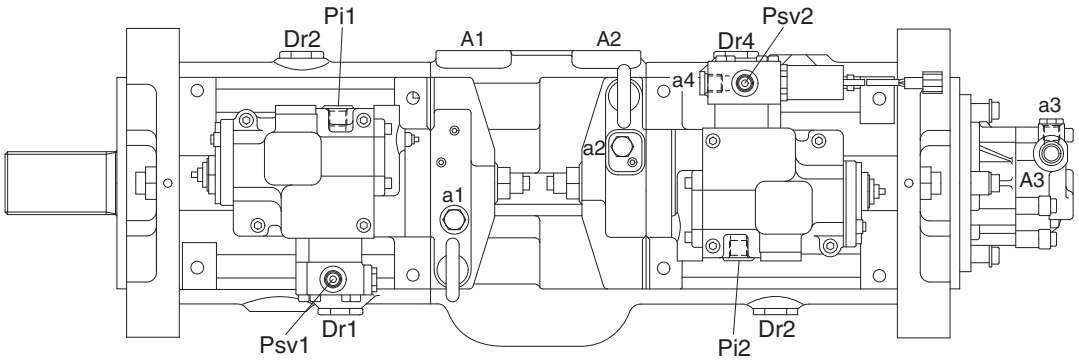
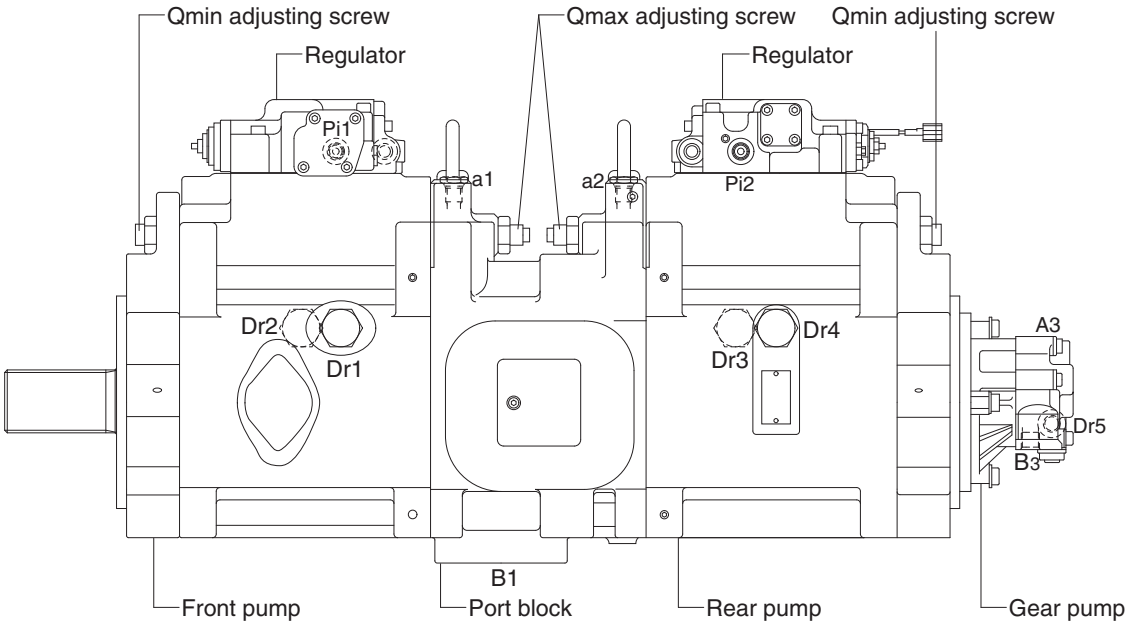
# SECTION 2 STRUCTURE AND FUNCTION

## GROUP 1 PUMP DEVICE

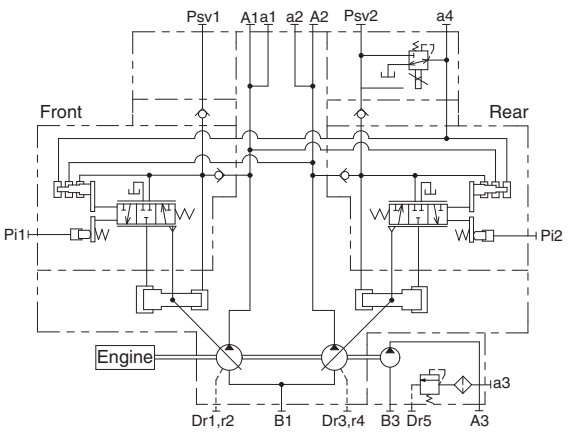
### 1. STRUCTURE

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



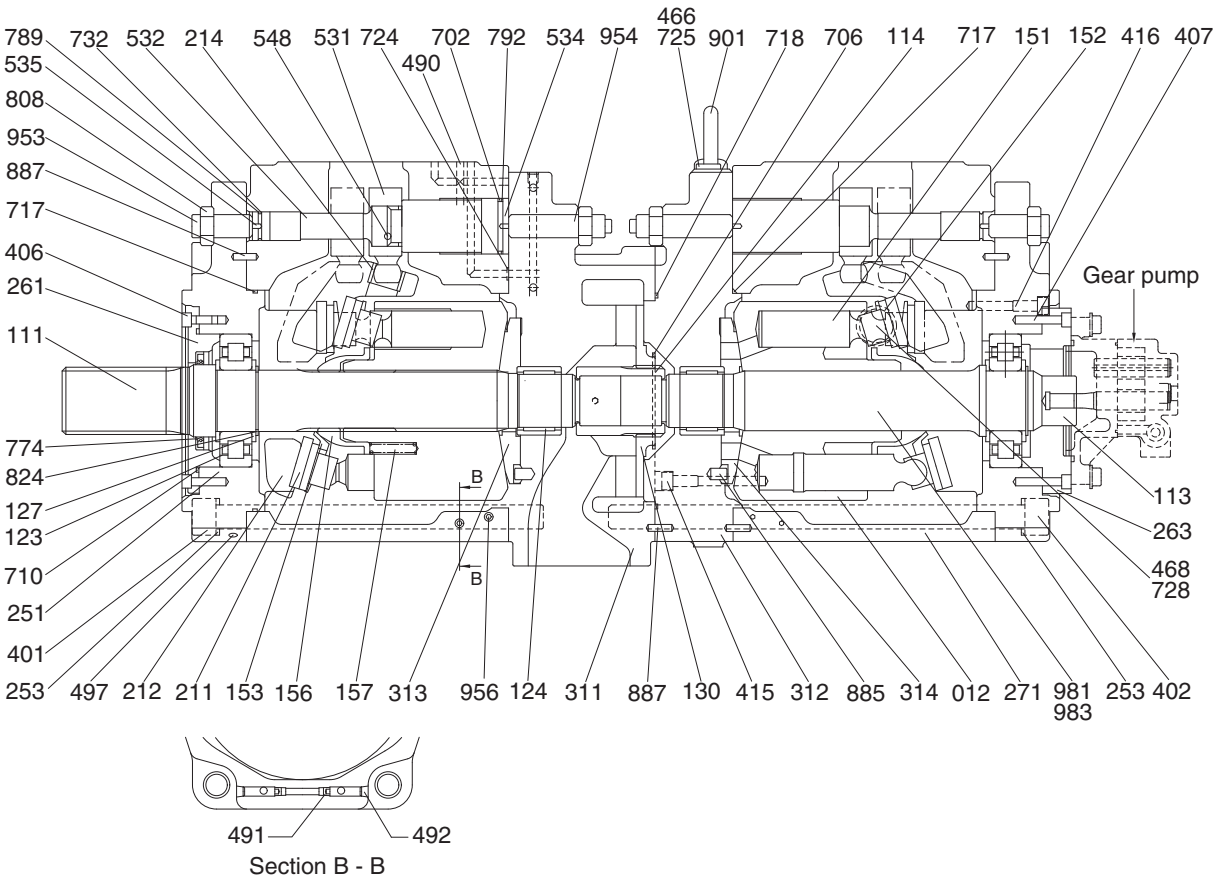

80092MP01




| Port | Port name | Port size |
|---|---|---|
| A1,A2 | Delivery port | SAE6000 psi 1 1/4" |
| B1 | Suction port | SAE2500 psi 3 1/2" |
| Dr1~Dr4 | Drain port | PF 3/4 - 23 |
| Pi1,Pi2 | Pilot port | PF 1/4 - 15 |
| Psv1, Psv2 | Servo assist port | PF 1/4 - 15 |
| a1, a2 | Gauge port | PF 1/4 - 15 |
| a3 | Gauge port | PF 1/4 - 14 |
| a4 | Gauge port | PF 1/4 - 13 |
| A3 | Gear delivery port | PF 1/2 - 19 |
| B3 | Gear suction port | PF 3/4 - 20.5 |
| Dr5 | Drain port | PF 3/8 - 15 |

## 1) MAIN PUMP (1/2)

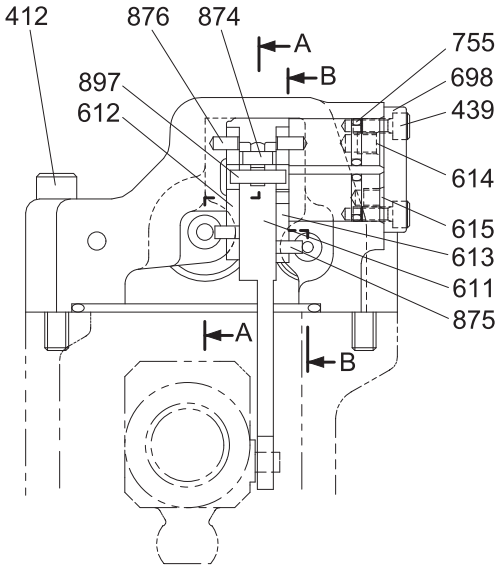
The main pump consists of two piston pumps (front & rear) and valve block.

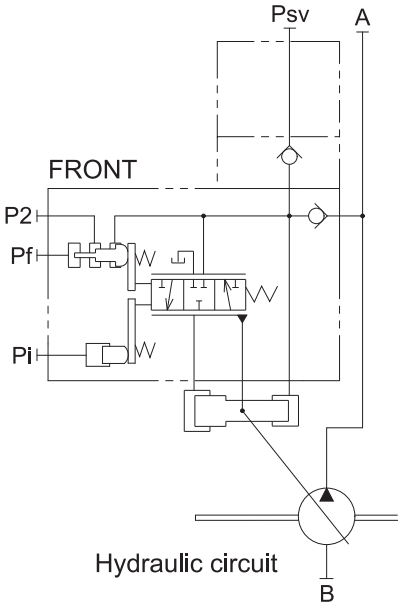


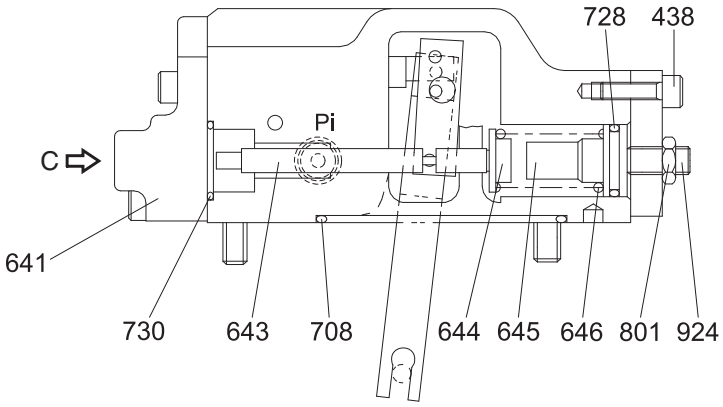

80092MP07

| | | | | | |
|---|---|---|---|---|---|
| 012 | Cylinder block | 311 | Valve cover (F) | 702 | O-ring |
| 111 | Drive shaft (F) | 312 | Valve cover (R) | 706 | O-ring |
| 113 | Driven shaft (R) | 313 | Valve plate (R) | 710 | O-ring |
| 114 | Coupling | 314 | Valve plate (L) | 717 | O-ring |
| 123 | Roller bearing | 401 | Hexagon socket bolt | 718 | O-ring |
| 124 | Needle bearing | 402 | Hexagon socket bolt | 724 | O-ring |
| 127 | Spacer | 406 | Hexagon socket bolt | 725 | O-ring |
| 130 | Booster | 407 | Hexagon socket bolt | 728 | O-ring |
| 151 | Piston | 415 | Hexagon socket bolt | 732 | O-ring |
| 152 | Shoe | 416 | Hexagon socket bolt | 774 | Oil seal |
| 153 | Plate | 466 | VP Plug | 789 | Back up ring |
| 156 | Bushing | 468 | VP Plug | 792 | Back up ring |
| 157 | Cylinder spring | 490 | VP Plug | 808 | Hexagon head nut |
| 211 | Shoe plate | 491 | Restrictor | 824 | Snap ring |
| 212 | Swash plate | 492 | VP Plug | 885 | Pin |
| 214 | Bushing | 497 | VP Plug | 887 | Spring pin |
| 251 | Support plate | 531 | Tilting pin | 901 | Eye bolt |
| 253 | Washer | 532 | Servo piston | 953 | Set screw |
| 261 | Seal cover (F) | 534 | Stopper (L) | 954 | Set screw |
| 263 | Seal cover (R) | 535 | Stopper (S) | 956 | Set screw |
| 271 | Pump casing | 548 | Feed back pin | | |

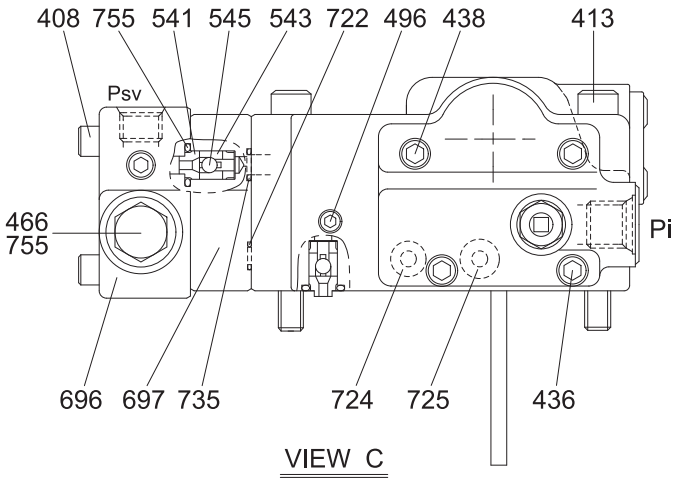
## 2) FRONT REGULATOR (1/2)




SECTION B-B

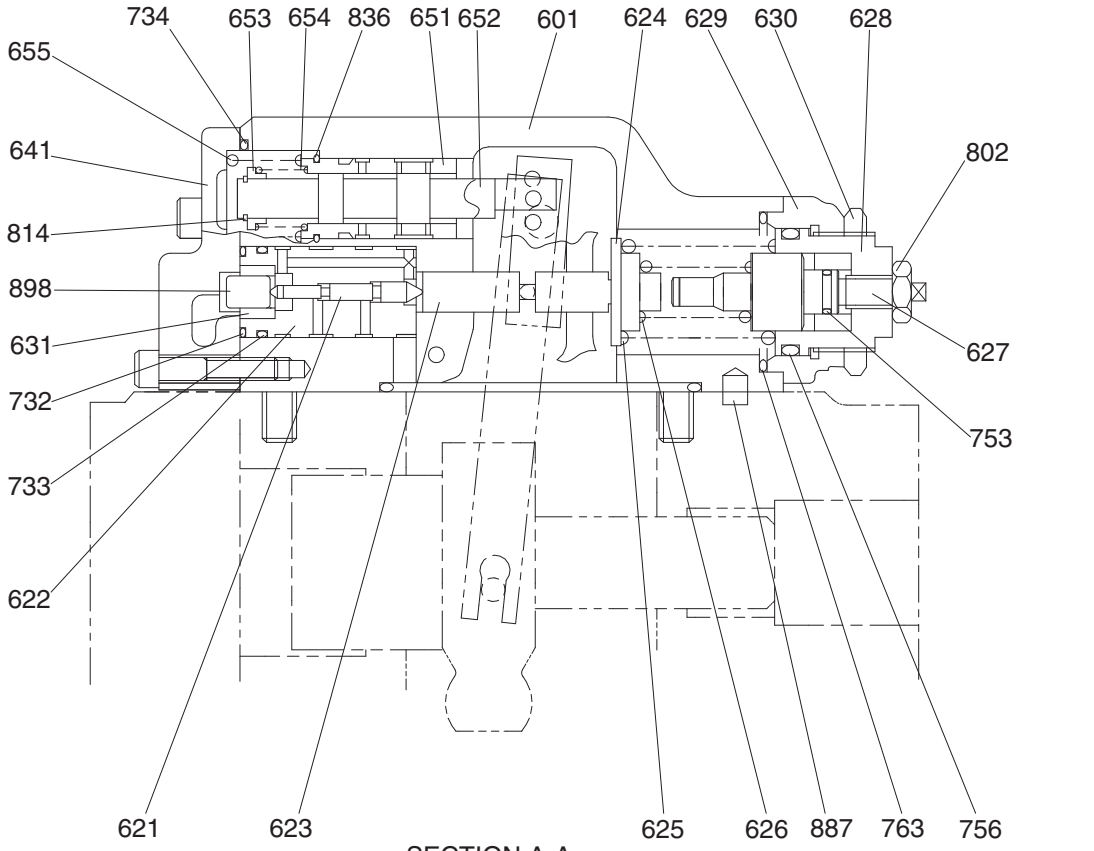



VIEW C

| Port | Port name | Port size |
|---|---|---|
| Pi | Pilot port | PF 1/4 - 15 |
| Psv | Servo assist port | PF 1/4 - 15 |
| P2 | Companion delivery pressure | - |
| Pf | Powershift pressure | - |

80092RG01

## FRONT REGULATOR (2/2)

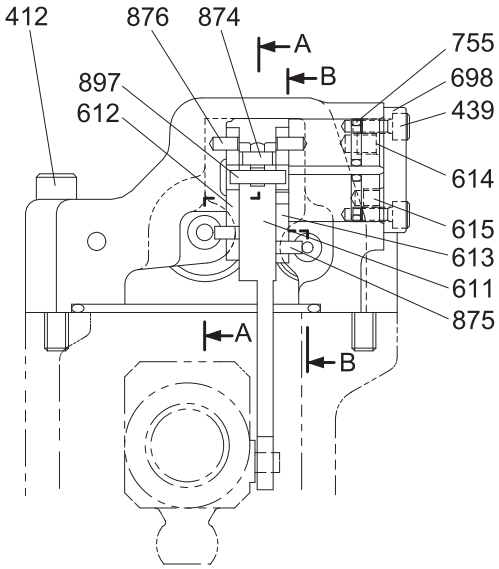


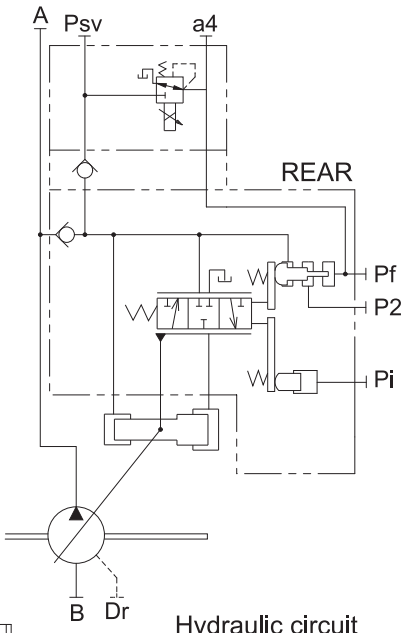

SECTION A-A

8007A2RG02

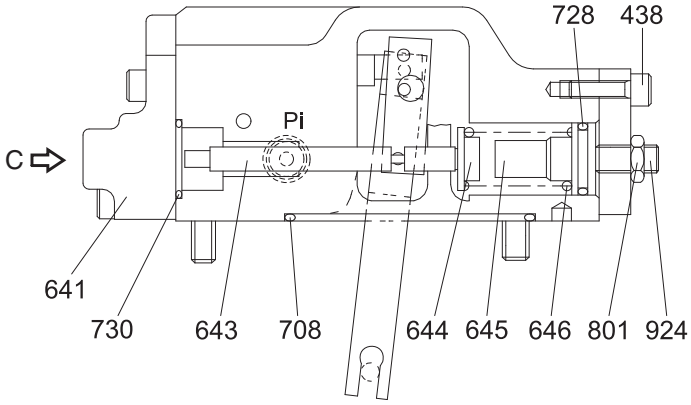
| | | | | | |
|---|---|---|---|---|---|
| 408 | Hexagon socket screw | 626 | Inner spring | 725 | O-ring |
| 412 | Hexagon socket screw | 627 | Adjust stem(C) | 728 | O-ring |
| 413 | Hexagon socket screw | 628 | Adjust screw(C) | 730 | O-ring |
| 436 | Hexagon socket screw | 629 | Cover(C) | 732 | O-ring |
| 438 | Hexagon socket screw | 630 | Lock nut | 733 | O-ring |
| 439 | Hexagon socket screw | 631 | Sleeve, pf | 734 | O-ring |
| 466 | Plug | 641 | Pilot cover | 735 | O-ring |
| 496 | Plug | 643 | Pilot piston | 753 | O-ring |
| 541 | Seat | 644 | Spring seat(Q) | 755 | O-ring |
| 543 | Stopper 1 | 645 | Adjust stem(Q) | 756 | O-ring |
| 545 | Steel ball | 646 | Pilot spring | 763 | O-ring |
| 601 | Casing | 651 | Sleeve | 801 | Nut |
| 611 | Feed back lever | 652 | Spool(A) | 802 | Nut |
| 612 | Lever(1) | 653 | Spring seat | 814 | Snap ring |
| 613 | Lever(2) | 654 | Return spring | 836 | Snap ring |
| 614 | Center plug | 655 | Set spring | 874 | Spring pin |
| 615 | Adjust plug | 696 | Port cover | 875 | Pin |
| 621 | Compensator piston | 697 | Check valve plate | 876 | Pin |
| 622 | Piston case | 698 | Cover | 887 | Pin |
| 623 | Compensator rod | 708 | O-ring | 897 | Pin |
| 624 | Spring seat(C) | 722 | O-ring | 898 | Pin |
| 625 | Outer spring | 724 | O-ring | 924 | Set screw |

### 3) REAR REGULATOR (1/2)

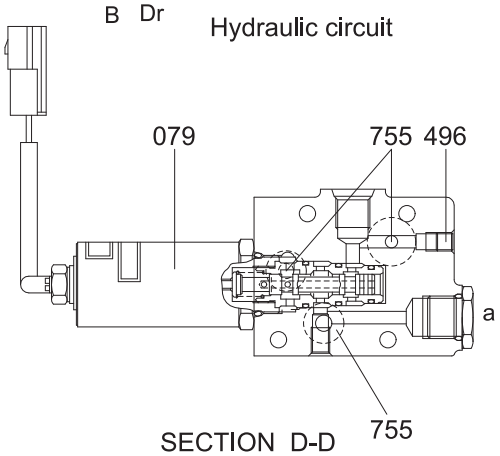


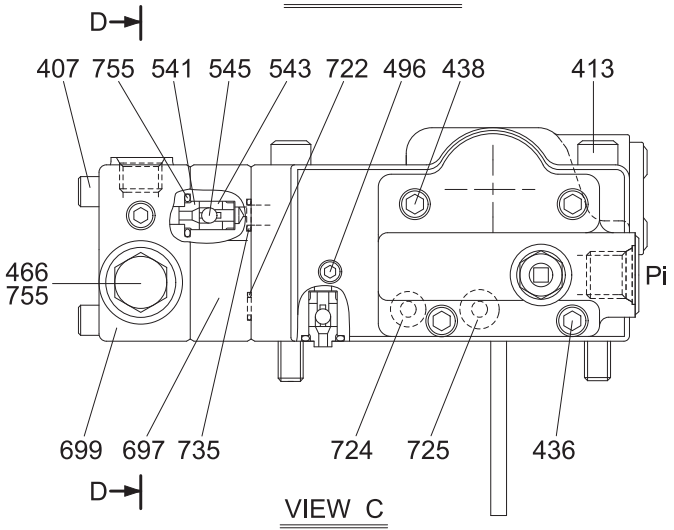

Hydraulic circuit




SECTION B-B




SECTION D-D

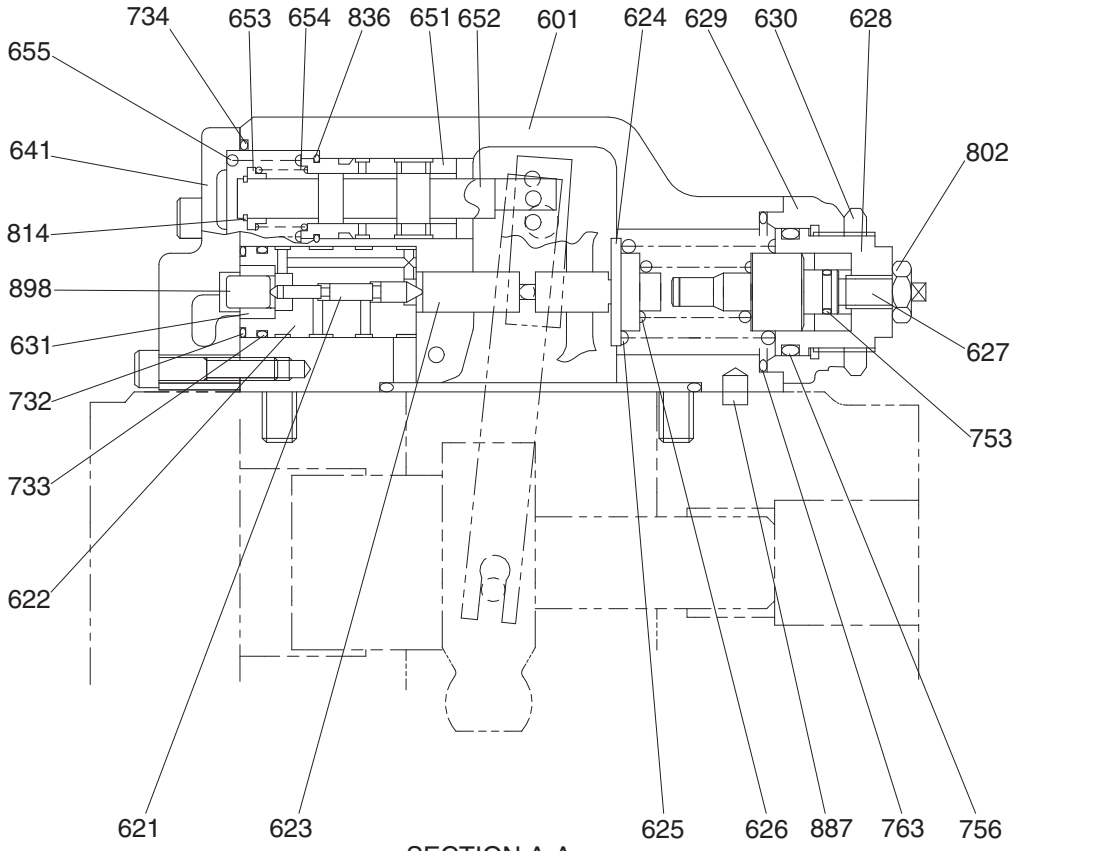



VIEW C

| Port | Port name | Port size |
|---|---|---|
| Pi | Pilot port | PF 1/4 - 15 |
| Psv | Servo assist port | PF 1/4 - 15 |
| P2 | Companion delivery pressure | - |
| Pf | Powershift pressure | - |
| a4 | Gauge port | PF 1/4 - 13 |

80092RG03

## REAR REGULATOR (2/2)

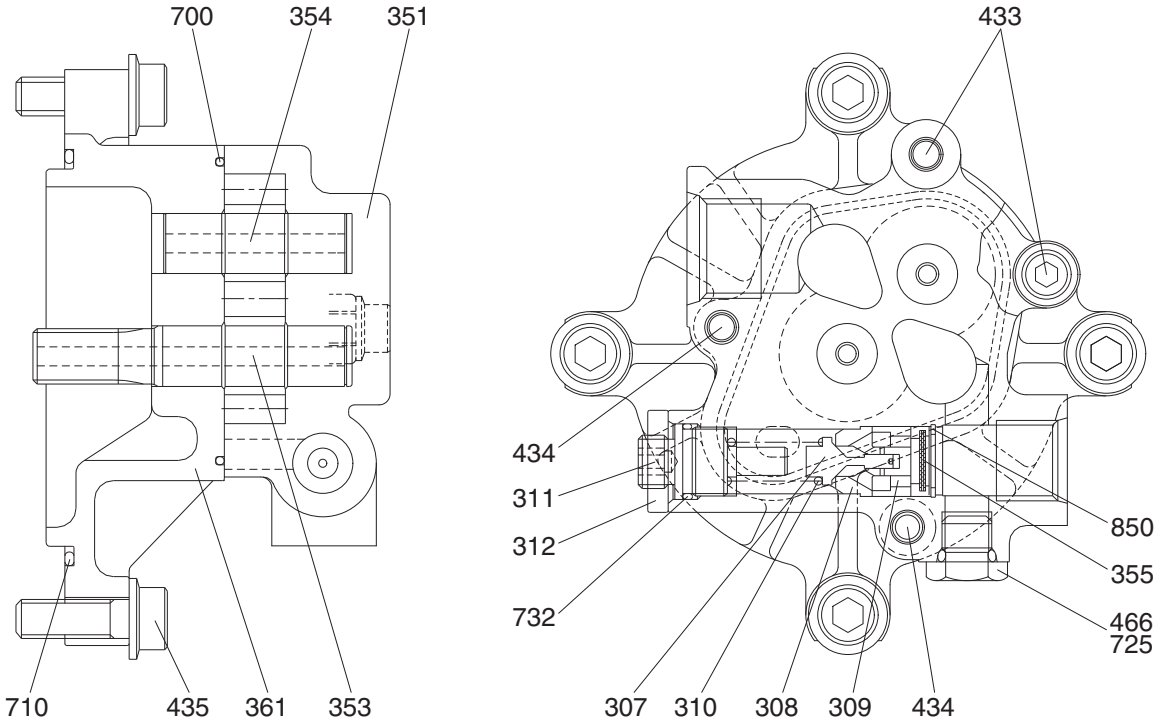



SECTION A-A

8007A2RG02

| | | | | | |
|---|---|---|---|---|---|
| 079 | EPPR valve | 626 | Inner spring | 728 | O-ring |
| 407 | Hexagon socket screw | 627 | Adjust stem (C) | 730 | O-ring |
| 412 | Hexagon socket screw | 628 | Adjust screw (C) | 732 | O-ring |
| 413 | Hexagon socket screw | 629 | Cover (C) | 733 | O-ring |
| 436 | Hexagon socket screw | 630 | Lock nut | 734 | O-ring |
| 438 | Hexagon socket screw | 631 | Sleeve, pf | 735 | O-ring |
| 439 | Hexagon socket screw | 641 | Pilot cover | 753 | O-ring |
| 466 | Plug | 643 | Pilot piston | 755 | O-ring |
| 496 | Plug | 644 | Spring seat (Q) | 756 | O-ring |
| 541 | Seat | 645 | Adjust stem (Q) | 763 | O-ring |
| 543 | Stopper | 646 | Pilot spring | 801 | Nut |
| 545 | Steel ball | 651 | Sleeve | 802 | Nut |
| 601 | Casing | 652 | Spool (A) | 814 | Snap ring |
| 611 | Feed back lever | 653 | Spring seat | 836 | Snap ring |
| 612 | Lever (1) | 654 | Return spring | 858 | Snap ring |
| 613 | Lever (2) | 655 | Set spring | 874 | Pin |
| 614 | Center plug | 697 | Check valve plate | 875 | Pin |
| 615 | Adjust plug | 698 | Cover | 876 | Pin |
| 621 | Compensator piston | 699 | Port cover | 887 | Pin |
| 622 | Piston case | 708 | O-ring | 897 | Pin |
| 623 | Compensator rod | 722 | O-ring | 898 | Pin |
| 624 | Spring seat (C) | 724 | O-ring | 924 | Set screw |
| 625 | Outer spring | 725 | O-ring | | |

## 4) GEAR PUMP




8007A2GP01

| | | | | | |
|---|---|---|---|---|---|
| 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 socket | 725 | O-ring |
| 311 | Screw | 433 | Flange socket | 732 | O-ring |
| 312 | Lock nut | 434 | Flange socket | 850 | Snap ring |
| 351 | Gear case | 435 | Flange socket | | |

## 2. FUNCTION

### 1) MAIN PUMP

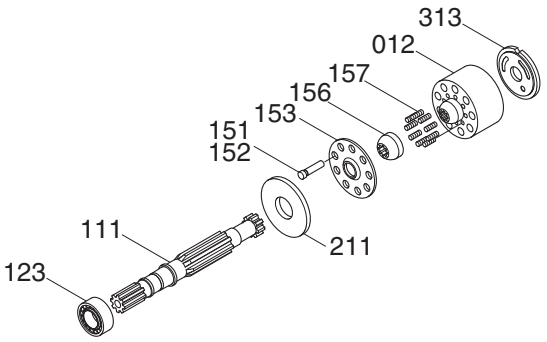
The pumps may classified roughly into the rotary group performing a rotary motion and working as the major part of the whole pump function: the swash plate group that varies the delivery rates: and the valve cover group that changes over oil suction and discharge.

#### (1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block (012), piston shoes (151,152), set plate (153), spherical bush (156), and cylinder spring (157).

The drive shaft is supported by bearing (123,124) at its both ends.

The shoe is caulked to the piston to from a spherical coupling. It has a pocket to relieve thrust force generated by loading pressure and the take hydraulic balance so that it slides lightly over the shoe plate (211). The sub group composed by a piston and a shoe is pressed against the shoe plate by the action of the cylinder spring via a retainer and a spherical bush. Similarly, the cylinder block is pressed against valve plate (313) by the action of the cylinder spring.

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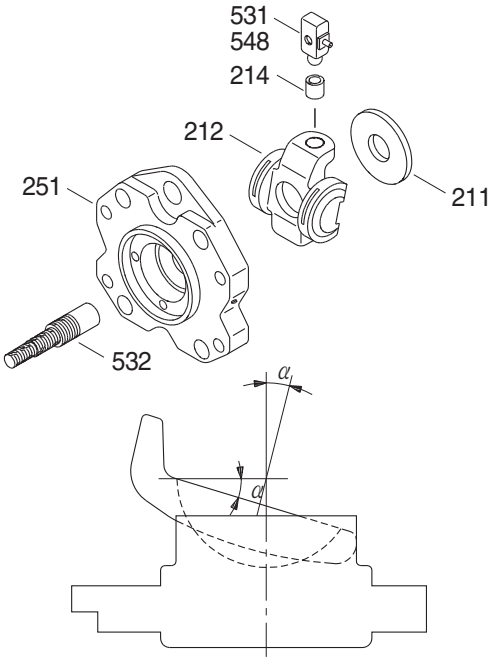
#### (2) Swash plate group

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 a cylindrical part formed on the opposite side of the sliding surface of the shoe and is supported by the swash support.

If the servo piston moves to the right and left as hydraulic force controlled by the regulator is admitted to hydraulic chamber located on both sides of the servo piston, the swash plate slides over the swash plate support via the spherical part of the tilting pin to change the tilting angle ( $\alpha$ ).




2-7 (210-7)

### (3) Valve cover group

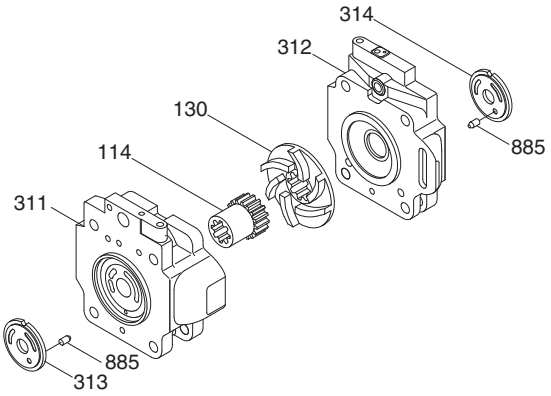
The valve cover group consists of valve cover (F, 311), valve cover (R, 312), valve plate (313, 314), spline coupling (114), booster (130) and valve plate pin (885).

The valve plate having two melon-shaped ports is fixed to the valve cover and feeds and collects oil to and from the cylinder cover.

The oil changed over by the valve plate is connected to an external pipeline by way of the valve cover.

Now, if the drive shaft is driven by a prime mover (electric motor, engine, etc), it rotates the cylinder block via a spline linkage at the same time. If the swash plate is tilted as in Fig (previous page) the pistons arranged in the cylinder block make a reciprocating motion with respect to the cylinder block, while they revolve with the cylinder block.

If you pay attention to a single piston, it performs a motion away from the valve plate (oil sucking process) within 180 degrees, and makes a motion towards the valve plate (or oil discharging process) in the rest of 180 degrees. When the swash plate has a tilting angle of zero, the piston makes no stroke and discharges no oil.




8007A2MP02

## 2) REGULATOR

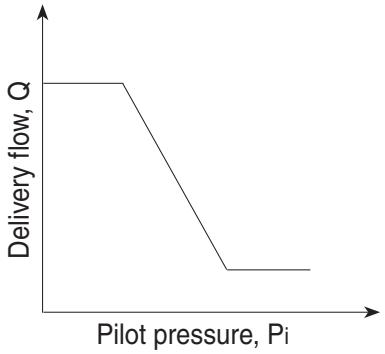
Regulator consists of the negative flow control, total horse power control and power shift control function.

### (1) Negative flow control

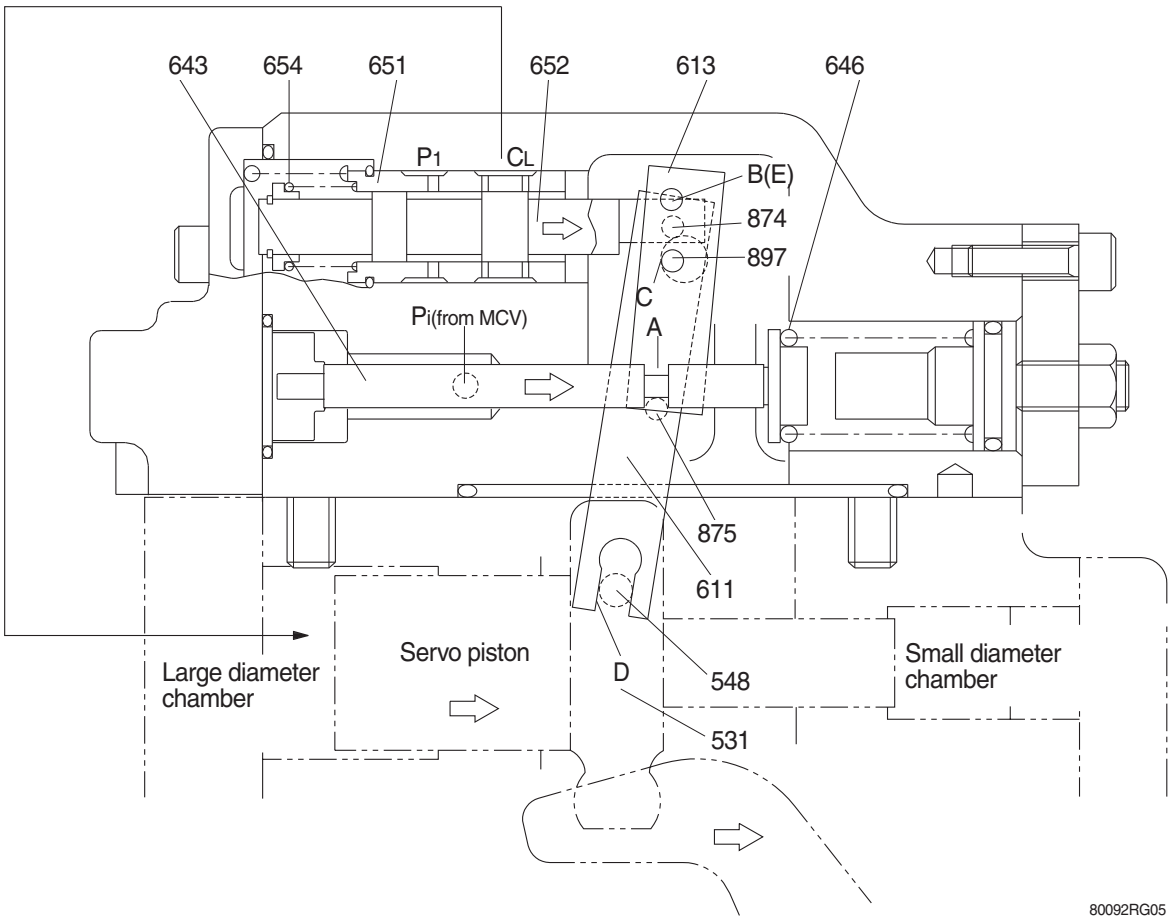
By changing the pilot pressure Pi, the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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



① Flow reducing function




As the pilot pressure Pi rises, the pilot piston (643) moves to the right to a position where the force of the pilot spring (646) balances with the hydraulic force.

The groove (A) in the pilot piston is fitted with the pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point B [Fixed by the fulcrum plug (614) and pin(875)]. Since the large hole section(C) of lever 2 contains a protruding pin (897) fixed to the feedback lever(611), the pin (897) moves to the right as lever 2 rotates. Since the opposing-flat section (D) of the feedback lever is fitted with the pin(548) fixed by the tilting pin (531) that swings the swash plate, the feedback lever rotates around the fulcrum of point D, as the pin (897) moves.

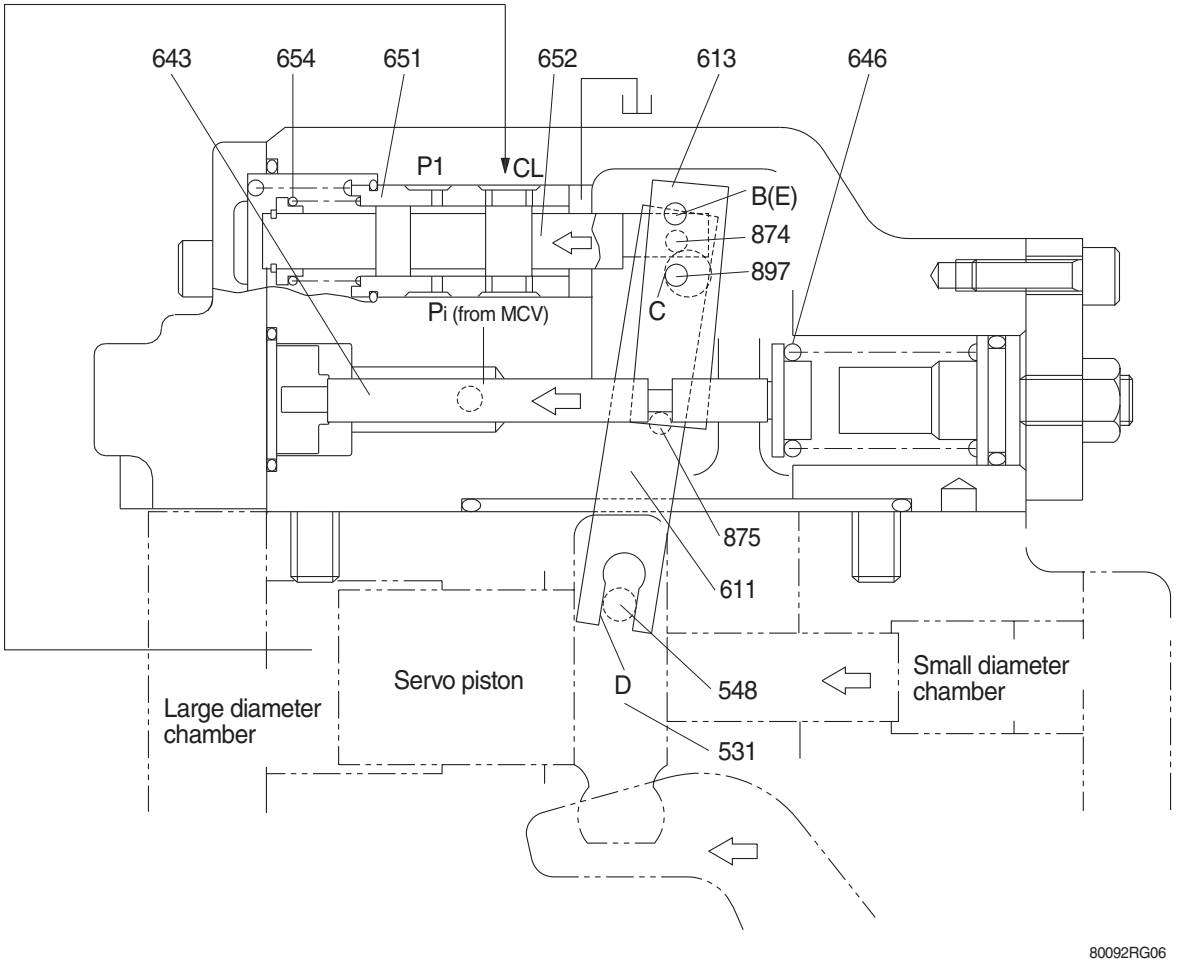
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

The movement of the spool causes the delivery pressure P1 to connect to port CL through the spool and to be admitted to the large diameter section of the servo piston. The delivery pressure P1 that is constantly admitted to the small diameter section of the servo piston moves the servo piston to the right due to the area difference, resulting in decrease of the tilting angle.

When the servo piston moves to the right, point D also moves to the right. The spool is fitted with the return spring (654) and is tensioned to the left at all times, and so the pin (897) is pressed against the large hole section (C) of lever 2.

Therefore, as point D moves, the feedback lever rotates around the fulcrum of point C, and the spool is shifted to the left. This causes the opening between the sleeve (651) and spool (652) to close slowly, and the servo piston comes to a complete stop when it closes completely.

② Flow increasing function

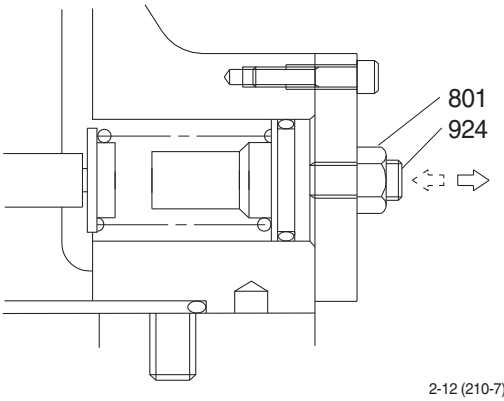



As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the left. Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P1 in the small diameter section, resulting in an increase in the flow rate.

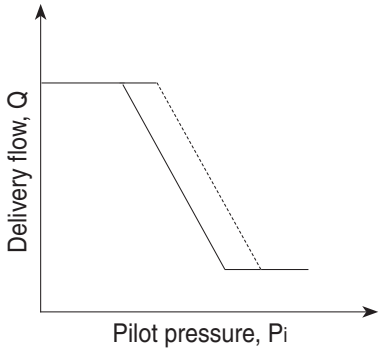
As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

### ③ Adjustment of flow control characteristic

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




2-12 (210-7)




### ※ Adjusting values are shown in table.

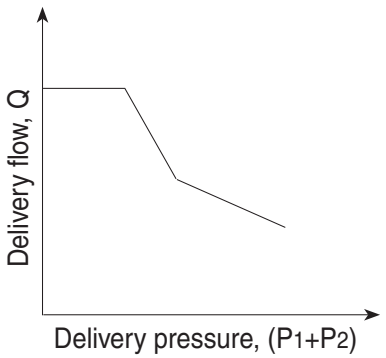
| Speed | Adjustment of flow control characteristic | | |
|---|---|---|---|
| | Tightening amount of adjusting screw (924) | Flow control starting pressure change amount | Flow change amount |
| (min $^{-1}$) | (Turn) | (kgf/cm$^2$) | ( ℓ /min) |
| 1800 | +1/4 | +1.3 | +30.2 |

### (2) Total horsepower control

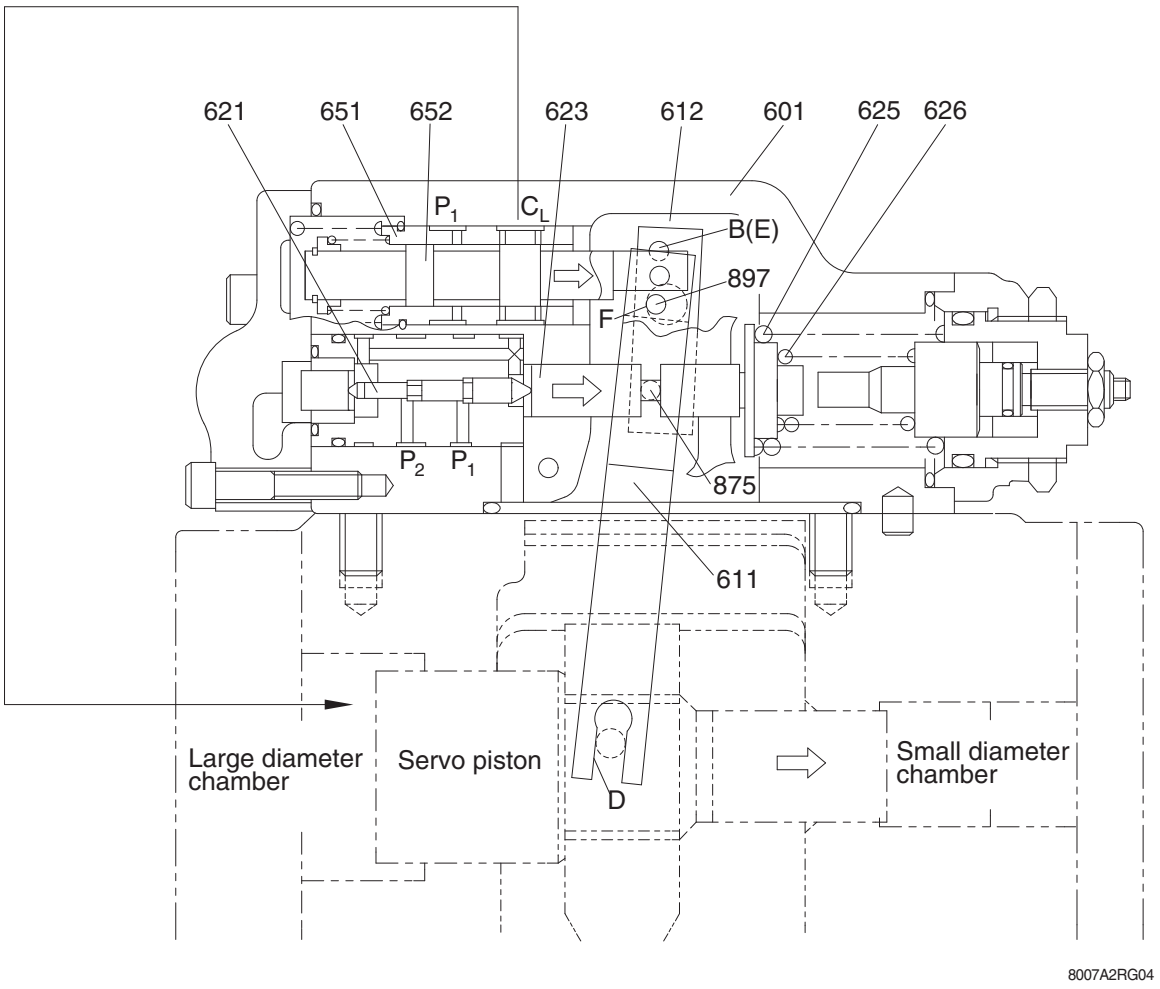
The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump.
(The input horsepower is constant when the speed is constant.)
Since the regulator is of the simultaneous total horsepower type that operates by the sum of load pressures of the two pumps in the tandem double-pump system, the prime mover is automatically prevented from being overloaded, irrespective of the load condition of the two pumps, when horsepower control is under way.
Since this regulator is of the simultaneous total horsepower type, it controls the tilting angles (displacement volumes) of the two pumps to the same value as represented by the following equation :

$$Tin = P1 \times q/2\pi + P2 \times q/2\pi$$
$$= (P1+P2) \times q/2\pi$$

The horsepower control function is the same as the flow control function and is summarized in the following. (For detailed behaviors of respective parts, refer to the section of flow control).



① Overload preventive function



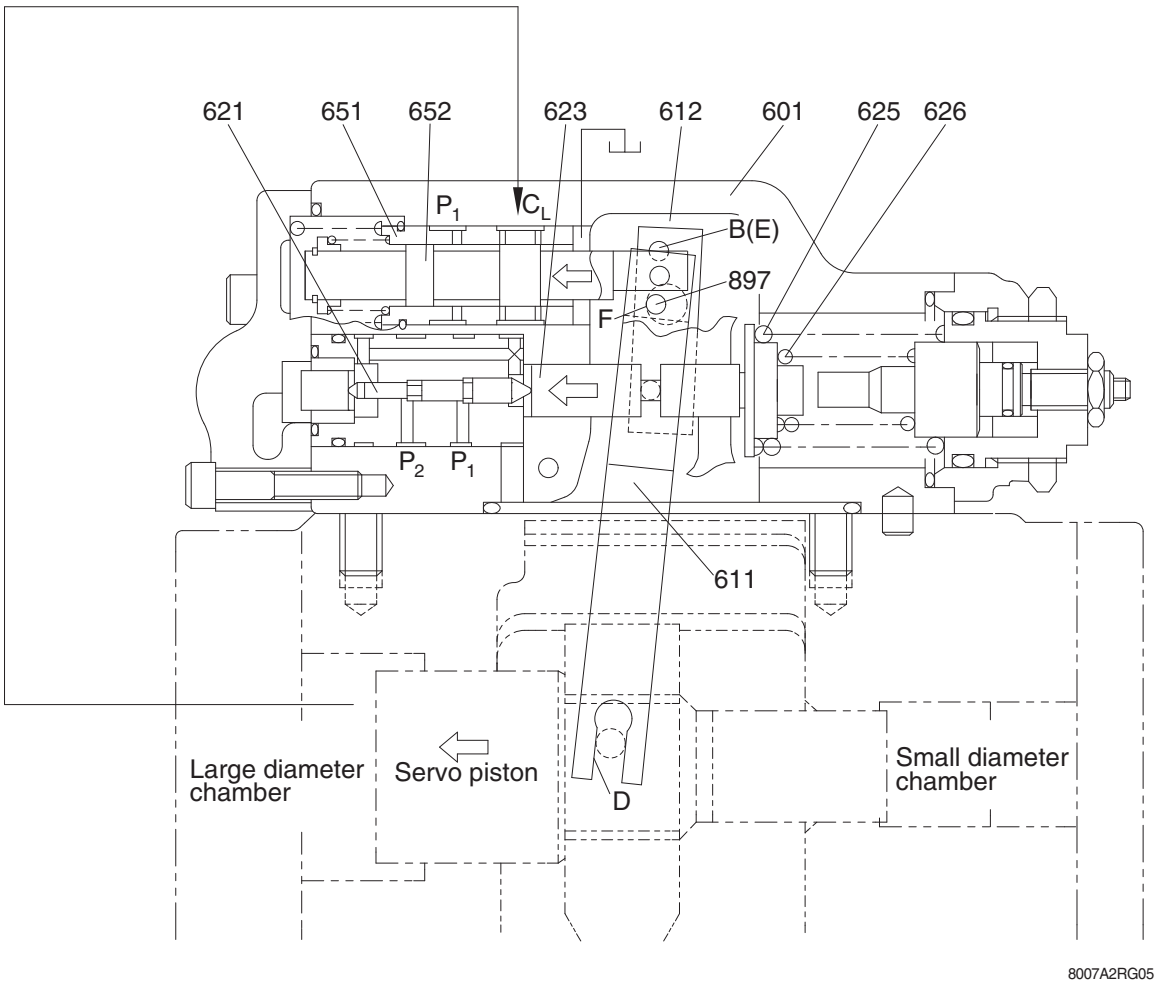

When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1 (612) via pin (875).

Lever 1 rotates around the pin (875) (E) fixed to the casing (601).

Since the large hole section (F) of lever 1 contains a protruding pin (897) fixed to the feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded.

The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool (652) and sleeve (651) is closed.

② Flow reset function




As the self pump delivery pressure P1 or the companion pump delivery pressure P2 decreases, the compensating rod (623) is pushed back by the action of the springs (625 & 626) to rotate lever 1 (612) around point E. Rotating of lever 1 causes the feedback lever (611) to rotate around the fulcrum of point D and then the spool (652) to move to the left. As a result, port CL opens a way to the tank port.

This causes the servo piston to move to the left and the pump's delivery rate to increase.

The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

### ③ Low tilting angle (low flow) command preferential function

As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins (Ø4) protruding from the large hole (Ø8), only the lever lessening the tilting angle contacts the pin (897) ; the hole (Ø8) in the lever of a larger tilting angle command is freed without contacting the pin (897). Such a mechanical selection method permits preference of the lower tilting angle command of the flow control and horsepower control.

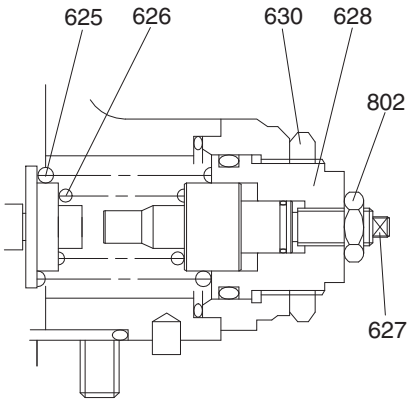
### ④ Adjustment of input horsepower

Since the regulator is of total cumulative horsepower type, adjust the adjusting screws of both the front and rear pumps, when changing the horsepower set values. The pressure change values by adjustment are based on two pumps pressurized at the same time, and the values will be doubled when only one pump is loaded.

#### a. Adjustment of outer spring

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628).

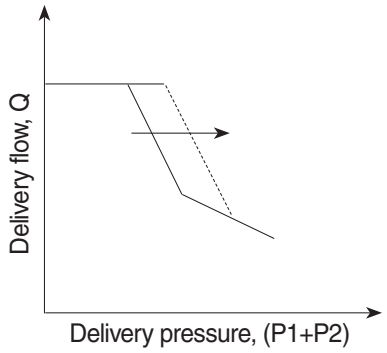
Tightening the screw shifts the control chart to the right and increases the input horse-power as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting stem QI (627) by N×A turns at first. (A=1.81)




8007A2MP03

#### ※ Adjusting values are shown in table.

| Speed | Adjustment of outer spring | | |
|---|---|---|---|
| | Tightening amount of adjusting screw (C) (928) | Compens-ating control starting pressure change amount | Flow change amount |
| (min $^{-1}$) | (Turn) | (kgf/cm$^2$) | ( ℓ /min) |
| 1800 | +1/4 | +17.7 | +14.2 |



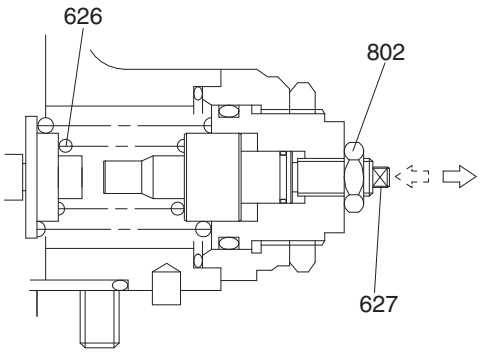
**b. Adjustment of inner spring**

Adjust it by loosening the hexagon nut (802) and by tightening (or loosening) the adjusting stem QI (627).

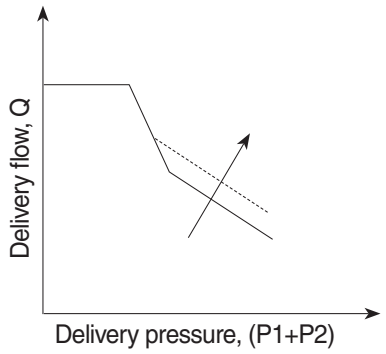
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

**※ Adjusting valves are shown in table.**

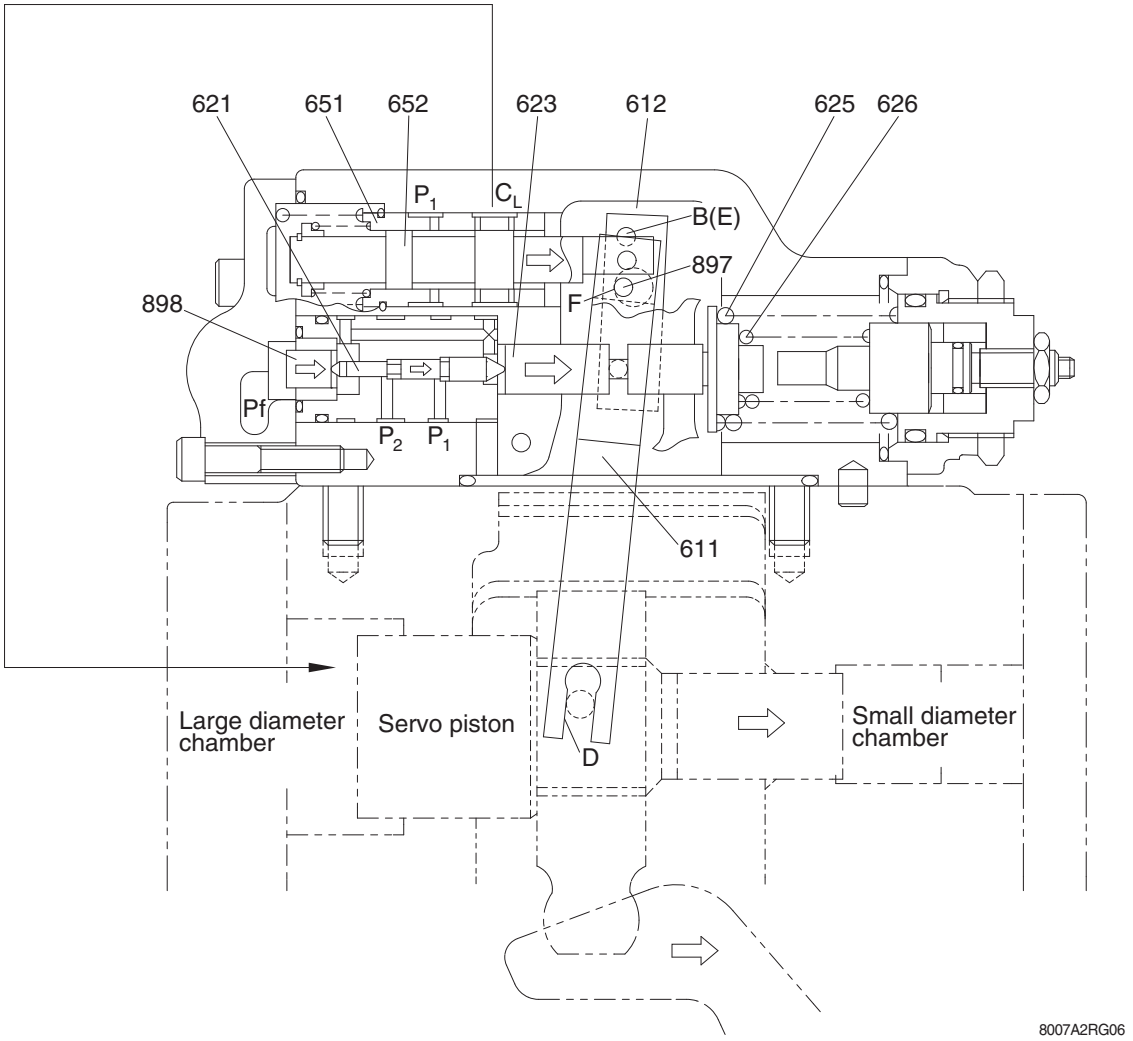
| Speed | Adjustment of outer spring | | |
|---|---|---|---|
| | Tightening amount of adjusting stem (QI) (627) | Flow change amount | Input torque change amount |
| (min $^{-1}$) | (Turn) | (kgf/cm$^2$) | ( ℓ /min) |
| 1800 | +1/4 | +22.8 | +11.4 |



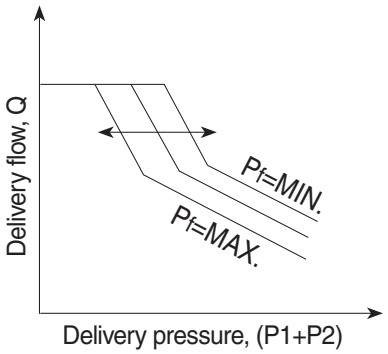

8007A2MP04



### (3) Power shift control




The set horsepower valve is shifted by varying the command current level of the proportional pressure reducing valve attached to the pump.
Only one proportional pressure reducing valve is provided. However, the secondary pressure Pf (power shift pressure) is admitted to the horsepower control section of each pump regulator through the pump's internal path to shift it to the same set horsepower level.




This function permits arbitrary setting of the pump output power, thereby providing the optimum power level according to the operating condition.
The power shift pressure Pf controls the set horsepower of the pump to a desired level, as shown in the figure.
As the power shift pressure Pf rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621).
This decreases the pump tilting angle and then the set horsepower in the same way as explained in the overload preventive function of the horsepower control. On the contrary, the set horsepower rises as the power shift pressure Pf falls.

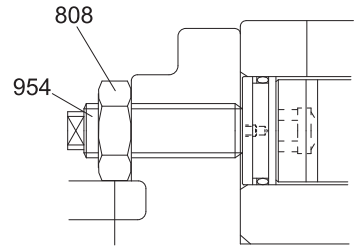
### (4) Adjustment of maximum and minimum flows

#### ① Adjustment of maximum flow

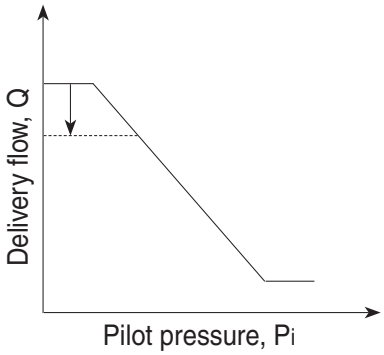
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

The maximum flow only is adjusted without changing other control characteristics.

| Speed | Adjustment of max flow | |
|---|---|---|
| | Tightening amount of adjusting screw (954) | Flow change amount |
| (min $^{-1}$) | (Turn) | ( ℓ /min) |
| 1800 | +1/4 | -9.2 |




8007A2MP06



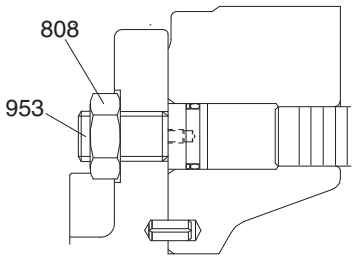

#### ② Adjustment of minimum flow

Adjust it by loosening the hexagon nut (808) and by tightening(or loosening) the hexagonal socket head set screw (953).

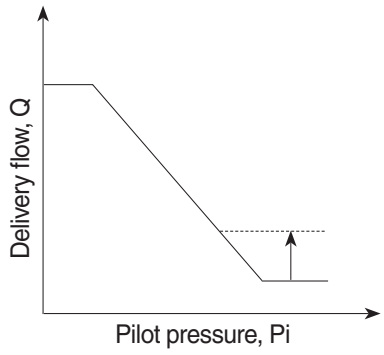
Similarly to the adjustment of the maximum flow, other characteristics are not changed.

However, remember that, if tightened too much, the required horsepower during the maximum delivery pressure (or during relieving) may increase.

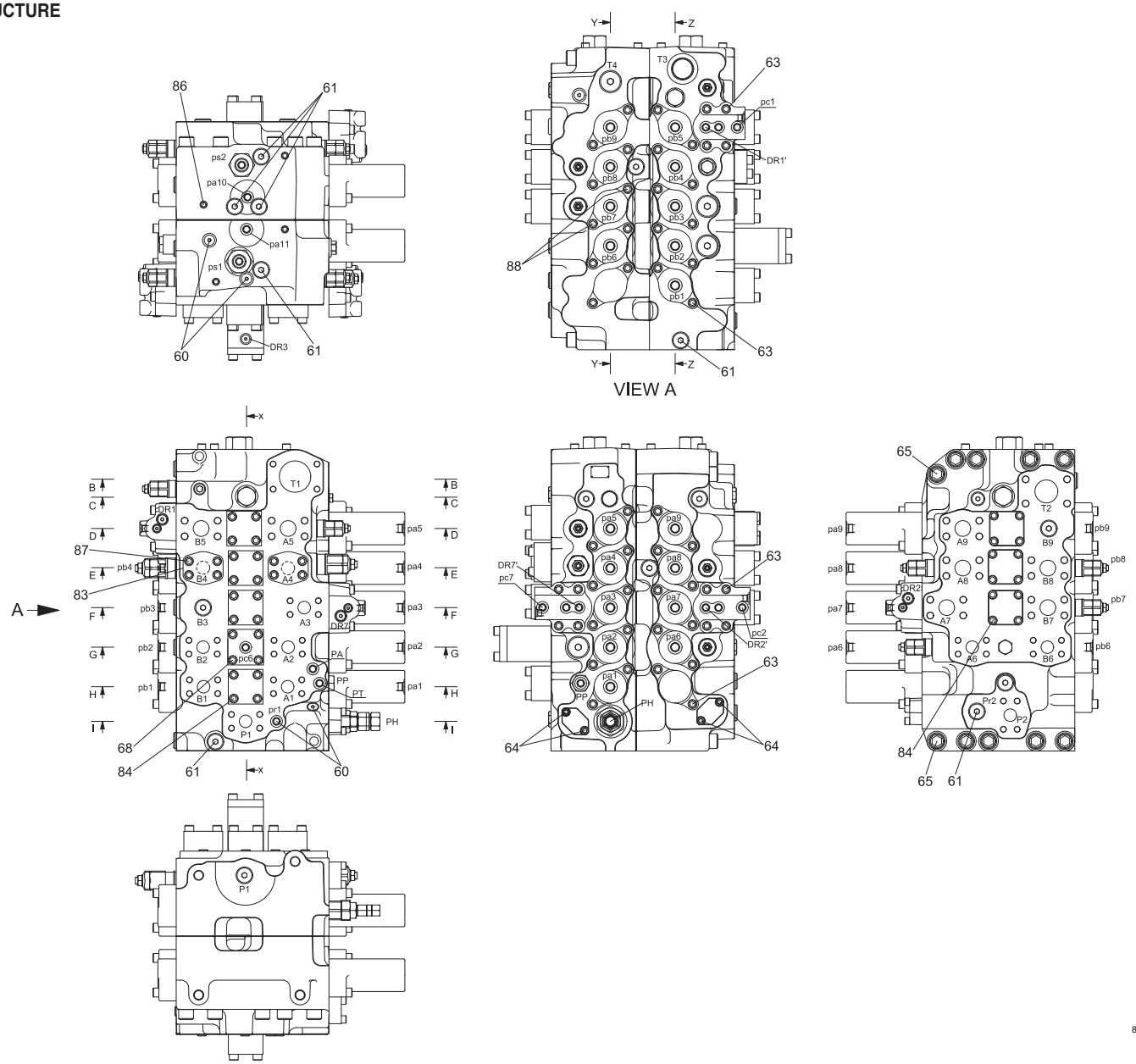
| Speed | Adjustment of min flow | |
|---|---|---|
| | Tightening amount of adjusting screw (953) | Flow change amount |
| (min $^{-1}$) | (Turn) | ( ℓ /min) |
| 1800 | +1/4 | +9.2 |




8007A2MP05

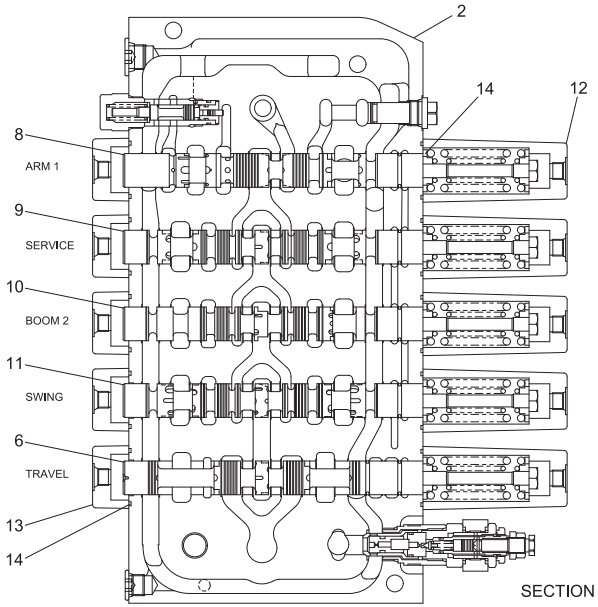


## 1. STRUCTURE

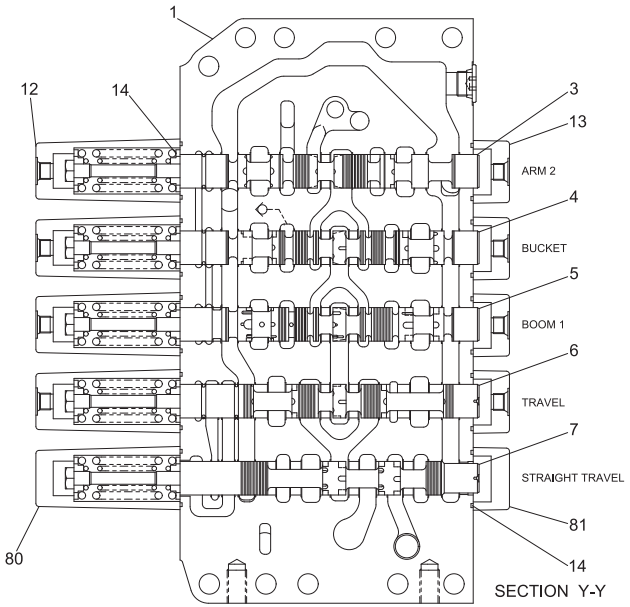



| Mark | Port size | Thread depth (mm) |
|---|---|---|
| DR1, DR2, DR3, DR1', DR2', DR7', pr1, ps1, ps2, pc1, pc2, pc6, pc7, pa10, pa11, PA, PP, PH | PF 1/4 | 12 |
| pa1~pa9, pb1~pb9 | PF 3/8 | 14 |
| pr2 | PF 1/2 | 16 |
| T3, T4 | PF 3/4 | 17 |

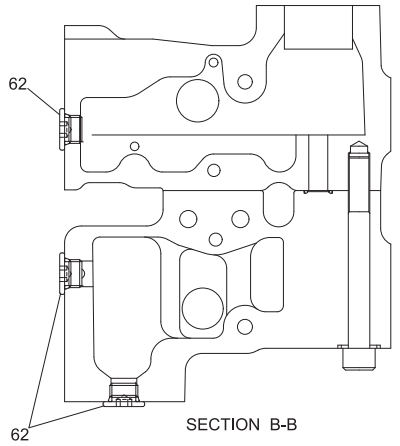
| | | | |
|---|---|---|---|
| 1 | Valve housing | 41 | Back up ring |
| 2 | Valve housing | 42 | Body |
| 3 | Spool assy(AM2) | 43 | Piston |
| 4 | Spool assy(BKT) | 44 | Flange |
| 5 | Spool assy(BM1) | 45 | O-ring |
| 6 | Spool assy(TR) | 46 | Poppet |
| 7 | Spool assy(S/TR) | 47 | Body assy |
| 8 | Spool assy(AM1) | 48 | Relief valve kit |
| 9 | Spool assy(SER) | 49 | Relief valve kit |
| 10 | Spool assy(BM2) | 50 | Relief valve assy |
| 11 | Spool assy(SW) | 51 | Plug assy |
| 12 | Cap | 52 | Poppet |
| 13 | Cap | 53 | Spring |
| 14 | O-ring | 54 | Plug |
| 15 | Poppet | 55 | O-ring |
| 16 | Spring | 56 | Flange |
| 17 | Spacer | 58 | Plug assy |
| 18 | O-ring | 59 | Plug assy |
| 19 | Back up ring | 60 | Plug assy |
| 20 | Spool assy | 61 | Plug assy |
| 21 | Spring seat(A) | 62 | Plug assy |
| 22 | Spring | 63 | Socket head bolt |
| 23 | Plug | 64 | Socket head bolt |
| 24 | Spool assy | 65 | Socket head bolt |
| 25 | Spring | 68 | Socket head bolt |
| 26 | O-ring | 69 | Poppet |
| 27 | Plug | 72 | Relief valve kit |
| 28 | Poppet | 73 | Relief valve kit |
| 29 | Spring | 76 | O-ring |
| 30 | Poppet | 77 | O-ring |
| 31 | Poppet | 78 | O-ring |
| 32 | Poppet | 79 | O-ring |
| 33 | Spring | 80 | Cap |
| 34 | Flange | 81 | Cap |
| 35 | O-ring | 82 | Steel ball |
| 36 | Poppet assy | 84 | Socket head bolt |
| 37 | Spring | 86 | Socket head bolt |
| 38 | Sleeve | 87 | Socket head bolt |
| 39 | Piston | 92 | Flange |
| 40 | O-ring | 93 | O-ring |



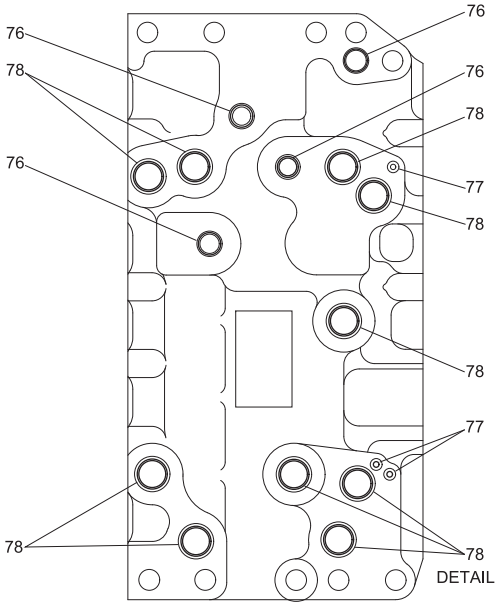

SECTION Z-Z



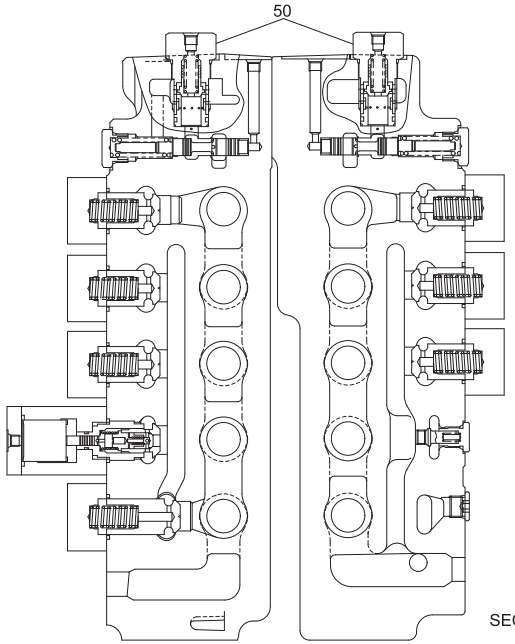

SECTION Y-Y



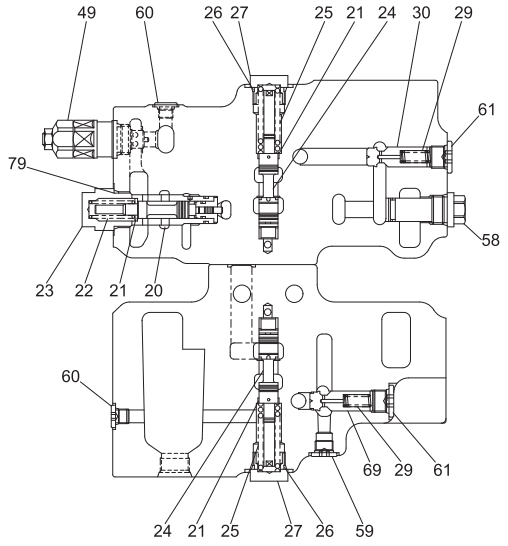

SECTION B-B




DETAIL OF COMBINED PLANE

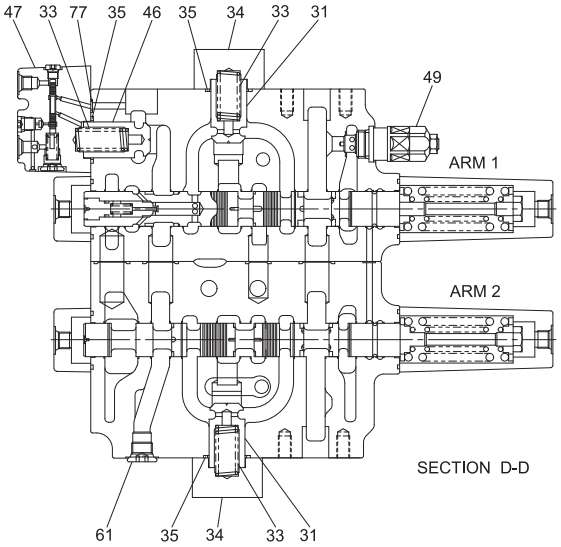


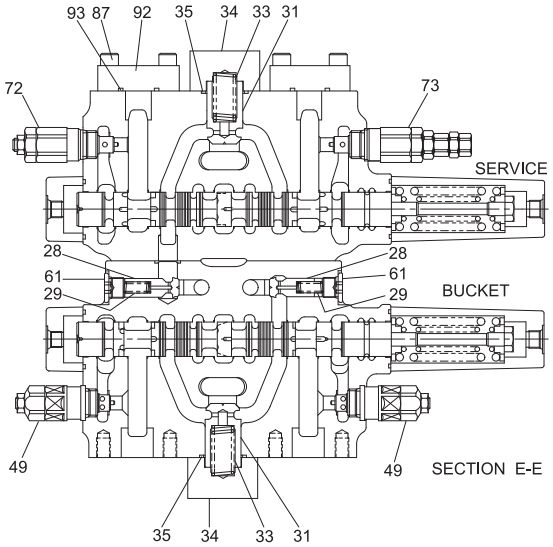

SECTION X-X

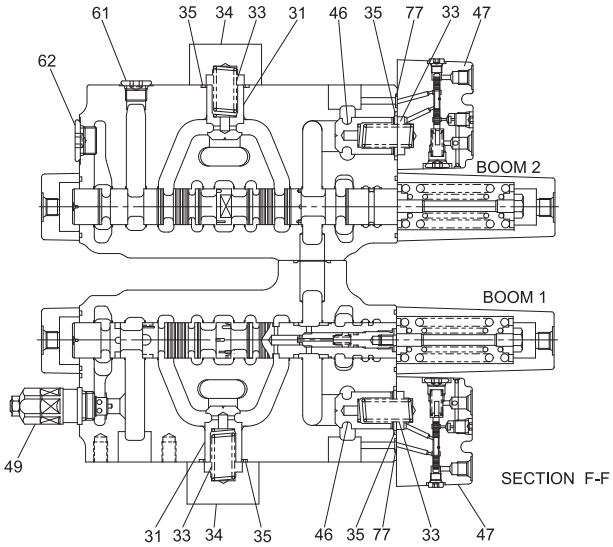


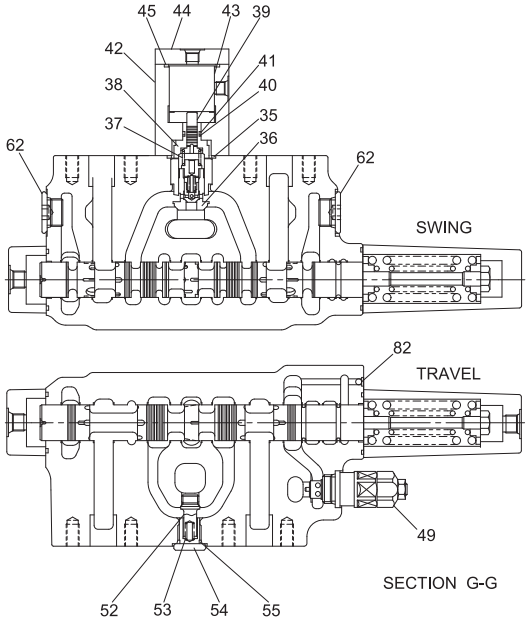

SECTION C-C

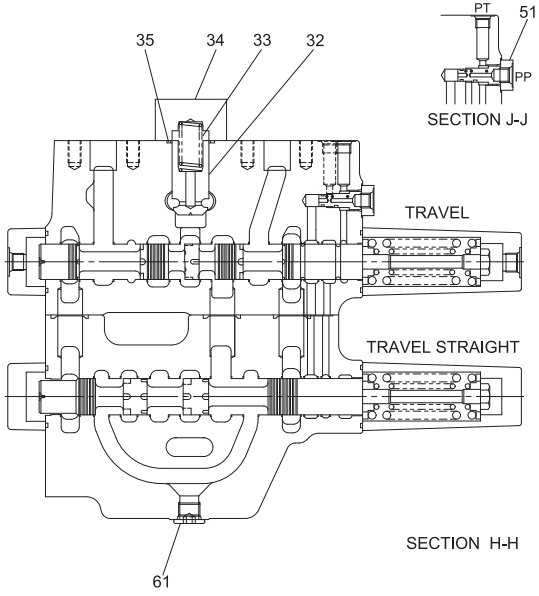
8007A2MC02

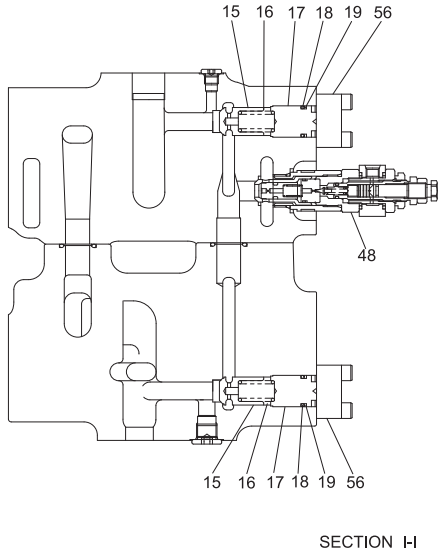

47 33 77 35 46 35 34 33 31
49
ARM 1
ARM 2
SECTION D-D
61 35 34 33 31


93 87 92 35 34 33 31
72
73
SERVICE
28
61
29
BUCKET
49
SECTION E-E
35 34 33 31


61 35 34 33 31 46 35 77 33 47
62
BOOM 2
BOOM 1
49
SECTION F-F
31 33 34 35 46 35 77 33 47

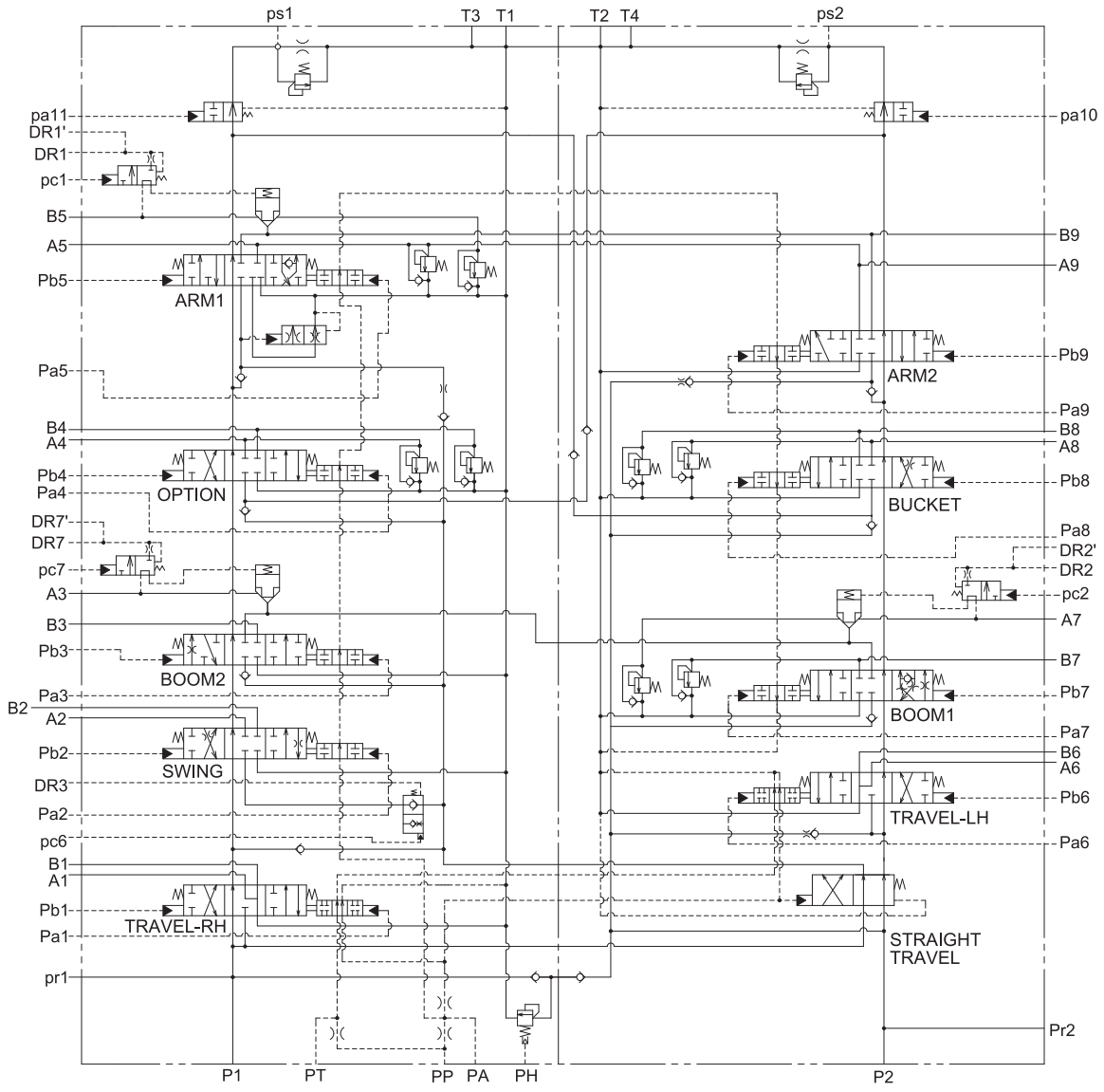

45 44 43 39
42
41
38
40
37
35
36
62
62
SWING
82
TRAVEL
49
SECTION G-G
52 53 54 55


PT
51
PP
SECTION J-J
35 34 33 32
TRAVEL
TRAVEL STRAIGHT
SECTION H-H
61


15 16 17 18 19 56
48
15 16 17 18 19 56
SECTION I-I

900L2MC03

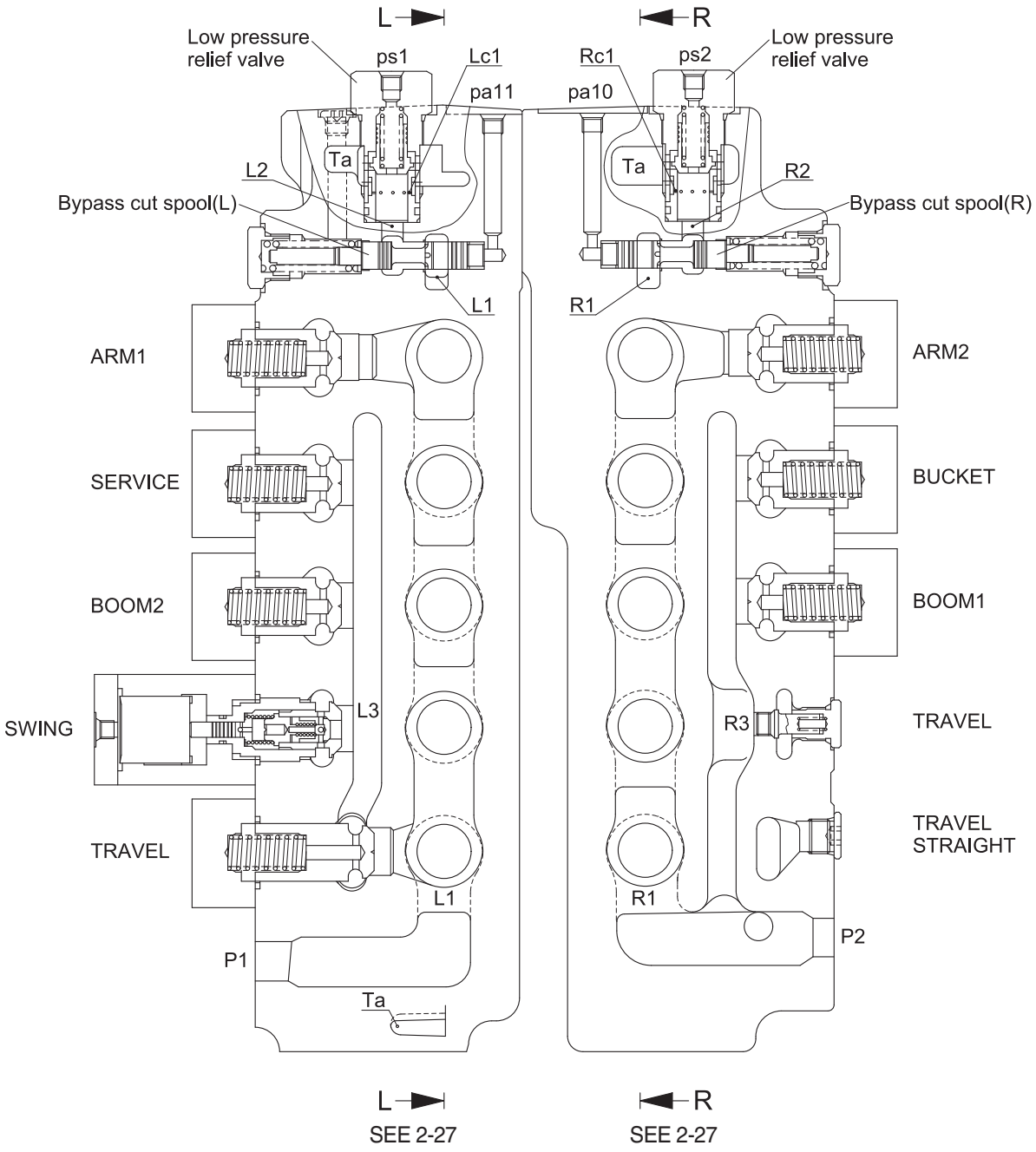
## 2. HYDRAULIC CIRCUIT




8007A2MC04

## 3. OPERATION

### 1) ALL SPOOL NEUTRAL




45071MC01

**(1) Neutral passage**

① Oil from pump P1 goes through neutral passage (L1) to the orifice (Lc1) of the low pressure relief valve and then oil returns to port T1 and T3 via tank passage (Ta).

② Oil from pump P2 goes through neutral passage (R1) to the orifice (Rc1) of the low pressure relief valve and then oil returns to port T1 and T3 via tank passage (Ta).

③ The pressure of upper chamber (L2), (R2) for the low pressure relief valve flow into pump through port ps1, ps2 and then controls the discharge of pump P1, P2.

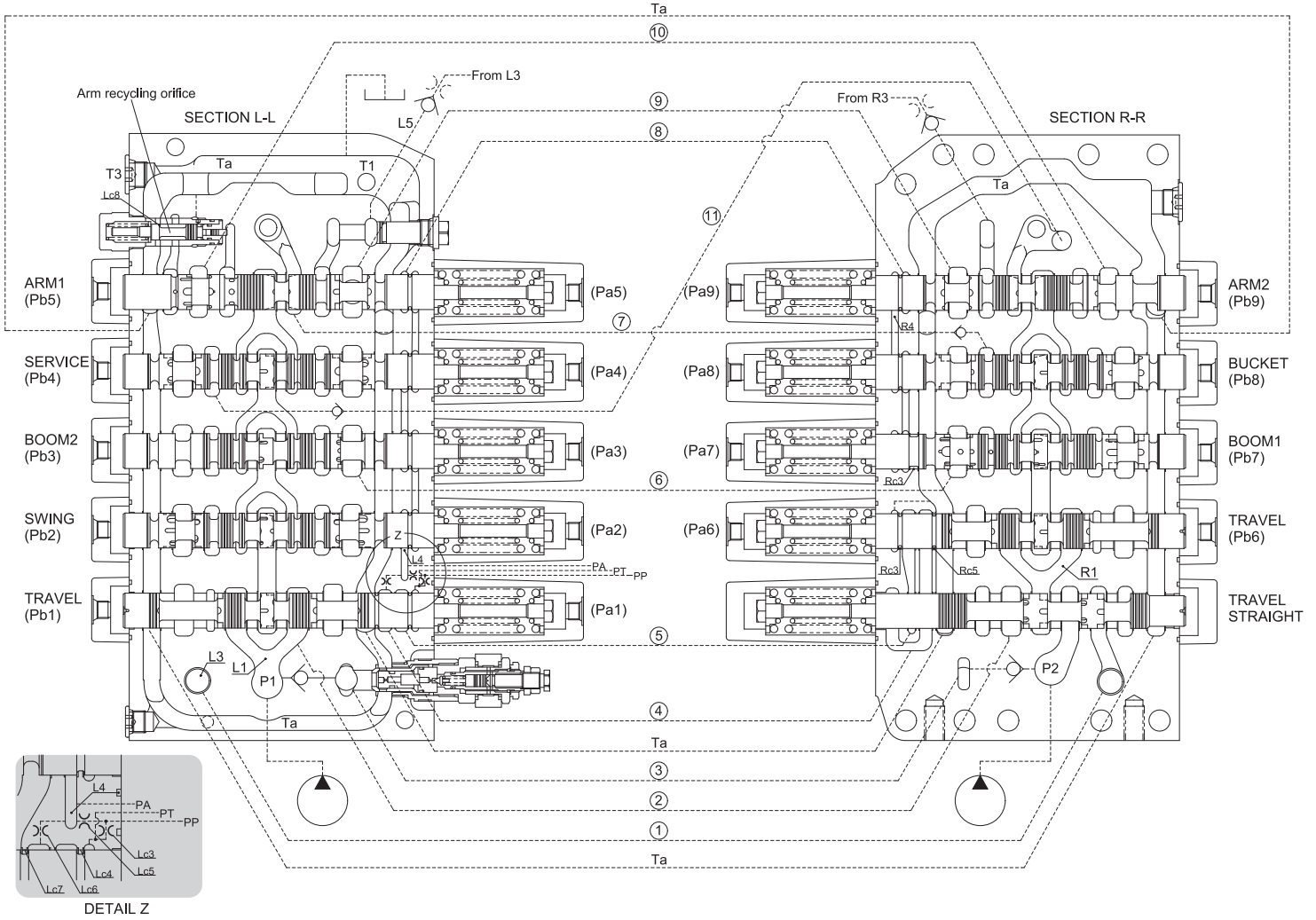
④ When a large amount of oil flows the neutral passage, the low pressure relief valves is operated. As a result, the shock pressure of port ps1, ps2 is prevented.

**(2) Signal passage**

① Oil from port PP flows into port PT via orifice (Lc3). At the same time, after passing through passage (⑤) via land (Lc4), oil returns to the tank passage (Ta) via land (Rc3).

② Meanwhile, some of oil from port PP flows into port PA via orifice (Lc5) and return to the tank passage (Ta) from boom 1 spool land (Rc4) via passage (L4,⑧ , R4).

③ Oil via orifice (Lc6) flows into the tank passage (Ta) from land (Lc7) and return to the tank passage (Ta) via travel spool land (Rc5) through the passage ④.




45071MC02

## 2) SINGLE OPERATION

### (1) Travel spool

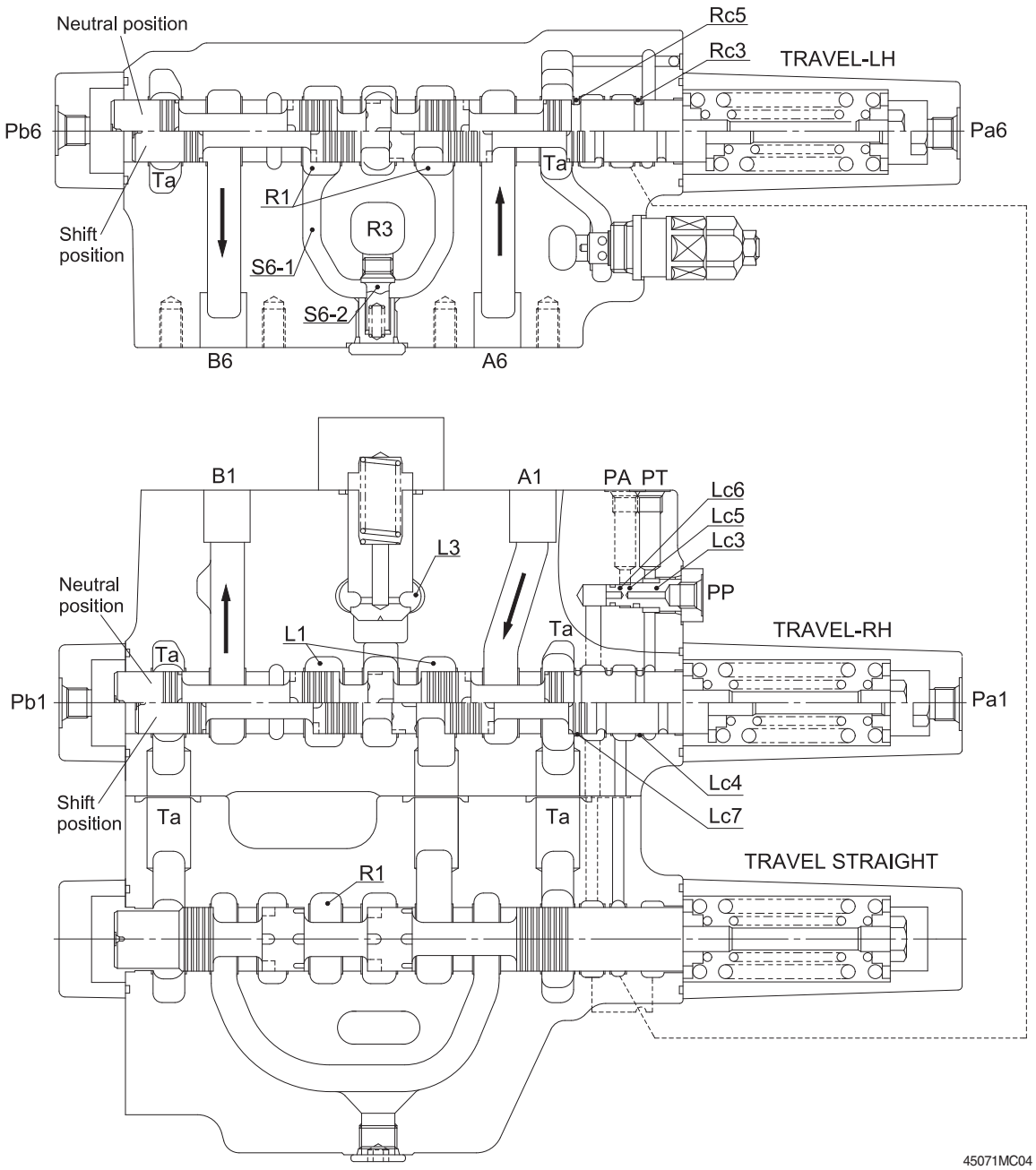
When the RH travel spool is pushed to right by the pilot pressure of port Pb1 the oil discharged from P1 port flows from the neutral passage (L1) to B1 port.

The oil from port A1 return to the tank via the tank passage (Ta).

When the LH travel spool is pushed to right by the pilot pressure of port Pb6 the oil discharged from P2 port flows from the neutral passage (R1) to B6 port through the passage S6-1.

At this time, the parallel passage (R3) and passage (S6-1) are to be maintained as same pressure as poppet (S6-2) is closed. The oil from A6 returns to the tank via the tank passage (Ta).

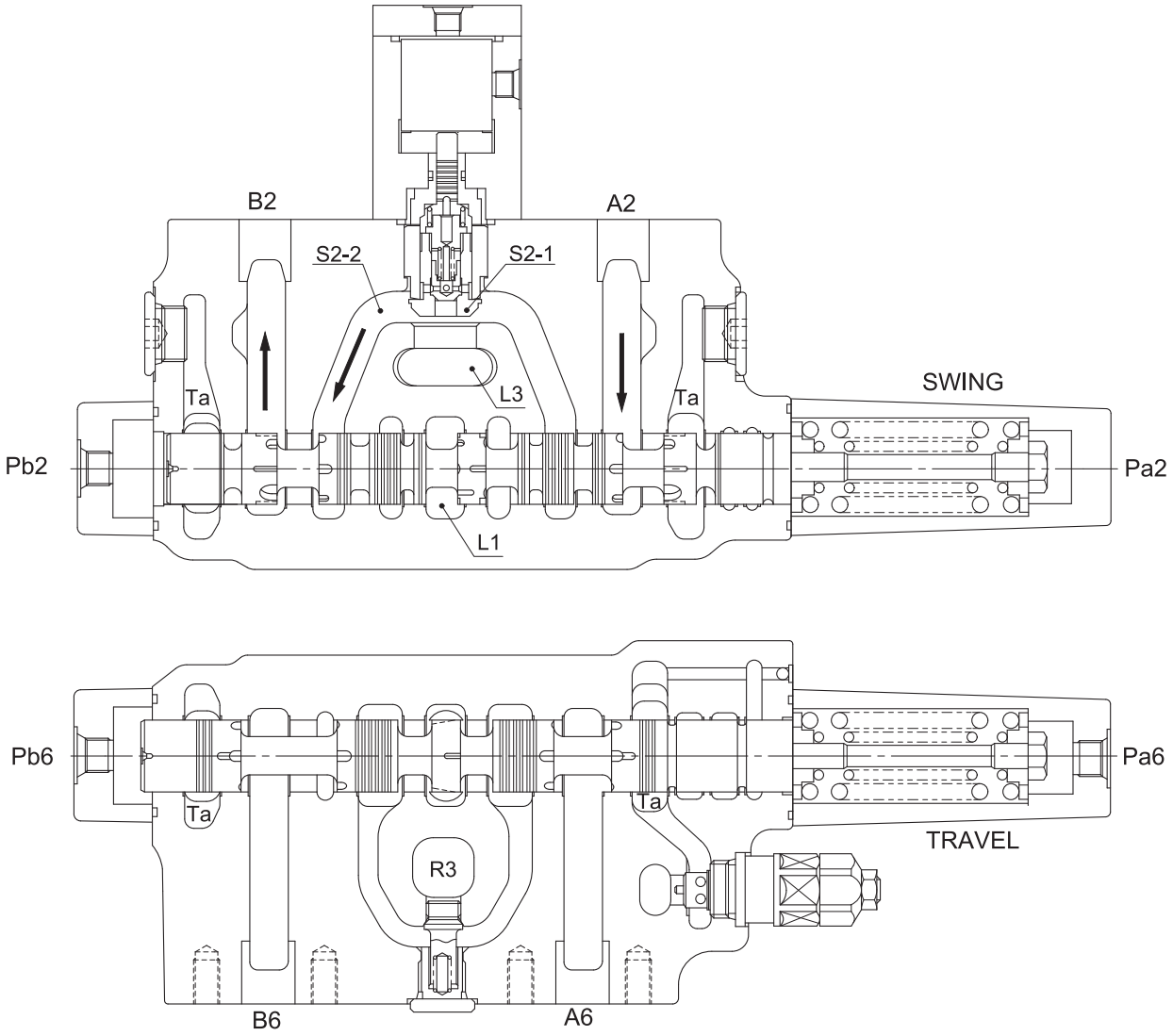
When the travel spool is pushed to the right by the pilot pressure, the land (Lc4, Rc3) is closed and the tank passage of the oil discharged from port PP is closed, and then the pressure of PT port is increased.



### (2) Swing spool

When the swing spool is pushed to the right by the pilot pressure of port Pb2, the neutral passage (L1) is closed, the oil discharged from pump P1 pushes up the load check valve (S2-1), passage (S2-2) via parallel passage (L3) and then flows into port B2.

The oil from port A2 return to the tank via the tank passage (Ta).

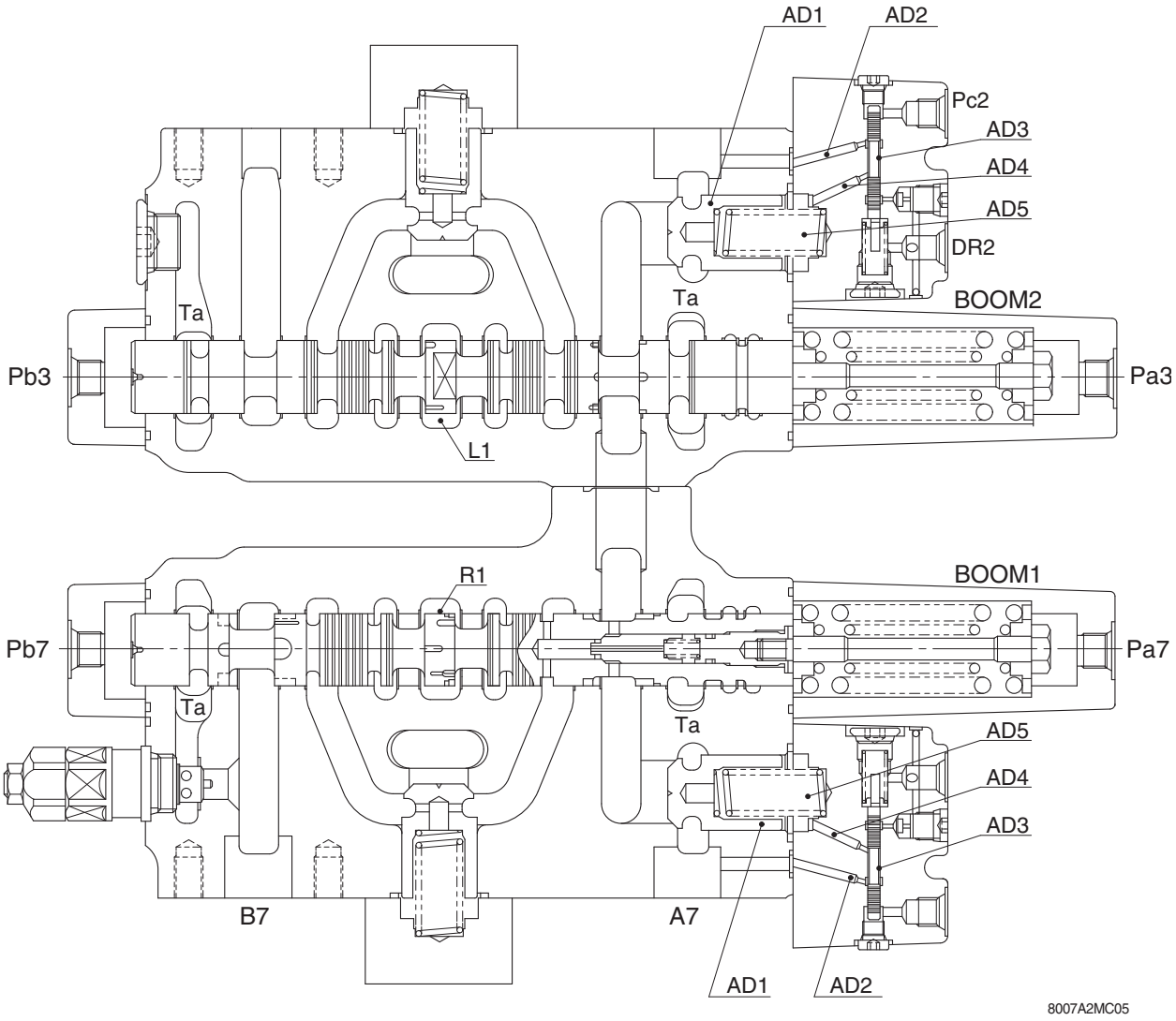



45071MC05

### 3) BOOM SPOOL

#### (1) Neutral

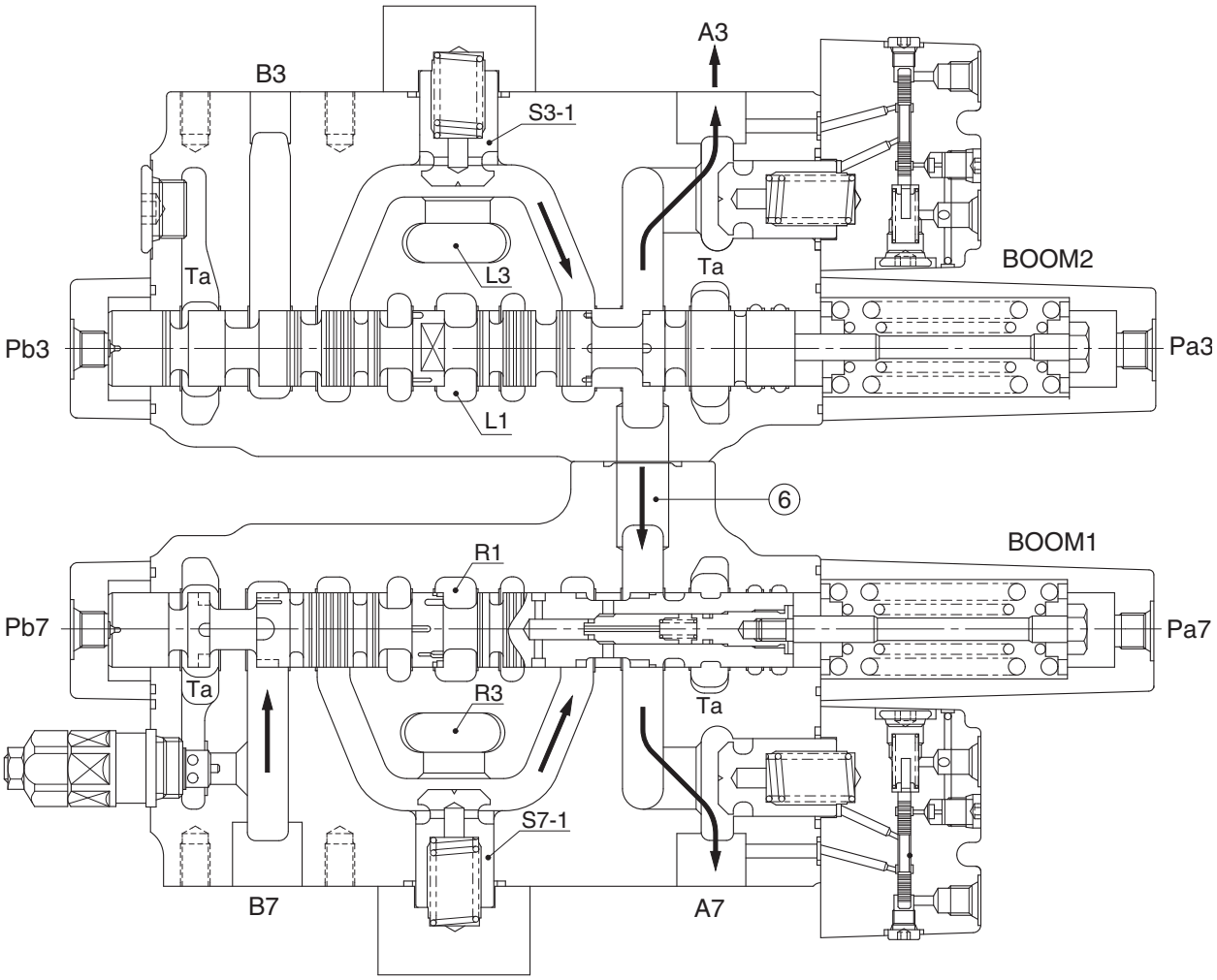
This valve is providing the anti-drift valve on the cylinder bottom side of boom 1 and boom 2 section. In neutral, the poppet (AD1) is seated by the pressure of spring chamber (AD5) because the oil from the port A7 is connection with spring chamber (AD5) via passage (AD2), spool (AD3) and passage (AD4).



### (2) Boom up (flow summation)

When the boom 1 spool is pushed to the left by the pilot pressure of port Pa7, the neutral passage (R1) is closed, the oil discharged from pump P2 flows into the port A7 via parallel passage (R3), the load check valve (S7-1). At the same time, the boom 2 spool is pushed to the left by the pilot pressure of port Pa3, the neutral passage (L1) is closed, the oil discharged from pump P1 flows into the port A7 via parallel passage (L3), the load check valve (S3-1) and then joins to the passage (⑥) and external piping (A3).

The return oil from port B7 flows into the tank via the tank passage (Ta).

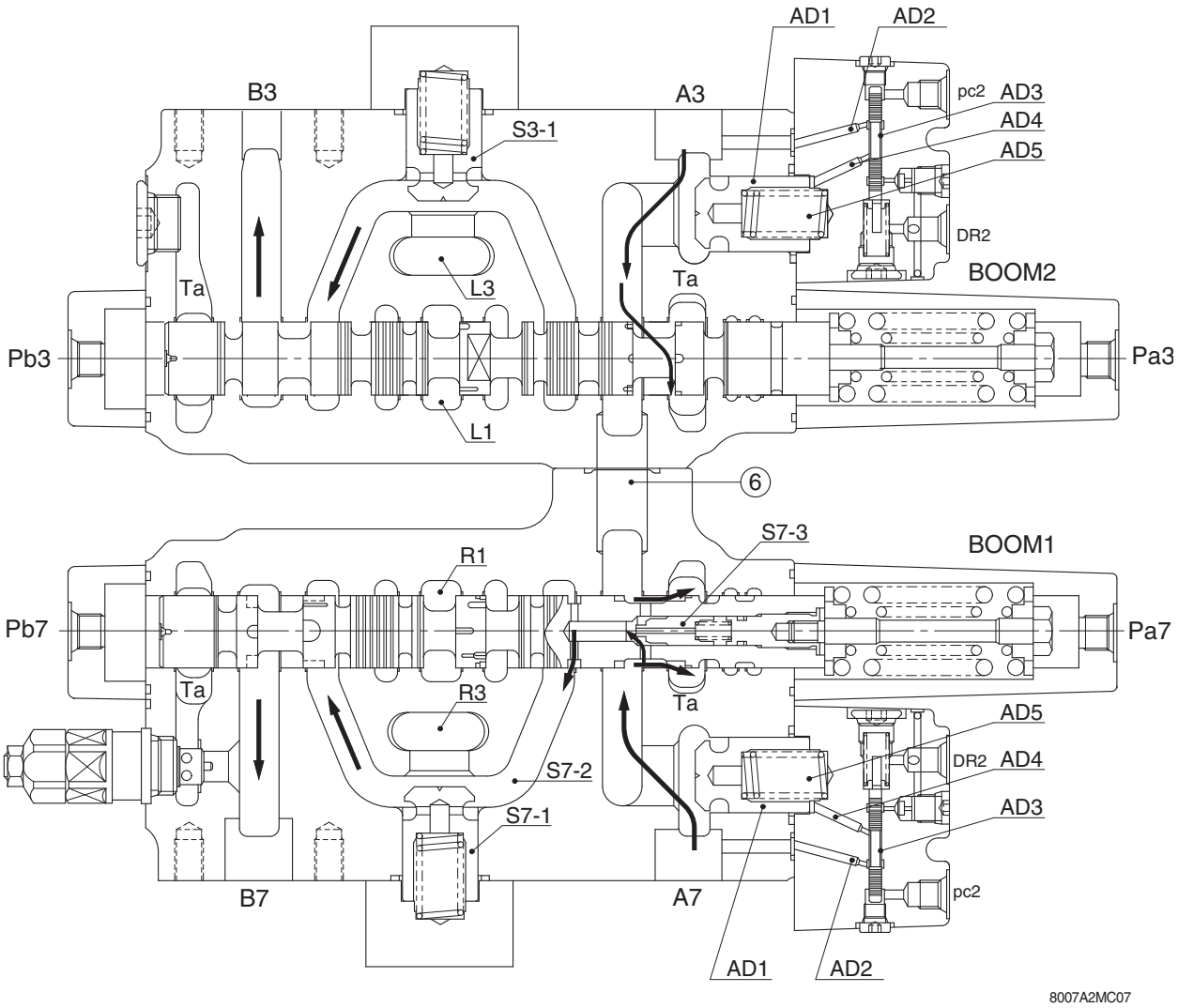



8007A2MC06

### (3) Boom down (recycling)

When the boom 1 and 2 spool is pushed to the right by the pilot pressure of port Pb3 and Pb7, the neutral passage (R1, L1) is closed, the oil discharged from pump P2 flows into the port B3 and B7 via parallel passage (R3, L3) and the load check valve (S3-1, S7-1). At the same time, as the port pc2 is pressurizing, the spool (AD3) of anti-drift valve is pushed up, the pressure of spring chamber (AD5) is released and the poppet (AD1) is opened and then the oil from port A3 and A7 flows into the tank passage (Ta).

Some of returned oil makes the poppet (S7-3) inside boom 1 spool to open and is connected to the passage (S7-2) and flows together into the port B7. This prevents the cavitation of cylinder rod side.



### 4) SERVICE SPOOL

When the service spool is pushed to the left by the pilot pressure of port Pb4, the neutral passage (L1) is closed, the oil discharged from pump P1 flows into the port B4 via parallel passage (L3), the load check valve (S4-1) and passage (S4-2).

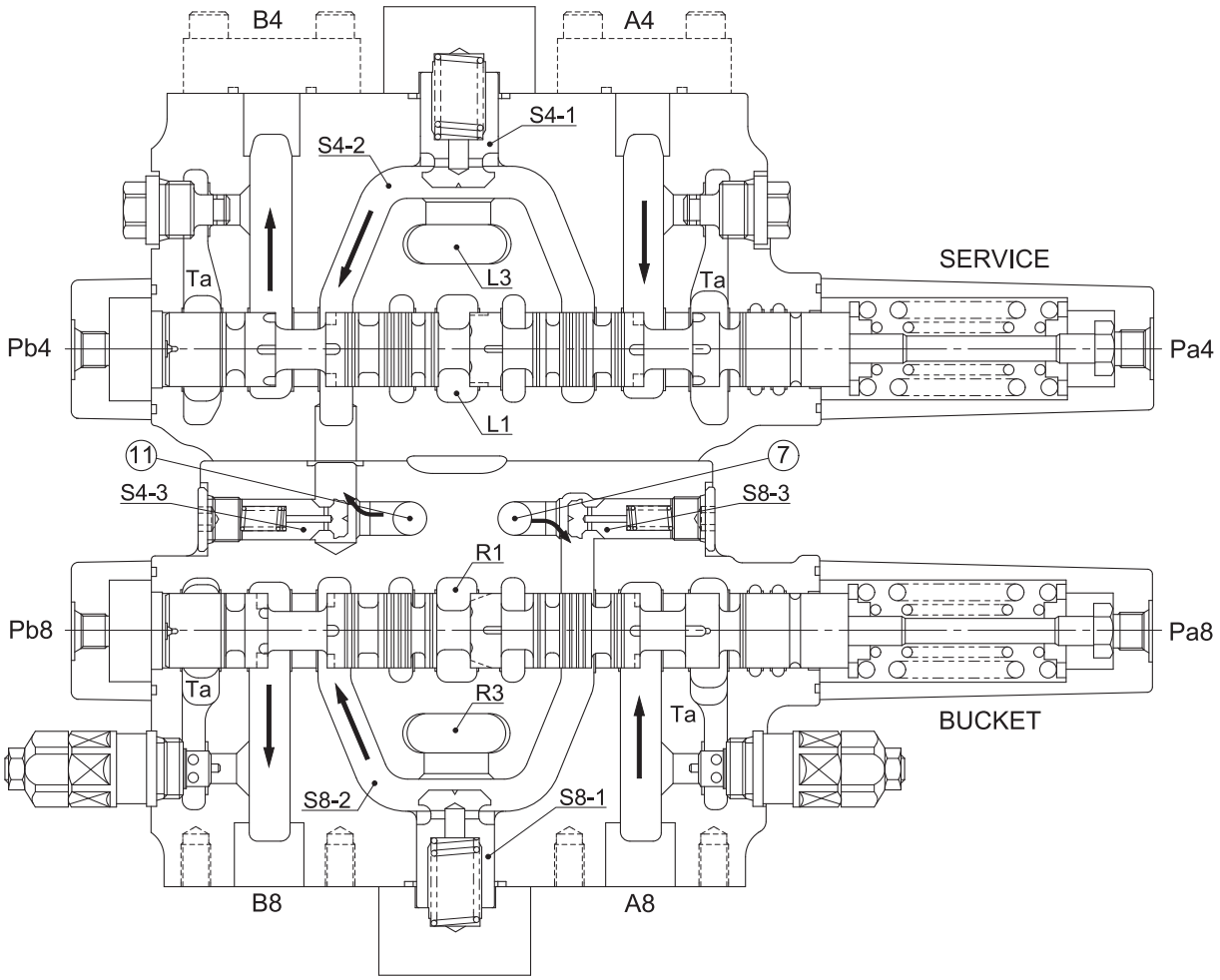
At the same time, as the port pa10 (see 2-24 page) is pressurizing and the bypass cut spool (R) is pushed, the oil discharged from pump P2 flows together into the port B7 via passage (11), poppet (S4-3). The oil returned from port A4 flows into the tank via the tank passage (Ta).

### 5) BUCKET SPOOL

When the bucket spool is pushed to the left by the pilot pressure of port Pb8, the neutral passage (R1) is closed, the oil discharged from pump P2 flows into the port B8 via parallel passage (R3), the load check valve (S8-1) and passage (S8-2).

At the same time, as the port pa11 is pressurizing and the bypass cut spool (R) is pushed, the oil discharged from pump P1 flows together the passage (S8-2) via passage (7), poppet (S8-3).

The return oil from port A8 flows into the tank via the tank passage (Ta).




45071MC09

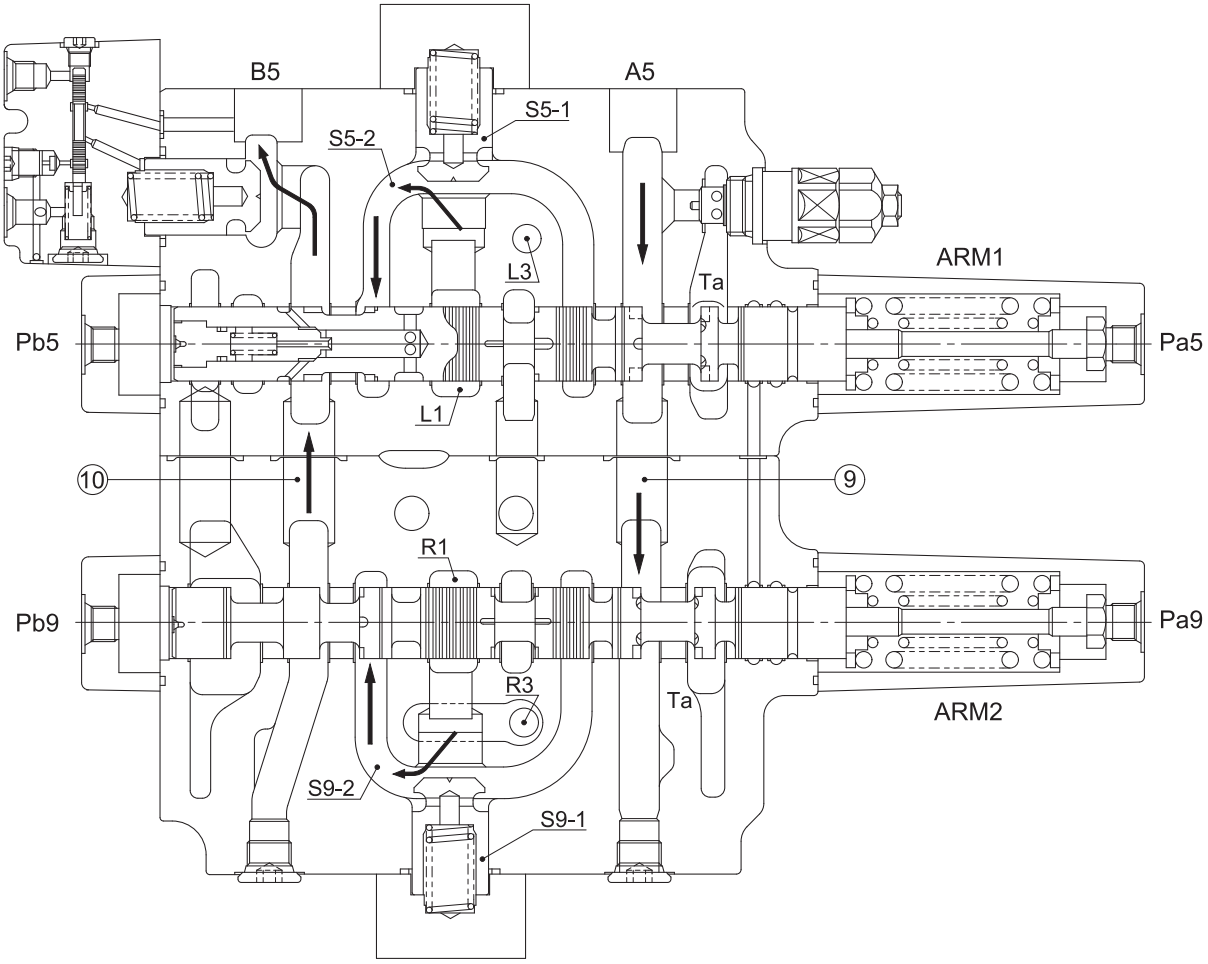
### 6) ARM SPOOL

#### (1) Arm out (flow summation)

When the arm 1 spool is pushed to the right by the pilot pressure of port Pb5, the oil discharged from pump P1 flows into the port B5 via neutral passage (L1), the load check valve (S5-1) and passage (S5-2).

When the arm 2 spool is pushed to the right by the pilot pressure of port Pb9, the oil discharged from pump P2 flows together the port B5 the passage (⑩) via the neutral passage (R1), the load check valve (S9-1) and passage (S9-2).

The return oil from port A5 flows into the tank via the tank passage (Ta).



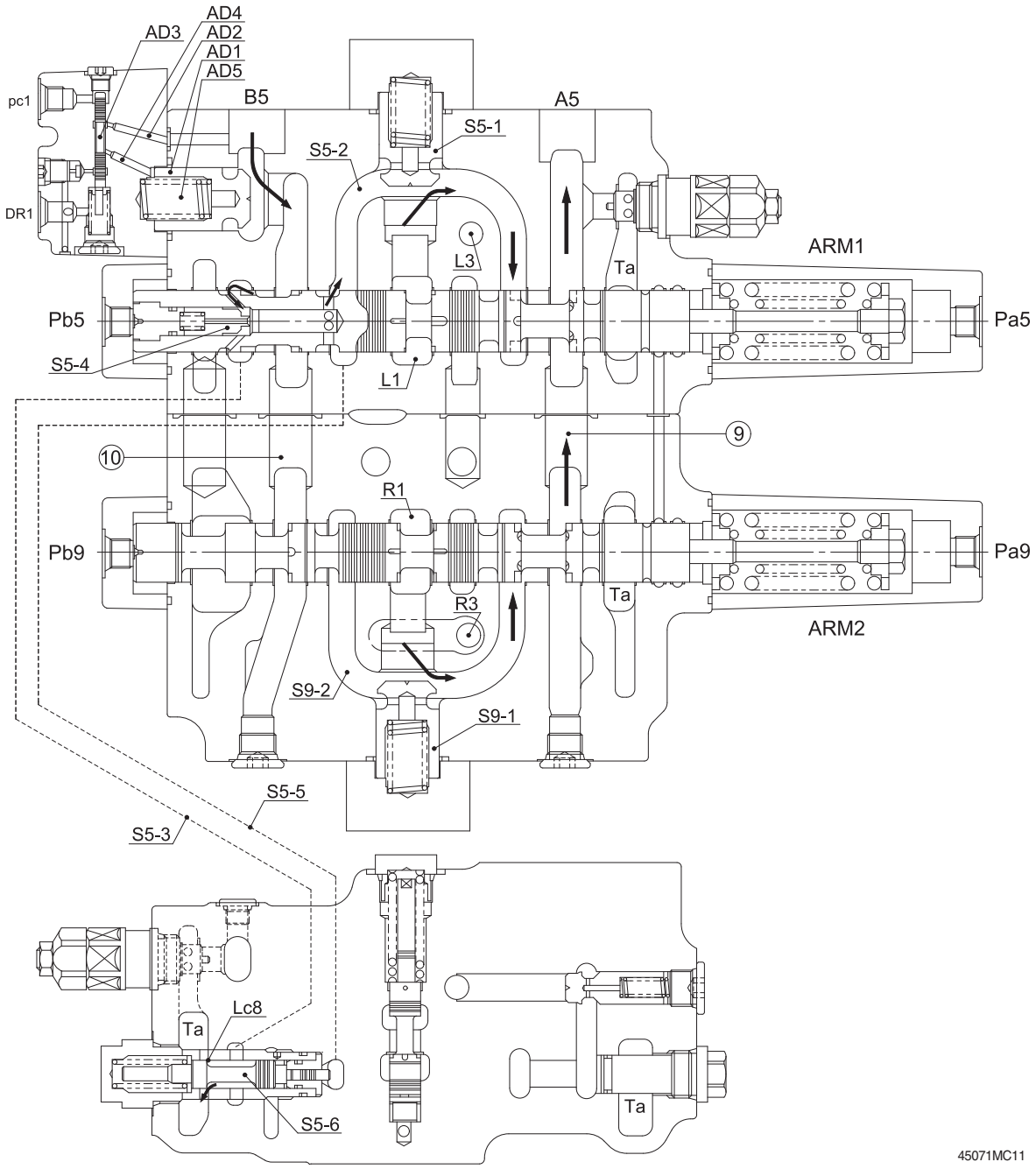

45071MC10

### (2) Arm in (flow summation)

When the arm 1 spool is pushed to the left by the pilot pressure of port Pa5, the oil discharged from pump P1 flow into the port A5 via neutral passage (L1), the load check valve (S5-1) and passage (S5-2).

When the arm 2 spool is pushed to the left by the pilot pressure of port Pa9, the oil discharged from pump P2 flows together into the port A5 via neutral passage (R1), the load check valve (S9-1) and passage (S9-2).

At the same time, as the port pc1 is pressurizing and the spool (AD3) of anti-drift valve is pushed down, the pressure of spring chamber (AD5) is released and the poppet (AD1) is opened and then the oil returned from port B5 flows into the tank passage (Ta) through the passage (S5-4) inside arm 1 spool to open and is connected to the passage (S5-2) and flows together into the port A5, the cylinder speed is raised and also is prevents the cavitation of bottom side.

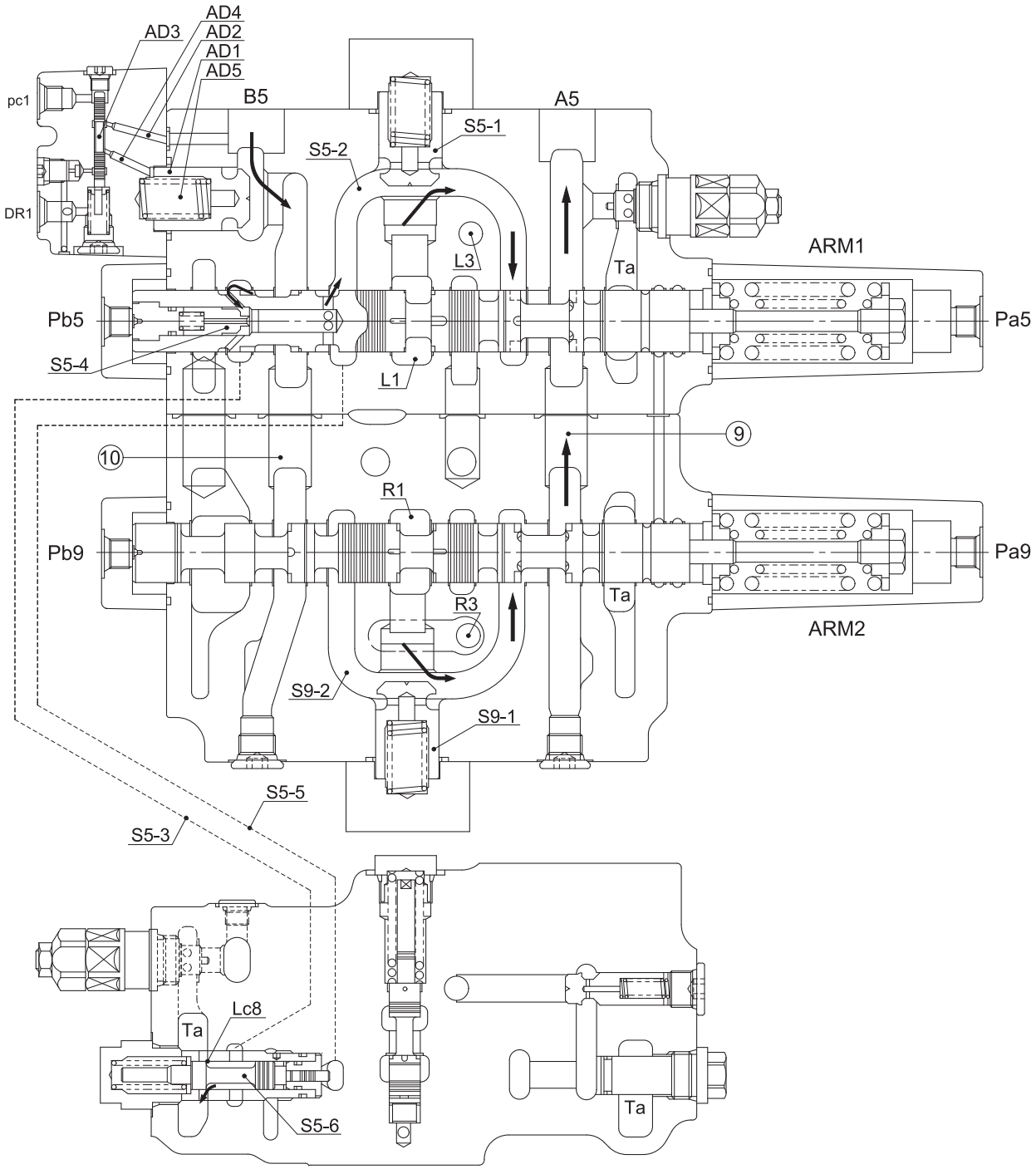


### (3) Arm recycling (arm in)

When the arm is at in position, the spool (S5-6) stroke against the passage (S5-2) pressure guided from the passage (S5-5) is changed according to the opening angle of arm recycling orifice (Lc8).

When the pressure of the passage (S5-2) is high and this stroke is increased, the opening angle of orifice (Lc8) become large. On the contrary, when the pressure of passage (S5-2) is low, this stroke is decreased, the opening angle of orifice (Lc8) become small.

Therefore, the flow rate for arm recycling is changed by the pressure in bottom side of arm cylinder.




45071MC11

### 7) BYPASS CUT SPOOL

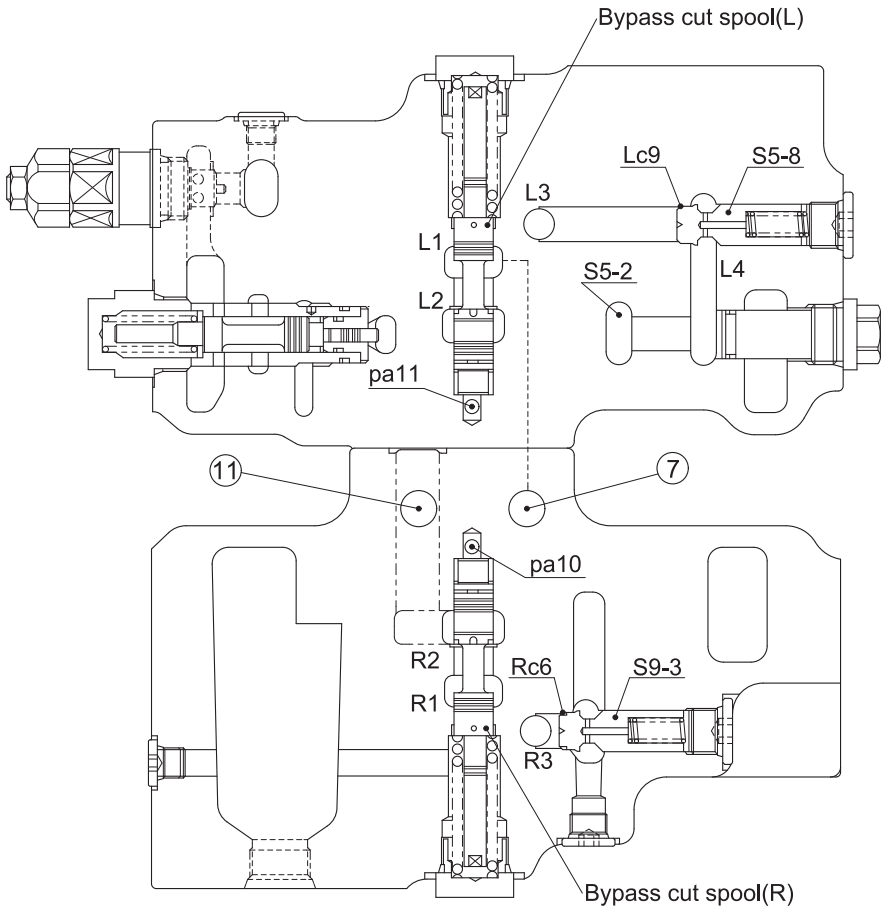
This valve is providing the bypass cut spool at the lowest stream of (upper stream of the low pressure relief valve) the neutral passage (L1, R1).

As the port pa10 (pa11) is pressurizing and the bypass cut spool (L, R) is pushed, the neutral passage (L1, R1) is closed. The oil discharged from port P1 flows together into the passage (S8-2, see 2-31 page) of bucket section via passage (⑦), poppet (S8-3) and the oil discharged from P2 port flows together into the passage (S4-2) of service section via the passage (⑪) and poppet (S4-3, see 2-31 page).

### 8) PARALLEL ORIFICE FOR ARM

The arm 1 and arm 2 section of this valve has orifices in the parallel circuit for arm. These orifices controls the speed of arm at combined operation.

The parallel circuit of arm 2 section is connected to the passage (S9-2, see 2-34) through orifice (Rc6) in the edge of the poppet (S9-3) from the parallel passage (R3), the parallel circuit of arm 1 section is connected to the passage (S5-2, see 2-34) through orifice (Lc9) in the edge of the poppet (S5-8) from the parallel passage (L3).




45071MC12

## 9) RELIEF VALVE

### (1) Main relief valve

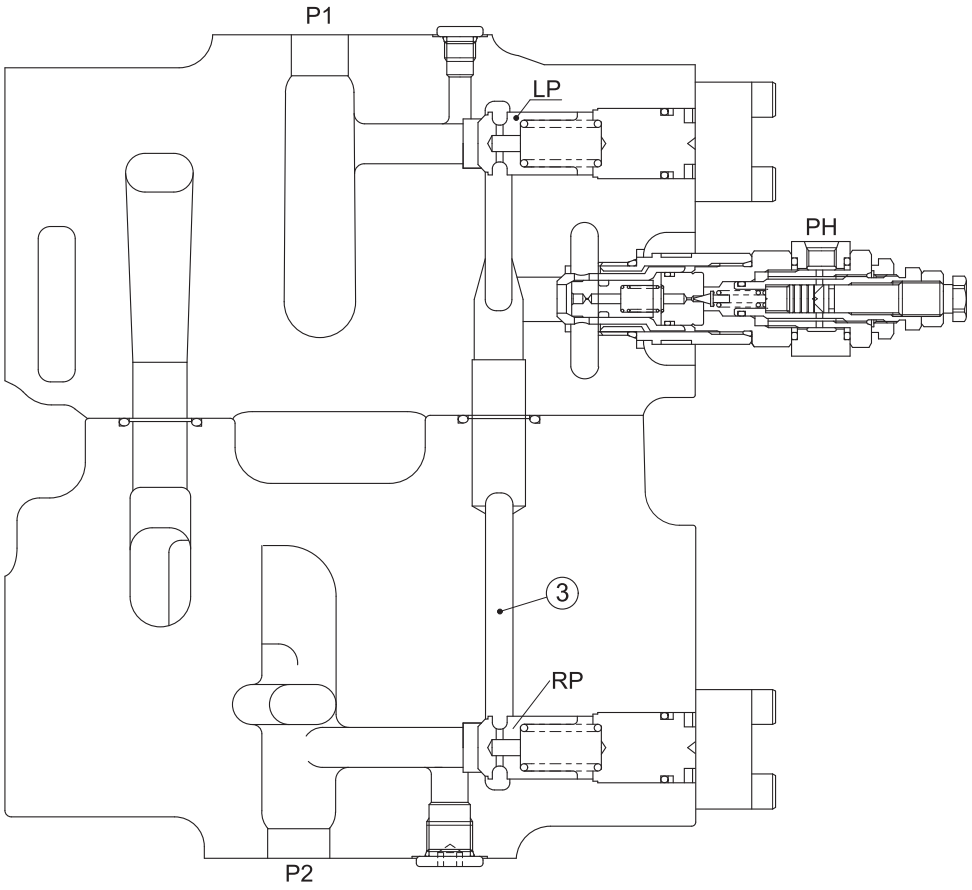
The oil discharged from P1 port via the poppet (LP) and the oil discharged from P2 port via the poppet (RP) flow into the main relief valve through the passage (3).

When the main relief valve is operating, the maximum pressure of pump P1, P2 is controlled.

### (2) Overload relief valve

Overload relief valves are provided each cylinder ports of boom1, arm1 and bucket. These prevents the abnormal high pressure of actuators by external force.

Also, when the pressure of cylinder ports create back pressure, this valve opens allowing oil from tank to cylinder port; and then prevents cavitation.

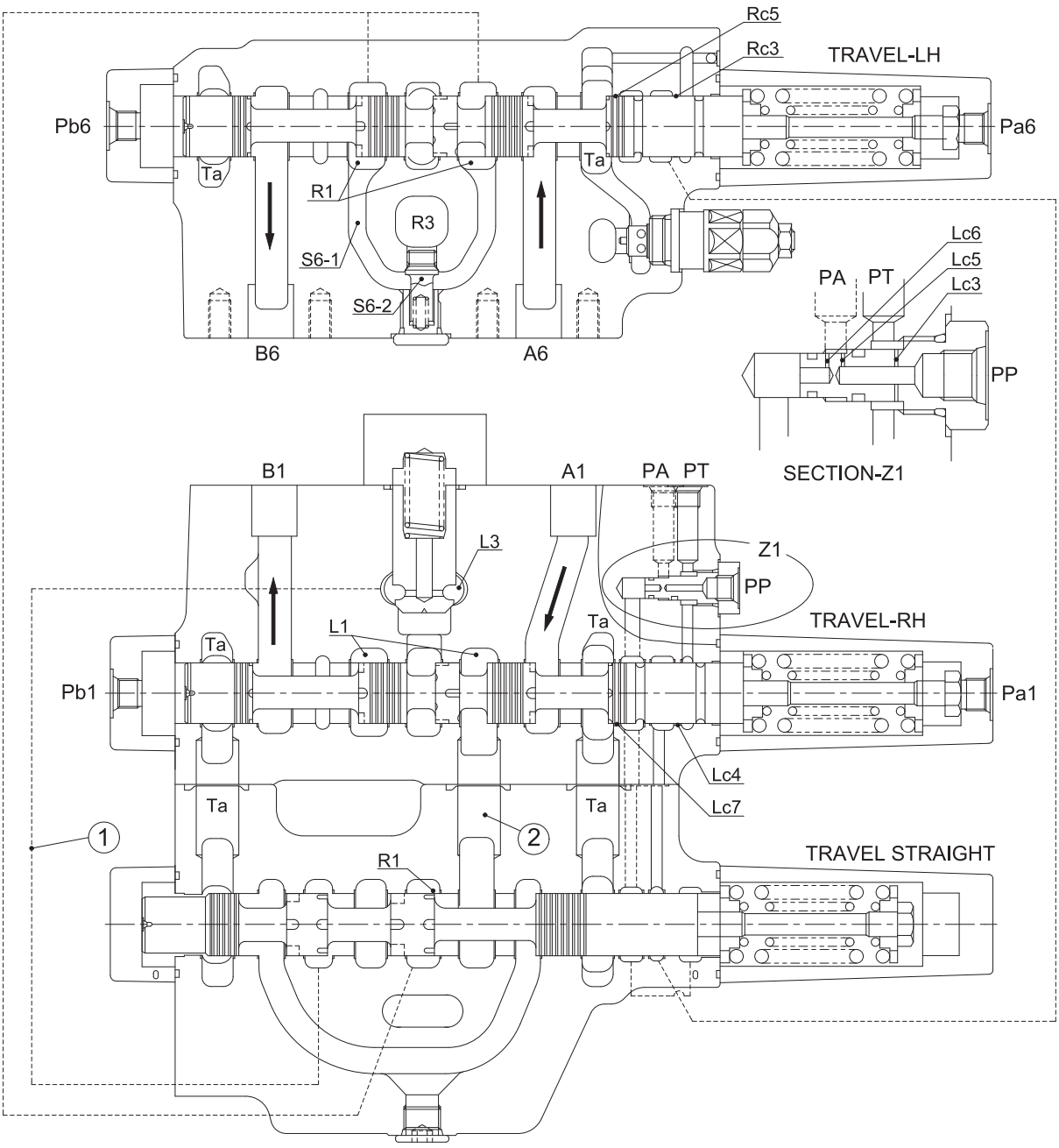



45071MC13

## 4. COMBINED OPERATION

### 1) TRAVEL COMBINED OPERATION

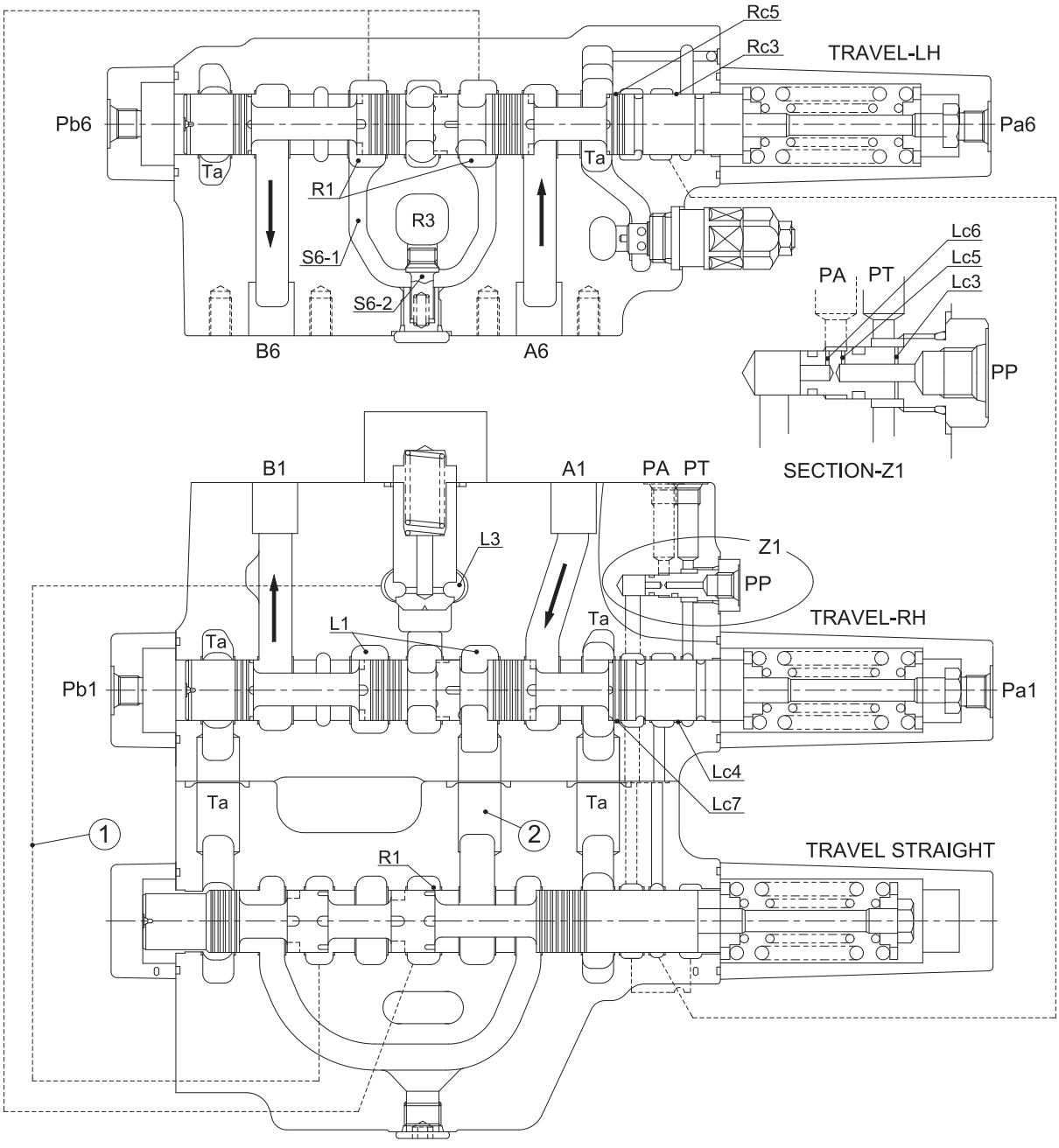
① While travel (forward, reverse and pivot turn) and front attachment (except travel section) functions are operated, the oil discharged from port PP is cut via land (Lc4, Lc7, Rc3, Rc5) and blocked from signal land except travel section to tank passage (Ta), the pressure of signal passage rises to the relief setting pressure of pilot pump and the straight travel spool is pushed to the left by raising of signal pressure and also, the pressure of port PT, PA port rises.




45071MC14

② When the straight travel spool is operated, the oil discharged from port P1 flows into RH travel section through the neutral passage (L1) and also flows into LH travel section via the neutral passage (R1) and passage (②). The oil discharged from port P2 flows into the parallel passage (L3) via passage (①).

③ In case the load pressure of the section except travel is higher than that of the RH travel section, the partial oil of discharged from port P2 pushes open the poppet (S6-2) and flows together into the passage (S6-1) through the orifice at the edge of poppet. The travel (LH, RH) is operated by the discharged oil from port P1 and the other actuators are operated by the discharged oil from port P2. Thus, when travel and front attachment functions are operated simultaneously, keeps the straight travel.

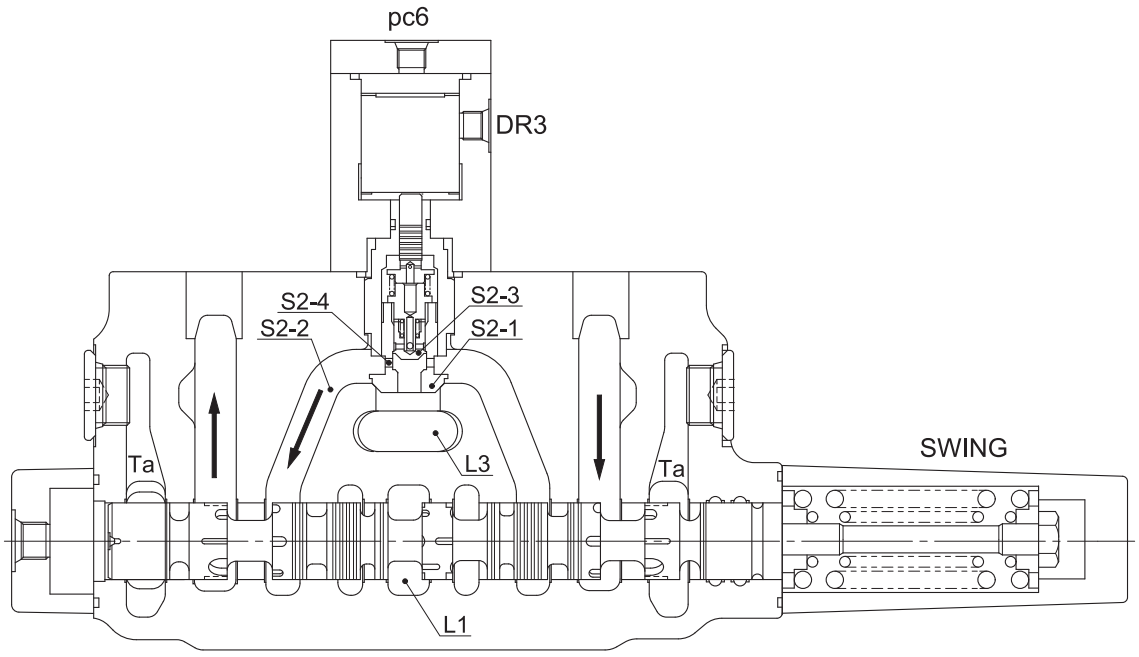



45071MC14

## 2) SWING COMBINED OPERATION

When swing and boom up functions are operated, the poppet (S2-1) is seated by pressure of port pc6 and the poppet (S2-3) only opened and the supply pressure of the parallel passage (L3) is rises by orifice (S2-4).

As a result, boom and swing simultaneous operation is ensured even if lower load of swing section.




45071MC15

## 5. ANTI-DRIFT VALVE

The anti-drift valve is provided the boom bottom and arm rod side of cylinder port for prevention of self drifting by boom weight or bucket loads.

### 1) WHEN NEUTRAL

The oil from cylinder port flows into spring chamber (AD5) via passage (AD2), the around of spool (AD3) and passage (AD4).

Because of the difference of poppet area and spring force, the poppet (AD1) is seated certainly.

### 2) WHEN BOOM UP OR ARM OUT

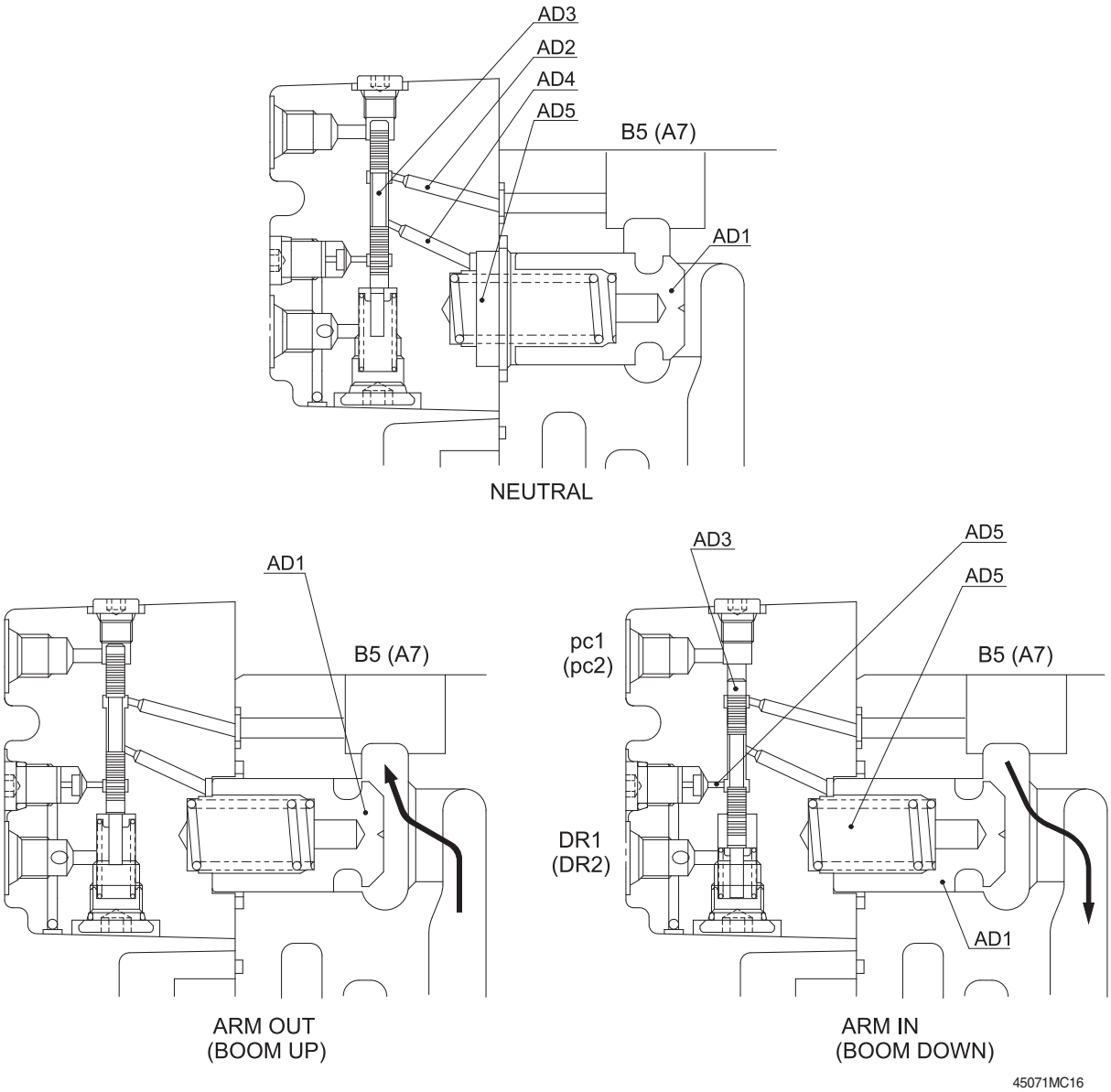
The oil from pump flows into cylinder by pushes open the poppet (AD1).

### 3) WHEN BOOM DOWN OR ARM IN

The spool (AD3) is pushed down by the pressure of pc1 (pc2).

Then the oil of spring chamber (AD5) flows into the drain port DR1 (DR2) and pushes open the poppet (AD1).

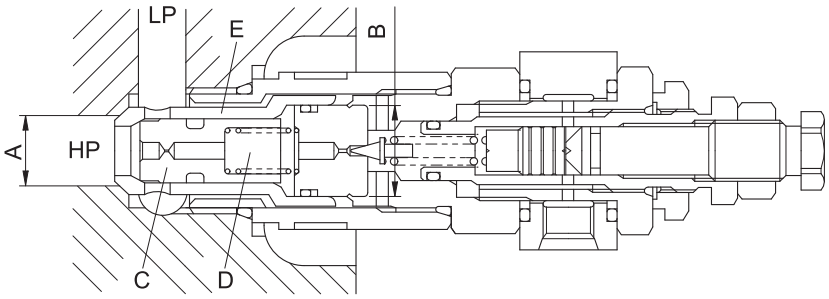
As a result, the oil from the cylinder port returns to tank passage (Ta).



## 6. RELIEF VALVE OPERATION

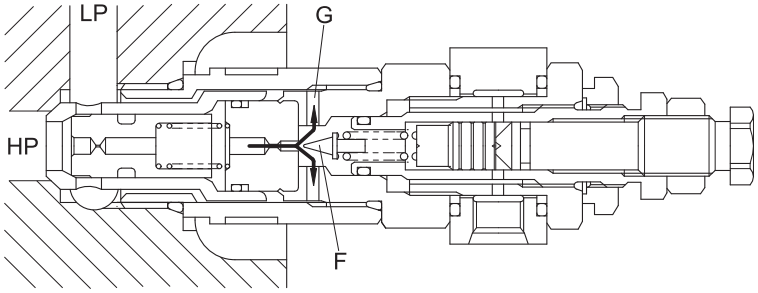
### 1) MAIN RELIEF VALVE

(1) This relief valve is built-in between the neutral passage (HP) and low pressure passage (LP), and the pressure oil fills up chamber (D) inside via orifice of main poppet (C).
Thus the sleeve (E) and the main poppet (C) are securely seated by difference area of A an B.



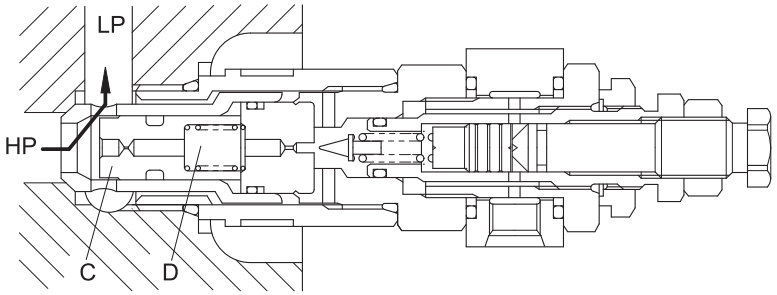

45071MC17

(2) When the pressure in neutral passage (HP) reaches the setting force of spring, pilot poppet (F) is opened.
The oil flows around poppet and into the low pressure passage(LP) via hole(G).



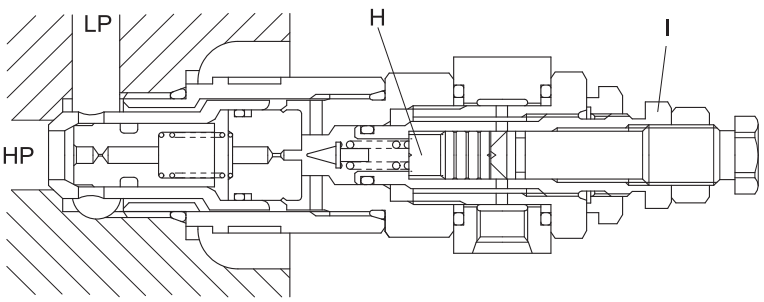

45071MC17-1

(3) When above flow is formed, the pilot poppet is opened; the pressure of chamber (D) drops, the main poppet (C) is opened and then the oil directly flows into the low pressure passage (LP).




45071MC17-2

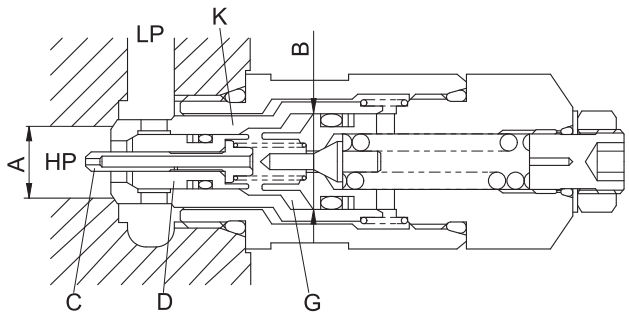
(4) High pressure setting pilot signal (Pi) : ON
The piston (H) moves to left by pilot pressure (Pi); set pressure of spring rises, making high pressure setting.




45071MC17-3

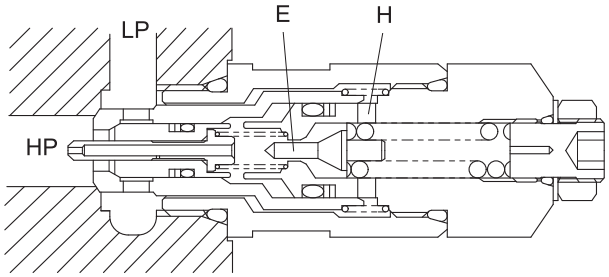
## 2) OVERLOAD RELIEF VALVE

(1) This relief valve is built-in the cylinder port (HP) and the low pressure (LP), and the pressure oil fills up camber (G) inside via hole of piston (C).
Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.



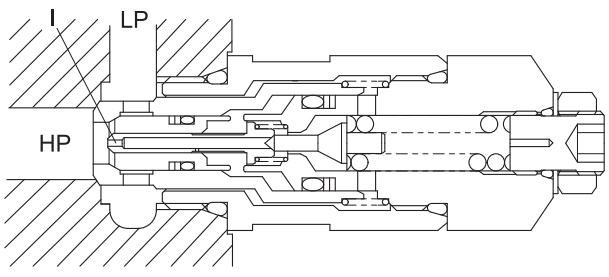

45071MC18

(2) When the pressure in cylinder port (HP) reaches the setting force of spring, the pilot poppet (E) is opened.
The oil flows around poppet and into the low pressure passage (LP) via hole (H).



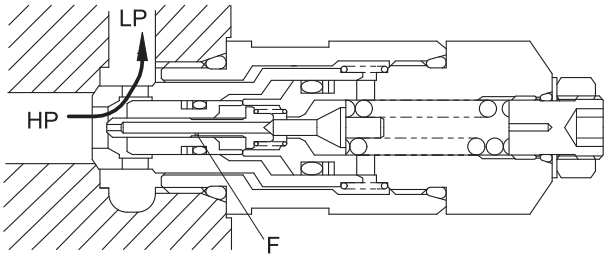

45071MC18-1

(3) When above flow is formed, the pilot poppet (E) is opened.
The pressure drops before and behind orifice (I); piston (C) moves to right and the piston (C) is seated at the tip of poppet (E).




45071MC18-2

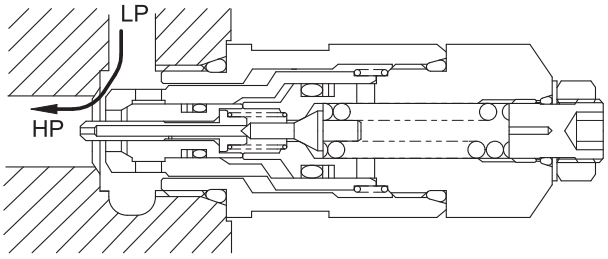
(4) The oil flow from the high pressure passage (HP) to the poppet (D) behind is only around poppet and orifice (F); then the high pressure passage (HP) is higher than the poppet (D) behind pressure.
Thus the poppet (D) is pushed open and the oil directly flows into low pressure passage (LP).




45071MC18-3

**(5) Make up operation**

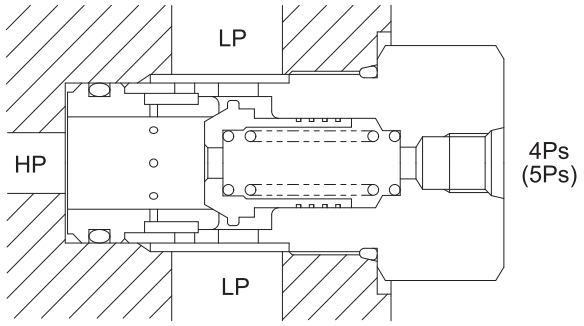
This relief valve is built-in the cylinder port (HP) and the low pressure passage (LP), and the pressure oil fills up camber (G) inside via hole of piston (C).
Thus the sleeve (K) and the main poppet (D) are securely seated by difference area of A and B.




45071MC18-4

### 3) LOW PRESSURE RELIEF VALVE

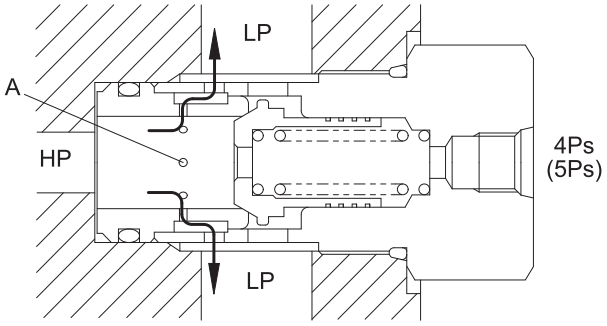
#### (1) When pump does not operational




45071MC19

#### (2) When spool neutral

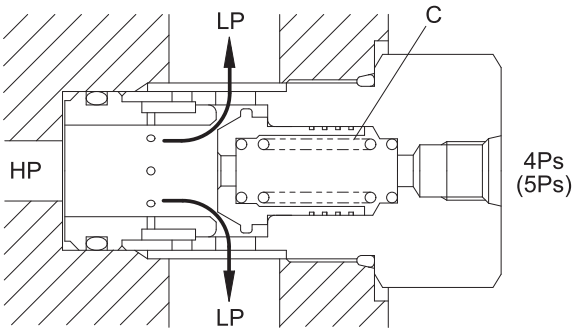
The neutral passage (HP) oil flows into the low pressure passage (LP) via signal orifice (S).
The signal port 4Ps (5Ps) pressure is raise by negative control orifice (A).




45071MC19-1

#### (3) Operation of low pressure relief

When the oil pressure neutral passage (HP) reaches the setting force of spring, the poppet is pushes open; the oil directly flows through passage (HP) to passage (LP) in order to prevent abnormal pressure.




45071MC19-2

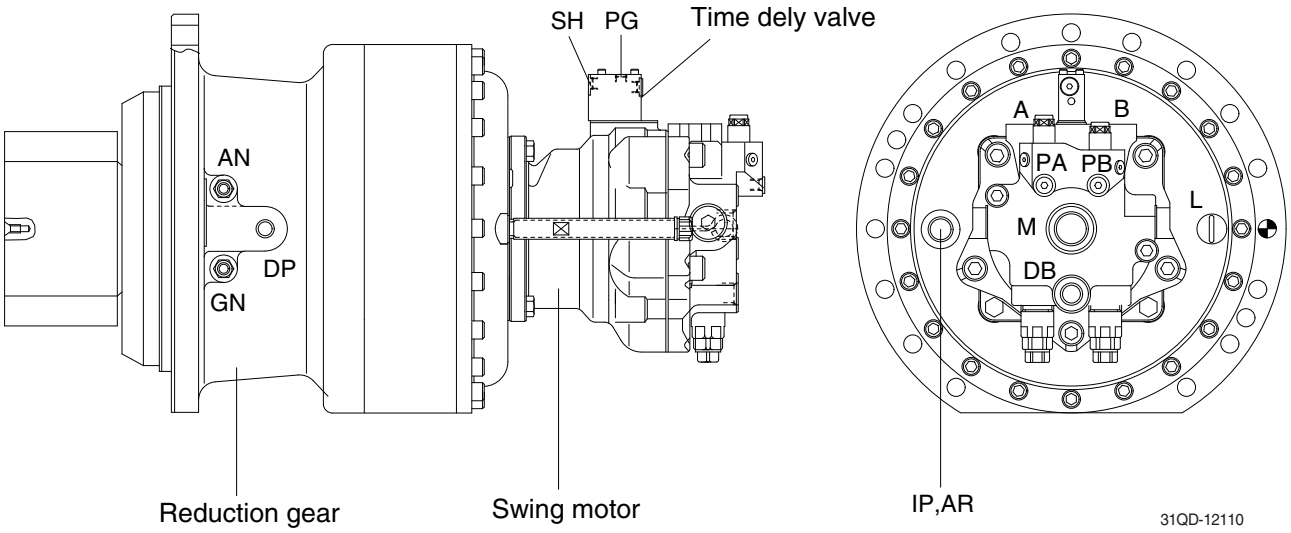
# GROUP 3 SWING DEVICE

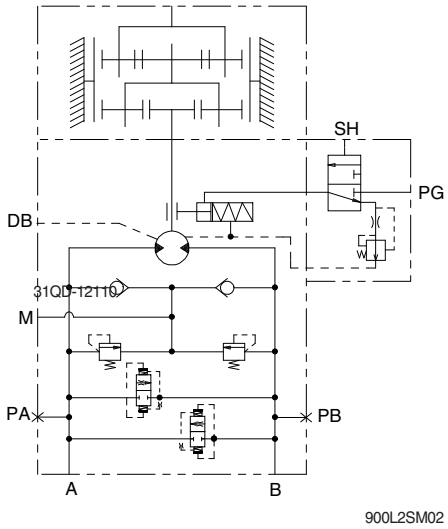
## 1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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

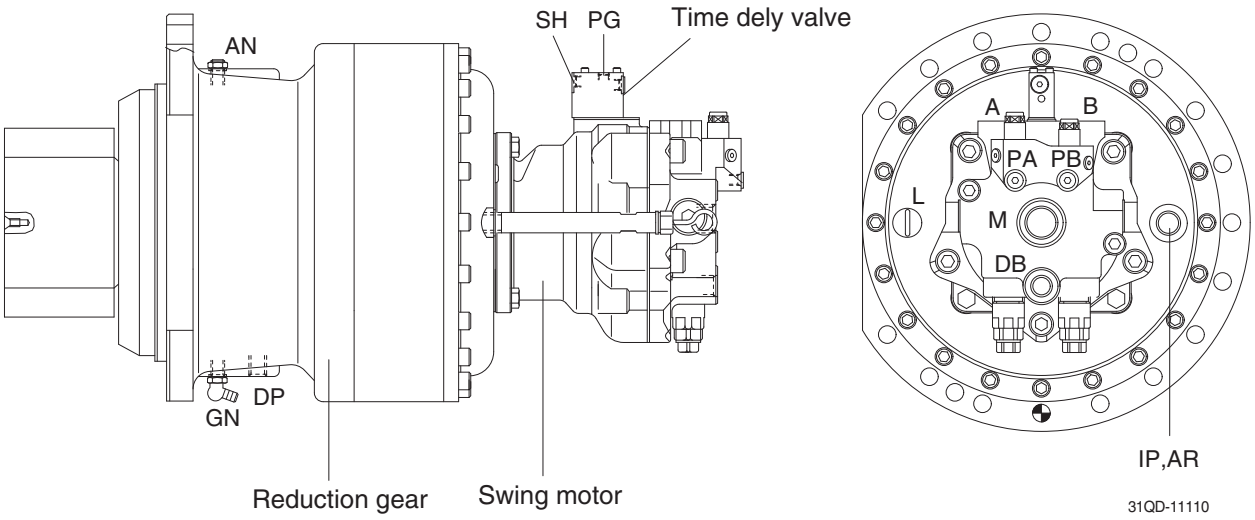
· FRONT

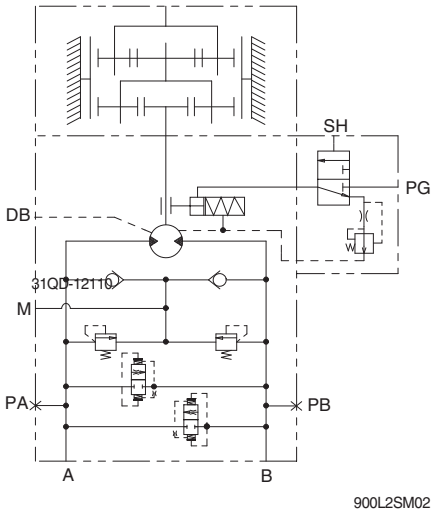



| Port | Port name | Port size |
|---|---|---|
| A, B | Main port | SAE 1" |
| DB | Drain port | PF 3/4 |
| M | Make up port | PF 1 1/4 |
| PG | Brake release stand by port | PF 1/4 |
| SH | Brake release pilot port | PF 1/4 |
| IP,AR | Motor gear oil inlet air bleed port | PT 3/4 |
| PA,PB | Gauge port | - |
| GN | Reduction gear grease fill port | PT 1/4 |
| AN | Reduction gear air vent port | - |
| DP | Reduction gear drain port | PT 1/2 |
| L | Level bar port | PT 1/2 |

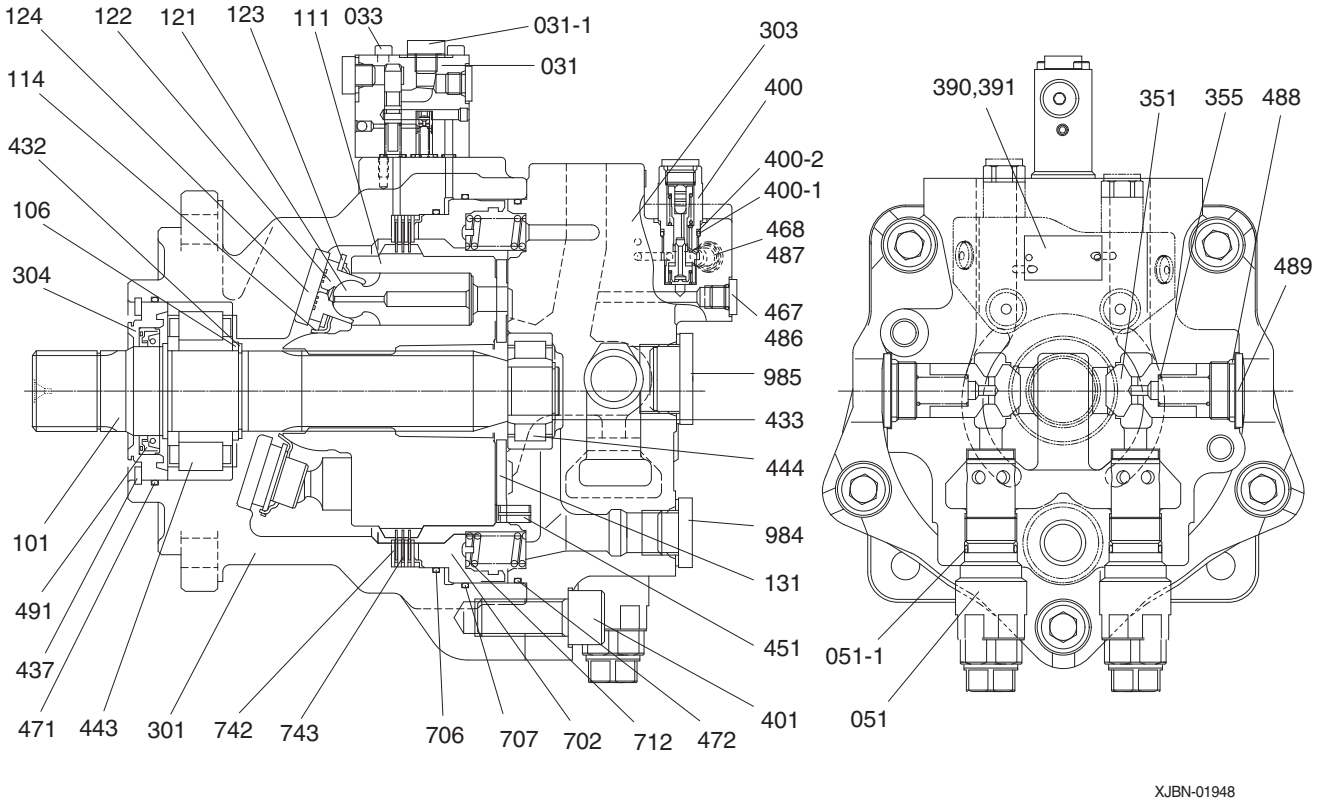
· **REAR**



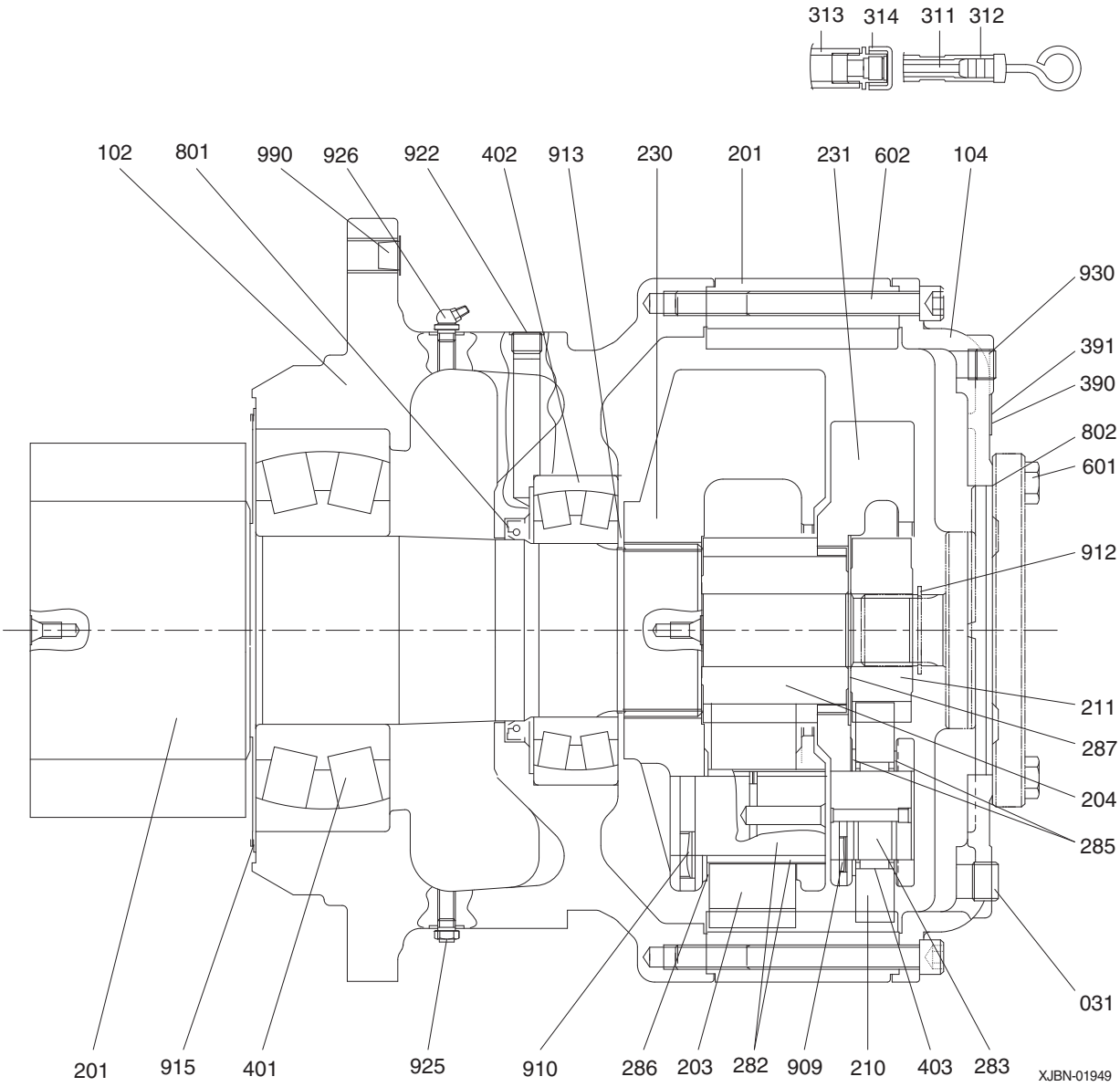

| Port | Port name | Port size |
|---|---|---|
| A, B | Main port | SAE 1" |
| DB | Drain port | PF 3/4 |
| M | Make up port | PF 1 1/4 |
| PG | Brake release port | PF 1/4 |
| SH | Brake pilot port | PF 1/4 |
| IP,AR | Motor gear oil inlet air bleed port | PT 3/4 |
| PA,PB | Gauge port | - |
| GN | Reduction gear grease fill port | PT 1/4 |
| AN | Reduction gear air vent port | - |
| DP | Reduction gear drain port | PT 1/2 |
| L | Level bar port | PT 1/2 |

## 1) SWING MOTOR




| | | | | | |
|---|---|---|---|---|---|
| 031 | Time delay valve | 304 | Front cover | 469 | Plug bolt |
| 0311 | Masking plug | 351 | Plunger | 471 | O-ring |
| 033 | Hex screw | 355 | Spring | 472 | O-ring |
| 051 | Relief valve | 390 | Name plate | 486 | O-ring |
| 0511 | O-ring | 391 | Pin | 487 | O-ring |
| 101 | Drive shaft | 400 | Swing valve | 488 | O-ring |
| 106 | Spacer | 4001 | O-ring | 491 | Oil seal |
| 111 | Cylinder | 4002 | Back up ring | 702 | Brake piston |
| 114 | Shoe plate | 401 | Hex screw | 706 | O-ring |
| 121 | Piston | 432 | Snap ring | 707 | O-ring |
| 122 | Shoe | 433 | W clip | 712 | Brake spring |
| 123 | Set plate | 437 | Snap ring | 742 | Friction plate |
| 124 | Shoe plate | 443 | Roller bearing | 743 | Separator plate |
| 131 | Valve plate | 444 | Roller bearing | 984 | Making plug |
| 301 | Casing B | 467 | Plug | 985 | Masking plug |
| 303 | Valve casing | 468 | Plug | | |

## 2) REDUCTION GEAR




| | | | | | |
|---|---|---|---|---|---|
| 104 | Rear casing | 287 | Thrust plate | 802 | O-ring |
| 201 | Drive shaft | 311 | Level bar | 909 | Spring pin |
| 202 | Ring gear | 312 | Y pipe | 910 | Spring pin |
| 203 | Planet gear B No.2 | 313 | Oiling pipe | 912 | Snap ring |
| 204 | Sun gear B No.2 | 314 | Oiling pipe | 913 | Stop ring |
| 210 | Planet gear B No.1 | 390 | Name plate | 915 | Bearing seal C |
| 211 | Sun gear B No.1 | 391 | Pin | 922 | Plug |
| 230 | Carrier No.2 | 401 | Spherical roller bearing | 925 | Relief fitting |
| 231 | Carrier B No.1 | 402 | Spherical roller bearing | 926 | Grease nipple |
| 282 | Pin A No.2 | 403 | Needle cage | 930 | Plug |
| 283 | Pin No.1 | 601 | Hex head bolt | 931 | Plug |
| 285 | Side plate | 602 | Hex head screw | 990 | Plug |
| 286 | Thrust washer | 801 | Oil seal | | |

## 2. FUNCTION

### 1) HYDRAULIC MOTOR SECTION

When high-pressure oil passes thought the inlet port (a) of the valve plate (1) and flows into the cylinder as shown in figure, the oil pressure acts upon the piston to generate the axial force "F".

This force "F" is divided into two vector forces thought the shoe (2) : namely, the force "F1" vertical to the swash plate (3) and the force "F2" perpendicular to the shaft. This force "F2" is transmitted to the cylinder block (4) via the piston and generates a couple of forces that turn the output shaft.

In the cylinder block nine pistons are equally spaced, and the pintons connected to the high pressure oil inlet ports give their rotating torque to the output shaft sequentially.

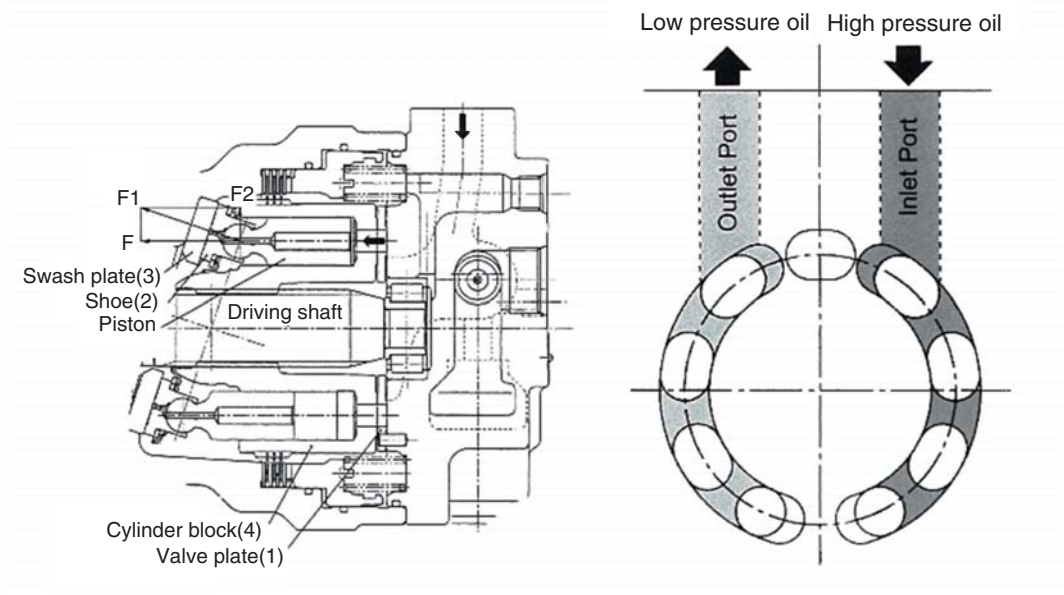
When the oil inflow/outflow direction are reversed, the rotating direction of the output shaft is reversed.

The theoretical output torque "T" is given by the following formula:

$$T = \frac{p \times q}{2 \times \pi} \cdot \frac{1}{100} \quad \text{N-m}$$

Where p : Effective pressure difference MPa

q : Displacement per revolution $cm^3$



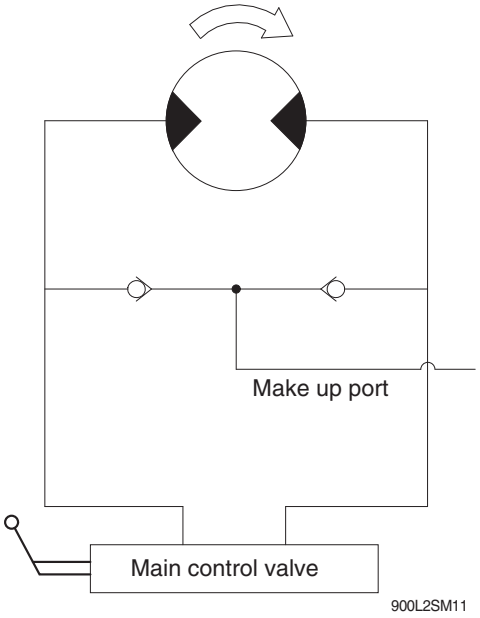

900L2SM10

## 2) VALVE CASING SECTION

### (1) Anti-cavitation check valve section

Some systems using motors of this type have no valves of counterbalance functions, and so the motors may be turned beyond their supplied oil flows.

In order to prevent cavitation due to oil shortage, check valves are fitted to suck short oil flows.




### (2) Relief valve

In acceleration or braking, the relief valve works and the pressure is kept at the set value. The relief valve provides a small shork less piston, and it works at the start of relief action and keeps the pressure low value for a short time. So smooth acceleration or braking with small shock is possible.

### (3) Anti-reaction valve

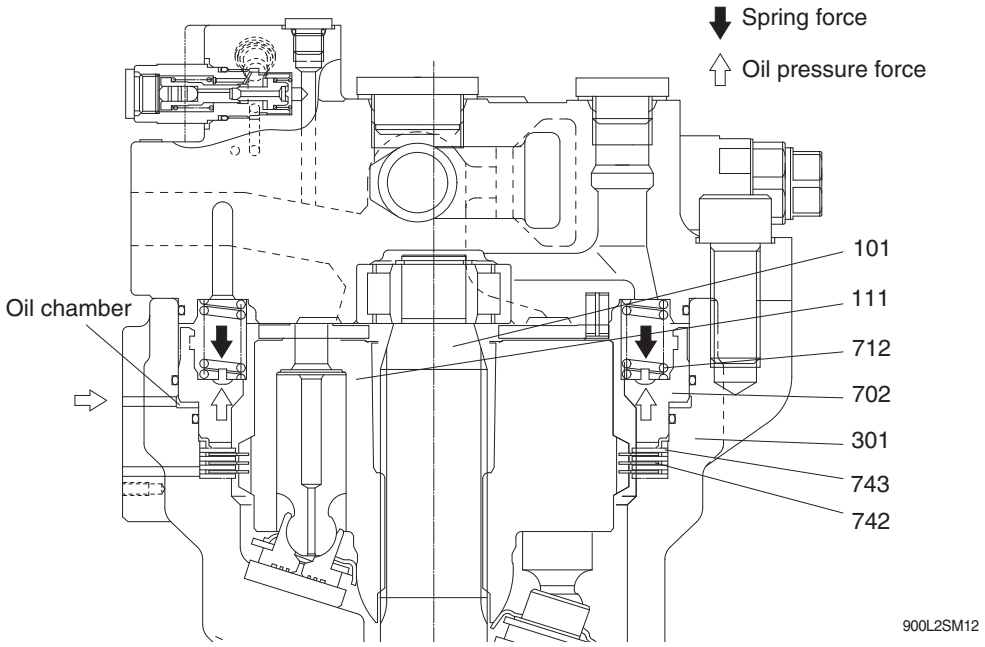
Right after braking, the high pressure remains a lttle at outlet port to make a motor swing back. Anti-reaction valves make oil passage from outlet side to inlet side in a moment to release the remained pressure. Therefore the swing back of the motor can be prevented.

### 3) BRAKE SECTION

The cylinder (111) is connected to the drive shaft (101) with a gear. In addition, the separator plate (743) is restrained from circumferentially - rotating by an arc groove cut on the casing (301).

When the friction plate (742) connected with a gear to the external periphery of the cylinder is pressed to the casing (301) by the brake spring (712) via the separator plate (743) and brake piston (702), friction force is generated among the friction plate, casing, separator plate and brake piston. This friction force restrains the driving gear and the brake is applied.

On the other hand, when the release pressure is applied to the oil chamber formed between the brake piston and casing and this pressure force overcomes the spring force, the brake piston moves and the fricrtion plate are not pushed to the casing and so the brake is released.



### 4) PARKING BRAKE

#### (1) PARKING BRAKE ON

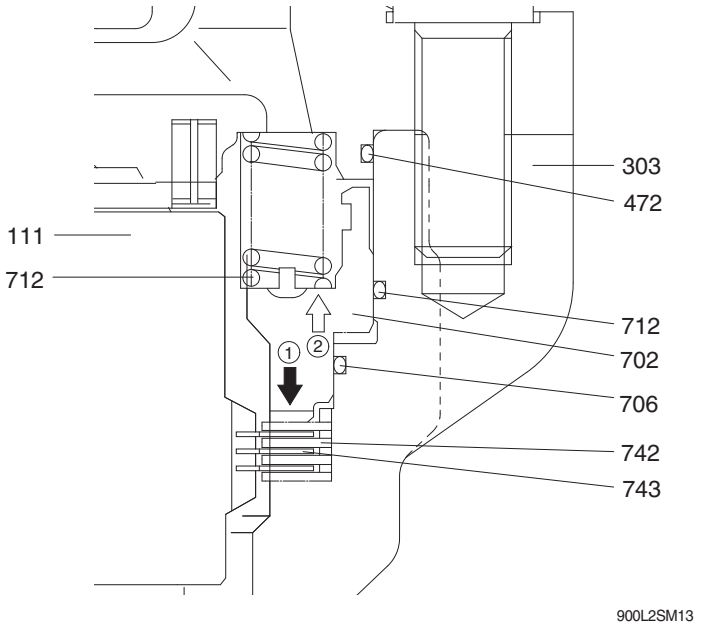
When the swing motor stops the parking brake is normally kept being fixed by mechanical force. When the brake release pressure is blocked, brake piston (702) is pushed by spring (712) force according to the arrow direction ①.

Consequently, friction plate (742) which is fixed to cylinder block (111) and separate plate (743) which is assembled to casing (303) are pressed. And then swing motor stops.

#### (2) PARKING BRAKE OFF

When the brake releases pressure-supply, the oil flows into room (G). Oil pressure is pressing the spring (712) force, and then brake piston (702) is pushed according to the arrow direction ②.

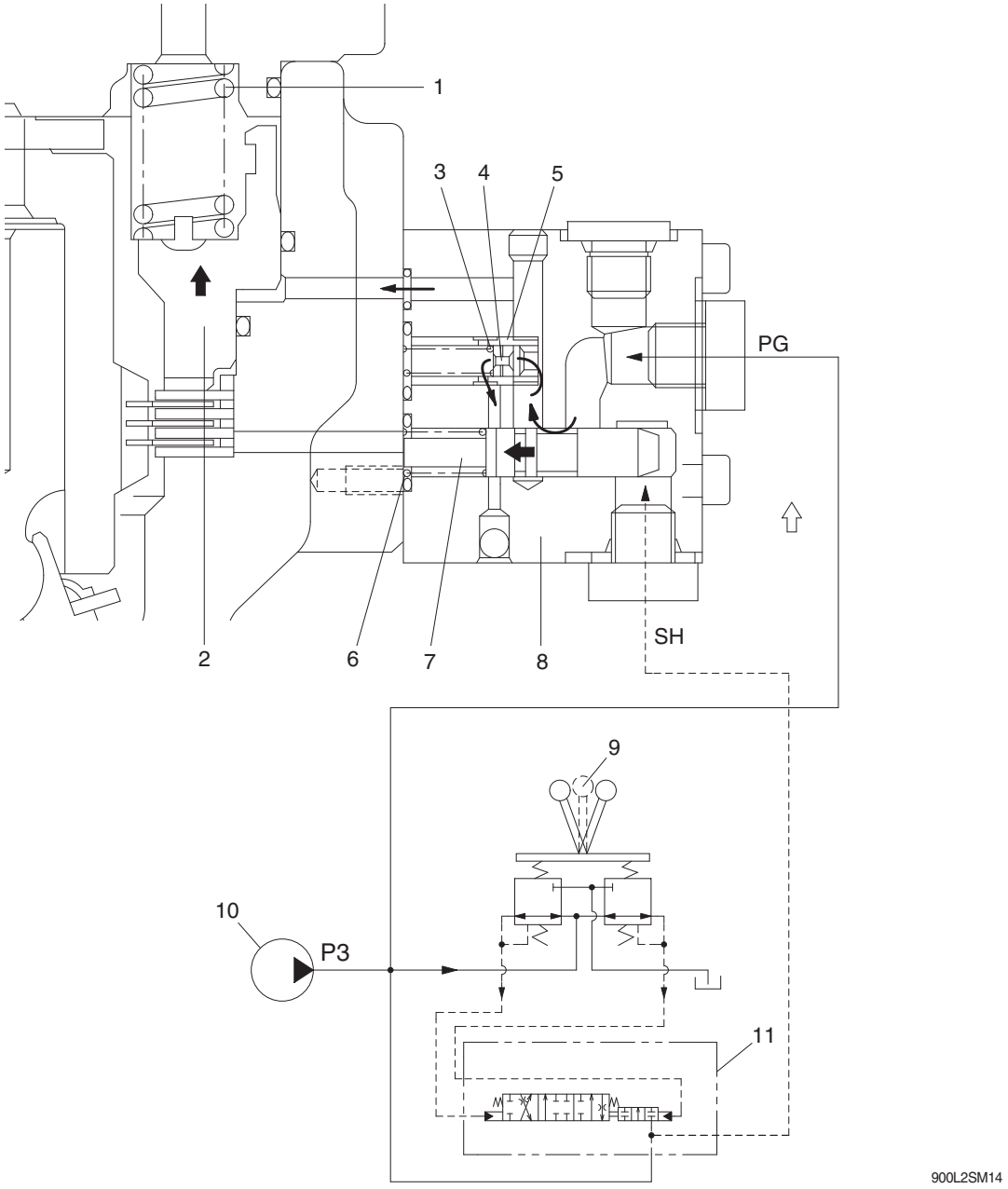
The pressure of friction plate (742) and separate plate (743) is released. Following this procedure the cylinder block (111) is rotating.




111 Cylinder block
303 Casing
472 O-ring
702 Brake piston
706 O-ring
707 O-ring
712 Spring
742 Friction plate
743 Separate plate

## 5) TIME DELAY VALVE

When the swing motor stops, time delay valve delays the parking brake function for a while.
For the parking brake works all of a sudden it may break the swing motor parts. When the swing control lever (9) sets up to the swing position, the pilot oil goes to the swing control valve (11) and to SH of the time delay valve (8) through the main control valve.
The oil pressure moves to the piston (2) to the upward against the force of the spring (1).
Thus the brake force is released.



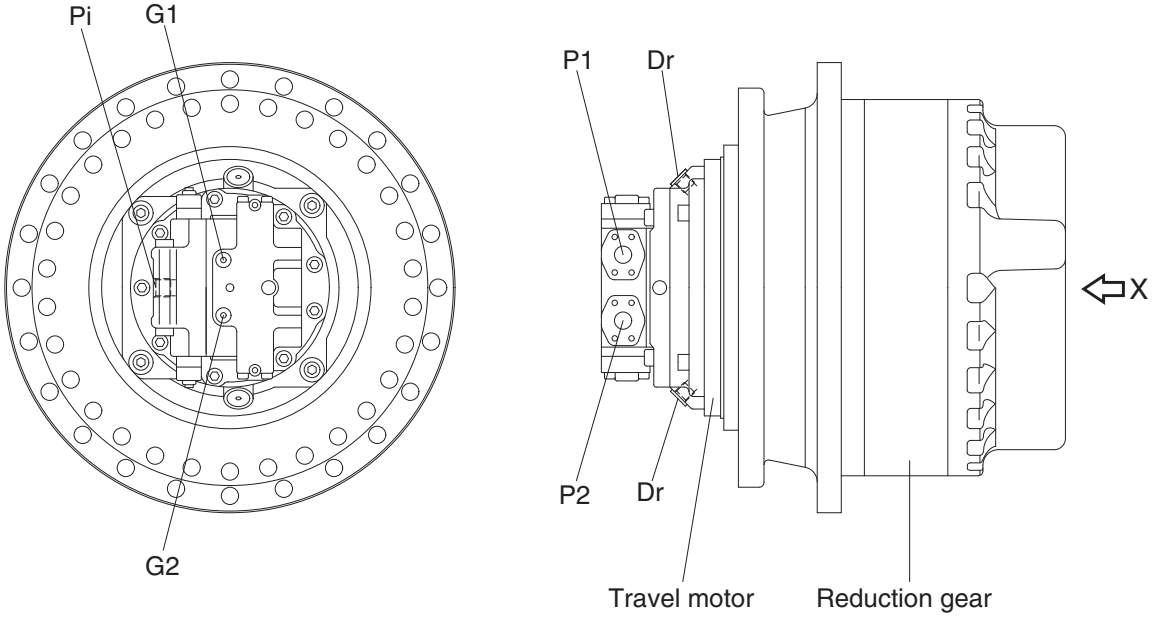

| | | | | | |
|---|---|---|---|---|---|
| 1 | Spring | 5 | Poppet | 9 | Swing control lever |
| 2 | Piston | 6 | Spring | 10 | Pilot pump |
| 3 | Spring | 7 | Spool | 11 | Main control valve |
| 4 | Orifice | 8 | Time delay valve | | |

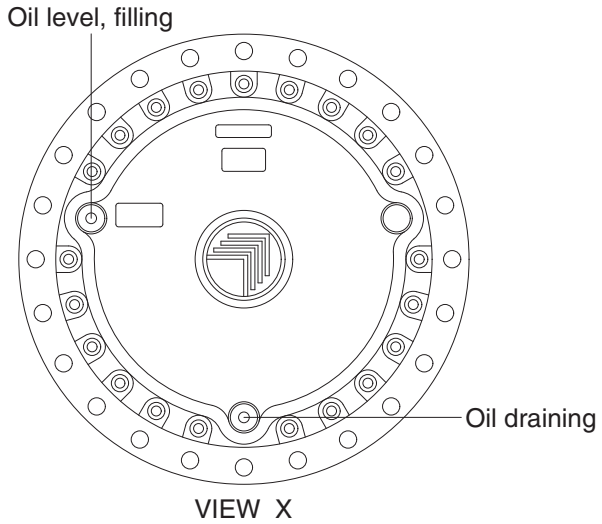
# GROUP 4 TRAVEL DEVICE

## 1. CONSTRUCTION

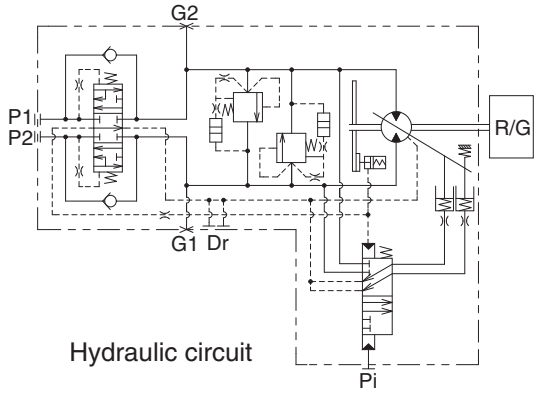
Travel device consists travel motor and gear box.

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



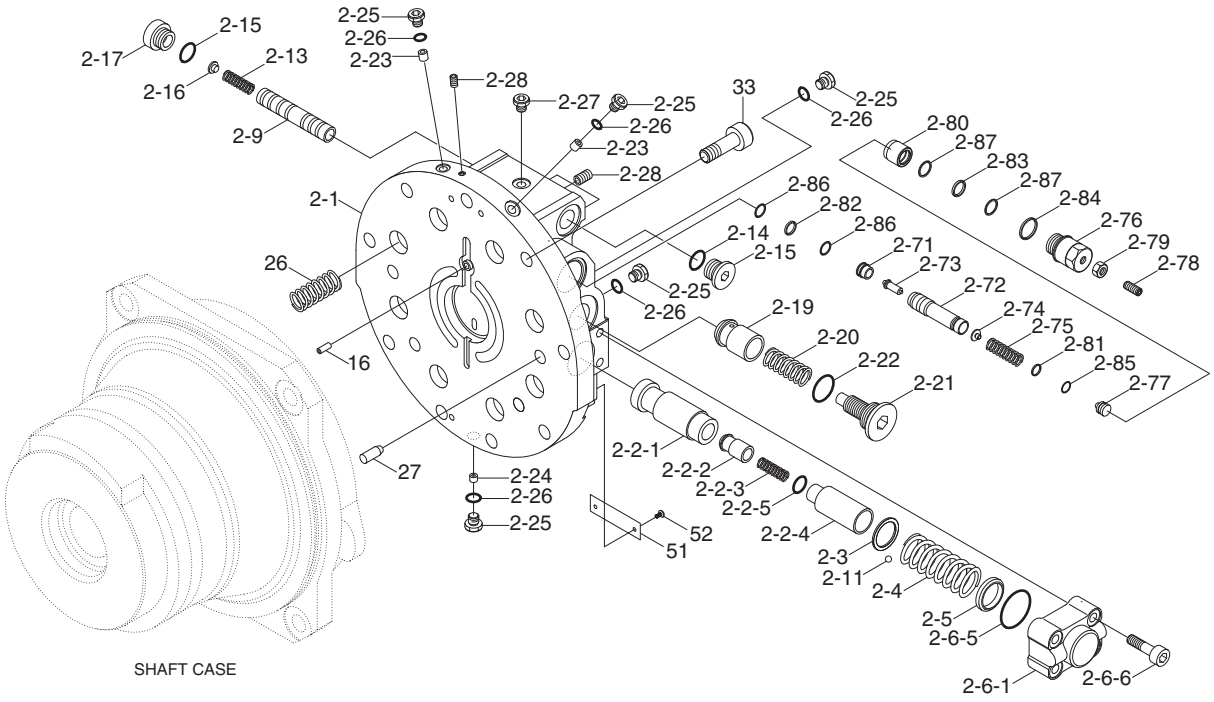




8007A2TM01




| Port | Port name | Port size |
|---|---|---|
| P1 | Main port | SAE 1" |
| P2 | Main port | SAE 1" |
| G1, G2 | Gauge port | PF 1/4 |
| Dr | Drain port | PF 3/4 |
| Pi | 2 speed control port | PF 1/4 |

## 1) TRAVEL MOTOR (1/2)

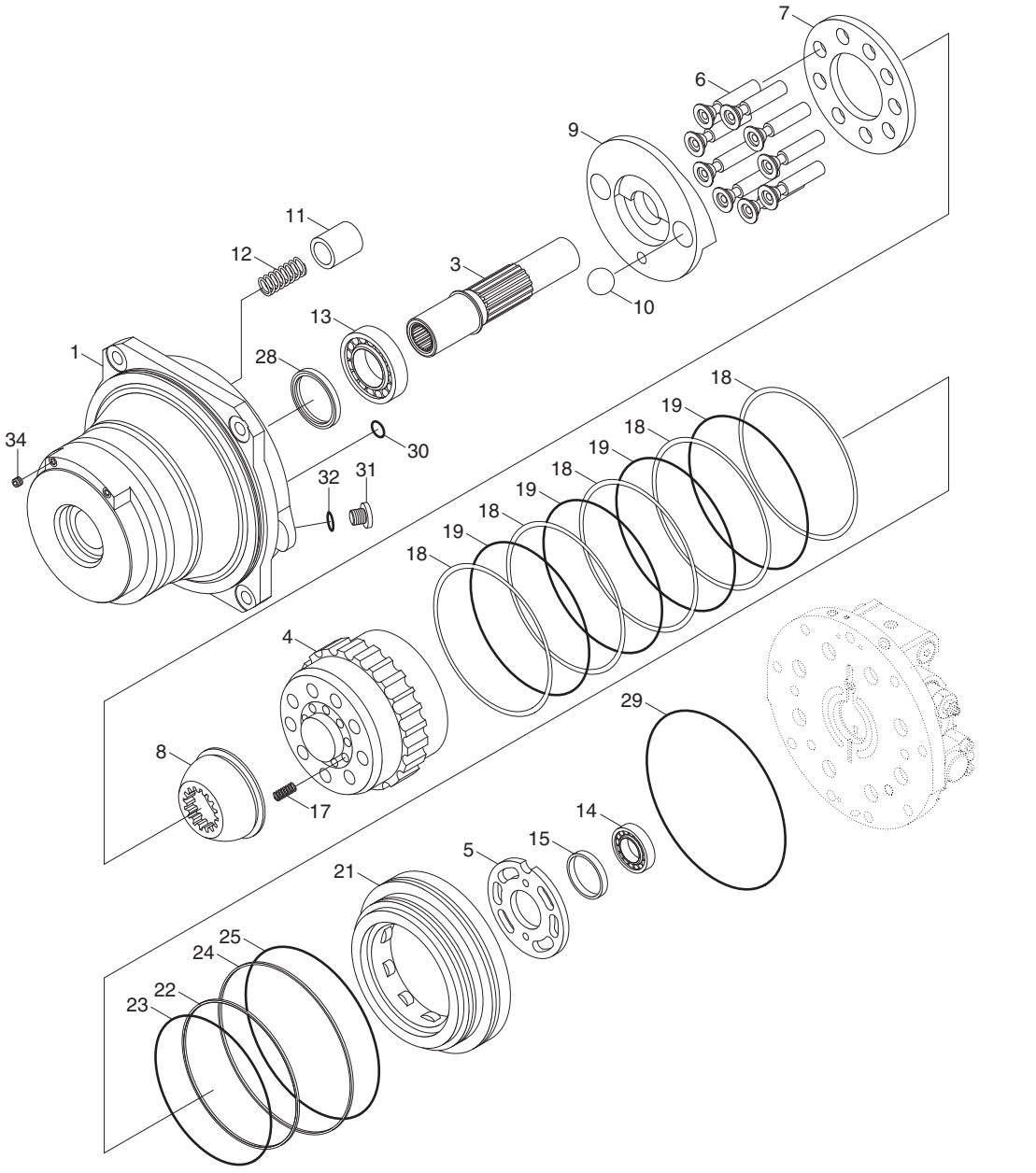



8007A2TM02

| | | | | | |
|---|---|---|---|---|---|
| 2-1 | Base plate | 2-7-5 | Spring | 2-15 | O-ring |
| 2-2 | Spool assy | 2-7-6 | Plug | 2-16 | Spring guide |
| 2-2-1 | Spool | 2-7-7 | Spring guide | 2-17 | Plug |
| 2-2-2 | Check valve | 2-7-8 | Set screw | 2-19 | Check valve |
| 2-2-3 | Spring | 2-7-9 | Nut | 2-20 | Spring |
| 2-2-4 | Plug | 2-80 | Free piston | 2-21 | Plug |
| 2-2-5 | O-ring | 2-81 | O-ring | 2-22 | O-ring |
| 2-3 | Spring seat | 2-82 | O-ring | 2-23 | Orifice |
| 2-4 | Spring | 2-83 | O-ring | 2-24 | Orifice |
| 2-5 | Spring seat | 2-84 | O-ring | 2-25 | Plug |
| 2-6 | Cap assy | 2-85 | Back up ring | 2-26 | O-ring |
| 2-6-1 | Cap | 2-86 | Back up ring | 2-27 | Shipping plug |
| 2-6-5 | O-ring | 2-87 | Back up ring | 2-28 | Plug |
| 2-6-6 | Bolt | 2-9 | Valve assy | 16 | Pin |
| 2-7 | Relief valve assy | 2-9-1 | Spool | 26 | Spring |
| 2-7-1 | Poppet seat | 2-9-2 | Spool-C | 27 | Pin |
| 2-7-2 | Relief housing | 2-11 | Orifice | 33 | Socket bolt |
| 2-7-3 | Poppet | 2-13 | Spring | 51 | Name plate |
| 2-7-4 | Spring seat | 2-14 | Plug | 52 | Drive screw |

## TRAVEL MOTOR (2/2)

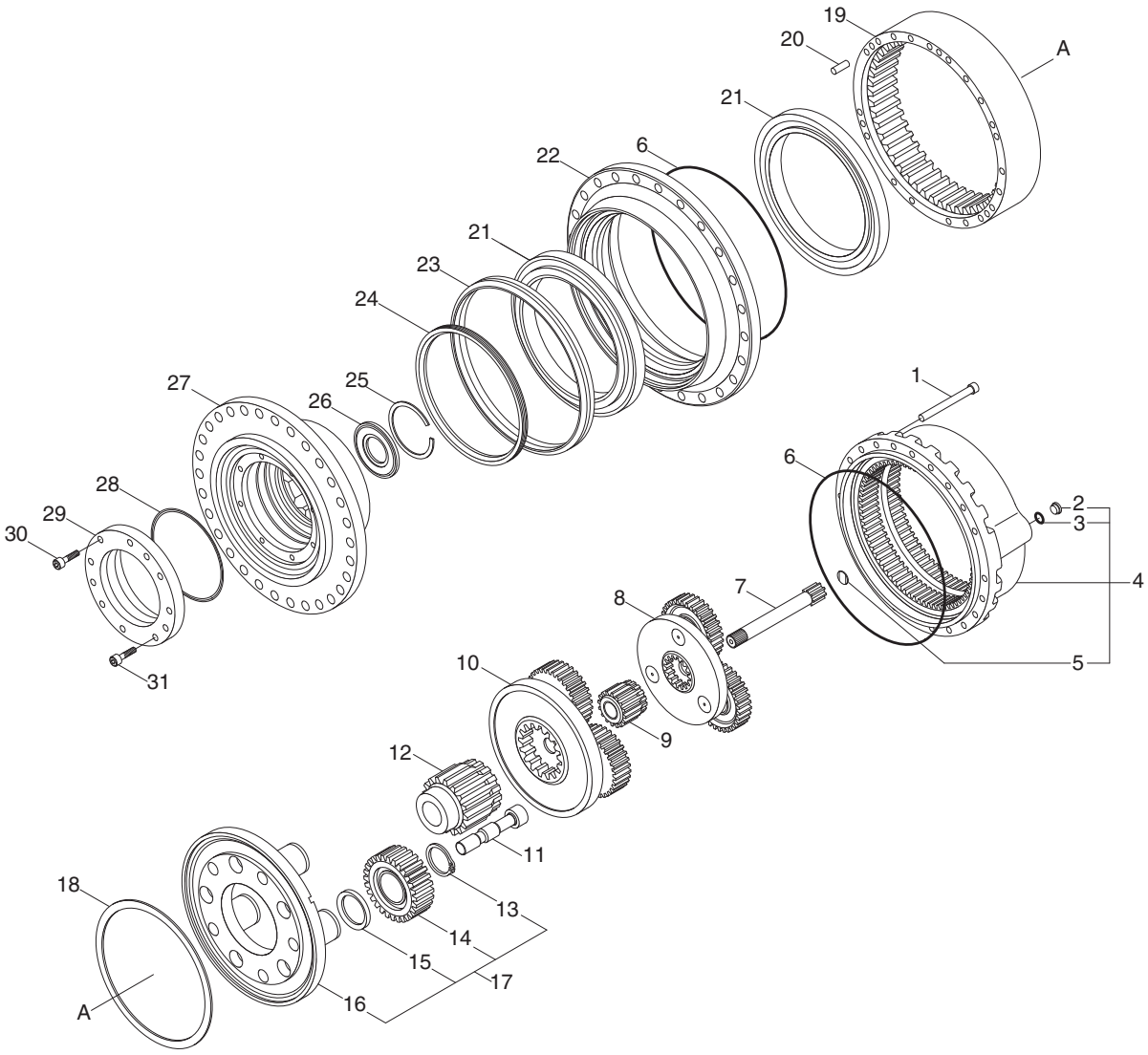
· Control part




8007A2TM03

| | | | | | |
|---|---|---|---|---|---|
| 1 | Case | 12 | Spring | 24 | O-ring |
| 3 | Shaft | 13 | Roller bearing | 25 | Back up ring |
| 4 | Cylinder block | 14 | Roller bearing | 28 | Oil seal |
| 5 | Valve plate | 15 | Collar | 29 | O-ring |
| 6 | Piston assy | 17 | Spring | 30 | O-ring |
| 7 | Retainer plate | 18 | Friction plate | 31 | Plug |
| 8 | Plate holder | 19 | Disc plate | 32 | O-ring |
| 9 | Swash plate | 21 | Brake piston | 34 | Plug |
| 10 | Steel ball | 22 | O-ring | | |
| 11 | Piston assy | 23 | Back up ring | | |

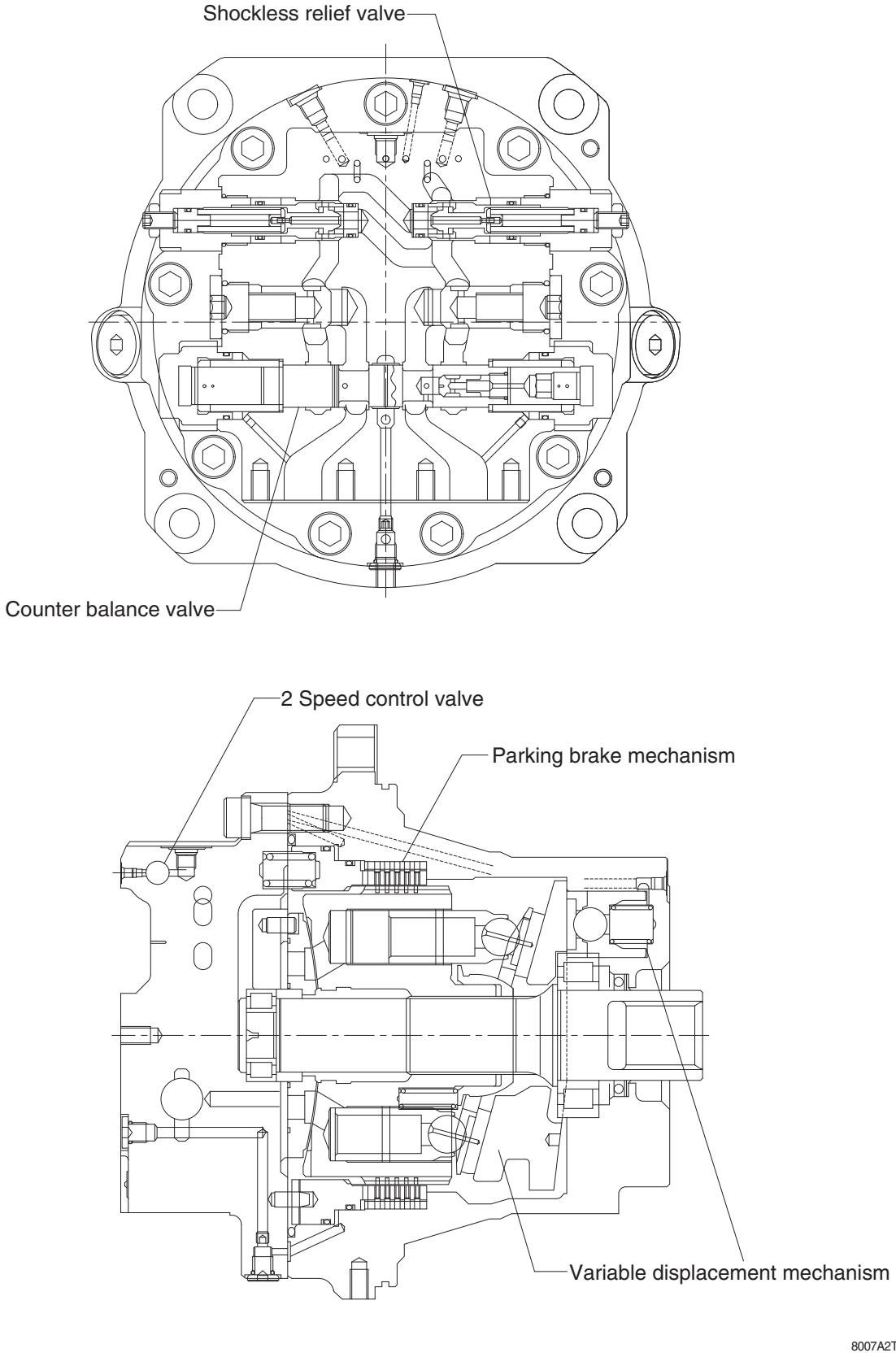
## 2) REDUCTION GEAR




8007A2TM04

| | | | | | |
|---|---|---|---|---|---|
| 1 | Screw | 12 | Sun gear | 23 | Life time seal |
| 2 | Oil breather plug | 13 | Circlip | 24 | Spacer |
| 3 | Washer | 14 | Planetary assy | 25 | Circlip |
| 4 | Cover assy | 15 | Spacer | 26 | Discs retainer |
| 5 | Pad | 16 | Planetary carrier | 27 | Hub |
| 6 | O-ring | 17 | Gear assy (3rd) | 28 | O-ring |
| 7 | Sun gear | 18 | Spacer | 29 | Motor adaptor |
| 8 | Gear assy(1st) | 19 | Toothed ring | 30 | Screw |
| 9 | Sun gear | 20 | Pin | 31 | Screw |
| 10 | Gear assy(2nd) | 21 | Bearing | | |
| 11 | Screw | 22 | Gear box housing | | |

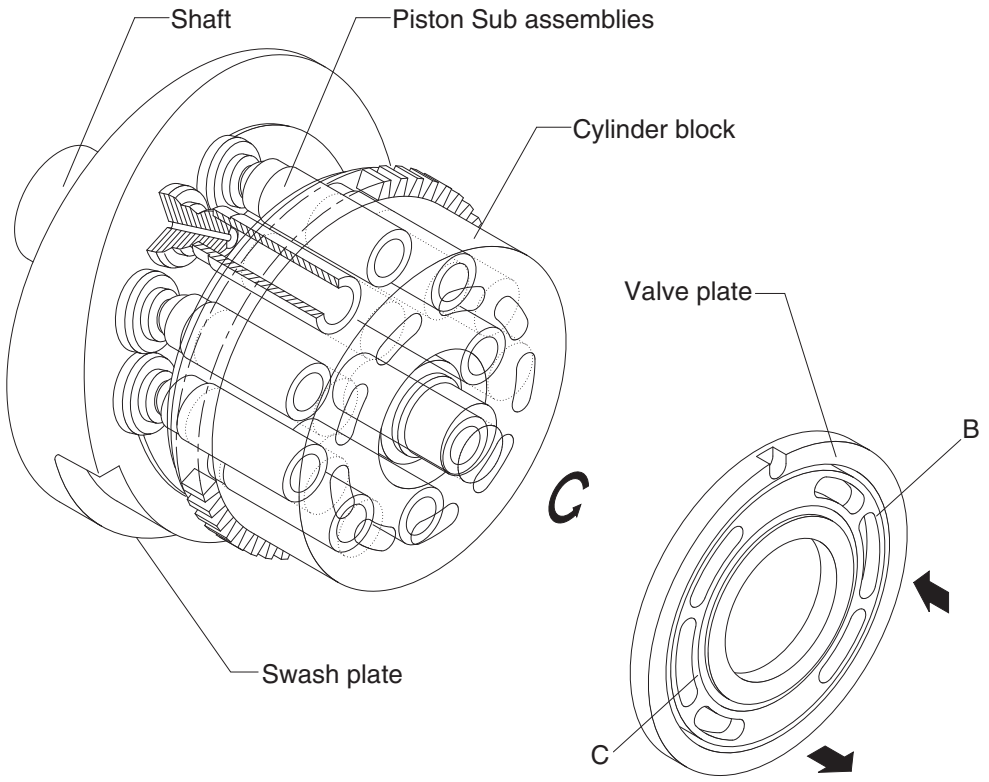
### 3) BASIC STRUCTURE




8007A2TM05

## 2. FUNCTION

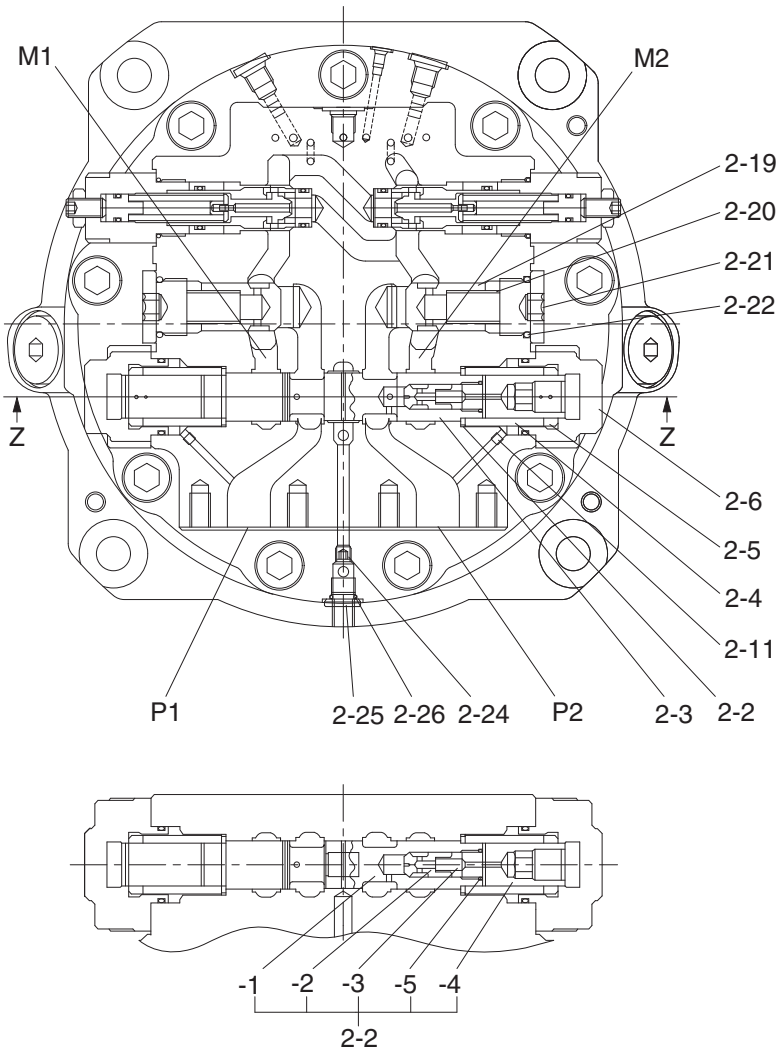
### 1) HYDRAULIC MOTOR




8007A2TM06

Nine piston sub assemblies are assembled in cylinder block. The end face of cylinder block is in contact with valve plate having two half moon shaped ports, B and C (high and low pressure ports).
When supplying pressure fluid (pressure P) to B port, swash plate is pushed by the force of piston sub assemblies having F = P · A (A: Piston pressure area). Piston sub assemblies receive the reaction force against it, and produce the reaction force (Ft) in rotating direction. The total force of high-pressure side piston sub assemblies in rotating direction produces a rotating force in the cylinder block, and the torque is transmitted to shaft through the spline resulting in the rotation of the shaft.

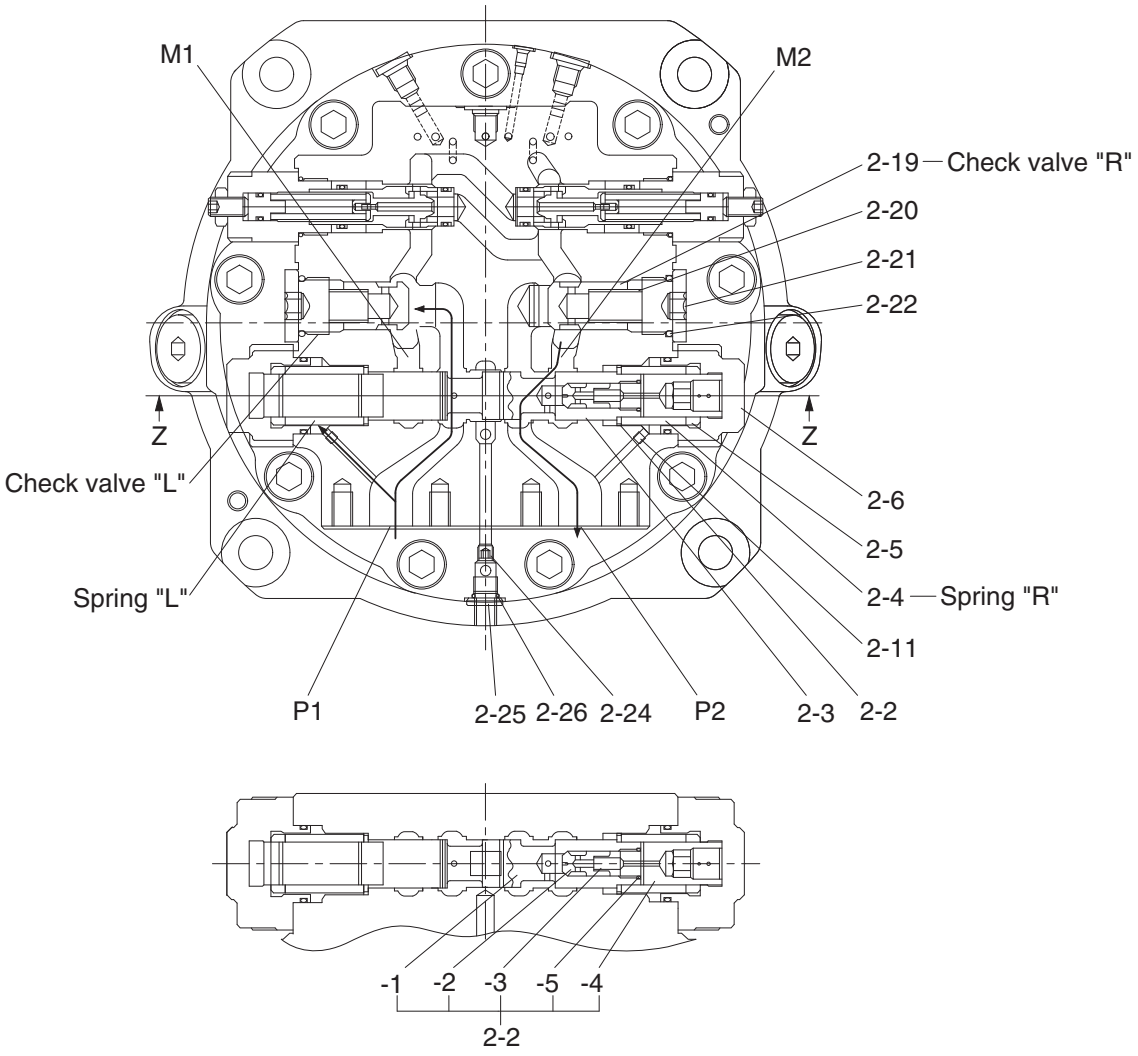
## 2) COUNTER BALANCE VALVE




8007A2TM07

The counter balance valve is provided to stop the axial piston motor and to prevent overrun. When the control valve is set to the neutral position, there is no pressure in the ports P1 and P2, and ports M1 and M2 are blocked by spool (2-2-1) and check valve (2-19), consequently the motor does not start rotating.

## (1) COUNTER BALANCE VALVE WORK




8007A2TM08

When the fluid is supplied from pump to counter balance valve port P1 through control valve, the fluid flows into piston motor through check valve "L" (2-19), and rotate the piston motor.

On the other hand, the return fluid from the piston motor flows into the counter balance valve through port M2, but the fluid is interrupted by check valve "R" (2-19), and consequently the pump delivery pressure will increase.

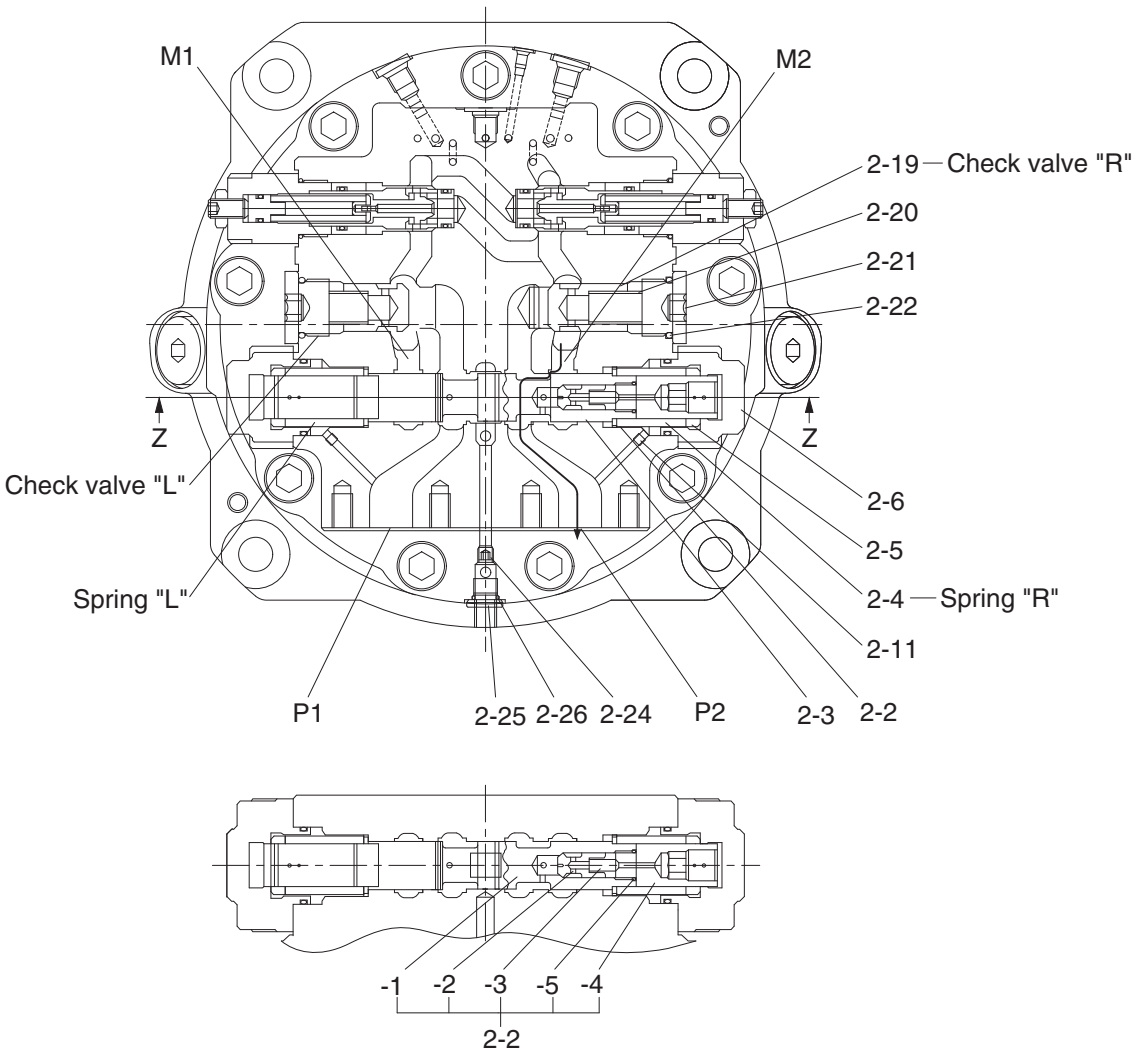
The high-pressure oil at port P1 passes through orifices "L" (2-11) pushes the end of face of spool assy (2-2) and pushes the plunger rightward against spring "R" (2-4) on the opposite side with the force proportional to the pressure.

When the hydraulic pressure rises to a certain pressure, spool assy (2-2) starts moving rightward, and the fluid in port M2 passes through the notch machined outer circular of spool assy (2-2) and flows into the port P2, producing a back pressure on the port M2, finally returning into the tank through a control valve.

And when the pump delivery pressure rises, the throttling aperture of the notch in spool assy (2-2) becomes larger, and consequently the backpressure of the port M2 becomes lower.

This way, the throttling aperture of the notch in spool assy (2-2) automatically adjusts the area of a return side passage in order to rotate the piston motor with the appropriate speed for Port P1 side flow rate (inlet flow).

## (2) BRAKE WORK




8007A2TM09

Then, when the control valve returns to the neutral position, the pressurized oil from the pump is shut off and the pressures of the ports P1 and P2 become equal. Spool assy (2-2) tries to be returned to neutral position by force of spring "R" (2-4).

When spool assy (2-2) moves, the throttle opening of plunger becomes small.

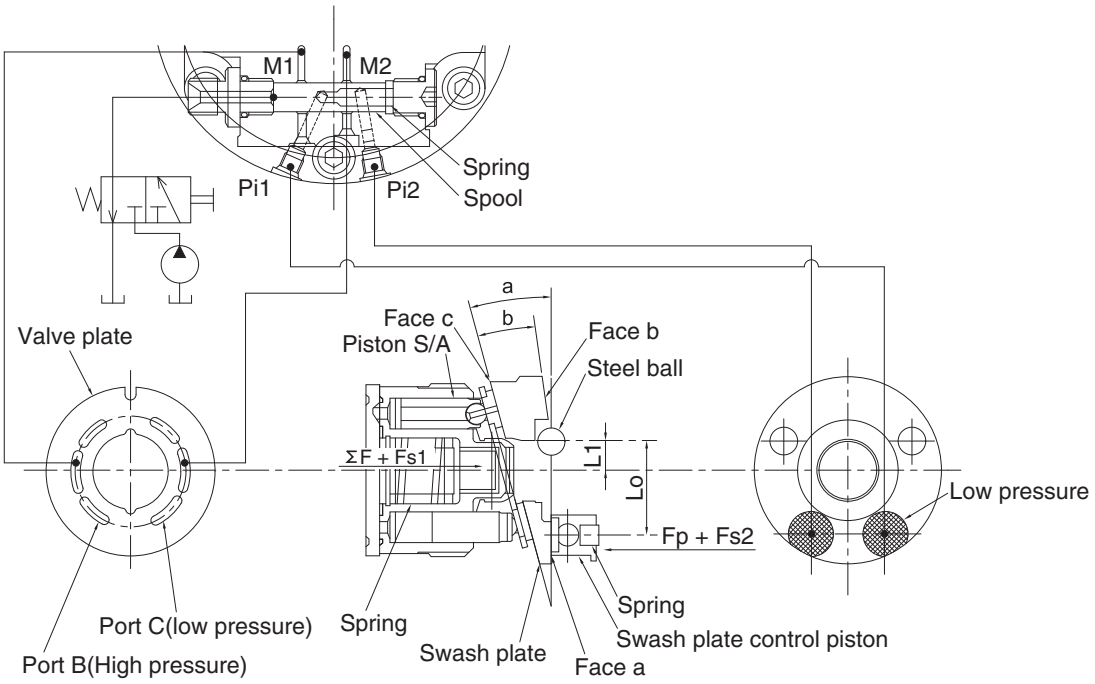
Piston motor tries to rotate with inertia energy (pumping action of motor) and the pressure rises on port M2.

With the movement of spool assy (2-2), the oil of spring "L" room flows out through orifices "L" (2-11) and controls the speed of spool assy (2-2).

By this movement, the shock pressure due to the inertia energy on the port M2 is absorbed, simultaneously preventing the cavitation on the port M1.

### 3) TWO SPEED CHANGE MECHANISM

#### (1) When running at 1st speed (low speed)



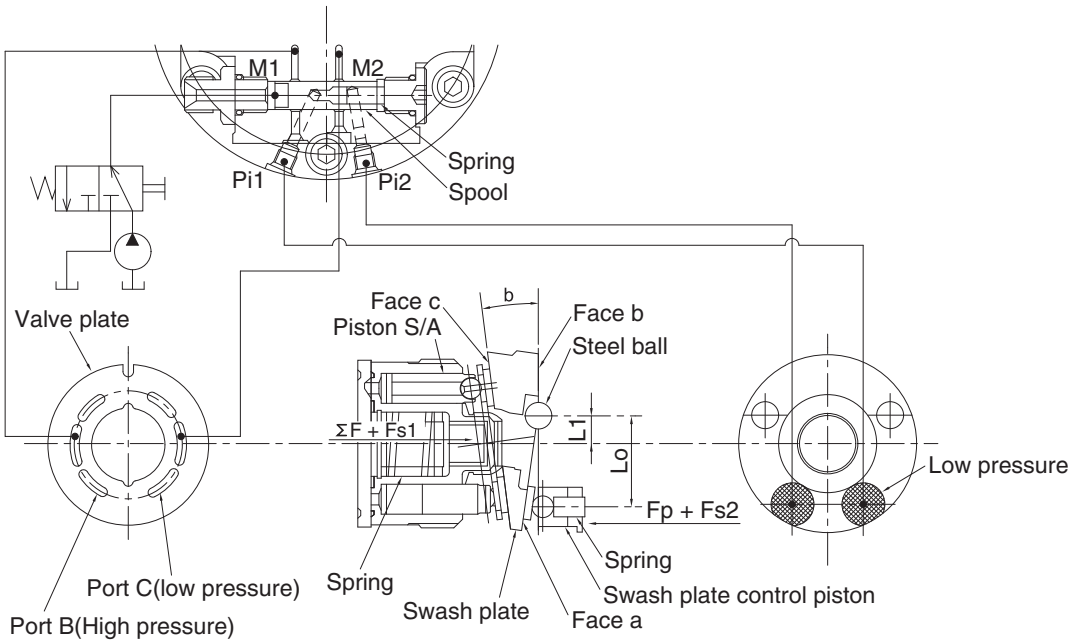

8007A2TM10

Swash plate has three faces, from "a" to "c", as shown in the figure, and installed in the flange holder with two steel balls in the condition where it can be tilted.
When the control valve is set to the 1st speed position, spool is placed in the position shown in upper figure by the force of spring, and the passage of swash plate control piston passes across the Pi1 and Pi2 port positions and led to the tank port. Therefore, the force pushing up the swash plate does not act on swash plate control piston.

Fp=(Ap×P)=0

Fp : Swash plate control piston thrust
Ap : Swash plate control piston pressure receiving area
P : Pressure

**(2) When running at 2nd speed** (high speed)




8007A2TM11

When control valve is set to the 2nd speed position, the pressure oil delivered by the pump is led to spool, and spool is switched to the position shown in the figure.
And the pressurized oil flows into each ports Pi1 and Pi2 through ports M1 and M2 and the motor driving pressure (P1: high pressure and P2: low pressure) is led to each swash plate control piston. Therefore the force pushing up the swash plate acts on swash plate control piston.

$$Fp1=Ap\times P1 \qquad Fp2=Ap\times P2$$

When steel ball is placed on the tilting center, the balance of moment acting on swash plate is in the condition of $(\sum F+Fs1)\times L1<(Fp+Fs2)\times Lo$ depending on the total $\sum F$ of driving force of piston S/A.
The face "b" of swash plate stabilizes and the swash plate angle becomes "$\beta$" angle, consequently the motor speed is the 2nd speed (high speed).
While the engine is stopped, spool is returned to the 1st speed position by the force of spring since pressurized oil does not flow. When steel ball is placed on the tilting center, the balance of moment acting on swash plate is in the condition of $Fs\times L1>Fp\times Lo$, the face "a" of swash plate stabilizes and the swash plate angle becomes "$\alpha$" angle, consequently the motor speed at starting is always the 1st speed.

## 4) AUTO TWO SPEED CHANGE MECHANISM

Auto two-speed control mechanism consists of two spools and spring. This valve automatically changes motor displacement in portion to motor pressure. This valve works while the pilot port "Ps" is pressurized.

### (1) Motor pressure is low.

The motor displacement is small (high speed displacement) as shown figure.

When the two-speed spool is on the right position. Motor pressure Pm1 and Pm2 are connected to each side of chamber of two speed piston. So swash plate is moved to high-speed position by two-speed piston and motor displacement is kept on high-speed position.

Pilot pressure is applied on the area "Ap" when Ps port is pressurized. Then the pressure of Ps pushes the spool to the right direction on figure. At the same time,

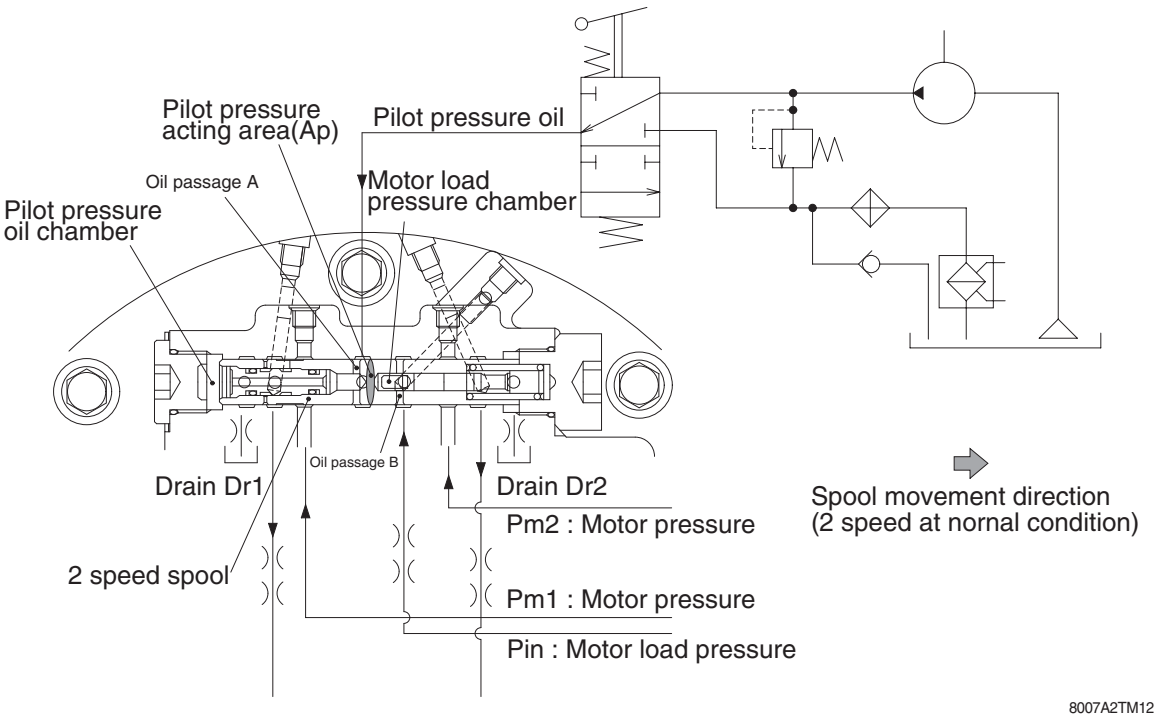
Motor inlet pressure is applied on the area "Am". So, the spool is also applied to the left direction by Am pressure. According to above, if the motor pressure is lower and keeps the following condition, the spool stays on the right position.

$$Ps \times Ap \rangle Am \times Pin + Kx$$

Kx : Spring force

AP : Swash plate control piston pressure receiving area

Ps : Pilot pressure




8007A2TM12

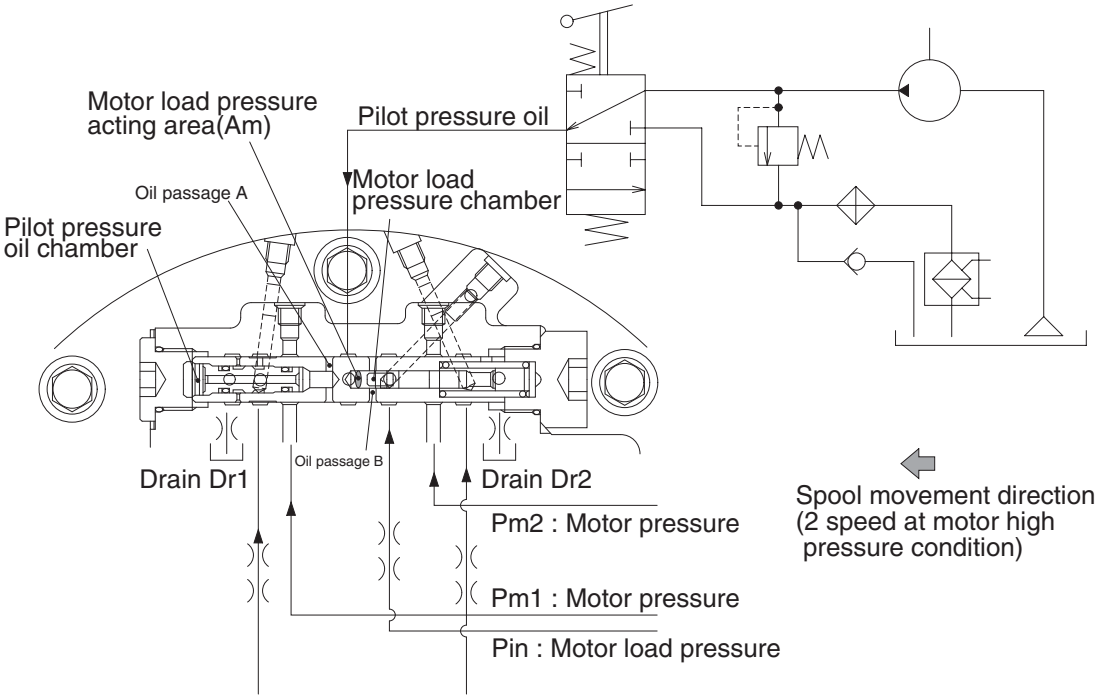
**(2) Motor pressure is low.**

The motor displacement is large (low speed displacement) as shown figure.

The two-speed spool is on the left position if Pin pressure is high. Then, Pm1 and Pm2 are shuttled by the spool.

If the motor pressure is higher and keeps the following condition, the spool stays on the left position.

$$Ps \times Ap < Am \times Pin + Kx$$




8007A2TM13

### 5) RELIEF VALVE

The relief valves determine the drive force and the brake force for hydraulic excavator travel and are installed in the main port M1 and M2 lines.

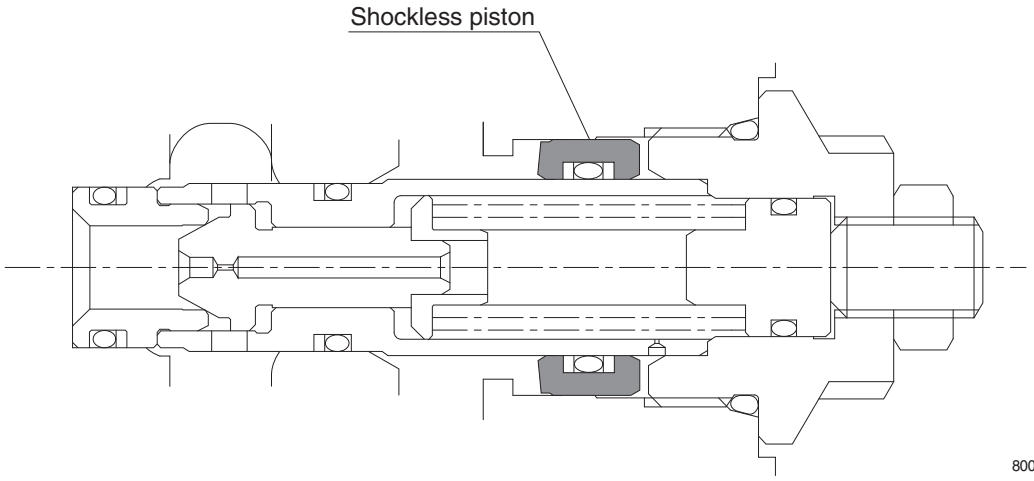
A shock less function is also incorporated to reduce shock produced at the start of both acceleration and deceleration.

#### (1) The construction of the relief valve.

① A direct-acting differential area type relief valve

② A shockless piston

The installation of a shockless type relief valve helps reduce.



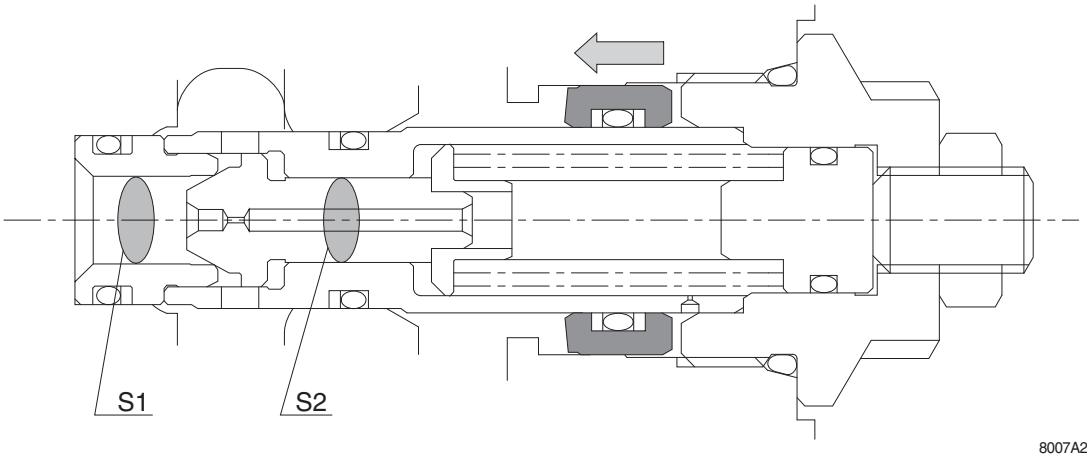

8007A2TM16

#### (2) The relief valve operates in two stages as follows.

① First stage

At the start of operation, the shockless piston moves to maintain the spring chamber at a low pressure. Thus, the pressure receiving area of the poppet becomes the poppet seat area (S1), a considerably larger area than the pressure receiving area (S1- S2) at the specified relief setting. For this reason, the relief operating pressure is kept at a low pressure until the shockless piston completes its movement.

The low pressure holding time depends on the poppet orifice diameter, the free piston pressure receiving area and the free piston stroke.

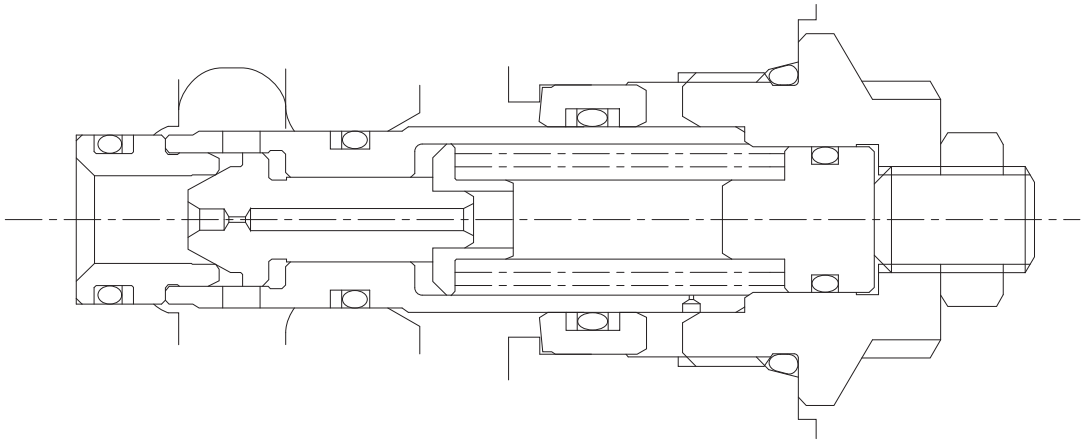



8007A2TM15

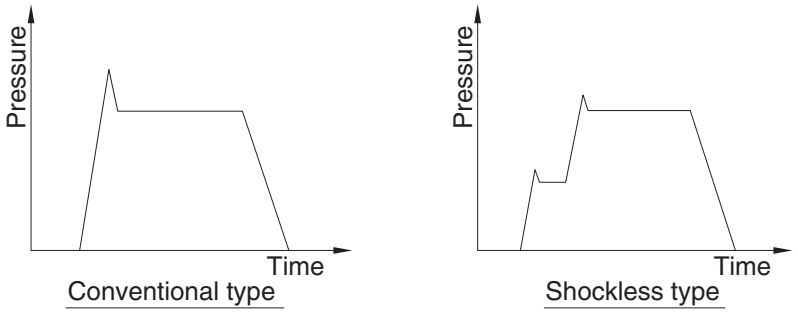
② **Second stage**

When the shockless piston completes its movement, the pressure inside the spring chamber increases to make the pressures before and after the poppet equal.

Then the relief valve operates at the specified set pressure.

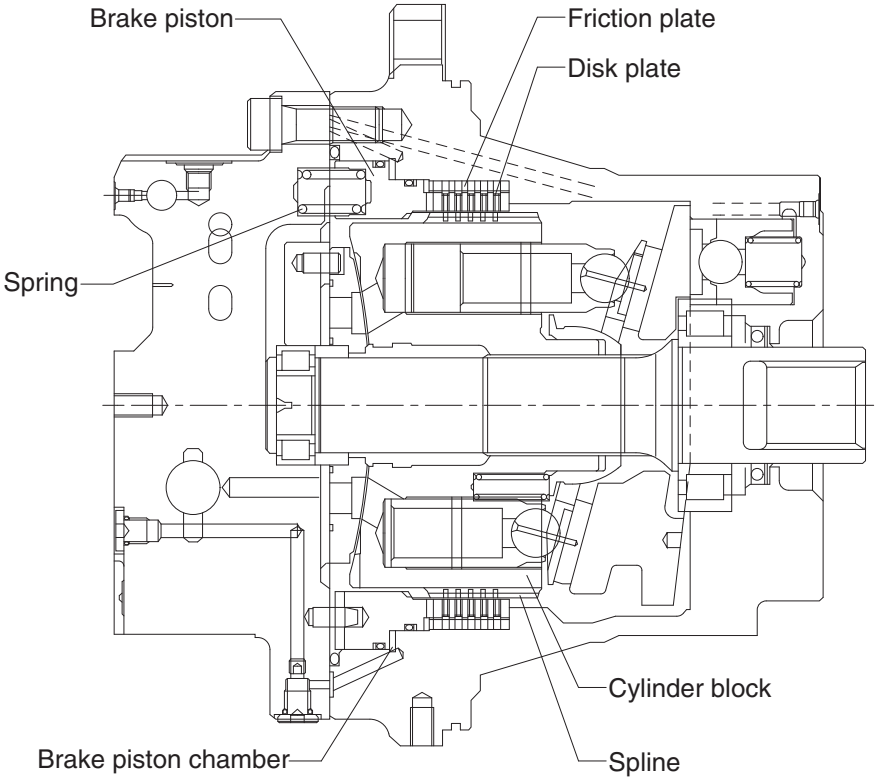


8007A2TM14




8007A2TM17

### 6) PARKING BRAKE

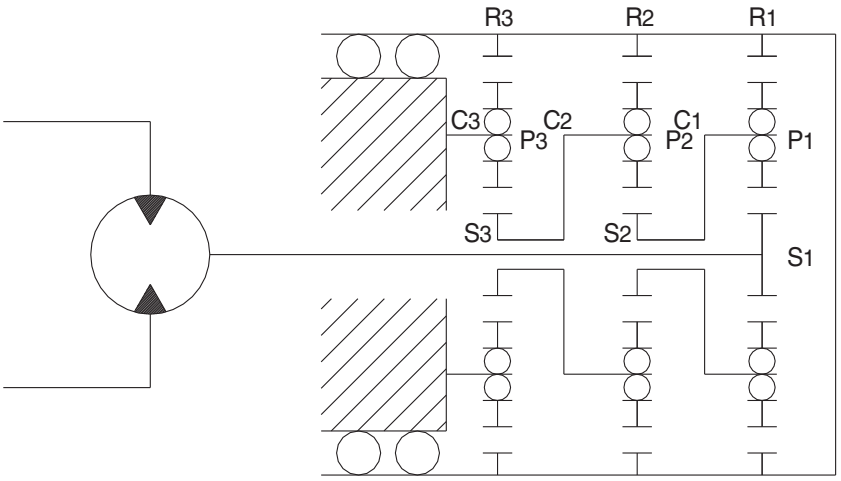



8007A2TM18A

The parking brake is a kind of negative brake which consist of disk, brake piston, friction plate and spring.
The cylinder block and disk are combined with a spline, and friction material is bonded on both sides of disk.
The disk generates frictional force between the case, the friction plate and the brake piston by the force of spring and restricts the rotating force of the motor, achieving the best performance of the parking brake.
When the pressurized oil flows into the motor, the plunger moves and the parking brake release port is opened.
After the oil flows into brake piston chamber, the thrust "F" is generated, corresponding to the pressure receiving surface of brake piston and the thrust "F" becomes larger than the force of spring "f", consequently the brake piston moves toward right.
Then, the disk rotates freely between the flange holder and brake piston, and parking brake is released.
When the motor is stopped, the plunger returns to the neutral position and the parking brake release port is closed. Consequently the pressurized oil in brake piston chamber flows into motor case, the parking brake acts by the force of spring.

## 7) REDUCTION GEAR

The reduction gear is composed of a three-stage planetary gear mechanism shown in the following figure. Since the sun gear is designed to have a floating mechanism, errors of the gears and carrier pin hole pitches will not affect the gears' lives heavily.




R290TM08(1)

The input rotation of the hydraulic motor is transmitted to No. 1 sun gear (S1) and this drives No. 1 planetary gears (P1). This No. 1 planetary gears (P1) drive No.1 ring gear (R1) with the same force as the meshing tangential force with No. 1 sun gear (S1), and also No. 1 carrier (C1) with the same force as the meshing reaction force. In other words, No. 1 planetary gears (P1) revolve rotating. This rotation of No. 1 carrier (C1) becomes the output of the 1st stage, and is transmitted directly to No. 2 sun gear (S2).

(No. 1 carrier is spline-coupled with No. 2 sun gear.) Similarly the revolution of No. 2 planetary gear (P2) are transmitted via No.2 carrier (C2) to No. 3 sun gear (S3). Since No. 3 carrier (C3) supporting No. 3 planetary gears (P3) are fixed, No. 3 planetary gears (P3) do not revolve, but rotates to drive No. 3 ring gears (R3).

Therefore, the rotating case is driven by the overall driving torque of numbers.

1,2 and 3 ring gears. This reduction ratio is expressed as shown below:

$$i = \frac{(Z_{S1} + Z_{r1})\,(Z_{S2} + Z_{r2})\,(Z_{S3} + Z_{r3})}{Z_{S1} \cdot Z_{S2} \cdot Z_{S3}} - 1$$

Where Z : Number of teeth of each gear

The direction of rotation is reverse to that of the input shaft.

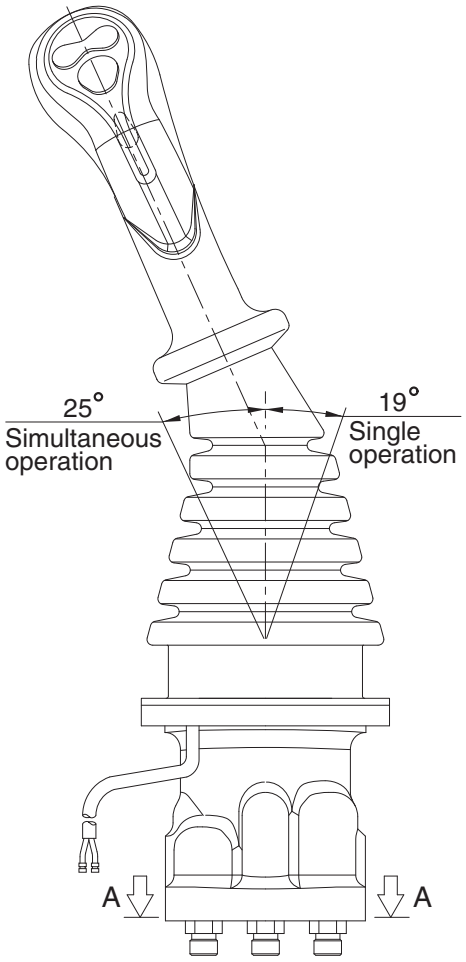
# GROUP 5 RCV LEVER

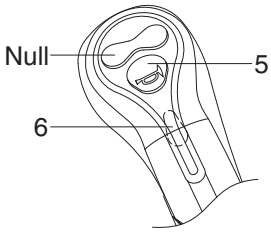
## 1. STRUCTURE

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 L1, L3, L10

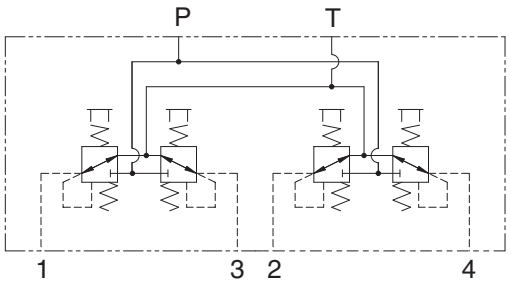


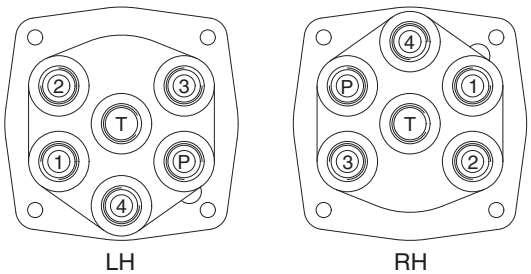

TYPE L1, L3, L10

**Switches**

| Type | No. | LH | RH |
|---|---|---|---|
| L1, L3, L10 | 5 | One touch decel | Horn |
| | 6 | Power boost | Breaker |




Hydraulic circuit




LH RH

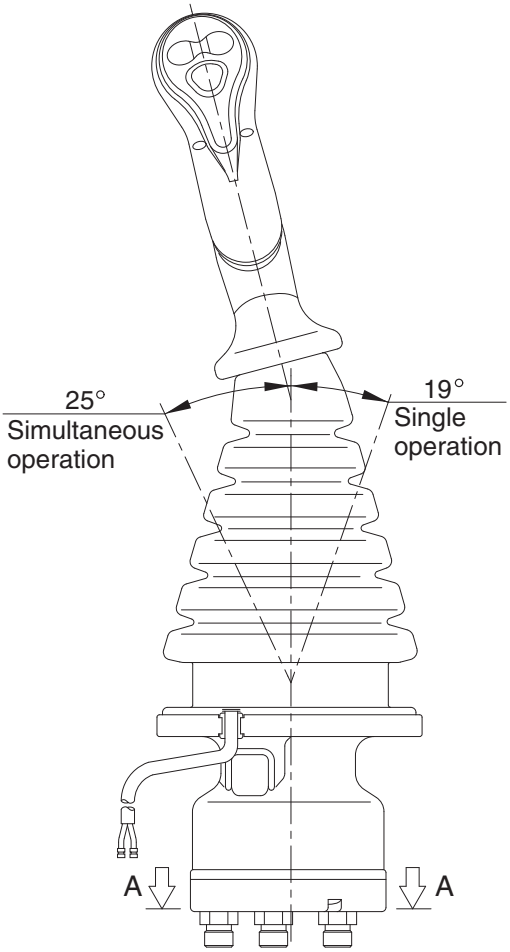
VIEW A-A

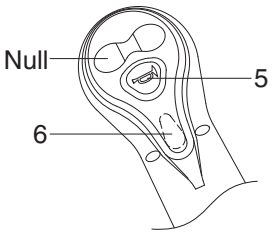
**Pilot ports**

| 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 | |

300L2RaL101

## 2) TYPE L2, L4, L9

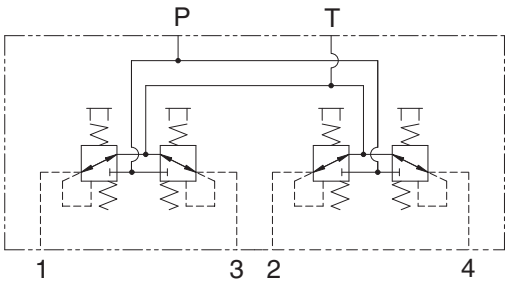


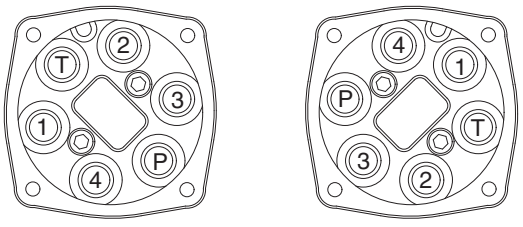

TYPE L2, L4, L9

**Switches**

| Type | No. | LH | RH |
|---|---|---|---|
| L2, L4, L9 | 5 | One touch decel | Horn |
| | 6 | Power boost | Breaker |




Hydraulic circuit




LH RH

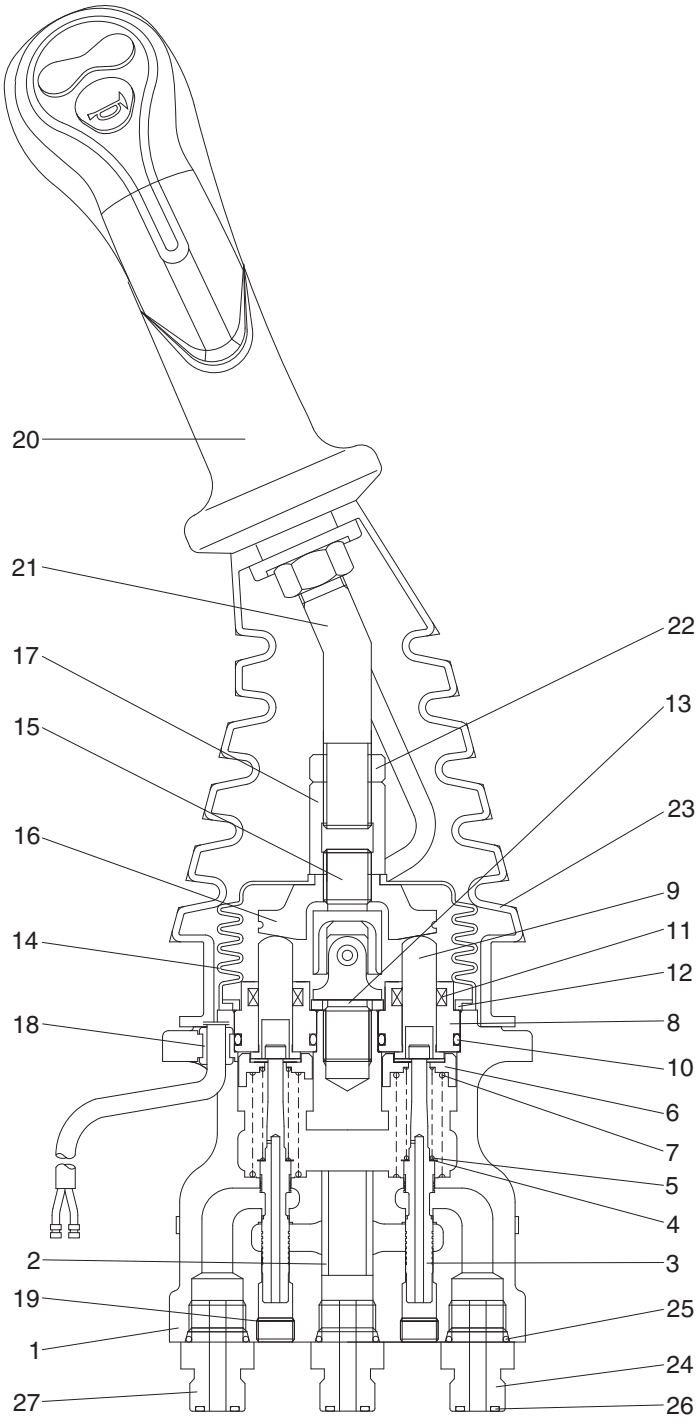
VIEW A-A

**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 | |

900L2RL105

### 3) CROSS SECTION




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

300L2RL06

**Item numbers are based on the type L1.**

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 $kgf/cm^2$ (depending on the type). The spool is pushed against the push rod (9) by the return spring.

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

## 2. FUNCTIONS

### 1) FUNDAMENTAL FUNCTIONS

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

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

(1) Inlet port (P) where oil is supplied from hydraulic pump.

(2) Output ports (1, 2, 3 & 4) to apply pressure supplied from inlet port to ends of control valve spools.

(3) Tank port (T) necessary to control the above output pressure.

(4) Spool to connect output port to inlet port or tank port.

(5) Mechanical means to control output pressure, including springs that work on the above spools.

### 2) FUNCTIONS OF MAJOR SECTIONS

**Item numbers are based on the type L1.**

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

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

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

For the purpose of changing the displacement of the push rod through the swash plate (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.

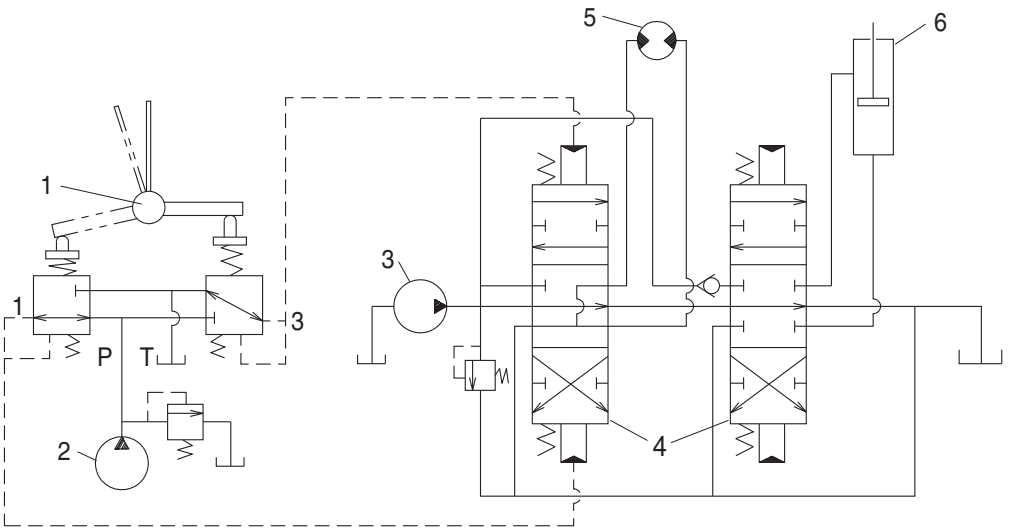
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

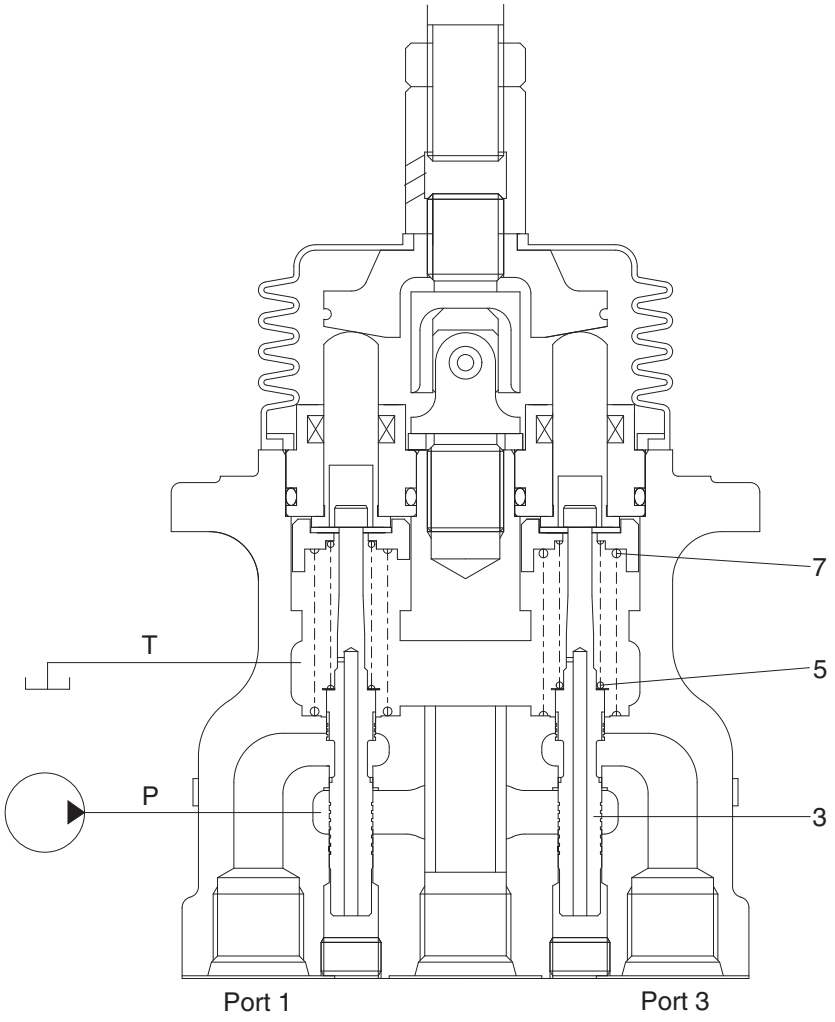
The diagram shown below is the typical application example of the pilot valve.




2-70

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

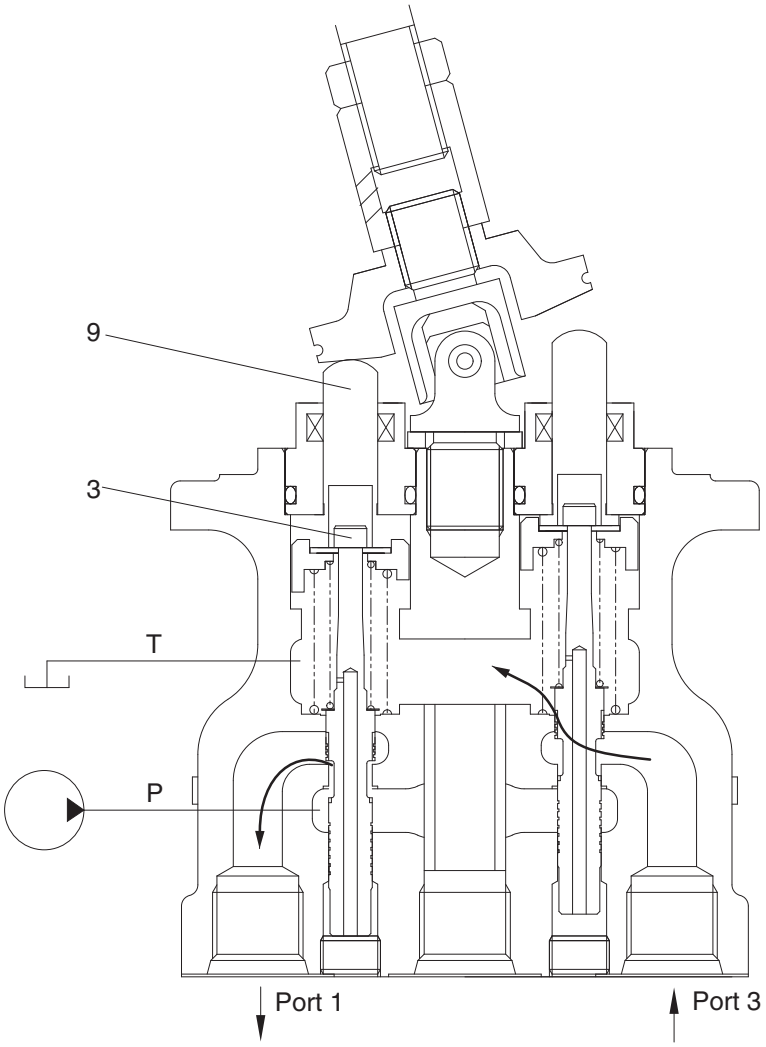
(1) Case where handle is in neutral position




300L2RL03

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

(2) Case where handle is tilted



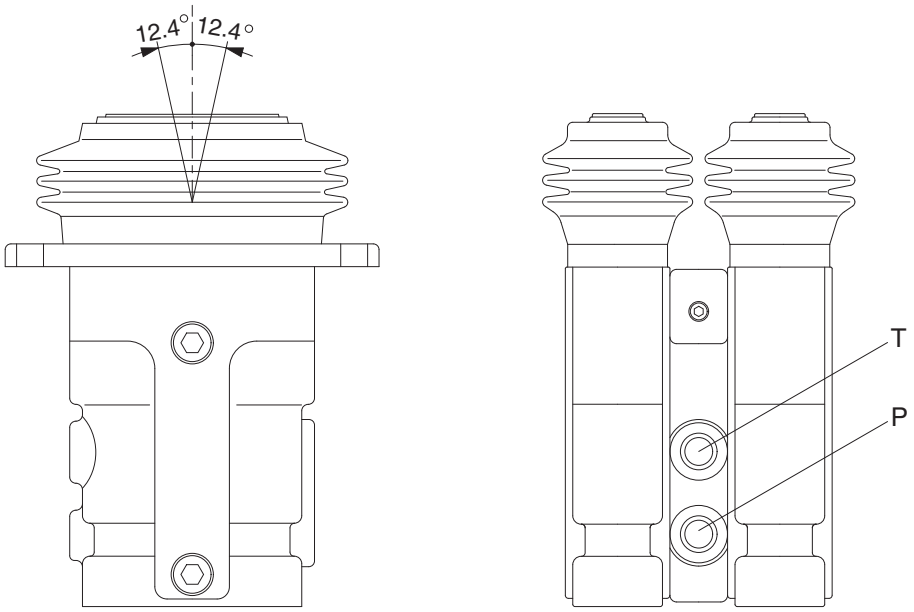

300L2RL04

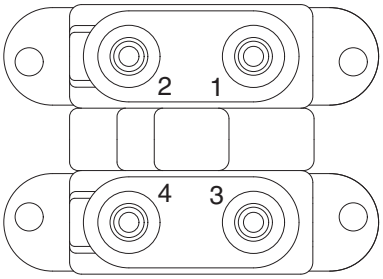
When the push rod (9) is stroked, the spool (3) moves downwards.
Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.
When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

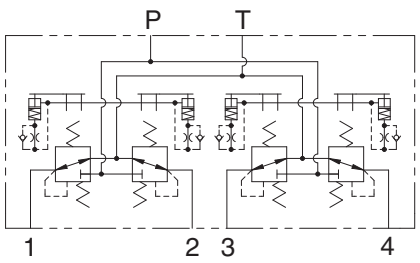
# GROUP 6 RCV PEDAL (-#0003)

## 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) | |

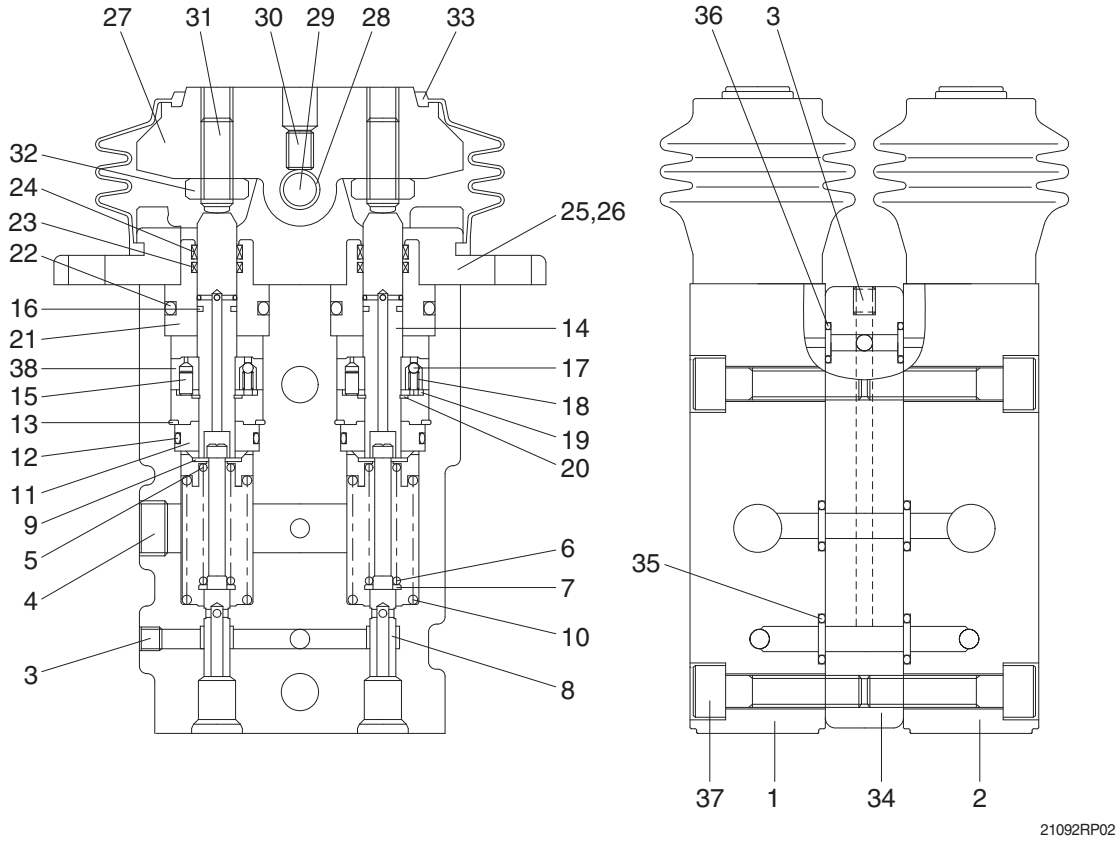
21092RP01

## CROSS SECTION

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

The pressure reducing section is composed of the spool (8), spring (6) for setting secondary pressure, return spring (10), stopper (9), and spring seat (7). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 19 kgf/cm² (depending on the type). The spool is pushed against the push rod (14) by the return spring.

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




| | | | | | |
|---|---|---|---|---|---|
| 1 | Body(1) | 14 | Push rod | 27 | Cam |
| 2 | Body(2) | 15 | Spring pin | 28 | Bushing |
| 3 | Plug | 16 | Seal | 29 | Cam shaft |
| 4 | Plug | 17 | Steel ball | 30 | Set screw |
| 5 | Spring seat | 18 | Spring | 31 | Set screw |
| 6 | Spring | 19 | Plate | 32 | Nut |
| 7 | Spring seat | 20 | Snap ring | 33 | Bellows |
| 8 | Spool | 21 | Plug | 34 | Space |
| 9 | Stopper | 22 | O-ring | 35 | O-ring |
| 10 | Spring | 23 | Rod seal | 36 | O-ring |
| 11 | Rod guide | 24 | Dust seal | 37 | Socket bolt |
| 12 | O-ring | 25 | Cover | 38 | Piston |
| 13 | Snap ring | 26 | Socket bolt | | |

## 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 (14) is inserted and can slide in the plug (21).

For the purpose of changing the displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

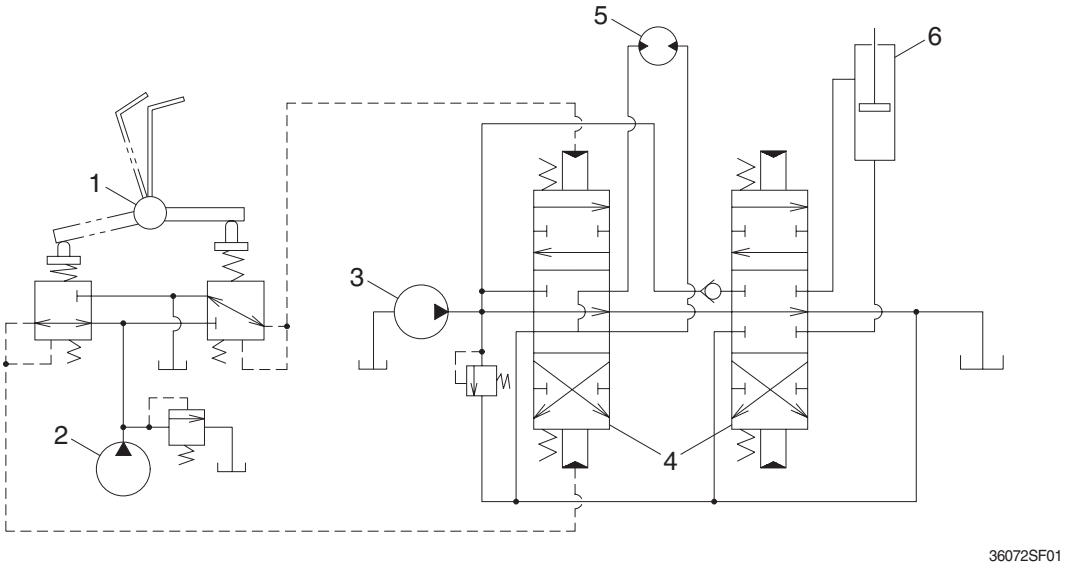
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

### 3) OPERATION

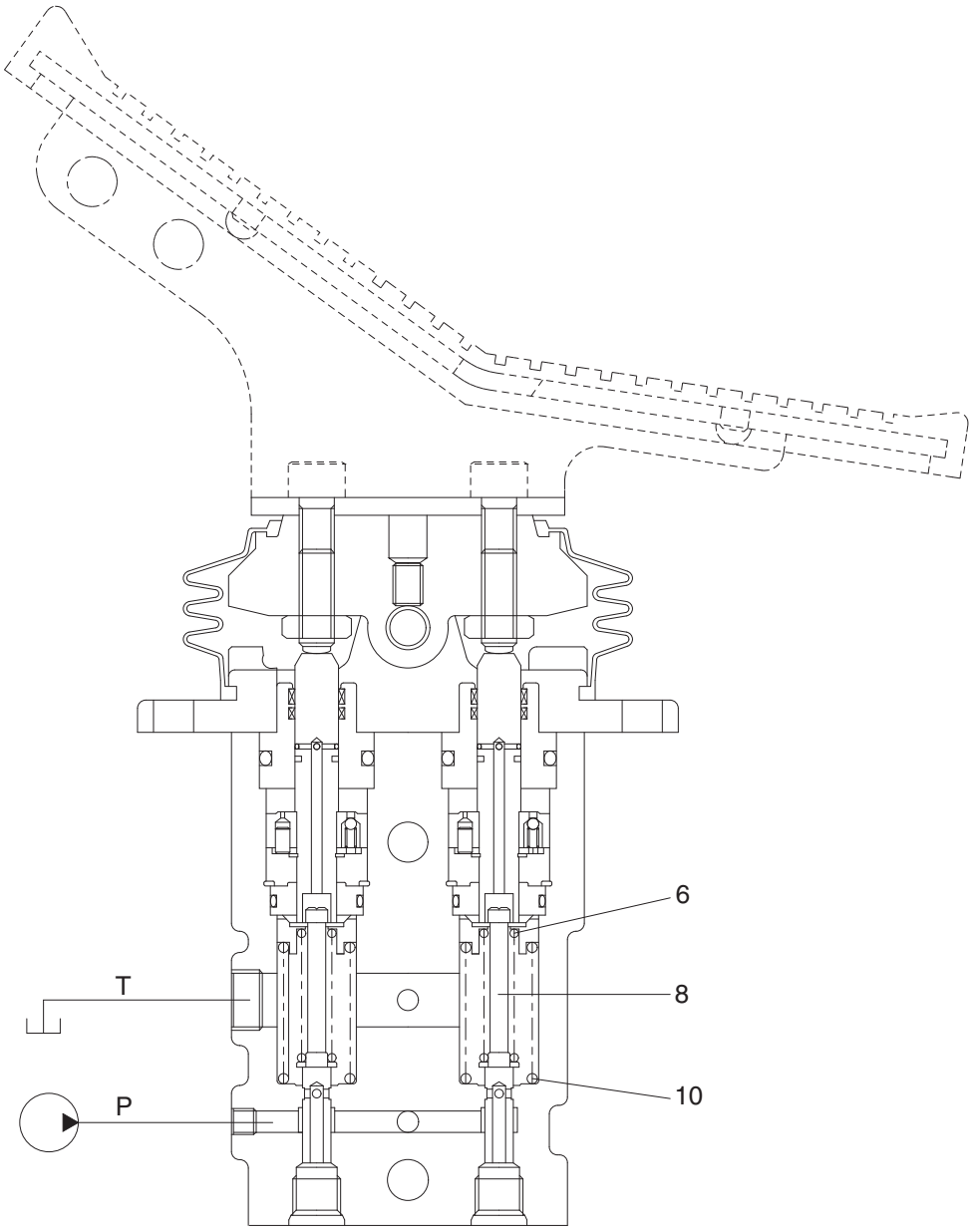
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below ant the attached operation explanation drawing.

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




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

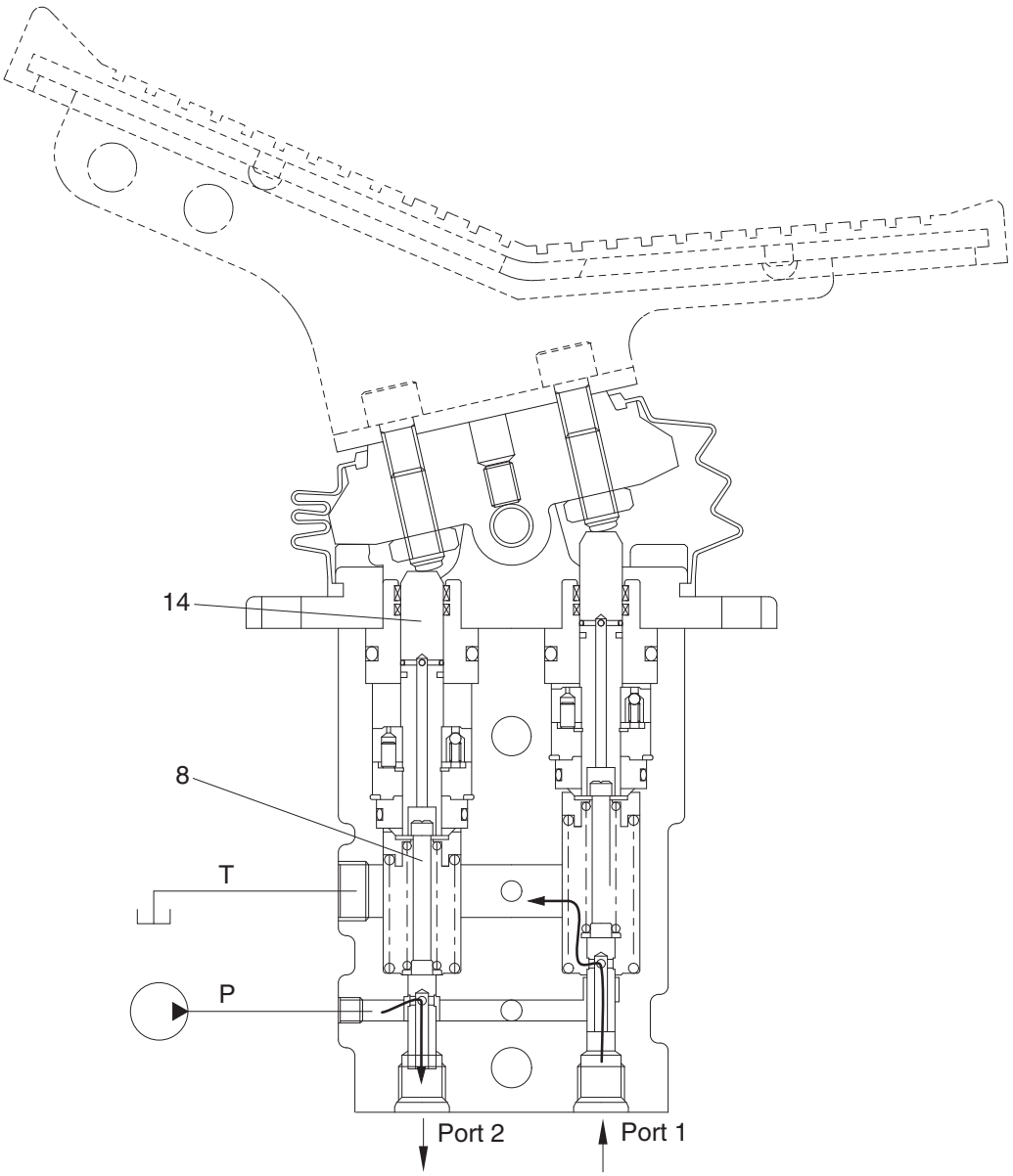
(1) Case where pedal is in neutral position




21092RP03

The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (8). Therefore, the spool is pushed up by the spring (10) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted



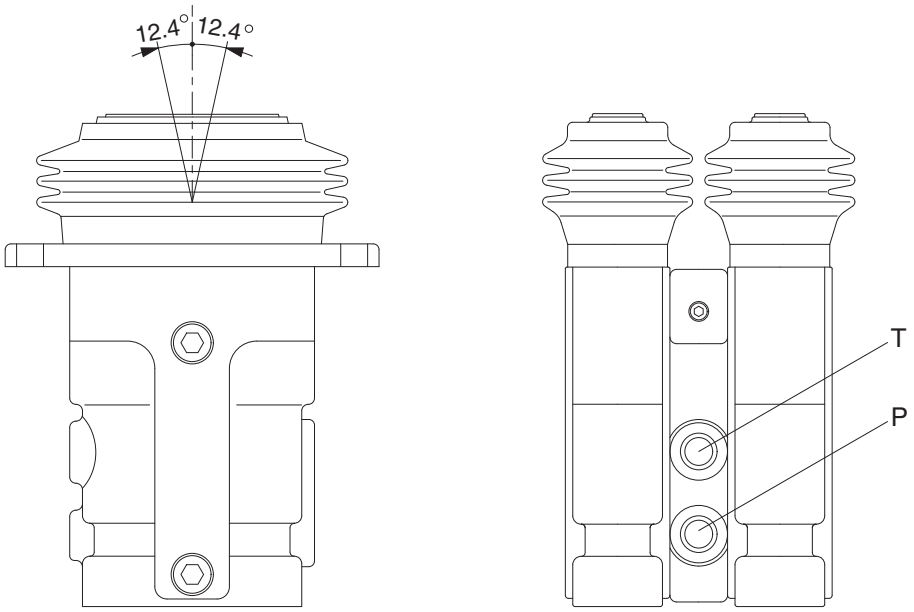

300L2RL08

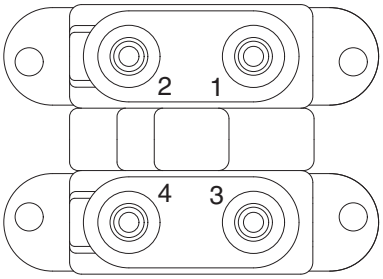
When the push rod (14) is stroked, the spool (8) moves downwards.
Then port P is connected with port (2), and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port (2) increases to the value corresponding to the spring force set by tilting the pedal, 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 (2). If it decreases lower than the set pressure, port P is connected with port (2) and port T is disconnected from port (2).
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the pedal 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.

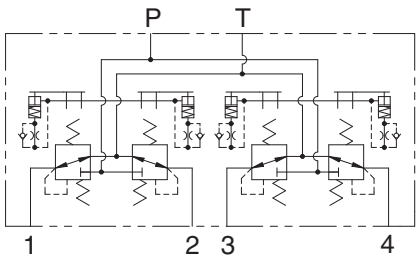
## RCV PEDAL (#0004-)

### 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) | |

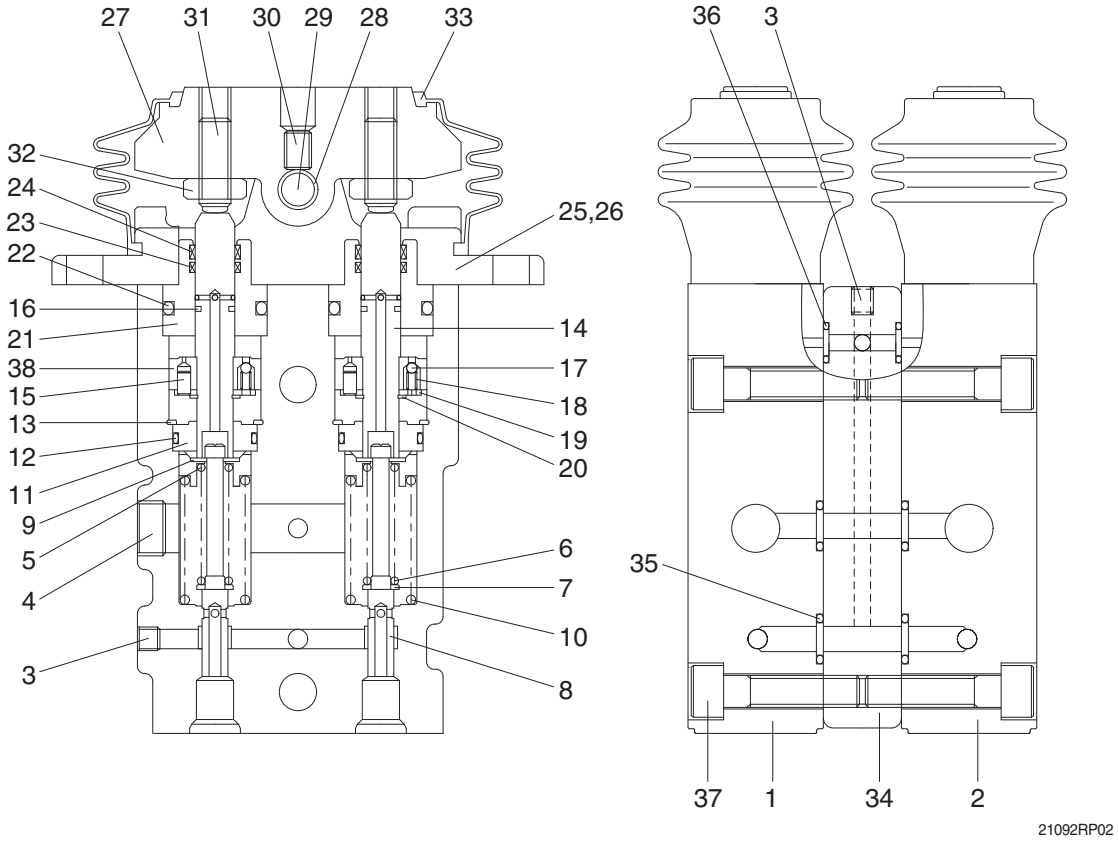
21092RP01

## CROSS SECTION

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

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

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




| | | | | | |
|---|---|---|---|---|---|
| 1 | Body(1) | 14 | Push rod | 27 | Cam |
| 2 | Body(2) | 15 | Spring pin | 28 | Bushing |
| 3 | Plug | 16 | Seal | 29 | Cam shaft |
| 4 | Plug | 17 | Steel ball | 30 | Set screw |
| 5 | Spring seat | 18 | Spring | 31 | Set screw |
| 6 | Spring | 19 | Plate | 32 | Nut |
| 7 | Spring seat | 20 | Snap ring | 33 | Bellows |
| 8 | Spool | 21 | Plug | 34 | Space |
| 9 | Stopper | 22 | O-ring | 35 | O-ring |
| 10 | Spring | 23 | Rod seal | 36 | O-ring |
| 11 | Rod guide | 24 | Dust seal | 37 | Socket bolt |
| 12 | O-ring | 25 | Cover | 38 | Piston |
| 13 | Snap ring | 26 | Socket bolt | | |

## 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 (14) is inserted and can slide in the plug (21).

For the purpose of changing the displacement of the push rod through the cam (27) and adjusting nut (32) are provided the pedal that can be tilted in any direction around the fulcrum of the cam (27) center.

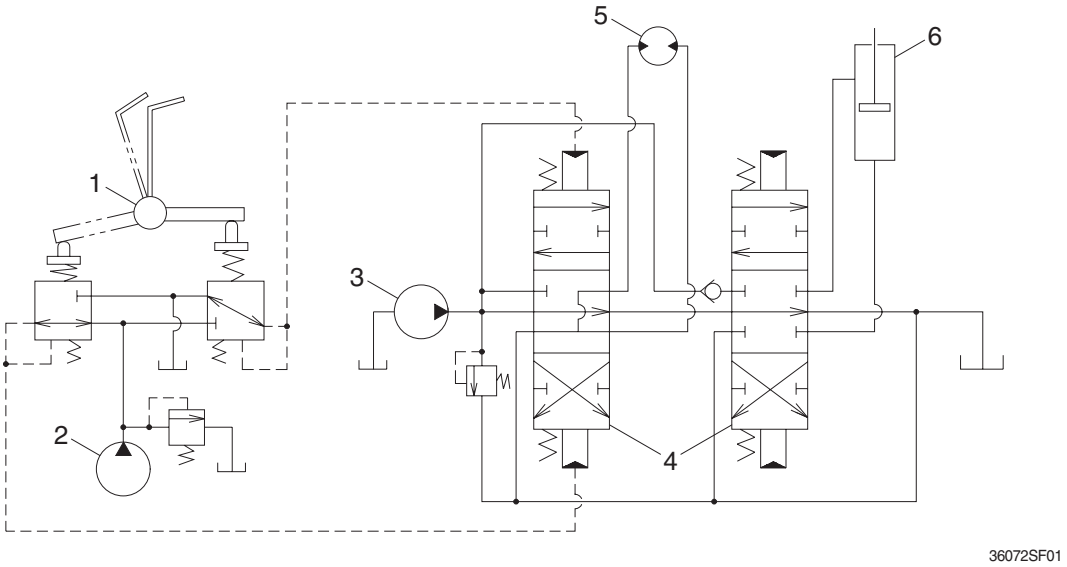
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

### 3) OPERATION

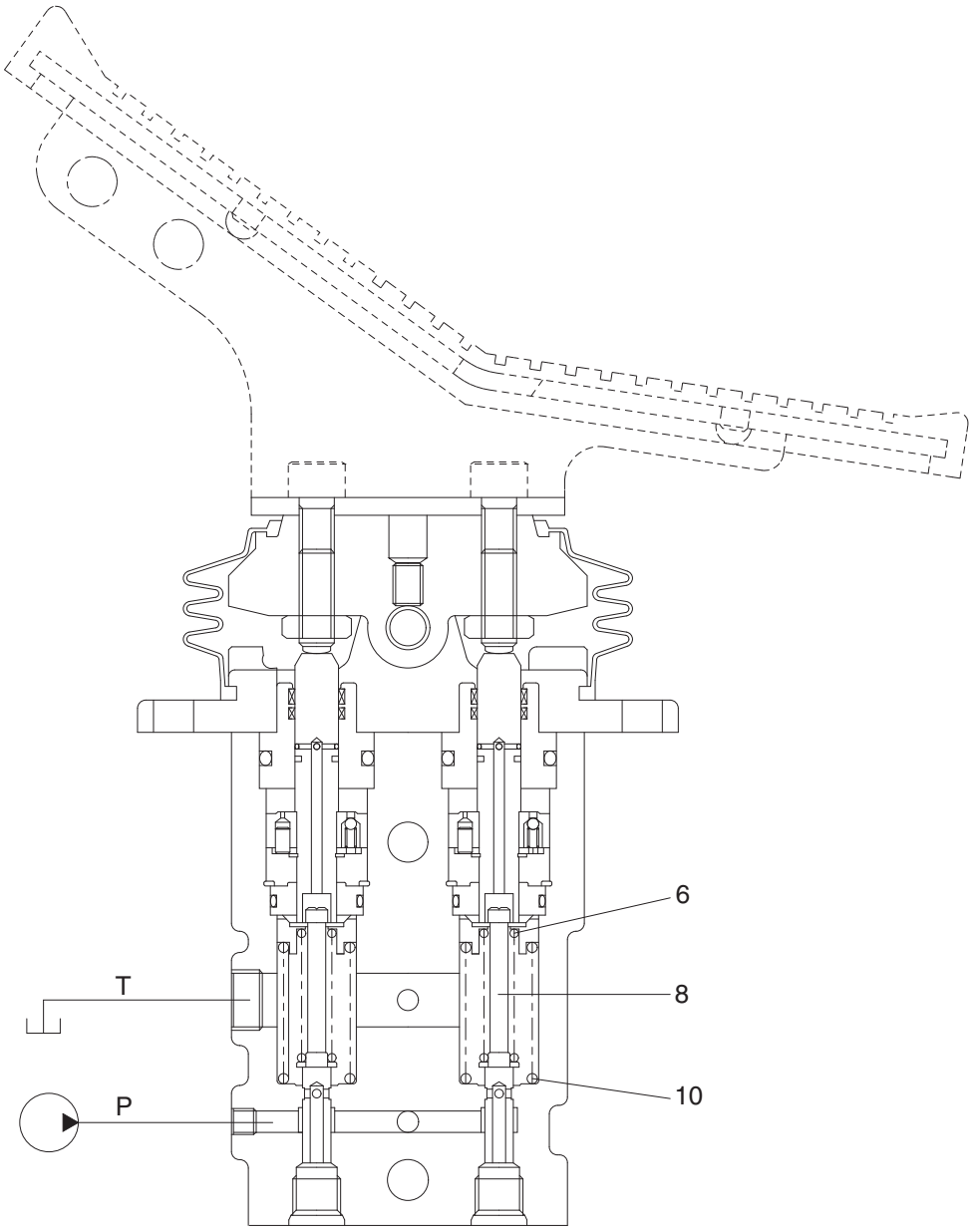
The operation of the pilot valve will be described on the basis of the hydraulic circuit diagram shown below ant the attached operation explanation drawing.

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




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

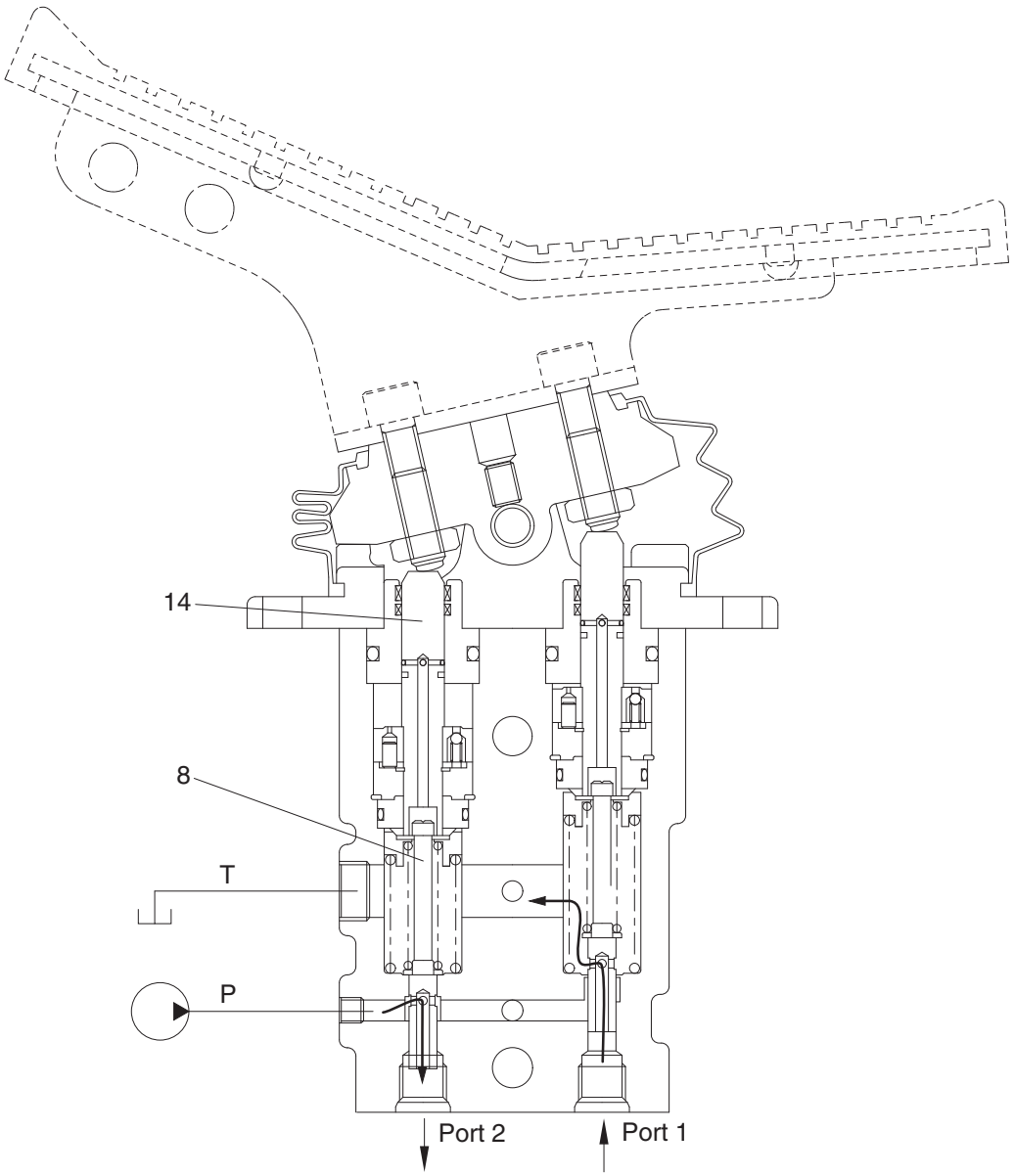
(1) Case where pedal is in neutral position




21092RP03

The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (8). Therefore, the spool is pushed up by the spring (10) to the position of port 2 in the operation explanation drawing. Then, since the output port is connected to tank port T only, the output port pressure becomes equal to tank pressure.

(2) Case where pedal is tilted




300L2RL08

When the push rod (14) is stroked, the spool (8) moves downwards.
Then port P is connected with port (2), and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port (2) increases to the value corresponding to the spring force set by tilting the pedal, 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 (2). If it decreases lower than the set pressure, port P is connected with port (2) and port T is disconnected from port (2).
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the pedal 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.