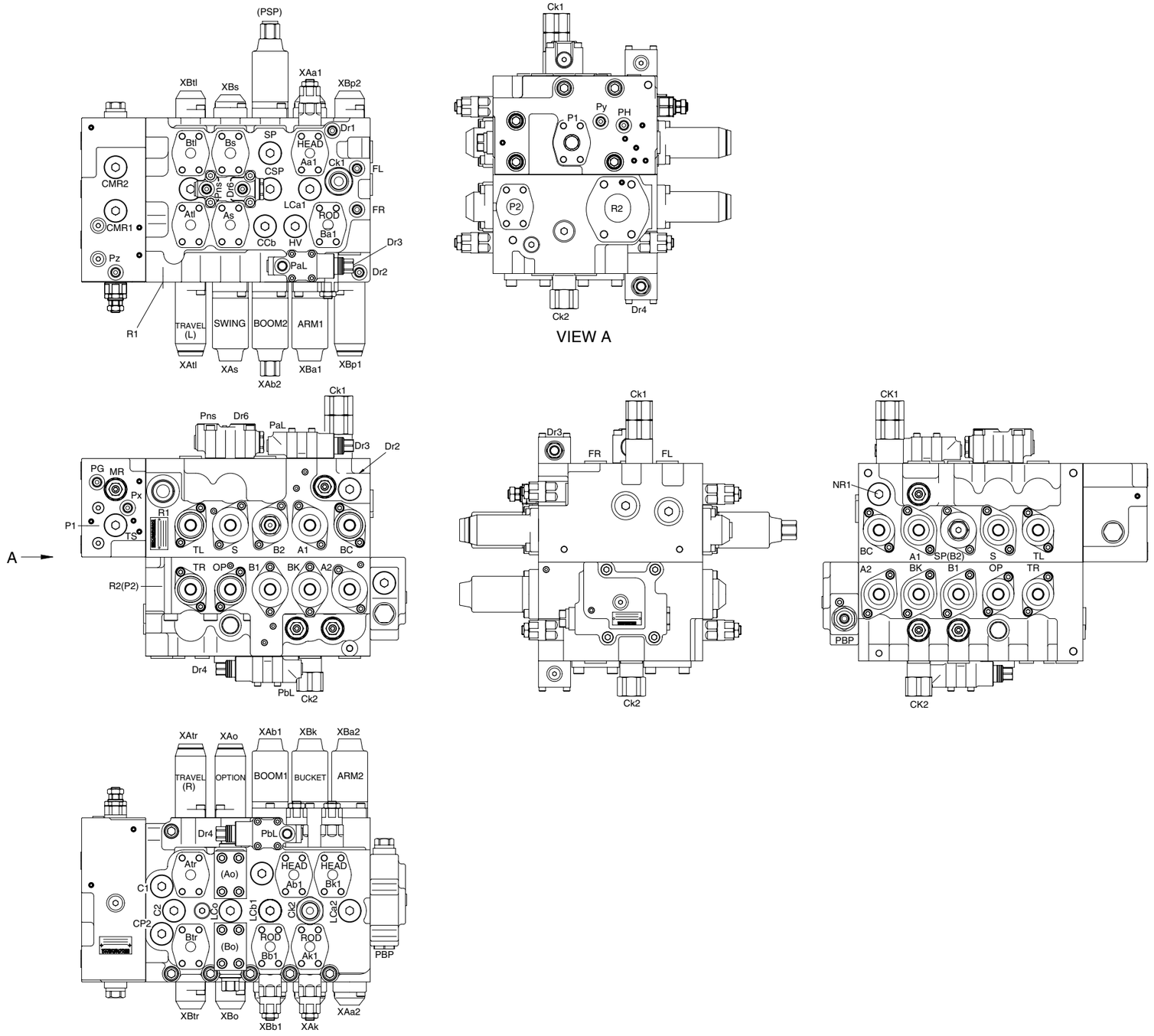
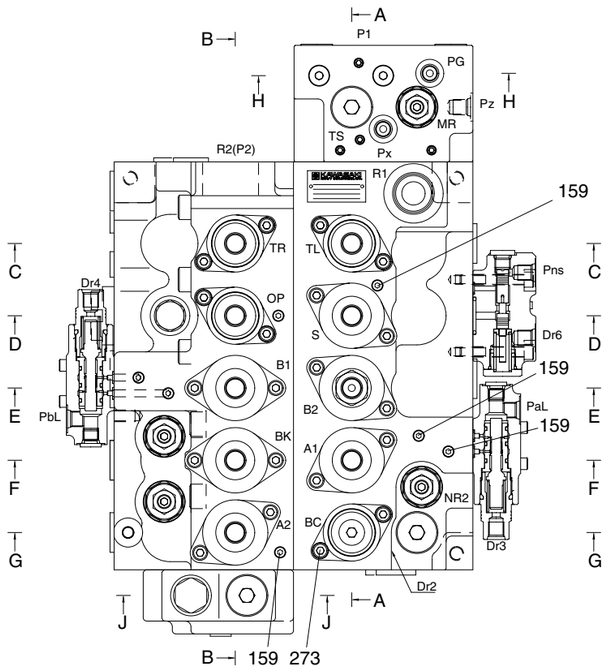
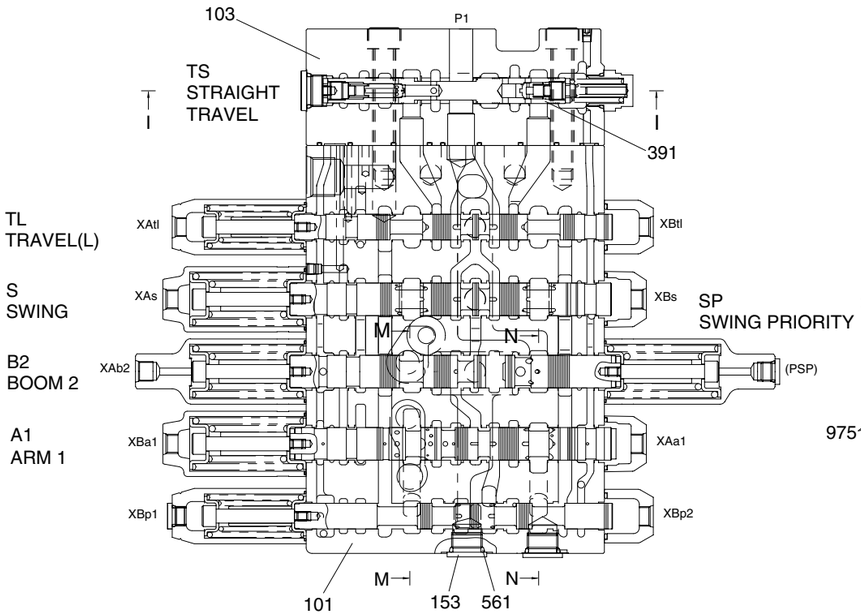
1. STRUCTURE



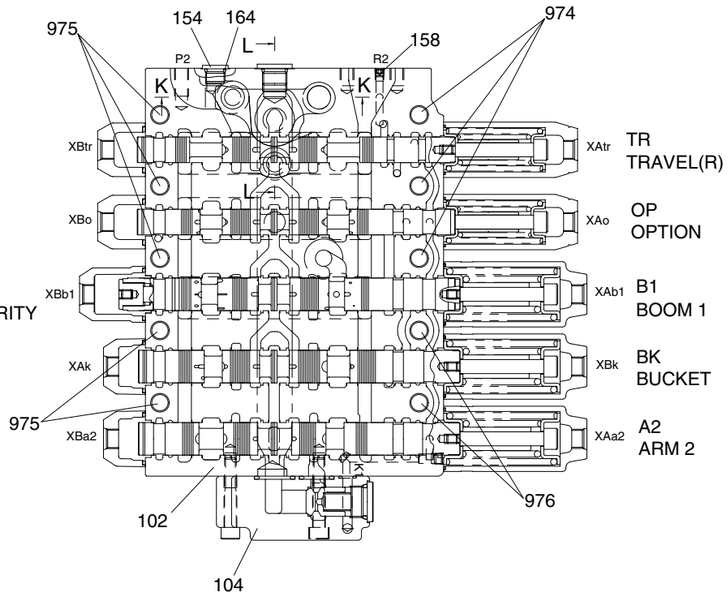
Mark	Port name	Port size	Tightening torque
R1	Make up port for swing	PF 1	20~25kgf · m (115~180lbf · ft)
Ck1 Ck2	Bucket in confluence port Bucket in confluence port	PF 3/4	15~18kgf · m (109~130lbf · ft)
XAtr XBtr XAo XBo XAk XBk XAb1 XBb1 XAa2 XBa2 XAtl XBtl XAs XBs XAa1 XBa1 XAb2 (Psp) (XBp1) (XBp2)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

2507A2MC01

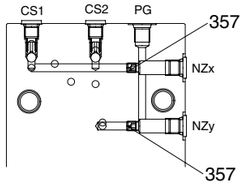




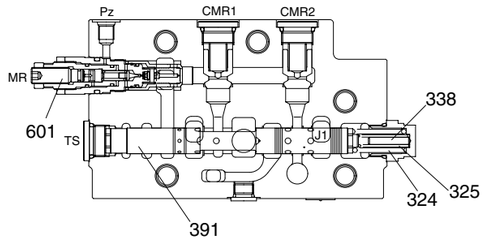
SECTION A-A



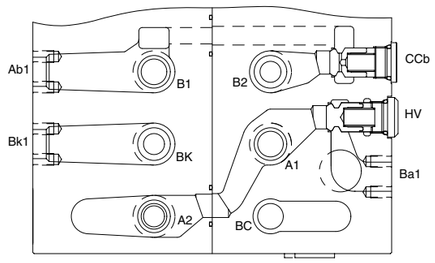
SECTION B-B



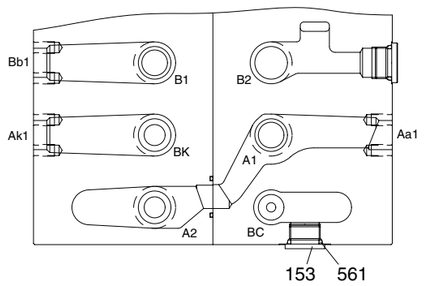
SECTION H-H



SECTION I-I



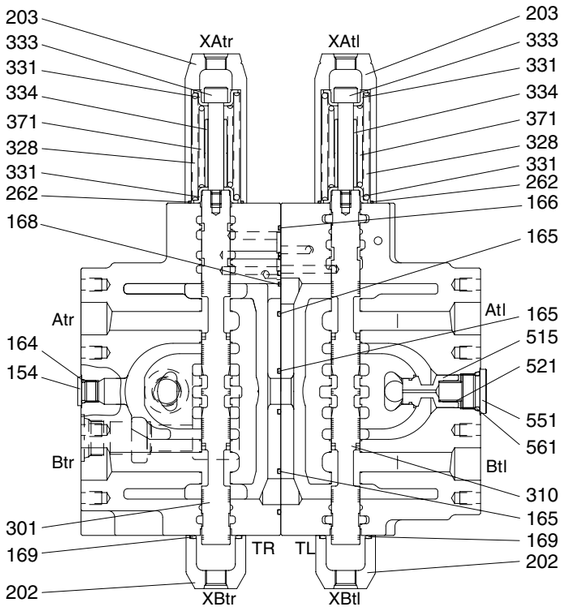
SECTION M-M



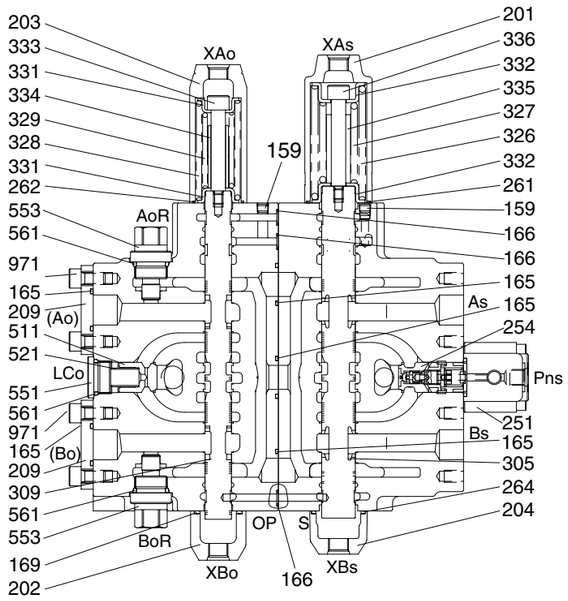
SECTION N-N

2507A2MC02

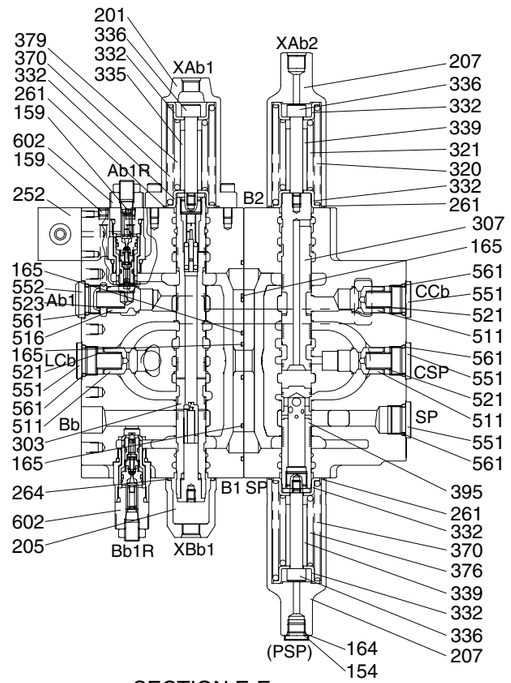
101	Casing A	302	Arm 1 spool assy	376	Spring
102	Casing B	303	Boom 1 spool assy	379	Spring
103	Straight travel valve	304	Bucket spool	391	Straight travel spool
104	Boom priority valve	305	Swing spool	392	Bypass cut spool
153	Plug	306	Arm 2 spool	395	Swing priority spool
154	Plug	307	Boom 2 spool	401	Spool
155	Plug	309	Spool(Option)	424	Spring
158	Plug	310	Travel spool	425	Spring
159	Plug	320	Spring	438	Rod
164	O-ring	321	Spring	511	Poppet
165	O-ring	322	Spring	513	Poppet
166	O-ring	323	Spring	515	Poppet
167	O-ring	324	Spring	516	Poppet
168	O-ring	325	Spring	521	Spring
169	O-ring	326	Spring	522	Spring
201	Cover	327	Spring	523	Spring
202	Cover	328	Spring	551	Plug
203	Cover	329	Spring	552	Plug
204	Cover	331	Spring seat	553	Plug
205	Cover	332	Spring seat	554	Plug
207	Cover	333	Bolt	555	Check valve assembly
209	Flange	334	Stopper	561	O-ring
251	Control valve assy	335	Stopper	601	Main relief valve
252	Lock valve assy	336	Bolt	602	Port relief valve
254	Swing logic valve assy	337	Stopper	611	Nega-con relief valve
261	O-ring	338	Stopper	971	Socket screw
262	O-ring	339	Stopper	974	Socket screw
264	O-ring	357	Orifice	975	Socket screw
273	Socket screw	370	Spring	976	Socket screw
301	Travel spool	371	Spring		



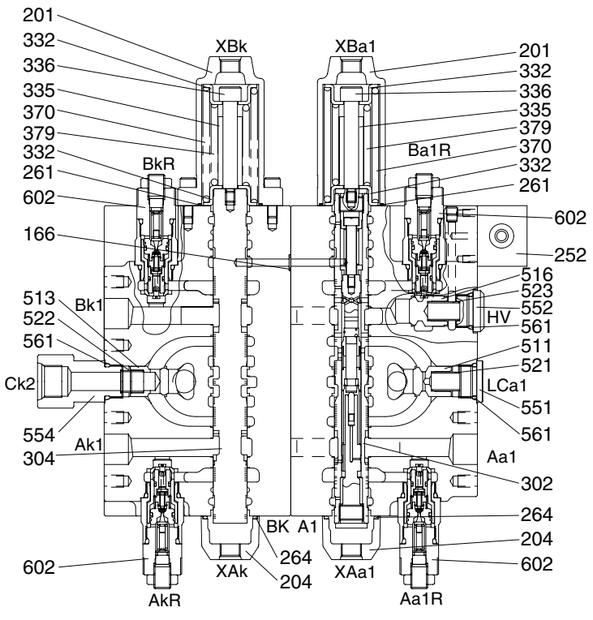
SECTION C-C



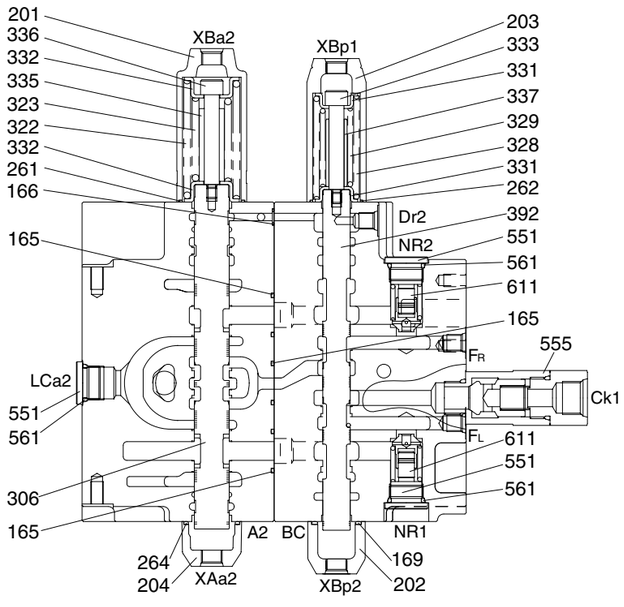
SECTION D-D



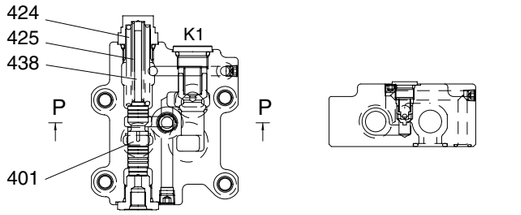
SECTION E-E



SECTION F-F

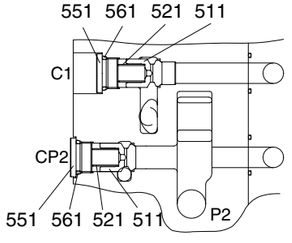


SECTION G-G

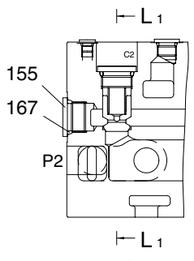


SECTION J-J

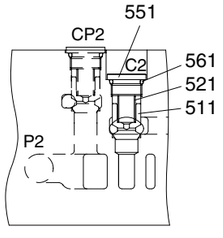
SECTION P-P



SECTION K-K



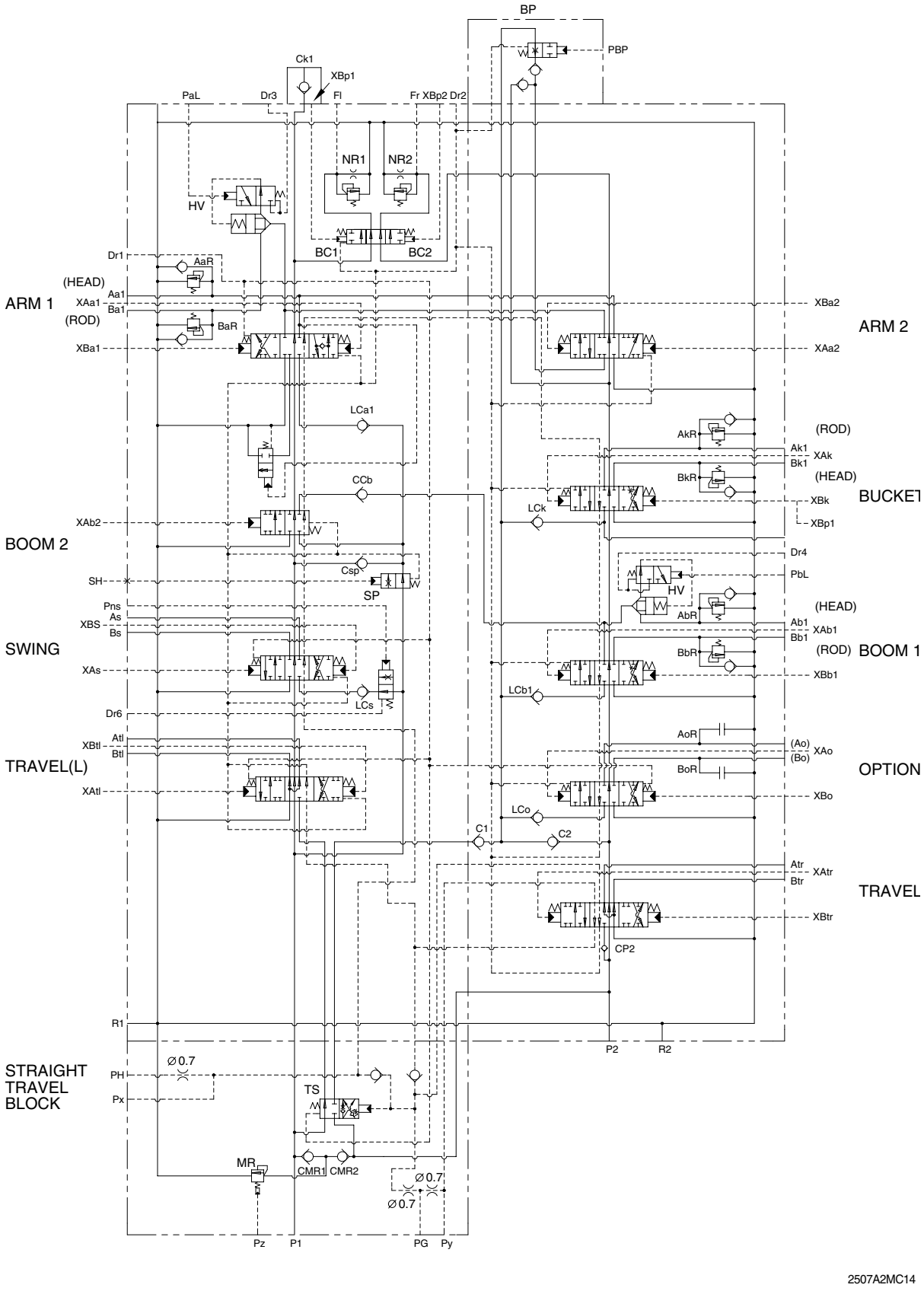
SECTION L-L



SECTION L 1 -L 1

2507A2MC03

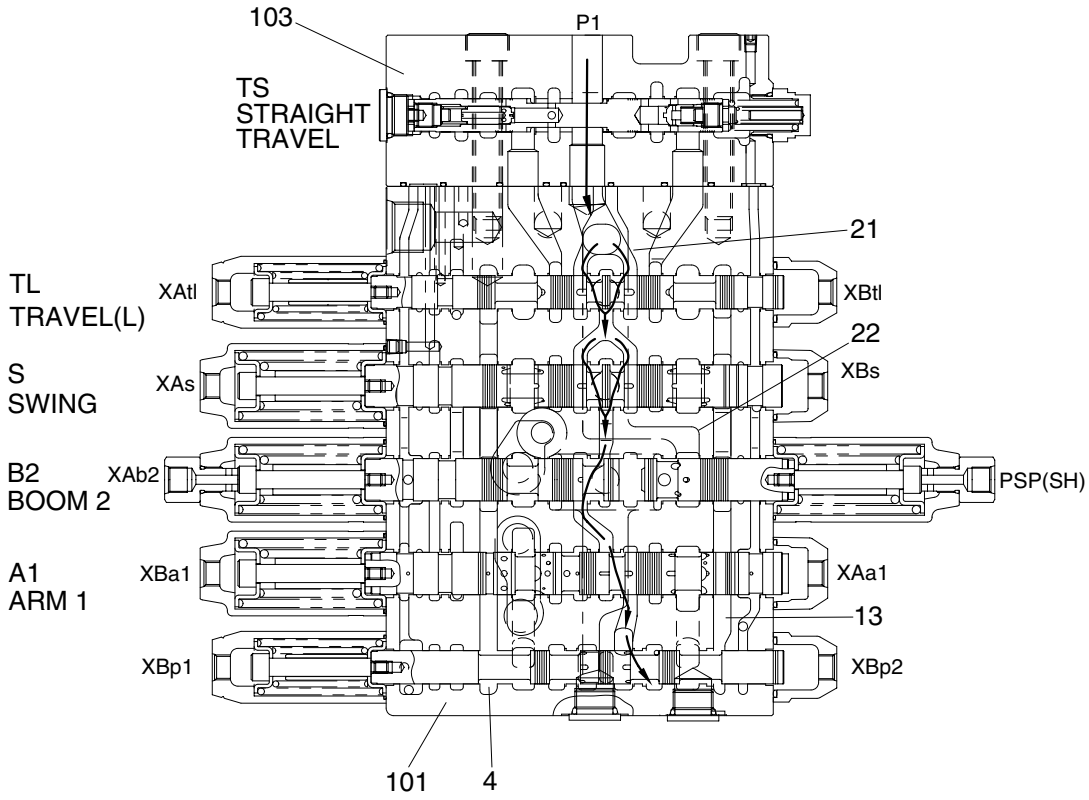
2. HYDRAULIC CIRCUIT



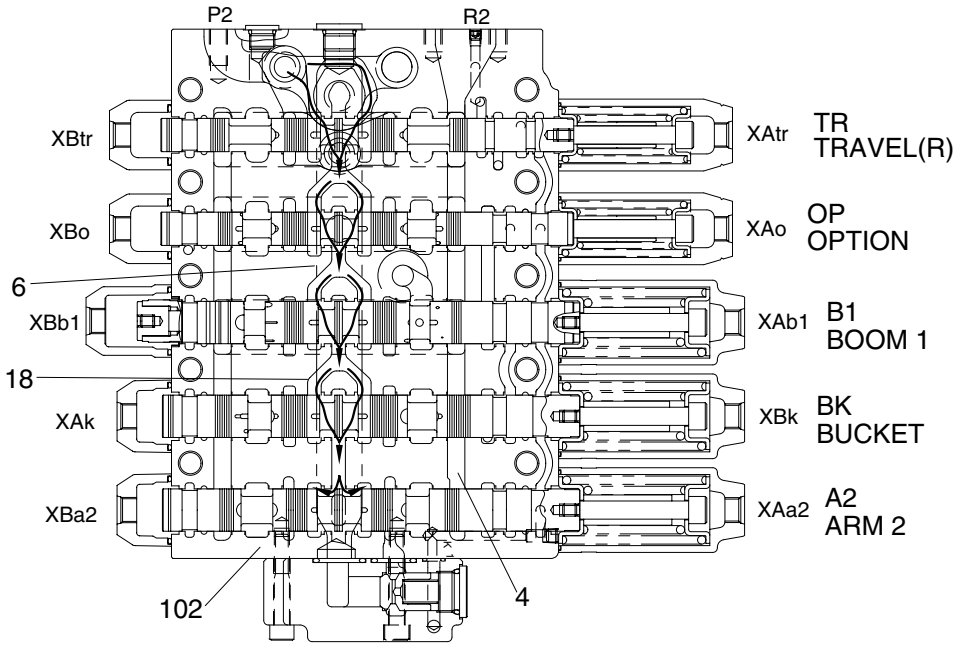
2507A2MC14

3. FUNCTION

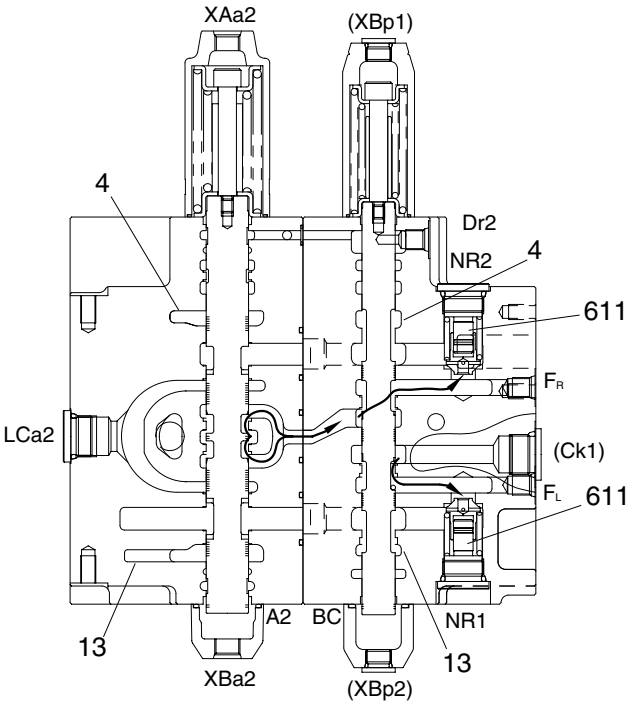
1) CONTROL IN NEUTRAL POSITION



SECTION A-A

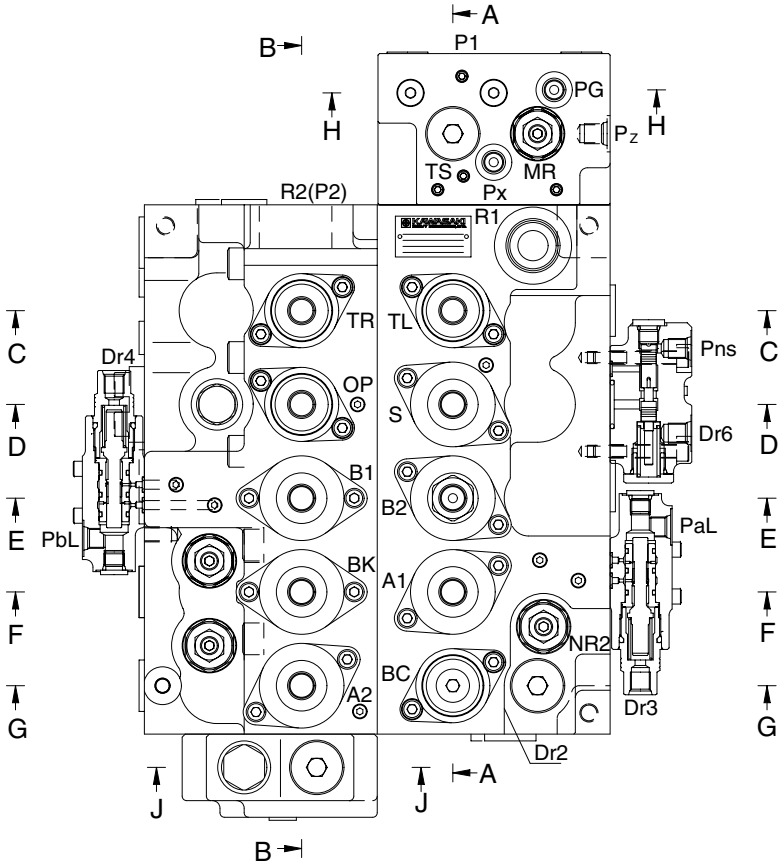


SECTION B-B



SECTION G-G

29072MC27

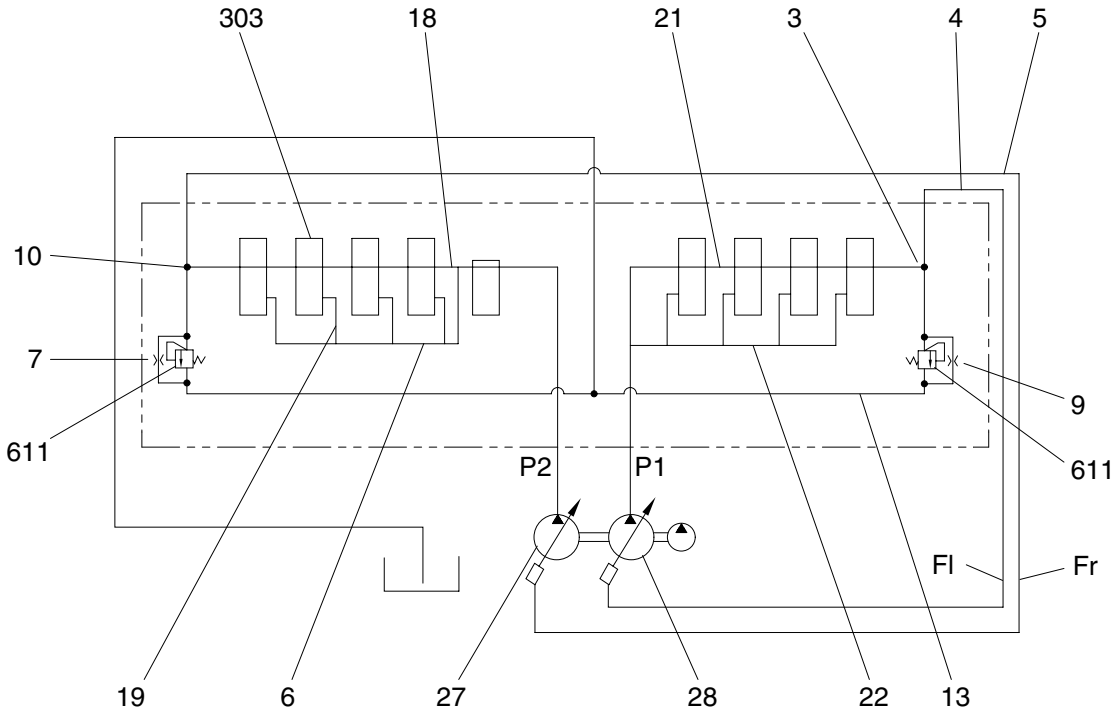


29072MC28

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

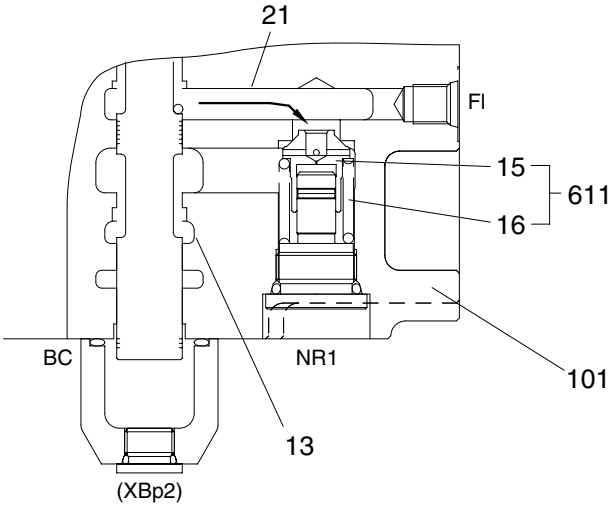


29072MC29

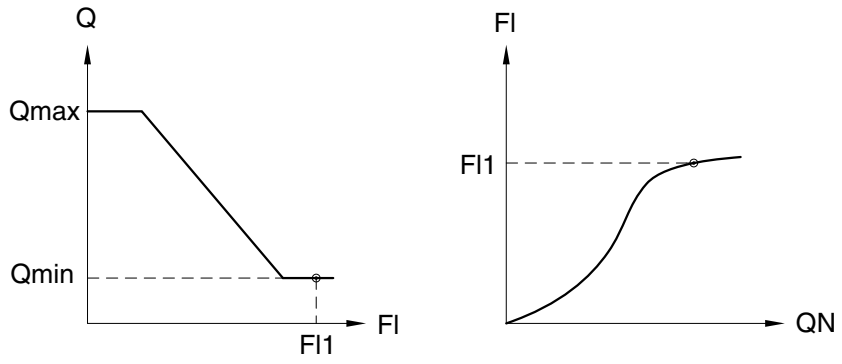
The negative control signal pressure from the center bypass(18, 21) occurs in the following cases and controls the discharge of the pump.

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).



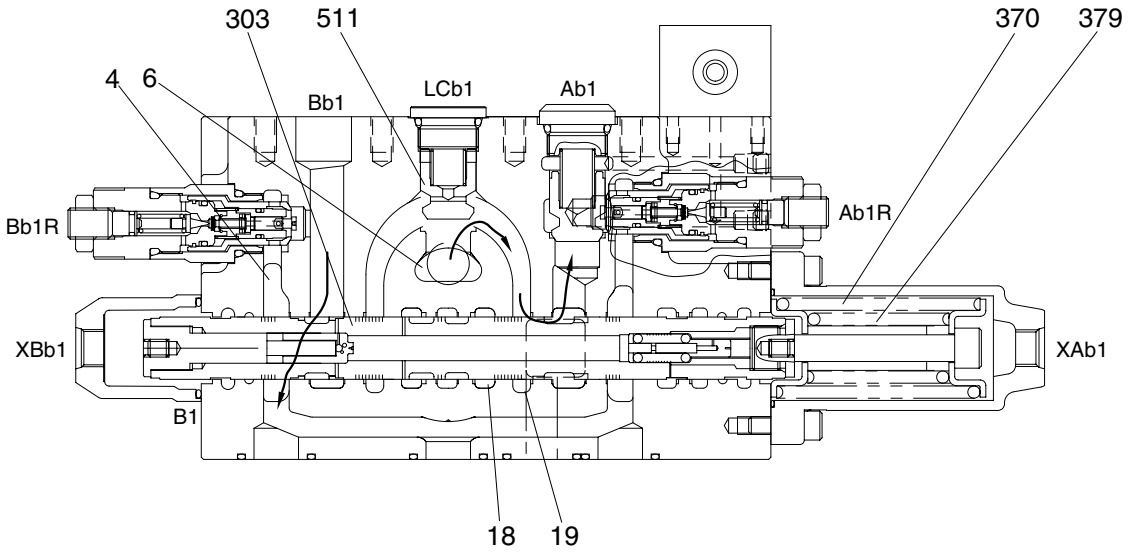
29072MC30



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)



2507A2MC06

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)

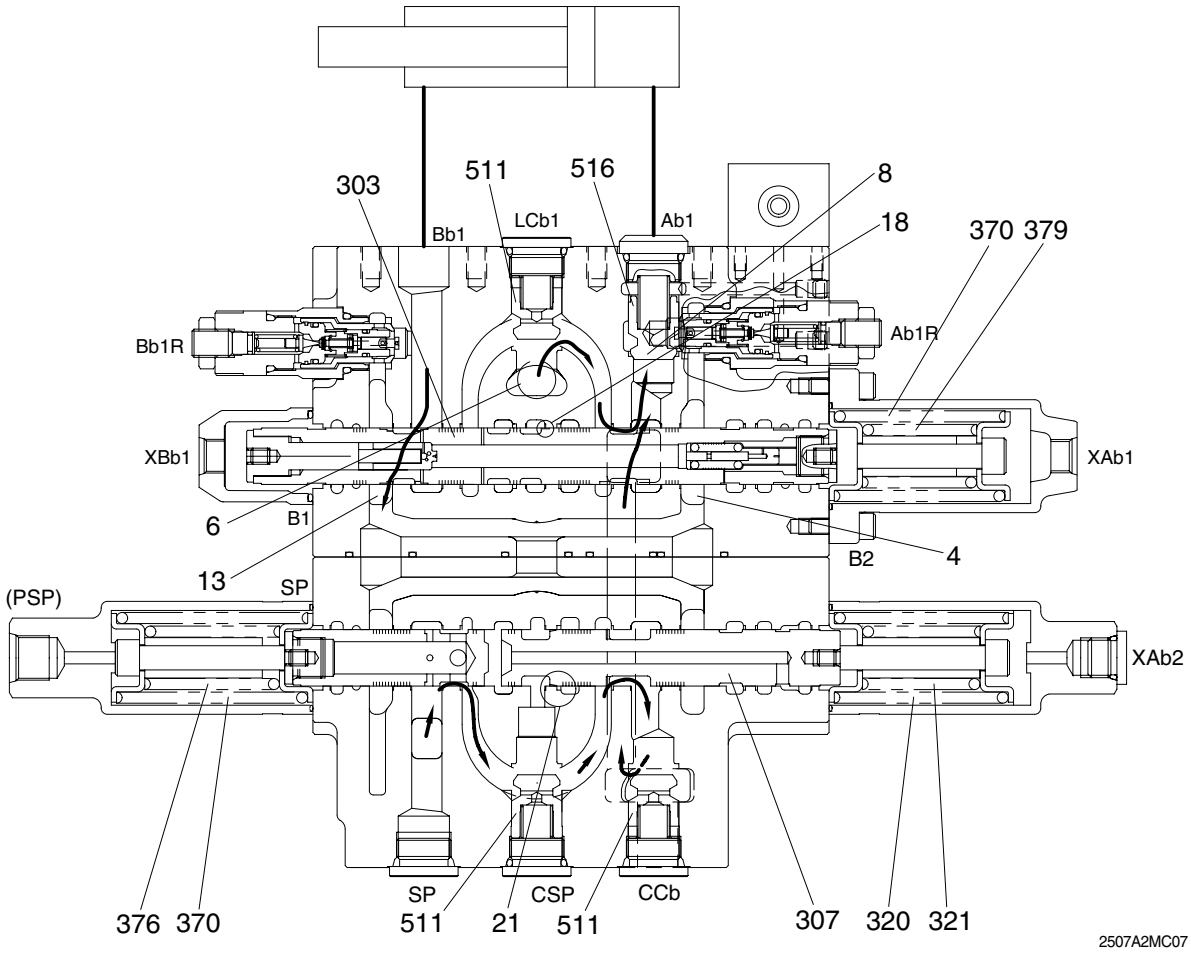
Because the discharge of the pump is adjusted by operating the pilot control lever slightly, the precise moving of the actuator is realized.

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.

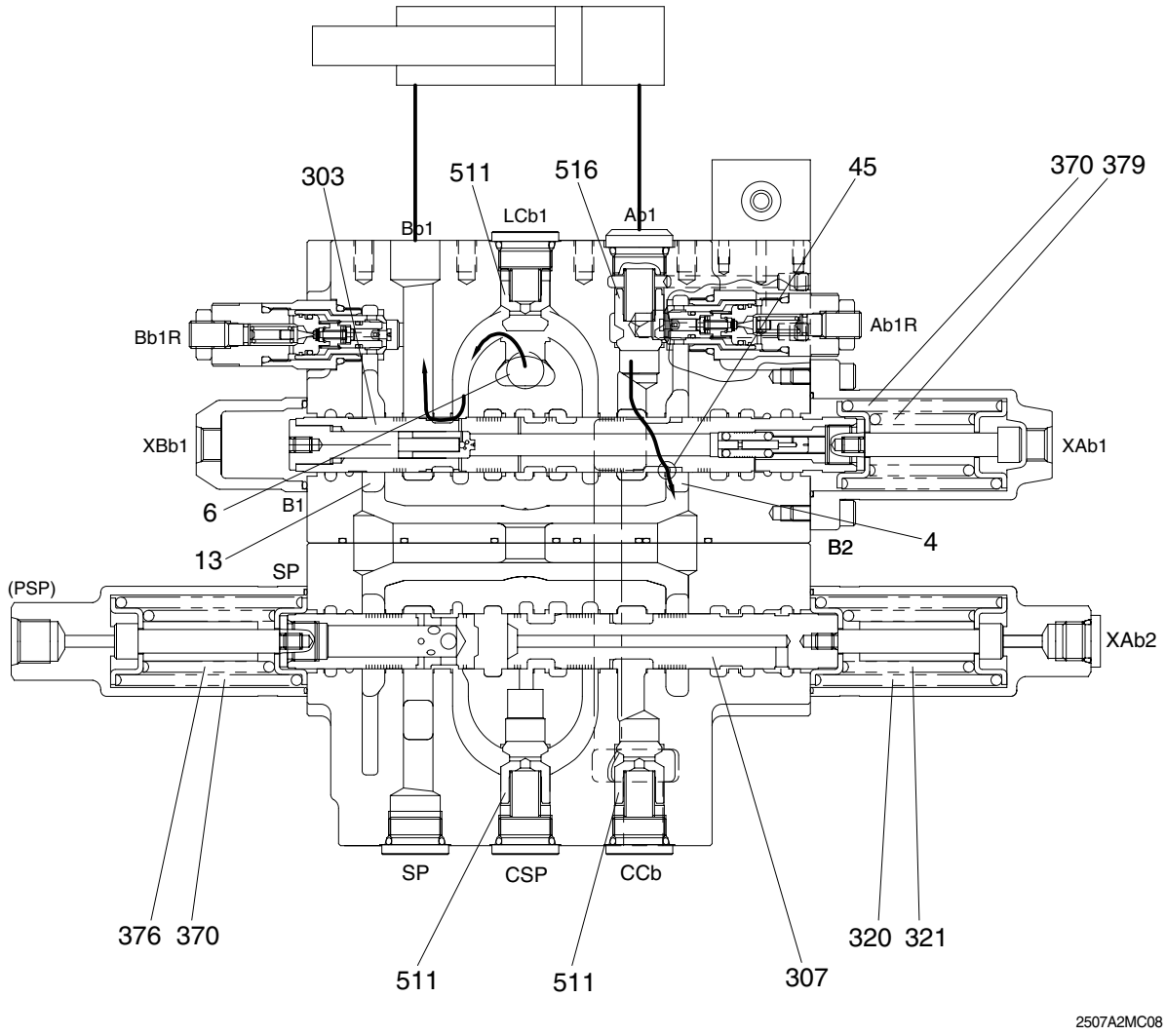
The hydraulic fluid from the pump P2 flows into the boom1 spool(303) through port P2 and parallel path(6). The hydraulic fluid from the pump P1 flows to the boom2 spool(307) through pump port P1 and the parallel path(22).

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 (320) and (321). 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



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).

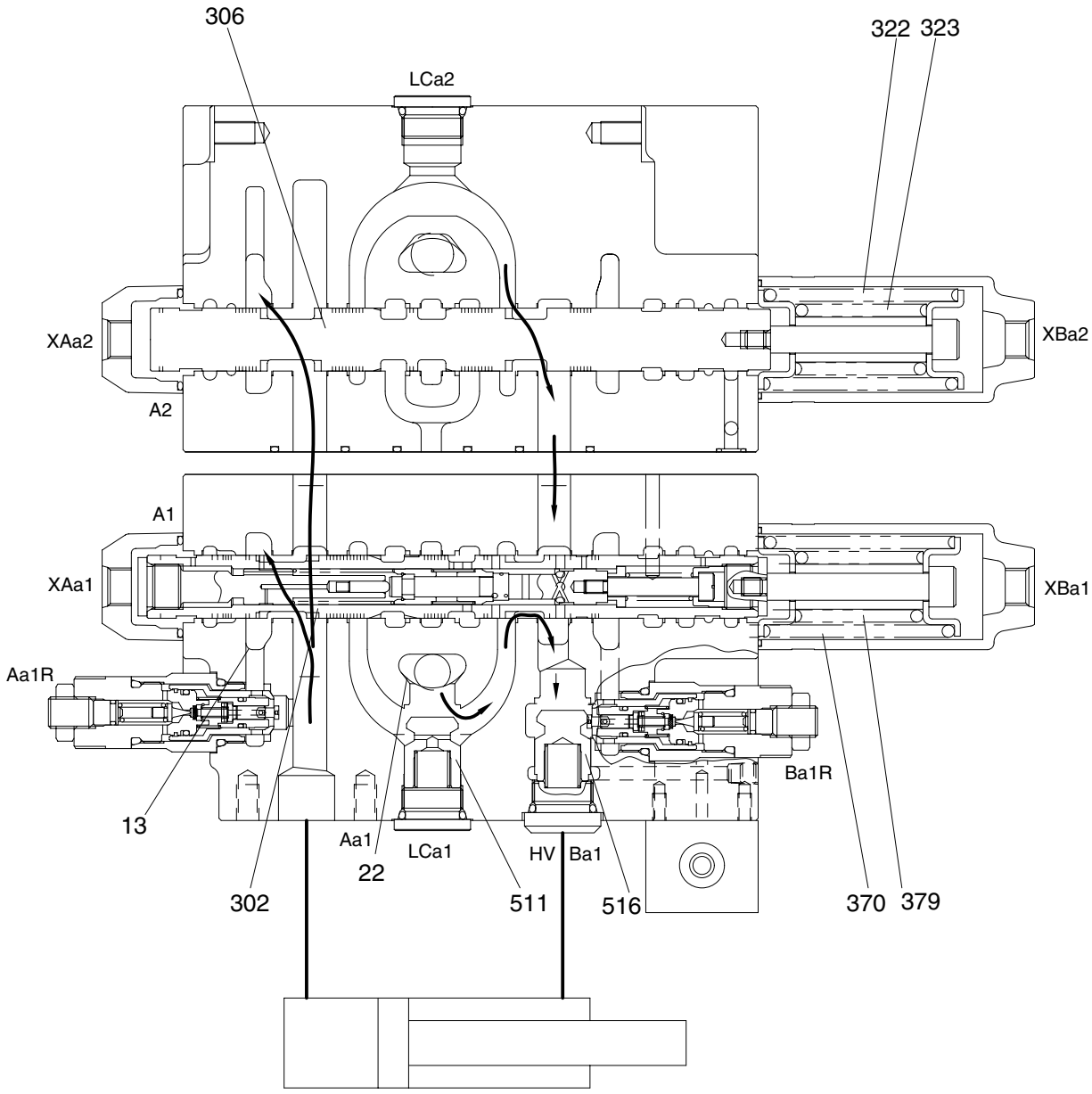
The hydraulic fluid from the pump P2 enters the parallel path(6) and is directed to the port Bb1 through the load check valve LCb1(511). Following this is flows into the rod side of the boom cylinder.

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



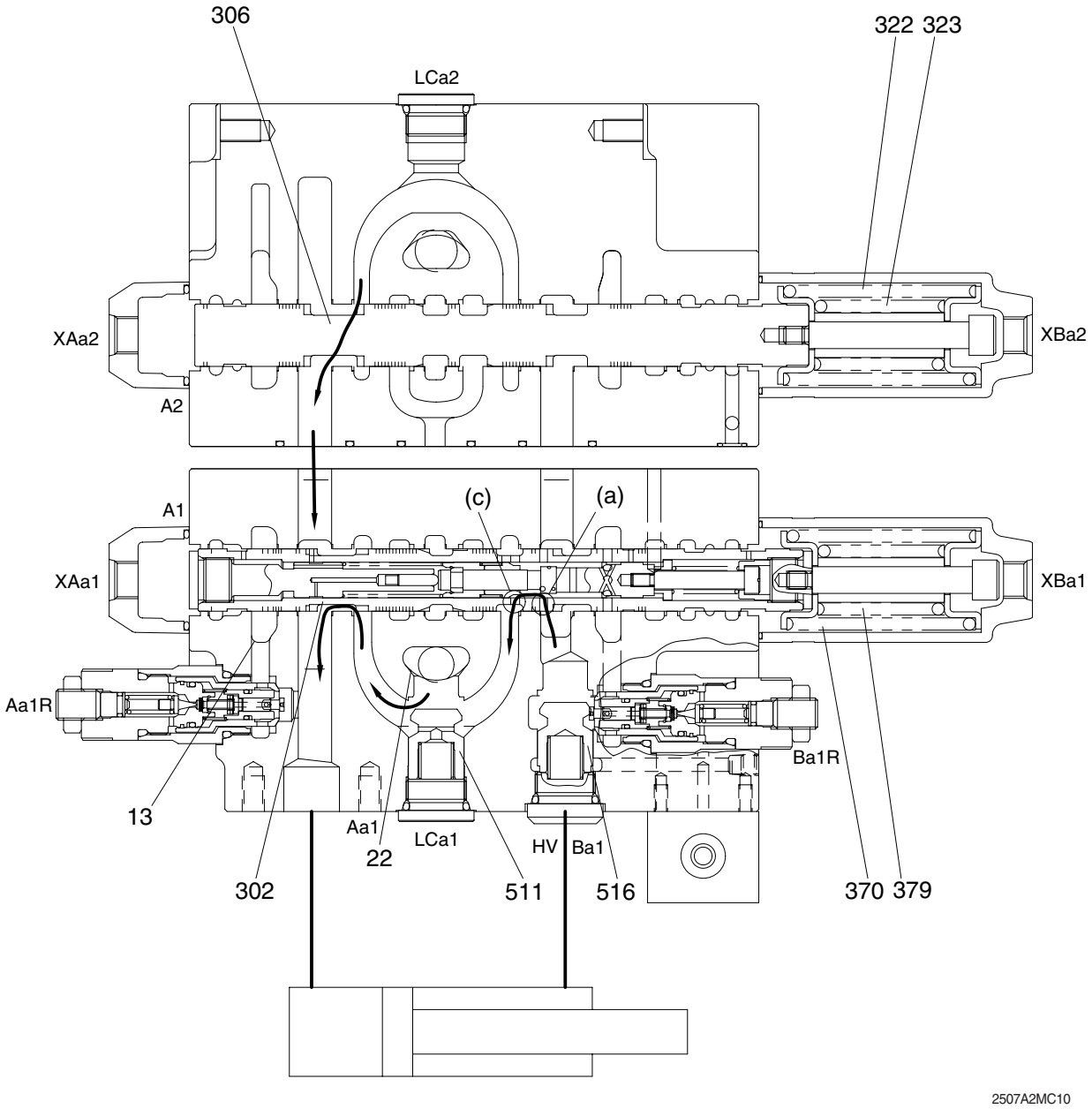
During the arm roll out operation, the pilot pressure from the pilot control valve is supplied to the pilot ports(XBa1& XBa2) and shifts the arm1 spool(302) in the left direction against the springs (370) and (379) and shifts the arm2 spool(306) in the left direction against the springs(374) and (372). 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 (322) and (323). 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.

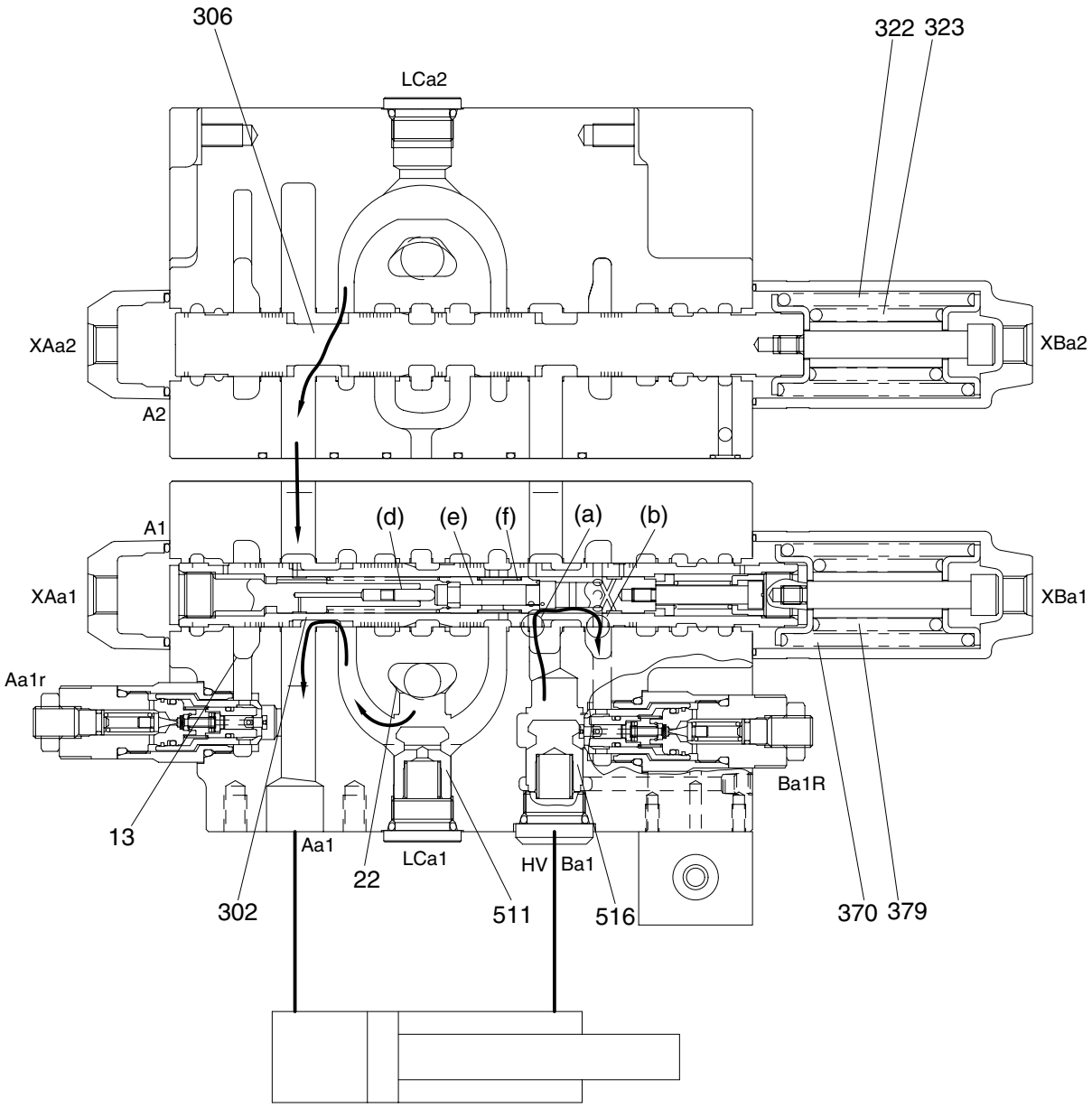
The flow from the head side of the arm cylinder returns to the arm1 spool(302) through the port Aa1. Thereafter it is directed to the return port R2 through path(13).

② Arm roll in operation

· During light load only



· The pressure in the arm cylinder head side increases

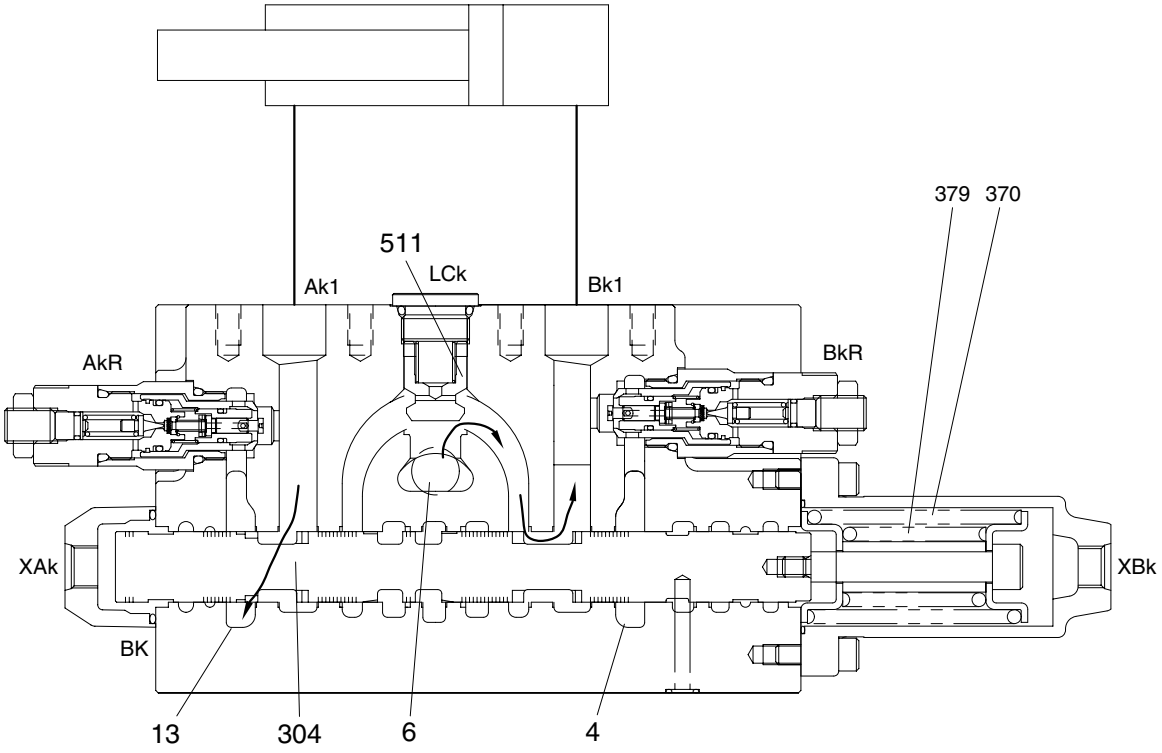


During the arm roll in operation, the pilot pressure from the pilot control valve is supplied to the ports XAa1, XAa2 and PaL and shifts the arm1 spool(302) in the right direction against the springs (370) and (379) and shifts the arm2 spool(306) in the right direction against the springs (322) and (323).
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



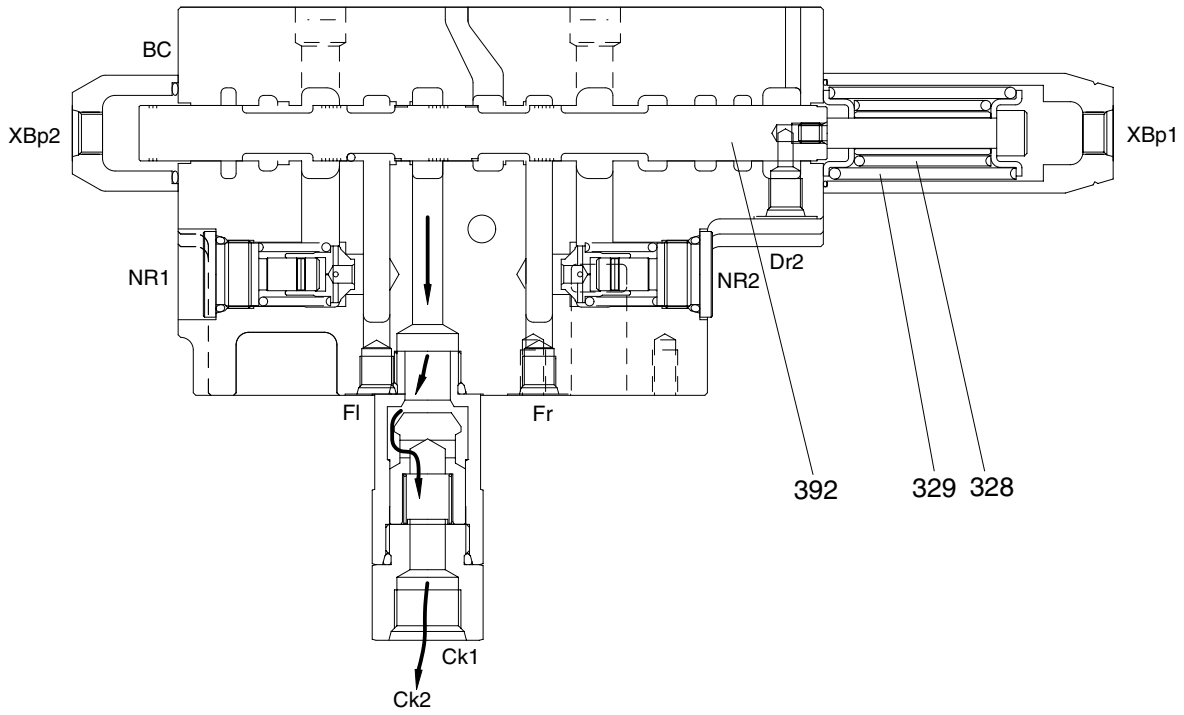
29072MC38

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 return 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).

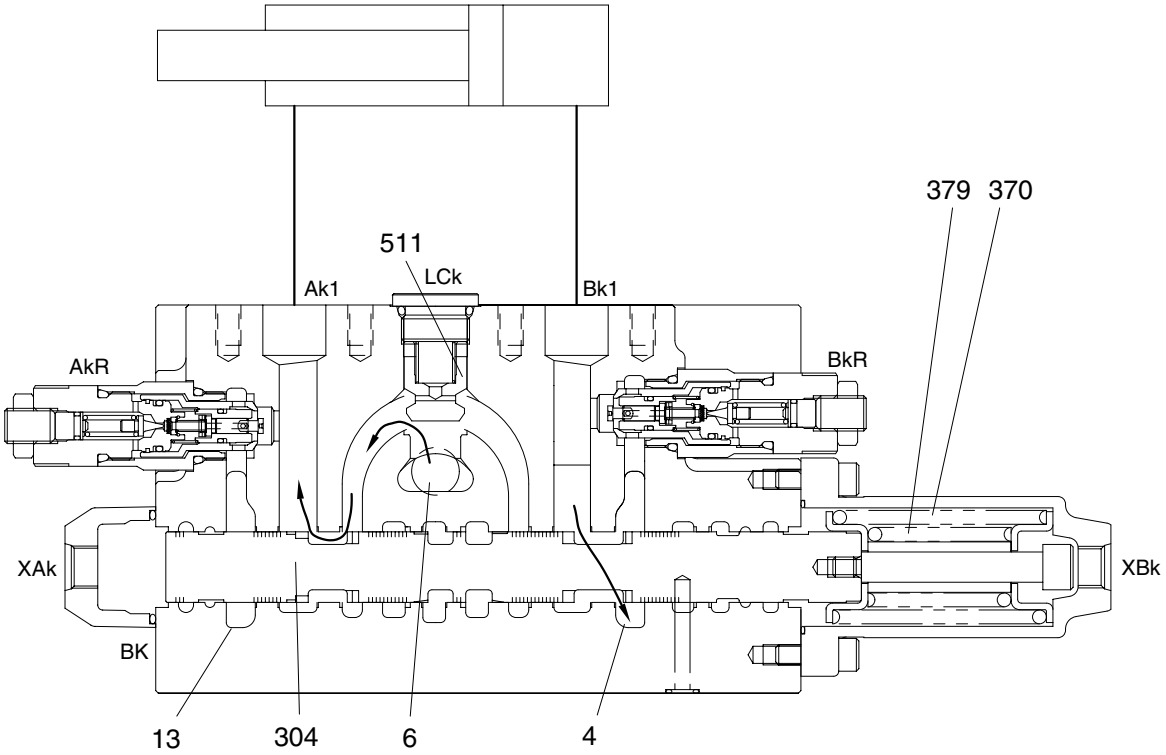
② Bucket confluence operation



25072MC09

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).

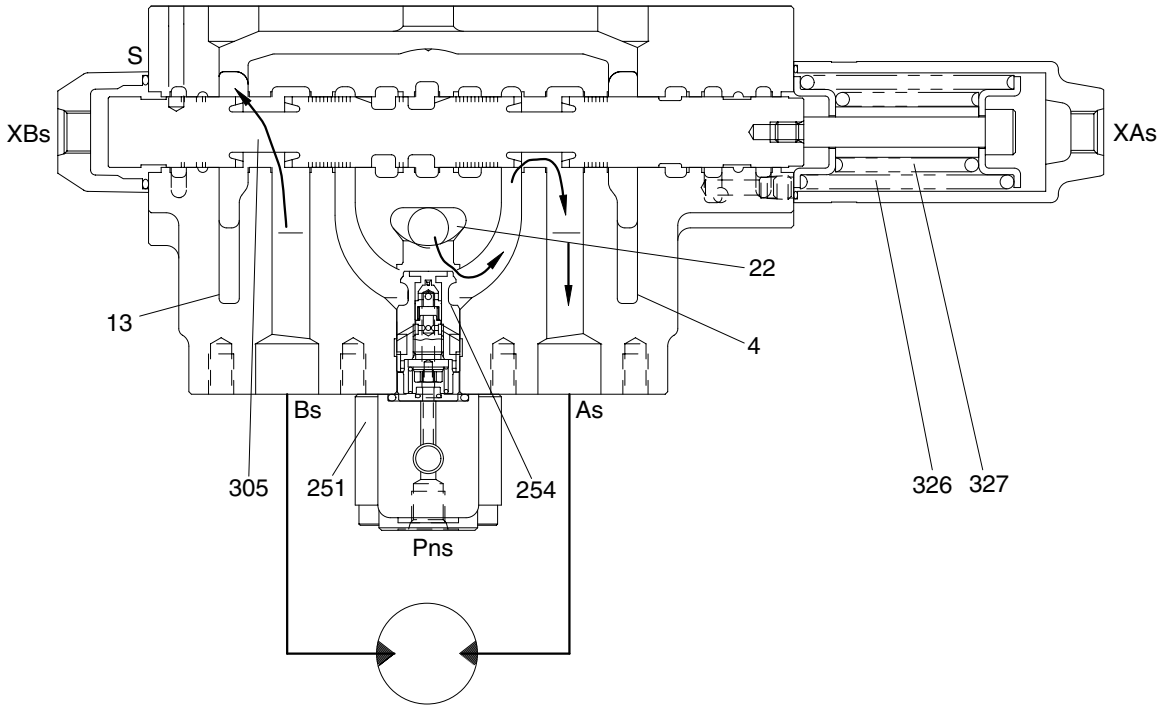
③ Bucket out operation



29072MC39

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

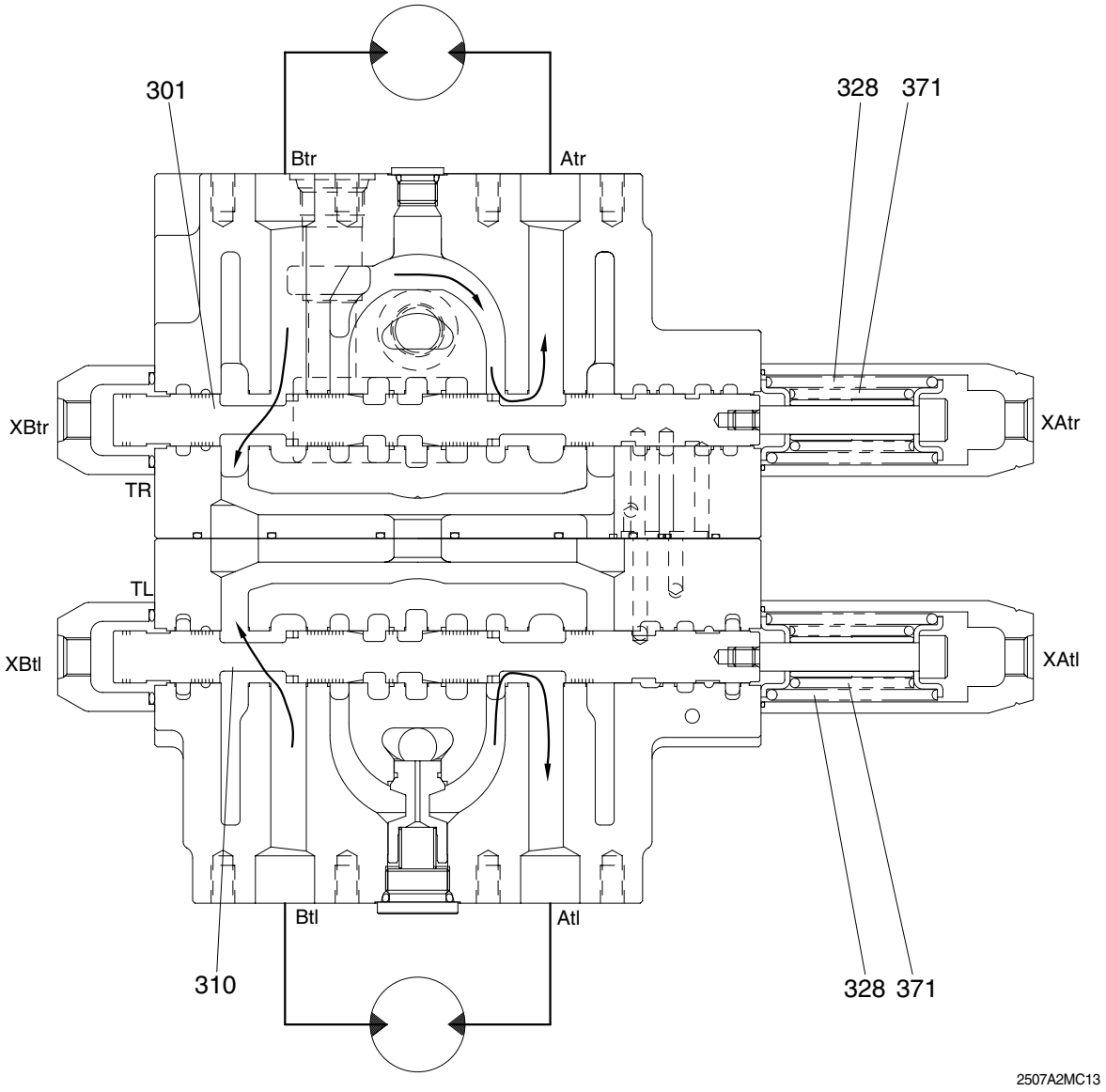


2907A2MC12

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 (326) and (327). 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



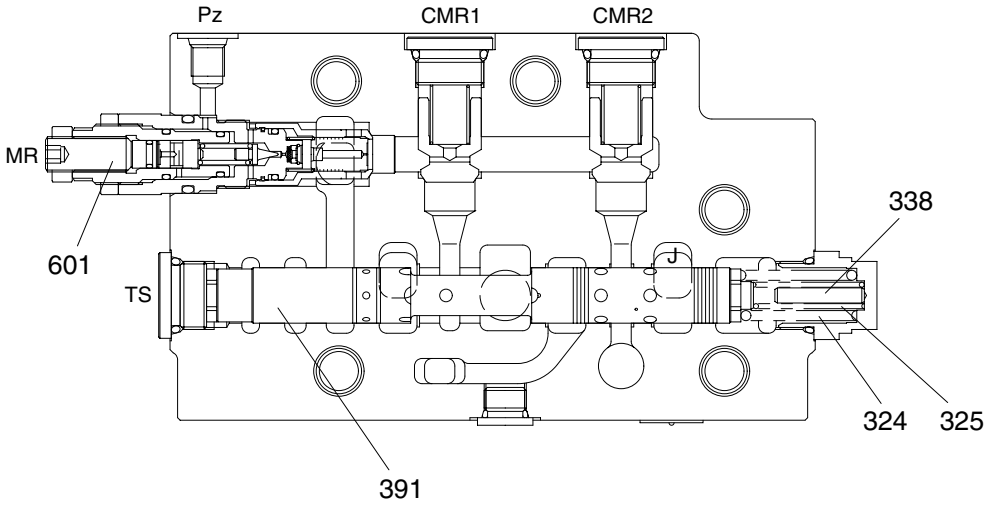
During the travel operation, the hydraulic fluid of the pump P1 is supplied to the travel motor and the hydraulic fluid of the pump P2 is supplied to the other travel motor.
The pilot pressure from the pilot control valve is supplied to the port XAtr and XAtl.
And it shifts the travel right spool(301) and travel left spool(310) in the left direction against springs (328) and (371). 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 PROTECTION

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

(1) Main relief valve

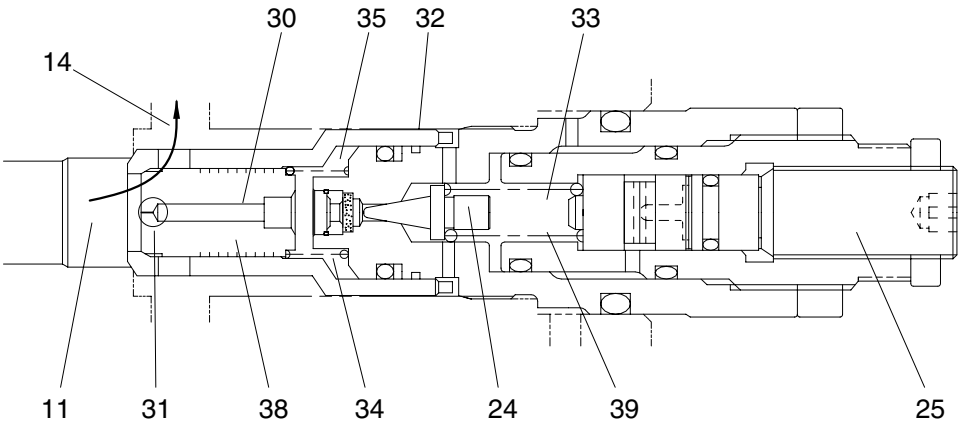
Limits the pressure of the main hydraulic system.



29072MC43

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

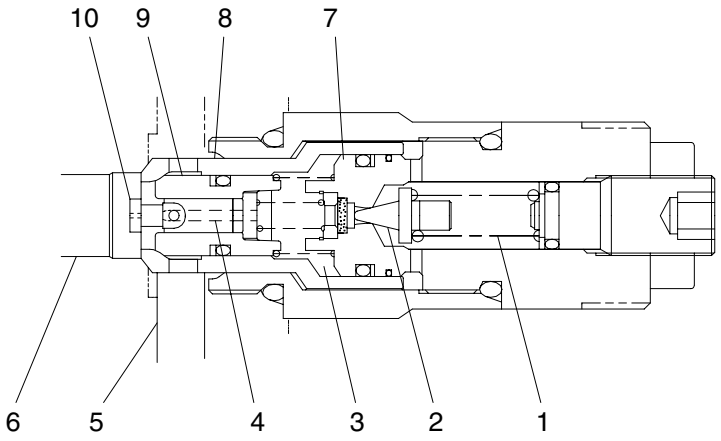


29072MC44

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.



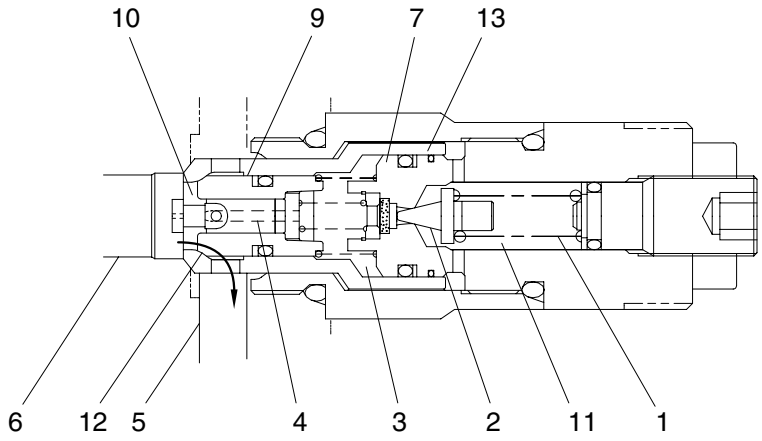
29072MC45

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).

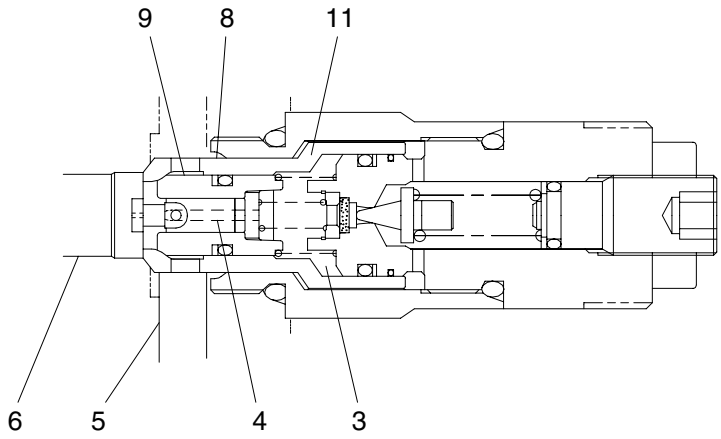
① Port relief function



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 vacuum 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.