

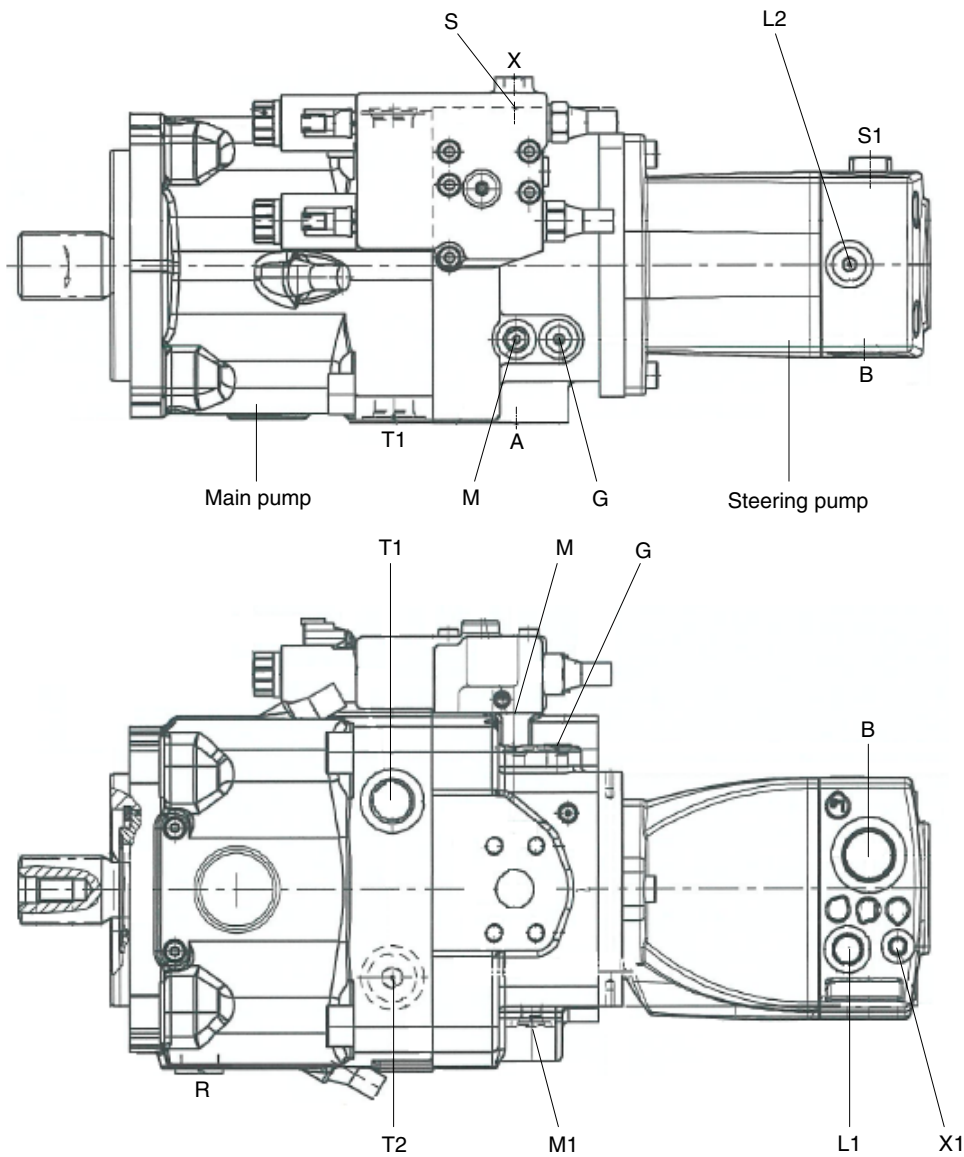
SECTION 2 STRUCTURE AND FUNCTION

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GROUP 1 PUMP DEVICE

1. STRUCTURE

The pump device consists of main pump, and steering pump.

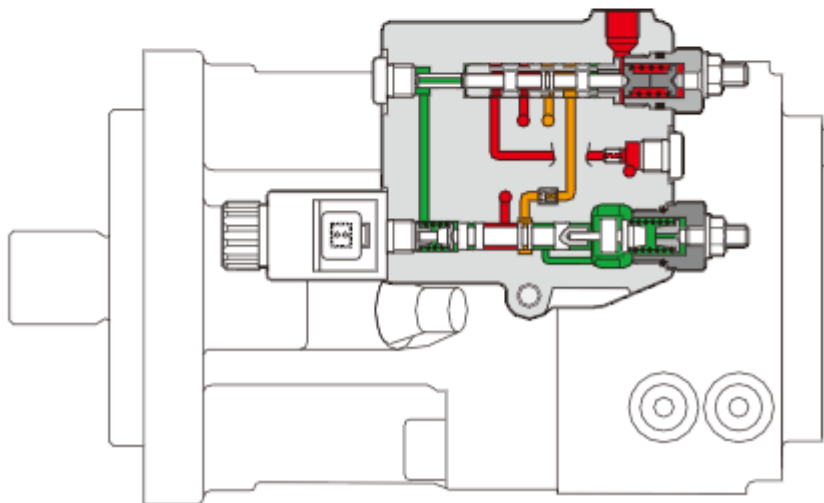
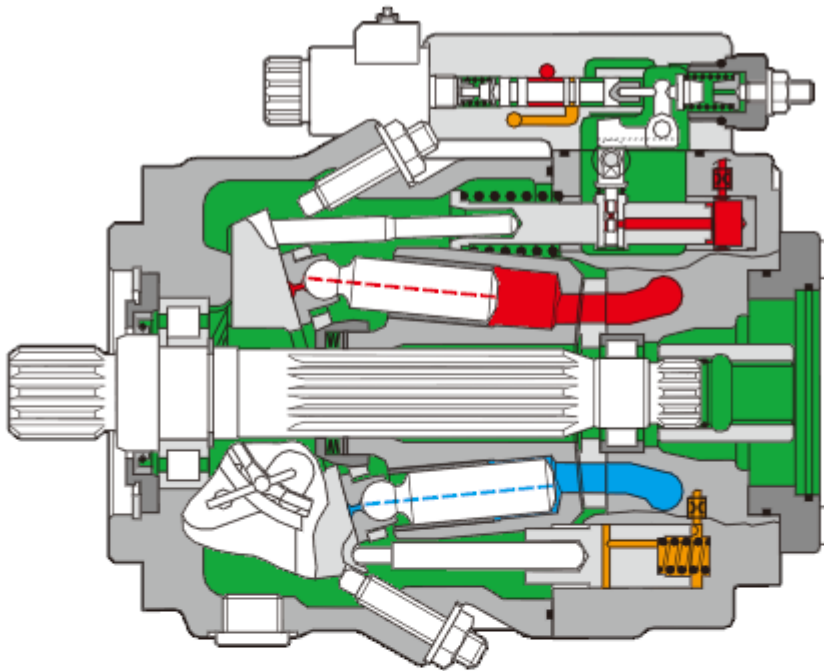


140WA2MP01

Port	Port name	Port size
A	Service port	1"
S	Suction port	3"
T1	Tank port	1 1/16-12UN
T2	Tank port	1 1/16-12UN
M1	Measuring stroking chamber	9/16-18UNF
M	Measuring service line	9/16-18UNF
R	Air bleed port	-
G	Control pressure port	9/16-18UNF
X	Pilot pressure port	9/16-18UNF
B	Service port	1 5/8-12UN
S1	Suction port	1 9/16-12UN
L1	Case drain port	3/4-16UNF
L2	Case drain port	3/4-16UNF
X1	Load sense port	7/16-20UNF

2. SCHEMATIC

1) MAIN PUMP



140WA2MP02

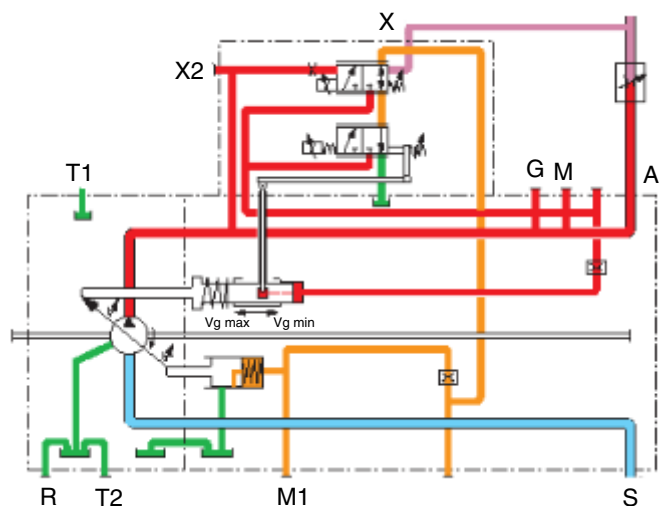
High pressure

Control pressure

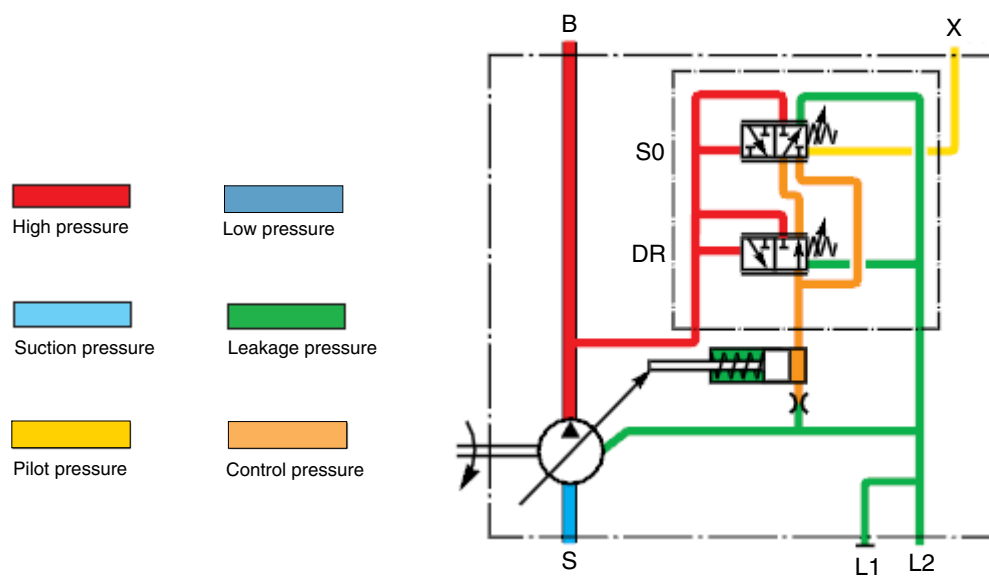
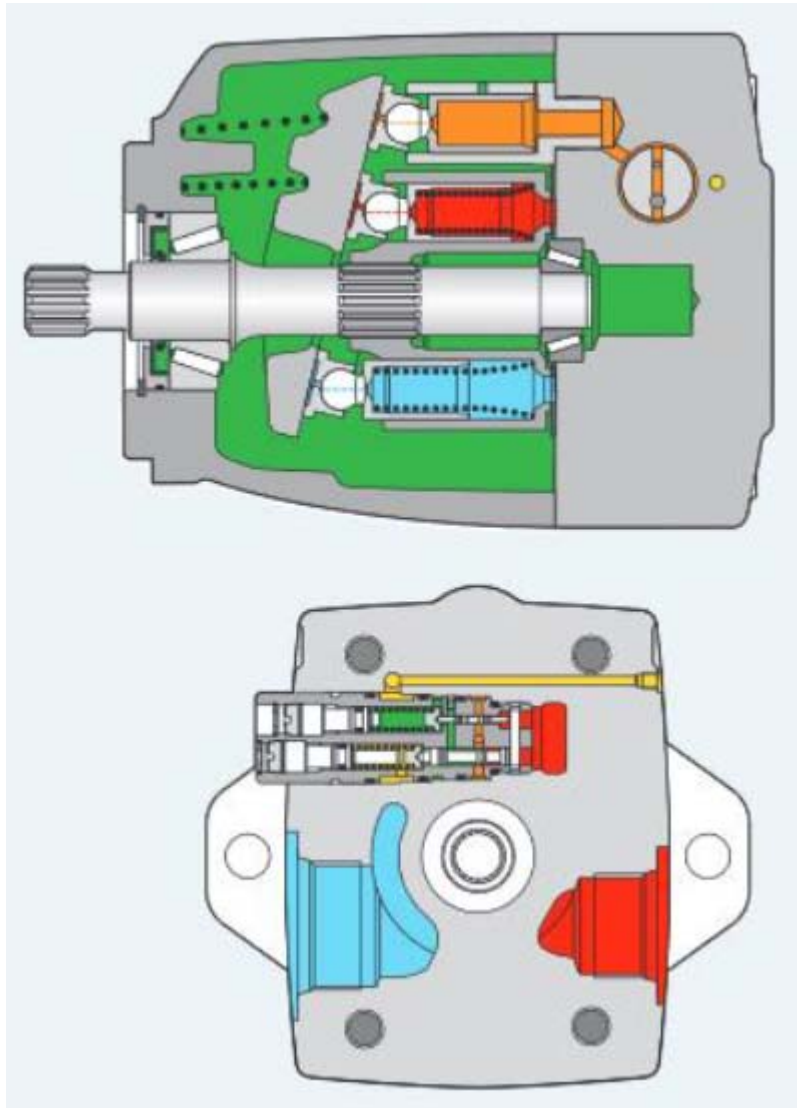
Suction pressure

Low pressure

Case pressure



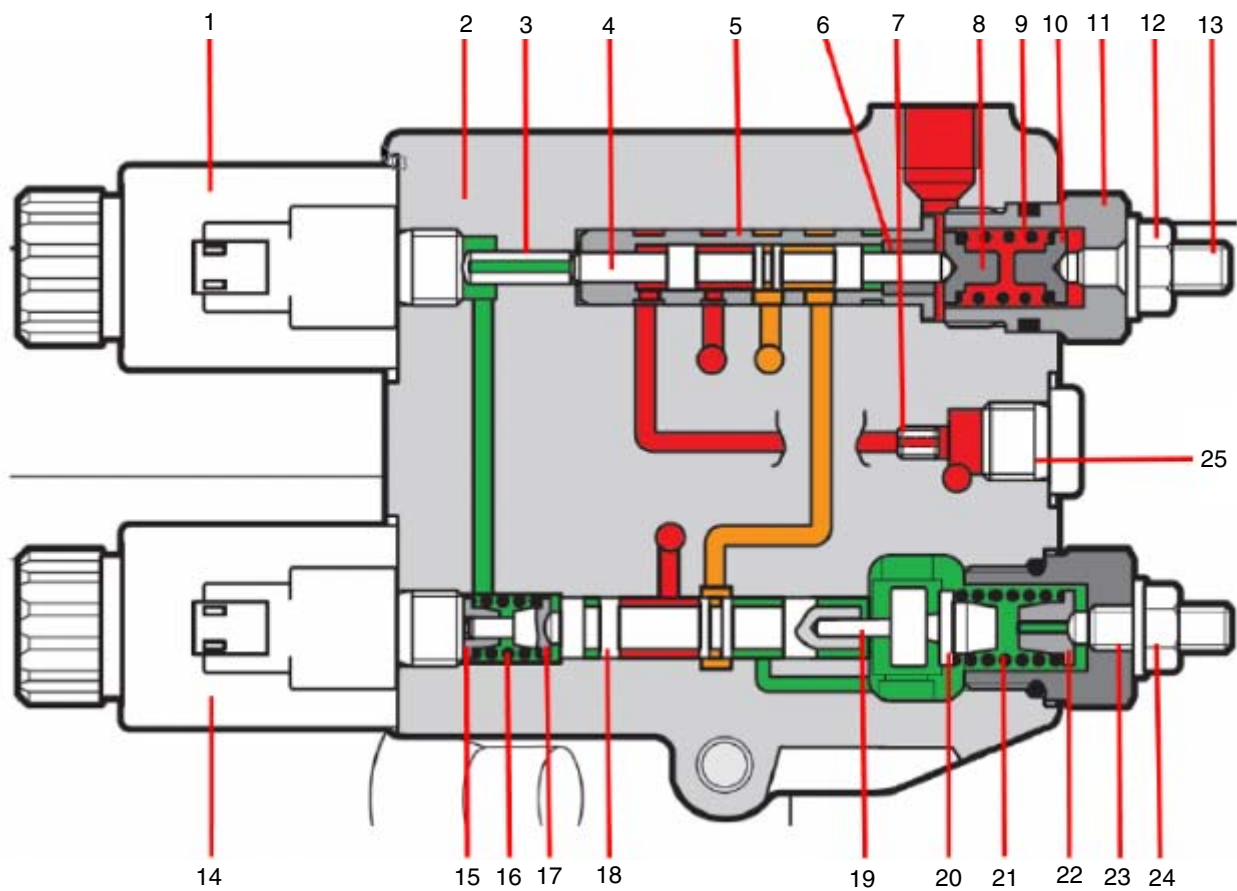
2) STEERING PUMP



140WA2MP03

3. PART LIST

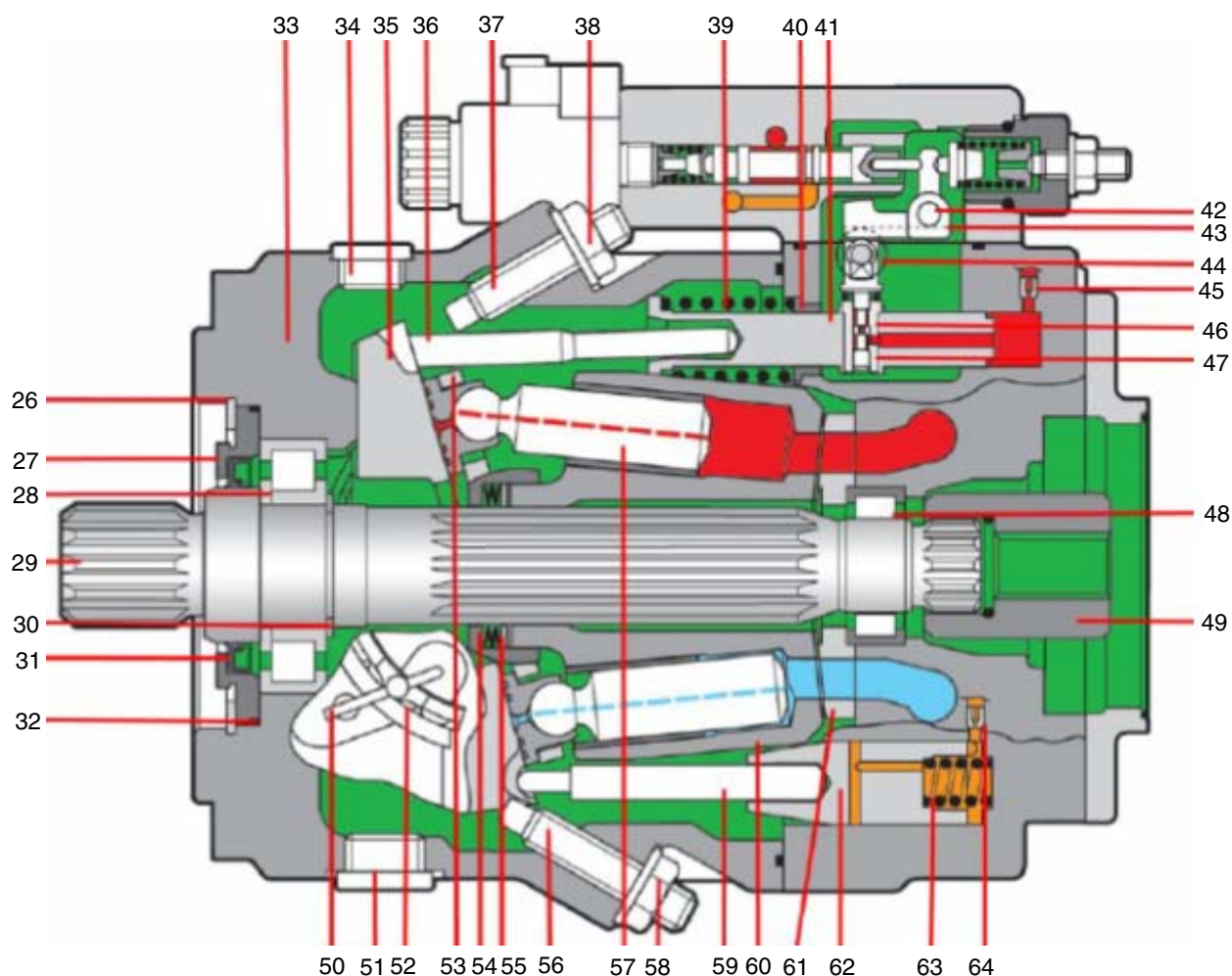
1) MAIN PUMP (1/2)



140WA2MP04

1	Prop. solenoid	10	Spring cup	19	Bolt
2	Control housing	11	Screw plug	20	Spring bolt
3	Pin	12	Sealing nut	21	Spring cup
4	Control piston LS	13	Set screw	22	Set screw
5	Control bushing LS	14	Prop. solenoid	23	Sealing nut
6	Bushing	15	Spring cup	24	Seal screw
7	Orifice	16	Spring	25	Screw plug
8	Spring cup	17	Spring cup		
9	Spring LS	18	Control piston LR		

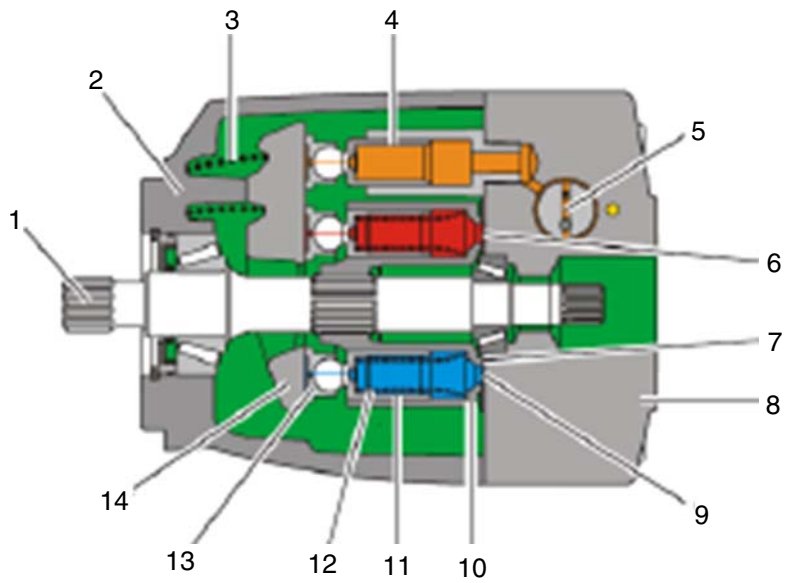
MAIN PUMP (2/2)



140WA2MP05

26	Snap ring	39	Spring	52	Cage pair
27	Locking ring	40	Bushing	53	Retaining plate
28	Cylindrical roller bearing	41	Adjusting bushing small	54	Retaining ball
29	Drive shaft	42	Bolt	55	Cup spring stack
30	Snap ring	43	Angle lever	56	Adjusting screw
31	Shaft seal ring	44	Measuring roll	57	Piston pad
32	O-ring	45	Orifice	58	Sealing nut
33	Housing	46	Measuring bushing	59	Adjusting rod big
34	Screw plug	47	Measuring piston	60	Cylinder
35	Cradle	48	Cylindrical roller bearing	61	Control plate
36	Adjusting rod small	49	Coupling hub	62	Adjusting bushing big
37	Adjusting screw	50	Wire	63	Spring
38	Sealing nut	51	Screw plug	64	Orifice

2) STEERING PUMP



140WA2MP06

- | | | |
|-----------------|----------------------|---------------------|
| 1 Drive shaft | 6 High pressure side | 11 Piston |
| 2 Case | 7 Control plate | 12 Spring in piston |
| 3 Spring | 8 Port plate | 13 Slipper pad |
| 4 Stroke piston | 9 Suction side | 14 Swash plate |
| 5 Control vavle | 10 Cylinder | |

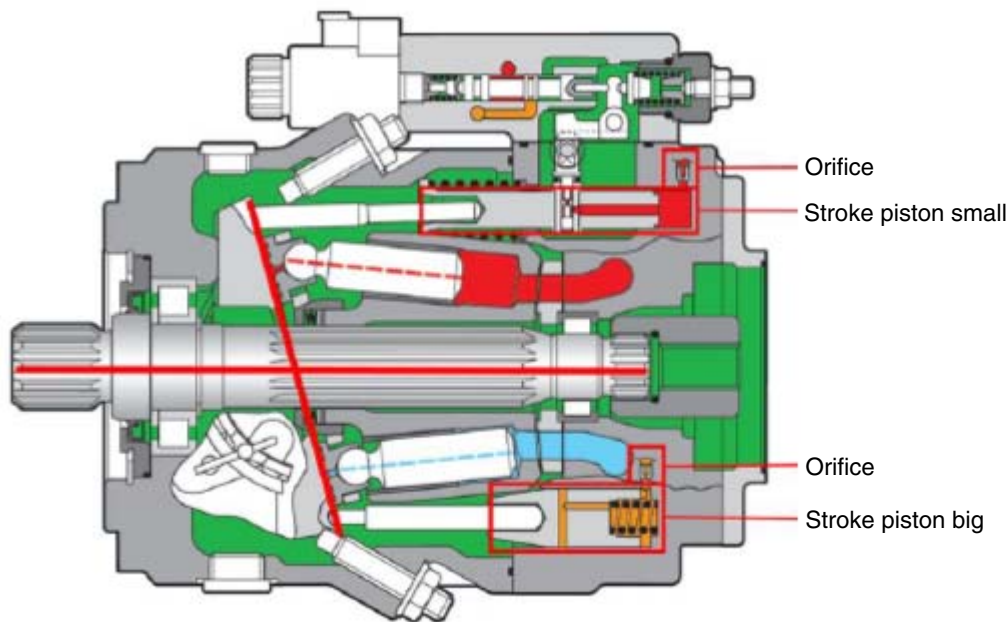
4. MAIN PUMP

1) FUNCTIONAL EXPLANATIONS

There is a priority between the individual controllers. The lowest priority has the LS controller with override function (S2).

The controller with the highest priority is the power control with override (LE2). This protects the diesel engine from overloading when the diesel engine is over-loaded.

(1) Basic function



140WA2MP07

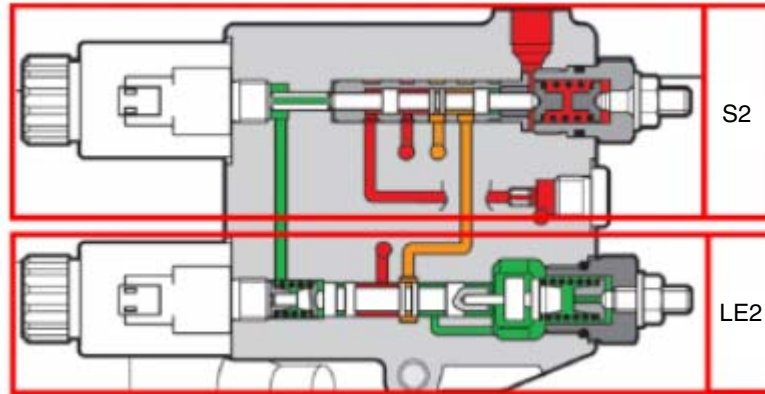
The basic function of the controllers is as follows. The high pressure (red) serves for the rotary group as a signal pressure. This pressure is sent to a smaller stroke piston. This causes the rotary group to swivel to V_{gmax} (large swivel angle). This stroke pressure is sent across the port plate to a bigger stroke piston. This is ensured by the larger piston area for the stroke pressure, inside the stroke piston we have area ratio of (2:1). If the forces of the stroke side are bigger than those of the high pressure side, then the unit swivel from V_{gmax} (large swivel angle) \rightarrow V_{gmin} (small swivel angle). The swivel time can additionally be influenced by two orifice.

You can measure the pressure of the smaller stroke piston at G and the pressure from the bigger stroke piston at M1.

As a special function, we also have a hydraulic V_{gmin} stop.

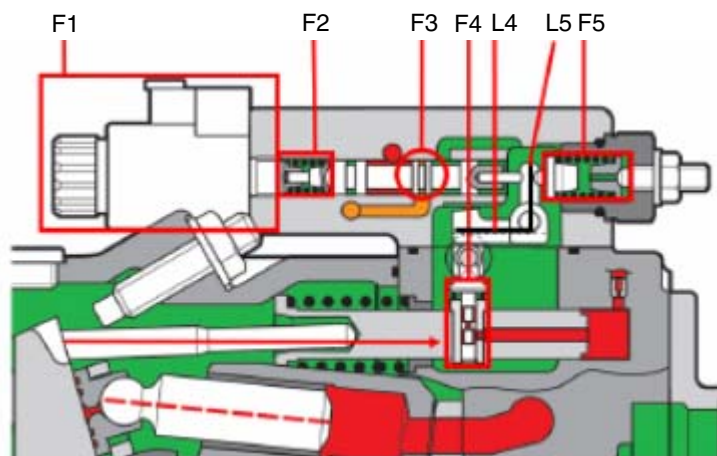
(2) Basic function controllers

The main pump has two controllers. A power controller (L) with electrical over-ride (E2) and a load sensing controller (S) with electrical override (2).



140WA2MP08

① Basic function power controller LE2



140WA2MP09

We first consider the basic function without the override.

The piston F3 has three functions.

- When the control edge is closed, the unit keeps its swing angle.
- When the control edge connects red and orange. The unit swivel until to Vgmin.
- When the control edge connects orange and green. The unit swivel until to Vgmax.

Two forces or torques act on the control piston. The first torque (D5) is set constantly. It consists of the spring force F5 and the lever arm L5. The second torque (D4) consists of the lever arm L4 and the force that is generated on the piston F4. $F4 = (\text{area} \times \text{high pressure})$ If the torque of D4 is greater than that of D5. The unit swivel to Vgmin. This reduce the angle lever arm L4 until the torques are balanced again.

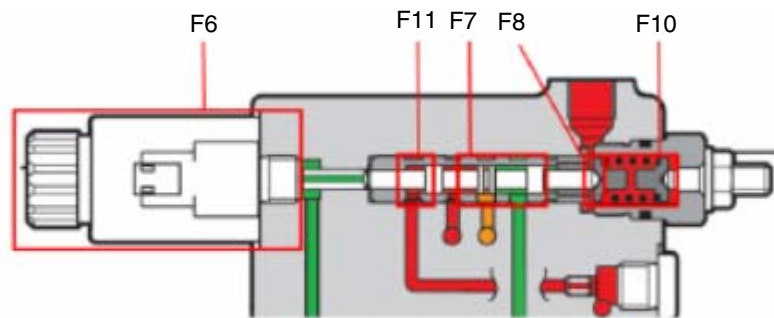
$$F4 \times L4 = M = F5 \times L5$$

Power override

The solenoid force F1 enables us to generate a new force that acts directly against the spring force F5 and thus reduces the force F4 required.

We can say: Higher current = lower power setting

② Load sensing controller S2



140WA2MP10

We first consider the basic function without the override.

The piston F7 has three functions.

- When the control edge is closed, the unit keeps its swivel angle.
- When the control edge connects red and orange. The unit swivel until to Vgmin.
- When the control edge connects orange and green. The unit swivel until to Vgmax.

With the load sensing controller, we consider the high pressure of the pump (F11) and the external load pressure (F8). The control Δp is set via the spring force (F10).

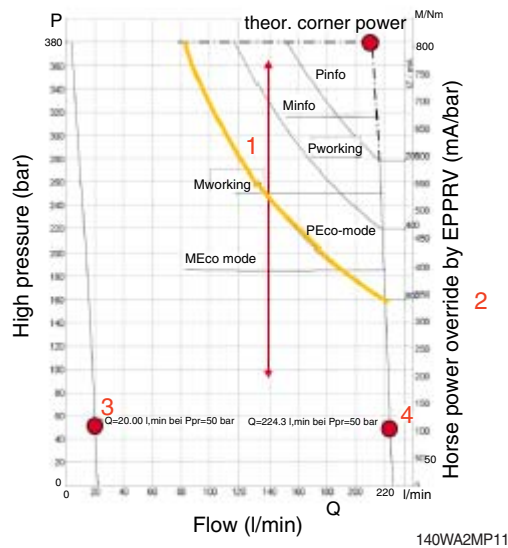
We can say $F11 = F8 + F10$.

If F11 is greater than $F8 + F10$, the unit swivel to Vgmin until it balances again. The spring force F8 is fixed. To change the Δp during the operation. We have the possibility to generate a new force via the solenoid F6.

We can say: higher current = smaller Δp setting.

2) ADJUSTMENT

(1) Power controller



P-Q diagram

- 1 Individual power control (hyperbolic regulator)
- 2 With load limiting control via solenoid
3. Qmin setting
4. Qmax setting

Because the power controller can be overridden with a solenoid. It need the following three points of information for the setting point.

Current, swivel angle of the pump and Δp pressure.

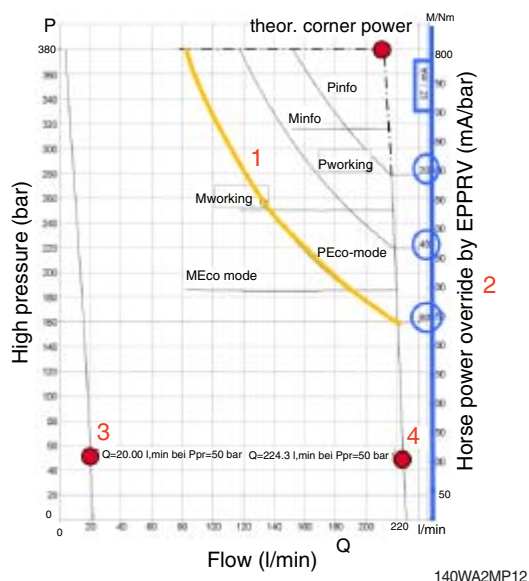
First we come to the swivel angle of the pump. Here is important that the unit stand on Vgman. You can check this over the measuring port G and M1. You should see the high pressure on G and no or a lower pressure than 1 (pressure on G) to 3 (pressure at M1). Than check, that you don't limited the Vg with the stroke limiter screw.

Current: You need the current from the diagram on the solenoid for the override function.

Pressure: You need the high pressure from the p-Q diagram on the measuring port G.

Example for the yellow line: pressure: 160 bar, current 600mA, Vg=145ccm
 $(q=145\text{ccm} \times 1600 \text{ l/min} / 1000 = 232 \text{ liter})$

(2) Power controller override (load limiting control)

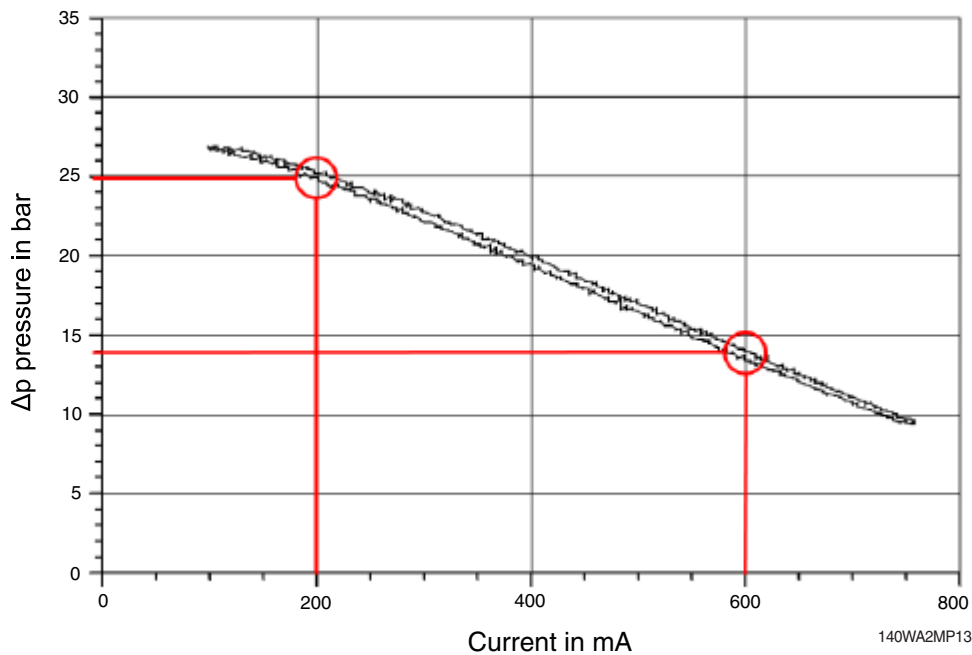


P-Q diagram

- 1 Individual power control (hyperbolic regulator)
- 2 With load limiting control via solenoid
3. Qmin setting
4. Qmax setting

■ Power override IX3 via ECU (enging control unit)

(3) Load sensing controller



Because the LS controller can be overridden with a solenoid. It need the following two pieces of information for the setting point. Current and Δp pressure. You can get this information individually from your HD Hyundai Construction Equipment dealer.

If you have this information, drive the current at the override to the desired value and set the desired Δp using the control screw on the LS controller.

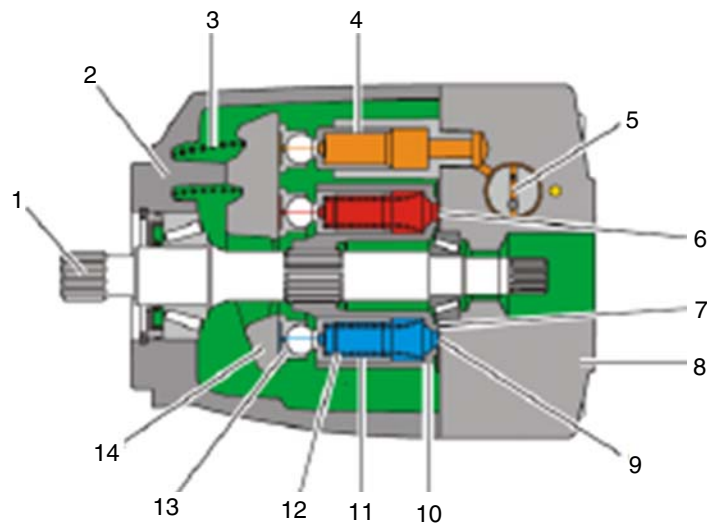
In the picture you see two examples.

You can give current to the controller with 200 mA and 25 bar Δp or 600 mA and 14 bar Δp . The result would be the same.

The controller moves on the characteristic from the diagram.

5. STEERING PUMP

1) FUNCTIONAL DESCRIPTION



140WA2MP03

1	Drive shaft	6	High pressure side	11	Piston
2	Case	7	Control plate	12	Spring in piston
3	Spring	8	Port plate	13	Slipper pad
4	Stroke piston	9	Suction side	14	Swash plate
5	Control valve	10	Cylinder		

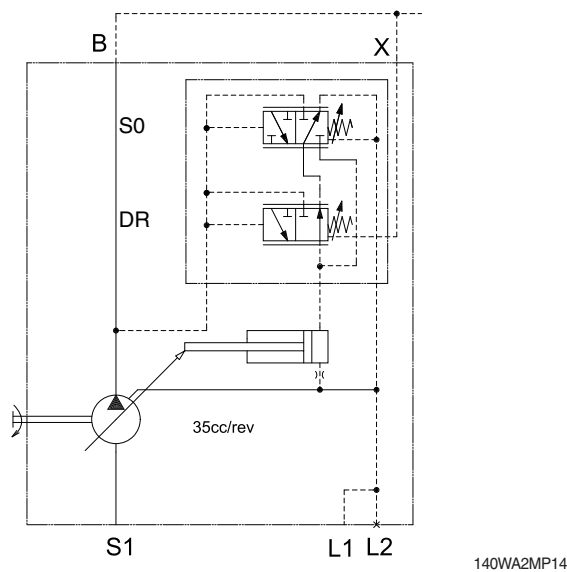
(1) Pump

Torque and rotational speed are applied to the drive shaft (1) by an engine. The drive shaft is connected by splines to the cylinder (10) to set this in motion. With every revolution, the pistons (11) in the cylinder bores execute one stroke whose magnitude depends on the setting of the swash plate (14). The slipper pads (13) are held on and guided along the glide surface of the swash plate by the spring in the piston (12). The swash plate setting during a rotation causes each piston to move over the bottom and top dead centers and back to its initial position. Here, hydraulic fluid is fed in and drained out through the two control slots in the control plate (7) according to the stroke displacement. On the suction side (9) hydraulic fluid flows into the piston chamber as the piston recedes. At the same time, on the high-pressure side (6) the fluid is pushed out of the cylinder chamber into the hydraulic system by the pistons.

(2) Control

The swivel angle of the swash plate (14) is steplessly variable. Controlling the swivel angle of the swash plate changes the piston stroke and therefore the displacement. The swivel angle is changed hydraulically by means of the stroke piston (4). The swash plate is mounted for easy motion in swivel bearings. When pressurized, the swash plate is held in balance by the swiveling forces of the rotary group, which are generated by the eccentrically mounted swash plate and by the control pressure. When depressurized, the spring (3) presses the swash plate to maximum swivel angle. Increasing the swivel angle increases the displacement; reducing the angle results in a corresponding reduction in displacement.

2) CONTROLLER (pressure controller with load sensing)



The pressure controller limits the maximum pressure at the pump outlet within the control range of the variable pump. The variable pump only supplies as much hydraulic fluid as is required by the consumers. If the operating pressure exceeds the pressure setting at the pressure valve, the valve opens the connection from P-channel (high pressure) to A-channel (stroking pressure) and the pump will regulate to a smaller displacement to reduce the control differential.

In addition to the pressure controller function, the load-sensing controller (S0) works as a flow controller to regulate the pump displacement to match the consumer flow requirement.

A variable orifice is used to adjust the differential pressure upstream and downstream of the orifice. The flow controller is working like a pressure compensator to keep a constant delta p by comparing the high pressure against the load-sensing (LS) pressure plus spring preload. If the LS pressure plus spring preload exceeds the high pressure, the controller piston opens the connection from A-channel (stroking pressure) to T-channel (tank/housing) and the pump displacement will increase. If the high pressure exceeds the LS pressure plus spring preload, the controller piston opens the connection from P-channel (high pressure) to A-channel (stroking pressure) and the pump displacement will decrease.

Basic position in depressurized state: Vg max

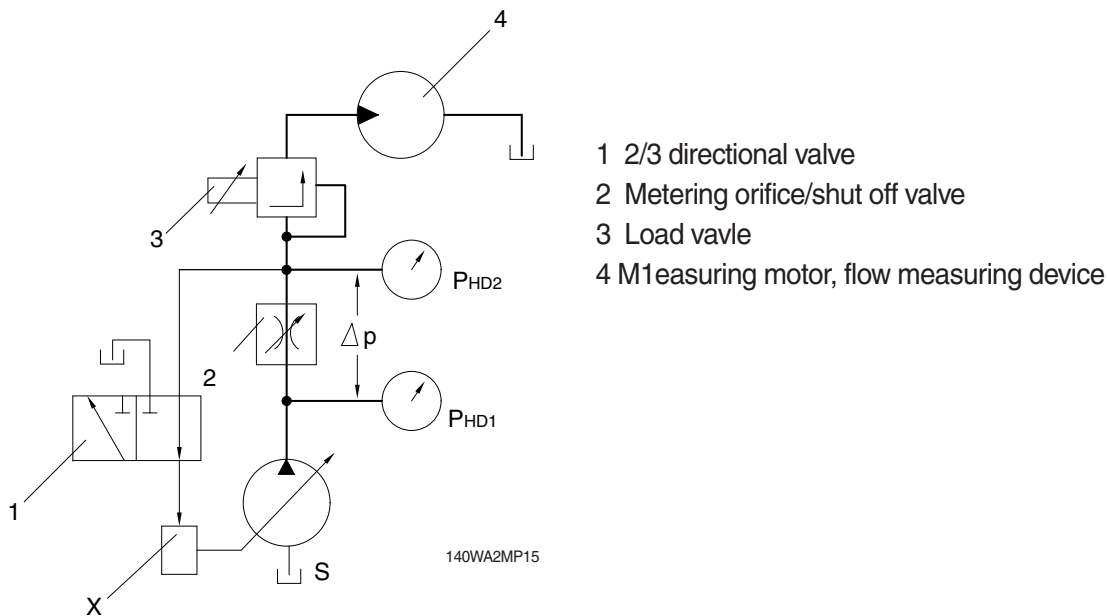
$$\text{Flow } q_v = \frac{V_g \times n \times \eta_v}{1000} \text{ [l/min]}$$

Vg - Displacement per revolution [cm³]

n - Rotational speed (rpm)

η_v - Volumetric efficiency

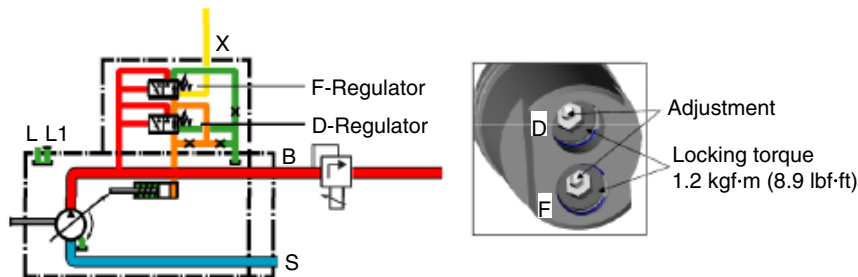
3) ADJUSTMENT OF PRESSURE CONTROLLER WITH LOAD SENSING



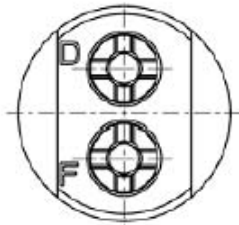
Please note the mounting position of the controller and watch out for the notched letters:

D = Pressure controller

F = Flow controller



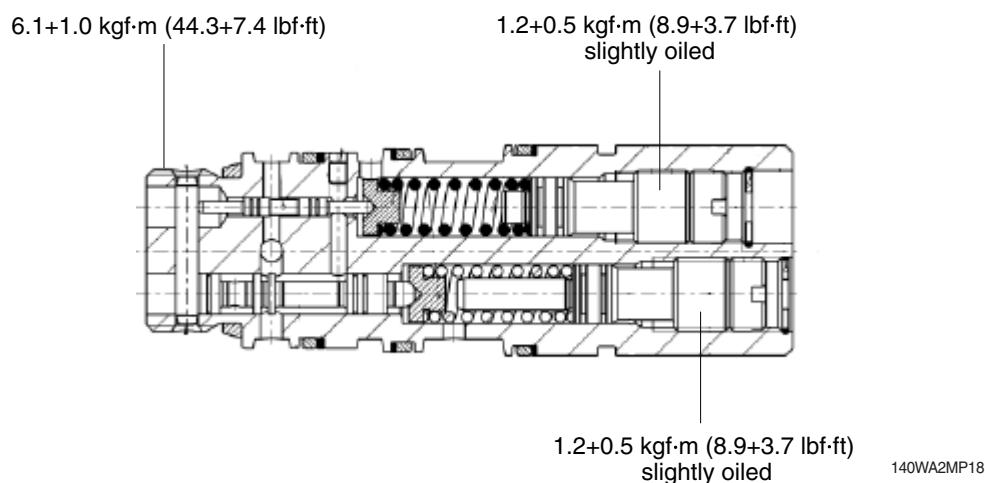
※ Special tool



For setting the controllers, we recommend using a special tool as you can see in the picture below. With this tool deviations of the values are prevented.

140WA2MP17

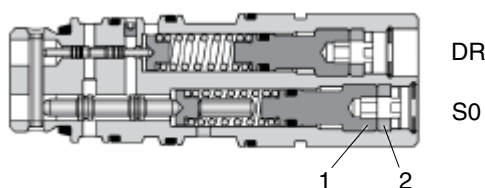
※ **Tightening torque**



(1) Adjustment of pressure controller (D)

Setting range until 250 bar

1. Turn adjusting screw of F-controller on block
2. Release the adjusting screw of D-controller
3. Close load valve
4. Tighten setting screw (1) of D-controller with lock nut (2) and $1.2 \pm 0.5 \text{ kgf}\cdot\text{m}$ torque until the pressure to be adjusted is reached (one revolution + 59.5 bar).



140WA2MP19

1 Setting screw

2 Lock nut

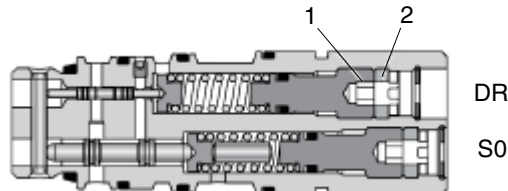
※ **Upon setting without a special tool the following must be kept in mind:**

After setting the controller setting screw (AF4) the set value can show an increase of approx. 7 bar due to tightening of the lock nut. The set values of the controller should therefore be correspondingly lower. Since especially new controllers can change their setting values in operation, due to settling of the springs, testing of the settings must be repeated 2-3 times, if needed correct settings. Make sure, that the load valve and the and the pressure control valve are unloaded. Setting of the pressure controller via the load valve according to the performance diagram.

(2) Adjustment of delta p setting (F)

Setting range 14 – 35 bar

1. Release the adjusting screw of F-controller
2. Release X-channel
3. Adjust standby-pressure at setting screw (1) (one revolution = 12.3 bar) and secure the lock nut (2) with a slotted screw driver (width 8.8 mm) with a torque of $1.2 \pm 0.5 \text{ kgf} \cdot \text{m}$.



140WA2MP20

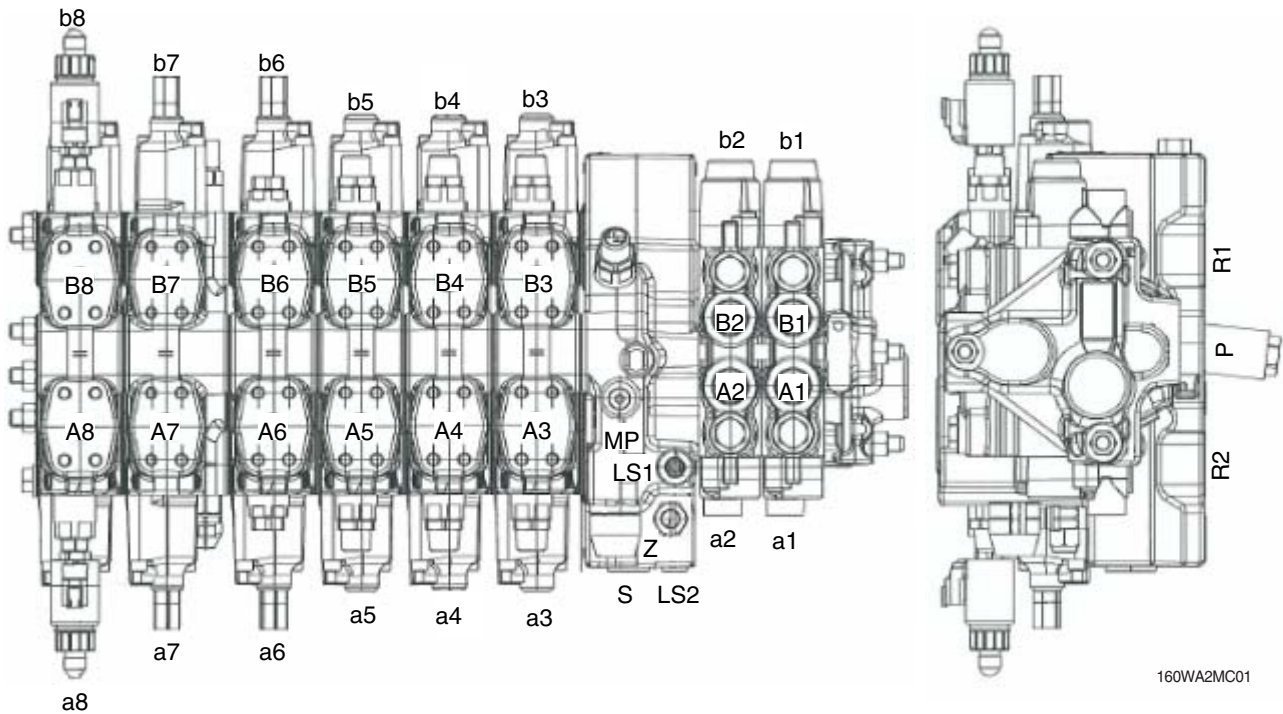
1 Setting screw

2 Lock nut

※ When settings are done without special tools, the following must be considered: After setting of the FR setting screw (AF4) the set value can be increased by approx. 1.5 bar through tightening of the lock nut. Therefore the set value of the FR controller should be set a bit lower. Since especially new controllers can change their setting values in operation, due to settling of the springs, testing of the settings must be repeated 2 to 3 times, if needed correct settings.

GROUP 2 MAIN CONTROL VALVE

1. OUTLINE

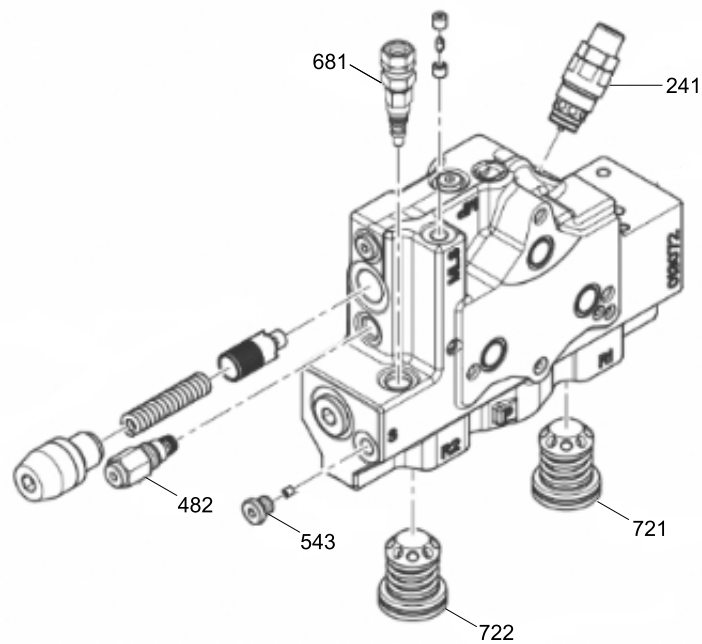


Mark	Port name
P	Pump port
R1	Tank port (cooler)
R2	Tank port
S	Make up port
LS1	Load sensing port
LS2	Pressure switch
MP	Plugged
Z	Power boost port
A1	Dozer down port
B1	Dozer up port
A2	2 pcs boom up port (opt)
B2	2 pcs boom down port (opt)
A3	Boom up port
B3	Boom down port
A4	Arm out port
B4	Arm in port
A5	Bucket in port
B5	Bucket out port
A6	Travel port (FW)
B6	Travel port (RR)

Mark	Port name
A7	Swing port (LH)
B7	Swing port (RH)
A8	Option port
B8	Option port
a1	Dozer down pilot port
b1	Dozer up pilot port
a2	2 pcs boom up pilot port (opt)
b2	2 pcs boom down pilot port (opt)
a3	Boom up pilot port
b3	Boom down pilot port
a4	Arm out pilot port
b4	Arm in pilot port
a5	Bucket in pilot port
b5	Bucket out pilot port
a6	Travel pilot port (FW)
b6	Travel pilot port (RR)
a7	Swing pilot port (LH)
b7	Swing pilot port (RH)
a8	Option pilot port
b8	Option pilot port

2. STRUCTURE

1) INLET SECTION



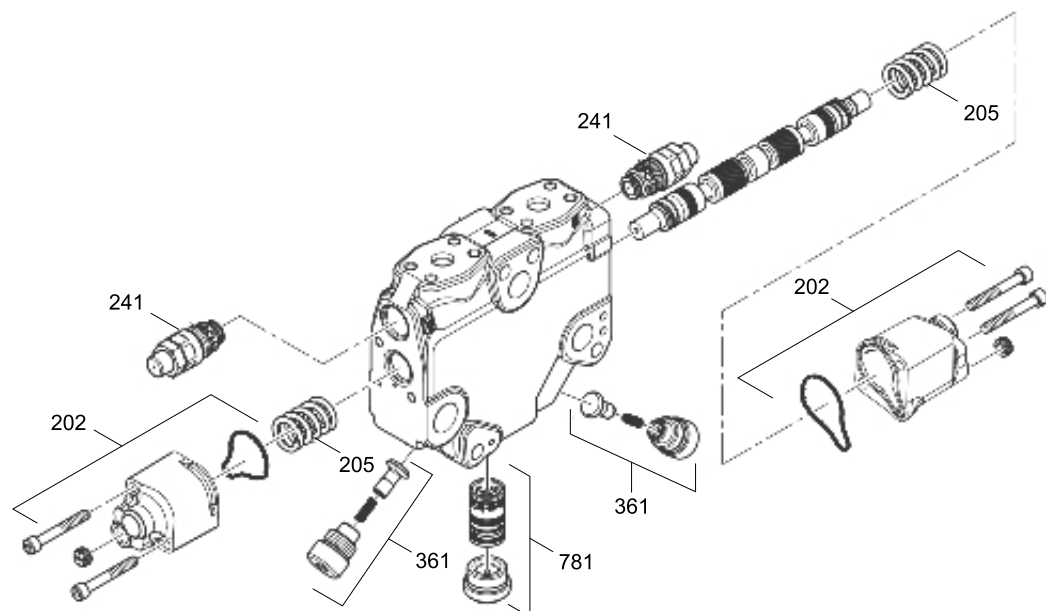
140WA2MC02

241 Pressure relief valve
482 Flow valve

543 Screw
681 Pressure relief valve

721 Check valve
722 Check valve

2) BOOM SECTION



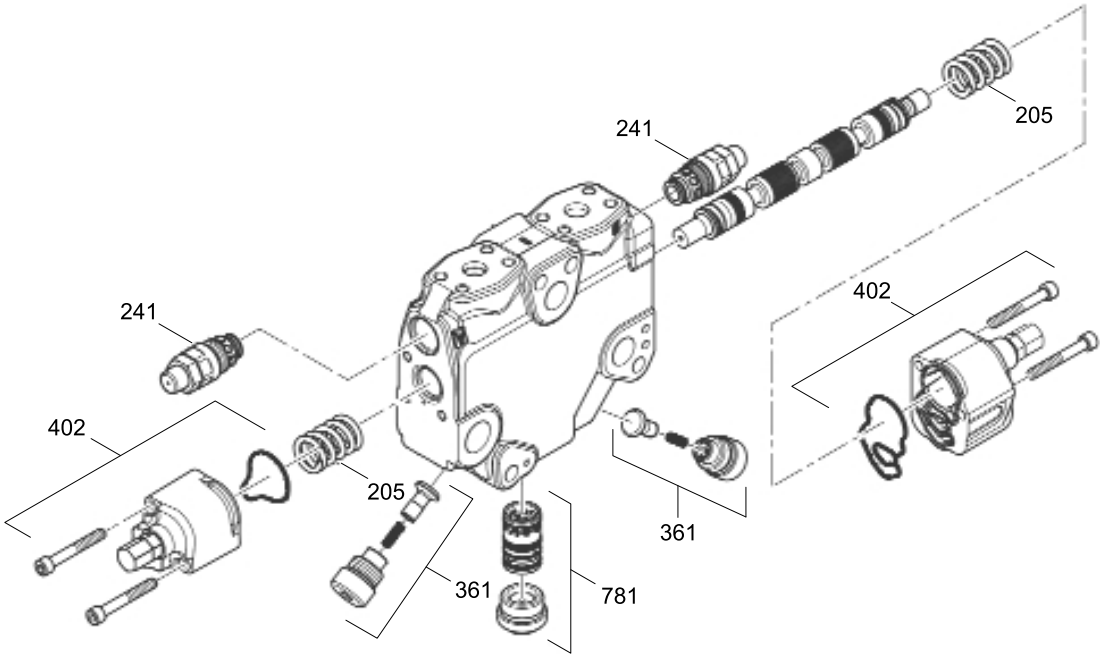
140WA2MC03

202 Cover assy
205 Spring

241 Pressure relief valve
361 Spool assy

781 Spool assy

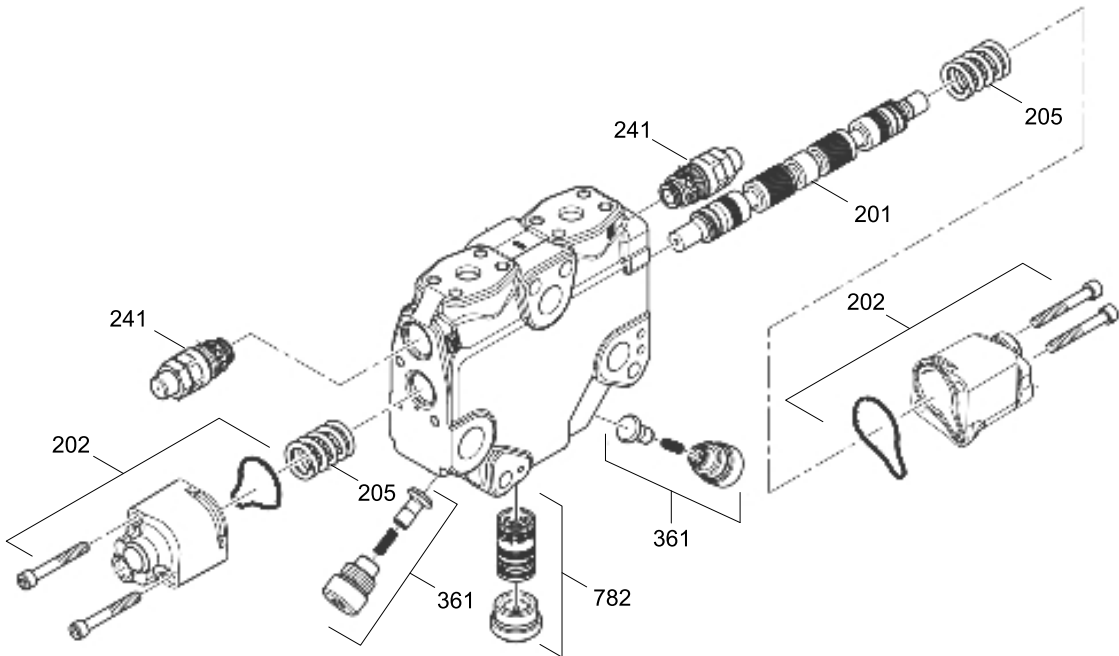
3) ARM SECTION



140WA2MC04

- | | | |
|---------------------------|----------------|----------------|
| 205 Spring | 361 Spool assy | 781 Spool assy |
| 241 Pressure relief valve | 402 Cover assy | |

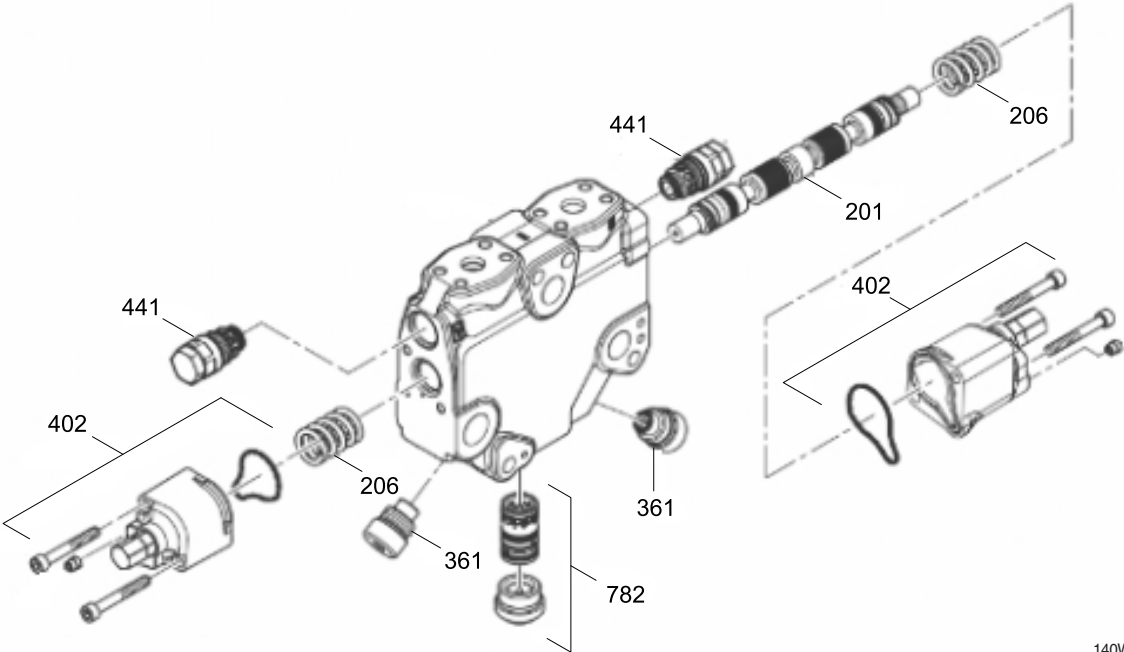
4) BUCKET SECTION



140WA2MC05

- | | | |
|----------------|---------------------------|----------------|
| 201 Spool assy | 205 Spring | 361 Spool assy |
| 202 Cover assy | 241 Pressure relief valve | 782 Spool assy |

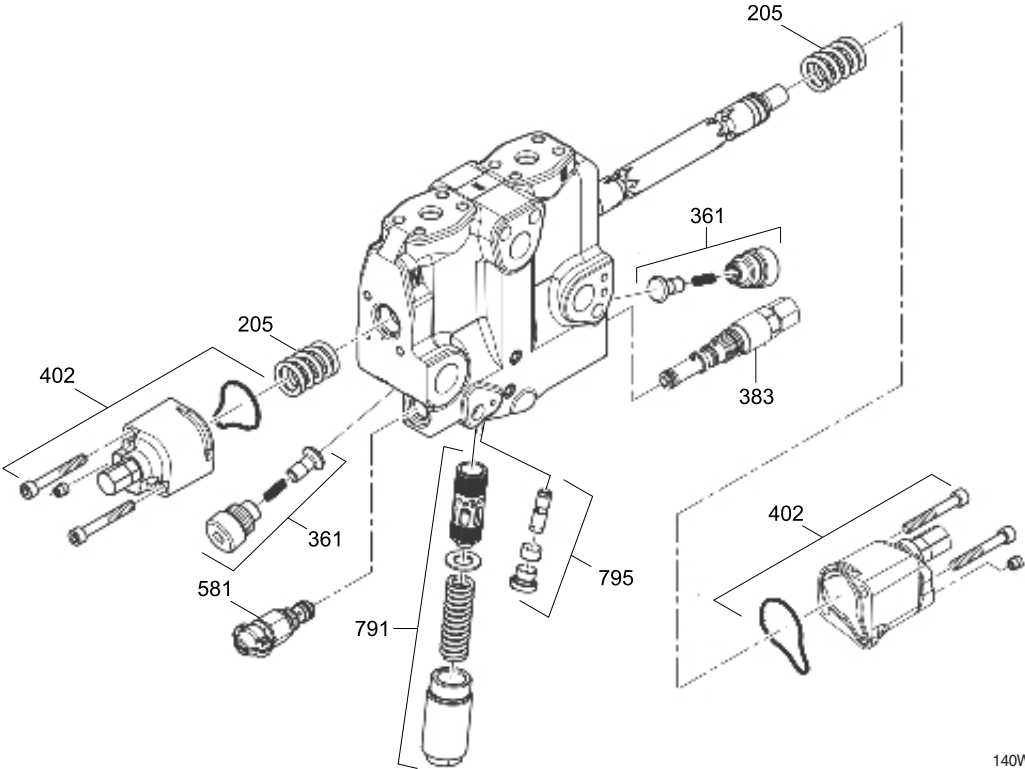
5) TRAVEL SECTION



140WA2MC06

- | | | |
|----------------|----------------|---------------------------|
| 201 Spool assy | 361 Spool assy | 441 Pressure relief valve |
| 206 Spring | 402 Cover assy | 782 Spool assy |

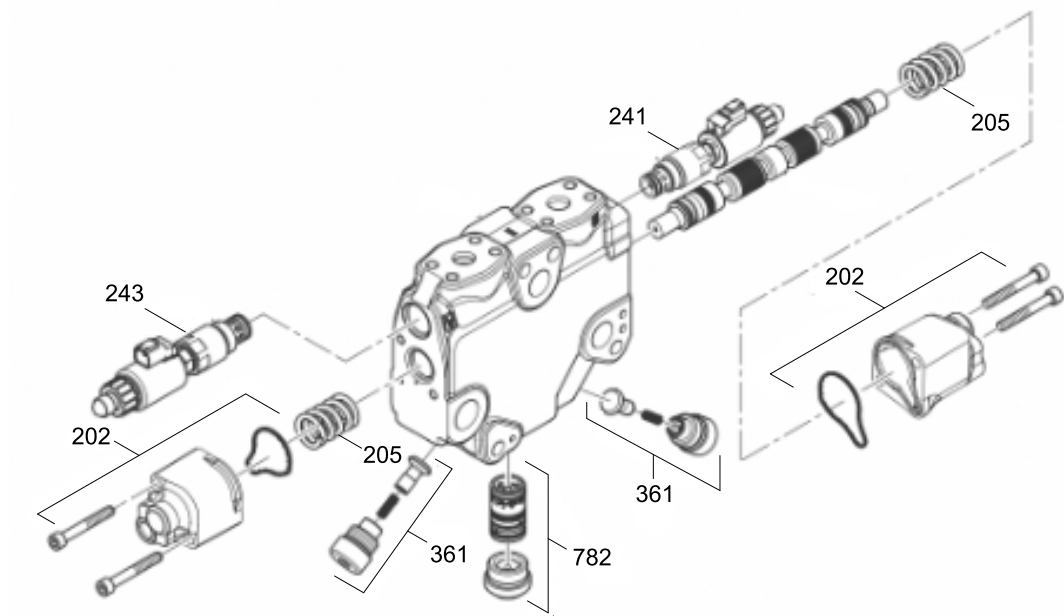
6) SWING SECTION



140WA2MC07

- | | | |
|----------------|------------------|----------------|
| 205 Spring | 402 Cover assy | 795 Spool assy |
| 361 Spool assy | 581 Relief valve | |
| 383 Spool assy | 791 Spool assy | |

7) OPTION SECTION



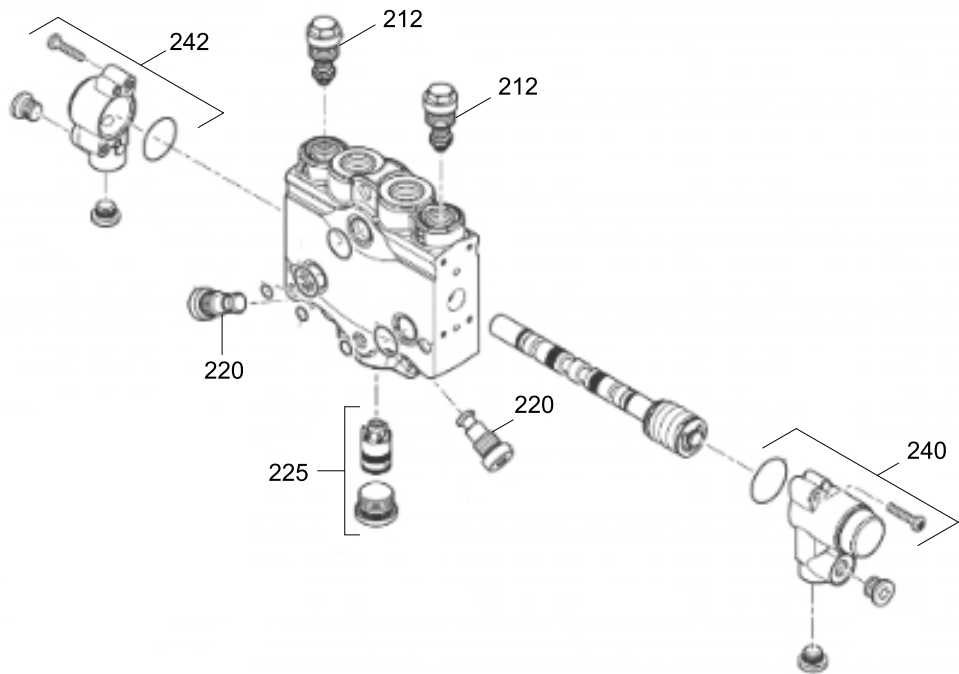
140WA2MC08

202 Spool assy
205 Spring

225 Spool assy
243 Pressure relief valve

361 Spool assy
781 Spool assy

8) 2 PIECE BOOM SECTION



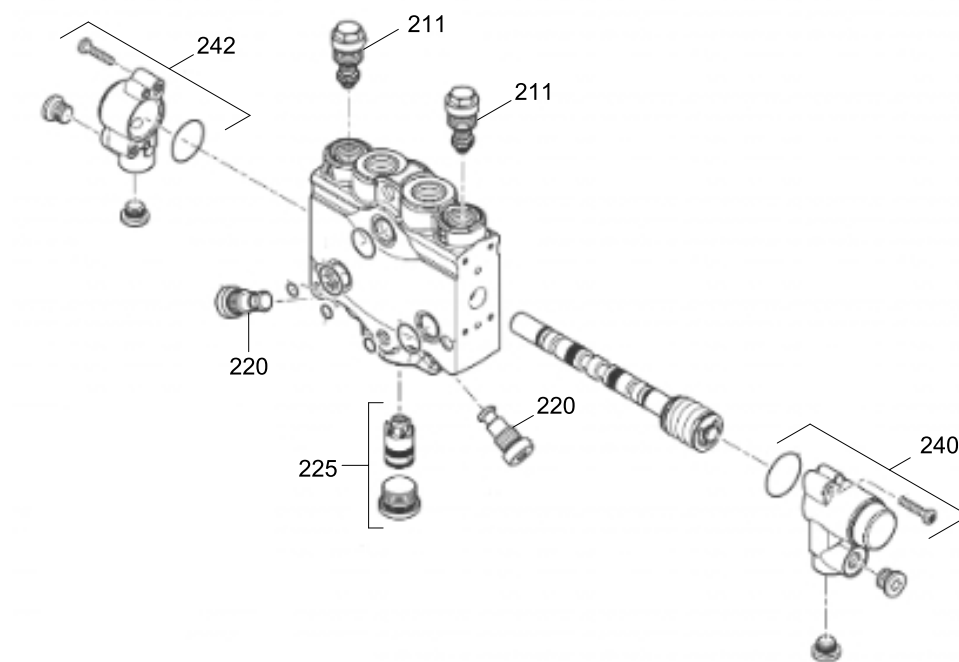
140WA2MC09

212 Pressure relief valve
220 Check vavle

225 Spool assy
240 Cover kit

242 Cover kit

9) DOZER (OUTRIGGER) SECTION



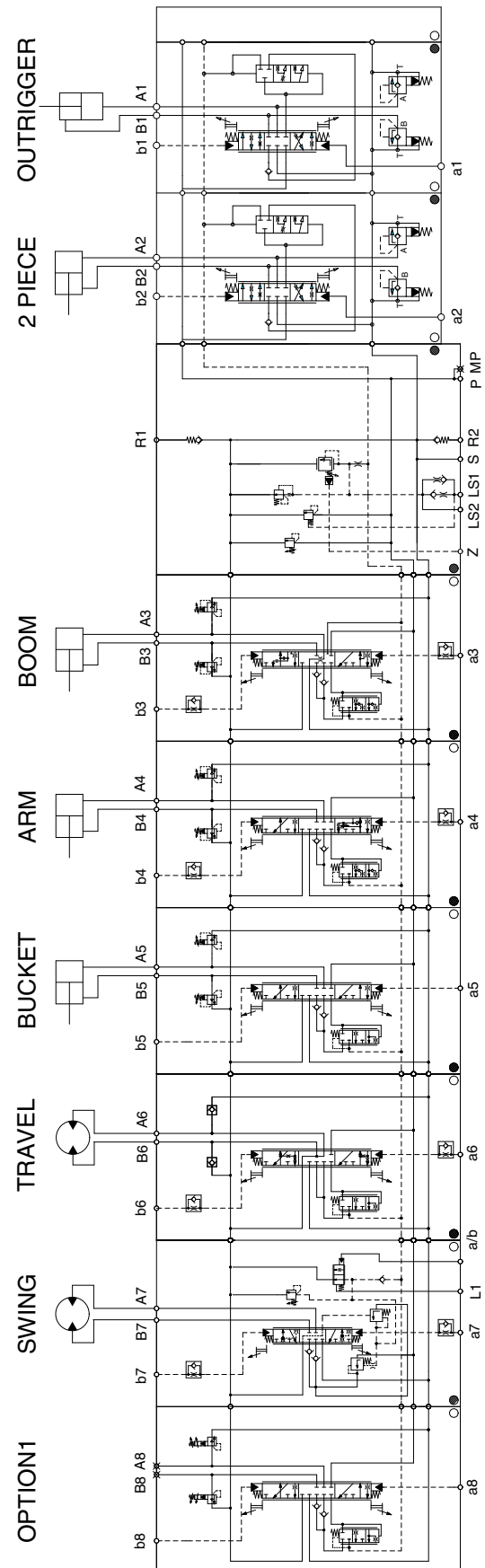
140WA2MC10

211 Pressure relief valve
220 Check valve

225 Spool assy
240 Cover kit

242 Cover kit

3. HYDRAULIC CIRCUIT

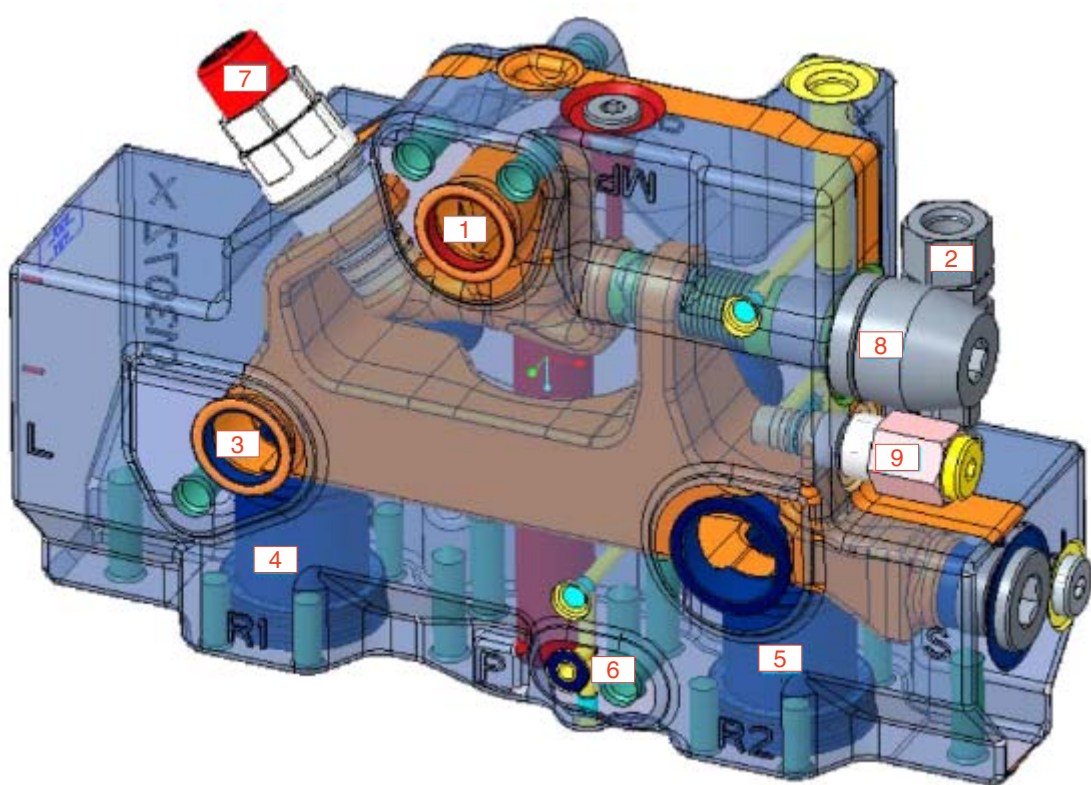


140WA2MC11

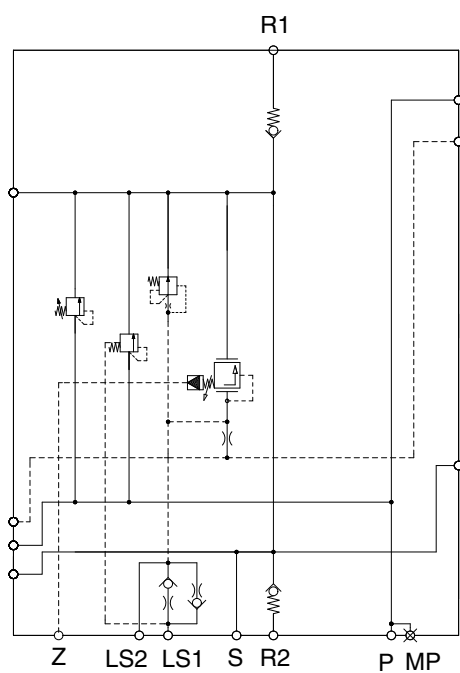
4. FUNCTION

1) INLET SECTION

(1) Structure



140WA2MC20

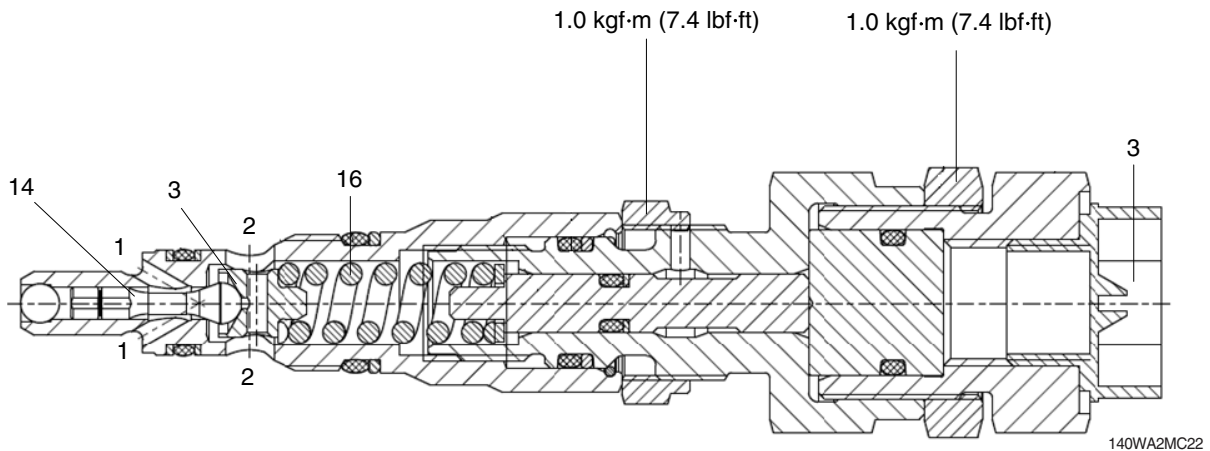


140WA2MC21

- 1 Pump channel (P)
- 2 2 stage LS pressure relief valve
- 3 Tank channel
- 4 Tank port (R1, cooler)
- 5 Tank port (R2)
- 6 LS channel
- 7 Primary relief valve
- 8 Unloading valve
- 9 LS drain valve

(2) 2 stage LS relief valve

The pressure valve type is a direct operated pressure relief valve for the installation in block designs. It is used to limit a system pressure. The system pressure can be set steplessly via the adjustment element.



※ For the case of unintentional adjustment during assembly process, we would recommend to mark the positions by sealing wax.

① Pressure relief function

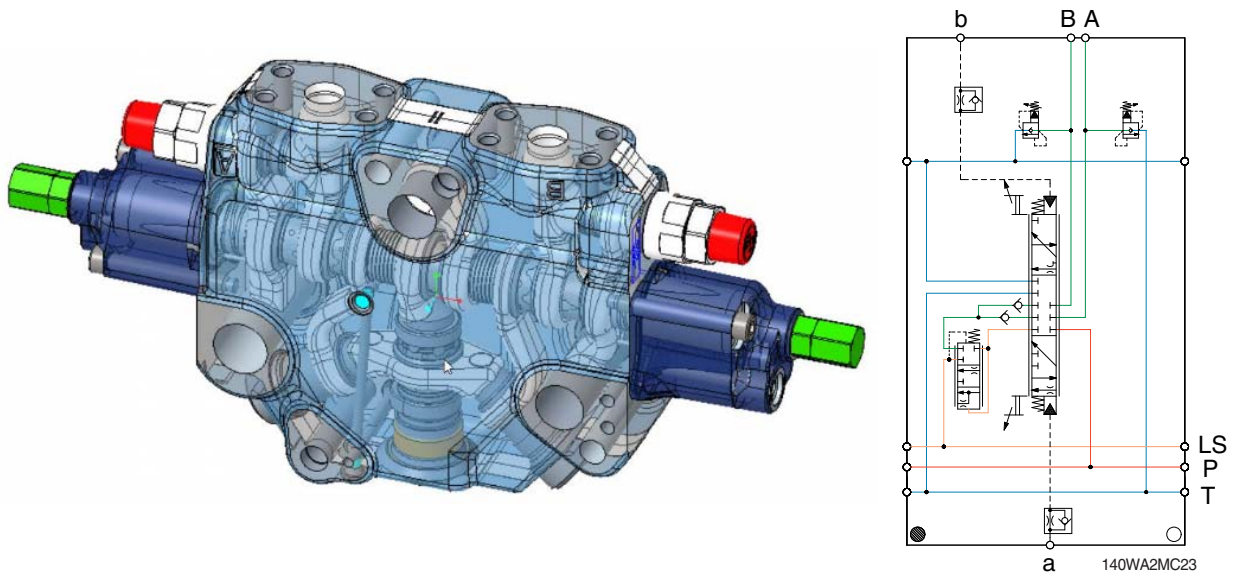
In the initial position the valve is closed. The pressure in the main port 1 acts on the spring plate (4) via pilot line (1) and poppet (14). If the pressure in the main port 1 rises above the value set at the comparison spring (16), poppet (14) opens and the pressure fluid flows in to the main port 2.

② Pressure connect function

When connecting the external port 3 with pilot pressure, piston (3) will be pressurised. The pretension of the spring and the maximum adjusted system pressure are increasing. A pressureinsation at the external port 3 affects the pressure at the main port 1. Ratio the following pages.

2) COMMON SECTION

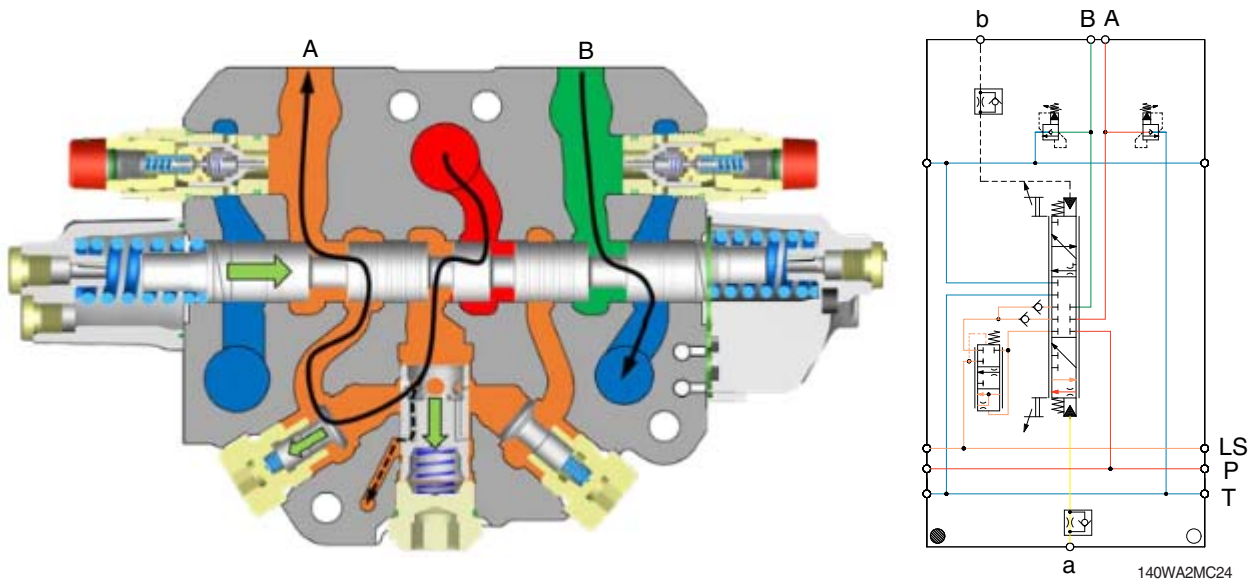
(1) Neutral position



In neutral position, no connection between pump and consumer and also no connection between consumer and tank channel.

Pressure compensator is completely closed, no movements possible.

(2) Single mode/highest load

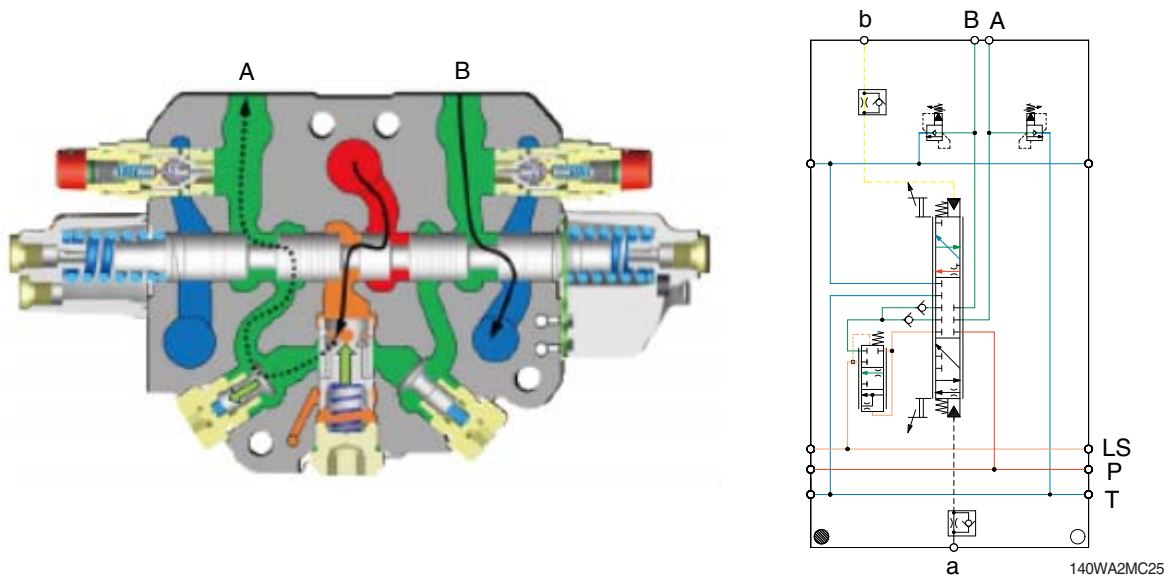


Pilot pressure on A-side opens the spool and connects pump to consumer A.

Compensator is completely open, because of single mode or highest system load of the section.

In parallel the spool opens consumer B to tank, based on defined opening area.

(3) Parallel mode/ lower load

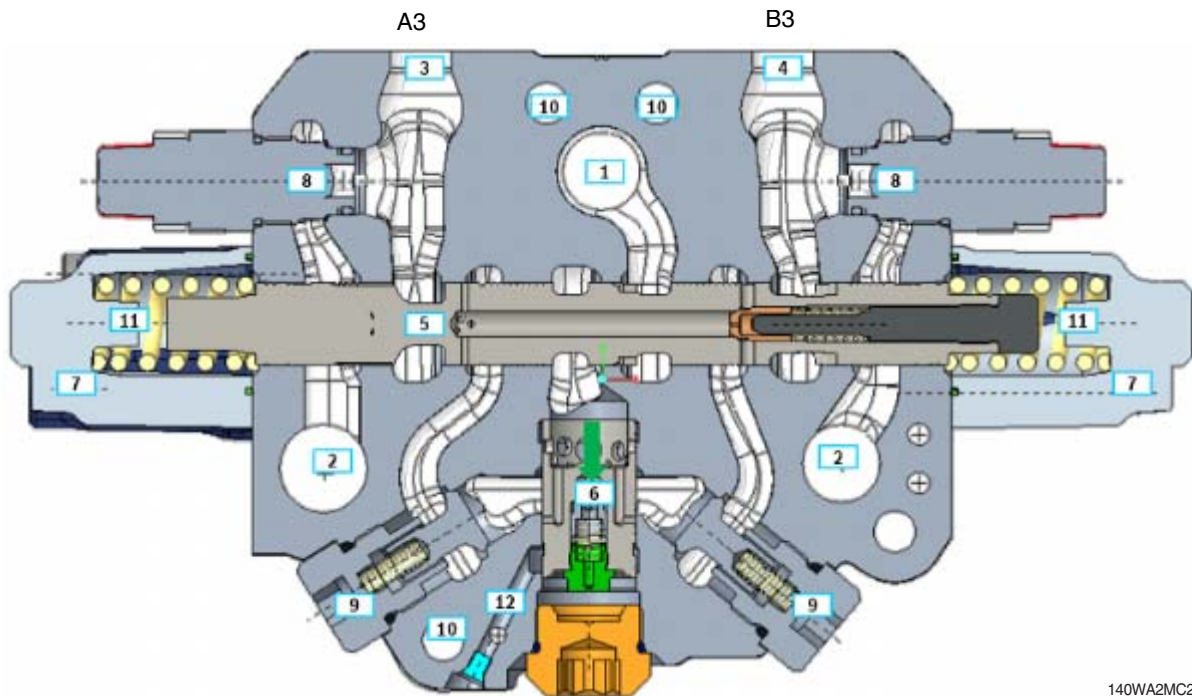


Pilot pressure on A-side opens the spool and connects pump to consumer A.

The compensator gets the signal of highest system load to the spring chamber and throttles automatically the difference between pump pressure and specific consumer load.

3) BOOM SECTION

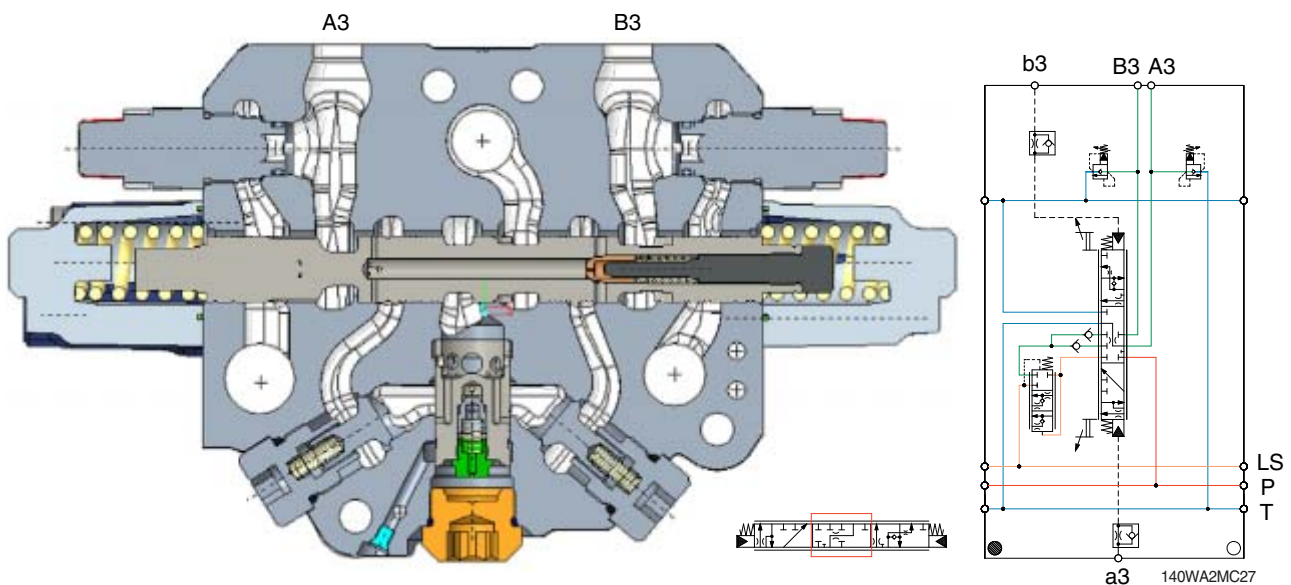
(1) Structure



140WA2MC26

- | | | |
|--------------------------------|--|-------------------|
| 1 Pump channel | 6 Pressure compensator | 10 Tie rod holes |
| 2 Tank channel | 7 Pilot cover | 11 Stroke limiter |
| 3 Port A3 | 8 Secondary relief valves with make-up functionality | 12 LS-line |
| 4 Port B3 | | |
| 5 Main spool with regeneration | 9 Load holding valves | |

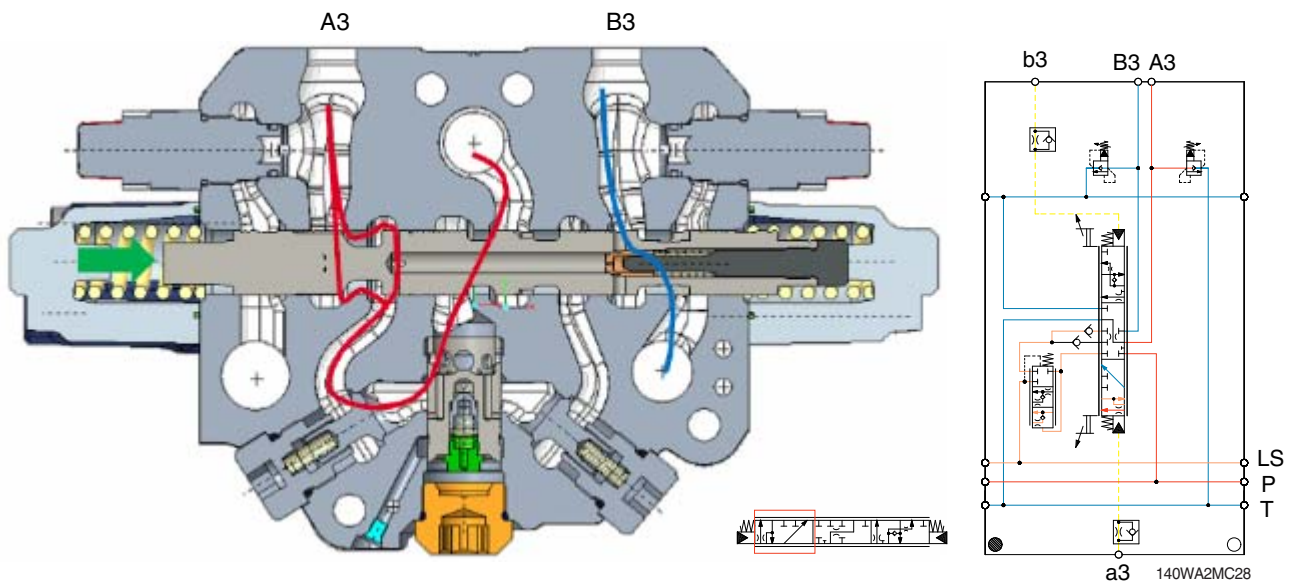
(2) Neutral position



140WA2MC27

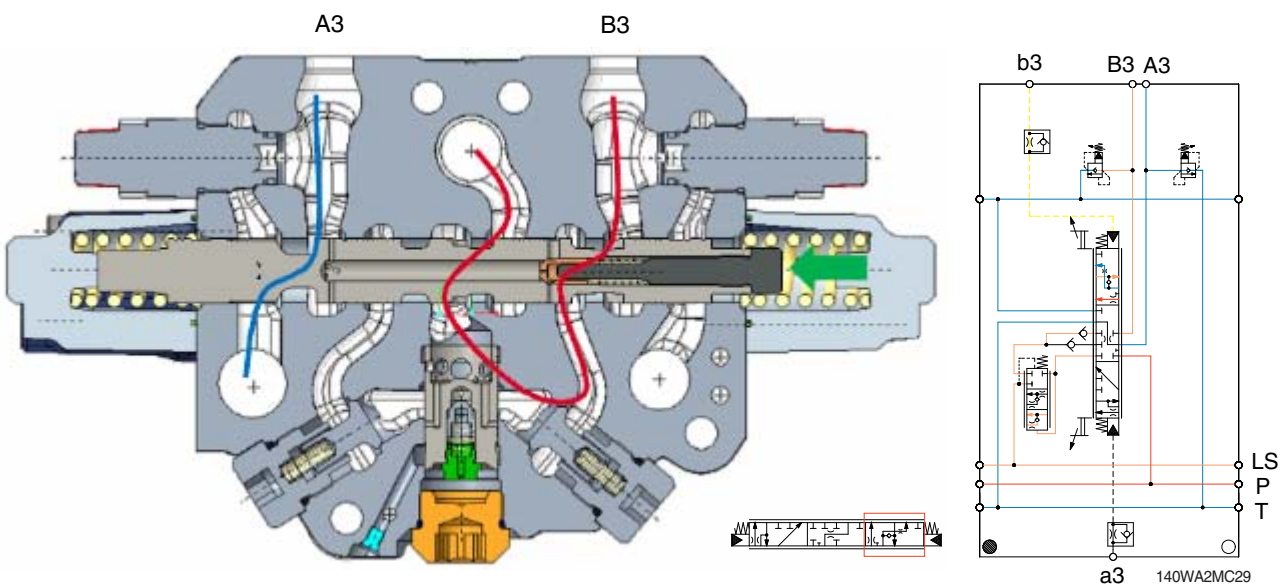
Neutral position of boom spool, port A3 is connected to tank by a small notch. All other connections of the spool are closed.

(3) Boom up position



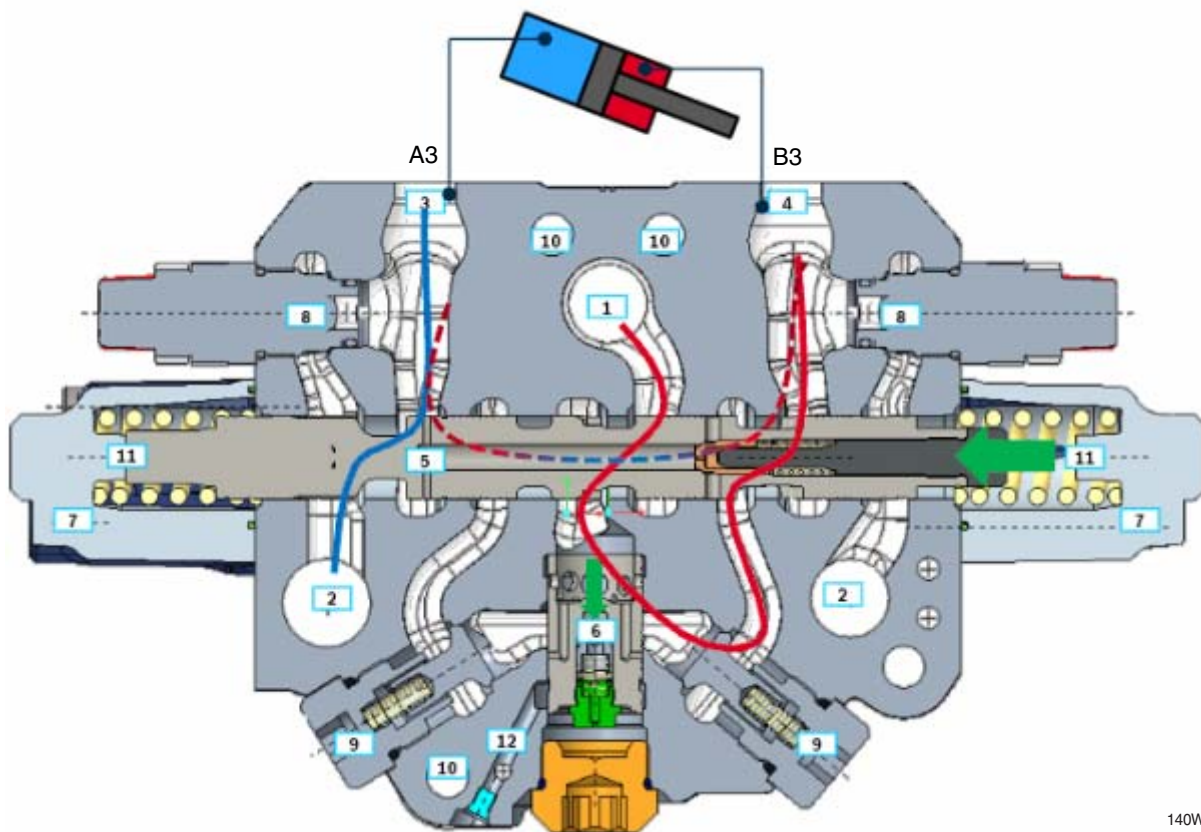
When the pilot pressure is led to the port a3, the oil from the pump flows to the cylinder port A3 and oil from the cylinder flows into the tank through the cylinder port B3.

(4) Boom down position



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.

(5) Boom regeneration spool



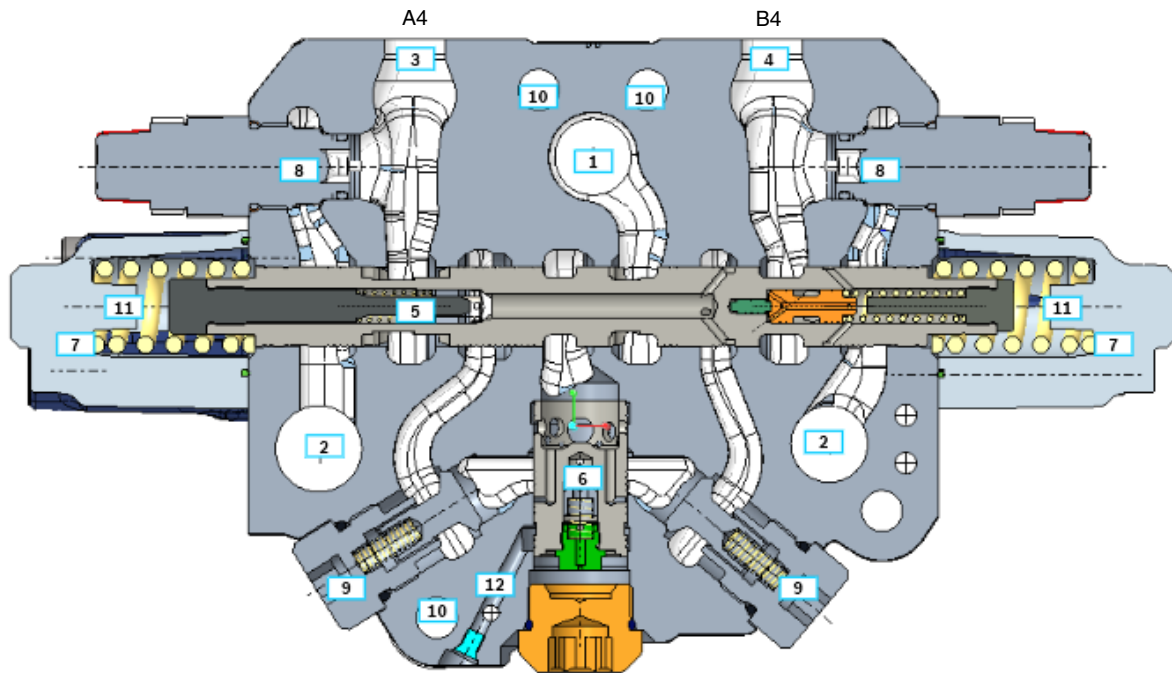
140WA2MC30

- | | | |
|--------------------------------|----------------------------|-------------------|
| 1 Pump channel | 6 Pressure compensator | 10 Tie rod holes |
| 2 Tank channel | 7 Pilot cover | 11 Stroke limiter |
| 3 Port A3 | 8 Secondary relief valves | 12 LS-line |
| 4 Port B3 | with make-up functionality | |
| 5 Main spool with regeneration | 9 Load holding valves | |

Pump is connected with B3 port. A3 port to tank. Internally connected to the poppet, as well as pump pressure. If pressure on A3 port is higher than on B3 port, the poppet opens and regeneration of flow starts. Flow depends on delta-p between A3 and B3.

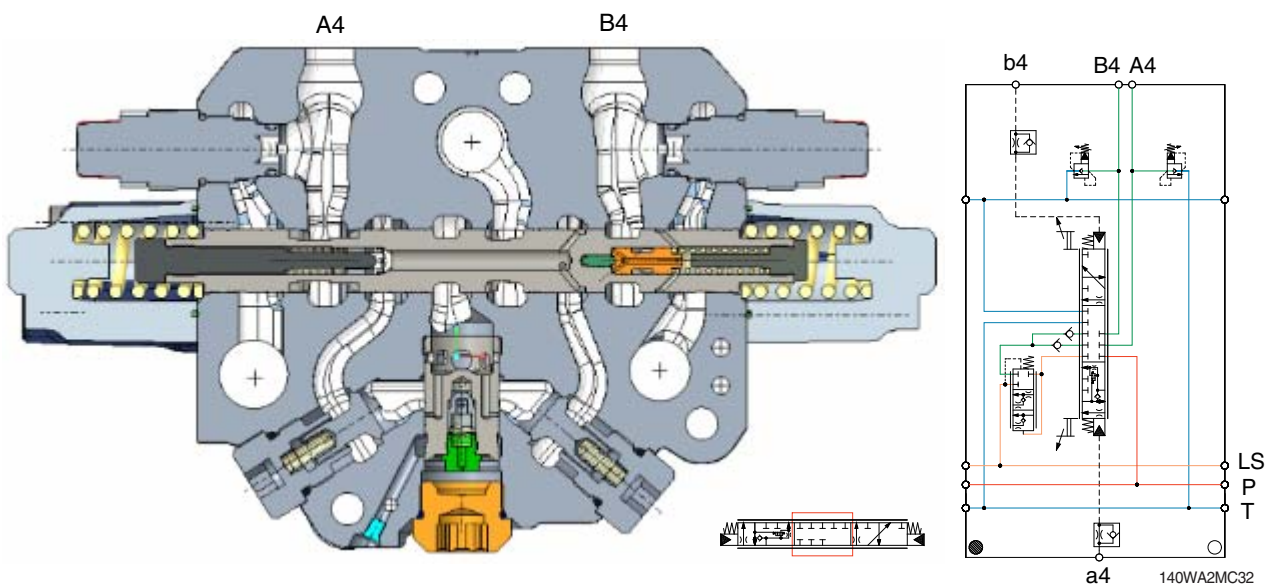
4) ARM SECTION

(1) Structure



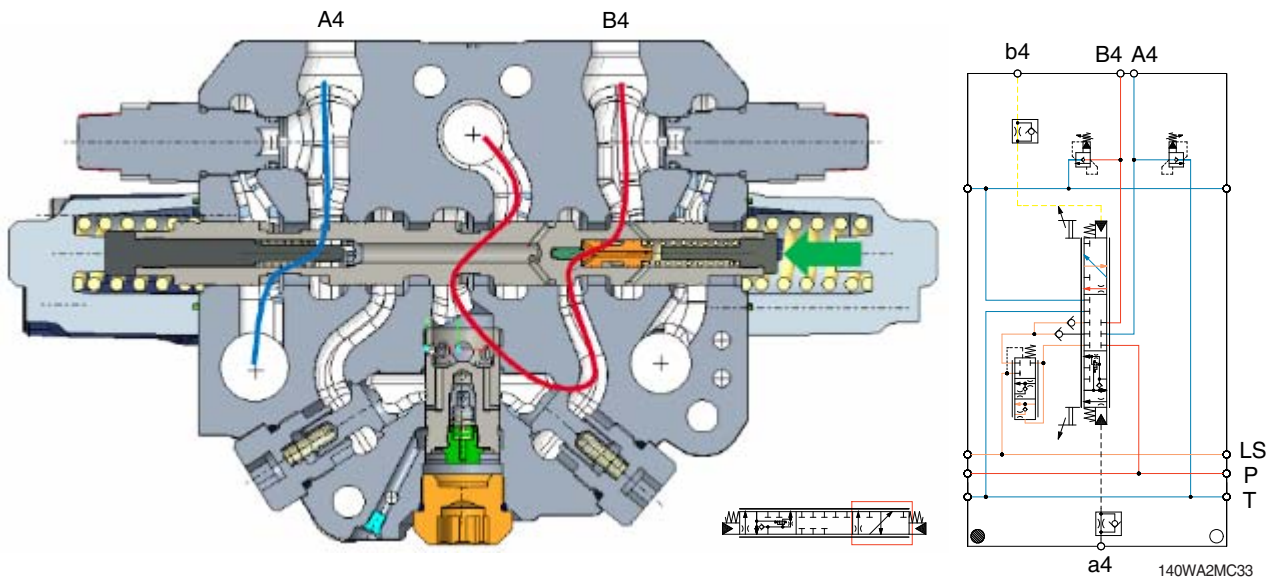
- | | | |
|--|--|-------------------|
| 1 Pump channel | 6 Pressure compensator | 11 Stroke limiter |
| 2 Tank channel | 7 Pilot cover | 12 LS-line |
| 3 Port A4 | 8 Secondary relief valves with make-up functionality | |
| 4 Port B4 | 9 Load holding valves | |
| 5 Main spool with Brake and regeneration functionality | 10 Tie rod holes | |

(2) Neutral position



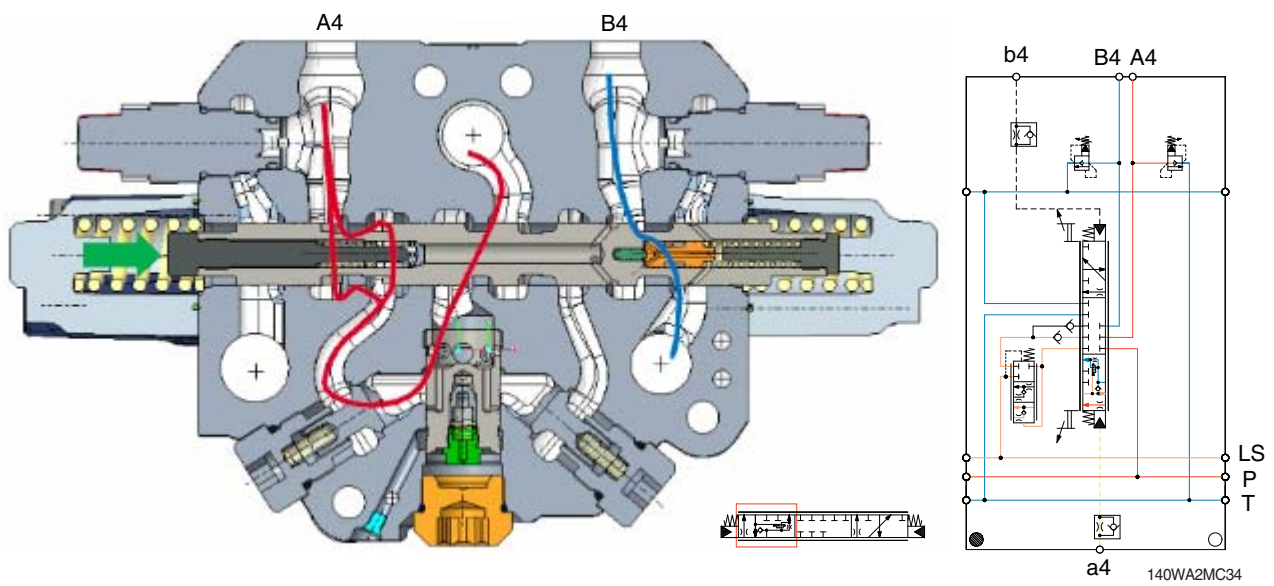
Neutral position of arm spool, all connections of the spool are closed and the A4 and B4 ports are not connected to the pump nor tank.

(3) Arm out position



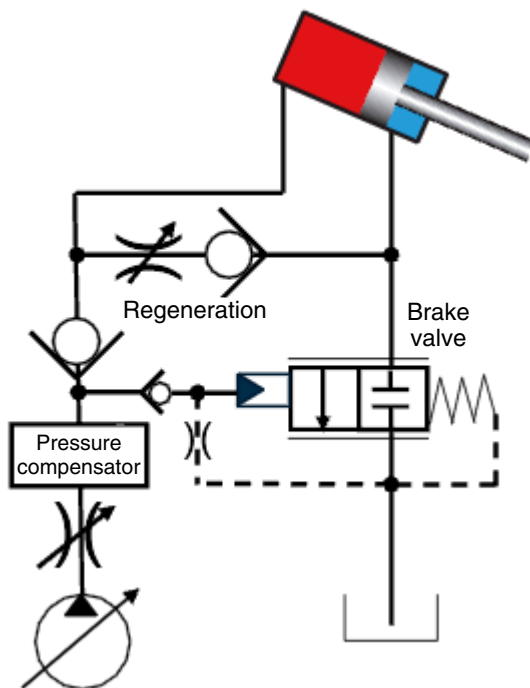
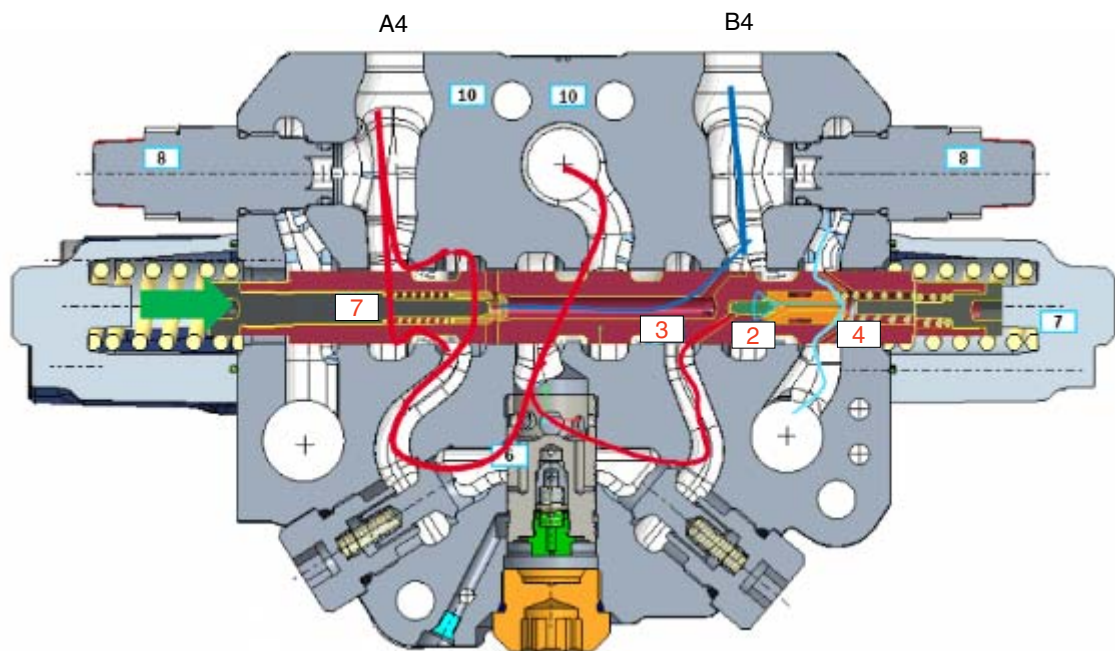
When the pilot pressure is led to the port b4 the oil from the pump flows to the cylinder port B4 and oil from the cylinder flows into the tank through the cylinder port A4.

(4) Arm in position



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 into the tank through the cylinder port B4.

(5) Brake and regeneration spool



- 1 Regeneration valve
- 2 Logic brake valve
- 3 Pilot spool brake valve
- 4 Spring chamber brake valve

140WA2MC35

Pump flow is connected over compensator and load holding valve to the port A4.

Regeneration valve is closed, because pressure on port A4 is bigger than on port B4.

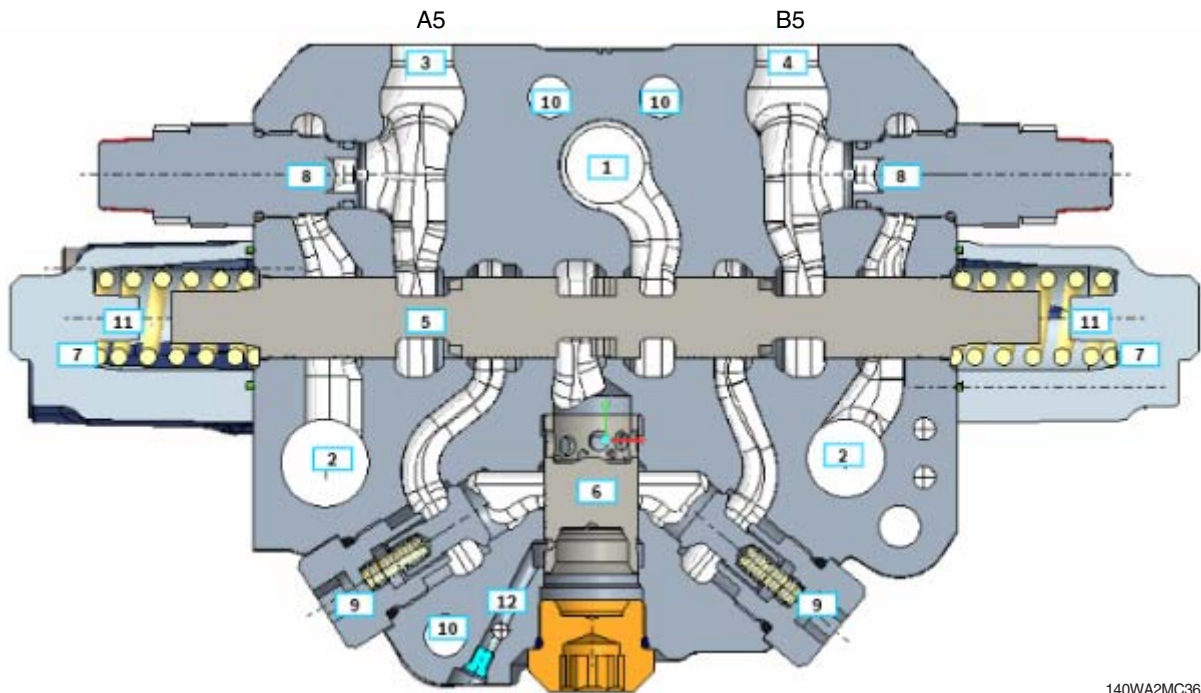
Port A4 is also connected to pilot spool brake valve.

Spring chamber of logic valve is released to tank pressure. Based on area ratio of the pilot spool and the logic brake valve, the port A4 pressure has to reach a pressure level of 120 bar.

Regeneration function is not active/closed, because pressure on port A4 is bigger than on port B4.

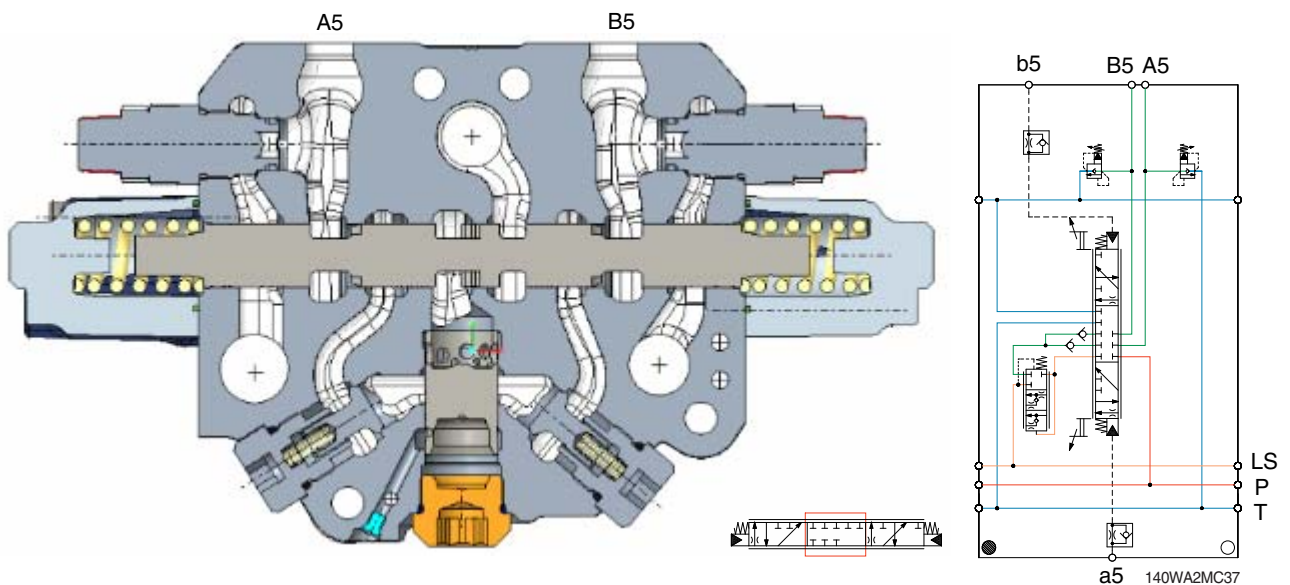
5) BUCKET SECTION

(1) Structure



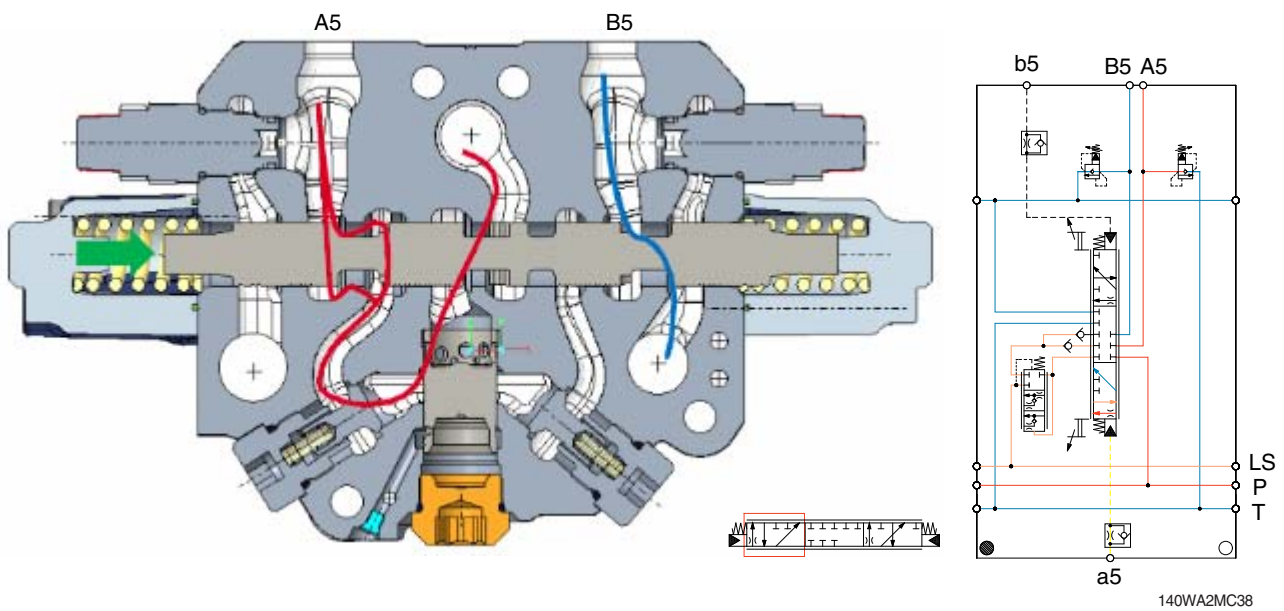
- | | | |
|----------------|--|-------------------|
| 1 Pump channel | 6 Pressure compensator | 10 Tie rod holes |
| 2 Tank channel | 7 Pilot cover | 11 Stroke limiter |
| 3 Port A5 | 8 Secondary relief valves with make-up functionality | 12 LS-line |
| 4 Port B5 | 9 Load holding valves | |
| 5 Main spool | | |

(2) Neutral position



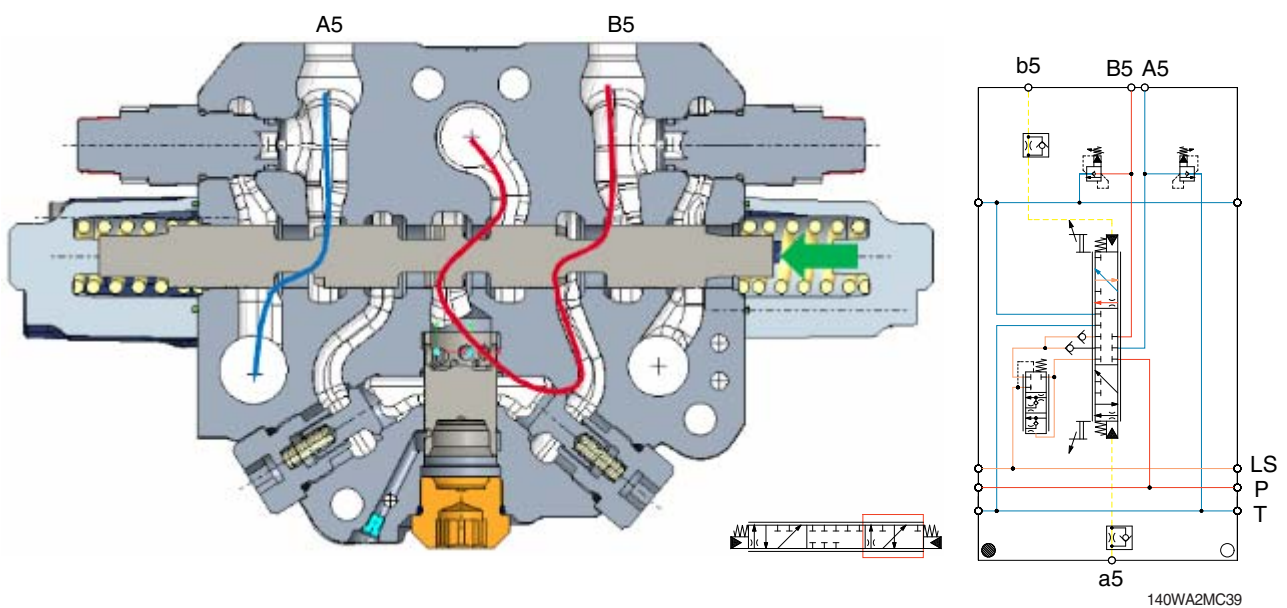
Neutral position of bucket spool, all connections of the spool are closed and the A5 and B5 ports are not connected to the pump nor tank.

(3) Bucket 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 out position

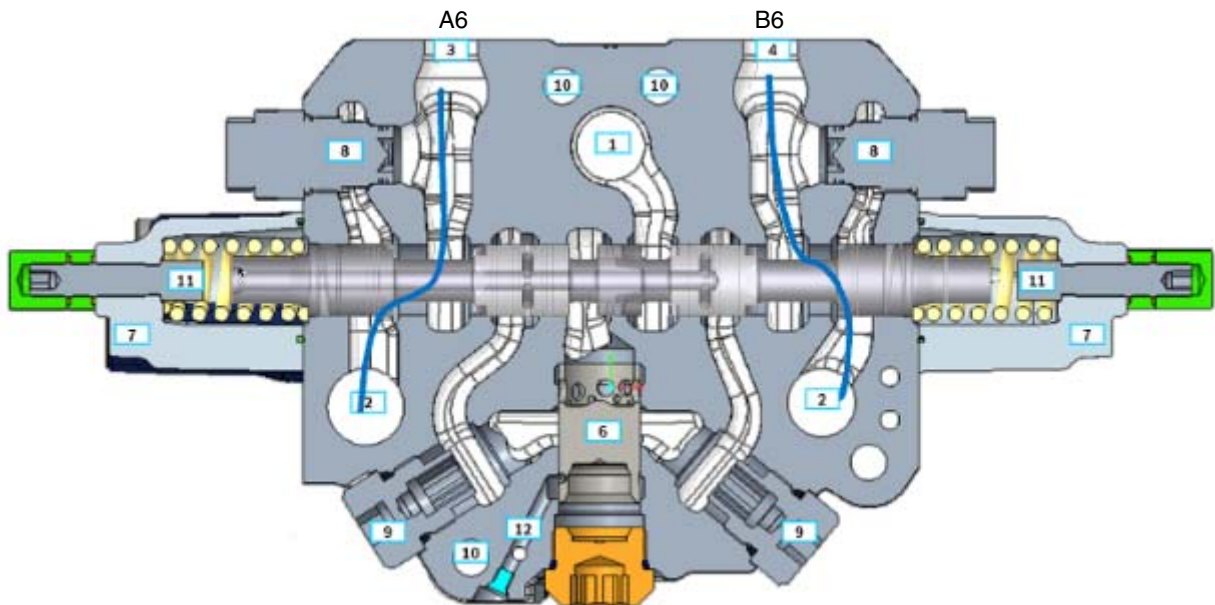


When the pilot pressure is led to the port b5, the oil from the pump flows to the cylinder port B5 and oil from the cylinder flows into the tank through the cylinder port A5.

6) TRAVEL SECTION

(1) Structure

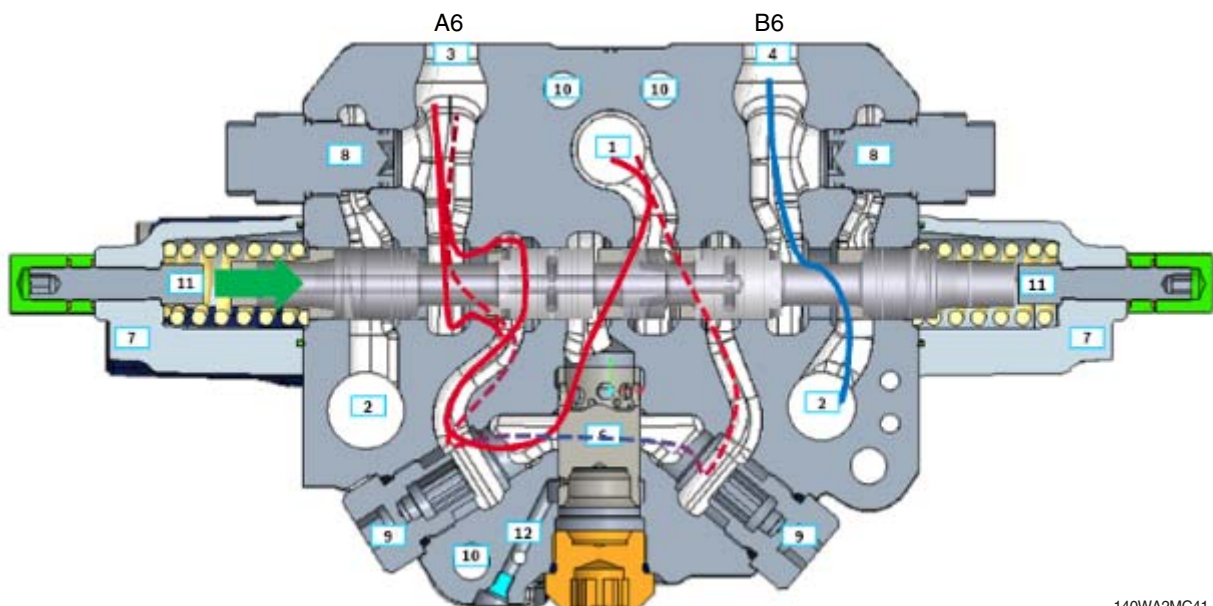
Both sides of the Travel spool B6->T and also A6->T are connected in neutral to tank.



140WA2MC40

- | | | |
|----------------|---------------------------|-----------------------|
| 1 Pump channel | 5 Main spool | 9 Load holding valves |
| 2 Tank channel | 6 Pressure compensator | 10 Tie rod holes |
| 3 Port A6 | 7 Pilot cover | 11 Stroke limiter |
| 4 Port B6 | 8 Secondary relief valves | 12 LS-line |

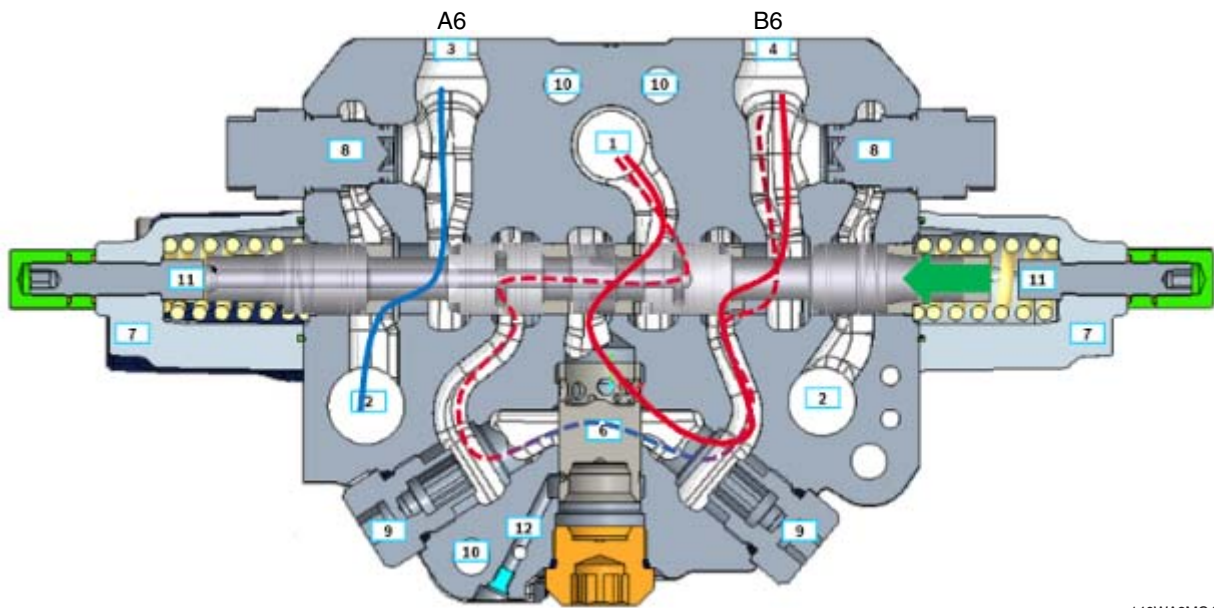
(2) Travel backward position



140WA2MC41

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

(3) Travel forward position

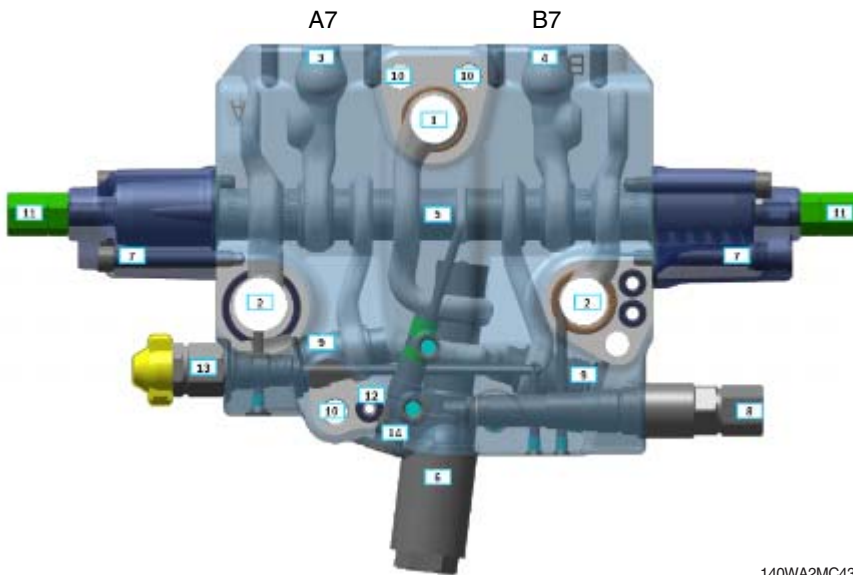


140WA2MC42

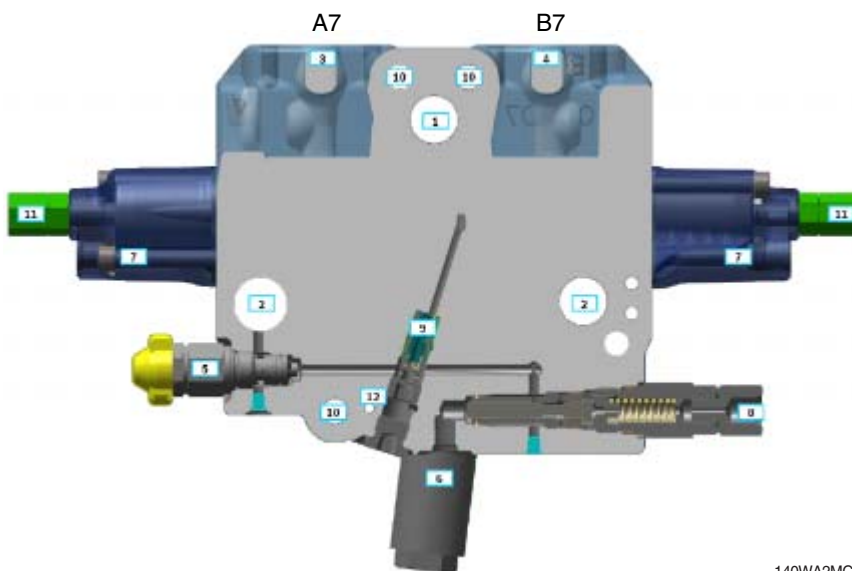
When the pilot pressure is led to the port b6, the oil from the pump flows to the port B6 and oil from the motor flows into the tank through the port A6.

7) SWING SECTION

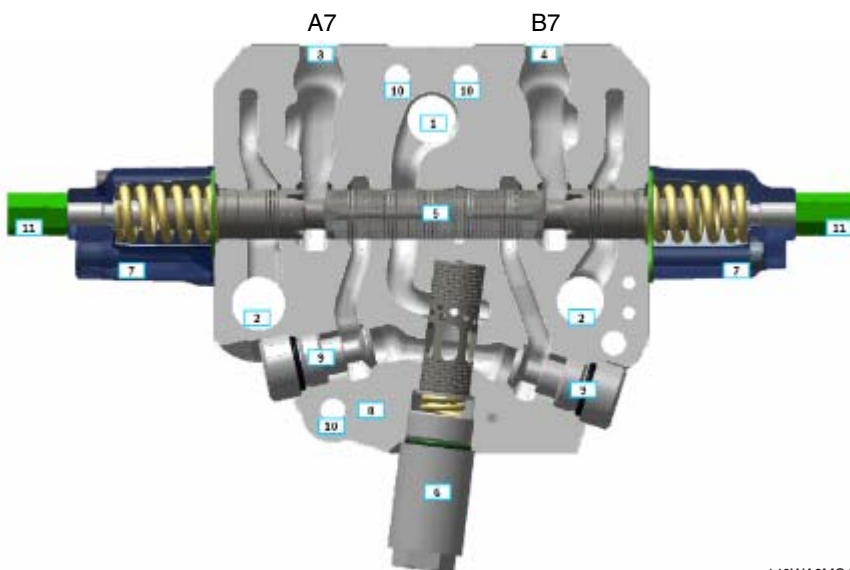
(1) Structure



140WA2MC43



140WA2MC44



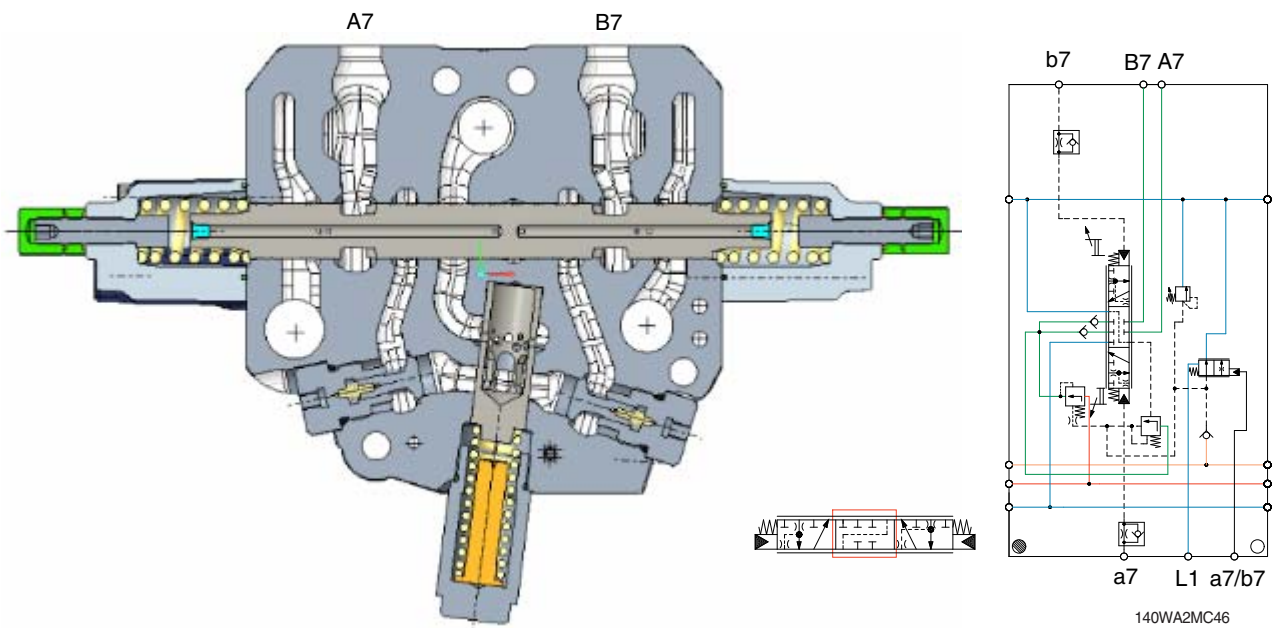
140WA2MC45

- 1 Pump channel
- 2 Tank channel
- 3 Port A7
- 4 Port B7
- 5 Main spool
- 6 Hollow Pressure compensator
- 7 Pilot cover
- 8 DTS cartridge
- 9 Load holding valves
- 10 Tie rod holes
- 11 Stroke limiter
- 12 LS-line
- 13 LS pressure reducing valve
- 14 LS copy valve

- 1 Pump channel
- 2 Tank channel
- 3 Port A7
- 4 Port B7
- 5 LS pressure reducing valve
- 6 Hollow pressure compensator
- 7 Pilot cover
- 8 DTS cartridge
- 9 LS copy valve
- 10 Tie rod holes
- 11 Stroke limiter
- 12 LS-line

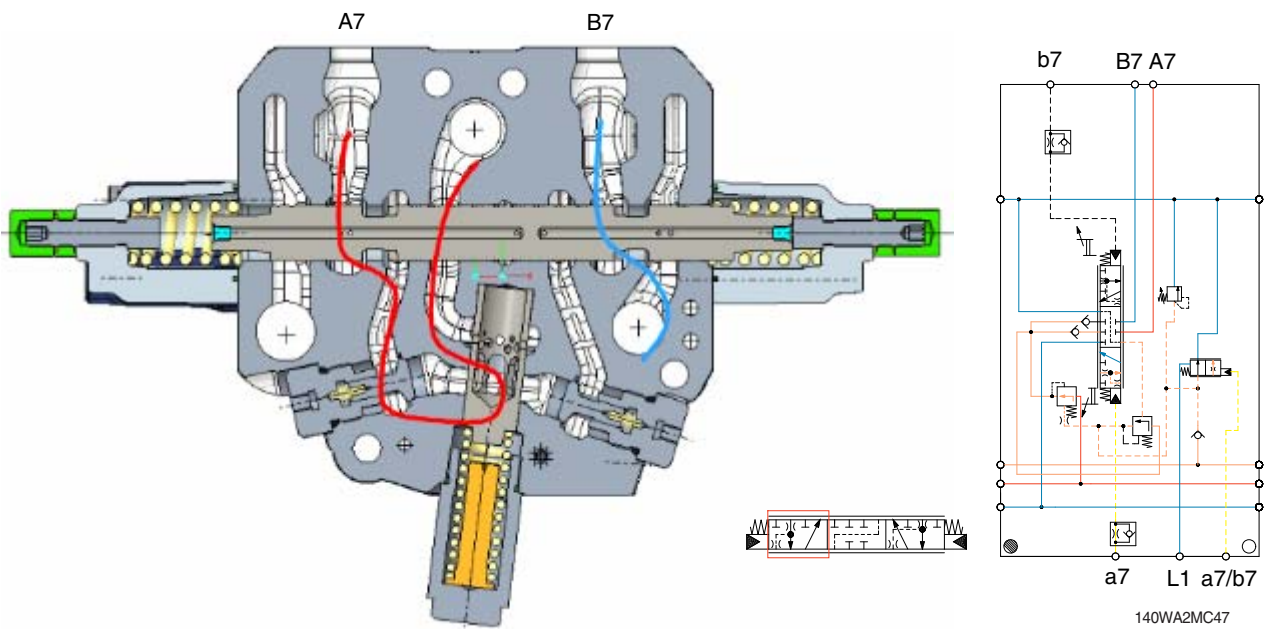
- 1 Pump channel
- 2 Tank channel
- 3 Port A7
- 4 Port B7
- 5 Main spool
- 6 Hollow Pressure compensator
- 7 Pilot cover
- 8 LS-line
- 9 Load holding valves
- 10 Tie rod holes

(2) Neutral position



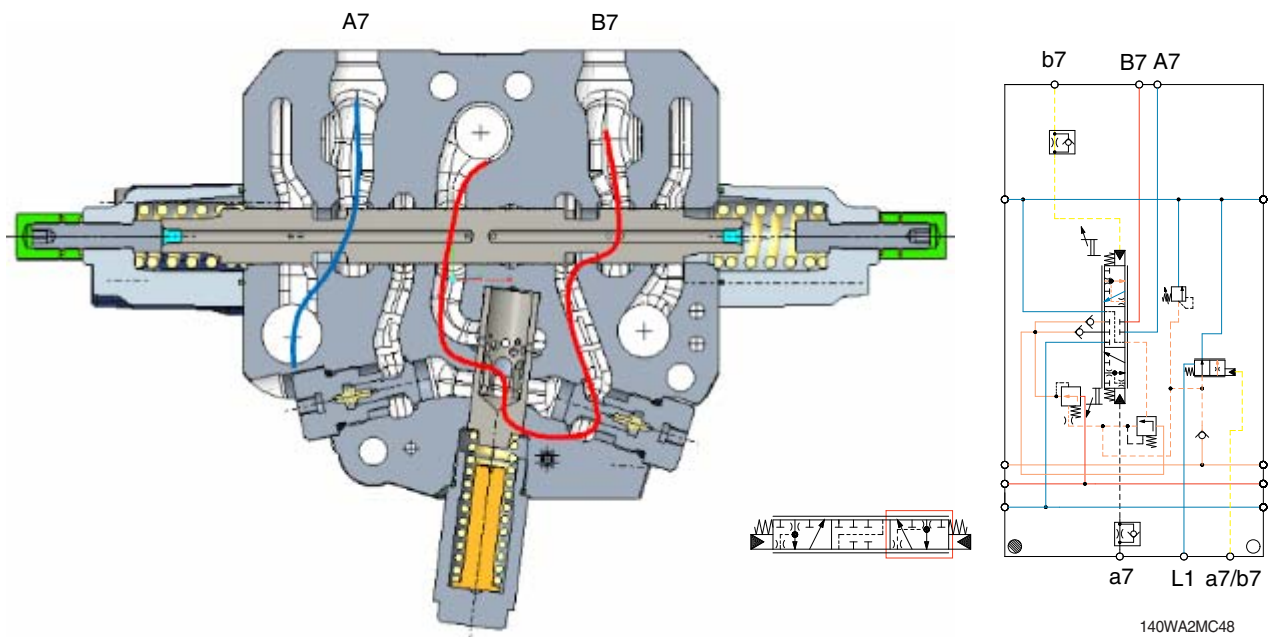
Neutral position of swing spool, all connections of the spool are closed and the A7 and B7 ports are not connected to the pump nor tank.

(3) Swing right position



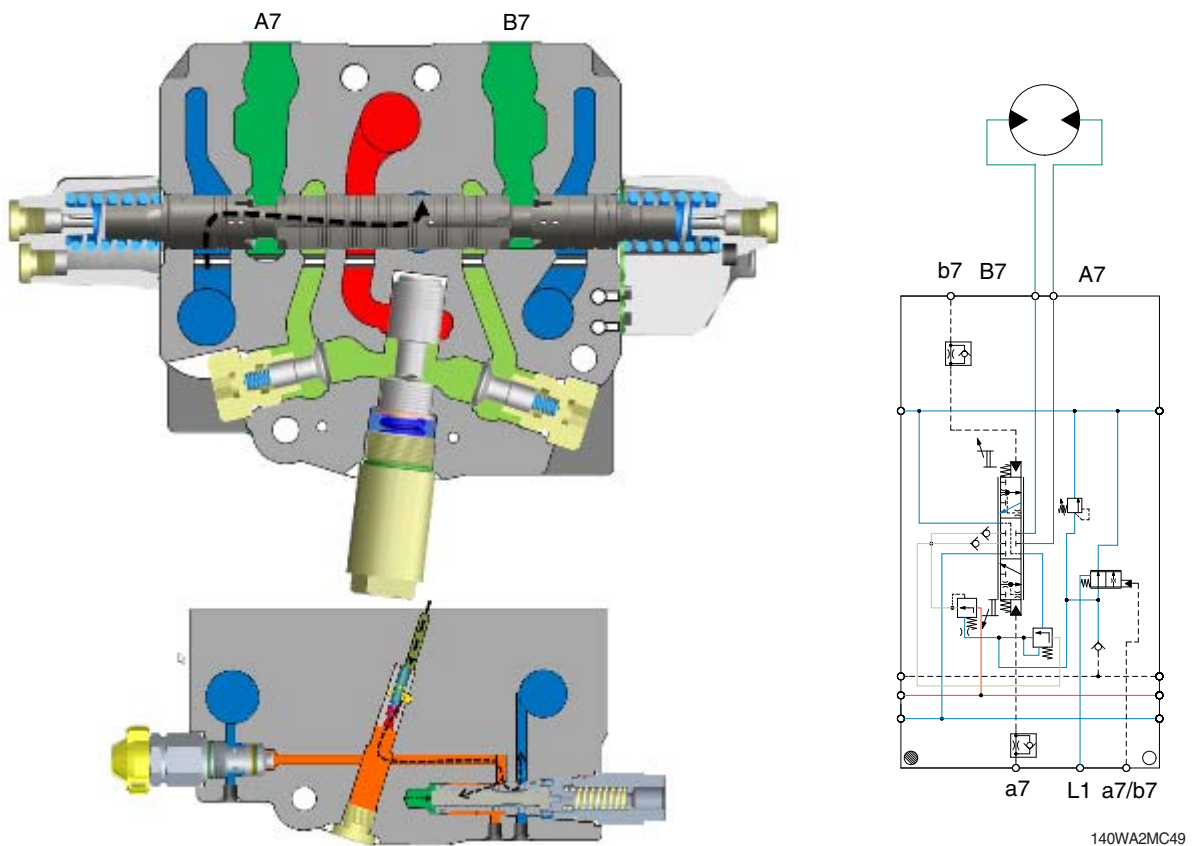
When the pilot pressure is led to the port a7, the oil from the pump flows to the port A7 and oil from the motor flows into the tank through the port B7.

(4) Swing left



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

(5) LS neutral position

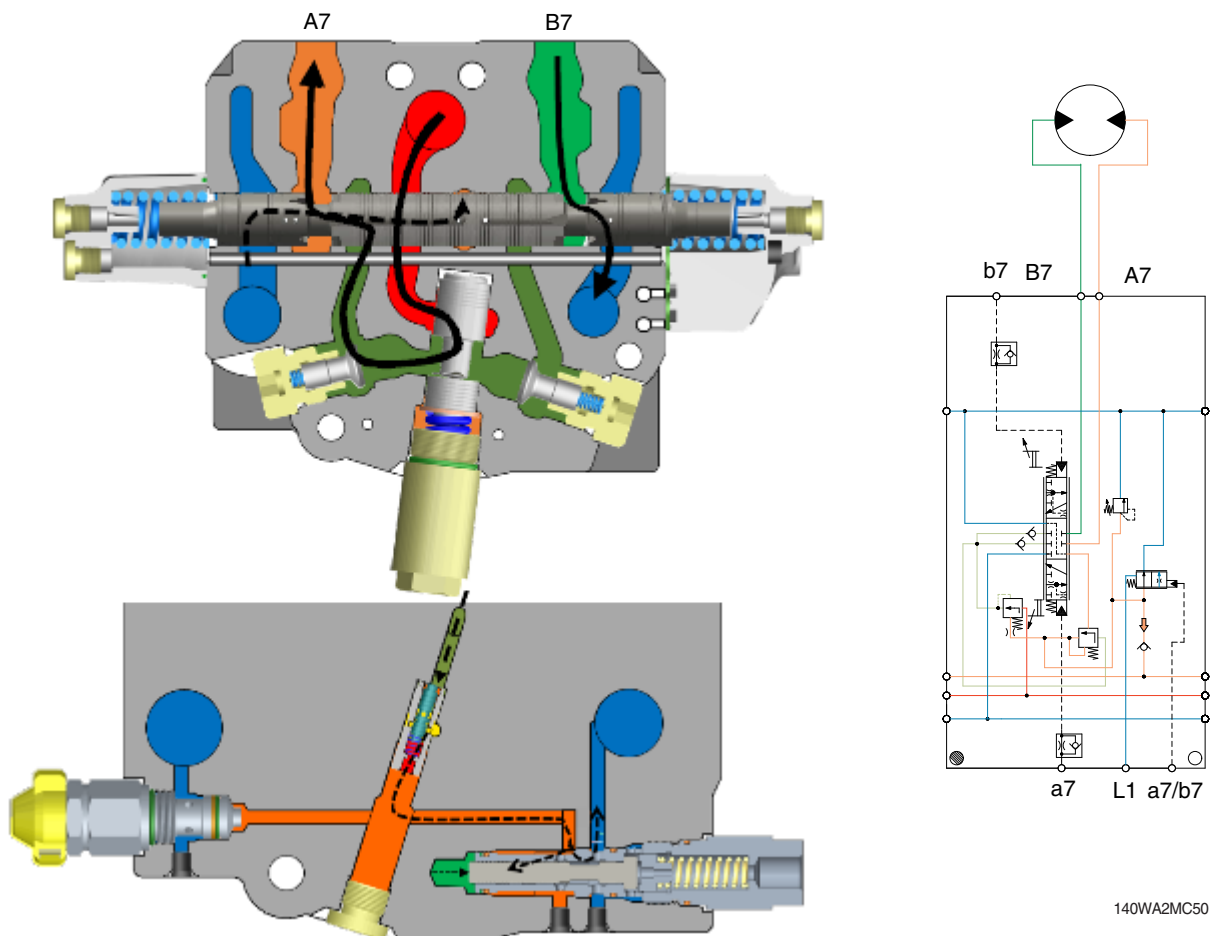


The pump channel is always connected to the compensator. If pump pressure is higher than LS + spring setting of the LS-compensator, the LS compensator will be closed.

The LS channel will be in parallel released to tank and also by the copy valve to the spring chamber of the compensator.

This secures no movement during neutral position of the spool.

(6) LS highest load



Pilot signal on port A7 opens pump -> port A7 and also port B7 -> tank channel.

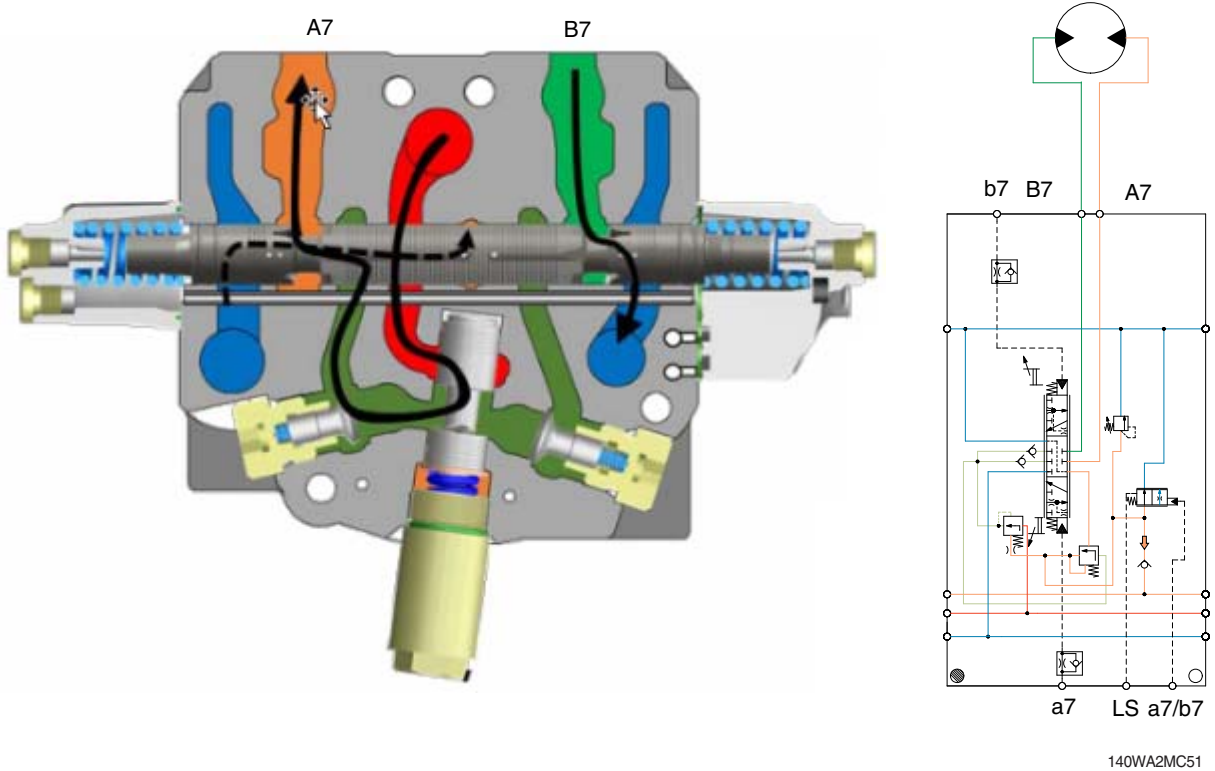
LS signal is spool internally connected to spring chamber of the compensator.

LS signal + spring force setting defines the Δp over main spool.

-> This combination leads to precise flow controllability.

The DTS drains the LS signal, in relation to the pilot signal, to the tank channel. The reduced LS pressure is connected to the compensator, which leads to "torque control" of the consumer.

(7) LS lowest consumer load



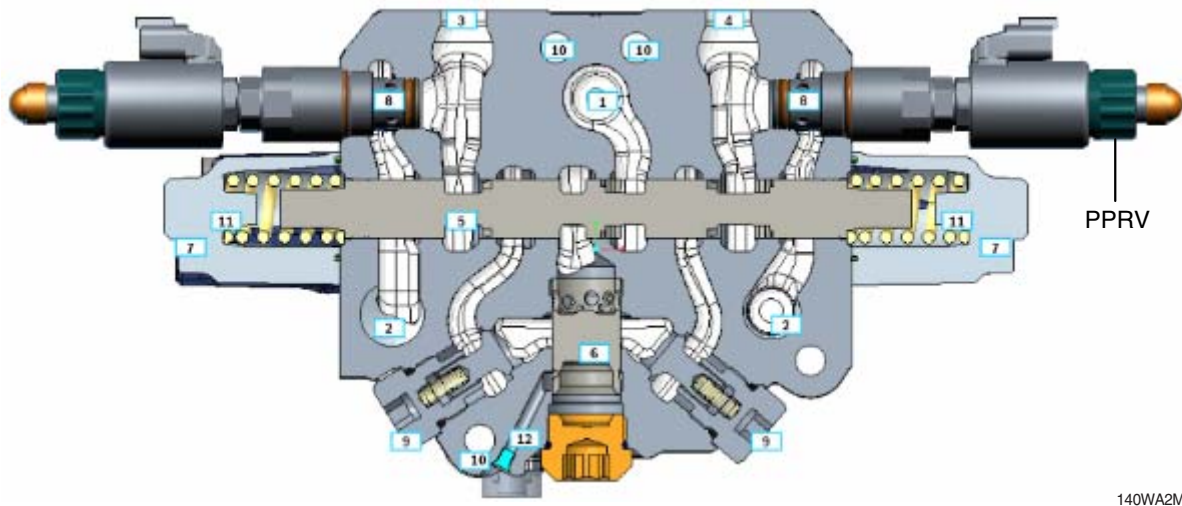
Against LUDV functionality, the LS section is not affected by parallel movements, as long as the system is able to build up the required pump pressure.
We call it “semi-priority” for LS consumers.

8) OPTION SECTION

(1) Structure

EPPR (position 8) should not be engaged with current, without connected hydraulic oil.

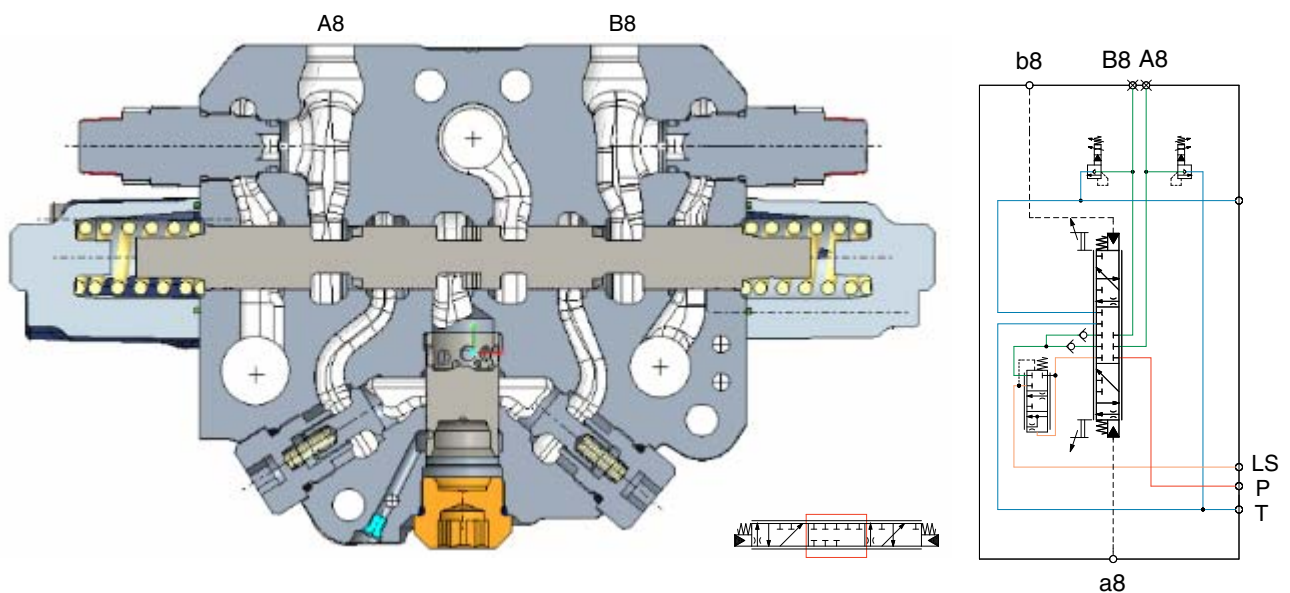
-> This avoids air injection into the PPRV.



140WA2MC52

- | | | |
|----------------|---|-----------------------|
| 1 Pump channel | 6 Pressure compensator | 9 Load holding valves |
| 2 Tank channel | 7 Pilot cover | 10 Tie rod holes |
| 3 Port A8 | 8 Electro-proportional secondary relief valves with make-up functionality | 11 Stroke limiter |
| 4 Port B8 | | 12 LS-line |
| 5 Main spool | | |

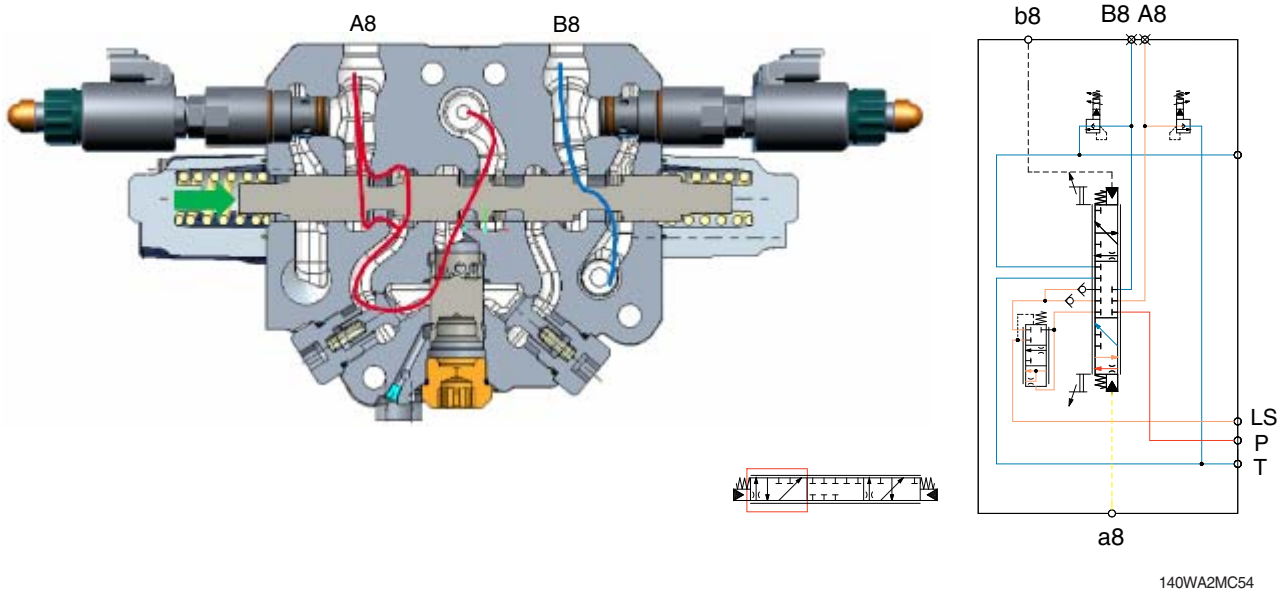
(2) Neutral position



140WA2MC53

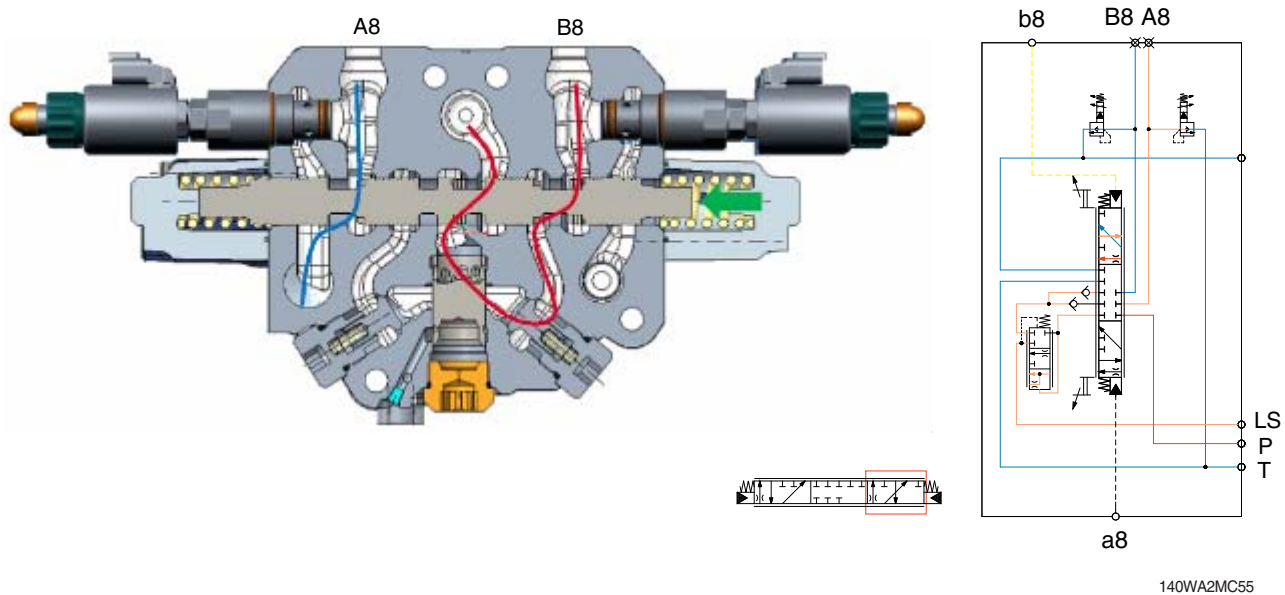
Neutral position of option spool, all connections of the spool are closed and the A8 and B8 ports are not connected to the pump nor tank.

(3) A8 side piloted



When the pilot pressure is led to the port a8, the oil from the pump flows to the port A8 and oil from the cylinder flows into the tank through the port B8.

(4) B8 side piloted



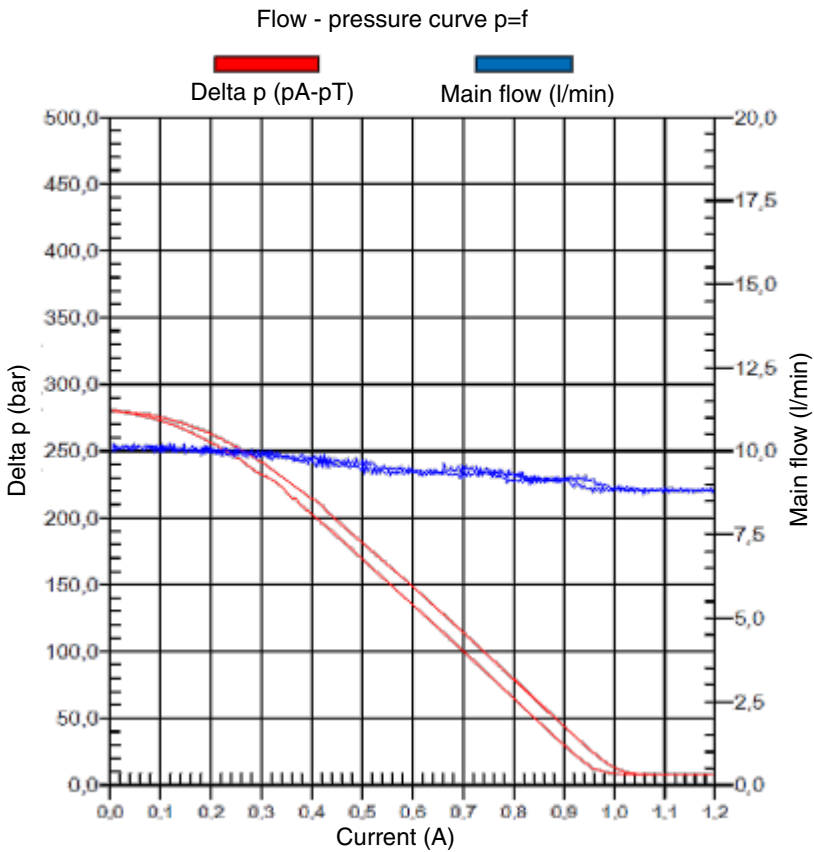
When the pilot pressure is led to the port b8, the oil from the pump flows to the port B8 and oil from the cylinder flows into the tank through the port A8.

(5) PPRV control information



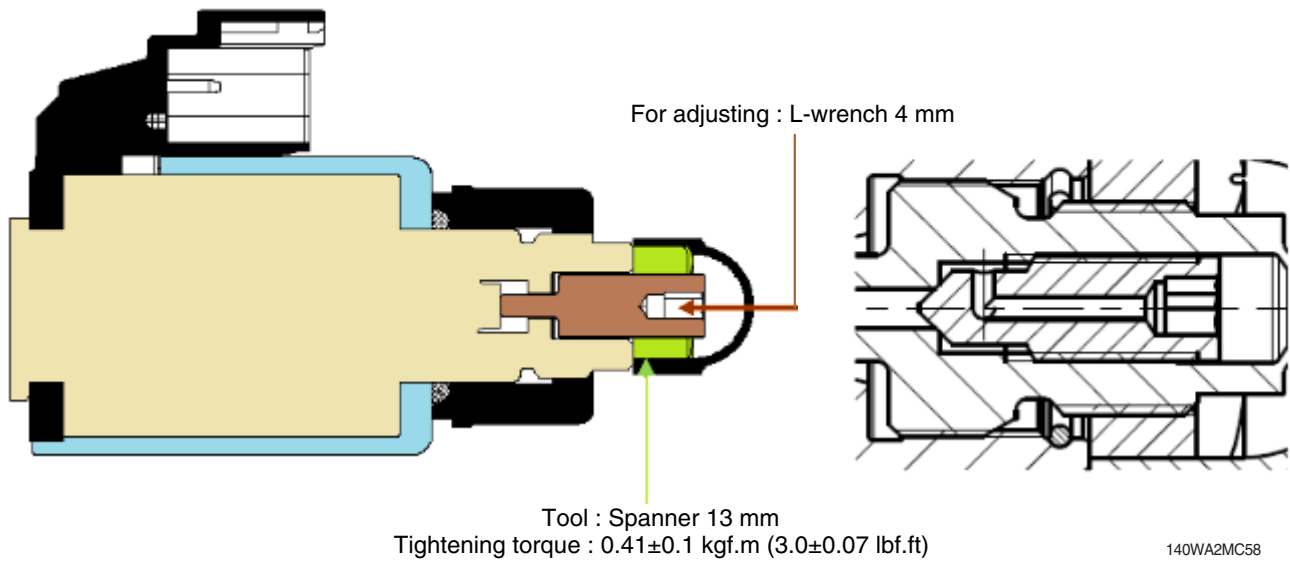
Tool : Spanner 30
Tightening torque : 10.2±1.0 kgf.m (73.8±7.4 lbf.ft)

140WA2MC56



140WA2MC57

• Adjustment

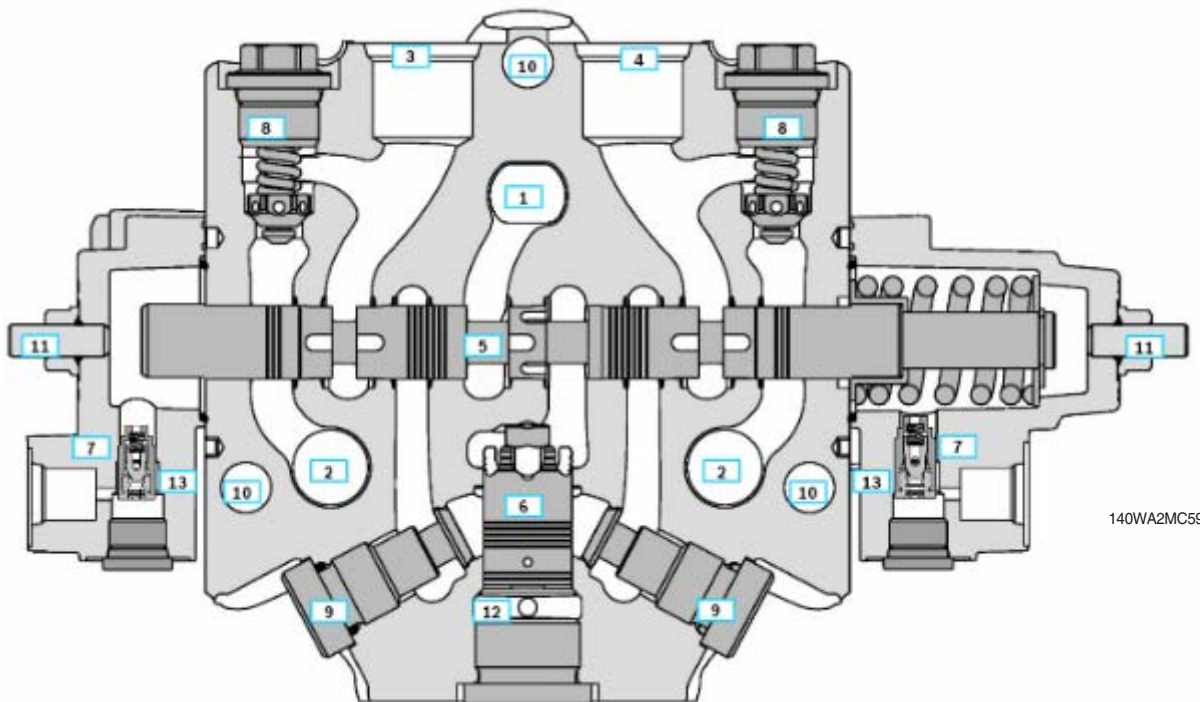


- Release the counter nut (green)
- Turn the positioning screw smoothly (brown)
- Fix the counter nut again (green)

※ In general the adjustment of the pressure settings will be done in our production line.
Afterwards we will seal the adjustment with sealing wax to avoid re-adjustment in the field.

9) 2-PIECE BOOM

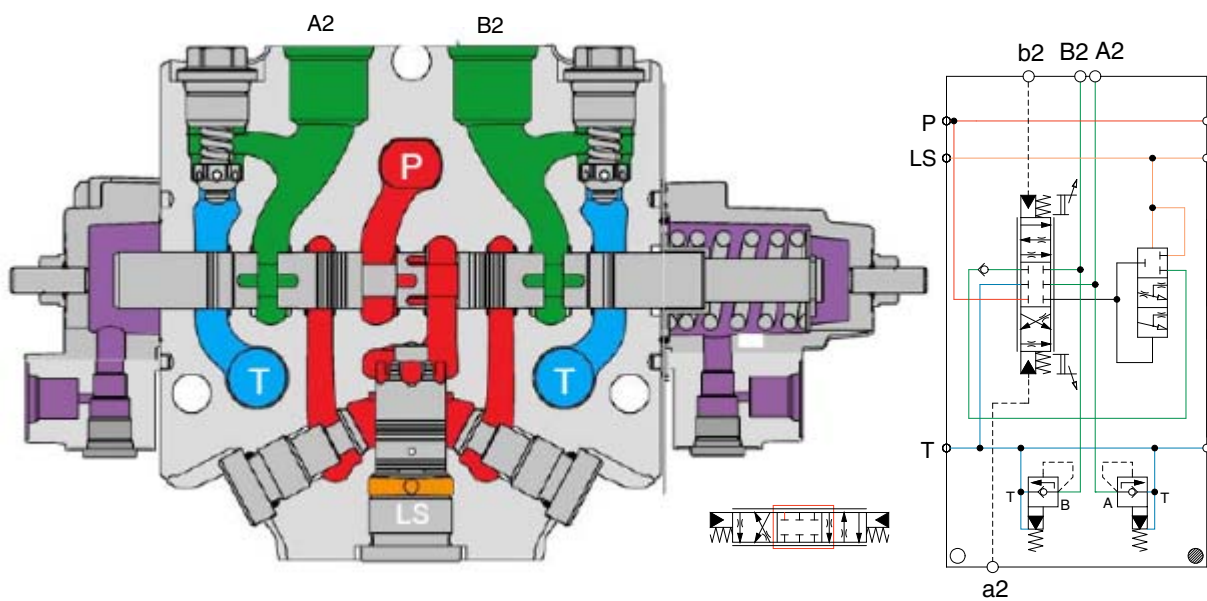
(1) Structure



140WA2MC59

- | | | |
|-------------------|--|-------------------|
| 1 Pump channel | 6 Pressure compensator | 10 Tie rod holes |
| 2 Tank channel | 7 Pilot cover | 11 Stroke limiter |
| 3 Consumer port A | 8 Secondary relief valves with make-up functionality | 12 LS-line |
| 4 Consumer port B | 9 Load holding valves | 13 Snubber |
| 5 Main spool | | |

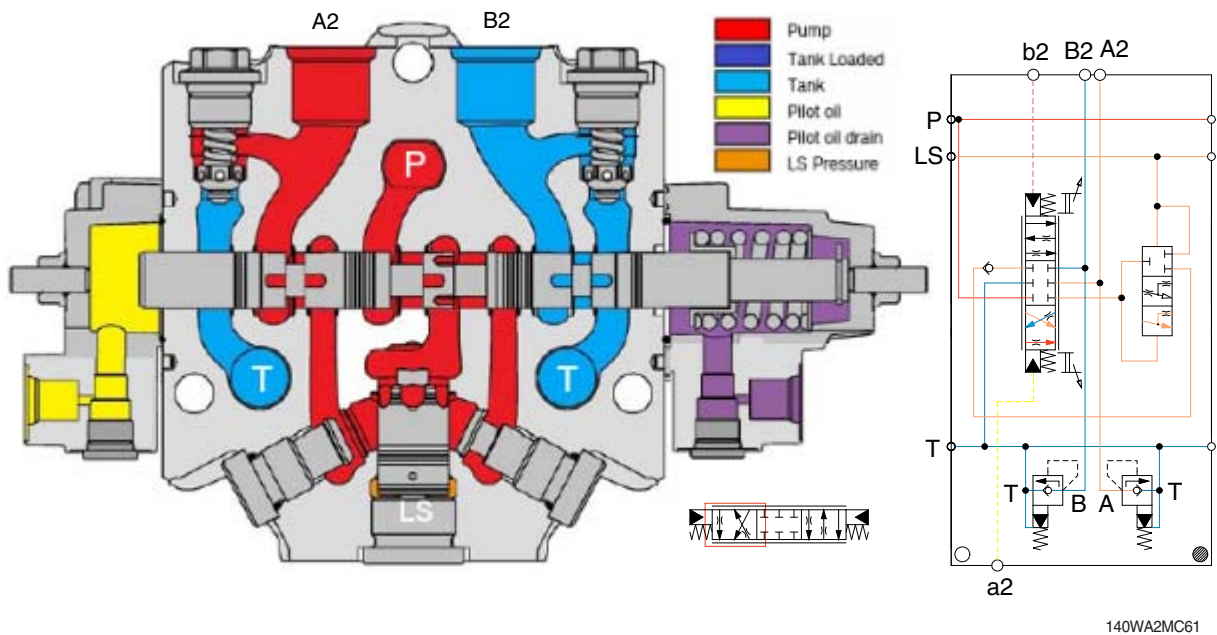
(2) Neutral position



140WA2MC60

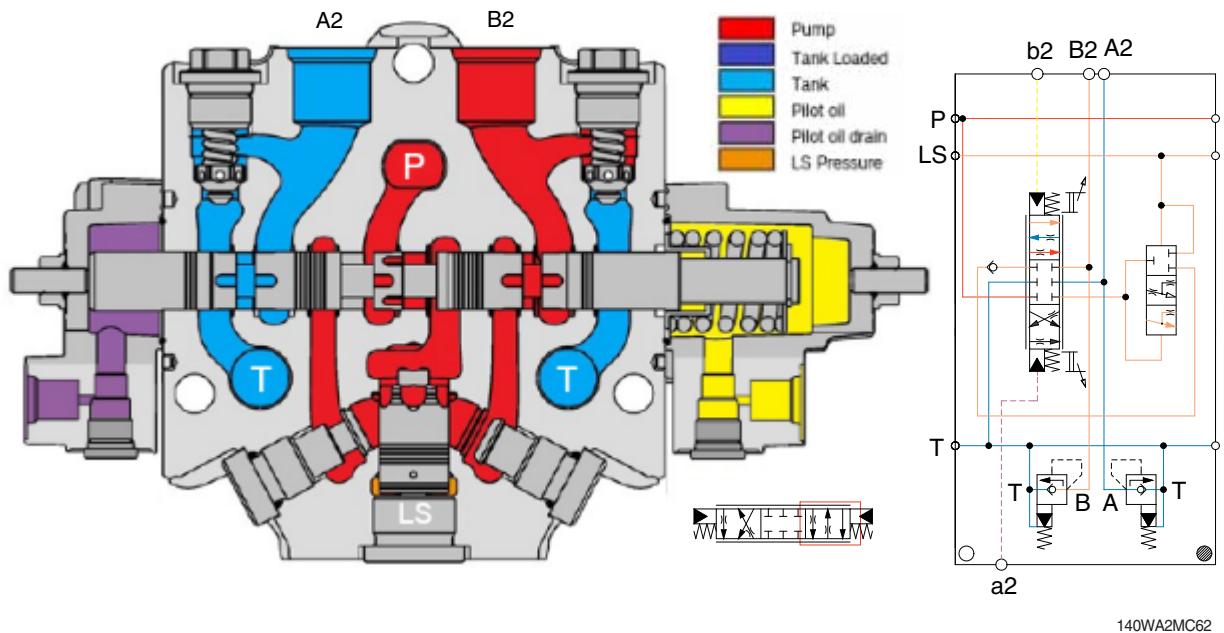
The spool is in neutral position, pump is in low pressure stand-by. The A2 and B2 ports are not connected to the pumps nor the tank.

(3) Boom up position



When the pilot pressure is led to the port a2, the oil from the pump flows to the cylinder port A2 and oil from the cylinder flows into the tank through cylinder port B2.

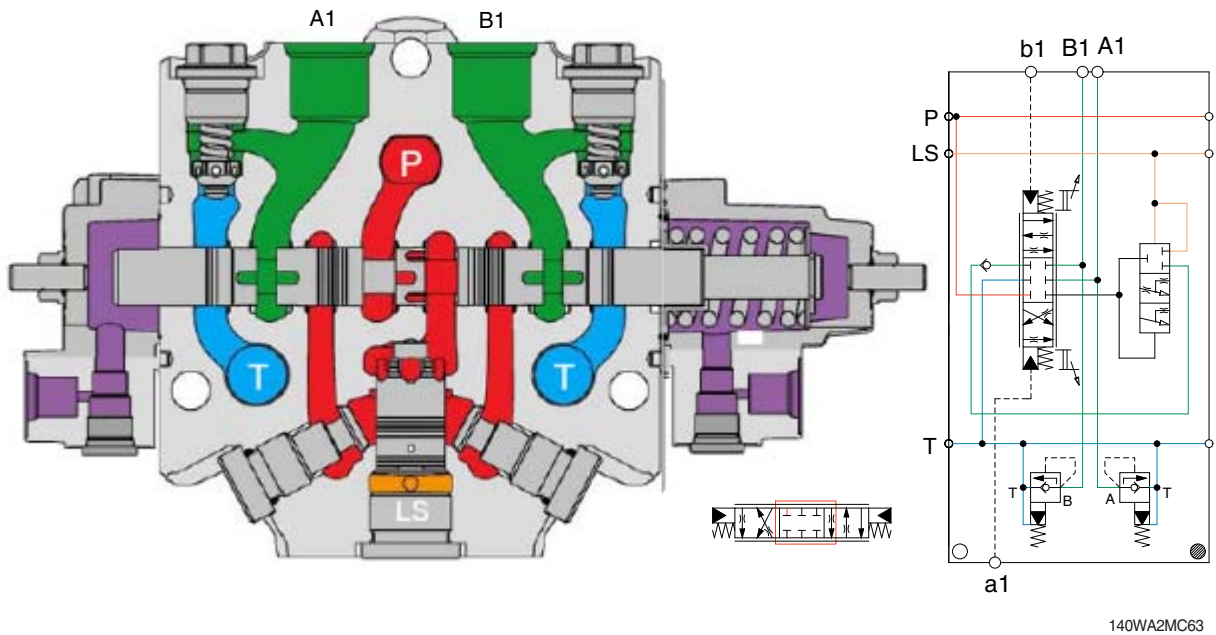
(4) Boom down position



When the pilot pressure is led to the port b2, the oil from the pump flows to the cylinder port B2 and oil from the cylinder flows into the tank through the cylinder port A2.

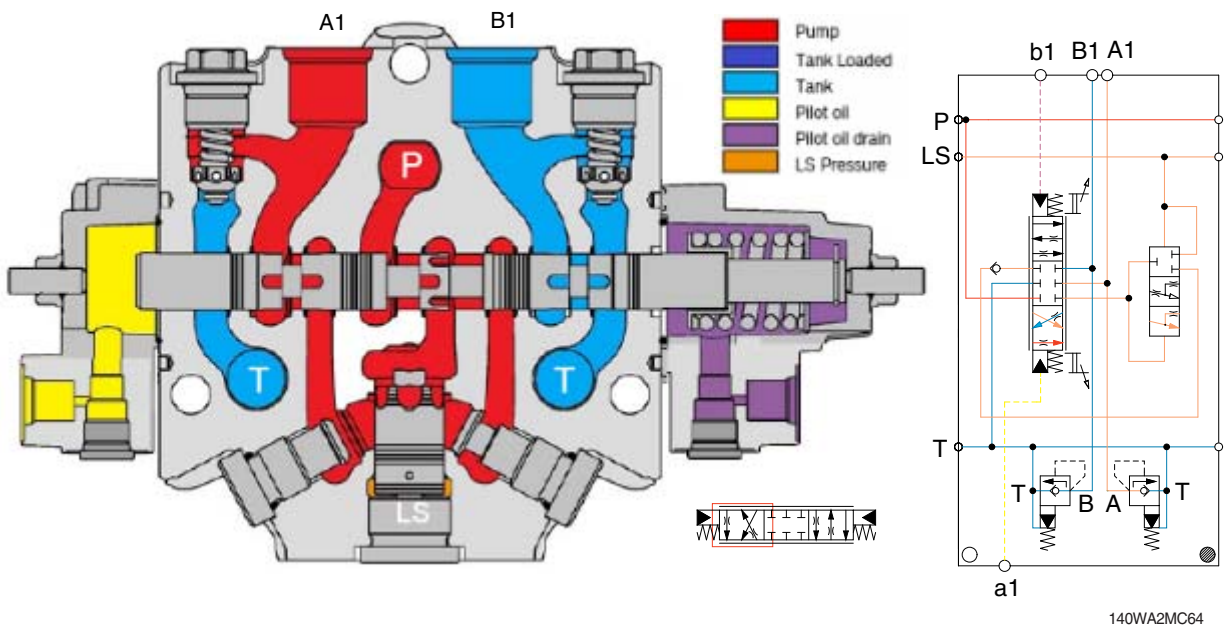
10) OUTRIGGER SECTION

(1) Neutral position



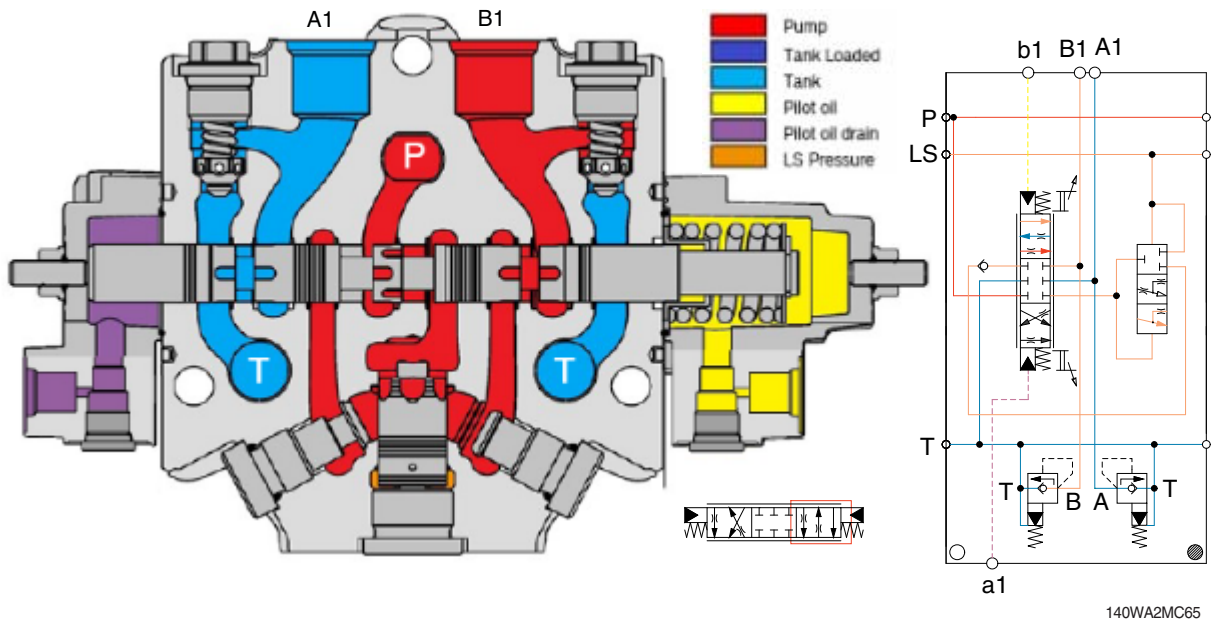
The spool is in neutral position, pump is in low pressure stand-by. The A1 and B1 ports are not connected to the pumps nor the tank.

(2) A1 side piloted



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 cylinder port B1.

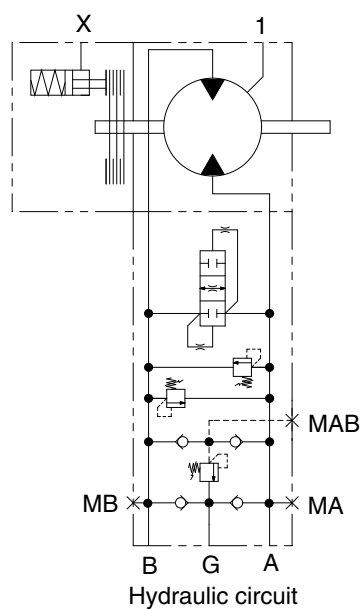
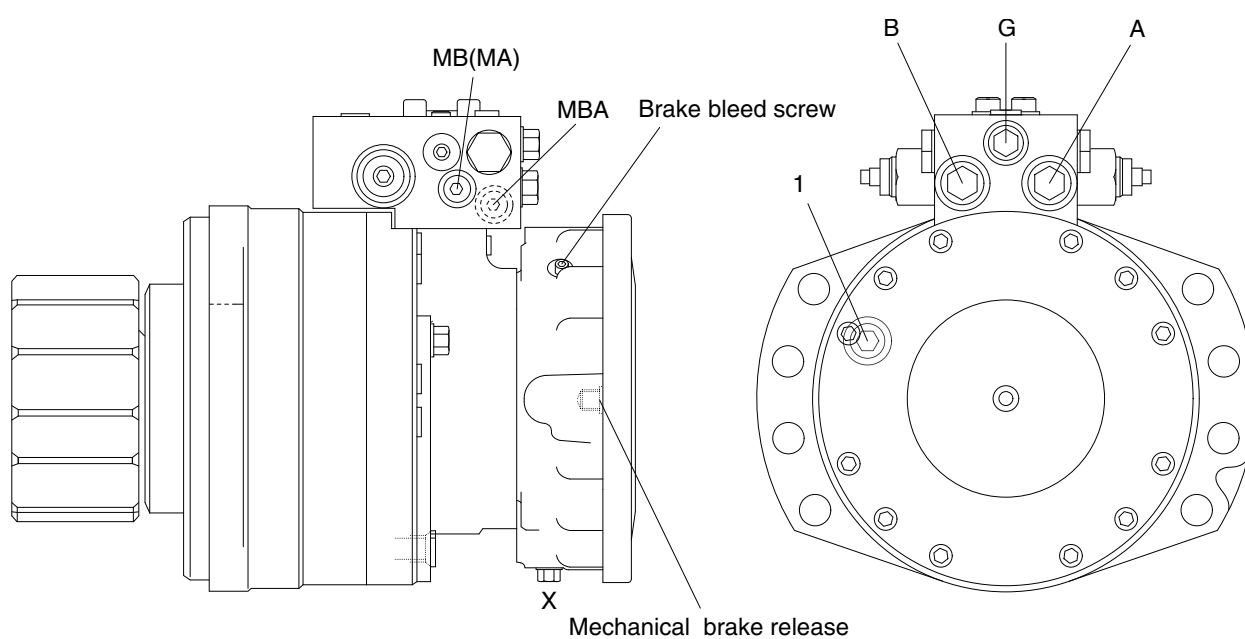
(3) B side piloted



When the pilot pressure is led to B1 side, 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.

GROUP 3 SWING DEVICE

1. STRUCTURE

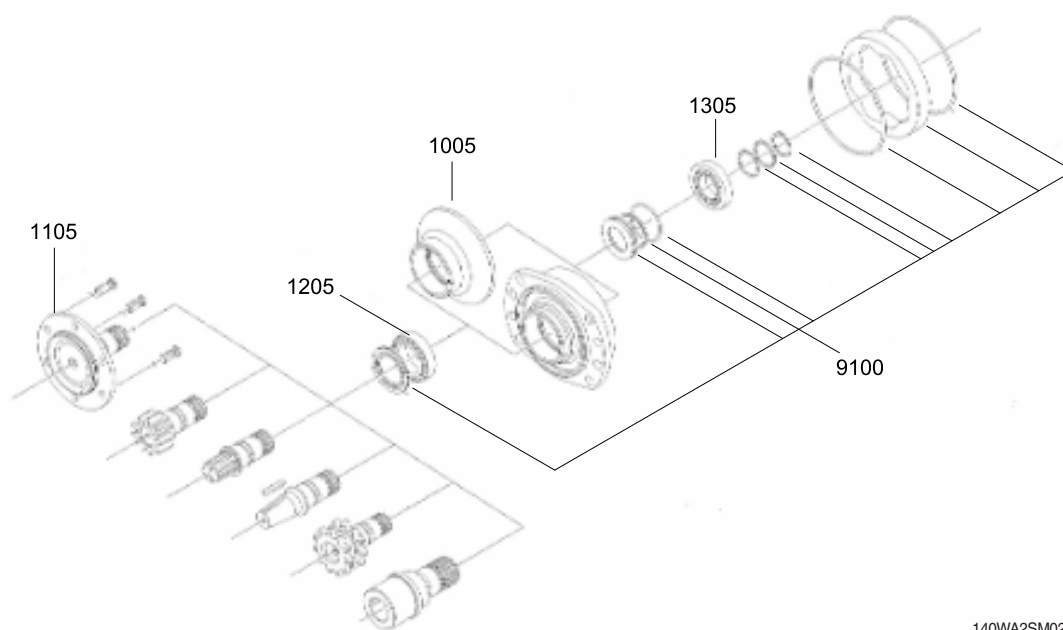


140WA2SM01A

Port	Port name	Port size
A	Main port	1-1/16-12 UNF
B	Main port	1-1/16-12 UNF
G	Make up port	7/8-14 UNF
MA	Gauge port	3/4-16 UNF
MB	Gauge port	3/4-16 UNF
MBA	Gauge port	7/16-20 UNF
X	Brake release port	9/16-18 UNF
1	Drain port	7/8-14 UNF

2. PART LIST

1) SUPPORT BEARING ASSY



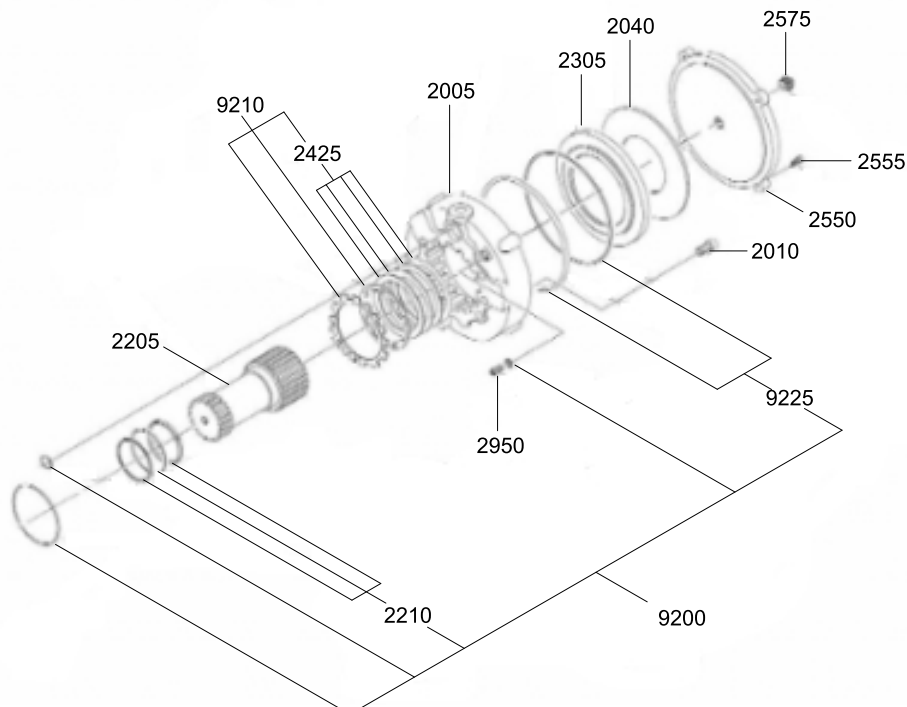
140WA2SM02

1005 Bearing housing
1105 Pinion shaft

1205 Taper bearing
1305 Taper bearing

9100 Full motor seal kit

2) BRAKE ASSY



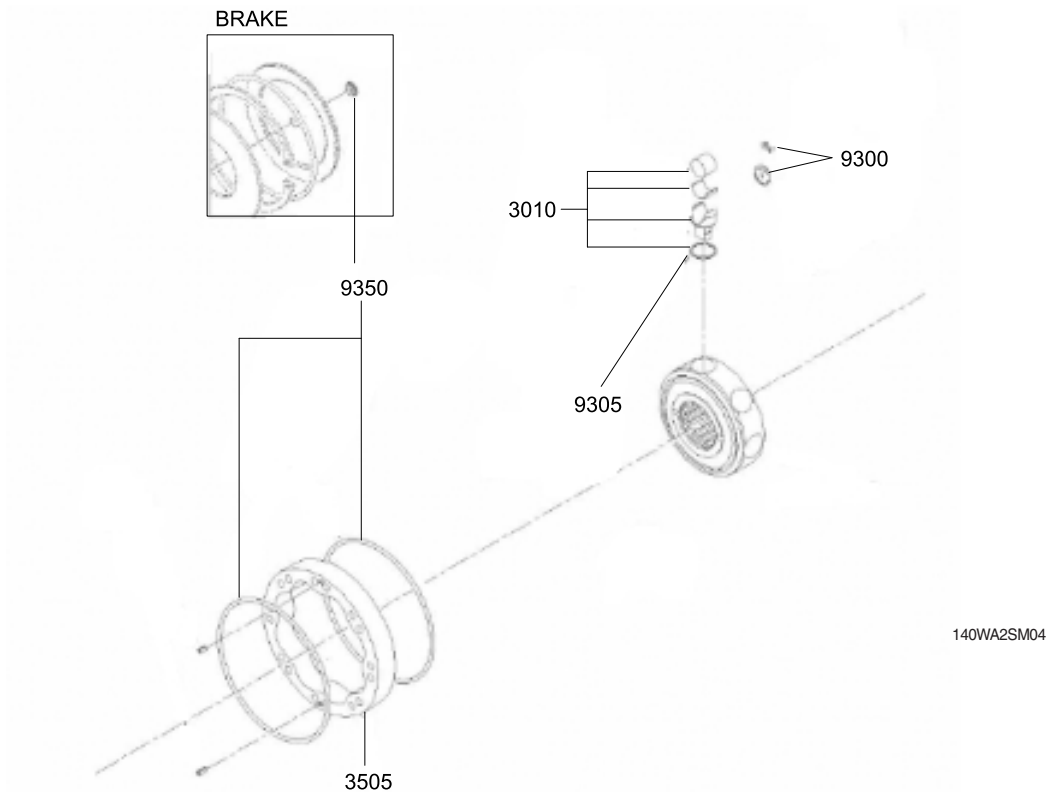
140WA2SM03

2005 Brake housing
2010 Screw
2040 Washer spring
2205 Brake shaft
2210 Brake shaft seal kit

2305 Brake piston
2425 Brake disk seal kit
2550 Lock plate
2555 Screw
2575 Plug

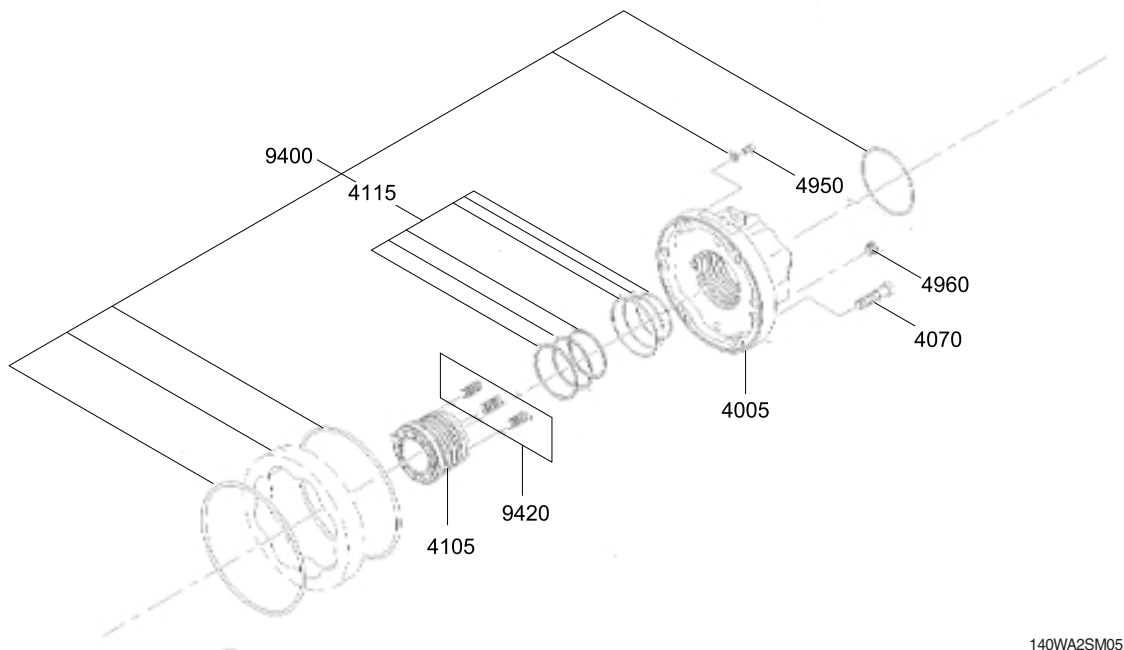
2950 Screw
9200 Brake repair kit
9210 Brake disc repair kit
9225 Brake cover repair kit

3) CYLINDER BLOCK ASSY



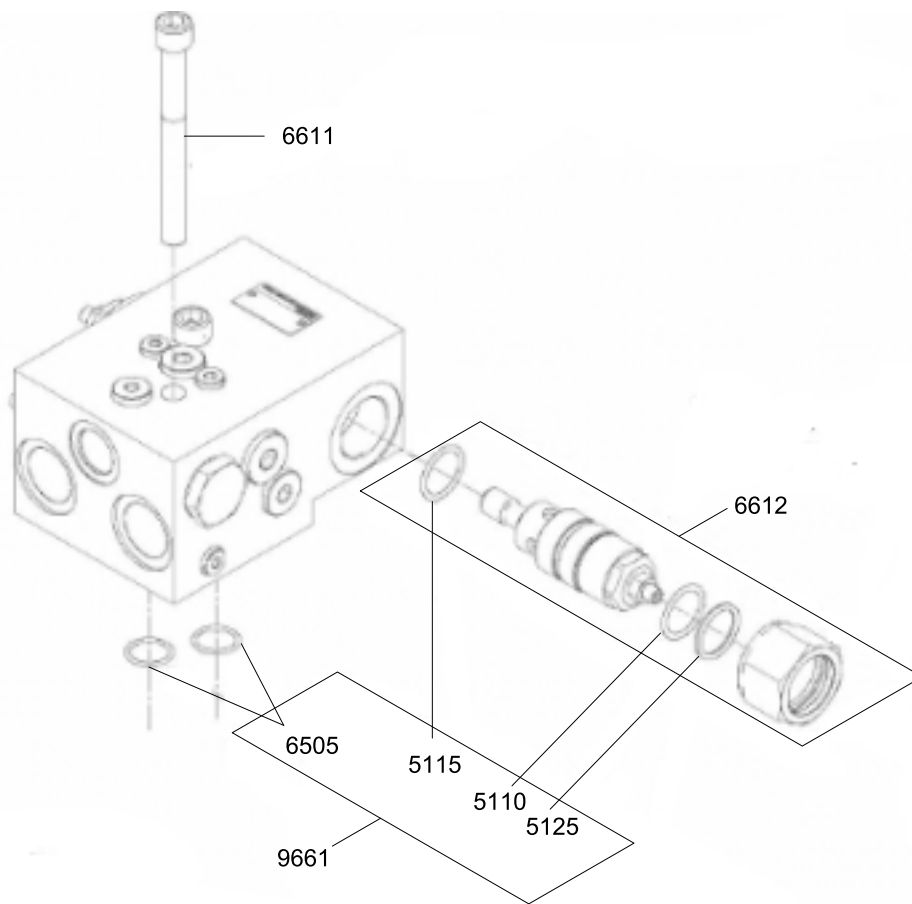
- | | | | | | |
|------|-------------------|------|------------------------|------|-----------------------|
| 3010 | Piston repair kit | 9300 | Piston insite kit | 9350 | Open motor repair kit |
| 3505 | Cam | 9305 | Piston ring repair kit | | |

4) VALVE COVER ASSY



- | | | | | | |
|------|---------------|------|---------------------|------|------------------------|
| 4005 | Valve housing | 4115 | Distribute seal kit | 9400 | Valve repair kit |
| 4070 | Screw | 4950 | Screw | 9420 | Compression spring kit |
| 4105 | Valve block | 4960 | Plug | | |

5) VMR VALVE ASSY



140WA2SM06

5110 O-ring
5115 O-ring
5125 Conte joint

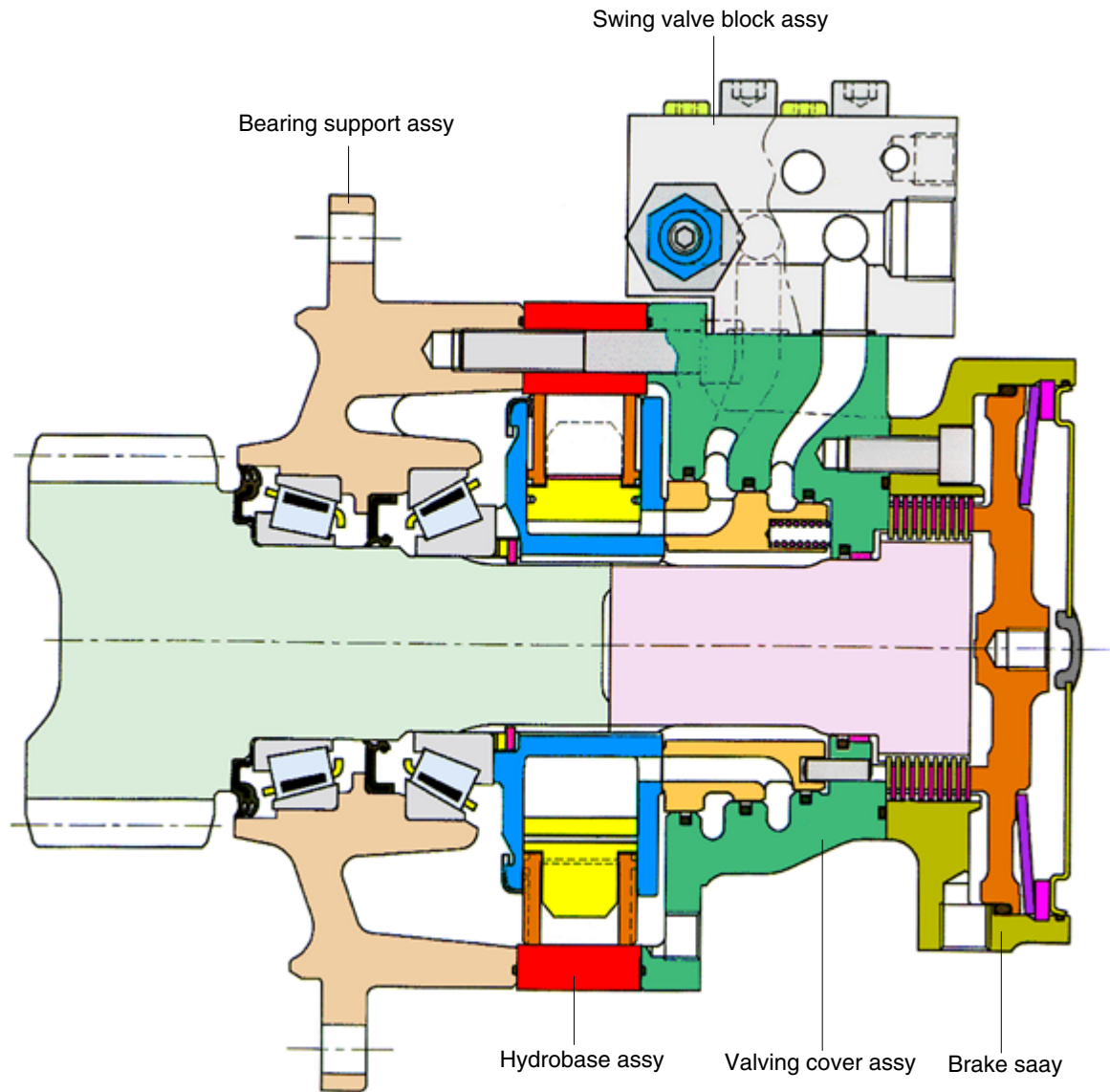
6505 O-ring
6611 Screw
6612 Relief valve

9661 Relief valve seal kit

3. GENERAL DESCRIPTION

This hydraulic motor is designed to swing the upper structure of the excavator and changes the hydraulic pressure oil supplied from the pump to the rotary motion.

This is the radial piston type for low speed-high torque and section is as blow.



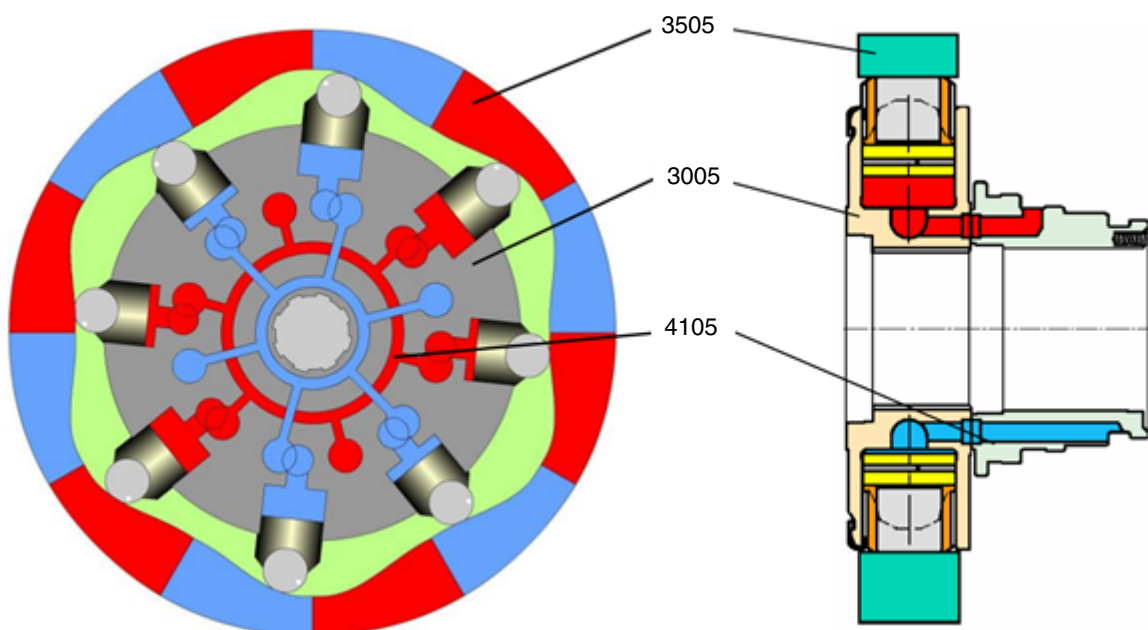
140WA2SM10

This hydraulic motor consists of the five major subassembly such as bearing support assembly, hydrobase assembly, valving cover assembly, brake assembly and swing valve block assembly (VMR valve assembly).

The hydraulic pressure oil flows into hydrobase through the valving cover assembly and the hydraulic energy changes to mechanical energy by the hydrobase. As a result, the upper structure is rotated through the pinion gear of the bearing support.

When the hydraulic oil is supplied to the A port (red) and this pressure oil flows through valving plate (fixed part, not rotating) and cylinder block (3005, rotating part, connect to the pinion shaft by inside spline) and push red area of the cam (3505) through the piston and cylinder roller. Thus rotating torque is occurred.

(The upper structure starts rotating)



140WA2SM11

The other way, the blue port oil flows into the piston through the cylinder roller and flows into B port through the cylinder block and valving plate. In case the upper structure stops from rotating, the resist rotating torque generates due to the throttle effect of the orifice by the slope of the blue area of the cam, then the upper structure stops. (hydrostatic brake function)

The green chamber is filled with oil during the operation, the internal leakage of the motor (leakage of the mechanical contact part of the 3005 and 4105) and leakage of between piston and cylinder block) flows in to green chamber and drains to hydraulic tank without resistance surely. The sealing status of the motor can be checked by measuring this drain oil.

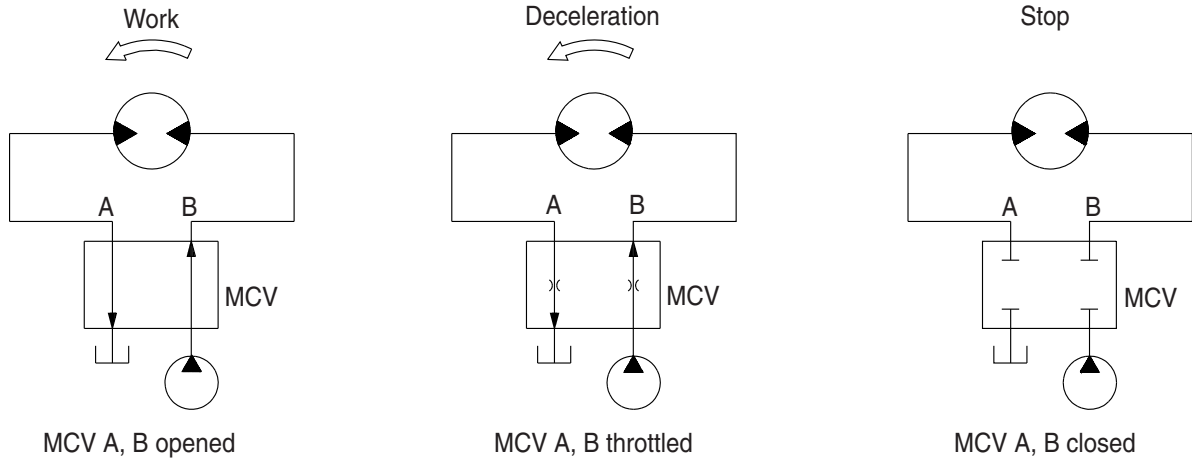
The internal leakage of the motor does not exceed 0.14 lpm at the drain port when the supply oil quantity is 30 lpm.

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.



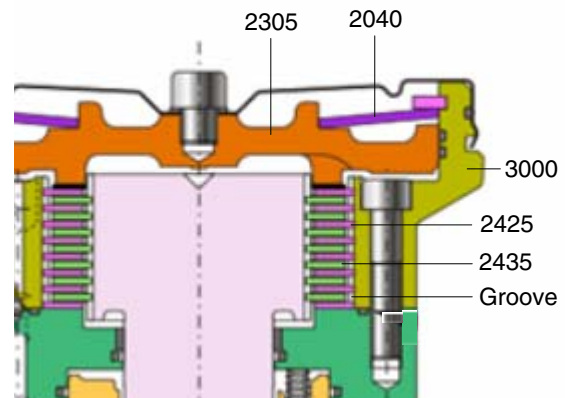
2-48(1)

(2) Mechanical swing parking brake system

This is function as a parking brake only when the swing control lever and arm in control lever are not operated.

① Brake assembly

Circumferential rotation of separate plate (2435) is constrained by the groove located at brake housing (2005). When housing is pressed down by washer spring (2040) through friction plate (2425), separate plate (2435) and brake piston (2305), friction force occurs between friction plate and separate plate. Friction force constrains motion of cylinder block (3000). When hydraulic force exceeds spring force, brake is released.

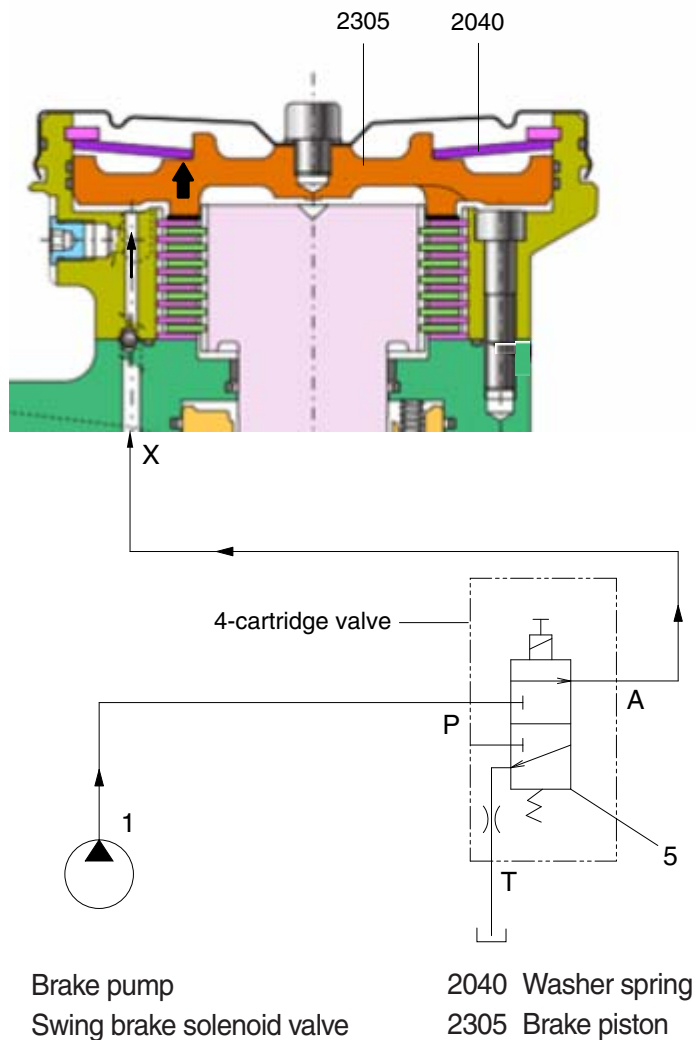


140WA2SM12

2005	Brake housing	2425	Friction plate
2040	Washer spring	2435	Separate plate
2305	Brake piston	3000	Cylinder block

② Operating principle

- When any of the swing or arm in function is operated, the swing brake solenoid valve (5) is shifted to the swing position, so brake pump charged oil goes to the chamber G through port X. This pressure is applied to move the parking piston (2305) to the upward against the force of the washer spring (2040). Thus, it releases the brake force.
- Stop operation and a few second has been elapsed, the swing brake solenoid valve (5) is shifted to the swing parking position and swing brake works.
- There is time delay for swing parking as below (single operation).
 - Swing : 5 sec, arm in : 1 sec, boom up : 2 sec, travel : 3 sec.



140WA2SM13

③ Manual override function

When the swing parking solenoid valve or related electric system is malfunction, the swing parking brake is not released even if the swing or arm in lever is operated.

To release the swing parking brake, the manual override function is needed.

※ Manual override solenoid valve

- a. Use hand only to turn the control knob (do not use a tool).

- b. **Parking brake release**

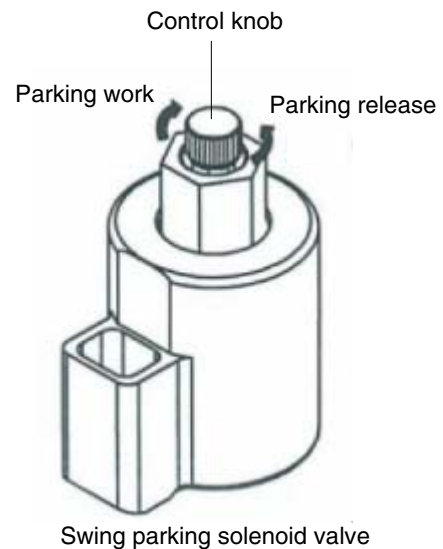
Turn the control knob to counterclockwise fully (about 2.5 mm)

- c. **Parking brake work**

Turn the control knob to clockwise fully.

- ※ **Be careful not damage the control knob by using a tool or tightening forcibly.**

It can cause malfunction of the solenoid valve.



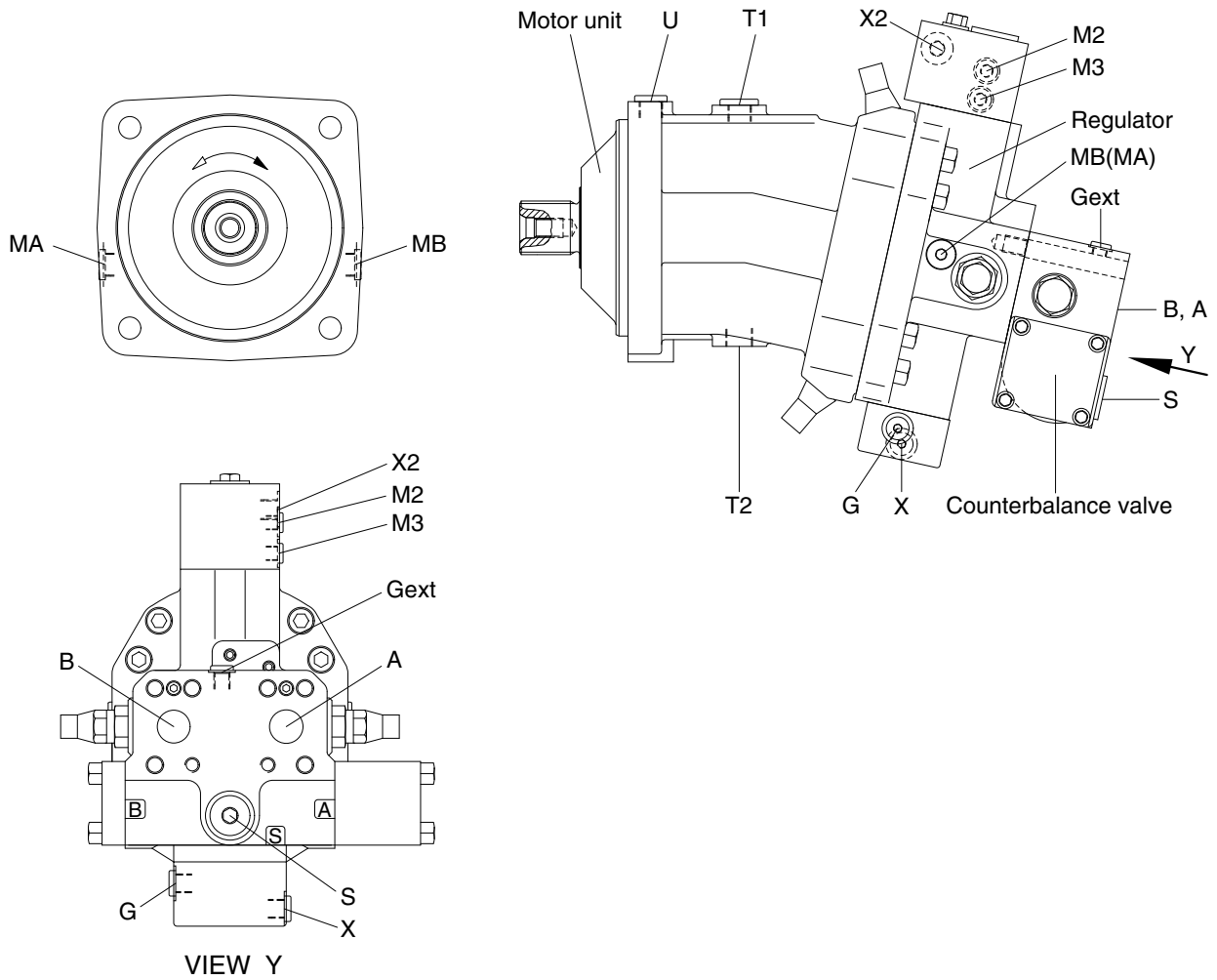
160A2SM11

GROUP 4 TRAVEL MOTOR

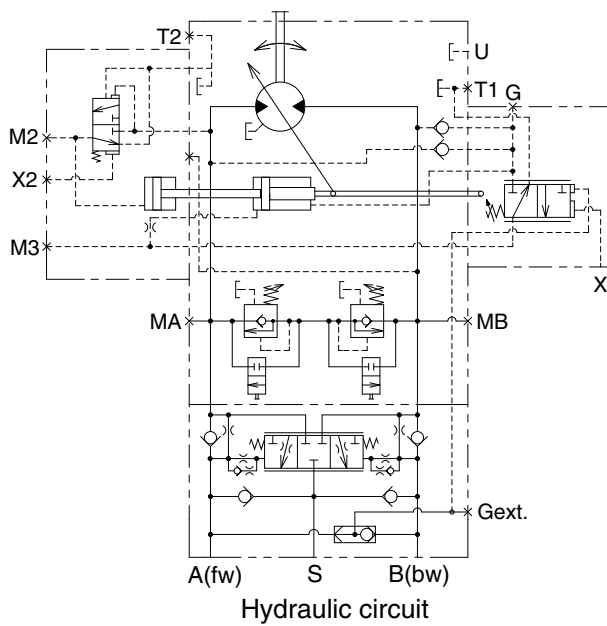
1. CONSTRUCTION

Travel motor consists motor unit, regulator and counterbalance valve.

- High speed (standard)

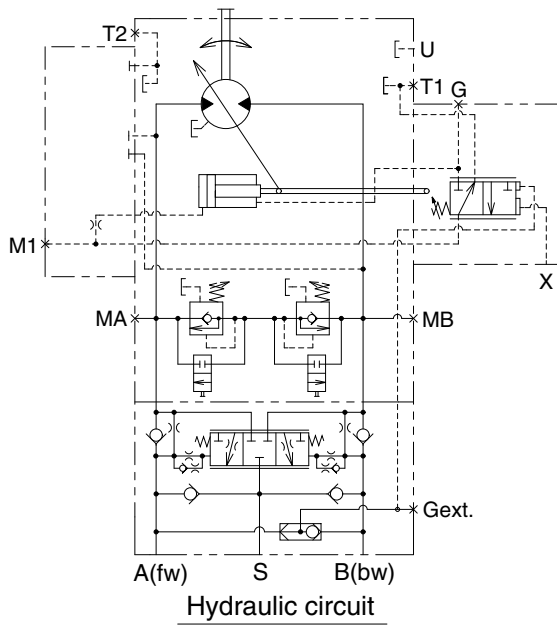
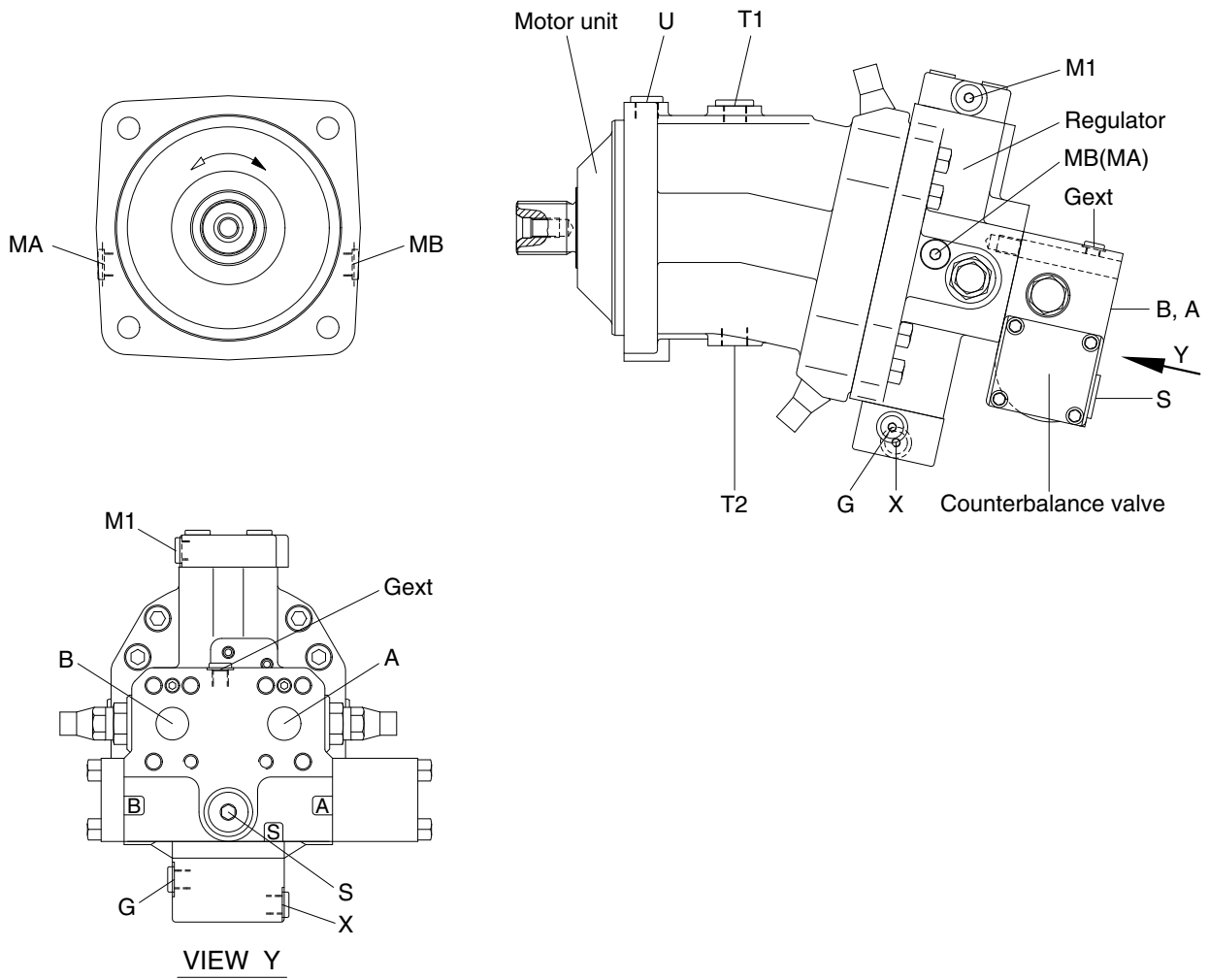


160WA2TR01



Port	Port name	Port size
A, B	Main port	SAE 1 1/4"
G	Plugged	M14 × 1.5 - 12
X	Pilot pressure port	M14 × 1.5 - 12
X2	Pilot pressure port	M14 × 1.5 - 12
T1	Drain port	PF 3/4 - 17
T2	Drain port	PF 3/4 - 12
U	Flushing port	PF 1/2 - 16
S	Make up port	M27 × 2.0 - 16
MA, MB	Gauge port	M18 × 1.5 - 12
M2, M3	Gauge port	M10 × 1.0 - 8
Gext	Brake release port	M12 × 1.5 - 12.5

- Low speed (option)

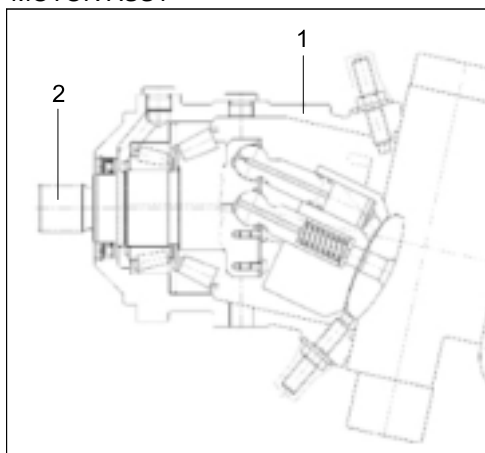


Port	Port name	Port size
A, B	Main port	SAE 1 1/4"
G	Plugged	M14×1.5 - 12
M1	Gauge port	M14×1.5 - 12
X	Pilot pressure port	M14×1.5 - 12
T1	Drain port	PF 3/4 - 17
T2	Drain port	PF 3/4 - 12
U	Flushing port	PF 1/2 - 16
S	Make up port	M27×2.0 - 16
MA, MB	Gauge port	M18×1.5 - 12
Gext	Brake release port	M12×1.5 - 12.5

1) PARTS LIST (1/3)

(1) High speed

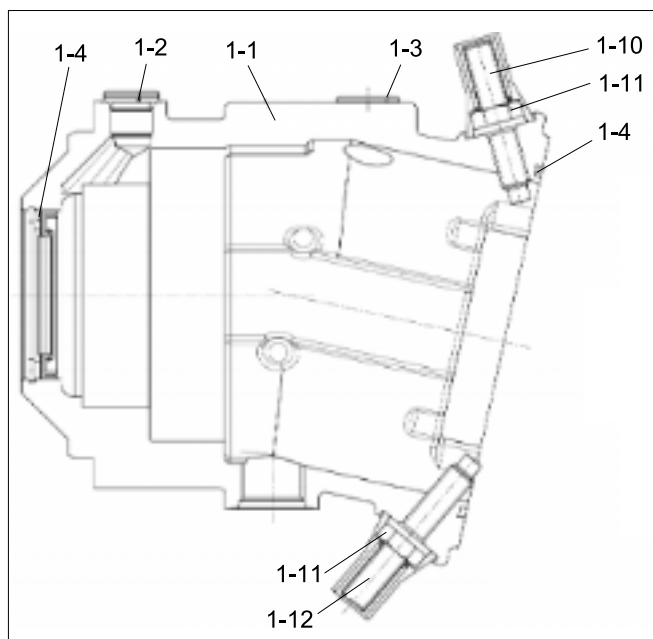
MOTOR ASSY



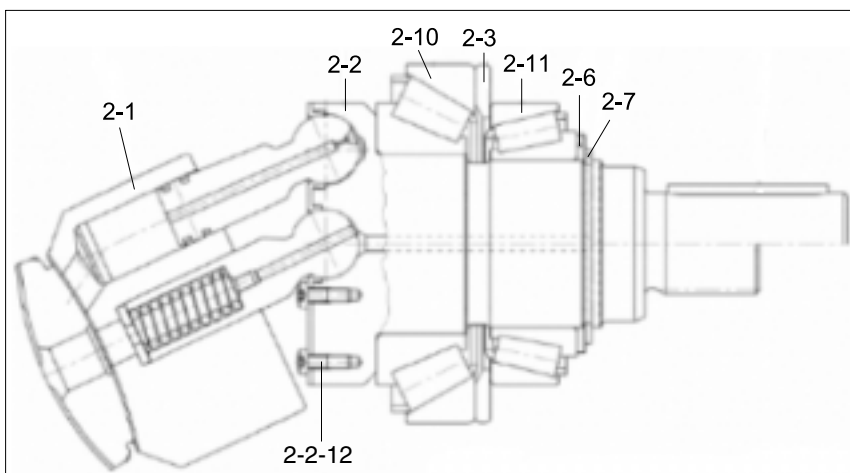
1 Motor housing assy

2 Rotary kit

ITEM 1



ITEM 2



140WA2TR10

1-1 Housing

1-2 Lock screw

1-3 Lock screw

1-4 Motor seal kit

1-10 Threaded pin

1-11 Sealing nut

1-12 Threaded pin

2-1 Hydraulic rotary section

2-2 Drive shaft

2-2-12 Screw

2-3 Shim

2-6 Backup plate

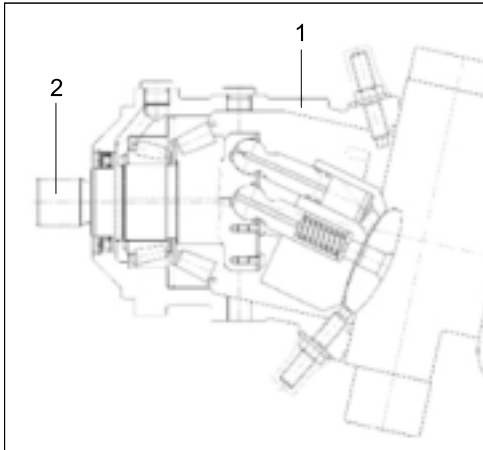
2-7 Retainer ring

2-10 Roller bearing

2-11 Roller bearing

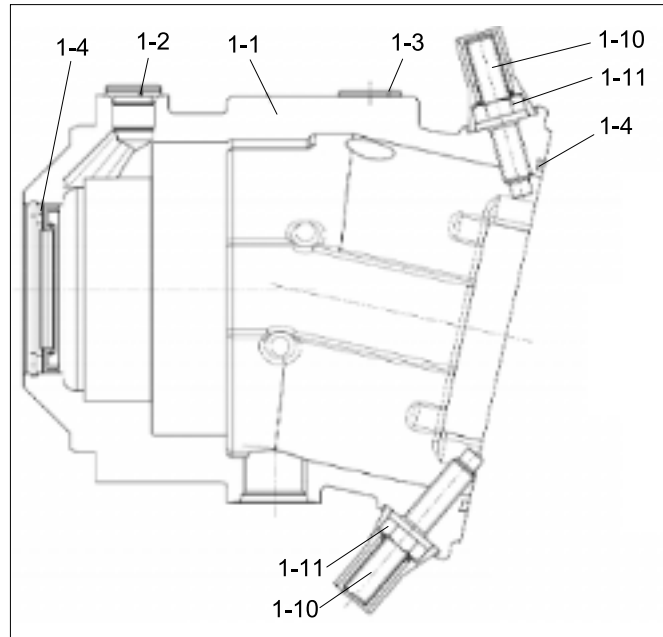
(2) Low speed

MOTOR ASSY

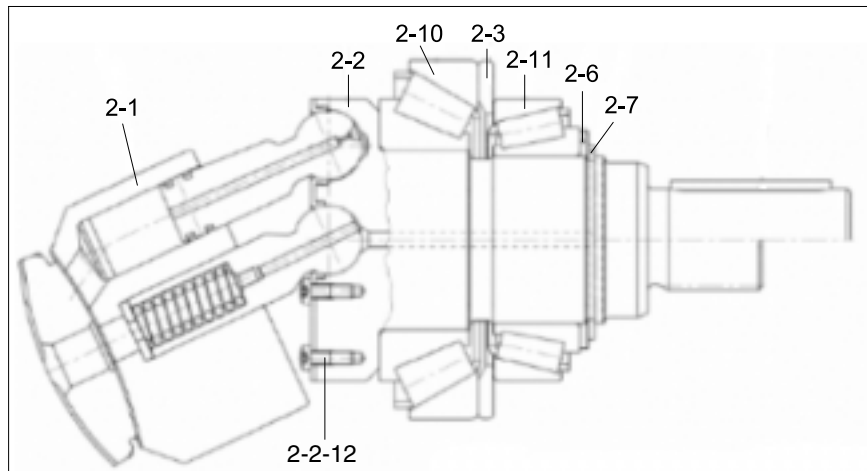


- 1 Motor housing assy
- 2 Rotary kit

ITEM 1



ITEM 2



140WA2T11

- | | | |
|--------------------|------------------------------|---------------------|
| 1-1 Housing | 1-11 Sealing nut | 2-6 Backup plate |
| 1-2 Lock screw | 2-1 Hydraulic rotary section | 2-7 Retainer ring |
| 1-3 Lock screw | 2-2 Drive shaft | 2-10 Roller bearing |
| 1-4 Motor seal kit | 2-2-12 Screw | 2-11 Roller bearing |
| 1-10 Threaded pin | 2-3 Shim | |

PARTS LIST (2/3)

(1) High speed

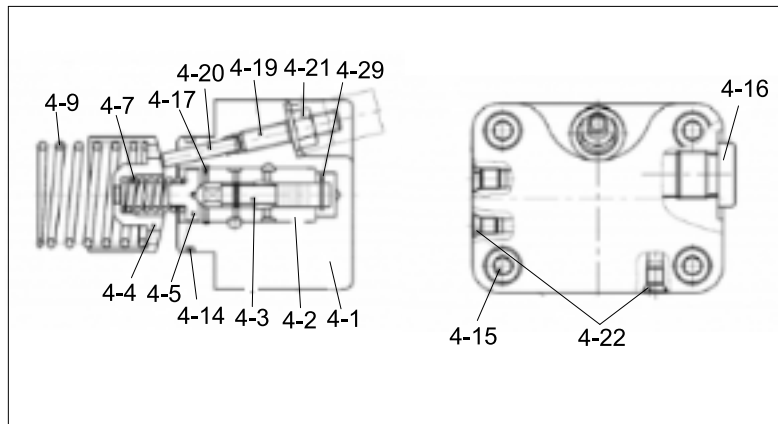
MOTOR ASSY



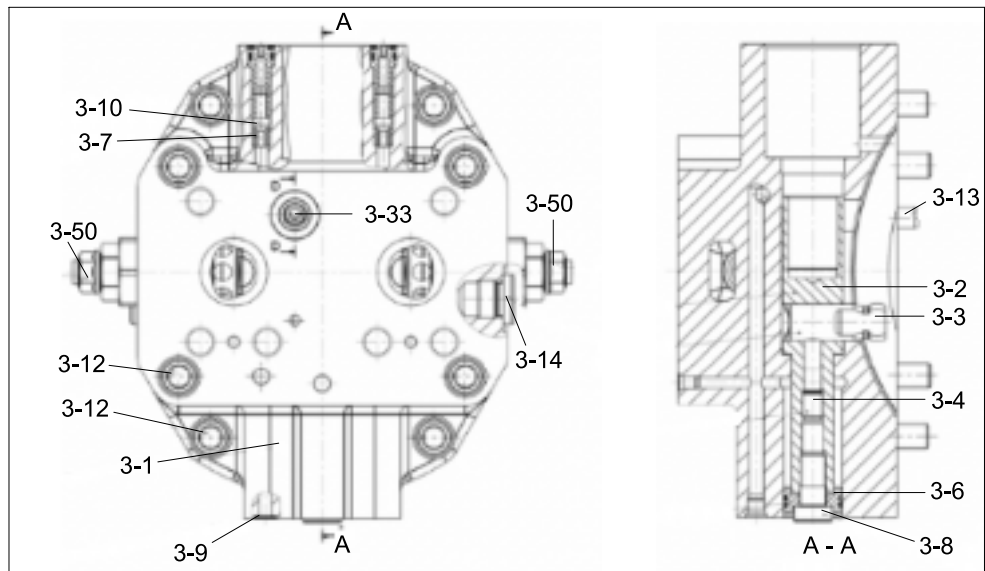
3 Port plate assy

4 Control unit

ITEM 4



ITEM 3

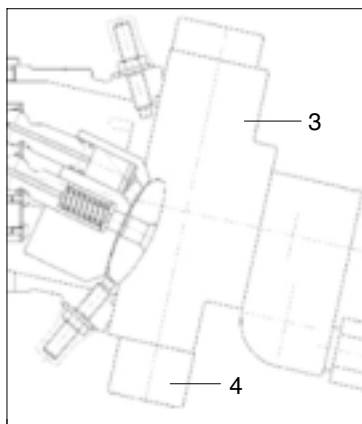


160WA2TR12

3-1 Port plate	3-13 Cylinder pin	4-9 Pressure spring
3-2 Positioning piston	3-14 Locking screw	4-14 O-ring
3-3 Positioning trunnion	3-33 O-ring	4-15 Socket screw
3-4 Threaded pin	3-50 Relief valve	4-16 Locking screw
3-6 Piston ring	4-1 Control housing	4-17 Retainer ring
3-7 Bushing	4-2 Control bushing	4-19 Thread pin
3-8 Socket screw	4-3 Control piston	4-20 Cylinder pin
3-9 O-ring	4-4 Adjust bushing	4-21 Seal lock nut
3-10 Check valve	4-5 Spring collar	4-22 Break pin
3-12 Socket screw	4-7 Pressure spring	4-29 Retainer disc

(2) Low speed

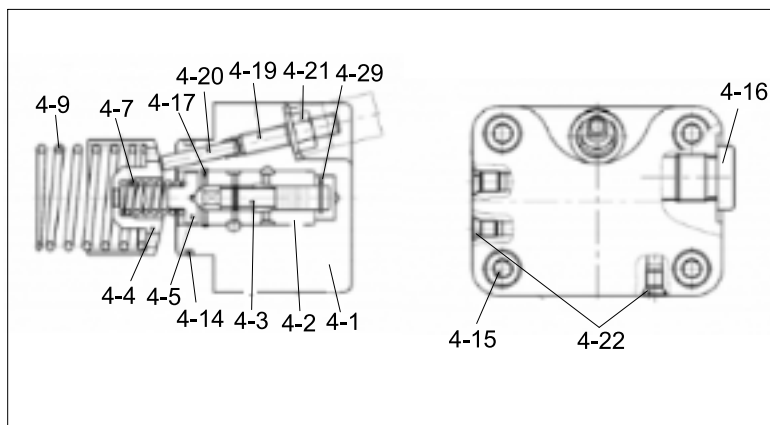
MOTOR ASSY



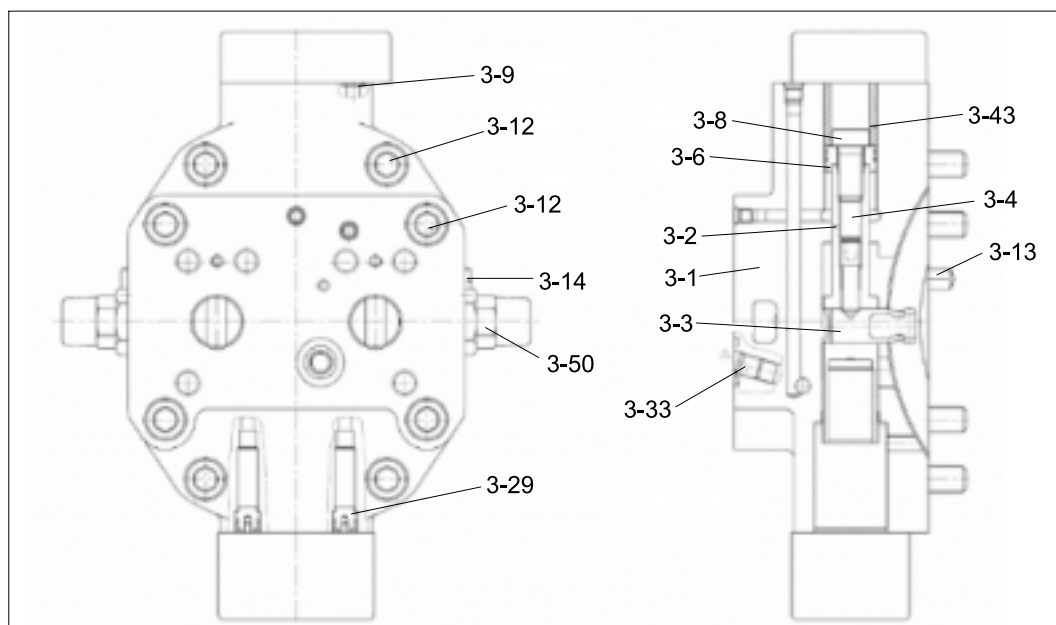
3 Port plate assy

4 Control unit

ITEM 4



ITEM 3



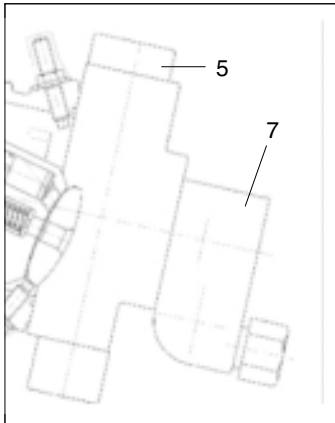
160WA2TR13

3-1 Port plate	3-29 Plug	4-9 Pressure spring
3-2 Positioning piston	3-33 O-ring	4-14 O-ring
3-3 Positioning trunnion	3-43 Stop bushing	4-15 Socket screw
3-4 Threaded pin	3-50 Relief valve	4-16 Locking screw
3-6 Piston ring	4-1 Control housing	4-17 Retainer ring
3-8 Socket screw	4-2 Control bushing	4-19 Thread pin
3-9 O-ring	4-3 Control piston	4-20 Cylinder pin
3-12 Socket screw	4-4 Adjust bushing	4-21 Seal lock nut
3-13 Cylinder pin	4-5 Spring collar	4-22 Break pin
3-14 Locking screw	4-7 Pressure spring	4-29 Retainer disc

PARTS LIST (3/3)

(1) High speed

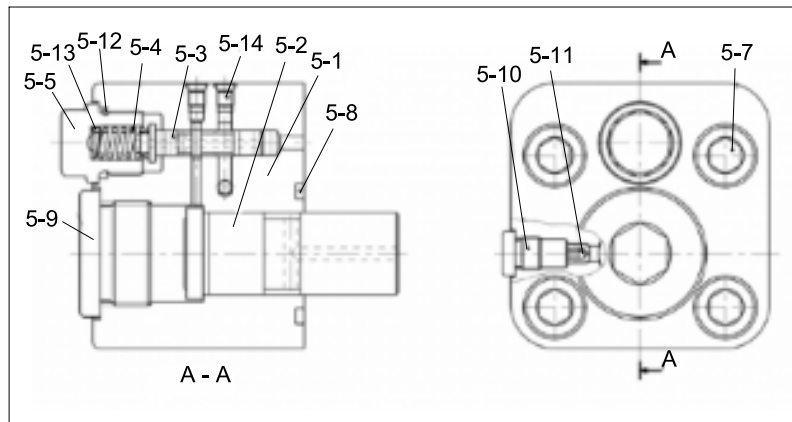
MOTOR ASSY



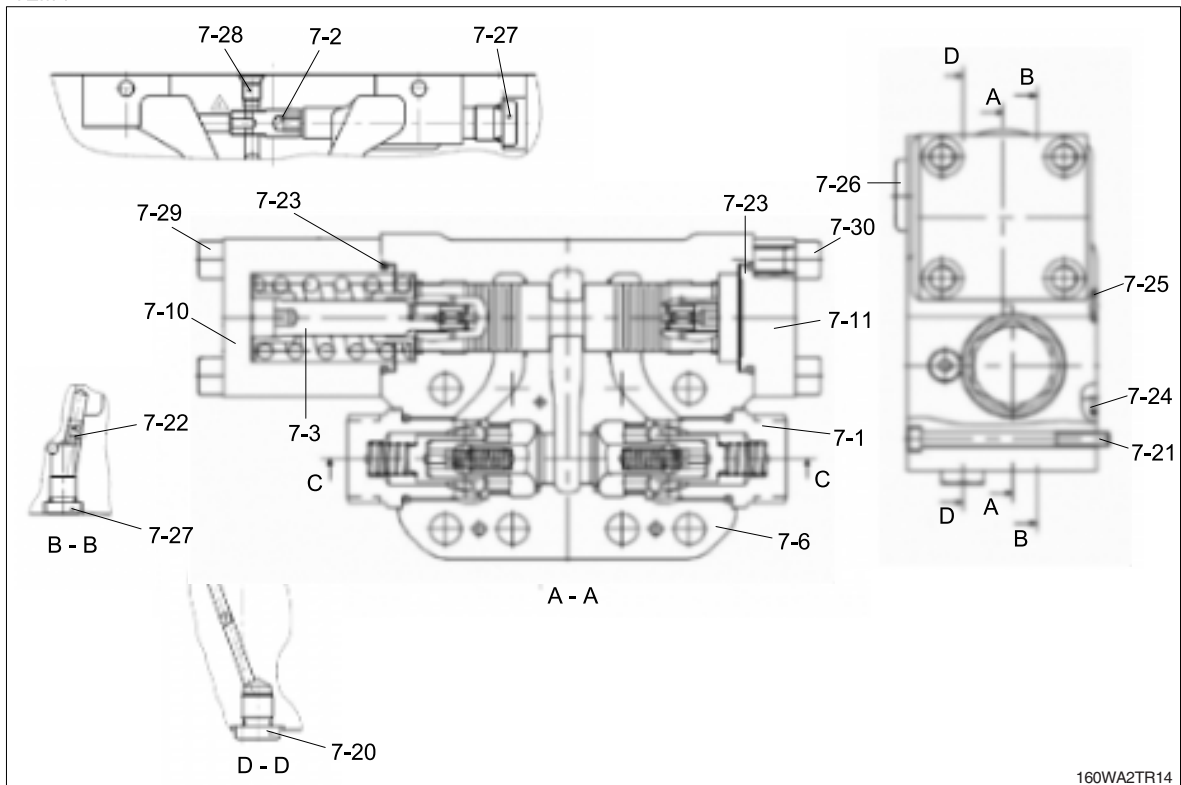
5 Hydraulic stroke limiter

7 Motion control valve assy

ITEM 5



ITEM 7



160WA2TR14

5-1 Limiter housing

5-2 Piston

5-3 Control piston

5-4 Pressure spring

5-5 Lock screw

5-7 Cap screw

5-8 O-ring

5-9 Lock screw

5-10 Lock screw

5-11 Orifice

5-12 O-ring

5-13 Shim

5-14 Break pin

7-1 Control valve assy

7-2 Shuttle valve

7-3 Brake piston assy

7-6 Housing

7-10 Cover

7-11 Cover

7-20 Locking screw

7-21 Socket screw

7-22 Plug

7-23 O-ring

7-24 O-ring

7-25 O-ring

7-26 Locking screw

7-27 Locking screw

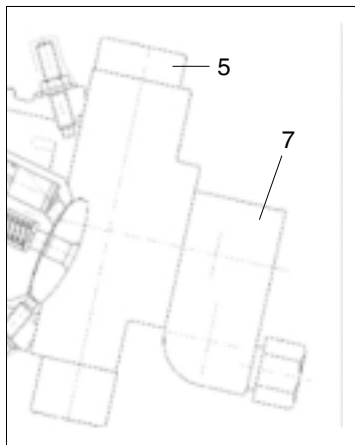
7-28 Break pin

7-29 Socket screw

7-30 Socket screw

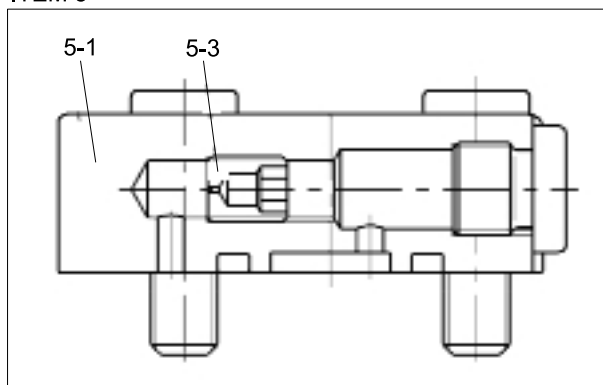
(2) Low speed

MOTOR ASSY

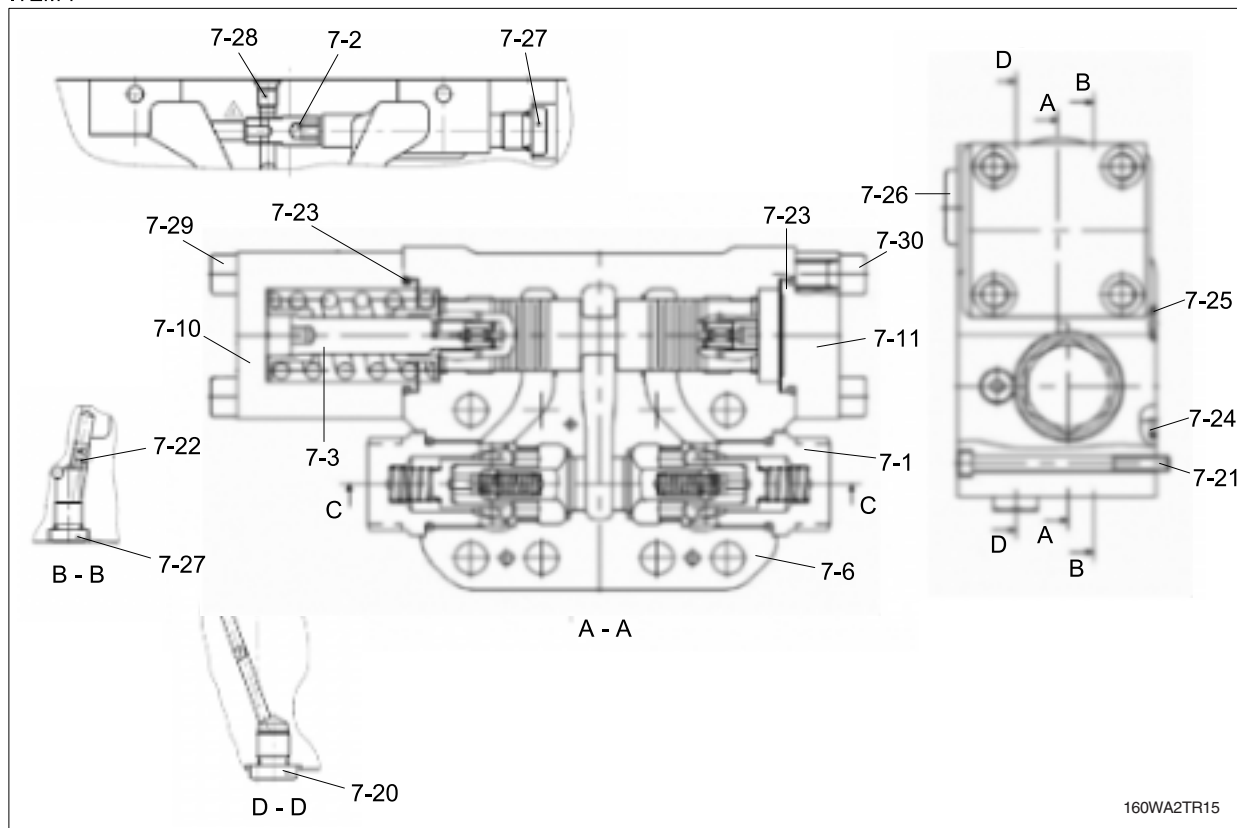


- 5 Hydraulic stroke limiter
7 Motion control valve assy

ITEM 5



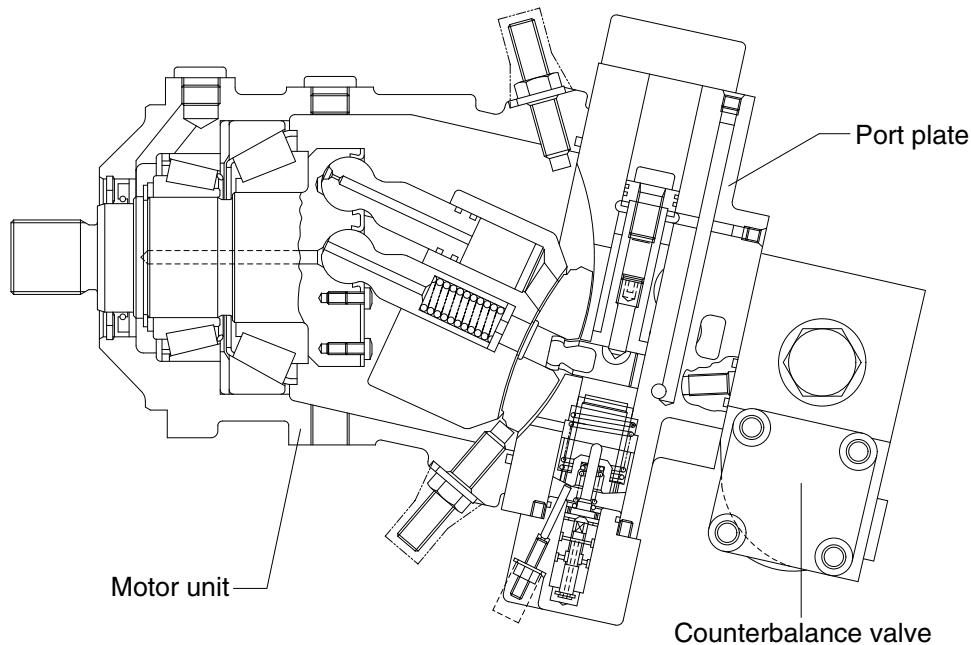
ITEM 7



160WA2TR15

- | | | |
|------------------------|--------------------|--------------------|
| 5-1 Cover | 7-11 Cover | 7-26 Locking screw |
| 5-3 Throttle screw | 7-20 Locking screw | 7-27 Locking screw |
| 7-1 Control valve assy | 7-21 Socket screw | 7-28 Break pin |
| 7-2 Shuttle valve | 7-22 Plug | 7-29 Socket screw |
| 7-3 Brake piston assy | 7-23 O-ring | 7-30 Socket screw |
| 7-6 Housing | 7-24 O-ring | |
| 7-10 Cover | 7-25 O-ring | |

2. FUNCTION



160WA2TR05

1) VARIABLE DISPLACEMENT MOTOR (with integrated counterbalance valve)

The variable displacement motor has a rotary group in bent axis design.

The torque is generated directly at the drive shaft.

The cylinder barrel is driven by a tapered piston arrangement.

The change of displacement is generated by the control lens via positioning piston. The control lens slides on a circular shaped surface.

In case of constant pump flow volume and high pressure

- The output speed is increased at smaller swivel angle, the torque is reduced
- The torque rises at swivel angle increase, the output speed is decreased

The max swivel angle is 25°, the min swivel angle is 0°.

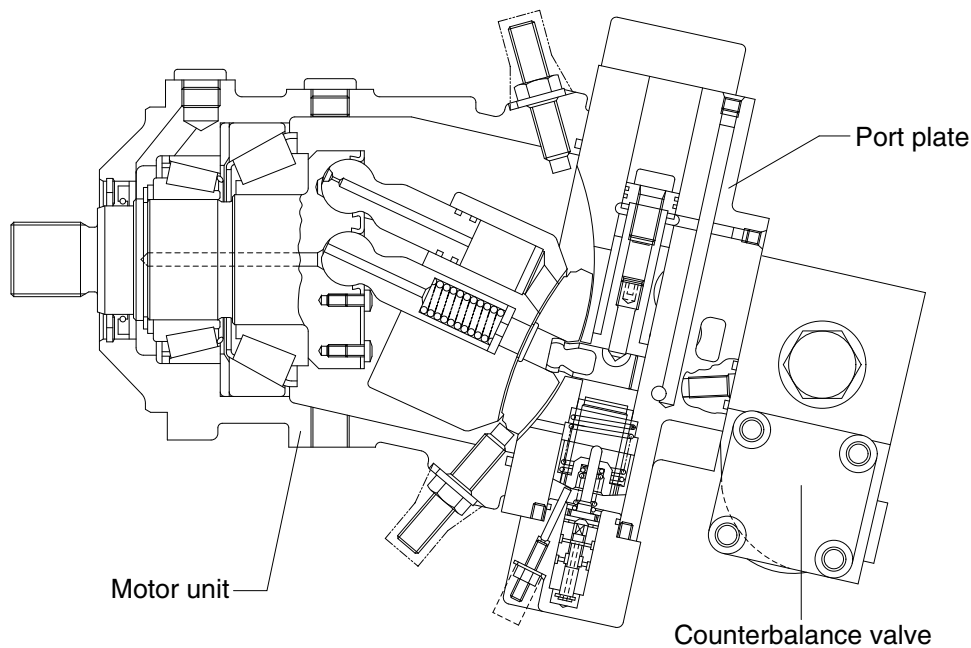
The variable displacement motor with integrated counterbalance valve is designed to be operated in open loop.

※ Min and max displacement are limited by a stop screw. Stepless adjustment to various higher values is possible.

Reduction to smaller displacement may result in overspeeding the motor.

2) PORT PLATE

With high pressure dependent control HA1, mounted counterbalance valve, integrated secondary pressure relief valves, plugged gauge and boosting ports, service ports to the rear.



160WA2TR05

3) HIGH PRESSURE DEPENDENT CONTROL

The displacement is dependent on operating pressure - automatically adjusted. Upon reaching the operating pressure set at the control valve - internally measured at A or B - the motor swivels from V_{gmin} to V_{gmax} until output torque = load torque. For values lower than the adjusted one the motor keeps min swivel angle. The necessary positioning energy is taken from the respective high pressure side via shuttle valve.

Swivelling results in a change of the displacement.

Swivel time is controlled by an orifice installed in the cover of the large positioning piston side.

4) COUNTERBALANCE VALVE

Mounted at the rear of the port plate.

In case of downhill traveling or deceleration of the machine a counterbalance valve avoids overspeeding and cavitation of hydraulic motor.

5) FUNCTION AS TO CIRCUIT DIAGRAM

Check valves in the inlet line A and B for by passing of the counterbalance valve.

At traveling forward the return oil flow is controlled by a counterbalance spool. At drop in inlet pressure the counterbalance spool throttles the return oil flow. The motor is locked. The oil behind the spool is led to the low pressure side via an additional check valve. Same function for traveling forward and backward.

Braking means for the motor that

- At reduced or zero inlet flow the counterbalance spool reaches a modulating position or a neutral position caused by spring force
- The high pressure oil (at outlet side of the motor) is returned to the low pressure side (at inlet side) of the motor via crossover relief valves.

As the control pressure for regulation of the HA control via the integrated shuttle valve is no longer available, the motor with HA control and counterbalance valve will swivel to its minimum displacement during deceleration.

In addition, an external boost flow/pressure can be applied at port S for preventing cavitation.

※ Counterbalance valves do not replace the service and parking brake.

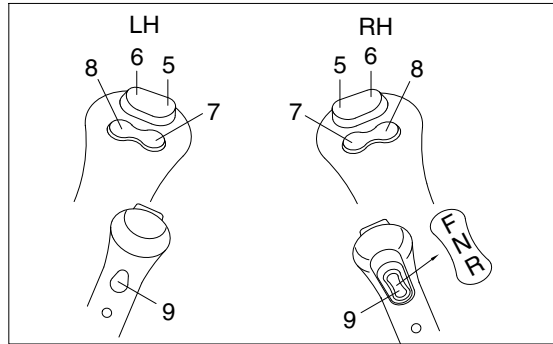
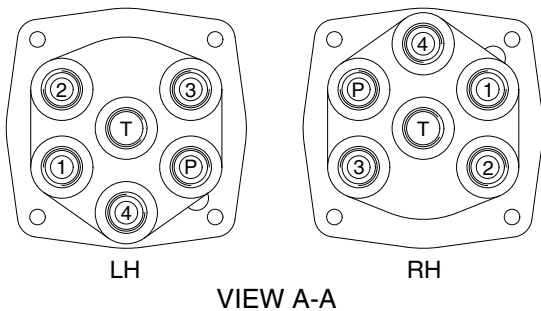
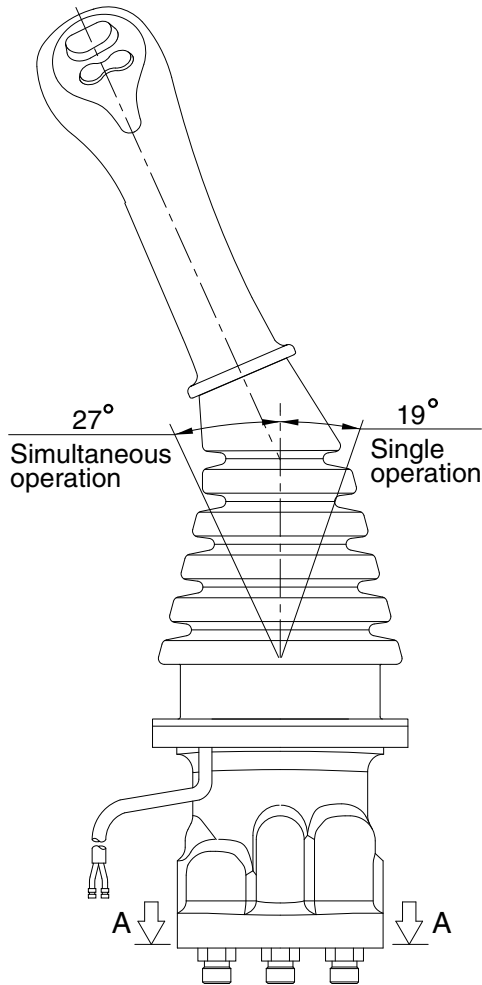
GROUP 5 RCV LEVER

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.

※ Refer to the parts manual for the types of the RCV lever.

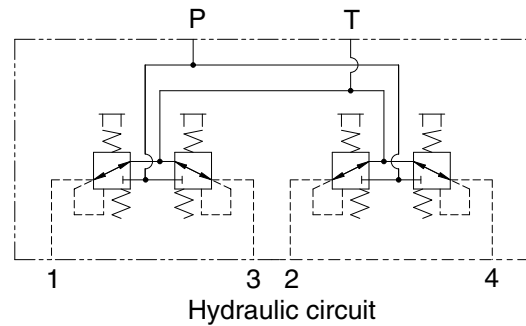
1) TYPE M25



TYPE M26

Switches

Type	No.	LH	RH
M25	5	Rotating-CW	2-way clamp
	6	Rotating-CCW	2-way release
	7	One touch decel	Quick coupler
	8	Ram lock	Horn
	9	Power max	FNR switch

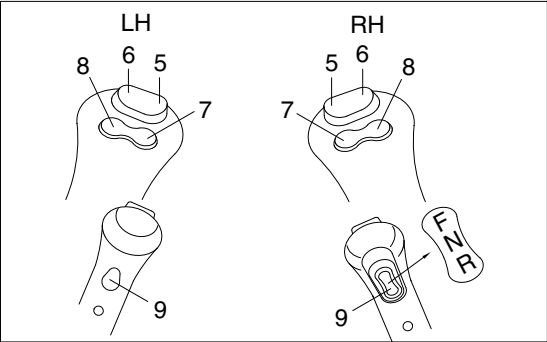
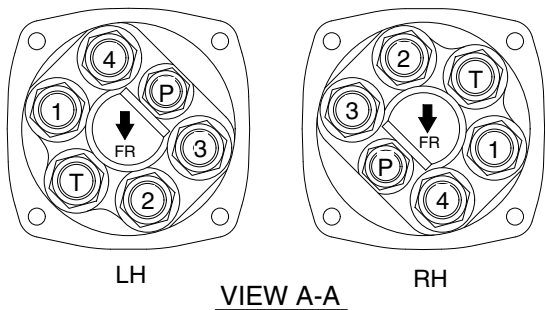
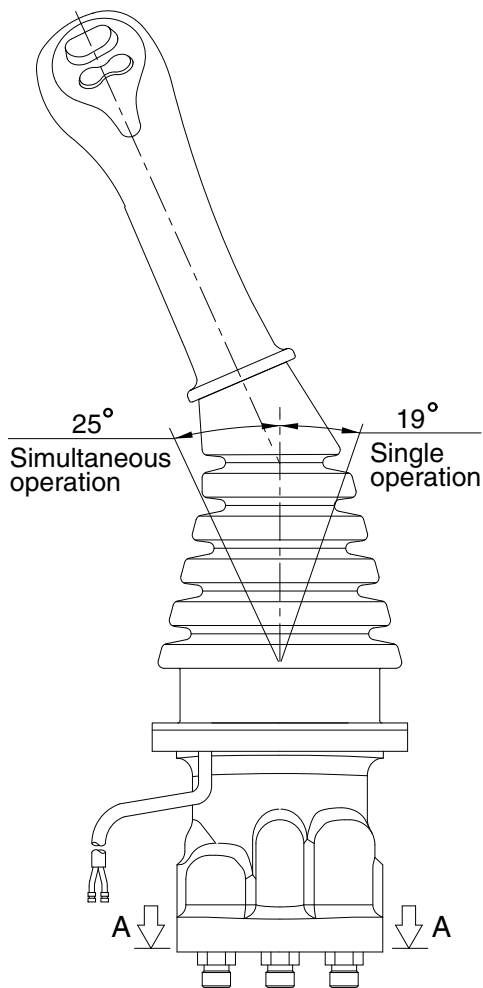


Pilot ports

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 out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

140WA2RL01A

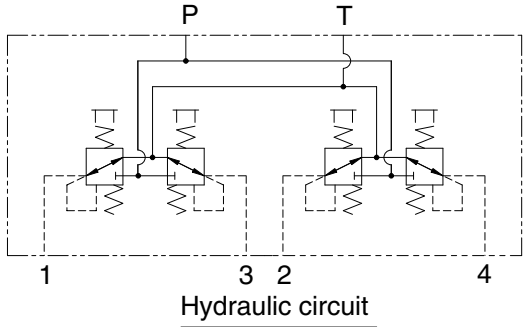
2) TYPE M26 (N.A)



TYPE M26

Switches

Type	No.	LH	RH
M26	5	Rotating-CW	2-way clamp
	6	Rotating-CCW	2-way release
	7	One touch decel	Quick coupler
	8	Ram lock	Horn
	9	Power max	FNR switch

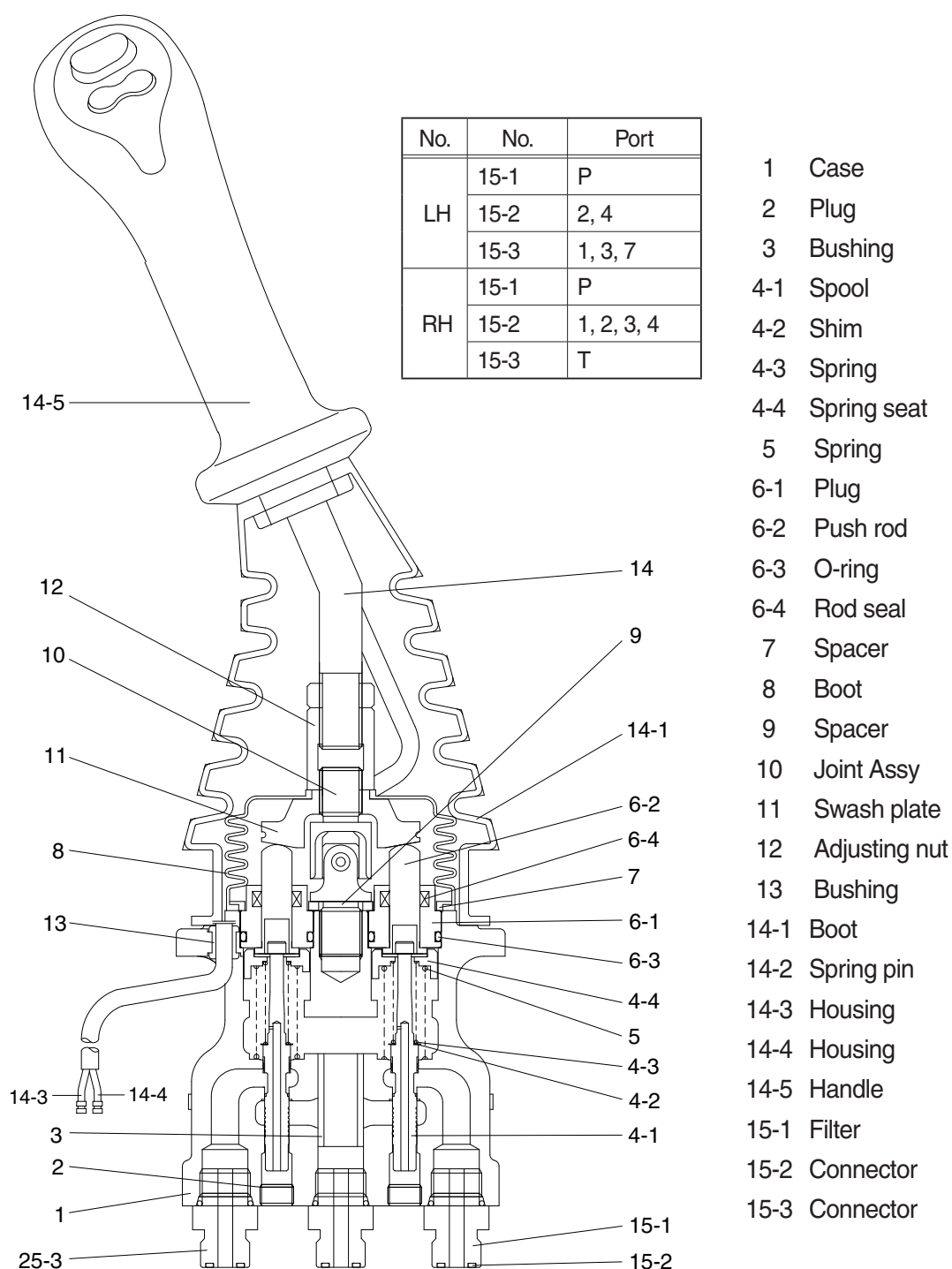


Pilot ports

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 out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

140WA2RL02A

3) CROSS SECTION



140WA2RL06

Item numbers are based on the type M25.

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 (4-1), spring (4-3) for setting secondary pressure, return spring (5), spring seat (4-4) and shim (4-2). 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 (6-2) 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 M25.

The functions of the spool (4-1) 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 (4-3) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (6-2) is inserted and can slide in the plug (6-1).

For the purpose of changing the displacement of the push rod through the swash plate (11) and adjusting nut (12) are provided the handle (14-5) that can be tilted in any direction around the fulcrum of the universal joint (10) center.

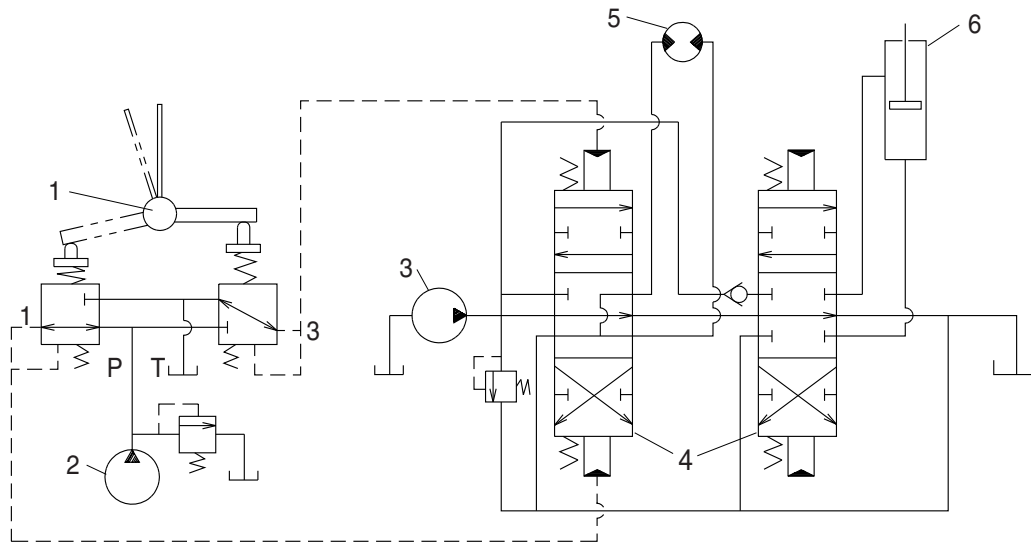
The spring (5) works on the case (1) and spring seat (4-4) and tries to return the push rod (6-2) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

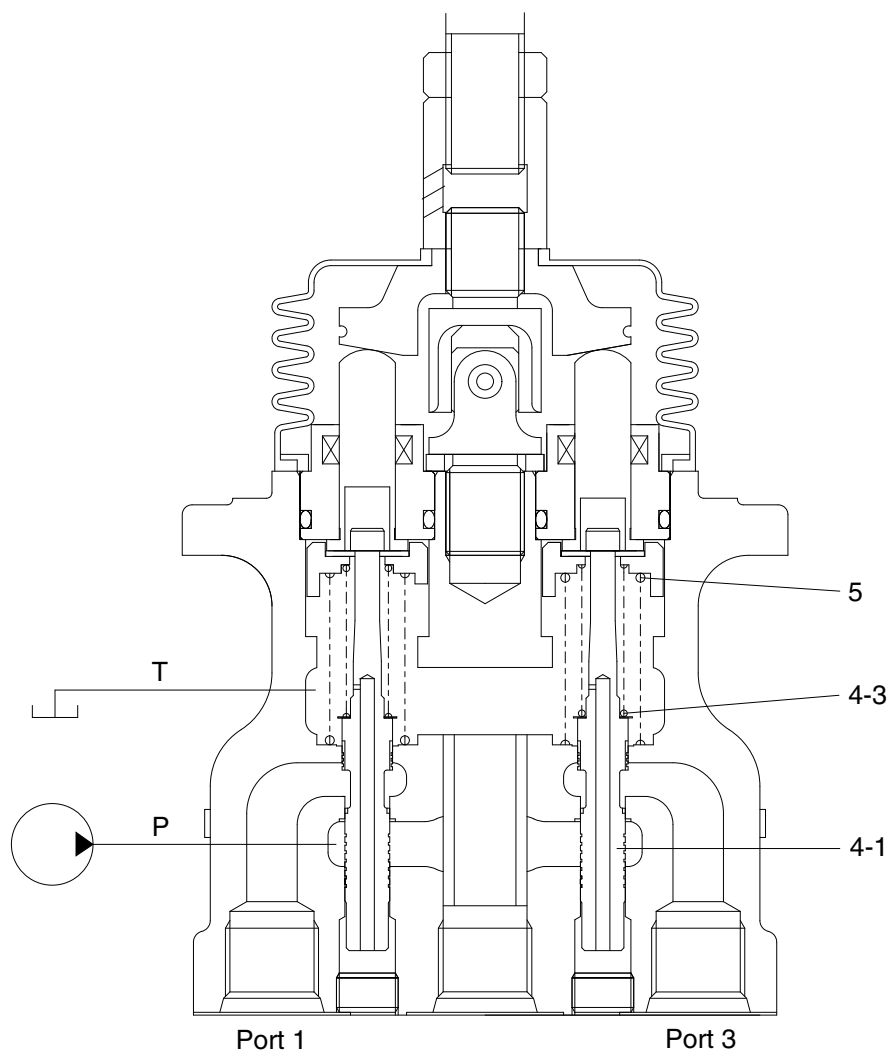
The diagram shown below is the typical application example of the pilot valve.



2-70

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

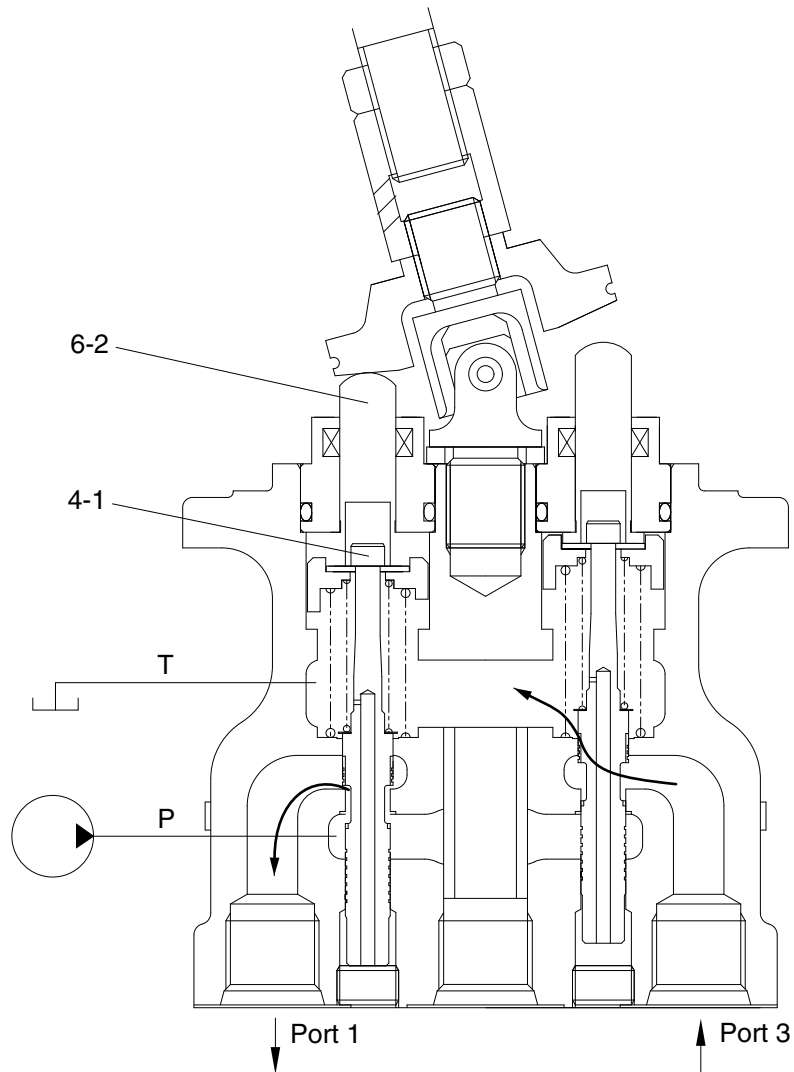
(1) Case where handle is in neutral position



140WAL2RL06

The force of the spring (4-3) that determines the output pressure of the pilot valve is not applied to the spool (4-1). Therefore, the spool is pushed up by the spring (5) 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



140WAL2RL07

When the push rod (6-2) is stroked, the spool (4-1) moves downwards.

Then port P is connected with port (1) and the oil supplied from the brake 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.

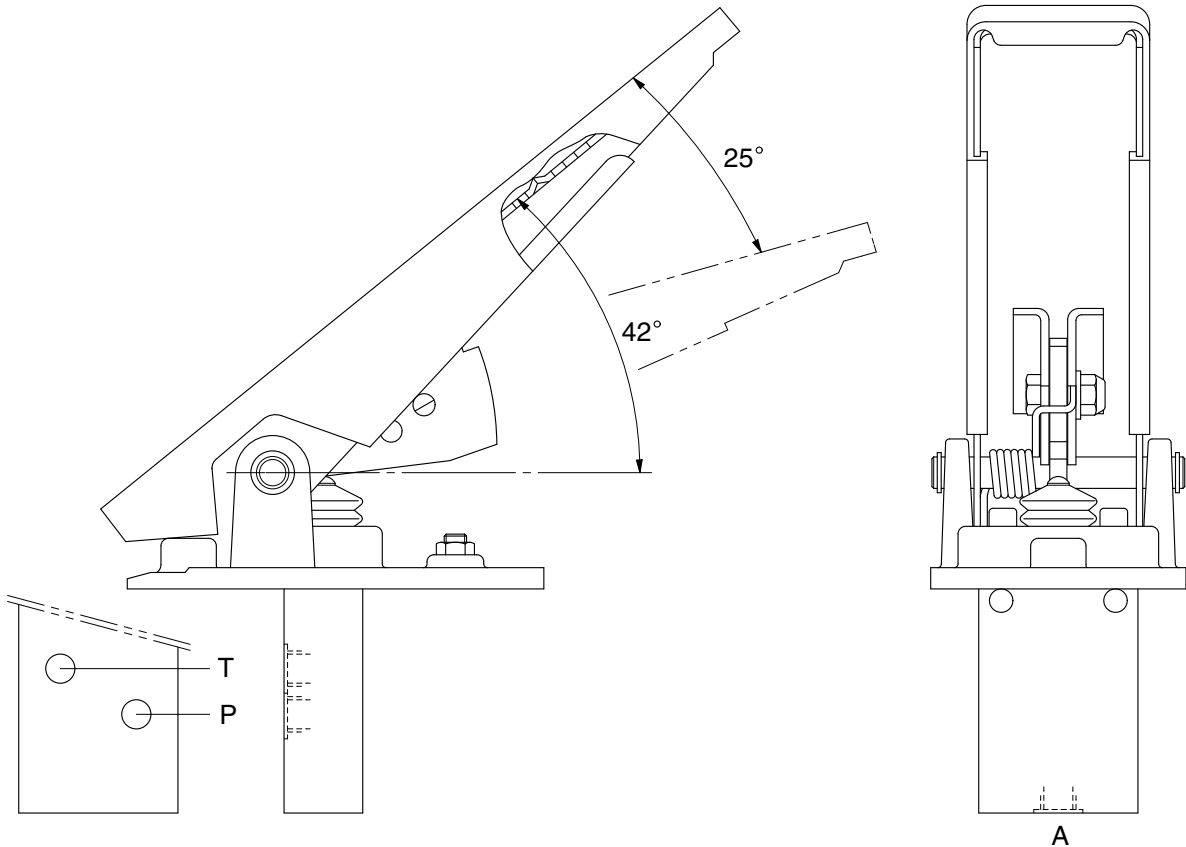
In this manner the secondary pressure is kept at the constant value.

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.

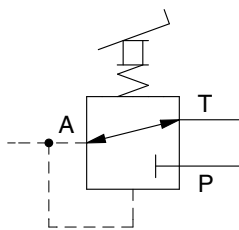
GROUP 6 ACCELERATOR PEDAL

1. STRUCTURE

The casing has the oil inlet port P (primary pressure), and the oil return port T (tank). In addition the secondary pressure is taken out through port A.



17032RP01



Hydraulic circuit

Port	Port name	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
A	Pilot oil output port	

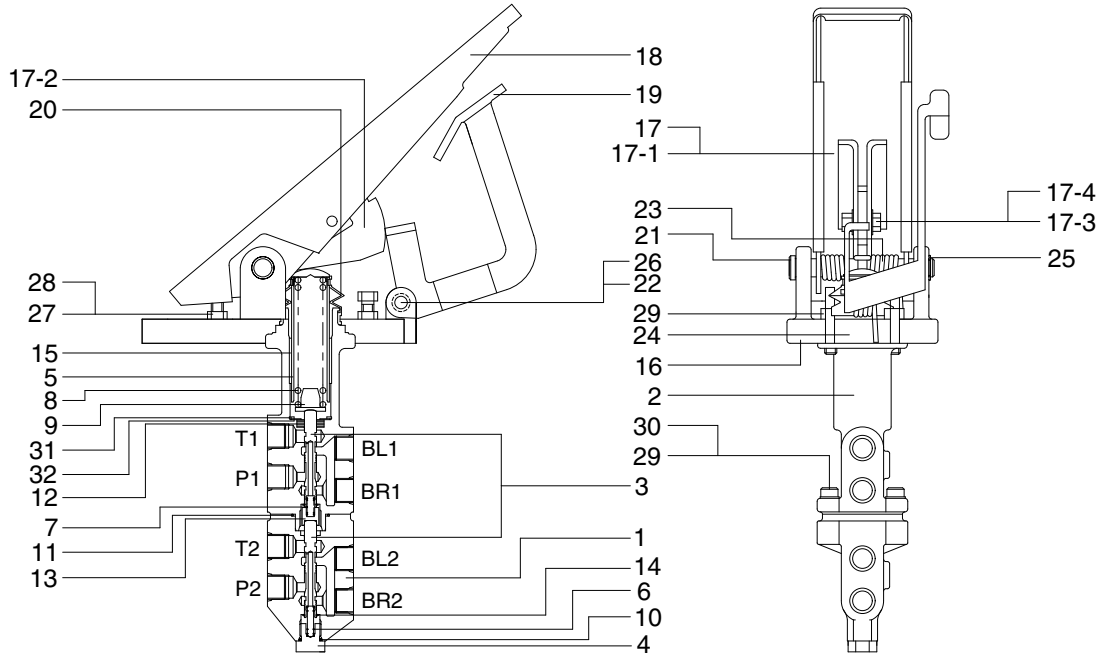
17032RP01(2)

GROUP 7 BRAKE DEVICE

■ BRAKE VALVE

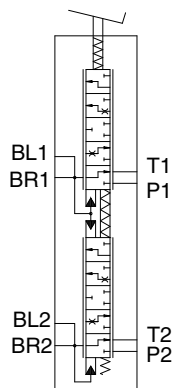
1. STRUCTURE

The body has the oil inlet port P1, P2 (primary pressure), and the oil outlet port T1, T2 (tank). In addition the secondary pressure is taken out through brake cylinder port BR1 (front axle) and BR2 (rear axle).



14W92BV01

- | | | |
|-------------------|-------------------|---------------------|
| 1 Lower body | 13 Spring guide | 21 Lock pin 1 |
| 2 Upper body | 14 Snap ring | 22 Lock pin 2 |
| 3 Spool | 15 DU bushing | 23 Torsion spring 1 |
| 4 Plug | 16 Pedal plate | 24 Torsion spring 2 |
| 5 Holder | 17 Pedal assy | 25 Retainer ring |
| 6 Lower spring | 17-1 Pedal | 26 E-ring |
| 7 Upper spring | 17-2 Lock plate | 27 Hex bolt |
| 8 Main spring | 17-3 Hex bolt | 28 Hex nut |
| 9 Spring retainer | 17-4 Plain washer | 29 Socket head bolt |
| 10 O-ring | 18 Pedal cover | 30 Spring washer |
| 11 O-ring | 19 Latch | 31 Plate washer |
| 12 Oil seal | 20 Rubber cover | 32 Retainer ring |



14W72BV02

Port	Port name	Port size
P1	Port	PF 3/8
P2	Port	
BR1	Brake cylinder port	
BR2	Brake cylinder port	
BL1	Plugging	
BL2	Plugging	
T1	Drain port	
T2	Drain port	

2. FUNCTION

1) PURPOSE

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

2) READY POSITION

When the braking system is ready for operation, its accumulator pressure acts directly on port P1/P2 of the brake valve. A connection is established between ports BR1/BR2 and port T1/T2 so that the wheel brakes ports BR1/BR2 are pressureless via the returns ports T1/T2.

3) PARTIAL BRAKING

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The main spring (8) beneath pedal plate (16) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool (3) is mechanically actuated via main spring (8), and the lower spool (3) is actuated hydraulically by spool (3). As spools (3) move downward, they will first close returns T1/T2 via the control edges, thus establishing a connection between accumulator port P1/P2 and ports BR1/BR2 for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools (3) are held in the control position by the force applied (spring assembly) above the spools and the hydraulic pressure below the spool (balance of forces).

After output of the braking pressure, spools (3) are in a partial braking position, causing ports P1/P2 and T1/T2 to close and holding the pressure in ports BR1/BR2.

4) FULL BRAKING POSITION

When pedal (17-1) is fully actuated, an end position of the brakes is reached and a connection established between accumulator ports P1/P2 and brake cylinder ports BR1/BR2. Returns T1/T2 are closed at this point.

When the braking process ended, a connection is once again established between brake cylinder ports BR1/BR2 and return ports T1/T2, closing accumulator ports P1/P2.

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

5) LIMITING THE BRAKING PRESSURE

Pedal restriction socket bolt (29) on pedal plate (16) below pedal assy (17) is used to limit the braking pressure.

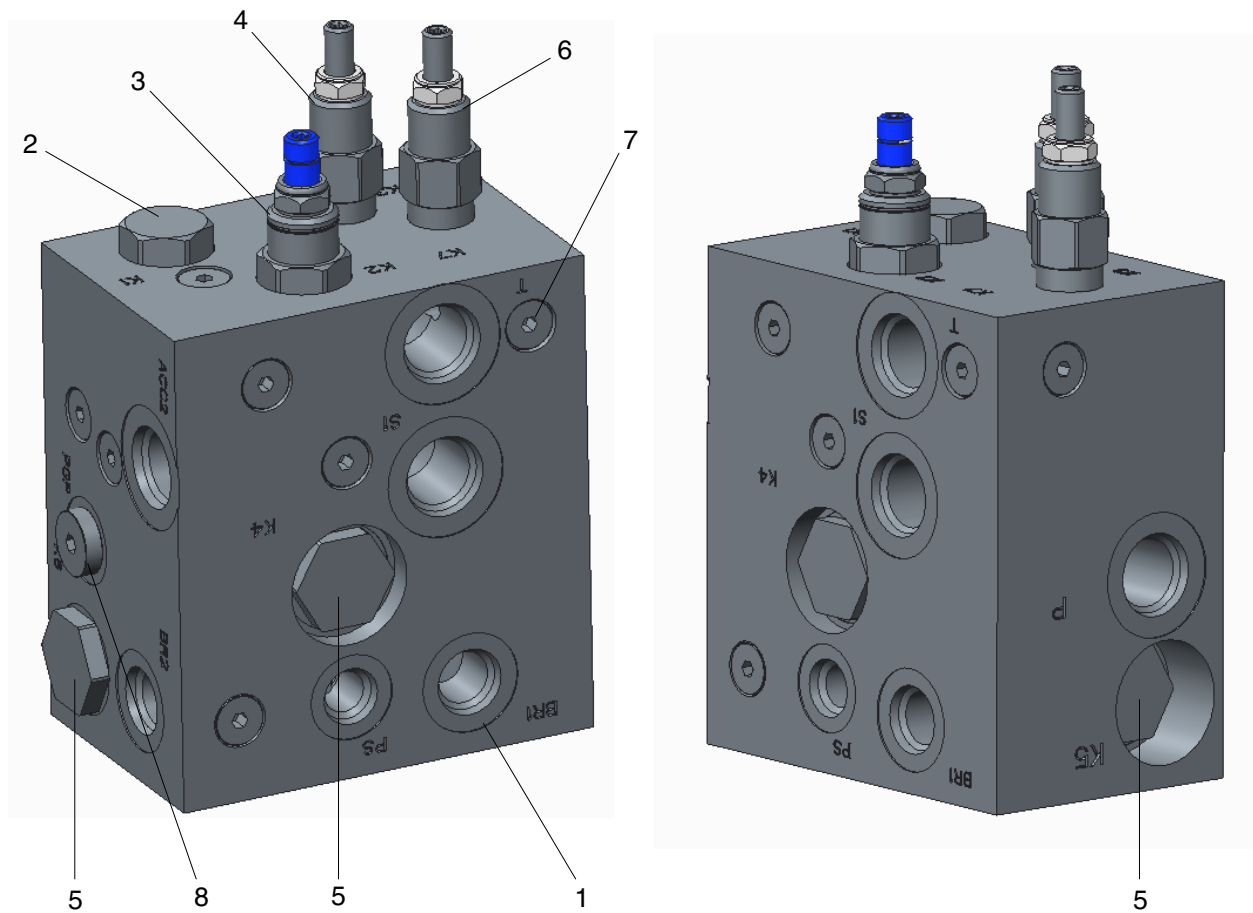
6) FAILURE OF A CIRCUIT

In the event of the lower circuit failing, the upper circuit will remain operational. Main spring (8) will mechanically actuate spool (3). In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool (3) is mechanically actuated by main spring (8) and spool (3).

■ BRAKE SUPPLY VALVE

1. STRUCTURE

The brake supply valve consists of the following parts.



140WA2BSV01

Item	Part name	Size	Qty	Remark
1	Manifold block	-	1	-
2	Logic valve	-	1	K1 port
3	Unloading valve	-	1	K2 port
4	Relief valve	-	1	K3 port
5	Check valve	-	3	K4, 5, 6 ports
6	Relief valve	-	1	K7 port
7	Plug	PF 1/8"	9	-
8	Plug	PF 1/4"	1	PGP port

2. FUNCTION

1) ASSEMBLY

This brake supply valve has the following functions.

- (1) Brake pump overload prevention function - energy saving function
- (2) Safety device function of brake braking system
- (3) Brake braking pressure supply function

2) FUNCTION FOR EACH VALVE

Symbol	Valve name	Description	Remark
K1	Logic valve	This valve is operated by remote control according to the set pressure value of the unloading valve (K2).	
K2	Unloading valve	This valve switches the operation of the pump to a no-load state by bypassing the pressure and flow rate discharged from the pump to the tank when a load occurs in the braking system.	Set pressure - Cut-in set value 112±5 kgf/cm ² - Cut-out set value 142±5 kgf/cm ²
K3	Relief valve	This valve functions to maintain the pressure of the flow flowing into the "S1" port at the set pressure.	Set pressure 8 l/min @ 32±2 kgf/cm ²
K4	Check valve	This valve prevents reverse flow against the pressure and flow rate formed in the braking system of the brake.	
K5, K6	Check valve	This valve prevents the loss of pressure and flow accumulated in the accumulators installed in the ACC1 and ACC2 ports. In other words, it prevents the back flow of pressure and flow accumulated in the accumulator.	
K7	Relief valve	This valve functions as a safety device to prevent breakage or damage to the system when overload or abnormal pressure occurs within the brake system.	Set pressure 30 l/min @ 173±2 kgf/cm ²

3) DETAIL FUNCTION AND USAGE

(1) Brake pump overload prevention function - energy saving

- ① The pressure and flow discharged from the brake pump are supplied to the brake device through the brake supply valve.
- ② When the engine rotation (rpm) of the machine increases, the rotation of the brake pump increases, increasing the discharge pressure and flow rate.
- ③ This increased pressure and flow rate causes loss of pump power source and fluid energy. This valve prevents energy loss by reducing power source and fluid energy loss.
- ④ When the braking system pressure of the brake exceeds the set pressure value of the unloading valve (K2), the pilot spool of the unloading valve is activated and the flow formed in the drain line of the logic valve (K1) is bypassed to the "T" line.
- ⑤ Therefore, when the flow rate of the drain line of the logic valve is bypassed, the spool of the logic valve is pushed and the pressure and flow rate discharged from the brake pump are bypassed to the tank, thereby converting the pump's operating state to a no-load state.
- ⑥ Also, when the brake system pressure falls below the set pressure value of the unloading valve, the pilot spool of the unloading valve is closed.
- ⑦ As the pilot spool of the unloading valve closes, a flow rate is formed in the drain line of the logic valve, and the spool of the logic valve also closes. When the spool of this logic valve is closed, the pressure and flow discharged from the pump are supplied to the brake braking device.
- ⑧ The discharge pressure and flow rate of the pump are called cut-out when bypassed to the tank, and cut-in when supplied to the brake device.
- ⑨ When this valve is shipped, the unloading valve setting value is as follows.

Unit : kgf/cm²

Flow rate	Reference value		Set value	
	Cut-in	Cut-off	Cut-in	Cut-off
30 l/min	112±5	142±5	112±5	142±5

(2) Safety device function of brake braking device

- ① If an overload occurs within the brake system due to an external force, an abnormal pressure rise may occur, which may cause damage or breakage to various brake systems.
- ② To prevent such machine problems, a relief valve (K7) is installed.
- ③ If the system pressure within the brake system exceeds the set pressure value of the relief valve, the relief valve operates to maintain the set pressure value of the relief valve.
- ④ In other words, the pressure above the set pressure value of the relief valve is returned to the tank to relieve the abnormal rise in pressure caused by overload within the system, thereby preventing damage and breakage of various devices within the system.
- ⑤ When this valve is shipped, the relief valve setting value is as follows.

Flow rate	Reference value	Set value	Remark
30 l/min	173±2 kgf/cm ²	173±2 kgf/cm ²	-

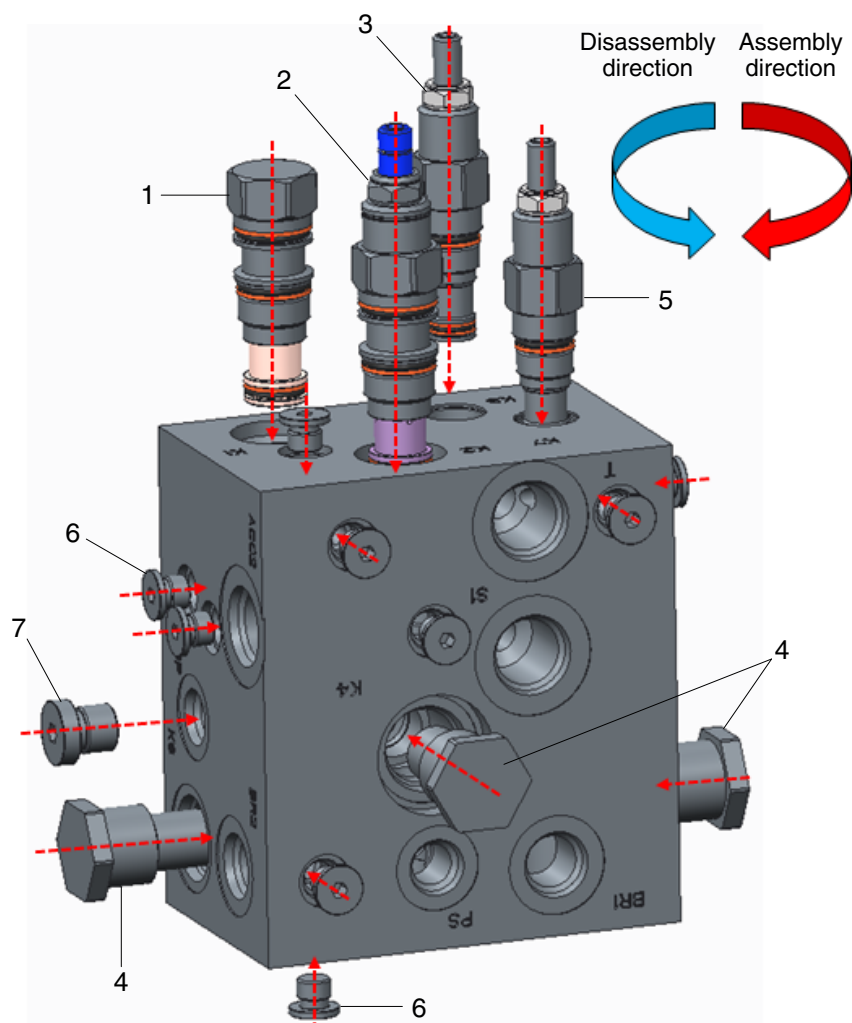
(3) Brake braking pressure supply function

- ① When the brake pedal is pressed, the pressure accumulated in the accumulator falls below the cut-in set pressure value of the unloading valve.
At this time, the pilot spool of the unloading valve is closed.
- ② As the pilot spool of the unloading valve closes, flow is formed in the drain line of the logic valve and the spool of the logic valve also closes.
- ③ When the spool of this logic valve is closed, the pressure and flow discharged from the pump are supplied to the accumulator and brake device.
- ④ Also, when the brake pressure is formed and exceeds the cut-out pressure value of the unloading valve, the logic valve and unloading valve operate to bypass the pressure and flow rate discharged from the pump to the tank, thereby maintaining the no-load start of the pump and prevents rise the pressure within the brake system.
- ⑤ Check valves (K5, K6) separate each brake circuit (front, rear) so that they do not affect the opposite brake and maintain each brake function.

3. ASSEMBLY DRAWING AND WORK TOOLS

See below for assembly, disassembly, and work tools for the brake supply valve.

※ The designated tools and tightening torque must be observed.



140WA2BSV02

No.	Part name	Screw spec	Torque (kg · cm)	Assembly tool
1	Logic valve	M20 × 1.5	480	Torque wrench/7/8" hex socket
2	Unloading valve	M20 × 1.5	480	Torque wrench/7/8" hex socket
3	Relief valve	M16 × 1.5	350	Torque wrench/3/4" hex socket
4 (3ea)	Check valve	UNF7/8-14"	400	Torque wrench/1" hex socket
5	Relief valve	M16 × 1.5	350	Torque wrench/3/4" hex socket
6 (9ea)	Plug	PF 1/8	100	Torque wrench/4 mm wrench socket
7	Plug	PF 1/4	300	Torque wrench/6 mm wrench socket

4. PRECAUTION WHEN DISASSEMBLING AND ASSEMBLING

- 1) Before assembling and disassembling, clean the surrounding area thoroughly to ensure there are no contaminants.
- 2) When disassembling and assembling parts, be sure to use the assembly torque and tools specified on the previous page.
- 3) Refer to the picture on the previous page for assembly and disassembly directions.
- 4) When reassembling after disassembly and inspection, be careful to prevent contaminants from entering the valve.
- 5) When disassembling and assembling all parts, be sure to wash them and then reassemble them.

5. INSPECTION ITEMS AND DETAILS FOR EACH PART WHEN AN ERROR OCCURS

Problem	Inspection item	Inspection detail and method	Repair
Brake pressure is not supplied	1. Check whether foreign substances and contaminants have entered the logic valve.	1. Disassemble the logic valve and check whether contaminants such as foreign matter or sludge have entered between the spool and body.	Removing foreign substances, cleaning, and assembling
	2. Check whether foreign substances and contaminants enter the relief valve.	2. Disassemble the relief valve and check whether contaminants such as foreign matter or sludge have entered between the poppet and body.	Removing foreign substances, cleaning, and assembling
	3. Check the discharge amount and discharge pressure of the brake pump	3. Install a pressure gauge on the "PGP" port to check the pressure value discharged from the brake pump. - Check at engine low speed - Check with the unloading valve fully closed. - Reference set value; $173 \pm 2 \text{ kgf/cm}^2$	Repair or replacement
Brake warning lamp comes ON	1. Check the unloading valve cut-in pressure value	1. Check the cut-in pressure value of the unloading valve (K2) - Install a pressure gauge on the "PGP" port to measure the pressure value at cut-in. - Reference set value; $112 \pm 5 \text{ kgf/cm}^2$	Readjust pressure value
	2. Check pressure switch operation	2. If the pressure measurement value in item 1 above is normal but the brake warning lamp continues to come on, check the contact status of the pressure switch.	Repair or replacement
	3. Check the degree of contamination of the brake filter element.	3. Check the element screen in the brake filter for contamination by foreign substances.	Cleaning or replacement
	4. Check whether foreign substances and contaminants are entering the logic valve and relief valve.	4. Refer to paragraphs 1 and 2 of "Brake pressure is not supplied" above.	Removing foreign substances, cleaning, and assembling

Problem	Inspection item	Inspection detail and method	Repair
The cycle of cut-in and cut-out is fast	1. Check whether the O-ring and back-up ring installed on each check valve are damaged.	1. After disassembling each check valve (K4, K5, K6), check whether the O-ring and back-up ring are damaged.	Replace check valve
	2. Check foot brake valve leakage	2. Remove the hydraulic hose installed at the outlet port (BR1, BR2) of the foot brake valve and check the amount of oil leakage. - Check without pressing the brake pedal- Neutral state - Reference set value; Refer to foot brake valve leakage management standards	Replace foot brake valve

6. CHECK BRAKE PRESSURE IN CASE OF ABNORMALITY

1) INSTALLATION OF PRESSURE GAUAGE

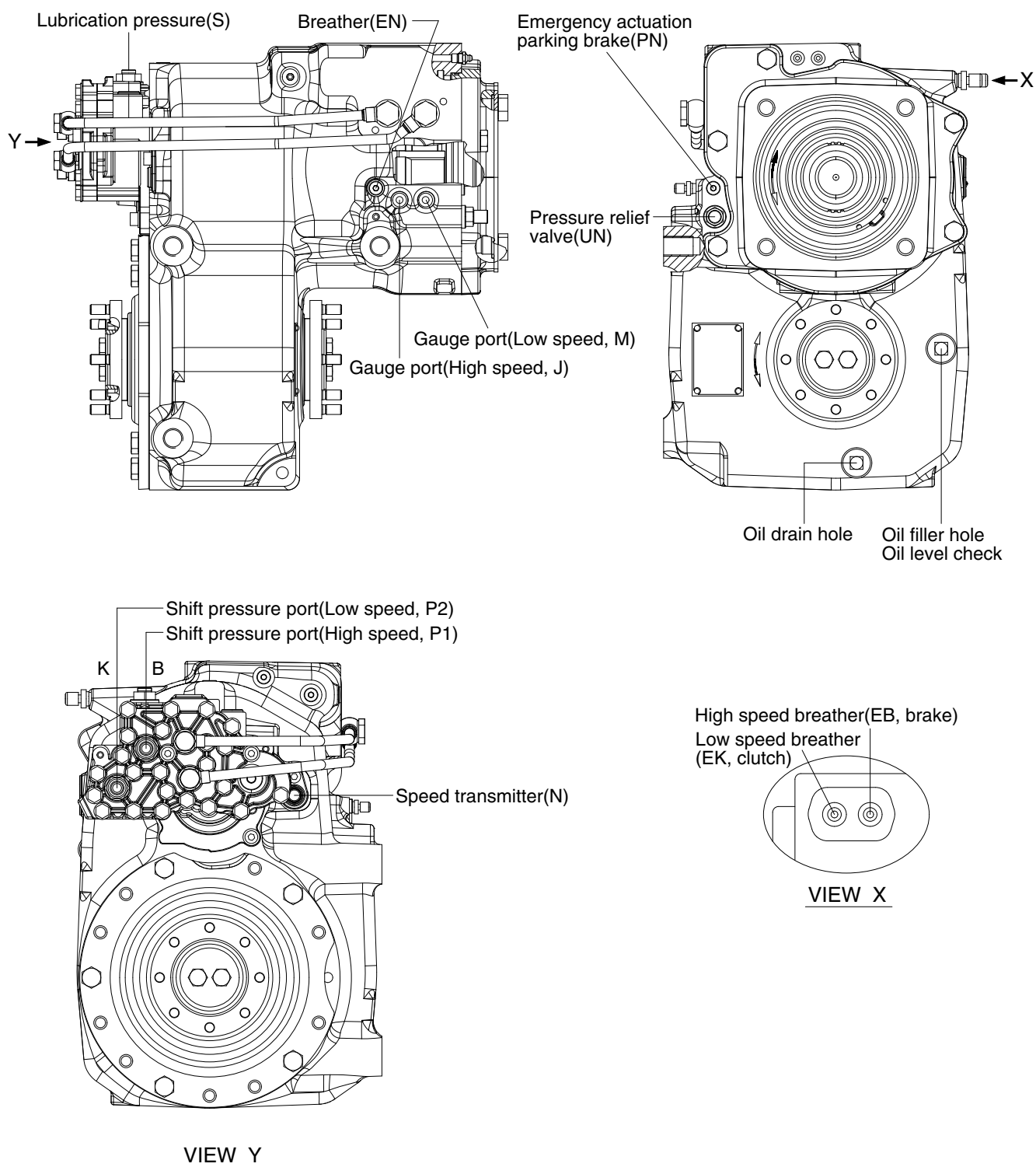
Pressure gauge installation port	Screw	Remark
PGP	PF1/4" O-ring boss	-

2) CHECK PRESSURE VALUE DURING INSPECTION

Pressure value confirmation port	Unloading valve operating status	
	Cut-in	Cut-off
PGP	112±5 kgf/cm ²	142±5 kgf/cm ²

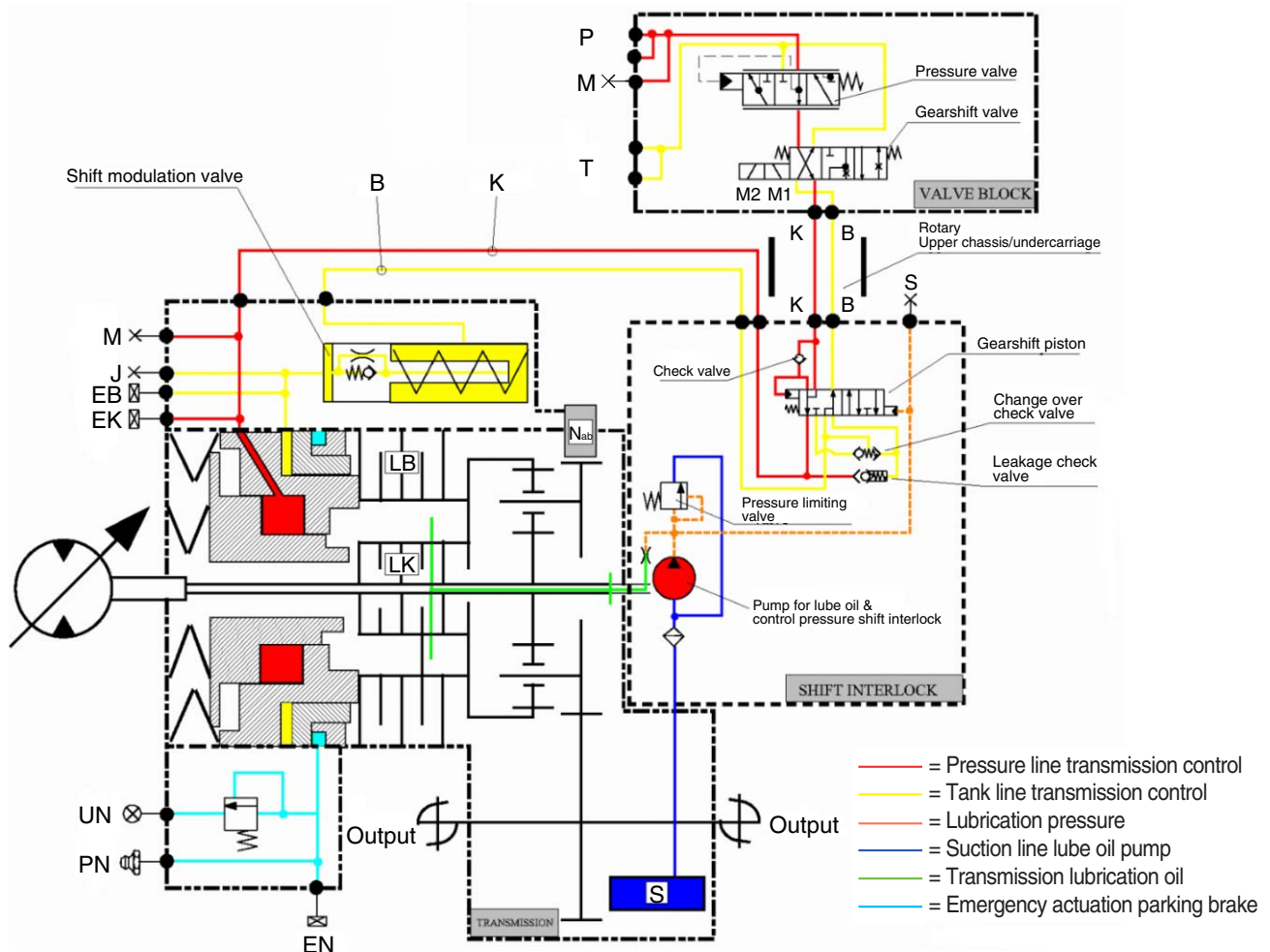
GROUP 8 TRANSMISSION

1. STRUCTURE



180W9A2TM01

2. TRANSMISSION DIAGRAM



14W7A2TM02

Measuring points-Transmission/Shift interlock :

J : High speed (brake)

M : Low speed (clutch)

S : Lubrication pressure

Connections-Transmission/Shift interlock :

B : Brake

K : Clutch

PN : Emergency actuation parking brake

Measuring points-Valve block :

M : System pressure transmission control

Connections-Valve block :

P : System pressure transmission control

T : Tank

B : Brake

K : Clutch

Solenoid valves-valve block :

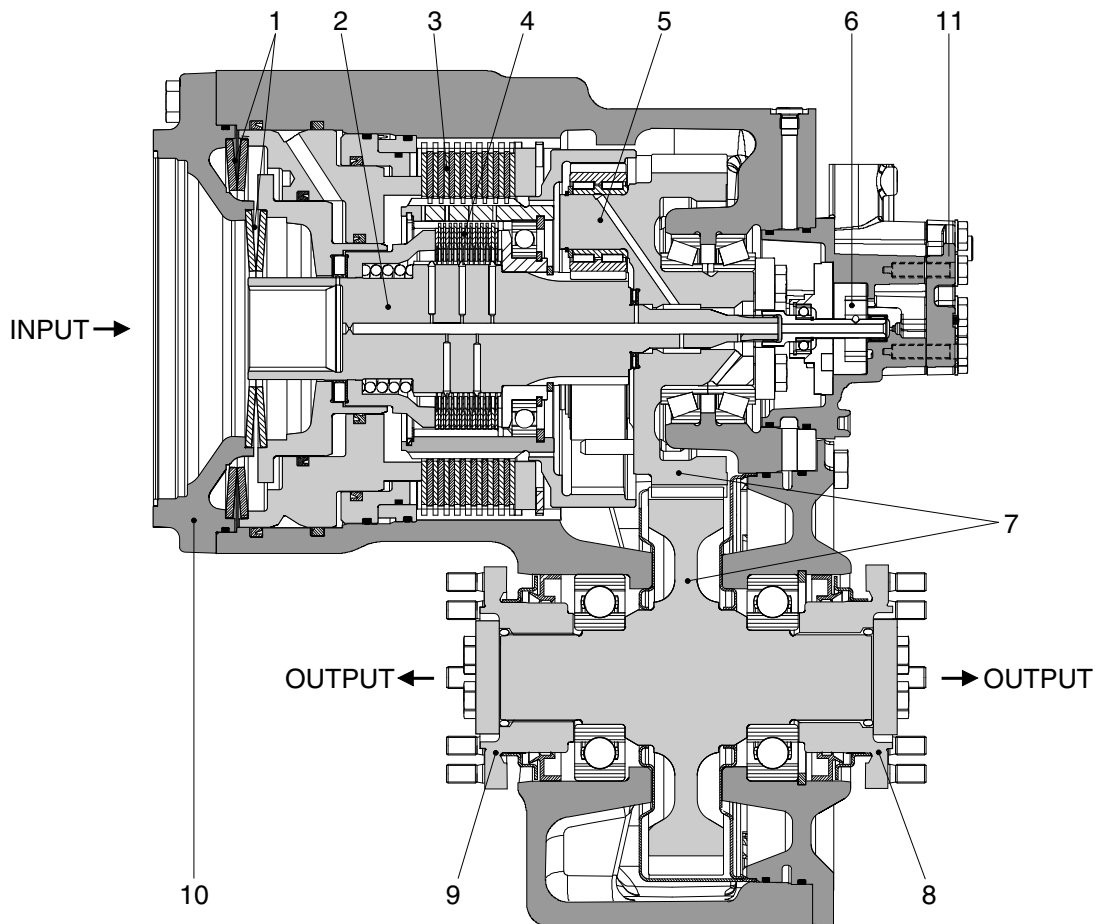
M1 : Solenoid valve (low speed)

M2 : Solenoid valve (high speed)

Port	Name	Size	Port	Name	Size
P1 (B)	Shift pressure, High speed	M16×1.5	M	Gauge port, Low speed	M10×1.0
P2 (K)	Shift pressure, Low speed	M16×1.5	S	Lubrication pressure port	M10×1.0
J	Gauge port, High speed	M10×1.0	PN	Parking brake lubricant	Grease nipple

3. OPERATION OF TRANSMISSION

1) DESCRIPTION



14W7A2TM03

- | | | | | | |
|---|-------------|---|-------------------------|----|--------------------------|
| 1 | Cup spring | 5 | Planetary drive | 9 | Output flange-front axle |
| 2 | Input shaft | 6 | Lub oil pump | 10 | Travel motor attachment |
| 3 | Disk brake | 7 | Spur gear drive | 11 | Shift interlock |
| 4 | Disk clutch | 8 | Output flange-rear axle | | |

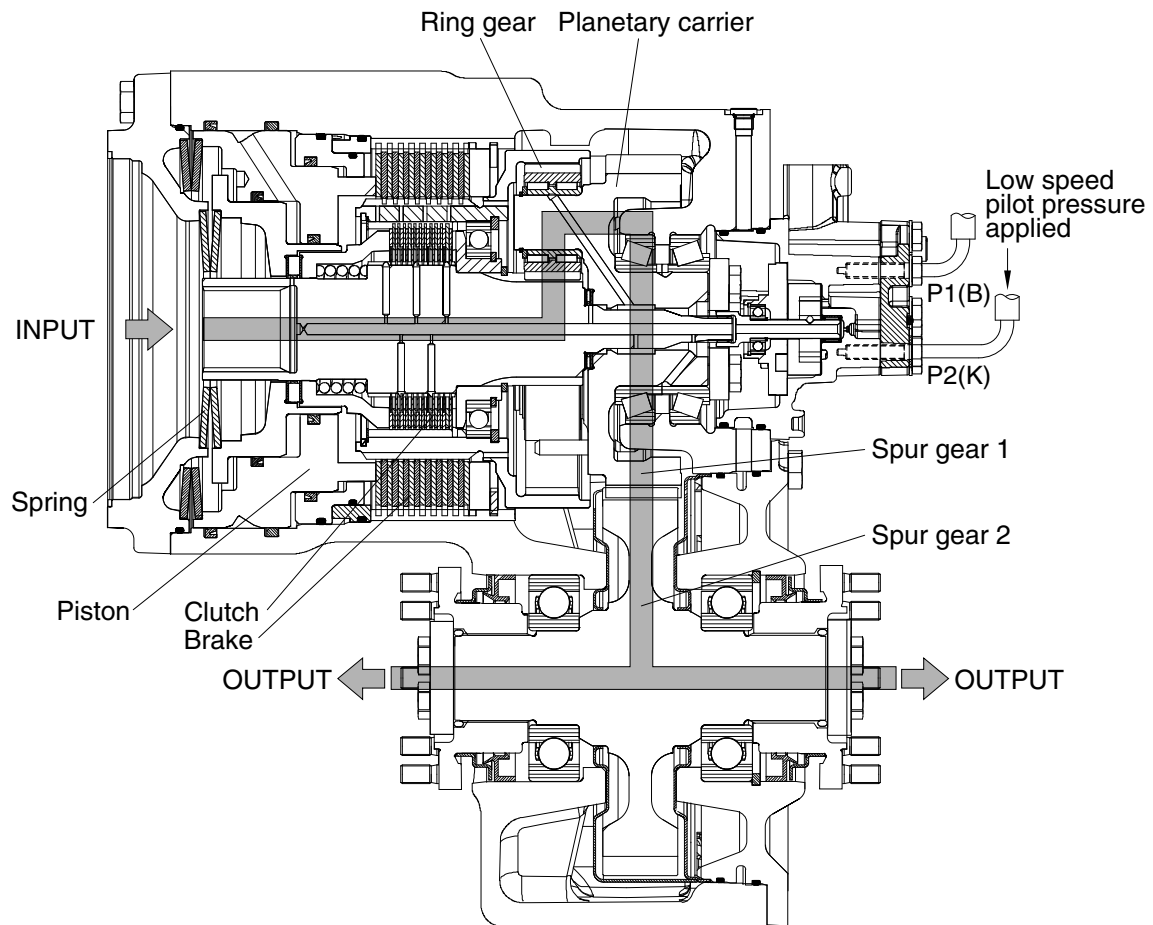
Coaxially-mounted variable displacement travel motor (10) with specific displacement 107 cm³/rev.

The 2-speed powershift transmission comprises a planetary drive (5), a 2 shaft spur gear drive (7) with output flanges to front and rear axle.

The powershift mechanism for the planet drive comprises a rotating multi-disk clutch (4) underneath a multi-disk brake (3) rigidly connected to the housing. Both are closed by spring pressure (2) and released hydraulically.

The shift interlock (11) prevents downshifts at high machine speeds and thus prevents over-rotation of the travel motor. If the low speed gear is selected while the high speed gear is engaged and input speed is above approx. 1000 rpm, the low speed gear shift is inhibited and only performed if input speed is below this limit. With higher viscosity oil (cold starting), the downshift is performed at a lower input speed. Upshifts are always possible. The speed-dependent interlock is effective in both directions. It does not prevent the possibility of over-rotation when the machine is coasting. For this, a drive brake valve should be fitted to the travel motor.

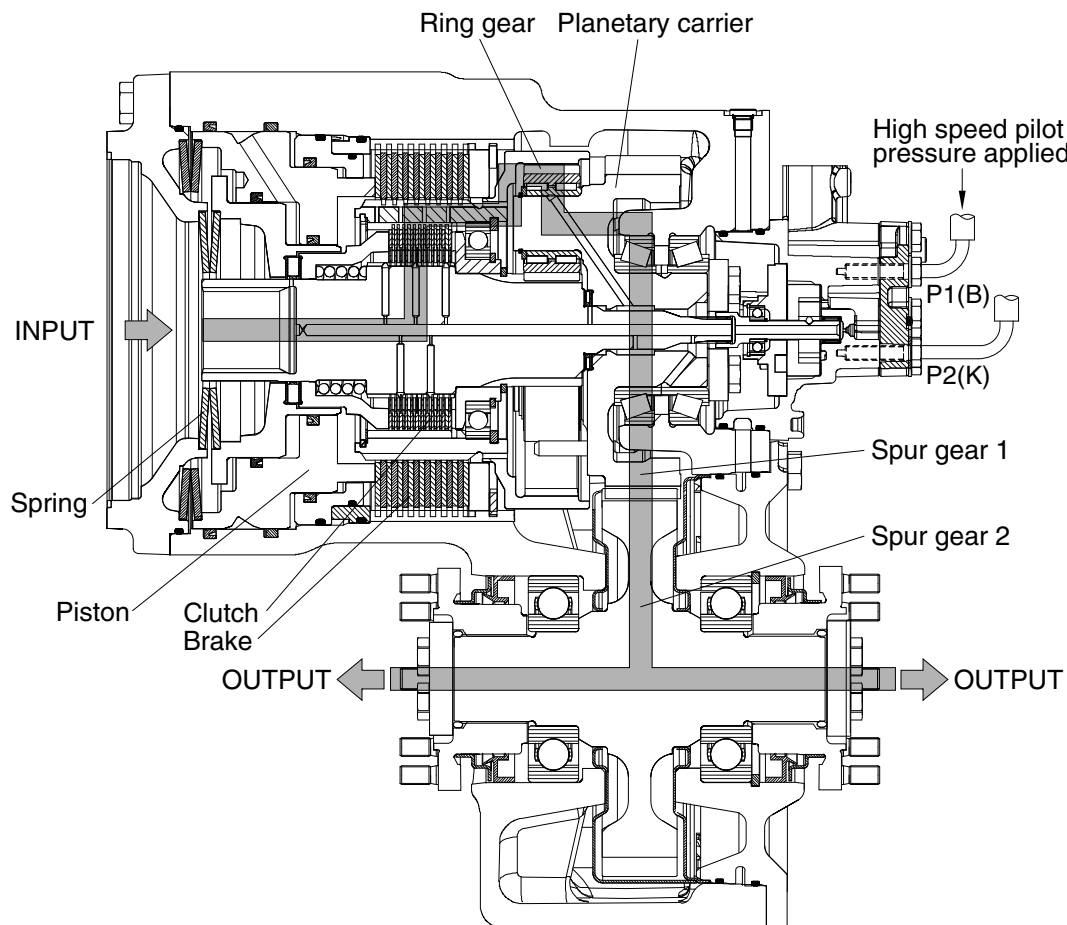
2) LOW SPEED (forward & reverse)



14W7A2TM04

In low speed operation, the internal gear of the planetary drive is backing upon the closed, case-rigid brake. In this speed the piston chamber of the brake is unpressurized, so that the elastic force and additionally the hydraulic pressure of the clutch piston is acting upon the disk pack. At this time the clutch is open, i.e. the hydraulic released.

3) HIGH SPEED (forward & reverse)



14W7A2TM05

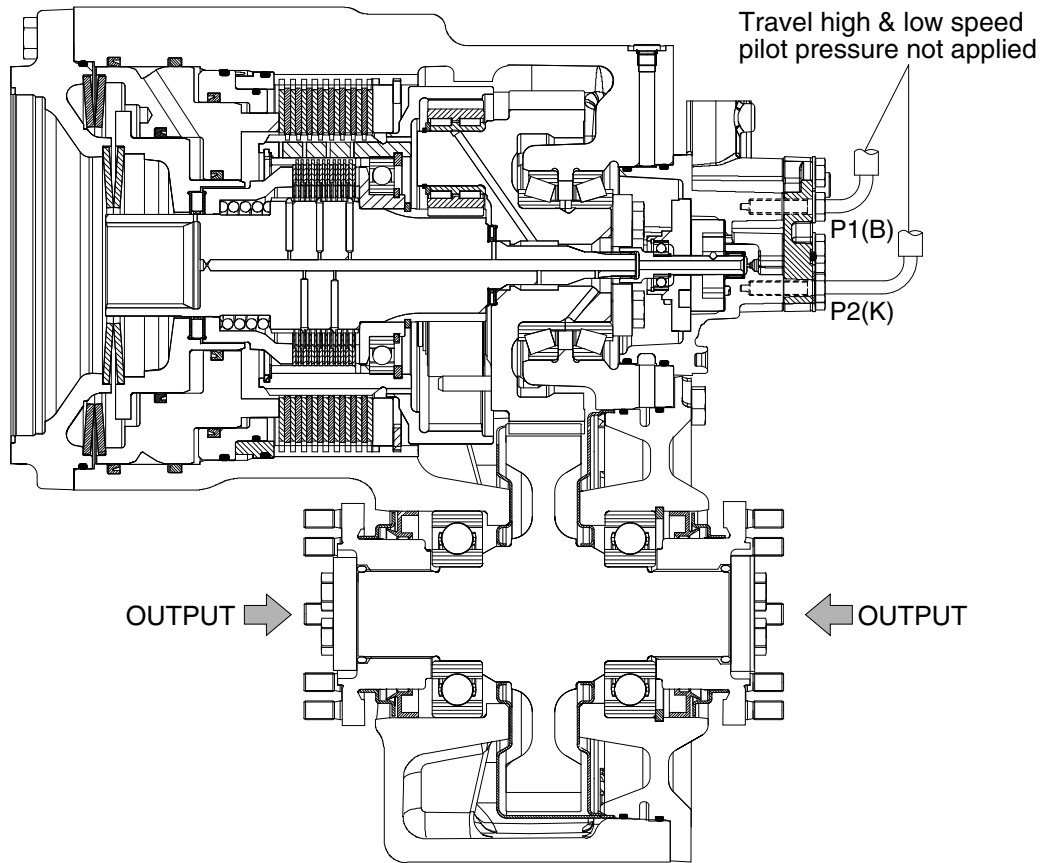
In high speed operation, the clutch is held closed under spring pressure and the brake is hydraulically opened.

When a gear shift occurs-for example from high speed to low speed gear- the oil from the brake piston space is fed back to the tank through a restrictor (change over check valve) due to the spring pressure acting on the brake piston. At the same time the clutch is filled with oil and opened. Required oil flow is necessary for the transmission control to ensure the clutch is open before the brake begins to transmit torque.

A shift modulation valve is also integrated in the transmission. This modulates the pressure sequence at the brake during an upshift in order to achieve good shift quality.

The gear shift equipment also has the function of a parking brake. When the brake is operated-for example with high speed gear engaged-the clutch is closed and is statically loaded.

4) BRAKES



14W7A2TM06

When the travel high/low speed pilot pressure is not applied in the piston space, the piston compress against the multi disk pack due to the spring force. Thus the parking brake is engaged.

4. TECHNICAL DATA

1) GENERAL DATA

- (1) Max input power : 110 kW
- (2) Max input torque : 78.5 kgf · m
- (3) Max output speed : 3500 rpm
- (4) Hydraulic motor : 140 cm³/rev
- (5) Transmission ratio
 - Gear step : 4.06
 - Low speed gear : 4.87
 - High speed gear : 1.20
- (6) Shift interlock
 - Downshift possible at operating temperature with input speed 1000 rpm (downshift point lower when oil temperature cold).
- (7) Disconnection device
 - For towing away machine auxiliary release device for parking brake.
- (8) Brake
 - Parking brake. Necessary brake deceleration by controlled locking of planetary drive. Braking torque depends on opening pressure set at brake valve (13 bar).
- (9) Output flange
 - Bolts for propshaft connection : M10×1.0 (class 10.9)
- (10) Transmission weight : 135 kg (300 lb)

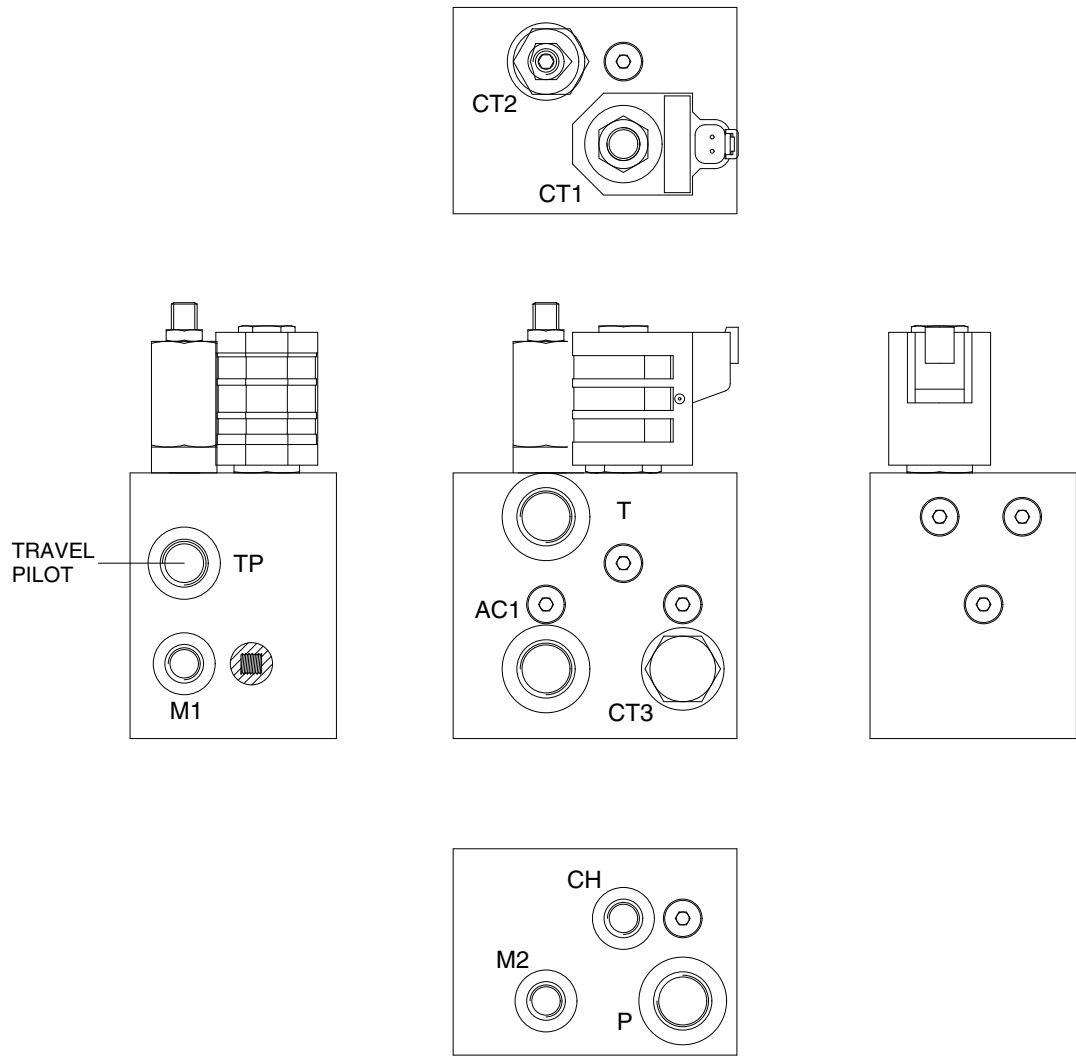
2) TRANSMISSION CONTROL

Following data are valid for oil temperature 30°C to 40°C in hydraulic tank, measured at connections at powershift transmission (see structure and diagram).

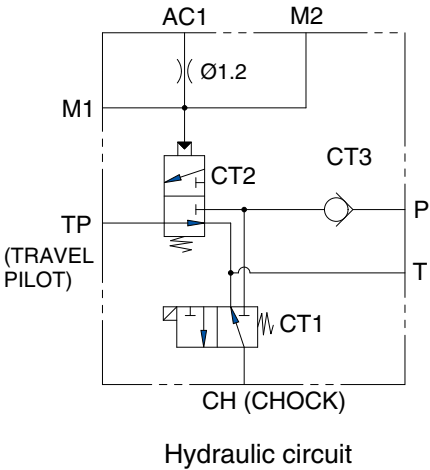
- (1) Control pressure
 - ① At connection P1 and P2 at Low/High engine speed : 33+2 kgf/cm²
 - ② Definition of lubricants : API CF-4, SAE 10W-30
- (2) Oil flow
 - ① Min oil flow at 24+1 kgf/cm² counter pressure (low engine speed) : 5.5 ℓ /min
 - ② Max oil flow : 25 ℓ /min
- (3) Residual pressure
 - ① Max residual pressure in control line to tank connection P1 and P2 : 1.0 kgf/cm²
- (4) Leakage oil transmission control
 - ① Pressure in input housing connection (E) max : 1.0 kgf/cm²
 - ② Max oil flow (low speed actuated) : 1 ℓ /min

GROUP 9 TRAVEL CONTROL VALVE

1. STRUCTURE

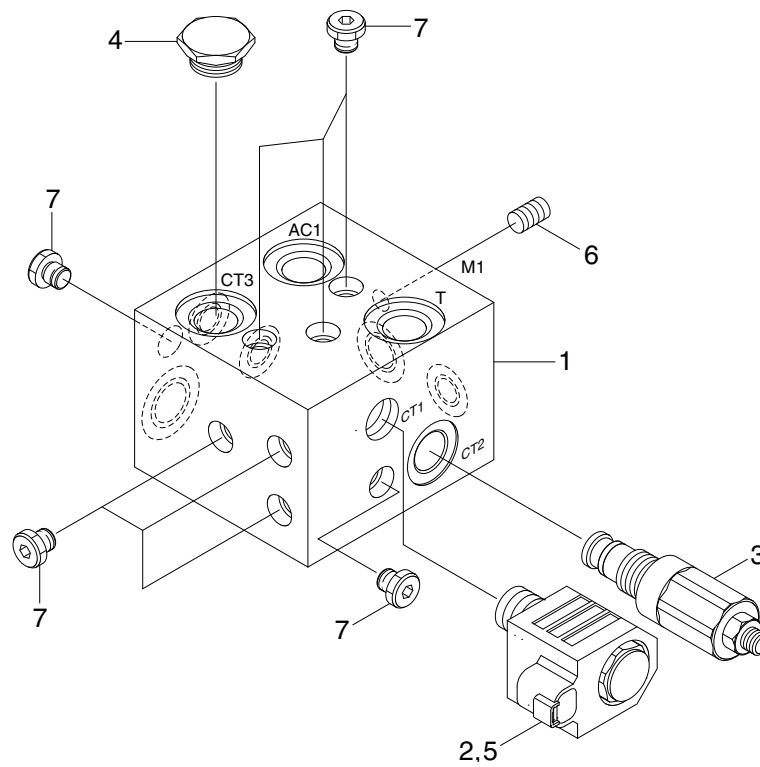


14W7A2TCV02



Port name	Port size
P, T, AC1	PF 1/2
TP	PF 3/8
M1, M2, CH	PF 1/4

2. COMPONENT



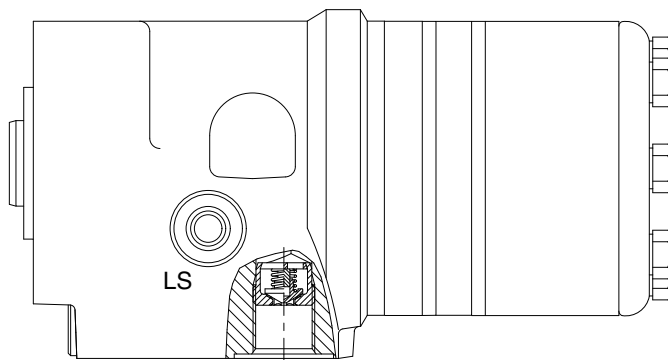
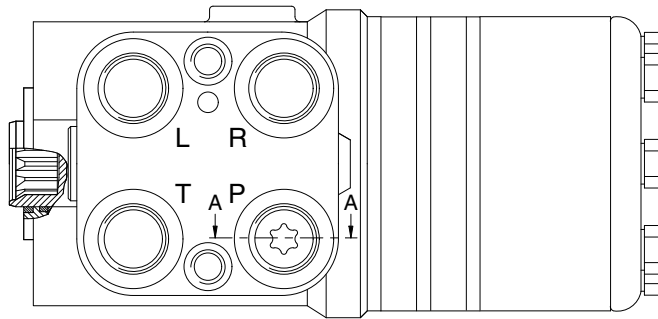
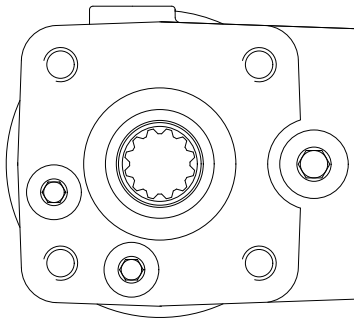
14W7A2TCV01

- | | | | |
|---|----------------|---|---------|
| 1 | Body | 5 | Coil |
| 2 | Solenoid valve | 6 | Orifice |
| 3 | POD valve | 7 | Plug |
| 4 | Check valve | | |

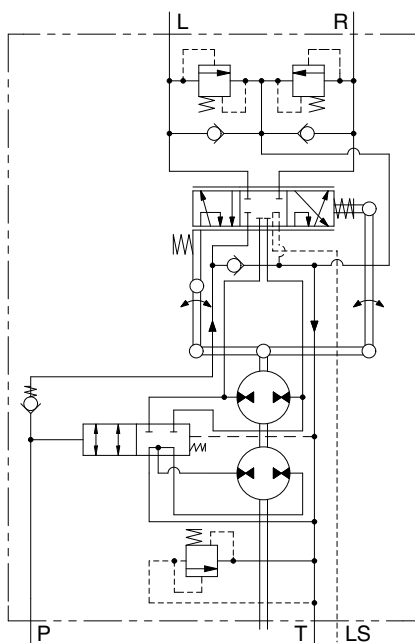
GROUP 10 STEERING VALVE

1. STRUCTURE

1) TYPE 1 (without joystick)



SECTION A-A

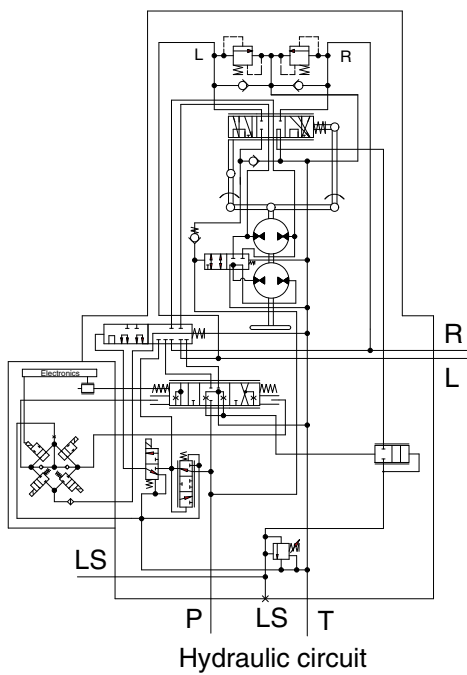
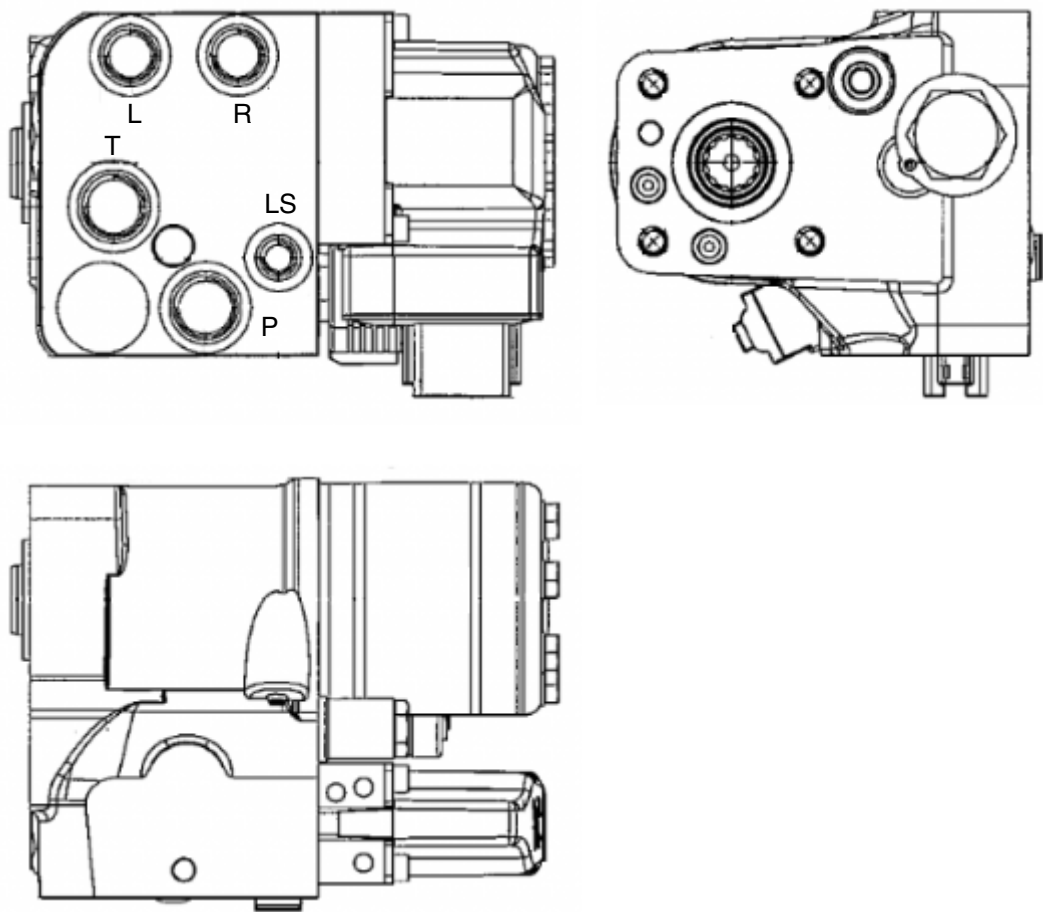


Hydraulic circuit

Port	Port name	Port size
L	Left port	3/4-16UNF
R	Right port	
T	Tank port	
P	Pump port	7/16-20UNF
LS	Load sensing port	

31U6-30020-E

2) TYPE 2 (joystick steering)

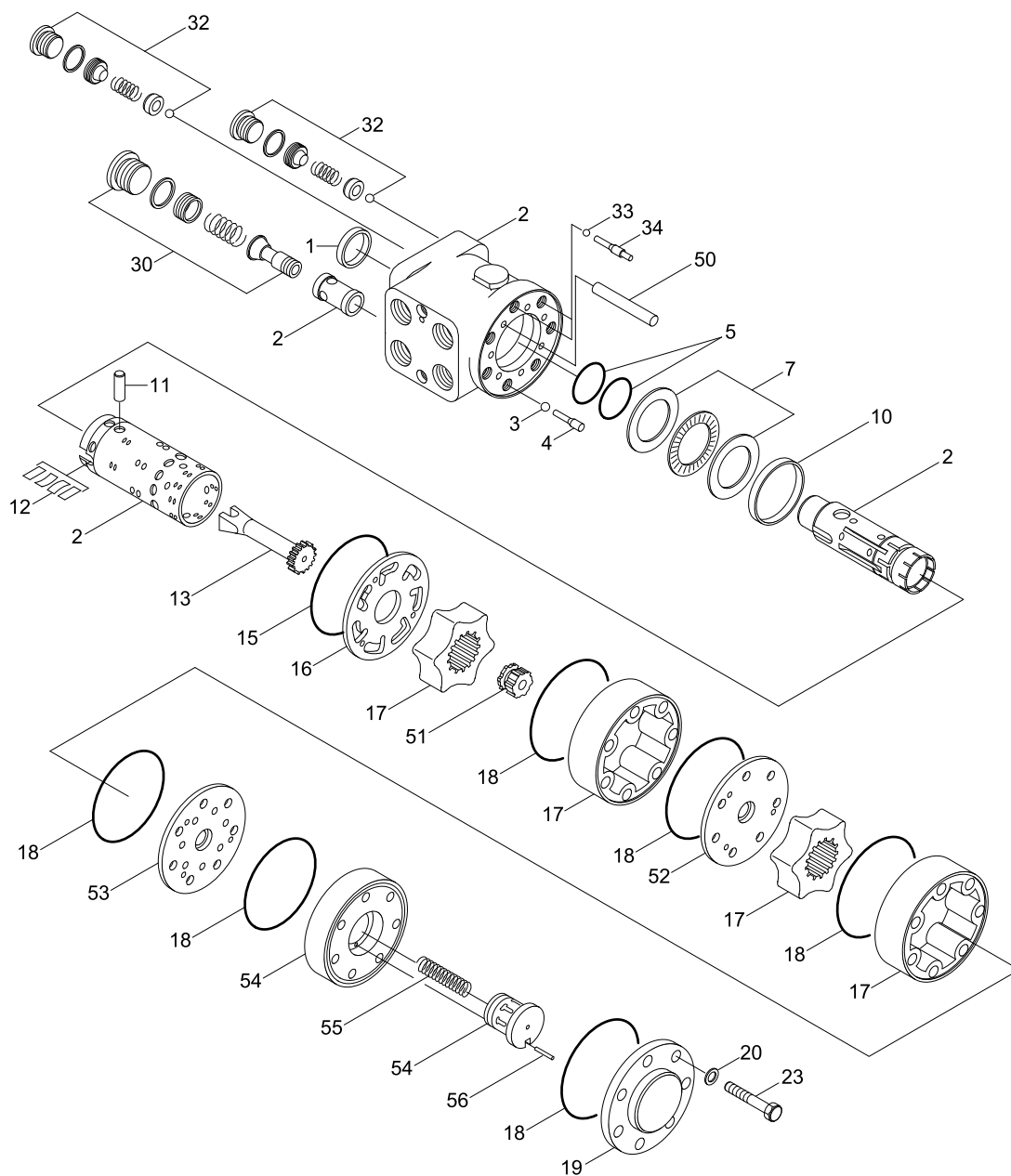


Port	Port name	Port size
L	Left port	M18x1.5
R	Right port	M18x1.5
T	Tank port	M22x1.5
P	Pump port	M22x1.5
LS	Load sensing port	M12x1.5

81K5-00030-E

2. COMPONENTS

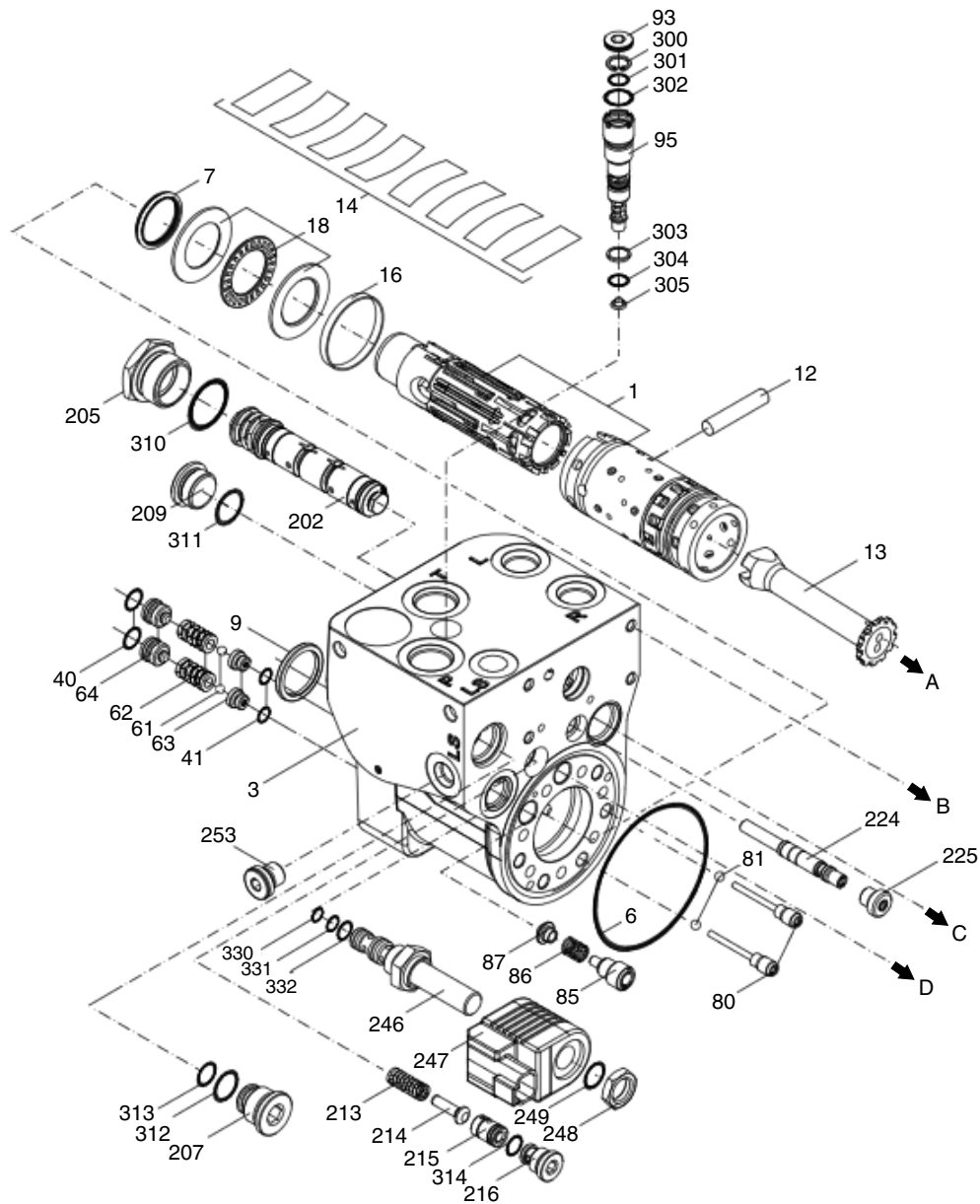
1) TYPE 1 (without joystick)



31U6-30020-P

1	Dust seal	13	Shaft	31	Relief valve assy
2	Housing, spool, sleeve	16	Distributor plate	32	Shock valve
3	Ball	17	Gear wheel set	33	Ball
4	Ball	18	O-ring	34	Bushing
5	O-ring	19	End cover	50	Mounting pin
7	Bearing assy	20	Washer	51	Cardan shaft
10	Ring	23	Screw	54	Valve and housing
11	Cross pin	24	name plate		
12	Spring set	30	Relief valve assy		

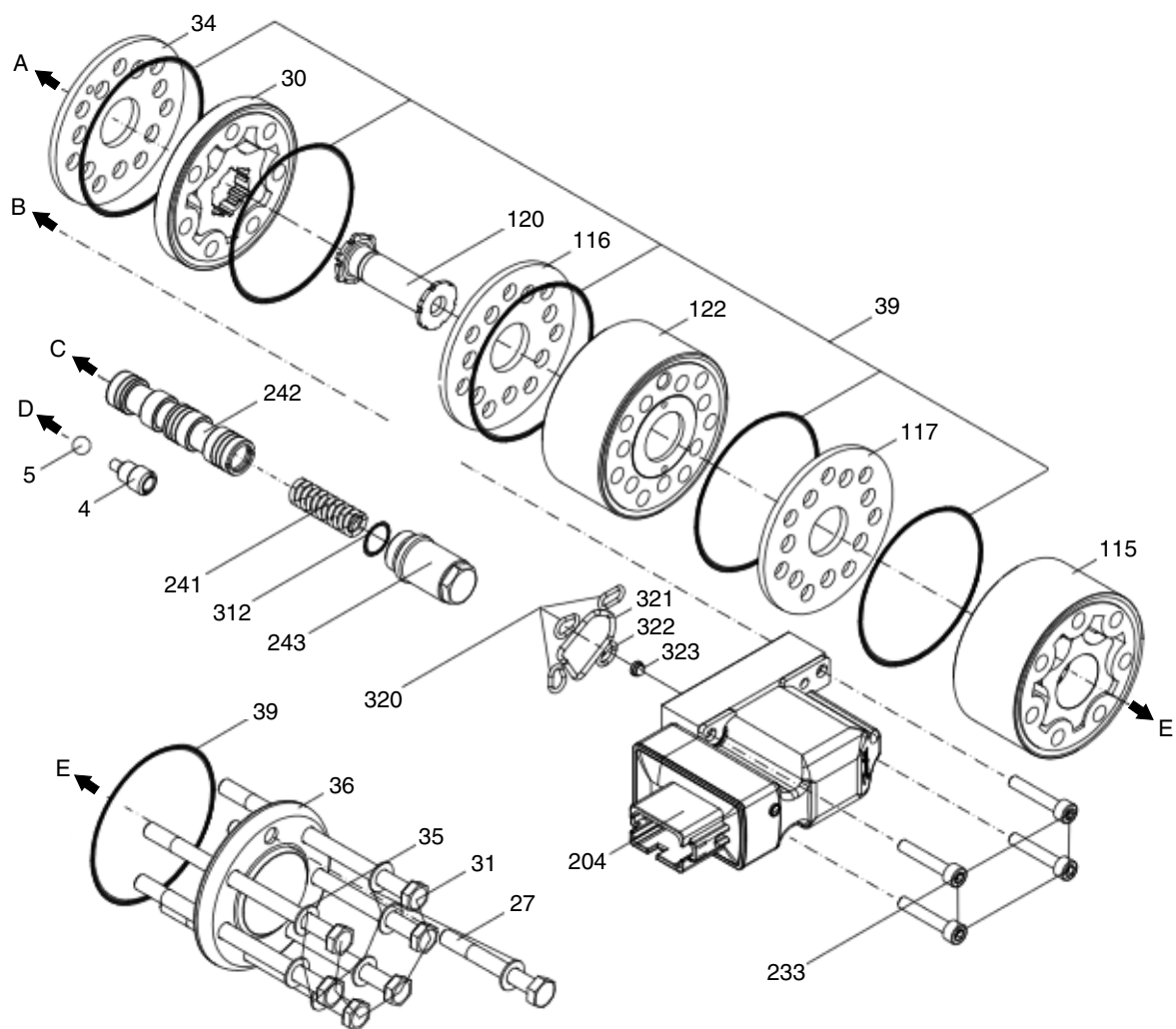
2) TYPE 2 (joystick steering, 1/2)



81K5-00030-P1

1	Spool/sleeve set	81	Ball	247	Coil
3	Housing	85	Screw	248	Nut
6	O-ring	86	Spring	249	O-ring
7	Shaft seal	87	Valve cone	253	Plug
9	Dust seal ring	93	Plug	300	Lock ring
12	Cross pin	95	Port relief valve cartridge	301	O-ring
13	Shaft	202	Spool	302	O-ring
14	Spring set	205	Plug	303	Backup ring
16	Ring	207	Plug	305	Filter
18	Bearing	209	Plug	310	O-ring
40	O-ring	213	Spring	311	O-ring
41	O-ring	214	Cone pilot supply	312	O-ring
61	Ball	215	Spool pilot supply	313	O-ring
62	Spring	216	Plug	314	O-ring
63	Valve seat	224	Spool	330	O-ring
64	Adjust screw	225	Plug	331	O-ring
80	Pin	246	Spool	332	O-ring

TYPE 2 (joystick steering, 2/2)



81K5-00030-P2

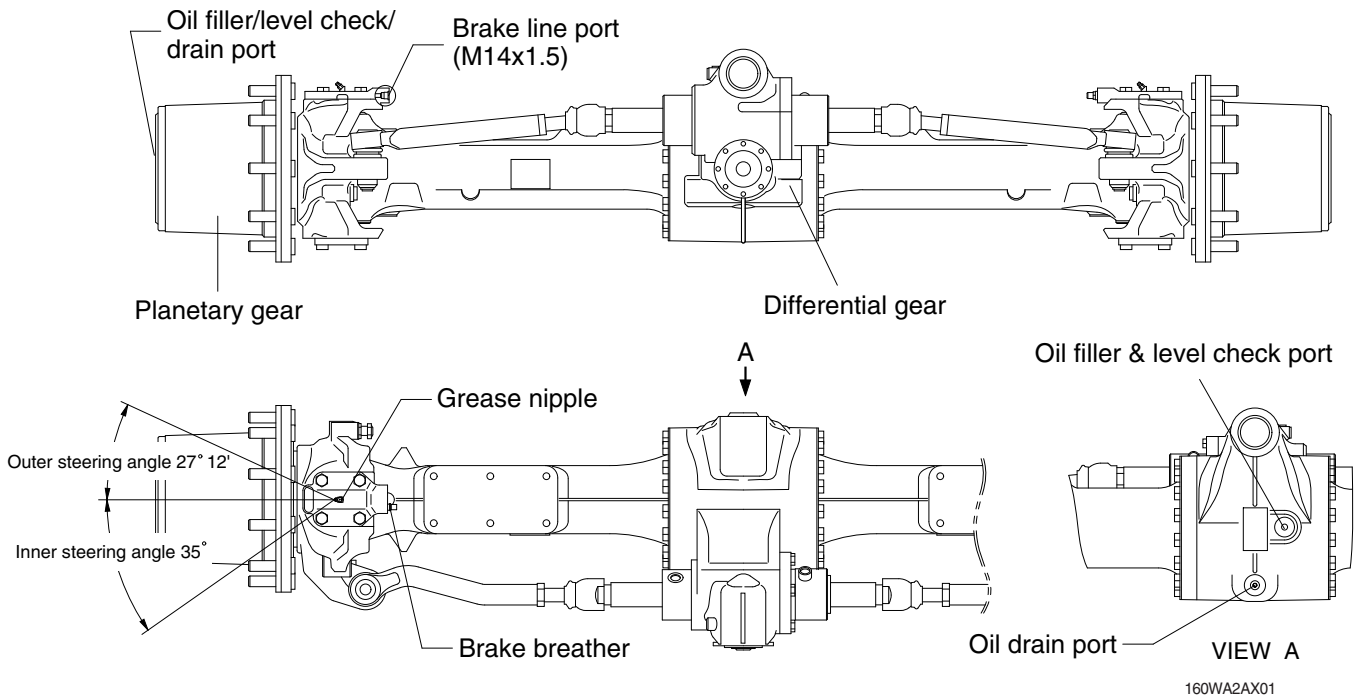
4	Screw	39	O-ring	241	Spring
5	Ball	115	Gear set	242	Spool
27	Short screw	116	Valve plate	243	Plug
30	Gear set	117	Valve plate	320	O-ring
31	Screw	120	Shaft	321	O-ring
34	Valve plate	122	Valve housing	322	O-ring
35	Washer	204	PVE	323	O-ring
36	End cover	233	Plug		

GROUP 11 FRONT AXLE AND REAR AXLE

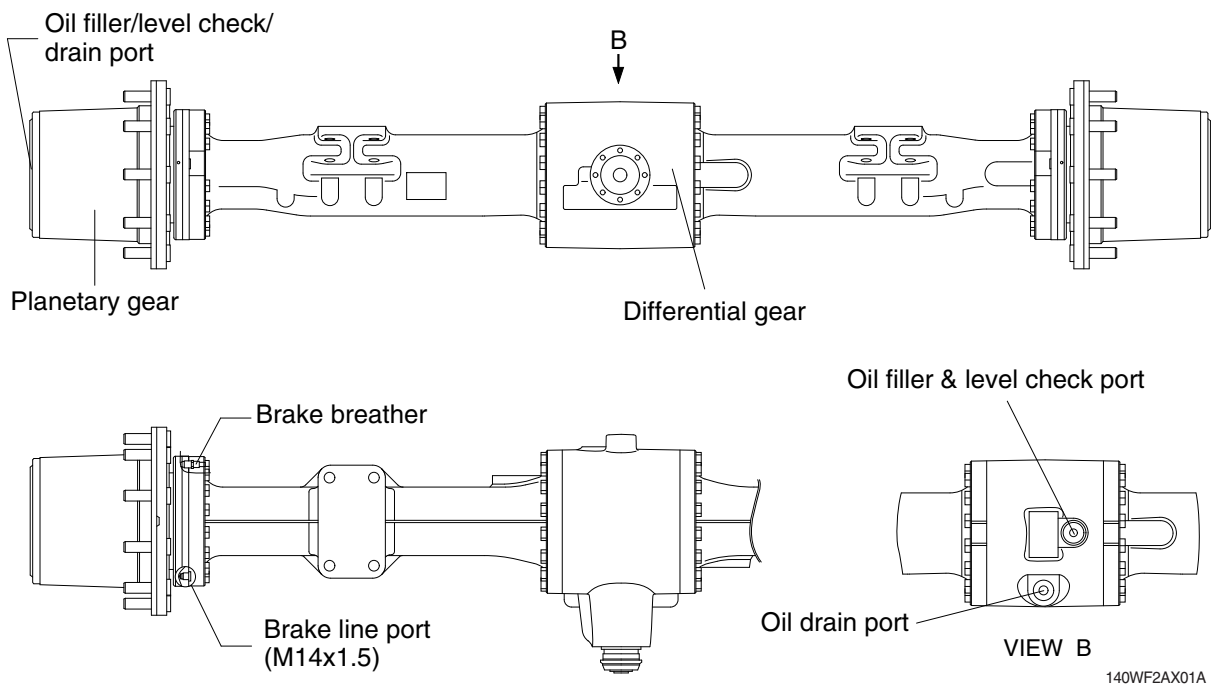
1. OPERATION

- The power from the engine passes through main pump, travel motor and transmission and drive shafts, and is then sent to the front and rear axles.
Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles.
- At the same time, the speed is reduced and passes through the both differentials to the axle shafts.
The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

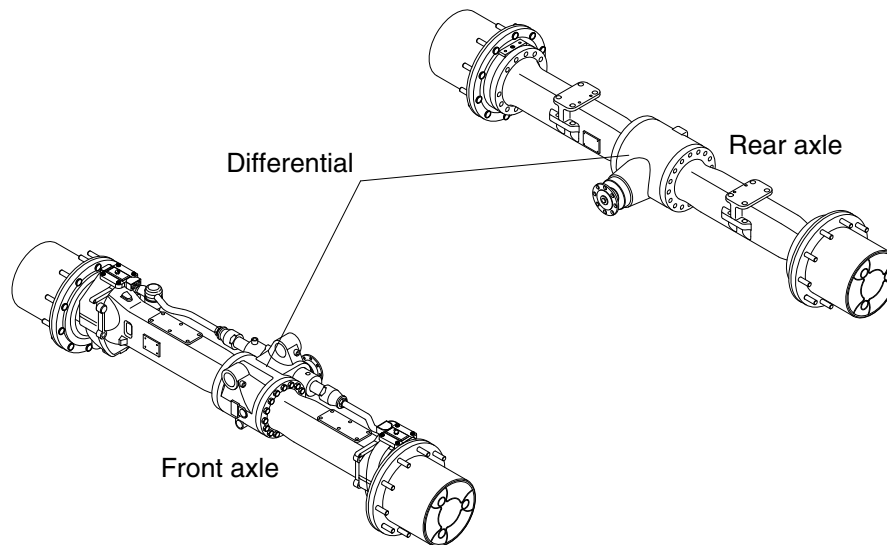
1) FRONT AXLE



2) REAR AXLE



2. DIFFERENTIAL



140WF2AX03

The differential is installed on the front and rear axle to transfer the driving torque from the axle to the wheels. The differential transfers half of the output torque of the transmission via the universal drive shaft to the planetary gear of the wheel hubs and transfers the rpm and torque from the gear via the pinion and the ring.

In addition, the differential also serves as an equalizer when going around curves. If the mechanical connection from the transmission to the universal drive shaft, differential, shaft, and planetary gears to the wheels would be rigid, every steering movement would strain the axle construction and would result in increased tire wear.

The equalizing function comes from the special construction of the differential. The power input from the input flange to the pinion shaft, ring and differential housing to the equalizing axle in the differential housing meshes the four equalizing tapered gears with the axle gears, which are located in the equalizing axles. This changes the relative direction of rotation between the shafts meshed with the side gears. This means that one shaft turns clockwise and the other counterclockwise, and one shaft turns faster than the other.

This balancing movement has the disadvantage that when traveling off road, traction is reduced on uneven ground, on loose ground or on snow or ice only one wheel per axle is engaged. This disadvantage can be corrected in part by installing a self locking differential.