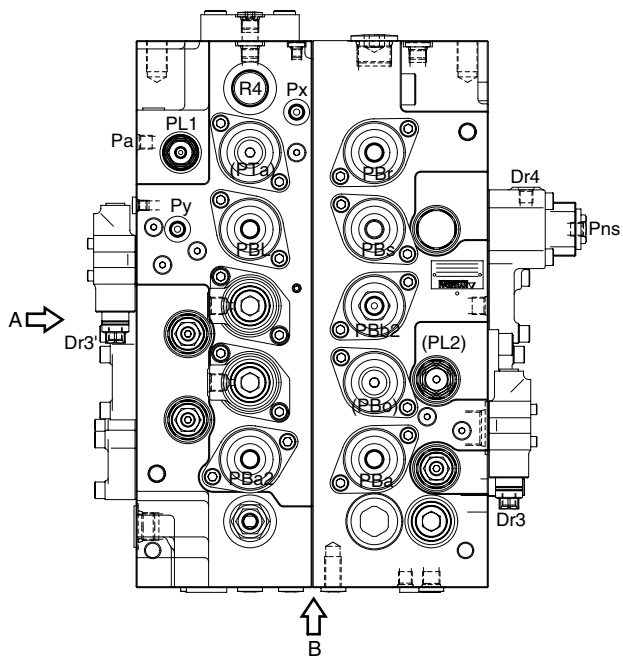
1. STRUCTURE (1/4)



VIEW A



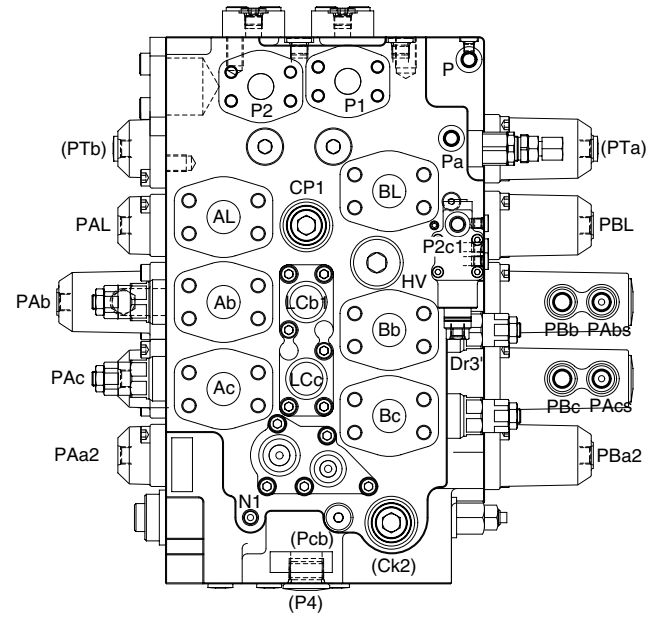
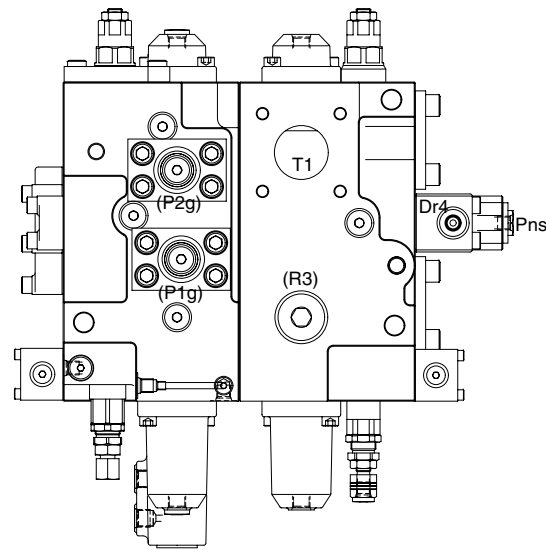
VIEW B



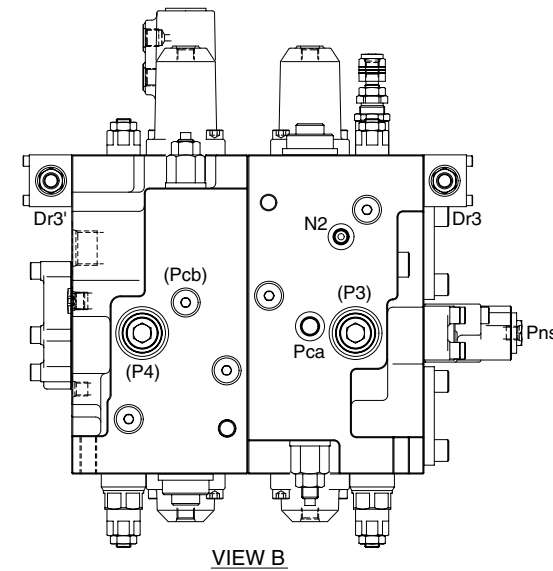
Mark	Port name	Port size	Tightening torque
(R3)	-	G-1	15~18 kgf · m (108.5~130 lbf · ft)
R4	Make up port		
(P3)	-		
(P4)	-		
(Ck2)	-		
PAa	Arm 1 (in) pilot port	G-3/8	7~8 kgf · m (50.6~57.8 lbf · ft)
PBa	Arm 1 (out) pilot port		
PAb	Boom (down) pilot port		
PBb	Boom (up) pilot port		
PAC	Bucket (in) pilot port		
PBC	Bucket (out) pilot port		
PAL	Travel right (reverse) pilot port		
PBL	Travel right (forward) pilot port		
PAr	Travel left (reverse) pilot port		
PBr	Travel left (forward) pilot port		
PAs	Swing (left) pilot port		
PBs	Swing (right) pilot port		
PAa2	Arm 2 (in) pilot port		
PBa2	Arm 2 (out) pilot port		
PBb2	Boom (up) confluence pilot port		
(PAo)	Optional pilot port		
(PBo)	Optional pilot port		
PABs	Boom (down) stroke limiter pilot port		
PACs	Bucket (in) stroke limiter pilot port		
Pca	Bypass cut spool (P2 side) pilot port		
(Pcb)	Bypass cut spool (P1 side) pilot port		
Dra	Drain port		
Drb	Drain port		
(PTa)	-	G-1/4	3.5~4.0 kgf · m (25.3~29 lbf · ft)
(PTb)	-		
(P1g)	Quick clamp solenoid valve supply port		
(P2g)	-		
(Psp)	Swing priority		
P	Pilot port		
Pa	Pilot port		
Px	Pressure port for attachment		
Py	Pressure port for travel		
(PL2)	Option(Bo) port relief valve pilot port for switching to high pressure		
Pns	Boom priority valve pilot port		
P2c1	Lock valve (boom head side) pilot port		
P2c2	Lock valve (arm rod side) pilot port		

3607A2MC12

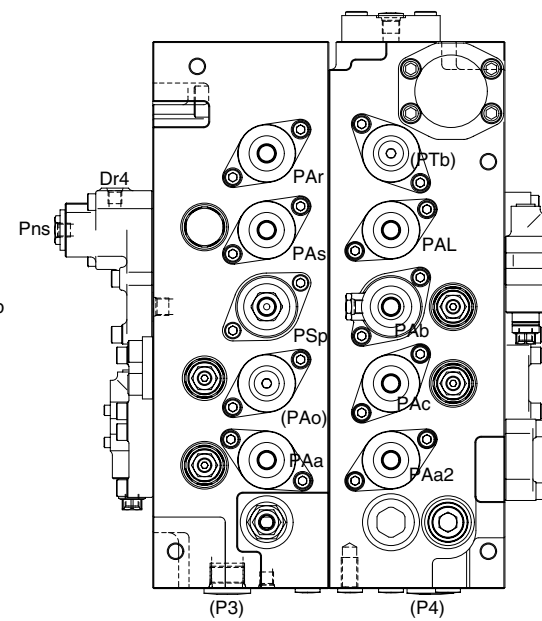
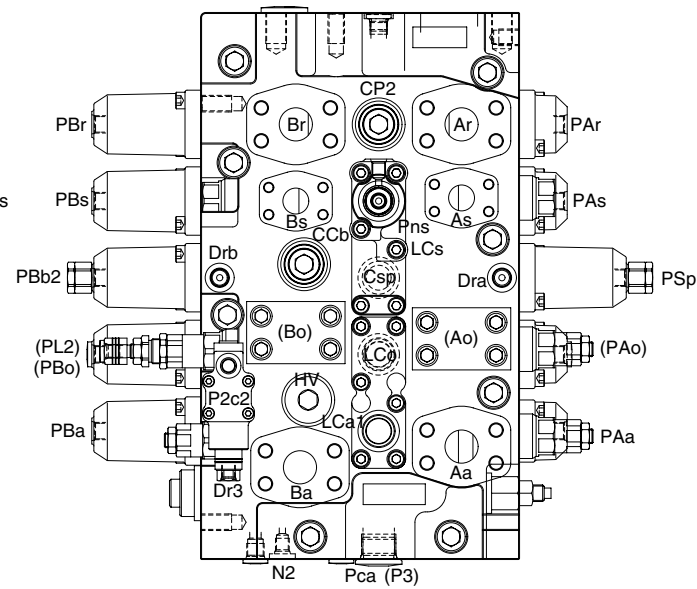
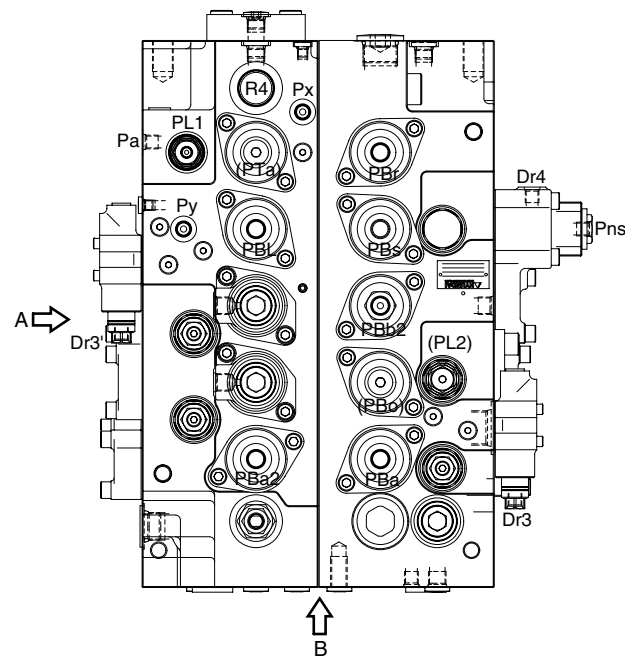
STRUCTURE (2/4)



VIEW A



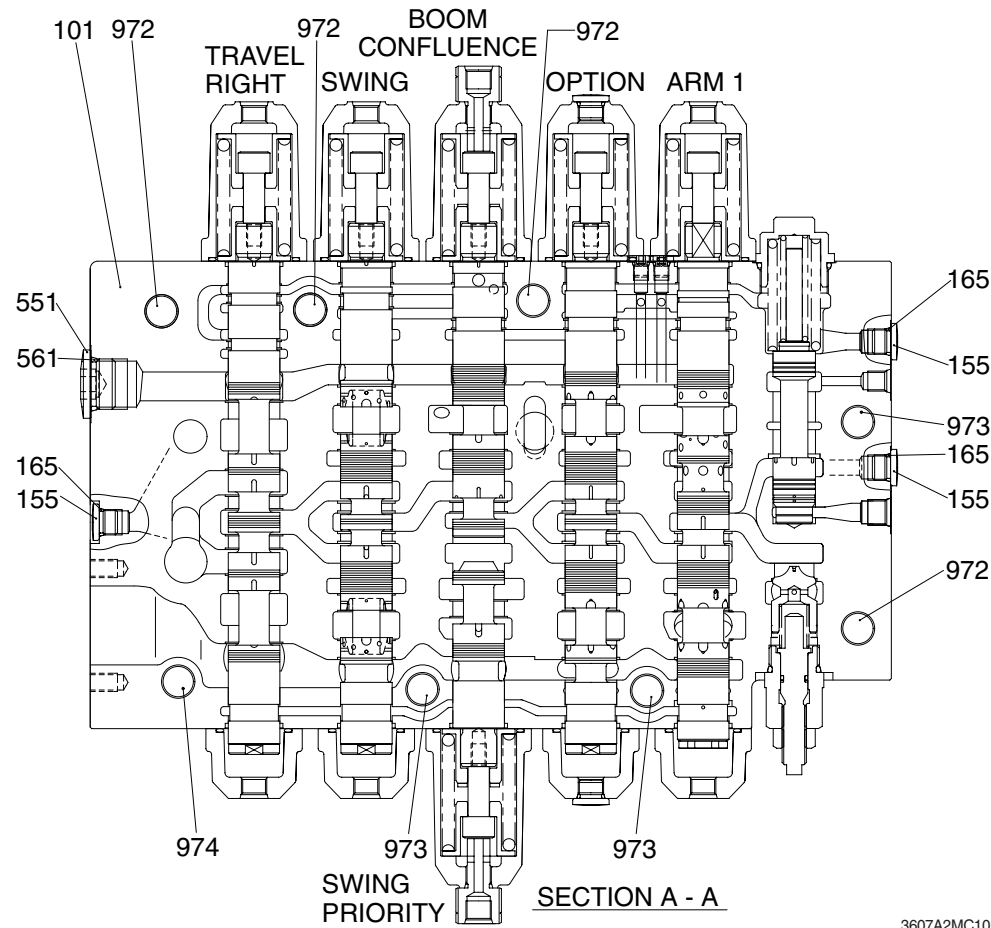
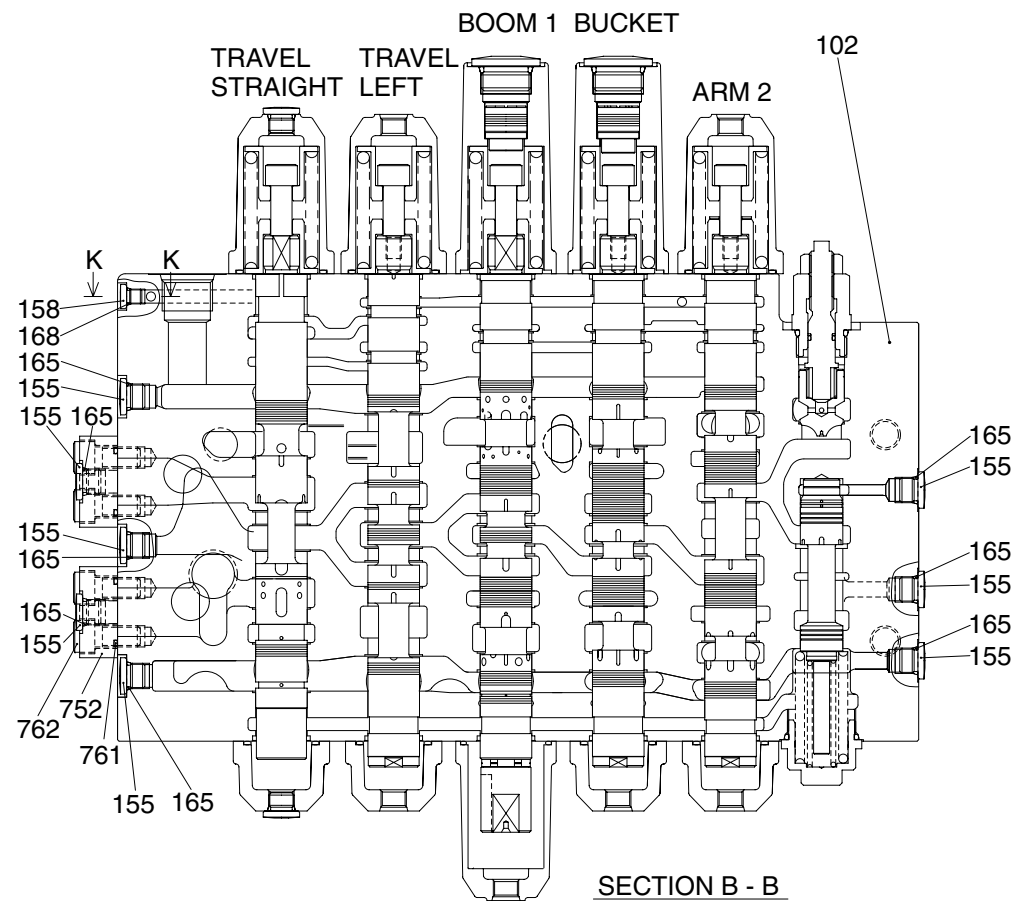
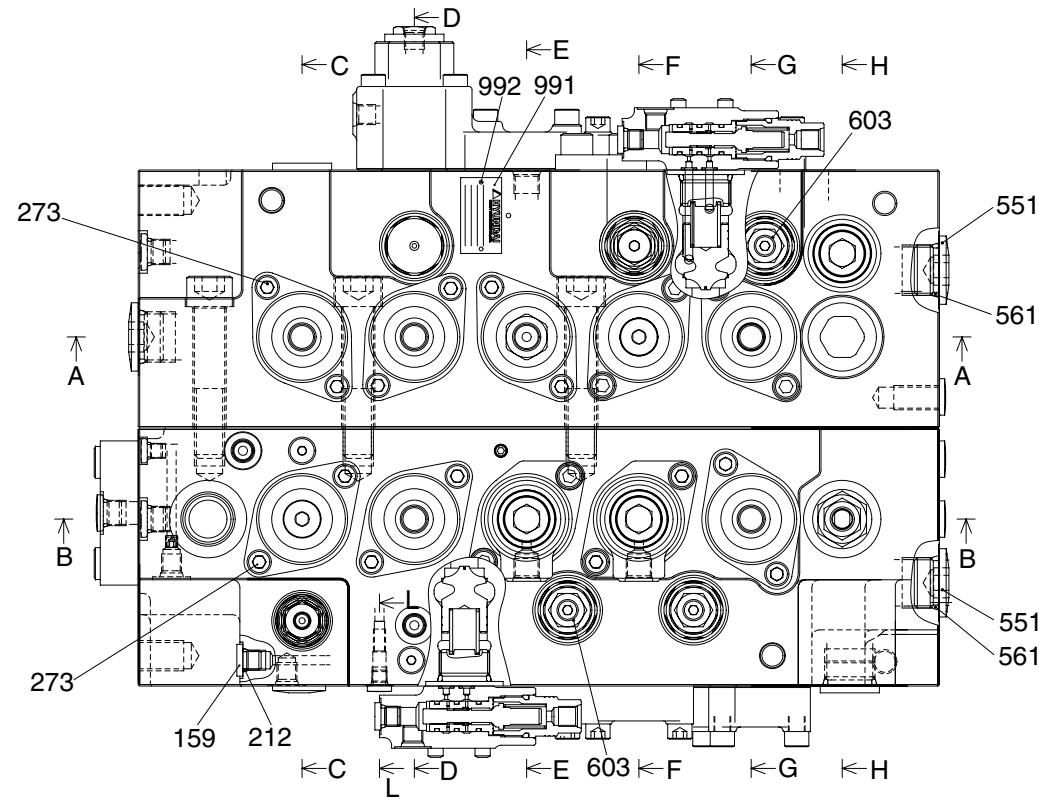
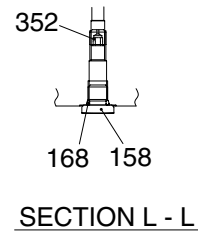
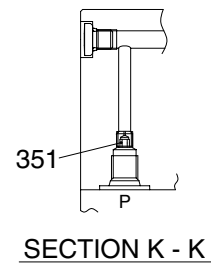
VIEW B



Mark	Port name	Port size	Tightening torque		
N1	Nega-con pressure (boom1 side) port	G-1/4	3.5~4.0 kgf · m (25.3~29 lbf · ft)		
N2	Nega-con pressure (arm1 side) port				
Dr3	Drain port				
Dr3'	Drain port				
Dr4	Drain port				
PL1	Main relief valve pilot port for switching to high pressure	G-1/8	1.5~1.9 kgf · m (10.8~13.7 lbf · ft)		
Aa	Arm cylinder head side port (in)	M14	14~18 kgf · m (101~130 lbf · ft)		
Ba	Arm cylinder rod side port (out)				
Ab	Boom cylinder rod side port (down)				
Bb	Boom cylinder head side port (up)				
Ac	Bucket cylinder head side port (in)				
Bc	Bucket cylinder rod side port (out)				
Ar	Travel left motor (reverse)				
Br	Travel left motor (forward)				
AL	Travel right motor (reverse)				
BL	Travel right motor (forward)				
(Ao)	Optional port				
(Bo)	Optional port				
P1	Pump port (A1 side)			M12	8.5~11 kgf · m (61.5~80 lbf · ft)
P2	Pump port (A2 side)				
T1	Return port				
As	Swing motor port (left)	M10	5~6.5 kgf · m (36~47 lbf · ft)		
Bs	Swing motor port (right)				

3607A2MC12

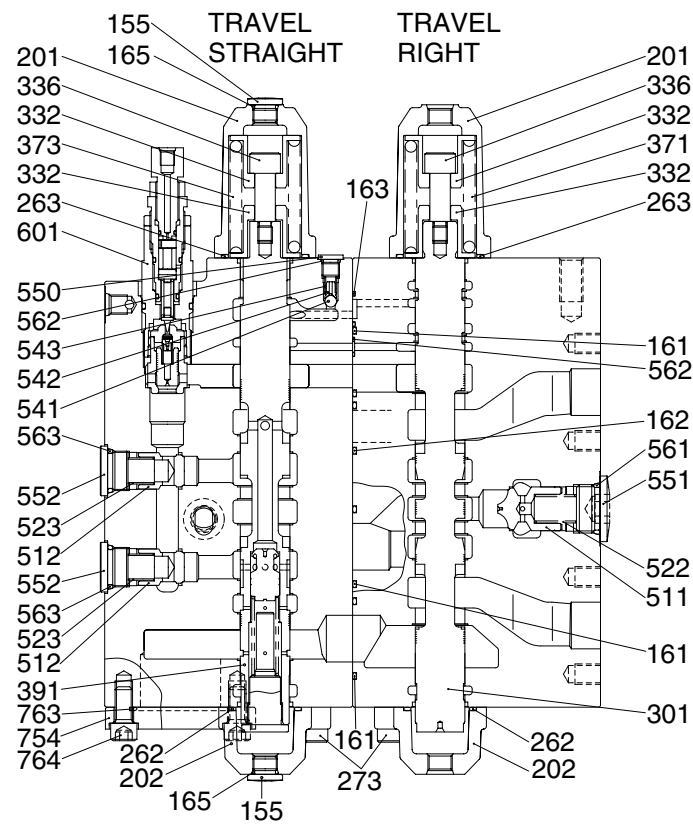
STRUCTURE (3/4)



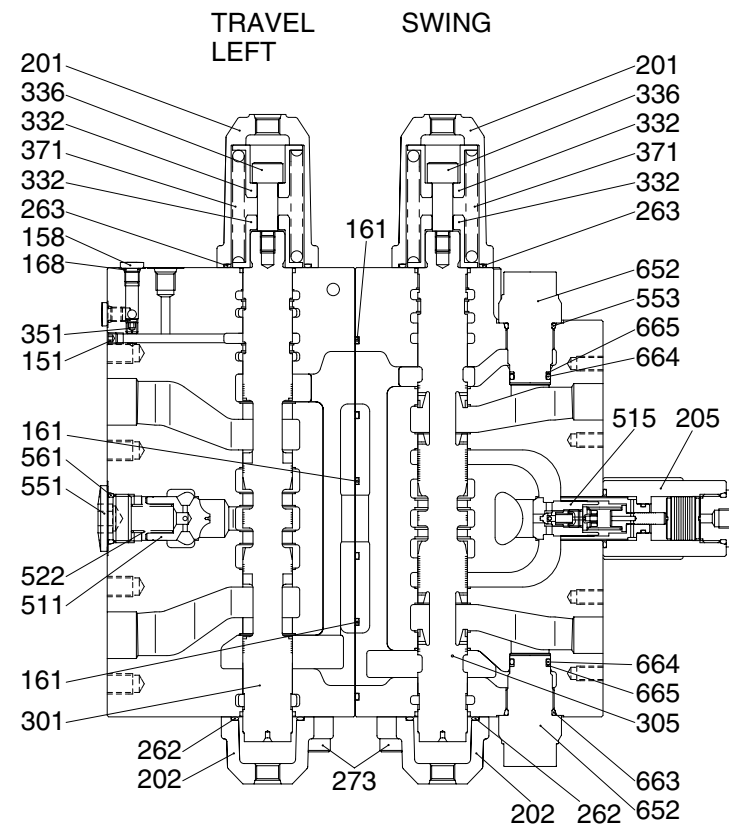
101	Casing-A	373	Spring
102	Casing-B	391	Travel straight spool assy
151	Plug	392	Bypass cut spool
155	Plug	393	Boom confluence spool
158	Plug	394	Arm confluence spool
159	Plug	395	Swing priority spool
161	O-ring	511	Poppet
162	O-ring	512	Poppet
163	O-ring	513	Poppet
165	O-ring	514	Poppet
168	O-ring	515	Boom priority valve assy
201	Cover	522	Spring
202	Cover	523	Spring
203	Cover	524	Spring
204	Cover	525	Spring
205	Cover assy	541	Steel ball
206	Cover	542	Spring seat
208	Cover	543	Spring
211	Plug	550	Plug
212	O-ring	551	Plug
251	Plug	552	Plug
252	Lock valve assy	553	Plug
262	O-ring	554	Plug
263	O-ring	557	Plug assy
264	O-ring	558	Plug
265	O-ring	561	O-ring
267	O-ring	562	O-ring
273	Bolt	563	O-ring
274	Bolt	601	Main relief valve
275	Bolt	603	Port relief valve
301	Travel spool	604	Port relief valve
302	Arm 1 spool assy	605	Port relief valve
303	Boom 1 spoo; assy	611	Negative control relief valve
304	Bucket spool	652	Plug
305	Swing spool	663	O-ring
308	Option spool	664	O-ring
313	Plug	665	Backup ring
326	Spring	751	Flange
327	Spring	752	Flange
332	Spring seat	754	Flange
335	Shim	761	O-ring
336	Bolt	762	Bolt
337	Rod	763	O-ring
351	Orifice	764	Bolt
352	Orifice	972	Bolt
355	Piston	973	Bolt
356	Piston	974	Bolt
371	Spring	991	Name plate
372	Spring	992	Pin

3607A2MC10

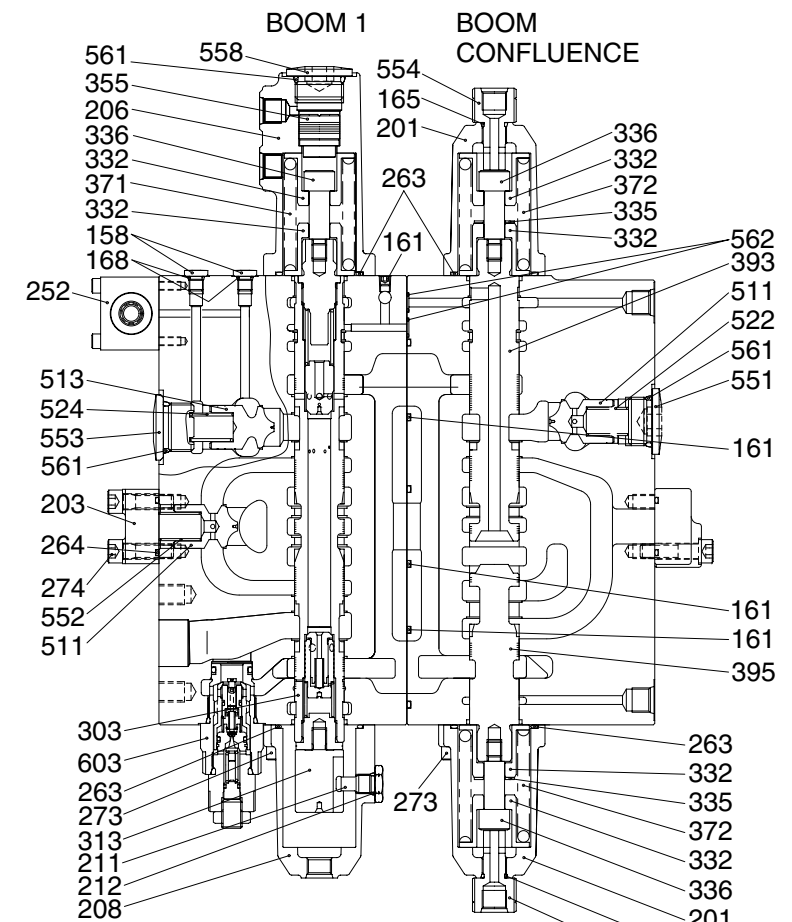
STRUCTURE (4/4)



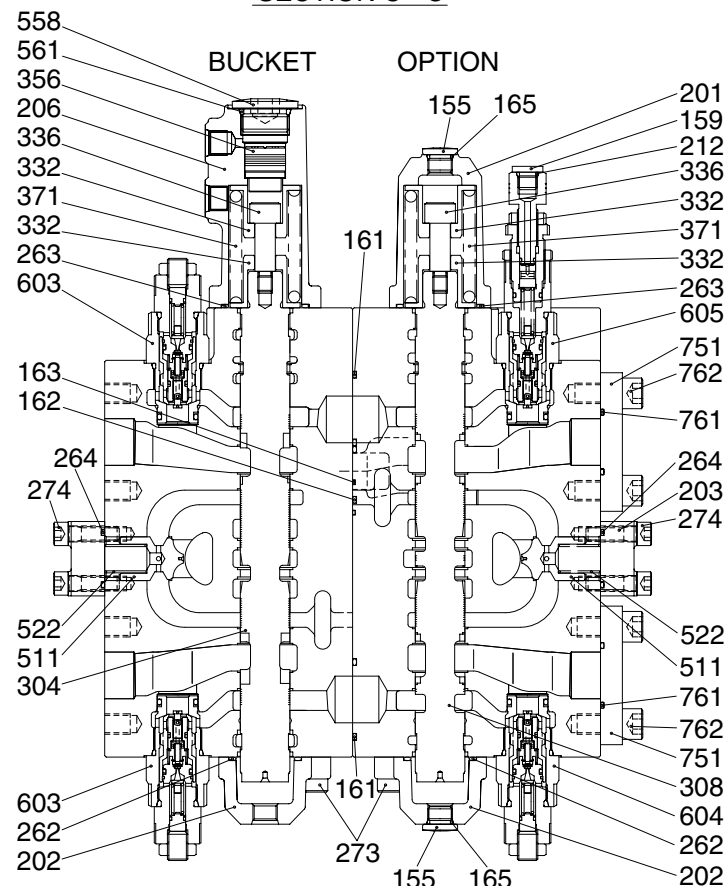
SECTION C - C



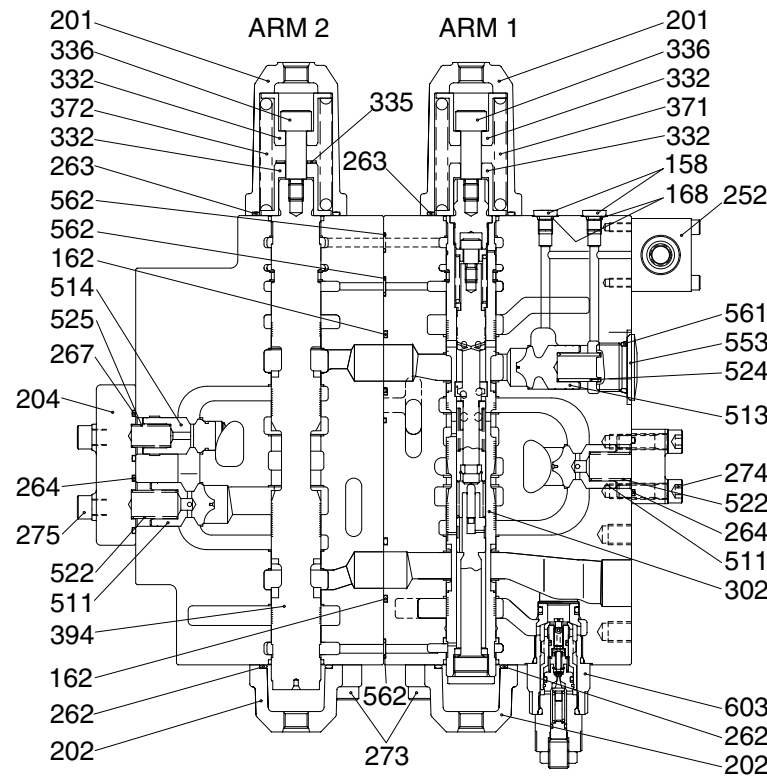
SECTION D - D



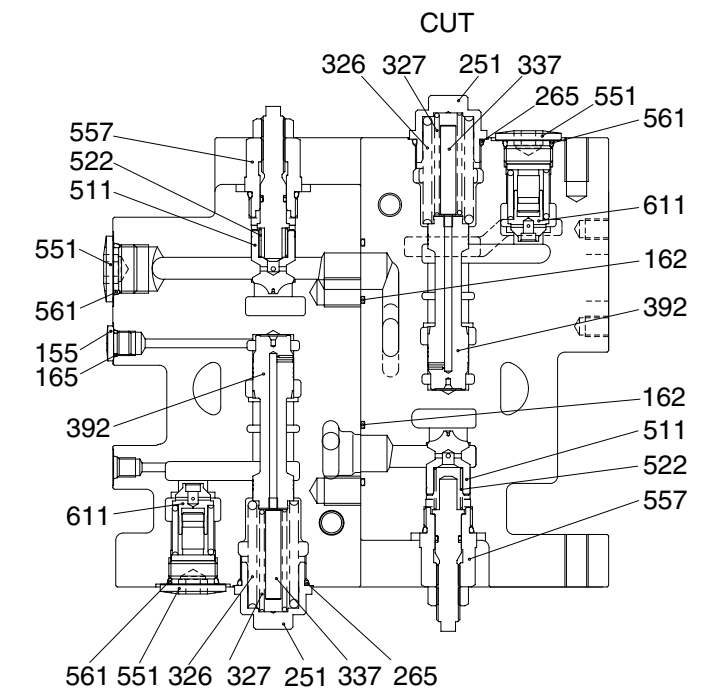
SECTION E - E



SECTION F - F



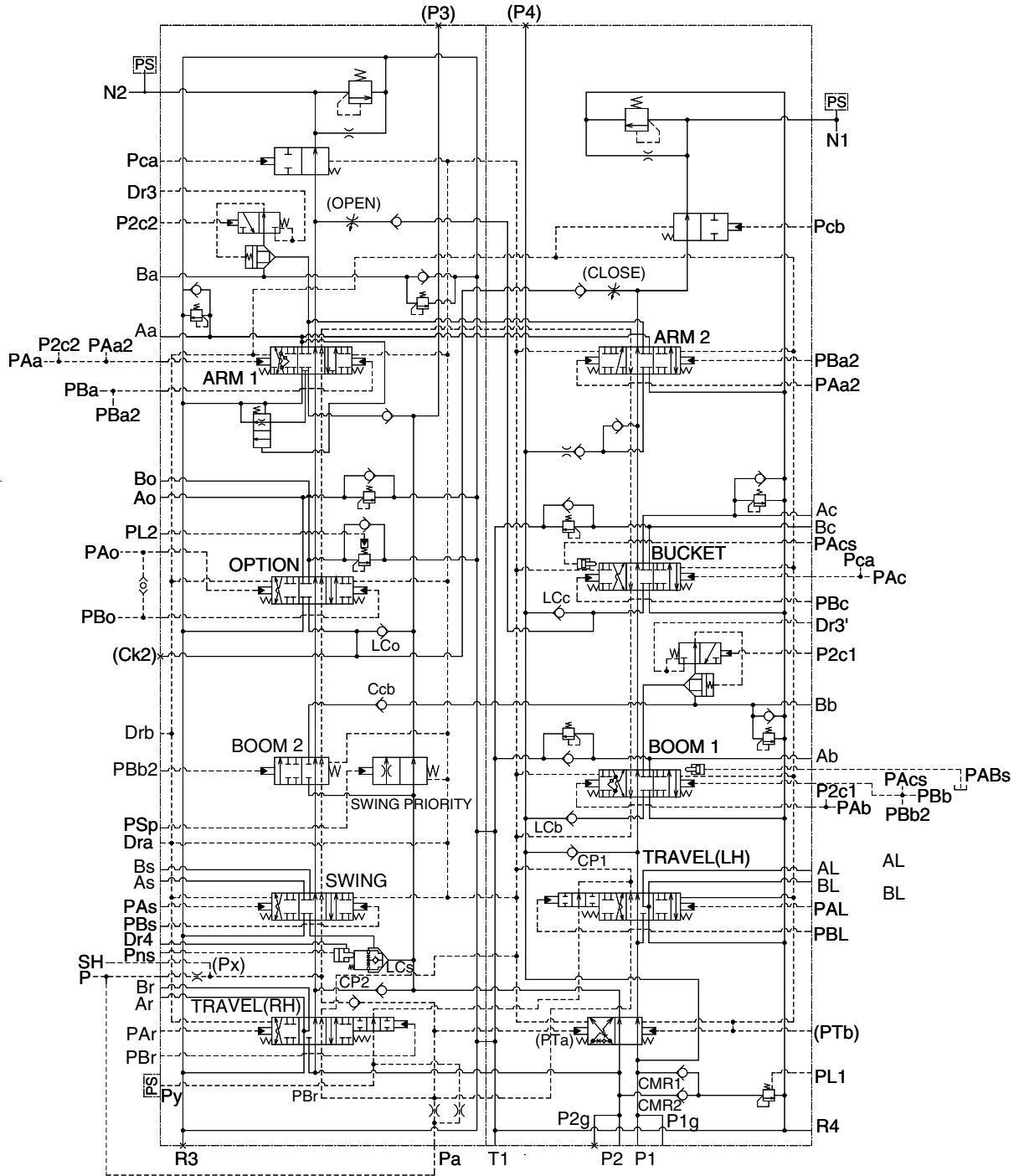
SECTION G - G



SECTION H - H

2. FUNCTION

1) HYDRAULIC CIRCUIT



3607A2MC13

2) OPERATION

(1) Neutral positions of spools

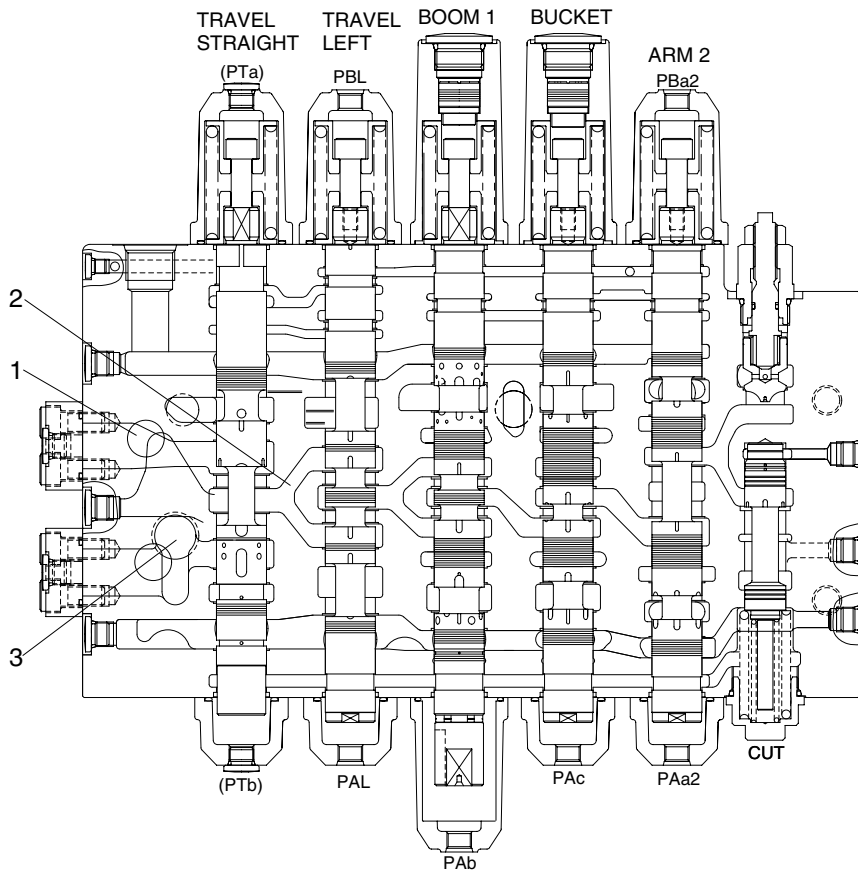
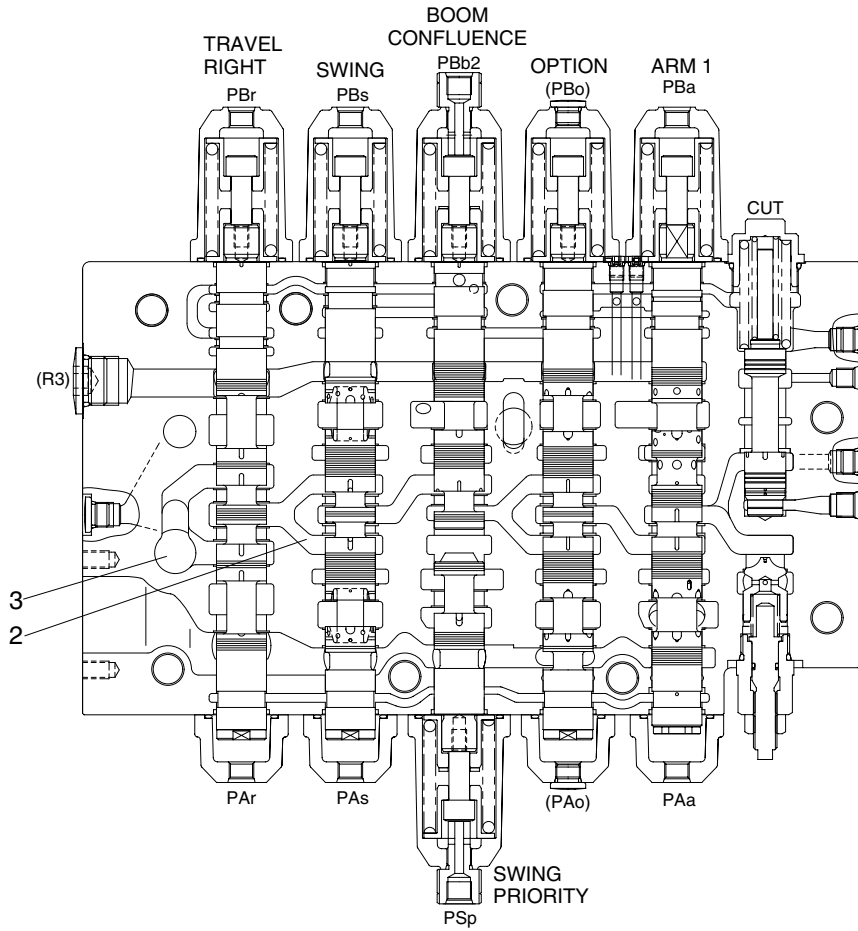
When all spools are in the neutral positions, the pressurized oil discharged from the hydraulic pump (A1) passes through Port P1, the main path (1), the bypass circuit (2) passing the spools for boom1, bucket and arm 2, and boom 1 side negative control orifice, and returns to the hydraulic oil tank through the tank port (T1).

The pressure upstream the boom 1 side negative control orifice (the negative control signal pressure) is led from port N1 to the regulator on the hydraulic pump (A1) side, and controls the pump discharge flow rate to its minimum value.

The oil discharged from the hydraulic pump (A2) passes through port P2, the main path (3), the bypass circuit (2) passing the spools for swing, boom confluence (boom 2), option and arm 1, and the arm 1 side negative control orifice, and returns to the hydraulic oil tank through the tank port (T1).

The pressure upstream the arm 1 side negative control orifice (the negative control signal pressure) is led from port N2 to the regulator on the hydraulic pump (A2) side, and controls the pump discharge flow rate to its minimum value.

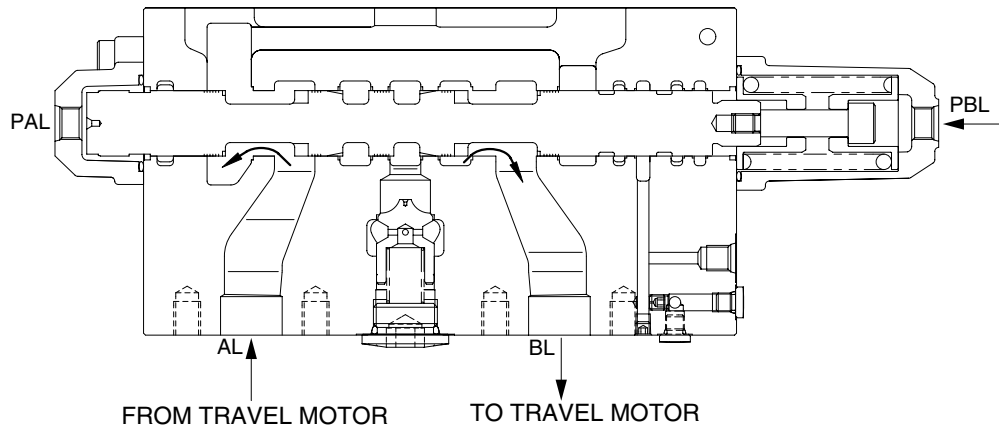
When any of nine main spools is changed over, the bypass circuit (2) is cut off and the hydraulic oil at port N1 or N2 in the negative control circuit is shut off.



3607A2MC14

(2) Travel operation

When pilot port PBL of the travel left spool is pressurized, the bypass circuit (2) in the arm 2 side is shut off and pressurized oil from port P2 passes through port BL and flows to the travel motor. On the other hand, the return oil from the travel motor passes through port AL and returns to the hydraulic oil tank through the tank port (T1).



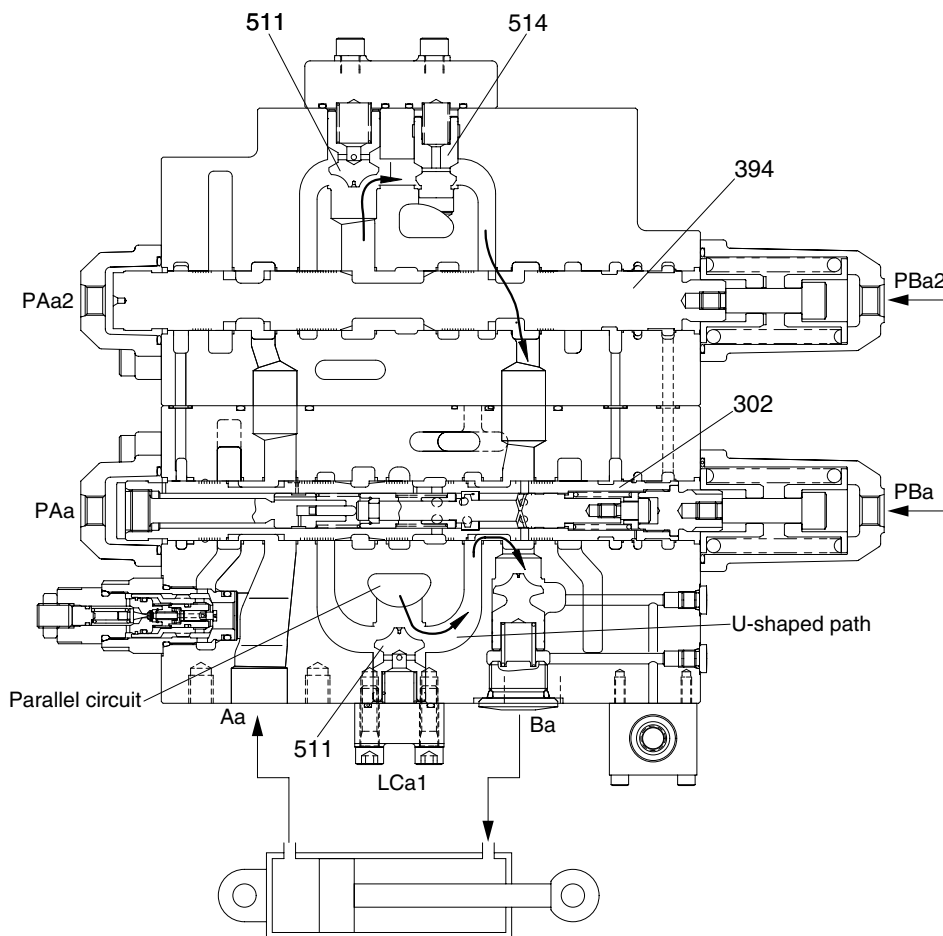
3607A2MC15

(3) Arm

① Arm out operation

During the arm out operation the pilot pressure enters through ports PBa and PBa2. When the pressure enters through port PBa, the spool transfers in the left direction in figure. The hydraulic oil entering through port P2 Passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool. Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm1 spool (302). Then, it flows around the periphery of the arm 1 spool (302) to port Ba, and is supplied to the arm cylinder rod side (R).

On the other hand, the oil entering through port P1 passes in the main path (1), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (394). Oil from the parallel circuit pushes open the check valve (514) and oil from the bypass circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (394). Then, it flows around the periphery of arm 2 spool in the inside path and joins into port Ba. Besides, the return oil from the arm cylinder head side (H) passes through port Aa, flows into tank line in arm 1 side and in arm 2 side and returns to the hydraulic oil tank through the tank port (T1).



3607A2MC16

② Arm in operation

During the arm in operation, the pilot pressure enters through ports PAa and PAa2. When the pressure enters through port PAa, the spool transfers in the right direction in figure MC17A. The hydraulic oil entering through port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool. Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 1 spool (302). Then, it flows around the periphery of the arm1 spool to port Aa, and is supplied to the arm cylinder head side (H).

Besides, the oil entering through port P1 passes in the main path (1), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (394). Oil from the parallel circuit pushes open the check valve (514) and oil from the bypass circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (394). Then, it flows around the periphery of arm 2 spool in the inside path and joins into port Aa.

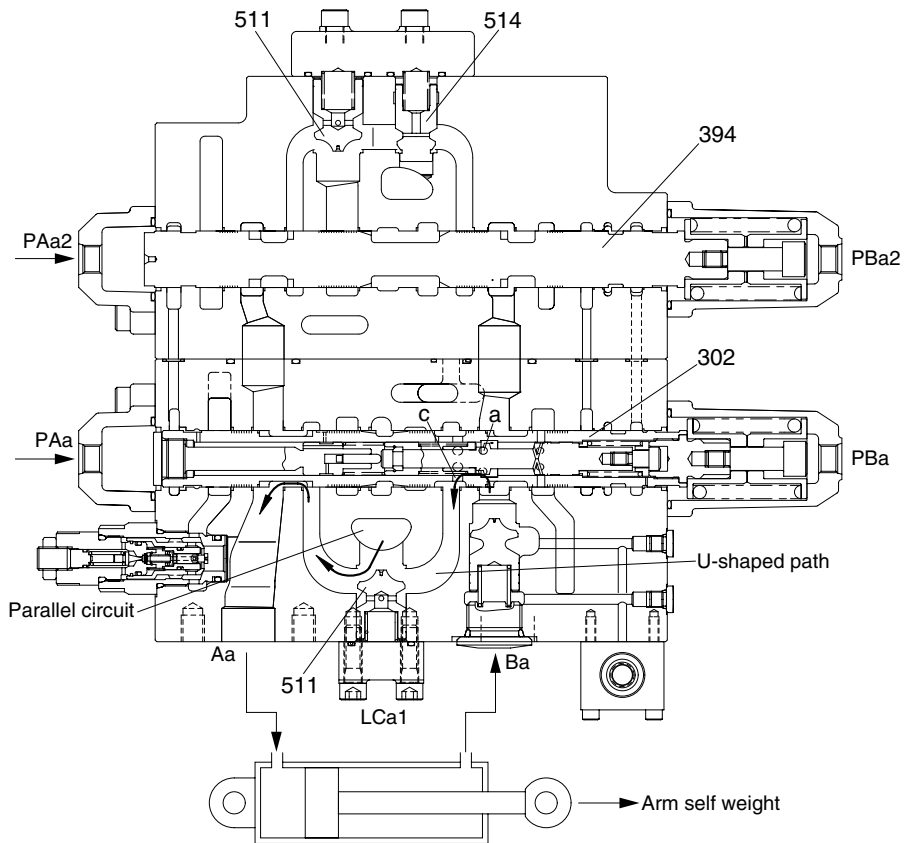
On the other hand, the return oil from the arm cylinder rod side (R) is pressurized by self-weight of the arms and so on, and returns to port Ba. The pressurized oil returning to Port Ba enters into the spool through the outside hole (a) of the arm1 spool (302). During a light load only, it pushes open the sleeve check valve and part of oil flows the U-shaped path reversely from the spool hole (c), and joins into port Aa. The rest of oil returns to the hydraulic oil tank through the tank port (T1).

This is called the arm regeneration function.

When the pressure in the arm cylinder head side (H) increases, the piston (d) and sub-spool (e) are transferred in the right direction, and at the same time the sleeve check valve (f) is closed by its backpressure. This shuts off the arm regeneration function, and the return oil from the arm cylinder rod side (R) enters from port Ba through the periphery hole (a) of the arm1 spool into the spool, flows out through the periphery hole (b) of the spool, and returns through the tank port (T1) to the hydraulic oil tank.

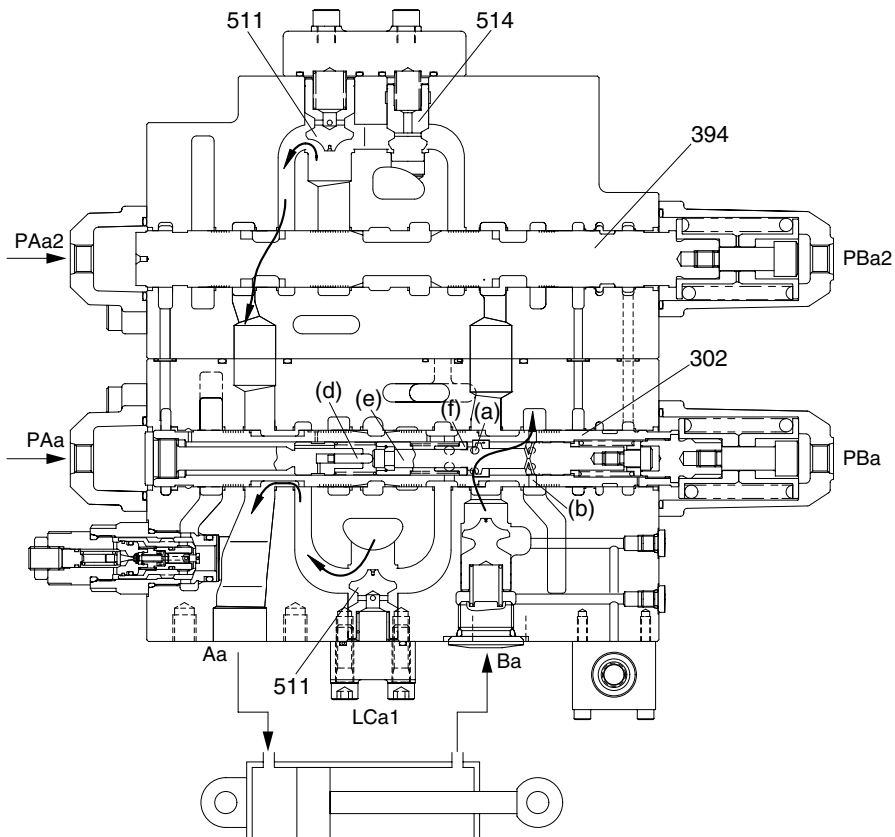
On the other hand, the pressurized oil entering through port P1 joins into port Aa through the inside path similarly to the case of the arm stretching operation.

- During light load only



3607A2MC17A

- The pressure in the arm cylinder head side (H) increases.



3607A2MC17B

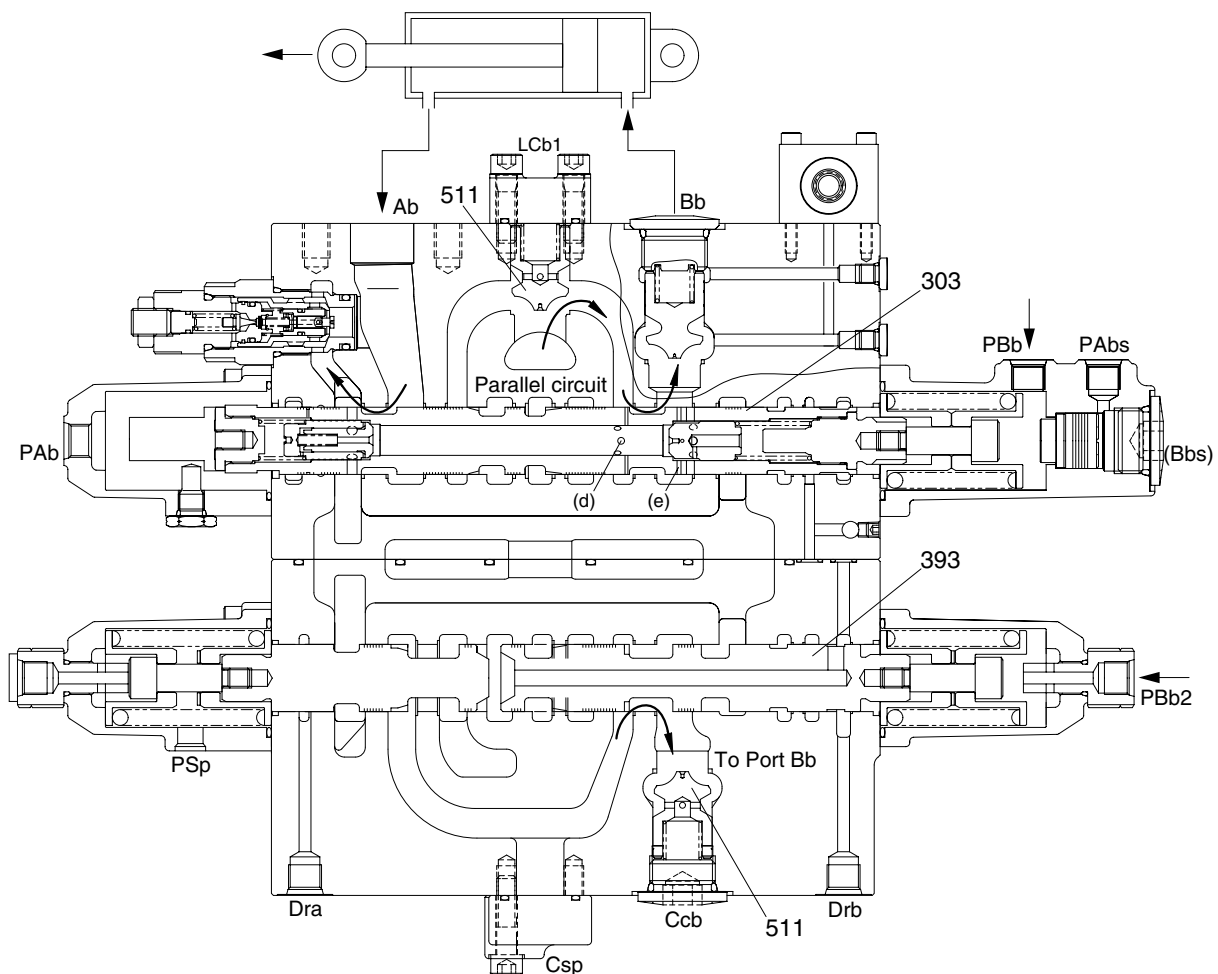
(4) Boom

① Boom up operation

During the boom up operation, the pilot pressure enters through port PBb and moves the boom 1 spool in the left direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the boom 1 spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through U-shaped path to the boom1 spool (303). When the stroke of the boom 1 spool is small, the oil enters through the periphery hole (d) of the spool to the inside of the spool, and flows out to port Bb through the periphery hole (e). When the stroke of the boom 1 spool is large, the oil flows out to port Bb through the periphery of the spool.

At the same time, the pilot pressure enters also through Port PBb2 to transfer the boom 2 spool (393) in the left direction in figure. Though the pressurized oil enters into port P2, the bypass is shut off due to transfer of the boom 2 spool. Therefore, the oil flows in the parallel circuit and flows through the U-shaped path to the boom 2 spool. Then, the oil passes through the periphery of the boom 2 spool, pushes open the check valve (511), joins into port Bb in the inside path, and is supplied to the boom cylinder head side (H). (Boom confluent flow)

On the other hand, the return oil from the boom cylinder rod side (R) enters through port Ab and returns to the hydraulic oil tank through the tank port (T1).



3607A2MC18

② Boom down operation

During the boom down operation, the pilot pressure enters through port PAb and transfers the boom1 spool in the right direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the boom 1 spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the boom 1 spool (303). Then, it flows around the periphery of the boom 1 spool to port Ab and is supplied to the boom cylinder rod side (R).

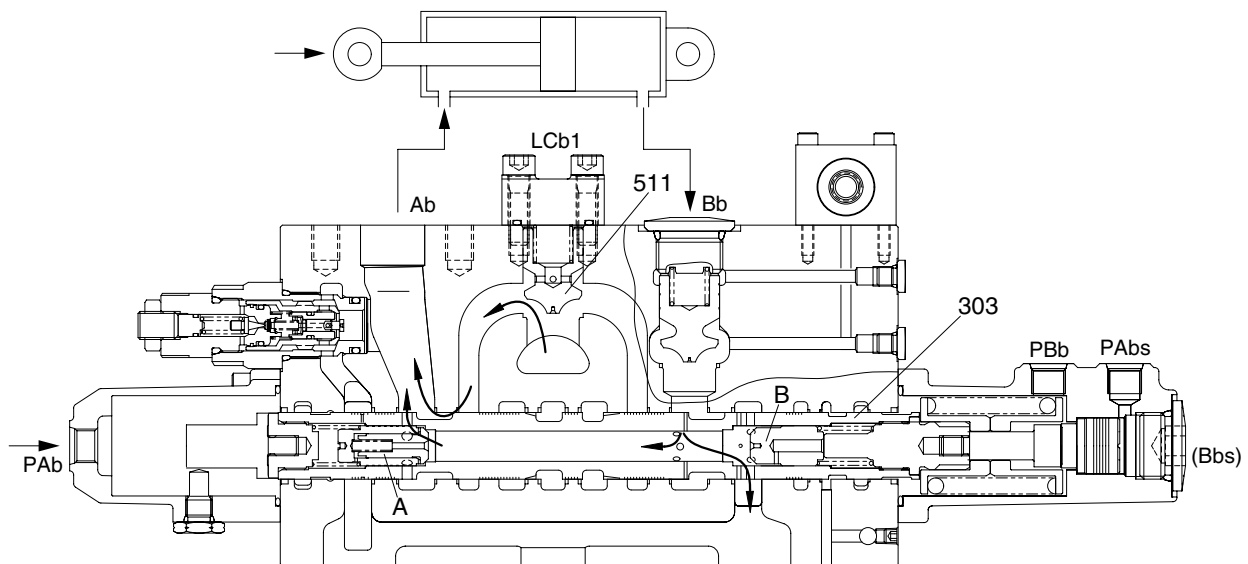
On the other hand, the return oil from the boom cylinder head side (H) passes to the notch of the boom 1 spool.

Since this return oil has a sufficient pressure caused by the weight of the boom, it passes through the path inside the spool, pushes the poppet A in the spool in the left direction shown in the figure, flows around the outside of the spool. Then, it is supplied again to the boom cylinder rod side (R) as hydraulic oil to lower the boom. (Boom regeneration)

Besides, a part of the return oil from the boom cylinder flows from the check valve B (boost check) into the tank.

The boost check boosts the hydraulic oil flowing to the tank to secure the sufficient regeneration flow rate.

During the boom down and arm stretching operation, the pilot pressure enters through port PAb and the boom 1 spool transfers in the half stroke not full stroke.



3607A2MC19

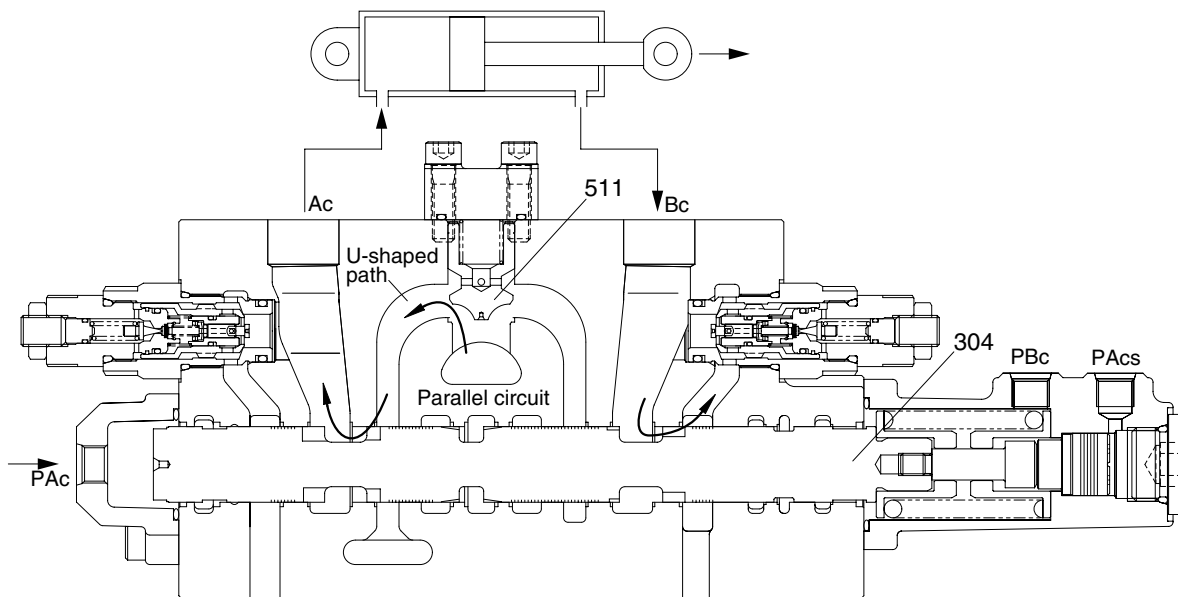
(5) Bucket

① Bucket in operation

During the bucket in operation, the pilot pressure enters through port PAc and transfers the bucket spool in the right direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit is shut off due to transfer of the bucket spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to port Ac and is supplied to the bucket cylinder head side (H).

On the other hand, the return oil from the bucket cylinder rod side (R) enters through port Bc, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (T1).

During the boom up and bucket in operation, the pilot pressure enters through Port PAc and the bucket spool transfers in the half stroke not full stroke. Therefore, the most of pressurized oil entering through Port P1 flows to the boom 1 spool (304) than the bucket spool (304) to make the boom up operation most preferential.

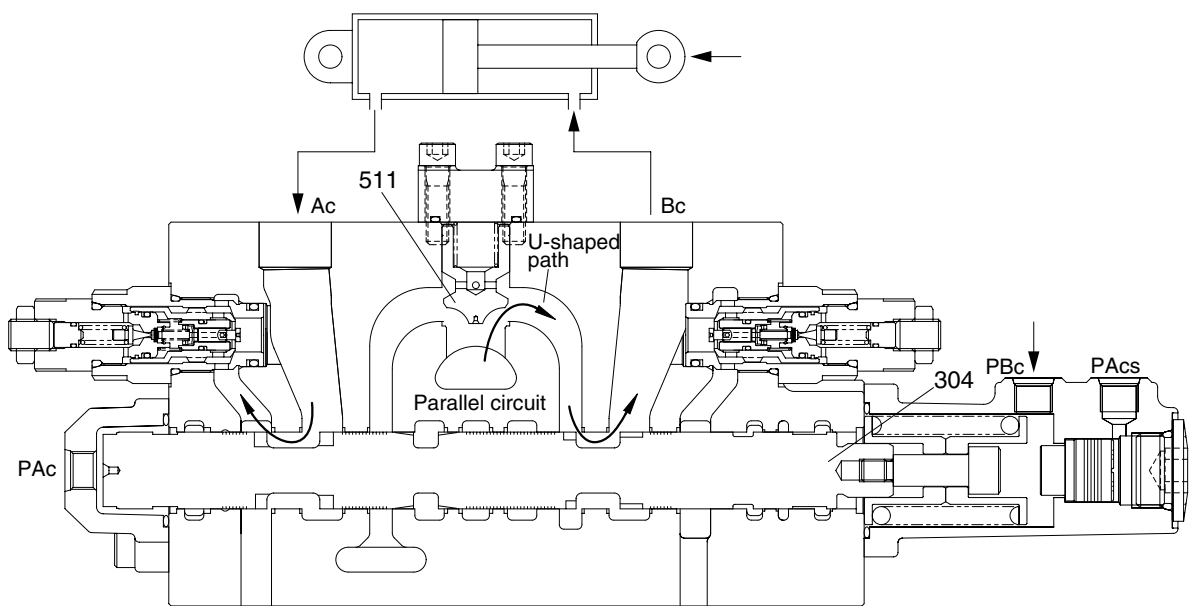


3607A2MC20

② Bucket out operation

During the bucket out operation, the pilot pressure enters through port PBc and transfers the bucket spool in the left direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit is shut off due to transfer of the bucket spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to port Bc and is supplied to the bucket cylinder rod side (R).

On the other hand, the return oil from the bucket cylinder head side (H) enters through port Ac, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (T1).



3607A2MC21

(6) Swing

① Independent swing operation

During the swing operation, the pilot pressure enters through port PAs (or PBs) and transfers the swing spool. The pressurized oil entering through Port P2 flows to Port As (or Bs) and is supplied to the swing motor. The return oil from the swing motor enters Port Bs (or As) and returns to the hydraulic oil tank through the tank port (T1).

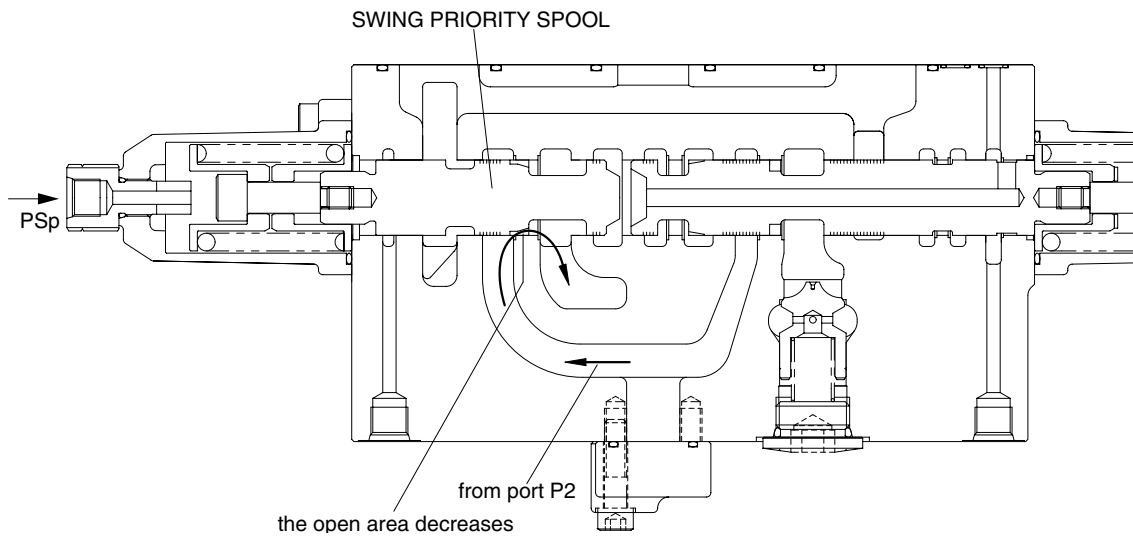
② Swing operation preference function

[Pilot Circuit]

The pilot pressure enters through Port PSp to transfer the swing priority spool (395).

[Main Circuit]

Due to transfer of the swing priority spool, the open area of the swing priority spool decreases, and the most of the pressurized oil entering through port P2 flows to the swing side to make the swing operation most preferential.



3607A2MC22

(7) Travel straight operation

Simultaneous operating of both travel spools and other spool.

A case where both travel spools and swing spool are changed over will be considered.

(The pilot ports PAL, PAr and PAs are pressurized.)

[Pilot Circuit]

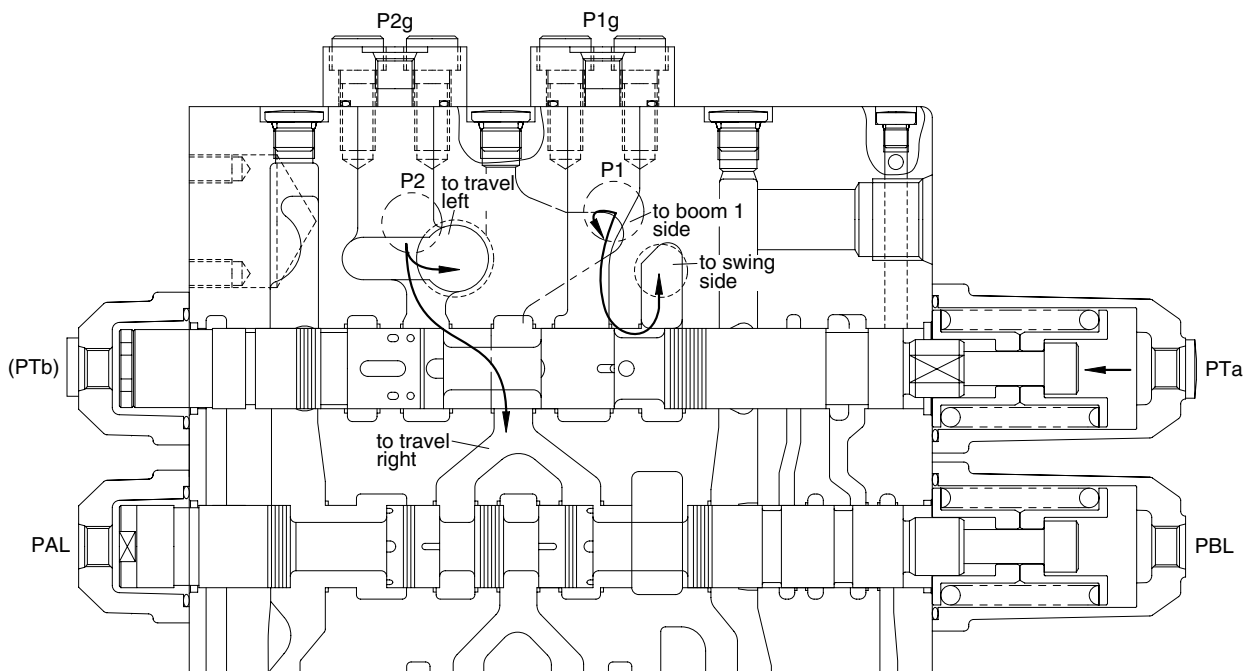
Since the side bypass sections of both travel spools close and the side bypass section of the downstream-side swing closes, the pilot pressure from the port Pa enters through the port PTa to transfer the travel straight spool.

[Main Circuit]

After changeover of the travel straight spool, the port P2 and both travel spools are connected preferentially and the port P1 and the parallel paths of swing, boom 2, option and arm 1 / boom 1, bucket and arm 2 are connected preferentially. Therefore, the pressurized oil entering through port P2 passes through mainly ports AL and Ar, and flows to both travel motors separately.

On the other hand, the pressurized oil entering through port P1 flows to port As and is supplied to the swing motor.

When the pressure of port P2 is lower than the pressure of port P1, part of oil entering through port P1 flows into port P2 side. Therefore, it prevents the rapid slowdown of travel.



3607A2MC23

(8) Function of lock valve

The lock valve is fitted between the arm cylinder rod side (R) and the arm1 spool (302). It decreases the leakage by the pressure of the cylinder.

Another lock valve is similarly fitted between the boom cylinder head side (H) and the boom1 spool (303). It decreases the leakage by the pressure of the cylinder.

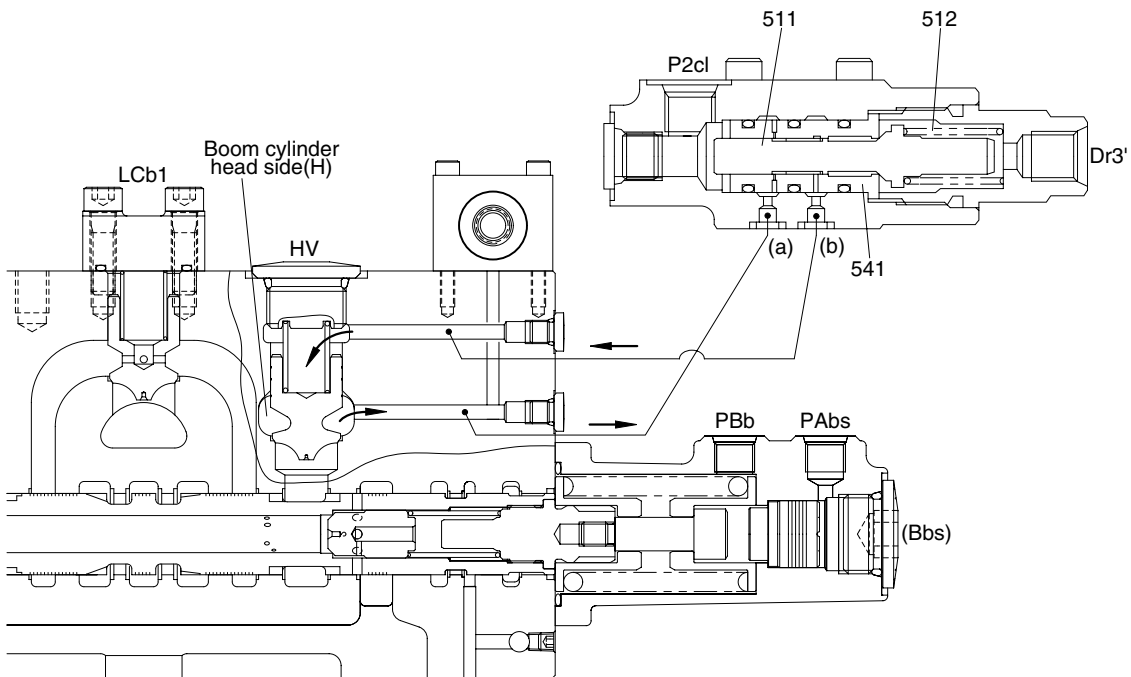
① Neutral positions of spools

The following is the case of the boom 1 spool.

(The case of the arm 1 spool is in the same way.)

During the boom 1 spool is in neutral position, the lock valve is kept in the position shown in figure. The spool (511) in lock valve is pushed to the seat of the bush (541) by the force of the spring (512).

In this position, pressurized oil from the boom cylinder head side (H) enters through hole (a), the periphery of the spool and hole (b), and it pushes the poppet to the casing seat, and the leakage is decreased.

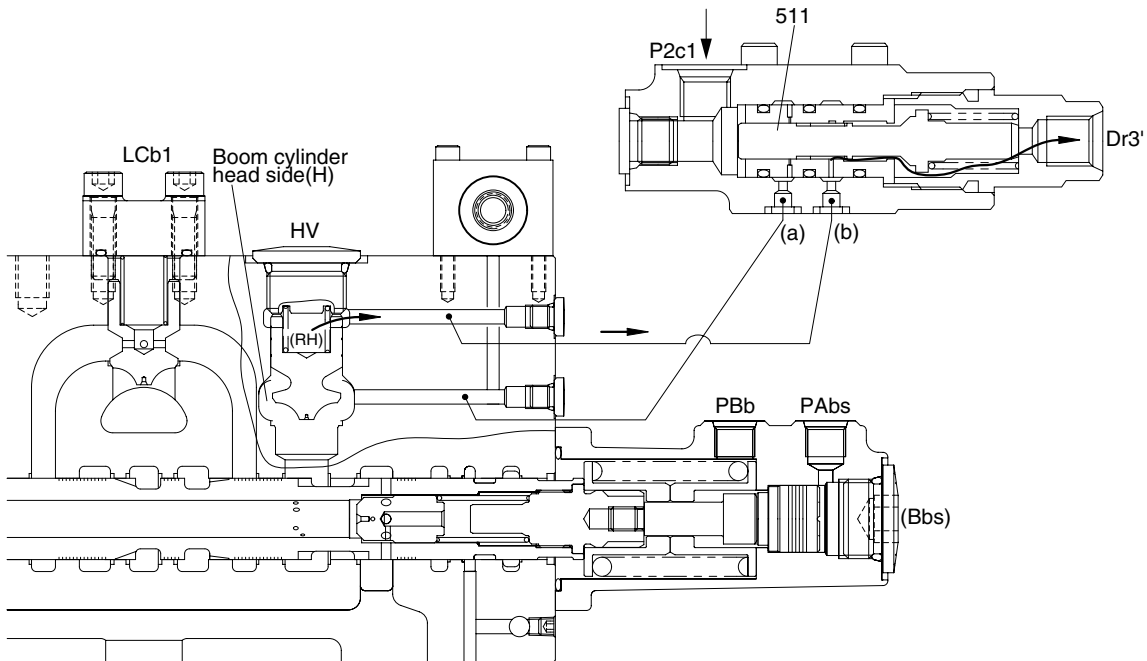


3607A2MC24

② Boom down operation

During the boom down operation, pilot pressure enters through port P2c1 and PAb. Pilot pressure transfers the spool (511) in lock valve assy in the right direction in figure. By the transfer of the spool, firstly the hole (a) is blocked and pressurized oil from the boom cylinder head side (H) does not enter to spring chamber (RH). Secondly, oil in spring chamber (RH) enters through hole (b) and flows to port Dr3'.

Therefore, the poppet is lifted by the pressure of the boom cylinder head side (H) and the function of the lock valve is released.



3607A2MC25

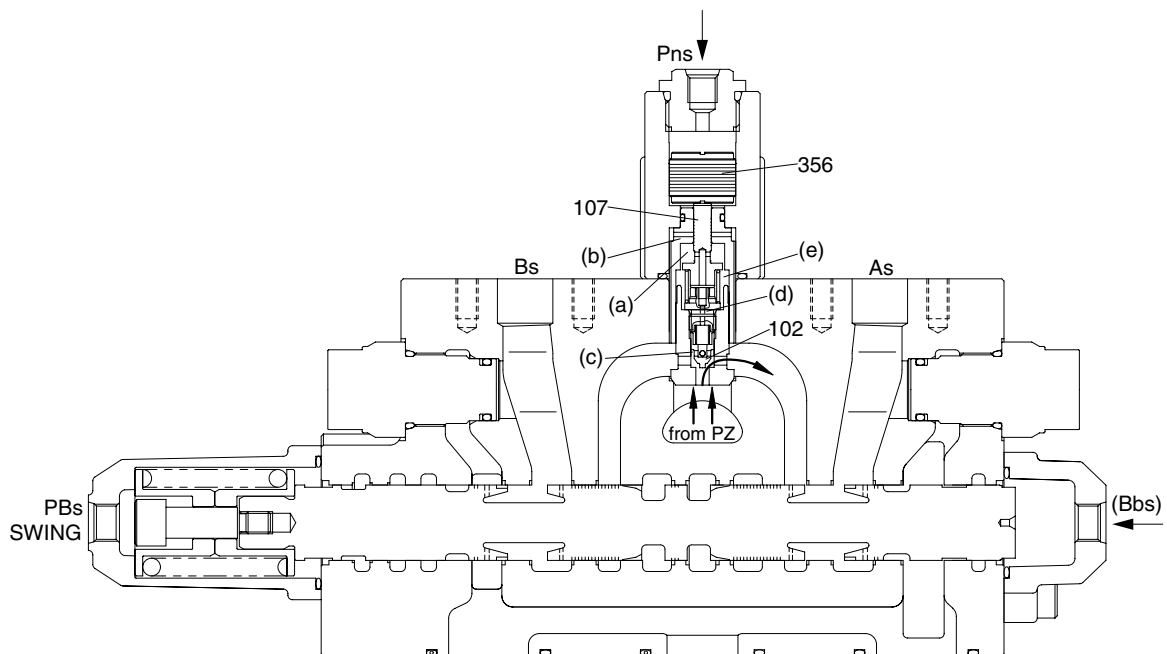
③ Boom up operation

During the boom up operation, the pilot pressure enters through port PBb. The oil flowing from the boom 1 spool pushes open the poppet (513) and flows to Port Bb.

(9) Function of boom priority valve

During both the swing operation and the boom hoisting operation, the pilot pressure enters through ports PAs(or PBs), PBb and Pns. The pressure Pns transfers the piston (356) and the spool (107) to the down direction, and the path from (a) to (b) is closed. Hereby, the pressurized oil pushes open the poppet (102), passes in the path (c) and (d), enters into the chamber (e), and the poppet (101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through port P2 flows to the boom priority spool (393) than the swing spool (305) to make the boom hoisting operation most preferential.

On the other hand, in the independent swing operation, the pilot pressure does not enter through ports Pns, and the path from (a) to (b) is not closed, and oil of chamber (e) flows to the path (a) and (b). The pressurized oil entering through port P2 pushes open the poppet (101) and flows to the swing spool (305).

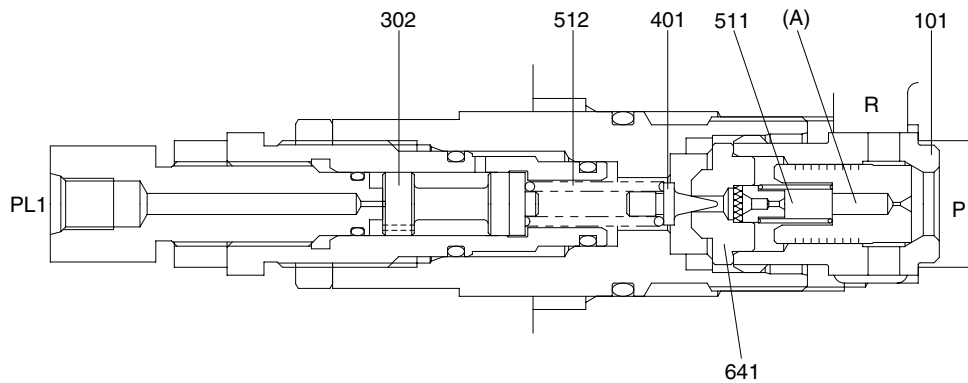


3607A2MC26

(10) Function of main relief valve

The main relief valve is fitted in the casing B and functions as follows :

- ① The hydraulic oil is filled up in the inside space chamber (A) from the path (P) through a hole of the body (101) and a restriction of the plunger (511), and seats the plunger (511) against body (101) securely.
- ② When the pressure in the path (P) becomes equal to the set load of the spring (512), the poppet (401) opens to make the hydraulic oil flow through a hole of the seat (2) (641), around the poppet (401) and into the low pressure path (R).
- ③ Opening of the poppet (401) causes the pressure in the chamber (A) to fall and the plunger (511) to open. As the result the pressurized oil in the path (P) runs into the low pressure path (R) directly.
- ④ When the pressurized oil higher than pressure 2.2MPa enters through the port PL1, it pushes the piston (302) to change the relief set pressure of the spring (512) to the high pressure.



3607A2MC27

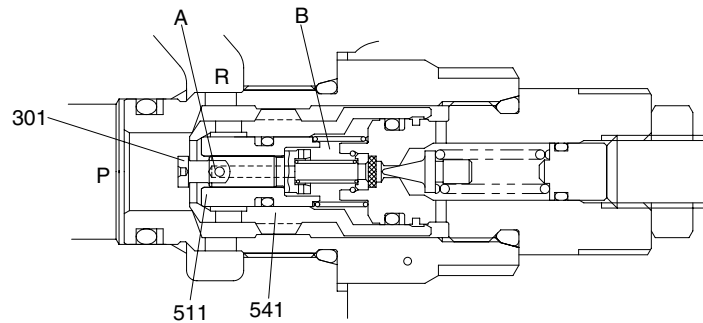
(11) Function of port relief valve

The port relief valve is fitted between the cylinder port and low-pressure path.

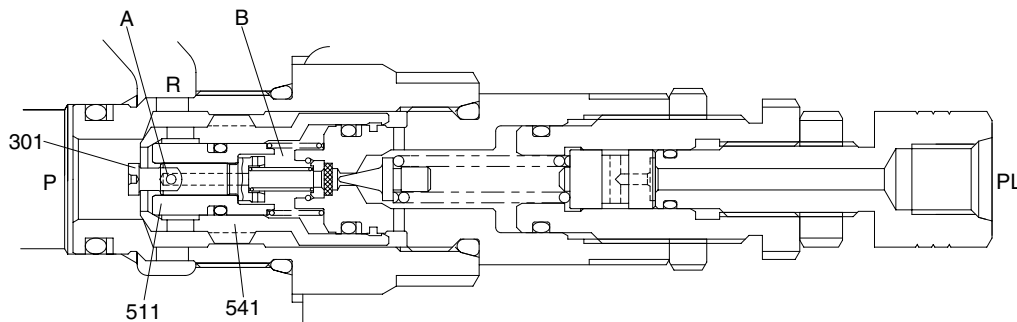
In addition to the relief valve, this serves also as an anti-cavitation check valve, and functions as follows:

(1) Function as relief valve

- ① The pressurized oil passes through hole A of the piston (301), is filled up in chamber B of the inside space, and seat the plunger (511) against the seat (541) securely.

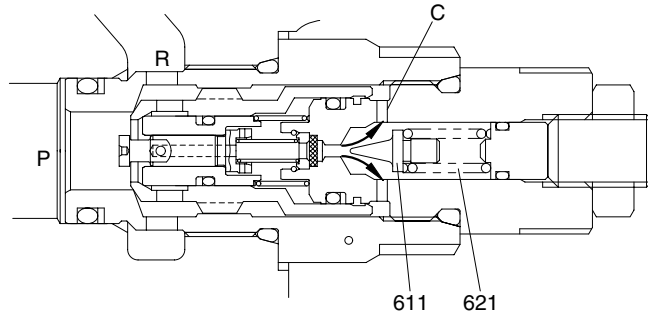


3607A2MC28

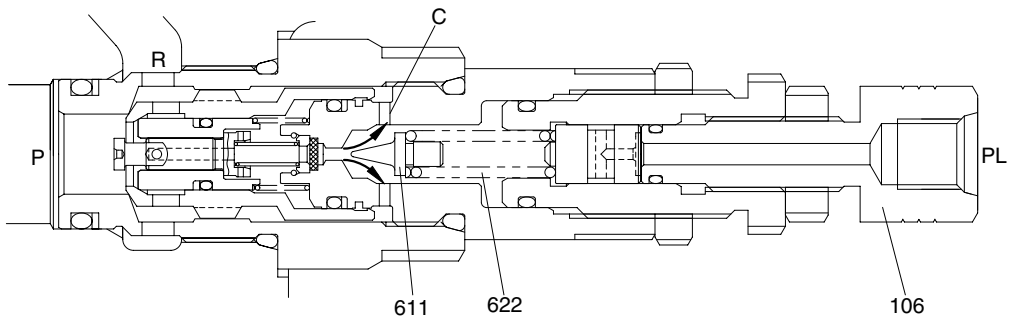


3607A2MC29

- ② When the pressure in the path (P) becomes equal to the set pressure of the spring (621 or 622), the pressurized oil pushes open the poppet (611), flows around it, and flows to the low pressure path (R) through Hole C.

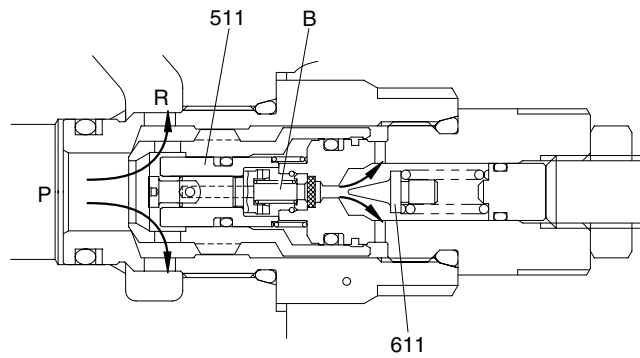


3607A2MC30

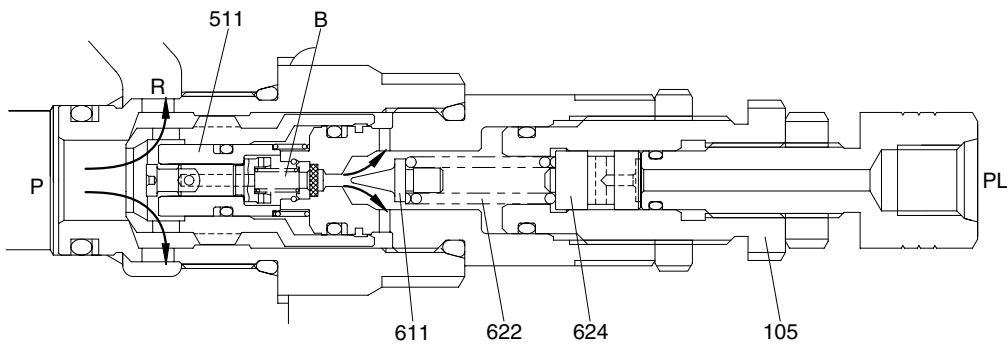


3607A2MC31

- ③ Opening of the poppet (611) causes the pressure in chamber B to fall and the plunger (511) to open. As the result the pressurized oil in the path (P) runs into the low pressure path (R) directly.



3607A2MC32



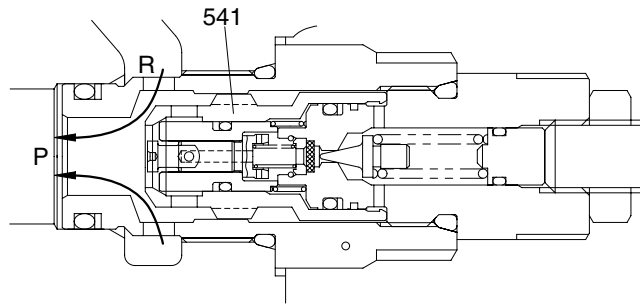
3607A2MC33

- ④ When the pressurized oil higher than pressure 1.5MPa enters through the port PL, it pushes the piston (614) to change the relief set pressure of the spring (622) to the high pressure.

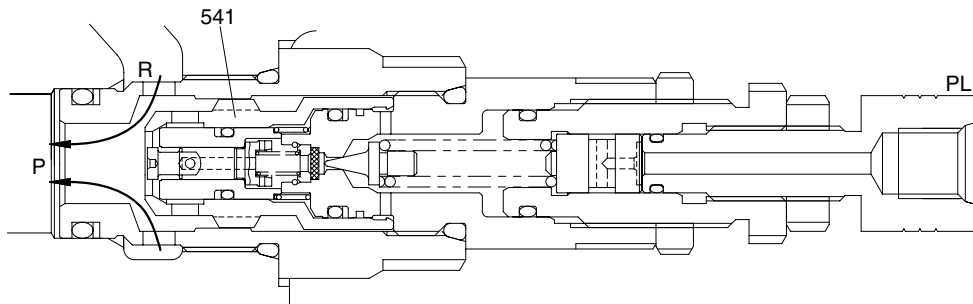
(2) Function as anti-cavitation check valve

When any negative pressure exists in the path (p), the oil is supplied through the path (R). When the pressure at (R) becomes higher than that in the path (P), the seat (541) moves in the right direction.

Then, sufficient oil passes around the seat (541) from the path (R) to the path (P) and prevents cavitation.



3607A2MC34

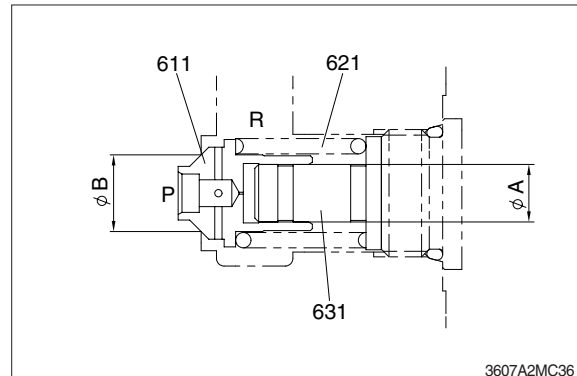


3607A2MC35

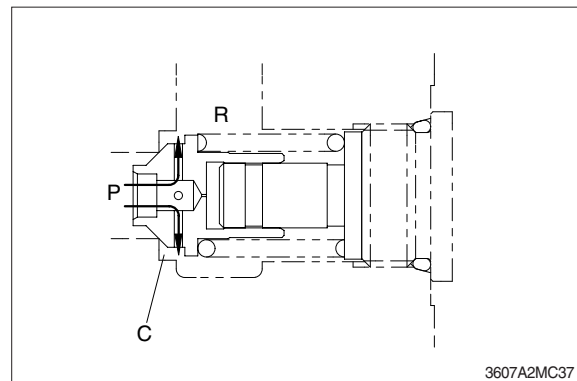
(12) Function of negative control relief valve

The negative control relief valve is fitted between the downstream of the center bypass path and low-pressure path, and functions as follows :

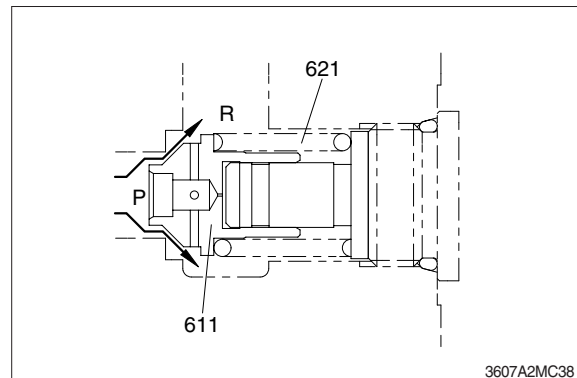
- ① When the pressure in the path (P) falls below the set level of the spring (621), the poppet (611) is in the condition shown in the figure. The pressure acting area of the poppet (611) is reduced to $(\phi B - \phi A)$, as the area ϕB is cancelled by the area ϕA of the damping rod (631).



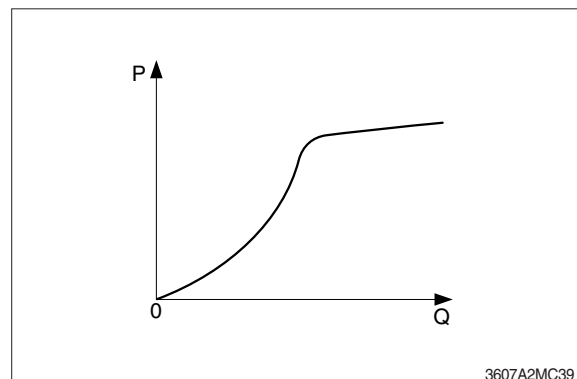
- ② In this condition, the pressurized oil in the path (P) runs out to the path (R) through the orifice (c).



- ③ When the pressure in the path (P) goes over the set pressure of the spring (621), the poppet (611) opens. Then, the pressurized oil in the path (P) passes around the outside of the poppet (611) and flows to the low-pressure path (R).



The relation between the flow rate Q and pressure P of the hydraulic oil that flows from the path (P) to the low-pressure path (R) is as shown in the diagram.

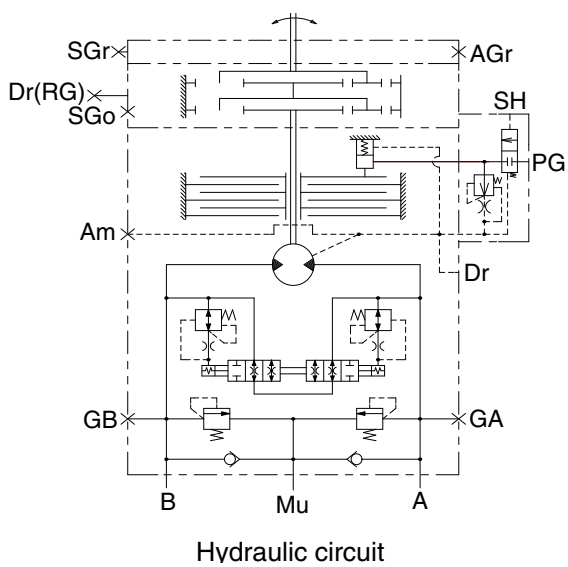
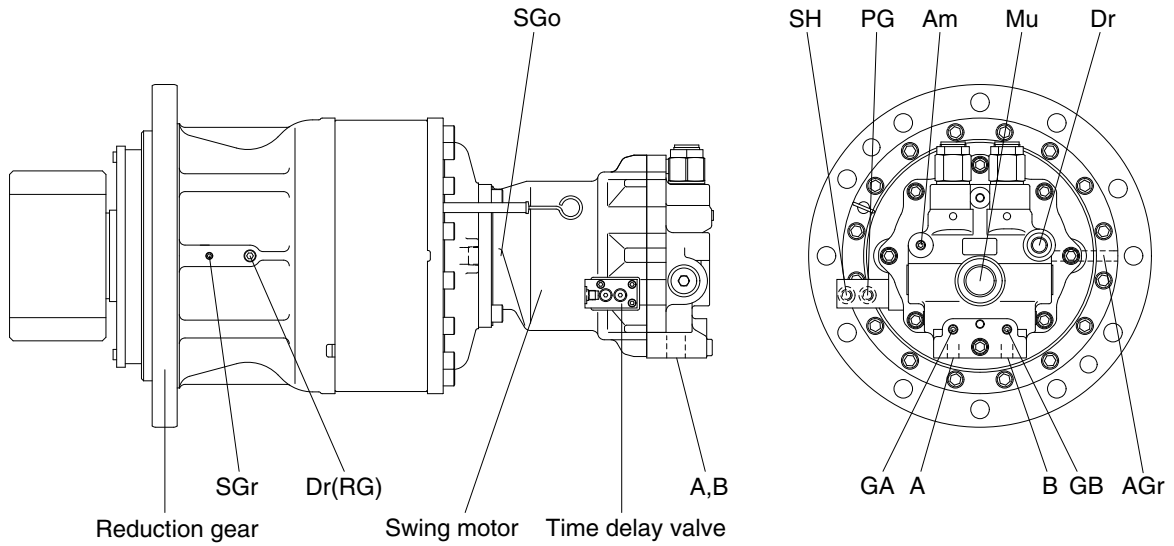


GROUP 3 SWING DEVICE

1. STRUCTURE (MACHINE SERIAL NO. : -#0704)

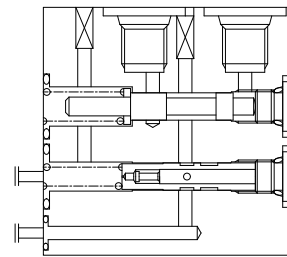
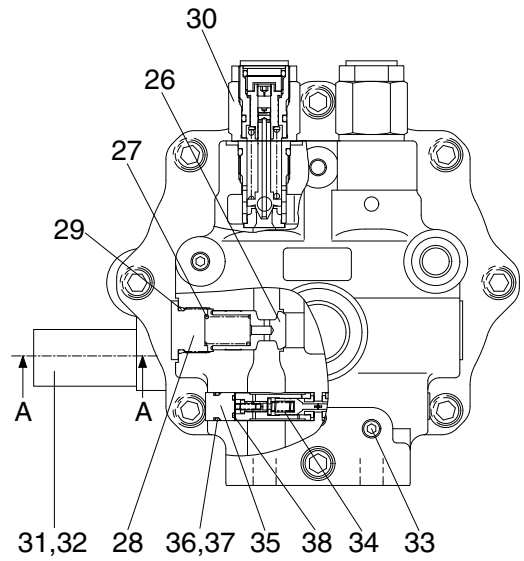
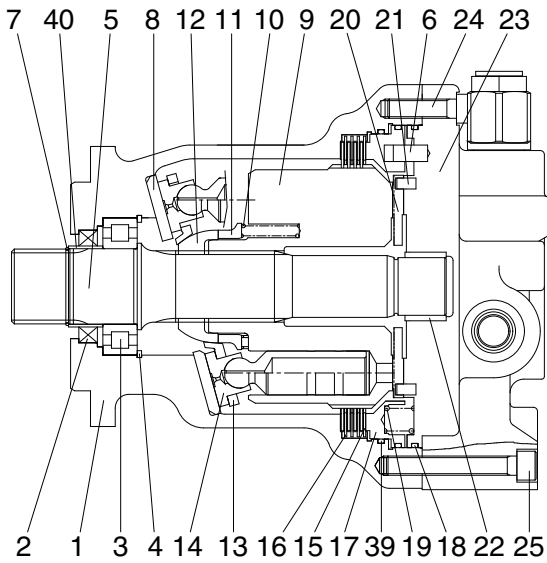
Swing device consists swing motor, swing reduction gear.

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



Port	Port name	Port size
A	Main port	SAE 1"
B	Main port	SAE 1"
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1 1/4
SH	Brake release stand byport	PF 1/4
PG	Brake release pilot port	PF 1/4
GA, GB	Gauge port	PF 1/4
Am	Motor air bleed port	PF 1/4
AGr	R/G air bleed port	PT 1/8
SGr	Grease filling port	PT 1/8
Dr(R/G)	Gear oil drain port	PT 1/2
SGo	Gear oil filling port	PT 3/4

1) SWING MOTOR (MACHINE SERIAL NO. : -#0704)



SECTION A-A

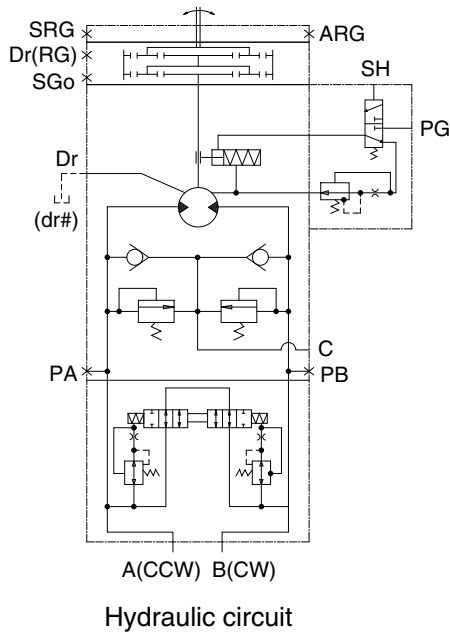
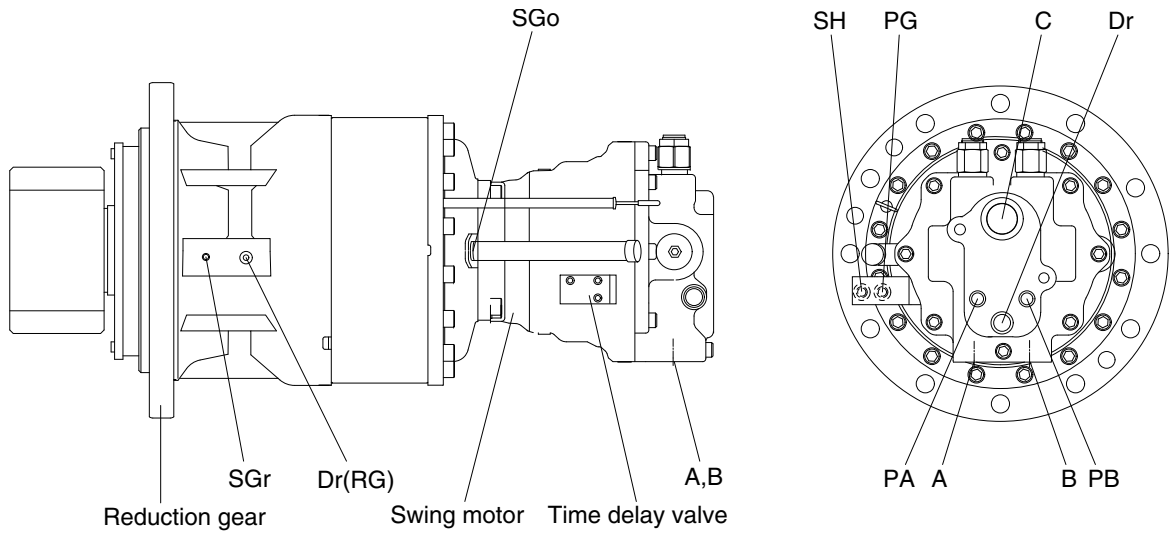
38092SM02

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

1. STRUCTURE (MACHINE SERIAL NO. : #0705-)

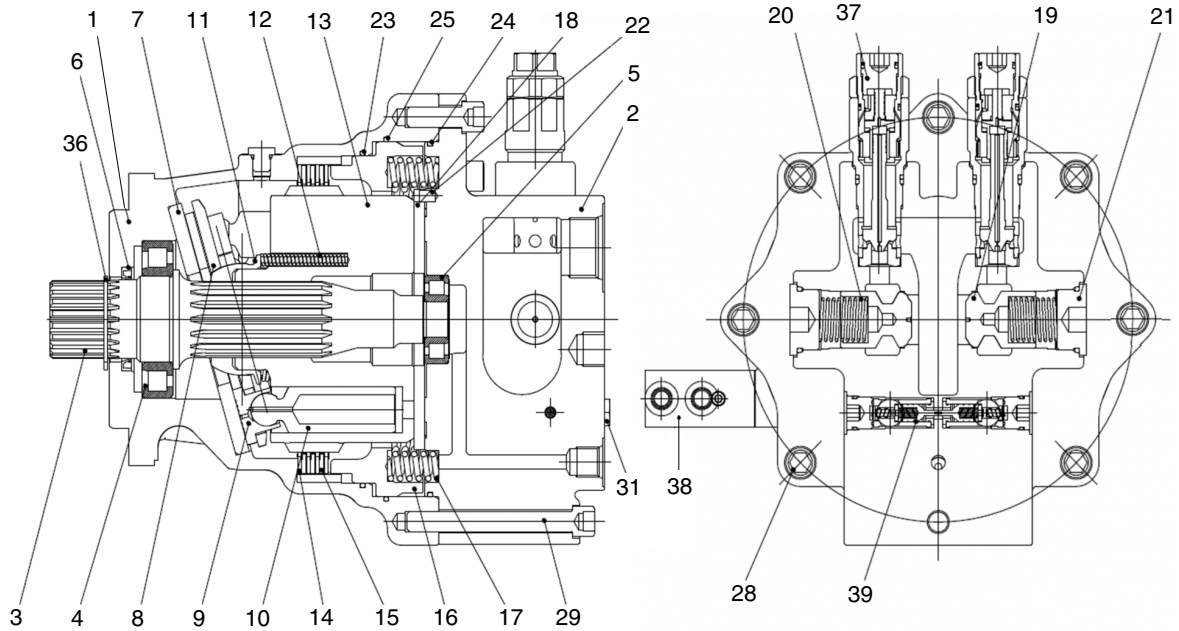
Swing device consists swing motor, swing reduction gear.

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



Port	Port name	Port size
A	Main port	SAE 1"
B	Main port	SAE 1"
DB	Drain port	PF 1/2
C	Make up port	PF 1 1/4
SH	Brake release pilot port	PF 1/4
PG	Brake release stand by port	PF 1/4
PA, PB	Gauge port	PF 1/4
SGr	Grease filling port	PT 1/8
Dr (R/G)	Gear oil drain port	PT 1/2
SGo	Gear oil filling port	PT 3/4

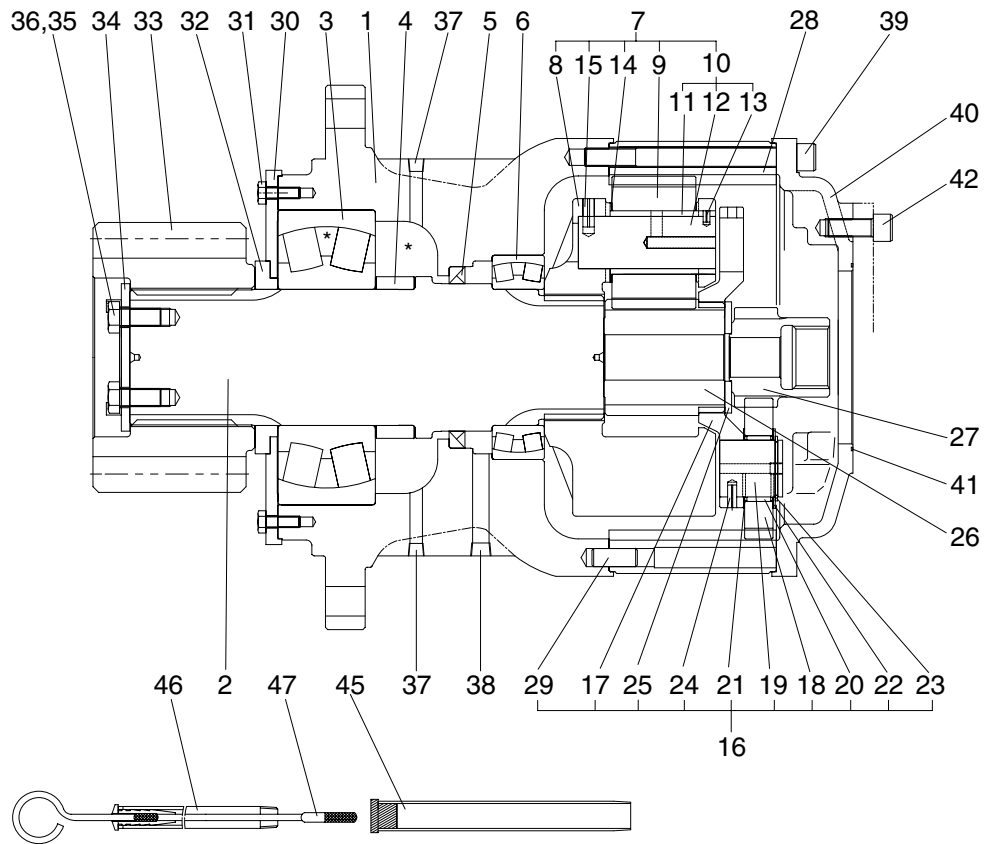
1) SWING MOTOR (MACHINE SERIAL NO. : #0705-)



380A8SM05

- | | | | | | |
|----|----------------|----|------------------|----|--------------------|
| 1 | Casing | 12 | Cylinder spring | 23 | O-ring |
| 2 | Valve casing | 13 | Cylinder block | 24 | O-ring |
| 3 | Drive shaft | 14 | Friction plate | 25 | O-ring |
| 4 | Roller bearing | 15 | Separation plate | 28 | Socket bolt |
| 5 | Roller bearing | 16 | Brake piston | 29 | Socket bolt |
| 6 | Oil seal | 17 | Brake spring | 30 | Socket bolt |
| 7 | Shoe plate | 18 | Valve plate | 31 | VP plug assy |
| 8 | Retainer plate | 19 | Plunger | 36 | Snap ring |
| 9 | Shoe | 20 | Check spring | 37 | Relief valve |
| 10 | Piston | 21 | RO plug assy | 38 | Brake valve |
| 11 | Thrust ball | 22 | Pin | 39 | Reactionless valve |

2) REDUCTION GEAR



38092SM03

1	Casing	16	Carrier assy 1	31	Hexagon bolt
2	Drive shaft	17	Carrier 1	32	Spacer
3	Roller bearing	18	Planetary gear 1	33	Pinion gear
4	Spacer ring	19	Pin 1	34	Lock plate
5	Oil seal	20	Needle cage	35	Hexagon bolt
6	Roller bearing	21	Side plate 1	36	Lock washer
7	Carrier assy 2	22	Side plate 2	37	Plug
8	Carrier 2	23	Stop ring	38	Plug
9	Planetary gear 2	24	Spring pin	39	Socket bolt
10	Pin assy 2	25	Thrust ring	40	Cover
11	Pin 2	26	Sun gear 2	41	O-ring
12	Bushing 2	27	Sun gear 1	42	Hexagon socket bolt
13	Spring pin	28	Ring gear	45	Air breather assy
14	Thrust washer	29	Knock pin	46	Gauge pipe
15	Spring pin	30	Cover plate	47	Gauge bar

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port (a), which is the inlet of balance plate (1), hydraulic pressure acting on the piston causes axial force F . The pressure force F works via the piston (2) upon the return plate (3) which acts upon the swash plate (4) via an hydrostatic bearing. Force F_1 perpendicular to swash plate (4) and force F_2 perpendicular to cylinder center.

Being transferred to the cylinder block (5) through piston, force F_2 causes rotational moment at surroundings of cylinder.

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

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

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

q : Displacement (cc/rev)

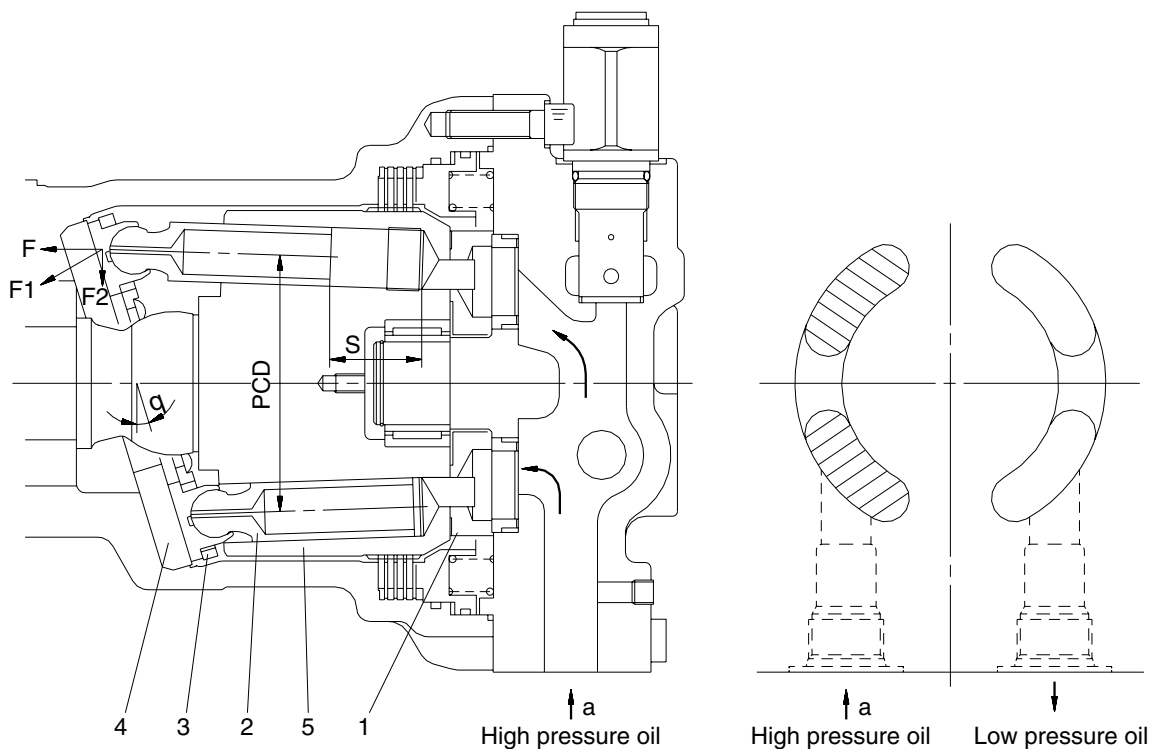
T : Output torque (kgf · cm)

Z : Piston number

A : Piston area (cm²)

θ : Tilting angle of swash plate (degree)

S : Piston stroke (cm)



36072SM04A

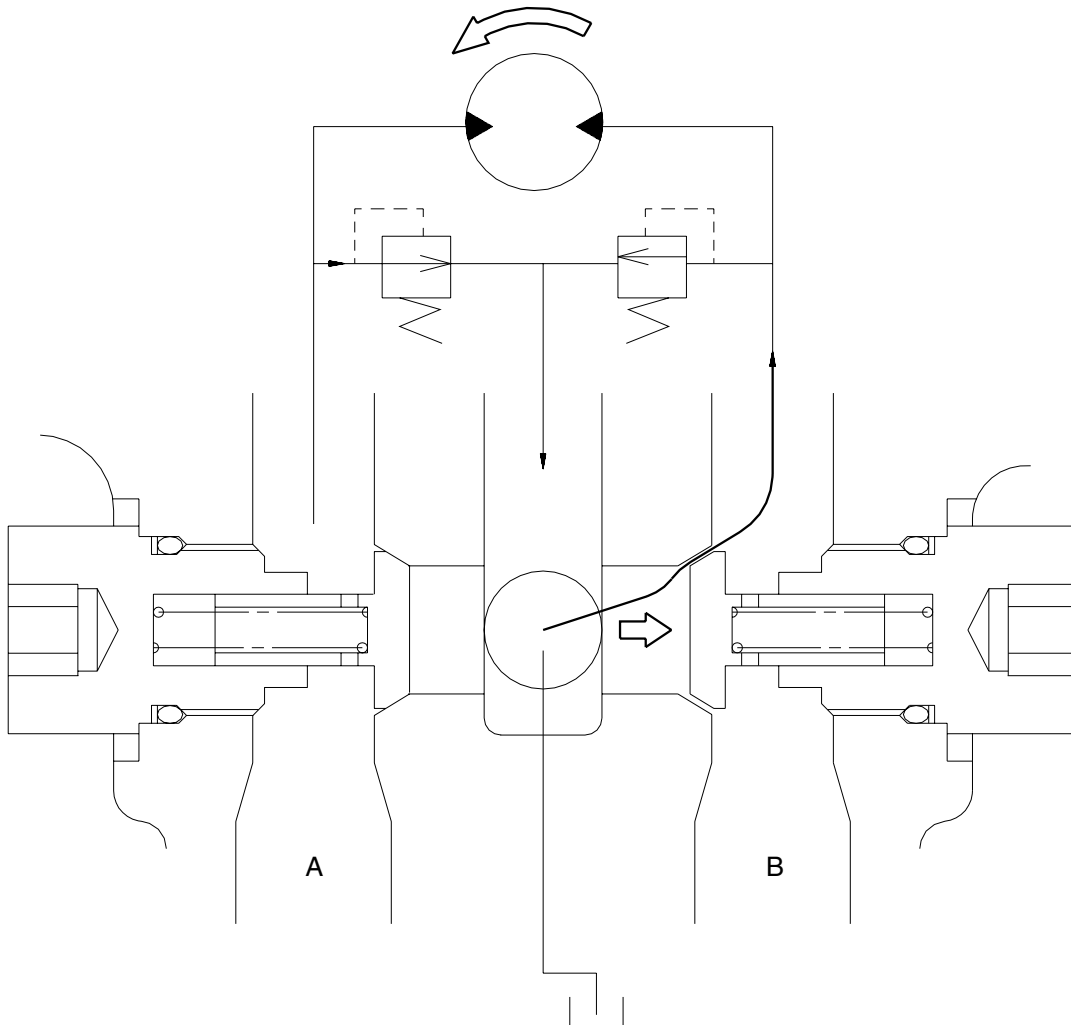
2) MAKE UP VALVE

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.

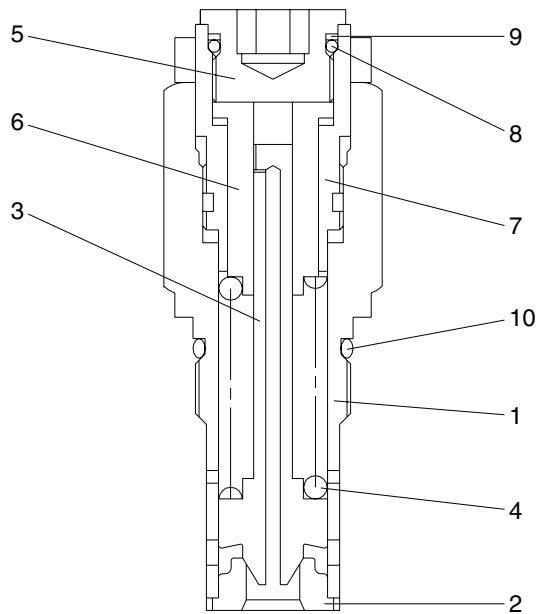
Pressurized oil into the port B, the motor rotate counterclockwise.

If the plunger of MCV moves neutral position, the drain oil from Mu port run into motor via right make up valve, which prevent the cavitation of motor.



36072SM05

3) RELIEF VALVE



- 1 Body
- 2 Seat
- 3 Plunger
- 4 Spring
- 5 Adjusting screw
- 6 Piston
- 7 Sleeve
- 8 O-ring
- 9 Back up ring
- 10 O-ring

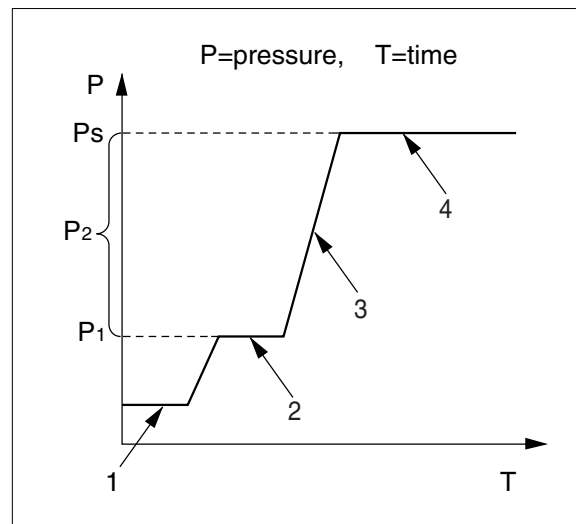
36072SM06

(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.

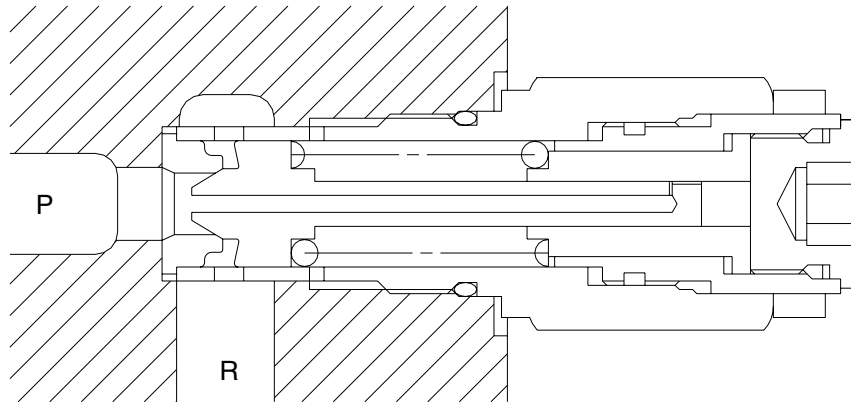
(2) Function of relief valve

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.



2-51(2) [360-7]

① Ports (P, R) at tank pressure.

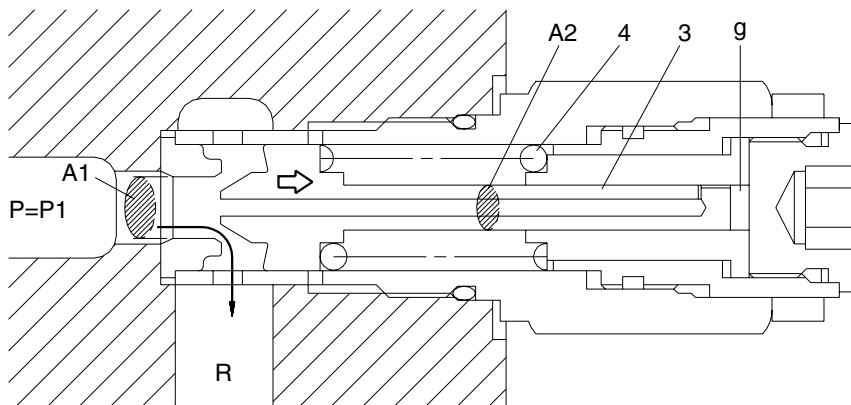


36072SM07

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.

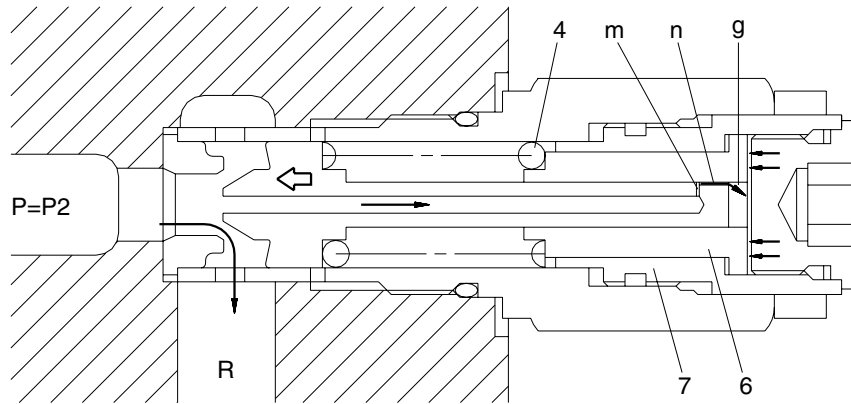
$$P_1 \times A_1 = F_{SP} + P_g \times A_2$$

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



36072SM08

- ③ The oil flow chamber g via orifice m and n. When the pressure 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 sleeve (7).

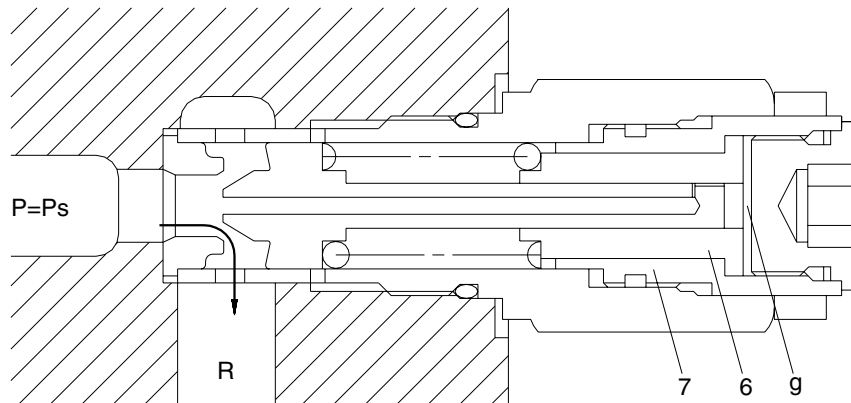


36072SM09

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

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

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

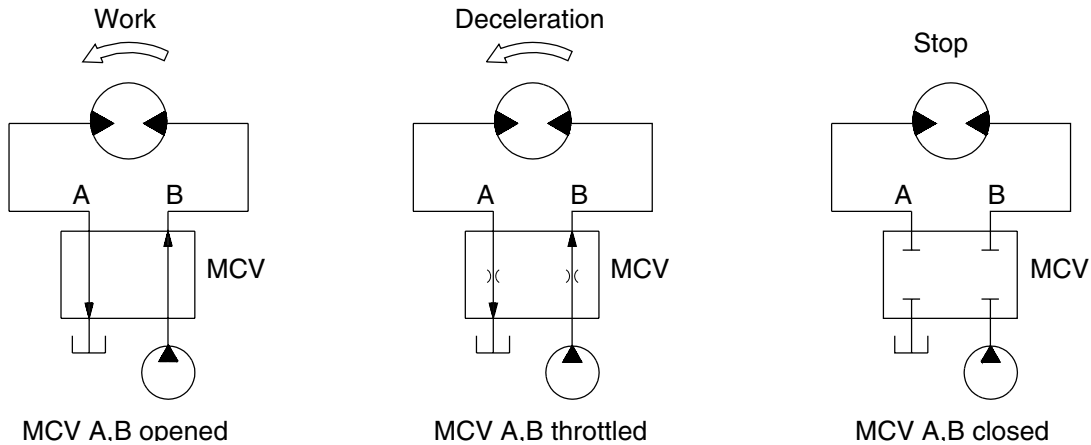


36072SM10

4) BRAKE SYSTEM

(1) Control valve swing brake system

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



R130SM05

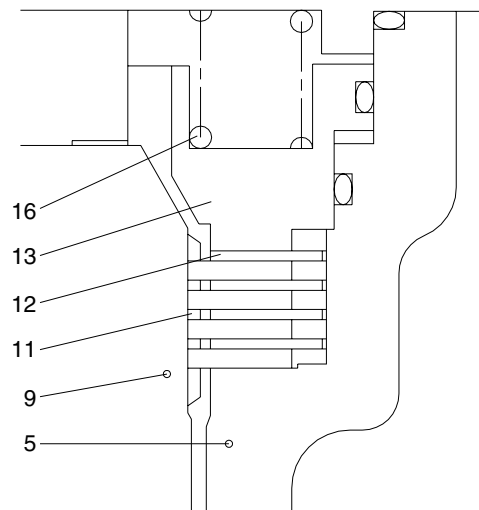
(2) Mechanical swing parking brake system

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

① Brake assembly

Circumferential rotation of separate plate (12) is constrained by the groove located at housing (5). When housing is pressed down by brake spring (16) through friction plate (11), separate plate (12) and brake piston (13), 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.

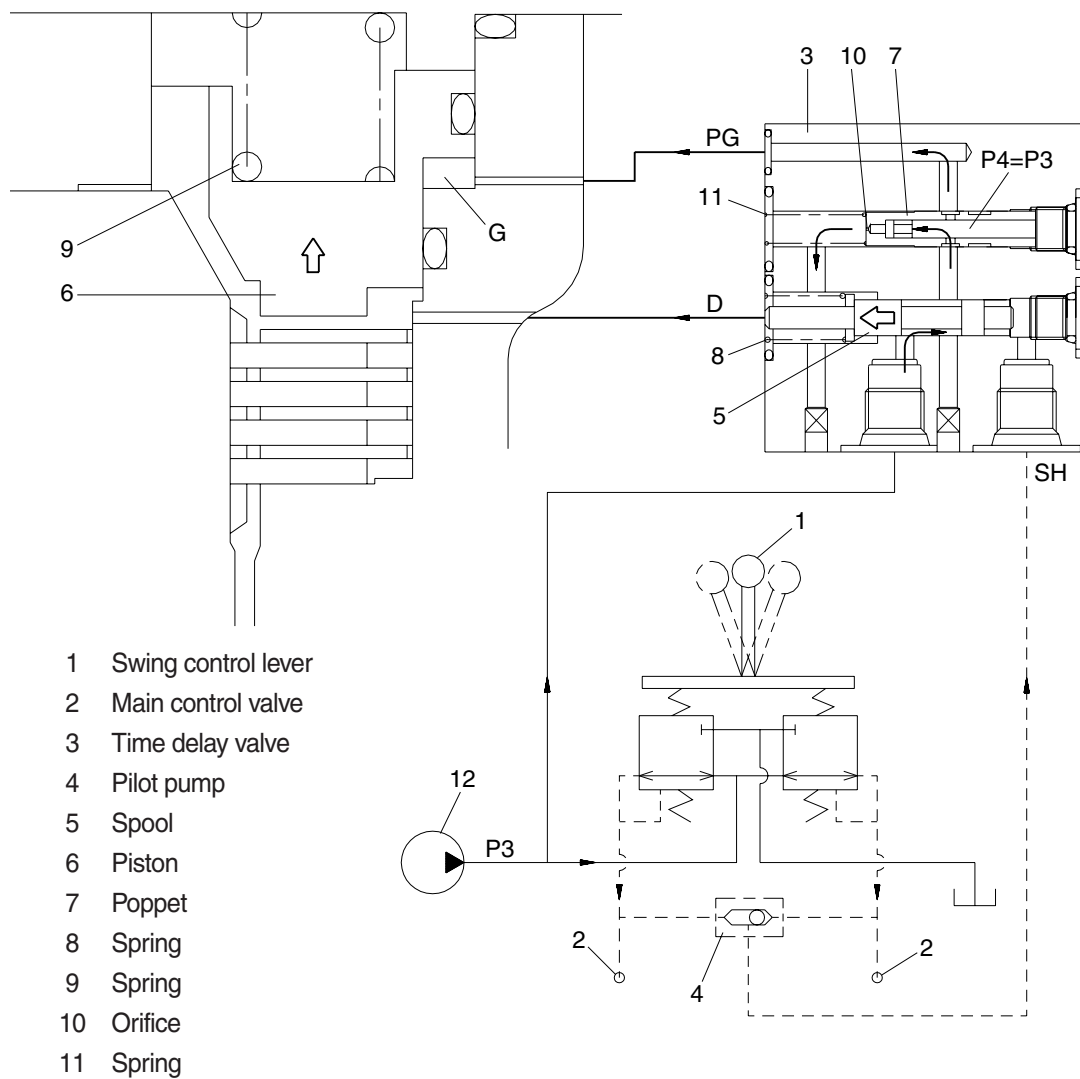


36072SM11

5	Housing	12	Separate plate
9	Cylinder block	13	Brake piston
11	Friction plate	16	Brake spring

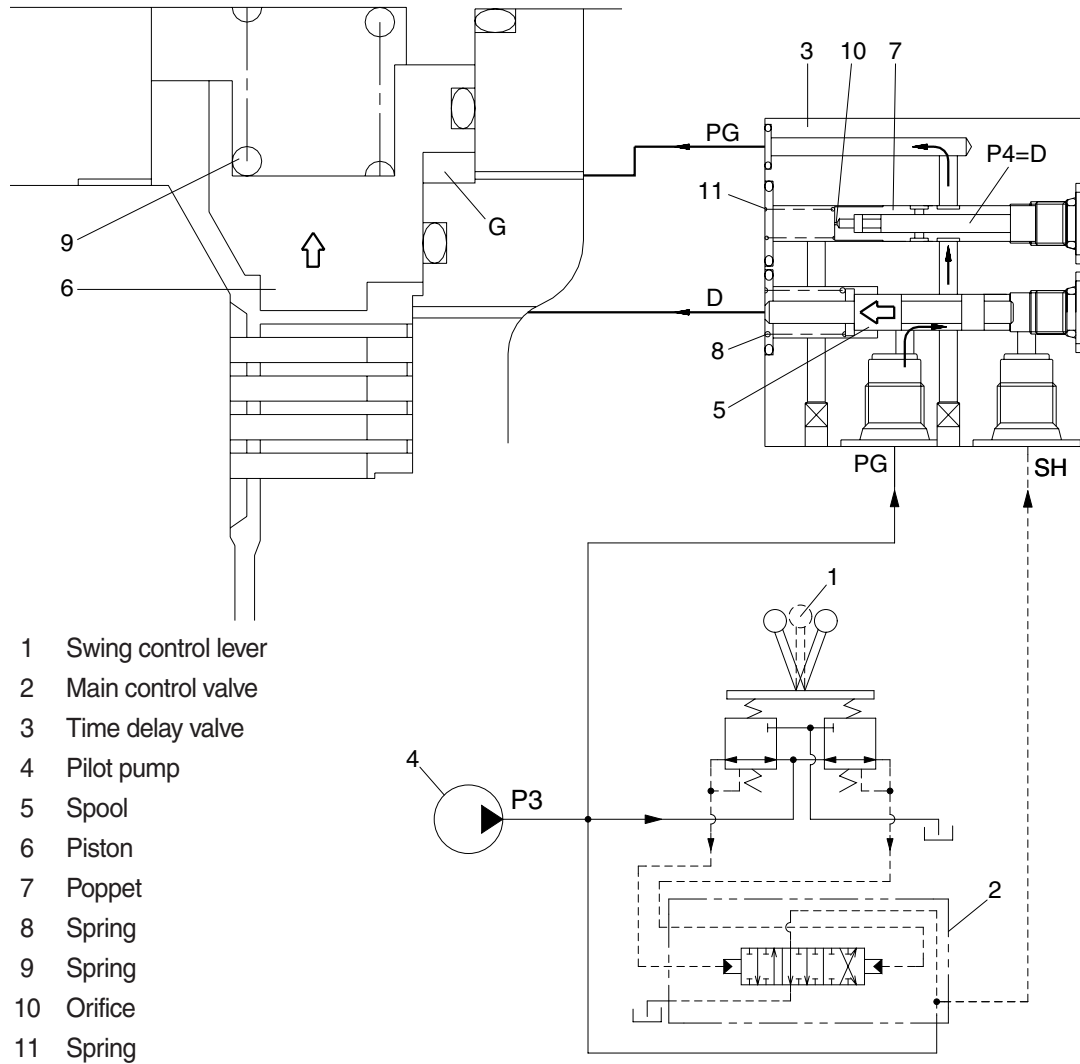
② Operating principle

- a. When one of the RCV lever (1) is set to the operation position, the each spool is shifted to left or right and the pilot oil flow is blocked. Then the pilot oil go to SH of the time delay valve (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 (6) to the upward against the force of the spring (9). Thus, it releases the brake force.



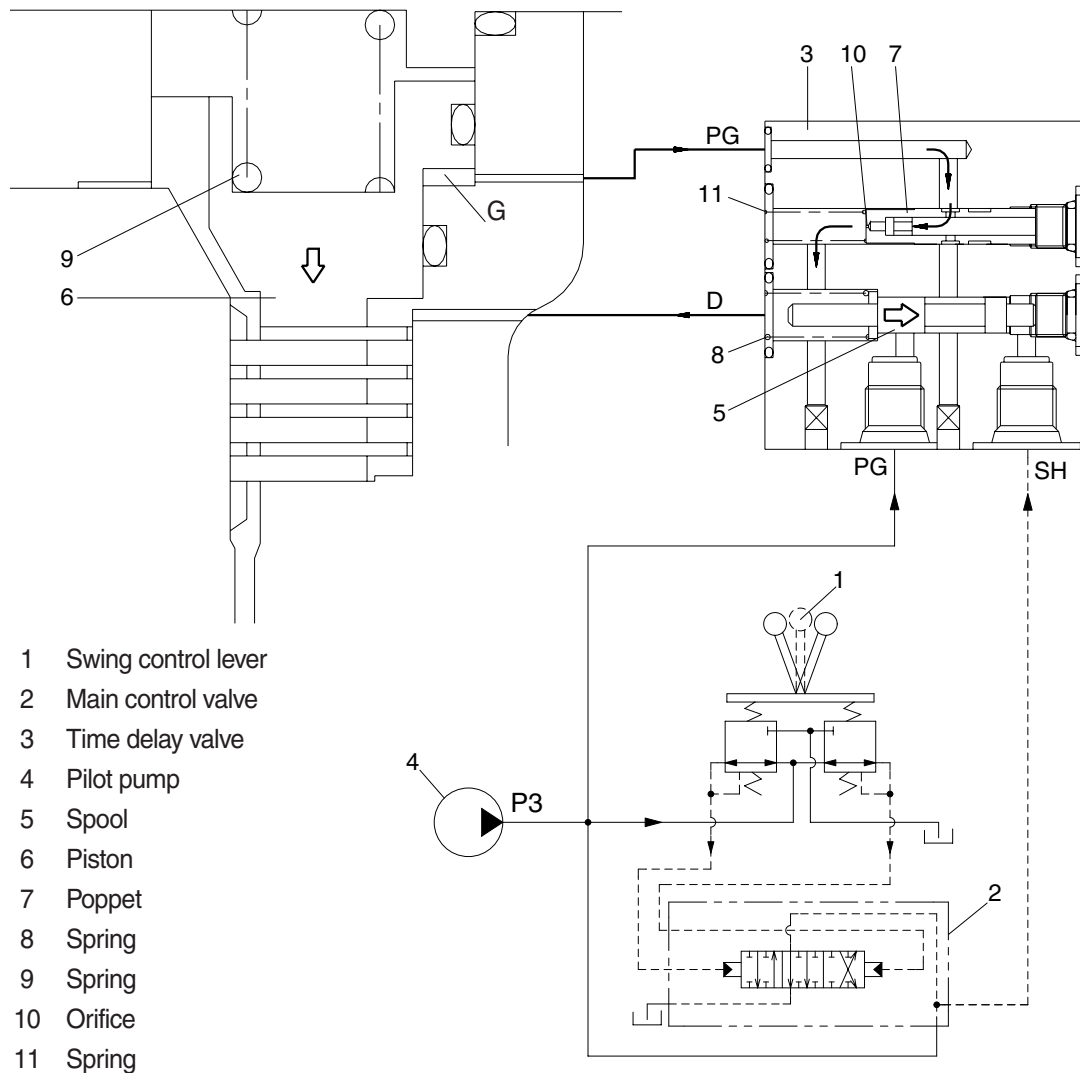
36072SM12

- b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to right.
 Then, the piston (6) 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.



36072SM13A

- c. When the swing control (1) lever is set the neutral position the spool (5) returns right in the time delay valve (3).
 Then, the piston (6) is moved lower by spring force and the return and the return oil from the chamber G flows back to D-port through orifice (10) of the poppet (7).
 At this time, the poppet (7) works to make a time lag for 5 seconds.



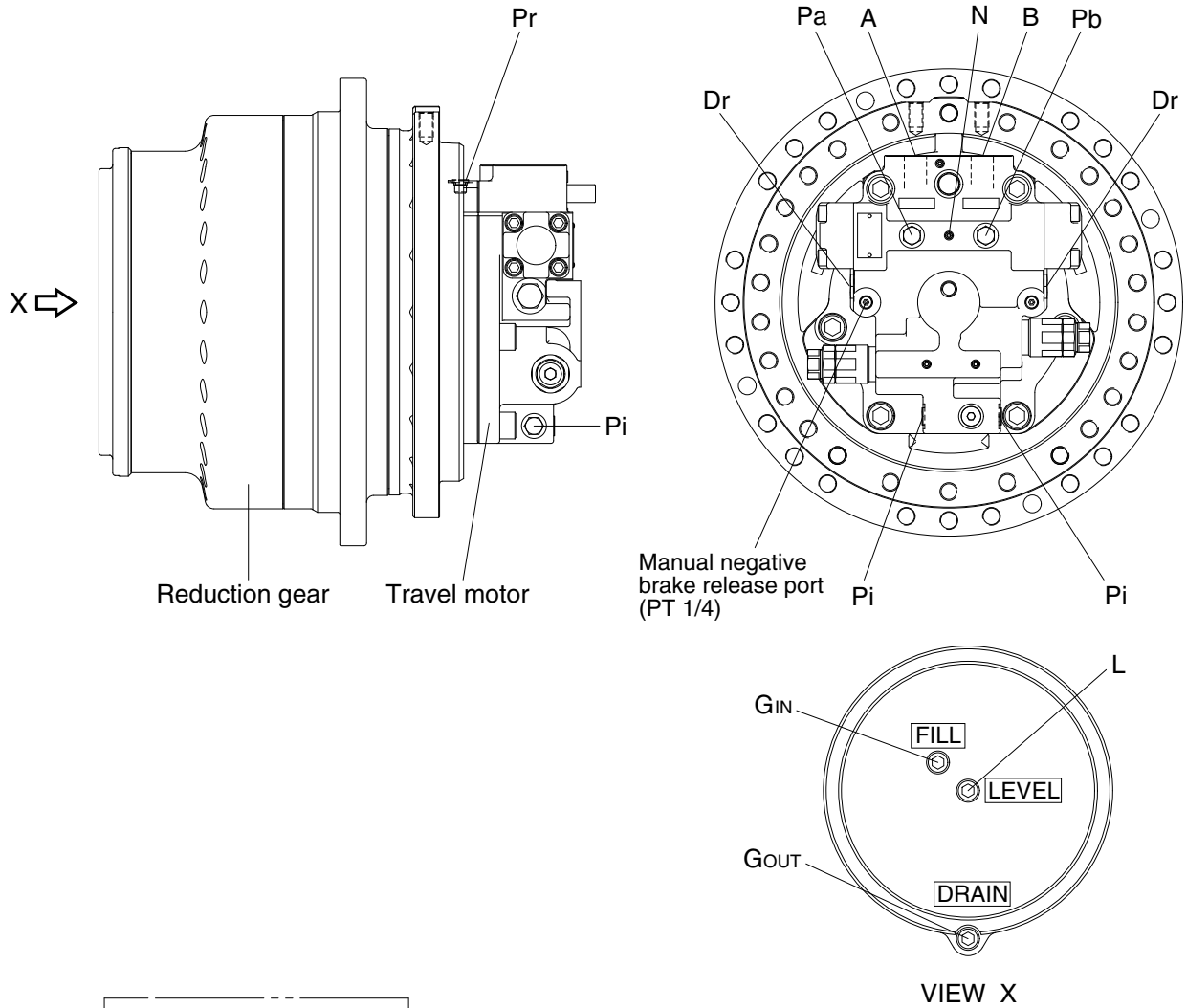
38092SM04

GROUP 4 TRAVEL DEVICE

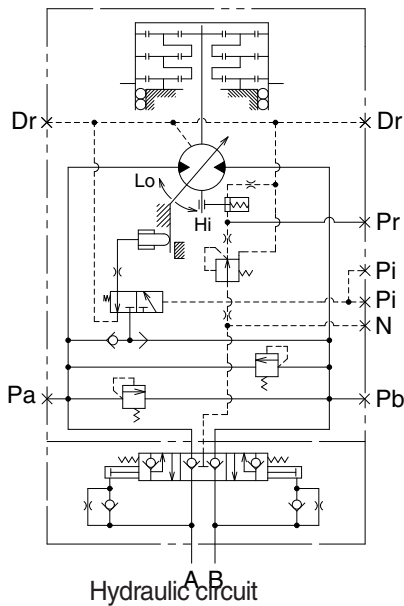
1. CONSTRUCTION (TYPE 1)

Travel device consists travel motor and gear box.

Travel motor include counter balance valve, cross over relief valve.

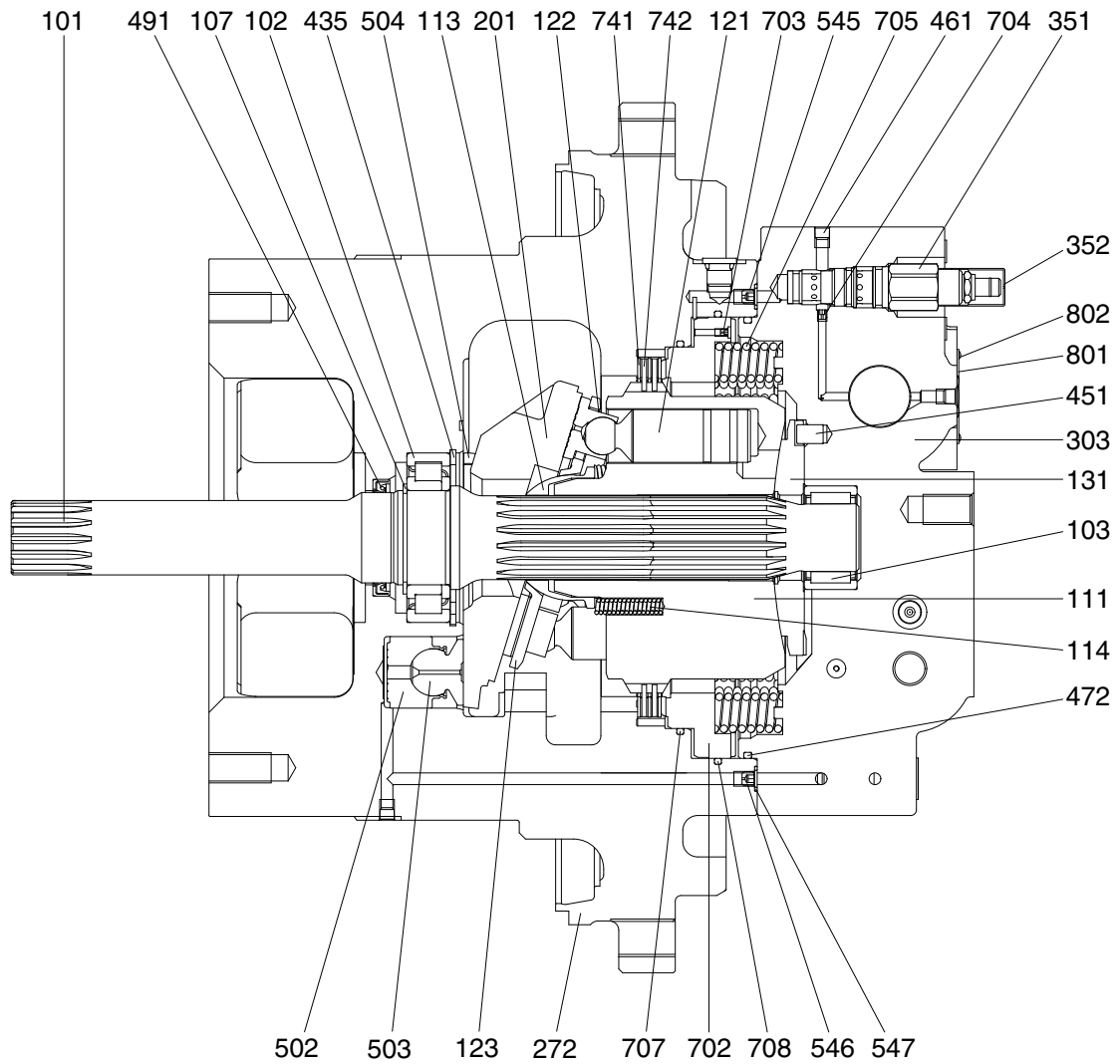


3607A2TM01



Port	Port name	Port size
A	Main port	SAE 6000 psi 1"
B	Main port	SAE 6000 psi 1"
Pi	Pilot port	PF 1/4
Dr	Drain port	PF 1/2
N	Negative brake release port	NPTF 1/16
Pa, Pb	Pressure gauge port	PF 1/4
Pr	Brake release pressure gauge port	PF 1/4
L	Level gauge	PF 1/2
GIN	Gear oil inlet port	PF 1/2
GOUT	Gear oil drain port	PF 1/2

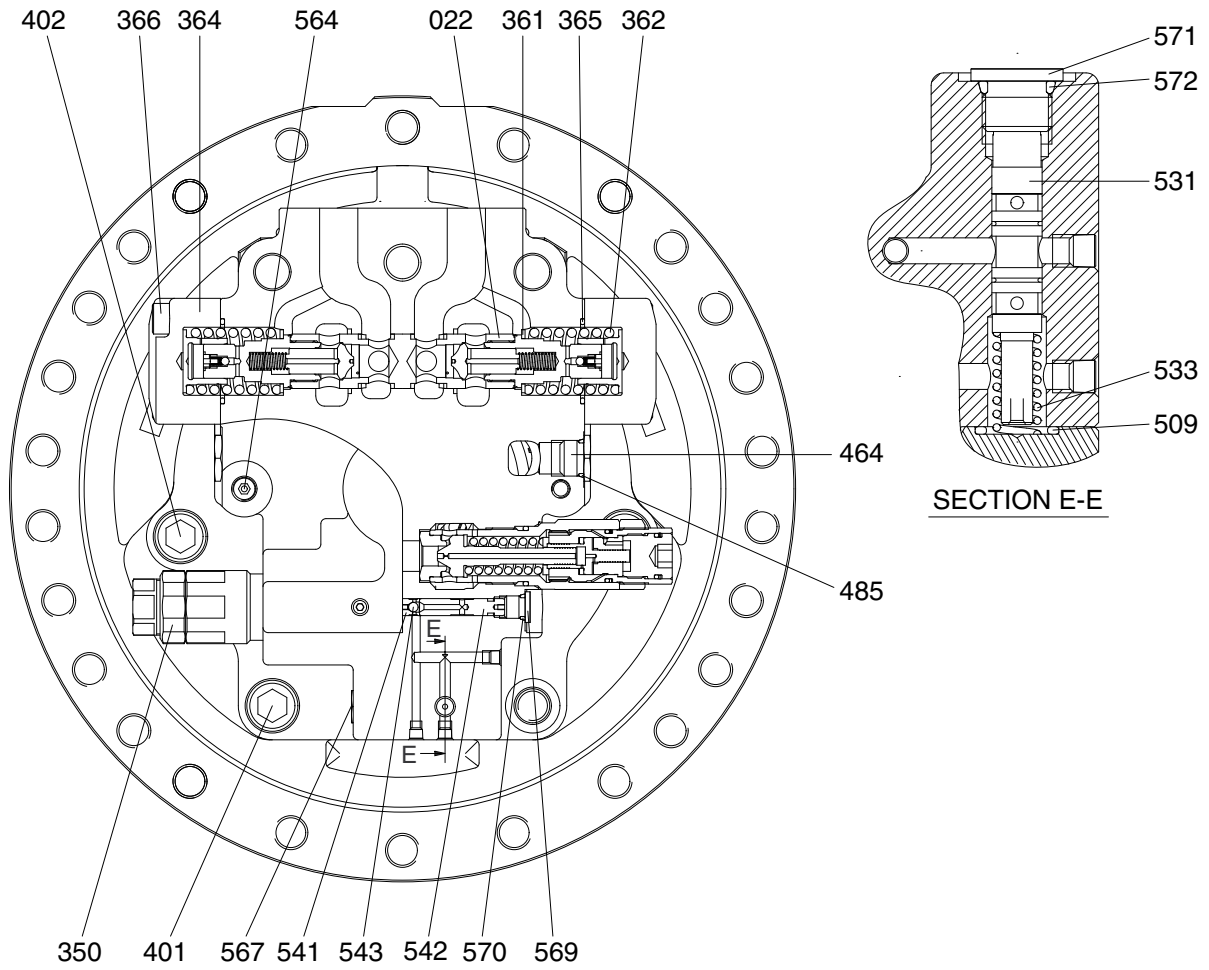
1) TRAVEL MOTOR (1/2)



3607A2TM02

101 Drive shaft	303 Valve casing	547 O-ring
102 Roller bearing	351 Reducing valve	702 Brake piston
103 Needle bearing	352 Cover	703 Orifice
107 Snap ring	435 Snap ring	704 Orifice
111 Cylinder block	451 Pin	705 Brake spring
113 Spherical bushing	461 Plug	707 O-ring
114 Cylinder spring	472 O-ring	708 O-ring
121 Piston	491 Oil seal	741 Separation plate
122 Shoe	502 Piston	742 Friction plate
123 Set plate	503 Shoe	801 Name plate
131 Valve plate	504 Pivot ball	802 Rivet
201 Swash plate	545 Orifice	
272 Shaft casing	546 Orifice	

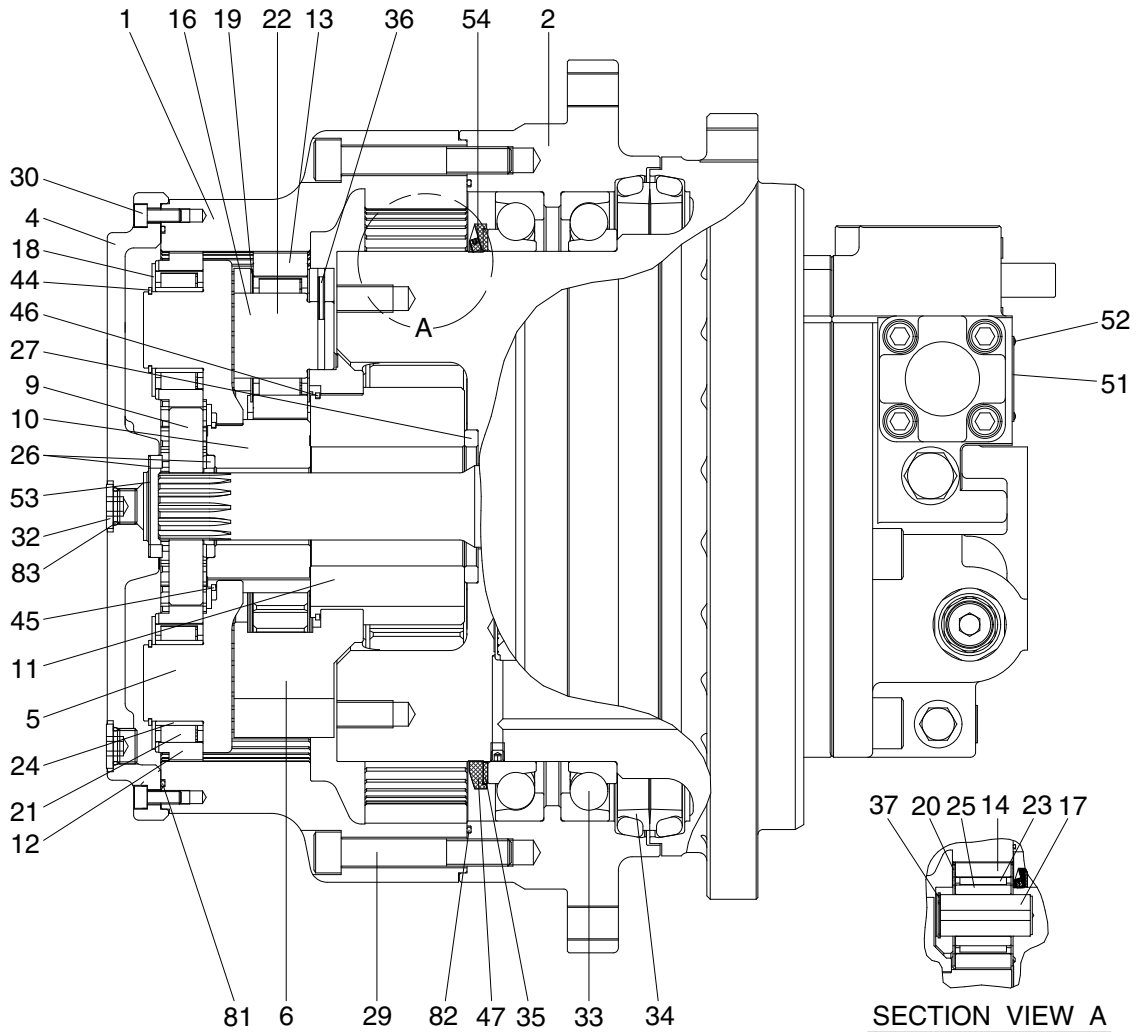
TRAVEL MOTOR (2/2)



022	Counterbalance spool	402	Hex socket bolt	543	Steel ball
350	Relief valve	464	VP plug	564	Plug
361	Washer	485	O-ring	567	VP plug
362	Counterbalance spring	509	O-ring	569	RO plug
364	Counterbalance cover	531	Tilting spool	571	RO plug
365	O-ring	533	Tilting spring	572	O-ring
366	Hex socket bolt	541	Seat		
401	Hex socket bolt	542	Stopper		

3607A2TM03

2) REDUCTION GEAR



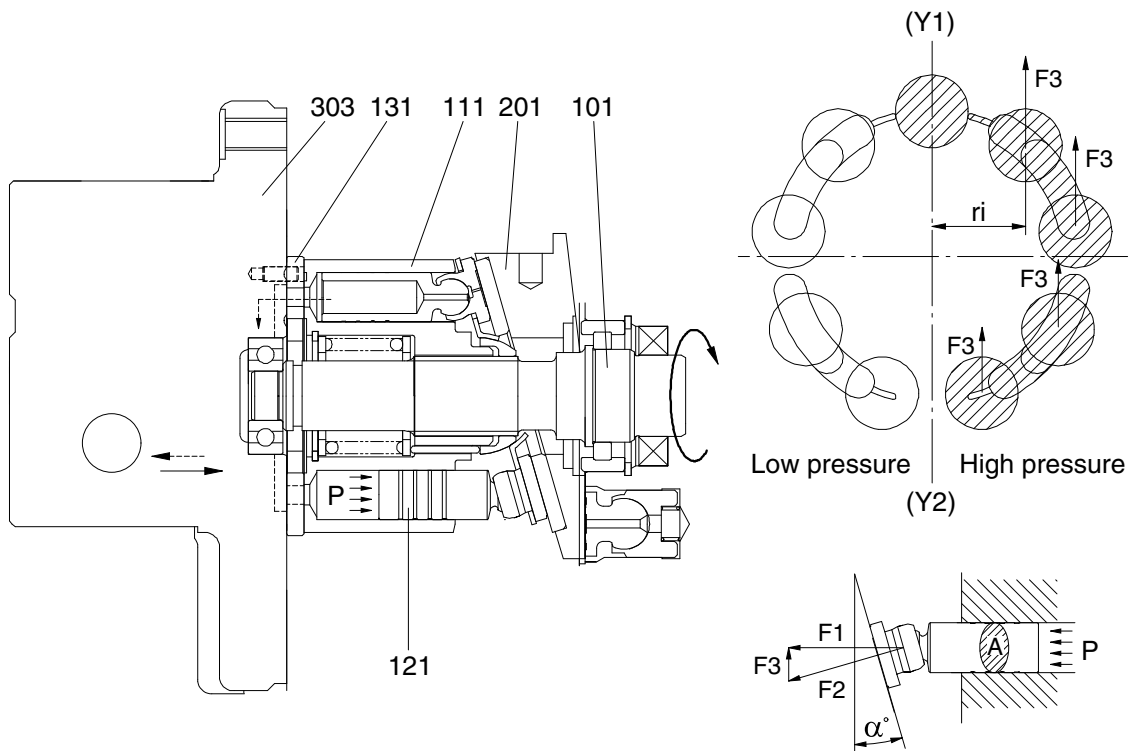
SECTION VIEW A

3607A2TRG01

1	Ring gear	19	Side plate	35	Shim
2	Housing	20	Side plate	36	Spring pin
4	Side cover	21	Needle cage	37	Snap ring
5	Carrier 1	22	Needle cage	44	Snap ring
6	Carrier 2	23	Needle cage	45	Clip
9	Sun gear 1	24	Inner ring	46	W clip
10	Sun gear 2	25	Floating bushing	47	Nut ring
11	Sun gear 3	26	Thrust ring	51	Name plate
12	Planetary gear 1	27	Thrust ring	52	Rivet
13	Planetary gear 2	29	Socket bolt	53	Washer
14	Planetary gear 3	30	Socket bolt	54	Set screw
16	Pin 2	32	RO plug	81	O-ring
17	Pin 3	33	Angular bearing	82	O-ring
18	Side plate	34	Floating seal	83	O-ring

2. FUNCTION

1) GENERATION OF TORQUE



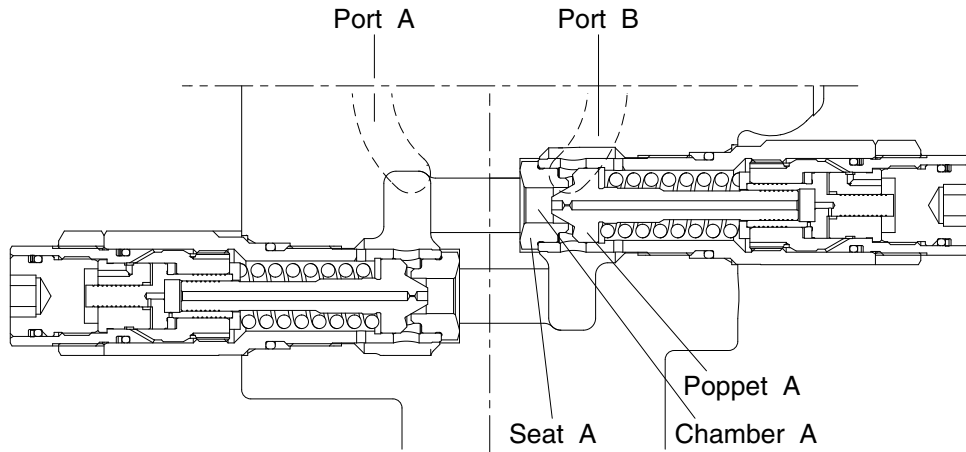
3607A2TRG02

The pressurized oil delivered from the hydraulic pump flows to valve casing (303) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block (111) via valve plate (131). This oil constructively introduced only to one side of (Y1)- (Y2) connecting the upper and lower dead points of stroke of piston (121). The pressurized oil led to one side in cylinder block (111) pushes each piston (121) four or five and generates a forec [$F \text{ (kgf)} = P \text{ (kgf/cm}^2) \times A \text{ (cm}^2)$]. This force acts on swash plate (201), and is resolves into components (F2 and F3) because swash plate (201) is fixed at an angle (α) with the axis of drive shaft (101). Radial component (F3) generates respective torques ($T=F3 \times ri$) for (Y1)- (Y2). This residual of torque [$T=S (F3 \times ri)$] rotates cylinder block (111) via piston (121). Since the cylinder block (111) is spline coupled with drive shaft (101). So the drive shaft (101) rotates and the torque is transmitted.

2) RELIEF VALVE

The relief valve mainly has the following two functions :

- (1) To keep the starting pressure of the hydraulic motor at a constant value and bypass to the return line excessive oil generated at the motor inlet depending upon the acceleration speed of the driven inertia.
- (2) To generate a brake pressure at the outlet during stopping of the driven inertia, and stop it forcedly.



3607A2TM06

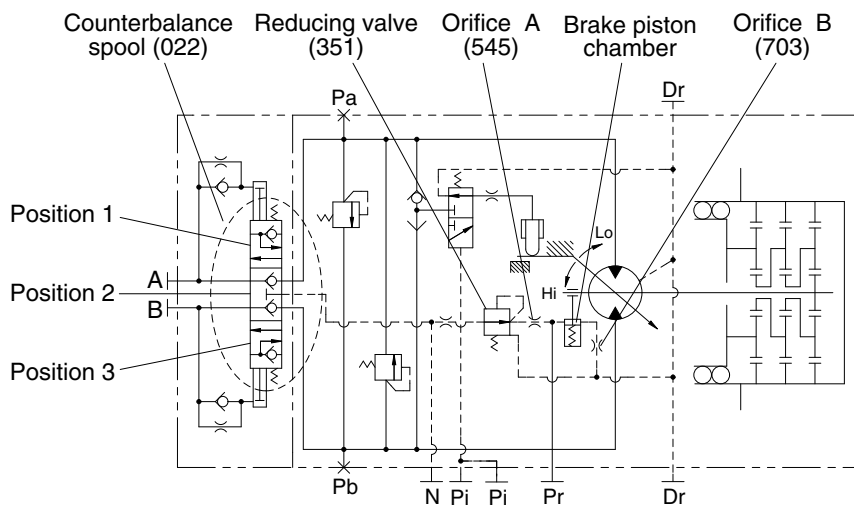
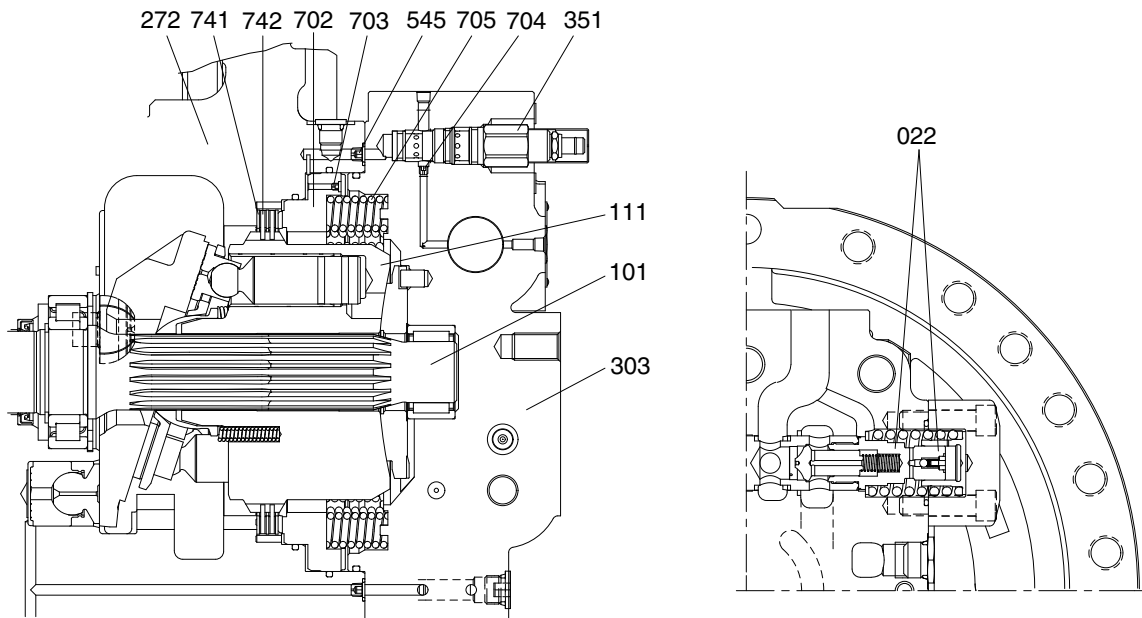
The chamber A is always connected to the port A of the motor.

When the pressure at port A increases and the force pushing poppet A is higher than the set pressure of the spring, then poppet A is pushed up from the contact surface of seat A, and oil flows from chamber A to port B.

3) NEGATIVE BRAKE

The negative brake is released applying to the brake piston (702) the pressure led through the built-in counterbalance spool sub-assembly (022).

With no pressure working, the brake force is always ensured.

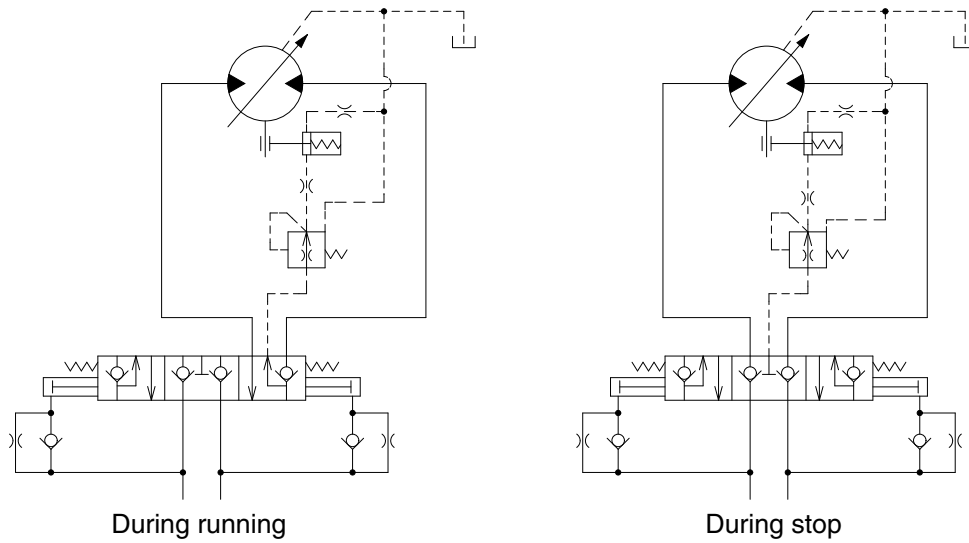


3607A2TM07

The brake force is the friction force generated on the surfaces of the friction plates (742) spline-coupled with the cylinder block (111), when their rotation is restricted by the shaft casing (272), separation plate (741), and brake piston (702).

Without pressure being applied to the brake piston, the brake piston is pushed by fourteen brake springs (705), and the friction plate and separation plate are held between the brake and shaft casing. This holding force functions as the friction force. This friction force restrains the shaft (101) spline-coupled with the cylinder block, and this function is the brake.

4) PRESSURE RELEASE VALVE (Flow control valve)



3607A2TM08A

This brake is of a backpressure-insensitive type. In other words, since the counterbalance spool used be overlapped at the neutral position, the pressure release valve prevents the circuit backpressure from working into the brake chamber when the machine stops traveling and works, and so the specified brake torque is available even on a slope.

During normal traveling, the pressure coming through the counterbalance valve is applied to the brake chamber to release the break, and is also applied to the pressure release valve section.

This pressure release valve is of a constant differential pressure type, and irrespective of the working pressure, the passing flow is constant and approximately 1 to 2 l / min.

When the condition changes from traveling to stop, the counterbalance spool returns to its neutral position. The brake piston is pushed by the brake spring, and the oil in the brake chamber flow to the motor drain line via the pressure release valve. Then the brake torque is generated.

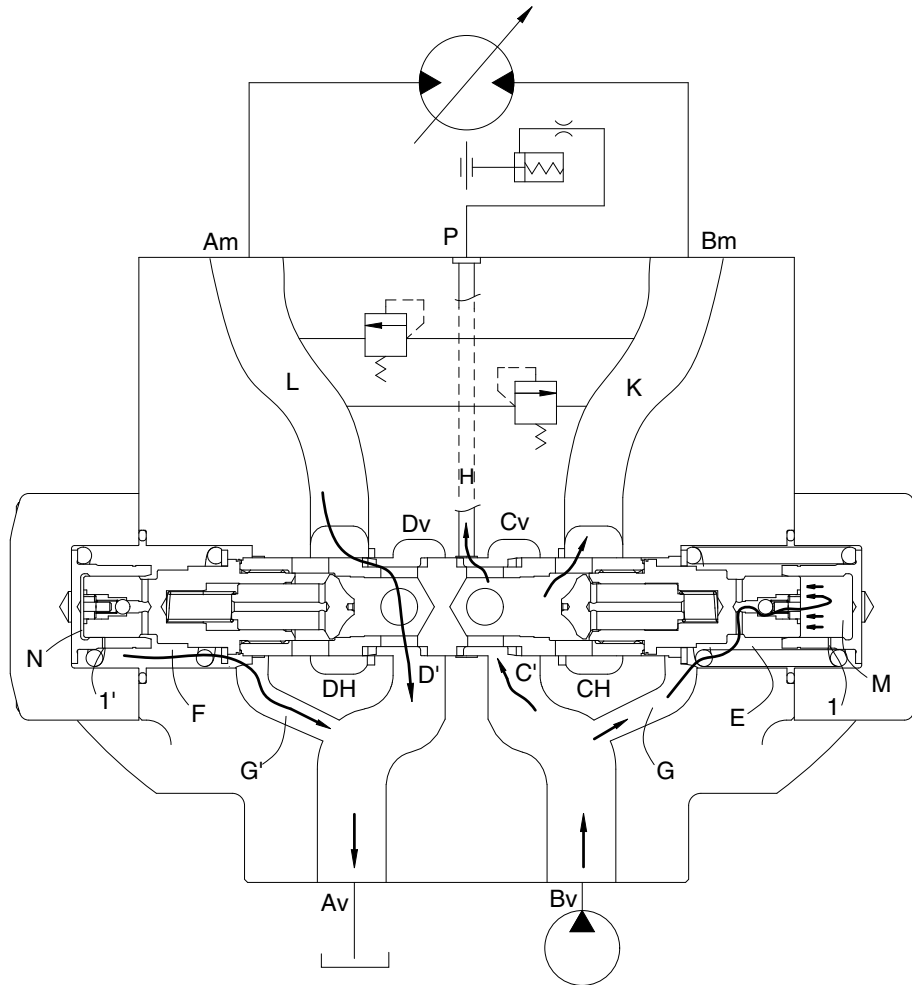
5) RELEASING METHOD OF NEGATIVE BRAKE

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

Details of work	Tools
Remove two plugs (564) from the valve casing (303). (For their position, see the attached installation dimension) Tighten an M10 screw of 135 mm in length into a tapped hole of the brake piston (702). Then the condition having the brake release pressure is attained and the brake is released.	Socket wrench 6 mm 8 mm

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

6) COUNTERBALANCE VALVE



3607A2TRG03

Suppose port Bv is connected to the hydraulic pump and Port Av, to the tank. The oil supplied from the hydraulic pump passes through Bv, Cv and C' in sequence, pushes up the poppet of the check valve, passes through K to Port Bm, and is supplied to the hydraulic motor to turn it.

Therefore, the pump discharge oil pressure increases, and the pressure is led via passage G to spring room E and via the ball check valve to dumping room M. When the pressure in rooms E and M exceeds the value equivalent to the force of the spring which holds the spool at its neutral position, the spool begins to move left. Since the working oil in room N flows into room F via throttle 1' or clearance 2' and that in room F is discharged via passage G' through port Av to the tank, the spool moves left to have passage L-Dm-D'-Dv composed. In addition, passage Cv-H-P is also composed, and the pump discharge pressure in port Bv is led to port P.

Because of the throttle or clearance provided for the working oil flow from room N, this changeover motion of the spool is comparatively slow.

When the pump discharge pressure is higher, the spool movement is larger and the above opening area of the spool is larger.

When the pump discharge pressure falls, pressures in rooms E and M fall and the spool will move right due to the spring on the room F side.

Since working oil in room M flows to room E via throttle 1 and that in room E, to port Bv via passage G, the spool moves right.

When the pressure at port Bv falls down to the tank pressure, the pressure in room E also falls to the tank pressure and becomes equal to that in room F, and so the spool returns to its neutral position.

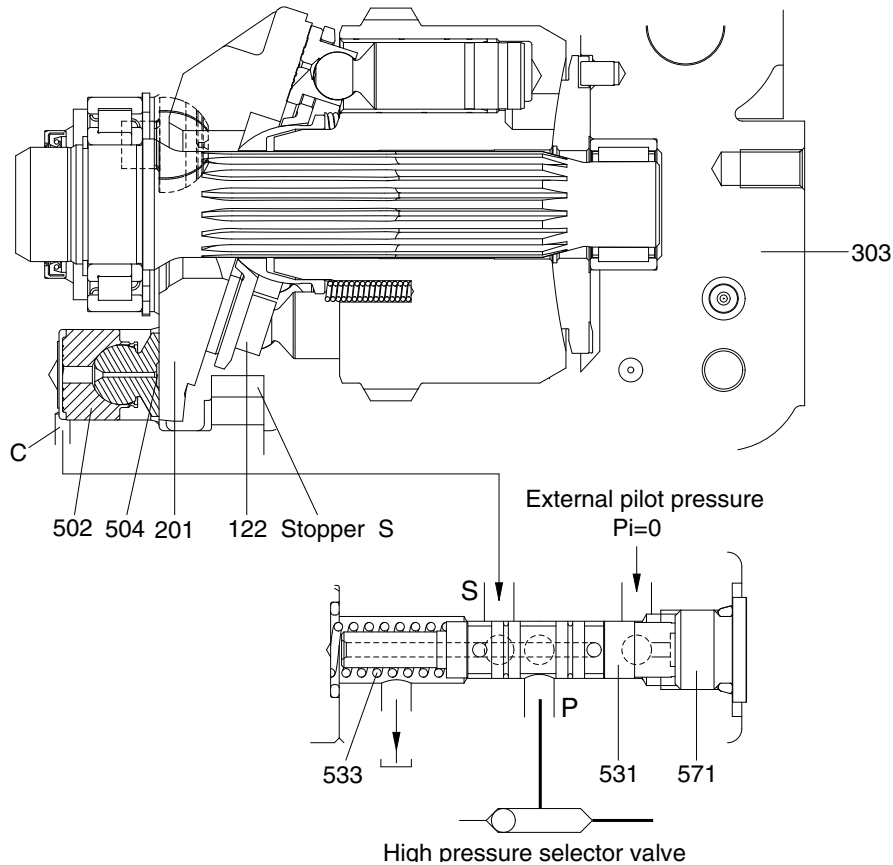
7) DISPLACEMENT CHANGEOVER SECTION

As a supporting mechanism for the swash plate (201) on which the shoes (122) slide, the pillar system is adopted to support the load with semi-cylindrical sliding bearings provided at both ends of the mechanism.

The capacity is changed by changing the tilting angle of this swash plate.

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

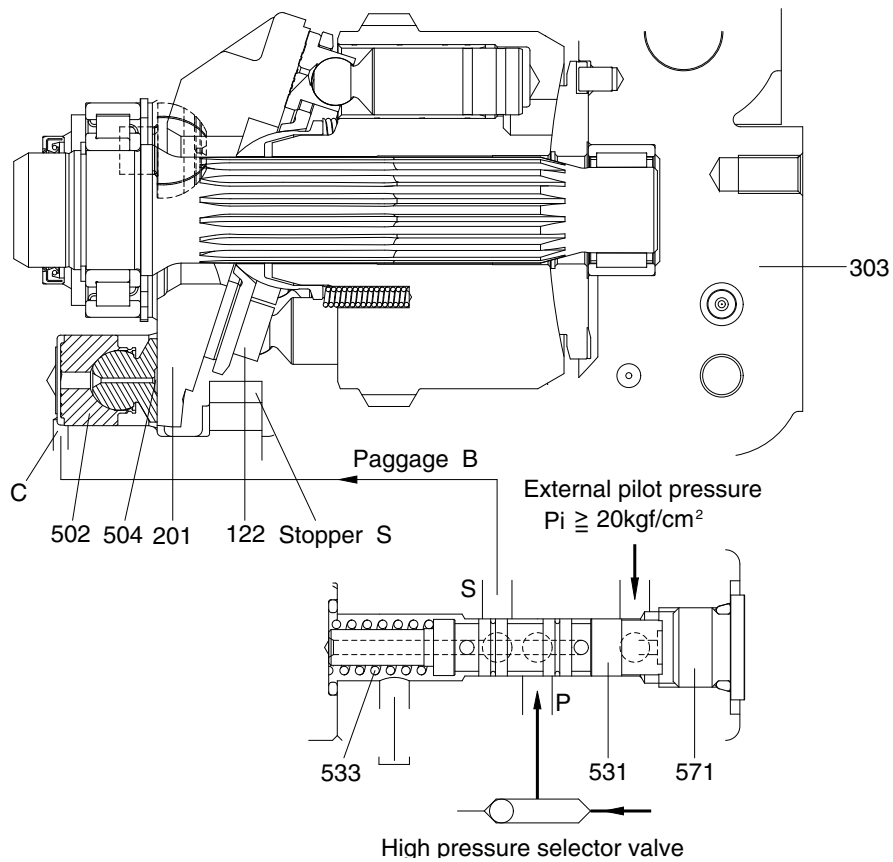
(1) External pilot pressure : $P_i = 0$ Large displacement



3607A2TM04

By means of the built-in high pressure selector mechanism in the valve casing (303), the high pressure oil working on the motor functions to port P of the displacement-changeover valve. This pressure becomes the servo pressure. Since the spool (531) assembled in the displacement changeover valve is pressed to plug (571) by thy spring (533), the high pressure oil at port P is enclosed.

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

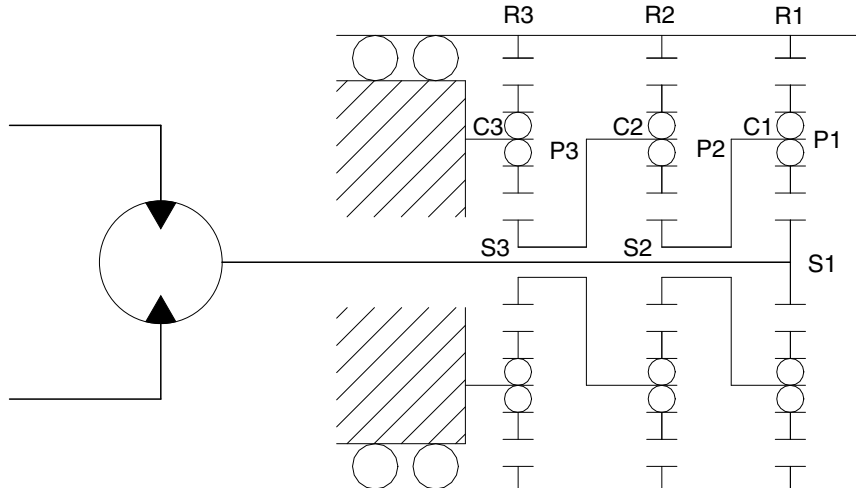


3607A2TM05

The force working on the spool (531) of the displacement-changeover valve becomes higher than that of the spring (533), and the spool moves left. The high pressure oil flows from port P of the displacement-changeover valve through port S and passage B to room C where it works. The displacement changeover piston (502) is pushed light by the high pressure oil and the swash plate moves in the arrowed direction. The swash plate moves until it touched stopper S, and then is fixed there.

8) REDUCTION GEAR

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



3607A2TRG04

The input rotation of the hydraulic motor is transmitted to No. 1 sun gear (S1) and this drives No. 1 planetary gears (P1). This No. 1 planetary gears (P1) drive No.1 ring gear (R1) with the same force as the meshing tangential force with No. 1 sun gear (S1), and also No. 1 carrier (C1) with the same force as the meshing reaction force. In other words, No. 1 planetary gears (P1) revolve rotating. This rotation of No. 1 carrier (C1) becomes the output of the 1st stage, and is transmitted directly to No. 2 sun gear (S2).

(No. 1 carrier is spline-coupled with No. 2 sun gear.) Similarly the revolution of No. 2 planetary gear (P2) are transmitted via No.2 carrier (C2) to No. 3 sun gear (S3). Since No. 3 carrier (C3) supporting No. 3 planetary gears (P3) are fixed, No. 3 planetary gears (P3) do not revolve, but rotates to drive No. 3 ring gear (R3).

Therefore, the rotating case is driven by the overall driving torque of No1, 2 and 3 ring gears.

This reduction ratio is expressed as shown below:

$$i = \frac{(Z_{S1} + Z_{R1}) (Z_{S2} + Z_{R2}) (Z_{S3} + Z_{R3})}{Z_{S1} \cdot Z_{S2} \cdot Z_{S3}} - 1$$

where Z : Number of teeth of each gear

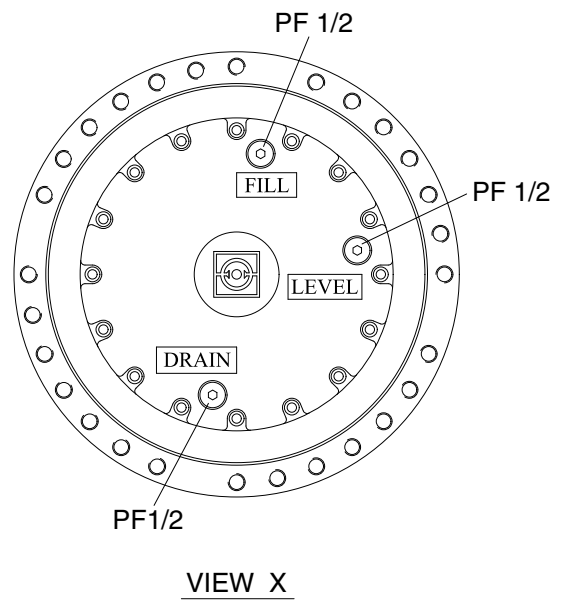
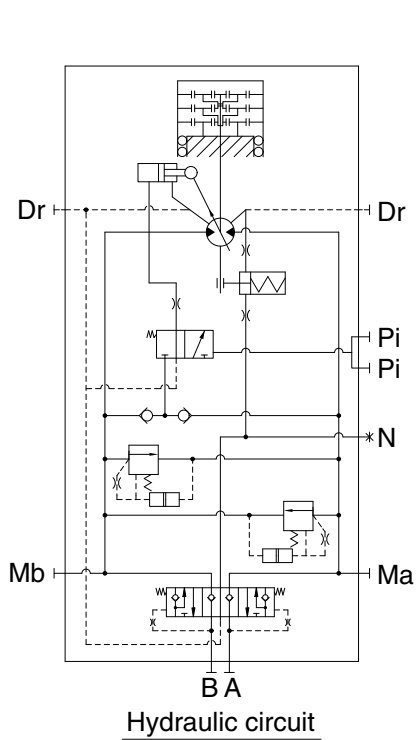
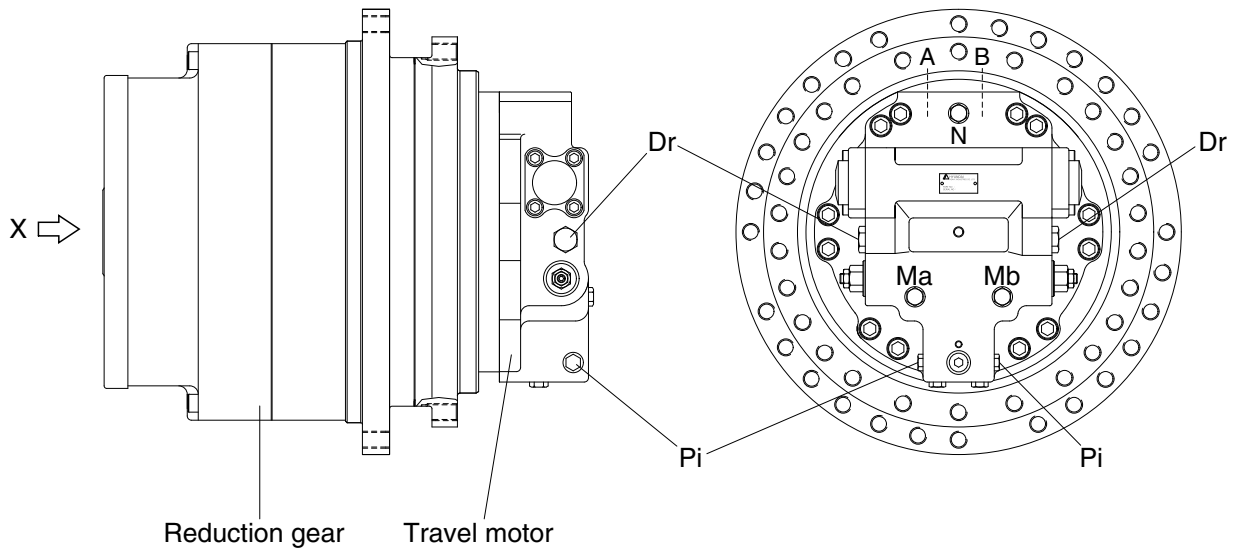
The direction of rotation is reverse to that of the input shaft.

■ 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.

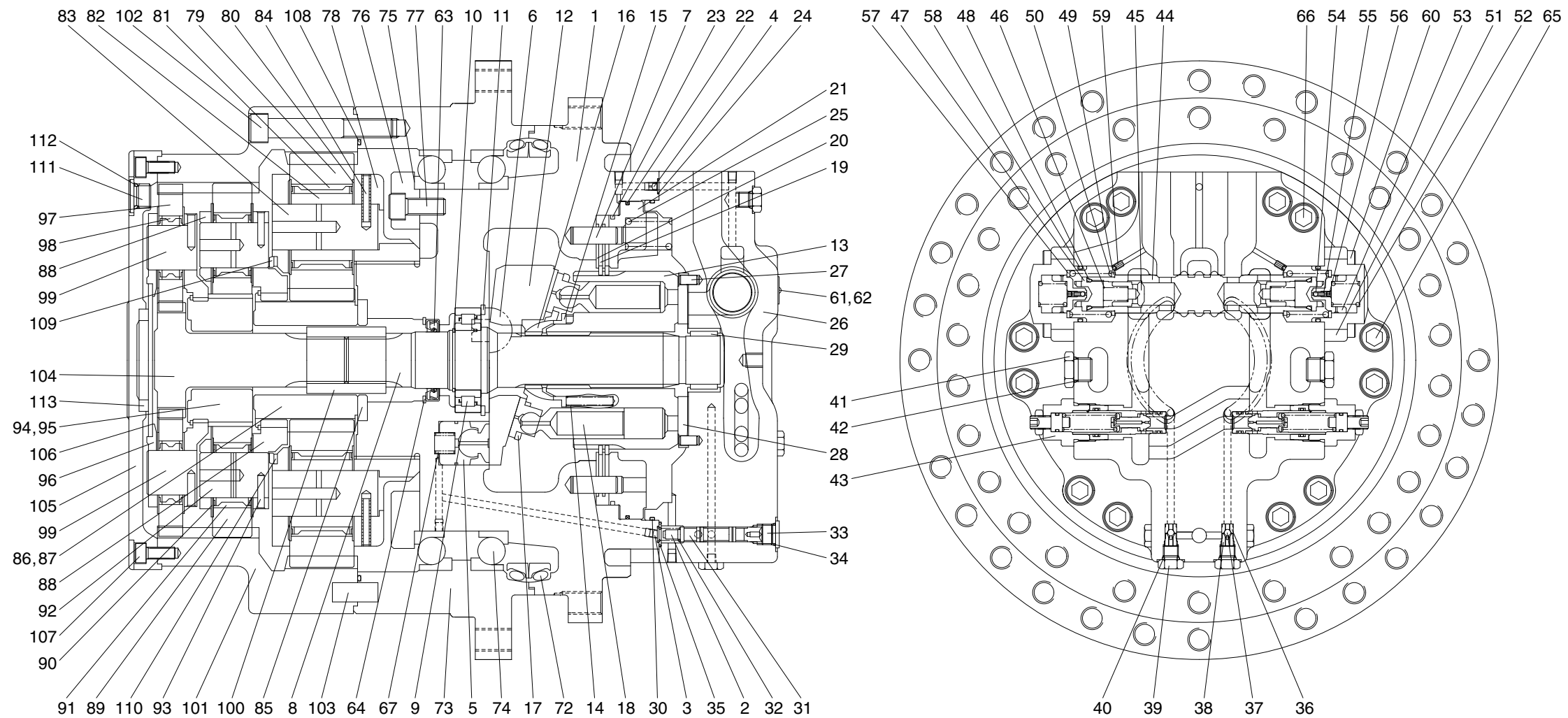


3809A2TM21

Port	Port name	Port size
A, B	Main port	SAE 6000 psi ϕ 25
Pi	Two speed control port	PF 1/4
Dr	Drain port	PF 1/2
Ma, Mb	Gage port	PF 1/4
N	Brake release port	PF 1/4

2. SPECIFICATION

1) TRAVEL MOTOR



3809A2TM22

1 Shaft casing	15 Spacer	29 Needle bearing	43 Relief valve assy	57 Spring seat	75 Shim	89 Planetary gear	103 Planetary pin
2 Plug	16 Ball guide	30 O-ring	44 Main spool	58 O-ring	76 Bearing guide	90 Plate	104 Drive gear
3 Orifice	17 Set plate	31 Swash spool	45 Check	59 Orifice	77 Wrench bolt	91 Needle bearing	105 End cover
4 Orifice screw	18 Piston & Shoe assy	32 Swash spring	46 Spring	60 Wrench bolt	78 Carrier	92 Pin	106 Plate
5 Swash piston	19 Friction plate	33 Plug	47 Plug	61 Name plate	79 Planetary gear	93 Spring pin	107 Wrench bolt
6 Swash ball	20 Separator plate	34 O-ring	48 O-ring	62 Rivet	80 Plate	94 Sun gear	108 O-ring
7 Brake pin	21 Brake piston	35 O-ring	49 Spring seat	63 Oil seal	81 Needle bearing	95 Snap ring	109 Ring
8 Shaft	22 Piston ring	36 Seat	50 Spring	64 Snap ring	82 Bearing bushing	96 Carrier	110 Ring
9 Roller bearing	23 Piston ring	37 Steel ball	51 Cover	65 Wrench bolt	83 Pin	97 Planetary gear	111 Plug
10 Stop ring	24 O-ring	38 Stopper	52 Spring	66 Wrench bolt	84 Spring pin	98 Needle bearing	112 O-ring
11 Lock ring	25 Brake spring	39 Plug	53 Spool	67 Spring pin	85 Thrust plate	99 Pin	113 Bushing
12 Swash plate	26 Valve casing	40 O-ring	54 Steel ball	72 Floating seal	86 Sun gear	100 Coupling	
13 Cylinder block	27 Valve plate pin	41 Plug	55 Spring	73 Hub	87 Snap ring	101 Ring gear	
14 Cylinder spring	28 Valve plate	42 O-ring	56 Plug	74 Bearing	88 Carrier	102 Wrench bolt	

3. PRINCIPLE OF DRIVING

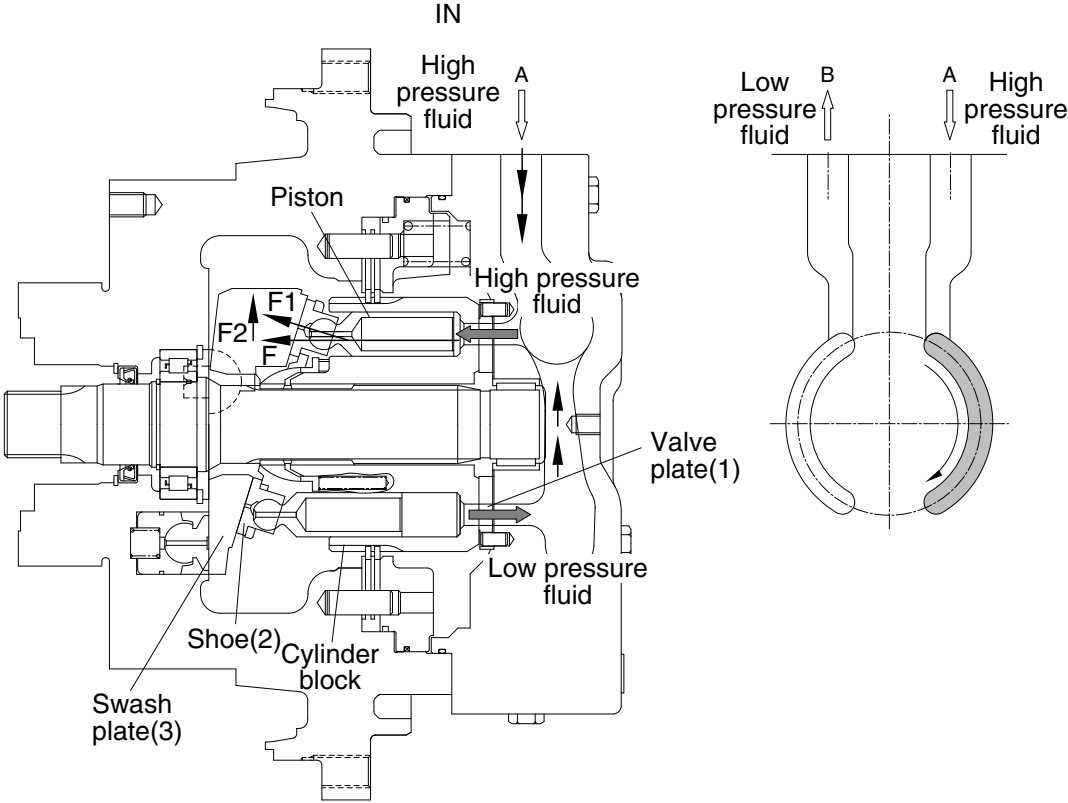
Travel motor comprises with rotary, relief valve, parking brake, counterbalance valve and 2-speed control.

1) WORKING OF ROTARY PART

In the figure below, axis direction power F occurs, when the high pressure oil flows in the cylinder block through to the valve plate (1) port, and the piston moves to the left hand side.

This power F , which takes shoe (2) as a medium, split into $F1$ power vertical to swash plate (3), and $F2$ power perpendicular from an axis. Through $F2$ power, cylinder block rotate with piston and shoe, while shoe (2) moves on the swash plate with piston. There are 9 pistons inserted into the cylinder block and they rotate with the cylinder block by taking high pressure gas in order at the entrance.

When you reverse the flow of the high pressure oil, piston and cylinder block rotate in the opposite direction above the shoe plate.



3809A2TM23

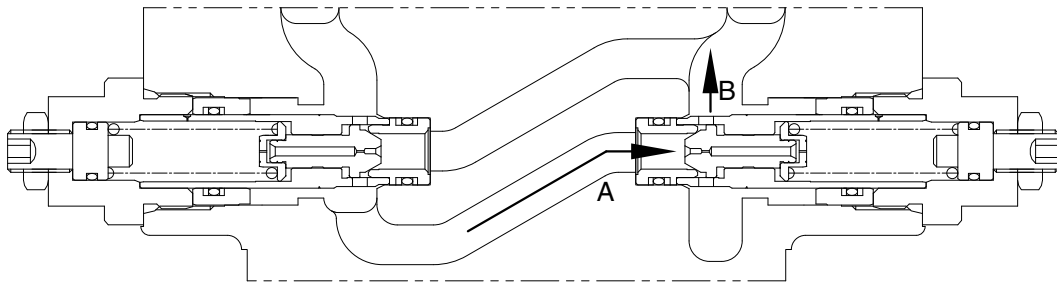
2) WORKING OF RELIEF VALVE

When the port from control valve to motor is closed, traveling movement stops.

However, motor continues rotating because of the traveling inertia of the machine's upper body.

By doing so, motor is damaged by the gradual rising of the pressure at the exit.

To prevent this damage, relief valve discharge the gradual rising pressure from the exit to the entrance which has lower pressure.



3809A2TM24

- Setting pressure : 360 kgf/cm²
- Back pressure : 5 kgf/cm²
- Cracking pressure : 330 kgf/cm² over

- AT THE BEGINNING OF TRAVELING

RELIEF VALVE A

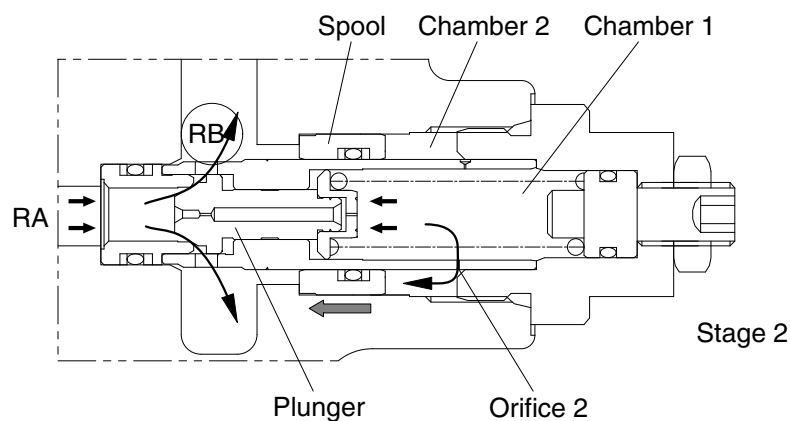
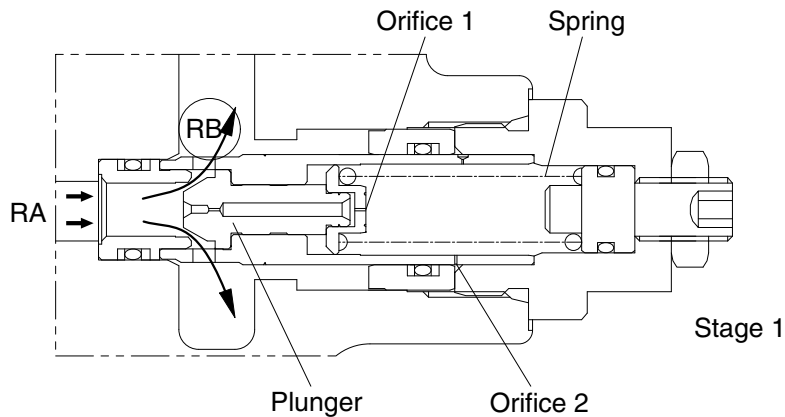
Traveling manipulation lever works to rise the pressure of RA port up. When this pressure oil press plunger to the right, and then sustain the power of the spring, the plunger moves to the right and release the pressure oil of RA port to RB port (stage 1).

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.

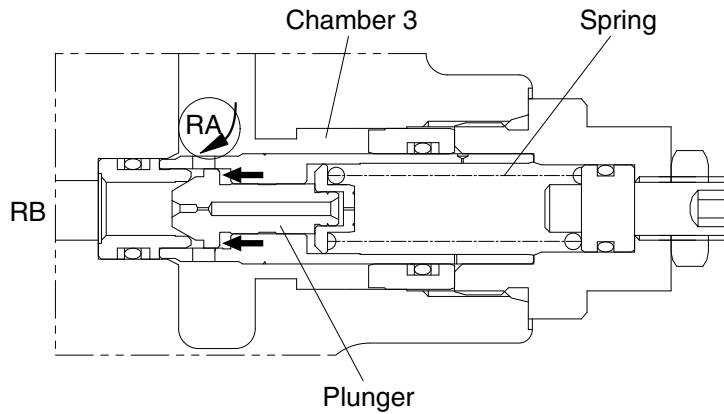


RELIEF VALVE A

- 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

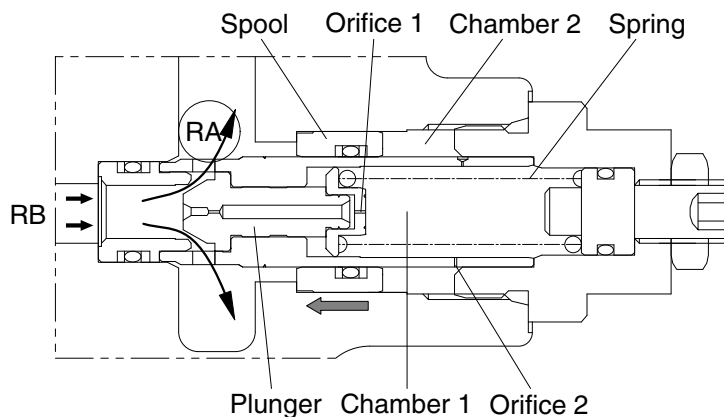
3809A2TM26

- WHEN IT STOP

RELIEF VALVE B

When it stops or operates reversely, RA port pressure is extremely lowered and RB port pressure gradually goes up because of the swing inertia from the upper swing part of machine.

Consequently, 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

3809A2TM27

3) WORKING OF PARKING BRAKE

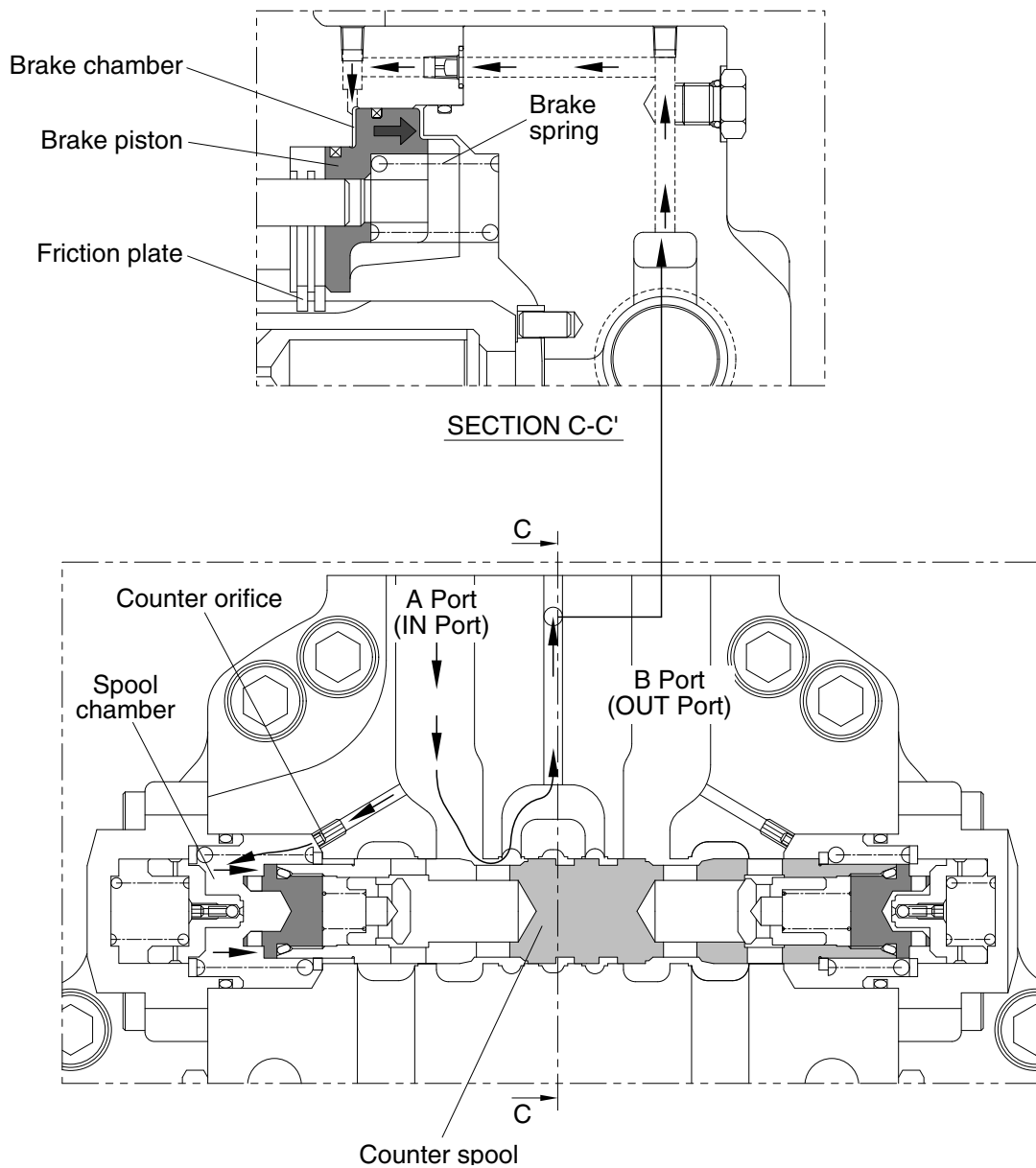
Parking brake consists of many wet friction plate. The brake is usually held with the power of spring, and it only removed by traveling pressure of motor.

- **Parking brake OFF**

If worker operates 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 flow to brake chamber of motor from brake line. Brake piston to force of brake spring moves to right and brake lift.



3809A2TM28

- **Parking brake ON**

If worker leave lever in neutral, pressurized oil supply to in port of motor stop.

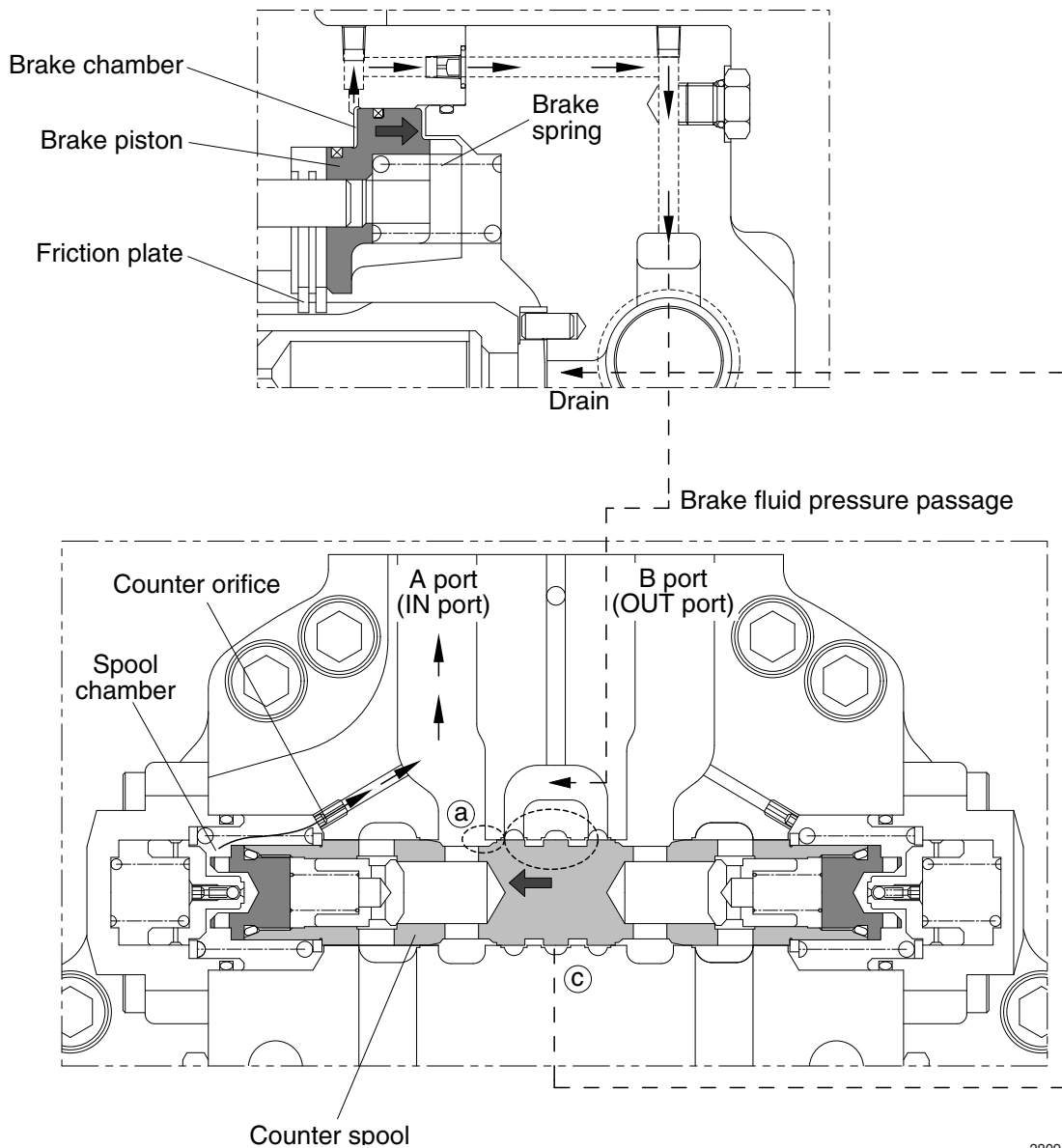
If pressurized oil supply stop, in port pressure decline and pressurized oil of spool chamber moves to oil tank through counter orifice. Therefore counter balance spool return in neutral.

If spool leave in neutral, notch ① part of spool obstructed and brake pressurized oil obstructed.

Brake pressurized oil line obstructed. So pressurized oil supply to brake chamber obstructed.

Therefore if pressure of brake chamber decline, brake piston to force of brake spring moves to left and push friction plate.

If brake force happens, brake stop. And pressurized oil to brake chamber drain to motor casing internal through line ② to counter spool center.



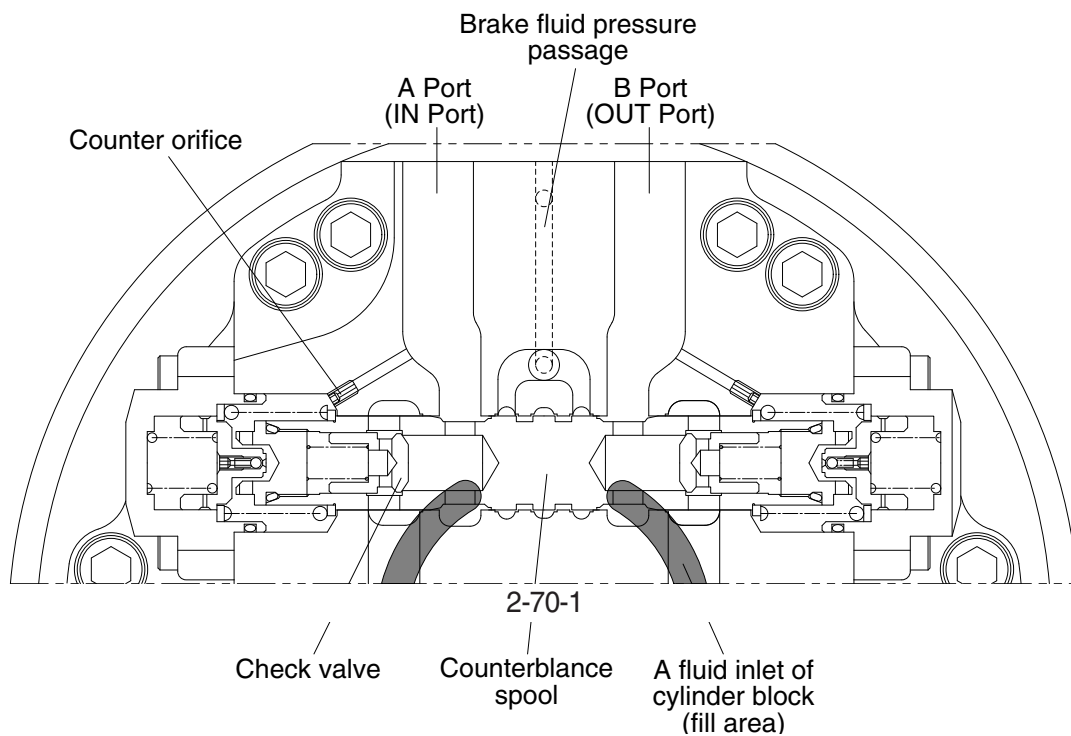
3809A2TM29

4) COUNTERBALANCE VALVE

- **Function of counterbalance valve**

- (1) Parking brake off and operation of motor
- (2) When motor descend in slope, traveling velocity control.
- (3) After motor stop in slope, slip prevention.
- (4) When motor stop, supplement the flow.

- **NEUTRAL**



3809A2TM30

5) HOW TO WORK

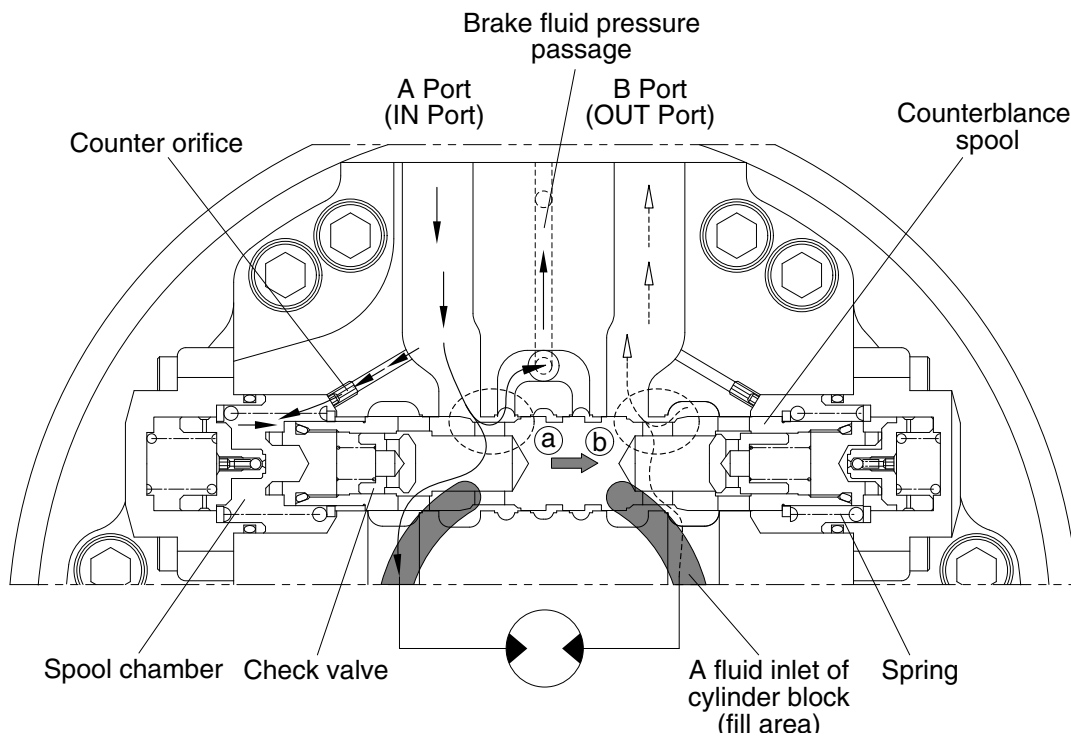
(1) When motor travel

If worker operates the traveling control lever, traveling working pressurized oil into IN PORT flows from spool chamber through counter orifice.

If spool moves to right, notch of spool open line ① of brake pressurized oil.

Then pressurized oil lift the brake. At the same time, notch of counterbalance spool opens the line ②.

Flowed pressurized oil to A port opens check valve and cylinder block of motor rotate.



3809A2TM31

(2) When motor stop

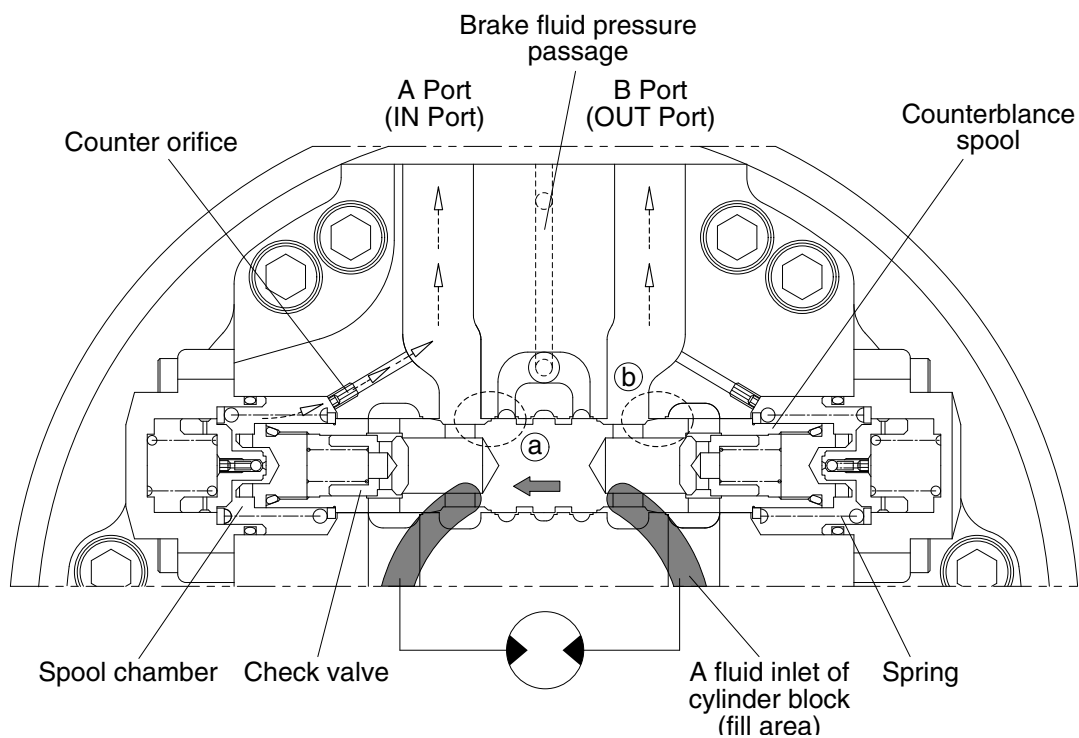
If worker leave lever in neutral, pressurized oil supply to in port of motor stop.

If pressurized oil supply stop, A port pressure decline and pressurized oil of spool chamber moves to oil tank through counter orifice. Therefore counterbalance spool return in neutral.

If counterbalance spool moves to left, line (b) by notch of counterbalance spool obstructed and brake pressurized oil obstructed.

At the same time, line (a) by notch of counterbalance valve obstructed. Therefore brake obstructed.

If brake force happens, brake stop.



3809A2TM32

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

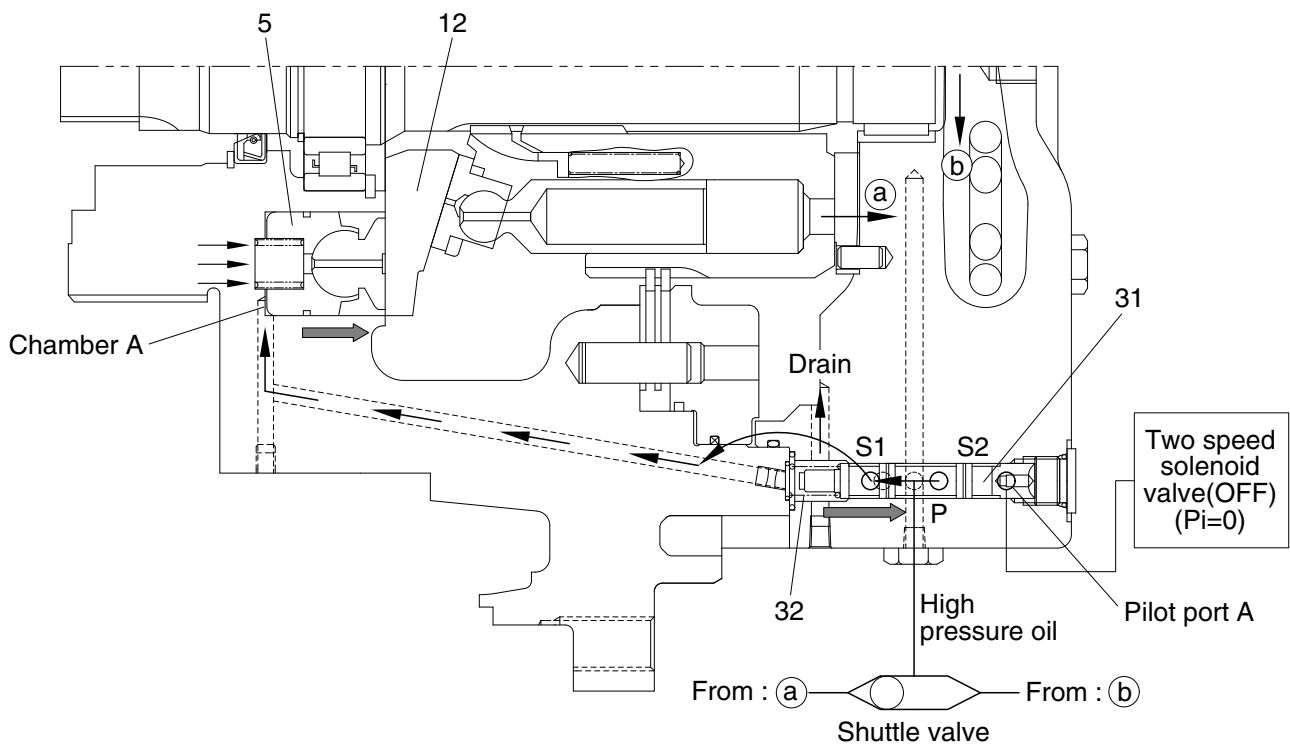
Rotation speed of track motor is depended on slope angle of swash plate (12).

When swash plate angle is Max, the motor rotates at low speed.

When swash plate angle is Min, the motor rotates at high speed.

• Low speed

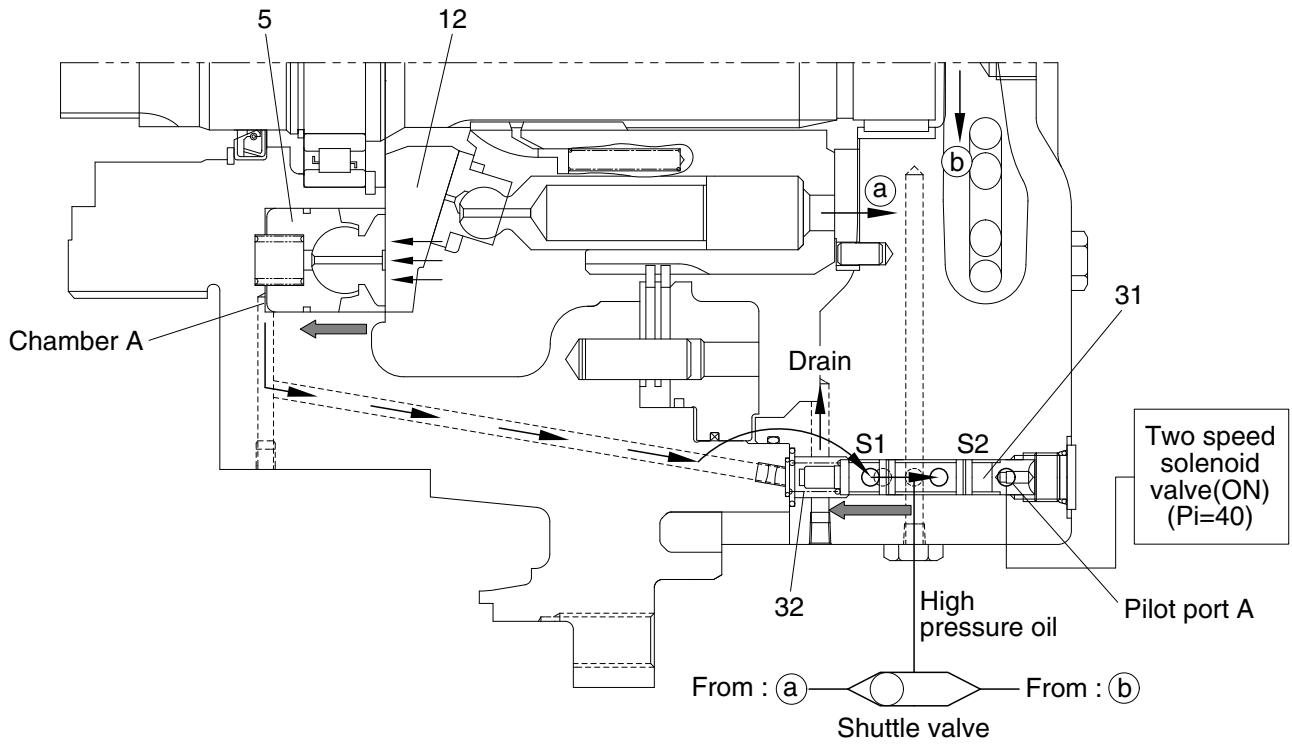
- When the pilot pressure on spool (31) is disconnected, pilot pressure does not pass to pilot port A. Two speed changeover spool (31) moves right by the spring (32) force.
- High pressure oil of (a) port (or (b) port) of cylinder block flow to P port of two speed changeover spool (31) through shuttle valve.
- Pressurized oil of two speed changeover spool flow to chamber A of swash piston (5) through S2 port.
- Swash plate moves to increase swash angle, so the motor rotates at low speed.



3809A2TM33

• **High speed**

- The pilot pressure on spool (31) of the displacement changeover valve overcomes the force of spring (32), and the spool moves left.
- High pressure oil of (a) port (or (b) port) of cylinder block flow to P port of two speed changeover spool (31) through shuttle valve.
- Swash plate moves to decrease swash angle, so the motor rotates at high speed.



3809A2TM34

4. REDUCTION GEAR

1) PLANETARY GEAR MECHANISM

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

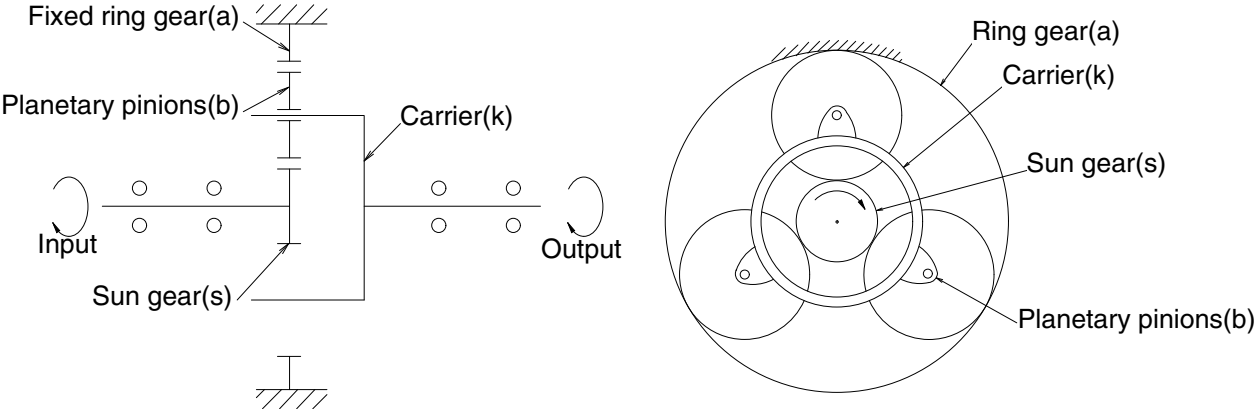
This reduction unit utilizes two stages, planetary reduction system.

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.



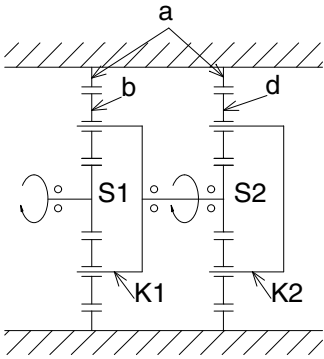
29072TM10

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.

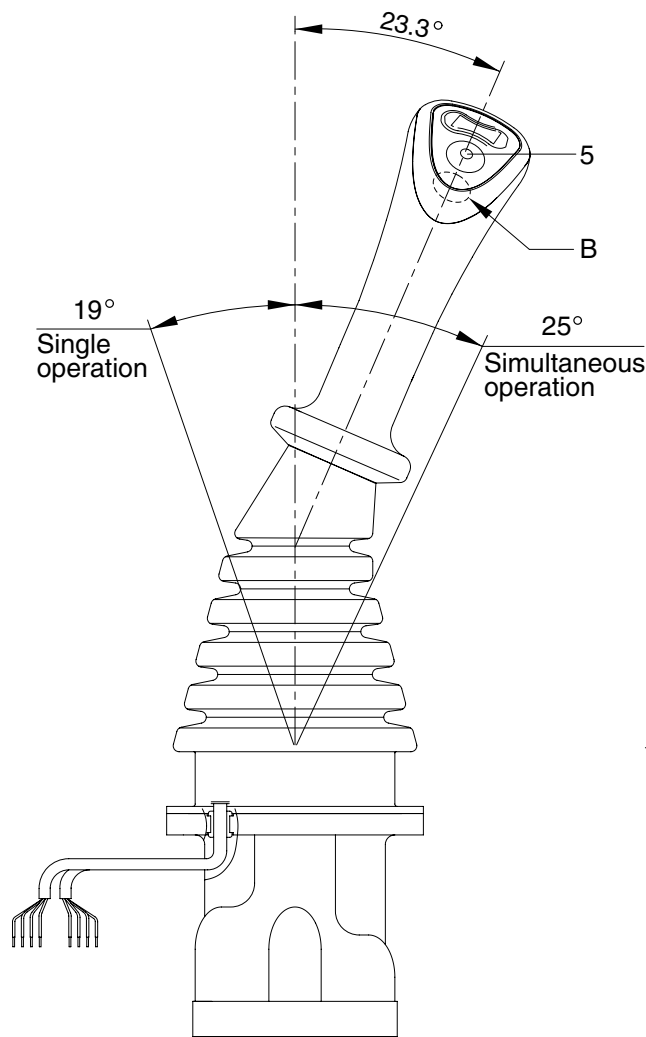


29072TM12

GROUP 5 RCV LEVER

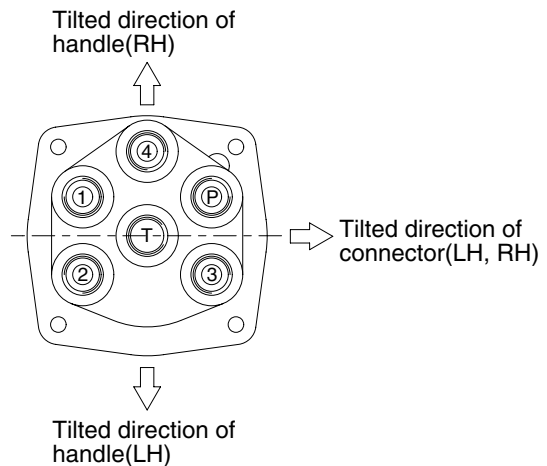
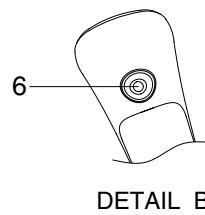
1. STRUCTURE

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

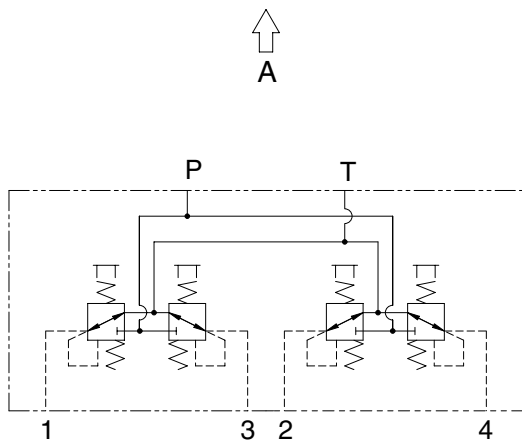


Switches

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



VIEW A



Hydraulic circuit

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

21092RL01

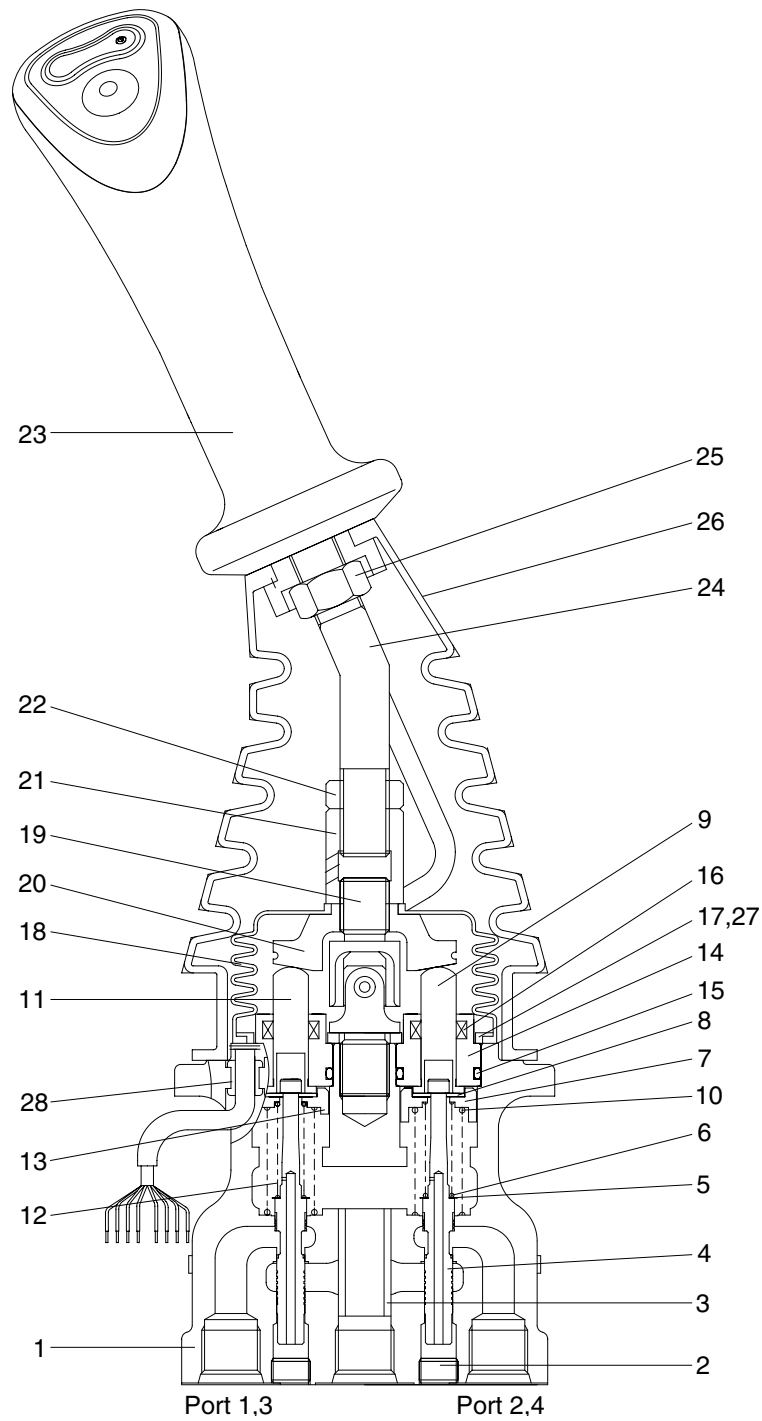
CROSS SECTION

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

The pressure reducing section is composed of the spool (4), spring (6) for setting secondary pressure, return spring (10), stopper (8), spring seat (7, 13) and shim (5). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm² (depending on the type). The spool is pushed against the push rod (9, 11) by the return spring.

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

CROSS SECTION



32092RL01

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

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

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

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

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

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

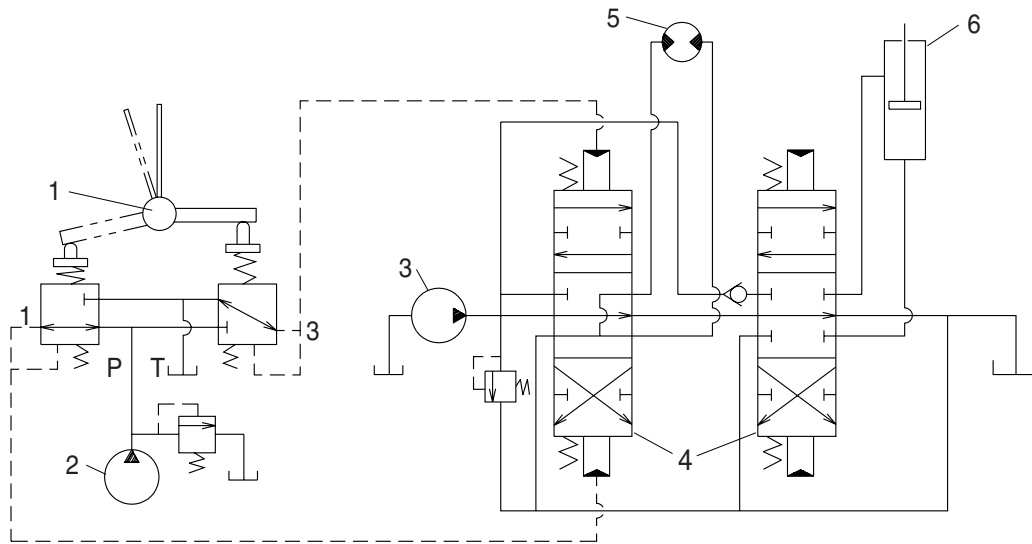
The spring (10) works on the case (1) and spring seat (7, 13) and tries to return the push rod (9,11) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

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



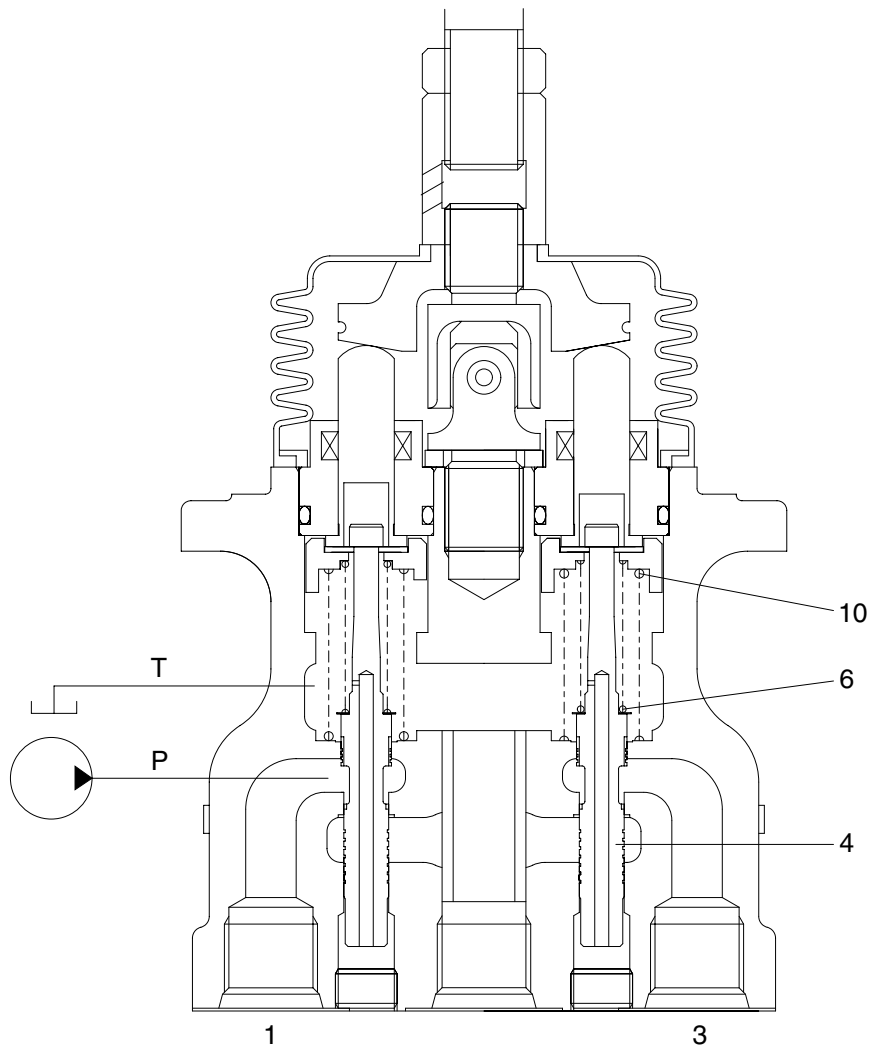
2-70

1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

5 Hydraulic motor
6 Hydraulic cylinder

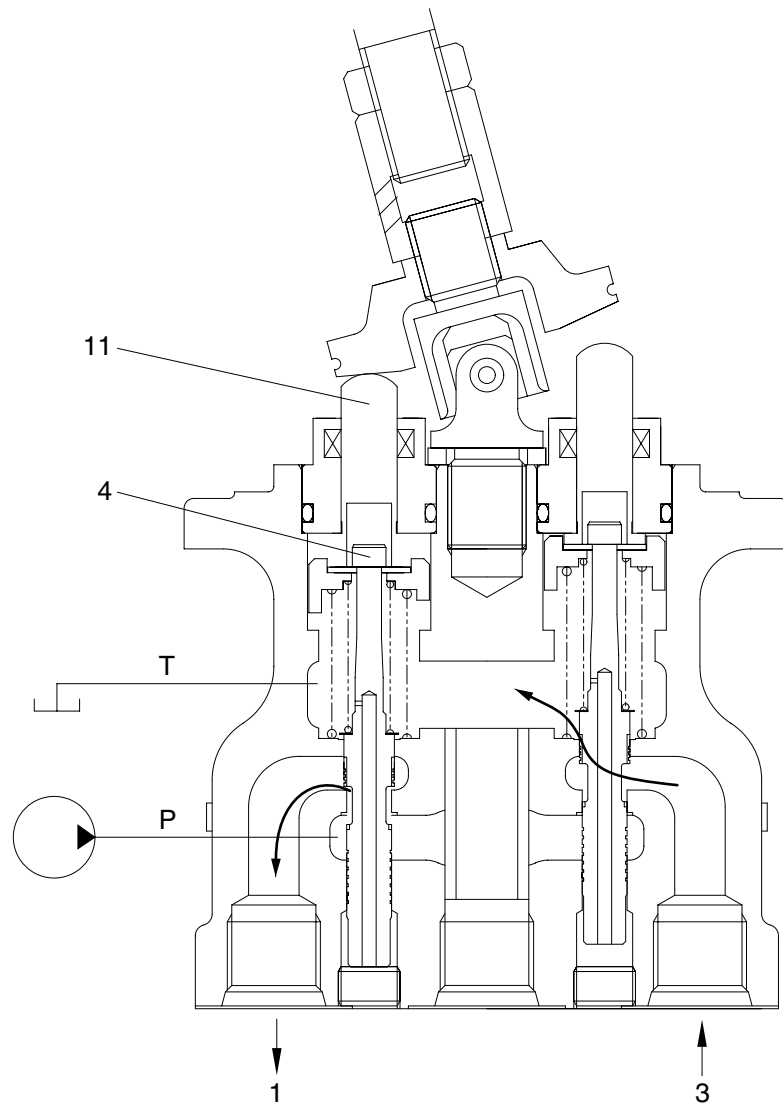
(1) Case where handle is in neutral position



21092RL03

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

(2) Case where handle is tilted



21092RL04

When the push rod (11) is stroked, the spool (4) moves downwards.

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

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

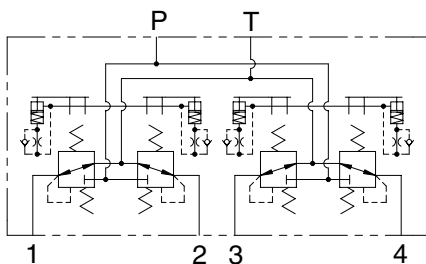
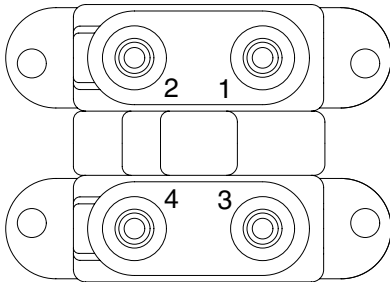
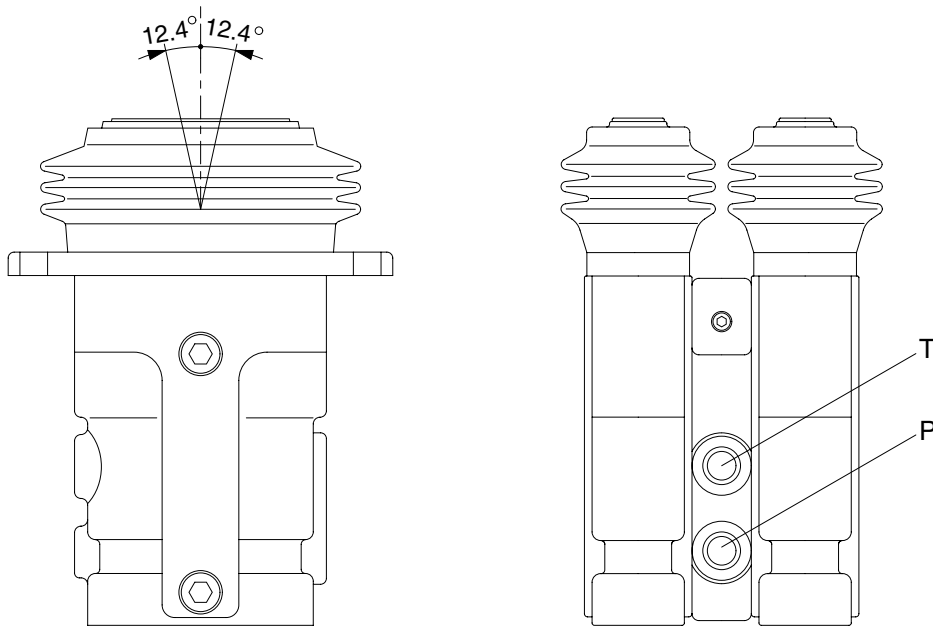
In this manner the secondary pressure is kept at the constant value.

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

GROUP 6 RCV PEDAL

1. STRUCTURE

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



Hydraulic circuit

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

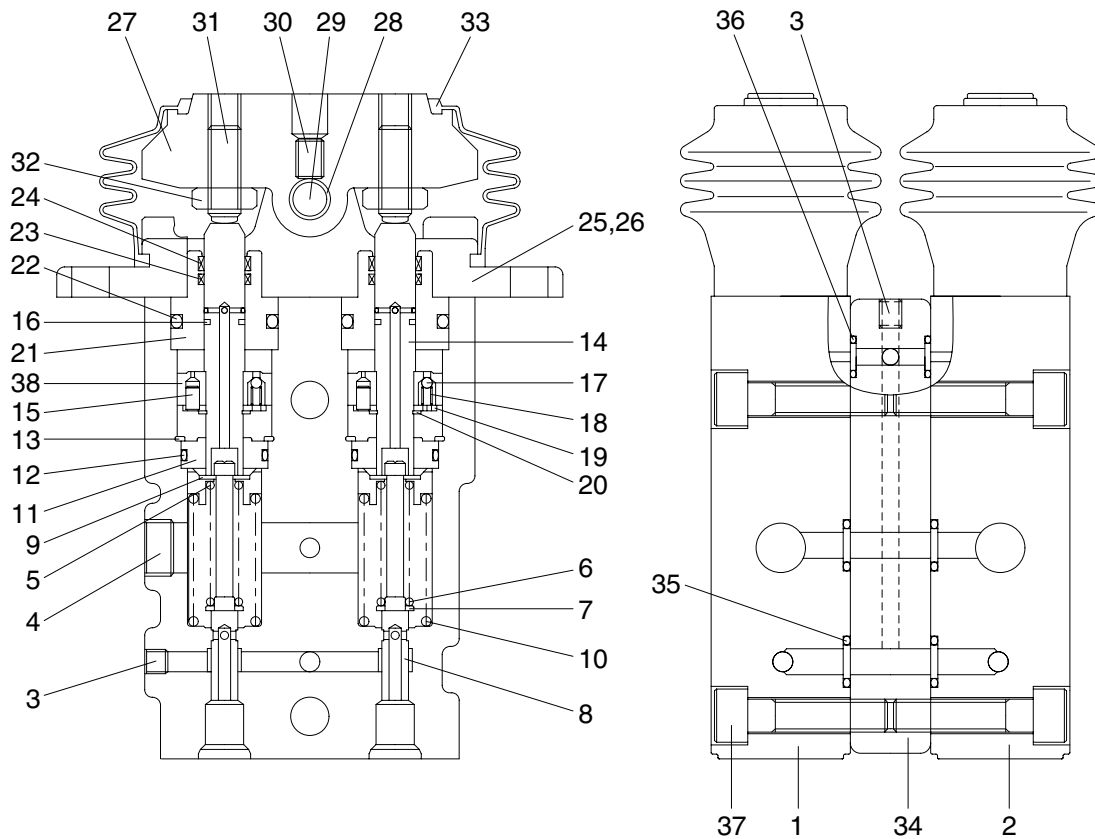
21092RP01

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.

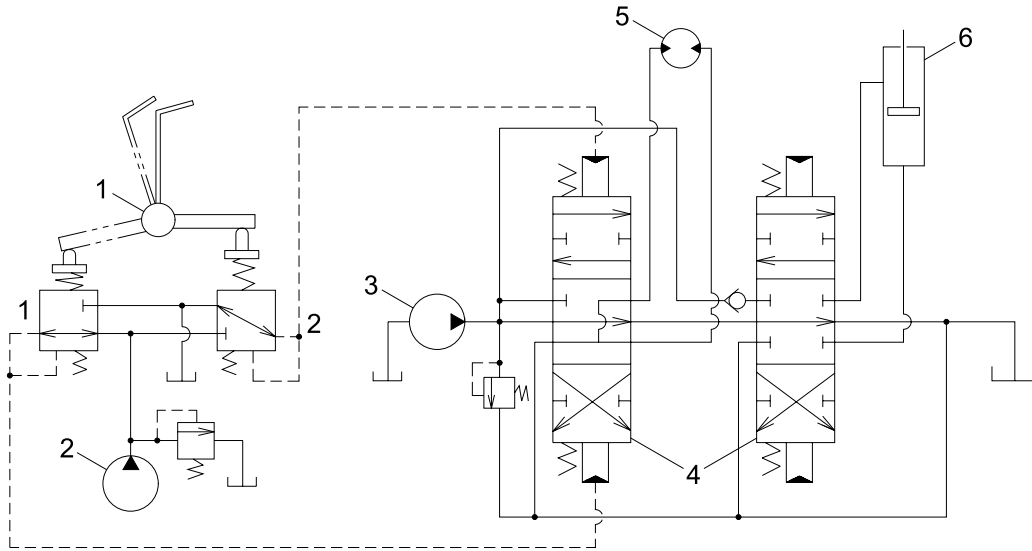
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



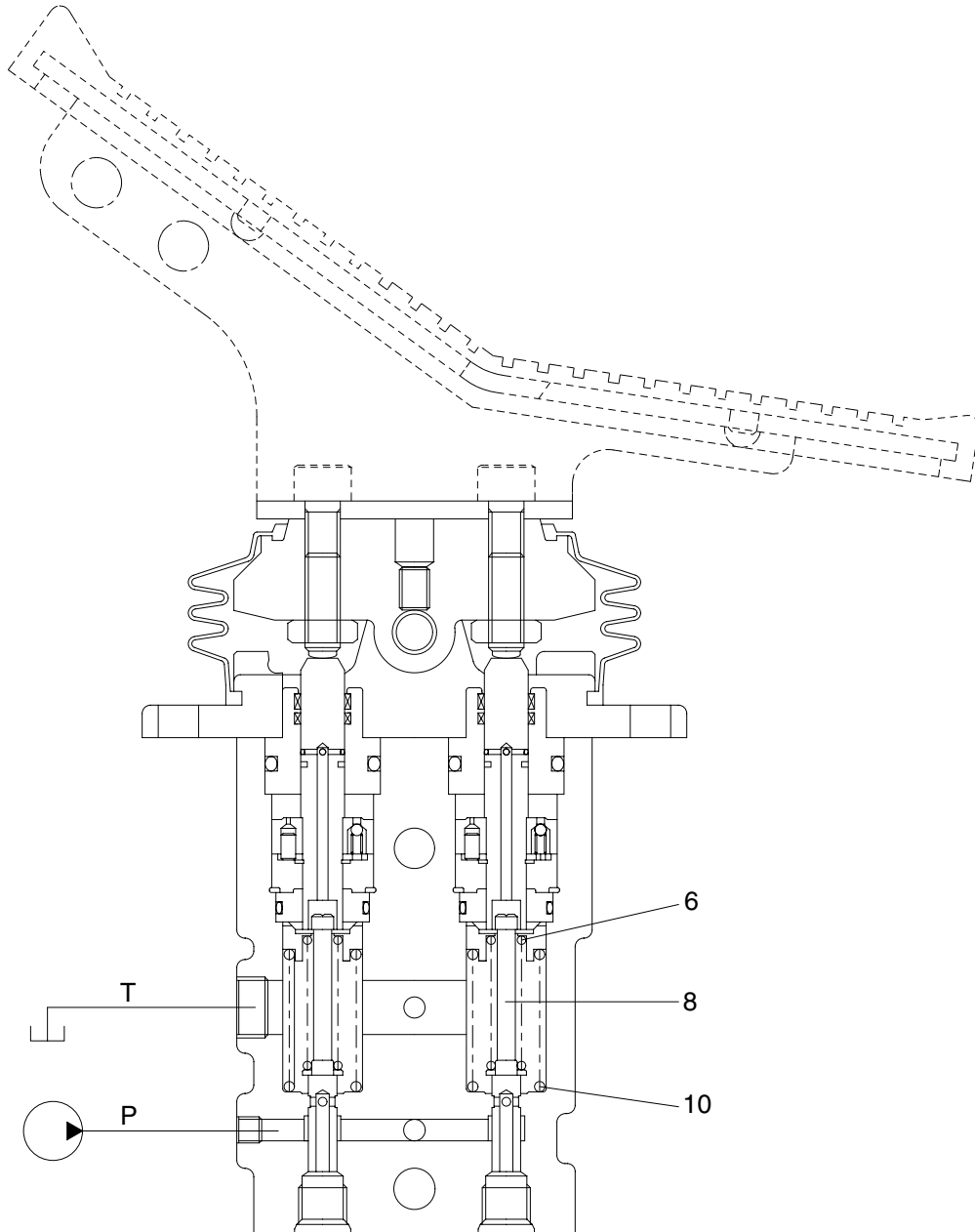
36072SF01

1 Pilot valve
2 Pilot pump

3 Main pump
4 Main control valve

5 Hydraulic motor
6 Hydraulic cylinder

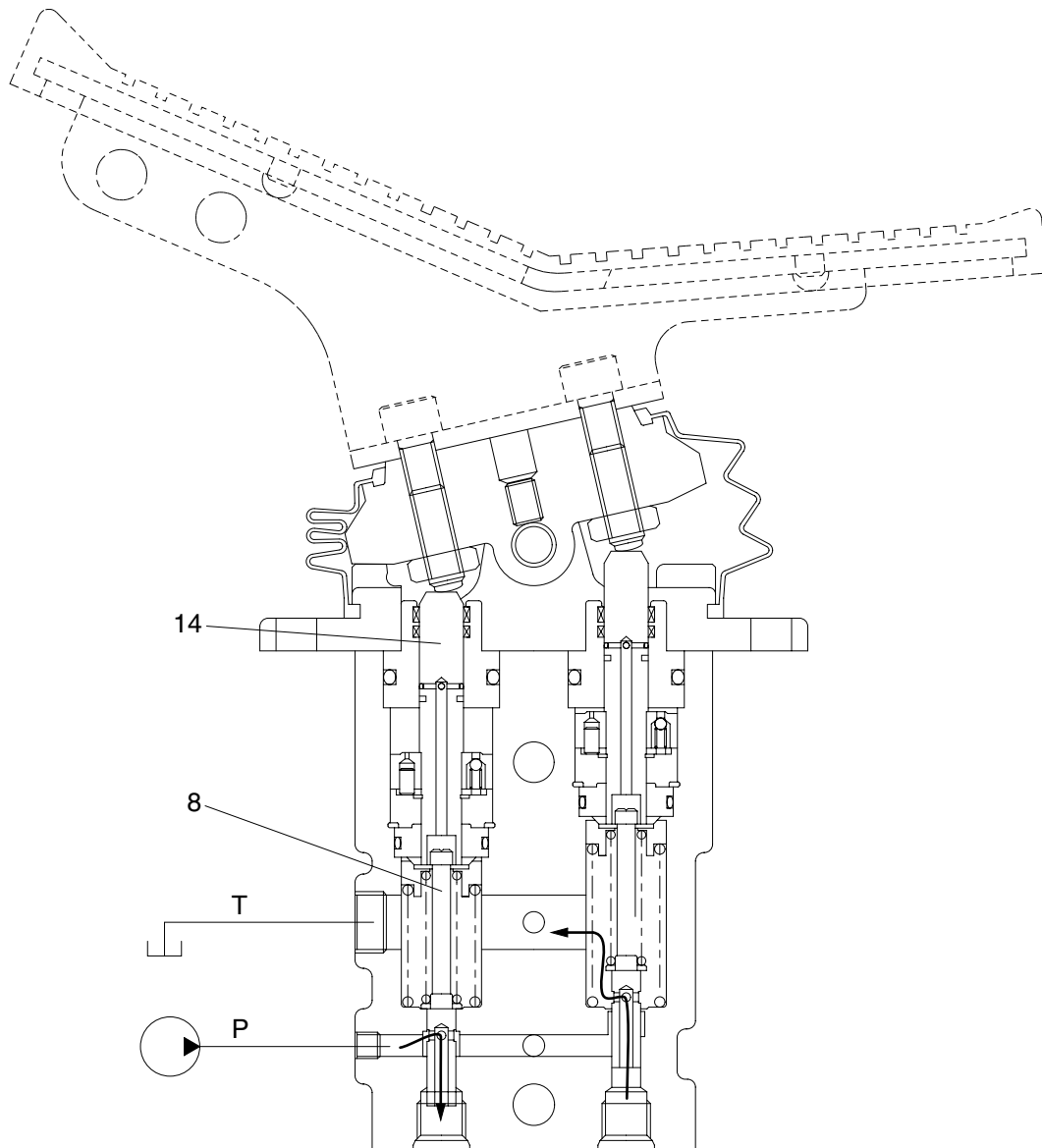
(1) Case where pedal is in neutral position



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.