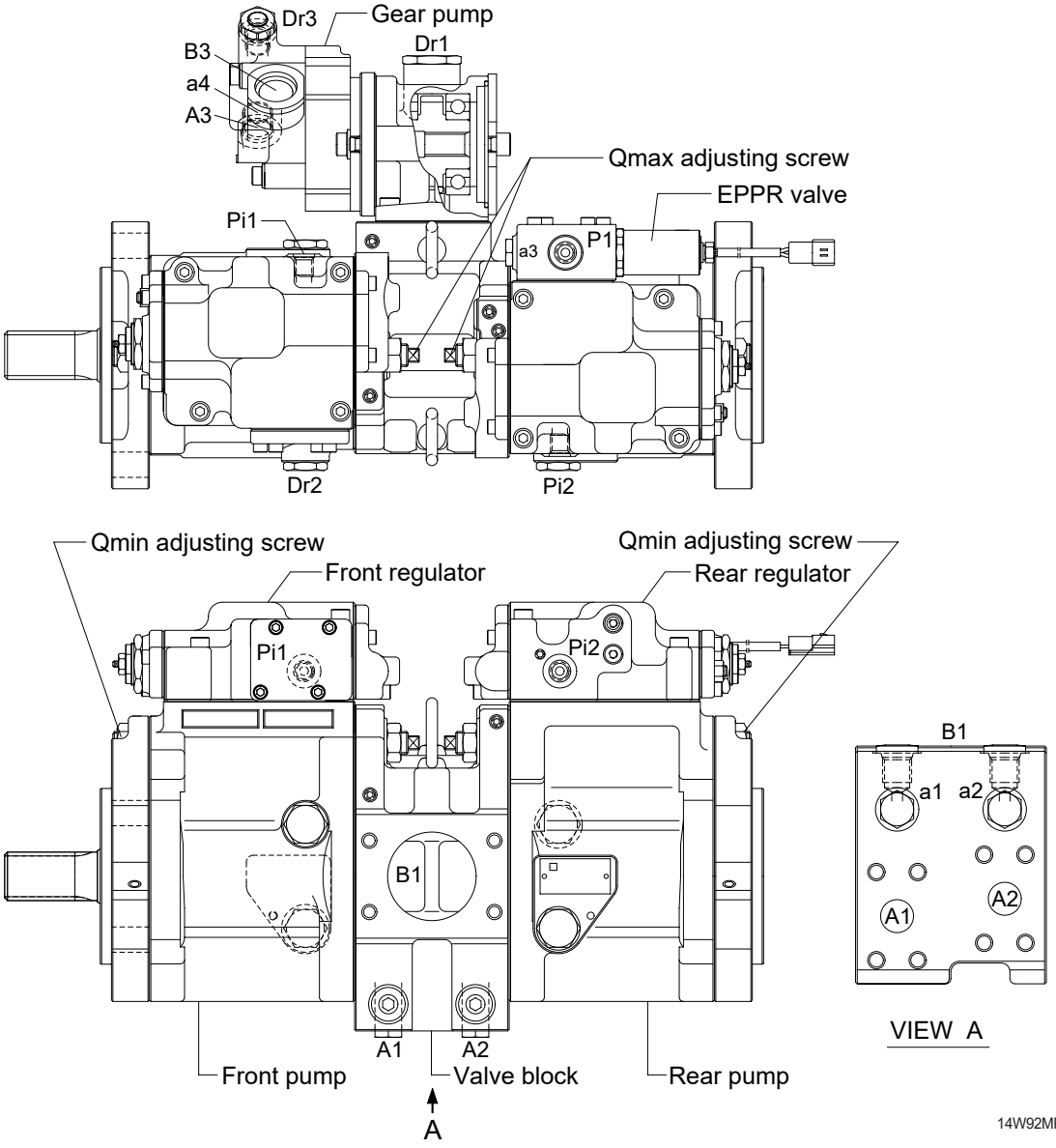
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. STRUCTURE

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



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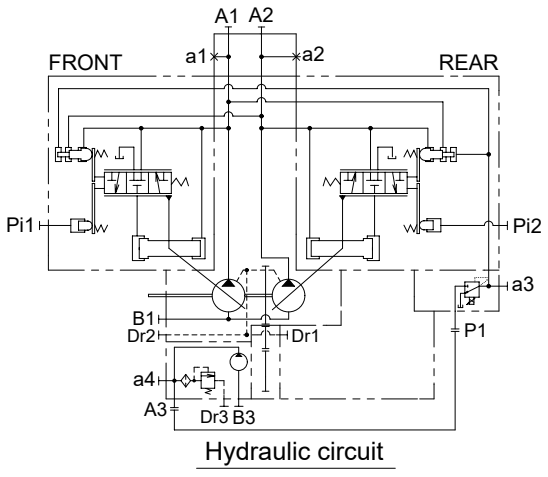
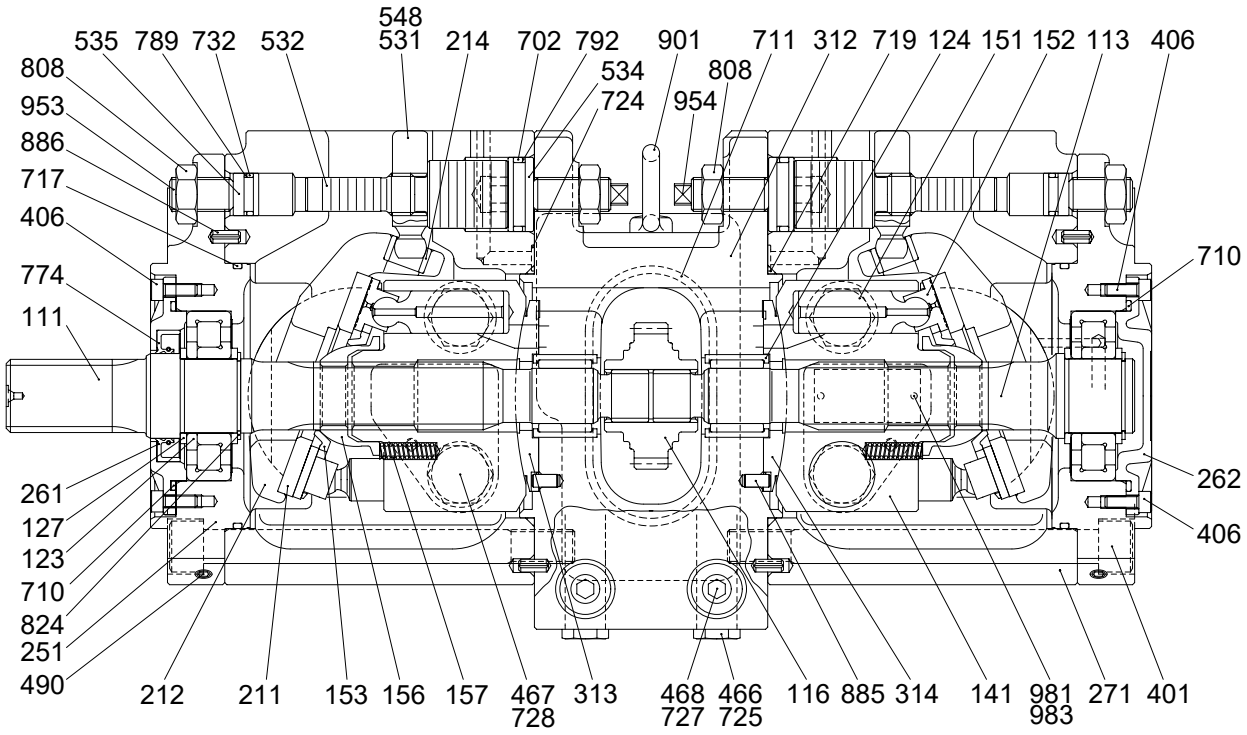


Hydraulic circuit

Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 3/4"
B1	Suction port	SAE2500psi 2 1/2"
Dr1	Drain port	PF 3/4 - 20
Dr2	Drain port	PF 1/2 - 19
Dr3	Drain port	PF 3/8 - 15
Pi1, i2	Pilot port	PF 1/4 - 15
P1	EPPR valve primary port	PF 1/4 - 15
a1,2,3	Gauge port	PF 1/4 - 15
a4	Gauge port	PF 1/4 - 14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

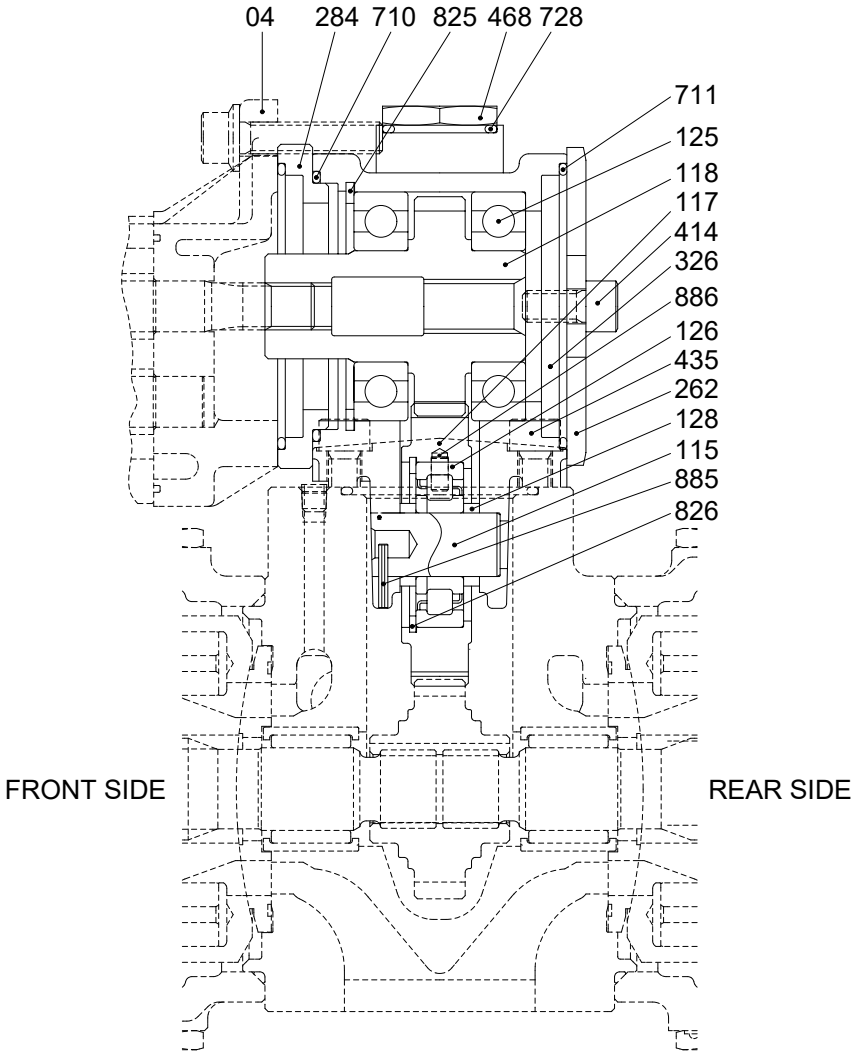
1) MAIN PUMP (1/2)

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



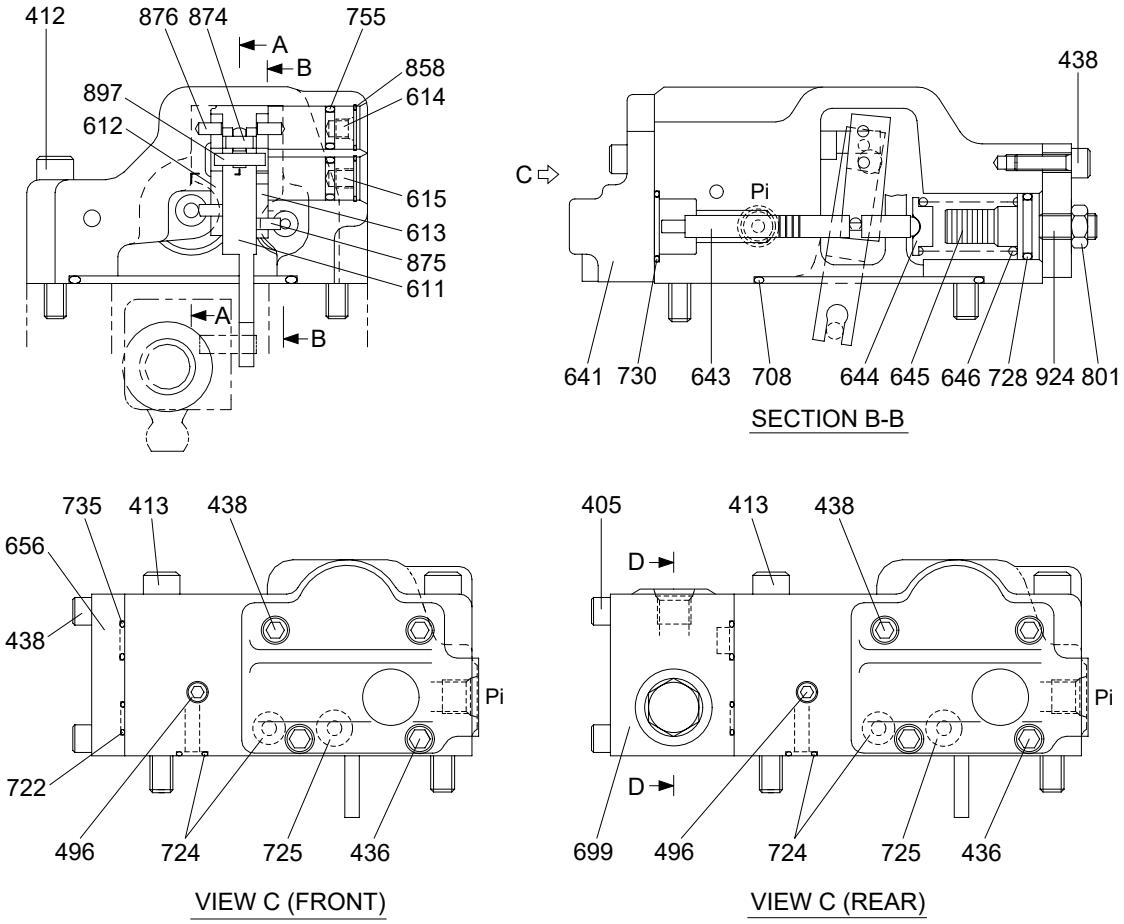
111	Drive shaft (F)	312	Valve block	724	O-ring
113	Drive shaft (R)	313	Valve plate (R)	725	O-ring
116	Gear	314	Valve plate (L)	727	O-ring
123	Roller bearing	401	Hexagon socket bolt	728	O-ring
124	Needle bearing	406	Hexagon socket bolt	732	O-ring
127	Bearing spacer	466	VP Plug	774	Oil seal
141	Cylinder block	467	VP Plug	789	Back up ring
151	Piston	468	VP Plug	792	Back up ring
152	Shoe	490	Plug	808	Hexagon head nut
153	Push-plate	531	Tilting pin	824	Snap ring
156	Bushing	532	Servo piston	885	Pin
157	Cylinder spring	534	Stopper (L)	886	Spring pin
211	Shoe plate	535	Stopper (S)	901	Eye bolt
212	Swash plate	548	Pin	953	Set screw
214	Bushing	702	O-ring	954	Set screw
251	Support	710	O-ring	981	Plate
261	Seal cover (F)	711	O-ring	983	Pin
262	Seal cover (R)	717	O-ring		
271	Pump casing	719	O-ring		

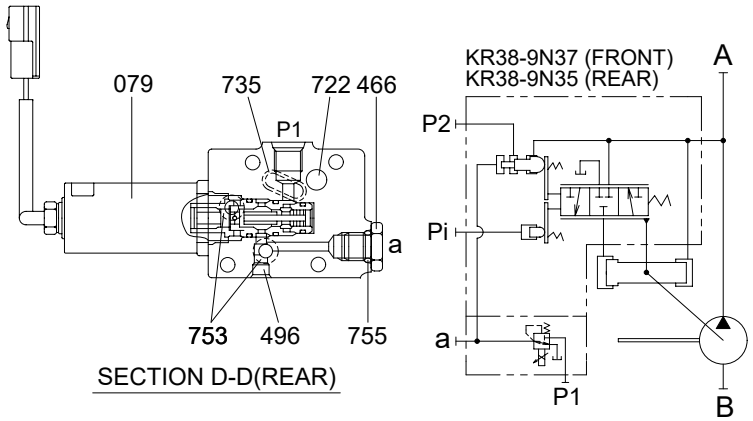
MAIN PUMP (2/2)



04	Gear pump	262	Cover	711	O-ring
115	Shaft	284	Plate	728	O-ring
117	Gear No. 2	326	Gear case	825	Retainer ring
118	Gear No. 3	414	Screw	826	Retainer ring
125	Ball bearing	435	Hexagon socket bolt	885	Spring pin
126	Roller bearing	468	Plug	886	Pin
128	Bearing spacer	710	O-ring		

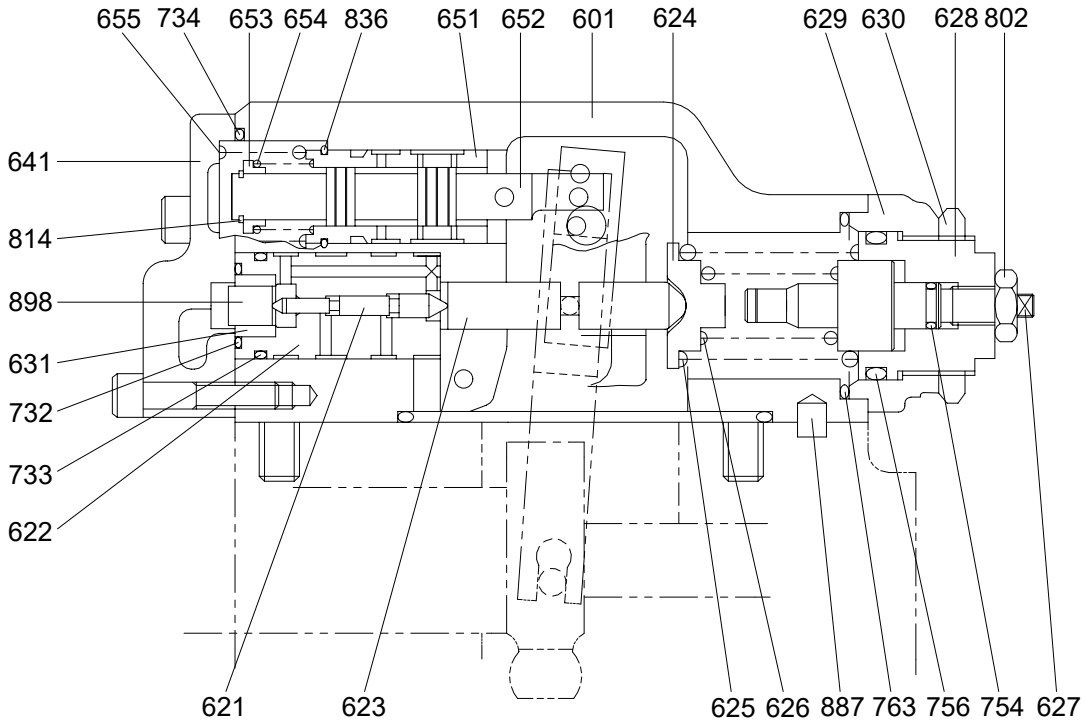
2) REGULATOR (1/2)





Port	Port name	Port size
A	Delivery port	3/4"
B	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
P1	EPPR valve primary port	PF 1/4-15
P2	Companion delivery port	Internal
a	Gauge port	PF 1/4-15

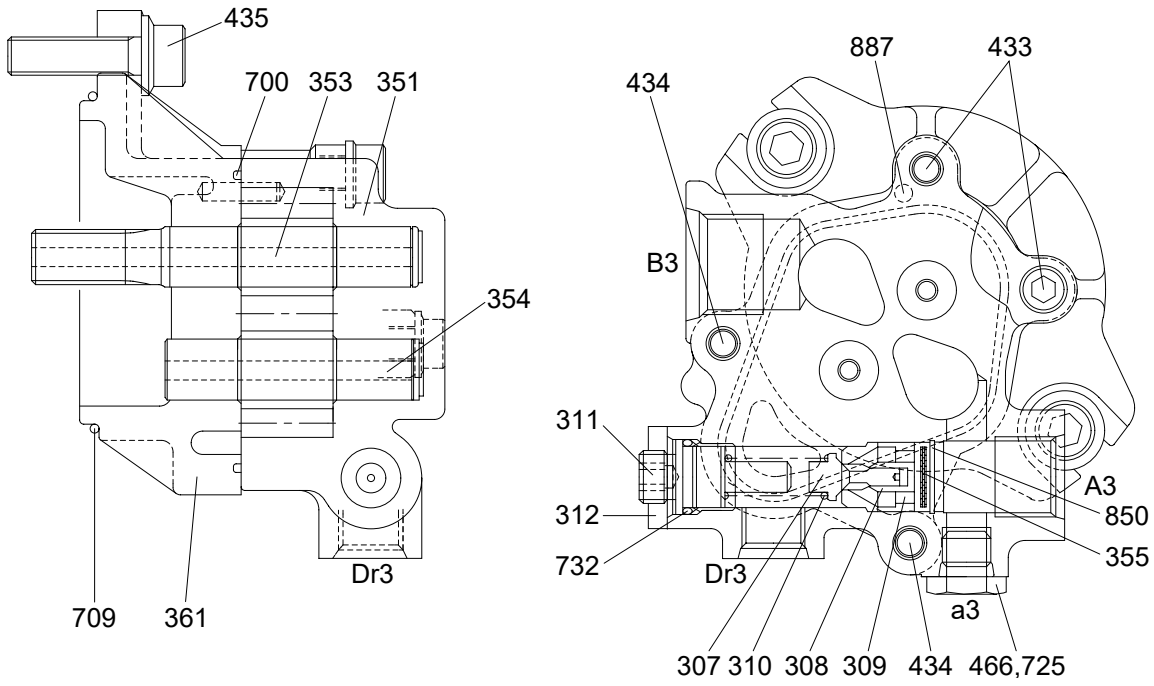
REGULATOR (2/2)



SECTION A-A

079	EPPR valve assembly	629	Cover (C)	733	O-ring
405	Hexagon socket screw	630	Lock nut	734	O-ring
412	Hexagon socket screw	631	Sleeve, Pf	735	O-ring
413	Hexagon socket screw	641	Pilot cover	753	O-ring
436	Hexagon socket screw	643	Pilot piston	754	O-ring
438	Hexagon socket screw	644	Spring seat (Q)	755	O-ring
466	Plug	645	Adjust stem (Q)	756	O-ring
496	Plug	646	Pilot spring	763	O-ring
601	Casing	651	Sleeve	801	Nut
611	Feed back lever	652	Spool	802	Nut
612	Lever (1)	653	Spring seat	814	Snap ring
613	Lever (2)	654	Return spring	836	Snap ring
614	Fulcrum plug	655	Set spring	858	Snap ring
615	Adjust plug	656	Block cover	874	Pin
621	Compensator piston	699	Valve casing	875	Pin
622	Piston case	708	O-ring	876	Pin
623	Compensator rod	722	O-ring	887	Pin
624	Spring seat (C)	724	O-ring	897	Pin
625	Outer spring	725	O-ring	898	Pin
626	Inner spring	728	O-ring	924	Set screw
627	Adjust stem (C)	730	O-ring		
628	Adjust screw (C)	732	O-ring		

3) GEAR PUMP



307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Spring seat	355	Filter	709	O-ring
310	Spring	361	Front case	725	O-ring
311	Screw	433	Flange socket	732	O-ring
312	Nut	434	Flange socket	850	Snap ring
351	Gear case	435	Flange socket	887	Pin

2. FUNCTION

1) MAIN PUMP

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

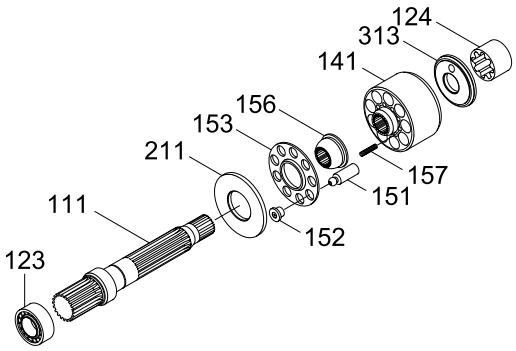
(1) Rotary group

The rotary group consists of drive shaft (F) (111), cylinder block (141), piston shoes (151,152), set plate (153), spherical bushing (156) and cylinder spring (157).

The drive shaft is supported by bearing (123,124) at its both ends.

The shoe is caulked to the piston to from a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and the take hydraulic balance so that it slides lightly over the shoe plate (211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush.

Similarly, the cylinder block is pressed against valve plate (313) by the action of the cylinder spring.



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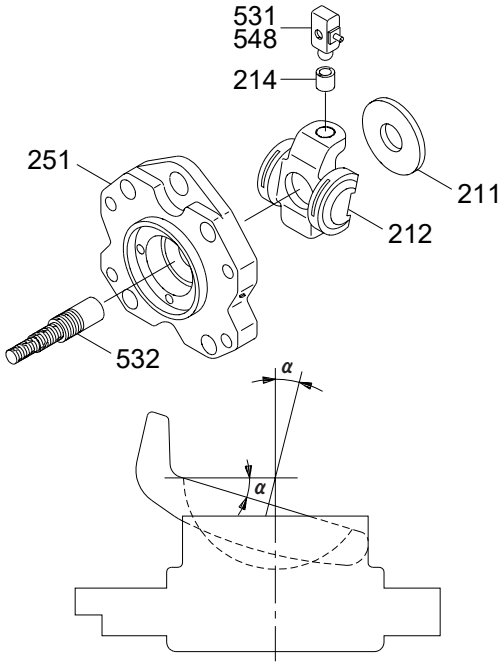
(2) Swash plate group

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

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

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



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(3) Valve block group

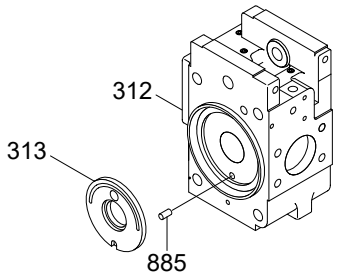
The valve block group consists of valve block (312), valve plate (313) and valve plate pin (885).

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

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

Now, if the drive shaft is driven by a prime mover (electric motor, engine, etc), it rotates the cylinder block via a spline linkage at the same time. If the swash plate is tilted as in Fig (previous page) the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block.

If you pay attention to a single piston, it performs a motion away from the valve plate (oil sucking process) within 180 degrees, and makes a motion towards the valve plate (or oil discharging process) in the rest of 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.



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2) REGULATOR

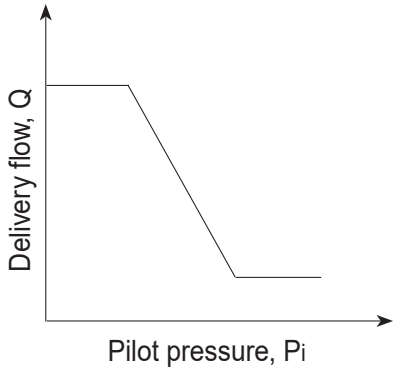
Regulator consists of the negative flow control, total horse power control and power shift control function.

(1) Negative flow control

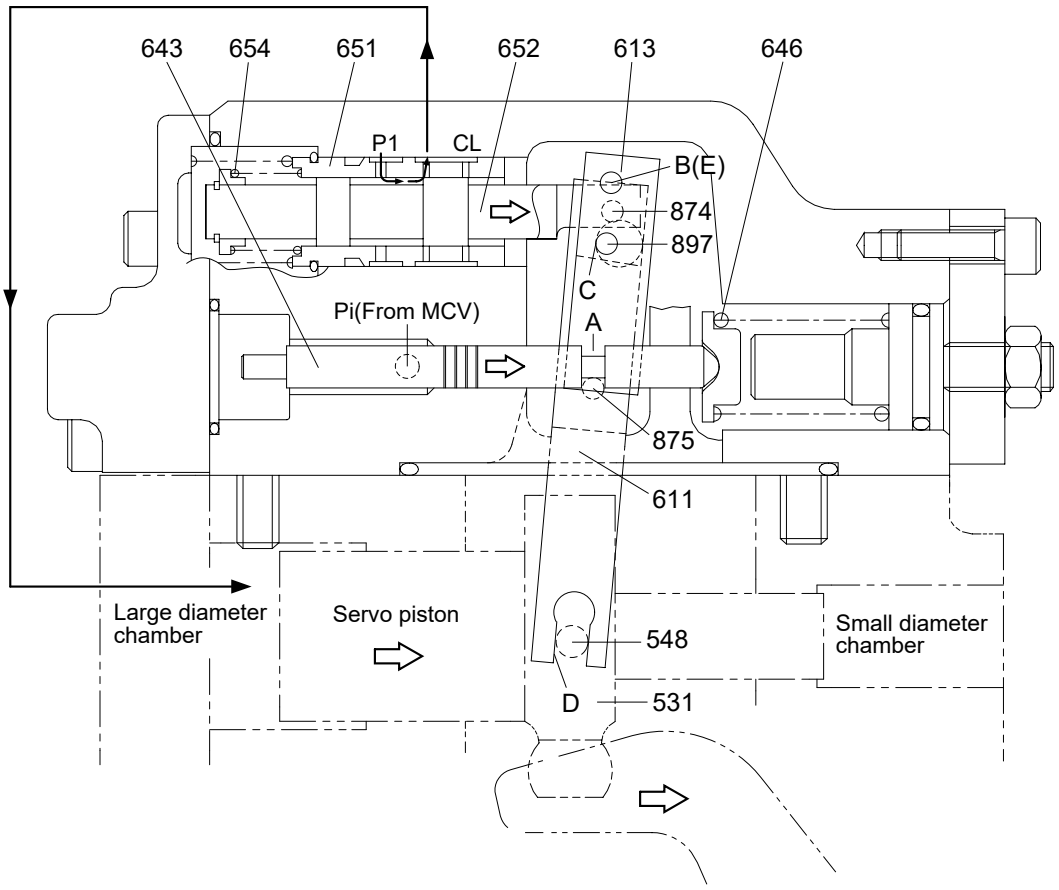
By changing the pilot pressure Pi, the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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

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



① Flow reducing function



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

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

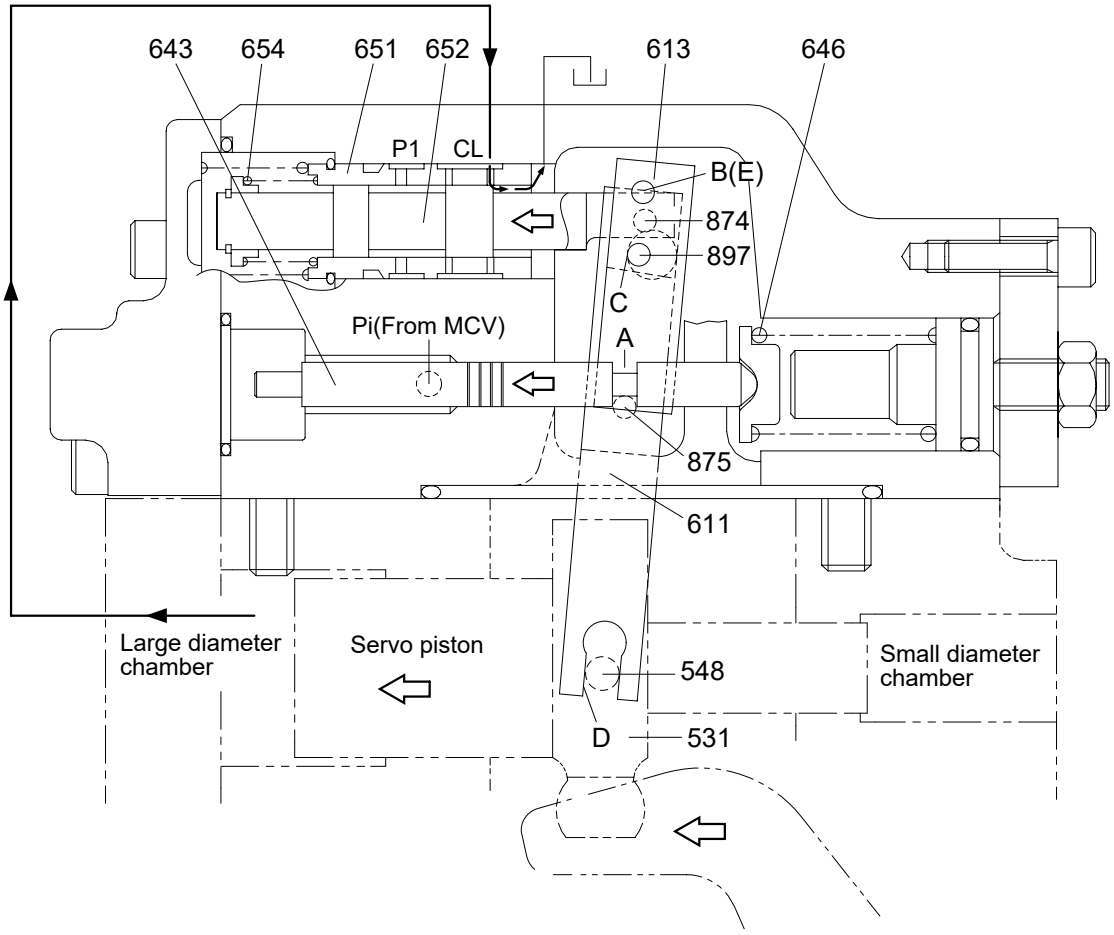
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

The movement of the spool causes the delivery pressure P1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P1 that is constantly admitted to the small diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

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

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

② Flow increasing function

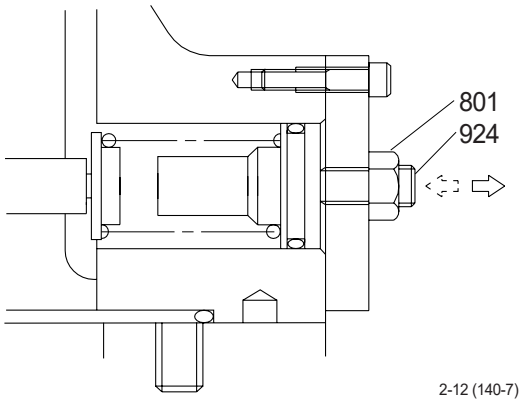


As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P1 in the small diameter section, resulting in an increase in the flow rate.

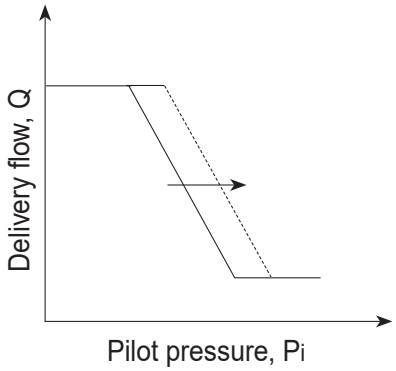
As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

③ Adjustment of flow control characteristic

The flow control characteristic can be adjusted with the adjusting screw.
Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the hexagonal socket head screw (924).
Tightening the screw shifts the control chart to the right as shown in the figure.



2-12 (140-7)



※ Adjusting value

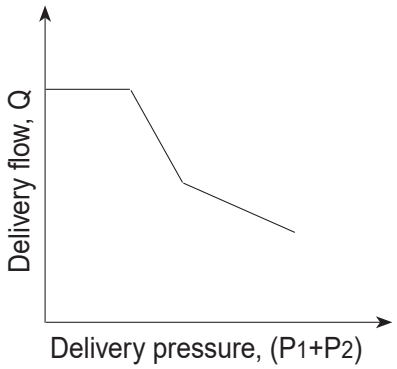
Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw (924)	Flow control starting pressure change amount	Flow change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(ℓ /min)
2100	+1/4	+1.53	+10

(2) Total horsepower control

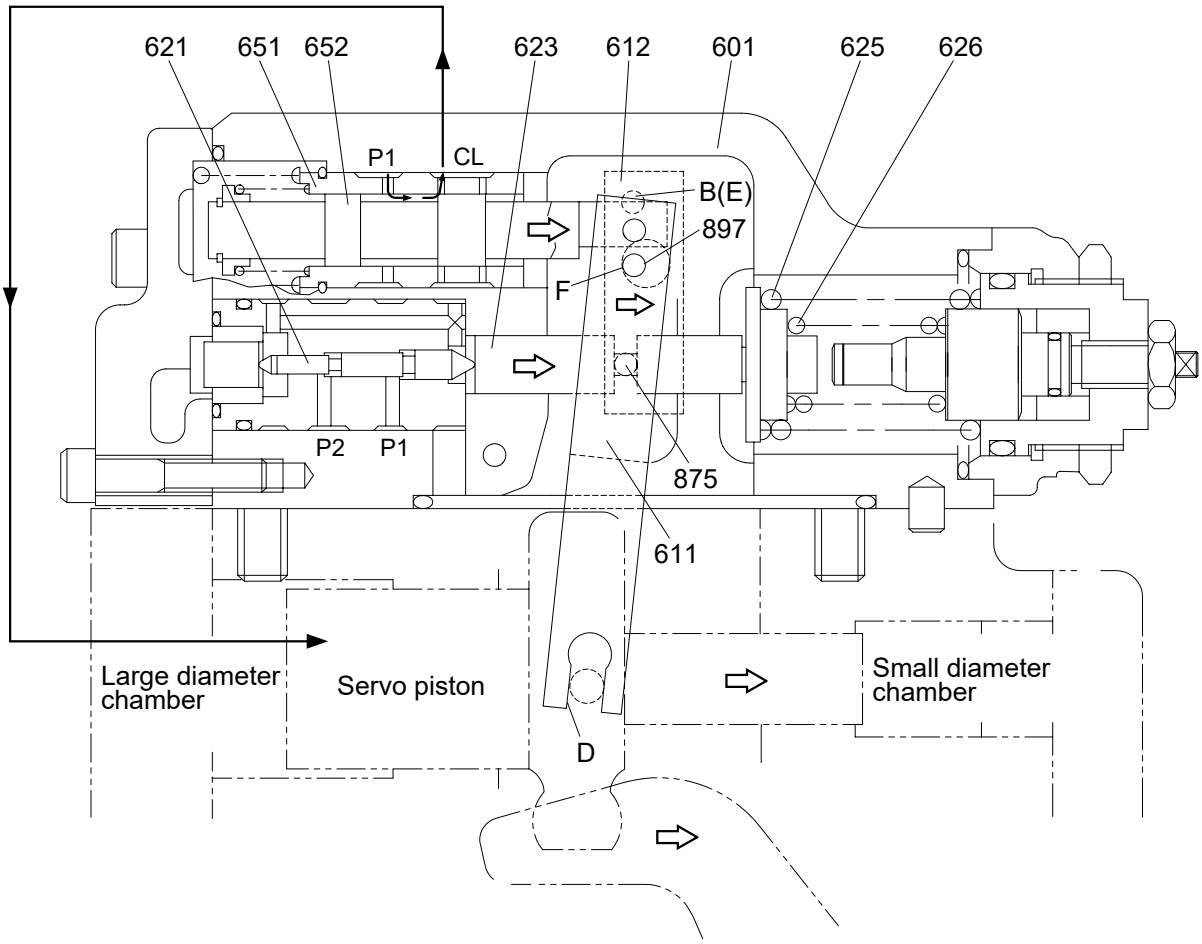
The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump.
(The input horsepower is constant when the speed is constant.)
Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation :

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

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



① Overload preventive function



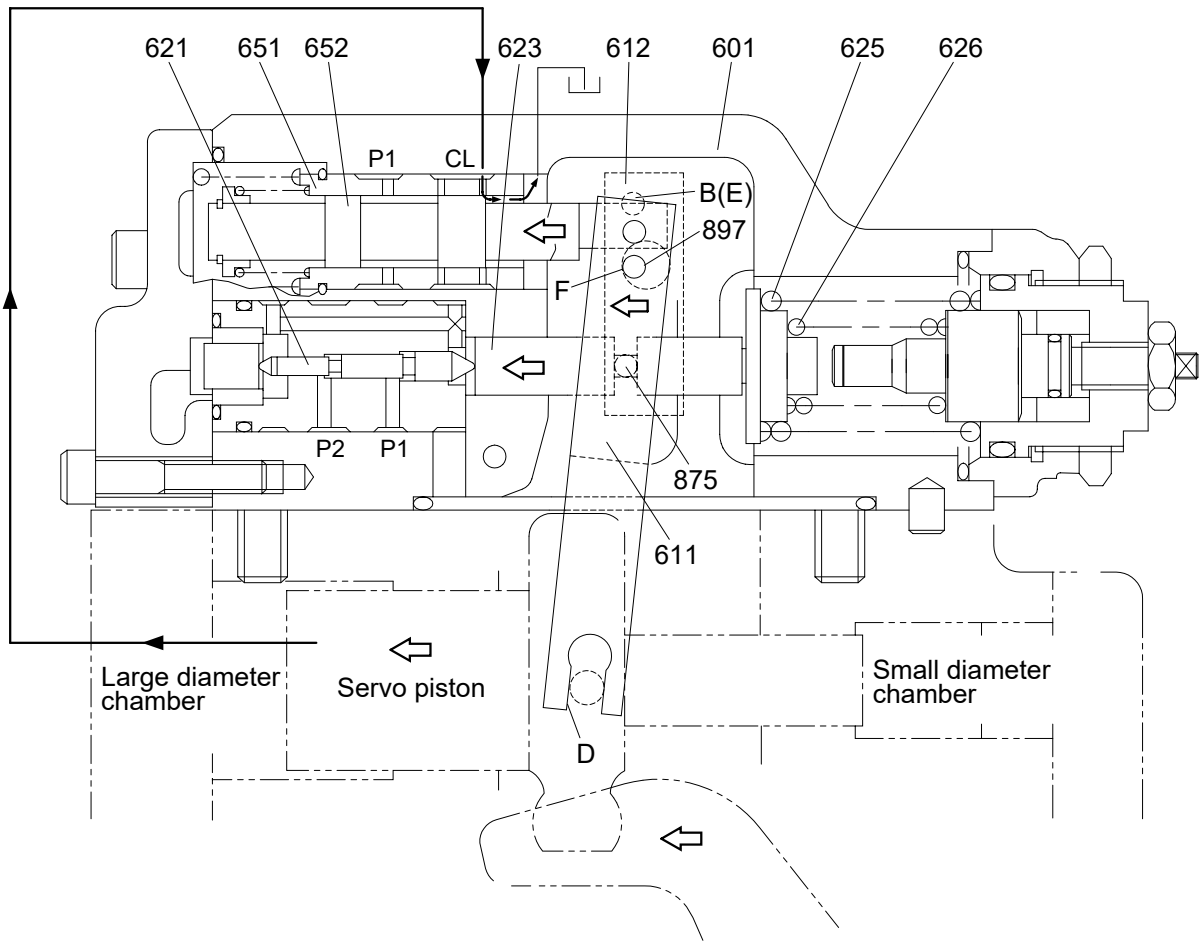
When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1 (612) via pin (875).

Lever 1 rotates around the pin (875) (E) fixed to the casing (601).

Since the large hole section (F) of lever 1 contains a protruding pin (897) fixed to the feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded.

The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool (652) and sleeve (651) is closed.

② Flow reset function



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

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

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

③ Low tilting angle (low flow) command preferential function

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

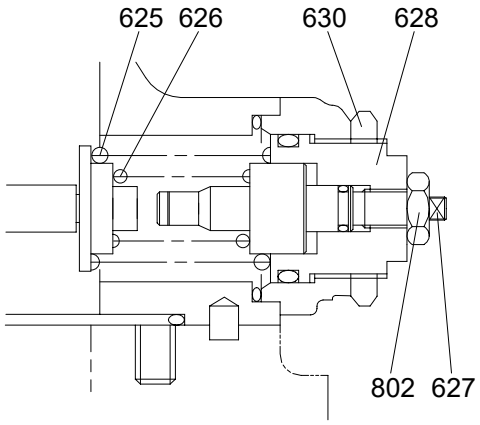
④ Adjustment of input horsepower

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

a. **Adjustment of outer spring**

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628).

Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure. Since turning the adjusting screw C (628) by N turns changes the setting of the inner spring (626), return the adjusting stem C (627) by N × A turns at first. (A=1.73)



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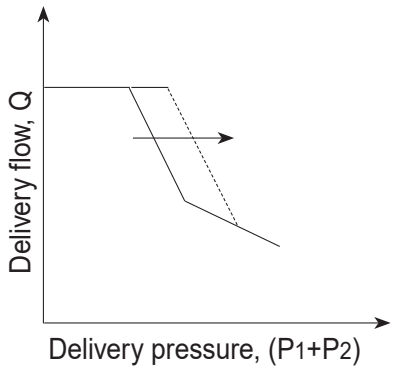
※ **Adjusting value**

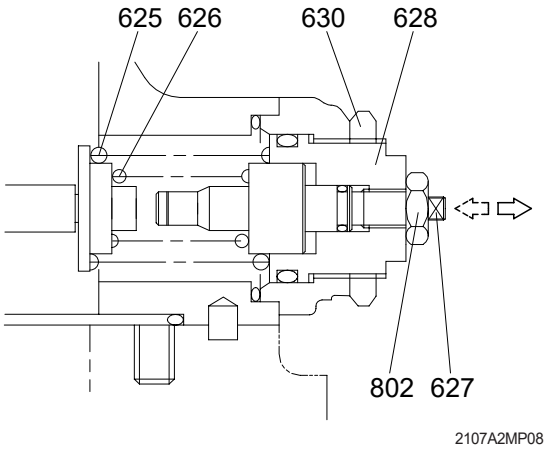
Speed	Adjustment of input horsepower		
	Tightening amount of adjusting screw (C) (628)	Compensa-ting control starting pressure change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(kgf · m)
2100	+1/4	+17.7	+3.58

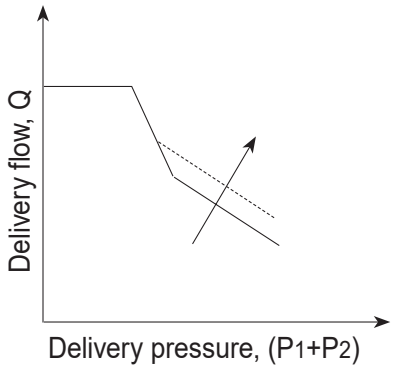


b. Adjustment of inner spring

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

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

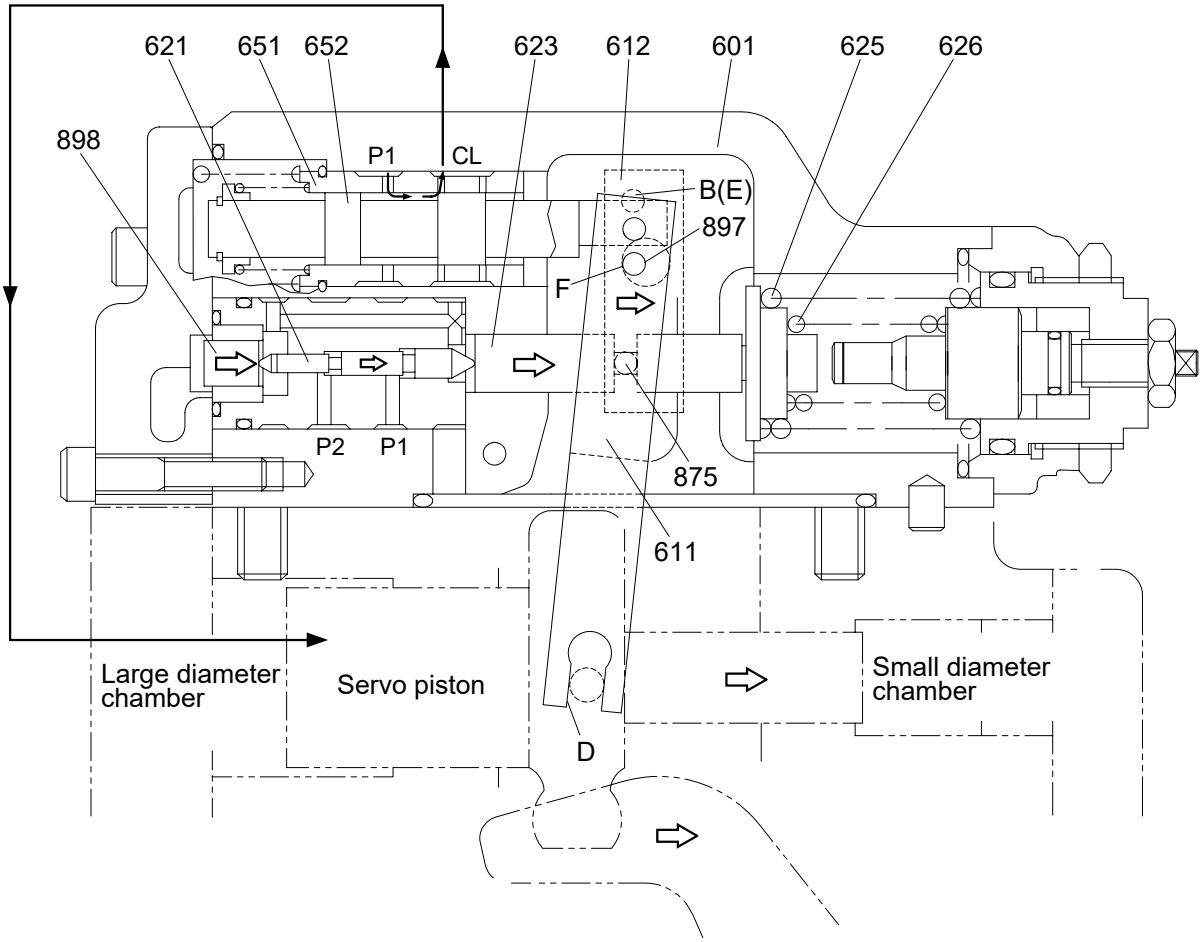




※ **Adjusting value**

Speed	Adjustment of input horsepower		
	Tightening amount of adjusting stem (C) (627)	Flow change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(ℓ /min)	(kgf · m)
2100	+1/4	+8.8	+3.8

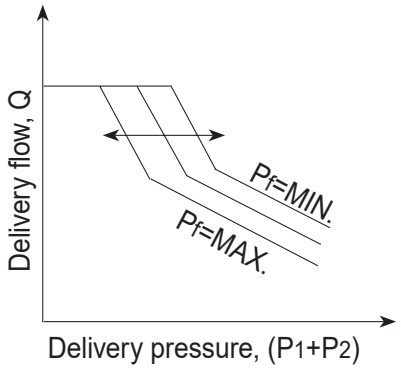
(3) Power shift control



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

Only one proportional pressure reducing valve is provided.

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



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

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

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

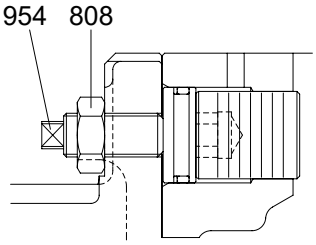
This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure Pf falls.

(4) Adjustment of maximum and minimum flows

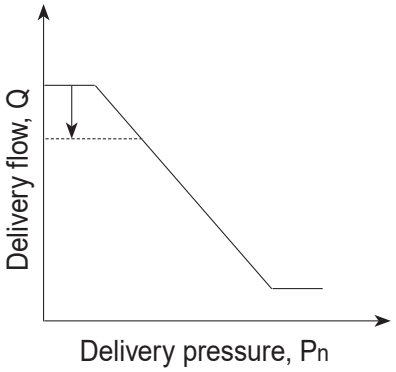
① Adjustment of maximum flow

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

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



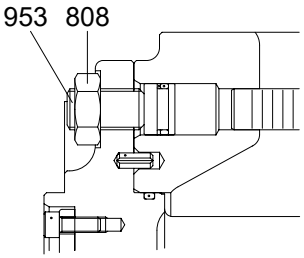
Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min $^{-1}$)	(Turn)	(l /min)
2100	+1/4	-3.4



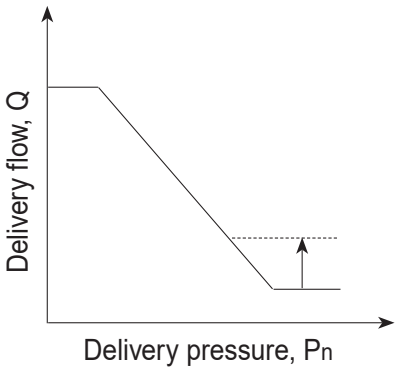
② Adjustment of minimum flow

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

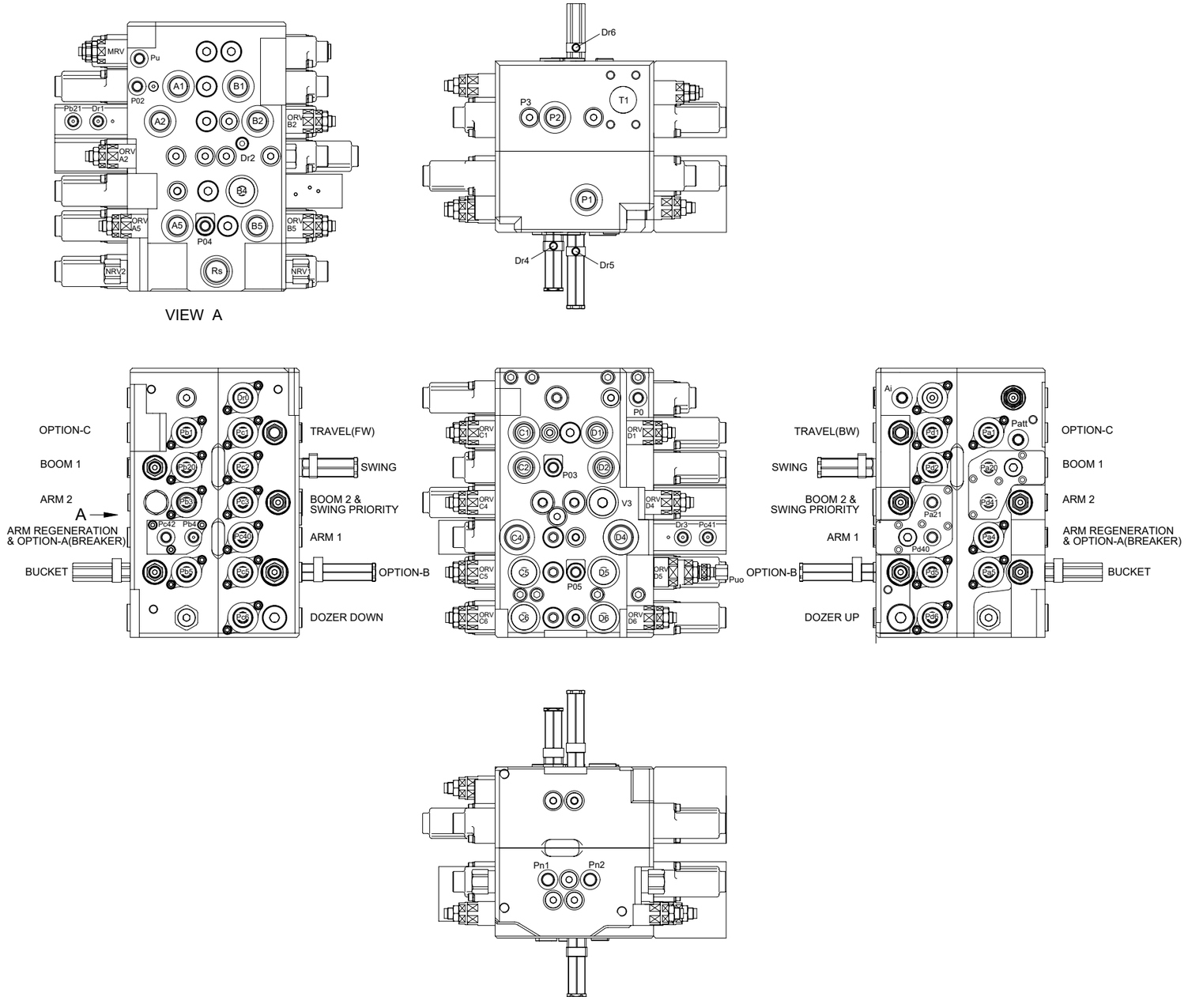
However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.



Speed	Adjustment of min flow	
	Tightening amount of adjusting screw (953)	Flow change amount
(min $^{-1}$)	(Turn)	(l /min)
2100	+1/4	+3.4

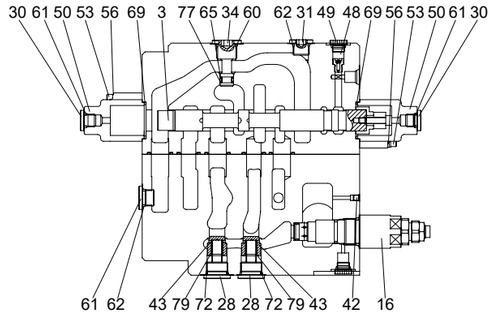


1. STRUCTURE

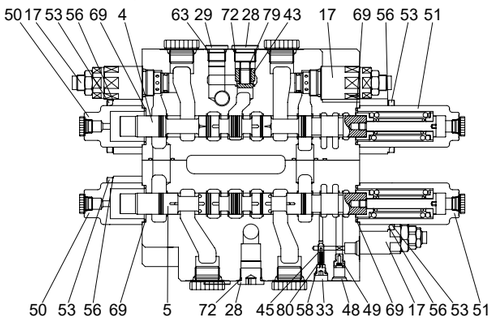


14W92MC01

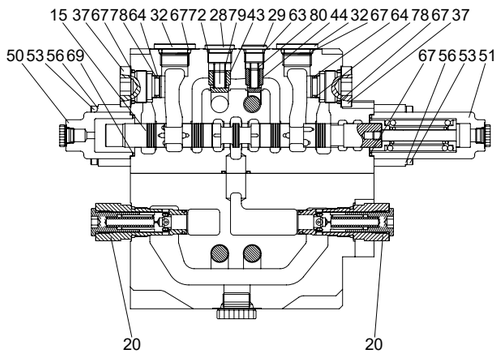
Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	UNF 1 3/16	18 kgf · m (130 lbf · ft)
Pa1 Pb1 Pc1 Pd1 Pa20 Pa21 Pb20 Pb21 Pc2 Pd2 Pb3 Pc3 Pa4 Pb4 Pc40 Pc41 Pc42 Pd40 Pd41 Pa5 Pb5 Pc5 Pd5 Pc6 Pd6 P0 Pu Ai Patt P02 P03 P04 P05 P3 Puo Dr0 Dr1 Dr2 Dr3	Option C pilot port Option C pilot port Travel pilot port (FW) Travel pilot port (BW) Boom up pilot port Boom up confluence pilot port Boom down pilot port Boom holding valve pilot port Swing pilot port (RH) Swing pilot port (LH) Arm in confluence pilot port Swing priority pilot port Option A pilot port (breaker) Arm in regeneration cut port Arm in pilot port Arm holding valve pilot port Arm in regen-cut signal selector port Arm out pilot port Arm out confluence pilot port Bucket in pilot port Bucket out pilot port Option B pilot port Option B pilot port Dozer down pilot port Dozer up pilot port Pilot pressure port Main relief pressure up Auto idle signal port Auto idle signal-attachment Pilot signal port Boom priority pilot port Boom parallel orifice pilot port Breaker summation pilot port Quick clamp port Pilot pressure port Drain port (travel straight) Drain port (boom holding valve) Drain port (boom2 & swing priority) Drain port (arm holding valve)	PF 1/4	3.5~3.9 kgf · m (25.3~28.2 lbf · ft)
Pn1 Pn2	Negative control signal port (P1 port side) Negative control signal port (P2 port side)	PF 3/8	7~8 kgf · m (50.6~57.8 lbf · ft)
A1 B1 C1 D1 B2 C2 D2 B4 A5 B5 C5 D5 C6 D6 P1 P2	Option C port Option C port Travel motor port (FW) Travel motor port (BW) Boom rod side port Swing motor port (RH) Swing motor port (LH) Option A port (breaker) Bucket head side port Bucket rod side port Option B port Option B port Dozer down port Dozer up port Pump port (P1 side) Pump port (P2 side)	PF 3/4	15~18 kgf · m (109~130 lbf · ft)
A2 C4 D4	Boom head side port Arm head side port Arm rod side port	PF 1	20~25 kgf · m (115~180 lbf · ft)
Dr4 Dr5 Dr6	Drain port (swing logic valve) Drain port (flow summation) Drain port (bucket load check)	PF 1/8	1.5~1.9 kgf · m (10.8~13.7 lbf · ft)
T1	Return port	SAE3000, 1 1/2 (M12 × 1.75)	8.5~11.5 kgf · m (61.5~83.1 lbf · ft)



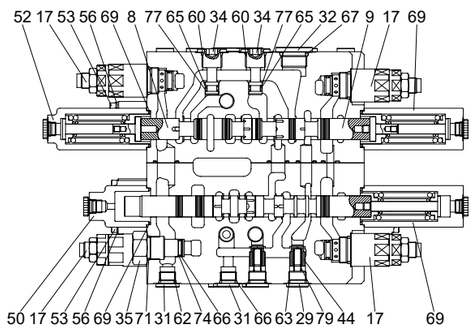
A-A (STRAIGHT-TRAVEL & SUPPLY)



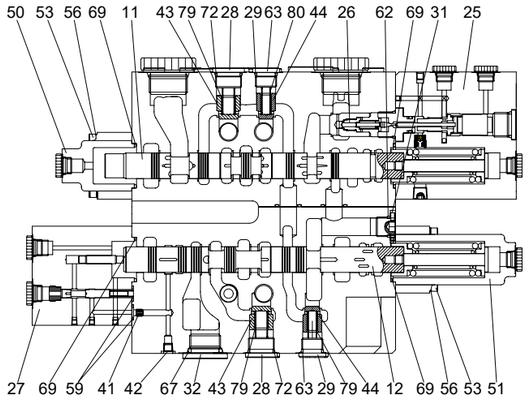
B-B (TRAVEL RIGHT & LEFT)



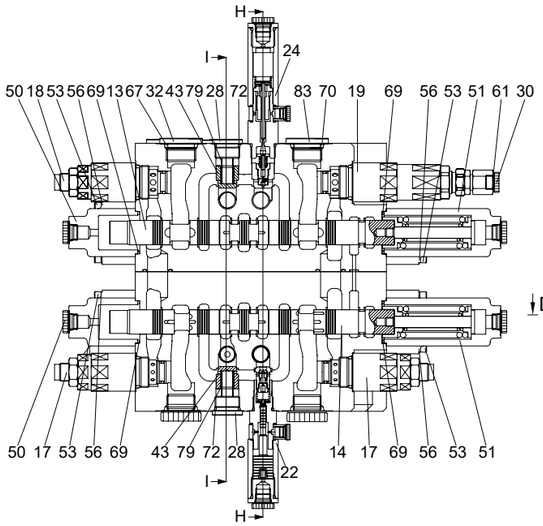
G-G (OPTION-C & NEGATIVE CONTROL)



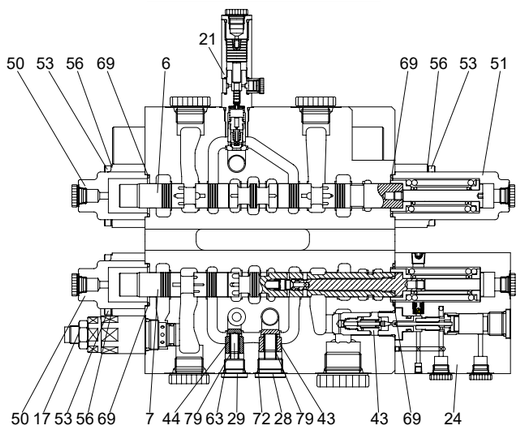
D-D (SWING PRIORITY & BOOM2 & ARM2)



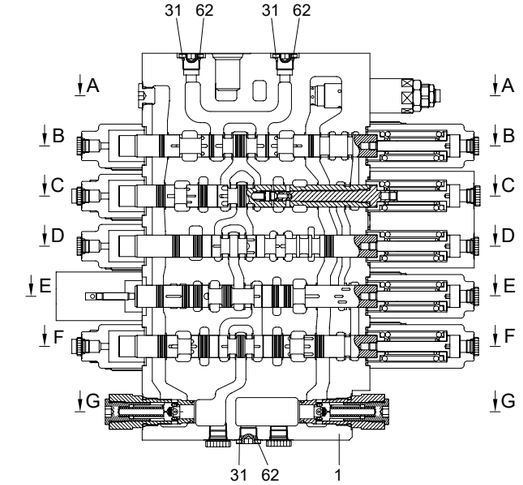
E-E (ARM & ARM REGENERATION /BREAKER)

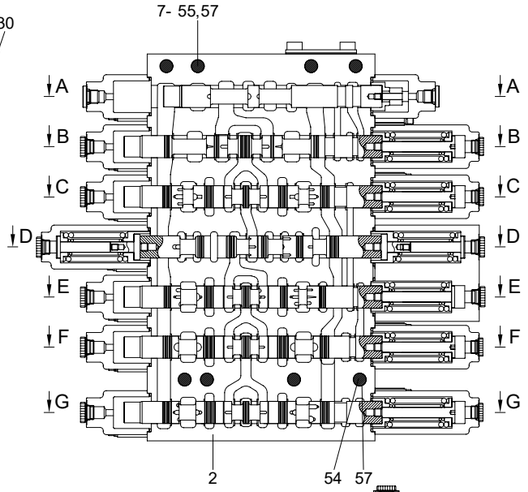


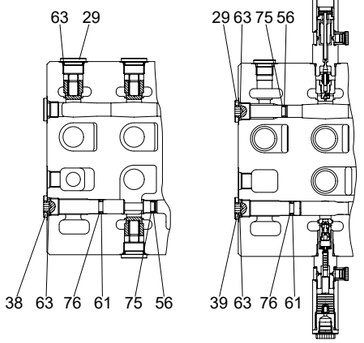
F-F (OPTION-B & BUCKET)



C-C (SWING & BOOM)



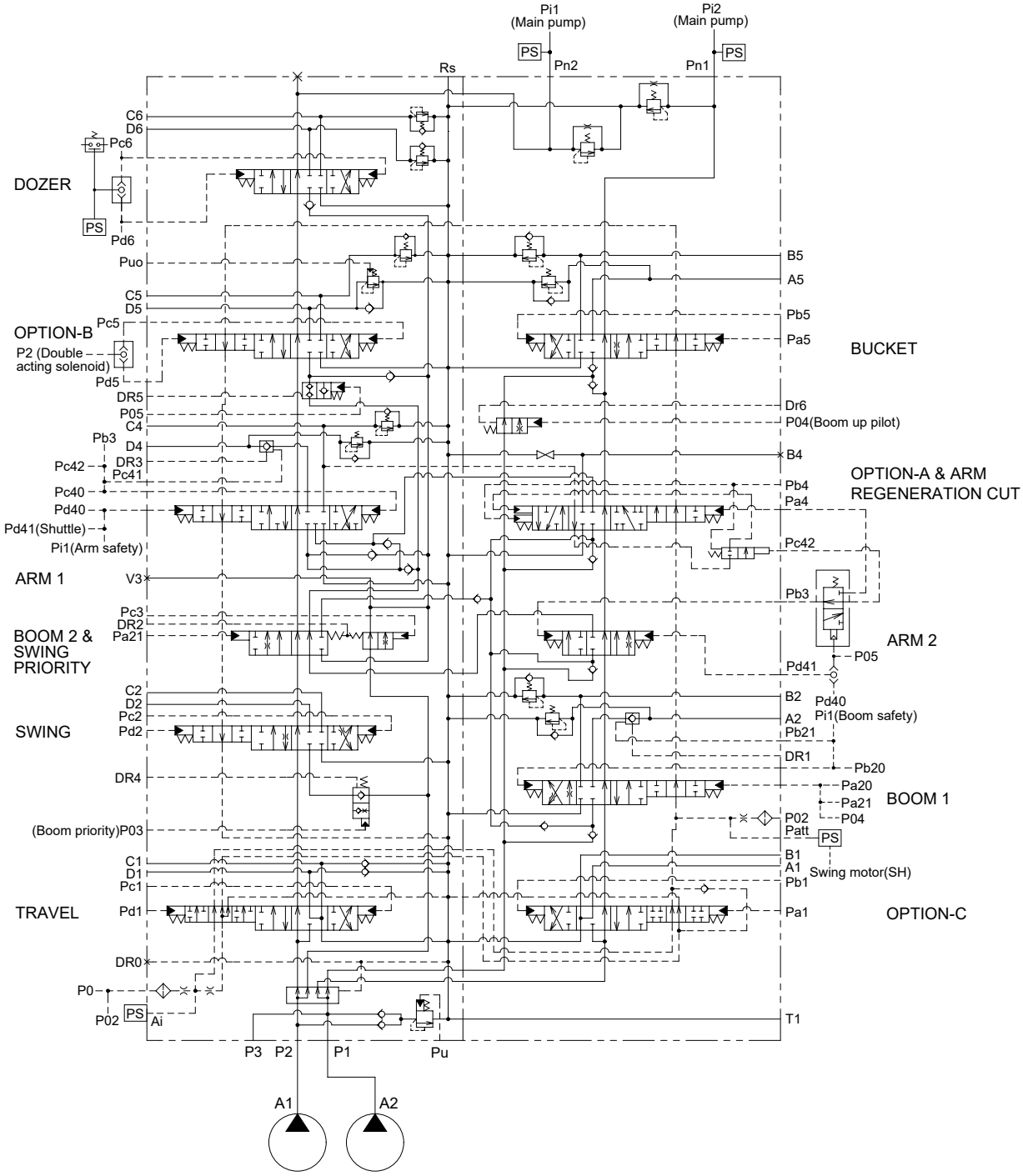




SECTION I-I SECTION H-H

1	Housing-P1	41	Plug-orifice
2	Housing-P2	42	Plug
3	Spool-straight travel	43	Load check-poppet
4	Spool-travel	44	Load check-poppet
5	Spool-option C	45	Signal-poppet
6	Spool-swing	46	Travel straight-sleeve
7	Spool-boom 1	47	Travel straight-piston
8	Spool-swing priority	48	Orifice signal
9	Spool-boom 2	49	Coin type filter
10	Spool-arm 2	50	Pilot cap
11	Spool-arm 1	51	Pilot cap
12	Spool-arm regeneration & breaker	52	Pilot cap
		53	Socket bolt
13	Spool-option B	54	Socket bolt
14	Spool-bucket	55	Socket bolt
15	Spool-dozer	56	Washer
16	Main relief valve	57	Spring washer
17	Overload relief valve	58	O-ring
18	Overload relief valve	59	O-ring
19	Overload relief valve	60	O-ring
20	Negacon relief valve	61	O-ring
21	Swing logic valve	62	O-ring
22	Bucket logic valve	63	O-ring
23	Option on-off valve	64	O-ring
24	Holding valve kit A1	65	O-ring
25	Holding valve kit A2	66	O-ring
26	Holding valve kit B	67	O-ring
27	Regeneration block	68	O-ring
28	Plug	69	O-ring
29	Plug	70	O-ring
30	Plug	71	O-ring
31	Plug	72	O-ring
32	Plug	73	O-ring
33	Plug	74	Backup-ring
34	Plug-parallel	75	Backup-ring
35	Plug-relief cat	76	Backup-ring
36	Plug-relief cat	77	Backup-ring
37	Plug-relief cat	78	Backup-ring
38	Plug-bucket	79	Load check spring
39	Plug-bucket parallel	80	Load check spring
40	Plug-option	81	Poppet signal spring

2. HYDRAULIC CIRCUIT



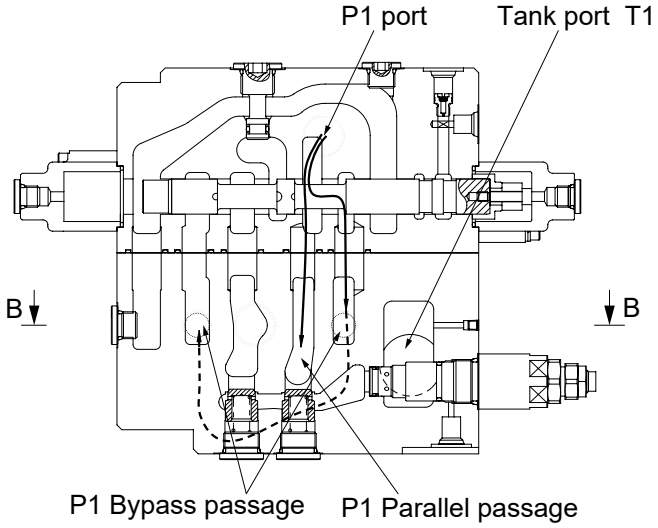
3. FUNCTION

1) CONTROL IN NEUTRAL

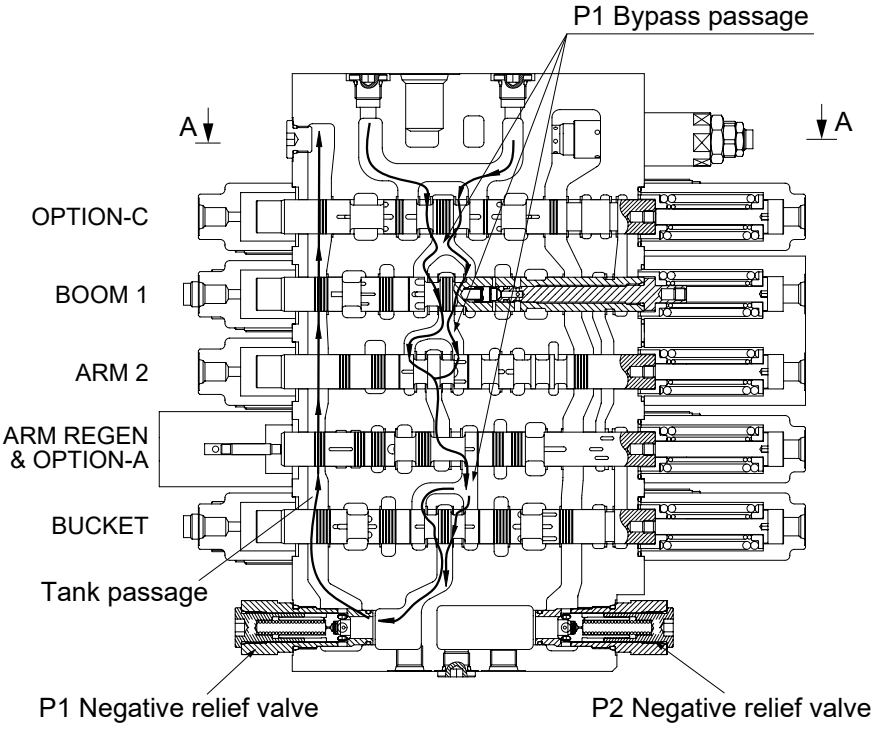
(1) P1 SIDE

The hydraulic fluid from pump A2 flows into the main control valve through the inlet port "P1", into the P1 bypass passage and P1parallel passage.

The hydraulic fluid from the pump A2 is directed to the tank through the bypass passage of spools : option C, boom 1, arm 2, arm regeneration & option A and bucket, the negative relief valve of P1, tank passage, and the tank port "T1"



SECTION A-A

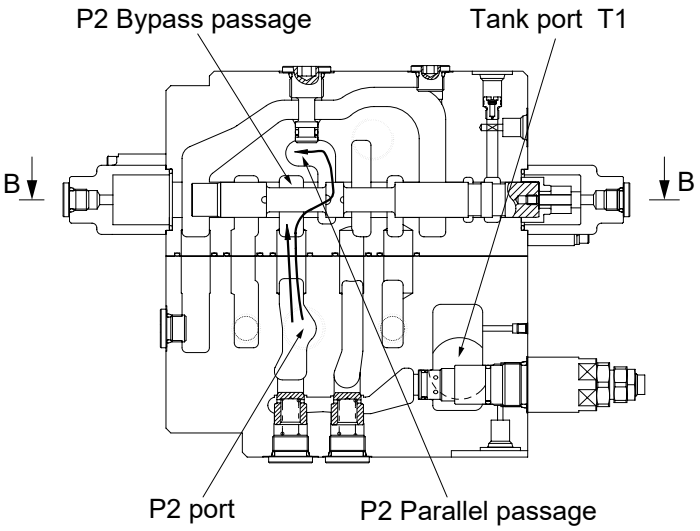


SECTION B-B

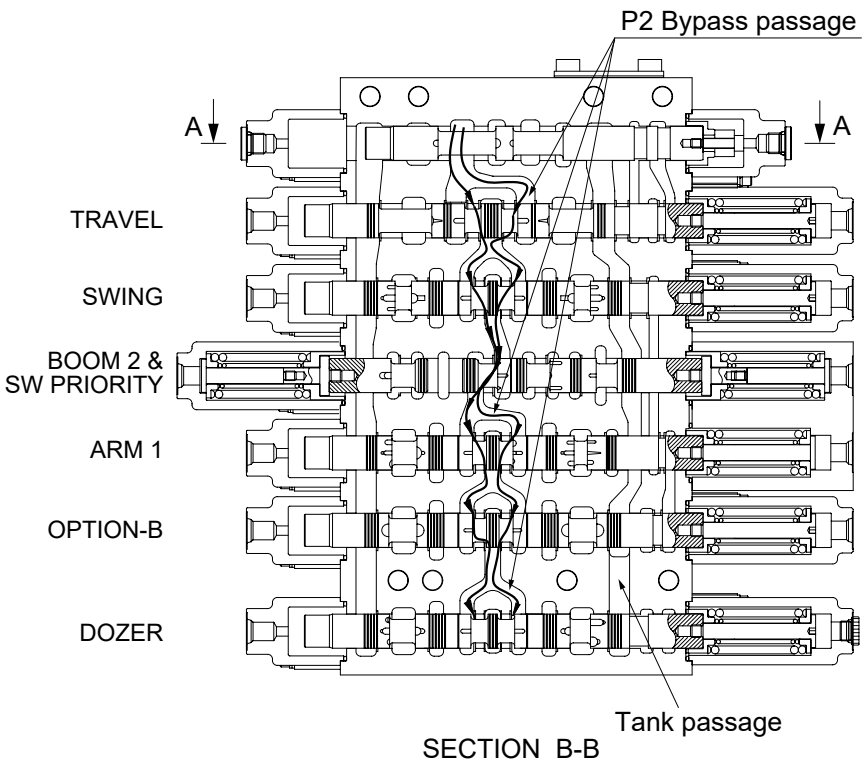
(2) P2 SIDE

The hydraulic fluid from pump A1 flows into the main control valve through the inlet port "P2", into the P2 bypass passage and P2 parallel passage.

The hydraulic fluid from the pump A1 is directed to the tank through the bypass passage of spools : travel, swing, boom 2 & swing priority, arm 1, option "B" and dozer, the negative relief valve of P2, tank passage and the tank port "T1".



SECTION A-A



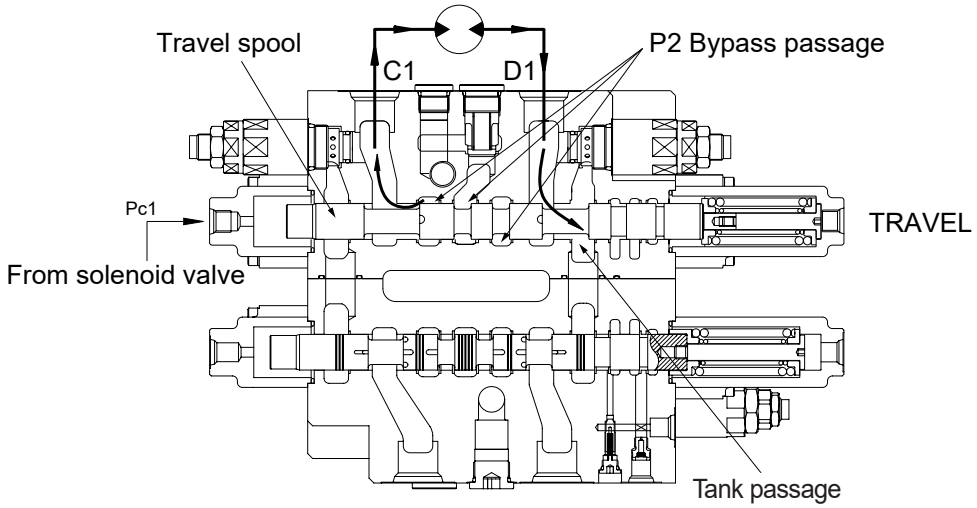
SECTION B-B

2) TRAVEL OPERATION

(1) TRAVEL FORWARD OPERATION

During the travel forward operation, the pilot pressure from the solenoid valve is supplied to the port Pc1 of the spring opposite side, and it shifts travel spool in the right direction against springs. Hydraulic fluid from the pump A1 flows into the travel spool through the bypass passage.

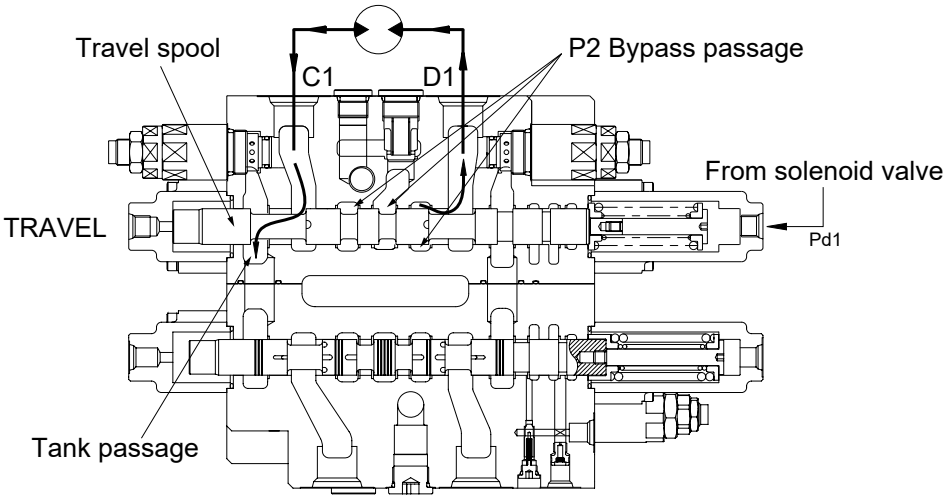
Then the bypass passage is shut off by the movement of the travel spool, it is directed to the travel motor through port C1. At the same time, the hydraulic fluid from the travel motor through port D1 returns to the tank passage through the travel spool.



(2) TRAVEL REVERSE OPERATION

During the travel reverse operation, the pilot pressure from the solenoid valve is supplied to the port Pd1 of the spring side, and it shifts travel spool in the left direction. Hydraulic fluid from the pump A1 flows into the travel spool through the bypass passage.

Then the bypass passage is shut off by the movement of the travel spool, it is directed to the travel motor through port D1. At the same time, the hydraulic fluid from the travel motor through port C1 returns to the tank passage through the travel spool.



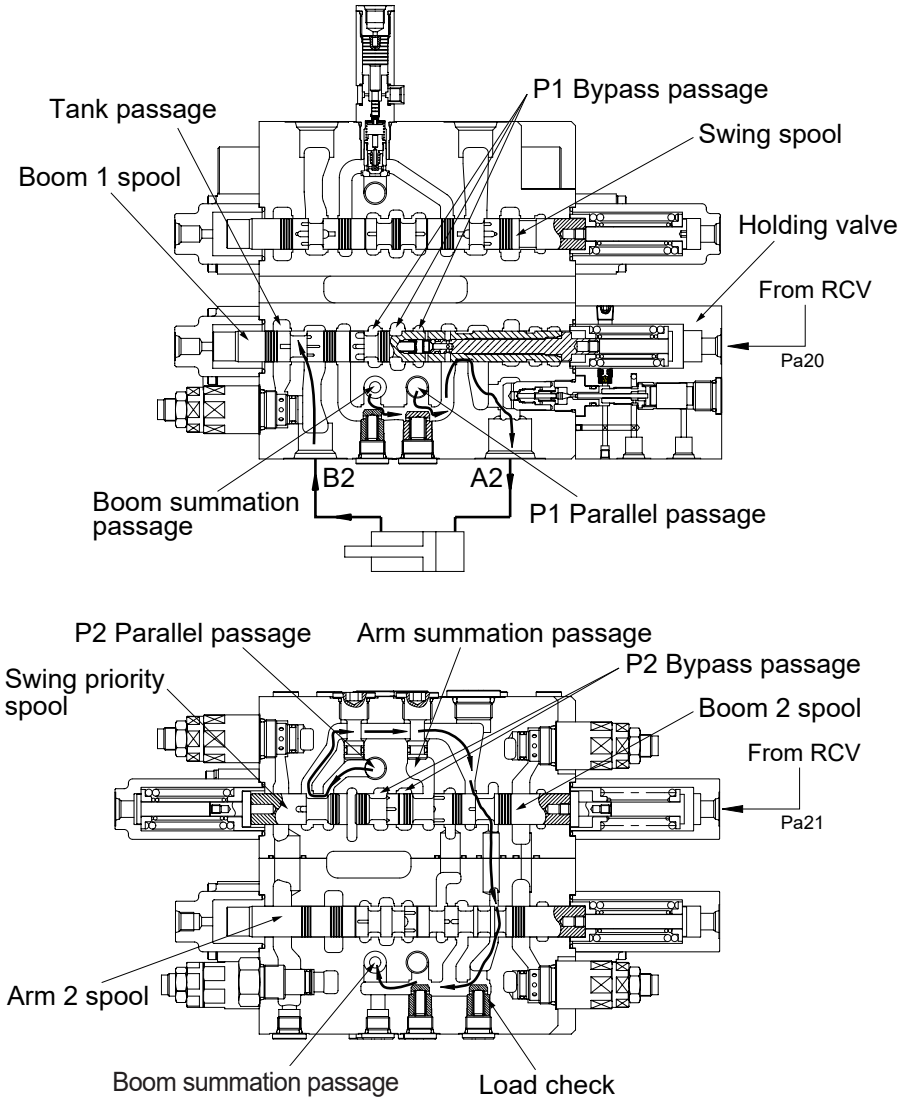
3) BOOM OPERATION

(1) BOOM UP OPERATION

During boom up operation, the pilot secondary pressure from RCV is supplied to the port Pa20 of the spring side and shifts the boom 1 spool in the left direction. The bypass passage is shut off by the movement of the boom 1 spool and the hydraulic oil fluid from pump A2 is entered P1 parallel passage and then passes through the load check, bridge passage and boom holding valve then flows into the port A2. Following this it flows into the head side of the boom cylinder. (In this case, the boom holding valve is free flow condition)

At the same time, the pilot pressure from RCV is supplied to the port Pa21 of the spring side of boom 2 and shifts the boom 2 spool. The bypass passage is shut off by the movement of the boom 2 spool and the hydraulic oil fluid from pump A1 entered boom summation passage via the P2 parallel passage, the land of the swing priority spool, notch of the boom 2 spool, arm 2 spool and the check. The flows combine in passage and are directed to port A2 and head side of boom cylinder.

At the same time, the flow from rod side of the boom cylinder return to the boom 1 spool through the port B2. Thereafter it is directed to the hydraulic oil tank through the tank passage.



(2) BOOM DOWN OPERATION

During the boom lowing operation, the pilot pressure from RCV is supplied to the port Pb20 of the spring opposite side and shifts the boom 1 spool in the right direction.

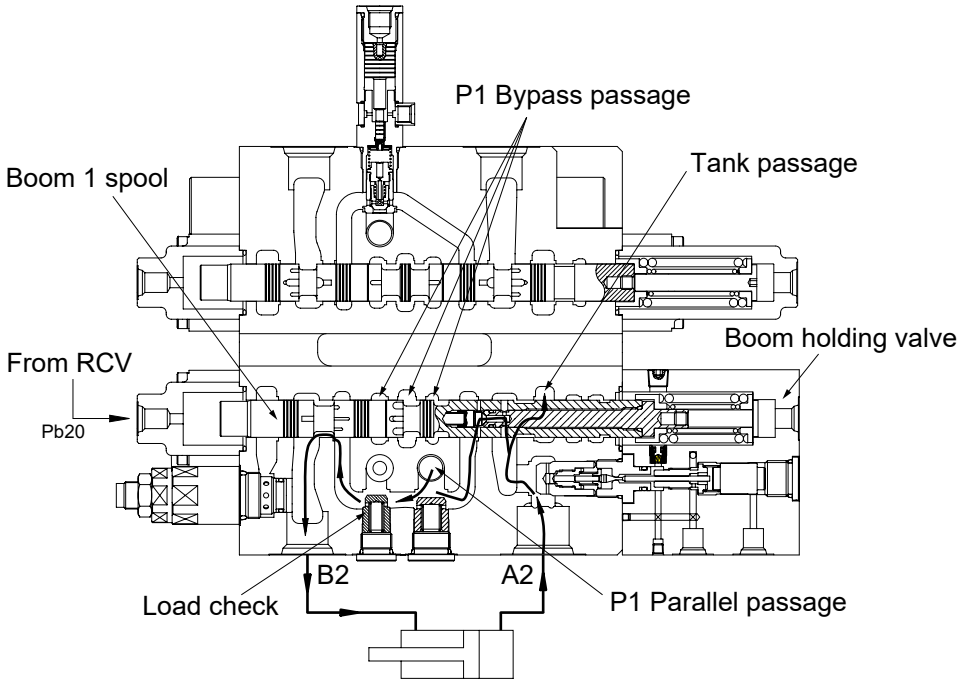
The bypass passage is shut off by the movement of the boom 1 spool and the hydraulic fluid from the pump A2 enters the parallel passage and is directed to the port B2 through the load check. Following this, it flows into the rod side of the boom cylinder.

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

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

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

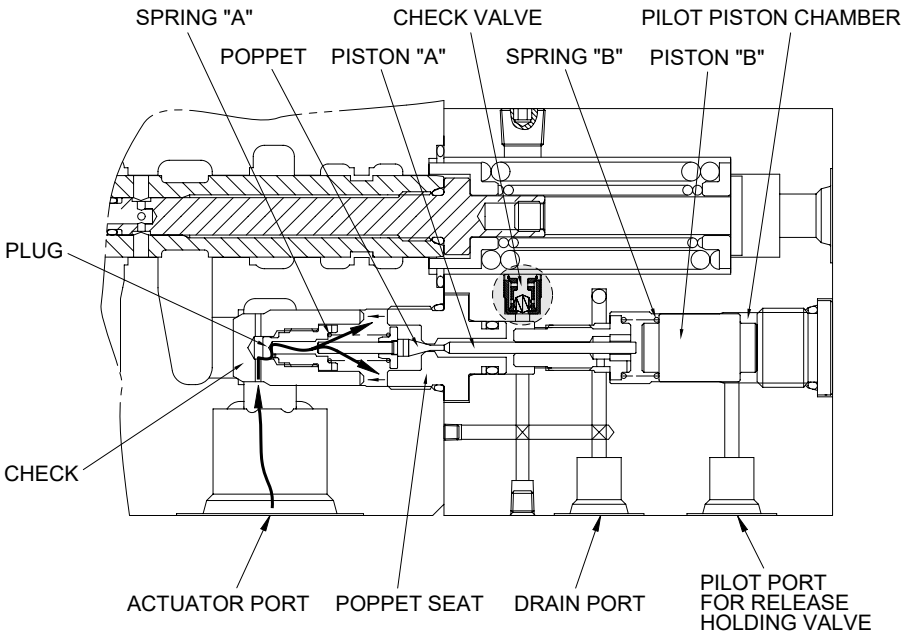
During the boom lowering operation, the fluid from A1 pump is not summation.



4) HOLDING VALVE OPERATION

(1) HOLDING OPERATION

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

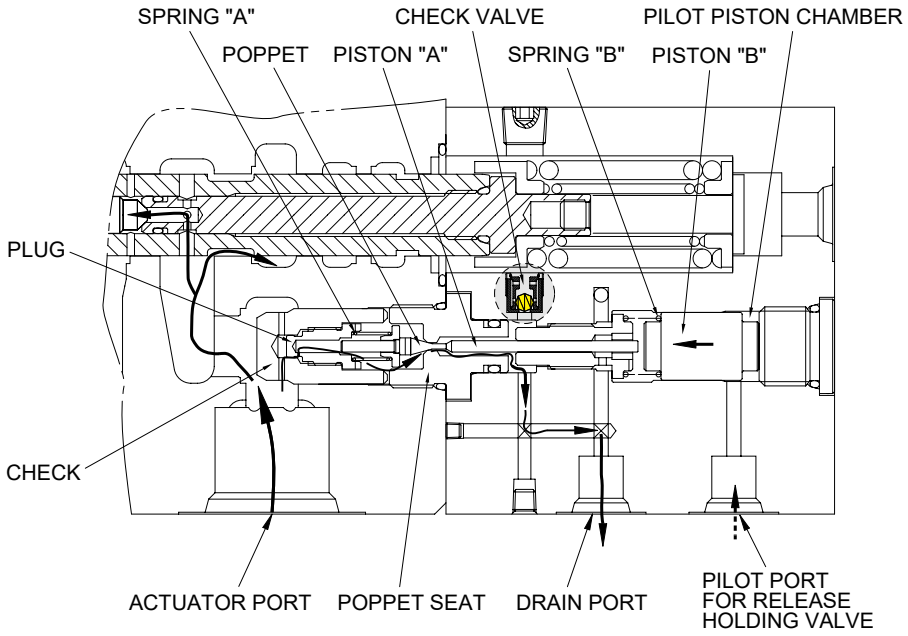


(2) RELEASE HOLDING OPERATION

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

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

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



5) BUCKET OPERATION

(1) BUCKET IN OPERATION

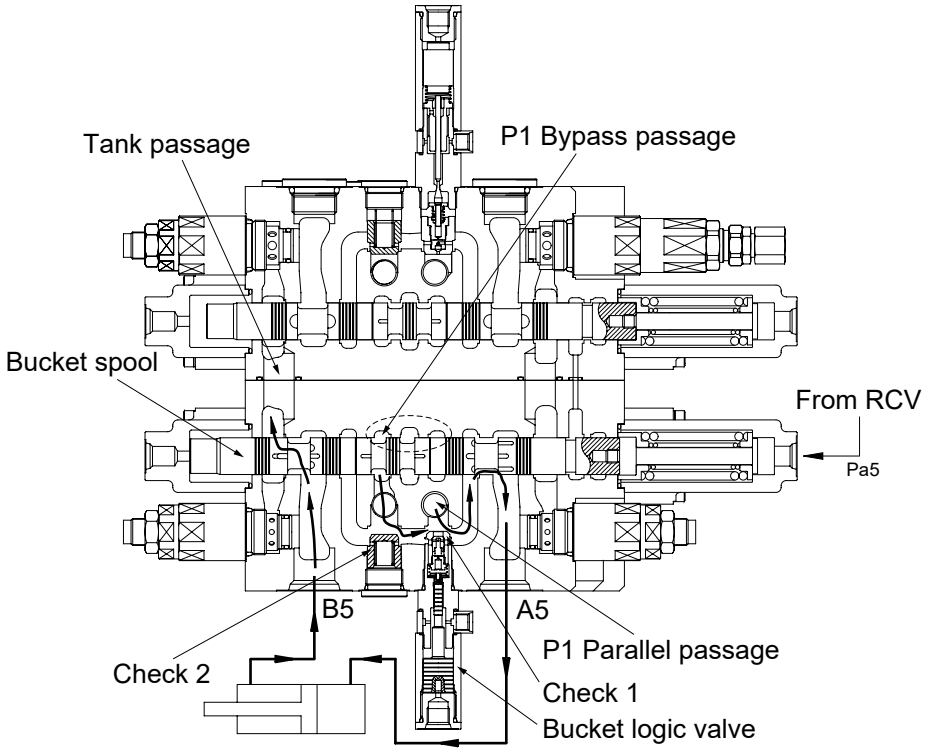
During the bucket in operation, the pilot secondary pressure from RCV is supplied to port Pa5 of the spring side and shifts the bucket spool in the left direction.

The bypass passage is shut off by the movement of the bucket spool and the hydraulic fluid from pump A2 entered P1 parallel passage and is directed to the port A5 through the check 1 of bucket logic valve.

At the same time, the hydraulic fluid from P1 bypass passage is directed to the port A5 through the check 2.

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

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



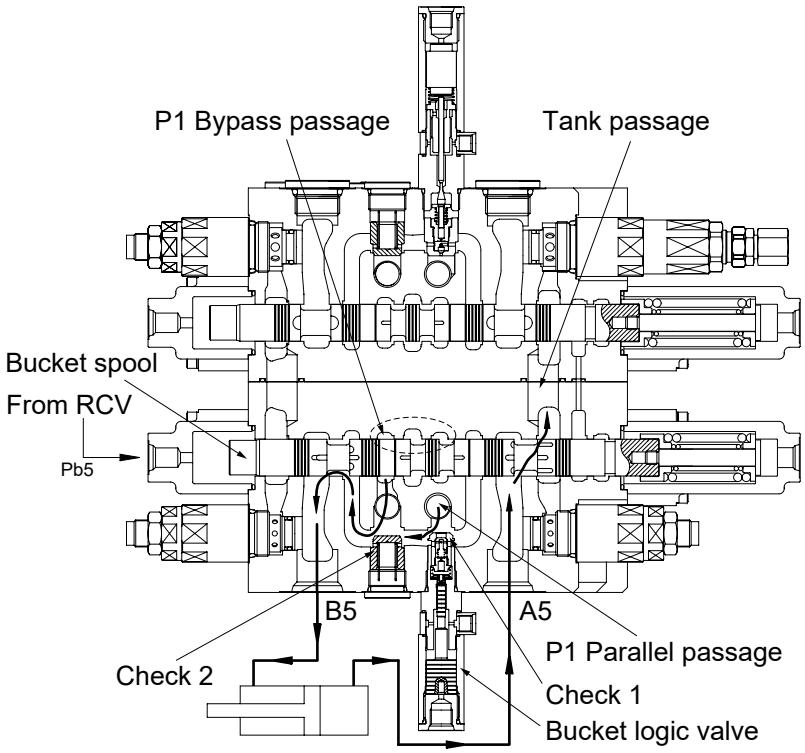
(2) BUCKET OUT OPERATION

During the bucket out operation, the pilot secondary pressure from RCV is supplied to port Pb5 of the spring opposite side and shifts the bucket spool in the right direction.

The bypass passage is shut off by the movement of the bucket spool and the hydraulic fluid from pump A2 entered P1 parallel passage and is directed to the port B5 through the check 1 of bucket logic valve.

At the same time, the hydraulic fluid from P1 bypass passage is directed to the port B5 through the check 2.

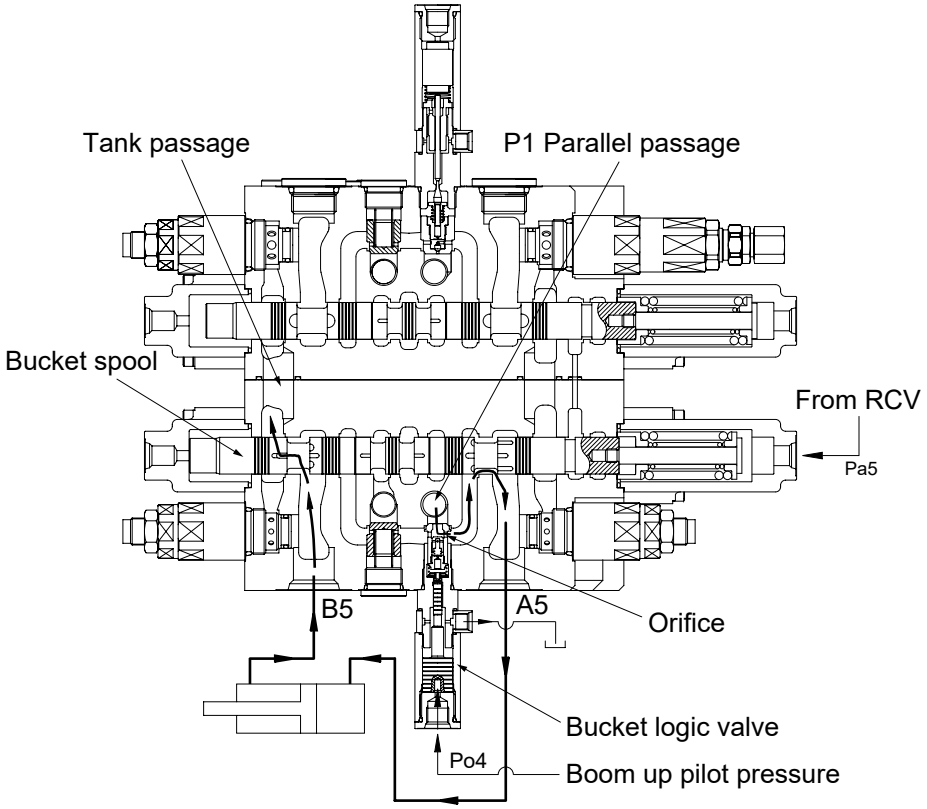
The return flow from the head side of the bucket cylinder returns to the hydraulic oil tank through the port A5 and the tank passage.



(3) BUCKET IN OPERATION WITH BOOM OPERATION

When combined operation, mostly same as previous page but the fluid from P1 bypass passage is empty.

So only the fluid from P1 parallel passage is supplied to the bucket cylinder. Also, parallel passage is installed the orifice of bucket logic valve for supplying the fluid from pump A2 to the boom operation prior to the bucket operation. In case of the bucket out operation with boom



6) SWING OPERATION

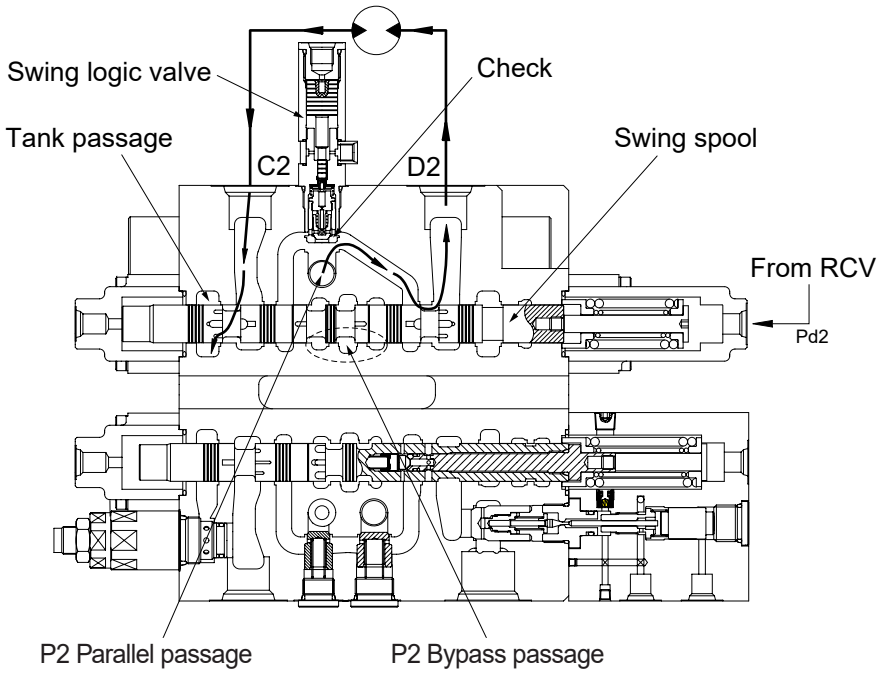
(1) SWING LEFT & RIGHT OPERATION

During the swing left operation, the pilot secondary pressure from the RCV is supplied to the port Pd2 of the spring side and shift the swing spool in left direction. The bypass passage is shut off by the movement of the swing spool and the hydraulic fluid from pump A1 flows into swing spool through the P2 parallel passage. Then it is directed to swing motor through the port D2.

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

In case of swing right operation, the operation is similar to swing left operation but the pilot secondary pressure from the RCV is supplied to the port Pc2 of the spring opposite side.

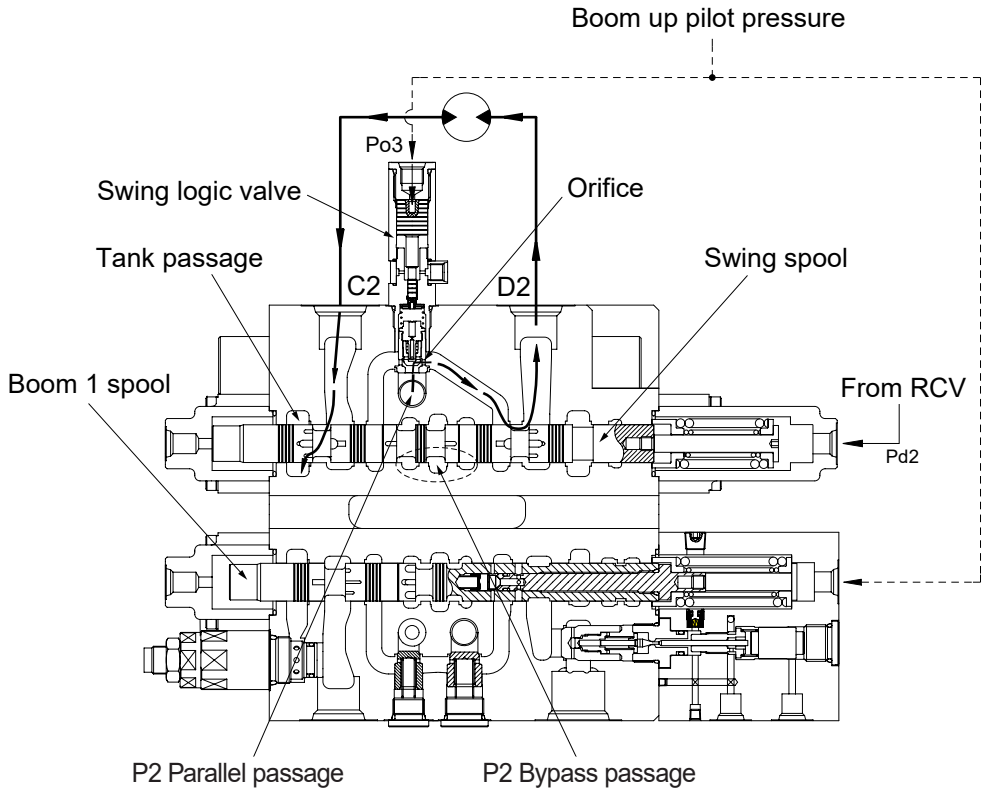
Accordingly, the hydraulic fluid from pump A1 flows into swing motor through the port C2 and returns to the hydraulic oil tank through the port D2 and the tank passage.



(2) SWING LEFT OPERATION WITH ARM OR BOOM OPERATION

When combined operation, mostly same as previous page but the fluid from P2 bypass passage is empty.

So only the fluid from parallel passage is supplied to the swing motor. Also, parallel passage is installed the orifice of swing logic valve for supplying the fluid from pump A1 to the boom or the arm operation prior to the swing operation. In case of the swing right operation with arm or boom



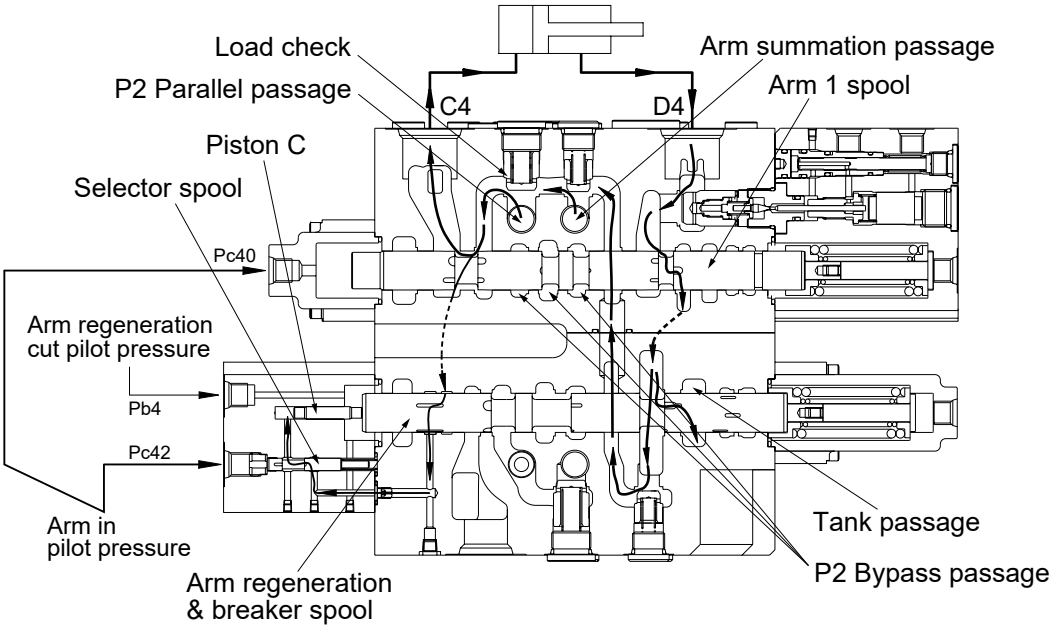
7) ARM OPERATION

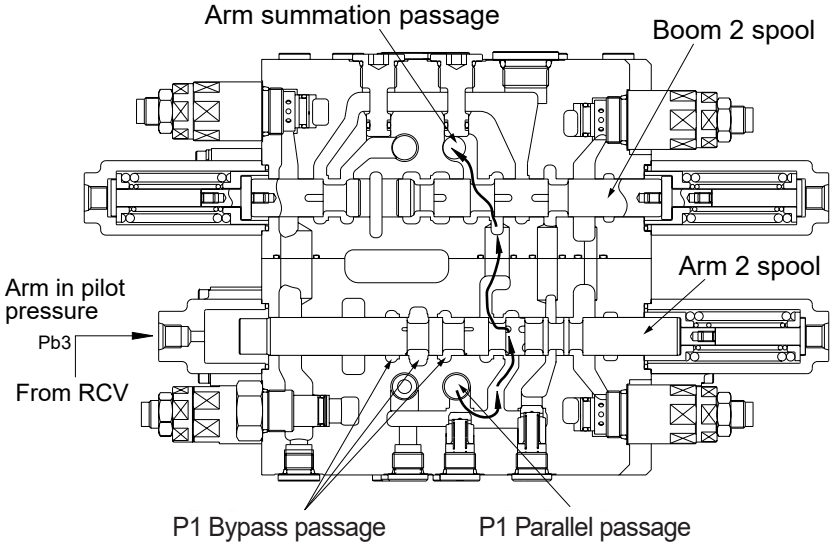
(1) ARM IN OPERATION

During arm in operation, the pilot secondary pressure from the RCV is supplied to the port Pc40 of spring opposite side and shifts arm 1 spool in the right direction.

The bypass passage is shut off by the movement of the arm 1 spool and the hydraulic oil from the pump A1 flows into the arm cylinder head side through P2 parallel passage, the load check valve, bridge passage and the port C4.

At same time, the pilot secondary pressure from the RCV is supplied to the port Pb3 of spring opposite side and shifts arm 2 spool in the right direction. The bypass passage is shut off by the movement of the arm 2 spool and the hydraulic fluid from the pump A2 flows into the arm summation passage through P1 parallel passage, the check valve, the arm 2 spool and the boom 2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm 1 spool.



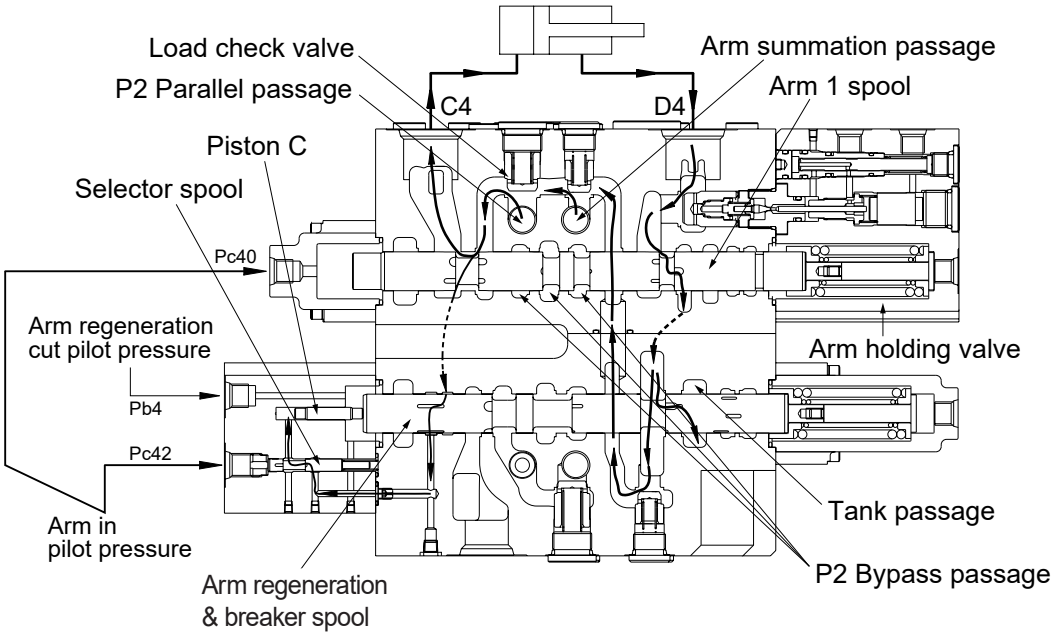


ARM REGENERATION

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

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

Furthermore, the arm regeneration cut pressure is supplied to the port Pb4 of spring opposite side and arm regeneration spool is move into the right direction fully. The flow from the arm cylinder rod is returned to the hydraulic oil tank and regeneration function is not activated. (The return fluid is maximum condition)



(2) ARM OUT OPERATION

During arm out operation, the pilot secondary pressure from RCV is supplied to the port Pd40 of spring side and shifts arm 1 spool in the left direction.

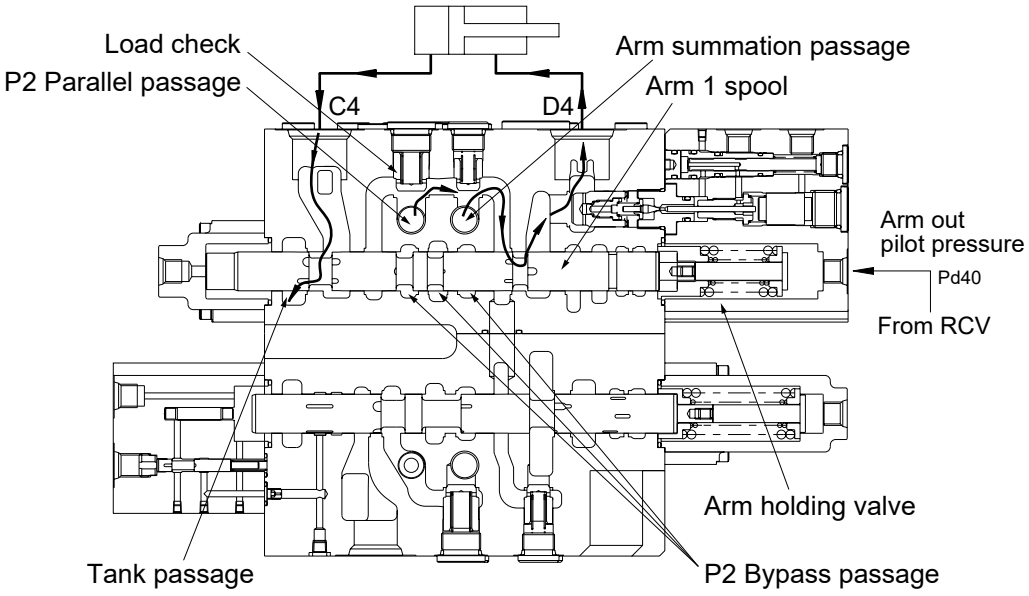
The bypass passage is shut off by the movement of the arm 1 spool and the hydraulic fluid from pump A1 flows into arm 1 spool through the P2 parallel passage. Then it enters into the arm cylinder rod side through the load check, bridge passage, arm holding valve and the port D4.

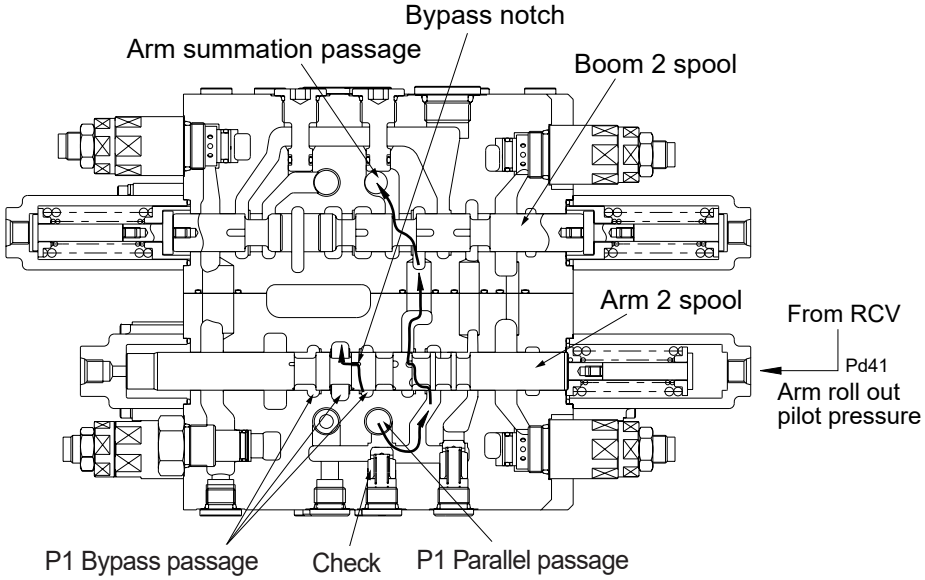
Also, the pilot secondary pressure from RCV is supplied to the port Pd41 of spring side and shifts arm 2 spool in the left direction.

The bypass passage is shut off by the movement of the arm 2 spool and some of the hydraulic fluid from pump A2 bypassed through bypass notch. The rest of hydraulic fluid from pump A2 flows into the arm summation passage through P1 parallel passage, the check valve, arm 2 spool and boom 2 spool.

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

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



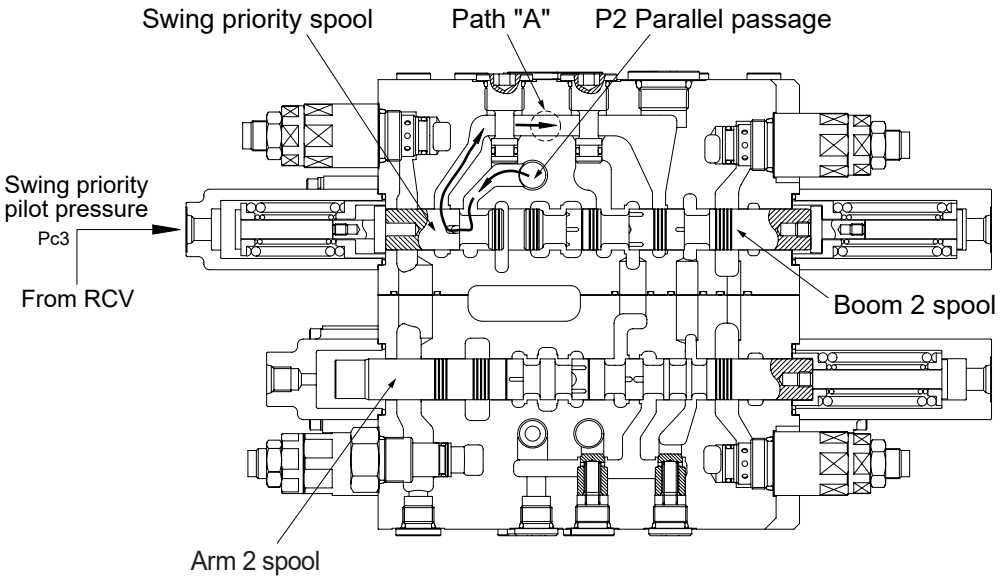


8) SWING PRIORITY FUNCTION

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

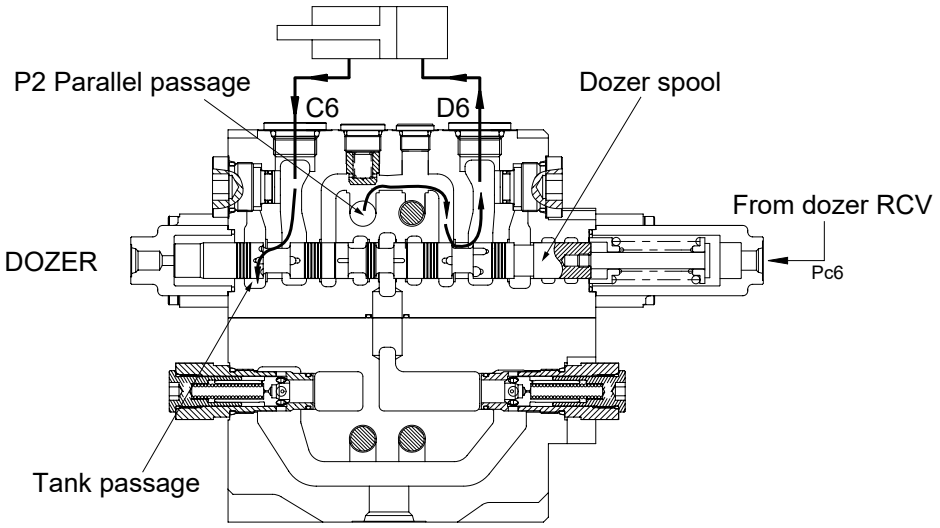
The hydraulic fluid from P2 parallel passage flows into the parallel passage of arm 1 side through swing priority spool and the path "A" and also flows into the boom 2 spool.

When the swing priority spool is neutral condition, the passage is same as normal condition. But due to shifting of the swing priority spool, the fluid from pump A1 flows to swing side more then the boom 2, arm 1, option B and dozer spools to make the swing operation most preferential.

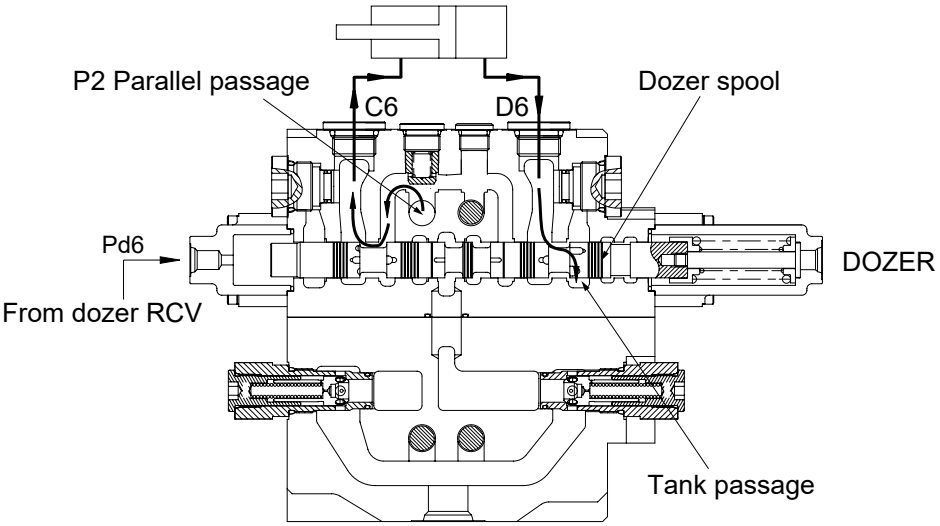


9) DOZER OPERATION

(1) Dozer down operation



(2) Dozer up operation



14W92MC31

During the dozer down operation, the pilot pressure from the dozer control valve is supplied into the port Pc6 of the spring side and it shifts the dozer spool in the left direction.
The hydraulic fluid from the pump A1 enters the parallel passage and is direction to the head side of the dozer cylinder through port D6.
The return flow from the rod side of the dozer cylinder returns to the dozer spool through C6 port. Thereafter it is directed to the hydraulic tank through tank passage.
In case of the dozer up operation, operation is similar.

10) NEGATIVE RELIEF VALVE OPERATION

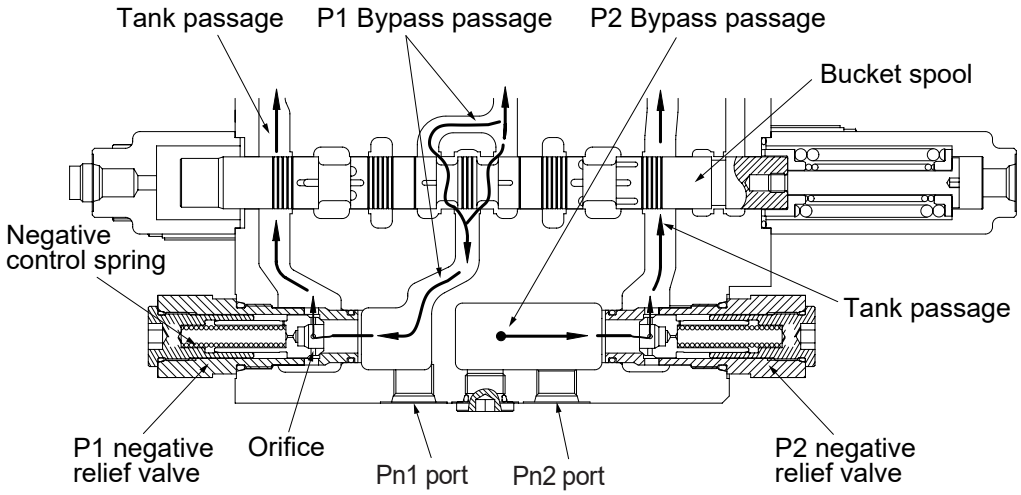
When no function is being actuated on P1 side, the hydraulic fluid from the pump A2, flows into the tank passage through the P1 bypass passage and orifice. The restriction caused by this orifice thereby pressurizes. This pressure is transferred as the negative control signal pressure Pn1 to the pump A2 regulator.

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

The bypass passage is shut off when the shifting of one or more spools and the flow through bypass passage became zero. The pressure of negative control signal becomes zero and the discharge of the pump A2 becomes maximum.

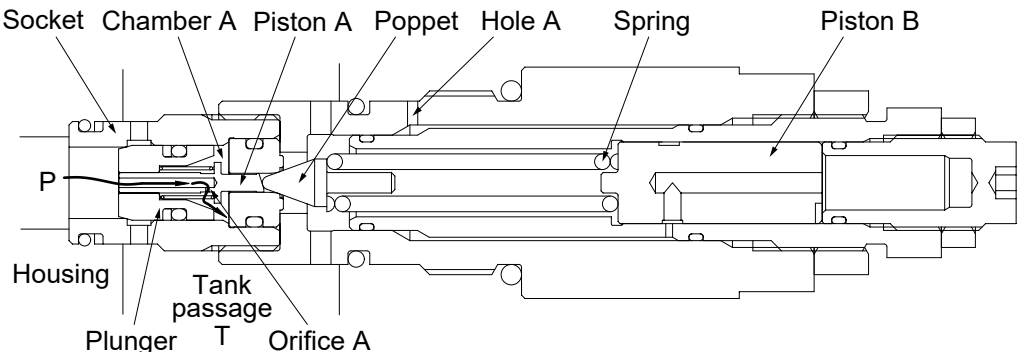
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump A1 the same negative control principle.

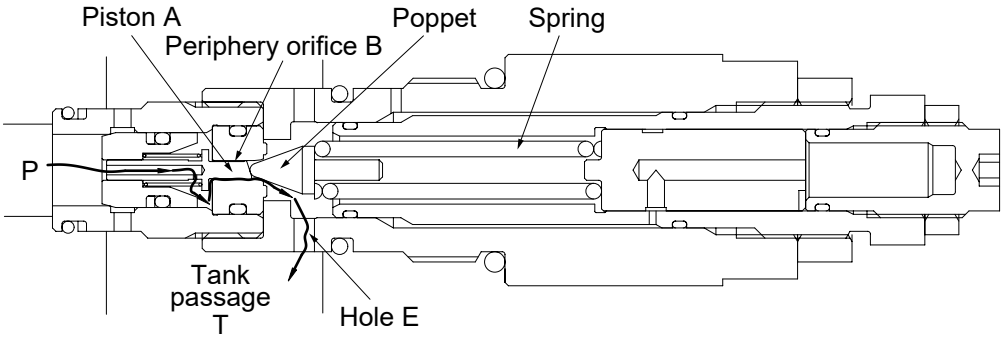


11) OPERATION OF MAIN RELIEF VALVE

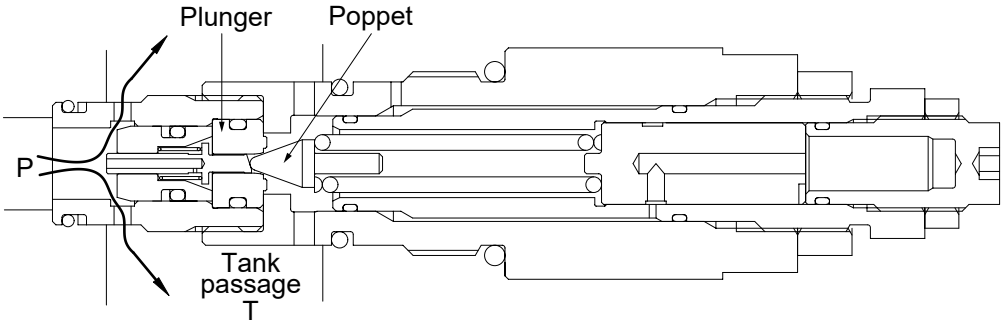
(1) The pressurized oil passes through the orifice (A) of the plunger is filled up in chamber A of the inside space, and seats the plunger against the housing securely.



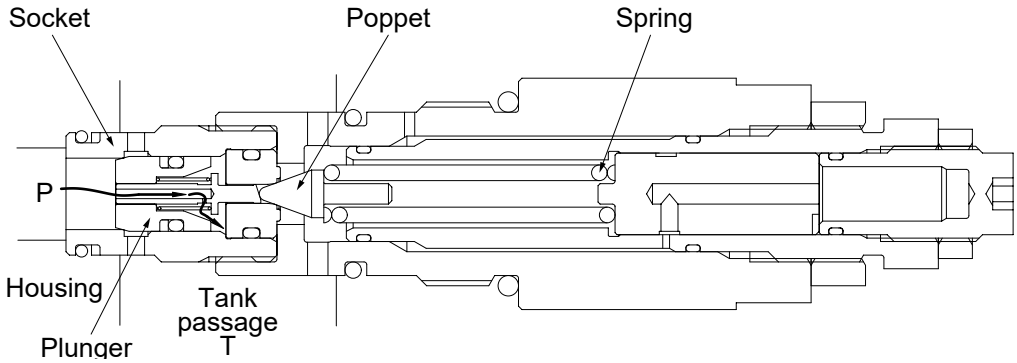
(2) When the pressure at (P) becomes equal to the set pressure of the spring the hydraulic oil passes through the piston (A) pushes open the poppet and flows to tank passage (T) through the plunger internal passage, periphery orifice A, chamber A, periphery orifice B and the hole (E).



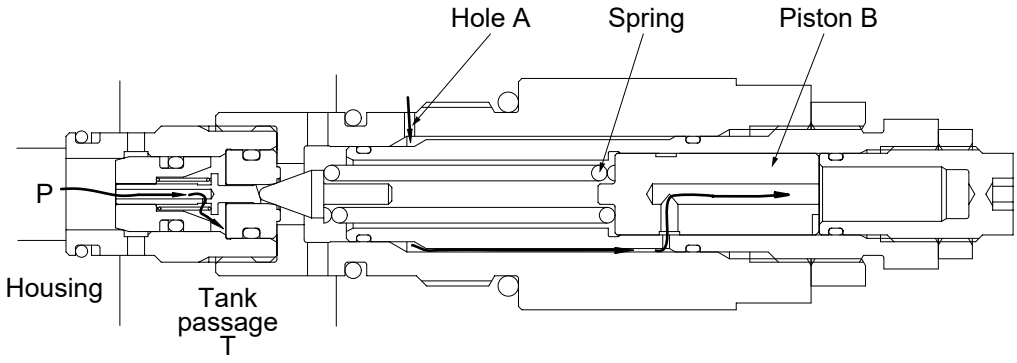
(3) Opening the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



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



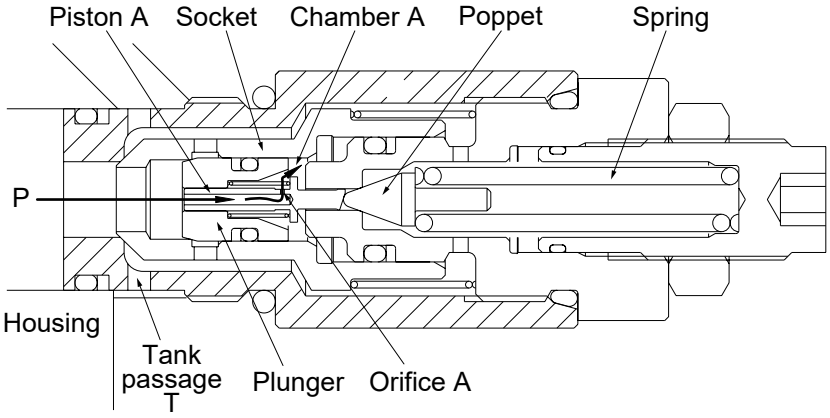
(5) When the power boost switch is ON, the pilot pressure enters through hole A.
It pushes the piston (B) in the left direction to increase the force of the spring and change the relief set pressure to the high pressure.



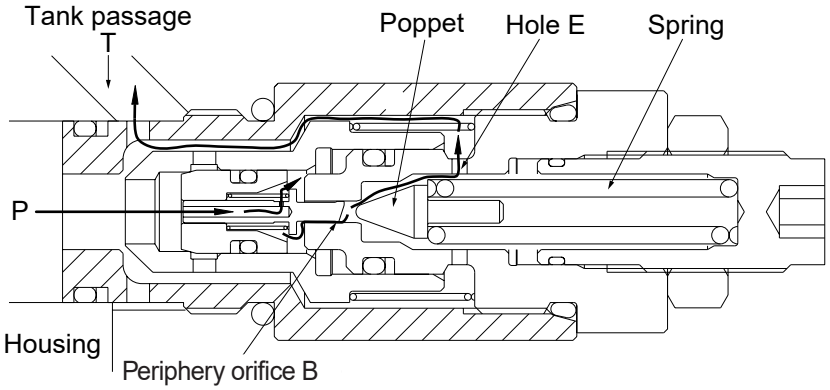
12) OPERATION OF OVERLOAD RELIEF VALVE

FUNCTION AS RELIEF VALVE

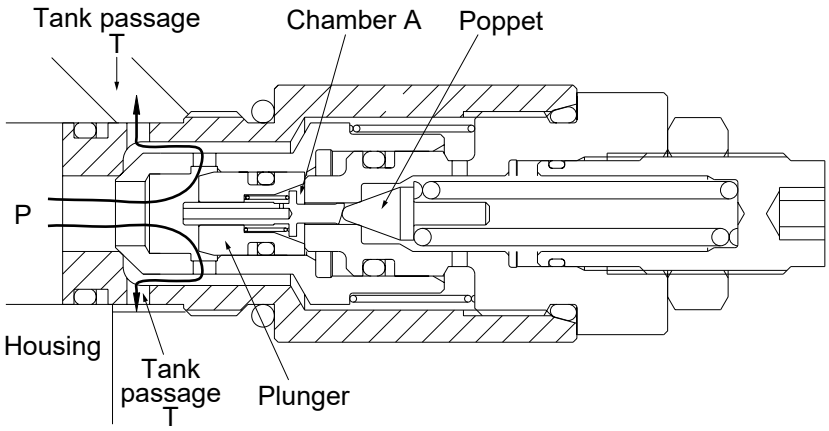
(1) The pressurized oil passes through the piston A and orifice A is filled up in chamber A of the inside space and seat the plunger against the socket and the socket against the housing securely.



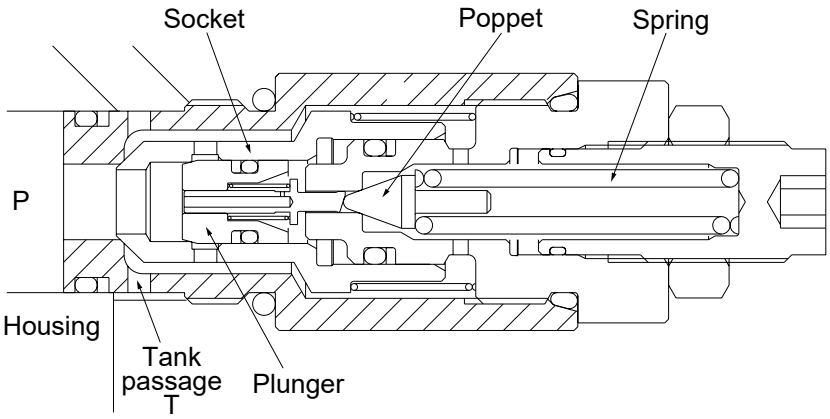
(2) When the pressure at port P becomes equal to the set pressure of the spring, the pressurized oil pushes open the poppet and flows to tank passage (T) through the plunger internal passage, orifice A, chamber A, periphery orifice B and hole E.



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

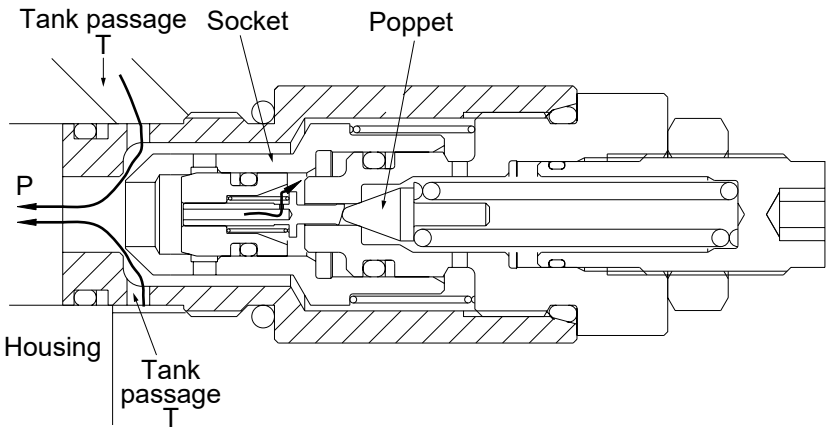


(4) The pressure at port P becomes lower than set pressure of the spring, the poppet is seated by spring force. Then the pressure at port P becomes equal to set pressure of the spring and the plunger is seated to the socket.



MAKE-UP FUNCTION

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

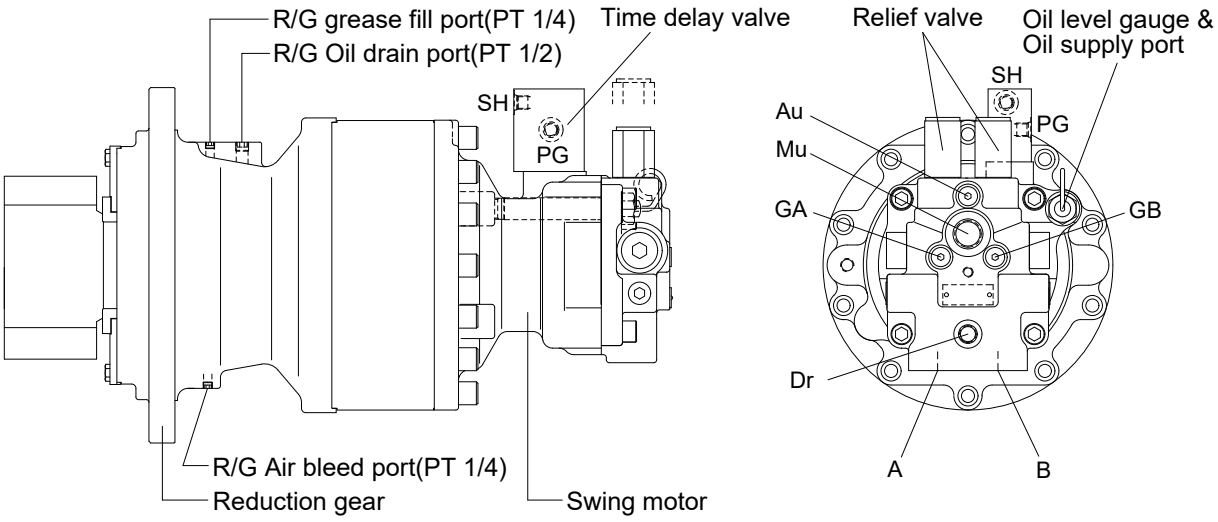


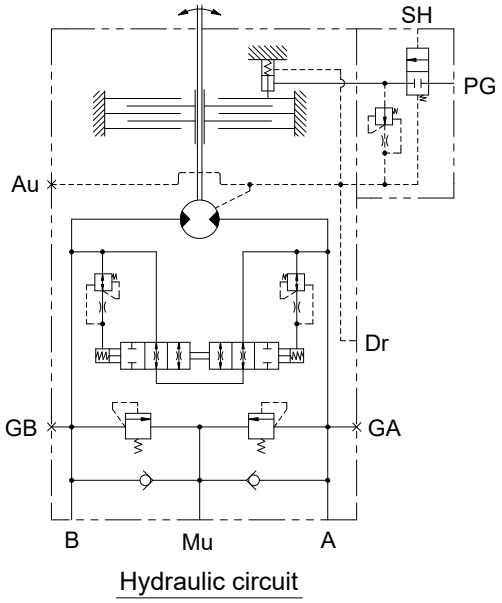
GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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

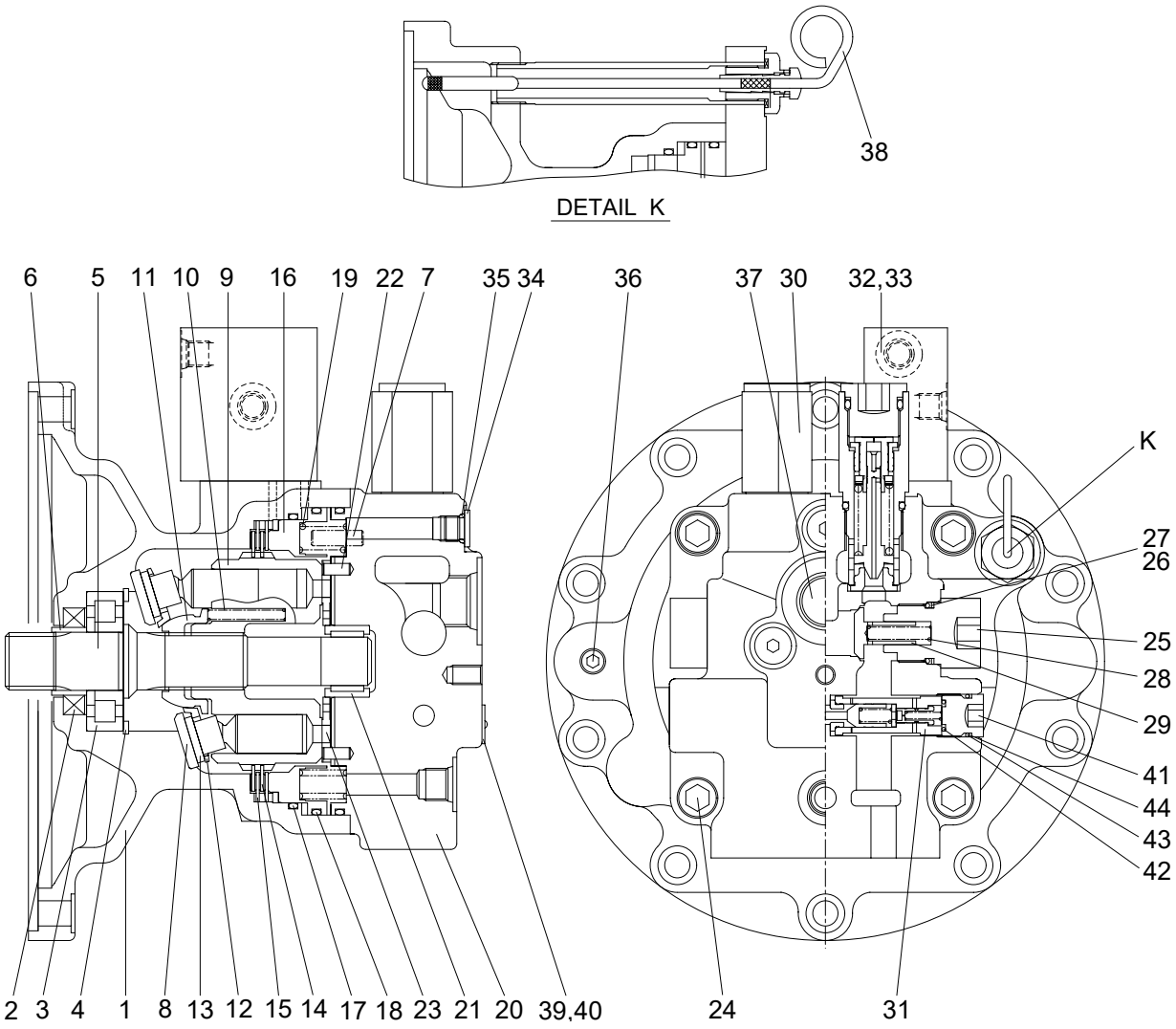




Hydraulic circuit

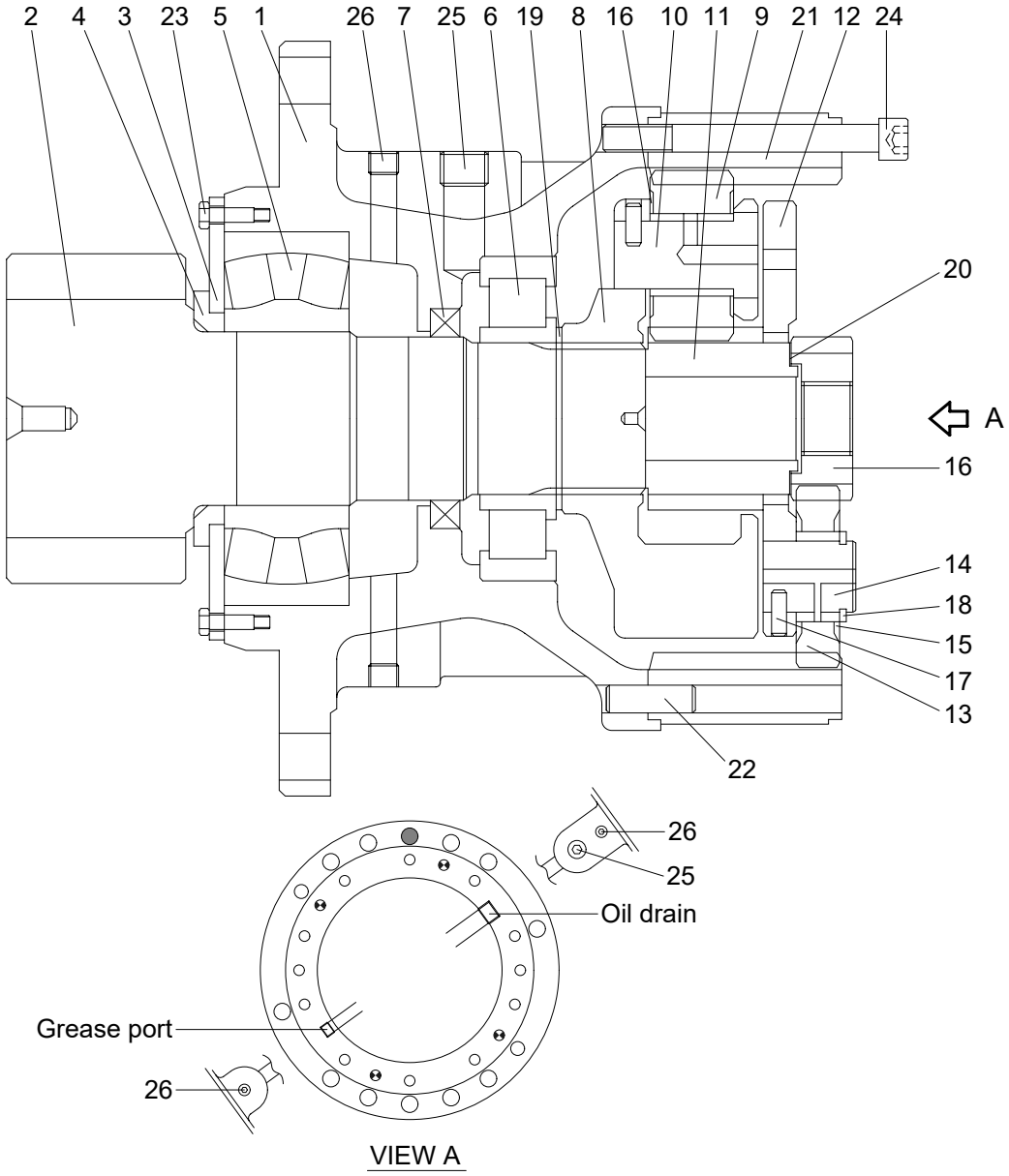
Port	Port name	Port size
A	Main port	ø 13
B	Main port	ø 13
Dr	Drain port	PF 3/8
Mu	Make up port	PF 3/4
SH	Brake release pilot port	PF 1/4
PG	Brake release stand by port	PF 1/4
GA, GB	Gage port	PF 1/4
Au	Air vent port	PF 1/4

1) SWING MOTOR



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

2) REDUCTION GEAR



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

2. PRINCIPLE OF DRIVING

1) GENERATING THE TURNING FORCE

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

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

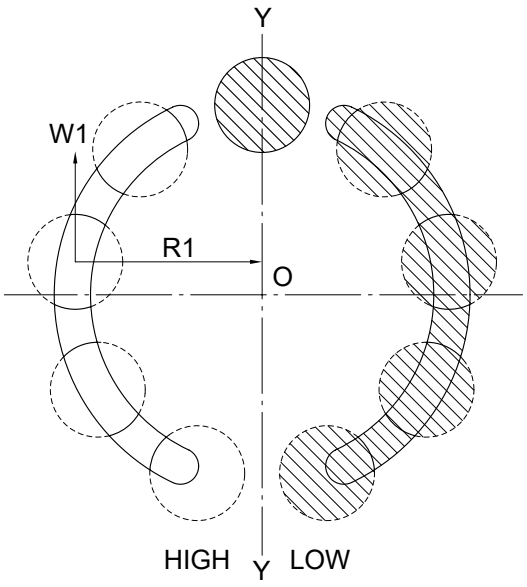
The high hydraulic can generate the force, F1=P×A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

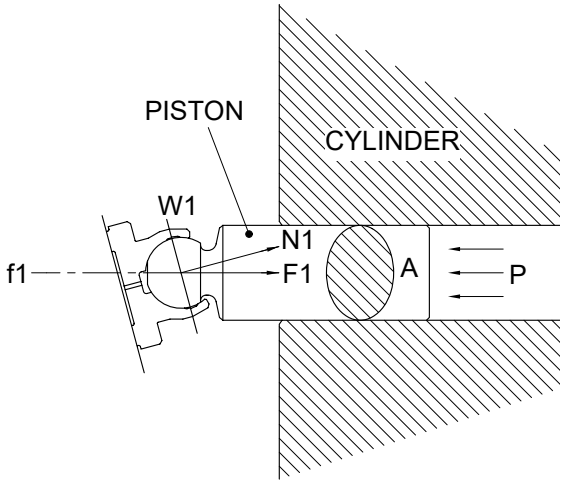
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle, α .

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

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

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





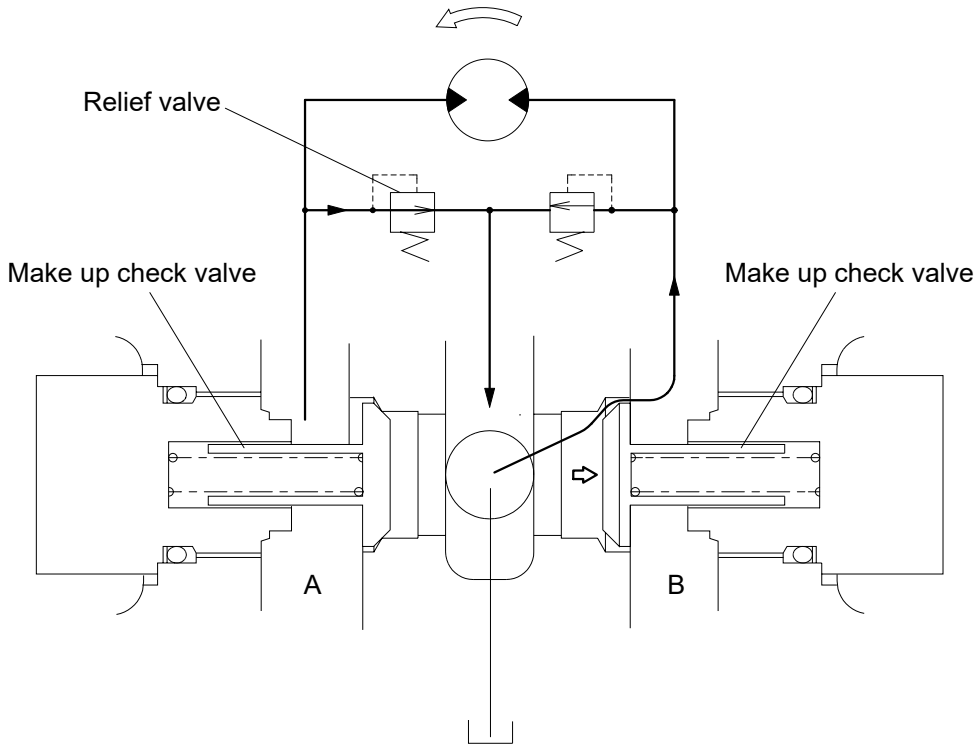
2) MAKE UP VALVE

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

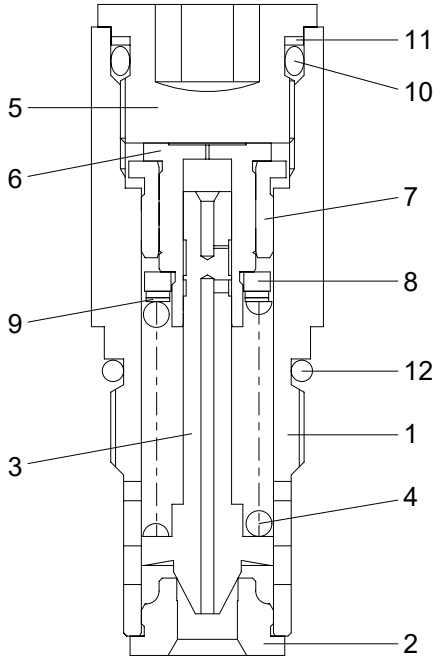
A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

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

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



3) RELIEF VALVE



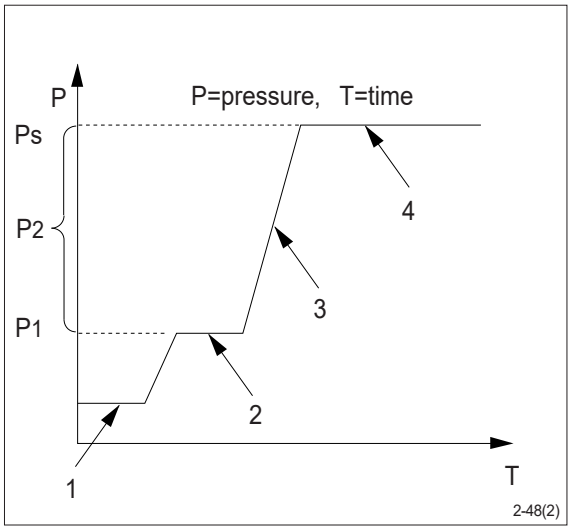
1	Body
2	Seat
3	Plunger
4	Spring
5	Adjusting screw
6	Piston
7	Bushing
8	Spring seat
9	Shim
10	O-ring
11	Back up ring
12	O-ring

(1) Construction of relief valve

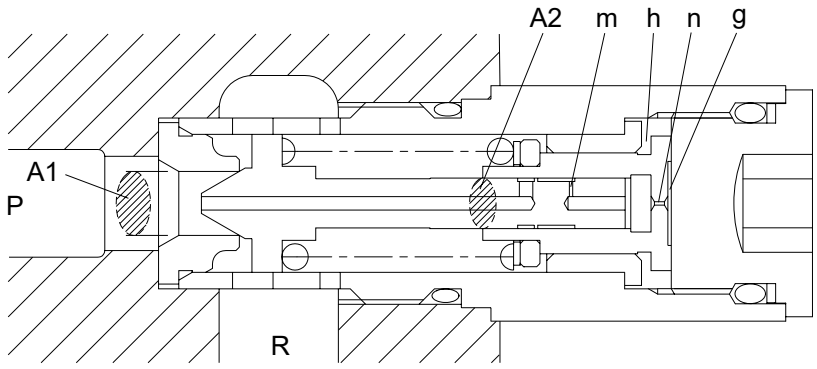
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

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



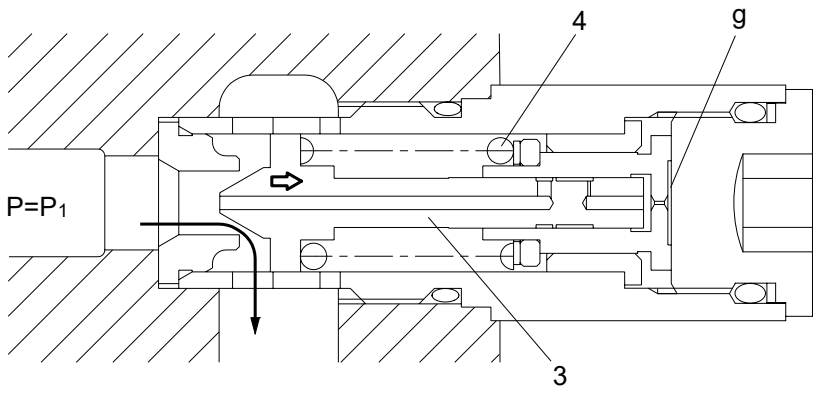
① Ports (P,R) at tank pressure.



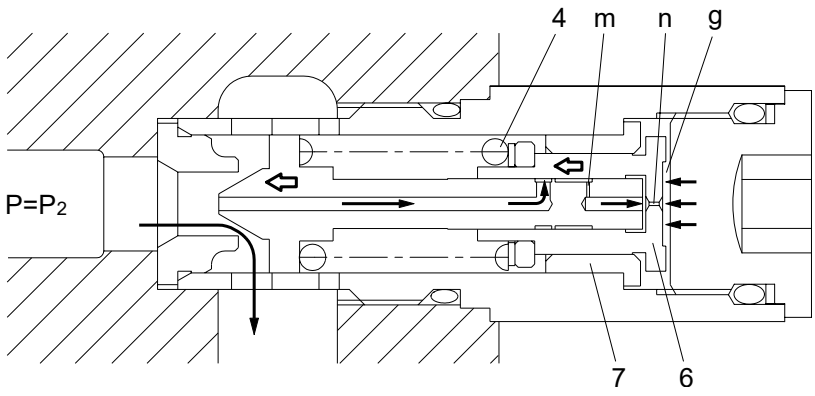
② When hydraulic oil pressure ($P \times A_1$) reaches the preset force (F_{SP}) of spring (4), the plunger (3) moves to the right as shown.

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

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



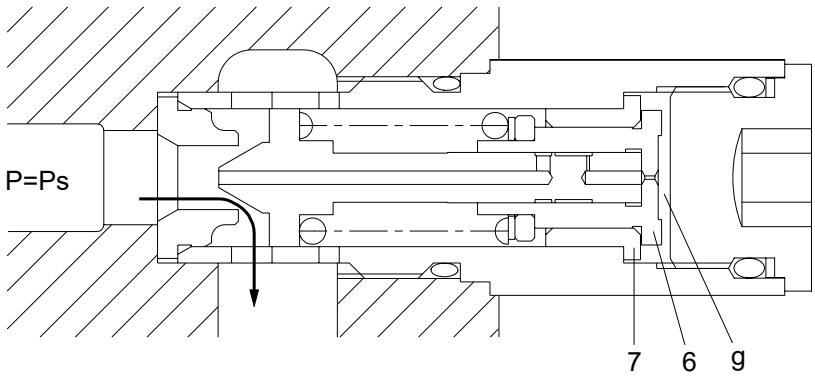
③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (FSP) of spring (4), the piston (6) moves left and stop the piston (6) hits the bottom of bushing (7).



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

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

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

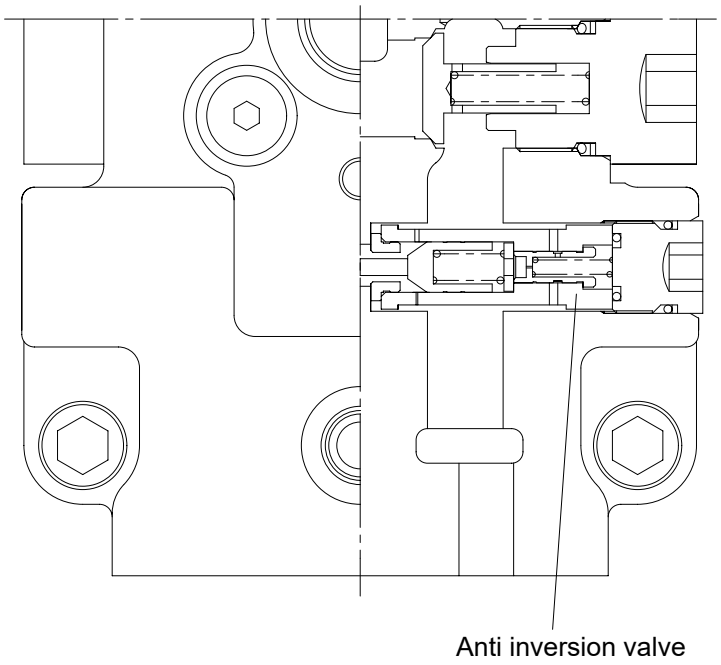


4) ANTI-INVERSION VALVE

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

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

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

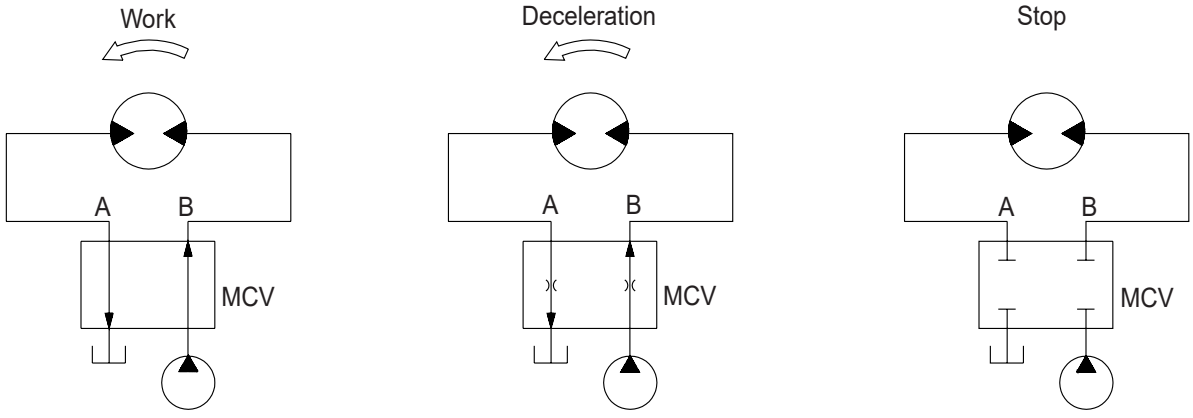


5) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



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

2-48(1)

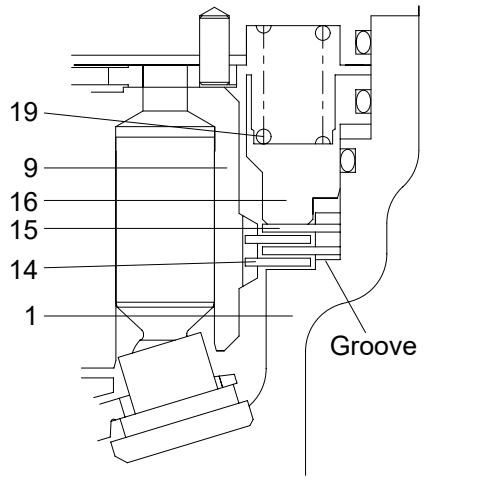
(2) Mechanical swing parking brake system

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

① Brake assembly

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

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

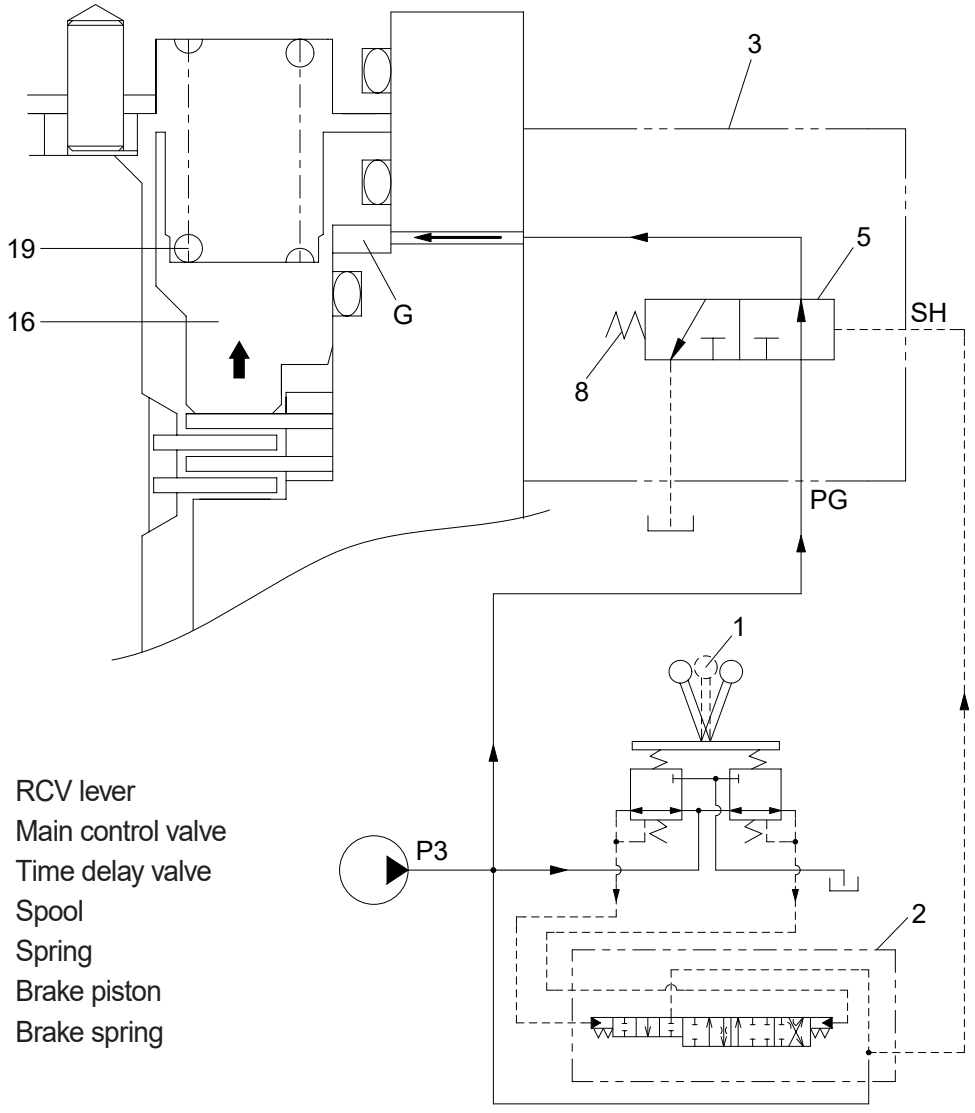


14W92SM15

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

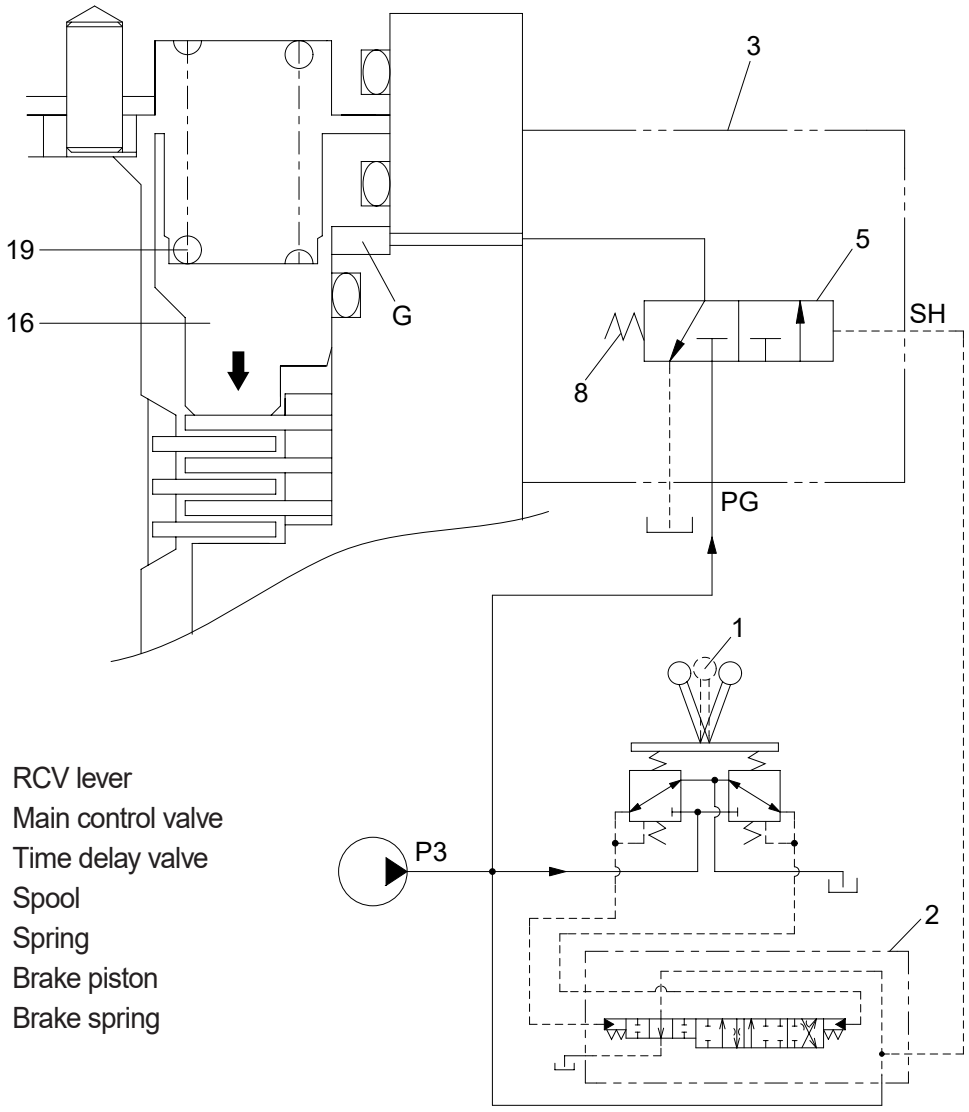
② **Operating principle**

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



1 RCV lever
2 Main control valve
3 Time delay valve
5 Spool
8 Spring
16 Brake piston
19 Brake spring

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

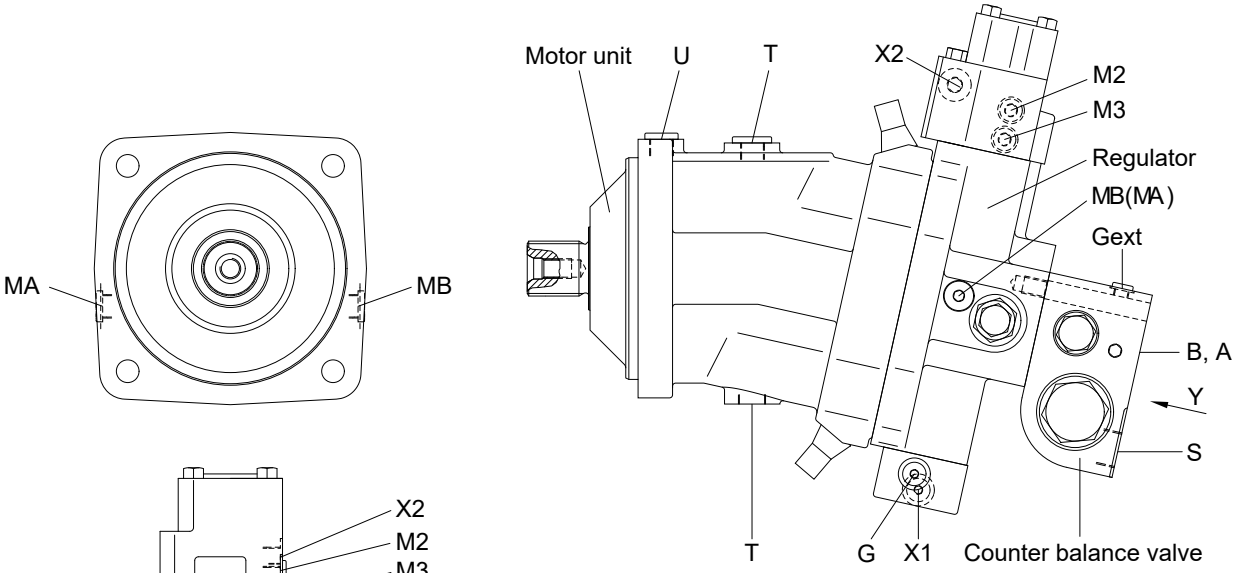


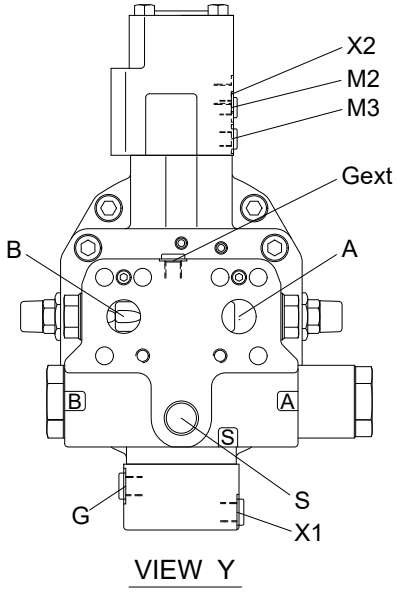
1 RCV lever
2 Main control valve
3 Time delay valve
5 Spool
8 Spring
16 Brake piston
19 Brake spring

GROUP 4 TRAVEL MOTOR (-#0406)

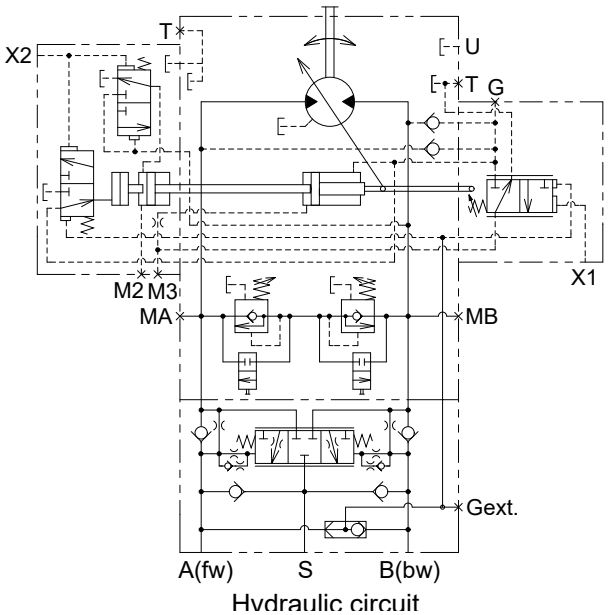
1. CONSTRUCTION

Travel motor consists motor unit, regulator and counter balance valve.





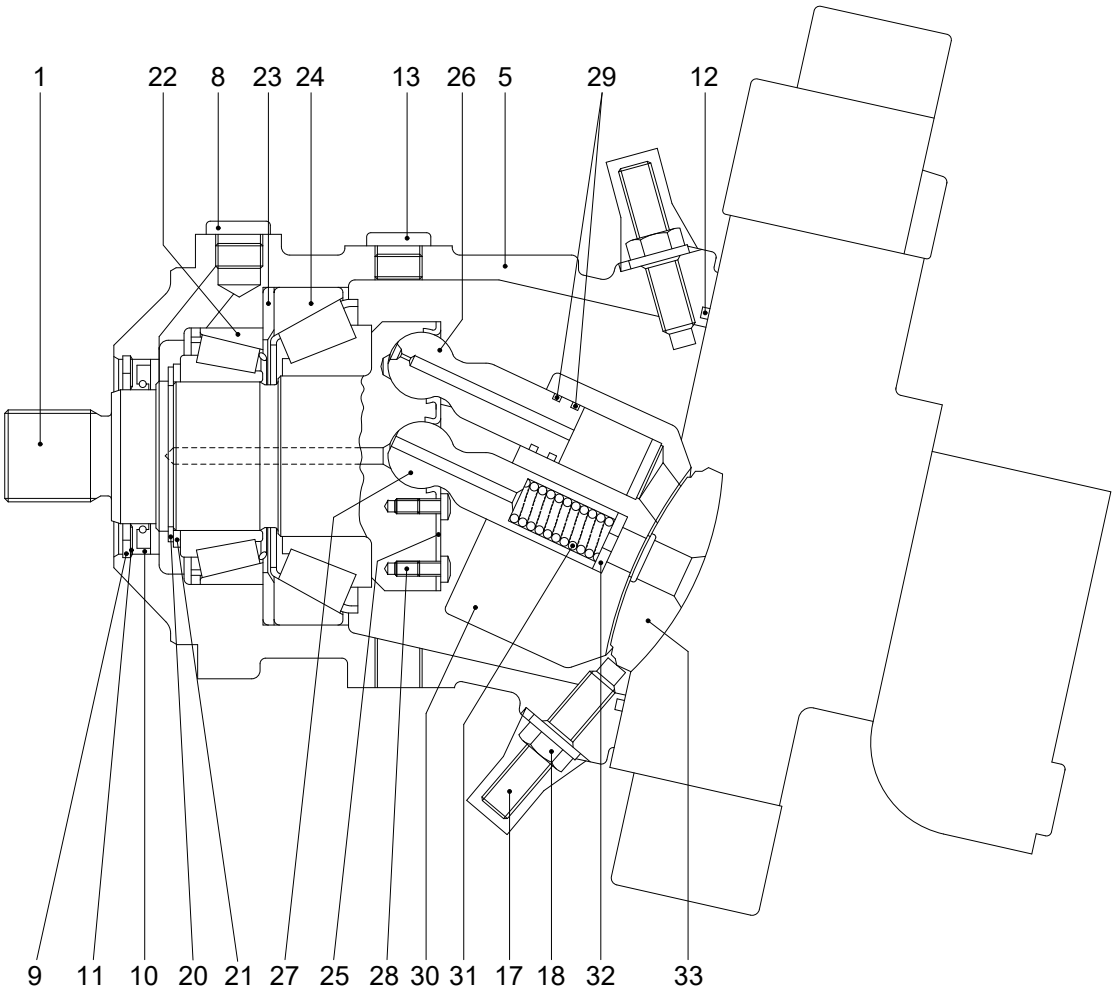
VIEW Y



Hydraulic circuit

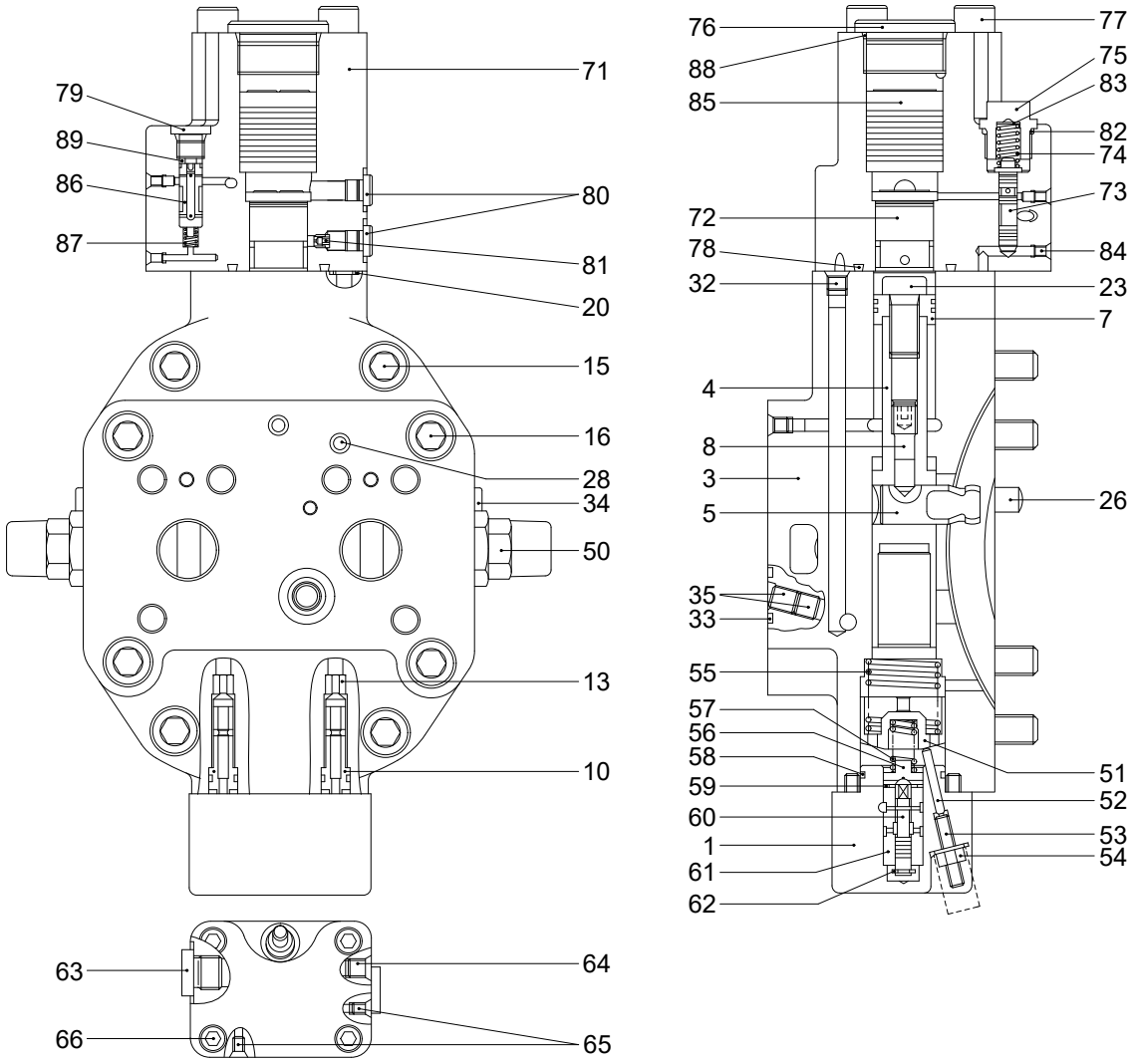
Port	Port name	Port size
A, B	Main port	SAE 6000psi 1"
G	N.A	M14×1.5-12
M1	Gauge port	M14×1.5-12
X1	Pilot pressure port	M14×1.5-12
X2	Pilot pressure port	M14×1.5-11.5
T	Drain port	PF 1/2-16
U	Flushing port	PF 1/2-16
S	Make up port	M27×2.0-14
MA, MB	Gauge port	M18×1.5-12
M2, M3	Gauge port	M10×1.0-8
Gext	Brake release port	M12×1.5-12.5

1) MOTOR UNIT



1	Drive shaft	17	Threaded pin	26	Piston
5	Housing	18	Seal lock nut	27	Center pin
8	Locking screw	20	Retaining ring	28	Pan head screw
9	Retaining ring	21	Back up plate	29	Steel sealing ring
10	Shaft seal ring	22	Taper roller bearing	30	Cylinder block
11	Back up plate	23	Shim	31	Pressure spring
12	O-ring	24	Taper roller bearing	32	Adjustment shim
13	Locking screw	25	Retaining plate	33	Control lens

2) REGULATOR



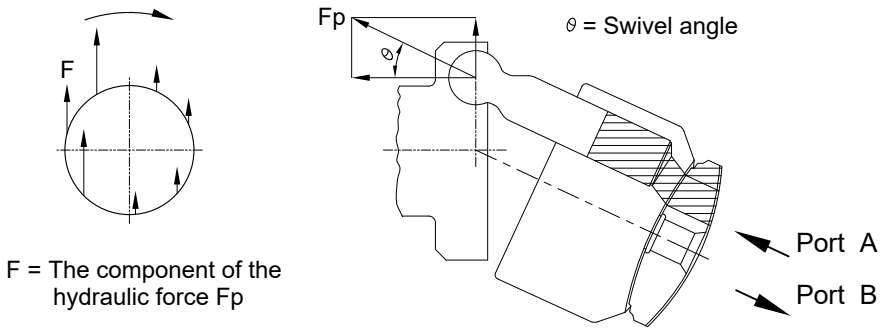
1	Control housing	50	Relief valve	72	Piston
2	Stroke limiter	51	Adjusting bushing	73	Control piston
3	Port plate	52	Cylinder pin	74	Pressure spring
4	Positioning piston	53	Threaded pin	75	Locking screw
5	Positioning trunnion	54	Seal lock nut	76	Locking screw
7	Piston	55	Pressure spring	77	Socket head screw
8	Threaded pin	56	Spring collar	78	O-ring
10	Check valve	57	Pressure spring	79	Locking screw
13	Valve seat	58	O-ring	80	Locking screw
15	Socket head screw	59	Retaining ring	81	Orifice
16	Socket head screw	60	Control piston	82	O-ring
20	O-ring	61	Control bushing	83	Shim
23	Socket head screw	62	Retaining disc	84	Double break off pin
26	Cylinder pin	63	Locking screw	85	Piston
28	Double break off pin	64	Double break off pin	86	Control piston
32	Double break off pin	65	Double break off pin	87	Pressure spring
33	O-ring	66	Socket head screw	88	O-ring
34	Locking screw	71	Housing	89	Shim

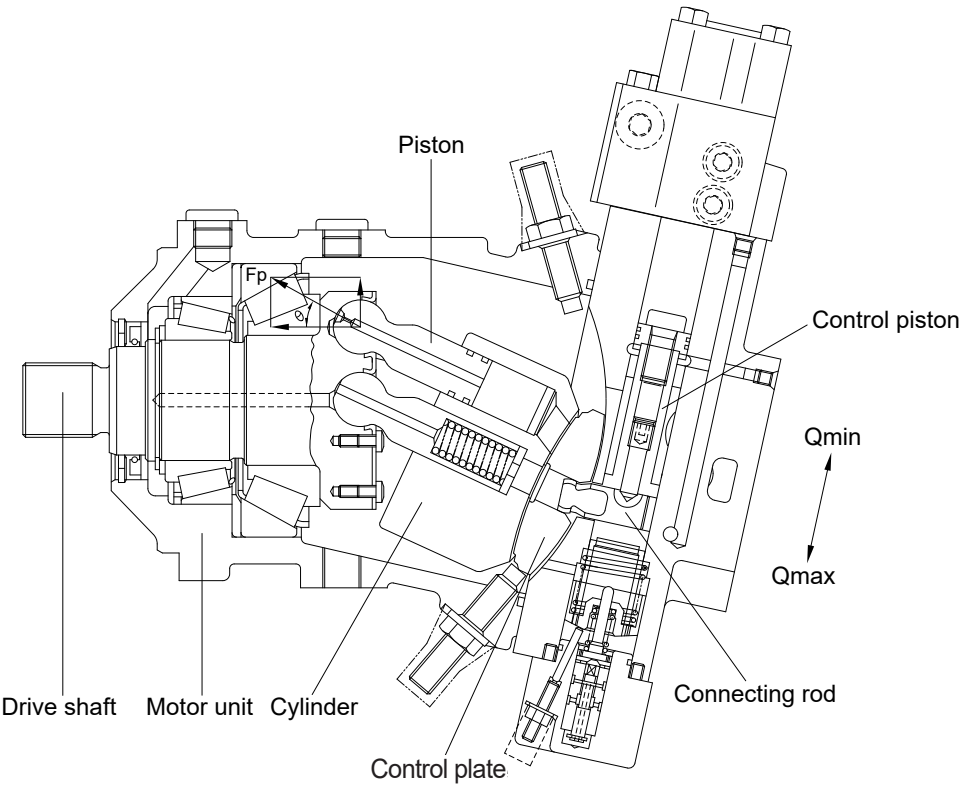
2. TRAVEL MOTOR FUNCTION

The direction of the drive shaft rotation is dependent on which is the port, port A or port B, the pressure oil shall be connected to.

When the pressure oil is led into the cylinder in which seven pistons are flexibly mounted in a circular formation, pistons press the shaft and set it in rotation. One piston travels one stroke during one rotation, which results in that oil is sucked and discharged. As each of seven pistons continuously acts such movement in turn, the drive shaft can do rotary movement smoothly. The component of the hydraulic force acting on the piston produces turning effect. Therefore, as the swivel angle becomes larger, the turning effect becomes larger. In addition, as the travel angle becomes larger, the displacement becomes larger, which results in that the operating speed becomes slower.

The control plate is connected to the control piston by means of the connecting rod, and the swivel angle is dependent on the position of the control piston.





3. REGULATOR FUNCTION

HA function

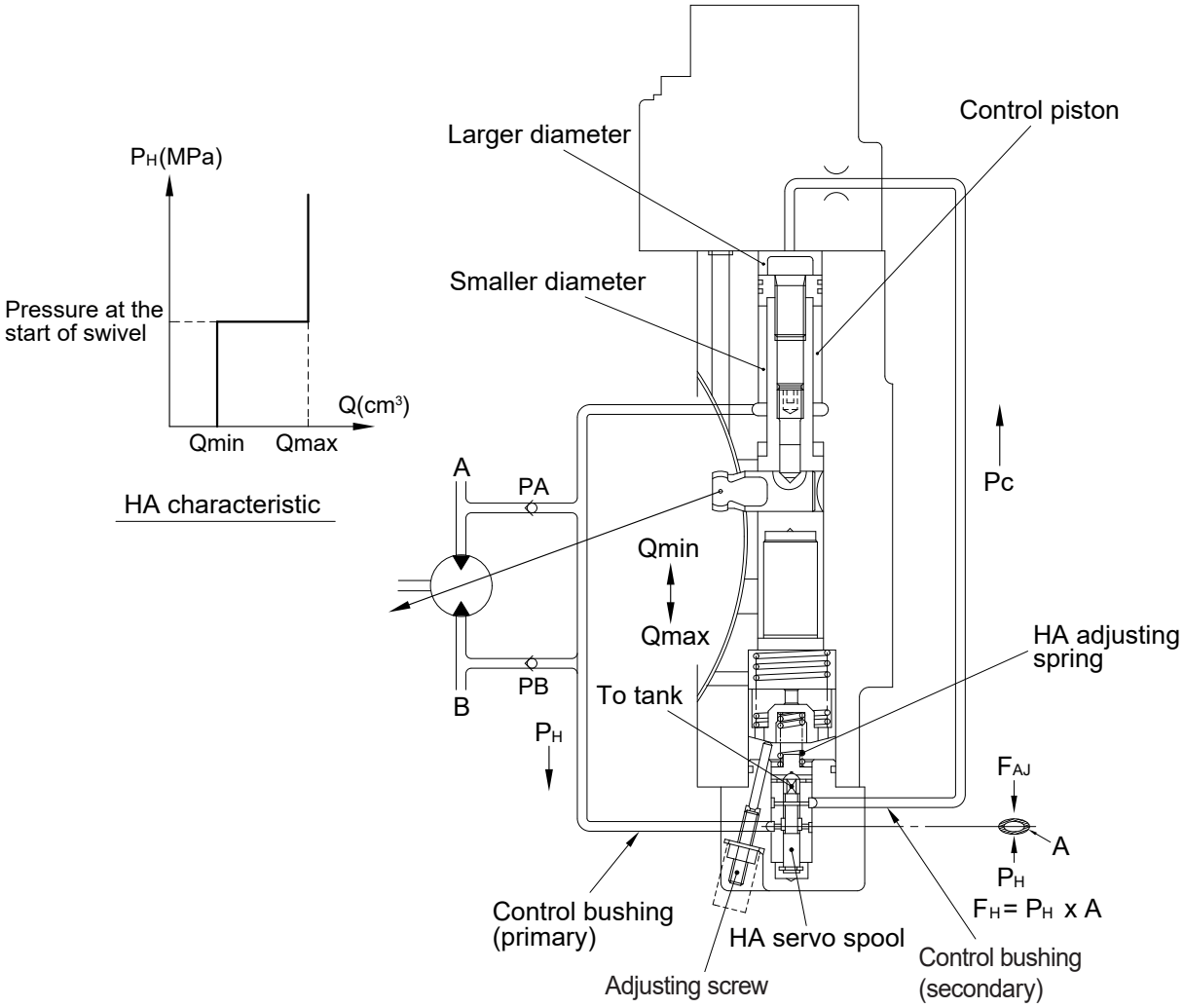
By sensing the load, the displacement varies.

HA operation

The high pressure PH at the either side of port A or port B is selected by the shuttle valve fitted in the counter balance valve, and it is led into the smaller diameter of the control piston and the spool.

If the circuit pressure value is lower than the pressure value at the start of swivel, the control pressure Pc acting on the larger diameter of the control piston becomes zero, and thus the swivel angle is the minimum. On the contrary, if the circuit pressure value is higher than the pressure value at the start of swivel, the spool is shifted and the control pressure increases, which causes the control piston to move toward the larger swivel angle.

The traveling speed is variable in proportion to the load pressure, by means of the function above. When the load pressure is high, for example, at starting or at climbing a slope, the swivel angle is set to be the maximum, and the torque is be the maximum. And as the load pressure drops down, the swivel angle is getting smaller, which results in higher speed of traveling. When the load pressure is low, for example, traveling on the flat, the swivel angle is set to be the minimum, which results in the maximum speed of traveling.

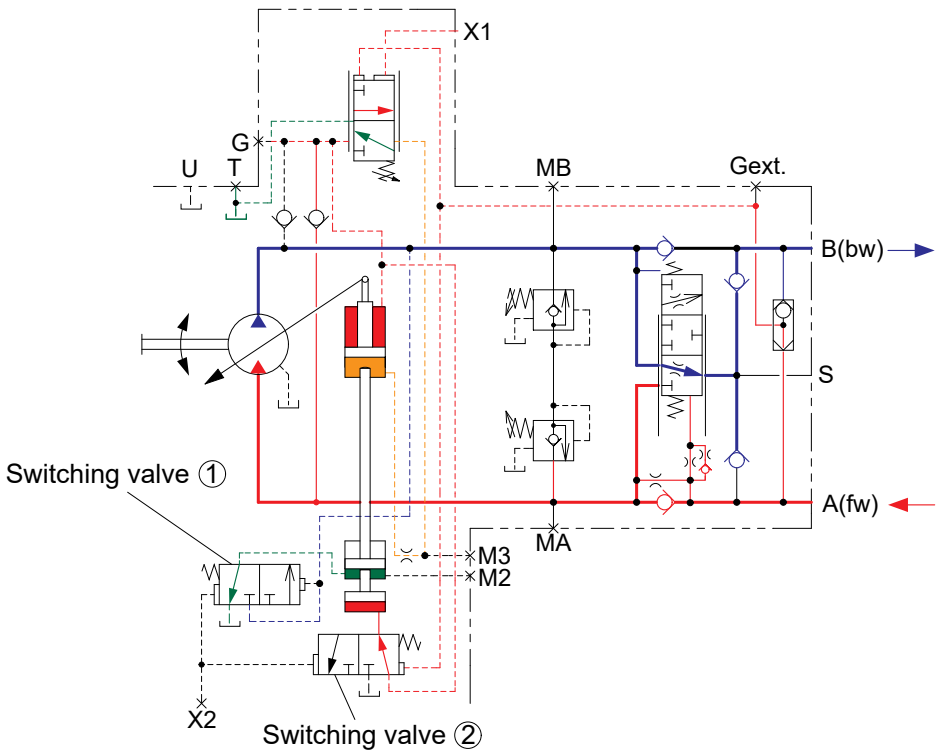


4. RETARDING FUNCTION

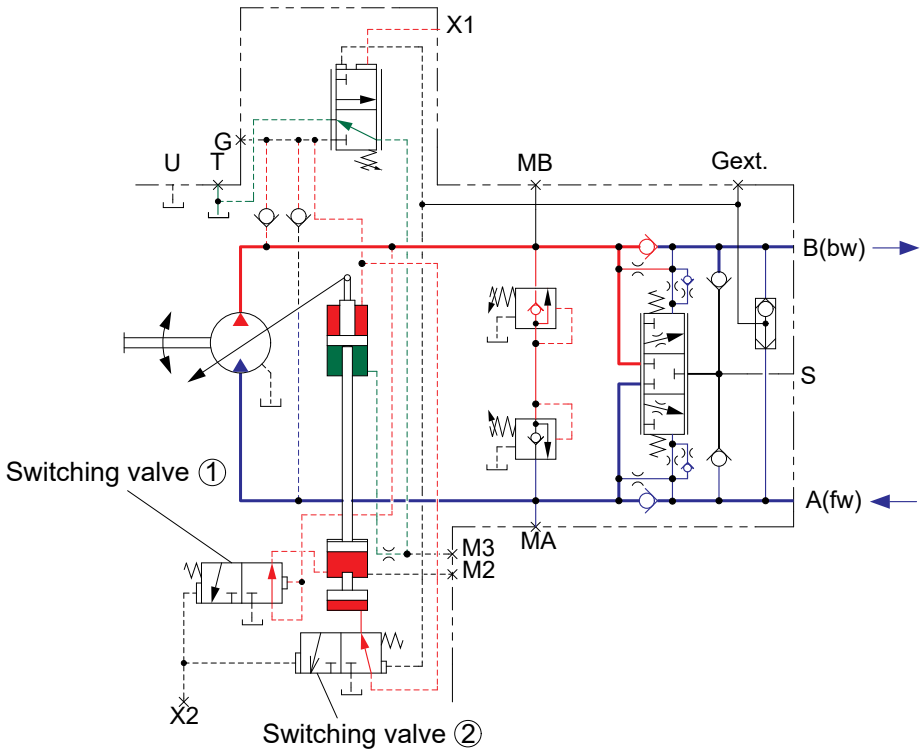
When the travel motor operates as a pump at putting on a brake or going down a hill, it causes braking pressure (counter pressure). By using this braking pressure, the displacement will be a little bit larger, which results in a better braking performance. We call that retarding function.
Because there are some concerns that the cavitation occurs when the variation of the displacement is large, it is necessary to select the proper displacement (Qmid) with considering the conditions and the feeling over the real machine.

In running at port A pressurized (Fig TR07), the pressure at port MB becomes a high pressure at the brake. When that pressure exceeds the setting pressure of the switching valve ①, the switching valve ① shifts and the high pressure line connects with port M2. This causes the control piston to move toward the larger swivel angle and thus the displacement becomes a middle displacement (Qmid) (Fig TR08). In this case, the pressure at port X2 is unloaded.
We recommend that the pressure at the start of swivel be about 2 MPa lower than the setting pressure of the switching valve ① and the setting pressure of relief valve be about 4 MPa higher than the setting pressure of the switching valve ①. Furthermore, by pressurizing port X2, the switching valve ① is kept off-state and the displacement doesn't changes (Fig TR09).
※ : The switching valve ② has the function to select the displacement in proportion to the gear ratio (first gear or second gear), by pressurizing port X2, the switching valve ② becomes on-state and the minimum displacement at first gear is selected.

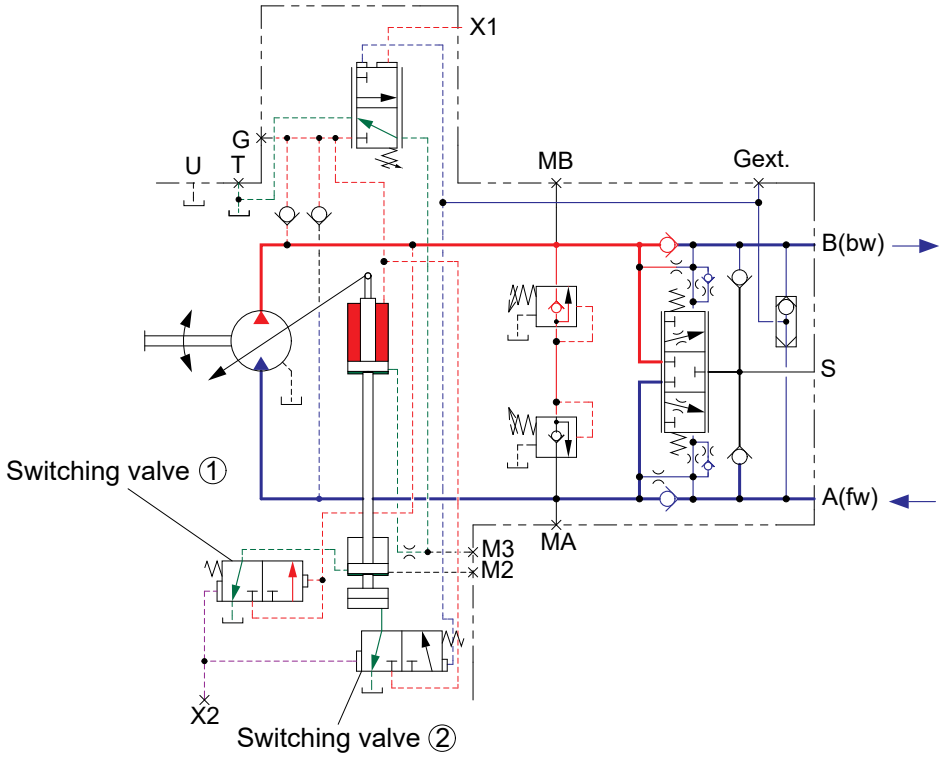
1) IN RUNNING : Port X2 : unloaded



2) **IN BRAKING** : Port X2 : unloaded



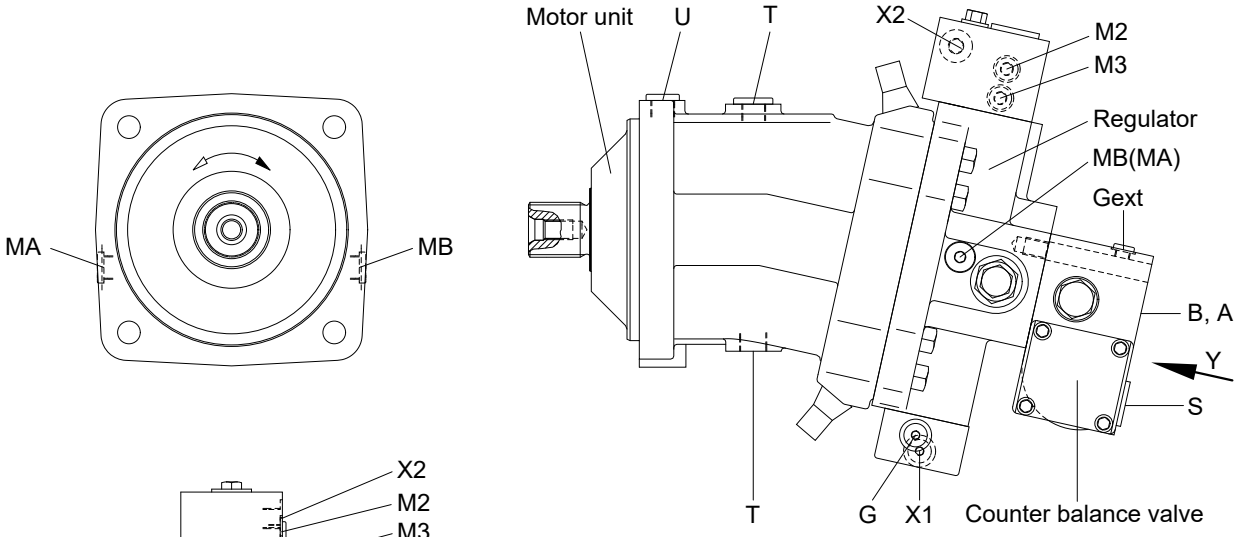
3) **IN BRAKING** : Port X2 : pressurized

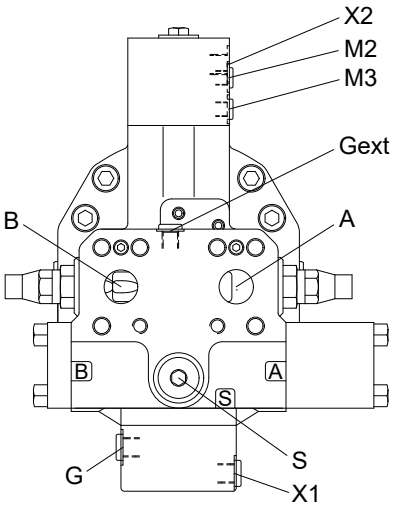


GROUP 4 TRAVEL MOTOR (#0407-)

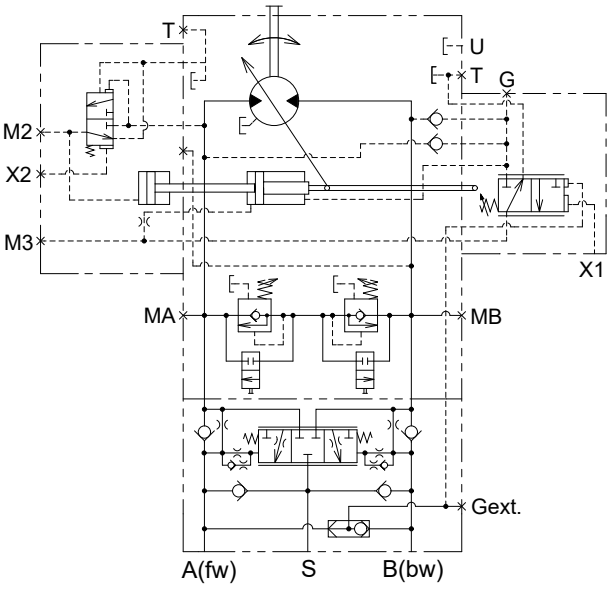
1. CONSTRUCTION

Travel motor consists motor unit, regulator and counter balance valve.





VIEW Y

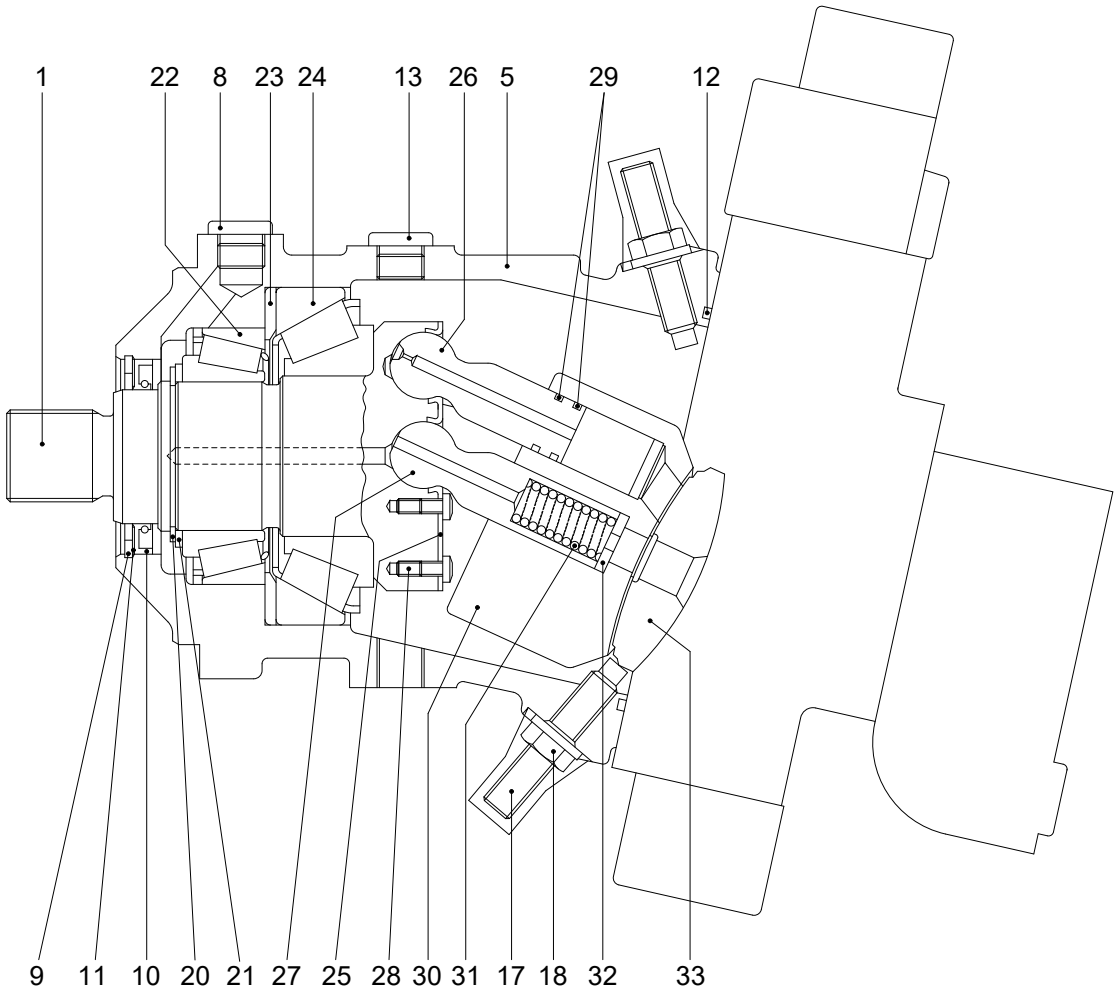


Hydraulic circuit

140W9A2TR01

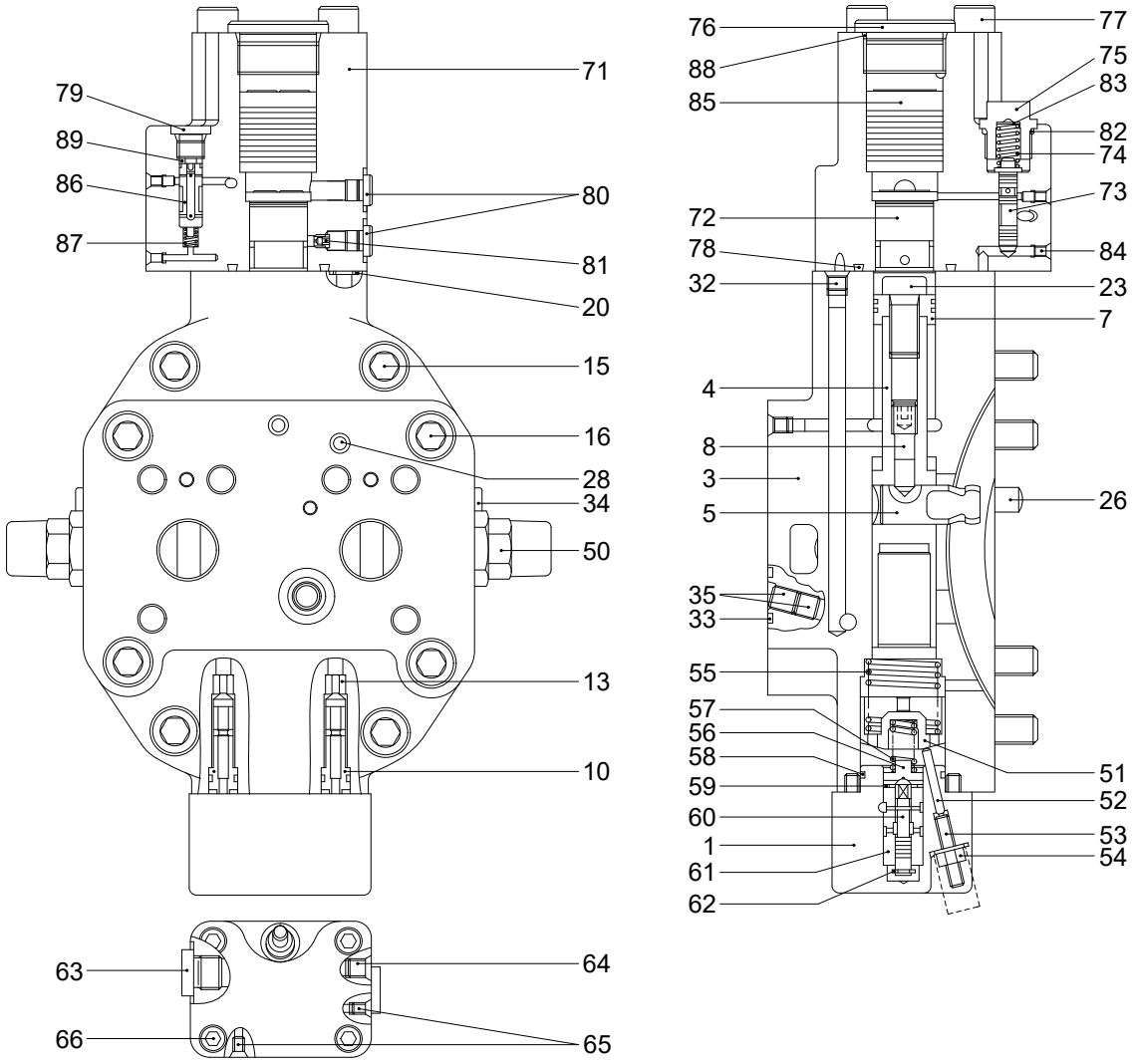
Port	Port name	Port size
A, B	Main port	SAE 1"
G	N.A	M14×1.5-12
M1	Gauge port	M14×1.5-12
X1	Pilot pressure port	M14×1.5-12
X2	Pilot pressure port	M14×1.5-11.5
T	Drain port	PF 1/2-16
U	Flushing port	PF 1/2-16
S	Make up port	M27×2.0-14
MA, MB	Gauge port	M18×1.5-12
M2, M3	Gauge port	M10×1.0-8
Gext	Brake release port	M12×1.5-12.5

1) MOTOR UNIT



1	Drive shaft	17	Threaded pin	26	Piston
5	Housing	18	Seal lock nut	27	Center pin
8	Locking screw	20	Retaining ring	28	Pan head screw
9	Retaining ring	21	Back up plate	29	Steel sealing ring
10	Shaft seal ring	22	Taper roller bearing	30	Cylinder block
11	Back up plate	23	Shim	31	Pressure spring
12	O-ring	24	Taper roller bearing	32	Adjustment shim
13	Locking screw	25	Retaining plate	33	Control lens

2) REGULATOR



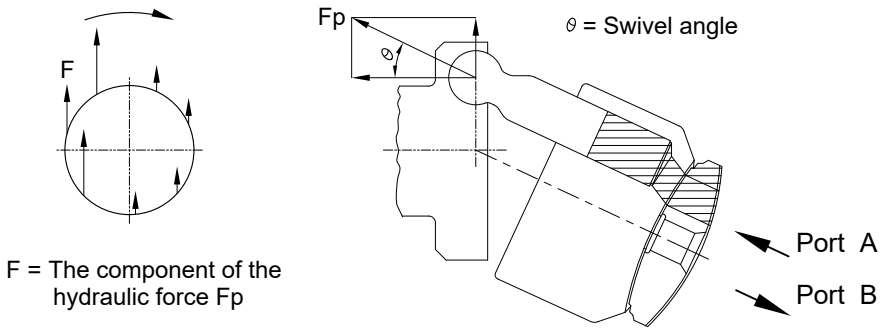
1	Control housing	50	Relief valve	72	Piston
2	Stroke limiter	51	Adjusting bushing	73	Control piston
3	Port plate	52	Cylinder pin	74	Pressure spring
4	Positioning piston	53	Threaded pin	75	Locking screw
5	Positioning trunnion	54	Seal lock nut	76	Locking screw
7	Piston	55	Pressure spring	77	Socket head screw
8	Threaded pin	56	Spring collar	78	O-ring
10	Check valve	57	Pressure spring	79	Locking screw
13	Valve seat	58	O-ring	80	Locking screw
15	Socket head screw	59	Retaining ring	81	Orifice
16	Socket head screw	60	Control piston	82	O-ring
20	O-ring	61	Control bushing	83	Shim
23	Socket head screw	62	Retaining disc	84	Double break off pin
26	Cylinder pin	63	Locking screw	85	Piston
28	Double break off pin	64	Double break off pin	86	Control piston
32	Double break off pin	65	Double break off pin	87	Pressure spring
33	O-ring	66	Socket head screw	88	O-ring
34	Locking screw	71	Housing	89	Shim

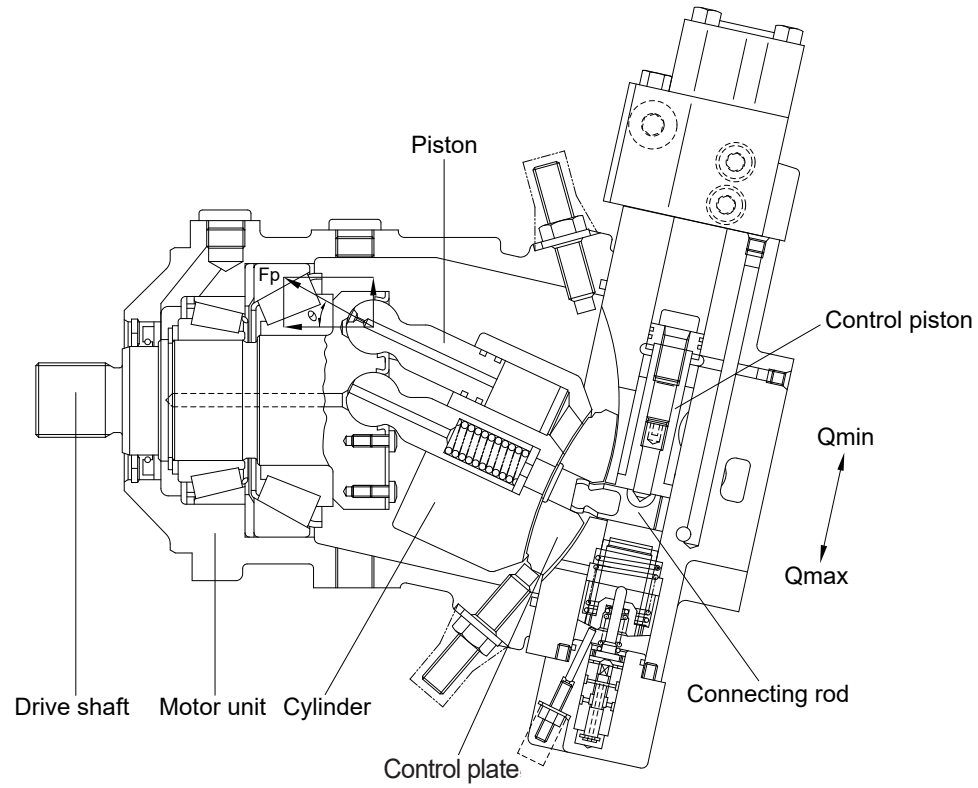
2. TRAVEL MOTOR FUNCTION

The direction of the drive shaft rotation is dependent on which is the port, port A or port B, the pressure oil shall be connected to.

When the pressure oil is led into the cylinder in which seven pistons are flexibly mounted in a circular formation, pistons press the shaft and set it in rotation. One piston travels one stroke during one rotation, which results in that oil is sucked and discharged. As each of seven pistons continuously acts such movement in turn, the drive shaft can do rotary movement smoothly. The component of the hydraulic force acting on the piston produces turning effect. Therefore, as the swivel angle becomes larger, the turning effect becomes larger. In addition, as the travel angle becomes larger, the displacement becomes larger, which results in that the operating speed becomes slower.

The control plate is connected to the control piston by means of the connecting rod, and the swivel angle is dependent on the position of the control piston.





3. REGULATOR FUNCTION

HA function

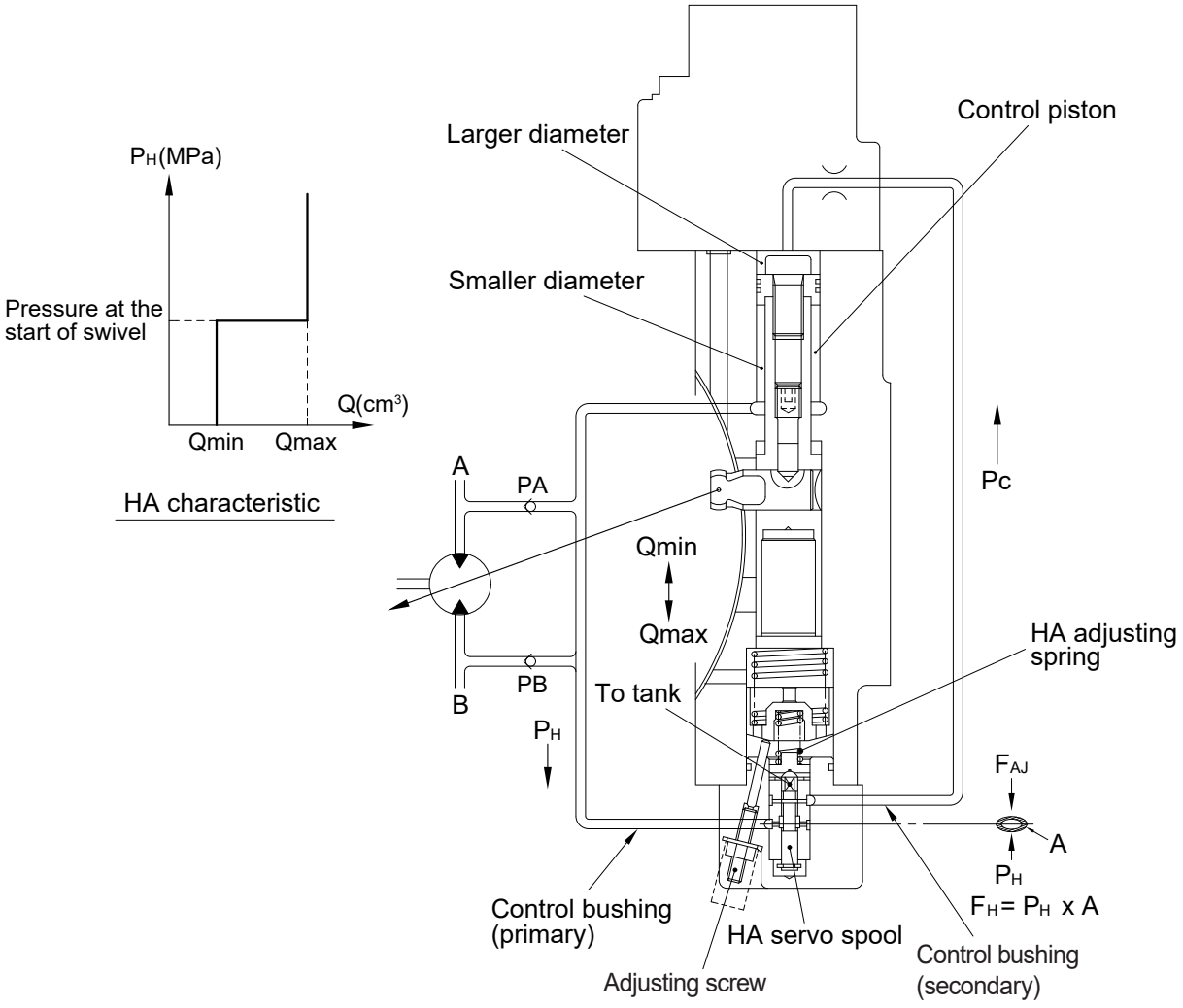
By sensing the load, the displacement varies.

HA operation

The high pressure PH at the either side of port A or port B is selected by the shuttle valve fitted in the counter balance valve, and it is led into the smaller diameter of the control piston and the spool.

If the circuit pressure value is lower than the pressure value at the start of swivel, the control pressure Pc acting on the larger diameter of the control piston becomes zero, and thus the swivel angle is the minimum. On the contrary, if the circuit pressure value is higher than the pressure value at the start of swivel, the spool is shifted and the control pressure increases, which causes the control piston to move toward the larger swivel angle.

The traveling speed is variable in proportion to the load pressure, by means of the function above. When the load pressure is high, for example, at starting or at climbing a slope, the swivel angle is set to be the maximum, and the torque is be the maximum. And as the load pressure drops down, the swivel angle is getting smaller, which results in higher speed of traveling. When the load pressure is low, for example, traveling on the flat, the swivel angle is set to be the minimum, which results in the maximum speed of traveling.

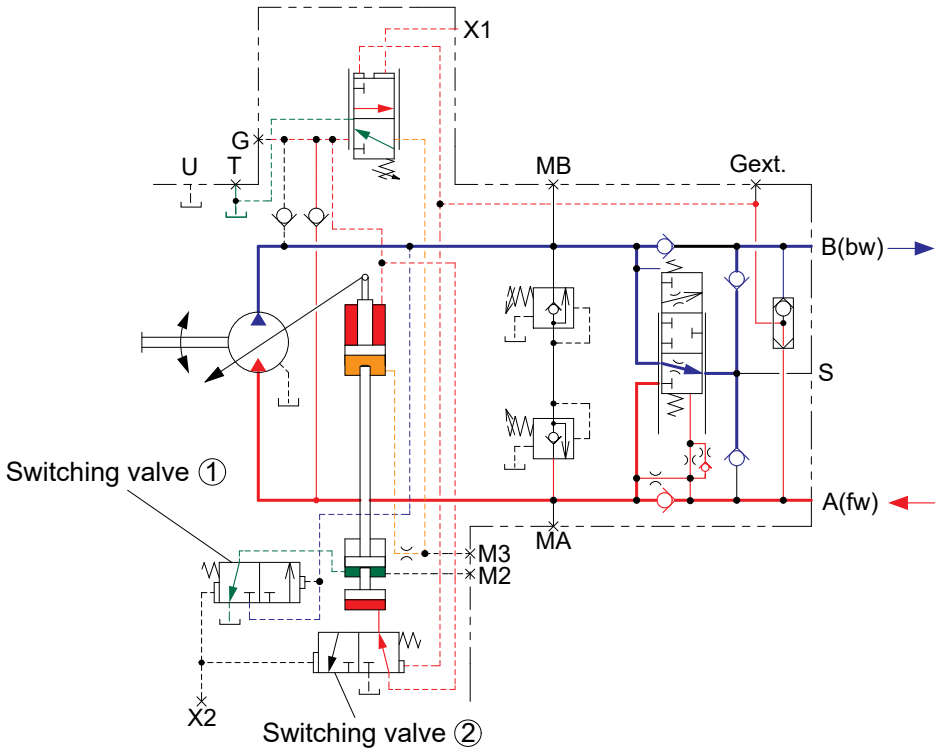


4. RETARDING FUNCTION

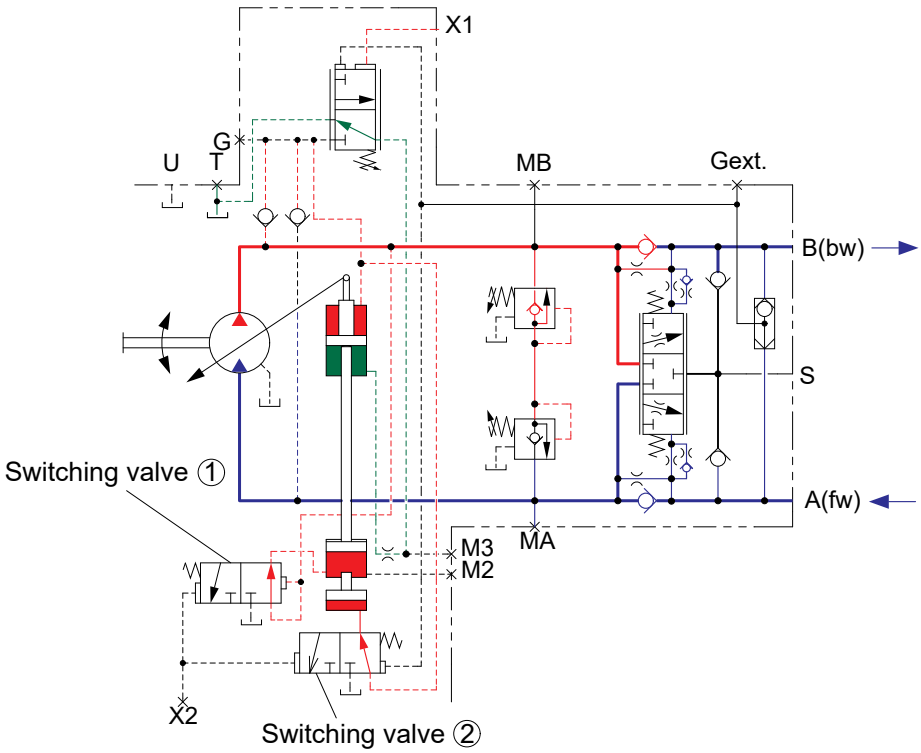
When the travel motor operates as a pump at putting on a brake or going down a hill, it causes braking pressure (counter pressure). By using this braking pressure, the displacement will be a little bit larger, which results in a better braking performance. We call that retarding function.
Because there are some concerns that the cavitation occurs when the variation of the displacement is large, it is necessary to select the proper displacement (Qmid) with considering the conditions and the feeling over the real machine.

In running at port A pressurized (Fig TR07), the pressure at port MB becomes a high pressure at the brake. When that pressure exceeds the setting pressure of the switching valve ①, the switching valve ① shifts and the high pressure line connects with port M2. This causes the control piston to move toward the larger swivel angle and thus the displacement becomes a middle displacement (Qmid) (Fig TR08). In this case, the pressure at port X2 is unloaded.
We recommend that the pressure at the start of swivel be about 2 MPa lower than the setting pressure of the switching valve ① and the setting pressure of relief valve be about 4 MPa higher than the setting pressure of the switching valve ①. Furthermore, by pressurizing port X2, the switching valve ① is kept off-state and the displacement doesn't changes (Fig TR09).
※ : The switching valve ② has the function to select the displacement in proportion to the gear ratio (first gear or second gear), by pressurizing port X2, the switching valve ② becomes on-state and the minimum displacement at first gear is selected.

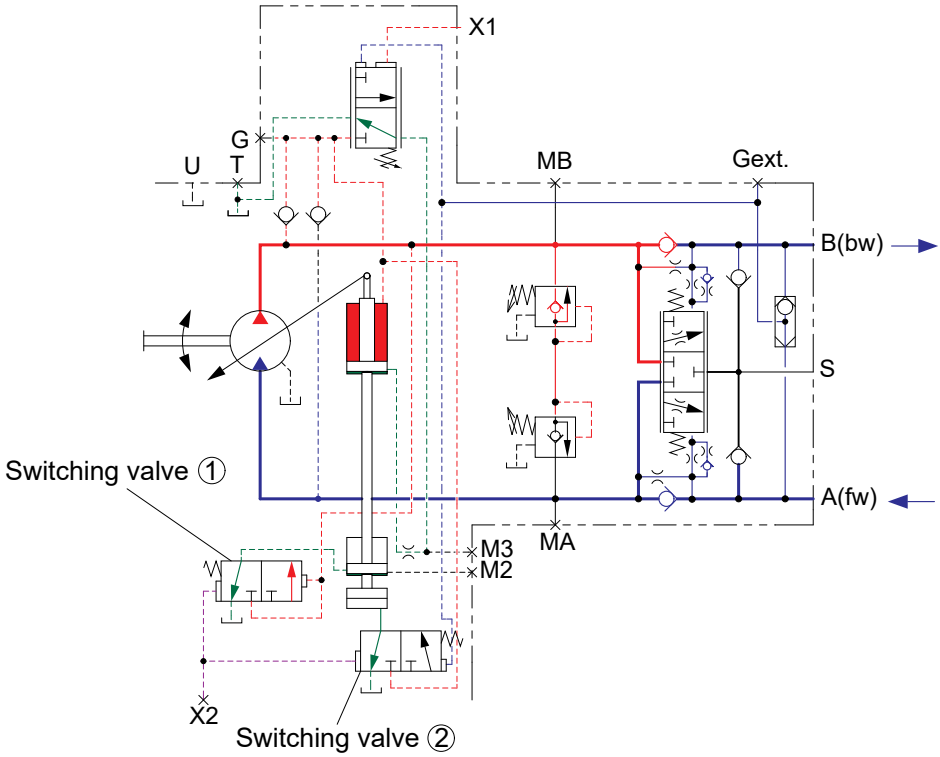
1) IN RUNNING : Port X2 : unloaded



2) **IN BRAKING** : Port X2 : unloaded



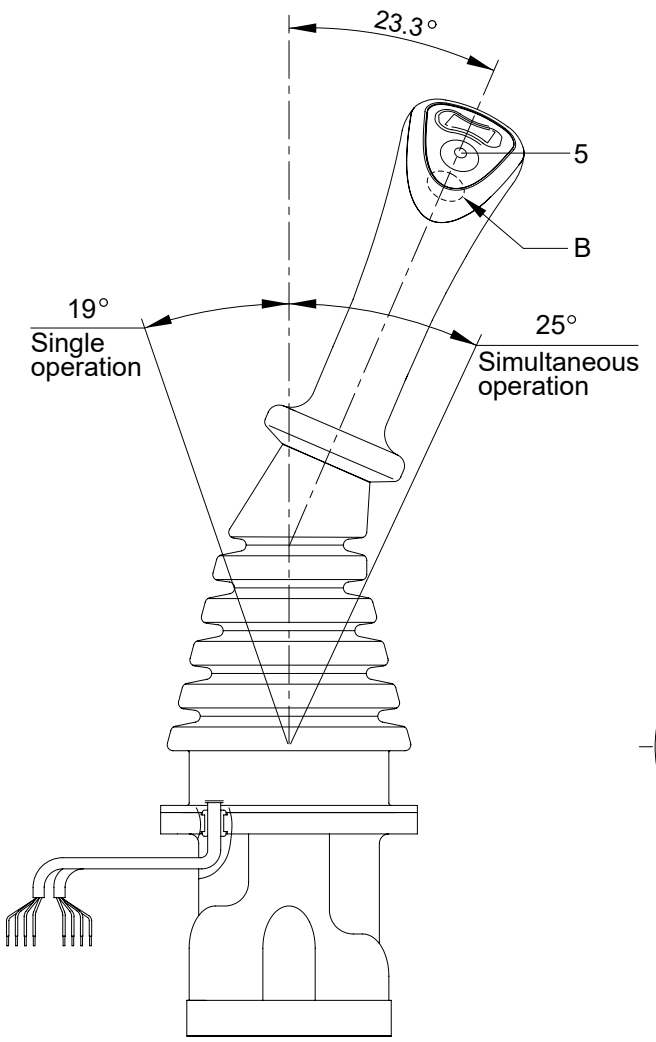
3) **IN BRAKING** : Port X2 : pressurized



GROUP 5 RCV LEVER

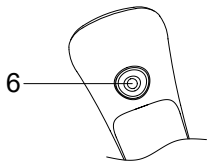
1. STRUCTURE

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

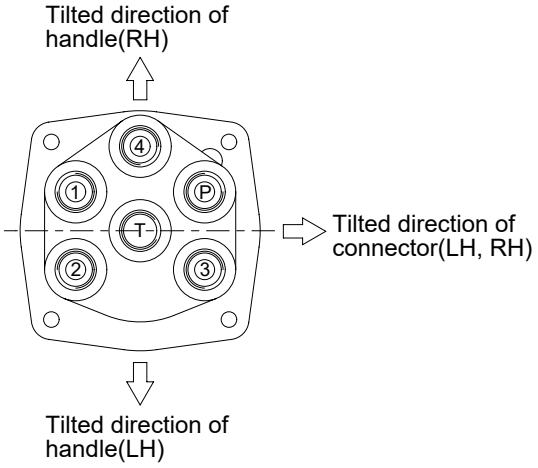


Switches

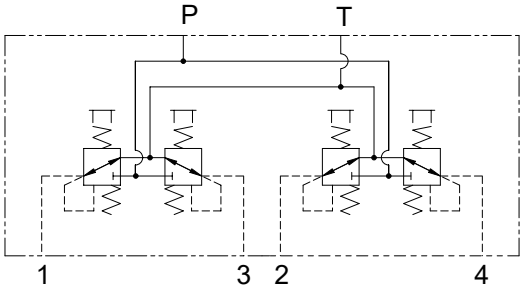
No.	LH	RH
5	One touch decel	Horn
6	Power boost	Breaker



DETAIL B



VIEW A



Hydraulic circuit

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 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

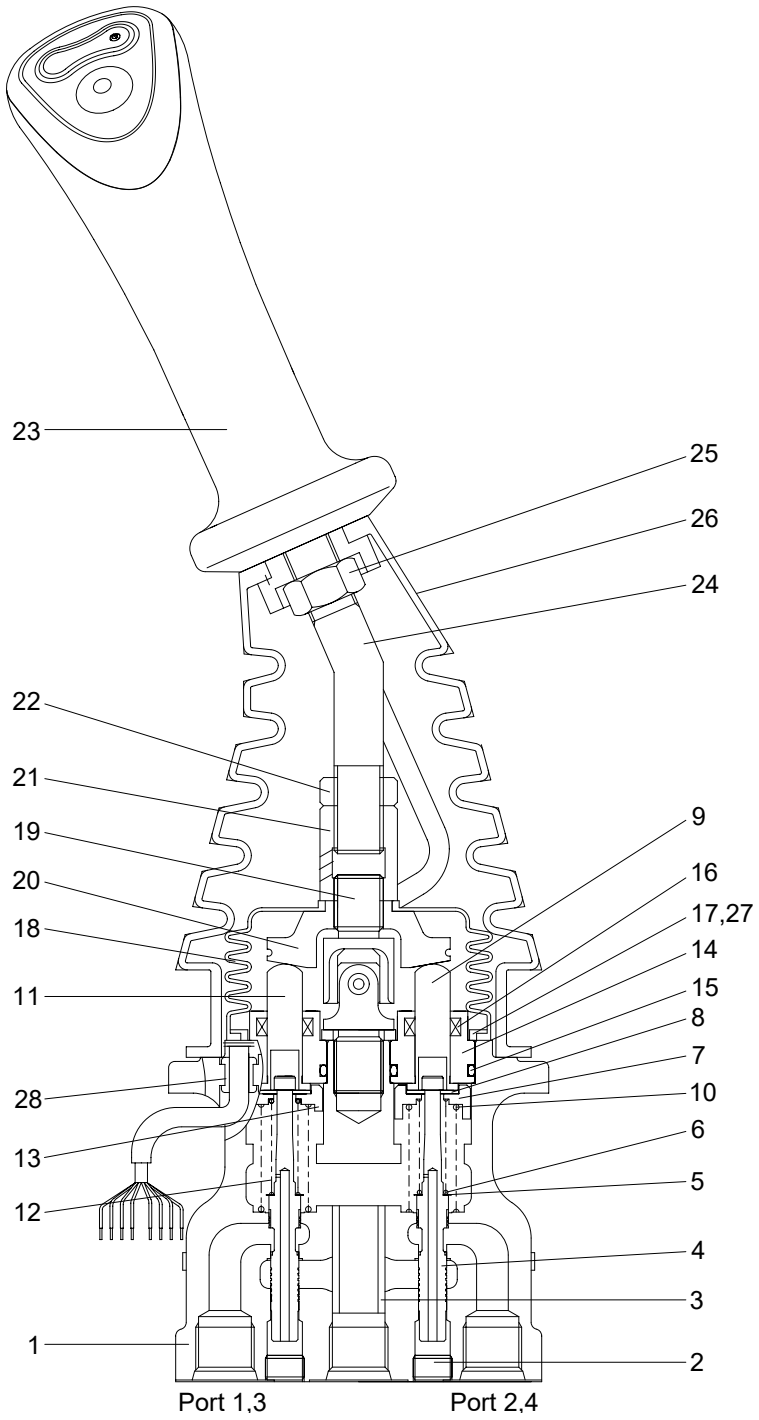
CROSS SECTION

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/cm^2 (depending on the type). The spool is pushed against the push rod (9, 11) by the return spring.

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

CROSS SECTION



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.

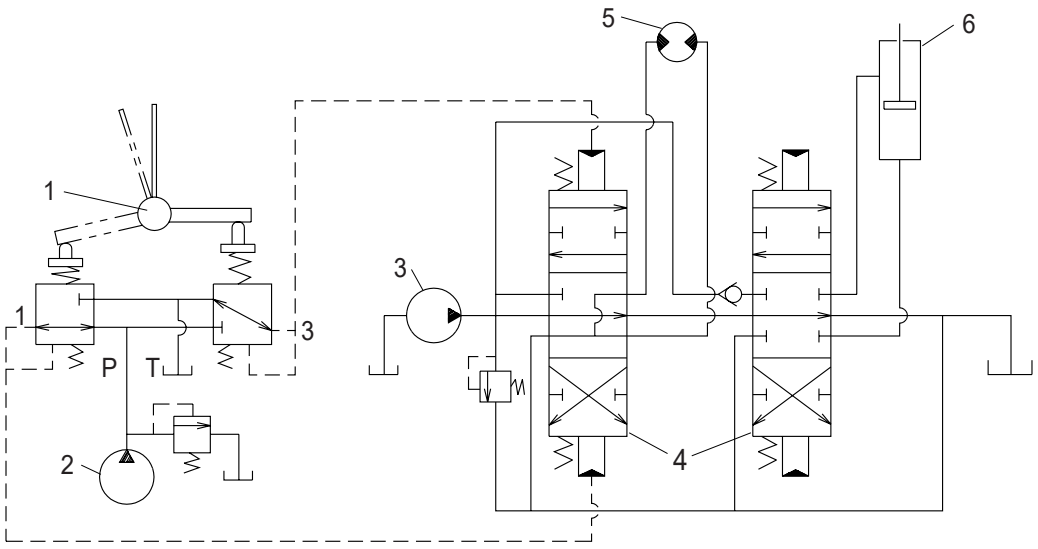
The spring (10) works on the case (1) and spring seat (7, 13) and tries to return the push rod (9,11) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

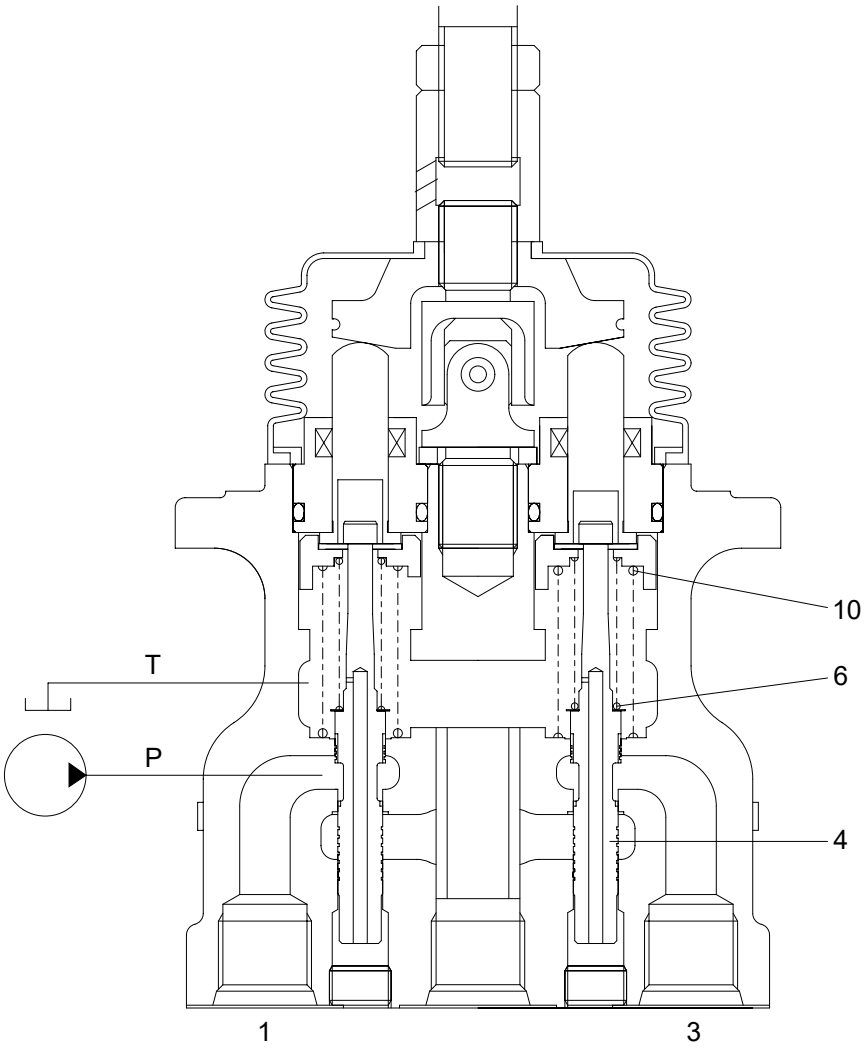
The diagram shown below is the typical application example of the pilot valve.



2-70

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

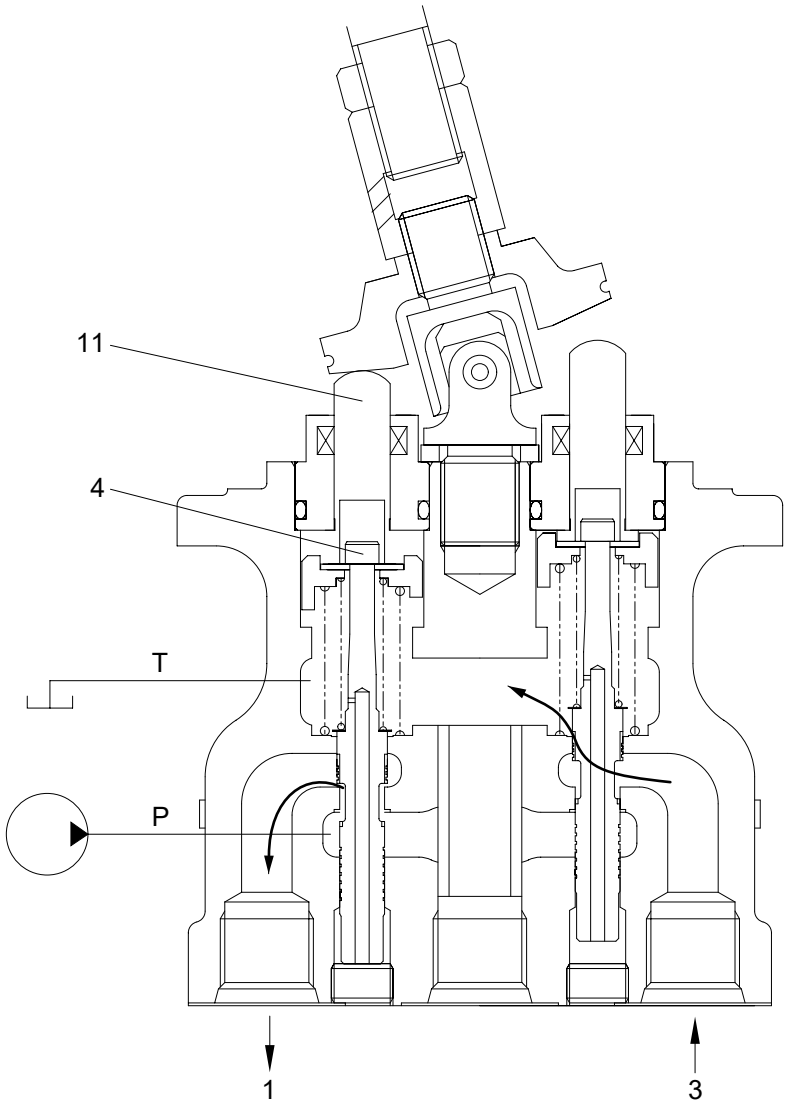
(1) Case where handle is in neutral position



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



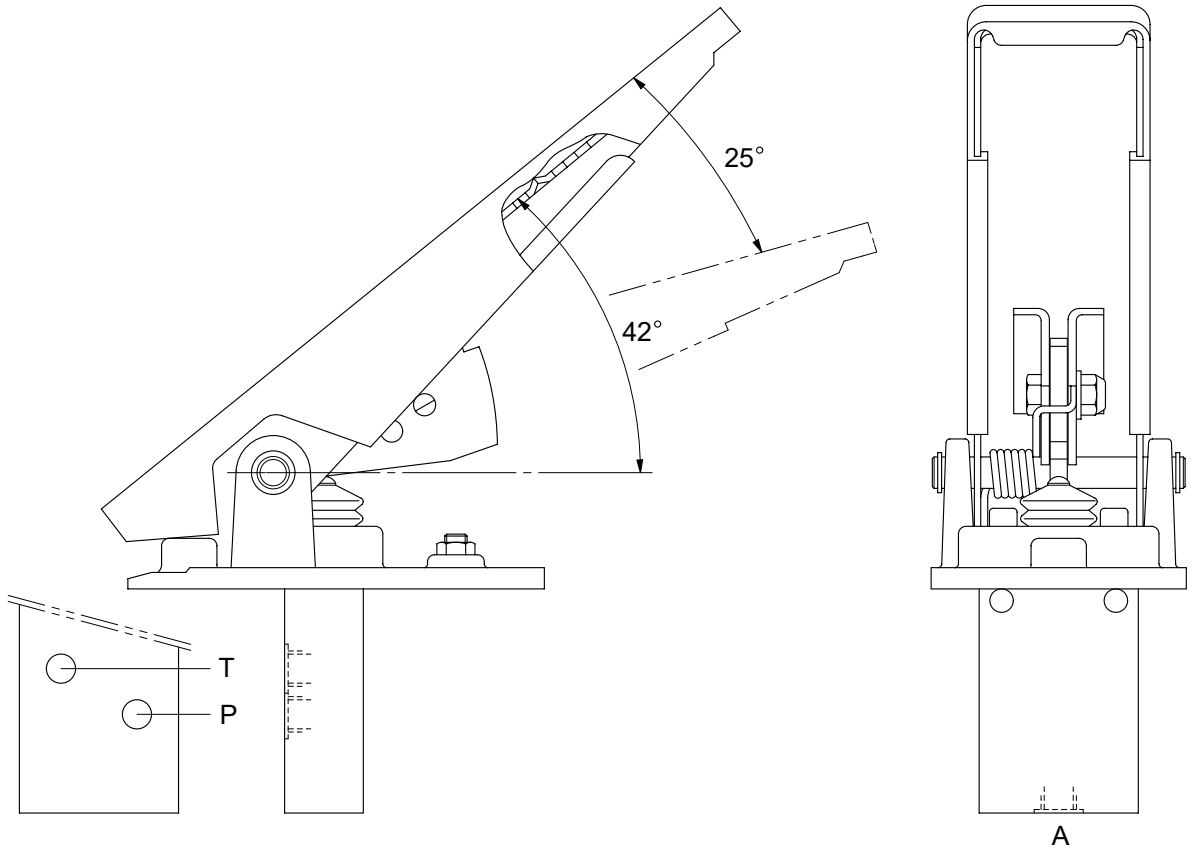
21092RL04

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.

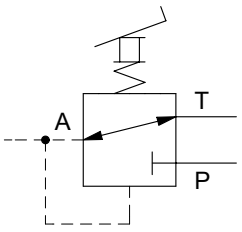
GROUP 6 ACCELERATOR PEDAL

1. STRUCTURE

The casing has the oil inlet port P (primary pressure), and the oil return port T (tank). In addition the secondary pressure is taken out through port A.



17032RP01



Hydraulic circuit

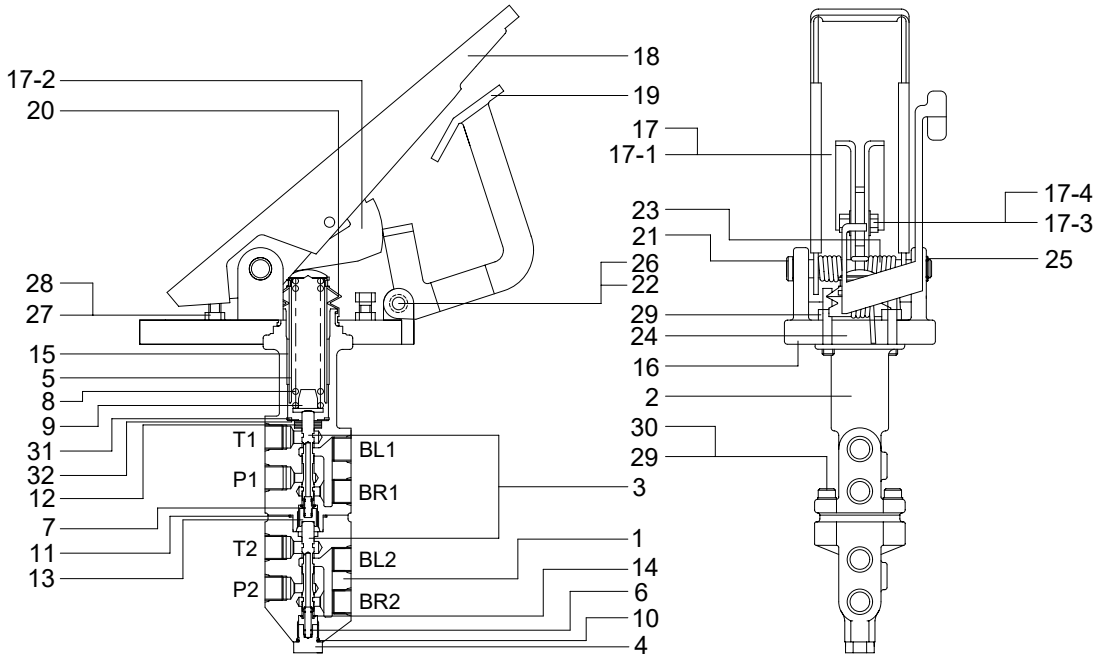
Port	Port name	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
A	Pilot oil output port	

17032RP01(2)

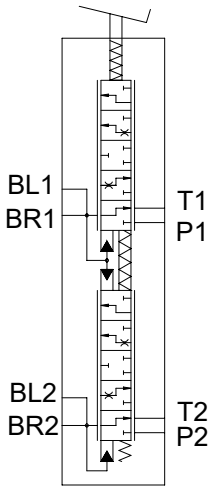
GROUP 7 BRAKE PEDAL (VALVE)

1. STRUCTURE

The casing (spacer) has the oil inlet port A (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.



1	Lower body	13	Spring Guide	21	Lock pin 1
2	Upper body	14	Snap ring	22	Lock pin 2
3	Spool	15	DU bushing	23	Torsion spring 1
4	Plug	16	Pedal plate	24	Torsion spring 2
5	Holder	17	Pedal assy	25	Retainer ring
6	Lower spring	17-1	Pedal	26	E-ring
7	Upper spring	17-2	Lock plate	27	Hex bolt
8	Main spring	17-3	Hex bolt	28	Hex nut
9	Spring retainer	17-4	Plain washer	29	Socket head bolt
10	O-ring	18	Pedal cover	30	Spring washer
11	O-ring	19	Latch	31	Plat washer
12	Oil seal	20	Bellows	32	Retainer ring



14W72BV02

Port	Port name	Port size
P1	Port	PF 3/8
P2	Port	
BR1	Brake cylinder port	
BR2	Brake cylinder port	
BL1	Pluging	
BL2	Pluging	
T1	Drain port	
T2	Drain port	

2. FUNCTION

1) PURPOSE

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

2) READY POSITION

When the braking system is ready for operation, its accumulator pressure acts directly on port P1/P2 of the brake valve. A connection is established between ports BR1/BR2 and port T1/T2 so that the wheel brakes ports BR1/BR2 are pressureless via the returns ports T1/T2.

3) PARTIAL BRAKING

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The spring assembly (8) beneath pedal plate (16) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool (3) is mechanically actuated via spring assembly (8), and the lower spool (3) is actuated hydraulically by spool (3). As spools (3) move downward, they will first close returns T1/T2 via the control edges, thus establishing a connection between accumulator port P1/P2 and ports BR1/BR2 for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools (3) are held in the control position by the force applied (spring assembly) above the spools and the hydraulic pressure below the spool (balance of forces).

After output of the braking pressure, spools (3) are in a partial braking position, causing ports P1/P2 and T1/T2 to close and holding the pressure in ports BR1/BR2.

4) FULL BRAKING POSITION

When pedal (17) is fully actuated, an end position of the brakes is reached and a connection established between accumulator ports P1/P2 and brake cylinder ports BR1/BR2. Returns T1/T2 are closed at this point.

When the braking process ended, a connection is once again established between brake cylinder ports BR1/BR2 and return ports T1/T2, closing accumulator ports P1/P2.

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

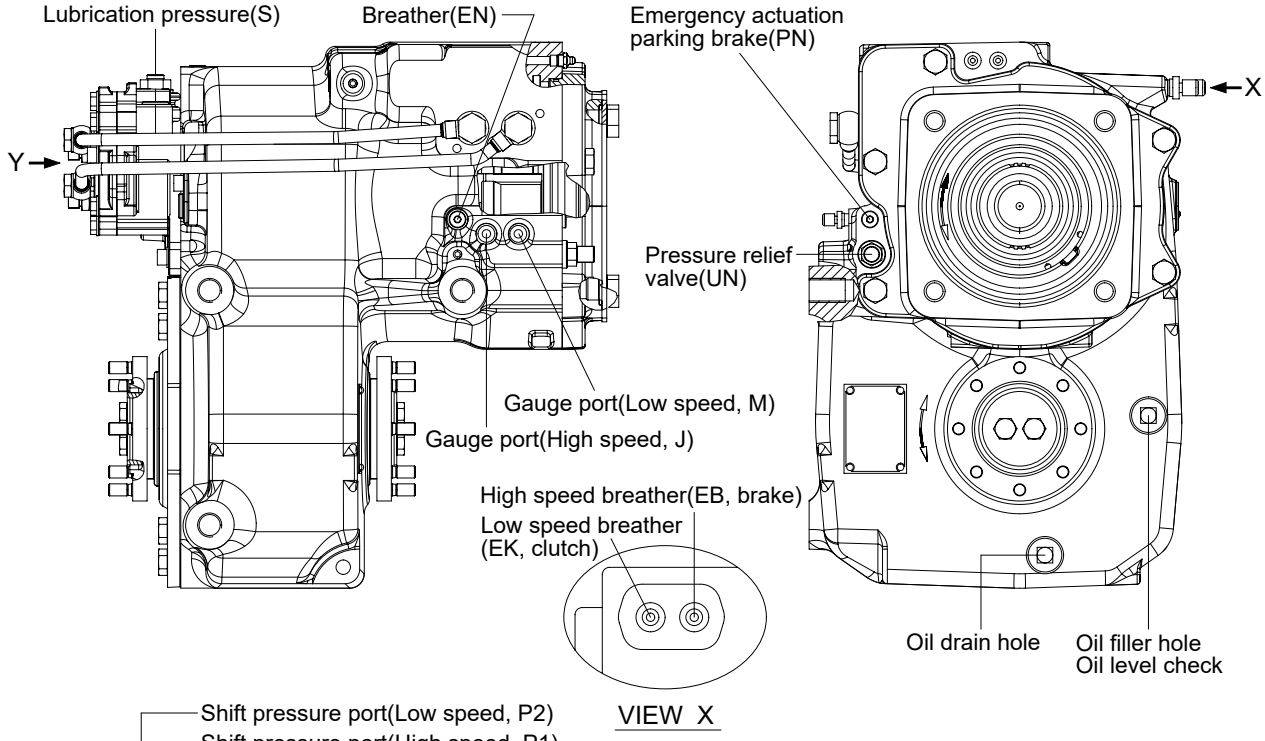
5) LIMITING THE BRAKING PRESSURE

Pedal restriction screw (29) on pedal plate (16) below pedal (17) is used to limit the braking pressure.

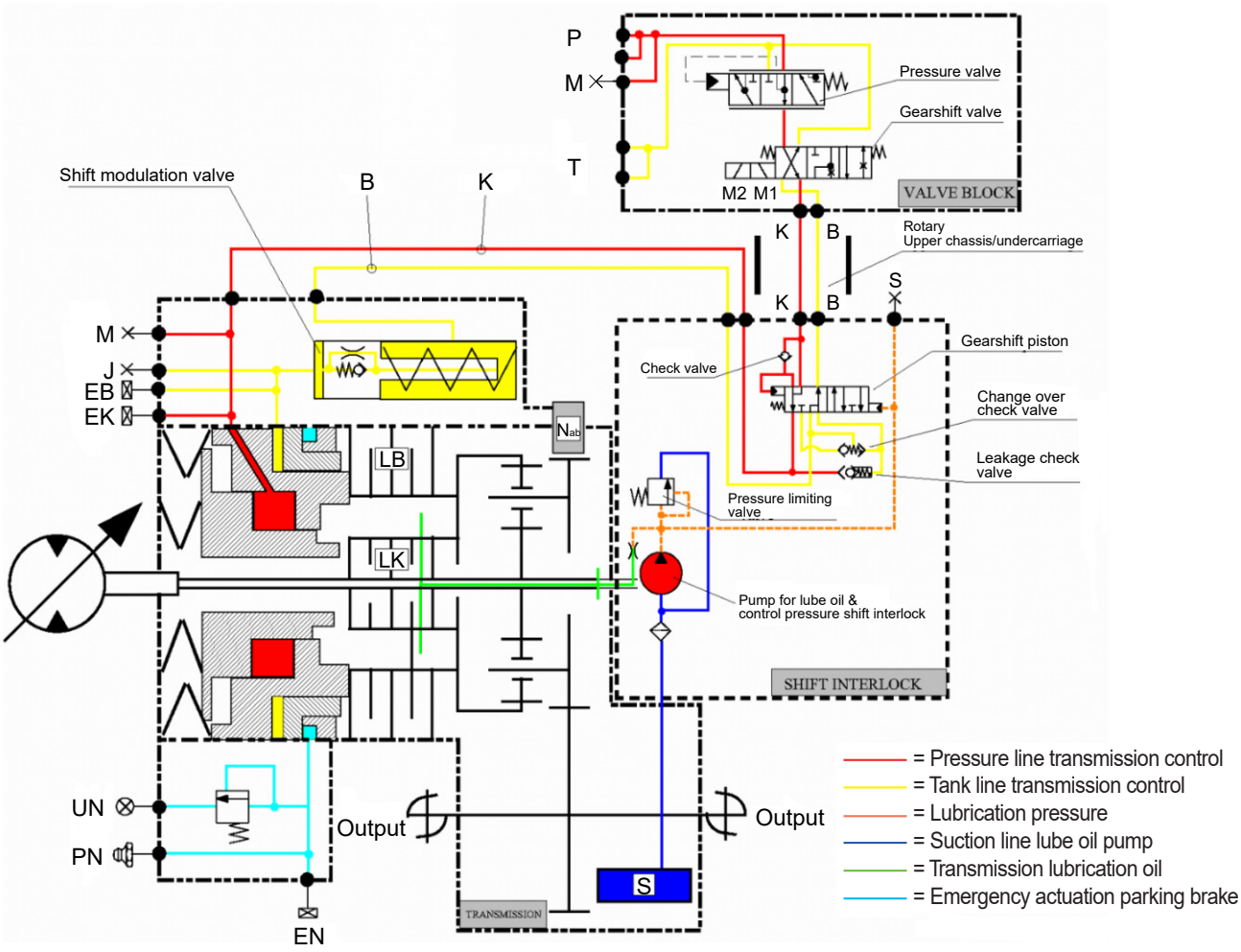
6) FAILURE OF A CIRCUIT

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (8) will mechanically actuate spool (3). In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool (3) is mechanically actuated by spring assembly (8) and spool (3).

1. STRUCTURE


Lubrication pressure(S)
Breather(EN)
Emergency actuation parking brake(PN)
Y
X
Pressure relief valve(UN)
Gauge port(Low speed, M)
Gauge port(High speed, J)
High speed breather(EB, brake)
Low speed breather (EK, clutch)
Oil drain hole
Oil filler hole
Oil level check
VIEW X
Shift pressure port(Low speed, P2)
Shift pressure port(High speed, P1)
K
B
Speed transmitter(N)
VIEW Y

2. TRANSMISSION DIAGRAM



Measuring points-Transmission/Shift interlock :
J : High speed (brake)
M : Low speed (clutch)
S : Lubrication pressure

Connections-Transmission/Shift interlock :
B : Brake
K : Clutch
PN : Emergency actuation parking brake

Measuring points-Valve block :
M : System pressure transmission control

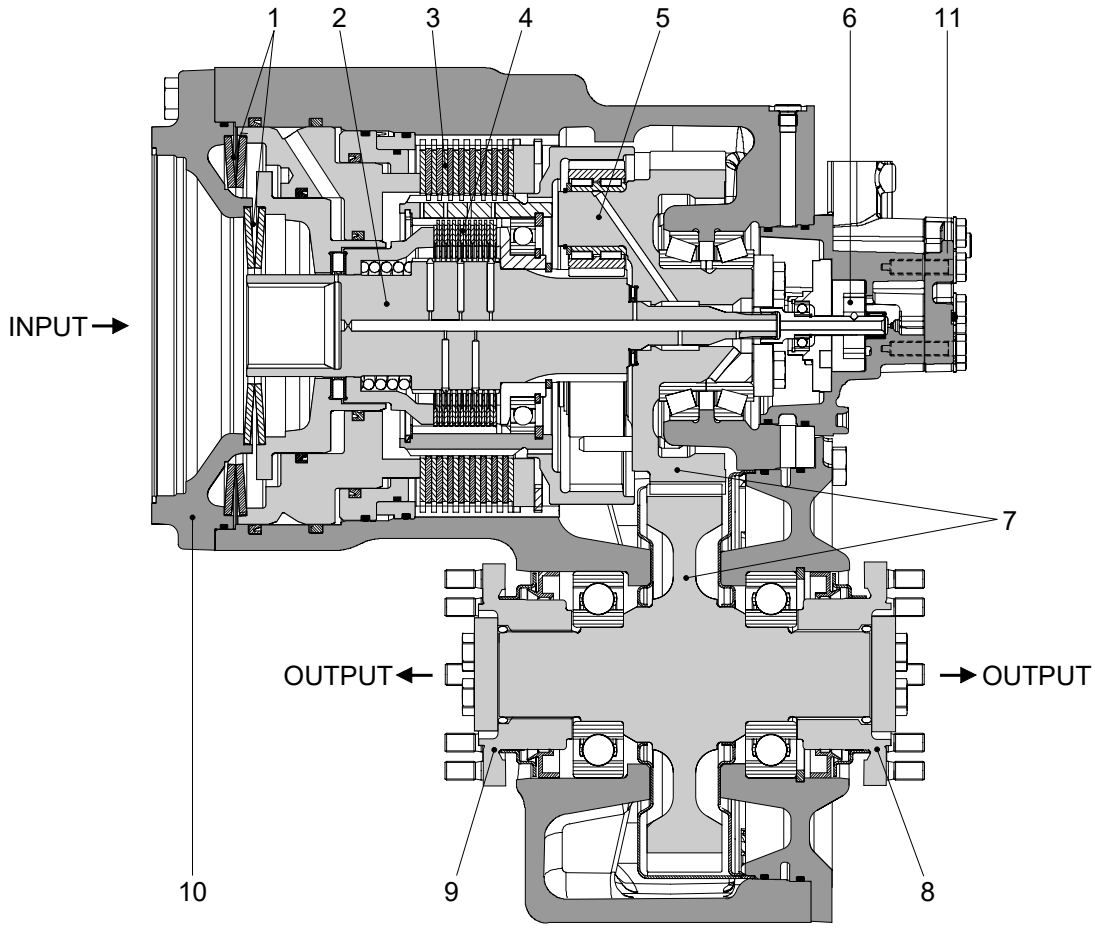
Connections-Valve block :
P : System pressure transmission control
T : Tank
B : Brake
K : Clutch

Solenoid valves-valve block :
M1 : Solenoid valve (low speed)
M2 : Solenoid valve (high speed)

Port	Name	Size	Port	Name	Size
P1 (B)	Shift pressure, High speed	M16×1.5	M	Gauge port, Low speed	M10×1.0
P2 (K)	Shift pressure, Low speed	M16×1.5	S	Lubrication pressure port	M10×1.0
J	Gauge port, High speed	M10×1.0	PN	Parking brake lubricant	Grease nipple

3. OPERATION OF TRANSMISSION

1) DESCRIPTION



1	Cup spring	5	Planetary drive	9	Output flange-Front axle
2	Input shaft	6	Lub oil pump	10	Travel motor attachment
3	Disk brake	7	Spur gear drive	11	Shift interlock
4	Disk clutch	8	Output flange-Rear axle		

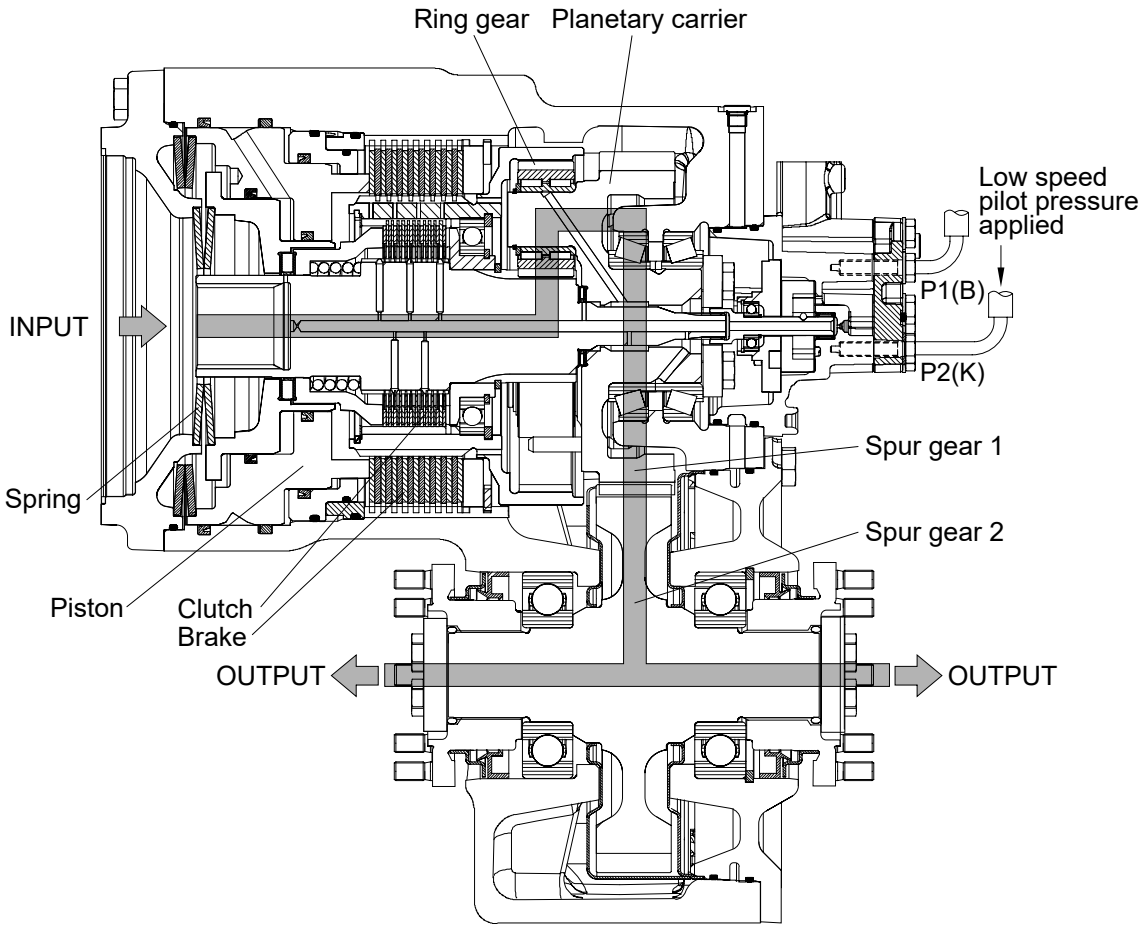
Coaxially-mounted variable displacement travel motor (10) with specific displacement 107 cm^3/rev.

The 2-speed powershift transmission comprises a planetary drive (5), a 2 shaft spur gear drive (7) with output flanges to front and rear axle.

The powershift mechanism for the planet drive comprises a rotating multi-disk clutch (4) underneath a multi-disk brake (3) rigidly connected to the housing. Both are closed by spring pressure (2) and released hydraulically.

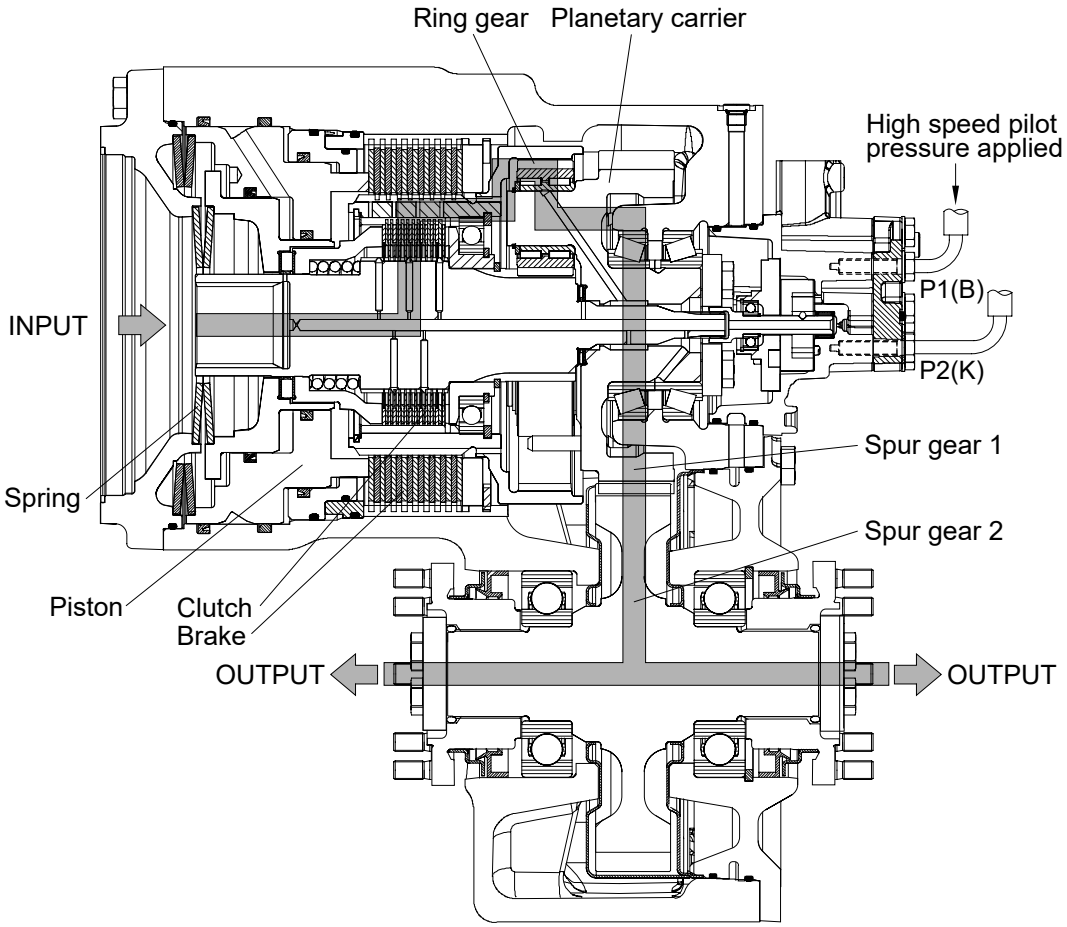
The shift interlock (11) prevents downshifts at high machine speeds and thus prevents over-rotation of the travel motor. If the low speed gear is selected while the high speed gear is engaged and input speed is above approx. 1000rpm, the low speed gear shift is inhibited and only performed if input speed is below this limit. With higher viscosity oil (cold starting), the downshift is performed at a lower input speed. Upshifts are always possible.The speed-dependent interlock is effective in both directions. It does not prevent the possibility of over-rotation when the machine is coasting. For this, a drive brake valve should be fitted to the travel motor.

2) LOW SPEED (forward & reverse)



In low speed operation, the internal gear of the planetary drive is backing upon the closed, case-rigid brake. In this speed the piston chamber of the brake is unpressurized, so that the elastic force and additionally the hydraulic pressure of the clutch piston is acting upon the disk pack.
At this time the clutch is open, i.e. the hydraulic released.

3) HIGH SPEED (forward & reverse)



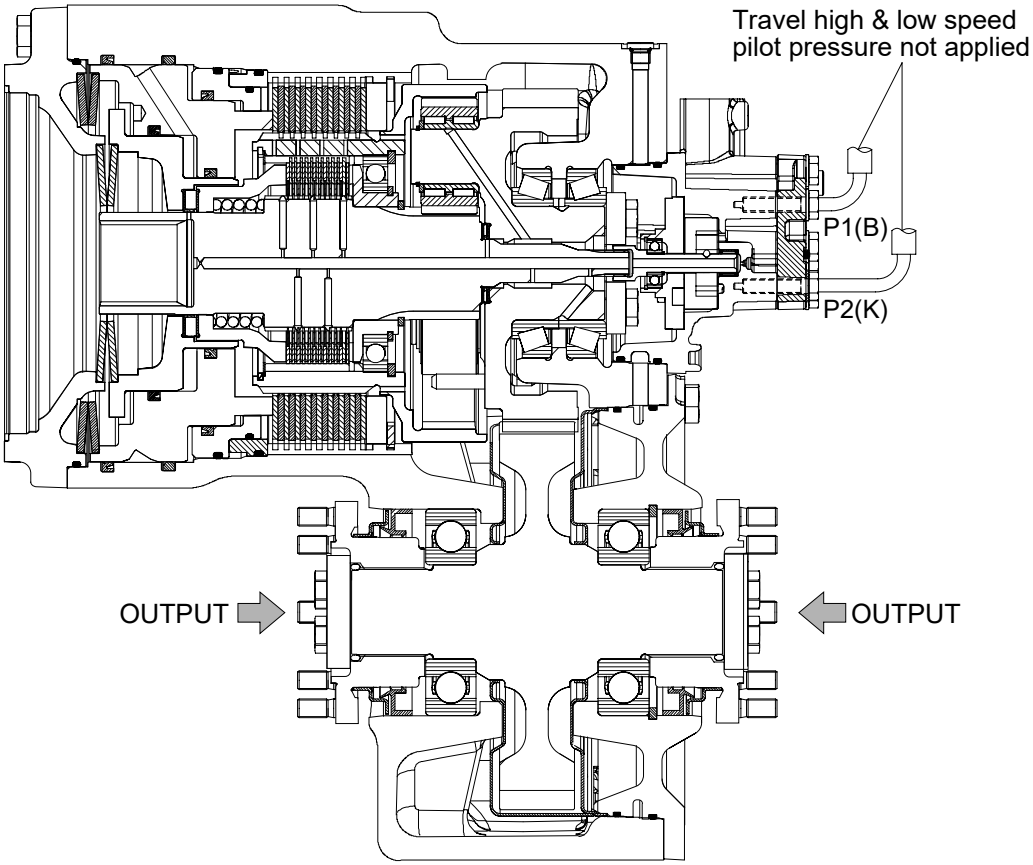
In high speed operation, the clutch is held closed under spring pressure and the brake is hydraulically opened.

When a gear shift occurs-for example from high speed to low speed gear- the oil from the brake piston space is fed back to the tank through a restrictor (change over check valve) due to the spring pressure acting on the brake piston. At the same time the clutch is filled with oil and opened. Required oil flow is necessary for the transmission control to ensure the clutch is open before the brake begins to transmit torque.

A shift modulation valve is also integrated in the transmission. This modulates the pressure sequence at the brake during a upshift in order to achieve good shift quality.

The gear shift equipment also has the function of a parking brake. When the brake is operated-for example with high speed gear engaged-the clutch is closed and is statically loaded.

4) BRAKES



When the travel high/low speed pilot pressure is not applied in the piston space, the piston compress against the multi disk pack due to the spring force. Thus the parking brake is engaged.

4. TECHNICAL DATA

1) GENERAL DATA

(1) Max input power : 110 kW

(2) Max input torque : 78.5 kgf · m

(3) Max output speed : 3500 rpm

(4) Hydraulic motor : 140 cm^3/rev

(5) Transmission ratio
Gear step : 4.06
· Low speed gear : 4.87
· High speed gear : 1.20

(6) Shift interlock
Downshift possible at operating temperature with input speed 1000rpm (downshift point lower when oil temperature cold).

(7) Disconnection device
For towing away machine auxiliary release device for parking brake.

(8) Brake
Parking brake. Necessary brake deceleration by controlled locking of planetary drive. Braking torque depends on opening pressure set at brake valve (13 bar).

(9) Output flange
Bolts for propshaft connection : M10 × 1.0 (class 10.9)

(10) Transmission weight : 135kg

2) TRANSMISSION CONTROL

Following data are valid for oil temperature 30°C to 40°C in hydraulic tank, measured at connections at powershift transmission (see structure and diagram).

(1) Control pressure
① At connection P1 and P2 at Low/High engine speed : 33+1 kgf/cm^2
② Definition of lubricants : API GL-5, SAE 10W-30, 15W-40

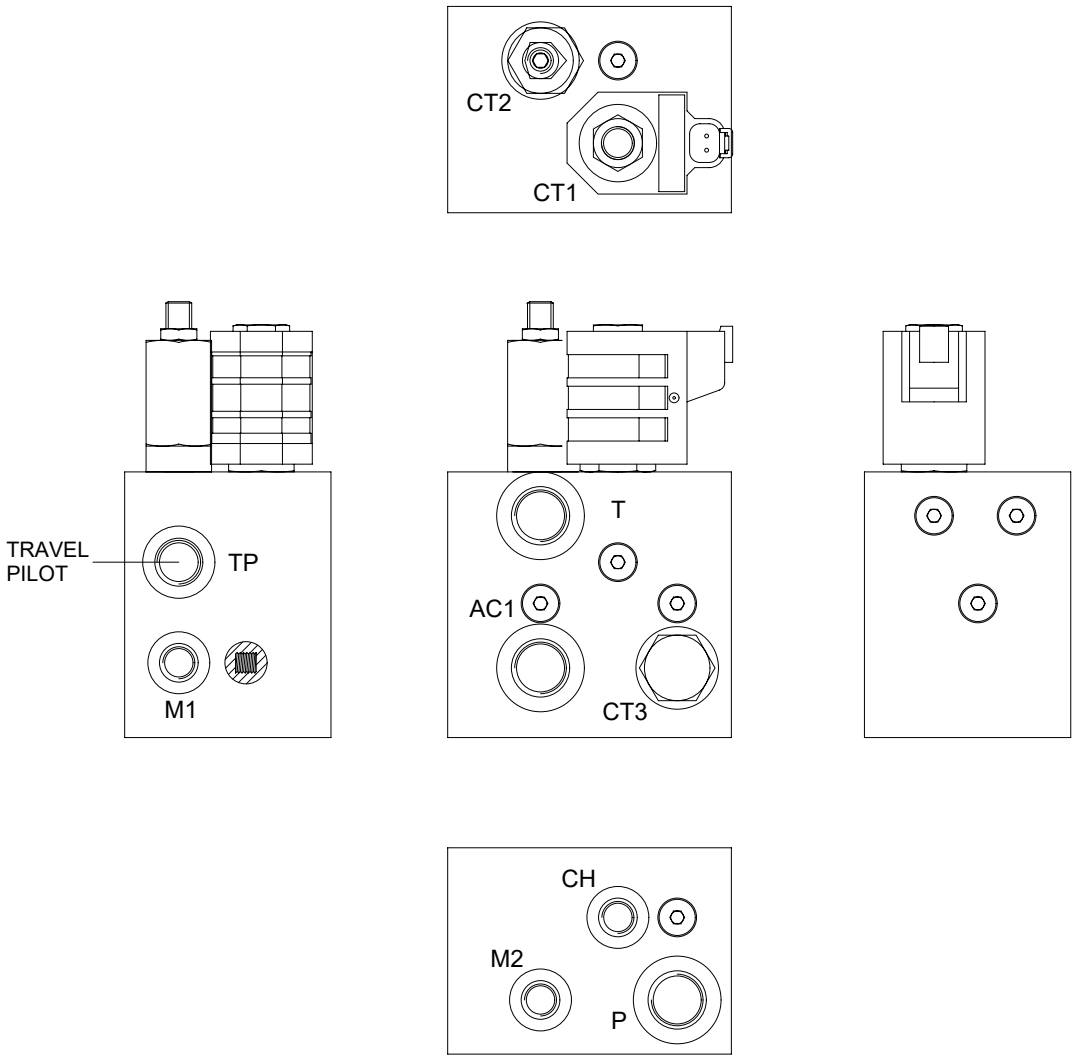
(2) Oil flow
① Min oil flow at 24+1 kgf/cm^2 counter pressure (low engine speed) : 5.5 ℓ /min
② Max oil flow : 25 ℓ /min

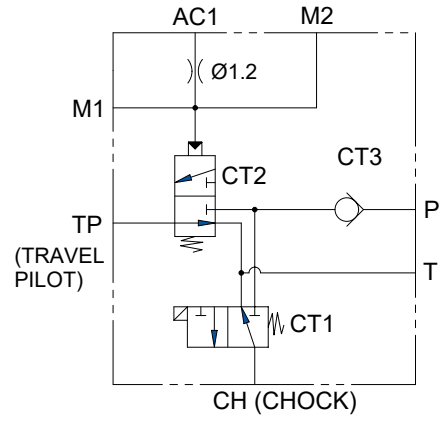
(3) Residual pressure
① Max residual pressure in control line to tank connection P1 and P2 : 1.0 kgf/cm^2

(4) Leakage oil transmission control
① Pressure in input housing connection (E) max : 1.0 kgf/cm^2
② Max oil flow (low speed actuated) : 1 ℓ /min

GROUP 9 TRAVEL CONTROL VALVE

1. STRUCTURE

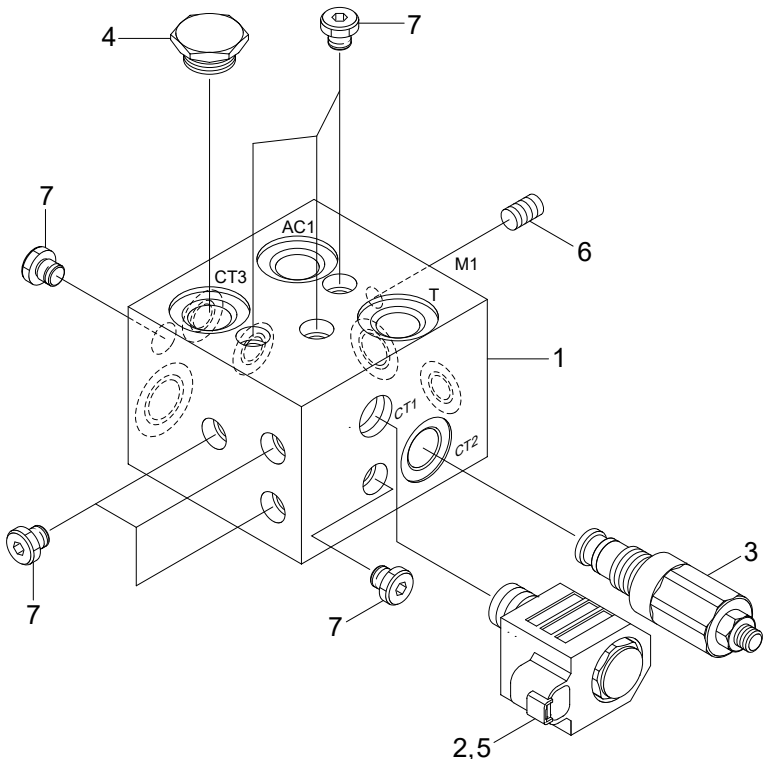




Hydraulic circuit

Port name	Port size
P, T, AC1	PF 1/2
TP	PF 3/8
M1, M2, CH	PF 1/4

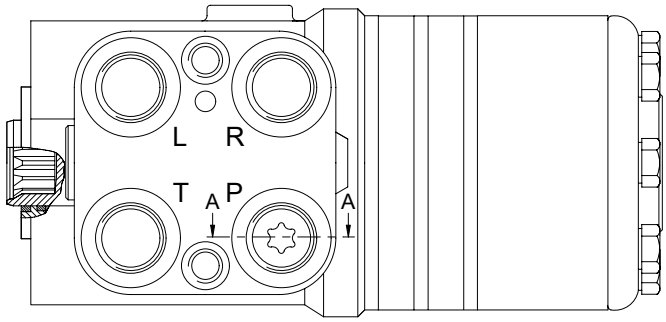
2. COMPONENT

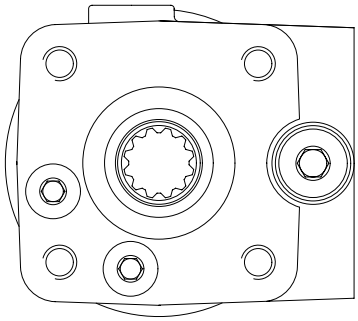


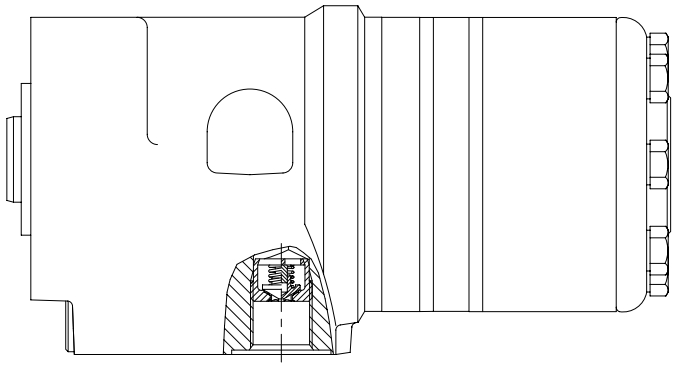
1	Body	5	Coil
2	Solenoid valve	6	Orifice
3	POD valve	7	Plug
4	Check valve		

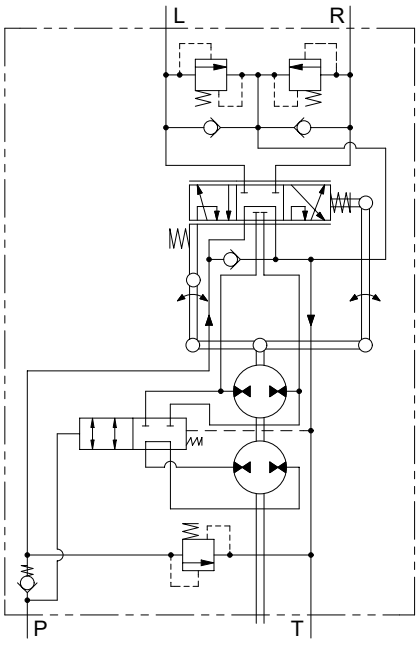
GROUP 10 STEERING VALVE

1. STRUCTURE





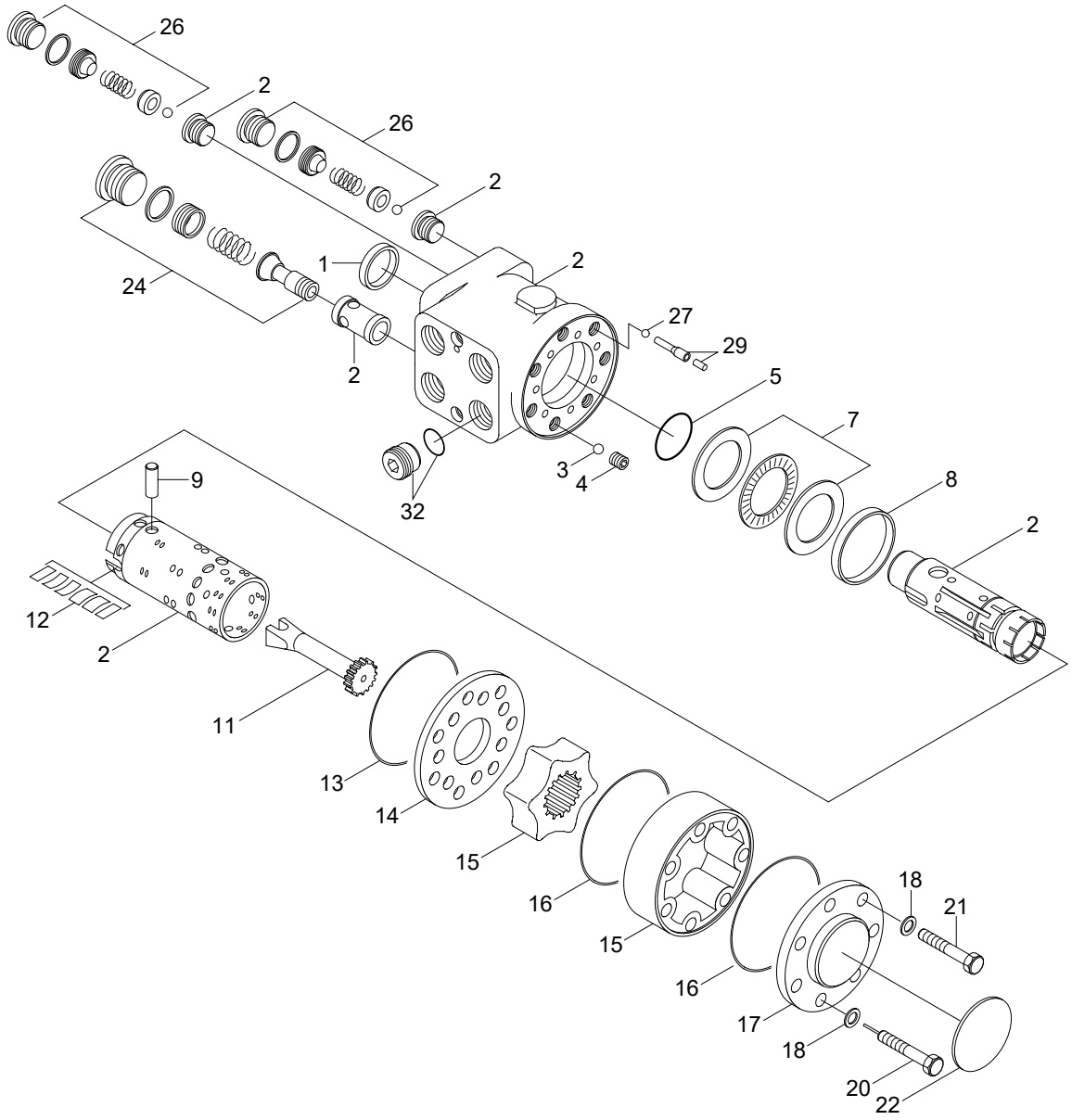




Hydraulic circuit

Port	Port name	Port size
L	Left port	3/4-16UNF
R	Right port	
T	Tank port	
P	Pump port	

2. COMPONENTS



1	Dust seal	11	Shaft	20	Pin screw
2	Housing, spool, sleeve	12	Spring set	21	Screw
3	Ball	13	O-ring	22	Name plate
4	Bushing	14	Distributor plate	24	Pressure relief valve
5	O-ring	15	Gear wheel set	26	Shock valve
7	Bearing assy	16	O-ring	27	Ball
8	Ring	17	End cover	29	Bushing
9	Cross pin	18	Washer	32	Check valve