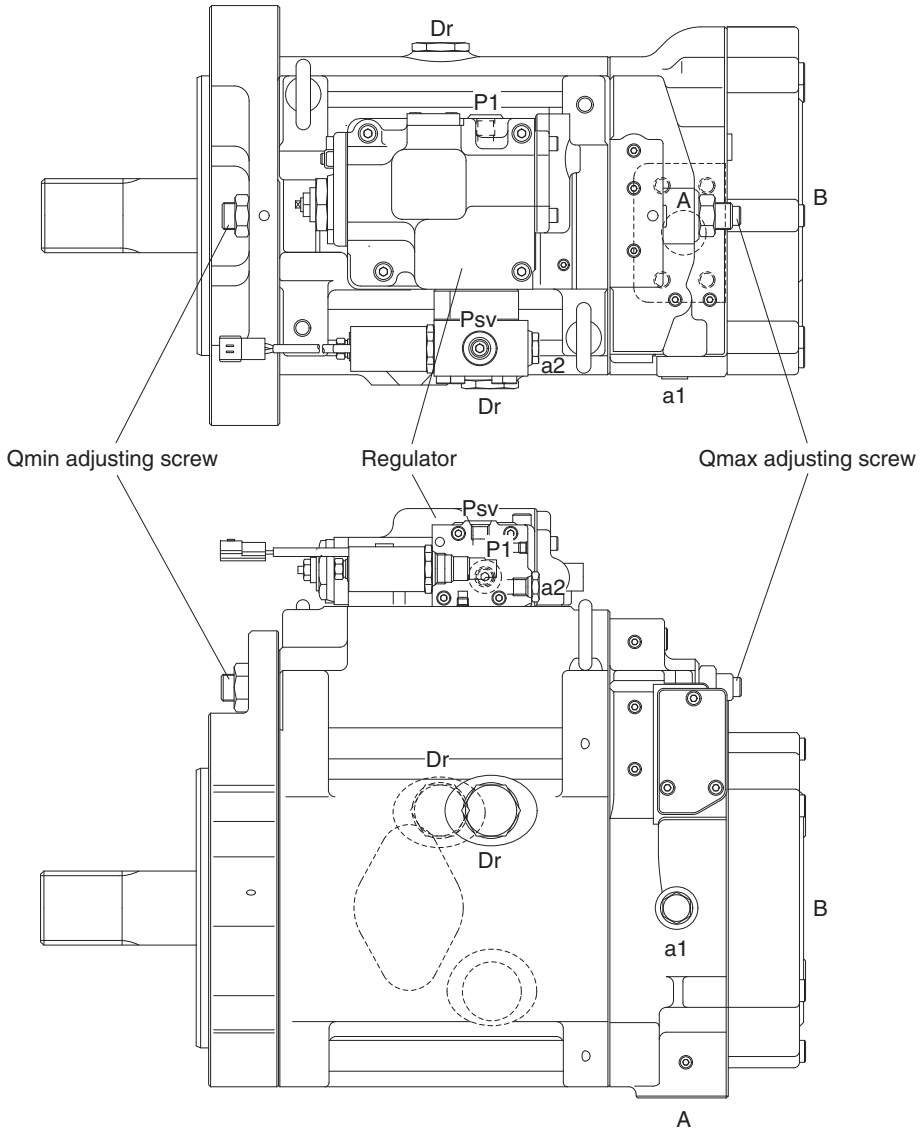
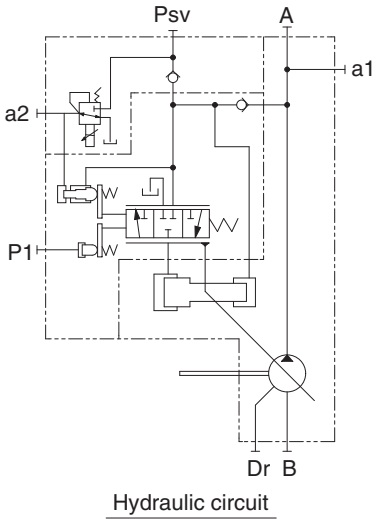
SECTION 2 STRUCTURE AND FUNCTION

GROUP 1 PUMP DEVICE

1. MAIN PUMP STRUCTURE

The pump device consists of main pump, regulator.





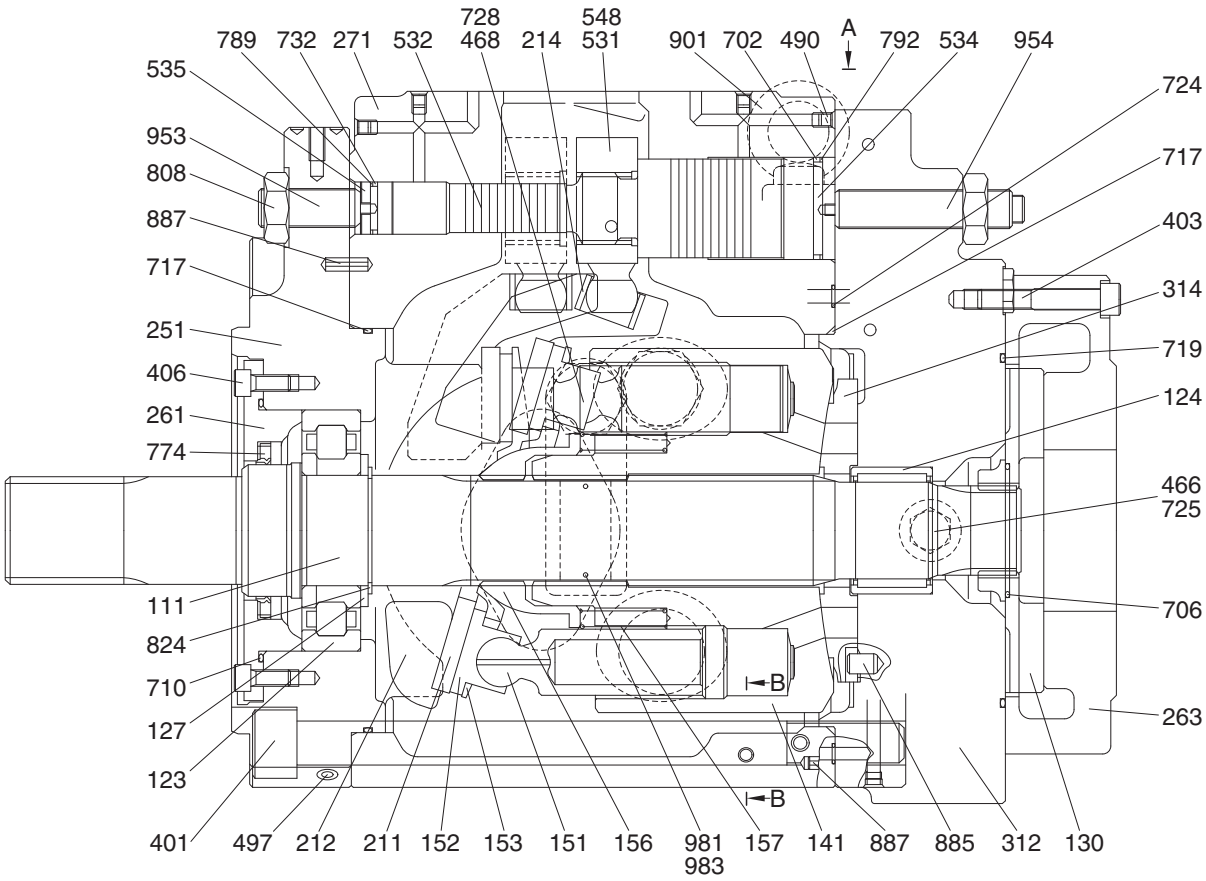
Hydraulic circuit

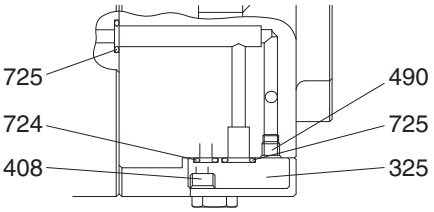
120092MP01

Port	Port name	Port size
A	Delivery port	SEA6000psi 1 1/4"
B	Suction port	SEA2500psi 3 1/2"
Dr	Drain port	PF 3/4 - 23
Psv	Servo assist port	PF 1/4 - 13
a1	Gauge port	PF 1/4 - 15
a2	Sensor port	PF 1/4 - 13
P1	Pilot port	PF 1/4 - 15

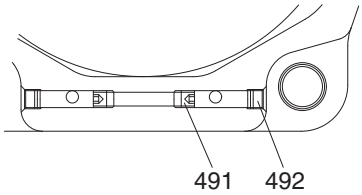
1) MAIN PUMP(1/2)

The main pump consists of piston pump and valve block.





VIEW A

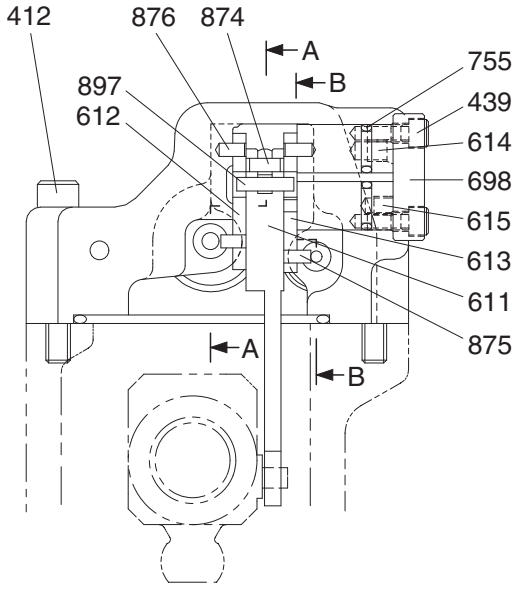


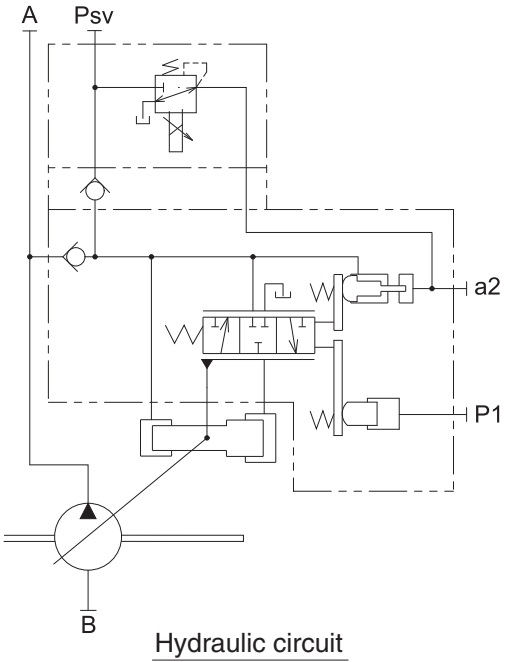
SECTION B -B

120092MP02

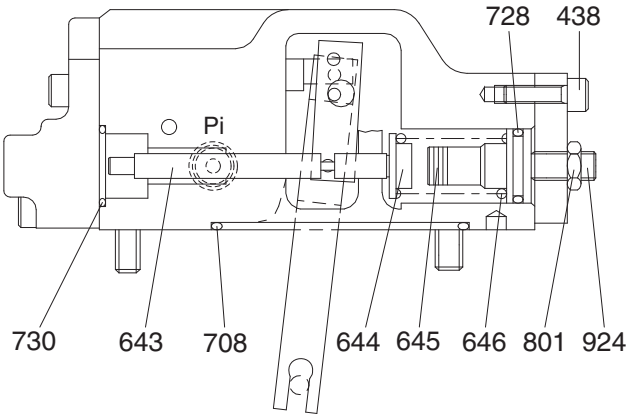
111	Drive shaft	261	Front cover	497	Plug	774	Oil seal
113	Roller bearing	263	Booster cover	531	Tilting pin	789	Back up ring
114	Needle bearing	271	Pump casing	532	Servo piston	792	Back up ring
123	Spacer	312	Valve cover	534	Stopper (L)	808	Nut
130	Booster	314	Valve plate (F)	535	Stopper (S)	824	Snap ring
141	Cylinder block	325	Cover	548	Feed back pin	885	Pin
151	Piston	401	Screw	702	O-ring	887	Spring pin
152	Shoe	403	Hexagon screw	706	O-ring	901	Eye bolt
153	Set plate	406	Hexagon screw	710	O-ring	953	Set screw
156	Bushing	408	Screw	717	O-ring	954	Set screw
157	Cylinder spring	466	Plug	719	O-ring	981	Name plate
211	Shoe plate	468	Plug	724	O-ring	983	Pin
212	Swash plate	490	Plug	725	O-ring		
214	Steel bearing	491	Restrictor	728	O-ring		
251	Support	492	Plug	732	O-ring		

2) REGULATOR (1/2)

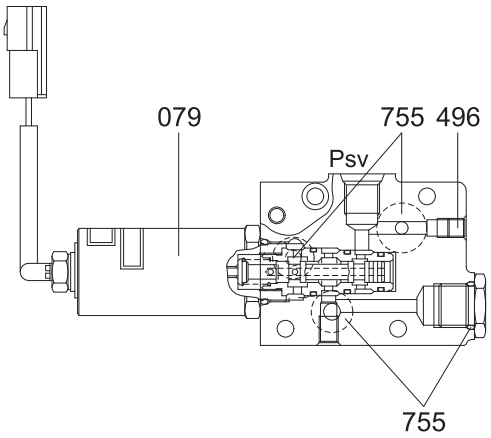




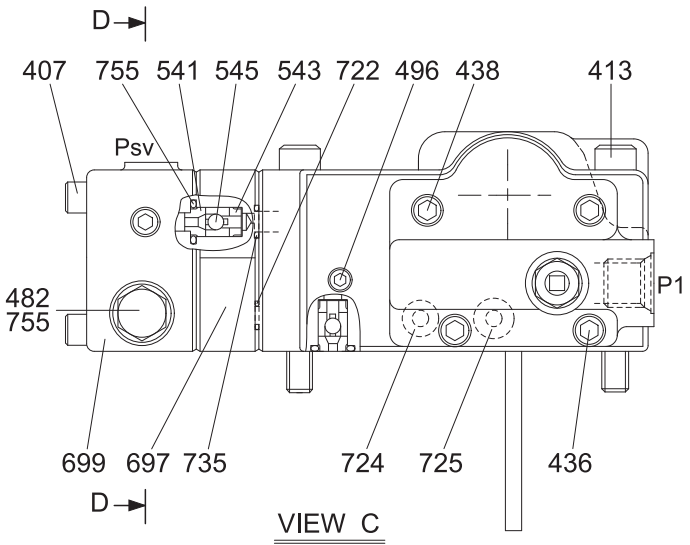
Hydraulic circuit



SECTION B-B



SECTION D-D

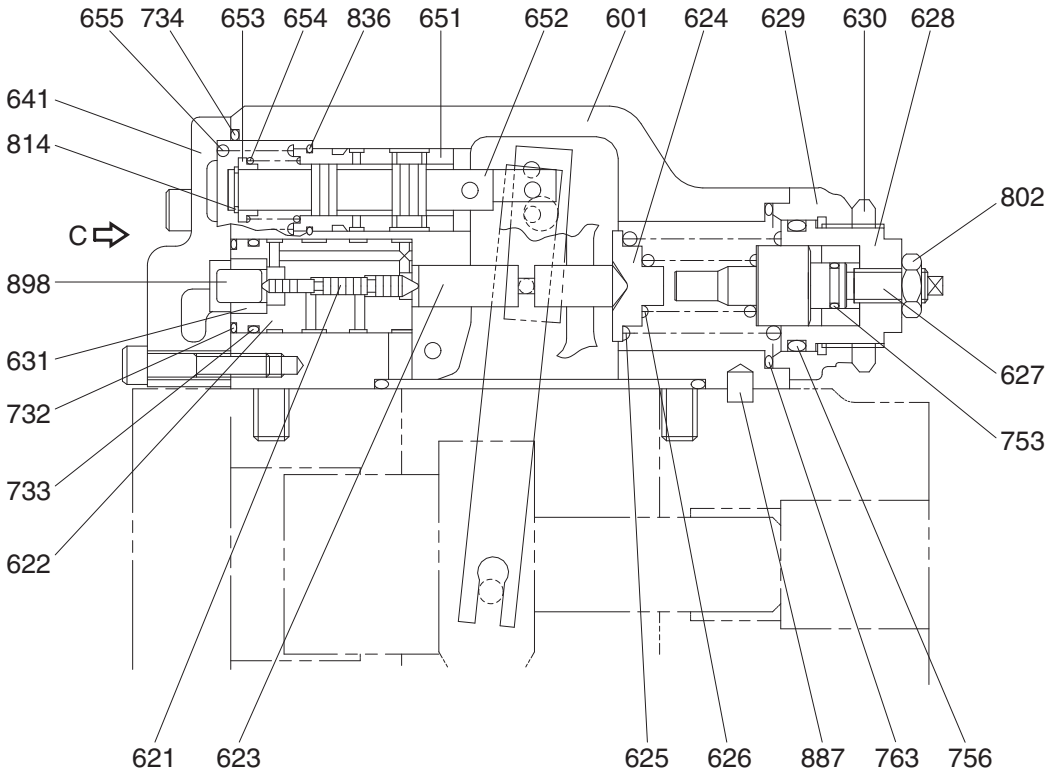


VIEW C

Port	Port name	Port size
P1	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 13
a2	Sensor port	PF 1/4 - 13

120092RG01

REGULATOR (2/2)



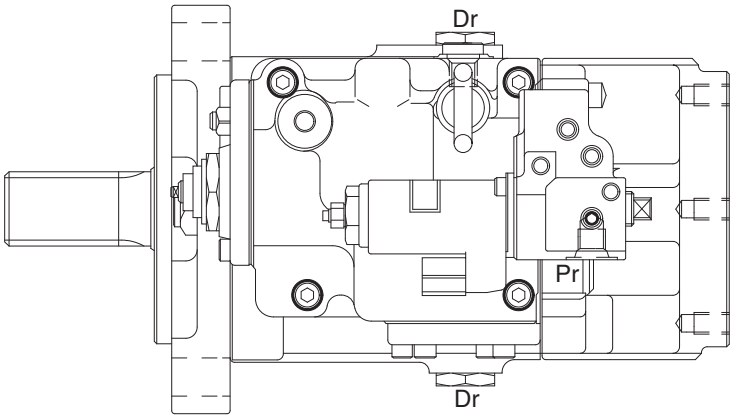
SECTION A-A

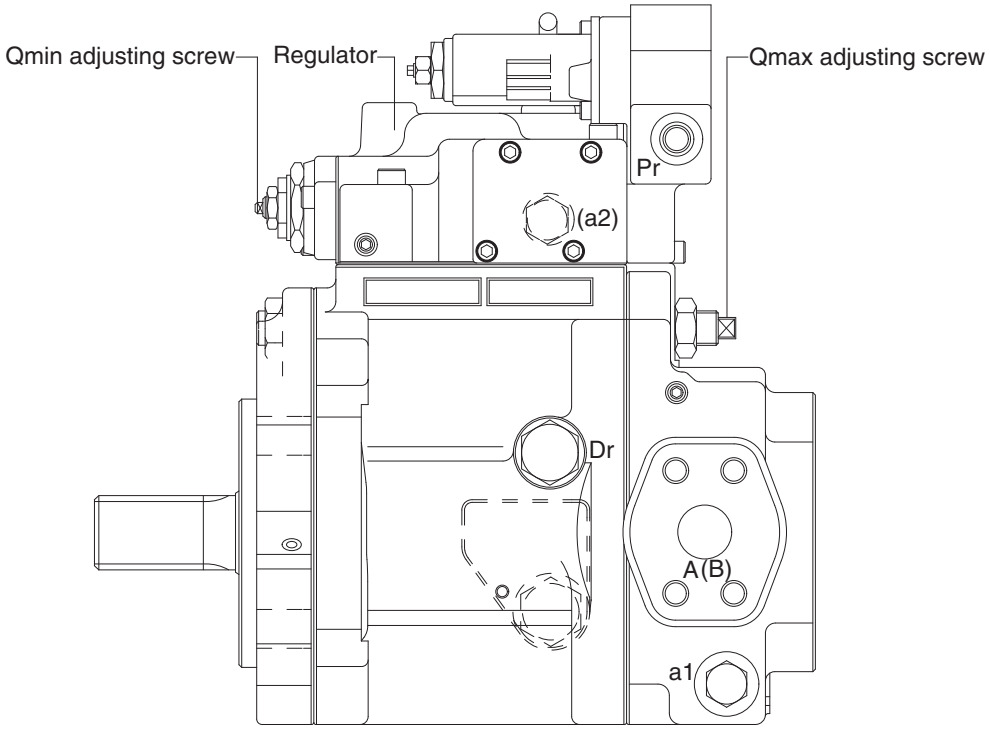
120092RG02

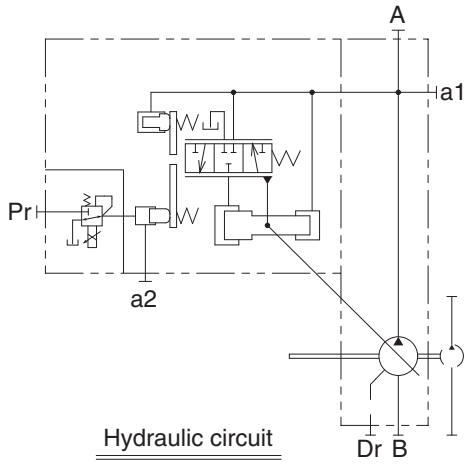
079	EPPR valve	626	Inner spring	728	O-ring
407	Hexagon socket screw	627	Adjust stem (C)	730	O-ring
412	Hexagon socket screw	628	Adjust screw (C)	732	O-ring
413	Hexagon socket screw	629	Cover (C)	733	O-ring
436	Hexagon socket screw	630	Lock nut	734	O-ring
438	Hexagon socket screw	631	Sleeve	735	O-ring
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	814	Snap ring
611	Feed back lever	653	Spring seat	836	Snap ring
612	Lever (1)	654	Return spring	874	Pin
613	Lever (2)	655	Set spring	875	Pin
614	Center plug	697	Plate	876	Pin
615	Adjust plug	698	Cover	887	Pin
621	Compensator piston	699	Casing	897	Pin
622	Piston case	708	O-ring	898	Pin
623	Compensator rod	722	O-ring	924	Set screw
624	Spring seat (C)	724	O-ring		
625	Valve casing	725	O-ring		

2. FAN PUMP STRUCTURE

The pump device consists of fan pump, regulator.







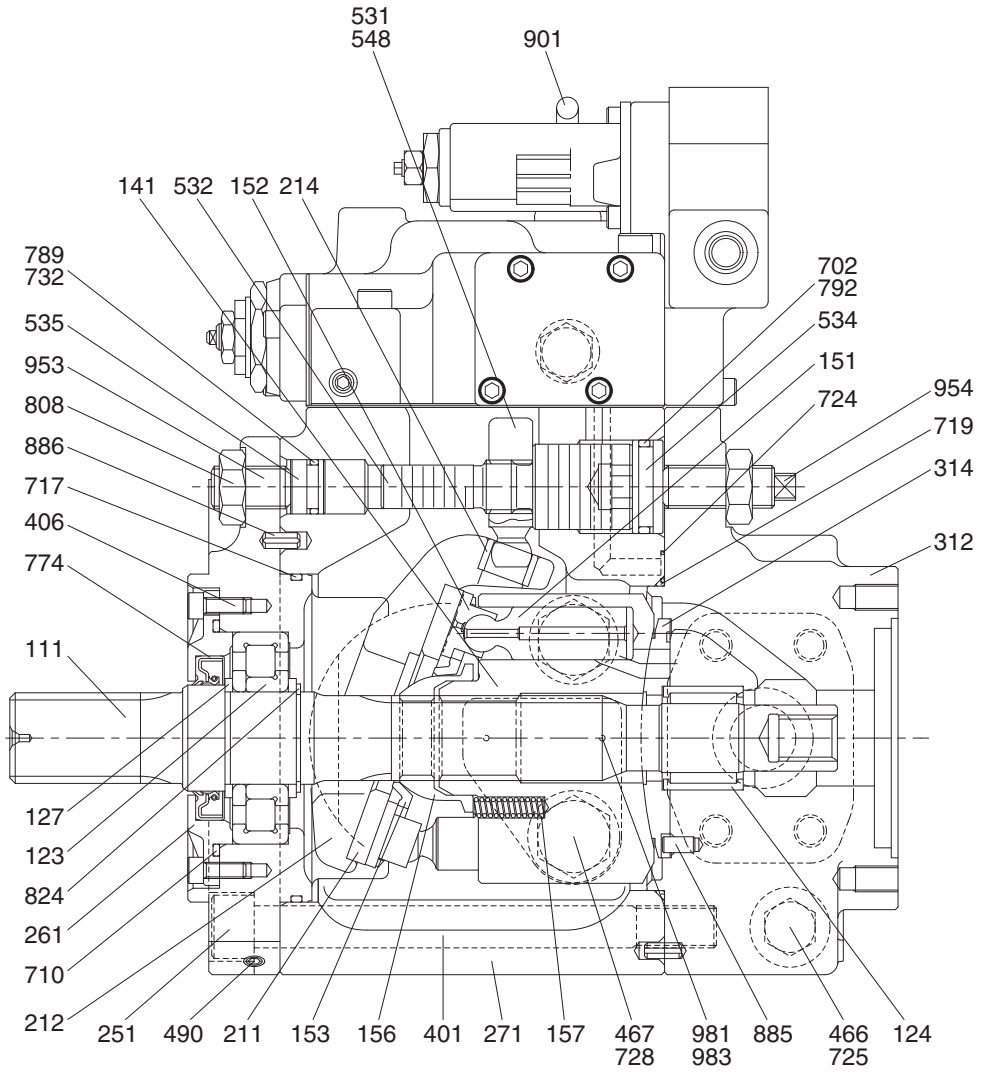
Hydraulic circuit

120092FP04

Port	Port name	Port size
A	Delivery port	SAE 6000psi 1"
B	Suction port	SAE 3000psi 1 1/2"
Dr	Drain port	PF 1/2-19
Pr	Servo assist port	PF 1/4-13
a1,a2	Gauge port	PF 1/4-15

1) FAN PUMP (1/2)

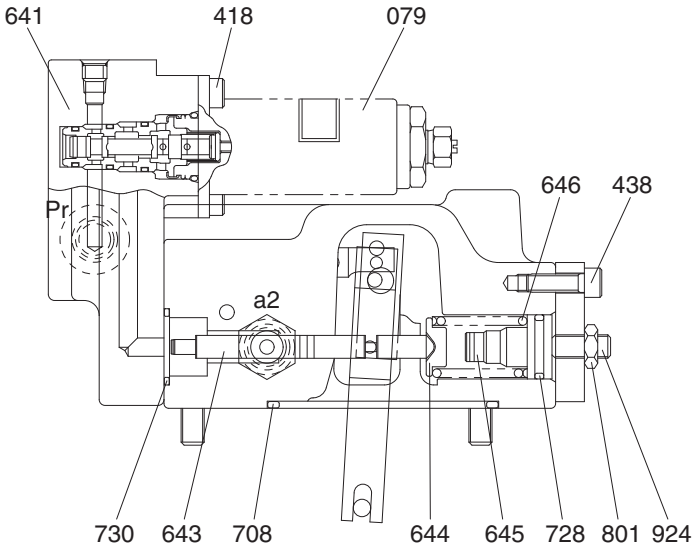
The fan pump consists of piston pump and valve block.



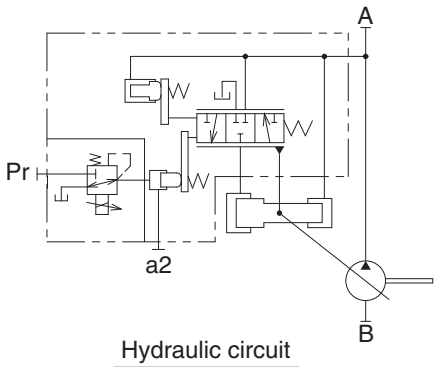
120092FP03

111	Drive shaft	312	Valve cover	724	O-ring
123	Roller bearing	314	Valve plate	725	O-ring
124	Needle bearing	401	Screw	728	O-ring
127	Spacer	406	Screw	732	O-ring
141	Cylinder block	466	Plug	774	Oil seal
151	Piston	467	Plug	789	Back up ring
152	Shoe	490	Plug	792	Back up ring
153	Set plate	531	Tilting pin	808	Hexagon head nut
156	Bushing	532	Servo piston	824	Stop ring
157	Cylinder spring	534	Stopper (L)	885	Pin
211	Shoe plate	535	Stopper (S)	886	Spring pin
212	Swash plate	548	Feed back pin	901	Eye bolt
214	Bushing	702	O-ring	953	Set screw
251	Support	710	O-ring	954	Set screw
261	Cover (FR)	717	O-ring	981	Name plate
271	Pump casing	719	O-ring	983	Pin

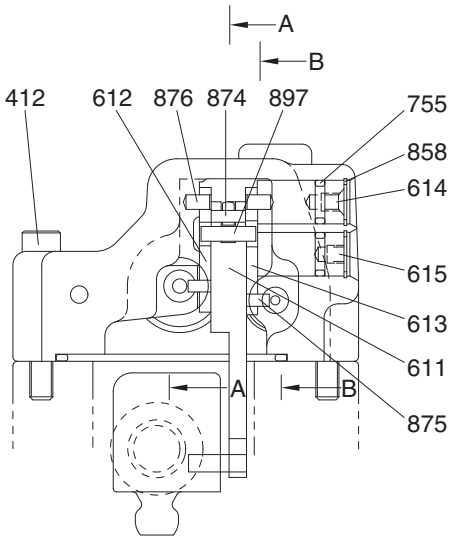
2) REGULATOR (1/2)

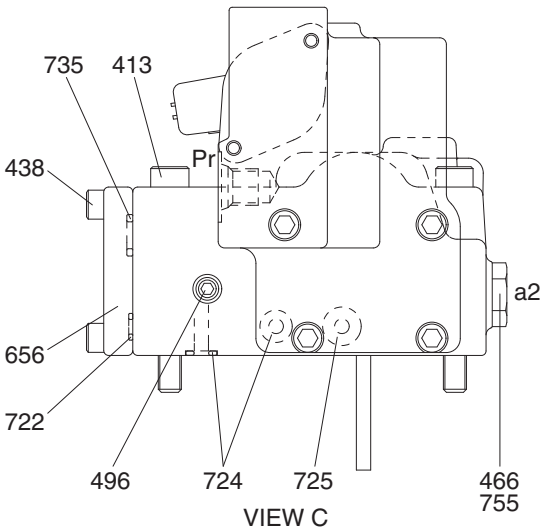


SECTION B-B



Hydraulic circuit



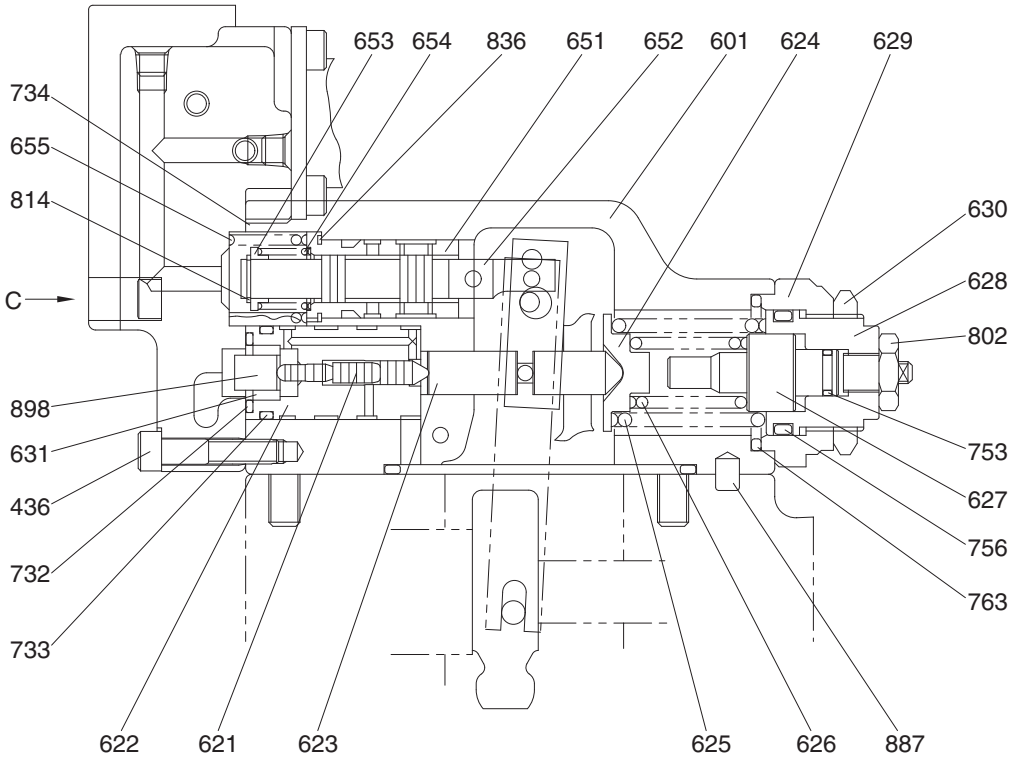


VIEW C

Port	Port name	Port size
Pr	Servo assist	FP 1/4-13
a2	Gauge port	FP 1/4-15

120092FP02

REGULATOR (2/2)

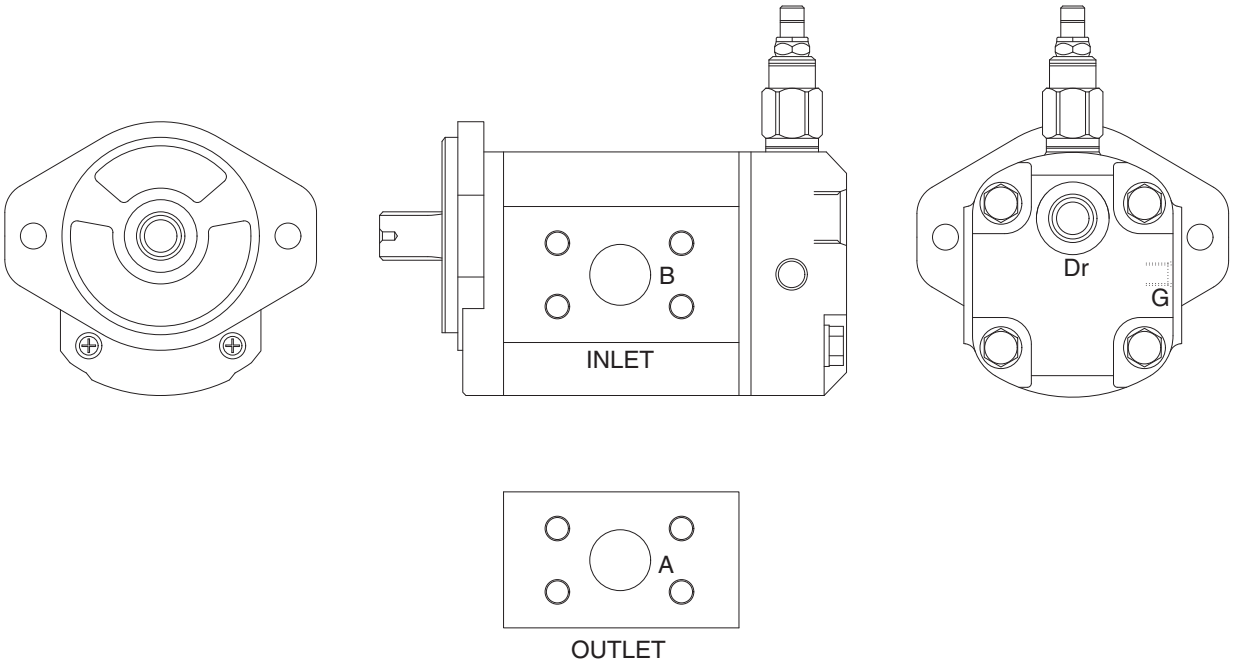


SECTION A-A

120092FP05

070	EPPR valve	628	Adjust screw (C)	732	O-ring
412	Screw	629	Cover (C)	733	O-ring
413	Screw	630	Lock nut	734	O-ring
418	Screw	631	Sleeve	735	O-ring
436	Screw	641	Pilot cover	753	O-ring
438	Screw	643	Pilot piston	755	O-ring
466	Plug	644	Spring seat (Q)	756	O-ring
496	Plug	645	Adjust stem (Q)	763	O-ring
601	Casing	646	Pilot spring	801	Nut
611	Lever	651	Sleeve	802	Nut
612	Lever (1)	652	Spool	814	Snap ring
613	Lever (2)	653	Spring seat	836	Snap ring
614	Center plug	654	Return spring	858	Snap ring
615	Adjust plug	655	Set spring	874	Pin
621	Compensator piston	656	Block cover	875	Pin
622	Piston case	708	O-ring	876	Pin
623	Compensator rod	722	O-ring	887	Pin
624	Spring seat (C)	724	O-ring	897	Pin
625	Outer spring	725	O-ring	898	Pin
626	Inner spring	728	O-ring	924	Set screw
627	Adjust stem (C)	730	O-ring		

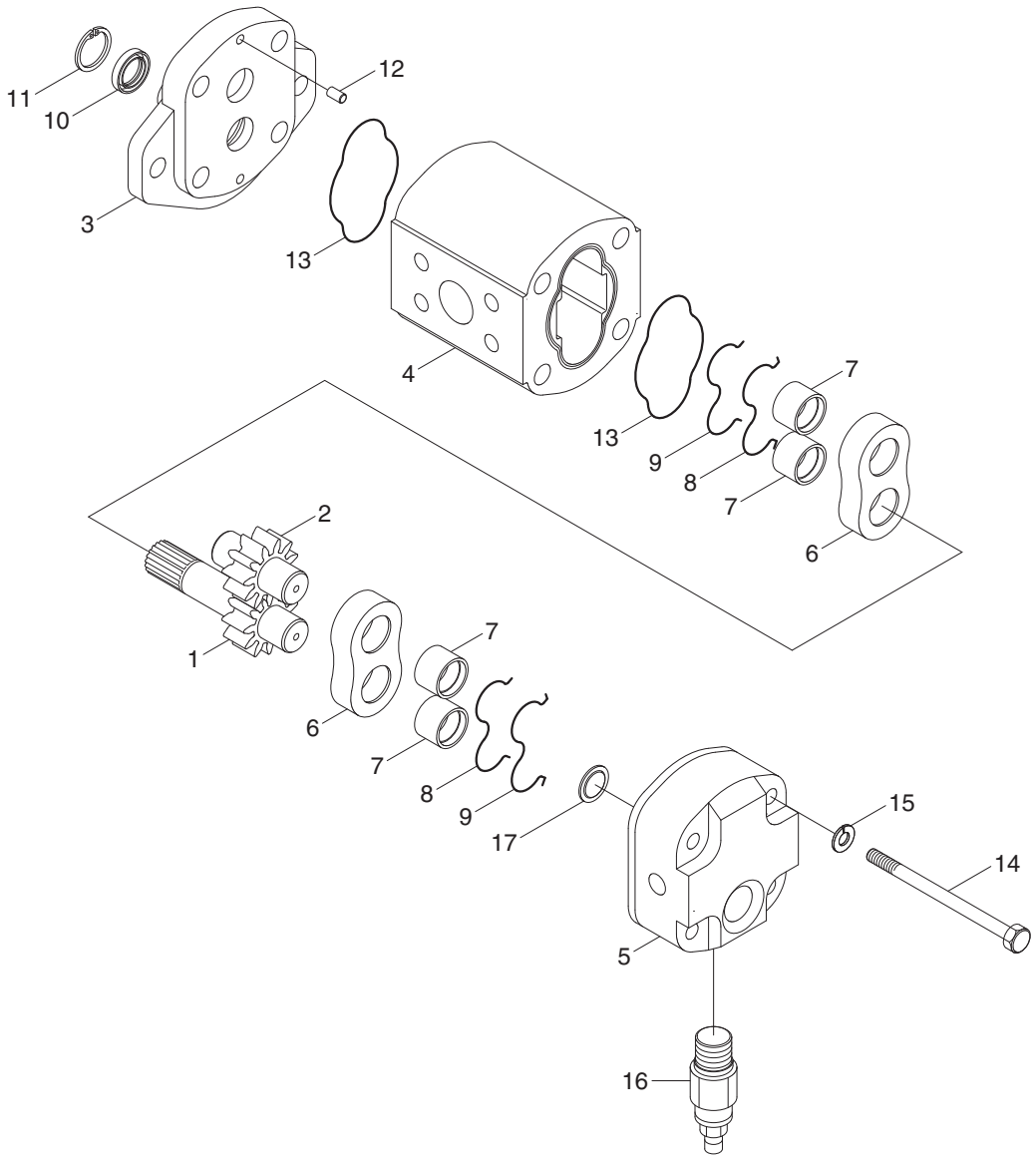
3) GEAR PUMP (1/2)



Port	Name	Size
A	Inlet port	SAE 3000 psi 1 1/2"
B	Outlet port	SAE 500 psi 1"
G	Guage port	PF 1/4
Dr	Drain port	PF 1/2

120092GP01

GEAR PUMP (2/2)



120092MP03

1	Shaft gear	7	Bushing	13	D-ring
2	Driven gear	8	Channel seal	14	Bolt
3	Front cover	9	Back up seal	15	Spring washer
4	Gear housing	10	Retainer seal	16	Relief valve
5	Gear cover	11	Snap ring	17	Filter
6	Bush block	12	Dowel pin		

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.

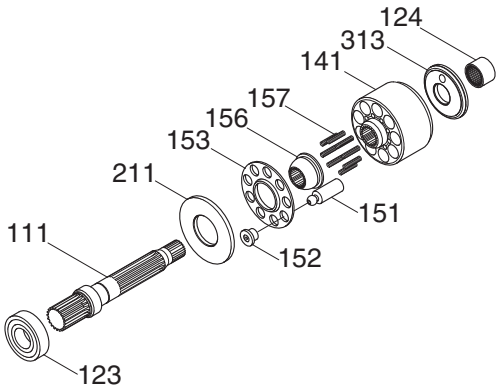
(1) Rotary group

The rotary group consists of drive shaft (F)(111), cylinder block (141), 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.



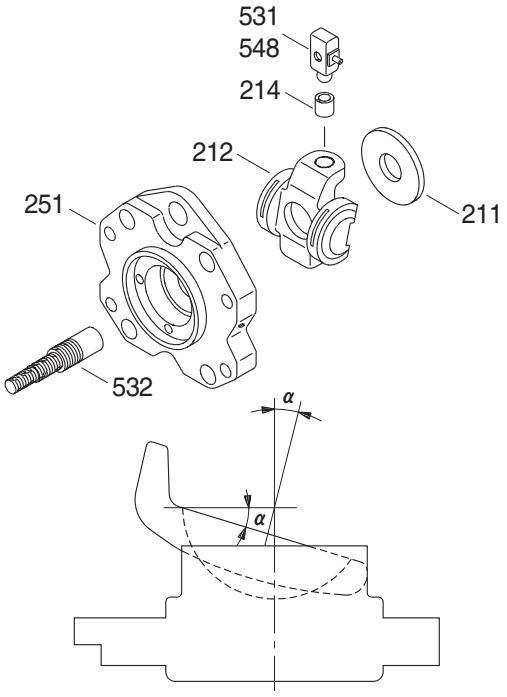
380H2MP04

(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 (α)



2-7 (210-7)

2) REGULATOR

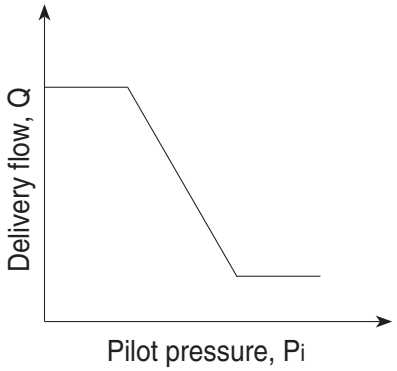
Regulator consists of the negative flow control, total horse power control and power shift control function

(1) Negative flow control

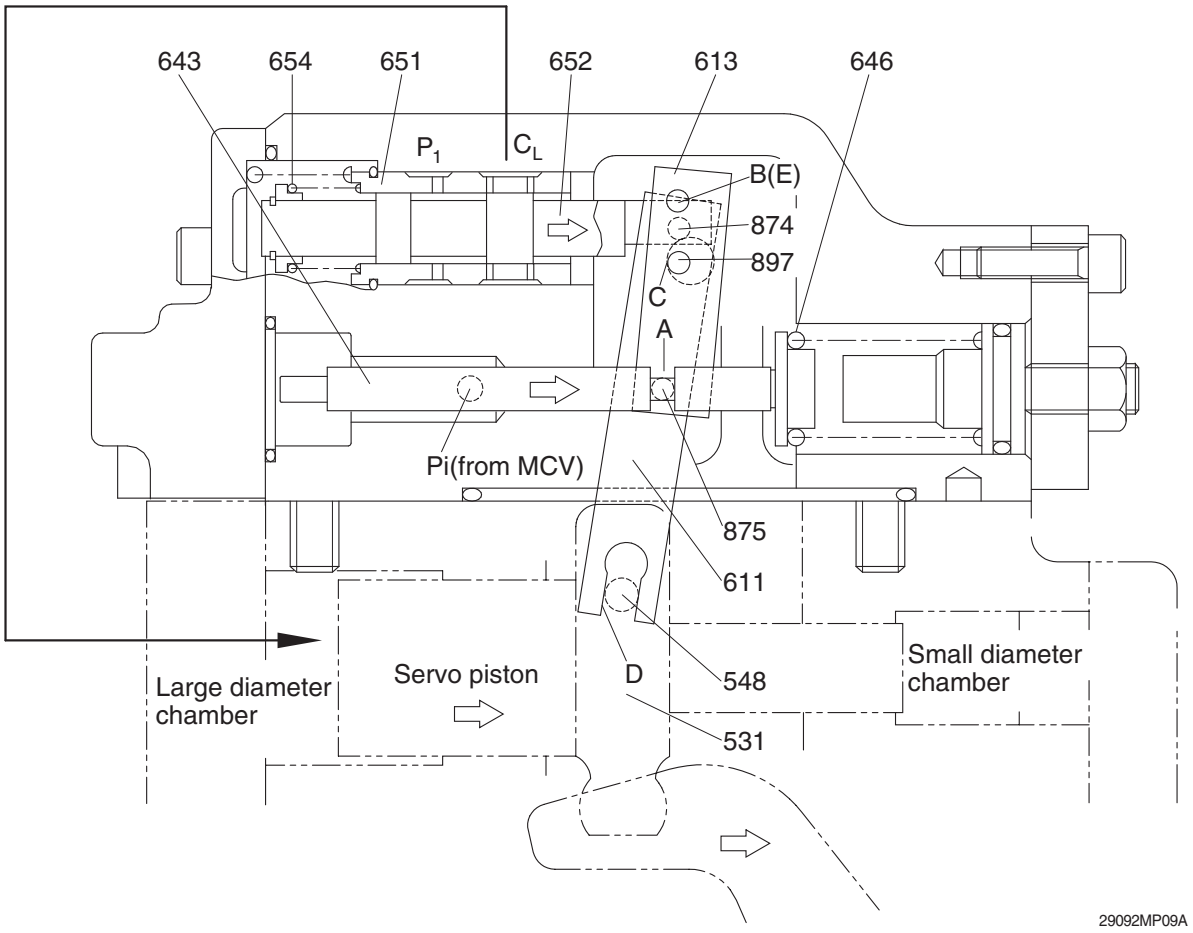
By changing the pilot pressure Pi, the pump tilting angle (delivery flow) is regulated arbitrarily, as shown in the figure.

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 com-manded, 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.

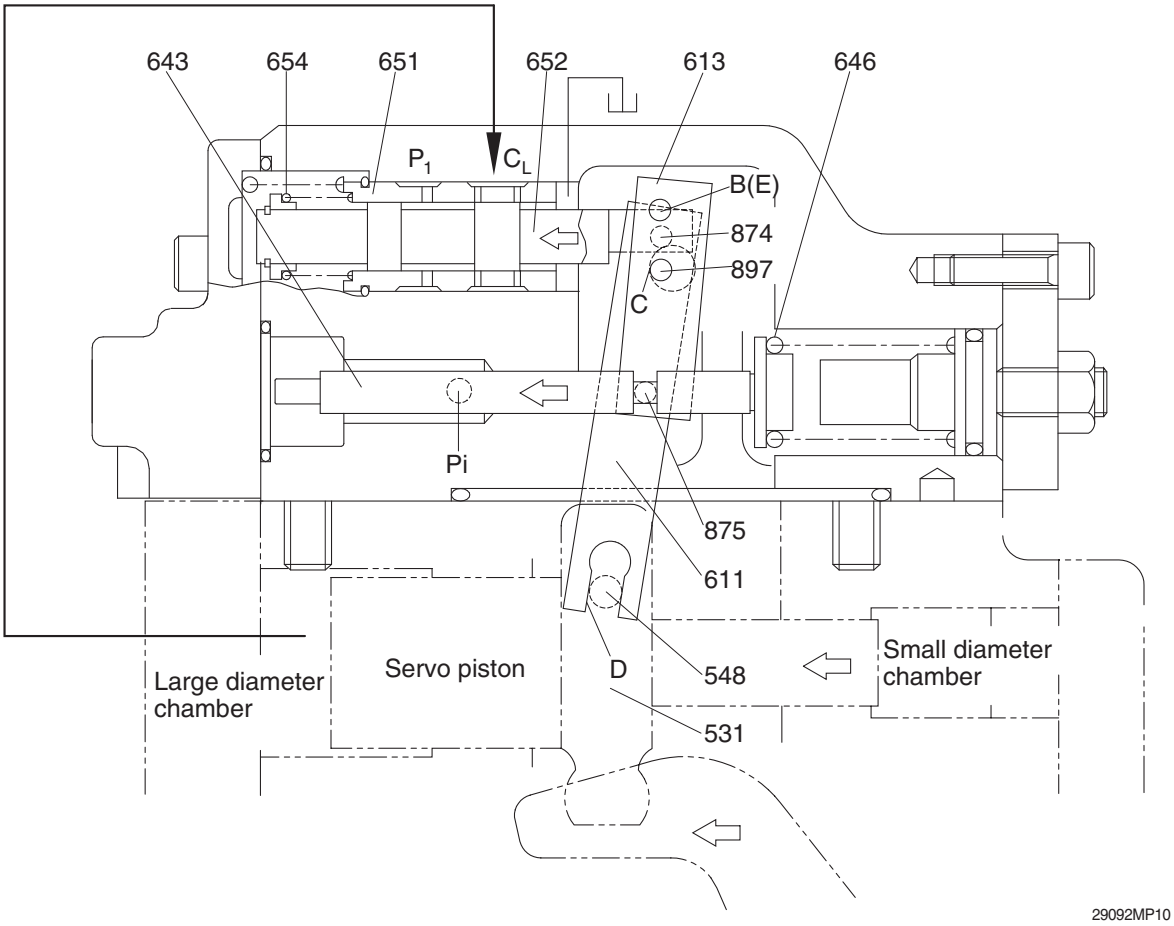
Since the feedback lever is connected with the spool (652) via the pin (874), the spool moves to the right.

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

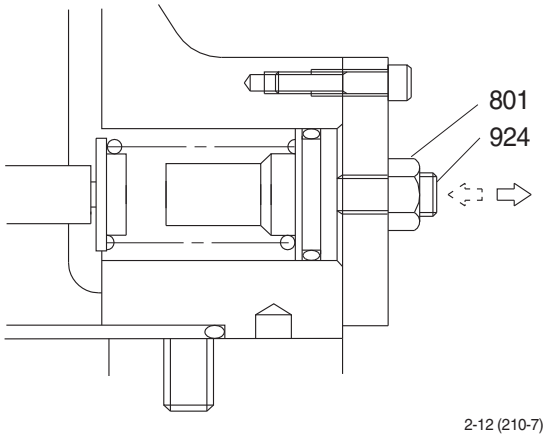


As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point B. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) 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

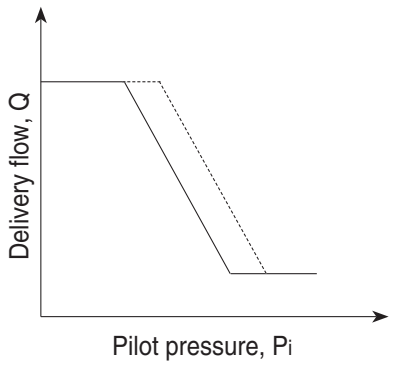
The flow control characteristic can be adjusted with the adjusting screw.
Adjust it by loosening the hexagon nut (801) and by tightening (or loosening) the hexagonal socket head screw (924).
Tightening the screw shifts the control chart to the right as shown in the figure.



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	+1.33	+30.2

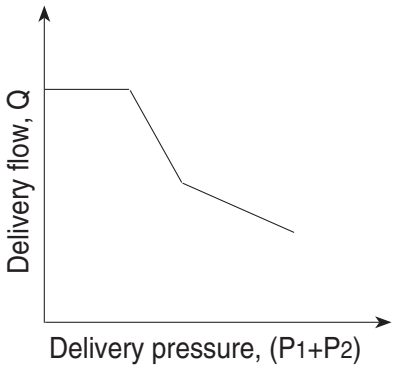


(2) Total horsepower control

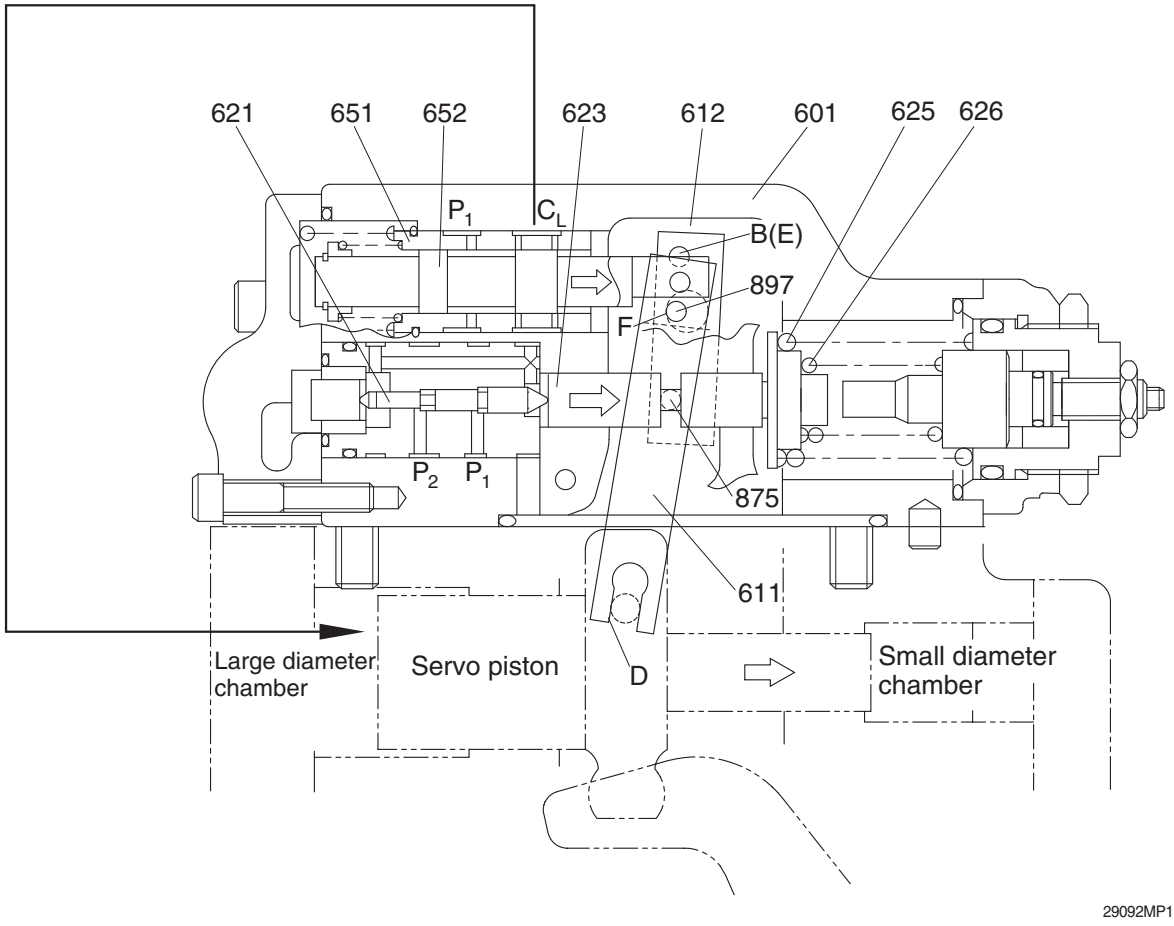
The regulator decreases the pump tilting angle (delivery flow) automatically to limit the input torque within a certain value with a rise in the delivery pressure P1 of the self pump and the delivery pressure P2 of the companion pump.
(The input horsepower is constant when the speed is constant.)
Since 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 beha-viors of respective parts, refer to the section of flow control).



① Overload preventive function



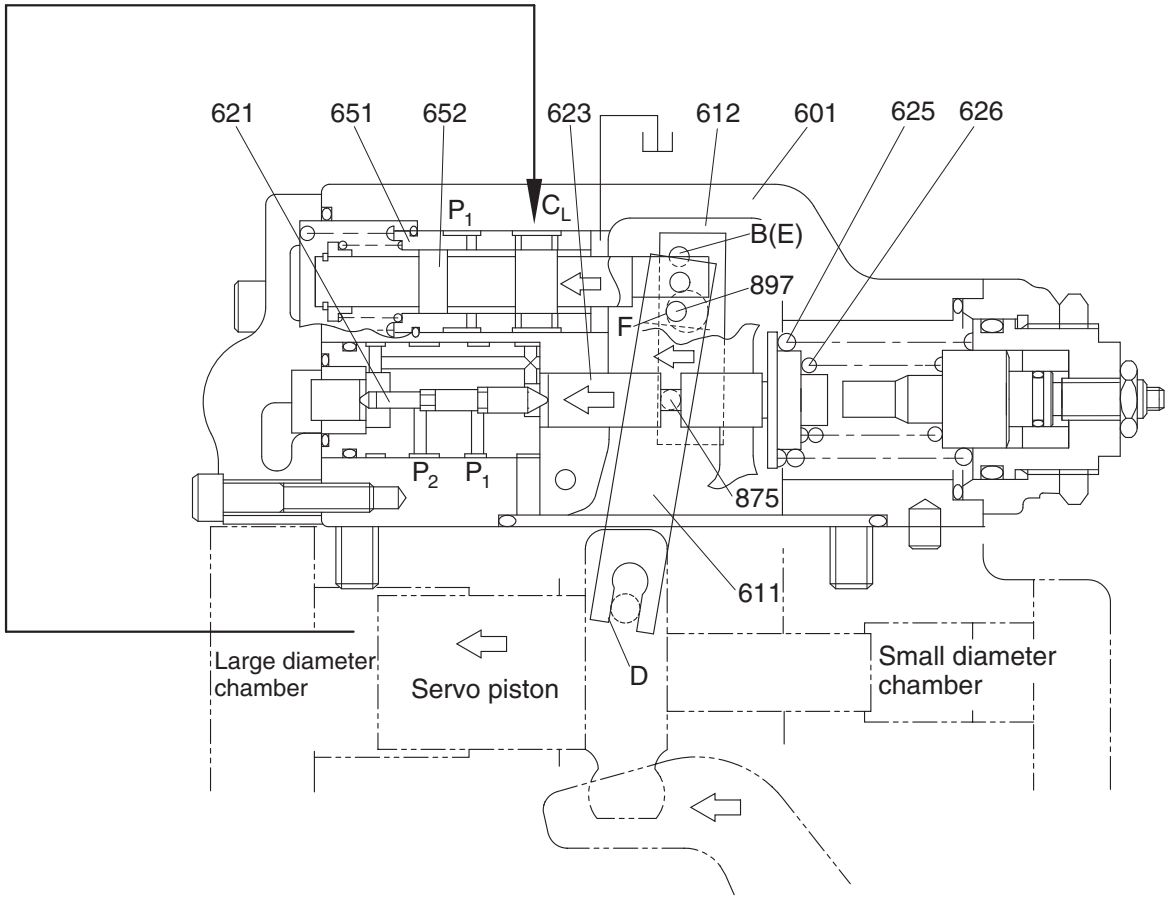
When the self pump delivery pressure P1 or the companion pump delivery pressure P2 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force.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



29092MP12

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

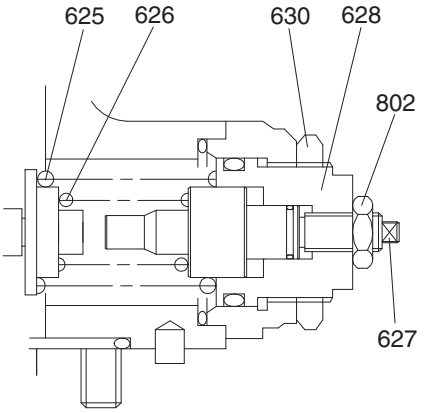
As mentioned above, flow control and horsepower control tilting angle commands are transmitted to the feedback lever and spool via the large-hole sections (C & F) of levers 1 and 2. However, since sections C and F have the pins (ø 4) protruding from the large hole (ø 8), only the lever lessening the tilting angle contacts the pin (897); the hole (ø 8) 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

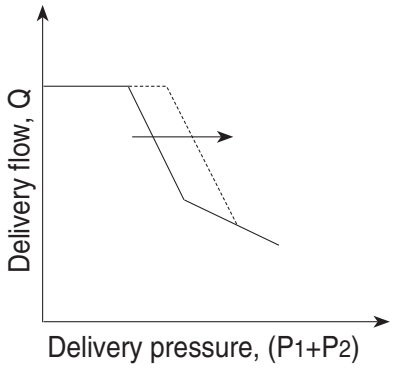
Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horse-power as shown in the figure. Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting screw QI (627) by N×A turns at first. (A=1.85)



8007A2MP03

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

Speed	Adjustment of outer spring		
	Tightening amount of adjusting screw (C) (627)	Compensating control starting pressure change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(kgf · m)
1800	+1/4	+17.7	+7.3



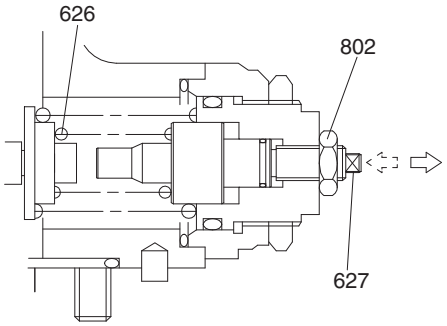
b. Adjustment of inner spring

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

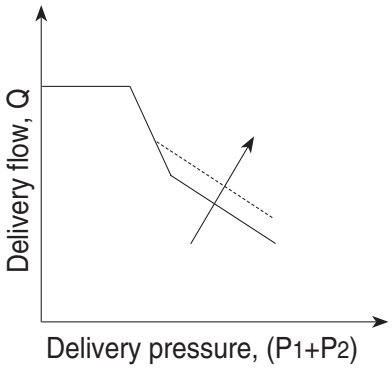
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valves are shown in table.

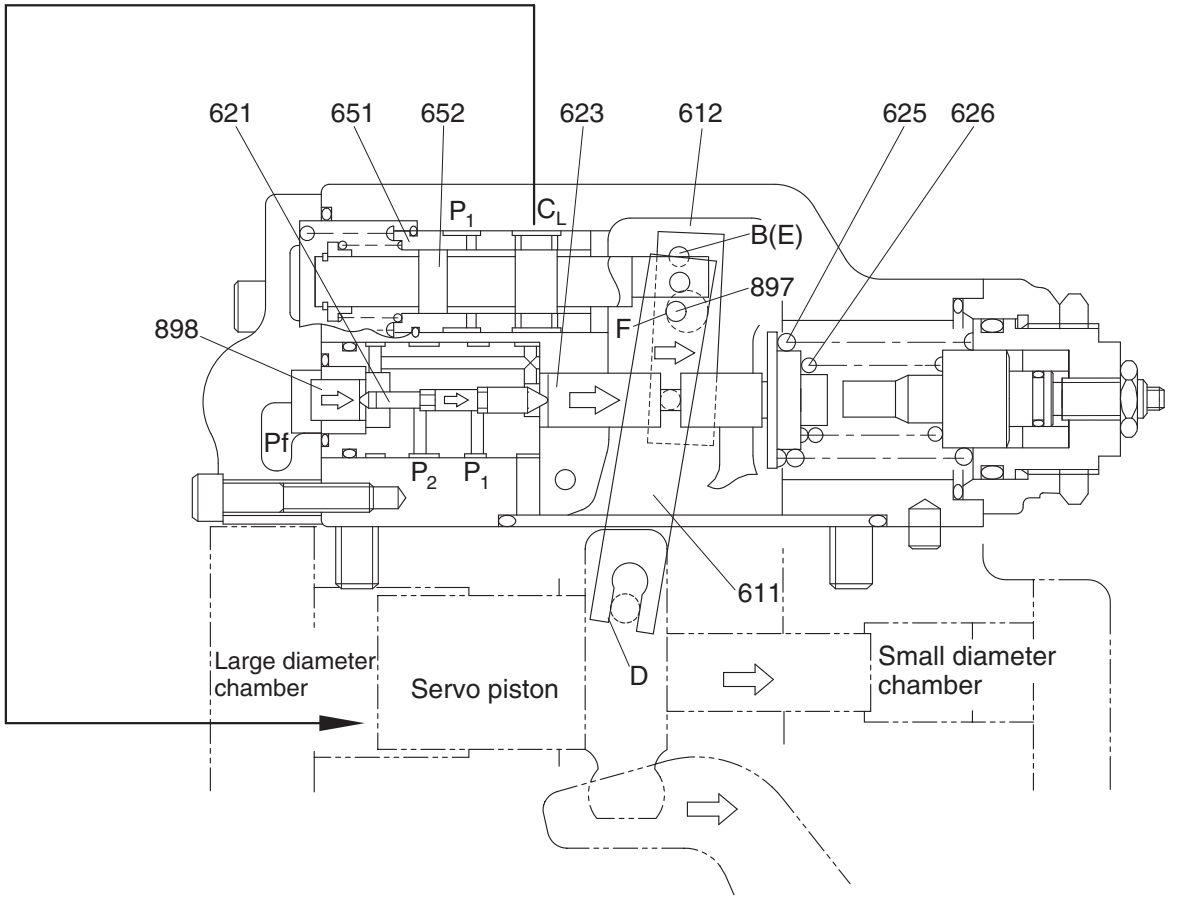
Speed	Adjustment of inner spring		
	Tightening amount of adjusting screw (QI) (627)	Flow change amount (lpm)	Input torque change amount
(min $^{-1}$)	(Turn)	(ℓ /min)	(kgf · m)
1800	+1/4	+22.8	+5.9



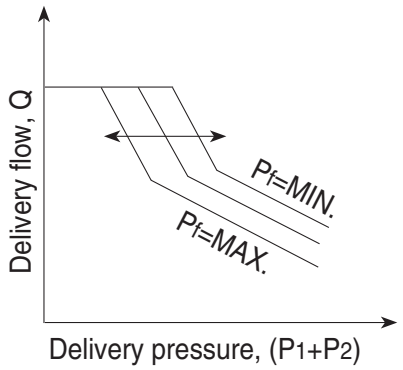
8007A2MP04



(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.



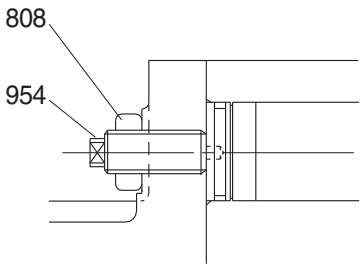
The power shift pressure Pf controls the set horsepower of the pump to a desired level, as shown in the figure.
As the power shift pressure Pf rises, the compensating rod (623) moves to the right via the pin (898) and compensating piston (621).
This decreases the pump tilting angle and then the set horsepower 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

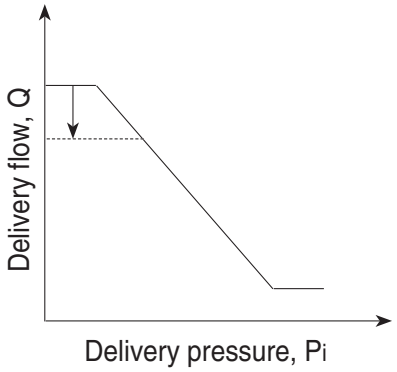
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

The maximum flow only is adjusted without changing other control charac-teristics.



2-19 (1)

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

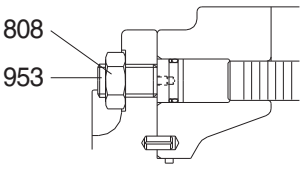


② Adjustment of minimum flow

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

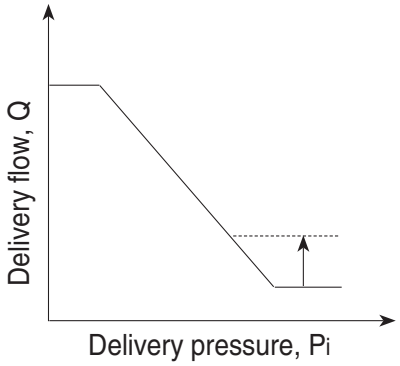
Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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

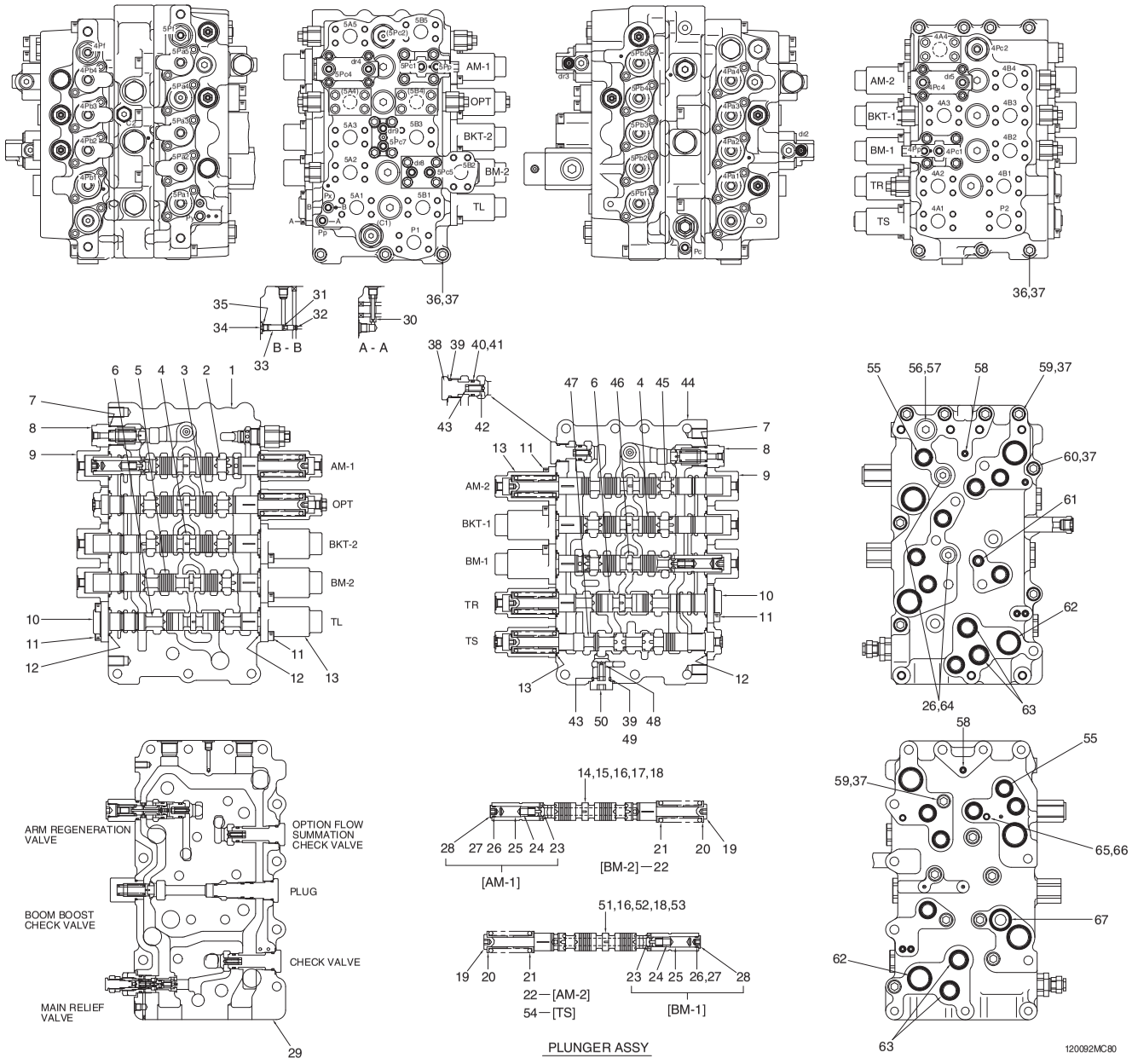


2-19 (2)

Speed	Adjustment of min flow spring	
	Tightening amount of adjusting screw (953)	Flow change amount
(min -1)	(Turn)	(ℓ /min)
1800	+1/4	+9.2

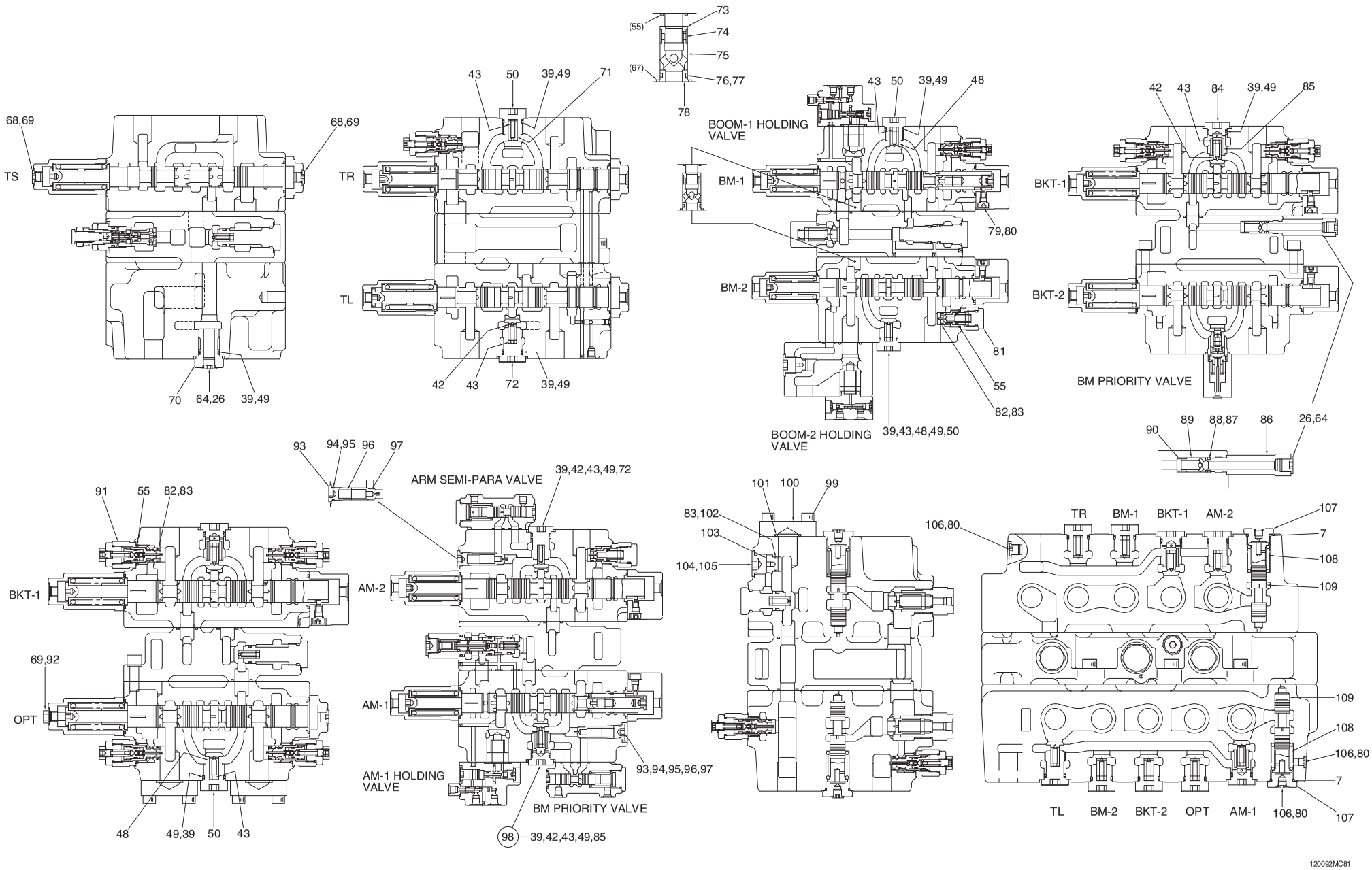


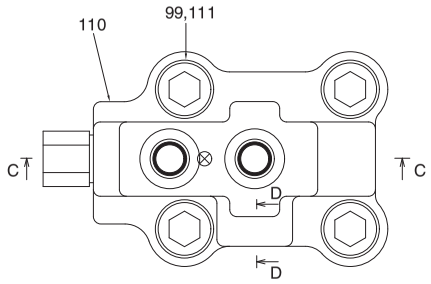
1. STRUCTURE (MCV1)

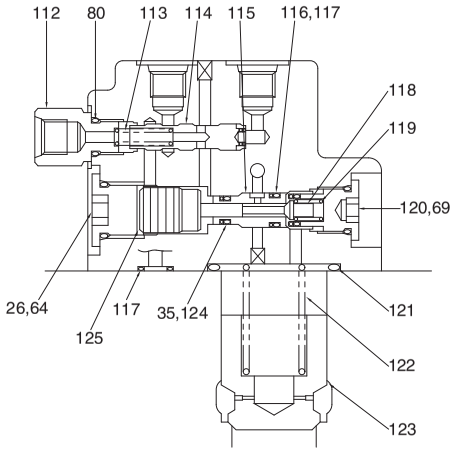


1	Housing	68	Cap	123	Poppet
2	Plunger A2 assy	69	O-ring	124	Back-up ring
3	Plunger D2 assy	70	Cap	125	Piston
4	Plunger C1 assy	71	Check	126	Check
5	Plunger B8 assy	72	Cap	127	Spring
6	Plunger M1 assy	73	Spring guide	128	Cover
7	O-ring	74	Spring	129	Hex socket head bolt
8	Foot relief assy	75	Check	130	Cap
9	Cover	76	O-ring	131	Spring
10	Cover	77	Back-up ring	132	Spool
11	Hex socket head bolt	78	Seat	133	Spring
12	O-ring	79	Plug	134	Spool
13	Cover	80	O-ring	135	Sleeve
14	Plunger A2	81	Make-up assy	136	Spring
15	Plunger D2	82	O-ring	137	Spring
16	Plunger C1	83	Back-up ring	138	O-ring
17	Plunger B8	84	Cap	139	Spool
18	Plunger M1	85	Check	140	Back-up ring
19	Plunger cap	86	Cap	141	O-ring
20	Spring guide	87	Back-up ring	142	Sleeve
21	Spring	88	O-ring	143	O-ring
22	Spring	89	Check	144	Back-up ring
23	Check	90	Spring	145	Piston
24	Spring	91	Relief assy	146	Cap
25	Spacer	92	Plug	147	Hex socket head bolt
26	O-ring	93	Cap	148	Boost check valve
27	Back-up ring	94	Back-up ring	149	Main relief assy
28	Cap	95	O-ring	150	Back-up ring
29	Manifold	96	Spring	151	O-ring
30	Orifice	97	Check	152	O-ring
31	Spring	98	Cap	153	Sleeve
32	Check	99	Hex socket head bolt	154	Cover
33	Spacer	100	Plunger	155	Spring
34	Cap	101	O-ring	156	Spool
35	O-ring	102	O-ring	157	Back-up ring
36	Hex socket head bolt	103	Plug	158	O-ring
37	Washer CD	104	Cap	159	Poppet
38	Cap	105	O-ring	160	Mainfold
39	O-ring	106	Cap	161	O-ring
40	Back-up ring	107	Cap	162	Cover
41	O-ring	108	Spring	163	Hex socket head bolt
42	Check	109	Spool CB	164	Piston
43	Spring	110	Cover assy	165	Spring
44	Housing	111	Washer	166	Plate
45	Plunger A3 assy	112	Cap	167	Back-up ring
46	Plunger A7 assy	113	Spring	168	O-ring
47	Plunger G assy	114	Piston	169	Spring
48	Check	115	Sleeve	170	Spring guide
49	Back-up ring	116	Back-up ring	171	Sleeve
50	Cap	117	O-ring	172	Poppet
51	Plunger A3	118	Poppet	173	Check
52	Plunger B7	119	Spring	174	Spring
53	Plunger G	120	Cap	175	Cap
54	Spring	121	O-ring	176	O-ring
55	O-ring	122	Spring	177	Back-up ring
56	Cap				
57	O-ring				
58	O-ring				
59	Hex socket head bolt				
60	Hex socket head bolt				
61	O-ring				
62	O-ring				
63	O-ring				
64	Cap				
65	O-ring				
66	Back-up ring				
67	O-ring				

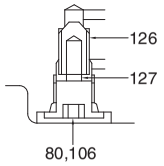
Port name	Port size
4Pc1, 2, 4, 5Pc1, 2, 4, 5, 7 4Pp, 4Pf, 5Pp, 5Pf, Pc Pg, Pp, Px, Py, dr 1~5, 8, 9	PF 1/4
4Pa 1~4, 4Pb 1~4, 5Pa 1~5 5Pb 1~5	PF 3/8
Rs1, Rs2	PF 1
C1, C2	PF 1/2


68,69
68,69
TS
70
64,26
39,49
43
50
39,49
71
TR
42
43
72
39,49
(55)
73
74
75
(67)
76,77
78
BOOM-1 HOLDING VALVE
43
50
39,49
48
BM-1
79,80
BM-2
81
55
82,83
39,43,48,49,50
BOOM-2 HOLDING VALVE
42
43
84
39,49
85
BKT-1
BKT-2
BM PRIORITY VALVE
90
89
88,87
86
26,64
91
55
82,83
BKT-1
69,92
OPT
48
49,39
50
43
93
94,95
96
97
ARM SEMI-PARA VALVE
39,42,43,49,72
AM-2
AM-1
AM-1 HOLDING VALVE
93,94,95,96,97
BM PRIORITY VALVE
98
39,42,43,49,85
101
100
99
83,102
103
104,105
106,80
TR
BM-1
BKT-1
AM-2
107
7
108
109
109
108
106,80
7
TL
BM-2
BKT-2
OPT
AM-1
106,80
107
120092MC81

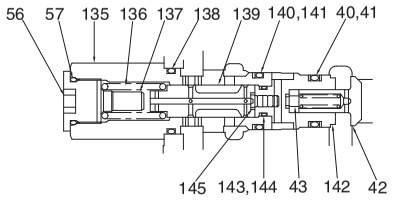




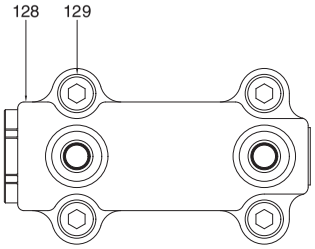
C - C
ARM1. BOOM-1 HOLDING VALVE

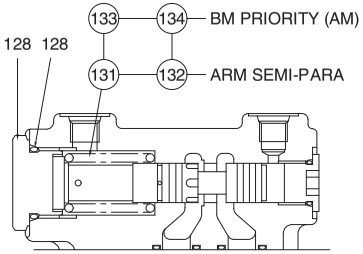


D - D

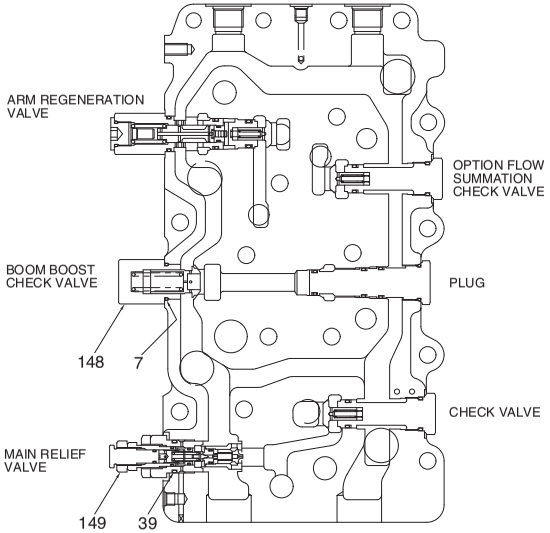


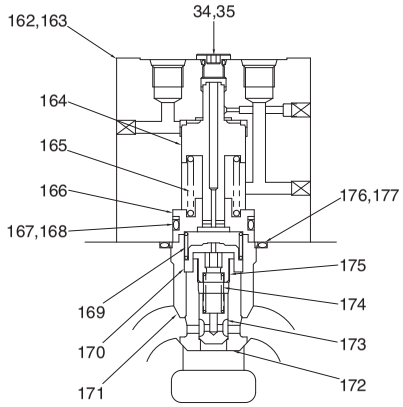
ARM REGENERATION VALVE



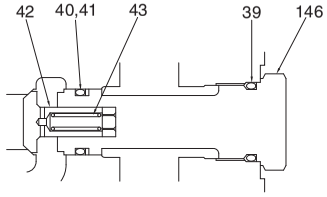


ARM SEMI-PARA VALVE
BOOM PRIORITY VALVE (AM)

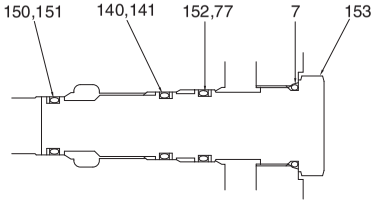




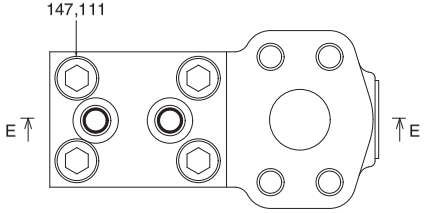
BOOM PRIORITY VALVE (BKT)

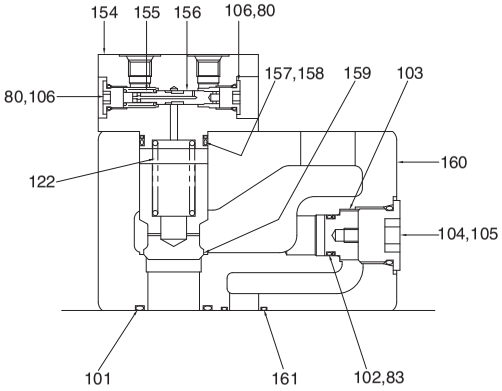


OPTION FLOW SUMMATION CHECK VALVE



PLUG

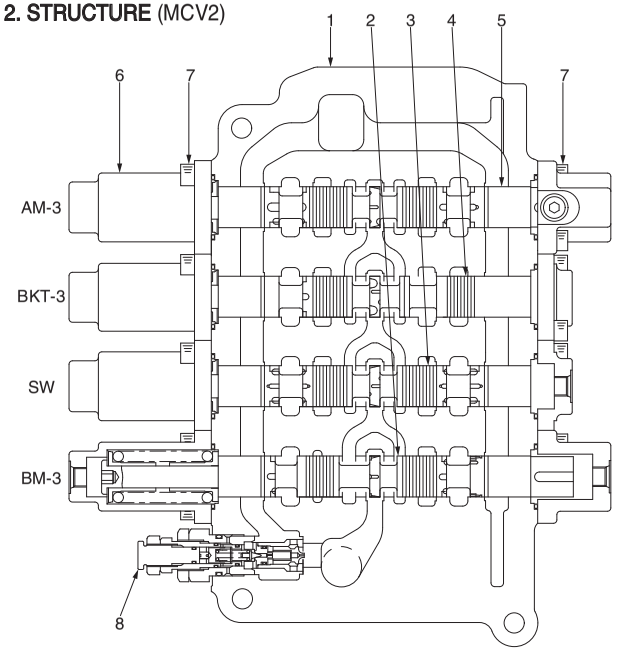


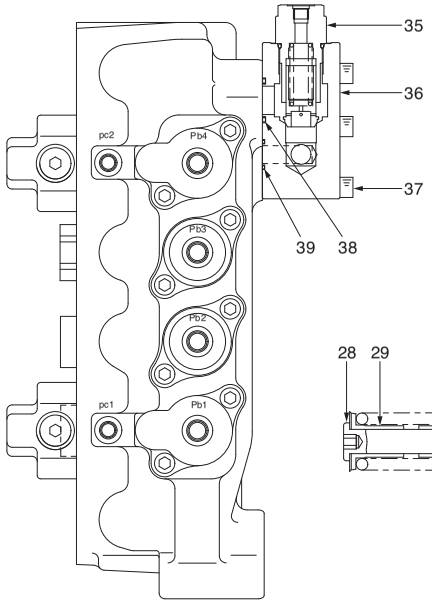


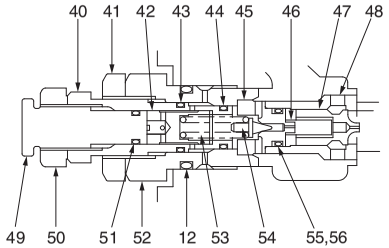
E - E
BOOM-2 HOLDING VALVE

120092MC82

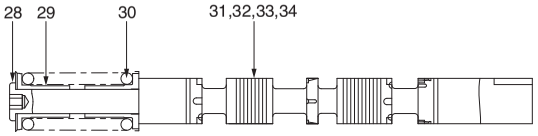
2. STRUCTURE (MCV2)



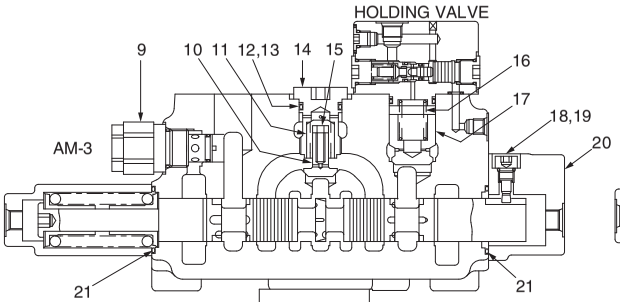


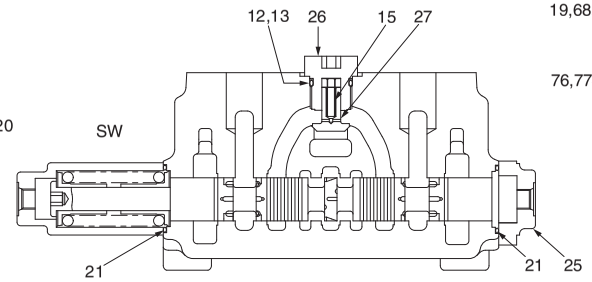


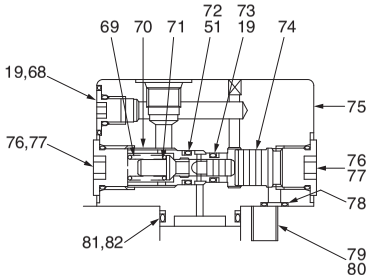
⑧ MAIN RELIEF AS



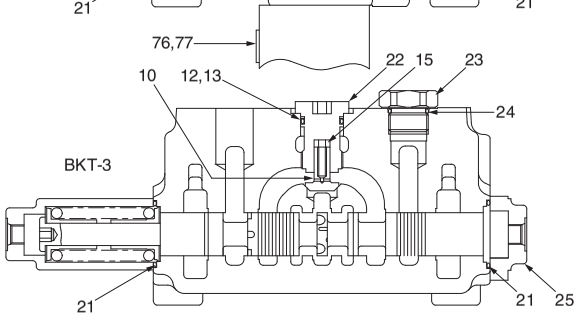
PLUNGER ASSY

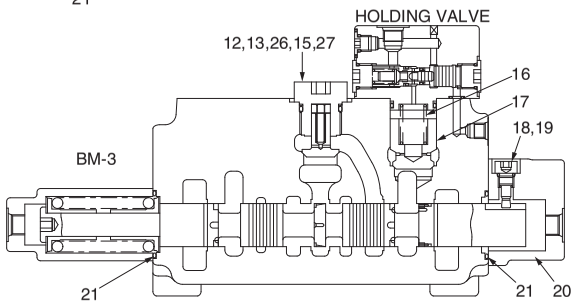


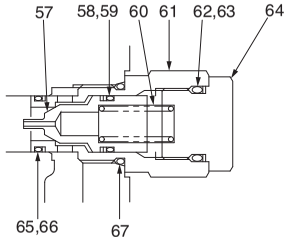




HOLDING VALVE PILOT PART







⑨ MAKE-UP AS

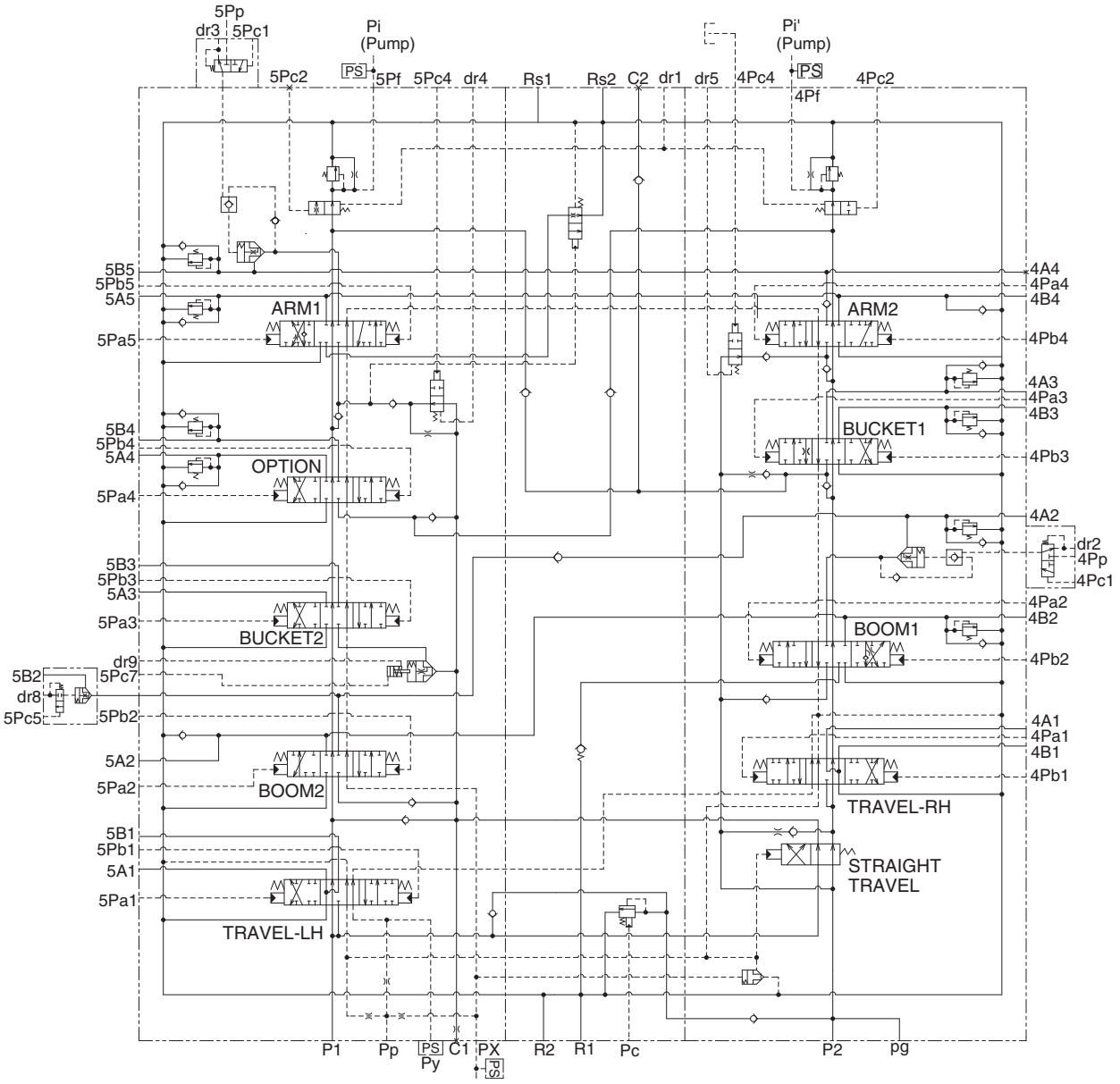
Port name	Port size
Pc1, Pc2, Pf	PF 1/4
Pa 1~4, Pb 1~4	PF 3/8
dr1, dr2	PF 3/8
B3	PF 1

1	Housing	42	Piston
2	Plunger B16 assy	43	O-ring
3	Plunger T5 assy	44	O-ring
4	Plunger C5 assy	45	Pilot sheet
5	Plunger A11 assy	46	Spring
6	Cover	47	Poppet
7	Hex socket head bolt	48	Sleeve
8	Main relief assy	49	Adjust screw
9	Make-up assy	50	Hex nut
10	Check	51	O-ring
11	Check	52	Cap
12	O-ring	53	Spring
13	Make-up ring	54	Pilot poppet
14	Cap	55	Back-up ring
15	Spring	56	O-ring
16	Spring	57	Poppet
17	Poppet	58	Back-up ring
18	Plug	59	O-ring
19	O-ring	60	Spring
20	Cover	61	Relief sleeve
21	O-ring	62	O-ring
22	Cap	63	Back-up ring
23	Cap	64	Cap
24	O-ring	65	O-ring
25	Cover	66	Back-up ring
26	Cap	67	O-ring
27	Check	68	Cap
28	Plunger cap	69	Spring
29	Spring guide	70	Sleeve
30	Spring	71	Poppet
31	Plunger B16	72	O-ring
32	Plunger T5	73	Back-up ring
33	Plunger C5	74	Piston
34	Plunger A11	75	Cover assy
35	Foot relief assy	76	Cap
36	Manifold	77	O-ring
37	Hex socket head bolt	78	O-ring
38	O-ring	79	Hex socket head bolt
39	O-ring	80	Washer
40	Sleeve	81	Back-up ring
41	Hex nut	82	O-ring

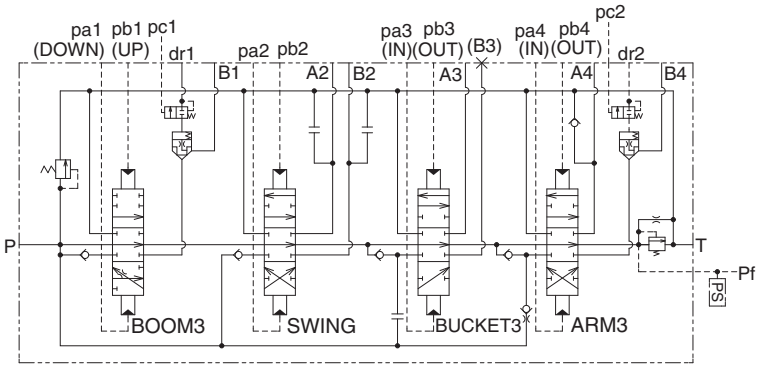
120092MC83

3. HYDRAULIC CIRCUIT

1) MAIN CONTROL VALVE 1



2) MAIN CONTROL VALVE 2



120092MC84

4. BASIC OPERATION

1) STRAIGHT TRAVEL CIRCUIT

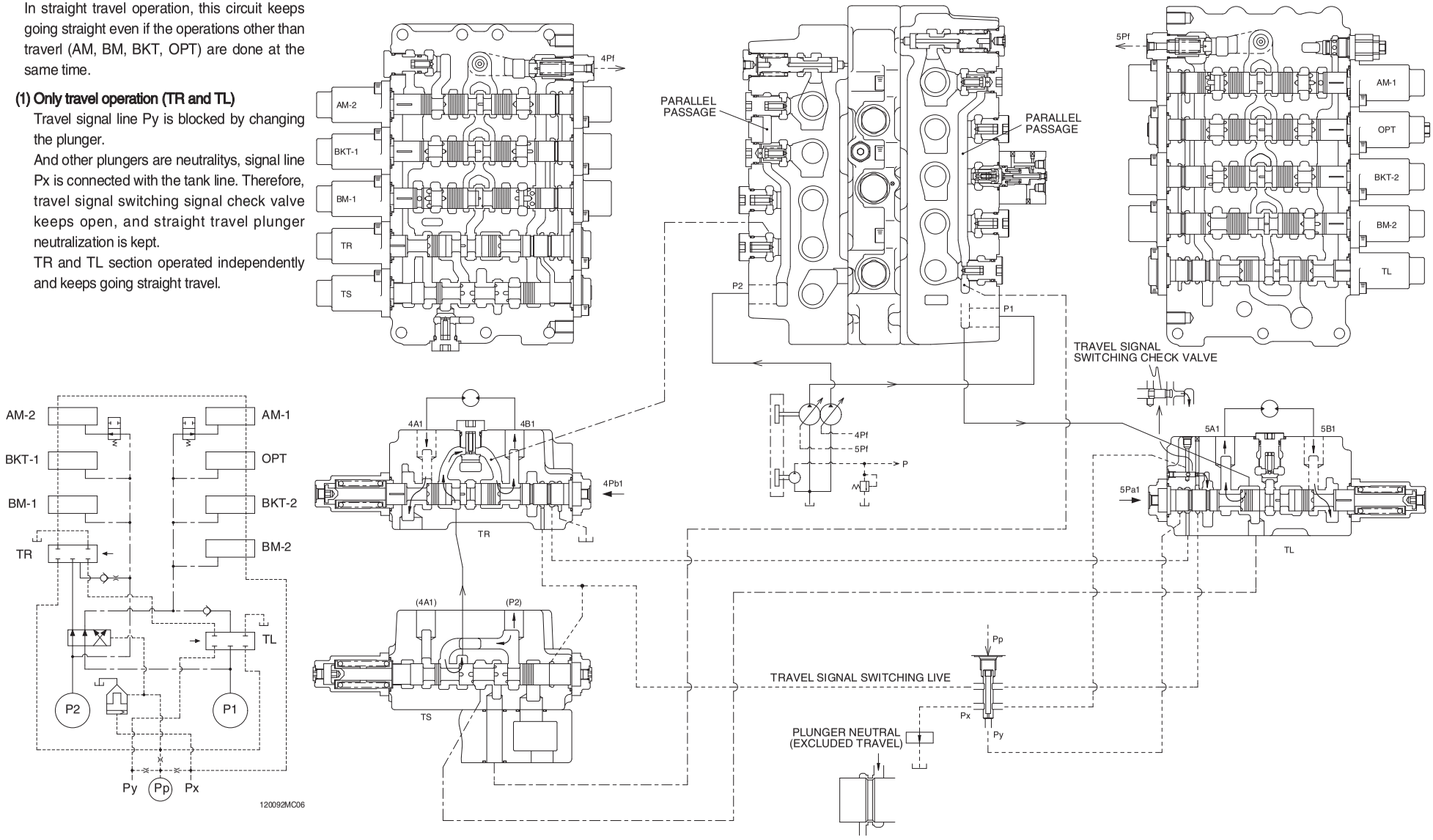
In straight travel operation, this circuit keeps going straight even if the operations other than traverl (AM, BM, BKT, OPT) are done at the same time.

(1) Only travel operation (TR and TL)

Travel signal line Py is blocked by changing the plunger.

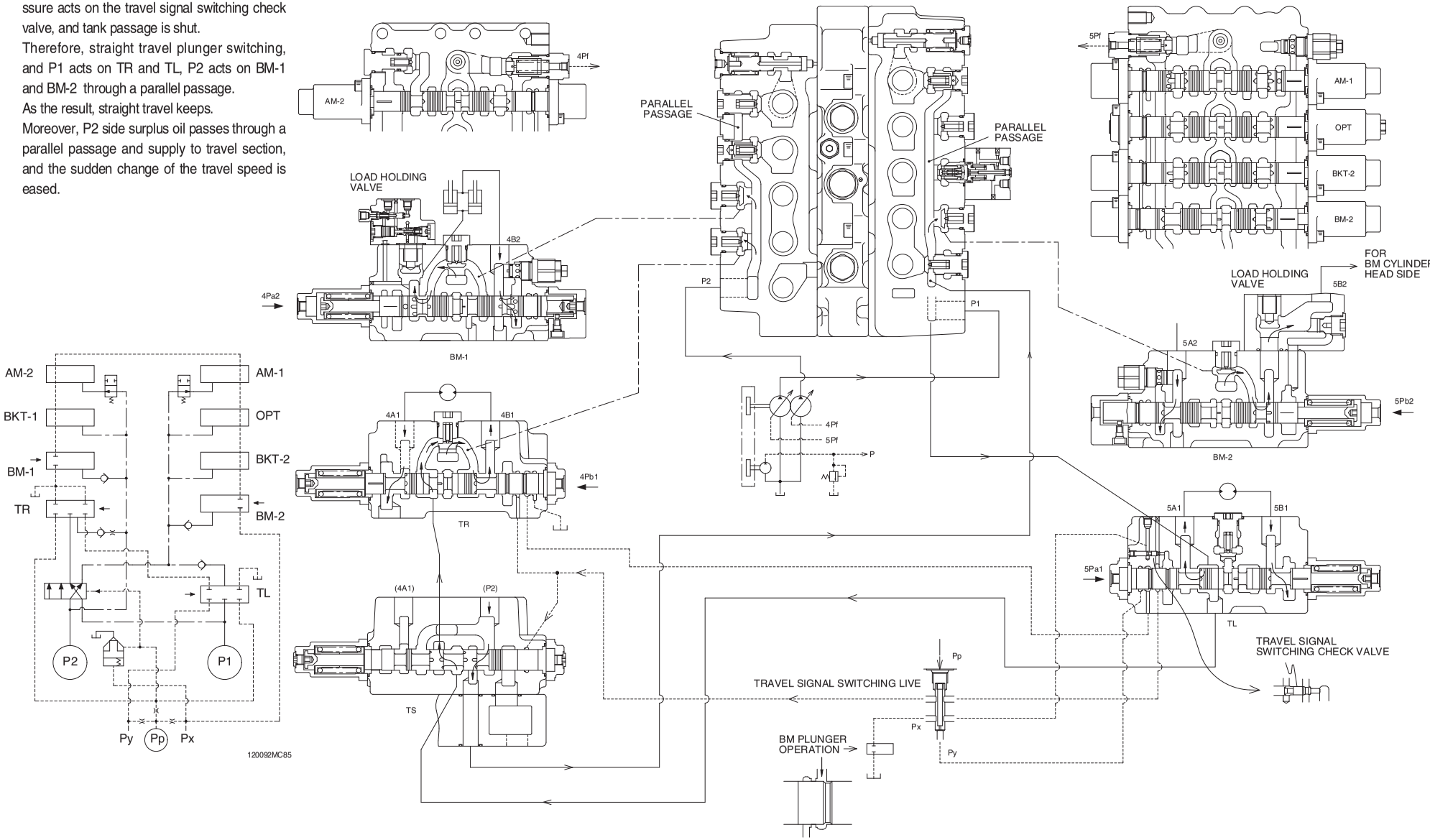
And other plungers are neutralitys, signal line Px is connected with the tank line. Therefore, travel signal switching signal check valve keeps open, and straight travel plunger neutralization is kept.

TR and TL section operated independently and keeps going straight travel.



(2) Both travel operation (TR and TL) and for instance BM-up operation

In BM operation, Px is blocked and pilot pressure acts on the travel signal switching check valve, and tank passage is shut.
Therefore, straight travel plunger switching, and P1 acts on TR and TL, P2 acts on BM-1 and BM-2 through a parallel passage.
As the result, straight travel keeps.
Moreover, P2 side surplus oil passes through a parallel passage and supply to travel section, and the sudden change of the travel speed is eased.

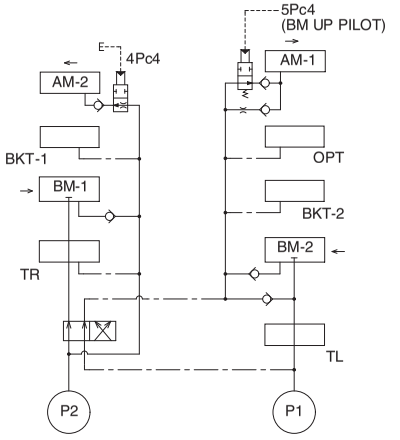


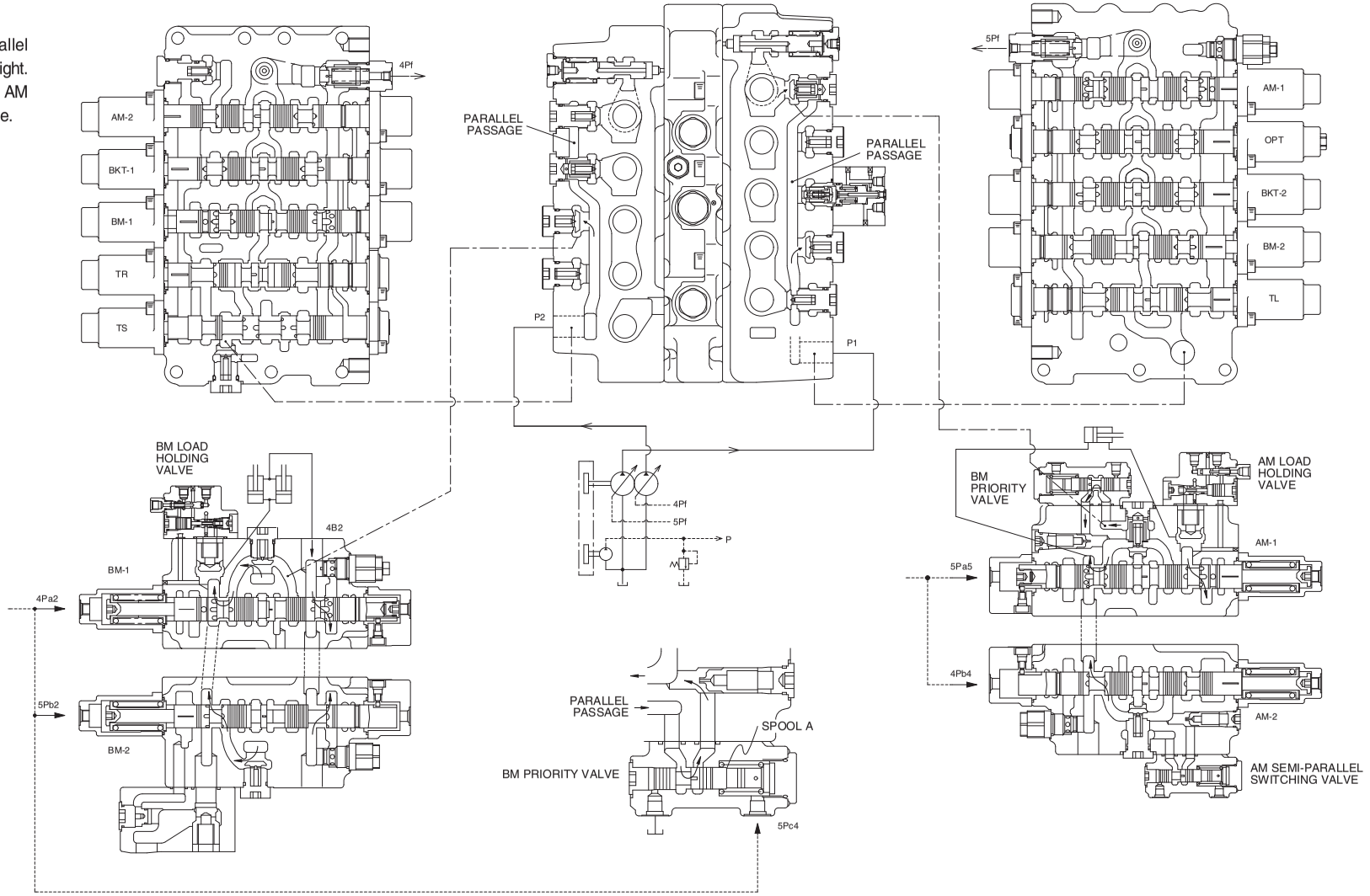
2) ARM SEMI-PARALLEL CIRCUIT

(1) Arm-crowd and BM-up operation

In BM-up operation, BM-up pilot pressure acts on 4Pc4 port, and spool A controls parallel passage open area by the stroke.

P2 is supplied to AM-2 through the parallel passage by priority, because AM-2 load is light. P1 is supplied to BM-2 by priority, because AM parallel valve squeezed the parallel passage.





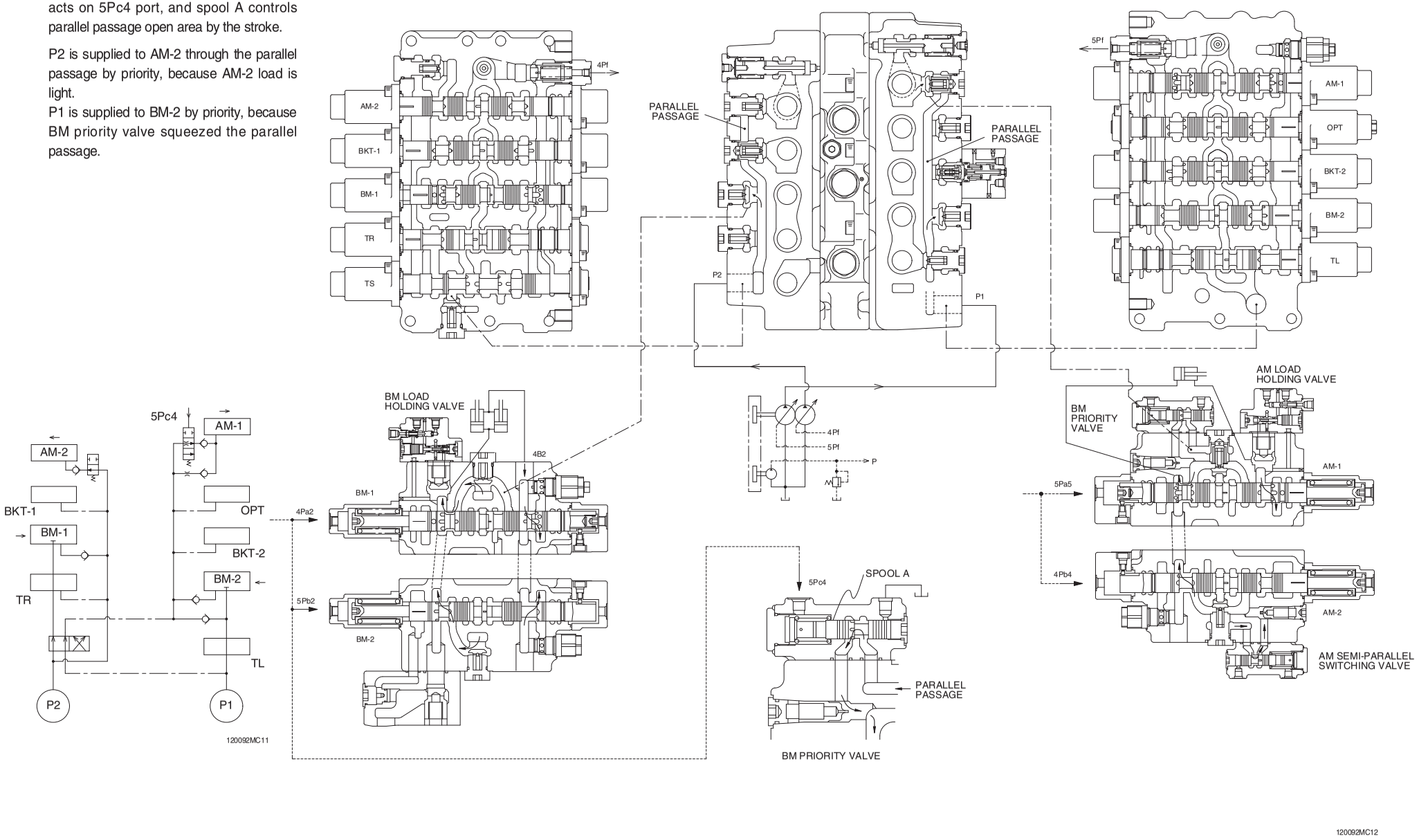
3) BOOM PRIORITY CIRCUIT

(1) Arm-crowd and Boom-up operation

In BM-up operation, BM-up pilot pressure acts on 5Pc4 port, and spool A controls parallel passage open area by the stroke.

P2 is supplied to AM-2 through the parallel passage by priority, because AM-2 load is light.

P1 is supplied to BM-2 by priority, because BM priority valve squeezed the parallel passage.



4) OPTION SUMMATION CIRCUIT

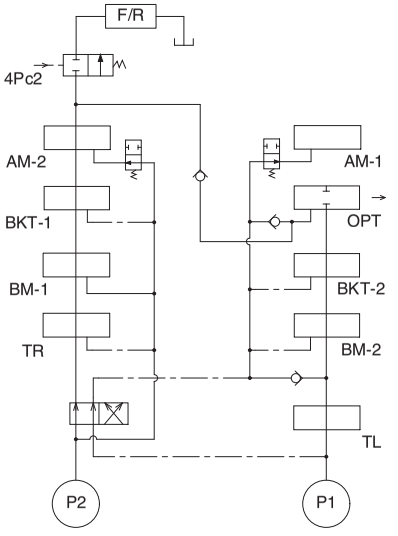
(1) Option single operation

P1 is supplied to 5A4.

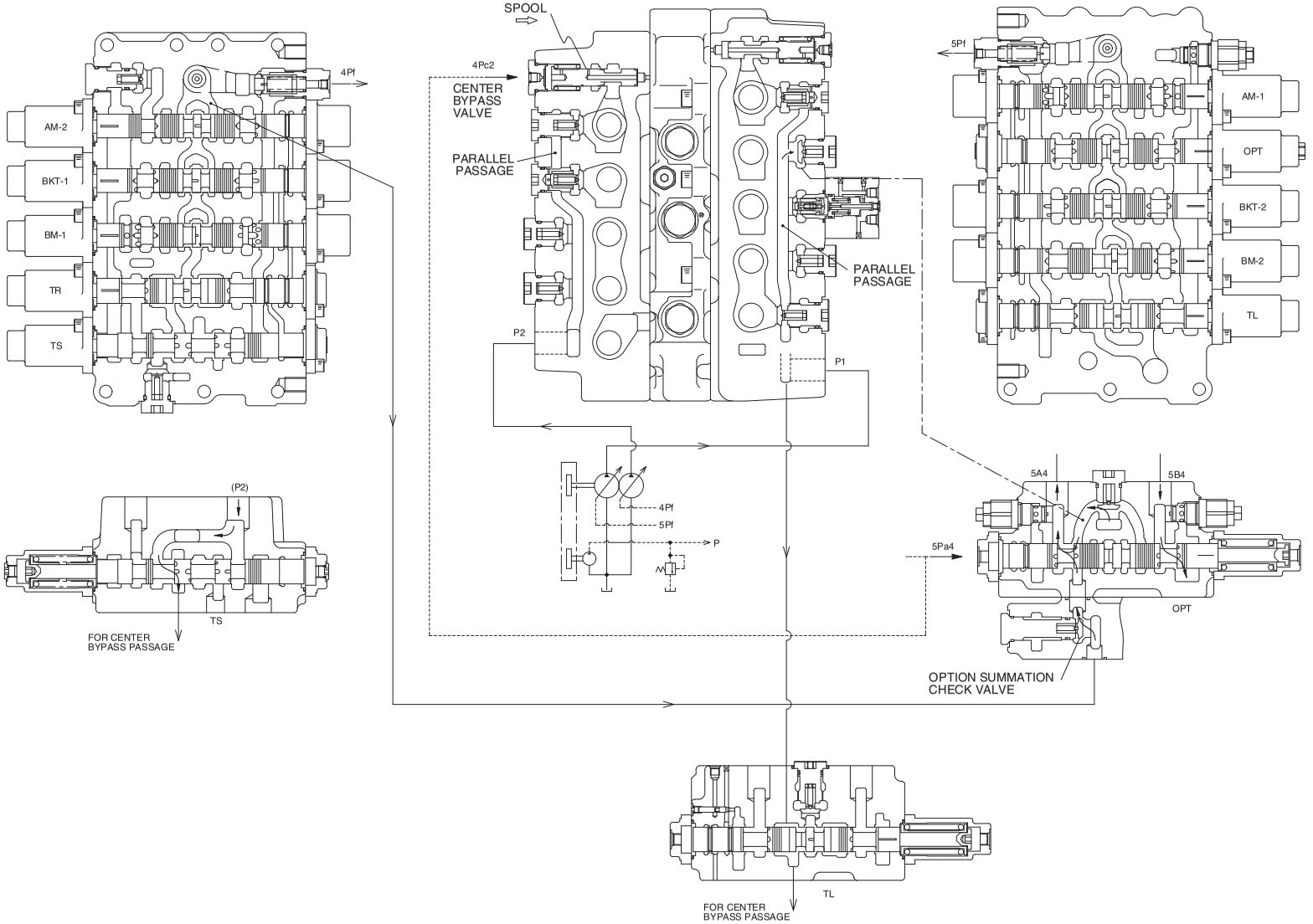
OPT pilot pressure acts on 4Pc2 port, and center bypass spool switch and tank passage shut.

Therefore, P2 supplied OPT port through the center bypass spool and OPT summation check valve.

As a result, two pumps are joined and it flows to OPT port.

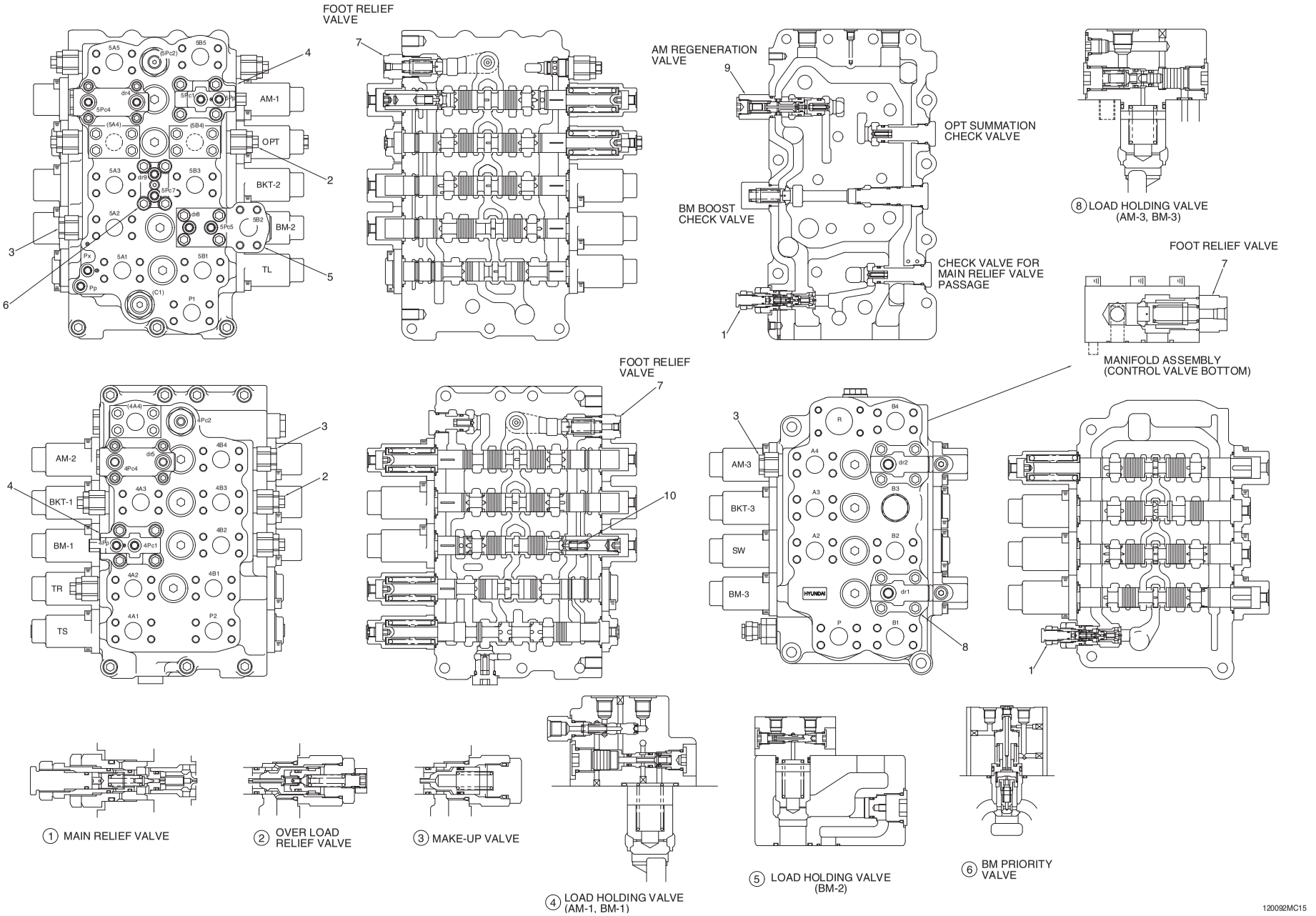


120092MC13



120092MC14

5. EACH PARTS OPERATIONAL DESCRIPTION

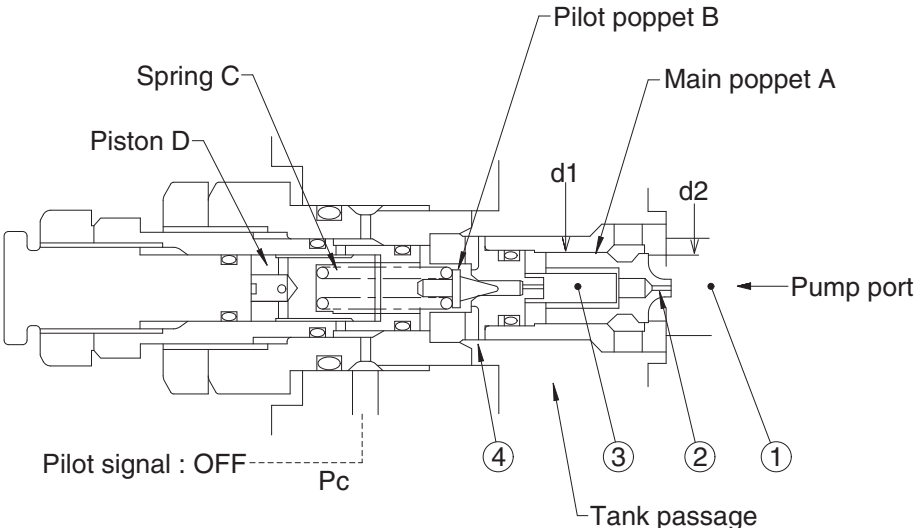


1) MAIN RELIEF VALVE

(1) Standard pressure setting (Pc pilot port : OFF)

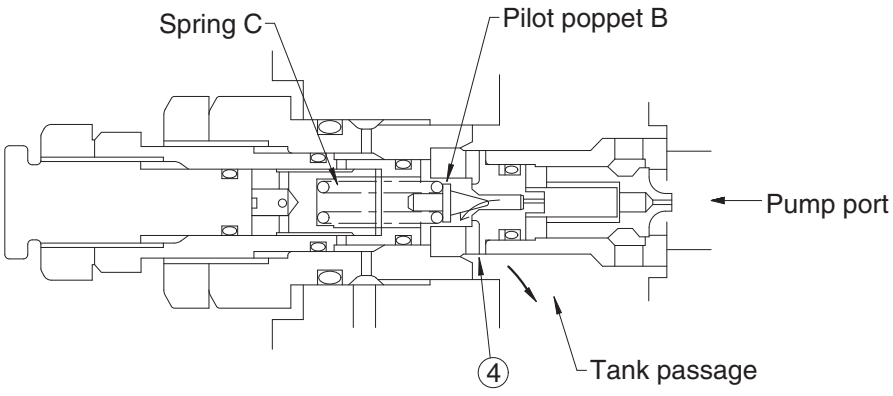
Piston "D" is positioned in left side by the spring "C".

① Oil from the pump port enters into the chamber "3" through the orifice "2" of the main poppet "A". As d1 > d2, main poppet "A" is securely seated.



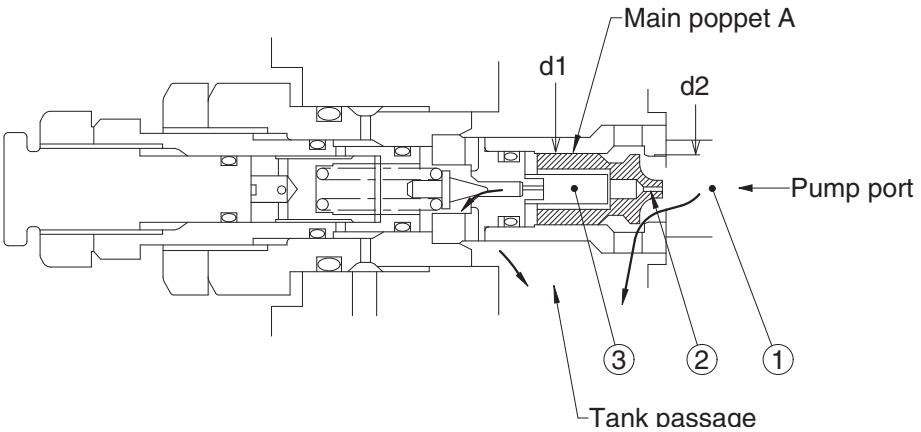
120092MC16

② When the pressure reaches the preset force of the spring "C" the pilot poppet "B" opens. Oil flows around pilot poppet "B" and flows into the tank passage through the side hole "4".



120092MC86

③ As oil flows from the pump port to the tank passage through the orifice "2" of the main poppet "A", the pressure of the chamber "3" comes to lower than that of the pump port. Then the main poppet "A" is lifted and pressured oil flows into the tank passage.

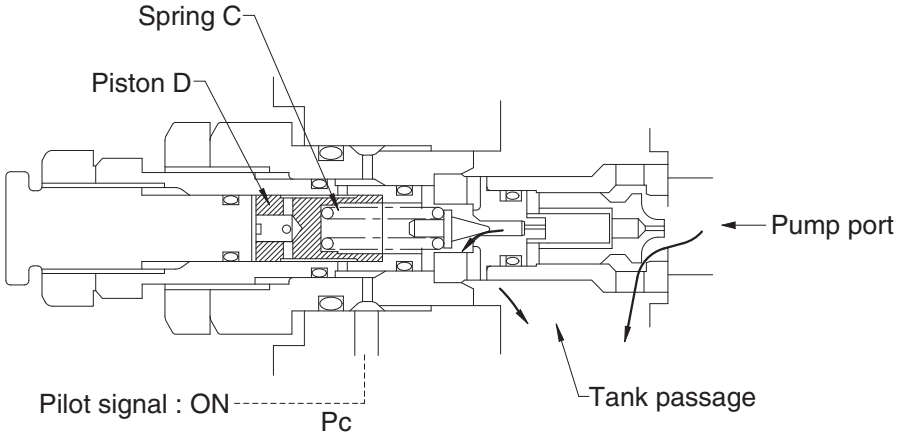


120092MC17

(2) High pressure setting (Pc2 pilot port : ON)

Piston "D" is positioned in right side by the pilot pressure "Pc".

The setting force of the spring "C" increases and the relief setting pressure changes to the high pressure.

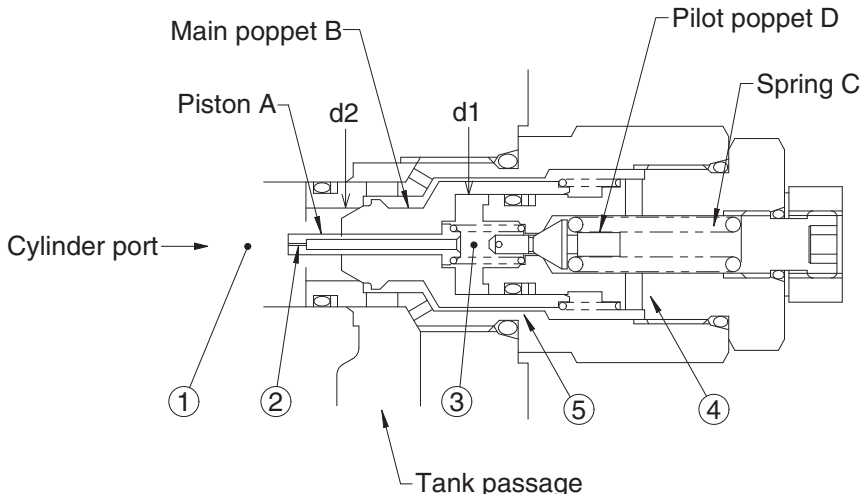


120092MC87

2) OVER LOAD RELIEF VALVE

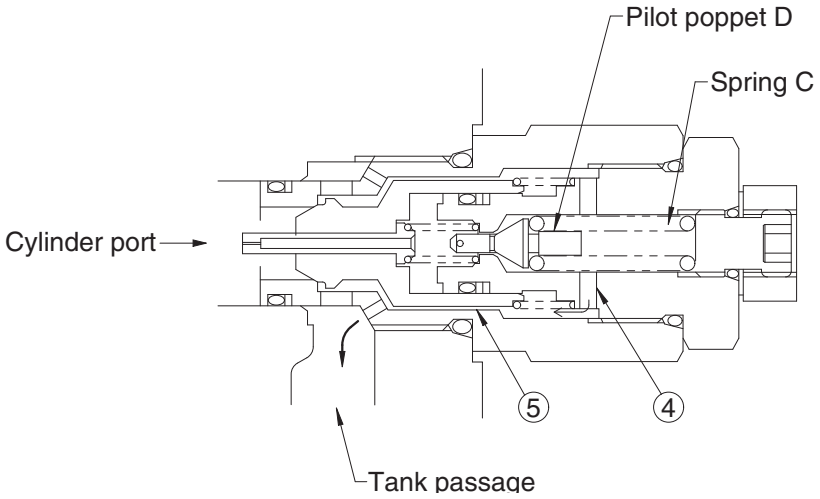
(1) Overload relief function

① Oil from the cylinder port enters into the chamber "3" through the orifice "2" of the piston "A". As d1 > d2, main poppet "B" is securely seated.



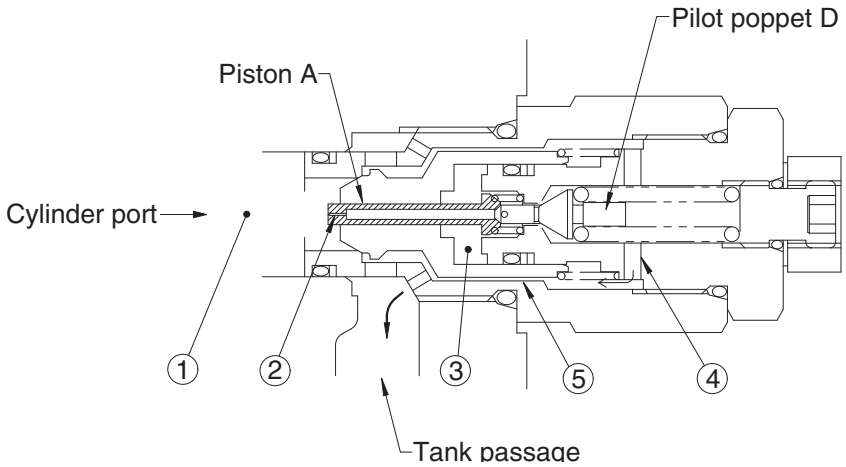
120092MC18

② When the pressure reaches the preset force of the spring "C" the pilot poppet "D" opens. Oil flows around pilot poppet "D" and flows into the tank passage through the side hole "4" and the passage "5".



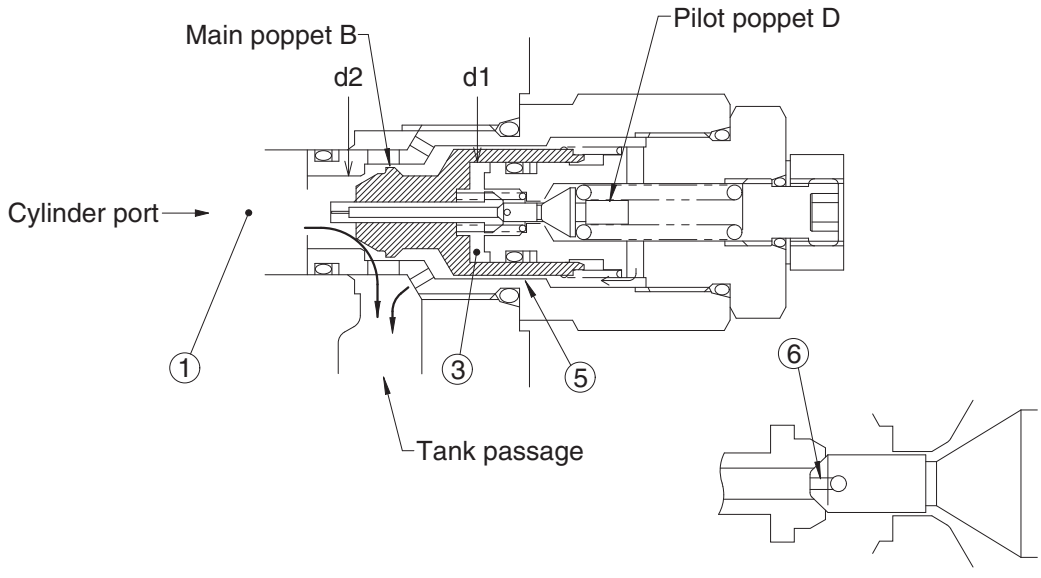
120092MC88

③ As oil flows from the cylinder port to the tank passage through the orifice "2" of the piston "A", the pressure of the chamber "3" comes to lower than that of the cylinder port. Then the piston "A" is lifted and seated to the pilot poppet "D".



120092MC19

④ Oil from the cylinder port flows to the tank passage through the orifice "6" of the pilot poppet "D" and the chamber "3". As the pressure of the chamber "3" comes to lower still more, the main poppet "B" is lifted and pressured oil flows into the tank passage.

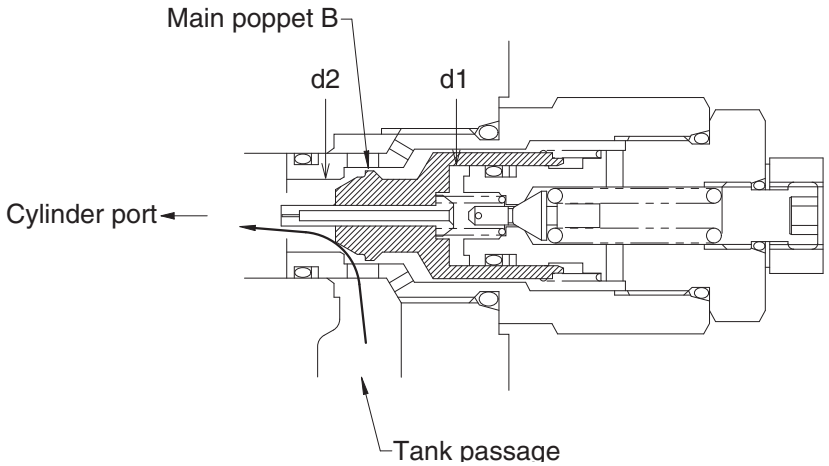


120092MC89

(2) Make-up function

① As the cylinder port pressure is normally higher than the tank passage pressure and d1 > d2, the main poppet "B" is securely seated.

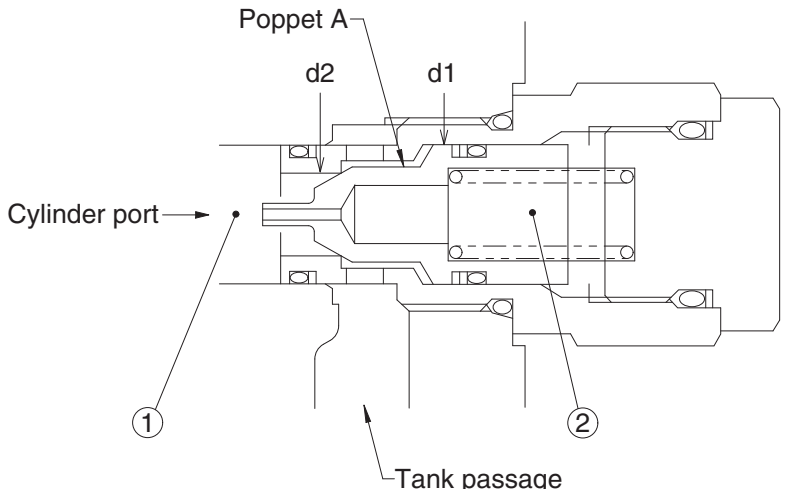
② When the cylinder port pressure comes to lower than the tank passage pressure (closer to negative pressure), the main poppet "B" opens receiving the tank passage pressure for the difference in area between "d1" and "d2". Oil flows from the tank passage flows to the cylinder port in order to prevent cavitation.



120092MC20

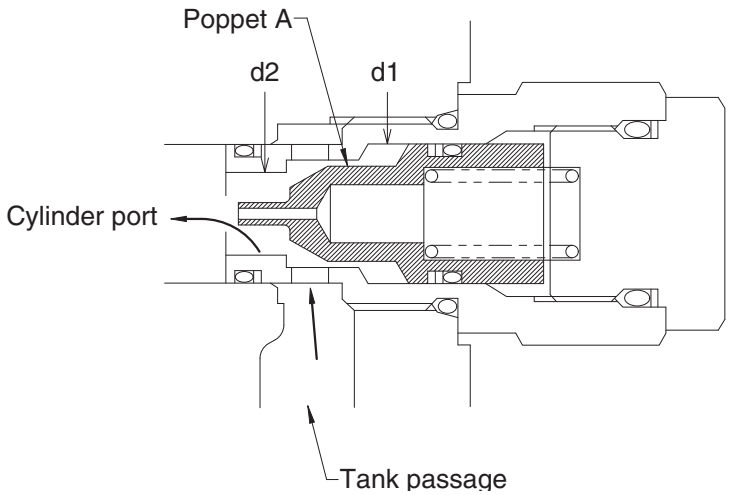
3) MAKE-UP VALVE

(1) Cylinder port pressure enters into the chamber "3" through the poppet "A. And the main poppet "B" is securely seated, because of d1 > d2.



120092MC21

(2) When the cylinder port pressure comes to lower than the tank passage pressure (closer to negative pressure), the main poppet "B" opens receiving the tank passage pressure for the difference in area between "d1" and "d2". Oil flows from the tank passage flows to the cylinder port in order to prevent cavitation.



120092MC90

4) LOAD HOLDING VALVE (ARM-1, BOOM-1)

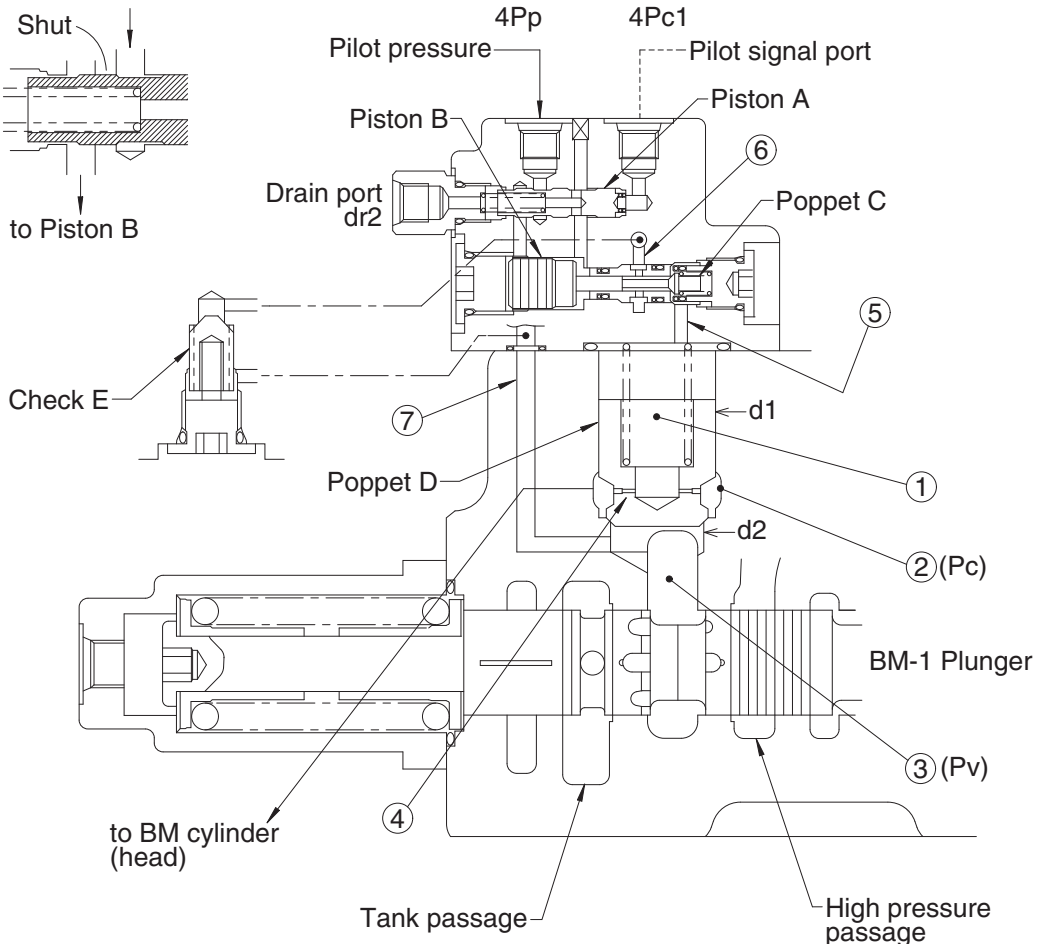
BM holding valve is explained as an example.

(1) When the plunger is in neutral position (4Pc1 pilot signal : OFF)

Piston "A" and piston "B" is in the status as shown, the pilot pressure (4Pp) is blocked. Therefore piston "B" and poppet "C" is in this status as shown, the passage "5" and "6" shut off by the poppet "C", and the passage "7" shut off by the check "E".

And, the pressure of chamber "1" is same to the pressure of "Pc", as it is connected with the passage "2" through the orifice "4".

Since d1 > d2, the poppet "C" is seated and the passage "2" and "3" are completely blocked.



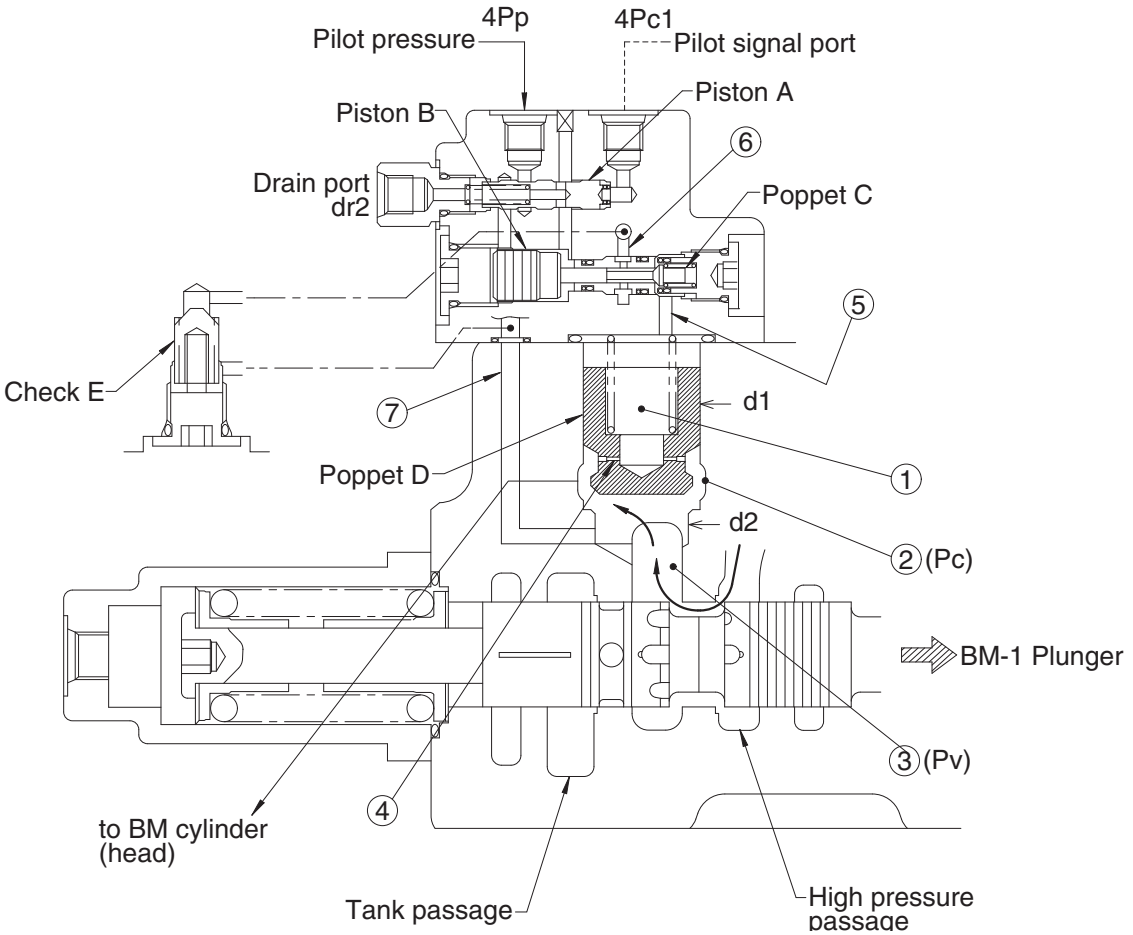
120092MC22

(2) When the plunger is operated

① **Boom-up operation** (Pv > Pc and pilot signal 4Pc1 : OFF)

The pressure of the chamber "1" is same to the pressure of "BM" cylinder (head), (equals to "Pc"), as it is connected with the core "2" through the orifice "4".

The poppet "D" is pushed up and oil from the high pressure passage flows into the "BM" cylinder port.



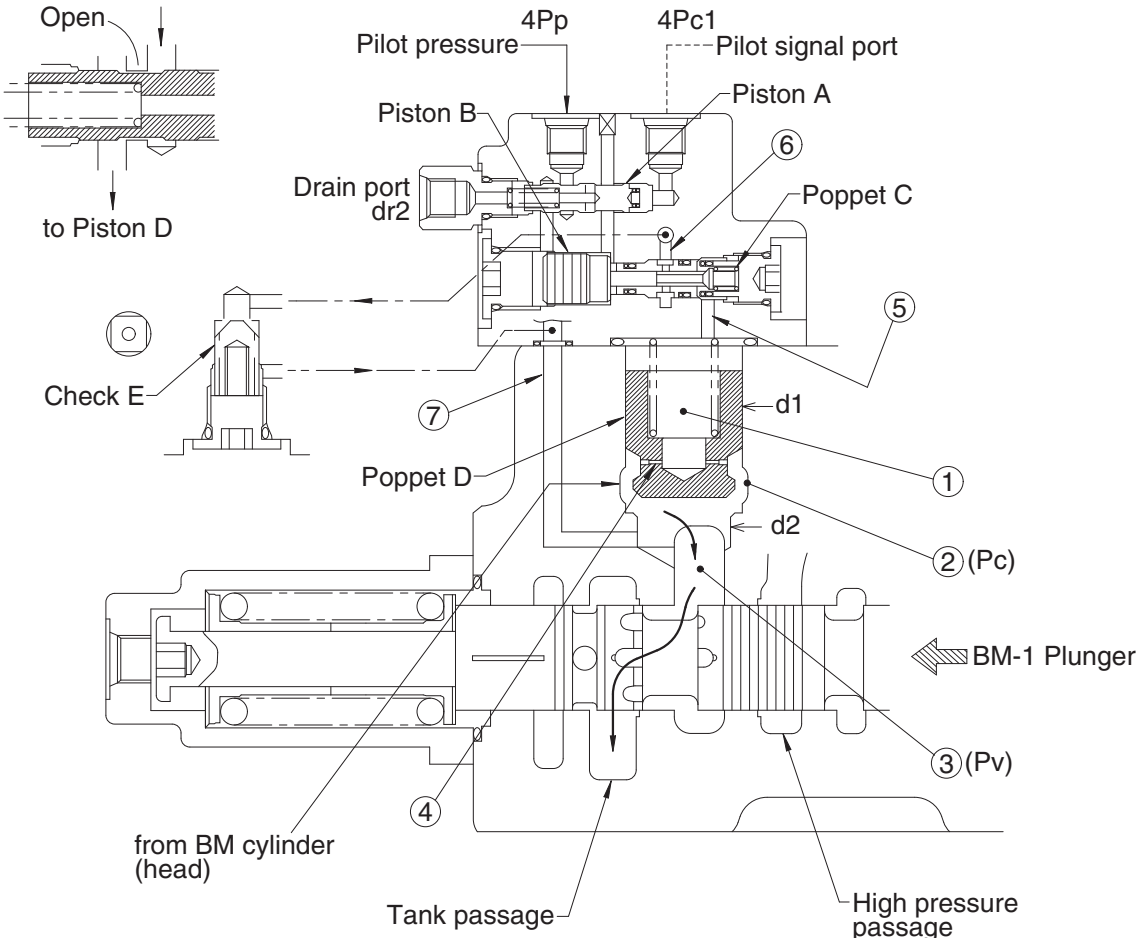
120092MC23

② **Boom-down operation** (Pc > Pv and pilot signal 4Pc1 : ON)

The BM-1 plunger moves the left side, the chamber "3" connected the tank passage. And the plunger pilot pressure is acts on the "4Pc1" port, the piston "A" moves the left side, and pilot pressure enter the chamber of piston "B".

The piston "B" and poppet "C" moves the right side, the passage "5", "6" and "7" that through the check "E" are connected the tank passage.

The chamber "A" pressure is falls, the pressure "Pc" acts on the area of difference between "d1" and "d2", the poppet "D" is opened by this. Therefore, the oil that returns from the BM cylinder head side is flows to the tank passage.



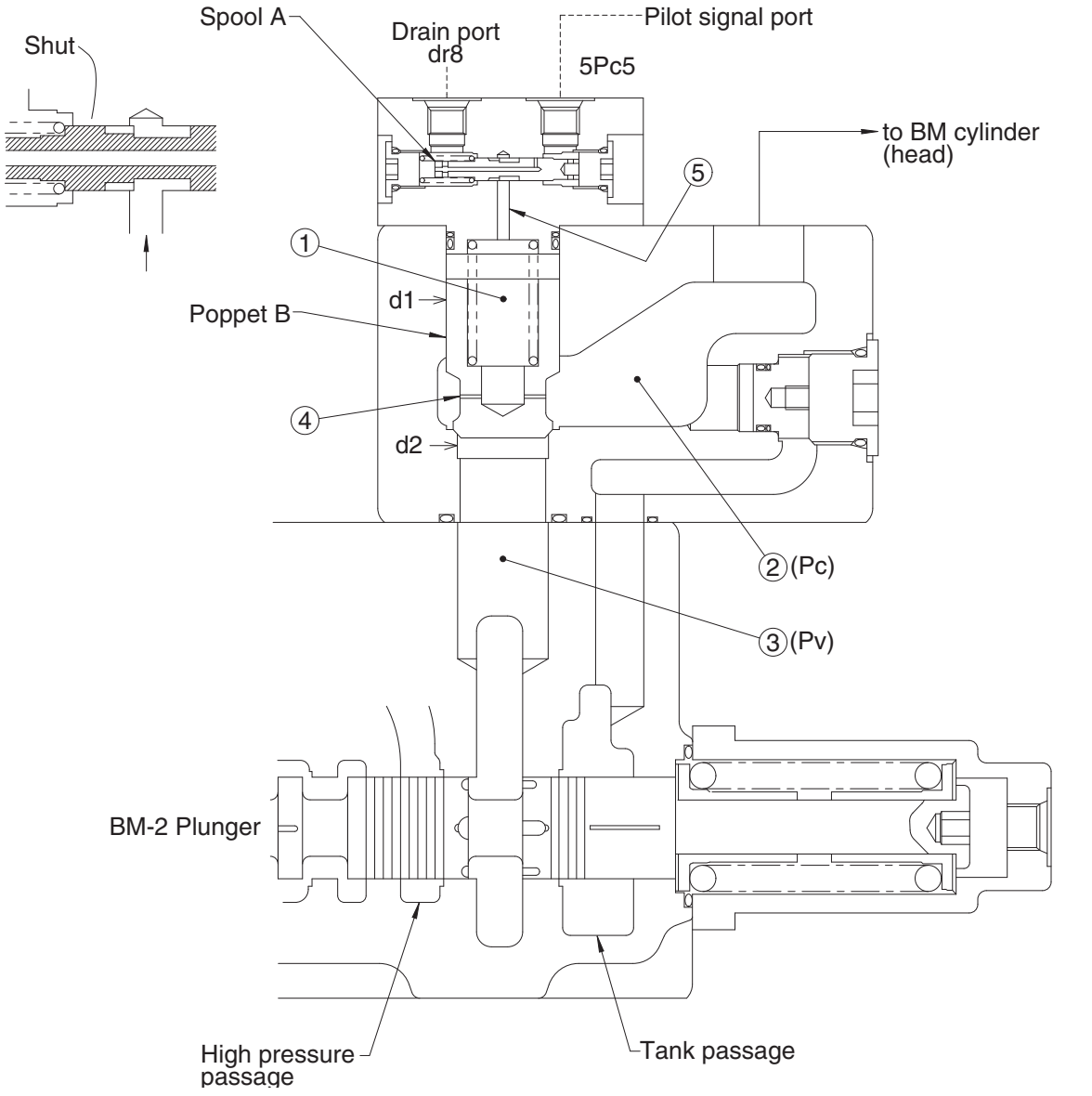
120092MC24

5) LOAD HOLDING VALVE (BOOM-2)

(1) When the plunger is in neutral position (5Pc5 pilot signal : OFF)

Spool "A" is in the status as shown, the passage "5" and drain port are shut off by the spool "A". And, the pressure of chamber "1" is same to the pressure of "Pc", as it is connected with the passage "2" through the orifice "4".

Since d1 > d2, the poppet "B" is seated and the passage "2" and "3" are completely blocked.



120092MC25

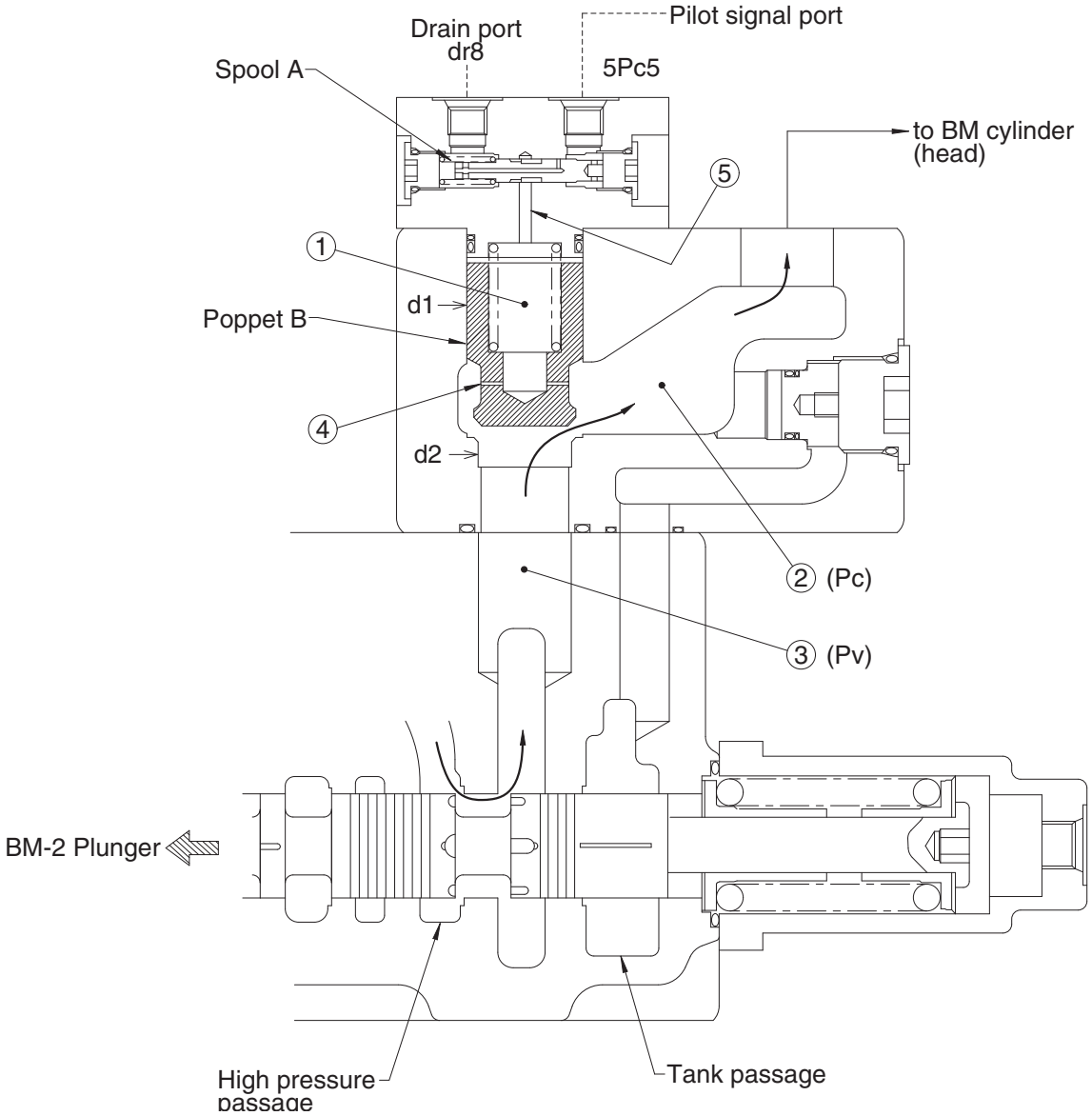
(2) When the plunger is operated

① **Boom-up operation** (Pv > Pc and pilot signal 5Pc5 : OFF)

The BM-2 plunger moves the left side, and oil from the high pressure passage flows into the core "3".

And, the pressure of chamber "1" that through the olifice "3" is same to the pressure of "Pc".

The poppet "B" is pushed up and oil from the high pressure passage flows into the "BM" cylinder port.

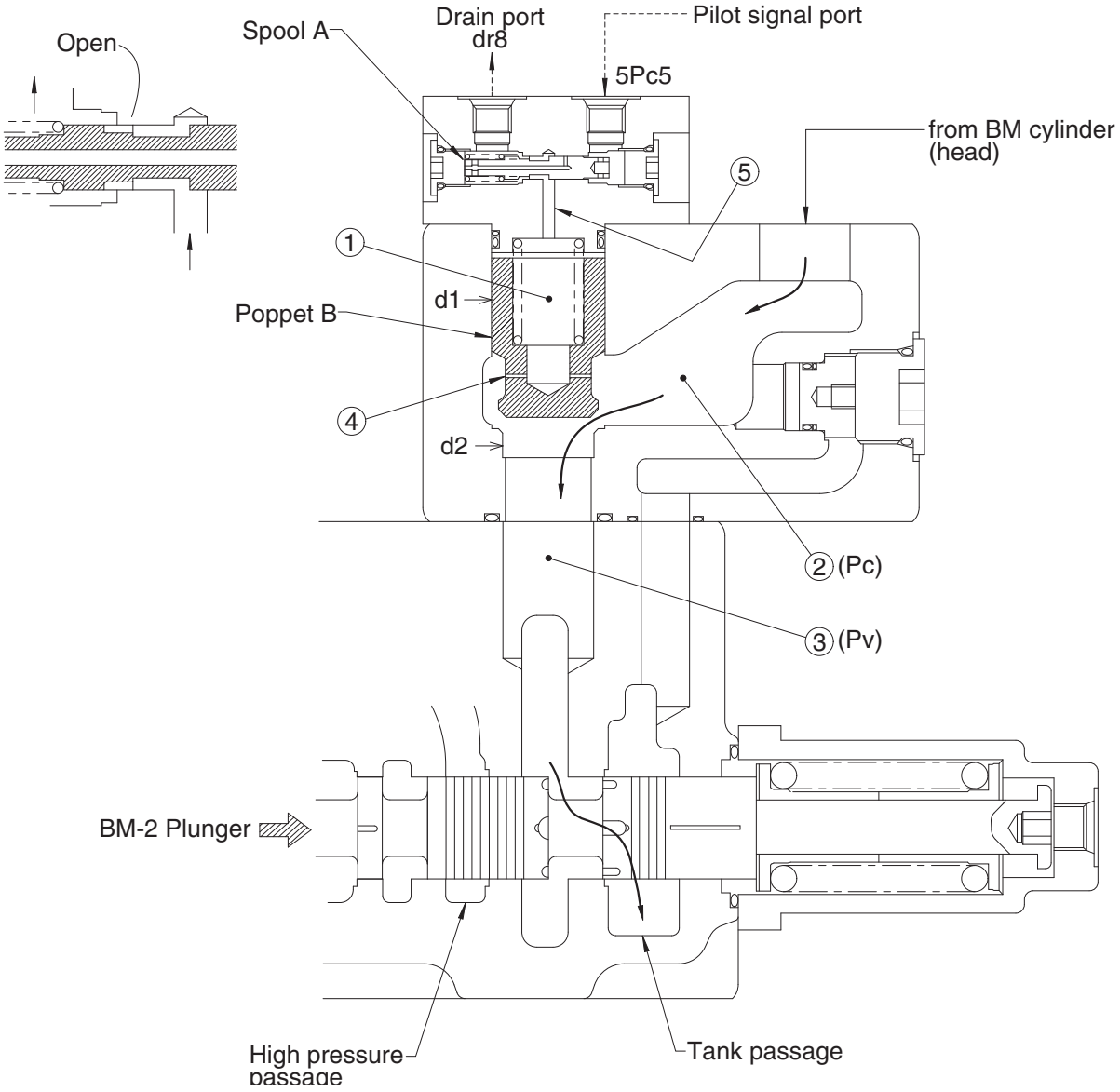


120092MC26

② **Boom-down operation** (Pc > Pv and pilot signal 5Pc5 : ON)

The BM-2 plunger moves the left side, the chamber "3" connected the tank passage. And the plunger pilot pressure is acts on the "5Pc5" port, the spool "A" moves the left side, and the passage "5" connected with the drain port.

The chamber "1" pressure is falls, the pressure "Pc" acts on the area of difference between "d1" and "d2", the poppet "B" is opened by this. Therefore, the oil that returns from the BM cylinder head side is flows to the tank passage.



120092MC27

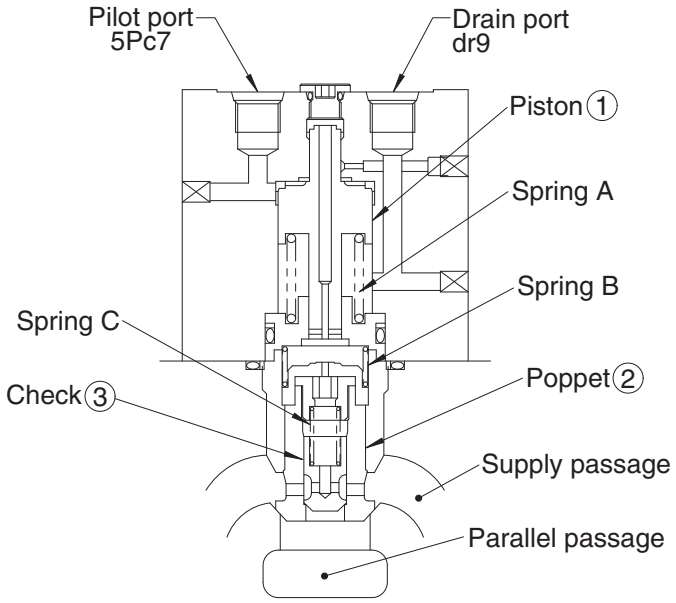
6) BOOM PRIORITY VALVE

BM priority valve (for the BKT-2 section)

(1) BKT operation (5Pc7 pilot signal : OFF)

① **When the parallel passage pressure lower than the supply passage pressure.**

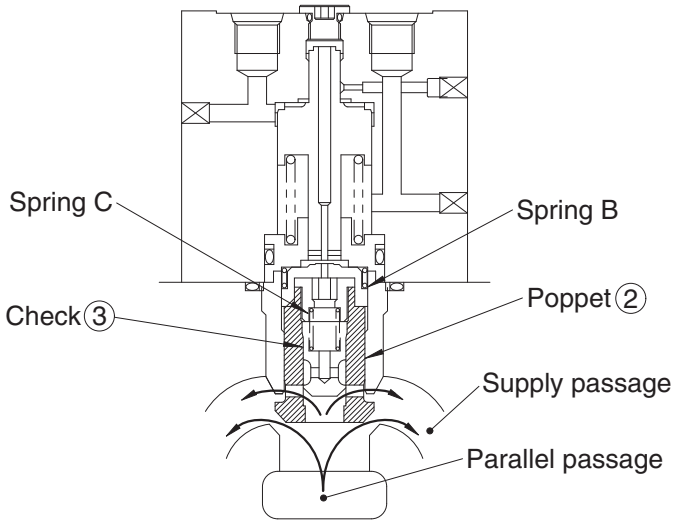
Piston "1", poppet "2" and check "B" are in the status as shown by the each springs "A", "B" and " C", and seated surely.



120092MC28

② **When the parallel passage pressure higher than the supply passage pressure.**

The oil for parallel passage that connected the pump line is supply the BKT cylinder through the supply passage, because spring force of "B" and "C" is very small, and poppet "2" and check "3" are opened.

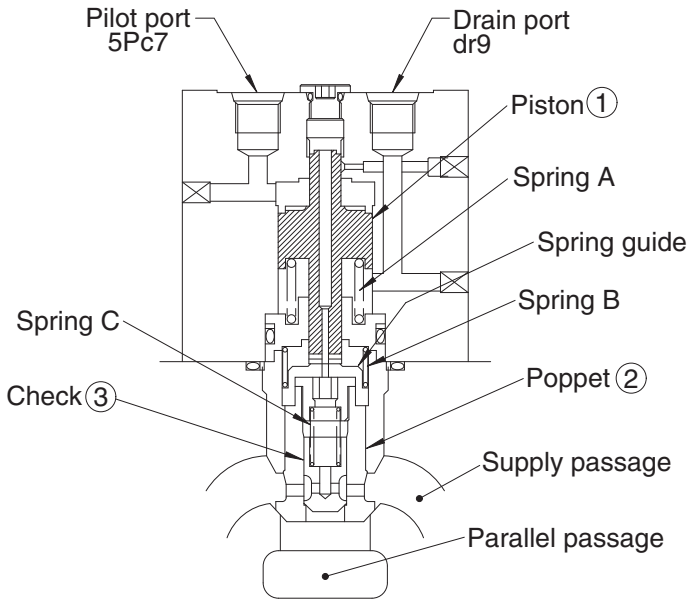


120092MC91

(2) BKT and BM up operation (5Pc7 pilot signal : ON)

① **When the parallel passage pressure lower than the supply passage pressure.**

BM up operation pilot pressure is acts on the pilot port "5Pc7", and its grows more than 0.1~0.15 MPa, the piston "1" moves to the position of figure, and presses poppet "2" and spring guide. Moreover, check "3" is in the status as shown and seated surely.



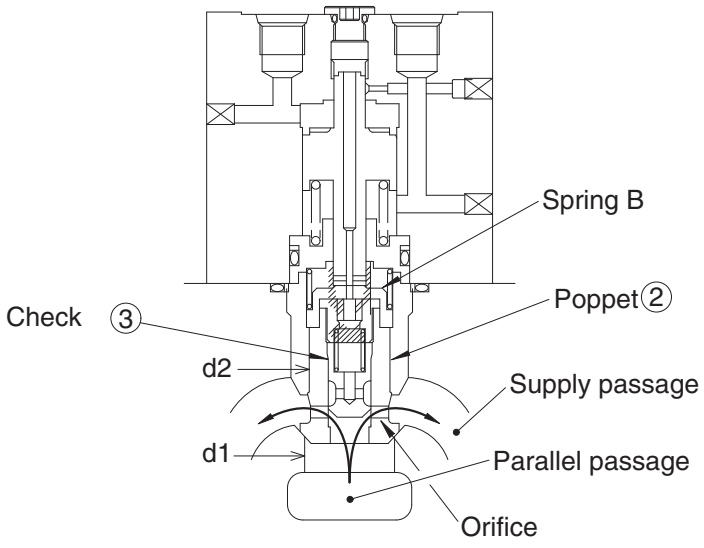
120092MC29

② **When the parallel passage pressure higher than the supply passage pressure.**

When the pilot pressure even a little, poppet "2" is seated, because "d1", "d2" are roughly the same.

The check "3" is opens and the oil of supply passage is flows to BKT cylinder. But this flow is controlled by the orifice of poppet "2".

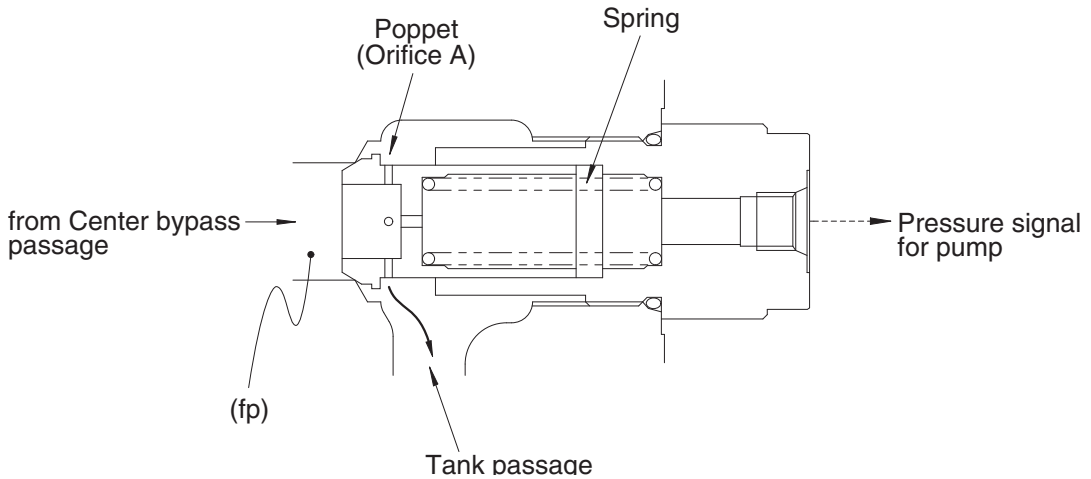
As a result, the oil that exhales the pump is supplied to the BM cylinder head side by priority.



120092MC92

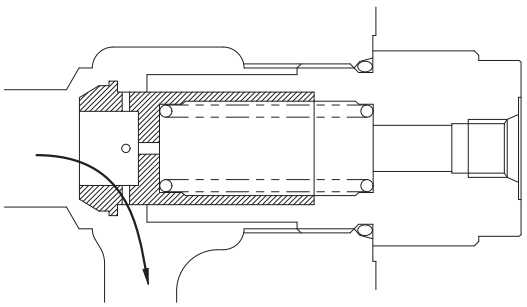
7) FOOT RELIEF VALVE

(1) The oil from center bypass passage flows tank passage through the orifice "A" of poppet. Pressure "Pf" generated when oil passes the orifice, that acts on the pump and controlled the displacement.



120092MC30

(2) For instance, the respons delay of the pump and large flow quantity flows, the pressure "Pf" grows more than the spring force that opens the poppet. And pressure oil flows to tank passage. These act like relief valve.



120092MC93

8) LOAD HOLDING VALVE (ARM-3, BOOM-3)

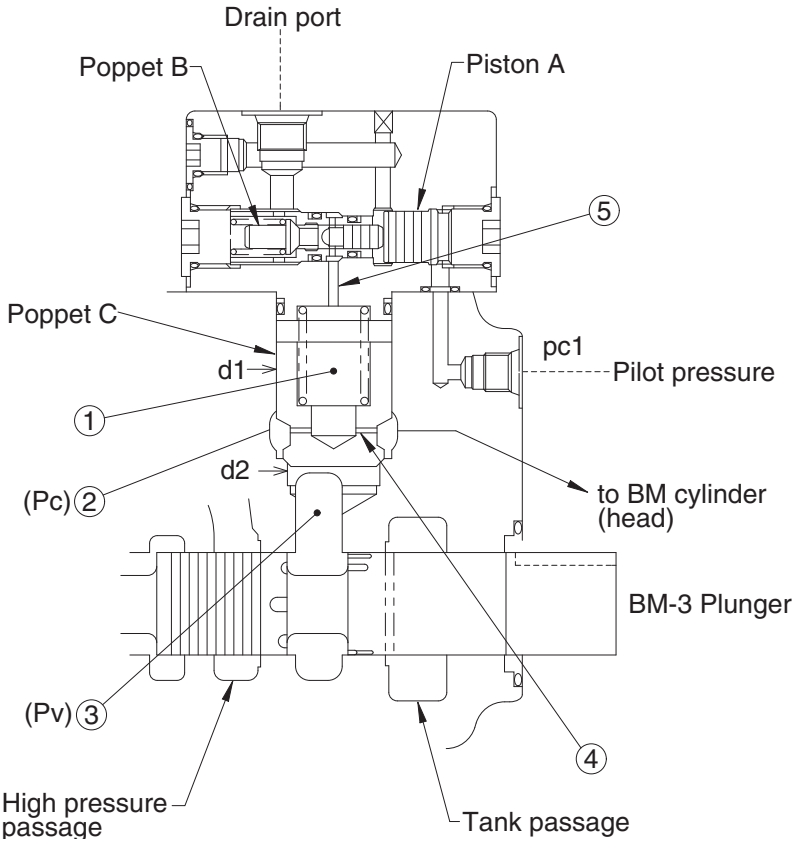
BM holding valve is explained as an example.

(1) When the plunger is in neutral position (Pc1 pilot signal : OFF)

Spool "A" and "B" are in the status as shown. The passage "5" and drain port are shut off by the poppet "B".

Therefore, the pressure of chamber "1" is same to "Pc", as it is connected with the core "2" through the orifice "4".

Since d1 > d2, the poppet "B" is seated and the core "2" and "3" are completely blocked.



120092MC31

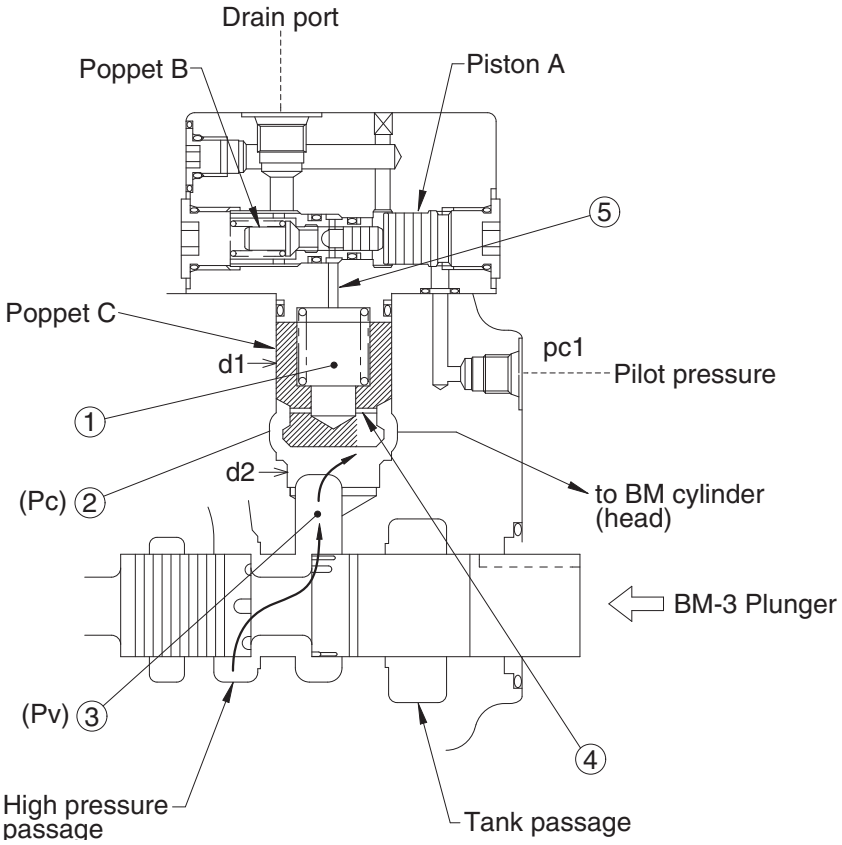
(2) When the plunger is operated

① **Boom-up operation** (Pv > Pc and pilot signal Pc1 : OFF)

The BM-3 plunger moves the left side, and oil from the high pressure passage flows into the core "3".

The pressure of the chamber "1" is same to the "Pc", as it is connected with the core "2" through the orifice "4" .

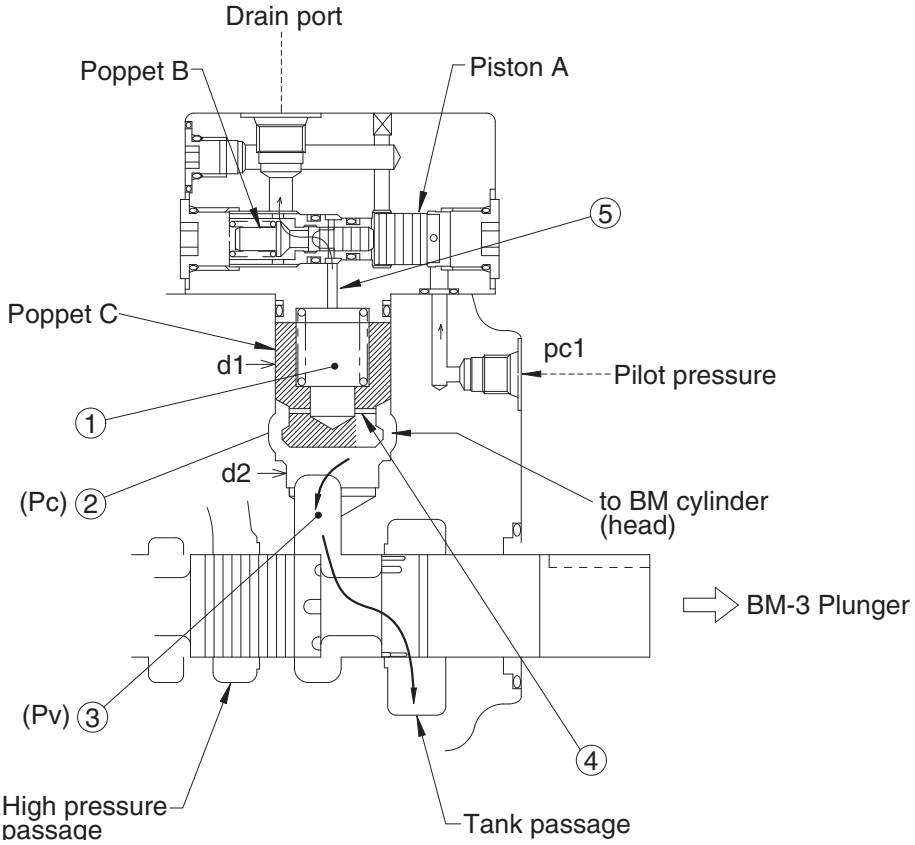
The poppet "C" is pushed up and oil from the high pressure passage flows into the cylinder port.



120092MC32

② **Boom-down operation** (Pilot signal Pc1 : ON)

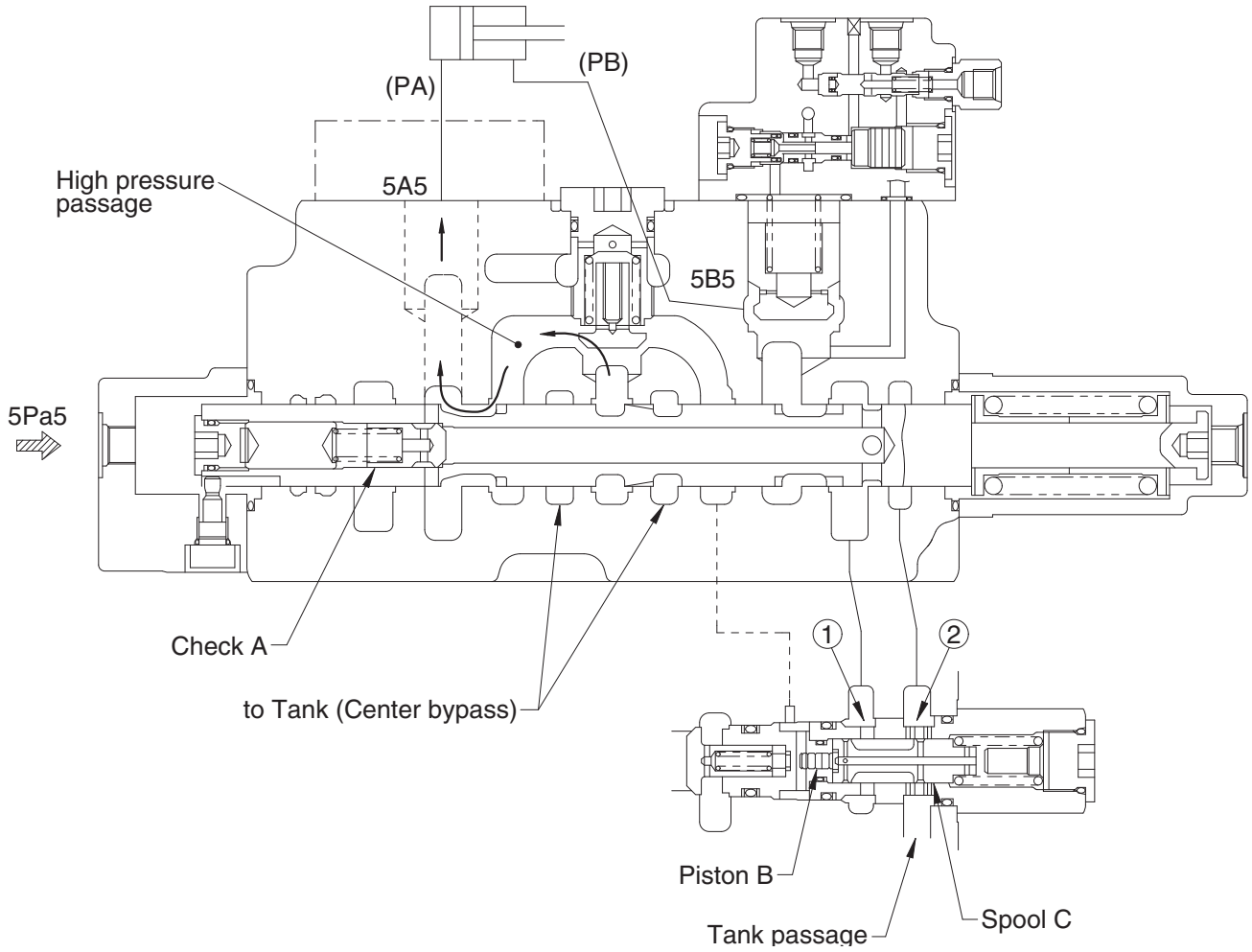
The BM-3 plunger moves the right side, and pilot pressure of "Pc1" acts on the piston chamber. Piston "A" and poppet "B" move the left side, and the passage "5" is connected to drain port. Spool "A" is switched by the pilot pressure, the passage "5" is connected to the drain port "dr6". The chamber "1" pressure is falls, the pressure "Pc" acts on the area of difference between "d1" and "d2", the poppet "C" is opened by this. Therefore, the oil that returns from the cylinder head side is flows to the tank passage.



120092MC33

9) ARM REGENERATION

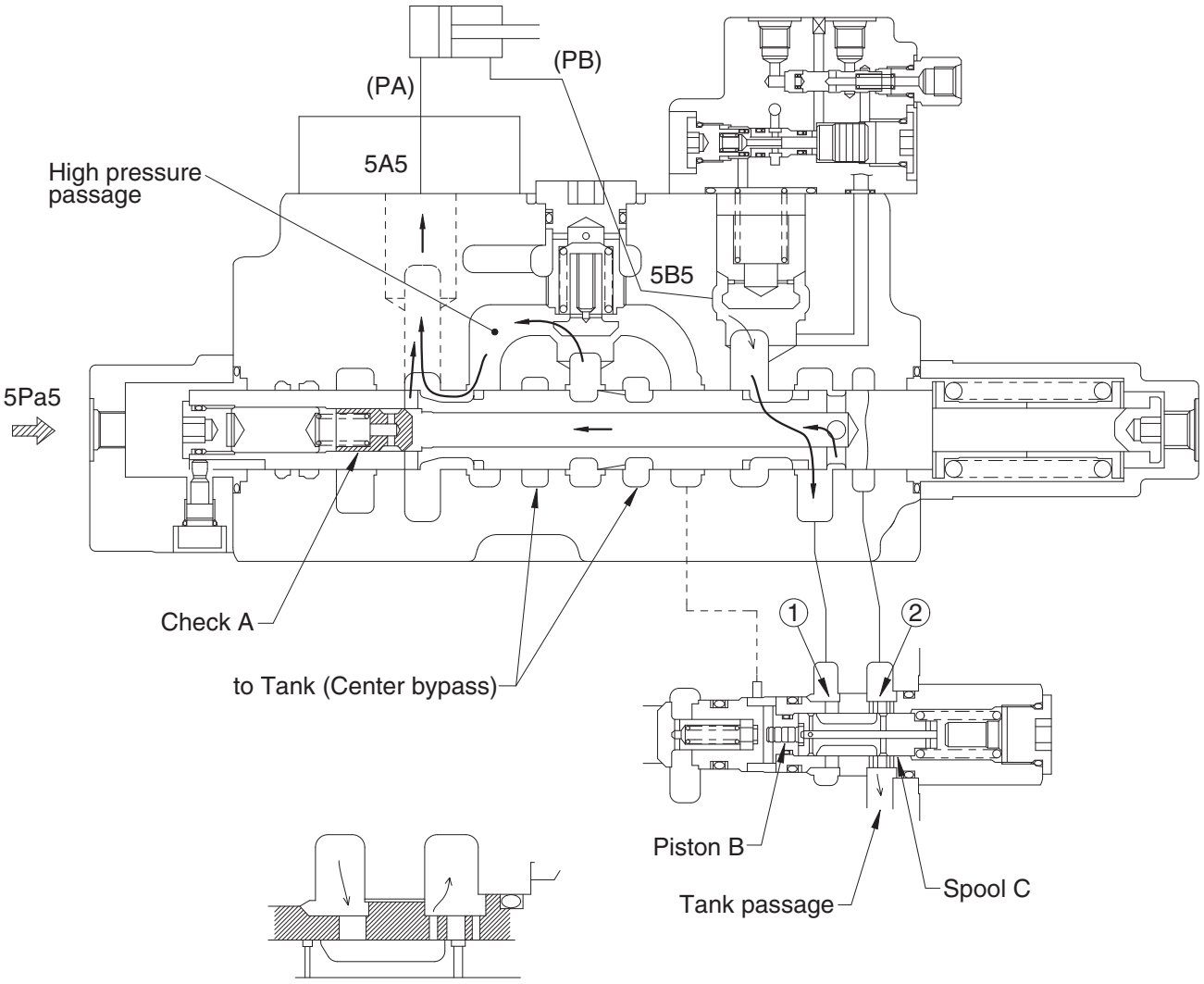
(1) When AM-crowd operation, the center bypass line from the inlet port "P" to the tank passage is shut off, oil from the center bypass passage pushes up the load check valve and flows to the AM cylinder head side through the high pressure passage.



120092MC34

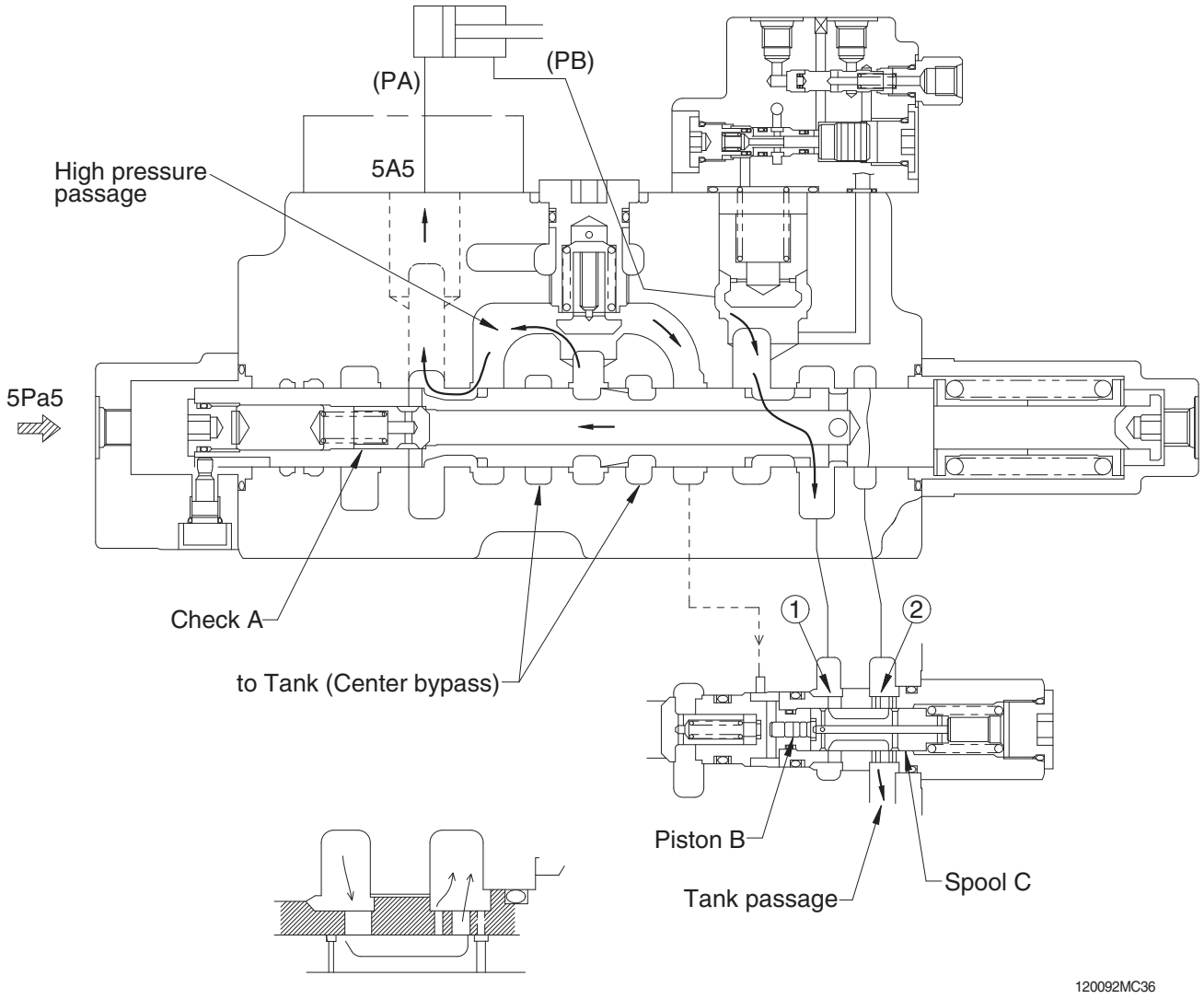
(2) When the rod side pressure of the "AM" cylinder is higher than head side one (PB > PA)

Return oil from cylinder rod side flows into the tank passage through the passage "1" and "2". Since area is small at this time, the pressure of oil rises, check "A" opens and is regenerated to the head side.



(3) When the head side pressure of the "AM" cylinder is higher than rod side one (PA > PB)

Return oil from cylinder head side acts on check "A" and shut the passage. And it's flows acts on the piston "B", that's moves spool "C" to the right side and the passage "2" is expanded.
Return oil from cylinder rod side flows to tank passage through the passage "1" and "2".

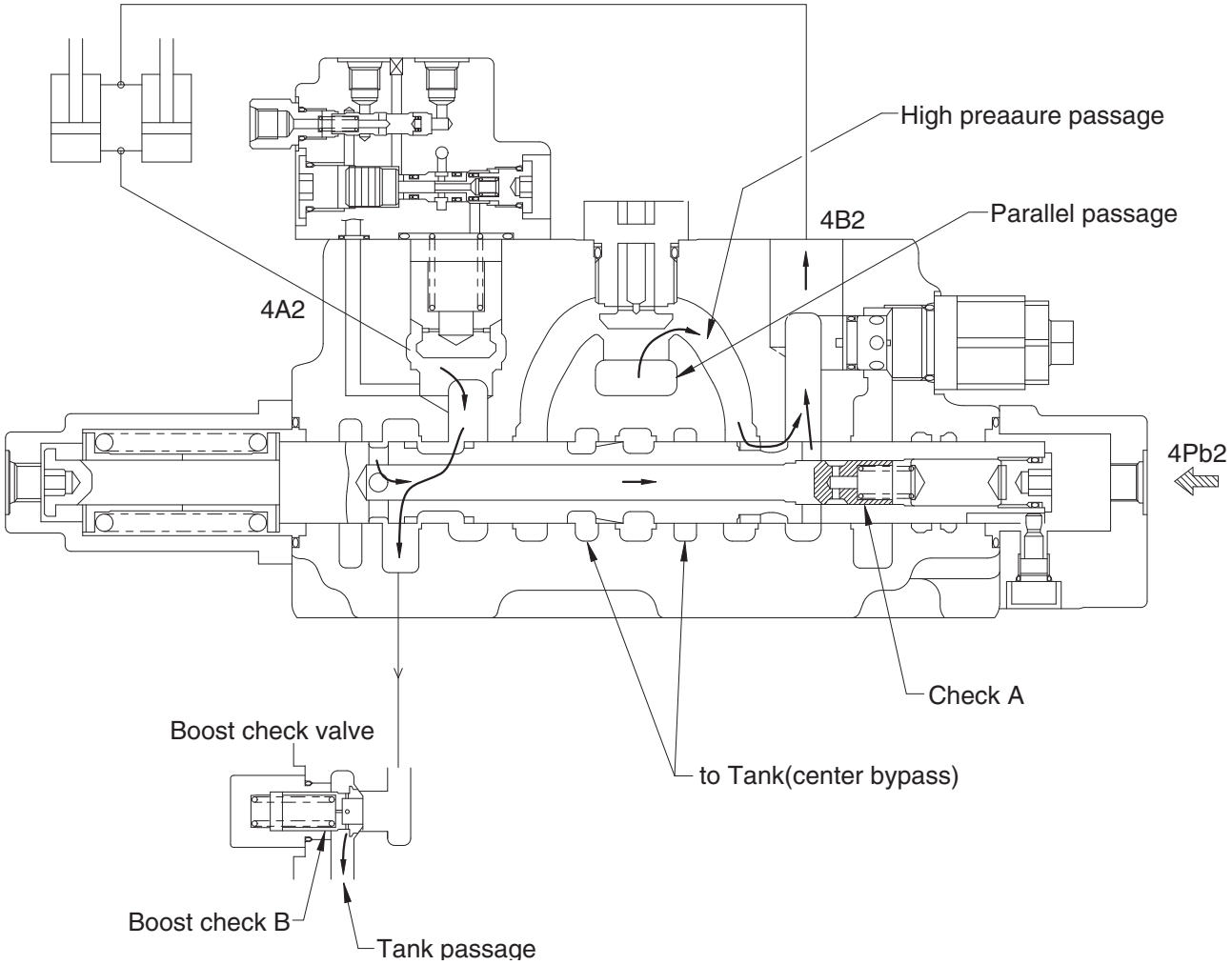


10) BOOM REGENERATION

When BM-down operation, the center bypass line from the inlet port "P" to the tank passage is shut off, the oil pushes up the load check valve and flows to BM cylinder rod side through the high pressure passage.

Return oil by the side of the BM cylinder head flows on a tank passage through the orifice of boost check "B".

The pressure of return oil rises, check "A" opens and oil is regenerated to the rod side.



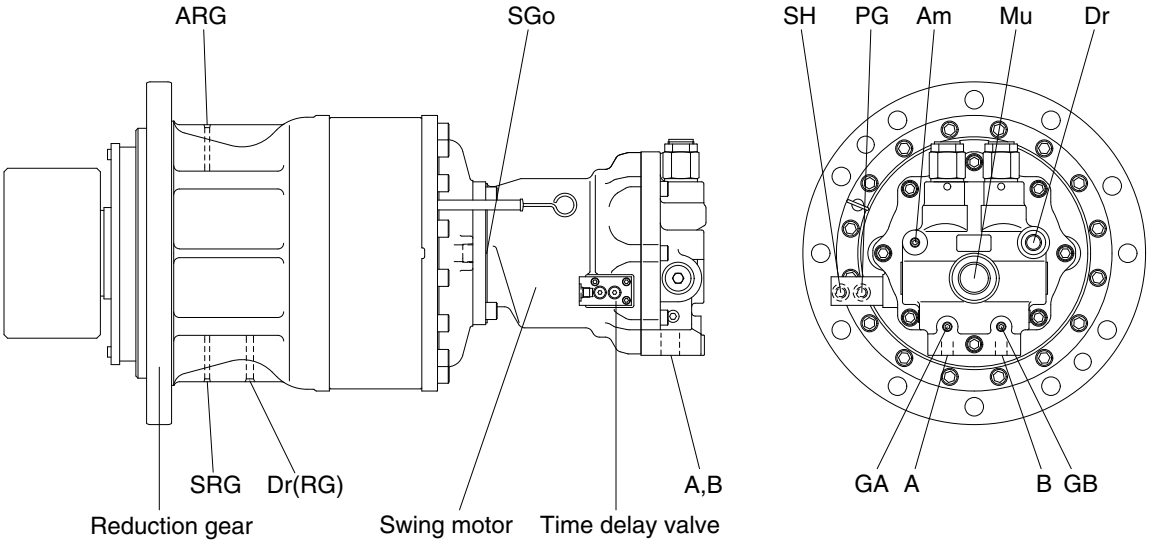
120092MC37

GROUP 3 SWING DEVICE

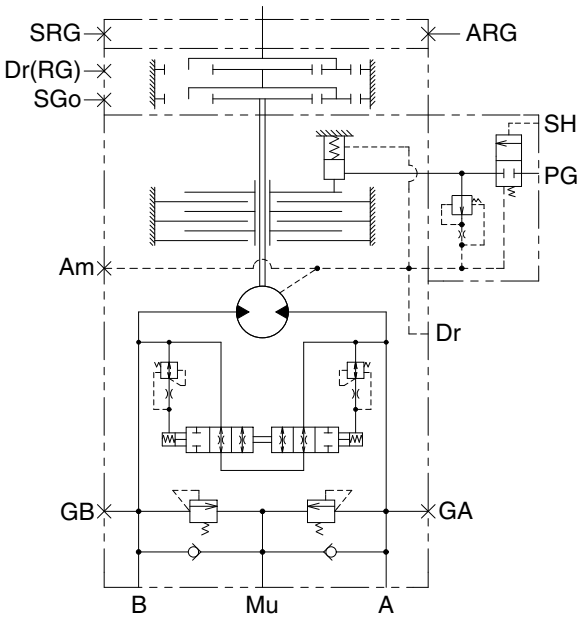
1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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



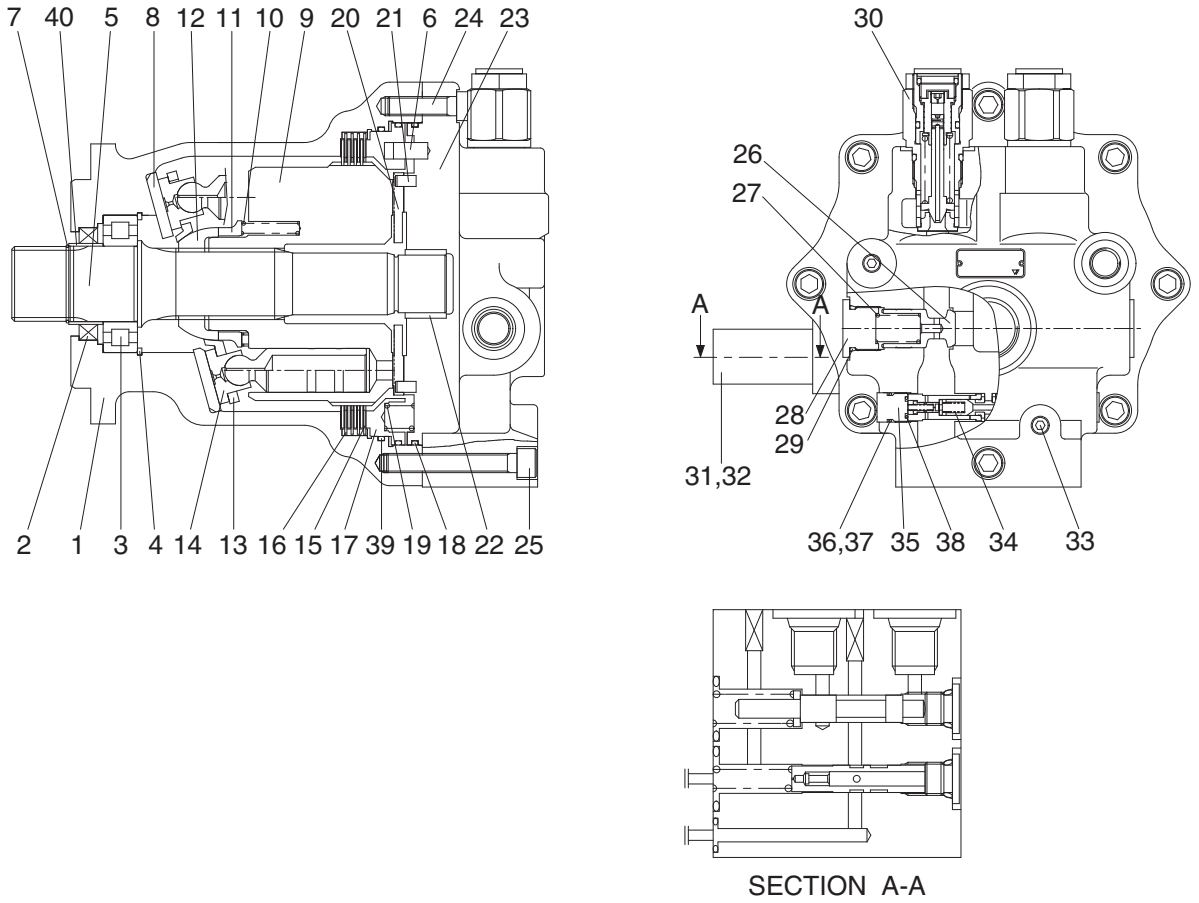
120092SM01



Hydraulic circuit

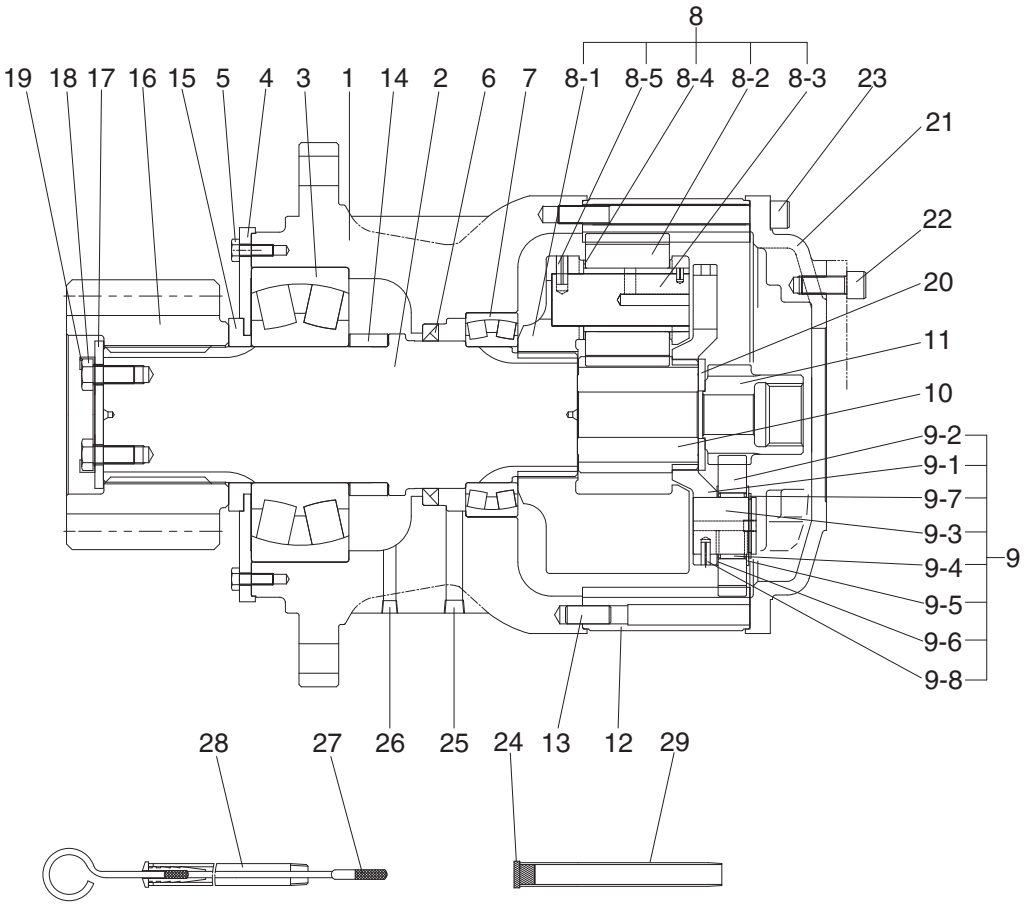
Port	Port name	Port size
A, B	Main port	SAE 1"
Dr	Drain port	PF 1/2
Mu	Make up port	PF 1 1/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
Am	Motor air bleed port	PF 1/4
GA,GB	Gauge port	PF 1/4
SGo	Reduction gear oil fill port	PT 3/4
SRG	Reduction gear grease fill port	PT 1/8
ARG	Reduction gear air vent port	PT 1/8
Dr(RG)	Reduction gear drain port	PT 1/2

1) SWING MOTOR



1	Body	15	Friction plate	29	O-ring
2	Oil seal	16	Plate	30	Relief valve assy
3	Roller bearing	17	Brake piston	31	Time delay valve
4	Snap ring	18	O-ring	32	Wrench bolt
5	Shaft	19	Spring	33	Plug
6	Pin	20	Valve plate	34	Reactionless valve assy
7	Stop ring	21	Pin	35	Plug
8	Shoe plate	22	Needle bearing	36	O-ring
9	Cylinder block	23	Rear cover	37	Back up ring
10	Spring	24	Wrench bolt	38	O-ring
11	Ball guide seat	25	Wrench bolt	39	O-ring
12	Ball guide	26	Poppet	40	Bushing
13	Set plate	27	Spring		
14	Piston assy	28	Plug		

2) REDUCTION GEAR



120092SM03

1	Casing	9-1	Carrier 1	16	Pinion gear
2	Drive shaft	9-2	Planetary gear 1	17	Lock plate
3	Roller bearing	9-3	Pin 1	18	Hex bolt
4	Cover plate	9-4	Needle cage	19	Lock washer
5	Hex bolt	9-5	Side plate 2	20	Thrust ring
6	Oil seal	9-6	Side plate 1	21	Cover
7	Roller bearing	9-7	Stop ring	22	Socket bolt
8	Carrier assy 2	9-8	Spring pin	23	Socket bolt
8-1	Carrier 2	10	Sun gear 2	24	Socket plug
8-2	Planet gear 2	11	Sun gear 1	25	Plug
8-3	Pin 2	12	Ring gear	26	Plug
8-4	Washer	13	Knock pin	27	Gauge bar
8-5	Spring pin	14	Spacer ring	28	Gauge pipe
9	Carrier assy 1	15	Spacer	29	Air breather assy

2. FUNCTION

1) ROTARY PART

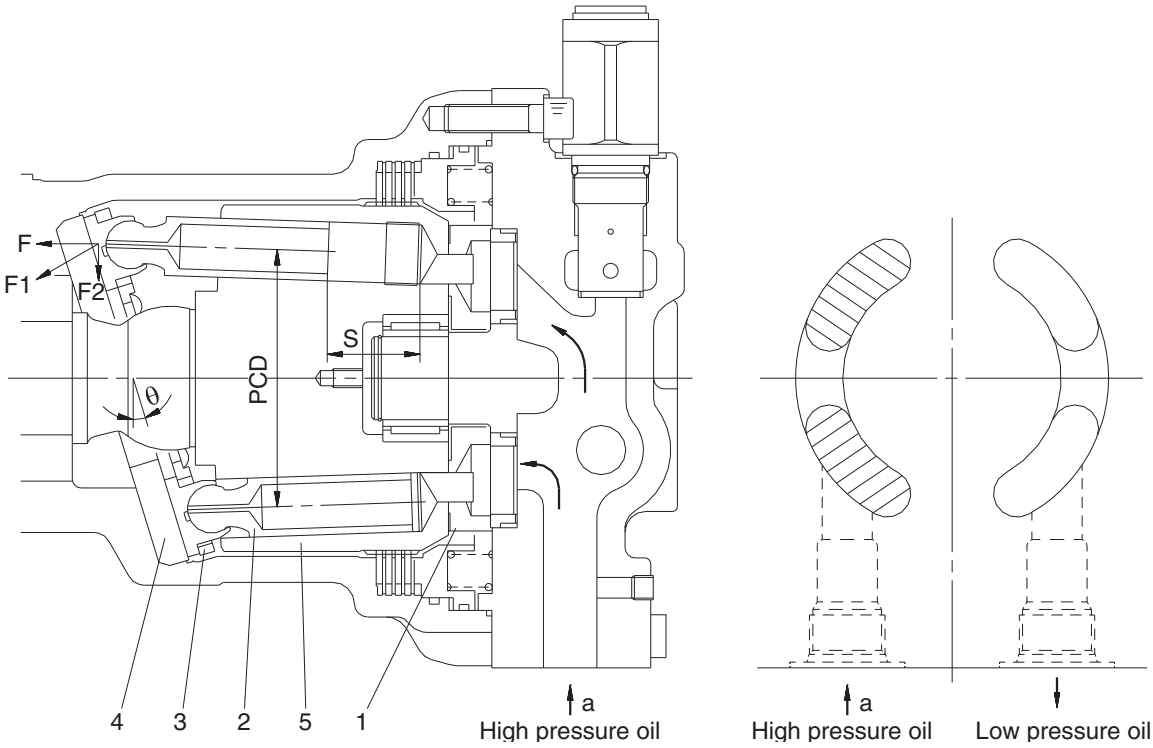
When high pressurized oil enters a cylinder through port(a), which is the inlet of balance plate(1), hydraulic pressure acting on the piston causes axial force F. The pressure force F works via the piston(2) upon the return plate(3) which acts upon the swash plate(4) via an hydrostatic bearing. Force F1 perpendicular to swash plate(4) and force F2 perpendicular to cylinder center.

Being transferred to the cylinder block(5) through piston, force F2 causes rotational moment at surroundings of cylinder.

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

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

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



36072SM04

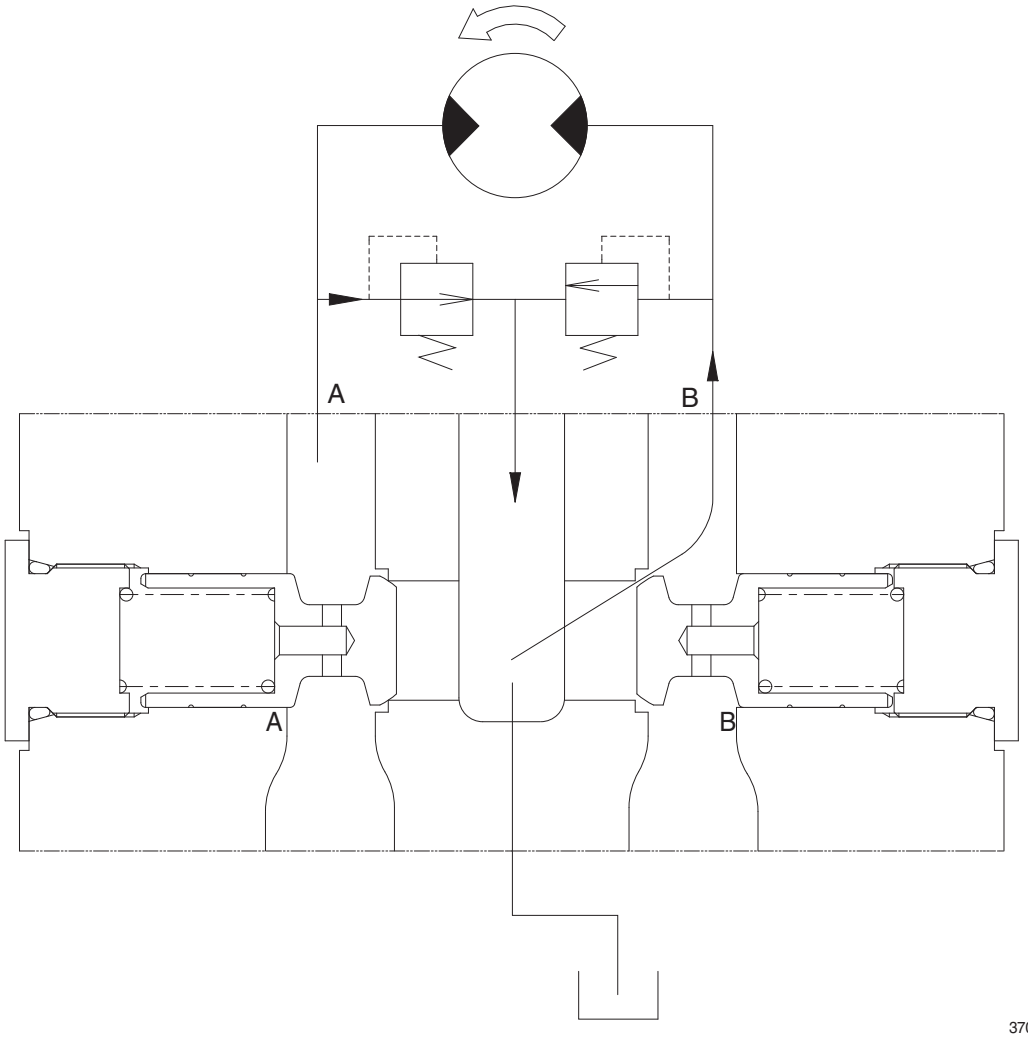
2) MAKE UP VALVE

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

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

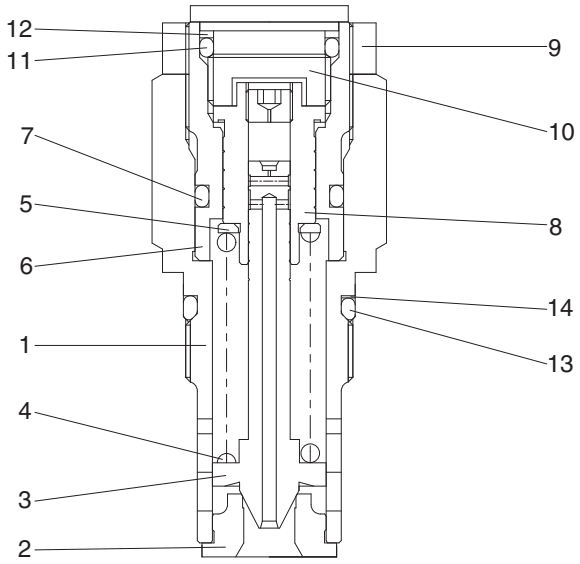
Pressurized oil into the port B, the motor rotate counterclockwise.

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



37007A2SM10

3) RELIEF VALVE



1	Body
2	Poppet seat
3	Poppet
4	Spring
5	Spring seat
6	Stopper
7	O-ring
8	Shockless valve
9	Nut
10	Plug
11	O-ring
12	Back up ring
13	O-ring
14	Back up ring

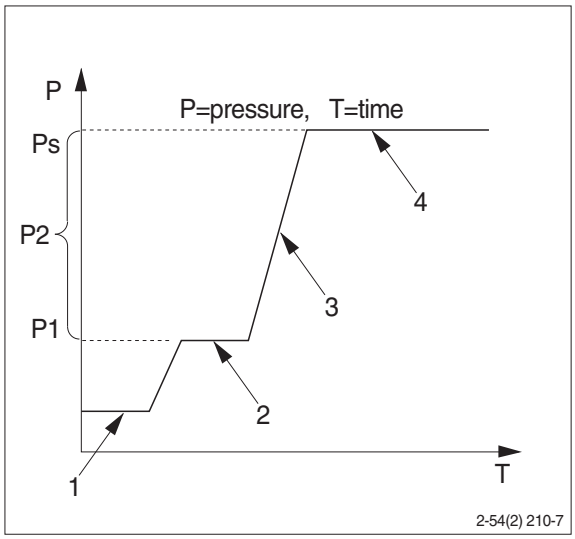
37007A2SM03

(1) Construction of relief valve

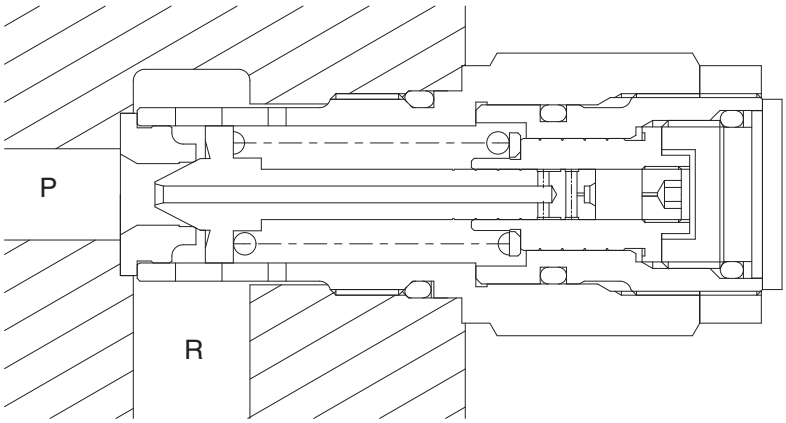
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

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



① Ports (P,R) at tank pressure.

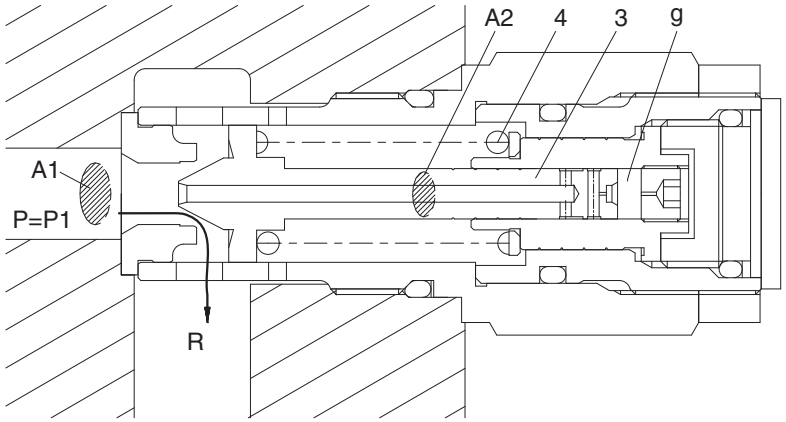


37007A2SM04

② When hydraulic oil pressure ($P \times A_1$) reaches the preset force (F_{SP}) of spring (4), the poppet (3) moves to the right as shown.

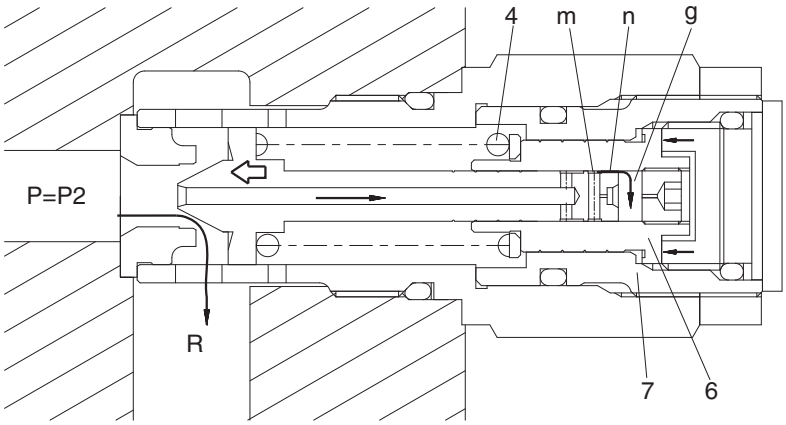
$P_1 \times A_1 = Fsp + Pg \times A_2$

$$P_1 = \frac{Fsp + Pg \times A_2}{A_1}$$



37007A2SM05

③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F_{SP}) of spring (4), the piston (6) moves left and stop the piston (6) hits the bottom of body (7).

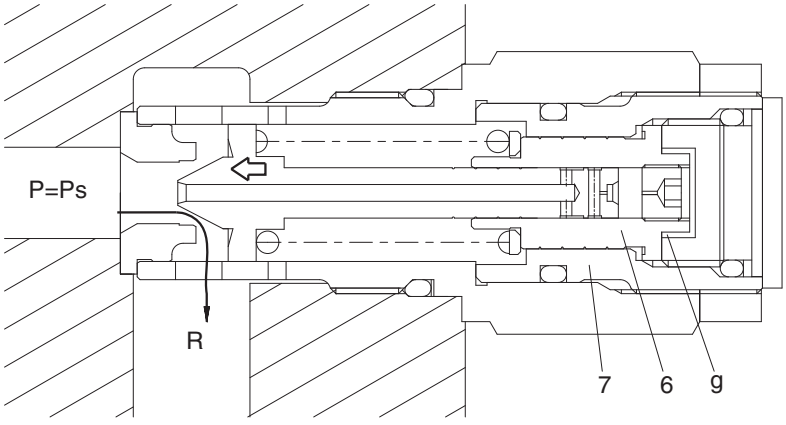


37007A2SM06

④ When piston (6) hits the bottom of body (7), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (Ps).

$Ps \times A_1 = Fsp + Ps \times A_2$

$$Ps = \frac{Fsp}{A_1 - A_2}$$



37007A2SM07

4) PARKING BRAKE

(1) PARKING BRAKE ON

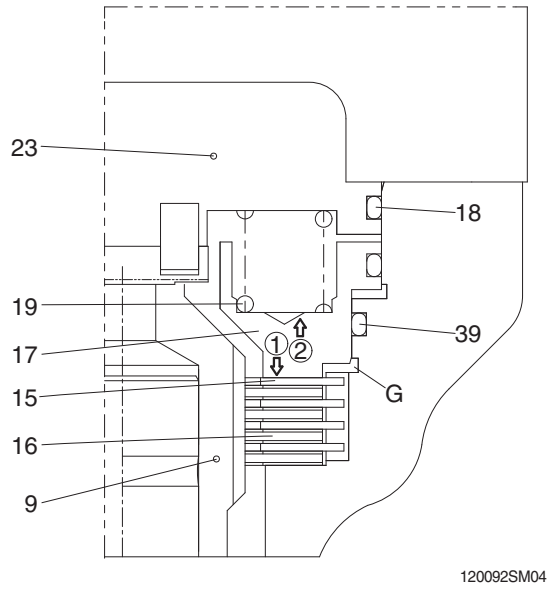
When the swing motor stops the parking brake is normally kept being fixed by mechanical force. When the brake release pressure is blocked, brake piston (17) is pushed by spring (19) force according to the arrow direction ①.

Consequently, pressure plate (16) which is fixed to cylinder block (9) and friction plate (15) which is assembled to casing (23) 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 (19) force, and then brake piston (17) is pushed according to the arrow direction ②.

The pressure of pressure plate (16) and friction plate (15) is released. Following this procedure the cylinder block (9) is rotating.

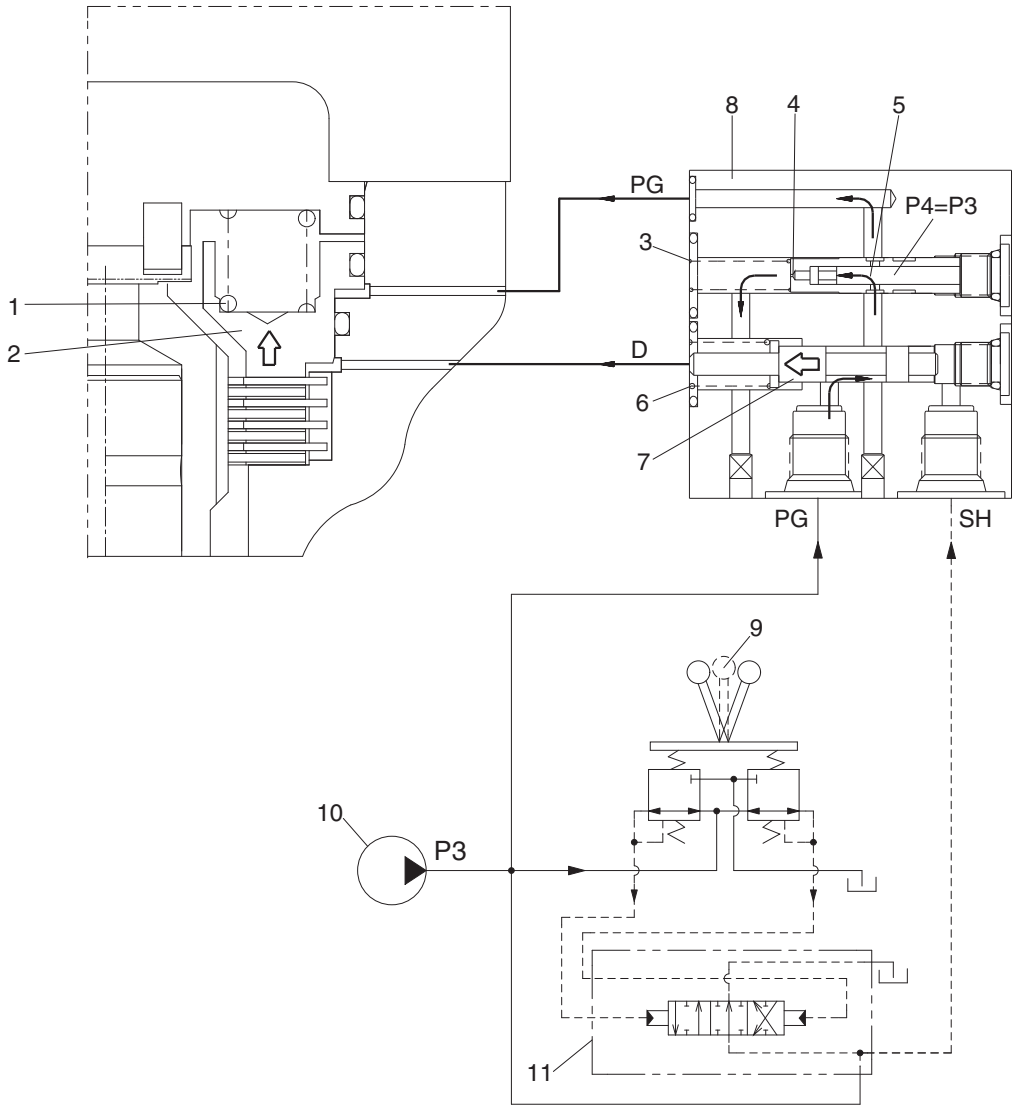


120092SM04

9 Cylinder block
15 Friction plate
16 Pressure plate
17 Brake piston
18 O-ring
19 Spring
23 Casing
39 O-ring

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 MCV.
The oil pressure moves to the piston (2) to the upward against the force of the spring (1).
Thus the brake force is released.



120092SM05

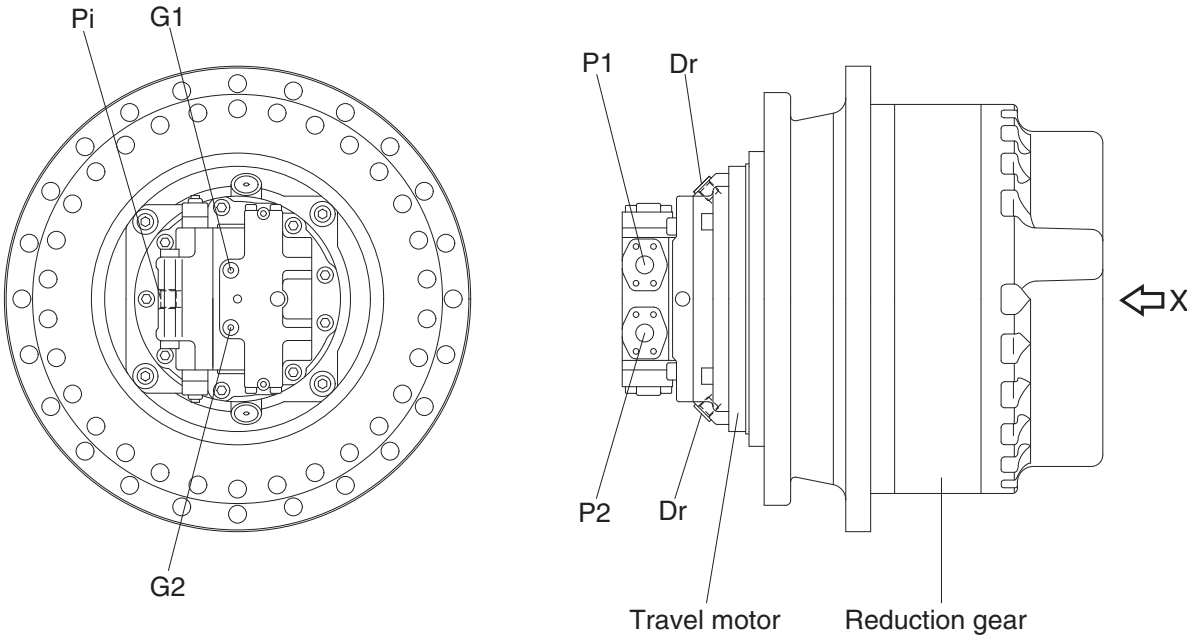
1 Spring
2 Piston
3 Spring
4 Orifice
5 Poppet
6 Spring
7 Spool
8 Time delay valve
9 Swing control lever
10 Pilot pump
11 Main control valve

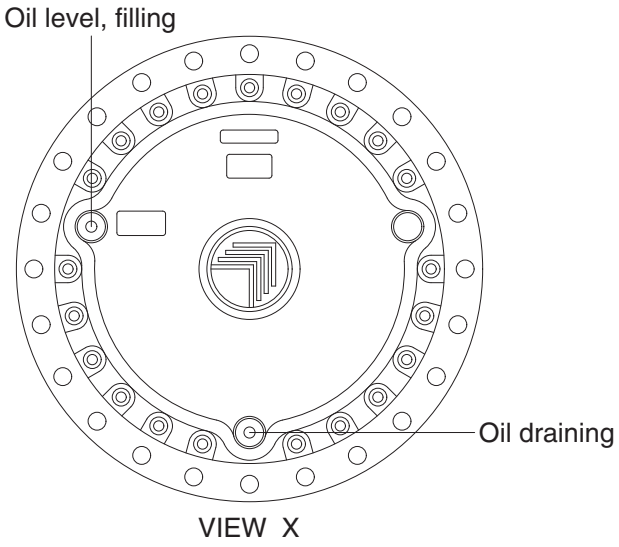
GROUP 4 TRAVEL DEVICE

1. CONSTRUCTION

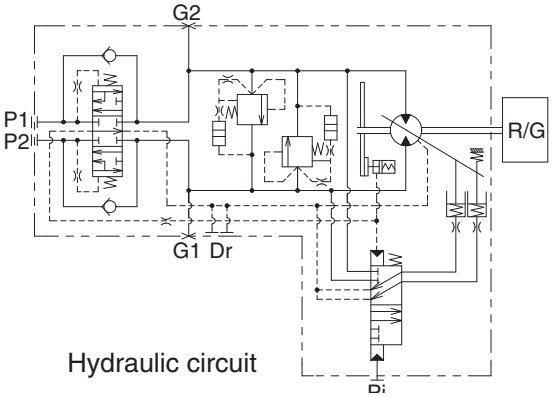
Travel device consists travel motor and gear box.

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





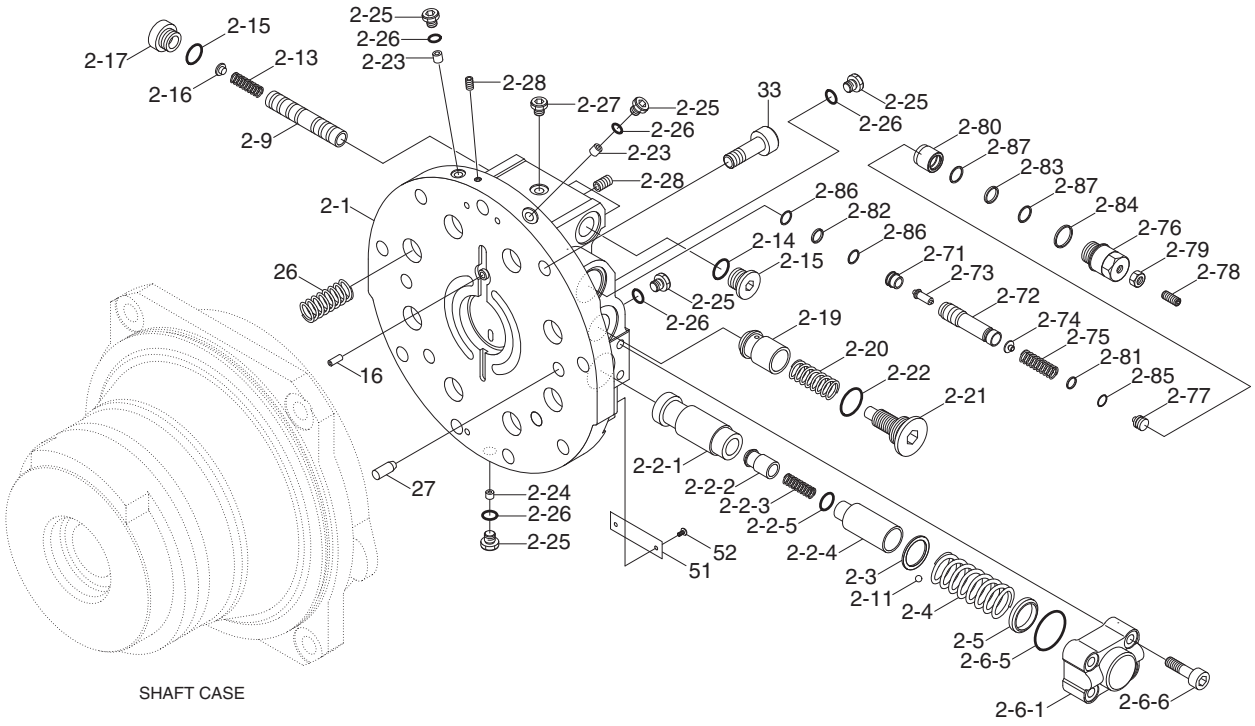
8007A2TM01



Hydraulic circuit

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

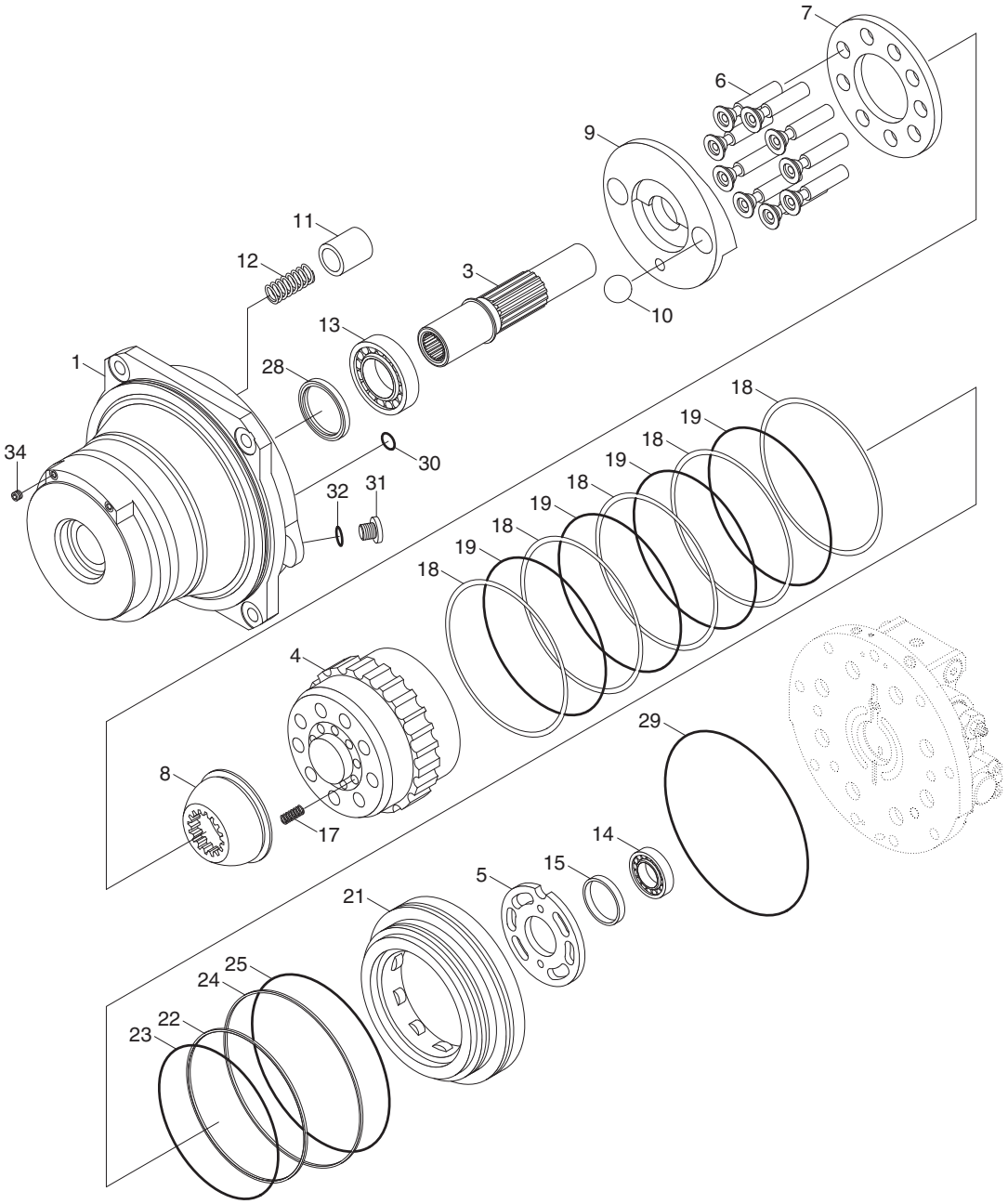


8007A2TM02

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)

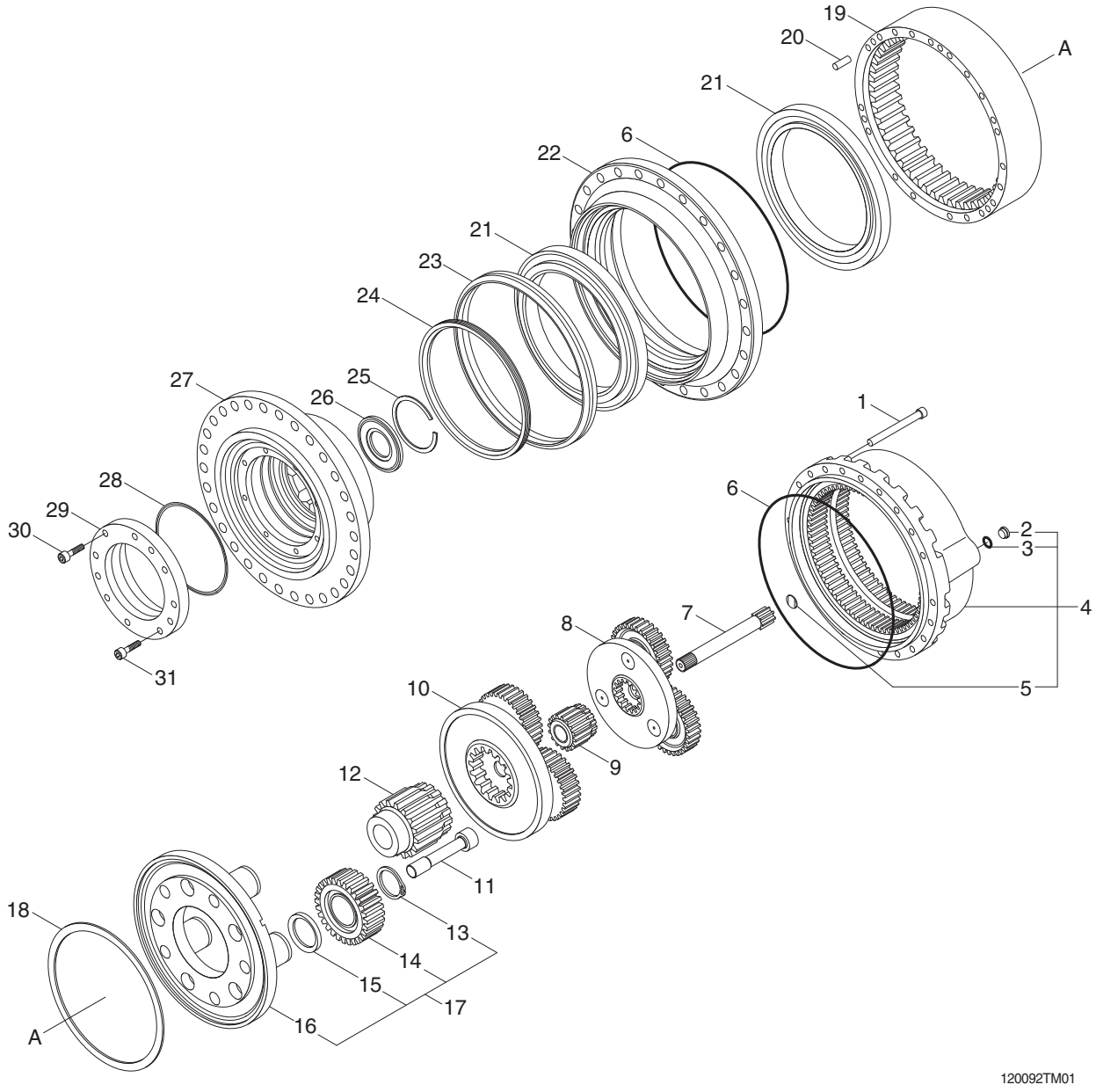
· Control part



8007A2TM03

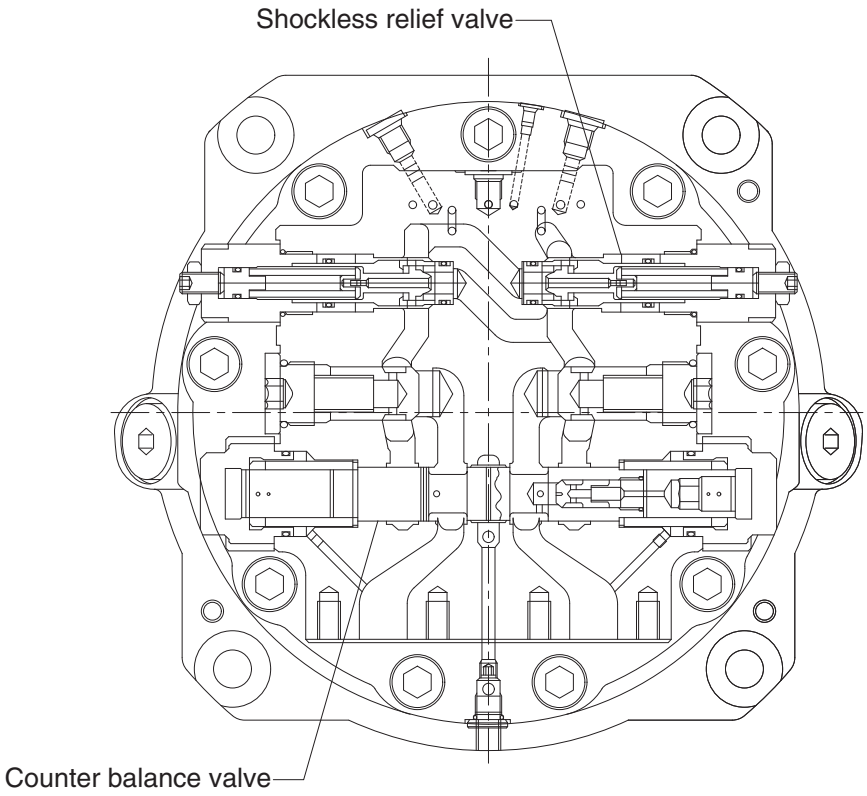
1	Case	12	Spring	24	O-ring
3	Shaft	13	Roller bearing	25	Back up ring
4	Cylinder block	14	Roller bearing	28	Oil seal
5	Valve plate	15	Collar	29	O-ring
6	Piston assy	17	Spring	30	O-ring
7	Retainer plate	18	Friction plate	31	Plug
8	Plate holder	19	Disc plate	32	O-ring
9	Swash plate	21	Brake piston	34	Plug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

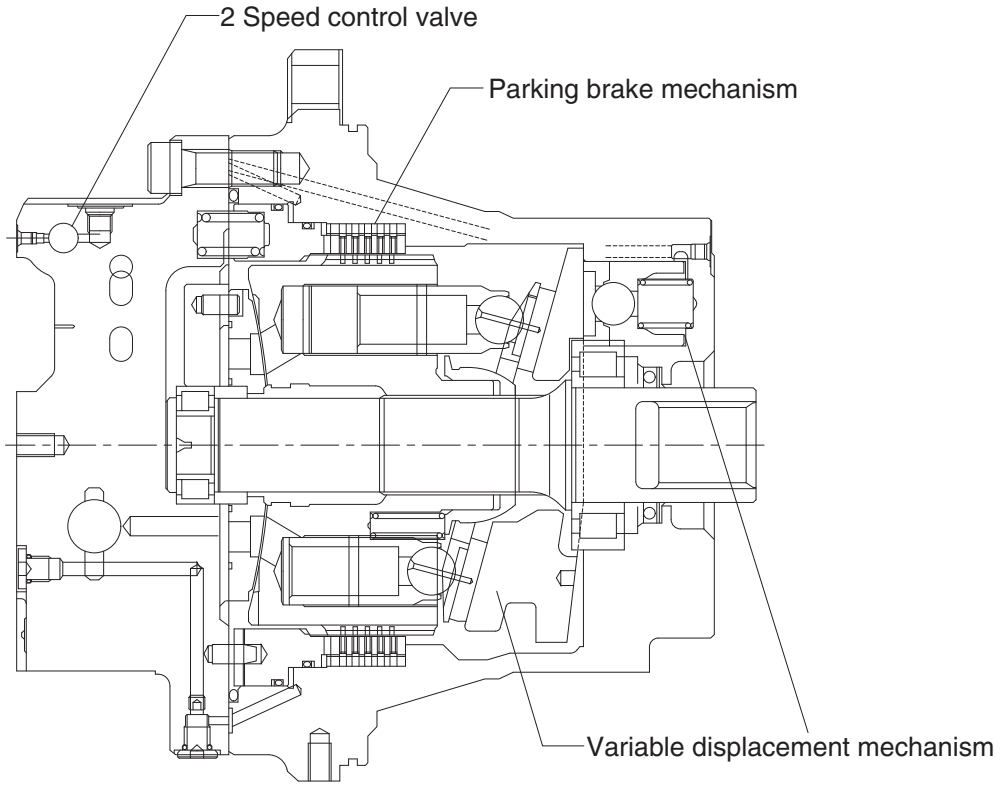
2) REDUCTION GEAR



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

3) BASIC STRUCTURE

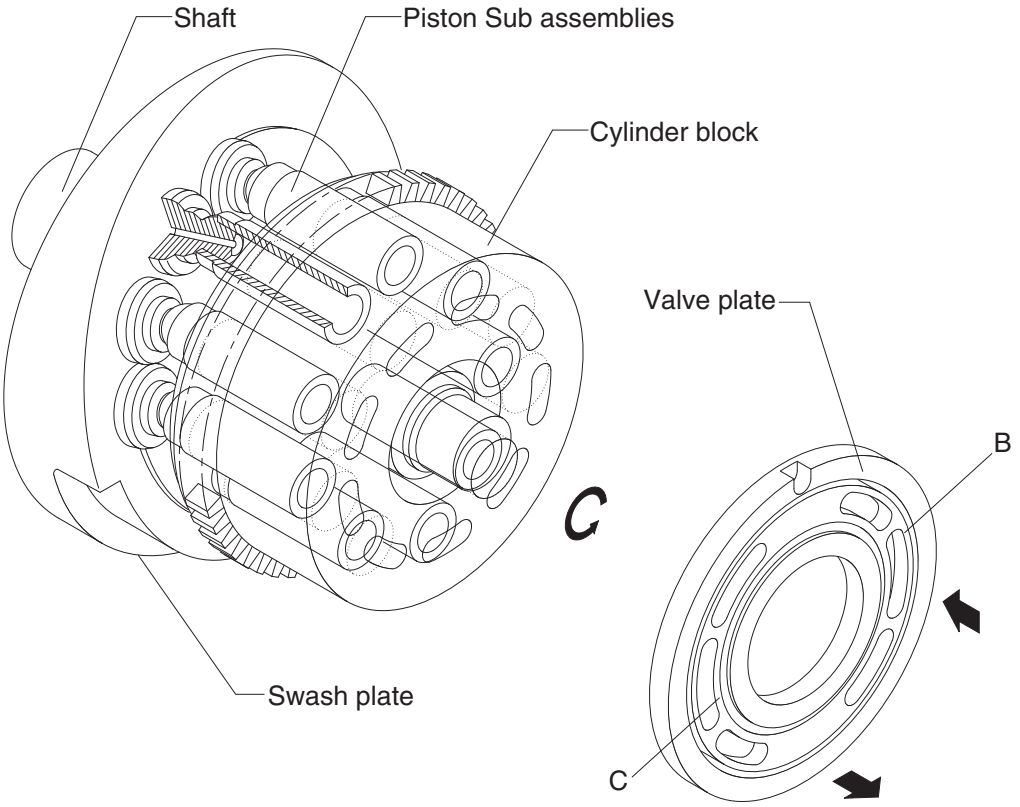




8007A2TM05

2. FUNCTION

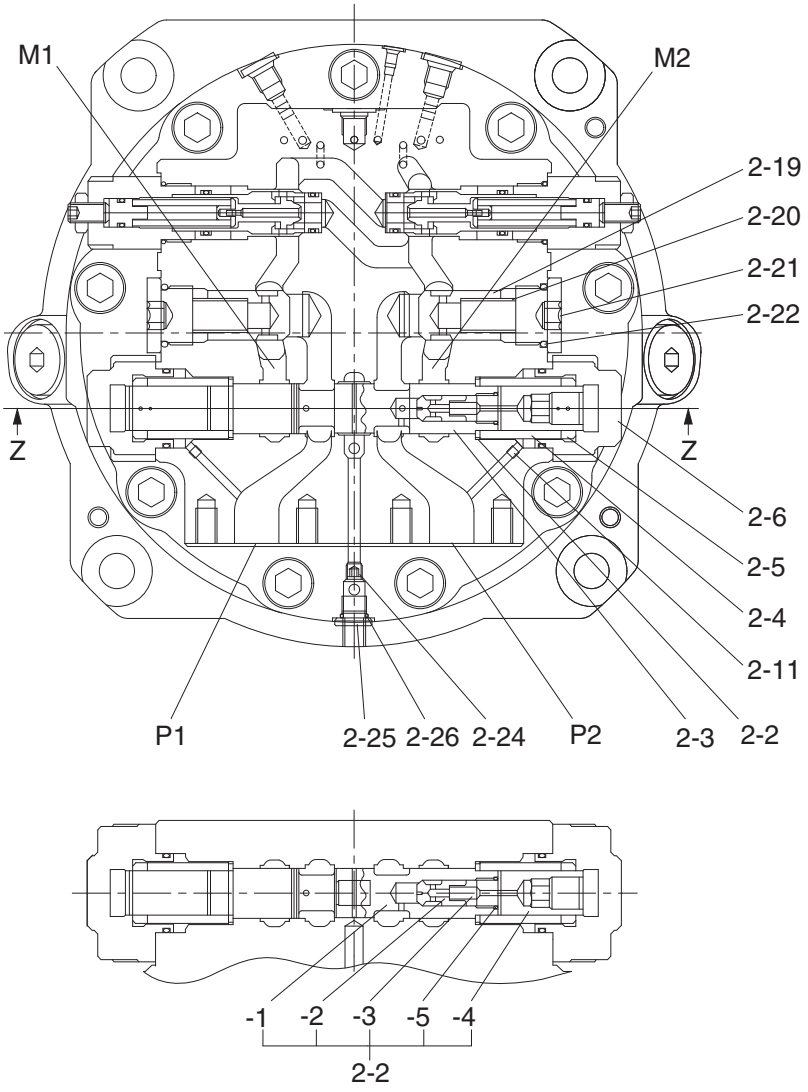
1) HYDRAULIC MOTOR



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 $F = P \cdot A$ (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.

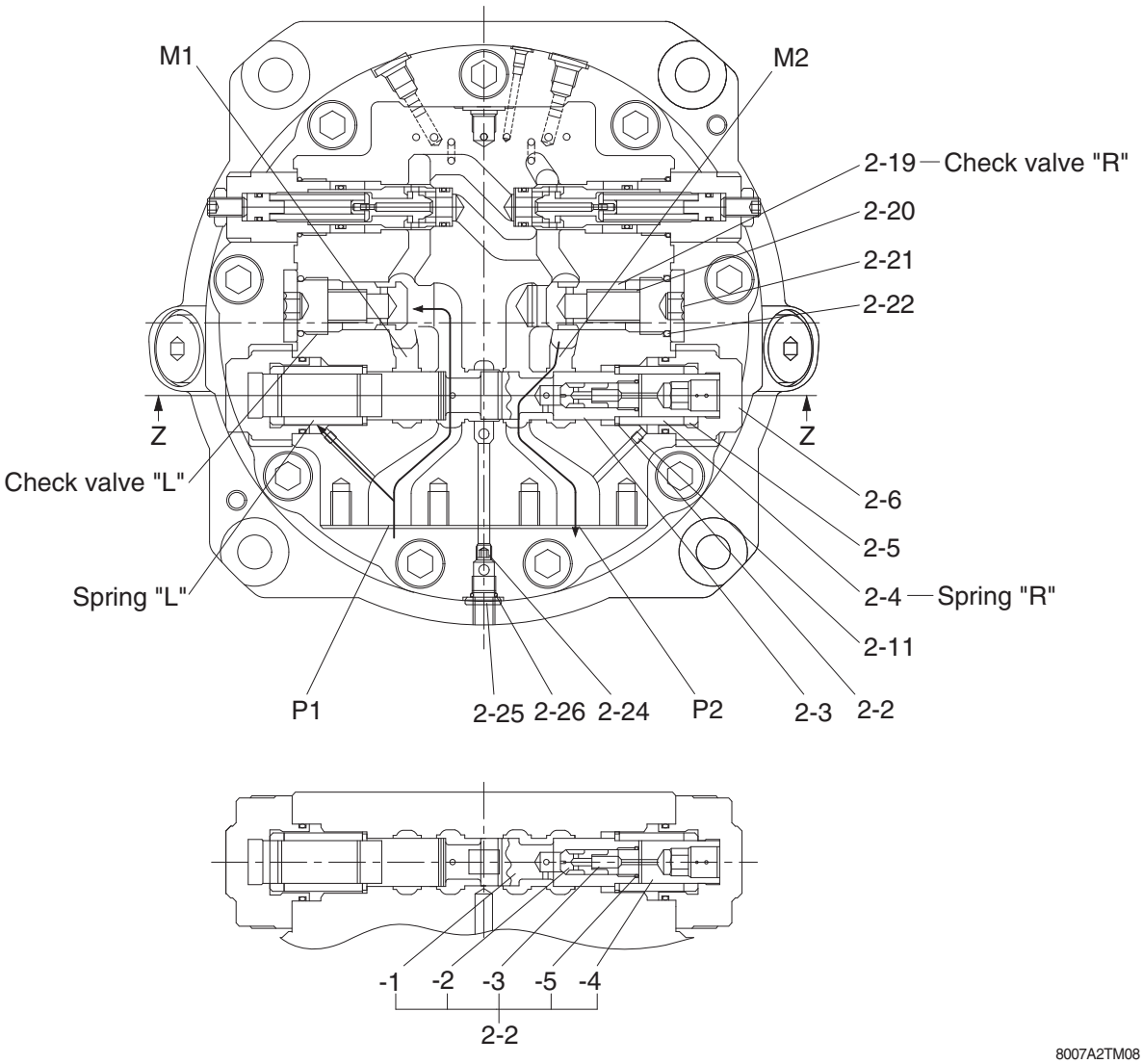
2) COUNTER BALANCE VALVE



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.

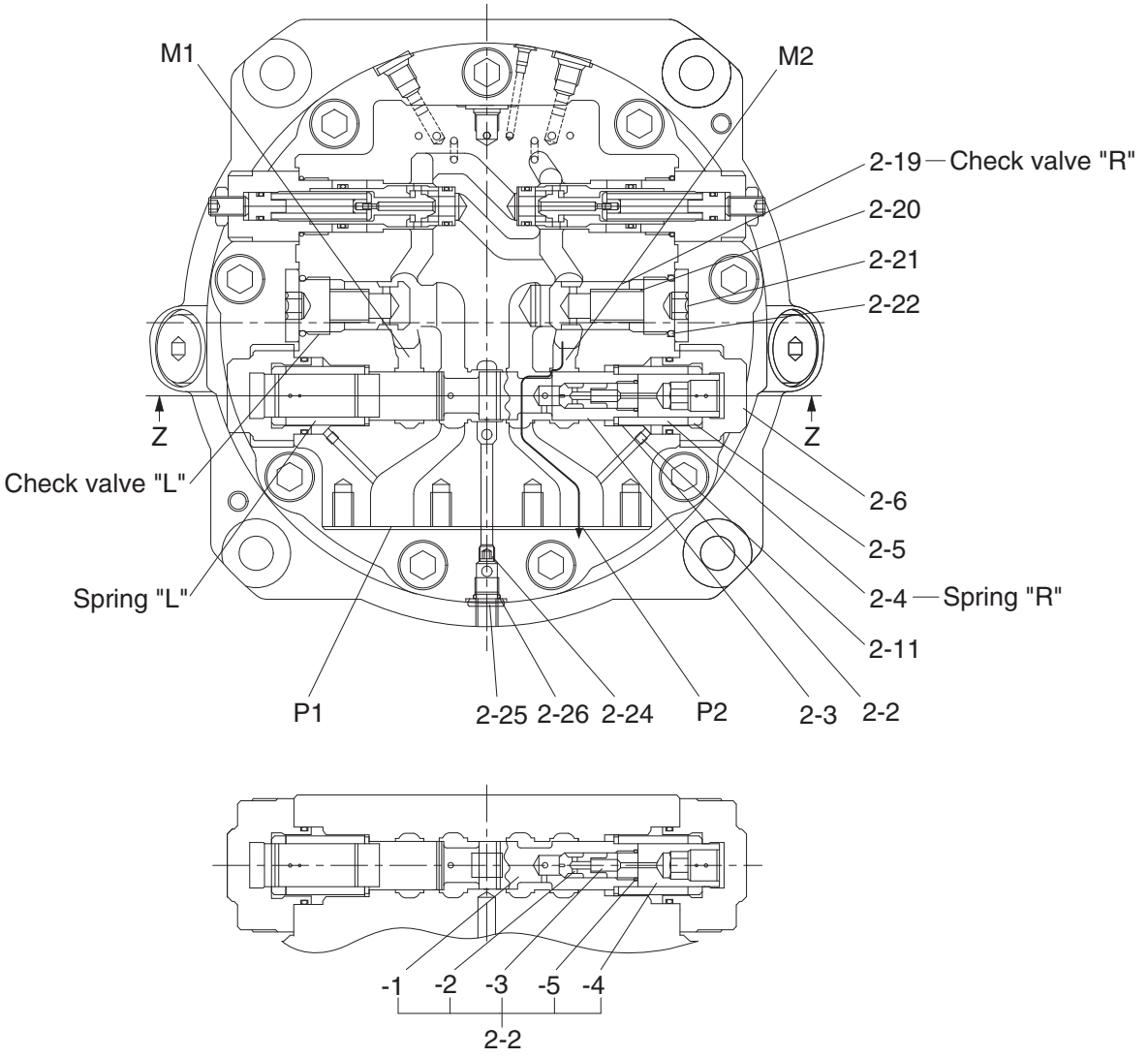
The high-pressure oil at port P1 passes through orifices "L" (2-11) pushes the end of face of spool assy (2-2) and pushes the plunger rightward against spring "R" (2-4) on the opposite side with the force proportional to the pressure.

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.

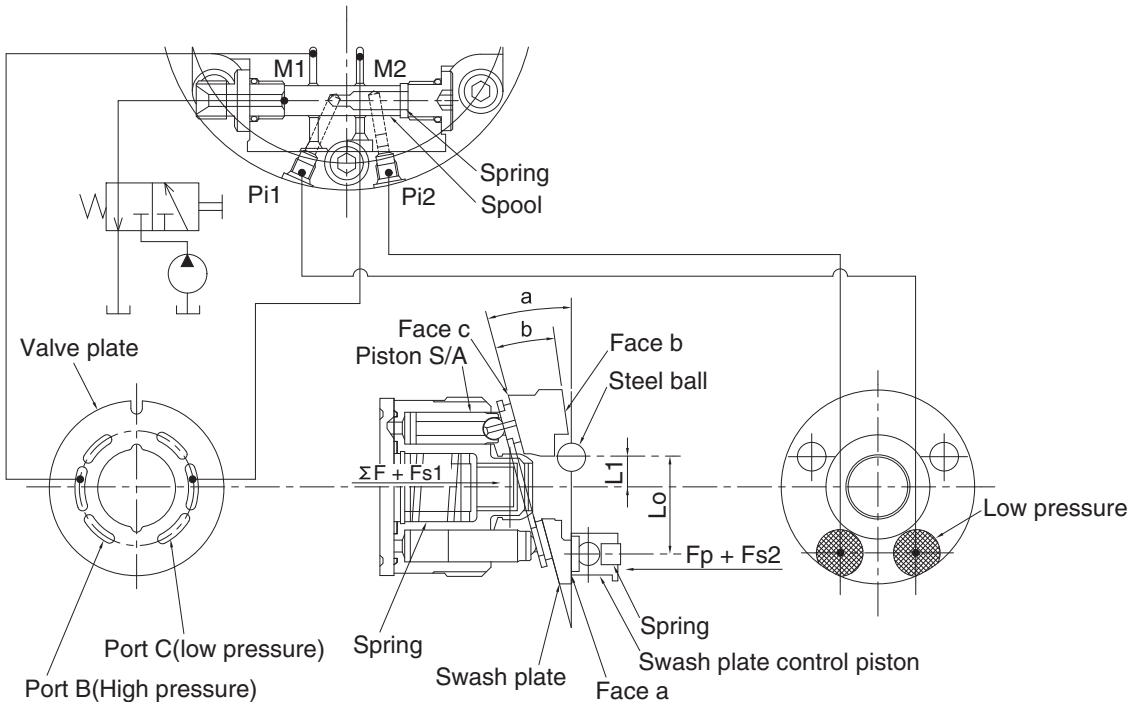
Piston motor tries to rotate with inertia energy (pumping action of motor) and the pressure rises on port M2.

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)



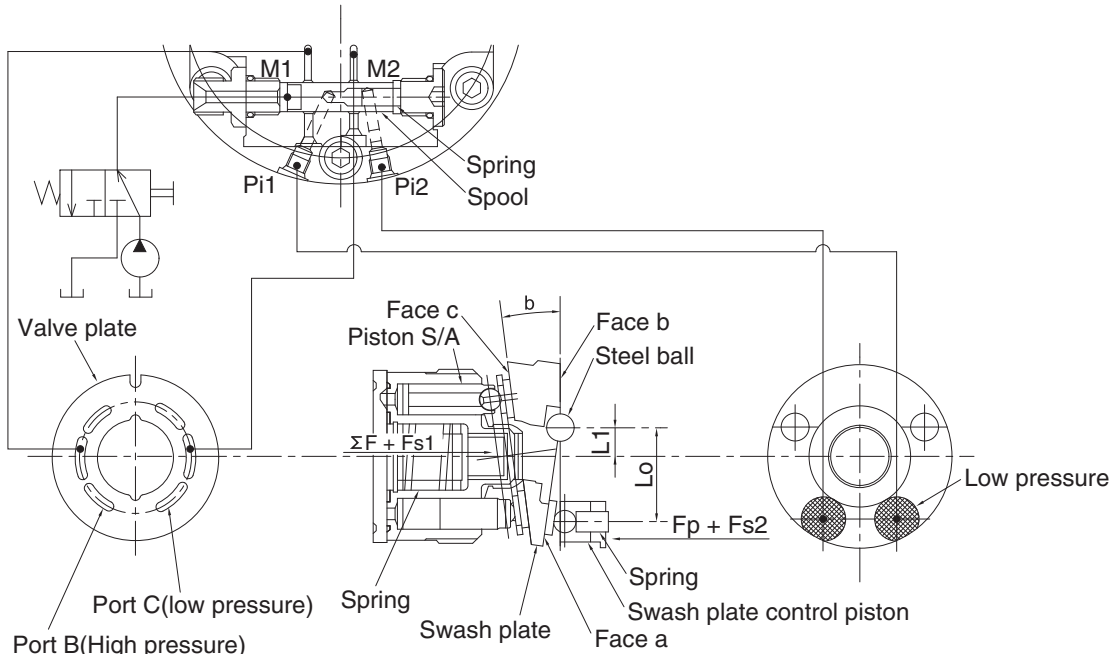
8007A2TM10

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.

$Fp=(Ap \times P)=0$

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 $(\Sigma F+Fs1)\times L1<(Fp+Fs2)\times Lo$ depending on the total ΣF of driving force of piston S/A.
The face "b" of swash plate stabilizes and the swash plate angle becomes "β " 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 "α " 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,

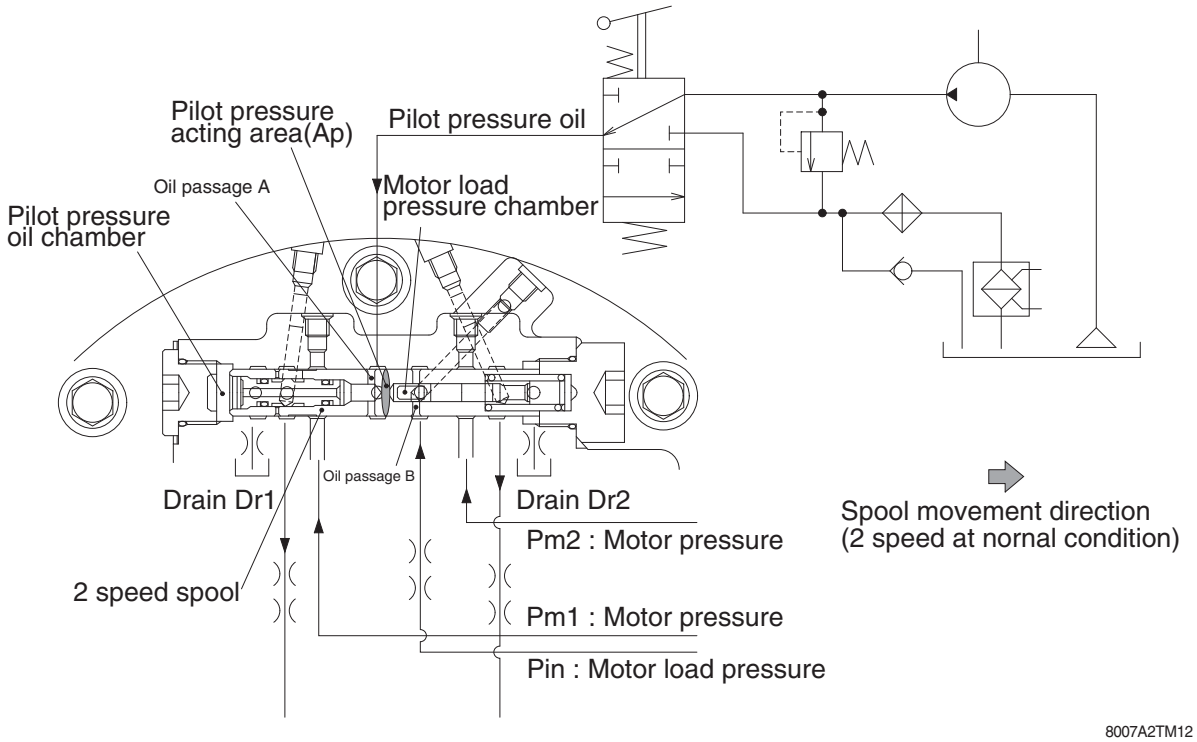
Motor inlet pressure is applied on the area "Am". So, the spool is also applied to the left direction by Am pressure. According to above, if the motor pressure is lower and keeps the following condition, the spool stays on the right position.

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

Kx : Spring force

Ap : Swash plate control piston pressure receiving area

Ps : Pilot pressure



8007A2TM12

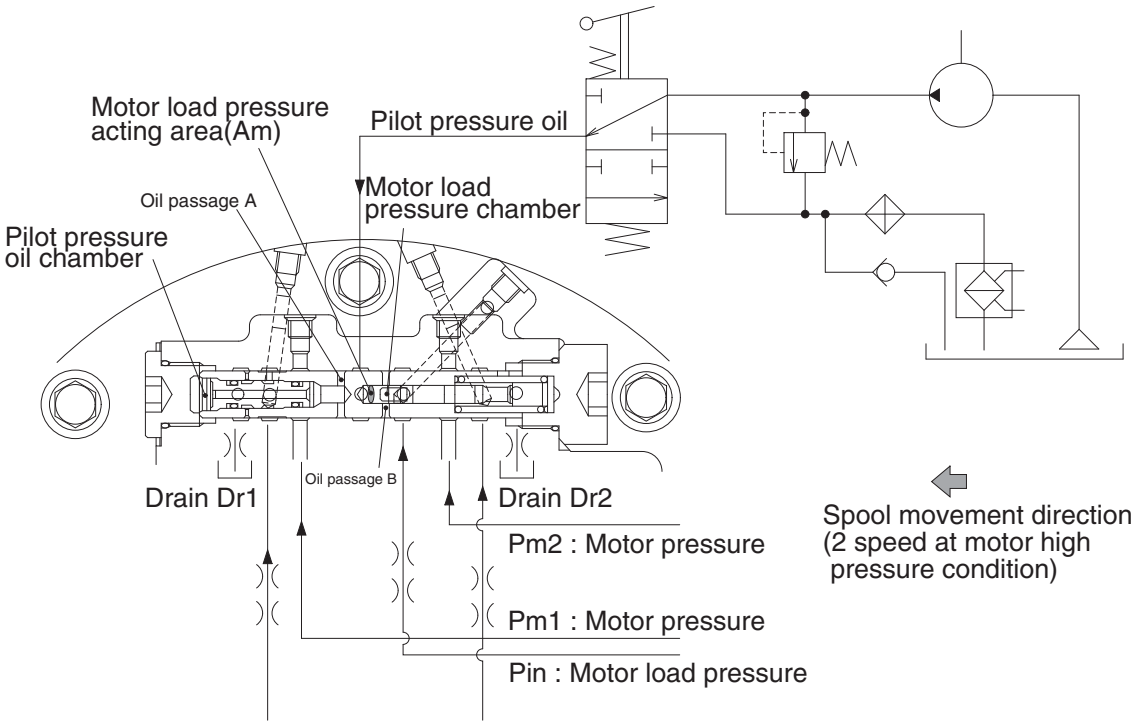
(2) Motor pressure is high.

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.

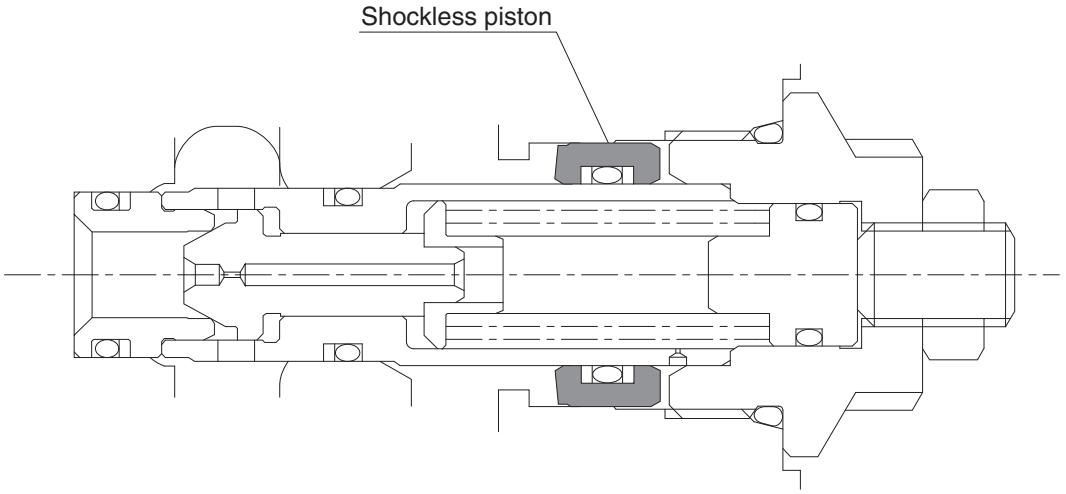
A shock less function is also incorporated to reduce shock produced at the start of both acceleration and deceleration.

(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

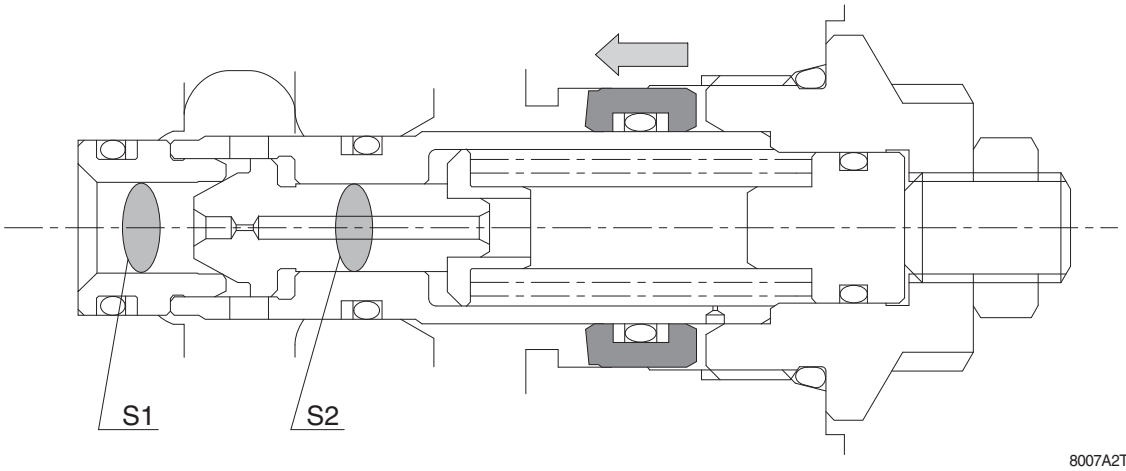
(2) The relief valve operates in two stages as follows.

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.

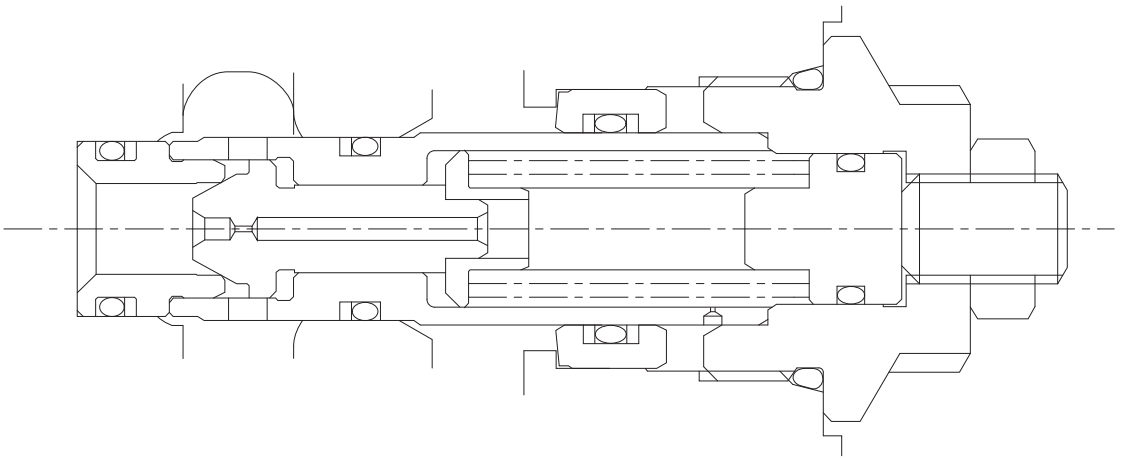


8007A2TM15

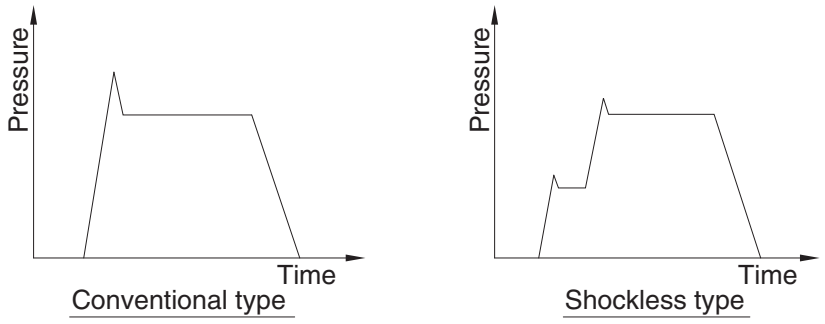
② **Second stage**

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.

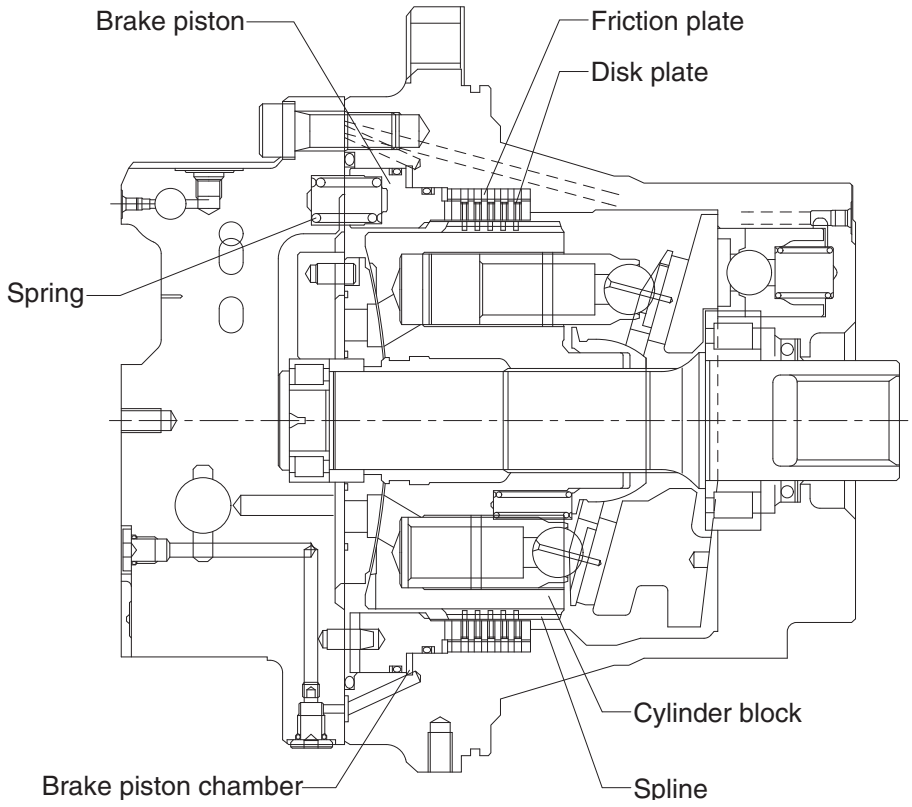


8007A2TM14



8007A2TM17

6) PARKING BRAKE

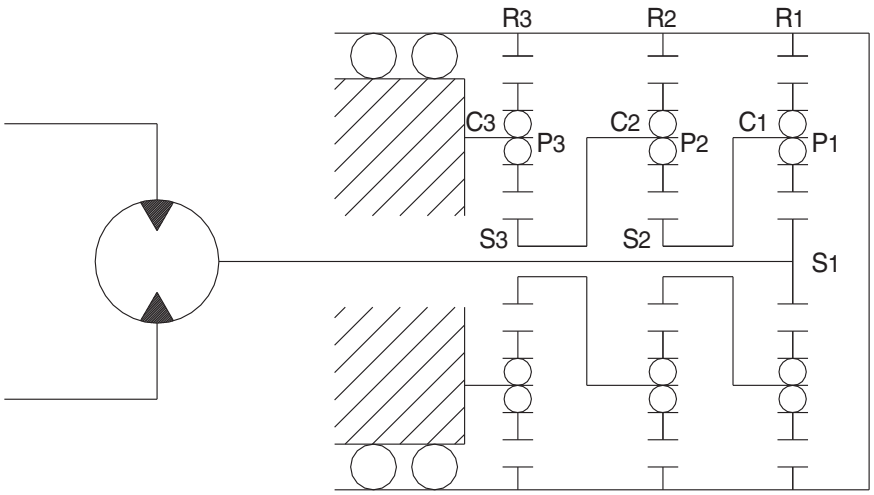


8007A2TM18A

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:

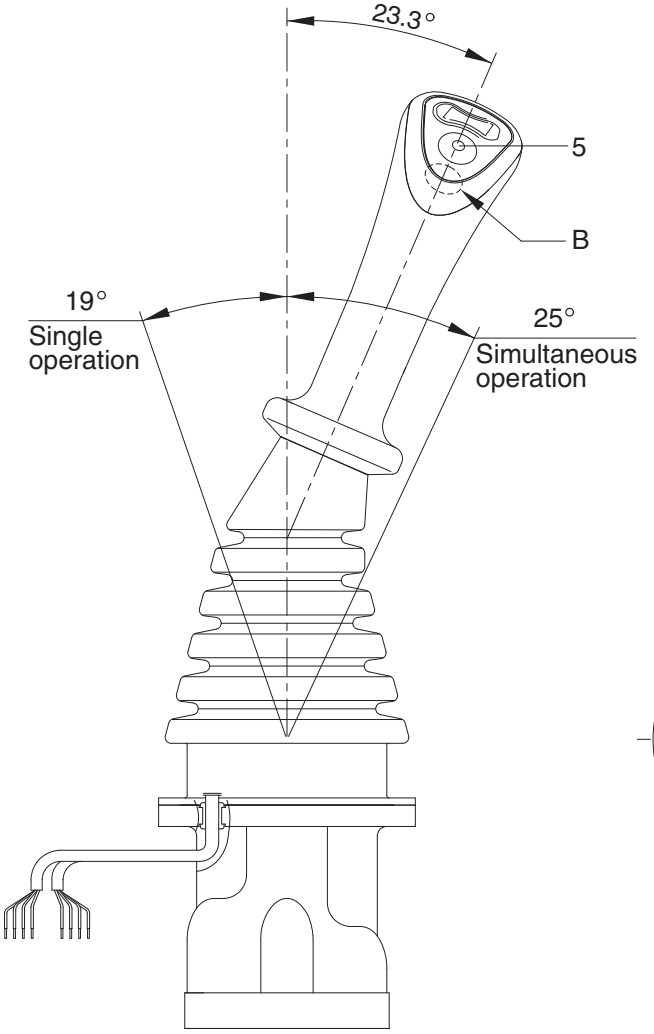
$$i = \frac{(Z_{S1} + Z_{r1})\,(Z_{S2} + Z_{r2})\,(Z_{S3} + Z_{r3})}{Z_{S1} \cdot Z_{S2} \cdot Z_{S3}} - 1$$

Where Z : Number of teeth of each gear
The direction of rotation is reverse to that of the input shaft.

GROUP 5 RCV LEVER

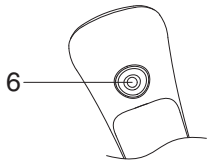
1. STRUCTURE

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.

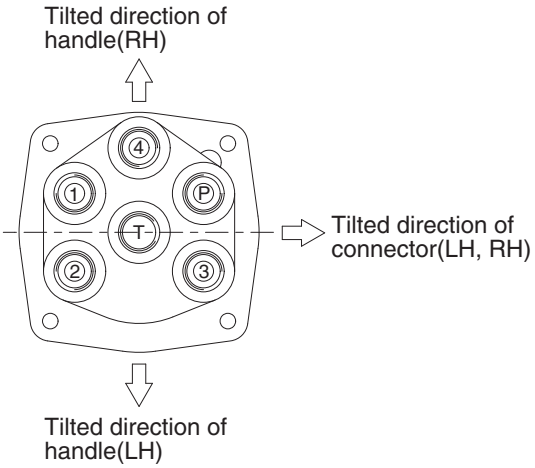


Switches

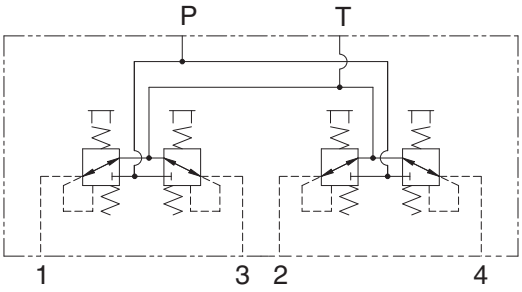
No.	LH	RH
5	One touch decel	Horn
6	Power boost	Breaker



DETAIL B



VIEW A



Hydraulic circuit

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

21092RL01

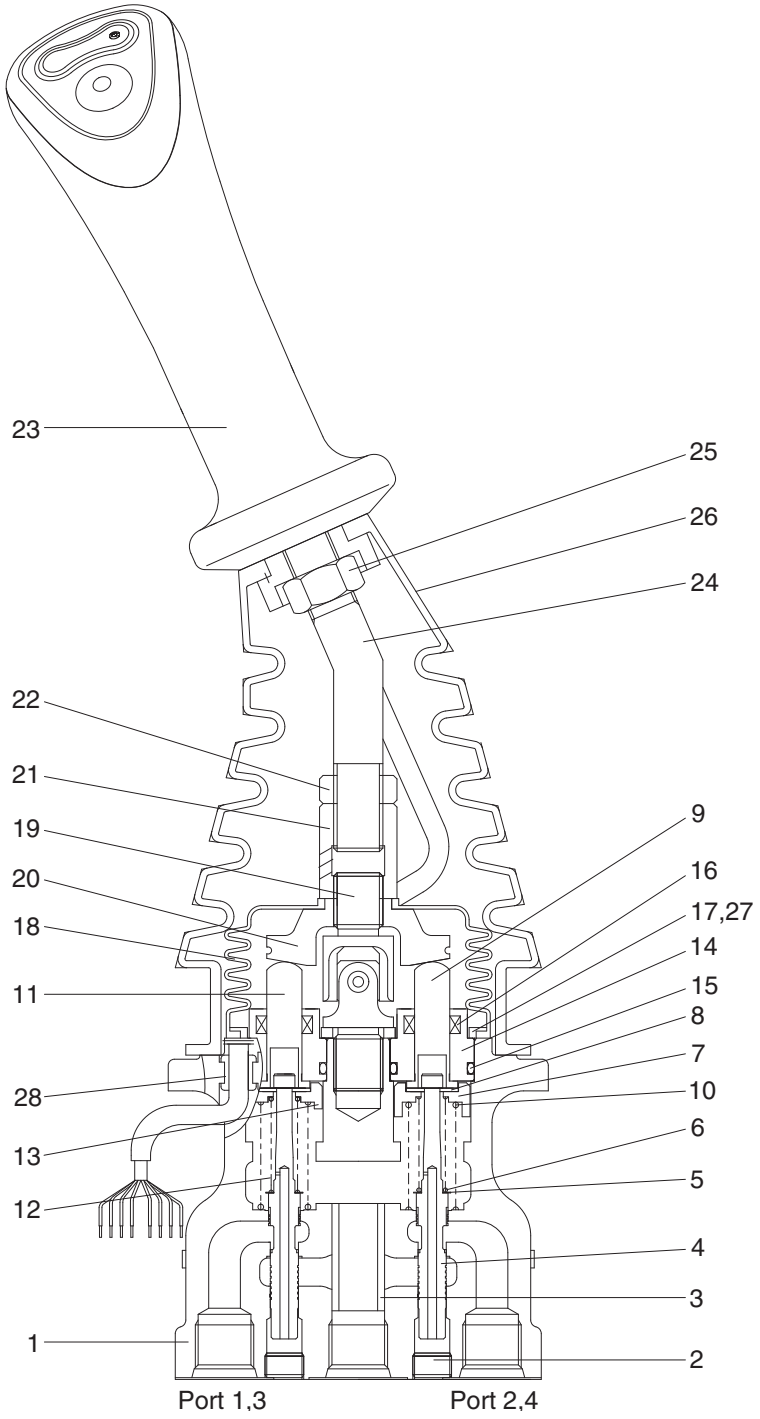
CROSS SECTION

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

The pressure reducing section is composed of the spool (4), spring (6) for setting secondary pressure, return spring (10), stopper (8), spring seat (7, 13) and shim (5). 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, 11) by the return spring.

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

CROSS SECTION



32092RL01

1	Case	8	Stopper	15	O-ring	22	Lock nut
2	Plug	9	Push rod	16	Rod seal	23	Handle assembly
3	Bushing	10	Spring	17	Plate	24	Handle bar
4	Spool	11	Push rod	18	Boot	25	Nut
5	Shim	12	Spring	19	Joint assembly	26	Boot
6	Spring	13	Spring seat	20	Swash plate	27	Spring pin
7	Spring seat	14	Plug	21	Adjusting nut	28	Bushing

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

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

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

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

The functions of the spool (4) 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 (6) works on this spool to determine the output pressure.

The change the deflection of this spring, the push rod (9,11) is inserted and can slide in the plug (14).

For the purpose of changing the displacement of the push rod through the swash plate (20) and adjusting nut (21) are provided the handle (23) that can be tilted in any direction around the fulcrum of the universal joint (19) center.

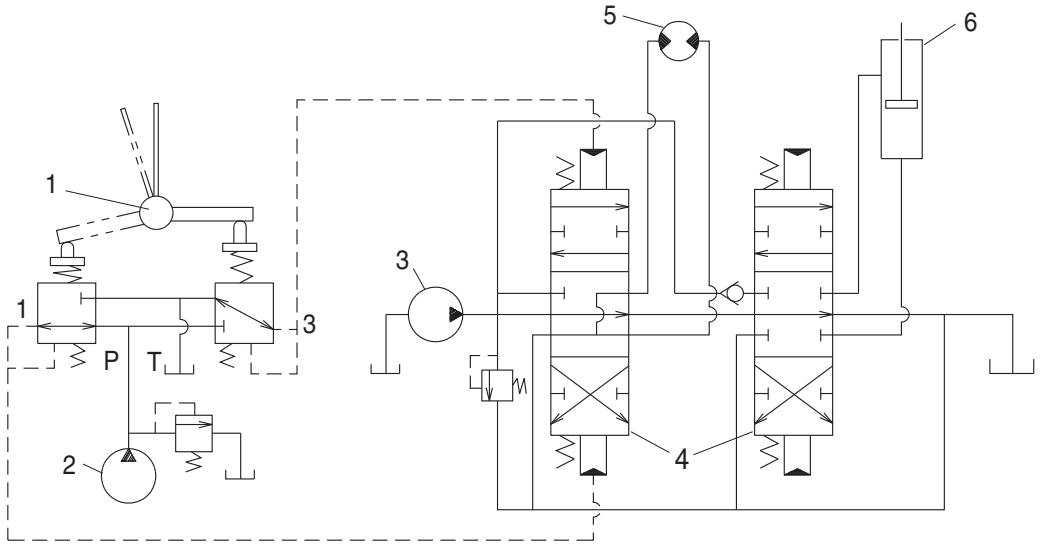
The spring (10) works on the case (1) and spring seat (7, 13) and tries to return the push rod (9,11) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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.

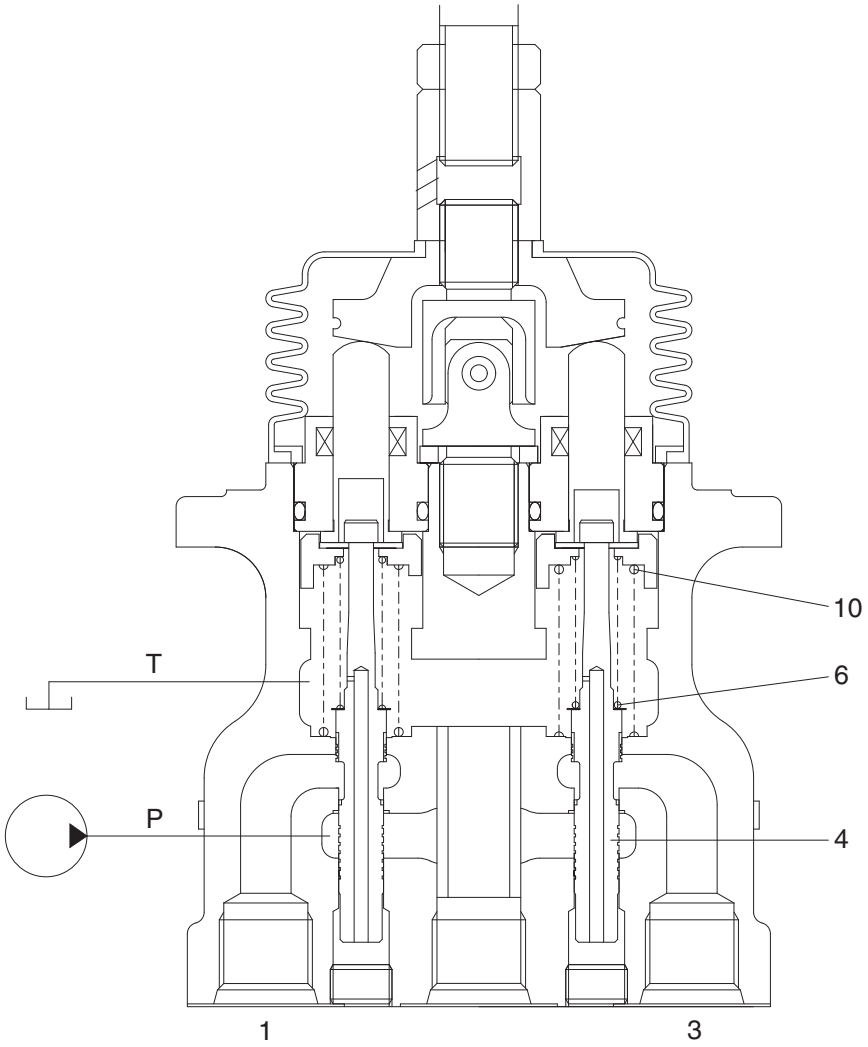
The diagram shown below is the typical application example of the pilot valve.



2-70

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

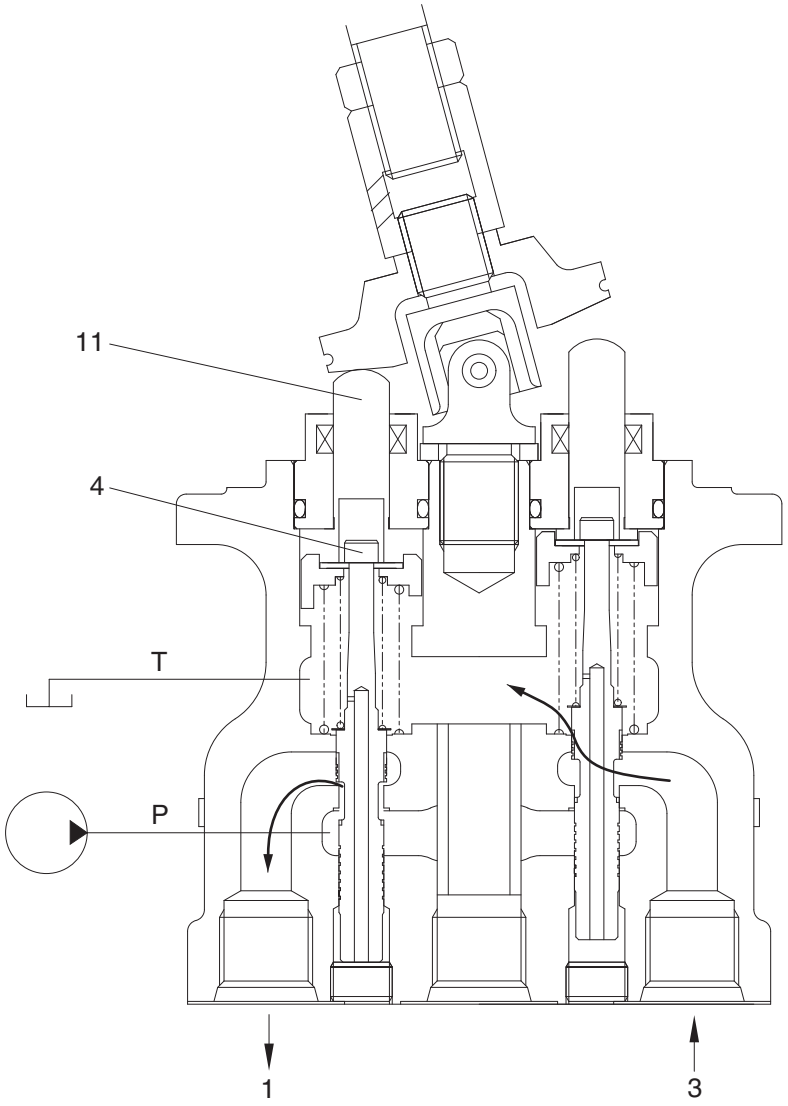
(1) Case where handle is in neutral position



21092RL03

The force of the spring (6) that determines the output pressure of the pilot valve is not applied to the spool (4). Therefore, the spool is pushed up by the spring (10) 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



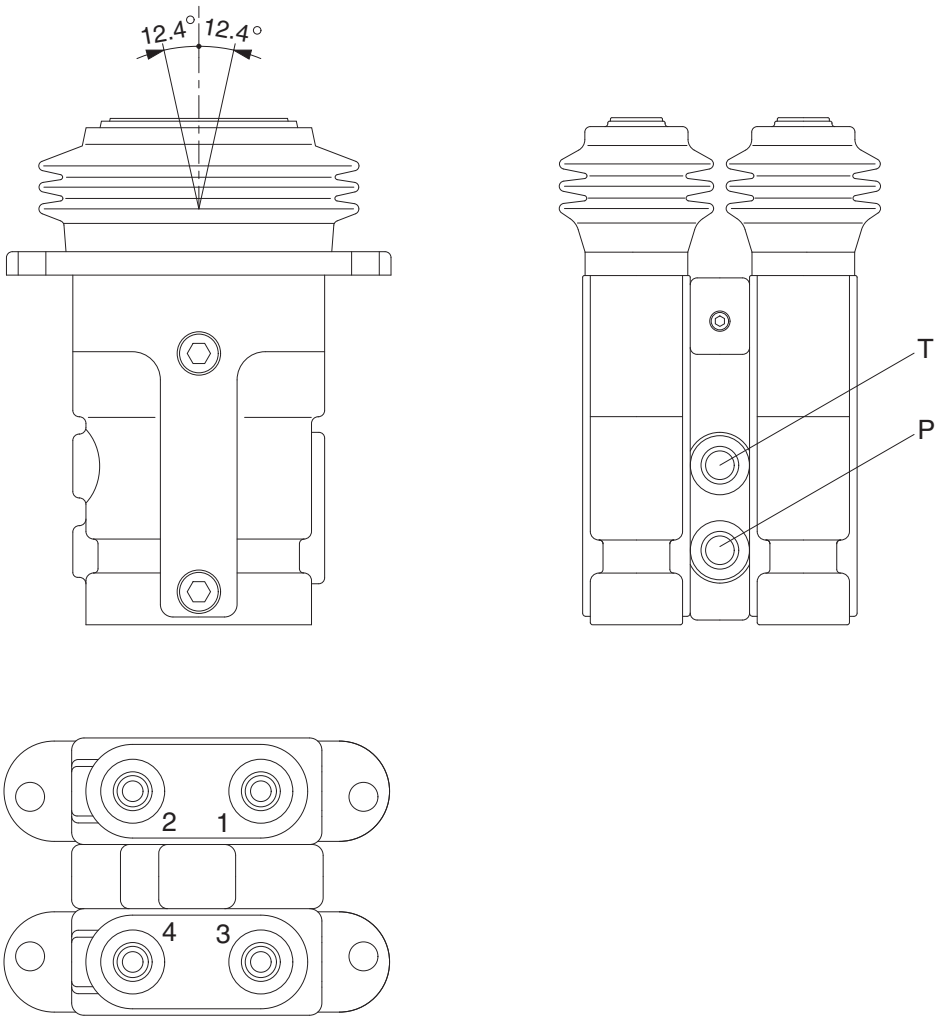
21092RL04

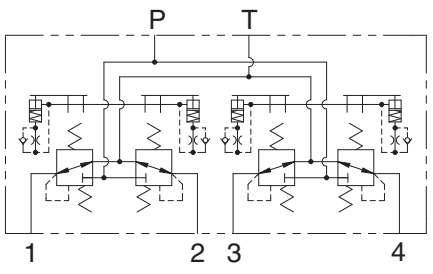
When the push rod (11) is stroked, the spool (4) moves downwards.
Then port P is connected with port (1) and the oil supplied from the pilot pump flows through port (1) to generate the pressure.
When the pressure at port (1) increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port (1) increases higher than the set pressure, port P is disconnected from port (1) and port T is connected with port (1). If it decreases lower than the set pressure, port P is connected with port (1) and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with the inside bottom of the push rod and the output pressure is left to be connected with port P.

GROUP 6 RCV PEDAL

1. STRUCTURE

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





Hydraulic circuit

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

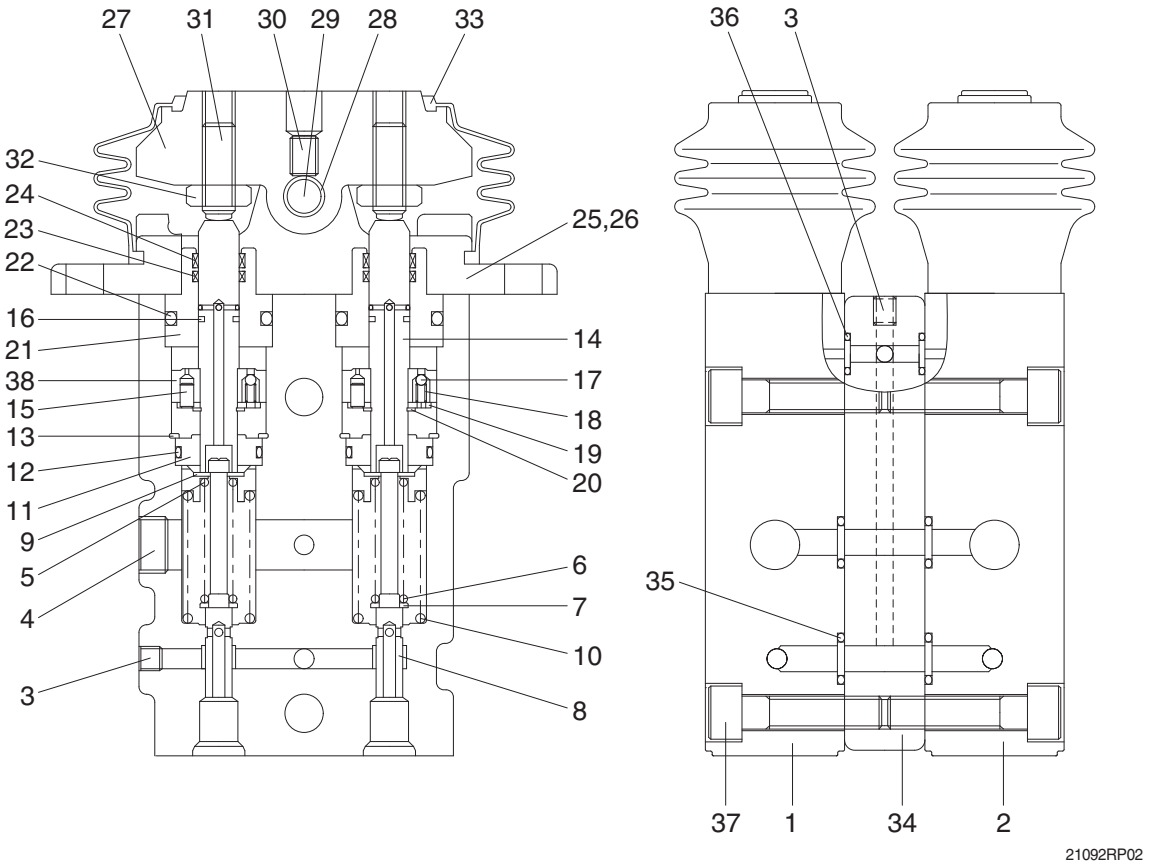
21092RP01

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

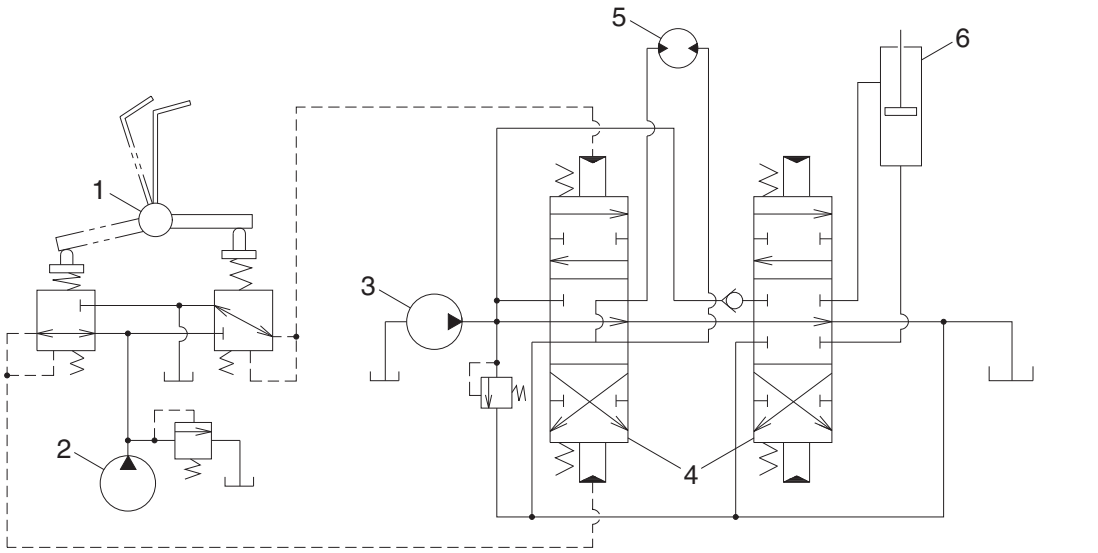
The spring (10) works on the casing (1) and spring seat (7) and tries to return the push rod (14) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

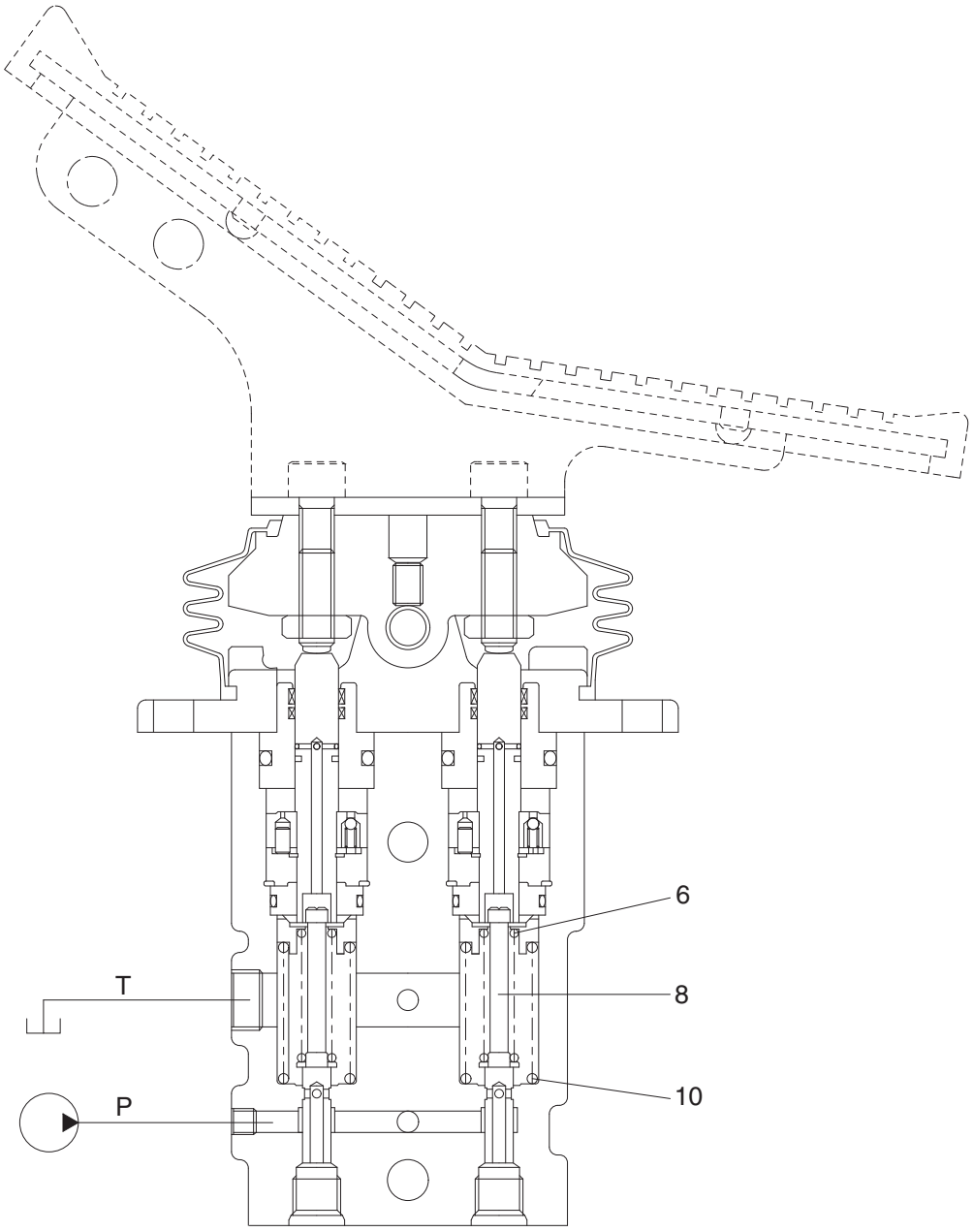
The diagram shown below is the typical application example of the pilot valve.



36072SF01

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

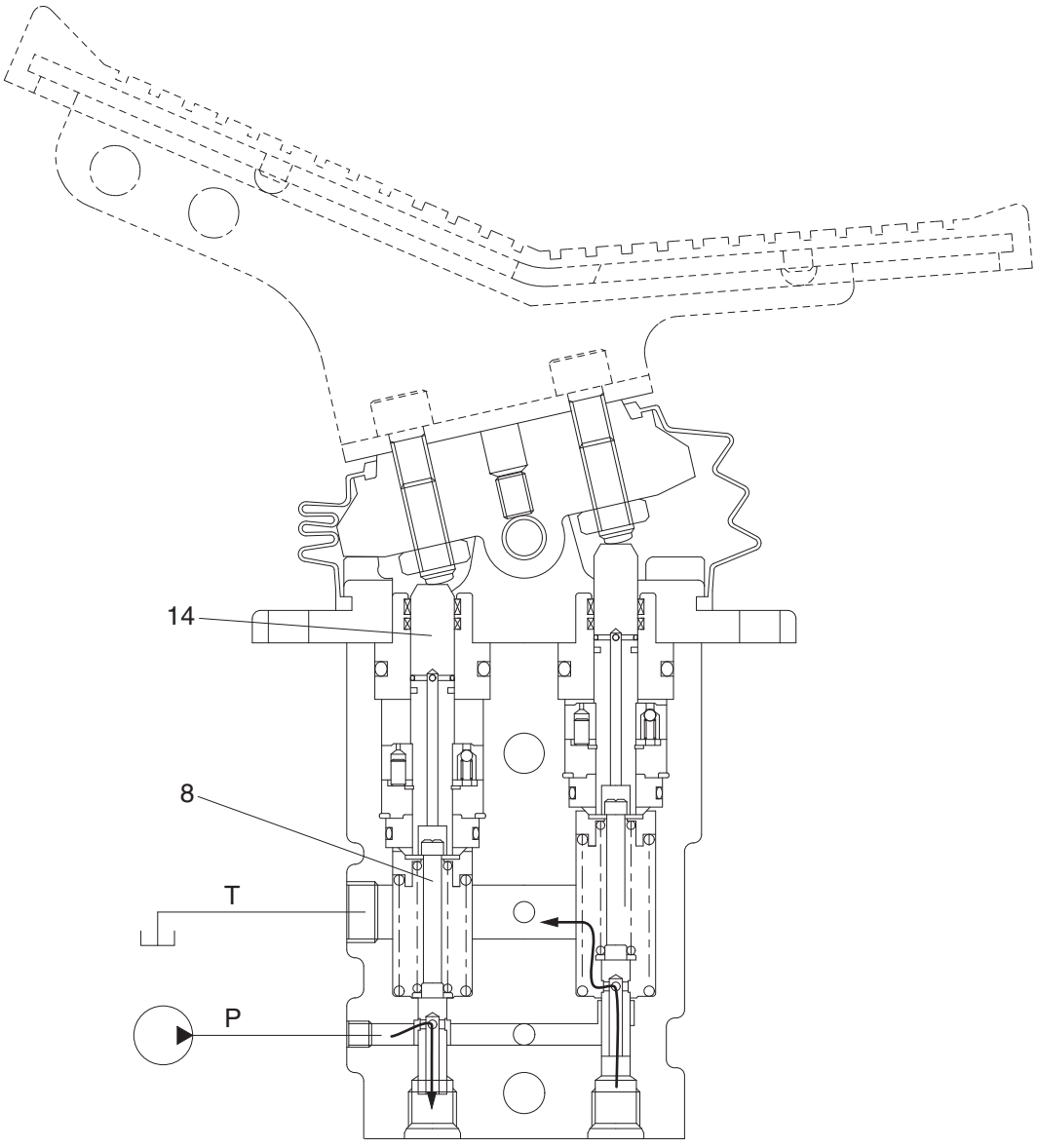
(1) Case where pedal is in neutral position



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



21092RP04

When the push rod (14) is stroked, the spool (8) moves downwards.
Then port P is connected with port 1, and the oil supplied from the pilot pump flows through port 1 to generate the pressure.
When the pressure at port 1 increases to the value corresponding to the spring force set by tilting the handle, the hydraulic pressure force balances with the spring force. If the pressure at port 1 increases higher than the set pressure, port P is disconnected from port 1 and port T is connected with port 1. If it decreases lower than the set pressure, port P is connected with port 1 and port T is disconnected from port 1.
In this manner the secondary pressure is kept at the constant value.
Besides, in some type, when the handle is tilted more than a certain angle, the upper end of the spool contacts with inside bottom of the push rod and the output pressure is left to be connected with port P.