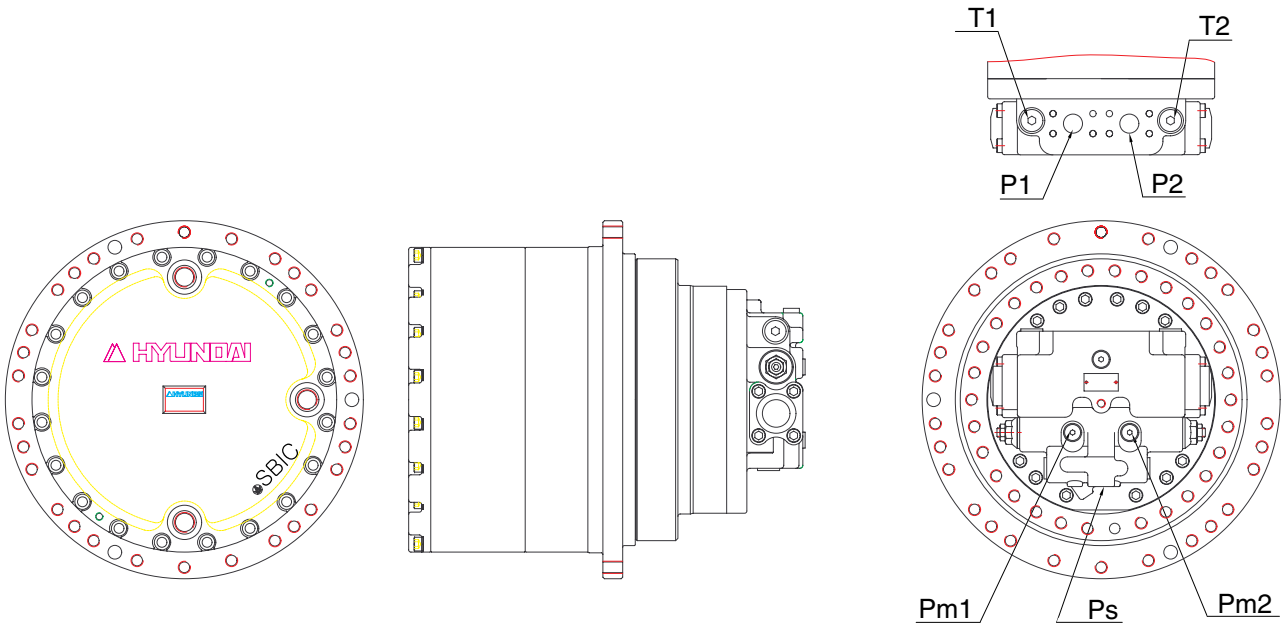
GROUP 4 TRAVEL DEVICE

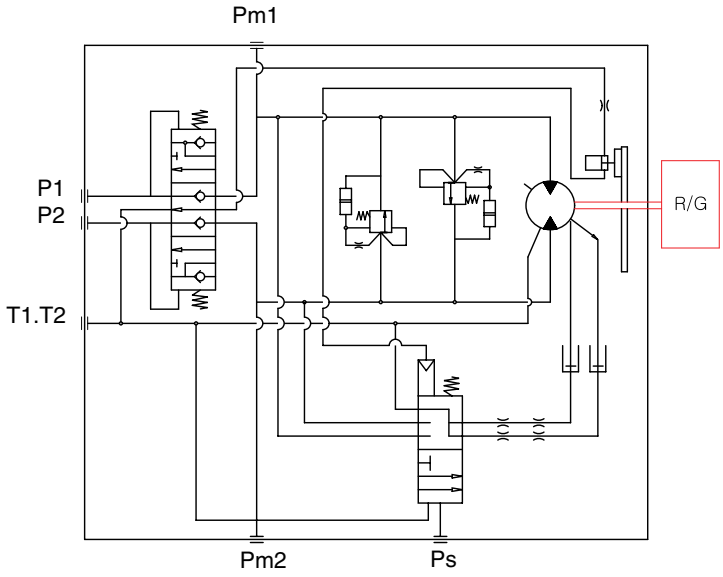
1. STRUCTURE

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



21078TM04

Port	Port name	Port size
P_1, P_2	Main port(IN)	SAE 4694psi
P_2, P_1	Main port(OUT)	SAE 4694ps
Pm_1, Pm_2	Gauge port	PF 1/4
T_1, T_2	Prain port	PF 1/2
Ps	2 speed control port	PF 1/4

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).

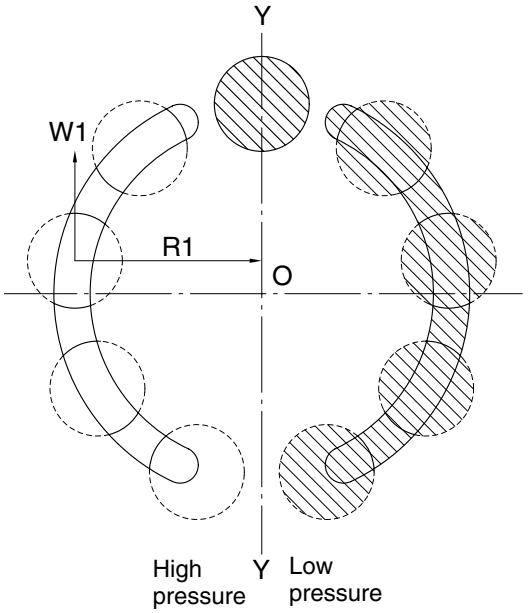
The high hydraulic can generate the force, F1 = P × A(P : Supplied pressure, A : water pressure area), like following pictures, working on a piston.

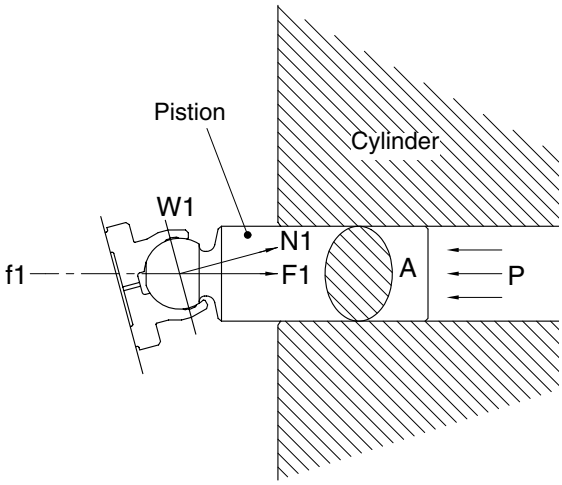
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate(09) of a tilt angle, α.

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

The sum of torque(ΣW1 × 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.





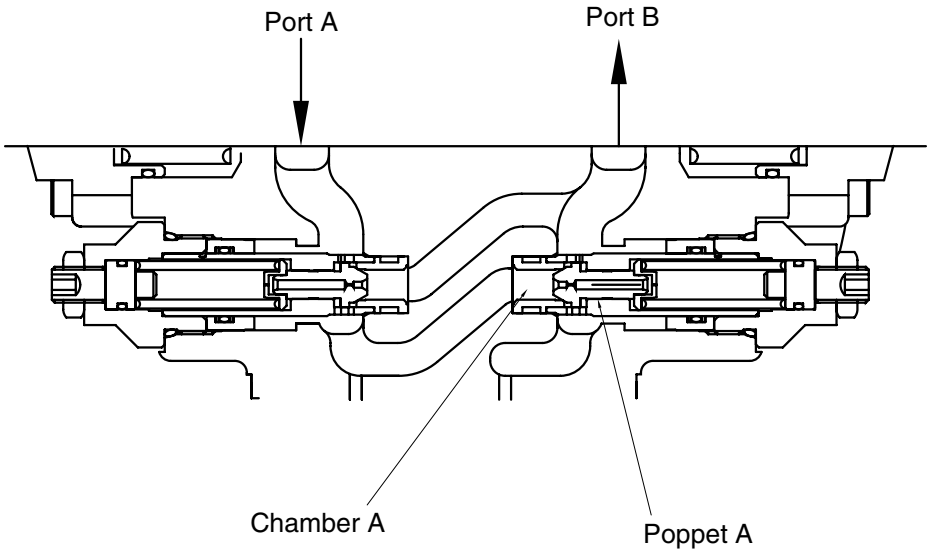
21078TM05

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.

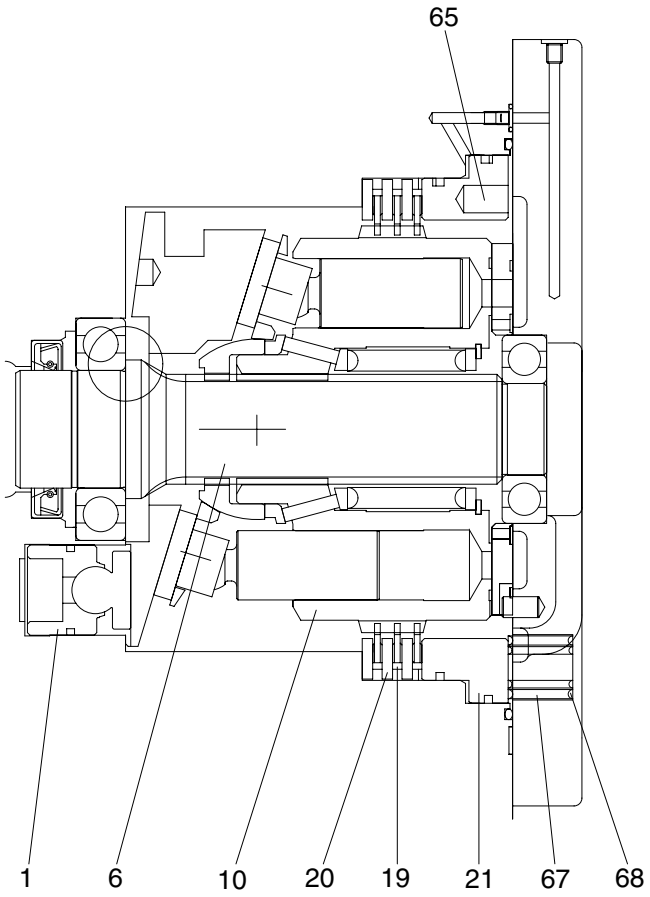
2) In case of an inertia stopped, it forces an equipment stopped, according to generating the pressure of a brake on the projected side.
Room A is always connected with port A of a motor. If the pressure of port is increased, press poppet A. And if it is higher than the setting pressure of a spring, the oil of an hydraulic flows from room A to port B, because poppet A is detached from the contact surface of seat A.



21078TM06

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.

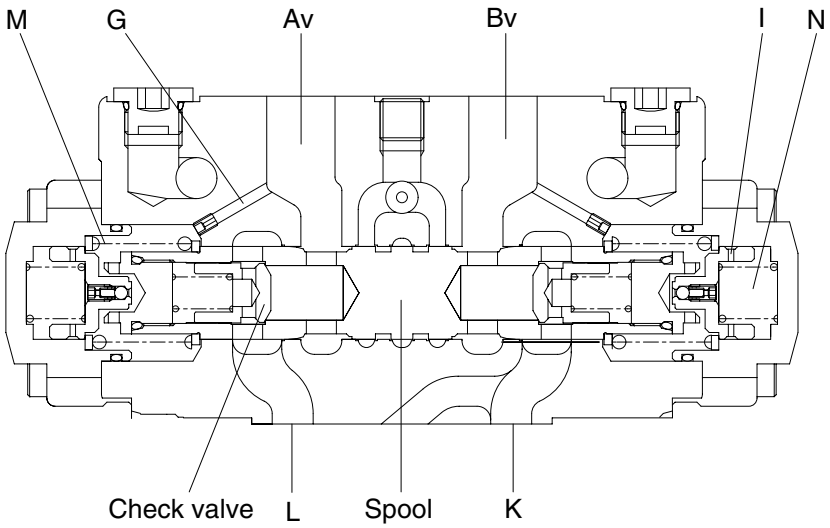


21078TM07

2.4 Counterbalance valve

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

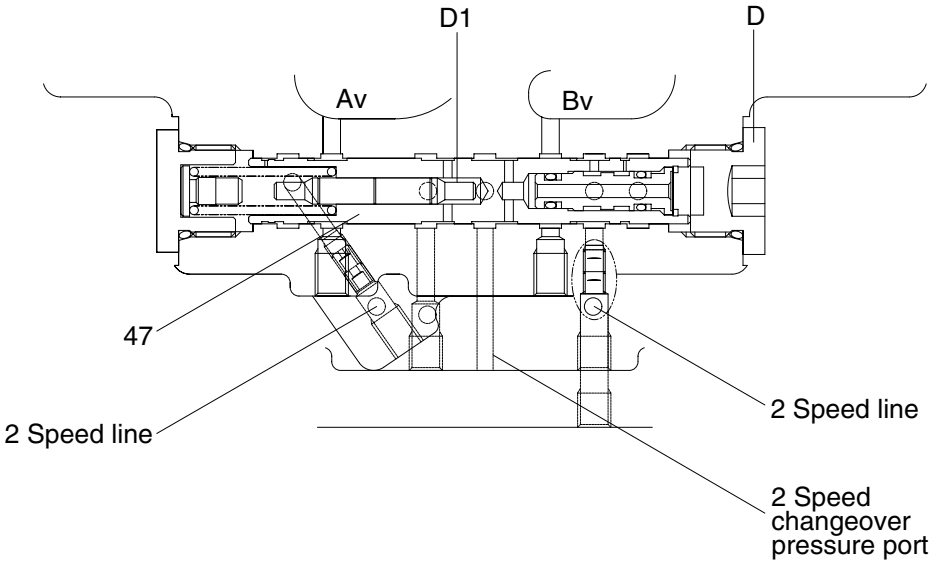
An oil supplied to a hydraulic pump presses check valve on Av → Cv; through L port, is provided to a hydraulic motor. It makes a hydraulic motor circulated. However, the oil pressure out of a pump is increased and transferred to spring room, M, through the path, G, because negative brake is working on. 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 → Bv.



21078TM08

2.5 Working description of automatic switch(at normal speed)

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



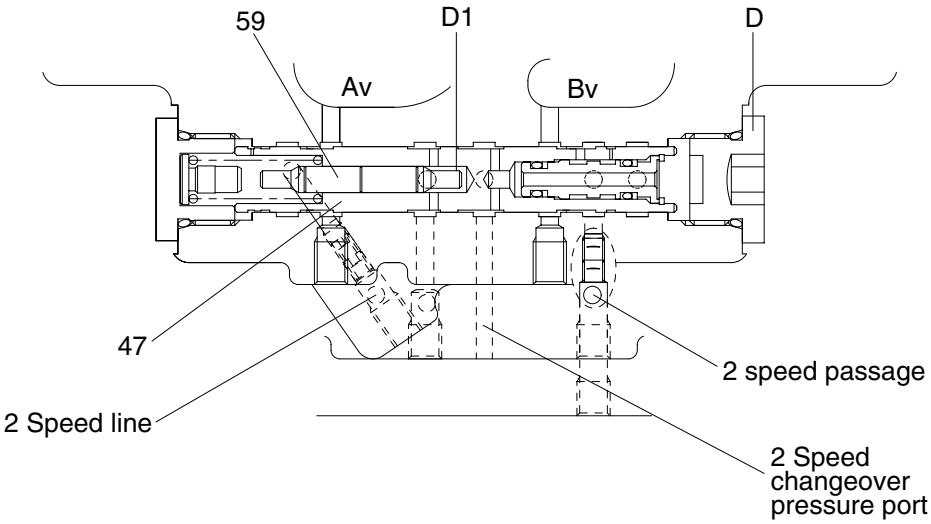
(Normal Speed)

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 : Pi = 35kgf/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, P1) 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)

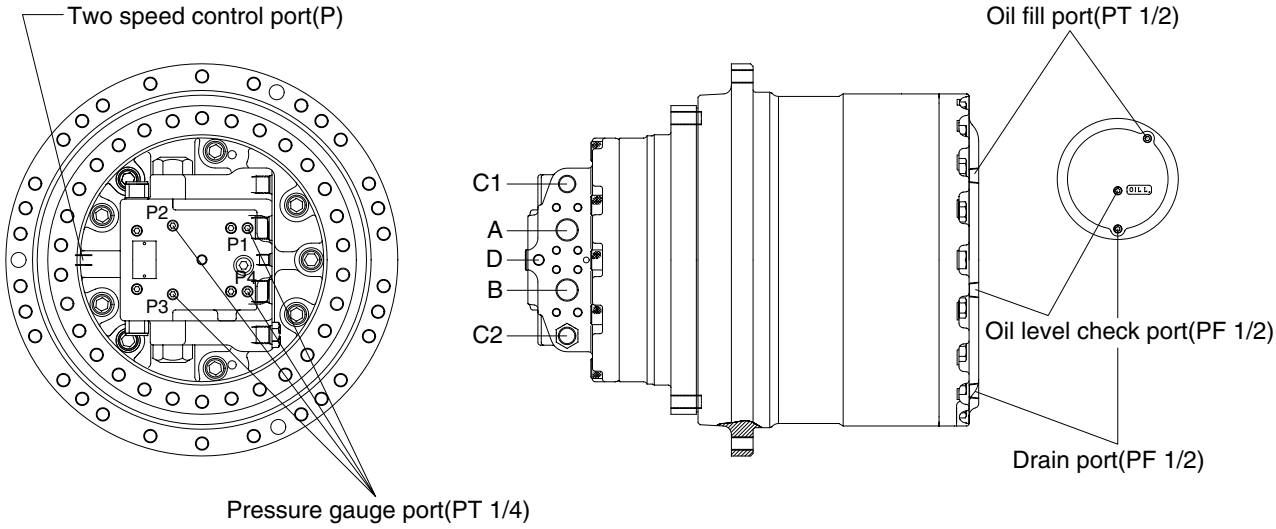
21078TM10

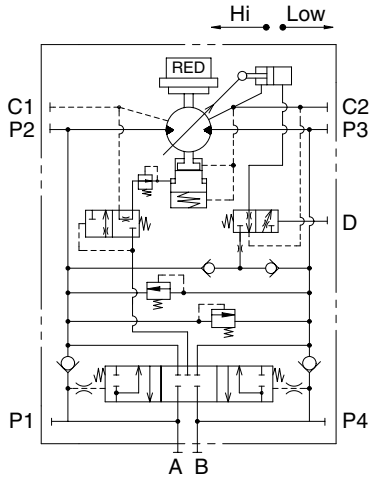
GROUP 4 TRAVEL DEVICE(TM40VC)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



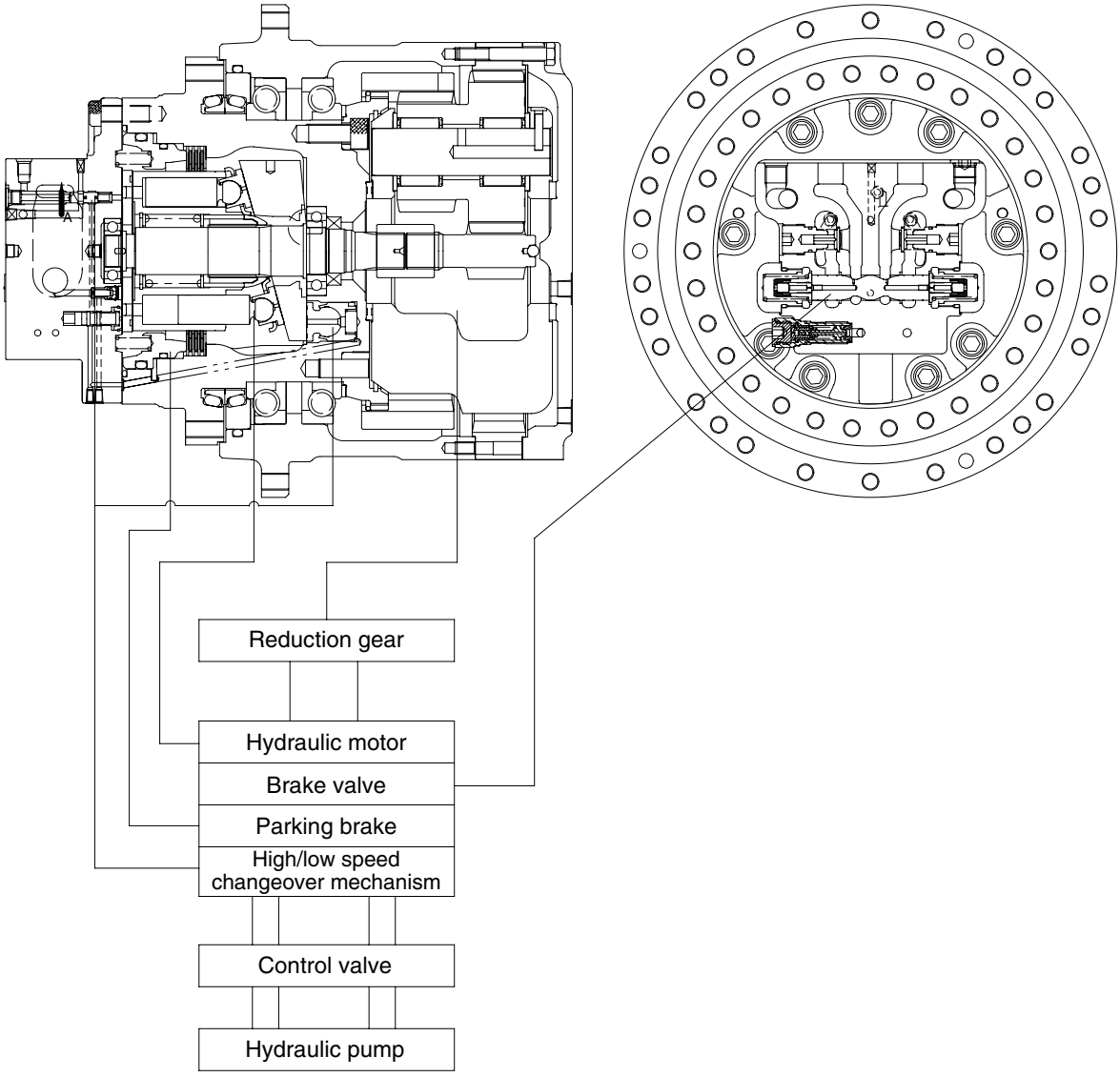


Hydraulic circuit

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, P4	Gauge port	PT 1/4
C1, C2	Drain port	PF 1/2
D	Drain port	PF 1/4
P	2 speed control port	PT 1/8

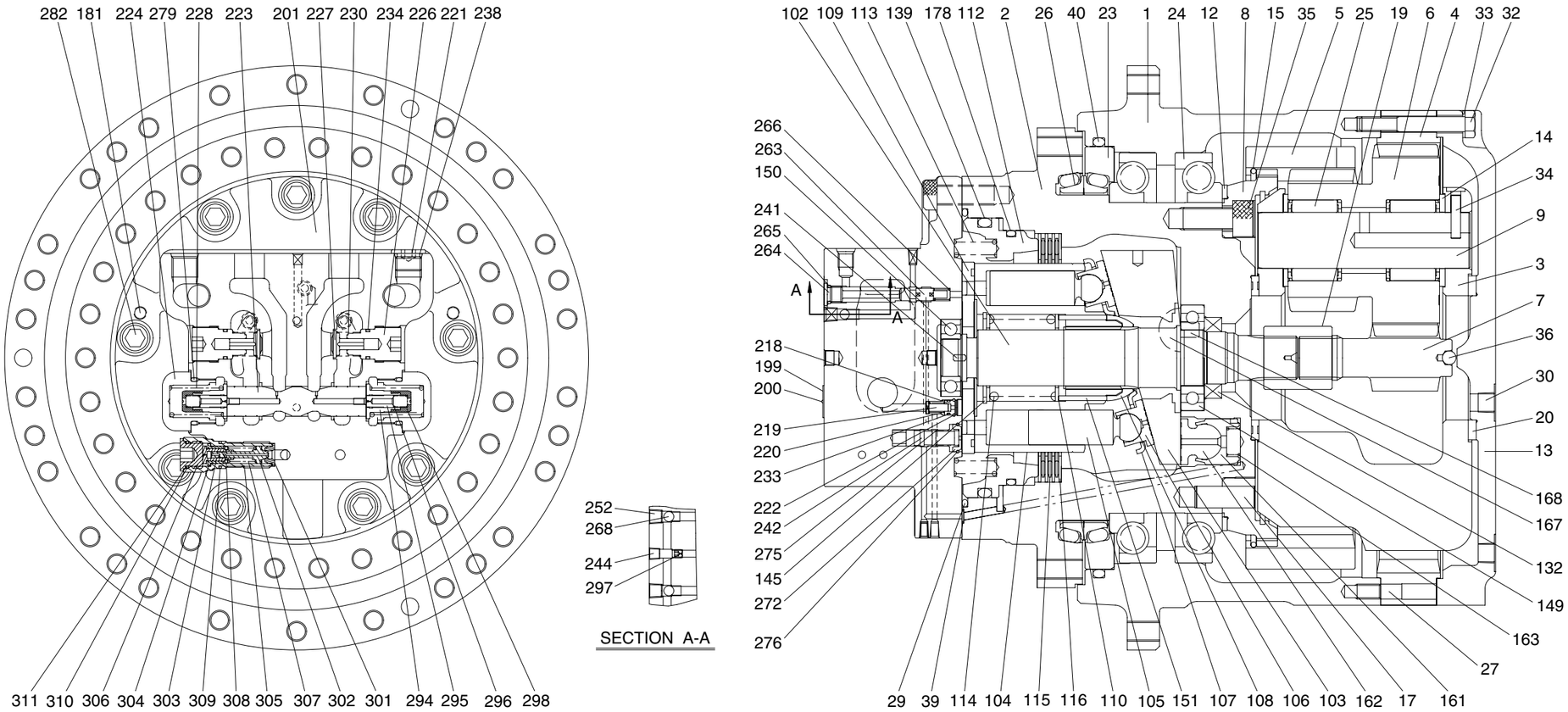
21C72TM01

1) BASIC STRUCTURE



21C72TM02

2) STRUCTURE



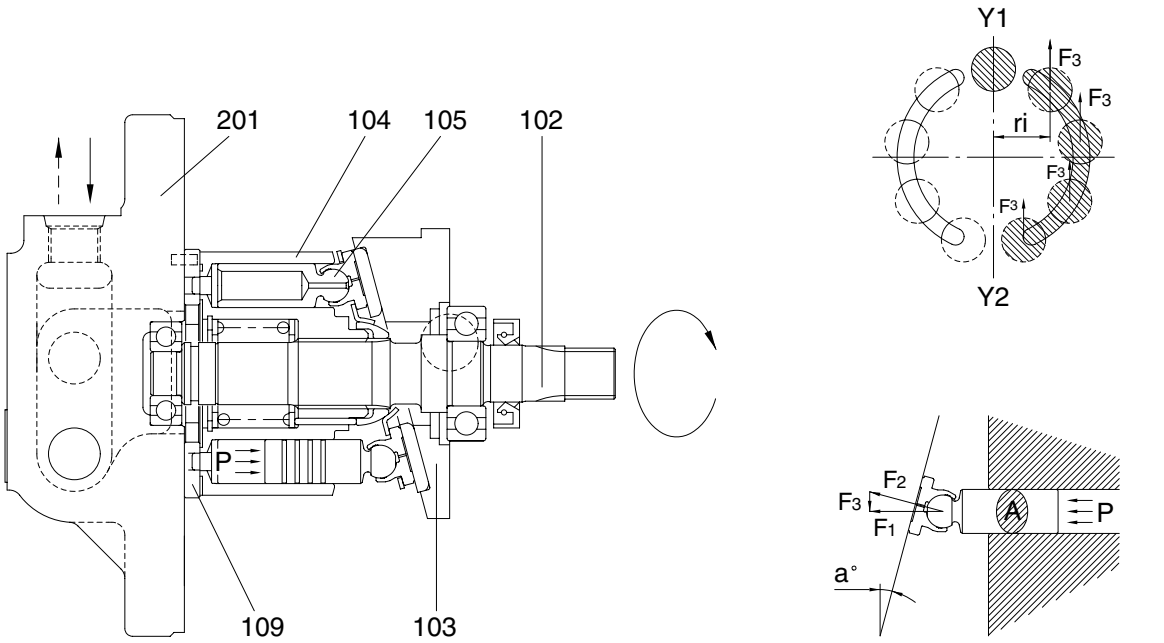
21C72TM03

1	Hub	19	Coupling	39	O-ring	115	Friction plate	181	Parallel pin	263	Valve	298	Stopper
2	Spindle	20	Thrust plate	40	O-ring	116	Mating plate	201	Rear flange	264	RO plug	301	Seat
3	Carrier	23	Seal ring	102	Shaft	132	Oil seal	224	Stopper	265	O-ring	302	Plunger
4	Ring gear A	24	Ball bearing	103	Swash plate	139	O-ring	226	Plug	266	Spring	303	Rod
5	Ring gear B	25	Needle bearing	104	Cylinder block	145	Snap ring	227	Check valve	268	Steel ball	304	Piston
6	Cluster gear	26	Floating seal	105	Piston	149	Ball bearing	228	Spring	272	Valve seat	305	Body
7	Sun gear	27	Pin	106	Shoe	150	Ball bearing	230	Spring	275	Spring	306	Plug
8	Coupling gear	29	O-ring	107	Retainer plate	151	Roller	233	O-ring	276	Ring	307	Spring
9	Shaft	30	PT plug	108	Thrust ball	161	Piston	234	O-ring	279	O-ring	308	Shim
12	Distance piece	32	Hexagon bolt	109	Timing plate	162	Shoe	238	O-ring	282	Hexagon socket bolt	309	O-ring
13	Cover	33	Spring washer	110	Washer	163	Spring	241	Pin	294	Stopper	310	O-ring
14	Thrust collar	34	Pin	112	Piston	167	Pivot	242	Valve	295	Spool	311	Back up ring
15	Ring	35	Hexagon socket bolt	113	Spring	168	Parallel pin	244	PT plug	296	Spring		
17	Pin	36	Steel ball	114	Spring	178	O-ring	252	PT plug	297	Orifice		

2. FUNCTION

1) HYDRAULIC MOTOR

(1) Rotary group



21C72TM04

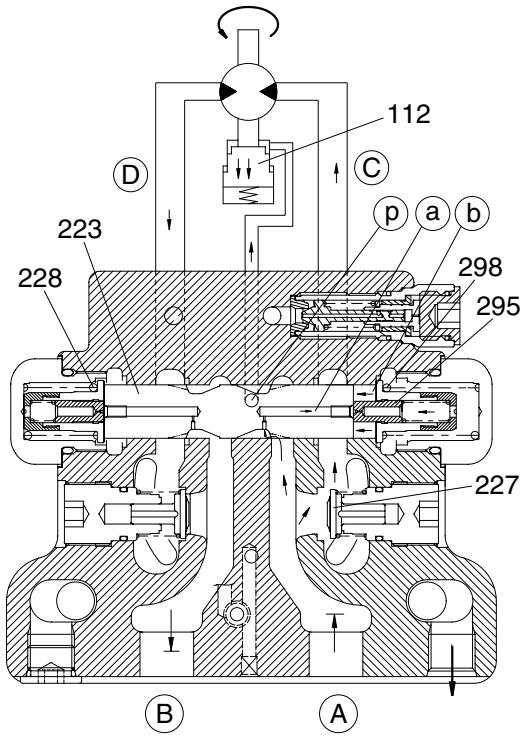
The pressurized oil delivered from the hydraulic pump flows to rear flange(201) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block(104) via timing plate(109). This oil constructively introduced only to one side of Y1-Y2 connecting the upper and lower dead points 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 kgf = P kgf/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.



21C72TM05

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

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

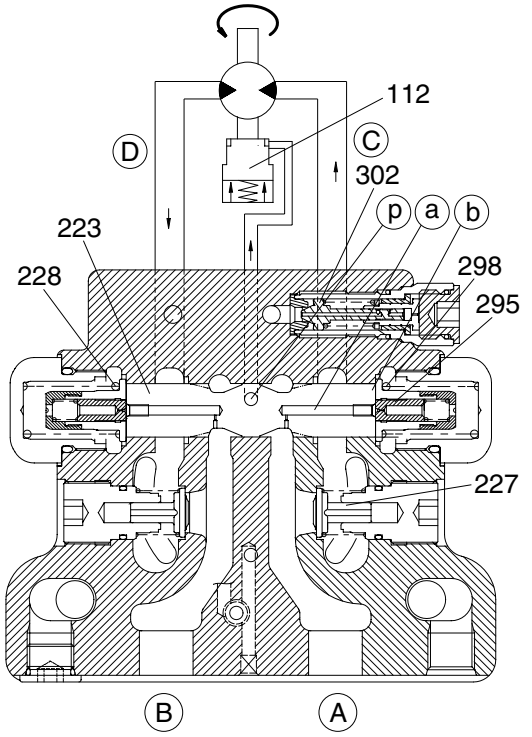
The oil in chamberⓑ will flow to port side through pipe lineⓐ spool(223).

However, a back pressure procedured by the restricting effect of pipe lineⓐ, 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 side from port through a passage between the groove in spool(223) and rear flange(201).

When spool(223) completely returns to neutral, the above-mentioned passage is fully closed and the hydraulic motor stops.



21C72TM06

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 side and the pressure is increased.

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

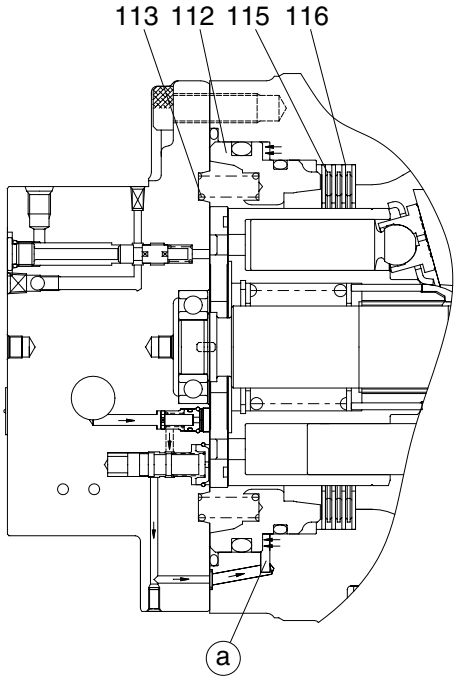
Valve(227) is activated by a slight negative pressure to open the oil passage between the oil line at port side and port at the suction side of motor, thus preventing cavitation of the hydraulic motor.

(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 11kgf/cm²(1.1Mpa) 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(4.4Mpa) or more, it is reduces by the reducing valve to set the pressure in cylinder chamberⓐ to 45kgf/cm²(4.4Mpa).



21C72TM07

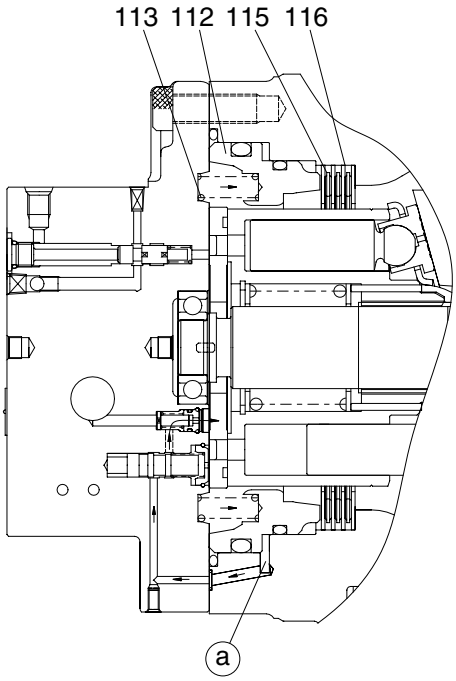
② Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber ⓐ drops 11kgf/cm² (1.1Mpa) 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.

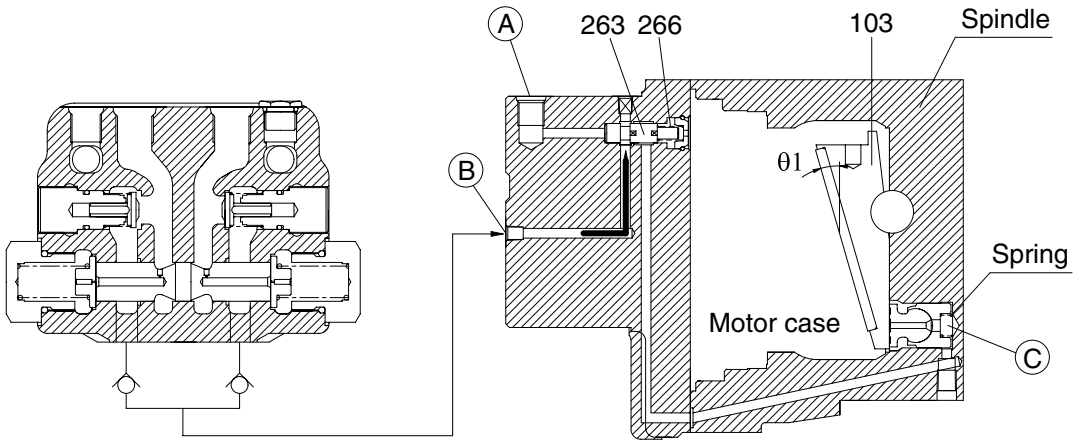
Note that oil control through a proper oil passage ensures smooth operation.



21C72TM08

(4) High/low speed changeover mechanism

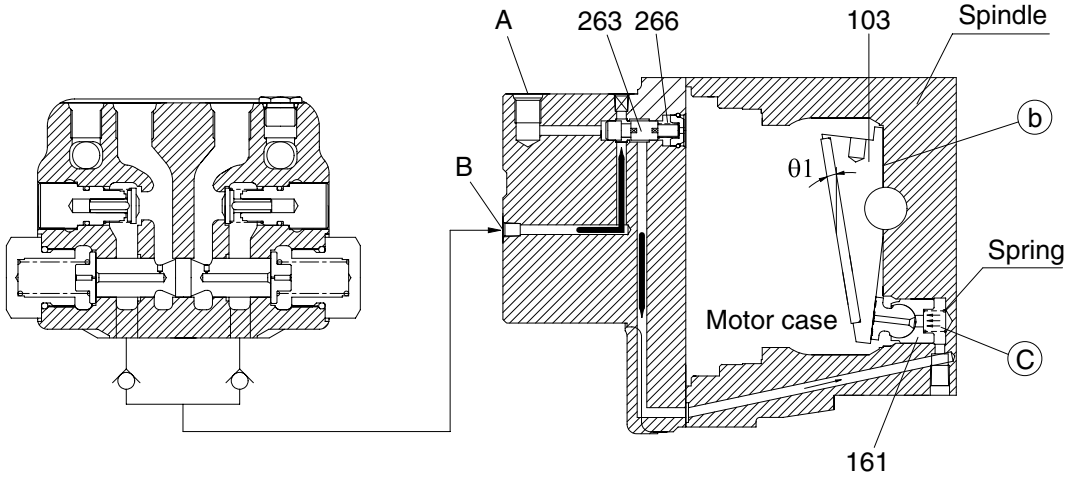
① **At low speed** - At pilot pressure of less than 15kgf/cm²(1.5Mpa)



21C72TM09

When the pilot pressure is supplied from port , 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 through the 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 rotation.

② **At high speed** - At pilot pressure of 15kgf/cm²(1.5Mpa) or more



21C72TM10

When a pilot pressure supplied from port (At a pressure of 15kgf/cm²(1.5Mpa) 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 through the 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 rotation.

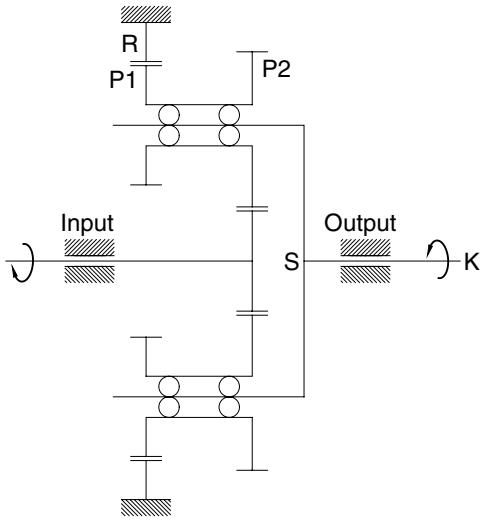
2) REDUCTION GEAR

(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.

Planetary gear mechanism



21C72TM11

(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).

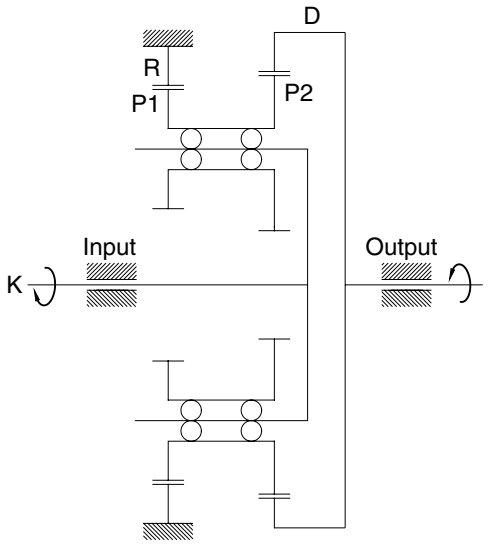
$$i1 = 1 + \frac{R \cdot P2}{S \cdot P1}$$

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.

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

Differential gear mechanism

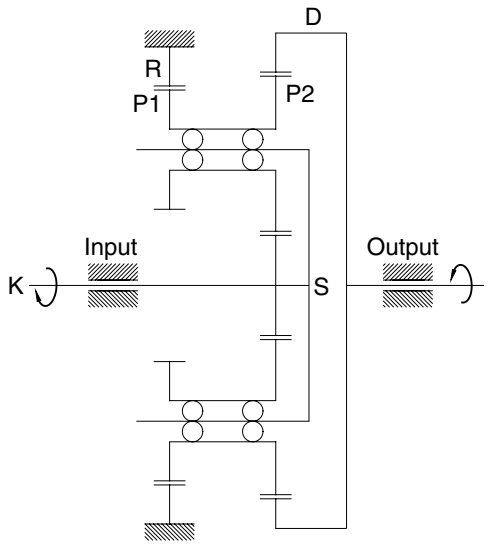


21C72TM12

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



21C72TM13