SECTION 2 STRUCTURE AND FUNCTION

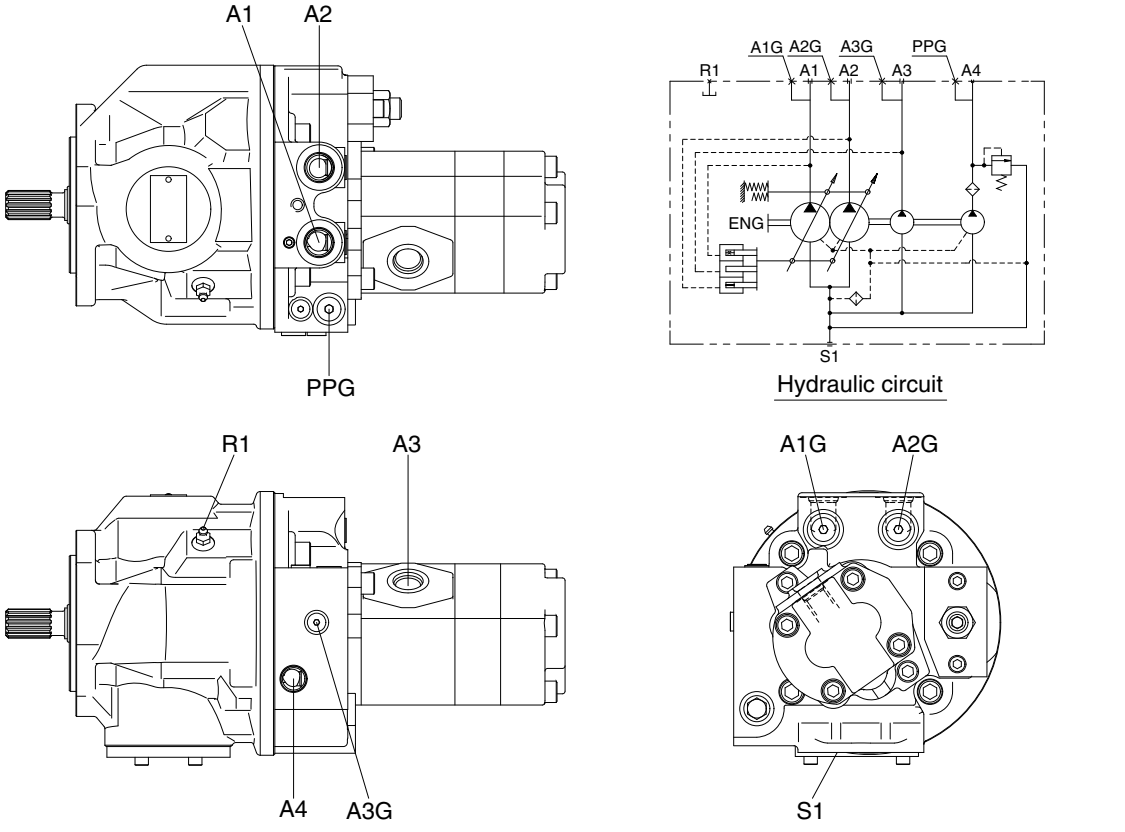
GROUP 1 HYDRAULIC PUMP

1. GENERAL

This is a variable displacement double-piston pump for discharge with equal displacements from one cylinder block. This pump is so compact as to appear a single pump though this is actually a double pump.

Because this pump has one swash plate, the tilting angle is the same for two pumps. Tilting of the pump changes in response to the total pressure of P1 + P2. Namely, the output is controlled to the constant value so that the relationship between the discharge pressure and flow rate Q becomes constant, (P1 + P2) × Q =Constant.

The third pump and pilot pump can be connected to the same shaft via a coupling.



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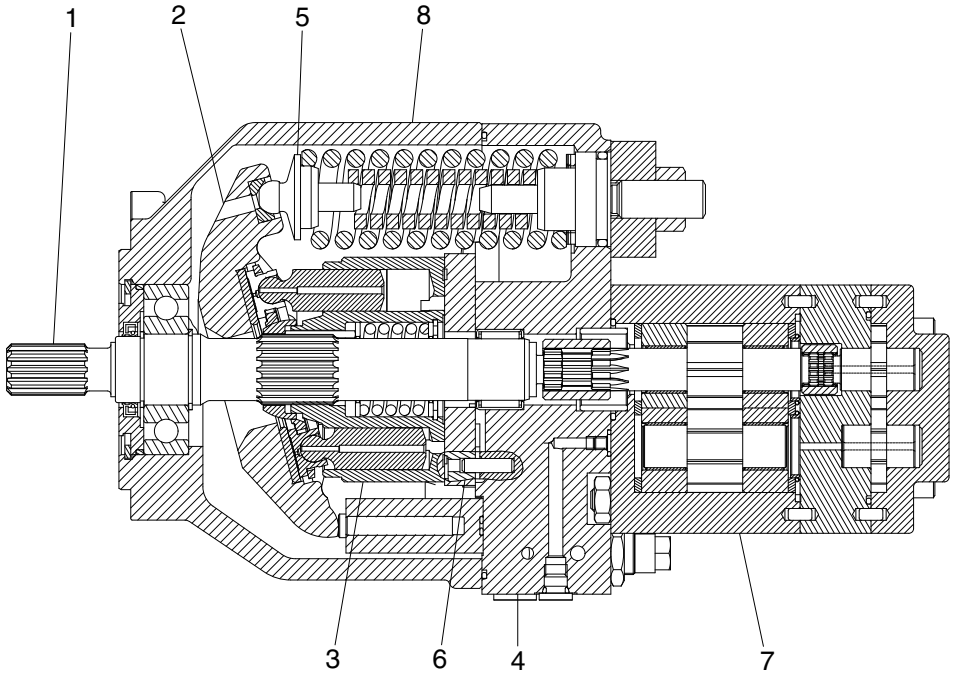
Description of the ports

Port	Name	Bore
S1	Suction port	SAE 1 1/2 (standard)
A1, A2	Discharge port	PF 1/2
A3	Discharge port	PF 1/2
A4	Discharge port	PF 1/4
A1G, A2G	Gauge port	PF 1/4 With quick coupler
A3G	Gauge port	PF 1/8 With quick coupler
A4G	Gauge port	PF 1/4 With quick coupler
R1	Air bleeder port	M10 × 1.0 (with bleeder valve)

2. PRINCIPAL COMPONENTS AND FUNCTIONS



1	Drive shaft	5	Control spring
2	Hanger	6	Control piston
3	Rotary group	7	Gear pump
4	Cover	8	Housing

SPECIFICATIONS

- Capacity : 2 × 27.5+18.3+4.5 cc/rev
- Rated oil flow : 2 × 57.8+38.4+9.5 ℓ /min
- Rated pressure : 3 × 220+30 kgf/cm²

This is a variable displacement double-piston pump for discharge with two equal displacements from one cylinder block. Because this is one rotary group, there is only one suction port.

The oil is divided into two equal flows by the control plate in the cover and directed to two discharge ports provided in the cover.

The discharge pressure directed to the control piston tilts the hanger by overcoming the spring force.

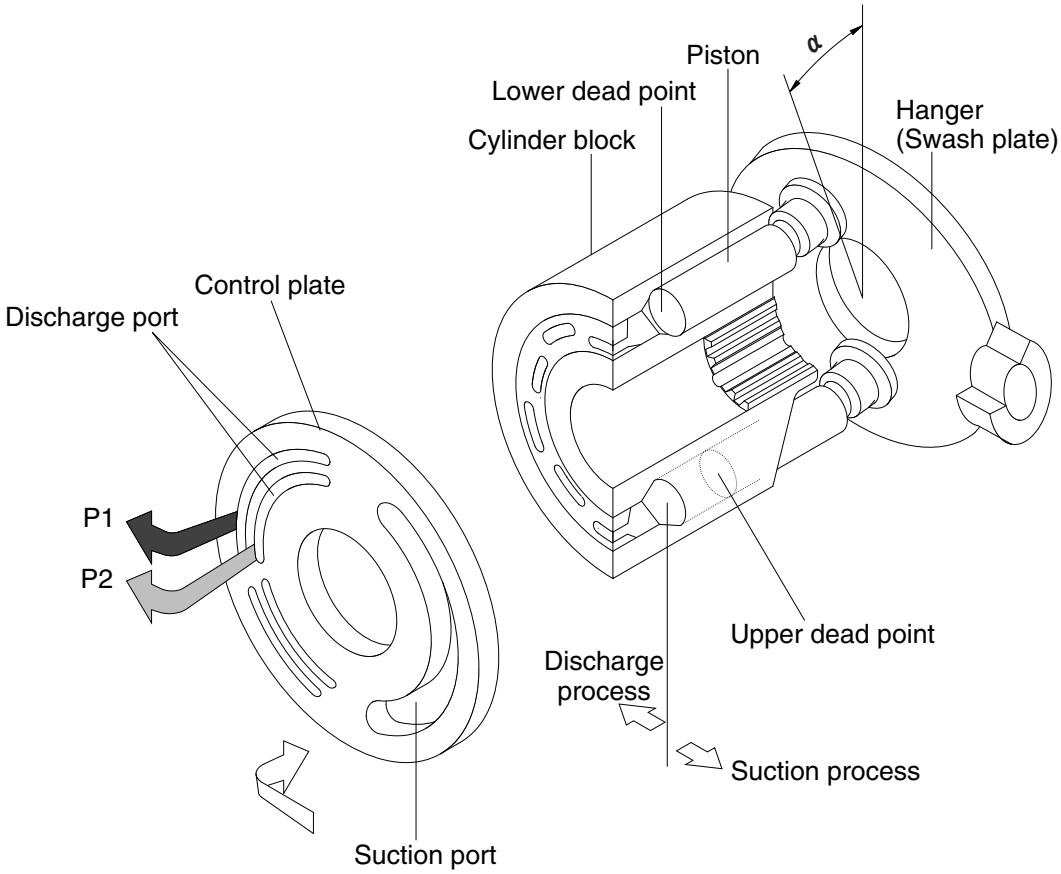
Since the piston stroke changes according to the tilting angle of the hanger, the flow can be changed.

The simultaneous tilting angle constant-output control method is employed.

The third pump and pilot pump can be connected to the same shaft via a coupling.

1) PRINCIPLE OF OPERATION

(1) Function of pump



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The cylinder block is connected via spline and can rotate together with the drive shaft.

The piston assembled into the cylinder block performs reciprocal operation while following the swash plate on the hanger.

The piston moves in a direction to increase the displacement during a stroke from the lower to the upper dead points. The oil flows from the suction port via a port plate into the cylinder block (suction process).

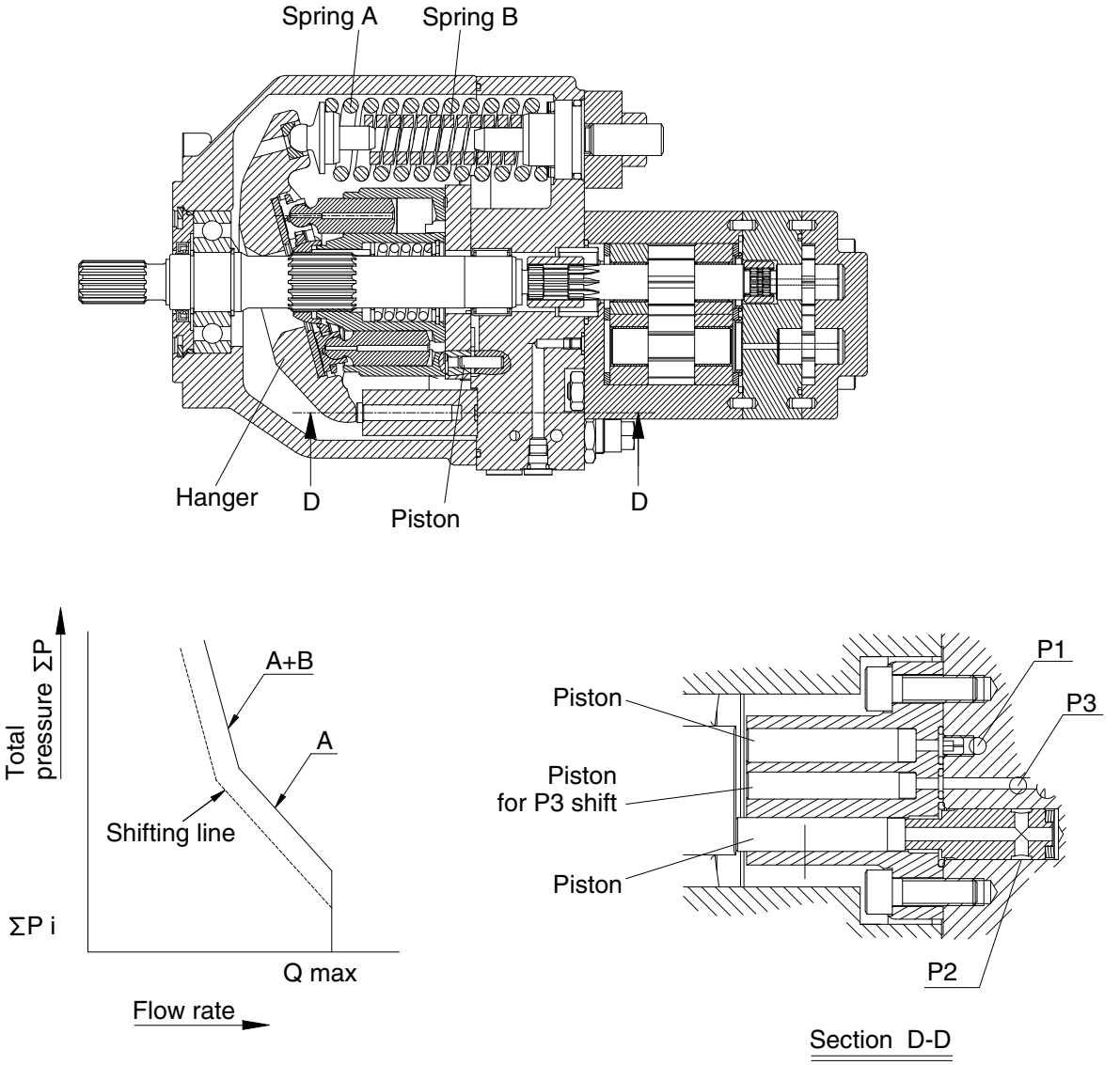
During a stroke from the upper to the lower dead points, the piston moves in a direction to decrease the displacement. The oil is discharged to the discharge port (discharge process).

The displacement can be changed by changing the tilting of the hanger (swash plate).

The oil sucked through the port in the cylinder block is discharged from the discharge port in the port plate.

The oil sucked through the port on the outside of the cylinder block is discharged from the discharge port on the outside of the port plate.

2) CONTROL FUNCTIONS



The discharge pressures P1 and P2 are directed to the pistons of equal area act on the hanger. The spring is provided to act against the discharge pressure. When the oil pressure acting on the piston is less than the installation load of the spring A (outer spring), the hanger is fixed to the maximum tilting position. When the oil, pressure acting on the piston exceeds the installation load of the spring A the hanger is tilted and kept tilted at a position where the oil pressure is balanced with the spring force. (region A in the middle of the figure above)

When the oil pressure acting on the piston rises further to reduce the tilting angle, the spring B which has been inactive up to now becomes active.

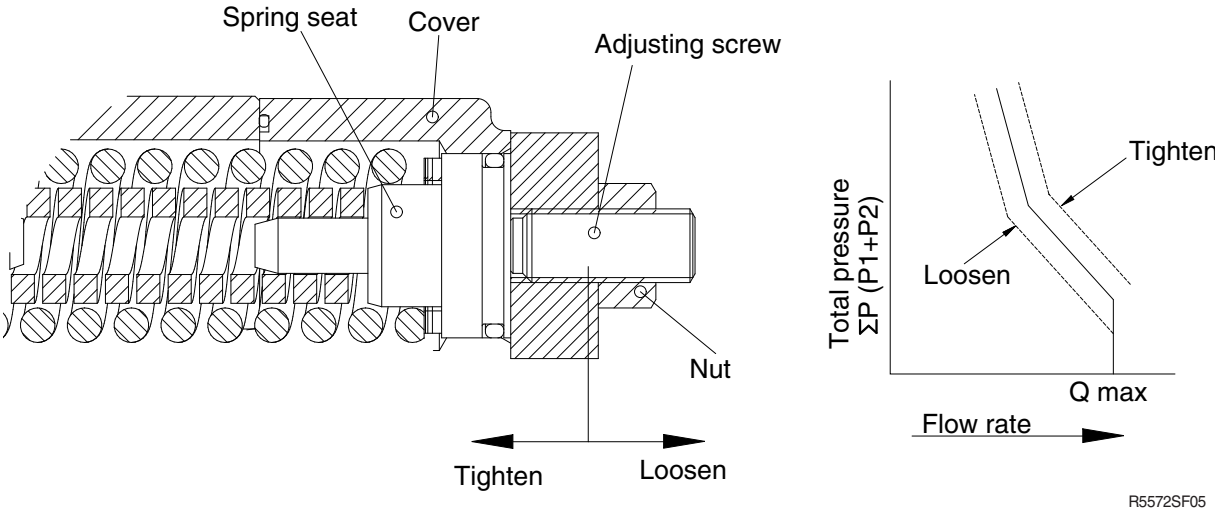
To overcome the spring force of two springs, the oil pressure must be higher and the shifting line becomes more steep. (regions A + B in the middle of the figure above)

When the P3 oil pressure acts on the shift piston, the control shifting line is shifted.

3) CONTROL / ADJUSTMENT PROCEDURE

(1) Loosen the hexagonal nut.

(2) Tighten or loosen the adjusting screw to set the power shifting line.



3. ADJUSTMENT

This hydraulic pump has been set and inspected according to your specified input power and control. Readjustment of all the adjusting portions may lead to the loss of functions specified for each control and the pump proper may be excluded from the scope of guarantee. Never attempt operating the adjusting screw, etc.

4. INSTALLATION

(1) Install the pump so that the input shaft becomes horizontal.
(2) Install the pump in a position lower than the lowest oil level in the tank to allow continuous flow of the oil into the pump.
(3) Since the pump is installed directly to the diesel engine, always use a flexible hose. Install the suction pipe firmly to prevent suction of an air.
(4) Use the high-pressure type flexible hoses for the discharge ports P1 and P2.
(5) After installation, fill the pump housing with the hydraulic oil.
(6) Do not direct the external drain piping from within the oil.

5. DRIVE

(1) Use a flexible coupling for connection to the motor.
(2) Insert the coupling firmly onto the input shaft. Do not hammer the coupling during insertion.
(3) The input shaft must rotate clockwise when viewed from the shaft end.

6. HYDRAULIC OIL

The hydraulic oil to be used must be a general petroleum, hydraulic oil or wear-resistant hydraulic oil (ISO 3448, VG 32 ~ 56 or equivalent).
The applicable viscosity range is as follows :

Maximum allowable viscosity : 1000 mm^2/s
Minimum allowable viscosity : 10 mm^2/s
Recommended viscosity range : 15 ~ 150 mm^2/s

7. STARTING PROCEDURE

※ Before start up, check the following points and observe the cautions :

(1) Check if the tank has been washed clean.
(2) Check if the piping is clean and installed in such a manner as to prevent stress on the pump.
(3) Check if the piping is connected correctly according to the piping (circuit) diagram.
(4) Check if the joint and flange are correctly tightened.
(5) Check if the joint between the motor and pump is correctly installed.
(6) Check if the motor rotation direction agrees with the pump rotation direction.
(7) Check if the specific hydraulic oil is supplied though the filter and filled in the tank to the specified position of the oil level gage.
(8) Check if the filter has the specified filtration accuracy (10 μm or less).
(9) Check if the filter has been installed correctly relative to the float direction.
(10) Check if the pump housing is filled with oil.
(11) Check if the control valve is set to the bypass position.
(12) Start the motor. If necessary, carry out warm-up operation at low speed.
(13) Check, without any load on the system, if the actuator operates correctly.

(14) When the motor has reached the operation speed, check the operation while applying the load to the actuator.
(15) Check the monitoring or measuring instrument if installed.
(16) Check the noise level.
(17) Check the oil level in the tank. Supply the oil. If required.
(18) Check the setting of the pressure control valve while applying the load to the actuator.
(19) Check the parts for any leakage.
(20) Stop the motor.
(21) Retighten all the bolts and plugs even when they have proved to by free from Leakage.
(Be sure to remove the pressure from the circuit before retightening.)
(22) Check the oil level in the tank.
(23) Check if the pump and actuator function correctly.
(24) Irregular operation of the actuator indicates that an air is left still in the circuit. When the air is bleeded completely from the circuit, all the parts operates smoothly without any irregular movement and there is no bubble in the oil of the tank.
(25) Check the oil temperature.
(26) Stop the motor.
(27) Check the filter if the element is fouled.
(28) If the element is heavily fouled, carry out flashing in the circuit.

※ To prevent damage to the pump, be sure to observe the following cautions during the operation which may allow entry of the actuator, hydraulic oil change, etc :

(1) After oil supply, fill the pump housing with the hydraulic oil.
(2) Start the pump with the speed of 1000 rpm or less and take care not to allow the oil level to lower below the specified level of the oil level gauge.
(3) When bleeding an air from the hydraulic circuit, keep the motor speed at 1000 rpm or less. Operate each actuator for three or more cycles and carry out idling for 5 minutes or more.

8. MAINTENANCE

The maintenance of this hydraulic pump is limited mainly to the tank, in particular, the hydraulic oil change.

Since the maintenance interval varies depending on respective operation and use conditions, the cautions described below for the users should be for reference only.

(1) Checking the filter

① Every day for the initial period after start up.
② Once a week when the operation becomes stable.
③ Once a month when the operation hours exceed about 100 hours.

※ When any part of the hydraulic system is changed (e.g., assembling of an additional part, change and repair of the piping), check the filter newly as in the case of startup.

(2) Changing the filter

① After startup
② After 500 hours of operation
③ Every 500 hours of operation after that, and each time the hydraulic oil is changed or the failure occurs. If any abnormal fouling of the filter is observed during daily check up to the first filter change after startup, find out the cause.
In this case, do not extend the check and filter change intervals to 500 hours.

※ The paper filter can not be cleaned. Change the filter as a whole.

(3) Changing the hydraulic oil

① After 2000 hours of operation.

② Every 2000 hours of operation or once a year after that.

The change interval may have to be shortened depending on the degree of fouling and the thermal load condition of the hydraulic oil.

If the hydraulic oil is not appropriate and need be changed, pay attention to the following points :

Be sure to control the oil temperature below the highest temperature and above the lowest temperature during operation in winter and summer.

Pay attention to the following points during change of the hydraulic oil :

- Change the hydraulic oil as a whole quantity.
- Do not allow dust to mix into the circuit.
- Clean the tank inside.
- Supply the oil through the filter.

(4) Checking for the oil leakage

① Daily during the initial period after startup.

② Once a week when the operation becomes stable.

(5) Checking the temperature

① Monitor the temperature continuously.

② When the viscosity is above the allowable value because of low hydraulic oil temperature, warm-up operation is necessary.

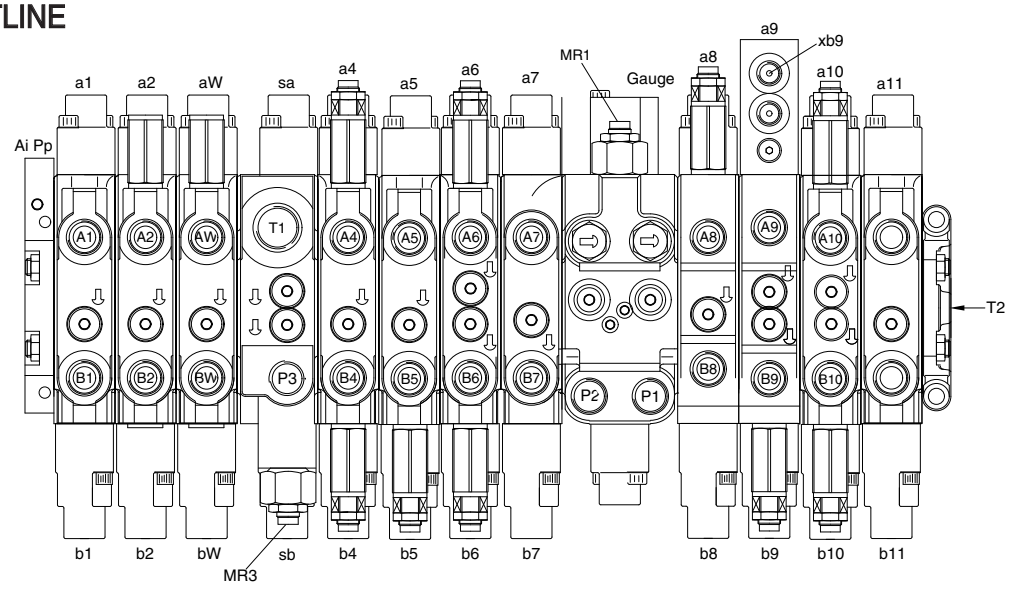
Start the motor with the speed set to about one half of the rated speed, then operate the actuator under the load for a short period.

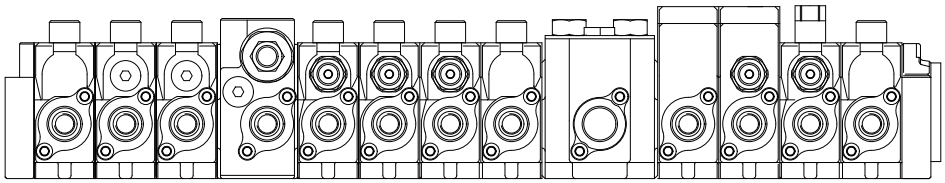
When the oil temperature is below the allowable ambient temperature, it is necessary to preheat the oil tank before start of the motor.

Take care not to allow the hydraulic oil temperature to exceed +90˚C

GROUP 2 MAIN CONTROL VALVE

1. OUTLINE





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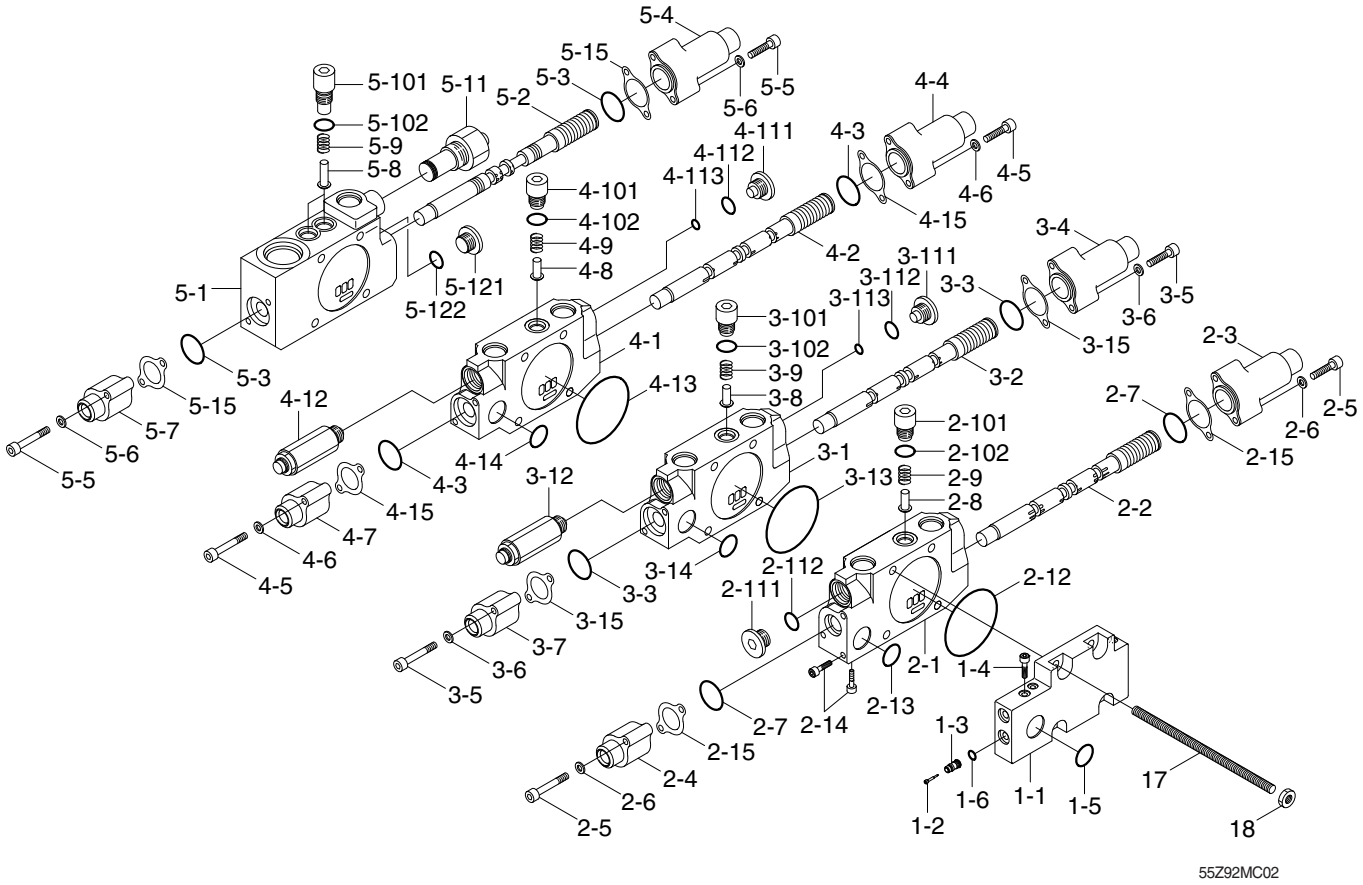
Mark	Port name	Port size	Tightening torque
P1	P1 pump port	PF 1/2	6.0~7.0 kgf · m
P2	P2 pump port		
P3	P3 pump port		
A1	Swing port (LH)		
B1	Swing port (RH)		
A2	Dozer down port		
B2	Dozer up port		
AW	Boom swing port (LH)		
BW	Boom swing port (RH)		
A4	2 Way (opt)		
B4	2 Way (opt)		
A5	Boom 2 port		
B5	Breaker port		
A6	Arm out port		
B6	Arm in port		
A7	Travel port [LH/FW]		
B7	Travel port [LH/RR]		
A8	Travel port [RH/FW]		
B8	Travel port [RH/RR]		
A9	Boom up port		
B9	Boom down port		
A10	Bucket out port		
MR1 MR3	Main relief valve	-	

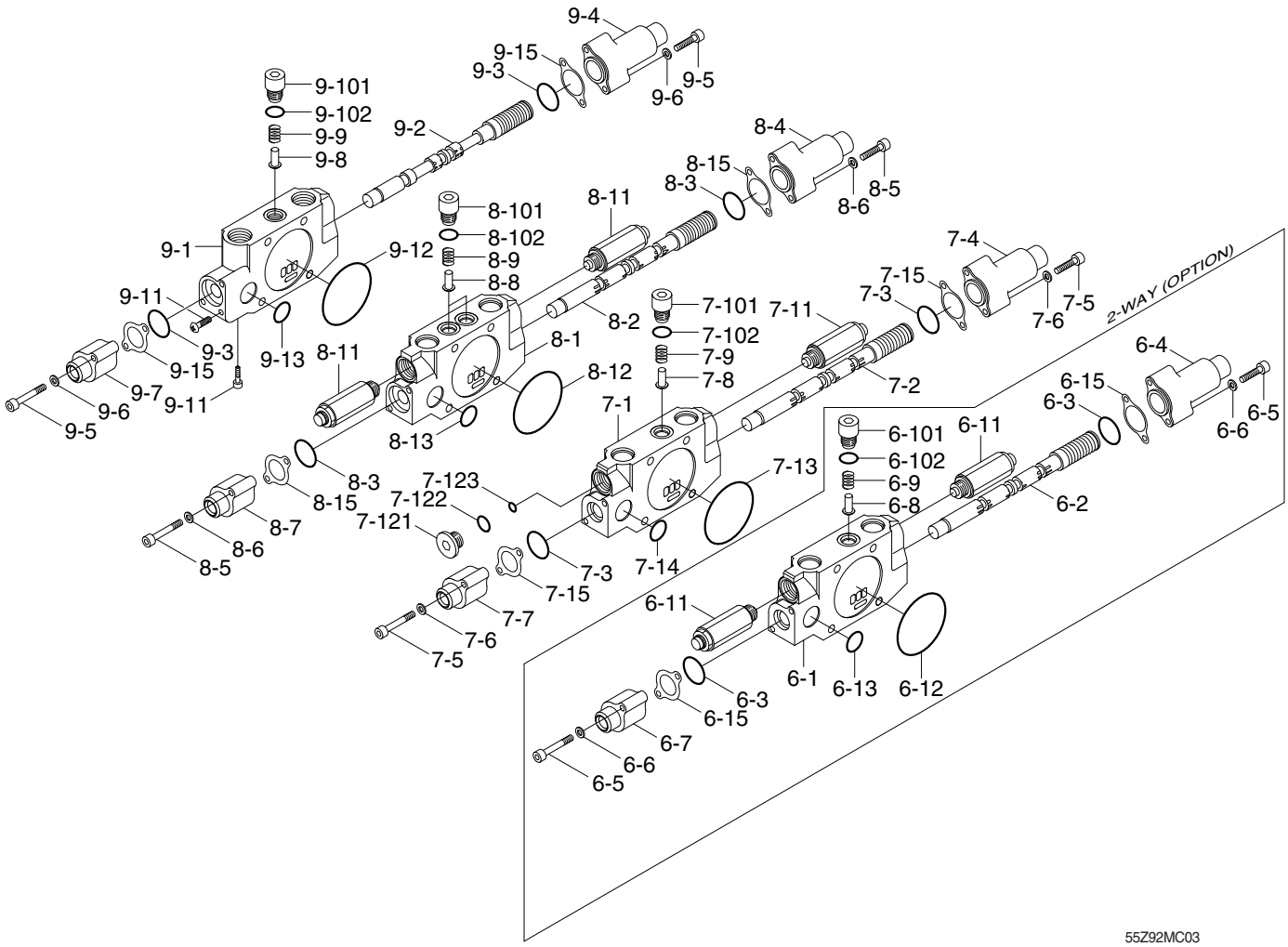
Mark	Port name	Port size	Tightening torque
B10	Bucket in port	PF1/2	6~7 kgf · m
B11	Arm 2 port		
T2	Tank return port	PF3/4	8~9 kgf · m
T1	Tank return port	PF1	10~12 kgf · m
a1	Swing pilot port (LH)	PF1/4	2.5~3.0 kgf · m
b1	Swing pilot port (RH)		
a2	Dozer down pilot port		
b2	Dozer up pilot port		
aw	Boom swing pilot port (LH)		
bw	Boom swing pilot port (RH)		
a4	2 Way pilot port (opt)		
b4	2 Way pilot port (opt)		
a5	Boom 2 pilot port		
b5	Breaker pilot port		
a6	Arm out pilot port		
b6	Arm in pilot port		
a7	Travel pilot port (LH/FW)		
b7	Travel pilot port (LH/RR)		
a8	Travel pilot port (RH/FW)		
b8	Travel pilot port (RH/RR)		
a9	Boom up pilot port		
b9	Boom down pilot port		
a10	Bucket out pilot port		
b10	Bucket in pilot port		
a11	Arm 2 pilot port		
b11	Arm 2 pilot port		
Pp	Pilot supply port	PF1/4	
Ai	Auto idle signal port		

2. STRUCTURE (1/4)



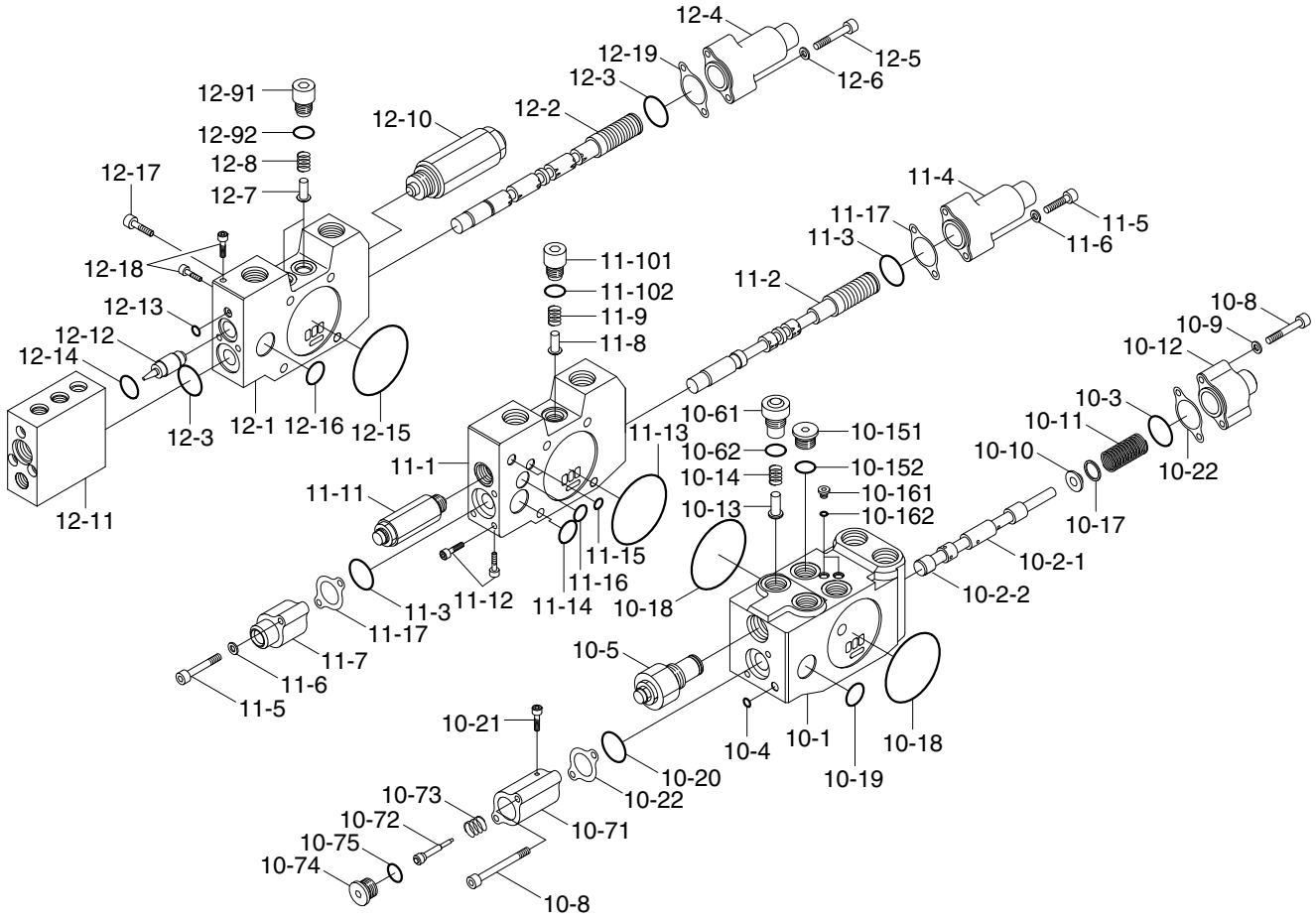
1	Ai cover	3	Dozer section assy	4	Boom swing assy	5	Inlet section assy-P3
2	Swing section assy	3-1	Work block	4-1	Work block	5-1	Work block (Ta)
2-1	Work block	3-2	Spool assy	4-2	Spool assy	5-2	Spool assy
2-2	Spool assy	3-3	O-ring	4-3	O-ring	5-3	O-ring
2-3	Pilot cap (A)	3-4	Pilot cap (A)	4-4	Pilot cap (A)	5-4	Pilot cap (A)
2-4	Pilot cap (B1)	3-5	Socket bolt	4-5	Wrench bolt	5-5	Wrench bolt
2-5	Wrench bolt	3-6	Plain washer	4-6	Plain washer	5-6	Plain washer
2-6	Plain washer	3-7	Pilot cap (B1)	4-7	Pilot cap (B1)	5-7	Pilot cap (B1)
2-7	O-ring	3-8	Check poppet	4-8	Check poppet	5-8	Check poppet
2-8	Check poppet	3-9	Check spring	4-9	Check spring	5-9	Check spring
2-9	Check spring	3-10	Plug	4-10	Plug assy	5-10	Plug assy
2-10	Plug	3-101	Check plug (M14)	4-101	Plug 1-Check (M14)	5-101	Plug 1-Check (M14)
2-101	Plug 1-Check M14	3-102	O-ring	4-102	O-ring	5-102	O-ring
2-102	O-ring	3-11	Plug	4-11	Plug assy	5-11	Main relief valve
2-11	Plug	3-111	Plug	4-111	Plug	5-12	Cap-PF1/4 plug
2-111	Plug-PF3/8	3-112	O-ring	4-112	O-ring	5-121	Cap-PF1/4 plug
2-112	O-ring	3-113	O-ring	4-113	O-ring	5-122	O-ring
2-12	O-ring	3-12	Check valve	4-12	Check valve	5-15	Gasket
2-13	O-ring	3-13	O-ring	4-13	O-ring	17	Tie bolt
2-14	Plug-Taper	3-14	O-ring	4-14	O-ring	18	Nut
2-15	Gasket	3-15	Gasket	4-15	Gasket		

STRUCTURE (2/4)



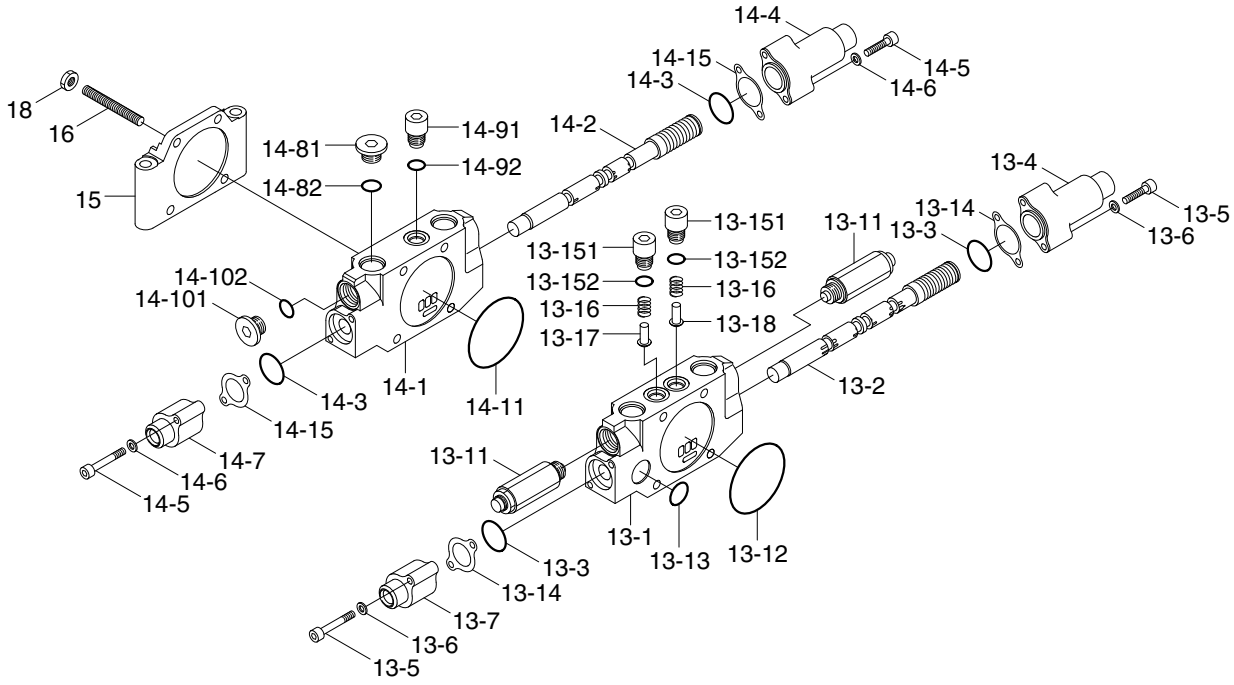
6	2- way section assy	7-1	Work block (Ba3)	7-14	O-ring	8-15	Gasket
6-1	Work block	7-2	Spool assy	7-15	Gasket	9	Travel section assy
6-2	Spool assy	7-3	O-ring	8	Arm 1 section assy	9-1	Work block (Dk)
6-3	O-ring	7-4	Pilot cap (A)	8-1	Work block (B3)	9-2	Spool assy
6-4	Pilot cap (A)	7-5	Wrench bolt	8-2	Spool assy	9-3	O-ring
6-5	Wrench bolt	7-6	Plain washer	8-3	O-ring	9-4	Pilot cap (A)
6-6	Plain washer	7-7	Pilot cap (B1)	8-4	Pilot cap (A)	9-5	Wrench bolt
6-7	Pilot cap (B1)	7-8	Check poppet	8-5	Socket bolt	9-6	Plain washer
6-8	Check poppet	7-9	Check spring	8-6	Plain washer	9-7	Pilot cap (B1)
6-9	Check spring	7-10	Plug assy	8-7	Pilot cap (B1)	9-8	Check poppet
6-10	Plug assy	7-101	Plug	8-8	Check poppet	9-9	Check spring
6-101	Plug 1-Check (M14)	7-102	O-ring	8-9	Check spring	9-10	Plug 1-Check (M14)
6-102	O-ring	7-11	Overload relief valve	8-10	Plug	9-101	Plug 1-Check (M14)
6-11	Overload relief valve	7-12	Plug assy	8-101	Plug 1-Check (M14)	9-102	O-ring
6-12	O-ring	7-121	Plug	8-102	O-ring	9-11	Taper plug
6-13	O-ring	7-122	O-ring	8-11	Overload relief valve	9-12	O-ring
6-15	Gasket	7-123	O-ring	8-12	O-ring	9-13	O-ring
7	Boom2/Breaker assy	7-13	O-ring	8-13	O-ring	9-15	Gasket

STRUCTURE (3/4)



10	Inlet assy-P1, P2	10-11	Pilot spring	11-4	Pilot cap (A)	12-4	Pilot cap (A)
10-1	Work block	10-12	Pilot cap (B2)	11-5	Wrench bolt	12-5	Wrench bolt
10-2	Spool (Ts)	10-13	Check poppet	11-6	Plain washer	12-6	Plain washer
10-2-1	Spool (Ts)	10-14	Check spring	11-7	Pilot cap (B1)	12-7	Check poppet
10-2-2	Spool plug bolt	10-15	Plug assy-PF3/8	11-8	Check poppet	12-8	Check spring
10-3	O-ring	10-151	Plug	11-9	Check spring	12-9	Plug assy
10-4	O-ring	10-152	O-ring	11-10	Plug 1 assy	12-91	Check plug 1 (M14)
10-5	Main relief valve	10-16	Plug-UNF5/16	11-101	Check plug 1 (M14)	12-92	O-ring
10-6	Plug 3 assy	10-161	Plug-UNF5/16	11-102	O-ring	12-10	Overload relief valve
10-61	Plug-PF3/8	10-162	O-ring	11-11	Overload relief valve	12-11	Holding valve
10-62	O-ring	10-17	Spring shim	11-12	Taper plug	12-12	Holding valve
10-7	Cap assy-Ts check	10-18	O-ring	11-13	O-ring	12-13	O-ring
10-71	Cap -Ts check	10-19	O-ring	11-14	O-ring	12-14	O-ring
10-72	Poppet check valve	10-20	O-ring	11-15	O-ring	12-15	O-ring
10-73	Check spring	10-21	Taper plug	11-16	O-ring	12-16	O-ring
10-74	Plug-PF1/8	10-22	Gasket	11-17	Gasket	12-17	Wrench bolt
10-75	O-ring	11	Travel section assy	12	Boom 1 section assy	12-18	Taper plug
10-8	Wrench bolt	11-1	Work block (Od)	12-1	Block boom 1	12-19	Gasket
10-9	Plain washer	11-2	Spool assy (R)	12-2	Spool assy		
10-10	Spring seat	11-3	O-ring	12-3	O-ring		

STRUCTURE (4/4)



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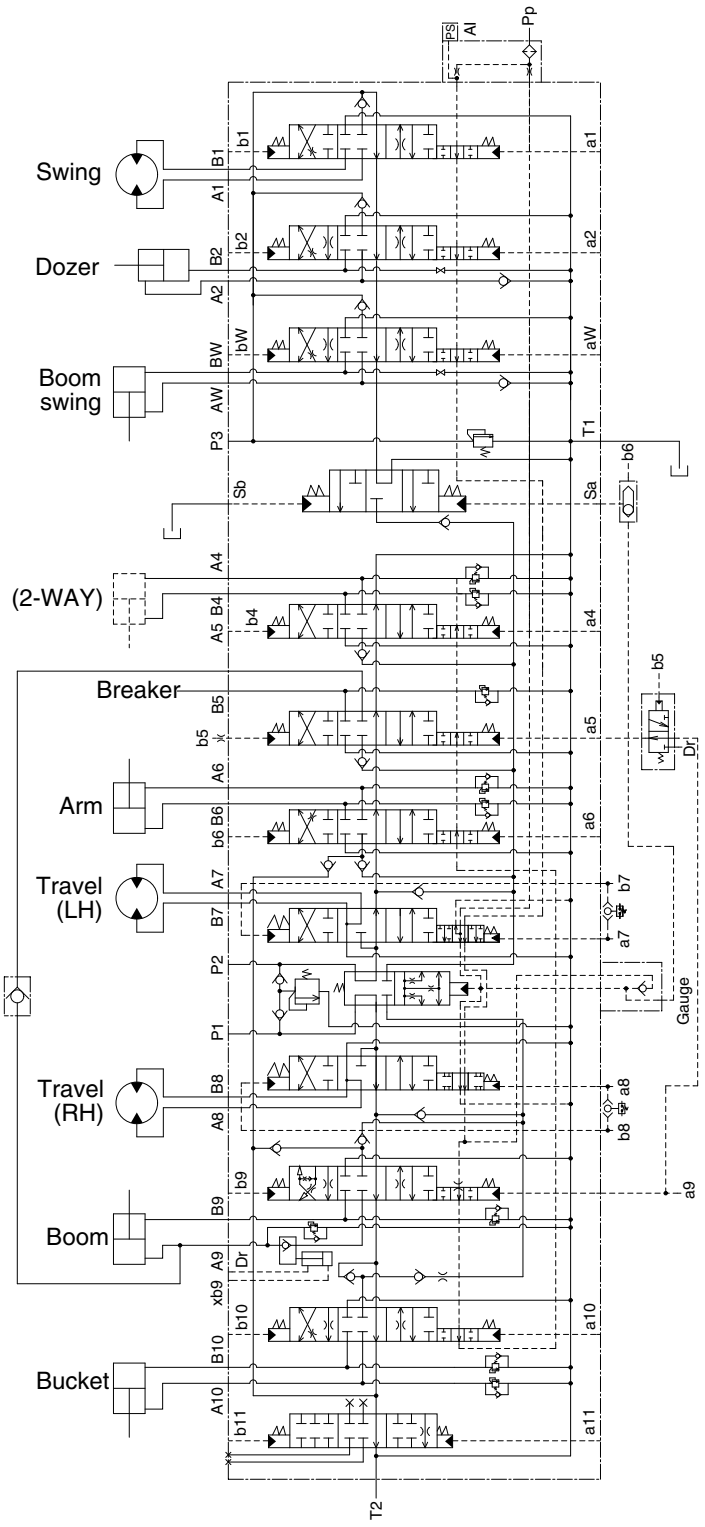
13	Bucket section assy	13-152	O-ring	14-81	Plug-PF1/2
13-1	Bucket block	13-16	Check spring	14-82	O-ring
13-2	Spool assy	13-17	Check poppet	14-9	Plug assy
13-3	O-ring	13-18	Check poppet	14-91	Check plug 1 (M14)
13-4	Pilot cap (A)	14	Arm 2 section assy	14-92	O-ring
13-5	Wrench bolt	14-1	Work block (Ae)	14-10	Plug assy
13-6	Plain washer	14-2	Spool assy	14-101	Plug-PF3/8
13-7	Pilot cap (B1)	14-3	O-ring	14-102	O-ring
13-11	Overload relief valve	14-4	Pilot cap (A)	14-11	O-ring
13-12	O-ring	14-5	Wrench bolt	14-15	Gasket
13-13	O-ring	14-6	Plain washer	15	End cover
13-14	Gasket	14-7	Pilot cap (B1)	16	Tie bolt
13-15	Plug assy	14-8	Plug-PF1/2	18	Nut
13-151	Check plug 1 (M14)				

3. HYDRAULIC CIRCUIT (boom swing, 2-way)



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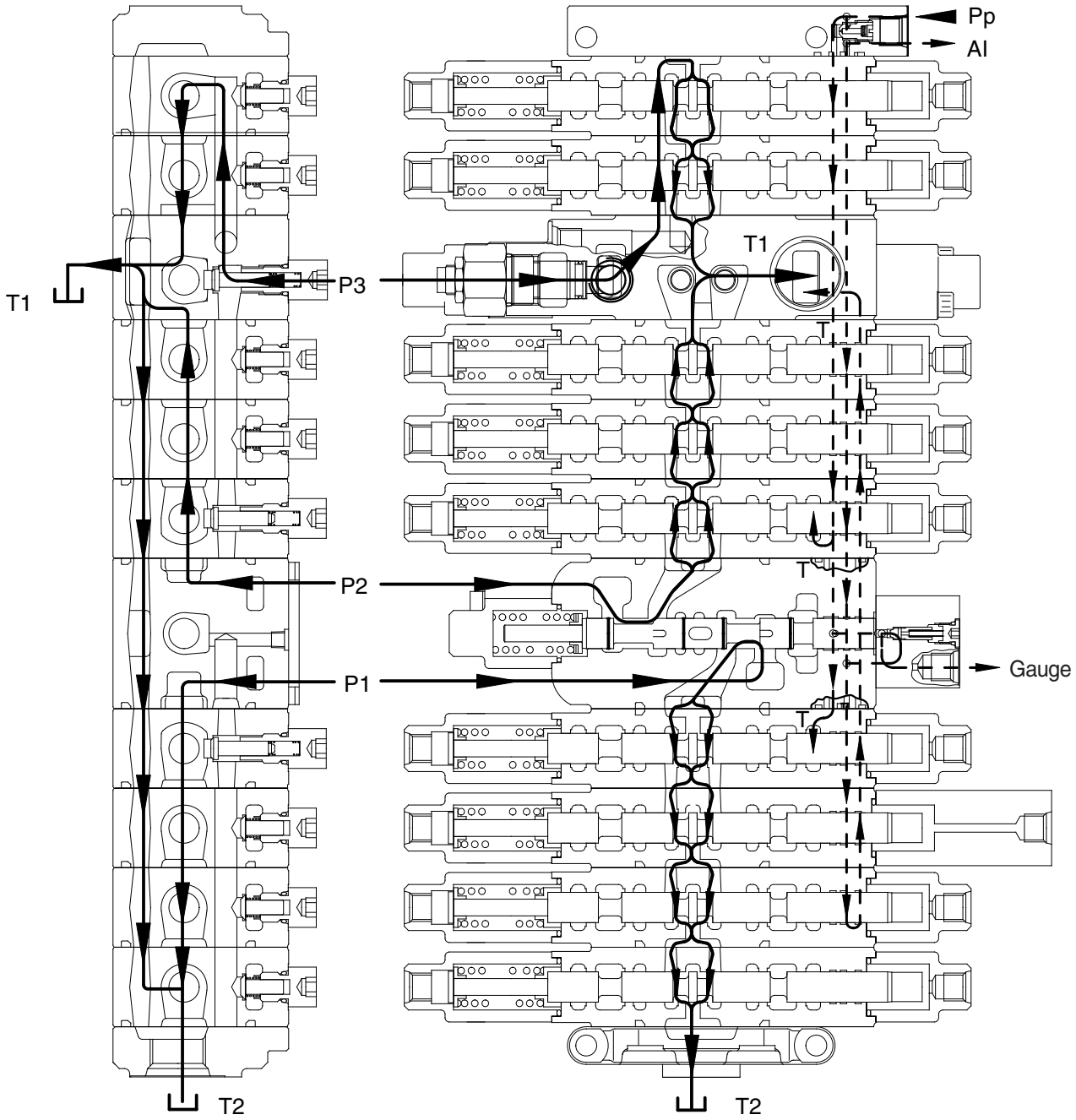
4. FUNCTION

1) CONTROL IN NEUTRAL FUNCTION



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In neutral, spring sets the spool at the neutral position, the hydraulic oil from pumps flows to the tank through the center bypass.

(1) P1

The oil discharged from the hydraulic pump flows into control valve P1 port, and then flows the right side travel valve through the travel straight valve. In neutral, the oil flows through the center bypass passage in the direction of right travel → boom 1 → bucket → arm 2 spool, and then flows from the center bypass passage to the tank port T1 and T2.

(2) P2

The oil discharged from the hydraulic pump flows into control valve P2 port, and then flows the left side travel valve through the travel straight valve. In neutral, the oil flows through the center bypass passage in the direction of left travel → arm 1 → boom 2/breaker spool, and then flows from the center bypass passage to the tank port T1 and T2.

(3) P3

The oil discharged from the hydraulic pump flows into control valve P3.

In neutral, the oil flows through the center bypass passage in the direction of swing → dozer spool, and then flows from the center bypass passage to the tank port T1 and T2.

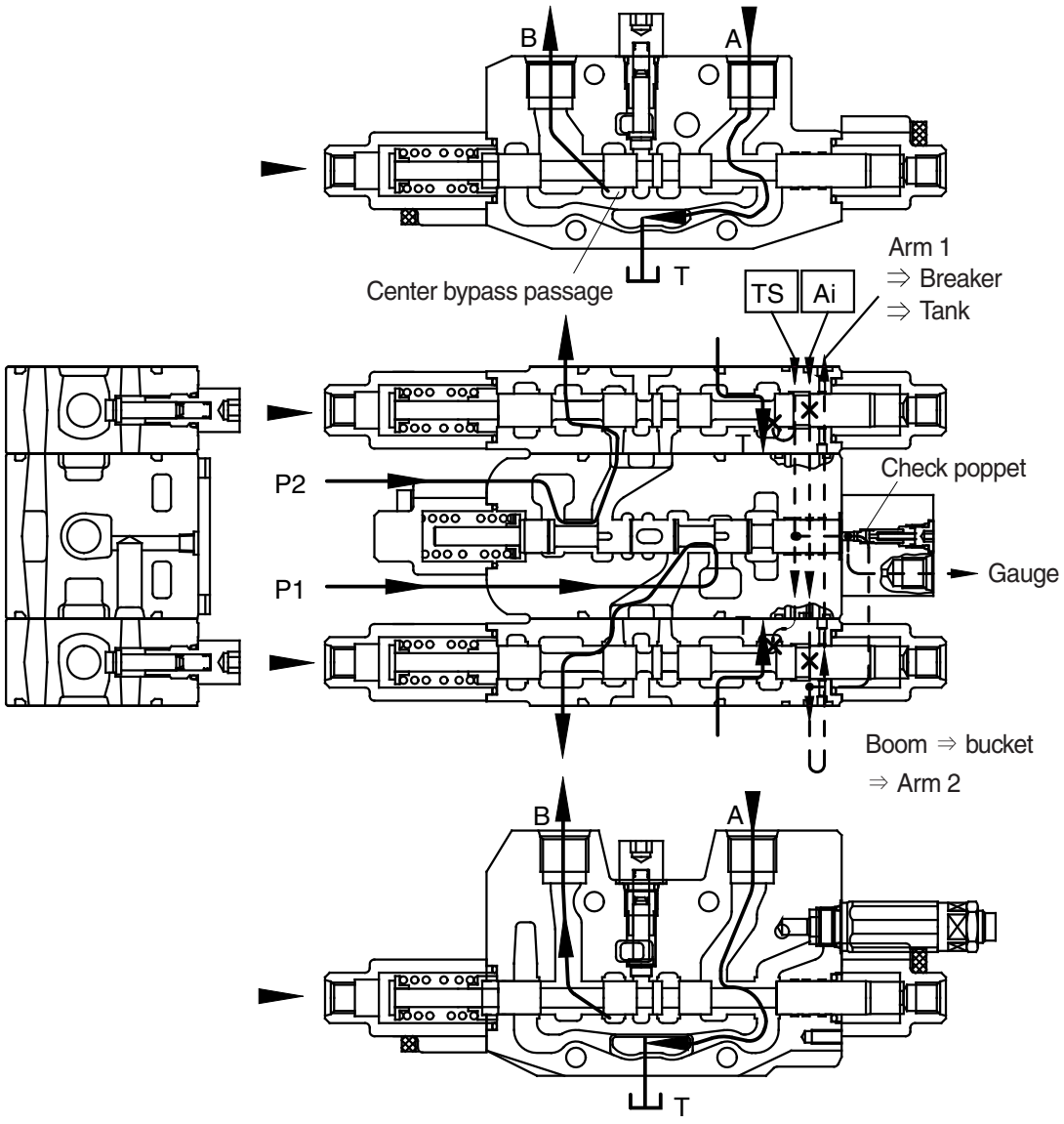
(4) Pp

When Pp port is applied with pilot pressure, the oil flows into the swing block through TS signal passage and Ai signal passage independently via an orifice.

With the spool in neutral, the oil flows into the tank passage through the all section of the control valve(except arm 2 section). As a result, the TS valve is not shifted and the auto idle signal pressure is not raised.

2) EACH SPOOL OPERATION

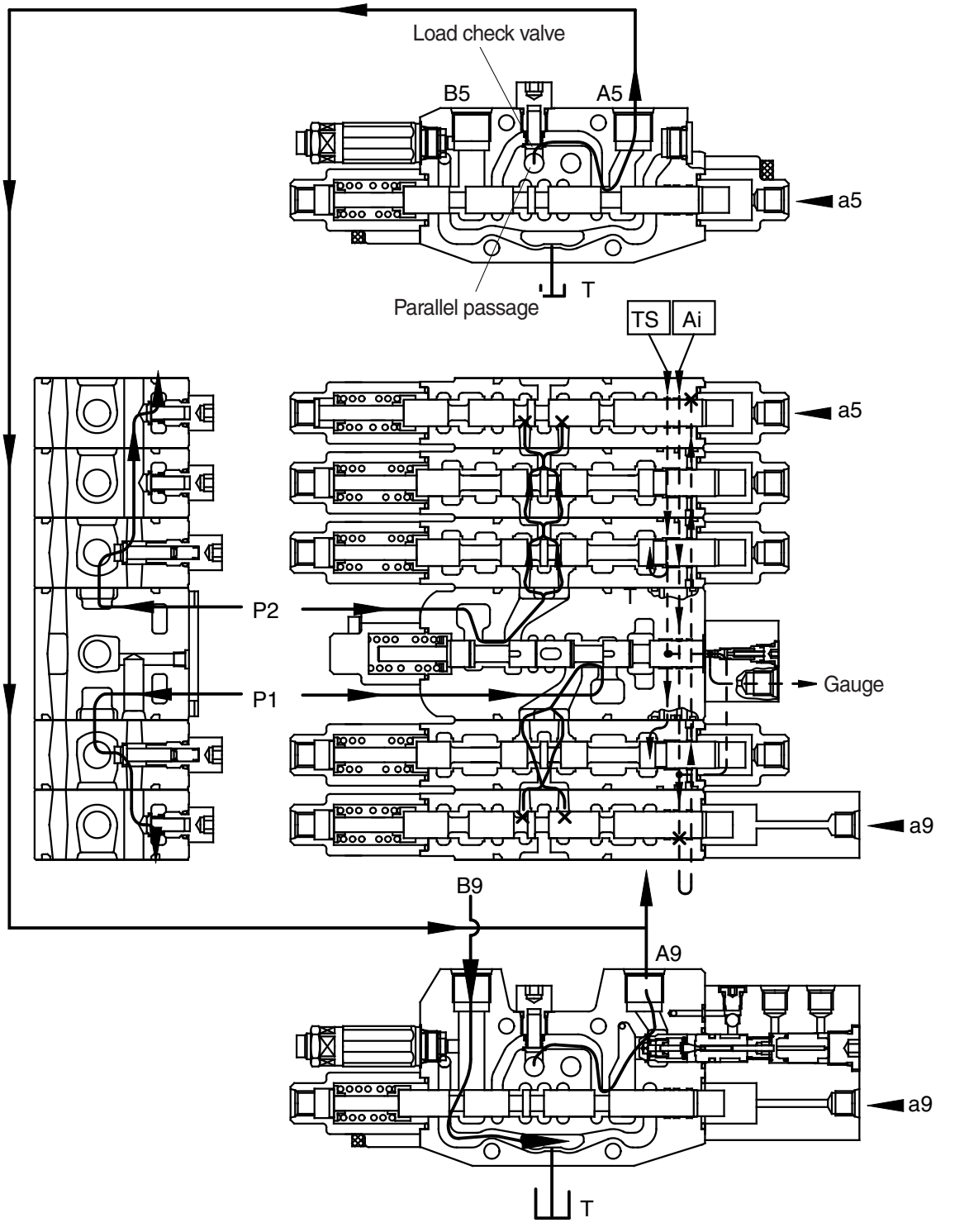
(1) Travel operation (forward / backward)



- During travel (forward/backward) operation, the pilot pressure from RCV is supplied into the travel pilot port and shift the travel spool in the right direction.
- The hydraulic oil fluid from pump is entered center bypass passage of inlet block (P1, P2) and then flows into the port of travel motor.
- The oil from the port A of travel motor flows into the main control valve and return to the hydraulic oil tank through the tank passage.
- The TS signal passage is shut off by shifting of the travel spool, but it is connected with Ai signal passage and drain to the hydraulic oil tank. As a result, the travel straight spool is not shifted.
- The Ai signal passage is connected with travel block through swing and dozer block and it is shut off by shifting of the travel spool and then signal pressure of auto idle is raised.

(2) Boom operation

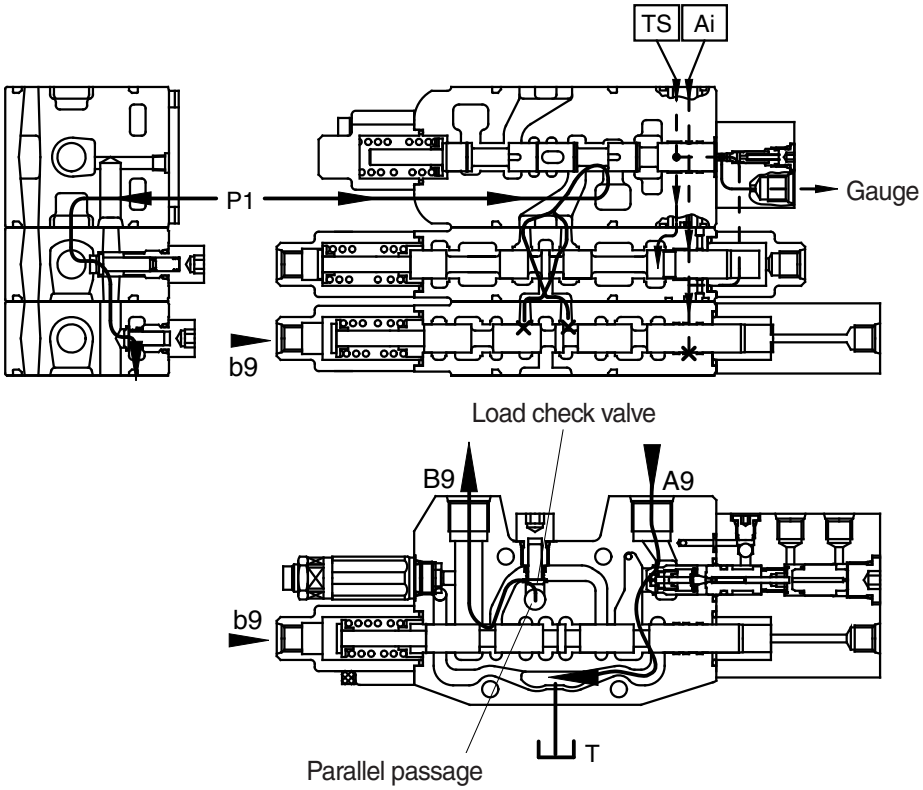
① **Boom up operation** (P1 and P2 summation)



555C92MC09

- During boom up operation, the pilot pressure from RCV is supplied into the port a9 and shift the boom 1 spool in the left direction. The hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes through the load check valve then flows into the port A9.
  Following this, it flows into the head side of the boom cylinder.
  At the same time the pilot pressure through the port a5 shifts the boom 2 spool. The hydraulic oil fluid from pump P2 is entered P2 parallel passage and then passes through the load check valve then flows into the port A5. The flows combine in hydraulic hoses and are directed to the cylinder head side of boom cylinder.
  The flow from rod side of the boom cylinder return to the boom 1 spool through the port B9. There after it is directed to the hydraulic oil tank through the tank passage.
- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the boom 1 spool and then signal pressure of auto idle is raised.

② **Boom down operation**



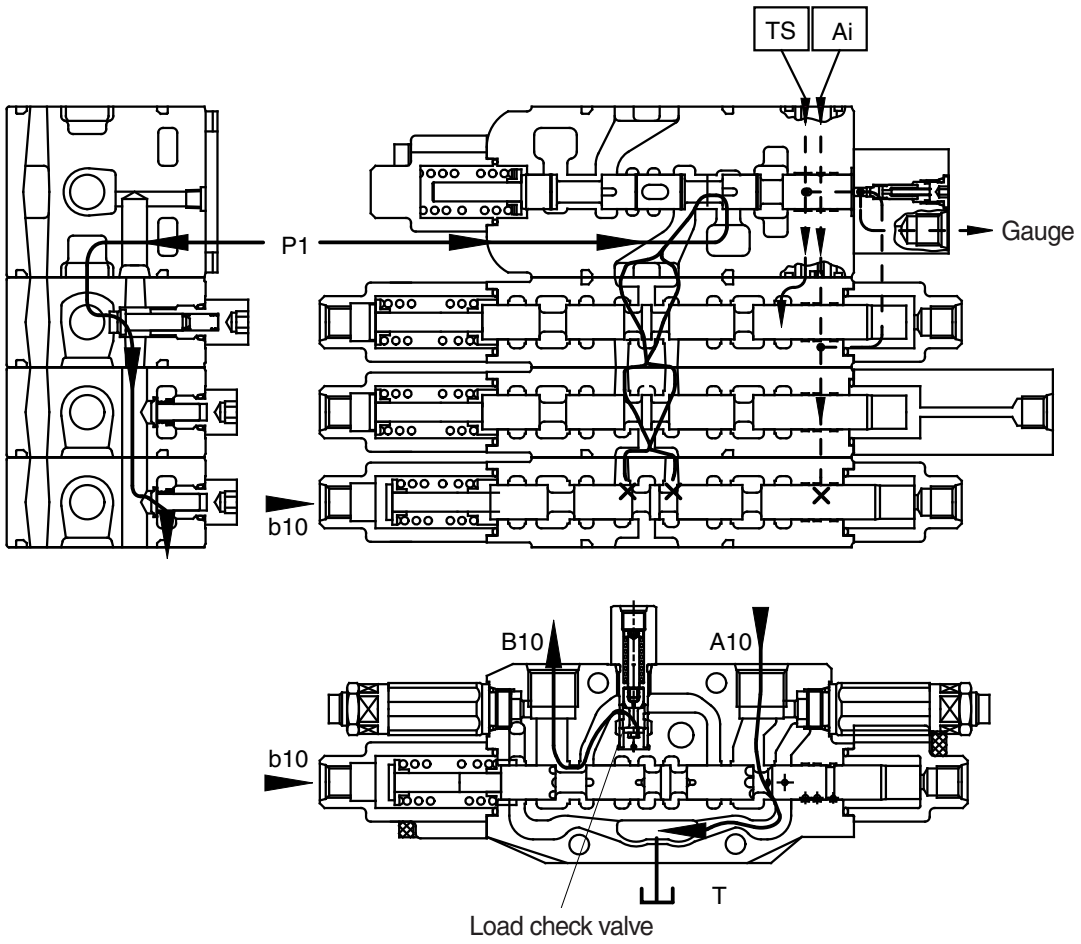
555C92MC10

- During the boom lowing operation, the pilot pressure from RCV is supplied to the port b9 and shift the boom 1 spool in the right direction.
  The hydraulic fluid from the pump P1 enters the parallel passage and is directed to the port B9 through the load check valve. Following this, it flows into the rod side of the boom cylinder.
  The return flow from the head side of the boom cylinder returns to the boom 1 spool through the port A9. Thereafter it is directed to the hydraulic oil tank through tank passage.
- The hydraulic oil flow from the Pp port is same as the boom up operation.

(3) Bucket operation

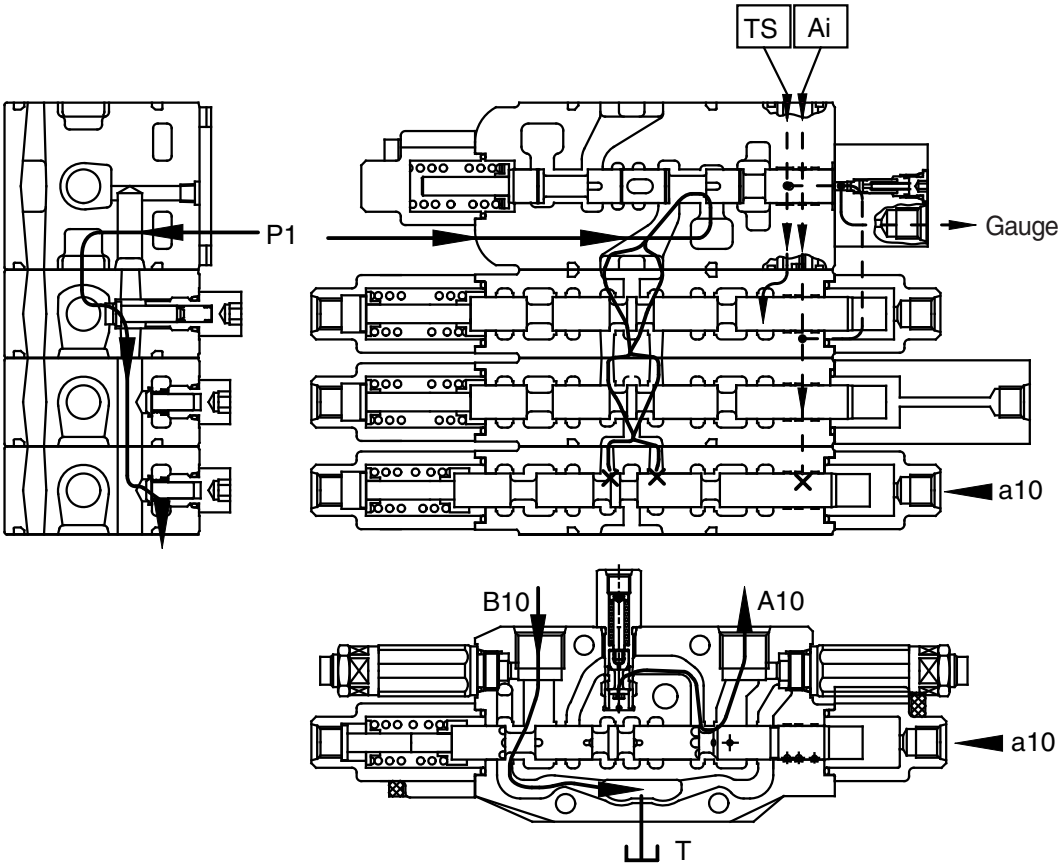
① Bucket roll in operation

-



- During the bucket roll in operation, the pilot pressure from RCV is supplied to port b10 and shift the bucket spool in the right direction.
  The hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port B10 through the load check valve.
  Following this, it flows into the head side of the bucket cylinder.
  The return flow from the rod side of the bucket cylinder returns to the bucket spool through the port A10. Thereafter it is directed to the hydraulic oil tank through the tank passage.
- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the bucket spool and then signal pressure of auto idle is raised.

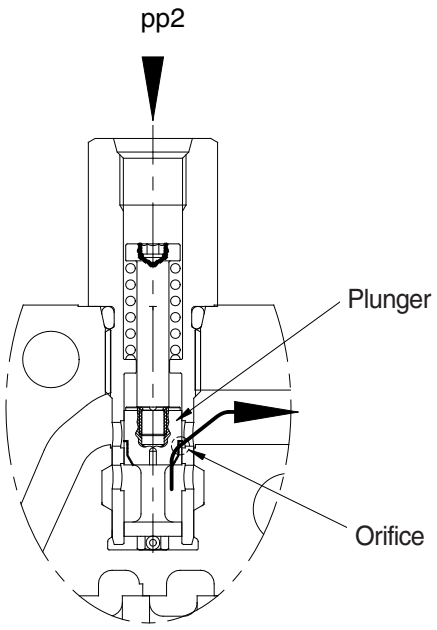
② **Bucket roll out operation**



555C92MC12

- In case of the bucket roll out operation, the operation is similar.
- The hydraulic oil flow from the Pp port is same as the bucket in operation.

③ Bucket load check valve operation

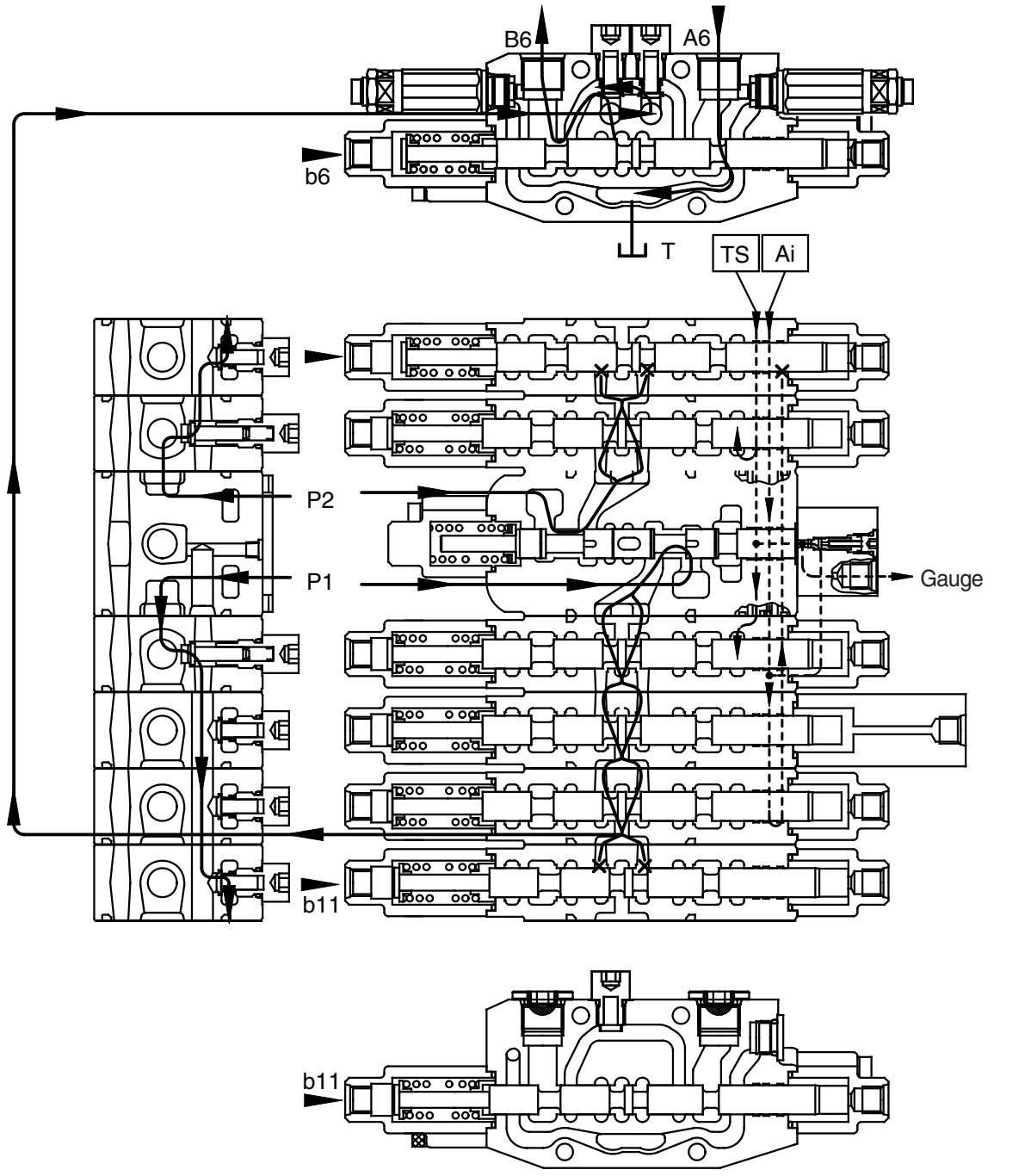


555C92MC13

- This function is used to speed up of the boom or arm by reducing the bucket speed when bucket operation with boom or arm operation simultaneously.
- When the signal pressure flows into port pp2, the plunger is shifted and orifice is made.
- The hydraulic oil from the port P1 flow into bucket cylinder via the orifice and then the speed of bucket cylinder is slow down.
  Accordingly, the much fluid from the port P1 is supplied other cylinder than the bucket cylinder.

(4) Arm operation

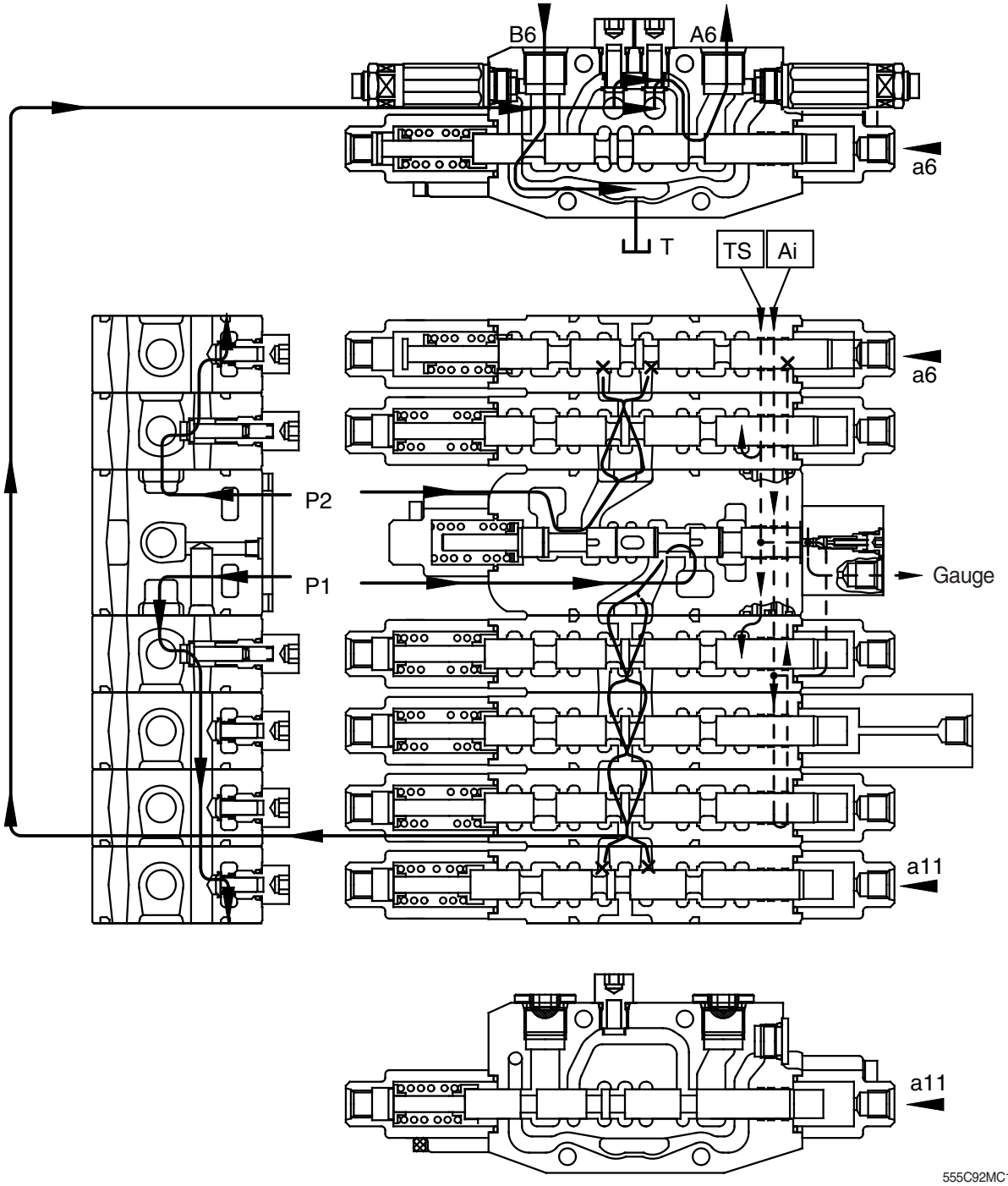
① **Arm roll in operation** (P1 and P2 summation)



555C92MC14

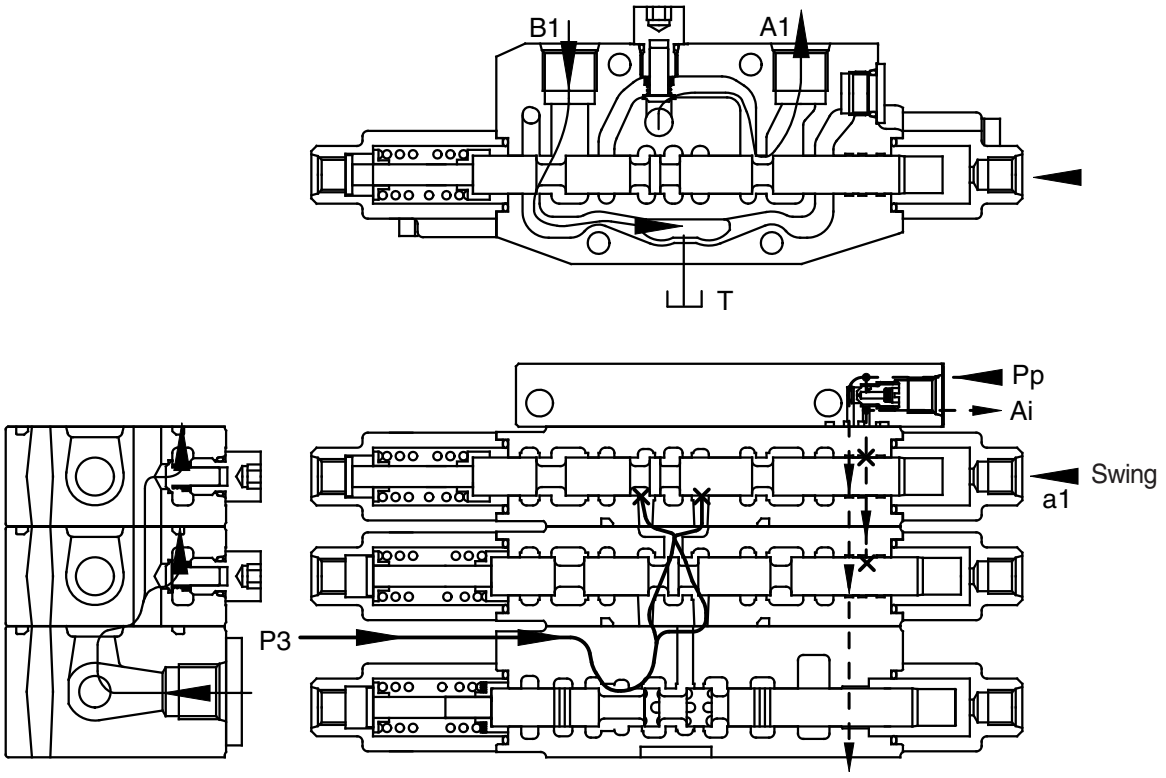
- During arm roll in operation the pilot pressure from the RCV is supplied to the port b6 and b11 and shifts arm 1 spool and arm 2 spool in the direction.
  The hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve and the port B6.
  At same time, the hydraulic fluid from the pump P1 flows into the arm summation passage in arm 1 spool through the arm 2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm 1 spool.
- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the arm spool and then signal pressure of auto idle is raised.

② **Arm roll out operation**



- During arm roll out operation the pilot pressure from RCV is supplied to the port a6 and the a11 and shifts arm 1 spool and arm 2 spool in the left direction.
  The hydraulic fluid from pump P2 flows into arm 1 spool through the parallel passage. Then it enters into the arm cylinder rod side through the load check valve and the port A6.
  At same time, the hydraulic oil from the pump P1 flows into the arm summation passage in arm 1 spool through the arm 2 spool.
  The return flow from the arm cylinder head side returns to the hydraulic tank through the port B6 the arm1 spool and tank passage.
- The hydraulic oil flow from the Pp port is same as the arm roll in operation.

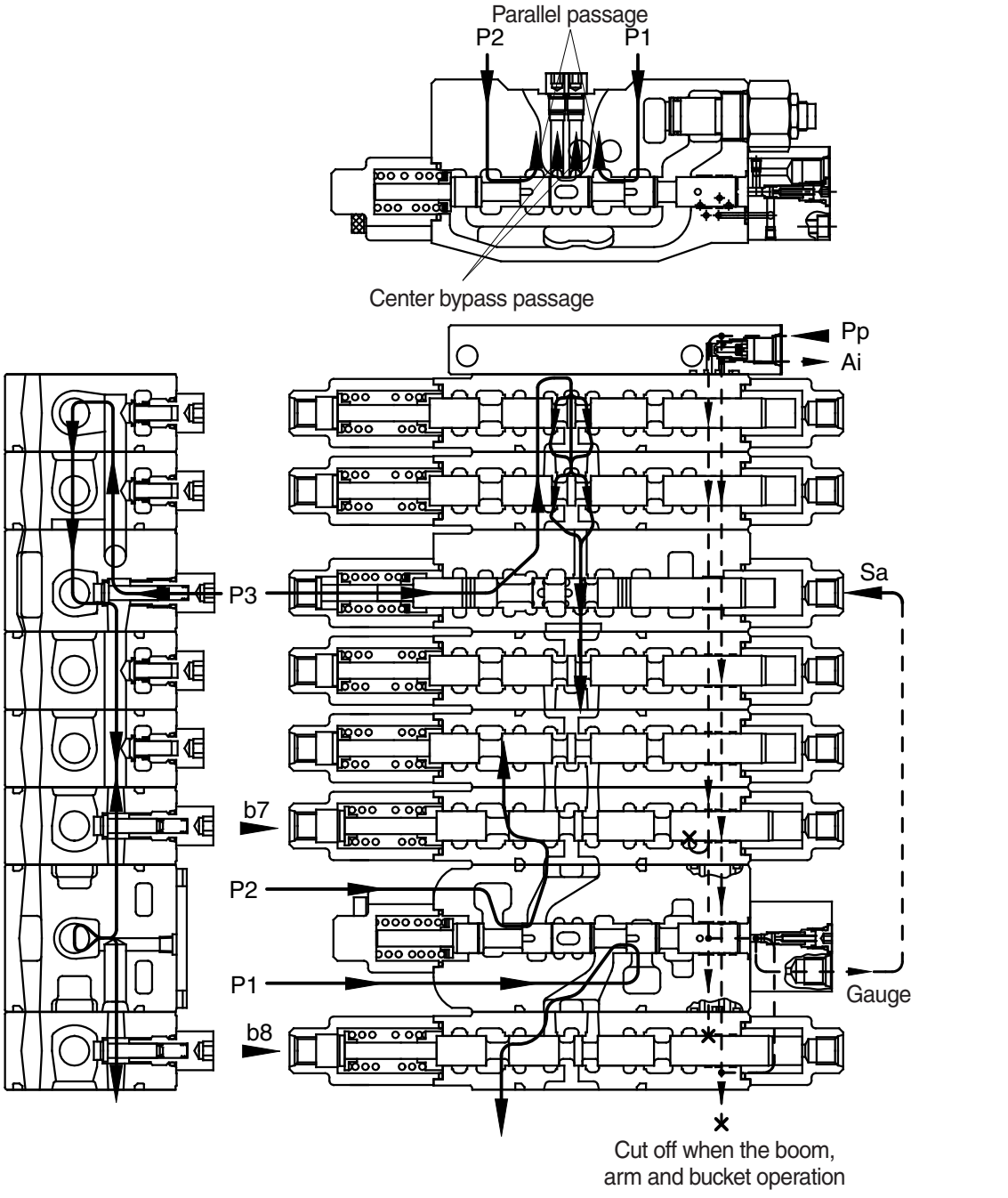
(5) Swing operation



555C92MC16

- The pilot pressure from the RCV is supplied to the a1 and shift the swing spool in left direction. The hydraulic fluid from pump P3 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port A1. As a result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port B1, swing spool and the tank passage.
  In case of swing left operation, the operation is similar.
- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the swing spool and then signal pressure of auto idle is raised.

(6) Travel straight function



555C92MC17

· This function keeps straight travel in case of simultaneous operation of other actuators (boom, arm, bucket, swing, woodgrab) during a straight travel.

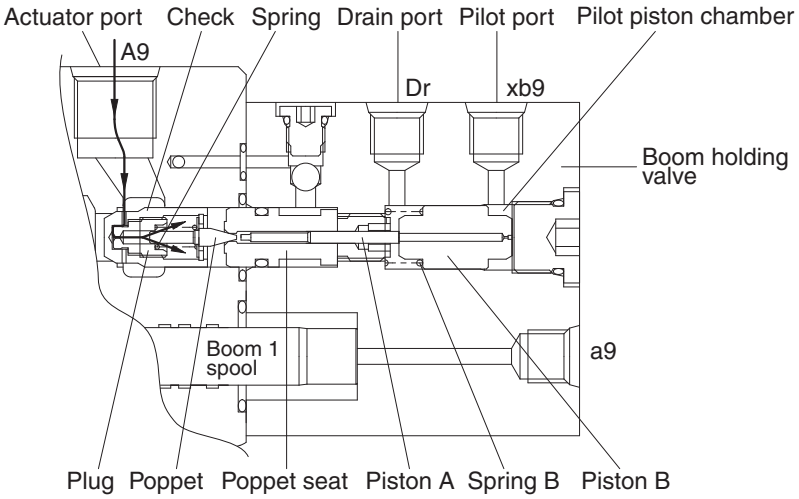
① During travel only :
The hydraulic fluid of the pump P1 is supplied to the travel motor and the pump P2 is supplied to the other motor.
Thus, the machine keep travel straight.

② The other actuator operation during straight travel operation.
When the other actuator spool(s) is selected under straight travel operation, the straight travel spool is moved.
Some of hydraulic fluid from pump P1 and P2 is supplied to the travel motors through parallel passage and the other hydraulic fluid is supplied to the actuator(s) through center bypass passage via orifice passage.
Thus, the machine keeps straight travel.

· The fluid flows into P3 pilot port Sa through the gauge port and the spool is shifted. As a result, the fluid of P3 pump is combined with the boom, arm and bucket and then the actuators speed up.

(7) Holding valve operation

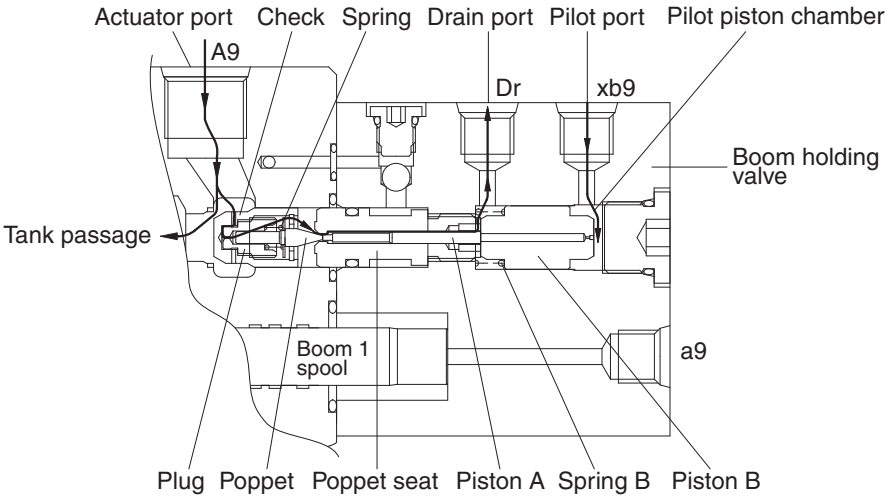
① Holding operation



55W72MC16

At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.
And the piston "B" is supported with spring "B".
Also, the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug.
Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body.
So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

② Release holding operation



55W72MC17

The pilot pressure is supplied to the pilot port for release holding valve and shifts the piston "B" in the left direction against the spring "B", and shifts the poppet in the left direction through piston "B" and piston "A" against spring "B" and shifts the spool in the left side.
At same time, the return fluid from actuator returns to the drain port through the periphery hole of check, crevice of the check and the plug, the periphery hole of the plug, in side of holding valve, crevice of the poppet and the poppet seat, the periphery hole of the poppet seat, crevice of socket and spool and internal passage of spool.
When the poppet is opened, pressure of inside of holding valve is decreased and the return fluid from actuator returns to the tank passage through the notch of spool.

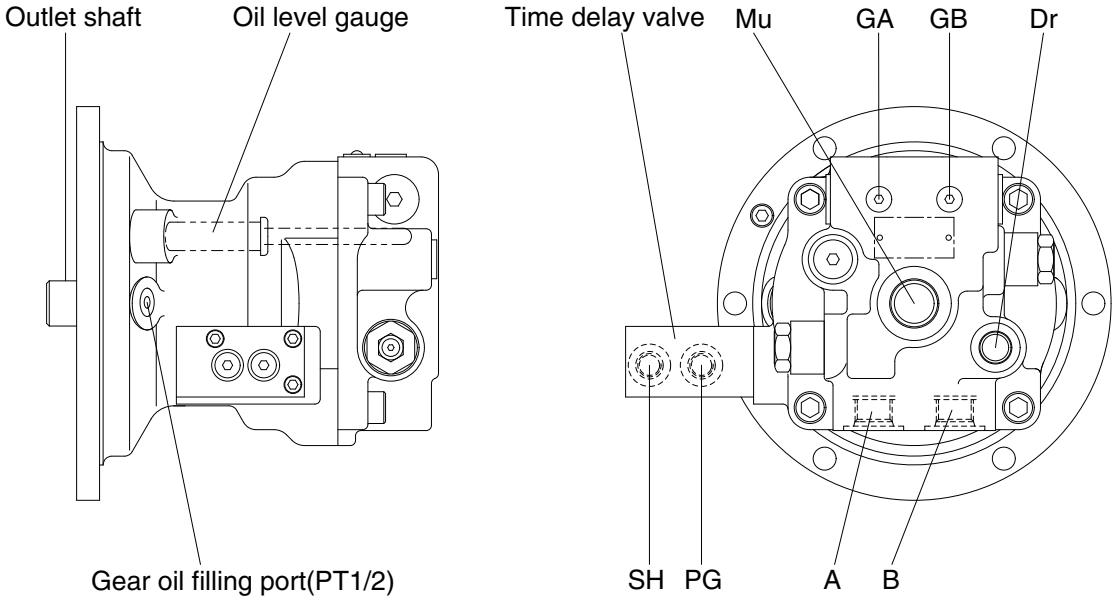
GROUP 3 SWING DEVICE

1. STRUCTURE

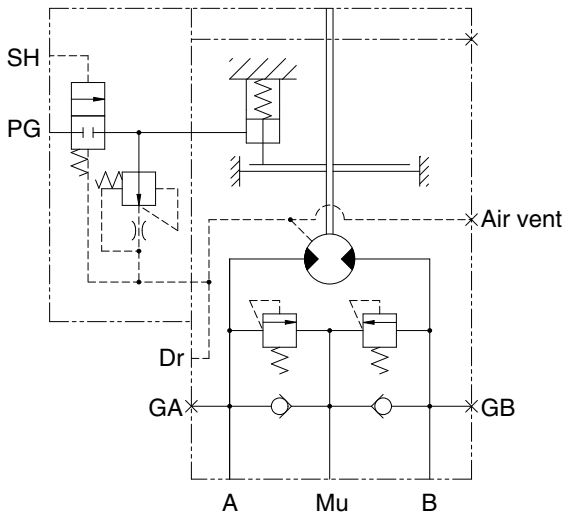
Swing device consists swing motor, swing reduction gear.

1) SWING MOTOR

Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.

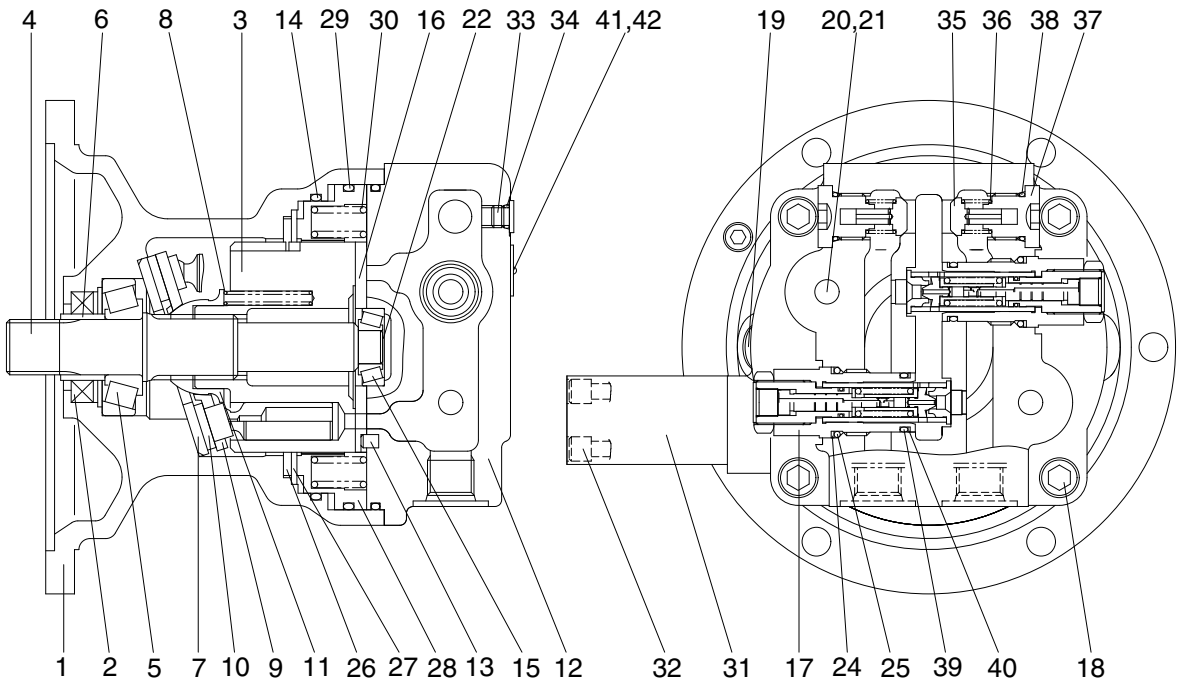


5592SM01



Hydraulic circuit

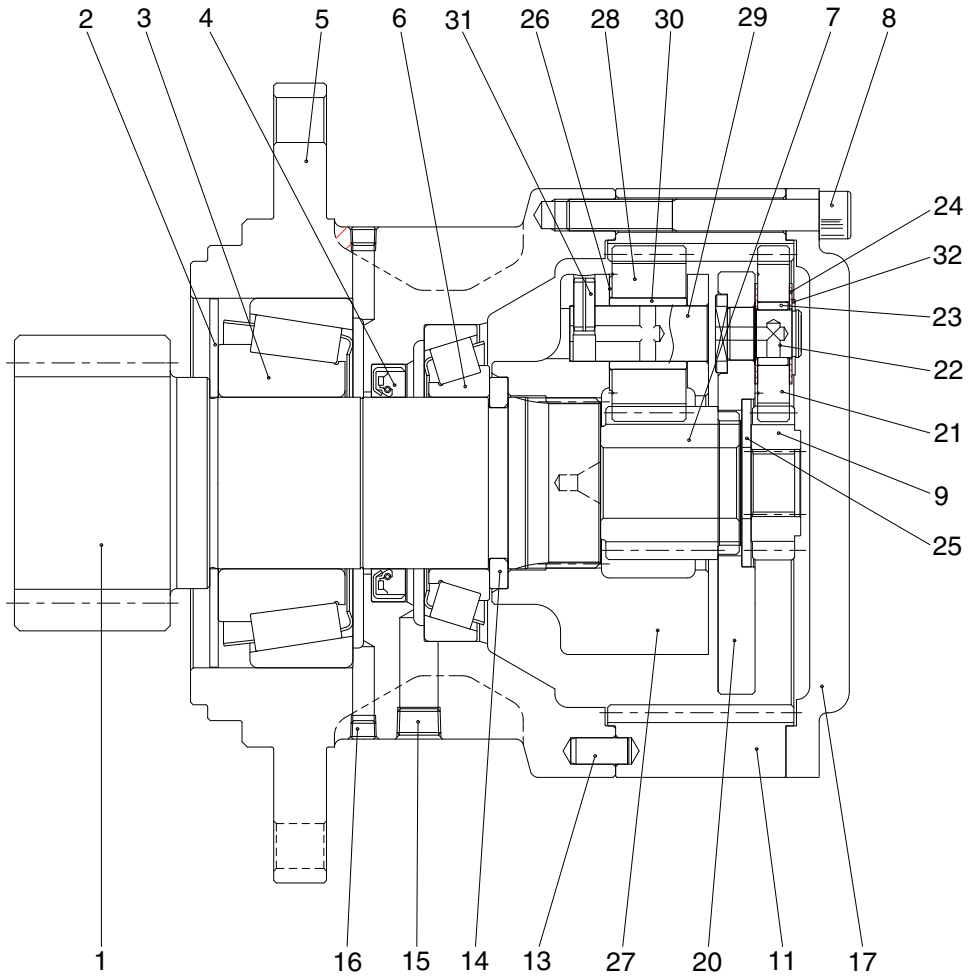
Port	Port name	Port size
A	Main port	SAE PF 1/2
B	Main port	SAE PF 1/2
Dr	Drain port	PF 3/8
Mu	Make up port	PF 3/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
GA,GB	Gauge port	PF 1/4



555K2SM03

1	Body	15	Taper bearing	29	O-ring
2	Oil seal	16	Valve plate	30	Spring
3	Cylinder block	17	Relief valve assy	31	Time delay valve
4	Shaft	18	Socket bolt	32	Socket bolt
5	Taper bearing	19	Plug	33	Plug
6	Bushing	20	Plug	34	O-ring
7	Shoe plate	21	O-ring	35	Valve
8	Spring	22	Shim	36	Spring
9	Set plate	23	Plug	37	Plug
10	Piston shoe assy	24	Back up ring	38	O-ring
11	Ball guide	25	O-ring	39	O-ring
12	Rear cover	26	Friction plate	40	Back up ring
13	Pin	27	Plate	41	Name plate
14	O-ring	28	Parking piston	42	Rivet

2) REDUCTION GEAR



1	Shaft	12	Carrier assy 2	23	Bushing 1
2	Bearing cover	13	Dowel pin	24	Thrust washer 1
3	Taper roller bearing	14	Collar	25	Thrust washer 3
4	Case	15	Plug	26	Thrust washer 2
5	Oil seal	16	Plug	27	Carrier assy 2
6	Taper roller bearing	17	Cover	28	Planet gear 2
7	Sun gear 2	18	Pipe	29	Pin 2
8	Socket bolt	19	Level gauge	30	Bushing 2
9	Sun gear 1	20	Carrier assy 1	31	Spring pin
10	Carrier assy 1	21	Planet gear 1	32	Snap ring
11	Ring gear	22	Pin 1	33	Thrust washer 4

2. FUNCTION

1) ROTARY PART

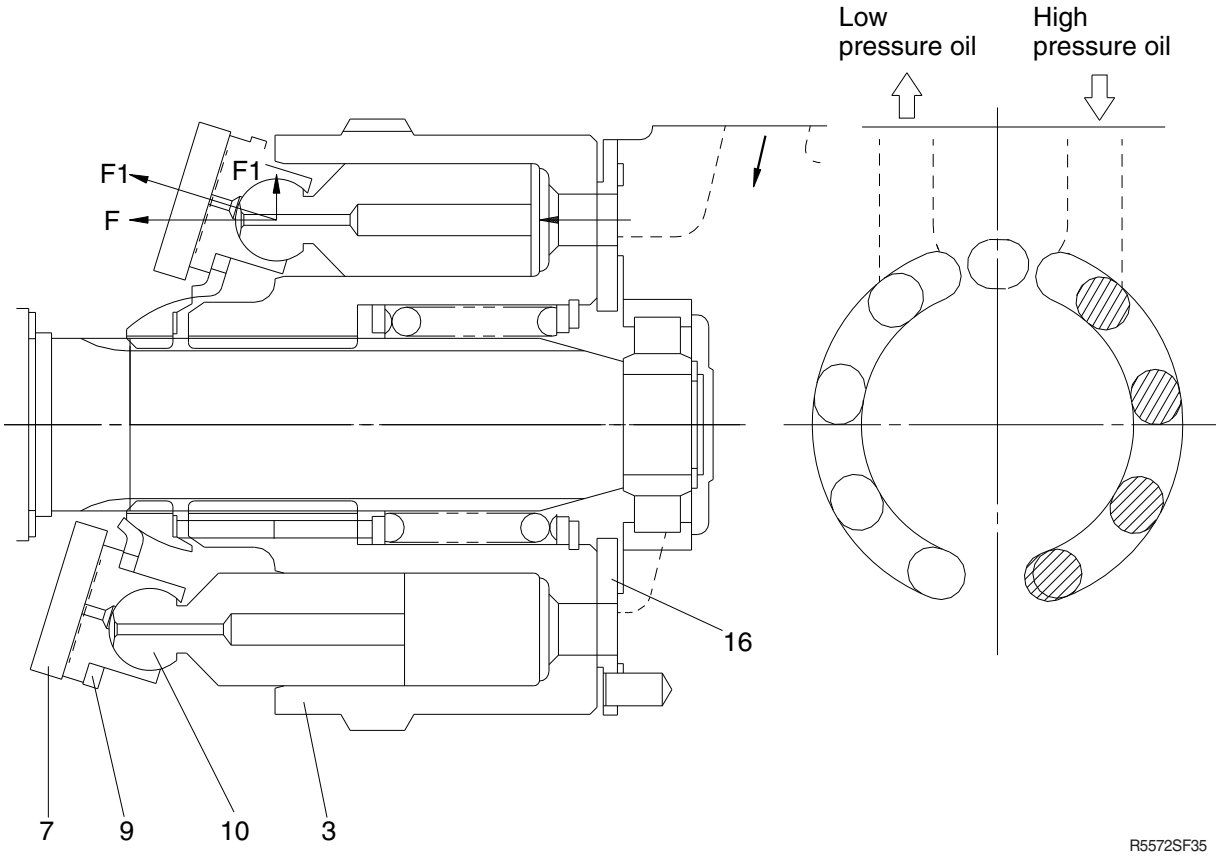
When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(16), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(10) upon the return plate(9) which acts upon the swash plate(7) via an hydrostatic bearing. Force F1 perpendicular to swash plate(7) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(3) through piston, force F2 causes rotational moment at surroundings of cylinder.

Since cylinder block has 9 equidistantly arrayed pistons, rotational torque is transmitted to cylinder shaft in order by several pistons connected to the inlet port of high pressurized oil. When the direction of oil flow is reversed, rotational direction of cylinder is also reversed. Output torque is given by the equation.

$$T = \frac{p \times q}{2\pi}, \quad q = Z \cdot A \cdot PCD \cdot \tan\theta, \quad F1 = \frac{F}{\cos\theta}, \quad F_2 = F \tan\theta, \quad S = PCD \times \tan\theta$$

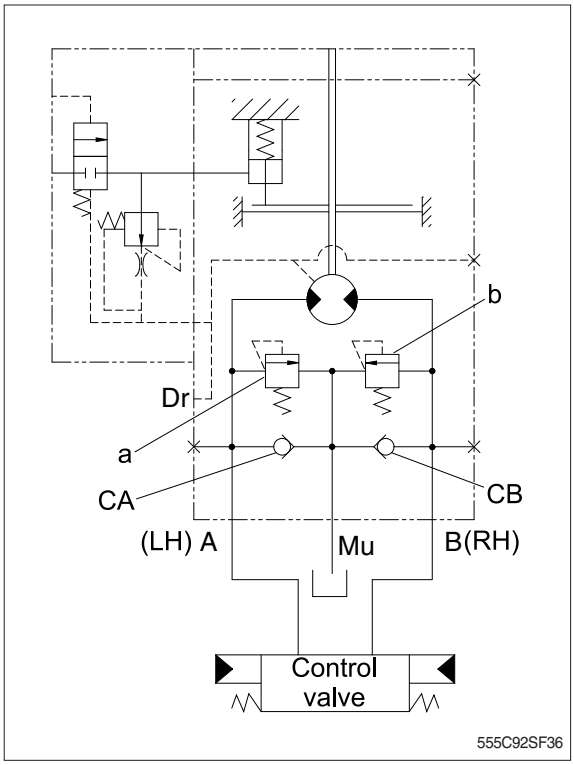
Where p : Effective difference of pressure (kgf/cm^2)
q : Displacement (cc/rev)
T : Output torque ($kgf \cdot cm$)
Z : Piston number (9EA)
A : Piston area (cm^2)
θ : Tilting angle of swash plate (degree)
S : Piston stroke (cm)



2) MAKE UP VALVE

(1) Outline

The safety valve portion consists of a check valve and safety valve.



(2) Function

When the swing is stopped, the output circuit of the motor continues to rotate because of inertia. For this reason, the pressure at the output side of the motor becomes abnormality high, and this will damage the motor. To prevent this, the oil causing the abnormal hydraulic pressure is allowed to escape from the outlet port (high-pressure side) of the motor to port Mu, thereby preventing damage to the motor.

Compared with a counterbalance valve, there is no closed-in pressure generated at the outlet port side when slowing down the swing speed. This means that there is no vibration when slowing down, so the ease of swing control is improved.

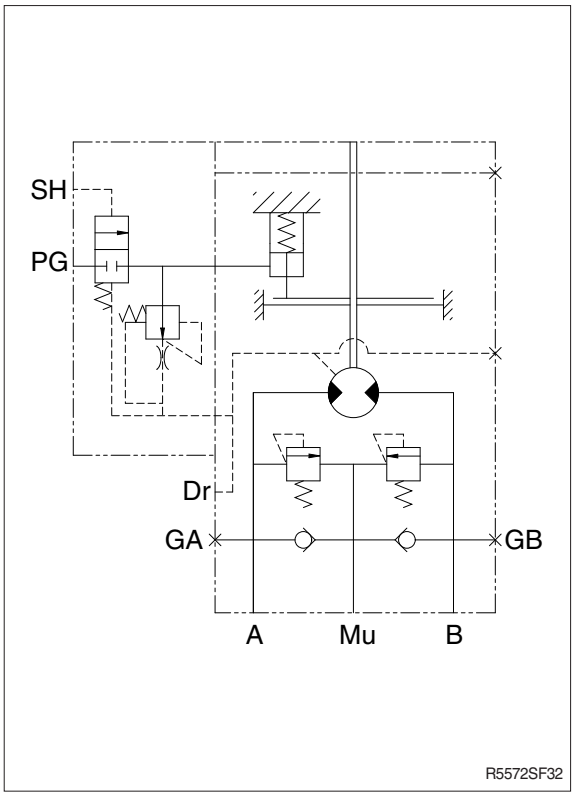
(3) Operation

① When starting swing

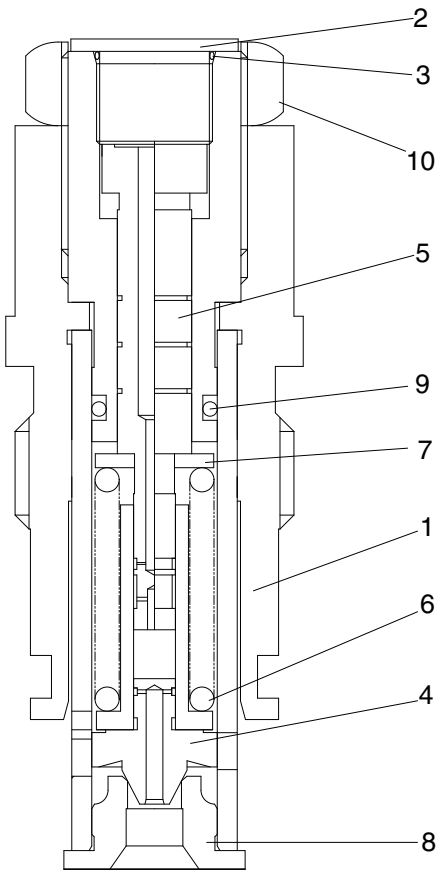
When the swing control lever is operated to left swing, the pressurized oil from the pump passes through the control valves and is supplied to port B. Because of this, the pressure at port B rises, staring torque is generated in the motor, and the motor starts to rotate. The oil from the outlet port of the motor passes from port A through the control valve and returns to the tank.

② When stopping swing

- When the swing control lever is returned to neutral, no pressurized oil is supplied from the pump to port B.
  The return circuit to the tank is closed by the control valve. So the oil from the outlet port of the motor increases in pressure at port A. Resistance to the rotation of the motor is created, and the brake starts to act.
- The pressure at port A rises to the set pressure of make up valve a, and in this way, a high brake torque acts on the motor, and the motor stops.
- When make up valve a is being actuated, the relief oil from make up valve a and the oil from port Mu pass through check valve CB and are supplied to port B. This prevents cavitation from forming at port B.



3) RELIEF VALVE



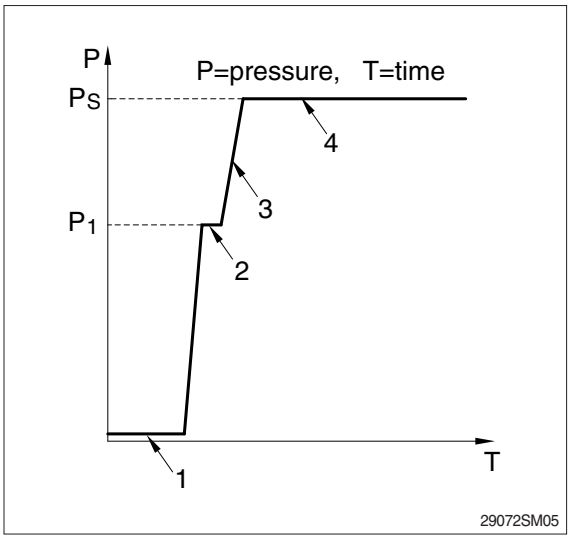
1 Body
2 Plug
3 O-ring
4 Plunger
5 Piston
6 Spring
7 Spring seat
8 Seat
9 O-ring
10 Nut

(1) Construction of relief valve

The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

Figure illustrates how the pressure acting on the relief valve is related to its rising process. Here is given the function, referring to the figure following page.

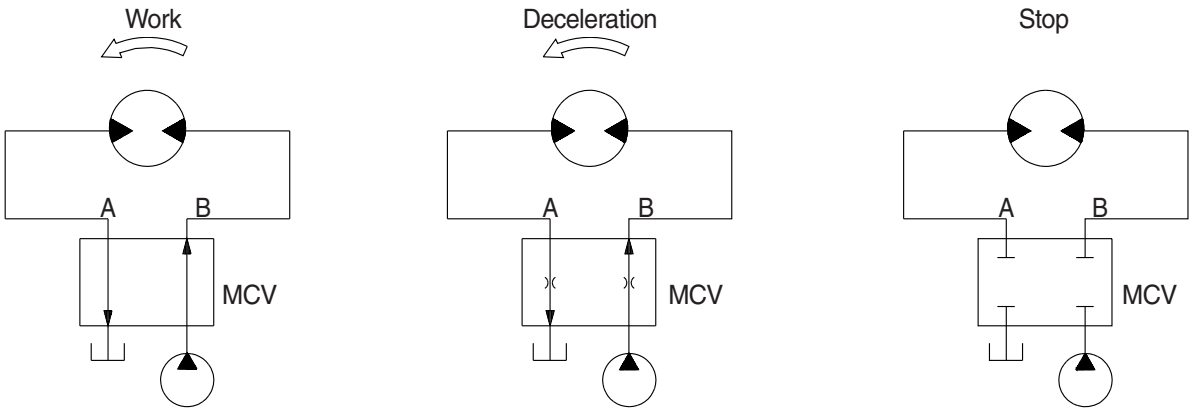


4) BRAKE SYSTEM

(1) Control valve swing brake system

This is the brake system to stop the swing motion of the excavator during operation.

In this system, the hydraulic circuit is throttled by the swing control valve, and the resistance created by this throttling works as a brake force to slow down the swing motion.



MCV A, B opened | MCV A, B throttled | MCV A, B closed

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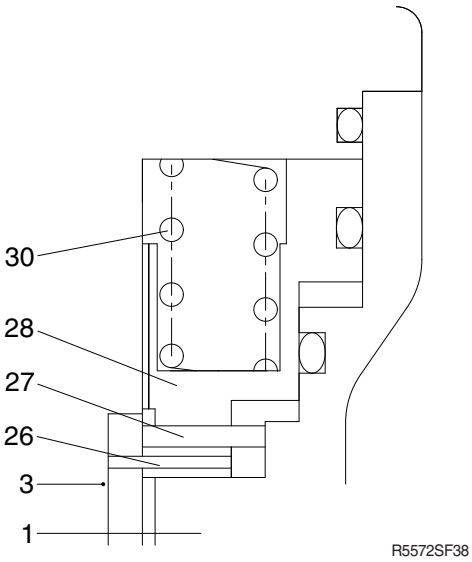
(2) Mechanical swing parking brake system

The mechanical swing parking brake system is installed to prevent the upper structure from swinging downhill because of its own weight when the excavator is parked on a slope since it completely eliminates the hydraulic drift of swing motion while the excavator is on a slop, work can be done more easily and safely.

① Brake assembly

Circumferential rotation of separate plate (27) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (30) through friction plate (26), separate plate (27) and brake piston (28), friction force occurs there.

Cylinder (3) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



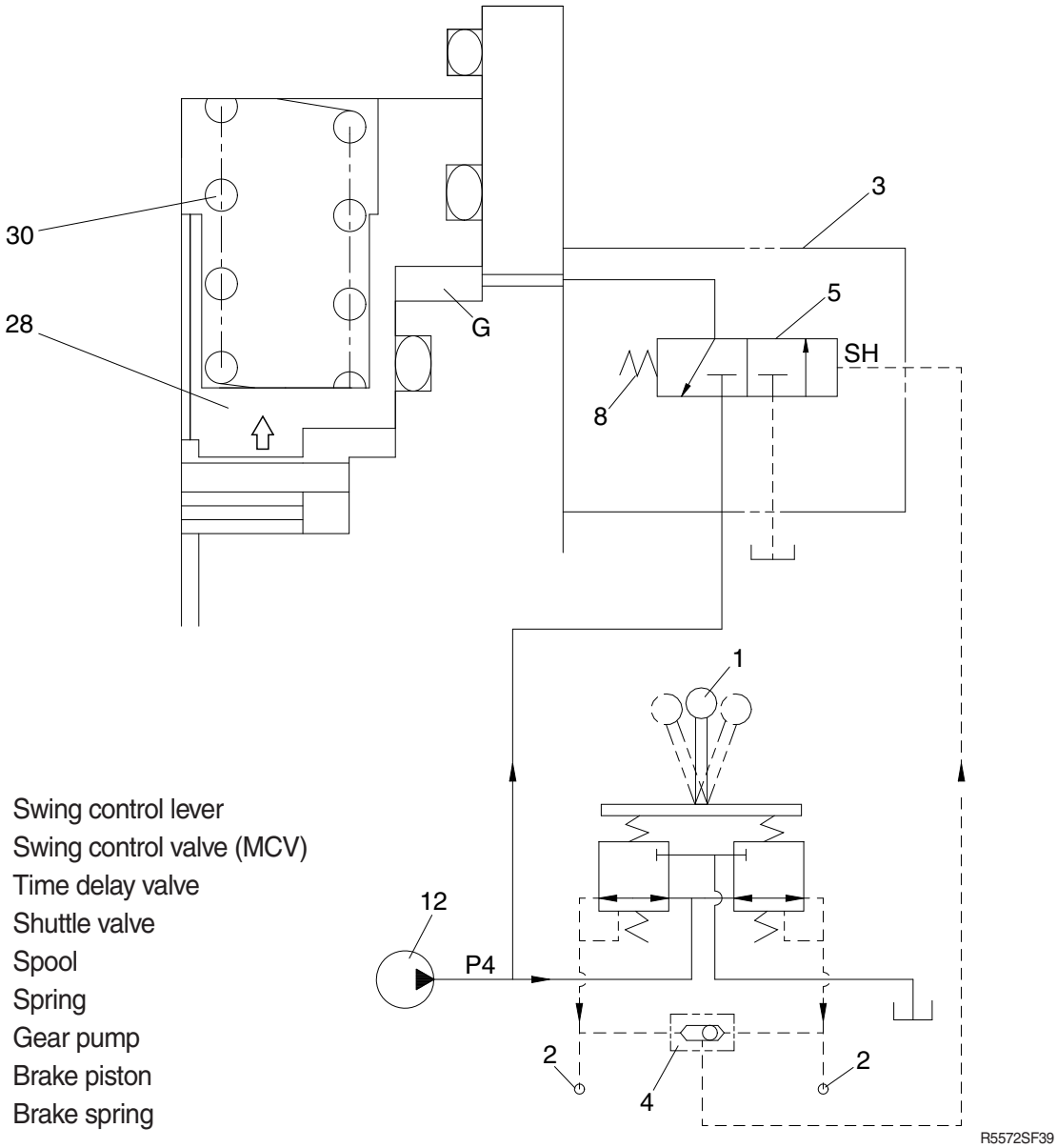
R5572SF38

1	Casing	27	Separate plate
3	Cylinder	28	Brake piston
26	Friction plate	30	Brake spring

② Operating principle

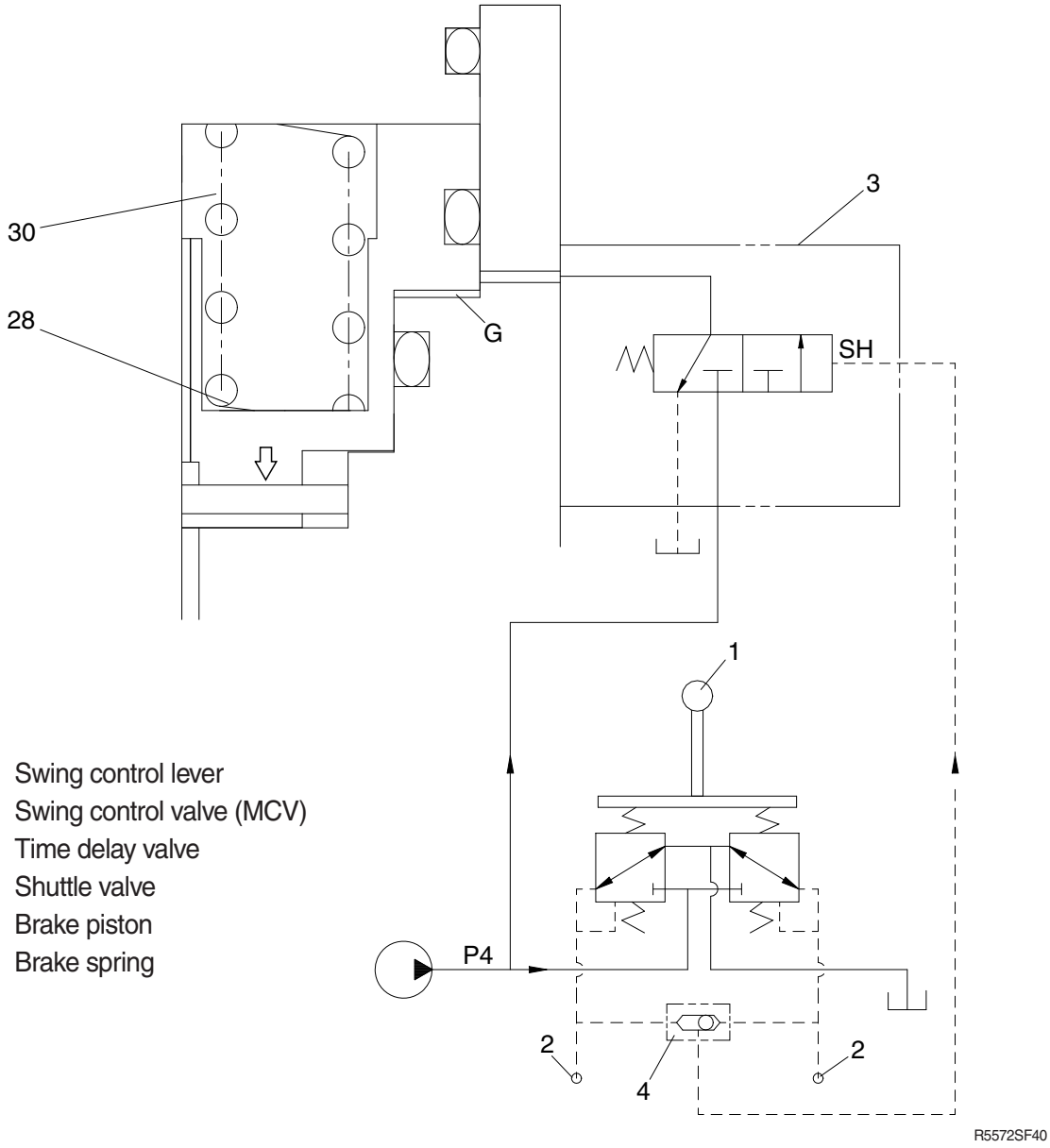
a. When the swing control lever (1) is set to the swing position, the pilot oil go to the swing control valve (2) and to SH of the time delay valve (3) via the shuttle valve (4), this pressure move spool (5) to the leftward against the force of the spring (8), so pilot pump charged oil (P4) goes to the chamber G.

This pressure is applied to move the piston (28) to the upward against the force of the spring (30). Thus, it releases the brake force.



1 Swing control lever
2 Swing control valve (MCV)
3 Time delay valve
4 Shuttle valve
5 Spool
8 Spring
12 Gear pump
28 Brake piston
30 Brake spring

b. When the swing control lever (1) is set the neutral position, the time delay valve (3) shifts the neutral position and the pilot oil blocked chamber G.
Then, the piston (28) is moved lower by spring (30) force and the return oil from the chamber G is drain.



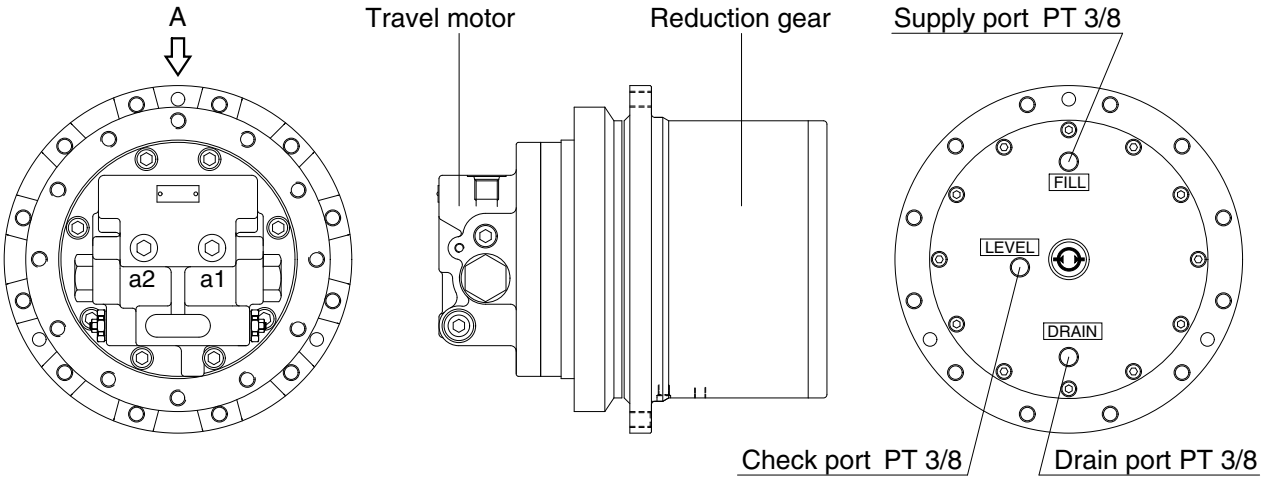
1 Swing control lever
2 Swing control valve (MCV)
3 Time delay valve
4 Shuttle valve
28 Brake piston
30 Brake spring

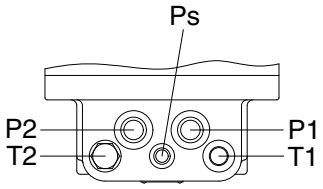
GROUP 4 TRAVEL DEVICE (TYPE 1)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

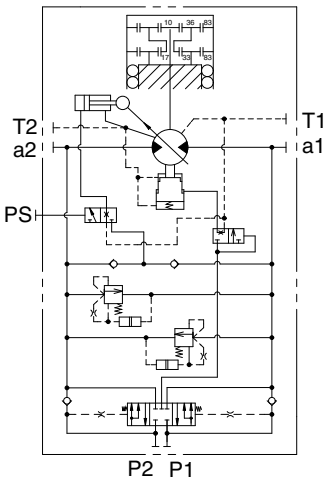
Travel motor includes brake valve, parking brake and high/low speed changeover mechanism.





VIEW A

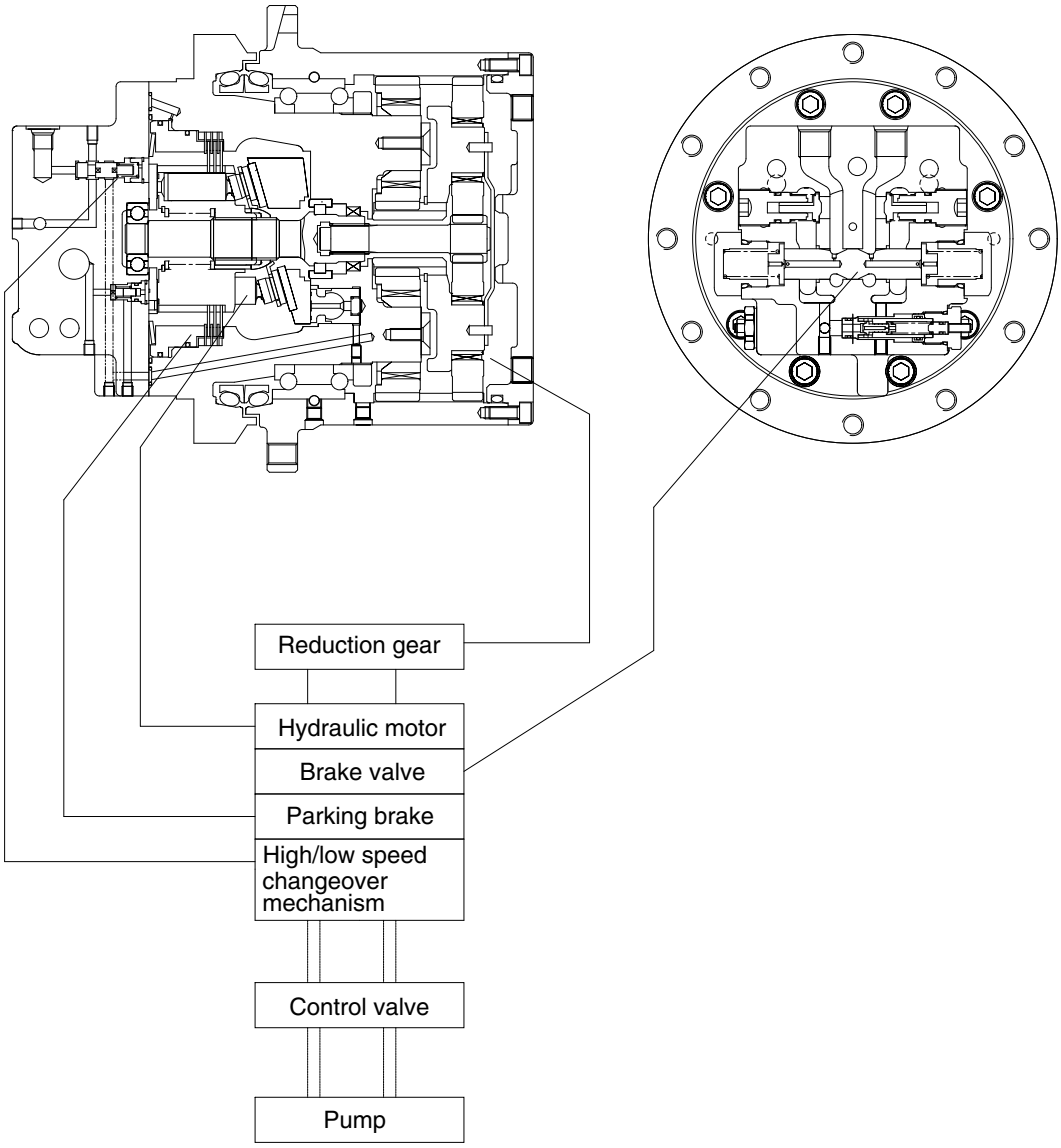
5592TM01



Hydraulic circuit

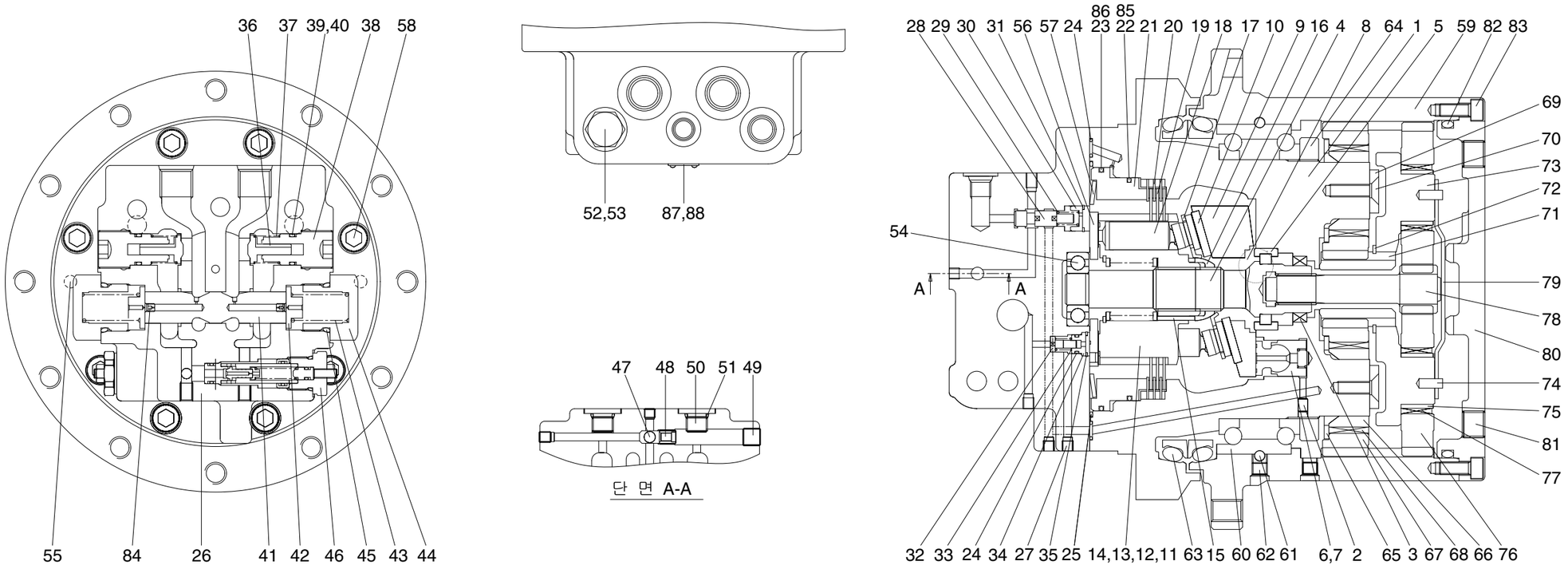
Port	Port name	Port size
P1	Main port	PF 1/2
P2	Main port	PF 1/2
a1,a2	Gauge port	PT 1/4
T1,T2	Drain port	PF 3/8
Ps	2 speed control port	PF 1/4

1) BASIC STRUCTURE



5592TM02

2) STRUCTURE



555K2TM03

1	Shaft casing	16	Ball guide	31	Snap ring	46	Relief valve assy	61	Steel ball	76	Planetary gear
2	Expand	17	Set plate	32	Check	47	Steel ball	62	Plug	77	Needle bearing
3	Oil seal	18	Piston kit	33	Spring	48	Check seat	63	Floating seal	78	Drive gear
4	Shaft	19	Friction plate	34	Seat	49	Plug	64	Nut	79	Thrust plate
5	Bearing	20	Parking plate	35	Snap ring	50	Plug	65	Washer	80	Ring gear cover
6	Swash piston kit	21	Parking piston	36	Check	51	O-ring	66	Collar	81	Plug
7	Spring	22	O-ring	37	Spring	52	Plug	67	Planetary gear	82	O-ring
8	Swash steel ball	23	O-ring	38	Plug	53	O-ring	68	Needle bearing	83	Wrench bolt
9	Swash plate	24	O-ring	39	O-ring	54	Ball bearing	69	Plate	84	Orifice
10	Shoe plate	25	O-ring	40	Back up ring	55	Pin	70	Bolt	85	Back up ring
11	Cylinder block	26	Rear cover	41	Main spool kit	56	Valve plate	71	Sun gear	86	Back up ring
12	Spring seat	27	Plug	42	Spring seat	57	Spring plate	72	Snap ring	87	Name plate
13	Spring	28	Spool	43	Spring	58	Wrench bolt	73	Carrier	88	Rivet
14	Snap ring	29	Spring	44	Plug	59	Ring gear	74	Spring pin		
15	Pin	30	Stopper	45	O-ring	60	Angular bearing	75	Collar		

2. PRINCIPLE OF DRIVING

1) GENERATING THE TURNING FORCE

The high hydraulic supplied from a hydraulic pump flows into a cylinder (11) through valve casing of motor (26), and valve plate (56).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (18).

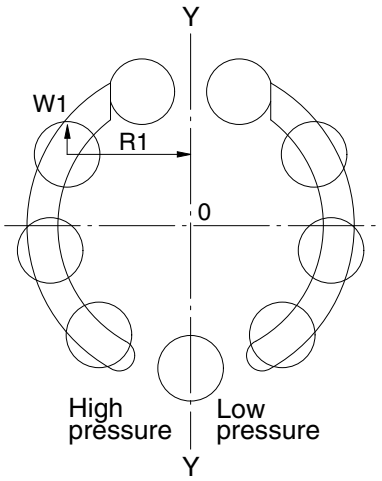
The high hydraulic can generate the force, F1 = P × A (P : Supplied pressure, A : water pressure area), like following pictures, working on a piston.

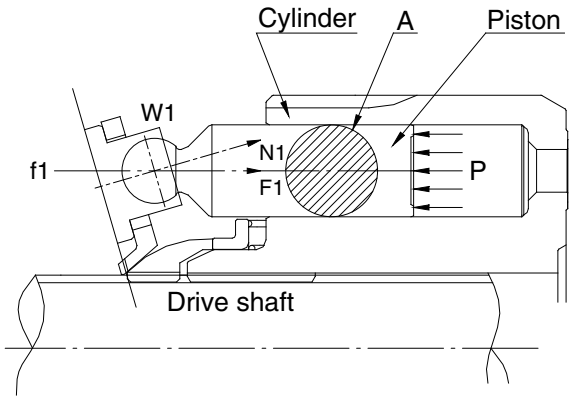
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the swash plate (9) of a tilt angle, α .

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 (11) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.





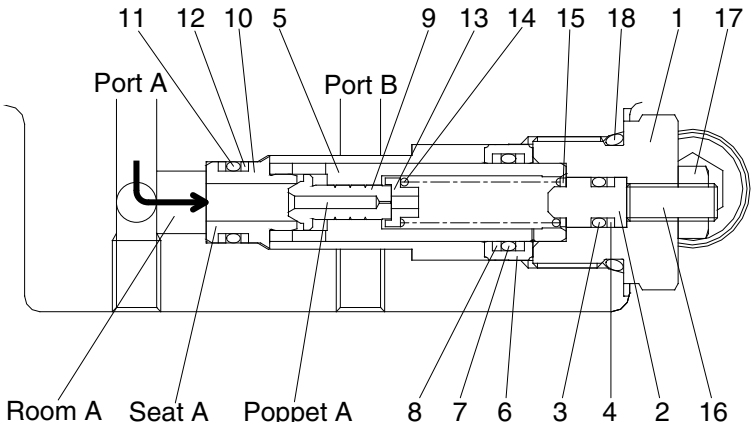
5592TM03

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 B. 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.



5592TM04

3) WORKING OF BRAKE

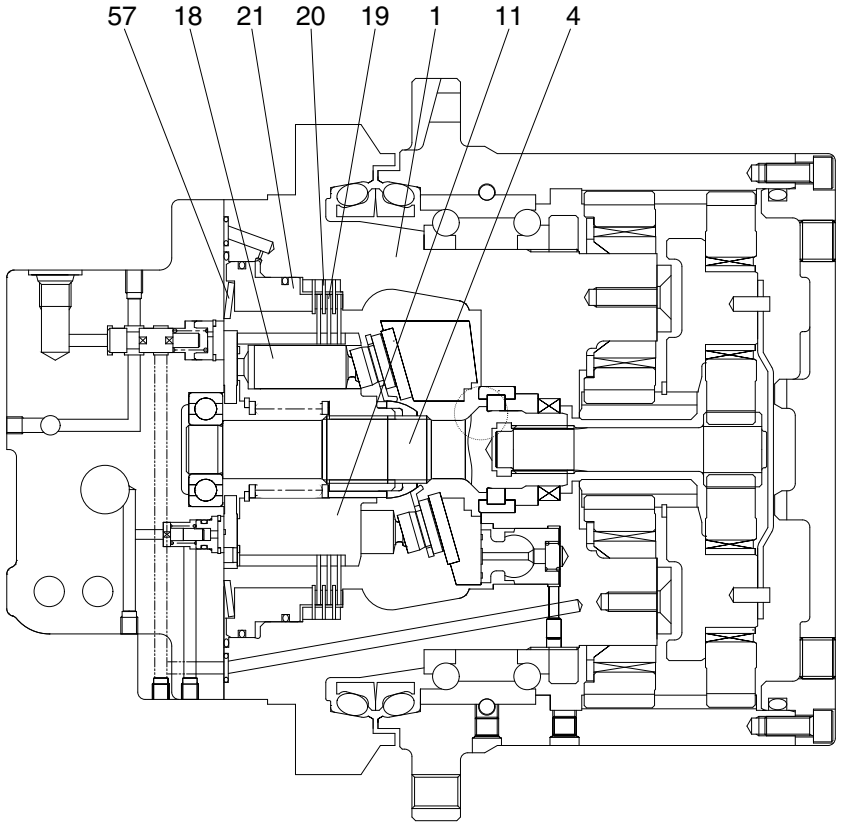
Brake operates the pressure supplied through SPOOL (simultaneous peripheral operation online) installed in valve casing (26) to the part of parking piston (21) and releases a brake.

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), brake piston (21) and a cylinder block (11) that is connected through spline which are fixed by shaft casing (1) with friction plate (19).

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 (19) and a detached plate in the middle of shaft casing and brake piston according to the force plate springs (57); finally, it makes a frictional force.

This frictional force helps the brake fixing a turning axis (3) connected by a cylinder and spline operated.



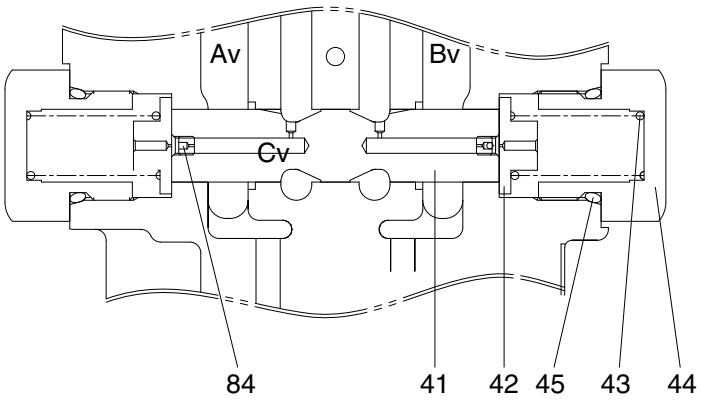
555K2TM06

4) COUNTERBALANCE VALVE

Av port is connected into a hydraulic pump and Bv port is into a tank. Hydraulic pump supplying oil is come into Av → Cv room. In accordance with spring force (43) that is working on the spool's side it moves to the spool (41) on the right side which is medium position and that time motor is turning.

When the spool (41) is come back to the medium position that time hydraulic motor is stopped.

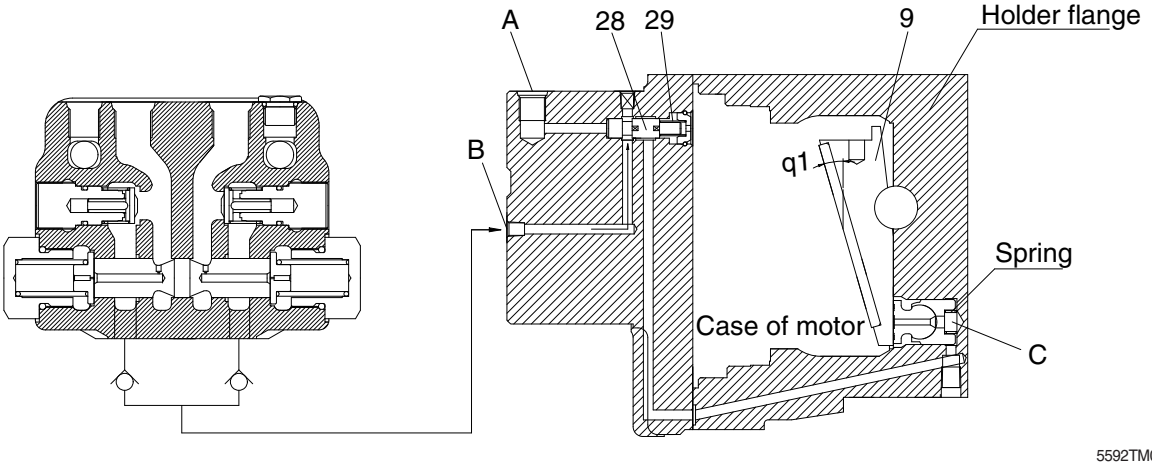
In accordance with spool's returning speed and shape control the working oil that is returning from hydraulic motor smoothly stopping the motor.



555K2TM07

4) HIGH/LOW SPEED CHANGEOVER MECHANISM

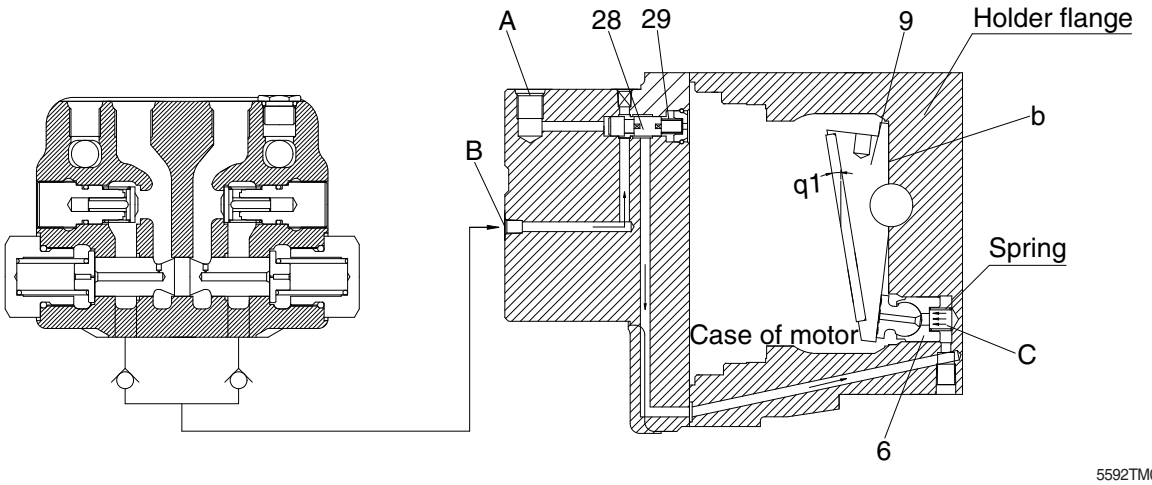
(1) At low speed-at pilot pressure of less than 10 kgf/cm² (0.98 Mpa)



5592TM05

When no pilot pressure is supplied from port (A) at a pressure of 10 kgf/cm² (0.98 Mpa) or less, spool (28) is pressed toward the left by the force of spring (29), the pressurized oil supply port B is shut off, and oil in chamber (C) is released into the motor case via spool (28).
Consequently, swash plate (9) 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 10 kgf/cm² (0.98 Mpa) or more



5592TM06

When a pilot pressure is supplied from port (A) at a pressure of 10 kgf/cm² (0.98 Mpa) or more, the pressure overcomes the force of spring (29) and spool (28) is pressed toward the right. The pressurized oil at supply port (B) is then introduced into chamber (C) via spool (28).
Piston (6) pushes up swash plate (9) until it touches side (b) of the holder flange.
At this time, swash plate (9) is tilted at a minimum angle (θ 2°) and the piston displacement of hydraulic motor becomes maximum, thus leading to high-speed rotation.

2. REDUCTION GEAR

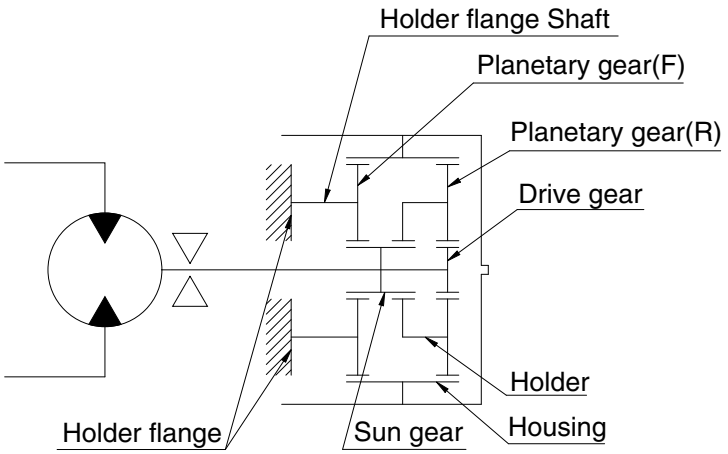
1) FUNCTION

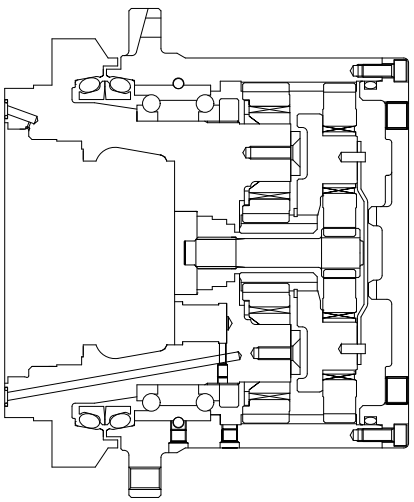
The reduction gear unit consists of a combination of simple planetaly gear mechanism.

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





5592TM07

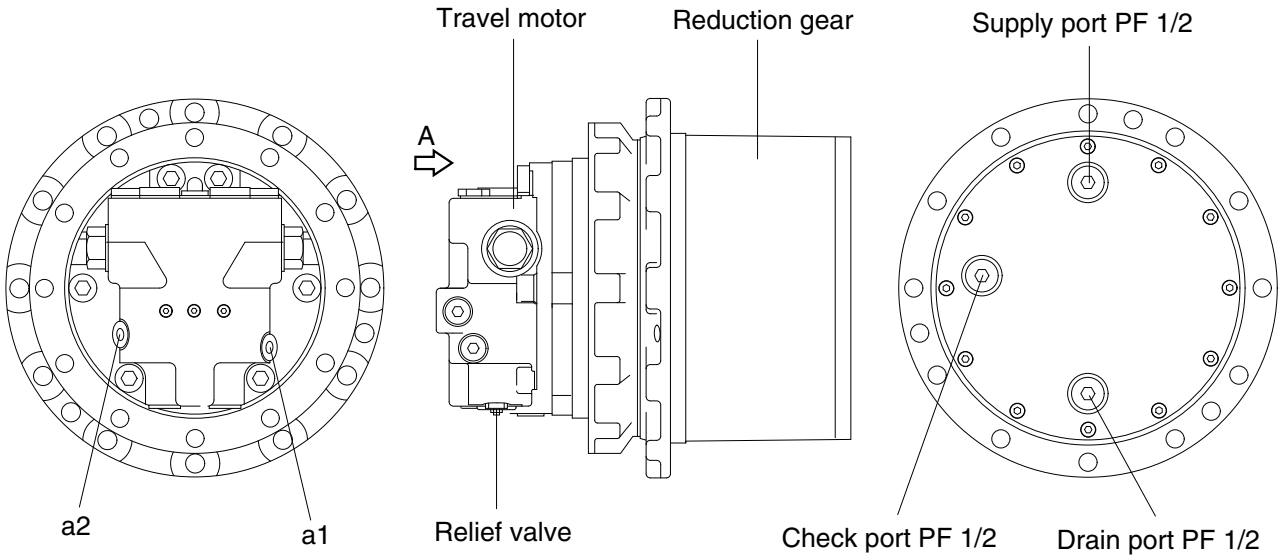
Reduction ratio = (Housing Teeth/Drive Gear Teeth + 1)
× (Housing Teeth/Sun Gear Teeth + 1) - 1.

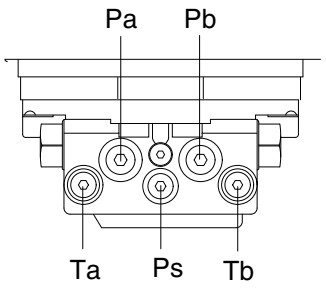
TRAVEL DEVICE (TYPE 2, MACHINE SERIAL NO. : #0812-)

1. CONSTRUCTION

Travel device consists travel motor and gear box.

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

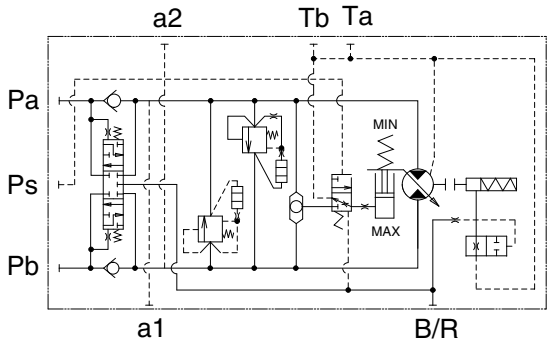




VIEW A

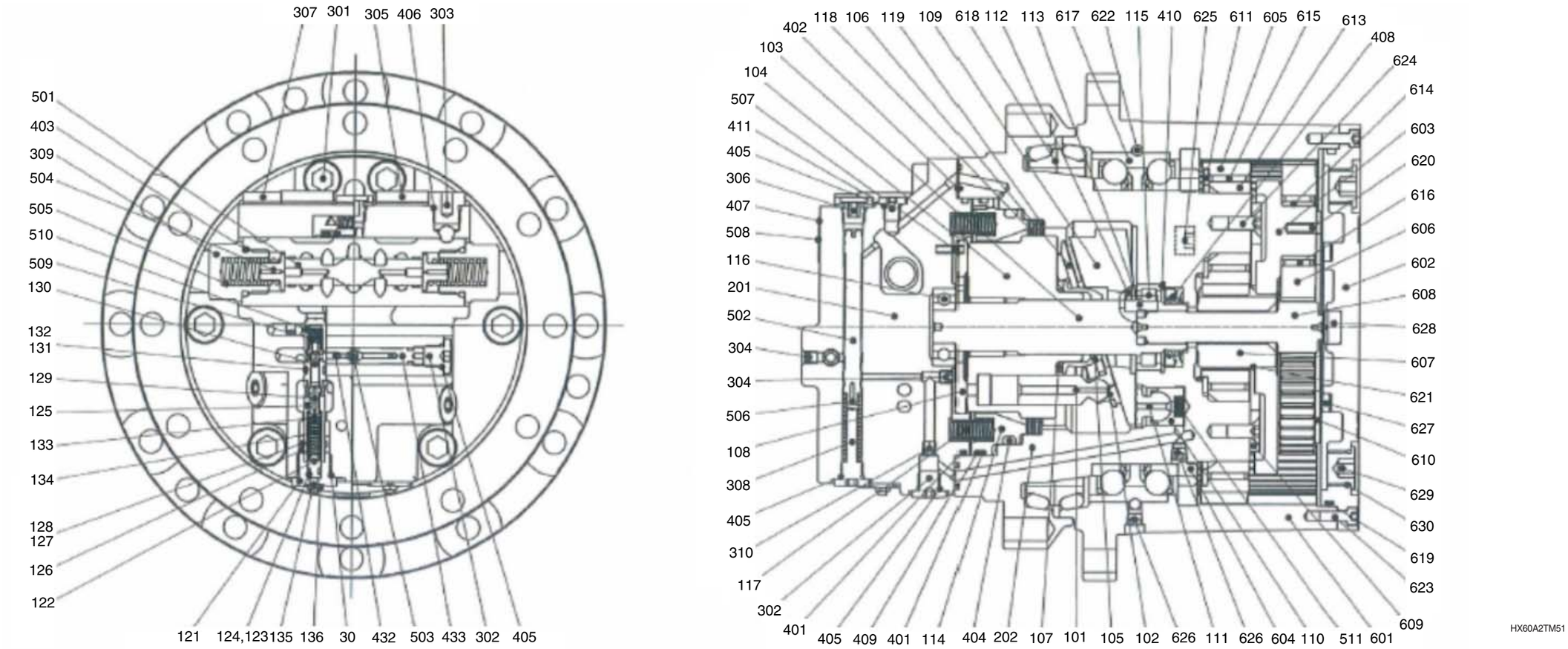
HX60A2TM50E

Port	Port name	Port size
Pa	Main port	PF 1/2
Pb	Main port	PF 1/2
a1,a2	Gauge port	PT 1/4
Ta,Tb	Drain port	PF 3/8
Ps	2 speed control port	PF 1/4



Hydraulic circuit

2) STRUCTURE

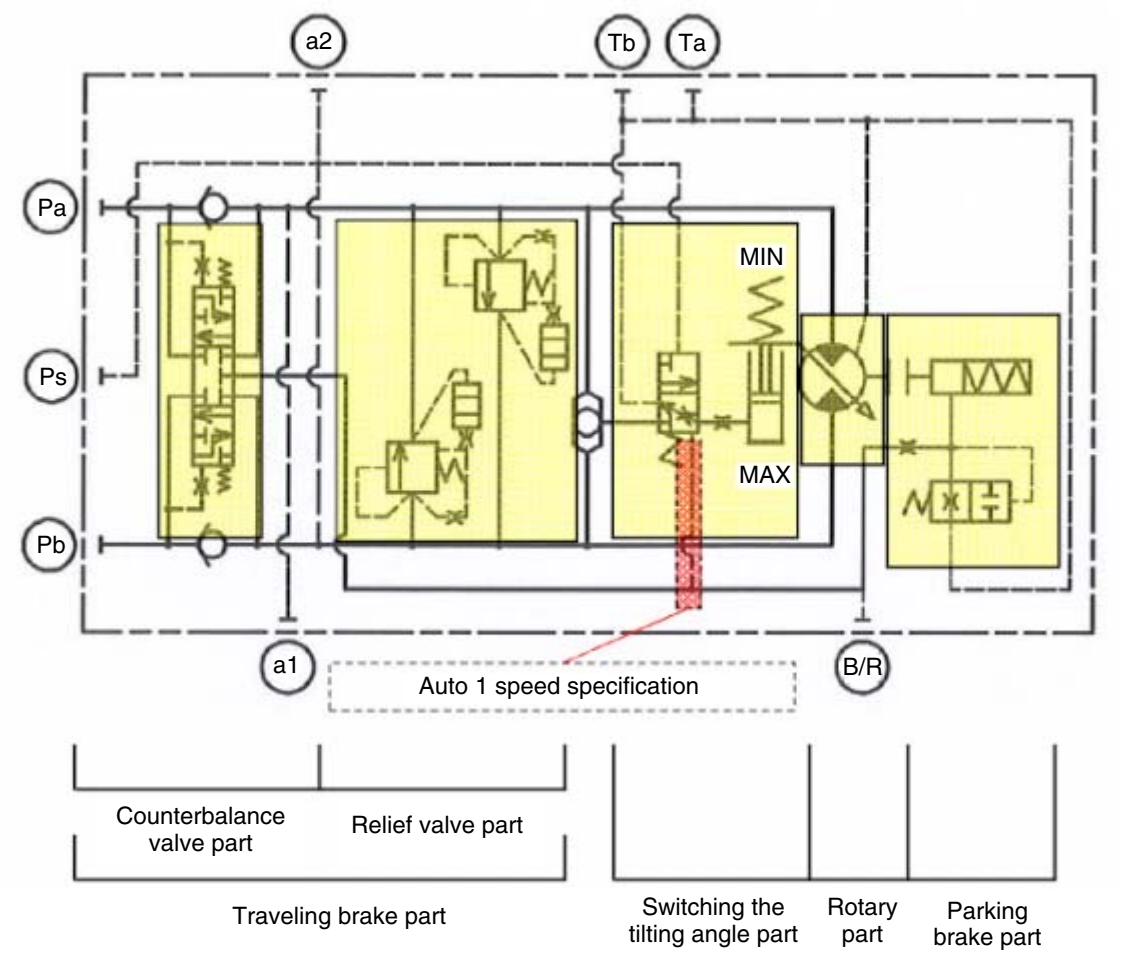


30	Relief valve assy	118	Friction plate	137	O-ring	405	O-ring	510	Cap	618	Floating seal kit
101	Piston	119	Separator plate	201	Valve casing	406	O-ring	511	Swash piston spring	619	O-ring
102	Shoe	121	Plug	202	Casing	407	Name plate	601	Housing	620	Spring pin
103	Drive shaft	122	Guide	301	Socket bolt	408	Oil seal	602	Cover	621	Snap ring
104	Cylinder block	123	O-ring	302	Plug	409	Back up ring	603	Holder	622	Steel ball
105	Spherical bushing	124	Back up ring	303	Drain plug	410	Snap ring	604	Ring nut	623	Socket bolt
106	Set plate	125	Sleeve	304	NPTF plug	411	O-ring	605	Planetary gear F	624	Bolt
107	Cylinder spring	126	Piston	305	Dust plug	432	Seat	606	Planetary gear R	625	Plug
108	Valve plate	127	O-ring	306	Dust plug	433	Seat casing	607	Sun gear	626	Plug
109	Swash plate	128	Back up ring	307	Dust plug	501	Main spool	608	Ring nut	627	Side plate A
110	Swash piston	129	Poppet	308	2 speed plug	502	2 speed spool	609	Thrust plate F	628	Side plate B
111	Swash shoe	130	Poppet seat	309	Set plug	503	Steel ball	610	Thrust plate R	629	Plug
112	Pivot	131	O-ring	310	Restrictor	504	Plunger	611	Thrust washer	630	O-ring
113	Pivot pin	132	Back up ring	311	Plug	505	Main spool spring	613	Collar		
114	Brake piston	133	Spring seat	401	O-ring	506	2 speed spool spring	614	Inner race		
115	Roller bearing	134	Spring	402	O-ring	507	Spring pin	615	Needle bearing		
116	Ball bearing	135	Adjust screw	403	O-ring	508	Pin	616	Needle bearing		
117	Brake spring	136	Hex nut	404	O-ring	509	Spring cap	617	Angular bearing		

2) MAJOR COMPONENT

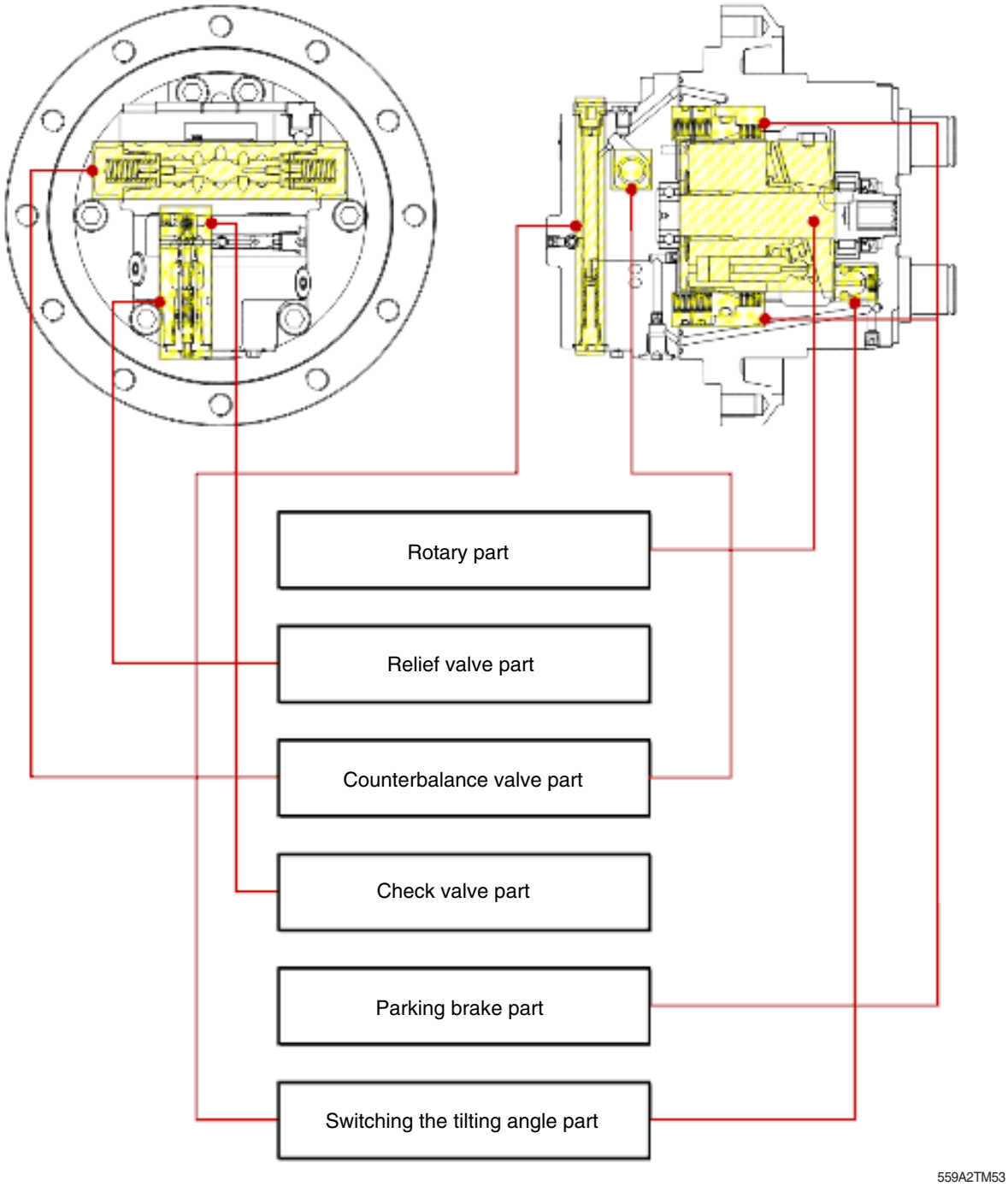
This product is only composed of hydraulic motor. Reduction parts are not composed.
This hydraulic motor is variable swash plate axial piston motor. It is composed of 4 parts.

- Rotary part which makes rotatory power
- Traveling brake valve part
- Parking brake part
- Switching the tilting angle part (auto 1/2 speed control part)



559A2TM52

3) BASIC STRUCTURE



2. WORKING PRINCIPLE

1) HYDRAULIC MOTOR SECTION

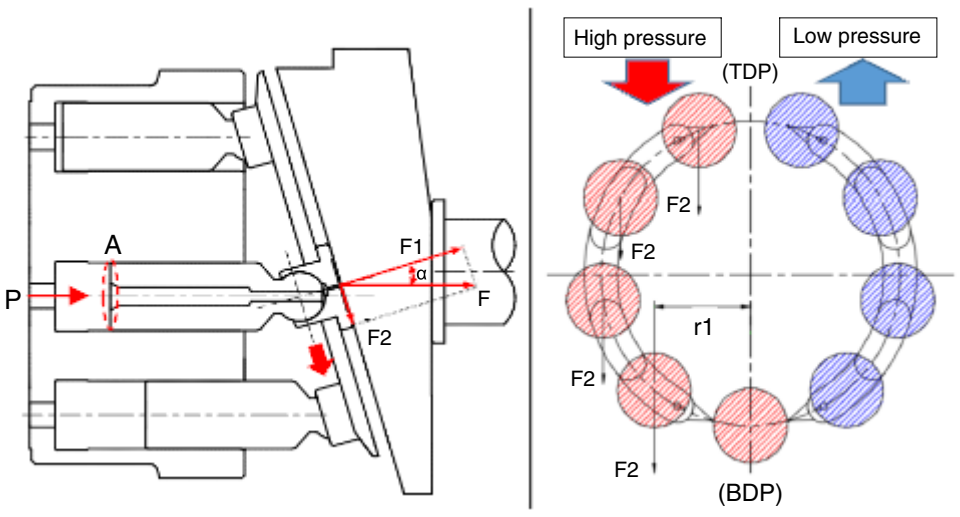
When high pressure oil passes from pump through the inlet port of the valve plate(108) and flows into the cylinder (104) as shown in figure, the oil pressure acts upon the piston (101) to generate the axial force "F". The force "F" acts on the swash (109) plane in the axial direction.

F = P × A (P : Pressure, A : Area)

The swash plate (109) is fixed with an inclination angle of α to the axis of the drive shaft (103).
Therefore, this force is divided into two vector forces through the shoe (102) : namely, the force F1 vertical to the swash plate (109) and the force F2 perpendicular to the drive shaft (103).
Because of the force "F2", piston (101) slides along with shoe (102) in the direction of the arrow in Figure. This force "F2" is transmitted to the cylinder block (104) via the piston (101) and generates a couple of forces which turn the output drive shaft (103).
In the cylinder block (104) nine pistons are equispaced and the pistons connected to the high pressure oil inlet ports give their rotating torque to the output shaft sequentially.
When the oil inflow/outflow direction are reversed, the rotating direction of the output shaft is reversed.
The theoretical output torque "T [N/m]" is given by the flowing.

$$T = \frac{P \times q}{2\pi}$$

P : Effective pressure difference (Mpa), q : Displacement per revolution (cm^3)



559A2TM54

2) TRAVELING BRAKE VALVE

Traveling brake valve is composed of relief valve, counterbalance valve and check port A is connected with hydraulic pump and port B is connected with tank.

(1) In case of traveling

When the compressed oil, which is supplied along the inlet port, exceeds certain pressure, it pushes cap (509). And, it is supplied to one side of the casing (202).

It is trying to rotate the hydraulic motor.

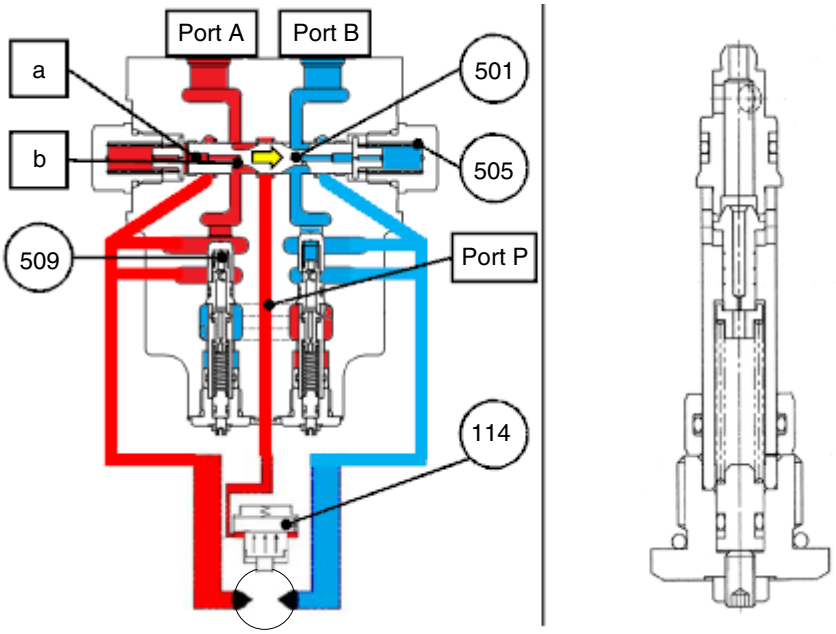
At the same time, the compressed oil enters the chamber {a} along small hole {b} of main spool (501) and acts on the face of main spool (501). After increasing pressure of oil, when this pressure exceeds the spring elasticity force of main spool spring (505), main spool (501), which is held in neutral by the spring elasticity force, moves to the right.

The inlet side and outlet side that was blocked by main spool (501) during stop connect with each other. So, return oil returns to the oil tank, so the hydraulic motor rotates.

Furthermore as main spool (501) moves, the path of parking brake (port P) is connected.

When compressed pressure, which enter to (port P) , becomes brake release pressure, it operates brake piston (114) and parking brake is released.

If the direction of oil inlet is reversed, main spool (501) and check valve motion is reversed. Output rotation direction is also reversed.



559A2TM55

(2) In case of stop

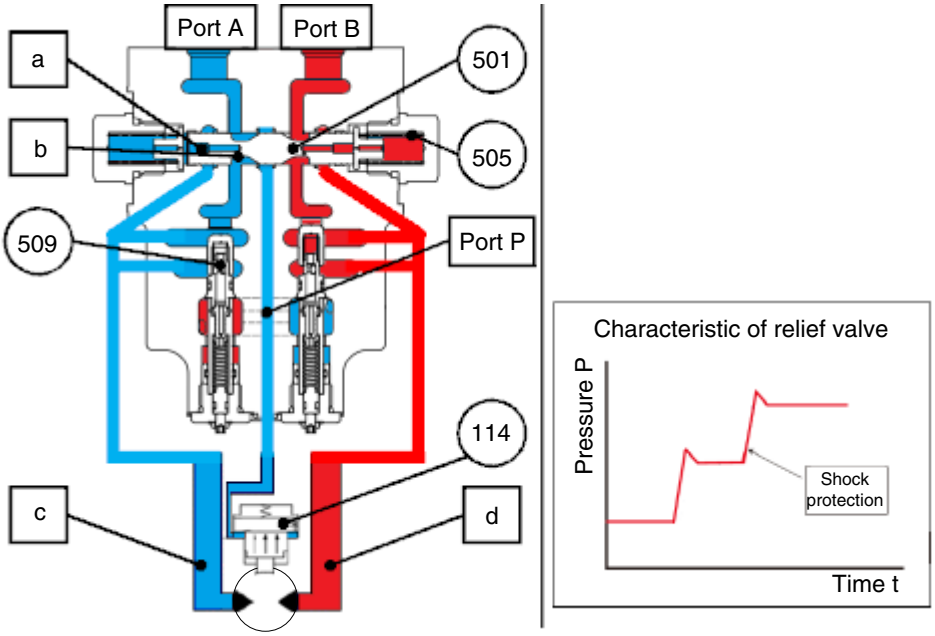
If the pressure supplied along the port to the inlet breaks while traveling, the pressure applied to the section of the main spool (501) is removed. Therefore, the main spool (501), which was pushed to the right, returns to neutral due to the spring elasticity force of the main spool spring (505).

The rotary part continues to rotate under inertia even if pressure is lost from the inlet side. As the main spool (501) returns to neutral, the connected inlet and outlet sides of the flow path are blocked. Since there is no escape location for the returned oil, the pressure of the exit side (D) is raised.

The returned oil with increased pressure enters the relief valve (30). if it exceeds the set pressure of the relief valve (30), operates the relief valve (30). The flow path from the outlet side {D} to the inlet side {C} is connected. And it controls the pressure on the outlet side.

At the same time it prevents cavitation on the inlet side.

It also relieves the shock during stop while controlling pressure on the outlet side with relief valve (30) in two stages, and apply soft braking to the hydraulic motor by applying an orifice and notch on the main spool (501).



559A2TM56

(2) In case of stop

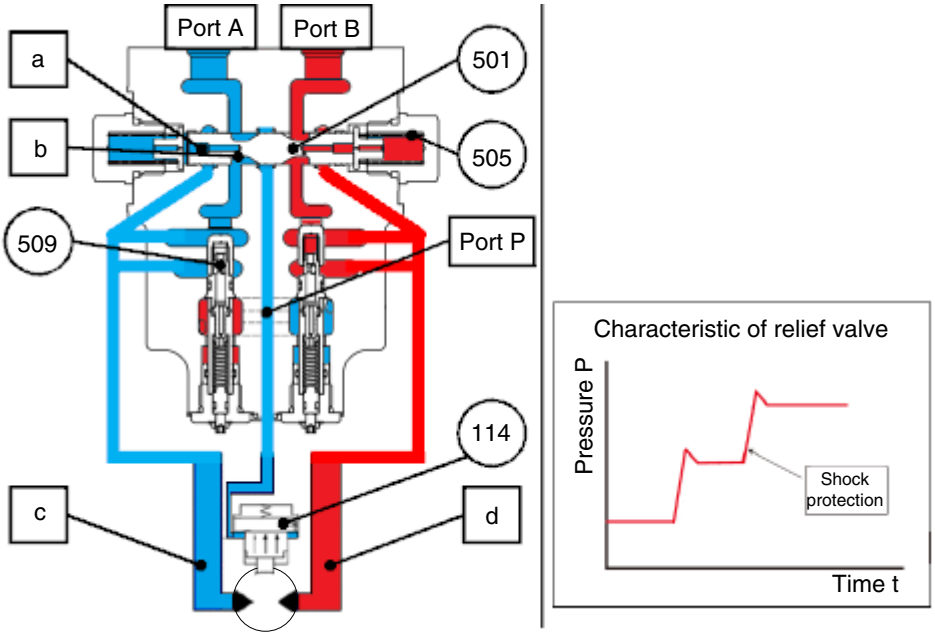
If the pressure supplied along the port to the inlet breaks while traveling, the pressure applied to the section of the main spool (501) is removed. Therefore, the main spool (501), which was pushed to the right, returns to neutral due to the spring elasticity force of the main spool spring (505).

The rotary part continues to rotate under inertia even if pressure is lost from the inlet side. As the main spool (501) returns to neutral, the connected inlet and outlet sides of the flow path are blocked. Since there is no escape location for the returned oil, the pressure of the exit side (D) is raised.

The returned oil with increased pressure enters the relief valve (30). if it exceeds the set pressure of the relief valve (30), operates the relief valve (30). The flow path from the outlet side {D} to the inlet side {C} is connected. And it controls the pressure on the outlet side.

At the same time it prevents cavitation on the inlet side.

It also relieves the shock during stop while controlling pressure on the outlet side with relief valve (30) in two stages, and apply soft braking to the hydraulic motor by applying an orifice and notch on the main spool (501).



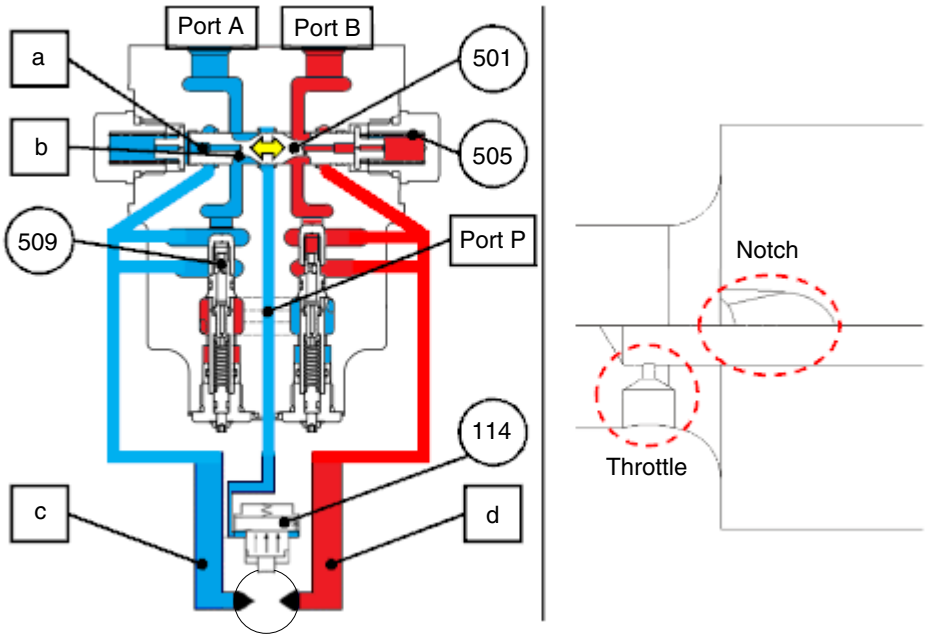
559A2TM56

(3) In case of overrun

Overrun is when the excavator's speed is increased by the it's gravity (inertia), such as when an excavator is going downhill, causing the hydraulic motor to rotate above the supply flow of the hydraulic pump.

In the case of overrun, the compressed oil on the inlet side is entered into the rotary and the pressure on the inlet side is reduced. Therefore, due to the spring elasticity force of the main spool spring (505), main spool (501) returns to neutral, as it stops.

At the same time, back pressure is generated due to the throttle (notch of main spool) between the outlet side (D) and the outlet port (port B) passage. The back pressure controls the return speed of the main spool (501) and hydraulic motor, which is about to be rotated by inertia forces, is decelerated. The operation of main spool (501) is controlled by the notch of main spool (501) and throttle. So motor smoothly moves according to the supply flow rate.



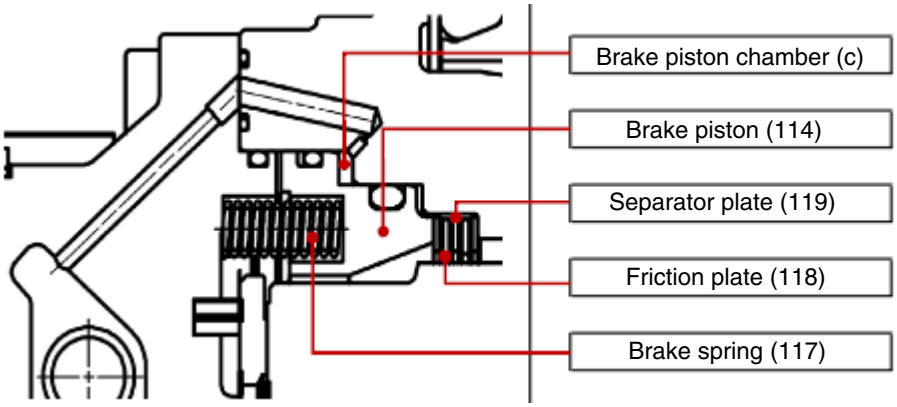
559A2TM57

3) PARKING BRAKE

The parking brake is wet-type multiple disk brakes. It is a negative brake system which is released when the brake release pressure enters the brake piston chamber.

The internal structure of parking brake is shown in figure. Friction plate (118) and separator plate (119) are alternately stacked, and acting on springs to produce brake torque with friction forces.

It prevents not only the braking of excavators but also overrun or slip during traveling and stopping on the slip.



559A2TM58

(1) In case traveling

The cylinder block (104) is connected to the drive shaft (103) with spline. In addition, the separator plate (119) is restrained from circumferentially-rotating by an arc groove cut on the casing (202).

The friction plate (118) which is connected to the arc groove cut on cylinder block (104), can be rotated along the cylinder block (104).

When pressurized oil is supplied from the inlet side during traveling operation, the blocked flow path is opened. so pressurized oil is supplied to the brake piston chamber (c) that is comprised inside brake piston (114) and casing (202).

If the hydraulic force F4 of the brake piston chamber (c) is greater than the spring elasticity force F3 of the brake spring (117), then brake piston (114) move to valve casing. (above brake release pressure)

F3 = k x n , k : Spring constant, x : Spring stroke, n : Number of spring brake

F4 = P × (A1 - A2), P : Main pressure of input, (A1 - A2) : Area difference of brake piston

The force that friction plate (118) and separator plate (119) pressurize the casing (202) disappears and the brake releases.

So, the hydraulic motor can rotate.

(2) In case of stop

If the pressurized oil supplied by the inlet is cut off during stop, the pressurized oil supplied to the brake piston chamber (c) will also be blocked. (below brake release pressure)

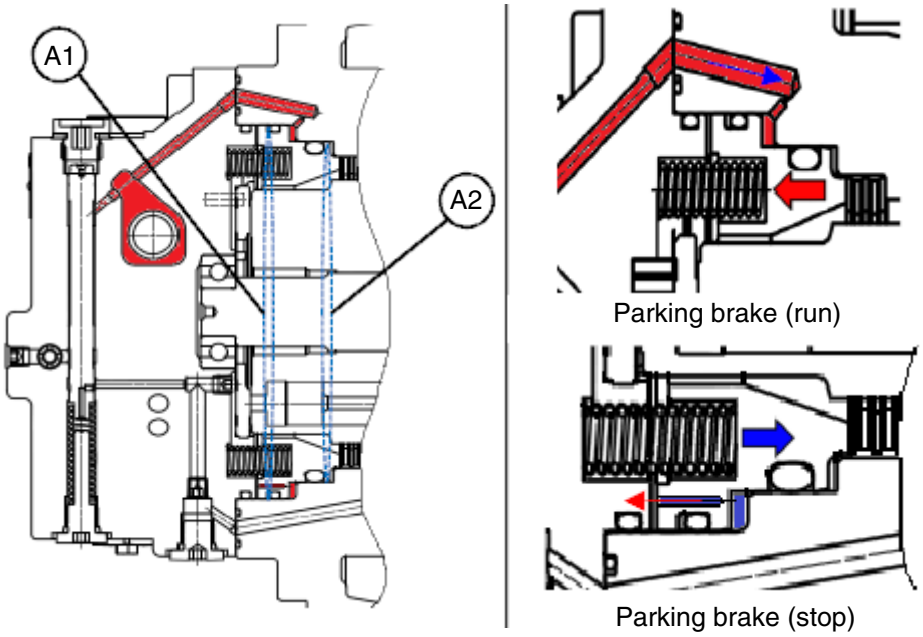
If the spring elasticity force F3 of the brake spring (117) is greater than the hydraulic force F4 of the brake piston chamber (c), then brake piston (114) move to casing by spring elasticity force. The hydraulic oil of the brake piston (114) is drained through the throttle. Therefore brake piston (114) smoothly operates.

F3 < F4

F3 = k x n , k : Spring constant, x : Spring stroke, n : Number of spring brake

F4 = P × (A1 - A2), P : Main pressure of input, (A1 - A2) : Area difference of brake piston

When the brake piston (114) pushes casing (202) by the brake spring (117), the frictional force appears between friction plate (118), casing (202), separator plate (119) and brake piston (114). parking brake appears by friction force and spring elasticity of the brake spring (117), the drive shaft (103) is constrained.



559A2TM59

4) 1/2 SPEED SWITCHING OPERATION (AUTOMATIC 1/2 SPEED CONTROL PART)

(1) Low speed traveling

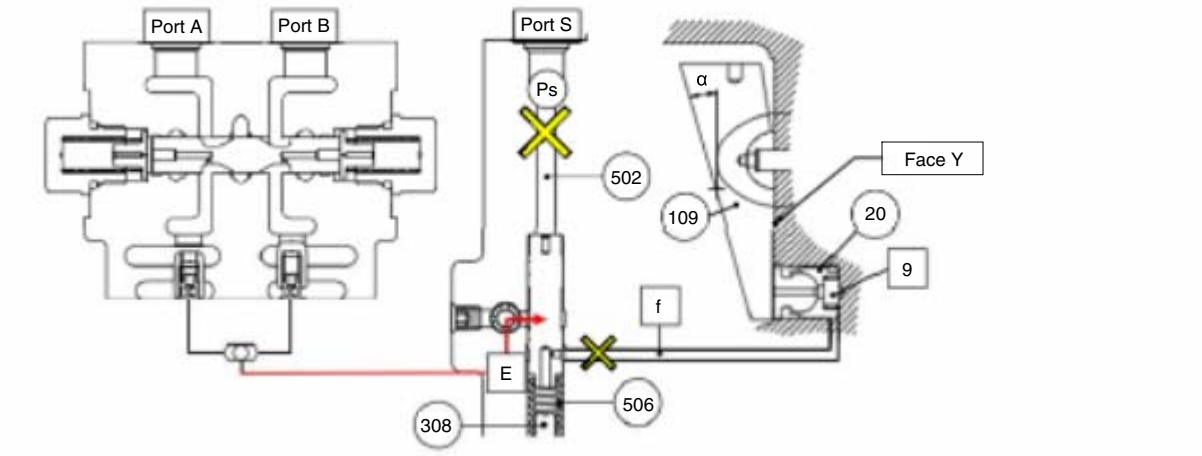
If pilot pressure is not supplied on pilot port (port S), 2 speed spool (502) is pushed in the direction of the port S by spring elasticity of 2 speed spool spring (506).

As a result, the compressed oil from the high pressure selection check valve (E) is not connected to the swash piston chamber (g).

The compressed oil of swash piston chamber{g} is drained through the flow path of 2 speed spool chamber (f).

So, the compressed oil from the high pressure selection check valve (E) is not connected to the swash piston chamber {g}. As a result, the swash plate (109) will be the maximum angle α and the stroke of the piston (101) will be long. So, a large amount of oil will be required for rotating the motor once.

Therefore the displacement of the hydraulic motor is maximized and rotated at low speed.



559A2TM60

(2) High speed traveling

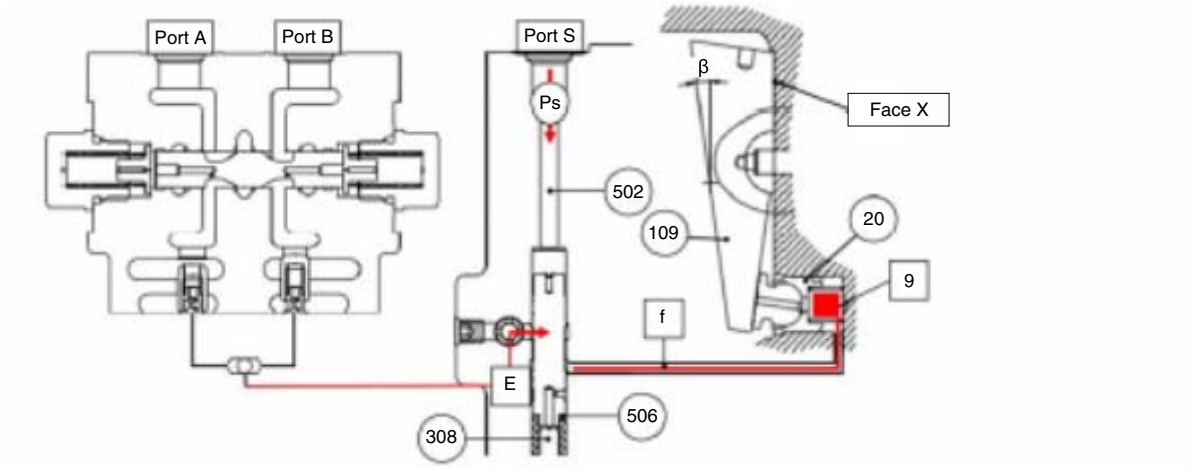
If the pilot pressure (20~50 kgf/cm²) is supplied to the port (port S), the pilot pressure overcomes the oil pressure in the main port and the spring elasticity force of the 2 speed spool spring (506). and it pushes the 2 speed spool (502) to the 2 speed plug (308) direction.

This is why the pressure from the high pressure selection check valve (E) is connected to the flow path (f).

The pressurized oil flows into the {g} chamber along the flow path {f} and pushes swash piston (20) to contact the face 'X' of swash plate (109) with the wall of the casing (202).

As a result, the swash plate (109) is the minimum angle β. Because stroke of piston (101) is shortened, a small amount of oil is used for one revolution.

Therefore, the displacement of the hydraulic motor is minimized and is rotated at high speed.



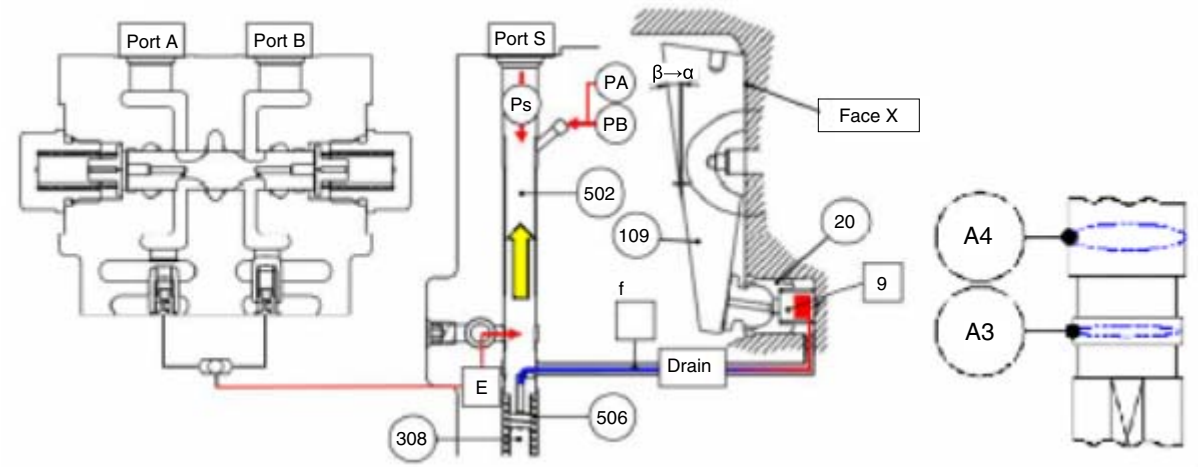
559A2TM61

(3) Automatic 1/2 speed control part

If the load is increased during the 2-speed driving, the hydraulic pressure on the main port is increased. The pressure (△P) of main port and spring elasticity force of 2 speed spool spring (506) will overcome the pressure of pilot, 2 speed spool (502) is pushed in port S direction.

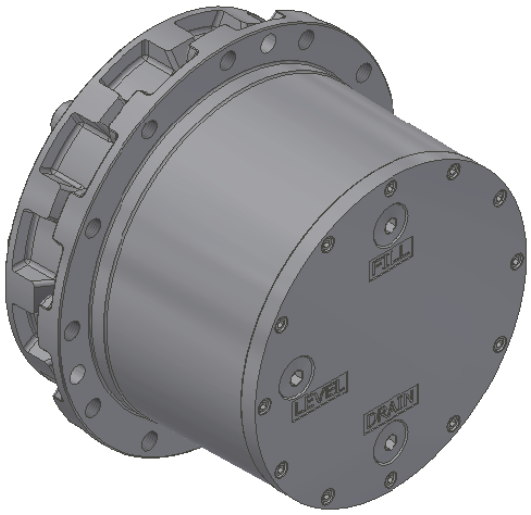
F5 < [{F6 × (A4 - A3)} + (Fspring)]
F5 = PS × A3, PS : Pilot pressure, A3 : 2 speed spool area
F6 = (PA or PB) × (A4 - A3), (PA or PB) : Main pressure difference between inlet side and outlet side
Fspring = K x X ; K : Spring constant of 2 speed spool spring, X : Spring stroke

Therefore, flow path from the high pressure selection check valve (E) to (f) is blocked.
And the pressure of (g) is slowly drained to 2 speed spool chamber (f) through throttle and a notch of 2 speed spool.
The angle of swash plate (109) transfers from β to α, and the motor automatically switches from 2 speed to 1 speed to rotate at low speed.



559A2TM62

5) REDUCTION GEAR



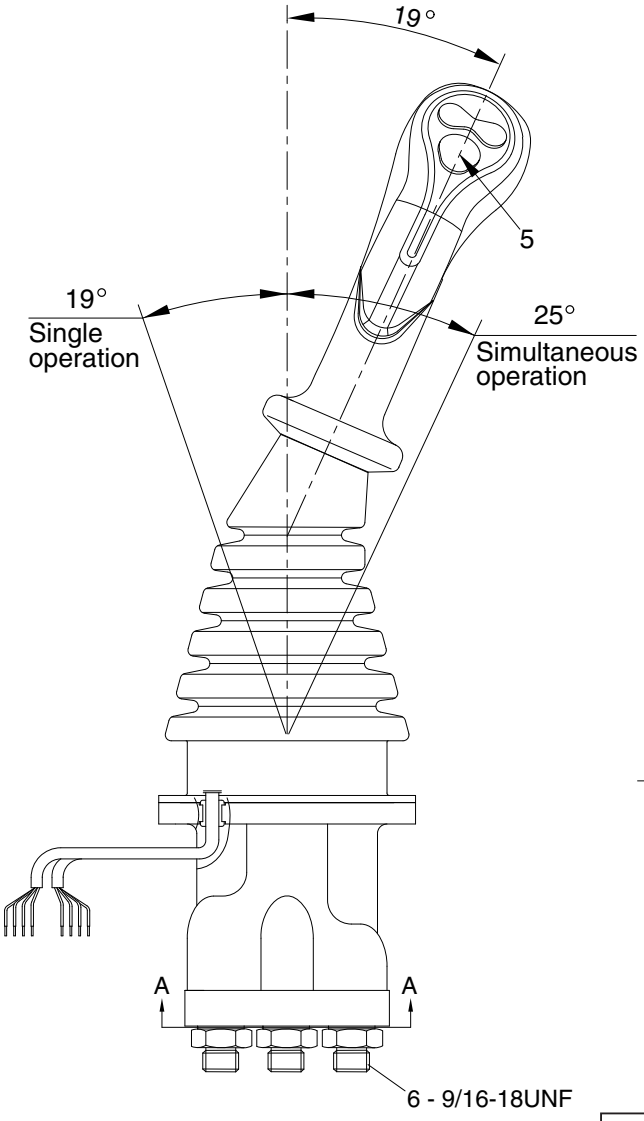
559A2TM63

(1) Refer to the section drawing for the basic construction.
(2) The reduction gear consists of two stage planetary gears.
(3) The reduction ratio is determined by the number of teeth of the gear, and the reduction ratio is 42.439.
In other words, the number of revolutions of the hydraulic motor is transmitted to the output shaft at 1 / reduction ratio.
(4) The direction of rotation of the input and output shafts is opposite.

GROUP 5 RCV LEVER

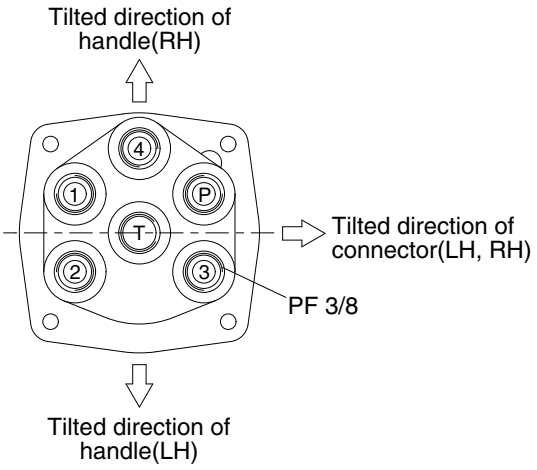
1. STRUCTURE

The casing has the oil inlet port P (primary pressure) and the oil outlet port T (tank). In addition the secondary pressure is taken out through ports 1, 2, 3 and 4 provided at the bottom face.



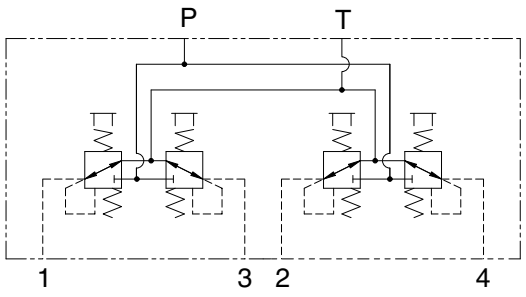
Switches

No.	LH	RH
5	Horn	Breaker



VIEW A

559A2RL01



Hydraulic circuit

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm in port	Boom down port	
3	Right swing port	Bucket in port	
4	Arm out port	Boom up port	

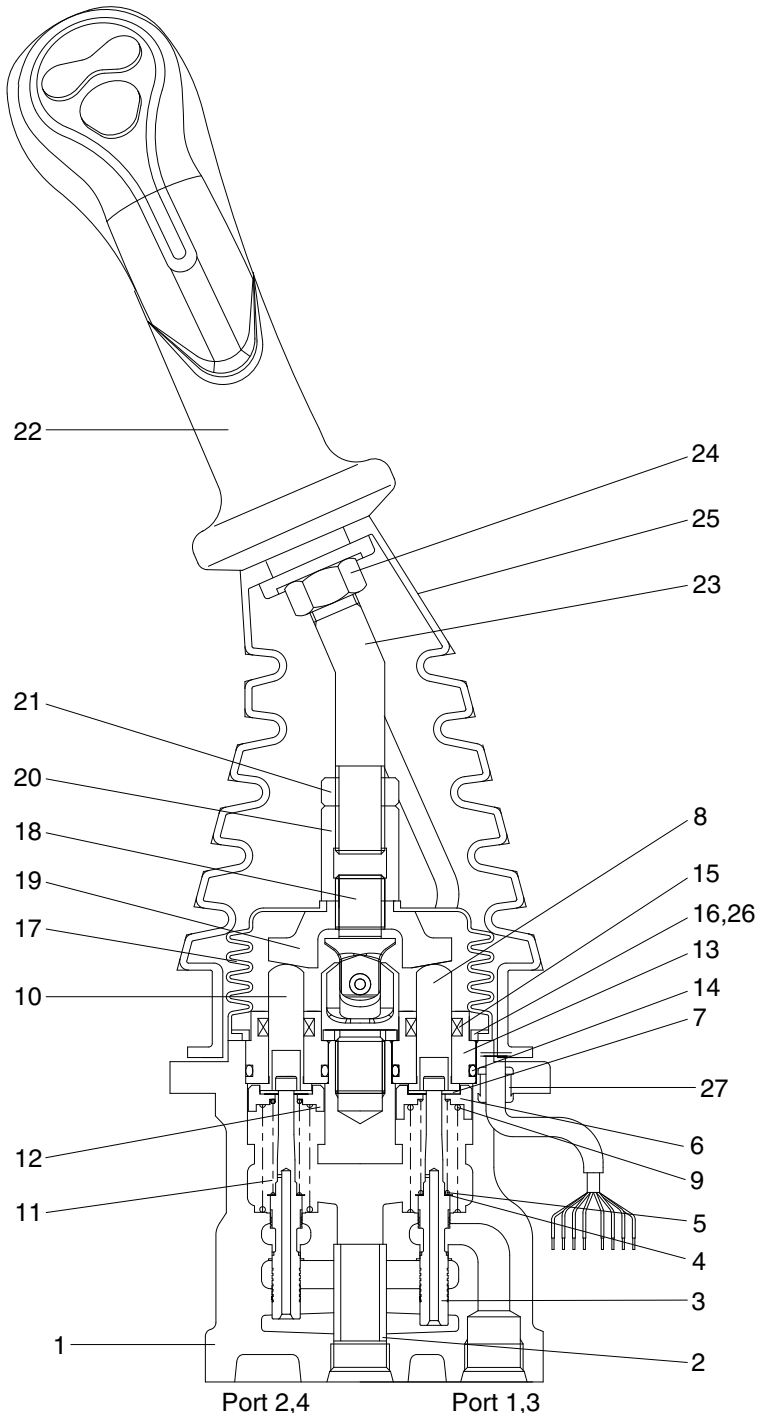
CROSS SECTION

The construction of the pilot valve is shown in the attached cross section drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (3), spring (5) for setting secondary pressure, spring (9), stopper (7), spring seat (6, 12) and shim (4). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm^2 (depending on the type). The spool is pushed against the push rod (8, 10) by the return spring.

When the push rod is pushed down by tilting the handle, the spring seat comes down simultaneously and changes setting of the secondary pressure spring.

CROSS SECTION



60W9S2RL02

1	Case	8	Push rod	15	Rod seal	22	Handle assembly
2	Bushing	9	Spring	16	Plate	23	Handle bar
3	Spool	10	Push rod	17	Boot	24	Nut
4	Shim	11	Spring	18	Joint assembly	25	Boot
5	Spring	12	Spring seat	19	Swash plate	26	Spring pin
6	Spring seat	13	Plug	20	Adjusting nut	27	Bushing
7	Stopper	14	O-ring	21	Lock nut		

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve that controls the spool stroke, direction, etc of a main control valve. This function is carried out by providing the spring at one end of the main control valve spool and applying the output pressure (secondary pressure) of the pilot valve to the other end.

For this function to be carried out satisfactorily, the pilot valve is composed of the following elements.

(1) Inlet port (P) where oil is supplied from hydraulic pump.

(2) Output ports (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.

(3) Tank port (T) necessary to control the above output pressure.

(4) Spool to connect output port to inlet port or tank port.

(5) Mechanical means to control output pressure, including springs that work on the above spools.

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (3) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output port pressure oil to tank port T.

The spring (5) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (8,10) is inserted and can slide in the plug (13).

For the purpose of changing the displacement of the push rod through the swash plate (19) and adjusting nut (20) are provided the handle (22) that can be tilted in any direction around the fulcrum of the universal joint (18) center.

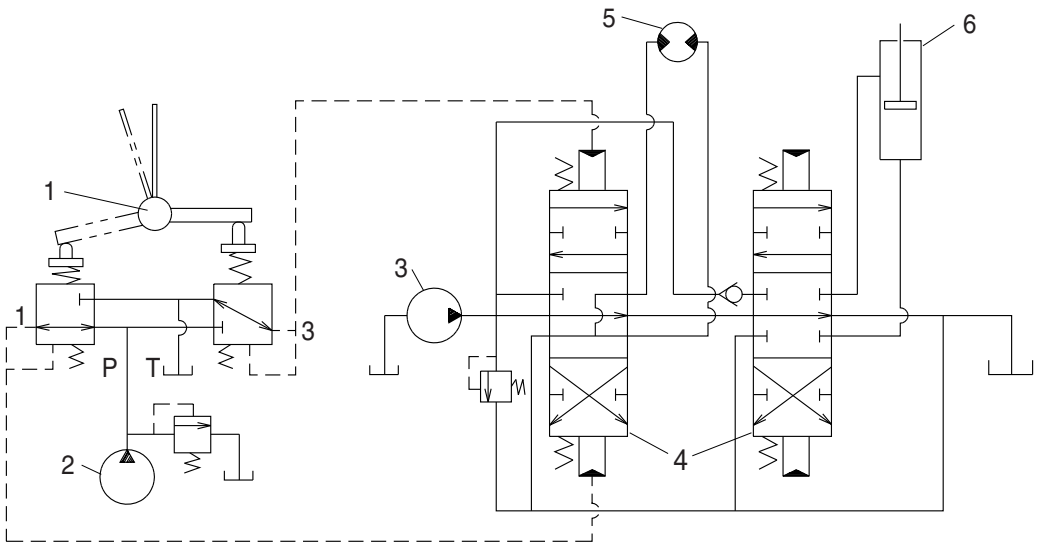
The spring (9) works on the case (1) and spring seat (6, 12) and tries to return the push rod (8,10) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

This also has the effect of a reaction spring to give appropriate control feeling to the operator.

3) OPERATION

The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below and the attached operation explanation drawing.

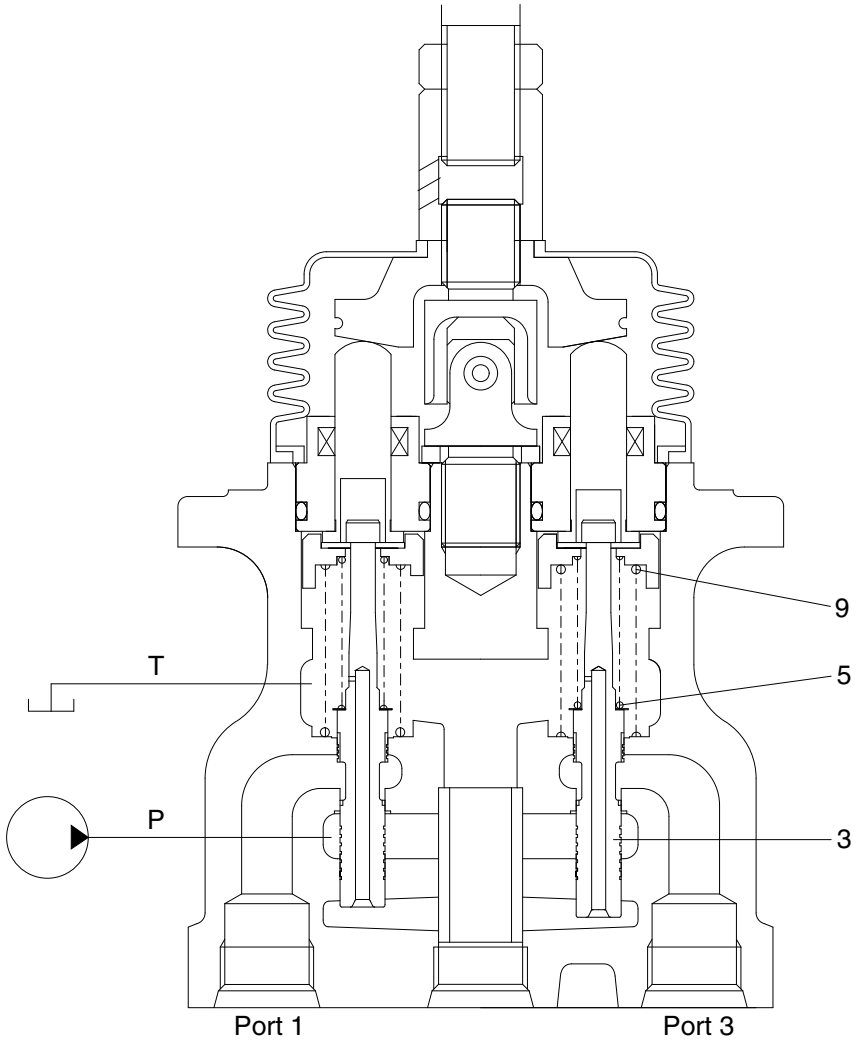
The diagram shown below is the typical application example of the pilot valve.



2-70

1	Pilot valve	3	Main pump	5	Hydraulic motor
2	Pilot pump	4	Main control valve	6	Hydraulic cylinder

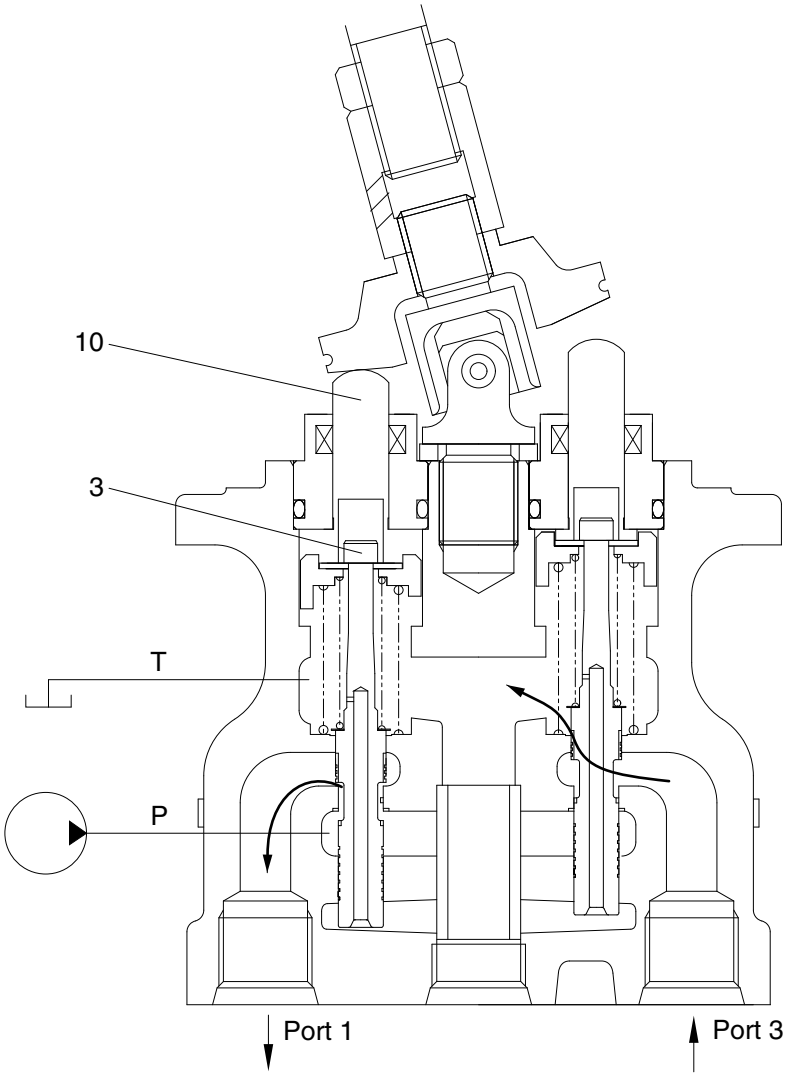
(1) Case where handle is in neutral position



60W9S2RL03

The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (3). Therefore, the spool is pushed up by the spring (9) to the position of port 1, 3 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where handle is tilted



60W9S2RL04

When the push rod (10) is stroked, the spool (3) moves downwards.
Then port P is connected with port 1 and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.