GROUP 2 MAIN CONTROL VALVE (-#0169)

1. STRUCTURE

Px2 dr









VIEW X

Mark Arm out conflu а b Bucketin conflu С Arm in conflue d Boom up confl Dr/dr Drain port dr1 Drain port dr2 Drain port FL Negative contr FR Negative contr Pi Pilot pressure 3Pi Lock valve pilo 4Pi Lock valve pilo 4Pc Swing logicval Px1 Signal port for Px2 Pilot pressure Signal port for Py1 Py2 Main relief pilo аF Pilot port аF Pilot port bF Pilot port bF Pilot port Rs Swing motor m AL1 Swing motor p AL2 Arm head side AL3 Option port AL4 Travel motor p AR1 Boom rod side AR2 Bucket head si AR3 Travel motor p BL1 Swing motor p BL2 Arm rod side p BL3 Option port BL4 Travel motor p BR1 Boom head sid BR2 Bucket rod sid BR3 Travel motor p R Return port

Port name	Port size
uence port luence port ence port luence port	
rol signal port(PL port side) rol signal port(PR portside) port ot port(Boom) ot port(Arm) lve pilot port attachment port for lock valve(Boom) travel ot pressure port	PF 1/4
	PF 3/8
nake up port	PF 1
port(RH) e port(In) port(LH, Forward) e port(Down) side port(In) port(RH, Forward) port(LH) port(Out) port(LH, Reverse) de port(Up) le port(Out) port(RH, Reverse)	ø 32
	ø 50







45

VIEW Z



SECTION G-G



A→ B→C→ 55,65 55,65 (0) \cap Ŧ J \bigcirc \bigcirc (\ 57,66 O 67,68,69 0 **∮** K \bigcirc \bigcirc \bigcirc Q \bigcirc $(\bigcirc$ \bigcirc \odot





37 38 39 40

41

42

	L / / `	γ -LL
	60 10 61	/
	02 12 01	
1	Cover assy	34
2	O-ring	35
3	O-ring	36
4	Spring	37
5	Poppet	38
6	Housing	39
7	O-ring	40
8	Socket bolt	41
9	Cover	42
10	Boom plunger assy	43
11	Bucket plunger assy	44
12	Travel plunger assy	45
13	Cover	46
14	Cap	47
15	Cap	48
16	Cap	49
17	Cover	50
18	Plug	51
19	O-ring	52
20	O-ring	53
21	O-ring	54
22	Selector assy	55
23	Back up ring	56
24	O-ring	57
26	Overload relief valve	58
27	O-ring	59

9 8 7

SW

AM

OPT

ΤL

┫

29 30 31

3607A2MC02

10	Doonn plunger usby	-10
11	Bucket plunger assy	44
12	Travel plunger assy	45
13	Cover	46
14	Сар	47
15	Сар	48
16	Сар	49
17	Cover	50
18	Plug	51
19	O-ring	52
20	O-ring	53
21	O-ring	54
22	Selector assy	55
23	Back up ring	56
24	O-ring	57
26	Overload relief valve	58
27	O-ring	59
28	Back up ring	60
29	O-ring	61
30	Check	62
31	Spring	63
32	Check	64
33	Foot relief valve	65

圓



SECTION E-E

O-ring Cap O-ring	66 67 68	O-ring Flange O-ring
Cap	69	Socket bolt
Cap	70	Poppet
Piston	71	Spring
Steel ball	72	O-ring
Spring	73	Back up ring
Spool	74	Cover assv
Plua	75	Socket bolt
Cap	76	Lock washer
Orifice	77	Manifold
Spool	78	O-ring
Spring	79	Cap
Cap	80	Piston
Main relief valve	81	Spring
O-ring	82	O-ring
Manifold	83	Sleeve
Logic check valve	84	Spring
O-ring	85	Check
Socket bolt	86	Poppet
Washer	87	Cap
O-ring	88	Spring guide
Сар	89	Spring
O-ring	90	Union
O-ring	91	Piston
Socket bolt	92	Cap
Housing	93	O-ring
Option plunger assy	94	Сар
Arm plunger assy	95	Сар
Swing plunger assy		
Socket bolt		

A→ B→C→





SECTION K-K

A (Priority valve)

2. FUNCTION

1) HYDRAULIC CIRCUIT



2) BASIC OPERATION

(1) Travel straight circuit

This circuit keeps straight travel in case of simultaneous operation of other actuators (SW, AM, BKT,BM) during a straight travel.

① During straight travel by operating left/right travel plunger (TL, TR):

Operation of travel spool, the pilot signal(Py1) line inside the control valve is blocked, but the pilot signal(PX1) line is connected to the tank via orifice therefore, the travel straight select valve is not operated ; oil from pump PL is fed into cylinder port BL4 only.

Oil from pump PR is fed into cylinder port BR3 by the operation of TR plunger.

Thus, straight travel is performed separately with pump PL driving rightward travel(TL) and pump PR driving rightward travel(TR).

(p)

Px1 Py1

(PL

___.

ΤL

SW

AM

OPT



② In case of a swing operation during straight travel for instance :

At the beginning of swing plunger stroke the pilot signal(PX1) line inside the control valve is blocked and the signal pressure makes the connection between the feed passages of right and left travel plungers(TL, TR) by switching spool of travel straight select valve. When the swing plunger is switched, oil discharged from pump PR preferentially flows into swing motor which is positioned upstream.

Thus, simultaneous operation of swing and straight travel is made possible as oil from pump PL is fed to swing and oil from pump PR is fed to right travel(TR) and left travel (TL).

The orifice at the upstream of the parallel feed passage sends surplus oil of swing to right and left travel(TL, TR) to avoid abrupt change of the vehicle speed.

The basic operation is same with swing even in the case of other actuators on upper frame of machine during straight travel.





(2) Arm flow summation circuit

· Arm out operation

Oil from pump PL is fed into cylinder port BL2 by adding pressure to arm plunger pilot port bl2.

Oil from pump PR flows into the center bypass valve assembly via the center bypass passage. Since the same pilot pressure of the arm plunger pilot port is applied to the pilot signal port of the center bypass valve assembly, the center bypass spool is switched;pushing up the arm flow summation check valve in the manifold through center bypass passage of RH travel section. Oil flows into the high pressure feed passage, and joins to the flow from the pump PL.

· Arm in operation is same as above, summing the flow of the PL pump.(Pilot signal pressure is applied **a** port.)





check valve

(3) Boom up flow summation circuit

Oil from pump PR is fed into cylinder port BR1 by adding pressure to boom plunger pilot port br1.

Oil from pump PL flows into spool of the center bypass valve assembly via the center bypass passage. Since the same pilot pressure of the boom plunger pilot port is applied to the pilot port(b), the center bypass spool assembly closes. At the same time, boom(up) signal works on the logic check valve and the valve opens; oil flows from the center bypass passage of swing section through the logic check assembly into the boom high pressure feed passage and joins to the flow from the pump PR.

(PL)

SW

AM

OPT

TL

*



2) OPERATIONAL DESCRIPTION OF CONTROL VALVE

(1) Plunger operation

① Neutral position of plunger



360SMCV10

In neutral, spring sets the plunger at the neutral position; the high pressure feed passage is shut off by the plunger; oil from the pump flows through the center bypass.

② Operation of plunger



When actuated(pressure is applied to pilot port a), the plunger moves to the left; the center bypass is shut off; oil from the center bypass pushes up the check valve C_1 and flows into cylinder port A via the high pressure feed passage. Meanwhile, oil from the parallel feed passage pushes down check valve C_2 and flows into cylinder port A via the high pressure feed passage.

The return oil from cylinder port B flows into the tank via the tank passage.

* Reversed when pressure is applied to pilot port b.

(2) Foot relief valve operation

① fp is lower than spring force



360SMCV17(1)

Hydraulic oil from the center bypass passage flows into the tank via orifice(C) of poppet(A). Pressure fp generated by orifice(C) is led to the pump, to control the pump delivery flow.

② fp is higher than spring force



360SMCV17(2)

If a large amount flows due to delayed pump response, etc., and pressure fp reaches the preset spring(B) force, then the poppet(A) is lifted and functions as a relief valve.

(3) Logic check valve operation

① Boom down or neutral

When boom up pilot pressure is not supplied.



360SMCV23(1)

Spring force sets piston (A) in the shown position;

Pressure in the passage a (Pa) enters chamber (Z) via passage (1) and passage(2). Pressure in the passage b (Pb) enters chamber (Z) via orifice(D).

If Pa > Pb

Check valve (C) is seated by area d1 > d2 and passage from a to b is blocked.

If Pa < Pb

Passage from b to a is blocked by the check valve (C).

② Boom up

When boom up pilot pressure is supplied.

Piston (A) moves to right; passage (1) is shut off from passage (2).



360SMCV23(2)

When Pa > Pb

Check valve (C) is lifted as the shown position; oil flows through from a to b.

When Pa < Pb

Passage from b to a is blocked by the check valve (C), because d1 > d2.

(4) Main relief valve operation

① High pressure setting pilot signal : OFF

Piston (D) is seated to the right by spring (C) force.



This relief value is built-in between the pump port side (1) and tank passage. Hydraulic oil from the pump port side enters chamber (3) via orifice (2) of poppet (A). Because d1 > d2, poppets (A) is securely seated.



360SMCV12(2)

When hydraulic oil reaches the pressure preset by spring (C), pilot poppet (B) opens; oil flows around pilot poppet (B) and into the tank passage via side hole (4) and passage (5).



360SMCV13(1)

When the above oil flow is formed, pressure drops before and behind orifice (2); when pressure of chamber (1) x area d₂ is larger than pressure of chamber (3) x area d₁, main poppet (A) is lifted and hydraulic oil flows into the tank passage.



② High pressure setting pilot signal : ON

Piston (D) moves to left; set pressure of spring (C) rises, making high pressure setting.

(5) Overload relief valve operation

① Overload working operation



Hydraulic oil from cylinder port enters chamber (2) via orifice of piston (A). Because d1 > d2, main poppet (B) is securely seated.



When hydraulic pressure reaches the preset force of spring (D), pilot poppet (C) opens; oil flows around poppet (C) and into the tank passage via side hole and passage (E).



Oil flow is formed; pressure drops before and behind orifice of piston (A); piston (A) moves to right and seats at the tip of pilot poppet (C).

Hydraulic oil from chamber (1) flows into the tank passage via orifice of piston (A) and pilot poppet (C), side hole and passage (E).



36072MCX

Pressure drops before and behind orifice of pilot poppet (C), making pressure of chamber (1)>pressure of chamber (2); poppet (B) is lifted and hydraulic oil flows into the tank passage.

② Make up operation



360SMCV16

Poppet (B) is securely seated because the cylinder port pressure is normally higher than the tank pressure and d1 > d2.

When the cylinder port pressure drops(closer to negative pressure) until the cylinder port pressure is lower than the tank pressure, poppet (B) opens receiving the tank pressure for the difference in area between d1 and d2; oil flows from the tank passage to the cylinder port in order to prevent cavitation.

(6) Arm regeneration circuit

① Arm in operation



36072MC11

When pressure is applied to pilot port al2 of the arm plunger, the plunger moves to right as shown; the center bypass passage is shut off; oil from the center bypass pushes up check valve (C1) and flows into cylinder bottom port via the high pressure feed passage.

2 PA is lower than PB



36072MC12

Return oil from cylinder rod side pushes up check valve (C2) in the plunger; it flows into cylinder bottom side after returning to the high pressure feed passage.

③ PA is higher than PB



36072MC13

The check (C2) is seated by the pressure (PA) of cylinder bottom side, the return oil from cylinder rod side flows into the tank passage.

(7) Boom load holding valve operation

① When the plunger is in neutral (3Pi pilot signal : OFF)



36072MC14

The piston(A) is in the status as shown and the passage from pilot signal(Px2) to chamber(Y) is blocked.

Therefore, piston (B) and poppet (C) are in the status as shown; passages (5) and (6) are shut off by poppet (C).

Therefore, the pressure of chamber (1) becomes PC as it is connected with chamber (2) via orifice (4). Since d1 > d2, check (D) is seated, chambers (2) and (3) are completely blocked.



When the plunger is operated (3Pi pilot signal : OFF)
A. When PC is lower than PV (in the case of Boom up)

Because check valve (D) is seated, passages (6) and (7) are shut off. Therefore, the pressure of chamber (1) becomes PC as it is connected to chamber (2) via orifice (4); poppet (E) is pushed up; oil from high pressure feed passage flows into the cylinder port.



③ When the plunger is operated (3Pi pilot signal : ON) B. When PC is higher than PV (In case of Boom down)

The piston(A) moves up and then the pilot passage(Px2) and chamber(Y) are connected. Therefore, piston (B) moves to right; poppet (C) opens; passages (5) and (6) are connected. If pressure PC of cylinder port chamber (2) is higher than pressure PV of chamber (3), oil from chamber (1) pushes up check valve (D) via passages (5) and (6) and enters chamber (3) through passage (7). Chamber (3) is connected with the tank passage because the boom plunger is moved to left. Therefore, pressure PC is applied to (area d1 - area d2), pushing up check (E), and oil from the cylinder port flows into the tank passage.

(8) Boom priority valve operation

- ① When swing is operated only (4Pc pilot signal : OFF)
 - A. When Po is lower than Ph



The piston(1) and (2) are in the position as shown by the spring (A) force, and the poppet(3) and the check(4) are seated to hold the pressure of Ph.

B. When Po is higher than Ph



Oil from the P port pushes up the poppet(3) and the check(4), and flows into the high pressure feed passage connecting to the cylinder port.

② Combined swing and boom up operation(4Pc pilot signal : ON)



As the poppet(3) is forced to the body by the piston(1) and (2), oil from the P port pushes up the check(4) and flows into the high pressure feed passage of the swing through the orifice put on the poppet(3). Then oil from P port flows into the boom section prior to the swing section.

(9) Arm load holding valve operation

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



36072MC21

The spool(A) is in the status as shown. The passage from the chamber(1) to the drain port(dr2) is shut off by the spool(A). Therefore, the pressure of the chamber(1) is same to the pressure of Arm cylinder(rod); (equals to Pc), as it is connected with the core(2) through the orifice(4) of the main poppet(B).

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

② When the plunger is operated

A. When PC is lower than PV (in the case of Arm out, 4Pi pilot signal : OFF)



36072MC22

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

The main poppet(B) is pushed up and oil from the high pressure feed line flows into the Arm cylinder port.

B. When PC is higher than PV (In case of Arm in, 4Pi pilot signal : ON)



36072MC23

The spool(A) is switched by the pilot pressure, the chamber(1) is connected to the drain port(dr2).

Then the pressure of the chamber(1) comes to lower than that of the core(2), and the pressure of the core(2) acts on the differential area(d1-d2) to push up the main poppet(B).

Return oil from Arm cylinder flows into the tank passage through the core(3) and around the main plunger.

GROUP 2 MAIN CONTROL VALVE (#0170-)

1. STRUCTURE (1/4)



3607A2MC12

Mark	Port name	Port size	Tightening torque
(R3)	-		
R4	Make up port		15 10 hef - m
(P3)	-	G-1	15~18 kgt ⋅ m (108 5~130 lbf ⋅ ft)
(P4)	-		(100.3*100 101 * 11)
(Ck2)	-		
PAa	Arm 1 (in) pilot port		
PBa	Arm 1 (out) pilot port		
PAb	Boom (down) pilot port		
PBb	Boom (up) pilot port		
PAc	Bucket (in) pilot port		
PBc	Bucket (out) pilot port		
PAL	Travel right (reverse) pilot port		
PBL	Travel right (forward) pilot port		
PAr	Travel left (reverse) pilot port		
PBr	Travel left (forward) pilot port		
PAs	Swing (left) pilot port		
PBs	Swing (right) pilot port		
PAa2	Arm 2 (in) pilot port		
PBa2	Arm 2 (out) pilot port	G-3/8	7~8 kgf ⋅ m
PBb2	Boom (up) confluence pilot port	0,0	(50.6~57.8 lbf · ft)
(PAo)	Optional pilot port		
(PBo)	Optional pilot port		
PAbs	Boom (down) stroke limitter pilot port		
PAcs	Bucket (in) stroke limitter pilot port		
Pca	Bypass cut spool (P2 side) pilot port		
(Pcb)	Bypass cut spool (P1 side) pilot port		
Dra	Drain port		
Drb	Drain port		
(PTa)	-		
(PTb)	-		
(P1g)	Quick clamp solenoid valve supply port		
(P2g)	-		
(Psp)	Swing priority		
Р	Pilot port		
Pa	Pilot port		
Px	Pressure port for attachment		
Ру	Pressure port for travel		0.5.4.0 hef. m
(PL2)	Option(Bo) port relief valve pilot port for	G-1/4	3.5~4.0 Kgī · m (25.3~29 lbf · ft)
	switching to high pressure		
Pns	Boom priority valve pilot port		
P2c1	Lock valve (boom head side) pilot port		
P2c2	Lock valve (arm rod side) pilot port		



3607A2MC12

Mark

Port name	Port size	Tightening torque
essure (boom1 side) port essure (arm1 side) port	G-1/4	3.5~4.0 kgf ⋅ m (25.3~29 lbf ⋅ ft)
alve pilot port for switching to high	G-1/8	1.5~1.9 kgf ⋅ m (10.8~13.7 lbf ⋅ ft)
head side port (in) rod side port (out) er rod side port (down) er head side port (up) der head side port (in) der rod side port (out) otor (reverse) otor (forward) notor (forward)	M14	14~18 kgf ⋅ m (101~130 lbf ⋅ ft)
A1 side) A2 side)	M12	8.5~11 kgf ⋅ m (61.5~80 lbf ⋅ ft)
port (left) port (right)	M10	5~6.5 kgf ⋅ m (36~47 lbf ⋅ ft)



101 Ca 102 151 155 158 159 161 162 163 165 168 201 Ca Plu Plu Plu O-O-O-O-Co 202 203 204 205 Сс Co Co 206 208 211 Ρlι 212 0-251 252 262 Ρlι Lo 0-263 0-264 265 273 274 275 301 302 303 304 305 308 313 0-0-0-Bo Bo Bo Tra Ar Bo Βu Sv Ör Plu 326 327 332 335 336 337 351 352 355 356 371 Sp Sp Sh Bo Ro Or Or Pis Pis Sp 372 Sp

asing-A	373	Spring
asing-B	391	Travel straight spool assy
ug	392	Bypass cut spool
uğ	393	Boom confluence spool
uq	394	Arm confluence spool
ua	395	Swing priority spool
-rina	511	Poppet
-ring	512	Poppet
-rina	513	Poppet
-rina	514	Poppet
-rina	515	Boom priority valve assy
over	522	Spring
over	523	Spring
over	524	Spring
over	525	Spring
over assv	541	Steel hall
over accy	542	Spring seat
over	543	Spring
	550	Plug
-rina	551	Plug
ling	552	Plug
nck valve assv	553	Plug
-rina	554	Plug
-ring	557	Plug assy
-ring	558	Plug
-ring	561	O-ring
-ring	562	O-ring
hing hit	563	O-ring
olt	601	Main relief valve
olt	603	Port relief valve
avol spool	604	Port roliof valvo
rm 1 encol asev	605	Port relief valve
nn i spoorassy	611	Nagativo control roliof valvo
uckot spool	652	
ving spool	663	O_ring
ntion spool	664	O-ring O-ring
	665	Backup ring
oring	751	Flance
oring	752	Flango
oring soat	754	Flango
him	761	O-ring
	762	Bolt
od	762	Doll O_ring
rifico	763	Bolt
rifice	704	Bolt
ston	912 072	Bolt
ston	074	Bolt
aring	9/4	Duit Namo plato
oring	991	Din
unig	99Z	ЕШ

STRUCTURE (4/4)







SECTION G - G





SECTION H - H

3607A2MC11A

2. FUNCTION

1) HYDRAULIC CIRCUIT



2) OPERATION

(1) Neutral positions of spools

When all spools are in the neutral positions, the pressurized oil discharged from the hydraulic pump (A1) passes through Port P1, the main path (1), the bypass circuit (2) passing the spools for boom1, bucket and arm 2, and boom 1 side negative control orifice, and returns to the hydraulic oil tank through the tank port (T1).

The pressure upstream the boom 1 side negative control orifice (the negative control signal pressure) is led from port N1 to the regulator on the hydraulic pump (A1) side, and controls the pump discharge flow rate to its minimum value.

The oil discharged from the hydraulic pump (A2) passes through port P2, the main path (3), the bypass circuit (2) passing the spools for swing, boom confluence (boom 2), option and arm 1, and the arm 1 side negative control orifice, and returns to the hydraulic oil tank through the tank port (T1).

The pressure upstream the arm 1 side negative control orifice (the negative control signal pressure) is led from port N2 to the regulator on the hydraulic pump (A2) side, and controls the pump discharge flow rate to its minimum value.

When any of nine main spools is changed over, the bypass circuit (2) is cut off and the hydraulic oil at port N1 or N2 in the negative control circuit is shut off.



(2) Travel operation

When pilot port PBL of the travel left spool is pressurized, the bypass circuit (2) in the arm 2 side is shut off and pressurized oil from port P2 passes through port BL and flows to the travel motor. On the other hand, the return oil from the travel motor passes through port AL and returns to the hydraulic oil tank through the tank port (T1).



(3) Arm

Arm out operation

During the arm out operation the pilot pressure enters through ports PBa and PBa2. When the pressure enters through port PBa, the spool transfers in the left direction in figure. The hydraulic oil entering through port P2 Passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool. Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm1 spool (302). Then, it flows around the periphery of the arm 1 spool (302) to port Ba, and is supplied to the arm cylinder rod side (R).

On the other hand, the oil entering through port P1 passes in the main path (1), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (394). Oil from the parallel circuit pushes open the check valve (514) and oil from the bypass circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (394). Then, it flows around the periphery of arm 2 spool in the inside path and joins into port Ba. Besides, the return oil from the arm cylinder head side (H) passes through port Aa, flows into tank line in arm 1 side and in arm 2 side and returns to the hydraulic oil tank through the tank port (T1).



② Arm in operation

During the arm in operation, the pilot pressure enters through ports PAa and PAa2. When the pressure enters through port PAa, the spool transfers in the right direction in figure MC17A. The hydraulic oil entering through port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the arm 1 spool. Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 1 spool (302). Then, it flows around the periphery of the arm1 spool to port Aa, and is supplied to the arm cylinder head side (H).

Besides, the oil entering through port P1 passes in the main path (1), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (394). Oil from the parallel circuit pushes open the check valve (514) and oil from the bypass circuit pushes open the check valve (514) and oil from the bypass circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (394). Then, it flows around the periphery of arm 2 spool in the inside path and joins into port Aa.

On the other hand, the return oil from the arm cylinder rod side (R) is pressurized by self-weight of the arms and so on, and returns to port Ba. The pressurized oil returning to Port Ba enters into the spool through the outside hole (a) of the arm1 spool (302). During a light load only, it pushes open the sleeve check valve and part of oil flows the U-shaped path reversely from the spool hole (c), and joins into port Aa. The rest of oil returns to the hydraulic oil tank through the tank port (T1).

This is called the arm regeneration function.

When the pressure in the arm cylinder head side (H) 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 closed by its backpressure. This shuts off the arm regeneration function, and the return oil from the arm cylinder rod side (R) enters from port Ba 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 (T1) to the hydraulic oil tank.

On the other hand, the pressurized oil entering through port P1 joins into port Aa through the inside path similarly to the case of the arm stretching operation.

· During light load only



3607A2MC17A

 \cdot The pressure in the arm cylinder head side (H) increases.



3607A2MC17B

(4) Boom

① Boom up operation

During the boom up operation, the pilot pressure enters through port PBb and moves the boom 1 spool in the left direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the boom 1 spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through U-shaped path to the boom1 spool (303). When the stroke of the boom 1 spool is small, the oil enters through the periphery hole (d) of the spool to the inside of the spool, and flows out to port Bb through the periphery hole (e). When the stroke of the boom 1 spool is large, the oil flows out to port Bb through the periphery of the spool.

At the same time, the pilot pressure enters also through Port PBb2 to transfer the boom 2 spool (393) in the left direction in figure. Though the pressurized oil enters into port P2, the bypass is shut off due to transfer of the boom 2 spool. Therefore, the oil flows in the parallel circuit and flows through the U-shaped path to the boom 2 spool. Then, the oil passes through the periphery of the boom 2 spool, pushes open the check valve (511), joins into port Bb in the inside path, and is supplied to the boom cylinder head side (H). (Boom confluent flow)

On the other hand, the return oil from the boom cylinder rod side (R) enters through port Ab and returns to the hydraulic oil tank through the tank port (T1).



② Boom down operation

During the boom down operation, the pilot pressure enters through port PAb and transfers the boom1 spool in the right direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows to the bypass circuit (2), but the bypass circuit is shut off due to transfer of the boom 1 spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the boom 1 spool (303). Then, it flows around the periphery of the boom 1 spool to port Ab and is supplied to the boom cylinder rod side (R).

On the other hand, the return oil from the boom cylinder head side (H) passes to the notch of the boom 1 spool.

Since this return oil has a sufficient pressure caused by the weight of the boom, it passes through the path inside the spool, pushes the poppet A in the spool in the left direction shown in the figure, flows around the outside of the spool. Then, it is supplied again to the boom cylinder rod side (R) as hydraulic oil to lower the boom. (Boom regeneration)

Besides, a part of the return oil from the boom cylinder flows from the check valve B (boost check) into the tank.

The boost check boosts the hydraulic oil flowing to the tank to secure the sufficient regeneration flow rate.

During the boom down and arm stretching operation, the pilot pressure enters through port PAbs and the boom 1 spool transfers in the half stroke not full stroke.



(5) Bucket

① Bucket in operation

During the bucket in operation, the pilot pressure enters through port PAc and transfers the bucket spool in the right direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit is shut off due to transfer of the bucket spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to port Ac and is supplied to the bucket cylinder head side (H).

On the other hand, the return oil from the bucket cylinder rod side (R) enters through port Bc, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (T1).

During the boom up and bucket in operation, the pilot pressure enters through Port PAcs and the bucket spool transfers in the half stroke not full stroke. Therefore, the most of pressurized oil entering through Port P1 flows to the boom 1 spool (304) than the bucket spool (304) to make the boom up operation most preferential.



② Bucket out operation

During the bucket out operation, the pilot pressure enters through port PBc and transfers the bucket spool in the left direction in figure. The pressurized oil entering through port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit is shut off due to transfer of the bucket spool. Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the bucket spool (304). Then, it flows through the periphery of the spool to port Bc and is supplied to the bucket cylinder rod side (R).

On the other hand, the return oil from the bucket cylinder head side (H) enters through port Ac, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (T1).



(6) Swing

1 Independent swing operation

During the swing operation, the pilot pressure enters through port PAs (or PBs) and transfers the swing spool. The pressurized oil entering through Port P2 flows to Port As (or Bs) and is supplied to the swing motor. The return oil from the swing motor enters Port Bs (or As) and returns to the hydraulic oil tank through the tank port (T1).

② Swing operation preference function

[Pilot Circuit]

The pilot pressure enters through Port PSp to transfer the swing priority spool (395).

[Main Circuit]

Due to transfer of the swing priority spool, the open area of the swing priority spool decreases, and the most of the pressurized oil entering through port P2 flows to the swing side to make the swing operation most preferential.



(7) Travel straight operation

Simultaneous operating of both travel spools and other spool. A case where both travel spools and swing spool are changed over will be considered. (The pilot ports PAL, PAr and PAs are pressurized.)

[Pilot Circuit]

Since the side bypass sections of both travel spools close and the side bypass section of the downstream-side swing closes, the pilot pressure from the port Pa enters through the port PTa to transfer the travel straight spool.

[Main Circuit]

After changeover of the travel straight spool, the port P2 and both travel spools are connected preferentially and the port P1 and the parallel paths of swing, boom 2, option and arm 1 / boom 1, bucket and arm 2 are connected preferentially. Therefore, the pressurized oil entering through port P2 passes through mainly ports AL and Ar, and flows to both travel motors separately.

On the other hand, the pressurized oil entering through port P1 flows to port As and is supplied to the swing motor.

When the pressure of port P2 is lower than the pressure of port P1, part of oil entering through port P1 flows into port P2 side. Therefore, it prevents the rapid slowdown of travel.



(8) Function of lock valve

The lock valve is fitted between the arm cylinder rod side (R) and the arm1 spool (302). It decreases the leakage by the pressure of the cylinder.

Another lock valve is similarly fitted between the boom cylinder head side (H) and the boom1 spool (303). It decreases the leakage by the pressure of the cylinder.

① Neutral positions of spools

The following is the case of the boom 1 spool.

(The case of the arm 1 spool is in the same way.)

During the boom 1 spool is in neutral position, the lock valve is kept in the position shown in figure. The spool (511) in lock valve is pushed to the seat of the bush (541) by the force of the spring (512).

In this position, pressurized oil from the boom cylinder head side (H) enters through hole (a), the periphery of the spool and hole (b), and it pushes the poppet to the casing seat, and the leakage is decreased.



② Boom down operation

During the boom down operation, pilot pressure enters through port P2c1 and PAb. Pilot pressure transfers the spool (511) in lock valve assy in the right direction in figure. By the transfer of the spool, firstly the hole (a) is blocked and pressurized oil from the boom cylinder head side (H) does not enter to spring chamber (RH). Secondly, oil in spring chamber (RH) enters through hole (b) and flows to port Dr3'.

Therefore, the poppet is lifted by the pressure of the boom cylinder head side (H) and the function of the lock valve is released.



3607A2MC25

③ Boom up operation

During the boom up operation, the pilot pressure enters through port PBb. The oil flowing from the boom 1 spool pushes open the poppet (513) and flows to Port Bb.

(9) Function of boom priority valve

During both the swing operation and the boom hoisting operation, the pilot pressure enters through ports PAs(or PBs), PBb and Pns. The pressure Pns transfers the piston (356) and the spool (107) to the down direction, and the path from (a) to (b) is closed. Hereby, the pressurized oil pushes open the poppet (102), passes in the path (c) and (d), enters into the chamber (e), and the poppet (101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through port P2 flows to the boom priority spool (393) than the swing spool (305) to make the boom hoisting operation most preferential.

On the other hand, in the independent swing operation, the pilot pressure does not enter through ports Pns, and the path from (a) to (b) is not closed, and oil of chamber (e) flows to the path (a) and (b). The pressurized oil entering through port P2 pushes open the poppet (101) and flows to the swing spool (305).



(10) Function of main relief valve

The main relief valve is fitted in the casing B and functions as follows :

- The hydraulic oil is filled up in the inside space chamber (A) from the path (P) through a hole of the body (101) and a restriction of the plunger (511), and seats the plunger (511) against body (101) securely.
- ② When the pressure in the path (P) becomes equal to the set load of the spring (512), the poppet (401) opens to make the hydraulic oil flow through a hole of the seat (2) (641), around the poppet (401) and into the low pressure path (R).
- ③ Opening of the poppet (401) causes the pressure in the chamber (A) to fall and the plunger (511) to open. As the result the pressurized oil in the path (P) runs into the low pressure path (R) directly.
- ④ When the pressurized oil higher than pressure 2.2MPa enters through the port PL1, it pushes the piston (302) to change the relief set pressure of the spring (512) to the high pressure.



(11) Function of port relief valve

The port relief value is fitted between the cylinder port and low-pressure path. In addition to the relief value, this serves also as an anti-cavitation check value, and functions as follows:

(1) Function as relief valve

① The pressurized oil passes through hole A of the piston (301), is filled up in chamber B of the inside space, and seat the plunger (511) against the seat (541) securely.



3607A2MC28



② When the pressure in the path (P) becomes equal to the set pressure of the spring (621 or 622), the pressurized oil pushes open the poppet (611), flows around it, and flows to the low pressure path (R) through Hole C.



3607A2MC30



③ Opening of the poppet (611) causes the pressure in chamber B to fall and the plunger (511) to open. As the result the pressurized oil in the path (P) runs into the low pressure path (R) directly.



3607A2MC32



3607A2MC33

④ When the pressurized oil higher than pressure 1.5MPa enters through the port PL, it pushes the piston (614) to change the relief set pressure of the spring (622) to the high pressure.

(2) Function as anti-cavitation check valve

When any negative pressure exists in the path (p), the oil is supplied through the path (R). When the pressure at (R) becomes higher than that in the path (P), the seat (541) moves in the right direction.

Then, sufficient oil passes around the seat (541) from the path (R) to the path (P) and prevents cavitation.



3607A2MC34



(12) Function of negative control relief valve

The negative control relief valve is fitted between the downstream of the center bypass path and low-pressure path, and functions as follows :

- When the pressure in the path (P) falls below the set level of the spring (621),the poppet (611) is in the condition shown in the figure. The pressure acting area of the poppet (611) is reduced to (ØB-ØA), as the area ØB is cancelled by the area ØA of the damping rod (631).
- ② In this condition, the pressurized oil in the path (P) runs out to the path (R) through the orifice (c).





③ When the pressure in the path (P) goes over the set pressure of the spring(621), the poppet (611) opens. Then, the pressurized oil in the path (P) passes around the outside of the poppet (611) and flows to the low-pressure path (R).



The relation between the flow rate Q and pressure P of the hydraulic oil that flows from the path (P) to the low-pressure path (R) is as shown in the diagram.

