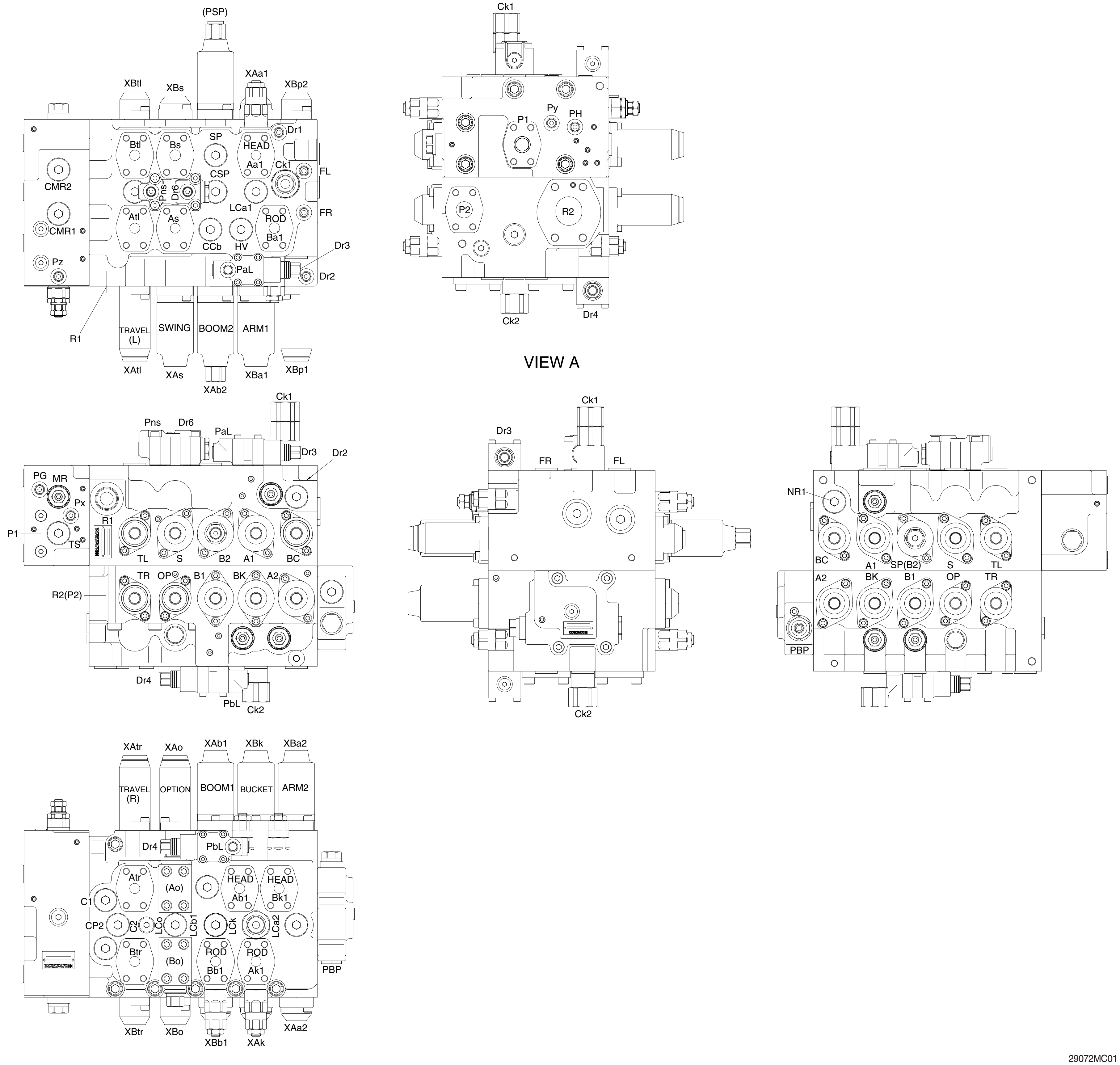
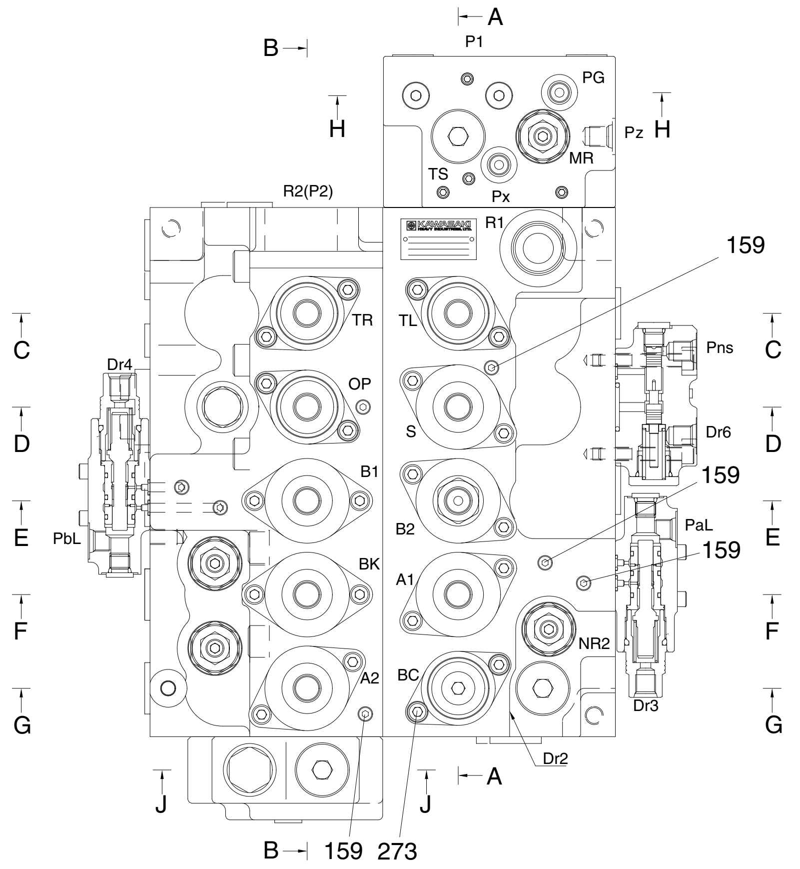
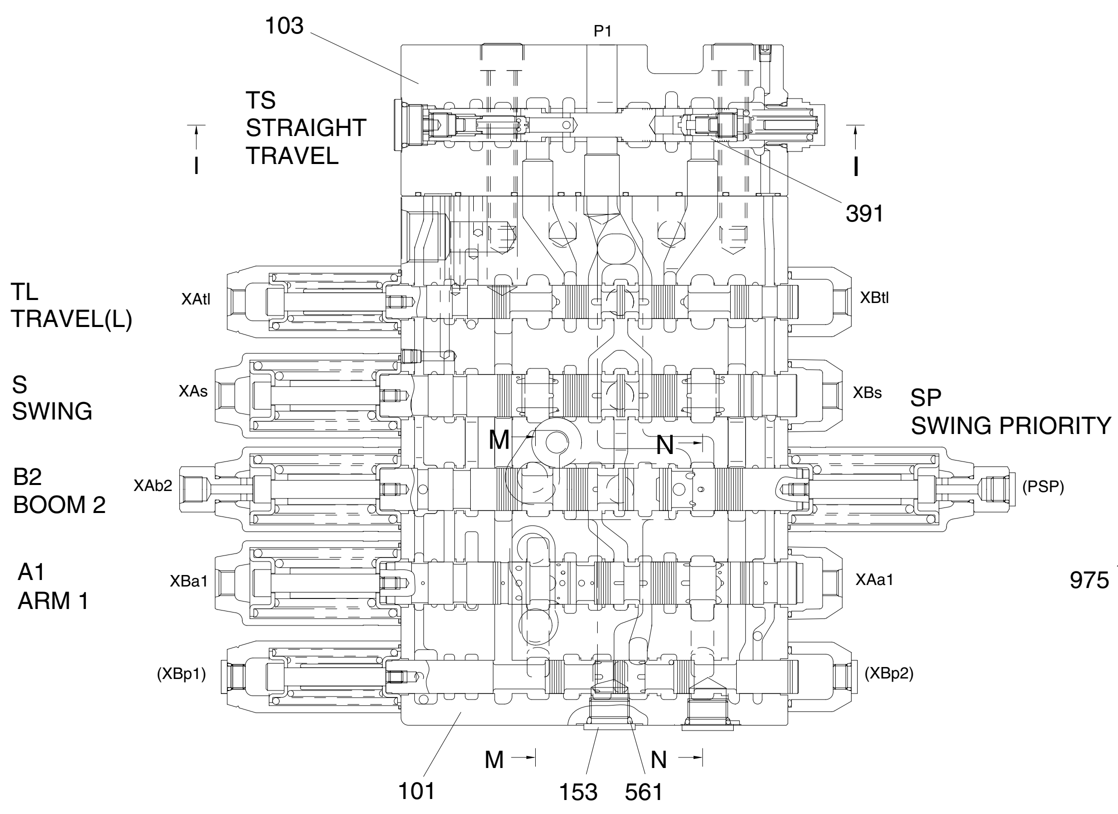
1. STRUCTURE

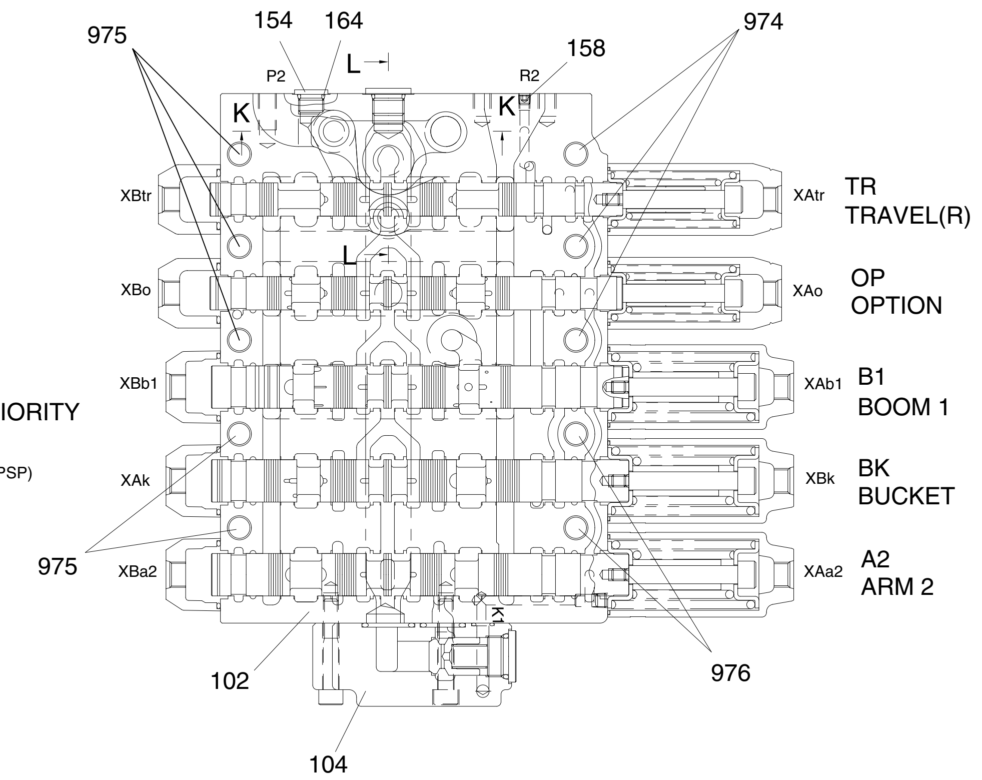


Mark	Port name	Port size	Tightening torque
R1	Make up port for swing	PF 1	20~25kgf · m (115~180lbf · ft)
Ck1	Bucket in confluence port	PF 3/4	15~18kgf · m (109~130lbf · ft)
Ck2	Bucket in confluence port		
XAtr	Travel right pilot port	PF 3/8	7~8kgf · m (50.6~57.8lbf · ft)
XBtr	Travel right pilot port		
XAo	Option pilot port		
XBo	Option pilot port		
XAk	Bucket out pilot port		
XBk	Bucket in pilot port		
XAb1	Boom up pilot port		
XBb1	Boom down pilot port		
XAa2	Arm in confluence pilot port		
XBa2	Arm out confluence pilot port		
XAtl	Travel left pilot port		
XBtl	Travel left pilot port		
XAs	Swing pilot port		
XBs	Swing pilot port		
XAa1	Arm in pilot port		
XBa1	Arm out pilot port		
XAb2	Boom up confluence pilot port		
(Psp)	(Swing priority pilot port)		
(XBp1)	(Bucket in confluence pilot port)		
(XBp2)	(Drain port)		
Pz	Main relief pilot pressure	PF 1/4	3.5~3.9kgf · m (25.3~28.2lbf · ft)
Py	Signal port for travel		
PG	Pilot pressure port		
PH	Pilot pressure port		
Px	Signal for other acutuators		
Dr1	Drain port		
Dr2	Drain port		
Dr3	Drain port		
Dr4	Drain port		
Dr6	Drain port		
FL	Negative control signal port(P1 port side)		
FR	Negative control signal port(P2 port side)		
Pns	Swing logic valve pilot port		
PaL	Lock valve pilot port		
PbL	Lock valve pilot port		
PBP	Drain port		
Atr	Travel motor right side port	M10	5~6.6kgf · m (36.1~47.7lbf · ft)
Btr	Travel motor right side port		
(Ao)	Option port		
(Bo)	Option port		
Ak1	Bucket rod side port		
Bk1	Bucket head side port		
Ab1	Boom head side port		
Bb1	Boom rod side port		
Atl	Travel motor left side port		
Btl	Travel motor left side port		
As	Swing motor port		
Bs	Swing motor port		
Aa1	Arm head side port		
Ba1	Arm rod side port		
P1	Pump port(P1 side)		
P2	Pump port(P2 side)		
R2	Return port	M12	8.5~11.5kgf · m (61.5~83.1lbf · ft)

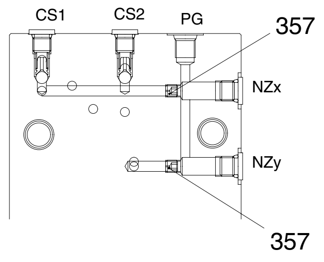




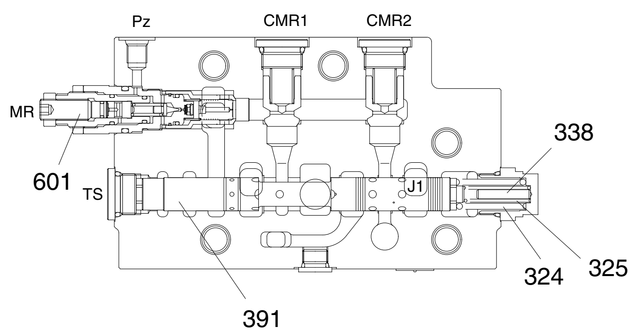
SECTION A-A



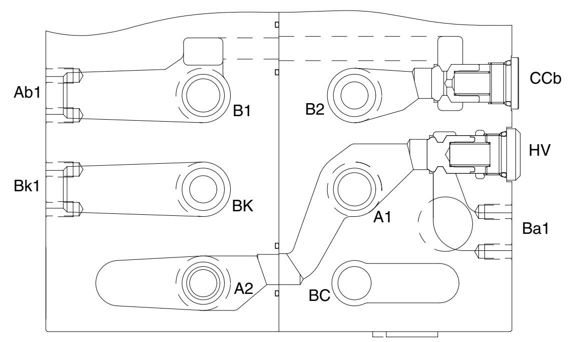
SECTION B-B



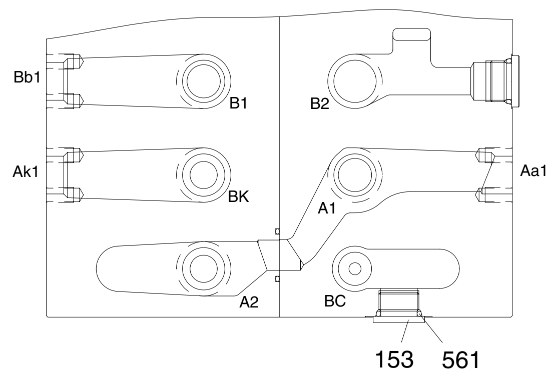
SECTION H-H



SECTION I-I



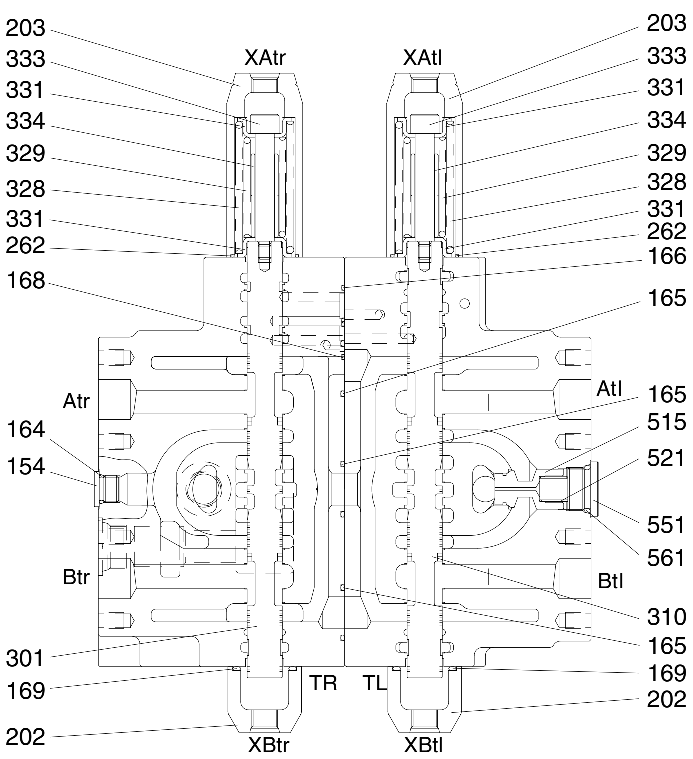
SECTION M-M



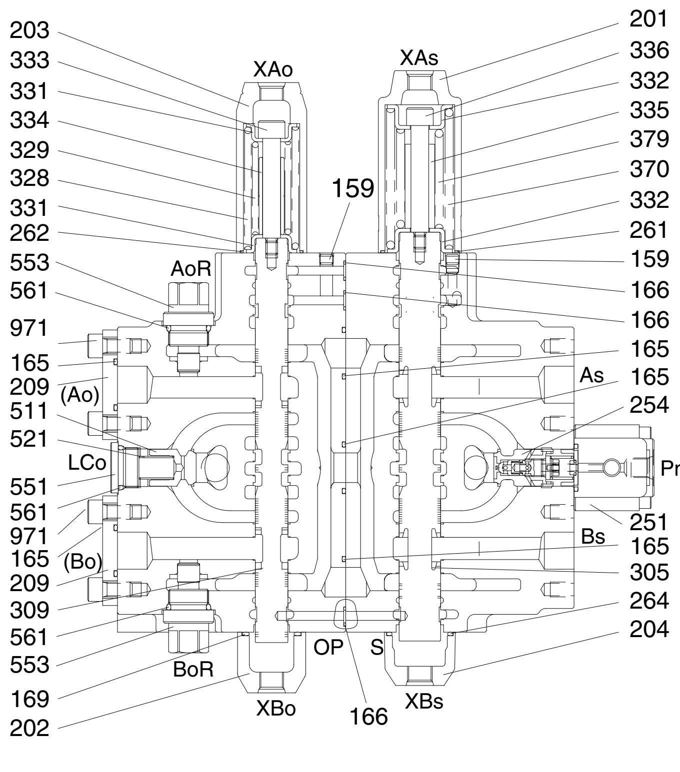
SECTION N-N

29072MC07

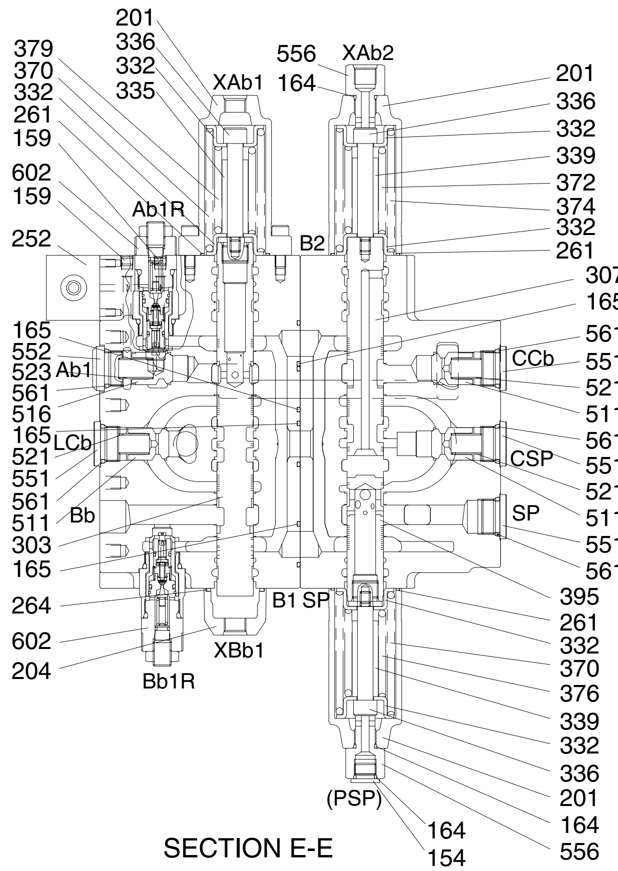
101	Casing A		301	Travel spool		379	Spring	
102	Casing B		302	Arm 1 spool assy		391	Straight travel spool	
103	Straight travel valve		303	Boom 1 spool assy		392	Bypass cut spool	
104	Boom priority valve		304	Bucket spool		395	Swing priority spool	
153	Plug		305	Swing spool		401	Spool	
154	Plug		306	Arm 2 spool		424	Spring	
155	Plug		307	Boom 2 spool		425	Spring	
156	Plug		309	Spool(Option)		438	Rod	
158	Plug		310	Travel spool		511	Poppet	
159	Plug		324	Spring		513	Poppet	
163	O-ring		325	Spring		515	Poppet	
164	O-ring		328	Spring		516	Poppet	
165	O-ring		329	Spring		521	Spring	
166	O-ring		331	Spring seat		522	Spring	
167	O-ring		332	Spring seat		523	Spring	
168	O-ring		333	Bolt		551	Plug	
169	O-ring		334	Stopper		552	Plug	
201	Cover		335	Stopper		553	Plug	
202	Cover		336	Bolt		554	Plug	
203	Cover		337	Stopper		555	Check valve assembly	
204	Cover		338	Stopper		556	Plug	
209	Flange		339	Stopper		561	O-ring	
251	Control valve assy		357	Orifice		601	Main relief valve	
252	Lock valve assy		370	Spring		602	Port relief valve	
254	Swing logic valve assy		372	Spring		611	Nega-con relief valve	
261	O-ring		374	Spring		971	Socket screw	
262	O-ring		376	Spring		974	Socket screw	
264	O-ring		377	Spring		975	Socket screw	
273	Socket screw		378	Spring		976	Socket screw	



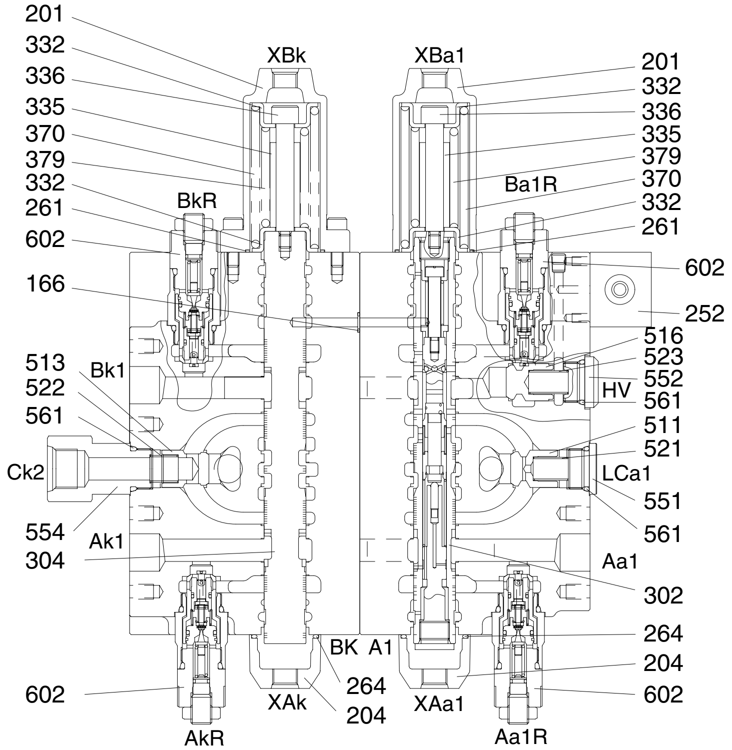
SECTION C-C



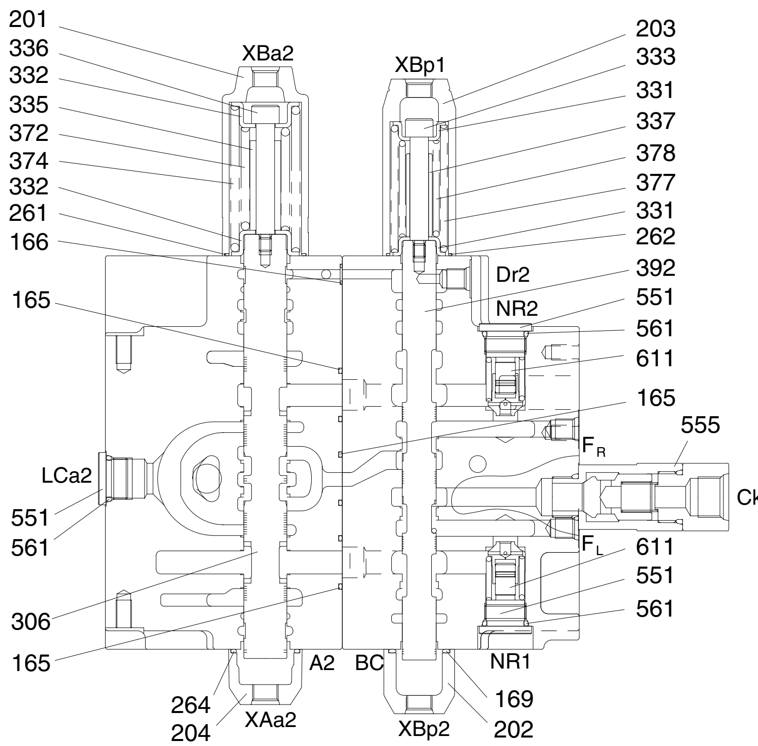
SECTION D-D



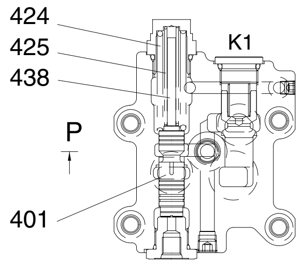
SECTION E-E



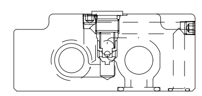
SECTION F-F



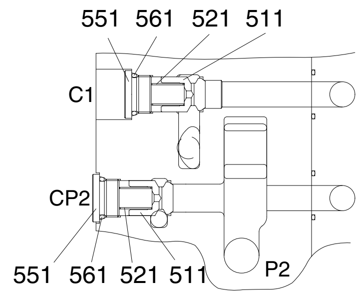
SECTION G-G



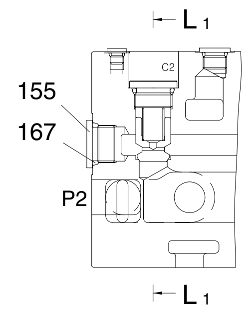
SECTION J-J



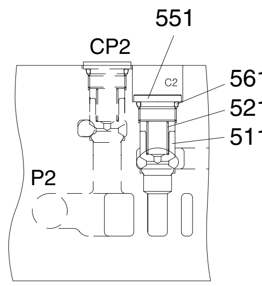
SECTION P-P



SECTION K-K



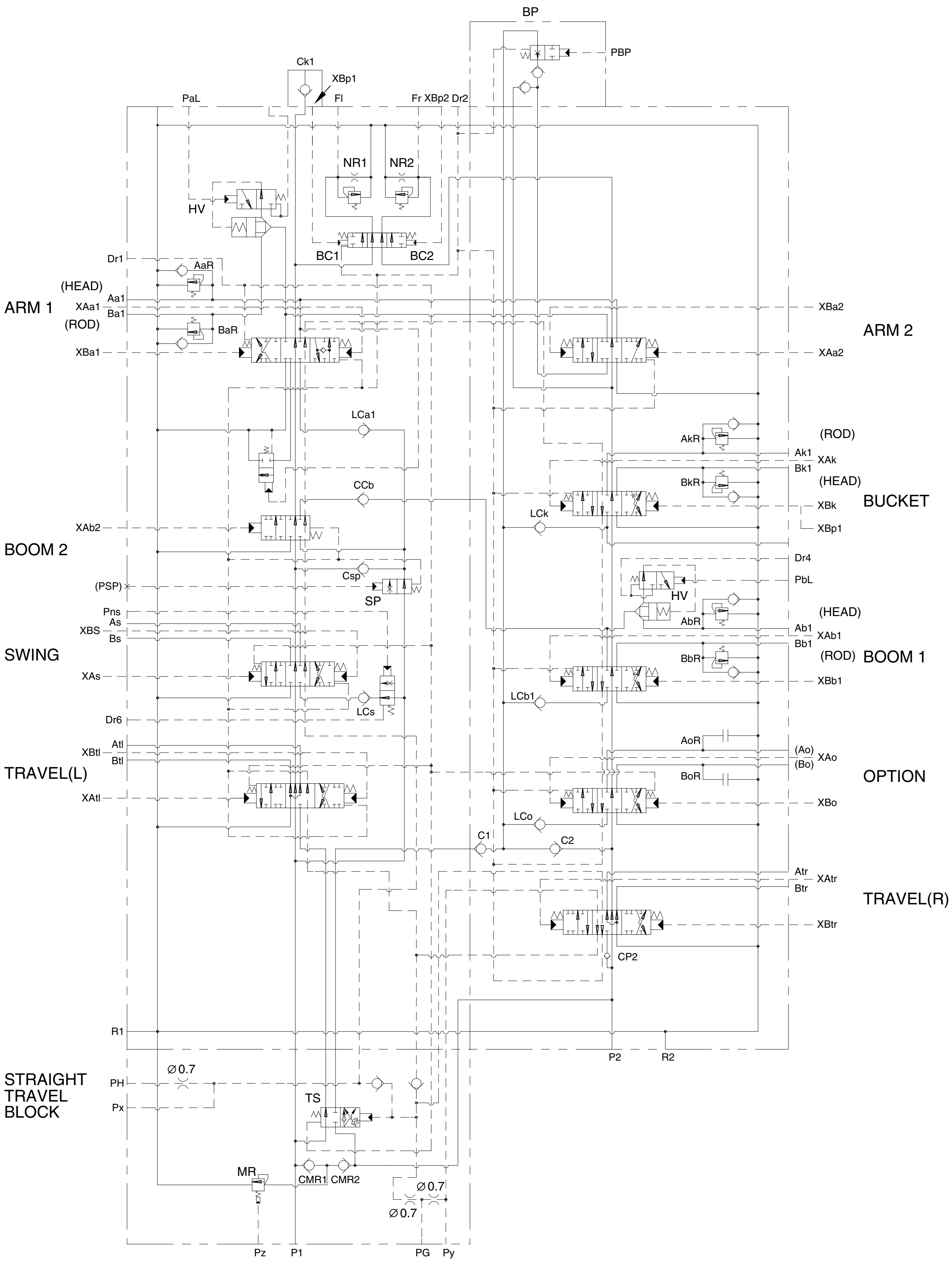
SECTION L-L



SECTION L$_1$-L$_1$

29072MC14

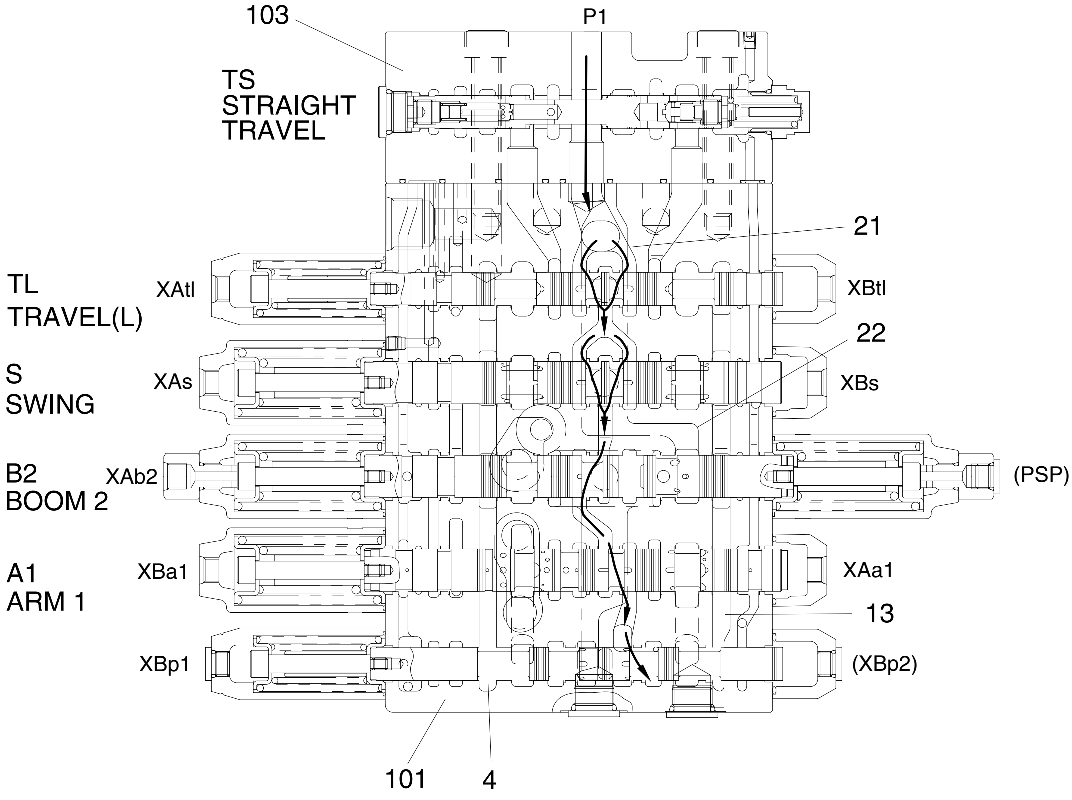
2. HYDRAULIC CIRCUIT



29072MC24

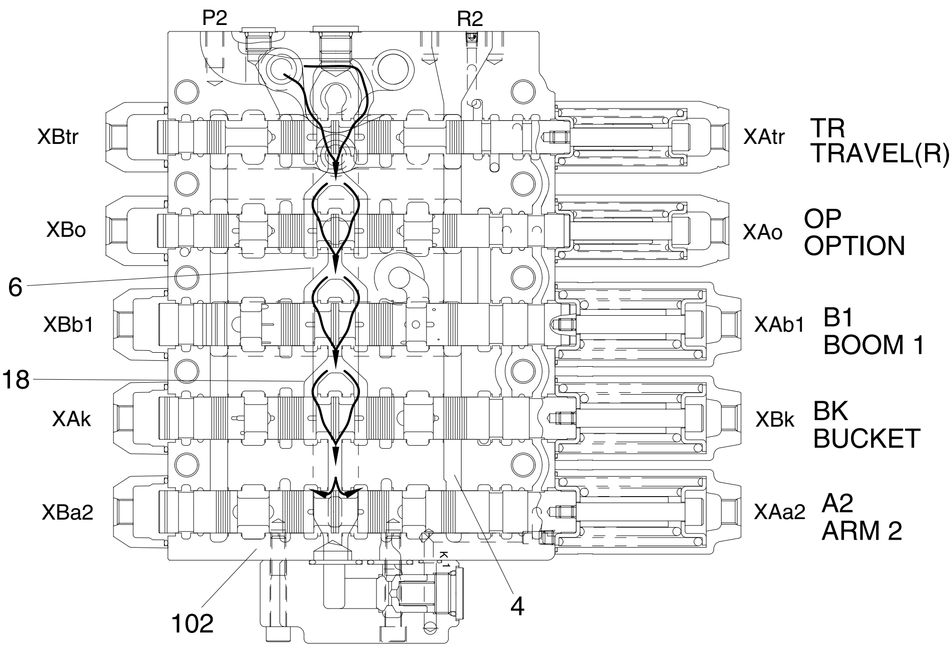
3. FUNCTION

1) CONTROL IN NEUTRAL POSITION



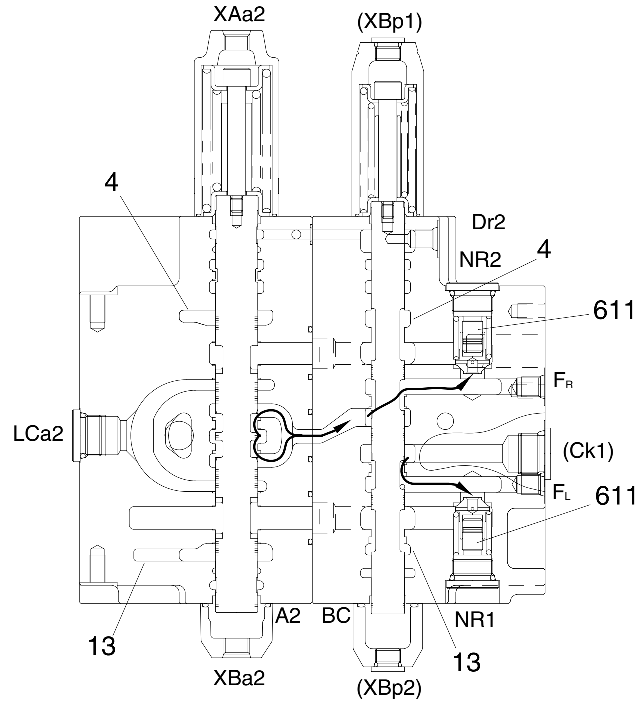
SECTION A-A

29072MC25



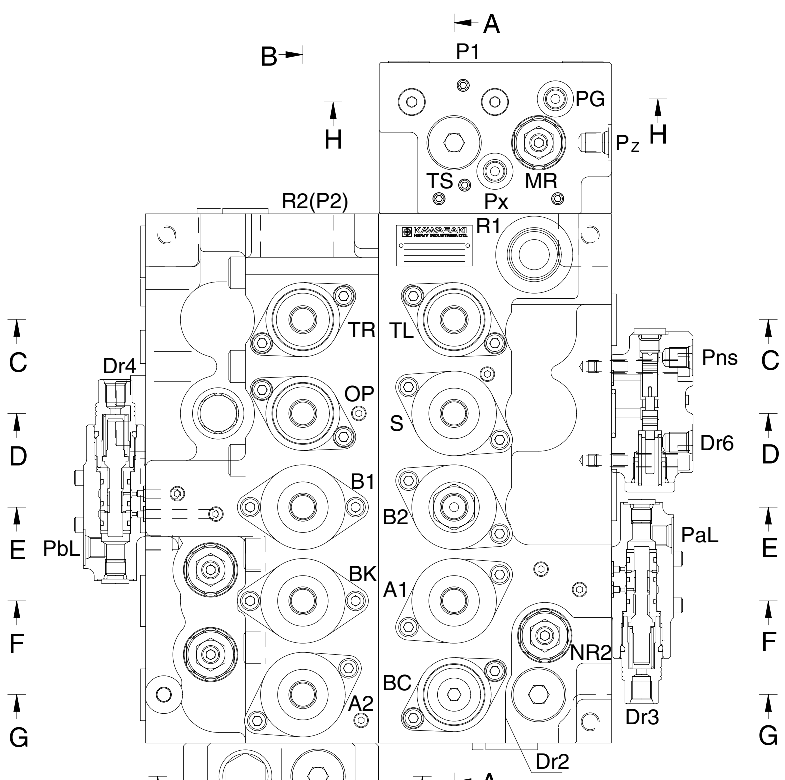
SECTION B-B

29072MC26



SECTION G-G

29072MC27

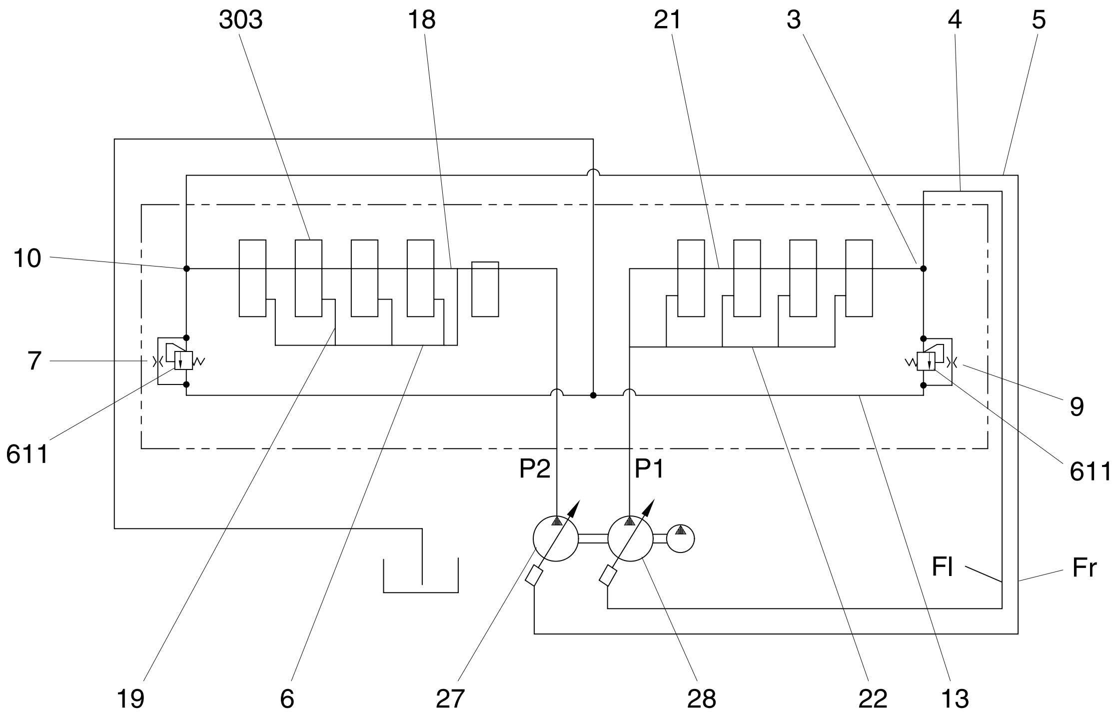


29072MC28

The hydraulic fluid from the pump P1 flows into casing A(101) through the inlet port(P1), through the center bypass(21) and the parallel path(22). The hydraulic fluid from the pump P2 flows into casing B(102) through the inlet port(P2) through the center bypass(18) and the parallel path(6).
The hydraulic fluid from the pump P1 is directed to the tank through the center bypass(21), negative control orifice(NR1), the return path(13) and the return port(R2). The hydraulic fluid from the pump P2 also flows to the tank through the center bypass(18), negative control orifice(NR2), return path (4) and return port(R2). The hydraulic fluid in paths (6) and (22) is blocked and cannot return to the tank.
In case a control lever is operated, the hydraulic fluid from the pump P2 is supplied to the travel right spool(301) from path(18) and to the spools: option(309), boom1(303), bucket(304) and arm2(306) from path(6). Additionally, the hydraulic fluid from the pump P1 is supplied to the travel left spool (310) from path(7) while the swing(305), boom2(307) and arm(302) spools are supplied from path(22).

2) NEGATIVE CONTROL

(1) General operation

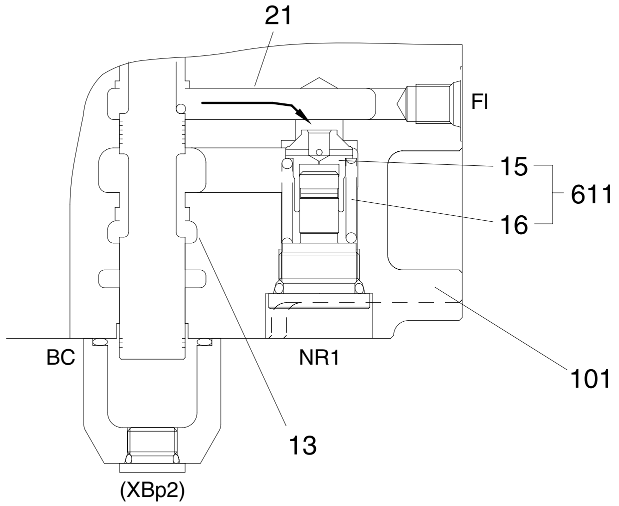


29072MC29

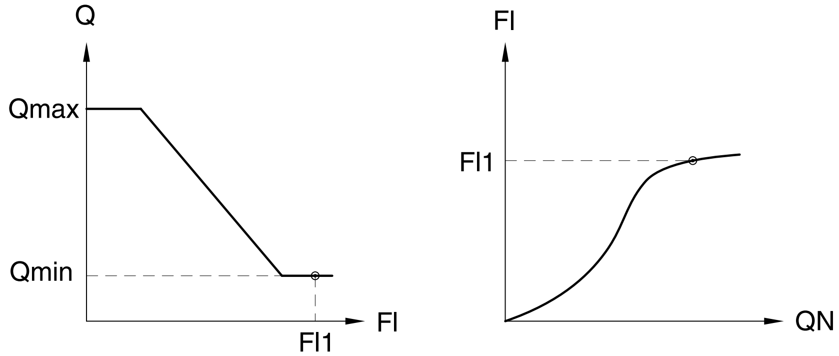
The negative control signal pressure from the center bypass(18, 21) occurs in the following cases and controls the discharge of the pump.

1. Neutral condition when no function is being actuated.
2. The pilot control lever is partially operated.

The hydraulic fluid of the pump P1(28) flows into the return passage(13) through the center bypass (21), the path(3) and orifice(9)(Within the poppet(15)). The restriction caused by this orifice thereby pressurizes path(3). This pressure is transferred as the negative control signal pressure Fl to the pump P1 regulator through the negative control line(4). It controls the pump regulator so as to decrease the discharge of the pump P1(28).



29072MC30

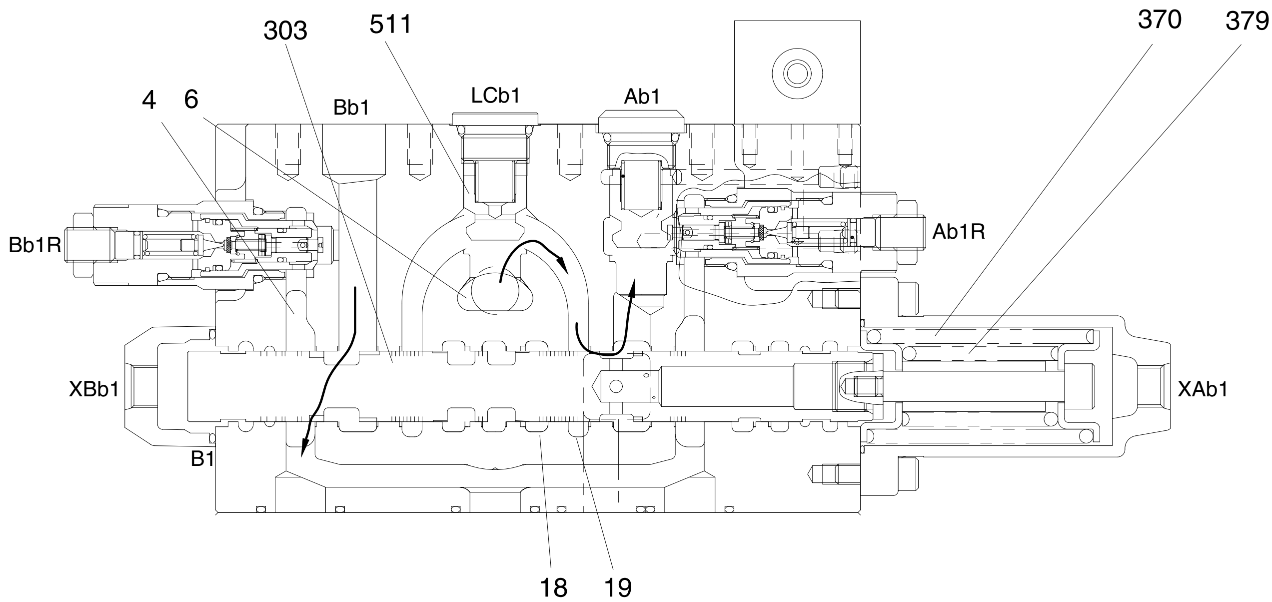


29072MC31

The negative control relief valve(611) consists of poppet(15), spring(16) and casing(101). When the hydraulic fluid in the center bypass increases to the level that the pressure in the path(3) reaches the set pressure of the spring(16), the hydraulic fluid in the path(3) pushes open the poppet (15) and escapes into the return path(13).

In the unloaded state, the hydraulic fluid of the pump P1(28) entirely flows to the tank through the path(21), orifice(9) and the return path(13). Therefore the pressure Fl in the path(3) becomes maximum(Fl1) because all the discharge is reduced by the orifice(9) which in turn destrokes the pump P1(28) so as to minimize the tilting angle and consequent discharge of the pump P1(28). (Qmin)

(2) Negative control(With fine metering)



29072MC32

In the case, for example, when the pilot control lever for main boom is slightly operated, the pilot pressure XAb1 shifts the main boom spool(303) partially in the left direction. So the path(19) is partially opened and the center bypass(18) is shut slightly. The hydraulic fluid thereby separates. One part flows via the orifice(7) through the path(18) and the other portion flows into the parallel path(6), the path(19) and the port Ab1. The flow from the path(18) through the orifice(7) decreases slightly and the pressure Fr in the path(10) thereby also slightly decreases. As the pressure Fr becomes lower, the discharge of the pump P2(27) increases. With the pilot control lever shifted even more the path(18) is shut off by the shifting of the spool(303) and then the flow through the bypass becomes zero. The pressure in the path(10) becomes zero and the discharge of the pump P2(27) becomes maximum.(Qmax)

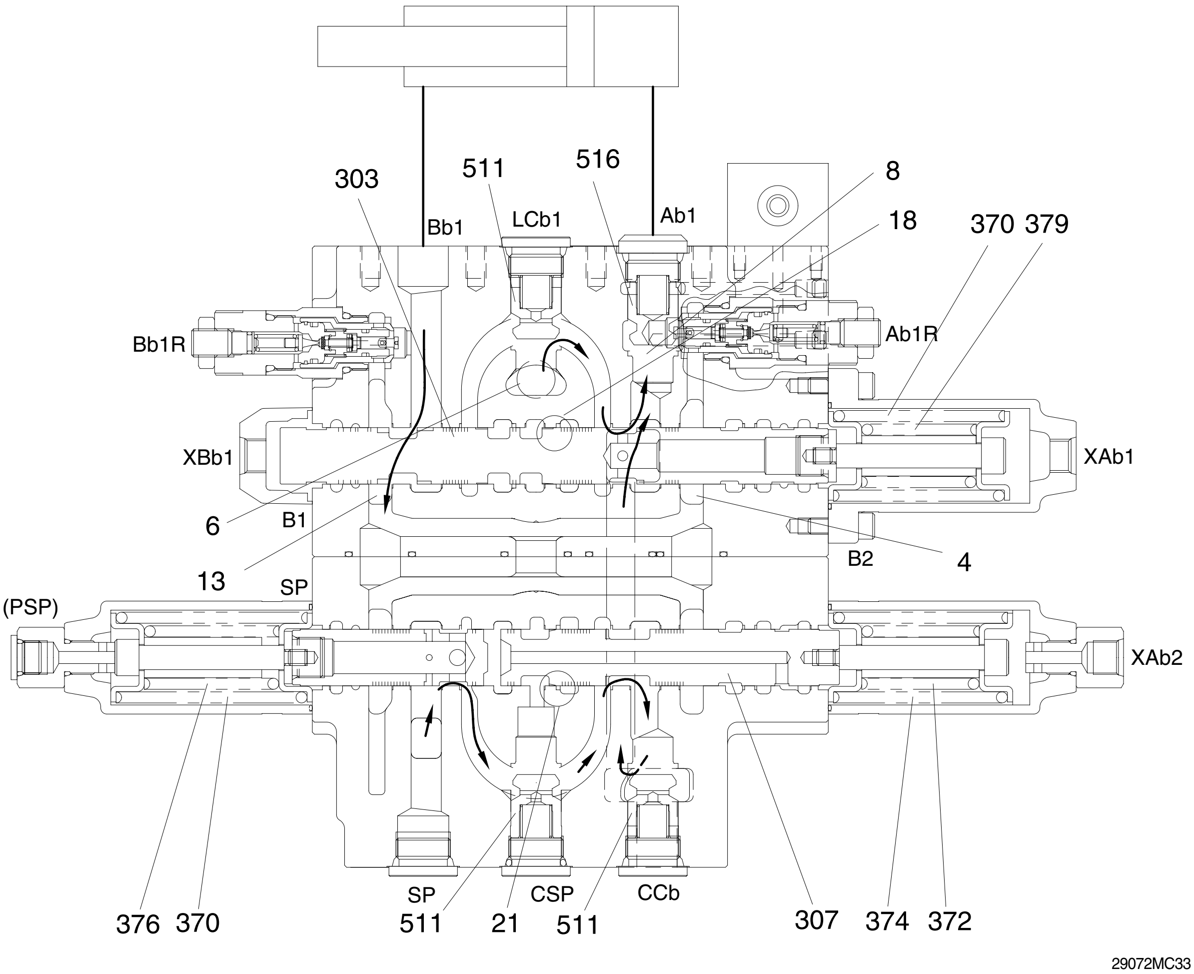
Because the discharge of the pump is adjusted by operating the pilot control lever slightly, the precise moving of the actuator is realized.

For the pump P1(28) the same negative control principle of operation occurs utilizing the orifice(9).

3) EACH SPOOL OPERATION

(1) Boom control

① Boom up operation

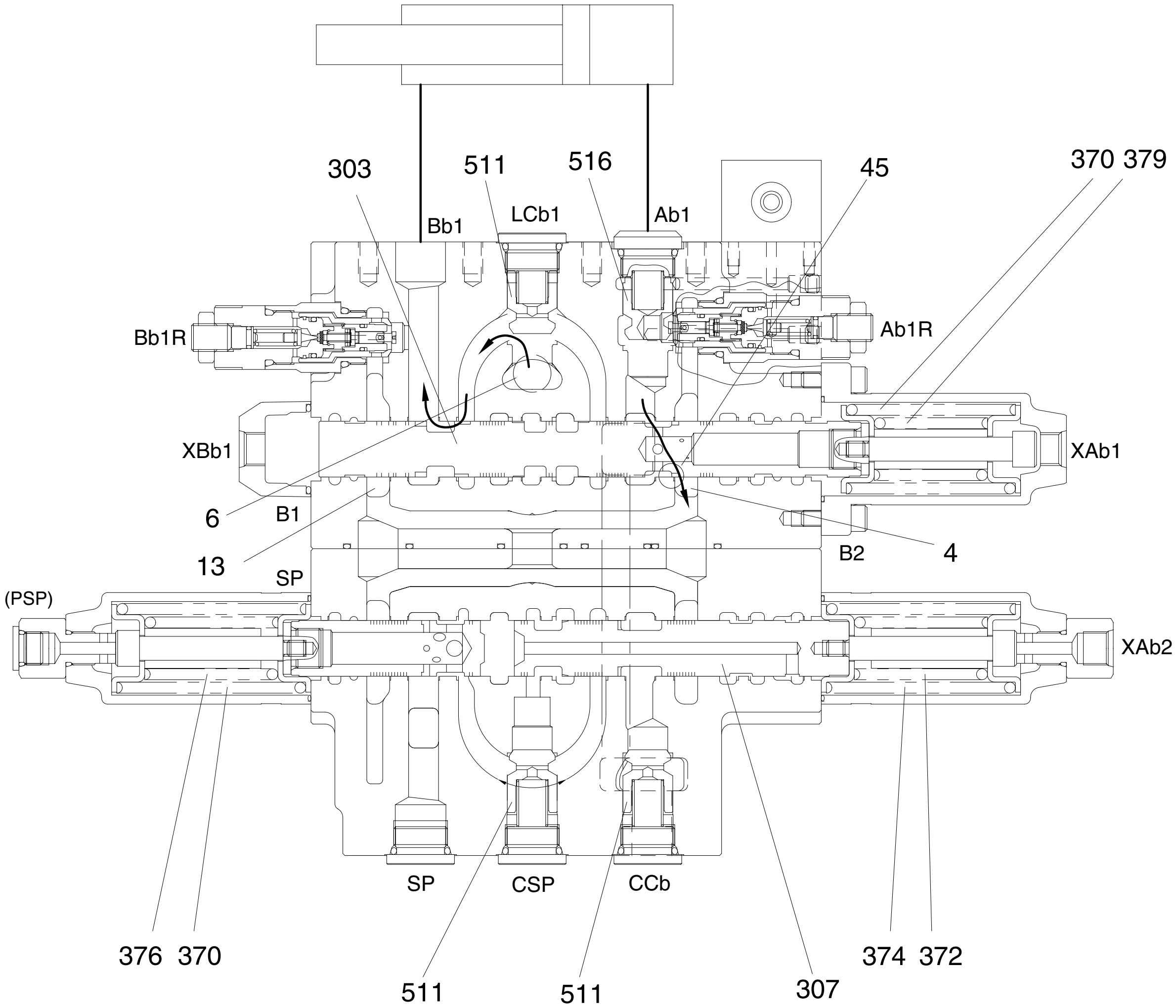


The main boom up operation becomes fast because the hydraulic fluid from the pump P2 that is directed to the port P2 is combined in the casing that of the pump P1 which enters port P1. The confluence flow is supplied to the head side of the boom cylinder. In low speed operation, only the boom1 spool(303) operates and is supplied with hydraulic fluid from the pump P2.

The hydraulic fluid from the pump P2 flows into the boom1 spool(303) through port P2 and parallel path(6). The hydraulic fluid from the pump P1 flows to the boom2 spool(307) through pump port P1 and the parallel path(22).
During the boom up operation, the pilot pressure from the pilot control valve is supplied into the port XAb1 and shifts the boom1 spool(303) in the left direction against the springs (370) and (370). The hydraulic fluid from the pump P2 enters the parallel path(6) and then passes through the load check valve LCb1(511) and boom1 spool(303) and check valve HV(516) then flows into the port Ab1. Following this it flows into the head side of the boom cylinder.

At the same time, the pilot pressure through the port XAb2 shifts the boom2 spool(307) in the left direction against the springs (374) and (372). The hydraulic fluid from the pump P1 enters via the parallel path(22) and center bypass(21), then passes through the load check valve CSP(511), boom2 spool(307) and the load check valve CCb(511). Then flows combine in path(8) and are directed to port Ab1 and the head side of the boom cylinder.
The flow from the rod side of the boom cylinder returns to the boom1 spool(303) through the port Bb1. Thereafter it is directed to the return port R2 through path(13).

② **Boom down operation**

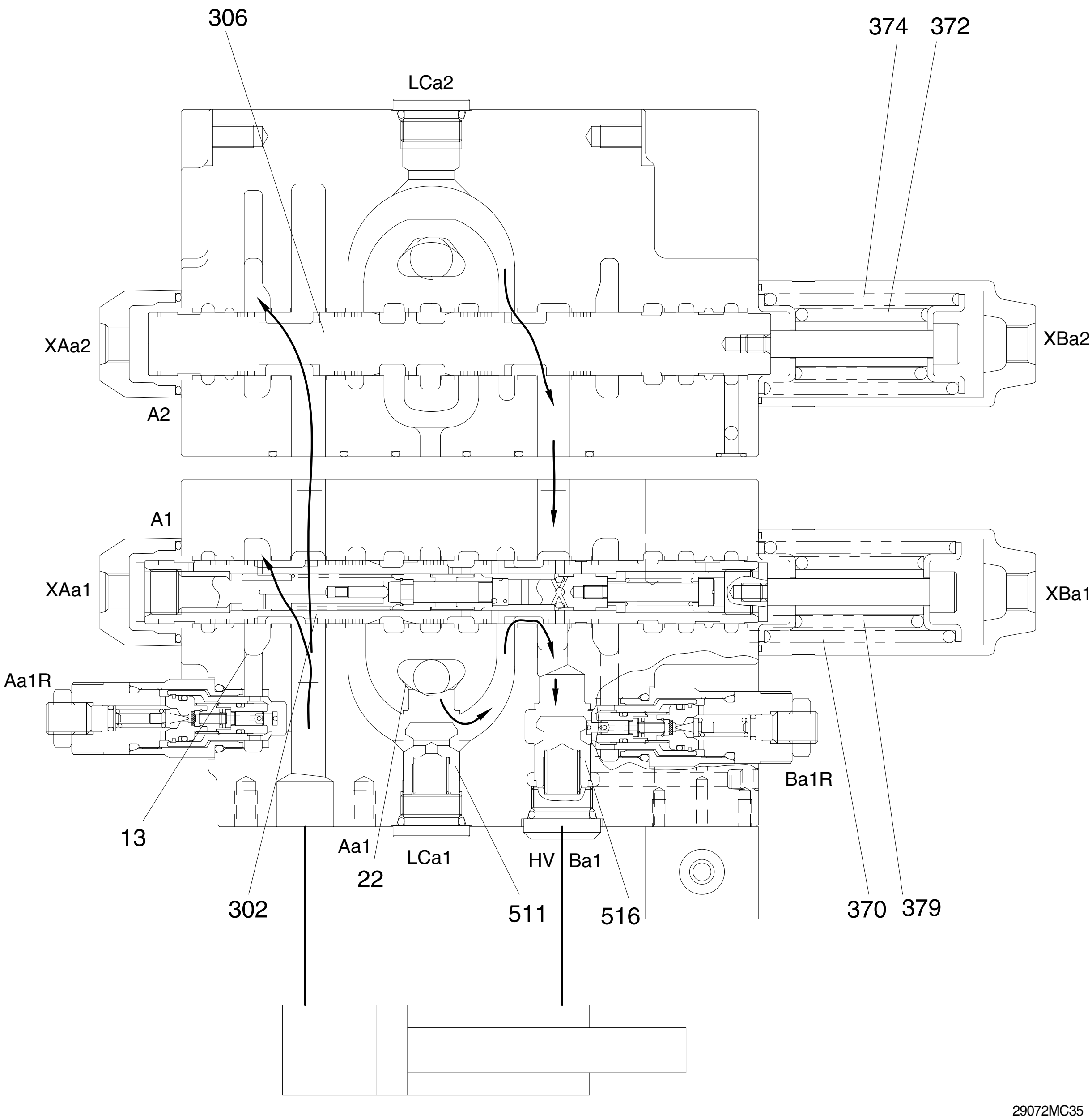


29072MC34

During the boom down operation, the pilot pressure from the pilot control valve is supplied to port XBb1 and PbL and shifts the boom1 spool(303) in the right direction against the springs (370) and (379).
The hydraulic fluid from the pump P2 enters the parallel path(6) and is directed to the port Bb1 through the load check valve LCb1(511). Following this is flows into the rod side of the boom cylinder.
The return flow from the head side of the boom cylinder returns to the boom1 spool(303) through the port Ab1. Thereafter it is directed to the return port R2 through path(4).
Additionally, the return flow is restricted in path(45), which lowers the boom cylinder at a suitable speed.

(2) Arm control

① Arm roll out operation



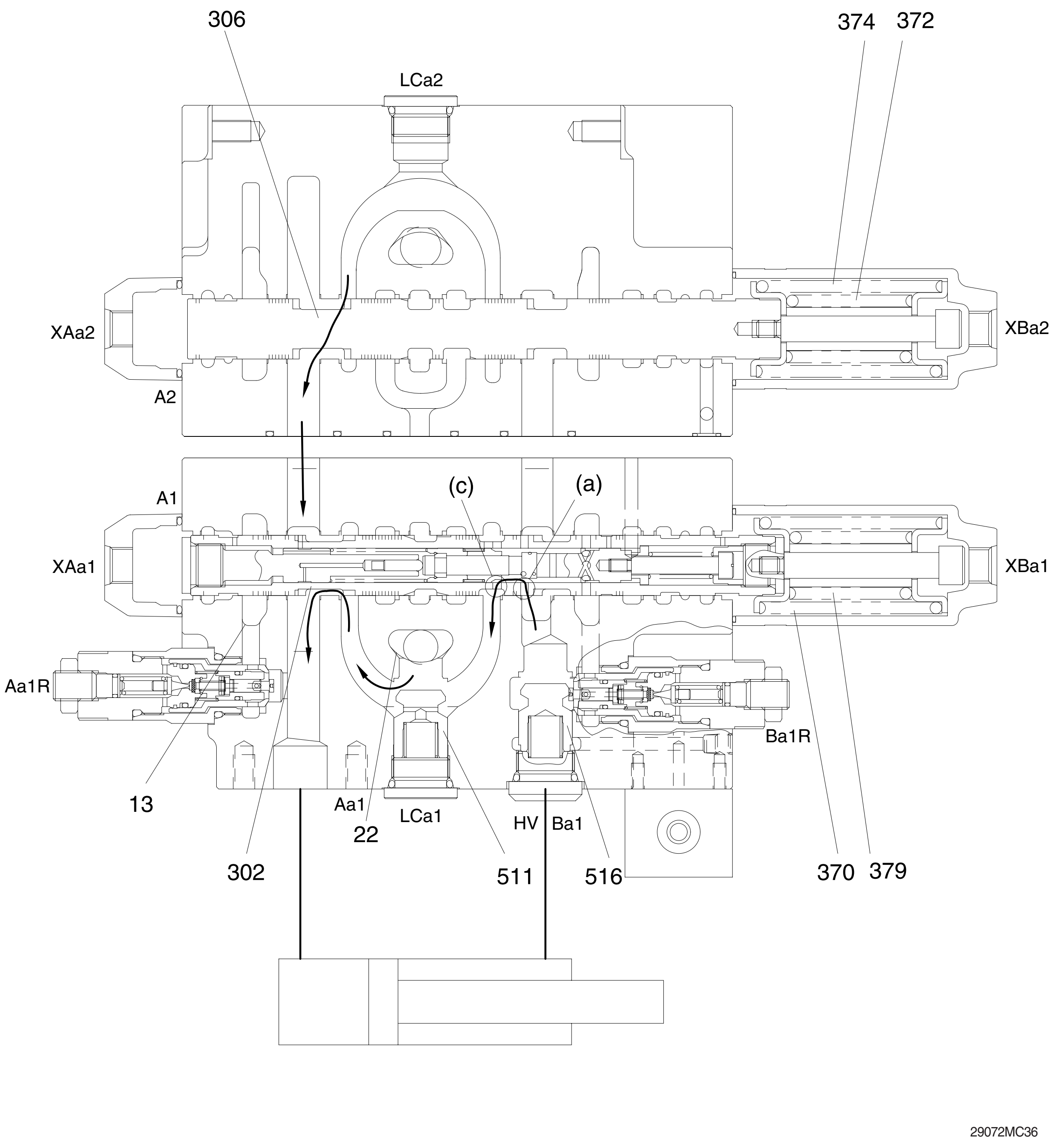
During the arm roll out operation, the pilot pressure from the pilot control valve is supplied to the pilot ports(XBa1& XBa2) and shifts the arm1 spool(302) in the left direction against the springs (370) and (379) and shifts the arm2 spool(306) in the left direction against the springs (374) and (372). The hydraulic fluid from the pump P1 flows through the load check valve LCa1(511), lock valve HV(516), and then through parallel path(22). It is then directed to the rod side of the arm cylinder through the port Ba1.

At the same time, the pilot pressure through the port XBa2 shifts the arm2 spool(306) in the left direction against the springs (374) and (372). The hydraulic fluid from the pump P2 enters via the parallel path(22) and center bypass(21), then passes through the check valve of the boom priority valve(104), arm2 spool(306). The flows are combined and directed to port Ba1 and the rod side of the arm cylinder.

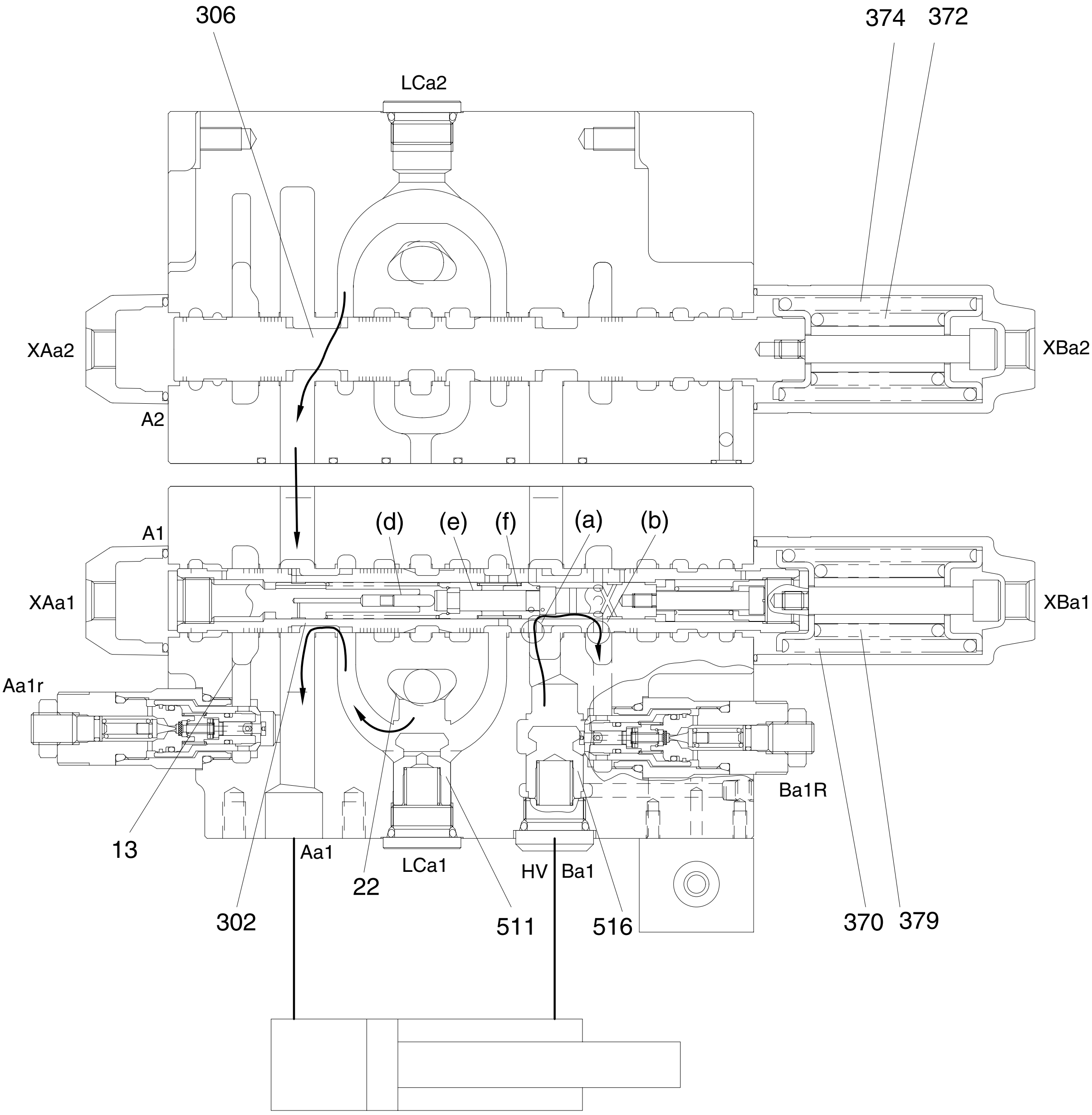
The flow from the head side of the arm cylinder returns to the arm1 spool(302) through the port Aa1. Thereafter it is directed to the return port R2 through path(13).

② **Arm roll in operation**

· **During light load only**



· The pressure in the arm cylinder head side increases



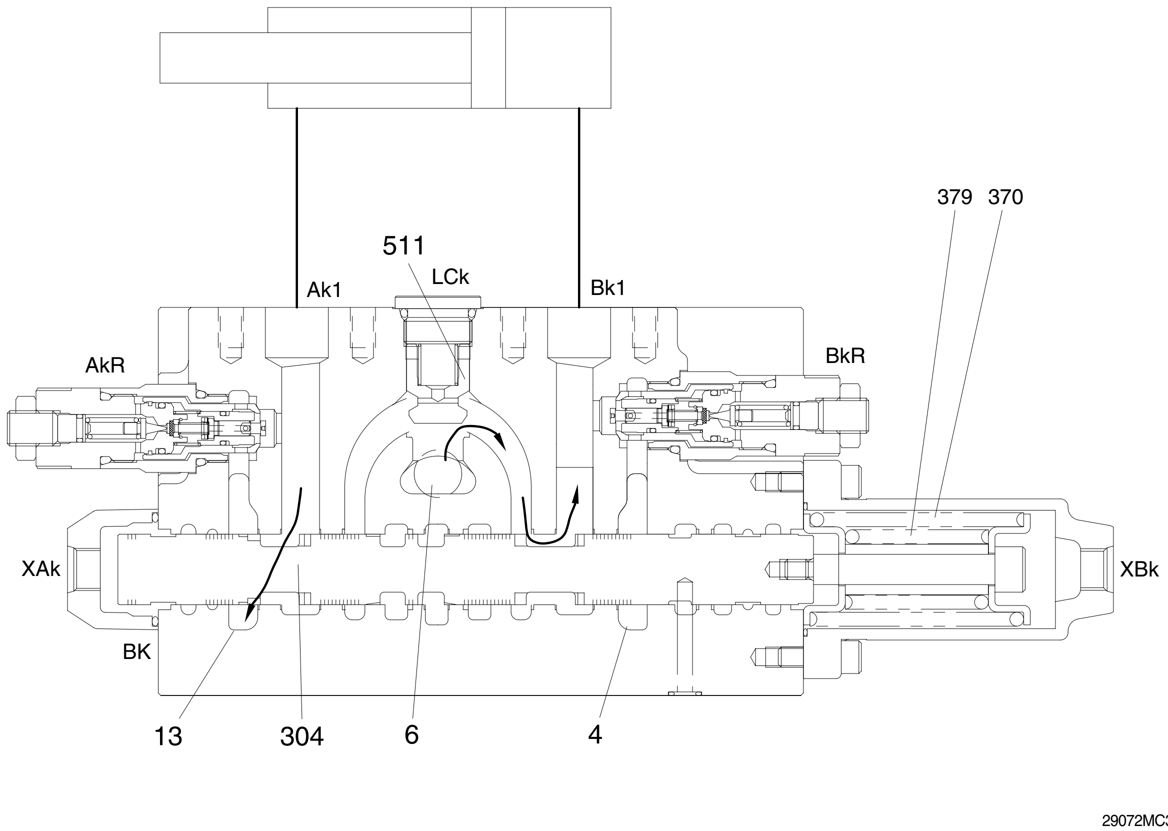
29072MC37

During the arm roll in operation, the pilot pressure from the pilot control valve is supplied to the ports XAa1, XAa2 and PaL and shifts the arm1 spool(302) in the right direction against the springs (370) and (379) and shifts the arm2 spool(306) in the right direction against the springs (384) and (372).
During the arm roll in operation, the hydraulic fluid from the pump P1 flows into the arm1 spool(302) through the parallel path(22). Then it enters into the head side of the arm cylinder through the load check valve LCa1(511), check valve HV(516) and port Aa1.
At the same time, the hydraulic fluid from the pump P2 flows into the arm2 spool(306) through the parallel path(22). Then it enters into the head side of the arm cylinder through the check valve of boom priority valve(104) and port Aa1.

The return flow from the rod side of the arm cylinder is pressurized by self-weight of arms and so on, and returns to port Ba1. The pressurized oil returning to port Ba1 enters into the arm1 spool through the outside of the arm1 spool. During a light load only, it pushes open the sleeve check valve, flows the parallel path reversely from spool hole(c), and joints into port Aa1. This is called the arm regeneration function.
When the pressure in the arm cylinder head side increases, the piston(d) and sub spool(e) are transferred in the right direction, and at the same time the sleeve check valve(f) is from the arm cylinder rod side enters flow port Ba1 through the periphery hole(a) of the arm1 spool into the spool, flows out through the periphery hole(b) of the spool, and returns through the tank port R2 to the hydraulic oil tank.

(3) Bucket control

① Bucket roll in operation

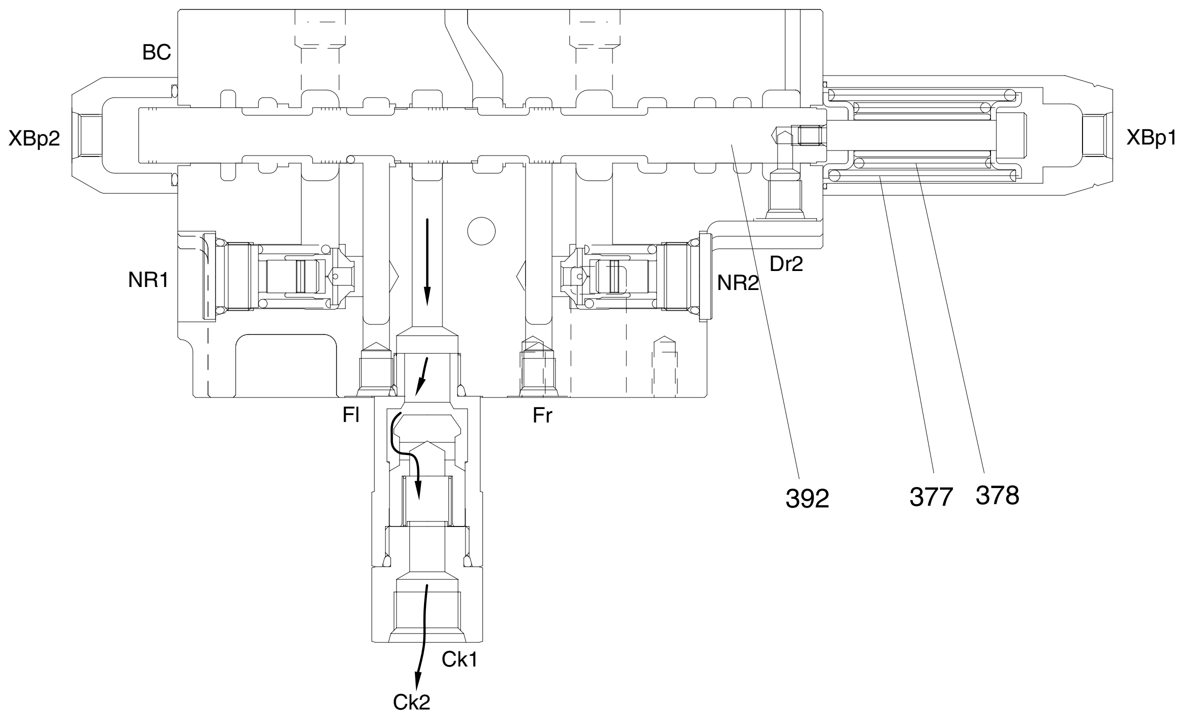


During the bucket roll in operation, the pilot pressure from the pilot control valve is supplied to port XBk and shifts the bucket spool(304) in the left direction against the springs (370) and (379).

The hydraulic fluid from the pump P2 enters the parallel path(6) and is directed to the port Bk1 through the load check valve LCk(511). Following this it flows into the head side of the bucket cylinder.

The retutn flow from the rod side of the bucket cylinder returns to the bucket spool(304) through the port Ak1. Thereafter it is directed to the return port R2 through path(13).

② Bucket confluence operation



29072MC40

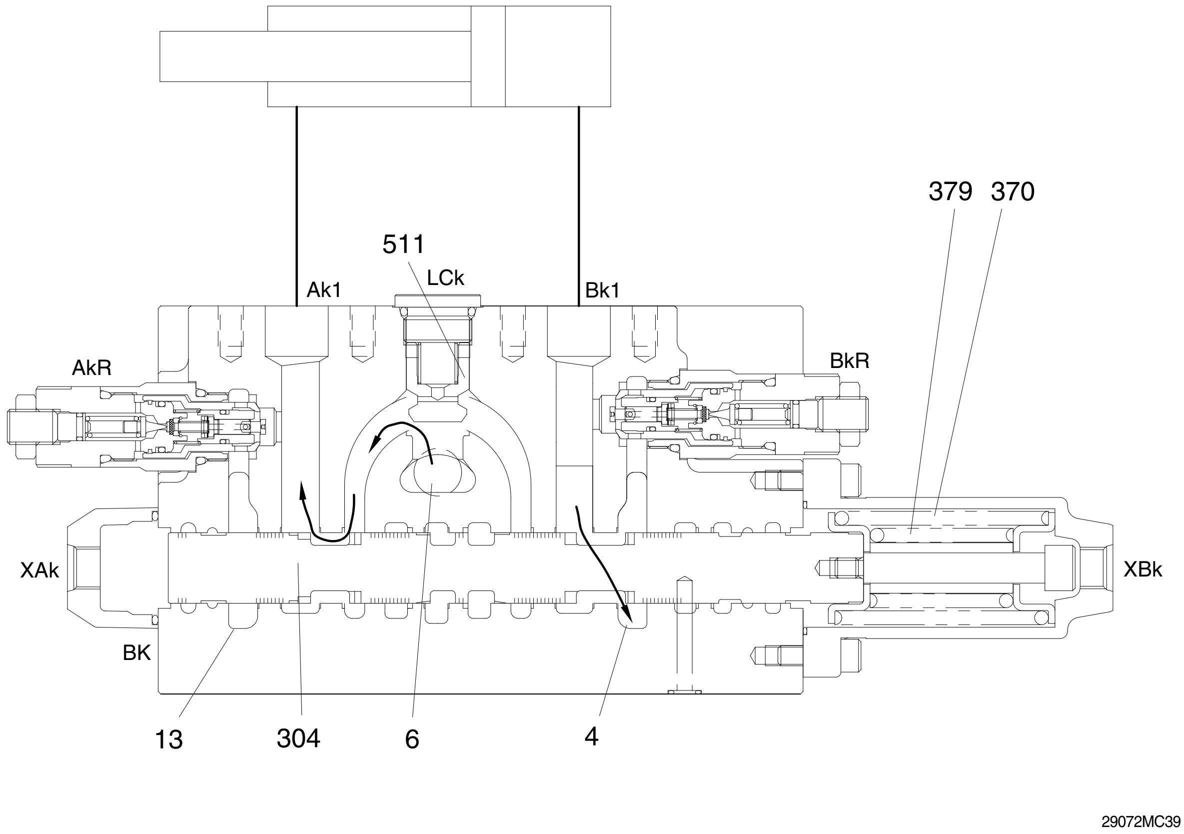
During the bucket roll in operation, the pilot pressure from the pilot control valve is supplied to port XBp1 and shifts the bypass cut spool(392) in the left direction against the springs(392) in the left direction against the springs (377) and (378).

The hydraulic fluid from the pump P1 enters the center bypass path(21).

But bypass path is shut off by the bypass cut spool. Therefore the hydraulic fluid is directed to port Ck2 after passing through the check valve Ck1.

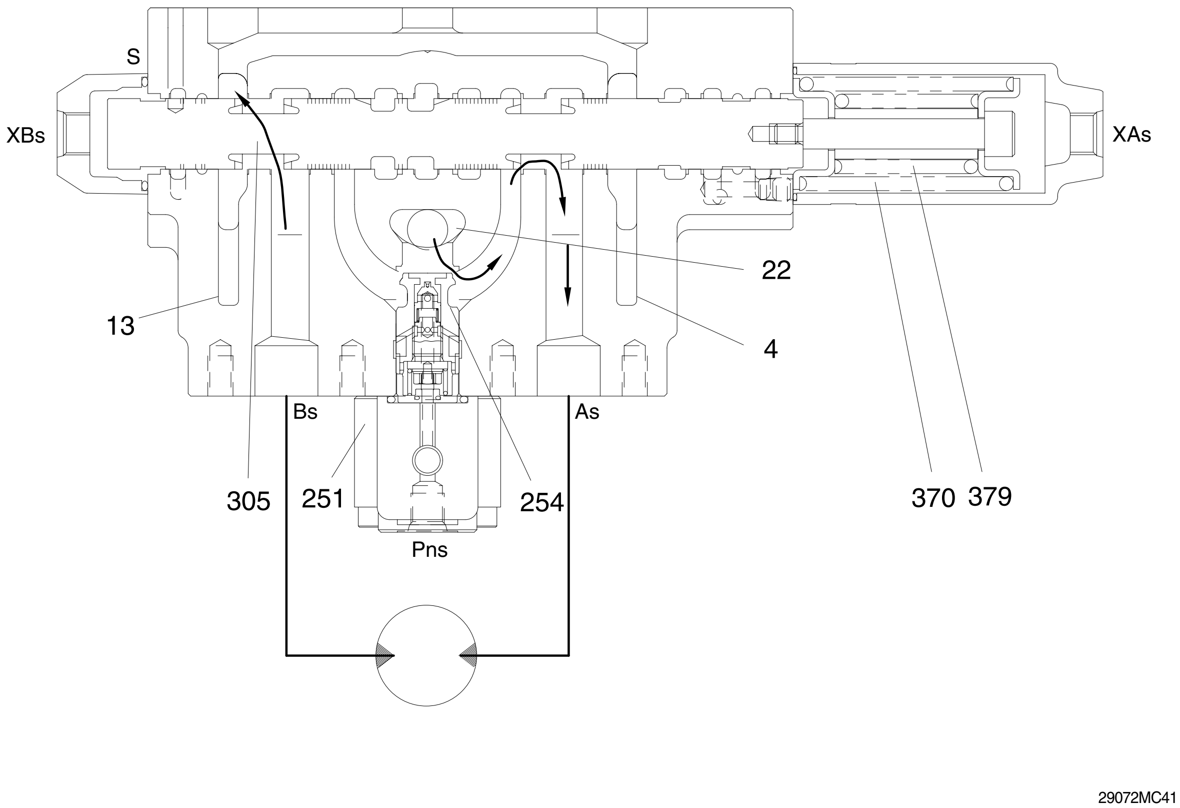
Then the fluid is directed to the bucket spool(304).

③ Bucket out operation



During the bucket roll out operation, the pilot pressure from the pilot control valve is supplied to port XAk and shifts the bucket spool(304) in the right directed agains the springs (370) and (370).
The hydraulic fluid from the pump P2 enters the parallel path(6) and is directed to the port AK1 through the load check valve LCk(511). Following this it flows into the rod side of the bucket cylinder.
The return flow from the head side of the bucket cylinder returns to the bucket spool(304) through the port Bk1. Thereafter it is directed to the return port R2 through path(4).

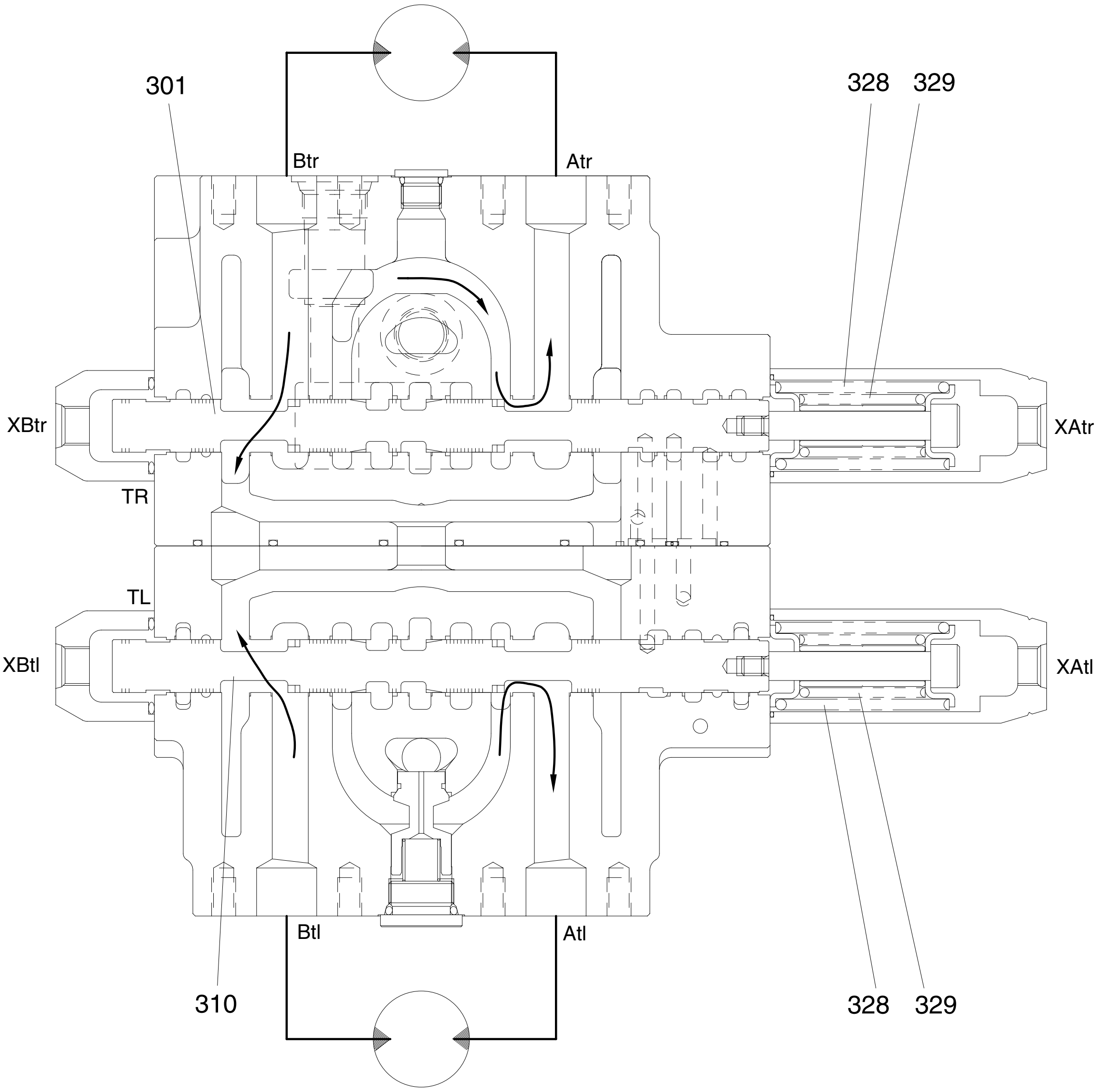
(4) Swing control



During the swing right or left operation, only the hydraulic fluid of the pump P1 is supplied to the swing motor.

The pilot pressure from the pilot control valve is supplied to the port XAs and shifts the swing spool (305) in the left direction against springs (370) and (379). Hydraulic fluid from the pump P1 flows into the swing spool(305) through the parallel path(22). Then it is directed to the swing motor through the check valve LCs(254) and the port As. As a result, the swing motor turns and the return flow from the swing motor enters port Bs. The flow from the motor returns to the tank port R2 through the swing spool(305) and path(13). In the case of the opposite operation, the operation is similar.

(5) Travel control



During the travel operation, the hydraulic fluid of the pump P1 is supplied to the travel motor and the hydraulic fluid of the pump P2 is supplied to the other travel motor.

The pilot pressure from the pilot control valve is supplied to the port XAtr and XAtl.

And it shifts the travel right spool(301) and travel left spool(310) in the left direction against springs (328) and (329). Hydraulic fluid from the pump P1 flows into the travel left spool(310) through the parallel path and hydraulic fluid from the pump P2 flows into the travel right spool(301). Then they are directed to the each travel motor through port Atl and Atr. As a result, the travel motors turn and the return flow from the travel motors enter port Btl and port Btr. The flow from the motors returns to the tank port R2 through the travel spools(310 and 301).

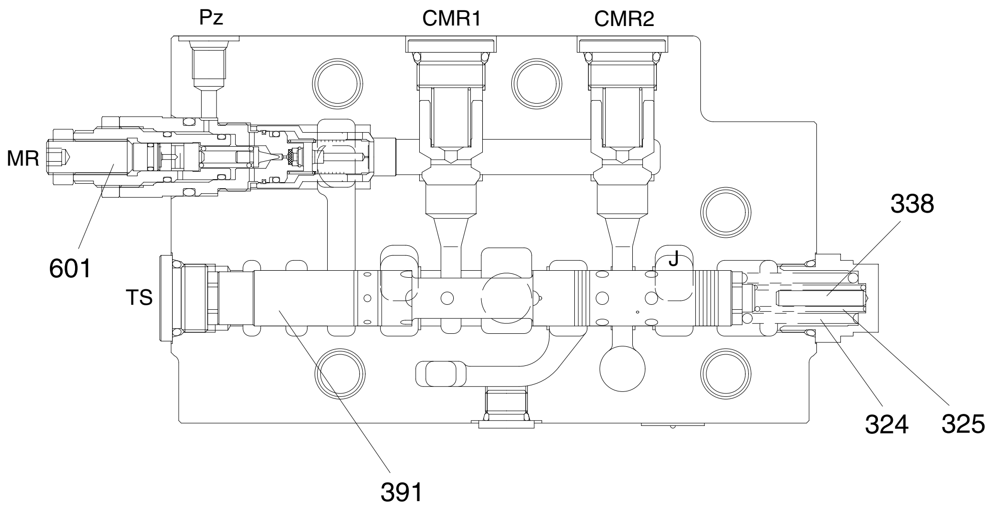
In the case of the opposite operation, the operation is similar.

4) CIRCUIT PRESSURE PROTENCTION

The control valve has two kinds of relief valve to limit the pressure in a circuit.

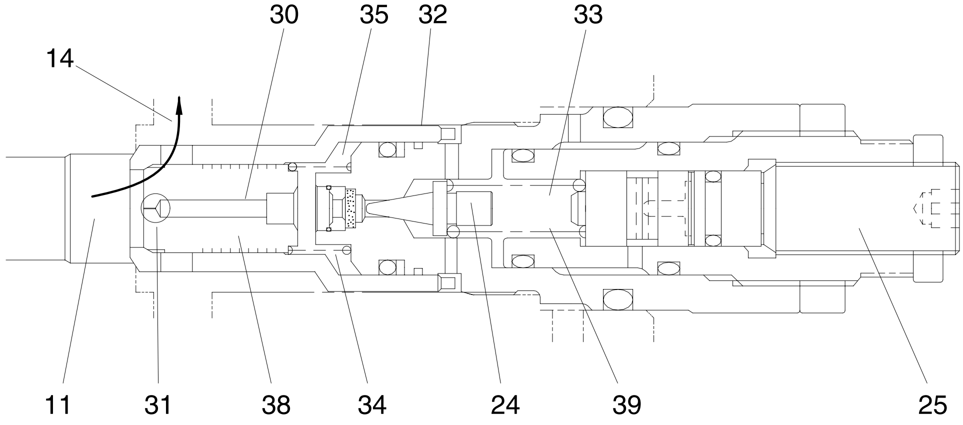
(1) Main relief valve

Limits the pressure of the main hydraulic system.



The hydraulic fluid from the pump P1 and the pump P2 enters the control valve through ports P1 and P2, respectively. From here the flow is directed to the main relief valve(601) through the check valve CMR1 or CMR2(511) and path(11). The pressure in path(11) is limited by the main relief valve(601) to its set pressure.

· **Main relief operation while working**

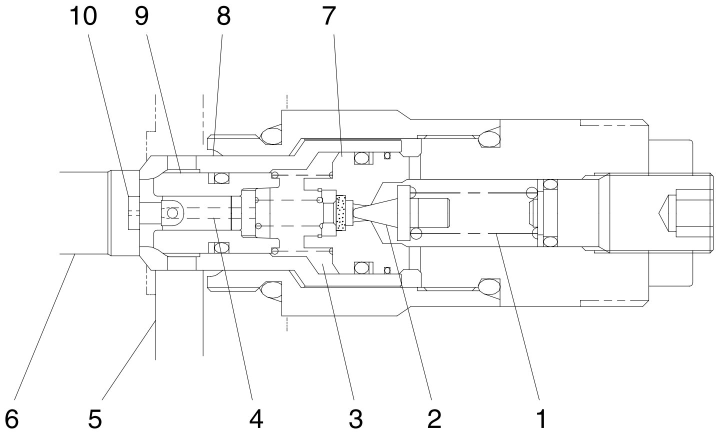


29072MC44

While the pressure in path(11) is lower than the set pressure of main relief valve(601), the poppet (24) is seated and the hydraulic fluid in path(11) can not escape to the return(14). When the pressure in path(11) approaches the pressure setting, poppet(24) opens against the spring(39). As the flow in chamber(33) escapes into the return(14) through path(32), its pressure decreases. At the same time, hydraulic fluid in path(11) flows into path(30) with a pressure drop across orifice(31). Then pressure in spring chamber(35) becomes lower because it bleeds off through path(30). The pressure from path(11) pushes the plunger(38) in the left direction against the spring(34). Then plunger(38) opens and hydraulic fluid in path(11) escapes into the return(14) and maintains the pressure setting. The pressure setting is adjusted with adjustment screw(25).

(2) Port relief valve

Limits the service pressure in a cylinder circuit.



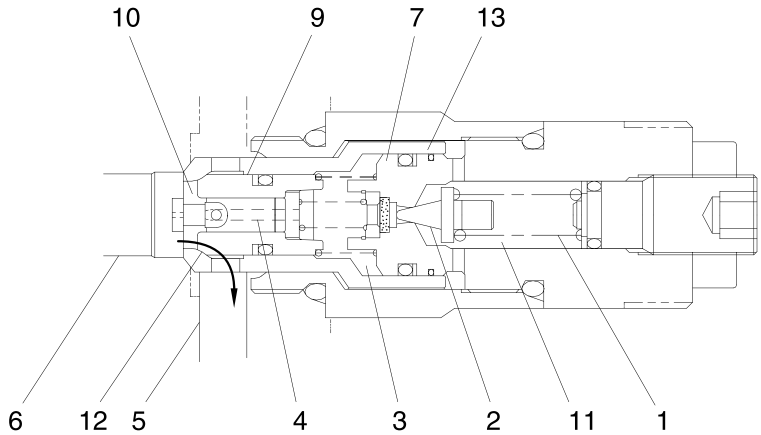
29072MC45

Port relief valves and make up valves are fitted between the cylinders of the working devices(Boom, arm, bucket) and their spools. In the case of an external force acting on the cylinder rod with its spool in neutral, the pressure in the cylinder could become excessive. The port relief valve(602) restricts this pressure to the set pressure of the valve.

Port relief valve(602) have also the additional function of a make up valve. It is possible, under the influence of an external force acting on a cylinder that a condition can occur where insufficient flow is available to match cylinder velocity. If this occurs then a vacuum and thereby cavitation could exist. To eliminate such an occurrence, a make up valve operates to break this vacuum by supplying the return flow into the cylinder.

The hydraulic fluid between the cylinder and its spool flows into the path(6) to pressurize the port relief valve(602). The hydraulic fluid in the path(6) flows into the spring chamber(3) through the path(4) in the piston(10). If the pressure is lower than the pressure setting, the poppet(2) is shut off because the force of the spring(1) overcomes the pressure. So the path(6) and the spring chamber(3) have the same pressure. Because the spring chamber(3) side pressured area of the seat(8) and the plunger(9) is larger than that of the path(6) side, seat(8) and the plunger(9) are pushed in the right direction to be seated securely and then the hydraulic fluid in the path(6) doesn't escape into the return path(5).

① Port relief function

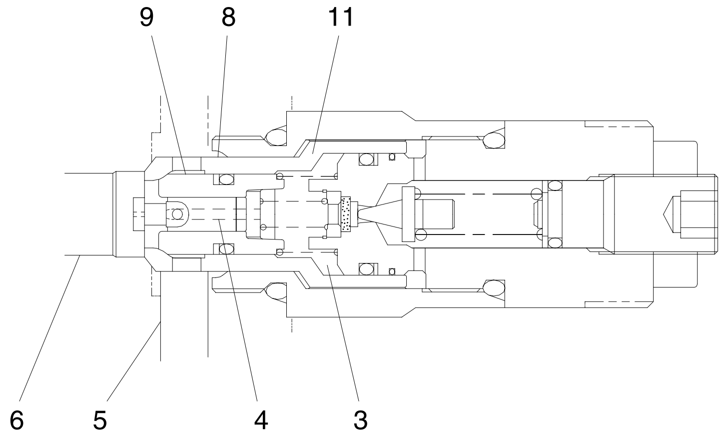


29072MC46

When the pressure in the path(6) is pressurized to the pressure setting, the poppet(2) is pushed open against the spring(1). The hydraulic fluid in the chamber(11) flows into the return path(5) through the path(13) with reducing its pressure. The piston(10) is shifted in the left direction by the pressure in the path(6) and stops on the end of the plug(7).

The hydraulic fluid in the path(6) flows into the chamber(11) through the path(4) in the piston(10) and the spring chamber(3). Because the differential pressure occurs between the pass(6) and the pass(4) by the orifice between the outernal diameter of the end of the piston(10) and the internal diameter of the plunger(9), the pressure in the spring chamber(3) becomes low and therefore the plunger(9) is pushed in the left direction with the path(12) opened so that the hydraulic fluid in the path(6) flows into the return path(5).

② Make up function

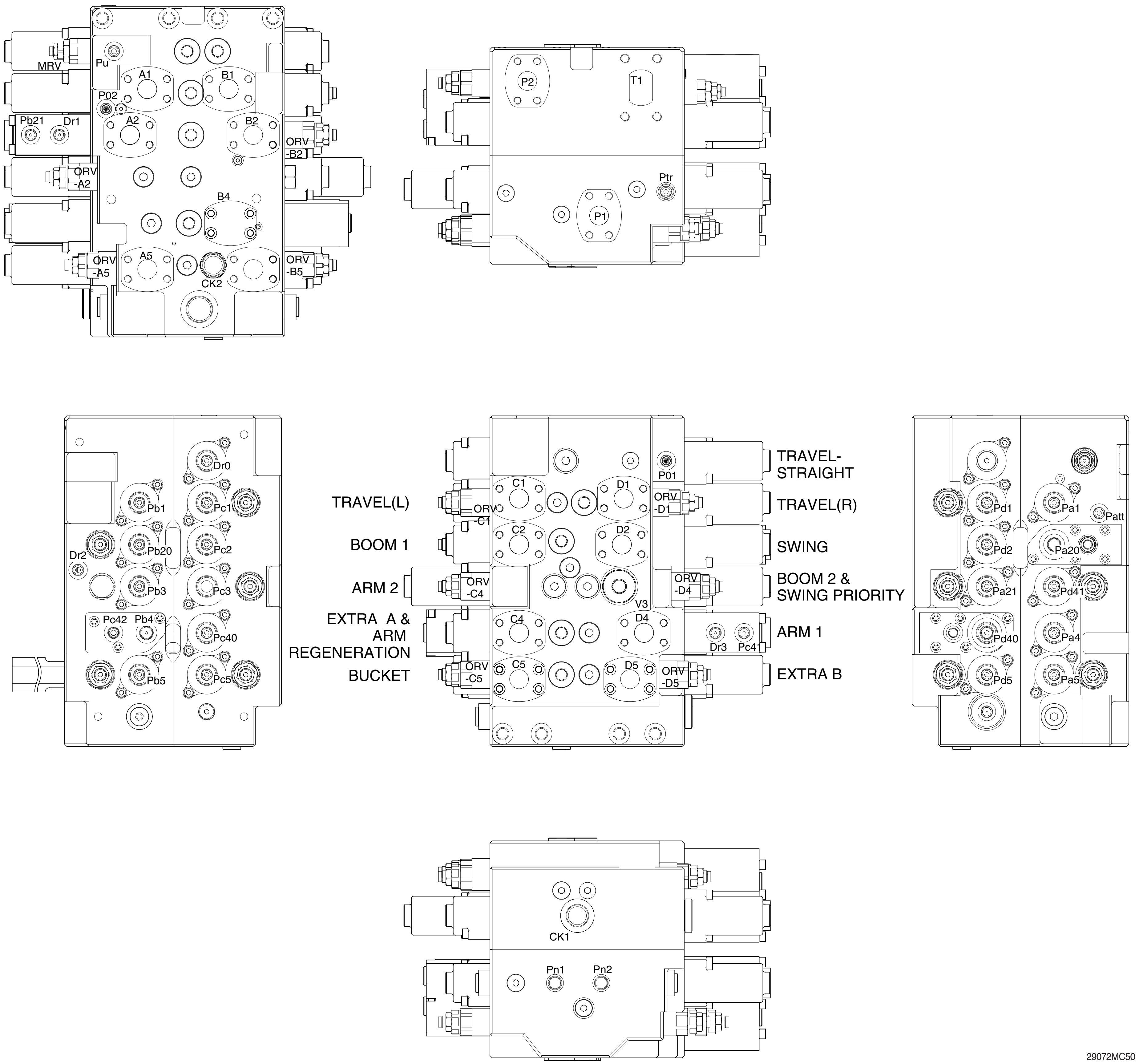


29072MC47

Following this then the case of a port relief valve operating as a make up valve is now explained. In the case that the hydraulic fluid in the cylinder rod(Head) side escapes from the port relief valve (602), then hydraulic fluid needs to be supplied because vacuum occurs in the head(Rod) side. When cacuum occurs in the side of the path(6), it also occurs in the spring chamber(3) through the path(4). The pressure in the side of the return path(5) acts on the seat(8). The seat(8) is shifted in the left direction by the return pressure because the spring chamber(3) sides of the seat(8) and the plunger(9) are under a vacuum. The hydraulic fluid in the return path(5) flows into the path(6) so as to break the vacuum in the path(6) side.

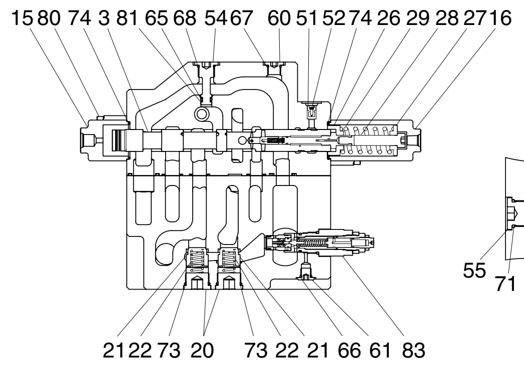
GROUP 2 MAIN CONTROL VALVE(#0120 and up)

1. STRUCTURE

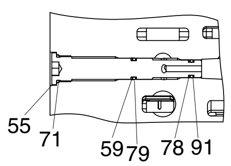


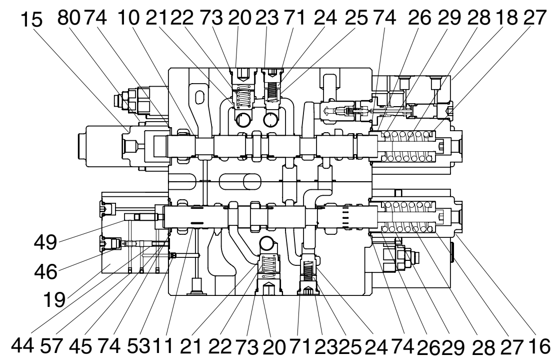
29072MC50

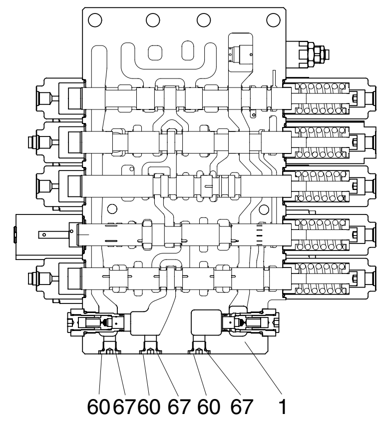
Mark	Port name	Port size	Tightening torque
Rs	Make up for swing motor	G1	20~25kgf · m (145~180lbf · ft)
Patt	Auto idle-attachment	G1/4	3.5~3.9kgf · m (25.3~28.2lbf · ft)
Pb21	Lock valve pilot port(Boom)		
Pcb	Bucket in confluence port		
Pd40	Arm out pilot port		
Pd41	Arm out confluence pilot port		
Po1	Pilot pressure		
Po2	Pilot pressure		
Ptr	Auto idle-travel		
Dr1	Drain port		
Dr2	Drain port		
Dr3	Drain port		
Ck1	Bucket confluence	G3/4	17~19kgf · m (123~137.4lbf · ft)
Ck2	Bucket confluence		
Pa1	Travel pilot port-LH(FW)	G3/8	7~8kgf · m (50.6~57.8lbf · ft)
Pb1	Travel pilot port-LH(BW)		
Pc1	Travel pilot port-RH(BW)		
Pd1	Travel pilot port-RH(FW)		
Pa20	Boom up pilot port		
Pa21	Boom up confluence pilot port		
Pb20	Boom down pilot port		
Pc2	Swing pilot port(LH)		
Pd2	Swing pilot port(RH)		
Pb3	Arm in confluence pilot port		
Pc3	Swing priority pilot port		
Pa4	Option A pilot port(Breaker)		
Pb4	Arm in regeneration cut port		
Pc40	Arm in pilot port		
Pc41	Lock valve pilot port(Arm)		
Pc42	Arm in regen-cut signal selector port		
Pa5	Bucket in pilot port		
Pb5	Bucket out pilot port		
Pc5	Option B pilot port		
Pd5	Option B pilot port		
Po	Pilot pressure port		
Pu	Main relief pressure up port		
Dr0	Drain port		
Pn1	Negative control signal port(P1 port side)		
Pn2	Negative control signal port(P2 port side)		
A1	Travel motor port-LH(FW)	SAE 5000, 1	7.5~9.2kgf · m (54.2~66.5lbf · ft)
B1	Travel motor port-LH(BW)		
C1	Travel motor port-RH(BW)		
D1	Travel motor port-RH(FW)		
A2	Boom up port		
B2	Boom down port		
C2	Swing motor port(LH)		
D2	Swing motor port(RH)		
B4	Option A port(Breaker)		
C4	Arm in port		
D4	Arm out port		
A5	Bucket in port		
B5	Bucket out port		
C5	Option B port		
D5	Option B port		
P1	Pump port(P1 side)		
P2	Pump port(P2 side)		
T1	Return port	SAE 3000, 2 (M12)	6.4~8.6kgf · m (46.2~62.2lbf · ft)



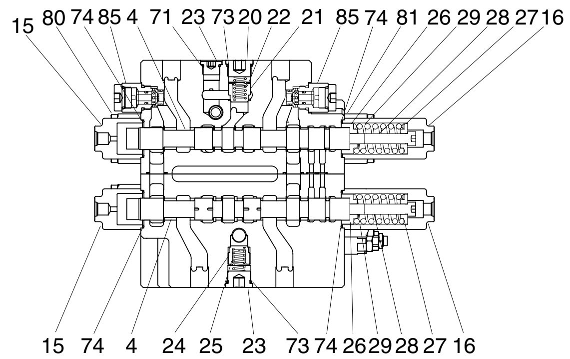
A-A (STRAIGHT-TRAVEL & SUPPLY)



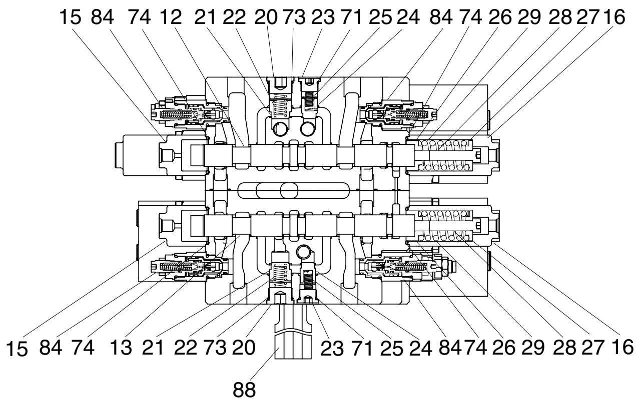




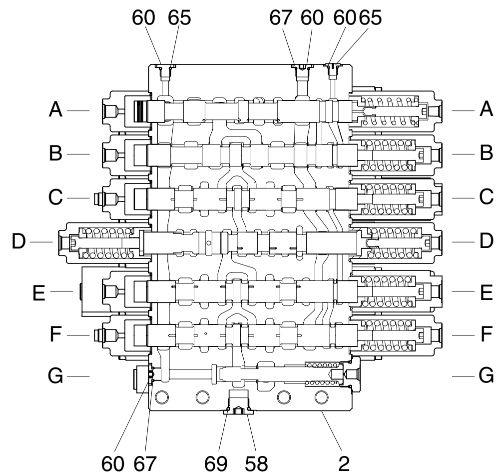
P1 BLOCK SPOOL SECTION



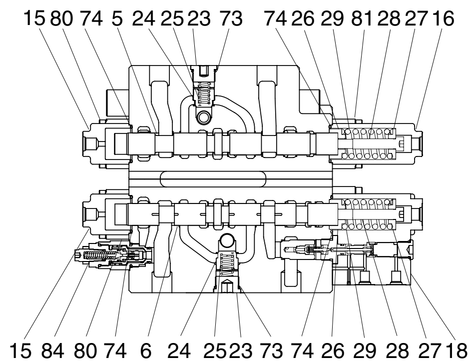
B-B (TRAVEL RIGHT& LEFT)



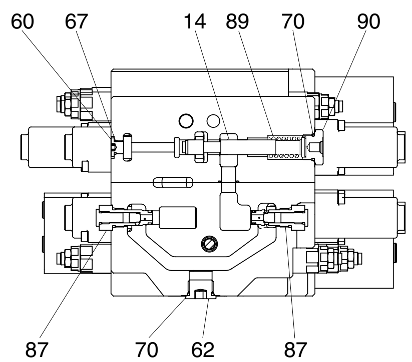
F-F (OPTION & BUCKET)



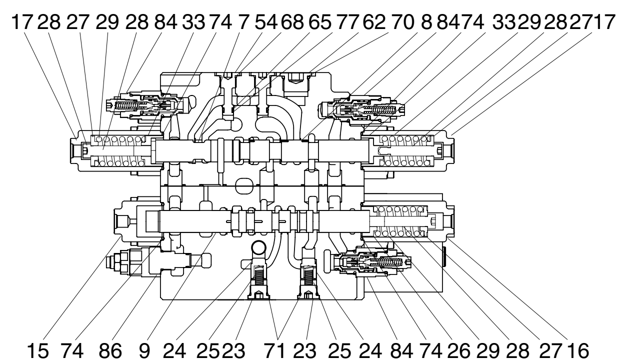
P2 BLOCK SPOOL SECTION



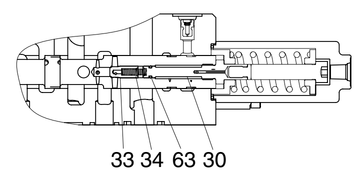
C-C (SWING & BOOM)



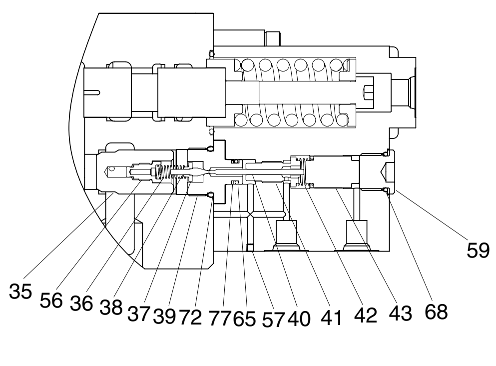
G-G (CENTER BYPASS CUT-OFF & NEGATIVE CONTROL)



D-D (SWING PRIORITY & BOO2 & ARM2)



STRAIGHT-TRAVEL SPOOL DETAIL

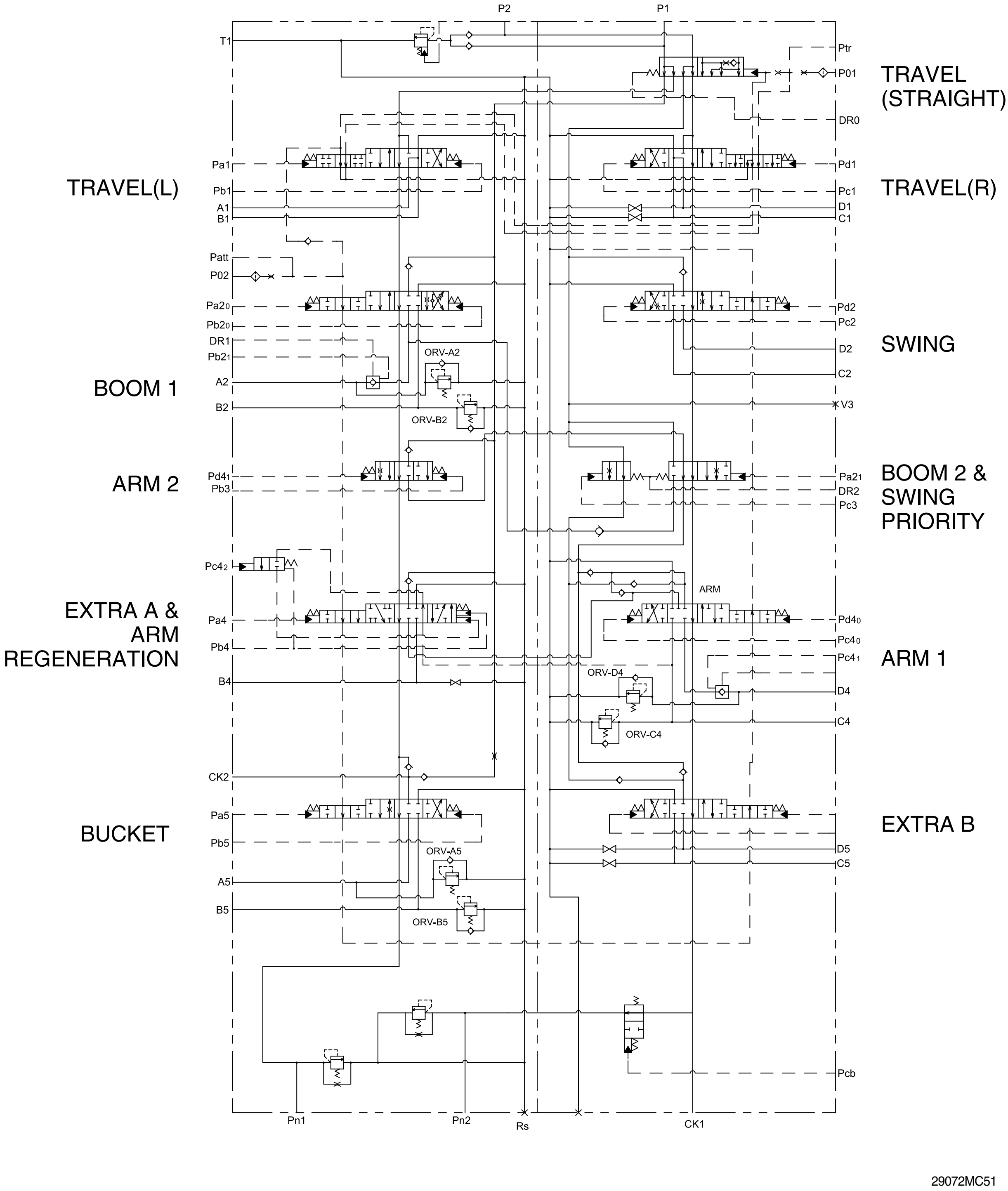


DETAIL OF LOCK VALVE (BOOM & ARM)

300072MCV02

1 Body(P1)
2 Body(P2)
3 Spool-travel straight
4 Spool-travel
5 Spool-swing
6 Spool-boom
7 Spool-swing priority
8 Spool-boom 2
9 Spool-arm 2
10 Spool-arm
11 Spool-arm regeneration
12 Spool-bucket
13 Spool-option
14 Spool-bypass cut
15 Cover-pilot A
16 Cover-pilot B1
17 Cover-pilot B2
18 Block-holding
19 Block-regeneration
20 Plug
21 Poppet 1-check valve
22 Spring-check valve
23 Plug
24 Poppet 2-check valve
25 Spring-check valve
26 Spring seat 1
27 Spring seat 2
28 Spacer bolt
29 Spring-return(L)
30 Stopper 1-TS
31 Stopper 2-priority
32 Spring seat 3
33 Poppet-check valve TS
34 Spring-check valve TS
35 Poppet-lock valve
36 Spring-lock valve pilot
37 Guide poppet
38 Poppet-pilot
39 Seat-poppet
40 Piston 1
41 Guide-piston
42 Spring 1-lock valve
43 Piston 2
44 Spool-regen selector
45 Spring-regeneration
46 Stopper-regeneration
47 Piston-cut off
48 Poppet-signal
49 Spring-signal
50 Plug
51 Orifice-signal
52 Coin type filter
53 Orifice-plug
54 Plug
55 Plug
56 Restrictor-lock valve
57 Plug
58 Plug
59 Plug
60 Plug
61 Plug
62 Plug
63 O-ring
64 O-ring
65 O-ring
66 O-ring
67 O-ring
68 O-ring
69 O-ring
70 O-ring
71 O-ring
72 O-ring
73 O-ring
74 O-ring
75 Back-up ring
76 Back-up ring
77 Back-up ring
78 Socket head bolt with washer
79 Socket head bolt with washer
80 Socket head bolt with washer
81 Main relief valve
82 Overload relief valve
83 Plug-relief valve
84 Plug-relief valve
85 Negative control valve
86 Socket head bolt with washer
87 Socket head bolt with washer
88 Nipple-check valve
89 Spring-bypass cut spool
90 Plug-bypass cut spool
91 Backup ring

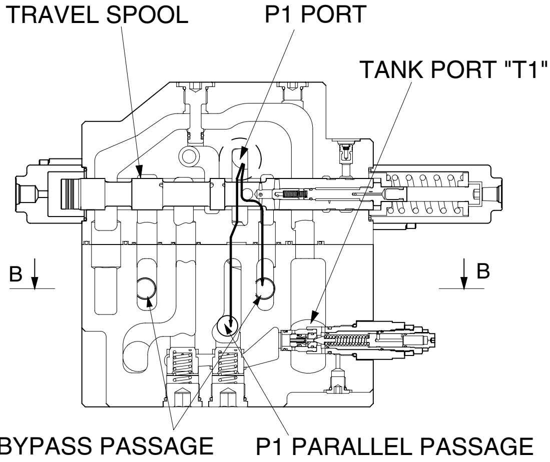
2. HYDRAULIC CIRCUIT



3. FUNCTION

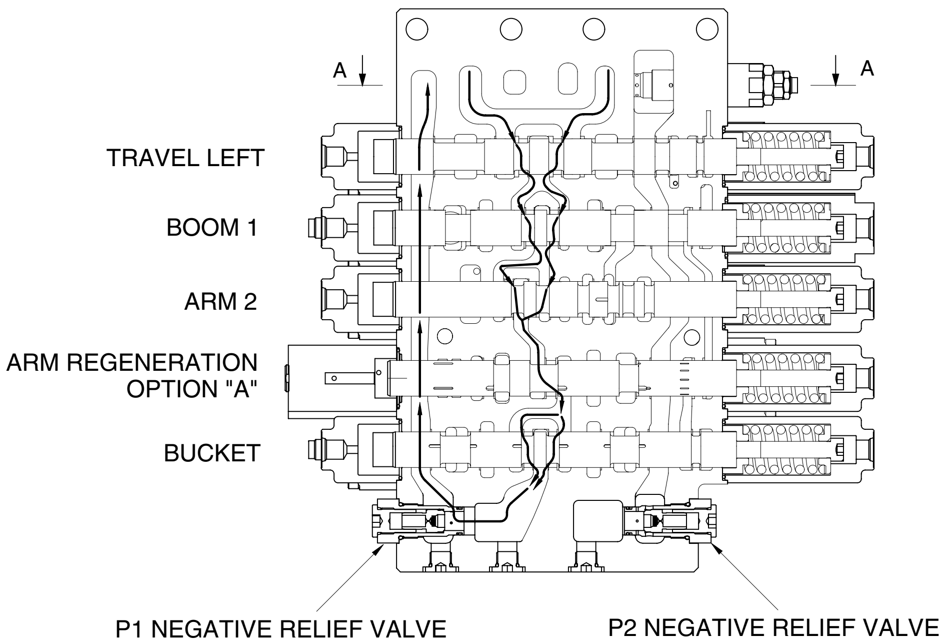
1) CONTROL IN NEUTRAL FUNCTION

(1) P1 SIDE



SECTION A-A

29072MC53



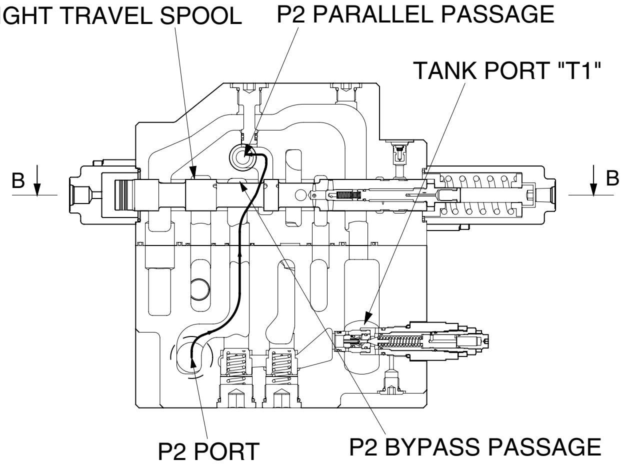
SECTION B-B

29072MC52

The hydraulic fluid from pump P1 flows into the main control valve through the inlet port "P1", pass the travel straight spool, into the P1 bypass passage and P1parallel passage.

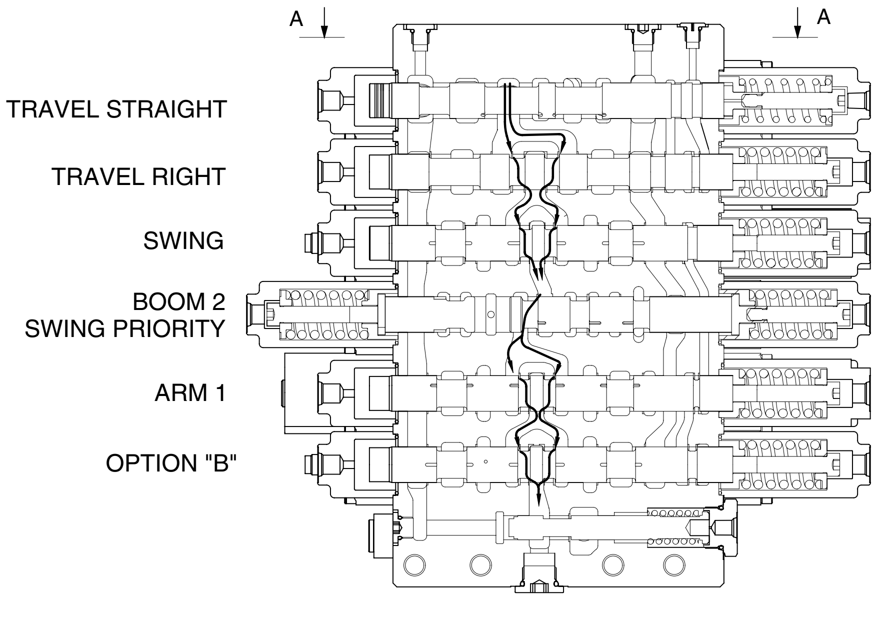
The hydraulic fluid from the pump P1 is directed to the tank through the bypass passage of spools : travel left, boom1, arm2, arm regeneration & option A and bucket, the negative relief valve, tank passage, and the tank port "T1"

(2) P2 SIDE



SECTION A-A

29072MC54



SECTION B-B

29072MC55

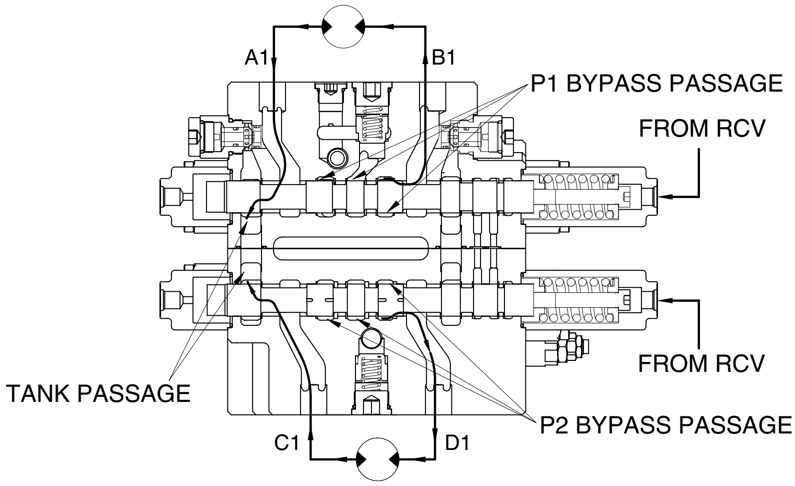
The hydraulic fluid from pump P2 flows into the main control valve through the inlet port "P2", pass the straight travel spool, into the P2 bypass passage and P2 parallel passage.

The hydraulic fluid from the pump P2 is directed to the tank through the bypass passage of spools : travel right, swing, boom2 & swing priority, arm1, option "B" and bypass passage of bucket summation, and the negative relief valve with the tank passage.

2) EACH SPOOL OPERATION

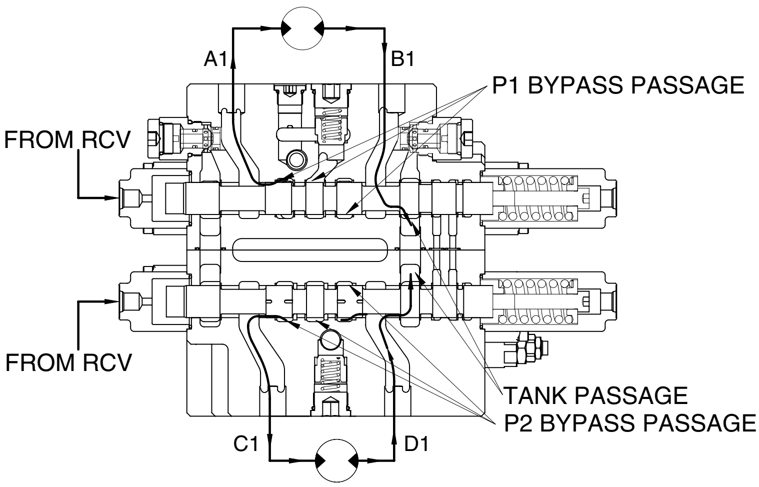
(1) TRAVEL OPERATION

① Travel forward operation



29072MC56

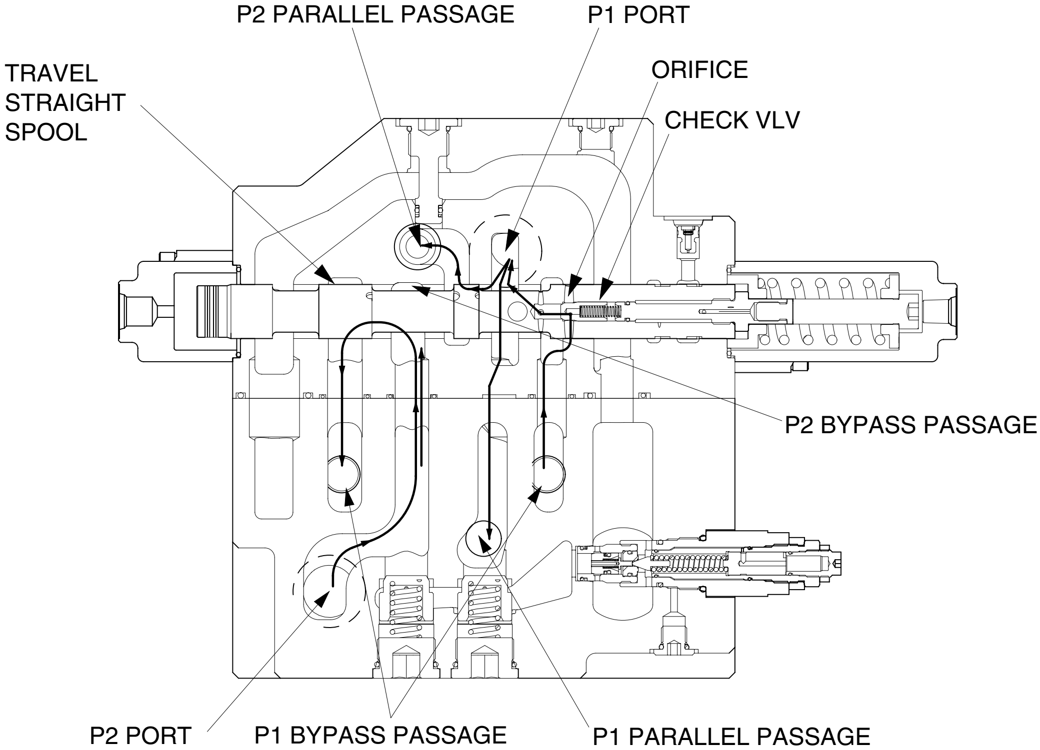
② Travel backward operation



29072MC57

During the travel operation, the hydraulic fluid of the pump P1 is supplied to the travel motor and the hydraulic fluid of the pump P2 is supplied to the other travel motor.
The pilot pressure from the pilot control valve is supplied to the spring side of pilot port (pa1, pd1).
And it shifts travel right and left spools in the left direction against springs. Hydraulic fluid from the pump P1 flow into the travel left spool through the bypass passage and hydraulic fluid from the pump P2 flow into the travel right spool through the bypass passage.
Then they are directed to the each travel motor through port A1 and D1. As a result, the travel motors turn and hydraulic fluid returns to the tank passage through the travel spools.
In case of the opposite operation, the operation is similar.

(2) TRAVEL STRAIGHT FUNCTION



29072MC58

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

① **During travel only :**

The hydraulic fluid of the pump P1 is supplied to the travel motor and the pump P2 is supplied to the other motor.

Thus, the machine keep travel straight.

② **The other actuator operation during straight travel operation :**

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

The hydraulic fluid from pump P1 is supplied actuator through P1 and P2 parallel pass and travel motors through orifice at side of straight travel spool.

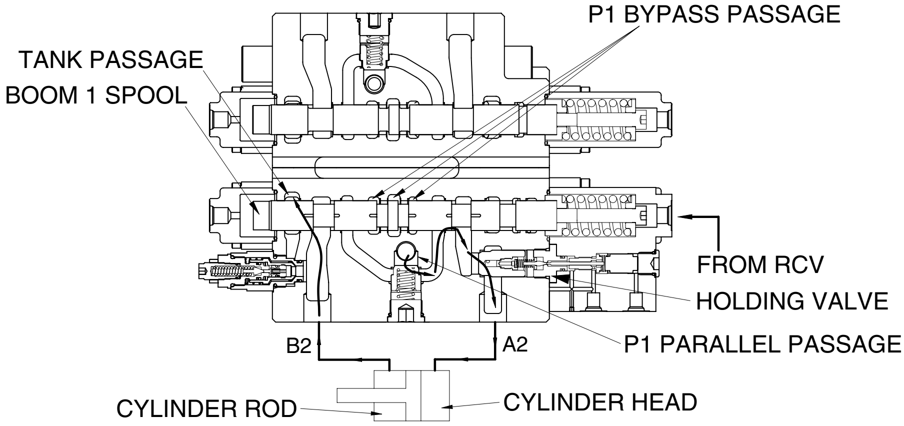
The hydraulic oil fluid from pump P2 is supplied to travel motors(left/right).

Therefore, the other actuator operation with straight travel operation, hydraulic oil fluid from pump P1 is mainly supplied to actuator, and the hydraulic oil fluid form pump P2 is mainly supplied to travel motors(left/right).

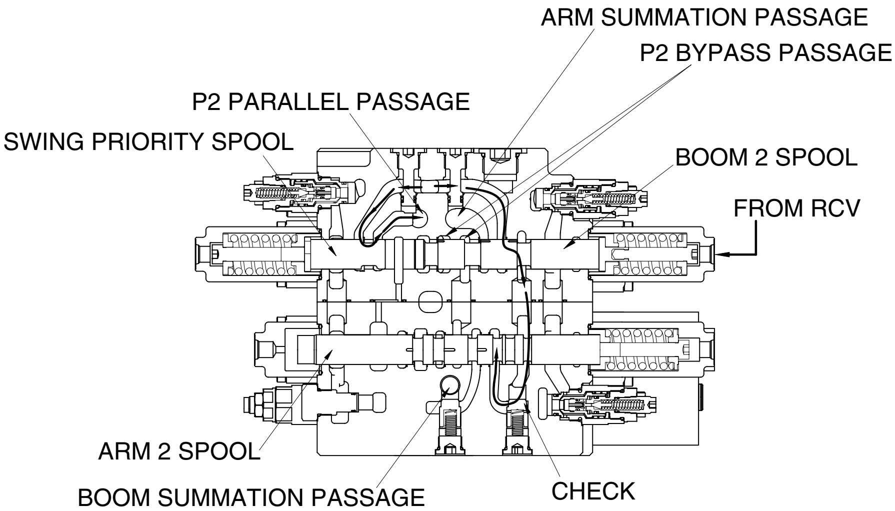
Then the machine keeps straight travel.

(3) BOOM OPERATION

① Boom up operation



29072MC59



29072MC60

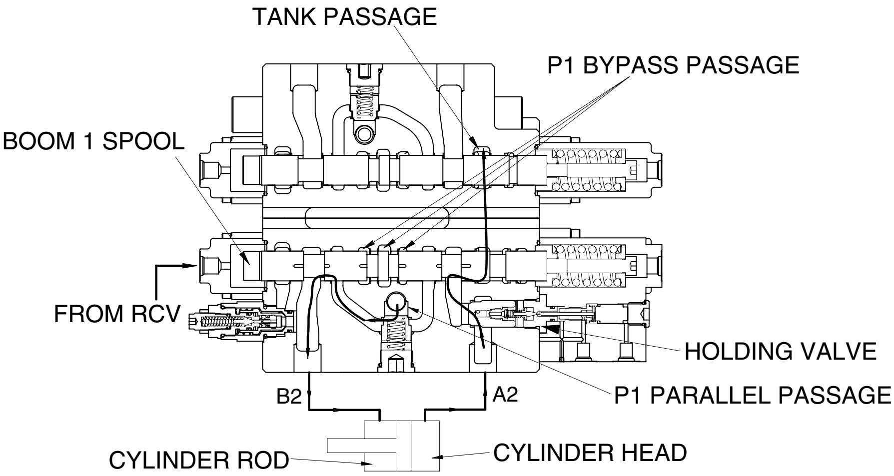
During boom up operation, the pilot pressure from RCV is supplied into the port Pa20 and shift the boom1 spool in the left direction. The hydraulic oil fluid from pump P1 is entered P1 parallel passage and then passes through the load check valve and boom holding valve then flows into the port A2. Following this it flows into the head side of the boom cylinder.

(In this case, the boom holding valve is free flow condition)

At the same time the pilot pressure through the port Pa21 shifts the boom2 spool. The hydraulic oil fluid from pump P2 entered boom summation passage via the P2 parallel passage, the swing priority spool, the boom2 spool, arm1 spool and the check. The flows combine in passage and are directed to port A2 and head side of boom cylinder.

The flow from rod side of the boom cylinder return to the boom1 spool through the port B2. There after it is directed to the hydraulic oil tank through the tank passage.

② Boom down operation

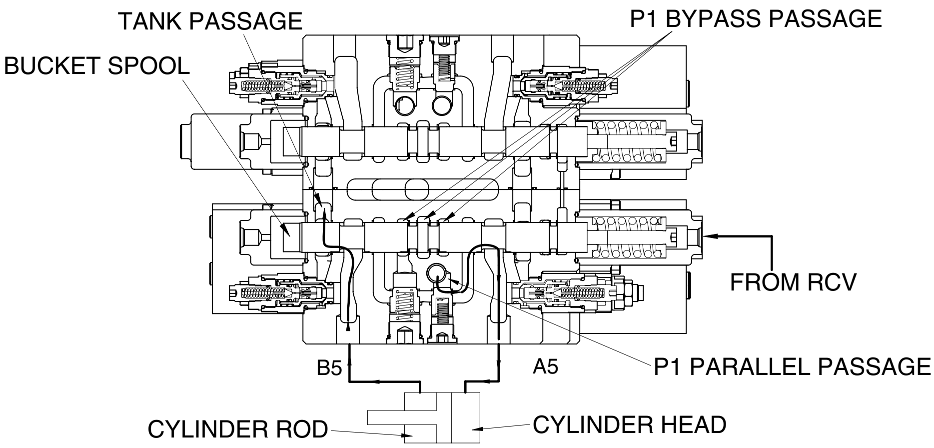


29072MC61

During the boom lowing operation, the pilot pressure from RCV is supplied to the port Pb20 and shift the boom1 spool in the right direction.
The hydraulic fluid from the pump P1 enters the parallel passage and is directed to the port B2 through the load check valve. Following this, it flows into the rod side of the boom cylinder.
The return flow from the head side of the boom cylinder returns to the boom1 spool through the port A2 and boom holding valve. Thereafter it is directed to the hydraulic oil tank through tank passage.
For details of the boom holding valve, see page 2-46-17.

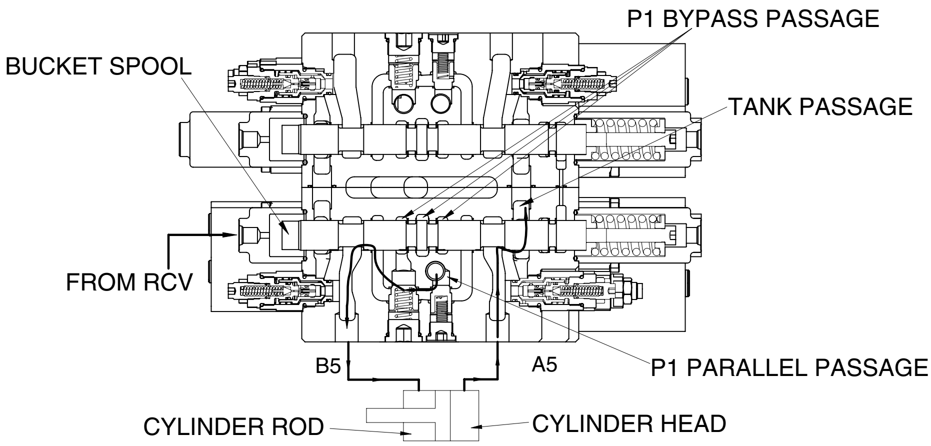
(4) BUCKET OPERATION

① Bucket roll in operation



29072MC62

② Bucket roll out operation



29072MC63

① **Bucket roll in operation**

During the bucket roll in operation, the pilot pressure from RCV is supplied to port Pa5 and shift the bucket spool in the left direction.

The hydraulic fluid from pump P1 entered P1 parallel passage and is directed to the port A5 through the check1.

At the same time, the hydraulic fluid from P1 bypass passage is directed to the port A5 through the check2.

Following this it flows into the head side of the bucket cylinder.

The return flow from the rod side of the bucket cylinder returns to the bucket spool through the port B5. Thereafter it is directed to the hydraulic oil tank through the tank passage.

② **Bucket roll out operation**

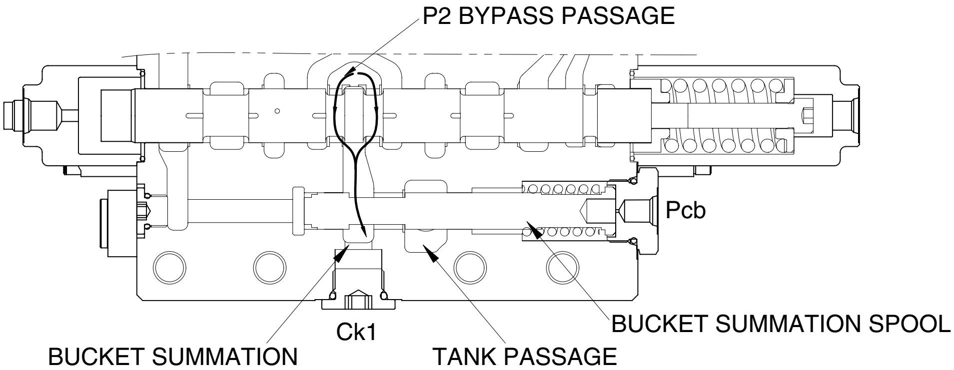
In case of the bucket roll out operation, the operation is similar

③ **Bucket operation with arm or boom operation**

When combined operation, mostly same as above but the fluid from bypass passage is empty.

So only the fluid from parallel passage is supplied to the bucket cylinder. Also, parallel passage is installed the orifice for supplying the fluid from pump to the boom or the arm operation prior to the bucket operation.

④ **Bucket summation**



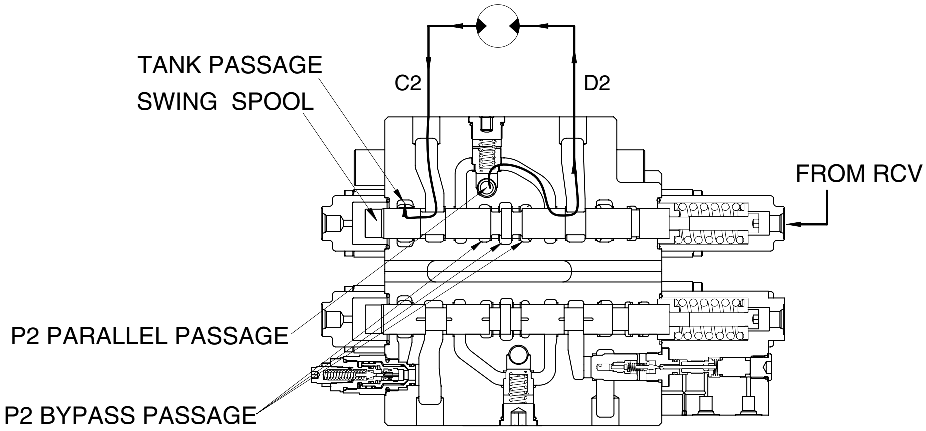
29072MC64

When bucket single operation, the pilot pressure from RCV is supplied to spring side port(pcb) of bucket summation spool and then bucket summation spool shift left direction. So the tank passage is blocked, and the hydraulic fluid from P2 by pass passage is joined with the hydraulic fluid of P1 via the check CK1 and external piping.

(Refer to hydraulic circuit page 3-1)

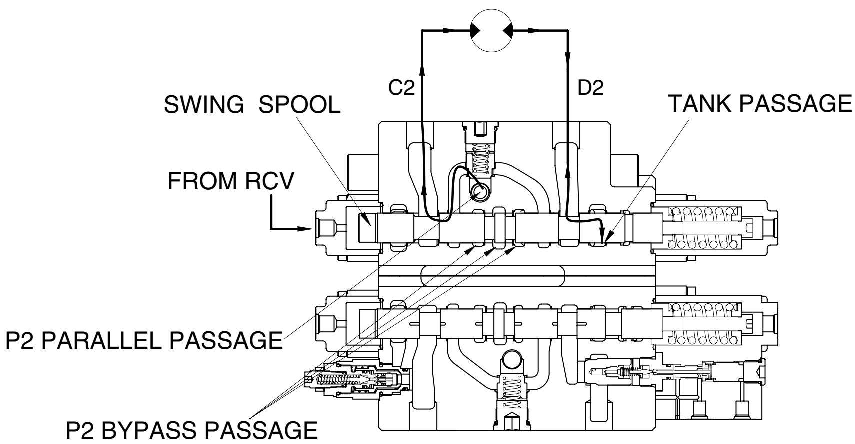
(5) SWING OPERATION

① Swing left operation



29072MC65

② Swing right operation

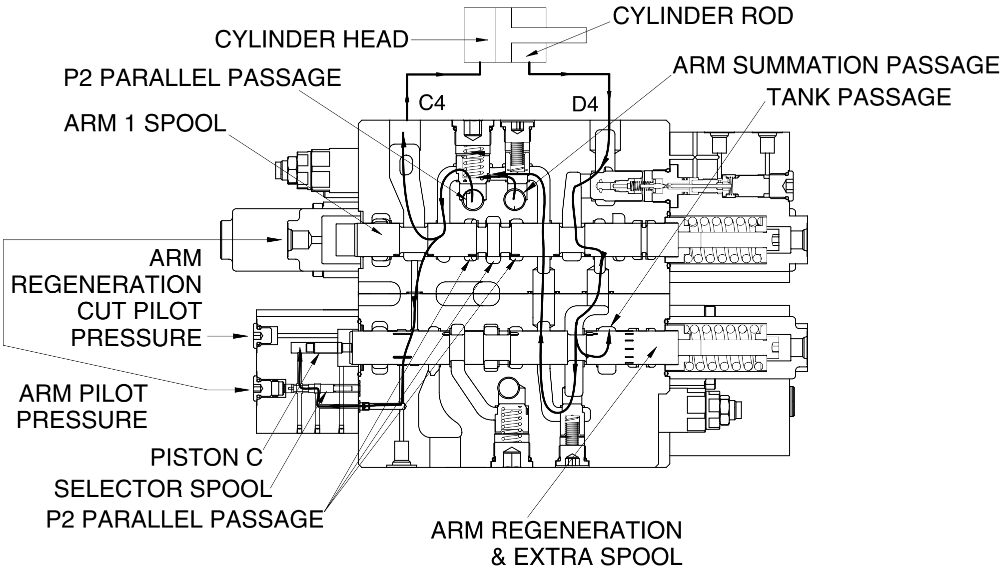


29072MC66

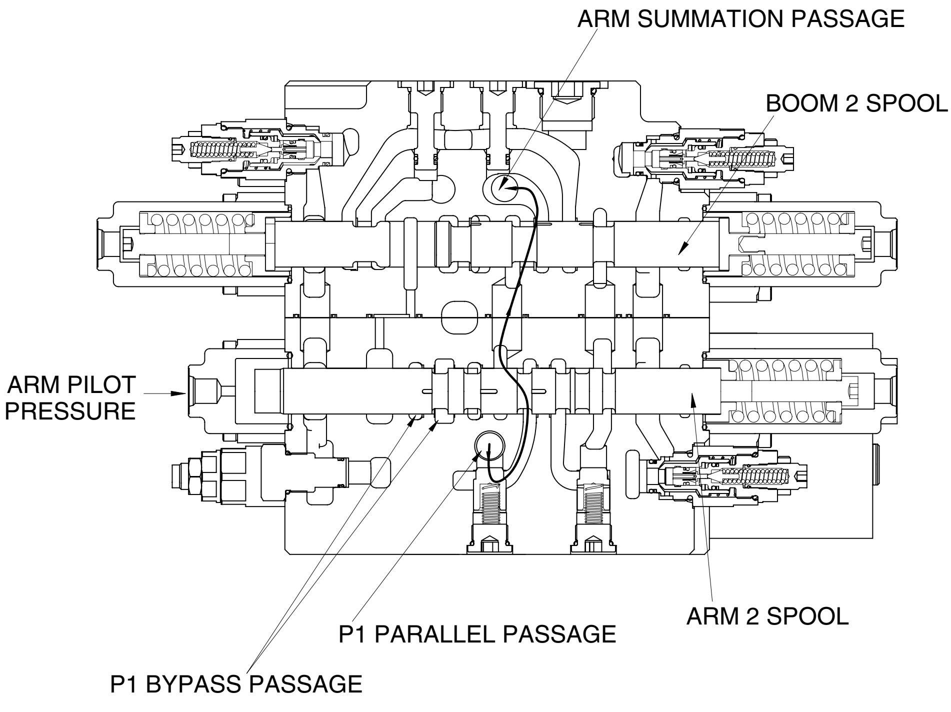
The pilot pressure from the RCV is supplied to the Pd2 and shift the swing spool in left direction. The hydraulic fluid from pump P2 flows into swing spool through the parallel passage. Then it is directed to swing motor through the port D2. As the result, swing motor turns and flow from the swing motor returns to the hydraulic oil tank through the port C2, swing spool and the tank passage .
In case of swing right operation, the operation is similar.

(6) ARM OPERATION

① Arm roll in operation



29072MC67



29072MC68

· **Arm roll in operation :**

During arm roll in operation the pilot pressure from the RCV is supplied to the port Pc40 and Pb3 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic oil from the pump P2 flows into the arm cylinder head side through P2 parallel passage, the load check valve and the port C4.

At same time, the hydraulic fluid from the pump P1 flows into the arm summation passage through parallel passage, the check valve, the arm2 spool and the boom2 spool. Then it entered the arm cylinder head side with hydraulic fluid from arm1 spool.

· **Arm regeneration :**

The return flow from the arm cylinder rod side is pressurized by self weight of arm and so, returns to port D4. The pressurized oil returning to port D4 enters the arm regeneration & breaker spool through the arm holding valve and the arm1 spool. It is suppled the arm cylinder head through internal passage. This is called the arm regeneration function.

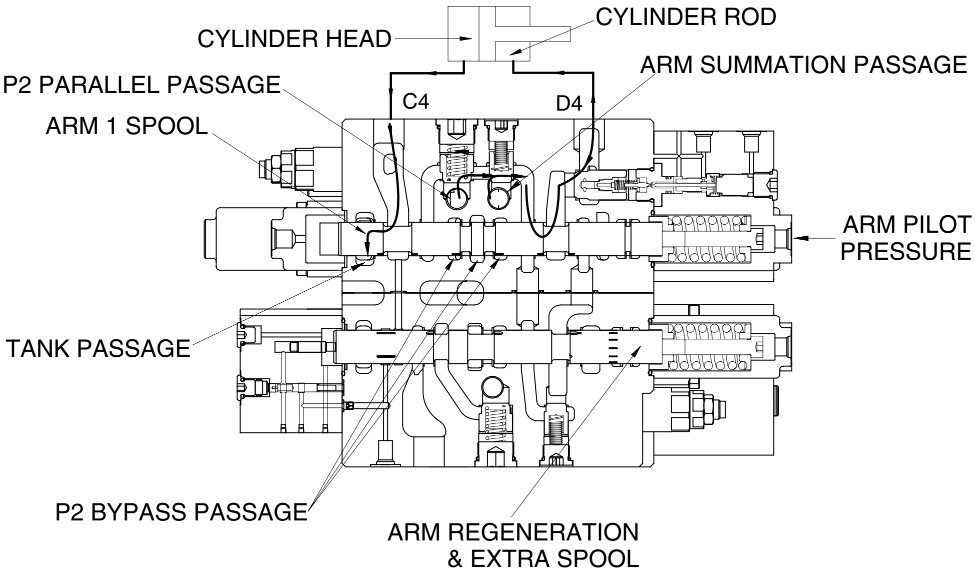
The amount of regeneration fluid are changed by movement of the arm regeneration & breaker spool.

A few fluid after P2 parallel passage is push piston "C" through the notch of arm regeneration spool and selector spool. At this time, the selector spool is opened by pilot pressure from RCV.

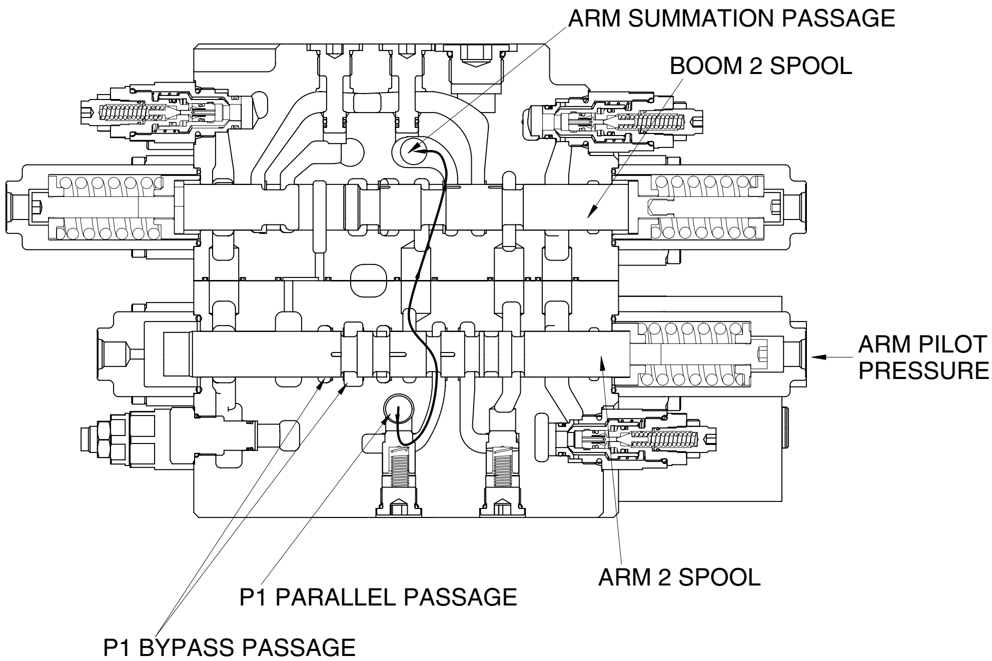
Then, the arm regeneration spool shift to right side and flow to tank pass increases and regeneration flow decreases. Therefore, pressure of arm cylinder head increases, then, arm regeneration flow decreases.

Furthermore, the arm regeneration cut pressure is supplied to port and arm regeneration spool is move into the right direction fully. The flow from the arm cylinder rod is returned to the hydraulic oil tank and regeneration function is not activated.

② **Arm roll out operation**



29072MC69



29072MC70

During arm roll out operation the pilot pressure from RCV is supplied to the port Pd40 and the Pd41 and shifts arm1 spool and arm2 spool in the right direction.

The hydraulic fluid from pump P2 flows into arm1 spool through the parallel passage. Then it enters into the arm cylinder rod side through the load check valve, bridge passage, arm holding valve and the port D4.

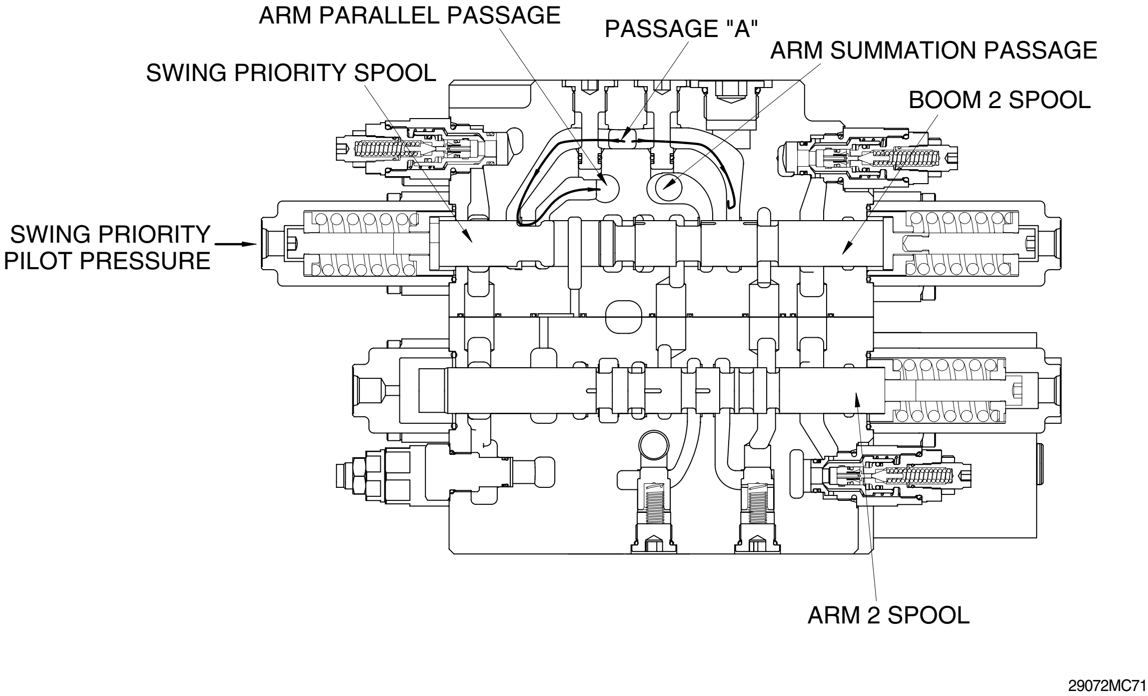
Some of the hydraulic fluid from pump P2 bypassed through bypass notch.

The rest of hydraulic fluid from pump P2 flows into the arm summation passage through P1 parallel passage the check valve arm2 spool and boom2 spool.

Then it enters into the arm cylinder rod side with the fluid from the arm1 spool.

The return flow from the arm cylinder head side returns to the hydraulic tank through the port C4 the arm1 spool and tank passage.

(7) SWING PRIORITY FUNCTION



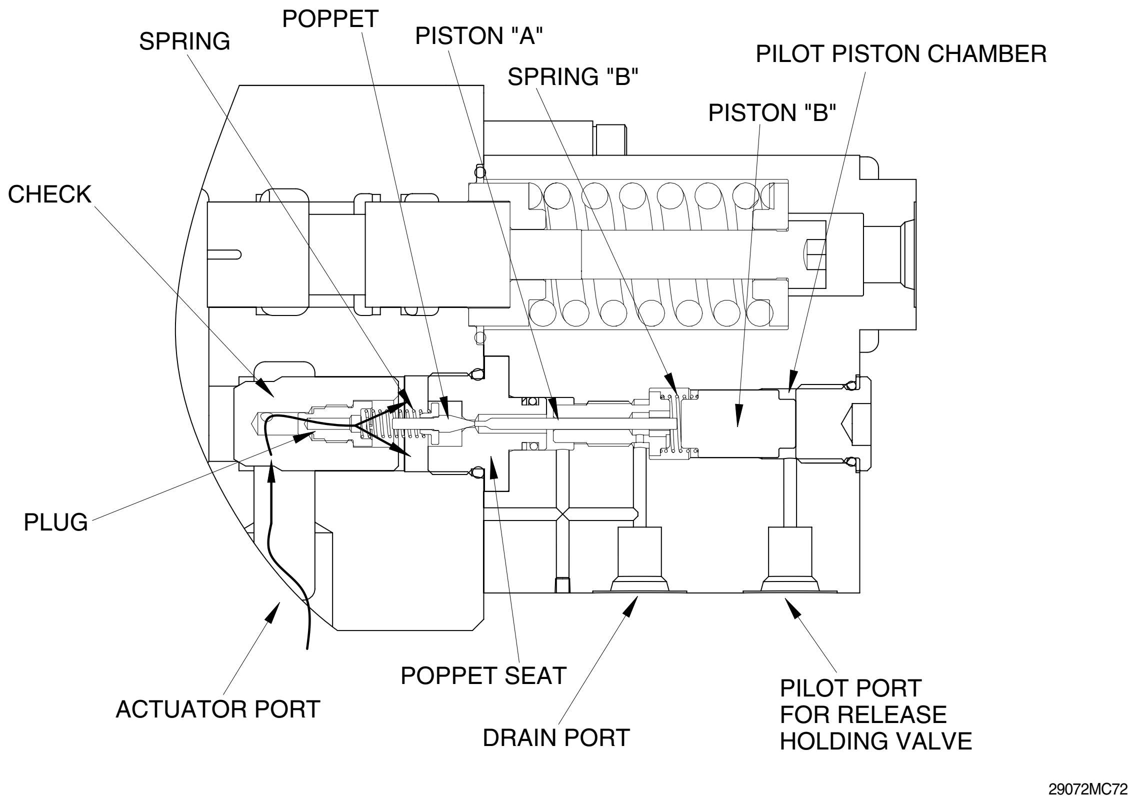
During swing priority operation, the pilot pressure is supplied to the port Pc3 and shift swing priority spool in the right direction.

The hydraulic fluid from P2 parallel passage flows into the parallel passage of arm1 side through swing priority spool and the passage "A" and also flows into the boom2 spool.

Due to shifting of the swing priority spool, the fluid from pump P2 flows to swing side more then next spools to make the swing operation most preferential.

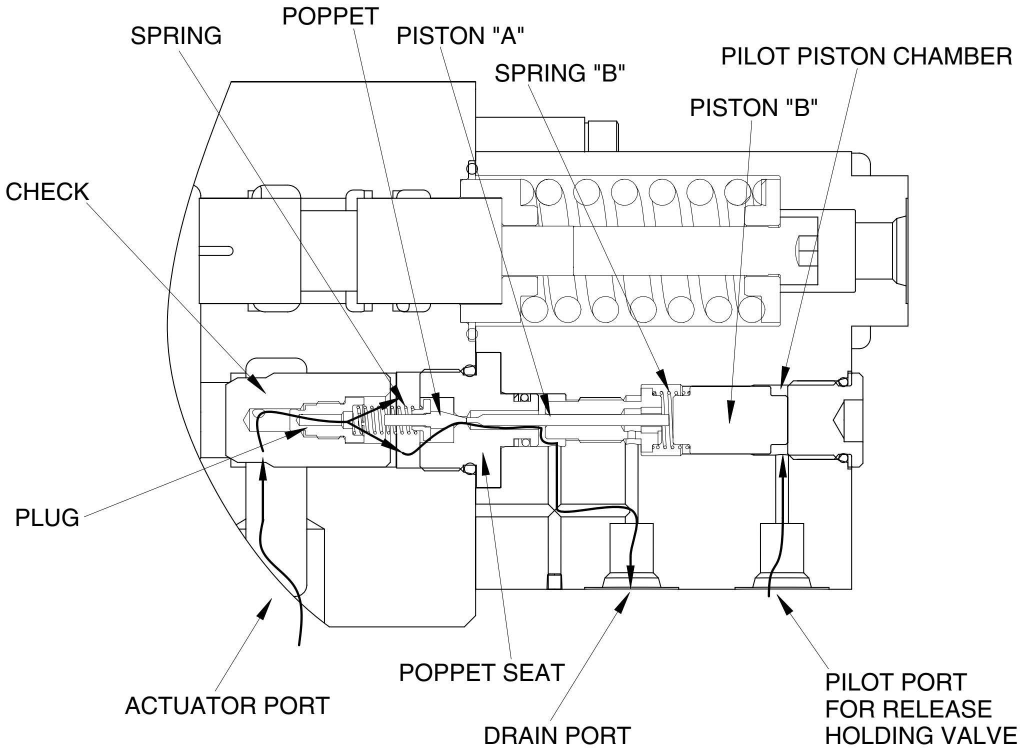
(8) HOLDING VALVE OPERATION

① Holding operation



At neutral condition, the pilot piston chamber is connected to drain port through the pilot port.
And the piston "B" is supported with spring "B" and the pressured fluid from actuator entered to inside of the holding valve through the periphery hole of check, crevice of the check and the plug and the periphery hole of plug.
Then, this pressured oil pushed the poppet to the poppet seat and the check to the seat of body.
So the hydraulic fluid from actuator is not escaped and the actuator is not moved.

② Release holding operation

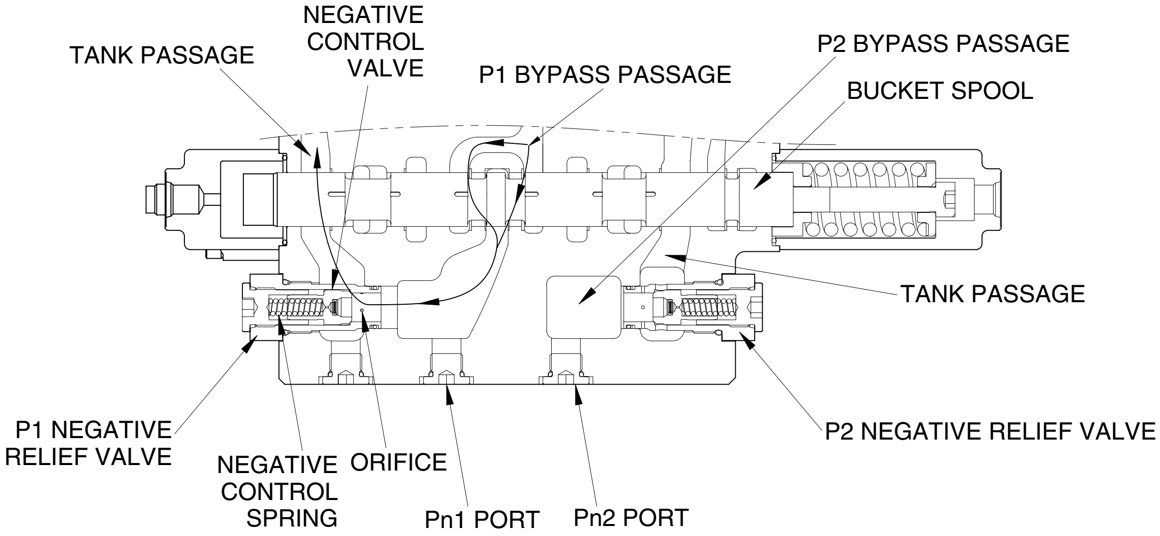


The pilot pressure is supplied to the pilot port for release holding valve and shifts the piston "B" in the left direction against the spring "B", and shifts the poppet in the left direction through piston "B" and piston "A" against spring "B" and shifts the spool in the left side.

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

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

(9) NEGATIVE CONTROL



29072MC74

When no function is being actuated on P1 side, the hydraulic fluid from the pump P1, flows into the tank passage through the bypass passage and orifice. The restriction caused by this orifice thereby pressurizes. This pressure is transferred as the negative control signal pressure Pn1 to the pump P1 regulator.

It controls the pump regulator so as to minimize the discharge of the pump P1.

The bypass passage is shut off when the shifting of one or more spools and the flow through bypass passage became zero. The pressure of negative control signal become zero and the discharge of the pump P1 become maximum.

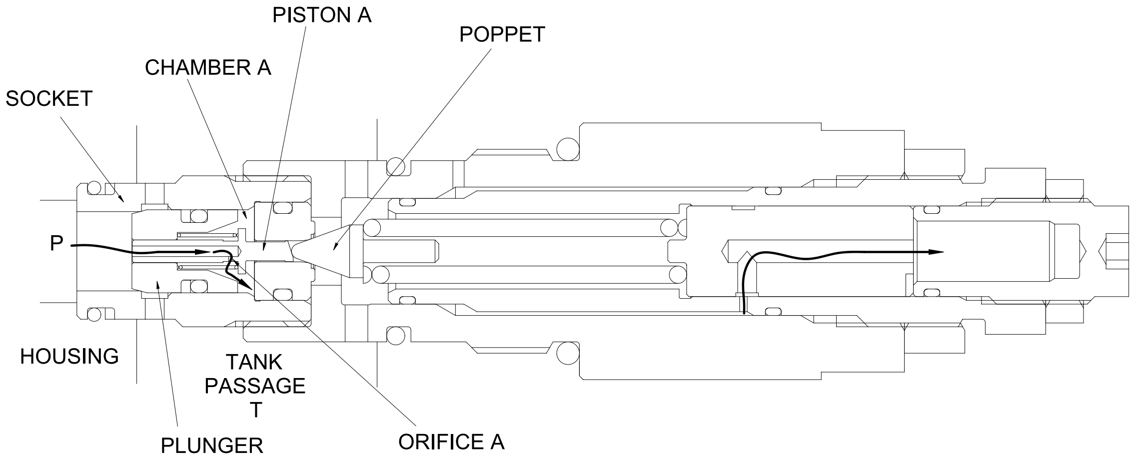
The negative control pressure reaches to the set level, the hydraulic fluid in the passage pushes open negative control valve and escapes into the return passage.

For the pump P2 the same negative control principle.

(10) OPERATION OF MAIN RELIEF VALVE

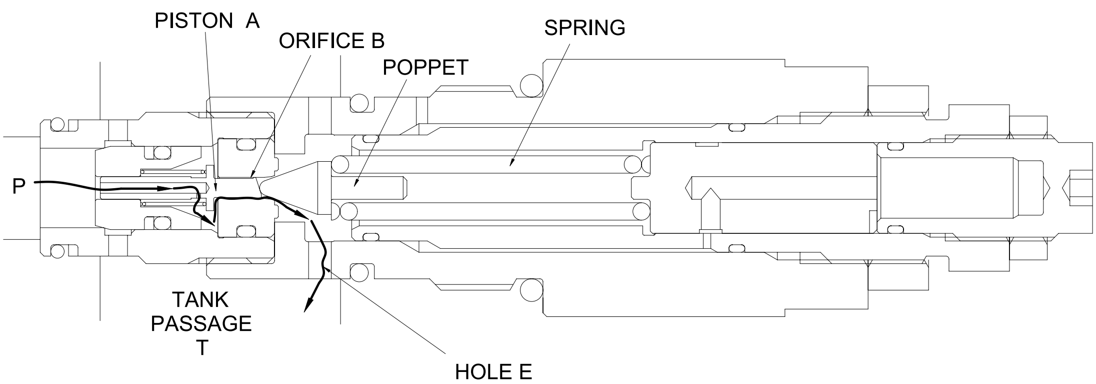
The main relief valve is fitted to the straight travel valve block and functions as follows :

① The pressurized oil passes through the orifice (A) of the plunger is filled up in chamber A of the inside space, and seats the plunger against the housing securely.



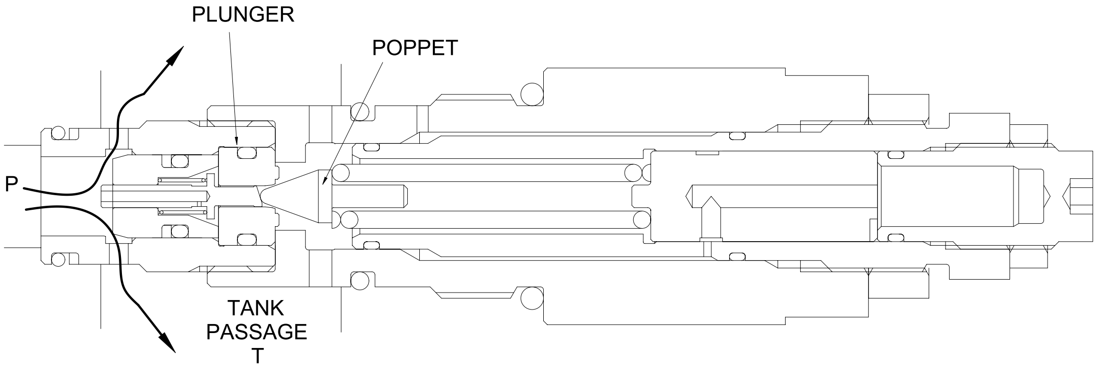
14072SF36

② When the pressure at (P) becomes equal to the set pressure of the spring the hydraulic oil passes through the piston (A) pushes open the poppet and flows to tank passage (T) through the hole (E).



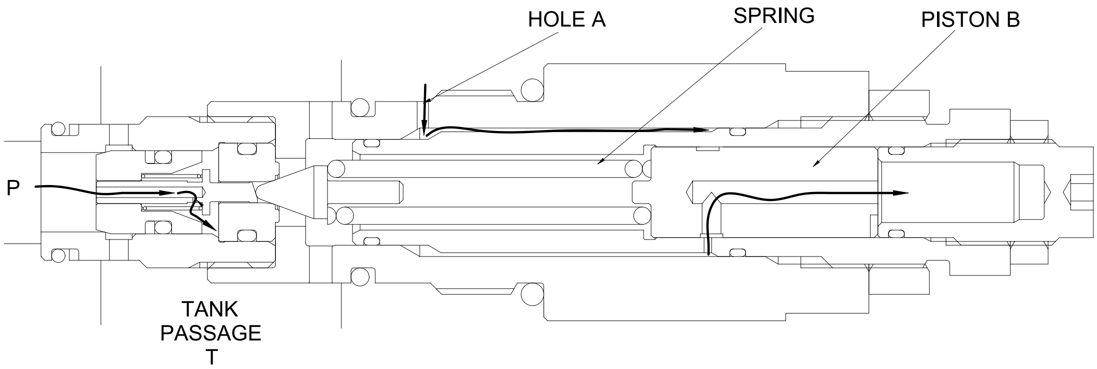
14072SF37

③ Opening the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T)



14072SF38

④ High pressure setting pilot signal(Pu) : ON
When the power boost switch is ON, the pilot pressure enters through hole A.
It pushes the piston(B) in the left direction to increase the force of the spring and change the relief set pressure to the high pressure.

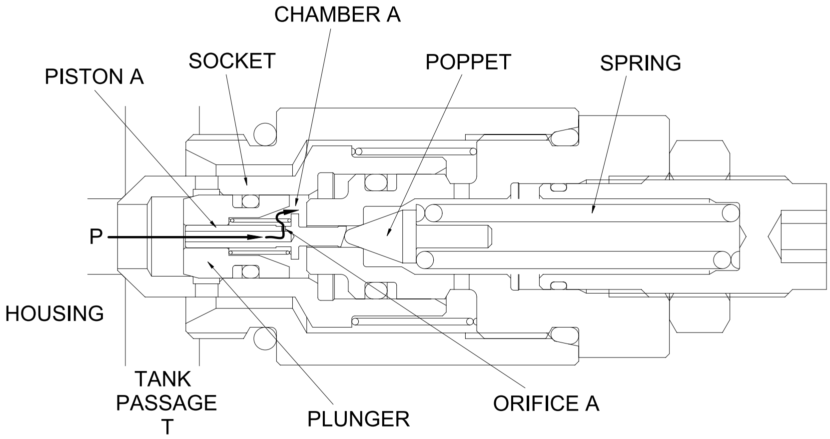


14072SF36

(11) OPERATION OF PORT RELIEF VALVE

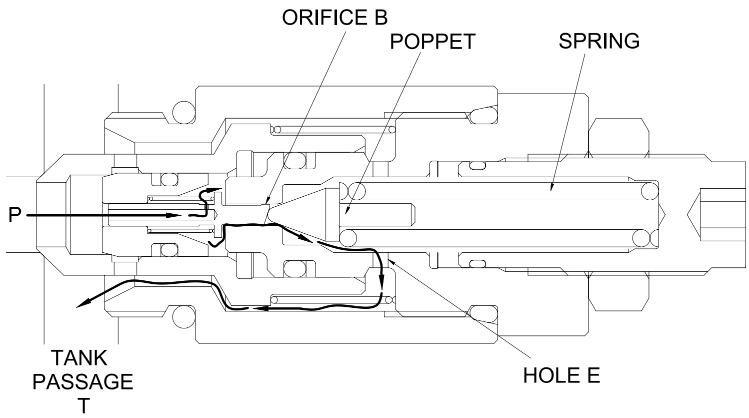
① **Function as relief valve**

ⓐ The pressurized oil passes through the piston A and orifice is filled up in chamber A of the inside space and seat the plunger against the socket and the socket against the housing securely.



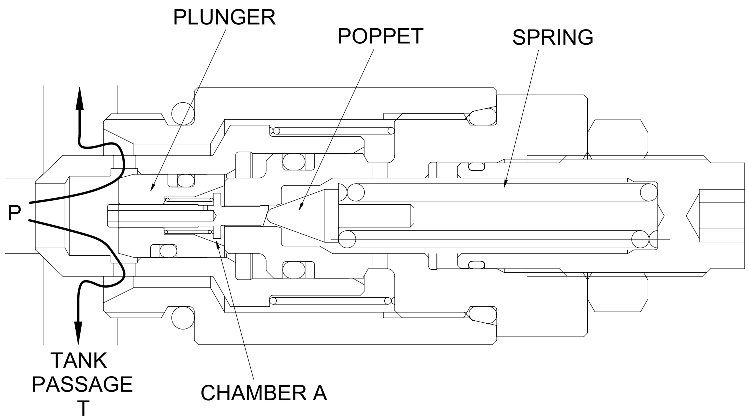
14072SF39

ⓑ When the pressure at port P becomes equal to the set pressure of the spring, the pressurized oil pushes open the poppet flows to tank passage (T) through hole E.



14072SF40

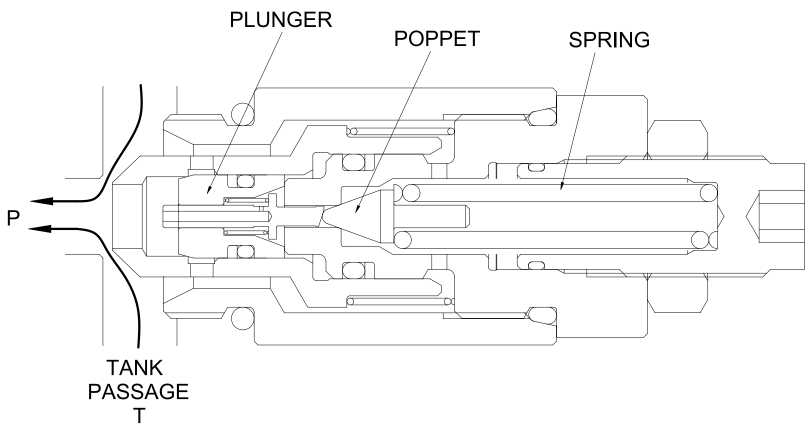
ⓒ Opening of the poppet causes the pressure in chamber A to fall and the plunger to open. As the result the pressurized oil at port P runs into tank passage (T).



14072SF41

② **Make-up function**

When negative pressure exists at port P, the oil is supplied through tank passage (T). When the pressure at tank passage (T) becomes higher than that at port P, the socket moves in the right direction. Then, sufficient oil passes around the socket from tank passage (T) to port P and fills up the space.



14072SF42