

## SECTION 2 STRUCTURE AND FUNCTION

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# SECTION 2 STRUCTURE AND FUNCTION

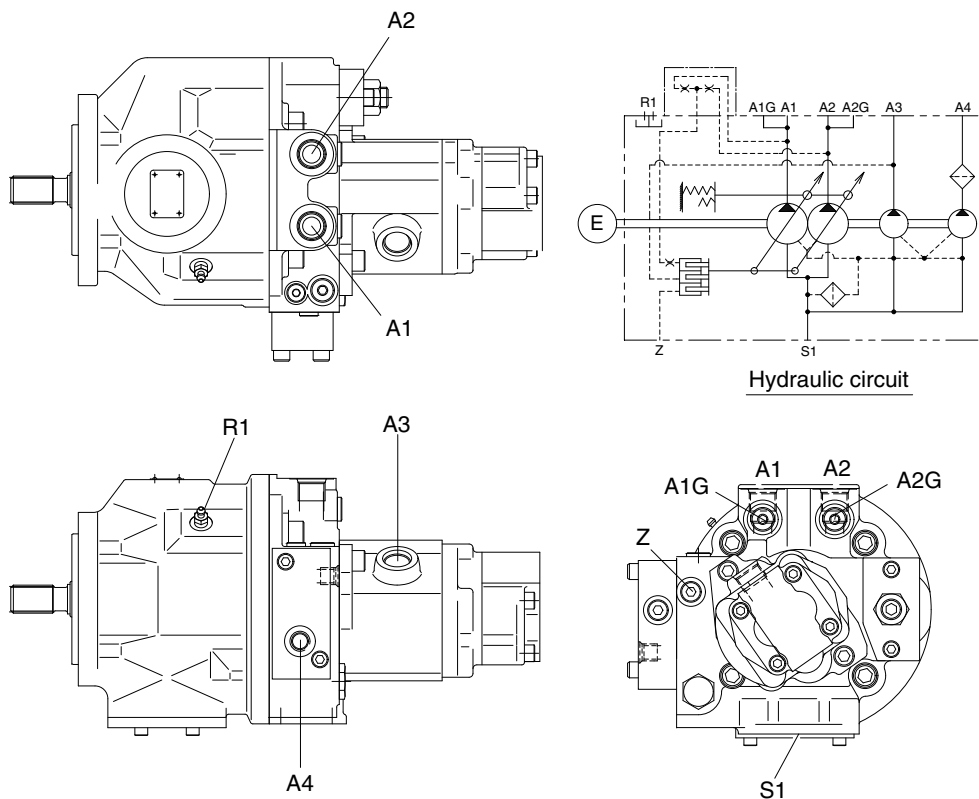
## GROUP 1 HYDRAULIC PUMP

### 1. GENERAL

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

Because this pump has one swash plate, the tilting angle is the same for two pumps. Tilting of the pump changes in response to the total pressure of  $P_1 + P_2$ . Namely, the output is controlled to the constant value so that the relationship between the discharge pressure and flow rate  $Q$  becomes constant,  $(P_1 + P_2) * Q = \text{Constant}$ .

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

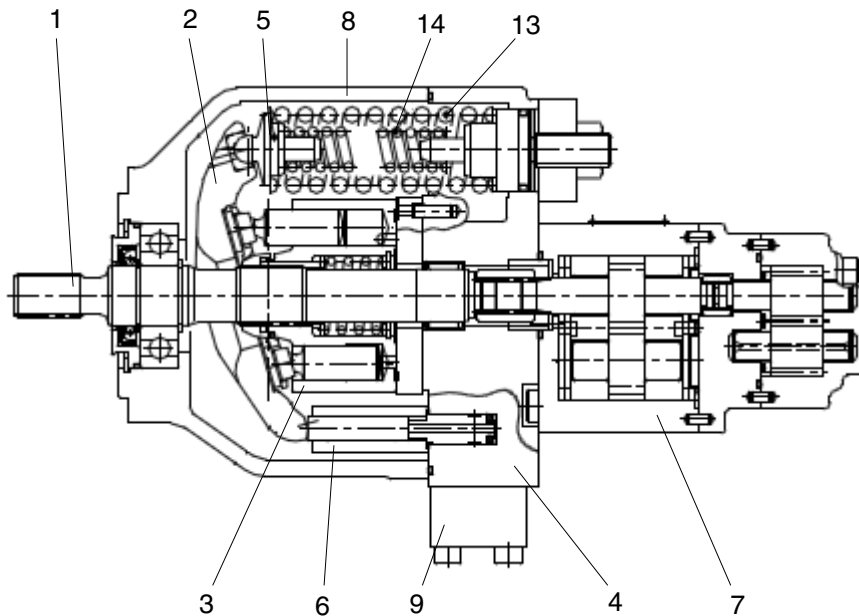


HW60A2MP01

#### Description of the ports

| Port     | Name                | Bore                         |
|----------|---------------------|------------------------------|
| S1       | Suction port        | SAE 1 1/2 (standard)         |
| A1, A2   | Discharge port      | PF 1/2                       |
| A3       | Discharge port      | PF 1/2                       |
| A4       | Discharge port      | PF 1/4                       |
| A1G, A2G | Gauge port          | PF 1/4 with quick coupler    |
| Z        | Pilot pressure port | PF 1/4                       |
| R1       | Air bleeder port    | M10 × 1.0 with bleeder valve |

## 2. PRINCIPAL COMPONENTS AND FUNCTIONS



HW60A2MP02

|   |              |   |                |    |        |
|---|--------------|---|----------------|----|--------|
| 1 | Drive shaft  | 5 | Spring sheet   | 9  | Body   |
| 2 | Hanger       | 6 | Control piston | 13 | Spring |
| 3 | Rotary group | 7 | Gear pump      | 14 | Spring |
| 4 | Port plate   | 8 | Housing        |    |        |

### SPECIFICATIONS

- Capacity :  $2 \times 25 + 16.2 + 6.5$  cc/rev
- Rated oil flow :  $2 \times 57.5 + 37.5 + 15$  l /min
- Rated pressure :  $2 \times 220 + 220 + 30$  kgf/cm<sup>2</sup>

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

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

The discharge pressure directed to the control piston tilts the hanger by overcoming the spring force. Since the piston stroke changes according to the tilting angle of the hanger, the flow can be changed.

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

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

### (1) Function of pump



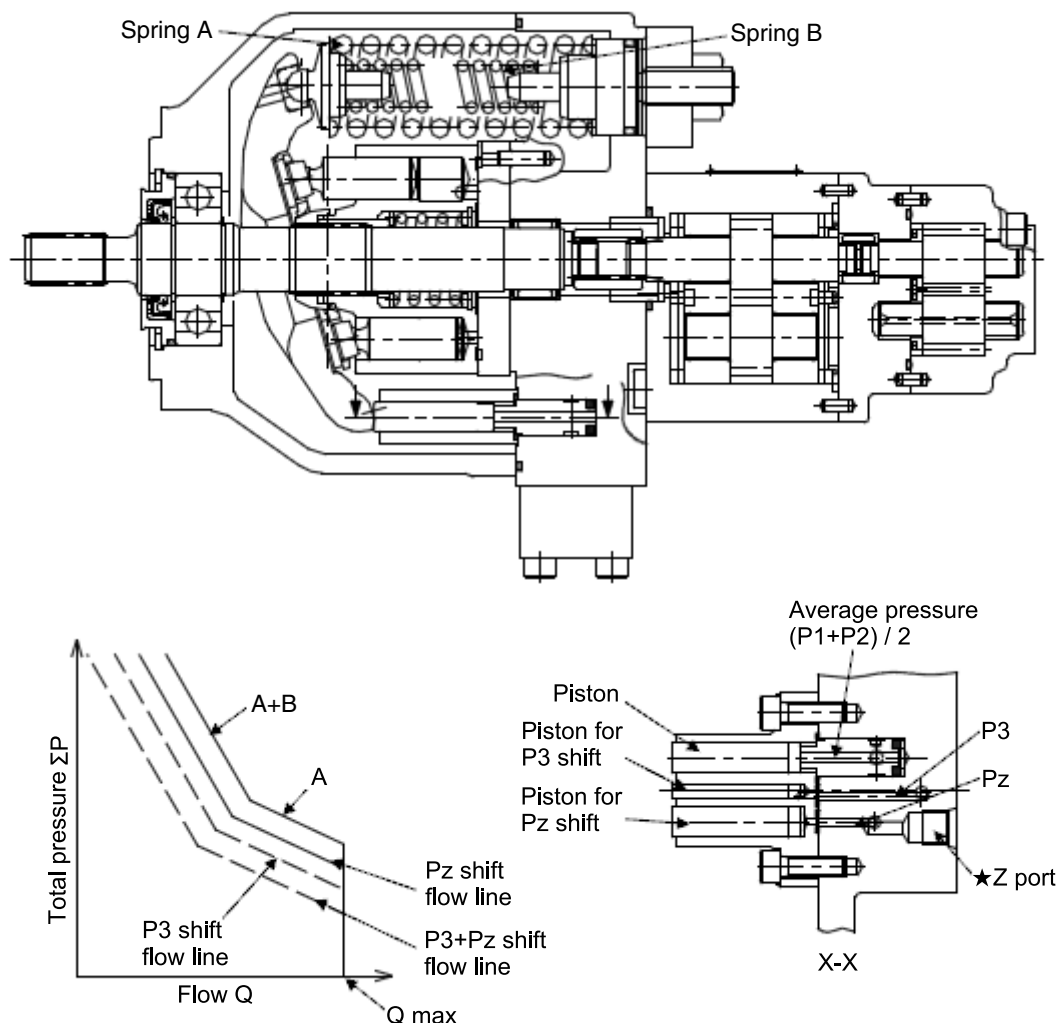
The piston assembled into the cylinder block performs reciprocal operation while following the swash plate on the hanger.

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

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

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

## 2) CONTROL FUNCTIONS



HW65AH2MP04

LV-constant power control with power shift.

The average pressure of P1 and P2 are directed to the piston which sides on the swash plate, and acts on the swash plate.

The spring is provided to act against the delivery pressure.

When the oil pressure via piston acting on the swash plate is less than the installation load of the spring, the swash plate is fixed to the maximum tilting position.

When the oil pressure via piston acting on the swash plate exceeds the installation load of the spring, the swash plate is tilted and the swash plate is kept at a position where the oil pressure is balanced with the spring force. (Region A or B in above figure)

When the P3 oil pressure acts on the shift piston, flow line is shifted to P3 shift flow line.

When the P3 oil pressure from Z port acts on the shift piston, flow line is shifted to P3 shift flow line.★

★When the Z port is not used, it is led to the drain.

### **3) CONTROL / ADJUSTMENT PROCEDURE**

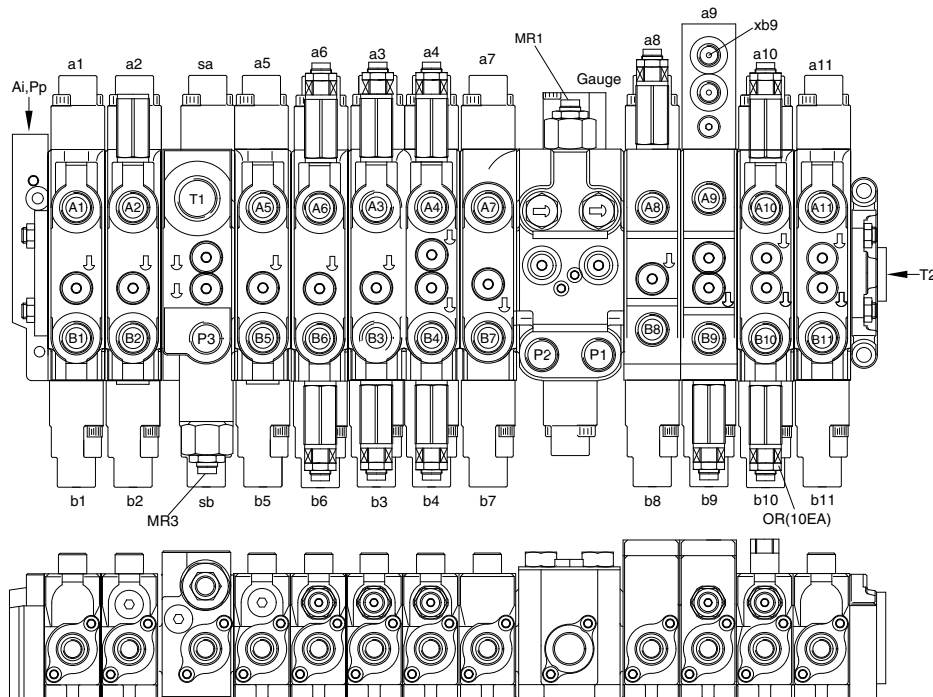
This hydraulic pump has been set and inspected according to your specified input power and control. Readjustment of all the adjusting portions may lead to the loss of functions specified for each control and the pump proper may be excluded from the scope of guarantee.

Never attempt operating the adjustment screw.

## GROUP 2 MAIN CONTROL VALVE

### 1. OUTLINE

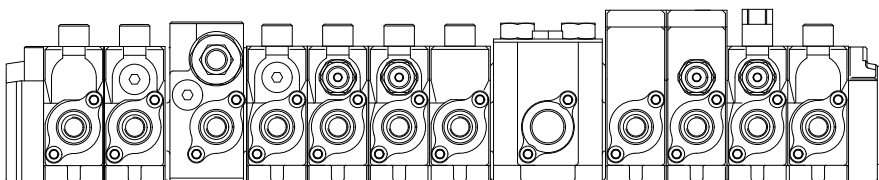
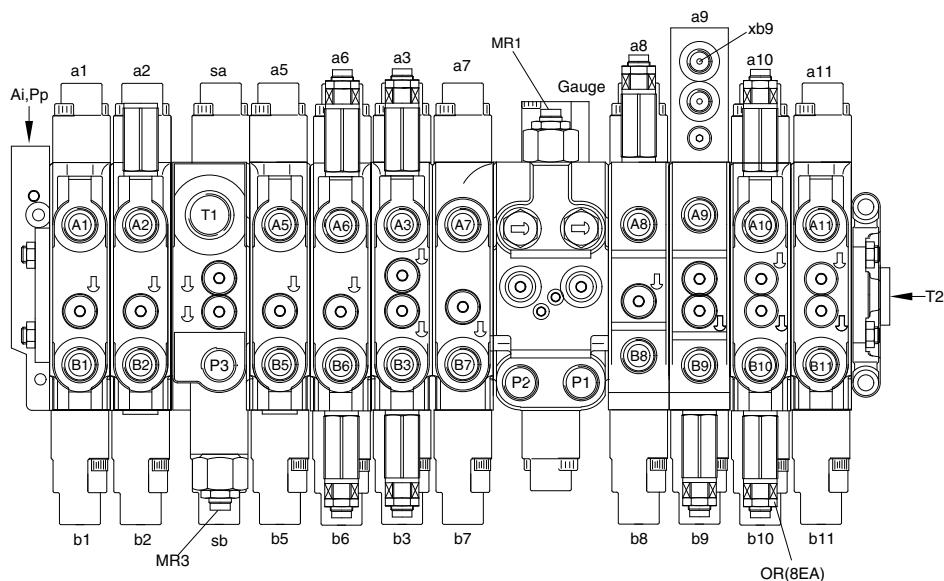
#### 1) 2-WAY



HW60A2MC01

| Mark | Port name             | Port size | Tightening torque | Mark | Port name                  | Port size | Tightening torque |
|------|-----------------------|-----------|-------------------|------|----------------------------|-----------|-------------------|
| P1   | P1 pump port          | PF 1/2    | 6.0~7.0 kgf · m   | T2   | Tank return port           | PF3/4     | 8~9 kgf · m       |
| P2   | P2 pump port          |           |                   | a1   | Swing pilot port (LH)      | PF1/4     | 2.5~3.0 kgf · m   |
| P3   | P3 pump port          |           |                   | b1   | Swing pilot port (RH)      |           |                   |
| A1   | Swing port (LH)       |           |                   | a2   | Dozer down pilot port      |           |                   |
| B1   | Swing port (RH)       |           |                   | b2   | Dozer up pilot port        |           |                   |
| A2   | Dozer down port       |           |                   | a3   | Boom swing pilot port (LH) |           |                   |
| B2   | Dozer up port         |           |                   | b3   | Boom swing pilot port RH)  |           |                   |
| A3   | Boom swing port (LH)  |           |                   | a4   | Wood grab in port          |           |                   |
| B3   | Boom swing port (RH)  |           |                   | b4   | Wood grab out port         |           |                   |
| A4   | Wood grab in port     |           |                   | a5   | Boom 2 pilot port          |           |                   |
| B4   | Wood grab out port    |           |                   | b5   | Breaker pilot port         |           |                   |
| A5   | Boom 2 port           |           |                   | a6   | Arm out pilot port         |           |                   |
| B5   | Breaker port          |           |                   | b6   | Arm in pilot port          |           |                   |
| A6   | Arm out port          |           |                   | a7   | Travel pilot port (LH/FW)  |           |                   |
| B6   | Arm in port           |           |                   | b7   | Travel pilot port (LH/RR)  |           |                   |
| A7   | Travel port (FW)      |           |                   | a8   | Travel pilot port (RH/FW)  |           |                   |
| B7   | Travel port (BW)      |           |                   | b8   | Travel pilot port (RH/RR)  |           |                   |
| A8   | Travel port (FW)      |           |                   | a9   | Boom up pilot port         |           |                   |
| B8   | Travel port (BW)      |           |                   | b9   | Boom down pilot port       |           |                   |
| A9   | Boom up port          |           |                   | a10  | Bucket out pilot port      |           |                   |
| B9   | Bucket out port       |           |                   | b10  | Bucket in pilot port       |           |                   |
| A10  | Bucket out port       |           |                   | a11  | Arm 2 pilot port           |           |                   |
| B10  | Bucket in port        |           |                   | b11  | Arm 2 pilot port           |           |                   |
| A11  | Arm 2 port            |           |                   | Ai   | Auto idle signal port      |           |                   |
| B11  | Arm 2 port            |           |                   | Pp   | Pilot supply port          |           |                   |
| MR1  | Main relief valve     | —         | 10~12 kgf · m     |      |                            |           |                   |
| MR3  | Overload relief valve | —         |                   |      |                            |           |                   |
| OR   | Overload relief valve | —         |                   |      |                            |           |                   |
| T1   | Tank return port      | PF1       | 10~12 kgf · m     |      |                            |           |                   |

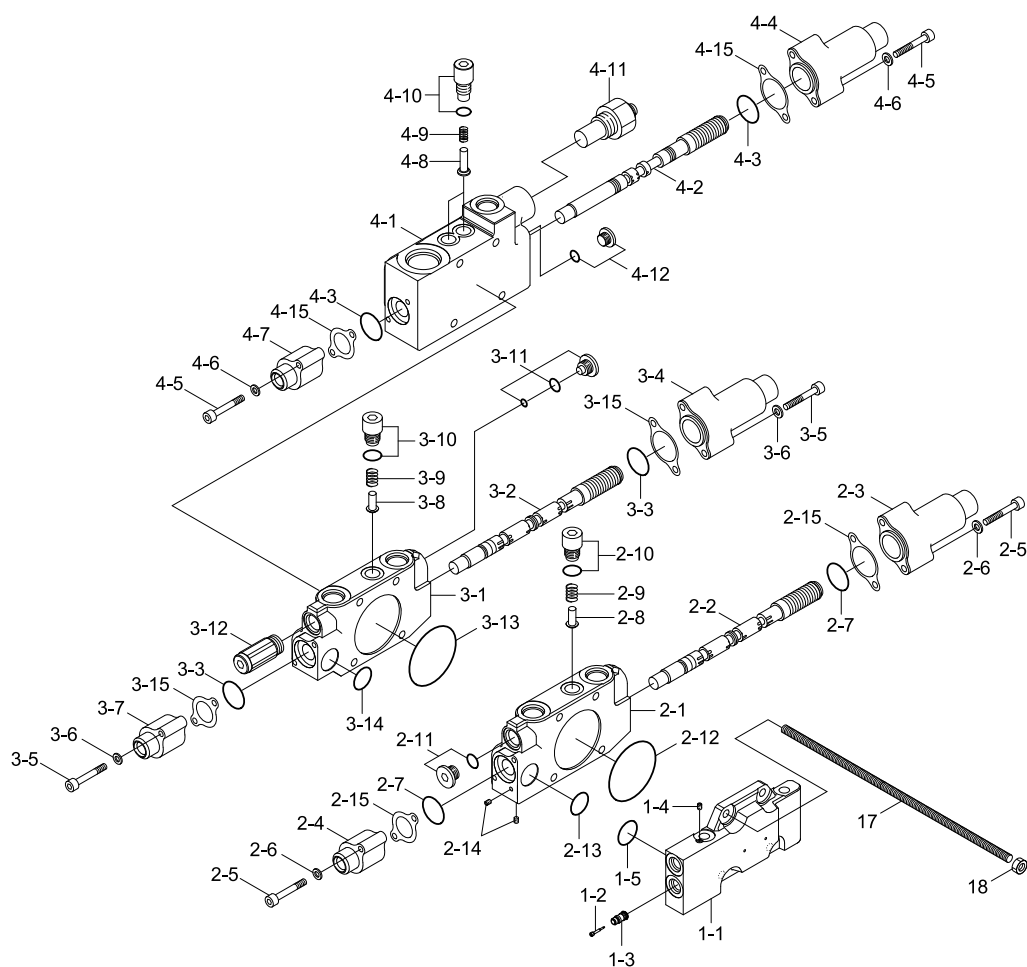
## 2) 1-WAY



HW60A2MC02

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

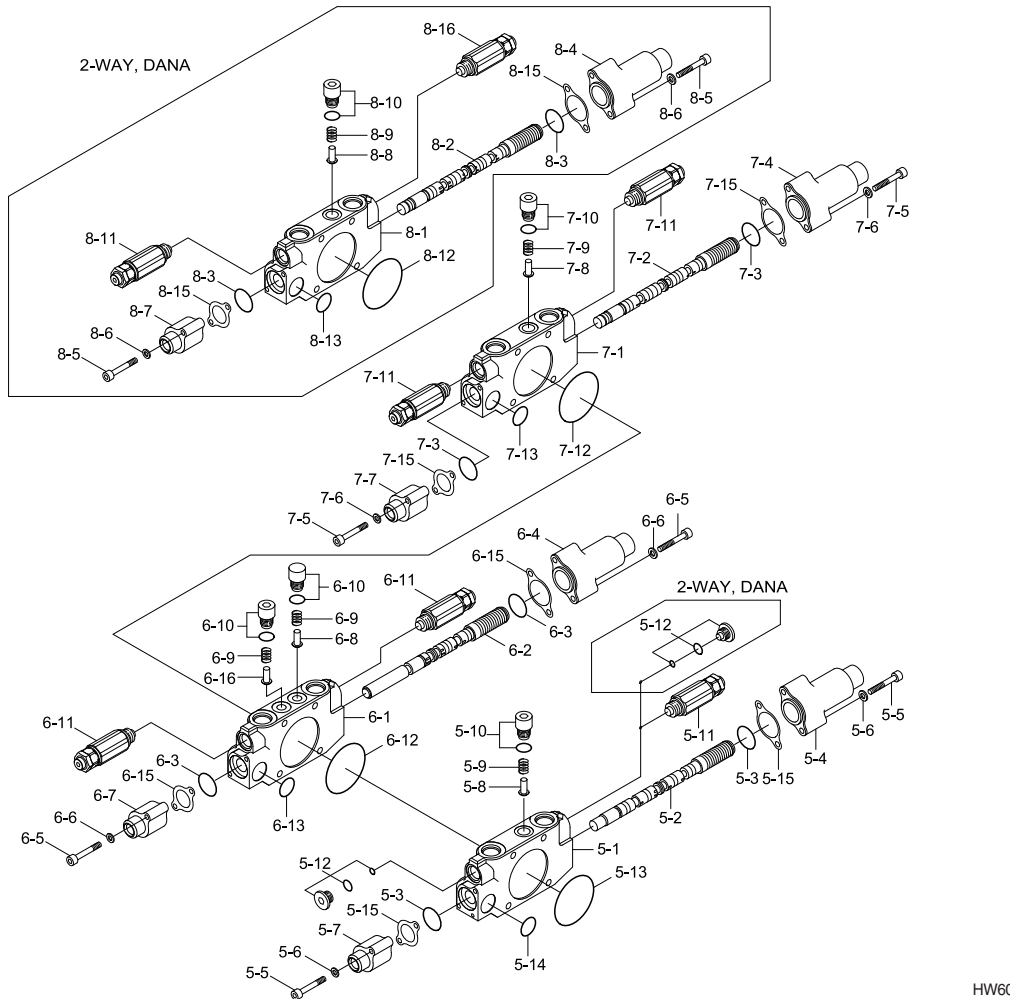
## 2. STRUCTURE (1/4)



HW60A2MC03

|      |                  |      |                       |      |                   |
|------|------------------|------|-----------------------|------|-------------------|
| 1    | Cover assy-port  | 2-12 | O-ring                | 3-14 | O-ring            |
| 1-1  | Cover-autoidle   | 2-13 | O-ring                | 3-15 | Gasket            |
| 1-2  | Orifice          | 2-14 | Screw-set             | 4    | Inlet block (P3)  |
| 1-3  | Filter assy      | 2-15 | Gasket                | 4-1  | Work block        |
| 1-4  | Screw-set        | 3    | Dozer block           | 4-2  | Slector spool     |
| 1-5  | O-ring           | 3-1  | Work block            | 4-3  | O-ring            |
| 2    | Swing block      | 3-2  | Dozer spool           | 4-4  | Pilot cap (A)     |
| 2-1  | Work block       | 3-3  | O-ring                | 4-5  | Wrench bolt       |
| 2-2  | Swing spool assy | 3-4  | Pilot cap (A)         | 4-6  | Plain washer      |
| 2-3  | Pilot cap (A)    | 3-5  | Wrench                | 4-7  | Pilot cap (B1)    |
| 2-4  | Pilot cap (B1)   | 3-6  | Plain washer          | 4-8  | Check poppet      |
| 2-5  | Wrench bolt      | 3-7  | Pilot cap (B1)        | 4-9  | Check spring      |
| 2-6  | Plain washer     | 3-8  | Check poppet          | 4-10 | Plug assy         |
| 2-7  | O-ring           | 3-9  | Check spring          | 4-11 | Main relief valve |
| 2-8  | Check proppet    | 3-10 | Plug assy             | 4-12 | Plug              |
| 2-9  | Check spring     | 3-11 | Plug assy             | 4-15 | Gasket            |
| 2-10 | Plug assy        | 3-12 | Anti-cavitation valve | 17   | Tie bolt          |
| 2-11 | Plug assy        | 3-13 | O-ring                | 18   | Nut               |

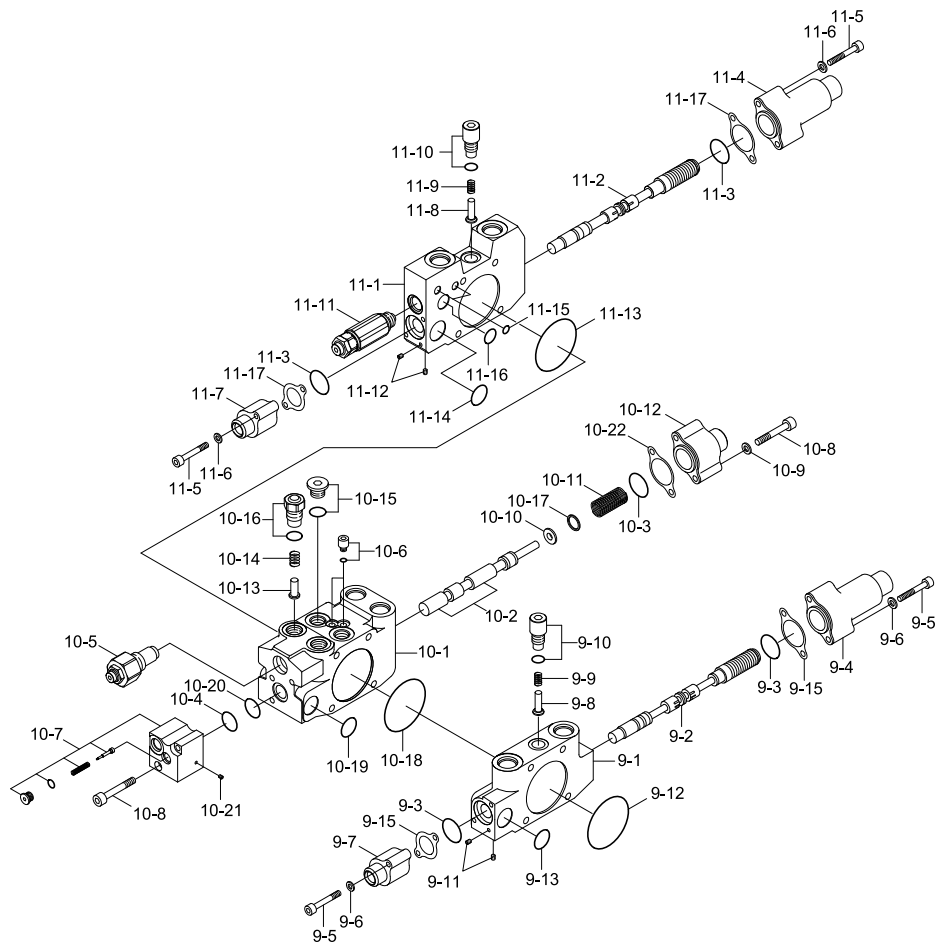
## STRUCTURE (2/4)



HW60A2MC04

|      |                       |      |                       |      |                       |
|------|-----------------------|------|-----------------------|------|-----------------------|
| 5    | Boom 2 block          | 6-5  | Wrench bolt           | 7-12 | O-ring                |
| 5-1  | Work block            | 6-6  | Plain washer          | 7-13 | O-ring                |
| 5-2  | Boom 2 spool          | 6-7  | Pilot cap (B1)        | 7-15 | Gasket                |
| 5-3  | O-ring                | 6-8  | Check poppet          | 8    | Wood grap block       |
| 5-4  | Pilot cap (A)         | 6-9  | Check spring          | 8-1  | Work block            |
| 5-5  | Wrench bolt           | 6-10 | Plug assy             | 8-2  | Rotator spool         |
| 5-6  | Plain washer          | 6-11 | Overload relief valve | 8-3  | O-ring                |
| 5-7  | Pilot cap (B1)        | 6-12 | O-ring                | 8-4  | Pilot cap (A)         |
| 5-8  | Check poppet          | 6-13 | O-ring                | 8-5  | Wrench bolt           |
| 5-9  | Check spring          | 6-15 | Gasket                | 8-6  | Plain washer          |
| 5-10 | Plug assy             | 7    | Boom swing block      | 8-7  | Pilot cap (B1)        |
| 5-11 | Overload relief valve | 7-1  | Work block            | 8-8  | Check poppet          |
| 5-12 | Plug assy             | 7-2  | Boom swing spool      | 8-9  | Check spring          |
| 5-13 | O-ring                | 7-3  | O-ring                | 8-10 | Plug assy             |
| 5-14 | O-ring                | 7-4  | Pilot cap (A)         | 8-11 | Overload relief valve |
| 5-15 | Gasket                | 7-5  | Wrench bolt           | 8-12 | O-ring                |
| 6    | Arm 1 block           | 7-6  | Plain washer          | 8-13 | O-ring                |
| 6-1  | Work block            | 7-7  | Pilot cap(B1)         | 8-15 | Gasket                |
| 6-2  | Arm 1 spool           | 7-8  | Check poppet          | 8-16 | Overload relief valve |
| 6-3  | O-ring                | 7-9  | Check spring          |      |                       |
| 6-4  | Pilot cap (A1)        | 7-10 | Plug assy             |      |                       |
|      |                       | 7-11 | Overload relief valve |      |                       |

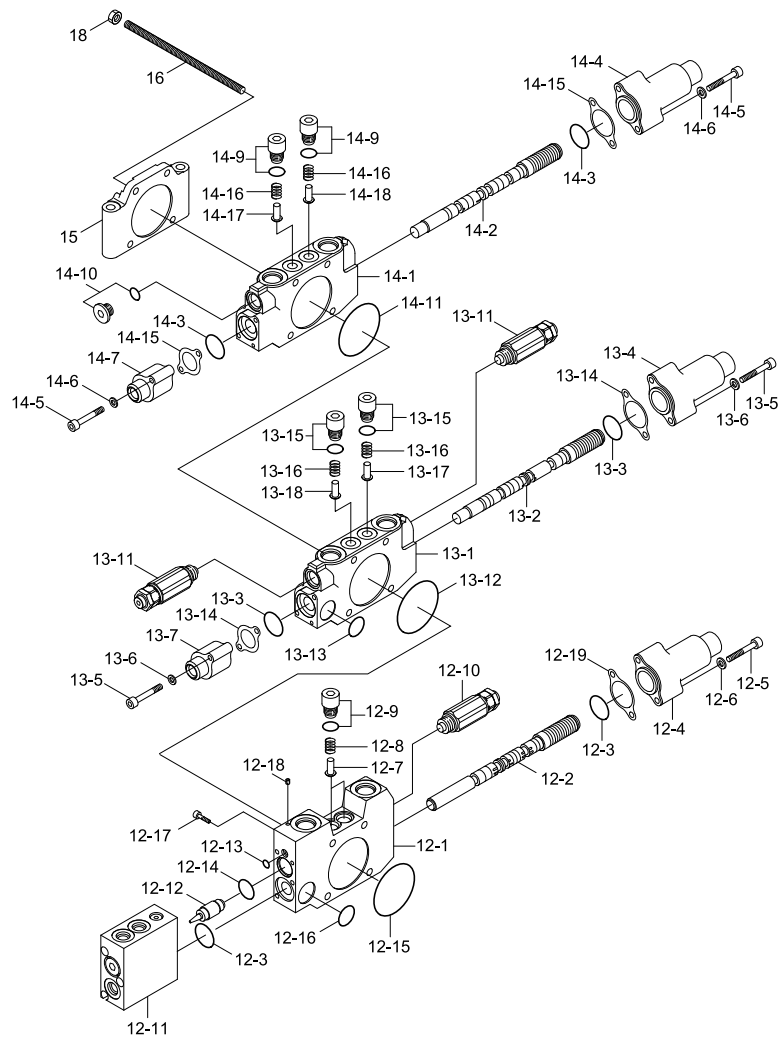
## STRUCTURE (3/4)



HW60A2MC05

|      |                |       |                   |       |                       |
|------|----------------|-------|-------------------|-------|-----------------------|
| 9    | Travel block   | 10-3  | O-ring            | 10-22 | Gasket                |
| 9-1  | Work block     | 10-4  | O-ring            | 11    | Travel block          |
| 9-2  | Travel spool   | 10-5  | Main relief valve | 11-1  | Work block            |
| 9-3  | O-ring         | 10-6  | Plug assy         | 11-2  | Travel spool          |
| 9-4  | Pilot cap (A)  | 10-7  | Cap assy          | 11-3  | O-ring                |
| 9-5  | Wrench bolt    | 10-8  | Wrench bolt       | 11-4  | Pilot cap (A)         |
| 9-6  | Plain washer   | 10-9  | Plain washer      | 11-5  | Wrench bolt           |
| 9-7  | Pilot cap (B1) | 10-10 | Spring seat       | 11-6  | Plain washer          |
| 9-8  | Check poppet   | 10-11 | Pilot spring      | 11-7  | Pilot cap (B1)        |
| 9-9  | Check spring   | 10-12 | Pilot cap (B2)    | 11-8  | Check poppet          |
| 9-10 | Plug assy      | 10-13 | Check poppet      | 11-9  | Check spring          |
| 9-11 | Set screw      | 10-14 | Check spring      | 11-10 | Plug                  |
| 9-12 | O-ring         | 10-15 | Plug assy         | 11-11 | Overload relief valve |
| 9-13 | O-ring         | 10-16 | Plug              | 11-12 | Set screw             |
| 9-15 | Gasket         | 10-17 | Shim spring       | 11-13 | O-ring                |
| 10   | Inlet block    | 10-18 | O-ring            | 11-14 | O-ring                |
| 10-1 | Work block     | 10-19 | O-ring            | 11-15 | O-ring                |
| 10-2 | Spool kit      | 10-20 | O-ring            | 11-16 | O-ring                |
|      |                | 10-21 | Set screw         | 11-17 | Gasket                |

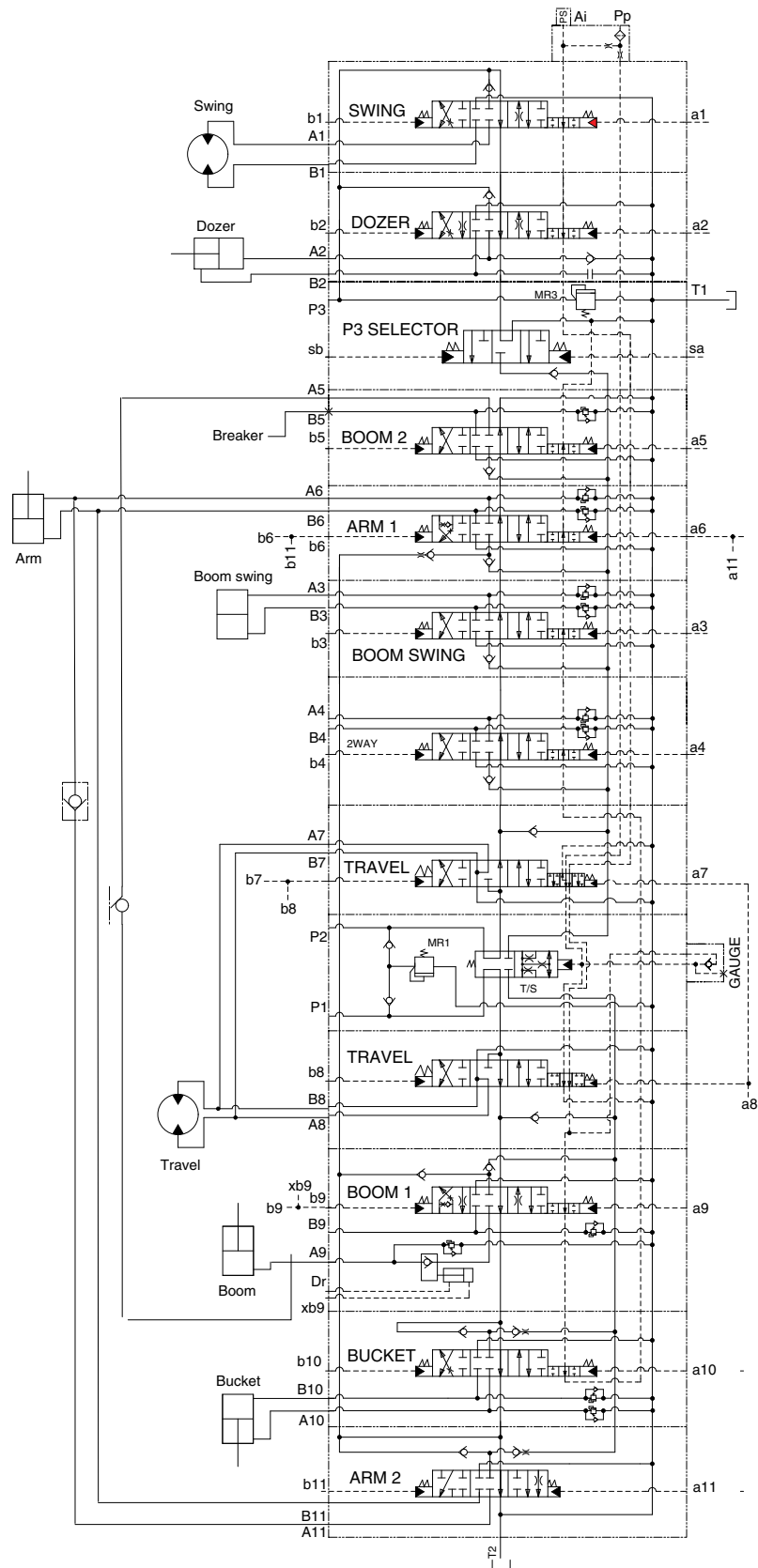
## STRUCTURE (4/4)



HW60A2MC06

|       |                       |       |                 |       |                |
|-------|-----------------------|-------|-----------------|-------|----------------|
| 13    | Bucket block assy     | 13-15 | Plug assy       | 14-7  | Pilot cap (B1) |
| 13-1  | Bucket block          | 13-16 | Check spring    | 14-9  | Plug assy      |
| 13-2  | Bucket spool assy     | 13-17 | Check poppet    | 14-10 | Plug assy      |
| 13-3  | O-ring                | 13-18 | Check poppet    | 14-11 | O-ring         |
| 13-4  | Pilot cap (A)         | 14    | Arm 2 assy      | 14-15 | Gasket         |
| 13-5  | Wrench bolt           | 14-1  | Work block (Ae) | 14-16 | Check spring   |
| 13-6  | Plain washer          | 14-2  | Arm 2 assy      | 14-17 | Check poppet   |
| 13-7  | Pilot cap (B1)        | 14-3  | O-ring          | 14-18 | Check poppet   |
| 13-11 | Overload relief valve | 14-4  | Pilot cap (A)   | 15    | End cover (He) |
| 13-12 | O-ring                | 14-5  | Wrench bolt     | 16    | Tie bolt       |
| 13-13 | O-ring                | 14-6  | Plain washer    | 18    | Nut            |
| 13-14 | Gasket                |       |                 |       |                |

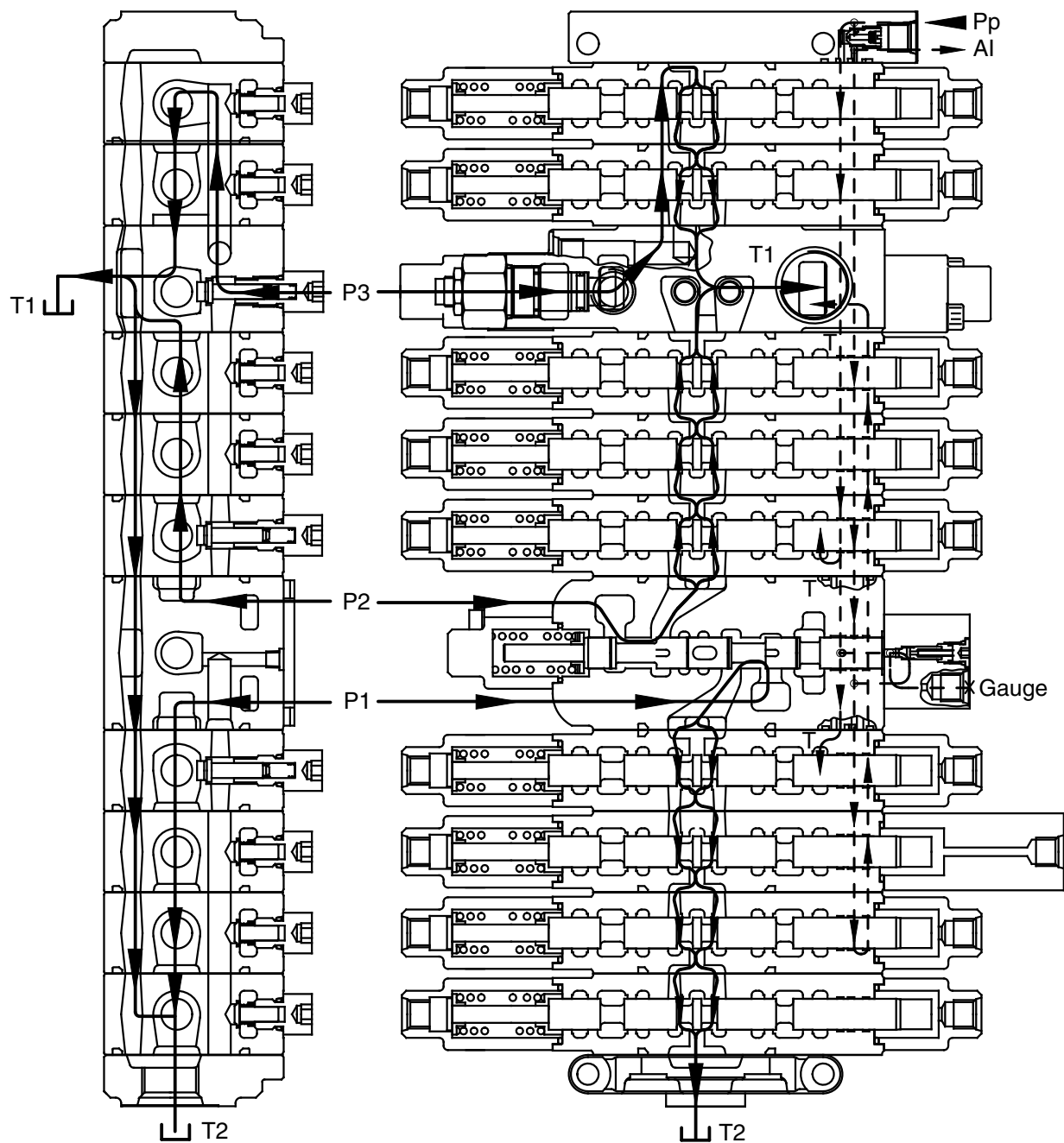
### 3. HYDRAULIC CIRCUIT (boom swing)



HW65A2MC07

## 4. FUNCTION

### 1) CONTROL IN NEUTRAL FUNCTION



55W92MC02

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

**(1) P1**

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

**(2) P2**

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

**(3) P3**

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

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

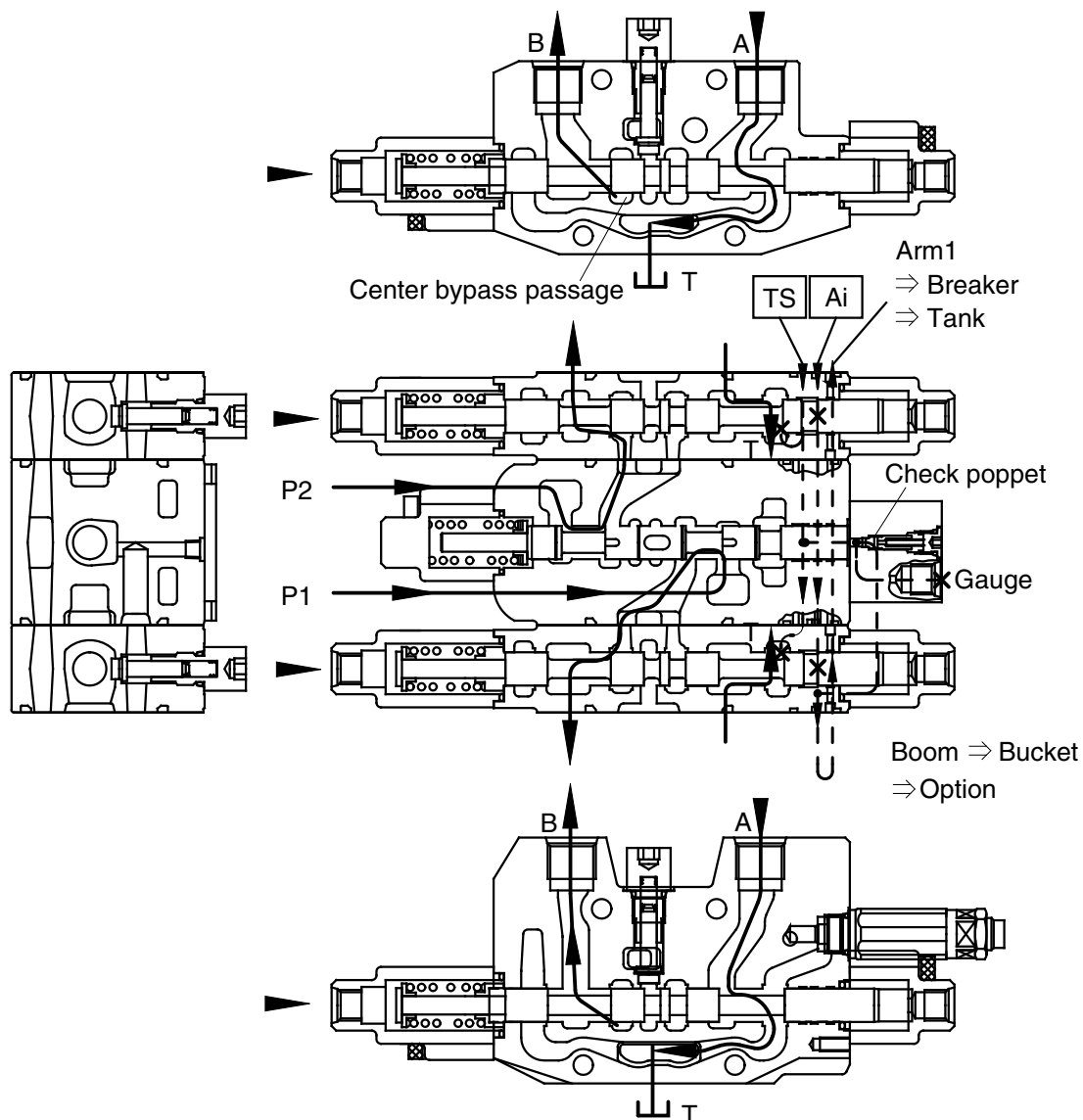
**(4) Pp**

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

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

## 2) EACH SPOOL OPERATION

### (1) Travel operation (forward / backward)

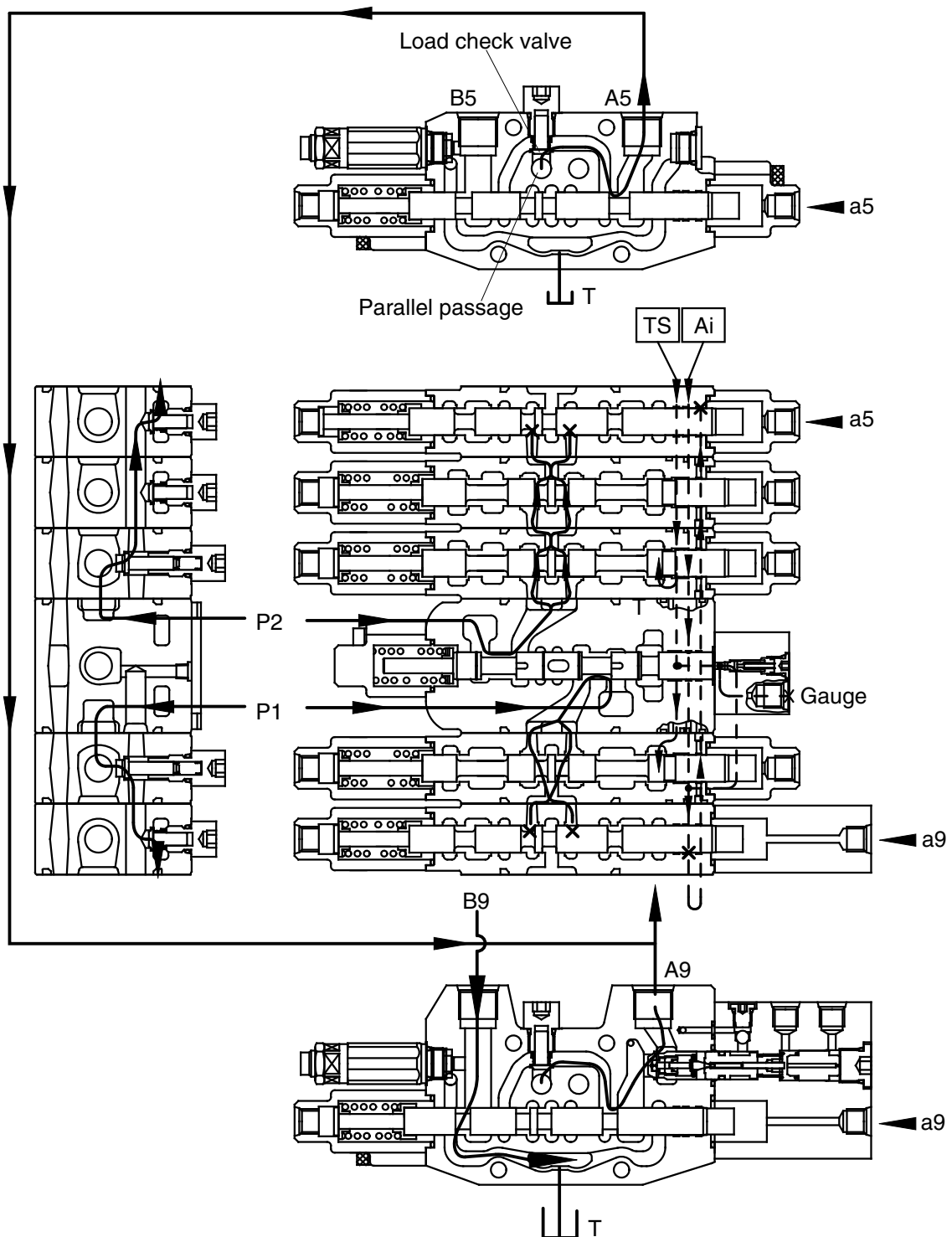


55W92MC03

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

## (2) Boom operation

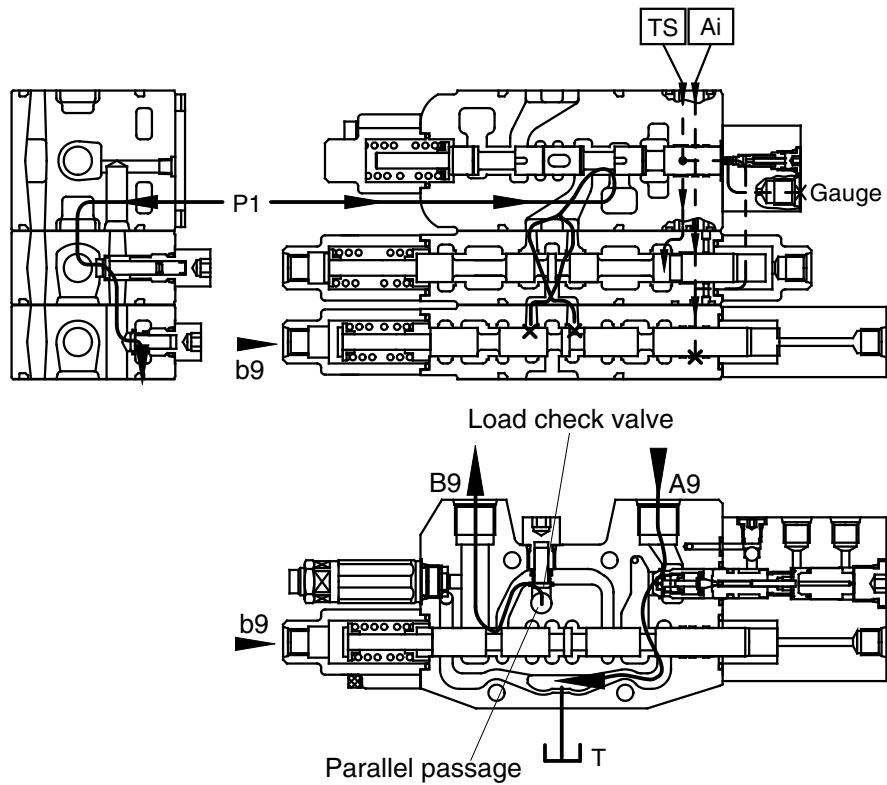
### ① Boom up operation (P1 and P2 summation)



55W92MC04

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

## ② Boom down operation

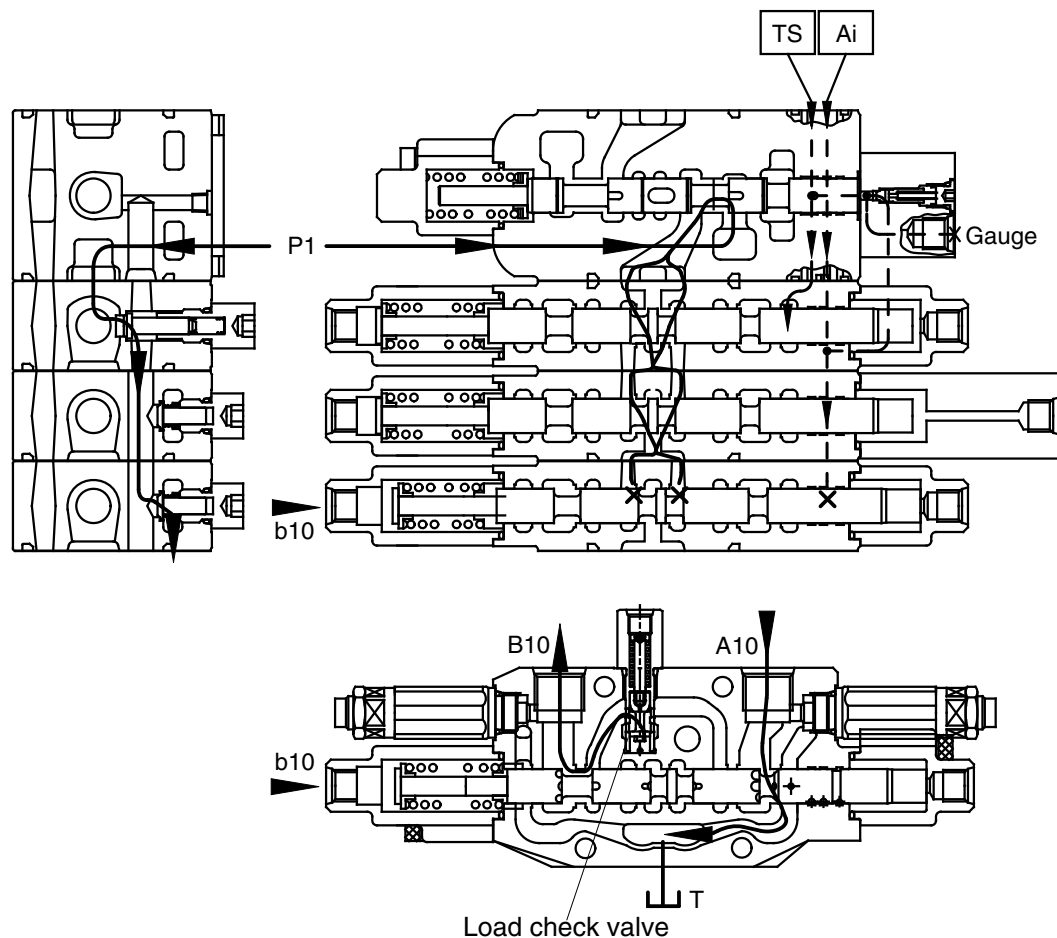


55W92MC05

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

### (3) Bucket operation

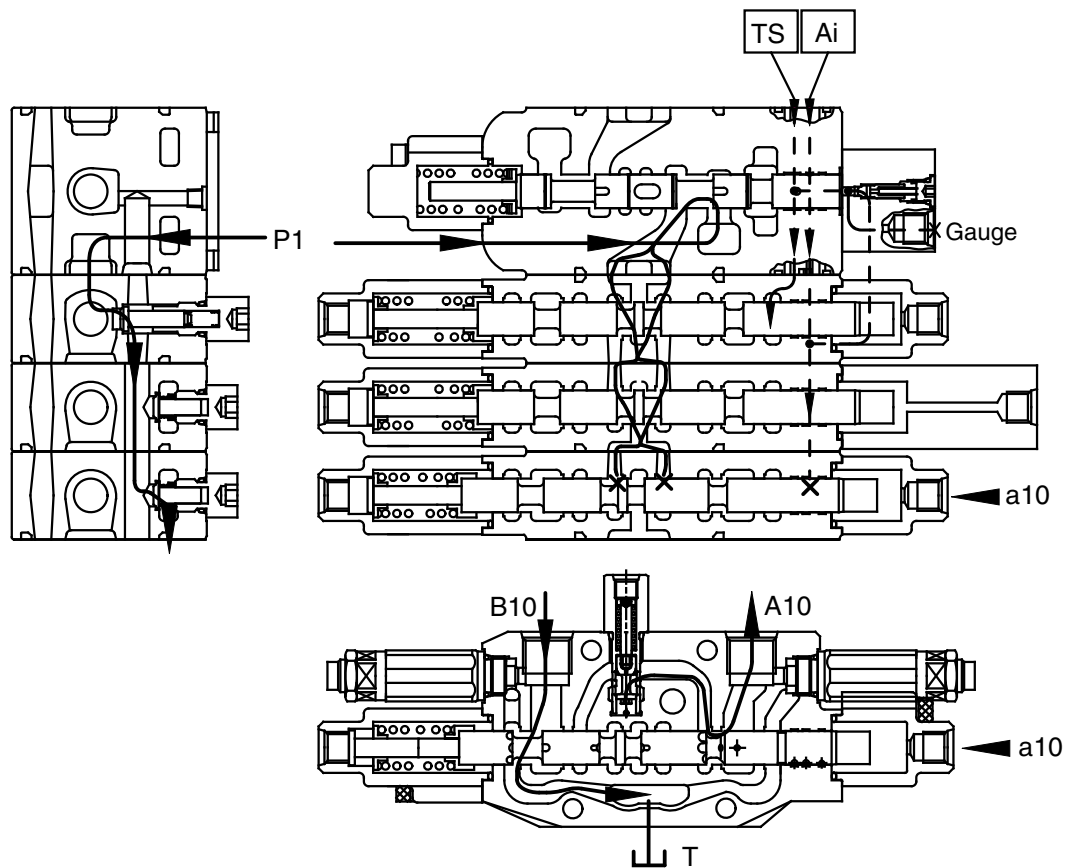
#### ① Bucket roll in operation



55W92MC06

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

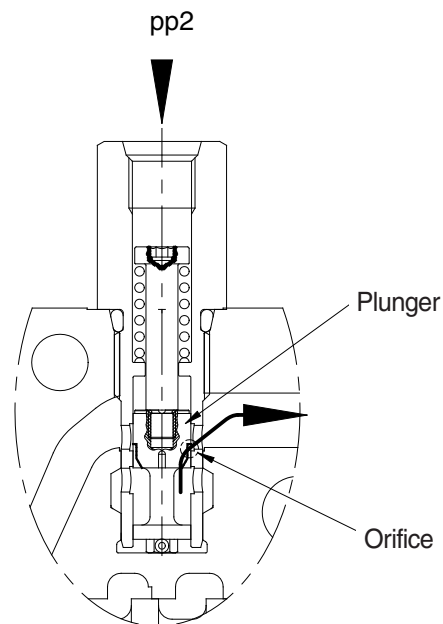
## ② Bucket roll out operation



55W92MC07

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

### ③ Bucket load check valve operation



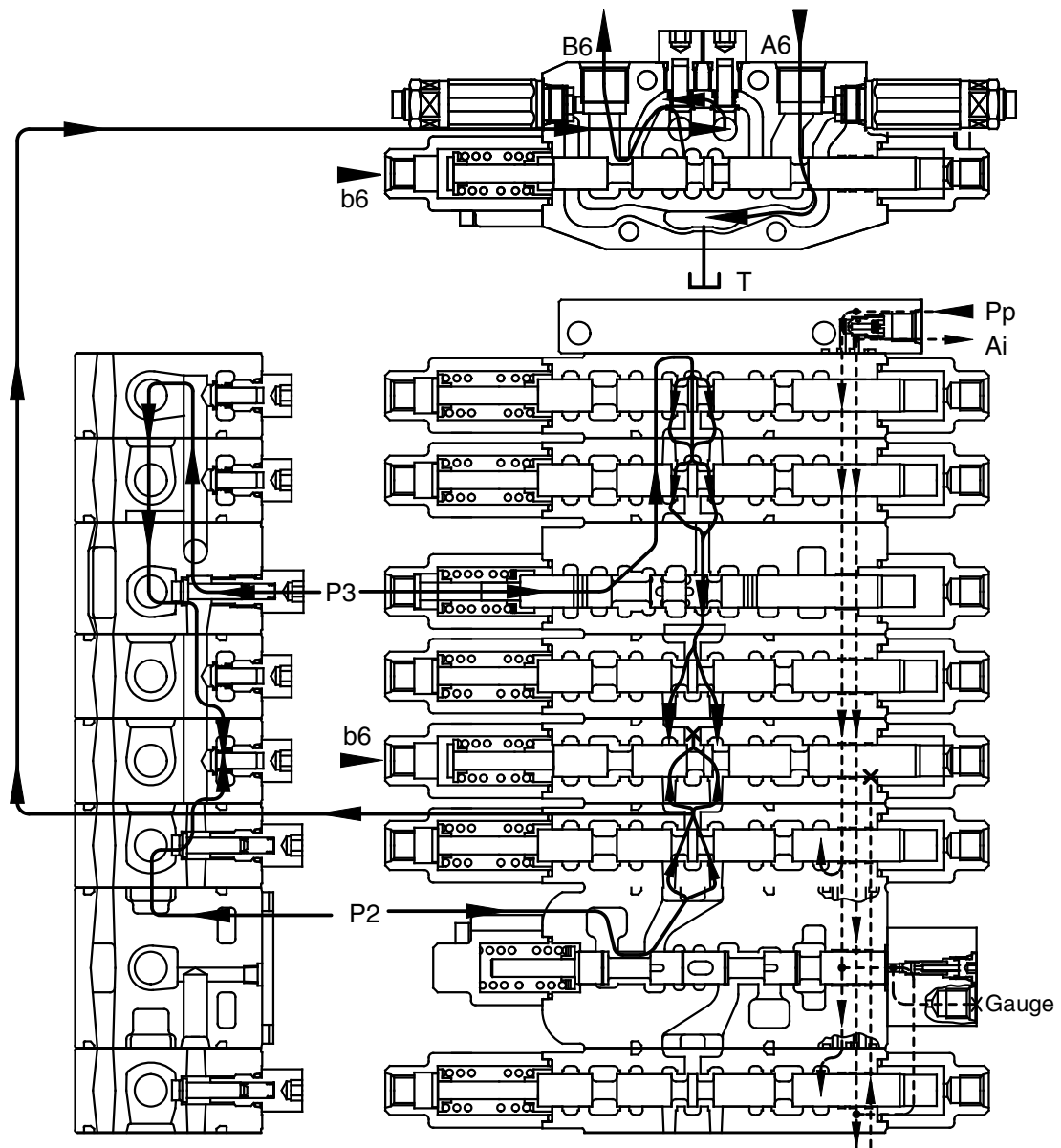
555C92MC13

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

Accordingly, the much fluid from the port P1 is supplied other cylinder than the bucket cylinder.

#### (4) Arm operation

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



55W92MC08

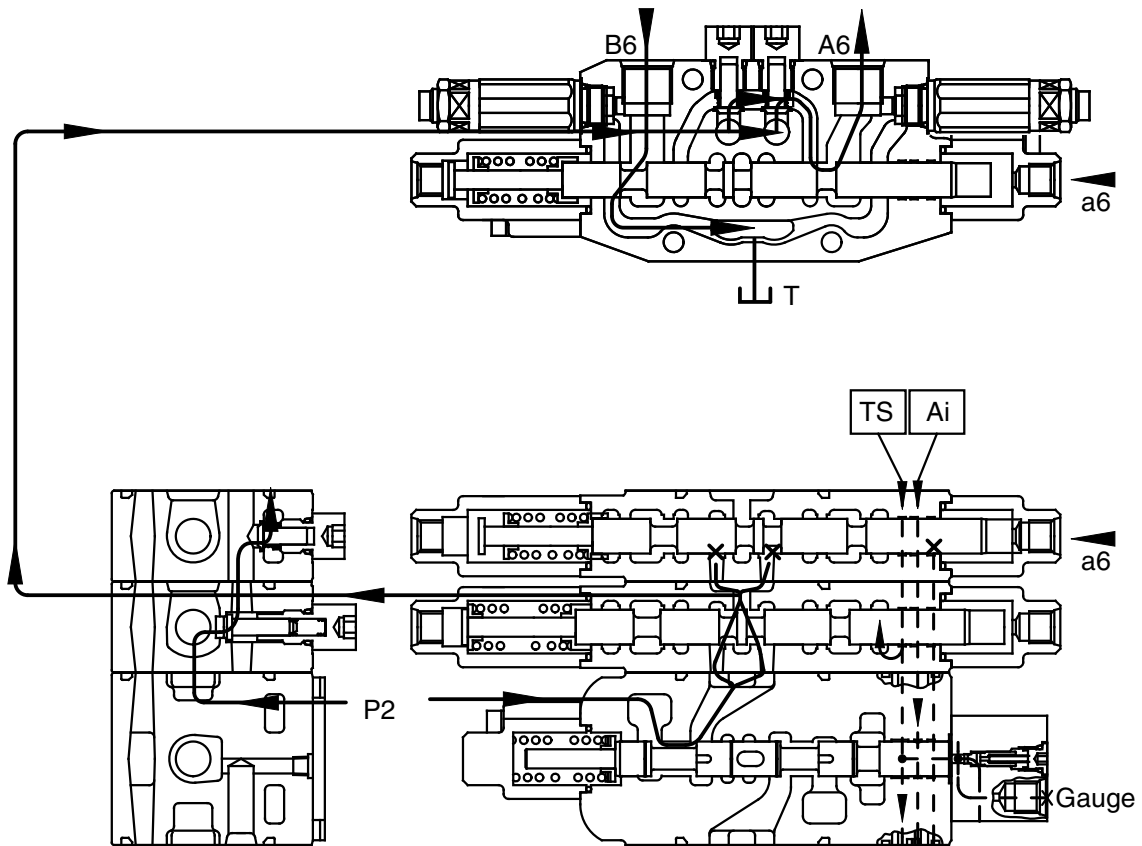
- During arm roll in operation the pilot pressure from the RCV is supplied to the port b6 and shifts arm 1 spool in the right direction.
- Also, the pilot pressure is supplied to the port Sa through the external piping and shift the spool of P3 inlet block.

The hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve and the port B6.

At same time, the hydraulic fluid from the pump P3 flows into the arm summation passage in arm 1 spool through the P3 inlet spool. Then it entered the arm cylinder head side with hydraulic fluid from arm 1 spool.

- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the arm spool and then signal pressure of auto idle is raised.

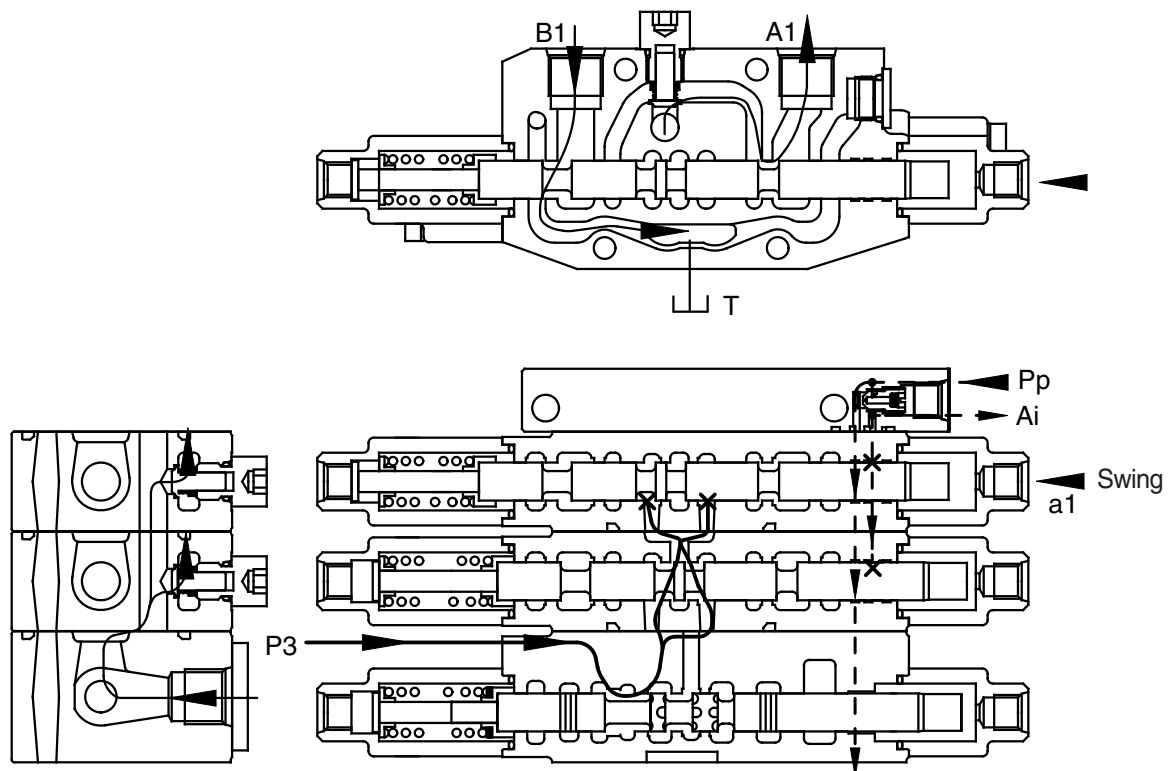
## ② Arm roll out operation



55W92MC09

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

## (5) Swing operation



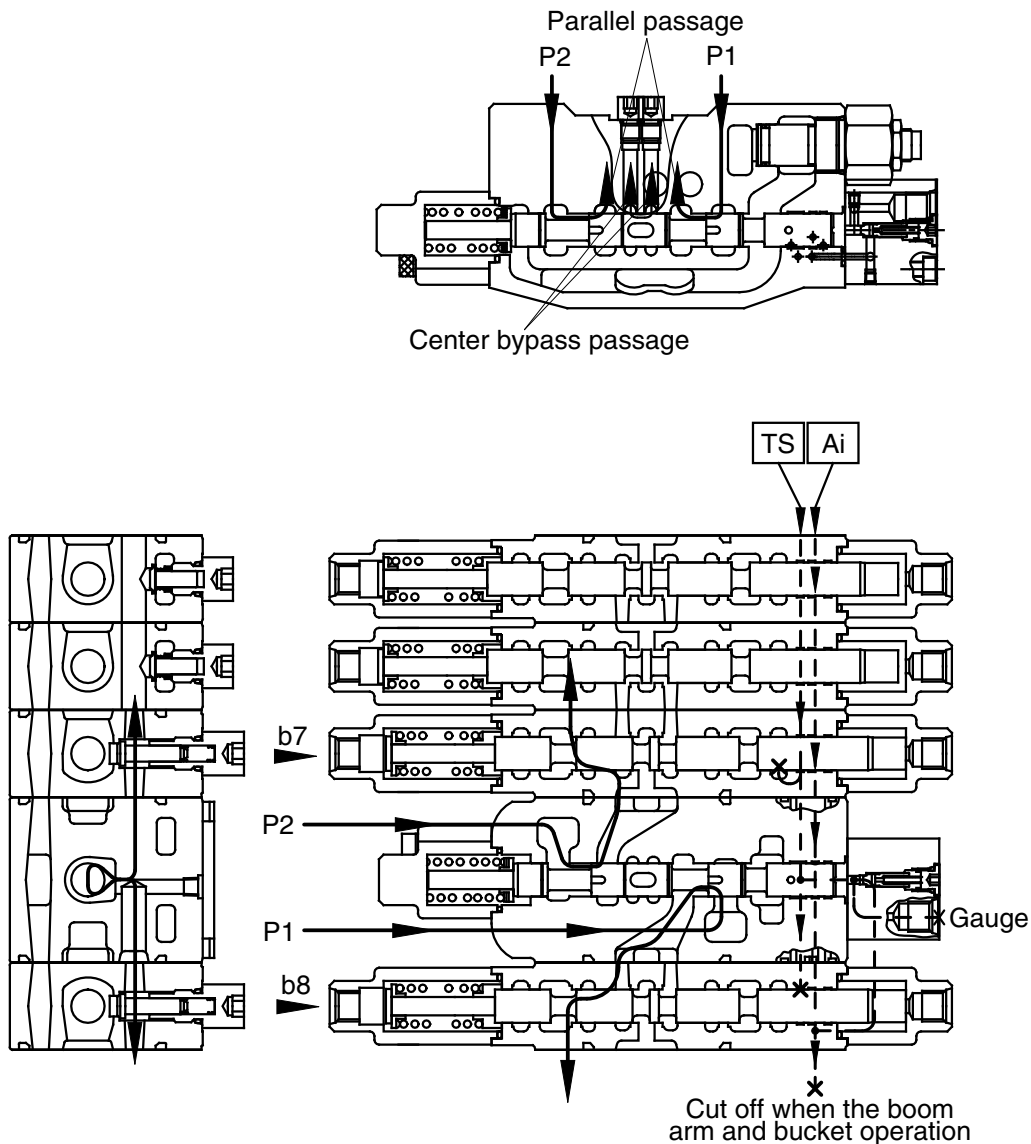
555C92MC16

- The pilot pressure from the RCV is supplied to the a1 and shift the swing spool in left direction. The hydraulic fluid from pump P3 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port A1. As a result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port B1, swing spool and the tank passage.

In case of swing left operation, the operation is similar.

- The TS signal passage oil from the Pp port is drain to the hydraulic oil tank through the left/right travel valve and the signal pressure is not raised.
- The Ai signal passage oil from the Pp port is shut off by shifting of the swing spool and then signal pressure of auto idle is raised.

## (6) Travel straight spool



55W92MC10

### ① The other actuator operation during travel operation.

When the other actuator spool(s) is selected under travel operation, the straight travel spool is moved.

Some of hydraulic fluid from pump P1 and P2 is supplied to the travel motors through parallel passage and the other hydraulic fluid is supplied to the actuator(s) through center bypass passage via orifice passage.

Thus, the machine keeps the speed and power of the actuator and travel.

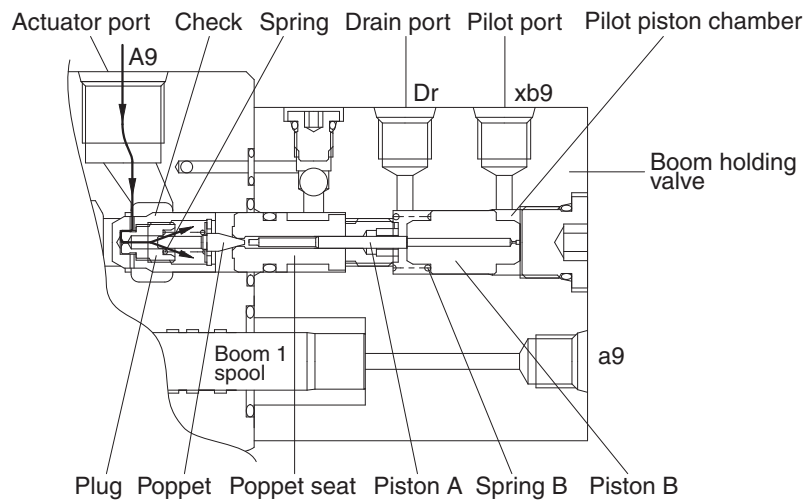
### ② The arm in operation during straight travel operation.

The arm in pilot pressure flows into P3 pilot port Sa through the external piping and the spool is shifted. As a result, the fluid of P3 pump is combined with the arm in operation through parallel passage and then the arm in speed up.

Refer to the arm in operation for the details.

## (7) Holding valve operation

### ① Holding operation



55W72MC16

At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.

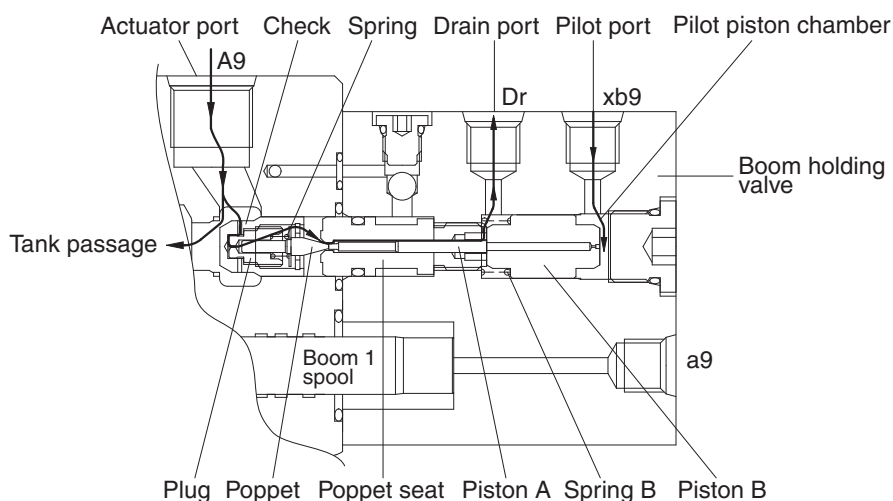
And the piston "B" is supported with spring "B".

Also, the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug.

Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body.

So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

### ② Release holding operation



55W72MC17

The pilot pressure is supplied to the pilot port for release holding valve and shifts the piston "B" in the left direction against the spring "B", and shifts the poppet in the left direction through piston "B" and piston "A" against spring "B" and shifts the spool in the left side.

At same time, the return fluid from actuator returns to the drain port through the periphery hole of check, crevice of the check and the plug, the periphery hole of the plug, in side of holding valve, crevice of the poppet and the poppet seat, the periphery hole of the poppet seat, crevice of socket and spool and internal passage of spool.

When the poppet is opened, pressure of inside of holding valve is decreased and the return fluid from actuator returns to the tank passage through the notch of spool.

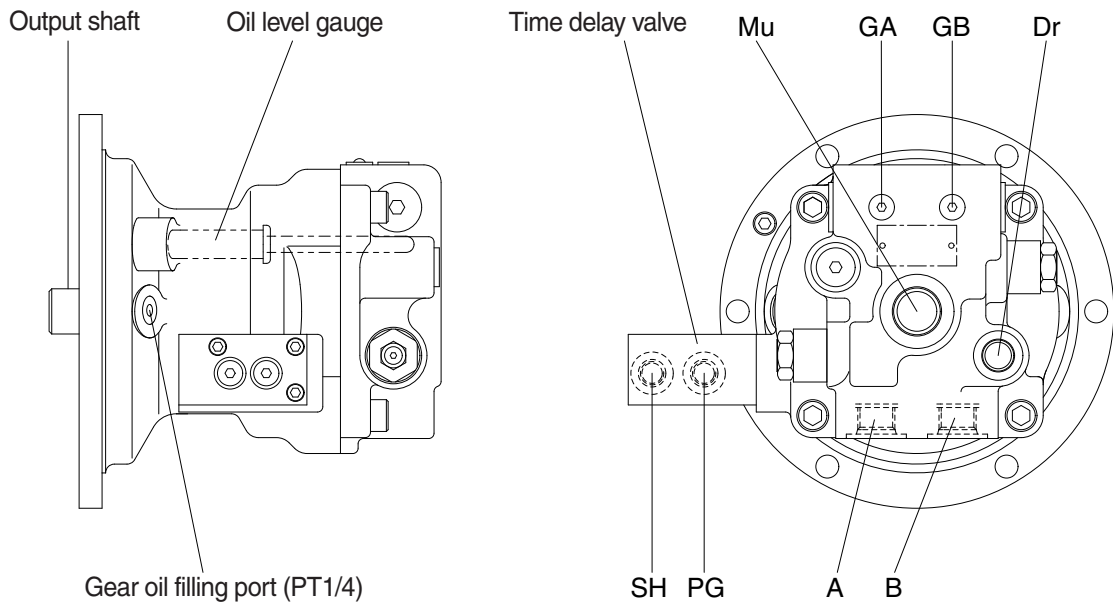
## GROUP 3 SWING DEVICE

### 1. STRUCTURE

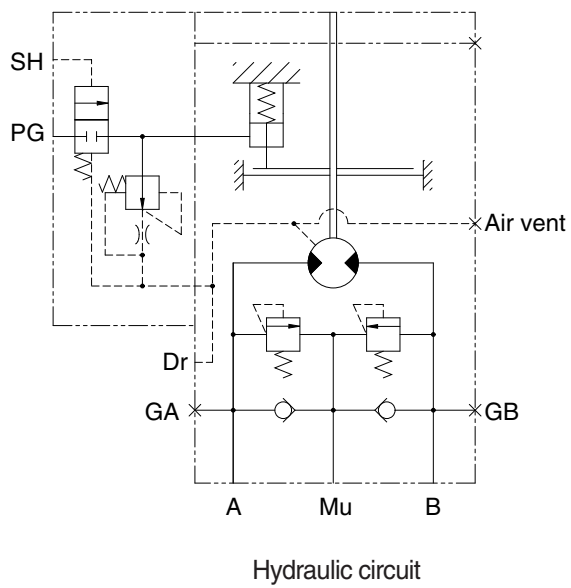
Swing device consists swing motor, swing reduction gear.

#### 1) SWING MOTOR

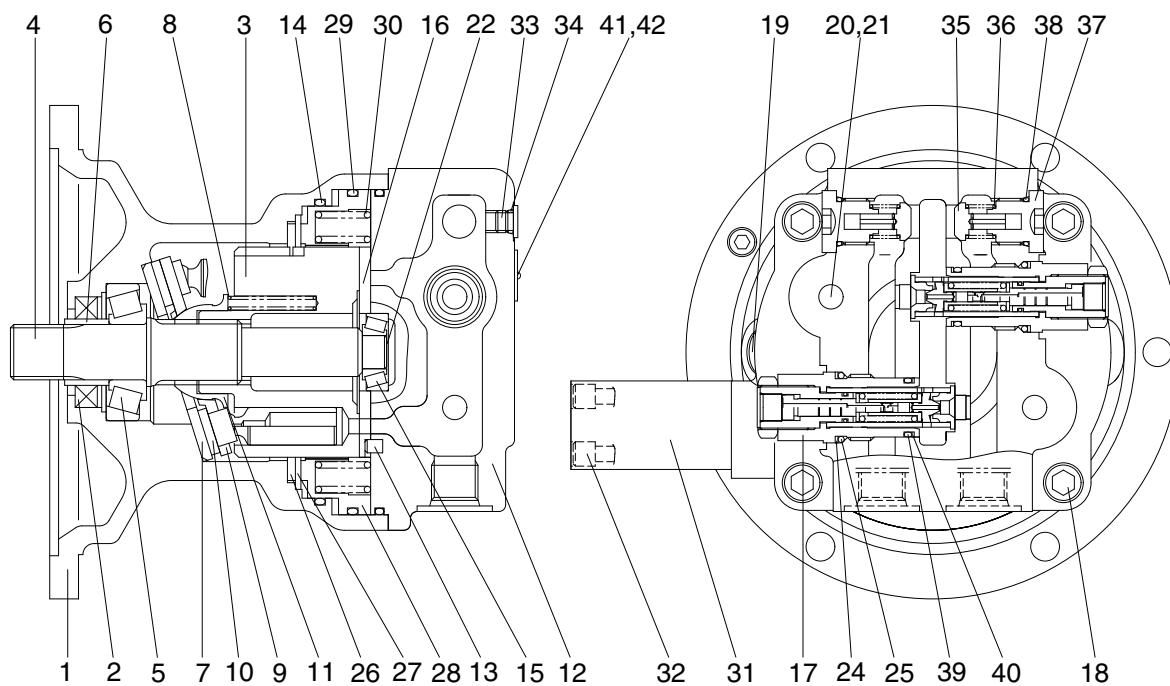
Swing motor include mechanical parking valve, relief valve, make up valve and time delay valve.



555K2SM01



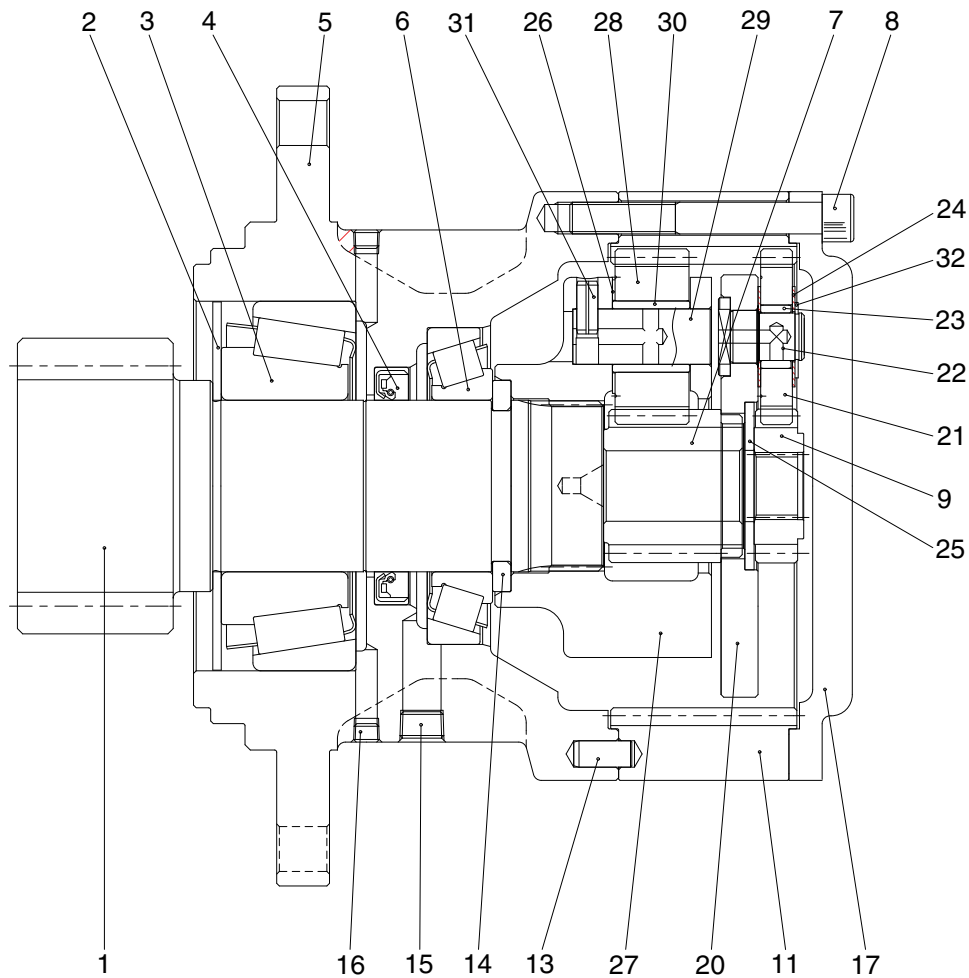
| Port  | Port name                   | Port size  |
|-------|-----------------------------|------------|
| A     | Main port                   | SAE PF 1/2 |
| B     | Main port                   | SAE PF 1/2 |
| Dr    | Drain port                  | PF 3/8     |
| Mu    | Make up port             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



555K2SM03

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

## 2) REDUCTION GEAR



55W72SM02

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

## 2. FUNCTION

### 1) ROTARY PART

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

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

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

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

p : Effective difference of pressure (kgf/cm<sup>2</sup>)

q : Displacement (cc/rev)

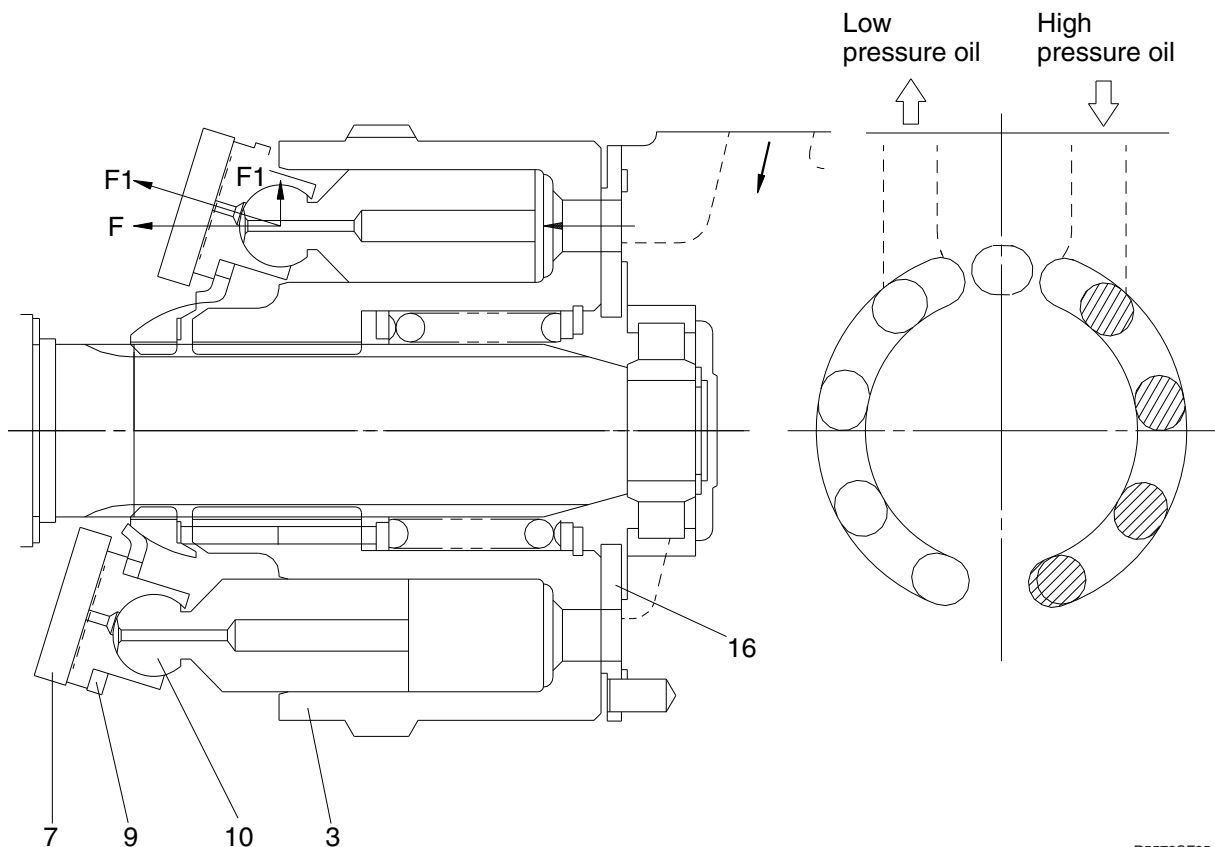
T : Output torque (kgf · cm)

Z : Piston number (9EA)

A : Piston area (cm<sup>2</sup>)

θ : Tilting angle of swash plate (degree)

S : Piston stroke (cm)



R5572SF35

## 2) MAKE UP VALVE

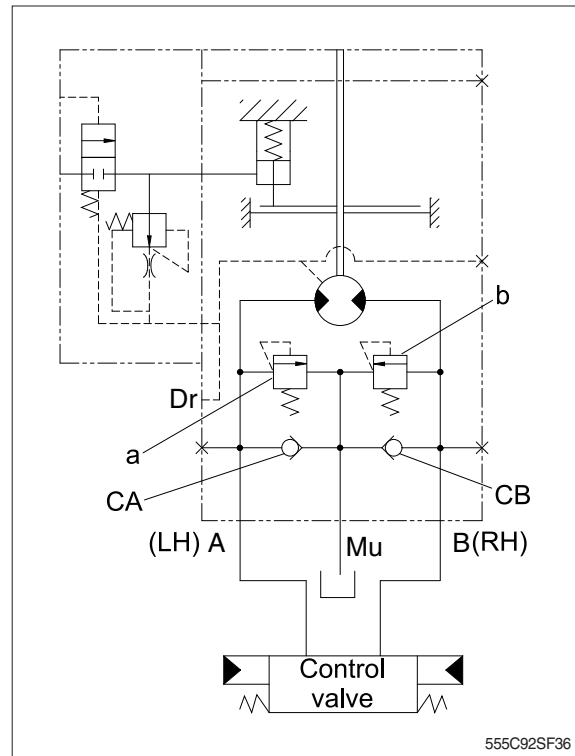
### (1) Outline

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

### (2) Function

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

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



### (3) Operation

#### ① When starting swing

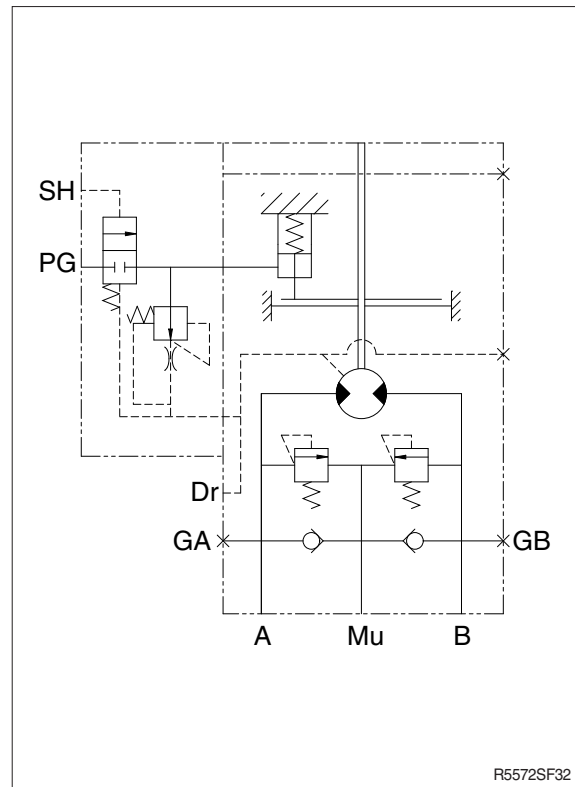
When the swing control lever is operated to left swing, the pressurized oil from the pump passes through the control valves and is supplied to port B. Because of this, the pressure at port B rises, starting torque is generated in the motor, and the motor starts to rotate. The oil from the outlet port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

② When stopping swing

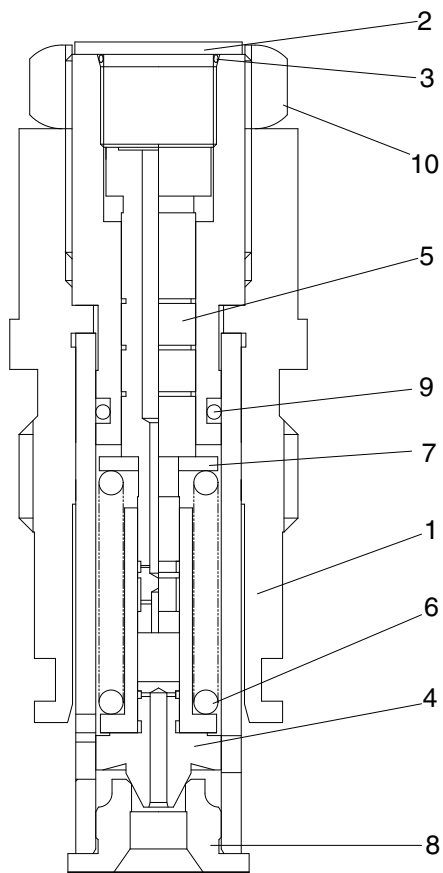
- When the swing control lever is returned to neutral, no pressurized oil is supplied from the pump to port B.

The return circuit to the tank is closed by the control valve. So the oil from the outlet port of the motor increases in pressure at port A. Resistance to the rotation of the motor is created, and the brake starts to act.

- The pressure at port A rises to the set pressure of make up valve a, and in this way, a high brake torque acts on the motor, and the motor stops.
- When make up valve a is being actuated, the relief oil from make up valve a and the oil from port Mu pass through check valve CB and are supplied to port B. This prevents cavitation from forming at port B.



### 3) RELIEF VALVE



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

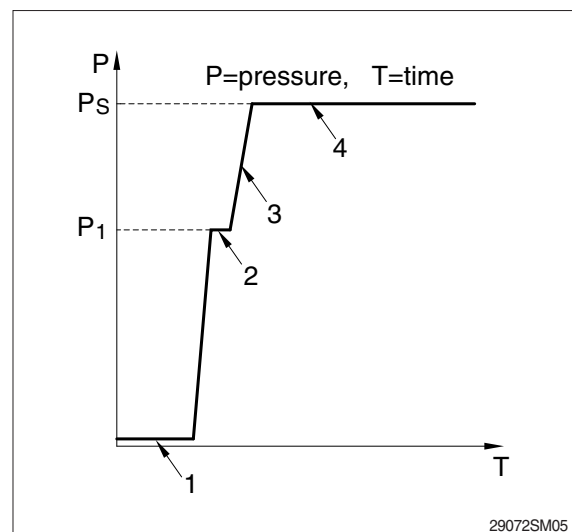
555C92SF37

#### (1) Construction of relief valve

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

#### (2) Function of relief valve

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



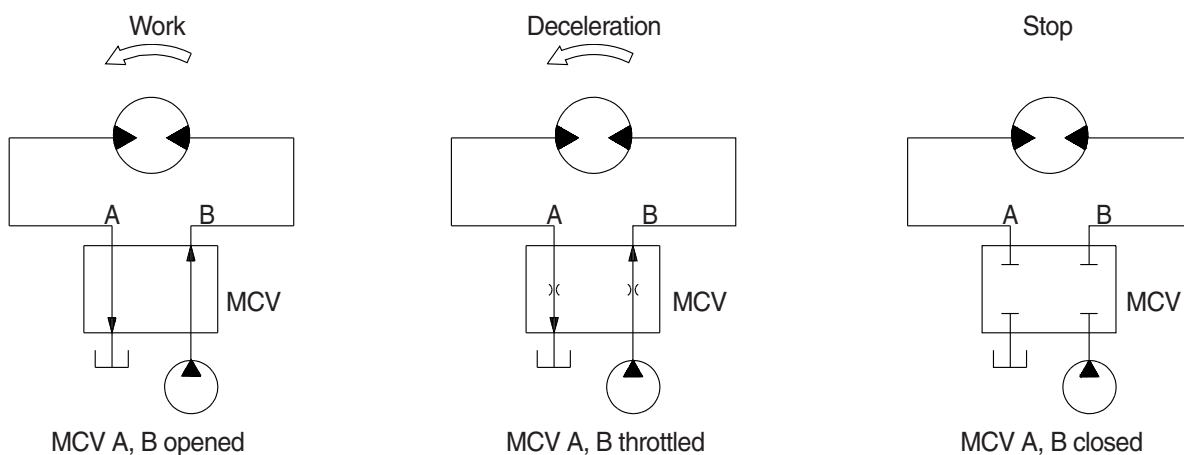
29072SM05

## 4) BRAKE SYSTEM

### (1) Control valve swing brake system

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

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



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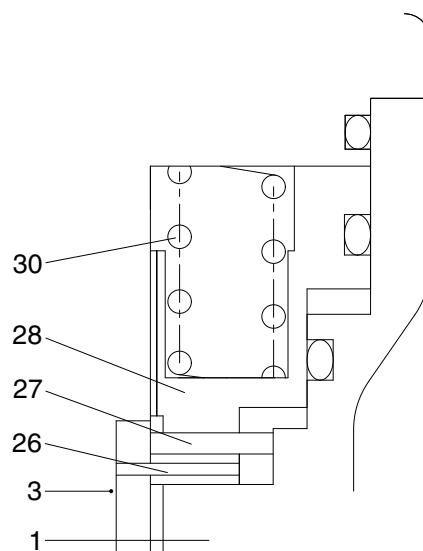
### (2) Mechanical swing parking brake system

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

#### ① Brake assembly

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

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



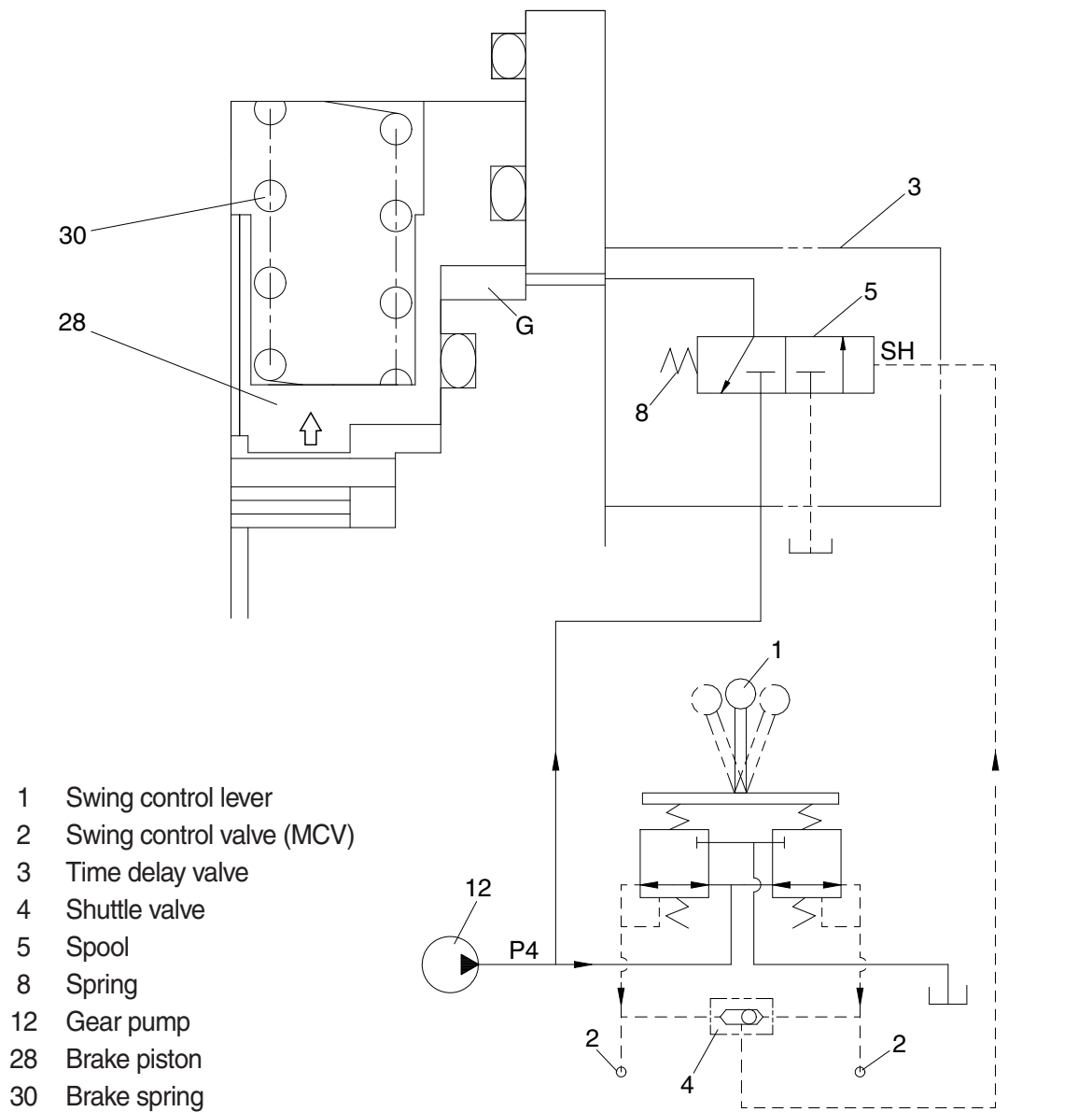
R5572SF38

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

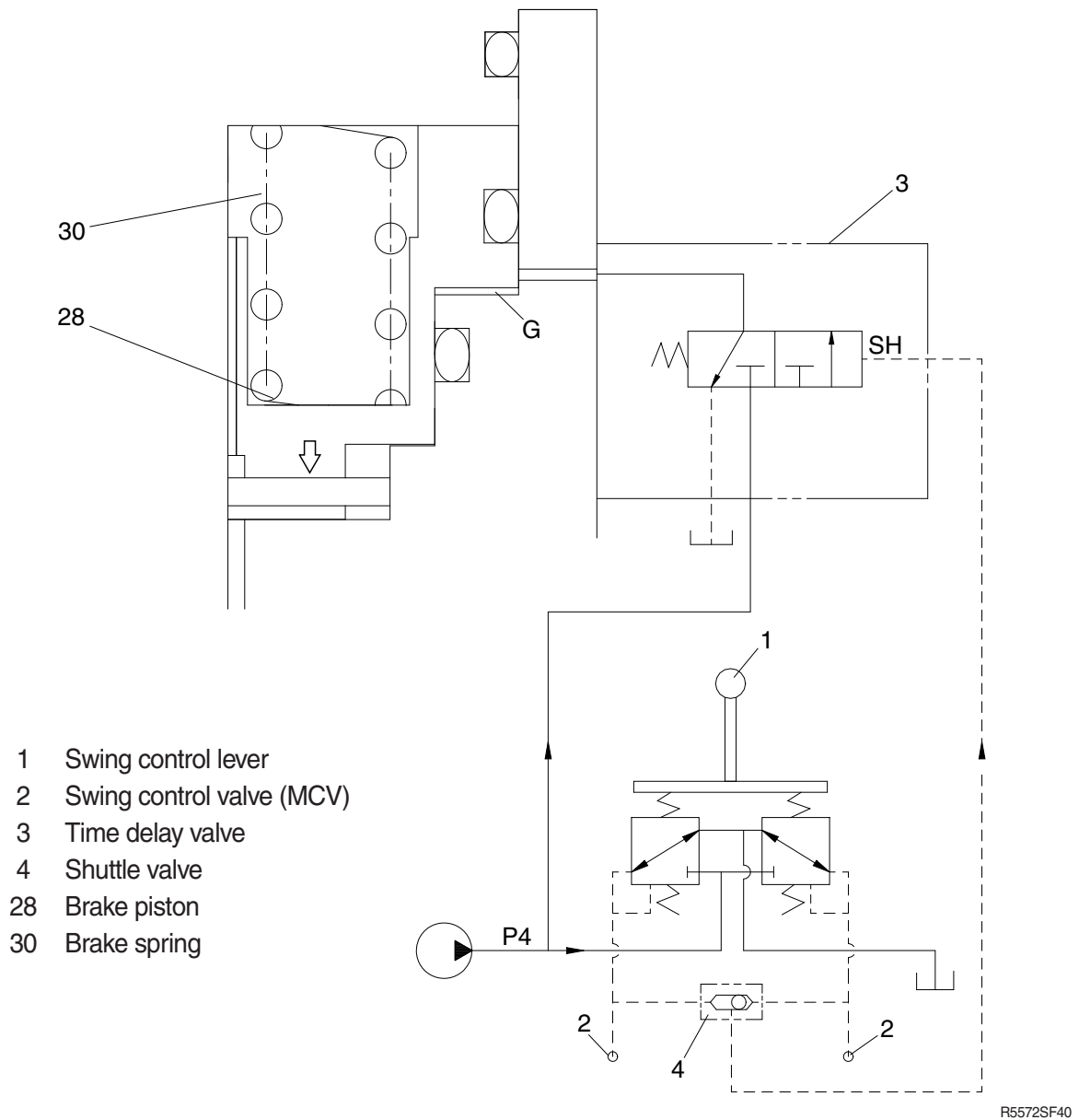
## ② Operating principle

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

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



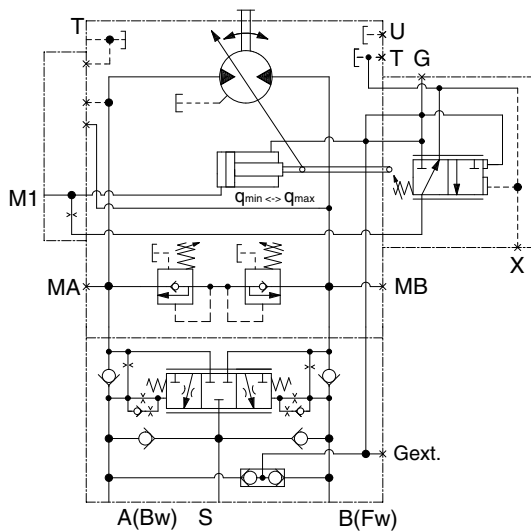
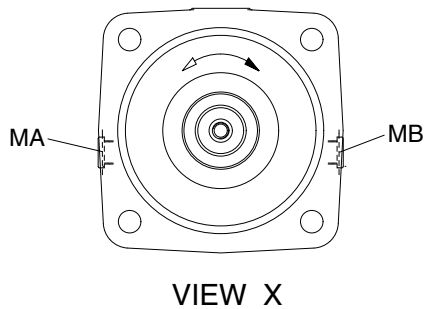
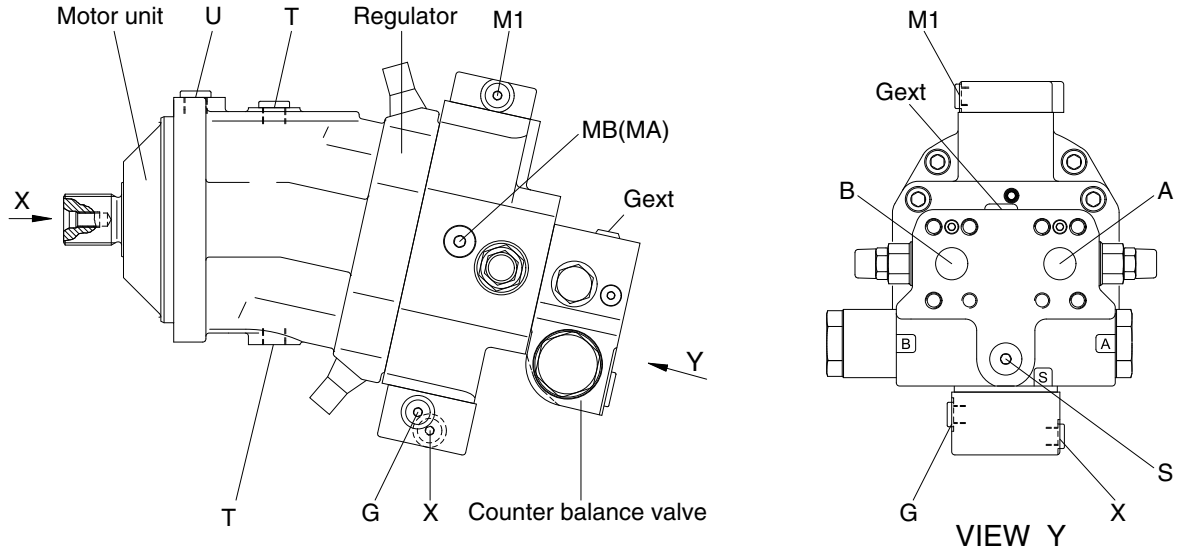
- b. When the swing control lever (1) is set the neutral position, the time delay valve (3) shifts the neutral position and the pilot oil blocked chamber G.
- Then, the piston (28) is moved lower by spring (30) force and the return oil from the chamber G is drain.



## GROUP 4 TRAVEL DEVICE

### 1. CONSTRUCTION

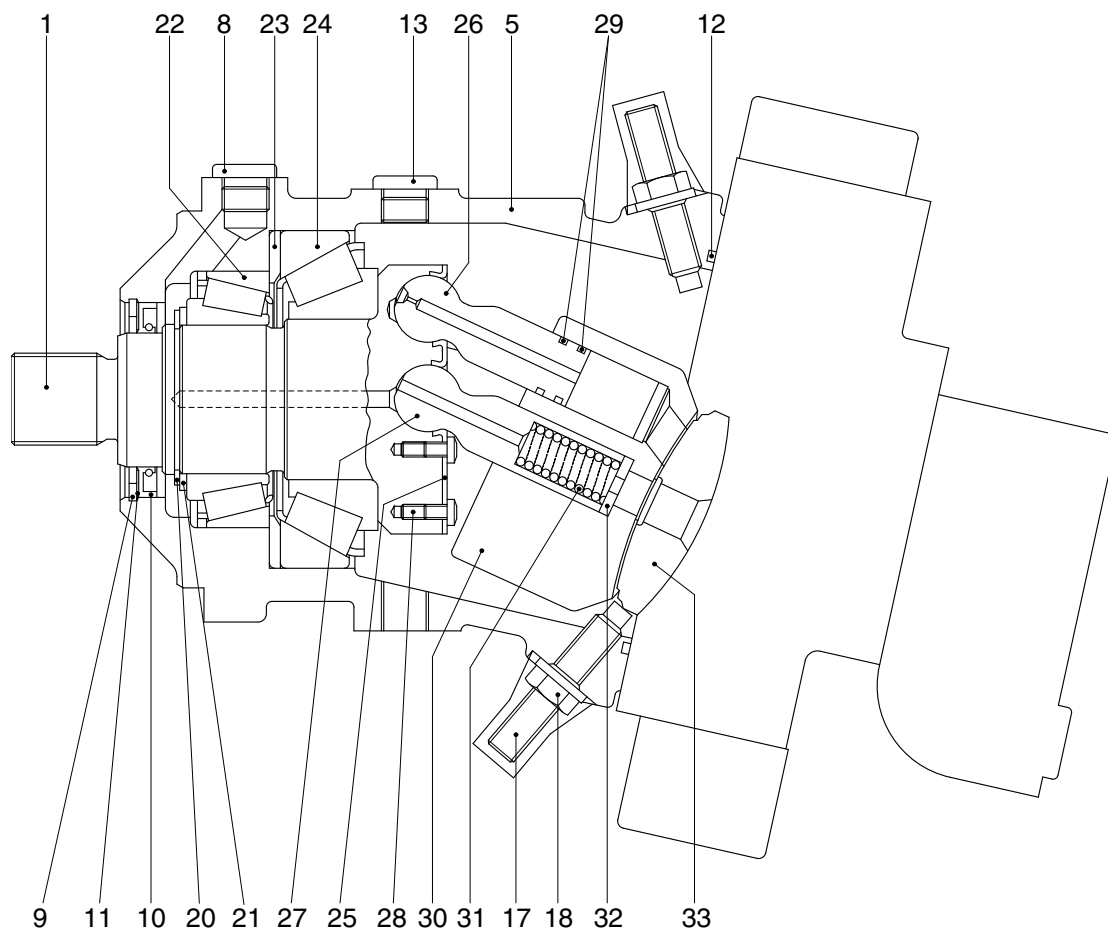
Travel motor consists motor unit, regulator and counter balance valve.



Hydraulic circuit

| Port  | Port name           | Port size     |
|-------|---------------------|---------------|
| A, B  | Main port           | SAE 6000psi 1 |
| G     | Gauge port          | M14 × 1.5     |
| M1    | Gauge port          | M14 × 1.5     |
| X     | Pilot pressure port | M14 × 1.5     |
| T     | Drain port          | PF1/2 - 15    |
| U     | Flushing port       | PF1/2 - 16    |
| S     | Make up port        | M22 × 1.5     |
| MA,MB | Gauge port          | M18 × 1.5     |
| Gext  | Brake release port  | M12 × 1.5     |

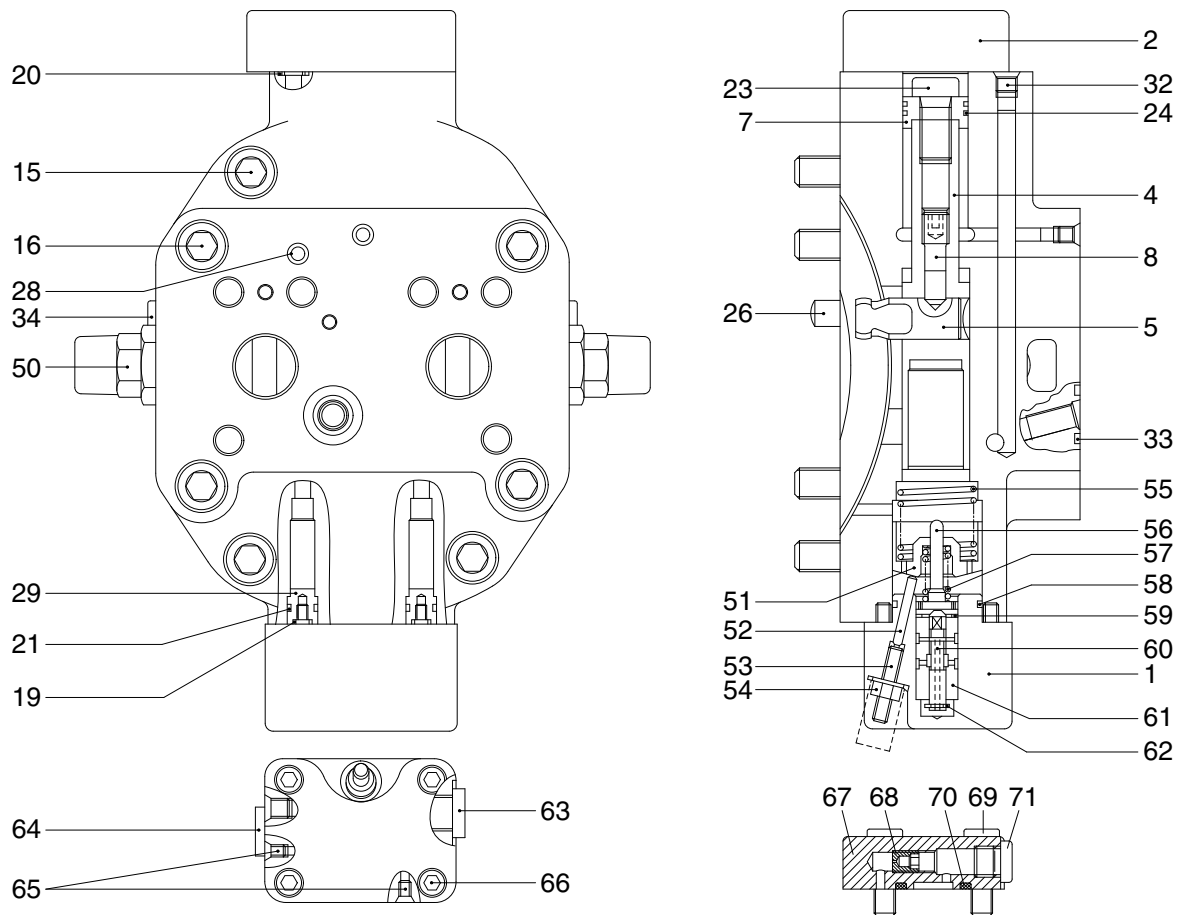
## 1) MOTOR UNIT



200W34TM02

|    |                 |    |                      |    |                    |
|----|-----------------|----|----------------------|----|--------------------|
| 1  | Drive shaft     | 17 | Threaded pin         | 26 | Piston             |
| 5  | Housing         | 18 | Seal lock nut        | 27 | Center pin         |
| 8  | Locking screw   | 20 | Retaining ring       | 28 | Pan head screw     |
| 9  | Retaining ring  | 21 | Back up plate        | 29 | Steel sealing ring |
| 10 | Shaft seal ring | 22 | Taper roller bearing | 30 | Cylinder block     |
| 11 | Back up plate   | 23 | Shim                 | 31 | Pressure spring    |
| 12 | O-ring          | 24 | Taper roller bearing | 32 | Adjustment shim    |
| 13 | Locking screw   | 25 | Retaining plate      | 33 | Control lens       |

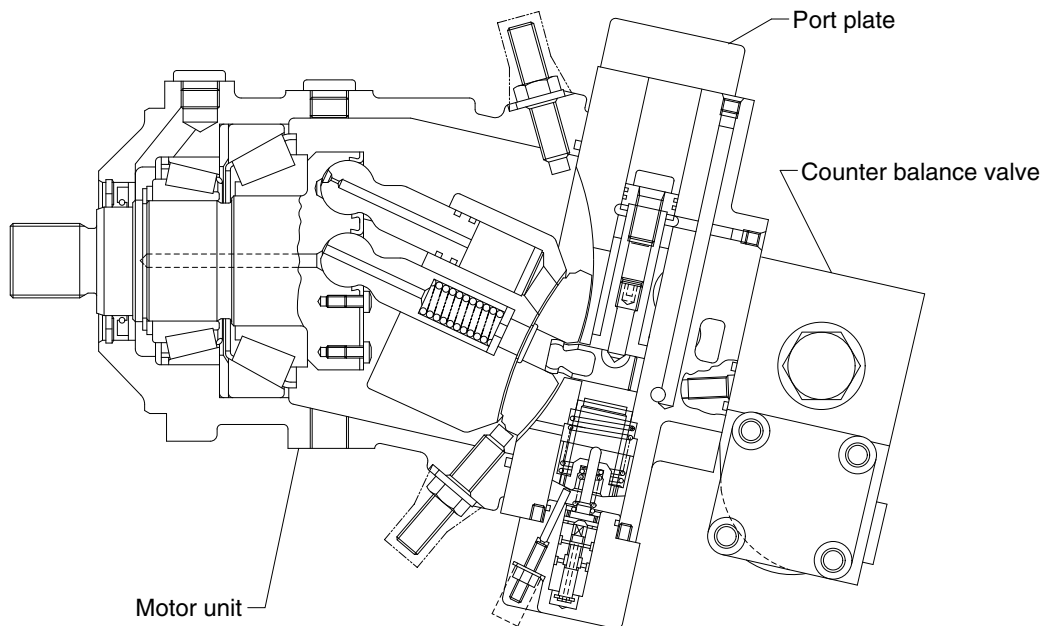
## 2) REGULATOR



55W72TM03

|    |                      |    |                      |    |                      |
|----|----------------------|----|----------------------|----|----------------------|
| 1  | Control housing      | 28 | Double break off pin | 59 | Retaining ring       |
| 2  | Cover                | 29 | Plug                 | 60 | Control piston       |
| 4  | Positioning piston   | 32 | Double break off pin | 61 | Control bushing      |
| 5  | Positioning trunnion | 33 | O-ring               | 62 | Retaining disc       |
| 7  | Piston               | 34 | Locking screw        | 63 | Locking screw        |
| 8  | Threaded pin         | 50 | Relief valve         | 64 | Locking screw        |
| 15 | Socket head screw    | 51 | Adjusting bushing    | 65 | Double break off pin |
| 16 | Socket head screw    | 52 | Cylinder pin         | 66 | Socket head screw    |
| 19 | O-ring               | 53 | Threaded pin         | 67 | Cover                |
| 20 | O-ring               | 54 | Seal lock nut        | 68 | Throttle screw       |
| 21 | O-ring               | 55 | Pressure spring      | 69 | Socket head screw    |
| 23 | Socket head screw    | 56 | Spring collar        | 70 | O-ring               |
| 24 | Square ring          | 57 | Pressure spring      | 71 | Locking screw        |
| 26 | Cylinder pin         | 58 | O-ring               |    |                      |

## 2. FUNCTION



14W72TM05

### 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°.

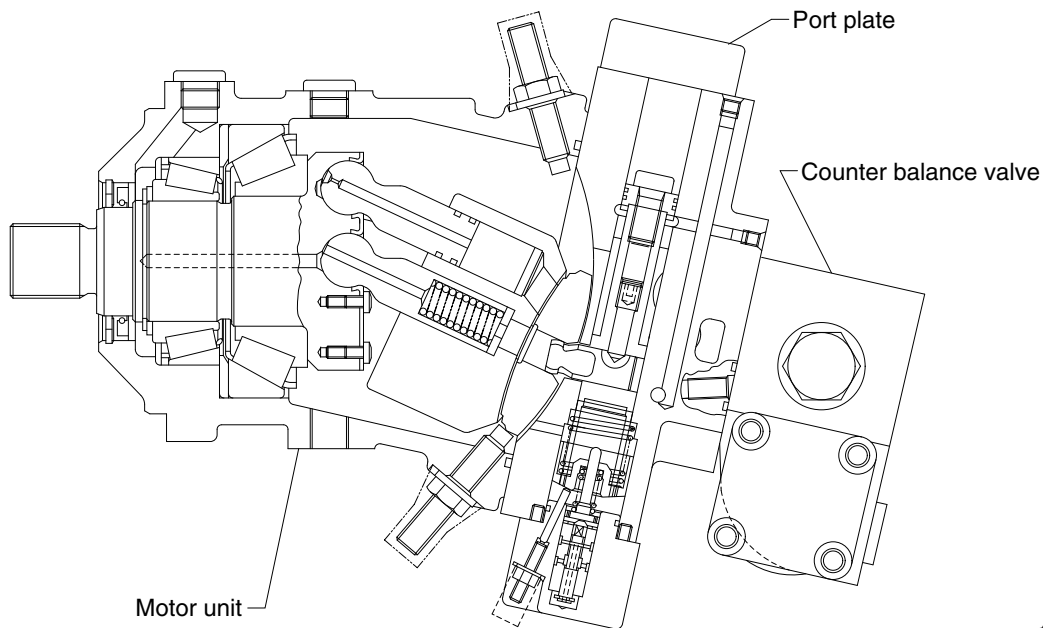
The variable displacement motor with integrated counterbalance valve is designed to be operated in open loop.

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.



14W72TM05

### 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.

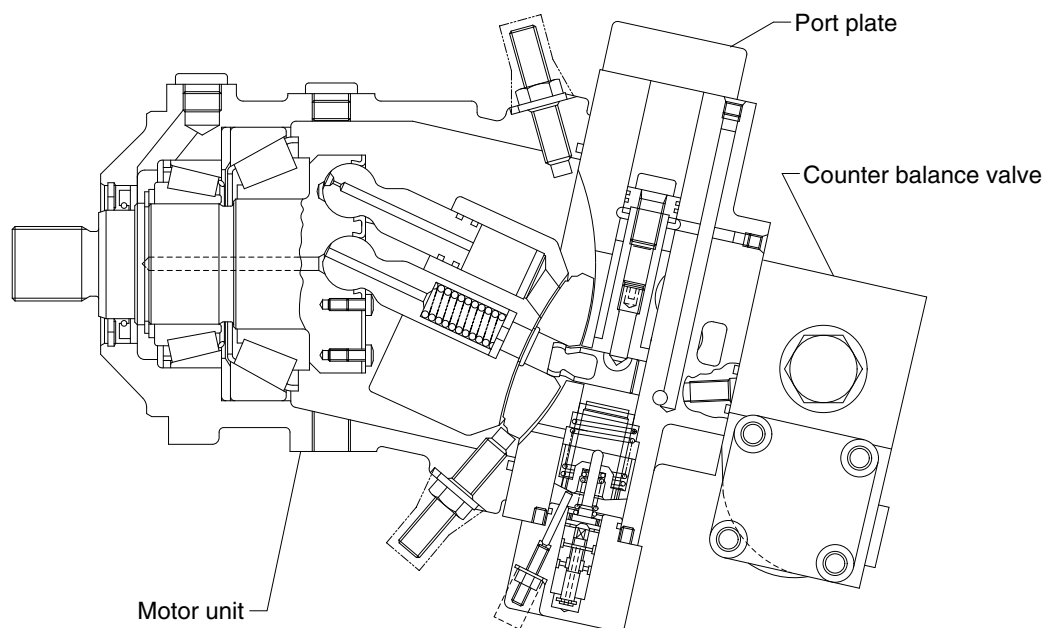
Braking means for the motor that

- 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.



14W72TM05

## 6) INSTALLATION

The housing must be filled entirely with oil and shall also not run empty at rotary group standstill.

## 7) FILTRATION

According to purity class 9 as to NAS 1638, 6 as to SAE, ASTM, AIA and 18/15 as to ISO/DIS 4406.

## 8) PRESSURE

Ports A or B : Normal 400bar, peak pressure 450 bar

Port A + B : Pressure summation below 700 bar

Max permissible intermittent case pressure : 6 bar

## 9) DIRECTION OF ROTATION/ DIRECTION OF FLOW

With view on the drive shaft - clockwise/ A to B; Counter-clockwise/ B to A

## 10) LEAKAGE OIL TEMPERATURE

In the bearing area max permitted -25°C to +80°C; Short time operation -40°C to +115°C

## 11) COMMISSIONING

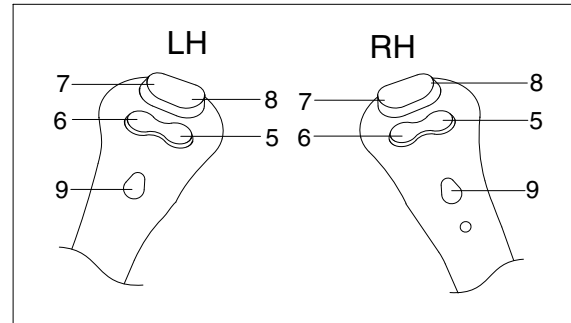
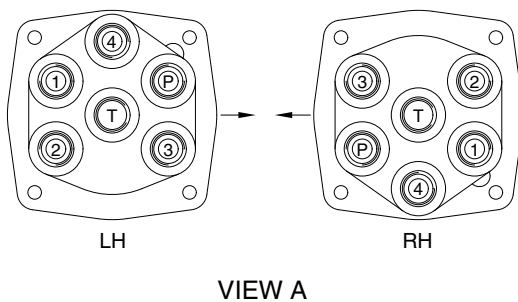
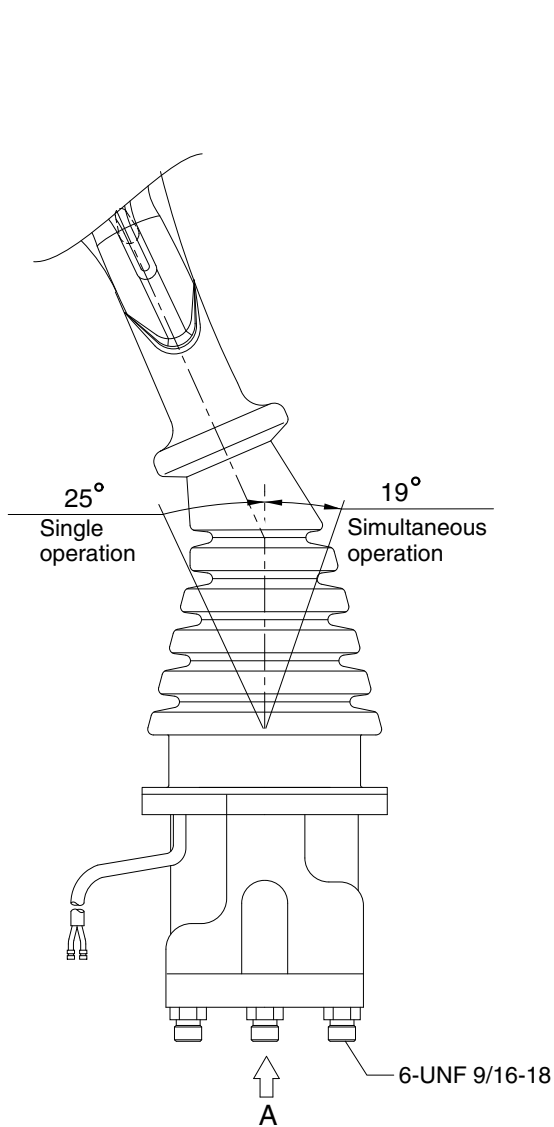
Fill the housing entirely with oil through highest located T port. Also connect the leakage oil pipe at this port. After commissioning check sealing and make visual control of the complete installation.

## 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.

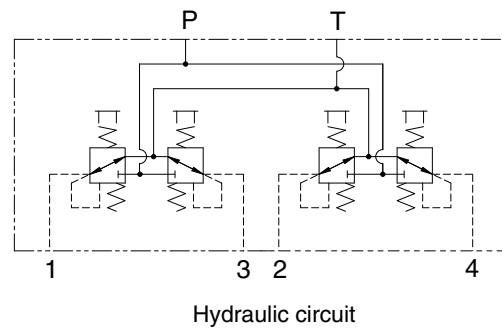
#### 1) 타입 S1, S2



Type S1

#### Switches

| Type   | No. | LH                         | RH                              |
|--------|-----|----------------------------|---------------------------------|
| S1, S2 | 5   | Horn                       | Breaker                         |
|        | 6   | Ram lock                   | Proportional type ON/OFF switch |
|        | 7   | Rotating-CCW               | Clamp                           |
|        | 8   | Rotating-CW                | Release                         |
|        | 9   | Boom swing/ Rotating (opt) | N.A                             |



#### Pilot port

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

HX60AMT2RL02K

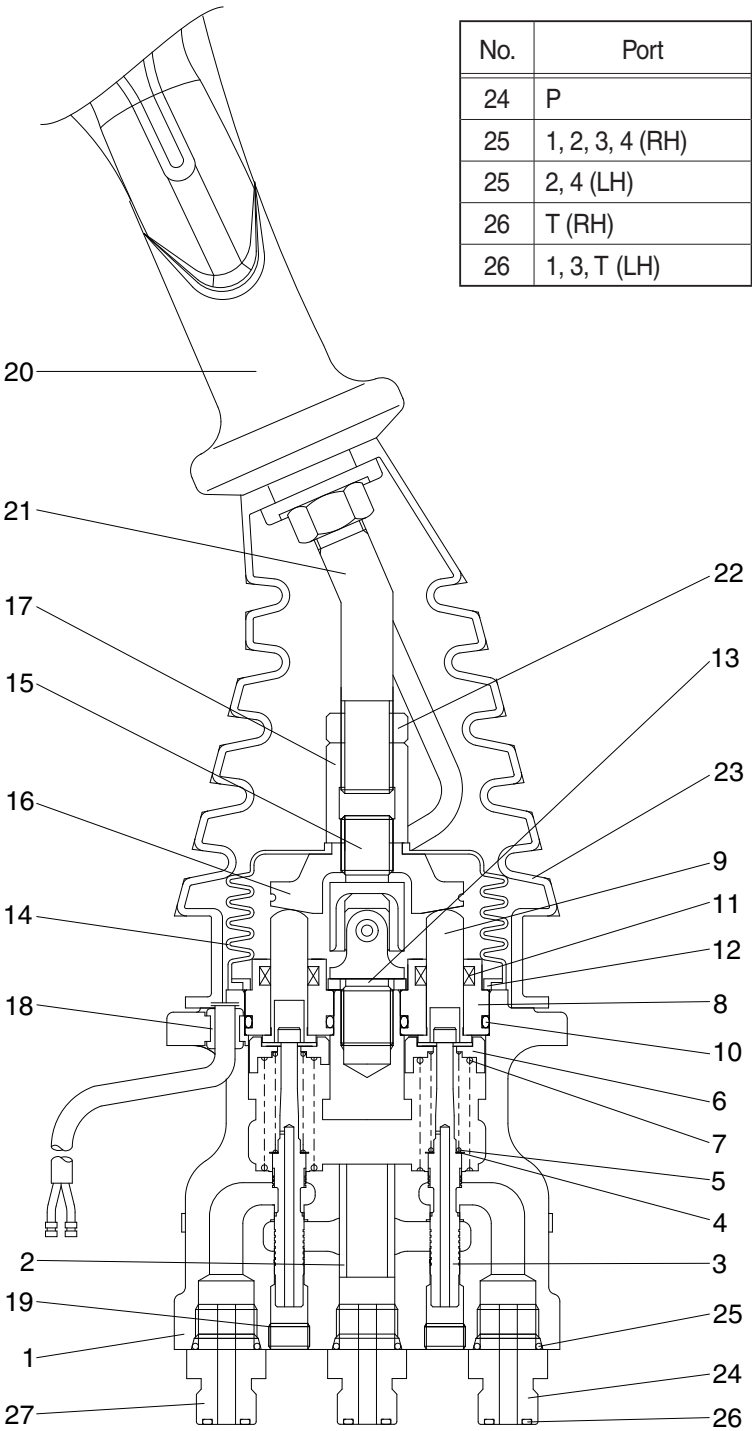
## CROSS SECTION

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

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

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

# CROSS SECTION



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

300L2RL06K

## **2. FUNCTIONS**

### **1) FUNDAMENTAL FUNCTIONS**

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

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

- (1) Inlet port (P) where oil is supplied from hydraulic pump.
- (2) Output ports (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.
- (3) Tank port (T) necessary to control the above output pressure.
- (4) Spool to connect output port to inlet port or tank port.
- (5) Mechanical means to control output pressure, including springs that work on the above spools.

### **2) FUNCTIONS OF MAJOR SECTIONS**

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

The spring (9) works on this spool to determine the output pressure.

The change the deflection of this spring (5), the push rod (9) is inserted and can slide in the plug (14).

For the purpose of changing the displacement of the push rod through the swash plate (16) and adjusting nut (17) are provided the handle (20) that can be tilted in any direction around the fulcrum of the universal joint (19) center.

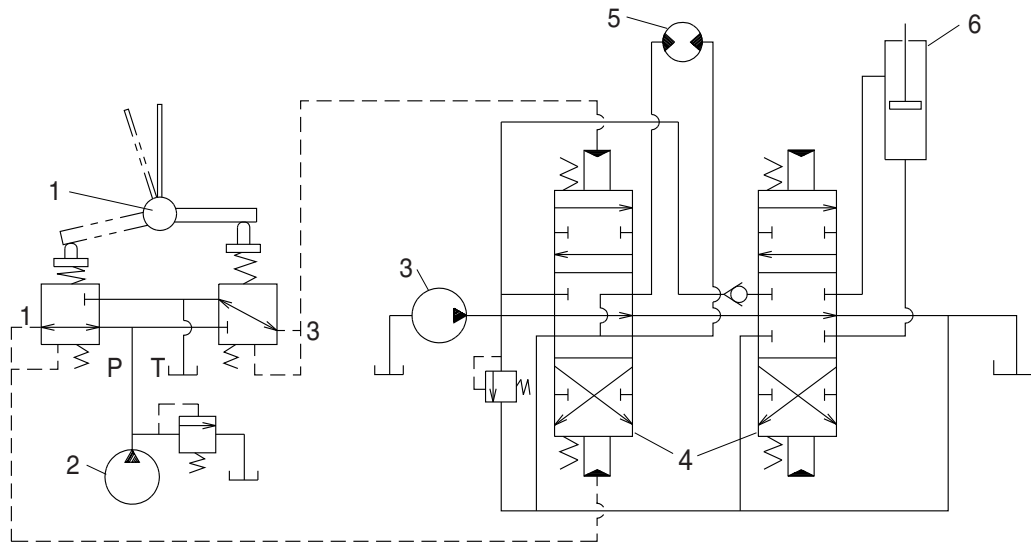
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

### 3) OPERATION

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

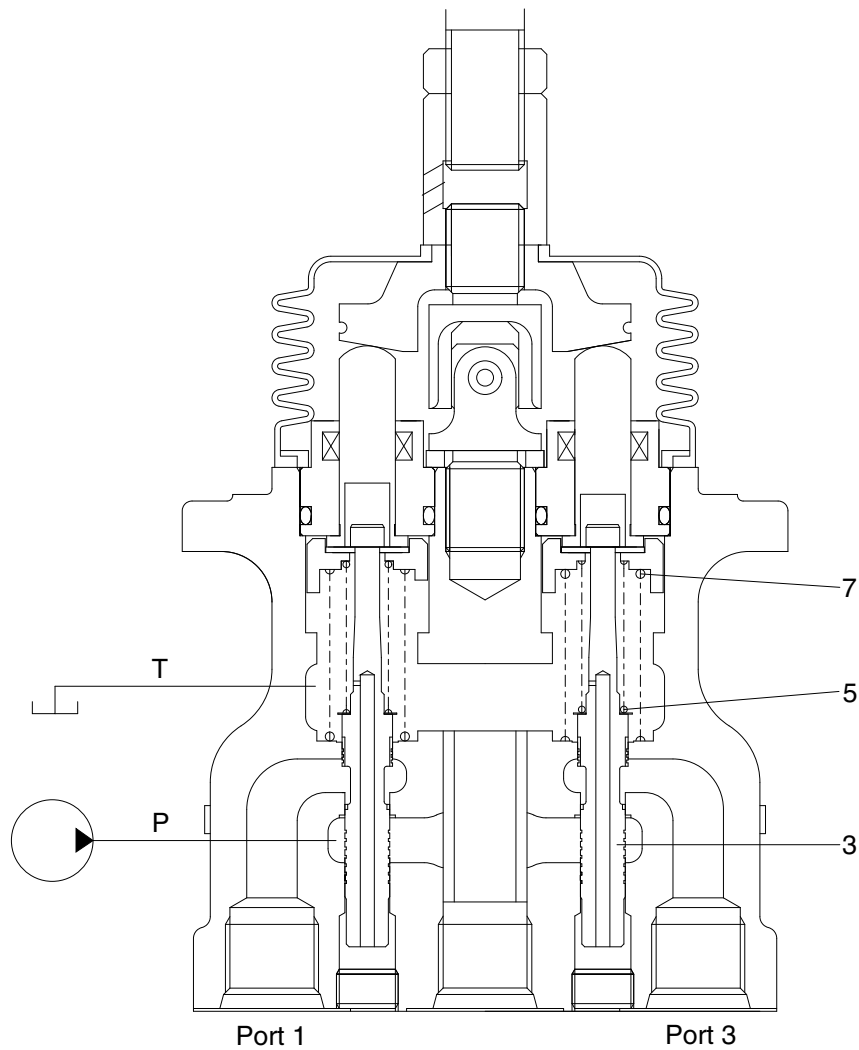
The diagram shown below is the typical application example of the pilot valve.



2-70

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

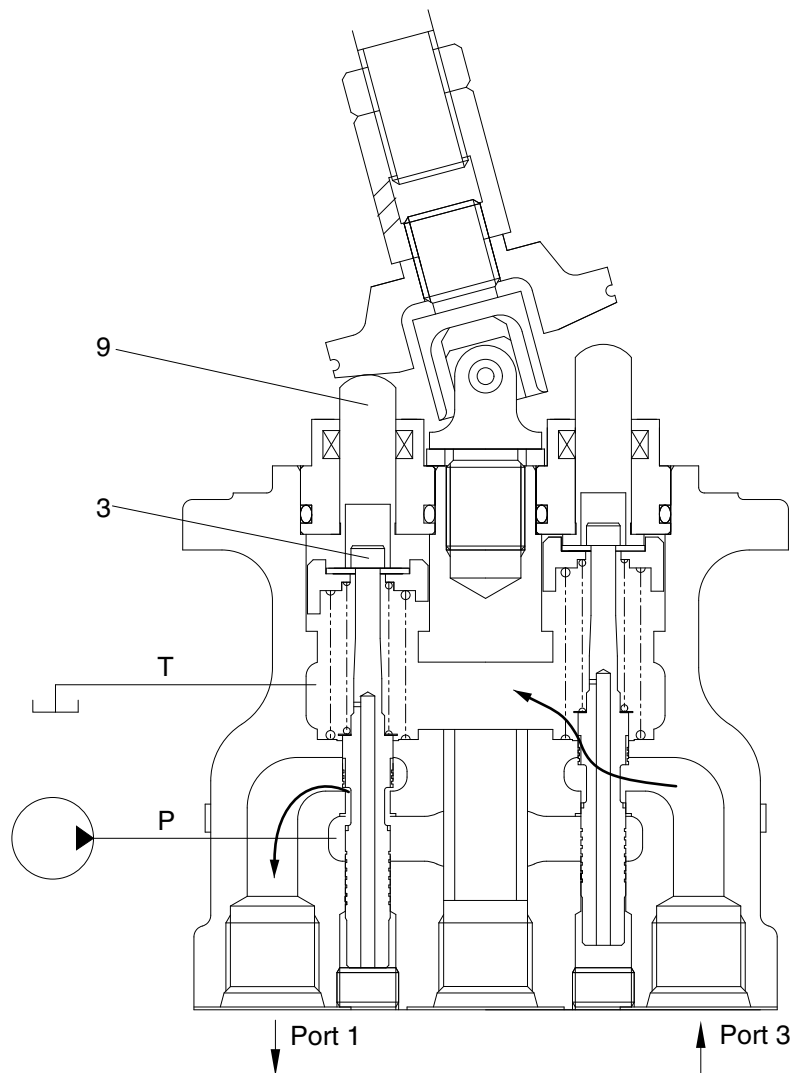
(1) Case where handle is in neutral position



300L2RL03

The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (3). Therefore, the spool is pushed up by the spring (7) to the position of port (1, 3) in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

## (2) Case where handle is tilted



300L2RL04

When the push rod (9) is stroked, the spool (3) moves downwards.

Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.

When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.

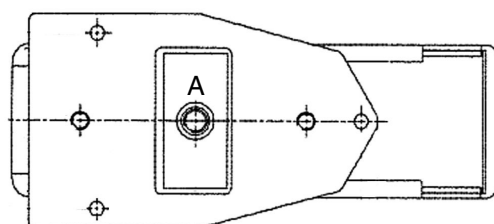
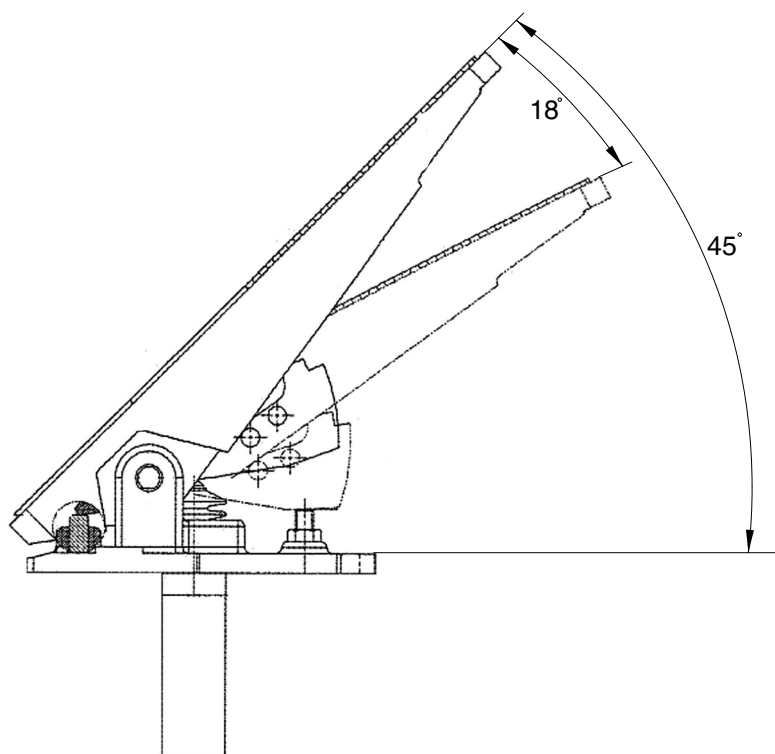
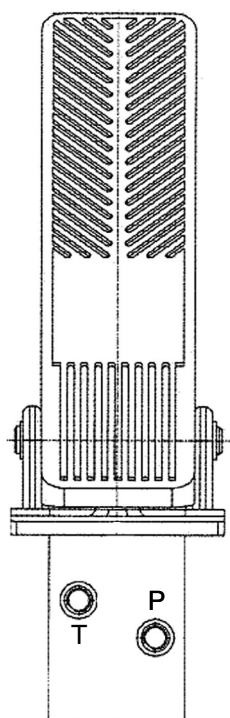
In this manner the secondary pressure is kept at the constant value.

Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

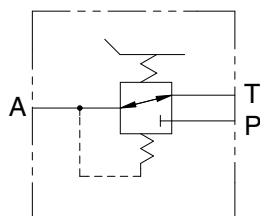
## GROUP 6 RCV PEDAL

### 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.



HW602AP01

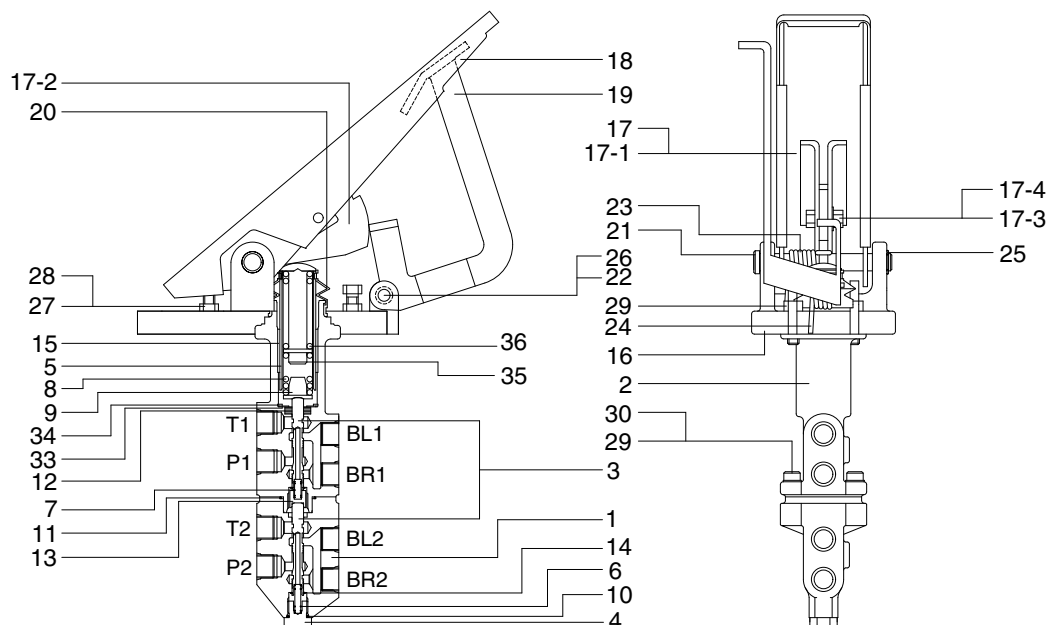


| Port | Port name             | Port size |
|------|-----------------------|-----------|
| P    | Pilot oil inlet port  | PF 1/4    |
| T    | Pilot oil return port |           |
| A    | Pilot oil output port |           |

## GROUP 7 BRAKE PEDAL (VALVE)

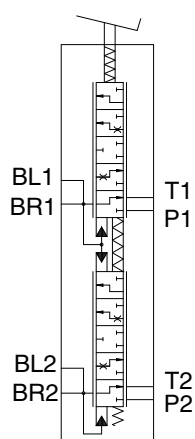
### 1. STRUCTURE

The casing (spacer) has the oil inlet port A(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.



HW60A2BV01

- |                   |                  |                     |
|-------------------|------------------|---------------------|
| 1 Lower body      | 14 Stop ring-C   | 23 Torsion spring 1 |
| 2 Upper body      | 15 DU bushing    | 24 Torsion spring 2 |
| 3 Spool           | 16 Pedal plate   | 25 Stop ring-C      |
| 4 Plug            | 17 Pedal assy    | 26 E-ring           |
| 5 Holder          | 17-1 Pedal       | 27 Hex bolt         |
| 6 Lower spring    | 17-2 Lock plate  | 28 Hex nut          |
| 7 Upper spring    | 17-3 Hex bolt    | 29 Socket head bolt |
| 8 Main spring     | 17-4 Plat washer | 30 Spring washer    |
| 9 Spring retainer | 18 Pedal rubber  | 33 Plat washer      |
| 10 O-ring         | 19 Latch         | 34 Stop ring-C      |
| 11 O-ring         | 20 Rubber cover  | 35 Spring retainer  |
| 12 Oil seal       | 21 Lock pin 1    | 36 Main spring      |
| 13 Spring guide   | 22 Lock pin 2    |                     |



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

## **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 spring assembly (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 spring assembly (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) 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**

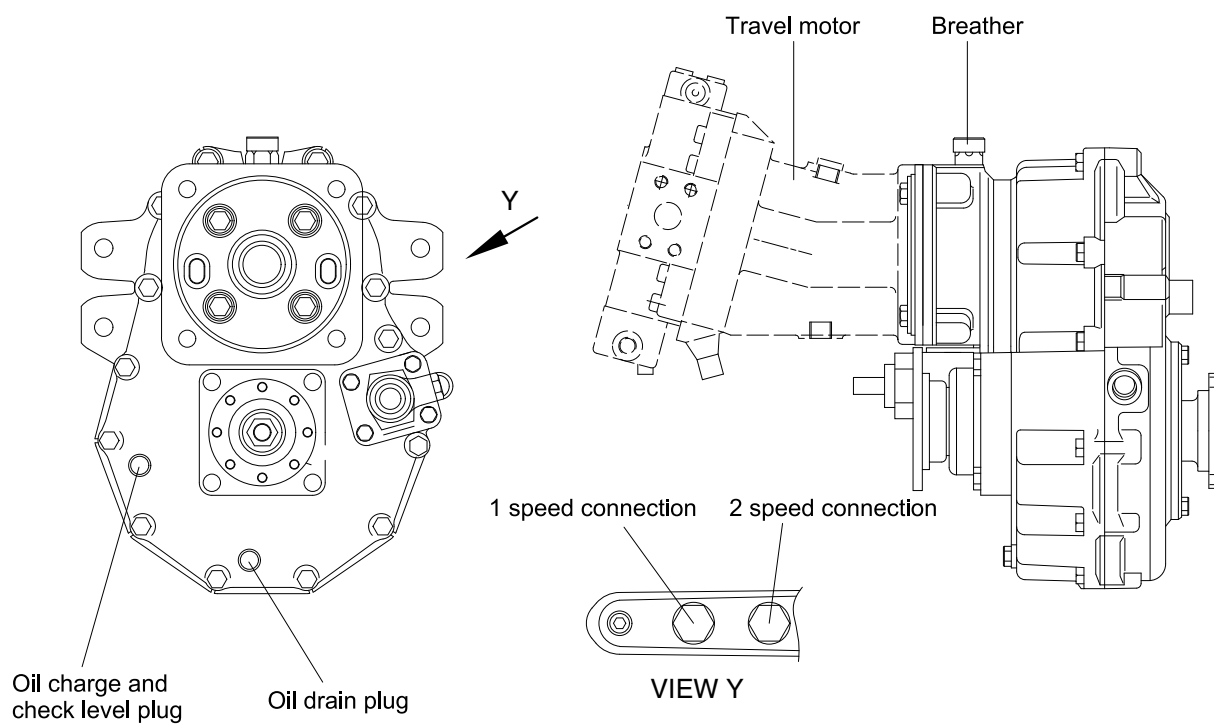
Pedal restriction screw (29) on pedal plate (16) below pedal (17) is used to limit the braking pressure.

### **6) FAILURE OF A CIRCUIT**

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (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 spring assembly (8) and spool (3).

## GROUP 8 GEAR BOX

### 1. STRUCTURE

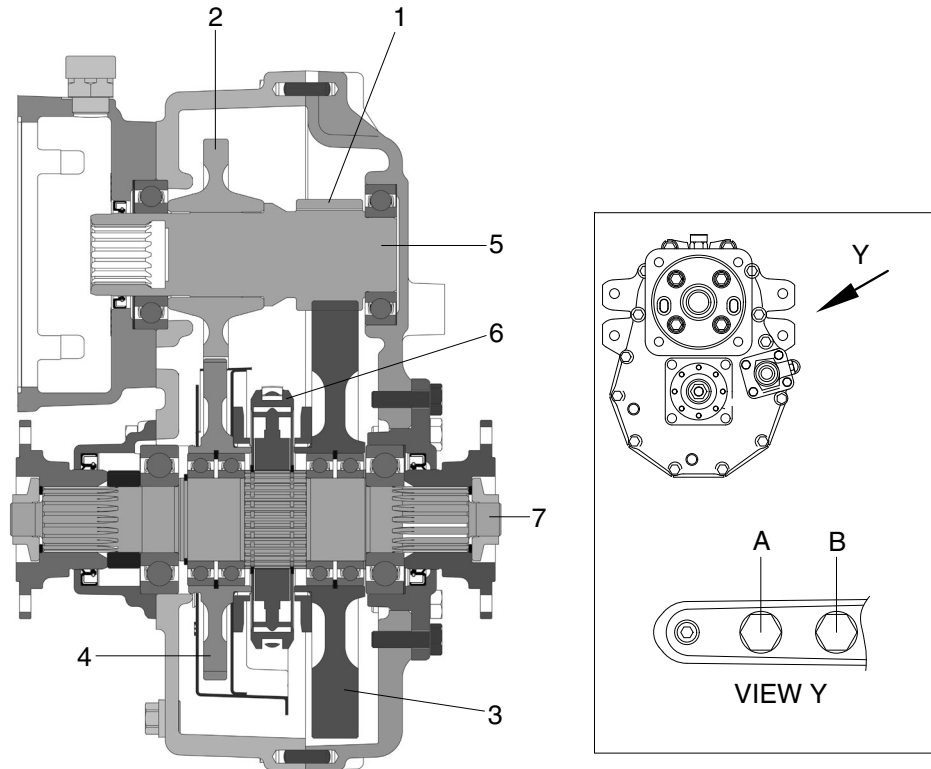


HW65AH2GB01

## 2. GEAR BOX FUNCTION

It explains mechanism, function operation principle and caution in the operation of transfer gear box applied to for this equipment.

### 1) GEAR BOX MECHANISM



HW60A2GB02

- |   |                     |   |                     |   |              |
|---|---------------------|---|---------------------|---|--------------|
| 1 | Input shaft gear 1  | 4 | Output shaft gear 2 | 7 | Output shaft |
| 2 | Input shaft gear 2  | 5 | Input shaft         |   |              |
| 3 | Output shaft gear 1 | 6 | Change selector     |   |              |

### 2) FUNCTION

Transfer gear box is a hydraulic system having 1, 2 speed gear and its system is dog clutch type.

Once pushing 1 speed button for speed change, exhausted hydraulic power flow from the pump supplied to port "A" by operating 1, 2 speed solenoid valve and change selector (6) pushed by selector shift goes in gear with output shaft gear 1 (3).

The power gear box is moved to input gear shaft 1 (1), output shaft gear 1 (3), change selector (6), output shaft (7) and this procedure lead to 1 speed operation status.

Meanwhile, once pushing 2 speed button in the equipment stop condition, hydraulic power flow from the pump supplied to port "B" and change selector (6) pushed by selector shaft goes in gear with output shaft gear 2 (4).

The power gear box is moved to input shaft gear 2 (2), output shaft gear 2 (4), change selector (6), output shaft (7) and this procedure lead to 2 speed operation status.

### 3. TECHNICAL DATA

#### 1) GENERAL DATA

- (1) Max. input power : 70 kW
- (2) Max. input torque : 71.4 kgf · m
- (3) Max. input speed : 4500 rpm
- (4) Hydraulic motor : 80 cc/rev
- (5) Gear ration
  - 1st speed : 4.06 : 1
  - 2nd speed : 1.31 : 1
- (6) Output flange
  - Bolt for propshaft connection : M10 × 1.25
  - Gear box weight : 75 kg (165 lb)

#### 2) GEAR BOX CONTROL

##### (1) Control pressure

- ① At connection P1 and P2 at Low/High speed : 26~32 kgf/cm<sup>2</sup>
- ② Definition of lubricants : SAE 80W-90 API GL-4

#### 3) HOW TO CHANGE THE TRAVEL SPEED

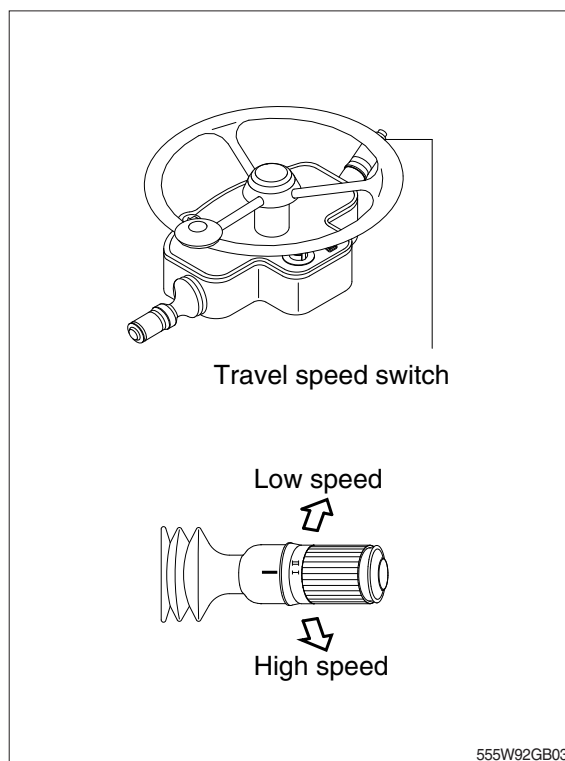
If you want to change the speed, be sure to operate according to the following procedure. Otherwise, unreasonable operation may cause fatal impact and failure to the transfer box (gear box).

- In case of changing the travel speed, be sure to stop the machine completely.
- Keep the machine on the stationary state and stepping the brake pedal to full stroke. Thereafter, select the speed switch to the desired position.

When operating the travel speed switch without stepping brake pedal and stopping the machine completely, the operation of gear box can not be worked actually even though the position of speed switch is left to the desired position.

- When turning the key switch to "OFF" position to stop the machine, be sure to transfer the travel speed switch to the low speed position.

Because the position of solenoid valve for travel is automatically transferred to the low speed position when turning the key switch to "OFF" position.

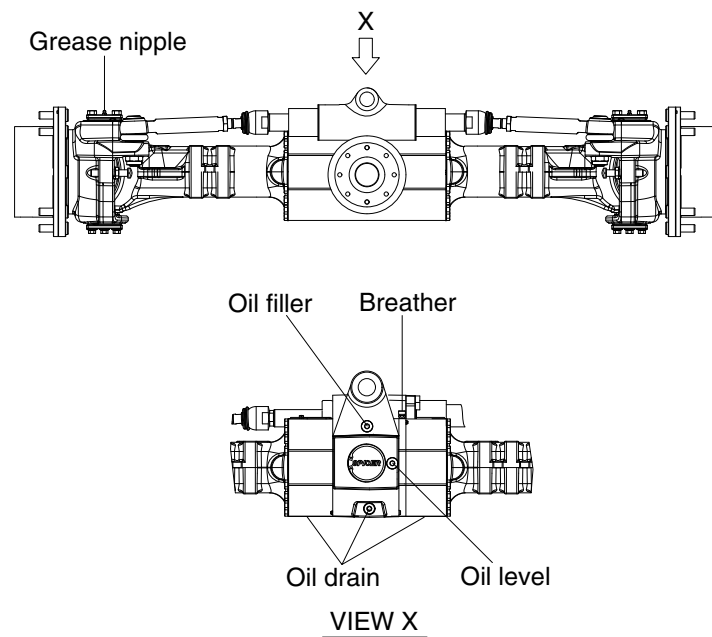


## GROUP 9 AXLE

### 1. OPERATION

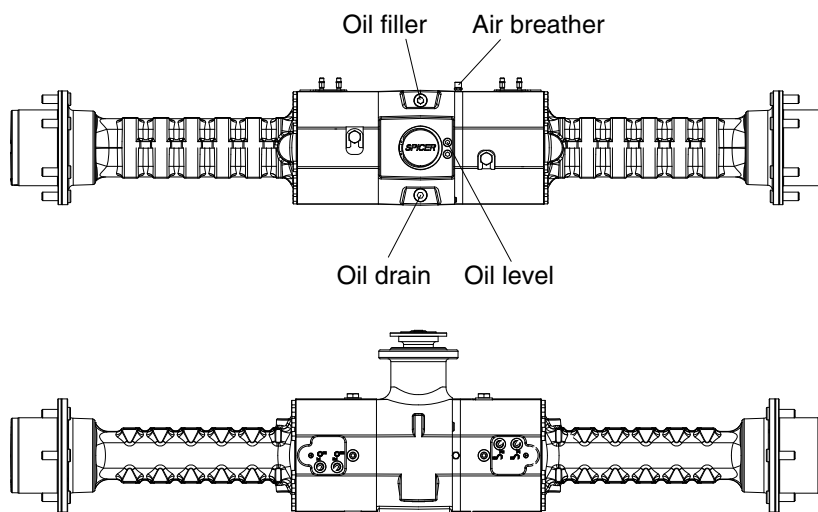
- The power from the engine passes through main pump, travel motor and transmission and drive shafts, and is then sent to the front and rear axles.
- Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles. At the same time, the speed is reduced and passes 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



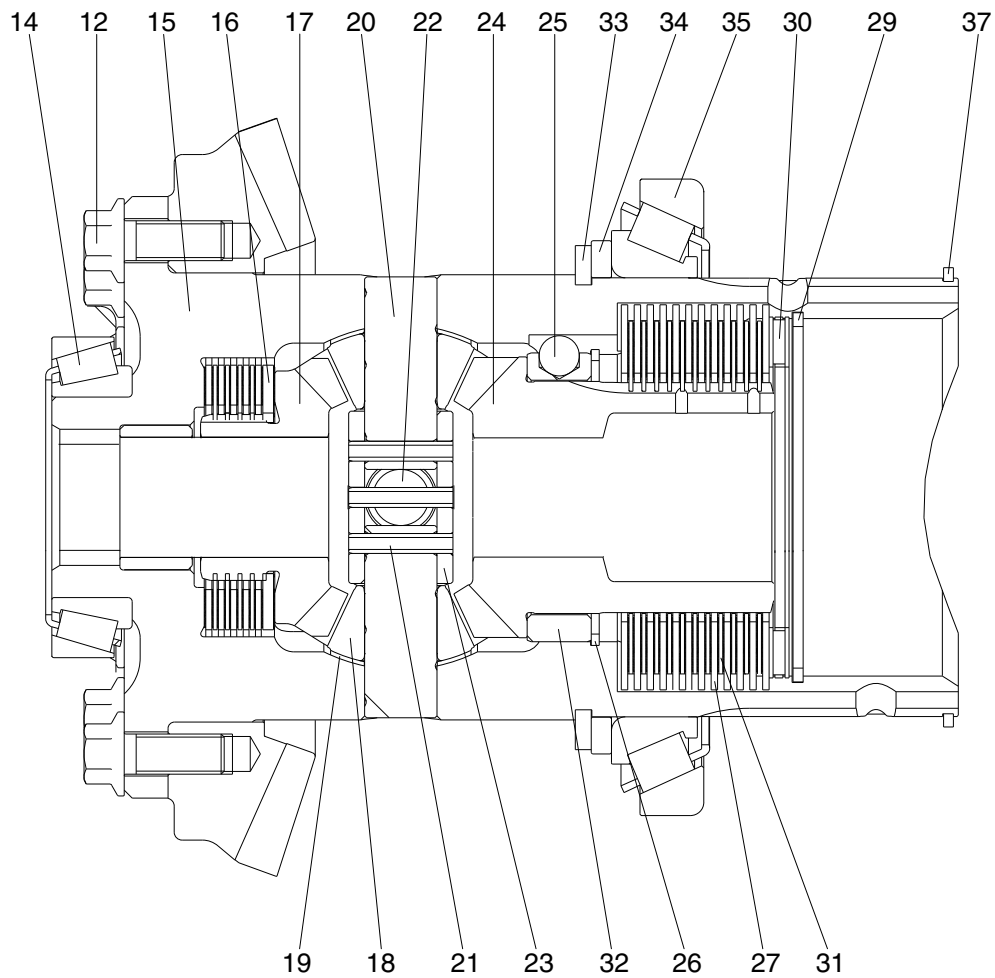
HW602AX01

#### 2) REAR AXLE



HW602AX02

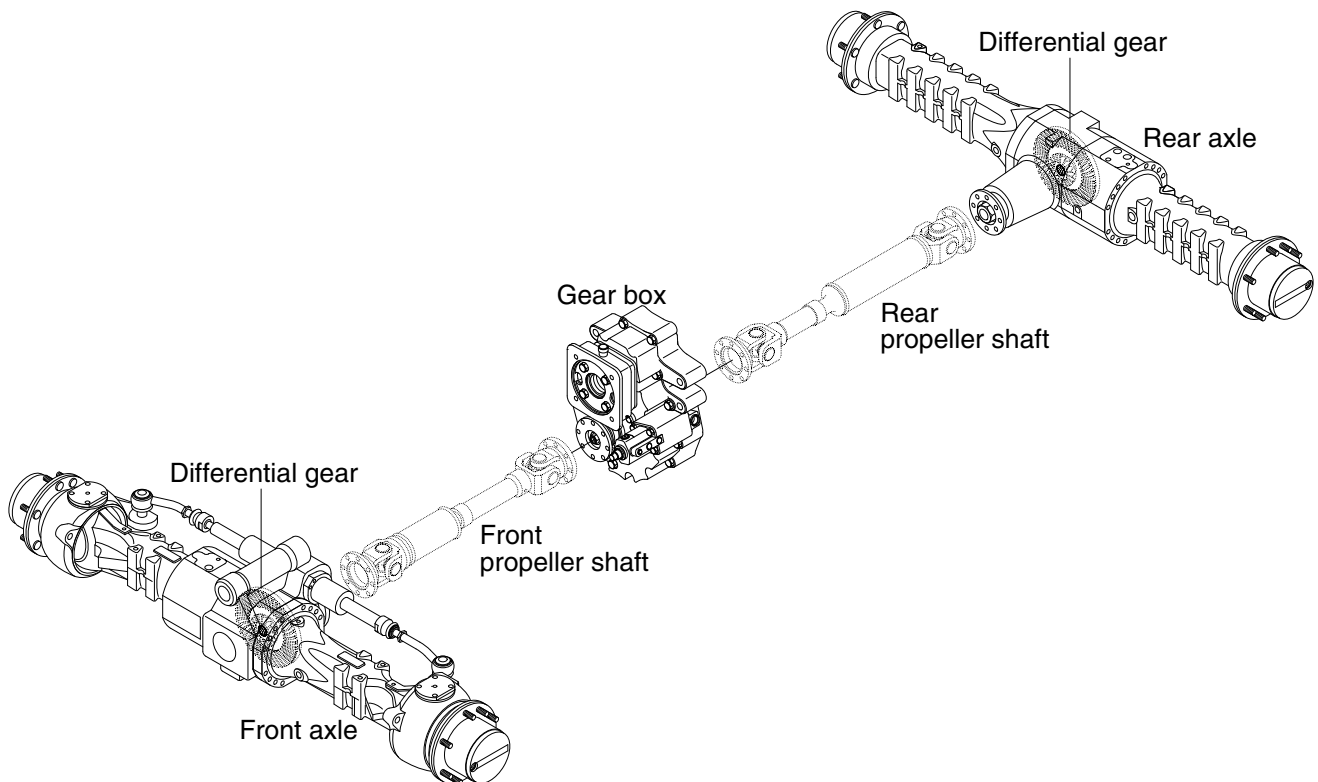
## 2. SECTION OF DIFFERENTIAL



55W72AX03

- |                           |                           |
|---------------------------|---------------------------|
| 11 Bevel gear set         | 24 Differential side gear |
| 12 Bolt                   | 25 Detend ball            |
| 14 Taper roller bearing   | 26 Circlip                |
| 15 Differential carrier   | 27 Clutch disc            |
| 16 Friction washer        | 29 Circlip                |
| 17 Differential side gear | 30 Bearing                |
| 18 Differential pinion    | 31 Clutch disc            |
| 19 Friction gear          | 32 Bushing                |
| 20 Pin                    | 33 Circlip                |
| 21 Dowel                  | 34 Spacer                 |
| 22 Pin                    | 35 Bearing                |
| 23 Shaft retainer         | 37 Circlip                |

### 3. DIFFERENTIAL



HW602AX04

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.

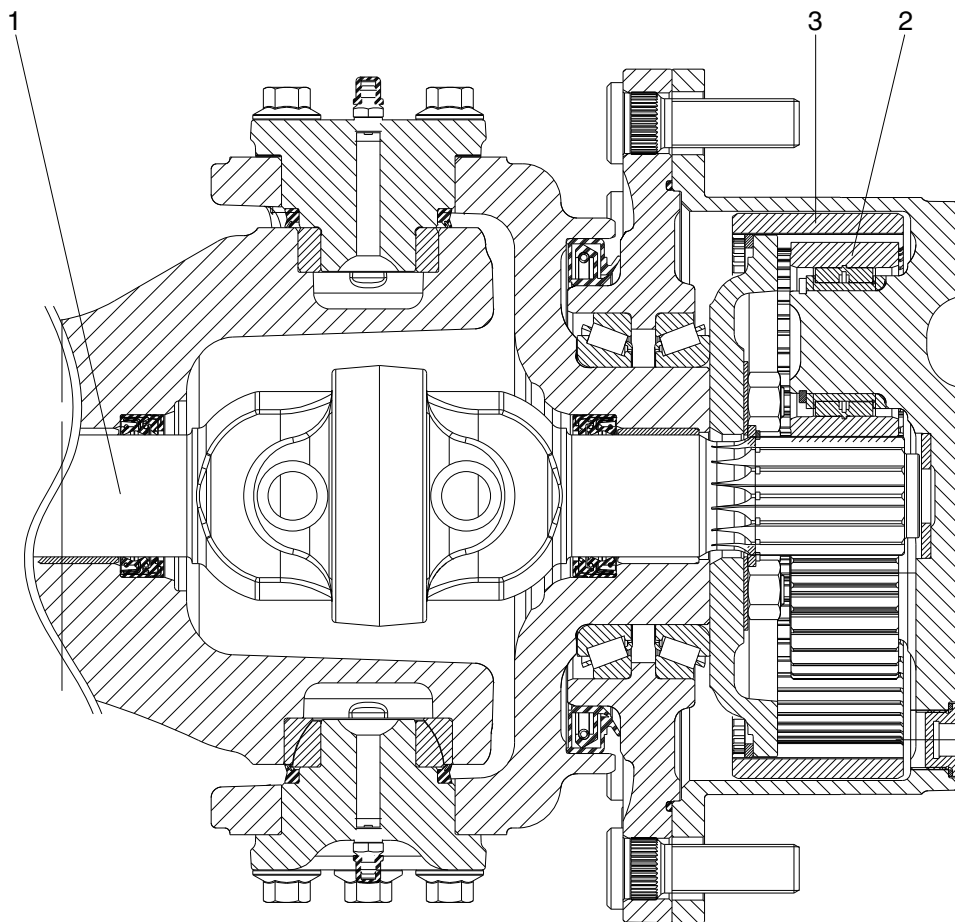
In addition, the differential also serves as an equalizer when going around curves. If the mechanical connection from the transmission to the universal drive shaft, differential, shaft, and planetary gears to the wheels would be rigid, every steering movement would strain the axle construction and would 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 wheel per axle is engaged. This disadvantage can be corrected in part by installing a self locking differential.

#### 4. FINAL DRIVE

##### 1) FRONT AXLE



55W72AX05

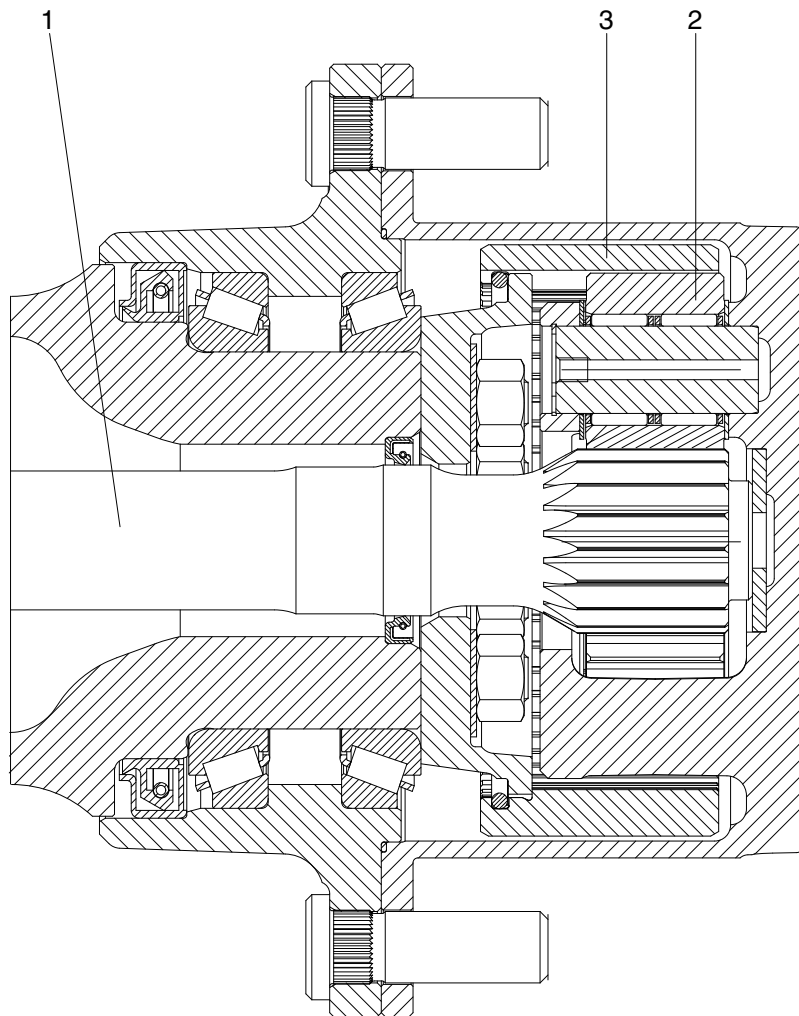
1 Universal joint

2 Pinion gear

3 Ring gear

- (1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.
- (2) The power transmitted from the differential through universal joint (1) to pinion gear (2).  
The pinion gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.  
This power is then sent to the wheels which are installed to the planetary carriers.

## 2) REAR AXLE

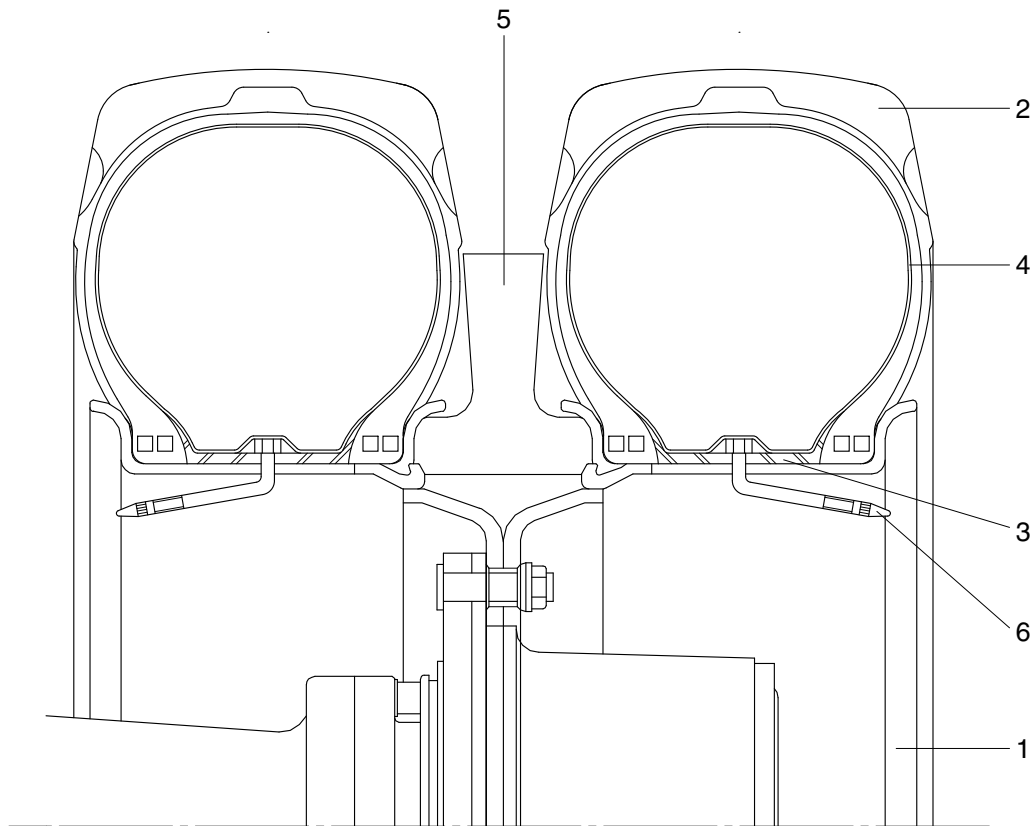


55W72AX06

- |   |                 |   |             |   |           |
|---|-----------------|---|-------------|---|-----------|
| 1 | Axle half shaft | 2 | Pinion gear | 3 | Ring gear |
|---|-----------------|---|-------------|---|-----------|

- (1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.
- (2) The power transmitted from the differential through axle half shaft (1) to pinion gear (2). The pinion gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.
- This power is then sent to the wheels which are installed to the planetary carriers.

## 5. TIRE AND WHEEL



17032T101

- |   |           |   |      |   |                     |
|---|-----------|---|------|---|---------------------|
| 1 | Wheel rim | 3 | Flap | 5 | Stone resister ring |
| 2 | Tire      | 4 | Tube | 6 | Valve assembly      |

- 1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.
- 2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.