

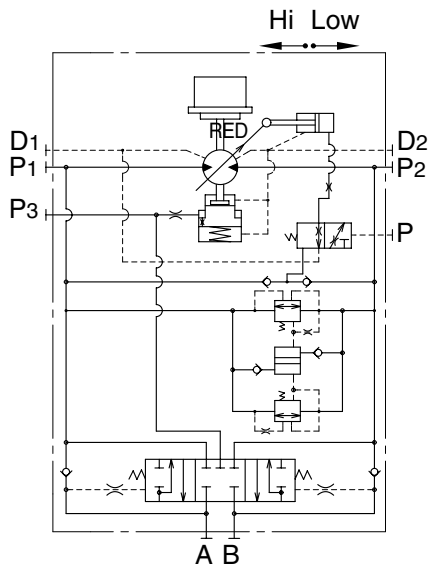
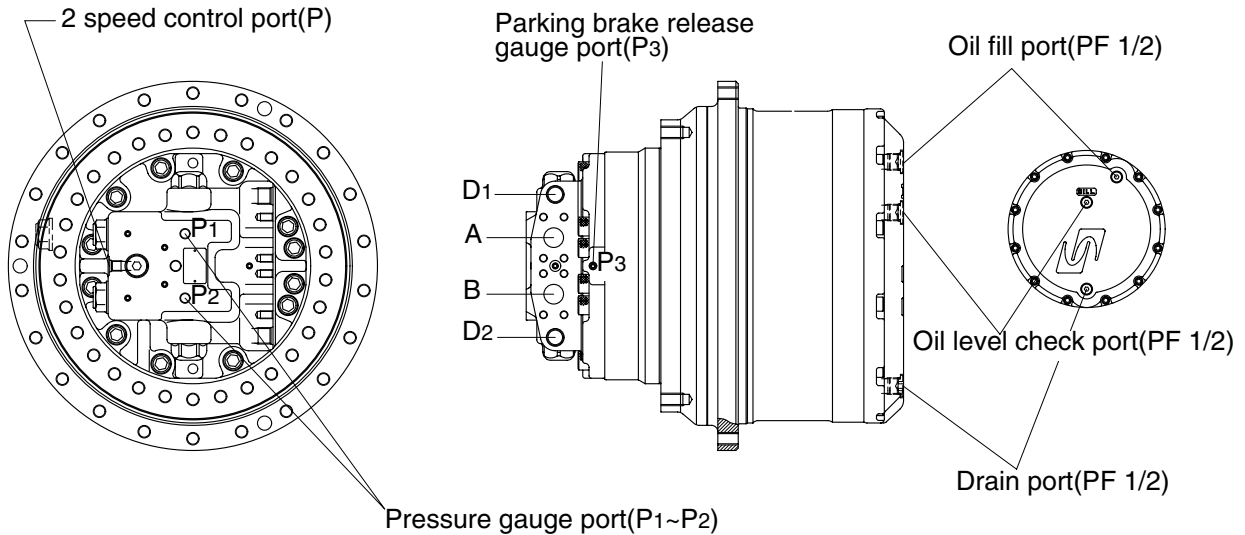
GROUP 4 TRAVEL DEVICE

A. TRAVEL DEVICE(GM35VL, up to #0109)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

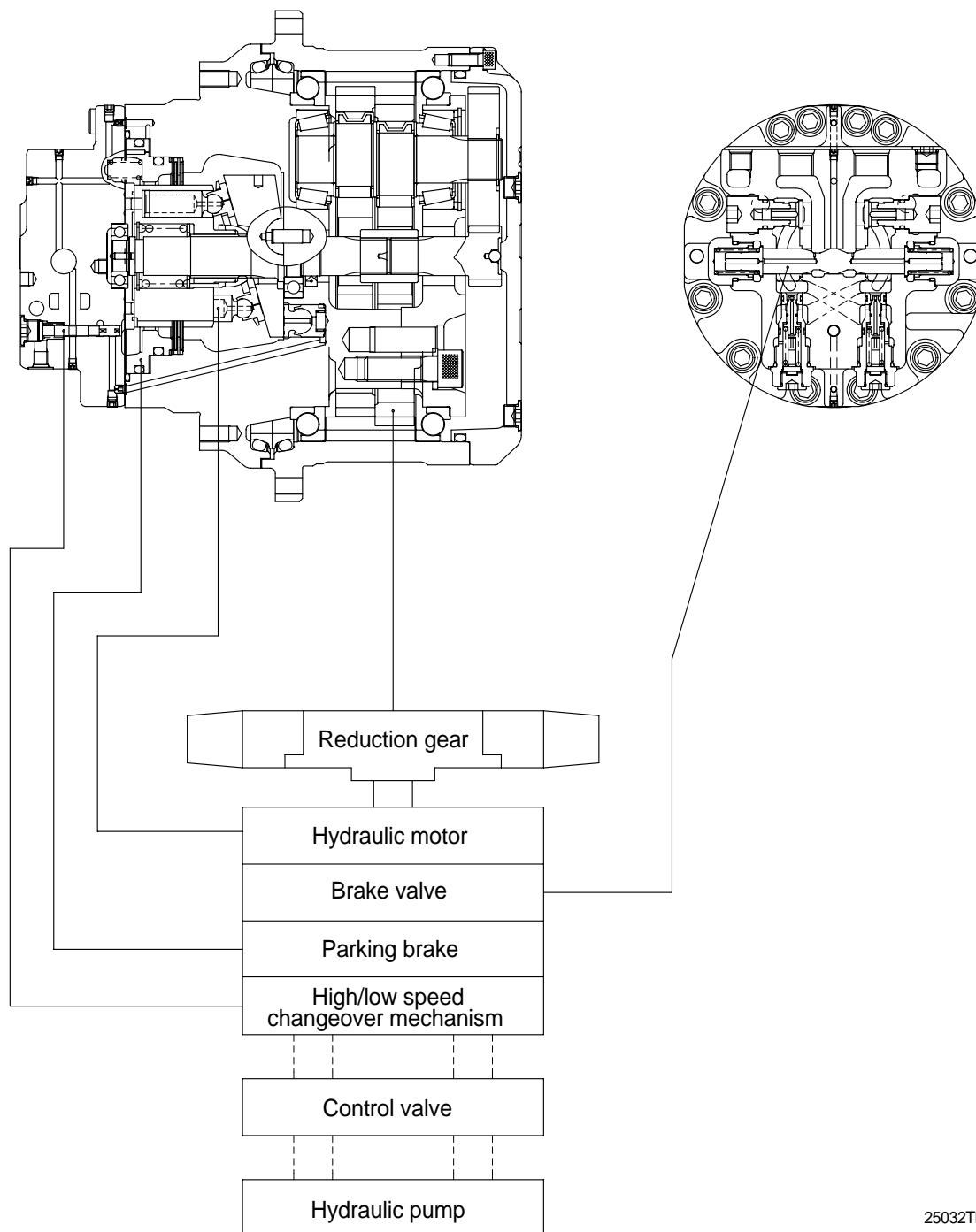
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.



Port	Port name	Port size
A	Main port	SAE 5000psi 1"
B	Main port	SAE 5000psi 1"
P1, P2	Gauge port	PT 1/4
P3	Gauge port	PT 1/8
D1, D2	Drain port	PF 1/2
P	2 speed control port	PF 1/4

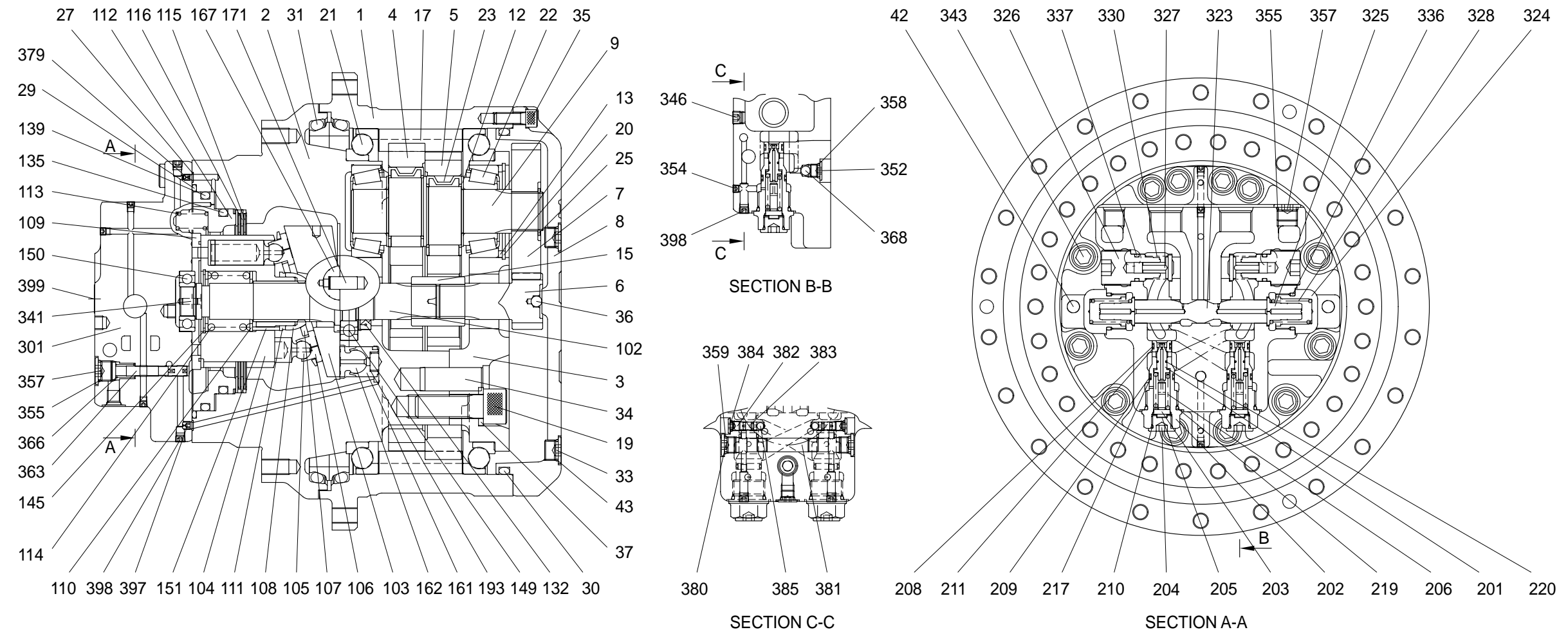
25032TM01

1) BASIC STRUCTURE



25032TM02

2) STRUCTURE



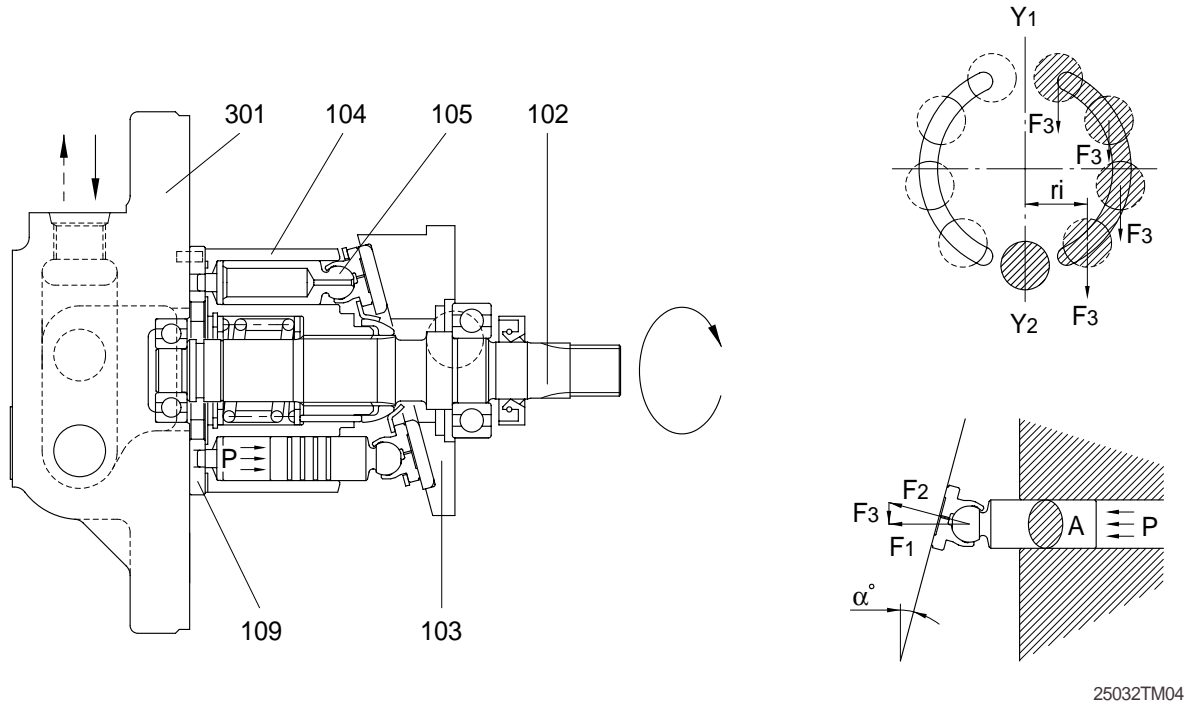
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1	Hub	23	Needle roller bearing	106	Shoe	151	Needle roller	219	O-ring	354	Hexagon socket plug
2	Spindle	25	Snap ring	107	Retainer plate	161	Piston	220	Piston seal	355	O-ring
3	Hold flange	27	O-ring	108	Thrust ball	162	Shoe	301	Rear flanger	357	Plug
4	RV gear A	29	O-ring	109	Timing plate	167	Pivot	323	Spool	358	O-ring
5	RV gear B	30	O-ring	110	Washer	171	Parallel pin	324	Plug	359	O-ring
6	Input gear	31	Floating seal	111	Washer	193	Spring	325	Stopper	363	Spool
7	Spur gear	33	Plug	112	Piston	201	Valve	326	Plug	368	Steel ball
8	Cover	34	Parallel pin	113	Spring	202	Sleeve	327	Valve	379	Filter
9	Crank shaft	35	Hexagon socket bolt	114	Spring	203	Spring retainer	328	Spring	380	Plug
12	Spacer	36	Steel ball	115	Firction plate	204	Plug	330	Spring	382	Plug
13	Distance piece	37	Washer	116	Mating plate	205	Shim	336	O-ring	383	O-ring
15	Coupling	42	Parallel pin	132	Oil seal	206	Spring	337	O-ring	384	O-ring
17	Pin	43	O-ring	135	O-ring	208	O-ring	341	Parallel pin	385	Steel ball
19	Hexagon socket bolt	102	Shaft	139	O-ring	209	O-ring	343	Hexagon socket bolt	397	Orifice
20	Snap ring	103	Swash plate	145	Snap ring	210	O-ring	346	Hexagon socket bolt	398	Hexagon socket plug
21	Ball bearing	104	Cylinder block	149	Ball bearing	211	Back up ring	352	Plug	399	Name plate
22	Taper roller bearing	105	Piston	150	Ball bearing	217	Back up ring				

2. FUNCTION

1) HYDRAULIC MOTOR

(1) Rotary group



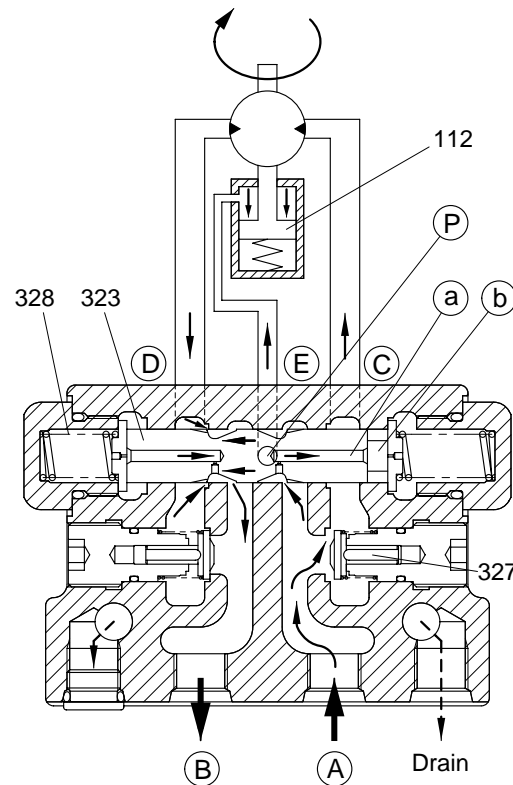
The pressurized oil delivered from the hydraulic pump flows to rear flange(301) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block(104) via timing plate(109). This oil constructively introduced only to one side of Y1-Y2 connecting the upper and lower dead points of stroke of piston(105). The pressurized oil fed to one side in cylinder block(104) pushes each piston(105, four or five) and generates a force($F \text{ kg} = P \text{ kg/cm}^2 \times A \text{ cm}^2$). This force acts on swash plate(103), and is resolved into components (F_2 and F_3) because swash plate(103) is fixed at an angle(α°) with the axis of drive shaft(102). Radial component(F_3) generates respective torques($T = F_3 \times r_i$) for Y1-Y2. This residual of torque($T = F_3 \times r_i$) rotates cylinder block(104) via piston(105). Cylinder block(104) is spline-coupled with drive shaft(102). So the drive shaft(102) rotates and the torque is transmitted.

(2) Brake valve

Brake released(Starting / Running)

When the pressurized oil supplied from port **P**, the oil opens valve(327) and flows into port **C** at the suction side of hydraulic motor to rotate motor. At the same time, the pressurized oil passes through pipe line **E** from a small hole in spool(323) and flows into chamber **D**. The oil acts on the end face of spool(323) which is put in neutral position by the force of spring(328), thus causing spool(323) to slide to the left. When spool(323) slides, port **C** on the passage at the return side of hydraulic motor, which is closed by the spool groove during stoppage, connected with port **A** at the tank side and the return oil from the hydraulic motor runs into the tank. In consequence, the hydraulic motor rotates. Moreover, sliding of spool(323) causes the pressurized oil to flow into ports **B** and **A**.

The pressurized oil admitted into port **P** activates piston(112) of the parking brake to release the parking brake force. (For details, refer to description of the parking brake.) When the pressurized oil is supplied from port **P**, spool(323) moves reversely and the hydraulic motor also rotates reversely.



25032TM05

Brake applied(Stopping / Stalling)

When the pressurized oil supplied from port is stopped during traveling, no hydraulic pressure is applied and spool(323) which has slid to the left will return on the right(Neutral) via stopper (325) by the force of spring(328).

At the same time, the hydraulic motor will rotate by the inertia even if the pressurized oil stopped, so the port D of the motor will become high pressure.

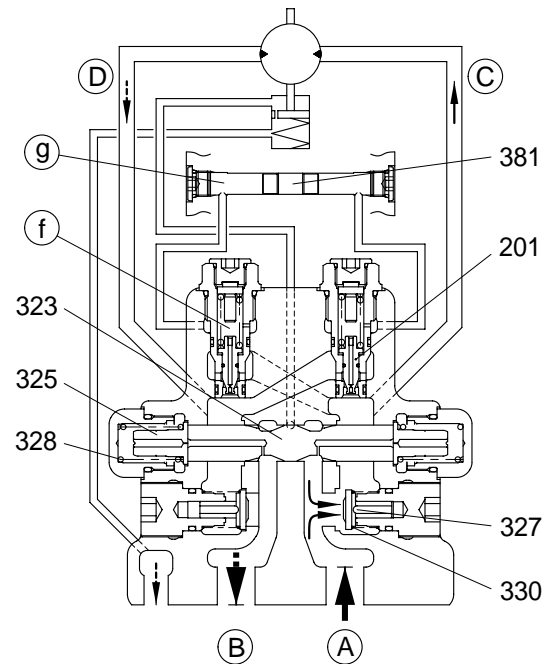
This pressurized oil goes from chamber to chamber through the left-hand valve(201).

When the oil enters chamber , the piston(381) slides to the right so as not to rise the pressure, as shown in the figure. Meanwhile, the left-hand valve(201) is pushed open by the pressurized oil in port D.

Therefore, the pressurized oil in port D flows to port C at a relatively low pressure, controlling the pressure in port D and preventing cavitation in port C.

When the piston(381) reaches the stroke end, the pressure in chamber and increase and the left-hand valve(201) closes again, allowing the oil pressure in port D to increase further. Then, the right-hand valve(201) opens port C with pressure higher than that machine relief set pressure.

In this way, by controlling the pressure in port D in two steps, the hydraulic motor is smoothly braked and brought to a stop.



25032TM06

Braking effect on downhill travel

If the machine traveling downhill with a relatively small supply of high pressure oil to its travel motors should start coasting, the same braking effect as the one described above would automatically occur.

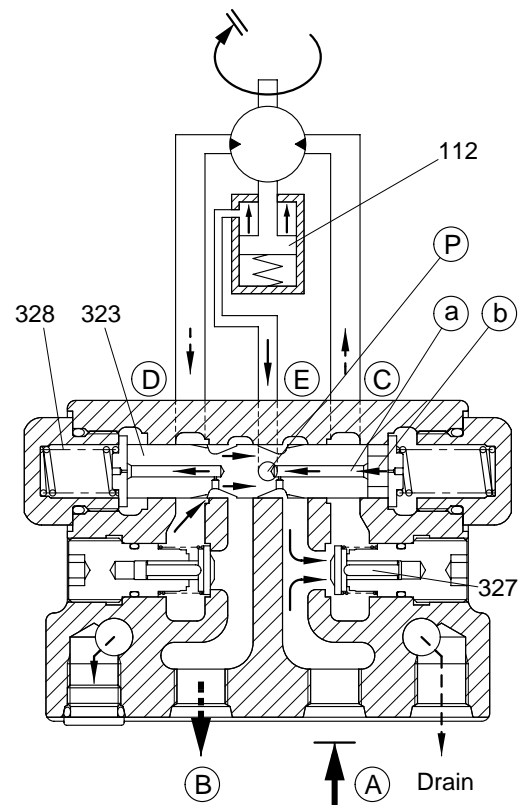
In the coasting condition, the motor is driven, instead of driving the track, from the ground and sucks high pressure oil in.

In other words, the motor tends to draw more high pressure oil than is being supplied.

Under this condition, port A goes negative to pull oil out of chamber through oil way , moving back the spool(323) rather rapidly.

The clearance on the left then becomes smaller to throttle the outgoing oil more than before, thereby obstructing the pumping action of the motor.

As in stopping the machine, pressure will build up in port D to make it harder to drive the motor from the ground: This is the braking action.

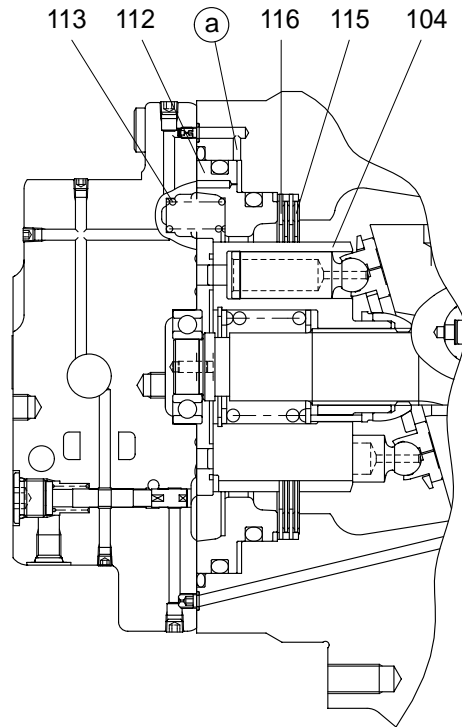


25032TM07

(3) Parking brake

Running

When the pressurized oil is supplied from the brake valve, the spool of brake valve in the hydraulic motor assembly actuates to open the passage to the parking brake and the pressurized oil is introduced into cylinder chamber which is composed of the spindle of reduction gear assembly and piston(112). When the hydraulic pressure reaches 6kgf/cm^2 (0.59Mpa) or more, it overcomes the force of spring (113) and shifts piston(112). With shift of piston(112), no pressing force is applied to mating plate(116) and friction plate (115) and the movement of friction plate (115) becomes free, whereby the brake force to the cylinder in the hydraulic motor assembly is released.



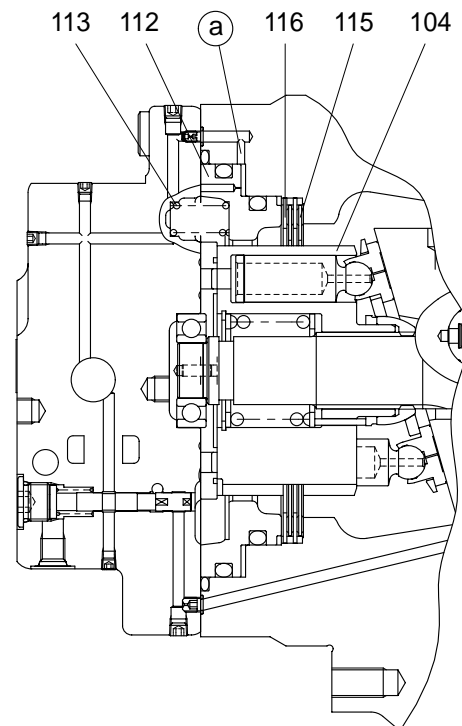
Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber drops 6kgf/cm^2 (0.59Mpa) or less, piston(112) will return by the force of spring(113).

Piston(112) is pushed by this force of spring(113), and mating plate(116) and friction plate(115) in free condition are pressed against the spindle of reduction gear assembly.

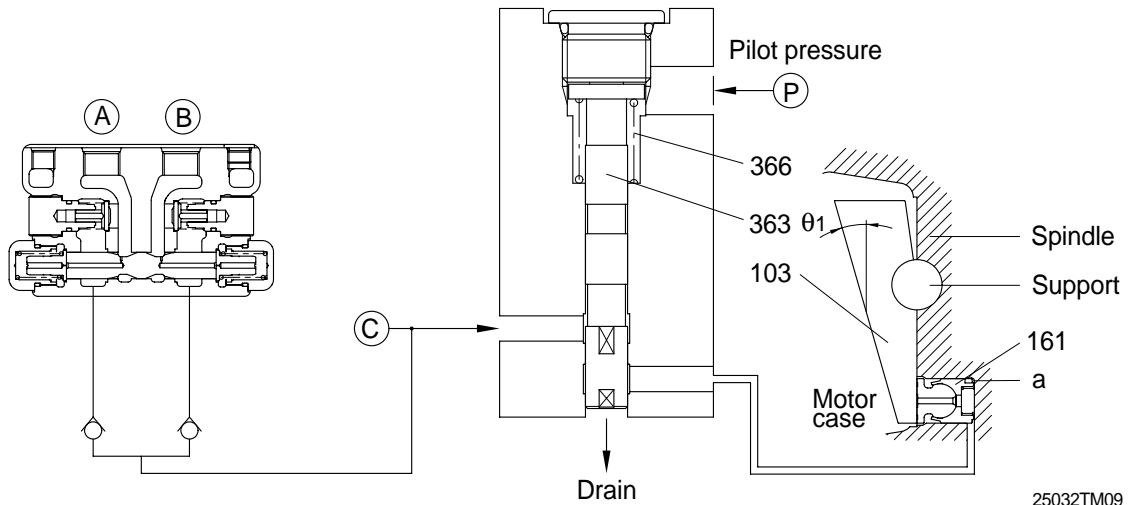
The friction force produced by this pressing stops rotation of the cylinder block(104) and gives a braking torque $40.6\text{kgf} \cdot \text{m}$ ($398\text{N} \cdot \text{m}$) to the hydraulic motor shaft.

Note that oil control through a proper oil passage ensures smooth operation.



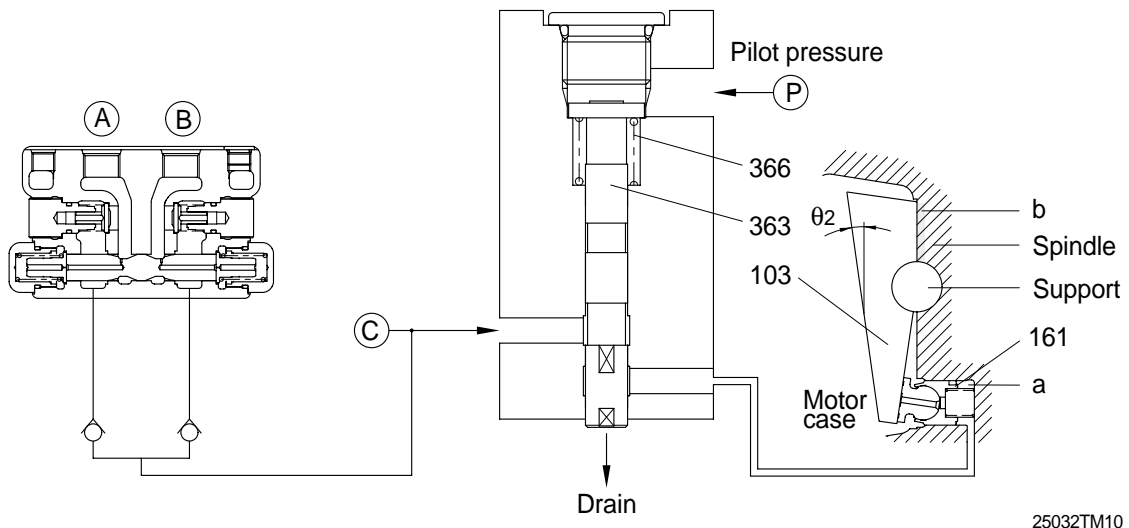
(4) High/low speed changeover mechanism

At low speed - At pilot pressure of less than 20kgf/cm²(1.96Mpa)



When the pilot pressure is shut off from port , valve(363) is pressed upward by the force of spring(366), the pressurized oil supply port is shut off, and oil in chamber is released into the motor case through the valve(363). Consequently, swash plate(103) is tilted at a maximum angle(θ_1) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed operation.

At high speed - At pilot pressure of 20kgf/cm²(1.96Mpa) or more



When a pilot pressure supplied from port (At a pressure of 20kgf/cm²(1.96Mpa) or more), the pressure overcomes the force of spring(366) and valve(363) is pressed downward. The pressurized oil supply port is then introduced into chamber through the valve(363). Piston (161) pushes up swash plate(103) until it touches side of the spindle. At this time, swash plate(103) is tilted at a minimum angle(θ_2) and the piston displacement of hydraulic motor becomes minimum, thus leading to high-speed operation.

2) REDUCTION GEAR

(1) Function

This reduction gear is composed of spur reduction gears(First reduction) and differential reduction gears(Second reduction). It decrease high rotating speed, increase output torque of a hydraulic motor and rotates a gear case.

(2) Operating principle

First reduction

At the right figure, the rotating motion of hydraulic motor is transmitted to the input gear(6) of first reduction. Then three spur gears(7) engaged with the input gear(6) rotate with reducing the rotating speed. Gear ratio of first reduction is described as the following.

$$i_1 = - \frac{Z_i}{Z_s}$$

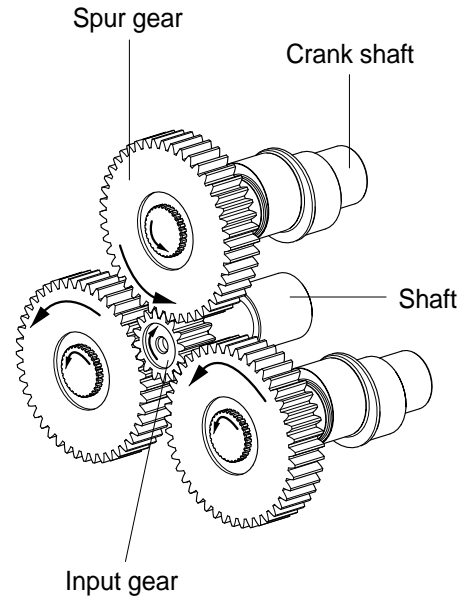
Z_i : Number of input gear teeth

Z_s : Number of spur gear teeth

Second reduction

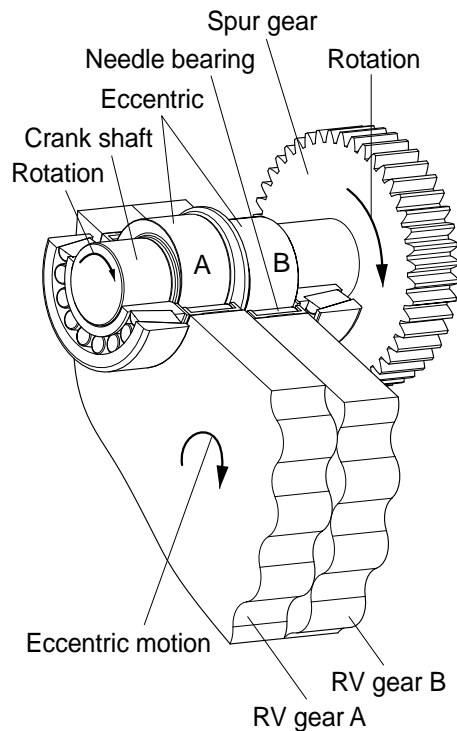
Three spur gears(7) are connected severally to the three crank shafts(9). These crank shafts(9) are input of second reduction.

Planetary gear mechanism



25032TM11(1)

Differential gear mechanism



25032TM11(2)

RV gears(4), (5) are fitted up the eccentric crank shaft(9) through bearings. According to rotating of the crank shafts(9), RV gears(4), (5) revolve (Eccentric motion) along pin-gears(17) within hub(1). As these crank shafts are supported by spindle(2), hub (1) rotates with reducing the speed. Gear ratio of second reduction is described as the following.

$$i_2 = \frac{(Z_p - Z_R)}{Z_p}$$

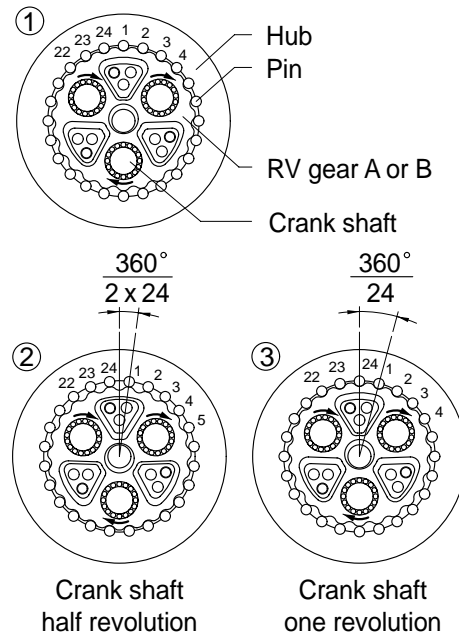
Z_p : Number of pin

Z_R : Number of RV gear teeth

Total gear ratio of this reduction gear is described as the following.

$$i = i_1 \cdot i_2 = - \frac{Z_i}{Z_s} \cdot \frac{(Z_p - Z_R)}{Z_p}$$

Combination of planetary gear mechanism and differential gear mechanism



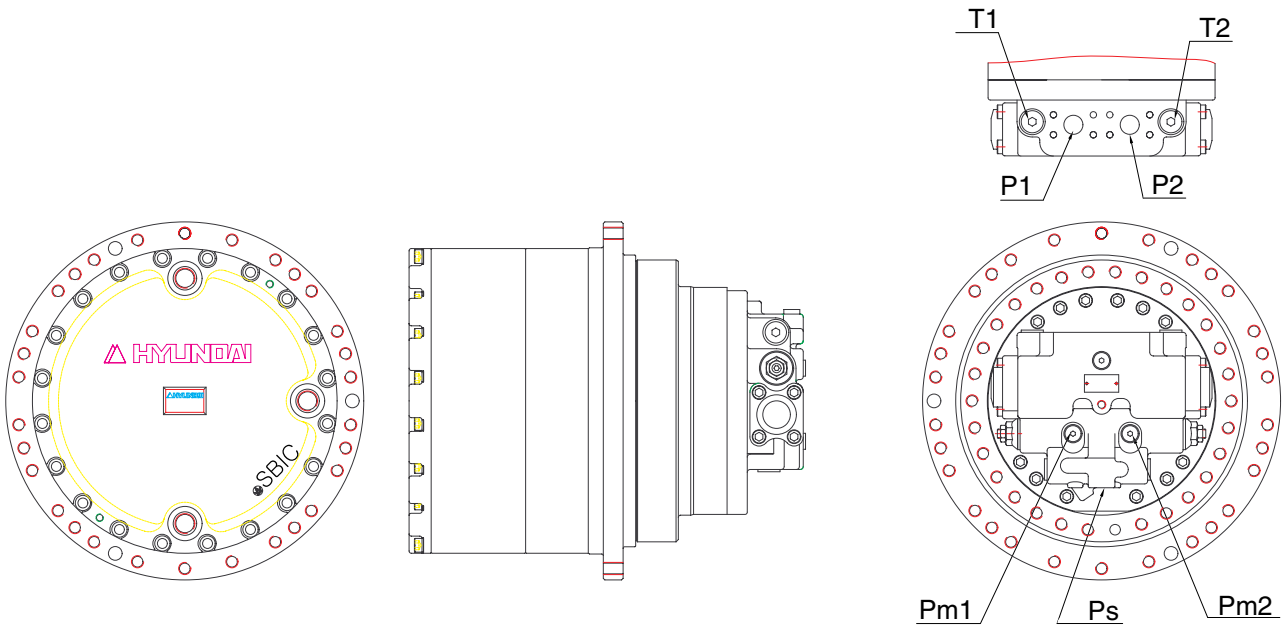
25032TM12

B. TRAVEL DEVICE(SBTR220, #0110 and up)

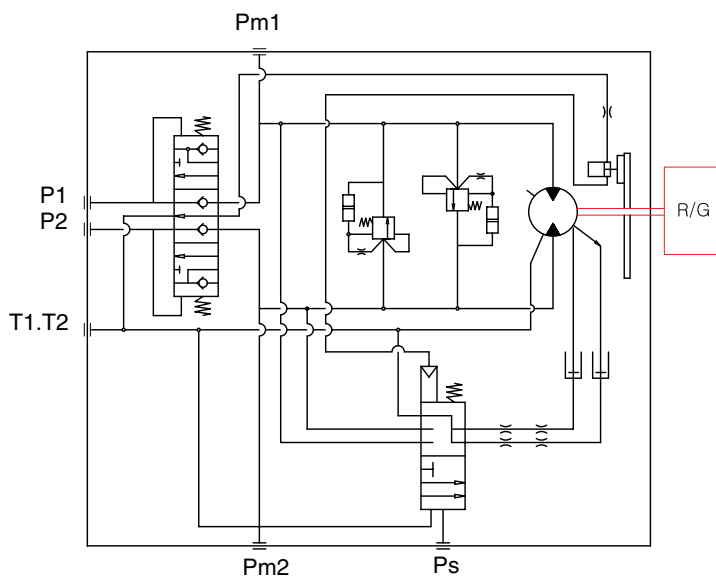
1. STRUCTURE

A hydraulic motor includes five followings.

- Part of rotary generating turning force
- Part of a valve of relief
- Part of Brake
- Part of a valve of counterbalance
- Part of plowing changeover
- Part of auto changeover



21078TM12



Port	Port name	Port size
P1, P2	Main port(IN)	SAE 4694psi
P2, P1	Main port(OUT)	SAE 4694ps
Pm1, Pm2	Gauge port	PF 1/4
T1, T2	Prain port	PF 1/2
Ps	2 speed contro port	PF 1/4

21078TM04

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder(10) through valve casing of motor(29), and valve plate(77).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston(18).

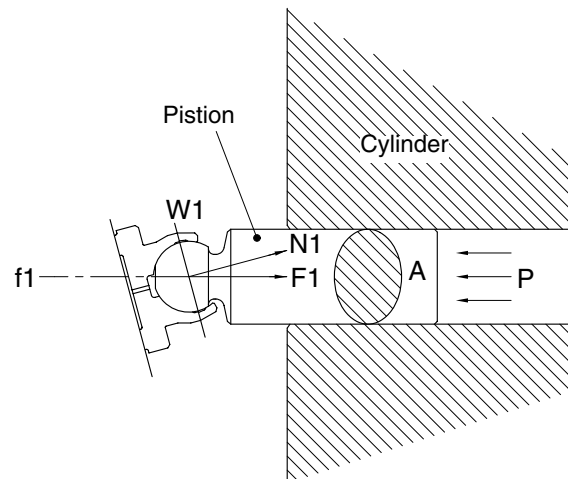
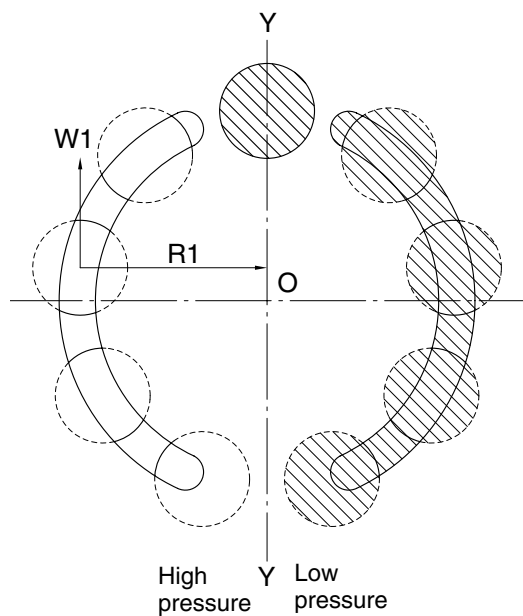
The high hydraulic can generate the force, $F1 = P \times A$ (P : Supplied pressure, A : water pressure area), like following pictures, working on a piston.

This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate(09) of a tilt angle, α .

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

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

This torque transfers the turning force to a cylinder(10) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



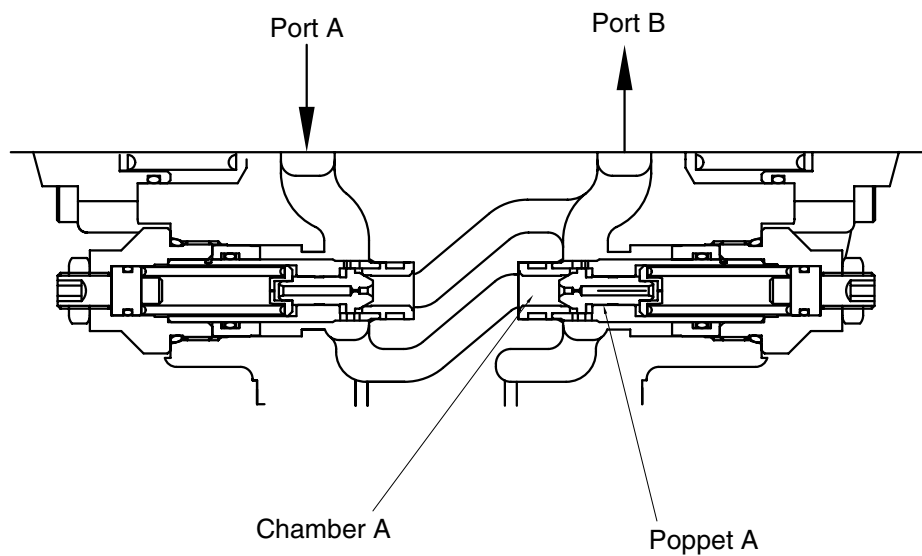
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2.2 Working of relief valve

Relief valve carries on two functions of followings.

- 1) It standardizes a pressure in case of driving a hydraulic motor ; bypasses and extra oil in a motor inlet related to acceleration of an inertia to an outlet.
- 2) In case of an inertia stopped, it forces an equipment stopped, according to generating the pressure of a brake on the projected side.

Room A is always connected with port A of a motor. If the pressure of port is increased, press poppet A. And if it is higher than the setting pressure of a spring, the oil of an hydraulic flows from room A to port B, because poppet A is detached from the contact surface of seat A.



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2.3 Working of negative brake

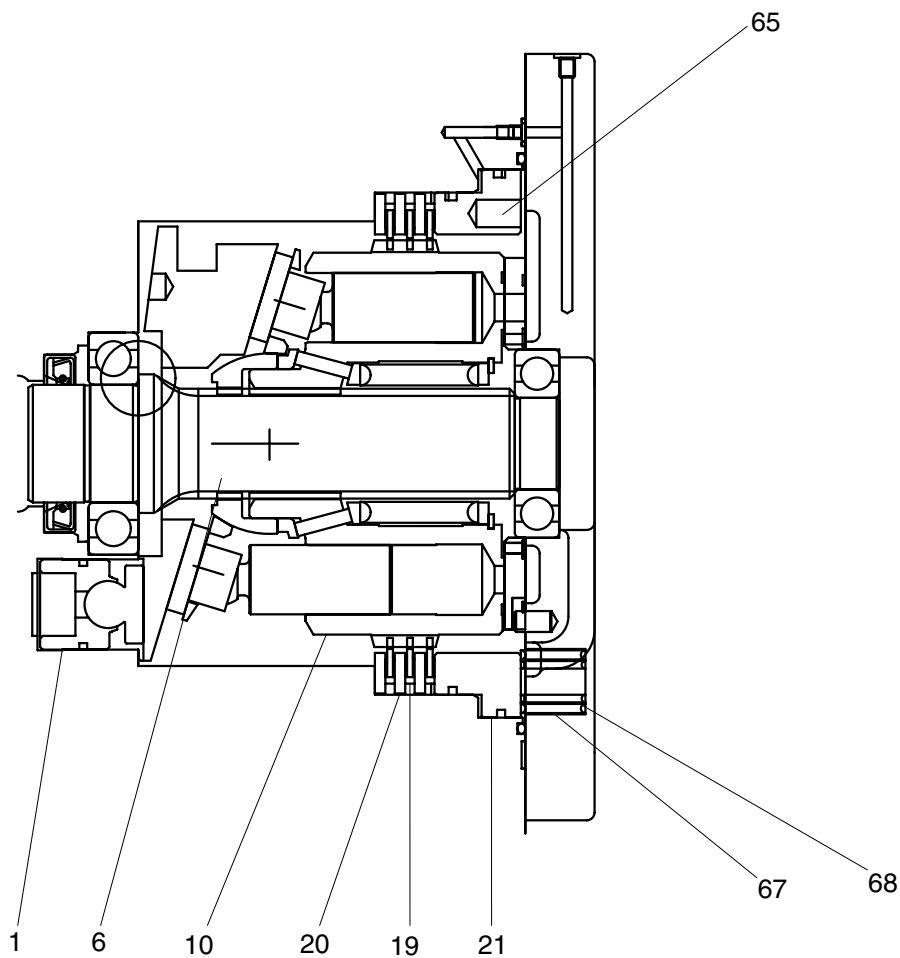
Negative brake operates the pressure supplied through SPOOL(simultaneous peripheral operation online) installed in valve casing(29) to the part of brake piston(21) and releases a brake.

When the pressure does not work, the brake always runs.

The force of a brake is generated by the frictional force among a plate(20) fixed by shaft casing, brake piston(21) and a frictional plate(19) connected through spline outside a cylinder(10).

When a pressure does not work on the part of piston, brake spring presses brake piston; oil in a brake room flows into the drain of a motor through an orifice; in that time, brake piston compresses a frictional plate and a detached plate in the middle of shaft casing and brake piston according to the force that presses 10 pieces of brake springs(68, 67); finally, it makes a frictional force.

This frictional force helps the brake fixing a turning axis(06) connected by a cylinder and spline operated.



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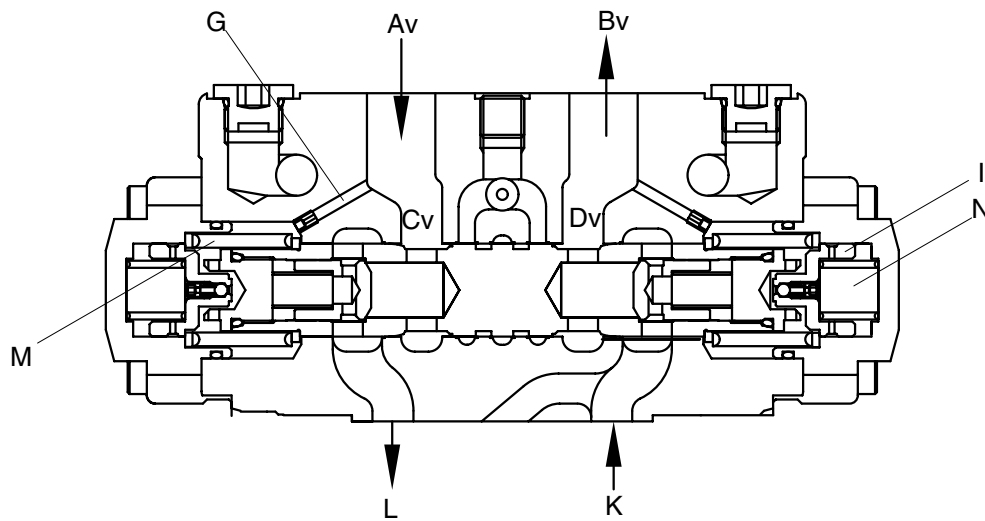
2.4 Counterbalance valve

Av port is connected into a hydraulic pump; Bv port is into a tank.

An oil supplied to a hydraulic pump presses check valve on Av \rightarrow Cv; through L port, is provided to a hydraulic motor. It makes a hydraulic motor circulated. However, the oil pressure out of a pump is increased and transferred to spring room, M, through the path, G, because negative brake is working on. If the pressure of room M is over the power of spring that keeps spool medium, spool moves to the right side.

An oil in room N is sent to room M by orifice I and discharged from G line to a tank.

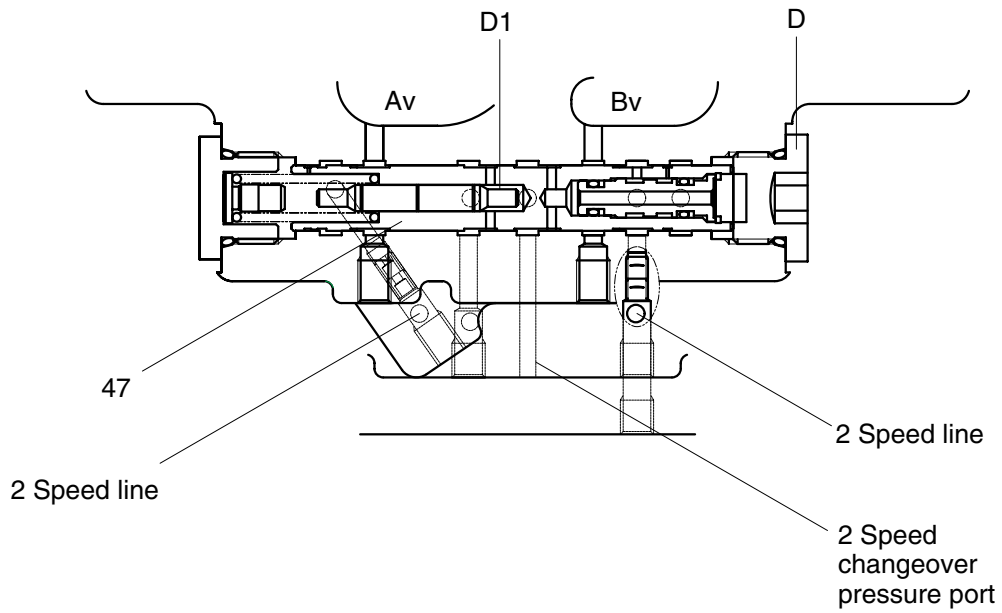
So spool moves to the right. The oil flows as the way of K \rightarrow Bv.



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2.5 Working description of automatic switch(at normal speed)

Due to no pressure on pilot now, spool(47) is not working.



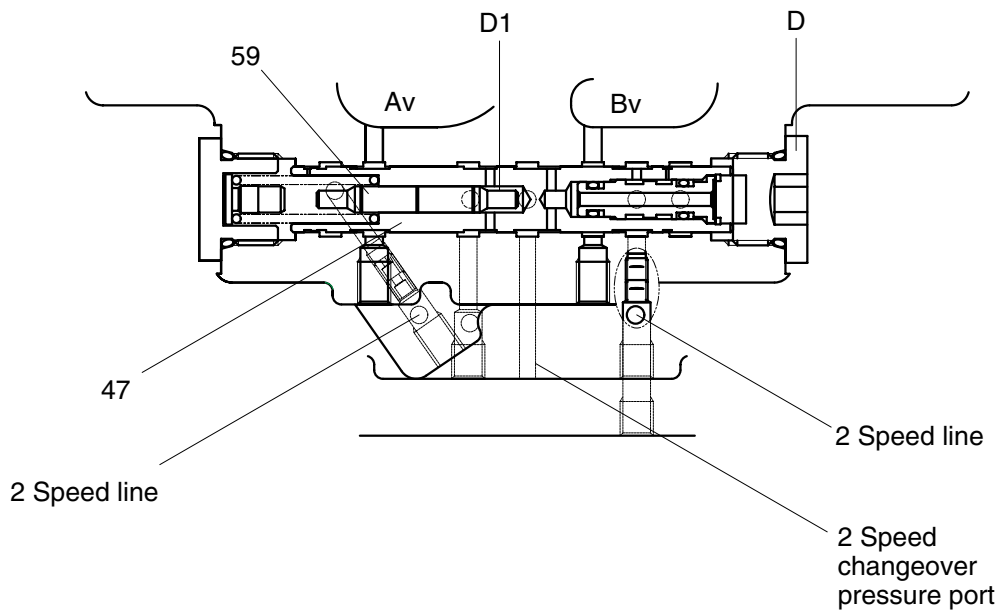
(Normal Speed)

21078TM09

2.6 Working description of automatic switch(at high speed)

At normal speed, once the hydraulic oil which is through the inner path of spool(47) flows into high speed switching pressure port(The pressure of external pilot : $P_i = 35\text{kgf/cm}^2$) spool(47) moves from right to left.

At high speed, turning pressure of motor(D1) is over 250kgf/cm^2 , when the power forcing to spool(59) (Pressure, P_1) is stronger than spool(47) and spool(59) is pushed out, after then spool(47) moves from left to right. So it is switched.



(High Speed)

21078TM10