

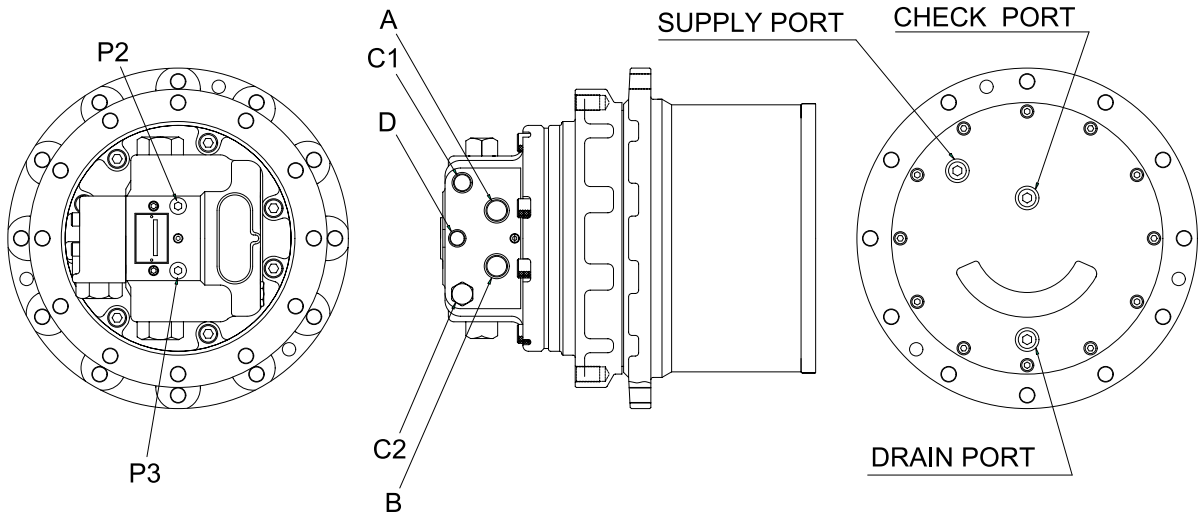
## GROUP 4 TRAVEL DEVICE

### A. TRAVEL MOTOR (GM09VL, UP TO #0697)

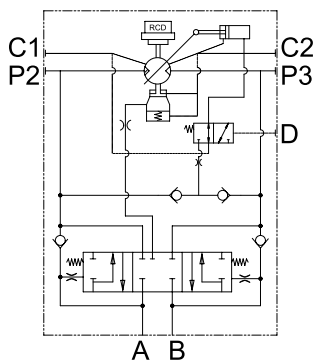
#### 1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



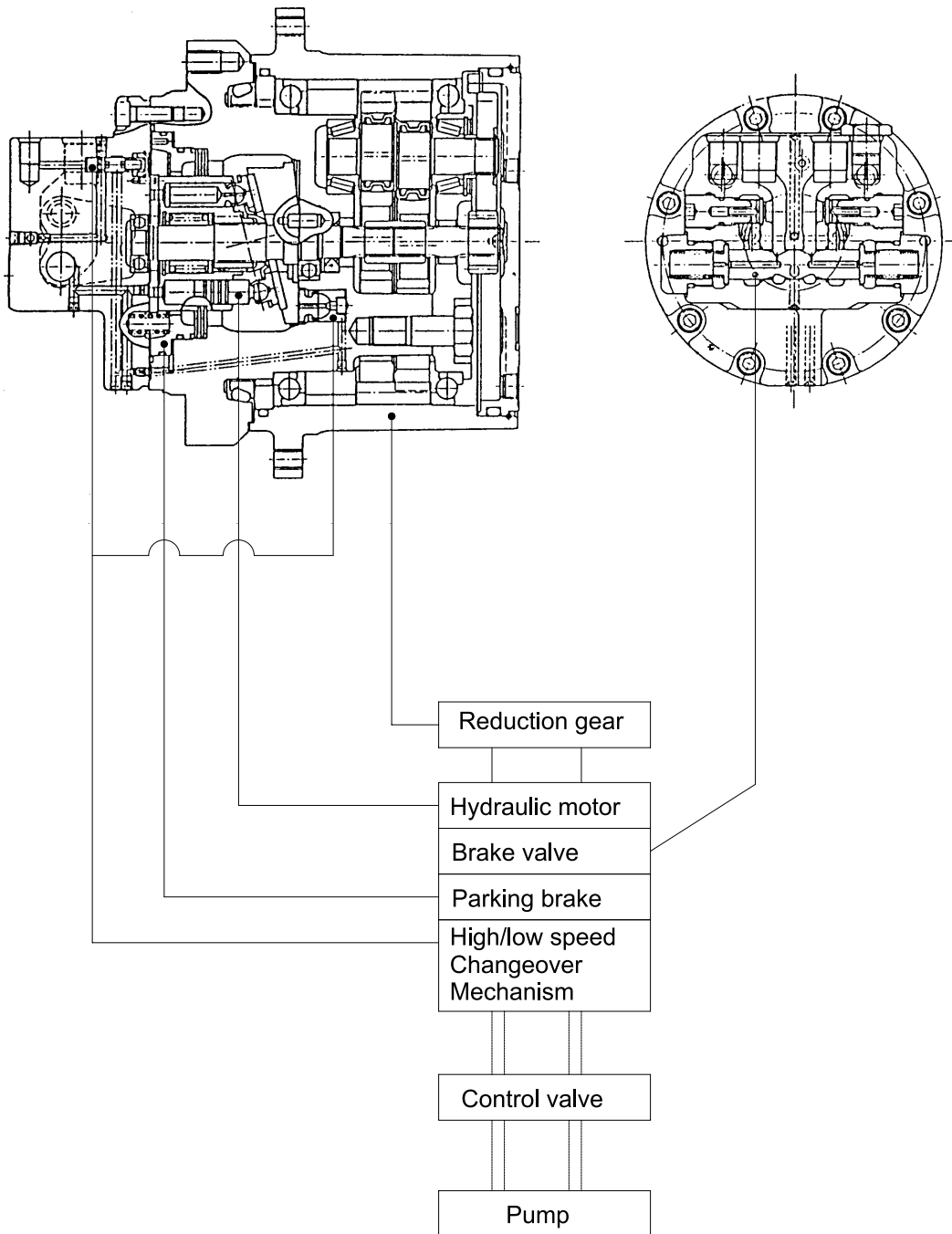
R55NM2SF52



R55NM2SF55

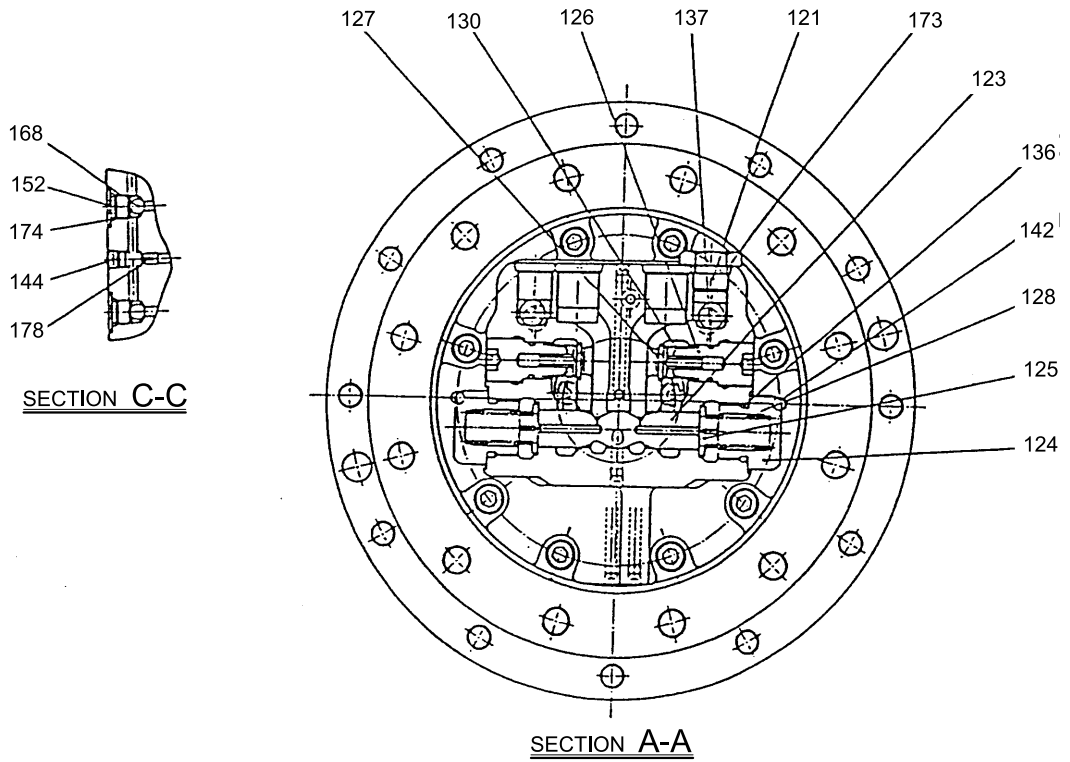
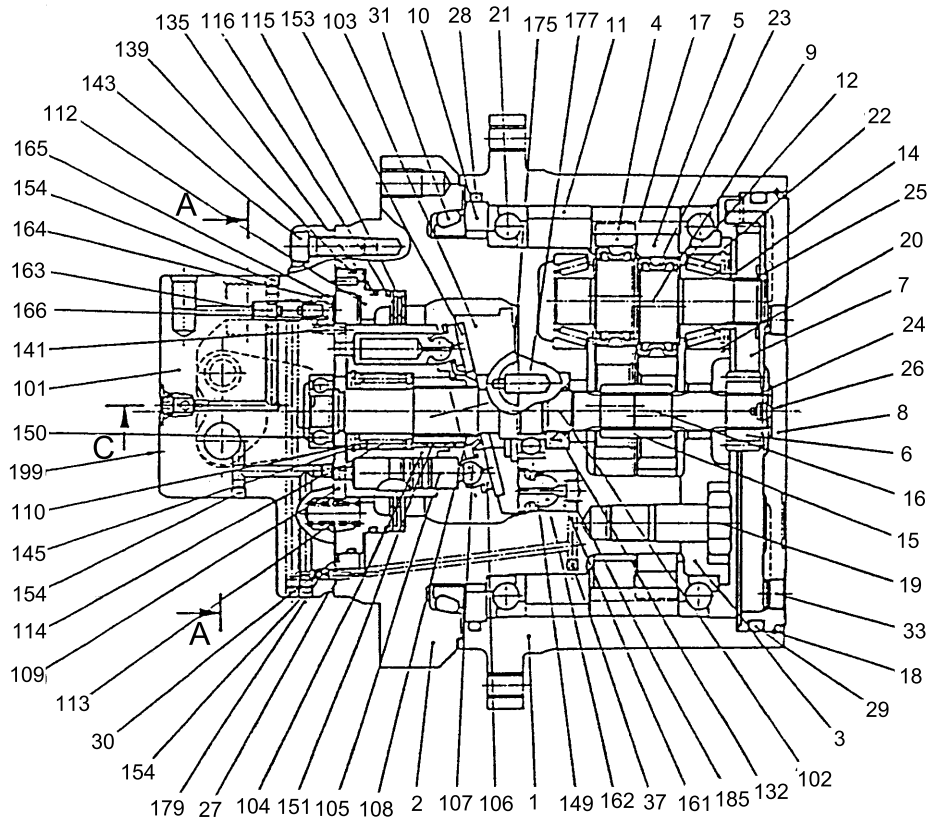
Port	Port name	Port size
A, B	Main port	M24
C1, C2	Drain port	M20
P2, P3	Gauge port	PT 1/8
D	2-speed control port	M14

# 1) BASIC STRUCTURE



R55NM2SF51

## 2) STRUCTURE



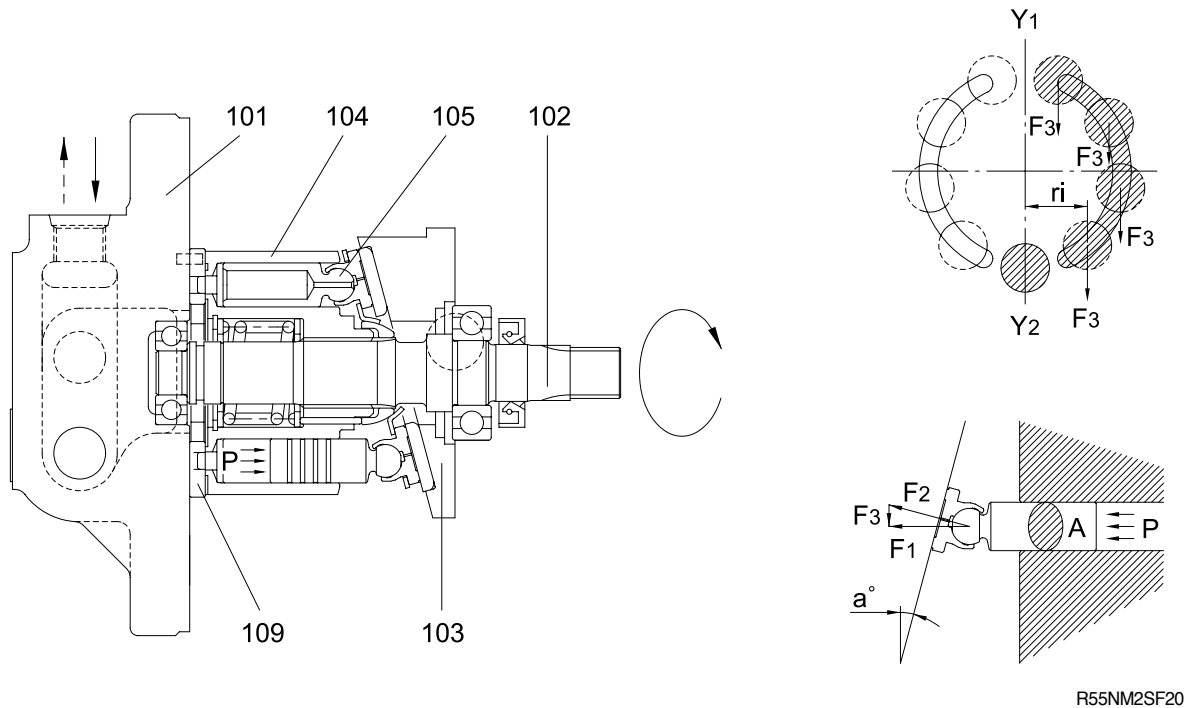
R55NM2SF50

	Spindle kit	27	O-ring	121	Plug
19	Reamer bolt	28	O-ring	124	Plug
37	Expander	29	O-ring	125	Spring retainer
	Spindle assembly	30	O-ring	126	Plug
2	Spindle	33	Hex socket plug	127	Valve
3	Hold flange		Rear flange kit	128	Spring
	RV gear assembly	101	Rear flange	130	Spring
9	Crank shaft	123	Spool	132	Oil seal
12	Spacer	144	Hex socket plug	135	O-ring
22	Taper roller bearing	154	Hex socket plug	136	O-ring
23	Needle bearing	178	Orifice	137	O-ring
	RV gear kit	179	Filter	138	O-ring
4	RV gear A	199	Name plate	139	O-ring
5	RV gear B		Piston kit	141	Parallel pin
	Spur gear kit		Piston assembly	142	Parallel pin
7	Spur gear	161	Piston	143	Hex socket bolt
	F seal kit	162	Shoe	145	THS snap ring
10	Distance piece		Piston kit	149	Ball Bearing
31	Floating seal		Piston assembly	150	Ball Bearing
1	Hub	105	Piston	151	Roller
6	Input gear	106	Shoe	152	Hex socket plug
8	Cover	102	Shaft	153	Thrust plate
11	Collar	103	Swash plate	163	Valve
14	Distance piece	104	Cylinder block	164	Stopper
15	Coupling	107	Retainer plate	165	Ring
16	Shaft	108	Thrust ball	166	Spring
17	Pin	109	Timing plate	168	Steel ball
18	Ring	110	Washer	173	O-ring
20	Snap ring	112	Piston	174	O-ring
21	Ball bearing	113	Spring	176	Pivot
24	Snap ring	114	Spring	177	Parallel pin
25	Snap ring	115	Friction plate	185	Spring
26	Steel ball	116	Mating plate		

## 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 ( $F \text{ kg} = P \text{ kgf/cm}^2 \cdot A \text{ cm}^2$ ). This force acts on swash plate (103), and is resolved into components (F2 and F3) because swash plate (103) is fixed at an angle ( ) with the axis of drive shaft(102).

Radial component (F3) generates respective torques ( $T = F3 \cdot ri$ ) for (Y1)-(Y2). This residual of torque ( $T = \sum (F3 \cdot ri)$ ) 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.

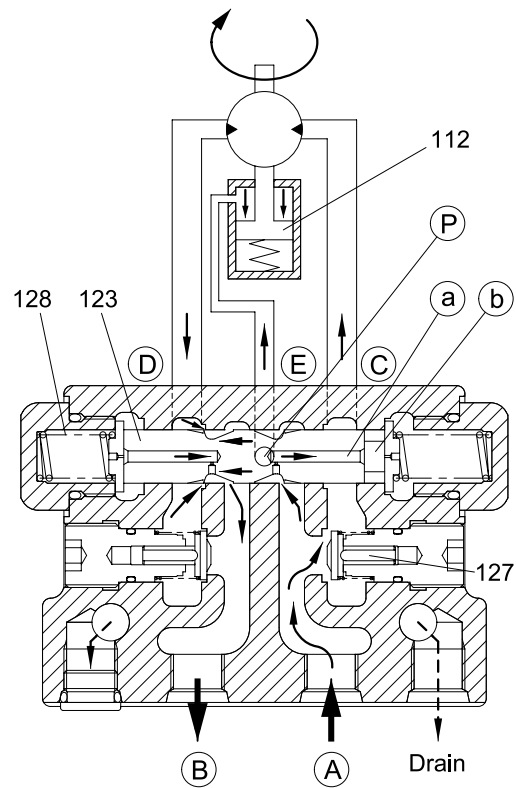
## (2) Brake valve

### Brake released (Starting / Running)

When the pressurized oil supplied from port A, the oil opens valve (127) 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 (a) from a small hole in spool (123) and flows into chamber (b). 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 D on the passage at the return side of hydraulic motor, which is closed by the spool groove during stoppage, communicates with port B 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 P and S.

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 B, spool (123) move reversely and the hydraulic motor also rotates reversely.



R55NM2SF21

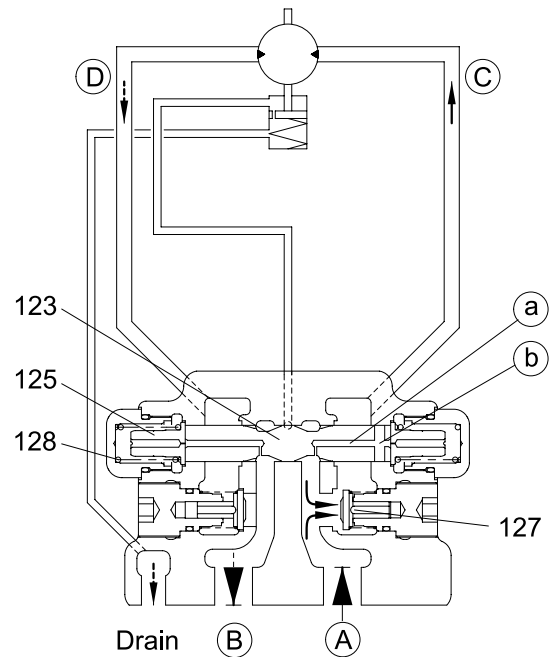
### Brake applied(Stopping / Stalling)

When the pressurized oil supplied from port A is stopped during traveling, no hydraulic pressure is applied and spool (123) which has slide to the left will return on the right (neutral) via stopper (125) by the force of spring (128). The oil in the chamber (b) will flow to port A side through pipe line (a) in spool (123).

However, a back pressure produced by the restricting effect of pipe line (a), 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 return to port B side from port D 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. However, no oil is supplied because the pressurized oil is stopped. In consequence, cavitation occurs on the hydraulic motor, thus adversely affecting it.



R55NM2SF22

### 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.

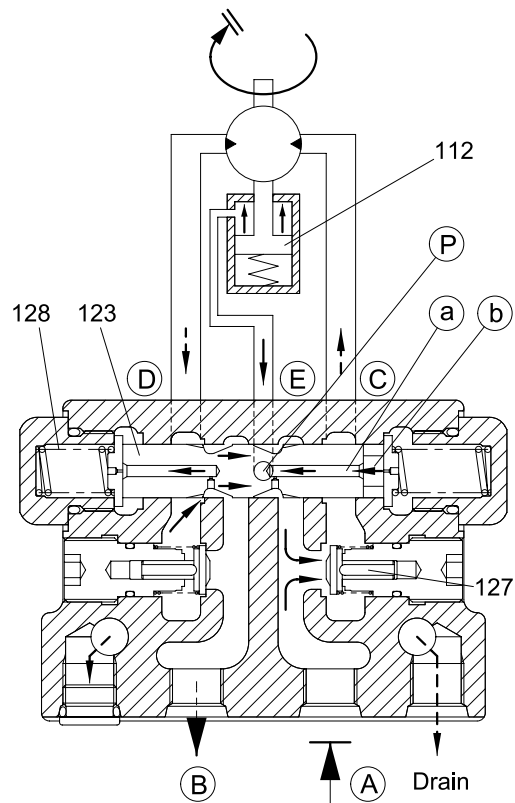
In the coasting condition, the motor is driven, instead of driving the track, from the ground and sucks high pressure oil in.

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(123) 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.

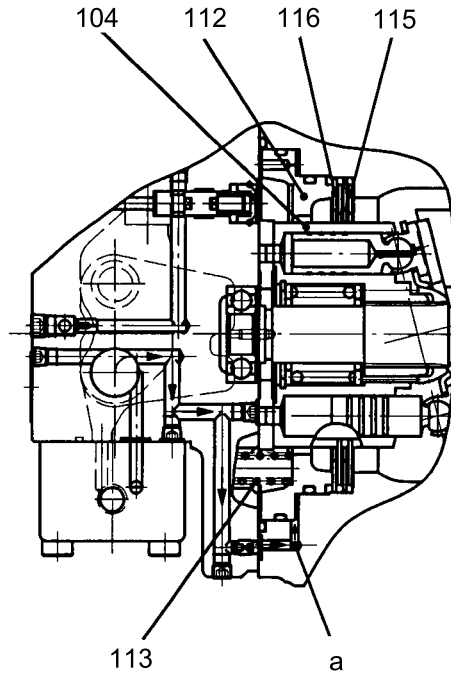


R55NM2SF23

### (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  $4.6\text{kgf/cm}^2$  ( $0.45\text{Mpa}$ ) or more, it overcomes the force of spring (113) and shifts piston(112). With shift of piston(112), no pressing force is applied to 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.



R55NM2SF70

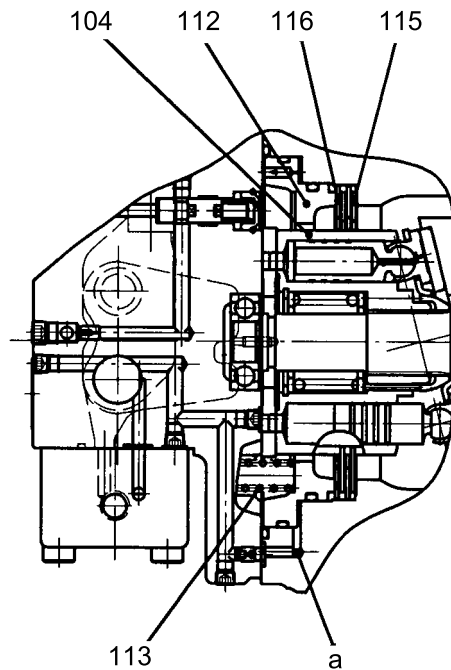
#### Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber drops  $6\text{kgf/cm}^2$  ( $0.59\text{Mpa}$ ) 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  $8.4\text{kgf} \cdot \text{m}$  ( $82.4\text{N} \cdot \text{m}$ ) to the hydraulic motor shaft.

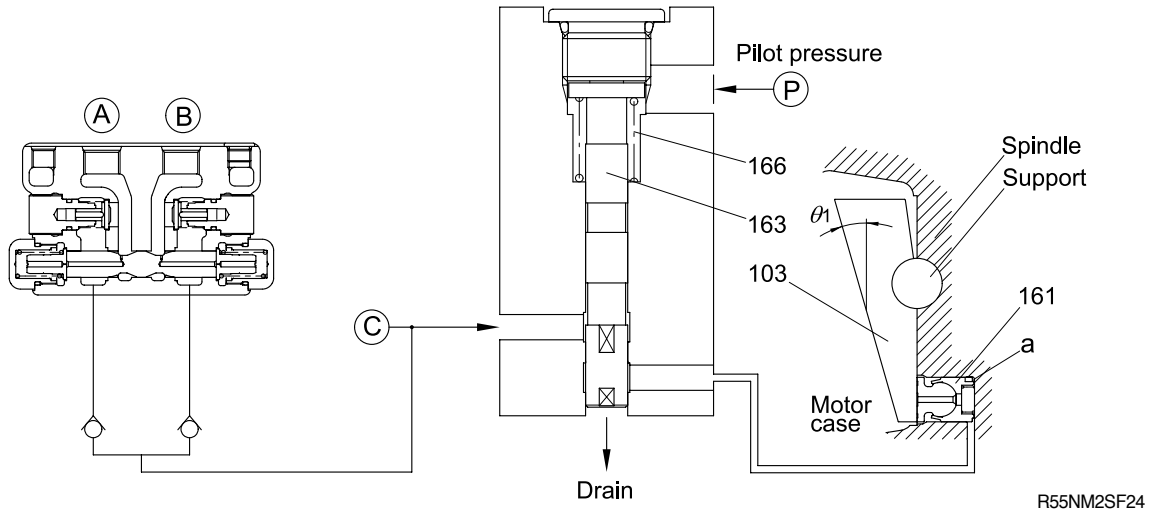
Note that oil control through a proper oil passage ensures smooth operation.



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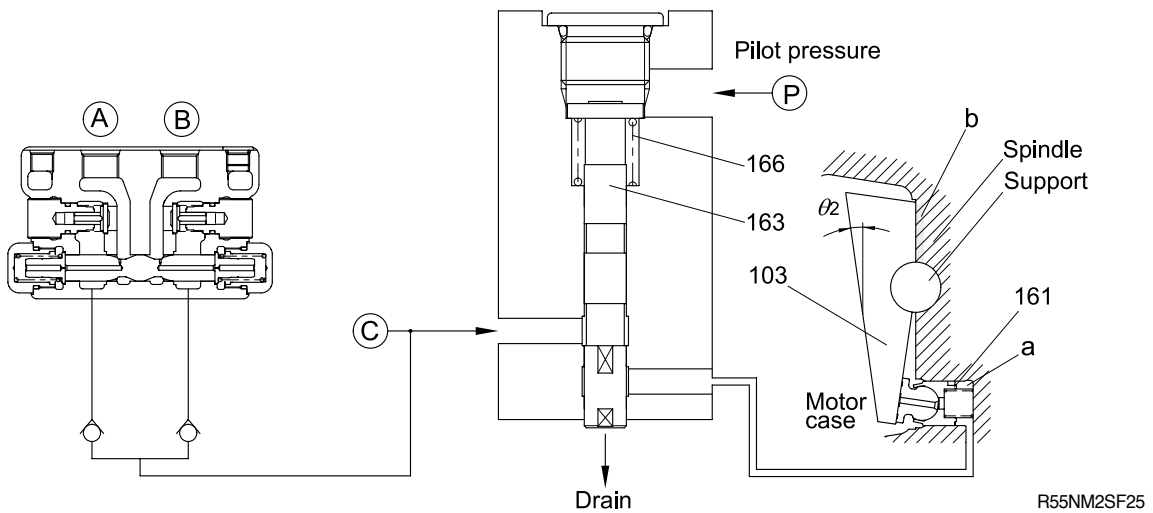
**(4) High/low speed changeover mechanism**

**At low speed** - At pilot pressure of less than 20kgf/cm<sup>2</sup>(1.96Mpa)



When the pilot pressure is shut off from port , valve(163) is pressed upward by the force of spring(166), the pressurized oil supply port is shut off, and oil in chamber is released into the motor case through the valve(163). Consequently, swash plate(103) is tilted at a maximum angle(  $\theta_1$ ) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed operation.

**At high speed** - At pilot pressure of 20kgf/cm<sup>2</sup>(1.96Mpa) or more



When a pilot pressure supplied from port (At a pressure of 20kgf/cm<sup>2</sup>(1.96Mpa) or more), the pressure overcomes the force of spring(166) and valve(163) is pressed downward. The pressurized oil supply port is then introduced into chamber through the 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(  $\theta_2$ ) 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.

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

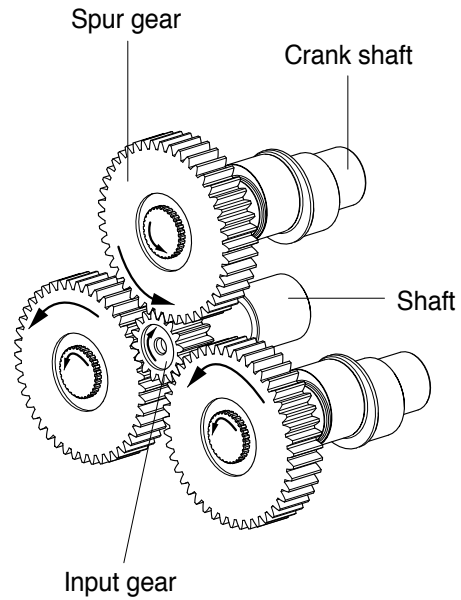
$Z_i$  : Number of input gear teeth

$Z_s$  : Number of spur gear teeth

#### Second reduction

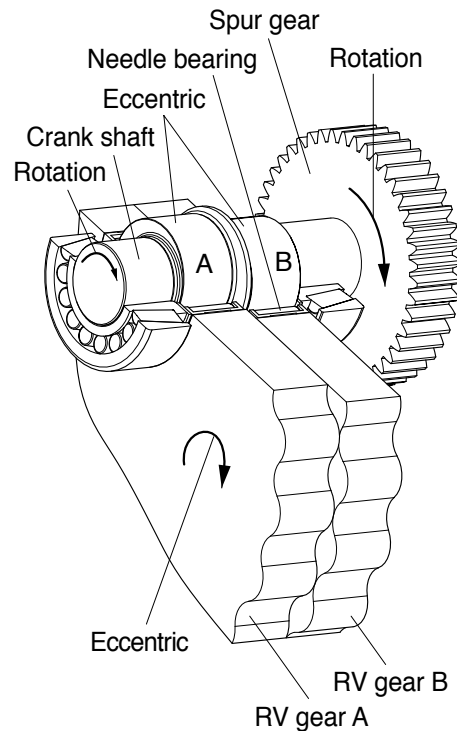
Three spur gears(7) are connected severally to the three crank shafts(9). These crank shafts(9) are input of second reduction.

### 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.

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

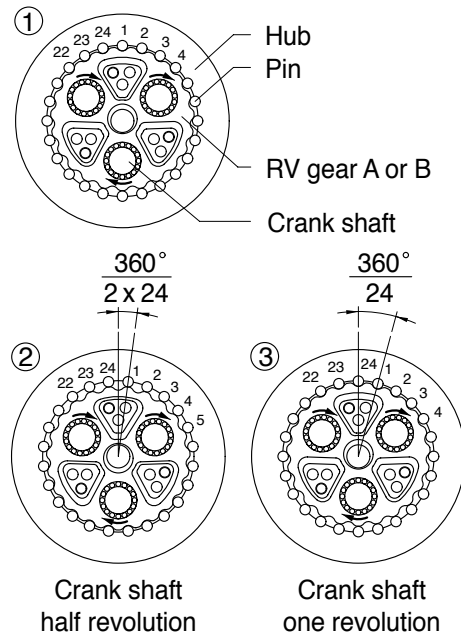
$Z_p$  : Number of pin

$Z_R$  : 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



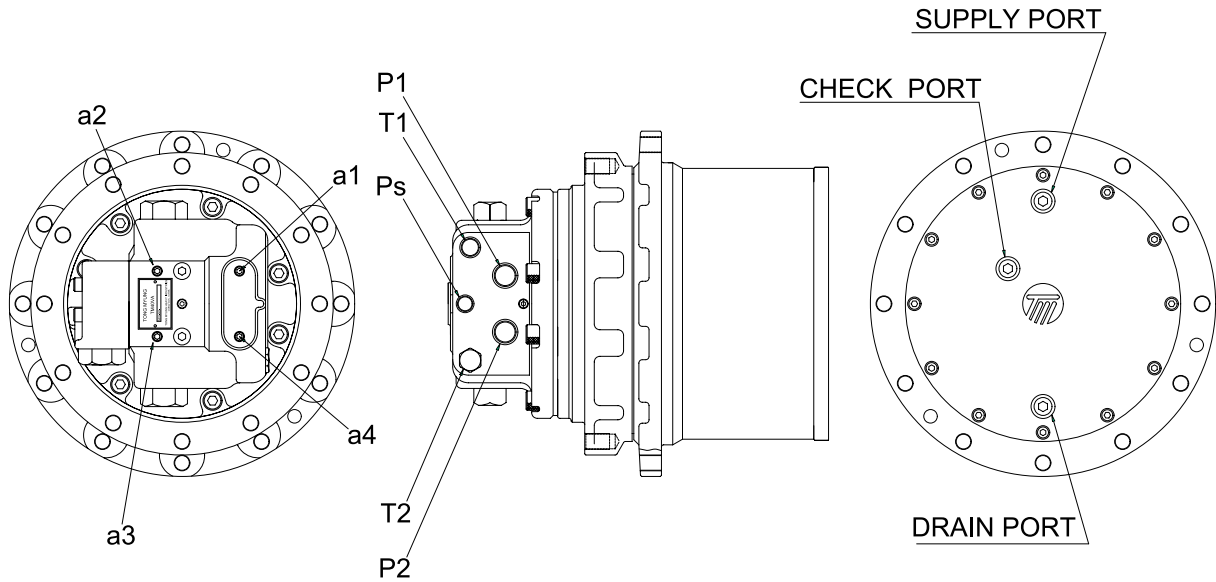
25032TM12

## B. TRAVEL MOTOR (TM07VA, #0698 AND UP)

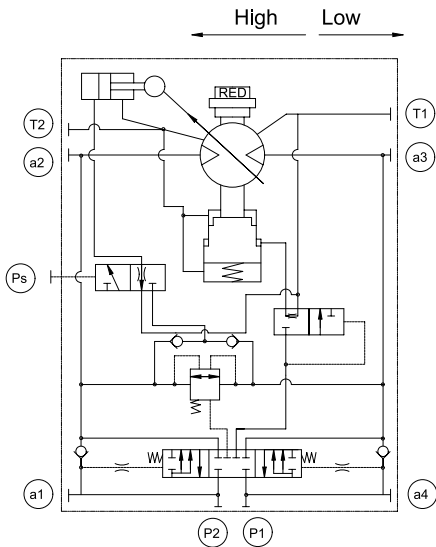
### 1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



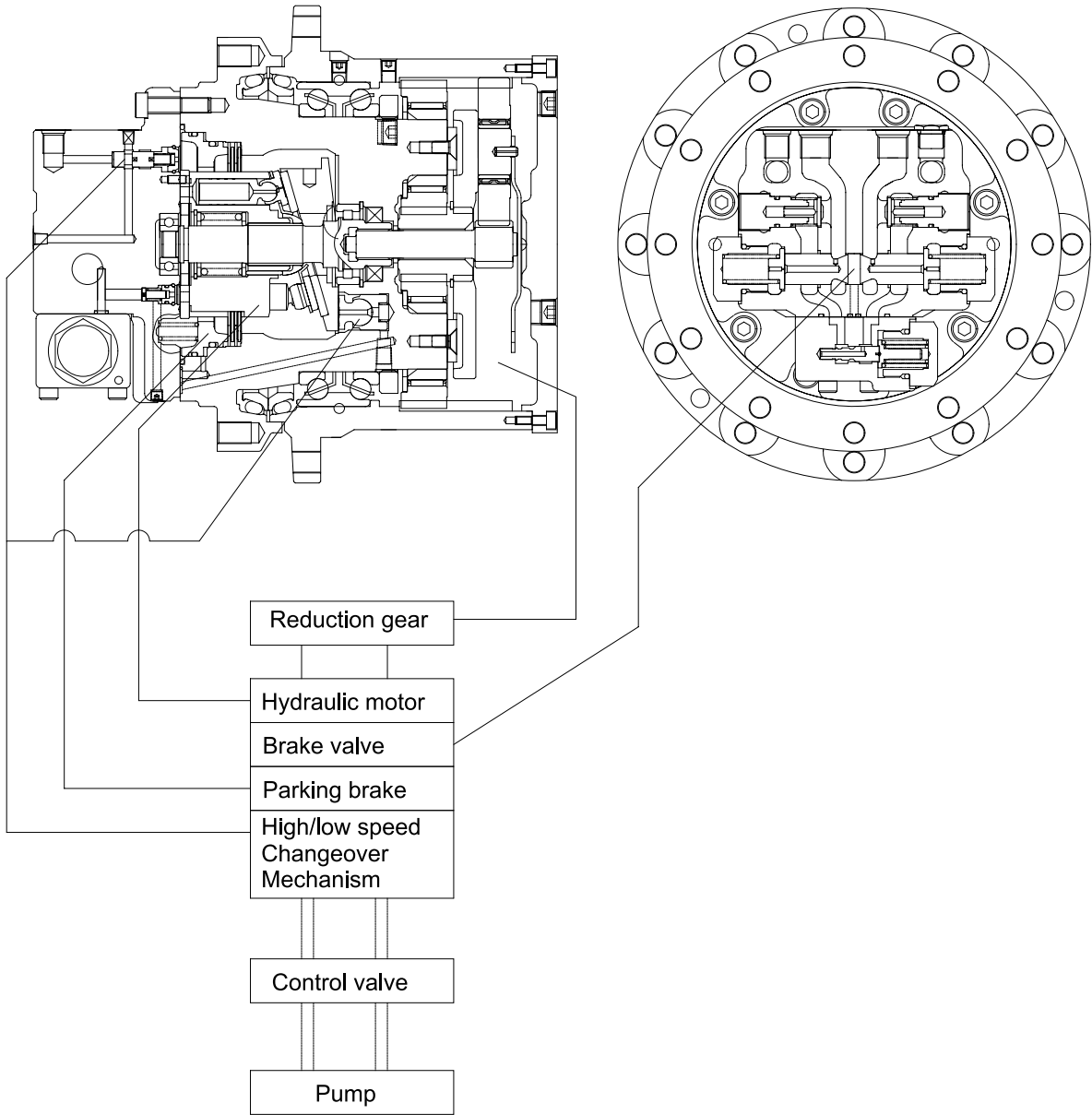
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R55NM2SF28

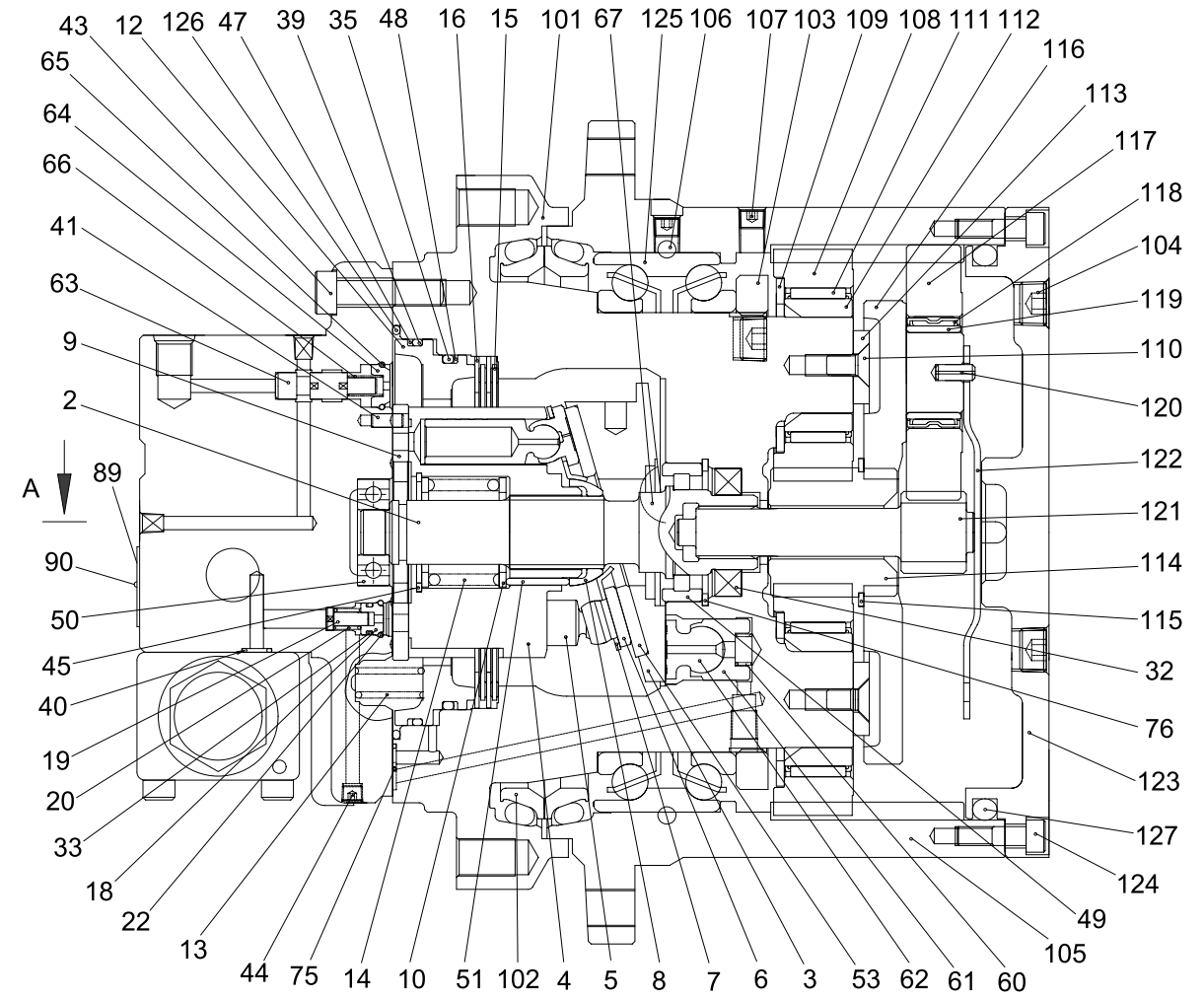
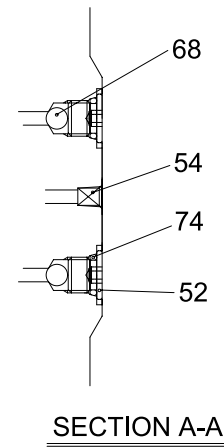
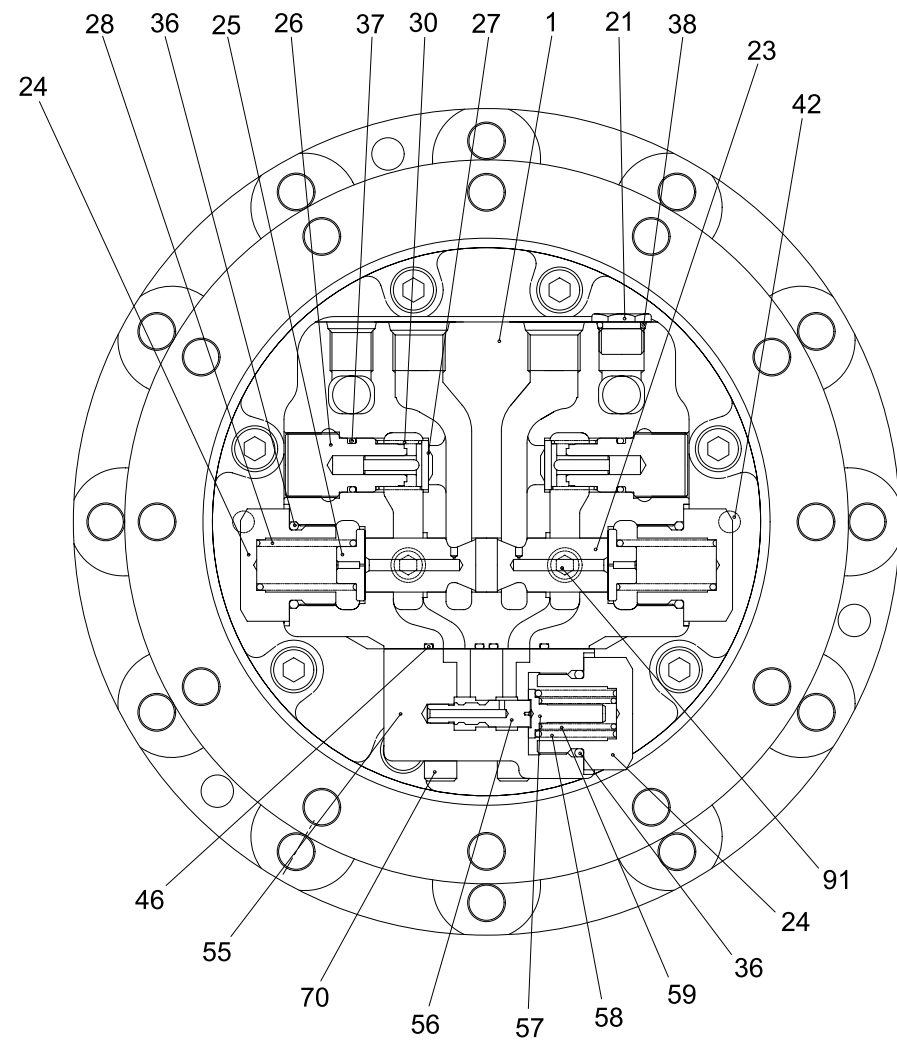
Port	Port name	Port size
P1	Main port	PF 1/2
P2	Main port	PF 1/2
T1, T2	Drain port	PF 3/8
Ps	2-speed control port	PF 1/8
a1, a2, a3, a4	Gauge port	PF 1/8

# 1) BASIC STRUCTURE



R55NM2SF27

## 2) STRUCTURE

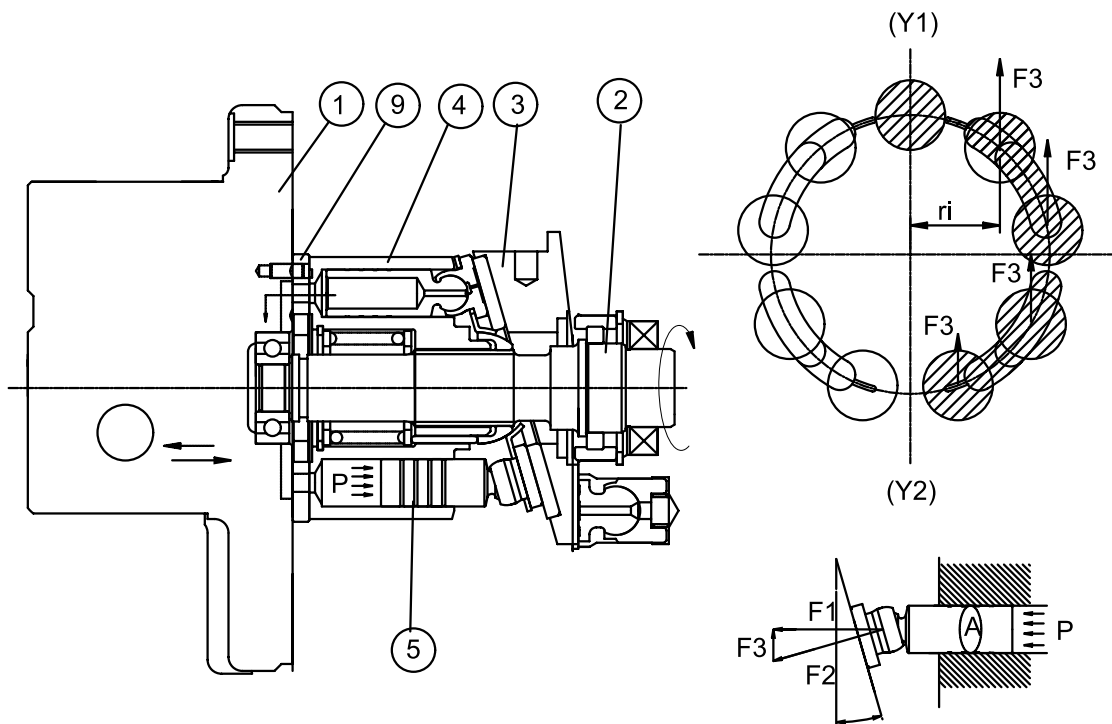


1 Rear flange	16 Mating plate	33 O-ring	48 Back up ring	62 Shoe	102 Floating seal	116 Holder
2 Shaft	18 Valve seat	35 O-ring	49 Roller bearing	63 Valve(2speed)	103 Nut ring	117 Planetary gear(R)
3 Swash plate	19 Valve(T valve)	36 O-ring	50 Ball bearing	64 Ring(2speed)	104 Plug	118 Needle bearing
4 Cylinder block	20 Spring	37 O-ring	51 Roller	65 Ring(2speed)	105 Housing	119 Inner race
5 Piston	21 Plug(VP)	38 O-ring	52 Plug(RO)	66 Spring(2speed)	106 Steel ball	120 Spring pin
6 Shoe	22 Ring	39 O-ring	53 Thrust plate	67 Steel ball	107 Plug	121 Drive gear
7 Retainer plate	23 Spool	40 O-ring	54 Plug(NPTF)	70 Socket bolt	108 Planetary gear(F)	122 Thrust plate(R)
8 Thrust ball	24 Plug(Main)	41 Parallel pin	55 Body	74 O-ring	109 Thrust washer	123 Cover
9 Timing plate	25 Spring retainer	42 Parallel pin	56 Spool	75 O-ring	110 Screw	124 Socket bolt
10 Washer	26 Plug	43 Socket bolt	57 Stopper	76 Snap ring	111 Needle bearing	125 Angular bearing
12 Piston(Parking)	27 Valve(Check)	44 Plug(PT)	58 Spring	89 Name plate	112 Collar	126 O-ring
13 Spring	28 Spring(Main)	45 Snap ring	59 Spring	90 Rivet screw	113 Thrust plate(F)	127 O-ring
14 Spring	30 Spring(Check)	46 O-ring	60 Spring	91 Plug(PT)	114 Sun gear	
15 Friction plate	32 Oil seal	47 Back up ring	61 Piston	101 Holder flange	115 Snap ring	

R55NM2SF26

# 1. FUNCTION

## 1) HYDRAULIC MOTOR



R55NM2SF73

The pressurized oil delivered from the hydraulic pump flows to rear flange(1) of the motor, passes through the brake valve mechanism, and is introduced into cylinder block(4) via timing plate(9). This oil constructively introduced only to one side of (Y1)-(Y2) connecting the upper and lower dead points of stroke of piston(5). The pressurized oil fed to one side in cylinder block(4) pushes each piston(5)(four or five) and generates a force  $F(\text{kgf}) = P(\text{kgf/cm}^2) \times A(\text{cm}^2)$ .

This force acts on swash plate(3), and is resolves into components(F2 and F3) because swash plate(3) is fixed at an angle with the axis of drive shaft(2).

Radial component(F3) generates respective torques ( $T = F3 \times ri$ ) for (T1)-(Y2). This residual of torque ( $T = S(F3 \times ri)$ ) rotates cylinder block(4) via piston(5). Cylinder block(4) is spline coupled with drive shaft(2).

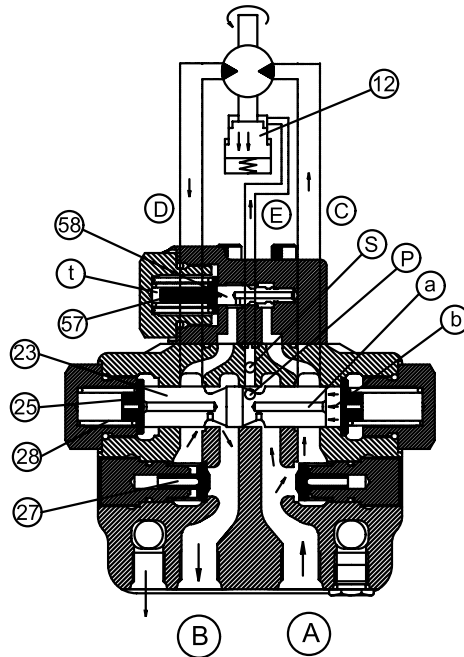
So the drive shaft(2) rotates and the torque is transmitted.

## 2) BRAKE VALVE

### (1) Brake released(starting/running)

When the pressurized oil supplied from port  $P$  the oil opens valve(27) and flows into port  $S$  at the suction side of hydraulic motor to rotate motor.

At the same time, the pressurized oil passes through pipe line  $C$  from a small hole in spool(23) and flow into chamber  $D$ . The oil acts on the end face of spool(23) which is put in neutral position by the force of spring(28), thus causing spool(23) to slide to the left. When spool(23) slides, port  $S$  on the passage at the return side of hydraulic motor, which is closed by the spool groove during stoppage, communicates with port  $P$  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(23) causes the pressurized oil to flow into ports  $a$  and  $b$ .



R55NM2SF74

The pressurized oil admitted into port  $P$  activates piston(12) 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  $P$  flows into chamber  $D$  and presses stopper(57) against the inside of body(55) to prevent spool(58) from moving, thus disabling communication at port  $S$  side of the hydraulic motor (Suction side and return side of hydraulic motor). When the pressurized oil is supplied from port  $P$  spool(23) and valve(27) 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(23) which has slid to the left will return on the right(neutral) via spring retainer(25) by the force of spring(28).

The oil in chamber will flow to port side through pipe line in spool(23).

However, a back pressure produced by the restricting effect of pipe line whereby the return speed of spool(23) 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(23) and rear flange(1). When spool(23) 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(23), its shape, etc.

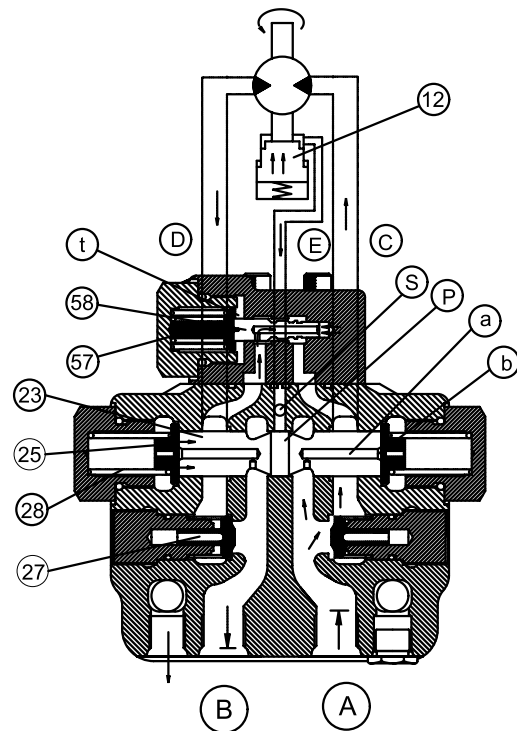
However, the hydraulic motor will rotate by the force of inertia. This means that the hydraulic motor will suck oil functioning as a pump.

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

This pressure slides spool(58) to the left to short-circuit port and which prevents pressure rise and cavitation (surge cut valve function and anti-cavitation valve function).

Valve(27) 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.



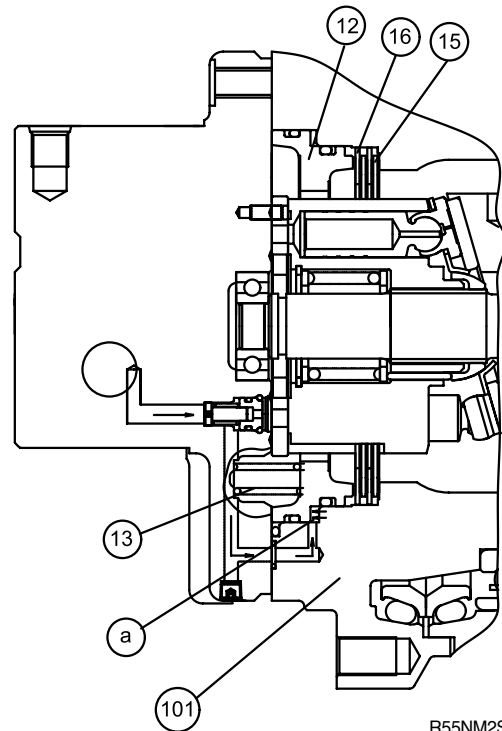
R55NM2SF75

### 3) PARKING BRAKE

#### (1) Running

When the pressurized oil is supplied from the 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(12).

When the hydraulic pressure reaches  $9\text{kgf/cm}^2(0.88\text{Mpa})$  or more, it overcomes the force of spring(13) and shifts piston(12) with shift of piston(12) no pressing force is applied to mating plate(16) and friction plate(15) and the movement of friction plate(15) becomes free, whereby the brake force to the cylinder in the hydraulic motor assembly is released.



R55NM2SF76

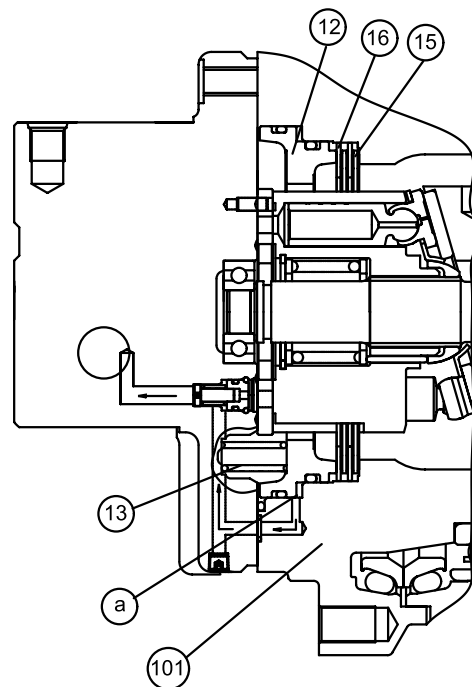
#### (2) Stopping

When the pressurized oil from the brake valve is shut off and the pressure in cylinder chamber drops  $9\text{kgf/cm}^2(0.88\text{Mpa})$  or less, piston(12) will return by the force of spring(13).

Piston(12) is pushed by this force of spring(13), and mating plate(16) and friction plate(15) in free condition are pressed against the holder flange of reduction gear assembly.

The friction force produced by this pressing stops rotation of the cylinder and gives a braking torque( $8.4\text{kgf} \cdot \text{m}(82.3\text{ N} \cdot \text{m})$ ) to the hydraulic motor shaft.

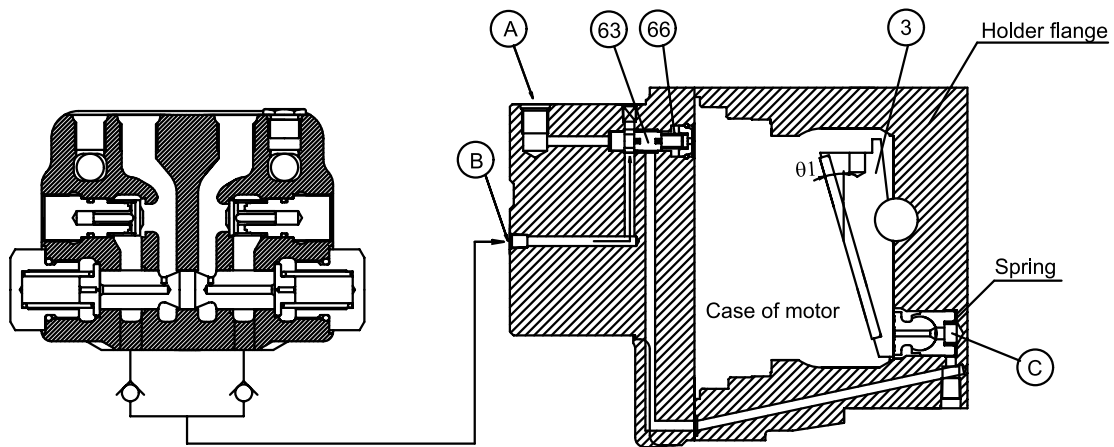
Note that oil control through a proper oil passage ensures smooth operation.



R55NM2SF77

#### 4) HIGH/LOW SPEED CHANGEOVER MECHANISM

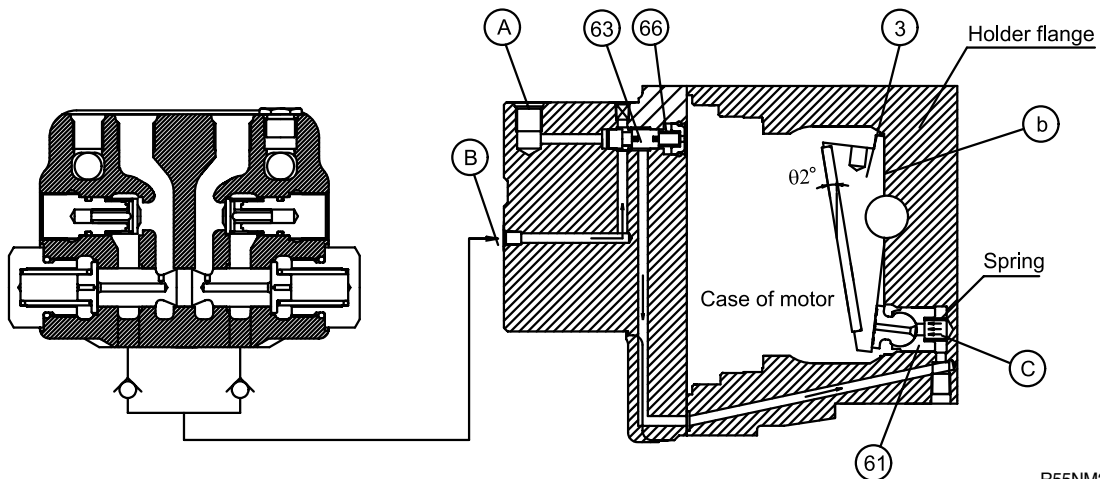
##### (1) At low speed-at pilot pressure of less than 10kgf/cm<sup>2</sup>(0.98Mpa)



R55NM2SF78

When no pilot pressure is supplied from port A at a pressure of 10kgf/cm<sup>2</sup>(0.98Mpa) or less, valve(63) is pressed toward the left by the force of spring(166), the pressurized oil supply port B is shut off, and oil in chamber C is released into the motor case via valve(63). Consequently, swash plate(3) is tilted at a maximum angle( θ<sub>1</sub>) and the piston displacement of hydraulic motor becomes maximum, thus leading to low-speed rotation.

##### (2) At high speed-at pilot pressure of 10kgf/cm<sup>2</sup>(0.98Mpa) or more



R55NM2SF79

When a pilot pressure is supplied from port A at a pressure of 10kgf/cm<sup>2</sup>(0.98Mpa) or more, the pressure overcomes the force of spring(66) and valve(63) is pressed toward the right. The pressurized oil at supply port B is then introduced into chamber C via valve(63). Piston(61) pushes up swash plate(3) until it touches side b of the holder flange. At this time, swash plate(3) is tilted at a minimum angle( θ<sub>2</sub>) and the piston displacement of hydraulic motor becomes maximum, thus leading to high-speed rotation.

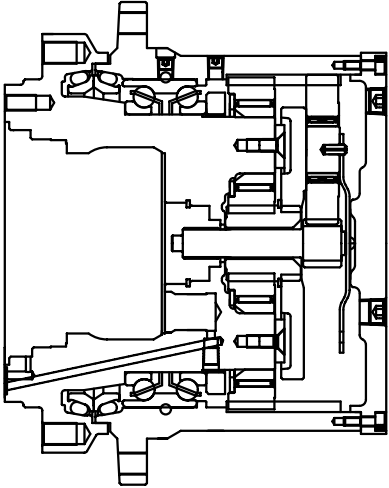
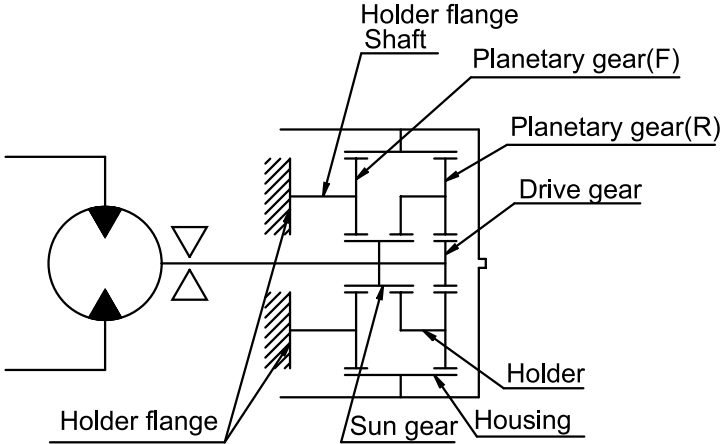
**2. REDUCTION GEAR**

**1) FUNCTION**

The reduction gear unit consists of a combination of simple planetary 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**

Shaft Drive gear Planetary Gear R Housing  
 Holder Sun gear Planetary Gear F Rotation of Housing



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$$\text{Reduction ratio} = \left( \frac{\text{Housing Teeth}}{\text{Drive Gear Teeth}} + 1 \right) \times \left( \frac{\text{Housing Teeth}}{\text{Sun Gear Teeth}} + 1 \right) - 1.$$