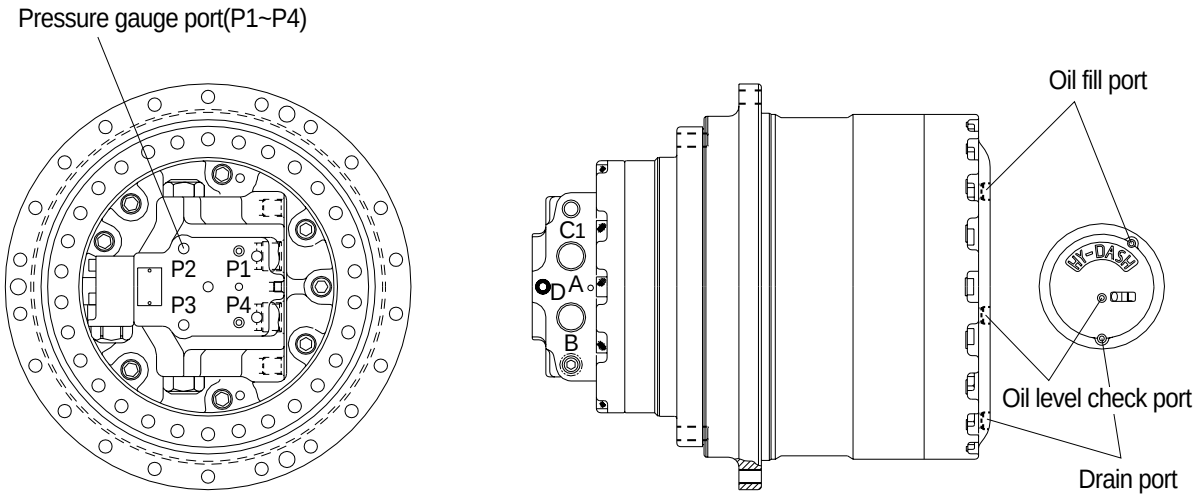
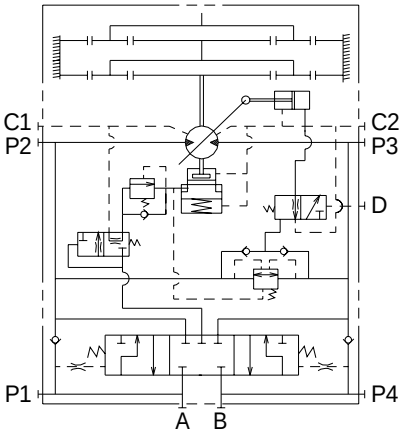
GROUP 4 TRAVEL DEVICE

1. CONSTRUCTION

Travel device consists travel motor and gear box.

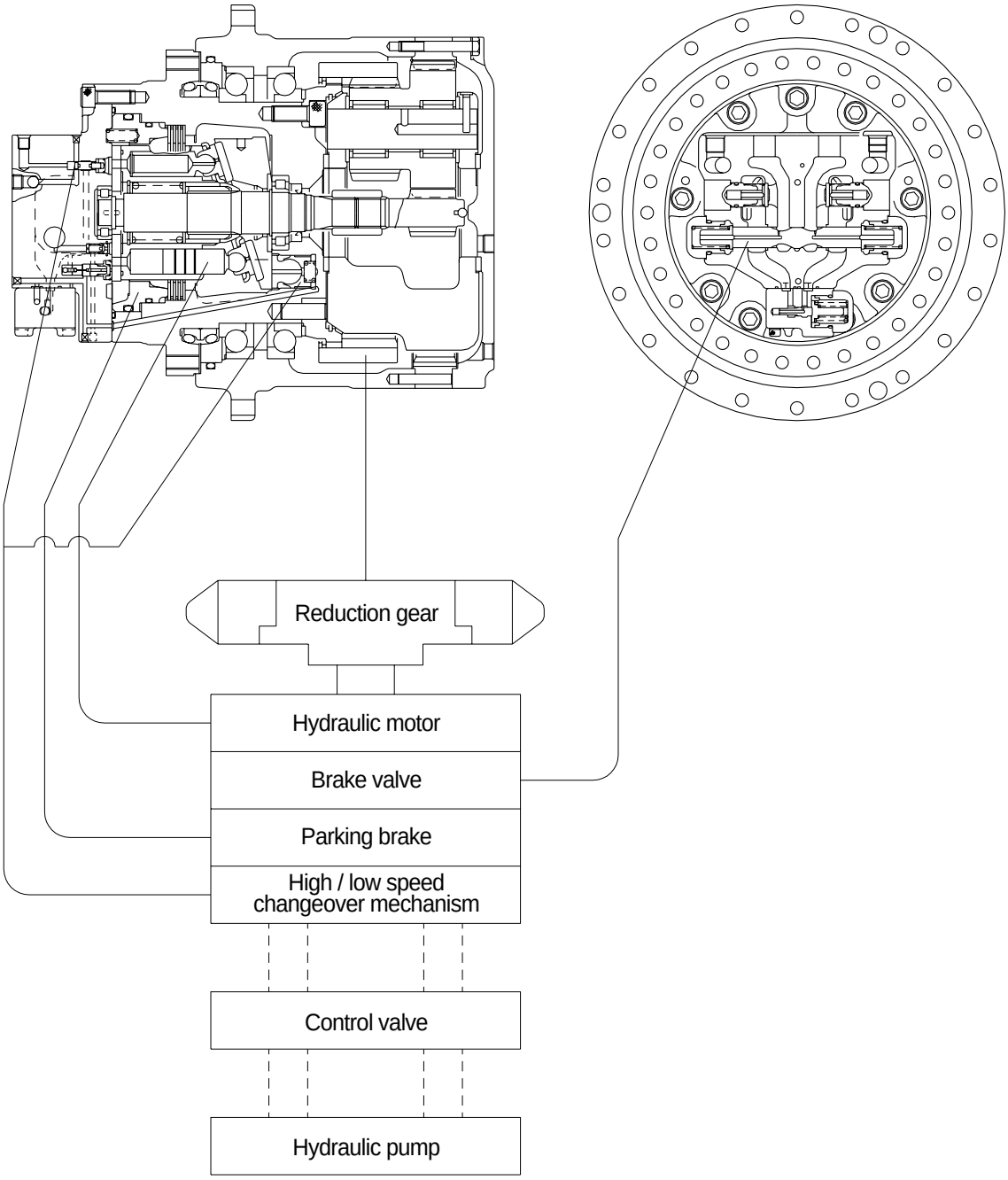
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.



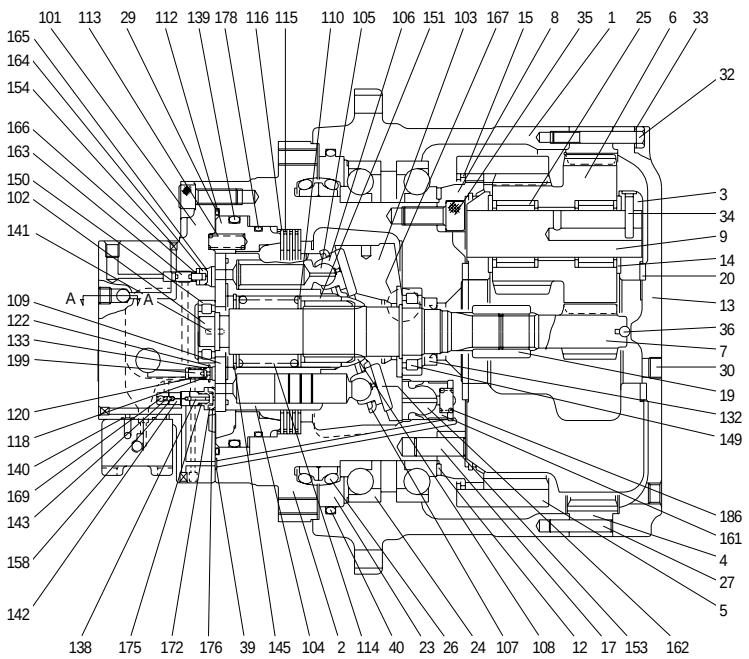


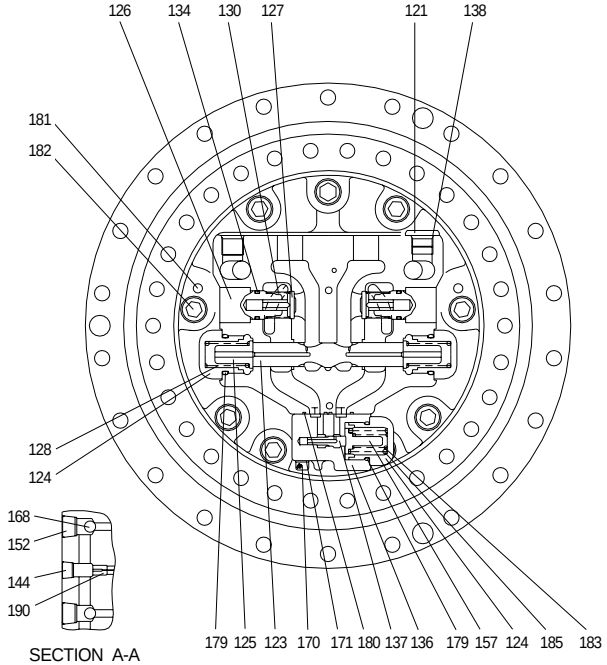
Port	Port name	Port size
A	Main port	PF 1
B	Main port	PF 1
P1~P4	Gauge port	PF 1/4
C1~C2	Drain port	PF 1/2
D	2 speed control port	PF 1/4

1) BASIC STRUCTURE



2) STRUCTURE





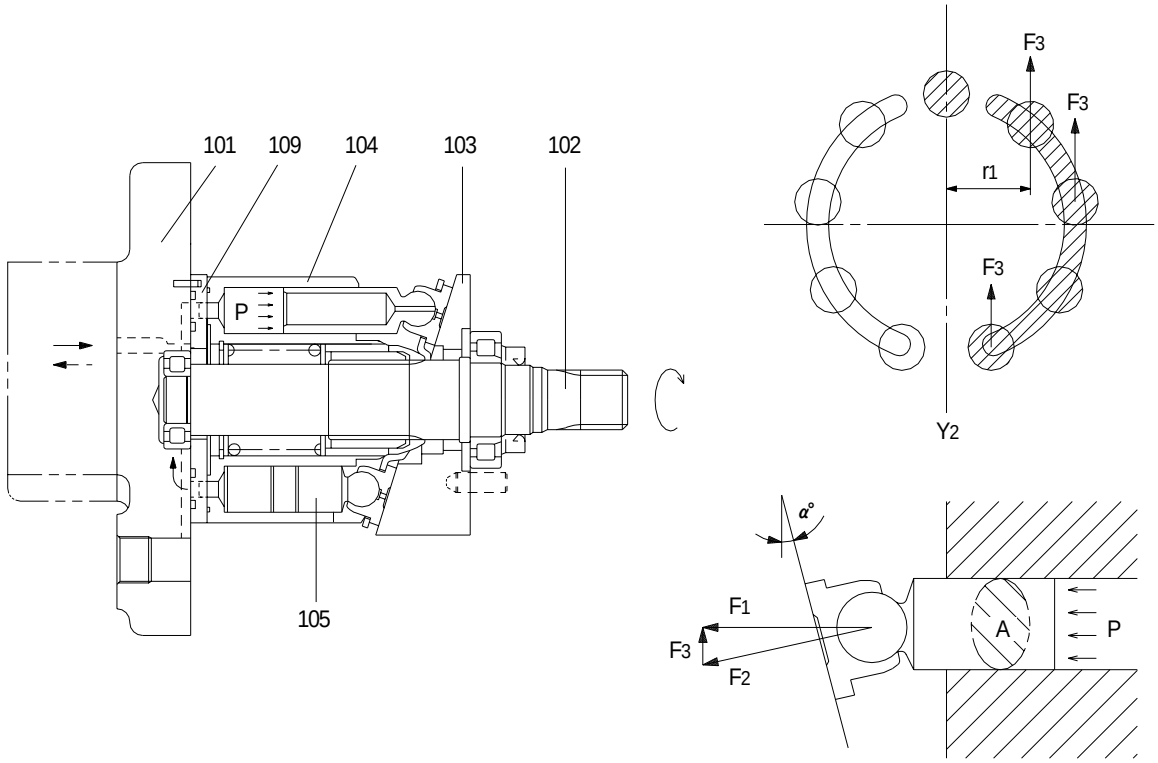
SECTION A-A

1	Hub	24	Ball bearing	105	Piston	124	Plug	143	Spring	167	Steel ball
2	Spindle	25	Needle bearing	106	Shoe	125	Stopper	144	Hexagon socket plug	168	Steel ball
3	Carrier	26	Floating seal	107	Retainer plate	126	Plug	145	Snap ring	169	Expander
4	Ring gear A	27	Pin	108	Thrust ball	127	Valve	149	Roller bearing	170	Hexagon socket bolt
5	Ring gear B	29	O-ring	109	Timing plate	128	Spring	150	Roller bearing	171	Lock washer
6	Cluster gear	30	Hexagon socket bolt	110	Washer	130	Spring	151	Roller	172	Valve seat
7	Sun gear	32	Hexagon bolt	112	Piston	132	Oil seal	152	Hexagon socket plug	175	Spring
8	Coupling gear	33	Lock washer	113	Spring	133	O-ring	153	Thrust plate	176	Ring
9	Shaft	34	Pin	114	Spring	134	O-ring	154	Expander	177	Ring
12	Distance piece	35	Hexagon socket bolt	115	Friction plate	135	Spring pin	157	Stopper	178	O-ring
13	Cover	36	Steel ball	116	Mating plate	136	Body	158	Steel ball	179	O-ring
14	Thrust collar	39	O-ring	118	Valve seat	137	Spool	161	Piston	180	O-ring
15	Ring	40	O-ring	119	Valve	138	O-ring	162	Shoe	181	Pin
17	Pin	101	Rear flange	120	Spring	139	O-ring	163	Valve	182	Hexagon socket bolt
19	Coupling	102	Shaft	121	Plug	140	O-ring	164	Stopper	183	Spring
20	Thrust bearing	103	Swash plate	122	Ring	141	Pin	165	Ring	185	Spring
23	Seal ring	104	Cylinder block	123	Spool	142	Valve	166	Spring	190	Orifice

2. FUNCTION

1) HYDRAULIC MOTOR

(1) Rotary group



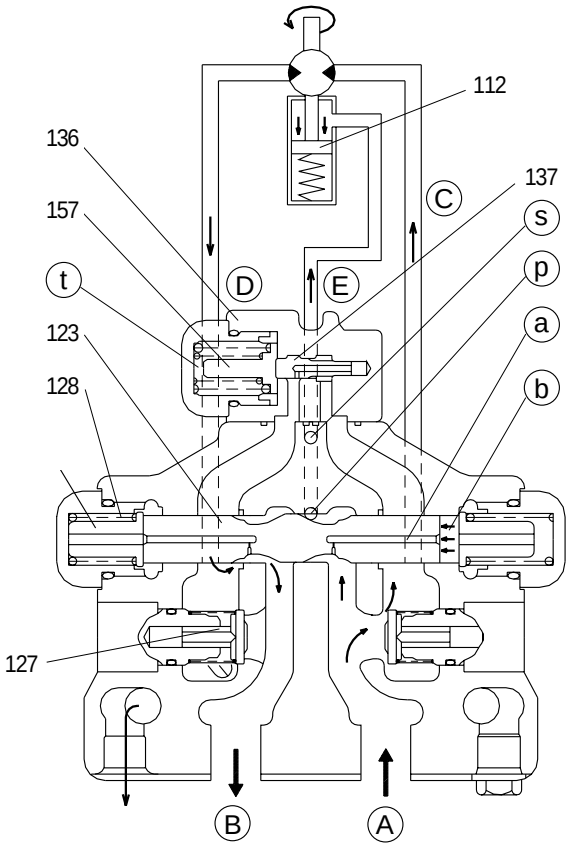
The pressurized oil delivered from the hydraulic pump flows to rear flange(101) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block(104) via timing plate(109). This oil constructively introduced only to one side of Y1 - Y2 connecting the upper and lower dead 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 kg = P kg/cm^2 × A cm^2). This force acts on swash plate(103), and is resolves into components (F2 and F3) because swash plate(103) is fixed at an angle(α°) with the axis of drive shaft(102). Redial component(F3) generates respective torques(T=F3 × ri) for Y1-Y2. This residual of torque(T=F3 × ri) 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

① Brake released (starting/running)

When the pressurized oil supplied for port Ⓐ, the oil opens valve(127) and flows into port Ⓒ at the suction side of hydraulic motor to rotate motor. At the same time, the pressurized oil passes through pipe line ⓐ from a small hole in spool(123) and flows into chamber ⓑ. The oil acts on the end face of spool(123) which is put in neutral position by the force of spring(128), thus causing spool(123) to slide to the left. When spool(123) slides, port Ⓓ on the passage at the return side of hydraulic motor, which is closed by the spool groove during stoppage, communicates with port Ⓑ 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(123) causes the pressurized oil to flow into ports Ⓟ and Ⓢ.

The pressurized oil admitted into port Ⓟ activates piston(112) of the parking brake to release the parking brake force. (For details, refer to description of the parking brake.) On the other hand, the pressurized oil introduced into port Ⓢ flows into chamber ⓣ and presses stopper(157) against the inside of body(136) to prevent spool(137) from moving, thus disabling communication at port Ⓒ side of the hydraulic motor. (suction side and return side of hydraulic motor). When the pressurized oil is supplied from port Ⓑ, spool(123) and valve(127) move reversely and the hydraulic motor also rotates reversely.



② Brake applied(stopping/stalling)

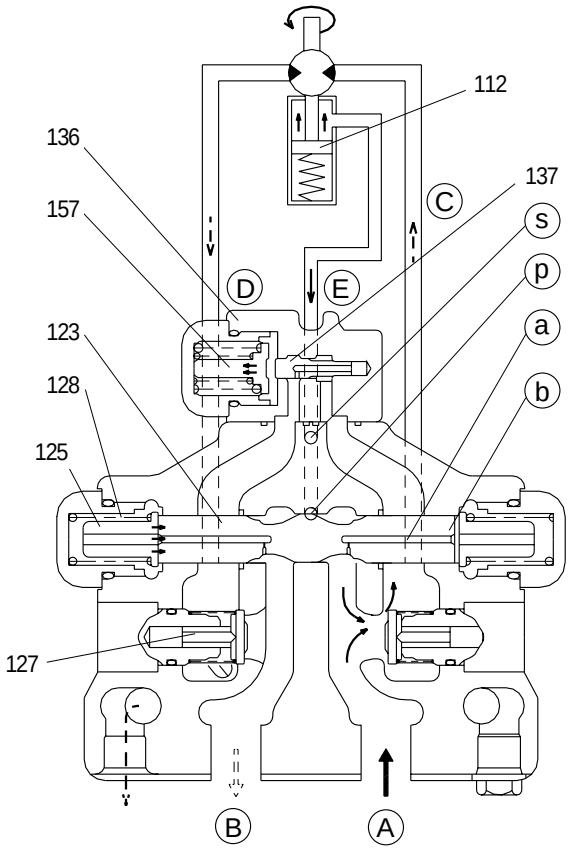
When the pressurized oil supplied from port Ⓐ is stopped during traveling, no hydraulic pressure is applied and spool(123) which has slided to the left will return on the right(neutral) via stopper(125) by the force of spring(128). The oil in chamber ⓑ will flow to port Ⓐ side through pipe line ⓐ in spool(123). However, a back pressure produced by the restricting effect of pipe line ⓐ, whereby the return speed of spool(123) is controlled. At the same time, the hydraulic motor will rotate by the force of inertia even if the pressurized oil is stopped. Accordingly, the return oil will return to port Ⓑ side from port Ⓓ through a passage between the groove in spool(123) and rear flange(101). When spool(123) completely returns to neutral, the above-mentioned passage is fully closed and the hydraulic motor stops.

As explained above, the hydraulic motor is smoothly braked and stopped by gradually controlling the return oil from the hydraulic motor by the return speed of spool(123), its shape, etc.

However, the hydraulic motor will rotate by the force of inertia. This means that the hydraulic motor will suck oil functioning as a pump.

However, no oil is supplied because the pressurized oil is stopped. In consequence, cavitation occurs on the hydraulic motor, thus adversely affecting it.

At the same time, the passage closed by spool(123), whereby the return oil from the hydraulic motor is enclosed at port Ⓓ side and the pressure is increased. This pressure slides spool(137) to the left to short-circuit ports Ⓓ and Ⓒ, which prevents pressure rise and cavitation. (surge cut valve function and anti-cavitation valve function).

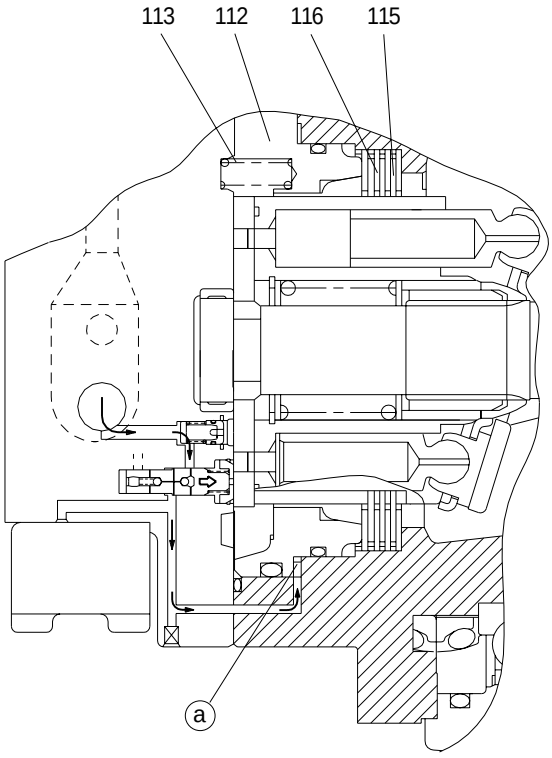


Valve(127) is activated by a slight negative pressure to open the oil passage between the oil line at port Ⓐ side and port Ⓒ at the suction side of motor, thus preventing cavitation of the hydraulic motor.

(3) Parking brake

① 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 9.5 kgf/cm^2 (0.93 Mpa) or more, it overcomes the force of spring(113) and shifts piston(112). With shift of piston(112), no pressing force is applied to pressure 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. When the hydraulic pressure reaches 45 kgf/cm^2 (4.41 Mpa) or more, it is reduced by the reducing valve to set the pressure in cylinder chamber ⓐ to 45 kgf/cm^2 (4.41 Mpa). Assembled in the reducing valve is a safety valve which is set to 100 kgf/cm^2 (9.81 Mpa).



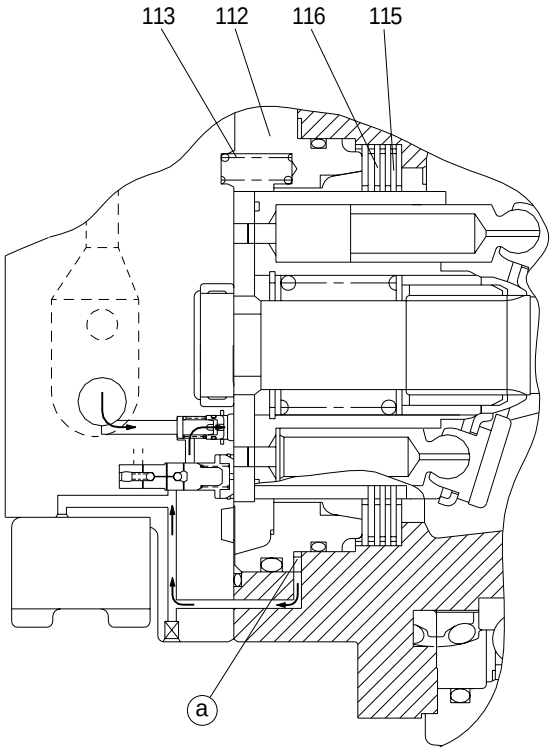
② Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber ⓐ drops 9.5 kgf/cm^2 (0.93 Mpa) or less, piston(112) will return by the force of spring(113).

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

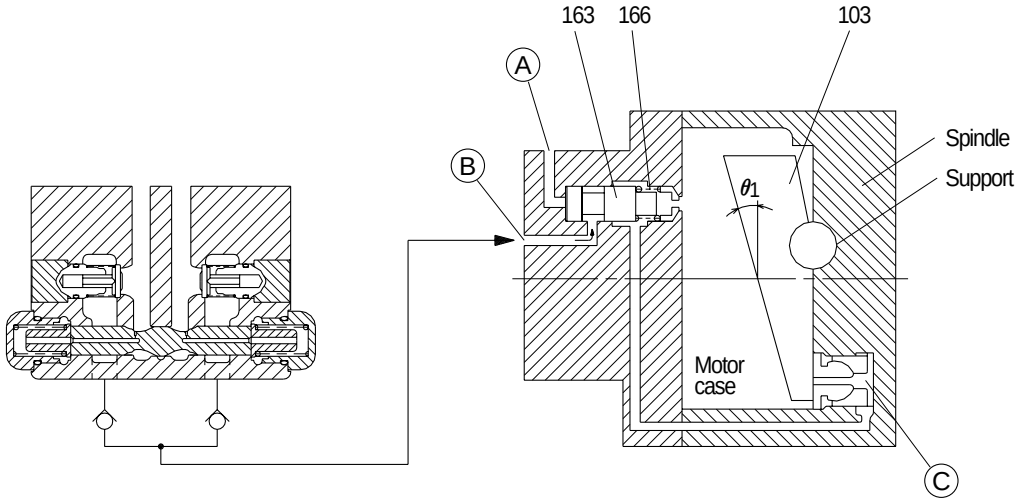
The friction force produced by this pressing stops rotation of the cylinder and gives a braking torque 49.3kgf·m (483 N·m) to the hydraulic motor shaft.

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



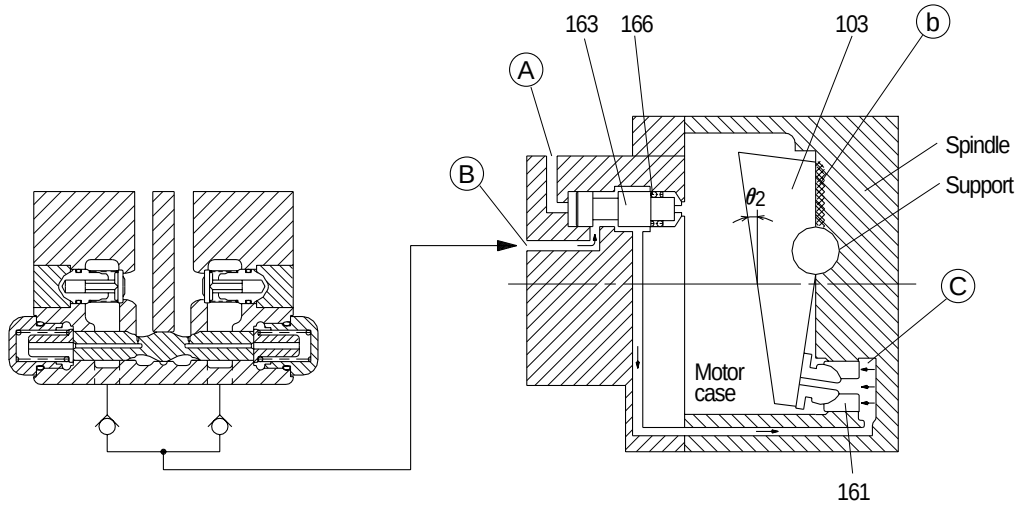
(4) High/low speed changeover mechanism

① **At low speed** - at pilot pressure of less than 20 kgf/cm² (1.96 Mpa)



When no pilot pressure is supplied from port Ⓐ (at a pressure of 20 kgf/cm² (1.96 Mpa) or less), valve(163) is pressed toward the left by the force of spring(166), the pressurized oil supply port Ⓑ is shut off, and oil in chamber Ⓒ is released into the motor case via valve(163). 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 rotation.

② **At high speed** - at pilot pressure of 20 kgf/cm² (1.96 Mpa) or more



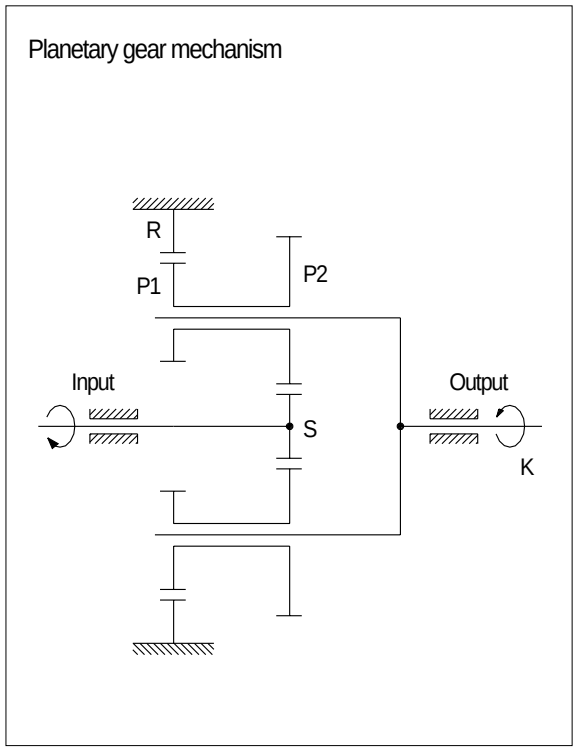
When a pilot pressure is supplied from port Ⓐ (at a pressure of 20 kgf/cm² (1.96 Mpa) or more), the pressure overcomes the force of spring(166) and valve(163) is pressed toward the right. The pressurized oil at supply port Ⓑ is then introduced into chamber Ⓒ via valve(163). Piston(161) pushes up swash 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 rotation.

2) REDUCTION GEAR

(1) Function

The reduction gear unit consists of a combination of simple planetary gear mechanism and differential gear mechanism.

This mechanism reduce the high speed rotation from the hydraulic motor and convert it into low speed, high torque to rotate the hub(or case), which in turn rotates the sprocket.



(2) Operating principle

Upon rotation of the sun gear(S) via the input shaft, the planetary gear(P) engages with the fixed ring gear(R) while rotating on its axis.

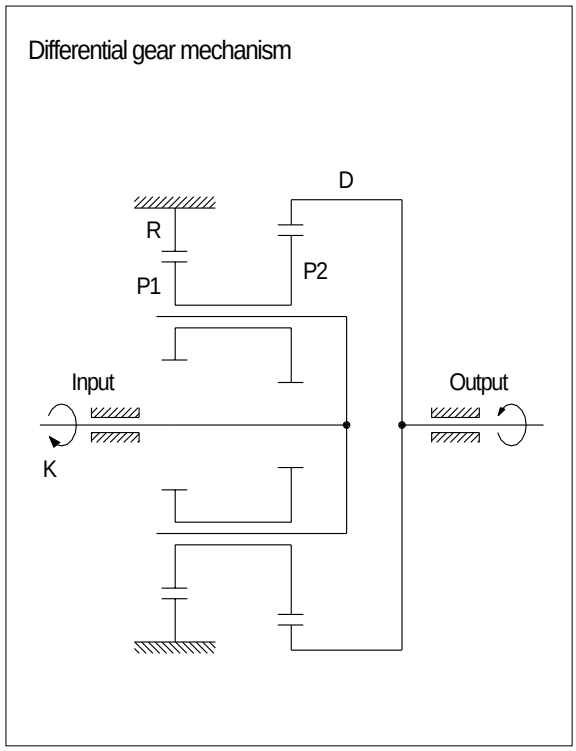
Rotation around the fixed ring gear(R) is transmitted to the carrier(K).

$$i1 = 1 + \frac{R \cdot P2}{S \cdot P1}$$

With rotation of the carrier(K), the planetary gears(P1) and (P2) rotate around the fixed ring gear(R).

When a proper difference in number of teeth is given between(P1) and (R) and between (P1) and (P2), a difference in rotation is produced on the gear(D) because the gears (P1) and (P2) are on the same axis.

$$i2 = \frac{1}{1 - \frac{R \cdot P2}{D \cdot P1}}$$



Upon rotation of the sun gear(S) via the input shaft, planetary motion is given among the gears(S), (P1) and (R) and rotation of the gear(P1) around another gear causes the carrier(K) to rotate.
This carrier rotation gives differential motion among the gears(R), (P1), (P2) and (D) to rotate the ring gear(D). The motor then rotates since the ring gear(D) is connected to the hub(case) of the motor.

$$i = i1 \times i2 = \frac{1 + \frac{R \cdot P2}{S \cdot P1}}{1 - \frac{R \cdot P2}{D \cdot P1}}$$

Combination of planetary gear mechanism and differential gear mechanism