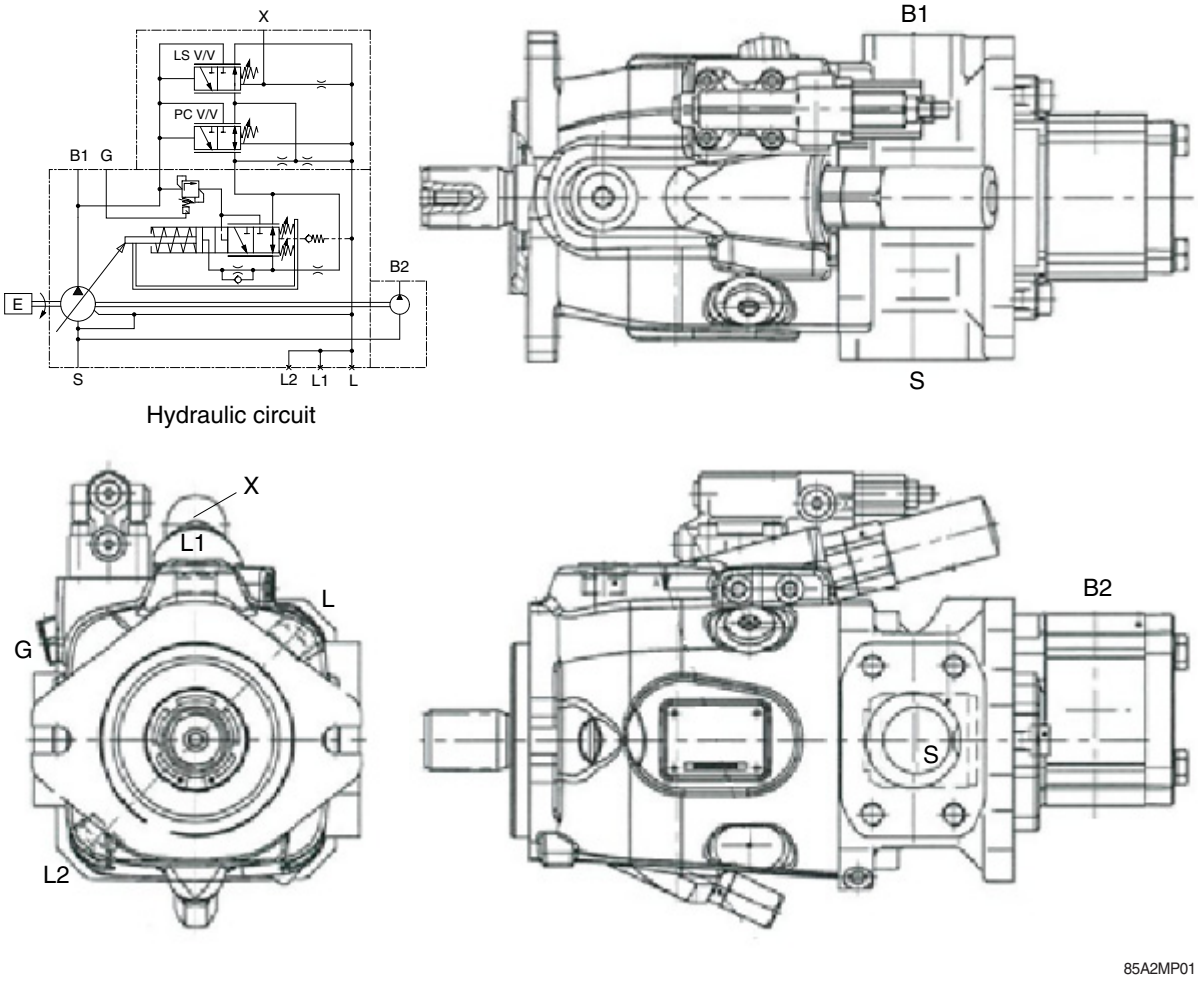
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 HYDRAULIC PUMP

1. GENERAL

This variable displacement piston pump consists of main pump and pilot pump.



Hydraulic circuit

Description of the ports

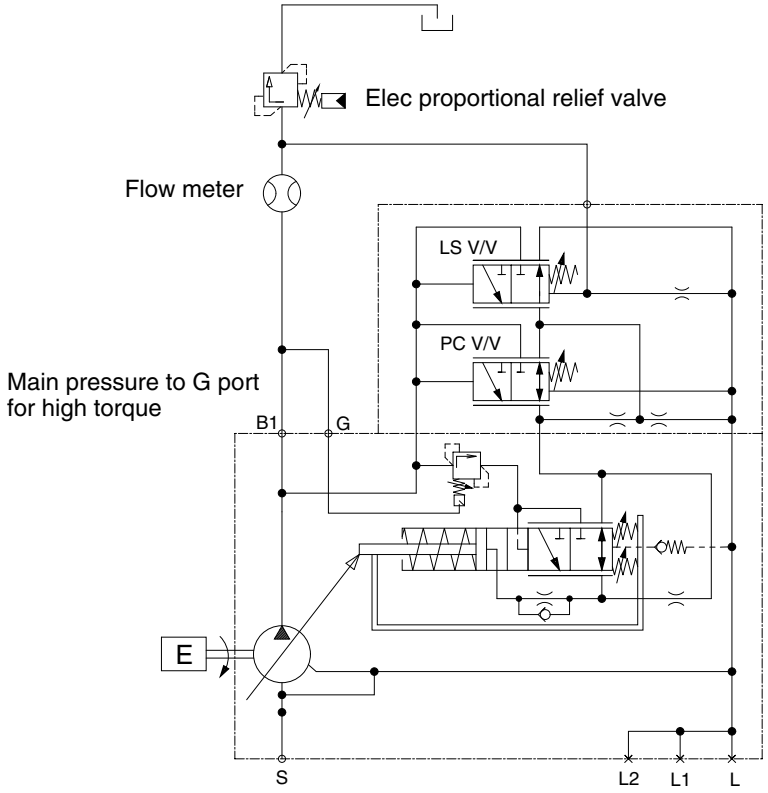
Port	Name	Bore
S1	Suction port	SAE 2"
B1	Discharge port	SAE 1"
B2	Discharge port	PF7/8-14UNF
G	High pressure port	M10x1
X	Pilot pressure port	PF7/16-20UNF
L, L1, L2	Case drain port	PF7/8-14UNF

2. START OF POWER CONTROL

Setting of starting point in P-Q curve shall be carried out as per following conditions and procedures.

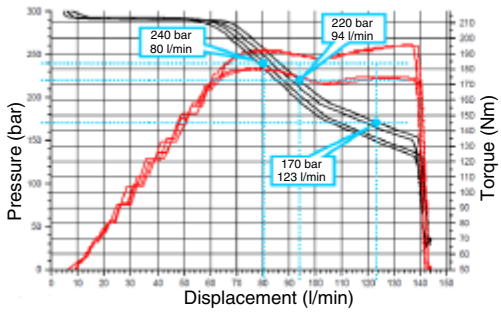
1) CONDITIONS

(1) Engine shall be running at 2000 rpm.
(2) Oil temperature shall be adjusted at 40 ℃.
(3) Pressure gauges and a flow meter shall be installed.

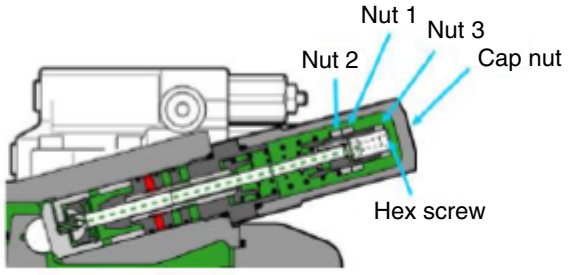


Schematic circuit

85A2MP10



P-Q curve



Pump schematic drawing

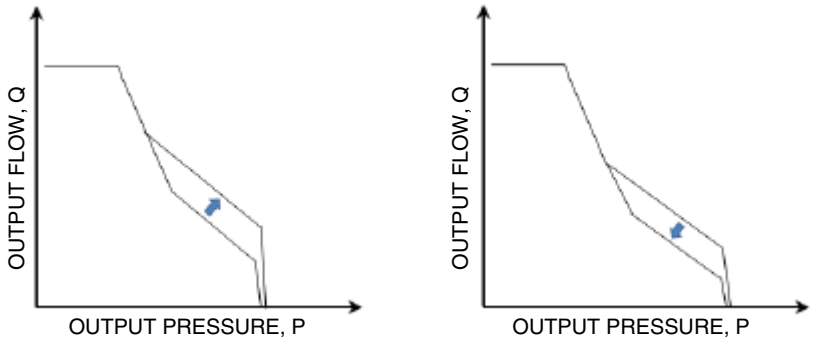
85A2MP11

2) PROCEDURES

(1) Loosen nut 1 fixing nut 2.
(2) Adjust outer spring by tightening or loosening nut 2.
① Increase pressure up to 170 bar.
② Turn Nut 2 clockwise to increase power until pumping flow reaches 123 ℓ/min (±4 ℓ/min).
(3) Secure the setting of nut 2 by tightening nut 1.

3) CHANGE OF P-Q CURVE

(1) If length of outer spring is decreased by tightening nut 2, the P-Q curve is moved to right in general like a graph left under as the spring tension is increased.
(2) If length of outer spring is increased by loosening nut 2, the P-Q curve is moved to left in general like a graph right under as the spring tension is decreased.



85A2MP12

3. END OF POWER CONTROL

Setting of ending point in P-Q curve shall be carried out following procedures and conditions.

1) CONDITIONS

(1) The conditions shall be set same as above.

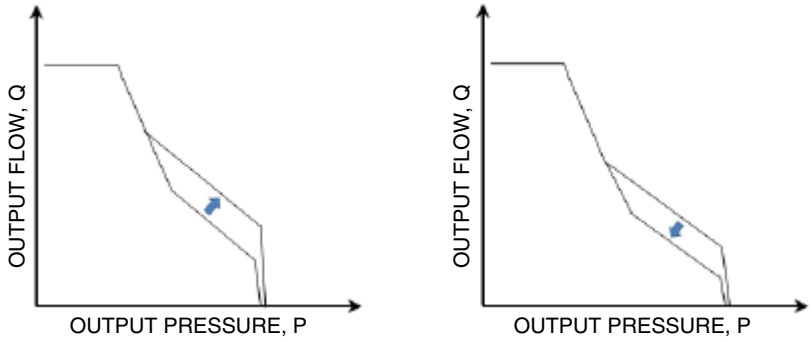
2) PROCEDURES

(1) Loosen the nut 3.
(2) Set end of control by turning Hexagonal screw.
① Increase pressure to 220 bar.
② Turn Screw clockwise to increase power until 92 ℓ /min (±4 ℓ /min) is reached.
(3) Secure the setting of nut 3.
(4) Tighten Cap nut.

3) CHANGE OF P-Q CURVE

(1) If length of Inner spring is deceased by tightening hexagonal screw, lower part of P-Q curve is moved to right like a graph left under as the tension force of spring is increased.

(2) If length of Inner spring is increased by loosening hexagonal screw, lower part of P-Q curve is moved to left like a graph left under as the tension force of spring is decreased.



85A2MP13

4. APPENDIXES

Required torque for bolt tightening

Part	Name	Required torque	
		kgf·m	lbf·ft
Nut 1	14 mm	5.1	36.9
Nut 2	14 mm	5.1	36.9
Nut 3	10 mm	4.1	29.7
Cap nut	32 mm	7.1	51.4
Hexagon screw	10 mm	-	-

5. DUAL TORQUE MODE

Pump power needs to be decreased in case that engine power is not enough to cover air condition operating at maximum pump operating. This function lets the pump power decrease by operating of dual torque valve.

(1) Normal operating condition (without air conditioner mode)

Solenoid valve (7) maintains the pushed position and allows oil to flow from passage (15) to passage (19). The pressure pushes dual torque valve (5) not to allow the pumping oil to flow toward control valve (6) inside. As a result, pressure in front of dual torque valve (5) does not effect on the angle of swash plate (25).

(2) Excessive operating condition (by air conditioner mode)

If air conditioner operates with maximum pump operating, the increased power will overload engine. Therefore, pump power needs to be decreased to share power consumption with air conditioner without overload to engine.

Connection between passage (15) and passage (19) is blocked by deactivation of solenoid valve (7). Dual torque valve which was pushed by the pressure in passage (19) also returns to initial position by spring force. This return allows the pumping oil to flow toward control valve (6) inside. The angel of swash plate (25) is decreased by the pressure in control valve. As a result, pump flow is decreased and power consumption by pump also is decreased.

6. UPSTROKE

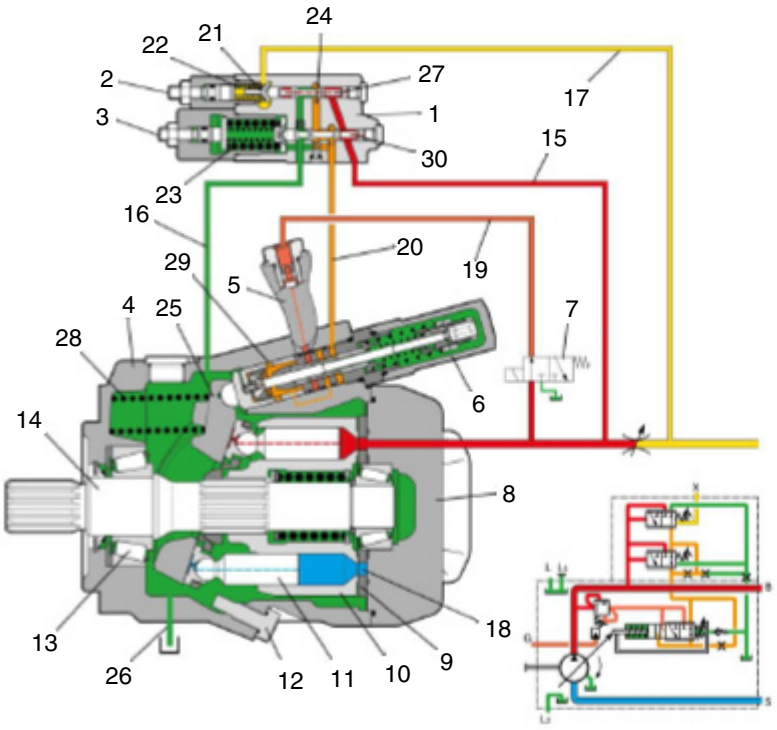
Upstroking of the pump occurs as a demand for flow from attachment.

The increased demand for flow causes a LS pressure in passage (17). The LS pressure in passage (17) combines with the force of spring (22) in cavity (21). The force of spring (22) causes pump pressure to be higher than pressure of passage (17).

If the combination of LS pressure and spring force is greater than the pump discharge pressure in passage (15), this difference pressure causes a spool (27) to move right. As the spool (27) moves right, the spool (27) blocks inflow of pumping oil to control piston (6) through passage (20). Swash plate (25) is controlled by pressure and flow as much as hydraulic system requests.

Pilot oil in passage (20) drains to passage (24). The oil then flows into housing through passage (16) into the housing and finally drains to tank. It also causes pumping flow to increase. As flow requirement is satisfied, pump output pressure increases. The pressure increases until the pressure in passage (24) moves flow compensator spool (27) up to be satisfied with system requirement for pressure and flow.

· Pump discharge pressure = force of spring (22) + LS pressure (17)



85A2MP14

1 Regulator
2 Flow adjustment screw
3 Pressure adjustment screw
4 Pump housing
5 Dual torque valve
6 Control valve
7 Solenoid valve
8 Port plate
9 Distributor plate
10 Cylinder block
11 Piston
12 Minimum flow limitation valve
13 Bearing
14 Drive shaft
15 Passage (high pressure)
16 Passage (leakage pressure)
17 Passage (pilot pressure)
18 Passage (suction pressure)
19 Passage (dual torque valve pilot pressure)
20 Passage (control piston pilot pressure)
21 Cavity
22 Spring
23 Spring
24 Passage
25 Swash plate
26 Casing drain
27 Flow compensator spool
28 Spring
29 Cross drilled hole
30 Pressure compensator spool

7. DESTROKE

The decreased flow demand causes LS pressure in passage (17). LS pressure in passage (17) combines with force of spring (22) in cavity (21).

This combination of LS pressure and spring force is less than the pump pressure in passage (15). It causes flow compensator spool (27) to move left.

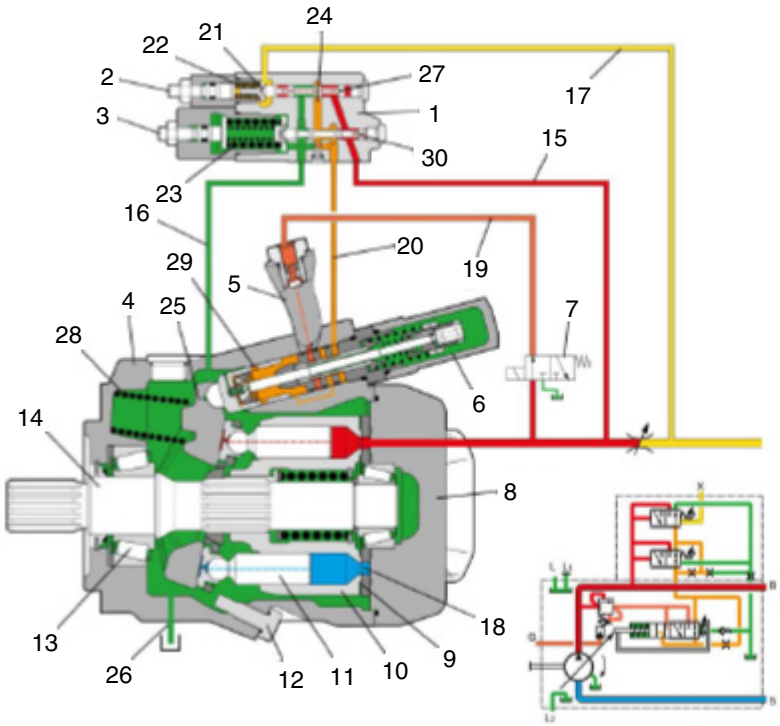
Pumping oil now flows through passage (15). The oil then flows past flow compensator spool (27), and then to control piston (6) through passage (20).

Combined force of pump pressure behind control piston (6) and counter spring (28) is bigger than force of springs inside control piston (6). Angle of swash plate (25) decreases.

This action results in decreasing of pump output and system pressure.

When the flow is decreased enough, flow compensator spool (27) moves right up to the balance position.

Swash plate (25) maintains the angle that is sufficient to provide the lower required pressure. If the operator does not operate RCV lever or pedal, the pump will return to low pressure stand-by.



85A2MP15

8. LOW PRESSURE STAND-BY

Low pressure standby constitutes the following condition: a running engine and inactive attachment. There is no flow demand or pressure demand on the pump. Therefore, there is no LS pressure in passage (17).

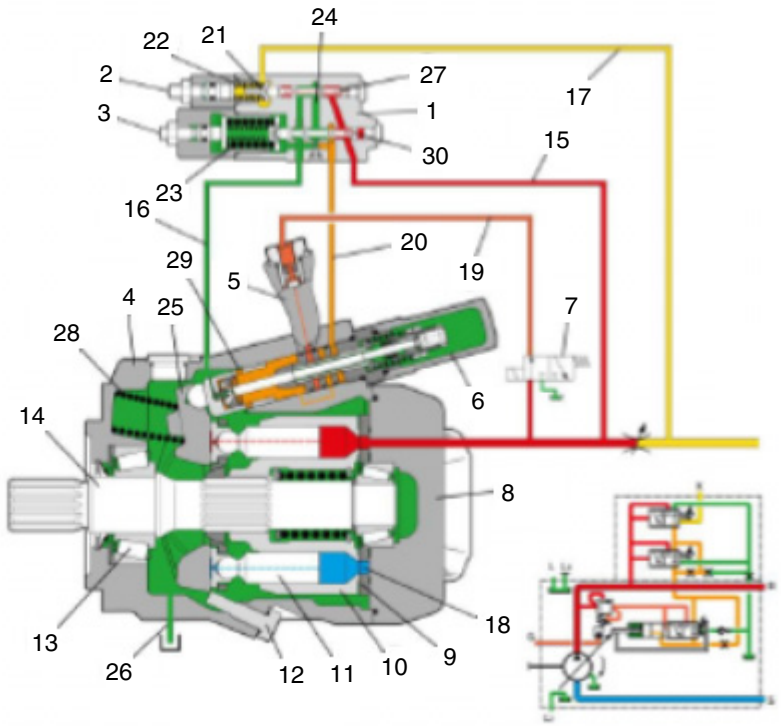
Before you start the engine, counter spring (28) holds swash plate (25) at the maximum angle. As the pump begins to operate, oil begins to flow and pressure increases in the system.

As the pressure increases, the pressure pushes flow compensator spool (27) against spring (22). It causes flow compensator spool (27) to move left. It opens passage (24) in order to allow pumping oil to flow to control piston (6) via passage (20).

The oil acts against control piston (6) in order to overcome the force of counter spring (28). The oil causes control piston (6) to move to the left. When control piston (6) moves to the left, the piston moves swash plate (25) toward the minimum angle. Control piston (6) continues to move to the left until cross-drilled hole (29) allows the oil to drain to pump housing. Cross-drilled hole (29) limits the maximum travel of control piston (6) toward the left.

The pump supplies a sufficient amount of flow that can compensate for the system leakage and the pump leakage. The leakage to the pump housing is flowed from the cross-drilled hole. The pump maintains low pressure stand-by. Low pressure stand-by should not exceed 15 bar.

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will slightly upstroke in order to compensate for the leakage increasing. Control piston (6) will cover much flow control than the flow through the cross-drilled hole.



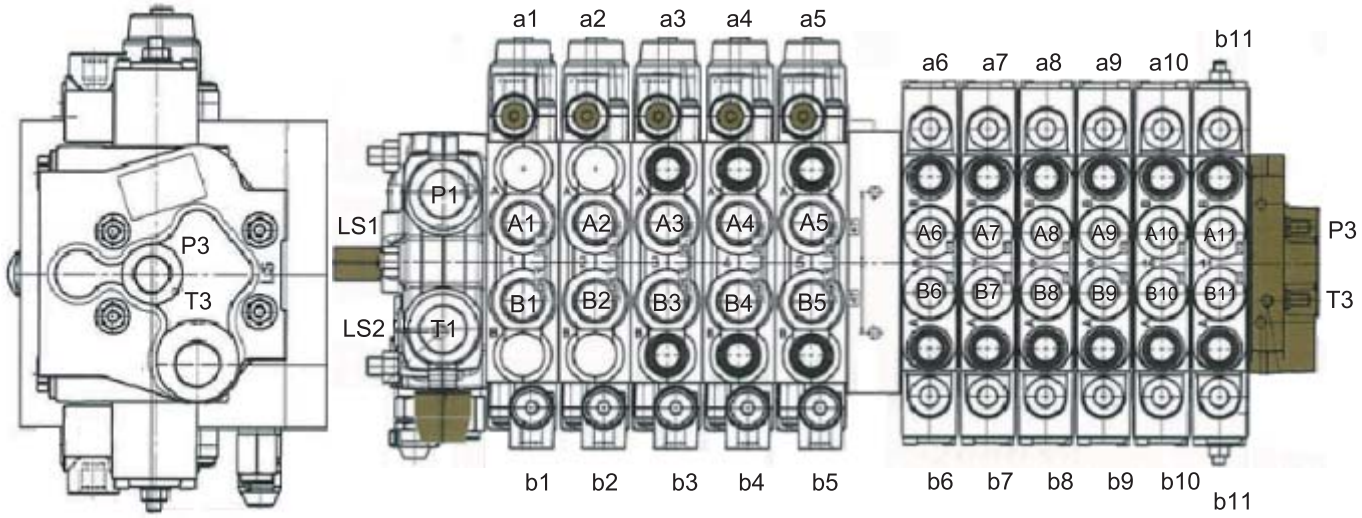
85A2MP16

9. CUT OFF FUNCTION

Once sudden pressure increasing in LS line occurs while attachments work, flow decreasing should be a necessary function to prevent a shock inside the pump. When high pressure in passage (15) flows to regulator (1), spools are likely to move by its force. However, shift of flow compensator spool (27) is restricted by LS pressure pushing spring (22) which is generated from attachments. Therefore, flow compensator spool (27) still blocks a connection from passage (27) to passage (24). The flow blocked by flow compensator spool (27) alternatively shifts pressure compensator spool (30) to right. Passage (15) connects to passage (20) by this shift. High pressure flows to control valve (6), then decreases an angle of swash plate (25). Pumping flow finally will decrease by shift of flow compensator spool (27) although flow compensator spool (27) does not shift.

GROUP 2 MAIN CONTROL VALVE

1. OUTLINE

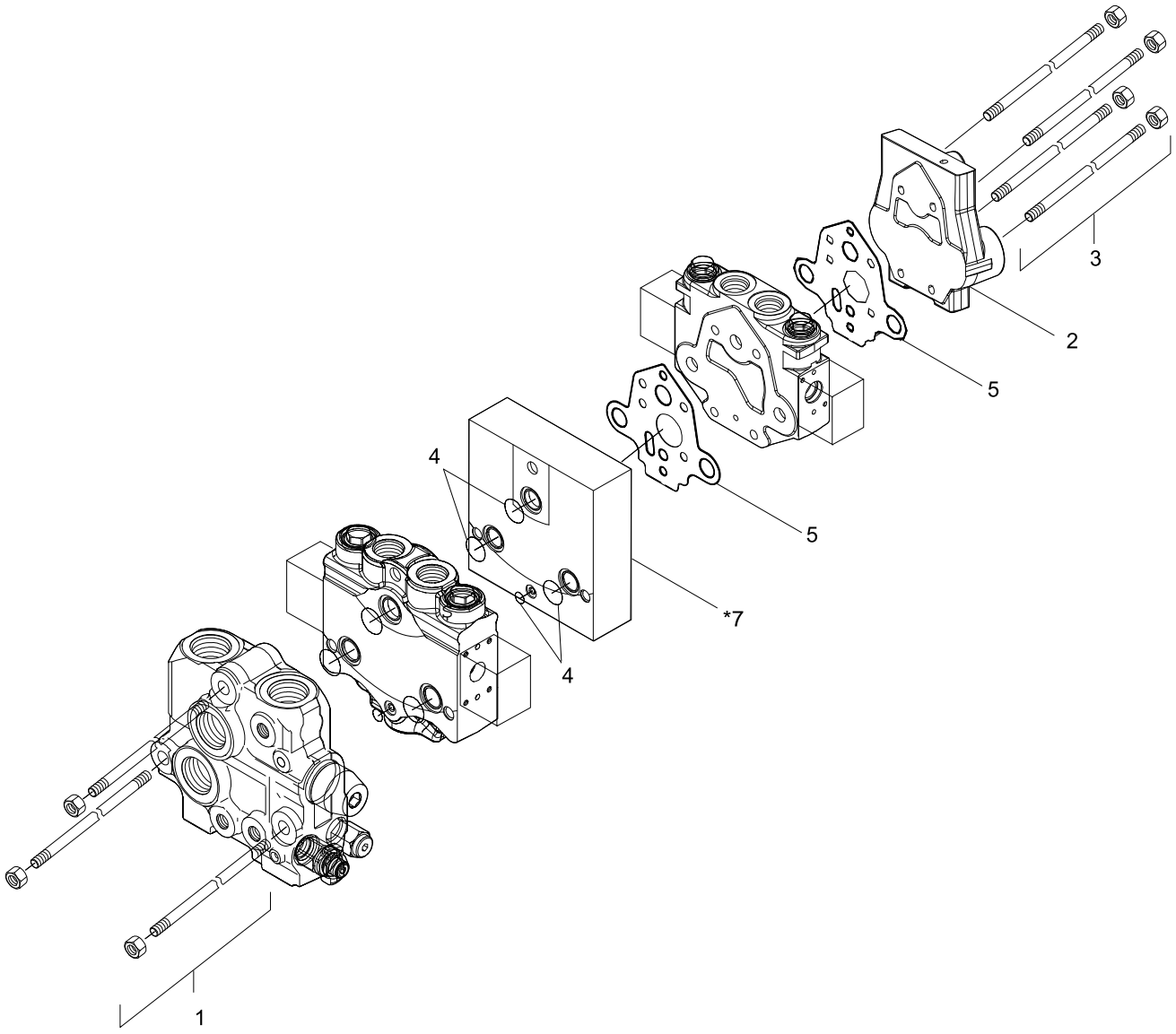


85A2MC01

Mark	Port name
P1	Pump port
P3	Pump port
A11	Swing port (LH)
B11	Swing port (RH)
A6	Dozer down port
B6	Dozer up port
A7	Boom swing port (LH)
B7	Boom swing port (RH)
A9	2 Way (opt)
B9	2 Way (opt)
A8	2 pcs boom up port (opt)
B8	2 pcs boom down port (opt)
A4	Arm out port
B4	Arm in port
A2	Travel port [LH/FW]
B2	Travel port [LH/RR]
A1	Travel port [RH/FW]
B1	Travel port [RH/RR]
A3	Boom up port
B3	Boom down port
A5	Bucket in port
B5	Bucket out port
A10	Auxiliary 1 port (opt)
B10	Auxiliary 1 port (opt)
T1	Tank return port

Mark	Port name
T3	Tank return port
a11	Swing pilot port (LH)
b11	Swing pilot port (RH)
a6	Dozer down pilot port
b6	Dozer up pilot port
a7	Boom swing pilot port (LH)
b7	Boom swing pilot port (RH)
a9	2 Way pilot port (opt)
b9	2 Way pilot port (opt)
a8	2 pcs boom up pilot port (opt)
b8	2 pcs boom down pilot port (opt)
a4	Arm out pilot port
b4	Arm in pilot port
a2	Travel pilot port (LH/FW)
b2	Travel pilot port (LH/RR)
a1	Travel pilot port (RH/FW)
b1	Travel pilot port (RH/RR)
a3	Boom up pilot port
b3	Boom down pilot port
a5	Bucket in pilot port
b5	Bucket out pilot port
a10	Auxiliary 1 pilot port (opt)
b10	Auxiliary 1 pilot port (opt)
LS1	Load sensing port (opt)
LS2	Load sensing port (opt)

2. STRUCTURE (1/5)

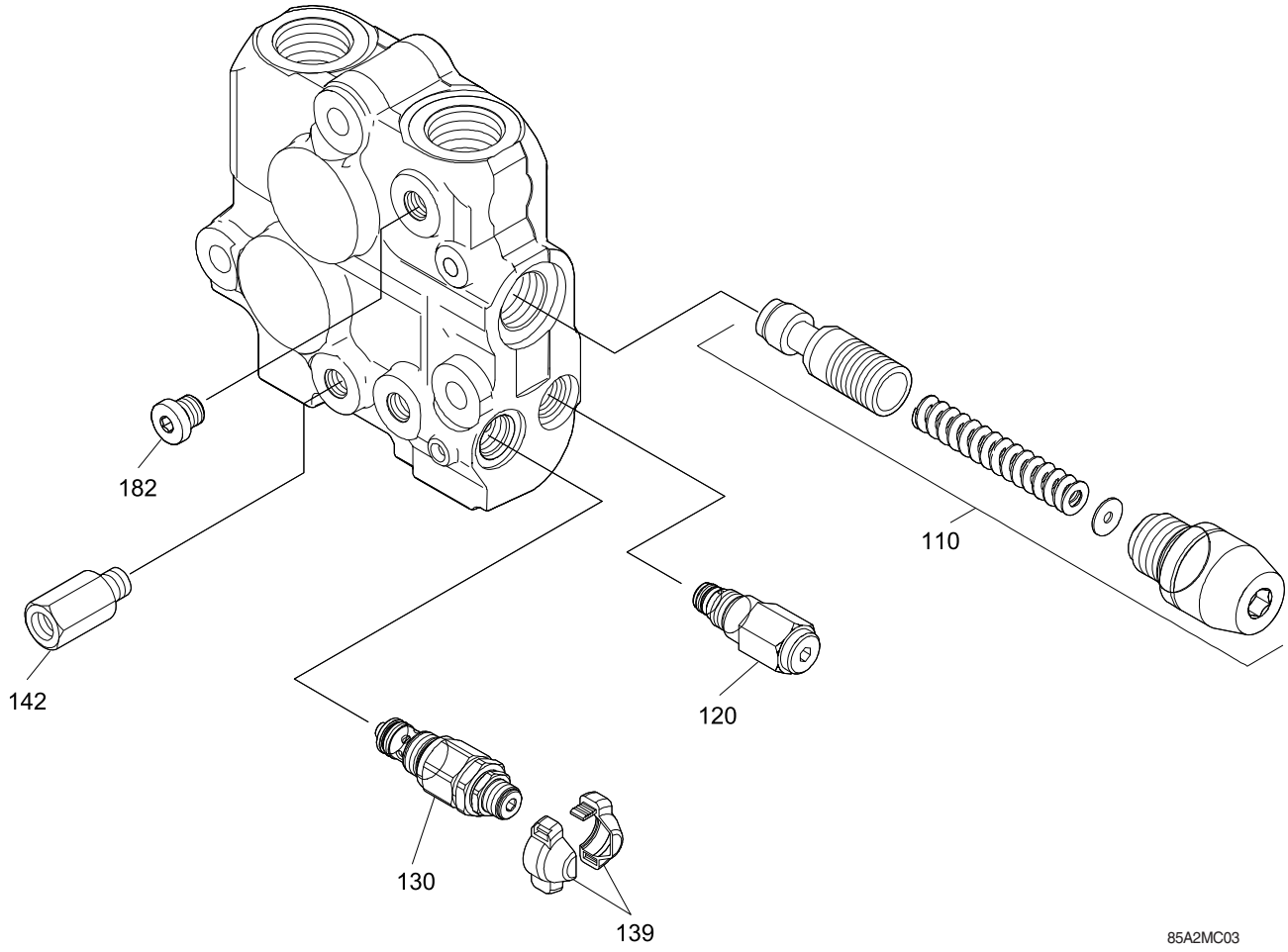


85A2MC02

1	Tie rod	3	Tie rod	5	Plate seal
2	Outlet block assy	4	Seal kit	7	Inner plate block assy

STRUCTURE (2/5)

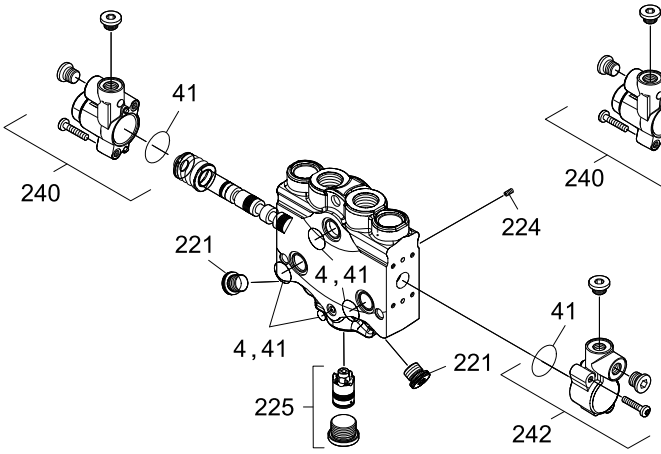
1 (INLET)



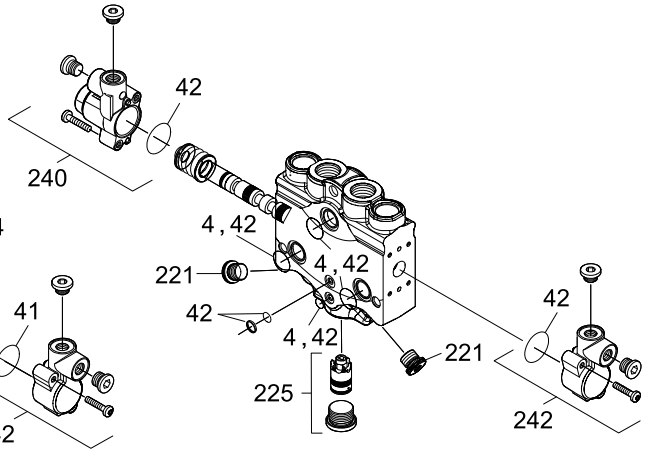
1-110 Regulator kit	1-130 Relief valve	1-142 Shuttle valve
1-120 Flow regulator	1-139 Half blue cover	1-182 Plug

STRUCTURE (3/5)

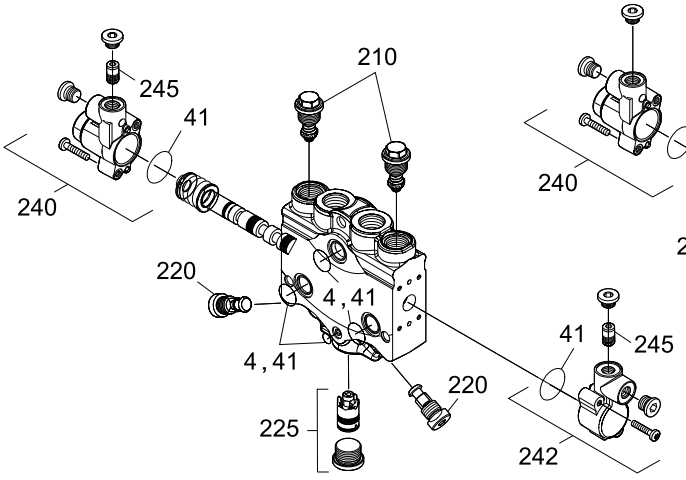
2 (TRAVEL-LH)



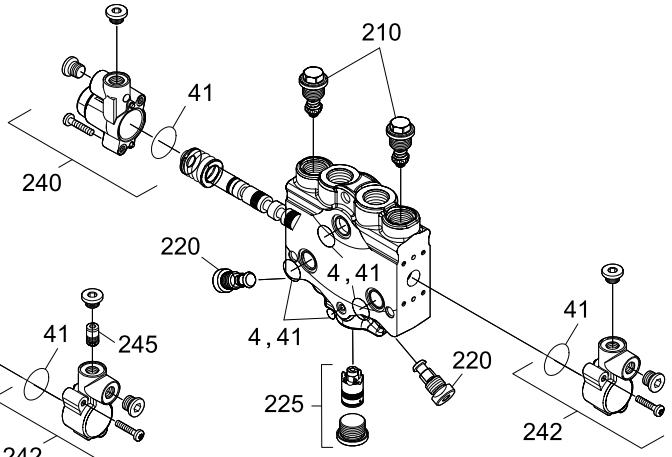
3 (TRAVEL-RH)



4 (BOOM), 5 (ARM)



6 (BUCKET)



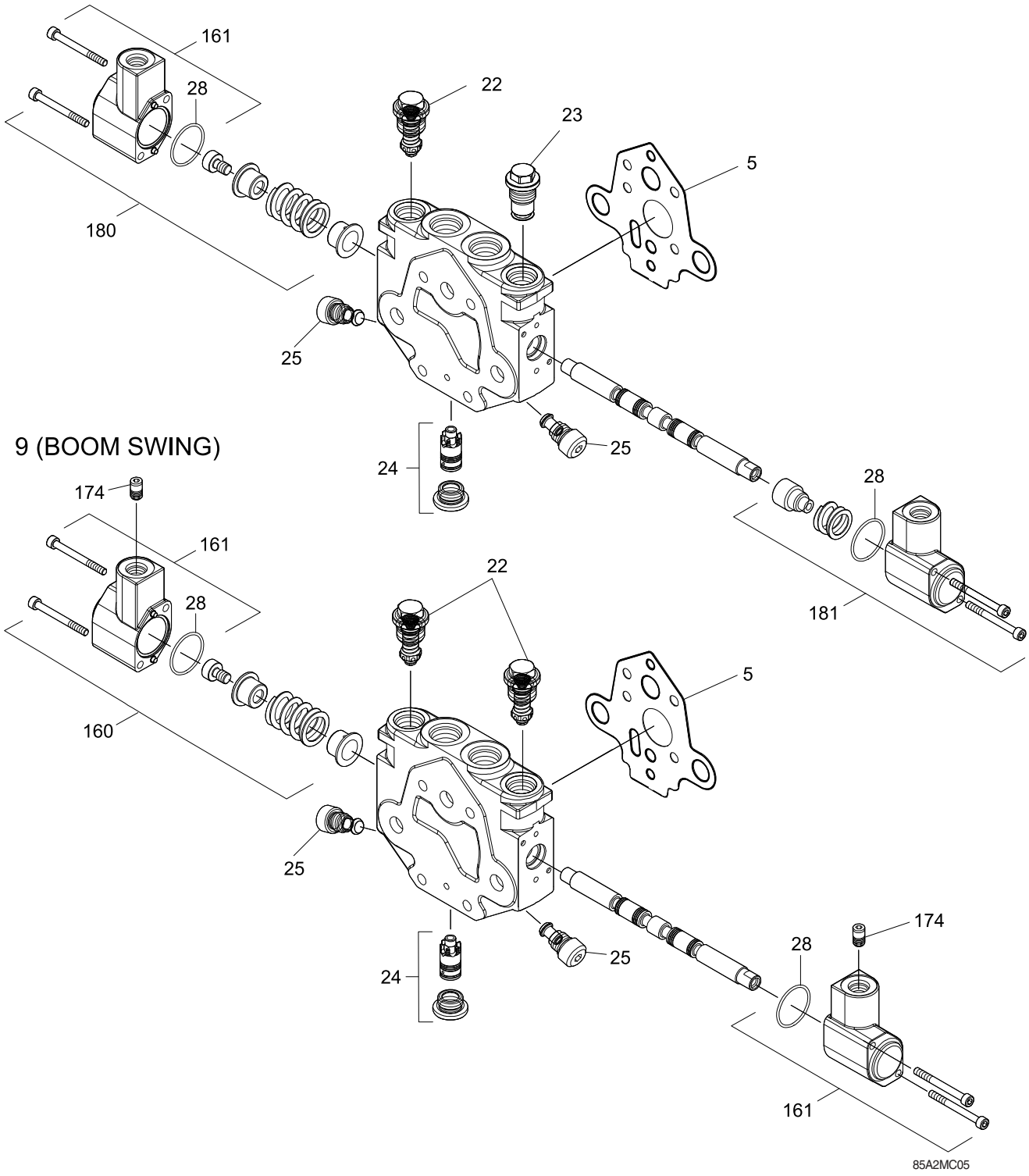
55Z92MC04

2-4	Seal kit	3-221	Plug	4-240	Cover kit	5-242	Cover kit
2-41	Seal kit	3-225	Compensator kit	4-242	Cover kit	5-245	Snubber
2-221	Plug	3-240	Cover kit	4-245	Snubber	6-4	Seal kit
2-224	Throttle element	3-242	Cover kit	5-4	Seal kit	6-41	Seal kit
2-225	Compensator kit	4-4	Seal kit	5-41	Seal kit	6-210	Relief valve
2-240	Cover kit	4-41	Seal kit	5-210	Relief valve	6-220	Check valve
2-242	Cover kit	4-210	Relief valve	5-220	Check valve	6-225	Compensator kit
3-4	Seal kit	4-220	Check valve	5-225	Compensator kit	6-240	Cover kit
3-42	Seal kit	4-225	Compensator kit	5-240	Cover kit	6-242	Cover ki

STRUCTURE (4/5)

8 (DOZER)

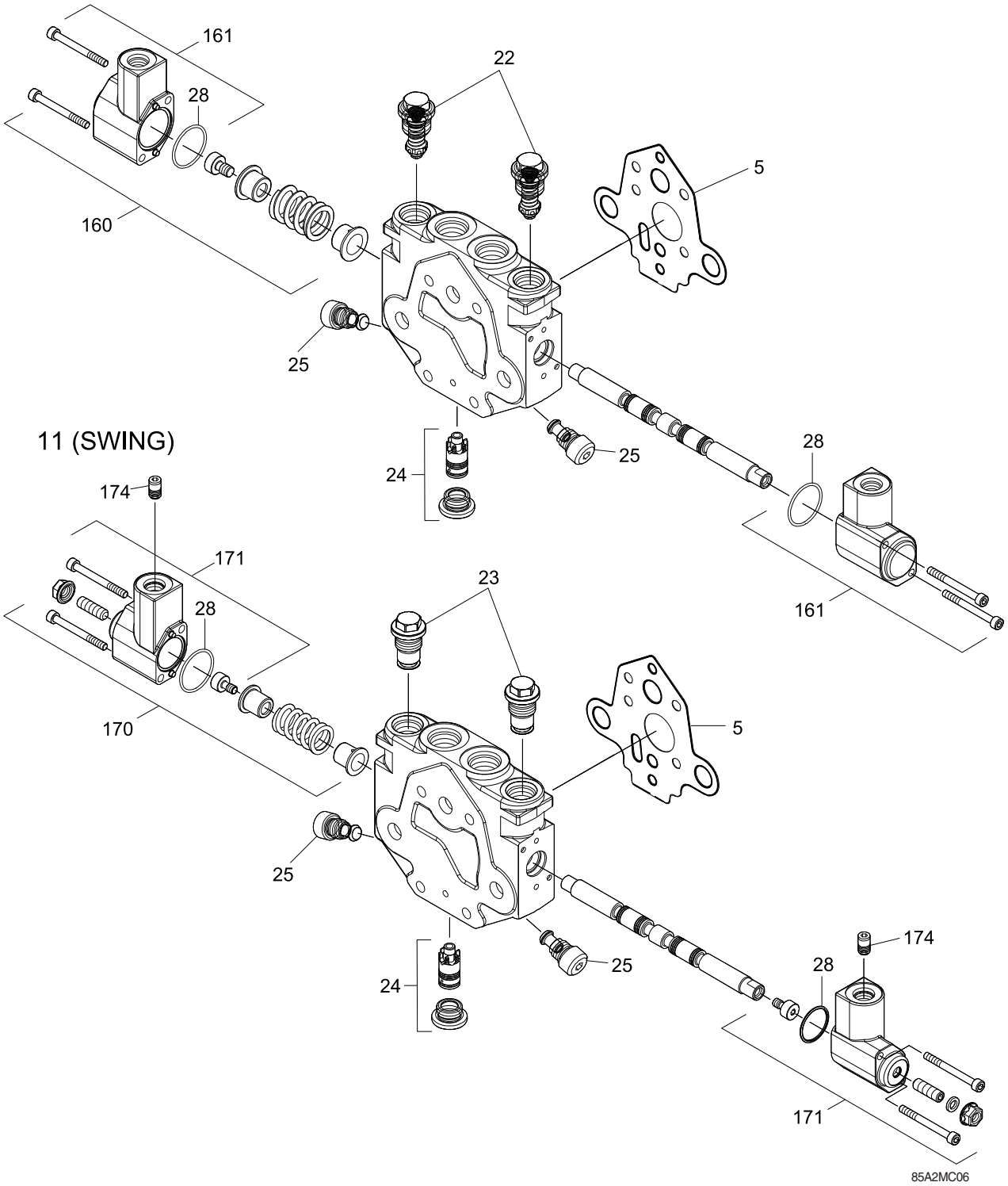
9 (BOOM SWING)



8-5	Plate seal	8-161	Cover kit	9-25	Check valve
8-22	Relief valve	8-180	W/spool cover kit	9-28	Seal kit
8-23	Plug	8-181	W/spool cover kit	9-160	W/spool cover kit
8-24	Compensator kit	9-5	Plate seal	9-161	Cover kit
8-25	Check valve	9-22	Relief valve	9-174	Snubber
8-28	Seal kit	9-24	Compensator kit		

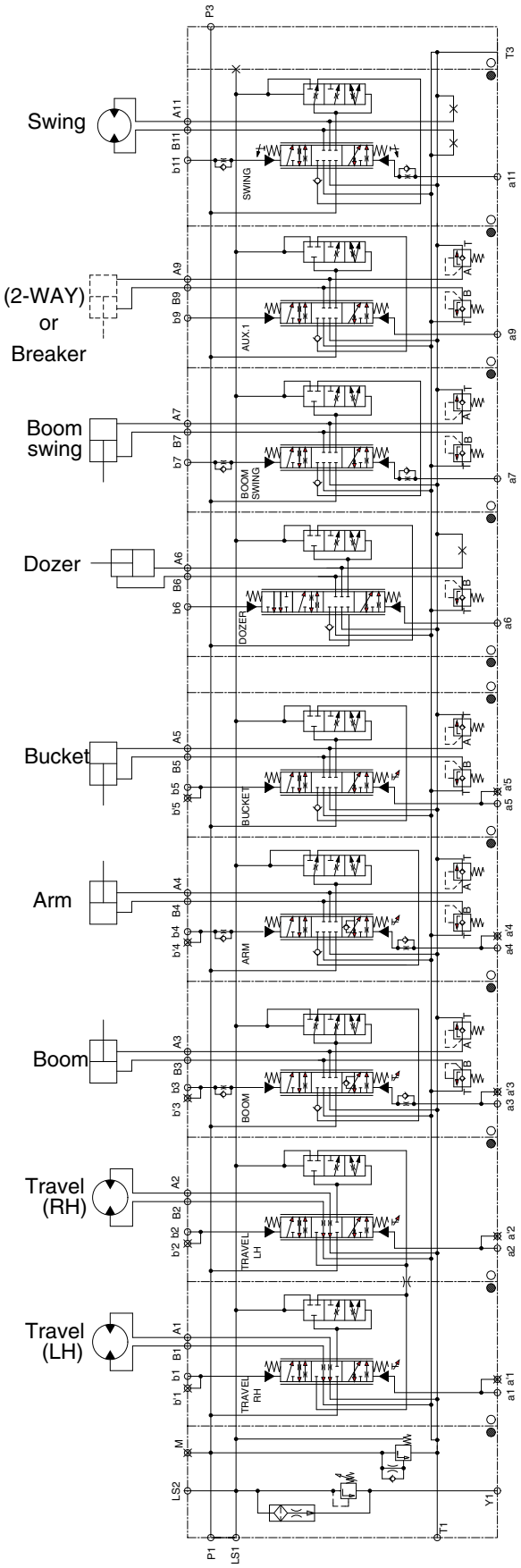
STRUCTURE (5/5)

10 (AUX 1)



10-5	Plate seal	10-160	W/spool cover kit	11-25	Check valve
10-22	Relief valve	10-161	Cover kit	11-28	Seal kit
10-24	Compensator kit	11-5	Plate seal	11-170	W/spool cover kit
10-25	Check valve	11-23	Plug	11-171	Cover kit
10-28	Seal kit	11-24	Compensator kit	11-174	Snubber

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

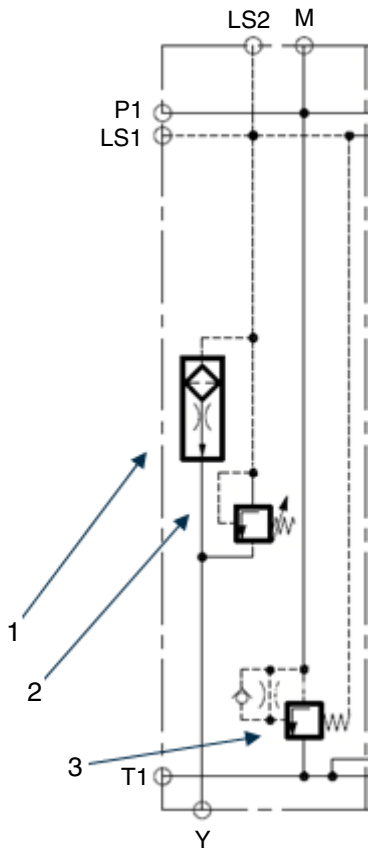


85A2MC07

4. FUNCTION

1) INLET ELEMENT DESCRIPTION

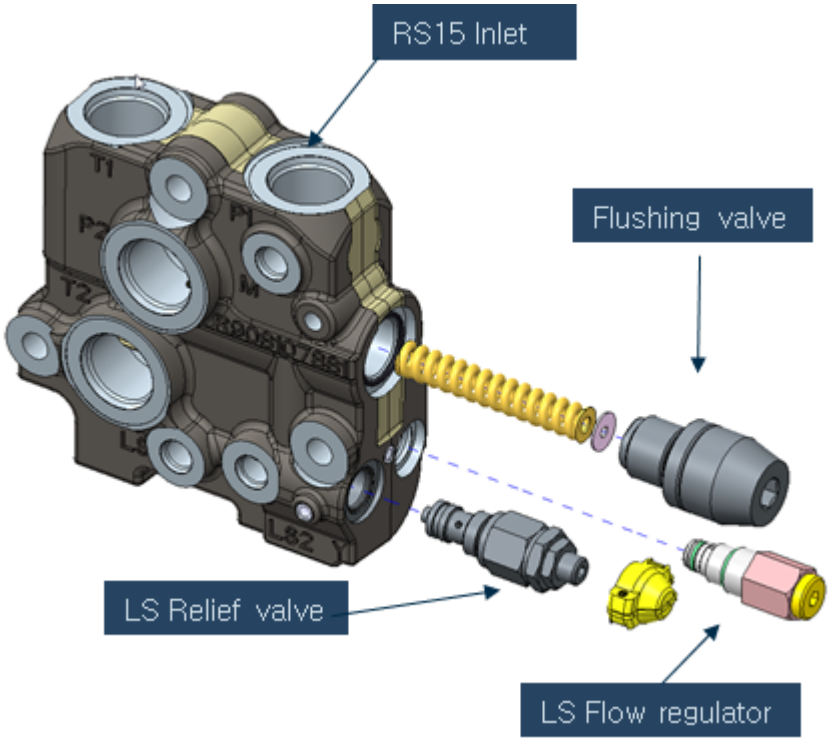
- The inlet plate has the line connections P, T, LS,Y and M.
- The inlet element moreover comprises all components necessary for the system function: One flow control valve (1) for the controlled unloading of the LS line and one LS pressure relief valve (2) to limit the maximum system pressure.
- Protection of the system by means of LS pressure relief valve (2) combined with flushing valve (3).



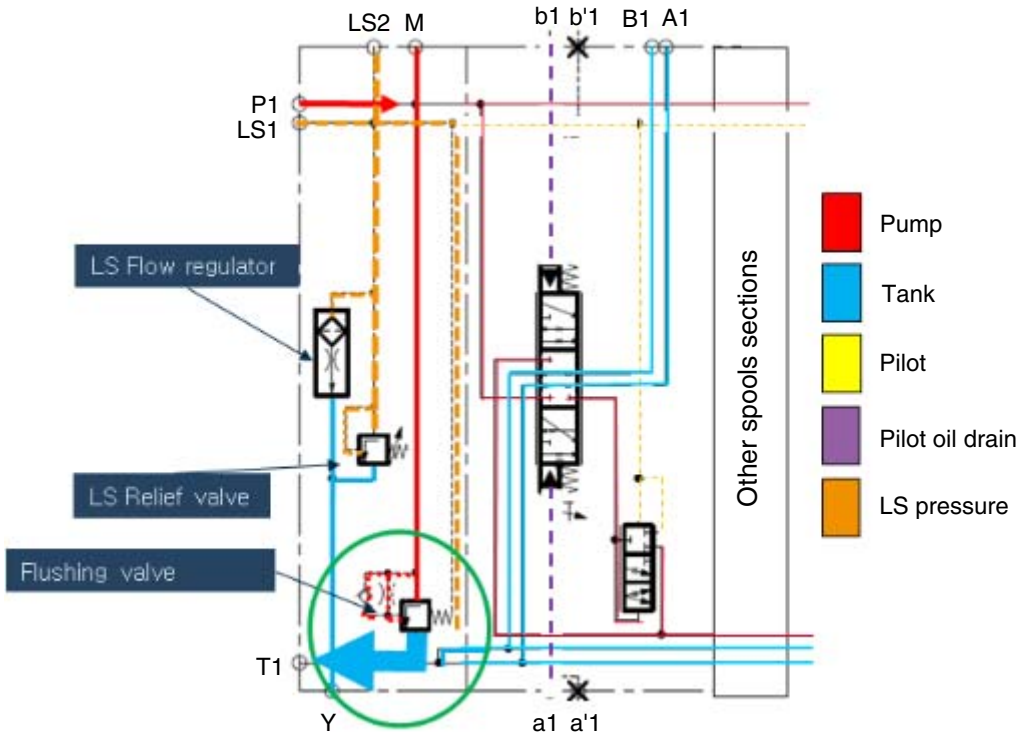
85A2MC10

(1) Inlet description - all spools at neutral position

First section-travel-represented at neutral



85A2MC11



85A2MC12

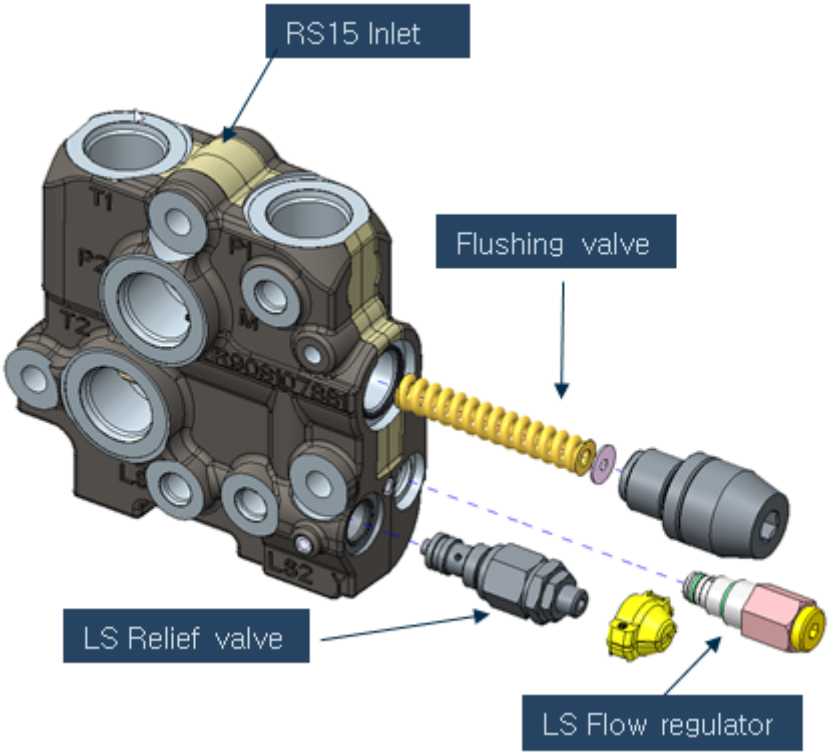
The Inlet element allows the exchange of the in the flow from the pump and the out flow to the tank.

When all sections are in neutral position, the pump is in stand-by and flow is reduced to the minimum pump flow (14 ℓ/min).

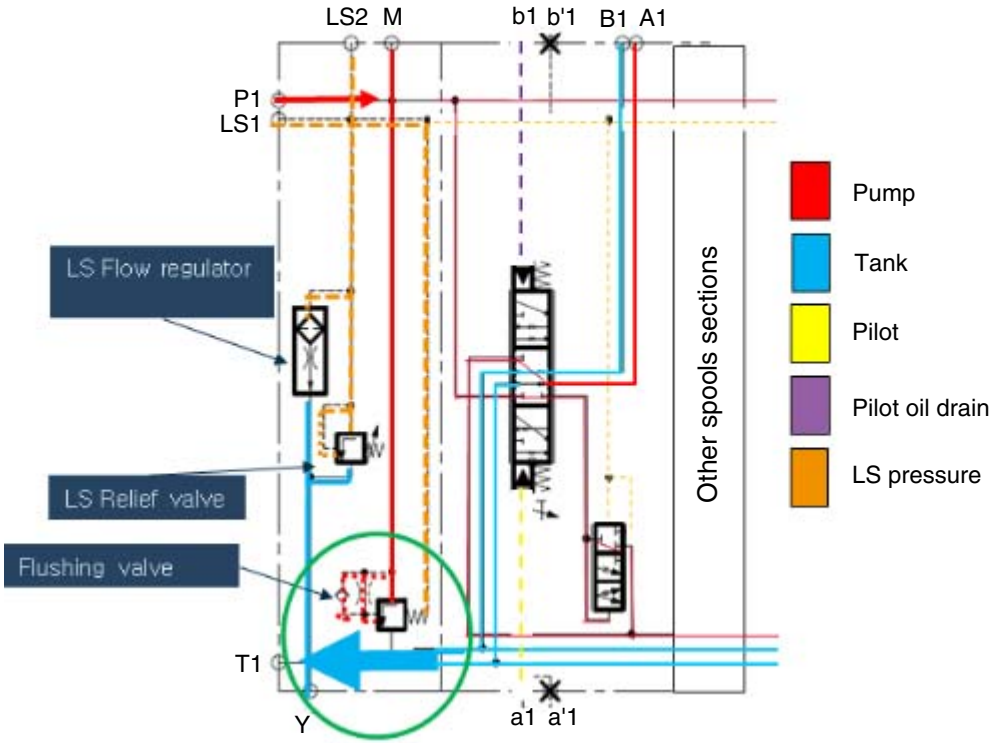
All the minimum pump flow pass through the flushing valve which is open, it means connected to the tank.

(2) Inlet description - spool actuated

First section-travel-PABT spool position represented.



85A2MC13

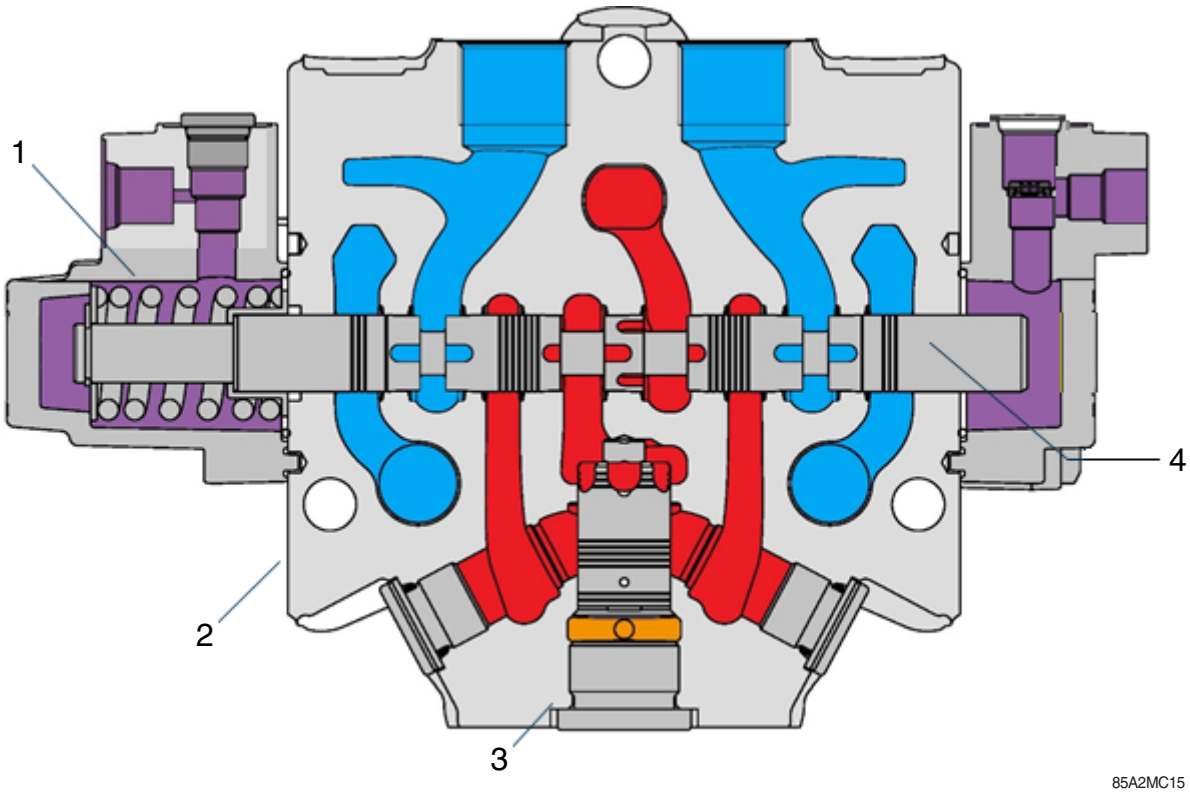


85A2MC14

As soon as one or more spool moves, the flow stop to pass trough the flushing valve, which is closed, not anymore connected to the tank. The flow pass trough the spool to reach the movement, and then go to the tank by the T line after the spool.

2) TRAVEL SECTION DESCRIPTION - SECTION 1 AND 2

(1) Component description



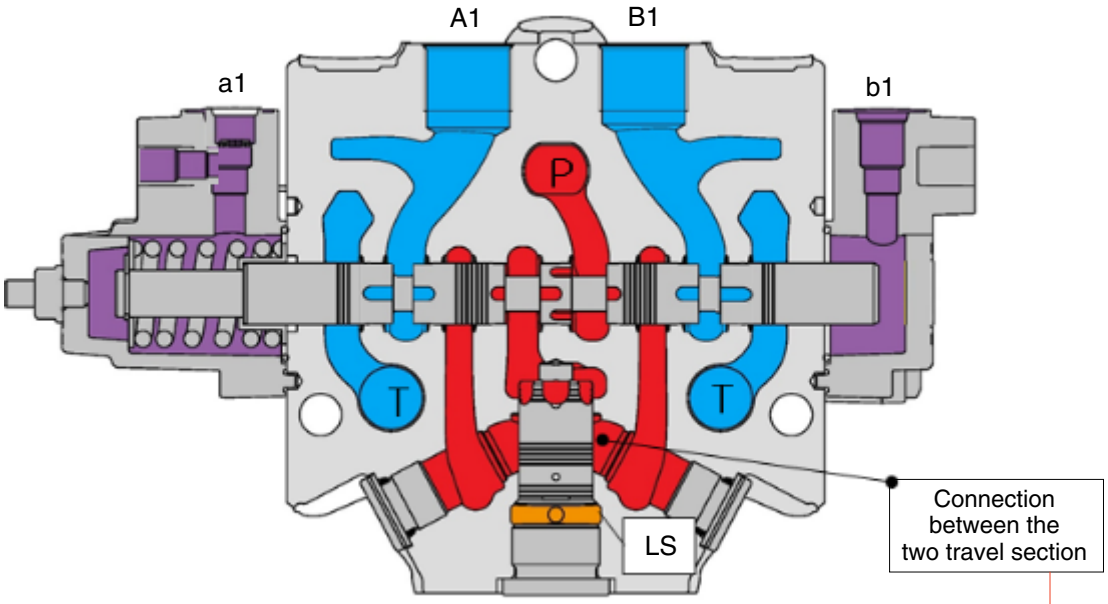
85A2MC15

Pump
Tank
Pilot
Pilot oil drain
LS pressure
Consumer

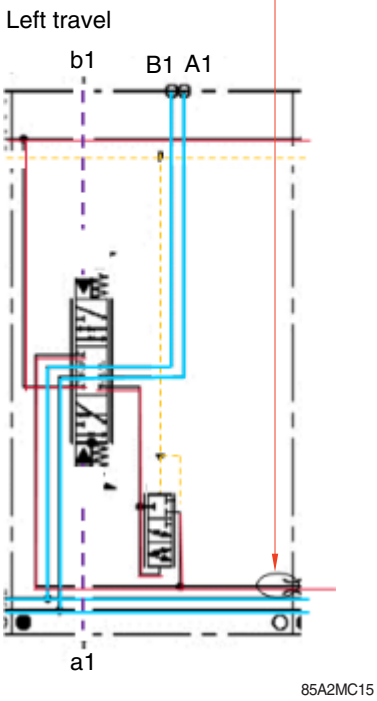
85A2MC16

1 Spring pack
2 Housing
3 Pressure compensator
4 Spool

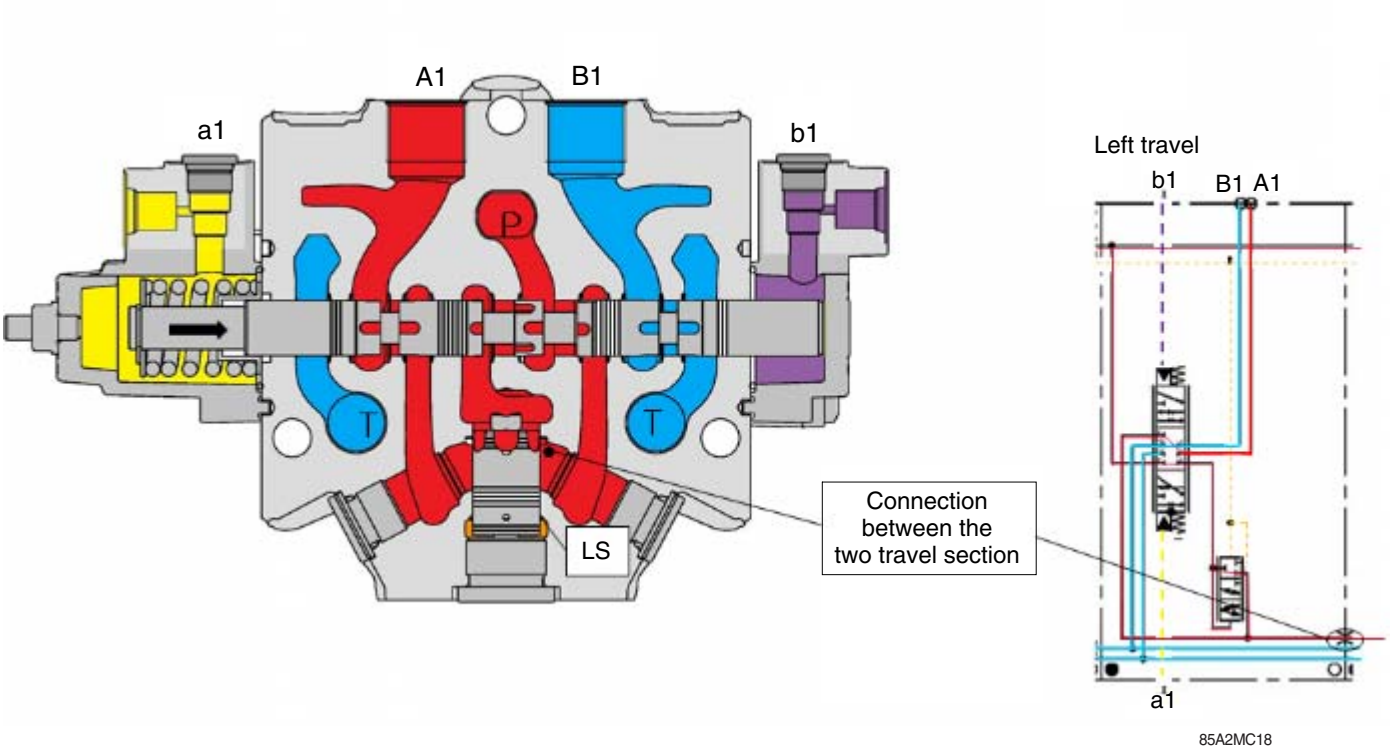
(2) Neutral position



The spool is in neutral position, pump is in low pressure stand-by. The A and B ports are not connected to the pumps but to the tank. This is in order to ensure A and B to be drained to tank. The two translation branches, 1 and 2, are connected in order not to have differences in traction.

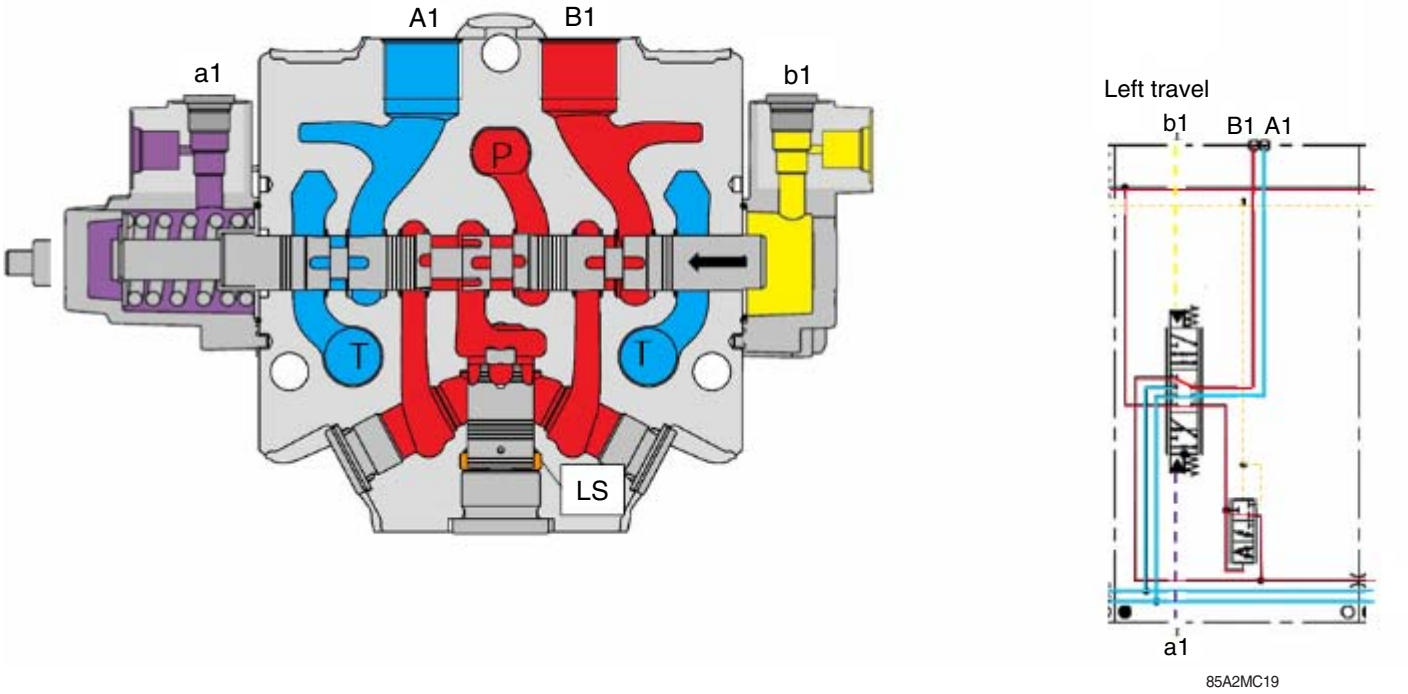


(3) Travel forward position



When the pilot pressure is led to the port a1, the oil from the pump flows to the cylinder port A1 and oil from the cylinder flows into the tank through the cylinder port B1.

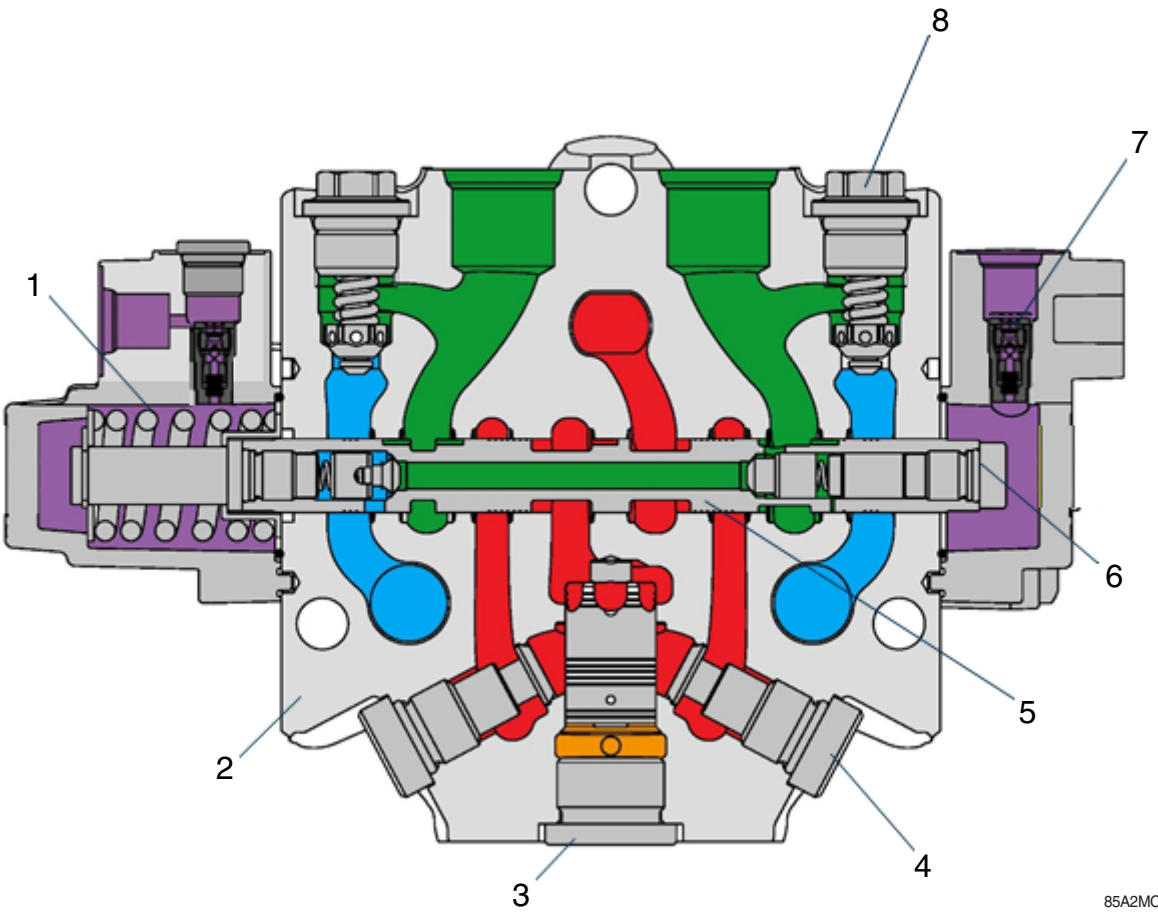
(4) Travel reverse position



When the pilot pressure is led to the port b1, the oil from the pump flows to the cylinder port B1 and oil from the cylinder flows into the tank through the cylinder port A1.

3) BOOM AND ARM SECTION 3 AND 4 DESCRIPTION - WITH REGENERATION SPOOLS

(1) Component description



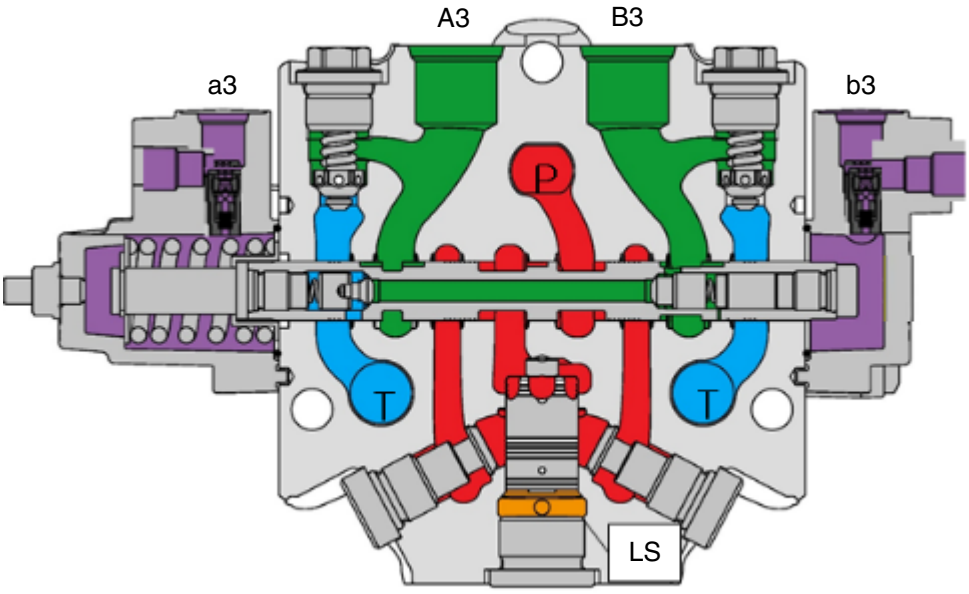
85A2MC20

- Pump
- Tank
- Pilot
- Pilot oil drain
- LS pressure
- Consumer
- Regeneration flow (position PABT on 2-25 pages)

85A2MC21

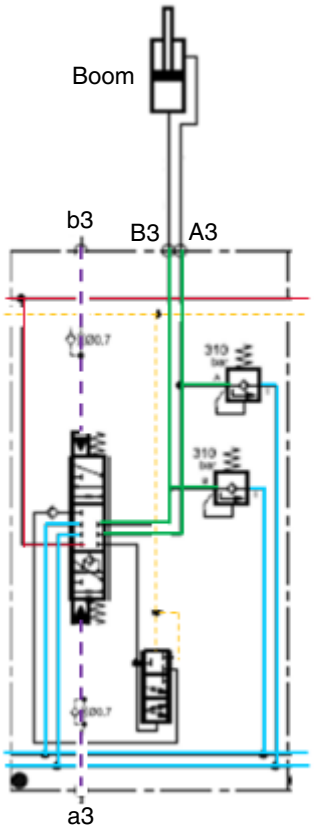
1 Spring pack
2 Housing
3 Pressure compensator
4 Check valves
5 Regeneration spool
6 Spool
7 Shuttle valve
8 Relief valves

(2) Neutral position



85A2MC22

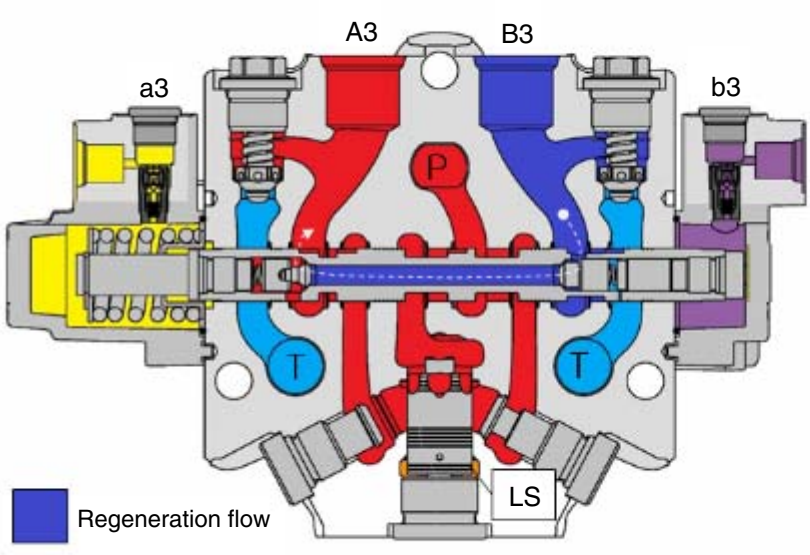
The spool is in neutral position, oil from the pump is blocked, pump is in low pressure stand-by. The A and B ports are not connected to the pump nor the tank.

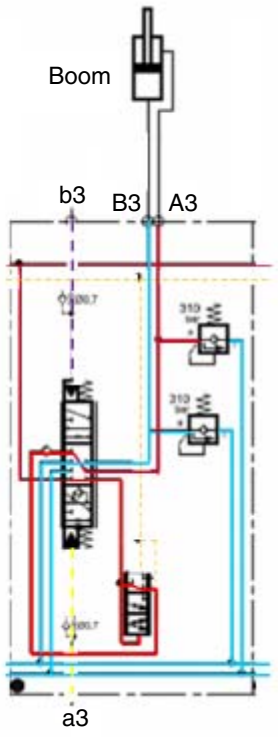


85A2MC23

(3) Boom section description

① Boom down position

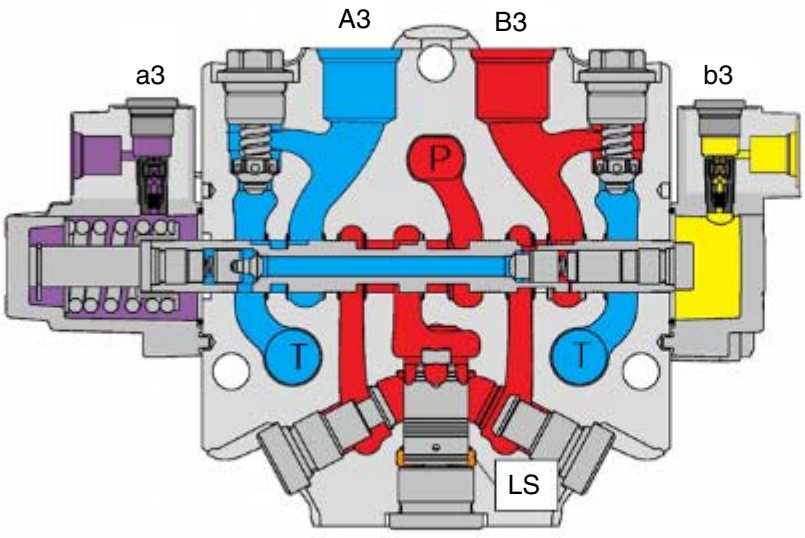


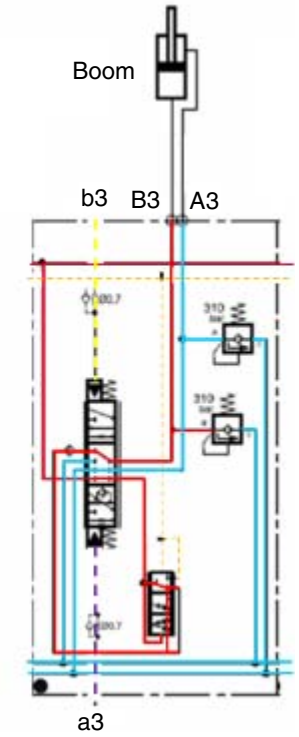


85A2MC24

When the pilot pressure is led to the port a3, the oil from the pump flows to the cylinder port A3 and oil from the cylinder flows partially into the tank and partially trough regeneration path B to A through the cylinder port B3.

② Boom up position



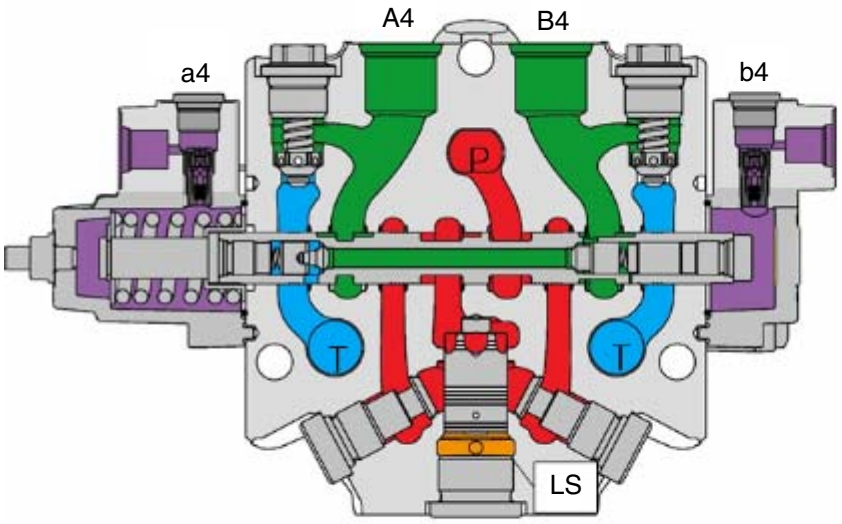


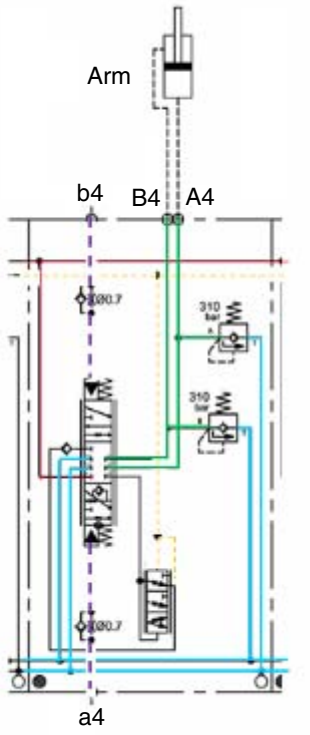
85A2MC25

When the pilot pressure is led to the port b3, the oil from the pump flows to the cylinder port B3 and oil from the cylinder flows into the tank through the cylinder port A3.

(4) Arm section description

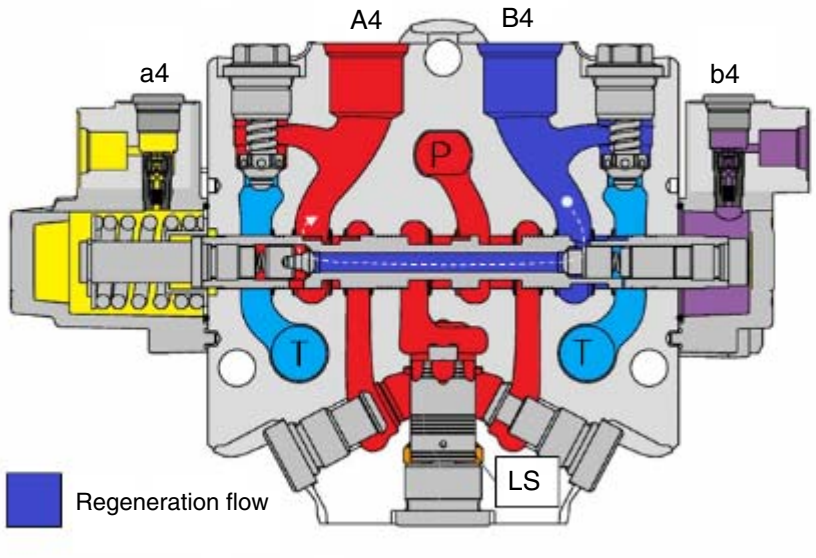
① Neutral position

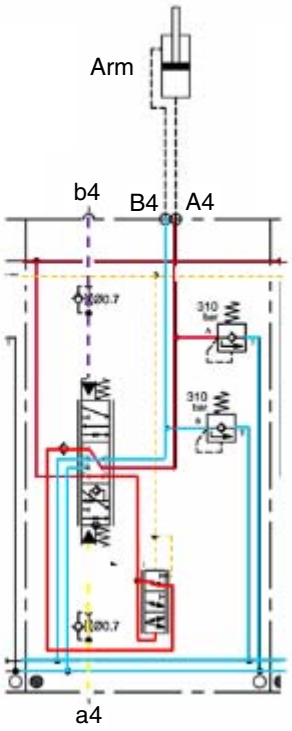




The spool is in neutral position, oil from the pump is blocked, pump is in low pressure stand-by. The A4 and B4 ports are not connected to the pump nor the tank.

② Arm roll in position

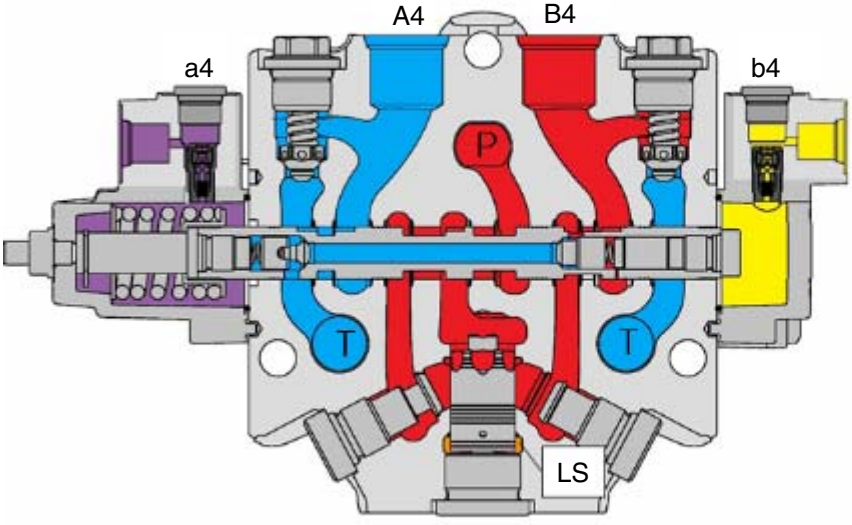


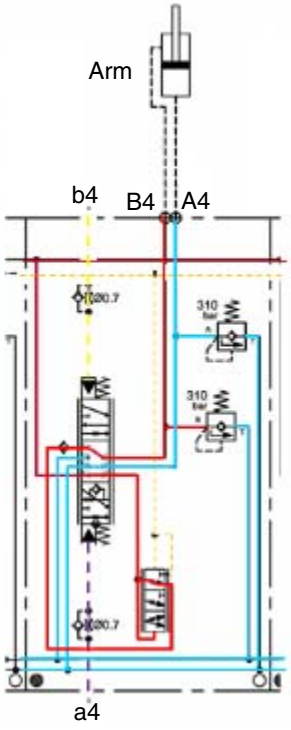


85A2MC27

When the pilot pressure is led to the port a4, the oil from the pump flows to the cylinder port A4 and oil from the cylinder flows partially into the tank and partially trough regeneration path B to A through the cylinder port B4 .

③ Arm roll out position



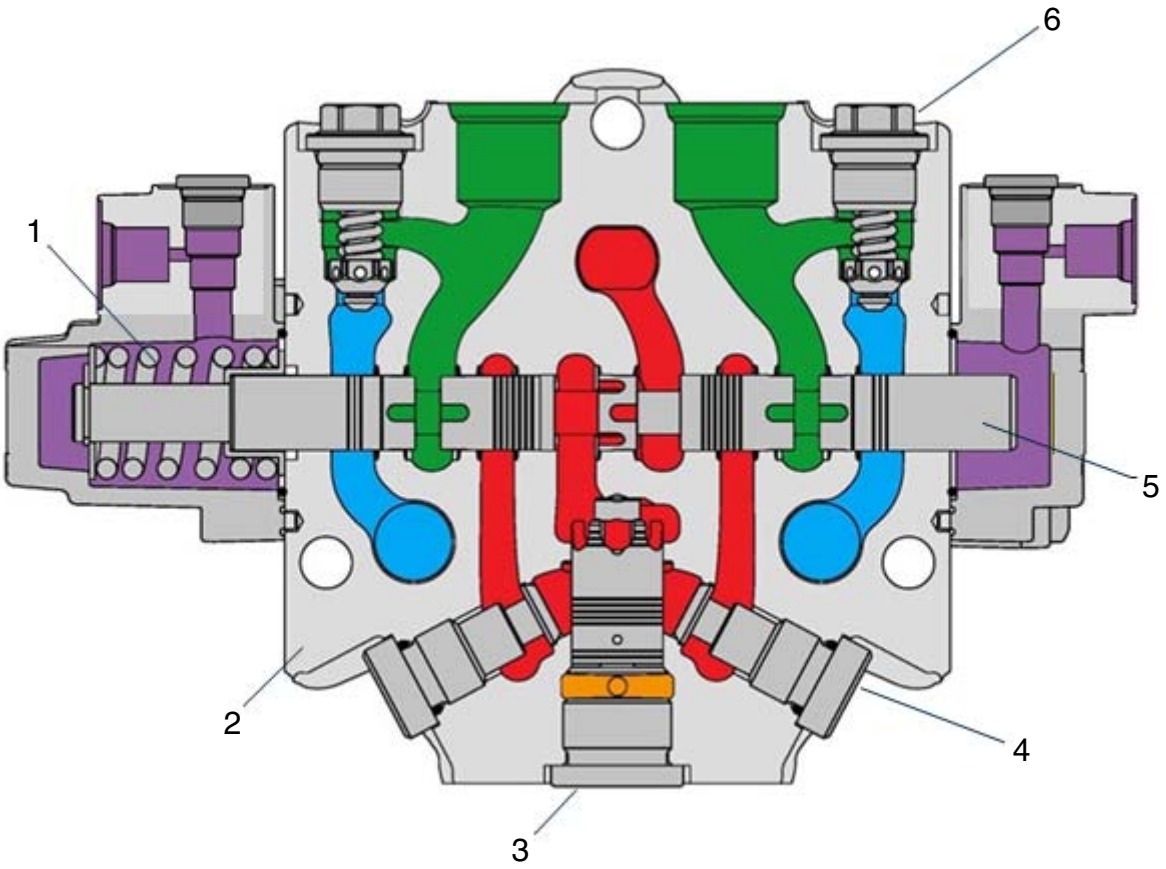


85A2MC28

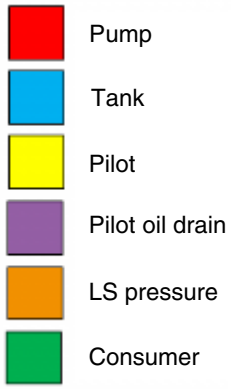
When the pilot pressure is led to the port b4, the oil from the pump flows to the cylinder port B4 and oil from the cylinder flows into the tank through the cylinder port A4.

4) BUCKET SECTION DESCRIPTION - SECTION 5

(1) Component description



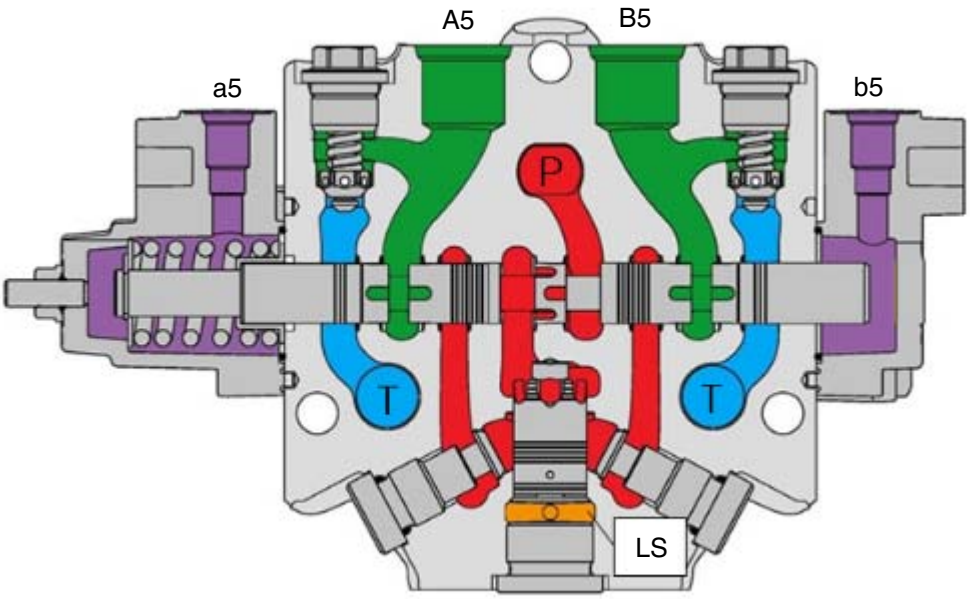
85A2MC29



85A2MC30

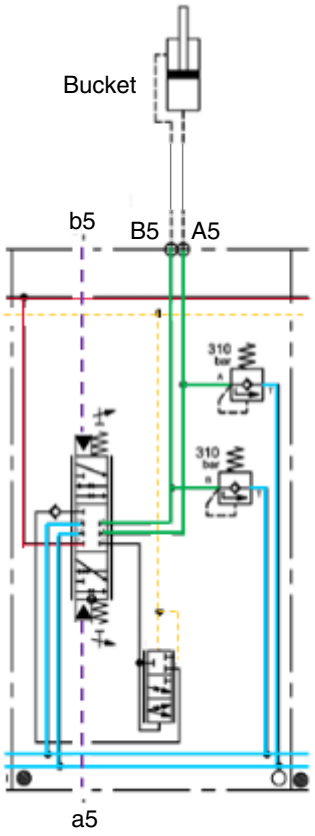
1 Spring pack
2 Housing
3 Pressure compensator
4 Check valves
5 Spool
6 Overload relief valves

(2) Neutral position



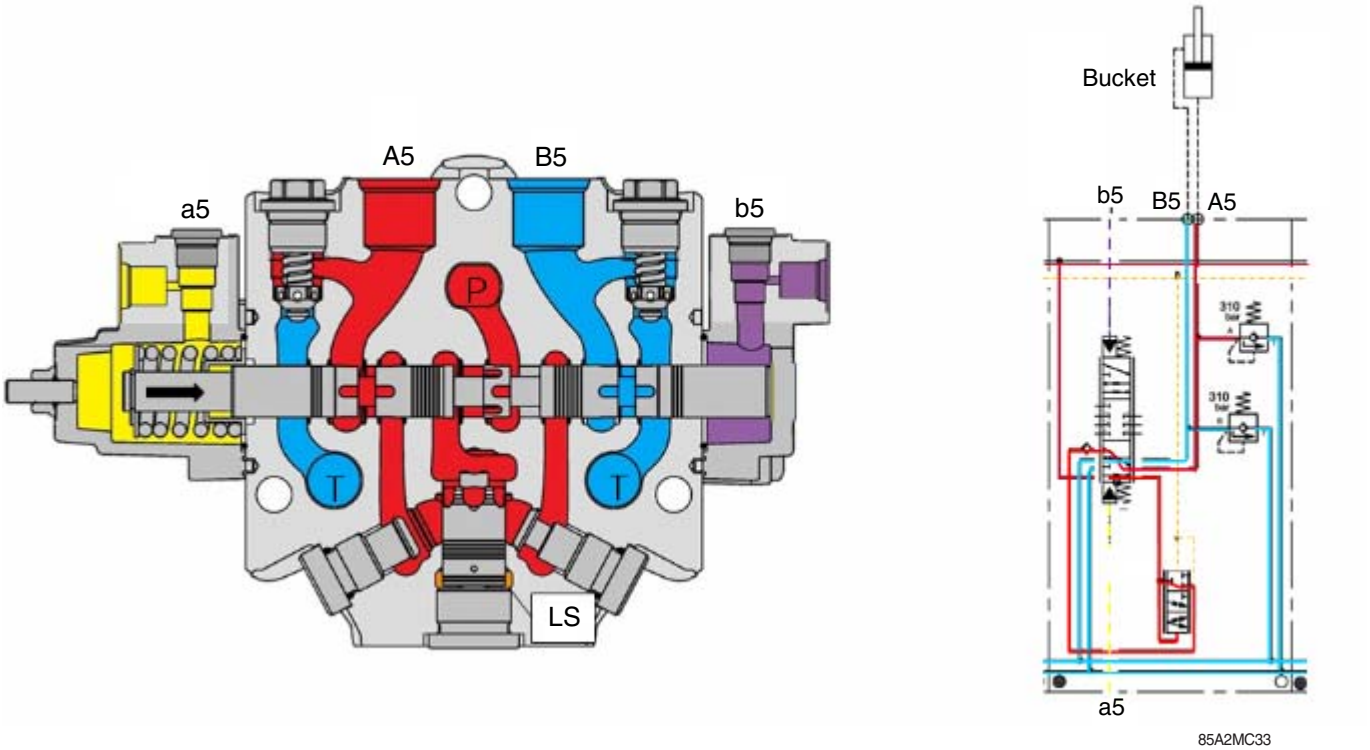
85A2MC31

The spool is in neutral position, pump is in low pressure stand-by. The A5 and B5 ports are not connected to the pumps nor the tank.



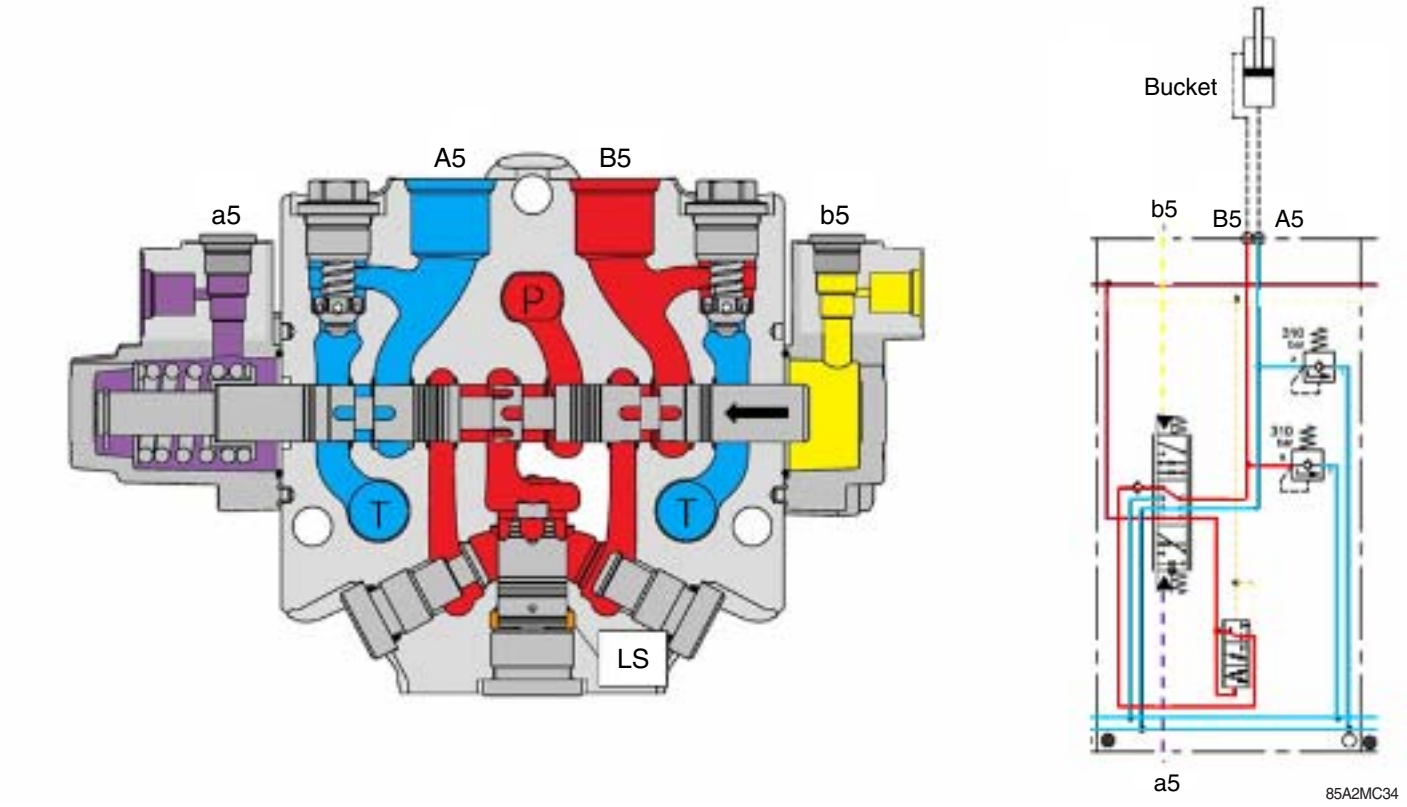
85A2MC32

(3) Bucket roll in position



When the pilot pressure is led to the port a5, the oil from the pump flows to the cylinder port A5 and oil from the cylinder flows into the tank through the cylinder port B5.

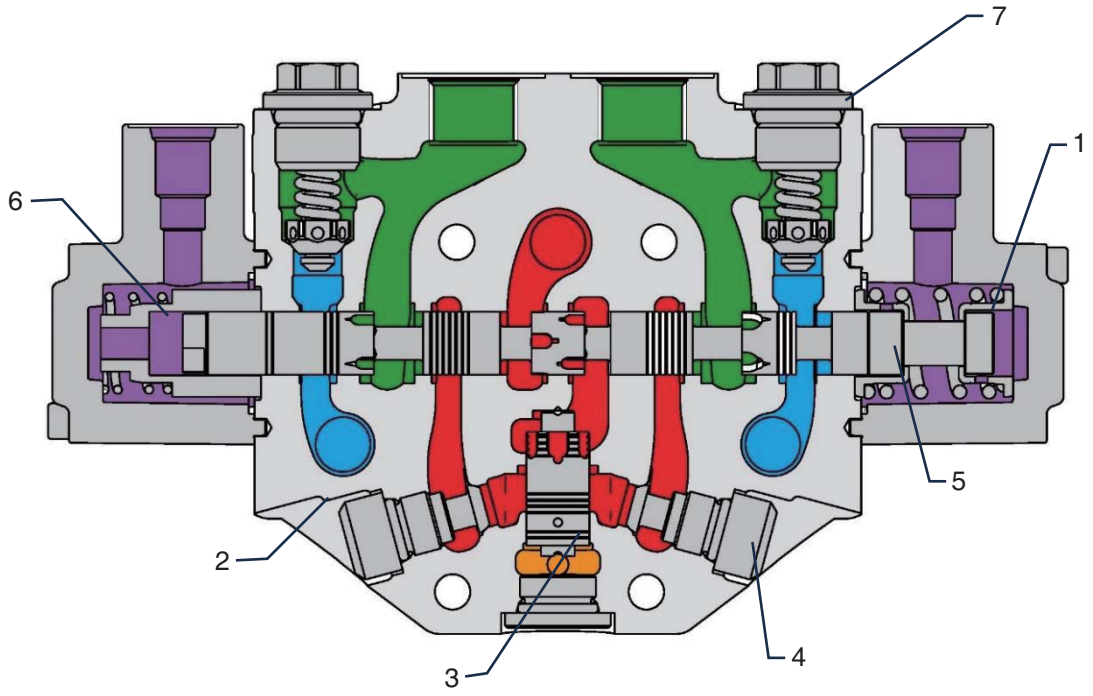
(4) Bucket roll out position



When the pilot pressure is led to the port b5, the oil from the pump flows to the cylinder port B5 and oil from the cylinder flows into the tank through the cylinder port A5.

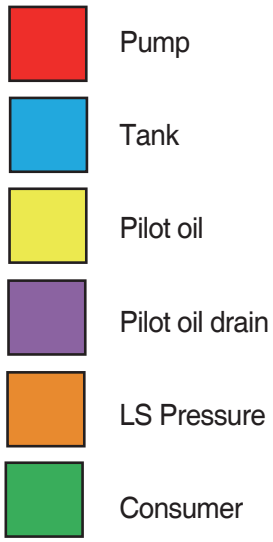
5) BUCKET SECTION DESCRIPTION - SECTION 6

(1) Component description



85A2MC35

※ This particular slide has a four position spool: neutral, roll in, roll out and floating position.

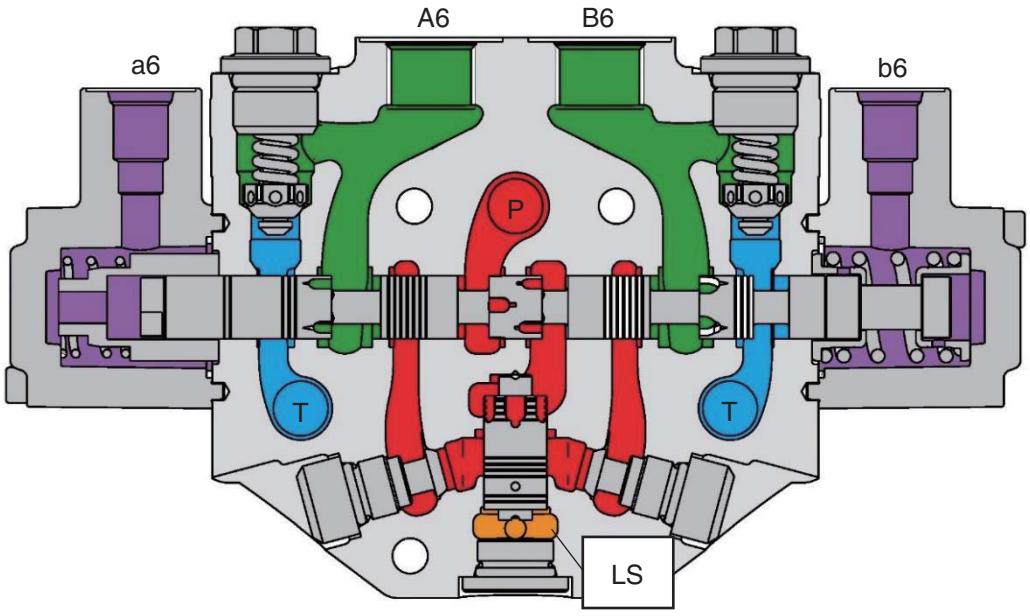


Pump
Tank
Pilot oil
Pilot oil drain
LS Pressure
Consumer

85A2MC36

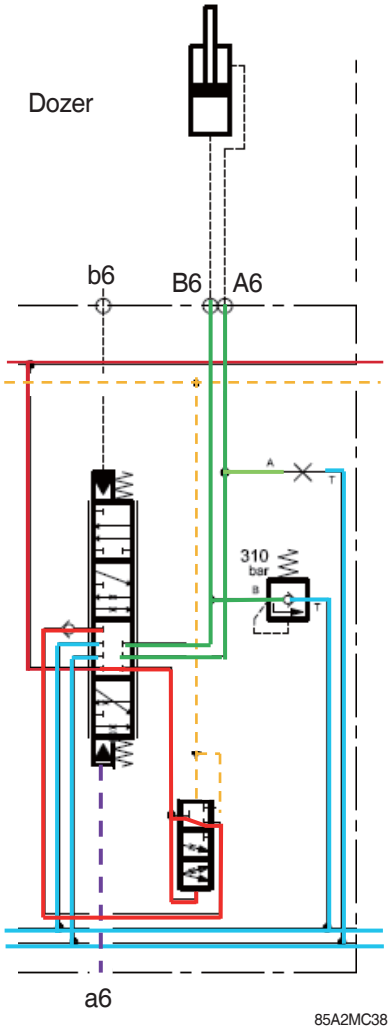
1 Spring pack
2 Housing
3 Pressure compensator
4 Check valves
5 Spool
6 Fourth position spring pack
7 Relief valves

(2) Neutral position



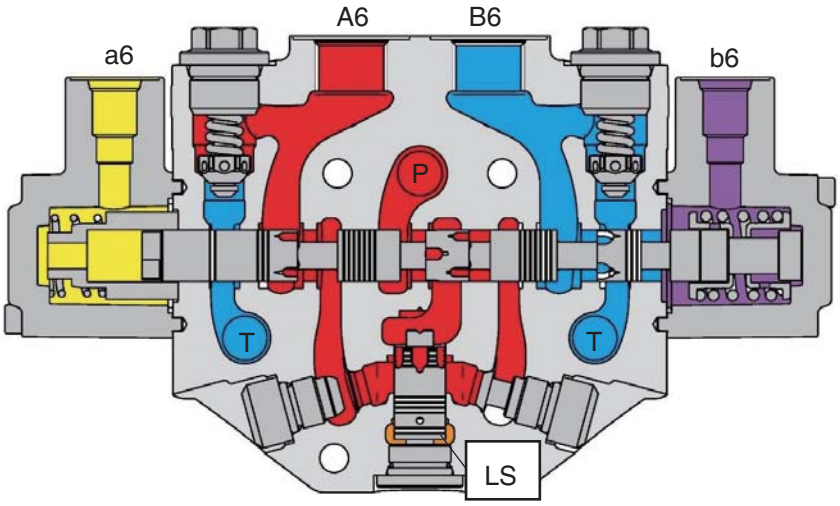
85A2MC37

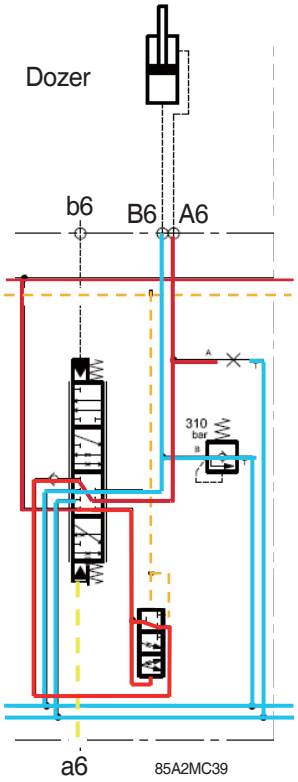
The spool is in neutral position, oil from the pump is not connected to the A6 or to the B6 ports. Pump is in low pressure stand-by.



85A2MC38

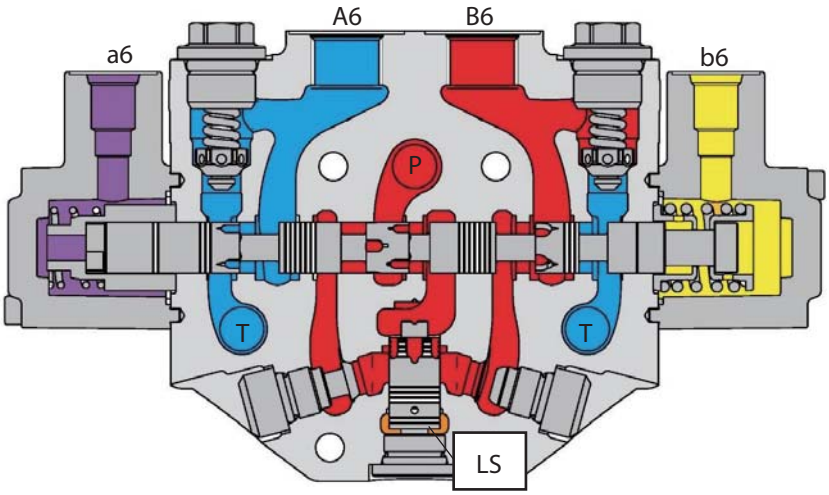
(3) PABT position (dozer up)

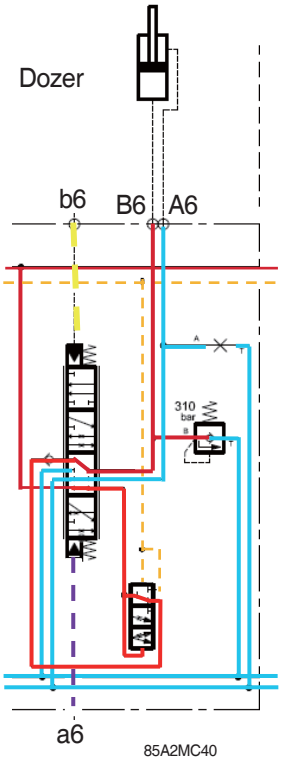




When the pilot pressure is led to the port a6, the oil from the pump flows to the cylinder port A6 and oil from the cylinder flows into the tank through the cylinder port B6.

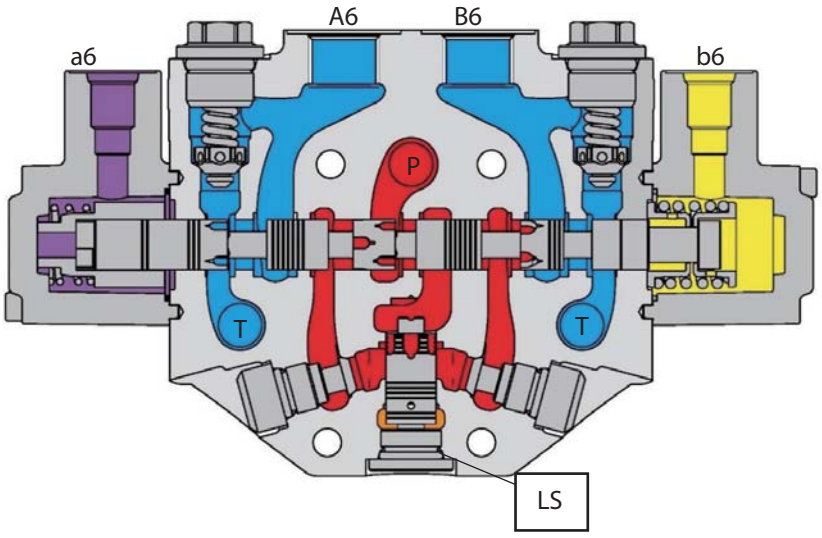
(4) PBAT position (dozer down)

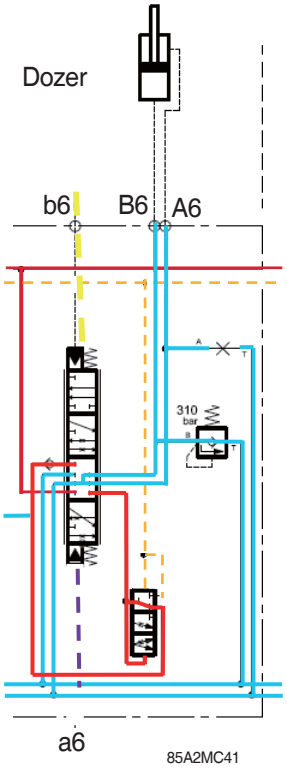




When the pilot pressure is led to the port b6, the oil from the pump flows to the cylinder port B6 and oil from the cylinder flows into the tank through the cylinder port A6.

(5) Floating position

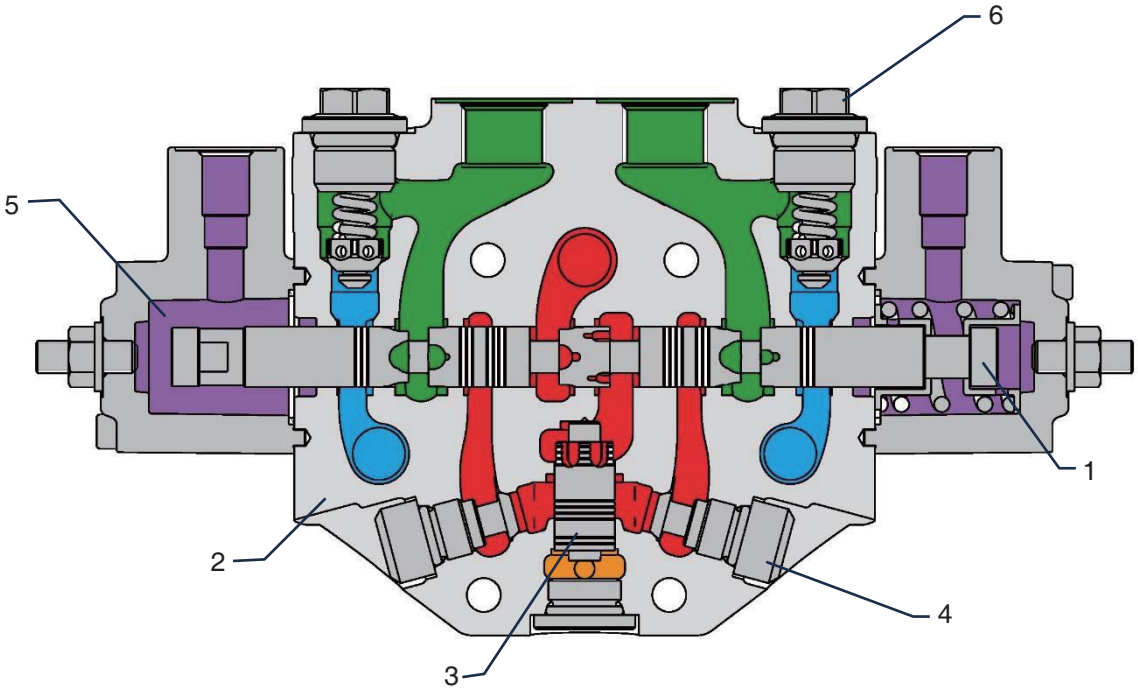




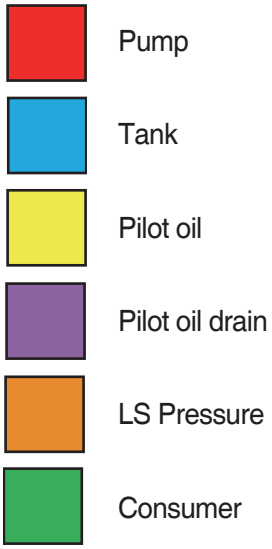
When the pilot pressure is led to the port b6 to maximal pressure, the spool is in the forth position, floating. The pump is in low pressure stand-by while A and B are connected to tank.

6) SLICES DESCRIPTION 7 : BOOM SWING

(1) Component description



85A2MC42

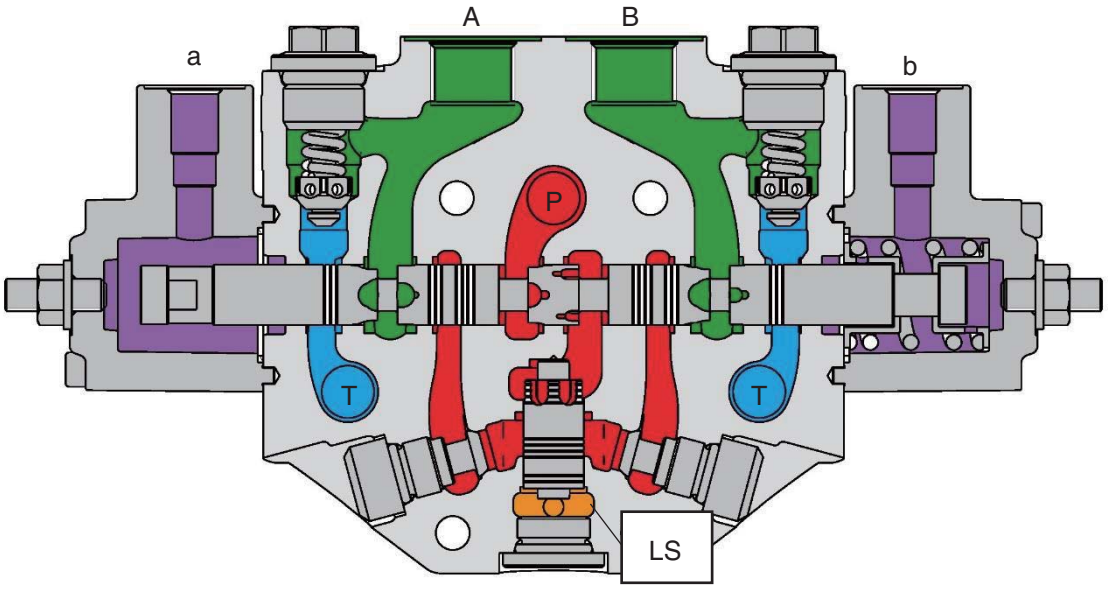


Pump
Tank
Pilot oil
Pilot oil drain
LS Pressure
Consumer

85A2MC43

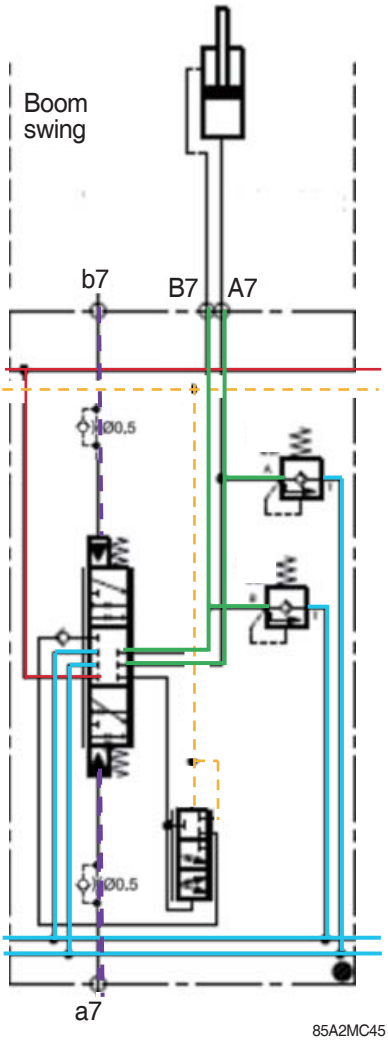
1 Spring pack
2 Housing
3 Pressure compensator
4 Check valves
5 Spool
6 Relief valves

(2) Neutral position



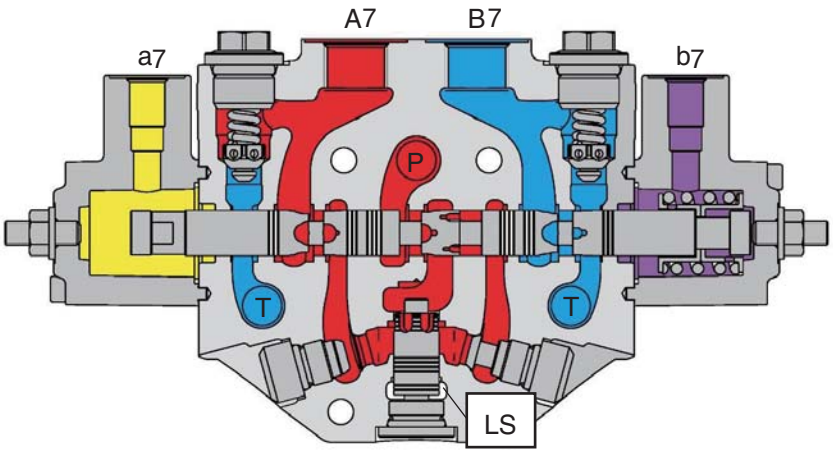
85A2MC44

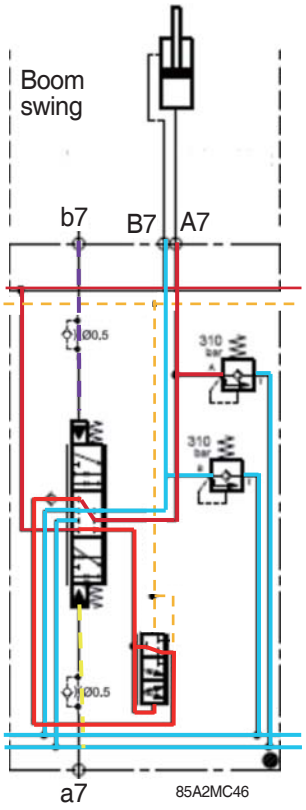
The spool is in neutral position, pump is in low pressure stand-by. The A7 and B7 ports are not connected to the pumps nor the tank.



85A2MC45

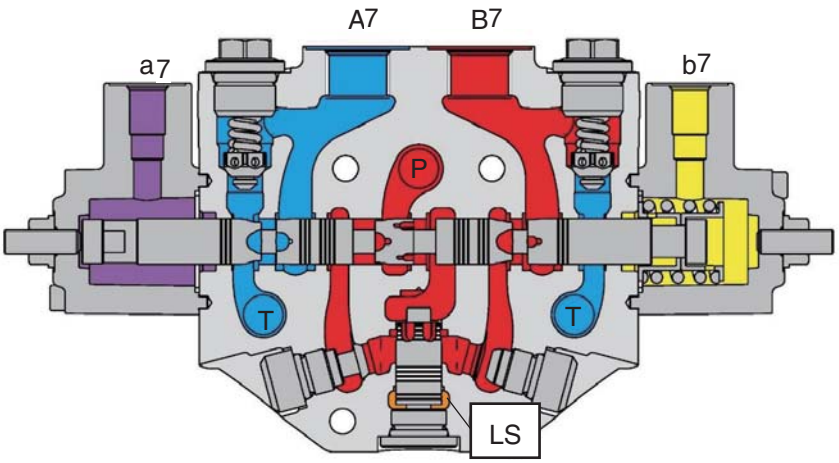
(3) PABT position

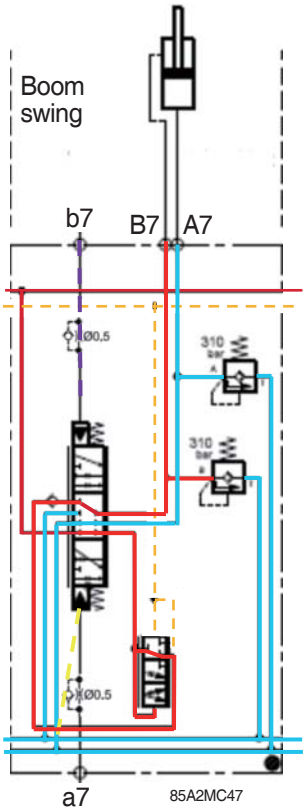




When the pilot pressure is led to the port a7, the oil from the pump flows to the cylinder port A7 and oil from the cylinder flows into the tank through the cylinder port B7.

(4) PBAT position

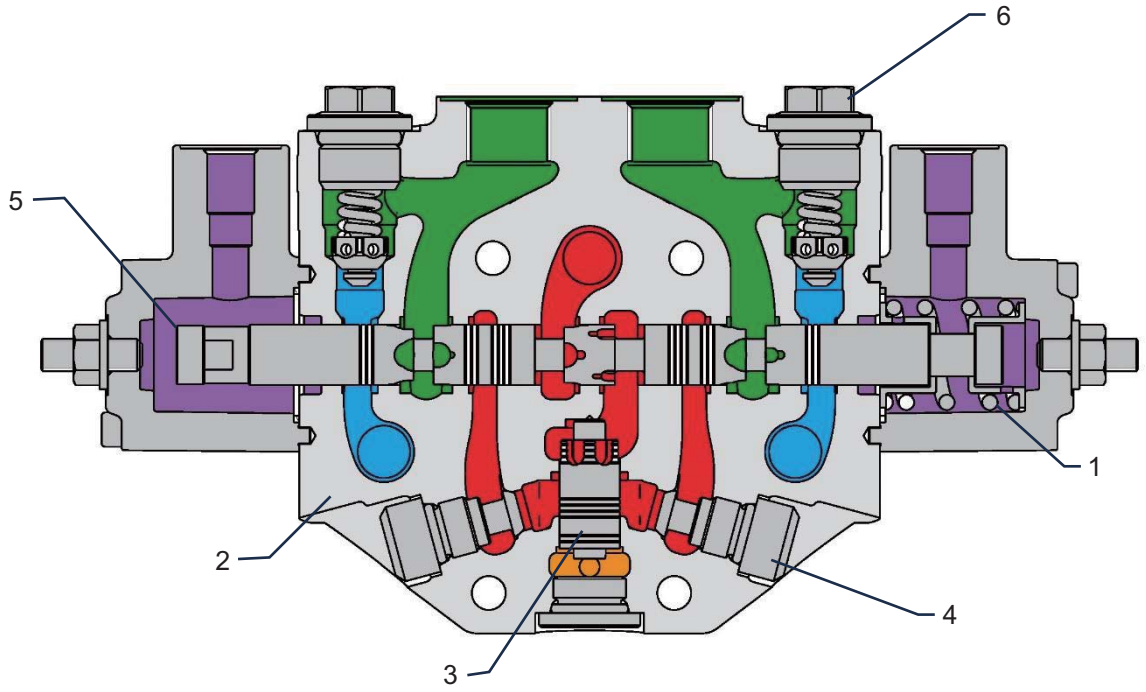




When the pilot pressure is led to the port b7, the oil from the pump flows to the cylinder port B7 and oil from the cylinder flows into the tank through the cylinder port A7.

7) SLICES DESCRIPTION 8 TO 10 : 2 PCS BOOM - AUX 1 - AUX 2

(1) Component description



85A2MC48

Pump

Tank

Pilot oil

Pilot oil drain

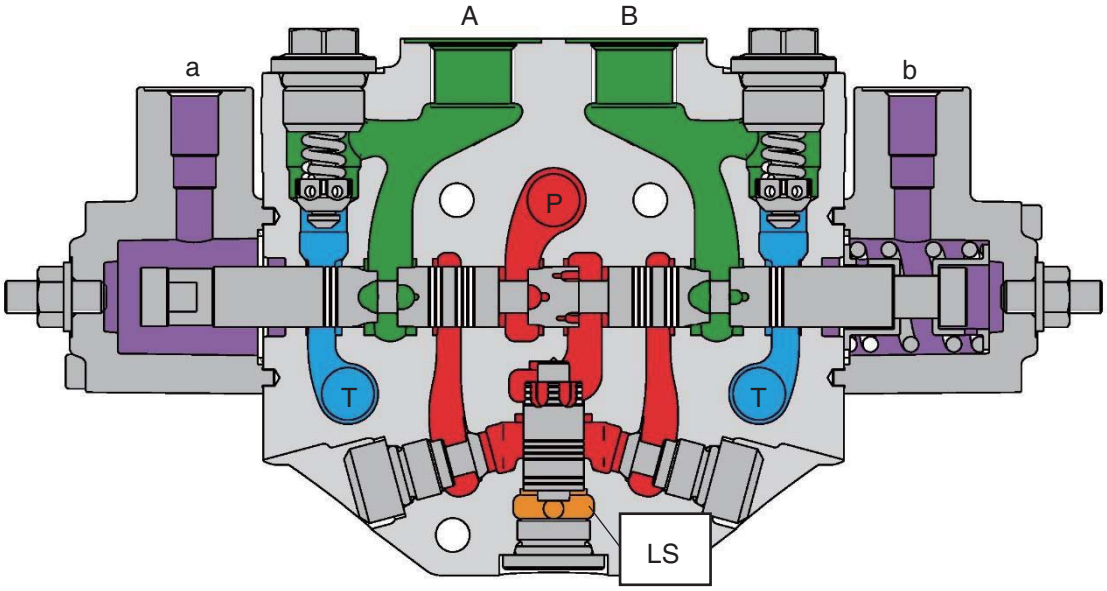
LS Pressure

Consumer

85A2MC43

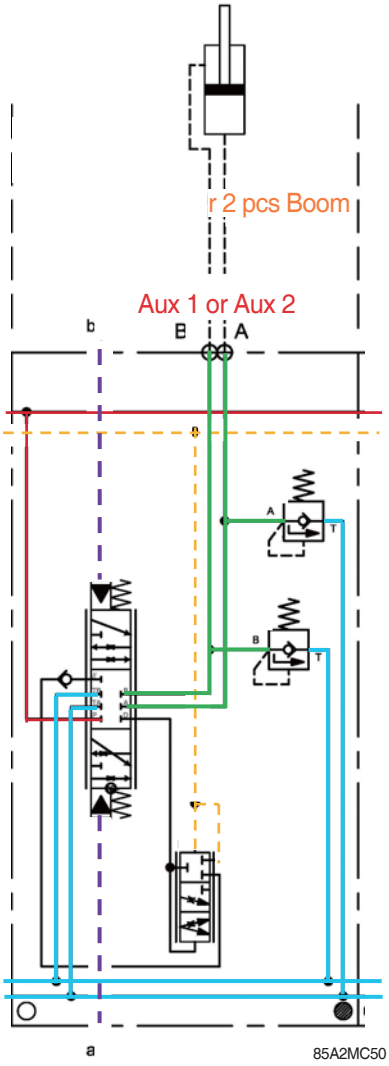
1 Spring pack
2 Housing
3 Pressure compensator
4 Check valves
5 Spool
6 Relief valves

(2) Neutral position



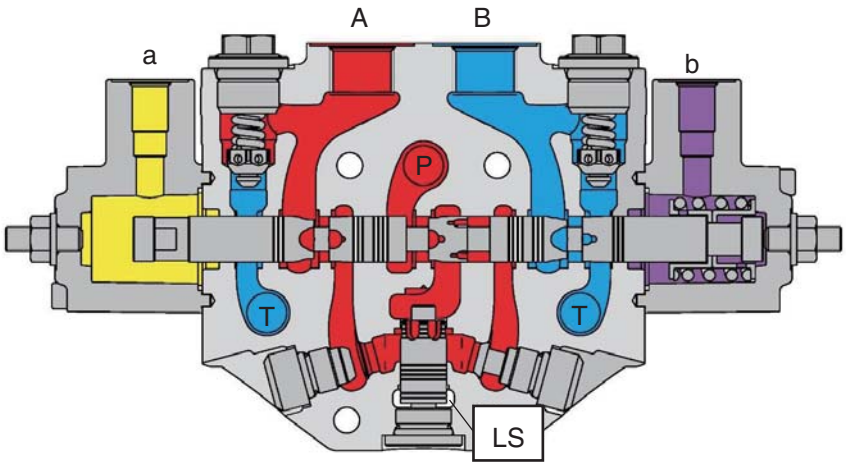
85A2MC49

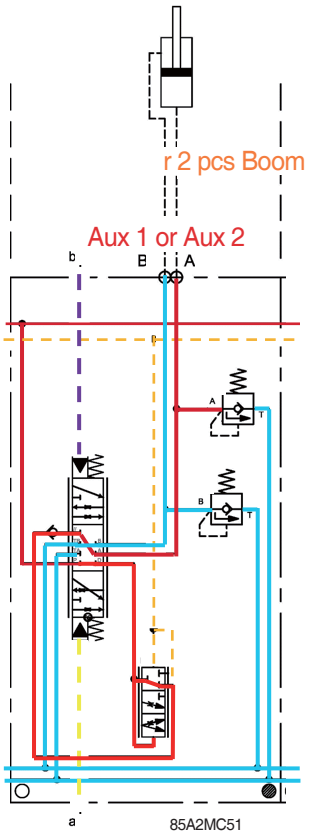
The spool is in neutral position, pump is in low pressure stand-by. The A and B ports are not connected to the pumps nor the tank.



85A2MC50

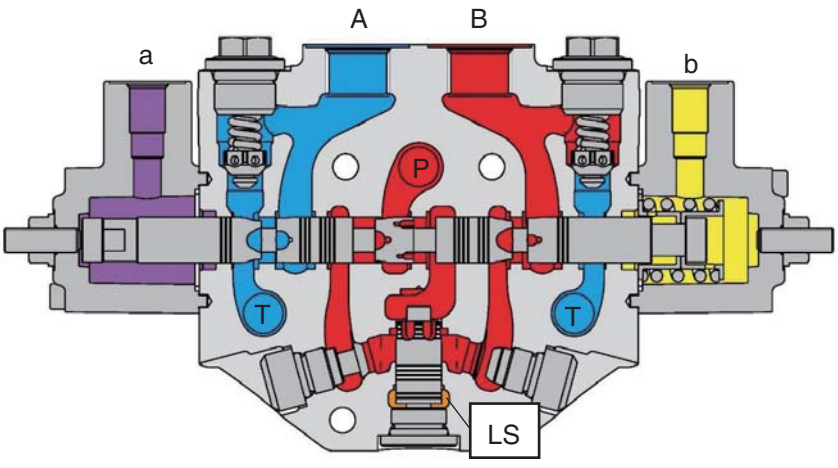
(3) PABT position

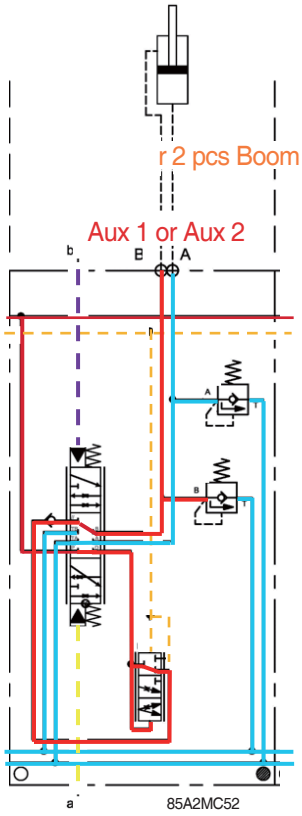




When the pilot pressure is led to the port a, the oil from the pump flows to the cylinder port A and oil from the cylinder flows into the tank through the cylinder port B.

(4) PBAT position

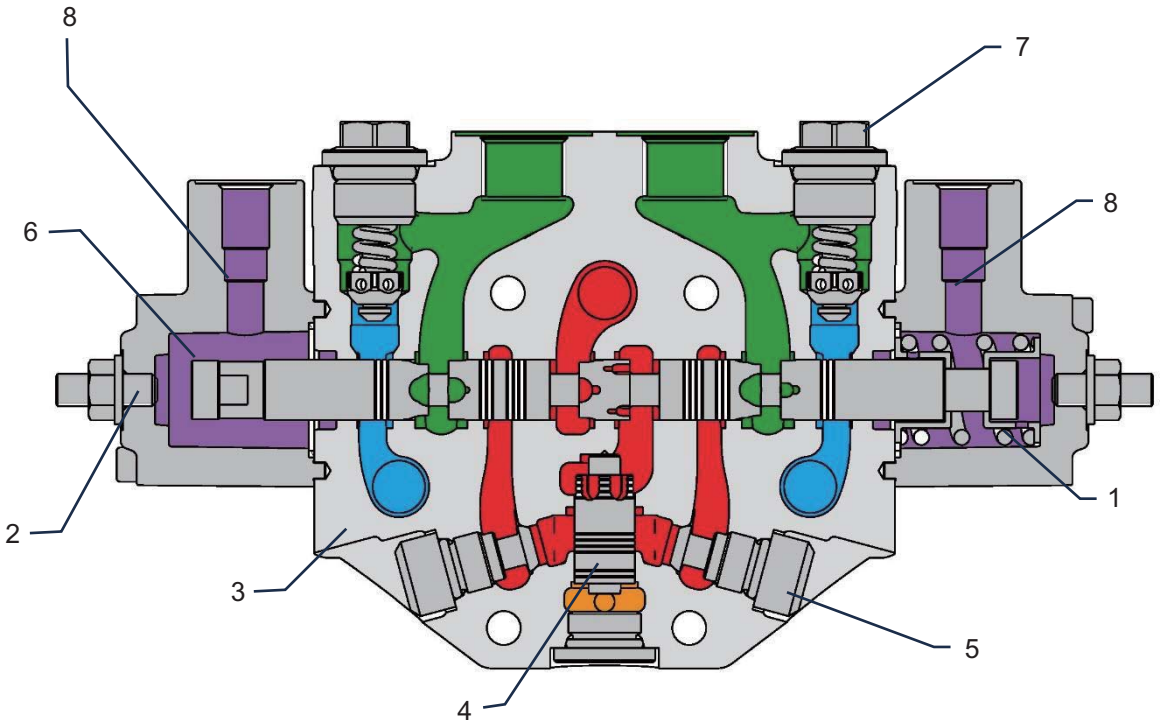




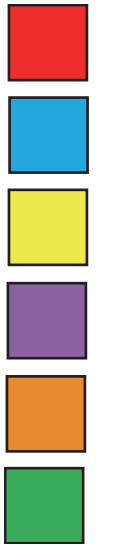
When the pilot pressure is led to the port b, the oil from the pump flows to the cylinder port B and oil from the cylinder flows into the tank through the cylinder port A.

8) SWING SLICE DESCRIPTION

(1) Component description



85A2MC53



Pump

Tank

Pilot oil

Pilot oil drain

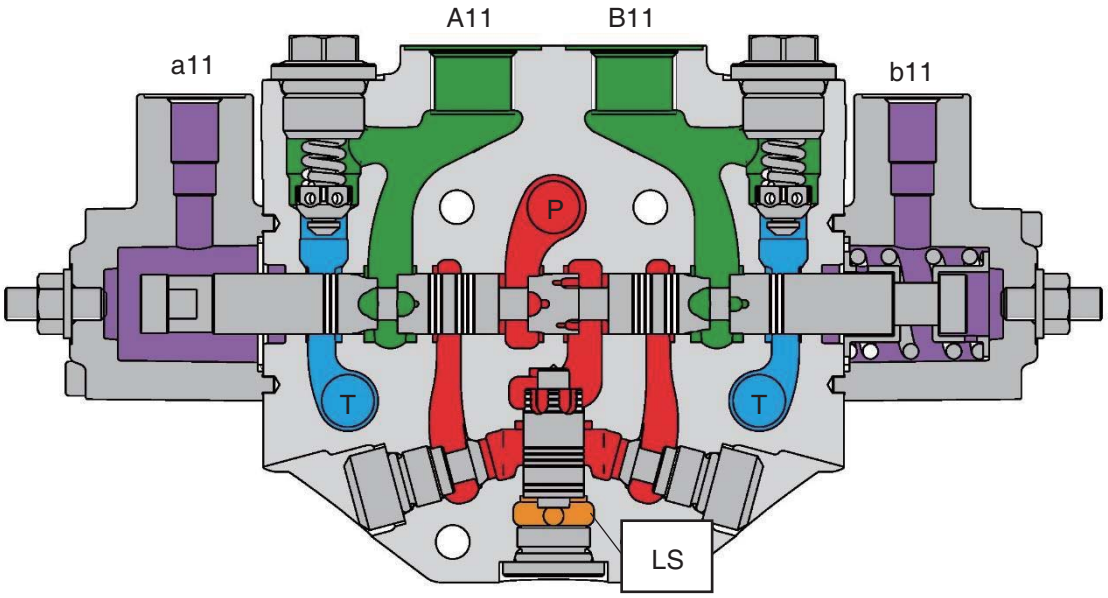
LS Pressure

Consumer

85A2MC43

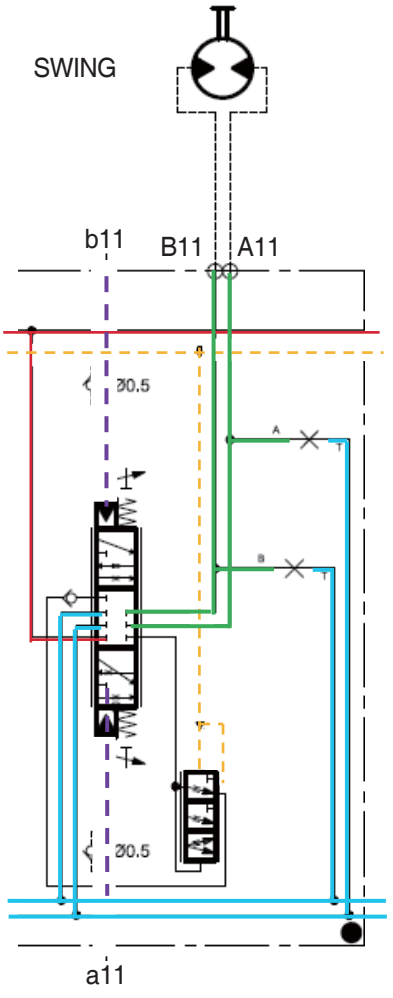
1 Spring pack
2 Stroke limitation device
3 Housing
4 Pressure compensator
5 Check valves
6 Spool
7 Plug
8 Snubbers

(2) Neutral position



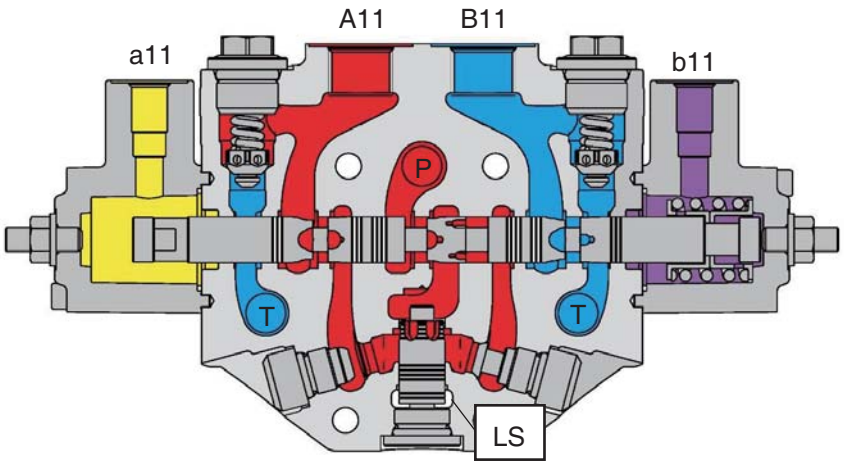
85A2MC54

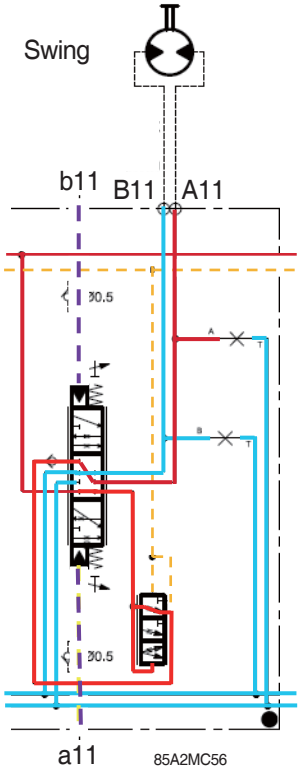
The spool is in neutral position, pump is in low pressure stand-by. The A and B ports are not connected to the pumps nor the tank. This slice is equipped with spool stroke limiters



85A2MC55

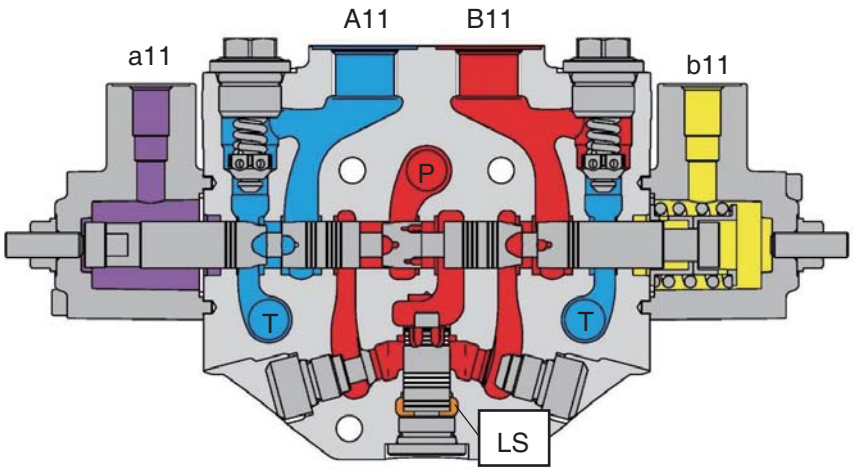
(3) PABT position

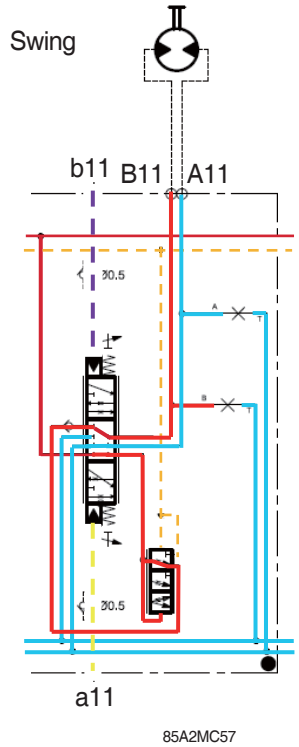




When the pilot pressure is led to the port a11, the oil from the pump flows to the motor port A11 and oil from the cylinder flows into the tank through the motor B11.

(4) PBAT position





When the pilot pressure is led to the port b11, the oil from the pump flows to the motor port B11 and oil from the cylinder flows into the tank through the motor port A11.

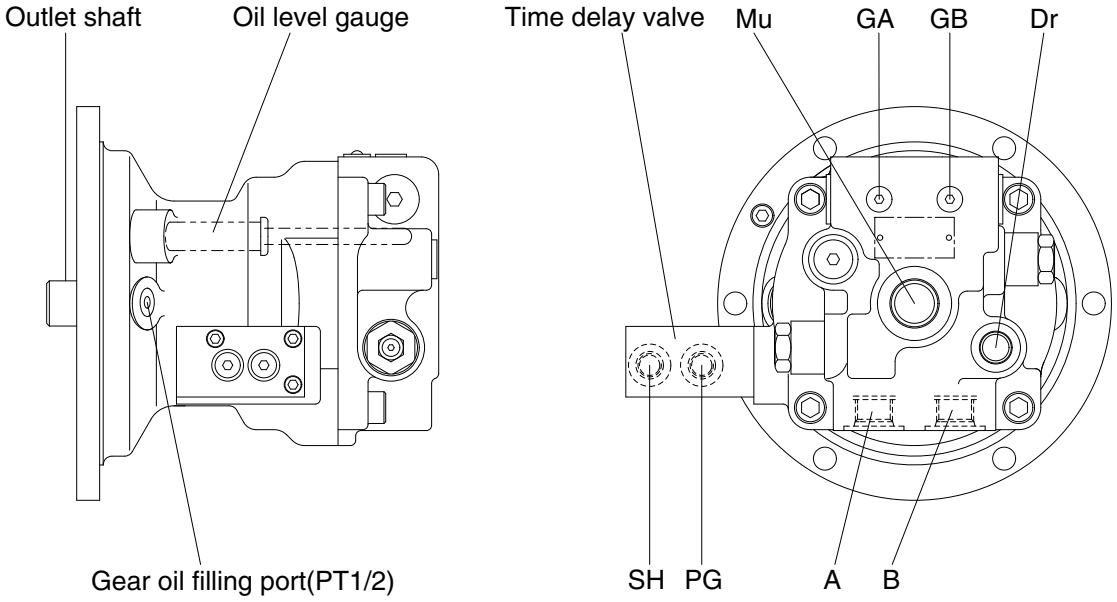
GROUP 3 SWING DEVICE

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.



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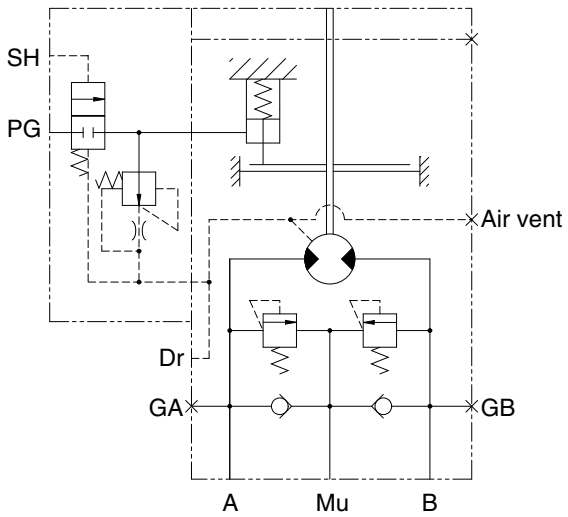
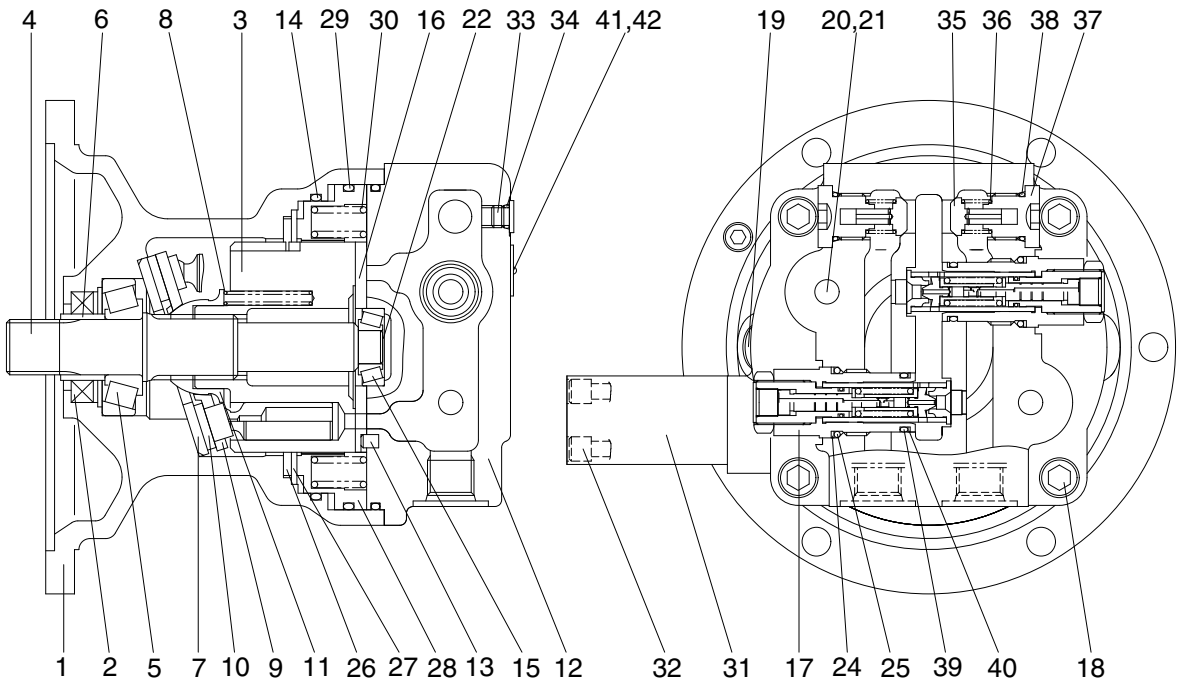


Hydraulic circuit

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



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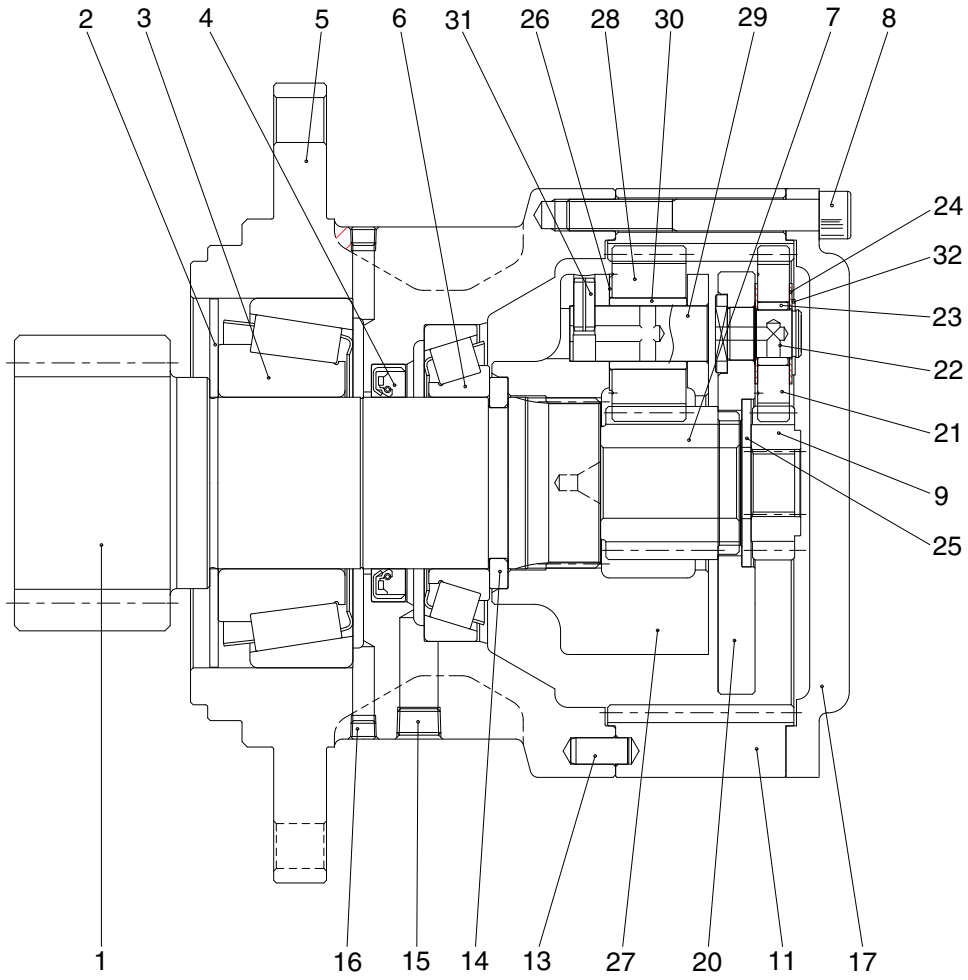
1	Body	15	Taper bearing	29	O-ring
2	Oil seal	16	Valve plate	30	Spring
3	Cylinder block	17	Relief valve assy	31	Time delay valve
4	Shaft	18	Socket bolt	32	Socket bolt
5	Taper bearing	19	Plug	33	Plug
6	Bushing	20	Plug	34	O-ring
7	Shoe plate	21	O-ring	35	Valve
8	Spring	22	Shim	36	Spring
9	Set plate	23	Plug	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

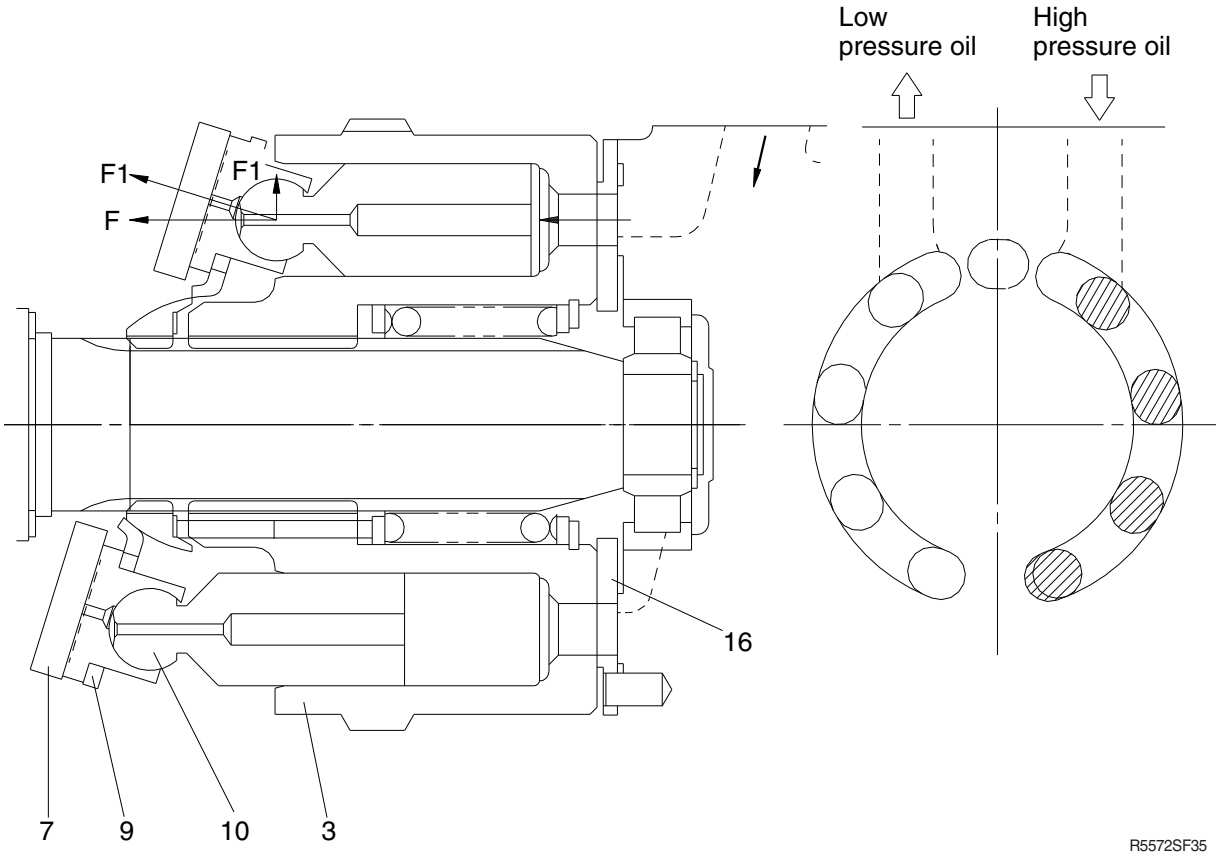
When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(16), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(10) upon the return plate(9) which acts upon the swash plate(7) via an hydrostatic bearing. Force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

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

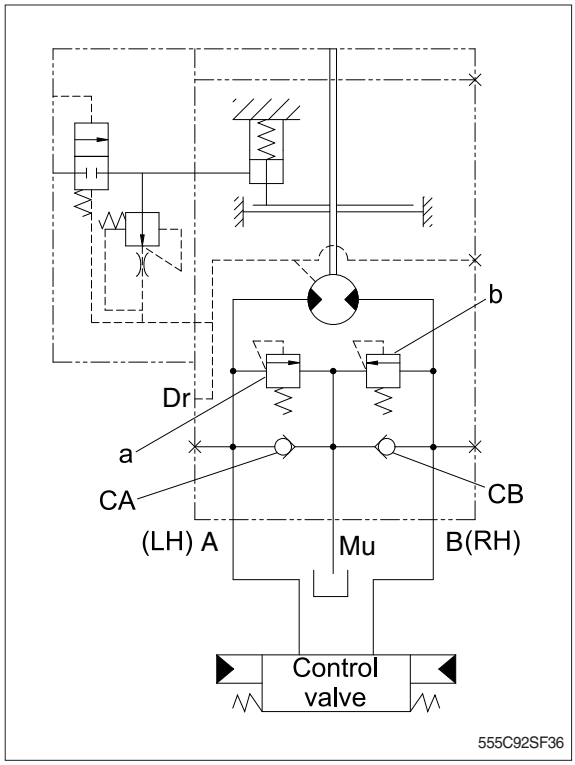
Where p : Effective difference of pressure (kgf/cm^2)
q : Displacement (cc/rev)
T : Output torque (kgf · cm)
Z : Piston number (9EA)
A : Piston area (cm^2)
θ : Tilting angle of swash plate (degree)
S : Piston stroke (cm)



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.

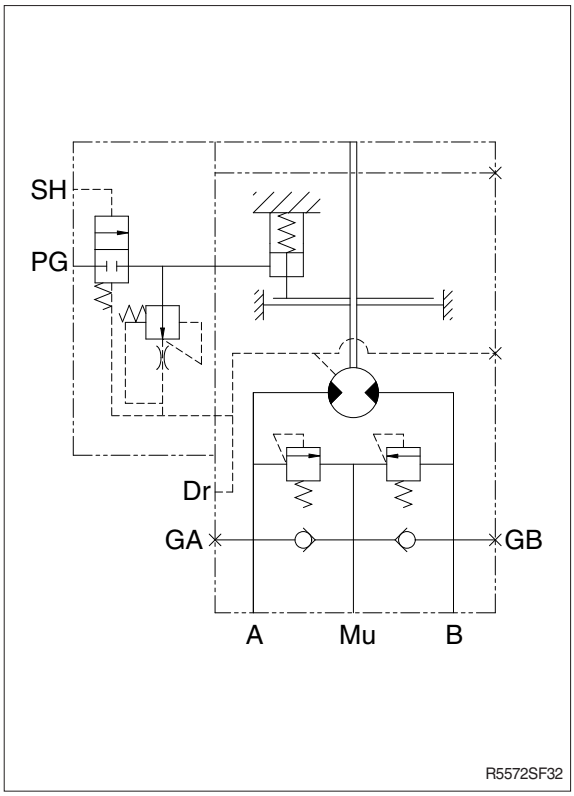
(3) Operation

① When starting swing

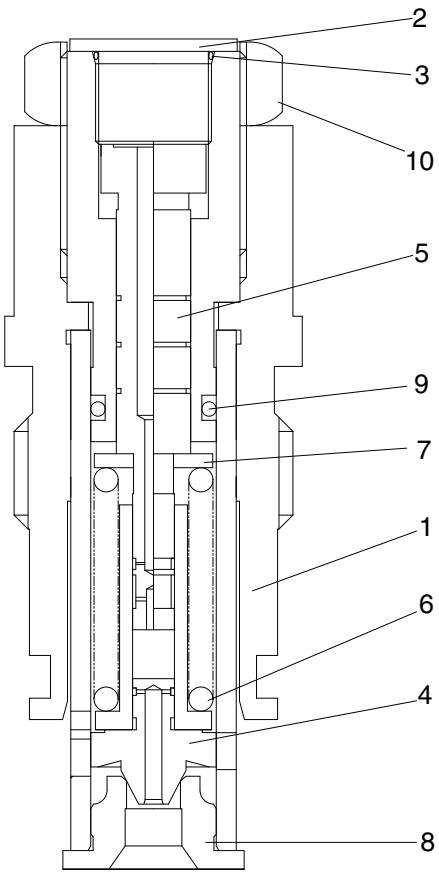
When the swing control lever is operated to left swing, the pressurized oil from the pump passes through the control valves and is supplied to port B. Because of this, the pressure at port B rises, staring torque is generated in the motor, and the motor starts to rotate. The oil from the outlet port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



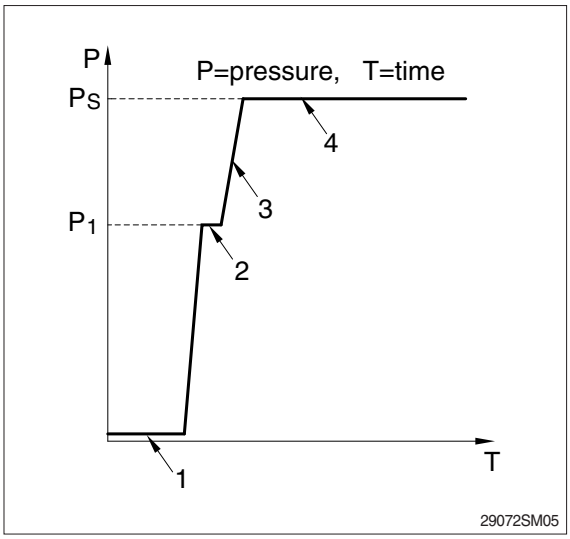
1 Body
2 Plug
3 O-ring
4 Plunger
5 Piston
6 Spring
7 Spring seat
8 Seat
9 O-ring
10 Nut

(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.

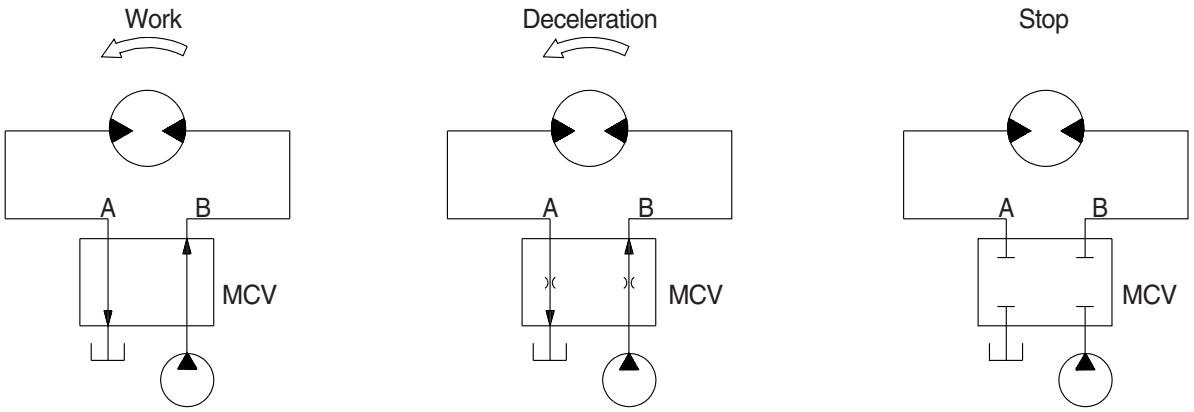


4) BRAKE SYSTEM

(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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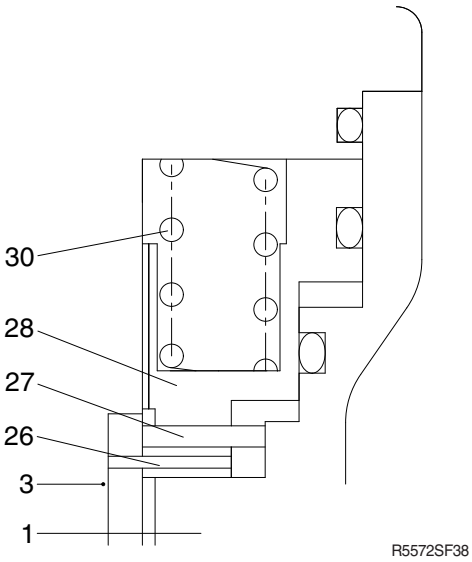
(2) Mechanical swing parking brake system

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.



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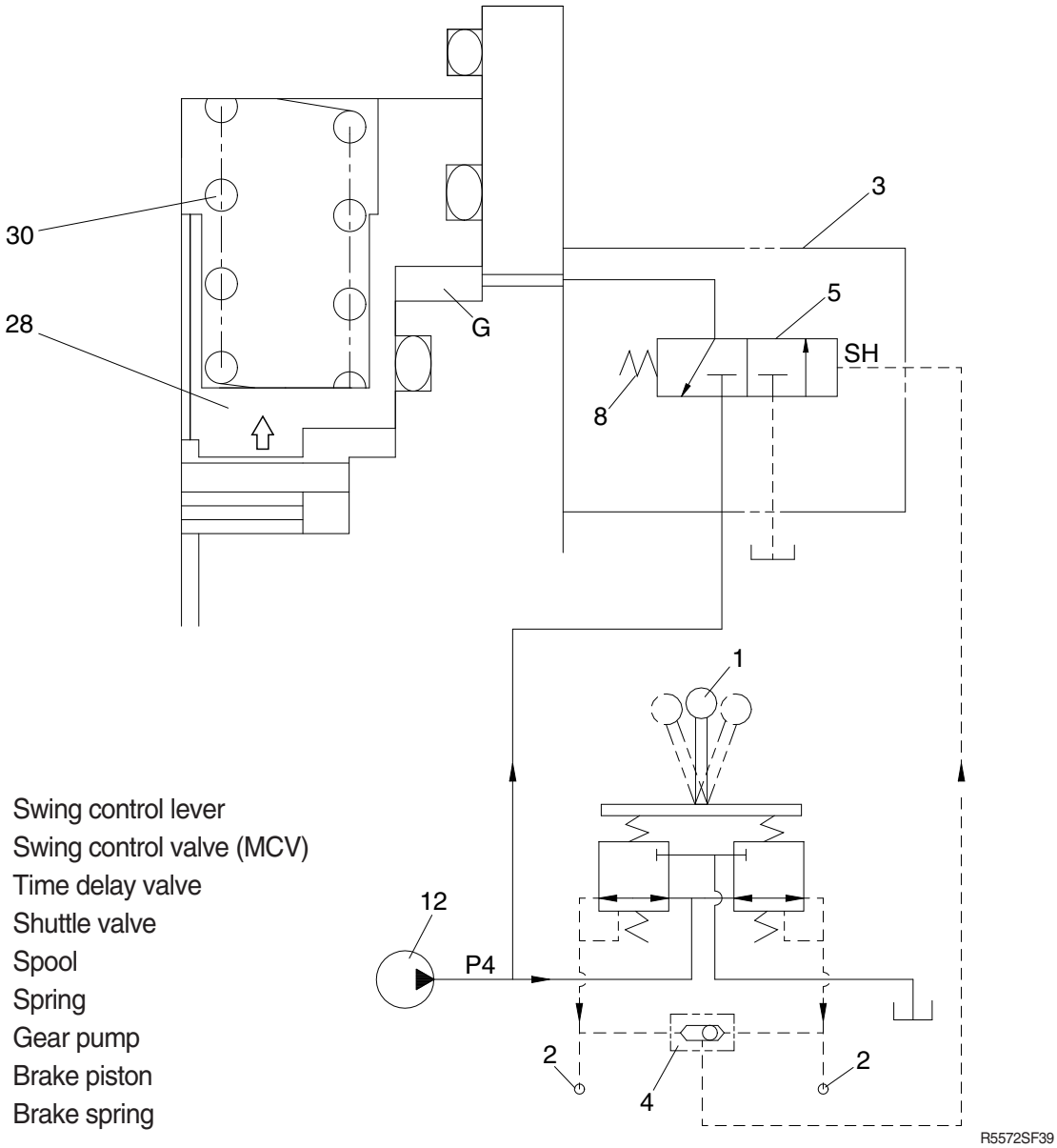
1	Casing	27	Separate plate
3	Cylinder	28	Brake piston
26	Friction plate	30	Brake spring

② Operating principle

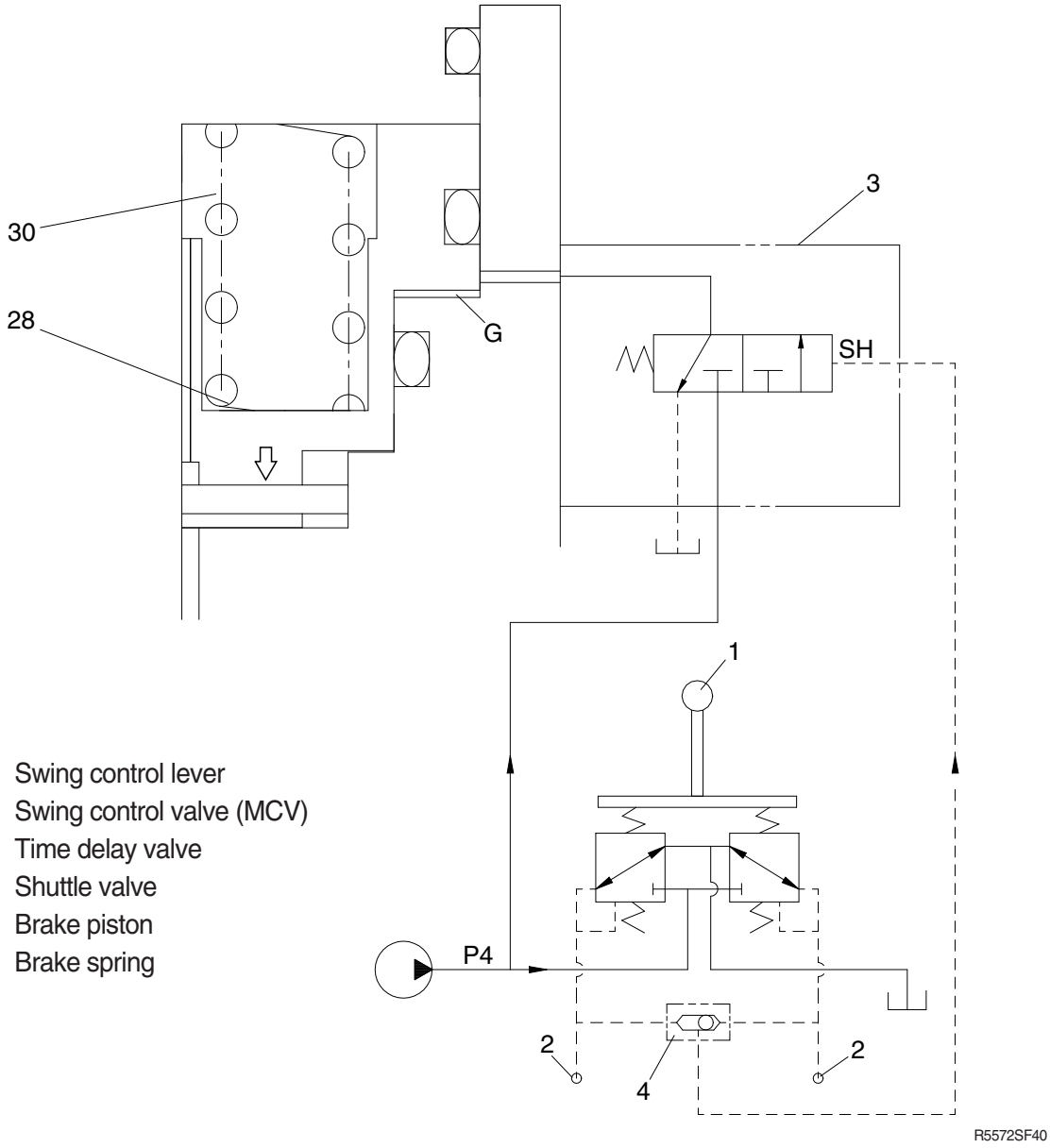
a. When the swing control lever (1) is set to the swing position, the pilot oil go to the swing control valve (2) and to SH of the time delay valve (3) via the shuttle valve (4), this pressure move spool (5) to the leftward against the force of the spring (8), so pilot pump charged oil (P4) goes to the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



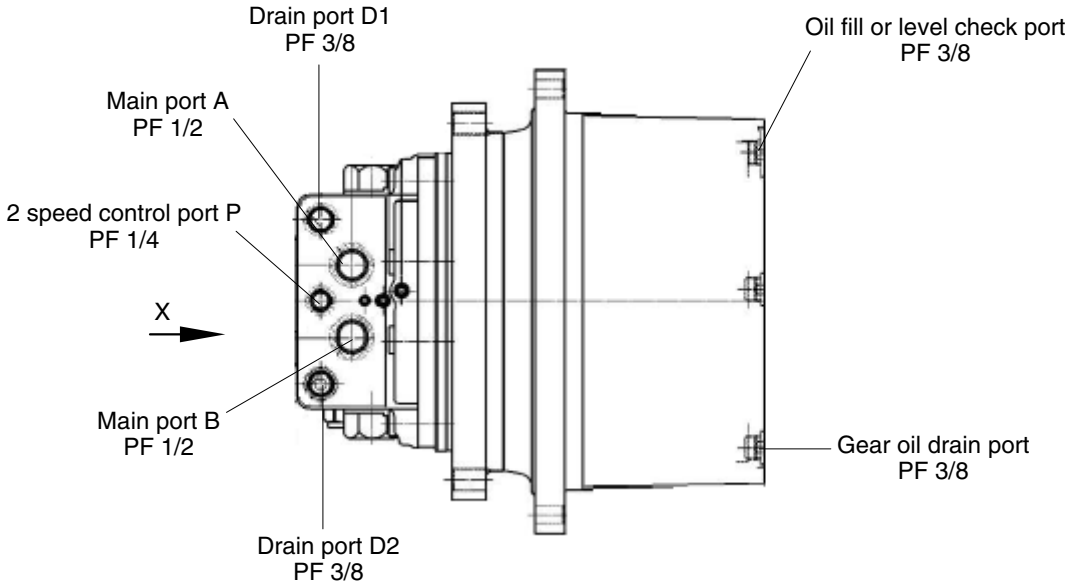
1 Swing control lever
2 Swing control valve (MCV)
3 Time delay valve
4 Shuttle valve
28 Brake piston
30 Brake spring

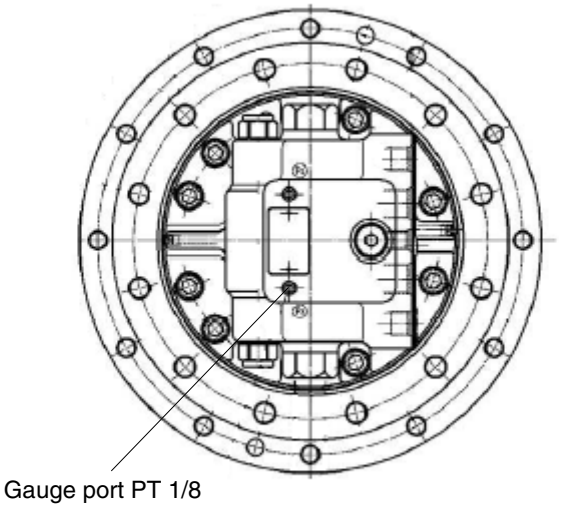
GROUP 4 TRAVEL DEVICE

1. CONSTRUCTION

Travel device consists travel motor and gear box.

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





VIEW X

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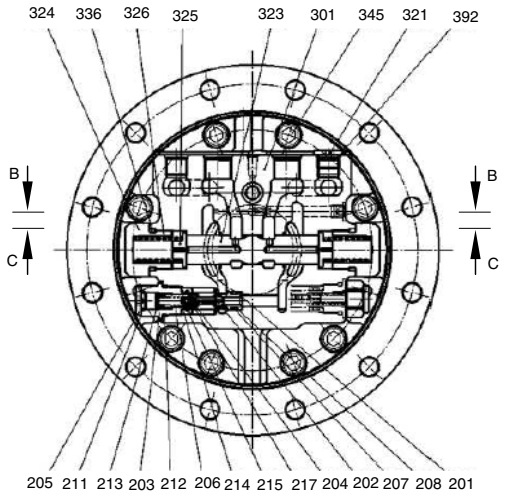
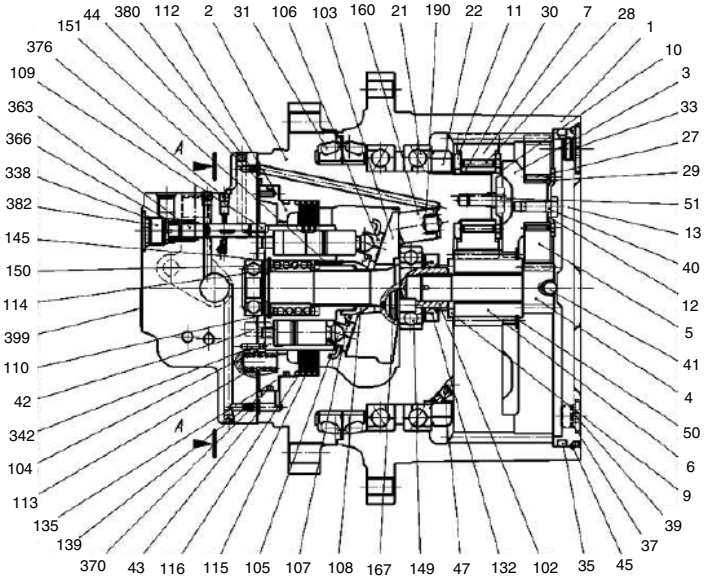
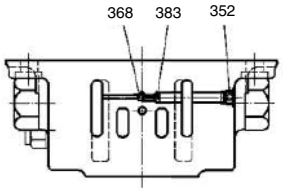
2) STRUCTURE

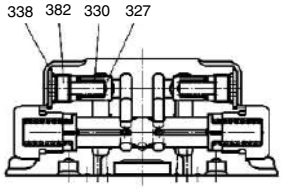


SECTION A-A





SECTION B-B



SECTION C-C

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1	Hub	29	Inner ring	104	Cylinder block	139	O-ring	211	O-ring	324	Plug
2	Spindle	30	Inner ring	102	Shaft	145	Snap ring for hole	212	O-ring	325	Spring retainer
3	Carrier	31	Floating seal	103	Swash plate	149	Ball bearing	213	Shim	327	Valve
4	Sun gear 1	33	Plug	105	Piston	150	Ball bearing	214	Piston	328	Spring
5	Planetary gear 1	35	O-ring	106	Shoe	151	Roller	215	O-ring	330	Spring
6	Sun gear 2	37	O-ring	107	Retainer plate	160	Piston	217	Orifice	336	O-ring
7	Planetary gear 2	39	Plug	108	Thrust ball	167	Pivot	301	Rear flange	338	O-ring
9	Thrust collar 1	40	Hex head bolt	109	Timing plate	170	Spring	323	Spool	342	Parallel pin
10	Thrust washer 1	41	Steel ball	110	Washer	201	Valve seat	352	Hex socket plug	345	Hex socket bolt
11	Thrust washer 2	42	Parallel pin	112	Piston	202	Valve	368	Steel ball	363	Spool
12	Thrust washer 3	43	O-ring	113	Spring	203	Sleeve	375	Hex socket plug	366	Spring
13	Cover	44	O-ring	114	Spring	204	Collar	379	Filter	382	Plug
21	Bell bearing	45	Ring	115	Friction plate	205	Plug	380	Orifice	392	O-ring
22	Ring nut	47	Hex socket set screw	116	Mating plate	206	Spring	383	Plug		
27	Needle roller bearing	50	Retaining ring for shaft	132	Oil seal	207	O-ring	390	Name plate		
28	Needle roller bearing	51	Hex head bolt	135	O-ring	208	Back-up ring	321	Plug		

2. OPERATING DESCRIPTION

1) REDUCTION GEAR

(1) Function

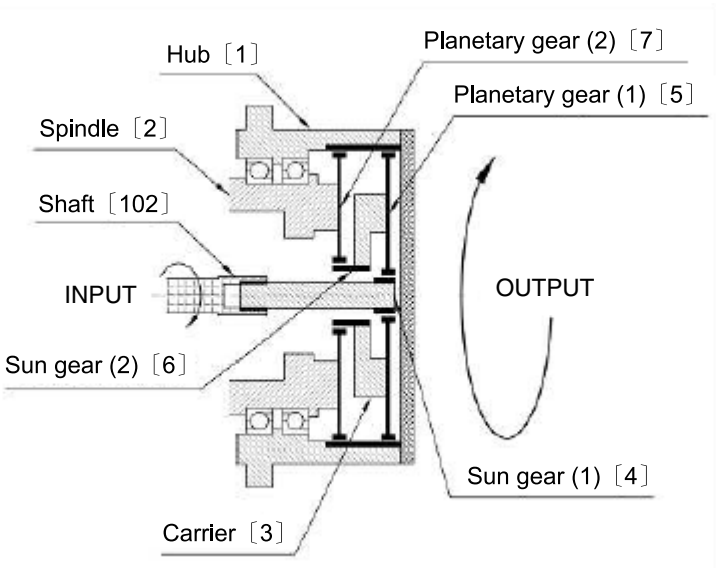
This reduction gear unit is composed of two stage planetary gear mechanism and reduces high speed rotation from hydraulic motor and converts it into low-speed, high-torque rotation.

(2) Operating description

The rotation of the shaft [102] is transmitted to the sun gear (1) [4] of the first stage which is linked with the shaft [102] by the spline. At this time, since the sun gear (1) [4] is meshed with the planetary gears (1) [5], and the planetary gears (1) [5] are also meshed with the hub [1], the planetary gears (1) [5] revolve.

Since the planetary gears (1) [5] are meshed with the carrier [3] and the carrier [3] meshed with the sun gear (2) [6], the revolution of the planetary gears (1) [5] makes the sun gear (2) [6] rotate.

The rotation of the sun gear (2) [6] is transmitted to the hub [1] through the planetary gear (2) [7] fixed by the pillar of the spindle [2]. The rotation of the hub [1] is output rotation.



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2) HYDRAULIC MOTOR (WITH BRAKE VALVE, PARKING BRAKE AND HIGH-LOW 2-SPEED SWITCHING MECHANISM)

(1) Function

① **Hydraulic motor**

This hydraulic motor is a swash-plate-type axial-piston motor.

Converting the force of pressurized oil supplied from a pump into rotary motion.

② **Brake valve**

a. It controls inertia when stopping the hydraulic motor, in order to provide smooth stopping.

b. It prevents cavitation from occurring inside the hydraulic motor.

c. It opens the ports for releasing the parking brake while travelling and closes the ports when stopping.

③ **Parking valve**

With friction-plate-type braking mechanism, the parking brake prevents an excavator from sliding downwards due to gravity when stopping on a slope. It is integrated as a part of the hydraulic motor.

④ **High-low 2-speed switching mechanism**

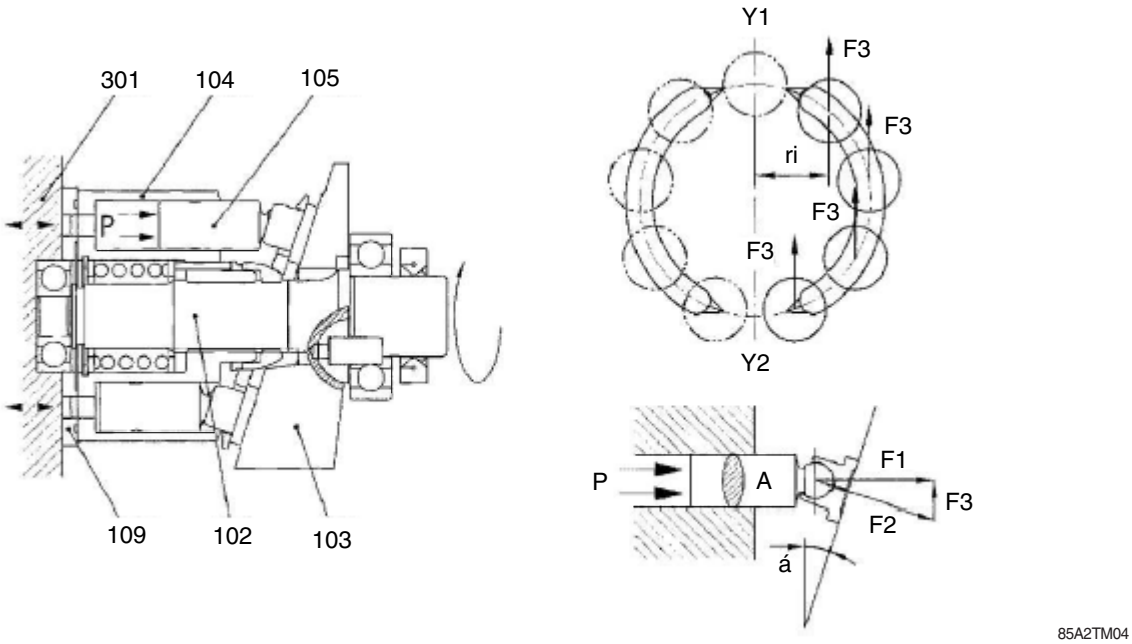
The movements of the switching spool and the control piston adjust an angle of the swash plate, and change the piston displacement in the hydraulic motor.

(2) Operation principle

① **Hydraulic motor**

Pressurized oil from the main port (A) enters the rear flange [301] of the traveling unit, passes through the brake valve and is led into the cylinder block [104] through the timing plate [109]. The oil only enters the cylinder block [104] on either side of axis Y1-Y2 and generates force (F [N] = P [MPa] × A [mm^2]) when it pushes the pistons [105] (4 or 5 pistons).

As the angle of swash plate [103] is fixed at the angle (α °) to the shaft [102] axis, the force generated on the swash plate [103] can be separated into two component forces (F2, F3). Only F3 generates radial force which turns into torque (T=F3×ri). The sum of all torques {T= Σ (F3×ri)} created by pistons [105] turns into rotational force which rotates the cylinder block [104]. As the cylinder block [104] is linked to the shaft [102] with the spline, the shaft [102] rotates and the rotational torque is transmitted.



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② Brake valve

The port (A) and Port (B) are the input and output ports for hydraulic oil. The following description assumes that hydraulic oil is fed through port (A). If the oil is fed through port (B), the flow and motion are reversed. The direction of rotation of the motor is also reversed.

a. Normal Operation

Hydraulic oil is fed from the pump to the port (A), causing the hydraulic motor to rotate. The details are as follows.

First, hydraulic oil fed from the pump enters at the port (A) and opens the valve [327]. The oil passes through the valve [327] enters the hydraulic motor through the port (C) and applies rotary force to the hydraulic motor.

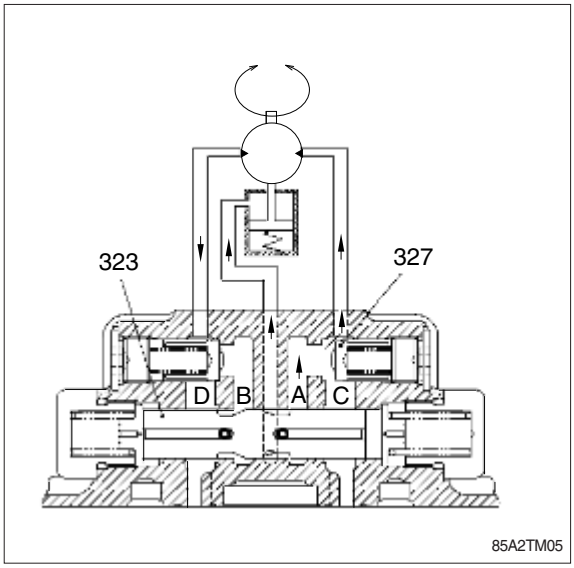
At the same time, the hydraulic oil also passes through the small holes in the spool [323] and through the passage (a) to the chamber (b).

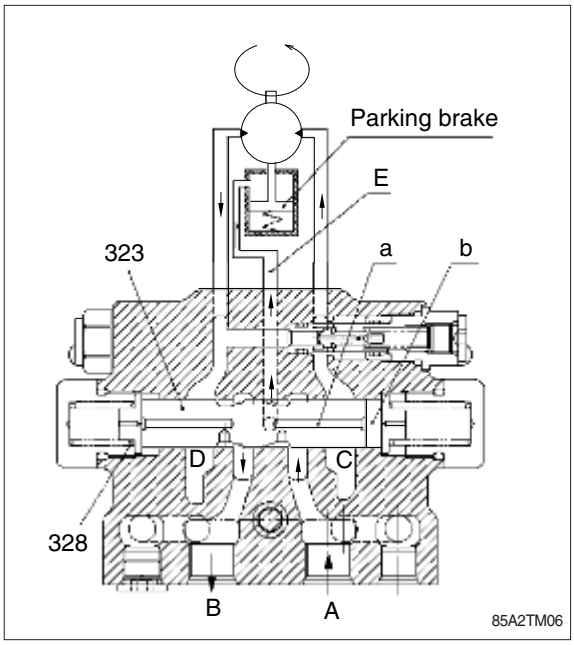
The hydraulic pressure in the chamber (b) causes the spool [323] to move from the central position to the left. At this time a groove in the

spool [323] forms a passage for the hydraulic oil

to pass between the port (D) and port (B). The hydraulic oil ejected from the hydraulic motor flows from the port (D) to the port (B), and the hydraulic motor rotates. The hydraulic oil from the port (B) returns to the oil tank.

Also, as the spool [323] moves to the left, the hydraulic oil enters the port (E). The hydraulic oil at the port (E) flows to the parking brake and the 2-speed switching valve.





b. Stop operation

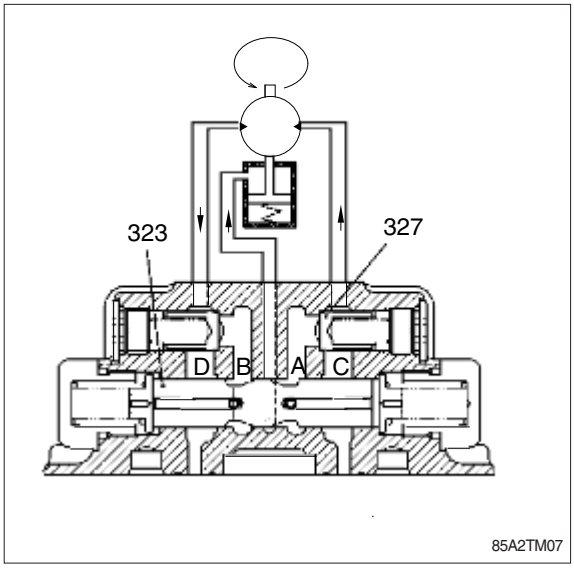
Braking Operation When pressurized oil supplies through the port (A) is suspended while traveling, the hydraulic force to push the spool [323] is lost, and the spool [323] which is slid to the left side, tries to return to the neutral position due to the spring [328] force. At that time, though the oil in the chamber (b) tries to flow out to the port (A) side through the passage (a) in the spool [323], its flow is restricted and the back pressure is generated by throttle effect in the passage (a). As the result, the return speed of the spool [323] is controlled. At the same time, the hydraulic motor tries to rotate with its inertia force even though the pressurized oil is suspended, and the return oil from the hydraulic motor tries to return to the port (B) from the port (D) through the passage formed from the spool groove and rear flange [301].

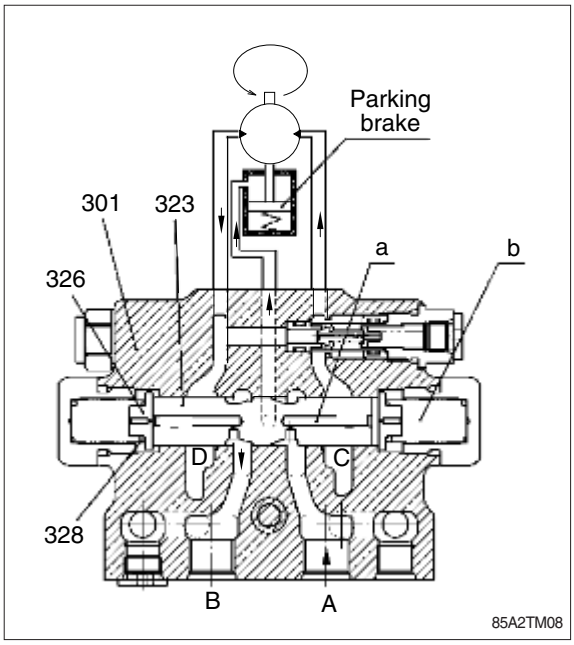
When the spool [323] entirely returns to the neutral position, the passage is completely closed by the spool [323], and the hydraulic motor ceases its rotation. While running, the brake valve smoothly stops rotation of the hydraulic motor which tries to rotate with its inertia force, by means of throttling the return side passage of the hydraulic motor, generating back pressure due to shape of the spool groove and controlling the return speed of the spool [323].

On the other hand, during brake operation, the hydraulic motor tries to rotate with its inertia force and to intake oil by its pumping function.

However, the intake side is closed its passage with the spool [323], oil supply is suspended. This causes cavitation in the hydraulic motor.

To prevent the cavitation, the valve [327] is operated by very slight negative pressure to open the passage of the port (A) side and intake the port (C) of the hydraulic motor.

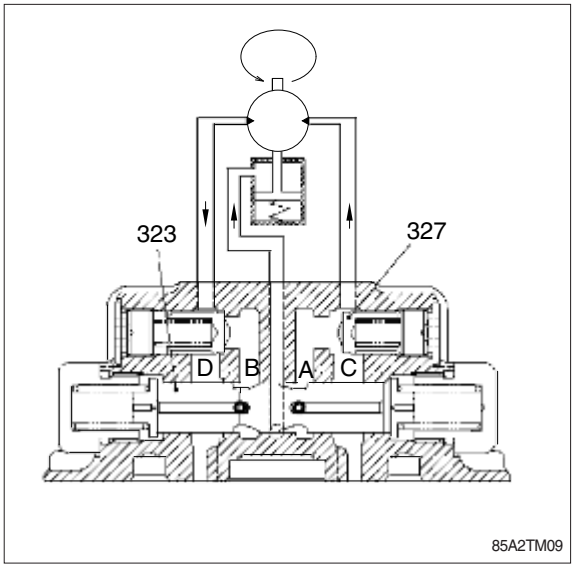


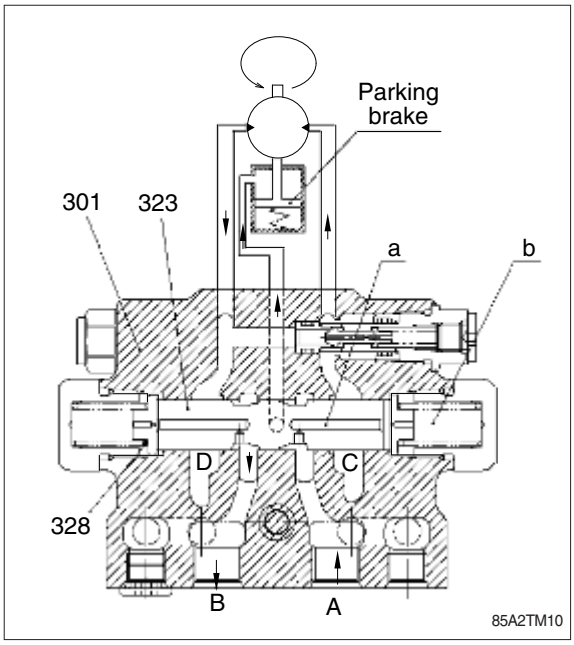


c. Down-hill

When going down-hill, external force acts to accelerate the hydraulic motor. As the result, the pressure at the port (A) and port (C) decrease and the spool [323] tries to return to the neutral position. The movement of the spool [323] reduces the size of flow channel from the port (D) to the port (B) on the output side of the hydraulic motor. This restricts the amount of hydraulic oil ejected from the port (D) to the port (B). At the same time, the pressure at the port (D) (back pressure) increases.

Thus overrunning when going down-hill is prevented by controlling the flow rate and pressure.



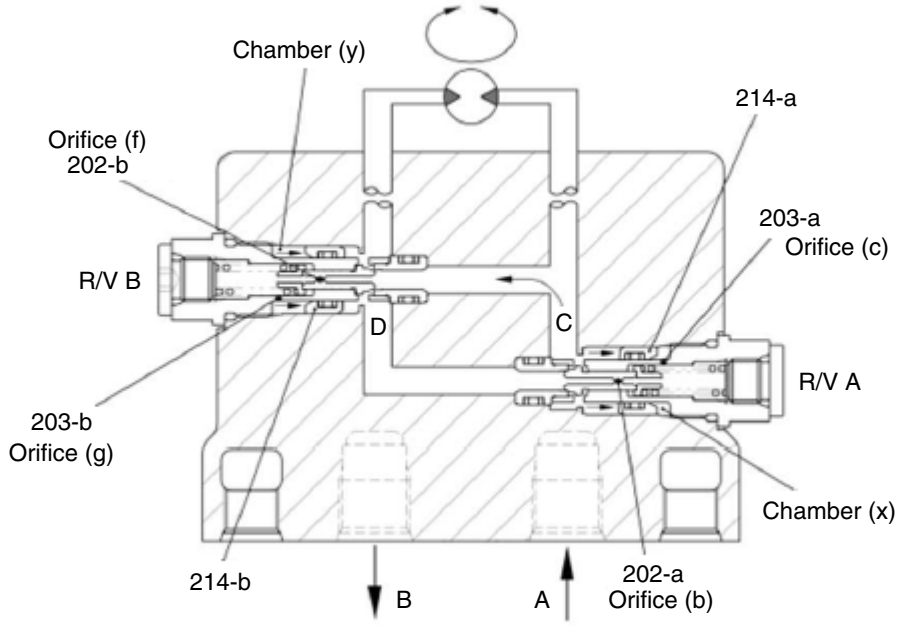


③ Operation description of relief valve

a. Starting

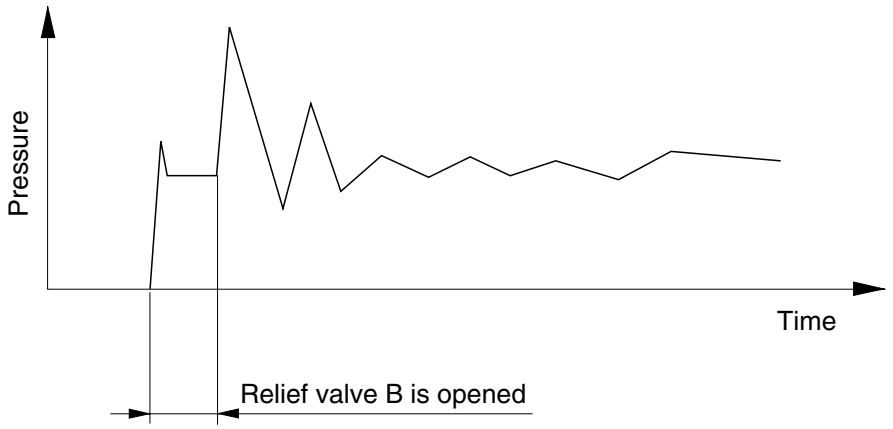
The pressurized oil supplied from the pump is led to the port (C) from the port (A). since the port (C) is connected with the hydraulic motor, the pressurized oil brings rotation to the hydraulic motor. At this time, the valve [202-a] of the relief valve(R/V) “A” is not opened for the pressurized oil of the port (C). The piston [214-a] moves to the stroke end of the direction of the arrow with the pressurized oil. The oil in the chamber (x) is led to the port (D) through the orifice (c) of the sleeve [203-a] and the orifice (b) of the valve [202-a]. The pressurized oil of the port (C) opens the valve [202-b] (b) of the relief valve “B” with set pressure, and the pressurized oil is led to the port (D). The pressurized oil from the port (C) is also led to the chamber (y) through the orifice (f) of the valve [202-b] and the orifice (g) of the sleeve [203-b]. When the piston [214-b] doesn’t reach the stroke end due to previous stopping condition, the piston [214-b] moves to the stroke end by the pressurized oil from the port “C” After the piston [214-b] reaches the stroke end, the pressure between the orifice (f) of the valve [202-b] and the orifice (g) of the sleeve [203-b] rises. Cracking pressure of the valve [202-b] turns into more than the system pressure of the excavator and the valve [202-b] is closed.

The pressure of the port (C) rises by operation of the relief valve(R/V) “A” and “B”, and the hydraulic motor can obtain torque.



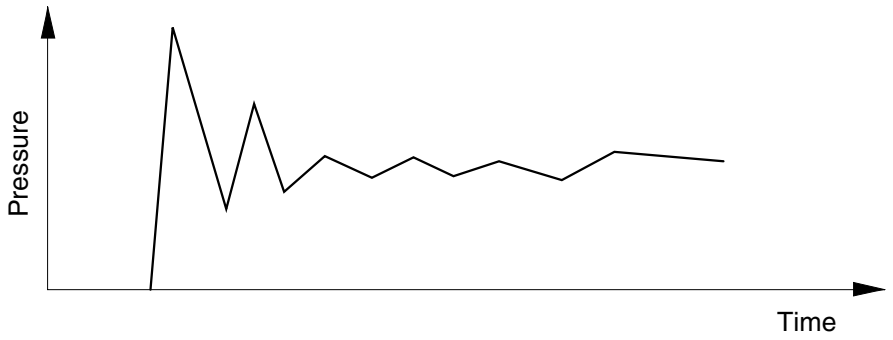
85A2TM11

The pressure of the port (C) at starting is as follows.



85A2TM12

When the piston [214-b] position has reached the stroke end due to the just before the stopping condition, the valve [202-b] of the relief valve (R/V) “B” is not opened.
The pressure of the port (C) in this case is as follows.



85A2TM13

The pressure of the port (C) at starting depends on the piston [214-b] position.

※ When the pressurized oil supplied from the pump is led to the port (D) from the port (B), operation explanation becomes what replaced the relief valve (R/V) “A” and relief valve (R/V) “B”.

b. Stopping

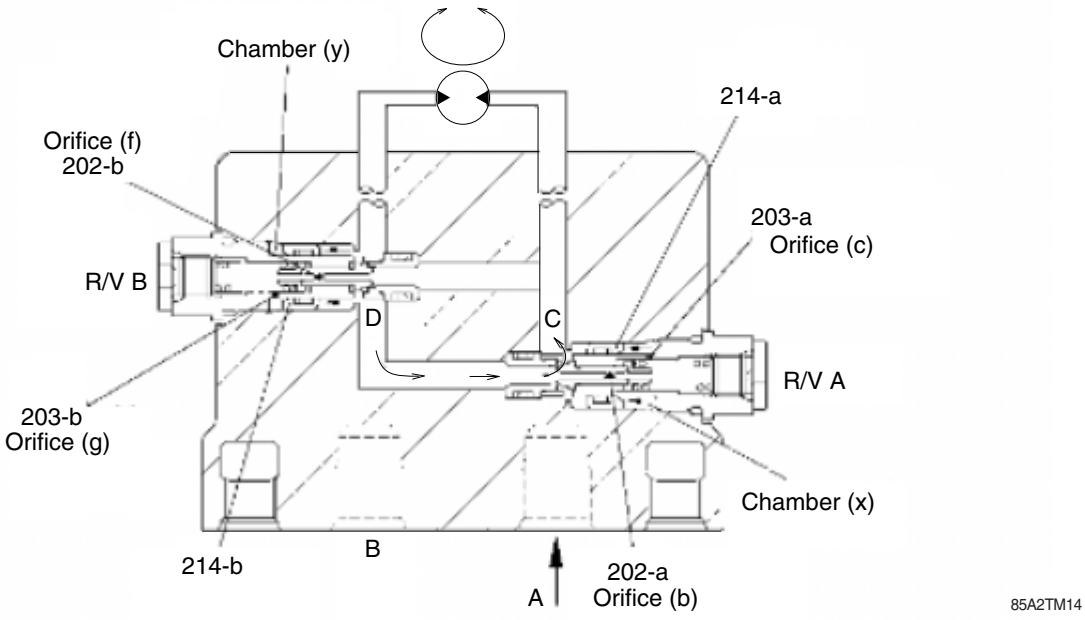
When the pressurized oil from the port “A” is suspended. The spool [323] tries to return to the neutral position and the pressure of the port “D” increases because the hydraulic motor tries to rotate with its inertia.

The pressurized oil of the port (D) is led to the chamber (x) through the orifice (b) of the valve [202-a] and the orifice (c) of the sleeve [203-a]. The piston [214-a] moves to the stroke end of the direction of the arrow with the pressurized oil led to the chamber (x). While the piston [214-a] is moving, the pressure in the chamber (x) does not rise. The pressurized oil of the port (D) opens the valve [202-a] of the relief valve (R/V) “A” with set pressure, and the pressurized oil flows into the port (C). (Pressure while the piston [214-a] is moving to the stroke end. : Primary relief pressure)

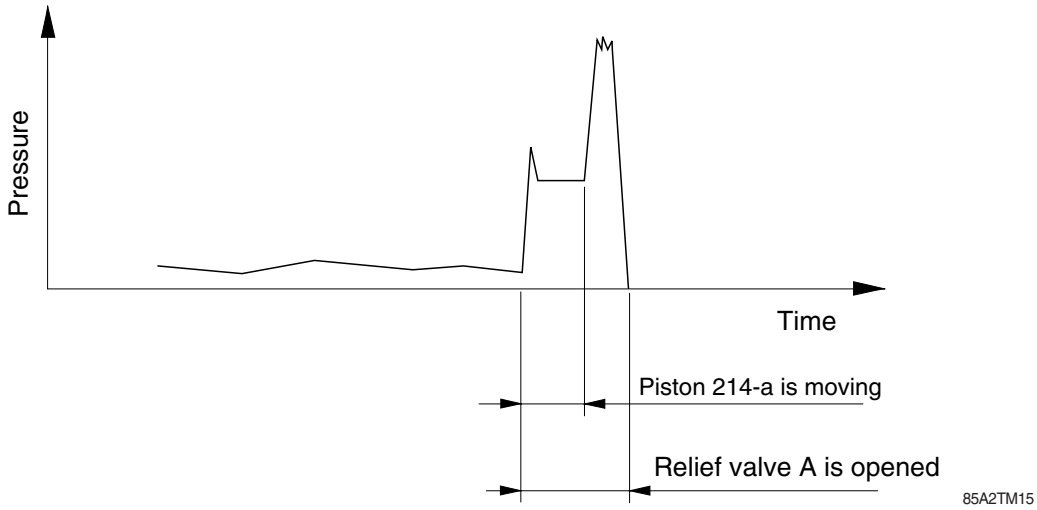
The pressure of the port (D) is controlled by operation of the relief valve (R/V) “A”, and cavitation is prevented by supplying oil to the port (C).

When the piston [214-a] reaches the stroke end, the pressure of the chamber (x) and the pressure between the orifice (b) of the valve [202-a] and the orifice (c) of the sleeve [203-a] rises, and the valve [202-a] is closed. At this time, the pressure when the valve [202-a] opens exceeds the system pressure of the excavator. (Pressure at the time of the completion of the piston move: Secondary relief pressure)

The piston [214-b] of the relief valve (R/V) “B” moves to the direction of the arrow with the pressurized oil of the port (D). The oil of the chamber (y) is led to the port (C) through the orifice (g) of the sleeve [203-b] and the orifice (f) of the valve [202-b].



The pressure of the port (D) at stopping is as follows.



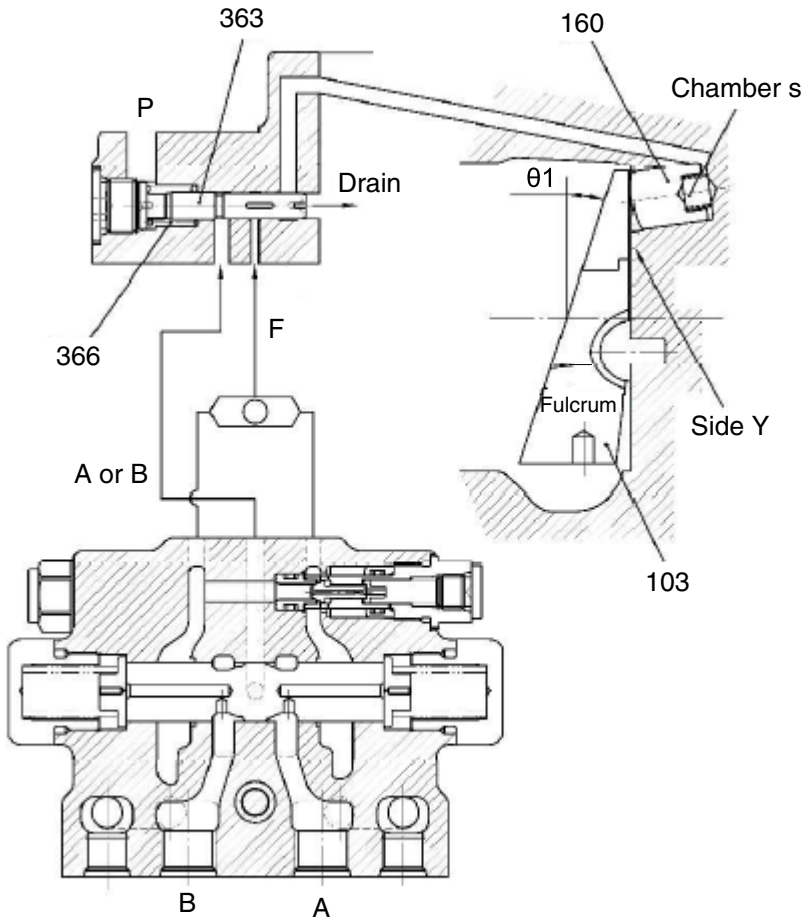
Pressure while the piston is moving to the stroke end : Primary relief pressure
Pressure at the time of completion of the piston move : Secondary relief pressure

④ High-low 2-speed switching mechanism

a. Low Speed

When the pilot pressure is not provided from the port (P), the traveling unit is low speed mode. At this time, the spool [363] is pressed to the left side by the force of the spring [366], the pressurized oil supplied from the port (F) is shut off, and the oil in the chamber (s) is released into the drain (motor case) through the spool [363].

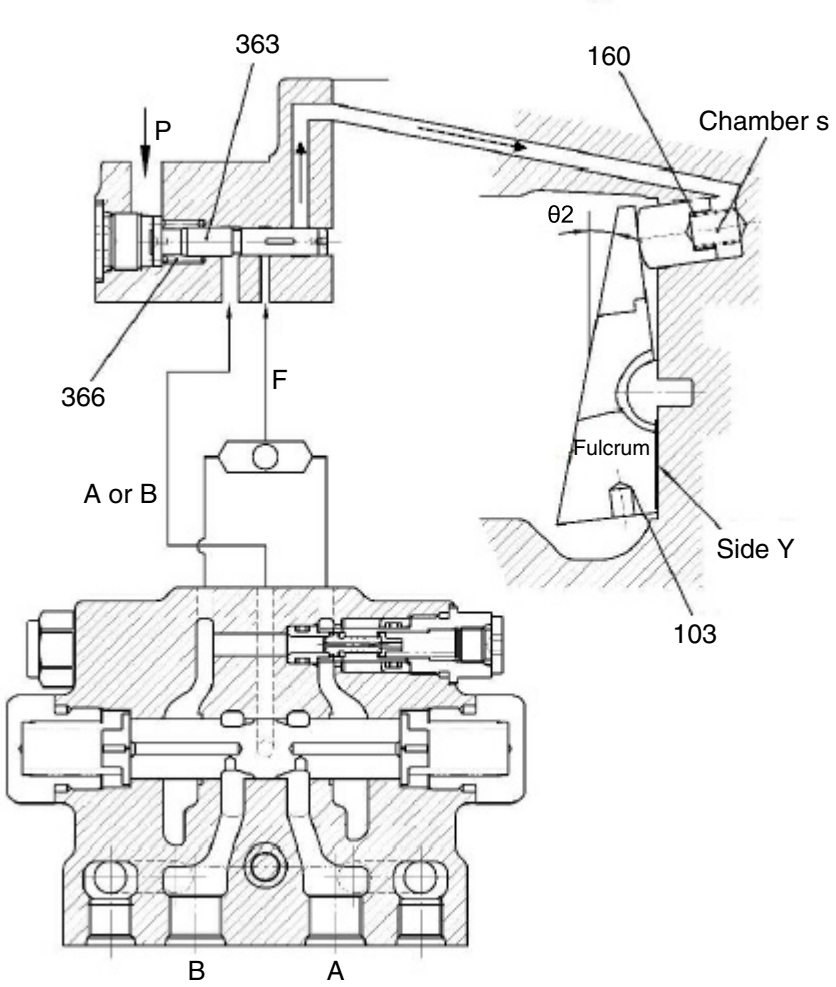
Since the force of the piston [160] is small, the swash plate [103] is parallel to side (Y). At this time, the swash plate [103] is tilted at the maximum angle (θ 1), thus leading to low speed operation.



b. High speed

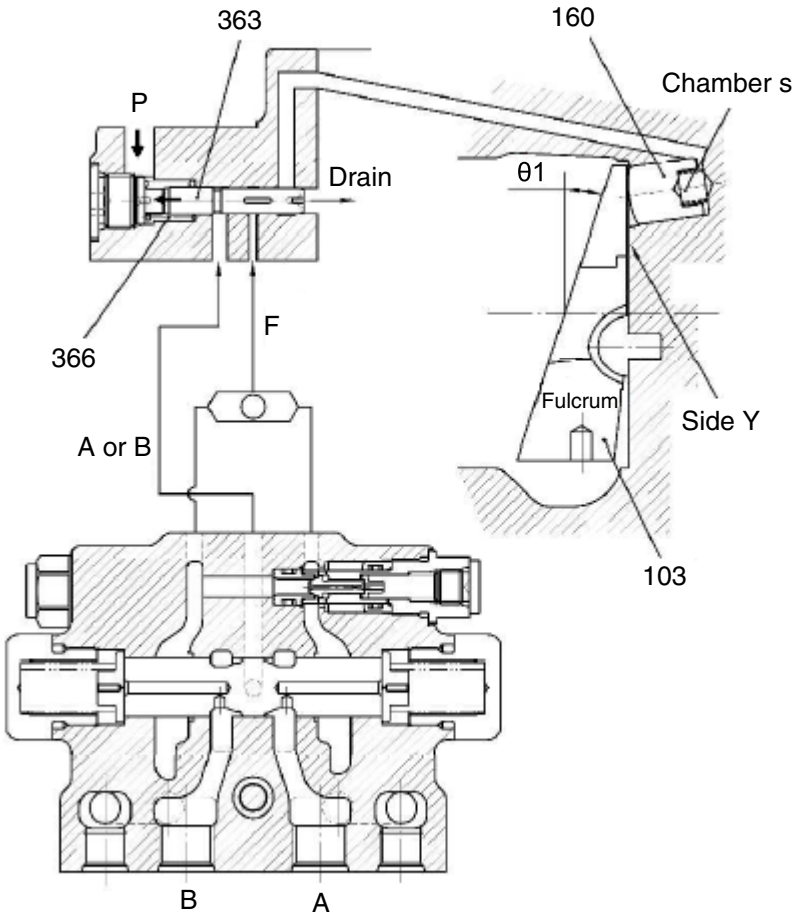
When the pilot pressure is supplied to the port (P), the traveling unit is high speed mode. At this time, the pressure overcomes the force of the spring [366] and spool [363] is slid to the right side. The pressurized oil supplied from the port (F) is then led to the chamber (s) through the spool [363].

Since the force that works to the swash plate [103] is increased by the pressurized oil of the chamber (s), the piston [160] pushes the swash plate [103] until the swash plate [103] touch on the side (x). At this time, the swash plate [103] is tilted at the minimum angle (θ 2), thus leading to high-speed operation.



c. Automatic switching from high speed to low speed

As the load on the hydraulic motor increases, the pressure at the port (A) or (B) also Increases. While operating at the high speed mode, when the pressure at the port (A) or (B) reaches the setting pressure, the spool [363] is pressed leftwards. From this point, the operation is as described for ' Low Speed mode '. The force that works to the swash plate [103] from the piston [160] is decreased, and the hydraulic oil of the chamber (s) is led to drain (motor case) through the spool [363]. The swash plate [103] touches on the side (Y). At this time, the swash plate [103] is tilted at the maximum angle (θ 1). Thus in this state the hydraulic motor has the maximum displacement with low rotary speed.



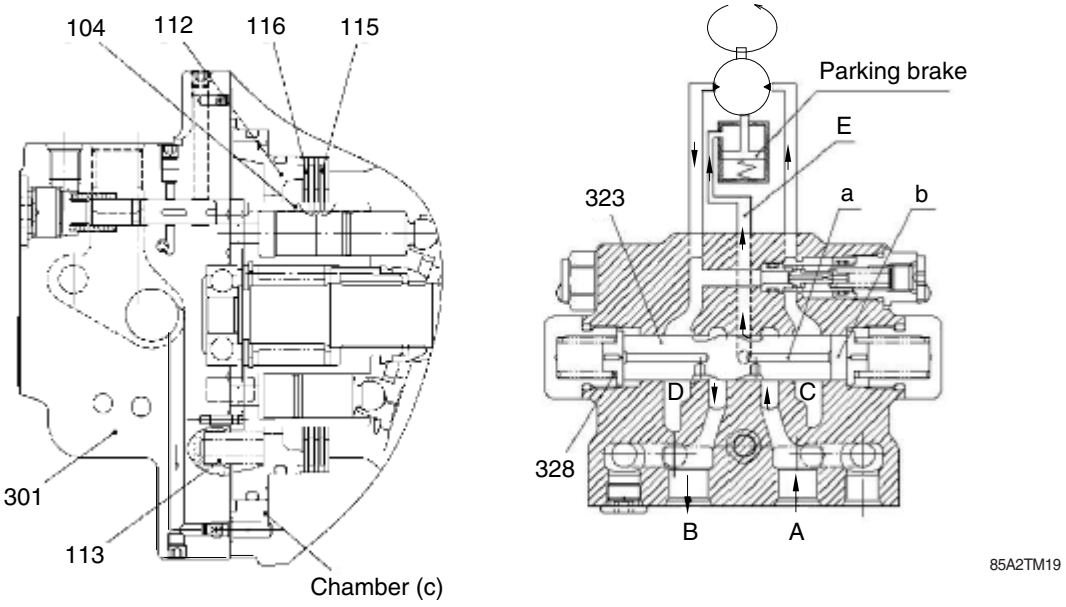
85A2TM18

⑤ Parking brake

a. Traveling

When hydraulic oil is fed from the pump to the port (A) or port (B), causing the spool [323] to move to the left or right. The movement of the spool [323] opens the port (E). The hydraulic oil is fed from the port (E) to the chamber (c). When the pressure increases more than the force of the springs [113], the piston [112] moves in the direction of the rear flange [301]. As the result, the force from the piston [112] onto the mating plates [116] and friction plates [115] lose, and the friction plates [115] are relieved from the fixing.

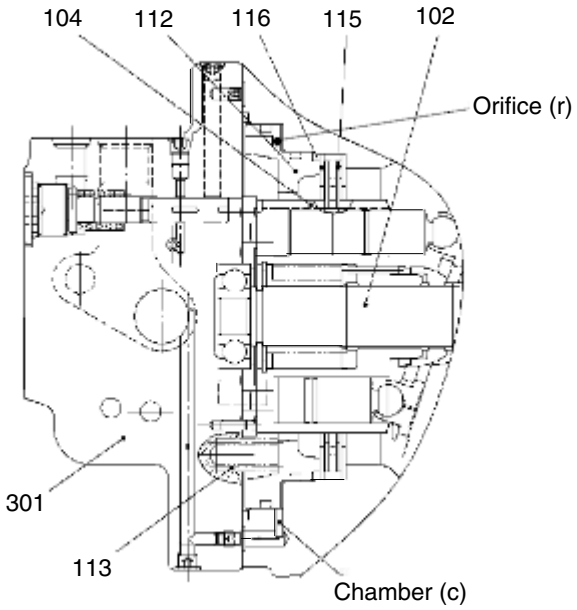
Since the friction plates [115] linked with the cylinder block [104], the braking force of the cylinder block [104] is released, and the hydraulic motor is able to rotate freely.



b. Stopping

When hydraulic oil fed from the pump to the port (A) or port (B) stops, the spool [323] moves to the neutral position and closes the port (E).

While the spool is returning to the neutral position, the pressurized oil in the chamber (c) is being drained to not only the port (A) or (B) but also to the drain (motor case) through the orifice (r). As the result, the pressure in the chamber (c) falls. When this pressure falls below the release pressure of the parking brake, the hydraulic force on the piston [112] becomes less than the force of the springs [113]. The springs [113] cause the piston [112] to press the mating plates [116] and friction plates [115]. The action creates the friction that serves as the braking force. Since the friction plates [115] are linked with both the cylinder block [104] and the shaft [102], the brake torque is applied to the hydraulic motor while stopped.

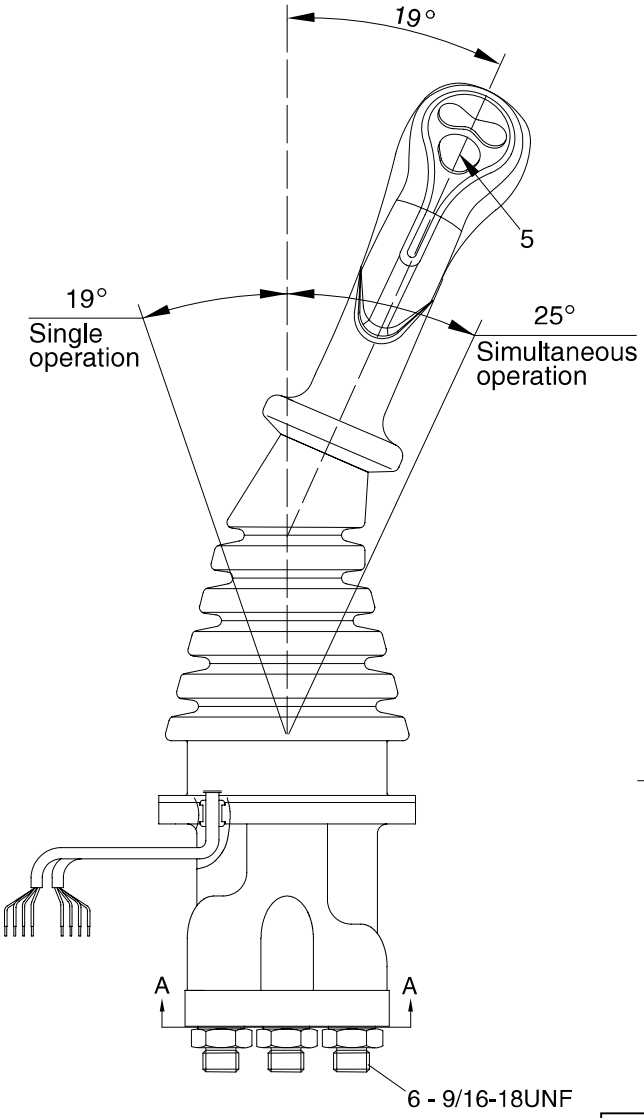


※ If torque exceeding the parking brake torque acts from the outside, the traveling unit will rotate.

GROUP 5 RCV LEVER

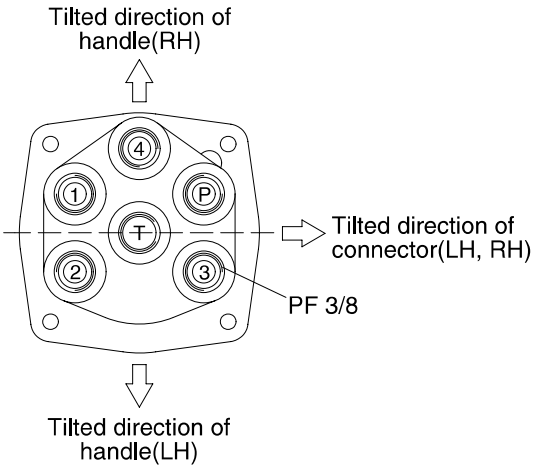
1. STRUCTURE

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.



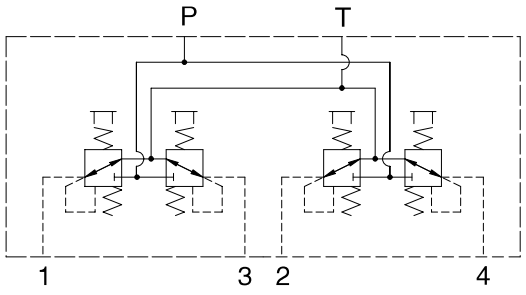
Switches

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	

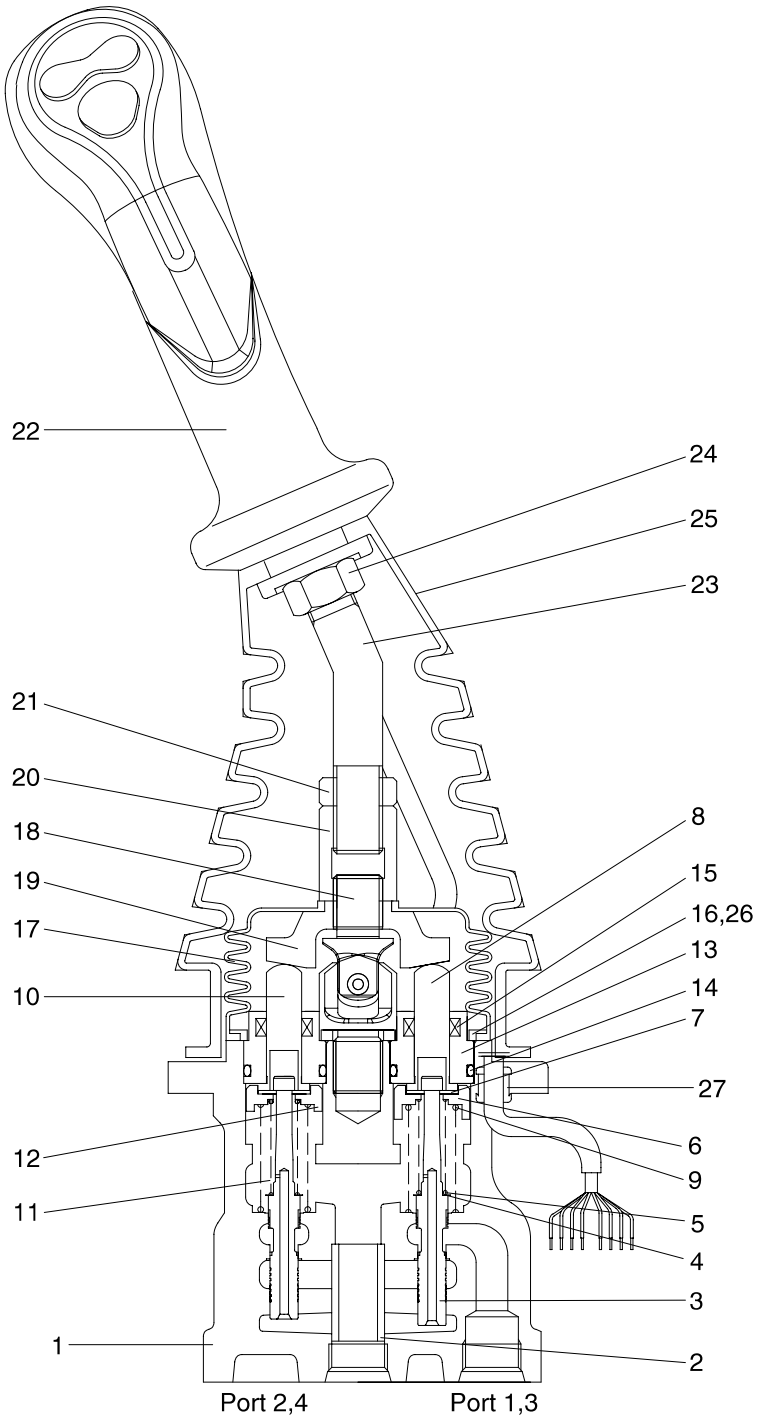
CROSS SECTION

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



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.

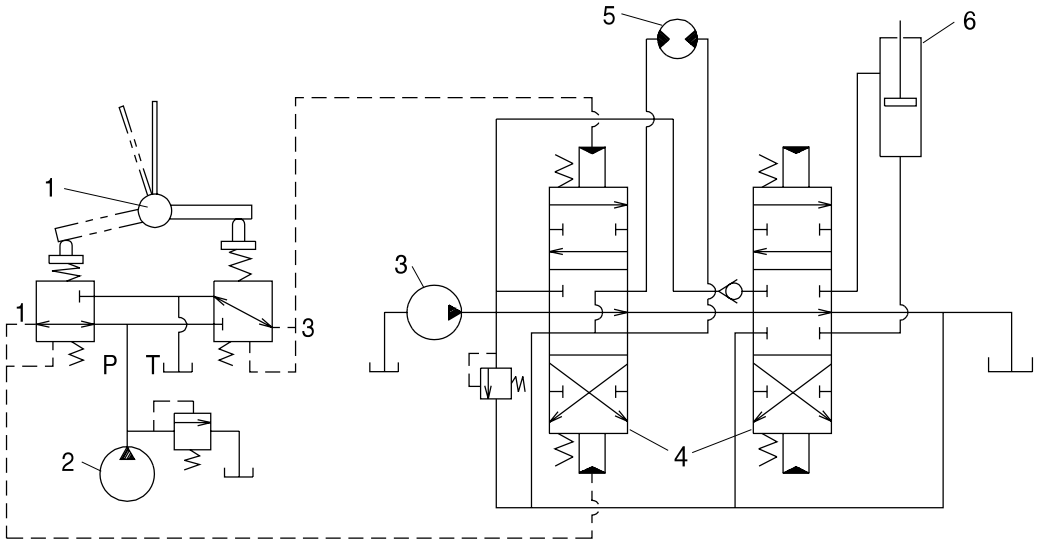
The spring (9) works on the case (1) and spring seat (6, 12) and tries to return the push rod (8,10) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

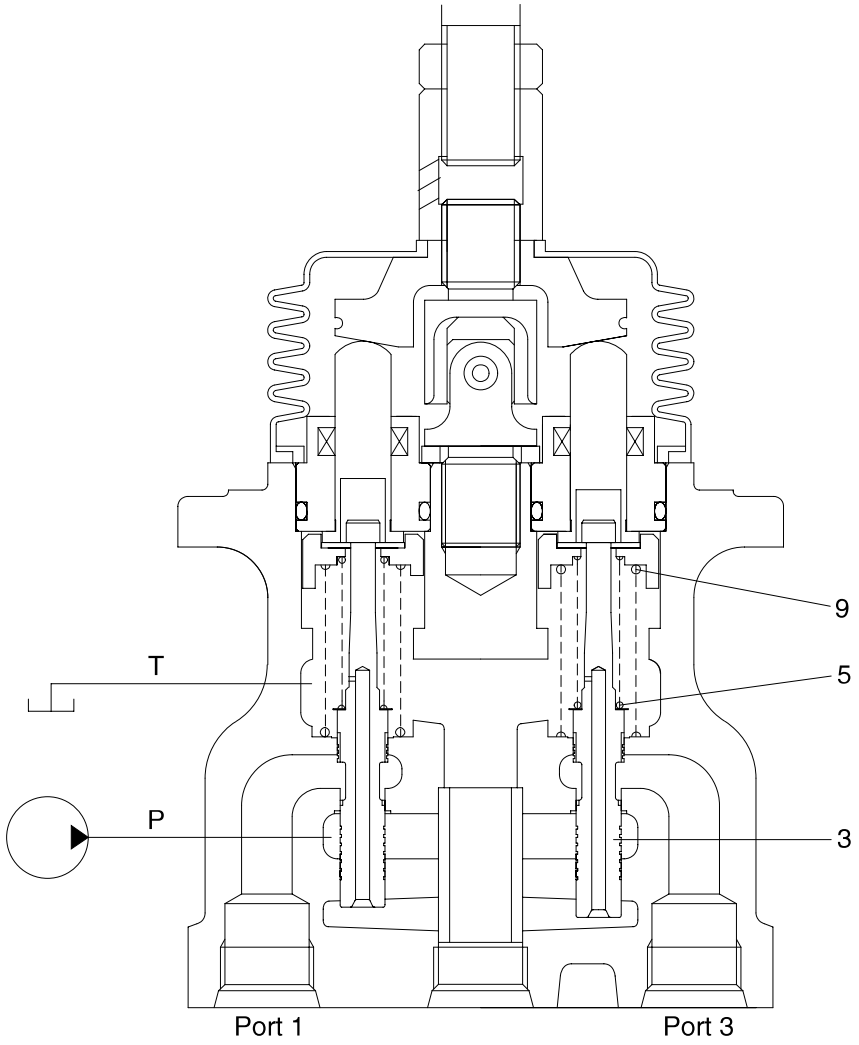
The diagram shown below is the typical application example of the pilot valve.



2-70

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

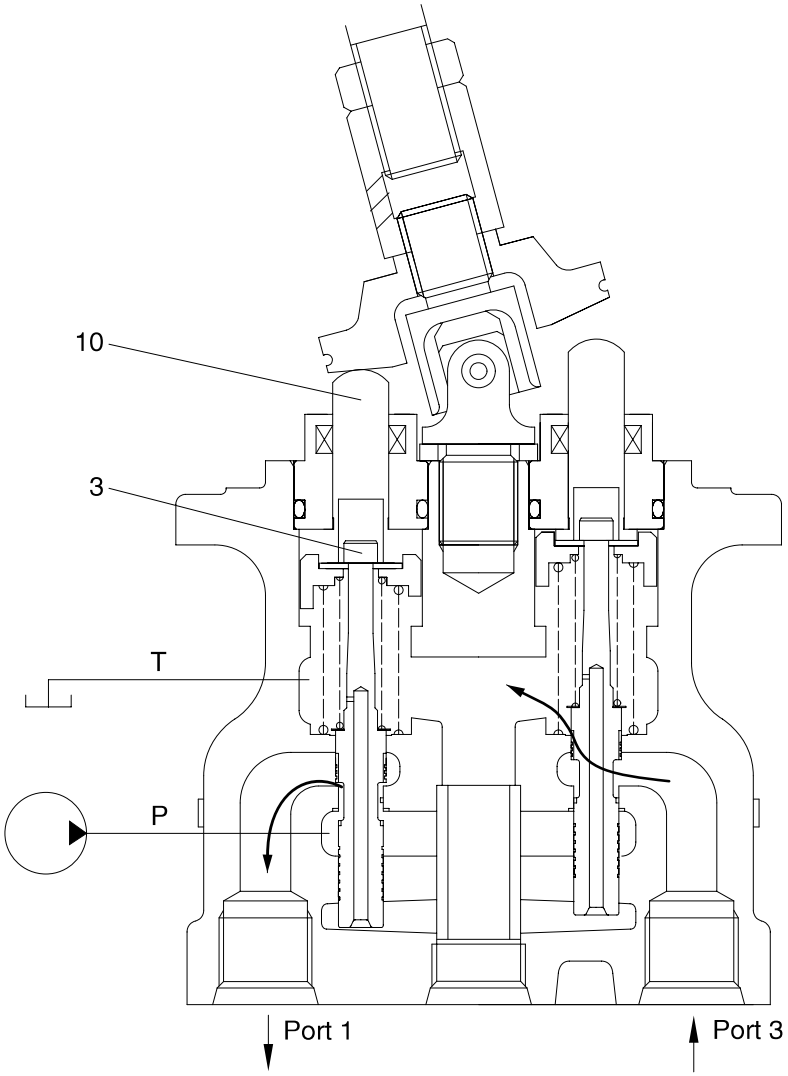
(1) Case where handle is in neutral position



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



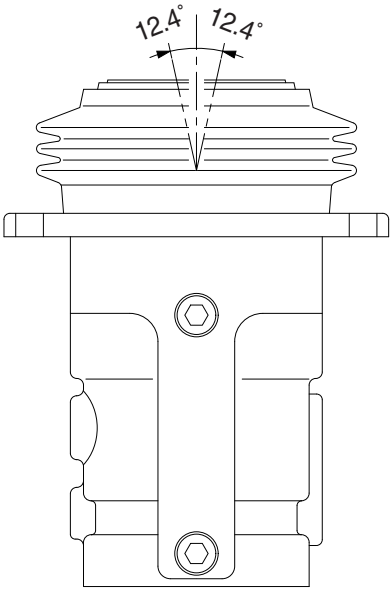
60W9S2RL04

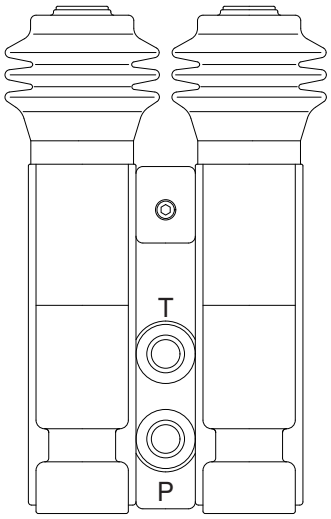
When the push rod (10) is stroked, the spool (3) moves downwards.
Then port P is connected with port 1 and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, 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.

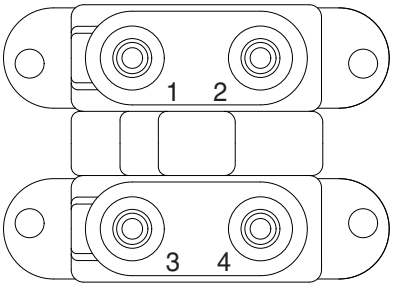
GROUP 6 RCV PEDAL

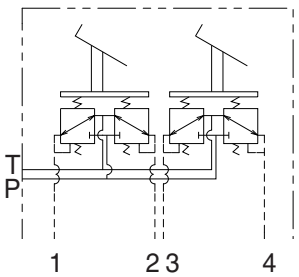
1. STRUCTURE

The casing (Spacer) 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.









Hydraulic circuit

Port	Port	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
1	Travel (LH, Forward)	
2	Travel (LH, Backward)	
3	Travel (RH, Forward)	
4	Travel (RH, Backward)	

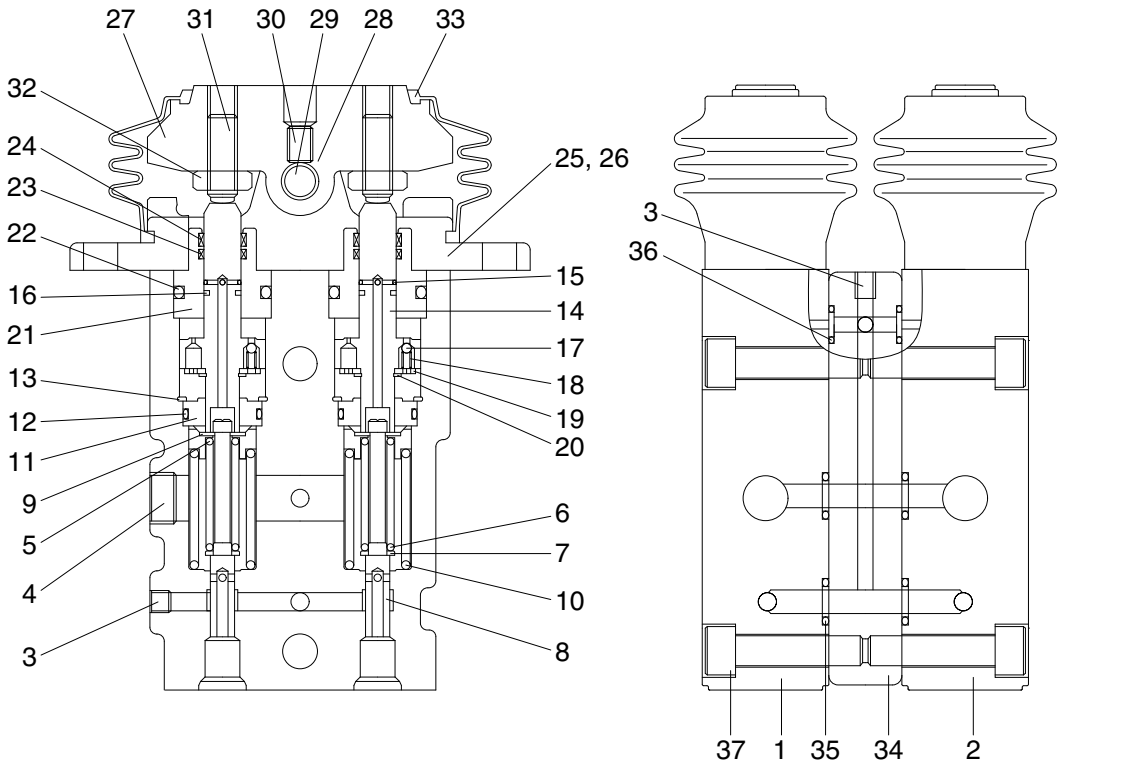
14072SF73

CROSS SECTION

The construction of the RCV pedal is shown in the below drawing. The casing has vertical holes in which reducing valves are assembled.

The pressure reducing section is composed of the spool (8), spring (6) for setting secondary pressure, return spring (10), stopper (9), and spring seat (7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm^2 (depending on the type). The spool is pushed against the push rod (14) by the return spring.

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



14072SF70

1	Body (1)	14	Push rod	27	Cam
2	Body (2)	15	Spring pin	28	Bushing
3	Plug	16	Seal	29	Cam shaft
4	Plug	17	Steel ball	30	Set screw
5	Spring seat	18	Spring	31	Set screw
6	Spring	19	Plate	32	Nut
7	Spring seat	20	Snap ring	33	Bellows
8	Spool	21	Plug	34	Space
9	Stopper	22	O-ring	35	O-ring
10	Spring	23	Rod seal	36	O-ring
11	Rod guide	24	Dust seal	37	Bolt
12	O-ring	25	Cover		
13	Snap ring	26	Bolt		

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

The pilot valve is a valve 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 port (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 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 (8) 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 spool to determine the output pressure.

The spring (6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (14) is inserted and can slide in the plug (21). For the purpose of changing th displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

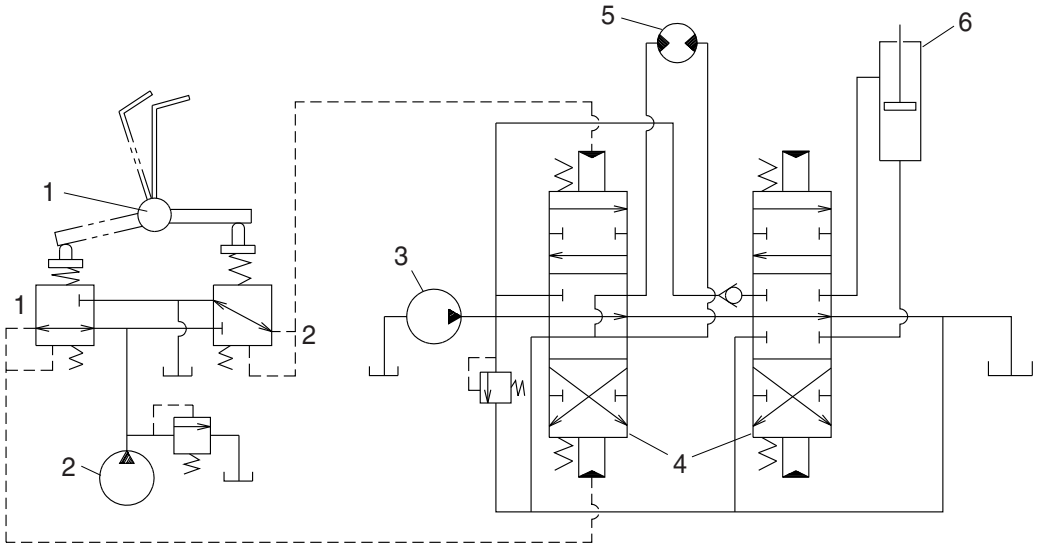
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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 ant the attached operation explanation drawing.

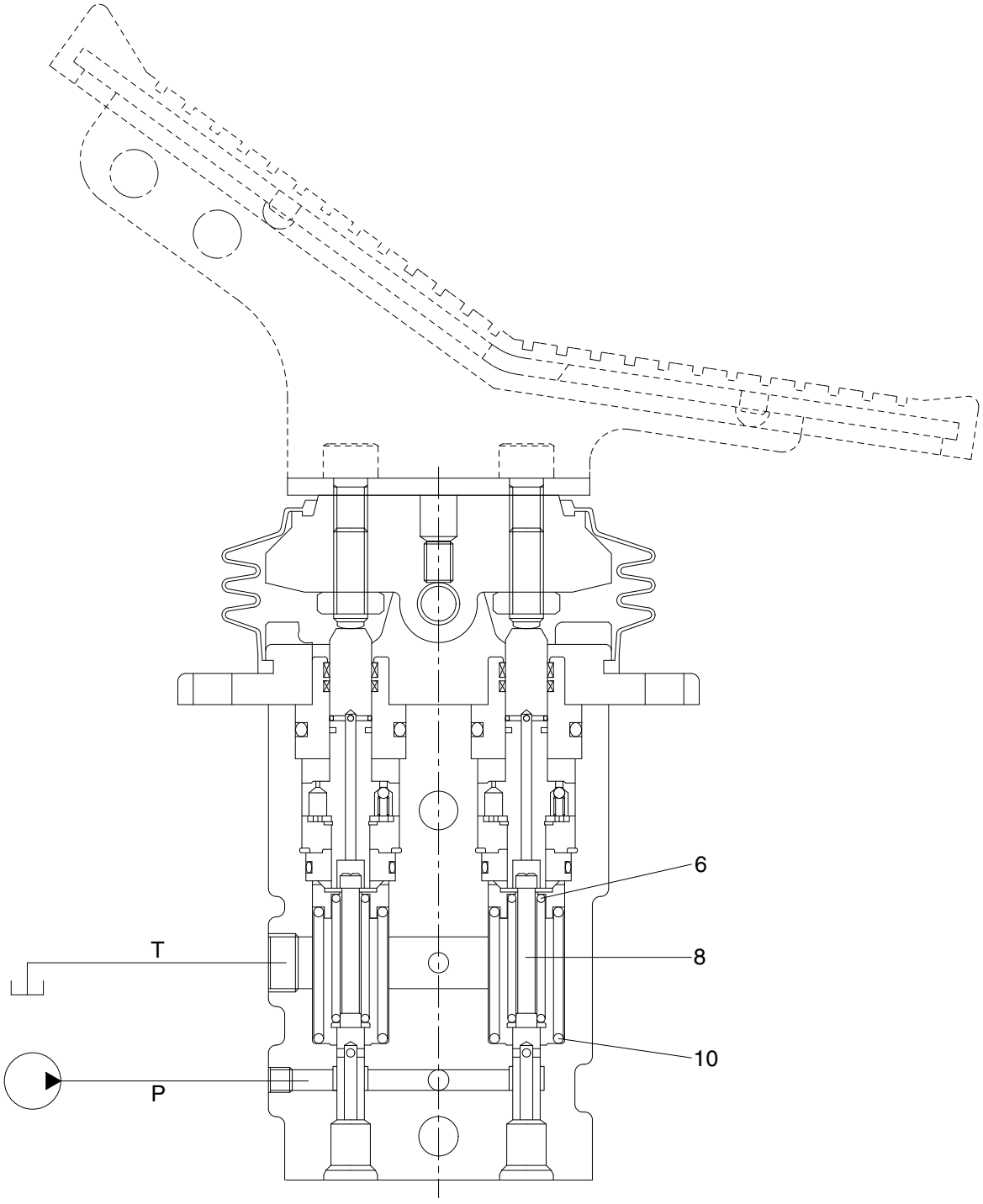
The diagram shown below is the typical application example of the pilot valve.



2-76

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

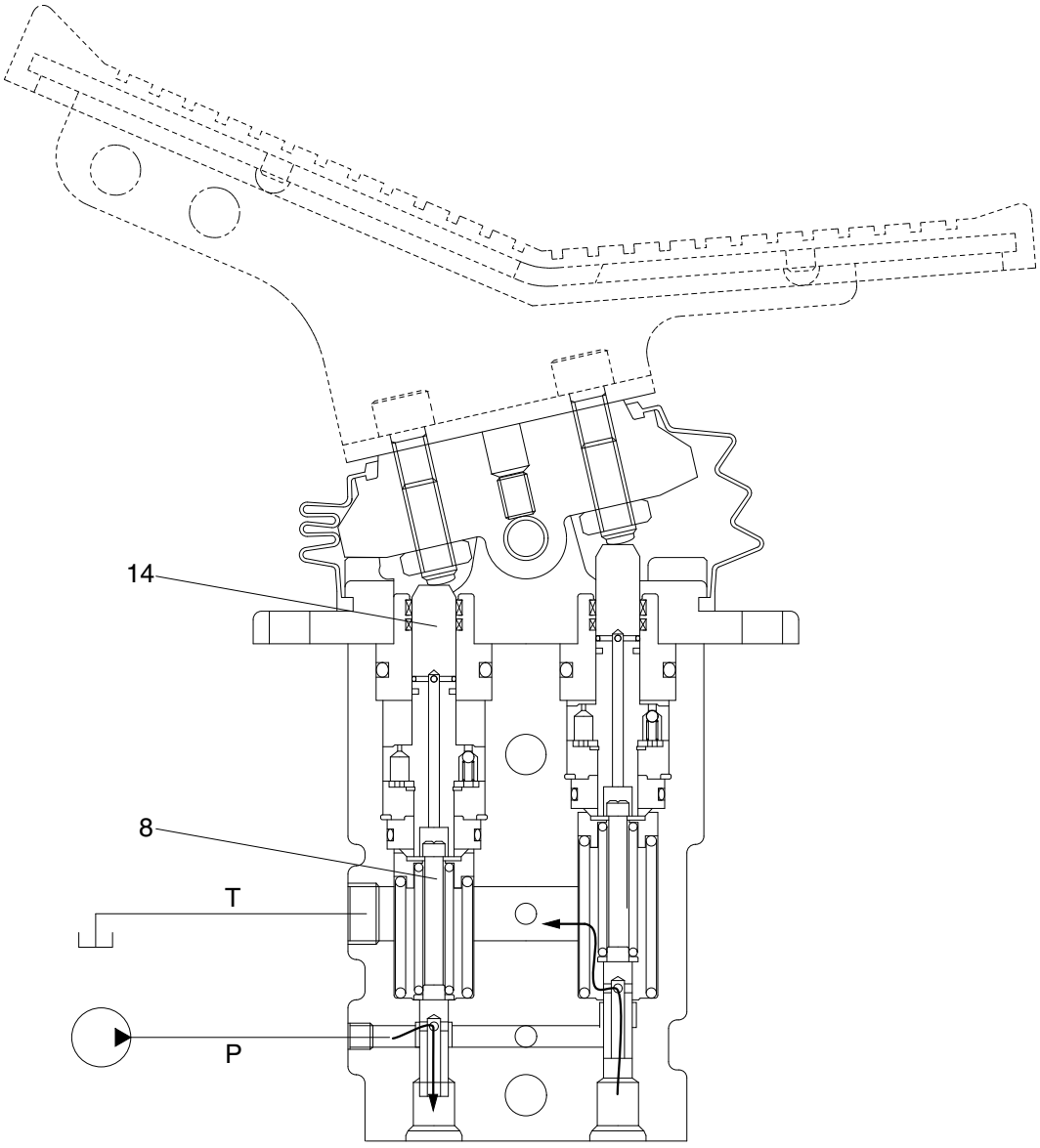
(1) Case where handle is in neutral position



14072SF74

The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (8). Therefore, the spool is pushed up by the spring (10) to the position of port 2 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



14072SF75

When the push rod (14) is stroked, the spool (8) 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 inside bottom of the push rod and the output pressure is left to be connected with port P.