SECTION 2 STRUCTURE AND FUNCTION

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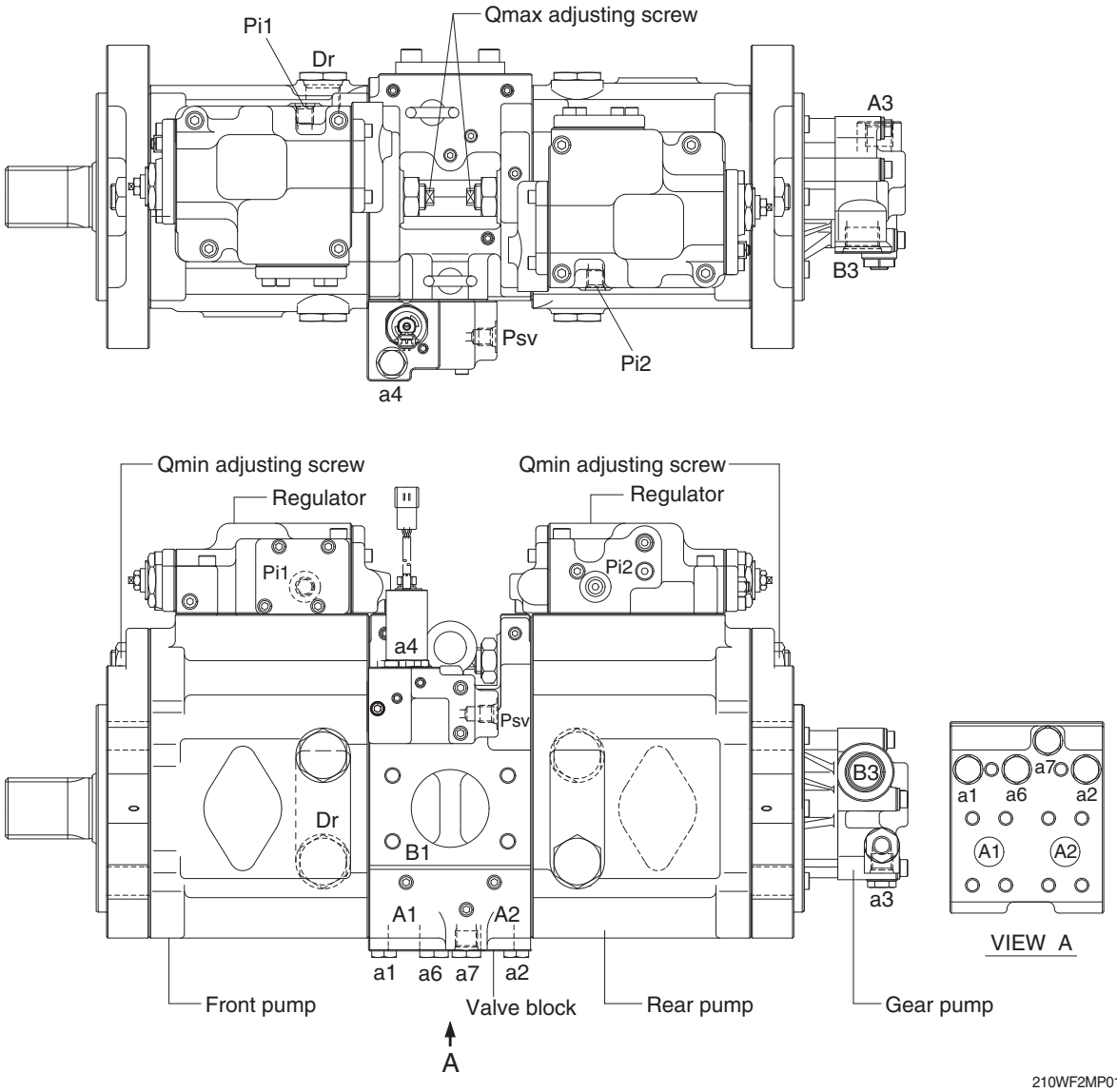
GROUP 1 PUMP DEVICE

1. STRUCTURE

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



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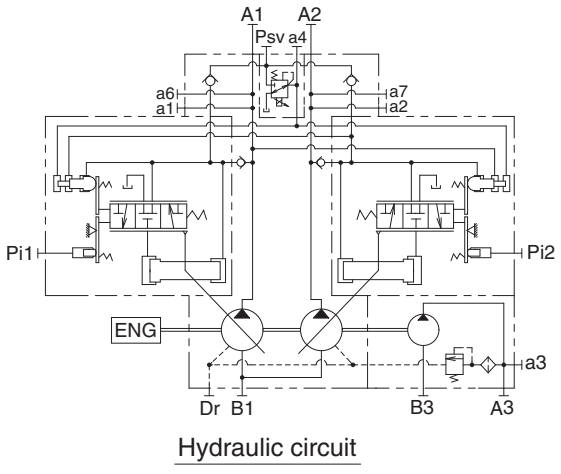
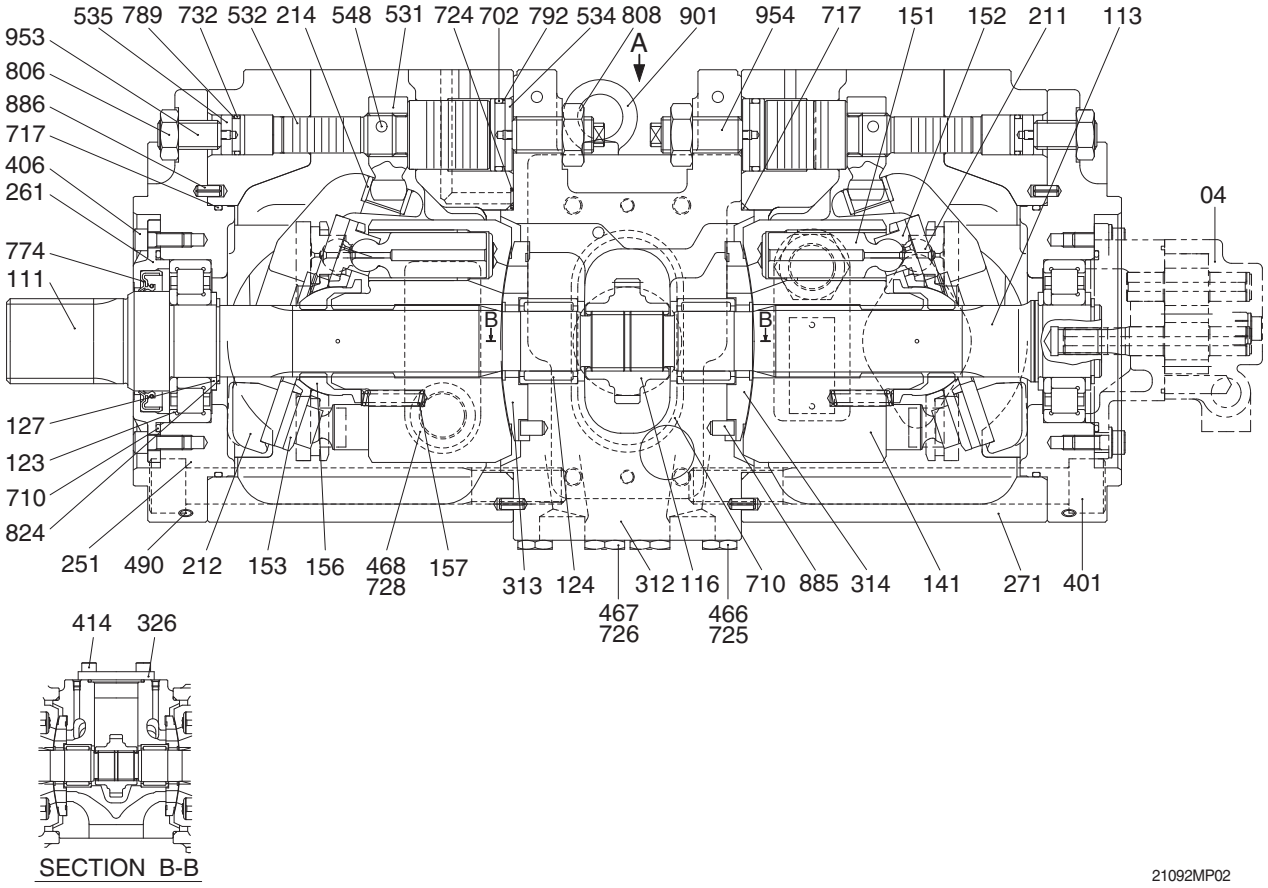


Hydraulic circuit

Port	Port name	Port size
A1,2	Delivery port	SAE6000psi 1"
B1	Suction port	SAE2500psi 2 1/2"
Dr	Drain port	PF 3/4 - 20
Pi1,i2	Pilot port	PF 1/4 - 15
Psv	Servo assist port	PF 1/4 - 15
a1,2,4	Gauge port	PF 1/4 - 15
a6, 7	Gauge port	PF 3/8 - 17
a3	Gauge port	PF 1/4 - 14
A3	Gear pump delivery port	PF 1/2 - 19
B3	Gear pump suction port	PF 3/4 - 20.5

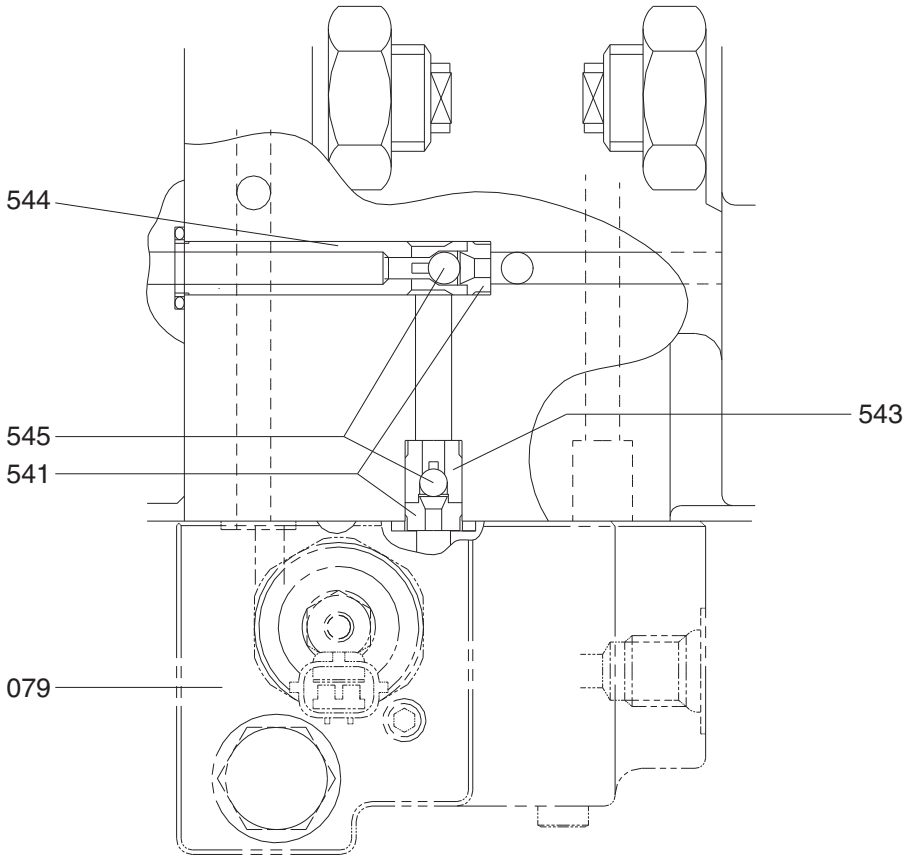
1) MAIN PUMP (1/2)

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



04	Gear pump	271	Pump casing	710	O-ring
111	Drive shaft (F)	312	Valve block	717	O-ring
113	Drive shaft (R)	313	Valve plate (R)	724	O-ring
116	Gear	314	Valve plate (L)	725	O-ring
123	Roller bearing	326	Cover	726	O-ring
124	Needle bearing	401	Hexagon socket bolt	728	O-ring
127	Bearing spacer	406	Hexagon socket bolt	732	O-ring
141	Cylinder block	414	Hexagon socket bolt	774	Oil seal
151	Piston	466	VP Plug	789	Back up ring
152	Shoe	467	VP plug	792	Back up ring
153	Set plate	468	VP Plug	806	Hexagon head nut
156	Bushing	490	Plug	808	Hexagon head nut
157	Cylinder spring	531	Tilting pin	824	Snap ring
211	Shoe plate	532	Servo piston	885	Pin
212	Swash plate	534	Stopper (L)	886	Spring pin
214	Bushing	535	Stopper (S)	901	Eye bolt
251	Support	548	Pin	953	Set screw
261	Seal cover (F)	702	O-ring	954	Set screw

MAIN PUMP (2/2)

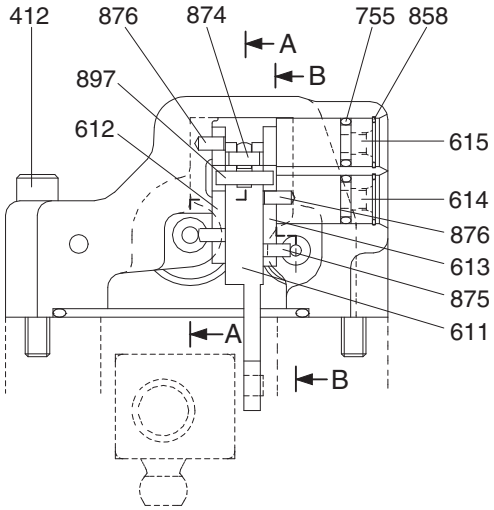


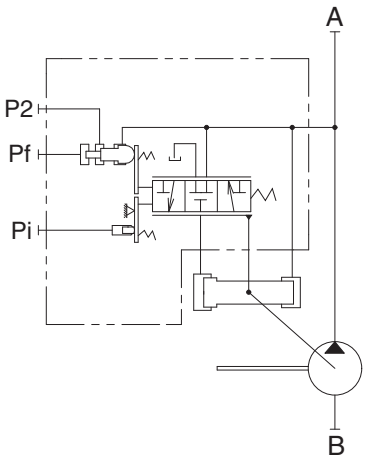
VIEW A

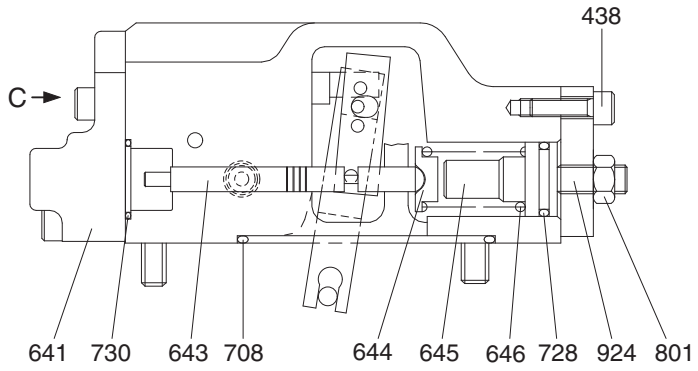
21092MP08

079	Proportional reducing valve	543	Stopper 1	545	Steel ball
541	Seat	544	Stopper 2		

2) REGULATOR (1/2)

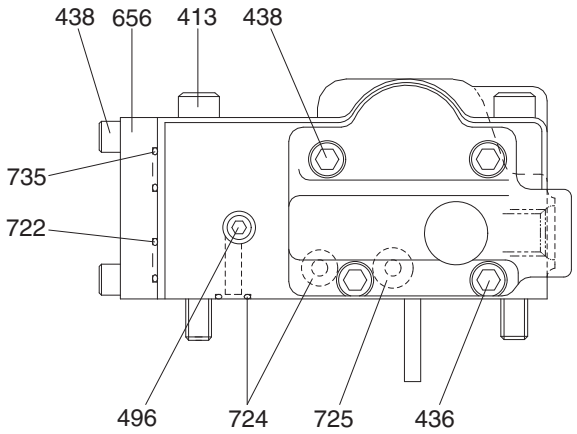






SECTION B-B

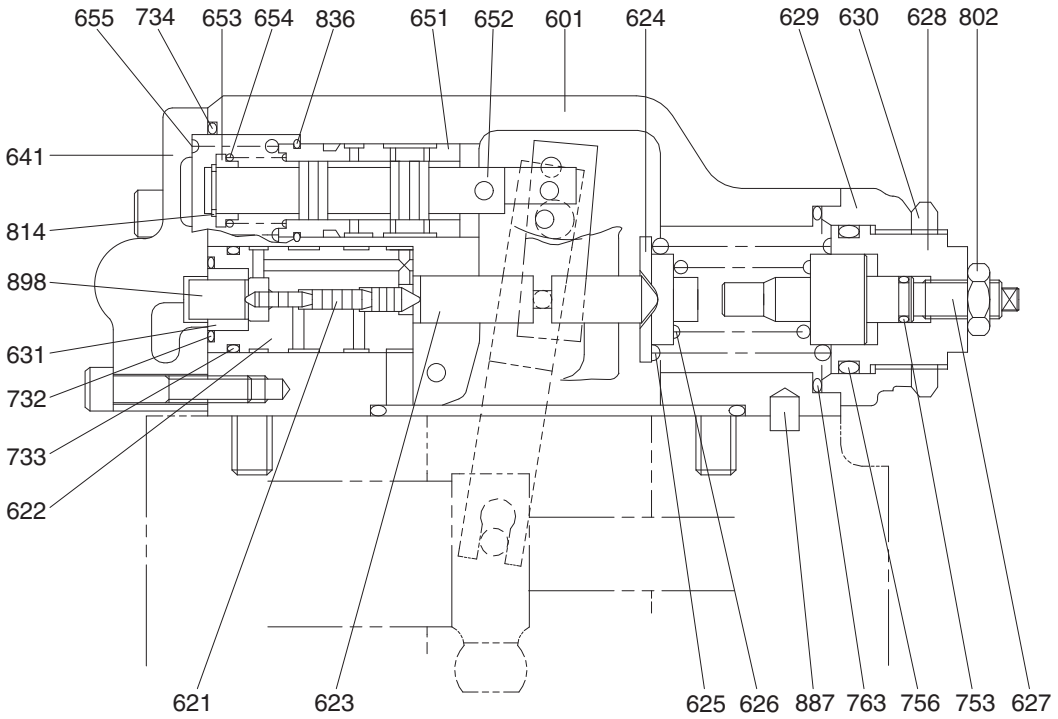
210WF2MP03



VIEW C

Port	Port name	Port size
A	Delivery port	1"
B	Suction port	2 1/2"
Pi	Pilot port	PF 1/4-15
Pf	Power shift port	-
P2	Companion delivery port	-

REGULATOR (2/2)

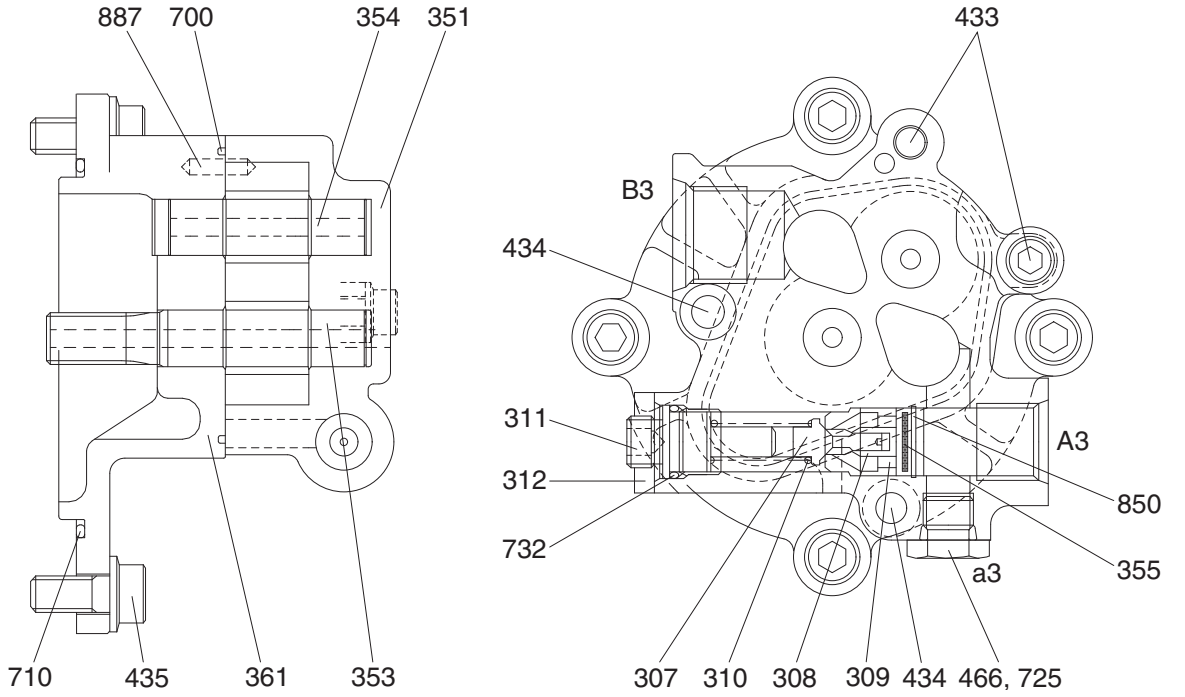


SECTION A-A

210WF2MP04

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

3) GEAR PUMP



21092MP05

307	Poppet	353	Drive gear	466	Plug
308	Seat	354	Driven gear	700	Ring
309	Spring seat	355	Filter	710	O-ring
310	Spring	361	Front case	725	O-ring
311	Screw	433	Flange socket	732	O-ring
312	Nut	434	Flange socket	850	Snap ring
351	Gear case	435	Flange socket	887	Pin

2. FUNCTION

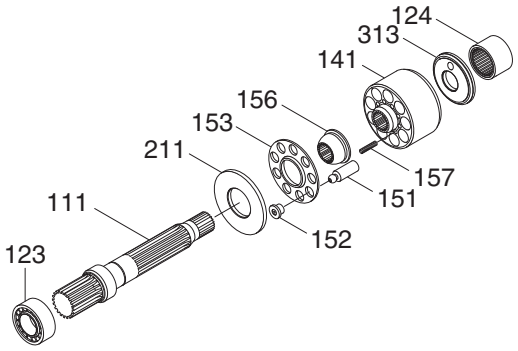
1) MAIN PUMP

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

(1) Rotary group

The rotary group consists of drive shaft (F) (111), cylinder block (141), piston shoes (151,152), set plate (153), spherical bushing (156) and cylinder spring (157). The drive shaft is supported by bearing (123,124) at its both ends.

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



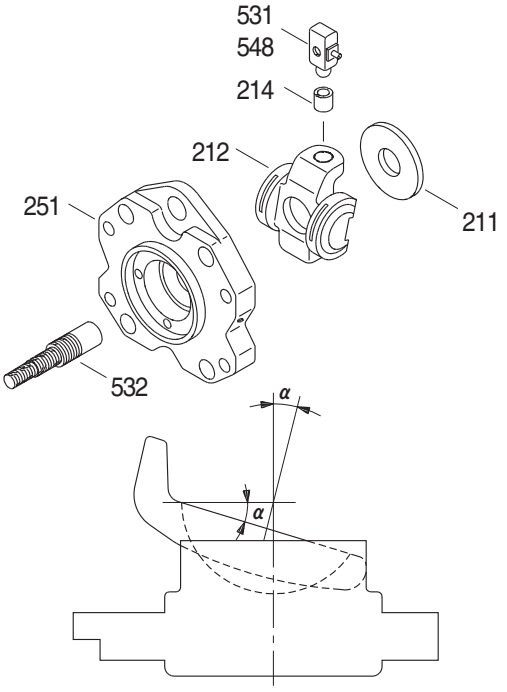
21092MP06

(2) Swash plate group

The swash plate group consists of swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and servo piston (532).

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

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



2-7

(3) Valve block group

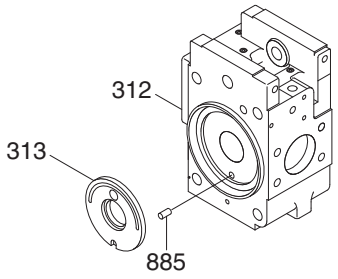
The valve block group consists of valve block (312), valve plate (313) and valve plate pin(885).

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

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

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

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



21092MP07

2) REGULATOR

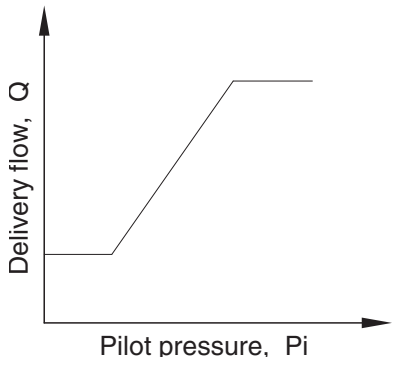
Regulator consists of the positive flow control, constant horse power control and variable horse power control function.

(1) Positive flow control

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

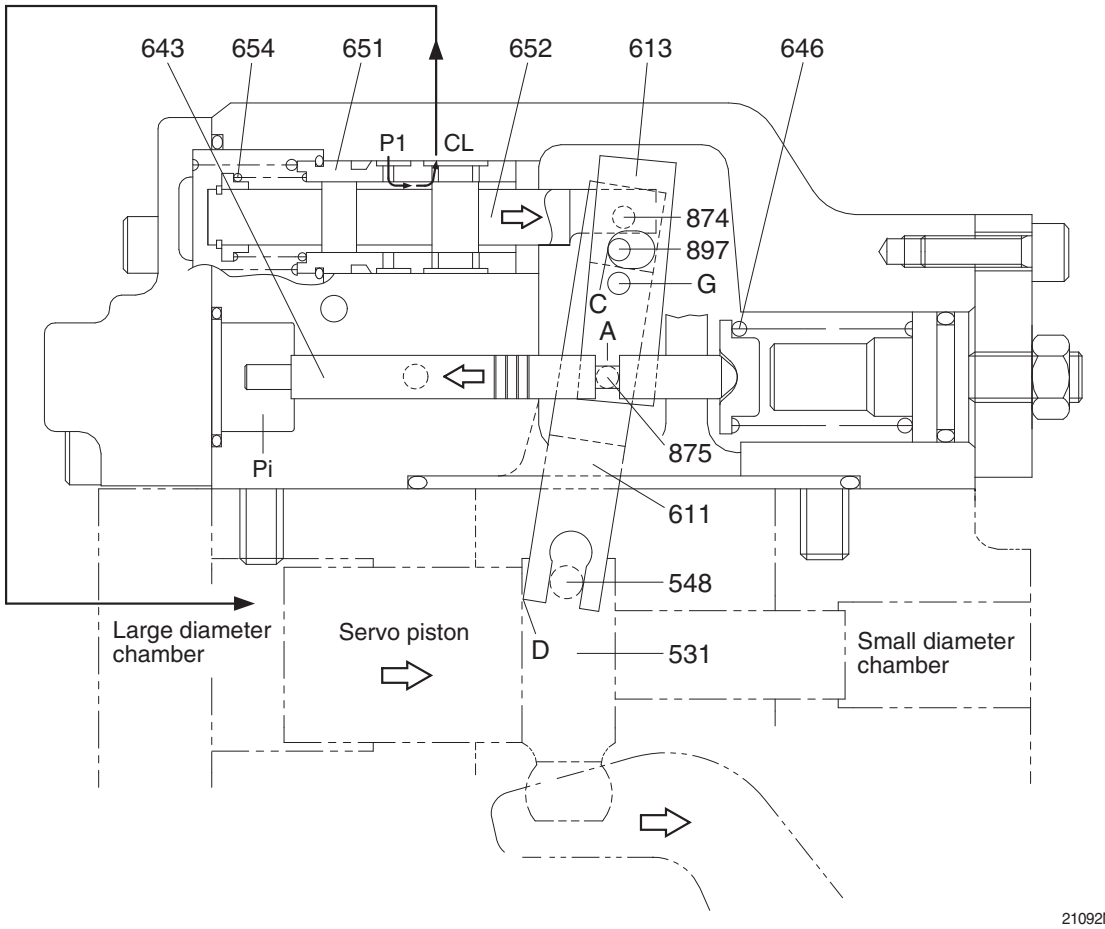
This regulator is of the positive flow control in which the delivery flow Q increases as the pilot pressure Pi rises.

With this mechanism, when the pilot pressure corresponding to the flow required for the work is commanded, the pump discharges the required flow only, and so it does not consume the power uselessly.



21092MP10

① Flow reducing function



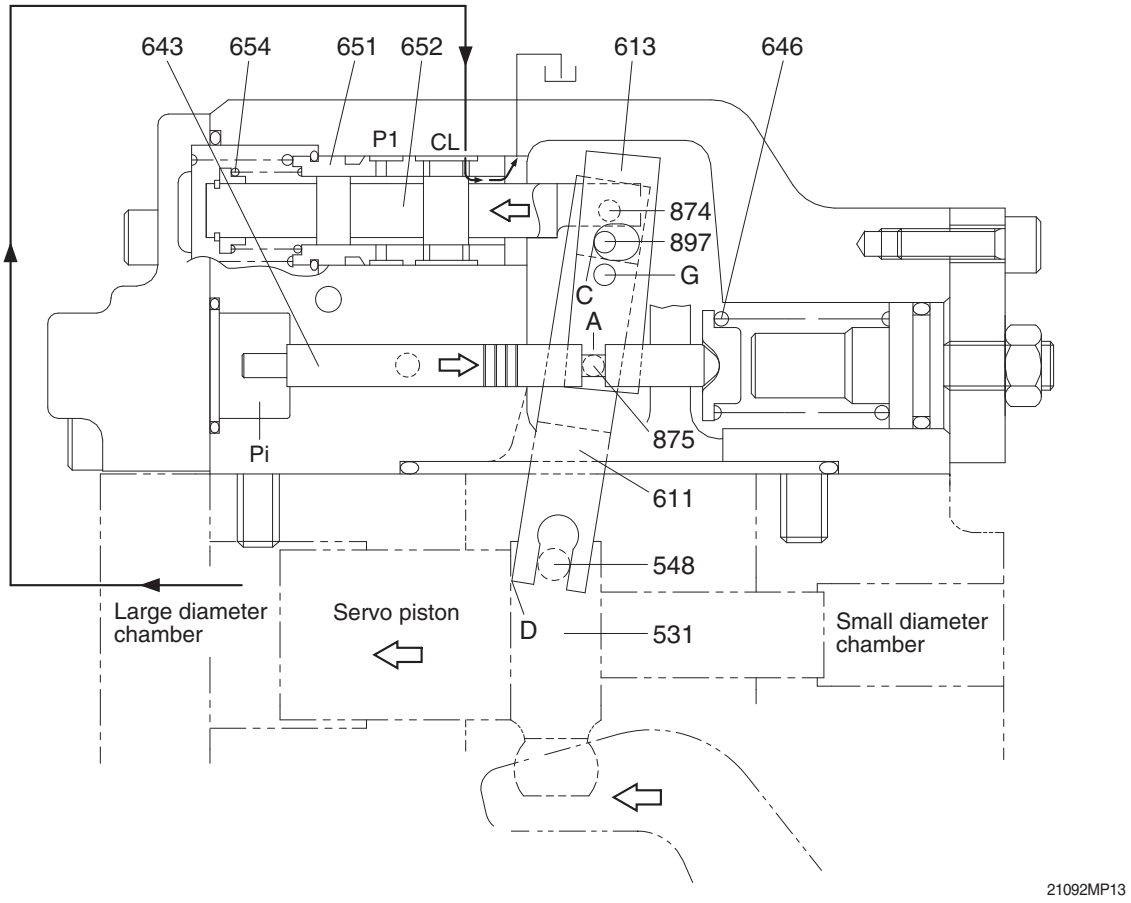
As the pilot pressure Pi decreases, the pilot piston (643) moves to the left by the action of the pilot spring (646) and causes lever 2 (613) to rotate around the fulcrum of point G. Since the pin (897) is pressed against the large hole section (C) of lever 2 by the action of the return spring (654) via the spool (652), pin (874), and feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 2 rotates, and shifts the spool to the right.

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

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

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

② **Flow increasing function**



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

The groove (A) in the pilot piston is fitted with the pin (875) that is fixed to lever 2 (613). Therefore, when the pilot piston moves, lever 2 rotates around the fulcrum of point G [fixed by the fulcrum plug (614) and pin (875)]. Since the large hole section (C) of lever 2 contains a protruding pin (897) fixed to the feedback lever (611), the pin (897) moves to the left as lever 2 rotates.

Port CL opens a way to the tank port as the spool moves. This deprives the large diameter section of the servo piston of pressure, and shifts the servo piston to the left by the discharge pressure P1 in the small diameter section, resulting in an increase in the flow rate.

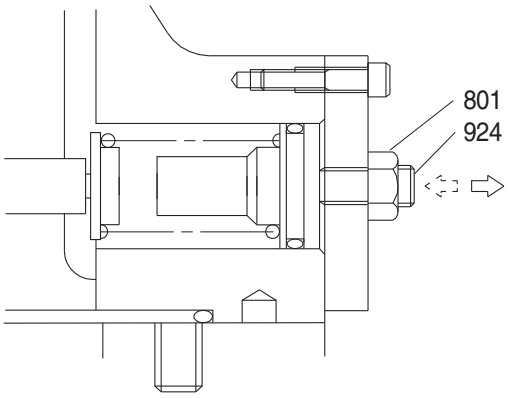
As the servo piston moves, point D also moves to the left, the feedback lever rotates around the fulcrum of point C, and the spool moves to the right till the opening between the spool and sleeve is closed.

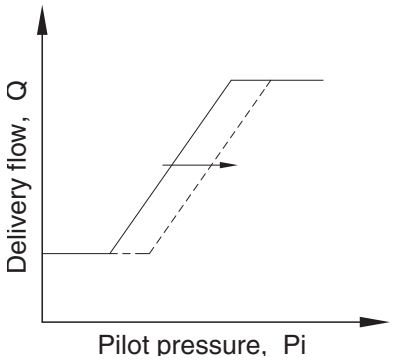
Adjustment of flow control characteristic

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

※ **Adjusting value**

Speed	Adjustment of flow control characteristic		
	Tightening amount of adjusting screw(924)	Flow control starting pressure change amount	Flow change amount
(min $^{-1}$)	(Turn)	(kgf/cm^2)	(ℓ /min)
1900	+1/4	+1.1	-17.6





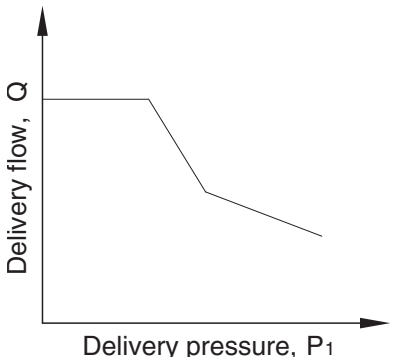
21092MP11

(2) Constant horsepower control

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

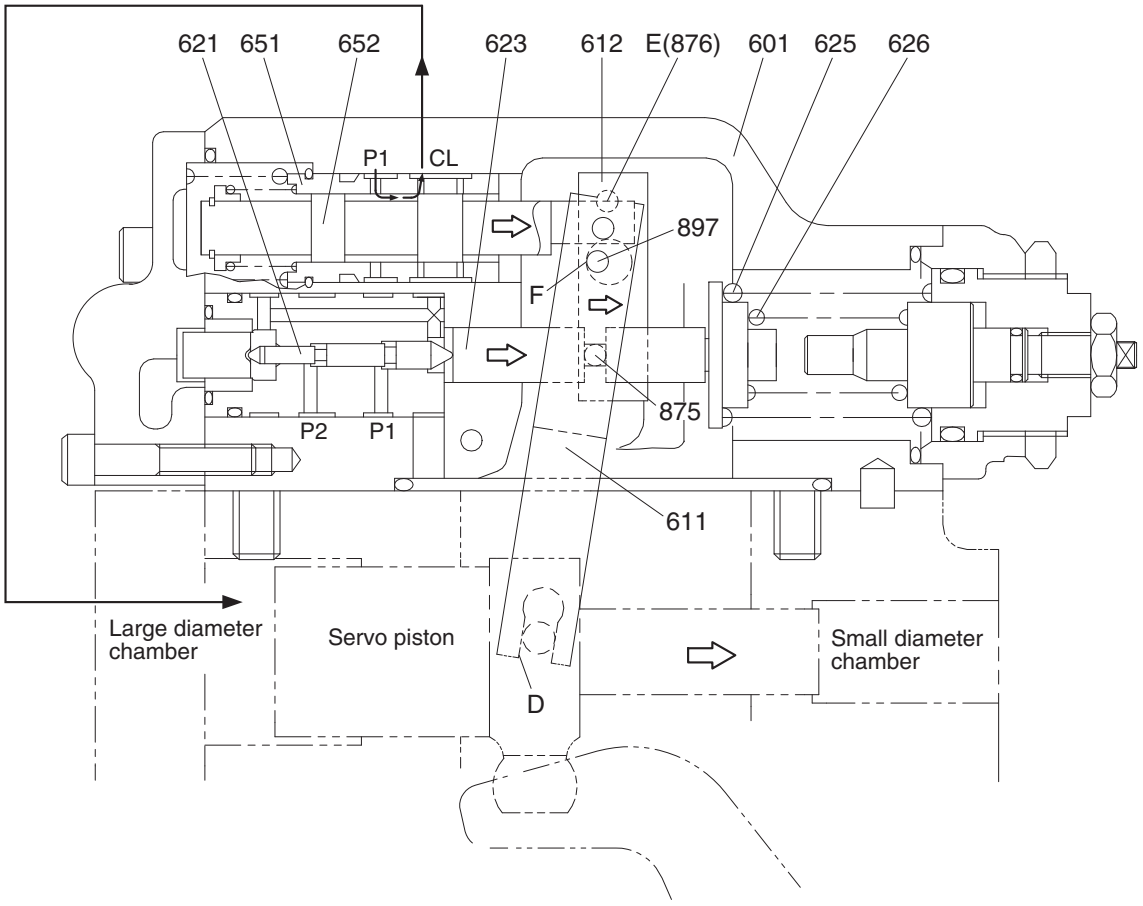
$$Tin = P1 \times q/2 + P2 \times q/2$$
$$= (P1+P2) \times q/2$$

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



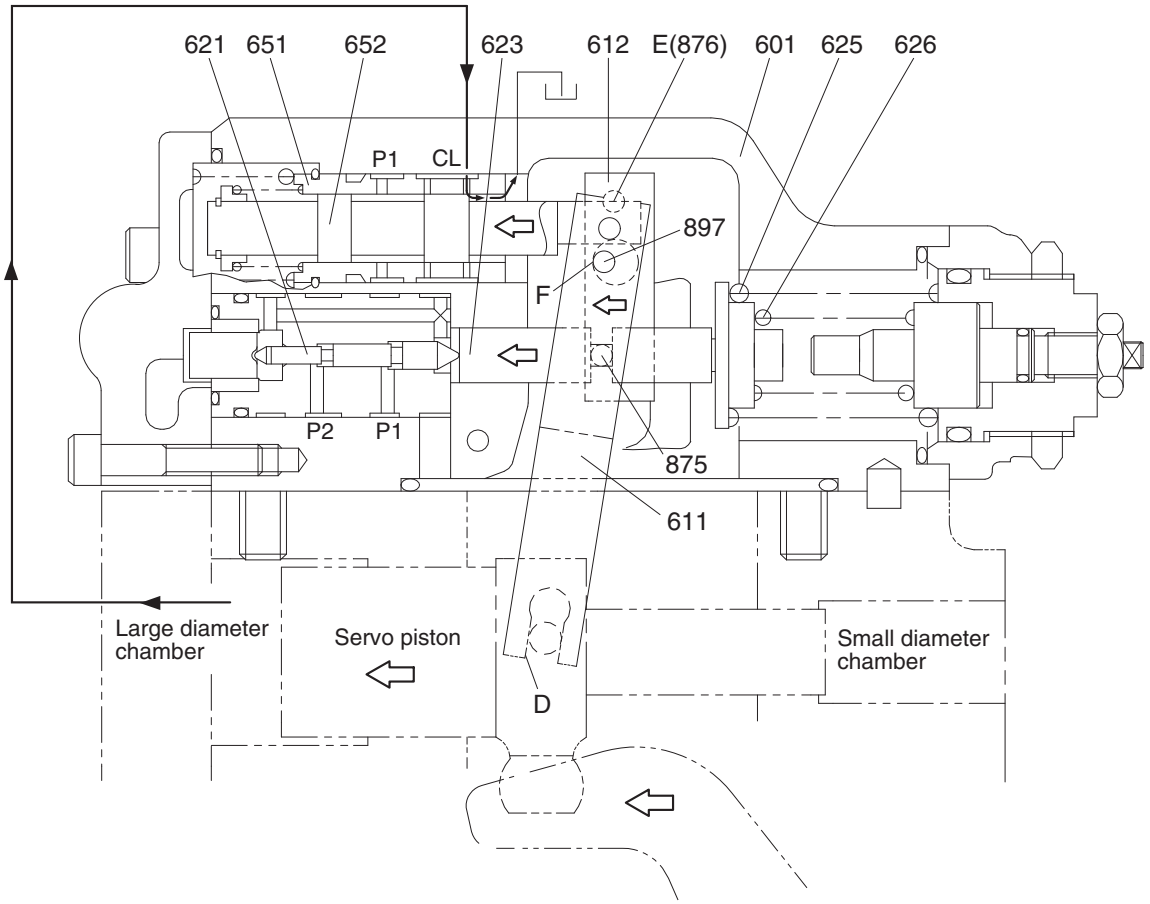
21092MP19

① Overload preventive function



When the self pump delivery pressure P1 rises, it acts on the stepped part of the compensating piston (621). It presses the compensating rod (623) to the right till the force of the outer spring (625) and inner spring (626) balances with the hydraulic force. The movement of the compensating rod is transmitted to lever 1 (612) via pin (875).
Lever 1 rotates around the pin (876) (E) fixed to the casing (601).
Since the large hole section (F) of lever 1 contains a protruding pin (897) fixed to the feedback lever (611), the feedback lever rotates around the fulcrum of point D as lever 1 rotates, and then the spool (652) is shifted to the right. As the spool moves, the delivery pressure P1 is admitted to the large diameter section of the servo piston via port CL, causes the servo piston move to the right, reduces the pump delivery, flow rate, and prevents the prime mover from being overloaded.
The movement of the servo piston is transmitted to the feedback lever via point D. Then the feedback lever rotates around the fulcrum of point F and the spool is shifted to the left. The spool moves till the opening between the spool (652) and sleeve (651) is closed.

② **Flow reset function**



As the self pump delivery pressure P1, the compensating rod (623) is pushed back by the action of the springs (625 & 626) to rotate lever 1 (612) around point E. Rotating of lever 1 causes the feedback lever (611) to rotate around the fulcrum of point D and then the spool (652) to move to the left. As a result, port CL opens a way to the tank port.
This causes the servo piston to move to the left and the pump's delivery rate to increase.
The movement of the servo piston is transmitted to the spool by the action of the feedback mechanism to move it till the opening between the spool and sleeve is closed.

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

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

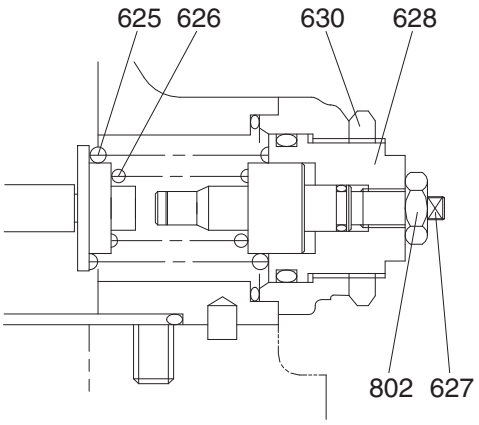
Adjustment of input horsepower

④

a. **Adjustment of outer spring**

Adjust it by loosening the hexagon nut (630) and by tightening (or loosening) the adjusting screw C (628). Tightening the screw shifts the control chart to the right and increases the input horsepower as shown in the figure.

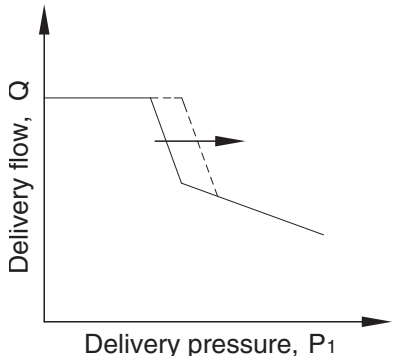
Since turning the adjusting screw C by N turns changes the setting of the inner spring (626), return the adjusting stem C (627) by N×A turns at first.(A=1.78)



2107A2MP07

※ **Adjusting value**

Speed	Adjustment of input horsepower		
	Tightening amount of adjusting screw(627)	Compensating control starting pressure change amount	Input torque change amount
(min^{-1})	(Turn)	(kgf/cm^2)	(kgf·m)
1900	+1/4	+15.9	+4.0



21092MP17

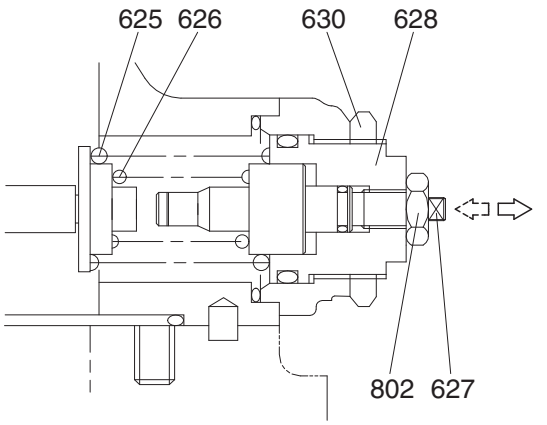
b. Adjustment of inner spring

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

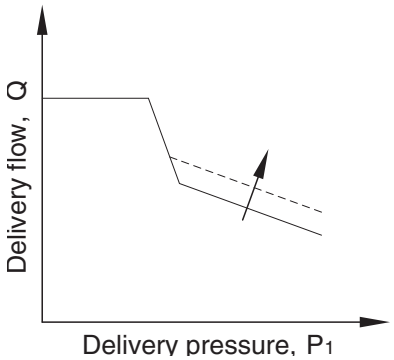
Tightening the screw increases the flow and then the input horsepower as shown in the figure.

※ Adjusting valve

Speed	Adjustment of input horsepower		
	Tightening amount of adjusting stem (C) (627)	Flow change amount	Input torque change amount
(min $^{-1}$)	(Turn)	(ℓ /min)	(kgf·m)
1900	+1/4	+11.3	+4.7



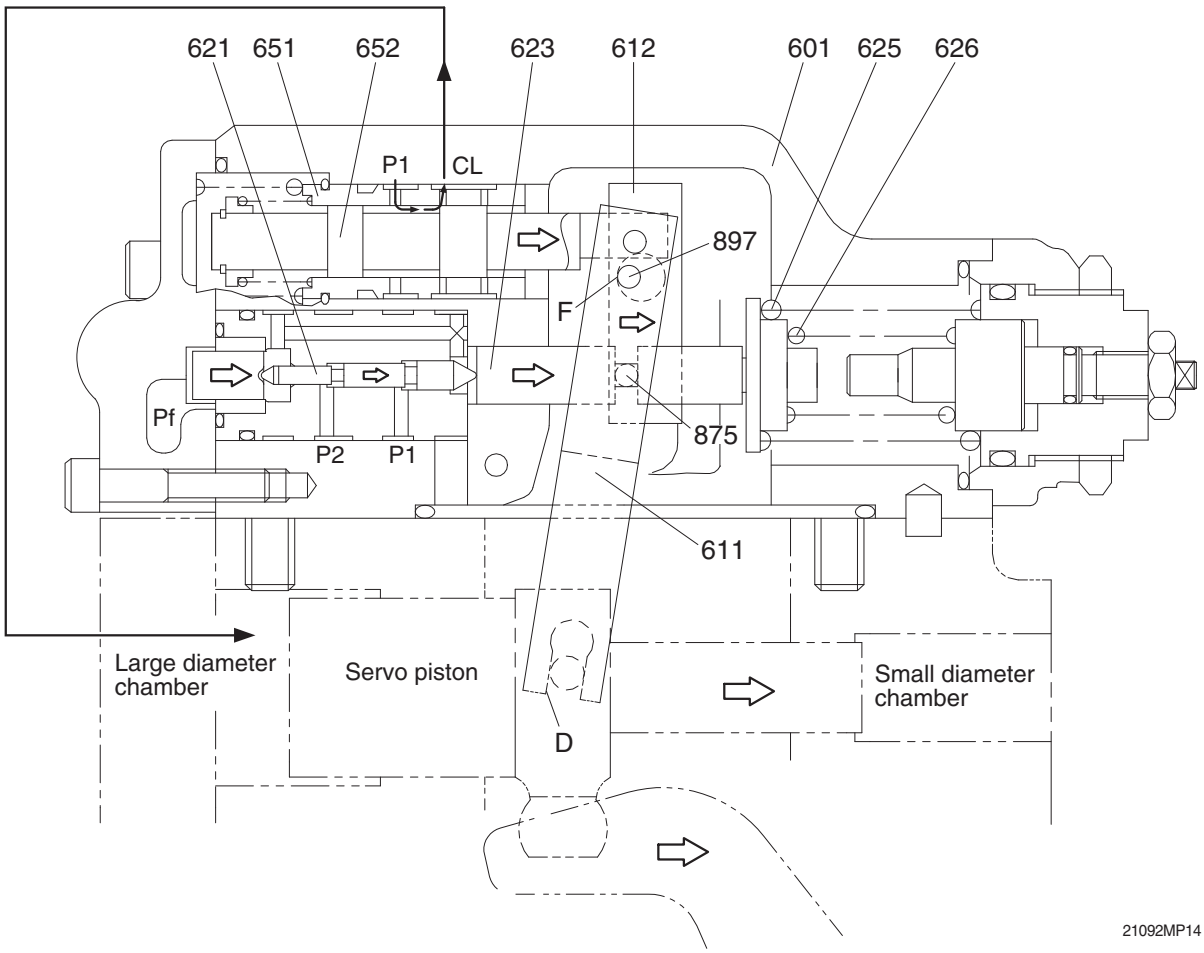
2107A2MP08



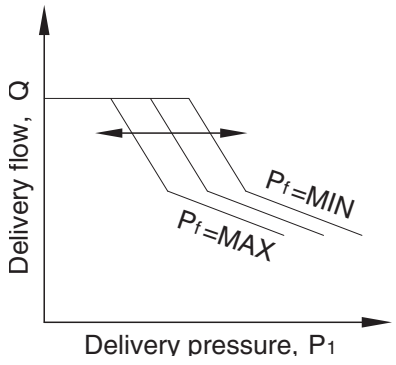
21092MP18

(3) Variable horsepower control

Variable horsepower control can be obtained by supplying pilot pressure.



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



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

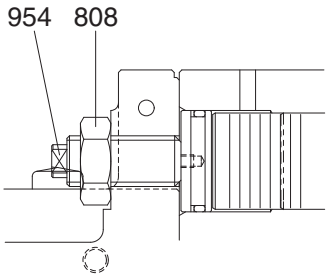
(4) Adjustment of maximum and minimum flows

The regulator can adjust the maximum and minimum flows with the adjusting screws.

① Adjustment of maximum flow

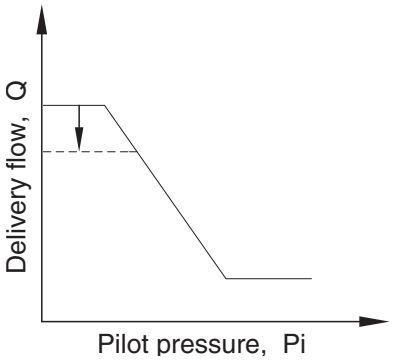
Adjust it by loosening the hexagon nut (808) and by tightening (or loosening) the set screw (954).

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



21092MP23

Speed	Adjustment of max flow	
	Tightening amount of adjusting screw (954)	Flow change amount
(min -1)	(Turn)	(l /min)
1900	+1/4	-5.5

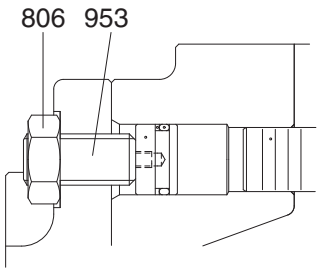


21092MP21

② Adjustment of minimum flow

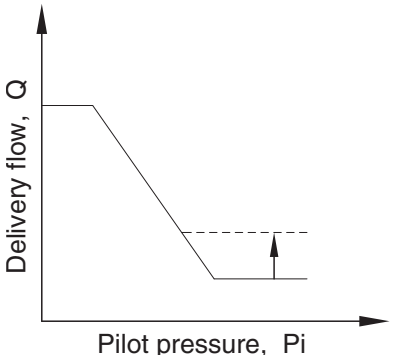
Adjust it by loosening the hexagon nut (806) and by tightening (or loosening) the hexagonal socket head set screw (953). Similarly to the adjustment of the maximum flow, other characteristics are not changed.

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



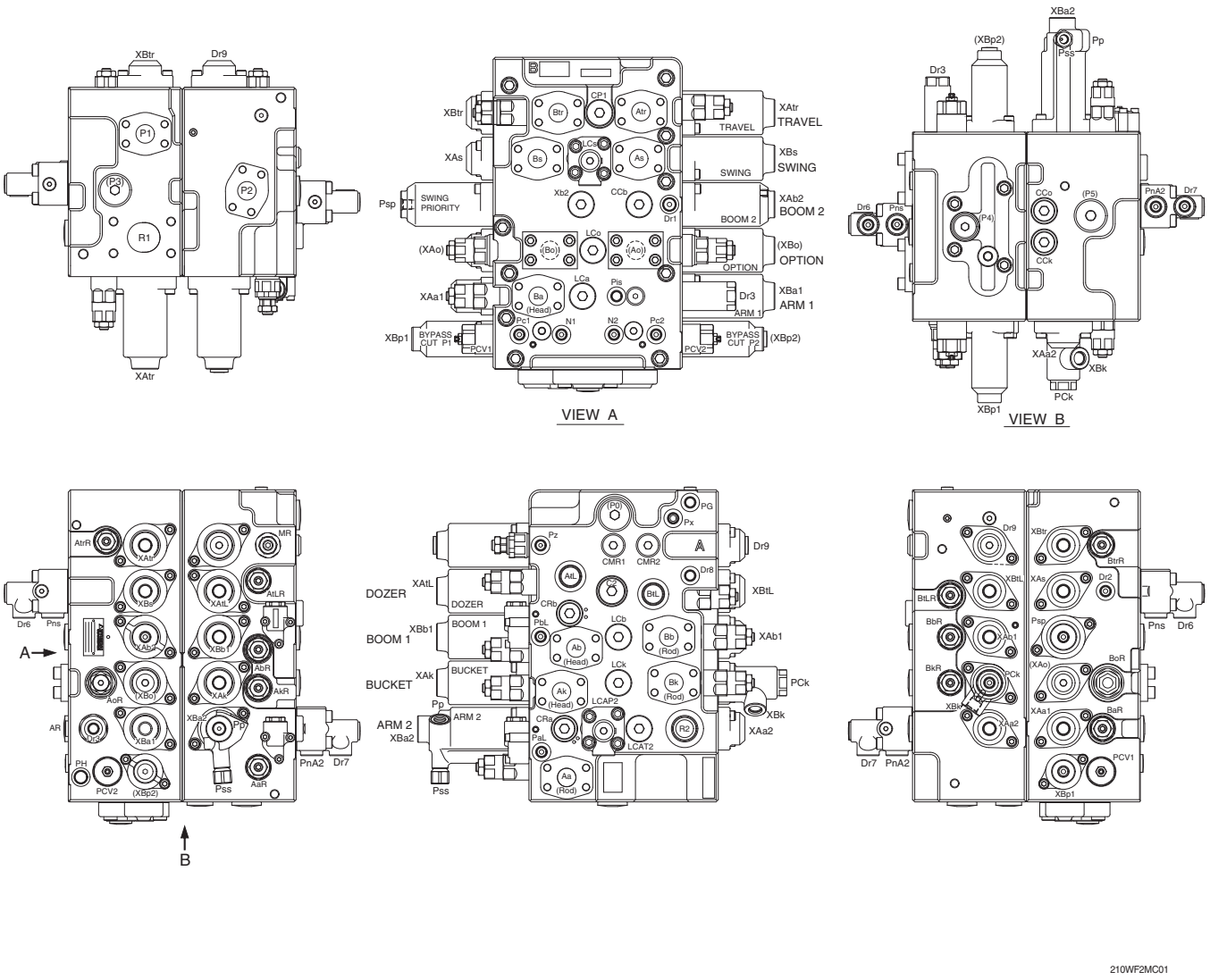
21092MP24

Speed	Adjustment of min flow	
	Tightening amount of adjusting screw (953)	Flow change amount
(min -1)	(Turn)	(l /min)
1900	+1/4	+4.4

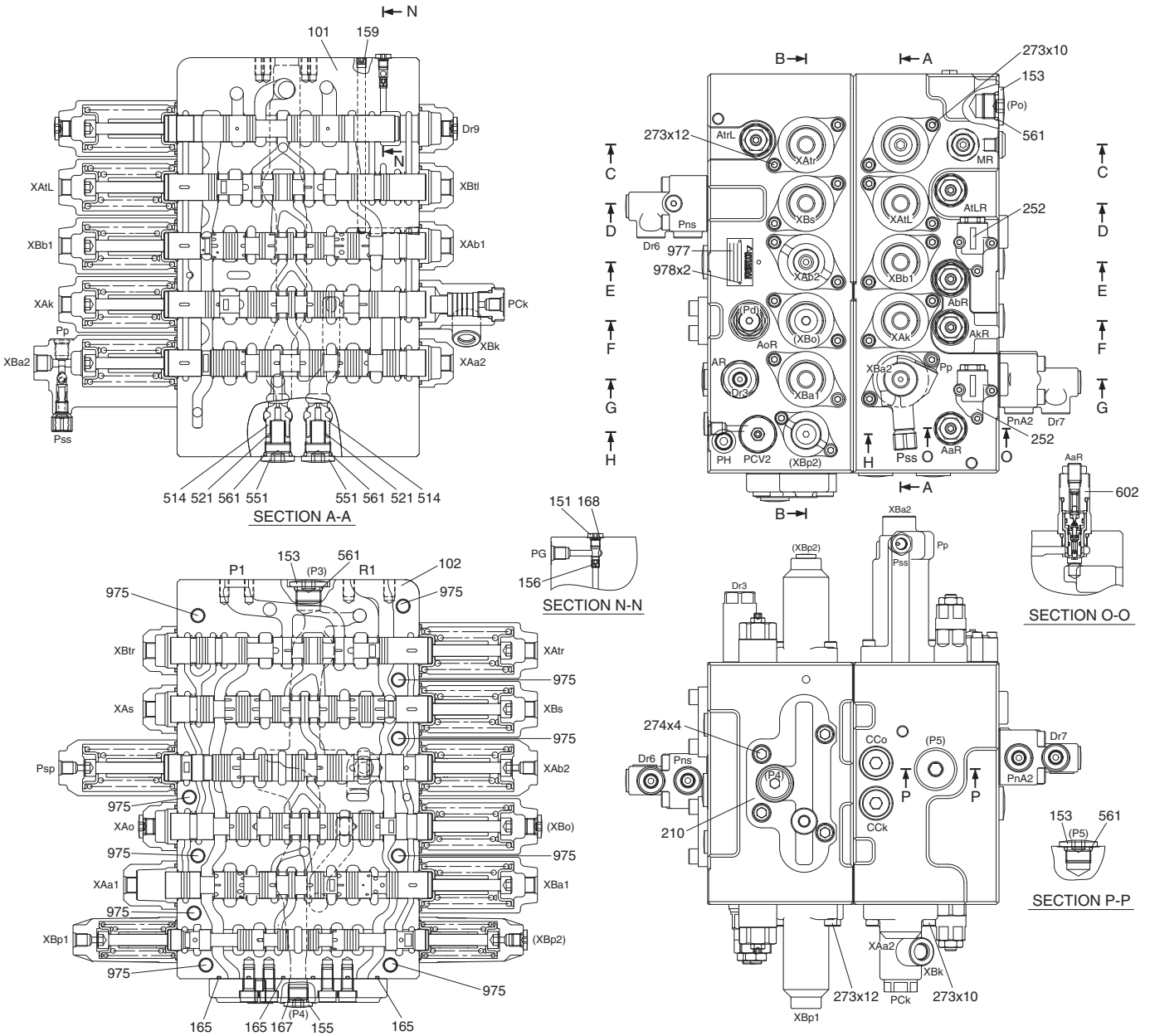


21092MP22

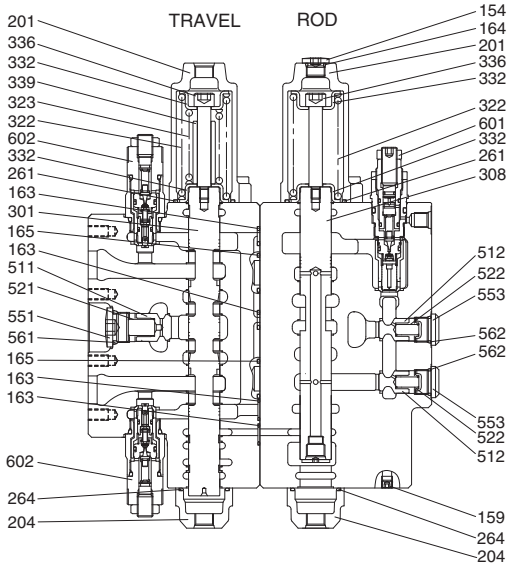
1. STRUCTURE



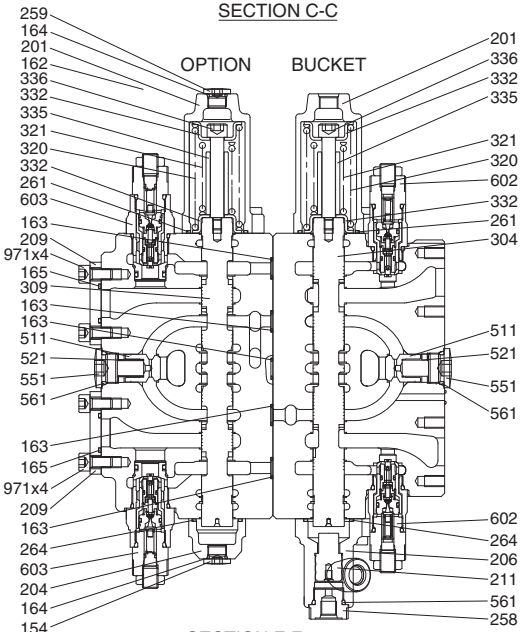
Mark	Port name	Port size	Tightening torque
R2	Make up port for swing	PF 1	20~25 kgf · m (115~180 lbf · ft)
XAtr XBtr (XAo) (XBo) XAk XBk XAb1 XBb1 XAa2 XBa2 XAtL XBtL XAs XBs XAa1 XBa1 PH Dr1 Dr9	Travel forward pilot port Travel reverse pilot port Optional pilot port Optional pilot port Bucket in pilot port Bucket out pilot port Boom up pilot port Boom down pilot port Arm out confluence pilot port Arm in confluence pilot port Dozer down pilot port Dozer up pilot port Swing right pilot port Swing left pilot port Arm out pilot port Arm in pilot port Pilot pressure port Drain port Drain port	PF 3/8	7~8 kgf · m (50.6~57.8 lbf · ft)
Pw Dr8 Pz PG Dr2 Dr3 Dr6 Dr7 Pns PaL PbL XAb2 Psp XBp1 (XBp2) Pc1 Pc2 PCk Pis (N1) (N2) PnA2 Pss Pp	Pressure port for auto idle signal Drain port Main relief set pressure up pilot pressure port Pilot pressure port Drain port Drain port Drain port Drain port Swing logic valve pilot port Lock valve pilot port (arm rod side) Lock valve pilot port (boom head side) Boom up confluence pilot port Swing priority pilot port Bypass cut spool pilot port (P1 side) Bypass cut spool pilot port (P2 side) Posi-nega pressure port (P1 side) Posi-nega pressure port (P2 side) Bucket in stroke limiter pilot port Arm regeneration cut pilot port Nega-con pressure port (P1 side) Nega-con pressure port (P2 side) Arm2 logic valve pilot port Shuttle-swing pilot pressure port Shuttle-swing or arm in pressure port	PF 1/4	3.5~3.9 kgf · m (25.3~28.2 lbf · ft)
Atr Btr (Ao) (Bo) Ak Bk Ab Bb As Bs Aa Ba P1 P2	Travel forward port Travel reverse port Optional port Optional port Bucket cylinder head side port Bucket cylinder rod side port Boom cylinder head side port Boom cylinder rod side port Swing motor right port Swing motor left port Arm cylinder rod side port Arm cylinder head side port Pump port (P1 side) Pump port (P2 side)	M10	5~6.6 kgf · m (36.1~47.7 lbf · ft)
R1	Return port	M12	8.5~11.2 kgf · m (61.5~81.1 lbf · ft)
AtL BtL (P0) (P3) (P5)	Dozer cylinder head side port Dozer cylinder rod side port Quick clamp solenoid valve supply port - -	PF 3/4	15.3~18.4 kgf · m (110.6~133 lbf · ft)
(P4)	-	PF 1/2	10~12.2 kgf · m (72.3~88.2 lbf · ft)



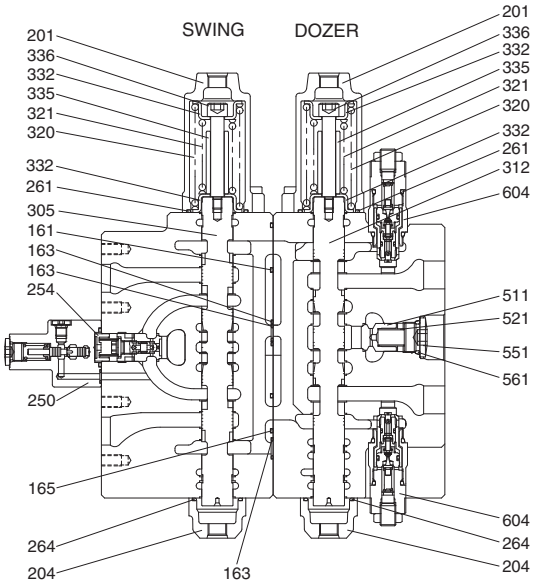
101	P2 housing	306	Arm 2 spool
102	P1 housing	307	Boom 2 spool
151	Plug	308	Rod spool
152	Plug	309	Spool (option)
153	Plug	310	Bypass cut spool
154	Plug	311	Swing priority spool
155	Plug	312	Dozer spool
156	Orifice	320	Spring
158	Plug	321	Spring
159	Plug	322	Spring
161	O-ring	323	Spring
162	O-ring	326	Spring
163	O-ring	327	Spring
164	O-ring	329	Spring
165	O-ring	331	Spring seat
167	O-ring	332	Spring seat
168	O-ring	333	Bolt
201	Cover	335	Stopper
202	Cover	336	Bolt
203	Cover	337	Stopper
204	Cover	339	Stopper
205	Cover	370	Spring
206	Cover	371	Spring
207	Cover	511	Poppet
209	Flange	512	Poppet
210	Plate	513	Poppet
211	Piston	514	Poppet
250	Logic control valve assy	521	Spring
251	Logic control valve assy	522	Spring
252	Lock valve selector sub assy	523	Spring
254	Swing Logic poppet assy	551	Plug
256	Arm 2 Logic poppet assy	552	Plug
257	Arm regeneration cut sub assy	553	Plug
258	Plug	561	O-ring
259	Plug	562	O-ring
261	O-ring	601	Main relief valve assy
262	O-ring	602	Port relief valve assy
264	O-ring	603	Port relief valve assy
273	Socket bolt	604	Port relief valve assy
274	Socket bolt	611	Posi-nega conversion valve assy
301	Travel spool	971	Screw
302	Arm 1 spool sub assy	975	Screw
303	Boom 1 spool sub assy	977	Name plate
304	Bucket spool	978	Pin
305	Swing spool		



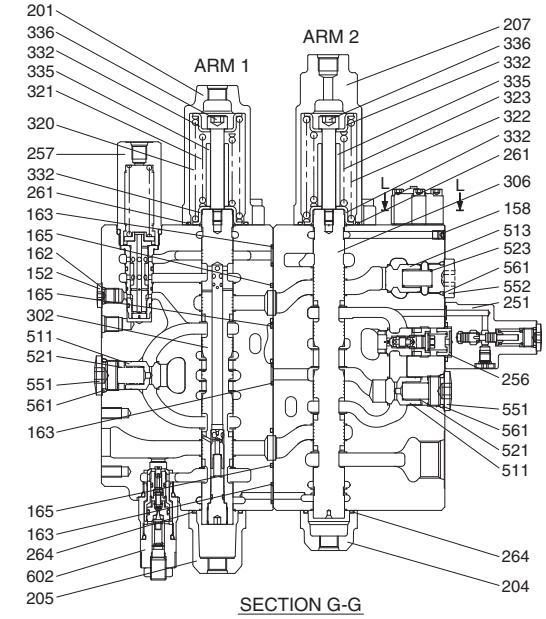
SECTION C-C



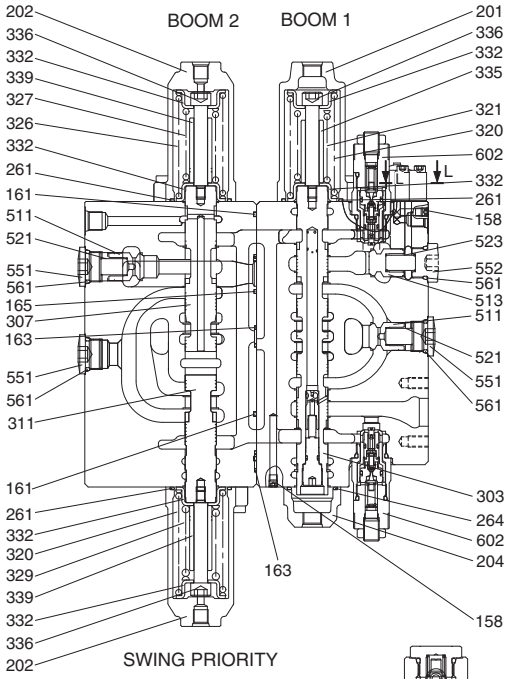
SECTION F-F



SECTION D-D

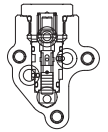


SECTION G-G

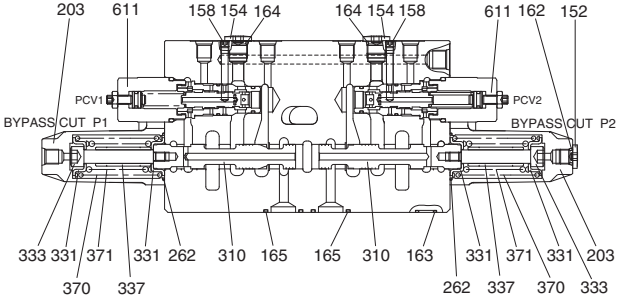


SWING PRIORITY

SECTION E-E



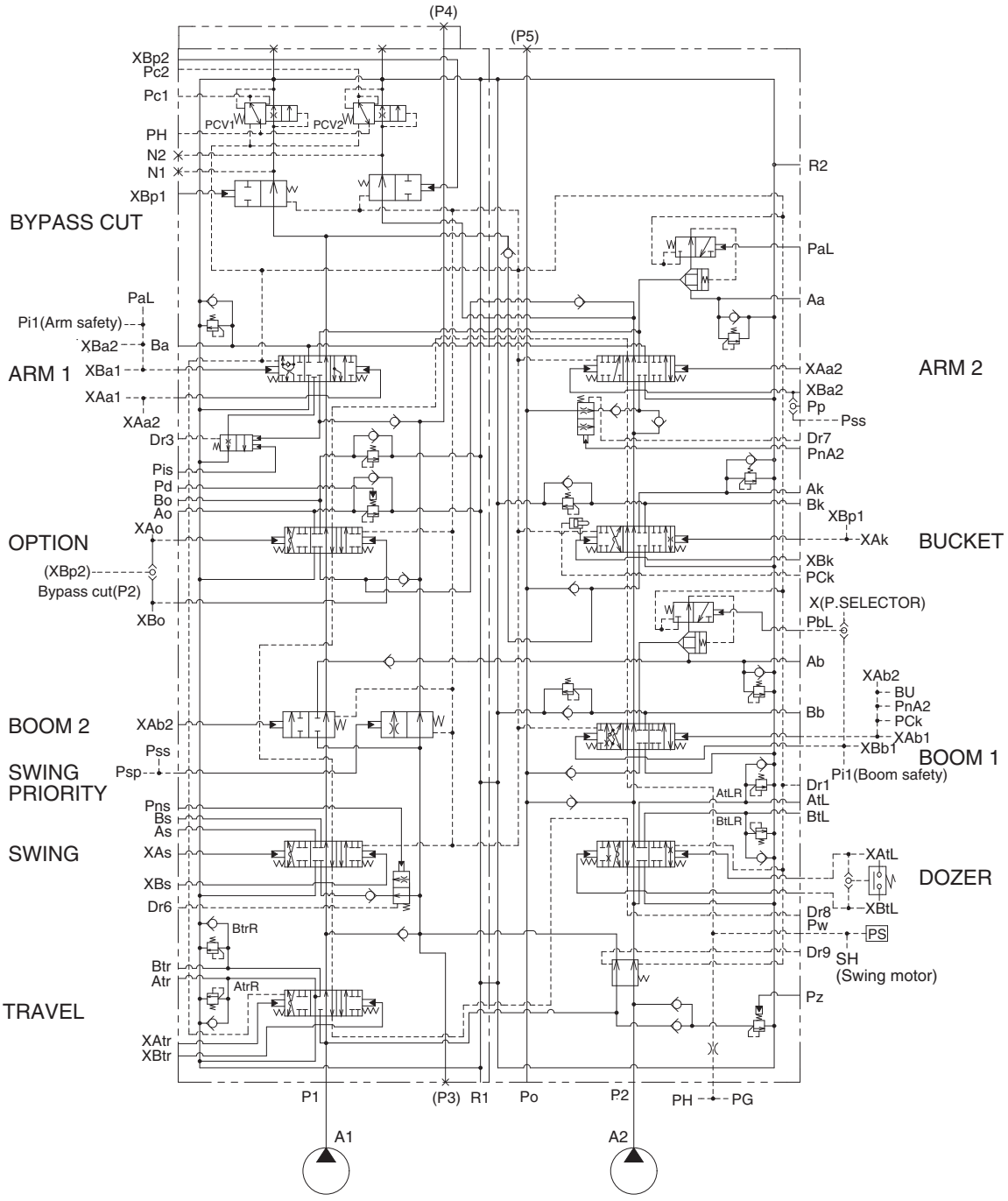
SECTION L-L



SECTION H-H

210WF2MC03

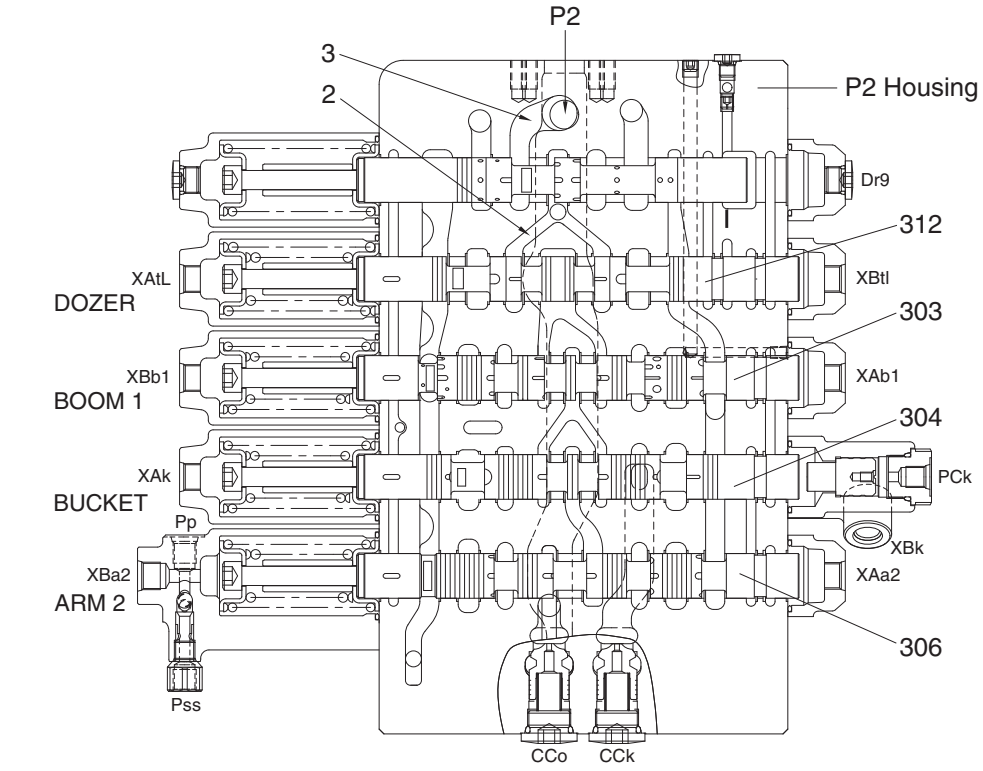
2. HYDRAULIC CIRCUIT



210WF2MC04

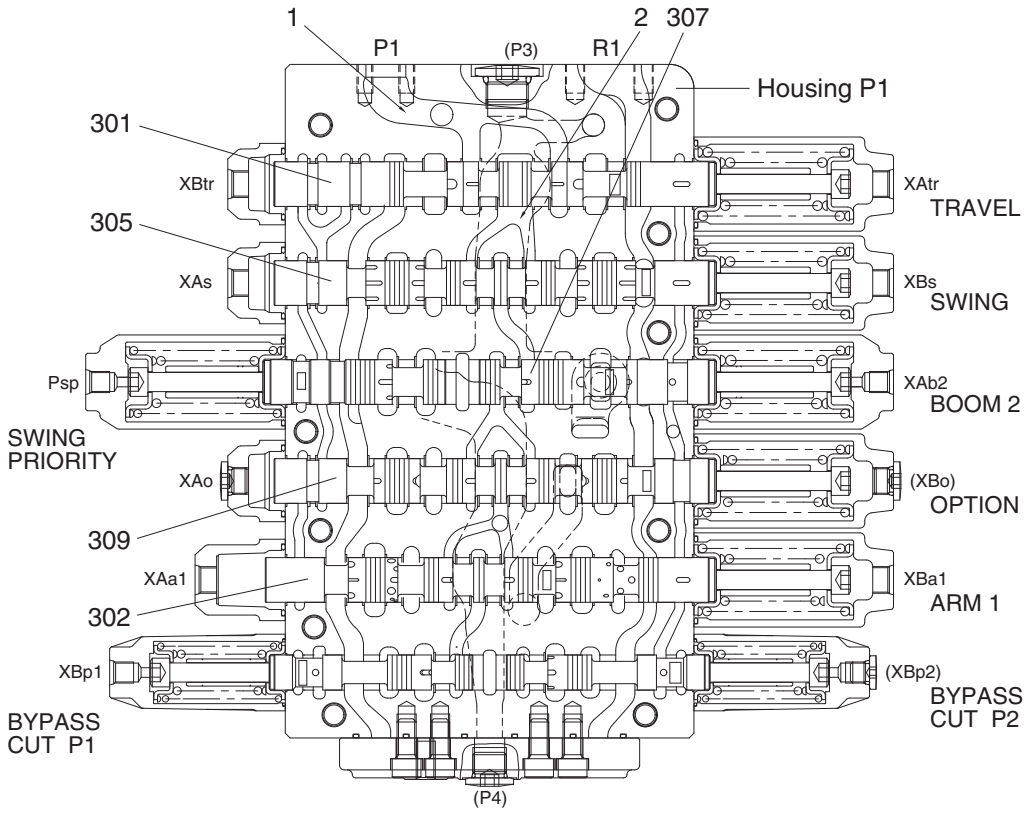
3. FUNCTION

1) CONTROL IN NEUTRAL POSITION



SPOOL SECTION(P2)

20W92MC05



SPOOL SECTION(P1)

20W92MC06A

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 travel (301), swing (305), boom confluence (boom 2; 307), option (309) and arm 1 (302), and the arm 1 side posi-nega conversion valve (611), and returns to the hydraulic oil tank through the tank port (R1).

The positive control signal pressure (Pi1) of the arm 1 side posi-nega conversion valve (611) is led from Port Pc1 to the regulator (Pi1) on the hydraulic pump (A1) side, and controls the pump discharge flow rate to its minimum value.

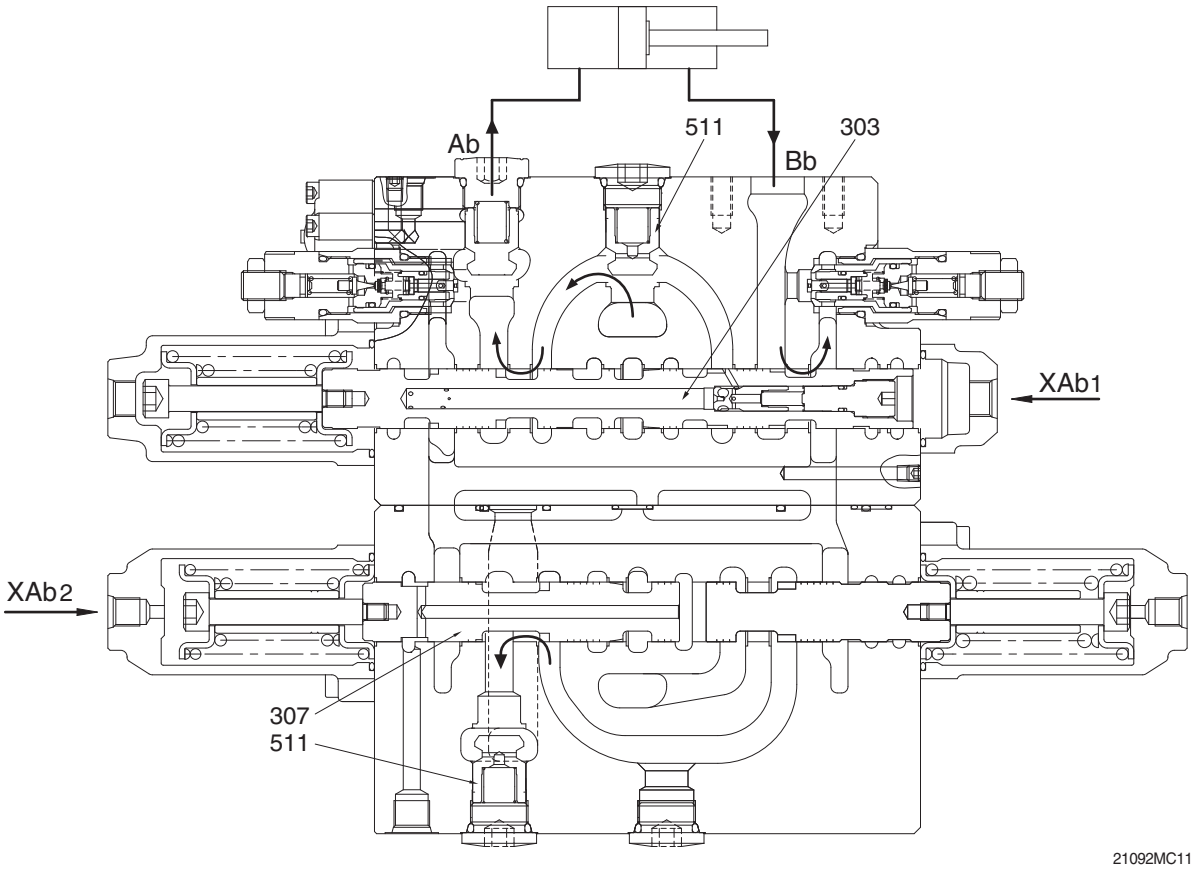
The oil discharged from the hydraulic pump (A2) passes through Port P2, the main path (3), the bypass circuit (2) passing the spools for dozer (312), boom 1 (303), bucket (304) and arm 2 (306), and the boom1 side posi-nega conversion valve (611), and returns to the hydraulic oil tank through the tank port (R1).

The positive control signal pressure (Pi2) of the boom 1 side posi-nega conversion valve (611) is led from Port Pc2 to the regulator (Pi2) 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) EACH SPOOL OPERATION

(1) Boom control

① Boom up operation



Pilot circuit

Since the boom 1 spool (303) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

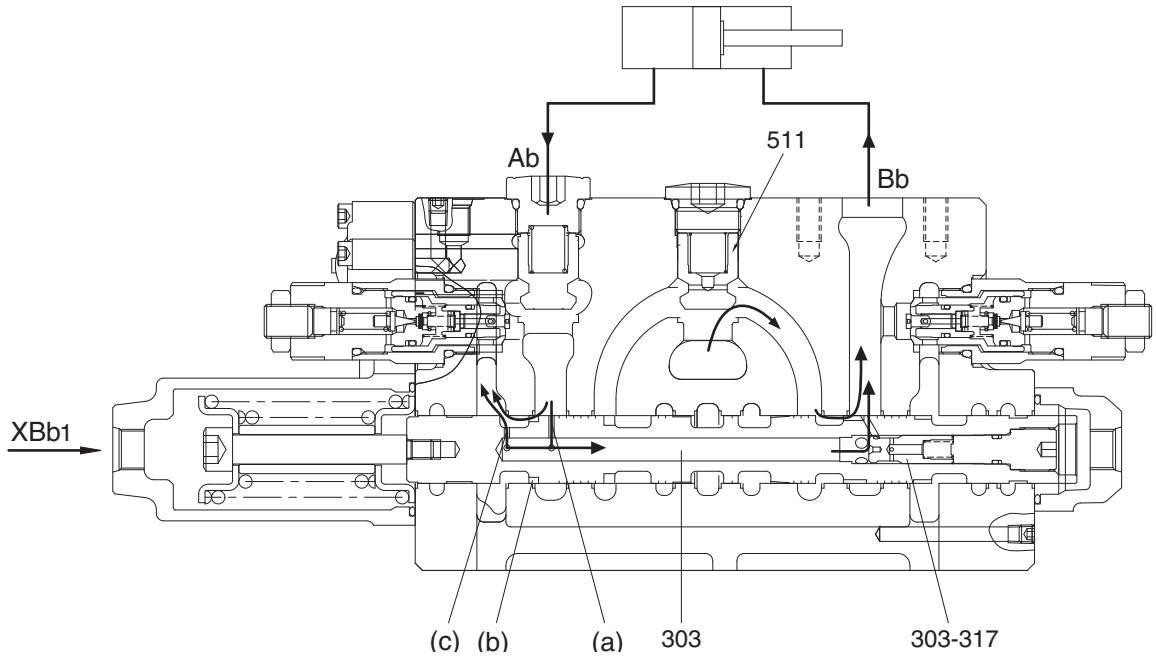
Main circuit

During the boom up operation, the pilot pressure enters through Port XAb1 and moves the boom 1 spool (303) in the left direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the boom 1 spool (303). 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 (303) to Port Ab, and is supplied to the boom cylinder head side.

At the same time, the pilot pressure enters also through Port XAb2 to transfer the boom 2 spool (307) in the right direction. Though the pressurized oil enters into Port P1, the bypass circuit (2) is shut off due to transfer of the boom 2 spool (307). Therefore, the hydraulic oil flows in the parallel circuit and flows through the U-shaped path to the boom 2 spool (307). Then, the hydraulic oil passes through the periphery of the boom 2 spool (307), pushes open the check valve (511), joins into Port Ab in the inside path, and is supplied to the boom cylinder head side. (Boom confluent flow)

On the other hand, the return oil from the boom cylinder rod side enters through Port Bb and returns to the hydraulic oil tank through the tank port (R1).

② **Boom down operation**



21092MC12

Pilot circuit

Since the boom 1 spool (303) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port PbL and the release signal is sent to the lock valve (252).

Main circuit

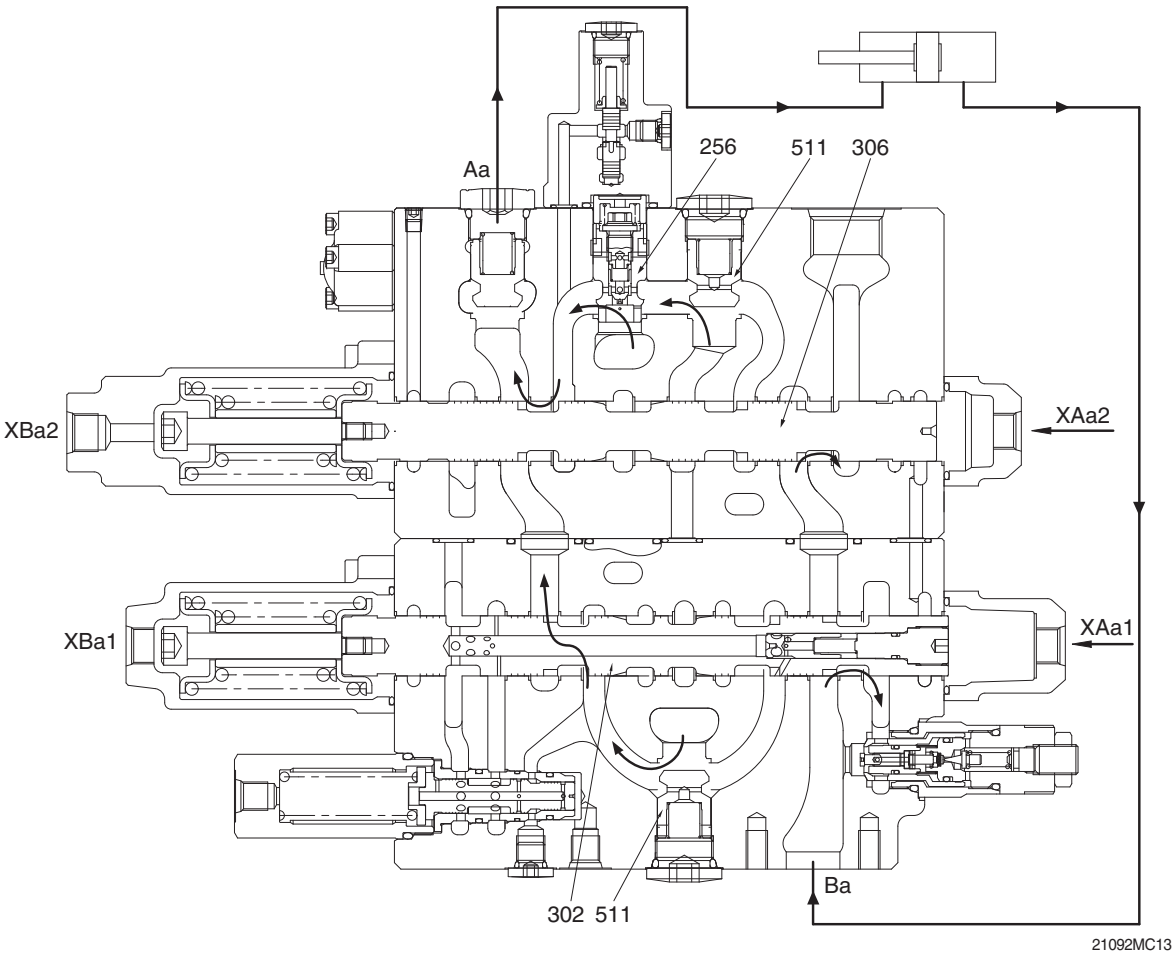
During the boom down operation, the pilot pressure enters through Port XBb1 and transfers the boom 1 spool (303) in the right direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows to the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the boom 1 spool (303). 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 (303) to Port Bb and is supplied to the boom cylinder rod side.

On the other hand, the return oil from the boom cylinder head side passes to the holes (a) and the notches (b) of the boom 1 spool (303).

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 (303-317) in the spool in the right direction, flows around the outside of the spool. Then, it is supplied again to the boom cylinder rod side as hydraulic oil to lower the boom. (Boom regeneration)
Besides, a part of the return oil from the boom cylinder flows from the hole (c) into the tank.

(2) Arm control

① Arm out operation



Pilot circuit

Since the arm 2 spool (306) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the arm out operation, the pilot pressure enters through Ports XAa1 and XAa2. When the pressure enters through Port XAa1 and XAa2, the spools transfer in the left direction. The hydraulic 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 arm 1 spool (302).

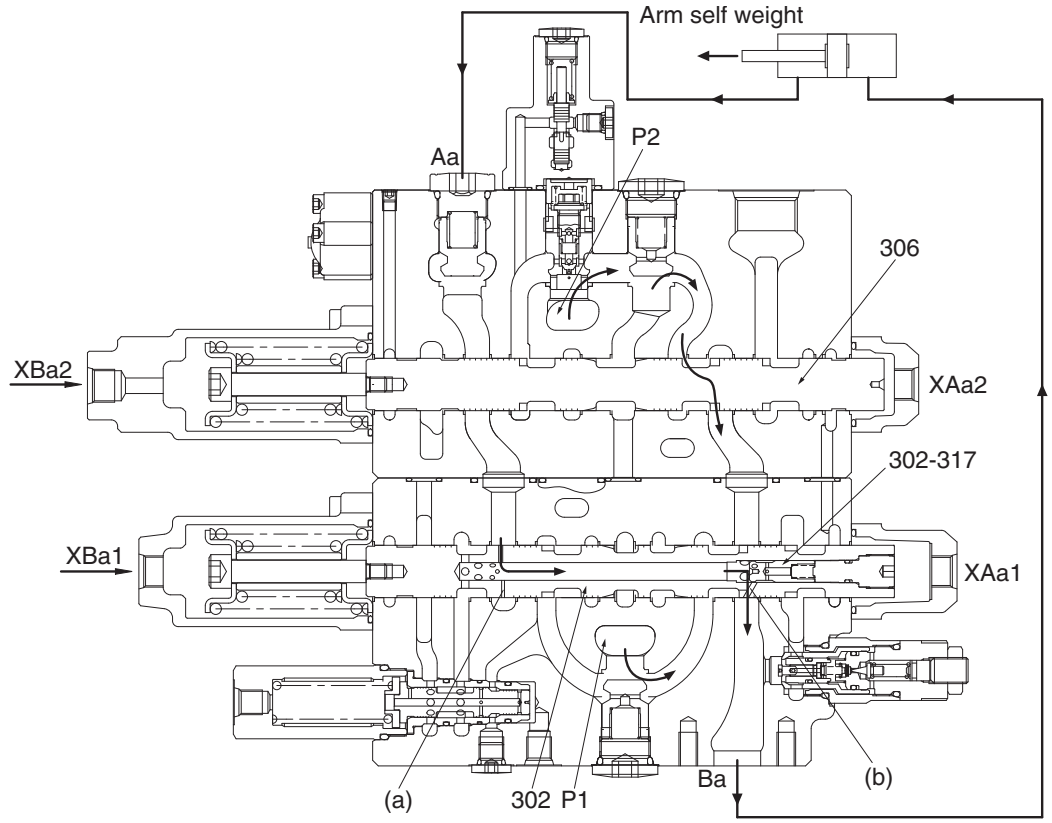
Therefore, the hydraulic oil from the parallel circuit pushes open the check valve (511) and flows through the U-shaped path to the arm 1 spool (302). Then, it flows around the periphery of the arm 1 spool (302) and the arm 2 spool (306) to Port Aa, and is supplied to the arm cylinder rod side.

On the other hand, the hydraulic oil entering through Port P2 passes in the main path (3), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (306). The hydraulic oil from the parallel circuit pushes open the logic poppet (256) and the hydraulic oil from the bypass circuit (2) pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (306). Then, it flows around the periphery of the arm 2 spool (306) in the inside path and joins into Port Aa.

Besides, the return oil from the arm cylinder head side passes through Port Ba, flows into tank line in arm 1 side and in arm 2 side, and returns to the hydraulic oil tank through the tank port (R1).

② Arm in operation

· During light load only



21092MC14

Pilot circuit

Since the arm 2 spool (306) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port PaL and the release signal is sent to the lock valve (252).

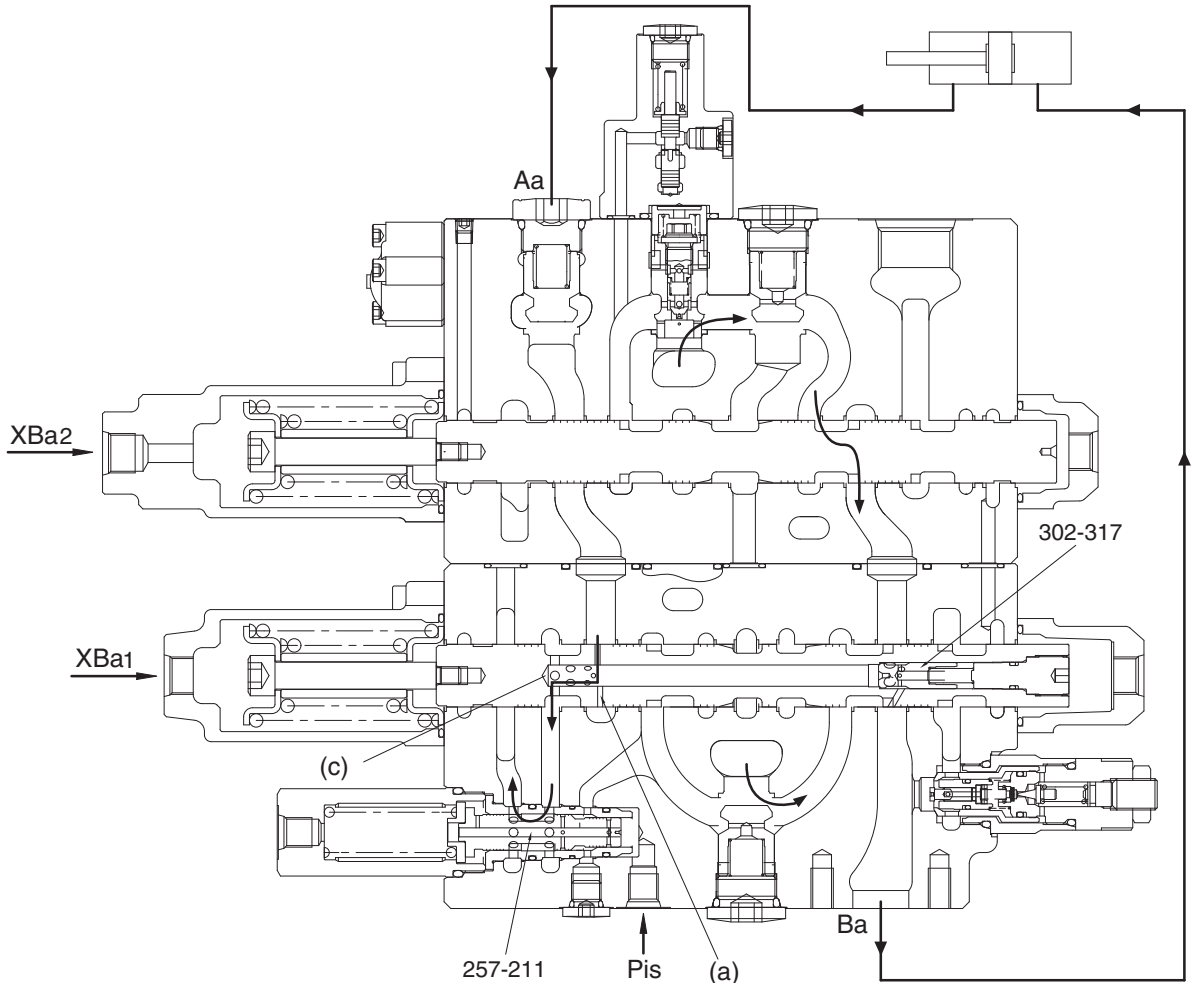
Main circuit

During the arm in operation, the pilot pressure enters through Ports XBa1 and XBa2. When the pressure enters through Port XBa1 and Port XBa2, the spools transfer in the right direction Fig. MC14. The hydraulic 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 arm 1 spool (302). 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 arm 1 spool (302) to Port Ba, and is supplied to the arm cylinder head side.

On the other hand, the hydraulic oil entering through Port P2 passes in the main path (3), and flows into the bypass circuit (2), and the bypass circuit is shut off due to transfer of the arm 2 spool (306). The hydraulic oil from the parallel circuit pushes open the logic poppet (256) and the hydraulic oil from the bypass circuit (2) pushes open the check valve (511) and flows through the U-shaped path to the arm 2 spool (306). Then, it flows around the periphery of the arm 2 spool (306) and the arm 1 spool (302) in the inside path and joins into Port Ba.

Besides, the return oil from the arm cylinder rod side is pressurized by self-weight of the arms and so on, and returns to Port Aa. The pressurized oil returning to Port Aa enters into the spool through the periphery hole (a) of the arm 1 spool (302). During a light load only, it pushes open the check valve (302-317) and joins into Port Ba from the spool hole (b). The rest of oil returns to the hydraulic oil tank through the tank port (R1). This is called the arm regeneration function.

· The pressure in the arm cylinder head side increases

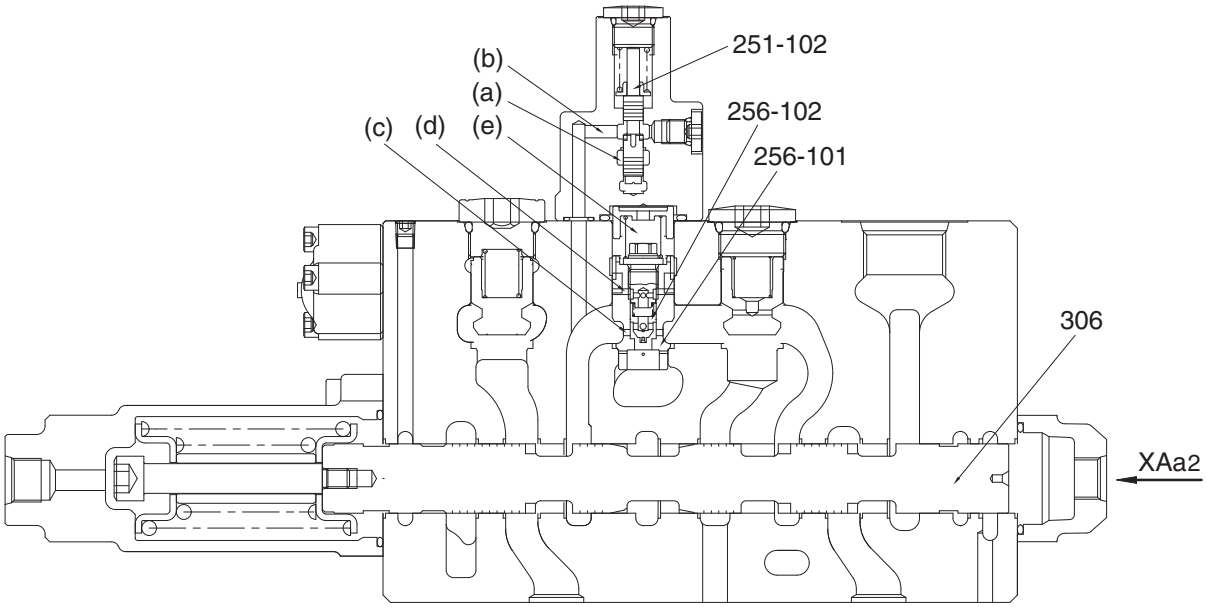


21092MC15

When the pressure in the arm cylinder head side and the U-shaped path increases, the arm regeneration cut spool (257-211) is transferred in the left direction, and at the same time the check valve (302-317) is closed by its backpressure. This shuts off the arm regeneration function, and the return oil from the arm cylinder rod side enters from Port Aa through the periphery hole (a) of the arm 1 spool (302) into the spool, flows to the arm regeneration cut valve (257) through the periphery hole (c) of the arm 1 spool (302), and returns through the tank port (R1) to the hydraulic oil tank.

When the Pilot Port Pis of the arm regeneration cut spool (257-211) is pressurized, a part of the return oil from the arm cylinder rod side flows to the arm regeneration cut valve (257) and returns through the tank port (R1) to the hydraulic oil tank. (Variable arm regeneration)

③ Arm 2 logic control valve operation



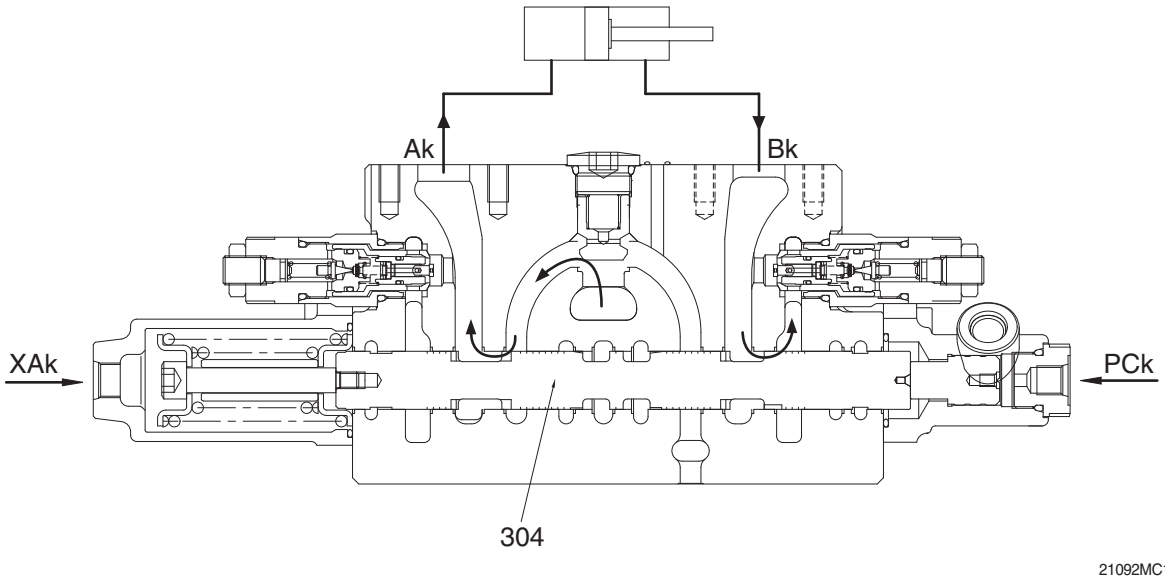
21092MC16

During both the arm in operation and the boom up operation, the pilot pressure enters through Ports XBa1, XBa2, XAb1, XAb2, PaL and PnA2. The pressure PnA2 transfers the spool (251-102) in the arm 2 logic control valve to the top direction, and the path from (a) to (b) is closed. Hereby, the pressurized oil pushes open the poppet (256-102), passes in the path (c) and (d), enters into the chamber (e), and the poppet (256-101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through Port P2 flows to the boom 1 spool (303) than the arm 2 spool (306) to make the boom hoisting operation most preferential.

On the other hand, in the independent arm in operation, the pilot pressure does not enter through Ports PnA2, and the path from (a) to (b) is not closed, and the hydraulic oil of the chamber (e) flows to the path (a) and (b). The pressurized oil entering through Port P2 pushes open the poppet (256-101) and flows to the arm 2 spool (306).

(3) Bucket control

① Bucket in operation



Pilot circuit

Since the bucket spool (304) transfers and shuts off the side-bypass path, the pressure at Port Px increases. Then, the pressure enters also through Port XBp1.

Main circuit

During the bucket in operation, the pilot pressure enters through Port XAk and transfers the bucket spool (304) in the right direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bucket spool (304). 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 Ak and is supplied to the bucket cylinder head side.

On the other hand, the return oil from the bucket cylinder rod side enters through Port Bk, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (R1).

During both the boom up operation and bucket in operation, the pilot pressure enters through Port PCk and the bucket spool transfers in the half stroke not full stroke. Therefore, the most of pressurized oil entering through Port P2 flows to the boom 1 spool (303) than the bucket spool (304) to make the boom up operation most preferential.

② **Bucket out operation**

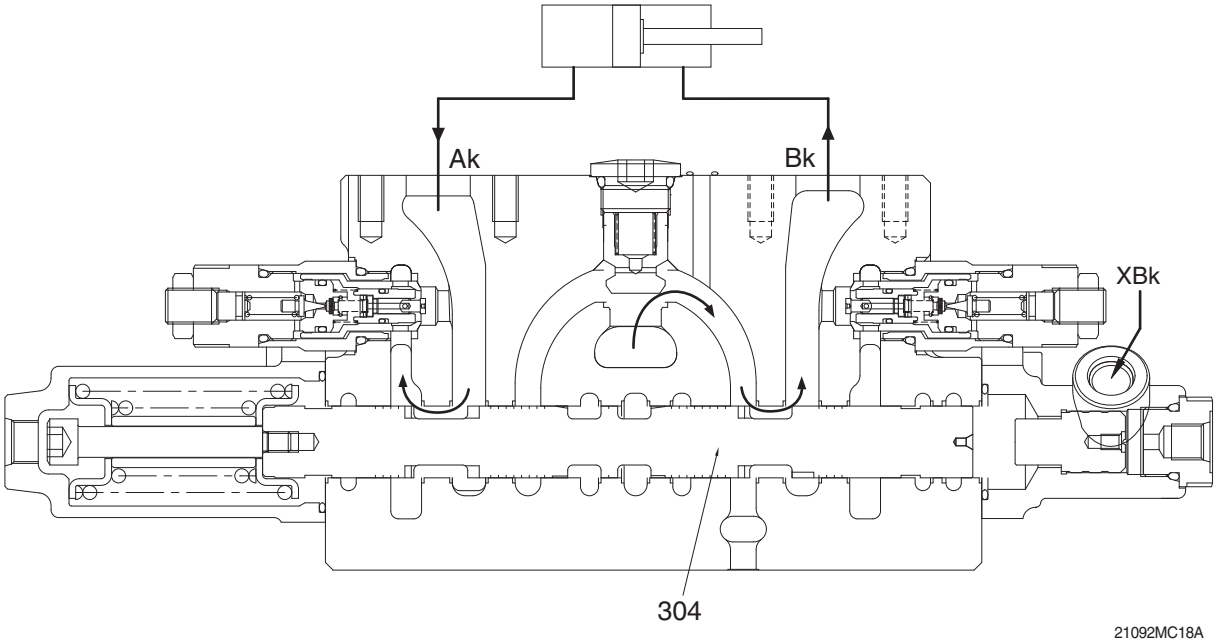
Pilot circuit

Since the bucket spool (304) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the bucket out operation, the pilot pressure enters through Port XBk and transfers the bucket spool (304) in the left direction. The pressurized oil entering through Port P2 passes through the main path (3) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bucket spool (304). 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 Bk and is supplied to the bucket cylinder rod side.

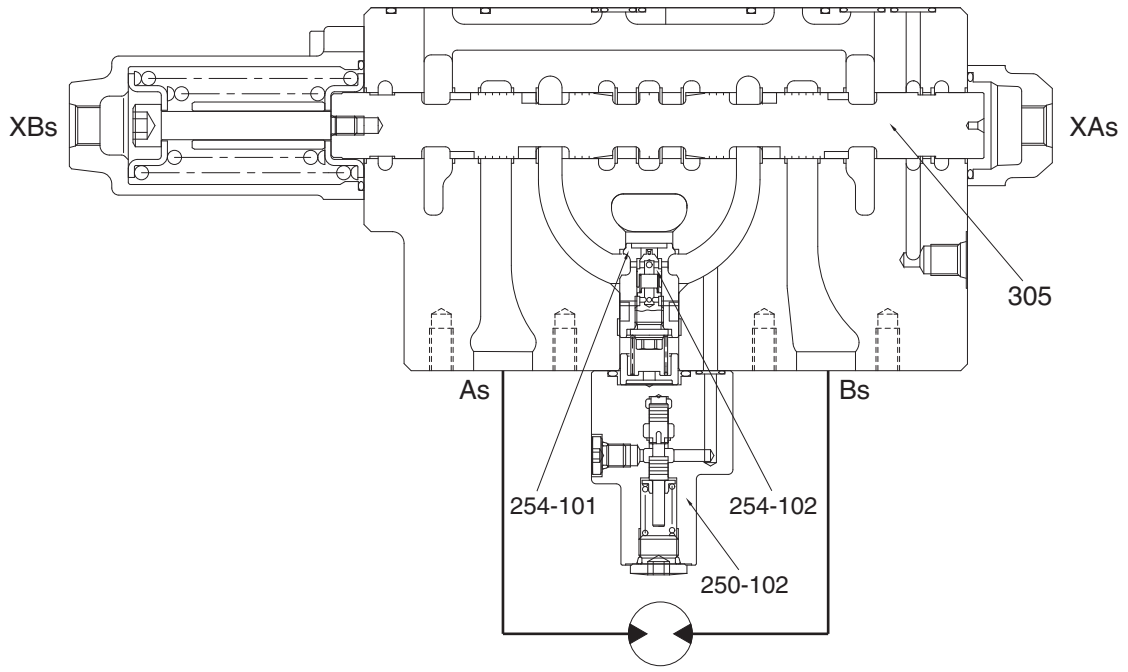
On the other hand, the return oil from the bucket cylinder head side enters through Port Ak, passes around the periphery of the spool, and returns to the hydraulic oil tank through the tank port (R1).



③ **Bucket in confluence**

During the bucket in operation, the pilot pressure enters also through Port XBp1 and transfers the bypass-cut spool (313). The pressurized oil entering through Port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the bypass-cut spool (313). Therefore, the pressurized oil pushes open the check valve CCk (514), and flows through inside path and the U-shaped path to the bucket spool (304).

(4) Swing control



① Swing operation

Pilot circuit

Since the swing spool (305) transfers and shuts off the side-bypass path, the pressure at Port Px increases.

Main circuit

During the swing operation, the pilot pressure enters through Port XAs (or XBs) and transfers the swing spool (305). The pressurized oil entering through Port P1 passes through the main path (1) and flows through the bypass circuit (2), but the bypass circuit (2) is shut off due to transfer of the swing spool (305). Therefore, the pressurized oil flows into the parallel circuit, pushes open the check valve (511), and flows through the U-shaped path to the swing spool (305). Then, it flows through the periphery of the spool to Port As (or Bs) and is supplied to the swing motor.

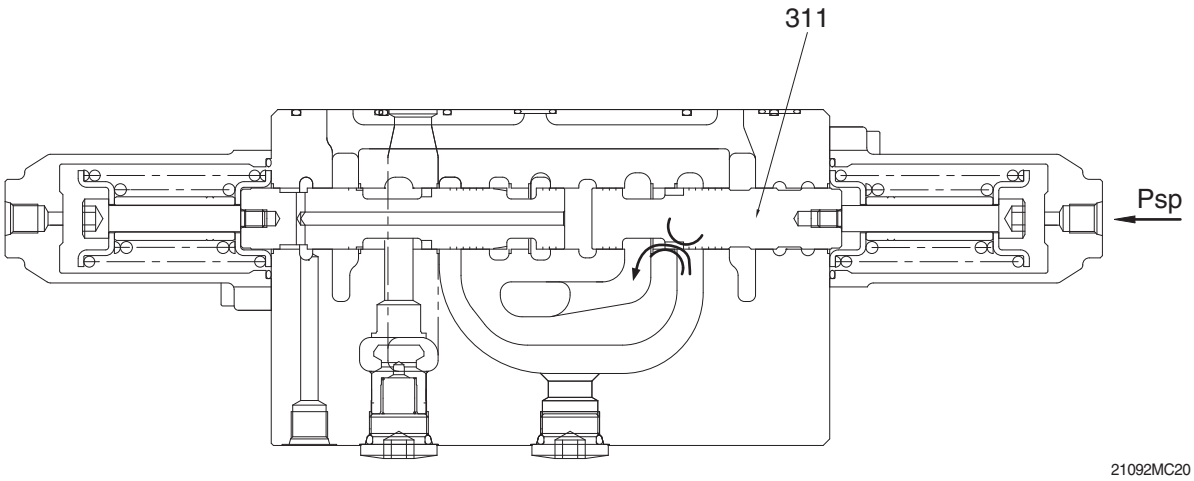
On the other hand, the return oil from the swing motor enters Port Bs (or As) and returns to the hydraulic oil tank through the tank port (R1).

② Swing logic control valve operation

During both the swing operation and the boom up operation, the pilot pressure enters through Ports XBs (or XAs), XAb1, XAb2 and Pns. The pressure Pns transfers the spool (250-102) in swing logic control valve. Hereby, the pressurized oil pushes open the poppet (254-102), and the poppet (254-101) is pushed to the casing seat. Therefore, the most of pressurized oil entering through Port P1 flows to the boom 2 spool (307) than the swing spool (305) to make the boom up operation most preferential.

On the other hand, in the independent swing operation, the pilot pressure does not enter through Ports Pns. The pressurized oil entering through Port P1 pushes open the poppet (254-101) and flows to the swing spool (305).

③ Swing operation preference function



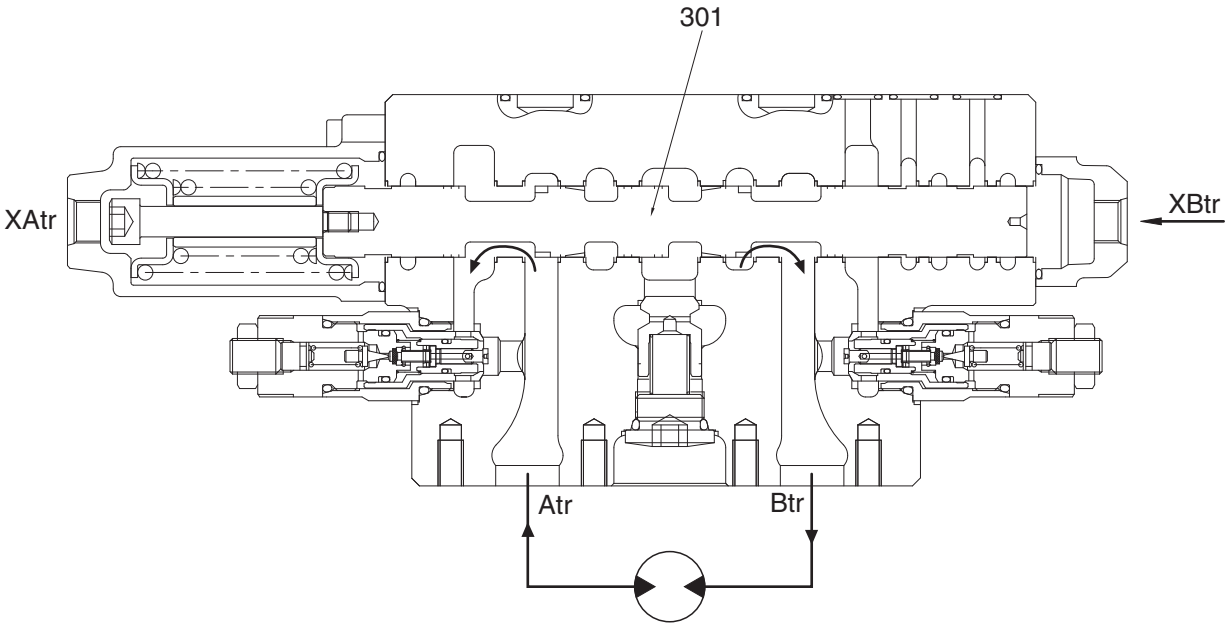
Pilot circuit

The pilot pressure enters through Port Psp to transfer the swing priority spool (311).

Main circuit

Due to transfer of the swing priority spool (311), the open area of the swing priority spool decreases, and the most of the pressurized oil entering through Port P1 flows to the swing side to make the swing operation most preferential.

(5) Travel control



20W92MC07

Pilot circuit

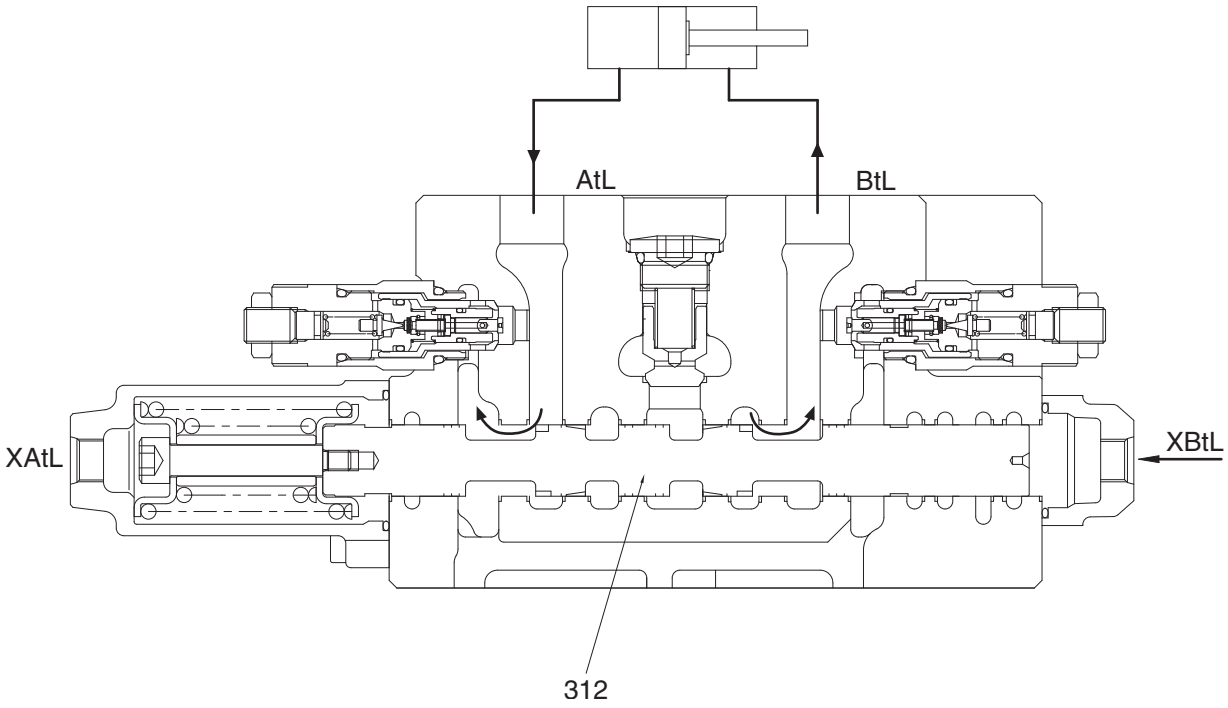
Since the travel spool (301) transfers and shuts off the side-bypass path, the pressure at Port Pw increases.

Main circuit

When Pilot Port XBtr of the travel spool (301) is pressurized, the bypass circuit (2) in the arm 1 side is shut off and the working fluid discharged from the hydraulic pump (A1) through Port Btr and flows to the travel motor.

On the other hand, the return oil from the travel motor passes flows from Port Atr to the travel spool (301) and returns to the hydraulic oil tank through the tank port (R1).
In the case of the opposite operation (when the pilot pressure is applied to Ports XAtr of the control valve), the operation is similar.

(6) Dozer operation



20W92MC08

Pilot circuit

Since the dozer spool (312) transfers and shuts off the side-bypass path, the pressure at Port Pw increases.

Main circuit

When Pilot Port XBtL of the dozer spool (312) is pressurized, the bypass circuit (2) in the boom 1 side is shut off and the working fluid discharged from the hydraulic pump (A2) through Port BtL and flows to the dozer cylinder rod side.

On the other hand, the return oil from the dozer cylinder rod side passes flows from Port AtL to the dozer spool (312) and returns to the hydraulic oil tank through the tank port (R1).
In the case of the opposite operation (when the pilot pressure is applied to Ports XAtL of the control valve), the operation is similar.

3) FUNCTION OF LOCK VALVE

The lock valve (252) is fitted between the arm cylinder rod side and the arm 2 spool (306). It decreases the leakage by the pressure of the cylinder.

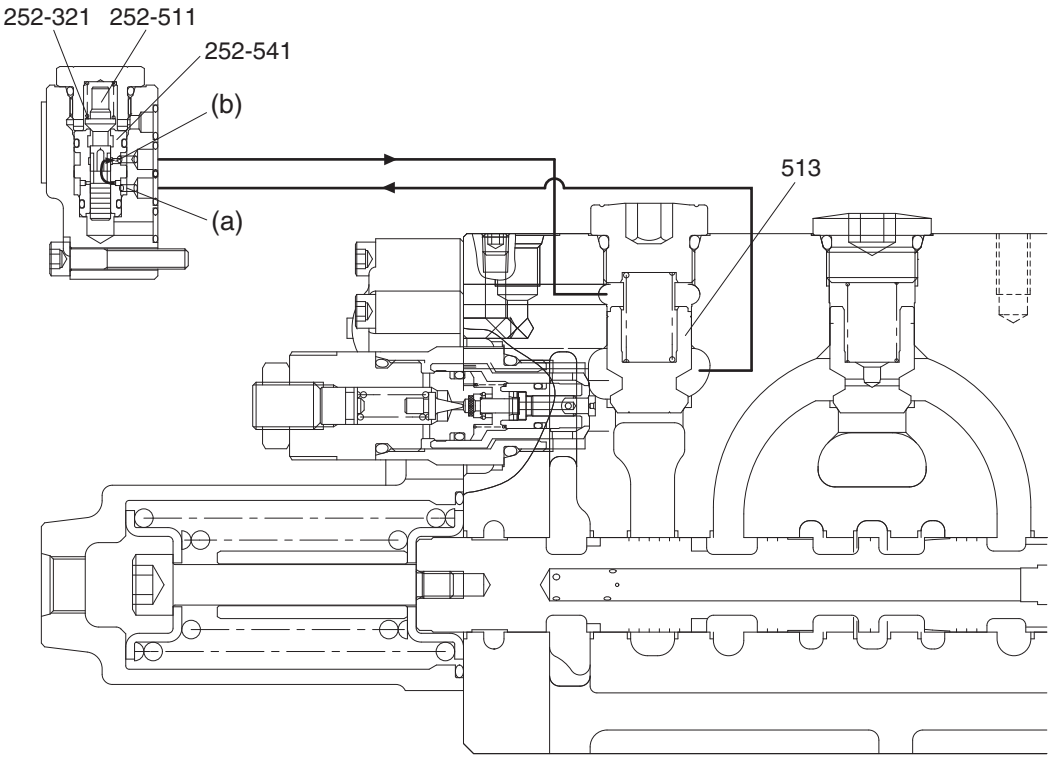
Another lock valve (252) is similarly fitted between the boom cylinder head side and the boom 1 spool (303). It decreases the leakage by the pressure of the cylinder.

(1) Neutral positions of spools

The following is the case of the boom 1 spool (303). (The case of the arm 2 spool (306) is in the same way.)

During the boom 1 spool (303) is in the neutral position, the lock valve (252) is kept in the position shown in figure. The spool (252-511) in the lock valve is pushed to the seat of the sleeve (252-541) by the force of the spring (252-321).

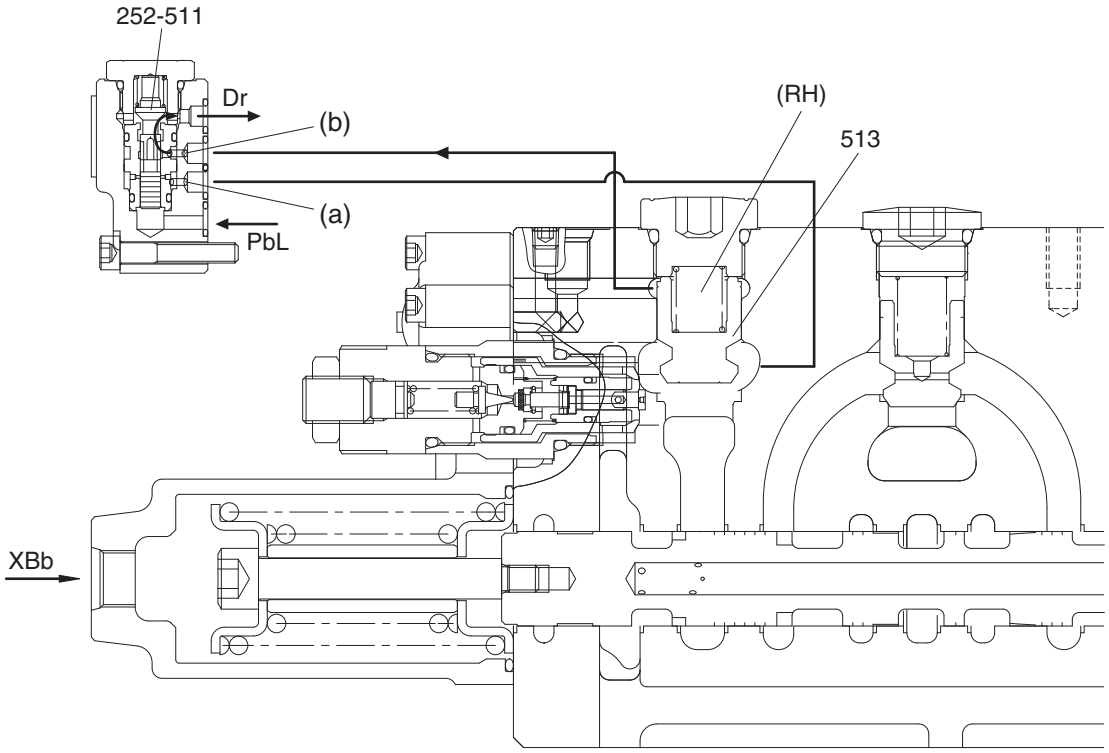
In this position, the pressurized oil from the boom cylinder head side enters through the hole (a), the periphery of the spool (252-511) in the lock valve and the hole (b), and it pushes the poppet (513) to the casing seat, and the leakage is decreased.



21092MC35

(2) Boom down operation

During the boom down operation, the pilot pressure enters through Port PbL and XBb1. The pilot pressure transfers the spool (252-511) in the lock valve assy in the top direction. By the transfer of the spool (252-511), firstly the hole (a) is blocked and the pressurized oil from the boom cylinder head side does not enter to the spring chamber (RH). Secondly, the oil in the spring chamber (RH) enters through the hole (b) and flows to drain circuit. Therefore, the poppet (513) is lifted by the pressure of the boom cylinder head side and the function of the lock valve (252) is released.



21092MC36

(3) Boom up operation

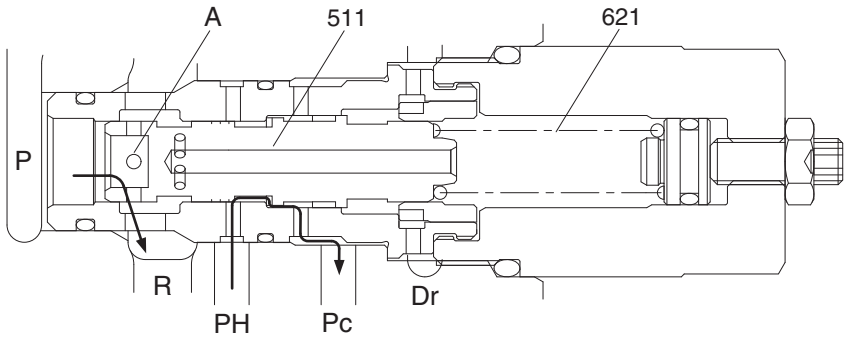
During the boom up operation, the pilot pressure enters through Port XAb1. The oil flowing from the boom 1 spool pushes open the poppet (513) and flows to Port Ab.

4) Posi-Nega Conversion Valve

The posi-nega conversion valve is installed between the downstream of the center bypass path and the low-pressure path, and functions as follows:

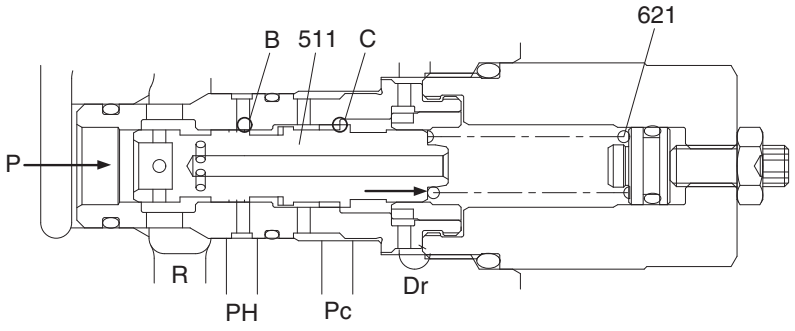
(1) The delivery oil (flow rate Q) from the pump is led to the path P after passing the center by-pass path (2).

Then, it flows to the path R passing through the orifice A. On the other hand, the primary pressure oil from the port PH flows to the port Pc1 (or Pc2) through the periphery of the spool (511). On that occasion, the spool (511) remains to be pressed by the spring (621) if the pressure at the path P and the pressure at the port Pc1 (or Pc2) are below the preset pressure.

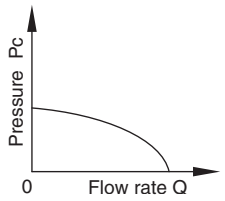


21092MC30

(2) When the flow rate Q increases and the pressure at the path P increases, the spool (511) begins to move to the right, and so adjusts the Pc1 (or Pc2) pressure at the notches of the path B and C that the pressure at the path P and the Pc1 (or Pc2) pressure are balanced with the spring (621) at the set pressure. When the pressure at the path P rises, the Pc1 (or Pc2) pressure is lowered. The relationship between the flow rate Q of the hydraulic oil flowing from the path P to the path R and the pressure at the port Pc1 (or Pc2) is as shown in graph.

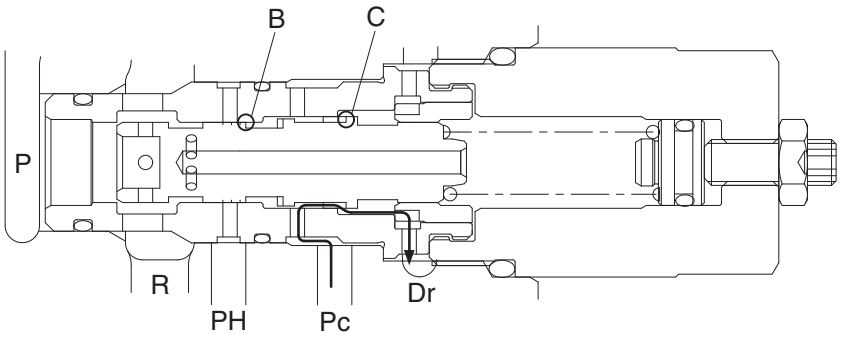


21092MC31



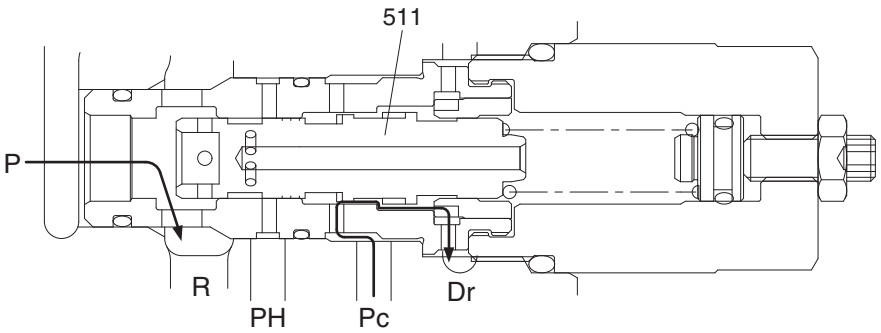
21092MC34

(3) The pressure at Pc1 (or Pc2) is used for the control of pump discharge flow rate, and the pump discharge flow rate can be reduced by lowering the Pc1 (or Pc2) port pressure.



21092MC32

(4) If the flow rate Q increases more than required, the spool strokes to largely open the P – R line, generating the relieving condition.



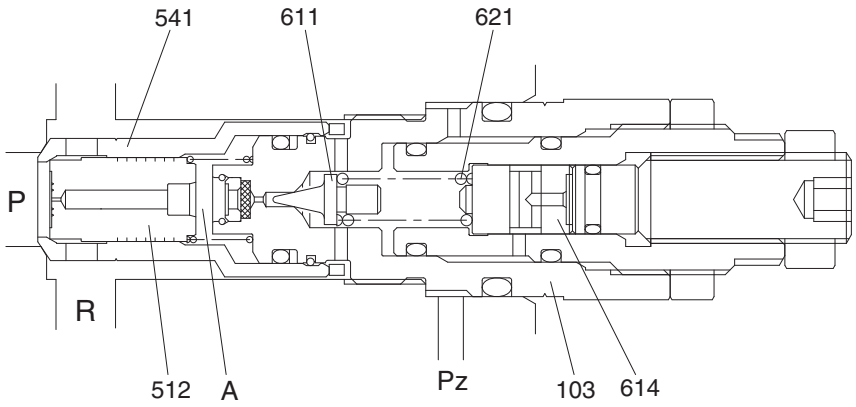
21092MC33

5) CIRCUIT PRESSURE PROTECTION

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

(1) Main relief valve

The main relief valve is fitted in the P2 housing and functions as follows.



21092MC25

① The hydraulic oil is filled up in the inside space chamber (A) from the path (P) through a hole of the seat (541) and a restriction of the plunger (512), and seats the plunger (512) against the seat (541) securely.

② When the pressure in the path (R) becomes equal to the set load of the spring (621), the poppet (611) opens to make the hydraulic oil flow through a hole of the plug (103), around the poppet (611) and into the low pressure path (R).

③ Opening of the poppet (611) causes the pressure in the chamber (A) to fall and the plunger (512) to open. As the result the pressurized oil in the path (R) runs into the low pressure path (R) directly.

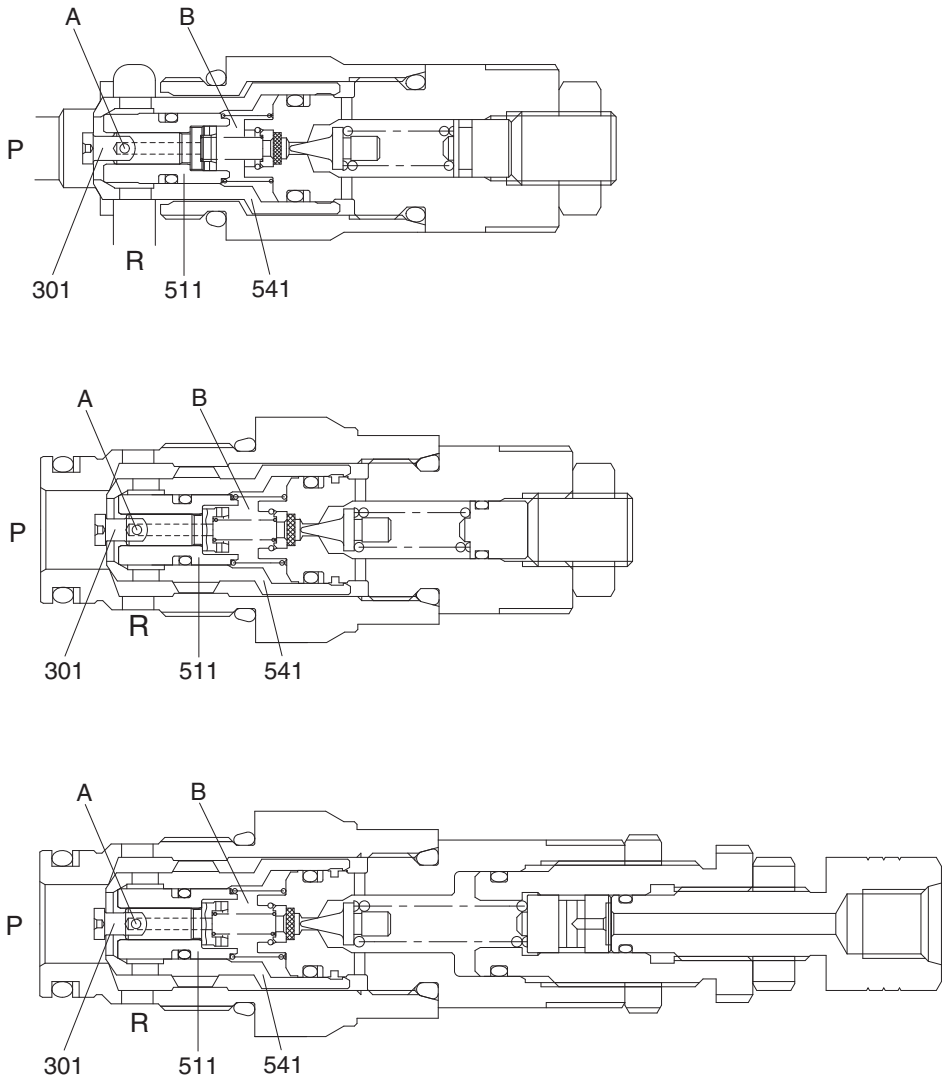
④ When the pressurized oil higher than pressure 30 kgf/cm^2 enters through the port Pz, it pushes the piston (614) to change the relief set pressure of the spring (621) to the high pressure.

(2) Port relief valve

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

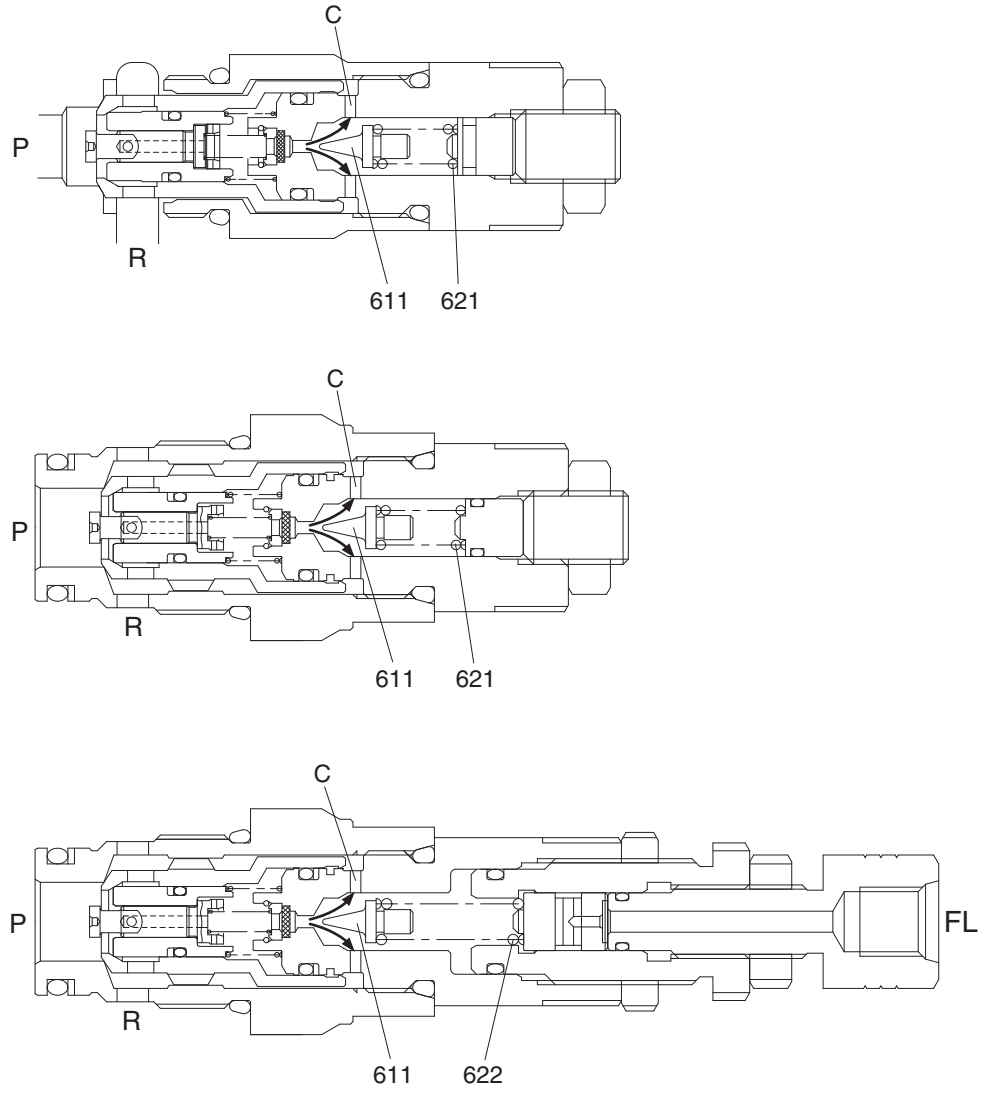
① Function as relief valve

a. 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.



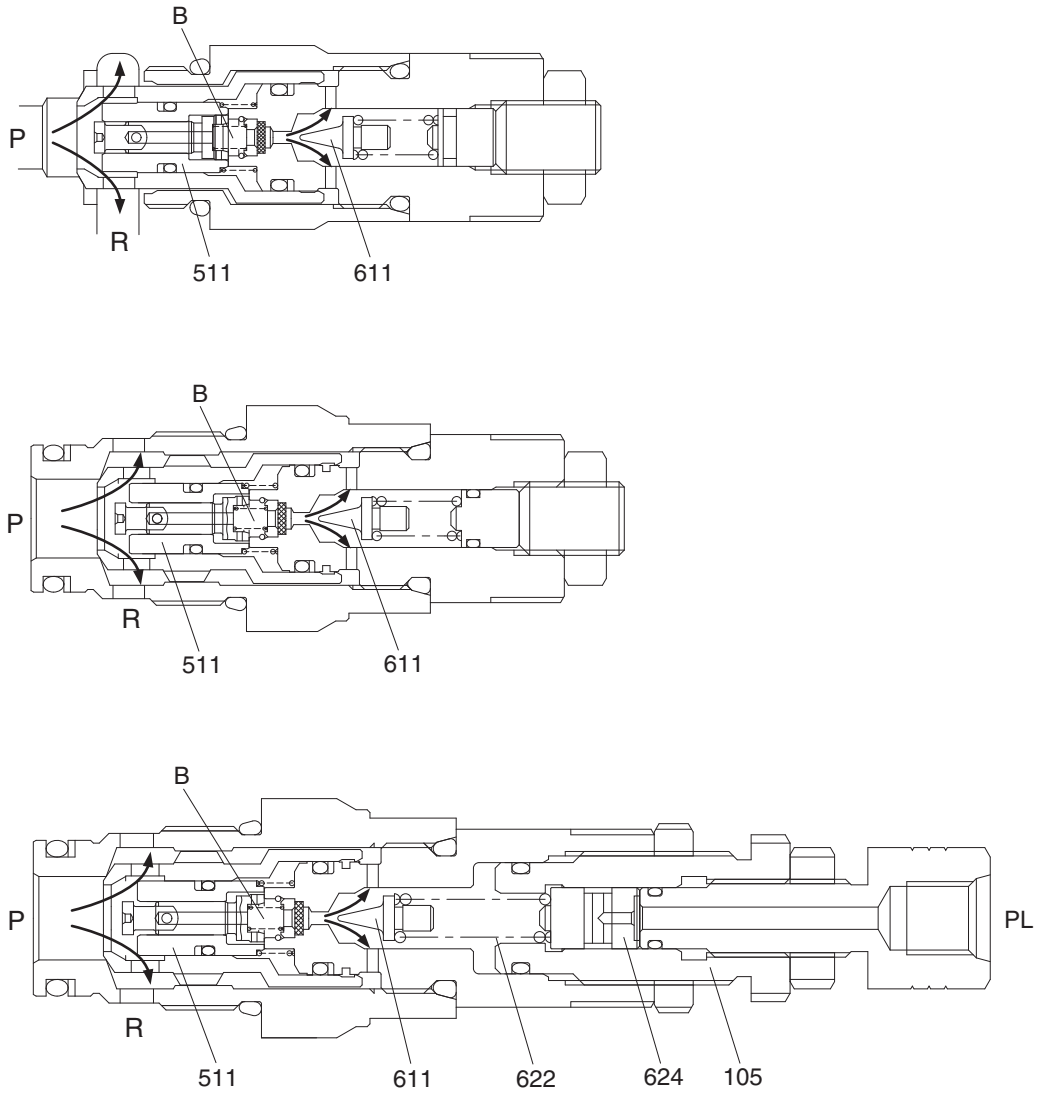
21092MC26

b. 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.



21092MC27

c. 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.

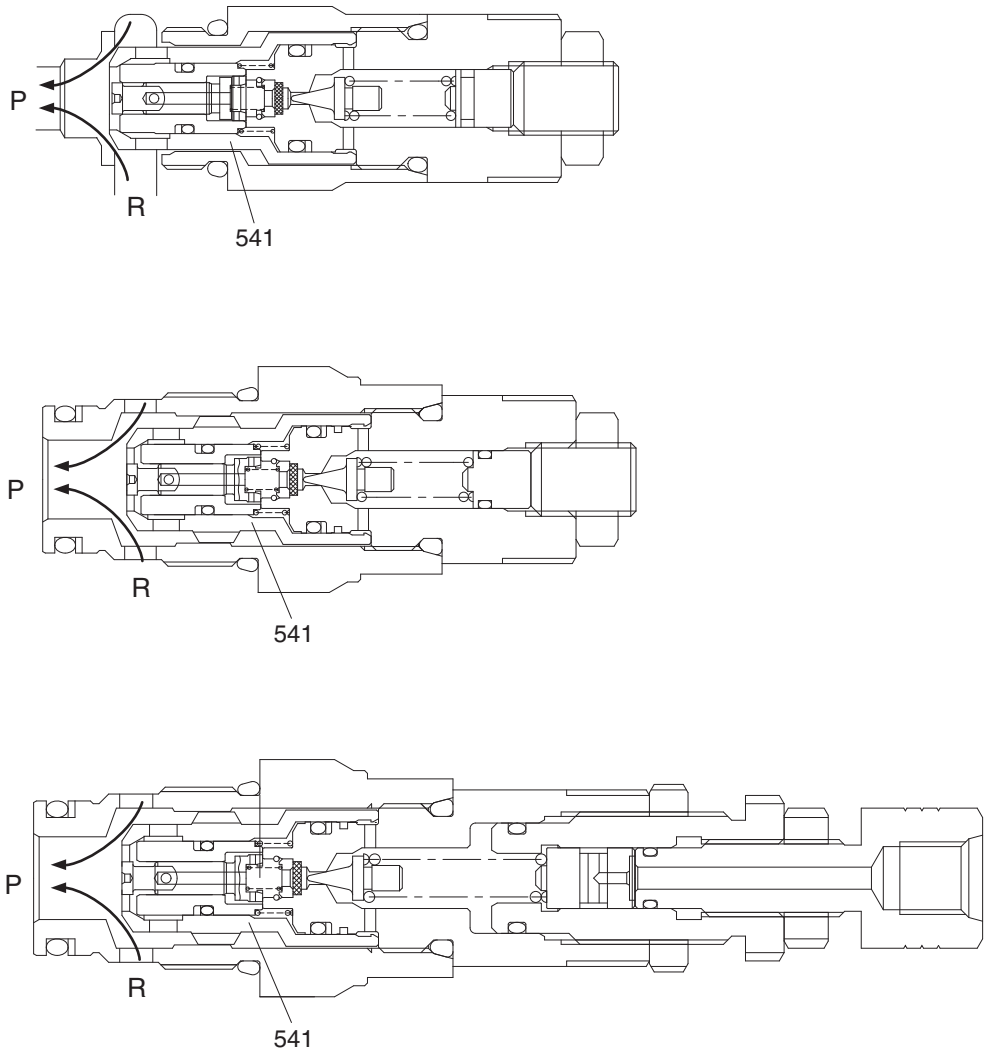


21092MC28

d. When the pressurized oil higher than pressure 25 kgf/cm^2 enters through the port PL, it pushes the piston (624) 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.



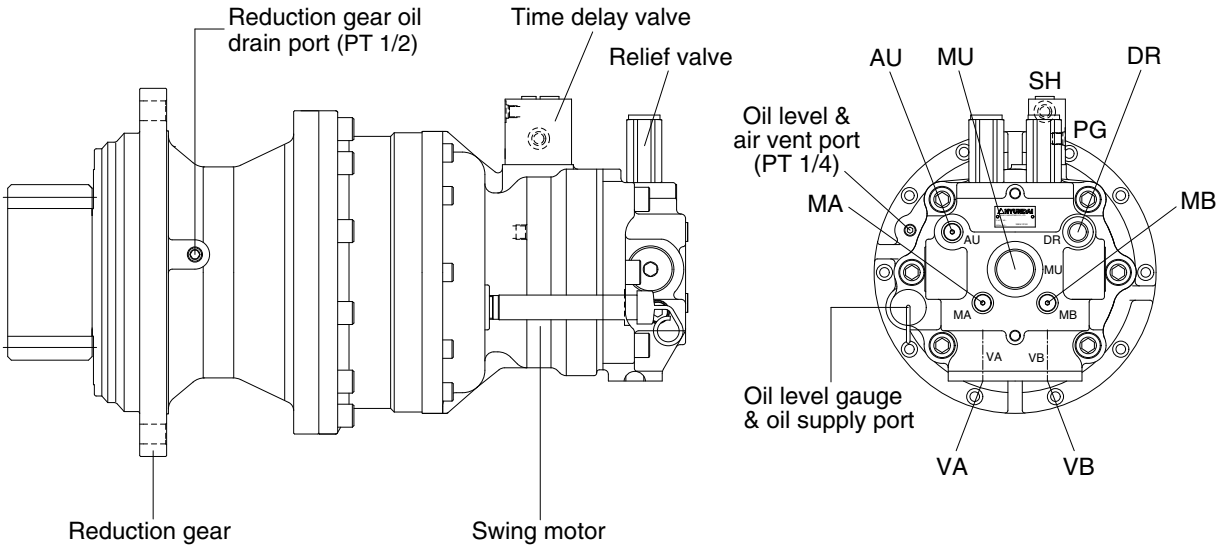
21092MC29

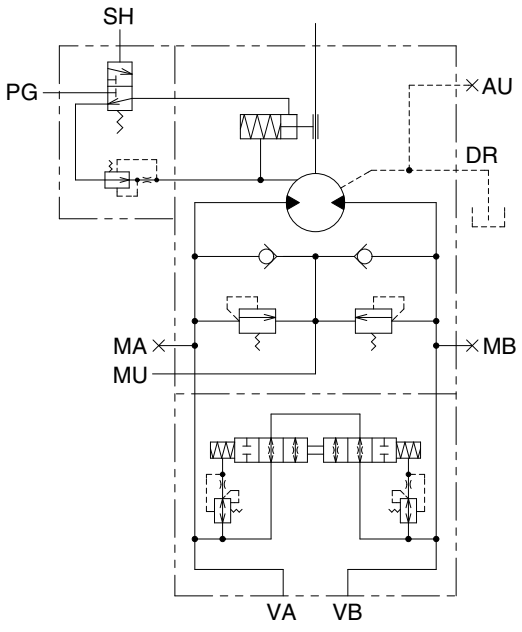
GROUP 3 SWING DEVICE (TYPE 1, 2)

1. STRUCTURE

Swing device consists swing motor, swing reduction gear.

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



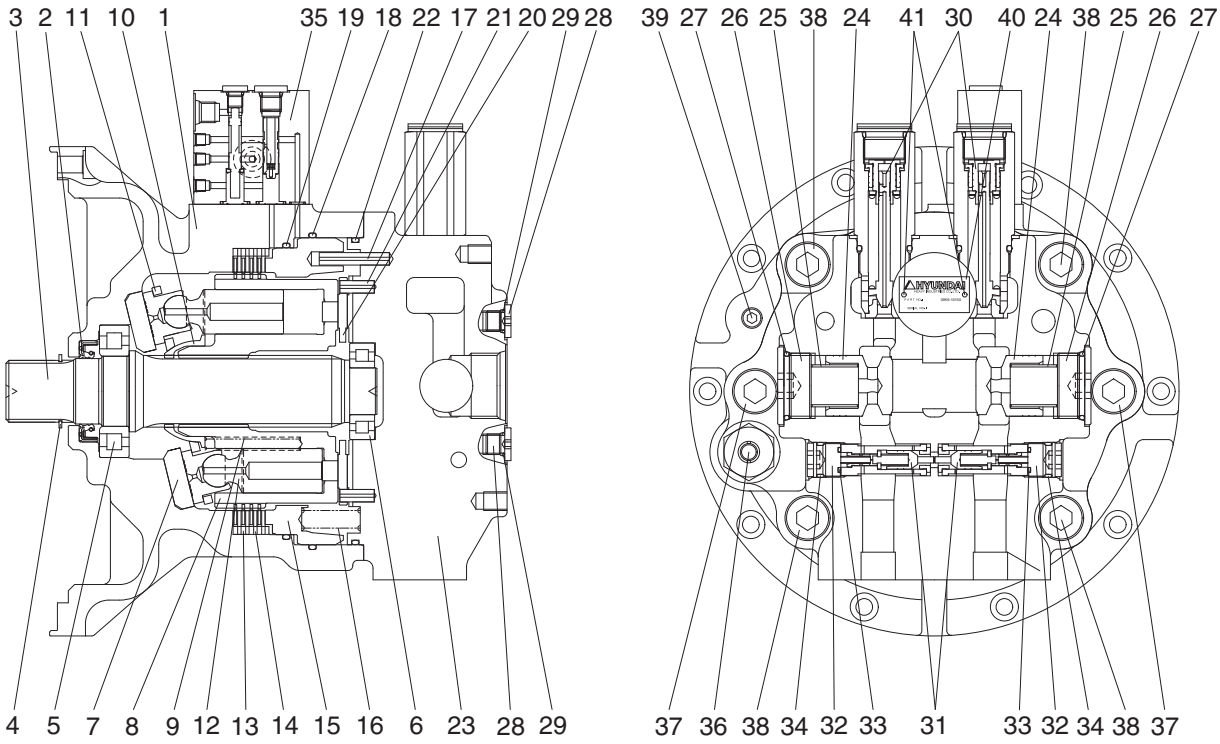


Hydraulic circuit

Port	Port name	Port size
VA	Main port	ø 20
VB	Main port	ø 20
DR	Drain port	PF 1/2
MU	Make up port	PF 1 1/4
PG	Brake release stand by port	PF 1/4
SH	Brake release pilot port	PF 1/4
MA, MB	Gauge port	PF 1/4
AU	Air vent port	PF 1/4

210WF2SM01

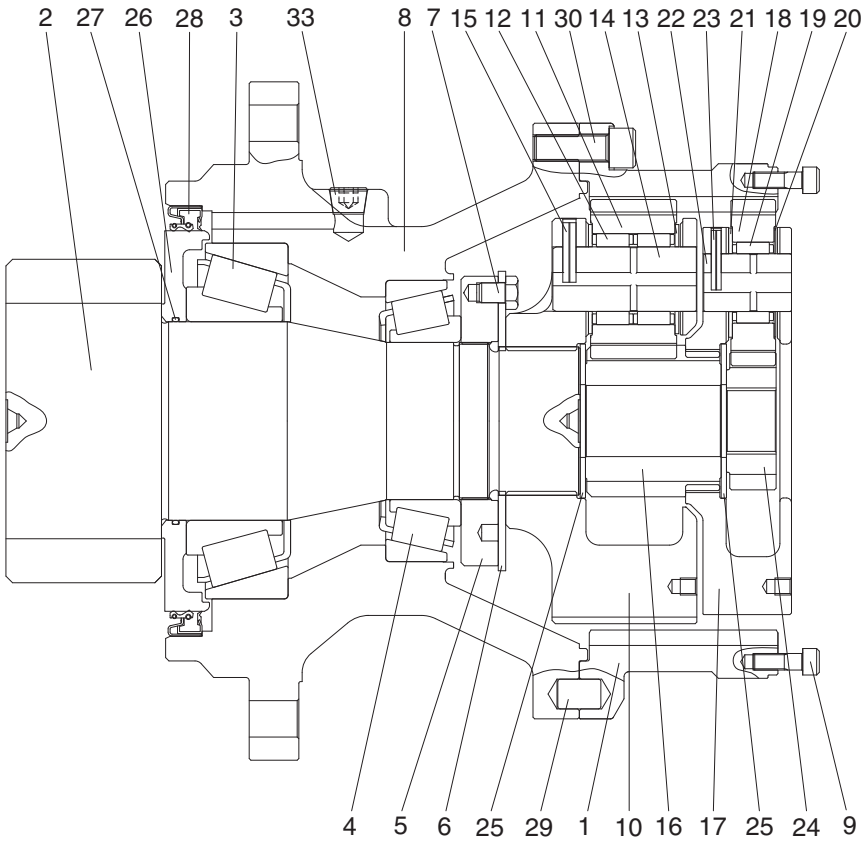
1) SWING MOTOR



210WF2SM02

1	Casing	15	Parking piston	29	O-ring
2	Oil seal	16	Brake spring	30	Relief valve assy
3	Shaft	17	Spring pin	31	Reactionless valve assy
4	Snap ring	18	O-ring	32	Plug
5	Roller bearing	19	O-ring	33	O-ring
6	Roller bearing	20	Valve plate	34	O-ring
7	Swash plate	21	Spring pin	35	Time delay valve assy
8	Cylinder block	22	O-ring	36	Level gauge
9	Spring	23	Valve casing	37	Socket bolt
10	Ball guide	24	Check valve	38	Socket bolt
11	Retainer plate	25	Spring	39	Plug
12	Piston assy	26	Plug	40	Name plate
13	Friction plate	27	O-ring	41	Rivet
14	Separate plate	28	Plug		

2) REDUCTION GEAR



210WF2SM03

1	Ring gear	12	Needle bearing 2	23	Spring pin 1
2	Drive shaft	13	Thrust washer 2	24	Sun gear 1
3	Taper roller bearing	14	Carrier pin 2	25	Thrust plate
4	Taper roller bearing	15	Spring pin 2	26	Sleeve
5	Ring nut	16	Sun gear 2	27	O-ring
6	Lock plate	17	Carrier 1	28	Oil seal
7	Hexagon bolt	18	Planetary gear 1	29	Parallel pin
8	Casing	19	Needle bearing 1	30	Socket bolt
9	Socket bolt	20	Thrust washer 1	33	Plug
10	Carrier 2	21	Thrust washer 1		
11	Planetary gear 2	22	Carrier pin 1		

2. PRINCIPLE OF DRIVING

2.1 Generating the turning force

The high hydraulic supplied from a hydraulic pump flows into a cylinder block (8) through valve casing of motor (23), and valve plate (20).

The high hydraulic is built as flowing on one side of Y-Y line connected by the upper and lower sides of piston (12).

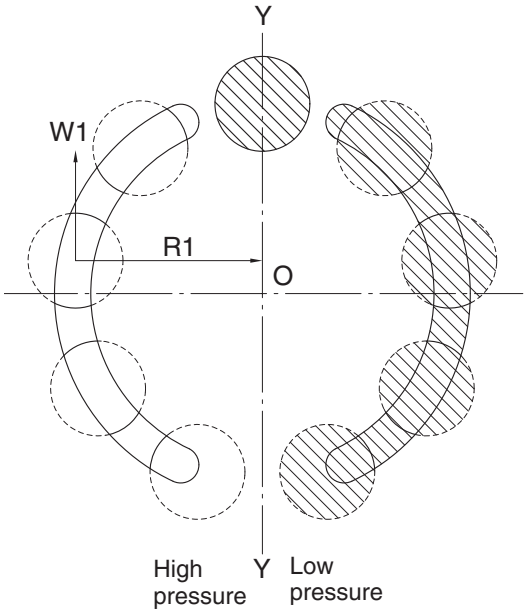
The high hydraulic can generate the force, F1=P × A (P : supplied pressure, A : water pressure area), like following pictures, working on a piston.

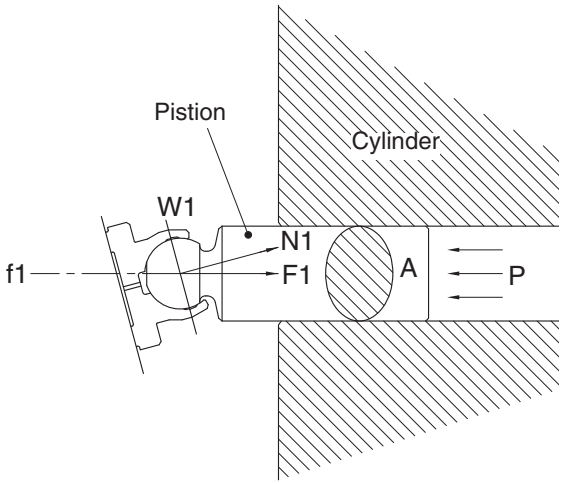
This force, F1, is divided as N1 thrust partial pressure and W1 radial partial pressure, in case of the plate of a tilt angle, α .

W1 generates torque, T=W1 × R1, for Y-Y line connected by the upper and lower sides of the piston as following pictures.

The sum of torque (ΣW1 × R1), generated from each piston (4~5 pieces) on the side of a high hydraulic, generates the turning force.

This torque transfers the turning force to a cylinder (8) through a piston; because a cylinder is combined with a turning axis and spline, a turning axis rotates and a turning force is sent.





21078TM05

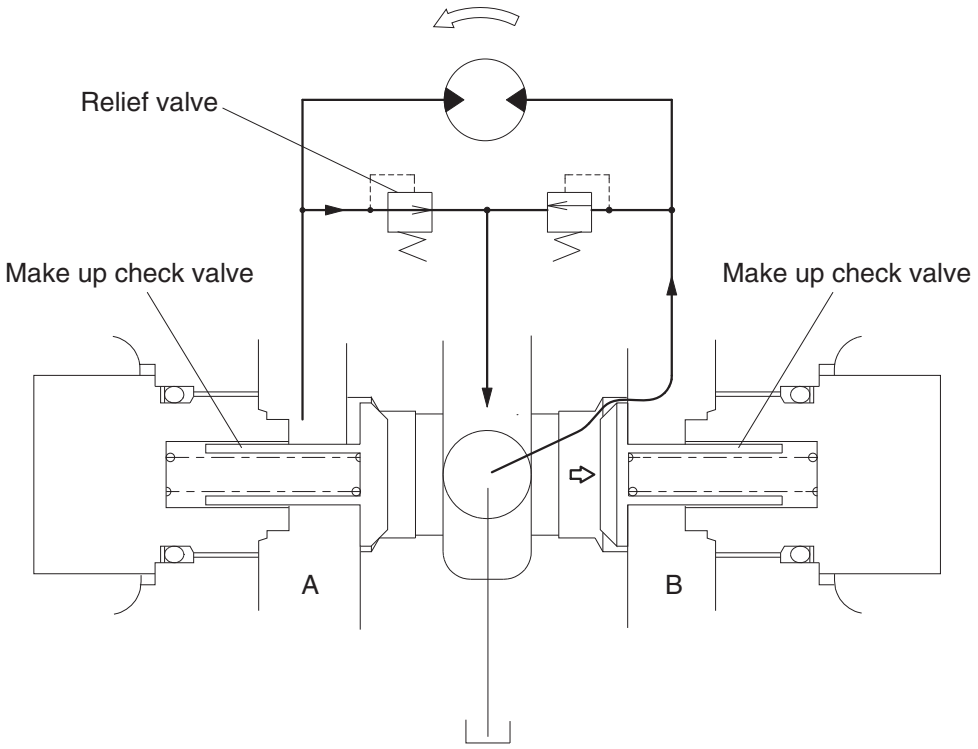
2) MAKE UP VALVE

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

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

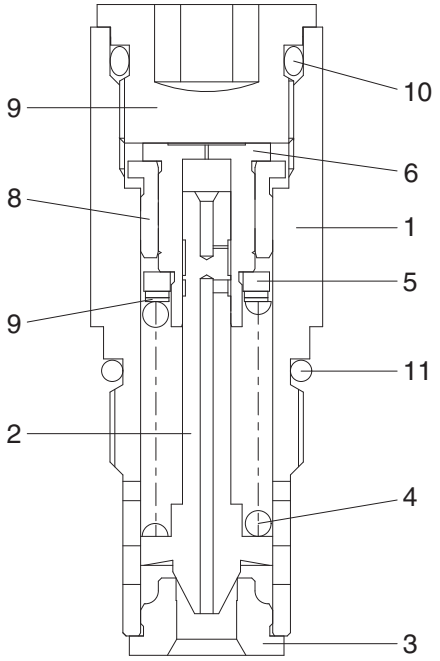
Pressurized oil into the port B, the motor rotate counterclockwise.

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



21092SM04

3) RELIEF VALVE



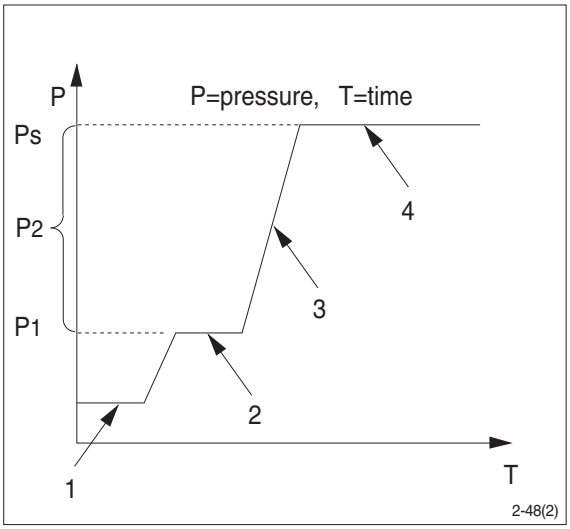
1	Sleeve
2	Poppet
3	Poppet seat
4	Spring
5	Spring seat
6	Shim
7	Piston
8	Stopper
9	Plug
10	O-ring
11	O-ring

(1) Construction of relief valve

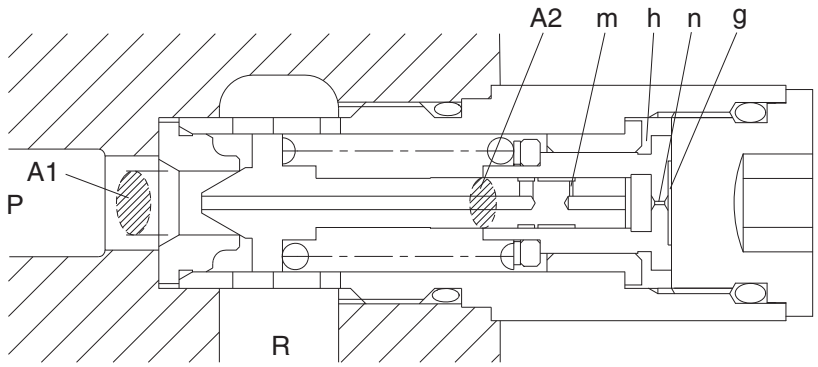
The valve casing contains two cartridge type relief valves that stop the regular and reverse rotations of the hydraulic motor. The relief valves relieve high pressure at start or at stop of swing motion and can control the relief pressure in two steps, high and low, in order to insure smooth operation.

(2) Function of relief valve

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



① Ports (P,R) at tank pressure.

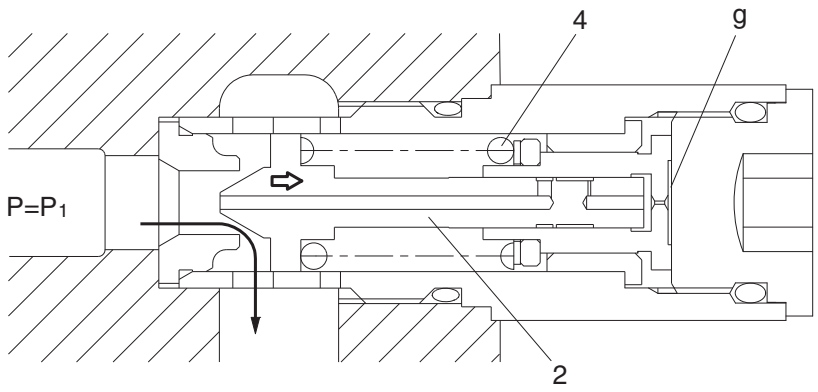


2209A2SM26

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

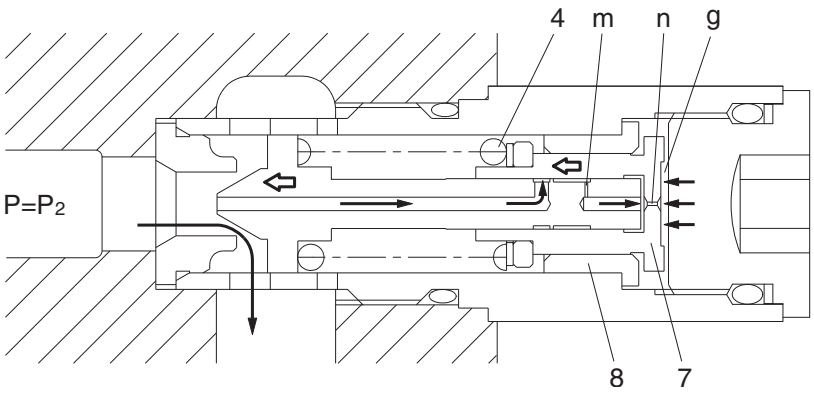
$P_1 \times A_1 = Fsp + Pg \times A_2$

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



2209A2SM27

③ The oil flow chamber g via orifice m and n. When the pressure of chamber g reaches the preset force (F_{SP}) of spring (4), the piston (7) moves left and stop the piston (7) hits the bottom of bushing (8).

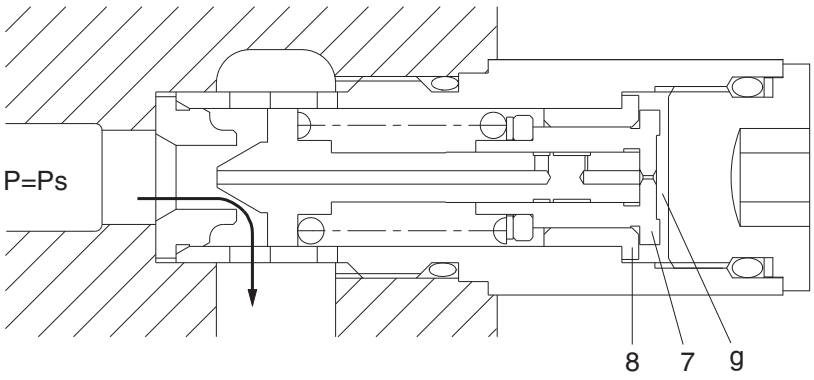


2209A2SM28

④ When piston (7) hits the bottom of bushing (8), it stops moving to the left any further. As the result, the pressure in chamber (g) equals (Ps).

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

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



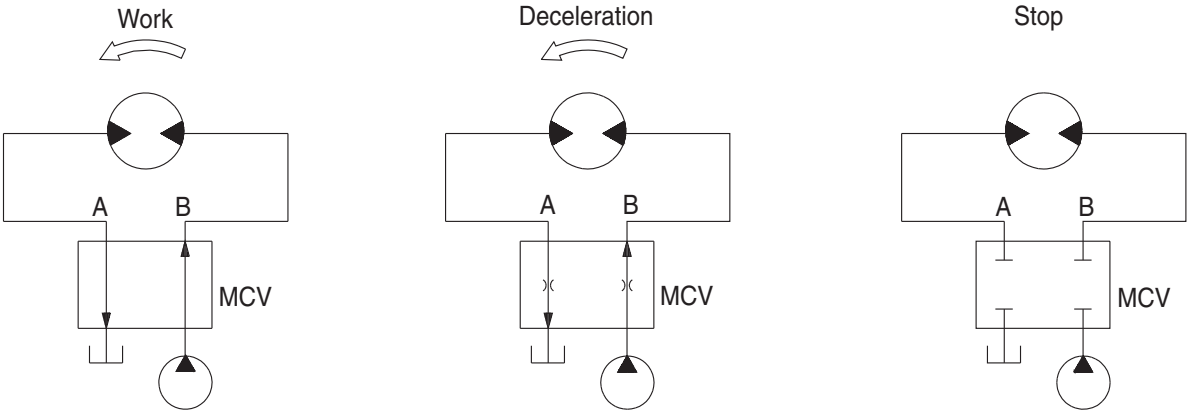
2209A2SM29

4) BRAKE SYSTEM

(1) Control valve swing brake system

This is the brake system to stop the swing motion of the excavator during operation.

In this system, the hydraulic circuit is throttled by the swing control valve, and the resistance created by this throttling works as a brake force to slow down the swing motion.



MCV A, B opened | MCV A, B throttled | MCV A, B closed

2-48(1)

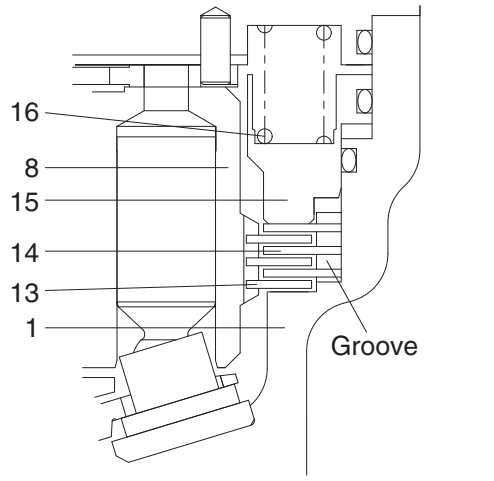
(2) Mechanical swing parking brake system

This is function as a parking brake only when all of the RCV lever (except swing, arm in) are not operated.

① **Brake assembly**

Circumferential rotation of separate plate (14) is constrained by the groove located at casing (1). When housing is pressed down by brake spring (16) through friction plate (13), separate plate (14) and parking piston (15), friction force occurs there.

Cylinder block (8) is constrained by this friction force and brake acts, while brake releases when hydraulic force exceeds spring force.

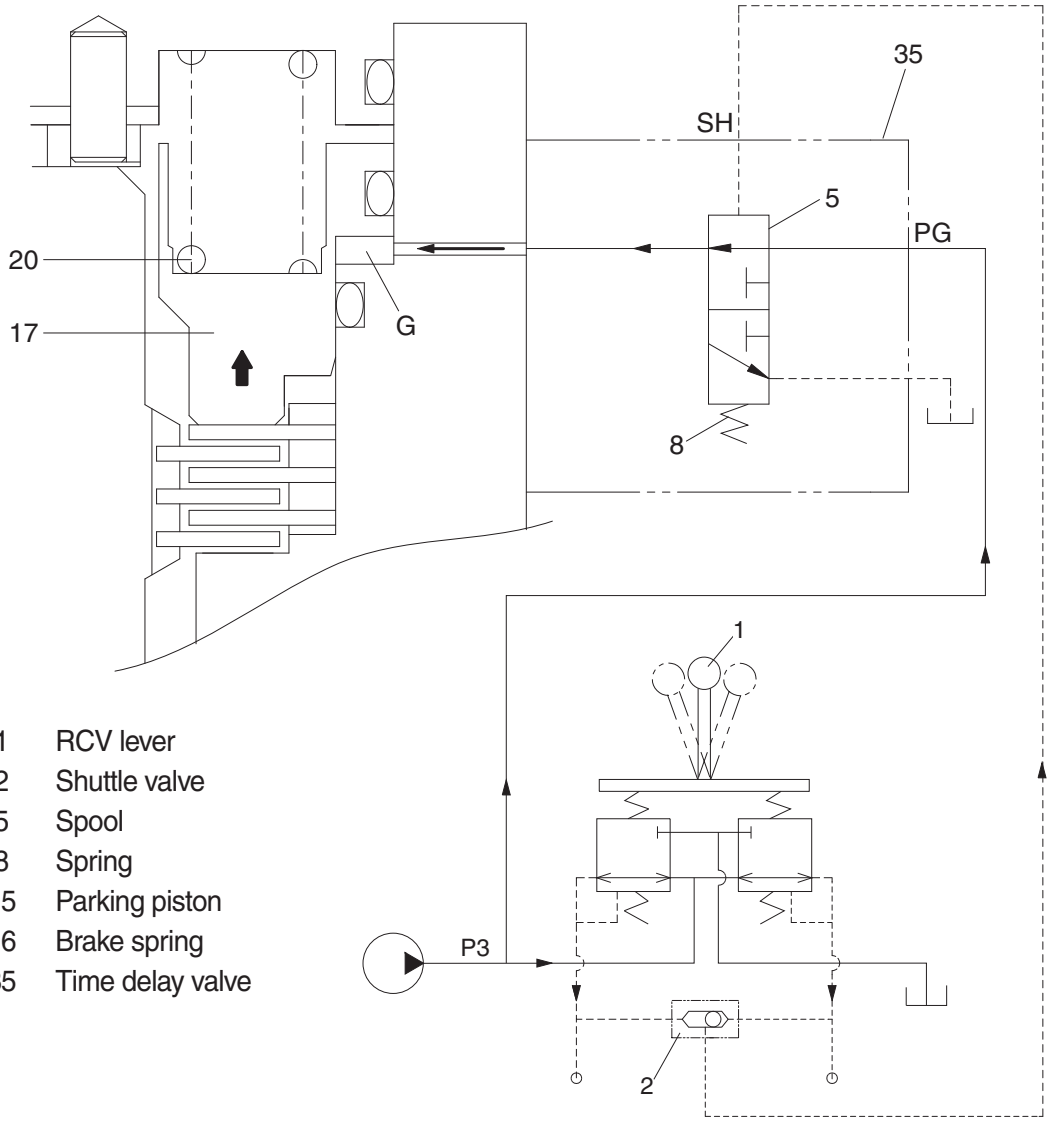


2209A2SM35

1	Casing	14	Separate plate
8	Cylinder block	15	Parking piston
13	Friction plate	16	Brake spring

② **Operating principle**

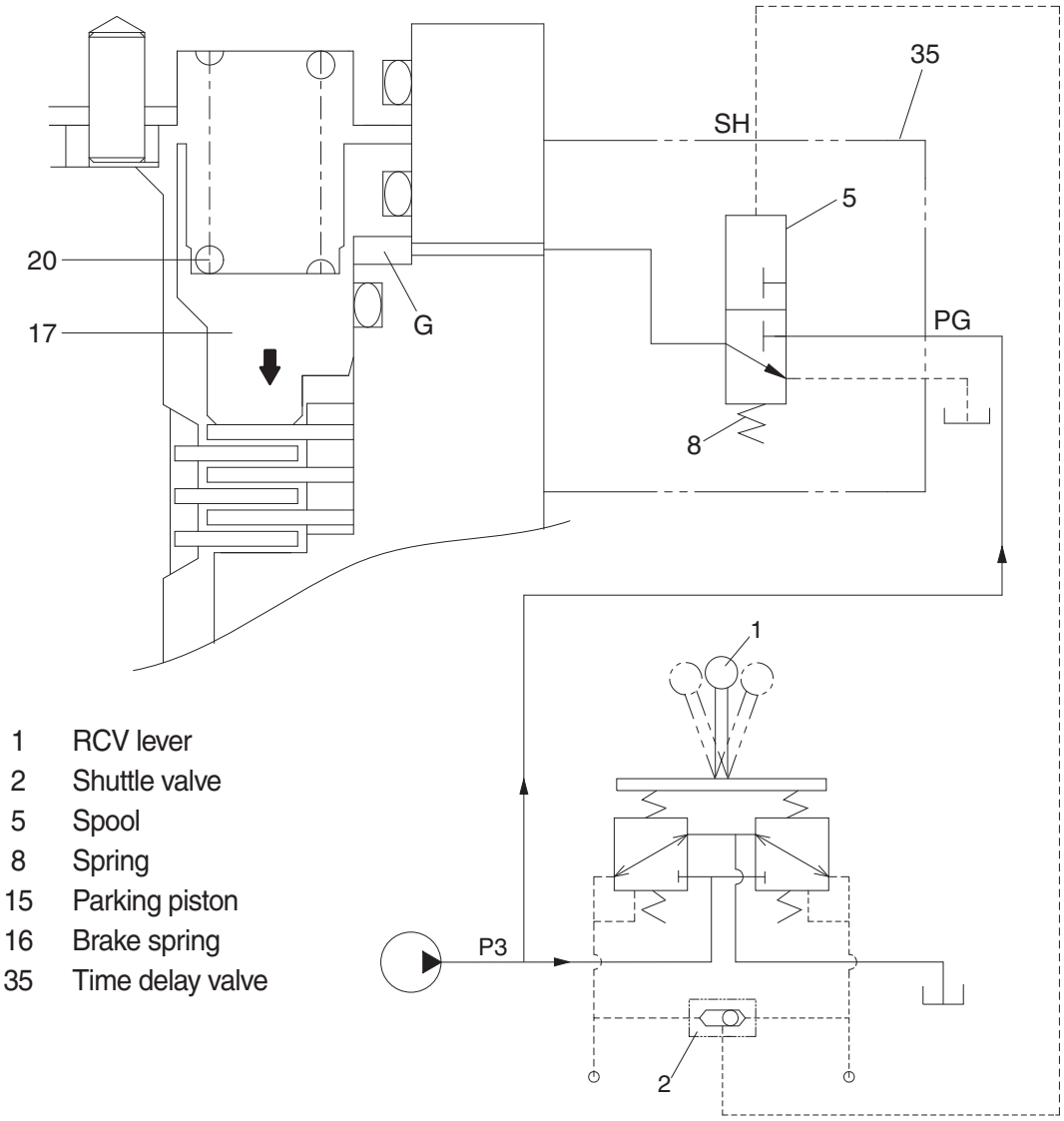
a. When the RCV lever (1) is set to the swing or arm in operating position, the pilot oil go to SH of the time delay valve (35).
This pressure moves spool (5) to the leftward against the force of the spring(8), so pilot pump charged oil (P3) goes to the chamber G through port PG.
This pressure is applied to move the parking piston (15) to the upward against the force of the brake spring (16). Thus, it releases the brake force.



1 RCV lever
2 Shuttle valve
5 Spool
8 Spring
15 Parking piston
16 Brake spring
35 Time delay valve

300L2SM04

b. When all of the RCV lever (1) are set the neutral position, the spool (5) returns to the top.
Then, the parking piston (15) is moved lower by spring force and the return oil from the chamber G flows back to tank port.
At this time, the brake works.



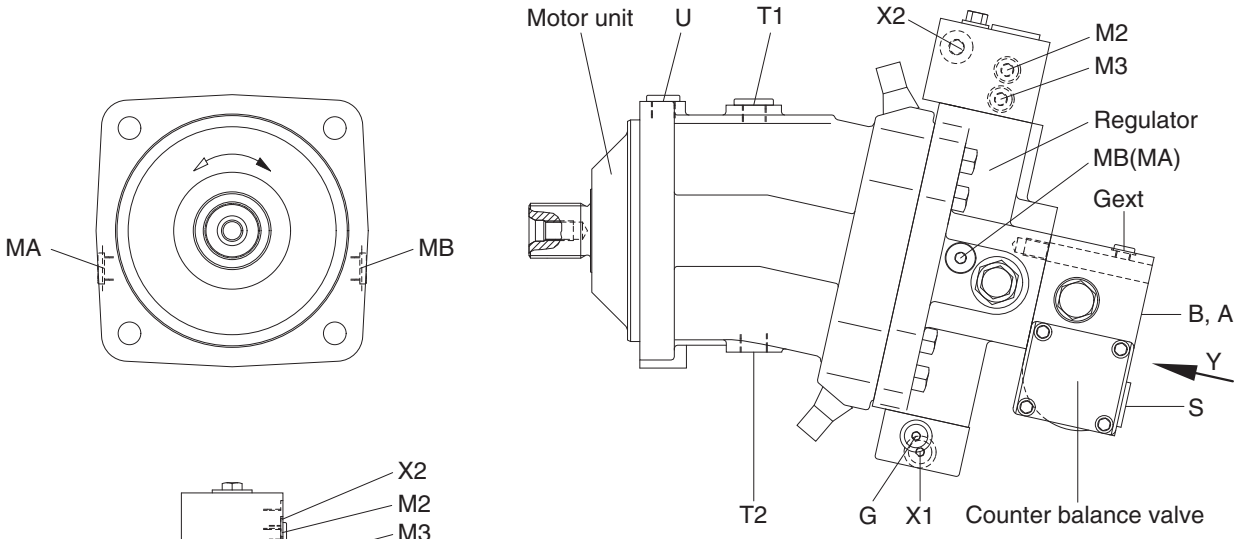
1 RCV lever
2 Shuttle valve
5 Spool
8 Spring
15 Parking piston
16 Brake spring
35 Time delay valve

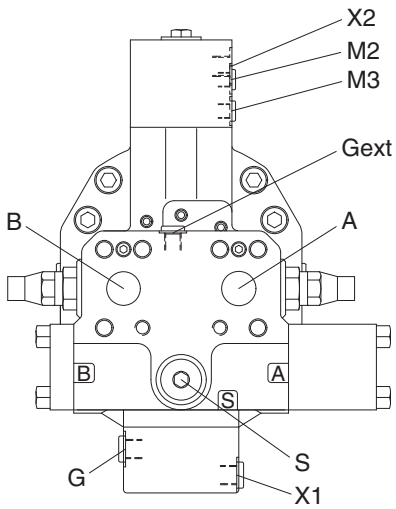
300L2SM05

GROUP 4 TRAVEL MOTOR

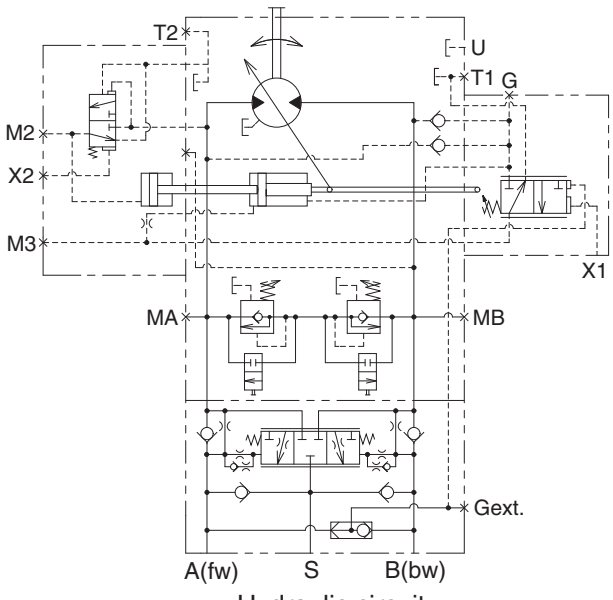
1. CONSTRUCTION

Travel motor consists motor unit, regulator and counter balance valve.





VIEW Y

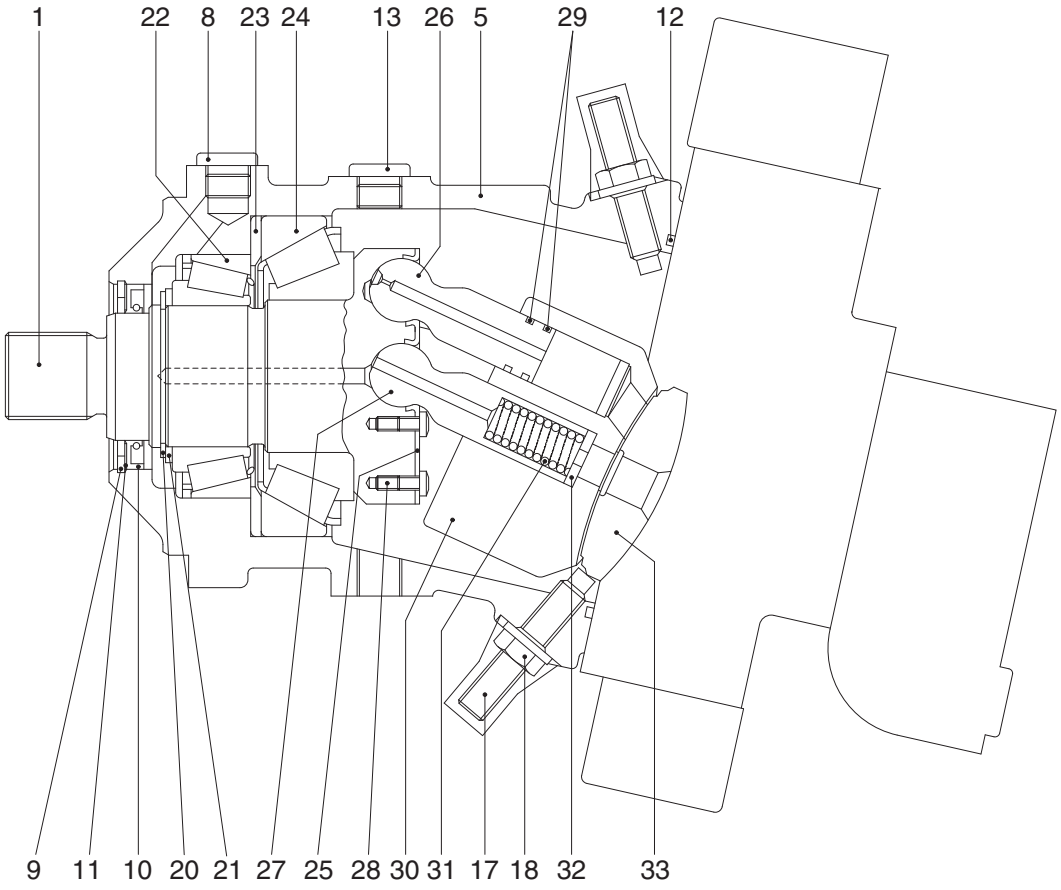


Hydraulic circuit

210W9A2TR01

Port	Port name	Port size
A, B	Main port	SAE 1 1/4"
G	N.A	M14×1.5 - 12
M1	Gauge port	M14×1.5 - 12
X1	Pilot pressure port	M14×1.5 - 12
X2	Pilot pressure port	M14×1.5 - 12
T1	Drain port	PF 3/4 - 17
T2	Drain port	PF 3/4 - 12
U	Flushing port	PF 1/2 - 16
S	Make up port	M27×2.0 - 16
MA, MB	Gauge port	M18×1.5 - 12
M2, M3	Gauge port	M10×1.0 - 8
Gext	Brake release port	M12×1.5 - 12.5

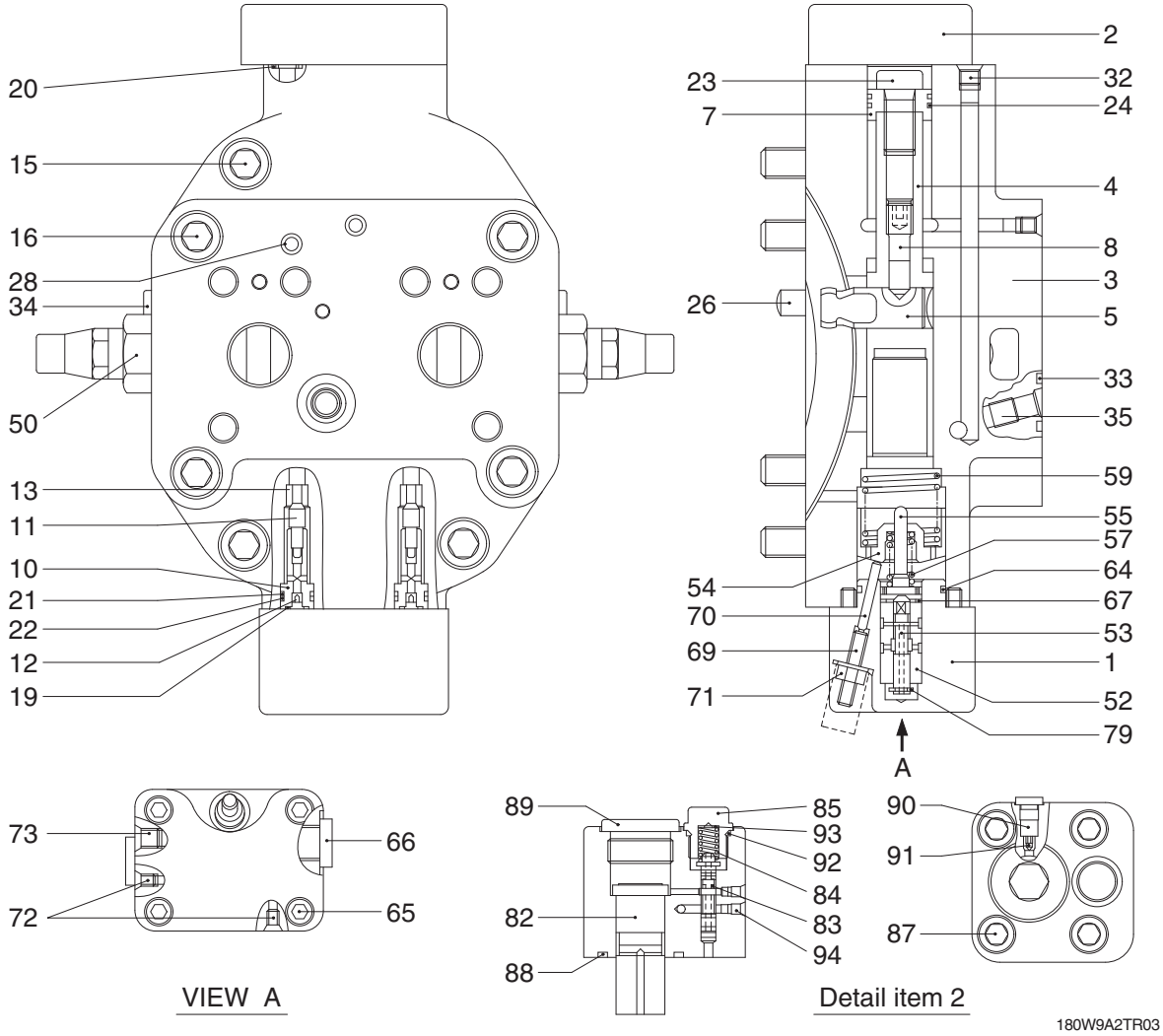
1) MOTOR UNIT



180W9A2TR02

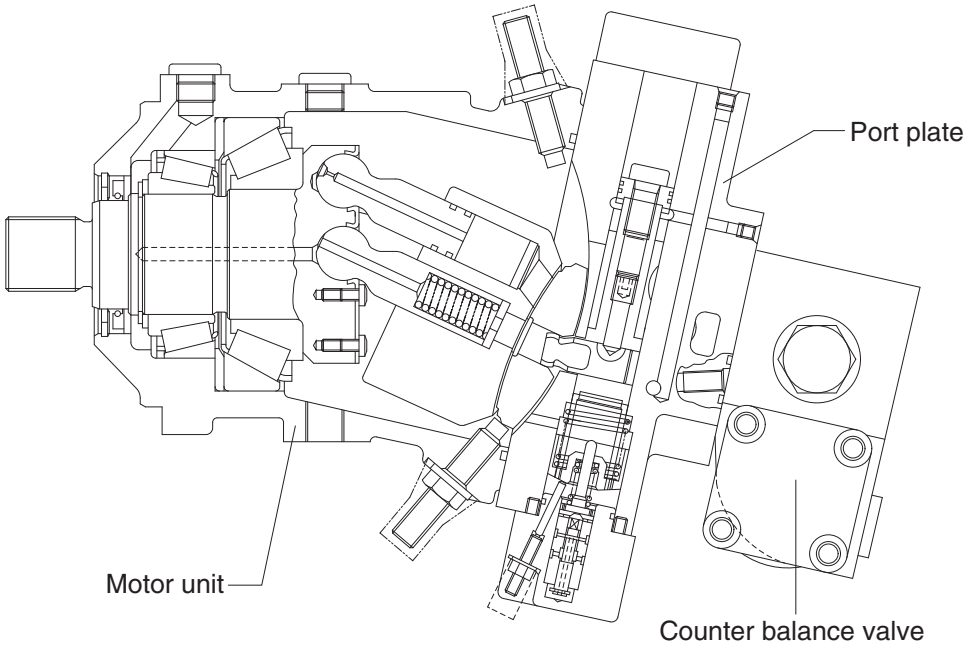
1	Drive shaft	17	Threaded pin	26	Piston
5	Housing	18	Seal lock nut	27	Center pin
8	Locking screw	20	Retaining ring	28	Pan head screw
9	Retaining ring	21	Back up plate	29	Steel sealing ring
10	Shaft seal ring	22	Taper roller bearing	30	Cylinder block
11	Back up plate	23	Shim	31	Pressure spring
12	O-ring	24	Taper roller bearing	32	Adjustment shim
13	Locking screw	25	Retaining plate	33	Control lens

2) REGULATOR



1	Control housing	24	Square ring	70	Cylinder pin
2	Stroke limiter	26	Cylinder pin	71	Seal lock nut
3	Port plate	28	Double break off pin	72	Double break off pin
4	Positioning piston	32	Double break off pin	73	Double break off pin
5	Positioning trunnion	33	O-ring	79	Retaining disc
7	Piston	34	Locking screw	82	Piston
8	Threaded pin	50	Relief valve	83	Control piston
10	Valve guide	52	Control bushing	84	Pressure spring
11	Bolt	53	Control piston	85	Locking screw
12	Throttle screw	54	Adjusting bushing	87	Socket head screw
13	Bushing	55	Spring collar	88	O-ring
15	Socket head screw	57	Pressure spring	89	Locking screw
16	Socket head screw	59	Pressure spring	90	Locking screw
19	O-ring	64	O-ring	91	Orifice
20	O-ring	65	Socket head screw	92	O-ring
21	O-ring	66	Locking screw	93	Shim
22	Back up ring	67	Retaining ring	94	Double break off pin
23	Socket head screw	69	Threaded pin		

2. FUNCTION



180W9A2TR05

1) VARIABLE DISPLACEMENT MOTOR (with integrated counterbalance valve)

The variable displacement motor has a rotary group in bent axis design.
The torque is generated directly at the drive shaft.
The cylinder barrel is driven by a tapered piston arrangement.
The change of displacement is generated by the control lens via positioning piston. The control lens slides on a circular shaped surface.

In case of constant pump flow volume and high pressure
- The output speed is increased at smaller swivel angle, the torque is reduced
- The torque rises at swivel angle increase, the output speed is decreased

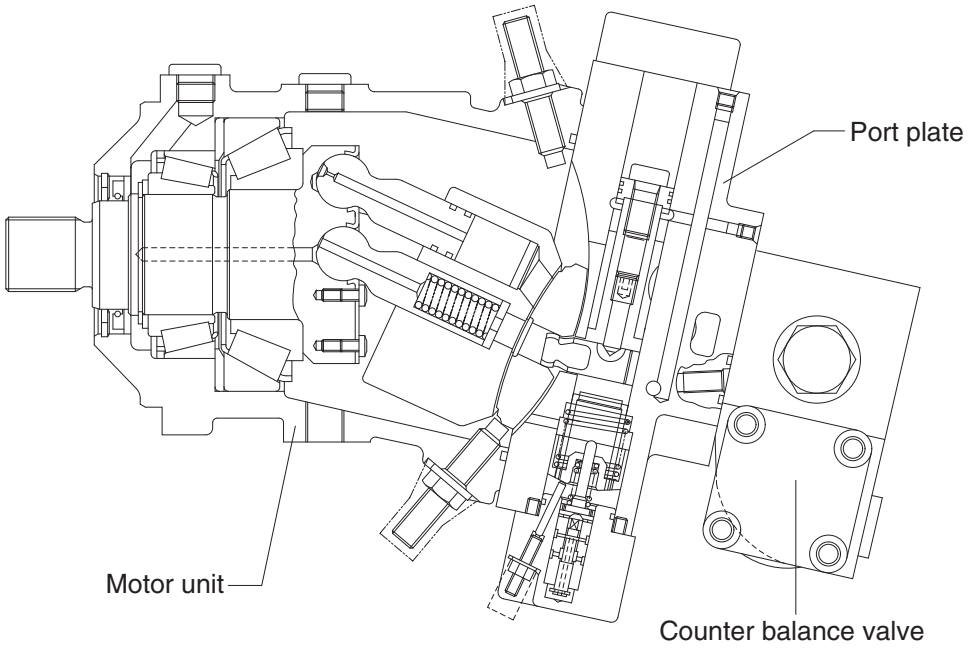
The max swivel angle is 25°, the min swivel angle is 0°.

The variable displacement motor with integrated counterbalance valve is designed to be operated in open loop.

※ Min and max displacement are limited by a stop screw. Stepless adjustment to various higher values is possible.
Reduction to smaller displacement may result in overspeeding the motor.

2) PORT PLATE

With high pressure dependent control HA1, mounted counterbalance valve, integrated secondary pressure relief valves, plugged gauge and boosting ports, service ports to the rear.



3) HIGH PRESSURE DEPENDENT CONTROL

The displacement is-dependent on operating pressure - automatically adjusted. Upon reaching the operating pressure set at the control valve - internally measured at A or B - the motor swivels from V_{gmin} to V_{gmax} until output torque = load torque. For values lower than the adjusted one the motor keeps min swivel angle. The necessary positioning energy is taken from the respective high pressure side via shuttle valve.

Swivelling results in a change of the displacement.
Swivel time is controlled by an orifice installed in the cover of the large positioning piston side.

4) COUNTER BALANCE VALVE

Mounted at the rear of the port plate.
Incase of downhill traveling or deceleration of the machine a counter balance valve avoids overspeeding and cavitation of hydraulic motor.

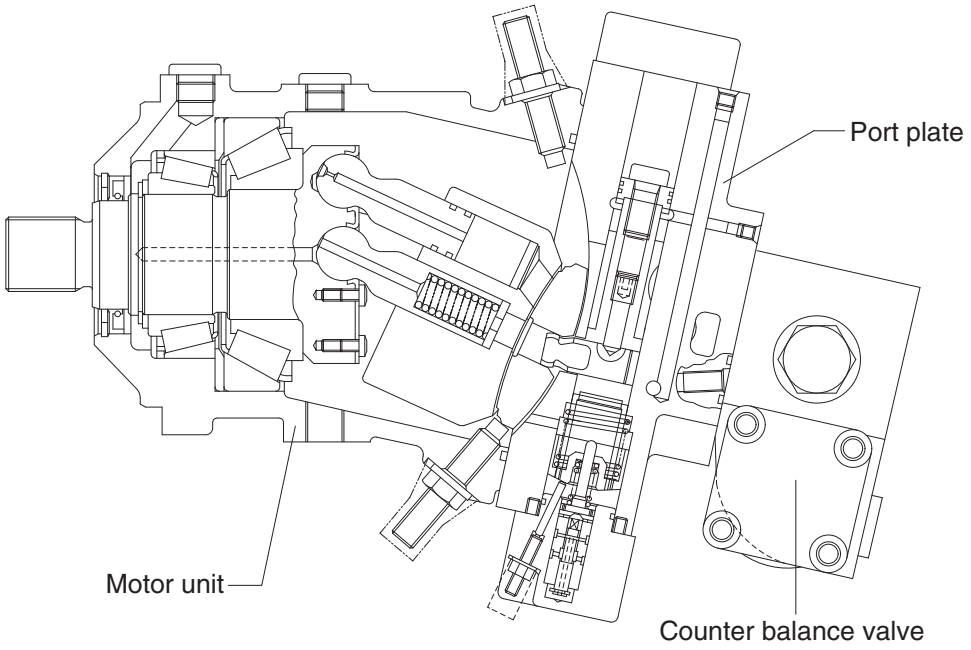
5) FUNCTION AS TO CIRCUIT DIAGRAM

Check valves in the inlet line A and B for by passing of the counter balance valve.
At traveling forward the return oil flow is controlled by a counter balance spool. At drop in inlet pressure the counter balance spool throttles the return oil flow. The motor is locked. The oil behind the spool is led to the low pressure side via an additional check valve. Same function for traveling forward and backward.

Braking means for the motor that
- At reduced or zero inlet flow the counterbalance spool reaches a modulating position or a neutral position caused by spring force
- The high pressure oil (at outlet side of the motor) is returned to the low pressure side (at inlet side) of the motor via crossover relief valves.

As the control pressure for regulation of the HA control via the integrated shuttle valve is no longer available, the motor with HA control and counter balance valve will swivel to its minimum displacement during deceleration.
In addition, an external boost flow/pressure can be applied at port S for preventing cavitation.

※ Counter balance valves do not replace the service and parking brake.



180W9A2TR05

6) INSTALLATION

The housing must be filled entirely with oil and shall also not run empty at rotary group standstill.

7) FILTRATION

According to purity class 9 as to NAS 1638, 6 as to SAE, ASTM, AIA and 18/15 as to ISO/DIS 4406.

8) PRESSURE

Ports A or B : Normal 400 bar, peak pressure 450 bar
Port A + B : Pressure summation below 700 bar
Max permissible intermittent case pressure : 6 bar

9) DIRECTION OF ROTATION/ DIRECTION OF FLOW

With view on the drive shaft - clockwise/ A to B; Counter-clockwise / B to A

10) LEAKAGE OIL TEMPERATURE

In the bearing area max permitted -25 °C to +80 °C; Short time operation -40 °C to +115 °C

11) COMMISSIONING

Fill the housing entirely with oil through highest located T port. Also connect the leakage oil pipe at this port. After commissioning check sealing and make visual control of the complete installation.

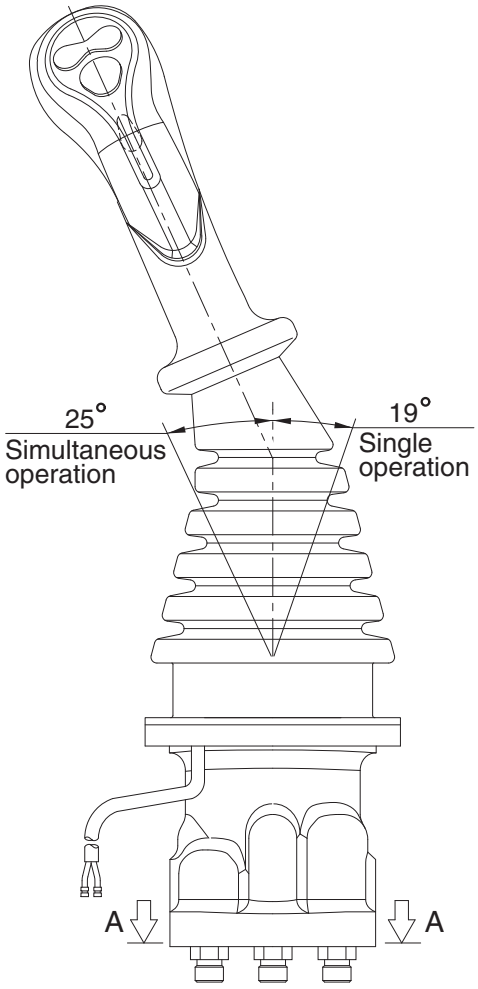
GROUP 5 RCV LEVER

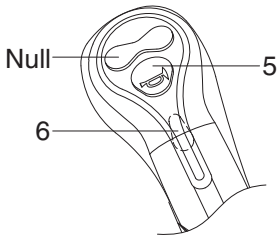
1. STRUCTURE

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

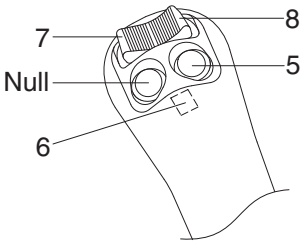
※ **Refer to the parts manual for the types of the RCV lever.**

1) TYPE M1, M3, M5





TYPE M1, M3

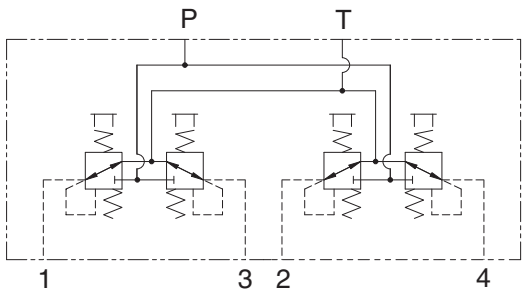


TYPE M5

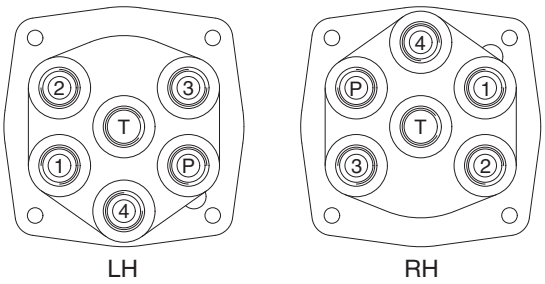
Switches

Type	No.	LH	RH
M1, M3	5	One touch decel	Horn
	6	Power boost	Breaker
M5	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment



Hydraulic circuit



LH RH

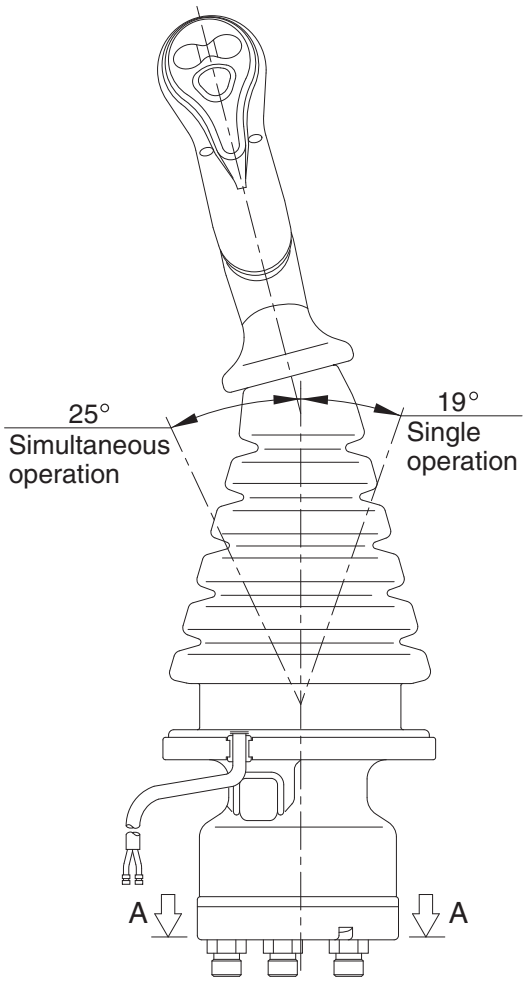
VIEW A-A

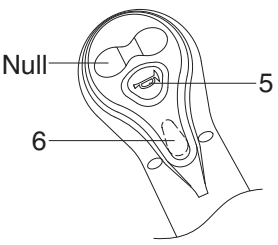
Pilot ports

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

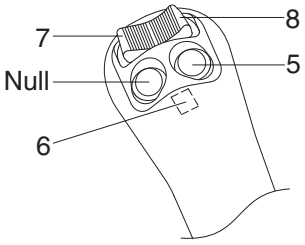
300L2RL01

2) TYPE M2, M4, M6





TYPE M2, M4

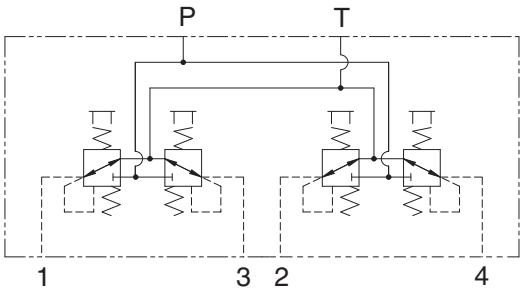


TYPE M6

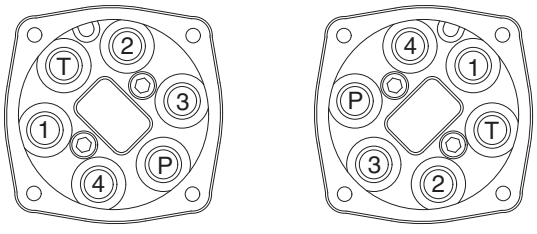
Switches

Type	No.	LH	RH
M2, M4	5	One touch decel	Horn
	6	Power boost	Breaker
M6	5	One touch decel	Horn
	6	Power boost	Null
	7	CCW rotation	Close
	8	CW rotation	Open

※ Number 7 and 8 : Option attachment



Hydraulic circuit



LH RH

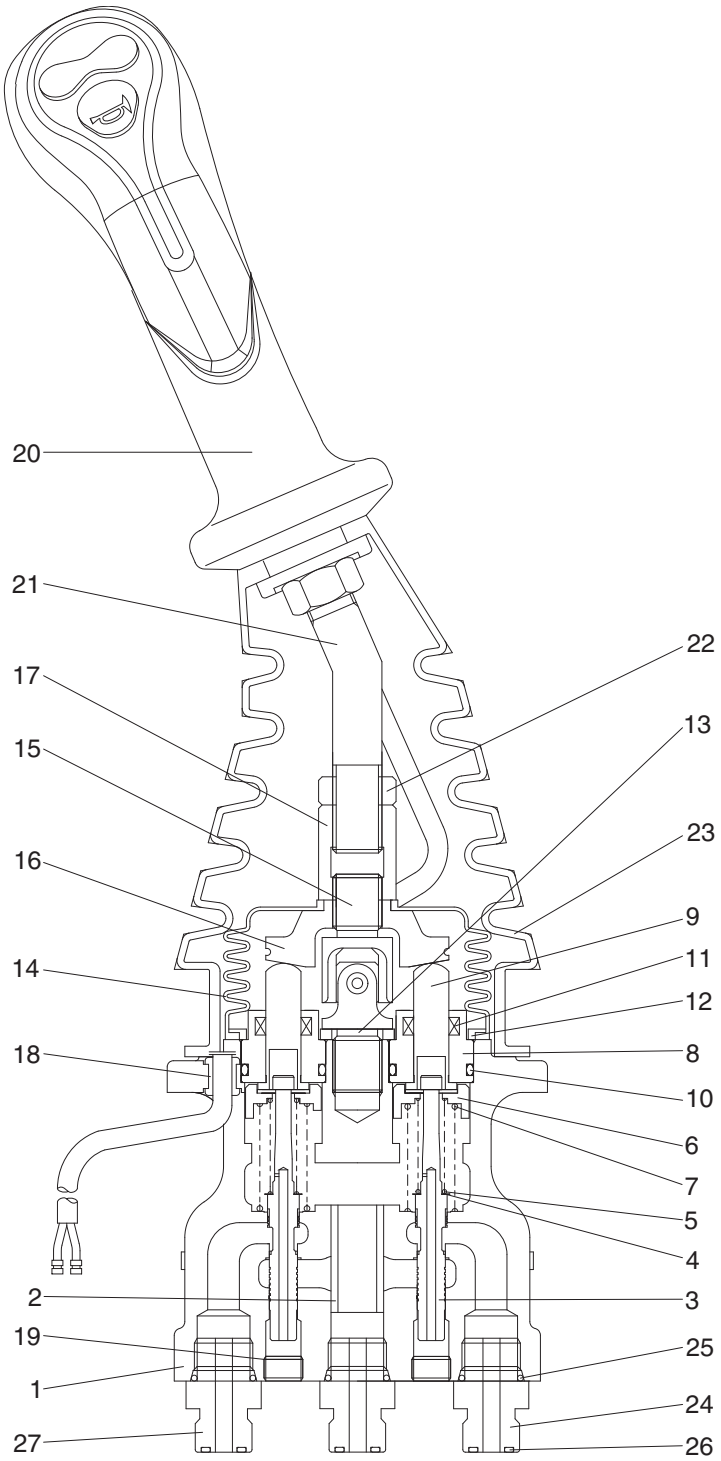
VIEW A-A

Pilot ports

Port	LH	RH	Port size
P	Pilot oil inlet port	Pilot oil inlet port	PF 3/8
T	Pilot oil return port	Pilot oil return port	
1	Left swing port	Bucket out port	
2	Arm out port	Boom up port	
3	Right swing port	Bucket in port	
4	Arm in port	Boom down port	

300L2RL05

3) CROSS SECTION



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

300L2RL06

Item numbers are based on the type M1.

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

The pressure reducing section is composed of the spool (3), spring (5) for setting secondary pressure, return spring (7), spring seat (6) and shim (4). The spring for setting the secondary pressure has been generally so preset that the secondary pressure is 5 to 20.5 kgf/cm^2 (depending on the type). The spool is pushed against the push rod (9) by the return spring.

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

2. FUNCTIONS

1) FUNDAMENTAL FUNCTIONS

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

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

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

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

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

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

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

2) FUNCTIONS OF MAJOR SECTIONS

Item numbers are based on the type M1.

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

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

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

For the purpose of changing the displacement of the push rod through the swash plate (16) and adjusting nut (17) are provided the handle assy (20) that can be tilted in any direction around the fulcrum of the universal joint (15) center.

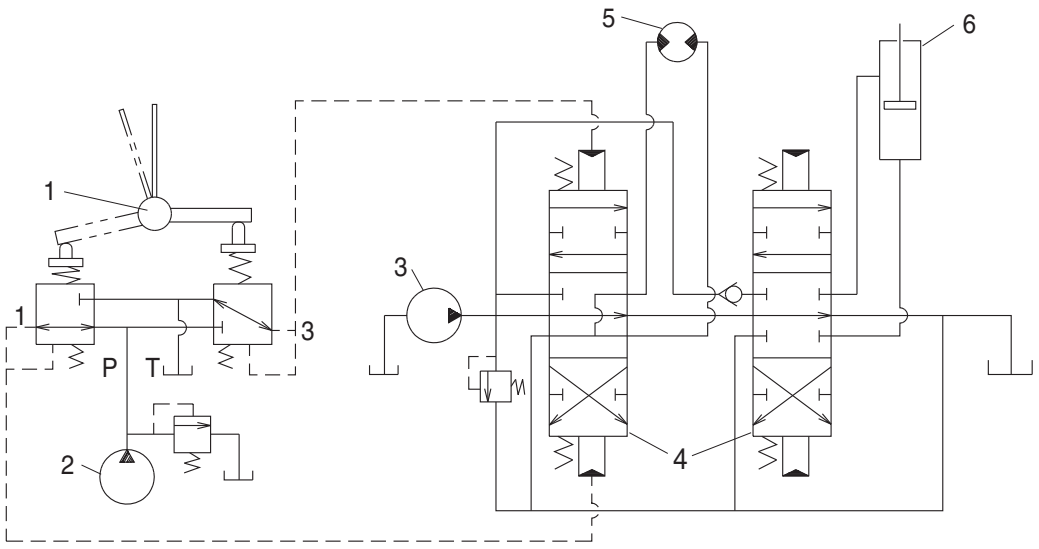
The spring (7) works on the case (1) and spring seat (6) and tries to return the push rod (9) to the zero-displacement position irrespective of the output pressure, securing its resetting to the center position.

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

3) OPERATION

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

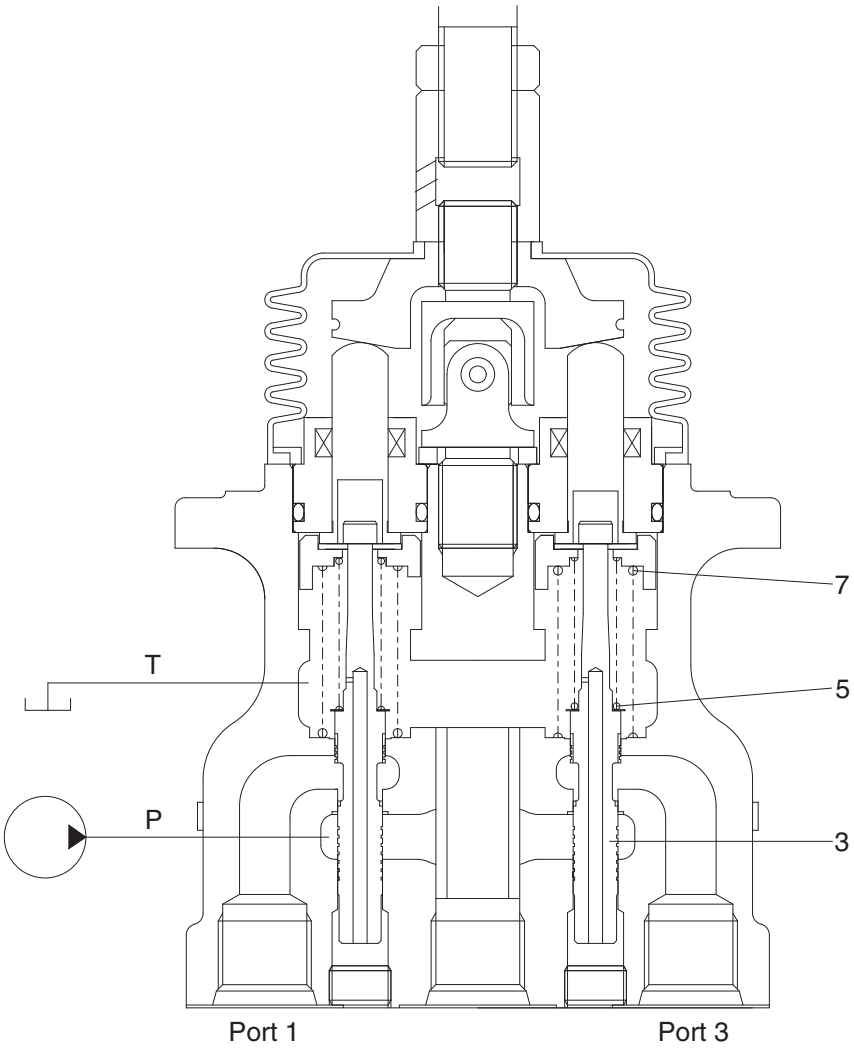
The diagram shown below is the typical application example of the pilot valve.



2-70

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

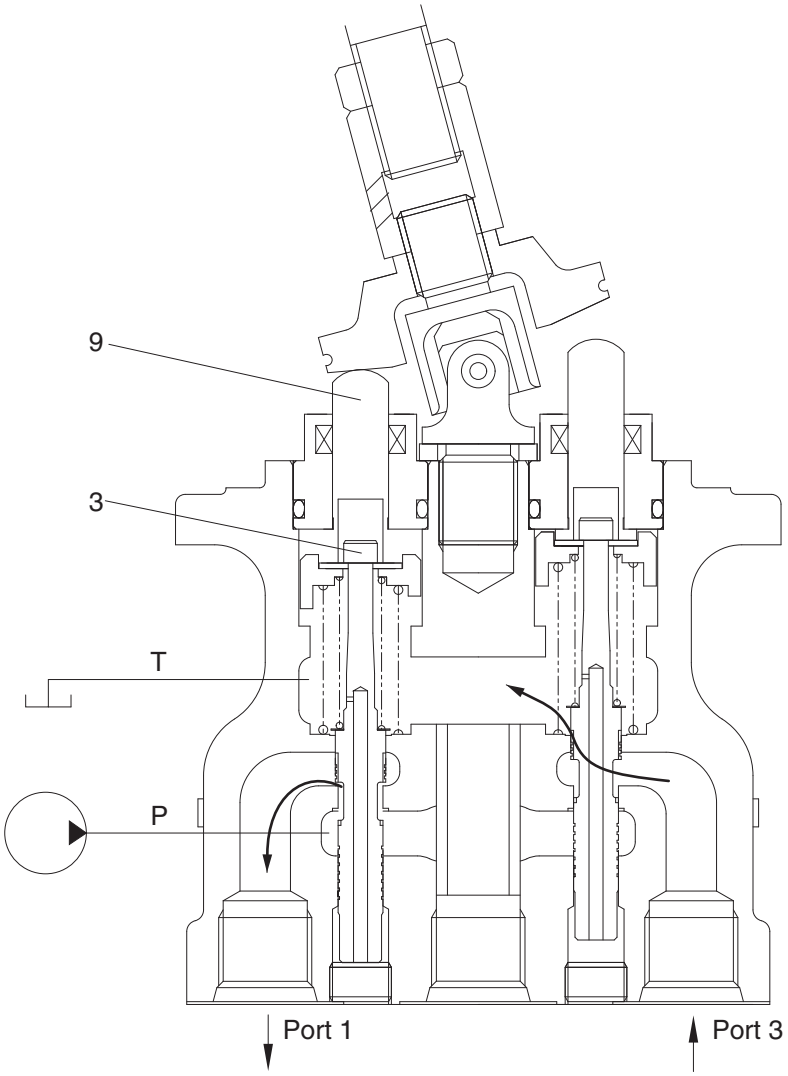
(1) Case where handle is in neutral position



300L2RL03

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

(2) Case where handle is tilted



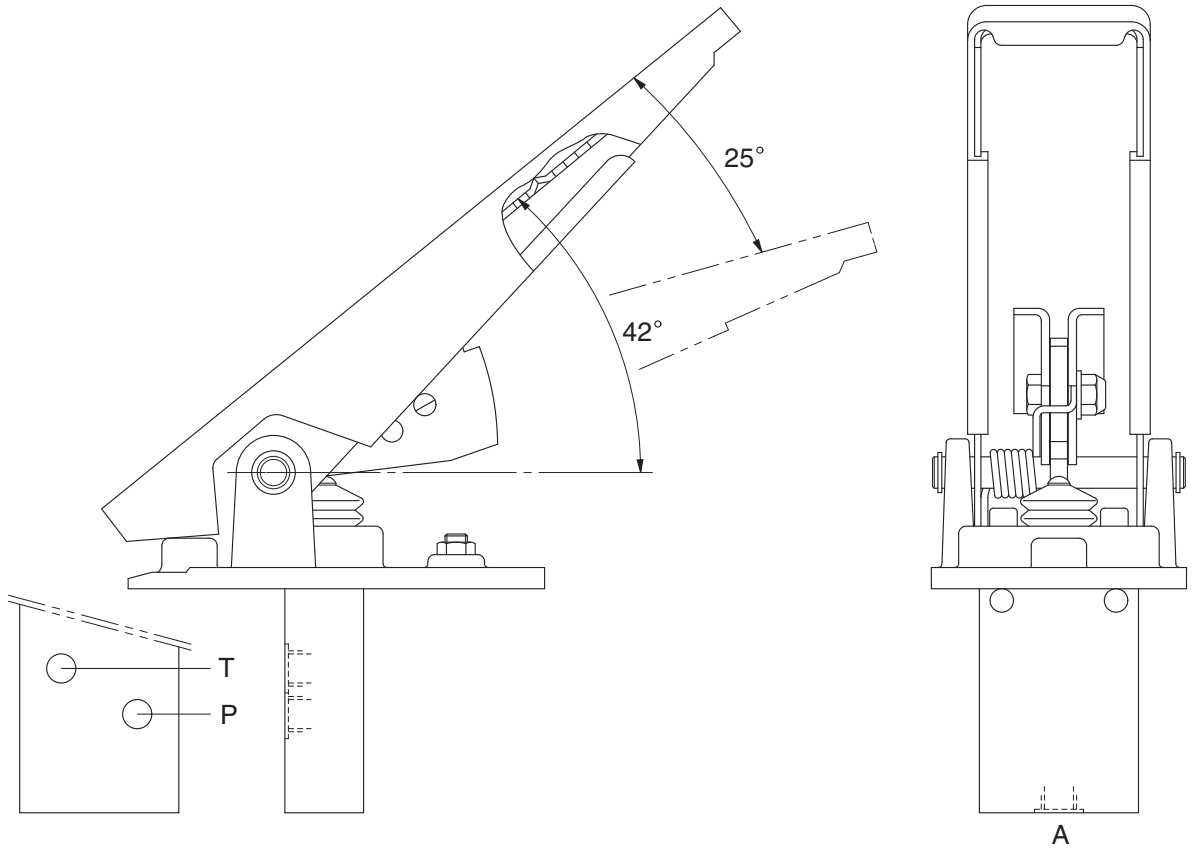
300L2RL04

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

GROUP 6 ACCELERATOR PEDAL

1. STRUCTURE

The casing has the oil inlet port P (primary pressure), and the oil return port T (tank). In addition the secondary pressure is taken out through port A.



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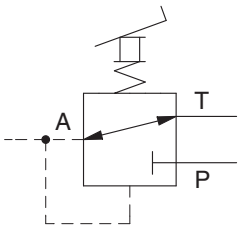


Hydraulic circuit

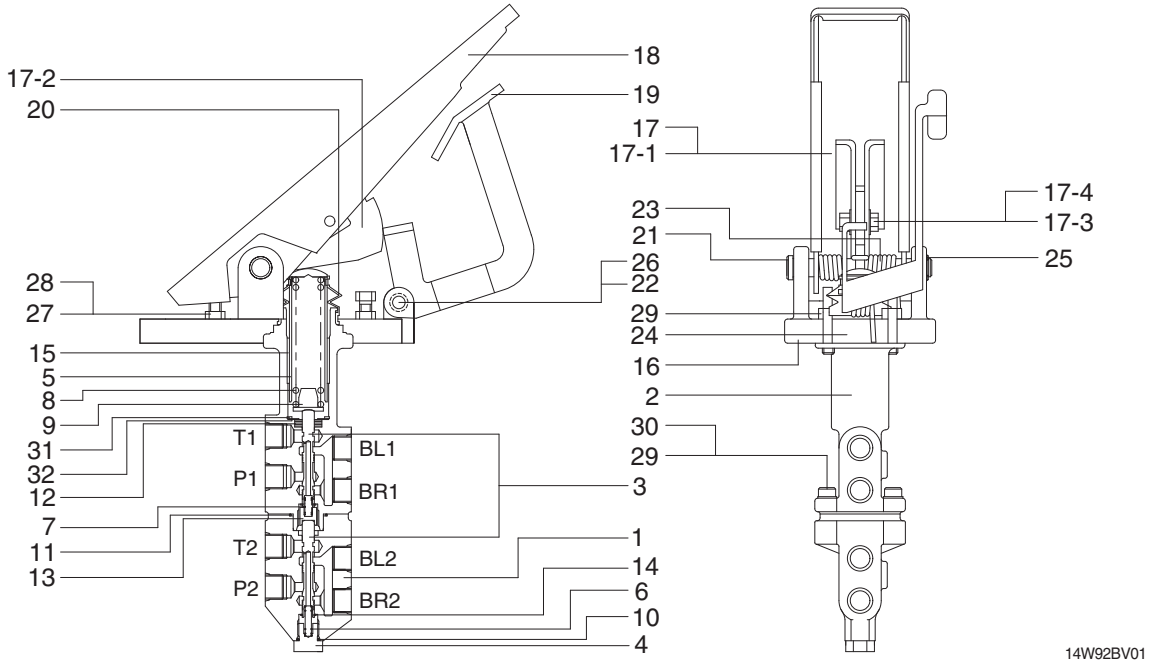
Port	Port name	Port size
P	Pilot oil inlet port	PF 1/4
T	Pilot oil return port	
A	Pilot oil output port	

17032RP01(2)

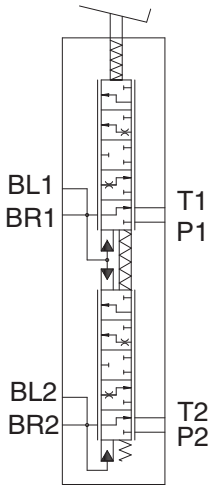
GROUP 7 BRAKE PEDAL (VALVE)

1. STRUCTURE

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



1	Lower body	13	Spring Guide	21	Lock pin 1
2	Upper body	14	Snap ring	22	Lock pin 2
3	Spool	15	DU bushing	23	Torsion spring 1
4	Plug	16	Pedal plate	24	Torsion spring 2
5	Holder	17	Pedal assy	25	Retainer ring
6	Lower spring	17-1	Pedal	26	E-ring
7	Upper spring	17-2	Lock plate	27	Hex bolt
8	Main spring	17-3	Hex bolt	28	Hex nut
9	Spring retainer	17-4	Plain washer	29	Socket head bolt
10	O-ring	18	Pedal cover	30	Spring washer
11	O-ring	19	Latch	31	Plat washer
12	Oil seal	20	Bellows	32	Retainer ring



Port	Port name	Port size
P1	Port	PF 3/8
P2	Port	
BR1	Brake cylinder port	
BR2	Brake cylinder port	
BL1	Pluging	
BL2	Pluging	
T1	Drain port	
T2	Drain port	

2. FUNCTION

1) PURPOSE

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

2) READY POSITION

When the braking system is ready for operation, its accumulator pressure acts directly on port P1/P2 of the brake valve. A connection is established between ports BR1/BR2 and port T1/T2 so that the wheel brakes ports BR1/BR2 are pressureless via the returns ports T1/T2.

3) PARTIAL BRAKING

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The spring assembly (8) beneath pedal plate (16) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the upper spool (3) is mechanically actuated via spring assembly (8), and the lower spool (3) is actuated hydraulically by spool (3). As spools (3) move downward, they will first close returns T1/T2 via the control edges, thus establishing a connection between accumulator port P1/P2 and ports BR1/BR2 for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools (3) are held in the control position by the force applied (spring assembly) above the spools and the hydraulic pressure below the spool (balance of forces).

After output of the braking pressure, spools (3) are in a partial braking position, causing ports P1/P2 and T1/T2 to close and holding the pressure in ports BR1/BR2.

4) FULL BRAKING POSITION

When pedal (17) is fully actuated, an end position of the brakes is reached and a connection established between accumulator ports P1/P2 and brake cylinder ports BR1/BR2. Returns T1/T2 are closed at this point.

When the braking process ended, a connection is once again established between brake cylinder ports BR1/BR2 and return ports T1/T2, closing accumulator ports P1/P2.

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

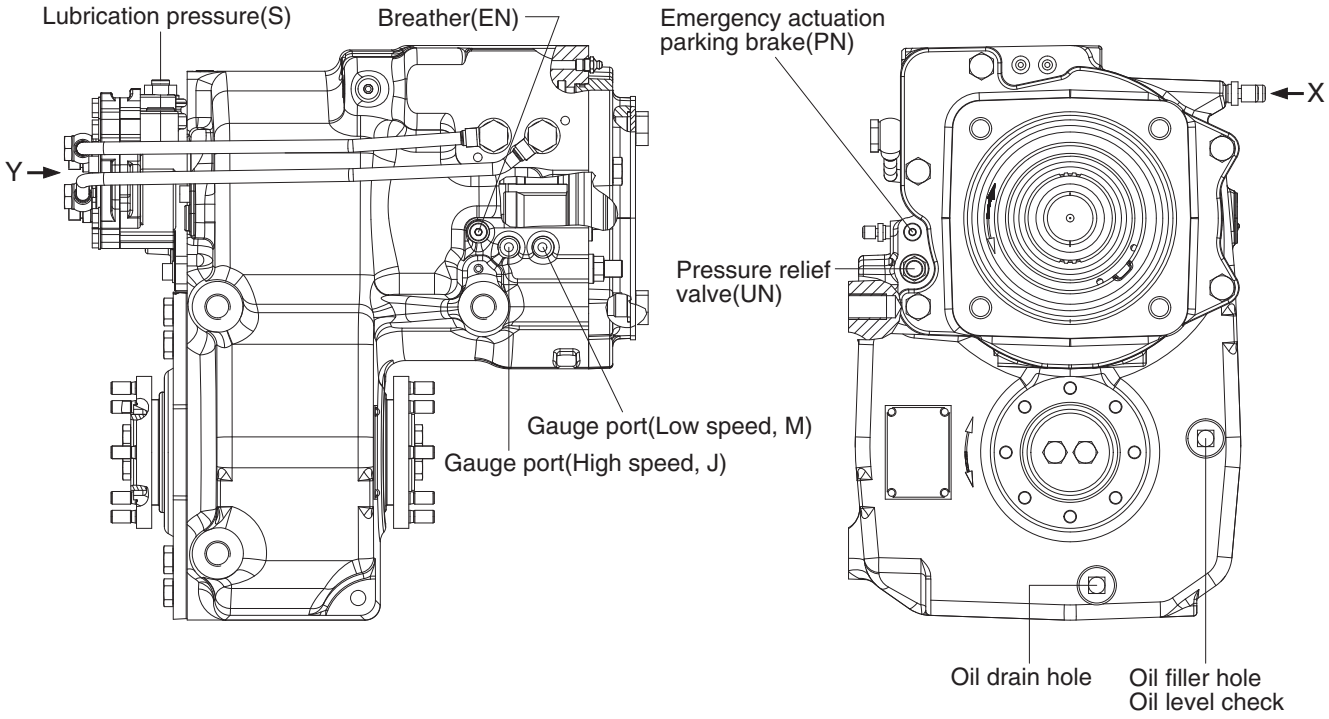
5) LIMITING THE BRAKING PRESSURE

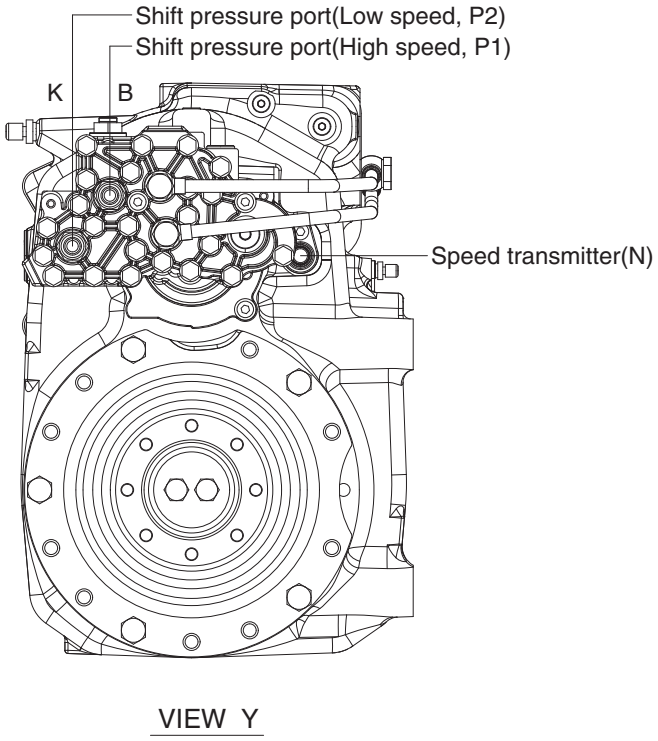
Pedal restriction screw (29) on pedal plate (16) below pedal (17) is used to limit the braking pressure.

6) FAILURE OF A CIRCUIT

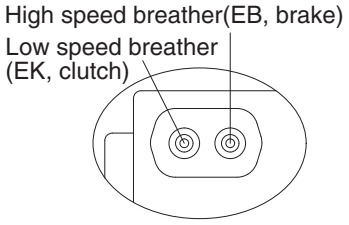
In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (8) will mechanically actuate spool (3). In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool (3) is mechanically actuated by spring assembly (8) and spool (3).

1. STRUCTURE





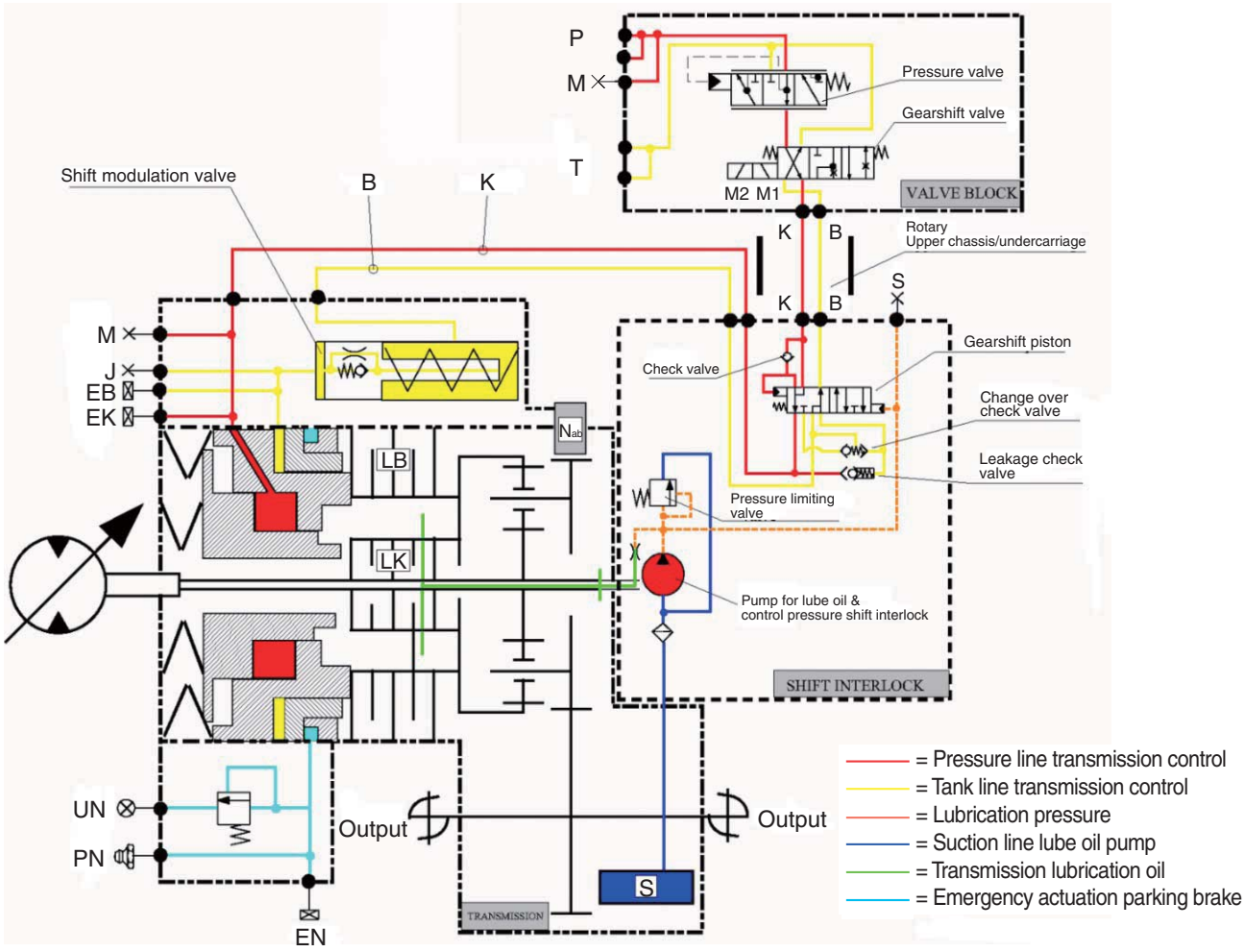
VIEW Y



VIEW X

180W9A2TM01

2. TRANSMISSION DIAGRAM



14W7A2TM02

Measuring points-Transmission/Shift interlock :
J : High speed (brake)
M : Low speed (clutch)
S : Lubrication pressure

Connections-Transmission/Shift interlock :
B : Brake
K : Clutch
PN : Emergency actuation parking brake

Measuring points-Valve block :
M : System pressure transmission control

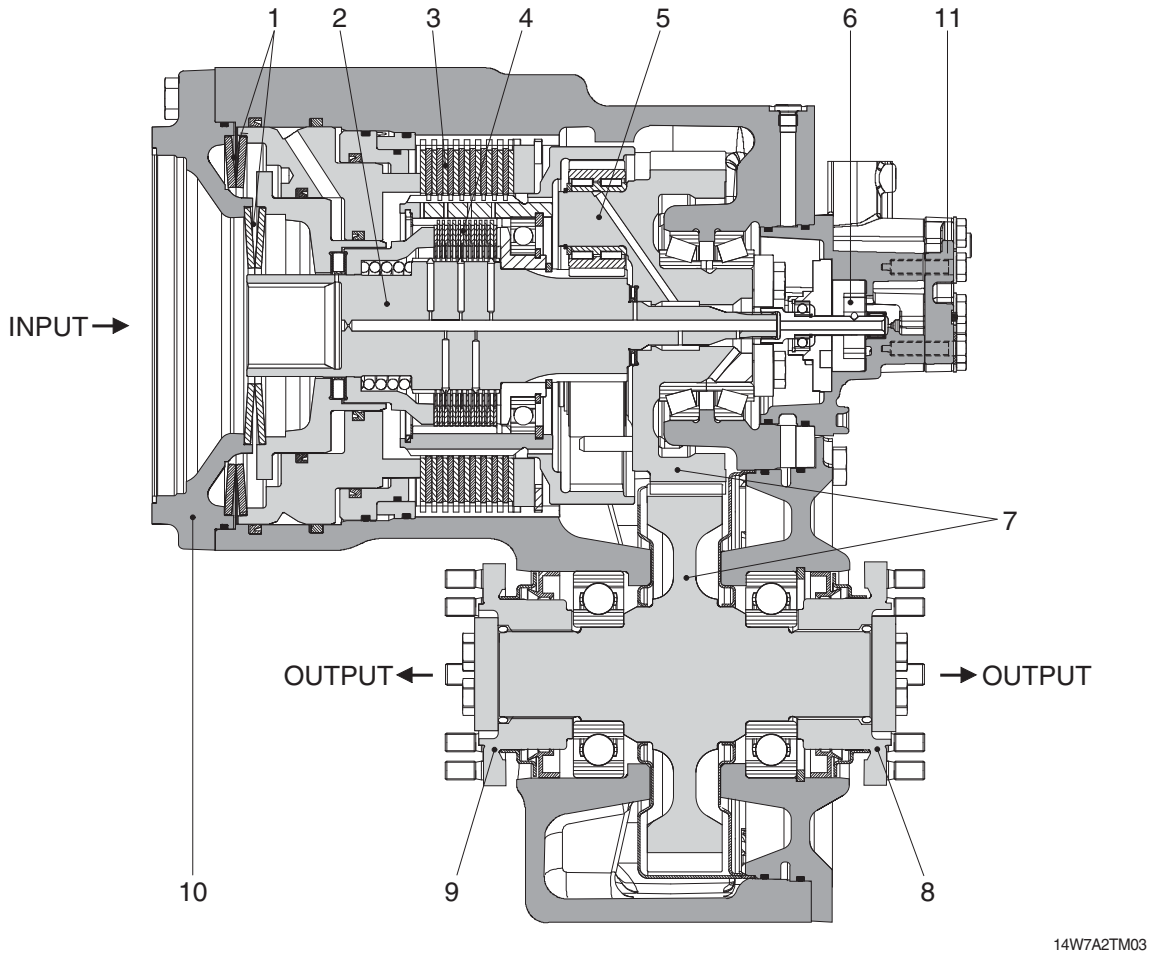
Connections-Valve block :
P : System pressure transmission control
T : Tank
B : Brake
K : Clutch

Solenoid valves-valve block :
M1 : Solenoid valve (low speed)
M2 : Solenoid valve (high speed)

Port	Name	Size	Port	Name	Size
P1 (B)	Shift pressure, High speed	M16×1.5	M	Gauge port, Low speed	M10×1.0
P2 (K)	Shift pressure, Low speed	M16×1.5	S	Lubrication pressure port	M10×1.0
J	Gauge port, High speed	M10×1.0	PN	Parking brake lubricant	Grease nipple

3. OPERATION OF TRANSMISSION

1) DESCRIPTION



1	Cup spring	5	Planetary drive	9	Output flange-Front axle
2	Input shaft	6	Lub oil pump	10	Travel motor attachment
3	Disk brake	7	Spur gear drive	11	Shift interlock
4	Disk clutch	8	Output flange-Rear axle		

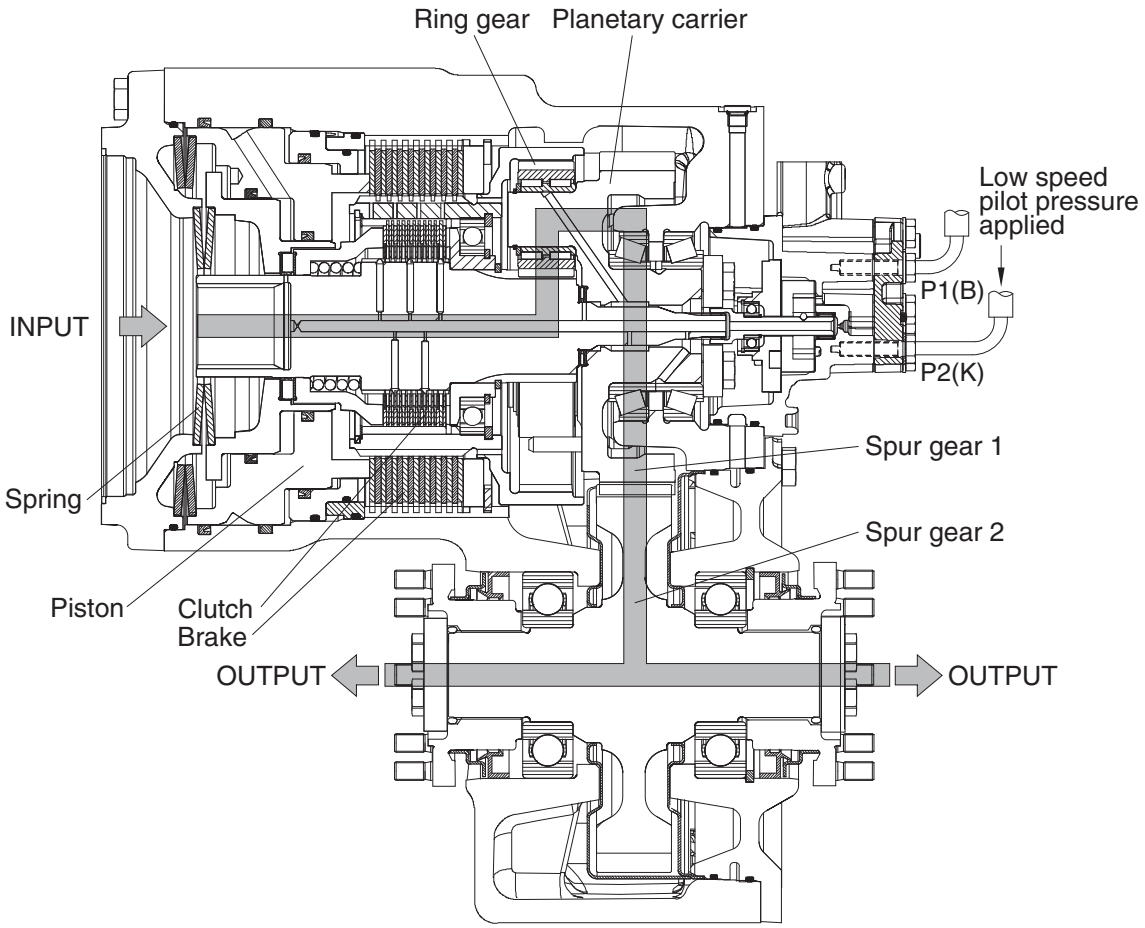
Coaxially-mounted variable displacement travel motor (10) with specific displacement 107 cm^3/rev.

The 2-speed powershift transmission comprises a planetary drive (5), a 2 shaft spur gear drive (7) with output flanges to front and rear axle.

The powershift mechanism for the planet drive comprises a rotating multi-disk clutch (4) underneath a multi-disk brake (3) rigidly connected to the housing. Both are closed by spring pressure (2) and released hydraulically.

The shift interlock (11) prevents downshifts at high machine speeds and thus prevents over-rotation of the travel motor. If the low speed gear is selected while the high speed gear is engaged and input speed is above approx. 1000 rpm, the low speed gear shift is inhibited and only performed if input speed is below this limit. With higher viscosity oil (cold starting), the downshift is performed at a lower input speed. Upshifts are always possible.The speed-dependent interlock is effective in both directions. It does not prevent the possibility of over-rotation when the machine is coasting. For this, a drive brake valve should be fitted to the travel motor.

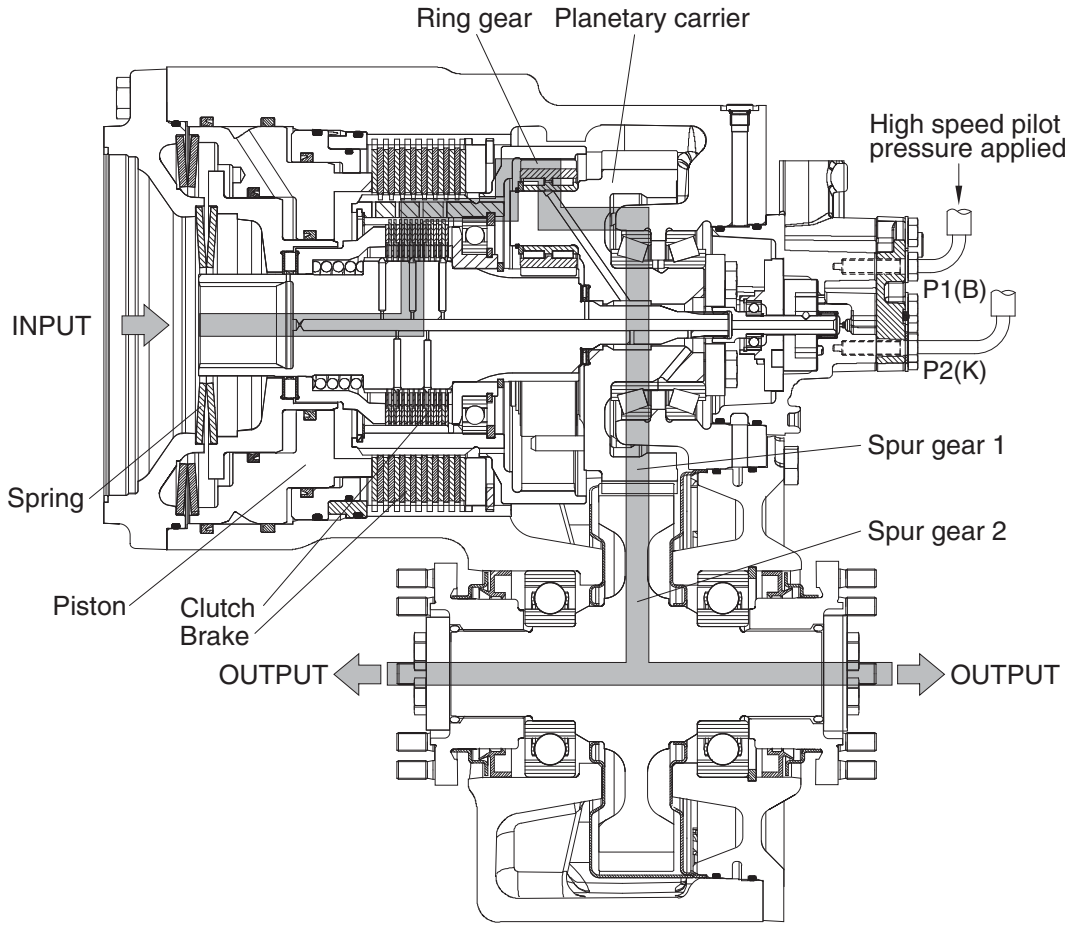
2) LOW SPEED (forward & reverse)



14W7A2TM04

In low speed operation, the internal gear of the planetary drive is backing upon the closed, case-rigid brake. In this speed the piston chamber of the brake is unpressurized, so that the elastic force and additionally the hydraulic pressure of the clutch piston is acting upon the disk pack.
At this time the clutch is open, i.e. the hydraulic released.

3) HIGH SPEED (forward & reverse)



14W7A2TM05

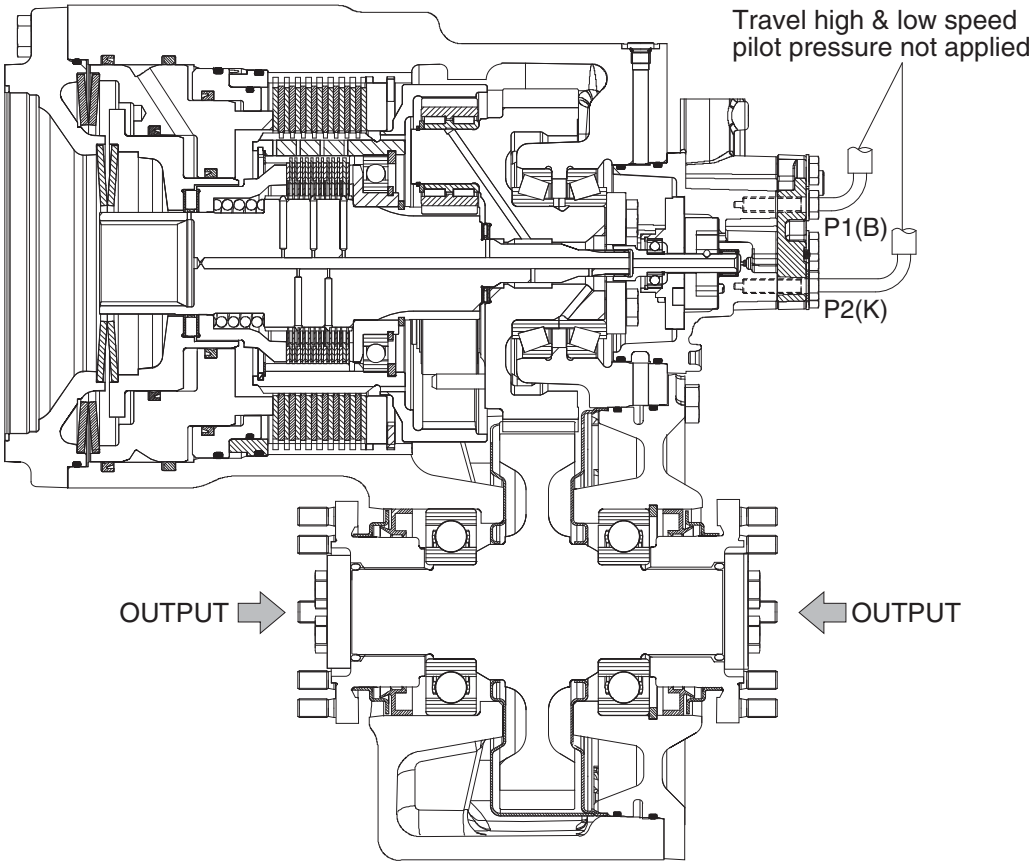
In high speed operation, the clutch is held closed under spring pressure and the brake is hydraulically opened.

When a gear shift occurs-for example from high speed to low speed gear- the oil from the brake piston space is fed back to the tank through a restrictor (change over check valve) due to the spring pressure acting on the brake piston. At the same time the clutch is filled with oil and opened. Required oil flow is necessary for the transmission control to ensure the clutch is open before the brake begins to transmit torque.

A shift modulation valve is also integrated in the transmission. This modulates the pressure sequence at the brake during a upshift in order to achieve good shift quality.

The gear shift equipment also has the function of a parking brake. When the brake is operated-for example with high speed gear engaged-the clutch is closed and is statically loaded.

4) BRAKES



14W7A2TM06

When the travel high/low speed pilot pressure is not applied in the piston space, the piston compress against the multi disk pack due to the spring force. Thus the parking brake is engaged.

4. TECHNICAL DATA

1) GENERAL DATA

(1) Max input power : 110 kW

(2) Max input torque : 78.5 kgf · m

(3) Max output speed : 3500 rpm

(4) Hydraulic motor : 140 cm^3/rev

(5) Transmission ratio
Gear step : 4.06
· Low speed gear : 4.87
· High speed gear : 1.20

(6) Shift interlock
Downshift possible at operating temperature with input speed 1000 rpm (downshift point lower when oil temperature cold).

(7) Disconnection device
For towing away machine auxiliary release device for parking brake.

(8) Brake
Parking brake. Necessary brake deceleration by controlled locking of planetary drive. Braking torque depends on opening pressure set at brake valve (13 bar).

(9) Output flange
Bolts for propshaft connection : M10 × 1.0 (class 10.9)

(10) Transmission weight : 135 kg

2) TRANSMISSION CONTROL

Following data are valid for oil temperature 30˚C to 40˚C in hydraulic tank, measured at connections at powershift transmission (see structure and diagram).

(1) Control pressure
① At connection P1 and P2 at Low/High engine speed : 33+1 kgf/cm^2
② Definition of lubricants : API GL-5, SAE 10W-30, 15W-40

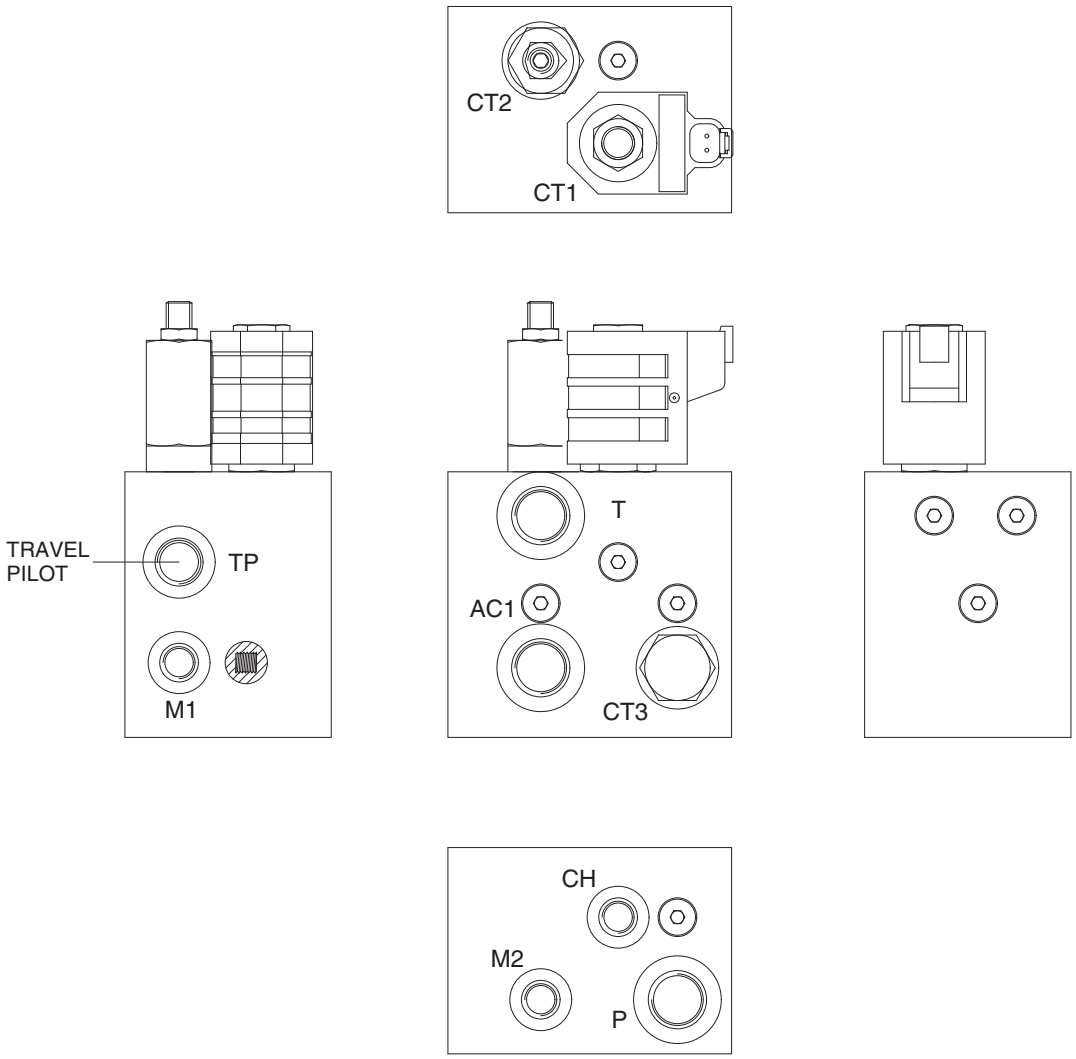
(2) Oil flow
① Min oil flow at 24+1 kgf/cm^2 counter pressure (low engine speed) : 5.5 ℓ /min
② Max oil flow : 25 ℓ /min

(3) Residual pressure
① Max residual pressure in control line to tank connection P1 and P2 : 1.0 kgf/cm^2

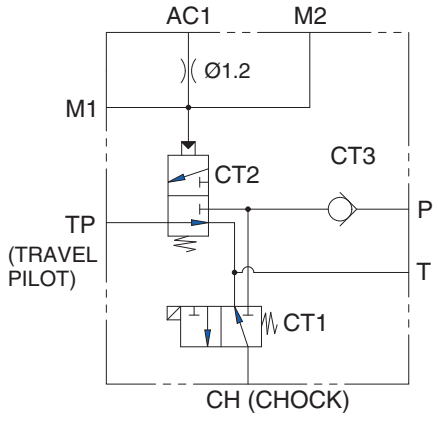
(4) Leakage oil transmission control
① Pressure in input housing connection (E) max : 1.0 kgf/cm^2
② Max oil flow (low speed actuated) : 1 ℓ /min

GROUP 9 TRAVEL CONTROL VALVE

1. STRUCTURE



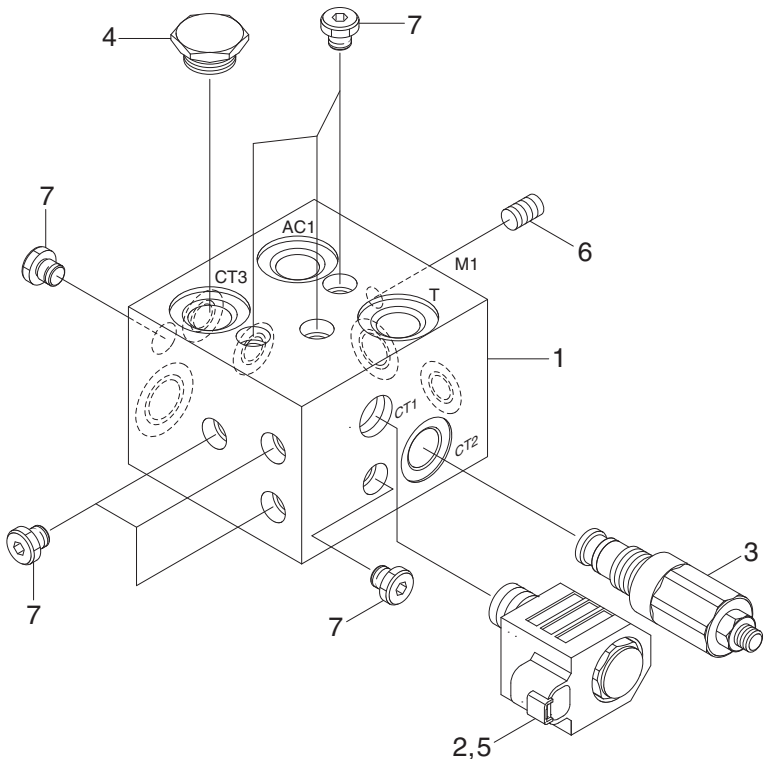
14W7A2TCV02



Hydraulic circuit

Port name	Port size
P, T, AC1	PF 1/2
TP	PF 3/8
M1, M2, CH	PF 1/4

2. COMPONENT

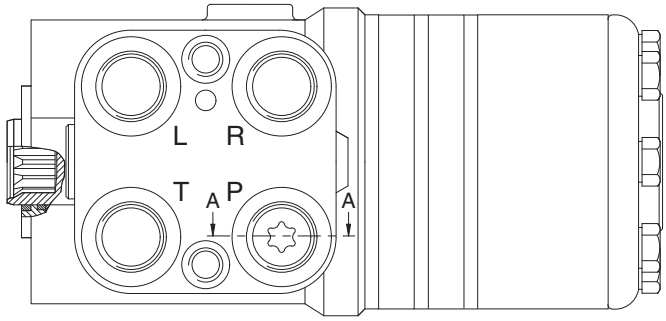


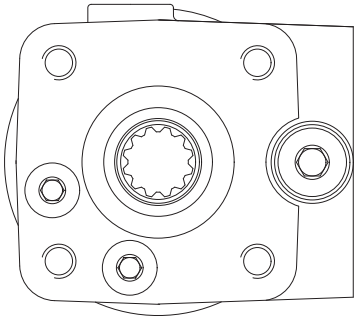
14W7A2TCV01

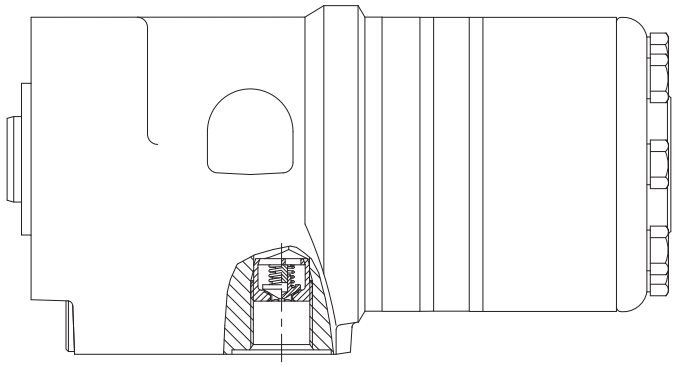
1	Body	5	Coil
2	Solenoid valve	6	Orifice
3	POD valve	7	Plug
4	Check valve		

GROUP 10 STEERING VALVE

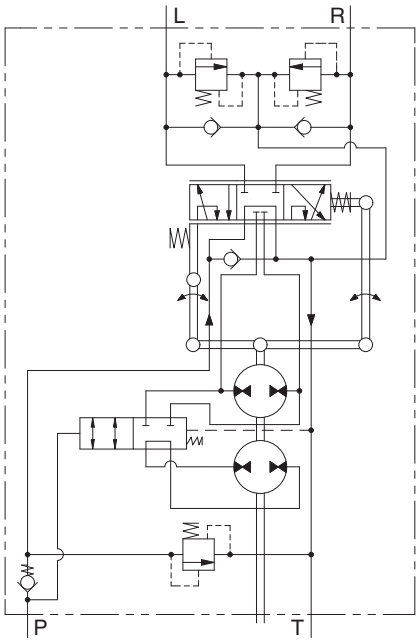
1. STRUCTURE







SECTION A-A

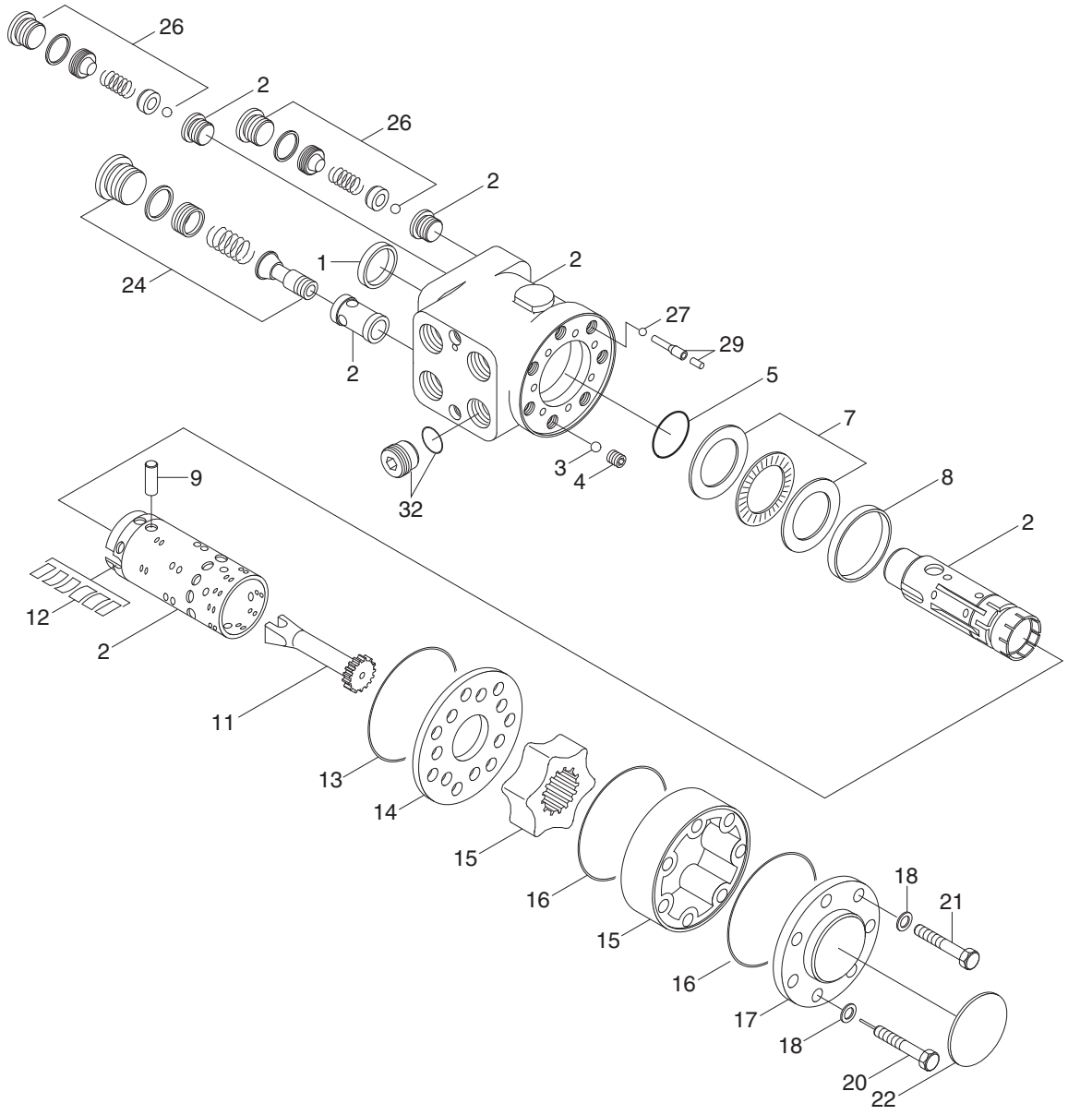


Hydraulic circuit

Port	Port name	Port size
L	Left port	3/4-16UNF
R	Right port	
T	Tank port	
P	Pump port	

14W92SV01

2. COMPONENTS



14W7A2STV01

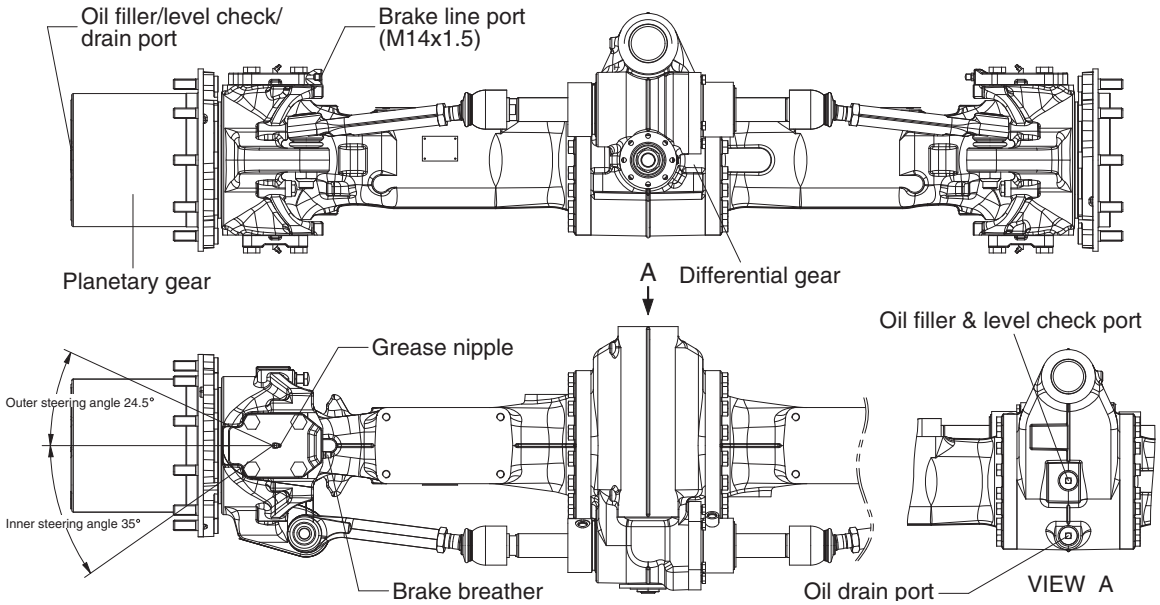
1	Dust seal	11	Shaft	20	Pin screw
2	Housing, spool, sleeve	12	Spring set	21	Screw
3	Ball	13	O-ring	22	Name plate
4	Bushing	14	Distributor plate	24	Pressure relief valve
5	O-ring	15	Gear wheel set	26	Shock valve
7	Bearing assy	16	O-ring	27	Ball
8	Ring	17	End cover	29	Bushing
9	Cross pin	18	Washer	32	Check valve

GROUP 11 AXLE

1. OPERATION

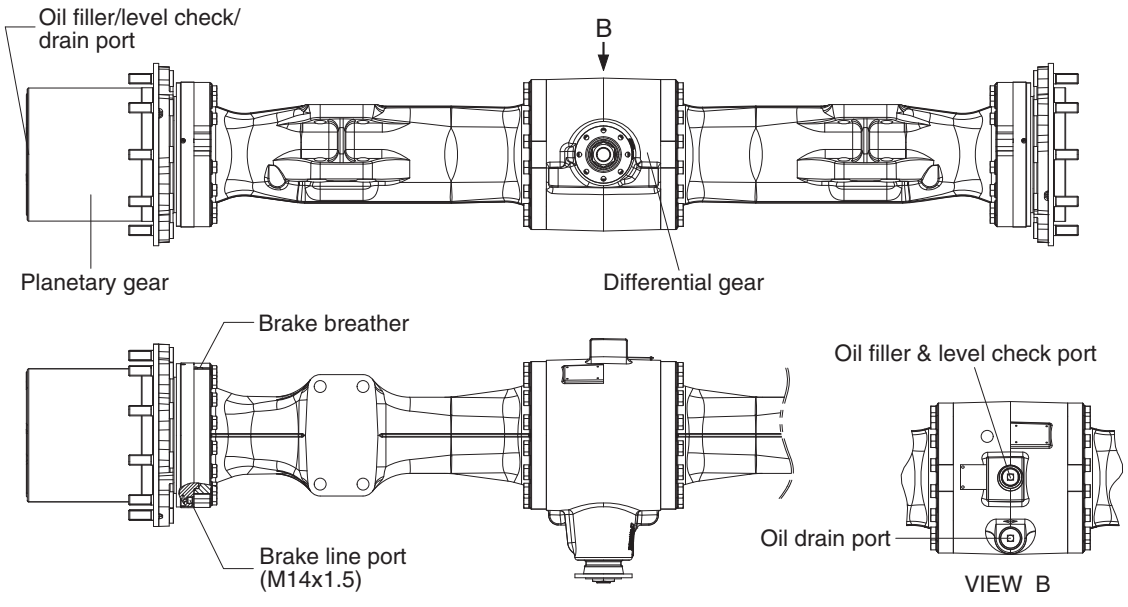
- The power from the engine passes through main pump, travel motor and transmission and drive shafts, and is then sent to the front and rear axles.
  Inside the axles, the power passes from the bevel pinion to the bevel gear and is sent at right angles.
- At the same time, the speed is reduced and passes through the both differentials to the axle shafts. The power of the axle shafts is further reduced by planetary-gear-type final drives and is sent to the wheels.

1) FRONT AXLE



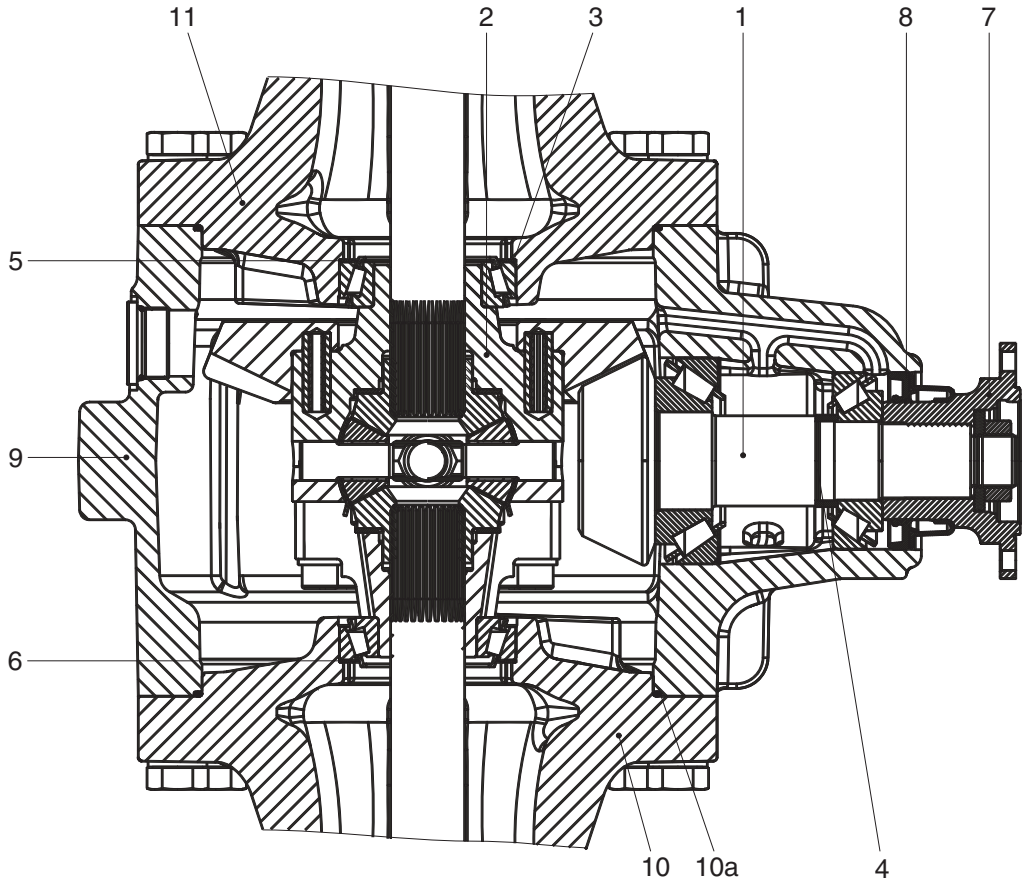
20W7A2AX01

2) REAR AXLE



20W7A2AX01A

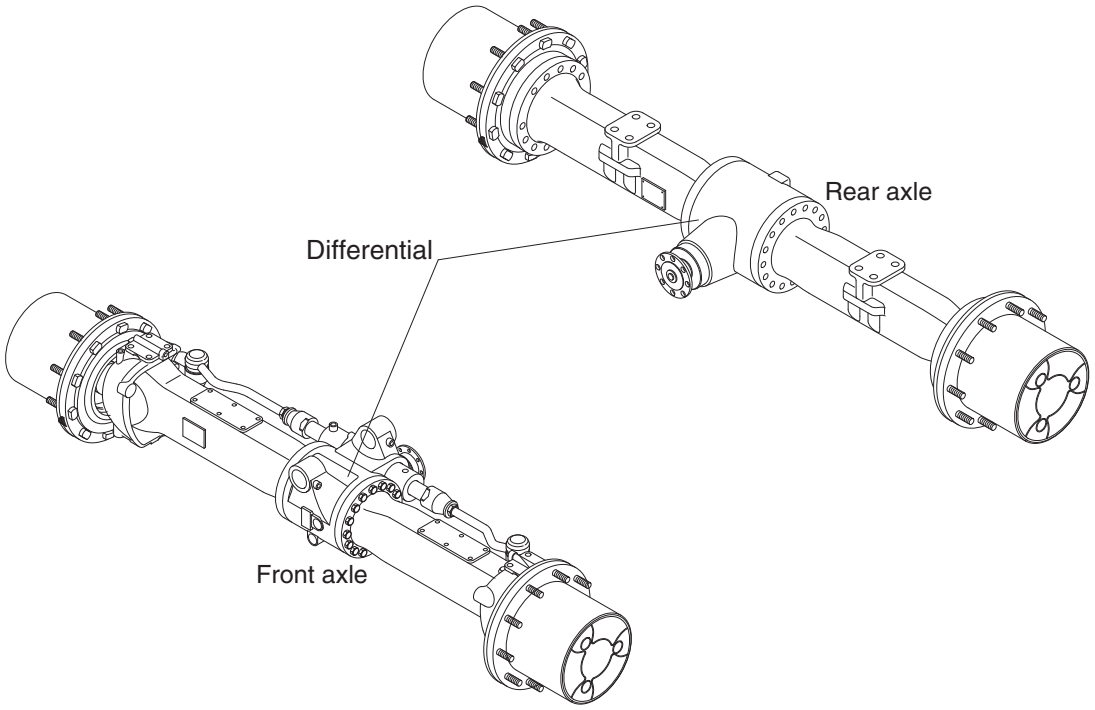
2. SECTION OF DIFFERENTIAL



17W7A2AX02

1 Drive pinion
2 Differential (with crown wheel)
3 Shim for contact pattern (bevel gear set)
4 Spacer ring (bearing rolling moment / pinion bearing)
5 Shim for backlash
6 Shim (bearing rolling moment / differential bearing)
7 Input flange
8 Seal ring
9 Axle drive housing
10 Axle housing
10a O-ring
11 Axle housing (crown wheel side)

3. DIFFERENTIAL



17W7A2AX03

The differential is installed on the front and rear axle to transfer the driving torque from the axle to the wheels. The differential transfers half of the output torque of the transmission via the universal drive shaft to the planetary gear of the wheel hubs and transfers the rpm and torque from the gear via the pinion and the ring.

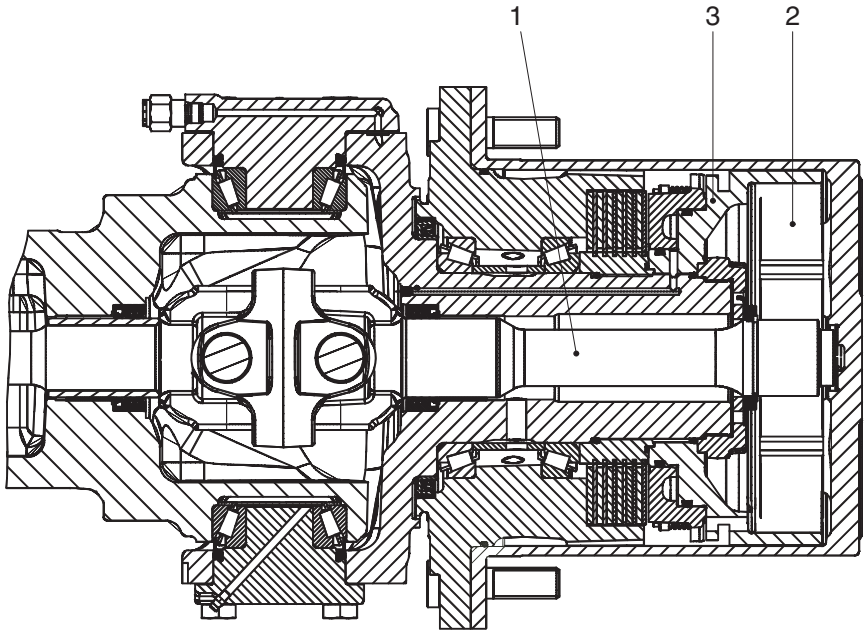
In addition, the differential also servers as an equalizer when going around curves. If the mechanical connection from the transmission to the universal drive shaft, differential, shaft, and planetary gears to the wheels would be rigid, every steering movement would strain the axle construction and would result in increased tire wear.

The equalizing function comes from the special construction of the differential. The power input from the input flange to the pinion shaft, ring and differential housing to the equalizing axle in the differential housing meshes the four equalizing tapered gears with the axle gears, which are located in the equalizing axles. This changes the relative direction of rotation between the shafts meshed with the side gears. This means that one shaft turns clockwise and the other counterclockwise, and one shaft turns faster than the other.

This balancing movement has the disadvantage that when traveling off road, traction is reduced on uneven ground, on loose ground or on snow or ice only wheel per axle is engaged. This disadvantage can be corrected in part by installing a self locking differential.

4. FINAL DRIVE

1) FRONT AXLE



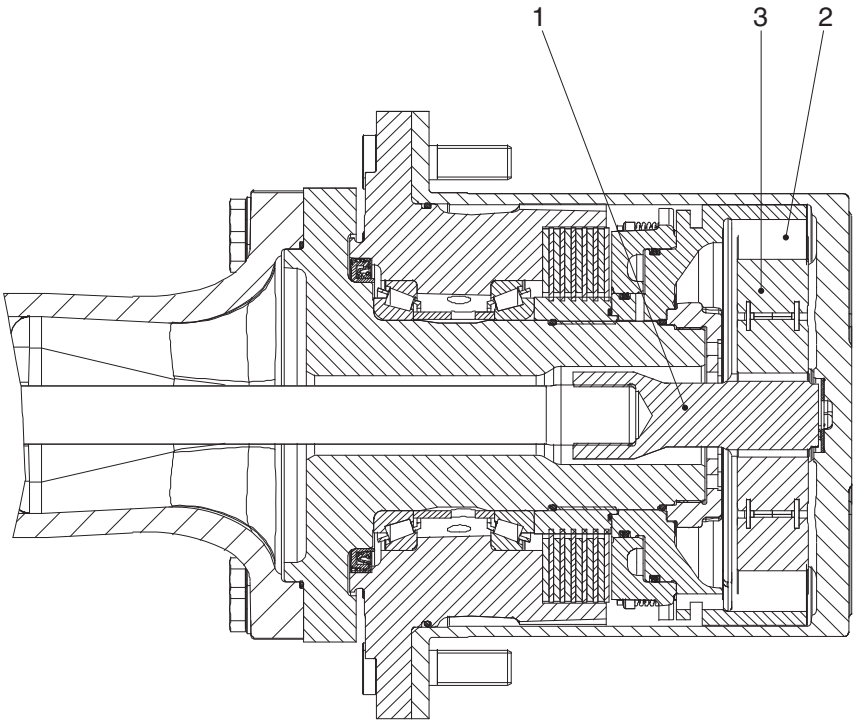
17W7A2AX04

1 Joint fork 2 Planetary gear 3 Ring gear

(1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.

(2) The power transmitted from the differential through joint fork (1) is transmitted to planetary gear (2). The planetary gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.
This power is then sent to the wheels which are installed to the planetary carriers.

2) REAR AXLE



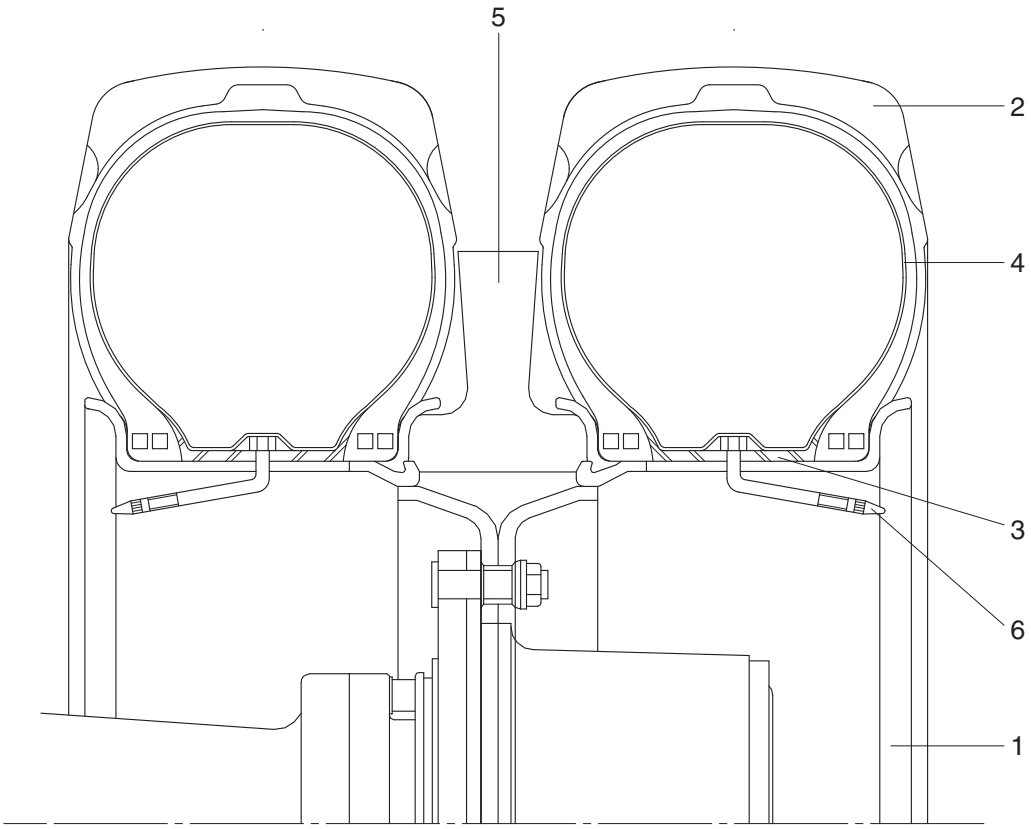
17W7A2AX05

1 Sun gear shaft 2 Planetary gear 3 Ring gear

(1) To gain a large drive force, the final drive uses a planetary gear system to reduce the speed and send drive force to the tires.

(2) The power transmitted from the differential through sun gear shaft (1) is transmitted to planetary gear (2). The planetary gear rotates around the inside of a fixed ring gear (3) and in this way transmits rotation at a reduced speed to the planetary carrier.
This power is then sent to the wheels which are installed to the planetary carriers.

5. TIRE AND WHEEL



17032TI01

1	Wheel rim	3	Flap	5	Stone resister ring
2	Tire	4	Tube	6	Valve assembly

1) The tire acts to absorb the shock from the ground surface to the machine, and at the same time they must rotate in contact with the ground to gain the power which drives the machine.

2) Various types of tires are available to suit the purpose. Therefore it is very important to select the correct tires for the type of work and bucket capacity.