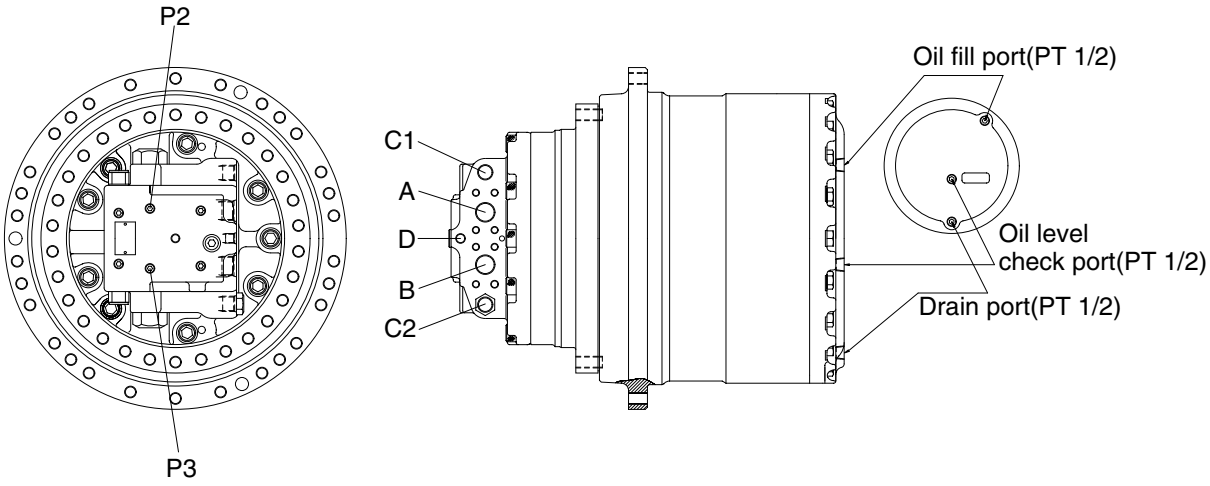
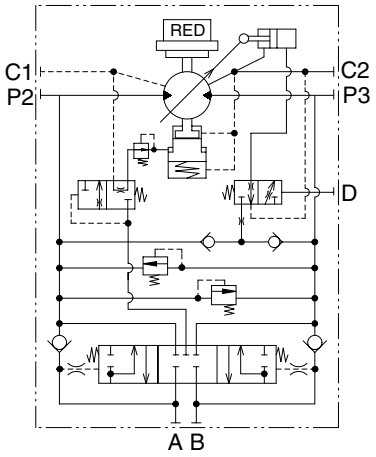
GROUP 4 TRAVEL DEVICE

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	SAE 5000psi 1"
B	Main port	SAE 5000psi 1"
P1~P4	Gauge port	PF 1/4
C1~C2	Drain port	PF 1/2
D	2 speed control port	PF 1/4

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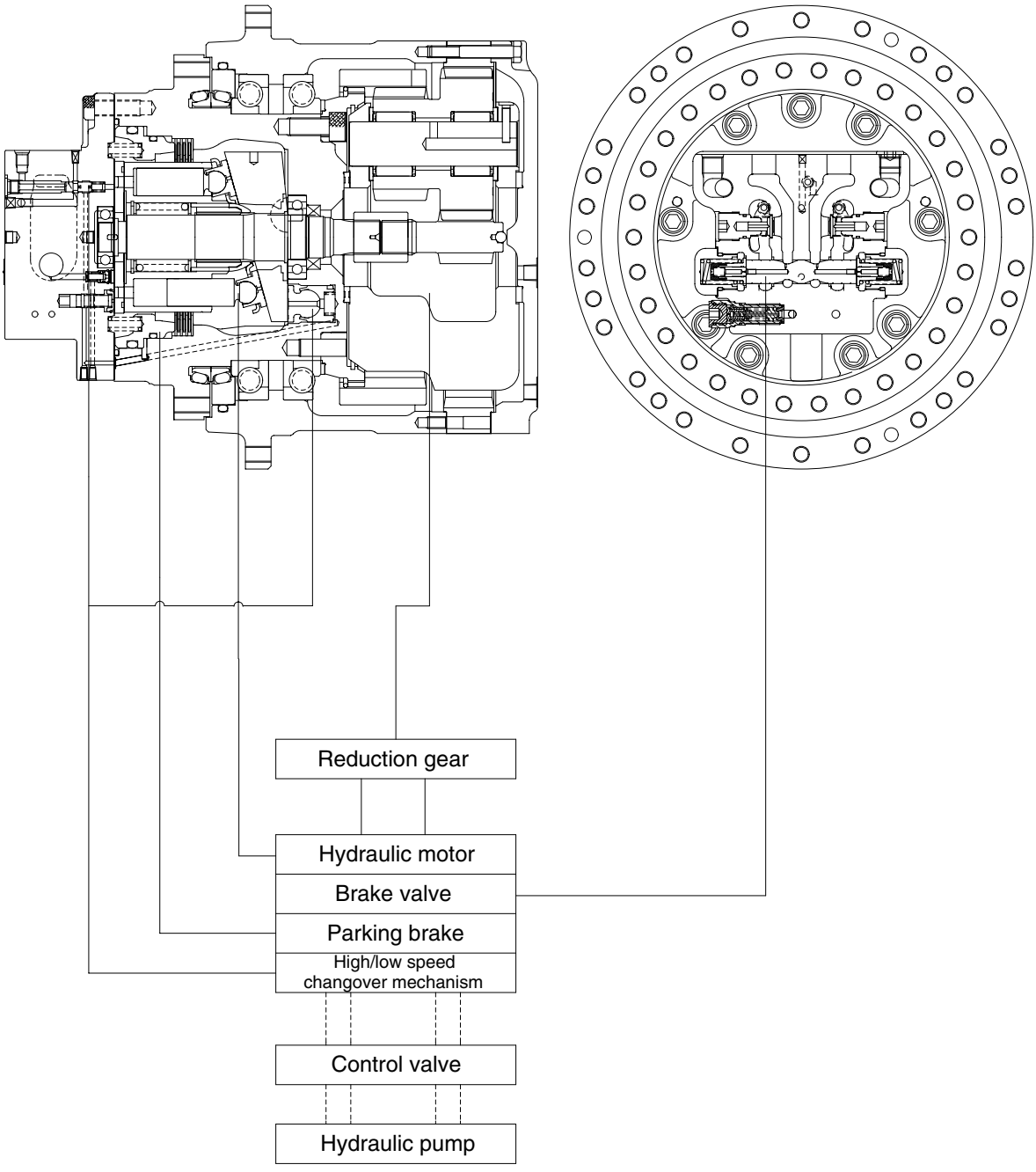
1) BASIC STRUCTURE



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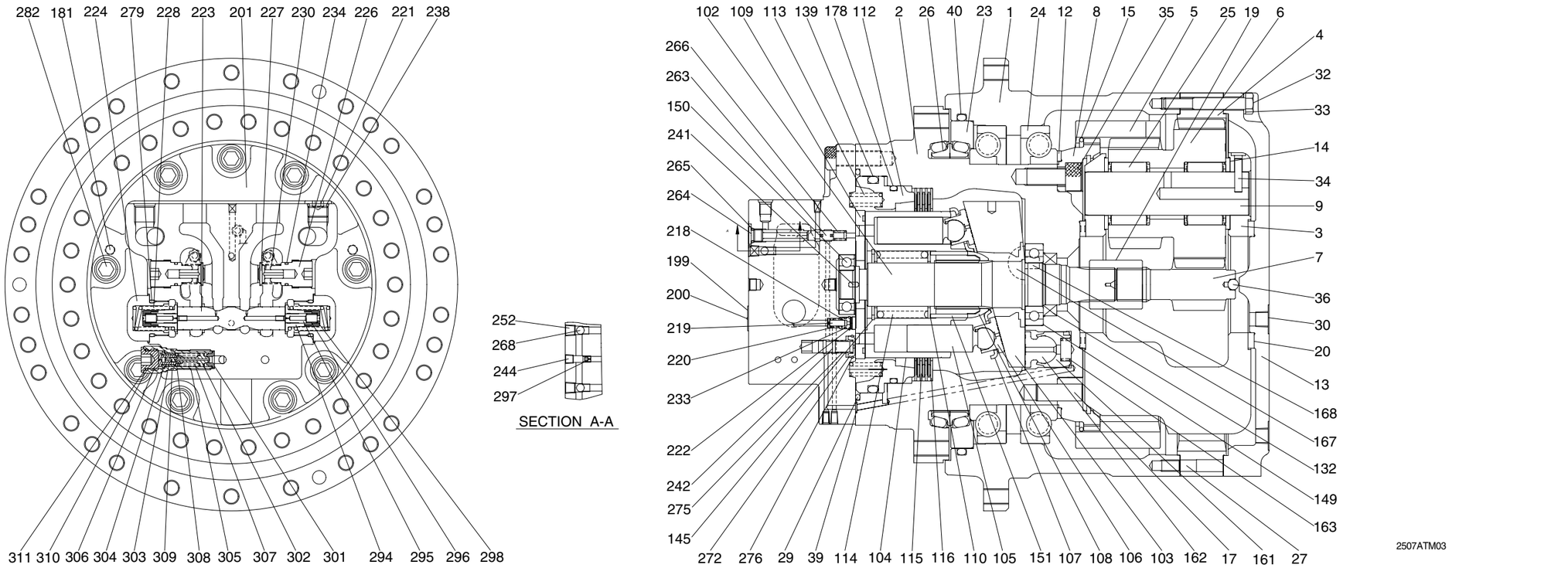
2) STRUCTURE

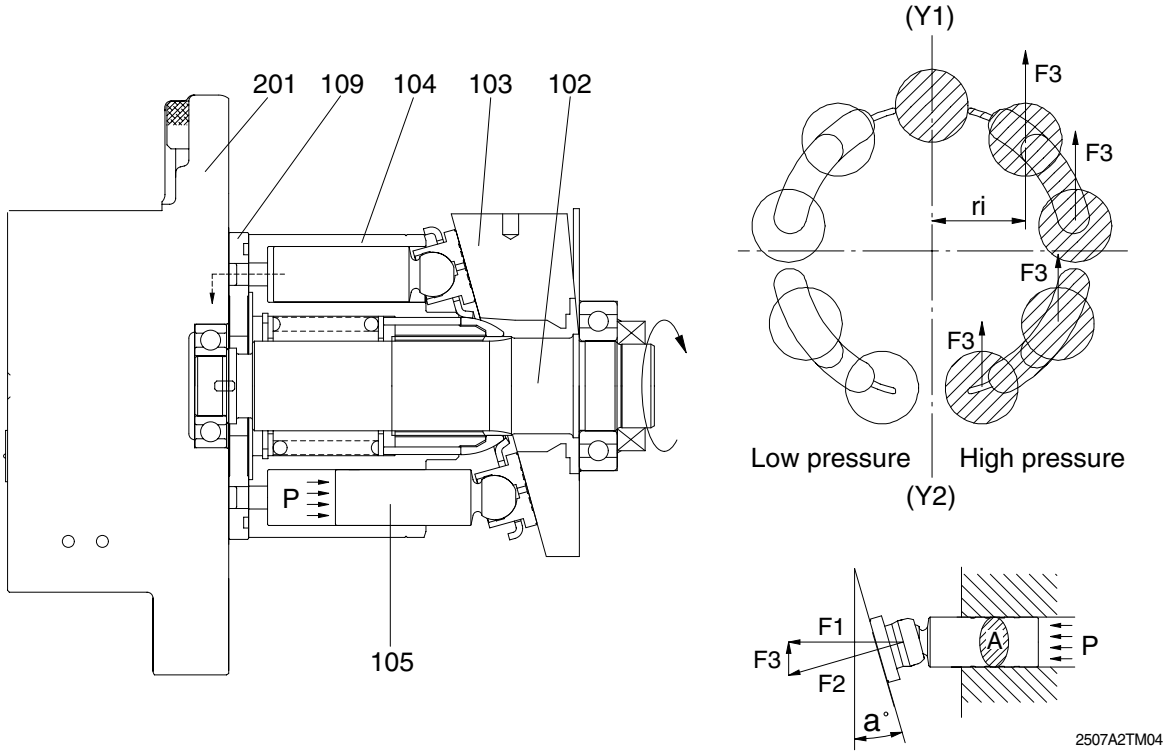


1	Hub	25	Needle roller bearing	108	Thrust ball	168	Parallel pin	234	O-ring	295	Spool
2	Spindle	26	Floating seal	109	Timing plate	178	O-ring	238	O-ring	296	Spring
3	Carrier	27	Parallel pin	110	Washer	181	Pin	241	Parallel pin	297	Orifice
4	Ring gear A	29	O-ring	112	Piston	199	Name plate	242	Reducing Valve	298	Stopper B
5	Ring gear B	30	Plug	113	Spring	200	Rivet screw	244	Plug	301	Seat
6	Cluster gear	31	Hexagon bolt	114	Spring	201	Rear flange	252	Plug	302	Plunger
7	Sun gear	33	Spring washer	115	Friction plate	218	Seat valve	253	Plug	303	Rod
8	Coupling gear	34	Parallel pin	116	Mating plate	219	Valve	263	Spool	304	Piston
9	Cluster shaft	35	Hexagon socket bolt	132	Oil seal	220	Spring	265	O-ring	305	Body
12	Distance piece	36	Steel ball	139	O-ring	221	Plug	266	Spring	306	Plug
13	Cover	39	O-ring	145	Snap ring	222	Ring	267	Set screw	307	Spring
14	Thrust collar	40	O-ring	149	Ball bearing	223	Main spool	268	Steel ball	308	Shim
15	O-ring	102	Shaft	150	Ball bearing	224	Plug	272	Valve seat	309	O-ring
17	Pin	103	Swash plate	151	Needle roller	226	Plug	275	Spring	310	O-ring
19	Coupling	104	Cylinder block	161	Piston	227	Valve	276	Ring	311	Back up ring
20	Thrust plate	105	Piston	162	Shoe	228	Spring	279	O-ring		
23	Seal ring	106	Shoe	163	Spring	230	Spring	282	Socket bolt		
24	Ball bearing	107	Retainer plate	167	Pivot	233	O-ring	294	Stopper A		

2. FUNCTION

1) HYDRAULIC MOTOR

(1) Rotary group



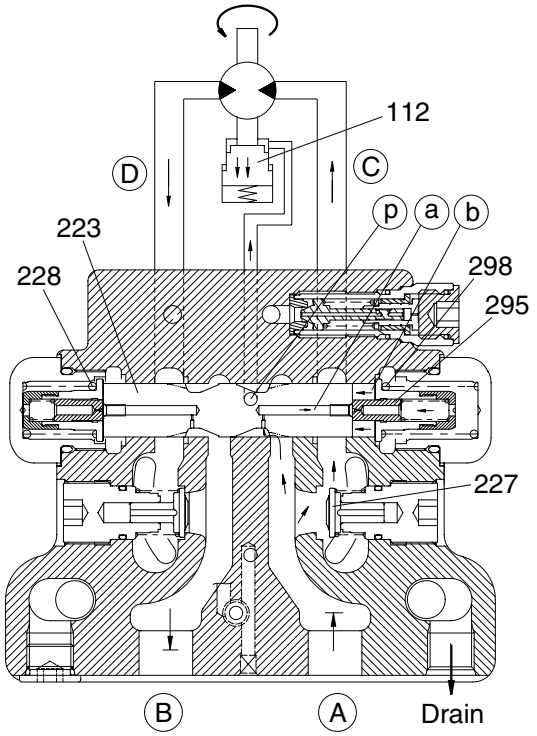
The pressurized oil delivered from the hydraulic pump flows to rear flange(201) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block(104) via timing plate(109). This oil constructively introduced only to one side of Y1-Y2 connecting the upper and lower dead points 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 from port , the oil opens valve(227) 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(223) and flows into chamber ⓑ. The oil acts on the end face of spool(223) which is put in neutral position by the force of spring(228), thus causing spool(223) to side to the left. When spool(223) slides, port on the passage at the return side of hydraulic motor, which is closed by the spool groove during stoppage, connected 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(223) causes the pressurized oil to flow into ports .

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.) When the pressurized oil is supplied from port , spool(223) and valve(227) move reversely and the hydraulic motor also rotates reversely.



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② **Brake applied**(Stopping / Stalling)

When the pressurized oil supplied from port(A) is stopped during traveling, no hydraulic pressure is applied and spool(223) which has slided to the left will return on the right(neutral) via stopper (295) by the force of spring(228).

The oil in chamber(b) will flow to port(A) side through pipe line(a) in spool(223). However, a back pressure produced by the restricting effect of pipe line(a), whereby the return speed of spool(223) 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(B) side from port(D) through a passage between the groove in spool(223) and rear flange(201).

When spool(223) completely 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(223), its shape, etc.

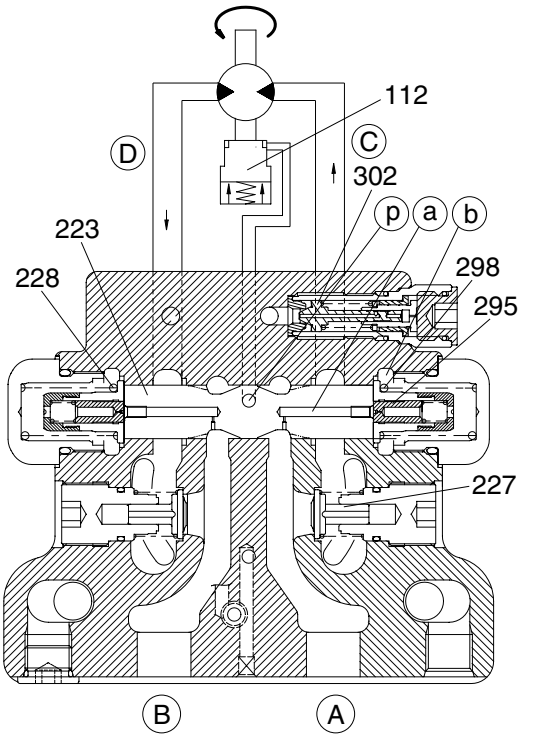
However, the hydraulic motor will rotate by the force of inertia. This means that the hydraulic motor will suck oil functioning as a pump.

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(223), whereby the return oil from the hydraulic motor is enclosed at port(D) side and the pressure is increased.

This pressure slides plunger[302] to the right to short-circuit port(D) and (C), which prevents pressure rise and cavitation.

Valve(227) is activated by a slight negative pressure to open the oil negative passage between the oil line at port(A) side and port(C) at the suction side of motor, thus preventing cavitation of the hydraulic motor.



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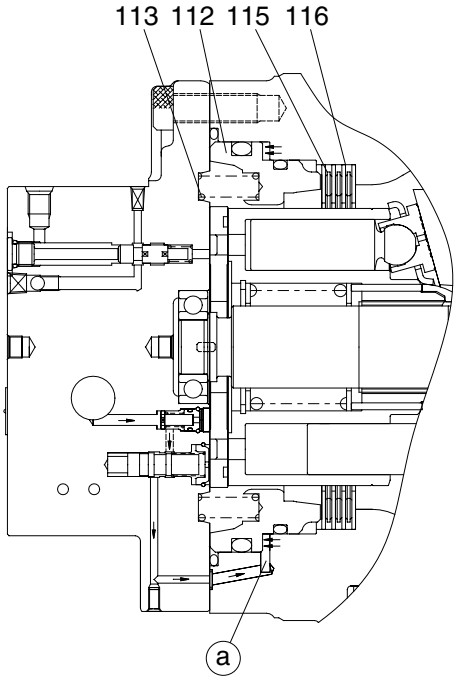
(3) Parking brake

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 11kgf/cm²(1.08Mpa) 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.

When the hydraulic pressure reaches 45kgf/cm²(4.41Mpa) or more it is reduces by the reducing valve to set the pressure in cylinder chamber ⓐ to 45kgf/cm² (4.41Mpa).



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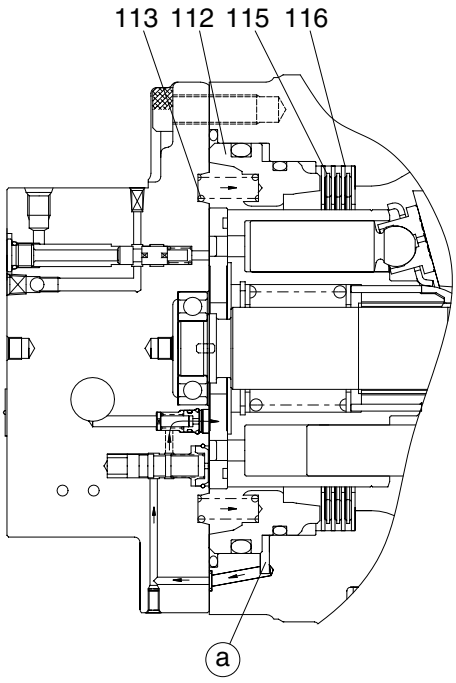
② Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber ⓐ drops 11kgf/cm² (1.08Mpa) 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 and gives a braking torque 49.3kgf · m (483N · m) to the hydraulic motor shaft.

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



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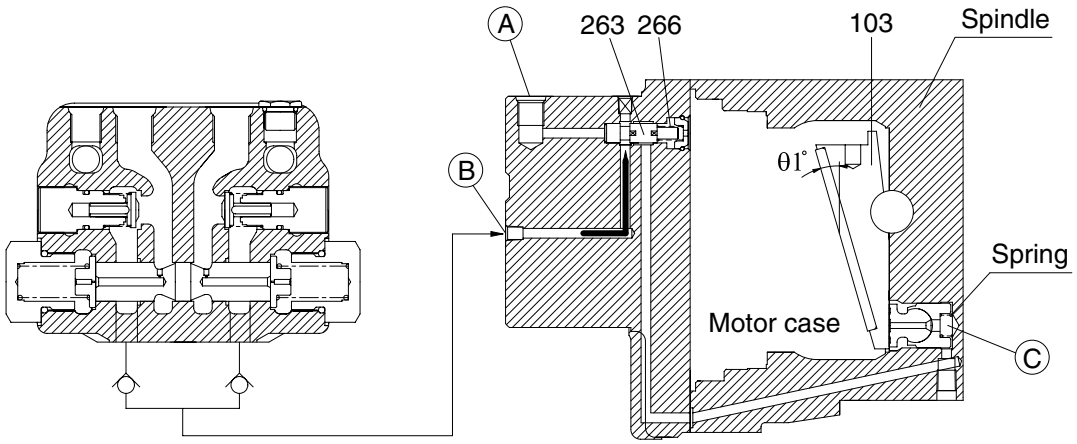
(4) High/low speed changeover mechanism

① **At low speed** - At pilot pressure of less than 15kgf/cm²(1.47Mpa)



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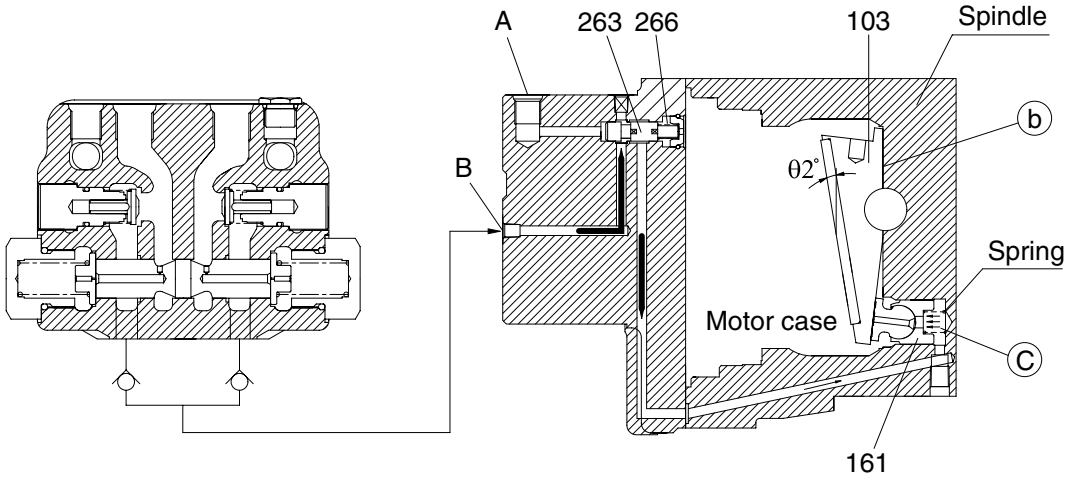
When the pilot pressure is supplied from port £ (at a pressure of 15kgf/cm², 1.47Mpa or less), valve(263) is pressed toward the left by the force of spring(266), the pressurized oil supply port £ is shut off, and oil in chamber £ is released into the motor case via valve(263). Consequently, swash plate(103) is tilted at a maximum angle(θ_1) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed operation.

② **At high speed** - At pilot pressure of 15kgf/cm²(1.47Mpa) or more



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When a pilot pressure supplied from port £ (At a pressure of 15kgf/cm², 1.47Mpa or more), the pressure overcomes the force of spring(266) and valve(263) is pressed toward the right. The pressurized oil supply port £ is then introduced into chamber £ via valve(263). 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

The reduction gear unit consists of 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).

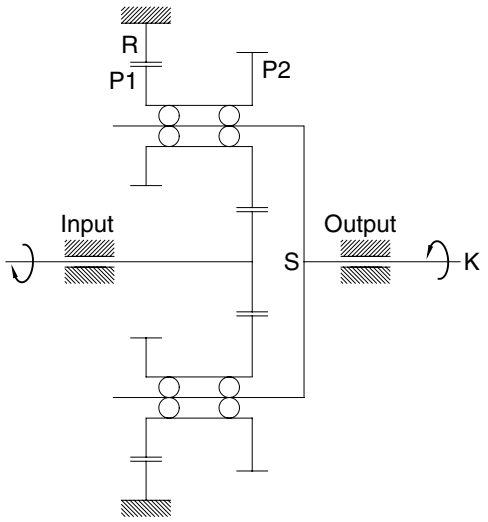
$$i1 = 1 + \frac{R \times P2}{S \times P1}$$

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.

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

Planetary gear mechanism



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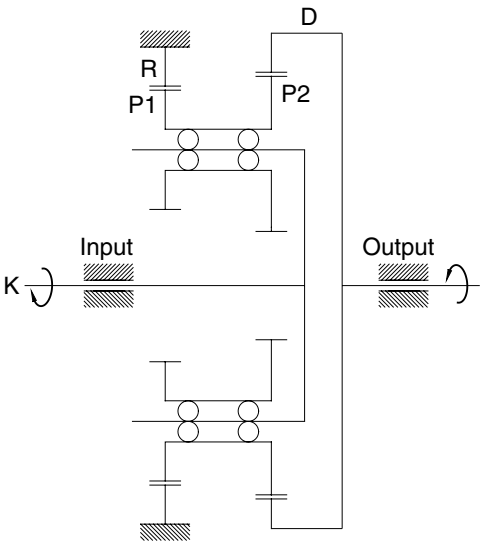
Differential gear mechanism



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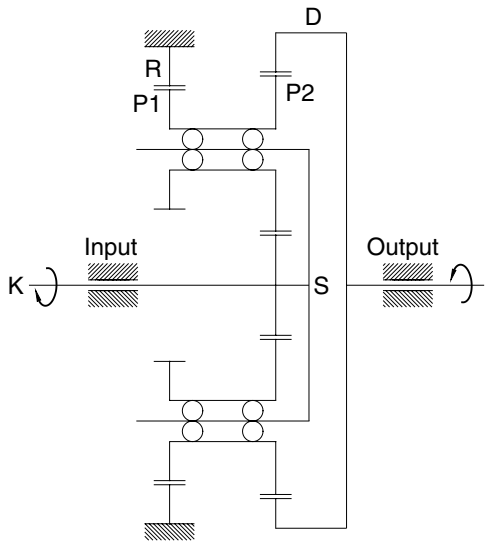
Upon rotation of the sun gear(S) via the input shaft, planetary motion is given among the gears(S), (P1) and (R) and rotation of the gear(P1) around another gear causes the carrier(K) to rotate.
This carrier rotation gives differential motion among the gears(R), (P1), (P2) and (D) to rotate the ring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

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

Combination of planetary gear mechanism and differential gear mechanism



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