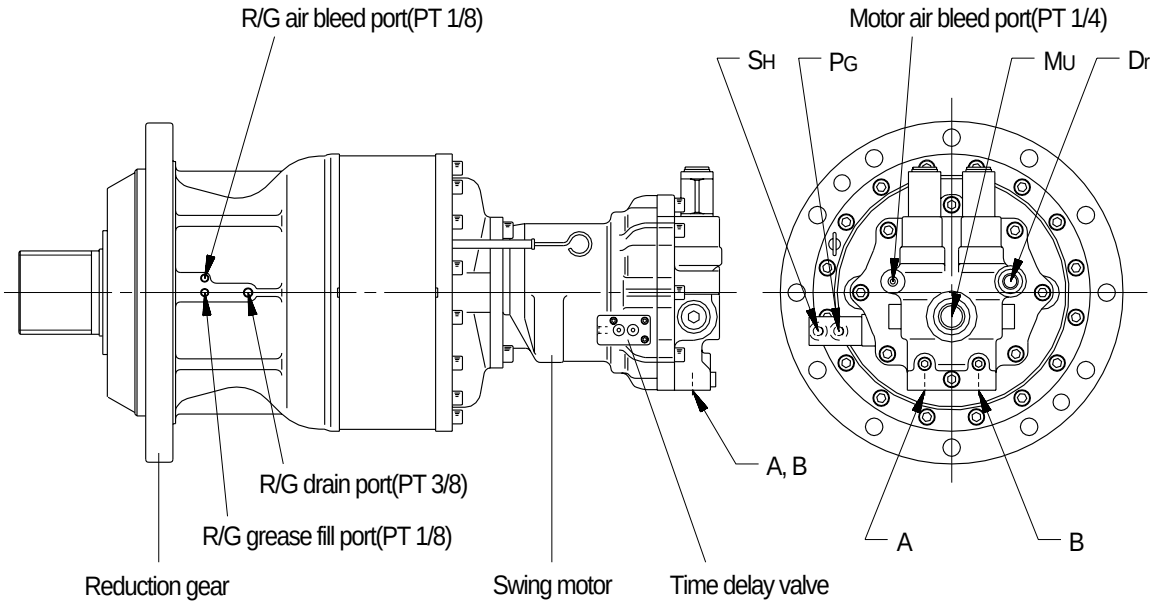
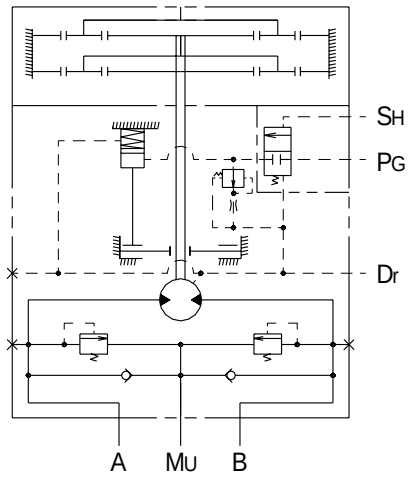
GROUP 3 SWING DEVICE

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

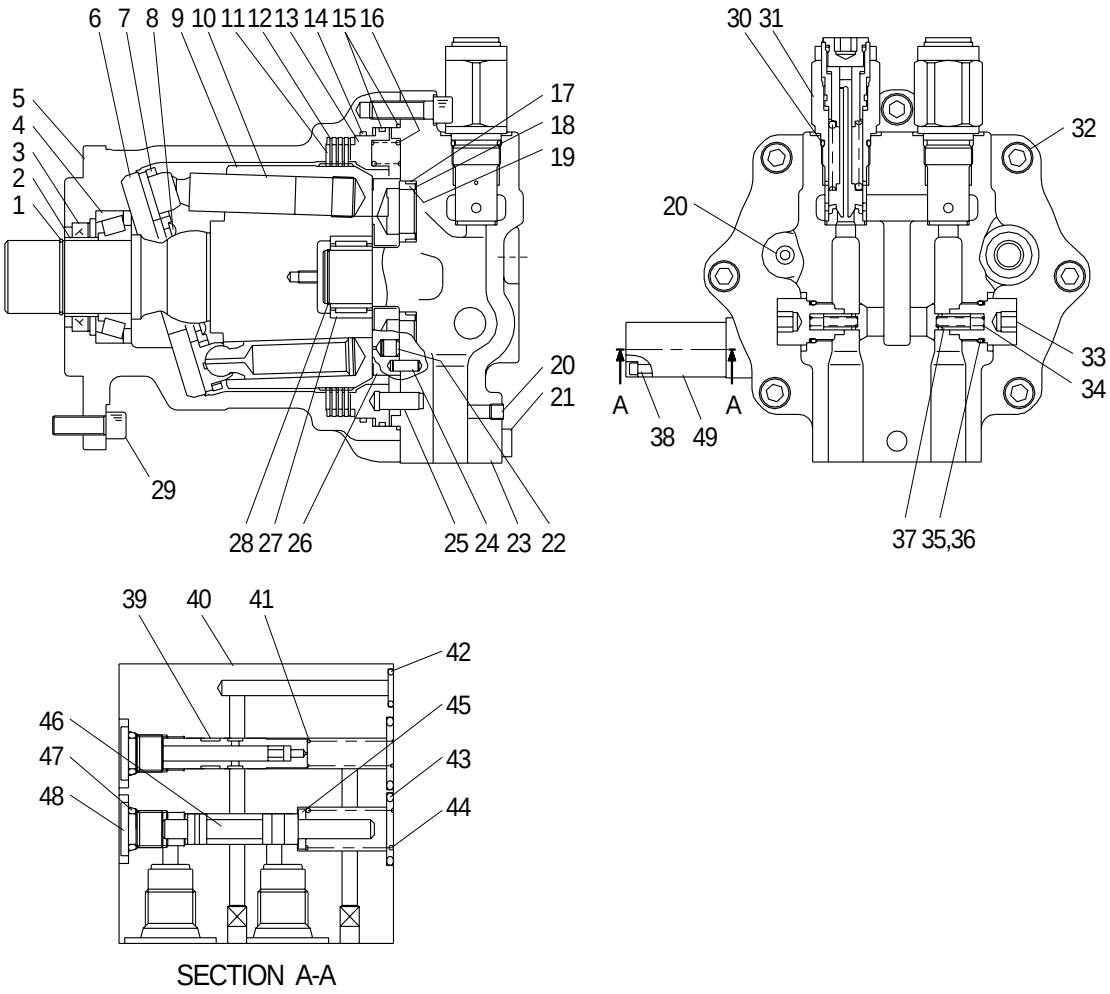
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.





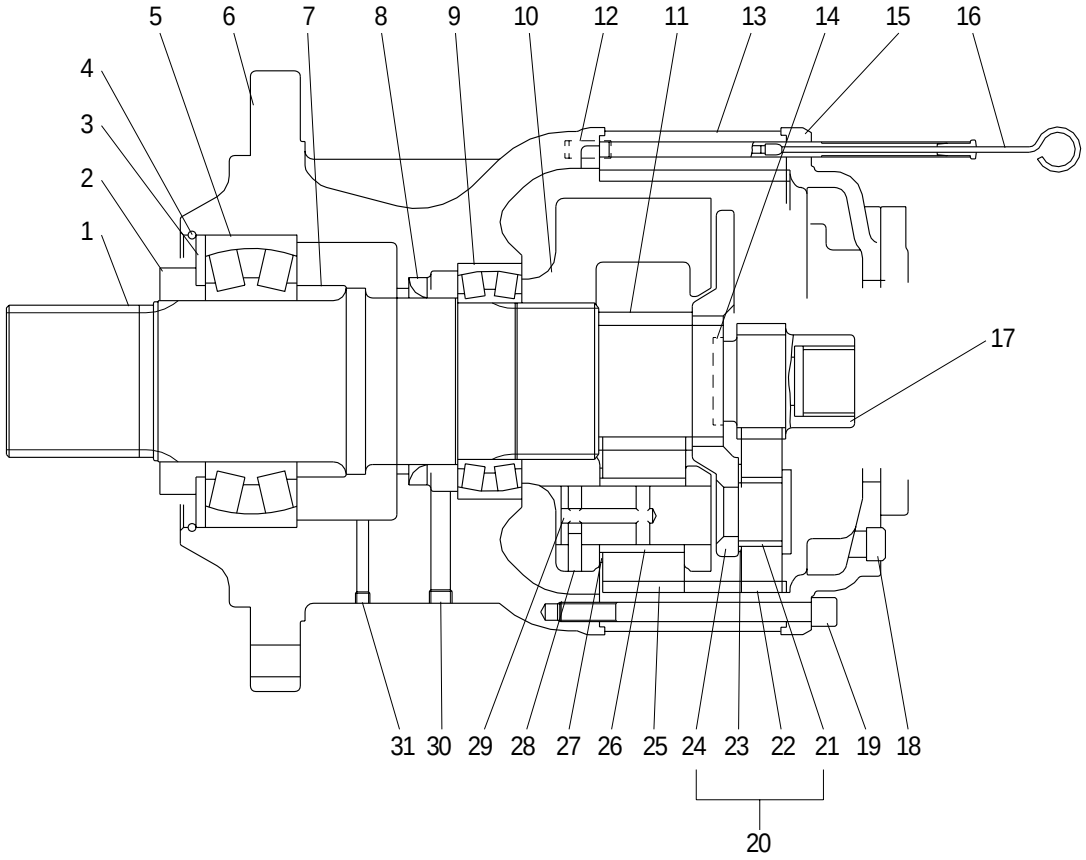
Port	Port name	Port size
A	Main port	SAE 1"
B	Main port	SAE 1"
Dr	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
SH	Brake release port	PF 1/4
PG	Stand by port	PF 1/4

1) SWING MOTOR



1	Snap ring	18	Dish spring	35	O-ring
2	Inner race	19	Bushing	36	Back up ring
3	Oil seal	20	Plug	37	Check
4	Roller bearing	21	Socket bolt	38	Socket bolt
5	Housing	22	Piston	39	Poppet assembly
6	Cam plate	23	Cover	40	Manifold
7	Return plate	24	Parallel pin	41	Spring
8	Spring	25	Parallel pin	42	O-ring
9	Cylinder assembly	26	Balance plate	43	O-ring
10	Piston assembly	27	Needle bearing	44	Spring
11	Friction plate	28	Snap ring	45	Spacer
12	Separate plate	29	Socket bolt	46	Spool
13	Piston	30	O-ring	47	O-ring
14	O-ring	31	Relief assembly	48	Cap
15	O-ring	32	Socket bolt	49	Time delay valve
16	Spring	33	Cap		
17	Teflon ring	34	Spring		

2) REDUCTION GEAR



1	Shaft	12	Parallel pin	23	Thrust plate 1
2	Collar	13	Ring gear	24	Holder 1
3	Plate	14	Thrust plate	25	Gear 5
4	Snap ring	15	Cover	26	Bushing 2
5	Roller bearing	16	Level gauge	27	Thrust plate 2
6	Gear casing	17	Sun gear	28	Spring pin
7	Collar	18	Plug	29	Shaft 2
8	Oil seal	19	Socket bolt	30	Plug
9	Roller bearing	20	Holder 1 assembly	31	Plug
10	Holder 2	21	Shaft 1		
11	Gear 4	22	Gear 2		

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(1), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(2) upon the return plate(3) which acts upon the swash plate(4) via an hydrostatic bearing. Force F1 perpendicular to swash plate(4) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(5) through piston, force F2 causes rotational moment at surroundings of cylinder.

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

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

Where p : Effective difference of pressure(kgf/cm^2)

q : Displacement(cc/rev)

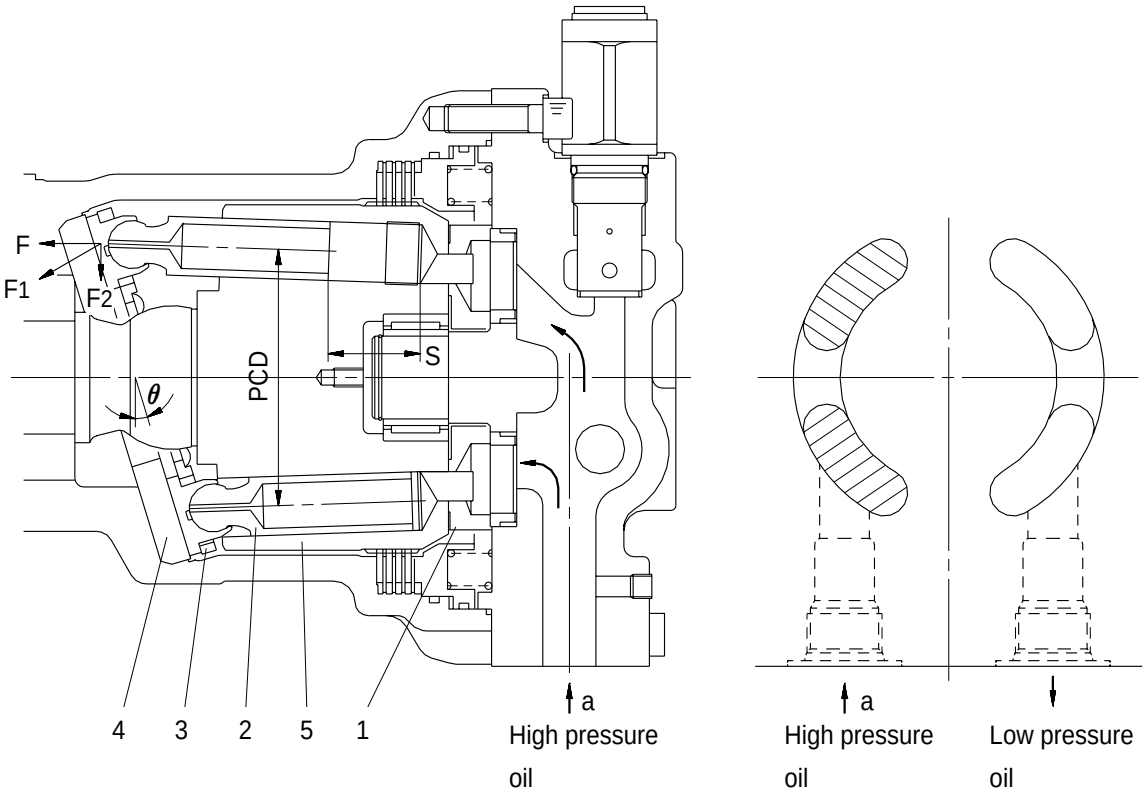
T : Output torque(kgf · cm)

Z : Piston number

A : Piston area(cm^2)

θ : Tilting angle of swash plate(degree)

S : Piston stroke(cm)



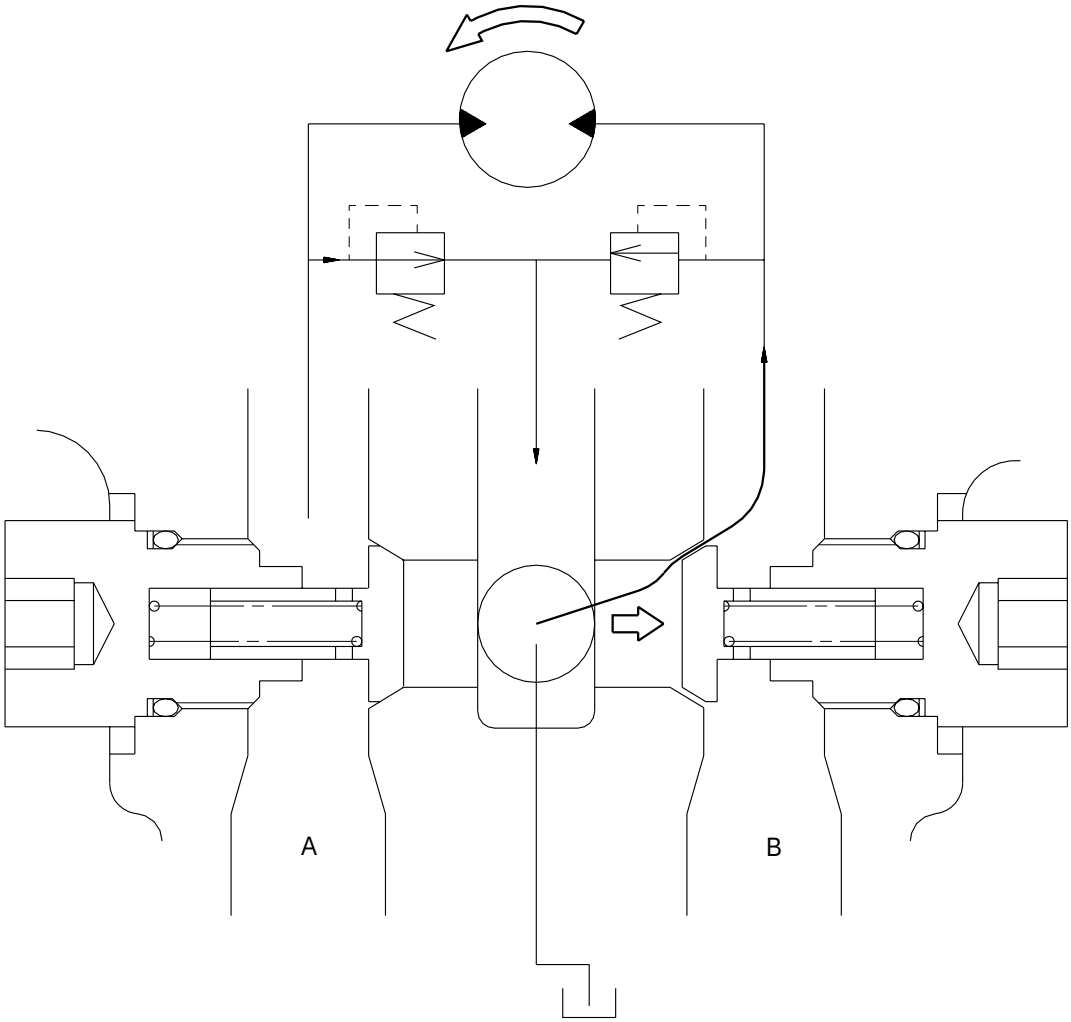
2) MAKE UP VALVE

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

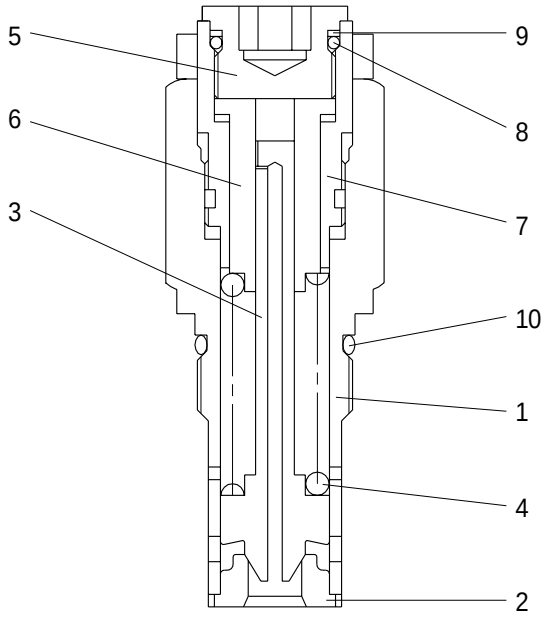
A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

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

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



3) RELIEF VALVE



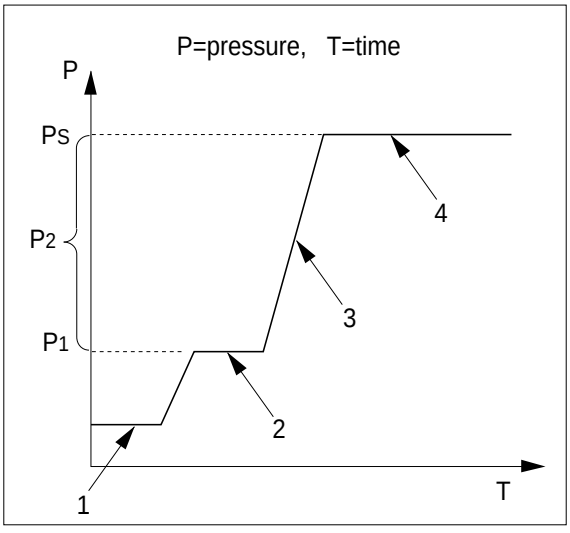
1 Body
2 Seat
3 Plunger
4 Spring
5 Adjusting screw
6 Piston
7 Sleeve
8 O-ring
9 Back up ring
10 O-ring

(1) Construction of relief valve

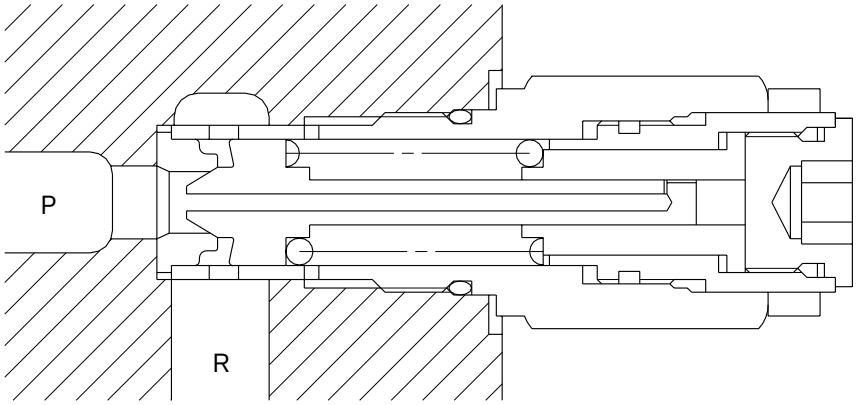
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(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.



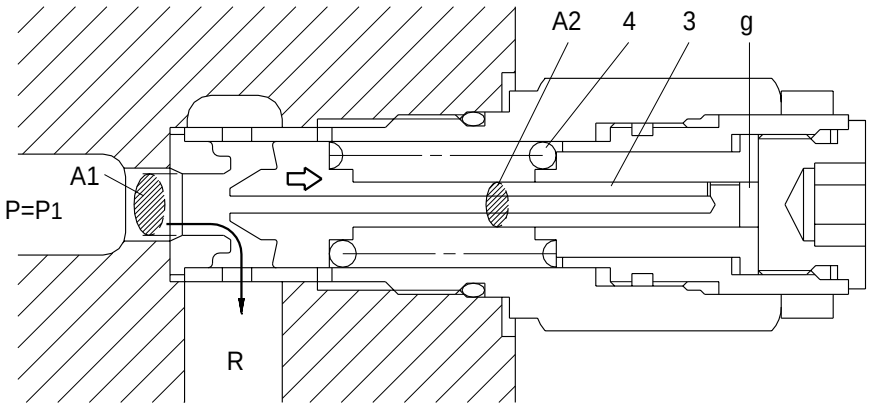
① Ports (P, R) at tank pressure.



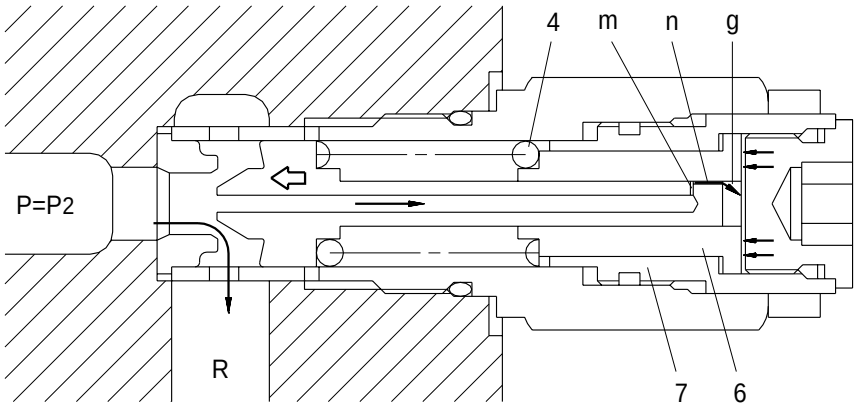
② When hydraulic oil pressure($P \times A1$) reaches the preset force(F_{SP}) of spring(4), the plunger(3) moves to the right as shown.

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

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



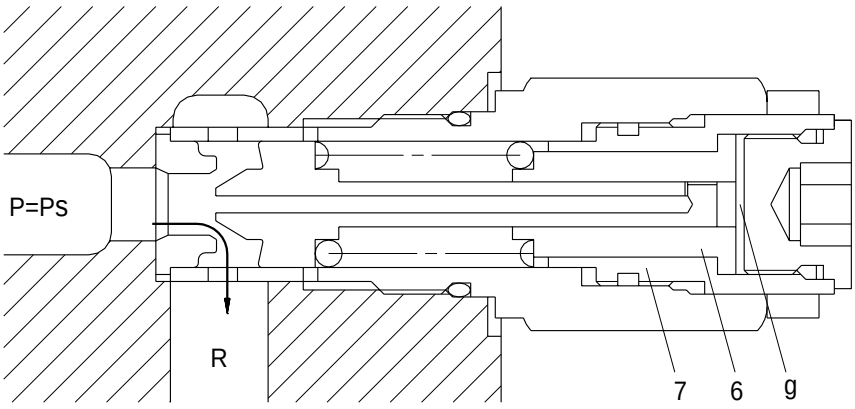
③ The oil flow chamber g via orifice m and n. When the pressure chamber g reaches the preset force(F_{SP}) of spring(4), the piston(6) moves left and stop the piston(6) hits the bottom of sleeve(7).



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

$P_S \times A_1 = F_{SP} + P_S \times A_2$

$$P_S = \frac{F_{SP}}{A_1 - A_2}$$

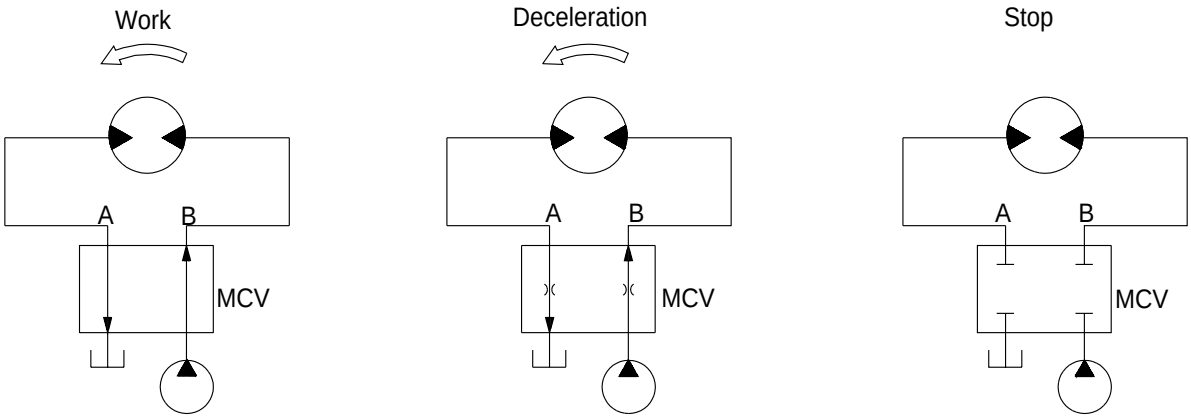


4) BRAKE SYSTEM

(1) Control valve swing brake system

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

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



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

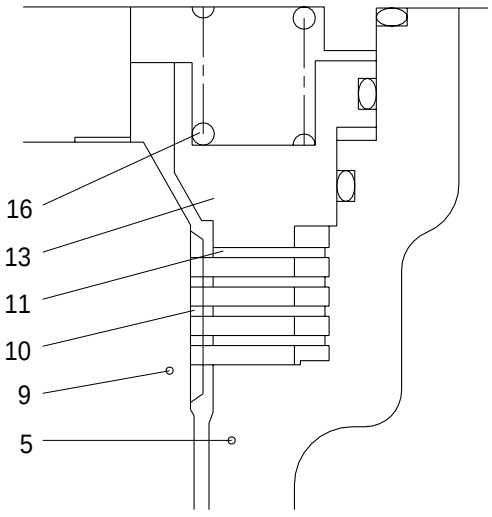
(2) Mechanical swing parking brake system

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

① Brake assembly

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

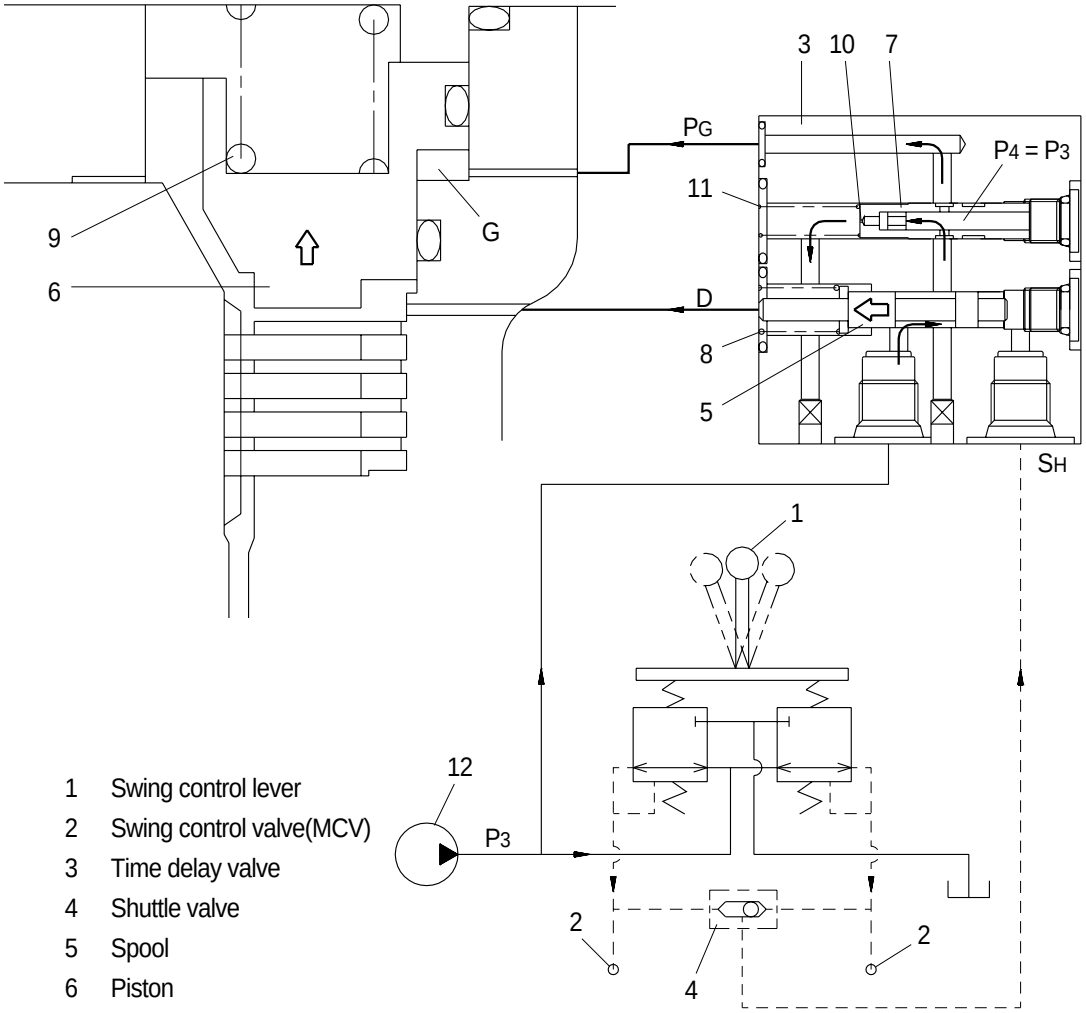
Cylinder(9) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



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

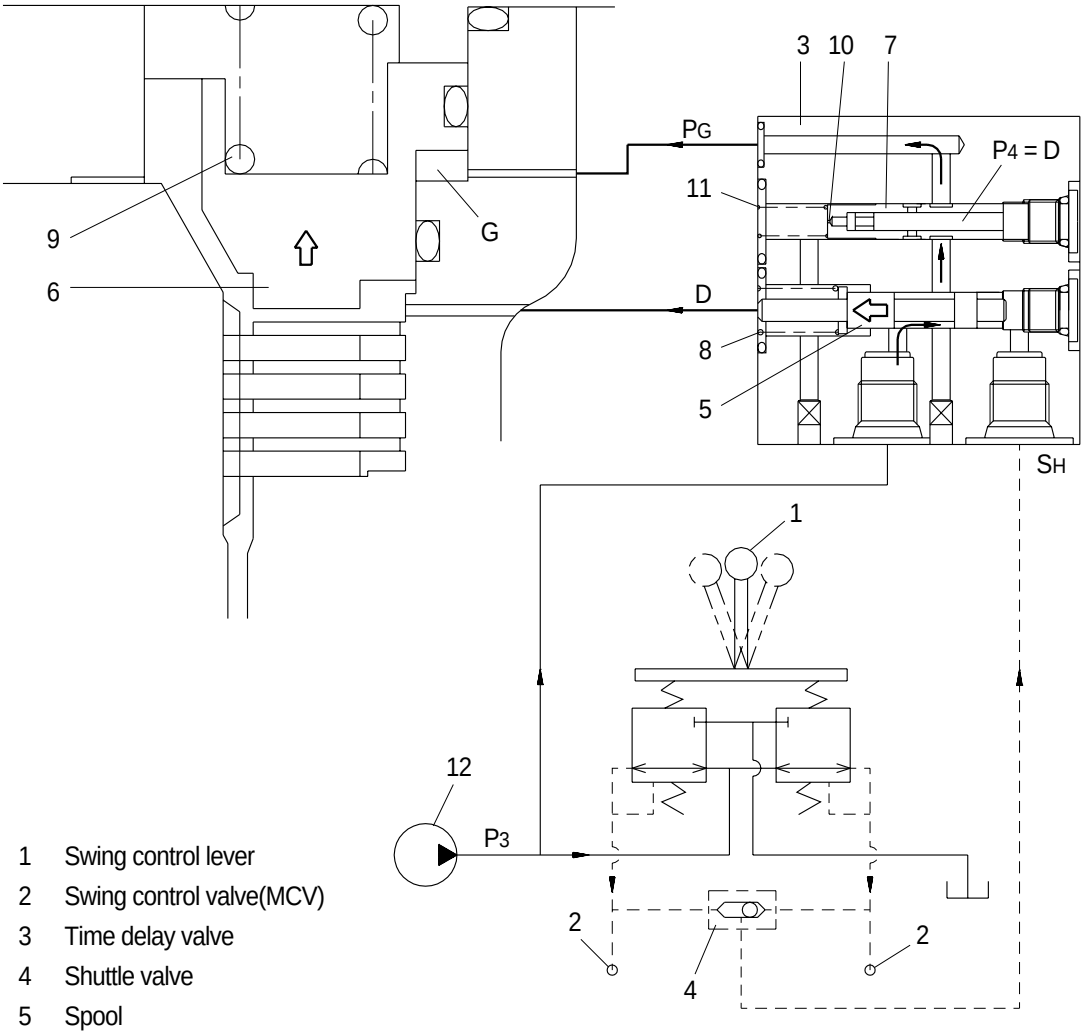
② Operating principle

a. When the swing control lever(1) is set to the swing position, the pilot oil go to the swing control valve(2) and to S_H of the time delay valve(3) via the shuttle valve(4), this pressure move spool(5) to the leftward against the force of the spring(8) so, pilot pump charged oil(P3) go to the P_G.
This pressure is applied to move the piston(6) to the upward against the force of the spring(9) thus releasing the brake force.



1 Swing control lever
2 Swing control valve(MCV)
3 Time delay valve
4 Shuttle valve
5 Spool
6 Piston
7 Poppet
8 Spring
9 Spring
10 Orifice
11 Spring
12 Pilot pump

b. Meantime, the oil pressure of port D balance with the preset force of spring(11), the pressure of chamber G keeps constant pressure.



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4 Shuttle valve
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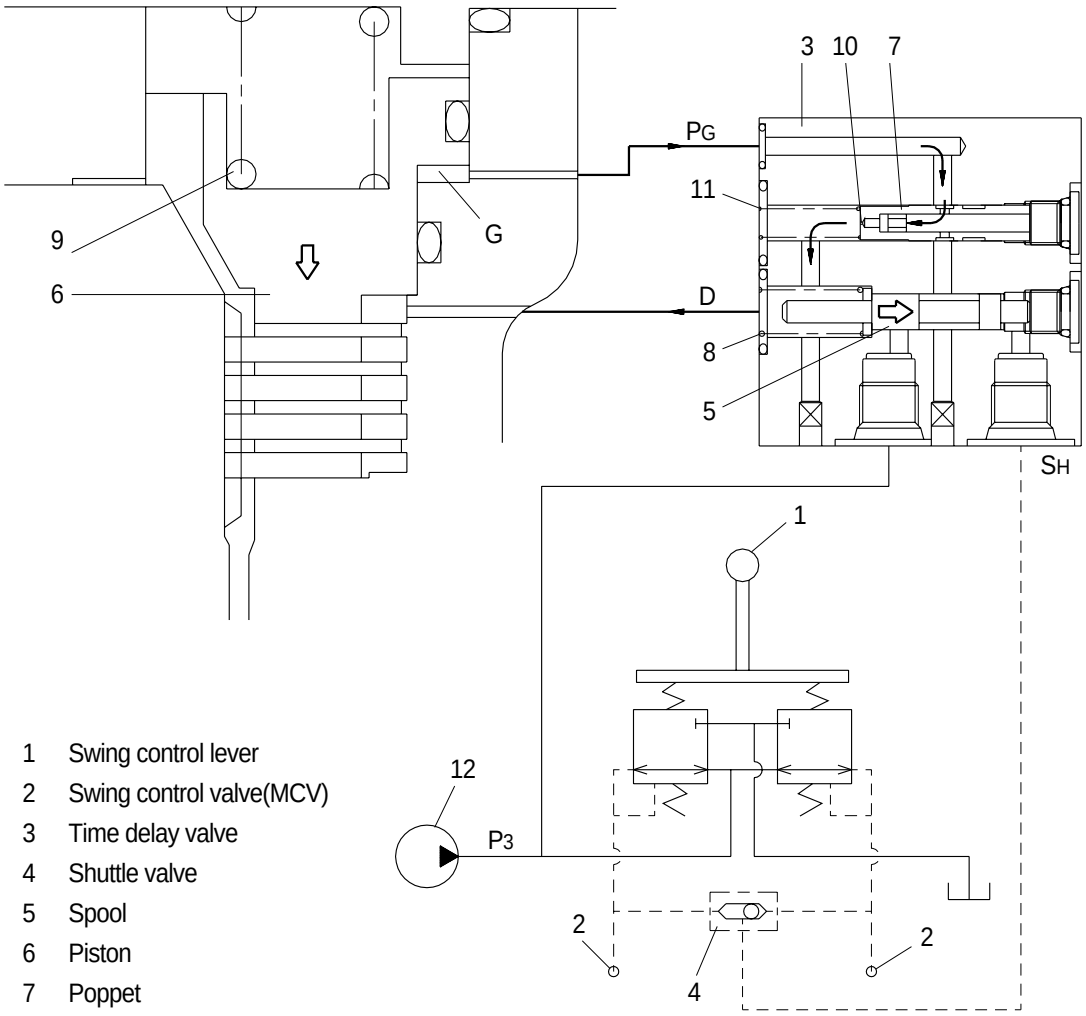
6 Piston
7 Poppet
8 Spring
9 Spring
10 Orifice
11 Spring
12 Pilot pump

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



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