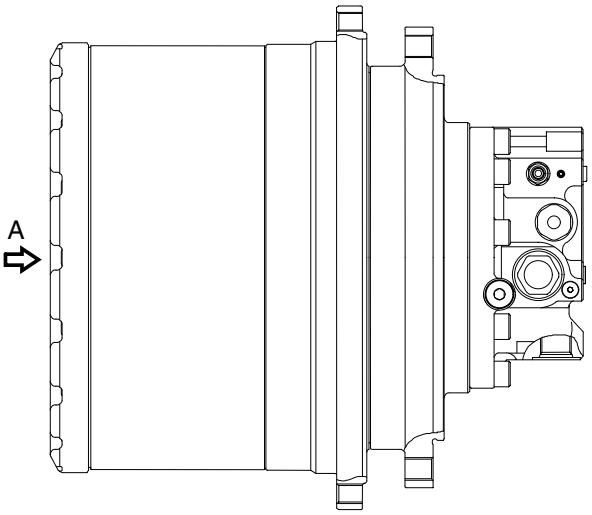
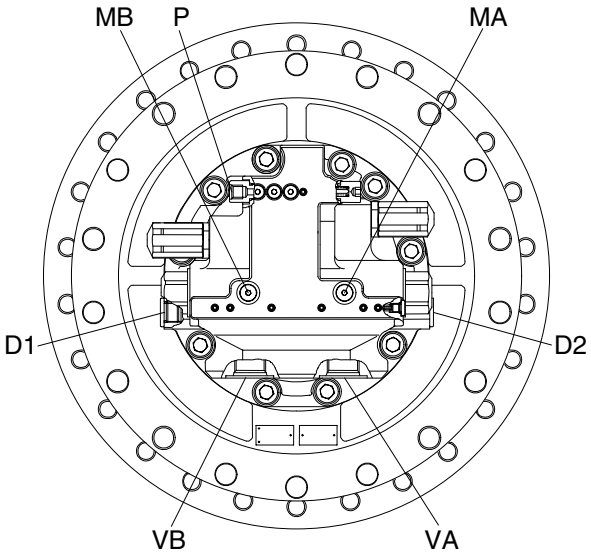
GROUP 4 TRAVEL DEVICE (up to #0306)

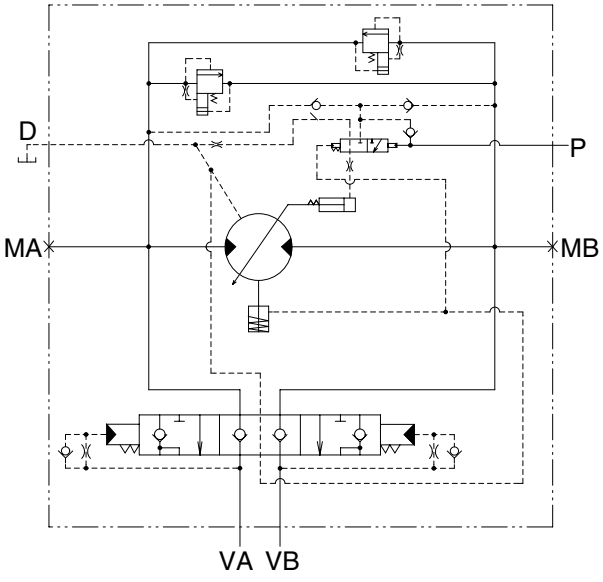
1. CONSTRUCTION

Travel device consists travel motor and gear box.

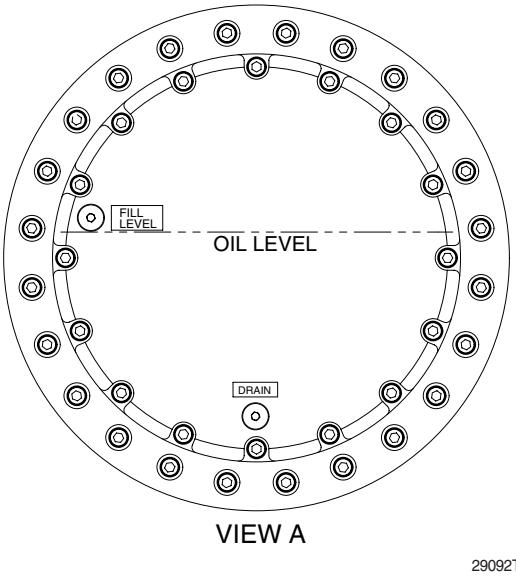
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.







CIRCUIT DIAGRAM



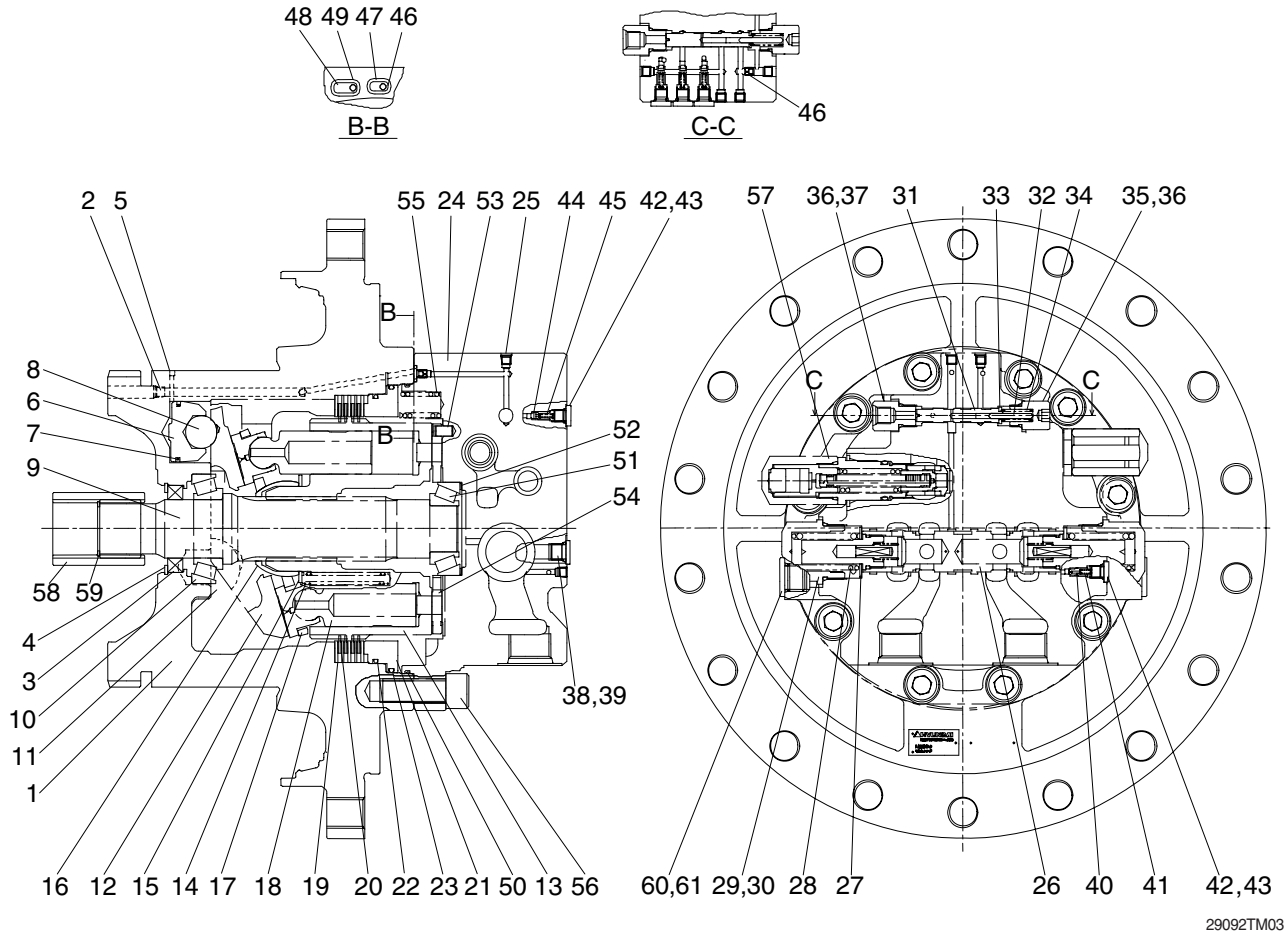
VIEW A

29092TM01

Port	Port name	Port size
VA, VB	Valve port	PF 1
P	Pilot port	PF 1/4
D1, D2	Drain port	PF 1/2
MA, MB	Gauge port	PF 1/4

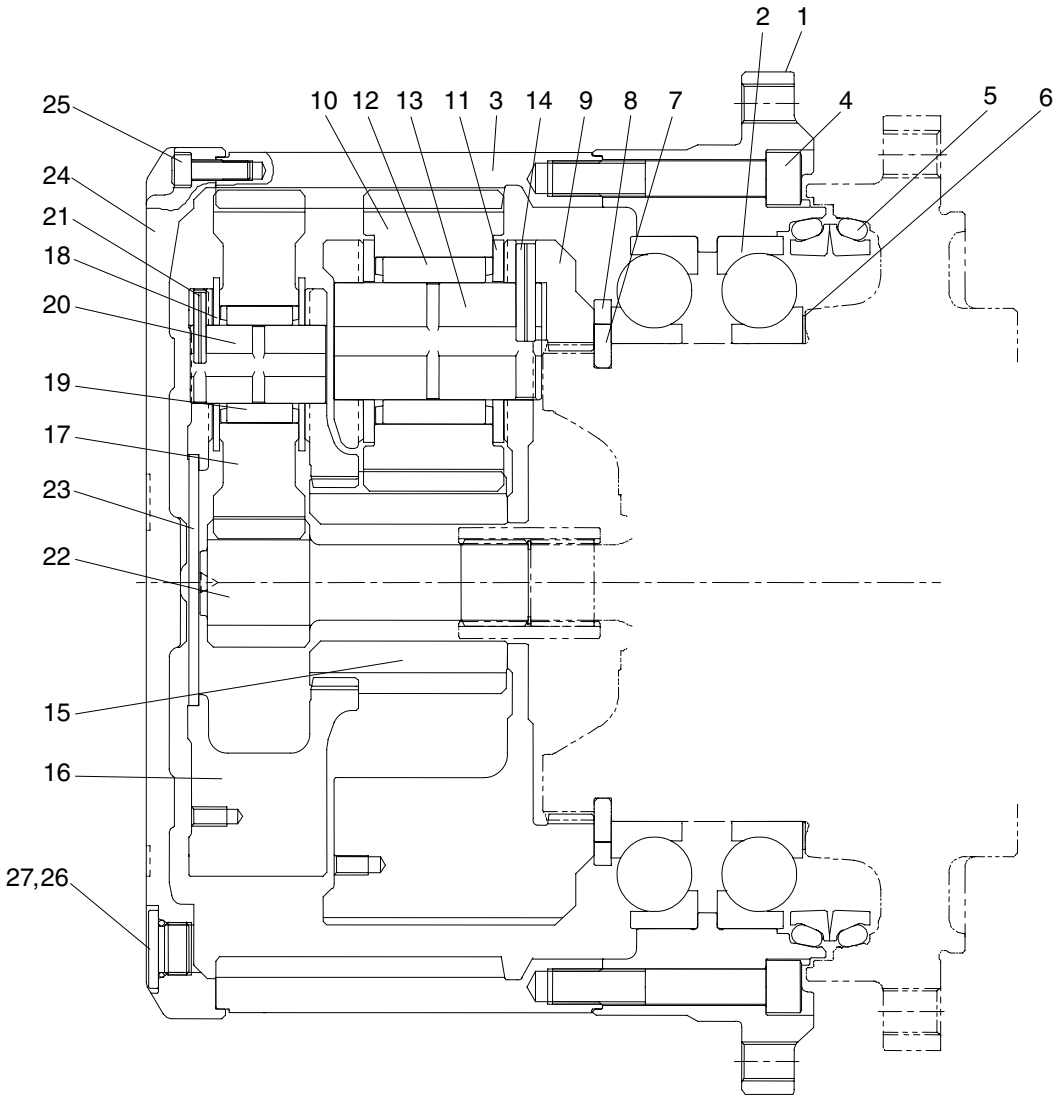
2. SPECIFICATION

1) TRAVEL MOTOR



1	Casing	22	D-ring	43	O-ring
2	Plug	23	D-ring	44	Check valve
3	Oil seal	24	Rear cover	45	Check valve spring
4	Retaining ring	25	Plug	46	Restrictor
5	Expander plug	26	Spool assy	47	O-ring
6	Shifter piston	27	Spring holder	48	Restrictor
7	Piston seal	28	Spring	49	O-ring
8	Steel ball	29	Plug	50	O-ring
9	Shaft	30	O-ring	51	Bearing
10	Bearing	31	Pilot valve spool	52	Shim
11	Pivot	32	Pin	53	Parallel pin
12	Swash plate	33	Spring holder	54	Valve plate
13	Cylinder block	34	Spring	55	Brake spring
14	Cylinder spring	35	Pilot valve plug	56	Hexagon socket head bolt
15	Spring holder	36	O-ring	57	Overload relief valve
16	Ball joint	37	Connector	58	Coupling
17	Shoe retainer	38	Plug	59	Retaining ring
18	Piston ass'y	39	O-ring	60	Plug
19	Separating plate	40	Restrictor	61	O-ring
20	Friction plate	41	Restrictor spring		
21	Brake piston	42	Plug		

2) TRAVEL REDUCTION GEAR



29092TM02

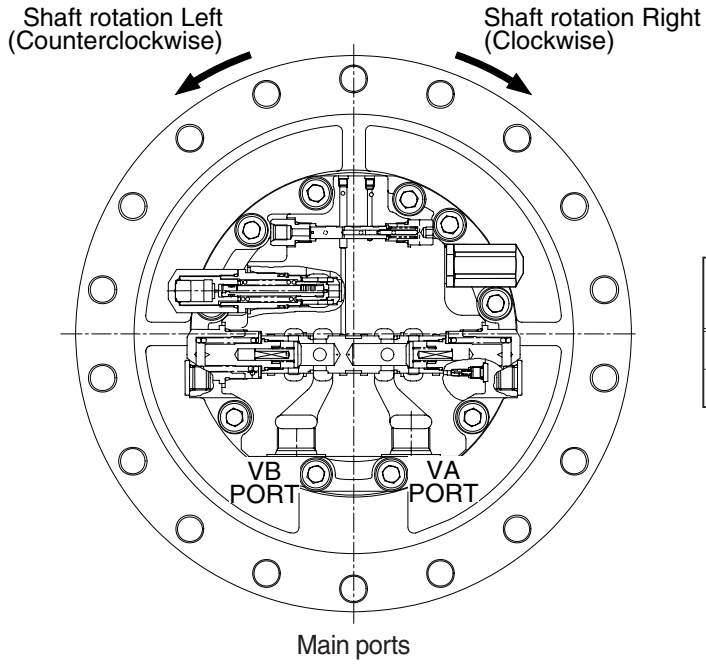
1	Housing	10	Planetary gear 2	19	Needle bearing
2	Bearing	11	Thrust washer 2	20	Carrier pin 1
3	Ring gear	12	Needle bearing	21	Spring pin
4	Hexagon socket head blot	13	Carrier pin 2	22	Sun gear 1
5	Floating seal	14	Spring pin	23	Thrust plate
6	Shim	15	Sun gear 2	24	Cover
7	Lock washer	16	Carrier 1	25	Hexagon socket head bolt
8	Support ring	17	Planetary gear 1	26	Plug
9	Carrier 2	18	Thrust washer 1	27	O-ring

3. OPERATION

1) MOTOR

High pressure oil delivered form hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (24) and valve plate (54), led to cylinder block (13).

The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclock wise)

29092TM06

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

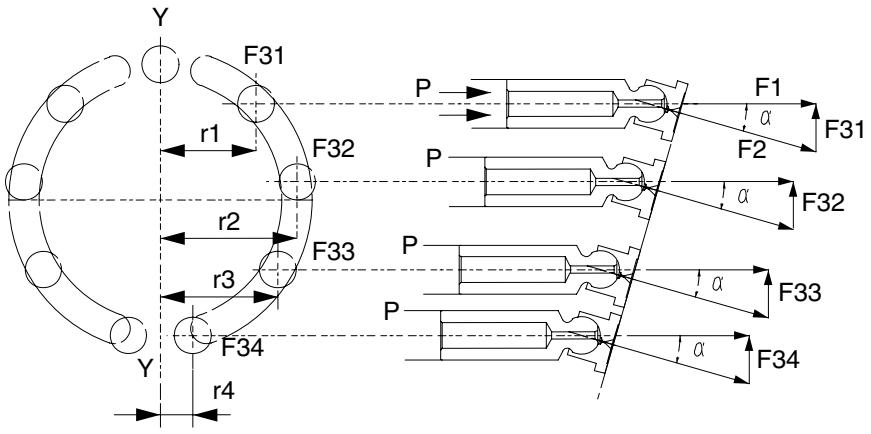
F1 = P × A (P : pressure, A : area of piston section)

The swash plate (12) with inclined angle of α divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$

This drive torque is transmitted via cylinder block (13) to driving shaft (9).

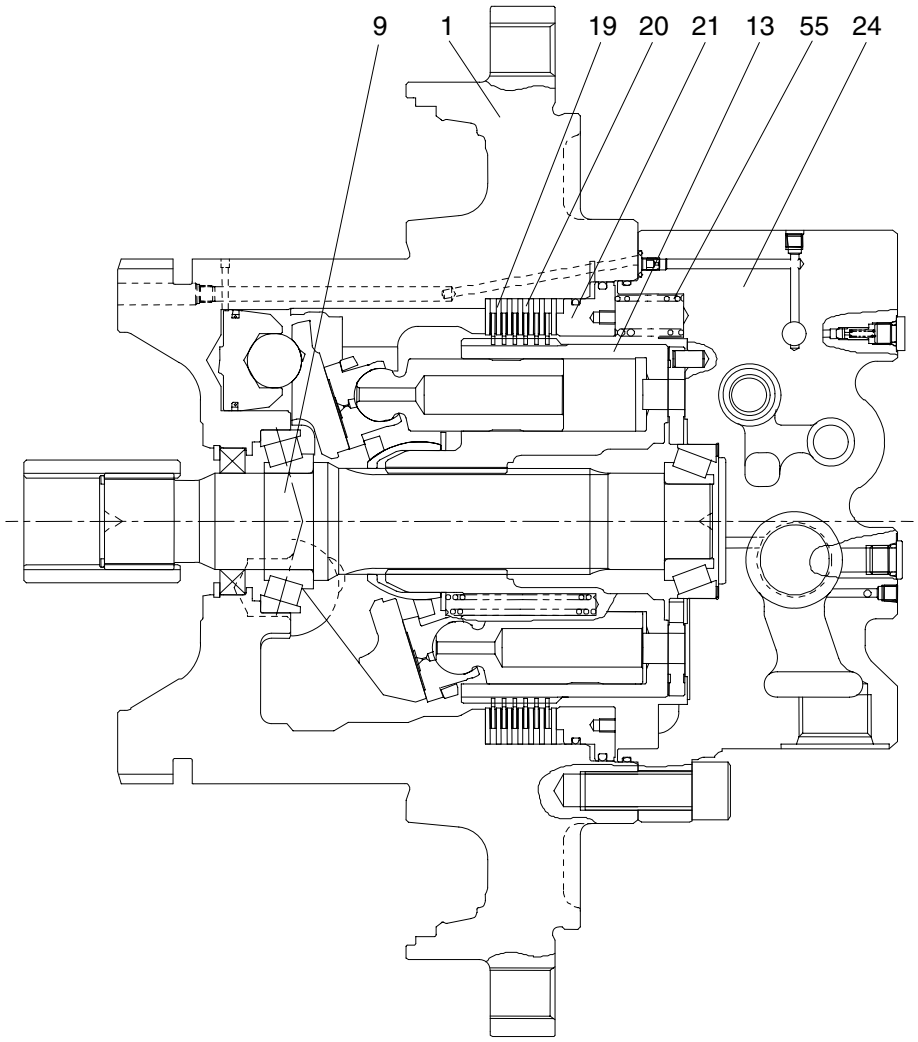


29092TM07

2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (24), is applied to the brake piston (21).
Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separating plates (19), inserted into the casing (1), and friction plates (20), coupled to cylinder block (13) by the outer splines.
When no pressure is activated on the brake piston (21), it is pushed by the brake springs (55) and it pushes friction plates (20) and separating plates (19) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (13) and hence the shaft (9)



29092TM08

3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure P_A that overcome the spring (34), the spring (34) is compressed and spool (31) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (44) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (6). As a result, swash plate (12) turns around the line L which connect the two pivots (11) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (12) keeps the position.

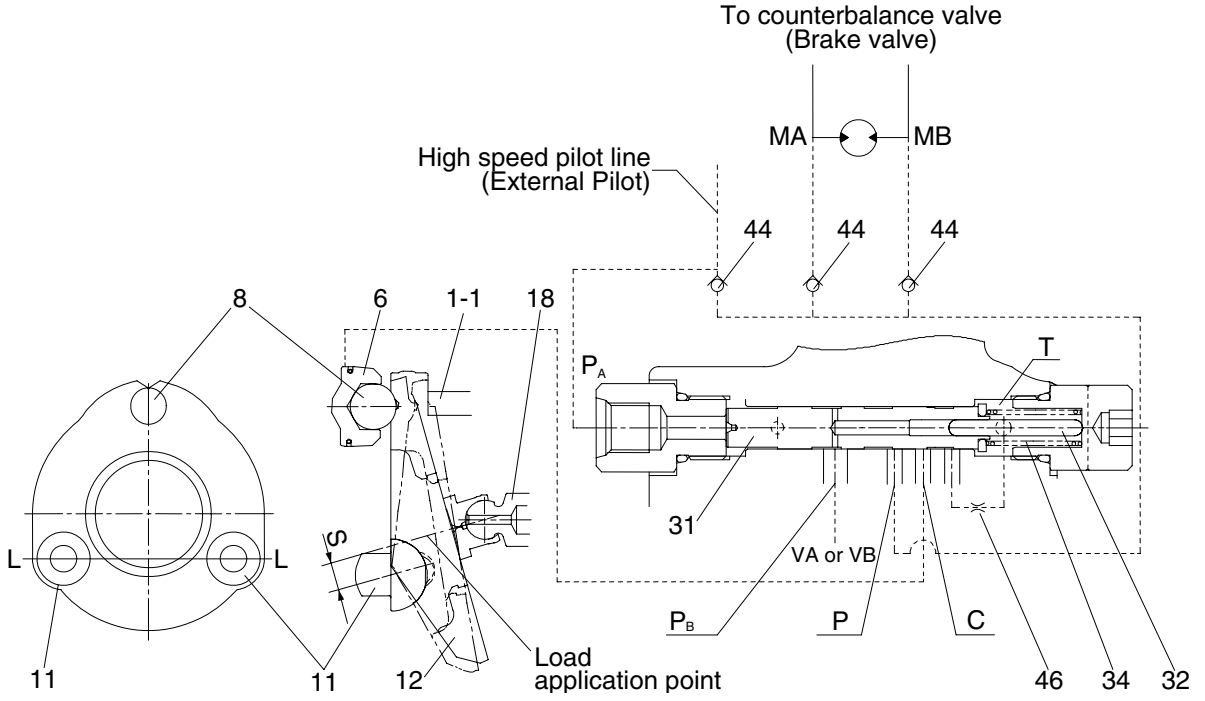
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.80 times, by the same volume of oil.

When no pressure is in the high speed pilot line P_A, spool (31) is pushed back by the spring (34) and pressure that pressed the shifter piston (6) is released to the hydraulic tank through restrictor (46).

Here, nine pistons are there and they equally spaced on the swash plate (12). The force that summed up those of pistons comes to almost the center of the swash plate (12) as shown. Since the pivots (11) are off-set by S from the center, the rotating force of product S and the force moves swash plate (12) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port P_B and this pressure activate on pin (32). When the pressure at P_B exceeds predetermined value, spool (31) returns to the left by the counter-pressure against pin (32) and the pressure on the shifter piston (6) through port C is released to the tank and the motor comes to low speed.

When P_B goes down, the spool (31) moves to the right and the speed become high.

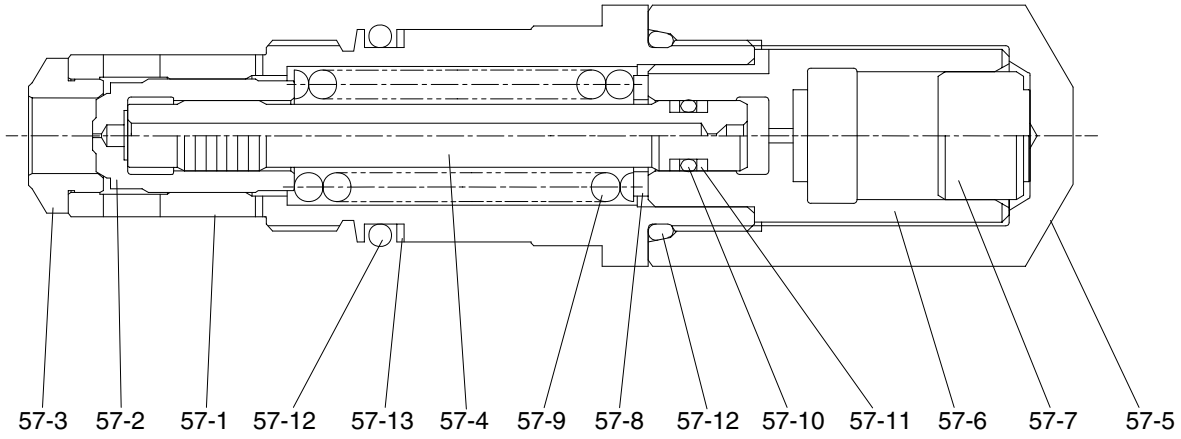


29092TM09

4) OVERLOAD RELIEF VALVE

(1) Structure

This valve is screwed in the motor rear cover (24) and consists of : socket (57-1) that is screwed and fixed in the rear cover (24) and supports the valve seat (57-3) which metallically seated in the hole of rear cover (24) : valve (57-2) that contact with valve seat (57-3) by adjusting spring (57-9) and fitted in the hole of socket (57-1) : coupling piston (57-4) that fitted in the hole of the valve (57-2) and functions also as an oil passage : piston (57-7) that is inserted in the pilot body (57-6) and : shim (57-8) that adjust the spring force.



29092TM16A

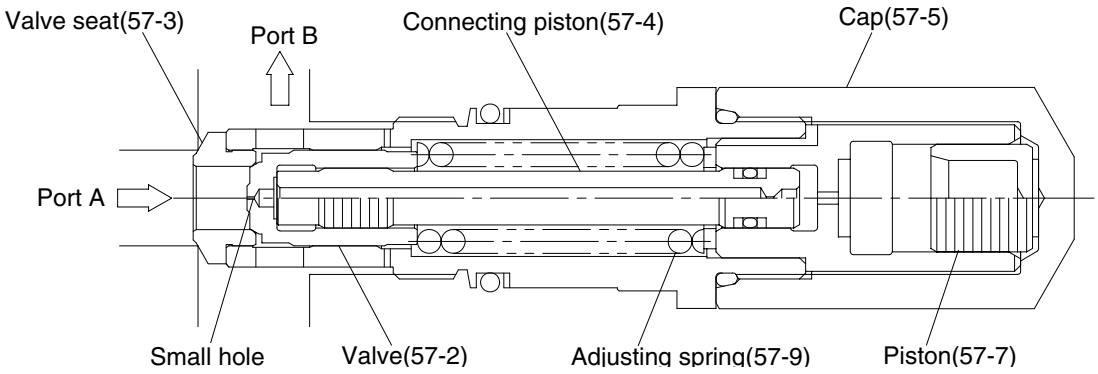
57-1 Socket	57-6 Pilot body	57-11 Back-up ring
57-2 Valve	57-7 Piston	57-12 O-ring
57-3 Valve seat	57-8 Shim	57-13 Back-up ring
57-4 Coupling piston	57-9 Adjusting spring	
57-5 Cap	57-10 O-ring	

(2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions:

① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of valve (57-2) which seats on the valve seat (57-3) and, at the same time, is delivered, via small hole, to the connecting piston (57-4) located inside the valve (57-2) and the piston bore pressure increases up to "A" port pressure. The valve (57-2) opposes to adjusting spring (57-9) by the force of the pressure exerted on the area difference between valve seat's effective diameter and piston bore and keep the predetermined pressure.
When hydraulically braking, the piston (57-7) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (57-7) through the small hole in the valve (57-2) and piston (57-7) moves rightward until it touches the cap (57-5). In this while, the valve (57-2) maintains "A" port pressure at comparatively low against the adjusting spring (57-9) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



29092TM10

5) BRAKE VALVE

(1) Structure

The brake valve portion mainly consists of the following parts:

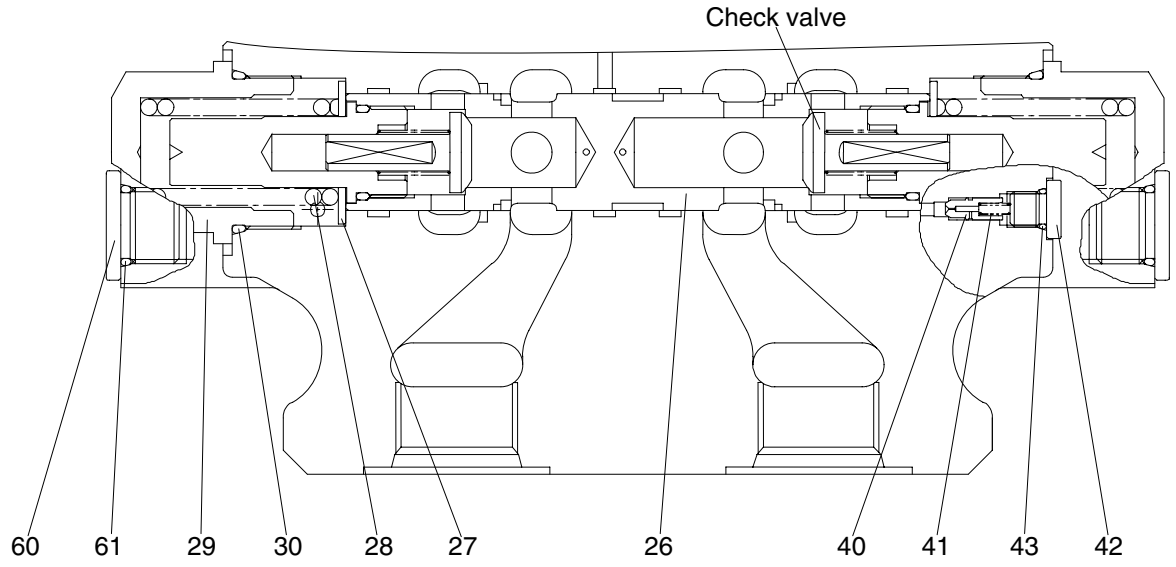
① **Spool**

By shifting the spool (26), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-74, (2) Operation)

② **Check valve** (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



29092TM15

26	Spool assy	30	O-ring	43	O-ring
27	Spring holder	40	Restrictor	60	Plug
28	Spring	41	Restrictor spring	61	O-ring
29	Plug	42	Plug		

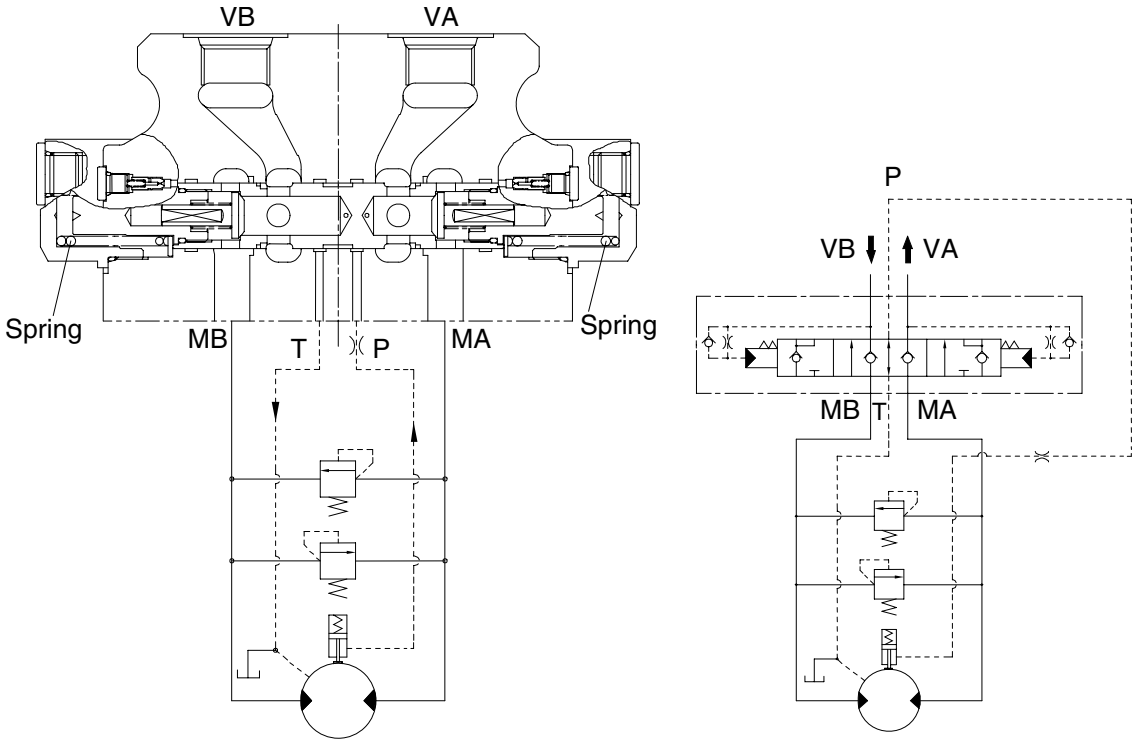
(2) Operation

① Holding operation

When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (28) located on both spool ends holds the spool (26) at central position.
Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.
If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (26), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.



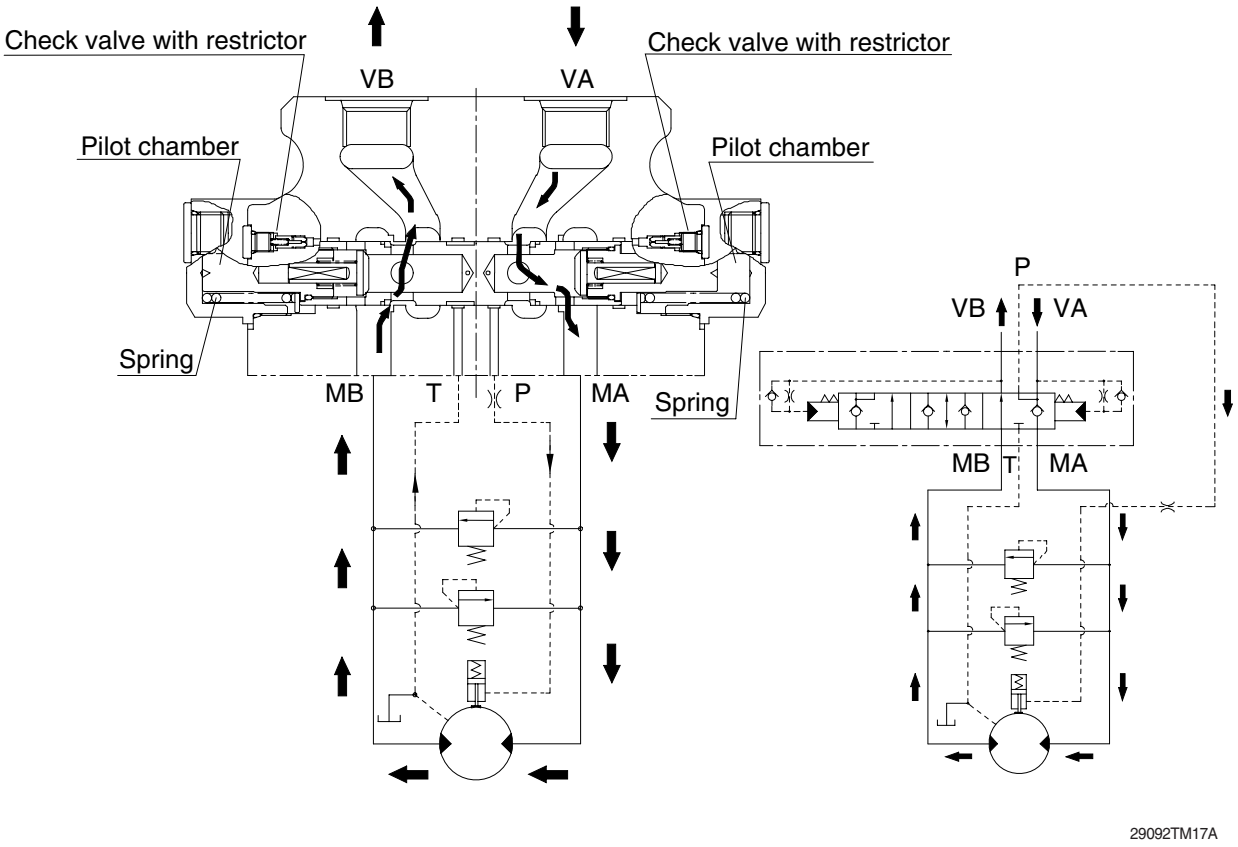
29092TM11

② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (26), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (26) leftwards, overcoming the spring (28) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed.
As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.

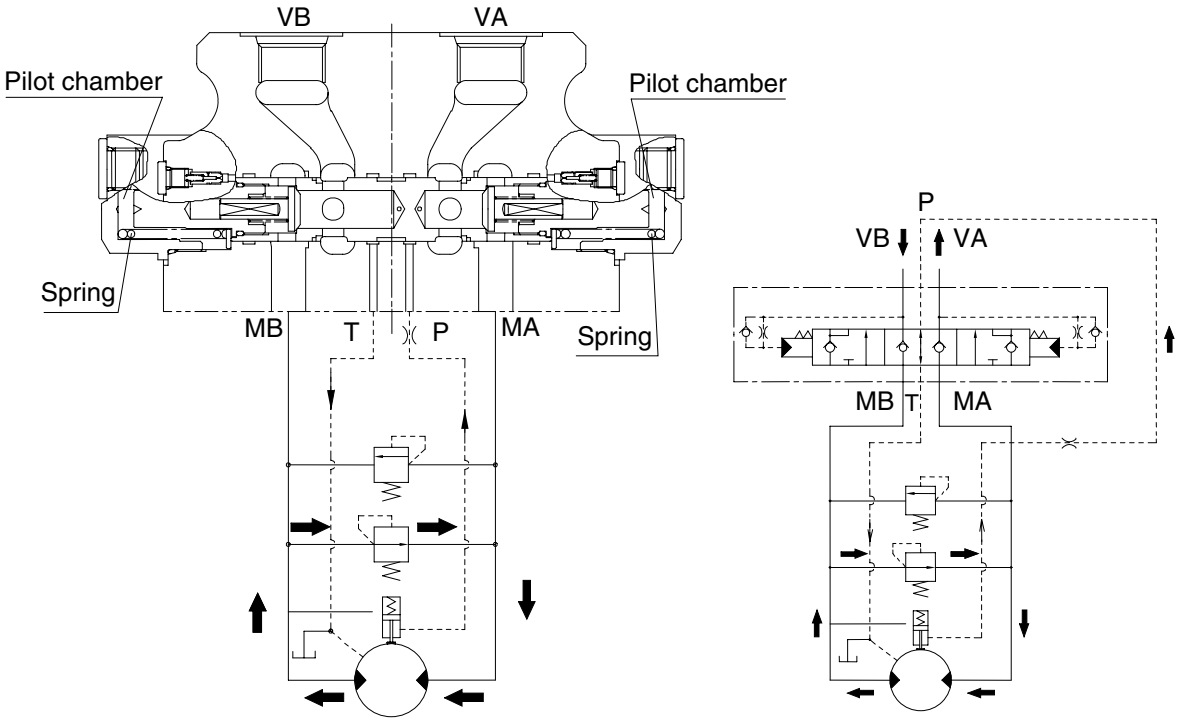


③ Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (26) returns to the neutral position by spring (28) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



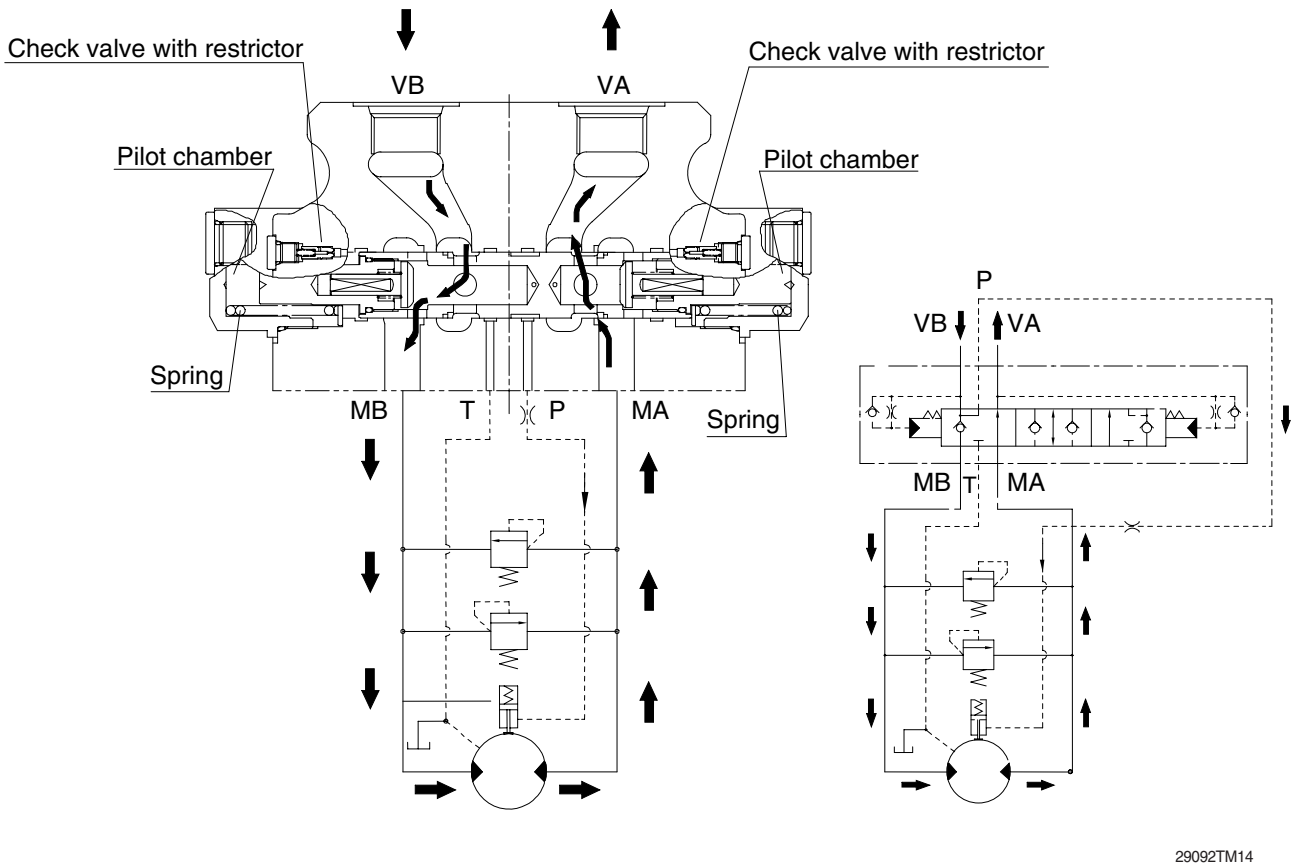
29092TM13

④ **Counterbalance operation**

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (28) force moves the spool (26) leftwards towards neutral position.
Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

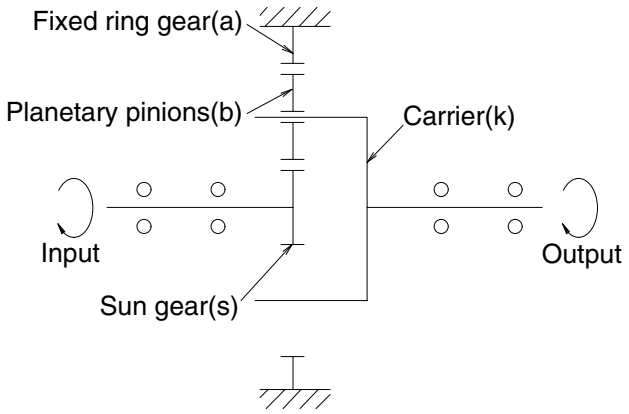
If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (26) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.
In order to give stable counterbalance operation, the restrictors (40) are set in the pilot chamber to damp the spool (26) movement.
The parking brake is released during pressure adjusting action of the spool (26).



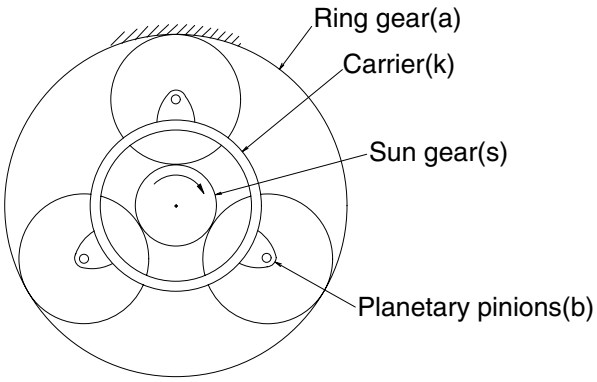
29092TM14

6) REDUCTION GEAR

Reduction unit slows down the rotating speed of motor and converts motor torque to strong rotating force.
This reduction unit utilizes two stages, planetary reduction system.
Planetary reduction system consists of sun gear, planetary gears, (planetary) carriers, and ring gear.
When the sun gear (s) is driven through input shaft, planetary pinions (b), rotating on their center, also move, meshing with fixed ring gear (a), around sun gear (s).
This movement is transferred to carrier (k) and deliver the torque.
This mechanism is called planetary gear mechanism.

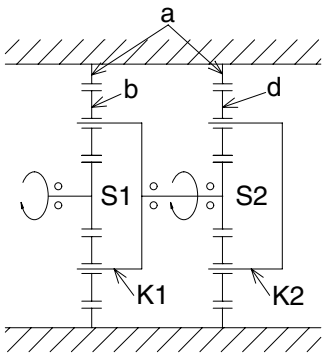


29072TM10



29072TM11

When the sun gear **S1** is driven by input shaft, planetary action occurs among gears **S1**, **a** and **b** and revolution of gear **b** transfers the rotation of carrier **K1** to second sun gear **S2**, and also evokes planetary action between gear **S2, a** and **d**.
This time, because carrier **K2** is fixed to frame, gear **d** drives ring gear **a** and then ring gear **a** rotates to drive sprocket.



29072TM12