

SECTION 2 STRUCTURE AND FUNCTION

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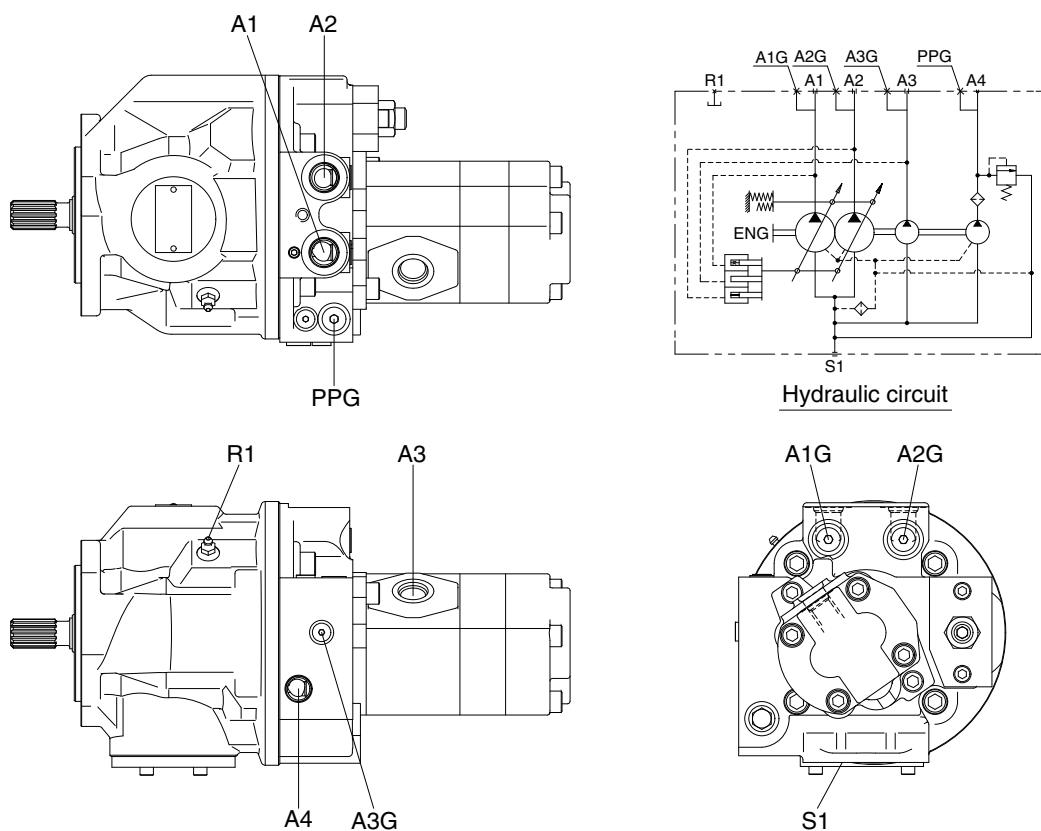
GROUP 1 HYDRAULIC PUMP

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, $(P1 + P2) \times Q = \text{Constant}$.

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

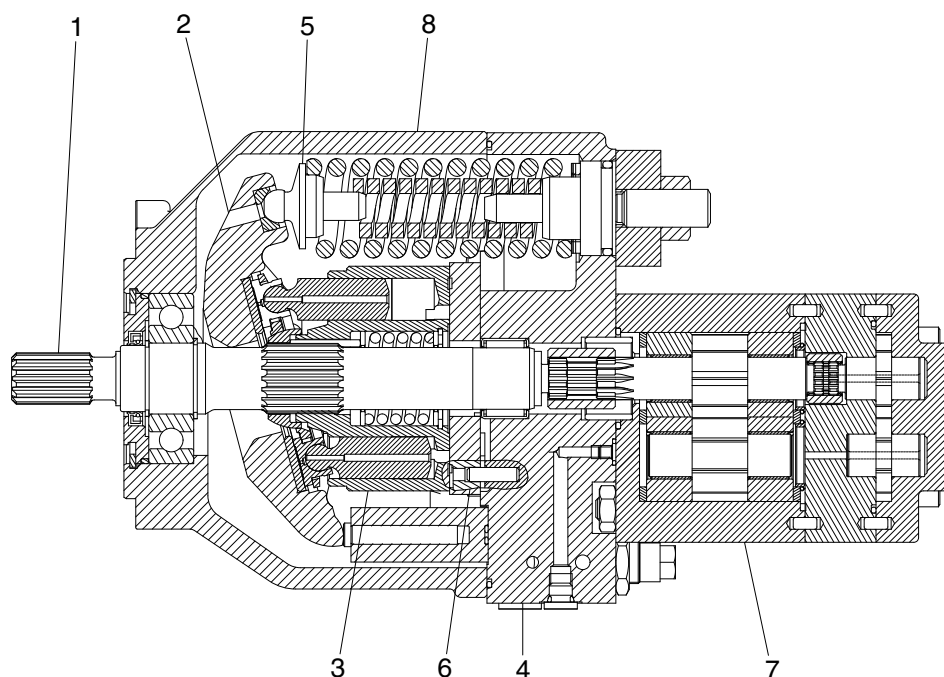


555C92MP01

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



R5572SF02

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

SPECIFICATIONS

- Capacity : $2 \times 27.5 + 18.3 + 4.5$ cc/rev
- Rated oil flow : $2 \times 55 + 38.4 + 9.5$ ℓ /min
- Rated pressure : $3 \times 220 + 30$ 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.

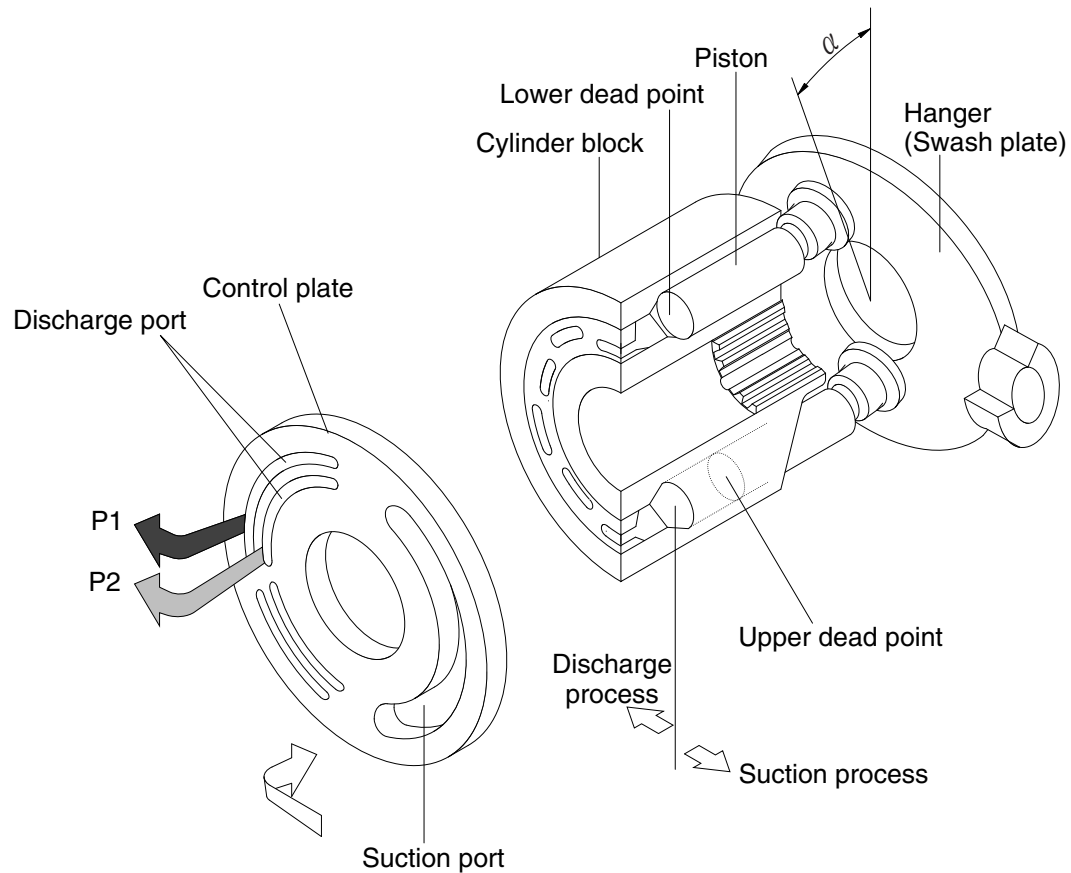
Since the piston stroke changes according to the tilting angle of the hanger, the flow can be changed.

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



R5572SF03

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).

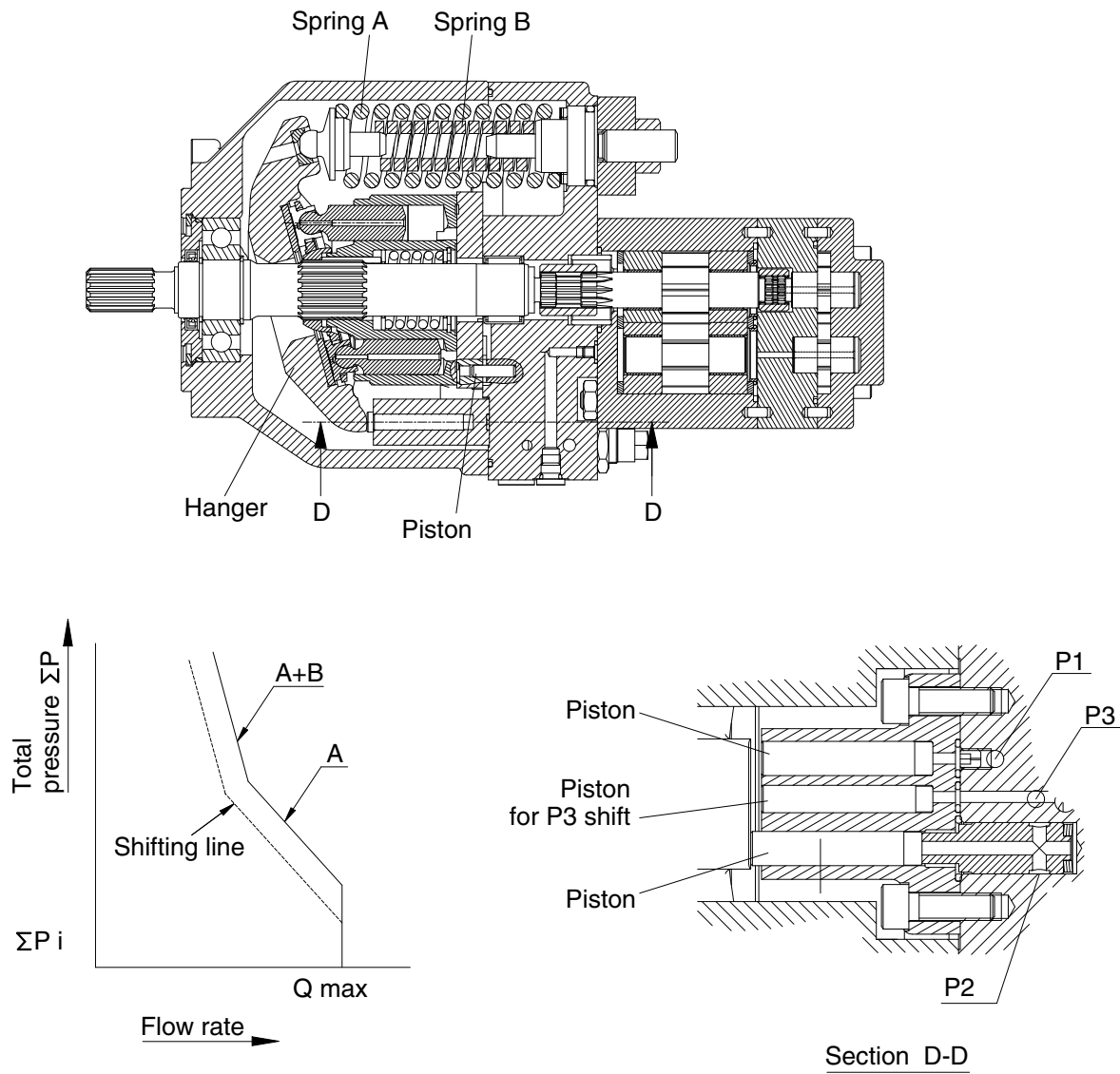
During a stroke from the upper to the lower dead points, the piston moves in a direction to decrease the displacement. The oil is discharged to the discharge port (discharge process).

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



R5572SF04

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)

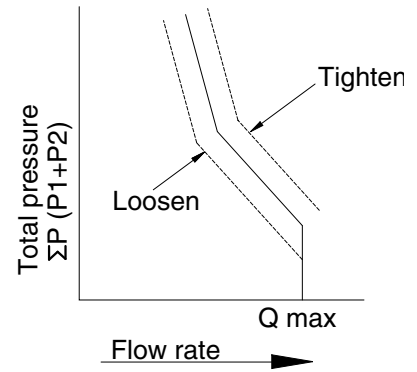
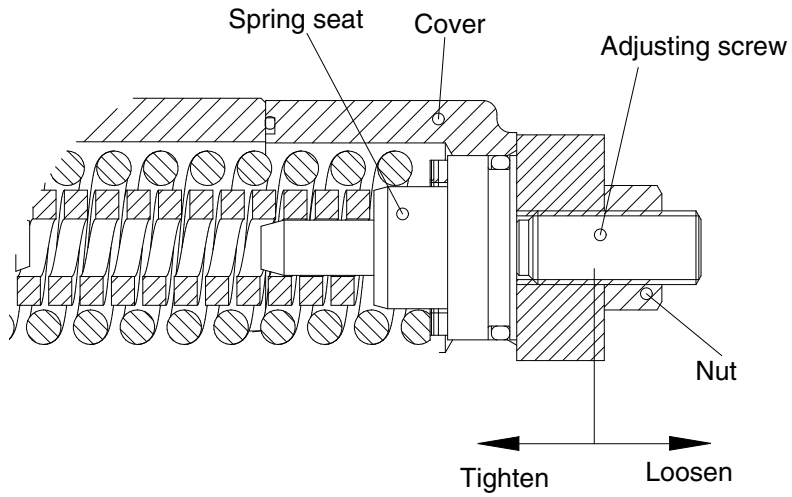
When the oil pressure acting on the piston rises further to reduce the tilting angle, the spring B which has been inactive up to now becomes active.

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

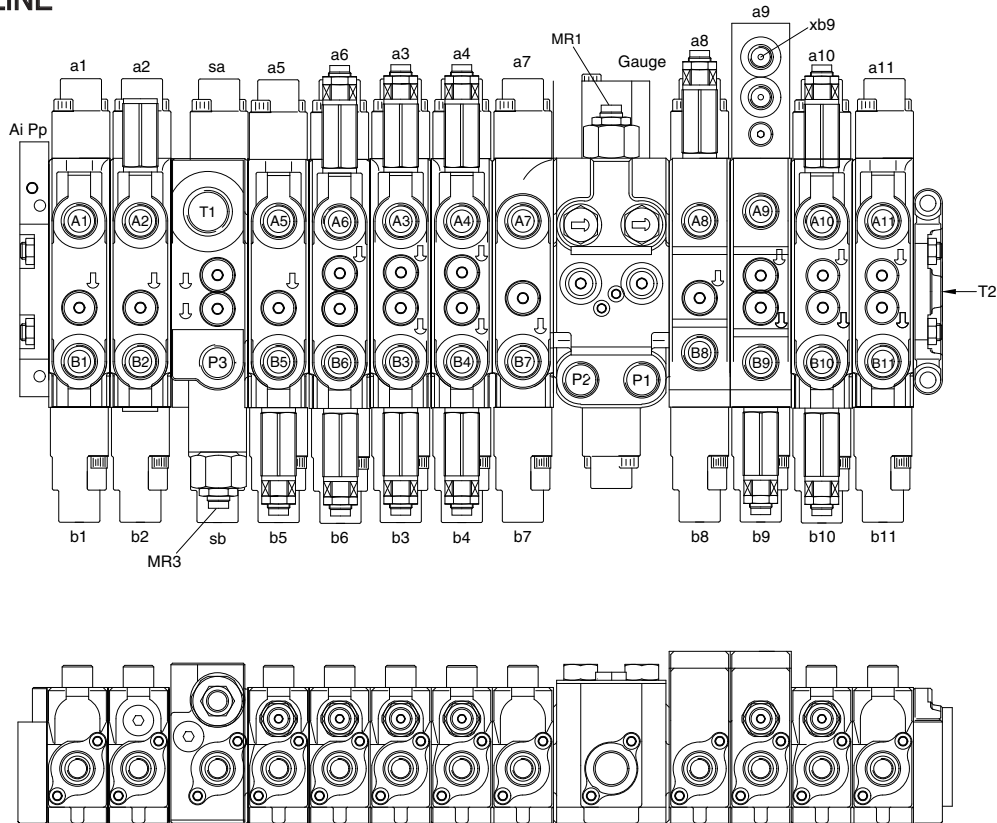
- (1) Loosen the hexagonal nut.
- (2) Tighten or loosen the adjusting screw to set the power shifting line.



R5572SF05

GROUP 2 MAIN CONTROL VALVE

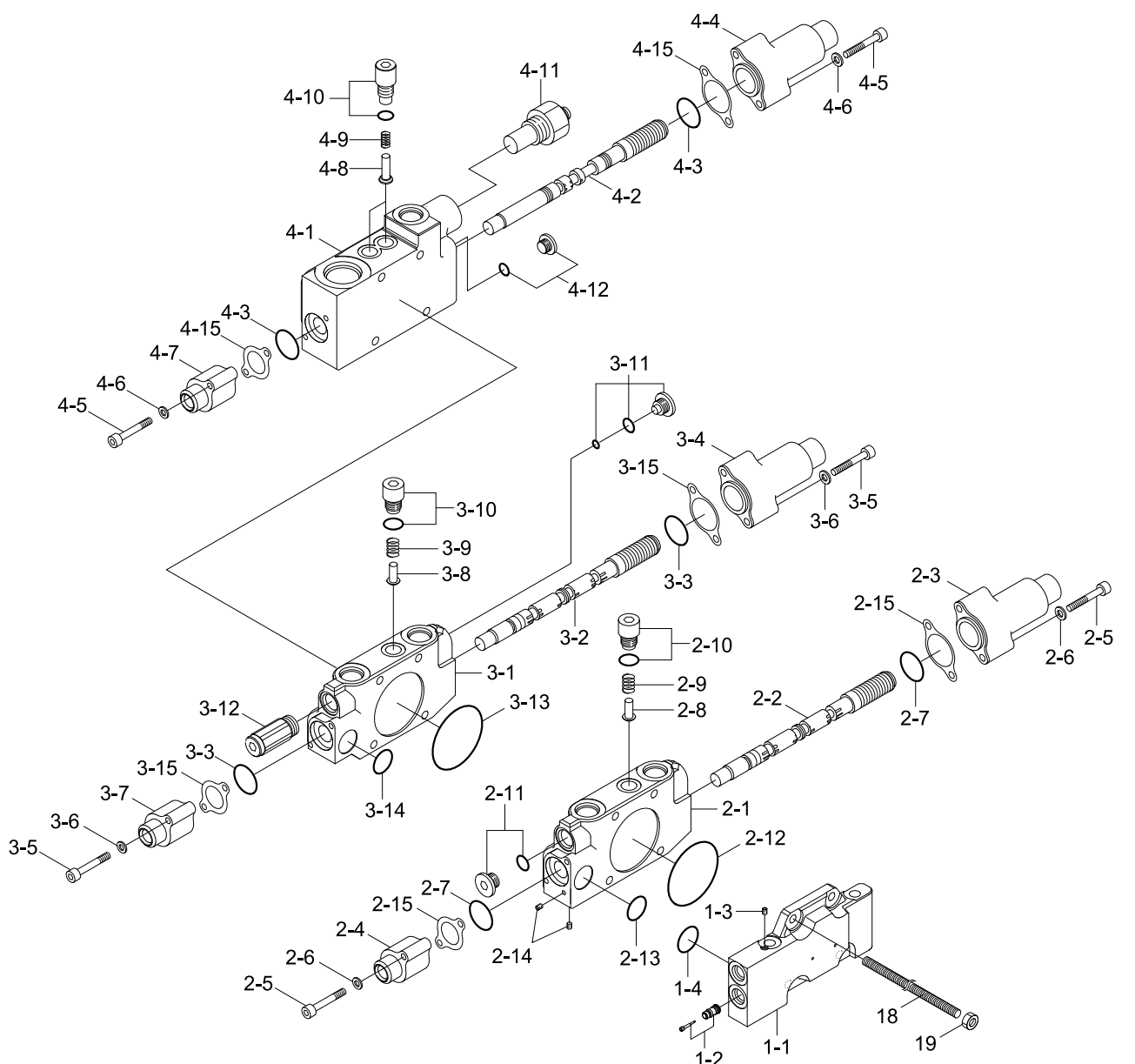
1. OUTLINE



65A2MC01

Mark	Port name	Port size	Tightening torque	Mark	Port name	Port size	Tightening torque
P1	P1 pump port	PF 1/2	6.0~7.0 kgf · m	B10	Bucket in port	PF1/2	6~7 kgf · m
P2	P2 pump port			B11	Arm 2 port	PF3/4	8~9 kgf · m
P3	P3 pump port			T2	Tank return port	PF3/4	8~9 kgf · m
A1	Swing port (LH)			T1	Tank return port	PF1	10~12 kgf · m
B1	Swing port (RH)			a1	Swing pilot port (LH)	PF1/4	2.5~3.0 kgf · m
A2	Dozer down port			b1	Swing pilot port (RH)		
B2	Dozer up port			a2	Dozer down pilot port		
A3	Boom swing port (LH)			b2	Dozer up pilot port		
B3	Boom swing port (RH)			a3	Boom swing pilot port (LH)		
A4	2 Way (opt)			b3	Boom swing pilot port (RH)		
B4	2 Way (opt)			a4	2 Way pilot port (opt)		
A5	Boom 2 port			b4	2 Way pilot port (opt)		
B5	Breaker port			a5	Boom 2 pilot port		
A6	Arm out port			b5	Breaker pilot port		
B6	Arm in port			a6	Arm out pilot port		
A7	Travel port [LH/FW]			b6	Arm in pilot port		
B7	Travel port [LH/RR]			a7	Travel pilot port (LH/FW)		
A8	Travel port [RH/FW]			b7	Travel pilot port (LH/RR)		
B8	Travel port [RH/RR]			a8	Travel pilot port (RH/FW)		
A9	Boom up port			b8	Travel pilot port (RH/RR)		
B9	Boom down port			a9	Boom up pilot port		
A10	Bucket out port			b9	Boom down pilot port		
MR1	Main relief valve	-		a10	Bucket out pilot port	PF1/4	
MR3				b10	Bucket in pilot port		
				a11	Arm 2 pilot port		
				b11	Arm 2 pilot port		
				Pp	Pilot supply port		
				Ai	Auto idle signal port		

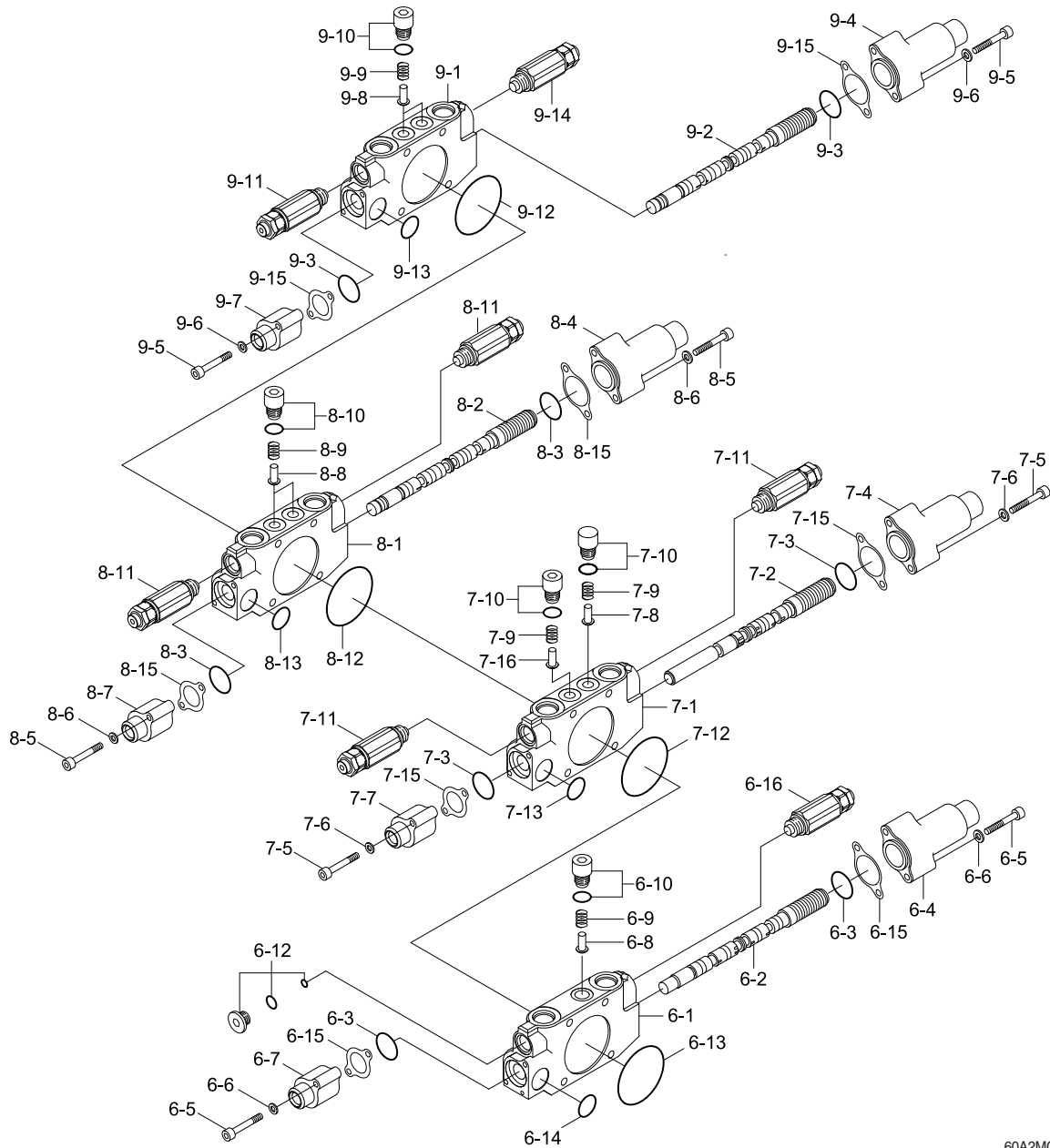
2. STRUCTURE (1/4)



60A2MCV02

1	Port cover assy	2-9	Check spring	3-7	Pilot cap B1	4-4	Pilot cap A
1-1	Autoidle cover	2-10	Plug assy	3-8	Check poppet	4-5	Wrench bolt
1-2	Filter assy	2-11	Plug assy	3-9	Check spring	4-6	Washer
1-3	Set screw	2-12	O-ring	3-10	Plug assy	4-7	Pilot cap B1
1-4	O-ring	2-13	O-ring	3-11	Plug assy	4-8	Check poppet
2	Swing section assy	2-14	Set screw	3-12	Check valve	4-9	Check spring
2-1	Work block	2-15	Gasket	3-13	O-ring	4-10	Plug assy
2-2	Swing spool assy	3	Dozer section assy	3-14	O-ring	4-11	Relief valve assy
2-3	Pilot cap A1	3-1	Work block	3-15	Gasket	4-12	Plug cap assy
2-4	Pilot cap B1	3-2	Dozer spool assy	4	Inlet section assy	4-15	Gasket
2-5	Wrench bolt	3-3	O-ring	4-1	Work block	18	Tie bolt
2-6	Washer	3-4	Pilot cap A	4-2	Selector spool assy	19	Nut
2-7	O-ring	3-5	Wrench bolt	4-3	O-ring		
2-8	Check poppet	3-6	Washer				

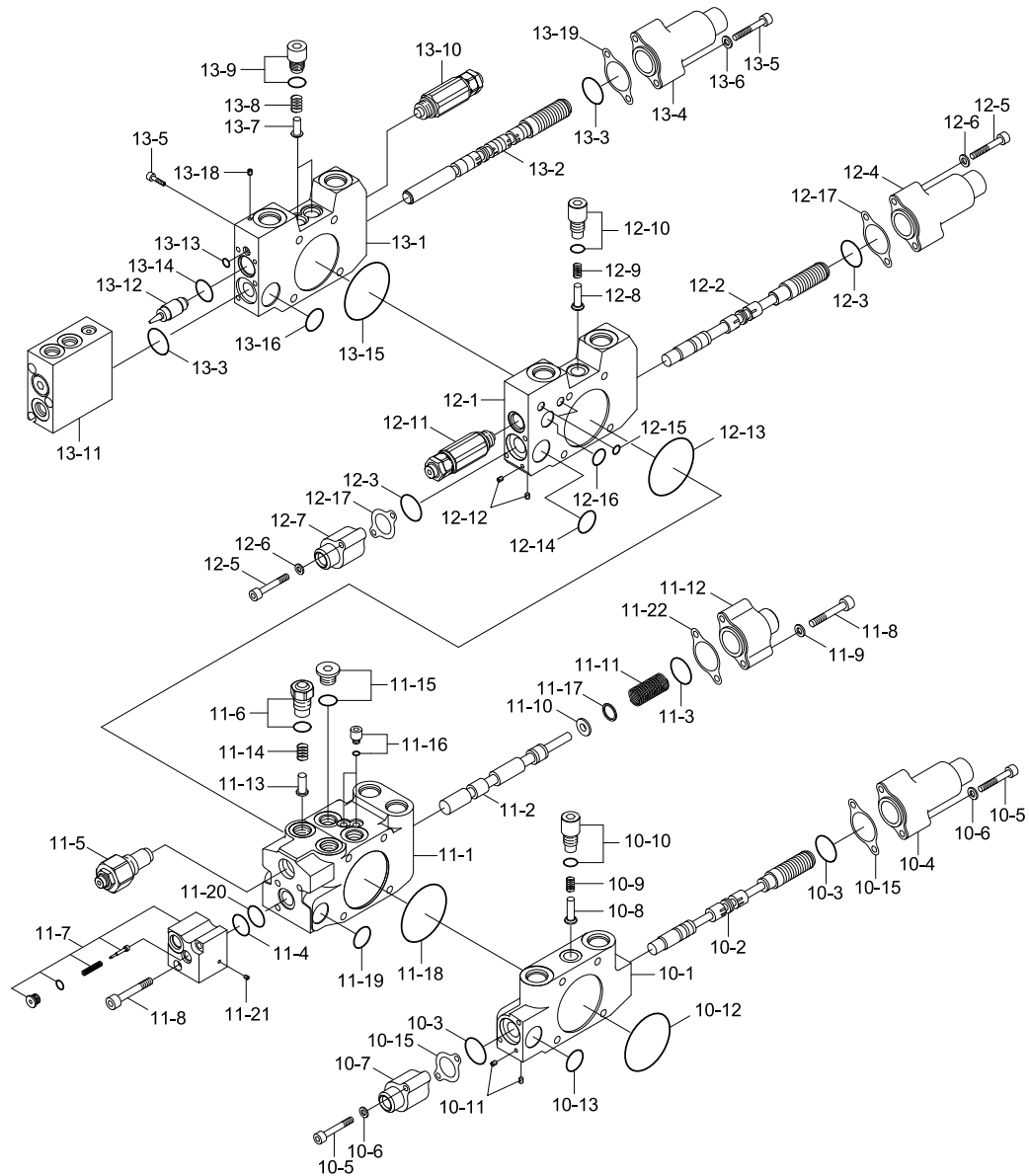
STRUCTURE (2/4)



60A2MCV03

6 Boom 2 section assy	7 Arm 1 section assy	8-1 Work block	9-2 Rotator spool assy
6-1 Work block	7-1 Work block	8-2 B/swing spool assy	9-3 O-ring
6-2 Boom 2 spool assy	7-2 Arm 1 spool assy	8-3 O-ring	9-4 Pilot cap A
6-3 O-ring	7-3 O-ring	8-4 Pilot cap A	9-5 Wrench bolt
6-4 Pilot cap A	7-4 Pilot cap A	8-5 Wrench bolt	9-6 Washer
6-5 Wrench bolt	7-5 Wrench bolt	8-6 Washer	9-7 Pilot cap B1
6-6 Washer	7-6 Washer	8-7 Pilot cap B1	9-8 Check poppet
6-7 Pilot cap B1	7-7 Pilot cap B1	8-8 Check poppet	9-9 Check spring
6-8 Check poppet	7-8 Check poppet	8-9 Check spring	9-10 Plug assy
6-9 Check spring	7-9 Check spring	8-10 Plug assy	9-11 Relief valve assy
6-10 Plug assy	7-10 Plug assy	8-11 Relief valve assy	9-12 O-ring
6-12 Plug assy	7-11 Relief valve assy	8-12 O-ring	9-13 O-ring
6-13 O-ring	7-12 O-ring	8-13 O-ring	9-14 Relief valve assy
6-14 O-ring	7-15 Gasket	8-15 Gasket	9-15 Gasket
6-15 Gasket	7-16 Check poppet	9 Option section assy	
6-16 Relief valve assy	8 B/swing section assy	9-1 Work block	

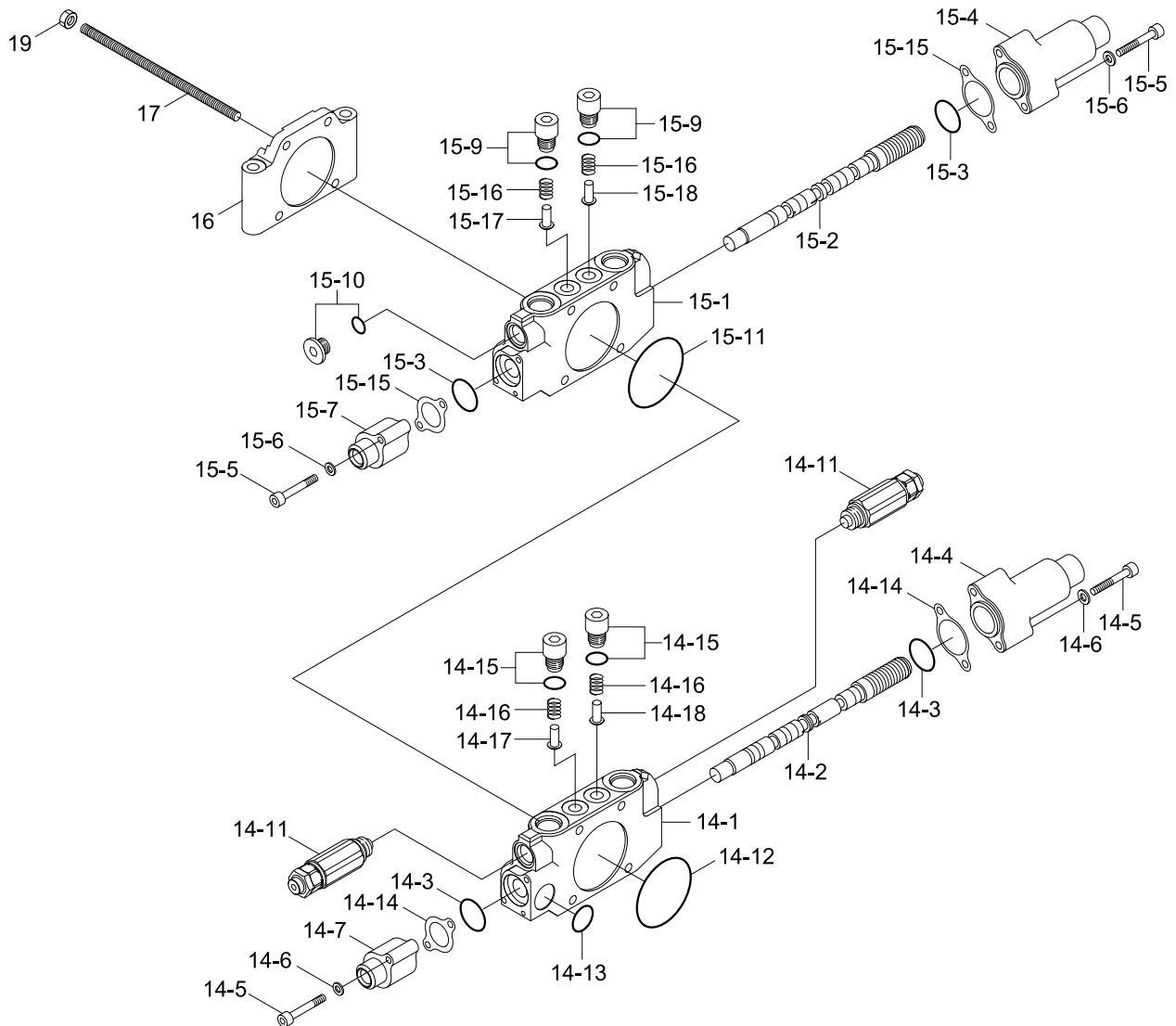
STRUCTURE (3/4)



60A2MCMV04

10 LH travel section assy	11-4 O-ring	12 RH travel section assy	13-1 Work block
10-1 Work block	11-5 Relief valve assy	12-1 Work block	13-2 Boom 1 spool assy
10-2 LH travel spool assy	11-6 Plug assy	12-2 RH travel spool assy	13-3 O-ring
10-3 O-ring	11-7 Check cap assy	12-3 O-ring	13-4 Pilot cap A
10-4 Pilot cap A	11-8 Wrench bolt	12-4 Pilot cap A	13-5 Wrench bolt
10-5 Wrench bolt	11-9 Washer	12-5 Wrench bolt	13-6 Washer
10-6 Washer	11-10 Spring seat	12-6 Washer	13-7 Check poppet
10-7 Pilot cap B1	11-11 Pilot spring	12-7 Pilot cap B1	13-8 Check spring
10-8 Check poppet	11-12 Pilot cap B2	12-8 Check poppet	13-9 Plug assy
10-9 Check spring	11-13 Check poppet	12-9 Check spring	13-10 O-ring
10-10 Plug assy	11-14 Check spring	12-10 Plug assy	13-11 Holding valve assy
10-11 Set screw	11-15 Plug assy	12-11 Relief valve assy	13-12 Holding valve assy
10-12 O-ring	11-16 Plug assy	12-12 Set screw	13-13 O-ring
10-13 O-ring	11-17 Spring shim	12-13 O-ring	13-14 O-ring
10-15 Gasket	11-18 O-ring	12-14 O-ring	13-15 O-ring
11 Inlet section assy	11-19 O-ring	12-15 O-ring	13-16 O-ring
11-1 Work block	11-20 O-ring	12-16 O-ring	13-18 Set screw
11-2 Track spool	11-21 Set screw	12-17 Gasket	13-19 Gasket
11-3 O-ring	11-22 Gasket	13 Boom 1 section assy	

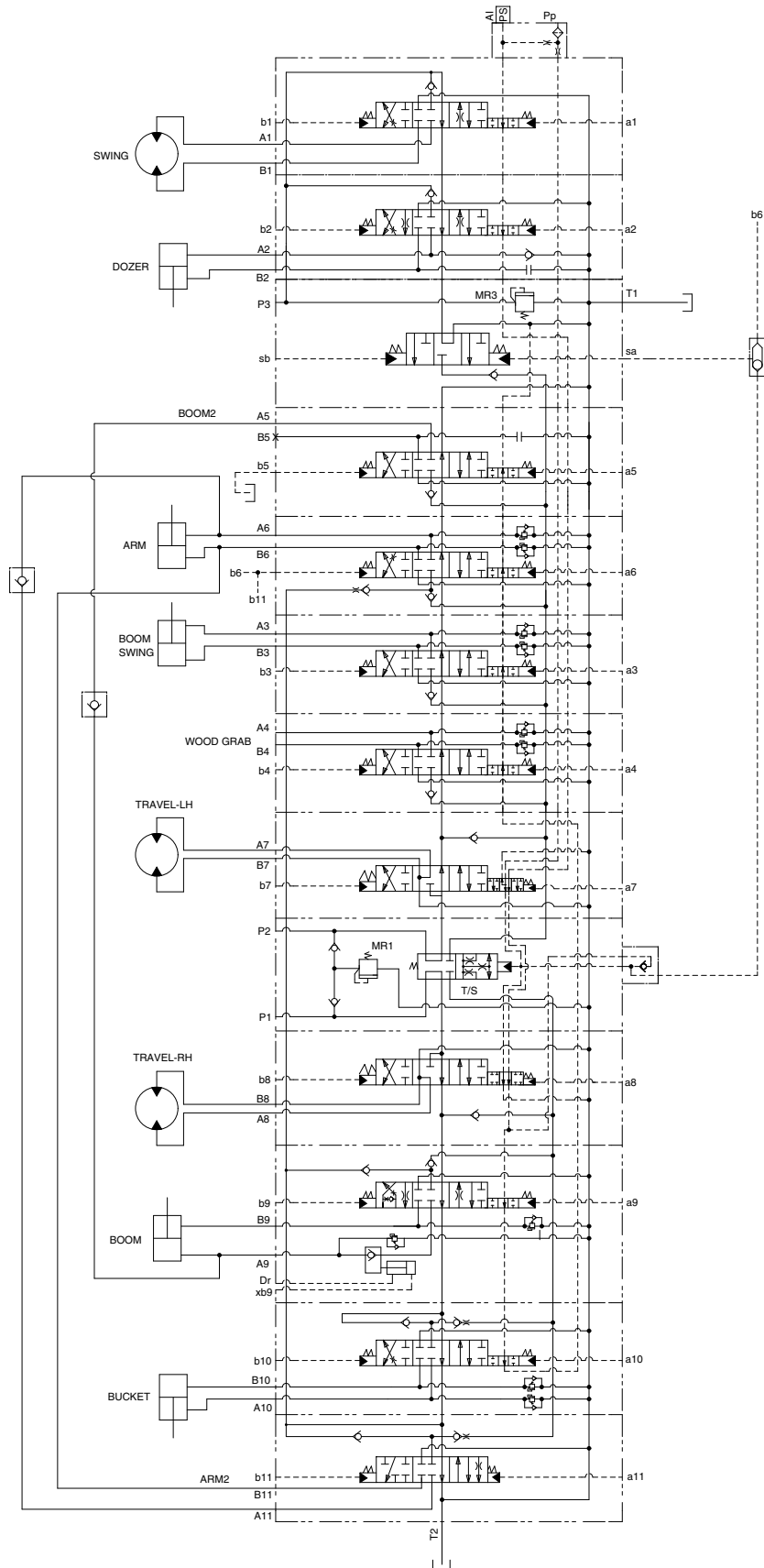
STRUCTURE (4/4)



60A2MCV05

- | | | |
|-------------------------|-----------------------|--------------------|
| 14 Bucket section assy | 12-15 Plug assy | 15-7 Pilot cap B1 |
| 14-1 Work block | 12-16 Check spring | 15-9 Plug assy |
| 14-2 Bucket spool assy | 12-17 Check poppet | 15-10 Plug assy |
| 14-3 O-ring | 12-18 Check poppet | 15-11 O-ring |
| 14-4 Pilot cap A | 15 Arm 2 section assy | 15-15 Gasket |
| 14-5 Wrench bolt | 15-1 Work block | 15-16 Check spring |
| 14-6 Washer | 15-2 Arm 2 spool assy | 15-17 Check poppet |
| 12-7 Pilot cap B1 | 15-3 O-ring | 15-18 Check poppet |
| 12-11 Relief valve assy | 15-4 Pilot cap A | 16 End cover |
| 12-12 O-ring | 15-5 Wrench bolt | 17 Tie bolt |
| 12-13 O-ring | 15-6 Washer | 18 Nut |
| 12-14 Gasket | | |

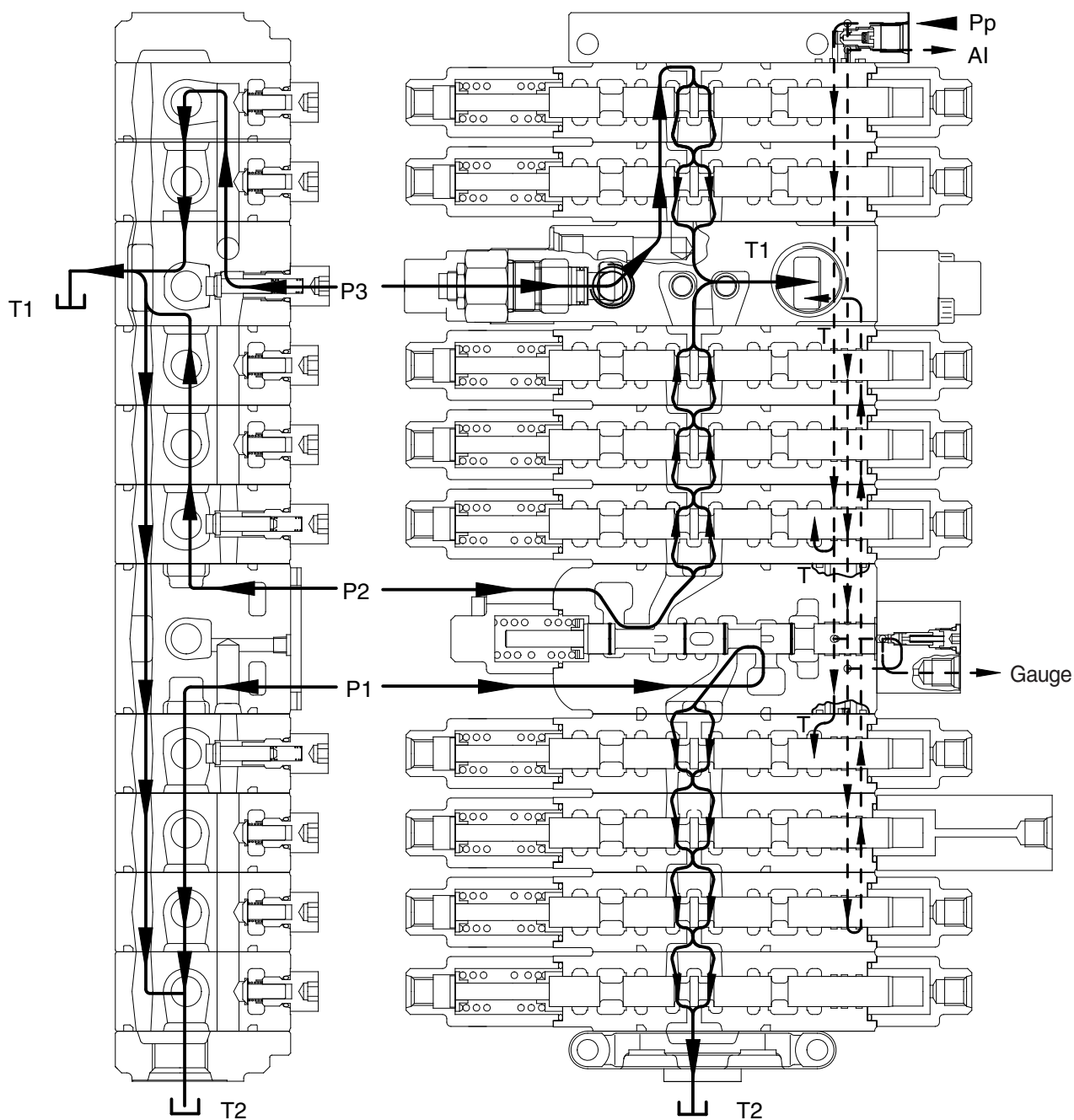
3. HYDRAULIC CIRCUIT



60A2MC06

4. FUNCTION

1) CONTROL IN NEUTRAL FUNCTION



555C92MC07

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.

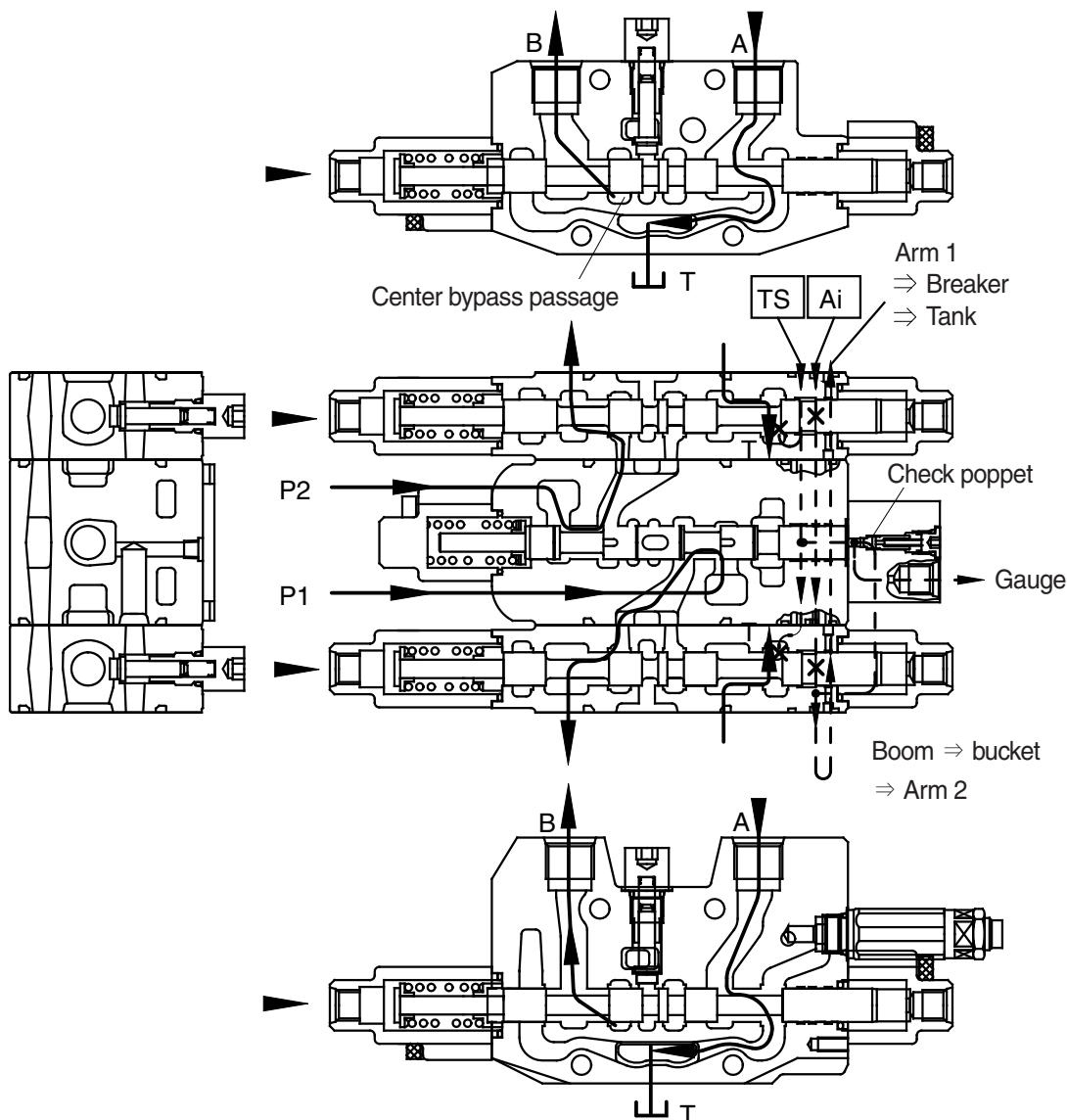
(4) Pp

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)

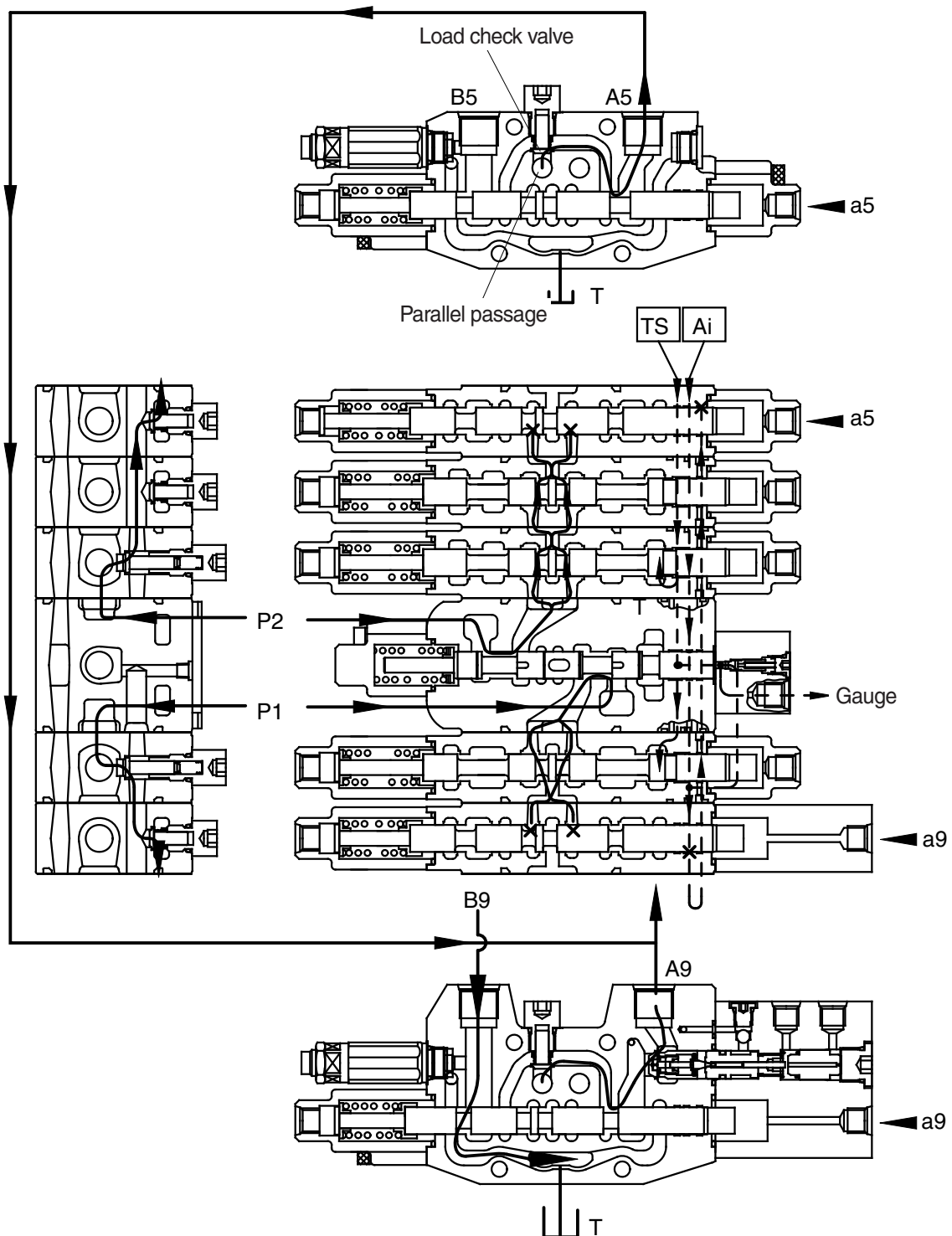


555C92MC08

- 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

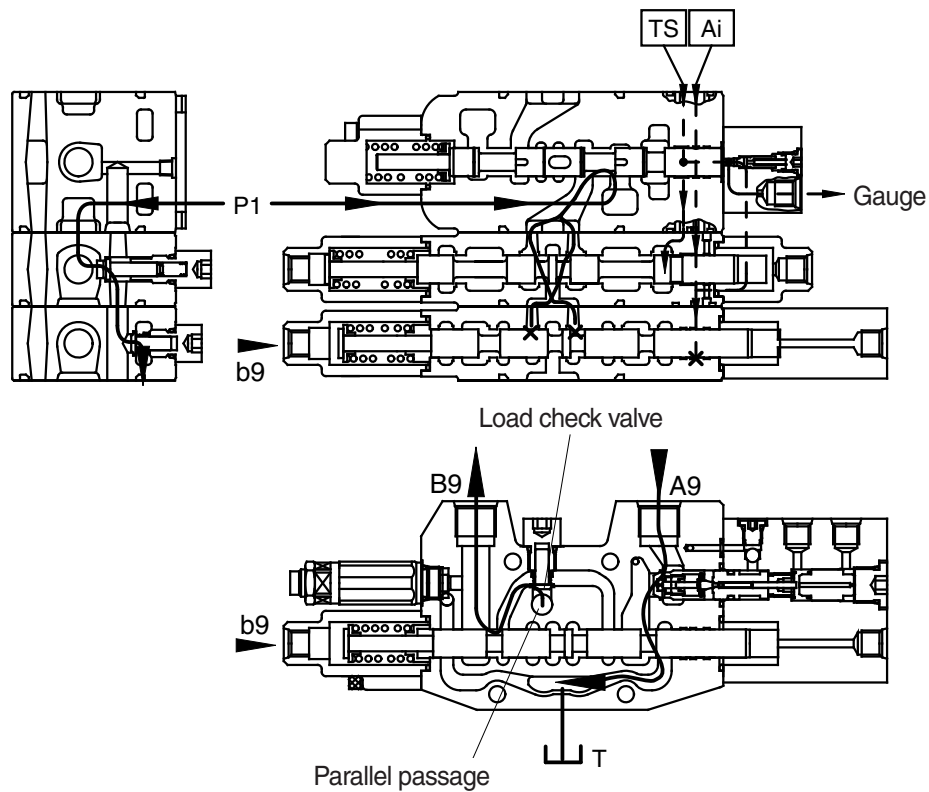
① Boom up operation (P1 and P2 summation)



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

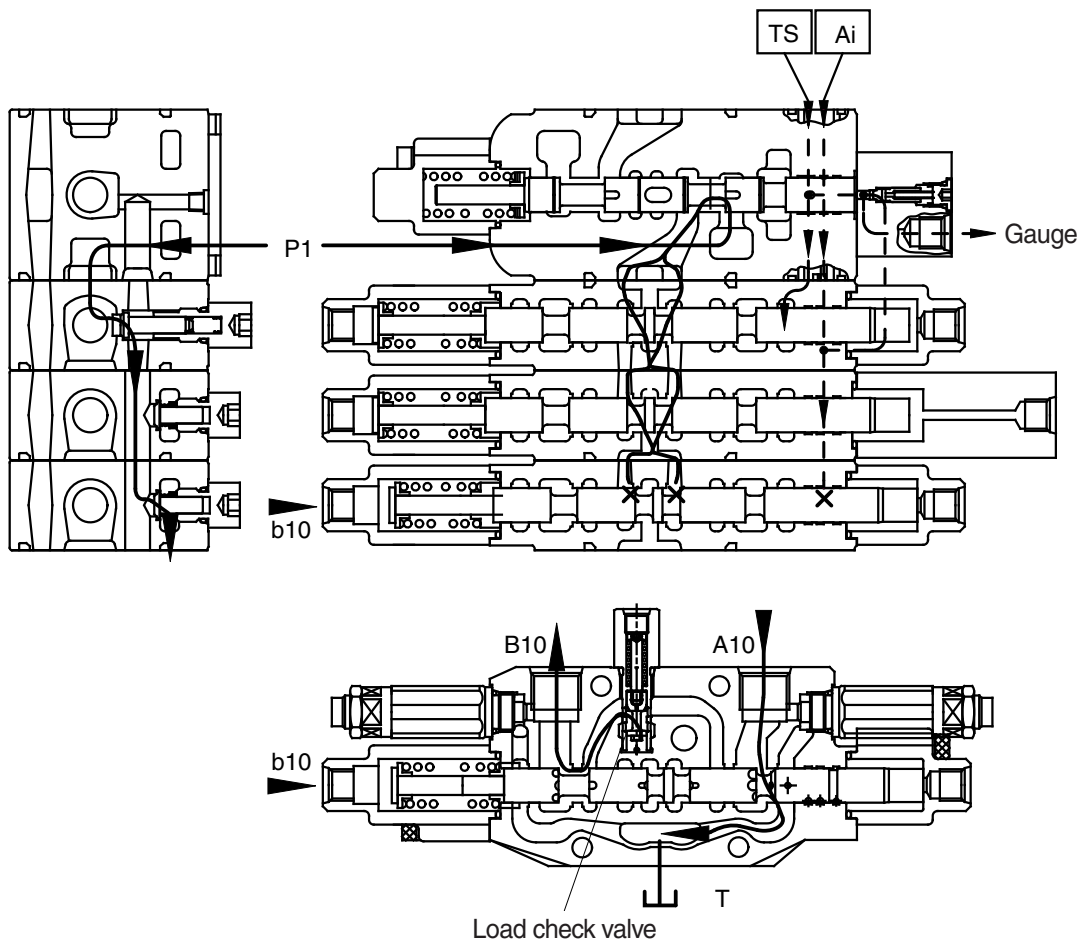


555C92MC10

- During the boom lowering 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

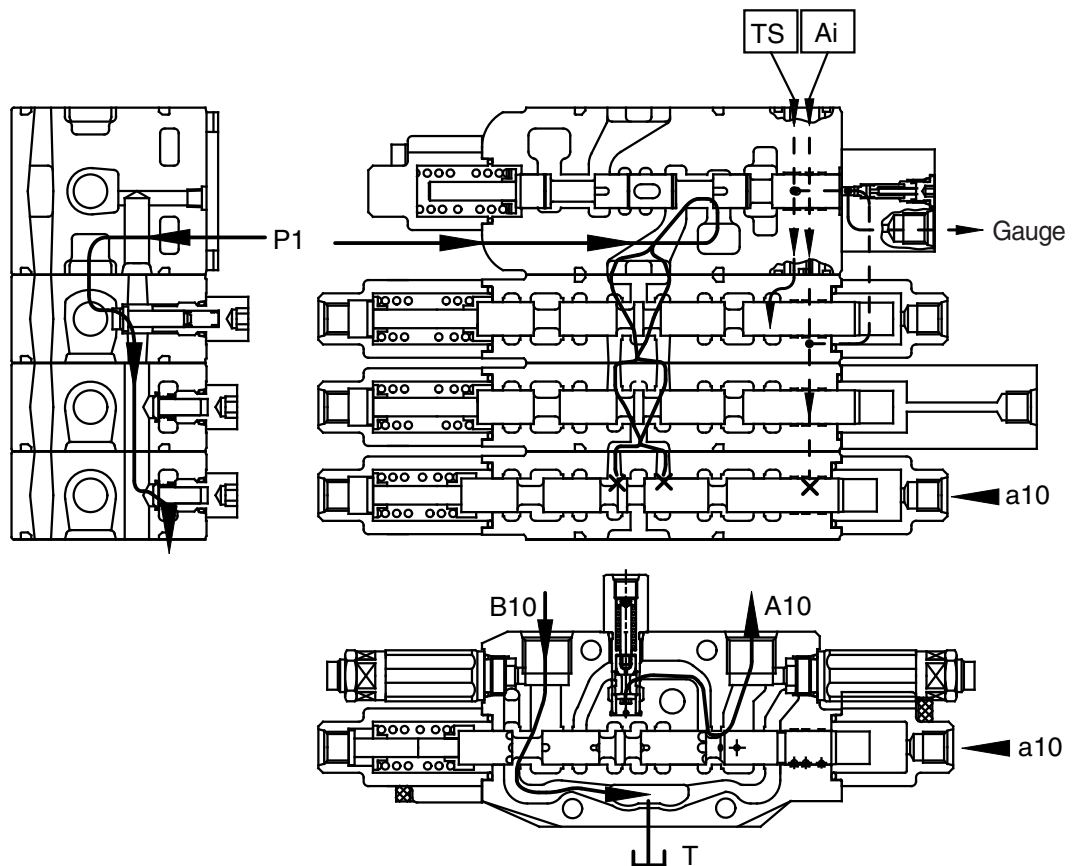
① Bucket roll in operation



555C92MC11

- 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.

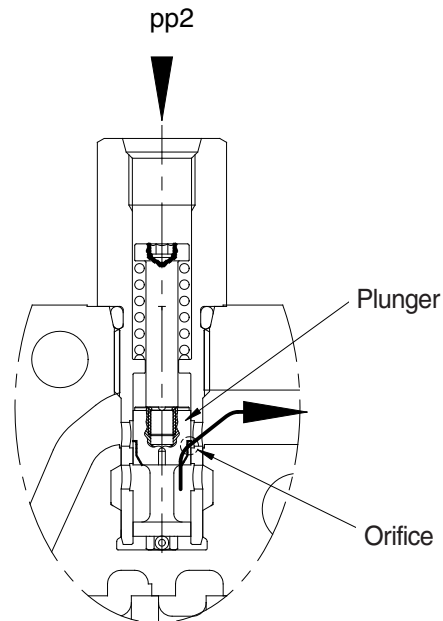
② Bucket roll out operation



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



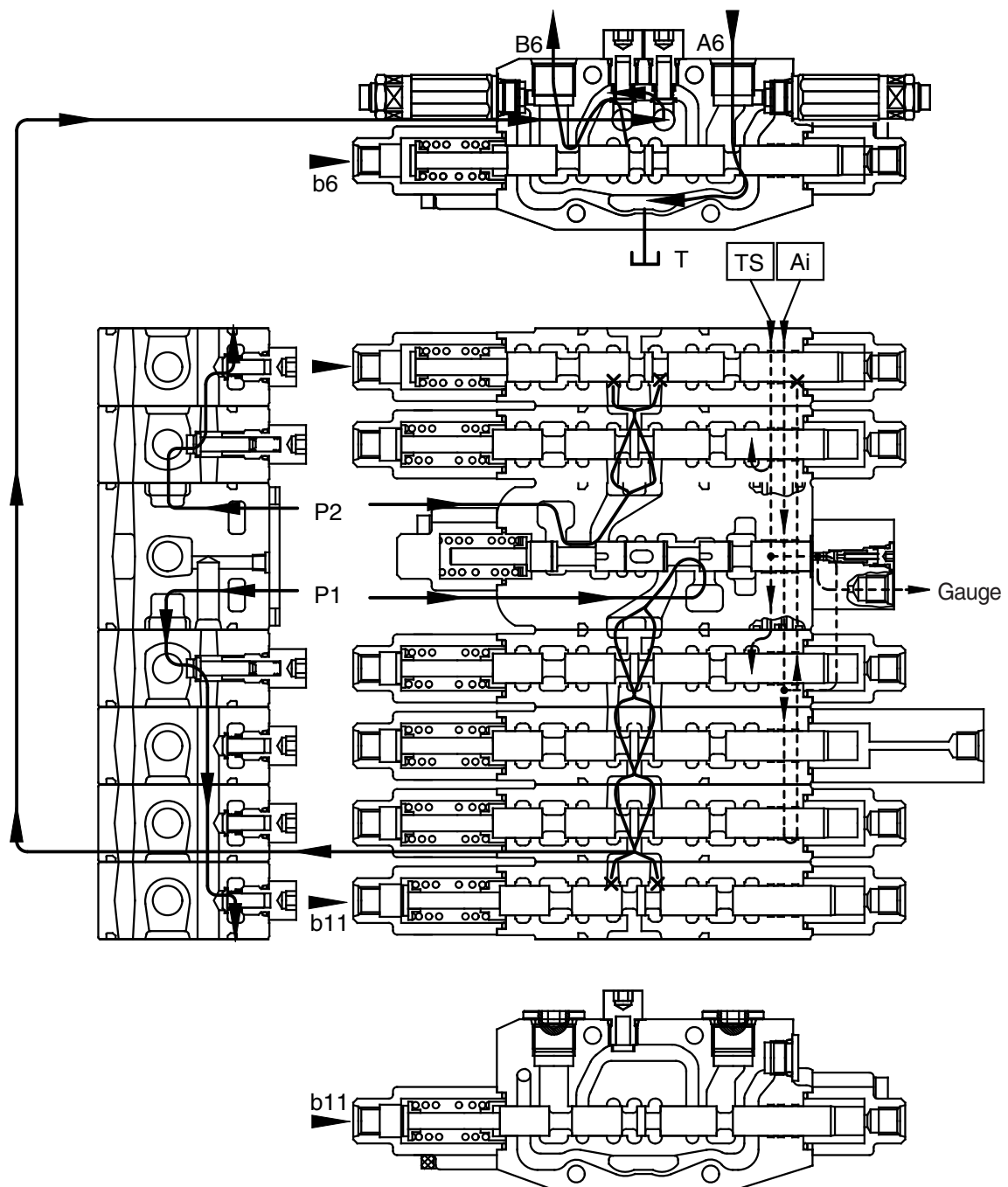
555C92MC13

- 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

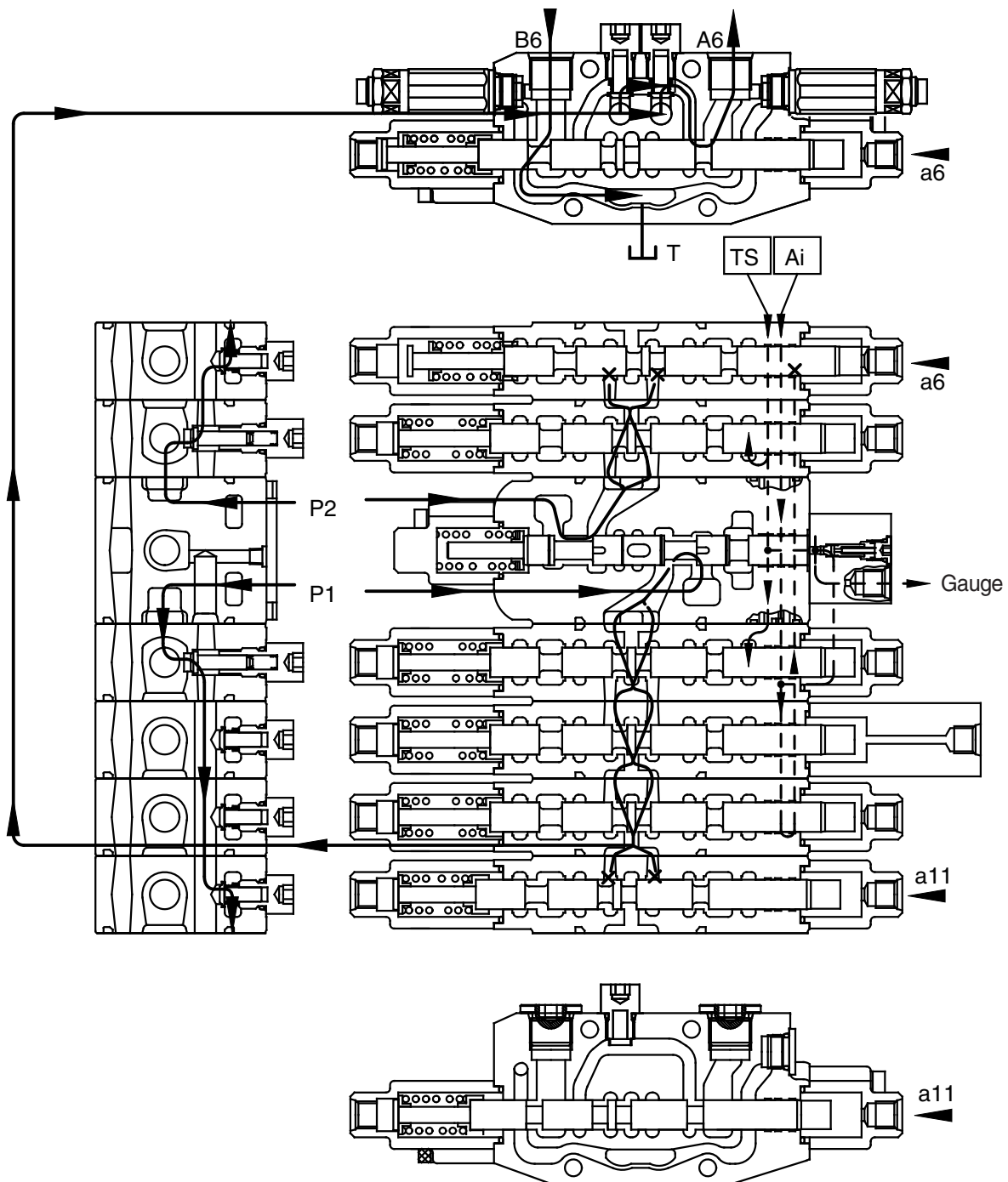
① Arm roll in operation (P1 and P2 summation)



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.

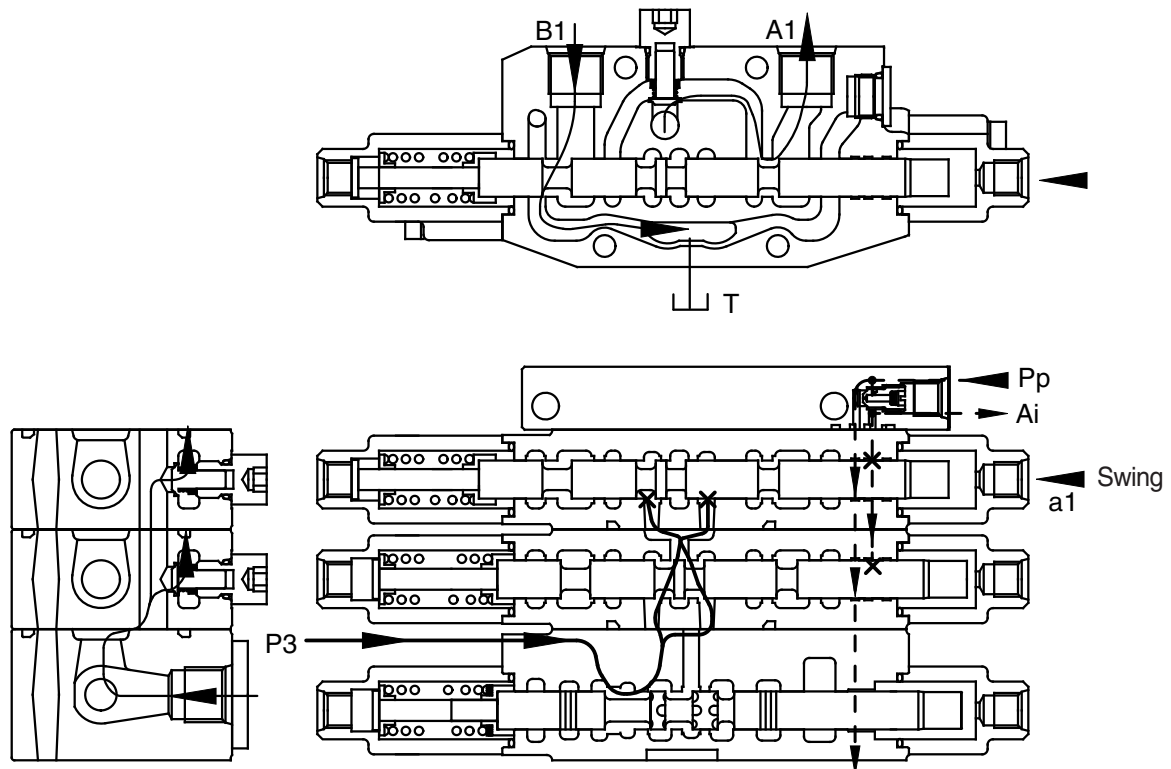
② Arm roll out operation



555C92MC15

- 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



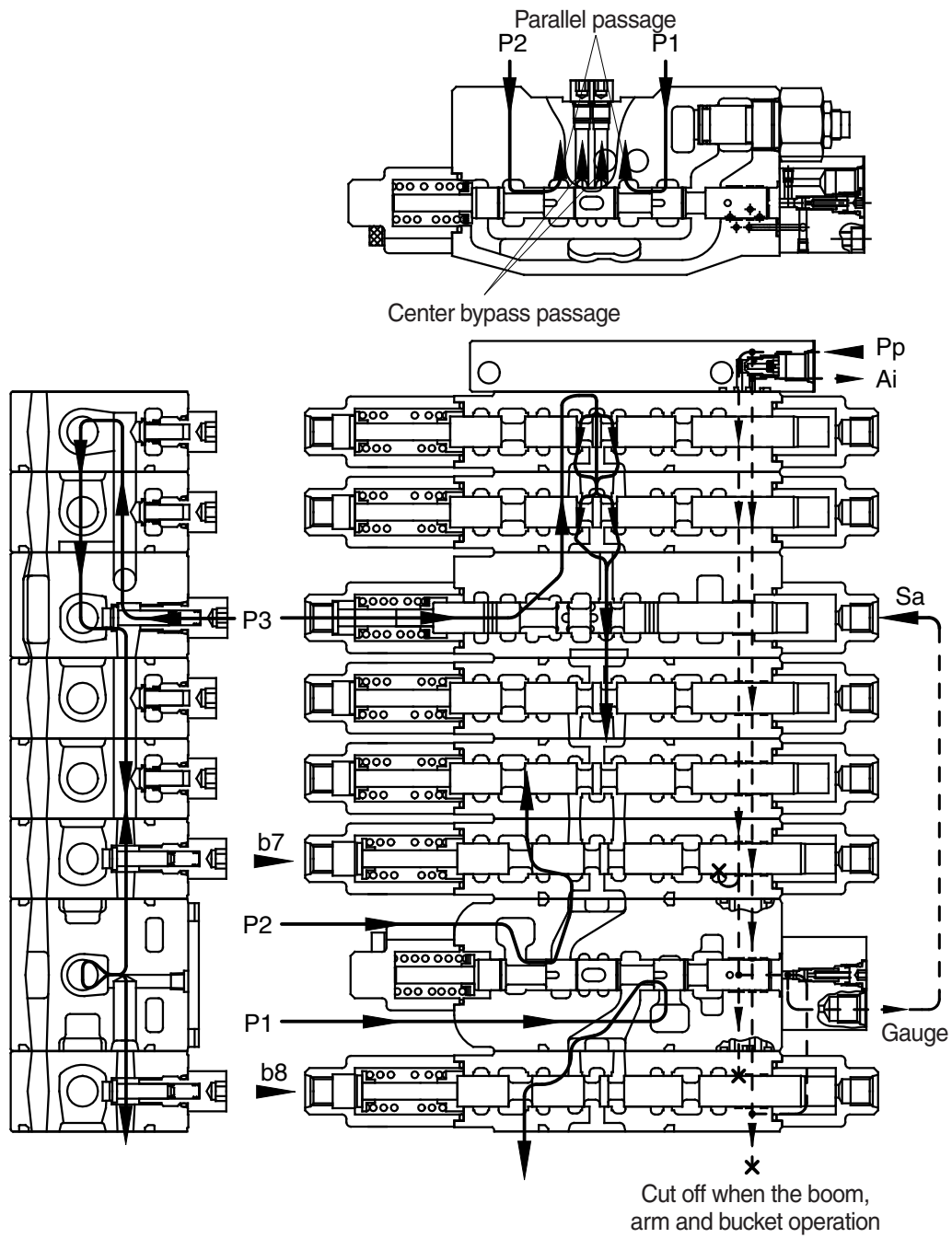
555C92MC16

- 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

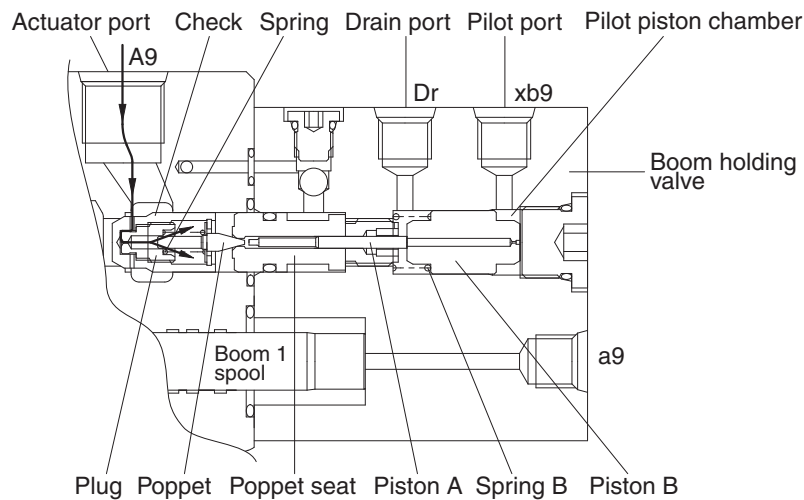


555C92MC17

- 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.

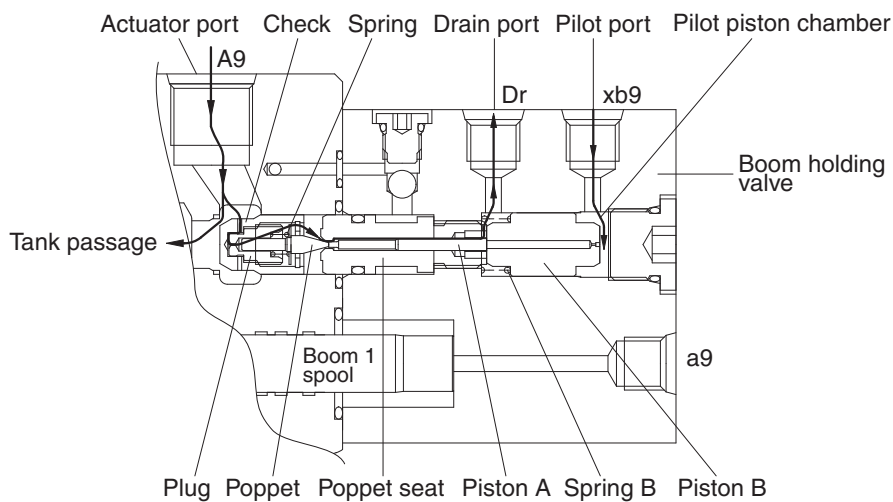
And the piston "B" is supported with spring "B".

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.

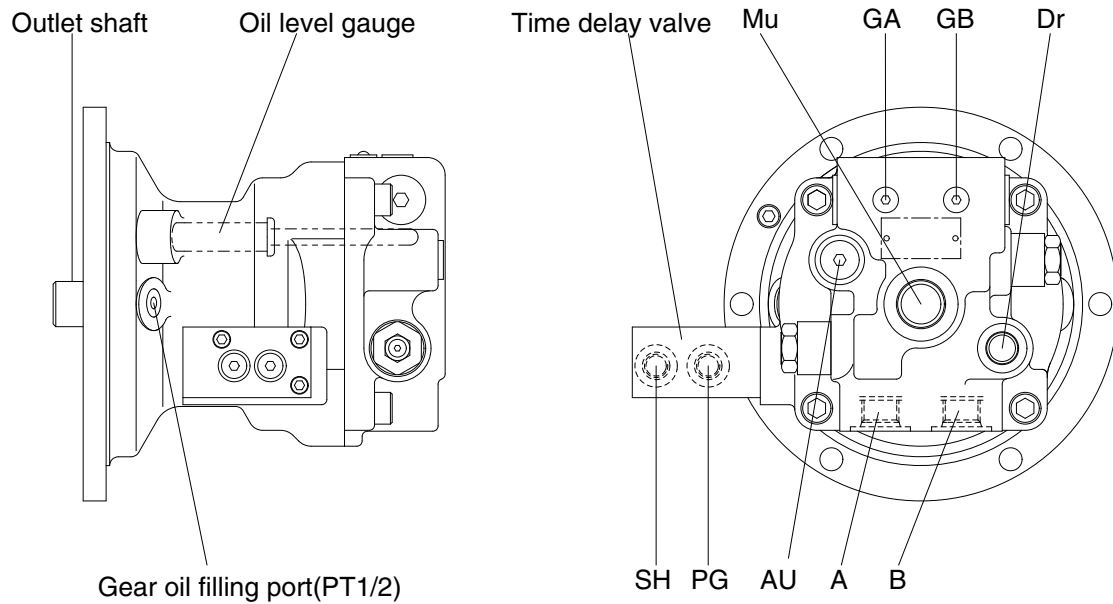
GROUP 3 SWING DEVICE

1. STRUCTURE

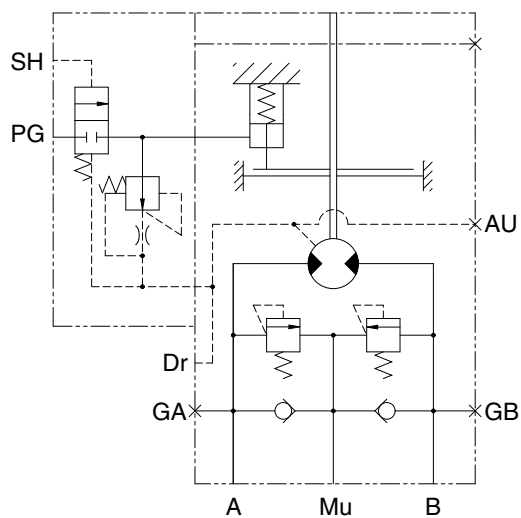
Swing device consists swing motor, swing reduction gear.

1) SWING MOTOR

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

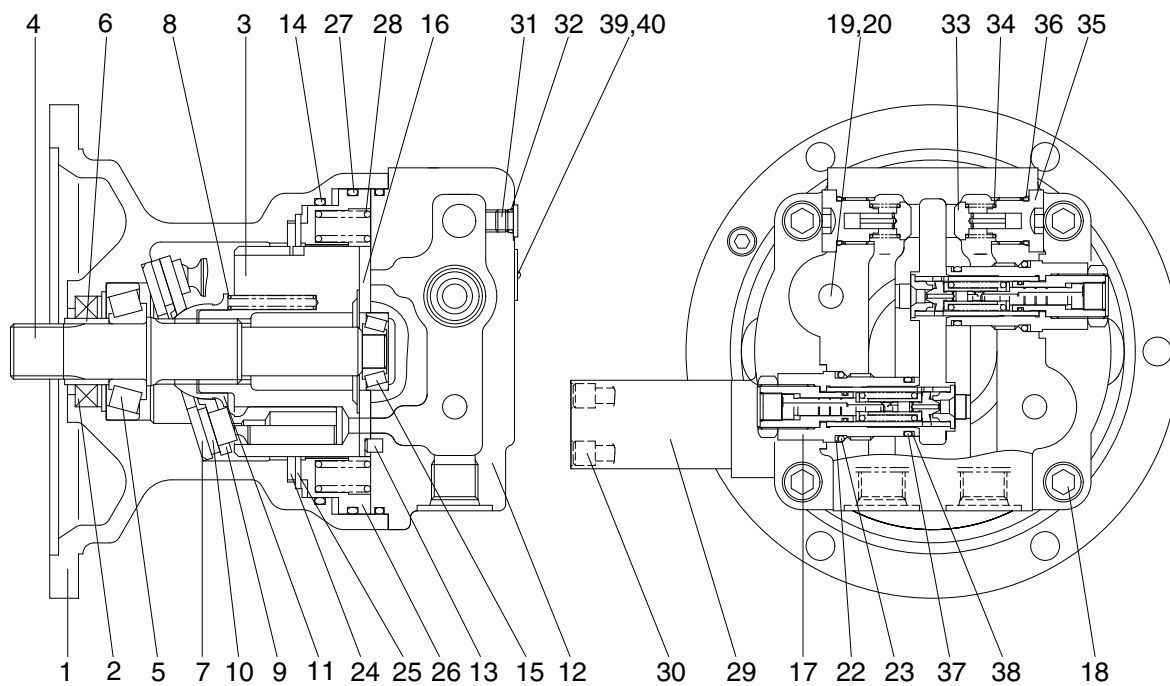


65A2SM01



Hydraulic circuit

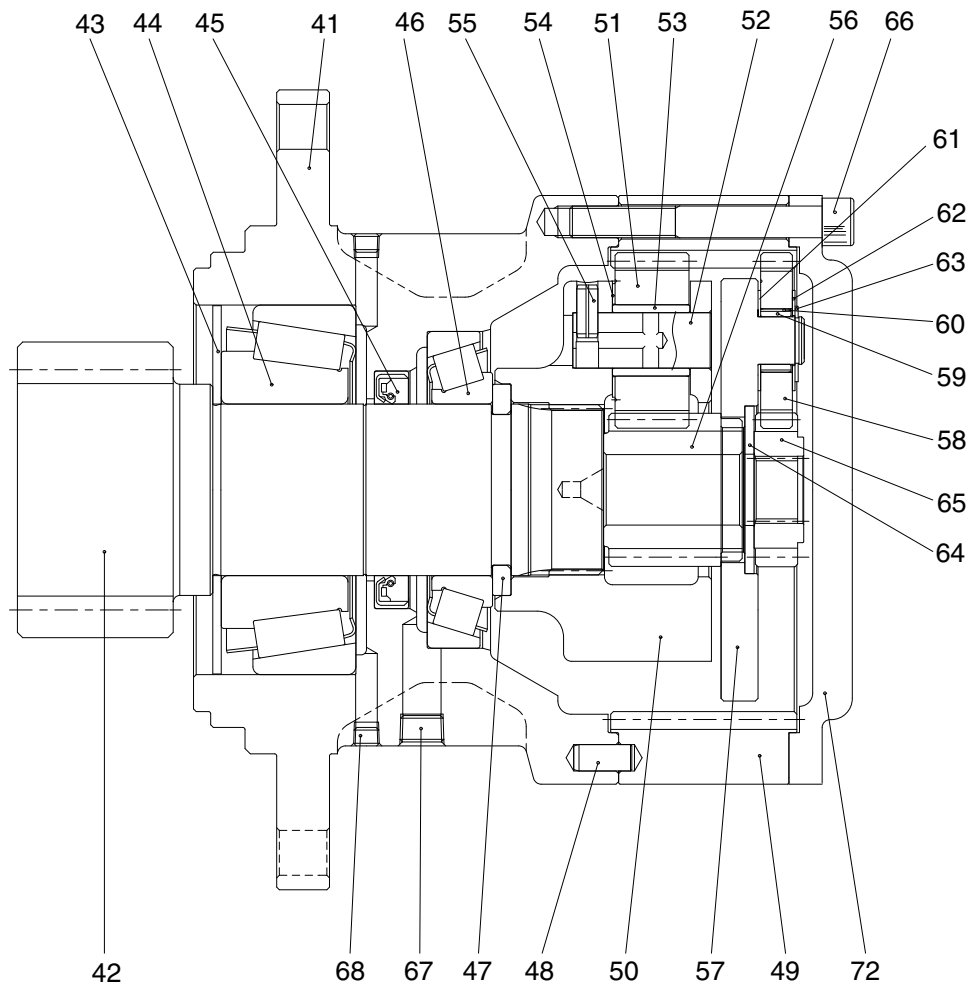
Port	Port name	Port size
A	Main port	PF 1/2
B	Main port	PF 1/2
Dr	Drain port	PF 3/8
Mu	Make up port	PF 3/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
GA,GB	Gauge port	PF 1/4
AU	Air vent port	PF 3/8



HX60A2SM03

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

2) REDUCTION GEAR



HX60A2SM02

41	Case	52	Pin 2	63	Snap ring
42	Pinion gear	53	Needle roller bearing	64	Side plate
43	Bearing cover	54	Thrust washer 2	65	Sun gear 1
44	Taper roller bearing	55	Spring pin	66	Lench bolt
45	Oil seal	56	Sun gear 2	67	Plug
46	Taper roller bearing	57	Carrier assy 1	68	Plug
47	Lock collar	58	Planet gear 1	69	Level bar
48	Pin	59	Needle roller bearing	70	Level pipe
49	Ring gear	60	Collar	71	Air breather
50	Carrier assy 2	61	Thrust washer 1	72	Cover
51	Planet gear 2	62	Thrust washer 2		

2. FUNCTION

1) ROTARY PART

When high pressurized oil enters a cylinder through port(a), which is the inlet of valve plate(16), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston and shoe (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.

$$T = \frac{p \times q}{2\pi}, q = Z \cdot A \cdot \text{PCD} \cdot \tan \theta, F_1 = \frac{F}{\cos \theta}, F_2 = F \tan \theta, S = \text{PCD} \times \tan \theta$$

Where p : Effective difference of pressure (kgf/cm²)

q : Displacement (cc/rev)

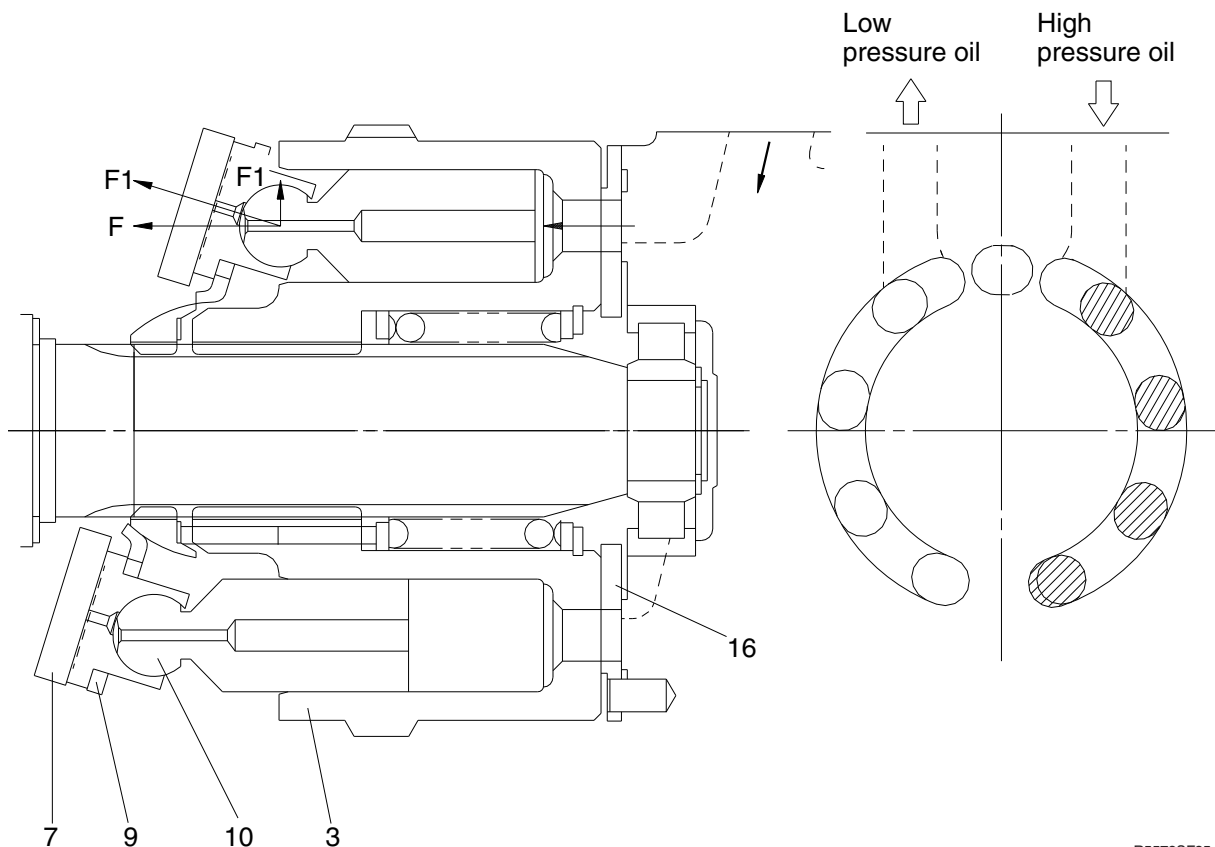
T : Output torque (kgf · cm)

Z : Piston number (9EA)

A : Piston area (cm²)

θ : Tilting angle of swash plate (degree)

S : Piston stroke (cm)



R5572SF35

2) MAKE UP VALVE

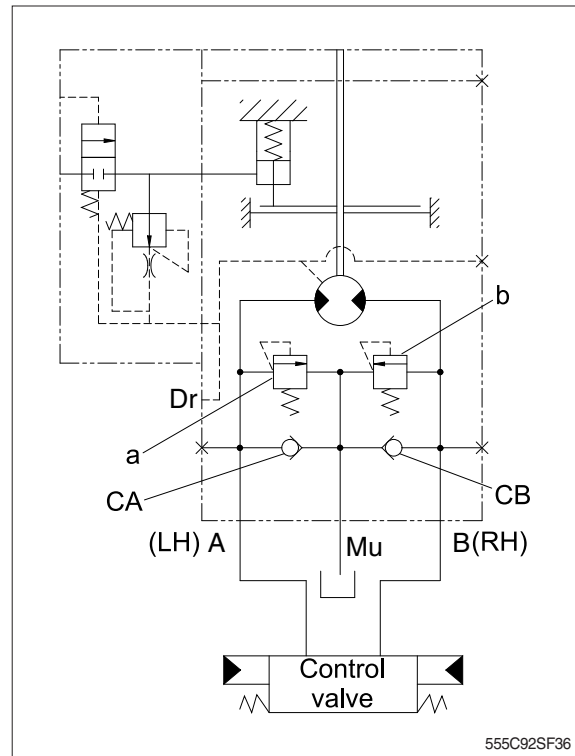
(1) Outline

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 abnormally 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

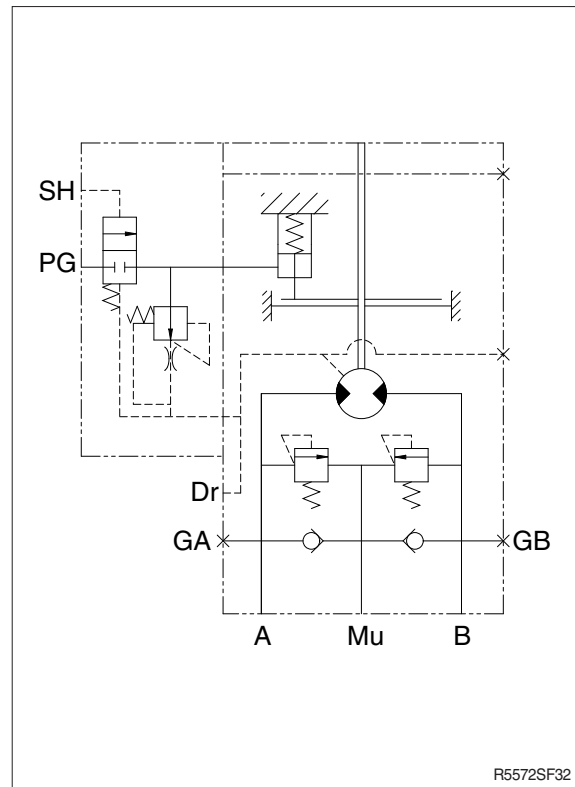
When the swing control lever is operated to left swing, the pressurized oil from the pump passes through the control valves and is supplied to port B. Because of this, the pressure at port B rises, starting torque is generated in the motor, and the motor starts to rotate. The oil from the outlet port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

② When stopping swing

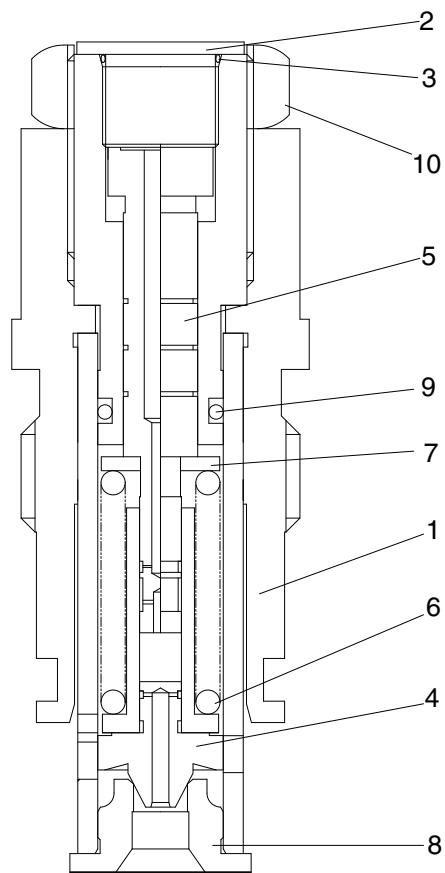
- When the swing control lever is returned to neutral, no pressurized oil is supplied from the pump to port B.

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

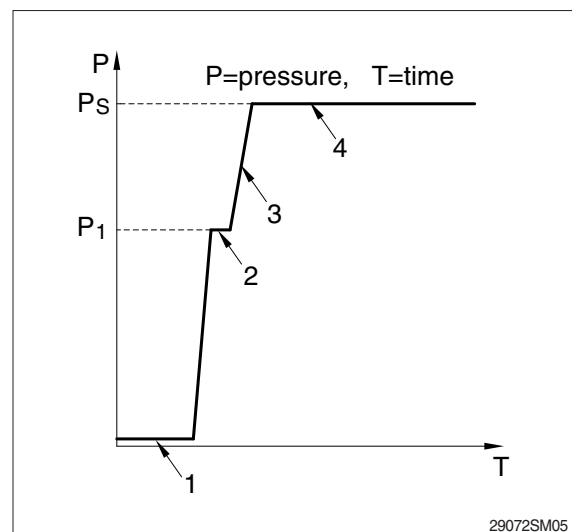
555C92SF37

(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.



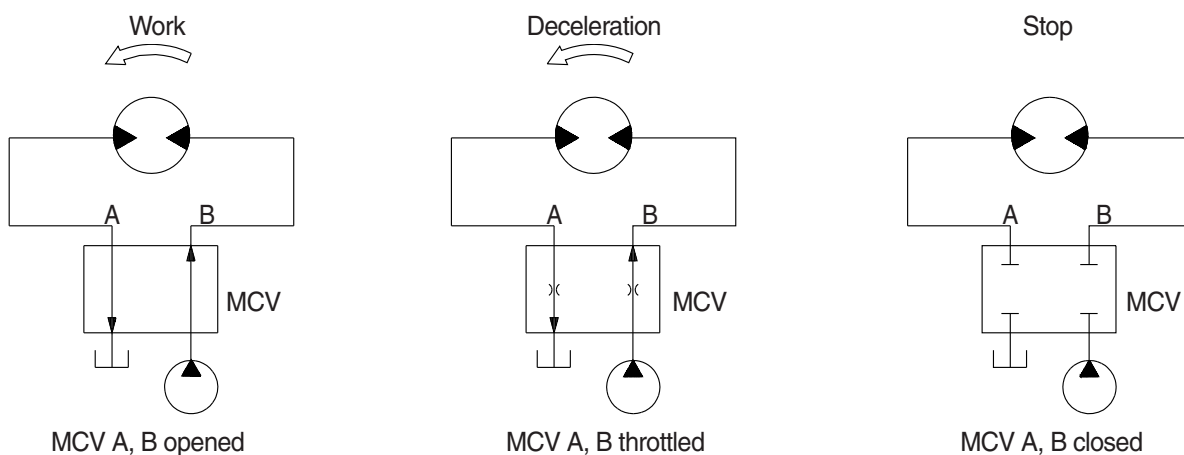
29072SM05

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.



210-7 2-48(1)

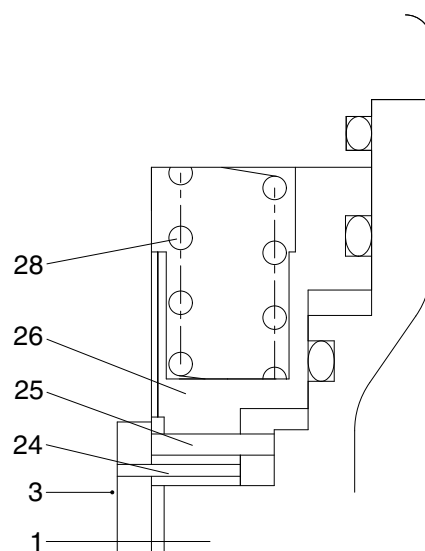
(2) Mechanical swing parking brake system

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 slope, work can be done more easily and safely.

① Brake assembly

Circumferential rotation of separate plate (25) is constrained by the groove located at body (1). When housing is pressed down by brake spring (28) through friction plate (25), separate plate (25) and brake piston (26), friction force occurs there.

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



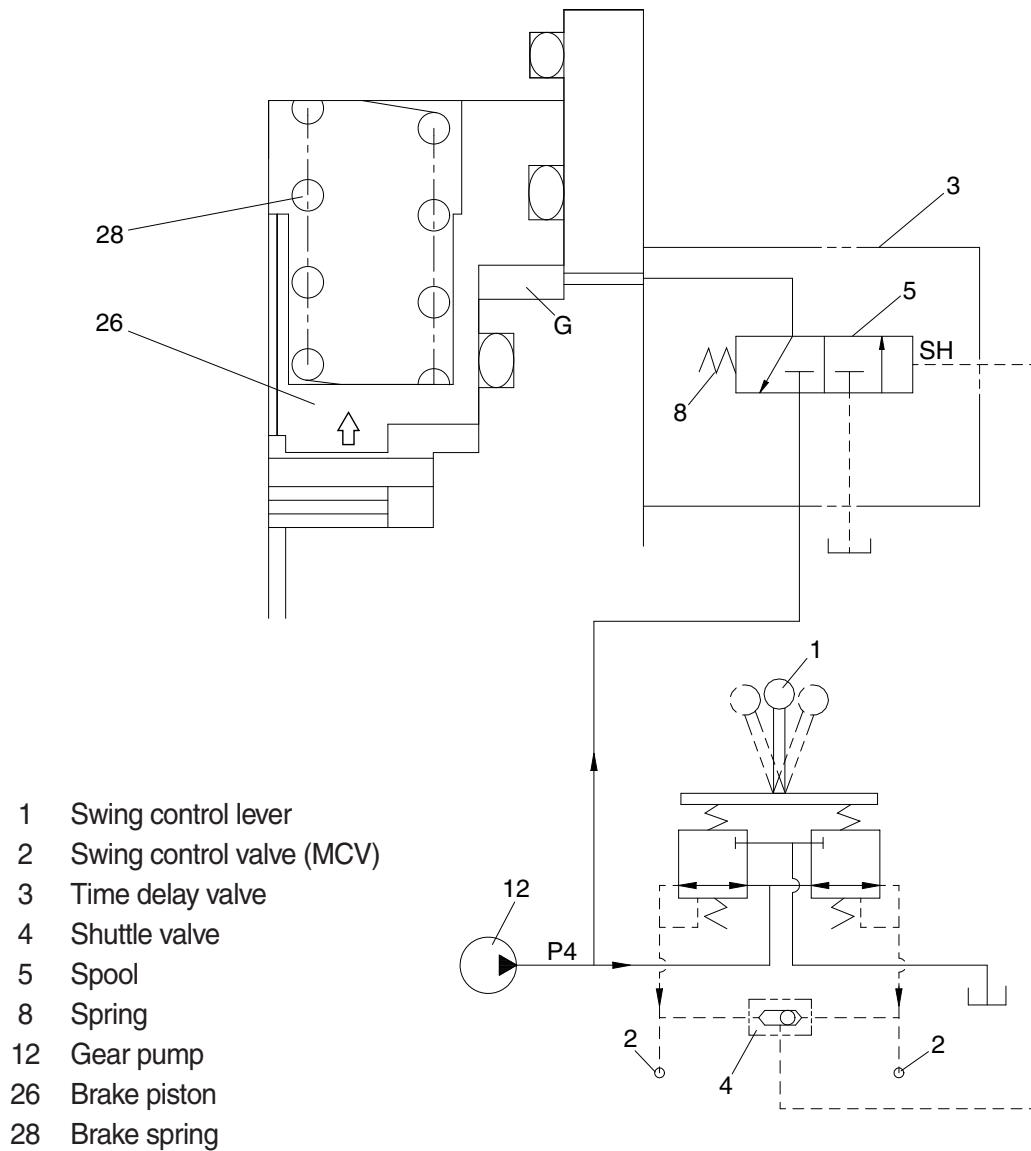
HX60A2SF38

1	Body	25	Separate plate
3	Cylinder block	26	Brake piston
24	Friction plate	28	Brake spring

② Operating principle

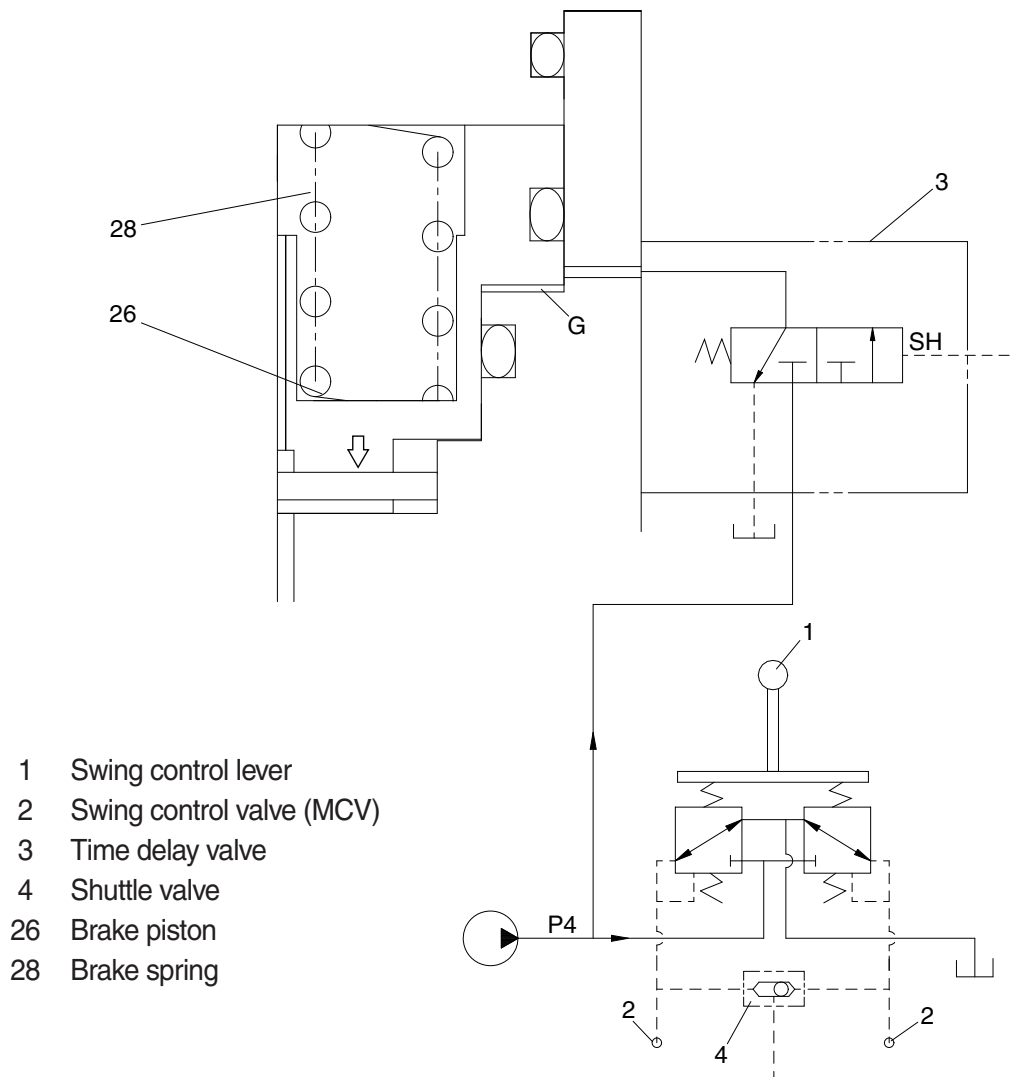
- a. When the swing control lever is set to the swing position, the pilot oil goes to the swing control valve (2) and to SH of the time delay valve (3) via the shuttle valve (4), this pressure move spool (5) to the leftward against the force of the spring (8), so pilot pump charged oil (P4) goes to the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

This pressure is applied to move the piston (26) to the upward against the force of the spring (28). Thus, it releases the brake force.



HX60A2SF39

- 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 (26) is moved lower by spring (28) force and the return oil from the chamber G is drain.



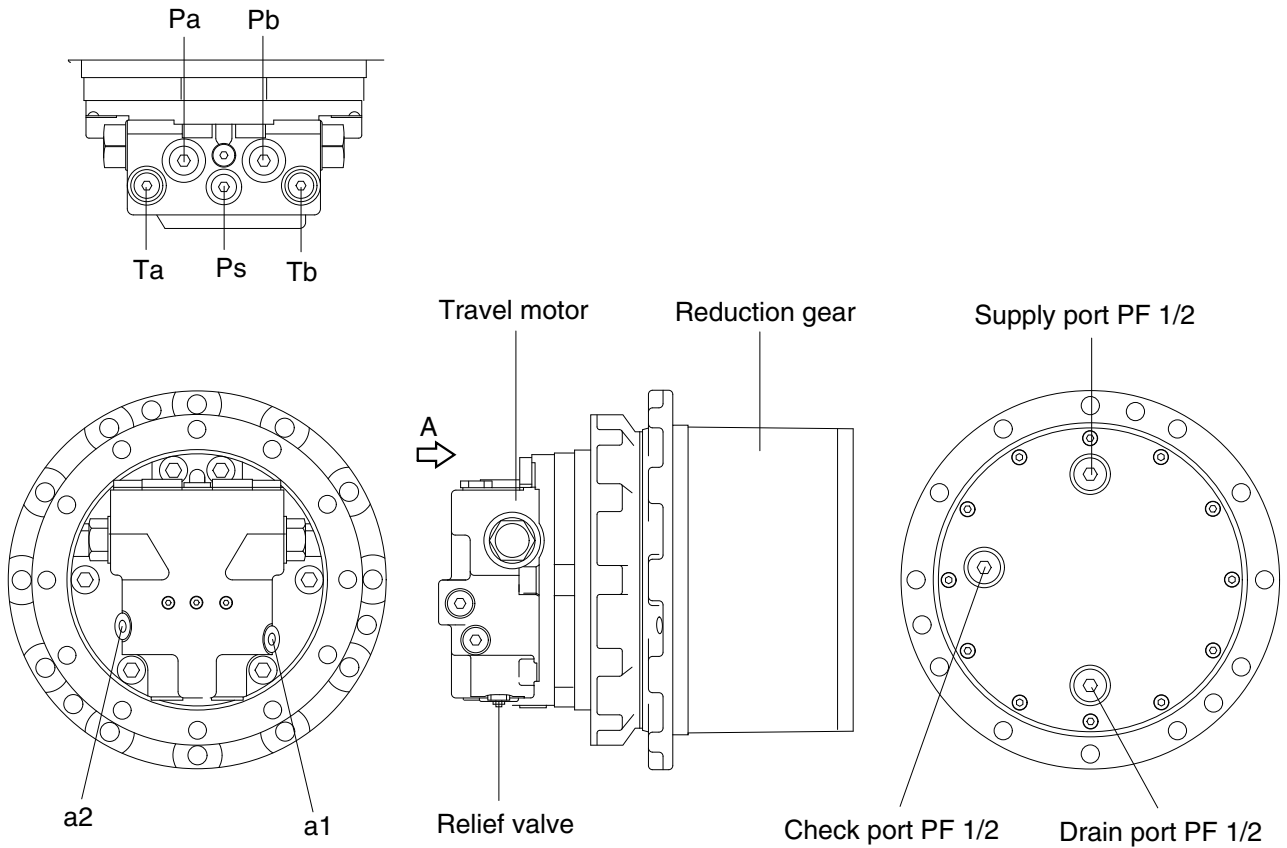
HX60A2SF40

GROUP 4 TRAVEL DEVICE

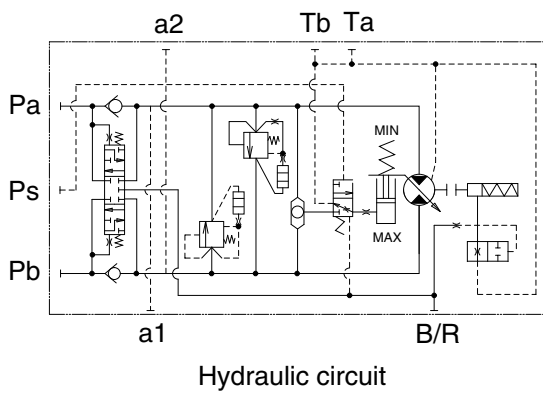
1. CONSTRUCTION

Travel device consists travel motor and gear box.

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

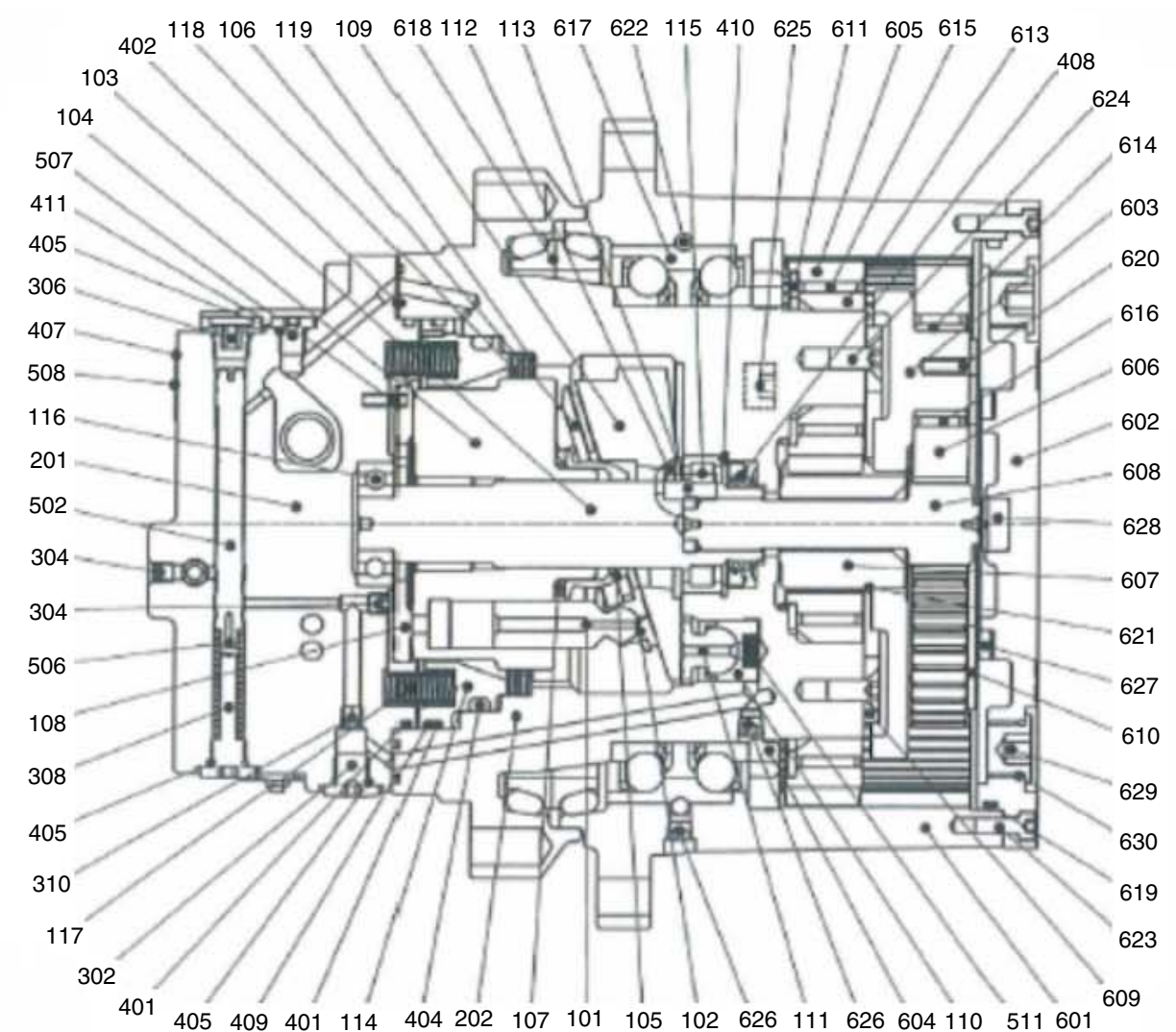
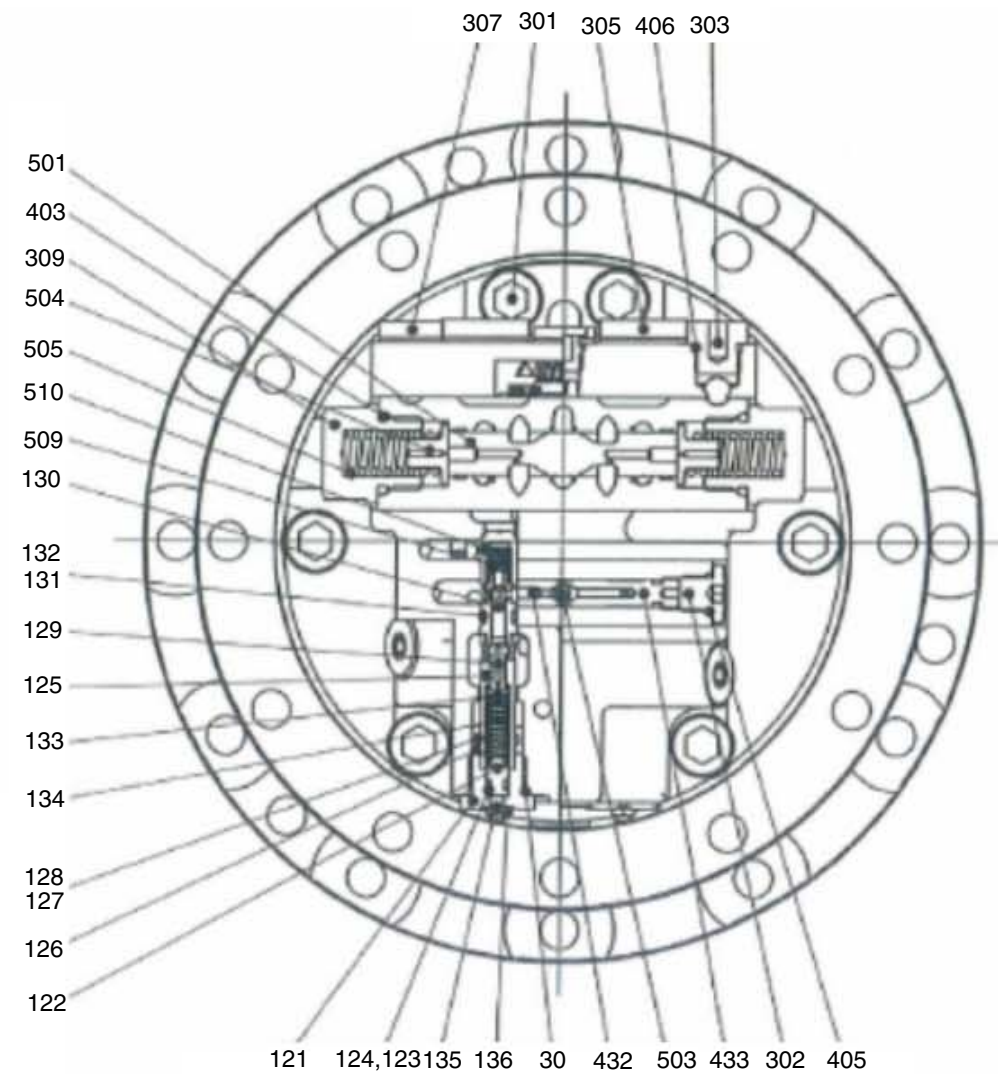


60A2TM50



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

1) STRUCTURE



30	Relief valve assy	118	Friction plate	137	O-ring
101	Piston	119	Separator plate	201	Valve casing
102	Shoe	121	Plug	202	Casing
103	Drive shaft	122	Guide	301	Socket bolt
104	Cylinder block	123	O-ring	302	Plug
105	Spherical bushing	124	Back up ring	303	Drain plug
106	Set plate	125	Sleeve	304	NPTF plug
107	Cylinder spring	126	Piston	305	Dust plug
108	Valve plate	127	O-ring	306	Dust plug
109	Swash plate	128	Back up ring	307	Dust plug
110	Swash piston	129	Poppet	308	2 speed plug
111	Swash shoe	130	Poppet seat	309	Set plug
112	Pivot	131	O-ring	310	Restrictor
113	Pivot pin	132	Back up ring	311	Plug
114	Brake piston	133	Spring seat	401	O-ring
115	Roller bearing	134	Spring	402	O-ring
116	Ball bearing	135	Adjust screw	403	O-ring
117	Brake spring	136	Hex nut	404	O-ring

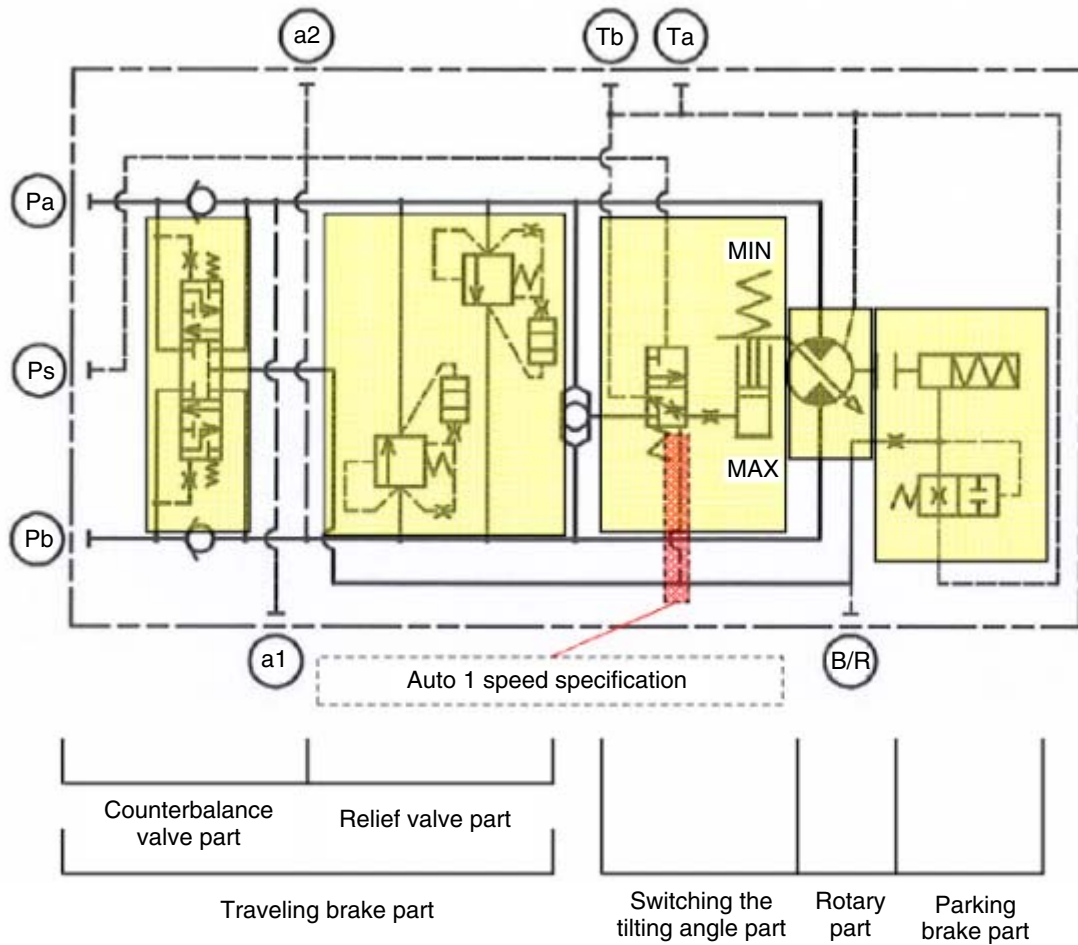
405	O-ring	510	Cap	618	Floating seal kit
406	O-ring	511	Swash piston spring	619	O-ring
407	Name plate	601	Housing	620	Spring pin
408	Oil seal	602	Cover	621	Snap ring
409	Back up ring	603	Holder	622	Steel ball
410	Snap ring	604	Ring nut	623	Socket bolt
411	O-ring	605	Planetary gear F	624	Bolt
432	Seat	606	Planetary gear R	625	Plug
433	Seat casing	607	Sun gear	626	Plug
501	Main spool	608	Drive gear	627	Side plate A
502	2 speed spool	609	Thrust plate F	628	Side plate B
503	Steel ball	610	Thrust plate R	629	Plug
504	Plunger	611	Thrust washer	630	O-ring
505	Main spool spring	613	Collar		
506	2 speed spool spring	614	Inner race		
507	Spring pin	615	Needle bearing		
508	Pin	616	Needle bearing		
509	Spring cap	617	Angular bearing		

2) MAJOR COMPONENT

This product is only composed of hydraulic motor. Reduction parts are not composed.

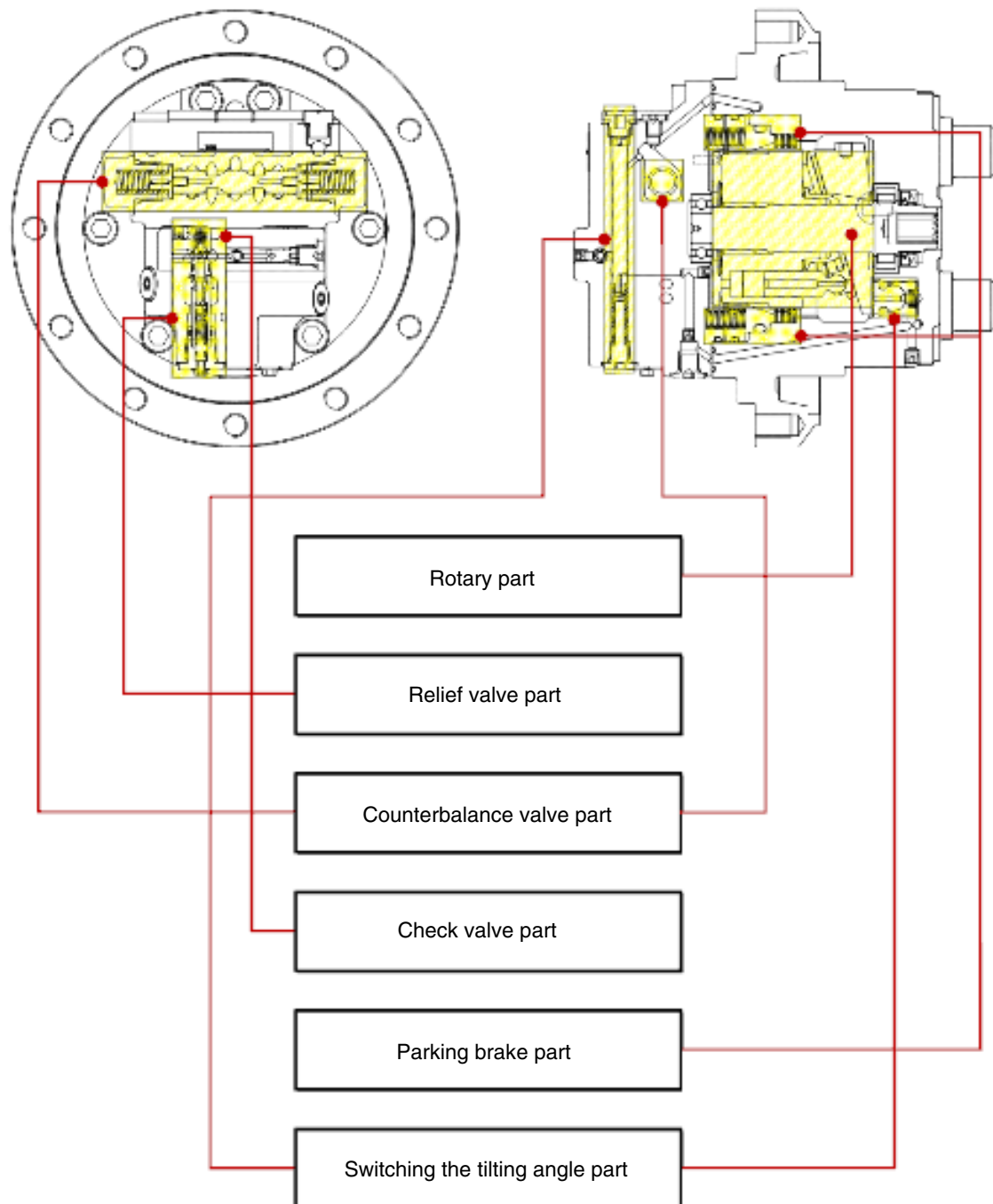
This hydraulic motor is variable swash plate axial piston motor. It is composed of 4 parts.

- 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



559A2TM53

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.

$$F = P \times A \text{ (P : Pressure, A : Area)}$$

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).

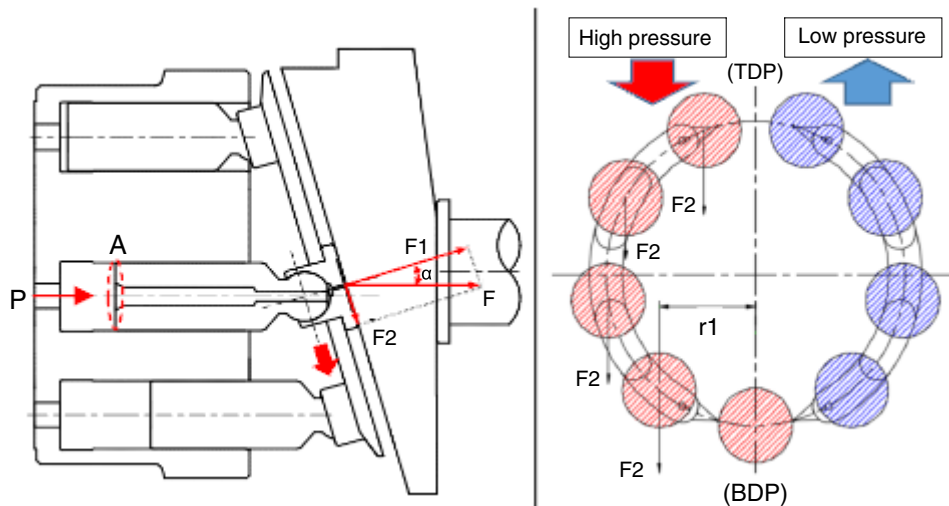
Because of the force "F2", piston (101) slides along with shoe (102) in the direction of the arrow in Figure. This force "F2" is transmitted to the cylinder block (104) via the piston (101) and generates a couple of forces which turn the output drive shaft (103).

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.

$$T = \frac{P \times q}{2\pi} \quad P : \text{Effective pressure difference (Mpa), } q : \text{Displacement per revolution (cm}^3\text{)}$$



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.

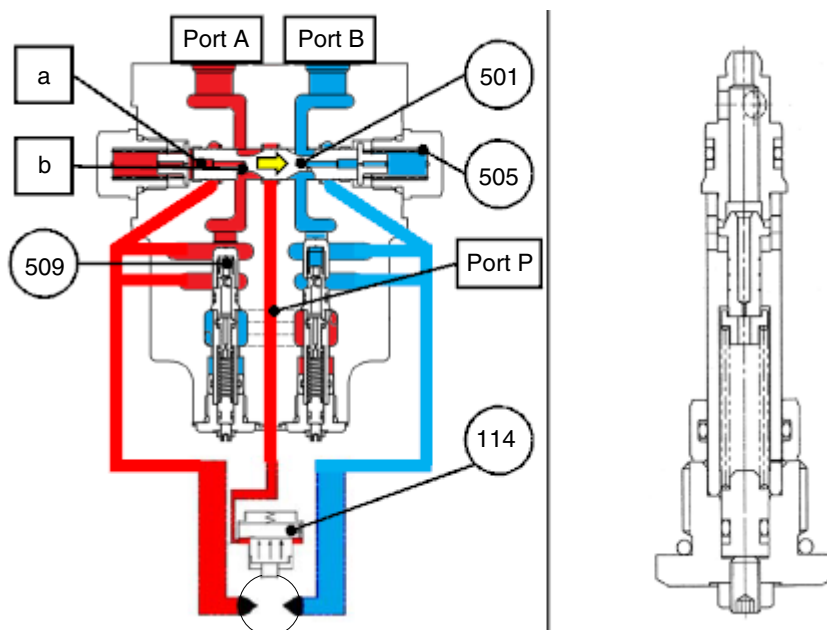
At the same time, the compressed oil enters the chamber {a} along small hole {b} of main spool (501) and acts on the face of main spool (501). After increasing pressure of oil, when this pressure exceeds the spring elasticity force of main spool spring (505), main spool (501), which is held in neutral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

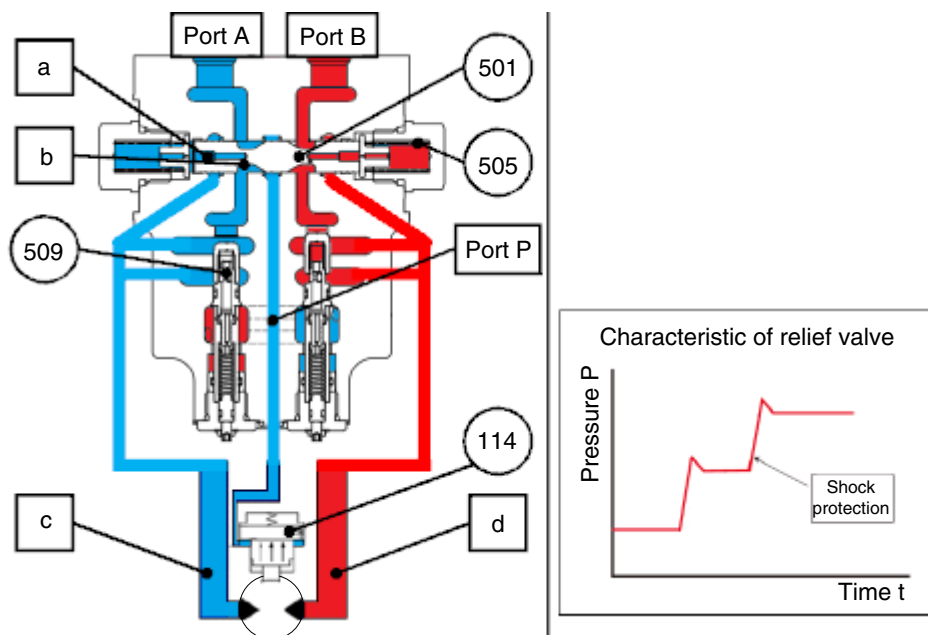
If the pressure supplied along the port to the inlet breaks while traveling, the pressure applied to the section of the main spool (501) is removed. Therefore, the main spool (501), which was pushed to the right, returns to neutral due to the spring elasticity force of the main spool spring (505).

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

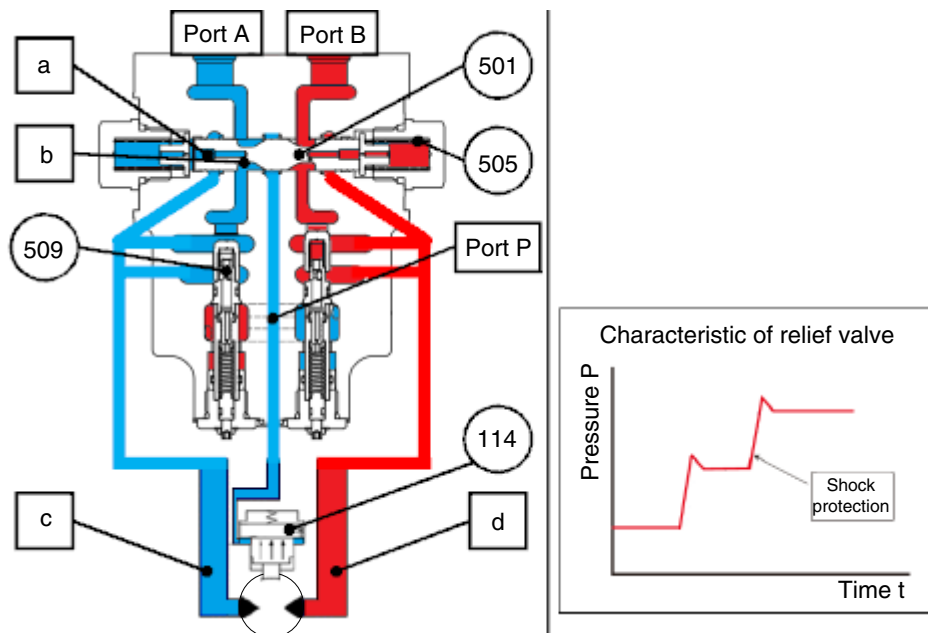
If the pressure supplied along the port to the inlet breaks while traveling, the pressure applied to the section of the main spool (501) is removed. Therefore, the main spool (501), which was pushed to the right, returns to neutral due to the spring elasticity force of the main spool spring (505).

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), it 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).



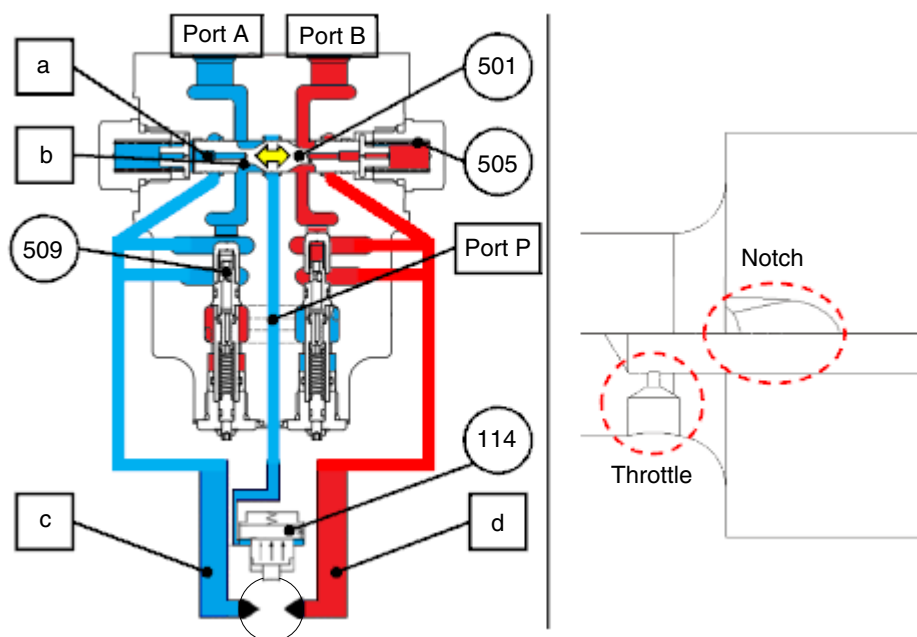
559A2TM56

(3) In case of overrun

Overrun is when the excavator's speed is increased by its 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.



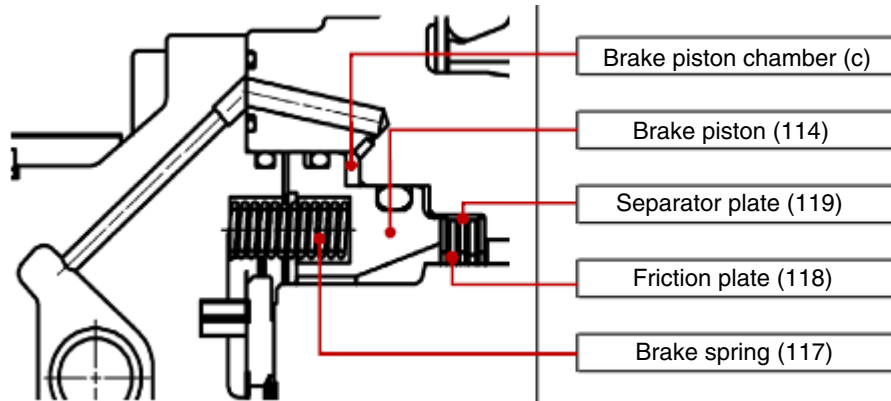
559A2TM57

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 F_4 of the brake piston chamber (c) is greater than the spring elasticity force F_3 of the brake spring (117), then brake piston (114) move to valve casing. (above brake release pressure)

$F_3 = k \times n$, k : Spring constant, x : Spring stroke, n : Number of spring brake

$$F_4 = P \times (A_1 - A_2), P: \text{Main pressure of input}, (A_1 - A_2): \text{Area difference of brake piston}$$

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)

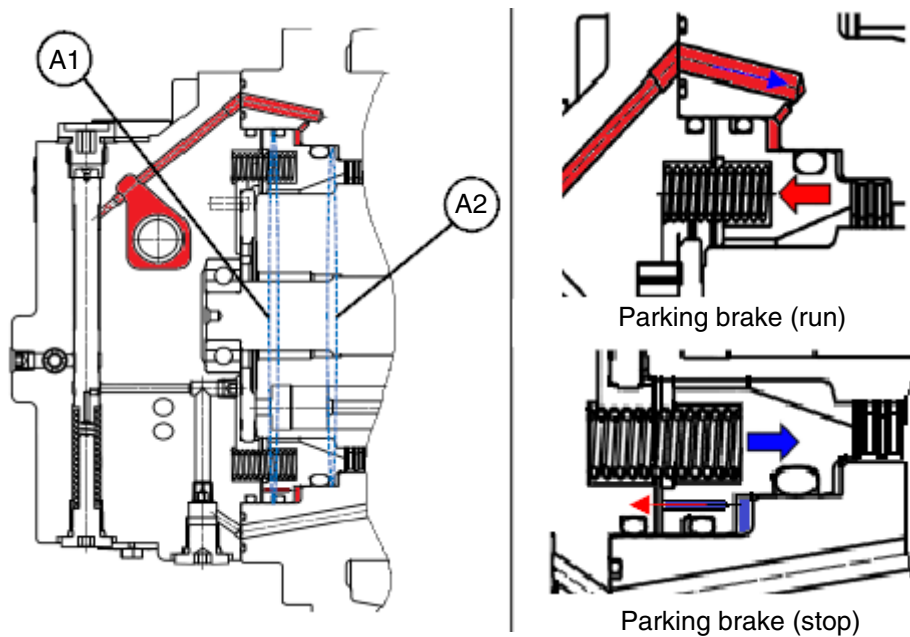
If the spring elasticity force F_3 of the brake spring (117) is greater than the hydraulic force F_4 of the brake piston chamber (c), then brake piston (114) move to casing by spring elasticity force. The hydraulic oil of the brake piston (114) is drained through the throttle. Therefore brake piston (114) smoothly operates.

$$F_3 < F_4$$

$F_3 = k \times n$, k : Spring constant, x : Spring stroke, n : Number of spring brake

$F_4 = P \times (A_1 - A_2)$, P : Main pressure of input, $(A_1 - A_2)$: 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

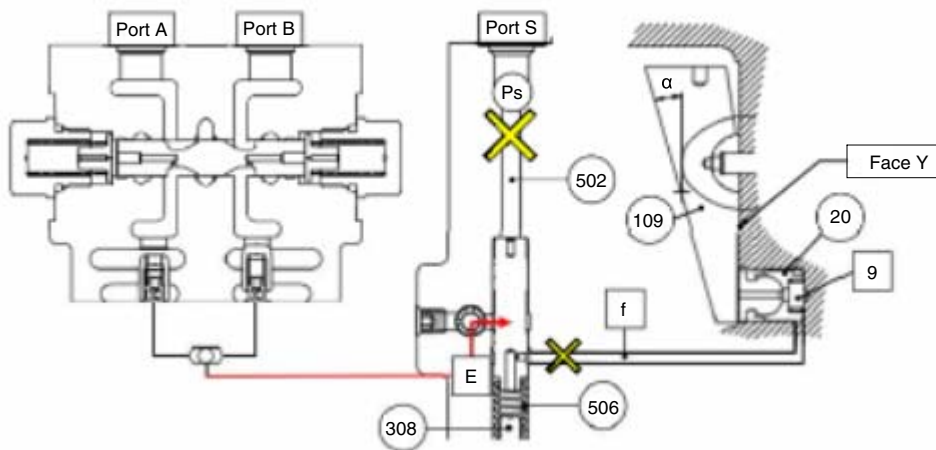
If pilot pressure is not supplied on pilot port (port S), 2 speed spool (502) is pushed in the direction of the port S by spring elasticity of 2 speed spool spring (506).

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

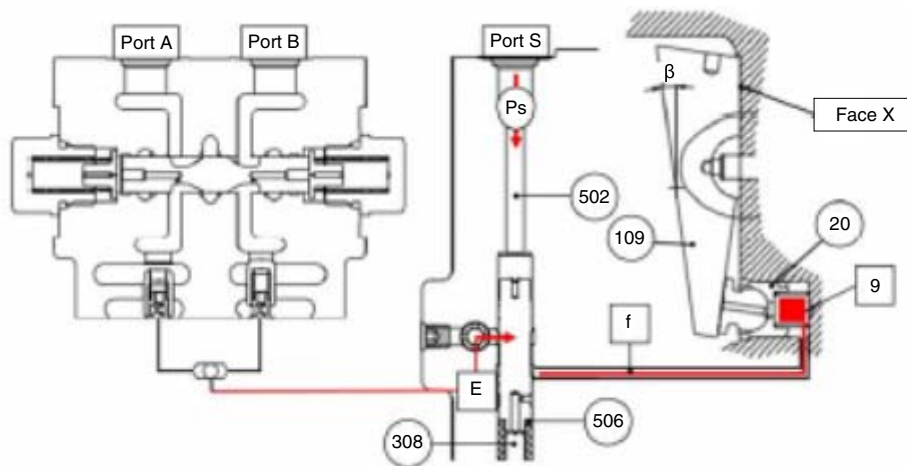
If the pilot pressure (20~50 kgf/cm²) is supplied to the port (port S), the pilot pressure overcomes the oil pressure in the main port and the spring elasticity force of the 2 speed spool spring (506). and it pushes the 2 speed spool (502) to the 2 speed plug (308) direction.

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 (ΔP) 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.

$$F_5 < [F_6 \times (A_4 - A_3)] + (F_{\text{spring}})]$$

$F_5 = P_S \times A_3$, P_S : Pilot pressure, A_3 : 2 speed spool area

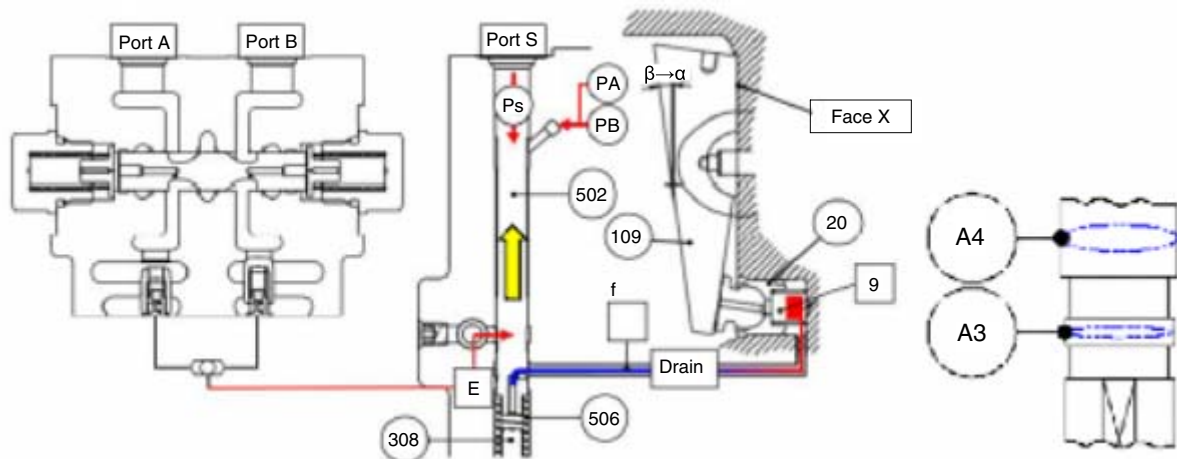
$F_6 = (P_A \text{ or } P_B) \times (A_4 - A_3)$, (P_A or P_B) : Main pressure difference between inlet side and outlet side

$F_{\text{spring}} = K \times X$; 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.

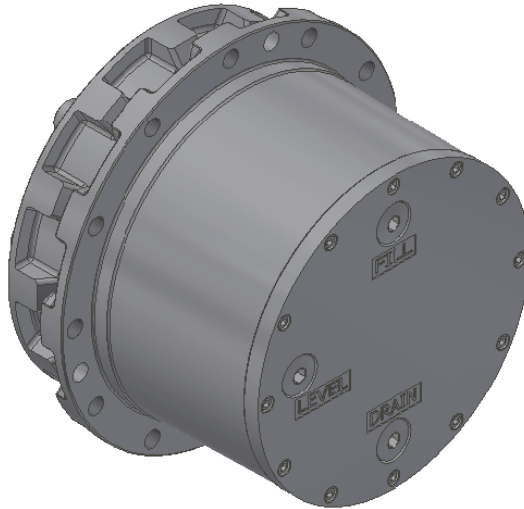
And the pressure of (g) is slowly drained to 2 speed spool chamber (f) through throttle and a notch of 2 speed spool.

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

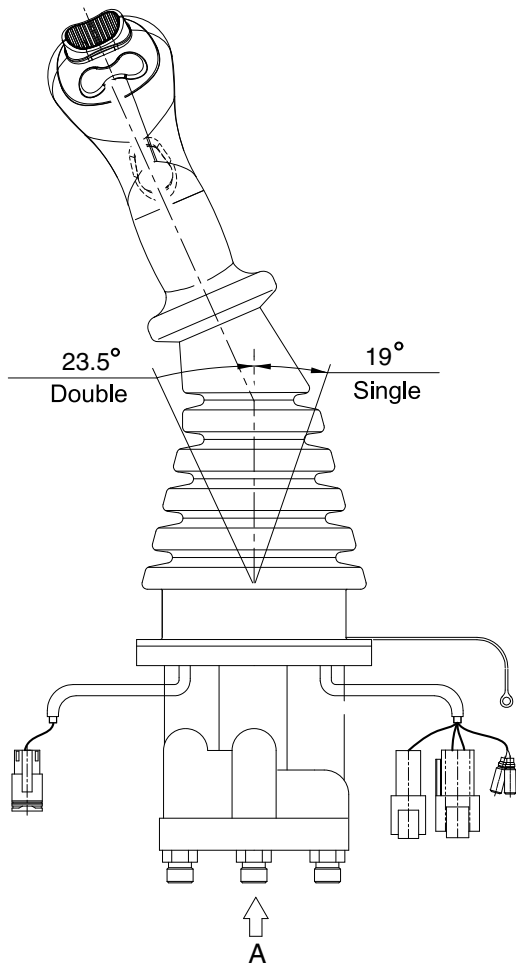
- (1) Refer to the section drawing for the basic construction.
- (2) The reduction gear consists of two stage planetary gears.
- (3) The reduction ratio is determined by the number of teeth of the gear, and the reduction ratio is 42.439.
In other words, the number of revolutions of the hydraulic motor 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

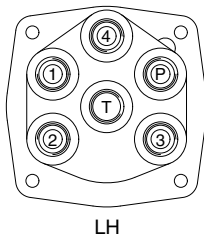
■ TYPE 1 (EATON)

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.

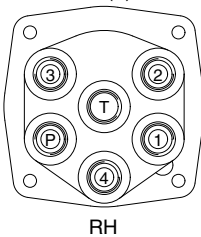


UNF 9/16-18 (2,4,P)
M16x1.5 (1,3,T)



LH

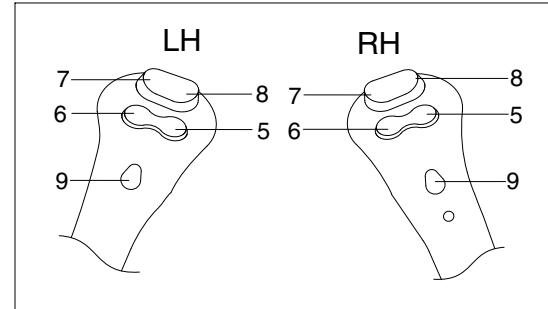
UNF 9/16-18 (1,2,3,4,P)
M16x1.5 (T)



RH

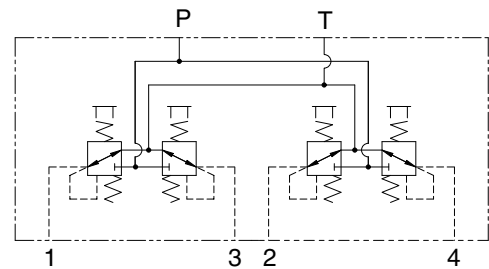
VIEW A

Switches



No.	LH	RH
5	Horn	Breaker
6	Not used	Quick clamp switch
7	Rotating -CCW	2-way clamp
8	Rotating -CW	2-way release
9	Boom swing Angle dozer selection switch (opt)	Proportional control ON/OFF switch

※ Refer to operator manual page 3-36.

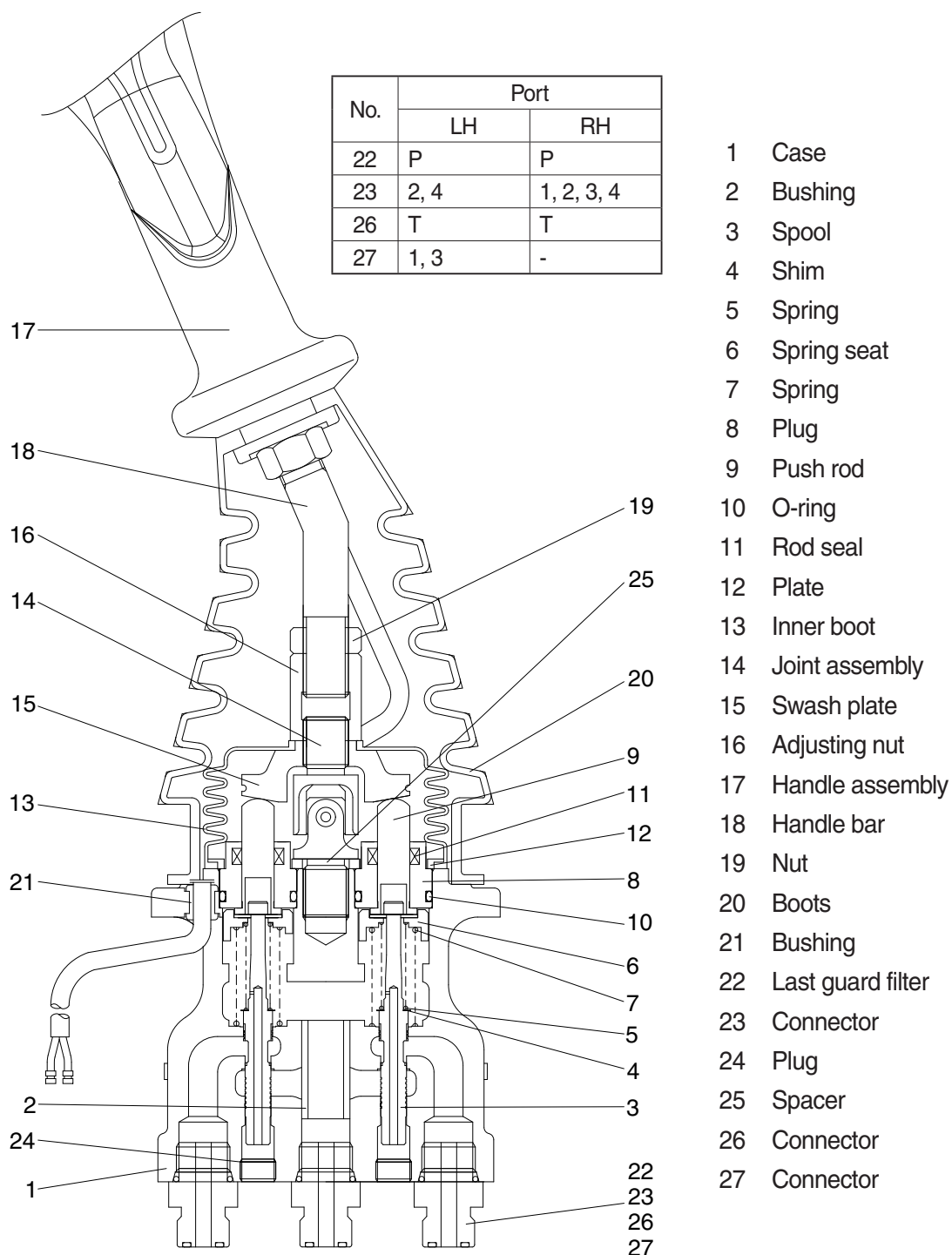


Hydraulic circuit

60A2RL02

Port	LH	RH	Remark
P	Pilot oil inlet port	Pilot oil inlet port	
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



60A2RL03

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, return spring (7), spring seat (6) 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/cm² (depending on the type). The spool is pushed against the push rod (9) 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.

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

Item numbers are based on the type L1.

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 (9) is inserted and can slide in the plug (8).

For the purpose of changing the displacement of the push rod through the swash plate (15) and adjusting nut (16) are provided the handle assy (17) that can be tilted in any direction around the fulcrum of the universal joint (14) center.

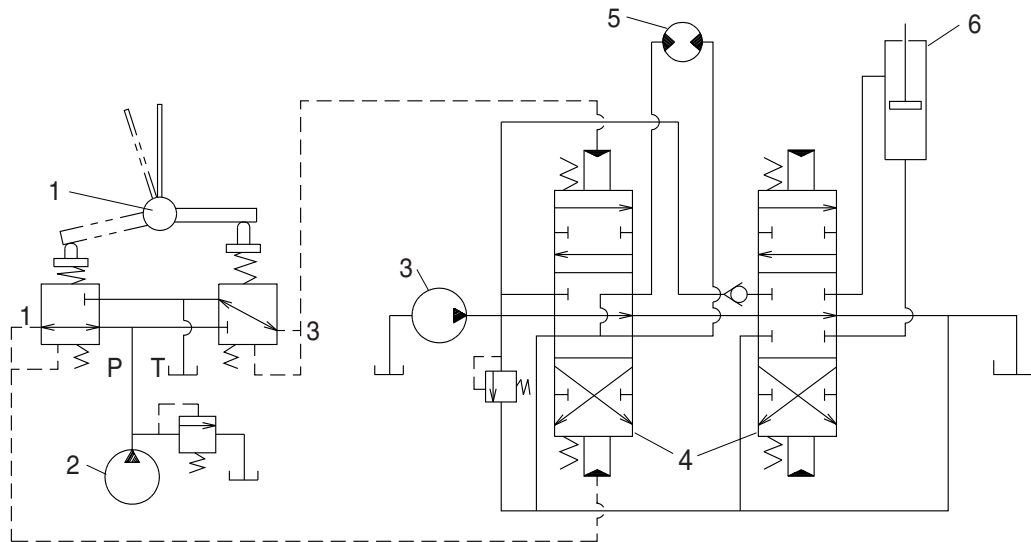
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

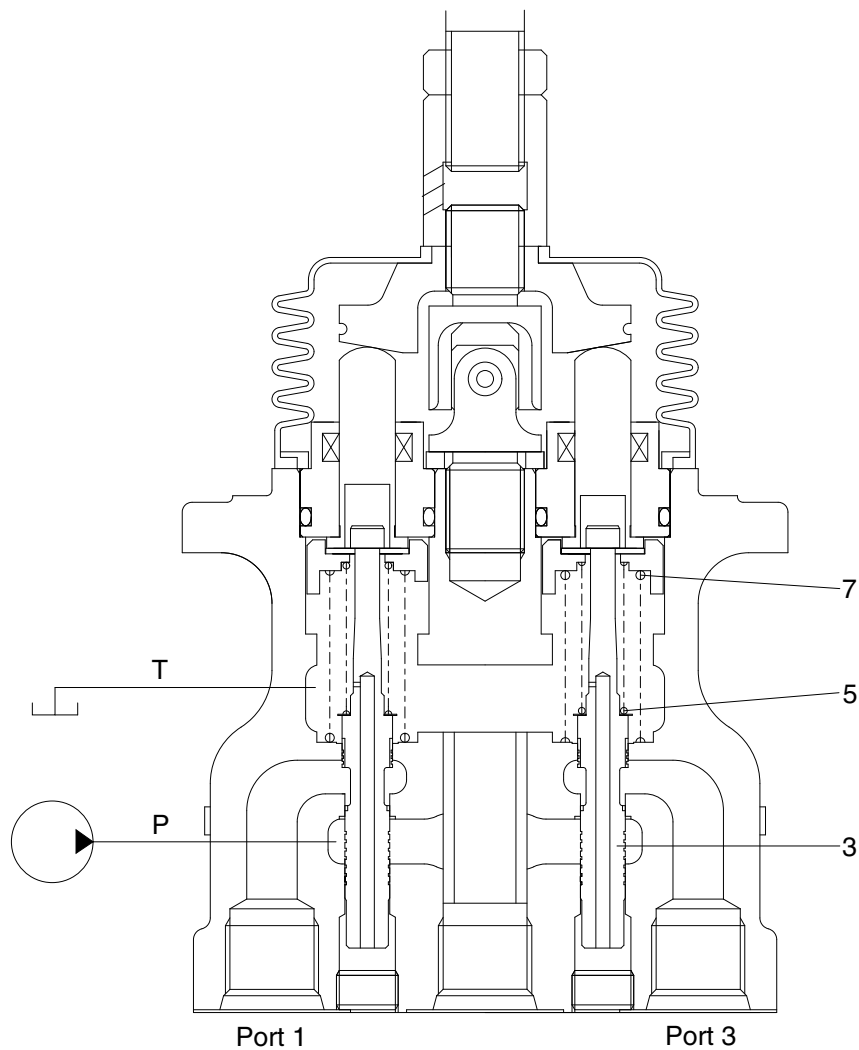
The diagram shown below is the typical application example of the pilot valve.



2-70

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

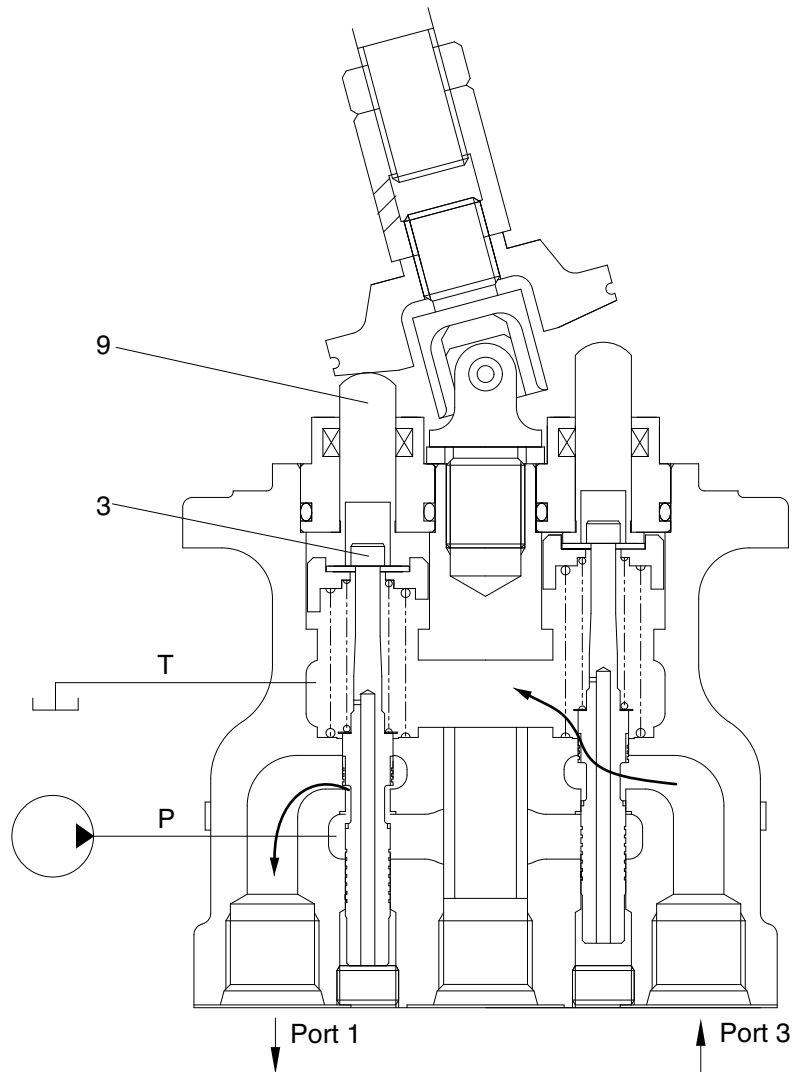
(1) Case where handle is in neutral position



300L2RL03

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 (7) 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



300L2RL04

When the push rod (9) 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.

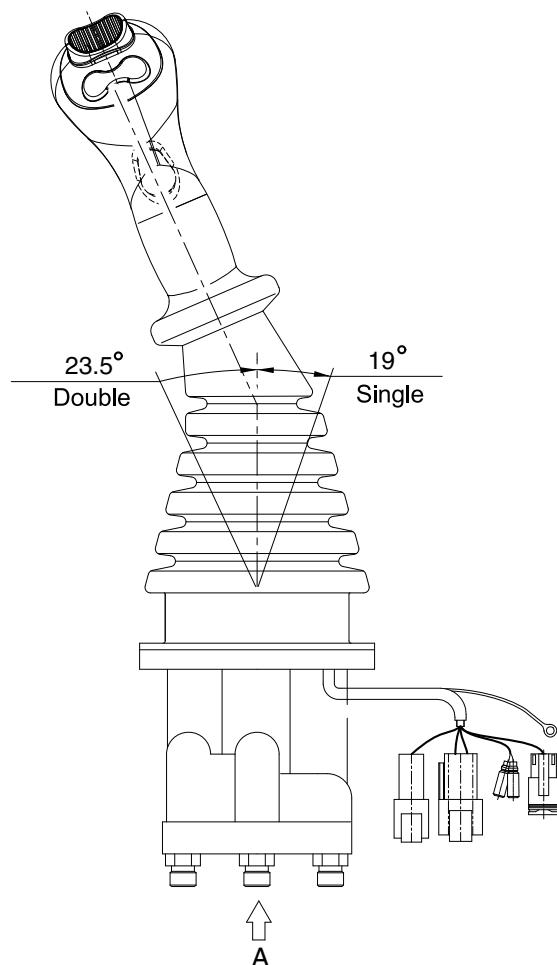
In this manner the secondary pressure is kept at the constant value.

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.

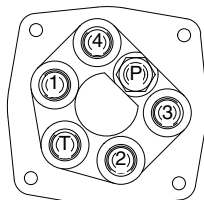
■ TYPE 2 (DAEHYUN)

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.

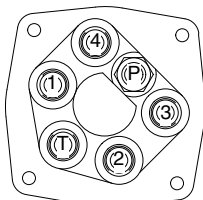


PF 1/4" (P)
PF 3/8" (T, 1, 2, 3, 4)



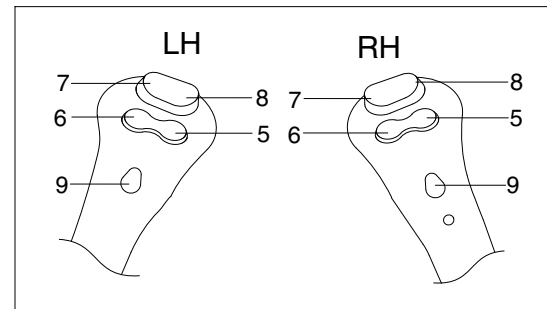
LH

PF 1/4" (P)
PF 3/8" (T, 1, 2, 3, 4)



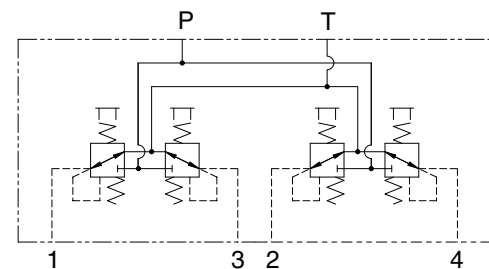
VIEW A

Switches



No.	LH	RH
5	Horn	Breaker
6	Not used	Quick clamp switch
7	Rotating -CCW	2-way clamp
8	Rotating -CW	2-way release
9	Boom swing Angle dozer selection switch (opt)	Proportional control ON/OFF switch

※ Refer to operator manual page 3-36.

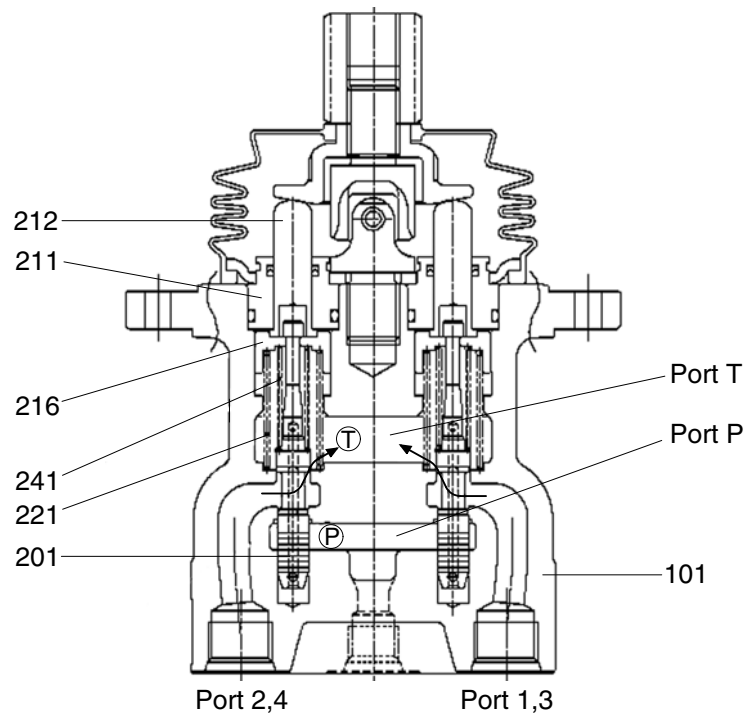


Hydraulic circuit

60A2RL05

Port	LH	RH	Remark
P	Pilot oil inlet port	Pilot oil inlet port	
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



17Z9A2RL02

- | | |
|--------------|---------------------------------------|
| 101 Casing | 216 Spring seat |
| 201 Spool | 221 Return spring |
| 211 Plug | 241 Secondary pressure setting spring |
| 212 Push rod | |

The structure of the remote control valve is as shown in the assembly. There is a vertical axial hole in the casing and the reduction valves are inserted into this.

The secondary pressure setting spring (241) is set such that the secondary pressure is calculated as $5 \sim 20.4 \text{ kgf/cm}^2$. Spool (201) is pushed onto the push rod (212) by return spring (221).

Tilting the control handle pushes down push rod (212), the spring seat (216) also moves down and the setting of the secondary pressure setting spring (241) is changed.

Port P, oil inlet (primary pressure) and port T outlet (tank) are in the casing (101).

2. PERFORMANCE

1) BASIC PERFORMANCE

The remote control valve controls the stroke and direction of the control valve spools. This is achieved by the output pressure of the remote control valve acting on the tip of the control valve spool.

To achieve satisfactory performance, the remote control valve comprises the following elements :

- (1) An inlet port (P) for oil fed from the hydraulic pump.
- (2) Multiple output ports (1, 2, 3 and 4) to allow pressure from the inlet port to act on the spool tips of the control valve.
- (3) A tank port (T) to control the output pressure.
- (4) A spool to connect the output port to the inlet port or tank port.
- (5) A mechanical assembly, which contains a spring which acts on the spool and controls the output pressure.

2) PERFORMANCE OF THE MAIN PARTS

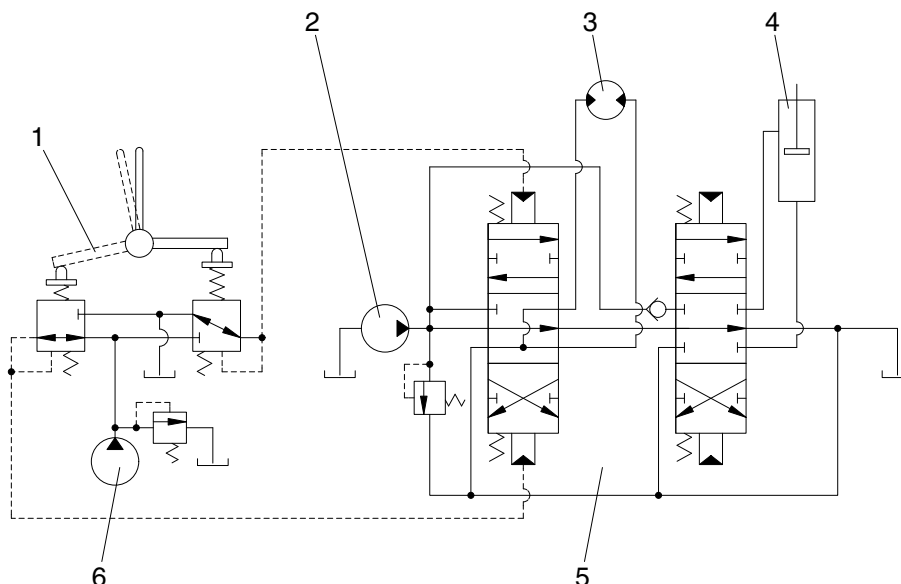
The spool (201) operates to take the supply oil pressure from the hydraulic pump. This switches the oil channel so that the port P oil pressure is directed to the output ports 1, 2, 3, 4 or to port T. The secondary pressure setting spring (241) determines the output pressure that acts on the spool (201).

The push-rod (212), which changes the strain of the secondary pressure setting spring (241), is inserted so that it can move smoothly into the plug (211).

The return spring (221) acts to return the push-rod (212) towards zero displacement without reference to the output pressure acting on the spring seat (216) and casing (101). This acts to ensure the return to neutral of the spool (201) and also acts as a resistance spring to provide the operator with an appropriate operating "feel".

3) OPERATION

The operation of the remote control valve is described in the hydraulic circuit plan and operation explanatory figures (see figures RL04, 05 and 06). The below figure shows a typical example of the use of the remote control valve.



17Z9A2RL03

- | | | |
|------------------------|----------------------|-----------------|
| 1 Remote control valve | 3 Hydraulic motor | 5 Control valve |
| 2 Main pump | 4 Hydraulic cylinder | 6 Pilot pump |

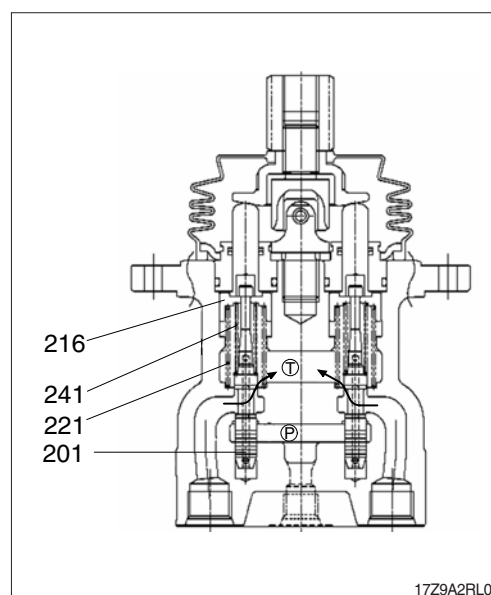
(1) Control handle neutral

The force of the secondary pressure setting spring (241) (which determines the output pressure of the pilot valve) does not act on the spool (201).

Spool (201) is pressed upward by the return spring (221) and spring seat (216).

Output ports (2, 4) and port T are open.

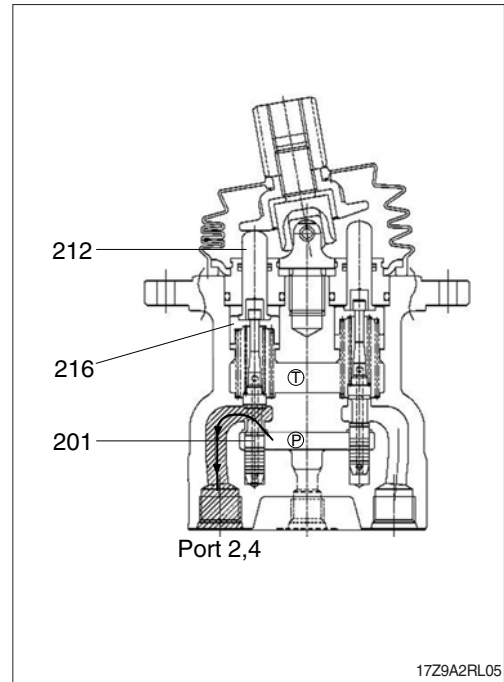
The output pressure is the same as the tank pressure.



17Z9A2RL04

(2) Control handle tilted

The push-rod moves, (spring seat (216)), spool (201) moves downward, port P and ports (2, 4) are open and the oil fed from the pilot pump flows to ports (2, 4) and generates pressure.



(3) Control handle held

The pressure of ports (2, 4) rises to become equal to the spring (241) force; the oil pressure and spring pressures become balanced. If the pressure of ports (2, 4) exceeds the set pressure, ports (2, 4) and port P close, ports (2, 4) and port T open. If the pressure of ports (2, 4) falls below the set pressure, ports (2, 4) and port P open and ports (2, 4) and port T close. The secondary pressure is kept constant.

