

## SECTION 2 STRUCTURE AND FUNCTION

Group 1 Pump Device .....	2-1
Group 2 Main Control Valve .....	2-23
Group 3 Swing Device .....	2-59
Group 4 Travel Device .....	2-70
Group 5 RCV Lever .....	2-98
Group 6 RCV Pedal .....	2-105

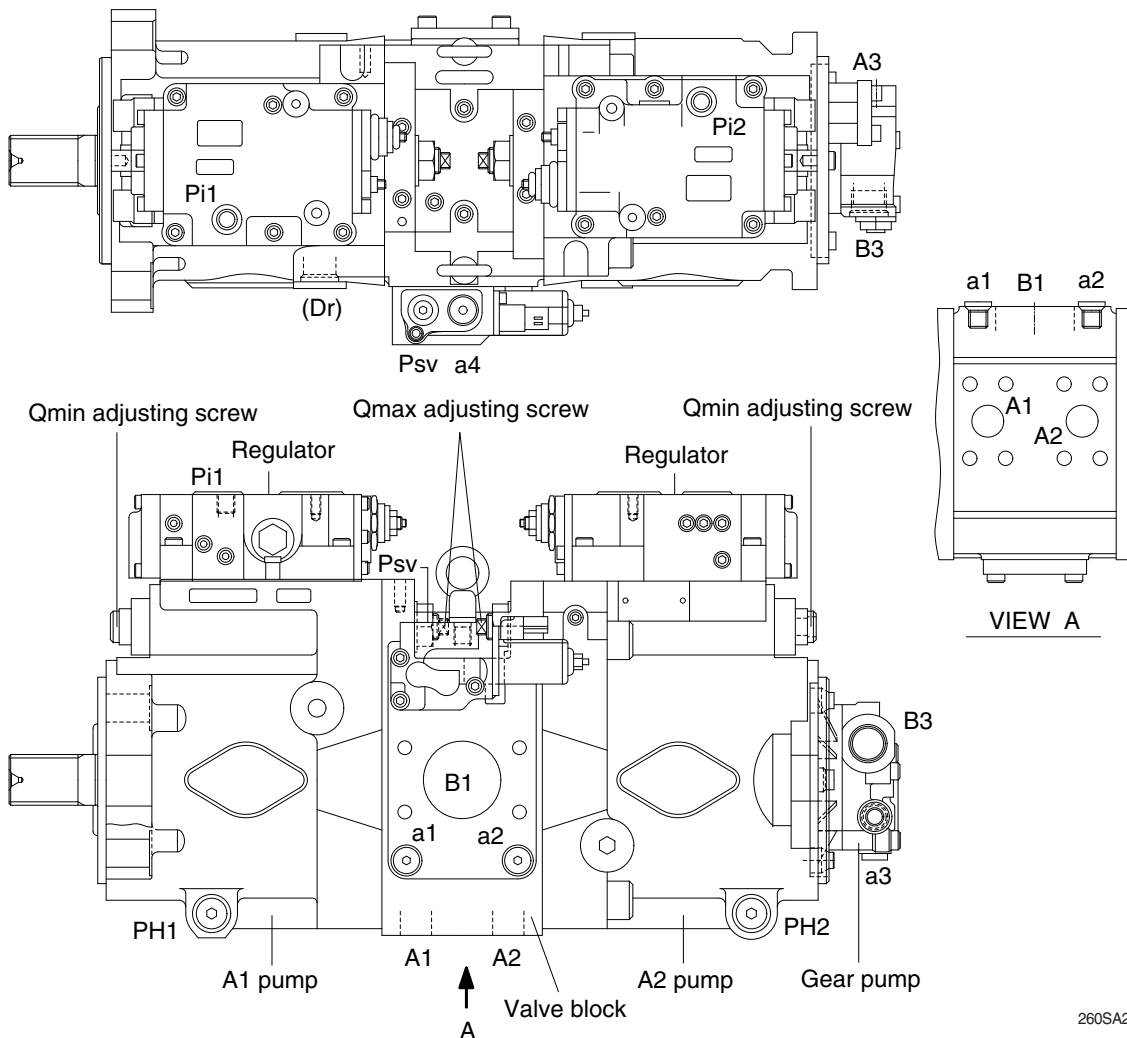
# SECTION 2 STRUCTURE AND FUNCTION

## GROUP 1 PUMP DEVICE

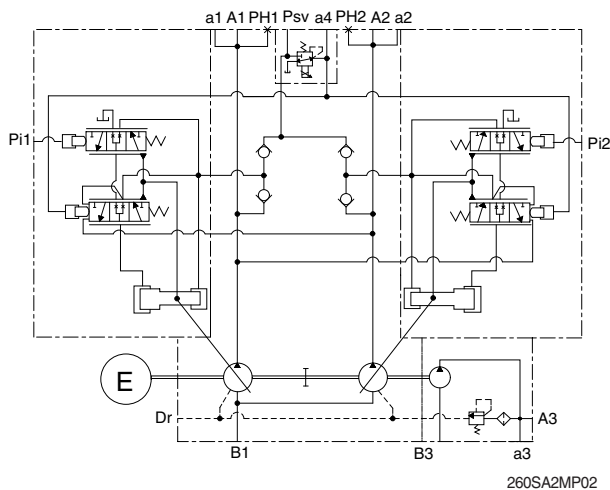
### 1. STRUCTURE

The pump device consists of main pump, regulator and gear pump.

- WITHOUT PTO TYPE



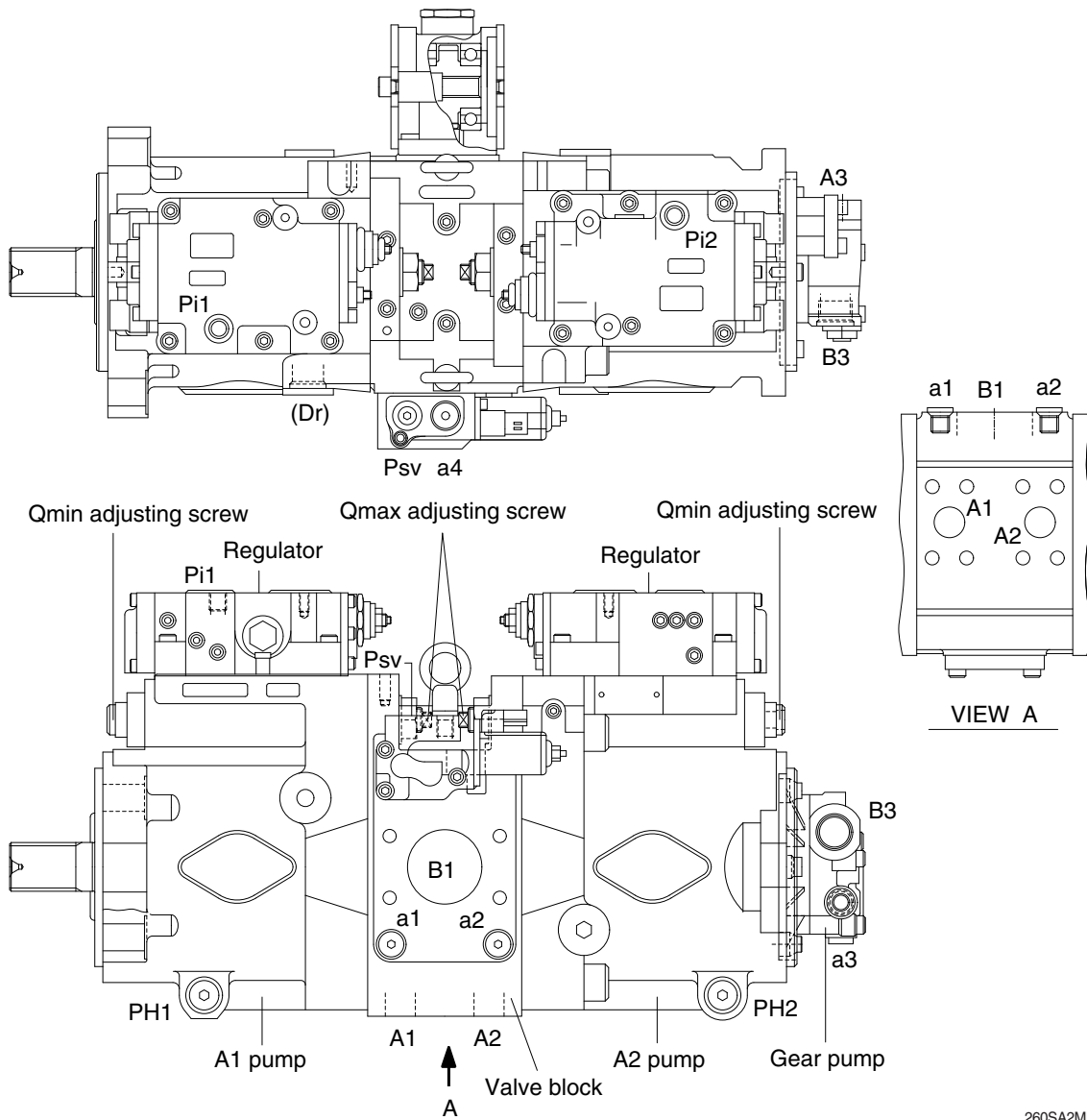
260SA2MP01



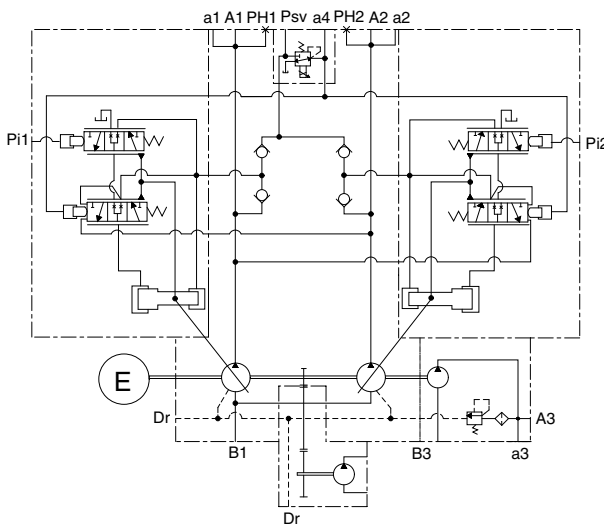
260SA2MP02

Port	Port name	Port size
A1,2	Delivery port	SAE 6000 psi 1"
B1	Suction port	SAE 2500 psi 2 1/2"
Dr	Drain port	PF 3/4 - 20
Pi1,i2	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
a1,2,4	Gauge port	PF 1/4 - 15
PH1,2	Pressure sensor port	PF 3/8-17
a3	Gauge port	PF 1/4-14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

· WITH PTO TYPE



260SA2MP03

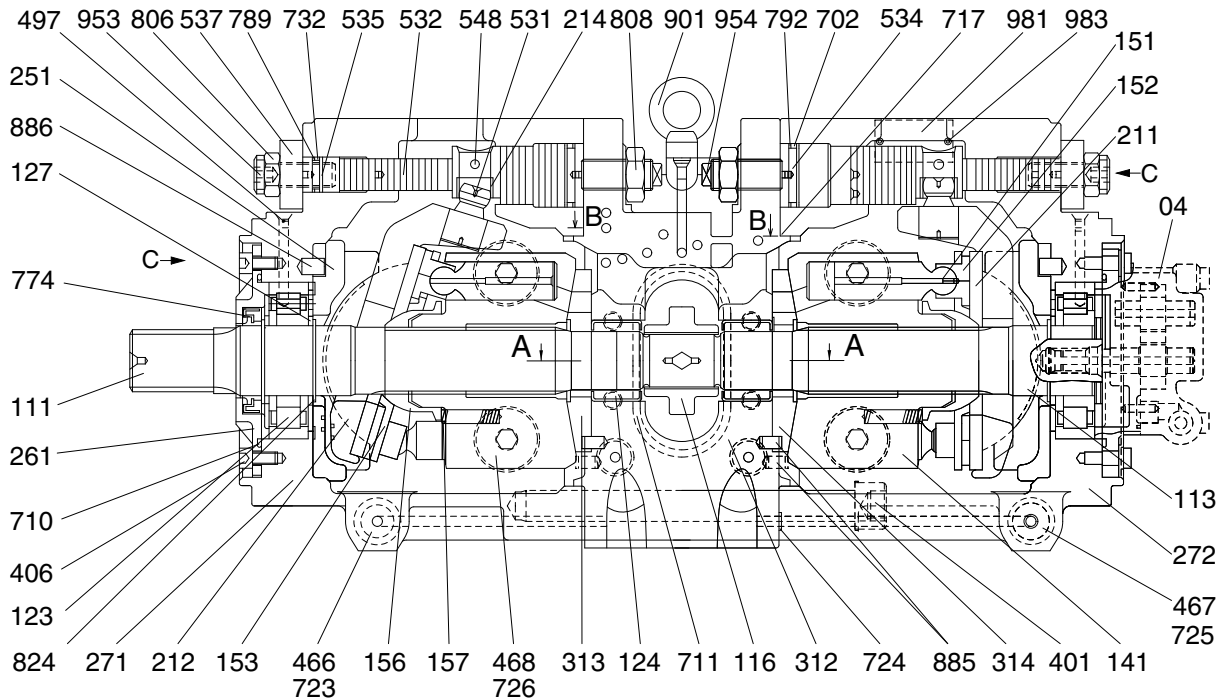


Port	Port name	Port size
A1,2	Delivery port	SAE 6000 psi 1"
B1	Suction port	SAE 2500 psi 2 1/2"
Dr	Drain port	PF 3/4 - 20
Pi1,i2	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
a1,2,4	Gauge port	PF 1/4 - 15
PH1,2	Pressure sensor port	PF 3/8-17
a3	Gauge port	PF 1/4-14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

260SA2MP04

## 1) MAIN PUMP (1/3)

The main pump consists of two piston pumps (A1 & A2) and valve block.

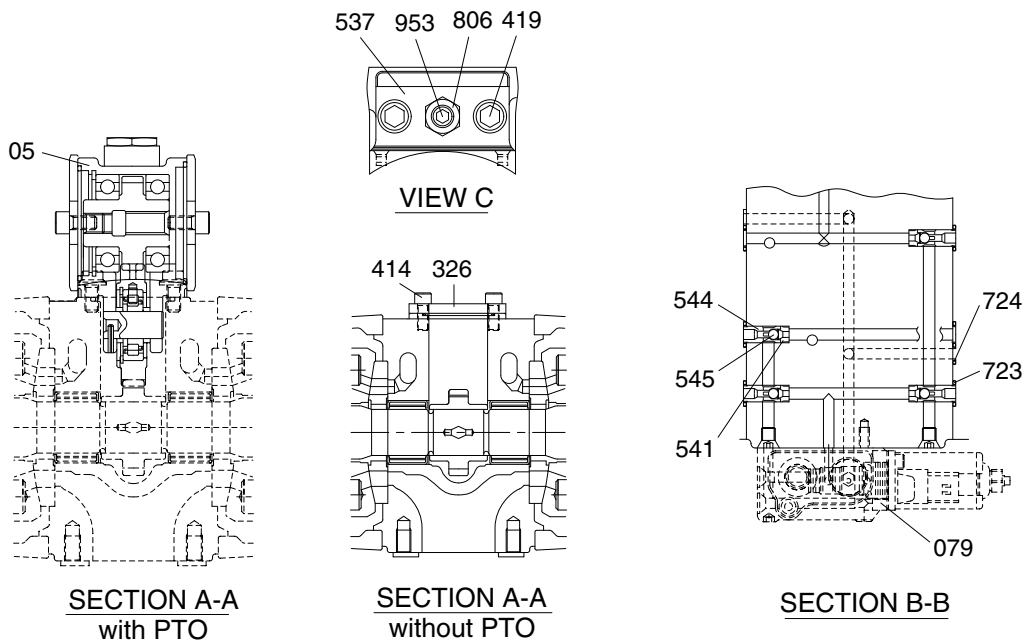


※ Section A-A, B-B, view C : see next page.

260SA2MP05

04	Gear pump	272	Pump casing (R)	711	O-ring
111	Drive shaft (F)	312	Valve block	717	O-ring
113	Drive shaft (R)	313	Valve plate (R)	723	O-ring
116	1st gear	314	Valve plate (L)	724	Square ring
123	Roller bearing	401	Hexagon socket bolt	725	O-ring
124	Needle bearing	406	Hexagon socket bolt	726	O-ring
127	Bearing spacer	466	Plug	732	O-ring
141	Cylinder block	467	Plug	774	Oil seal
151	Piston	468	Plug	789	Back up ring
152	Shoe	497	MH Plug	792	Back up ring
153	Set plate	531	Tilting pin	806	Hexagon head nut
156	Spherical bushing	532	Servo piston	808	Hexagon head nut
157	Cylinder spring	534	Stopper (L)	824	Snap ring
211	Shoe plate	535	Stopper (S)	885	Pin
212	Swash plate	537	Servo cover (S)	886	Pin
214	Tilting Bushing	548	Feed-back pin	901	Eye bolt
251	Support	702	O-ring	953	Set screw
261	Seal cover (F)	710	O-ring	954	Set screw
271	Pump casing (F)				

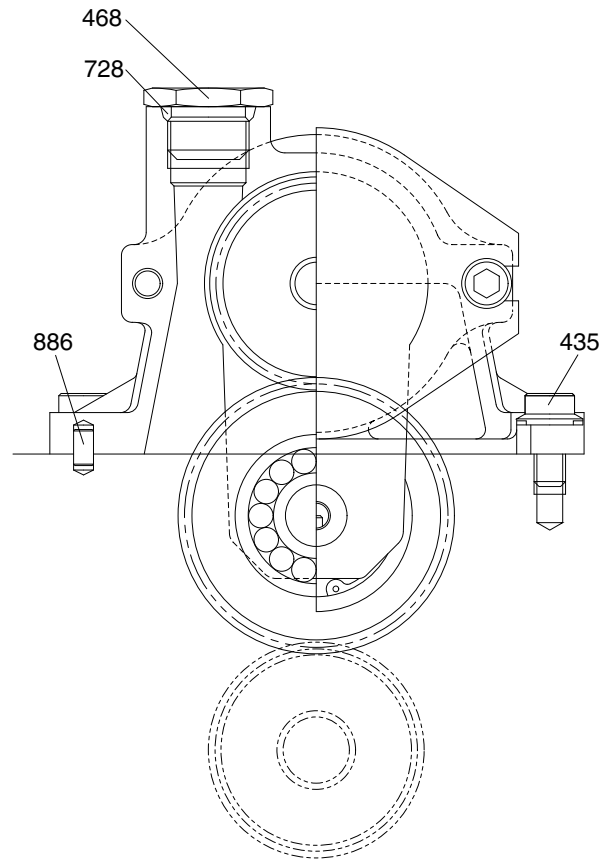
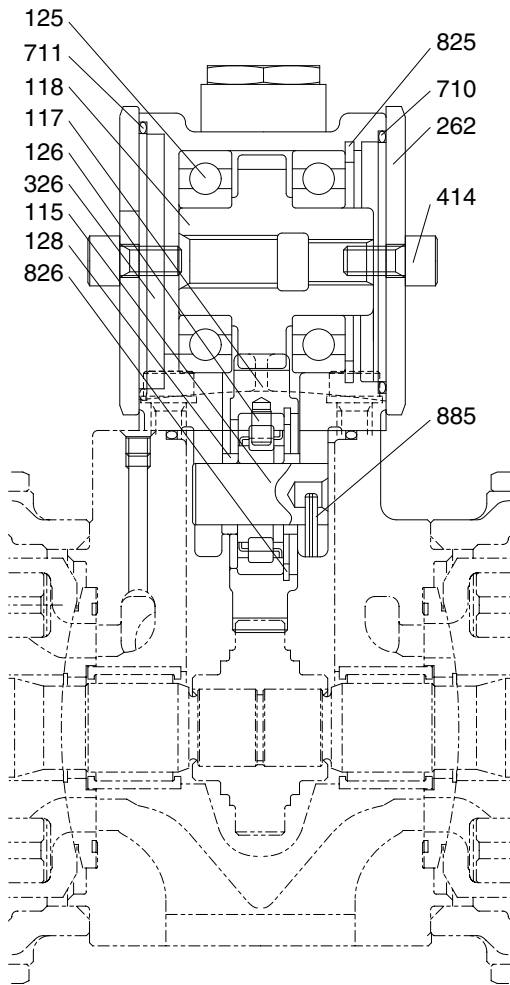
## MAIN PUMP (2/3)



220S2MP06

05	PTO unit (with PTO)	537	Servo cover	724	Square ring
079	Proportional reducing valve	541	Seat	806	Hexagon head nut
326	Cover (without PTO)	544	Stopper 1	953	Set screw
414	Hexagon socket bolt (without PTO)	545	Steel ball		
419	Hexagon socket bolt	723	O-ring		

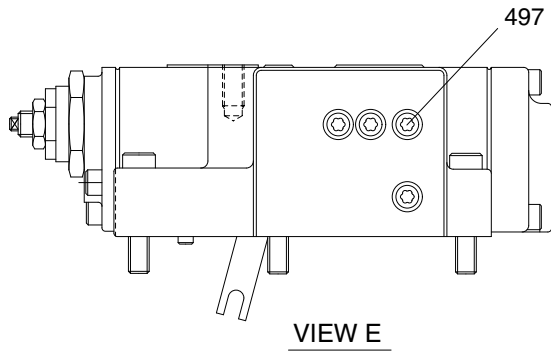
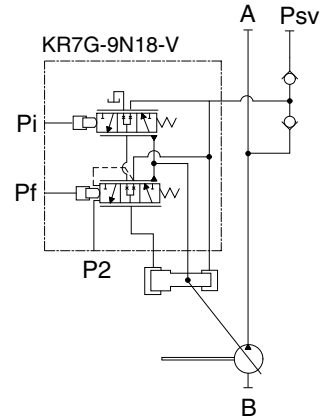
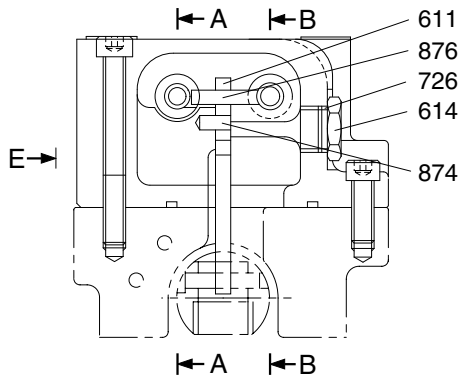
## MAIN PUMP (3/3, WITH PTO TYPE)



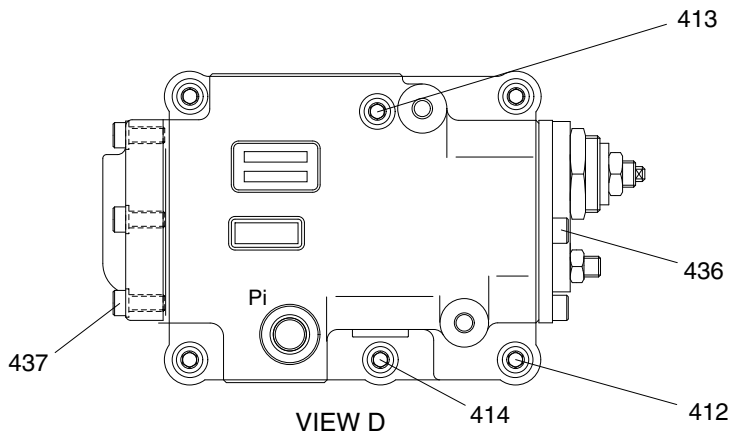
220S2MP07

115	Idler shaft	262	Cover	711	O-ring
117	Gear No. 2	326	Gear case	728	O-ring
118	Gear No. 3	414	Socket head screw	825	Retainer ring
125	Ball bearing	435	Flange head socket bolt	826	Retainer ring
126	Roller bearing	468	Plug	885	Spring pin
128	Bearing spacer	710	O-ring	886	Pin

## 2) REGULATOR (1/2)



VIEW E



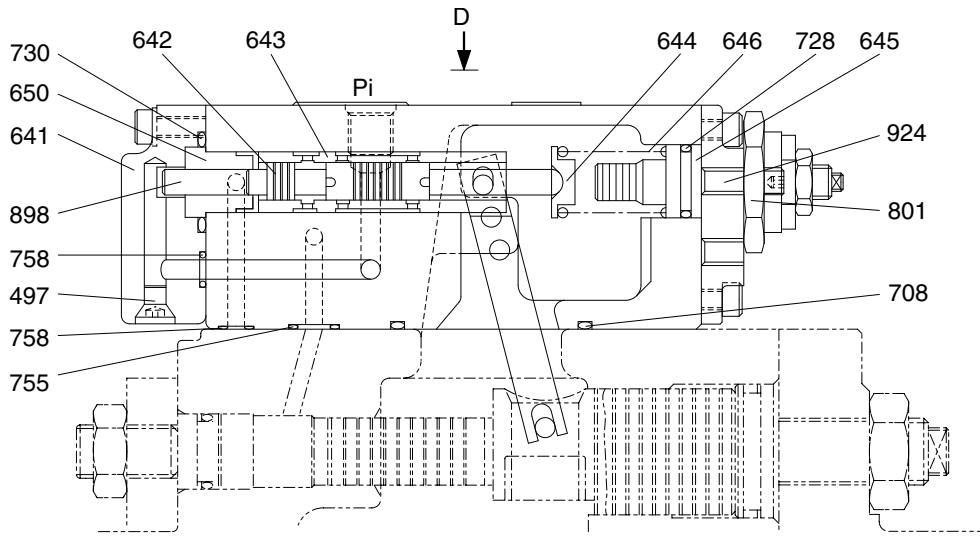
VIEW D

260SA2MP08

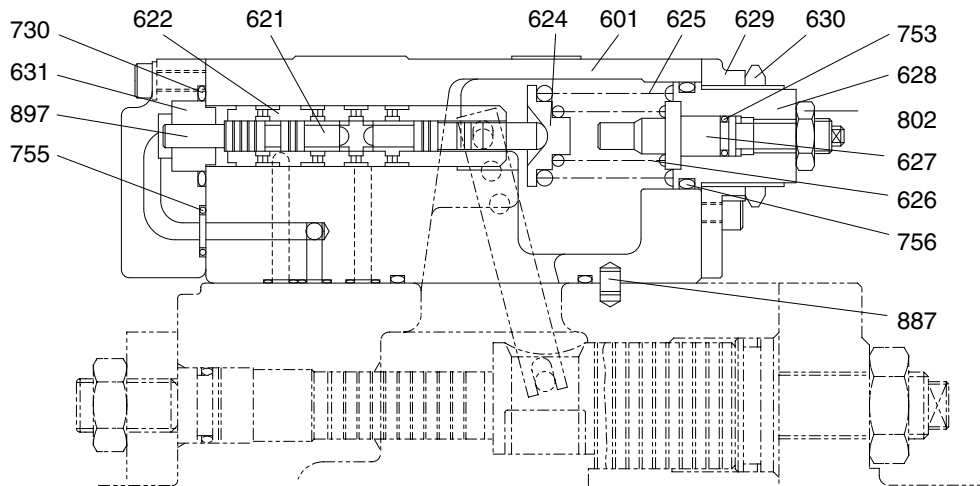
- 412 Hexagon socket screw
- 413 Hexagon socket screw
- 414 Hexagon socket screw
- 436 Hexagon socket screw
- 437 Hexagon socket screw
- 497 Plug
- 611 Feed back lever
- 614 Adjust plug
- 726 O-ring
- 874 Pin
- 876 Pin

Port	Port name	Port size
A	Delivery port	SAE 6000 psi 1"
B	Suction port	SAE 2500 psi 2 1/2"
Pi	Pilot port	PF 1/4-15
Pf	Power shift port	-
P2	Companion delivery port	-

# REGULATOR (2/2)



SECTION B-B



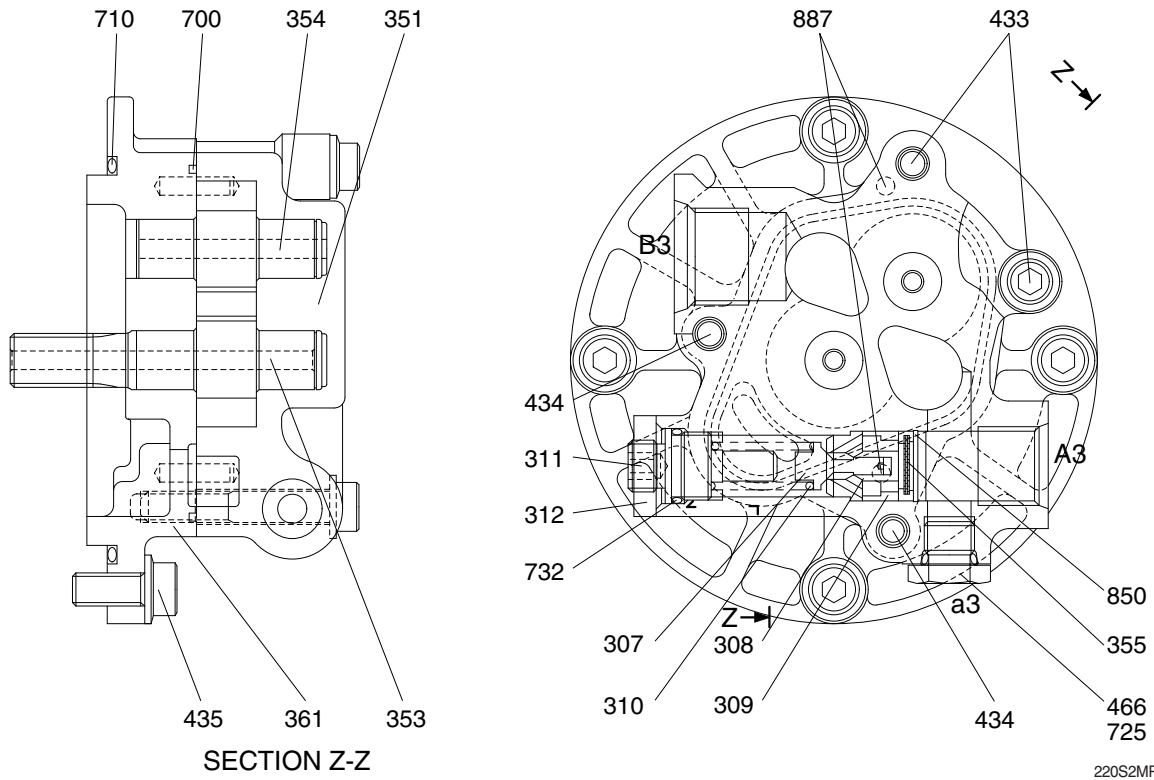
SECTION A-A

220S2MP09A

- |                        |                     |                 |
|------------------------|---------------------|-----------------|
| 497 Plug               | 630 Lock nut        | 730 O-ring      |
| 601 Casing             | 631 Sleeve, pf      | 753 O-ring      |
| 621 Compensator spool  | 641 Pilot cover     | 755 O-ring      |
| 622 Compensator sleeve | 642 Pilot spool     | 756 O-ring      |
| 624 Spring seat (C)    | 643 Pilot sleeve    | 758 Square ring |
| 625 Outer spring       | 644 Spring seat (Q) | 801 Nut         |
| 626 Inner spring       | 645 Adjust stem (Q) | 802 Nut         |
| 627 Adjust stem (C)    | 646 Pilot spring    | 887 Pin         |
| 628 Adjust screw (C)   | 650 Sleeve, pi      | 897 Piston, pf  |
| 629 Cover (C)          | 708 O-ring          | 898 Piston, pi  |
|                        | 728 O-ring          | 924 Set screw   |



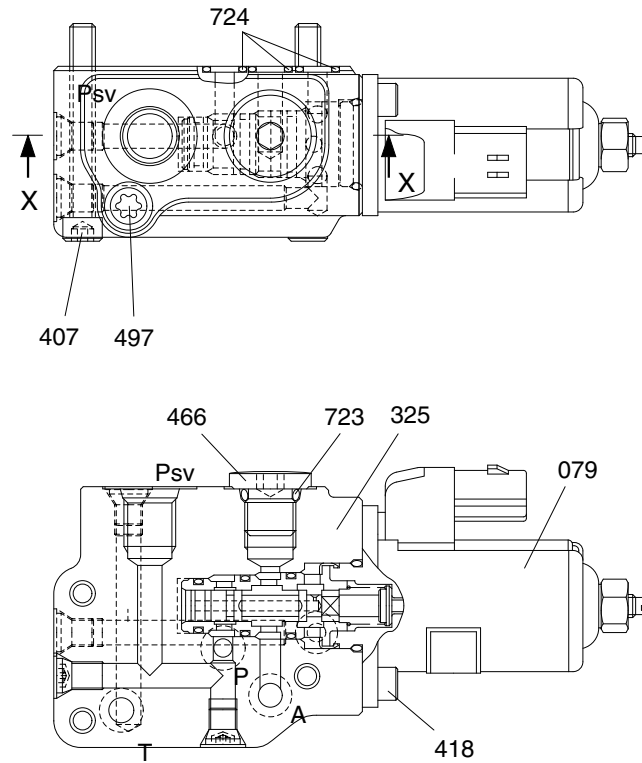
### 3) GEAR PUMP



220S2MP10A

307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Ring	355	Filter	710	O-ring
310	Spring	361	Front case	725	O-ring
311	Adjusting screw	433	Flange socket	732	O-ring
312	Lock nut	434	Flange socket	850	Snap ring
351	Gear case	435	Flange socket	887	Pin

#### 4) PROPORTIONAL REDUCING VALVE AND CASING ASSY

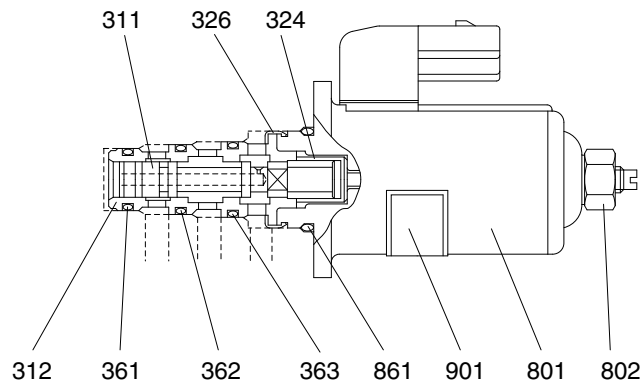


SECTION X-X

220S2MP11

- |                                 |                              |                 |
|---------------------------------|------------------------------|-----------------|
| 079 Proportional reducing valve | 418 Hexagon socket head bolt | 723 O-ring      |
| 325 Valve casing (f)            | 466 Plug                     | 724 Square ring |
| 407 Hexagon socket head bolt    | 497 Plug                     |                 |

#### 5) PROPORTIONAL REDUCING VALVE ASSY



220S2MP12

- |                    |              |                |
|--------------------|--------------|----------------|
| 311 Spool          | 361 O-ring   | 802 Seal nut   |
| 312 Sleeve         | 362 O-ring   | 861 O-ring     |
| 324 Spring         | 363 O-ring   | 901 Name plate |
| 326 Retaining ring | 801 Solenoid |                |

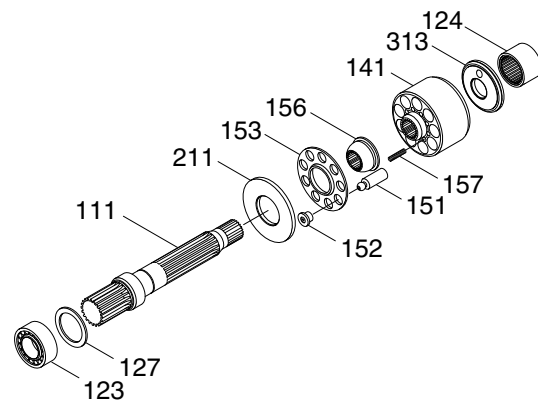
## 2. MAIN PUMP

The pumps may be classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery flow: and the valve block group that changes over oil suction and discharge: and the PTO group to attach on auxiliary gear pump.

### 1) ROTARY GROUP

The rotary group consists of drive shaft (F) (111), bearing spacers (127), cylinder block (141), piston shoes (151,152), set plates (153), spherical bushings (156) and cylinder springs (157). The drive shaft is supported by bearings (123,124) at its both ends.

The shoe is caulked to the piston to form a spherical joint for lessening thrust force generated by load pressure and has grooves to slide on the shoe plate (211) smoothly and hydraulically balanced. The piston-shoe sub group is pushed onto the shoe plate by the cylinder springs through the set plate and spherical bushing for enabling smooth sliding on the shoe plate. Similarly, the cylinder block is pushed onto the valve plate (313, 314) by the cylinder springs.



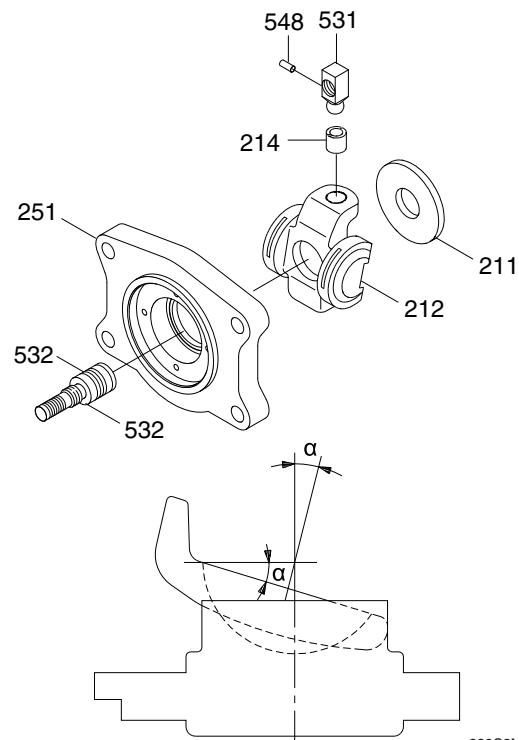
220S2MP13

### 2) SWASH PLATE GROUP

The swash plate group consists of swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and servo piston (532).

The swash plate is supported by the swash plate support at the cylindrical portion formed on the opposite side of the shoe sliding face.

When the servo piston is moved to the left or right by introducing the hydraulic force controlled by the regulator into the hydraulic chamber provided on both ends of the servo piston, the swash plate slides over the swash plate support through the spherical portion of the tilting pin and can vary the tilting angle ( $\alpha$ ).



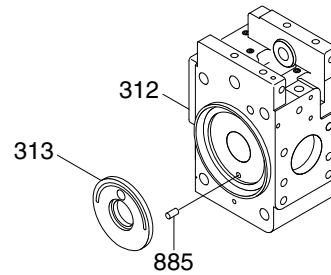
220S2MP14

### 3) VALVE BLOCK GROUP

The valve block group consists of valve block (312), valve plate (313, 314) and valve plate pin(885).

The valve plate having two arc ports is attached to the valve block and feeds and collects oil to and from the cylinder block.

The oil exchanged by the valve plate is connected to an external piping through the valve block.



220S2MP15

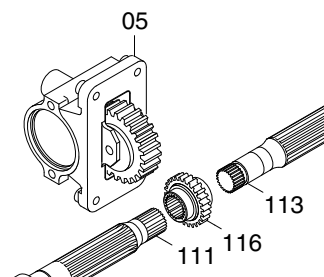
### 4) PTO GROUP

The PTO group is composed of the PTO unit (05), 1st gear (116), front drive shaft (111) and rear drive shaft (113).

The front and rear shafts are supported by the bearings, respectively and attached to the valve block.

Now, suppose the drive shaft is rotated by the motor or engine, the cylinder block is also rotated through the spline connection. If the swash plate is tilted, the pistons arranged inside the cylinder reciprocate relatively to the cylinder, rotating with the cylinder block. Accordingly, if a piston is focused on, its motion is separating from the valve plate (oil suction process) for 180 degrees, and approaching the valve plate (oil delivery process) for the remaining 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.

In the meantime, the rotation of the drive shaft is picked up by the 1st gear (116), transmitted to the 3rd gear through the 2nd gear, and drives the auxiliary pump connected to the 3rd gear.



220S2MP15

### 3. REGULATOR

#### 1) OUTLINE

The regulator for the K7V series axial piston pump has various models to satisfy various kinds of specifications required.

##### (1) Horsepower control

The pump tilting angle is automatically decreased as the discharge pressure  $P_{d1}$ ,  $P_{d2}$  rises, and restricts the input torque below a designated value. (The input horsepower is constant when the speed is constant.)

In case of tandem type double pump, the control is total horsepower control. During the horsepower control, the regulators of the respective pumps are controlled at the same tilting angle. Therefore, overload of the motor is automatically prevented regardless of load of the two pumps.

##### (2) Power shift control

The power shift command pressure  $P_f$  is shifted by the input current to the solenoid-operated proportional reducing valve. And, the horsepower setting is shifted by the command pressure  $P_f$ . The power shift command pressure  $P_f$  (secondary pressure of the solenoid-operated proportional reducing valve) is led to the horsepower control portion of the regulator for each pump through the pump internal passage, and shifted to the same horsepower setting.

##### (3) Flow control

By changing the pilot pressure  $P_i$ , the pump tilting angle (delivery flow) is regulated arbitrarily. This regulator is the negative flow control in which the delivery flow  $Q$  decreases as the pilot pressure  $P_i$  raises.

With this mechanism, when the pilot pressure corresponding to the required for the work is commanded, the pump discharges the required flow only, and so does not consume the power uselessly.

This regulator has the above three control mechanisms, but in case of combined operation of these controls, priority is given to the lower tilting angle (lower flow) command as described later.

## 2) FUNCTION

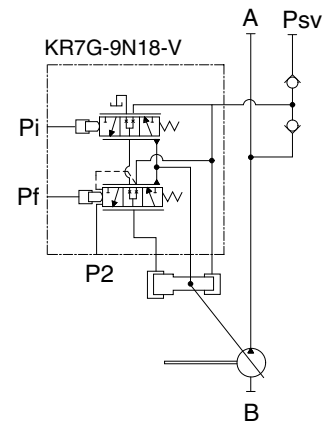
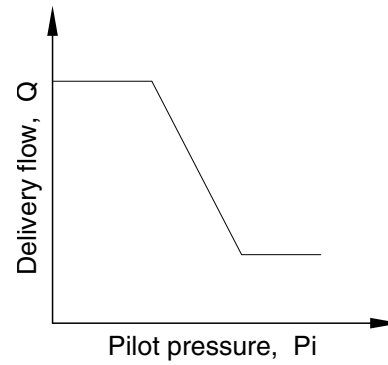
Regulator consists of the negative flow control, horse power control, power shift control and priority mechanism for lower tilting (lower flow) command function.

### (1) Negative flow control

By changing the pilot pressure  $P_i$ , the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

This regulator is of the negative flow control in which the delivery flow  $Q$  decreases as the pilot pressure  $P_i$  rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.

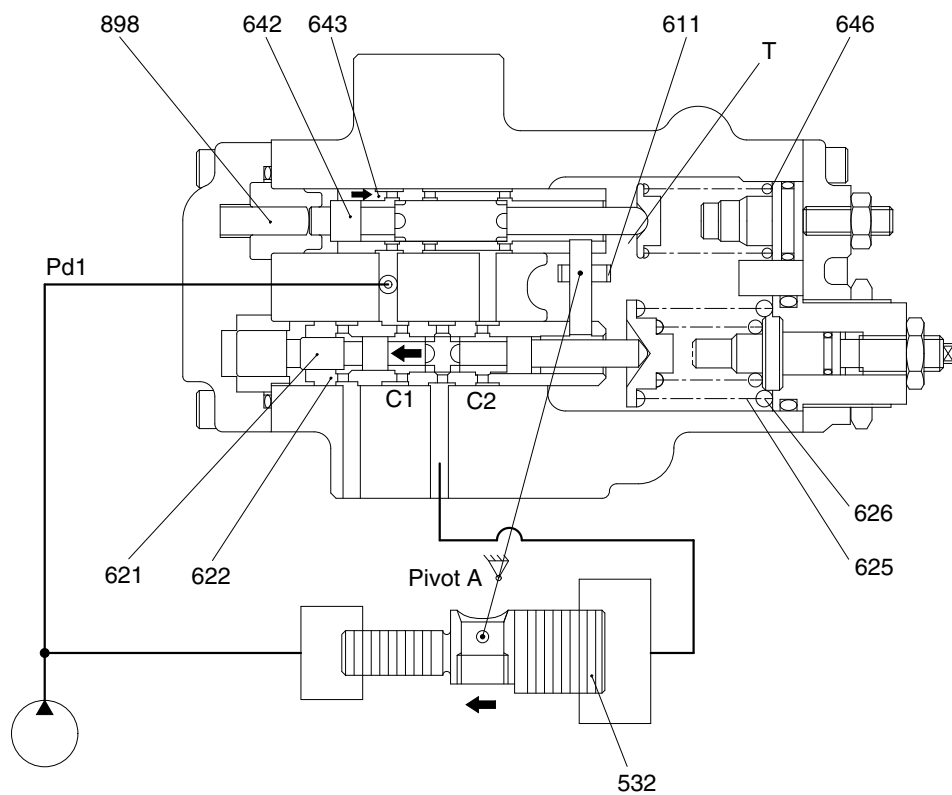


260SA2MP17

① **Flow decreasing funtion**

As the pilot pressure  $P_i$  increases, the pilot spool (642) through the pilot piston (898) moves to right direction, and stops at the position where the force of the pilot spring (646) and hydraulic pressure balances.

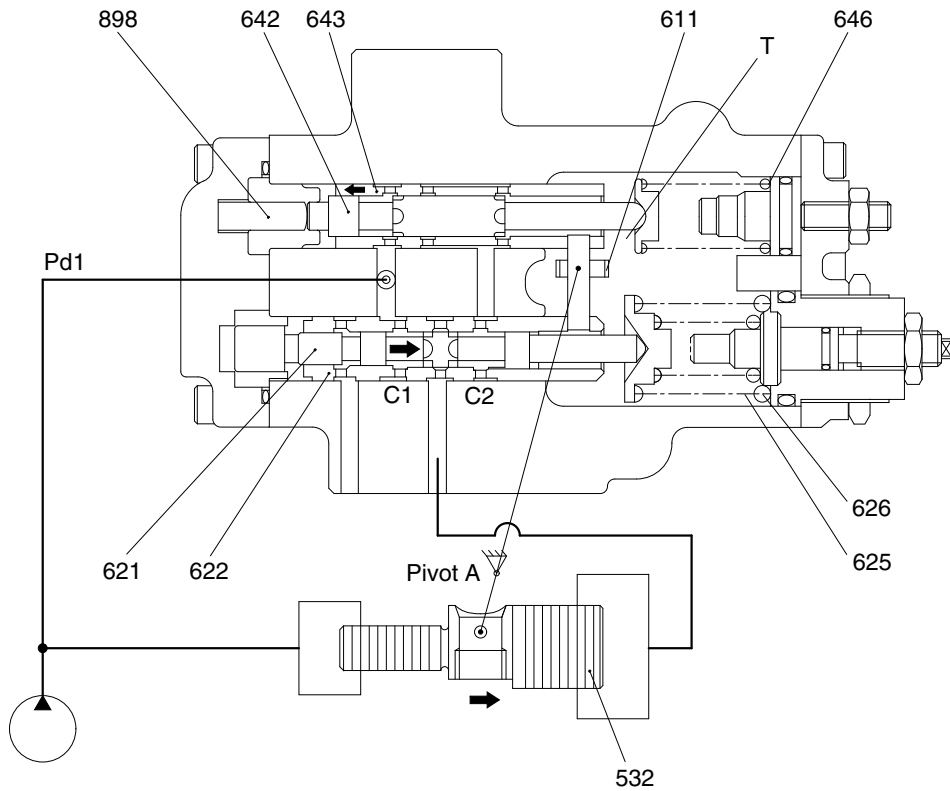
The movement of the pilot spool (642) causes the delivery pressure  $P_{d1}$  to connect to the port Q1 through the pilot spool spool (642) and to be admitted to the large-diameter section of the servo piston (532). Although the delivery pressure  $P_{d1}$  is constantly admitted to small-diameter section fo servo piston (532), the servo piston (532) moves to left direction because of its difference of the area between large and small-diameter section. As a result, the tilting angle is decreased. As the servo piston (532) moves, the feedback lever (611) rotates around the pivot. A, and pilot sleeve (643) moves to right direction till the opening between the spool and sleeve being closed.



220S2MP18

② Flow increasing function

As the pilot pressure  $P_i$  decreases, the pilot spool (642) moves to left direction. The movement of the spool causes the port Q2 connects to the tank port. This deprives the large-diameter section of the servo piston (532) of pressure, and moves the servo piston (532) to right direction by the discharge pressure  $P_{d1}$  in the small-diameter section, resulting in the flow rate increase.



220S2MP19

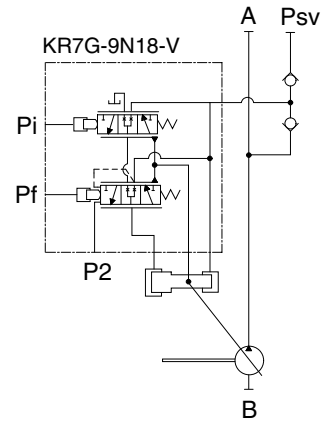
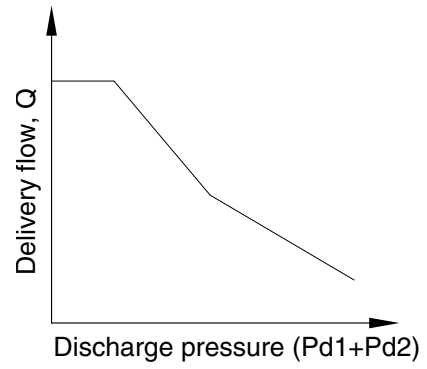


## (2) Horsepower control

As shown in the figure, when the discharge pressure increases, overloading of the motor is prevented by decreasing the pump tilting angle.

The operation of the horsepower control is similar to that of the flow control, and explained below briefly.

$$P_f = P_{d1} + P_{d2}$$



260SA2MP20

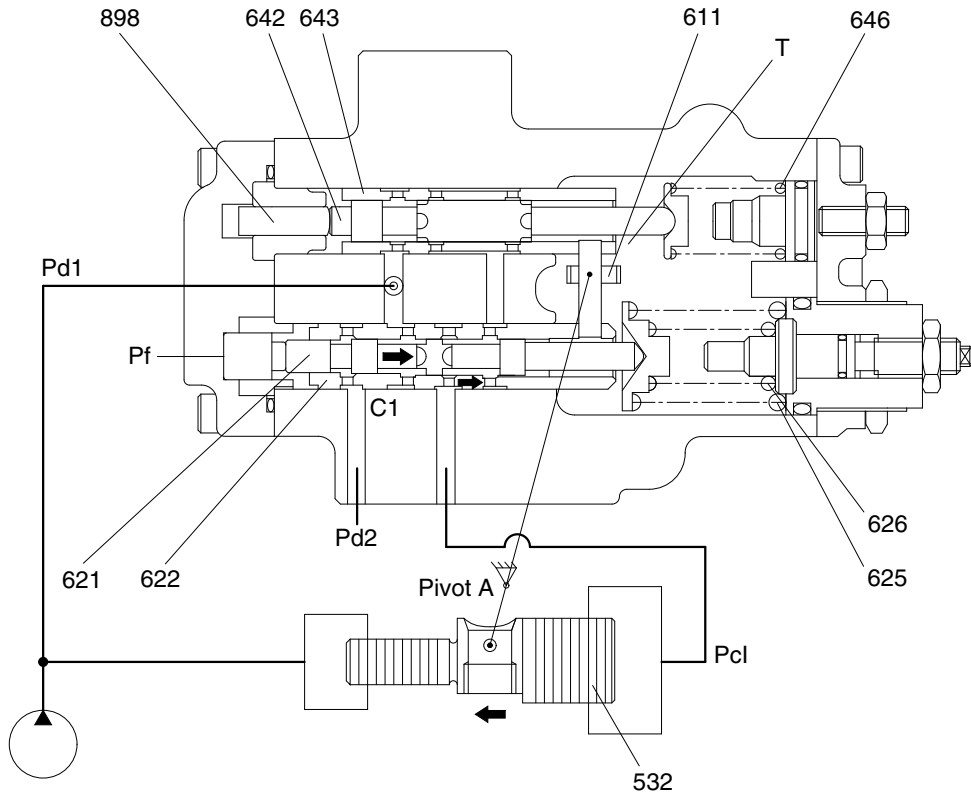
① **Overload prevention function**

As own pump discharges pressure Pd1, or partner pump discharges pressure Pd2 increase, Pd1, and Pd2 work on the stepped section of the compensator spool (621), and spool moves toward right direction. And stops at the position where the force of the outer spring (625) and inner spring (626) and hydraulic pressure balances.

The movement of the compensator spool (621) causes the delivery pressure Pd1 to connect to the port C1 and to be admitted to the large-diameter section of the servo piston (532).

Although the delivery pressure Pd1 is constantly admitted to small diameter section of servo piston (532), the servo piston (532) moves to the left because of its difference of the area between large and small-diameter section.

As a result, the tilting angle is decreased. As the servo piston (532) moves, the feedback lever (611) rotates around the pivot A, and the compensator sleeve (622) moves to right direction till the opening between the spool and sleeve being closed.



220S2MP21

## ② Flow return function

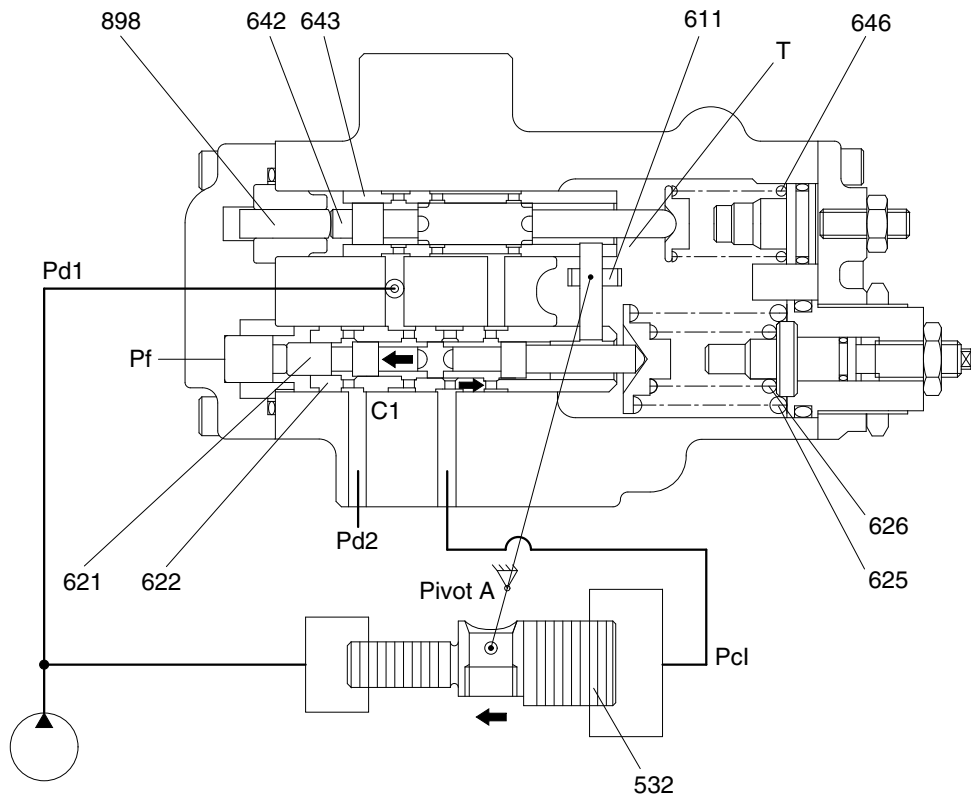
As own pump discharges pressure Pd1, or partner pump discharges pressure Pd2 decrease, the compensator spool (621) moves to left direction by the outer spring (625) and inner spring (626).

And the spool stops at the position where the force of their springs and hydraulic pressure balances.

The movement of the compensator spool causes the delivery pressure Pd1, to connect to the port C1 through the compensator spool (621) and to be admitted to the large-diameter section of the servo piston (532). Although the delivery pressure Pd1, is constantly admitted to small-diameter section of servo piston (532), the servo piston moves to the left direction because of its difference of the area between large and small-diameter section. As a result, the tilting angle is decreased. As the servo piston (532) moves, the feedback lever (611) rotates around the pivot A, and the compensator sleeve (622) moves to right direction fill the opening between the spool and compensator sleeve being closed.

Priority mechanism for lower tilting (lower flow) command

As described above, flow and horsepower control commands are generated independently. In case if the flow and horsepower control commands are generated simultaneously, lower tilting command is selected hydro-mechanically to prevent overload.



220S2MP22

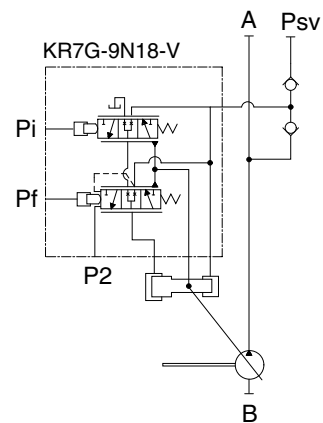
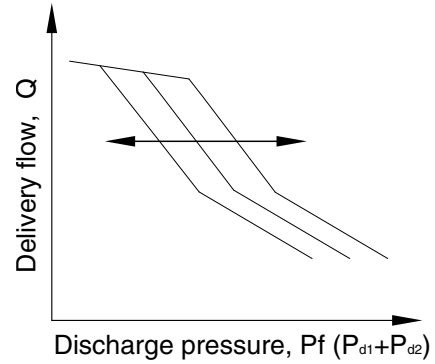
## (3) Priority mechanism for lower tilting (lower flow) command

As described previous, flow and horsepower control commands are generated independently. In case if the flow and horsepower control commands are generated simultaneously, lower tilting command is selected hydro-mechanically to prevent overload.

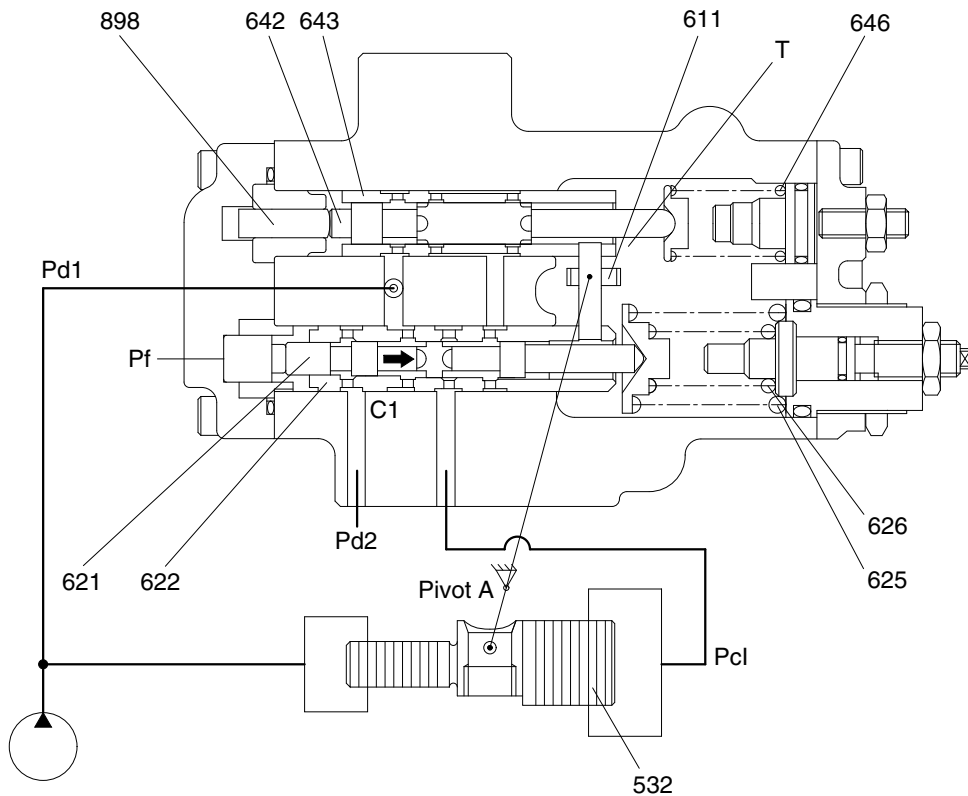
**(4) Power shift control (horsepower reduction control)**

The pump horsepower control setting is controlled by the power shift pressure  $P_f$  ( $P_{d1} + P_{d2}$ ) as shown in the figure.

When the power shift pressure  $P_f$  increases, the compensator spool (621) moves right direction through the  $P_f$  piston (897), so the pump tilting angle decreases and horsepower setting decreases, as explained in the overload prevention operation. Conversely, if the power shift pressure  $P_f$  decrease, the horsepower setting rises.



260SA2MP23



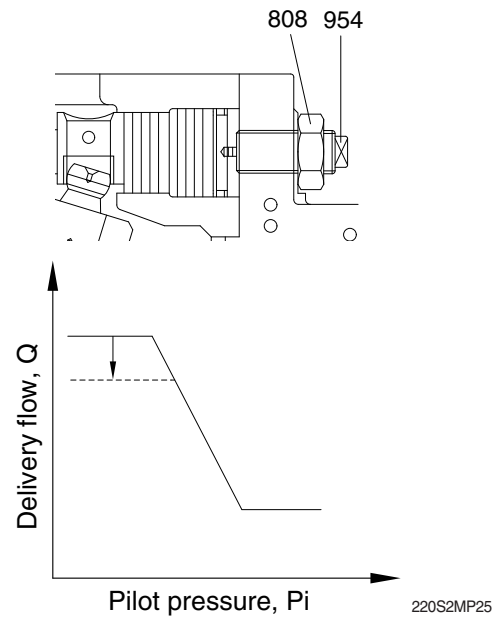
220S2MP24

#### 4. ADJUSTMENT OF PUMP AND REGULATOR

The maximum flow and minimum flow can be adjusted with the adjusting screws (954, 953) of the pump. The flow control characteristics can be adjusted with the hexagon socket head cap (924). The horsepower control characteristics can be adjusted with the adjusting screw (C, 628) and adjusting stem (C, 627) of the regulator. The maximum flow and minimum flow can be adjusted with the adjusting screws of the pump.

##### 1) ADJUSTMENT OF MAXIMUM FLOW (MAIN PUMP SIDE)

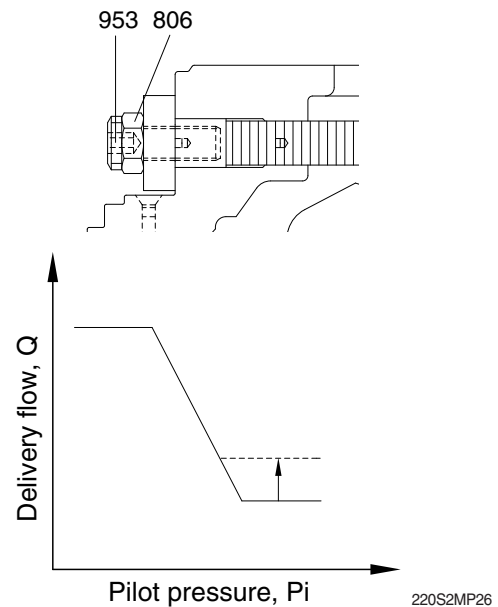
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the hexagonal socket head screw (954). As tightening the flow decreases, as loosening the flow increases. Only the maximum flow can be adjusted without changing other control characteristics.



##### 2) ADJUSTMENT OF MINIMUM FLOW (MAIN PUMP SIDE)

Adjust it by loosening the hexagon nut (806) and by tightening (or loosening) the hexagon socket head set screw (953). As tightening the flow increases, as loosening the flow decreases.

Similarly to the adjustment of the maximum flow, other characteristics are not changed. However, remember that, if tightened too much, the required horsepower at the maximum delivery pressure (or during relieving) may increase.



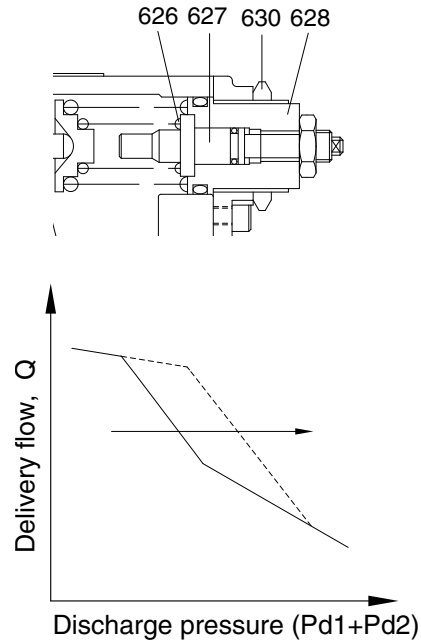
### 3) ADJUSTMENT OF INPUT HORSEPOWER

This regulator is 2 pump total horsepower control system, so when you change horsepower set, please adjust the adjust stem (C, 627) and the adjust screw (C) (628) both front and rear pumps. In addition, changes of pressure values by adjustments are values when 2 pump pressure risings are simultaneously.

#### (1) Adjustment of outer spring

Loosen the hexagon nut (630), and make adjustment by tightening (or loosening) the adjusting screw (C, 628).

When the adjusting screw (C, 628) is tightening, the control diagram moves right, and input horsepower increases as shown in the drawing right. However, if the adjusting screw (C, 628) is turned, the setting of the inner spring (626) also changes, so temporarily turn the adjusting ring (C, 627) reversely.

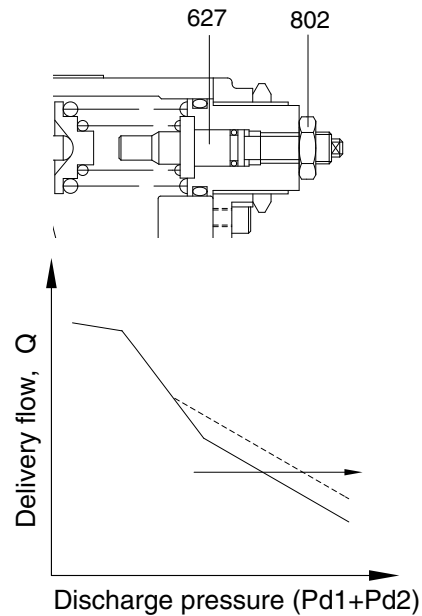


220S2MP27

#### 2) Adjustment of inner spring

Loosen the hexagon nut (802), and make adjustment by tightening (or loosening) the adjusting stem (C, 627).

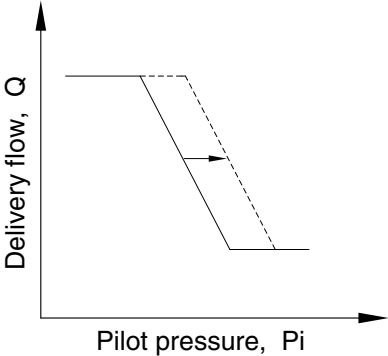
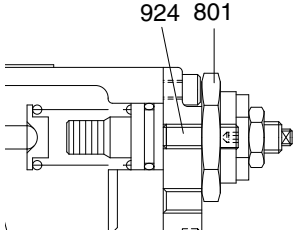
When the adjusting stem (C, 627) is tightening, flow increases, and input horsepower increases as shown in the drawing right.



220S2MP28

**4) Adjustment of flow control characteristic**

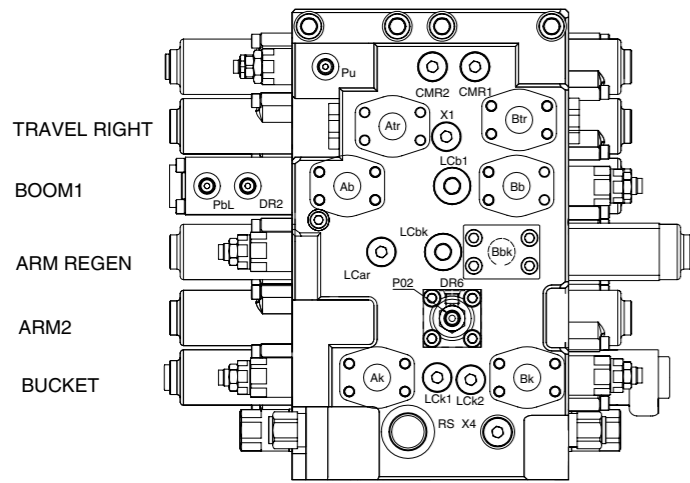
The flow control characteristic can be adjusted with the adjusting screw. Adjust it by tightening (or loosening) the hexagonal socket head screw (924) after loosening the hexagon nut (801). Tightening the screw shifts control chart to right as shown in the figure.



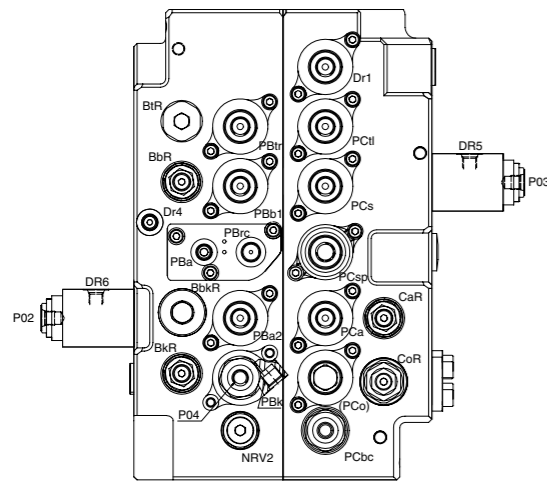
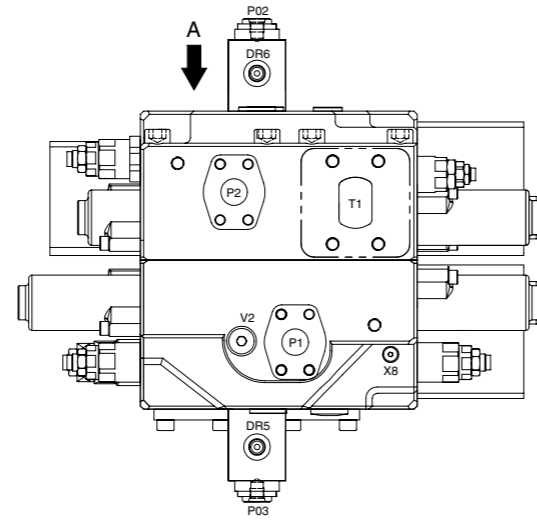
220S2MP29

# GROUP 2 MAIN CONTROL VALVE

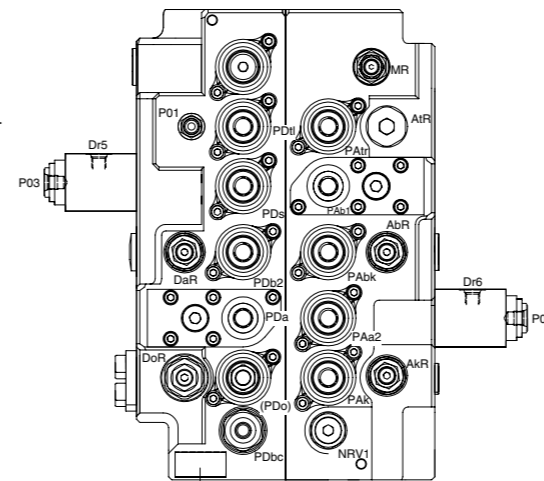
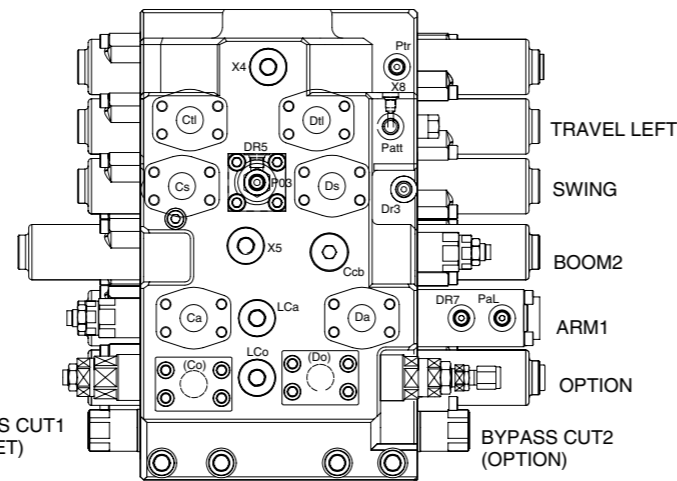
## 1. STRUCTURE (1/8)



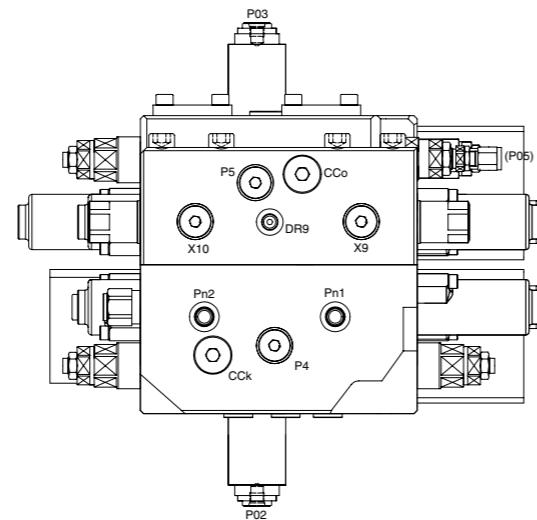
VIEW A



SWING PRIORITY



Name plate

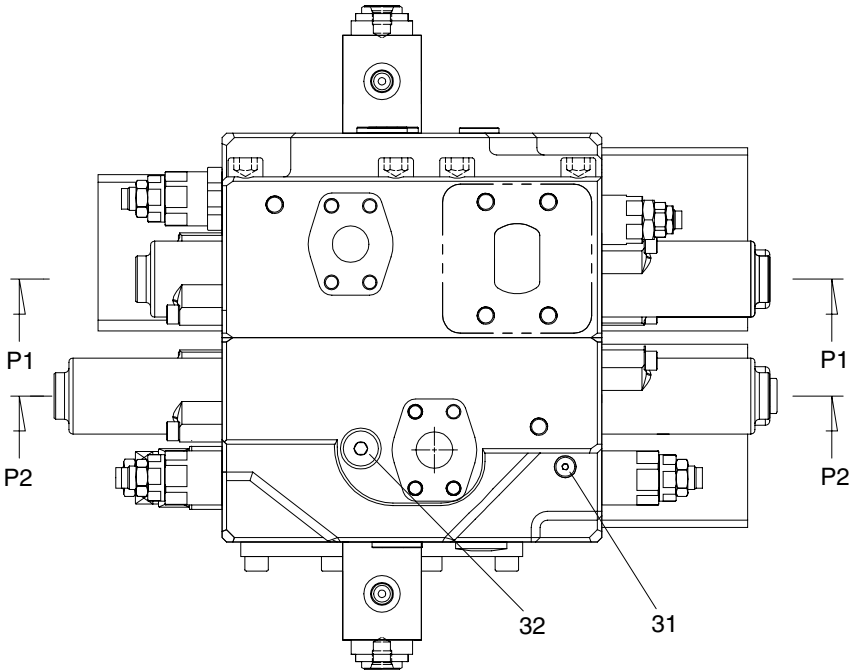


Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	PF1	20~25 kgf · m (145~180 lbf · ft)
Patt	Auto idle signal-attachment	PF1/4	3.5~4.0 kgf · m (25.3~28.9 lbf · ft)
PbL	Lock valve pilot port (boom)		
PCbc	Bucket in confluence pilot port		
PDbc	Option confluence pilot port		
P01	Pilot signal port		
P02	Pilot signal port		
P03	Swing logic pilot port		
P04	Bucket parallel orifice pilot port		
(P05)	Option B confluence pilot port		
PaL	Lock valve pilot port (arm)		
Ptr	Auto idle signal-travel		
Pu	Power boost		
PBa	Arm in regen-cut signal selector port		
DR1	Drain port		
DR2	Drain port		
DR3	Drain port		
DR4	Drain port		
DR5	Drain port		
DR6	Drain port		
DR7	Drain port		
DR9	Drain port		
(P4) (P5)	-	PF1/2	10~12 kgf · m (72.3~86.8 lbf · ft)
PAtr	Travel pilot port-RH (FW)	PF3/8	7~8 kgf · m (50.6~57.8 lbf · ft)
PBtr	Travel pilot port-RH (BW)		
PCtl	Travel pilot port-LH (BW)		
PDtl	Travel pilot port-LH (FW)		
PAb1	Boom up pilot port		
PDb2	Boom up confluence pilot port		
PBb1	Boom down pilot port		
PCs	Swing pilot port (LH)		
PDs	Swing pilot port (RH)		
PBa2	Arm in confluence pilot port		
PCsp	Swing priority pilot port		
PAbk	Option A pilot port (breaker)		
PBrc	Arm in regeneration cut port		
PCa	Arm in pilot port		
PDa	Arm out pilot port		
PAa2	Arm out confluence pilot port		
PAk	Bucket in pilot port		
PBk	Bucket out pilot port		
(PCo)	Option B pilot port		
(PDO)	Option B pilot port		
Pn1	Negative control signal port (A2 port side)		
Pn2	Negative control signal port (A1 port side)		
V2	Carry-over port		
Atr	Travel motor port-LH (FW)	M10	5.0~6.5 kgf · m (36.2~47.0 lbf · ft)
Btr	Travel motor port-LH (BW)		
Ctl	Travel motor port-RH (BW)		
Dtl	Travel motor port-RH (FW)		
Ab	Boom up port		
Bb	Boom down port		
Cs	Swing motor port (LH)		
Ds	Swing motor port (RH)		
(Bbk)	Option A port (breaker)		
Ca	Arm in port		
Da	Arm out port		
Ak	Bucket in port		
Bk	Bucket out port		
(Co)	Option B port		
(Do)	Option B port		
P1	Pump port (A2 side)		
P2	Pump port (A1 side)		
T1	Return port	M12	8.0~11.0 kgf · m (57.9~79.6 lbf · ft)

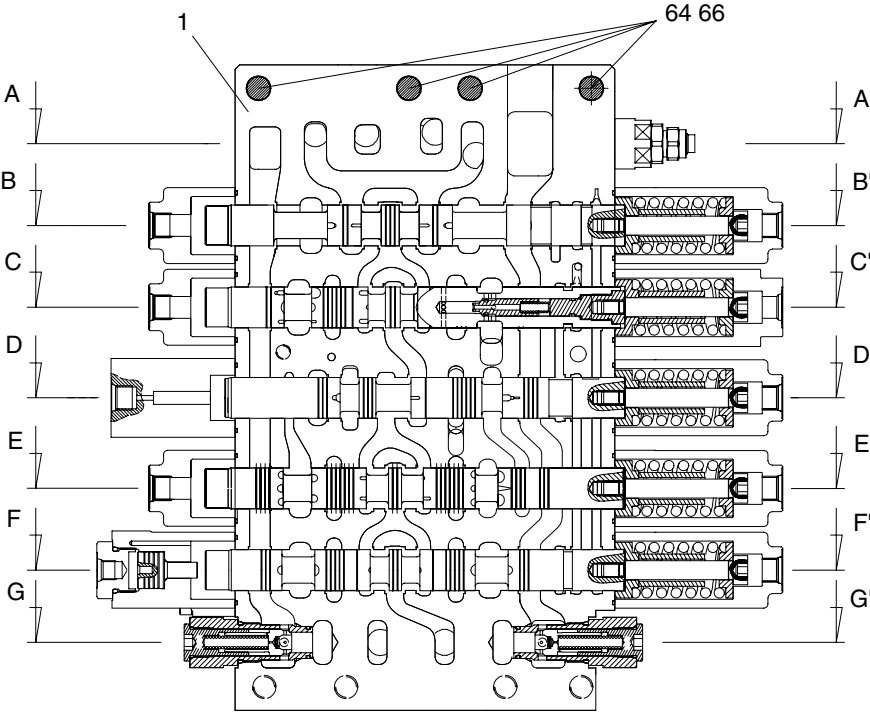
220SA2MC01



STRUCTURE (2/8)



TOP VIEW

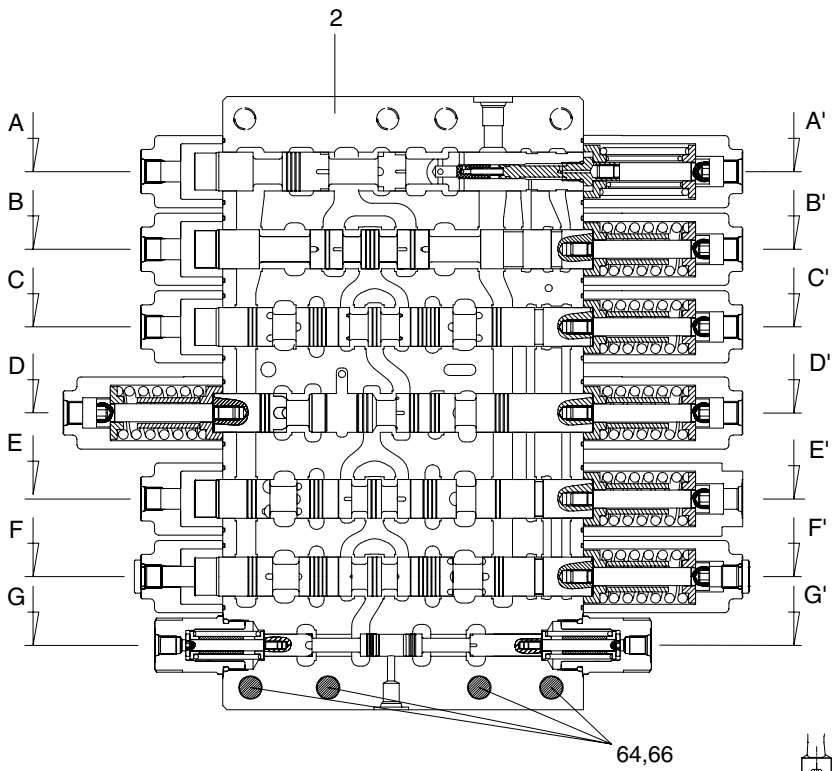


- 1 Housing P1
- 31 Plug
- 32 Plug
- 64 Hex socket head bolt
- 66 Spring washer

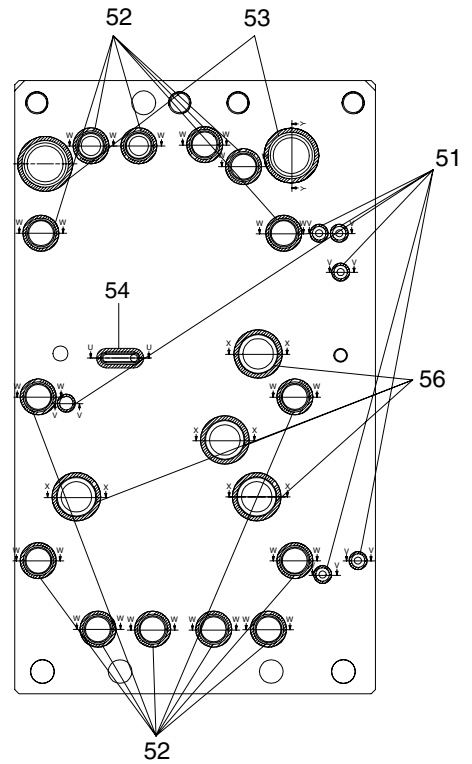
P1 BLOCK SPOOL SECTION

220SA2MC02

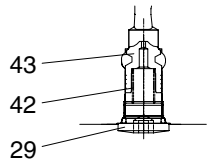
# STRUCTURE (3/8)



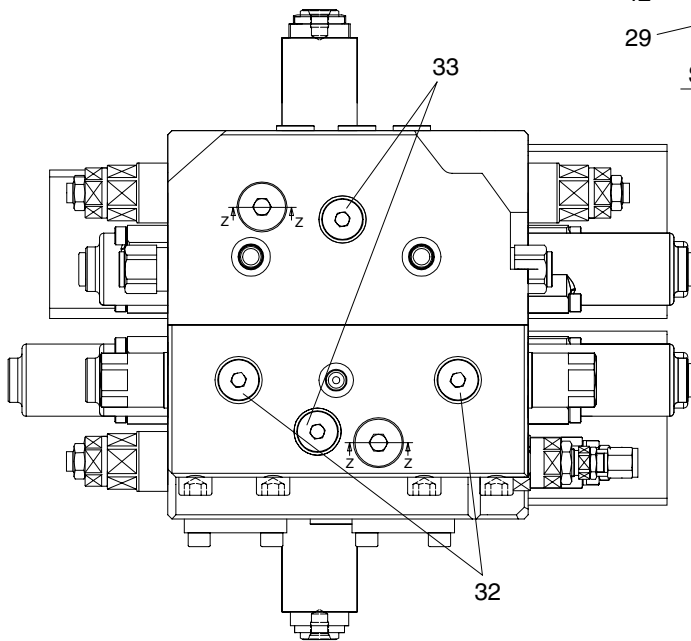
**P2 BLOCK SPOOL SECTION**



**CONTACT FACE**



**SECTION Z-Z**

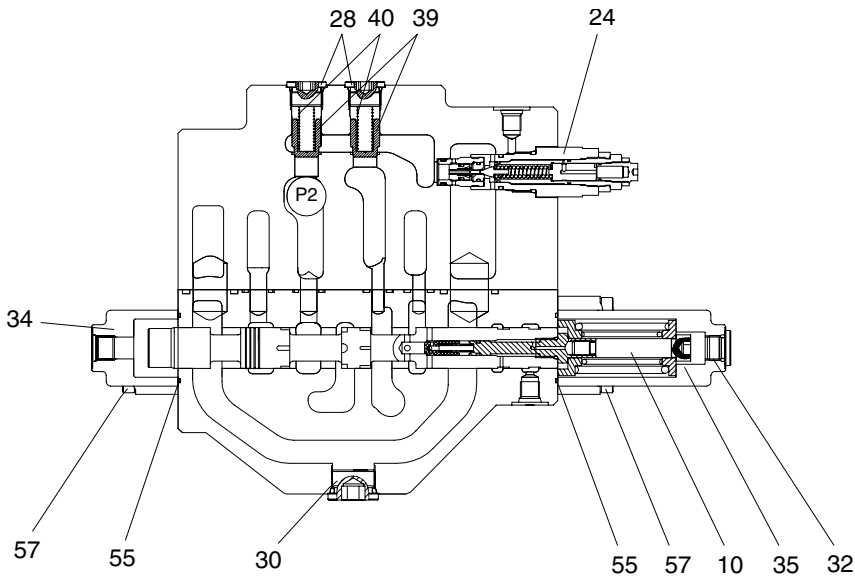


**BOTTOM VIEW**

- 2 Housing 2
- 29 Plug
- 32 Plug
- 33 Plug
- 42 Check valve spring 3
- 43 Check valve poppet 4
- 51 O-ring
- 52 O-ring
- 53 O-ring
- 54 O-ring
- 56 O-ring
- 64 Hex socket head bolt
- 66 Spring washer

220SA2MC03

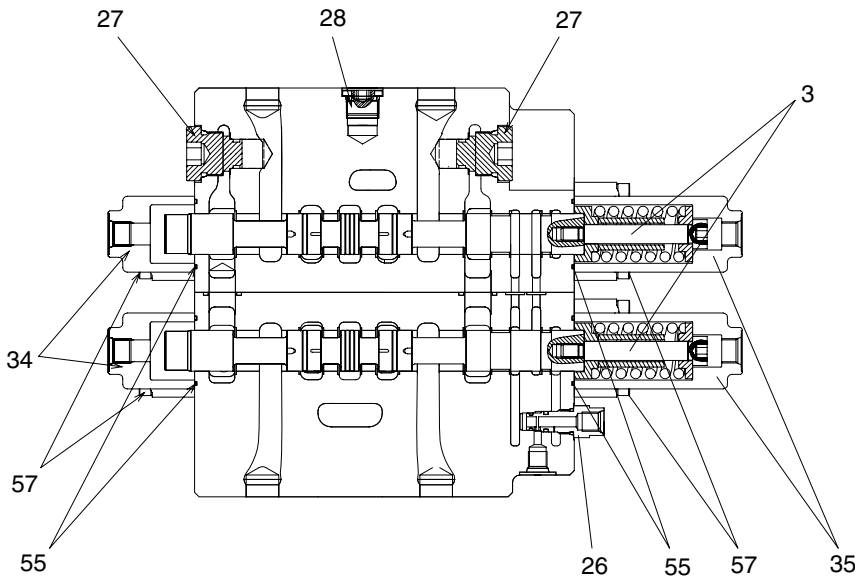
# STRUCTURE (4/8)



- 10 Travel straight spool kit
- 24 Main relief valve
- 28 Plug
- 30 Plug
- 32 Plug
- 34 Pilot cover A
- 35 Pilot cover B
- 39 Check valve poppet 2
- 40 Check valve spring 2
- 55 O-ring
- 57 Hex socket head bolt

A-A' (STRAIGHT TRAVEL AND SUPPLY)

220SA2MC04

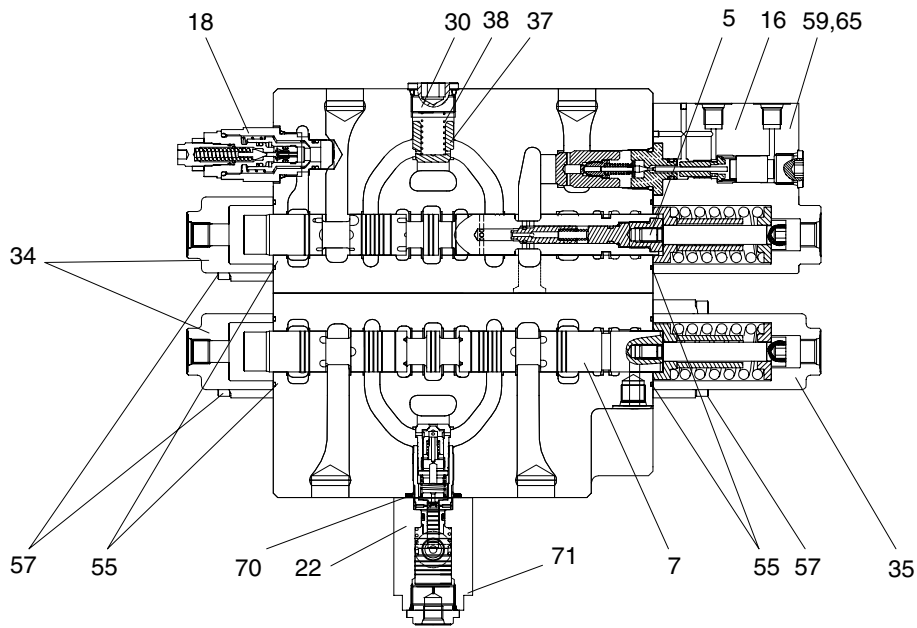


- 3 Travel spool kit
- 26 Orifice signal plug
- 27 ORV plug
- 28 Plug
- 34 Pilot cover A
- 35 Pilot cover B
- 55 O-ring
- 57 Hex socket head bolt

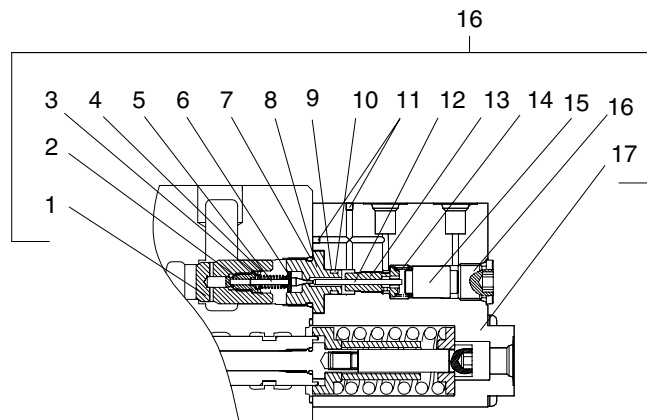
B-B' (TRAVEL RIGHT AND LEFT)

220S2MC05

# STRUCTURE (5/8)



C-C' (SWING AND BOOM1)

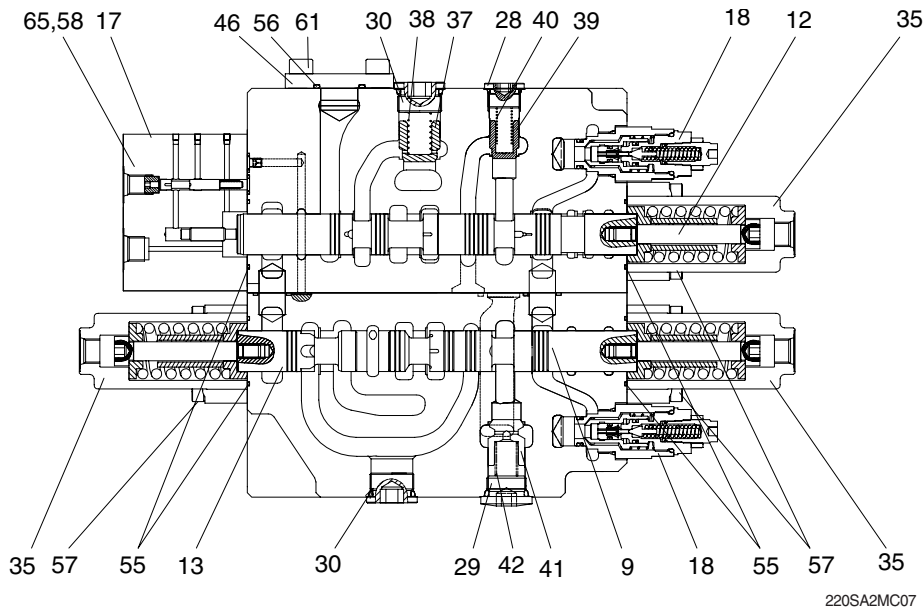


HOLDING VALVE

220SA2MC06

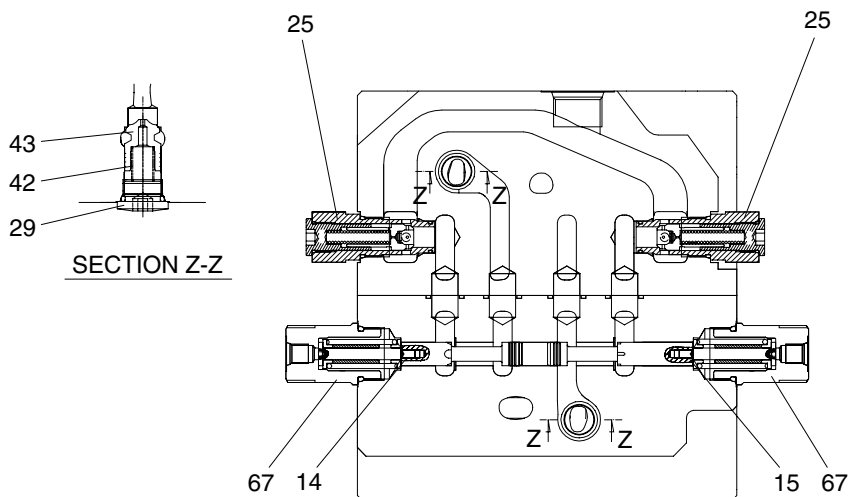
- |                       |                          |                         |
|-----------------------|--------------------------|-------------------------|
| 5 Boom 1 spool kit    | 16-9 Back up ring        | 30 Plug                 |
| 7 Swing spool kit     | 16-10 O-ring             | 34 Pilot cover A        |
| 16 Holding valve assy | 16-11 Plug               | 35 Pilot cover B        |
| 16-1 Main poppet      | 16-12 Pilot piston       | 37 Check valve poppet 1 |
| 16-2 Restrictor       | 16-13 Piston guide       | 38 Check valve spring 1 |
| 16-3 Pilot spring     | 16-14 Spring             | 55 O-ring               |
| 16-4 C-ring           | 16-15 Main piston        | 57 Hex socket head bolt |
| 16-5 Pilot poppet     | 16-16 Plug               | 59 Hex socket head bolt |
| 16-6 Poppet guide     | 16-17 Block              | 65 Spring washer        |
| 16-7 O-ring           | 18 Overload relief valve | 70 O-ring               |
| 16-8 Poppet seat      | 22 Swing logic valve     | 71 Hex socket head bolt |

## STRUCTURE (6/8)



D-D' (SWING PRI, BOOM 2 & ARM REGEN)

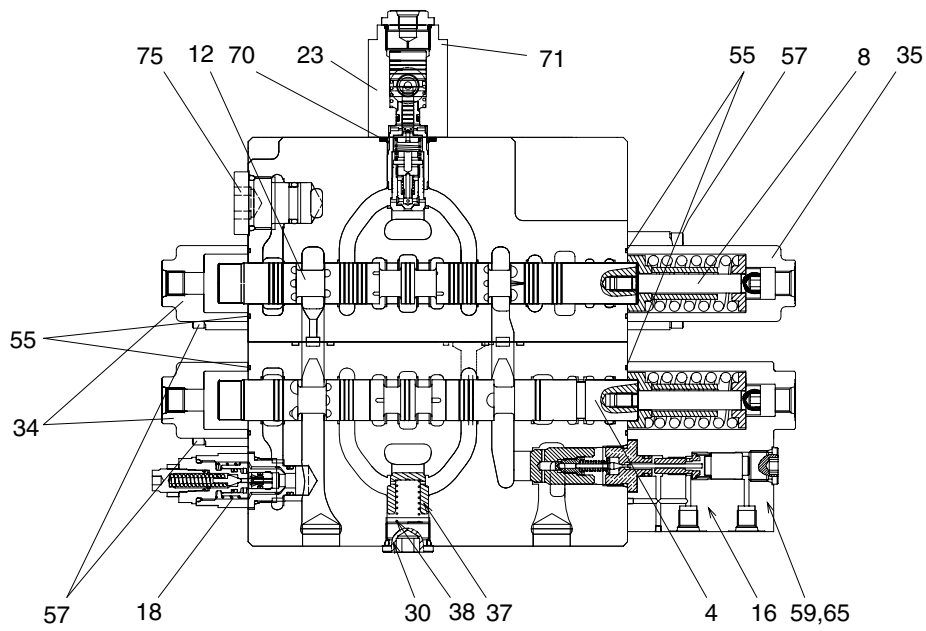
- 9 Boom 2 spool kit
- 12 Arm regen spool kit
- 13 Swing priority spool kit
- 17 Regen valve
- 18 Overload relief valve
- 28 Plug
- 29 Plug
- 30 Plug
- 35 Pilot cover B
- 37 Check valve poppet 1
- 38 Check valve spring 1
- 39 Check valve poppet 2
- 40 Check valve spring 2
- 41 Check valve poppet 3
- 42 Check valve spring 3
- 46 Flange
- 55 O-ring
- 56 O-ring
- 57 Hex socket head bolt
- 58 Hex socket head bolt
- 61 Hex socket head bolt
- 65 Spring washer



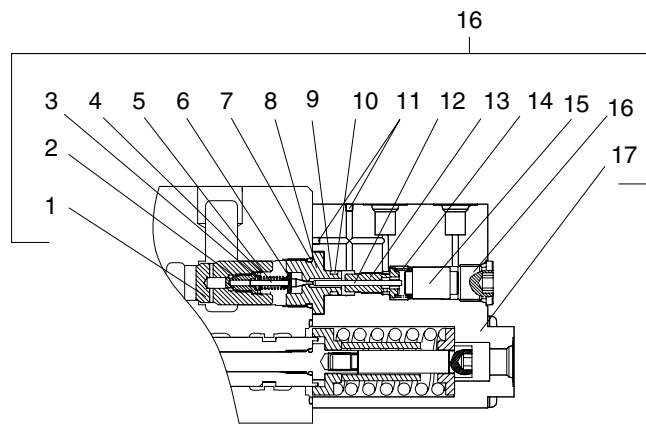
G-G' (BYPASS CUT & NEGATIVE CONTROL)

- 14 Bypass cut 1 spool kit (bucket)
- 15 Bypass cut 1 spool kit (option)
- 25 Negacon valve
- 29 Plug
- 42 Check valve spring 3
- 43 Check valve poppet 4
- 67 BC plug

## STRUCTURE (7/8)



E-E' (ARM 1 & ARM 2)

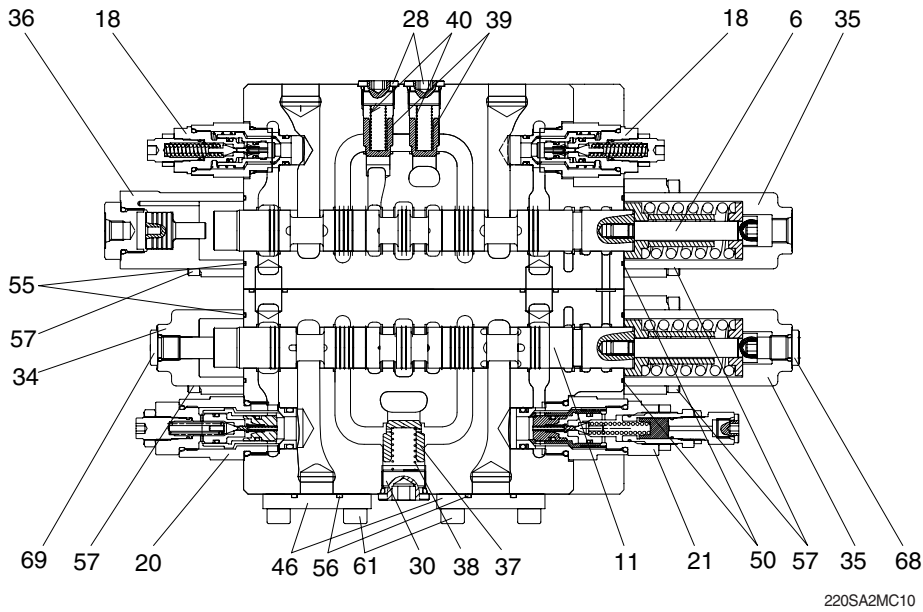


HOLDING VALVE

220SA2MC09

- |      |                     |       |                       |    |                      |
|------|---------------------|-------|-----------------------|----|----------------------|
| 4    | Arm 1 spool kit     | 16-9  | Back up ring          | 34 | Pilot cover A        |
| 8    | Arm 2 spool kit     | 16-10 | O-ring                | 35 | Pilot cover B        |
| 12   | Arm regen spool kit | 16-11 | Plug                  | 37 | Check valve poppet 1 |
| 16   | Holding valve assy  | 16-12 | Pilot piston          | 38 | Check valve spring 1 |
| 16-1 | Main poppet         | 16-13 | Piston guide          | 55 | O-ring               |
| 16-2 | Restrictor          | 16-14 | Spring                | 57 | Hex socket head bolt |
| 16-3 | Pilot spring        | 16-15 | Main piston           | 59 | Hex socket head bolt |
| 16-4 | C-ring              | 16-16 | Plug                  | 65 | Spring washer        |
| 16-5 | Pilot poppet        | 16-17 | Block                 | 70 | O-ring               |
| 16-6 | Poppet guide        | 18    | Overload relief valve | 71 | Hex socket head bolt |
| 16-7 | O-ring              | 23    | Arm logic valve       | 75 | Plug                 |
| 16-8 | Poppet seat         | 30    | Plug                  |    |                      |

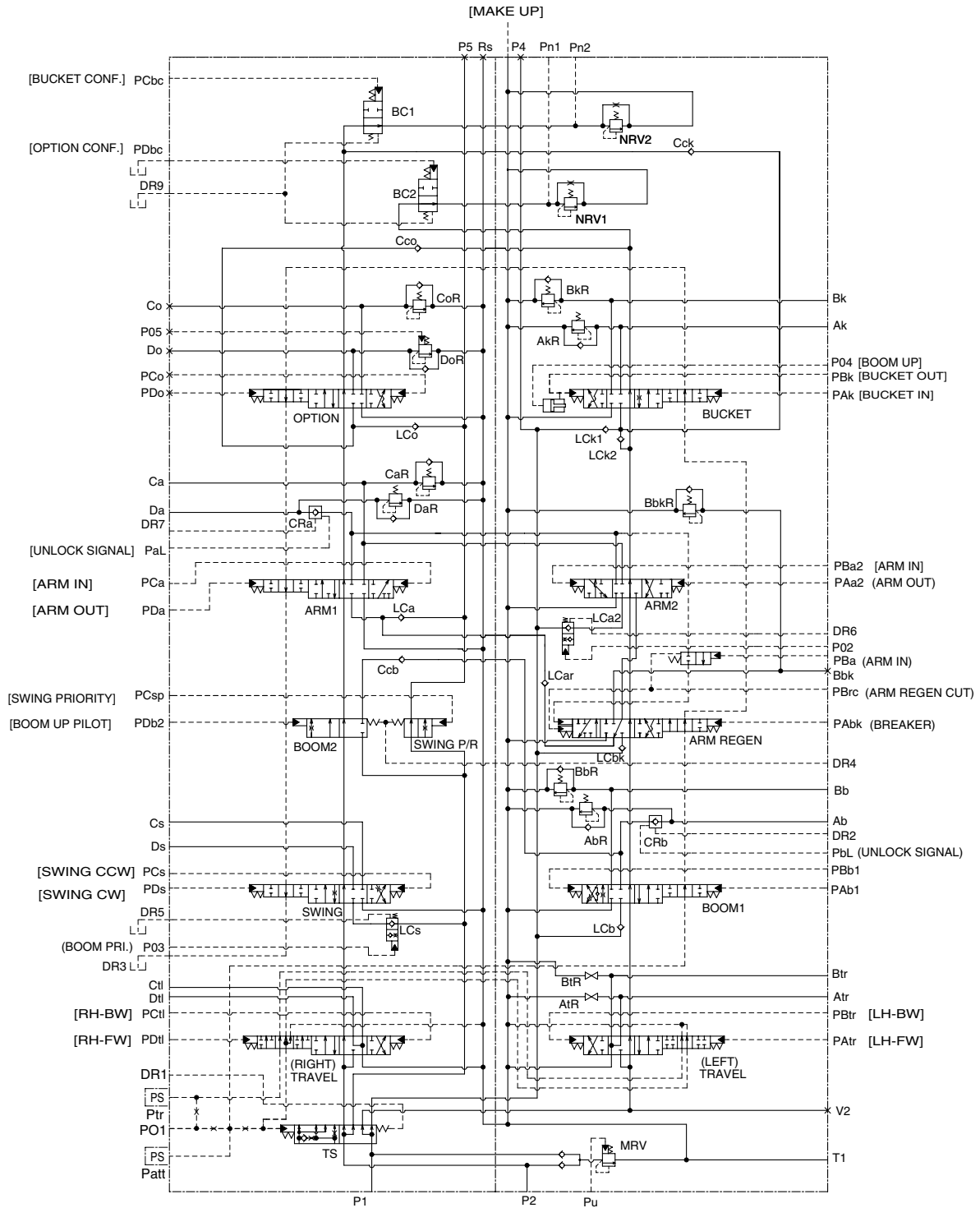
## STRUCTURE (8/8)



F-F' (OPTION & BUCKET)

- 6 Bucket spool kit
- 11 Option spool kit
- 18 Overload relief valve
- 20 Overload relief valve
- 21 Overload relief valve
- 28 Plug
- 30 Plug
- 34 Pilot cover A
- 35 Pilot cover B
- 36 Pilot cover (stroke limit)
- 37 Check valve poppet 1
- 38 Check valve spring 1
- 39 Check valve poppet 2
- 40 Check valve spring 2
- 46 Flange
- 55 O-ring
- 56 O-ring
- 57 Hex socket head bolt
- 61 Hex socket head bolt
- 68 Plug kit 1
- 69 Plug kit 2

## 2. HYDRAULIC CIRCUIT



260SA2MC11



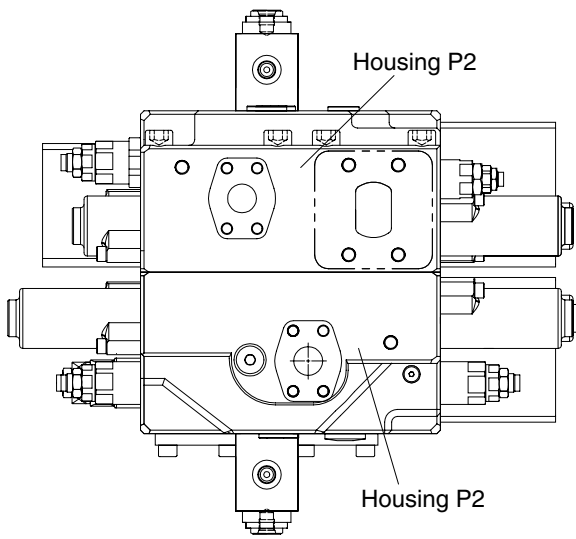
### 3. FUNCTION

#### 1) CONTROL IN NEUTRAL POSITION

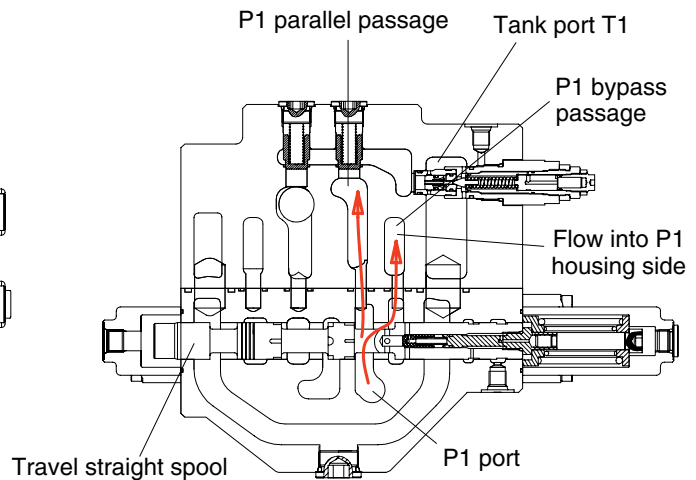
##### (1) P1 housing side

The pressurized oil discharged from hydraulic pump flows into the main control valve through the inlet port P1 and pass the land of the straight travel spool into the P1 bypass passage and P1 parallel passage.

When the straight travel spool is neutral, the P1 side bypass passage is not cut-off and the pressurized oil is directed to the tank port T1 through the bypass passage of spools (travel right -> boom 1 -> arm regeneration -> arm 2 -> bucket), the negative control valve of P1 and tank passage.

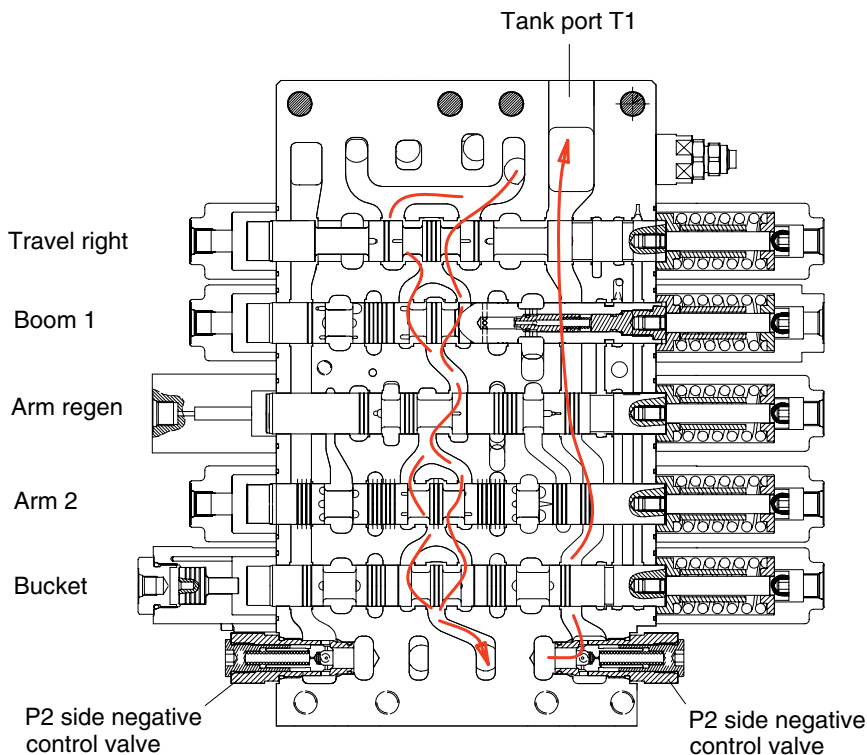


TOP VIEW



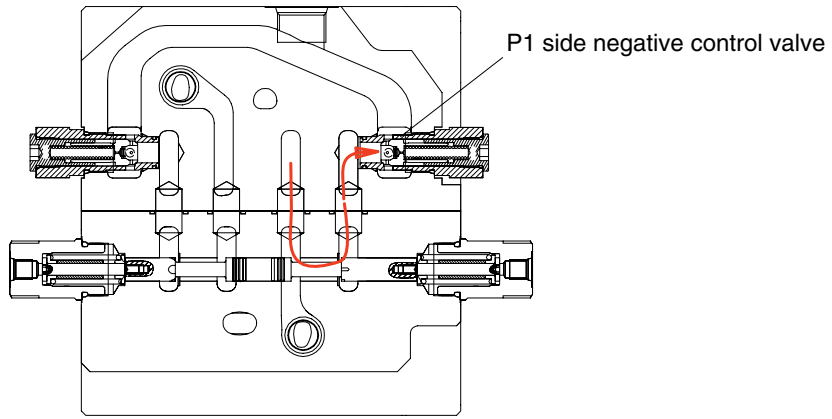
A-A' (STRAIGHT TRAVEL AND SUPPLY)

220SA2MC13



P1 BLOCK SPOOL SECTION

220SA2MC14



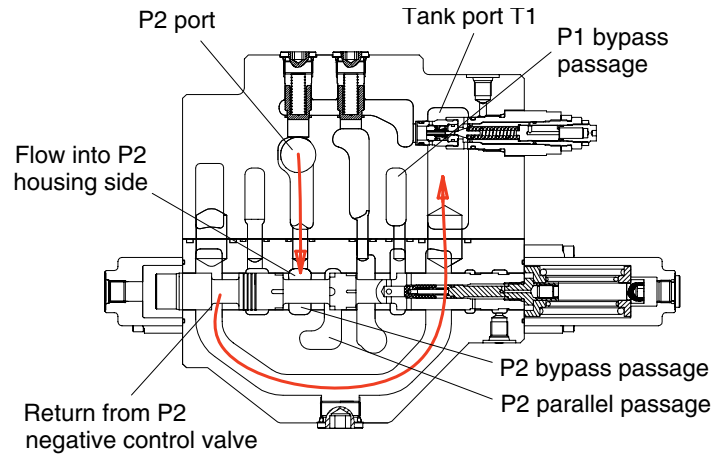
G-G' (BYPASS CUT & NEGATIVE CONTROL)

220S2MC15

## (2) P2 housing side

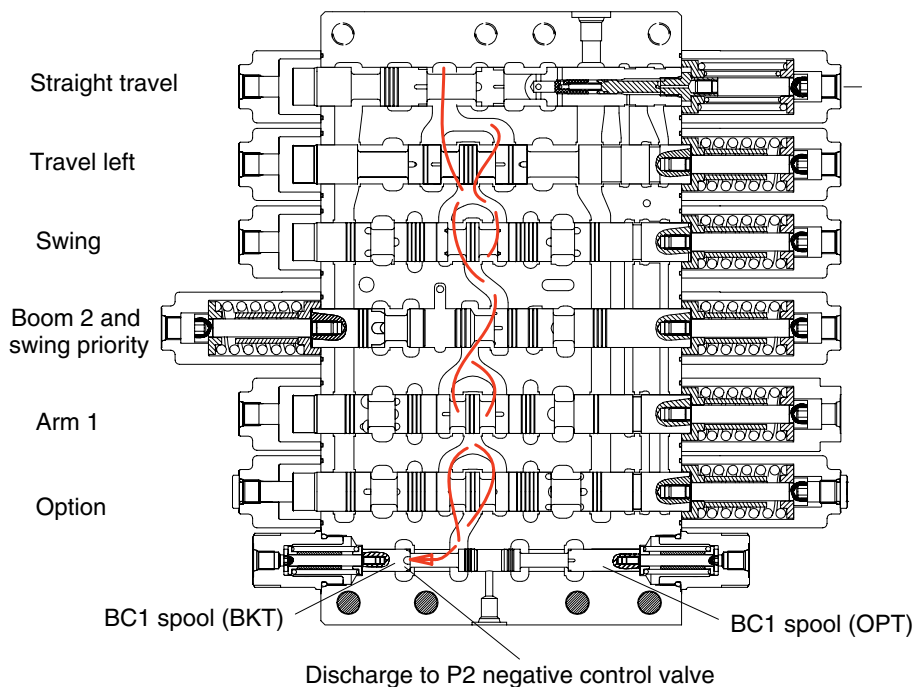
The pressurized oil discharged from hydraulic pump flows into the main control valve through the inlet port P2 and pass the land of the straight travel spool into the P2 bypass passage and P2 parallel passage.

When the straight travel spool is neutral, the P2 side bypass passage is not cut-off and the pressurized oil is directed to the tank port T1 through the bypass passage of spools (travel left -> swing -> boom 2 and swing priority -> arm 1 -> option), the negative control valve of P2 and tank passage.



A-A' (STRAIGHT TRAVEL AND SUPPLY)

220SA2MC16



P2 BLOCK SPOOL SECTION

220S2MC17

## 2) TRAVEL OPERATION

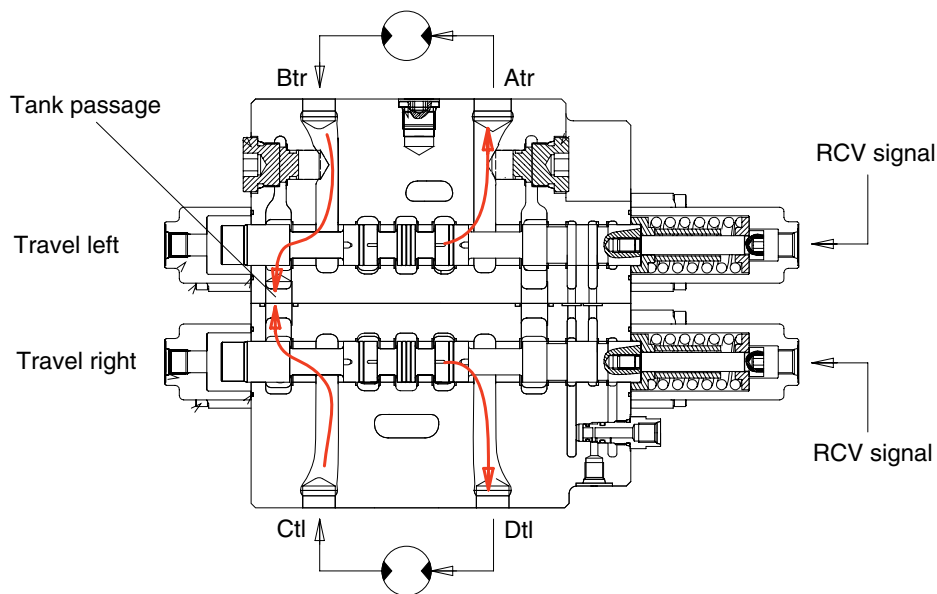
### (1) Travel forward operation

During the travel forward operation, the pilot secondary pressure from the remote control valve is supplied to the spring side of pilot port and it shifts travel spools to the left direction.

The pressurized oil from the pump flows into the bypass passage of the travel spools through the land of the straight travel spool.

When the travel spools is shifted and the bypass passage is shut-off. The pressurized oil flowed into bypass passage is supplied to the travel motors through opened port Atr and Dtl.

On the other hand, the return oil from the travel motors flows into main control valve inside through the port Btr and Ctl and return to the tank passage.



B-B' (TRAVEL RIGHT AND LEFT)

220S2MC18

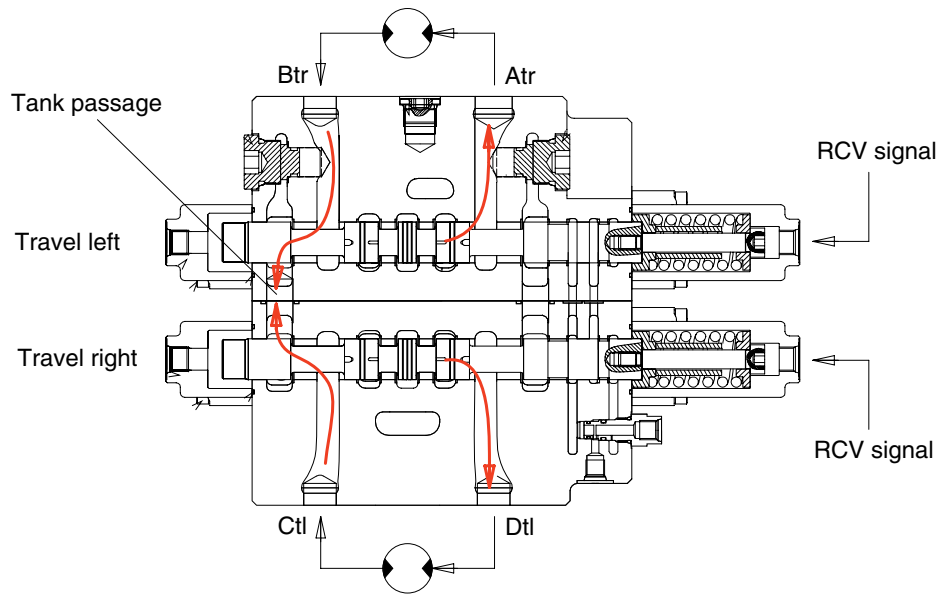
### (2) Travel backward operation

During the travel backward operation, the pilot secondary pressure from the remote control valve is supplied to the against pilot port of the spring side and it shifts travel spools to the right direction.

The pressurized oil from the pump flows into the bypass passage of the travel spools through the land of the straight travel spool.

When the travel spools are shifted and the bypass passage is shut-off. The pressurized oil flowed into bypass passage is supplied to the travel motors through opened port Btr and Ctl.

On the other hand, the return oil from the travel motors flows into main control valve inside through the port Atr and Dtl and return to the tank passage.



B-B' (TRAVEL RIGHT AND LEFT)

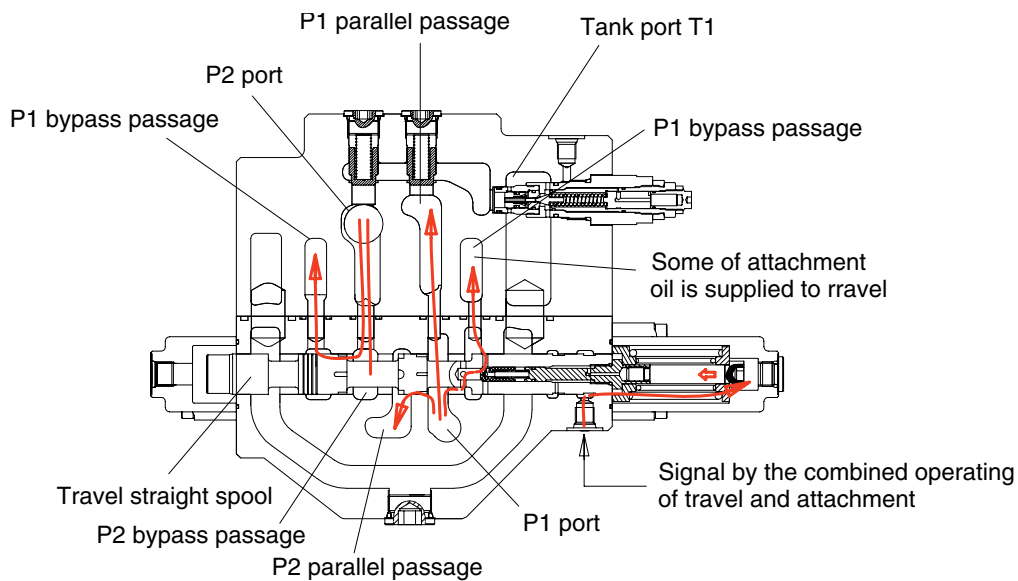
220S2MC19

### (3) Travel straight function

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

In normal conditions, travel straight spool keeps neutral conditions, the pressurized oil of the P1 and P2 pumps is supplied to each passage independently.

When the attachment spool is operated under the travel operation of both sides, the pilot pressure is supplied to the spring side port of the travel straight spool and then the travel straight spool is shifted to the left direction.



A-A' (STRAIGHT TRAVEL AND SUPPLY)

220SA2MC20

After changeover of the travel straight spool, the pressurized oil discharged from the P1 pump is connected with P2 port oil and is supplied to the attachment line through both parallel passage of the P1 and P2.

Also, some of the pressurized oil open the check valve of the spool inside through side of the travel straight spool and is connected with the bypass passage of the P2 side.

On the other hand, the pressurized oil discharged from the P2 pump is connected with P1 port oil and is supplied to the travel line through both parallel passage of the P1 and P2.

Accordingly the attachment spool is operated under the travel operation of both sides, the pressurized oil discharged from P2 pump is mainly supplied to left and right travel line and the pressurized oil discharged from P1 pump is mainly supplied to attachment line.

As a result, simultaneous operation of both travel spools and attachment is not influenced to the travel operation of the both sides and the machine keeps straight travel.

### 3) BOOM OPERATION

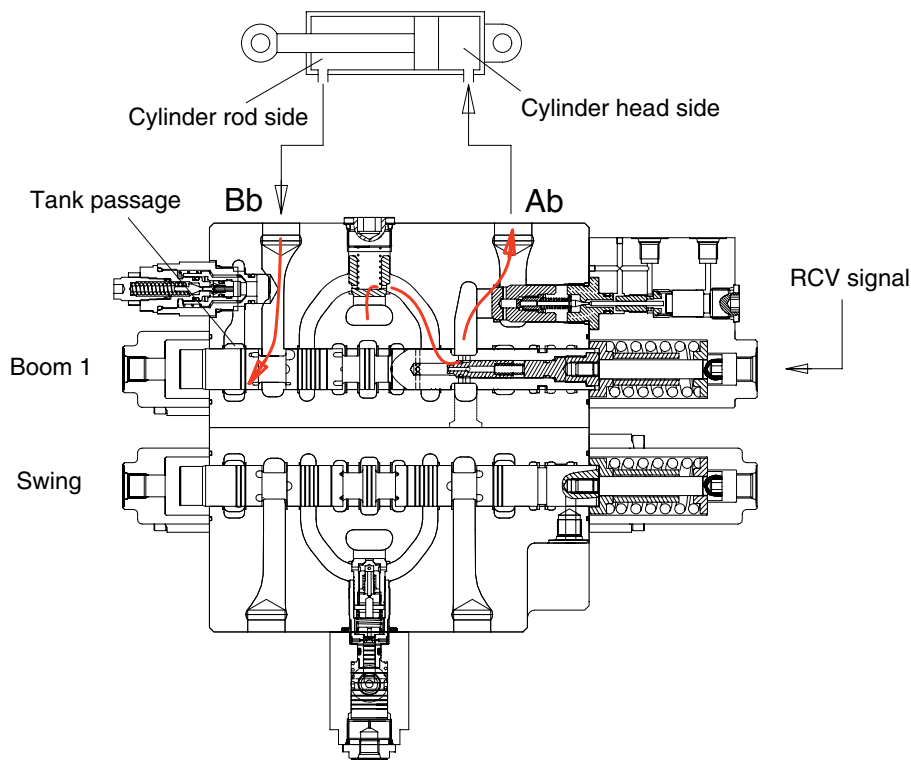
#### (1) Boom up operation

During the boom up operation, the pilot secondary pressure from the RCV is supplied to the port of the spring side and shifts the boom 1 spool to the left direction. The P1 bypass passage is shut off by the movement of the boom 1 spool and the pressurized oil from P2 port is entered P1 parallel passage and then passes through the load check valve, bridge passage and boom holding valve then flows into the head side of the boom cylinder via Ab port. (In this case, the boom holding valve is free flow condition)

At the same time, the pilot secondary pressure from RCV is supplied to the port of the spring side of boom 2 and shifts the boom 2 spool. The bypass passage is shut off by the movement of the boom 2 spool and the pressurized oil from P2 port entered boom summation passage via the P2 parallel passage, notch of the boom 2 spool, the check valve.

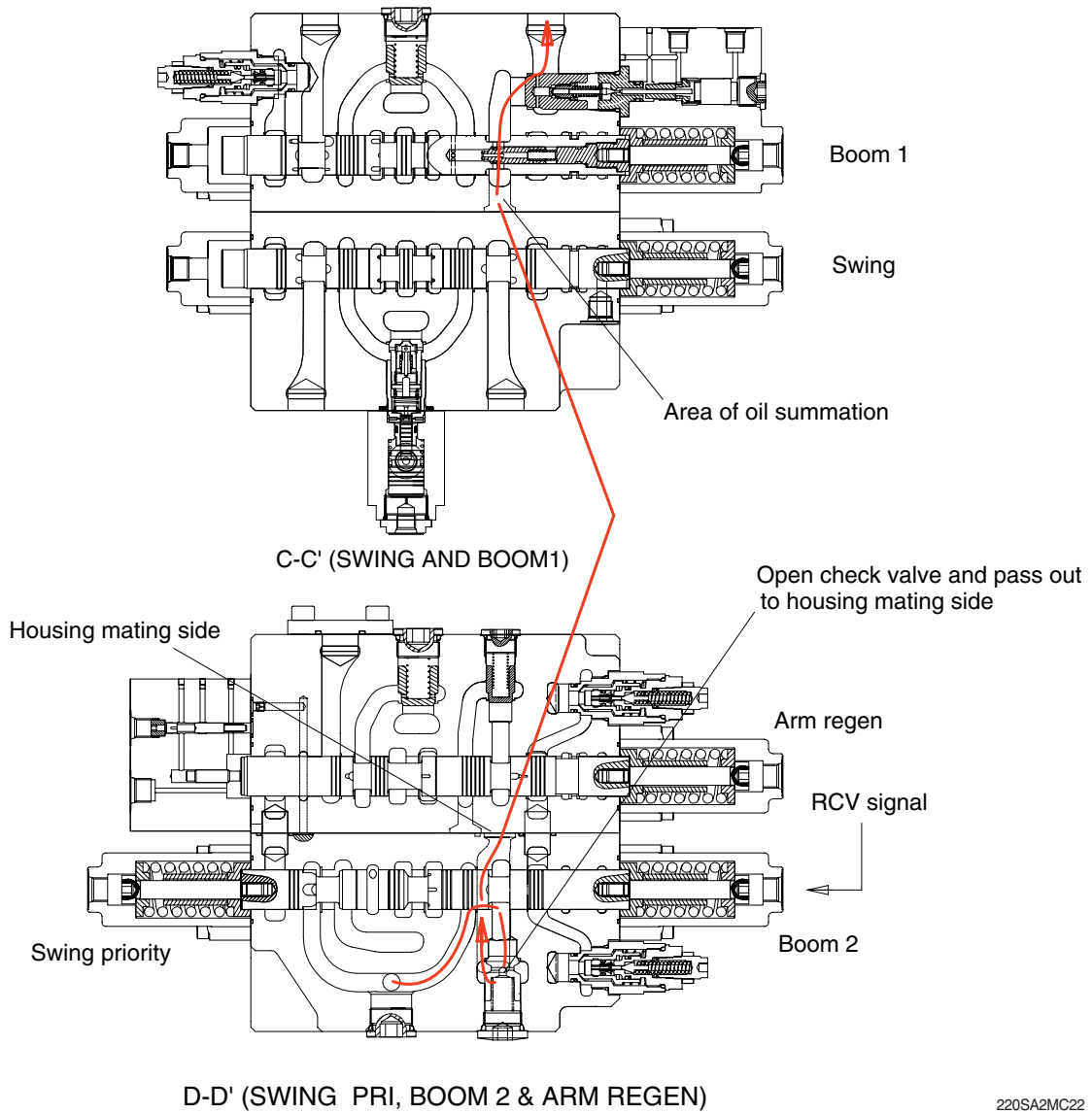
The oil from boom 2 spool combined with the boom 1 spool oil and is supplied Ab port.

At the same time, the return oil from rod side of the boom cylinders flows the boom 1 spool through the Bb port and return to the hydraulic oil tank through the tank passage.



C-C' (SWING AND BOOM1)

220SA2MC21



220SA2MC22



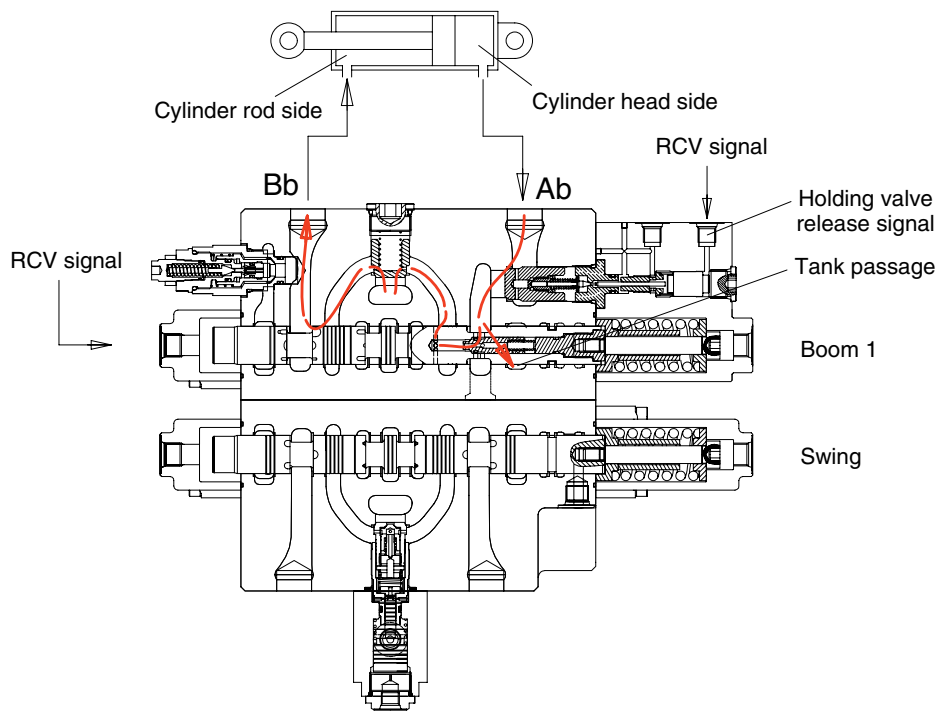
## (2) Boom down operation

During the boom down operation, the pilot secondary pressure from the RCV is supplied to the against port of the spring side and shifts the boom 1 spool to the right direction. The P1 bypass passage is shut off by the movement of the boom 1 spool and the pressurized oil from P1 port is entered P1 parallel passage and then passes through the load check valve and bridge passage then flows into the rod side of the boom cylinder via Bb port.

At the same time, the return oil from head side of the boom cylinders flows the boom 1 spool through the Ab port and the boom holding valve and return to the hydraulic oil tank through the tank passage.

At this time, some of the return oil from the boom head side passes to the connected passage of the boom 1 spool inside and flows into the P1 parallel passage. (Boom spool inside regeneration function). At this time, the boom holding valve is open status and the operation principles are described following page.

During the boom down operation, the flow is not combined.



C-C' (SWING AND BOOM1)

220SA2MC23

#### 4) HOLDING VALVE OPERATION

##### (1) Holding operation

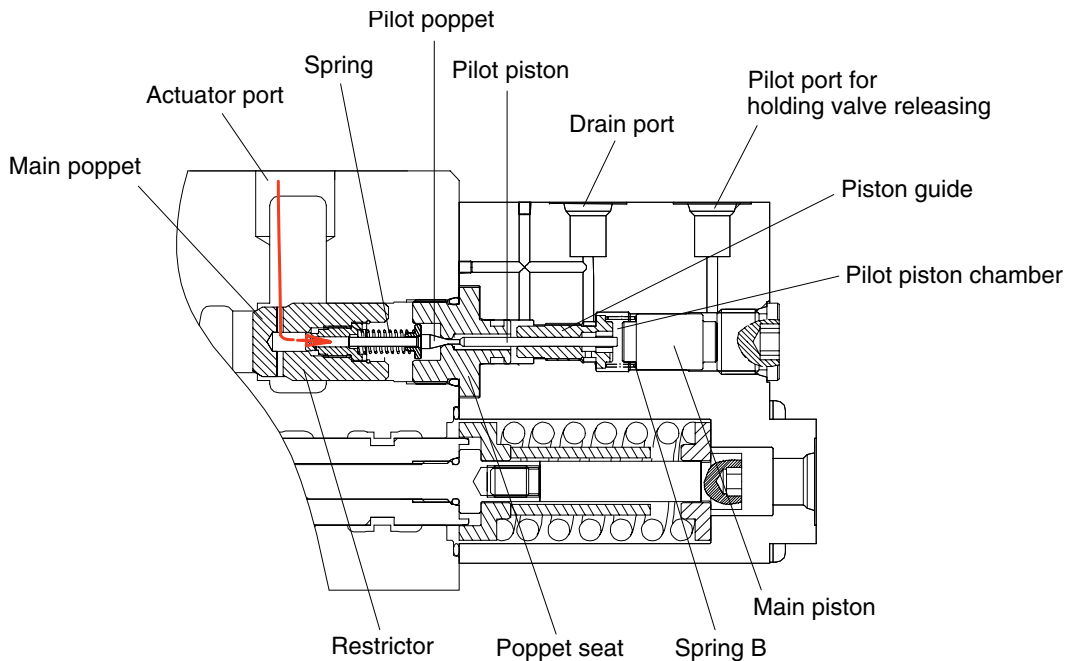
At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.

And the main piston is seated by the spring B.

Also, the pressurized oil from the actuator entered to inside of the holding valve through the periphery hole of the main poppet, crevice of the main poppet and the restrictor and the periphery hole of the restrictor.

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

So the pressurized oil from the holding side of the actuator is not escaped and the actuator is not moved.



HOLDING VALVE BLOCK SECTION

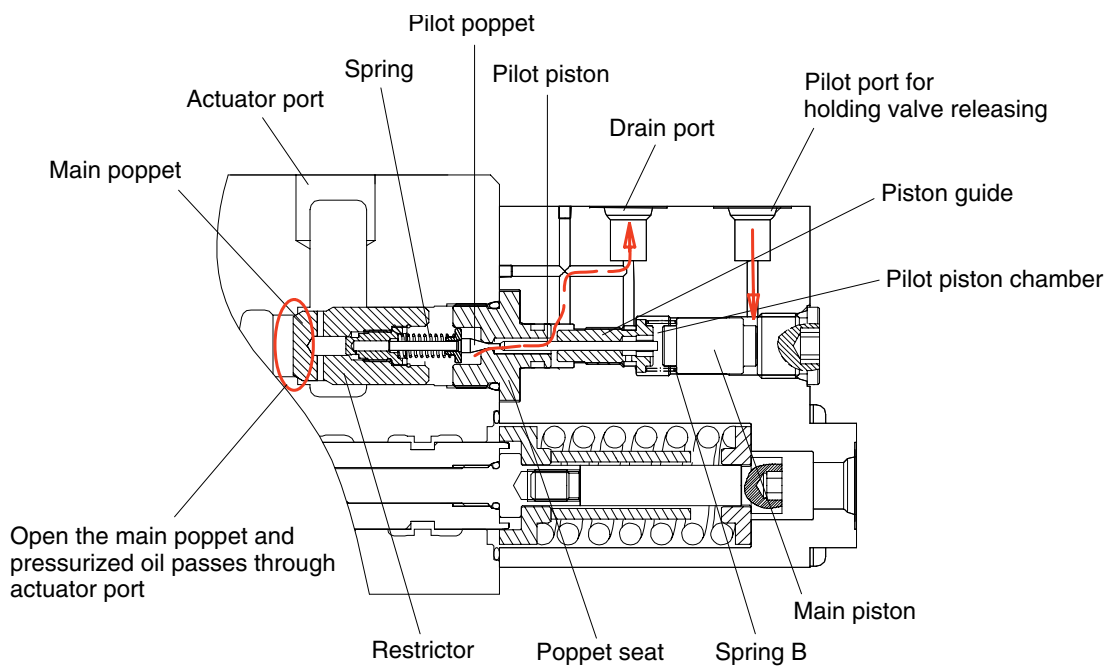
220S2MC24

## (2) Releasing holding operation

The pilot pressure is supplied to the pilot port for releasing holding valve and shifts the main piston to the left direction against the spring B and shifts the pilot poppet to the left direction through the pilot piston and open the passage for the drain.

At same time, the return oil from actuator returns to the drain port through the periphery hole of main poppet, crevice of the main poppet and the restrictor, the periphery hole of the restrictor, inside of holding valve, crevice of the pilot poppet and the drain passage of the holding valve.

After above operation, pressure of inside of holding valve is decreased and the main poppet is opened by the return oil of the actuator and the return oil from actuator returns to the tank passage through the notch of spool.



HOLDING VALVE BLOCK SECTION

220S2MC25

## 5) BUCKET OPERATION

### (1) Bucket in operation

#### ① Bucket operation only

During the bucket in operation, the pilot secondary pressure from the RCV is supplied to port of the spring side and shifts the bucket spool to the left direction.

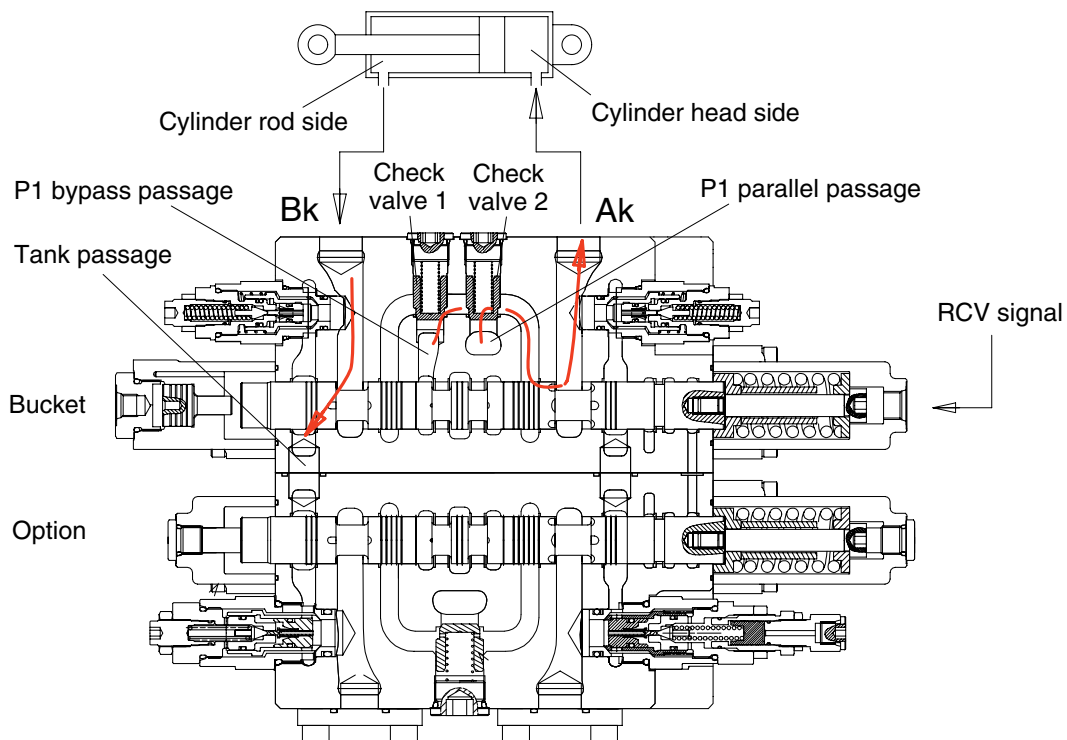
The P1 bypass passage is shut off by the movement of the bucket spool and the pressurized oil from P1 port entered P1 parallel passage and is directed to the Ak port through the check valve 2. At the same time, the pressurized oil from P1 bypass passage is directed to the AK port through the check valve 1.

The return oil from the rod side of the bucket cylinder (Bk port) returns to the hydraulic oil tank through the tank passage.

#### ② Combined operation

When combined operation of the bucket and other actuators, mostly same as above operation but the fluid from P1 bypass passage is empty by the upstream operation such as the arm or boom operation.

So only the fluid from P1 parallel passage is supplied to the Ak port.



F-F' (OPTION AND BUCKET)

220SA2MC26

**(2) Bucket slow operation (incase bucket in)**

This function is used to speed up of the boom or arm by reducing the bucket speed when the bucket operation with boom or arm operation simultaneously.

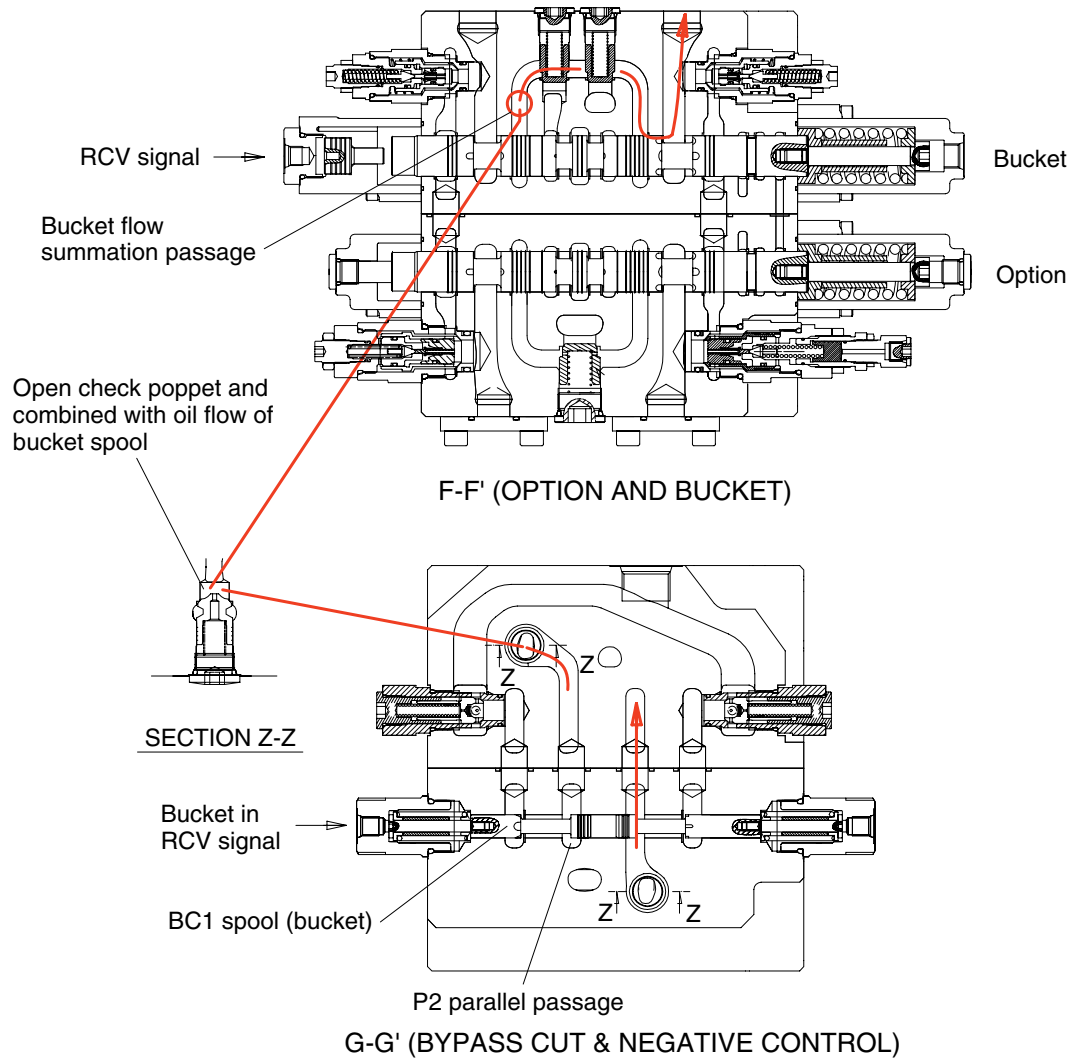
The bucket slow pilot pressure is supplied the pilot port of the BC1 spool and the piston is shifted to the right and then the bucket spool stroke is limited and the oil passage from P1 to the bucket cylinder is reduced and the oil flow of the bucket spool is reduced.

**Bucket flow summation function, bypass cut-off 1 spool**

During the bucket in operation, the pilot secondary pressure from the RCV is supplied to port of the spring side and shifts the BC1 (bucket) spool to the right direction.

The P2 parallel passage is shut off by the movement of the BC1 spool and the pressurized oil from P2 port opens the check poppet and combined with the flow of the bucket spool.

(Only bucket in operation)



FLOW SUMMATION BY THE SHIFTING OF THE BC1 SPOOL

220SA2MC27

### (3) Bucket out operation

#### ① Bucket operation only

During the bucket out operation, the pilot secondary pressure from the RCV is supplied to against port of the spring side and shifts the bucket spool to the right direction.

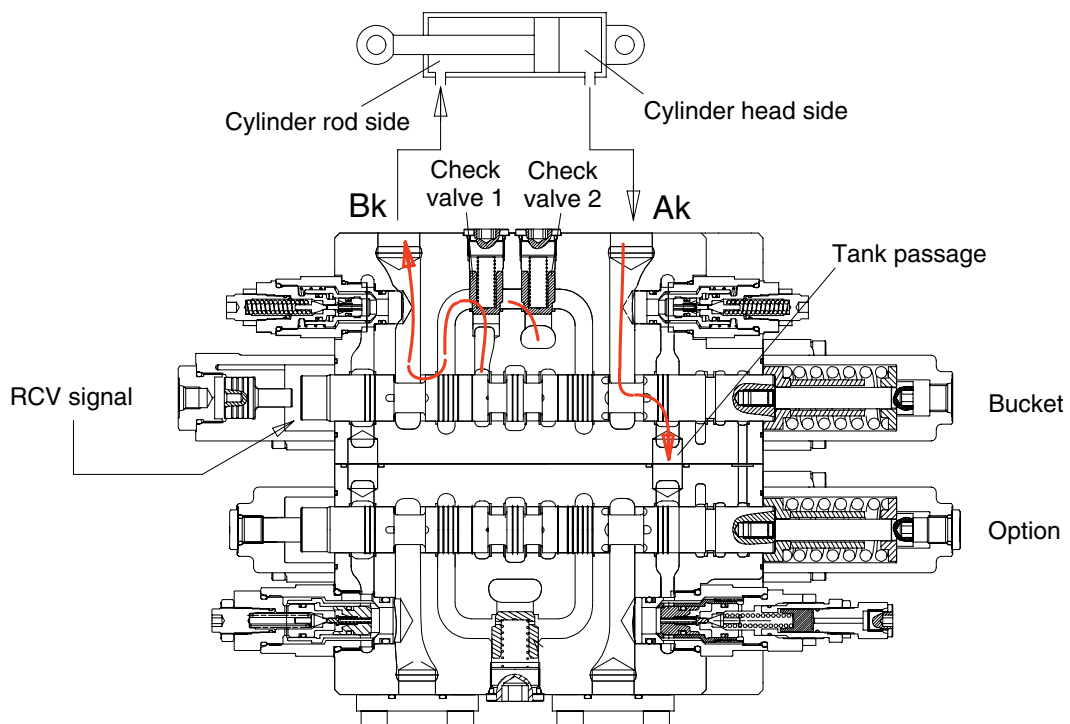
The P1 bypass passage is shut off by the movement of the bucket spool and the pressurized oil from P1 port entered P1 parallel passage and is directed to the Bk port through the check valve 2.

At the same time, the pressurized oil from P1 bypass passage is directed to the Bk port through the check valve 1.

The return oil from the head side of the bucket cylinder (Ak port) returns to the hydraulic oil tank through the tank passage.

#### ② Combined operation

When combined operation of the bucket and other actuators, exactly same as above operation.



F-F' (OPTION AND BUCKET)

220SA2MC28

## 6) SWING OPERATION

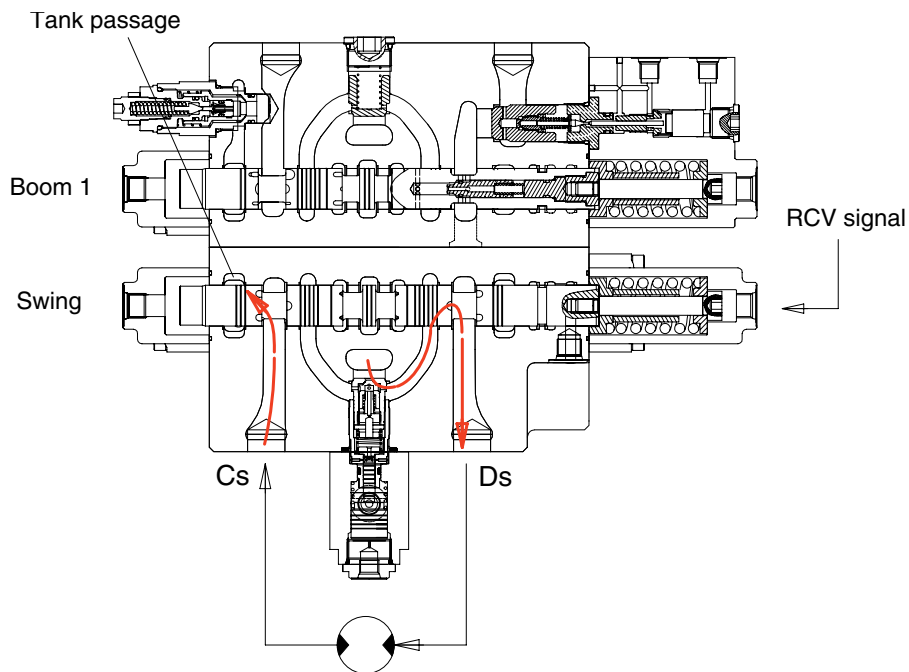
### (1) Swing left and right operation

During the swing left operation, the pilot secondary pressure from the RCV is supplied to the port of the spring side and shifts the swing spool in left direction. The P2 bypass passage is shut off by the movement of the swing spool and the pressurized oil from P2 port flows into the P2 parallel passage and open the load check valve and is supplied to swing motor through the Ds port.

As the result, the return oil from the swing motor flows into the main control inside through Cs port and returns to the hydraulic oil tank through the swing spool and the tank passage.

In case of swing right operation, the operation is similar to swing left operation but the pilot secondary pressure from the RCV is supplied to the port of the spring opposite side.

Accordingly, the pressurized oil from P2 parallel passage flows into swing motor through the Cs port and returns to the hydraulic oil tank through the Ds port and the tank passage.



C-C' (SWING AND BOOM1)

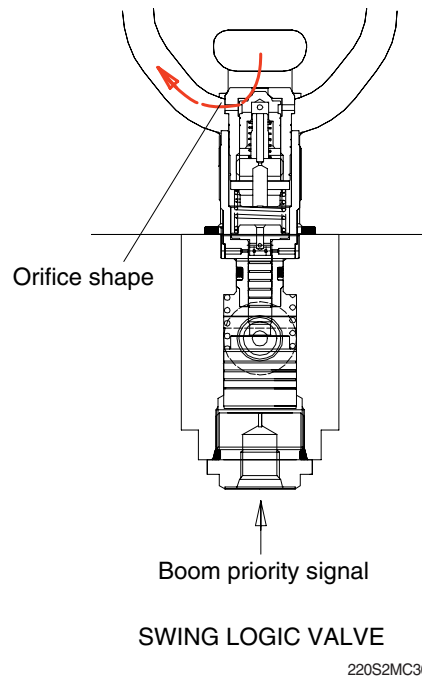
220SA2MC29

## (2) Boom priority function

This function is used to speed up of the boom by reducing the swing speed when the swing operation with boom operation simultaneously.

The boom priority signal is supplied the pilot port and the poppet of the swing logic valve is closed and then the pressurized oil from P2 port is reduced by the oil leaking through the orifice.

As a result, the swing speed is slowed.





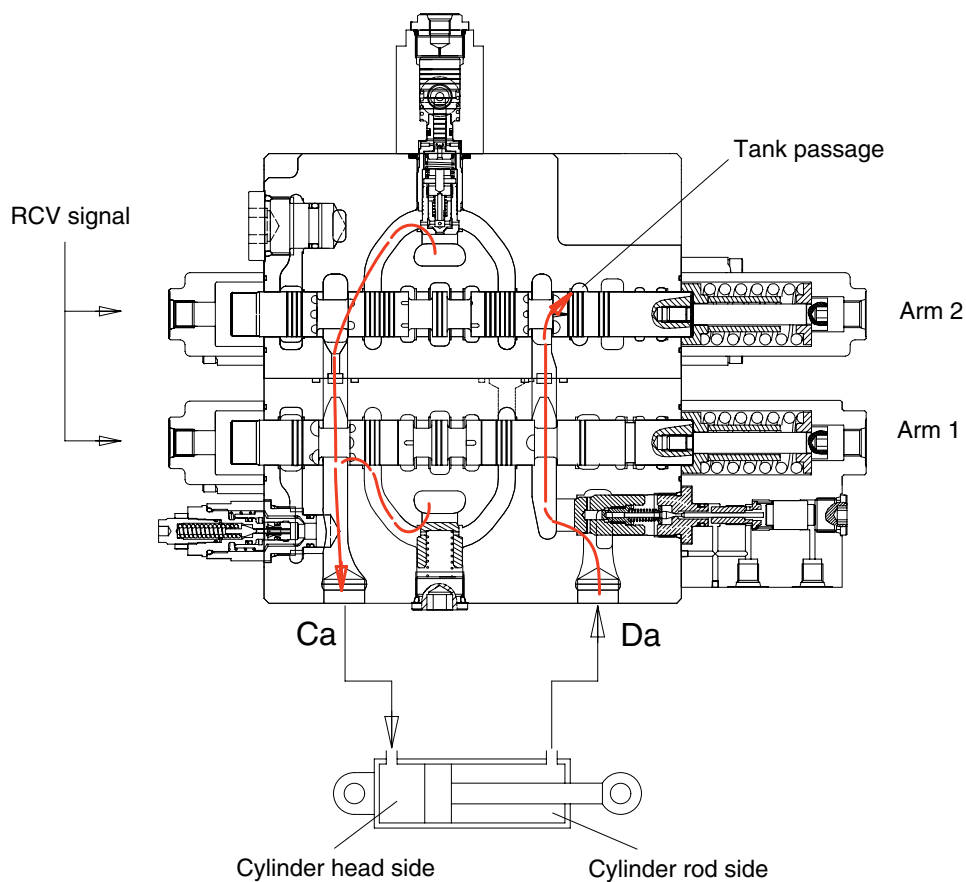
## 7) ARM OPERATION

### (1) Arm in operation

During the arm in operation, the pilot secondary pressure from the RCV is supplied to the port of the spring opposite side and shifts the arm 1 spool in the right direction.

The P2 bypass passage is shut off by the movement of the arm 1 spool and the pressurized oil from the P2 port flows into the arm cylinder head side through P2 parallel passage, the load check valve, bridge passage and the Ca port.

At the same time, the pilot secondary pressure from the RCV is supplied to the port of spring opposite side and shifts the arm 2 spool in the right direction. The P2 bypass passage is shut off by the movement of the arm 2 spool and the pressurized oil from the P1 port flows into the arm summation passage through P1 parallel passage, the check valve and the notch of the arm 2 spool.



E-E' (ARM 1 AND ARM 2)

220S2MC31

### ARM REGENERATION

The return oil from the arm cylinder rod side passes the arm holding valve (open condition) through the Da port and the notch of the arm 1 and arm 2, and swing priority spool. And some of the oil return to the tank passage through the notch of the arm regeneration spool and most of the oil is supplied to the head side of the arm cylinder through internal summation passage.

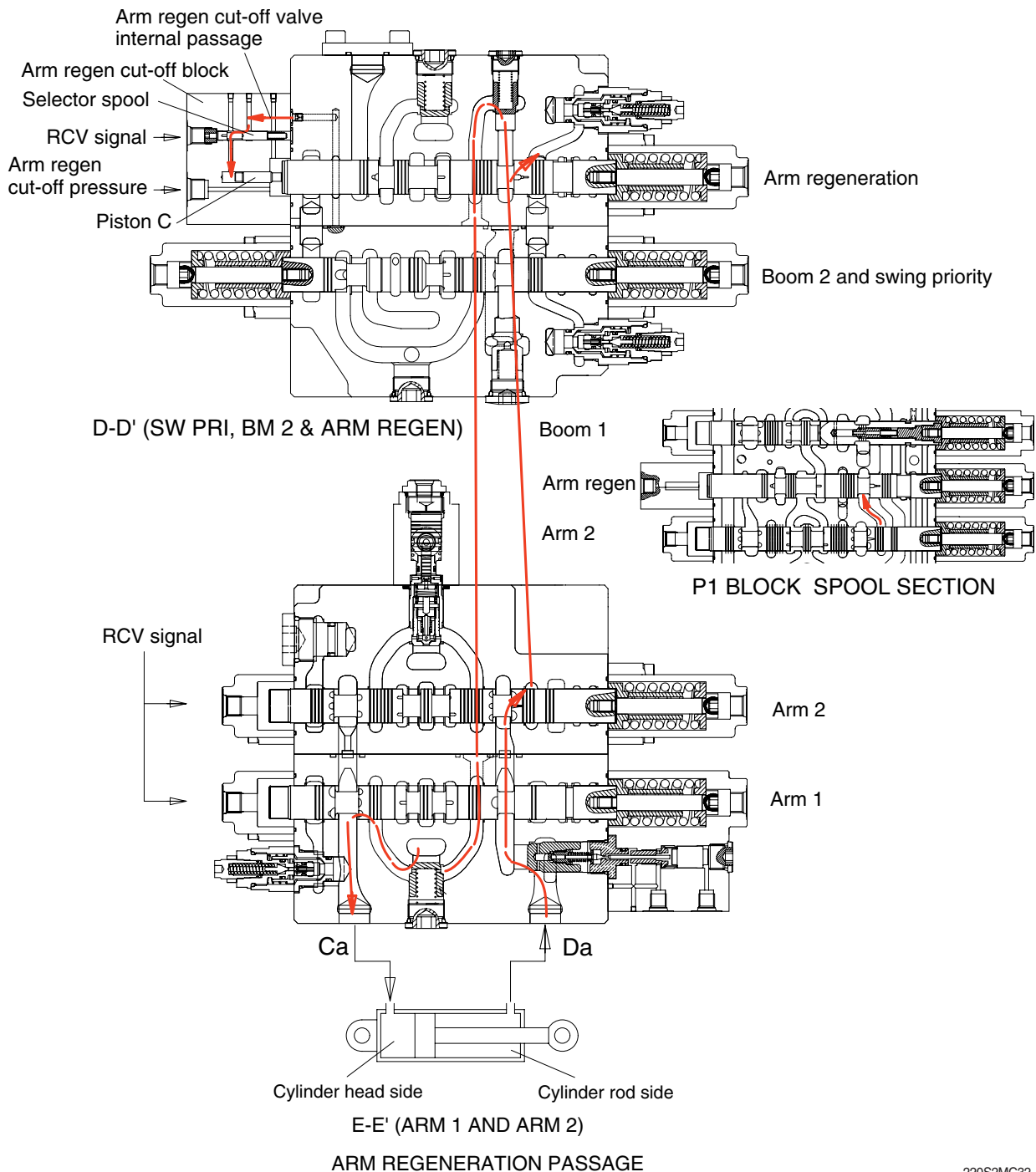
This is called the arm regeneration function.

The amount of regeneration fluid is changed by movement of the arm regeneration spool. A few fluids of the oil that is supplied to the head side of the arm cylinder passes the selector spool ( in this case, the selector spool is opened by the arm in pilot pressure) built in the arm regeneration block through internal passage and is pushed the piston C.

The amount of the regeneration oil from the rod side of the arm cylinder to the tank passage is increased by the movement of the piston C and the arm regeneration spool to the right direction and the arm regeneration flow is decreased as much increased oil.

The pressure of the arm cylinder head increases, then, the arm regeneration flow decreases.

Furthermore, the arm regeneration cut-off pressure is supplied to the port of the spring opposite side and the arm regeneration spool is moved to the right direction fully. The flow from the arm cylinder rod to the tank passage is maximum condition.



## (2) Arm out operation

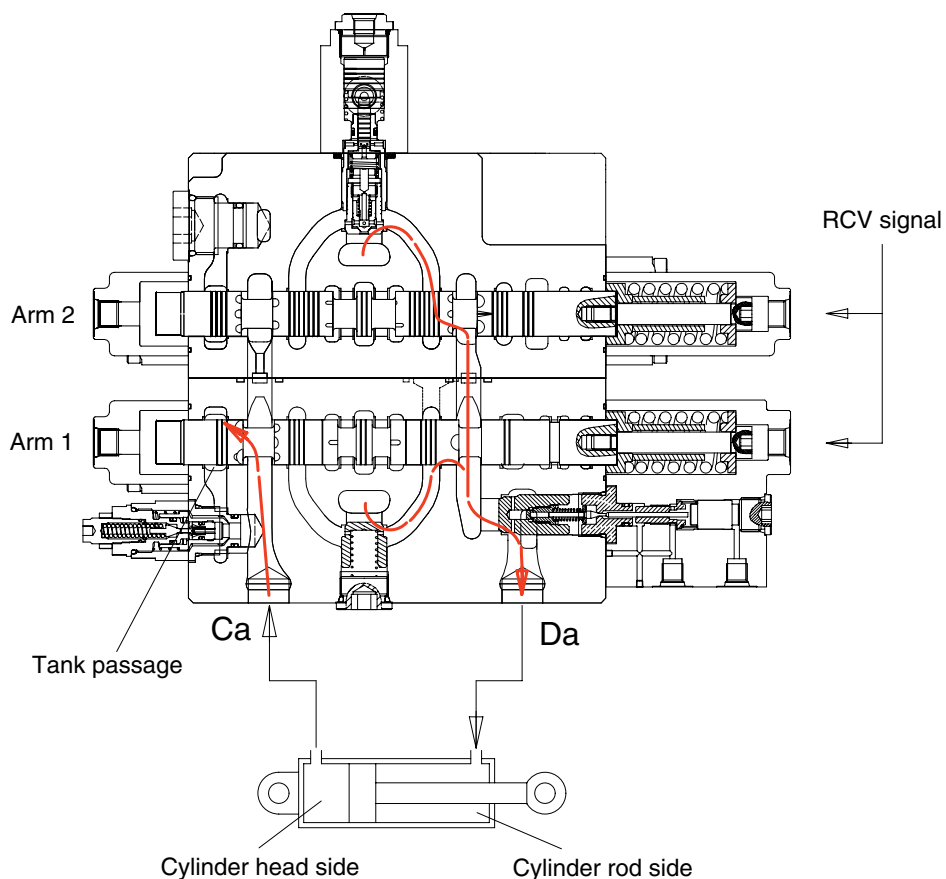
During arm out operation, the pilot secondary pressure from the RCV is supplied to the port of the spring side and shifts the arm 1 spool to the left direction.

The bypass passage is shut off by the movement of the arm 1 spool and the pressurized oil from the P2 port flows into arm 1 spool through the P2 parallel passage. Then it enters into the arm cylinder rod side through the load check, bridge passage, arm holding valve (oped status) and the port Da.

Also, the pilot secondary pressure from the RCV is supplied to the port of the spring side and shifts the arm 2 spool to the left direction.

The bypass passage is shut off by the movement of the arm 2 spool and the pressurized oil from the P2 port through the P2 parallel passage. Then it combined with the flow of the arm 1 passage through P1 parallel passage, the check valve, bridge passage, the notch of the arm 1 and the arm holding valve (open status).

On the other hand, the return flow from the arm cylinder head side returns to the hydraulic tank through the port Ca, the notch of the arm 1 spool and tank passage.



E-E' (ARM 1 AND ARM 2)

220S2MC33

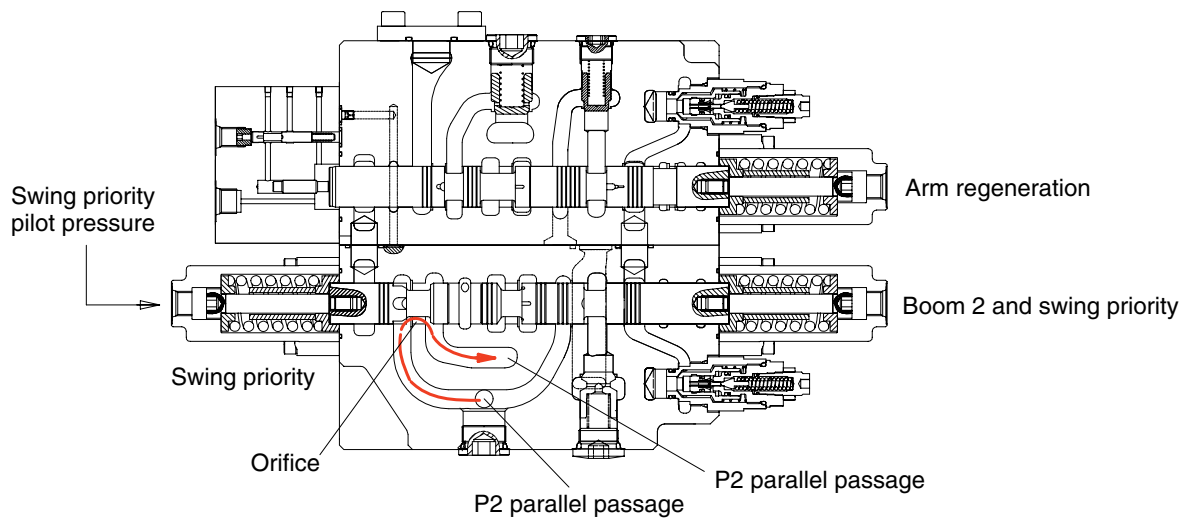
## 8) OPERATION OF SWING PRIORITY SPOOL

During swing priority operation, the pilot secondary pressure is supplied to the port of the spring side of the swing priority spool and shift swing priority spool to the right direction.

The pressurized oil from the P2 port flows into the P2 parallel passage through the notch of the swing priority spool.

When the swing priority spool is neutral condition, the passage is same as normal condition. But due to shifting of the swing priority spool, the orifice is formed between the notch of the swing priority spool and the land of the block housing and then the fluid to the swing side more than the downstream of the swing spool such as the arm 1 and option spool.

As a result, the flow is supplied to the swing operation most preferential.



D-D' (SWING PRI, BOOM 2 & ARM REGENERATION)

220S2MC34

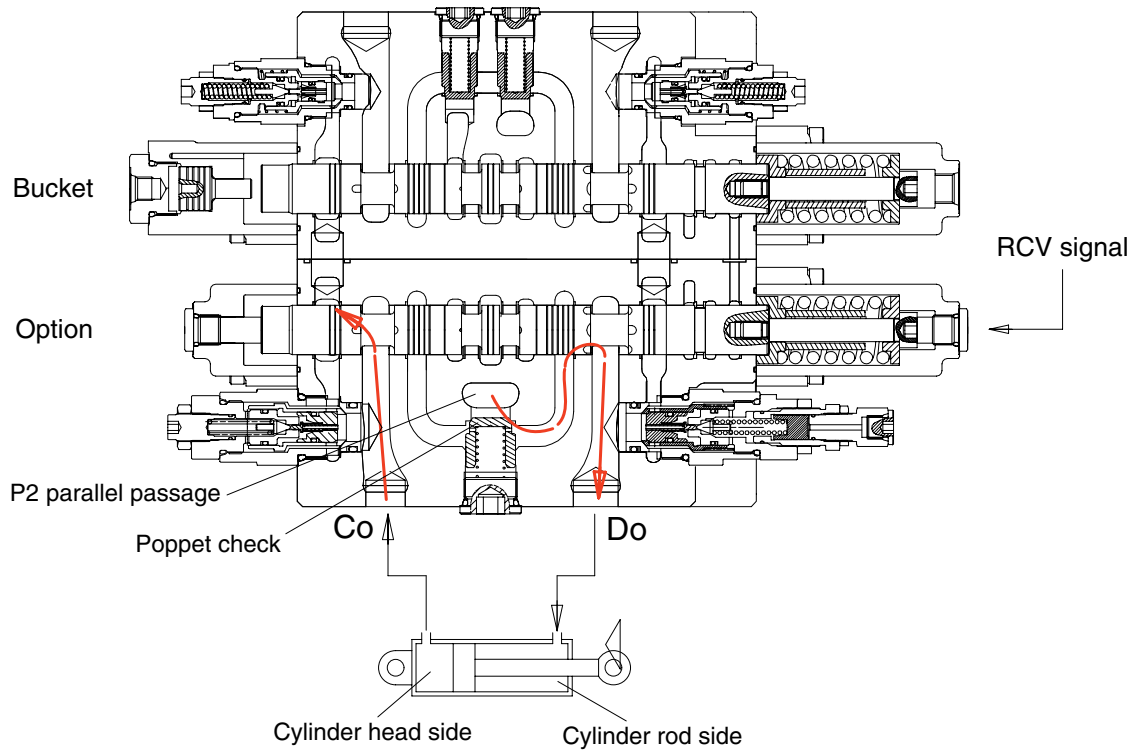
## 9) OPERATION OF OPTION SPOOL

### (1) 1-way operation

- ※ The pilot pressure is supplied to the port of the spring side and shifts spool to the left direction. The pilot secondary pressure from the RCV is supplied to the port of the spring opposite side of the option spool, the P2 bypass passage is shut off by the movement of the option spool and the pressurized oil from the P2 port flows into the actuator through the P2 parallel passage, the check valve, bridge passage and the Do port.

### (2) 2-way operation

- ※ Shifts spool to the left and right direction.
  - When the spool shifts to the left, same as 1-way operation.
  - When the spool shifts to the right, the pressurized oil from the P2 port flows into the actuator through the P2 parallel passage, the check valve, bridge passage and the Co port.



F-F' (OPTION AND BUCKET)

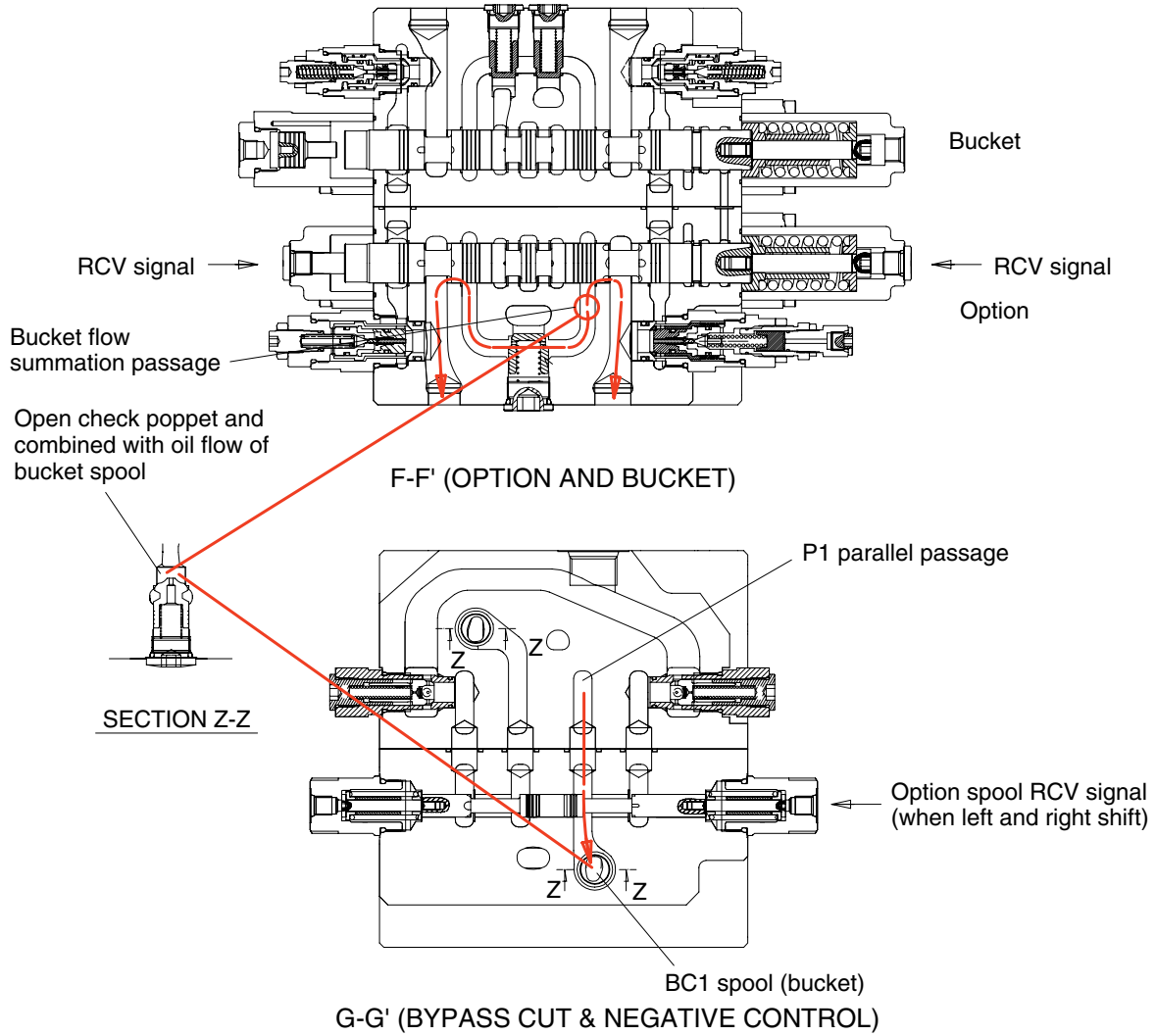
220SA2MC35

**Option flow summation function, bypass cut-off 2 spool**

During the 2-way option operation, the pilot secondary pressure from the RCV is supplied to port of the spring side and shifts the BC2 (option) spool.

The P1 parallel passage is shut off by the movement of the BC2 spool and the pressurized oil from P1 port opens the check poppet and combined with flow of the option spool.

(Only bucket in operation)



FLOW SUMMATION BY THE SHIFTING OF THE BC2 SPOOL

220SA2MC36

## 10) OPERATION OF NEGATIVE CONTROL VALVE

When no function is being actuated on P1 side, the hydraulic fluid from the P2 port, flows into the tank passage through the P1 bypass passage and the orifice of the negative control valve.

The negative control pressure caused by this operation is transferred to the regulator of the piston pump through the Pn1 port.

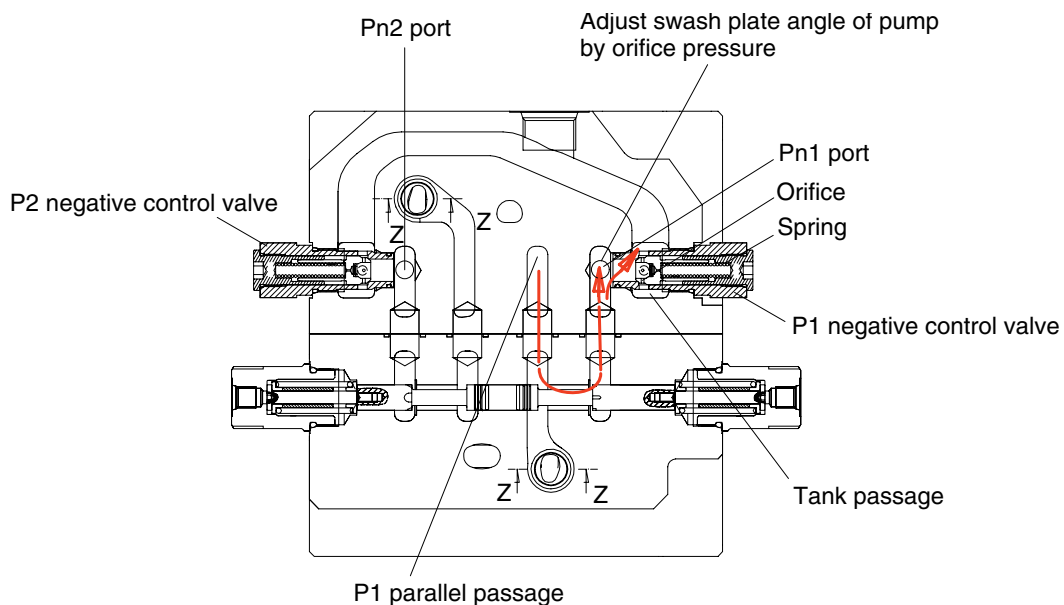
This pressure controls the swash plate angle of the pump to the minimum and minimize the flow of the P1 side.

When one or more spools are shifted, the P1 bypass passage is shut-off and the flow is almost zero.

Accordingly, the negative control pressure that is supplied to the pump through Pn1 port is lowered and the swash plate angle becomes maximum and the flow of the P1 side becomes maximum.

On the other hand, the negative control pressure is increased and high than the setting pressure of the spring, the negative control valve is opened and the flow passes to the hydraulic tank and functions as a relief valve.

The operation of the negative control valve of the P2 side is same as that of the P1 side.



OPERATION OF NEGATIVE CONTROL VALVE

220S2MC37

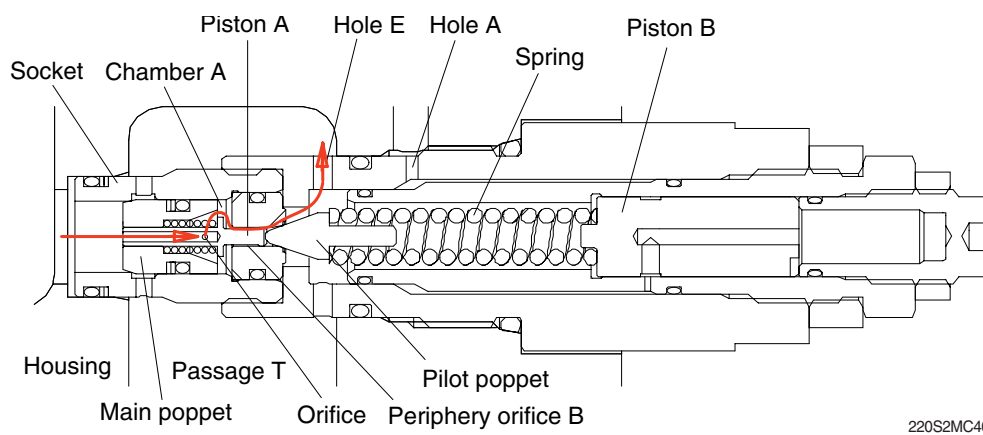
## 11) OPERATION OF MAIN RELIEF VALVE

### (1) Neutral

The pressurized oil passes through the internal passage of the piston A, fitted in the main poppet and the orifice A and is filled up in the chamber A of the inside and seats the main poppet against socket and socket against the housing securely.

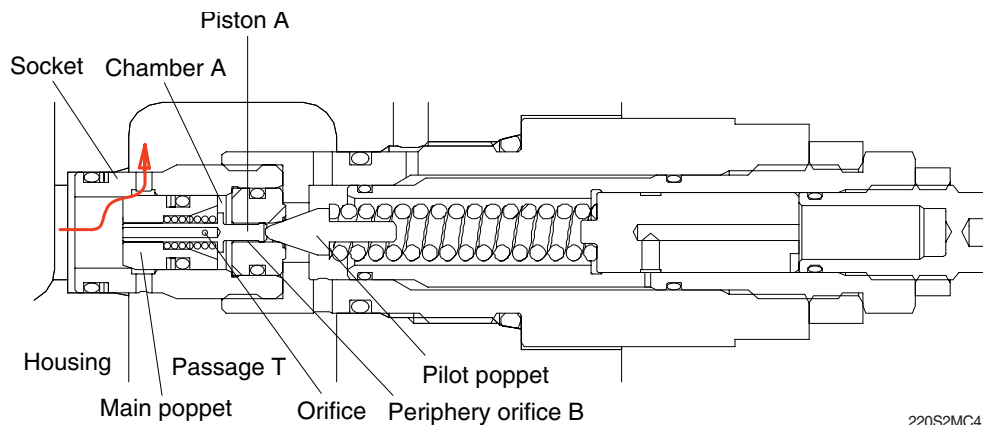
### (2) When operation (relief)

- ① When the pressurized oil flowed in the chamber A through the orifice becomes equal to the set pressure of the spring, the hydraulic oil apply to the main poppet through the piston and pushes open the pilot poppet and flows to tank passage through the piston A internal passage, orifice A, chamber A, periphery orifice B and the hole E.



OPERATION 1 OF MAIN RELIEF VALVE

- ② The pressure in chamber A is lowered by moving of the pilot poppet and the main poppet is opened. As a result, the pressurized oil flows out to the tank passage through the hole of the socket side.



OPERATION 2 OF MAIN RELIEF VALVE



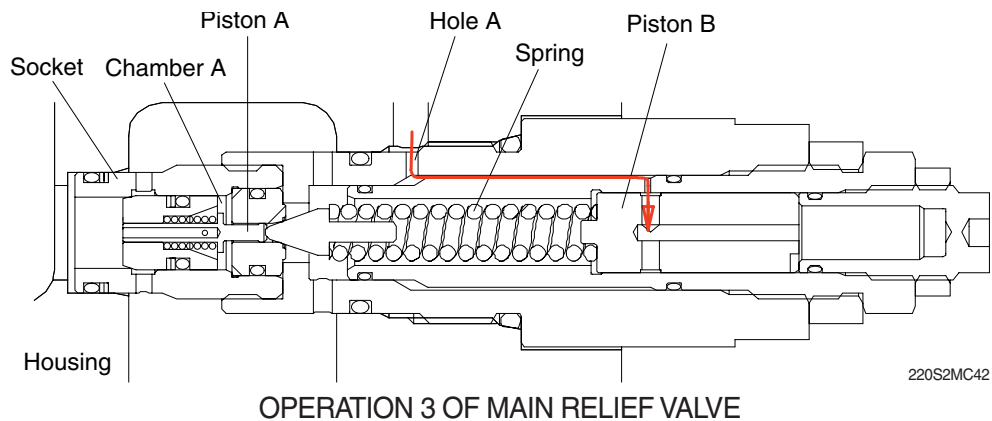
### (3) When retraction (return)

On the other hand, the pressure of the pressurized oil becomes lower than set pressure of the spring, the main poppet is seated by spring force. Then the pressure of the chamber A becomes equal to the pressure of the P port and the main poppet is seated to the seat of the socket. The valve returns to the initial condition.

#### Power boost function

During power boost operation, the pilot pressure for the power boost enters inside of the piston B through the hole A, the crevice passage and the side hole of the piston B.

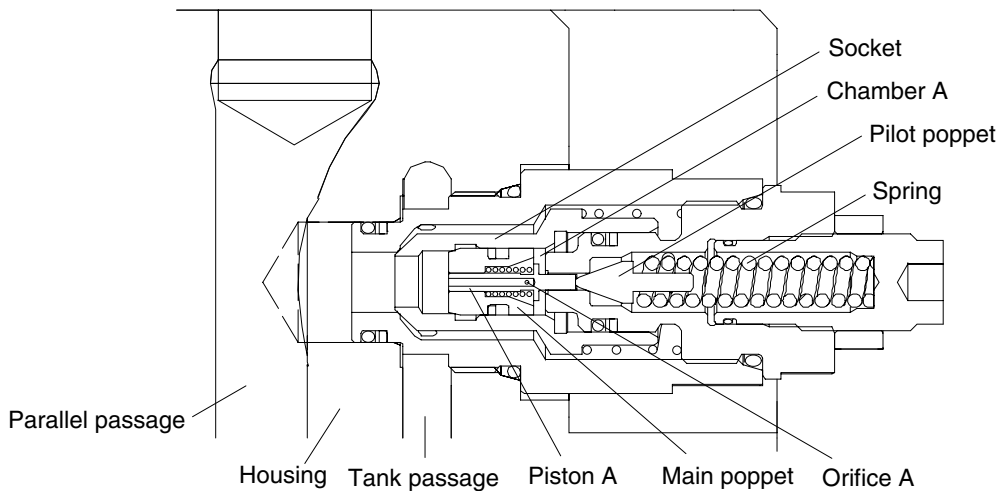
It pushes the piston to the left direction and the set pressure of the spring is increased.



## 12) OPERATION OF PORT RELIEF VALVE

### (1) Function as relief valve

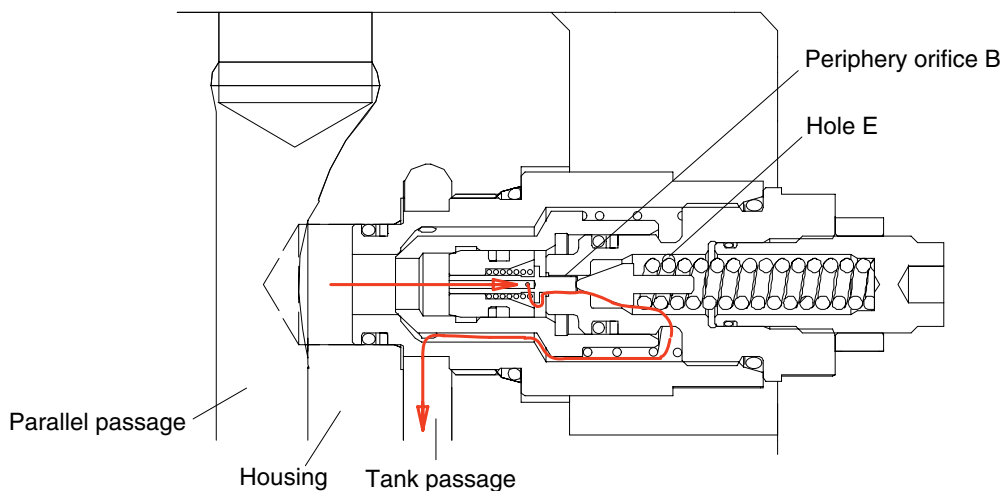
- ① The pressurized oil passes through the internal passage of the piston A, fitted in the main poppet and the orifice A and is filled up in the chamber A of the inside and seats the main poppet against socket and socket against the housing securely.



PORT RELIEF VALVE

220S2MC43

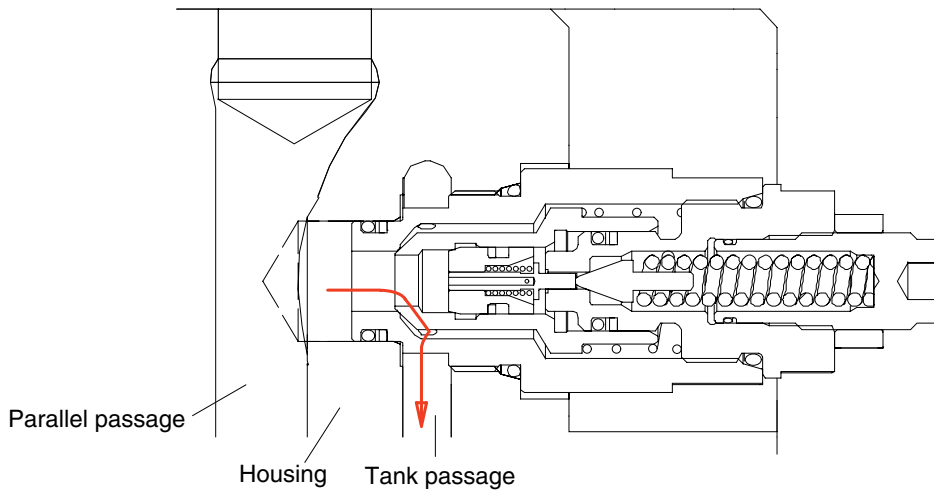
- ② When the pressurized oil from the actuators becomes equal to the set pressure of the spring, the hydraulic oil apply to the pilot poppet and pushes the pilot poppet to the right direction and flows to tank passage through the piston A internal passage, orifice A, chamber A, periphery orifice B and the hole E.



OPERATION 1 OF PORT RELIEF VALVE

220S2MC44

- ③ The pressure in chamber A is lowered by moving of the pilot poppet and the main poppet is opened. As a result, the pressurized oil from the actuator port flows out to the tank passage through the hole of the socket side.



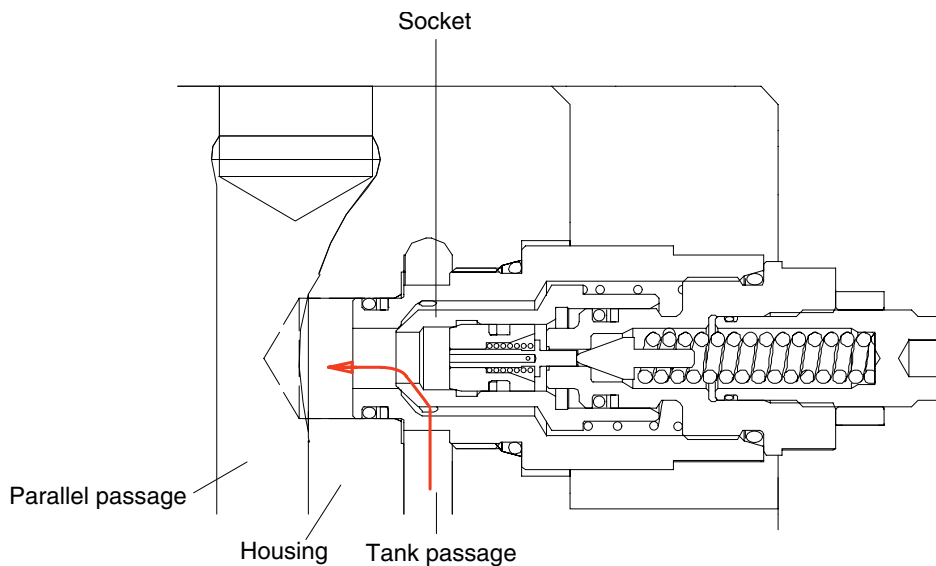
OPERATION 2 OF PORT RELIEF VALVE

220S2MC45

- ④ On the other hand, the pressure of the actuator becomes lower than set pressure of the spring, the pilot poppet is seated by spring force. Then the pressure of the chamber A becomes equal to the pressure of the actuator port and the main poppet is seated to the seat of the socket. The valve returns to the initial condition.

**Make up function**

When negative pressure exists at the actuator port, the oil is supplied through tank passage. When the pressure at tank passage becomes higher than that of at the actuator port, it pushed the socket moves in the right direction. Then, the gap between the housing and socket is opened and pressurized oil from the tank passage flows into parallel passage side.



MAKE UP FUNCTION OF PORT RELIEF VALVE

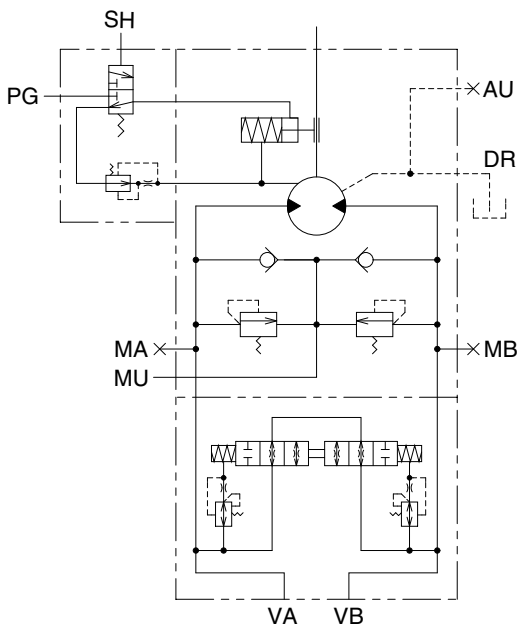
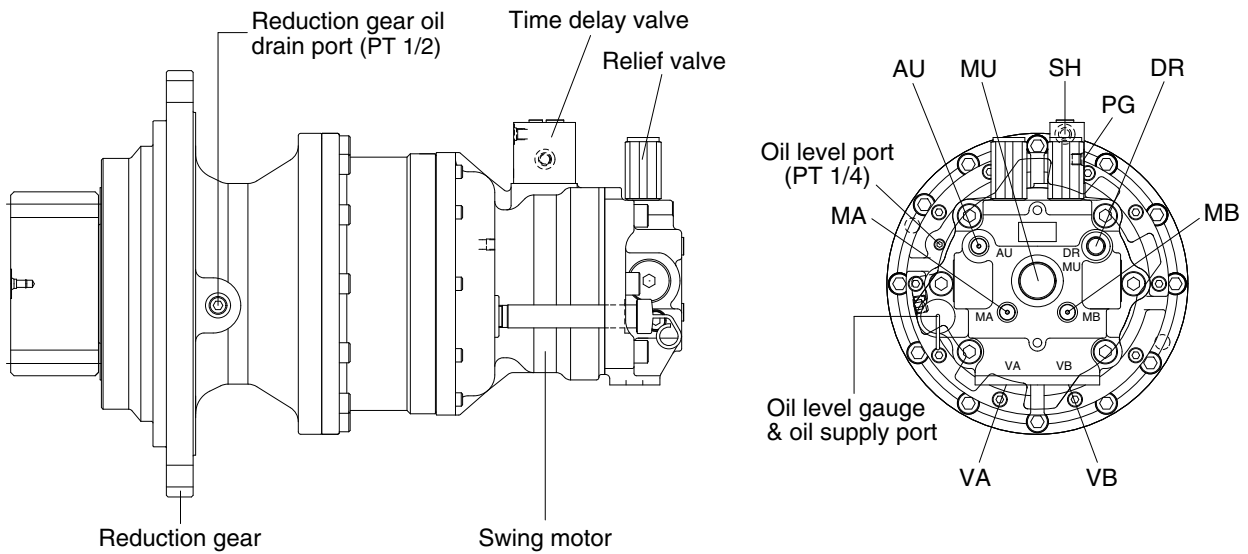
220S2MC46

## GROUP 3 SWING DEVICE

### 1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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

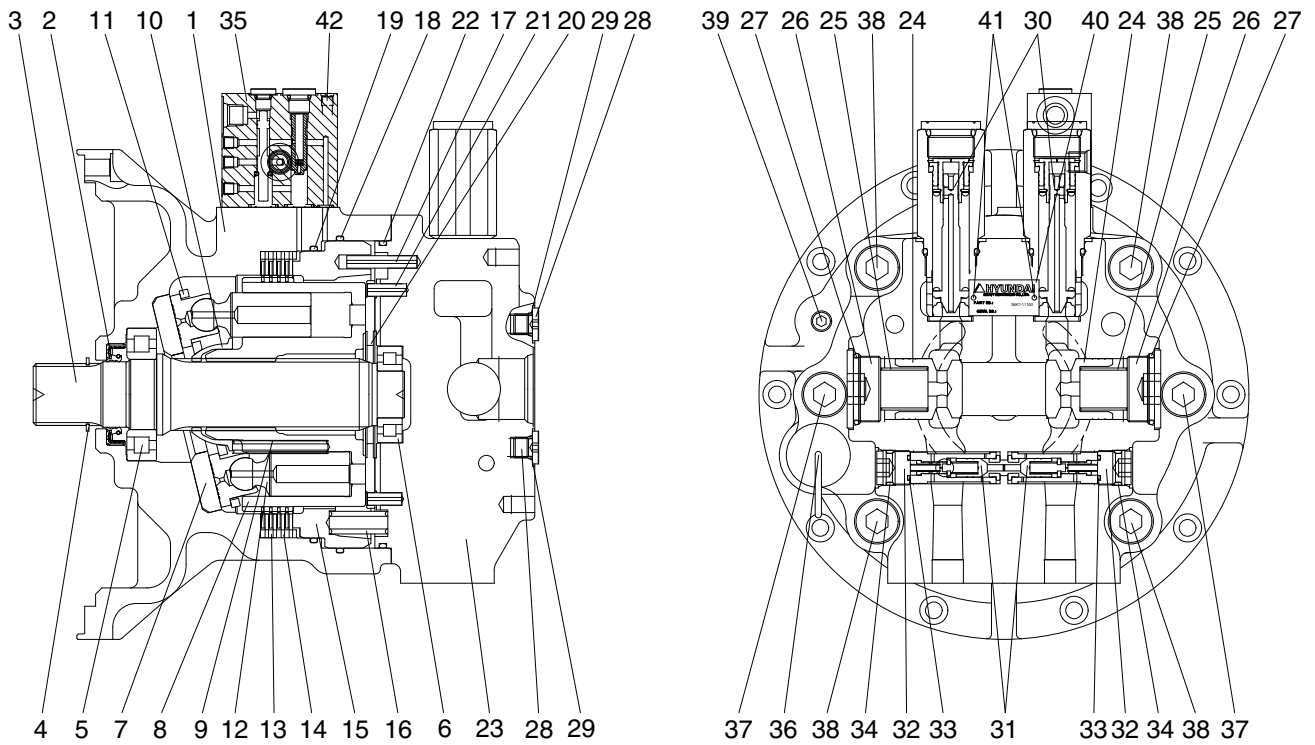


Hydraulic circuit

Port	Port name	Port size
VA	Main port	Ø20
VB	Main port	Ø20
DR	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
PG	Stand by port	PF 1/4
SH	Brake release port	PF 1/4
MA, MB	Gauge port	PF 1/4
AU	Air vent port	PF 1/4

260L2SM01

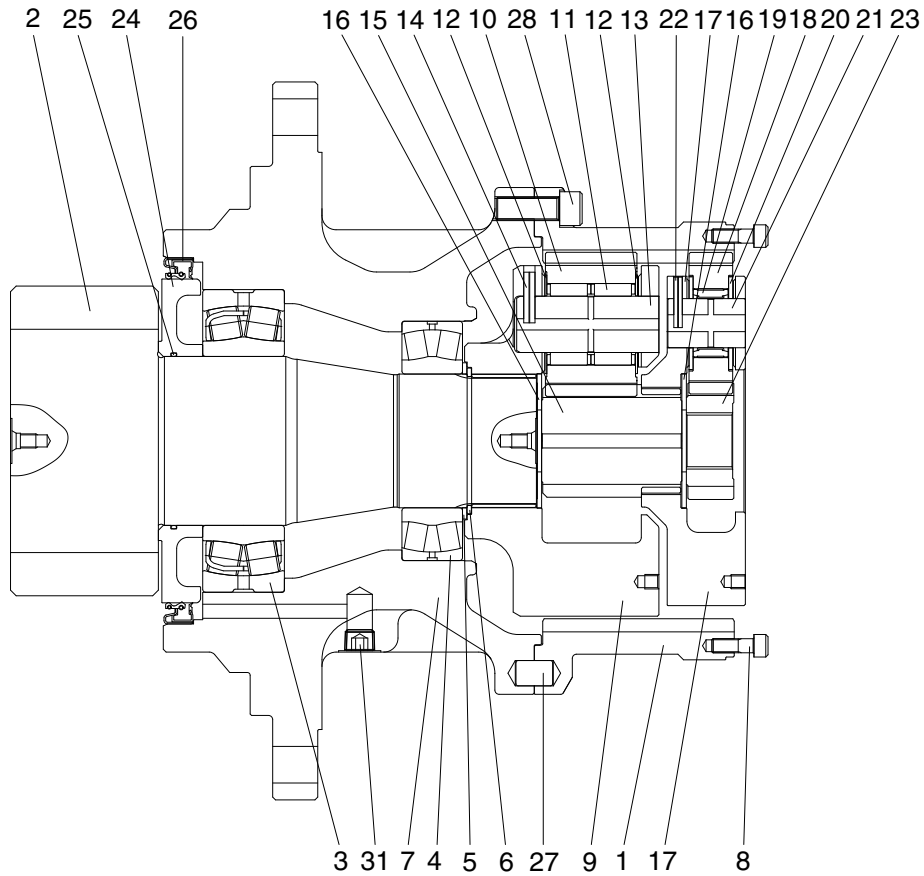
## 1) SWING MOTOR



260L2SM02

1	Casing	15	Parking piston	29	O-ring
2	Oil seal	16	Brake spring	30	Relief valve assy
3	Shaft	17	Spring pin	31	Anti rotating valve assy
4	Snap ring	18	O-ring	32	Plug
5	Roller bearing	19	O-ring	33	O-ring
6	Roller bearing	20	Valve plate	34	O-ring
7	Swash plate	21	Spring pin	35	Time delay valve assy
8	Cylinder block	22	O-ring	36	Level gauge assy
9	Spring	23	Valve casing	37	Socket bolt
10	Ball guide	24	Check valve	38	Socket bolt
11	Retainer plate	25	Spring	39	Plug
12	Piston assy	26	Plug	40	Name plate
13	Friction plate	27	O-ring	41	Rivet
14	Separate plate	28	Plug	42	Socket bolt

## 2) REDUCTION GEAR



260L2SM03

1	Ring gear	11	Needle bearing 2	21	Carrier pin 1
2	Drive shaft	12	Thrust washer 2	22	Spring pin 1
3	Roller bearing	13	Carrier pin 2	23	Sun gear 1
4	Roller bearing	14	Spring pin	24	Sleeve
5	Thrust plate	15	Sun gear 2	25	O-ring
6	Retainer ring	16	Thrust plate	26	Oil seal
7	Casing	17	Carrier 1	27	Parallel pin
8	Socket bolt	18	Planetary gear 1	28	Socket bolt
9	Carrier 2	19	Needle bearing 1	31	Socket plug
10	Planetary gear 2	20	Thrust washer 1		

## 2. PRINCIPLE OF DRIVING

### 2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder block (8) through valve casing of motor (23), and valve plate (20).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (12).

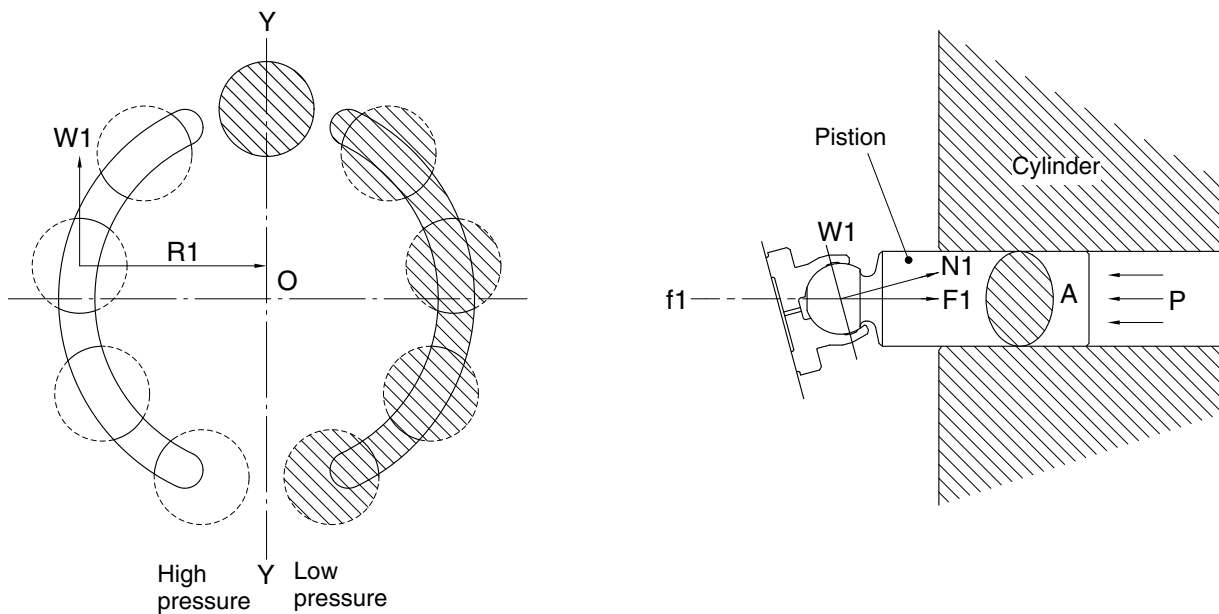
The high hydraulic can generate the force,  $F1=P \times A$  ( $P$  : supplied pressure,  $A$  : water pressure area), like following pictures, working on a piston.

This force,  $F1$ , is divided as  $N1$  thrust partial pressure and  $W1$  radial partial pressure, in case of the plate of a tilt angle,  $\alpha$ .

$W1$  generates torque,  $T=W1 \times R1$ , for Y-Y line connected by the upper and lower sides of the piston as following pictures.

The sum of torque ( $\sum W1 \times R1$ ), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (8) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.



21078TM05

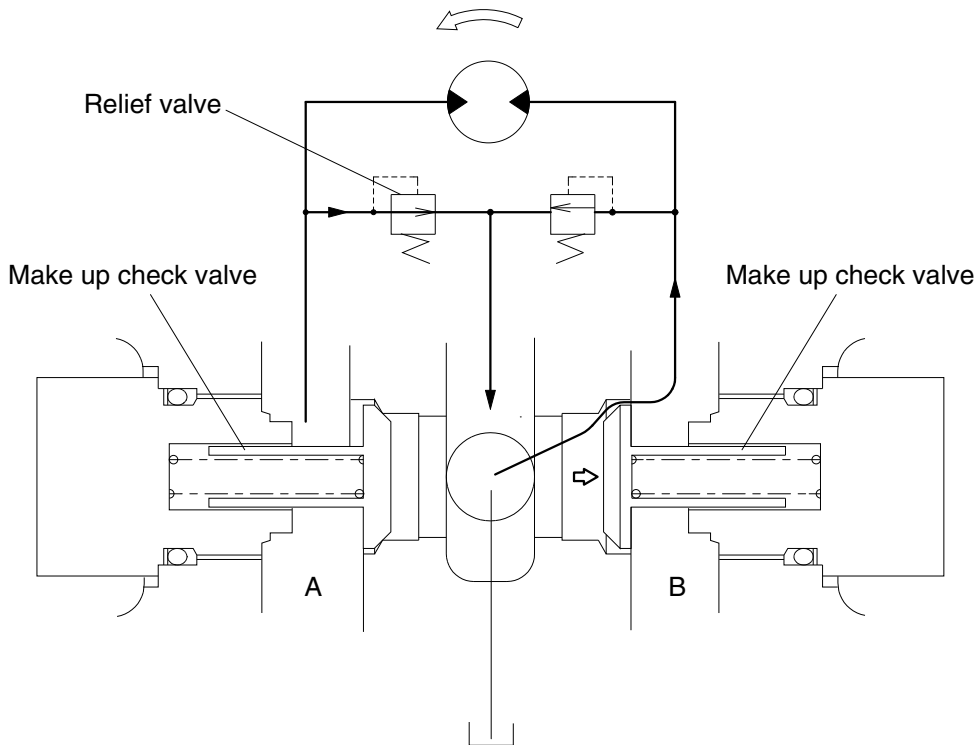
## 2) MAKE UP VALVE

In the system using this type of motor, there is no counter balance functioning valve and there happens the case of revolution exceeding hydraulic supply of motor. To prevent the cavitation caused by insufficient oil flow there is a make up valve to fill up the oil insufficiency.

A make up valve is provided immediately before the port leading to the hydraulic oil tank to secure feed pressure required when the hydraulic motor makes a pumping action. The boost pressure acts on the hydraulic motor's feed port via the make up valve.

Pressurized oil into the port B, the motor rotate counterclockwise.

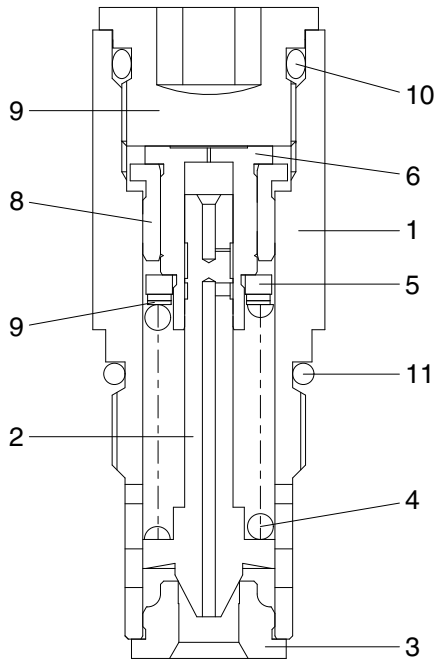
If the plunger of MCV moves neutral position, the oil in the motor is drain via left relief valve, the drain oil run into motor via right make up valve, which prevent the cavitation of motor.



21092SM04



### 3) RELIEF VALVE



- 1 Sleeve
- 2 Poppet
- 3 Poppet seat
- 4 Spring
- 5 Spring seat
- 6 Shim
- 7 Piston
- 8 Stopper
- 9 Plug
- 10 O-ring
- 11 O-ring

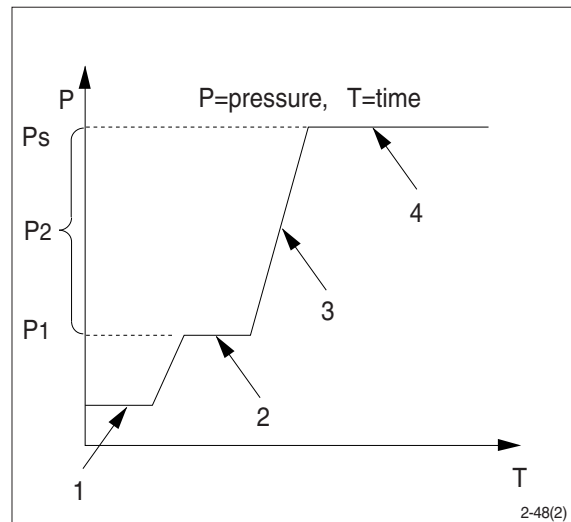
2209A2SM25

#### (1) Construction of relief valve

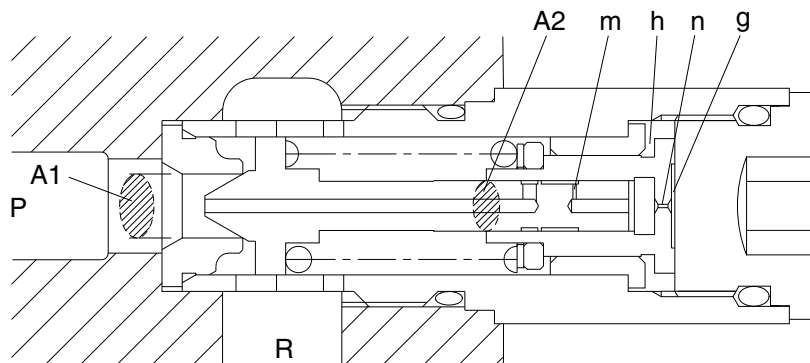
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

#### (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.



① Ports (P,R) at tank pressure.

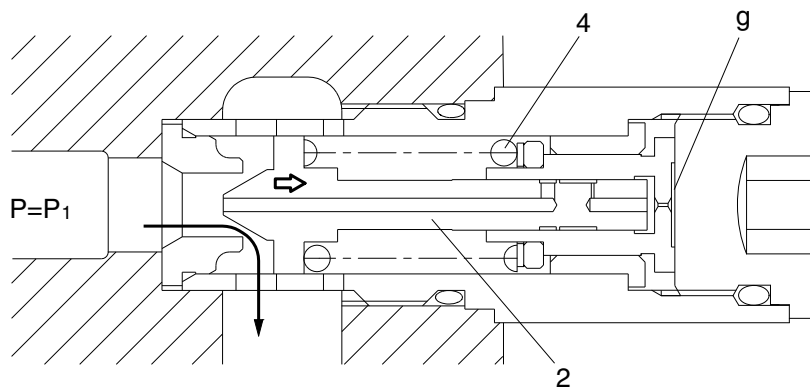


2209A2SM26

② When hydraulic oil pressure ( $P \times A_1$ ) reaches the preset force ( $F_{SP}$ ) of spring (4), the plunger (2) moves to the right as shown.

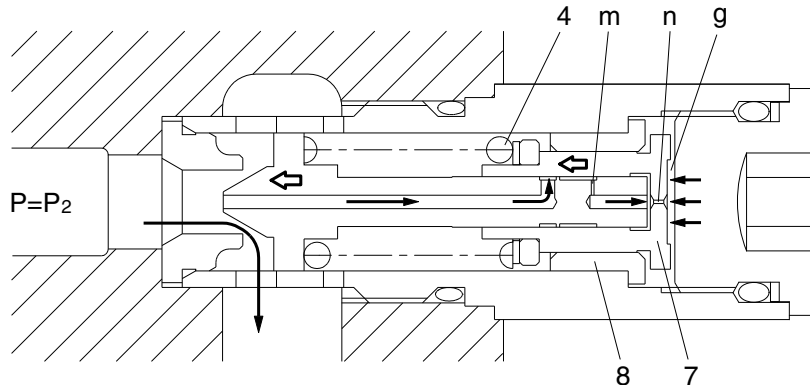
$$P_1 \times A_1 = F_{SP} + P_g \times A_2$$

$$P_1 = \frac{F_{SP} + P_g \times A_2}{A_1}$$



2209A2SM27

- ③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F<sub>SP</sub>) of spring (4), the piston (7) moves left and stop the piston (7) hits the bottom of bushing (8).

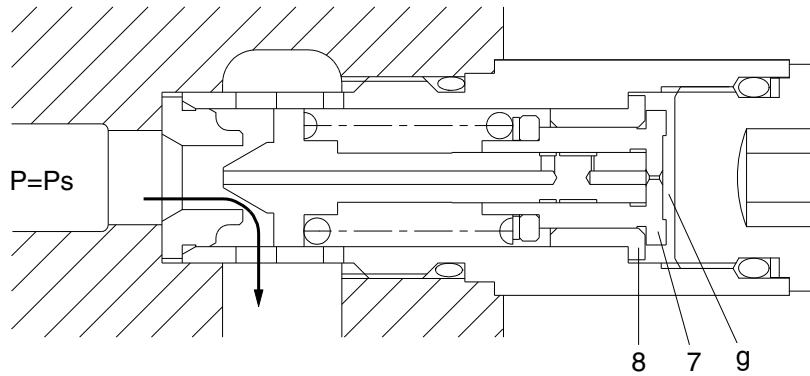


2209A2SM28

- ④ When piston (7) hits the bottom of bushing (8), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (P<sub>s</sub>).

$$P_s \times A_1 = F_{sp} + P_s \times A_2$$

$$P_s = \frac{F_{sp}}{A_1 - A_2}$$



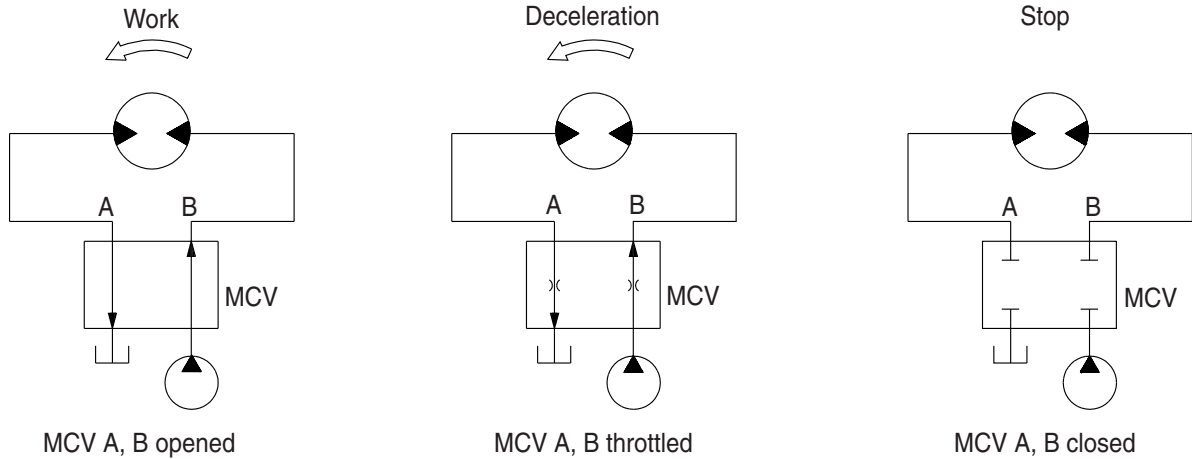
2209A2SM29

## 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)

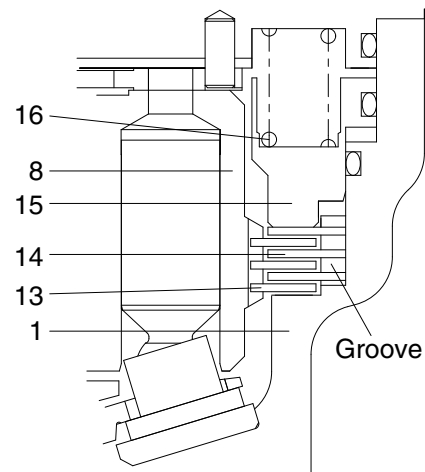
### (2) Mechanical swing parking brake system

This is function as a parking brake only when all of the RCV lever (except swing, arm in) are not operated.

#### ① Brake assembly

Circumferential rotation of separate plate (14) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (16) through friction plate (13), separate plate (14) and parking piston (15), friction force occurs there.

Cylinder block (8) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.



2209A2SM35

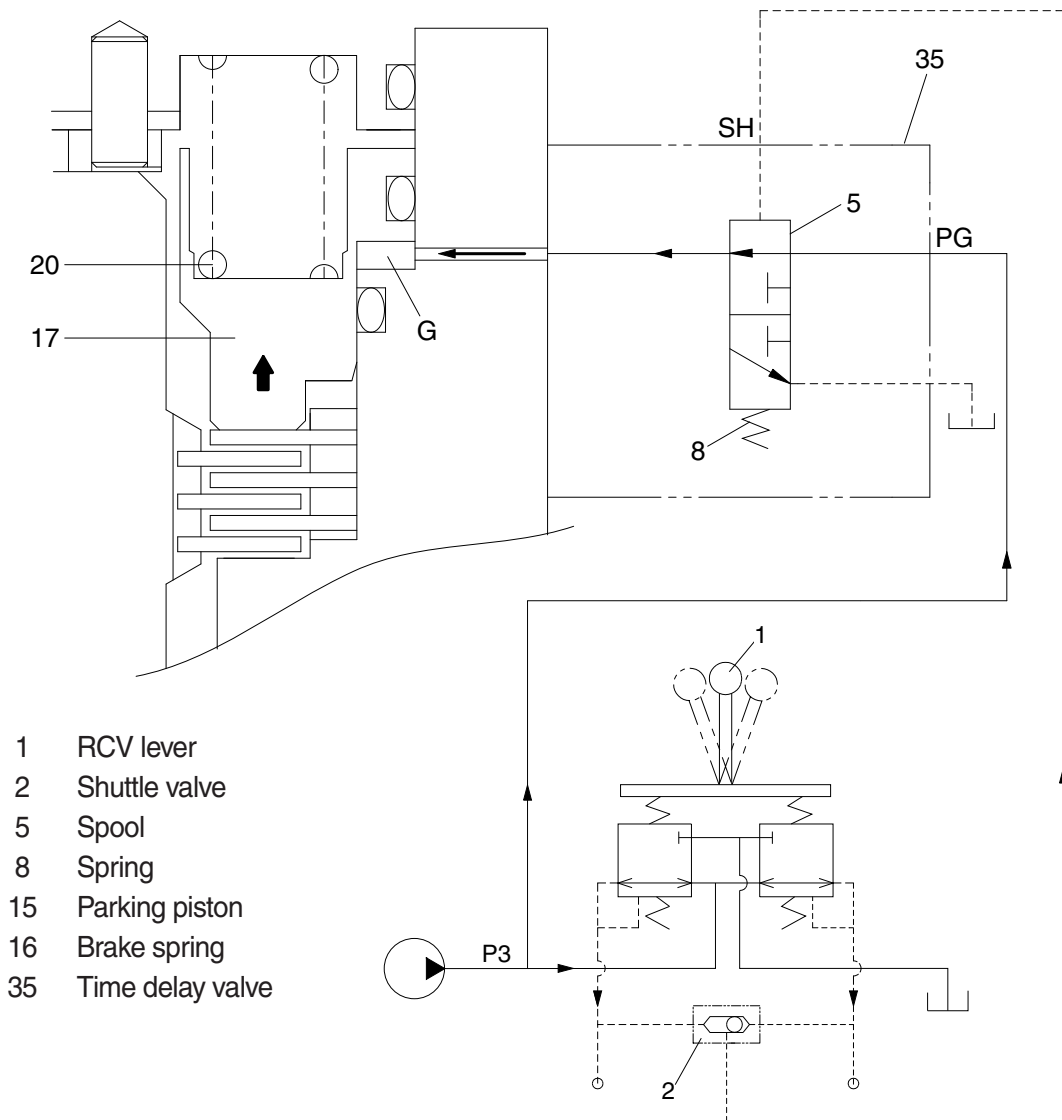
1	Casing	14	Separated plate
8	Cylinder block	15	Parking piston
13	Friction plate	16	Brake spring

② **Operating principle**

a. When the RCV lever (1) is set to the swing or arm in operating position, the pilot oil go to SH of the time delay valve (35).

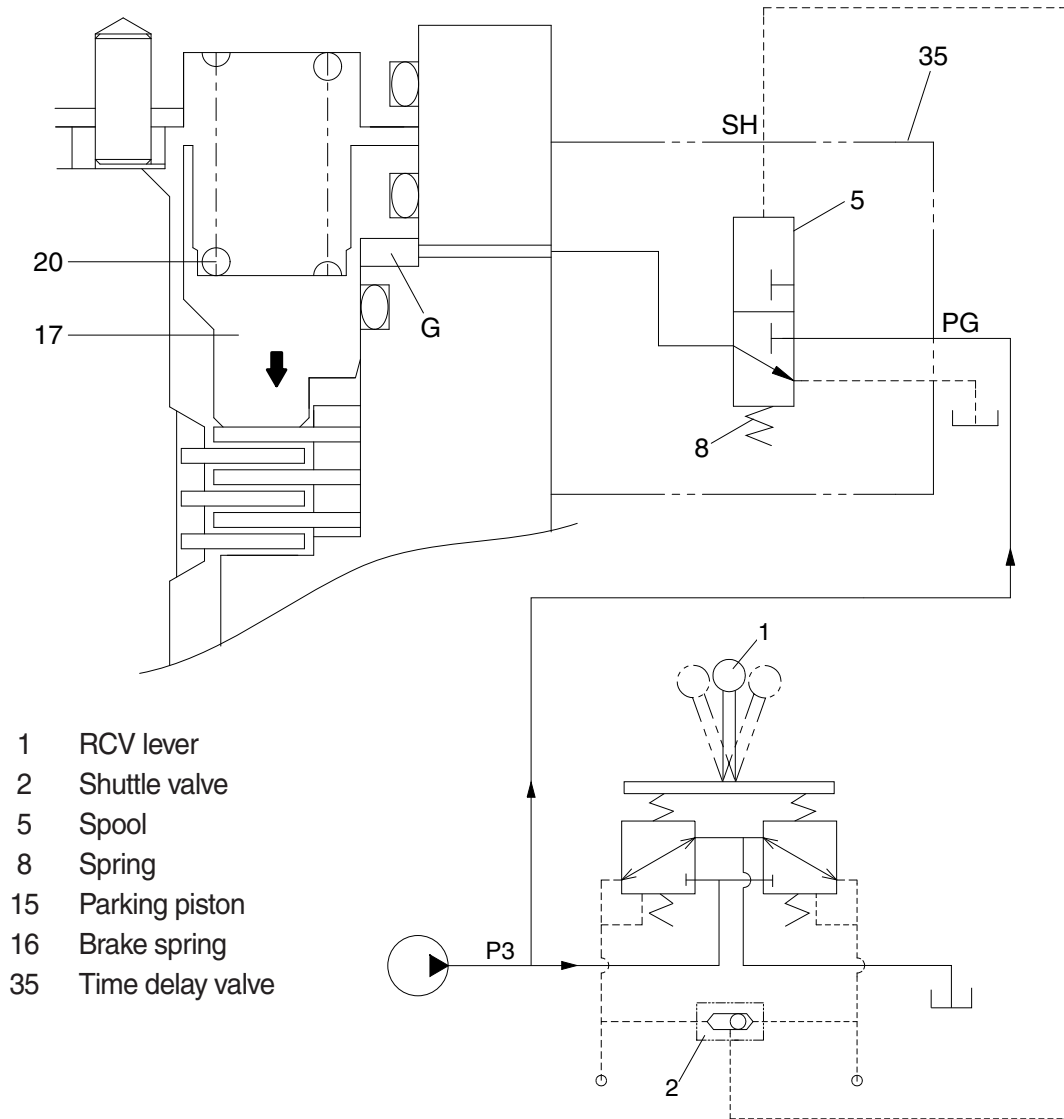
This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged oil (P3) goes to the chamber G through port PG.

This pressure is applied to move the parking piston (15) to the upward against the force of the brake spring (16). Thus, it releases the brake force.



300L2SM04

- b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to the top. Then, the parking piston (15) is moved lower by spring force and the return oil from the chamber G flows back to tank port. At this time, the brake works.



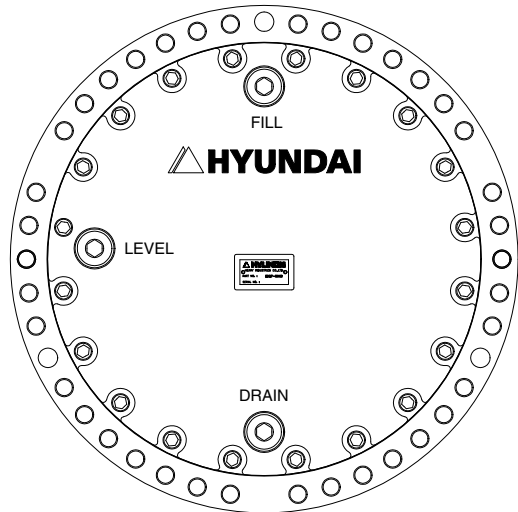
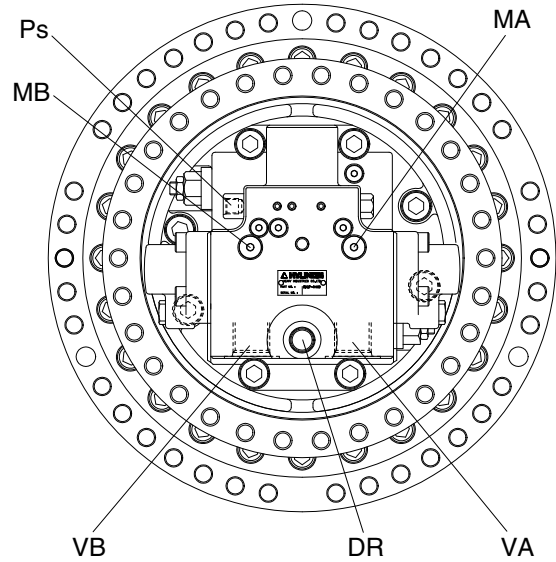
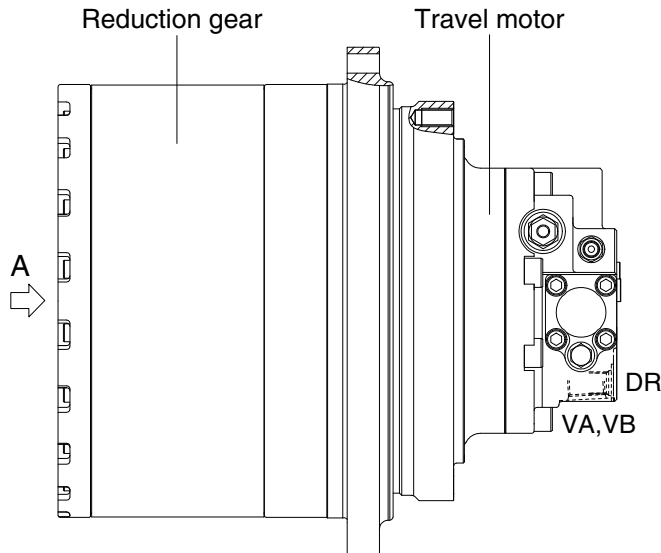
300L2SM05

## GROUP 4 TRAVEL DEVICE (STD)

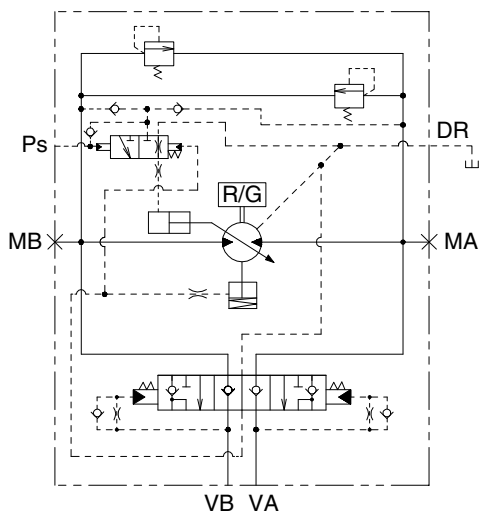
### 1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



VIEW A



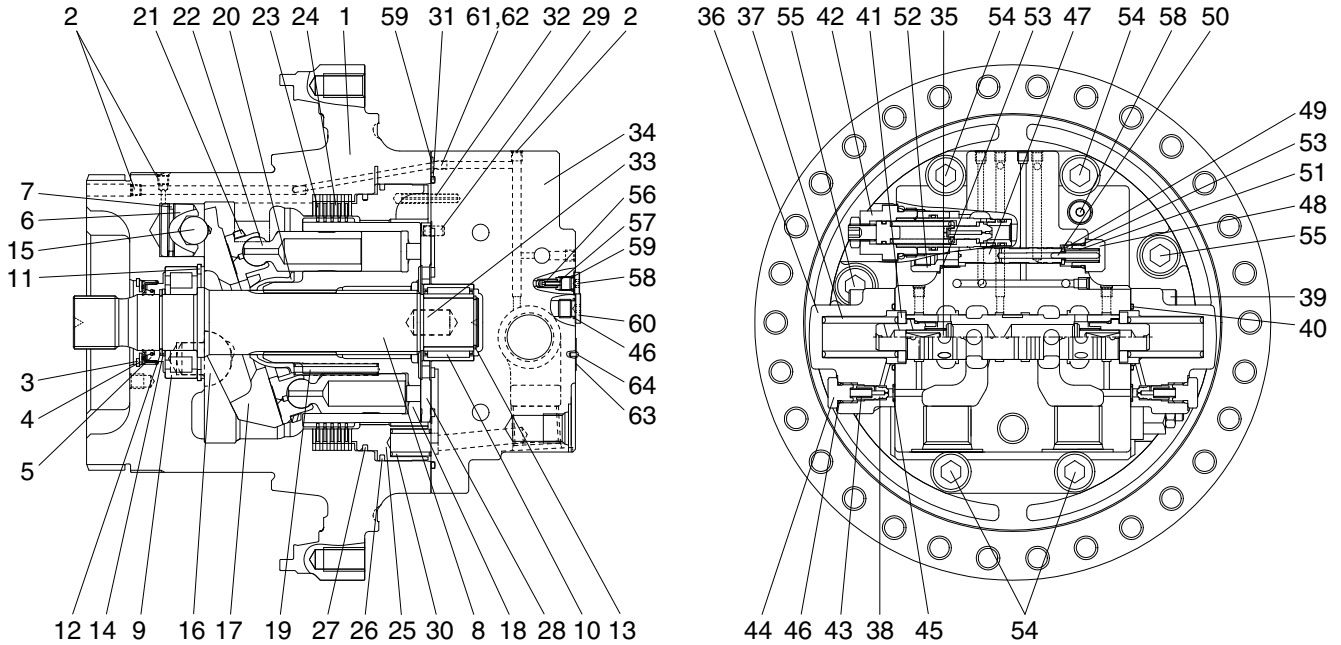
Hydraulic circuit

260L2TM01

Port	Port name	Port size
VA, VB	Valve port	PF 1
Ps	Pilot port	PF 1/4
DR	Drain port	PF 1/2
MA, MB	Gauge port	PF 1/4

## 2. SPECIFICATION

### 1) TRAVEL MOTOR

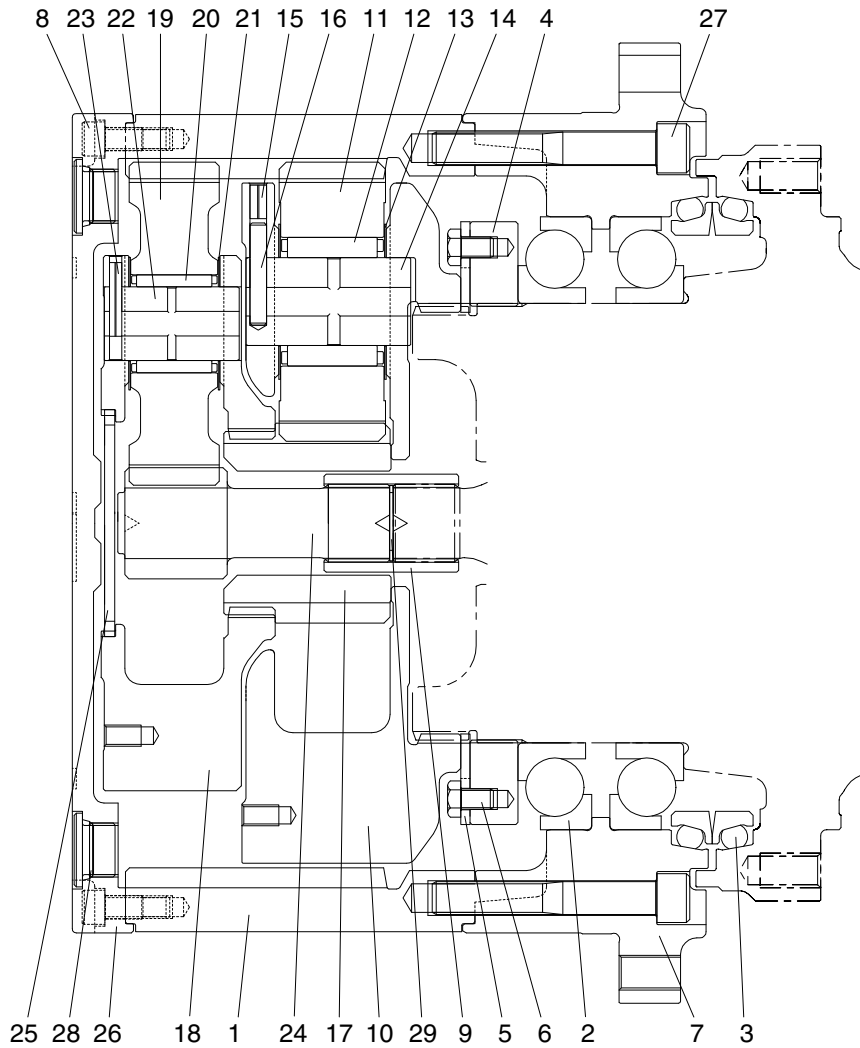


1	Casing	23	Friction plate	44	Plug
2	Plug	24	Separated plate	45	O-ring
3	Oil seal	25	Parking piston	46	O-ring
4	Thrust plate	26	D-ring	47	Spool
5	Snap ring	27	D-ring	48	Plug
6	Piston	28	Valve plate	49	Spring seat
7	Piston seal	29	Parallel pin	50	Parallel pin
8	Shaft	30	Spring	51	Spring
9	Cylinder roller bearing	31	O-ring	52	Connector
10	Needle bearing	32	Spring pin	53	O-ring
11	Snap ring	33	Parallel pin	54	Hexagon socket head bolt
12	Snap ring	34	Rear cover	55	Hexagon socket head bolt
13	Snap ring	35	Main spool assy	56	Check valve
14	Thrust plate	36	Cover	57	Spring
15	Steel ball	37	Spring	58	Plug
16	Pivot	38	Restrictor	59	O-ring
17	Swash plate	39	Hexagon socket head bolt	60	Plug
18	Cylinder block	40	O-ring	61	Restrictor
19	Spring	41	Spring seat	62	Restrictor
20	Ball guide	42	Relief valve assy	63	Name plate
21	Retainer plate	43	Spring	64	Rivet
22	Piston assy				

260L2TM02



## 2) TRAVEL REDUCTION GEAR



2209A2TM22

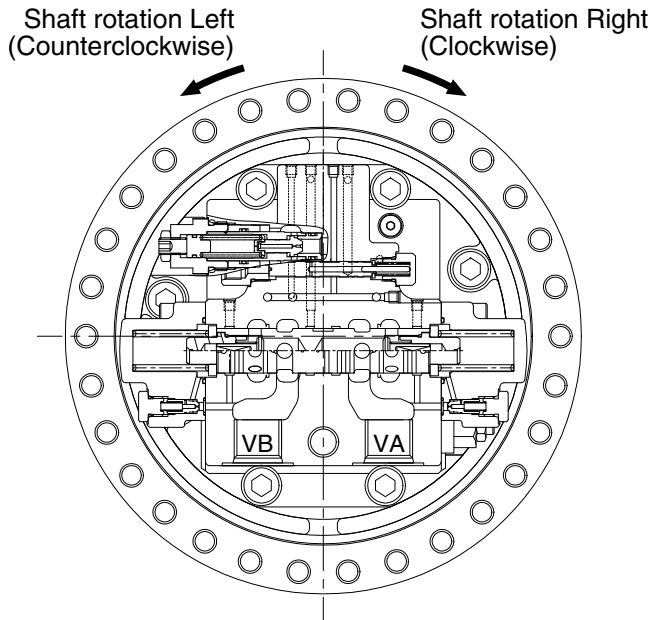
- |    |                          |    |                  |    |                          |
|----|--------------------------|----|------------------|----|--------------------------|
| 1  | Gear ring                | 12 | Needle bearing 2 | 22 | Carrier pin 1            |
| 2  | Ball bearing             | 13 | Thrust washer 2  | 23 | Spring pin 1             |
| 3  | Floating seal assy       | 14 | Carrier pin 2    | 24 | Sun gear 1               |
| 4  | Nut ring                 | 15 | Spring pin 2     | 25 | Thrust plate             |
| 5  | Lock plate               | 16 | Solid pin 2      | 26 | Cover                    |
| 6  | Hexagon bolt             | 17 | Sun gear 2       | 27 | Hexagon socket head bolt |
| 7  | Housing                  | 18 | Carrier 1        | 28 | Plug                     |
| 8  | Hexagon socket head bolt | 19 | Planetary gear 1 | 29 | Snap ring                |
| 9  | Coupling                 | 20 | Needle bearing 1 | 30 | Name plate               |
| 10 | Carrier 2                | 21 | Thrust washer 1  | 31 | Rivet                    |
| 11 | Planetary gear 2         |    |                  |    |                          |

### 3. OPERATION

#### 1) MOTOR

High pressure oil delivered from hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (34) and valve plate (28), led to cylinder block (18).

The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclockwise)

25092TM23

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

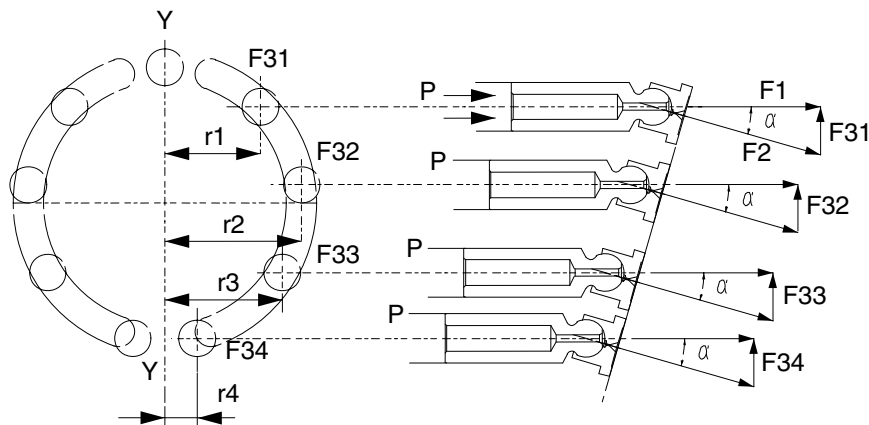
$$F1 = P \times A \quad (P : \text{pressure}, A : \text{area of piston section})$$

The swash plate (17) with inclined angle of  $\alpha$  divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$$

This drive torque is transmitted via cylinder block (18) to driving shaft (8).



29092TM07

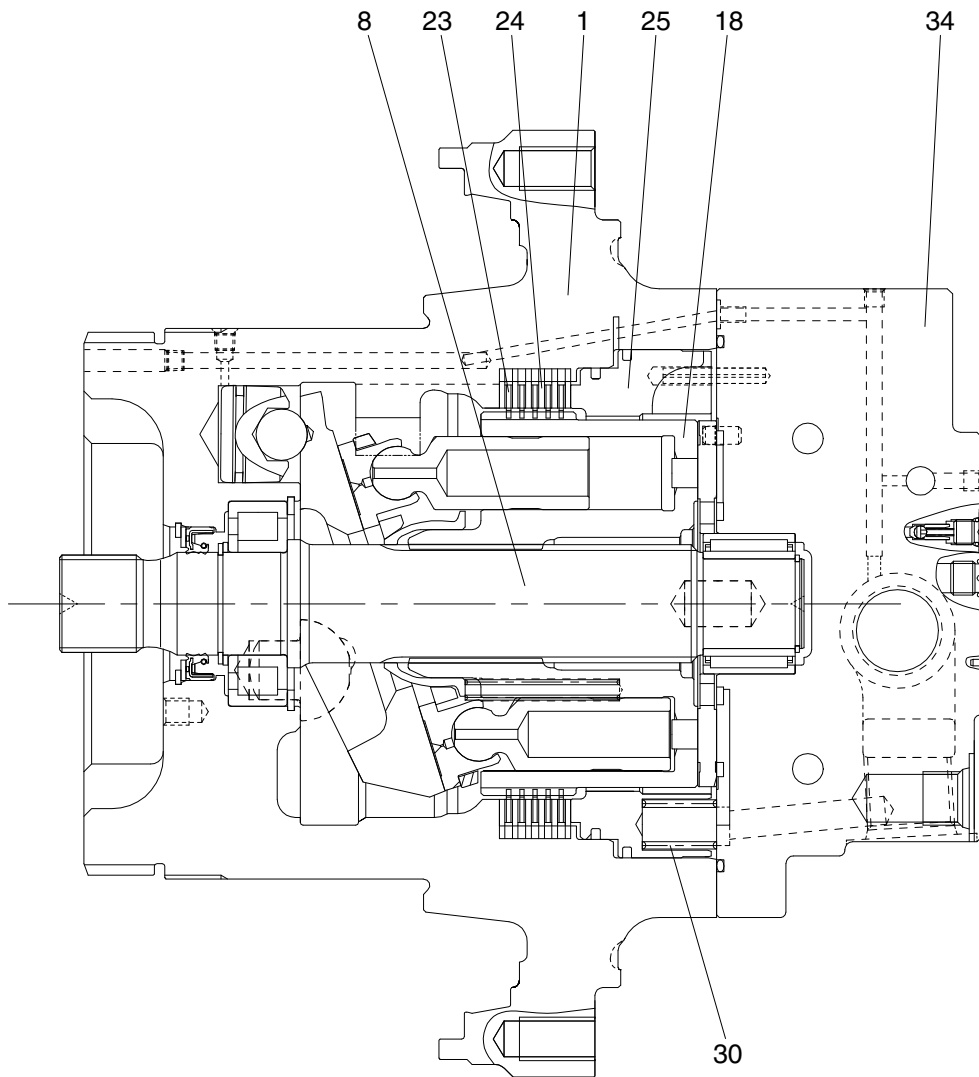
## 2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (34), is applied to the parking piston (25).

Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separated plates (24), inserted into the casing (1), and friction plates (23), coupled to cylinder block (18) by the outer splines.

When no pressure is activated on the parking piston (25), it is pushed by the brake springs (30) and it pushes friction plates (23) and separated plates (24) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (18) and hence the shaft (8).



25092TM24

### 3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure  $P_A$  that overcome the spring (51), the spring (51) is compressed and spool (47) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (56) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (6). As a result, swash plate (17) turns around the line L which connect the two pivots (16) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (17) keeps the position.

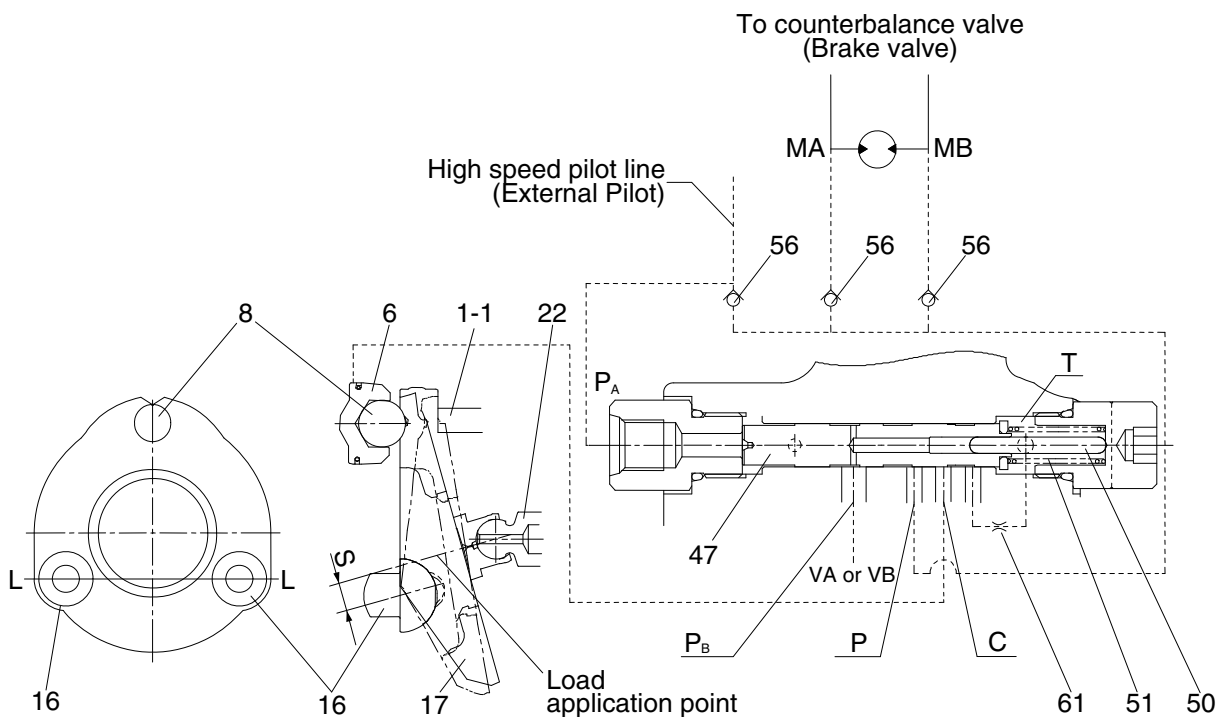
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

When no pressure is in the high speed pilot line  $P_A$ , spool (35) is pushed back by the spring (51) and pressure that pressed the shifter piston (6) is released to the hydraulic tank through restrictor (61).

Here, nine pistons are there and they equally spaced on the swash plate (17). The force that summed up those of pistons comes to almost the center of the swash plate (17) as shown. Since the pivots (16) are off-set by S from the center, the rotating force of product S and the force moves swash plate (17) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port  $P_B$  and this pressure activate on pin (50). When the pressure at  $P_B$  exceeds predetermined value, spool (47) returns to the left by the counter-pressure against pin (50) and the pressure on the shifter piston (6) through port C is released to the tank and the motor comes to low speed.

When  $P_B$  goes down, the spool (47) moves to the right and the speed become high.

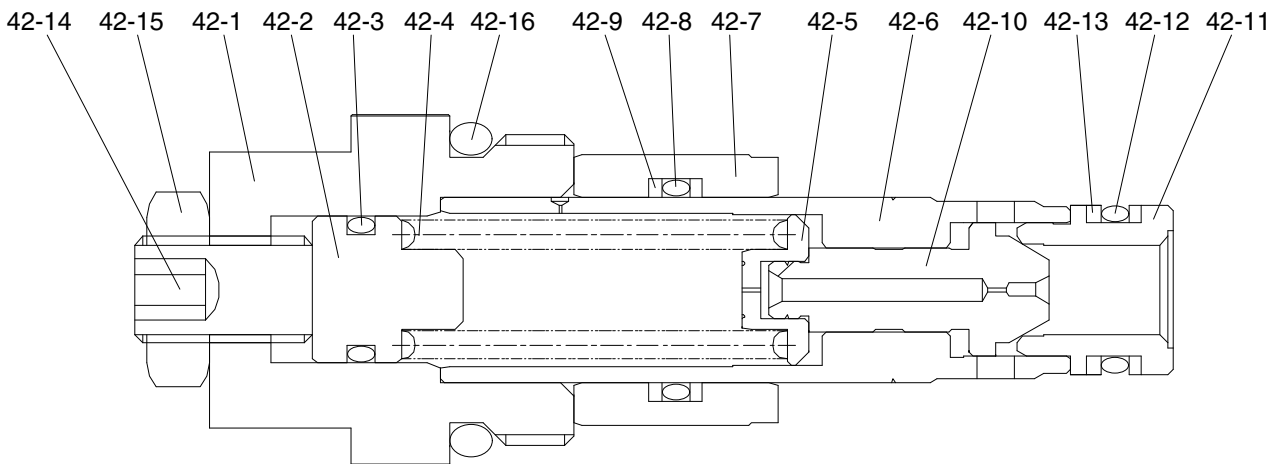


25092TM19

#### 4) OVERLOAD RELIEF VALVE

##### (1) Structure

This valve is screwed in the motor rear cover (34) and consists of : plug (42-1) that is screwed and fixed in the rear cover (34), poppet (42-10) and supports the poppet seat (42-11), spring (42-4) that is operating relief valve setting pressure and supports the spring seat (42-5), that is inserted in the sleeve (42-6), screw (42-14) that is adjust the spring force, nut (42-15) that fix screw (42-14), piston (42-7) that reduce the shock.



25092TM25

- |                  |                   |                    |
|------------------|-------------------|--------------------|
| 42-1 Plug        | 42-7 Piston       | 42-12 O-ring       |
| 42-2 Guide       | 42-8 O-ring       | 42-13 Back-up ring |
| 42-3 O-ring      | 42-9 Back-up ring | 42-14 Socket screw |
| 42-4 Spring      | 42-10 Poppet      | 42-15 Hexagon nut  |
| 42-5 Spring seat | 42-11 Poppet seat | 42-16 O-ring       |
| 42-6 Sleeve      |                   |                    |

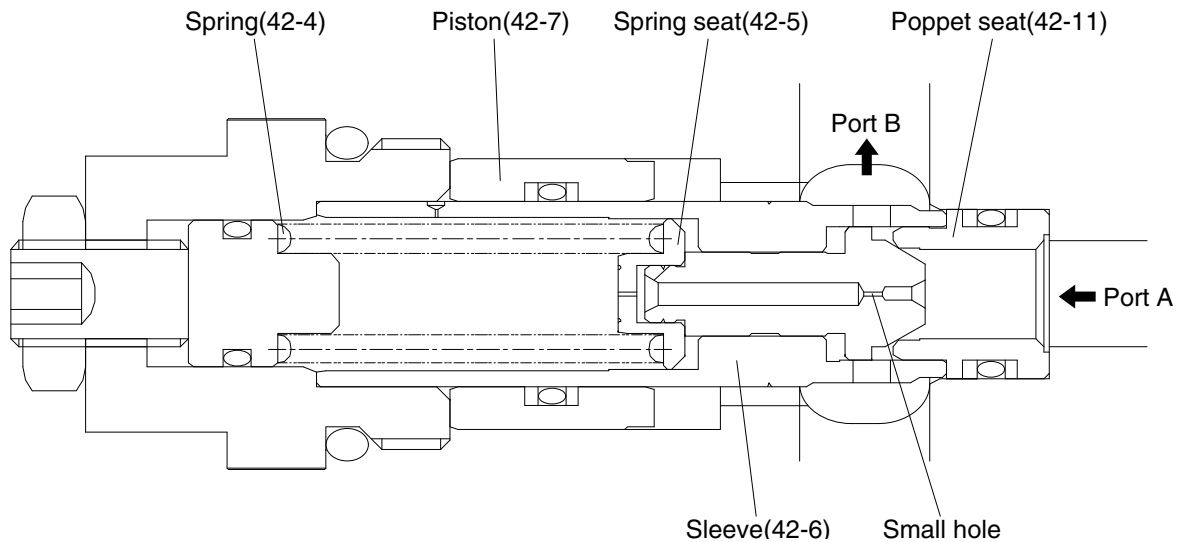
## (2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions :

- ① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
- ② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
- ③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of poppet (42-10) which seats on the poppet seat (42-11) and, at the same time, is delivered, via small hole, to the spring seat (42-5) located inside the sleeve (42-6) and the seat bore pressure increases up to "A" port pressure. The poppet (42-10) opposes to spring (42-4) by the force of the pressure exerted on the area difference between poppet seat's effective diameter and spring seat bore and keep the predetermined pressure.

When hydraulically braking, the piston (42-7) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (42-7) through the small hole in the poppet (42-10) and piston (42-7) moves rightward until it touches the stopper in rear cover. In this while, the poppet (42-10) maintains "A" port pressure at comparatively low against the spring (42-4) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



25092TM27

## 5) BRAKE VALVE

### (1) Structure

The brake valve portion mainly consists of the following parts:

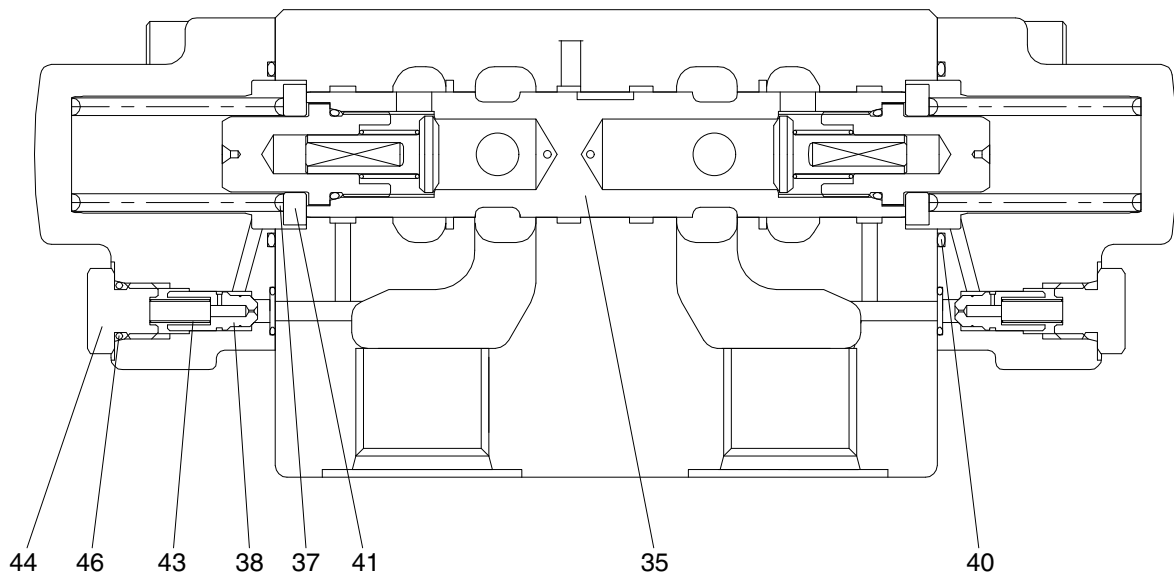
#### ① Spool

By shifting the spool (35), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-79, (2) Operation)

#### ② Check valve (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



25092TM28

35	Main spool	40	O-ring	44	Plug
37	Spring	41	Spring seat	46	O-ring
38	Restrictor	43	Restrictor spring		

## (2) Operation

### ① Holding operation

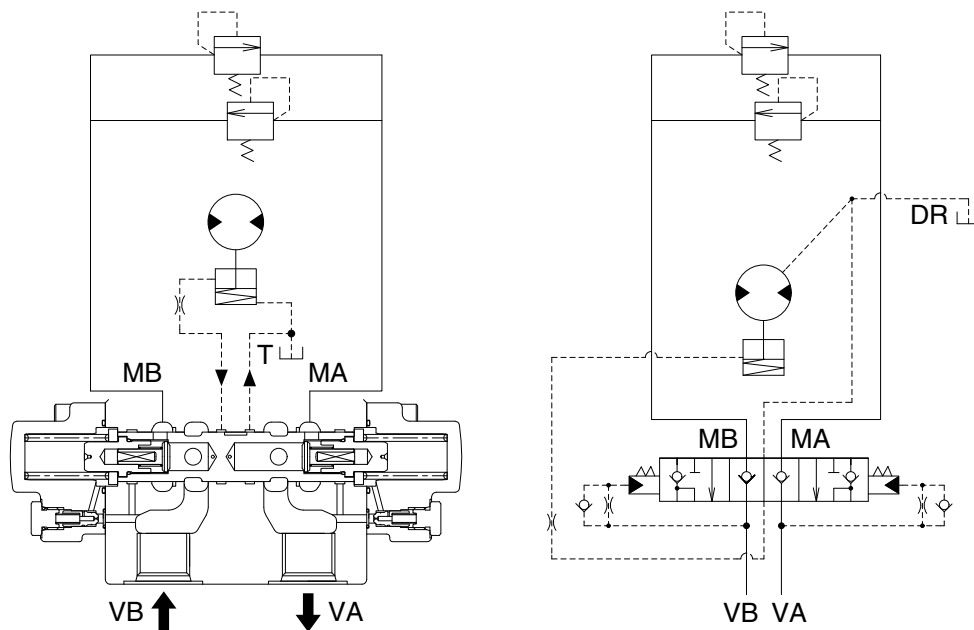
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (37) located on both spool ends holds the spool (35) at central position.

Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.

If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (35), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.



25092TM29



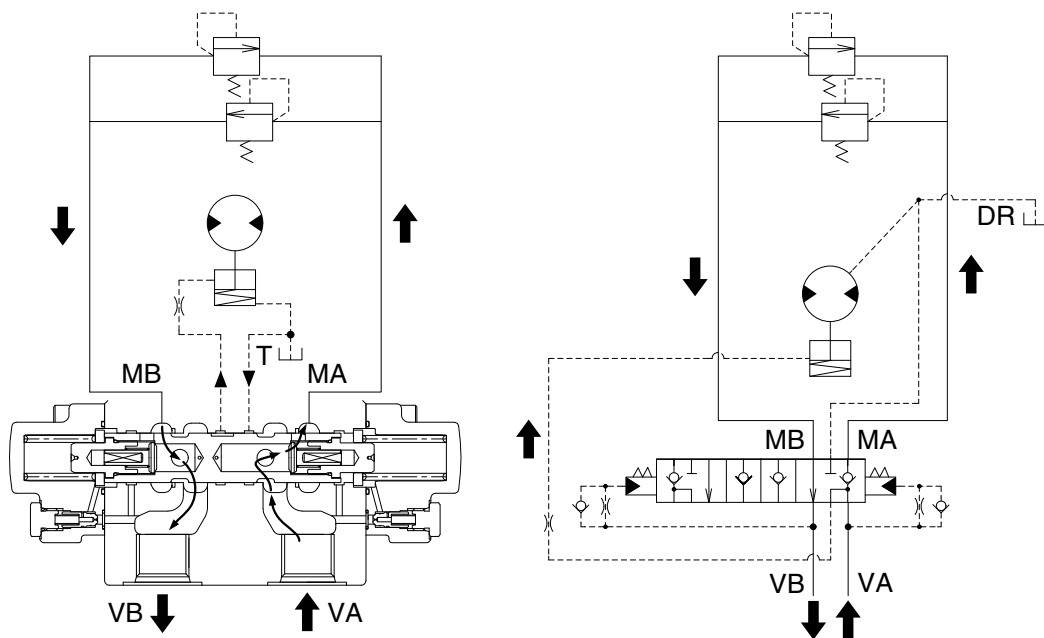
## ② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (35), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (35) leftwards, overcoming the spring (37) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed.

As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.



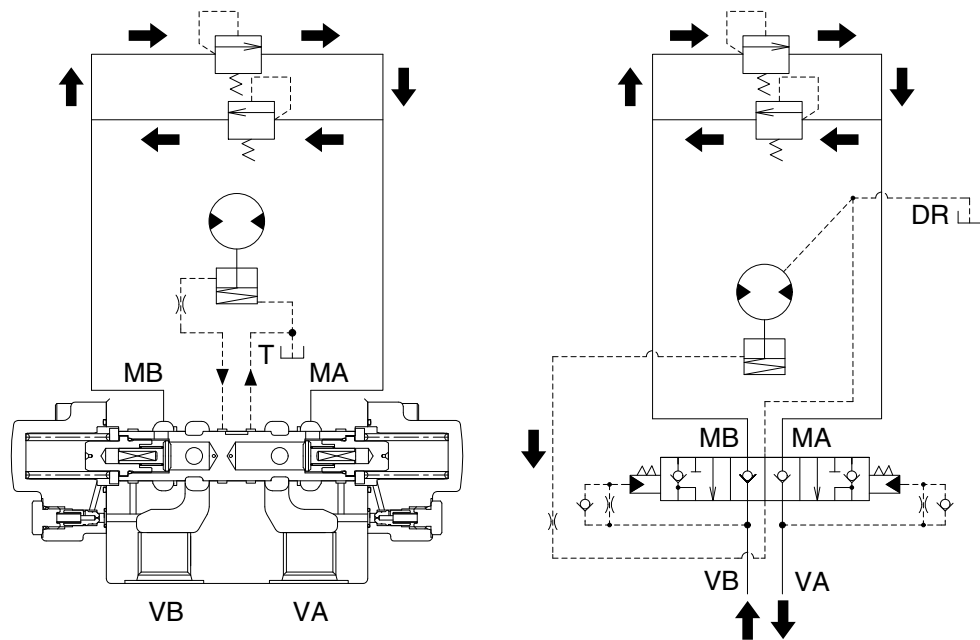
25092TM30

### ③ Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (35) returns to the neutral position by spring (37) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



25092TM31

#### ④ Counterbalance operation

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.

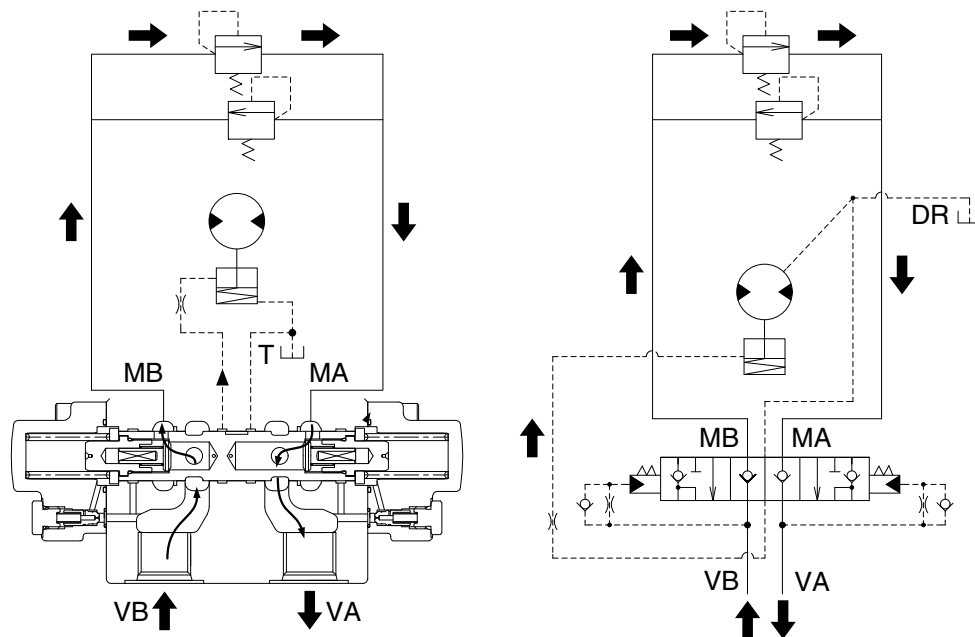
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (37) force moves the spool (35) leftwards towards neutral position.

Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (35) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.

In order to give stable counterbalance operation, the restrictors (38) are set in the pilot chamber to damp the spool (35) movement.

The parking brake is released during pressure adjusting action of the spool (35).



25092TM32

## 6) REDUCTION GEAR

Reduction unit slows down the rotating speed of motor and converts motor torque to strong rotating force.

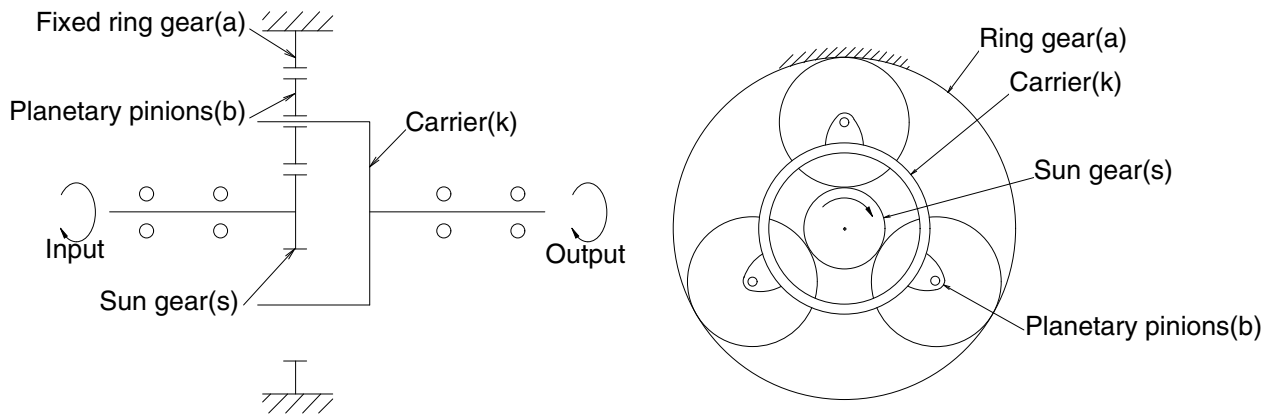
This reduction unit utilizes two stages, planetary reduction system.

Planetary reduction system consists of sun gear, planetary gears, (planetary) carriers, and ring gear.

When the sun gear (s) is driven through input shaft, planetary pinions (b), rotating on their center, also move, meshing with fixed ring gear (a), around sun gear (s).

This movement is transferred to carrier (k) and deliver the torque.

This mechanism is called planetary gear mechanism.

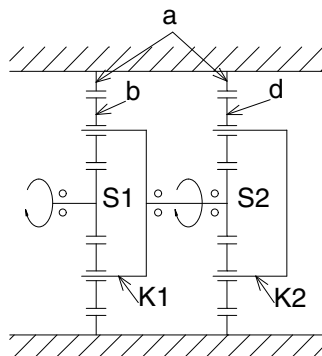


29072TM10

29072TM11

When the sun gear **S1** is driven by input shaft, planetary action occurs among gears **S1**, **a** and **b** and revolution of gear **b** transfers the rotation of carrier **K1** to second sun gear **S2**, and also evokes planetary action between gear **S2**, **a** and **d**.

This time, because carrier **K2** is fixed to frame, gear **d** drives ring gear **a** and then ring gear **a** rotates to drive sprocket.



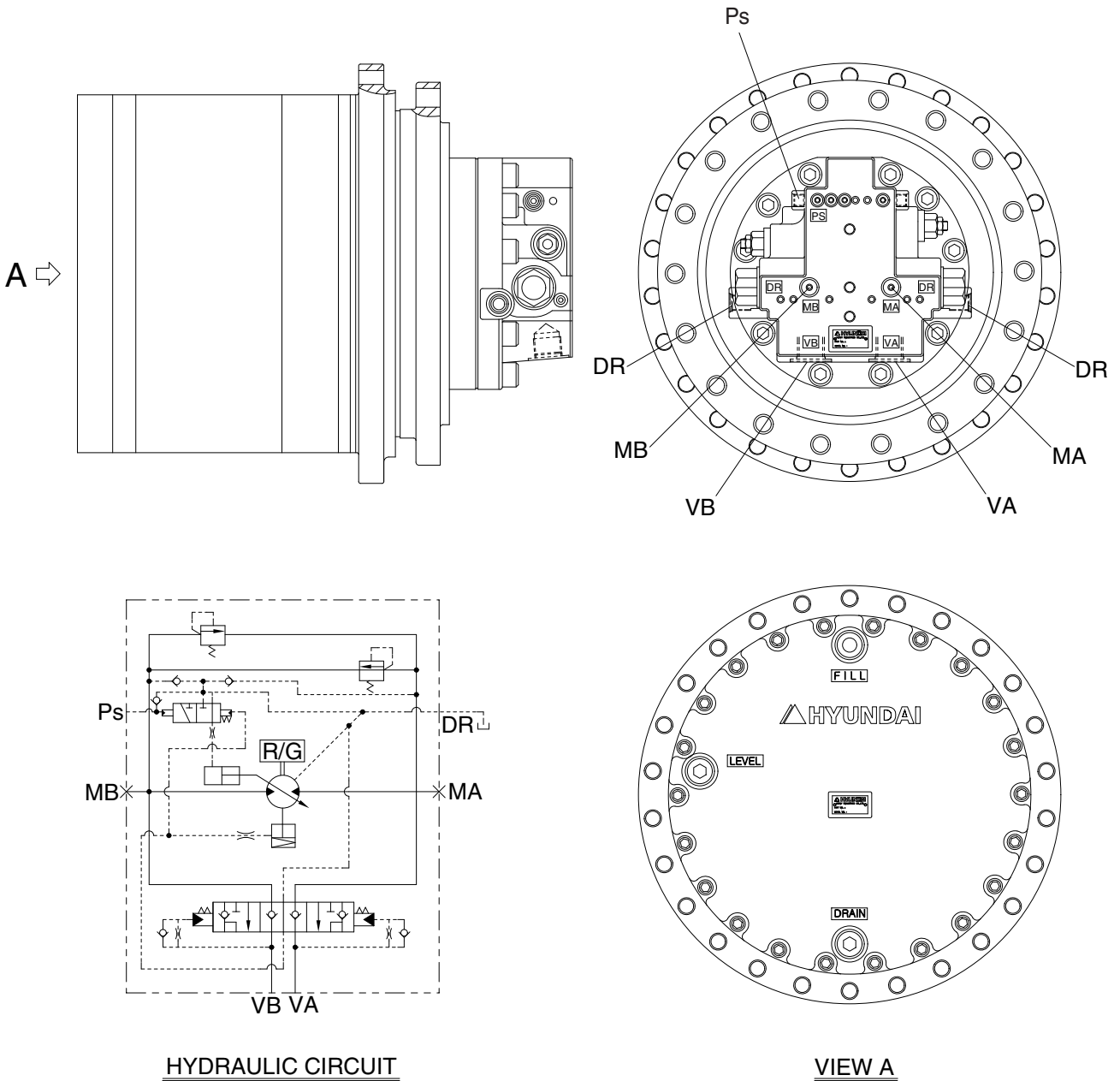
29072TM12

# TRAVEL DEVICE (HIGH WALKER)

## 1. CONSTRUCTION

Travel device consists travel motor and gear box.

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



HYDRAULIC CIRCUIT

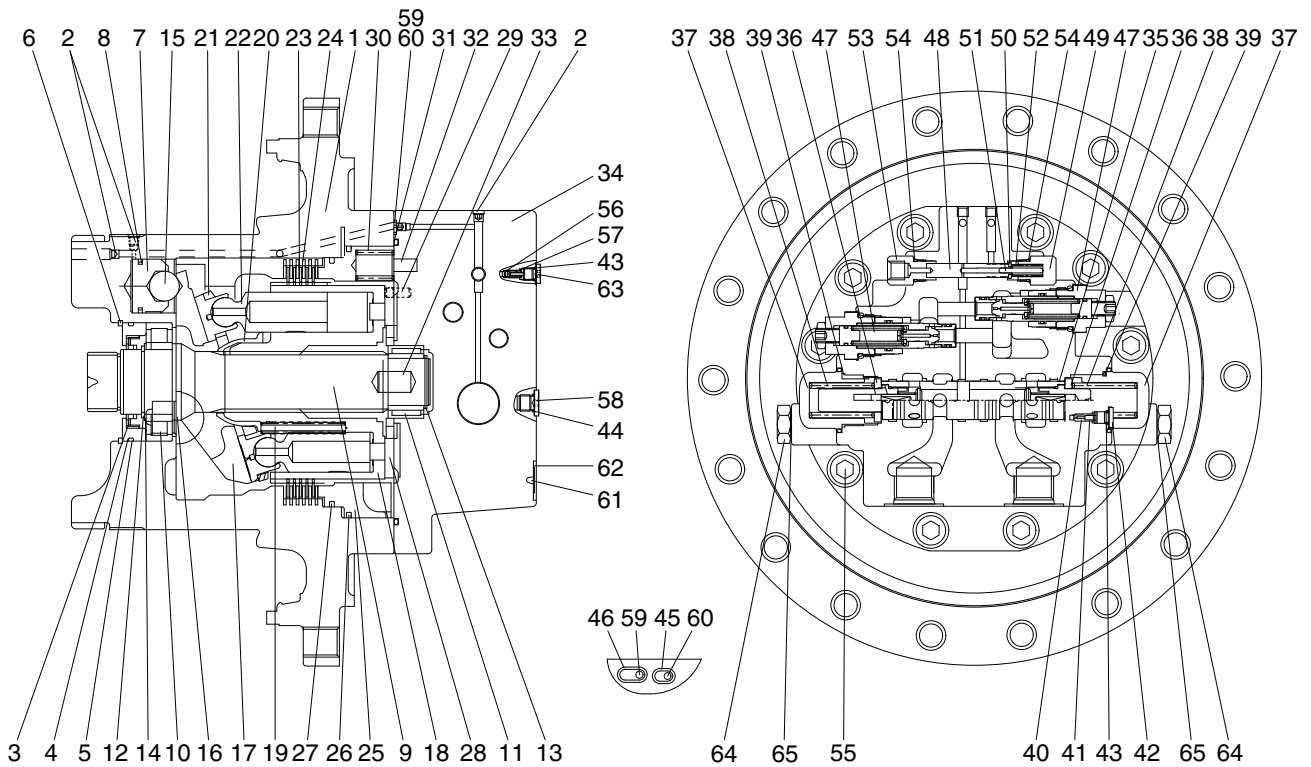
VIEW A

300L2TM01

Port	Port name	Port size
VA, VB	Valve port	PF 1
Ps	Pilot port	PF 1/4
DR	Drain port	PF 1/2
MA, MB	Gauge port	PF 1/4

## 2. SPECIFICATION

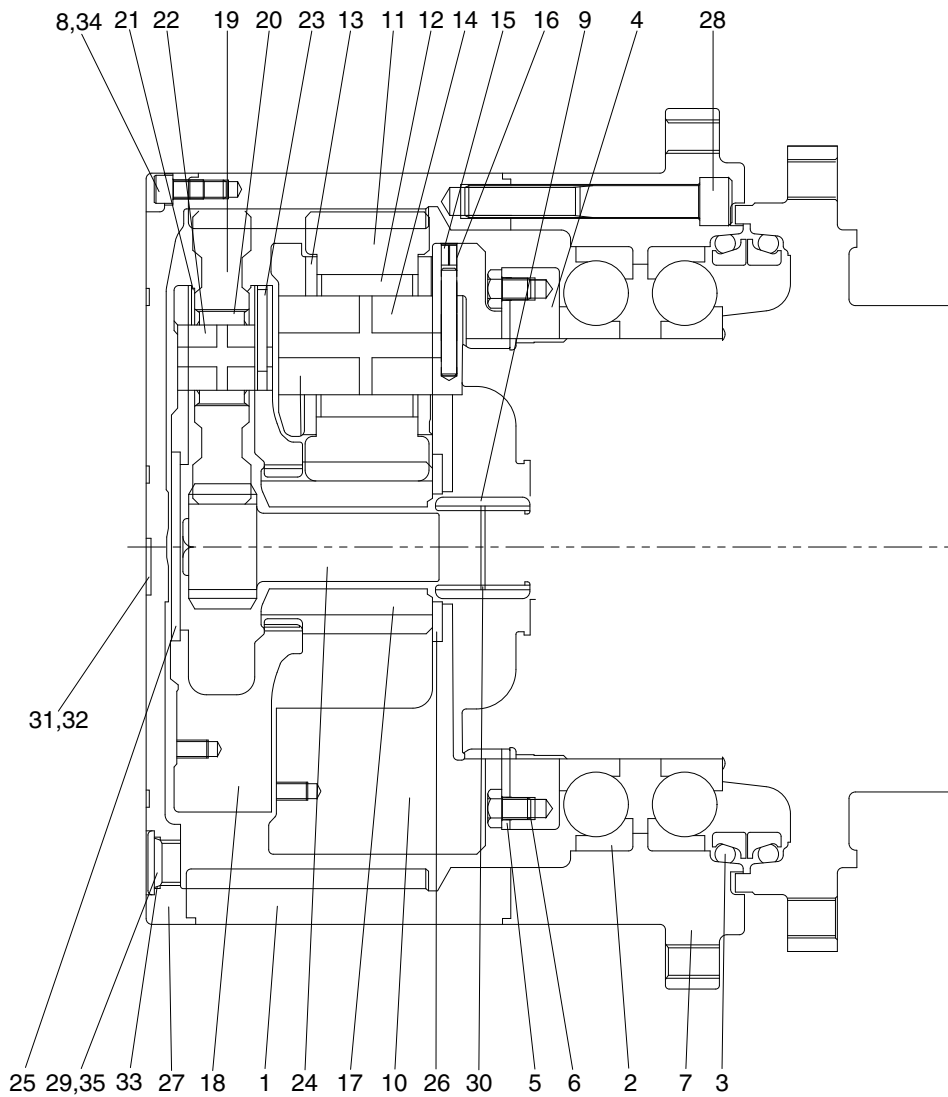
### 1) TRAVEL MOTOR



300L2TM02

1	Casing	23	Friction plate	45	O-ring
2	Plug	24	Separated plate	46	O-ring
3	Oil seal	25	Parking piston	47	Relief valve assy
4	Thrust block	26	D-ring	48	Spool
5	O-ring	27	D-ring	49	Plug
6	Retainer ring	28	Valve plate	50	Spring seat
7	Piston	29	Parallel pin	51	Parallel pin
8	Piston seal	30	Spring	52	Spring
9	Shaft	31	O-ring	53	Connector
10	Cylinder roller bearing	32	Spring pin	54	O-ring
11	Needle bearing	33	Parallel pin	55	Hexagon socket head bolt
12	Retainer ring	34	Rear cover	56	Check valve
13	Retainer ring	35	Main spool assy	57	Spring
14	Thrust plate	36	Spring seat	58	Plug
15	Steel ball	37	Plug	59	Restrictor
16	Swash pivot	38	Spring	60	Restrictor
17	Swash plate	39	O-ring	61	Name plate
18	Cylinder block	40	Restrictor	62	Rivet
19	Spring	41	Spring	63	Plug
20	Ball guide	42	Plug	64	Plug
21	Retainer plate	43	O-ring	65	O-ring
22	Piston assy	44	O-ring		

## 2) TRAVEL REDUCTION GEAR



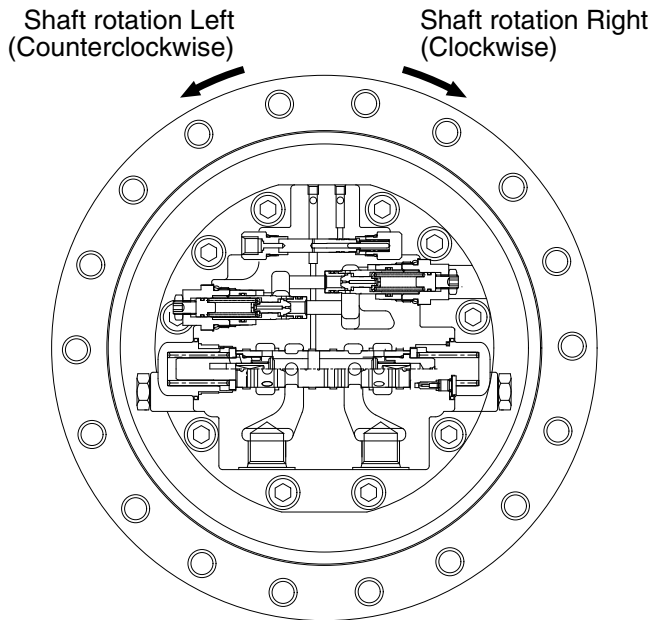
260SA2TM03

1	Ring gear	13	Thrust washer 2	25	Thrust plate
2	Ball bearing	14	Carrier pin 2	26	Thrust plate
3	Floating seal assy	15	Spring pin 2	27	Cover
4	Ring nut	16	Solid pin 2	28	Hexagon socket head bolt
5	Lock plate	17	Sun gear 2	29	Socket plug
6	Hexagon head bolt	18	Carrier 1	30	Retainer ring
7	Housing	19	Planetary gear 1	31	Name plate
8	Hexagon socket head bolt	20	Needle bearing 1	32	Rivet
9	Coupling	21	Thrust washer 1	33	O-ring
10	Carrier 2	22	Carrier pin 1	34	Rubber cap
11	Planetary gear 2	23	Spring pin 1	35	Rubber cap
12	Needle bearing 2	24	Sun gear 1		

### 3. OPERATION

#### 1) MOTOR

High pressure oil delivered from hydraulic pump is led to inlet port that is provided in the brake valve portion and, through the rear cover (34) and valve plate (28), led to cylinder block (18). The oil flow and direction of shaft rotation are indicated in table.



Inlet port	Outlet port	Direction of shaft rotation (viewing from rear cover)
VB	VA	Right (clockwise)
VA	VB	Left (counterclockwise)

300L2TM04

As shown in below figure, high pressure oil is supplied to the pistons which are on one side of the line Y-Y that connects upper and lower dead points and produces force F1.

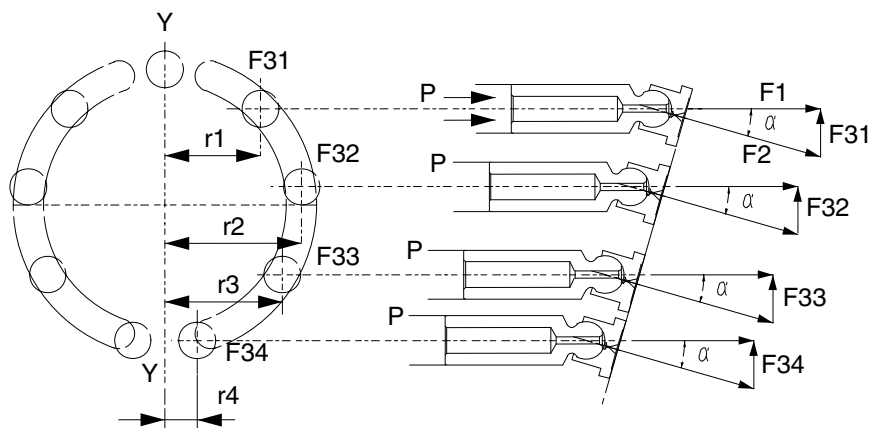
$$F1 = P \times A \text{ (P : pressure, A : area of piston section)}$$

The swash plate (17) with inclined angle of  $\alpha$  divides this force F1 into thrust force F2 and radial force F31-34.

This radial force is applied to axis Y-Y as turning force and generate drive torque of T.

$$T = r_1 \cdot F31 + r_2 \cdot F32 + r_3 \cdot F33 + r_4 \cdot F34$$

This drive torque is transmitted via cylinder block (18) to driving shaft (9).



29092TM07



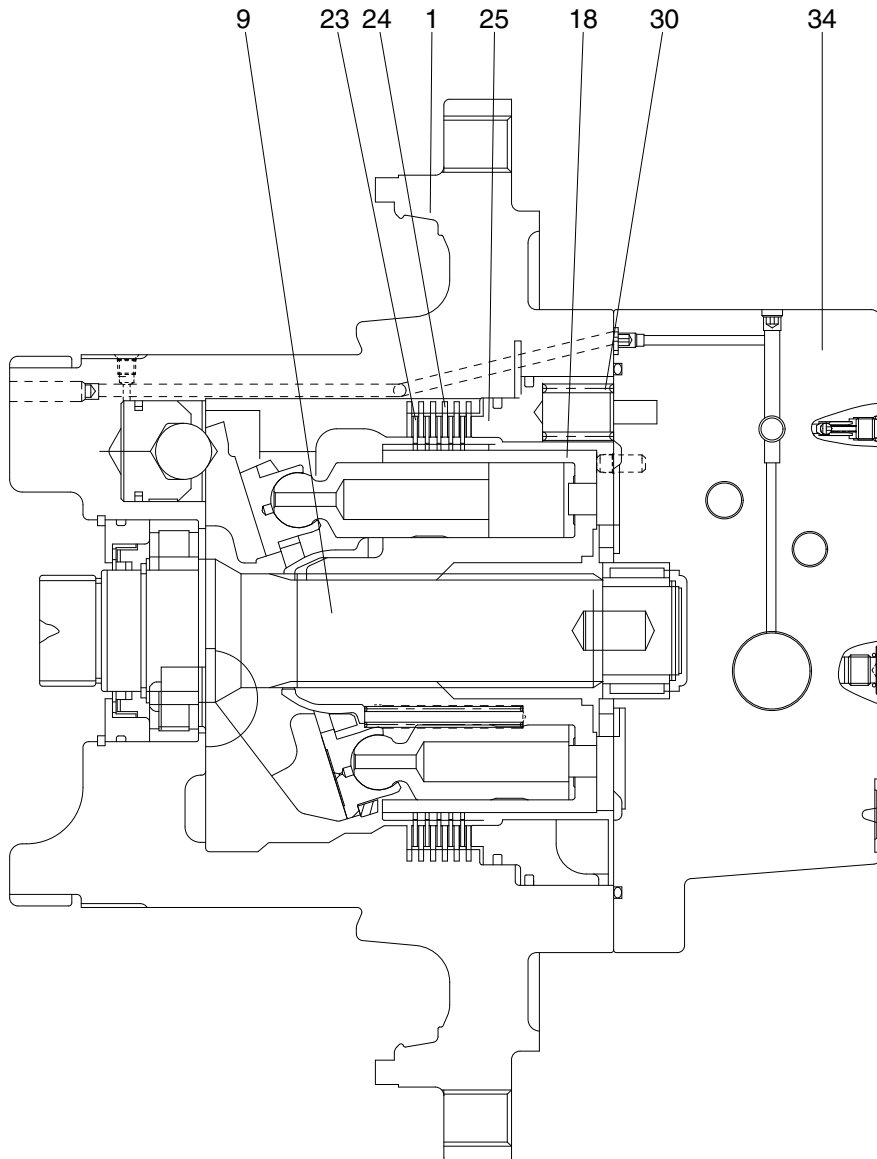
## 2) PARKING BRAKE

Parking brake is released when high pressure oil selected by the brake valve portion that is connected directly to the rear cover (34), is applied to the parking piston (25).

Otherwise the braking torque is always applied.

This braking torque is generated by the friction between the separated plates (24), inserted into the casing (1), and friction plates (23), coupled to cylinder block (18) by the outer splines.

When no pressure is activated on the parking piston (25), it is pushed by the brake springs (30) and it pushes friction plates (23) and separated plates (24) towards casing (1) and generates the friction force which brakes the rotation of cylinder block (18) and hence the shaft (9).



2609A2TM05

### 3) CAPACITY CONTROL MECHANISM

Figure typically shows the capacity control mechanism.

When high speed pilot line is charged with the pressure  $P_A$  that overcome the spring (52), the spring (52) is compressed and spool (48) shifts to the right to connect the port P and port C.

Then, the highest pressure is selected by the check valve (56) from inlet and outlet pressure of the motor and high speed pilot line pressure and pushes shifter piston (7). As a result, swash plate (17) turns around the line L which connect the two pivots (16) as shown by dotted lines. The turn stops at the stopper (1-1) of casing and swash plate (17) keeps the position.

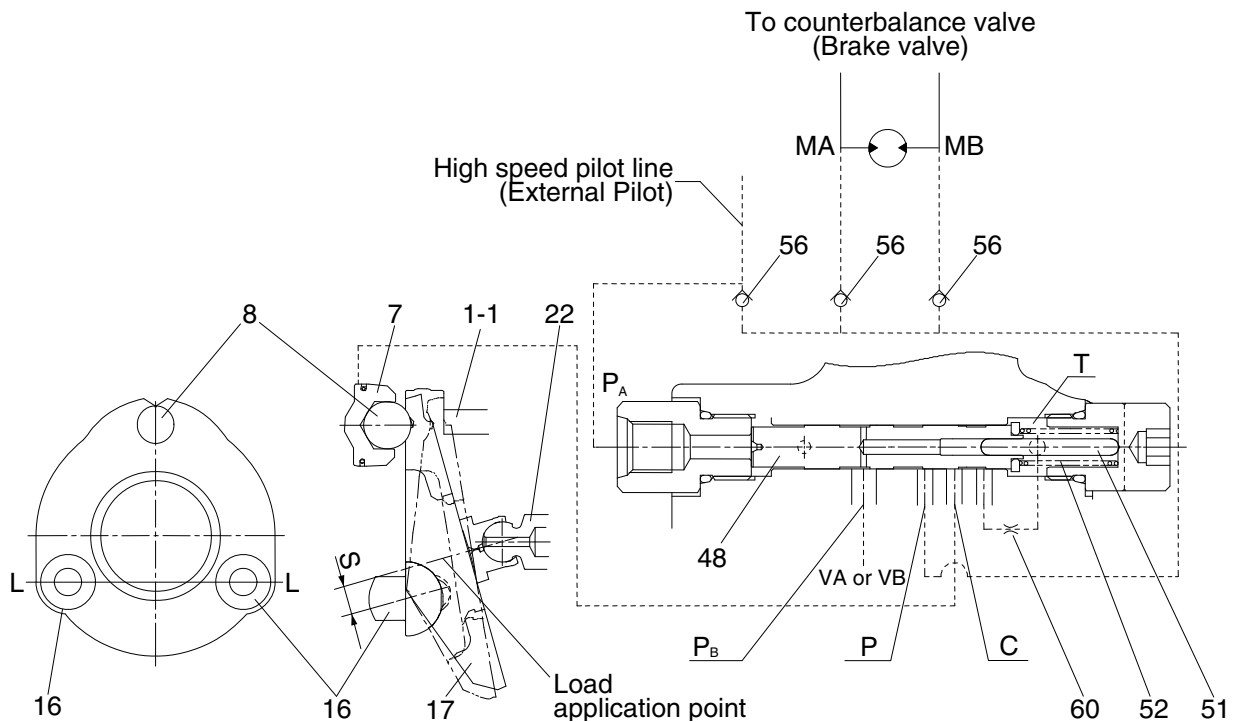
In this case, the piston stroke become shorter and motor capacity become smaller and motor rotates faster, around 1.60 times, by the same volume of oil.

When no pressure is in the high speed pilot line  $P_A$ , spool (35) is pushed back by the spring (52) and pressure that pressed the shifter piston (7) is released to the hydraulic tank through restrictor (60).

Here, nine pistons are there and they equally spaced on the swash plate (17). The force that summed up those of pistons comes to almost the center of the swash plate (17) as shown. Since the swash pivots (16) are off-set by S from the center, the rotating force of product S and the force moves swash plate (17) to the former position and the speed returns to low.

When the power demand exceeds the engine power, such as in steep slope climbing or turning at high speed mode, the system step down to the low speed automatically. The mechanism is that: pump pressure is led to the port  $P_B$  and this pressure activate on pin (51). When the pressure at  $P_B$  exceeds predetermined value, spool (48) returns to the left by the counter-pressure against pin (51) and the pressure on the shifter piston (7) through port C is released to the tank and the motor comes to low speed.

When  $P_B$  goes down, the spool (48) moves to the right and the speed become high.

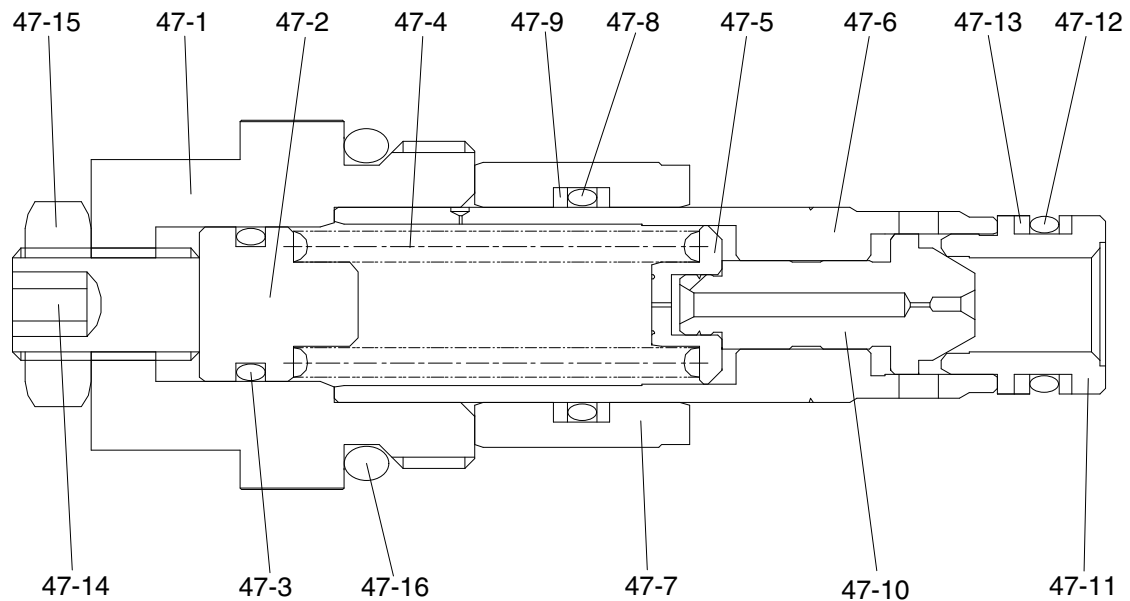


2609A2TM06

#### 4) OVERLOAD RELIEF VALVE

##### (1) Structure

This valve is screwed in the motor rear cover (34) and consists of : plug (47-1) that is screwed and fixed in the rear cover (34), poppet (47-10) and supports the poppet seat (47-11), spring (47-4) that is operating relief valve setting pressure and supports the spring seat (47-5), that is inserted in the sleeve (47-6), screw (47-14) that is adjust the spring force, nut (47-15) that fix screw (47-14), piston (47-7) that reduce the shock.



2609A2TM07

47-1 Plug	47-7 Piston	47-12 O-ring
47-2 Guide	47-8 O-ring	47-13 Back-up ring
47-3 O-ring	47-9 Back-up ring	47-14 Socket screw
47-4 Spring	47-10 Poppet	47-15 Hexagon nut
47-5 Spring seat	47-11 Poppet seat	47-16 O-ring
47-6 Sleeve		

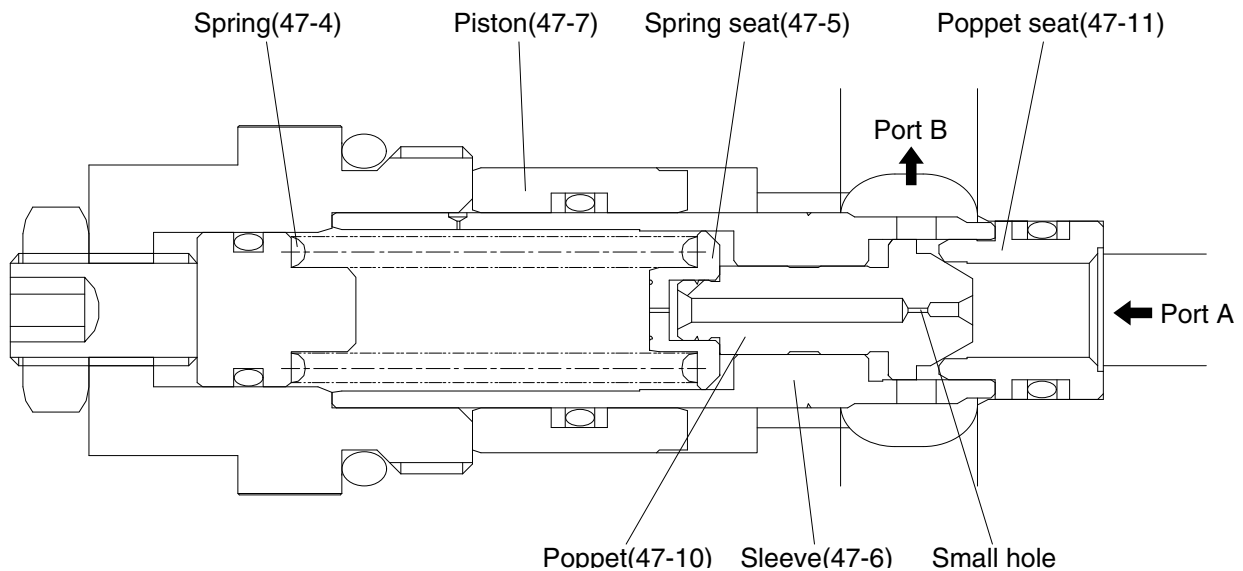
## (2) Operation

Two pieces of overload valves are located at cross-over position in the counterbalance circuit of brake valve and have the following functions:

- ① When hydraulic motor starts, keep the driving pressure below predetermined value and while accelerating, bypasses surplus oil to return line.
- ② When stopping the motor, keep the brake pressure, that develops on the outlet side of motor, under the predetermined value to stop the inertial force.
- ③ To accelerate sharply while starting, and to mitigate the braking shock while stopping. For these purposes, the developed pressure is kept comparatively low for a short period, then keep the line pressure as normal value. While the pressure is low, meshing of reduction gears, crawler and sprocket etc. can be smoothly done and the shock are absorbed.

When starting, "A" port pressure of overload valve increases, this pressure is applied to the effective diameter of poppet (47-10) which seats on the poppet seat (47-11) and, at the same time, is delivered, via small hole, to the spring seat (47-5) located inside the sleeve (47-6) and the seat bore pressure increases up to "A" port pressure. The poppet (47-10) opposes to spring (47-4) by the force of the pressure exerted on the area difference between poppet seat's effective diameter and spring seat bore and keep the predetermined pressure.

When hydraulically braking, the piston (47-7) is at the left position by the driving pressure, and when "A" port pressure increases, the pressure is applied also to the piston (47-7) through the small hole in the poppet (47-10) and piston (47-7) moves rightward until it touches the stopper in rear cover. In this while, the poppet (47-10) maintains "A" port pressure at comparatively low against the spring (47-4) force and exhaust oil to "B" port side. After the piston reached to the plug, the valve acts the same as at starting.



2609A2TM08

## 5) BRAKE VALVE

### (1) Structure

The brake valve portion mainly consists of the following parts:

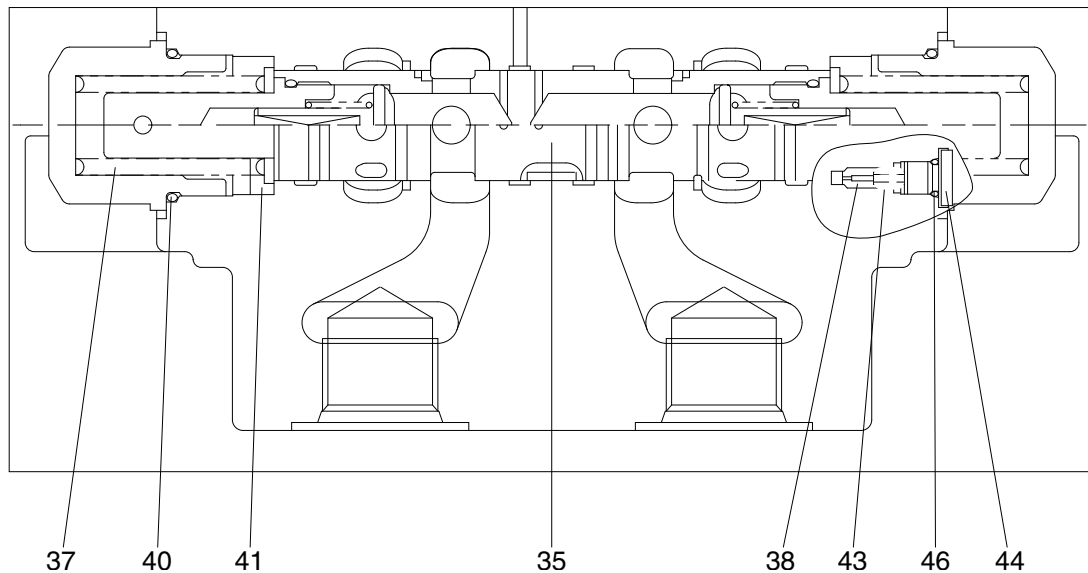
#### ① Spool

By shifting the spool (35), the discharged oil from hydraulic motor is automatically shut off or restricted according to the condition and give the effect of holding, accelerating, stopping and counterbalance operations.

(See page 2-93, (2) Operation)

#### ② Check valve (built in the spool)

This valve is located in the oil supplying passage to hydraulic motor, and at the same time functions to lock oil displacement. Therefore, this valve serves as not only a suction valve but also a holding valve for hydraulic motor.



2609A2TM09

35 Main spool  
36 Spring seat  
38 Spring

39 O-ring  
40 Restrictor  
41 Restrictor spring

42 Plug  
43 O-ring

## (2) Operation

### ① Holding operation

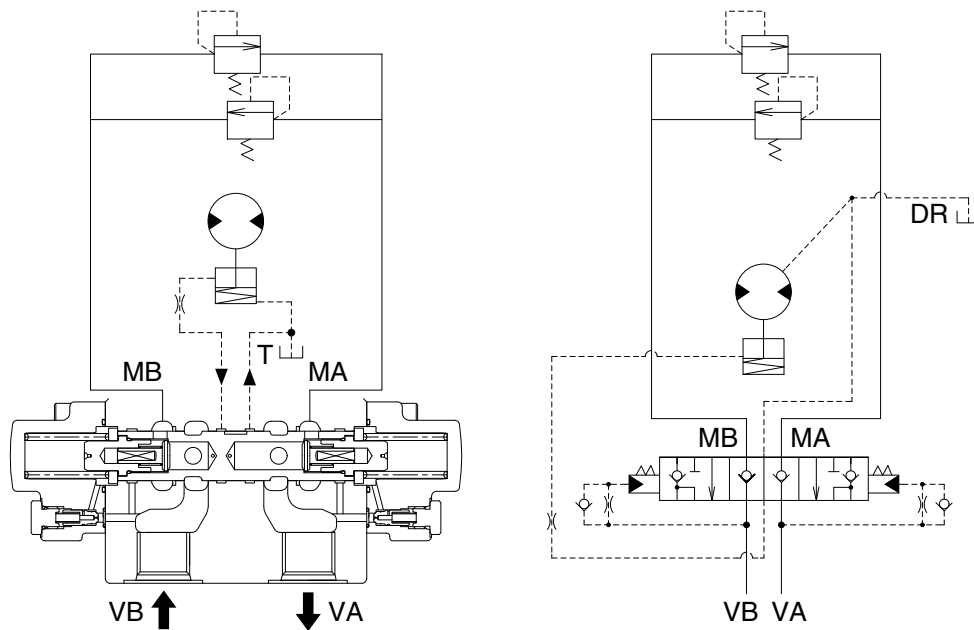
When the control valve is at neutral position, VA and VB ports are connected to the tank, and the spring (38) located on both spool ends holds the spool (35) at central position.

Therefore, the passages from VA to MA and VB to MB are closed, which result in closing MA and MB ports connected to hydraulic motor.

Since the passage to parking brake is connected to the tank line, the brake cylinder pressure is equal to the tank pressure and the brake is applied by the springs. Thus, the rotation of the motor is mechanically prevented.

If external torque is exerted on the motor shaft, the motor would not rotate as usual by this negative parking brake.

In case the brake should be released for some reason, pressure is built on MA or MB port. But, due to oil leakage inside hydraulic motor or so, high-pressure oil escapes from the closed circuit and motor rotates a bit. So, the cavitation tends to occur in the lower pressure side of the closed circuit. Then, the check valve, built in the spool (35), operates to avoid the cavitation and opens the passage from VA to MA or from VB to MB. Then the oil equivalent to the leakage is sucked from the tank line to the closed circuit.



25092TM29

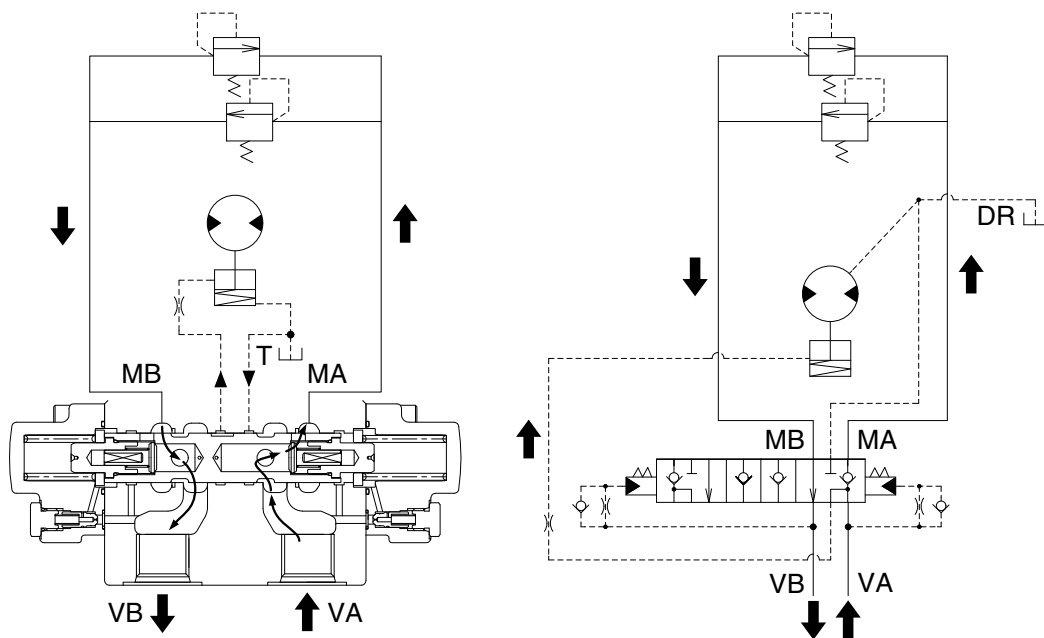
## ② Accelerating operation

When VA and VB ports are connected respectively to pump and tank by operating the control valve, hydraulic oil from pump is forwarded through VA port to push open the check valve provided inside spool (35), and oil flows to motor via MA port to rotate the motor.

Therefore, the pressure increases and negative brake is released by the pressure supplied from pump. At the same time, the pressure of pilot chamber increases to push and move the spool (35) leftwards, overcoming the spring (38) force. Thus, the return line from MB to VB opens to rotate the motor.

In case inertia load is too big to start rotation, accelerating pressure reaches the set pressure of relief valve and high pressure oil is being relieved while the motor gains the rotational speed.

As the rotational speed goes up, the relieved volume decreases, and finally the motor rotates at a fixed speed.



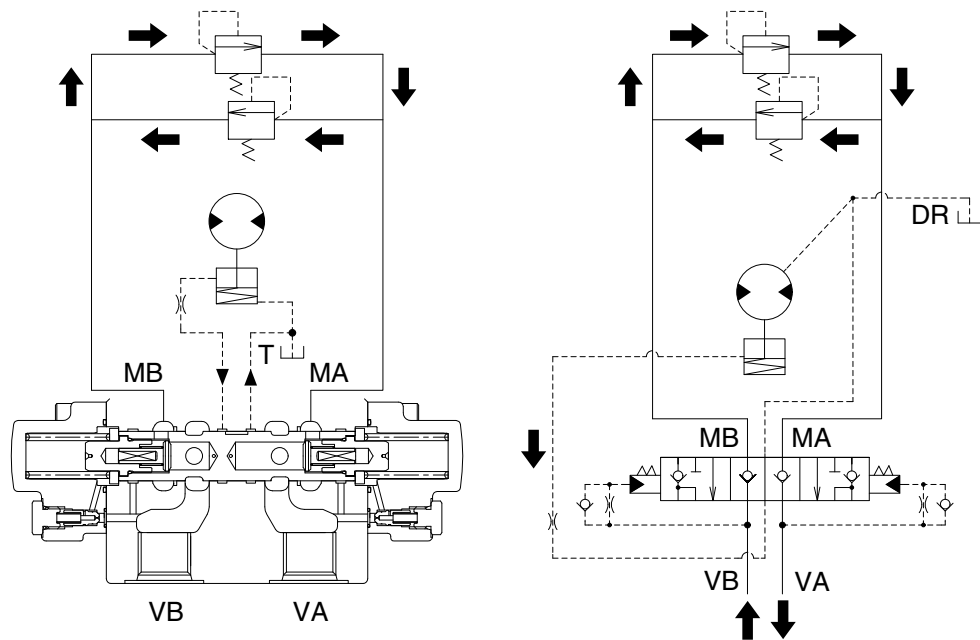
25092TM30

### ③ Stopping operation

Returning the control valve to neutral position while running the motor, the oil supply is cut off and VA and VB ports are connected to the tank line. Then the pressure of the pilot chamber located on both spool ends become equal, and the spool (35) returns to the neutral position by spring (38) force. Thus, the passage from MA to VA is closed.

Owing to the inertia force of the load, the hydraulic motor tends to continue the rotation. Here, the motor functions as a pump and forwards the oil to MB port but the passage is blocked and MB port pressure increases. Then the relief valve opens to relieve the pressure and rotational speed decelerates and at last the motor stops.

Negative brake release pressure is gradually lowered due to the restrictor and finally the brake works and the motor is mechanically stopped.



25092TM31



#### ④ Counterbalance operation

Counterbalance operation is required to decelerate slowly the hydraulic motor while absorbing inertia force.

In case the hydraulic oil is gradually decreased from pump to VB port, the drive shaft of hydraulic motor tends to rotate faster than that matched to the volume of oil supply.

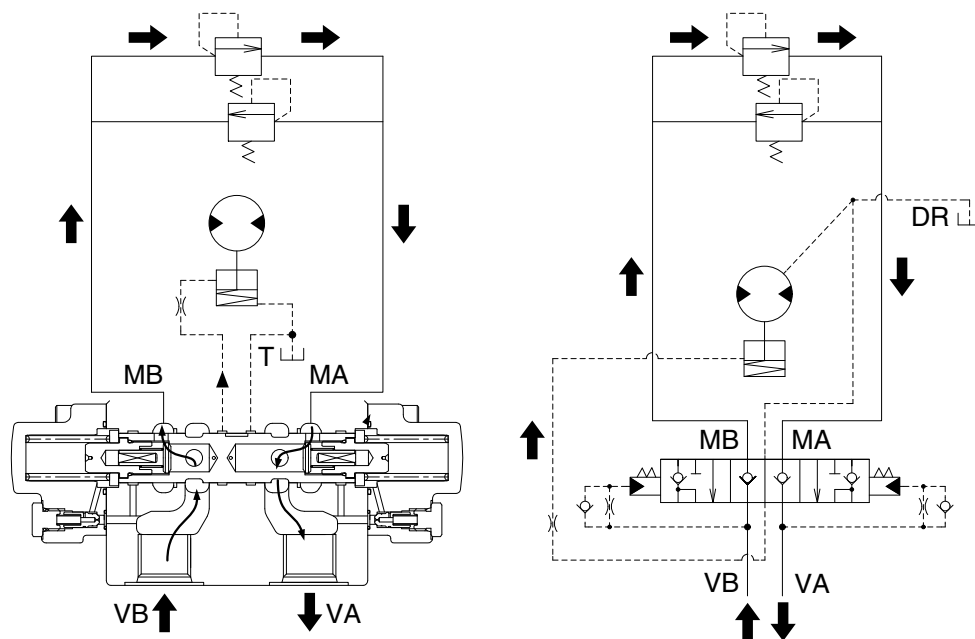
Consequently, the pilot chamber pressure on MB to VB side decreases and the spring (38) force moves the spool (35) leftwards towards neutral position.

Therefore, the area of passage from MA to VA becomes smaller and the pressure on MA side rises due to increased resistance in the passage and the motor receives hydraulic braking effect.

If the motor rotates slower than that matched to the volume of supplied oil, the pilot chamber pressure on VB port increases, and spool (35) moves rightwards to enlarge the area of passage from MA to VA. Therefore the braking effect becomes smaller and the rotational speed of motor is controlled to correspond to the volume of supplied oil.

In order to give stable counterbalance operation, the restrictors (40) are set in the pilot chamber to damp the spool (35) movement.

The parking brake is released during pressure adjusting action of the spool (35).



25092TM32

## 6) REDUCTION GEAR

Reduction unit slows down the rotating speed of motor and converts motor torque to strong rotating force.

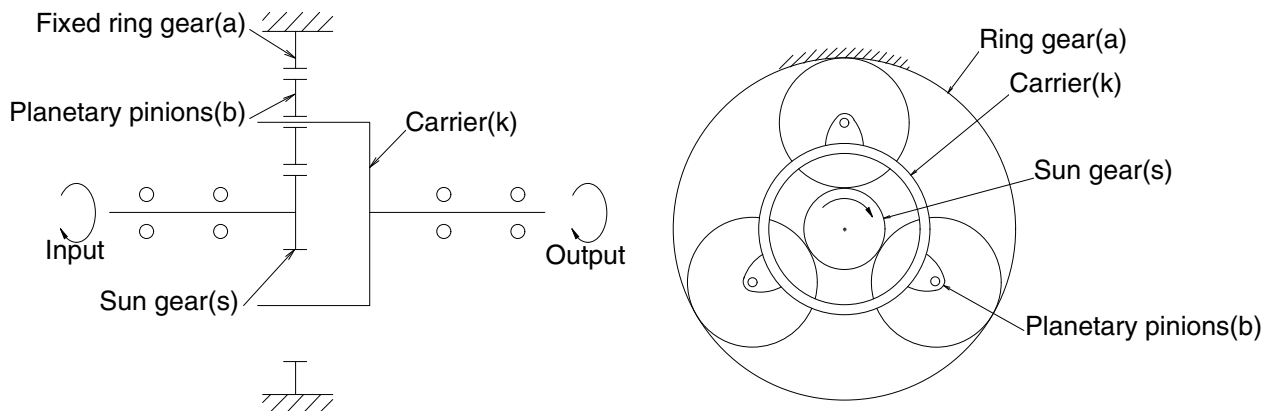
This reduction unit utilizes two stages, planetary reduction system.

Planetary reduction system consists of sun gear, planetary gears, (planetary) carriers, and ring gear.

When the sun gear (s) is driven through input shaft, planetary pinions (b), rotating on their center, also move, meshing with fixed ring gear (a), around sun gear (s).

This movement is transferred to carrier (k) and deliver the torque.

This mechanism is called planetary gear mechanism.

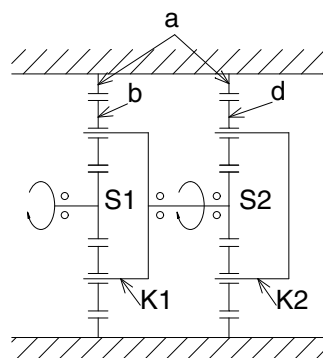


29072TM10

29072TM11

When the sun gear **S1** is driven by input shaft, planetary action occurs among gears **S1**, **a** and **b** and revolution of gear **b** transfers the rotation of carrier **K1** to second sun gear **S2**, and also evokes planetary action between gear **S2**, **a** and **d**.

This time, because carrier **K2** is fixed to frame, gear **d** drives ring gear **a** and then ring gear **a** rotates to drive sprocket.



29072TM12

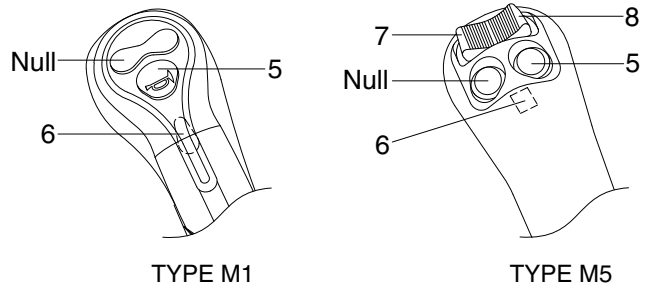
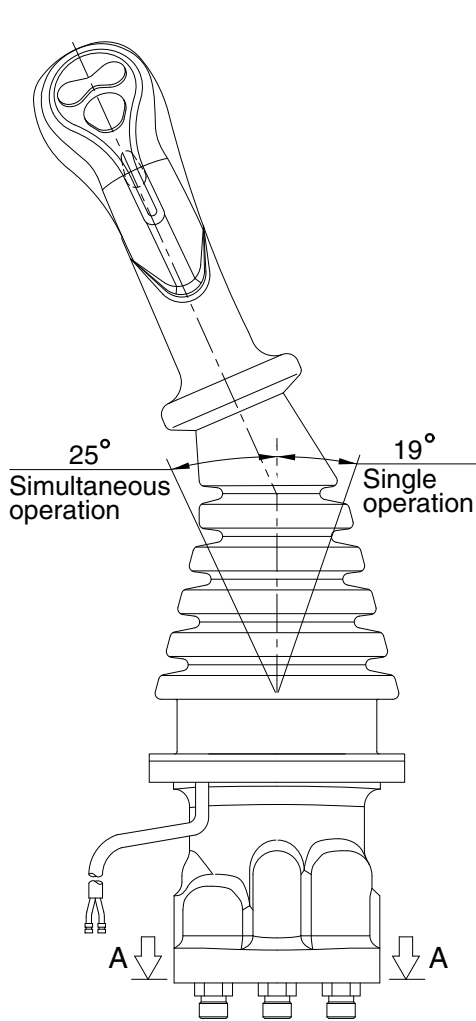
## GROUP 5 RCV LEVER

### 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.

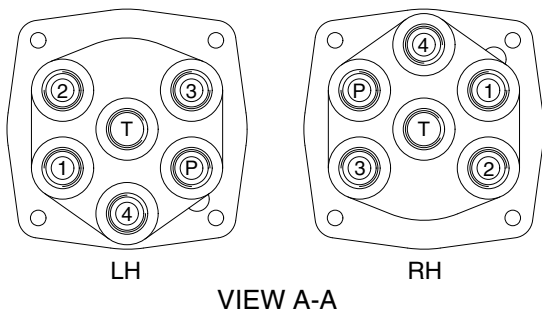
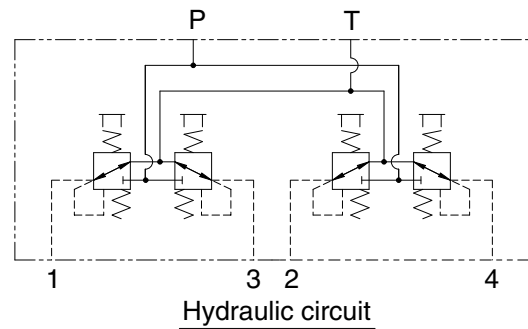
#### 1) TYPE M1, M5



#### Switches

Type	No.	LH	RH
M1	5	One touch decel	Horn
	6	Power boost	Breaker
M5	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment

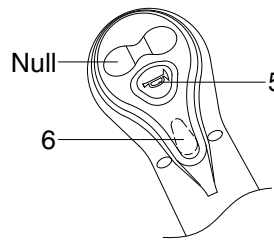
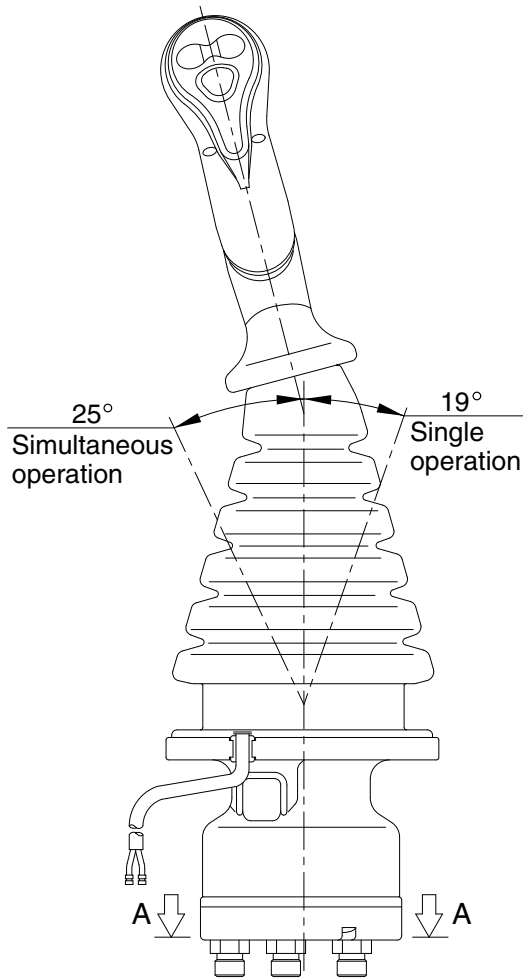


#### Pilot ports

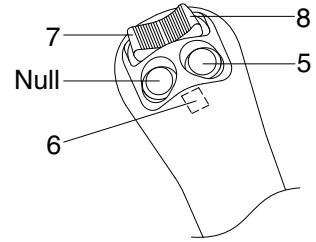
Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

210A2RL01

## 2) TYPE M11, M12



TYPE M12

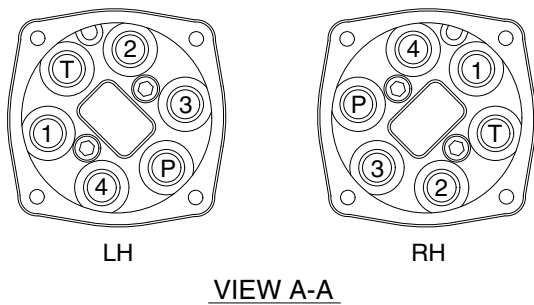
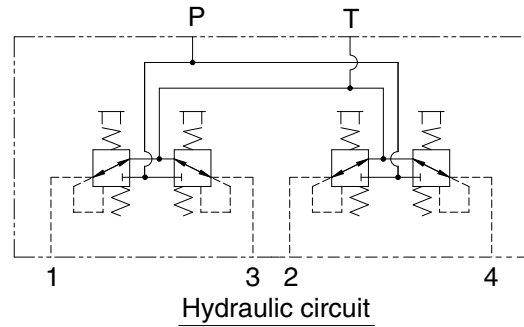


TYPE M11

### Switches

Type	No.	LH	RH
M12	5	One touch decel	Horn
	6	Power boost	Breaker
M11	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment

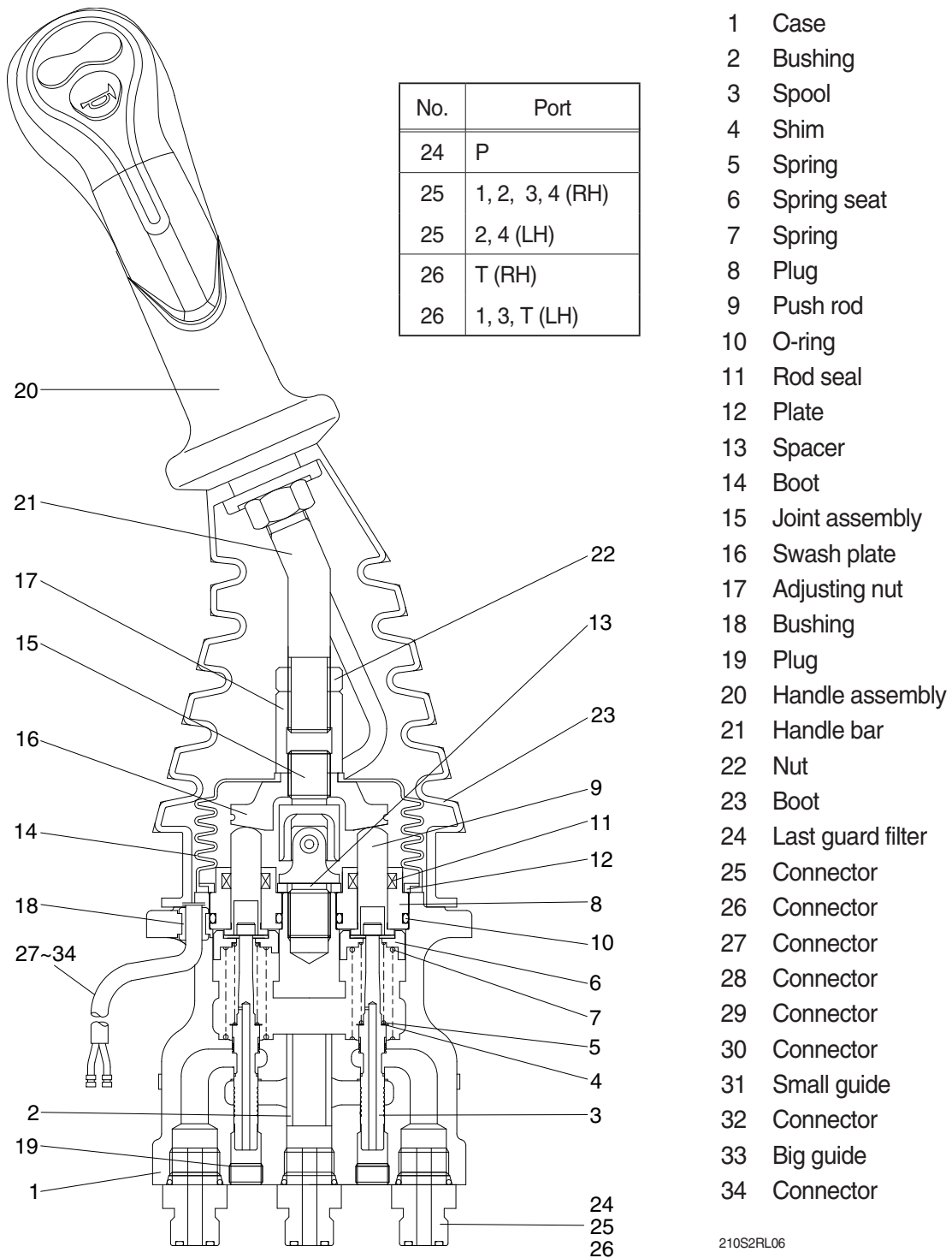


### Pilot ports

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	

210A2RL05

### 3) CROSS SECTION



Item numbers are based on the type M1.

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.

## 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 M1.**

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

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

The change the deflection of this spring, the push rod (9) is inserted and can slide in the plug (8).

For the purpose of changing the displacement of the push rod through the swash plate (16) and adjusting nut (17) are provided the handle assy (20) that can be tilted in any direction around the fulcrum of the universal joint (15) center.

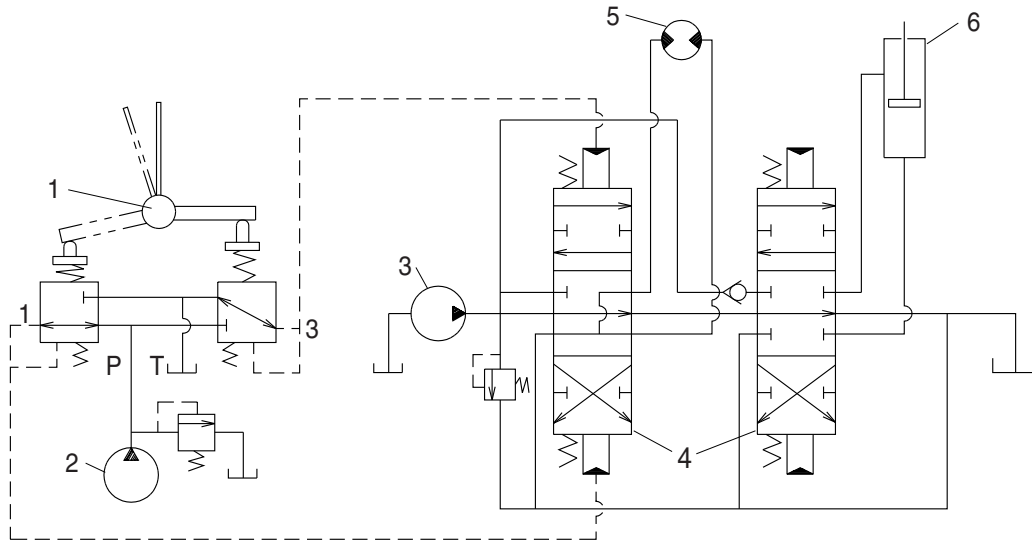
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



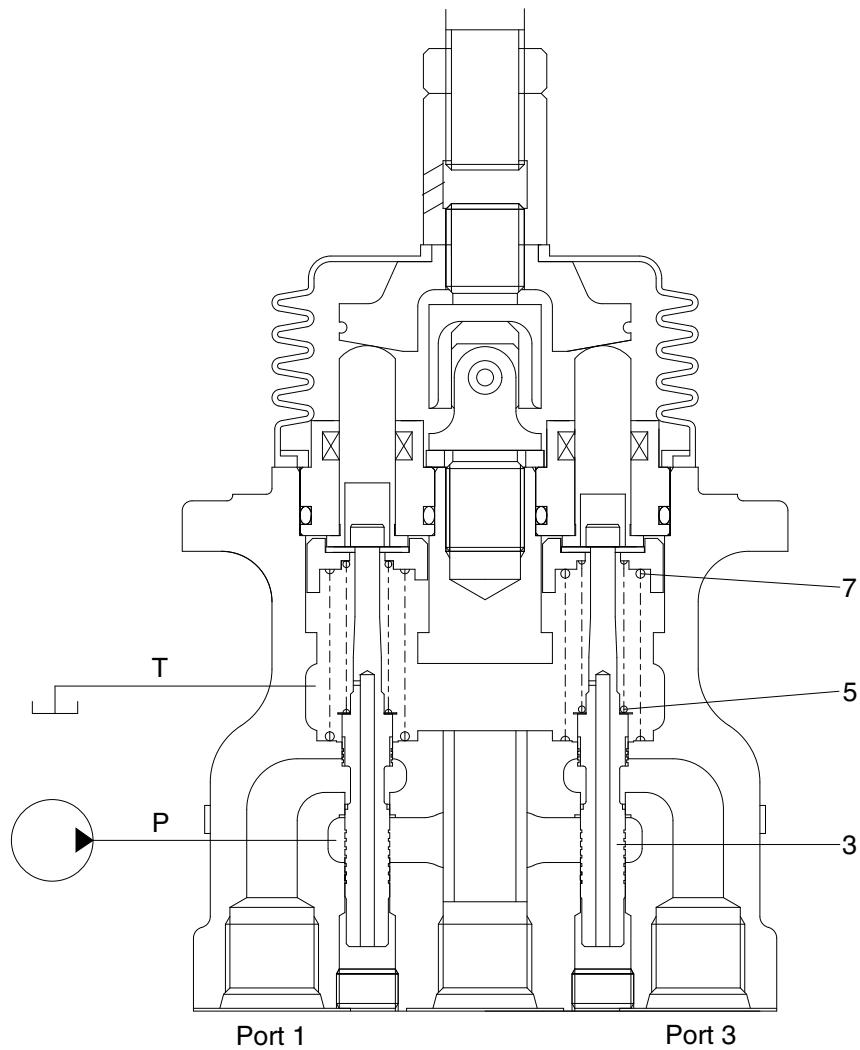
2-70

- 1 Pilot valve
- 2 Pilot pump

- 3 Main pump
- 4 Main control valve

- 5 Hydraulic motor
- 6 Hydraulic cylinder

(1) Case where handle is in neutral position

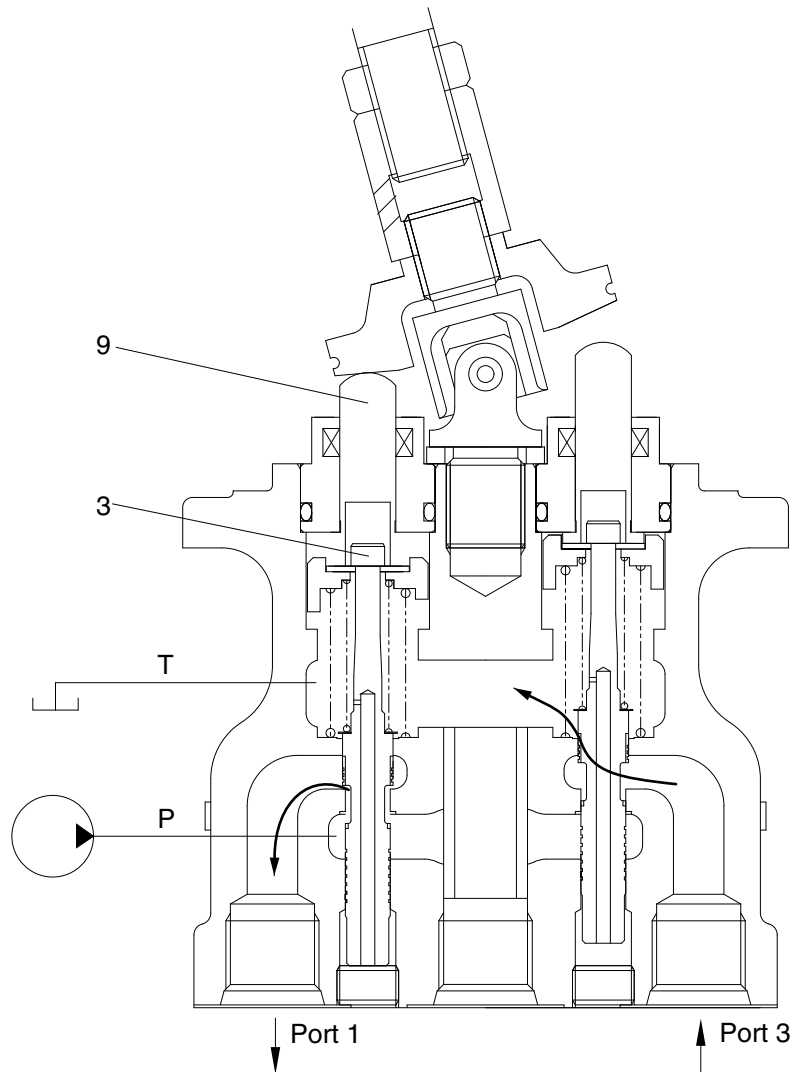


300L2RL03

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.

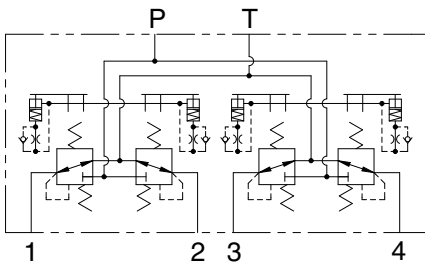
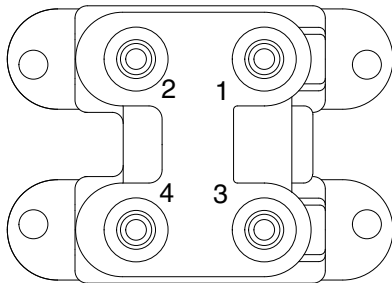
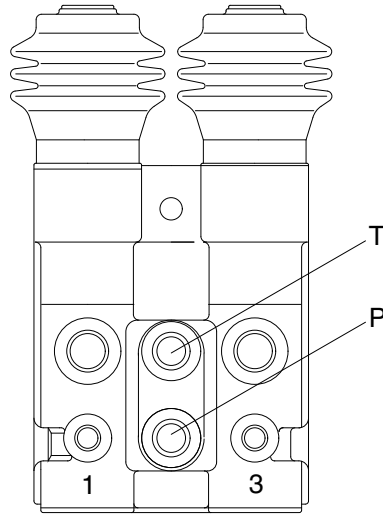
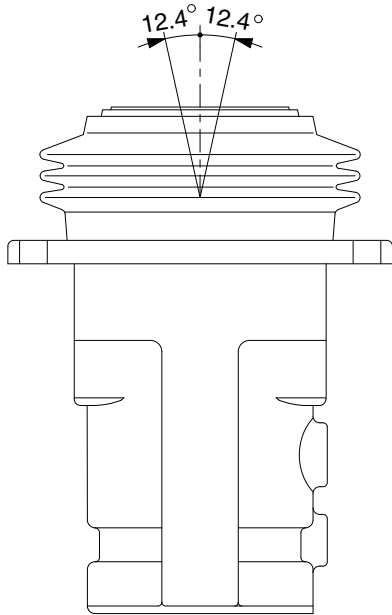
In this manner the secondary pressure is kept at the constant value.

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



Hydraulic circuit

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

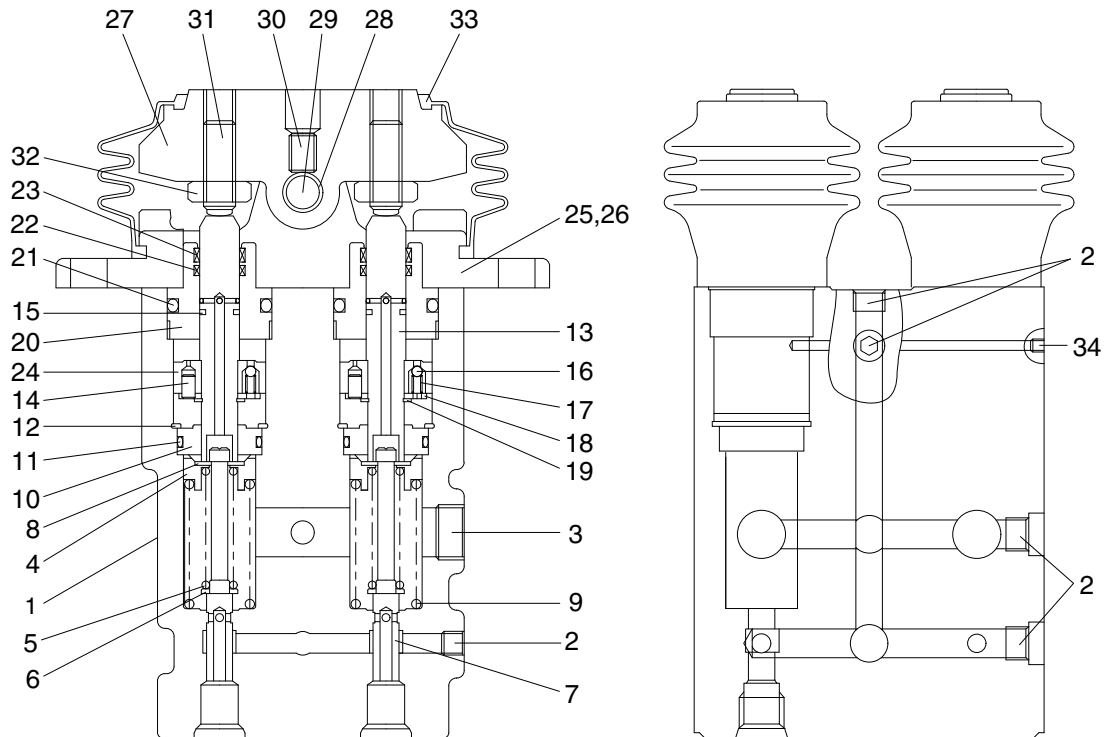
130ZF2RP01

## CROSS SECTION

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

The pressure reducing section is composed of the spool (7), spring (5) for setting secondary pressure, return spring (9), stopper (8), and spring seat (6). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is  $6.3 \pm 1$  to  $24.9 \pm 1.5$  kgf/cm<sup>2</sup> (depending on the type). The spool is pushed against the push rod (13) by the return spring.

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



130ZF2RP02

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

## 2. FUNCTION

### 1) FUNDAMENTAL FUNCTIONS

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

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

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

### 2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (8) are to receive the supply oil pressure from the hydraulic pump at its port P, and to change over oil paths to determine whether the pressure oil of port P is led to output ports 1, 2, 3 & 4 or the output spool to determine the output pressure.

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

The change the deflection of this spring, the push rod (13) is inserted and can slide in the plug (20). For the purpose of changing th displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

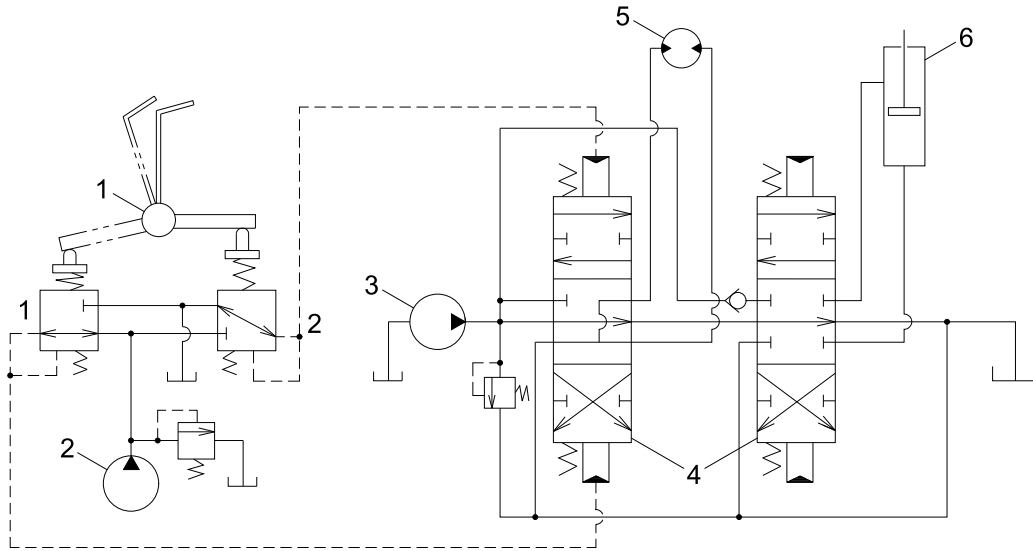
The spring (9) works on the body (1) and spring seat (6) and tries to return the push rod (13) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.



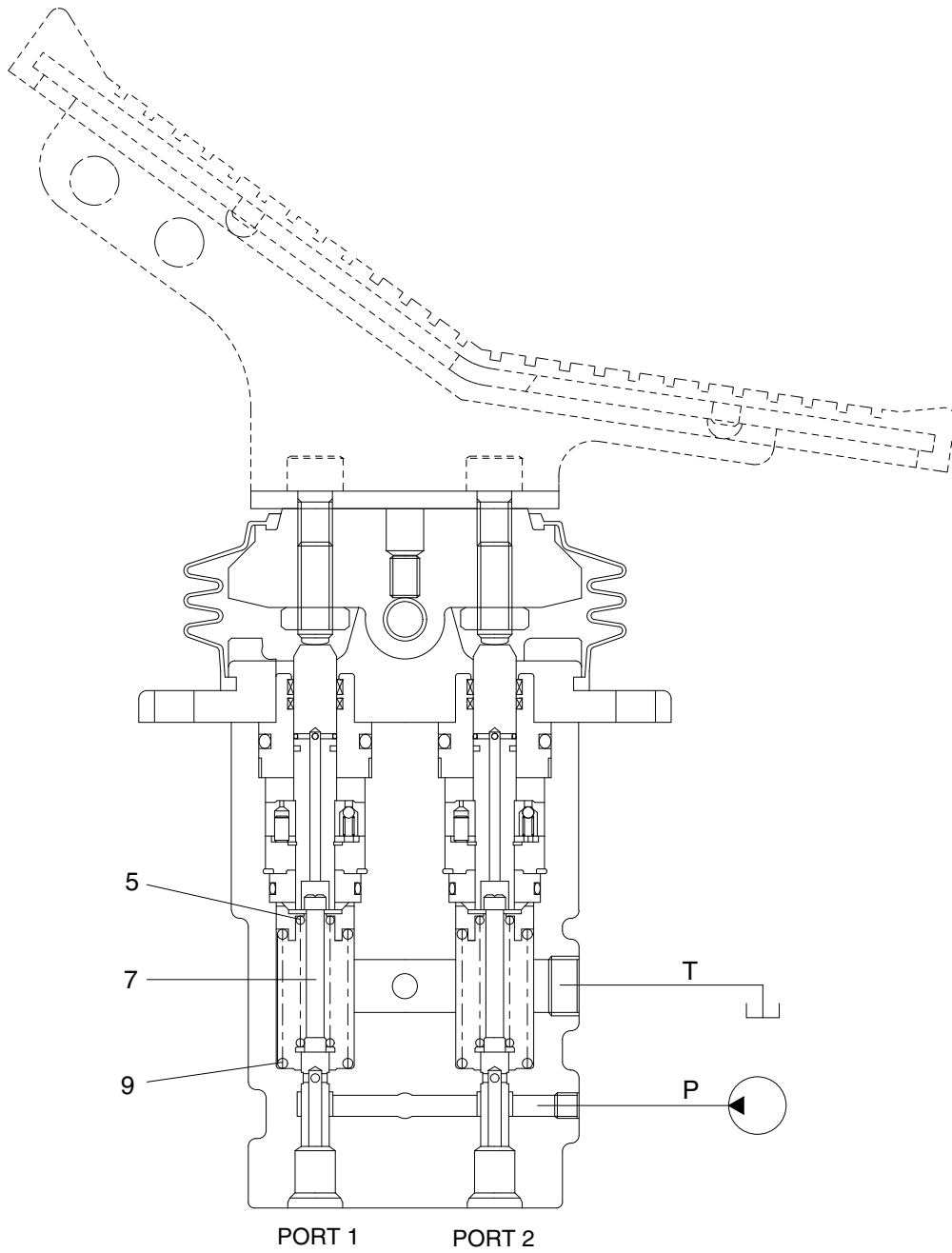
36072SF01

1 Pilot valve  
2 Pilot pump

3 Main pump  
4 Main control valve

5 Hydraulic motor  
6 Hydraulic cylinder

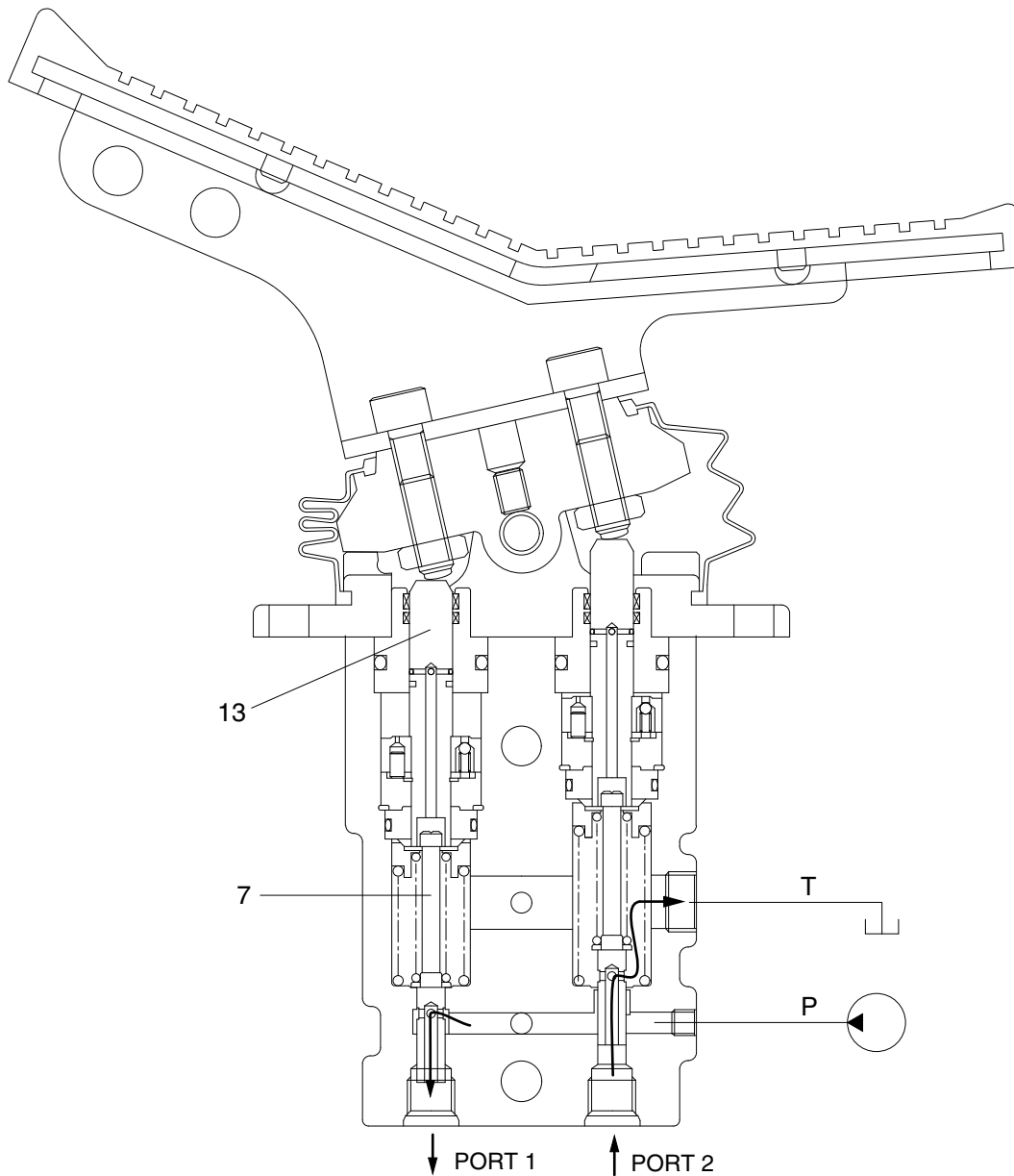
(1) Case where pedal is in neutral position



220SA2RP03

The force of the spring (5) that determines the output pressure of the pilot valve is not applied to the spool (7). Therefore, the spool is pushed up by the spring (9) to the position of port 1 and 2. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

## (2) Case where pedal is tilted



220SA2RP04

When the push rod (13) is stroked, the spool (7) moves downwards.

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

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

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

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