SECTION 6 HYDRAULIC SYSTEM

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GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The hydraulic system is a pilot operated, close center system which is supplied with flow from the variable displacement main hydraulic pump.
The pilot control system is a low pressure, open center hydraulic system which is supplied with flow from the auxiliary pump.

The hydraulic system components are :

- Main pump
- Auxiliary pump
- Main control valve
- Lift cylinder
- Tilt cylinders
- Remote control valve (Pilot control valve)
- OPSS solenoid valve
- Cut-off valve

The oil from the B2 main pump via the priority spool built in the main control valve is combined with oil from the B1 main pump by parallel passage and flows the main control valve.

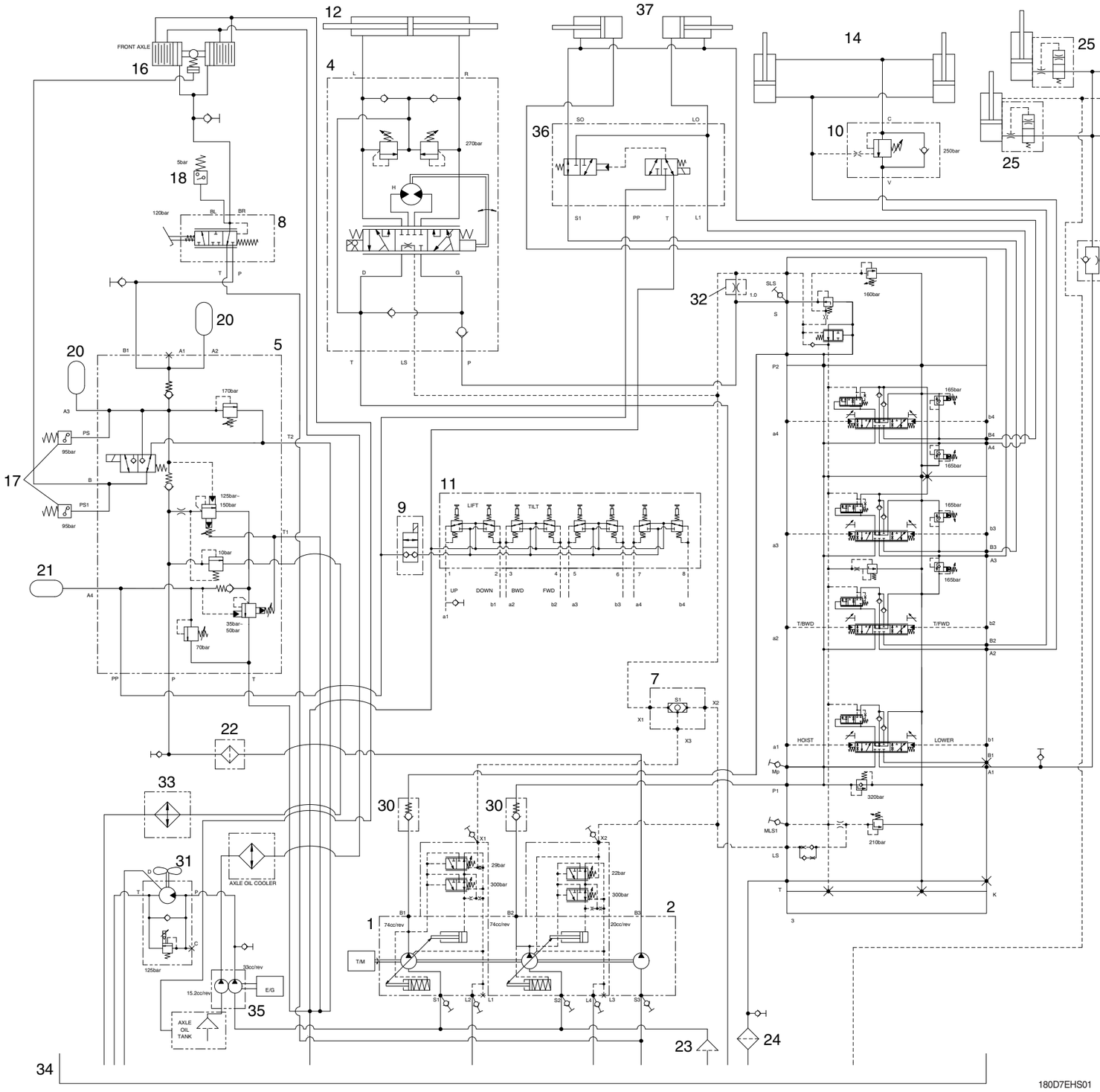
The main control valve is a parallel circuit type, closed center valve which routes flow to the lift, tilt and or auxiliary cylinders when the respective spools are shifted.

Flow from the brake pump is routed to the cut-off valve that charges the pressure in accumulators. After charging the pressure in accumulators for braking, the flow gose to accumulators for RCV. The cut-off valve flow either to the brake valve or to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on pilot supply unit supplies a secondary pressure source to operate remote control valve so the boom can be lowered if the engine is off.

The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

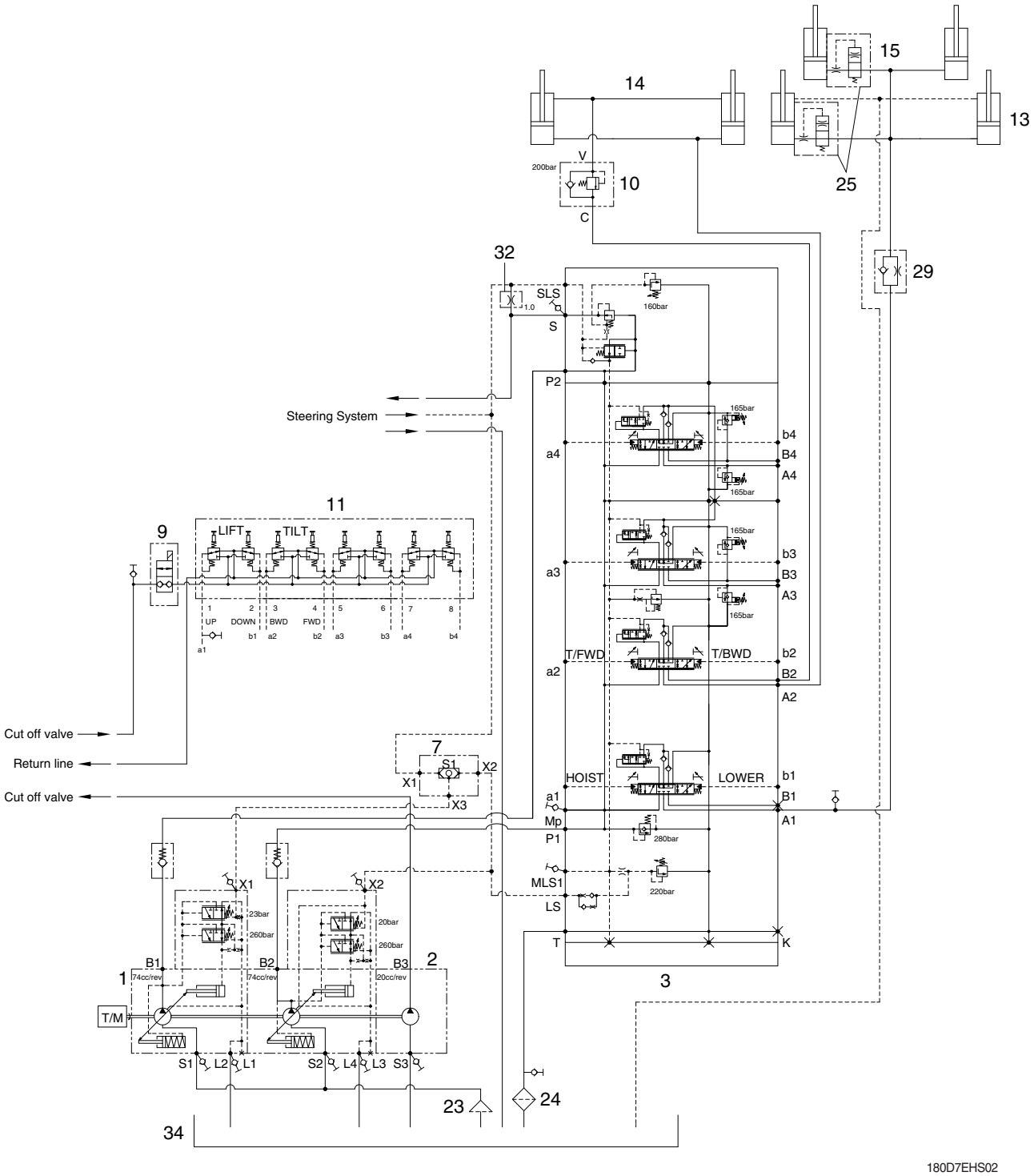
2. HYDRAULIC CIRCUIT



Tilting Cabin Hyd. Circuit

1	MAIN PUMP	29	DOWN CONTROL VALVE
2	AUXILIARY PUMP	30	CHECK VALVE
3	MAIN CONTROL VALVE	31	FAN DRIVE
4	STEERING UNIT	32	ORIFICE
5	CUT OFF VALVE	33	OIL COOLER
7	SHUTTLE VAVLE	34	HYDRAULIC OIL TANK
8	BRAKE VALVE	35	FAN DRIVE PUMP
9	OPSS SOLENOID VALVE	36	SIDE SHIFT SOLENOID VALVE
10	TILT LOCK VALVE	37	FORK POSITIONER CYLINDER
11	RCV	38	HAND PUMP
12	STEERING CYLINDER	39	ELEC. PUMP
13	LIFT CYLINDER	40	CAB TILT CYLINDER
14	TILT CYLINDER	41	LATCH CYLINDER
15	FREE LIFT CYLINDER		
16	FRONT AXLE		
17	PRESSURE SWITCH		
18	PRESSURE SWITCH		
20	ACCUMULATOR		
21	ACCUMULATOR		
22	PRESSURE FILTER		
23	STRAINER		
24	RETURN FILTER		
25	SAFETY VALVE		

3. WORK EQUIPMENT HYDRAULIC CIRCUIT

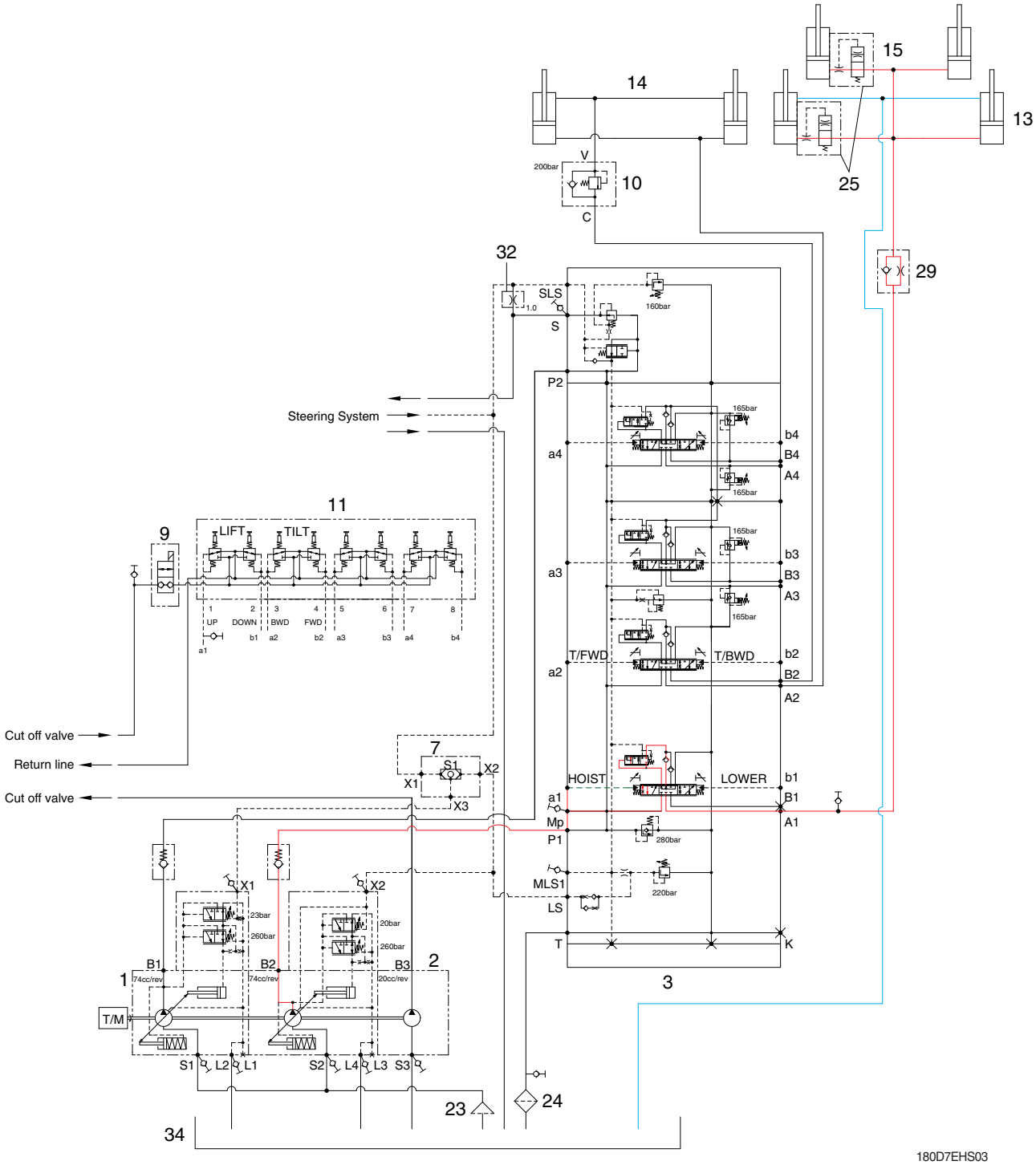


180D7EHS02

1	Main pump	11	Remote control valve	25	Down safety valve
2	Auxiliary pump	13	Lift cylinder	29	Down control valve
3	Main control valve	14	Tilt cylinder	32	Orifice
7	Shuttle valve	15	Free lift cylinder	34	Hydraulic oil tank
9	OPSS solenoid valve	23	Strainer		
10	Tilt lock valve	24	Return filter		

※ The circuit diagram may differ from the equipment, so please check before a repair.

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



When the lift control lever is pulled back, the spool is moves to lift position by the pilot oil pressure from the remote control valve (11).

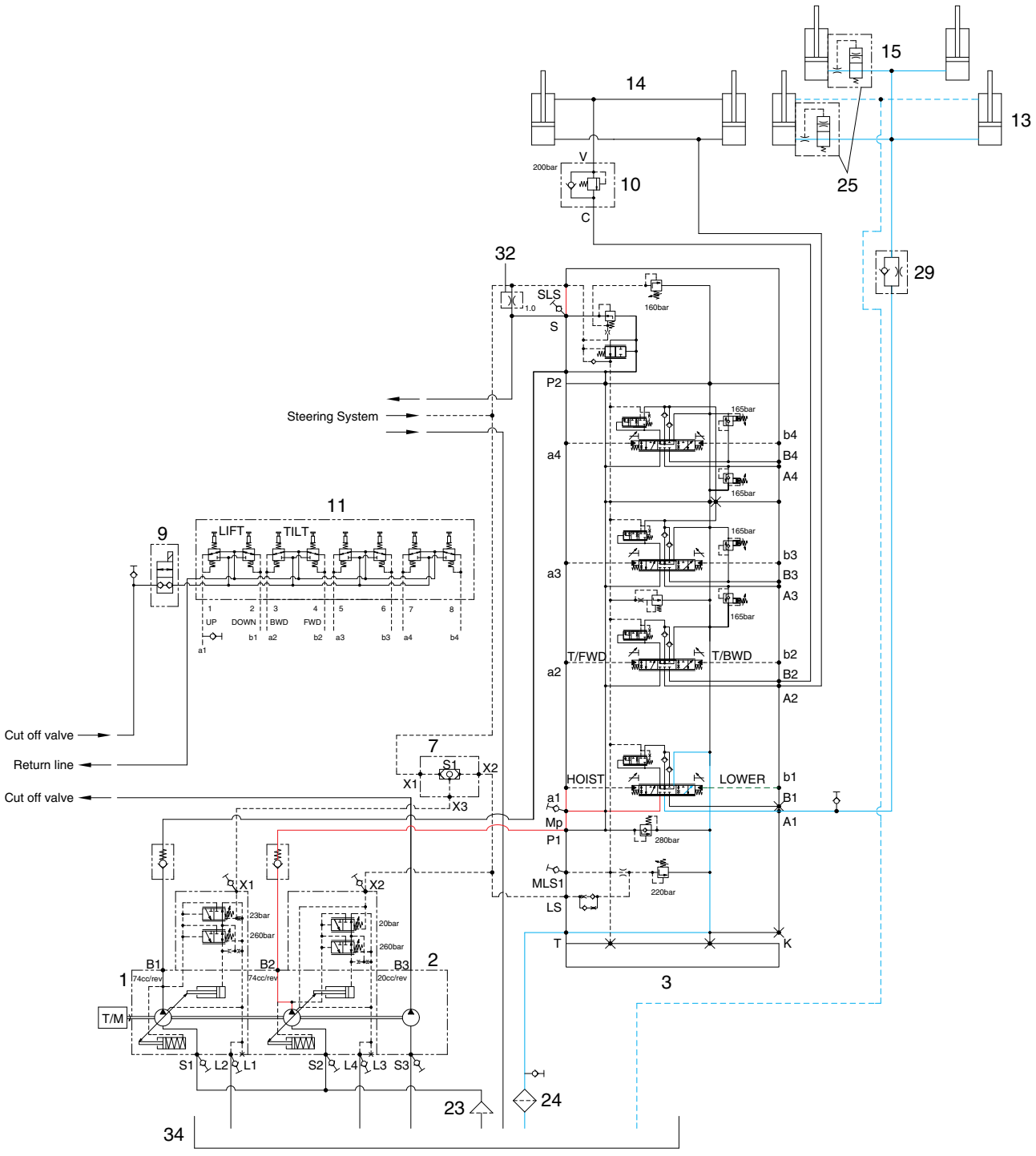
The oil from hydraulic main pump (1) flows into main control valve (3) and then goes to the large chamber of lift cylinder (13) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder (13) returns to hydraulic oil tank (34) at the same time.

When this happens, the forks go up.

※ The circuit diagram may differ from the equipment, so please check before a repair.

2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION

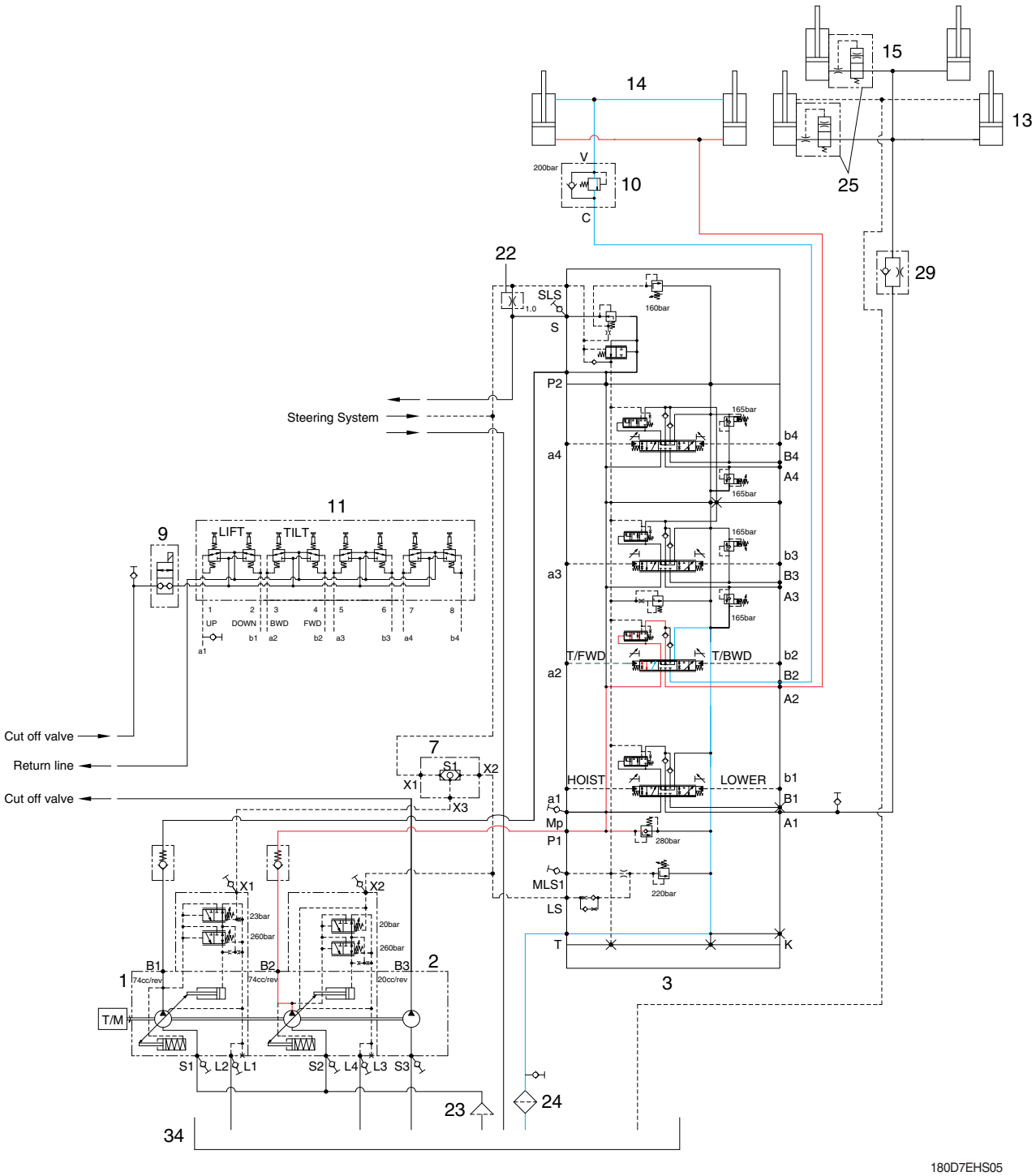


180D7EHS04

When the lift control is pushed forward, the spool is moved to lower position by the pilot oil pressure from the remote control valve (11).
The work ports (A1, A3) and the small chamber and the large chamber are connected to the return passage, so the lift will be lowered due to its own weight.

※ The circuit diagram may differ from the equipment, so please check before a repair.

3) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION

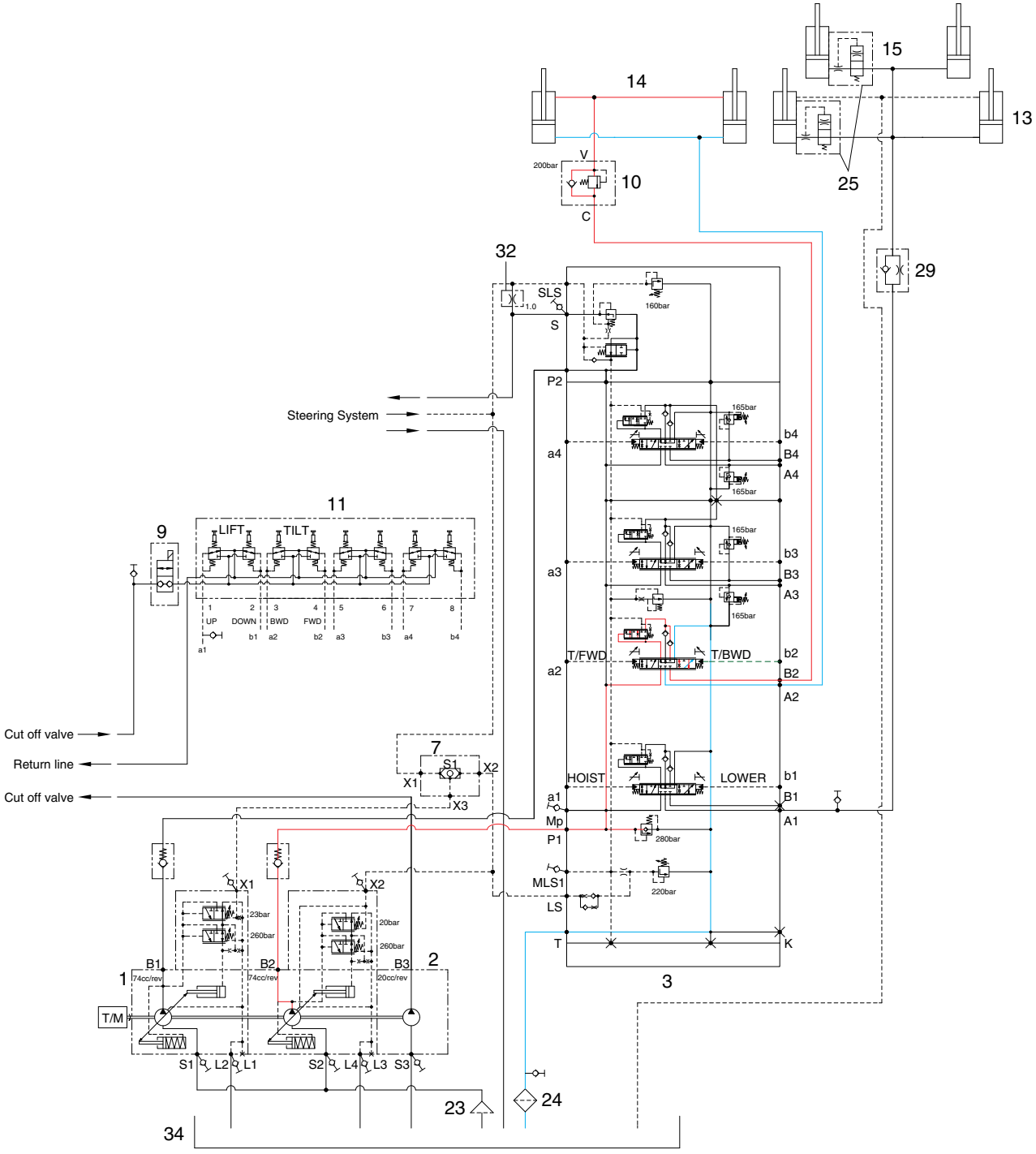


180D7EHS05

When the tilt control lever is pushed forward, the spool is moved to tilt forward position by the pilot oil pressure from the remote control valve (11).
The oil from hydraulic main pump (1) flows into main control valve (3) and then goes to the large chamber of tilt cylinder (14) by pushing the load check valve of the spool.
The oil at the small chamber of tilt cylinder (14) returns to hydraulic tank (34) at the same time.
When this happens, the mast tilt forward.

※ The circuit diagram may differ from the equipment, so please check before a repair.

4) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION



180D7EHS06

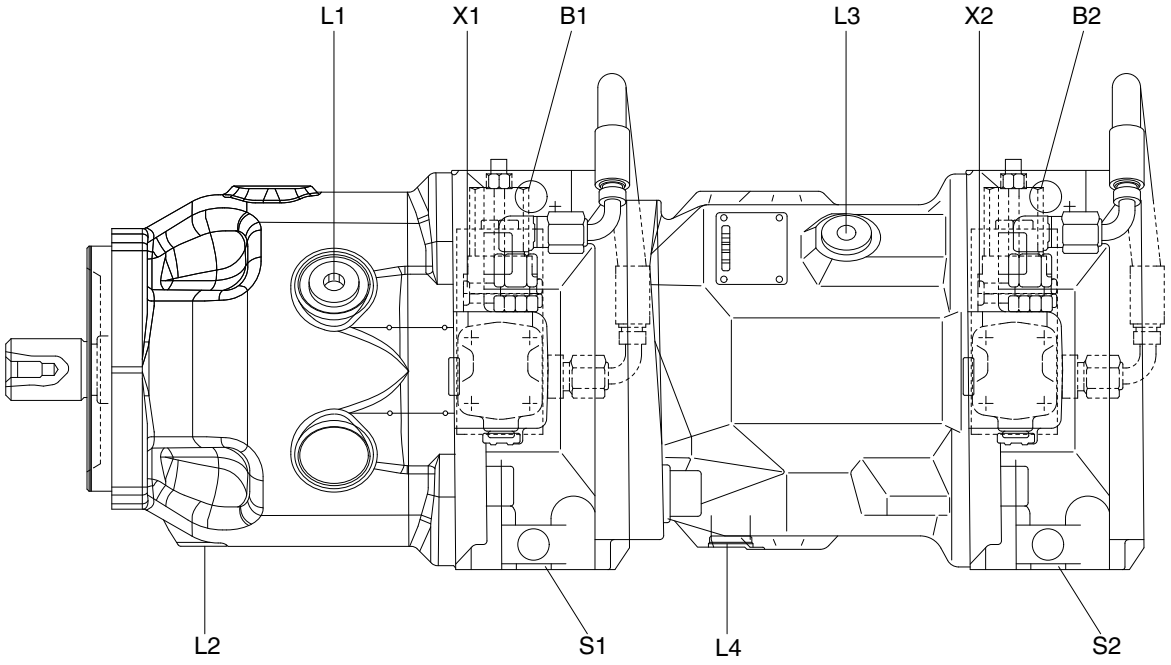
When the tilt control lever is pulled back, the spool is moved to tilt backward position by the pilot oil pressure from the remote control valve (11).
The oil from hydraulic main pump (1) flows into main control valve (3) and then goes to the small chamber of tilt cylinder (14) by pushing the load check valve of spool.
The oil at the large chamber of tilt cylinder (14) returns to hydraulic tank (34) at the same time.
When this happens, the mast tilt backward.

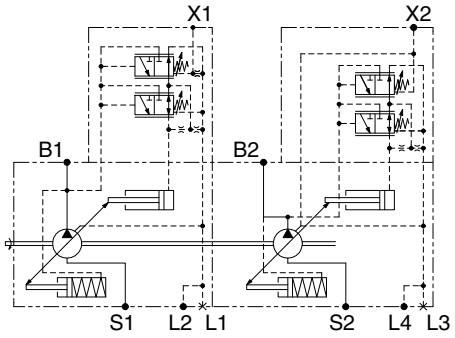
※ The circuit diagram may differ from the equipment, so please check before a repair.

4. MAIN PUMP

1) STRUCTURE (1/2)

This variable displacement piston pump consists of steering pump and working pump.



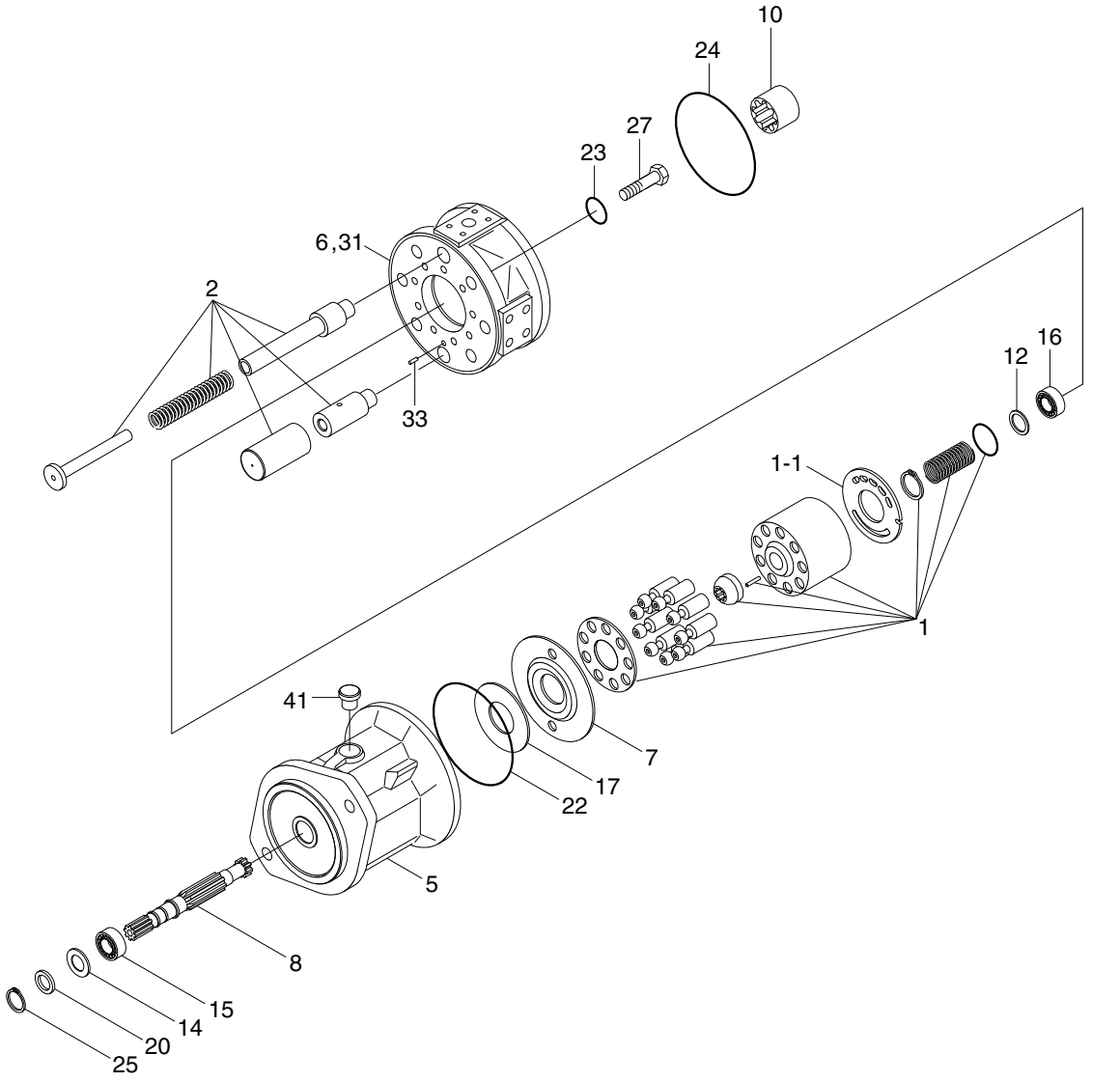


HYDRAULIC CIRCUIT

180D7EMP04

Port	Port name	Size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S1	Suction port	SAE 2"
S2	Suction port	SAE 2"
L1, L2	Case drain port	7/8-14UNF-28
L3, L4	Case drain port	7/8-14UNF-28
X1, X2	Pilot pressure port	7/16-20UNF-28

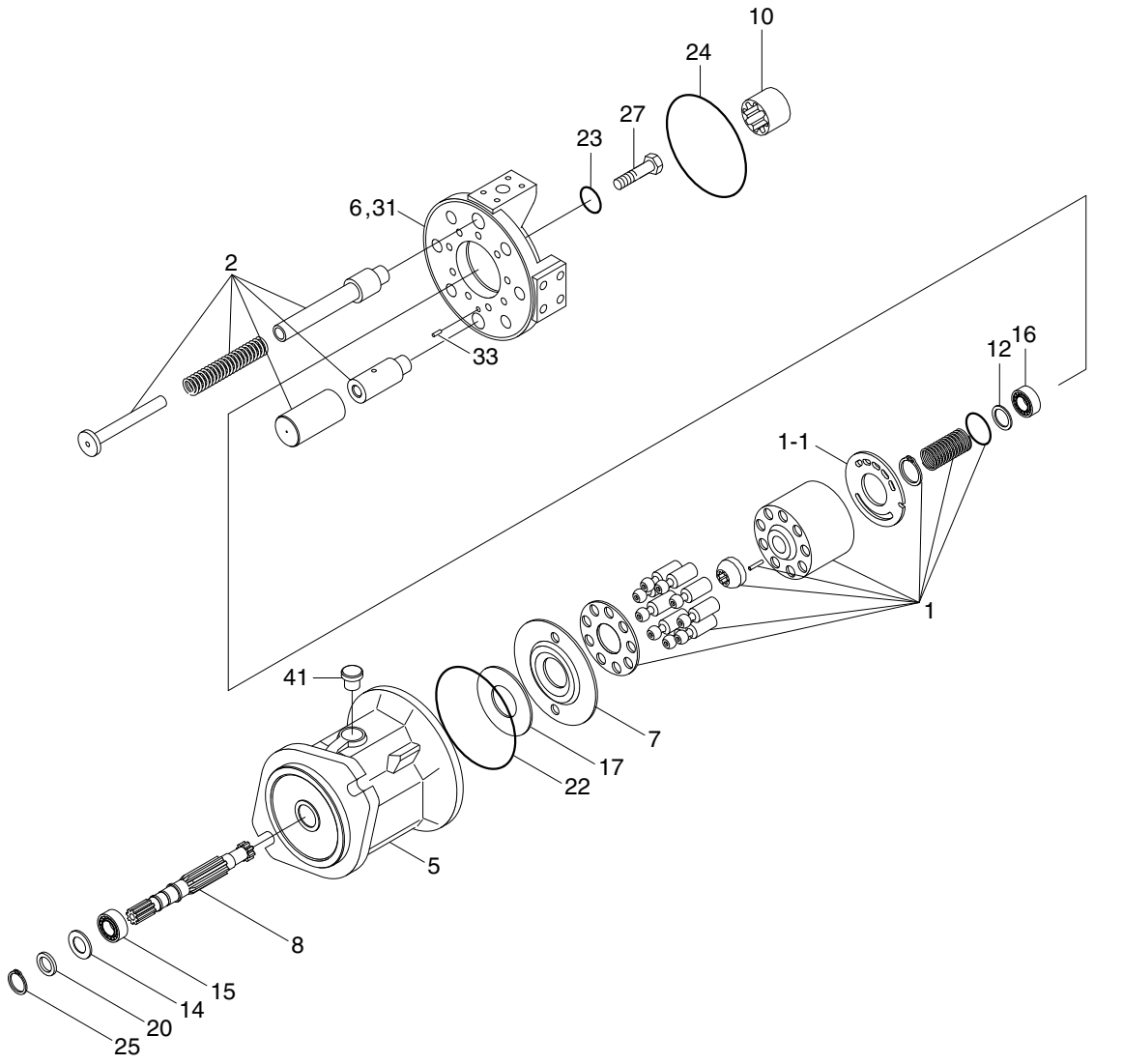
· FRONT PUMP



180D9MP01

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Splined hub	23	O-ring		

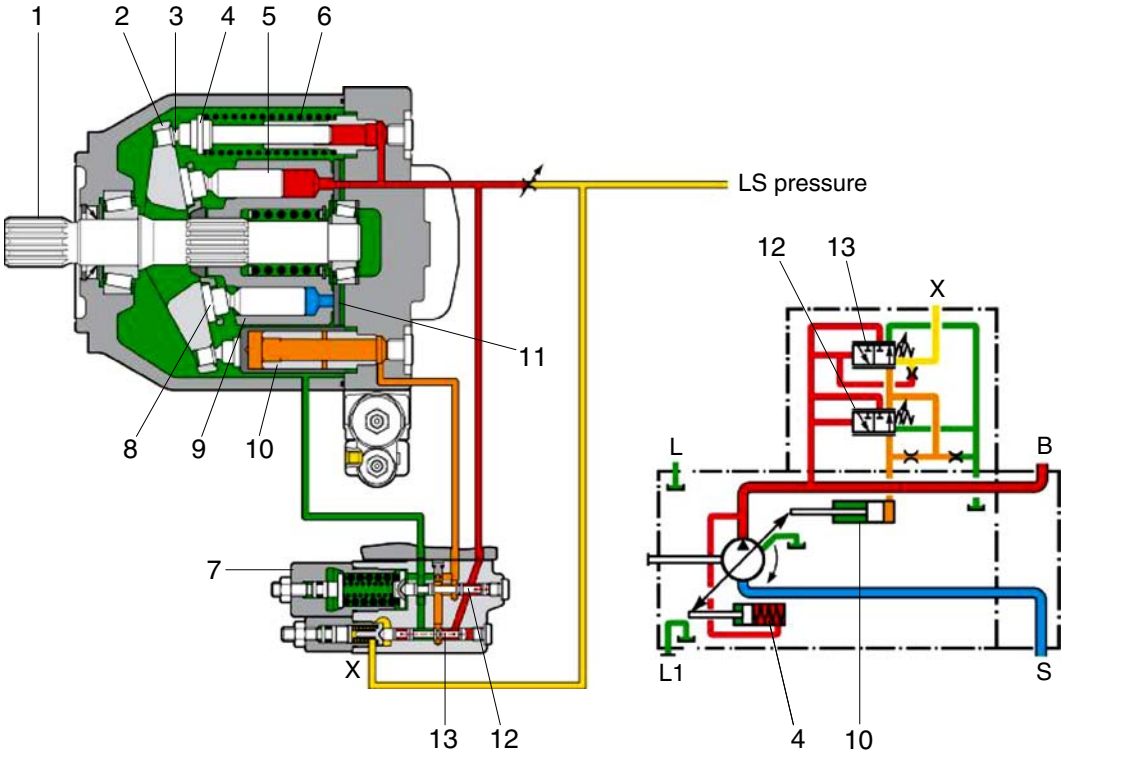
· REAR PUMP



180D9MP02

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Spline hub	23	O-ring		

2) FUNCTION



1	Drive shaft	6	Counter spring	11	Control plate
2	Swash plate	7	Pressure & flow compensator valve	12	Pressure compensator spool
3	Shoe plate	8	Piston shoe	13	Flow compensator spool
4	Counter piston	9	Cylinder		
5	Piston	10	Control piston		

The steering pump and attachment pump are variable displacement piston pump. The steering pump and attachment pump are flow controlled by LS signal. When the steering and attachment are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and attachment hydraulic systems flows to flow compensator spool (13). This spool keeps the pump output at a level that is necessary to fulfill the requirements for the system flow and for the pressure.

The pressure compensator spool (12) also limits maximum system pressure. The pressure compensator spool (12) prevents damage to the steering and attachment hydraulic components from excessive pressure.

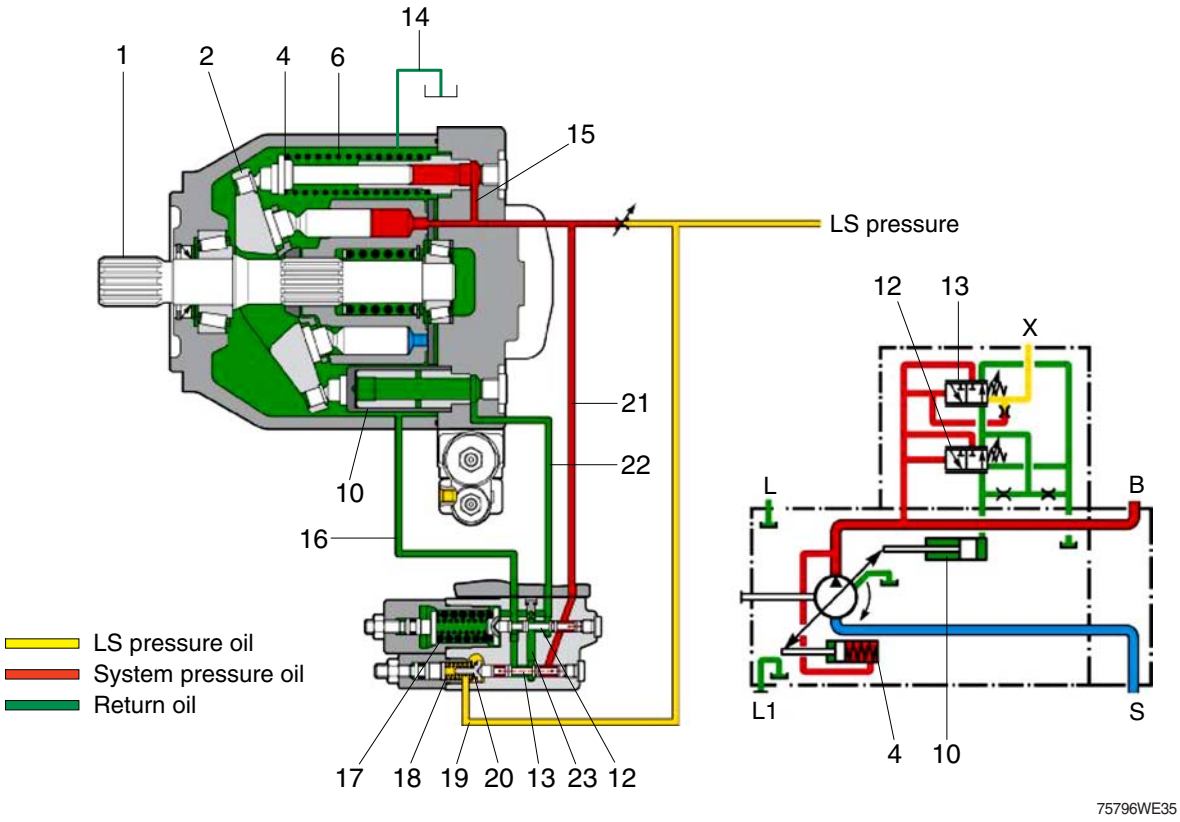
The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.
Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure.
When steering and attachment pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

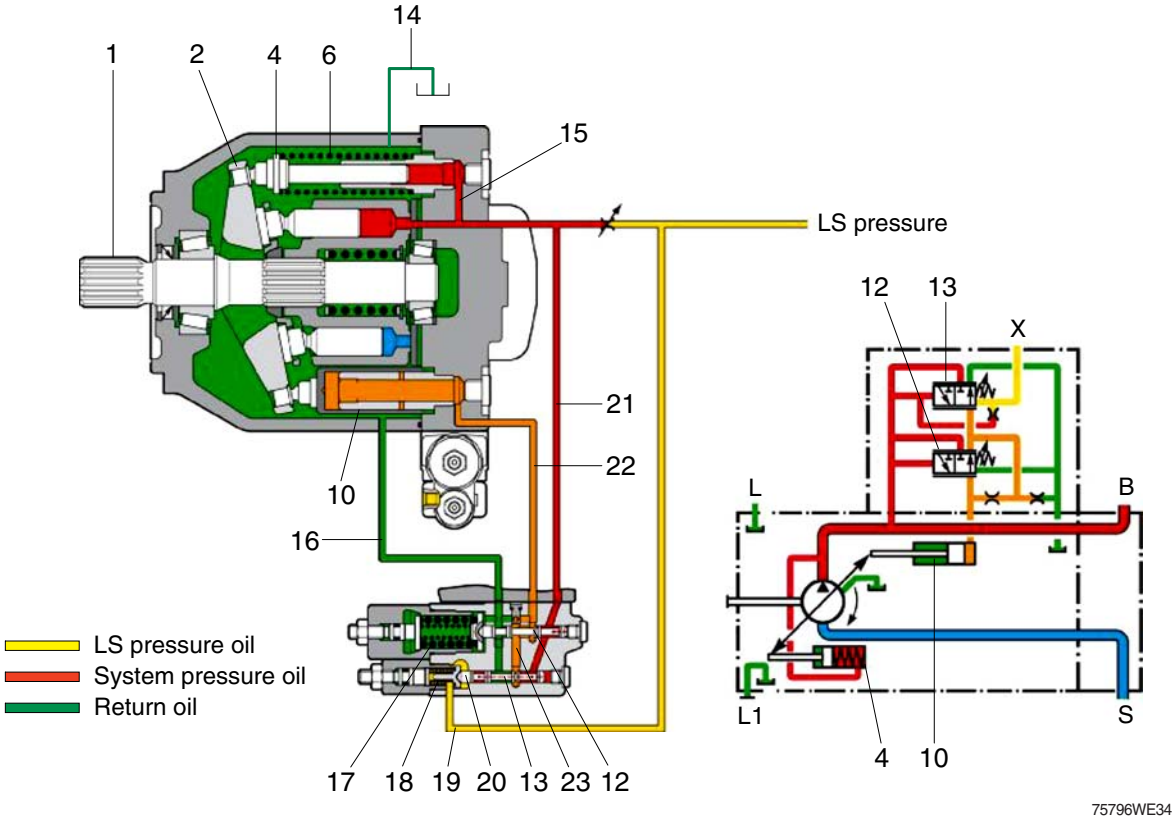
Upstroking of the pump occurs as flow demand from attachment and steering system.
The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).
The force of spring (18) causes pump pressure to be higher than the LS pressure (19).
If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4).
The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.
Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

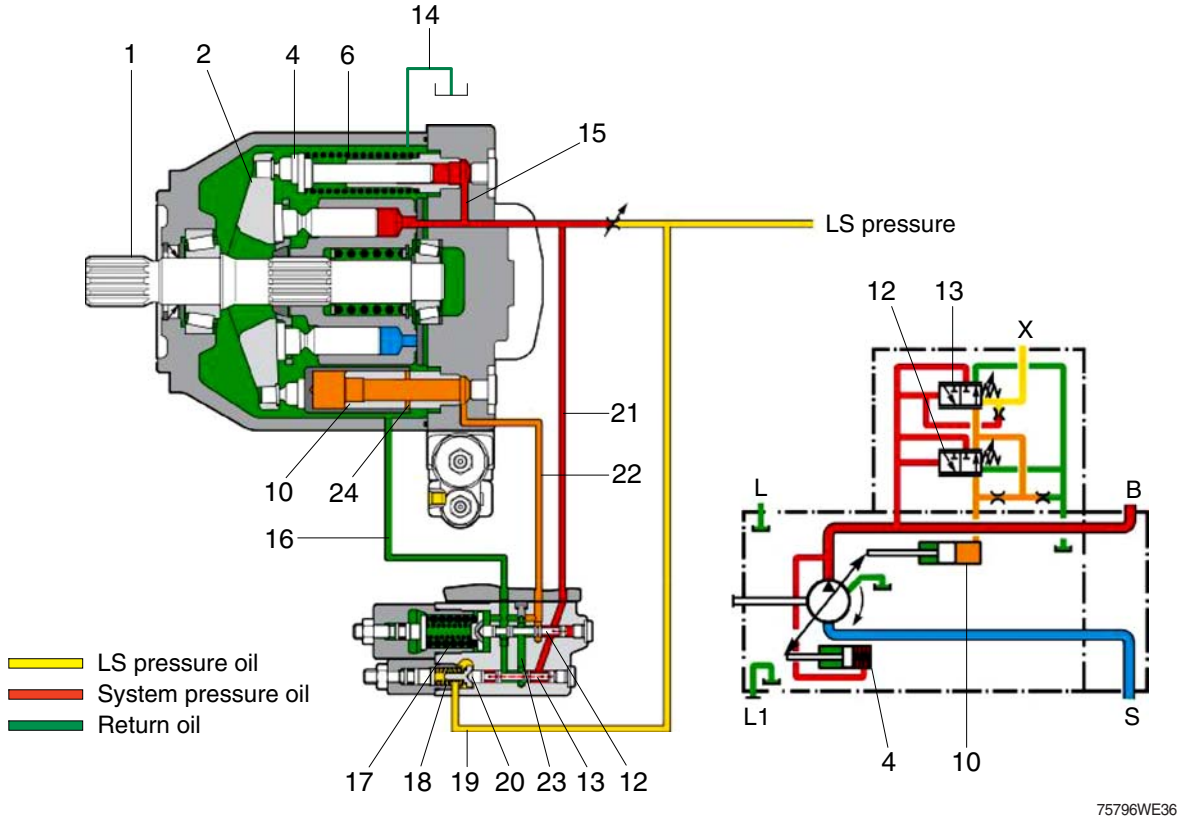
The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).
This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.
Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases.
This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move lever, then the pump will return to low pressure standby.

※ Control piston ¡æ Changes pump displacement ; influenced by controller.
Counter piston ¡æ Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring	24	Cross-drilled hole

Low pressure standby constitutes the following condition: a running engine and inactive steering and attachment. There are no flow demands on the pump or pressure demands on the pump. Therefore, there is no LS pressure in line (19).
Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.
Because of close centered steering control valve and close centered attachment hydraulic system.

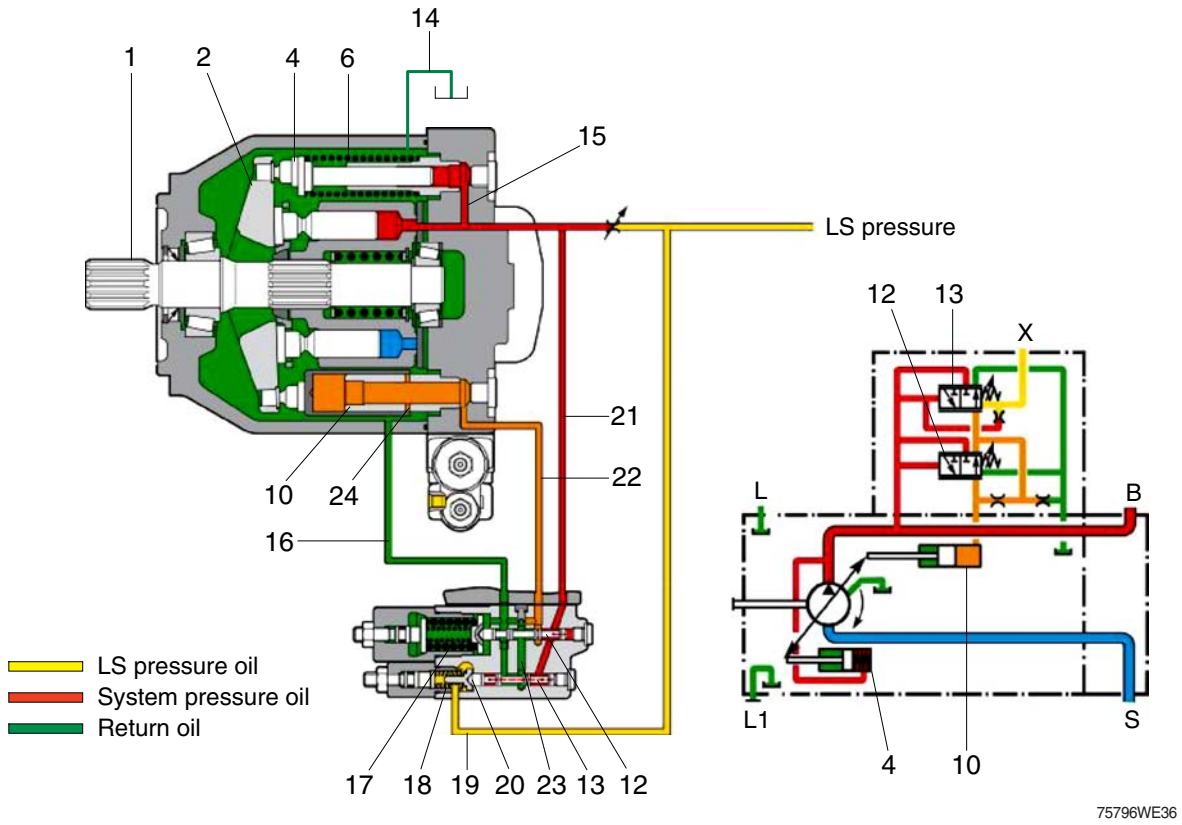
As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.
When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and attachment system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).

Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and lever, then the pump will return to low pressure standby.

(5) Adjustment of flow control

Flow compensator setting must be carried out following procedures and conditions.

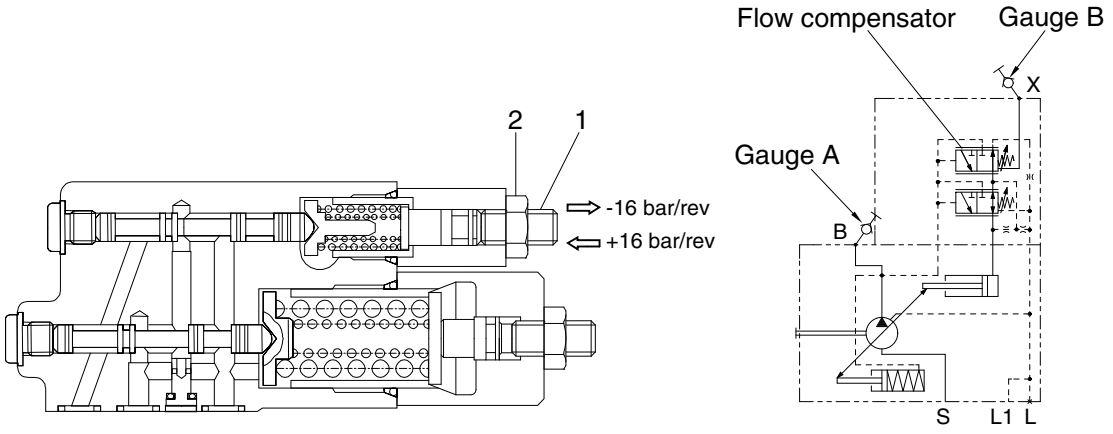
① **Conditions**

- Engine is running (at high or low idle).
- Lever is operated slowly (example : Mast up).
- Pressure gauges are installed.

※ Discharge pump flow should be less than max pump flow.

② **Procedures**

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).
  · Flow setting : △P = Gauge A - Gauge B
  · Specification : Steering pump (29 bar) / Attachment pump (22 bar)



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(6) Adjustment of pressure control

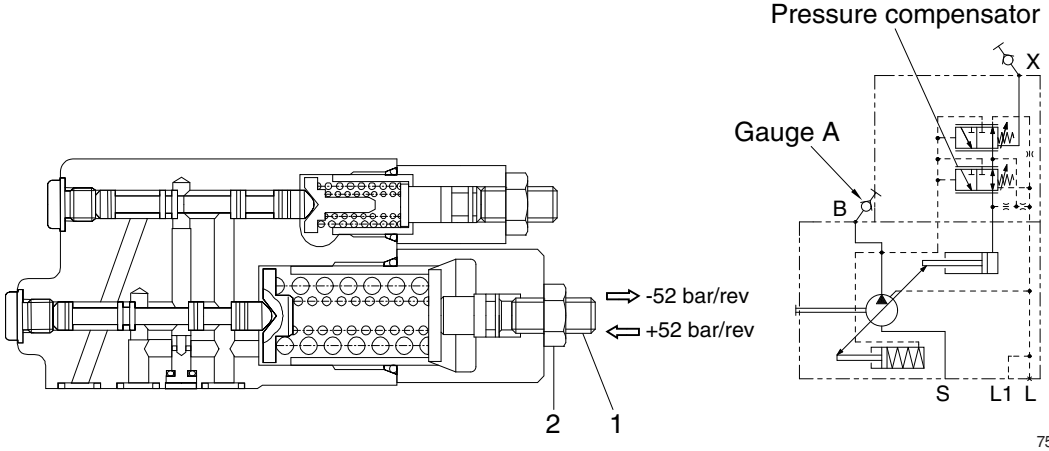
Pressure compensator setting must be carried out following procedures and conditions.

① **Conditions**

- Engine is running.
- System is at relief condition.

② **Procedures**

- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).
  · Maximum pressure setting = Gauge A
  · Specification : Steering pump (250 bar) / Attachment pump (300 bar)



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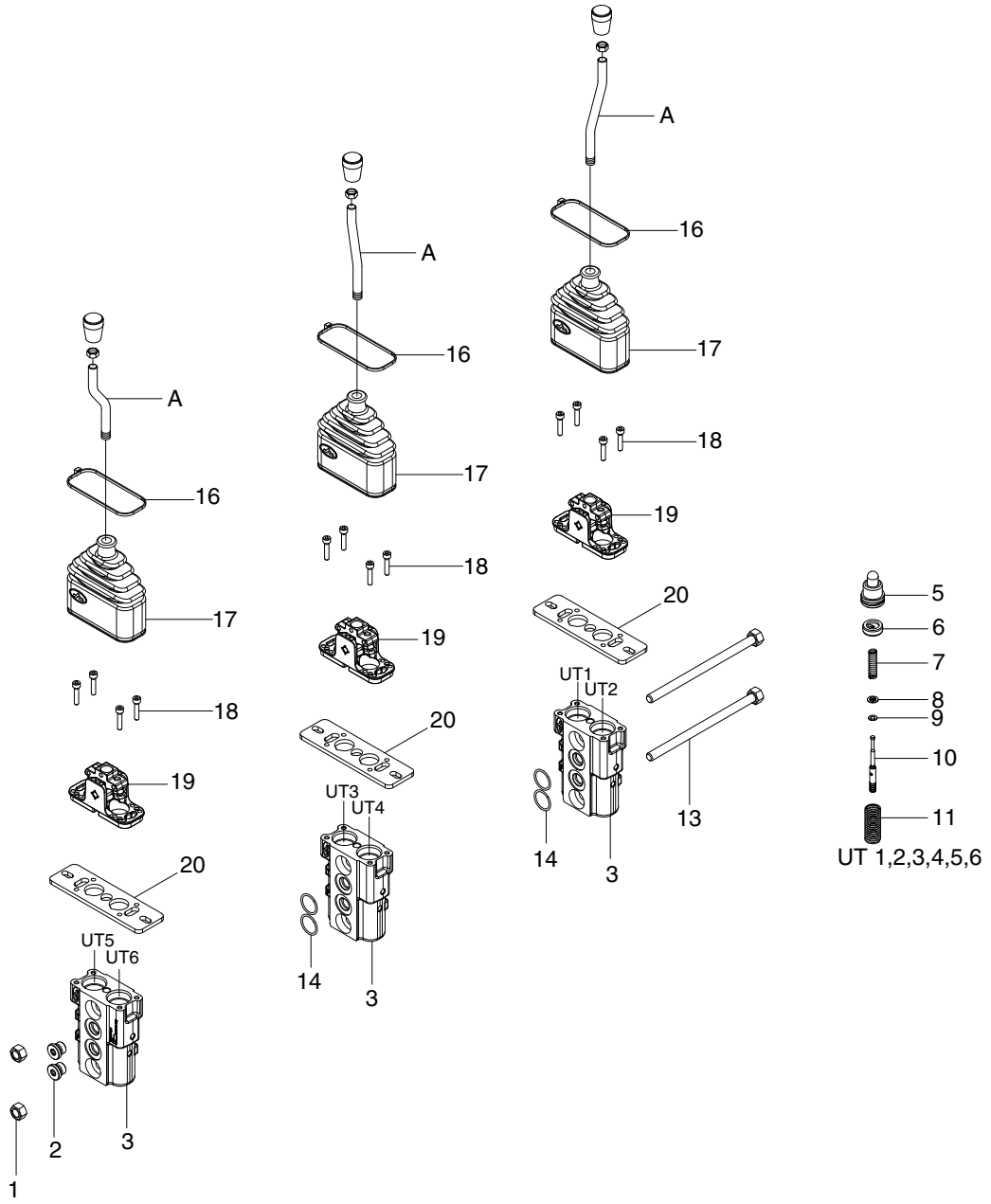
5. REMOTE CONTROL VALVE

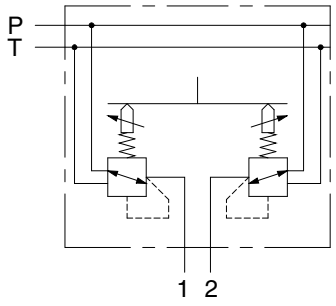
1) STRUCTURE



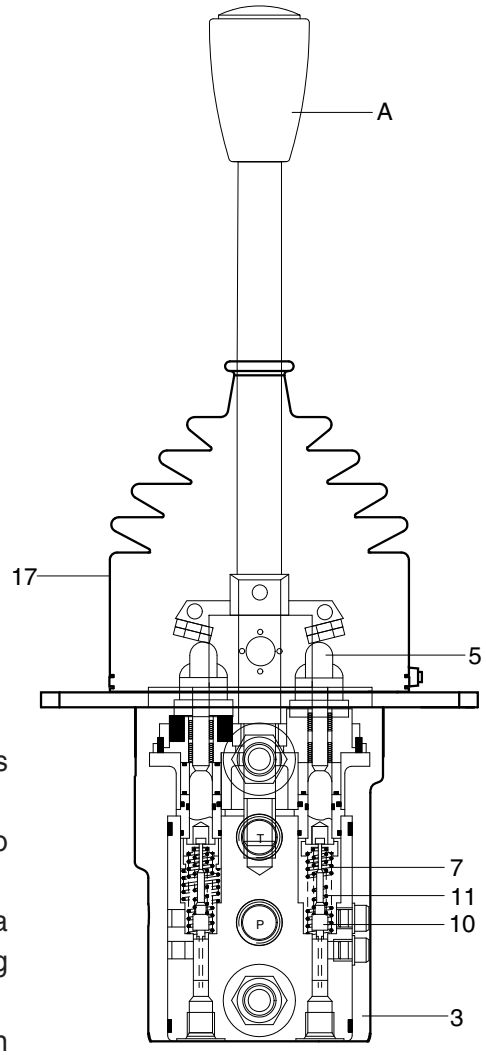
100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellows
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) OPERATION



HYDRAULIC CIRCUIT



100D7RCV01

(1) Hydraulic functional principle

Pilot devices with end position locks operate as direct operated pressure reducing valves.

They basically comprise of control lever (A), two pressure reducing valves, body (3) and locks.

Each pressure reducing valve comprises of a plunger kit (5), a metering spring (7) and a spring (11).

At rest, control lever (A) is held in its neutral position by return springs (11). Ports (1, 2) are connected to tank port T.

When control lever (A) is deflected, plunger kit (5) is pressed against return spring(11) and metering spring (7).

Metering spring (7) initially moves docking rod (10) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P. The control phase starts as soon as docking rod (10) finds its balance between the force from metering spring (7) and the force, which results from the hydraulic pressure in the relevant port (ports 1, 2).

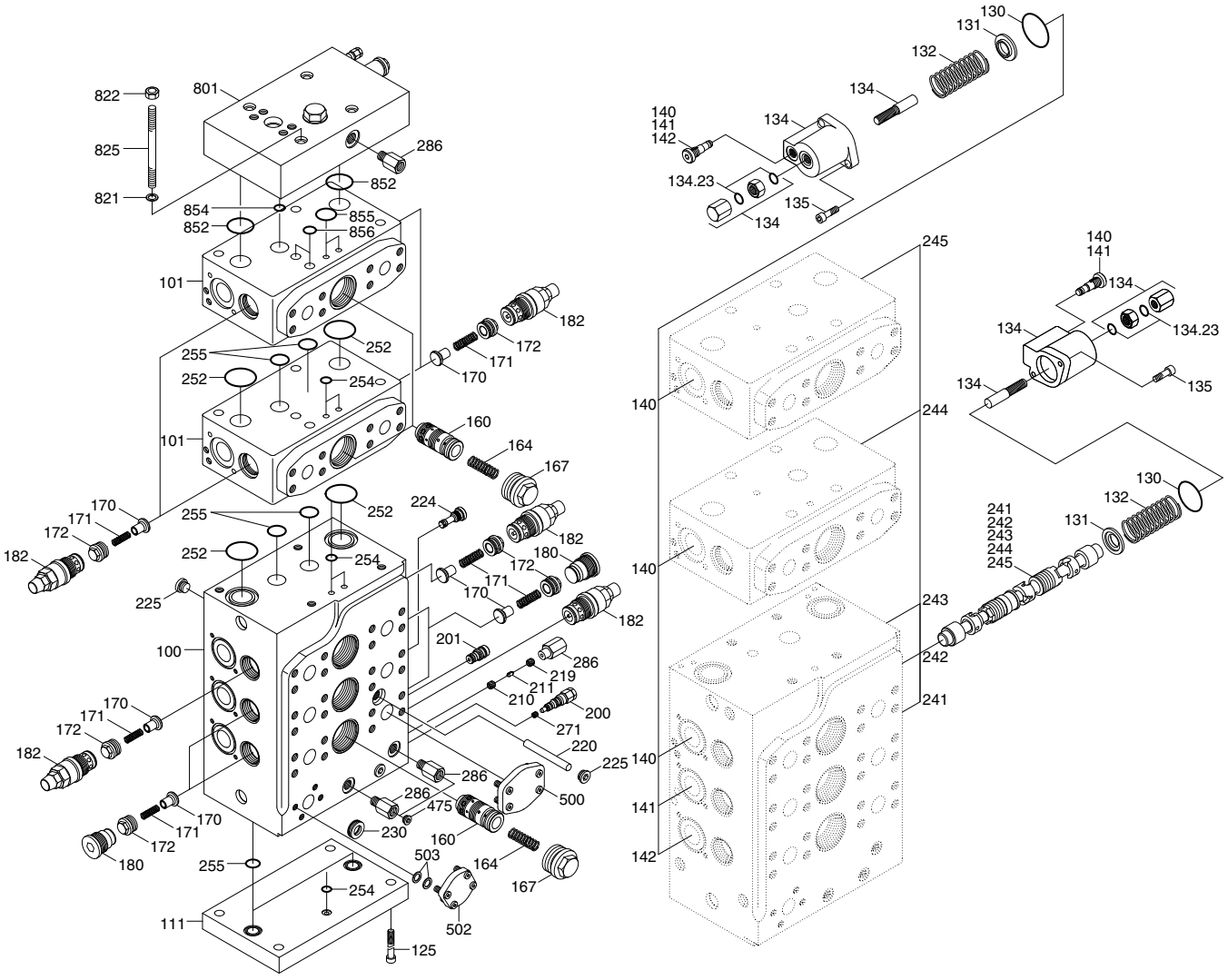
Due to the interaction between docking rod (10) and metering spring (7) the pressure in the relevant port is proportional to the stroke of plunger (5) and hence to the position of control lever (A).

This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of the main directional valves and high response valves for hydraulic pumps.

A rubber bellows (17) protects the mechanical components in the housing from contamination.

6. MAIN CONTROL VALVE

1) STRUCTURE



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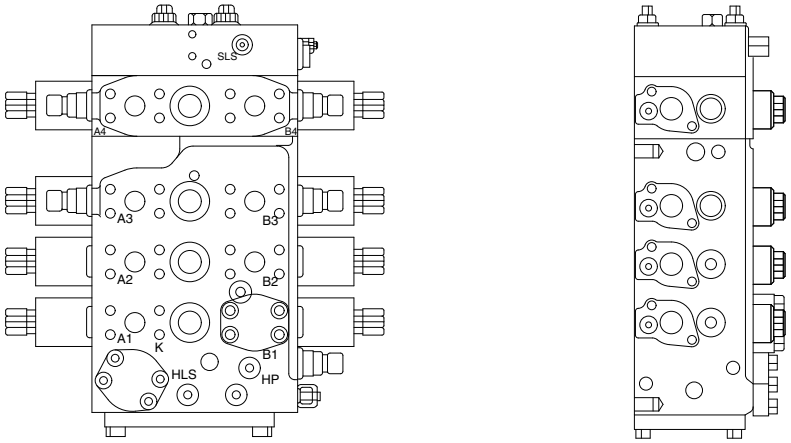
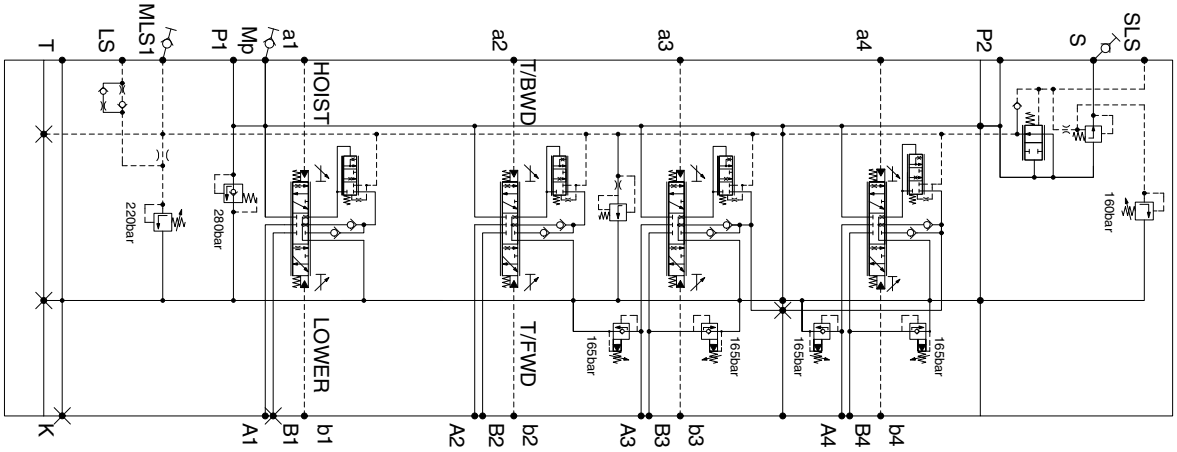
100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

STRUCTURE

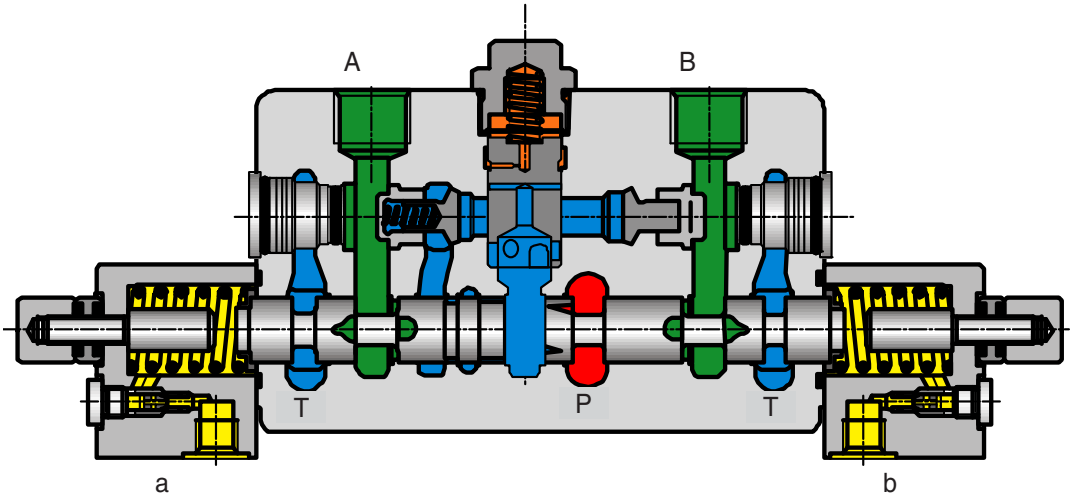




180D7EMCV02

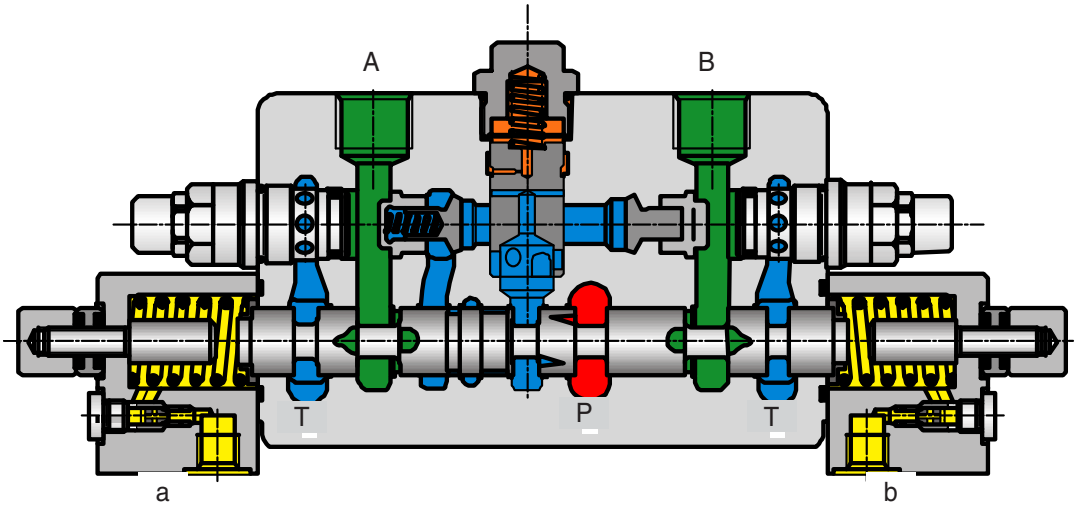
Port	Port name	Size	Port	Port name	Size
P1	From main pump	SAE 6000 psi 1 1/14"	a1, b1	From RCV lift port	9/16" - 18UNF
T	To hydraulic tank	SAE 6000 psi 1 1/14"	a2, b2	From RCV tilt port	9/16" - 18UNF
A1, B1	To lift cylinder port	SAE 6000 psi 1"	a3, b3	From RCV aux port	9/16" - 18UNF
A2, B2	To tilt cylinder port	SAE 6000 psi 1"	a4, b4	From RCV aux port	9/16" - 18UNF
A3, B3	To aux cylinder port	SAE 6000 psi 1"	LS	To shuttle valve	9/16" - 18UNF
A4, B4	To aux cylinder port	SAE 6000 psi 1"			
P2	From main pump	SAE 6000 psi 3/4"			
S	To steering unit	SAE 6000 psi 3/4"			

2) LIFT & TILT SECTION



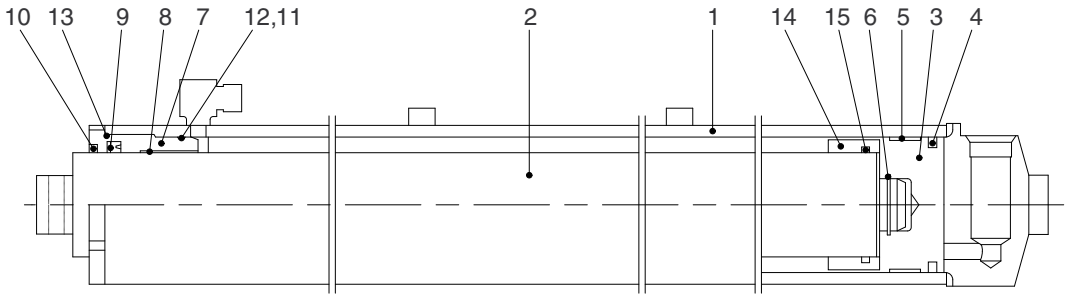
180D7EMCV12

3) AUXILIARY SECTION



180D7EMCV13

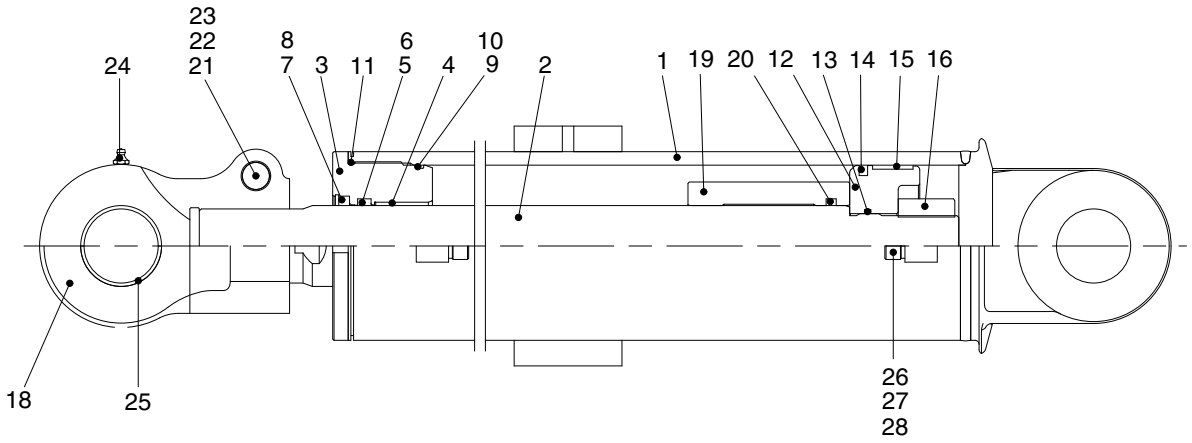
7. LIFT CYLINDER



180D9CYL01

1	Tube assembly	6	Stop ring	11	O-ring
2	Rod assembly	7	Rod cover	12	Back up ring
3	Piston	8	Rod bushing	13	O-ring
4	Rod seal	9	U-packing	14	Spacer
5	Wear ring	10	Dust wiper	15	O-ring

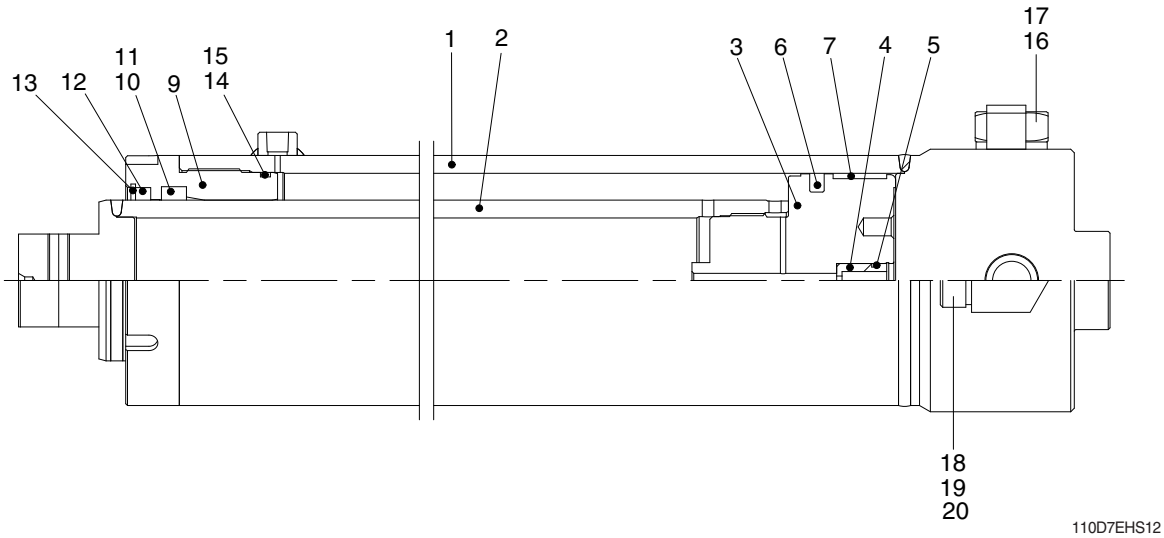
8. TILT CYLINDER



110D7EHS11

1	Tube assembly	10	Back up ring	20	O-ring
2	Rod assembly	11	Back up ring	21	Hexagon bolt
3	Rod cover	12	Piston	22	Hexagon nut
4	DU-bushing	13	O-ring	23	Spring washer
5	U-packing	14	Piston seal	24	Grease nipple
6	Back up ring	15	Wear ring	25	DU-bushing
7	Dust wiper	16	Hexagon nut	26	Dust cap
8	Stop ring	18	Eye	27	O-ring
9	O-ring	19	Spacer	28	O-ring

9. FREE CYLINDER

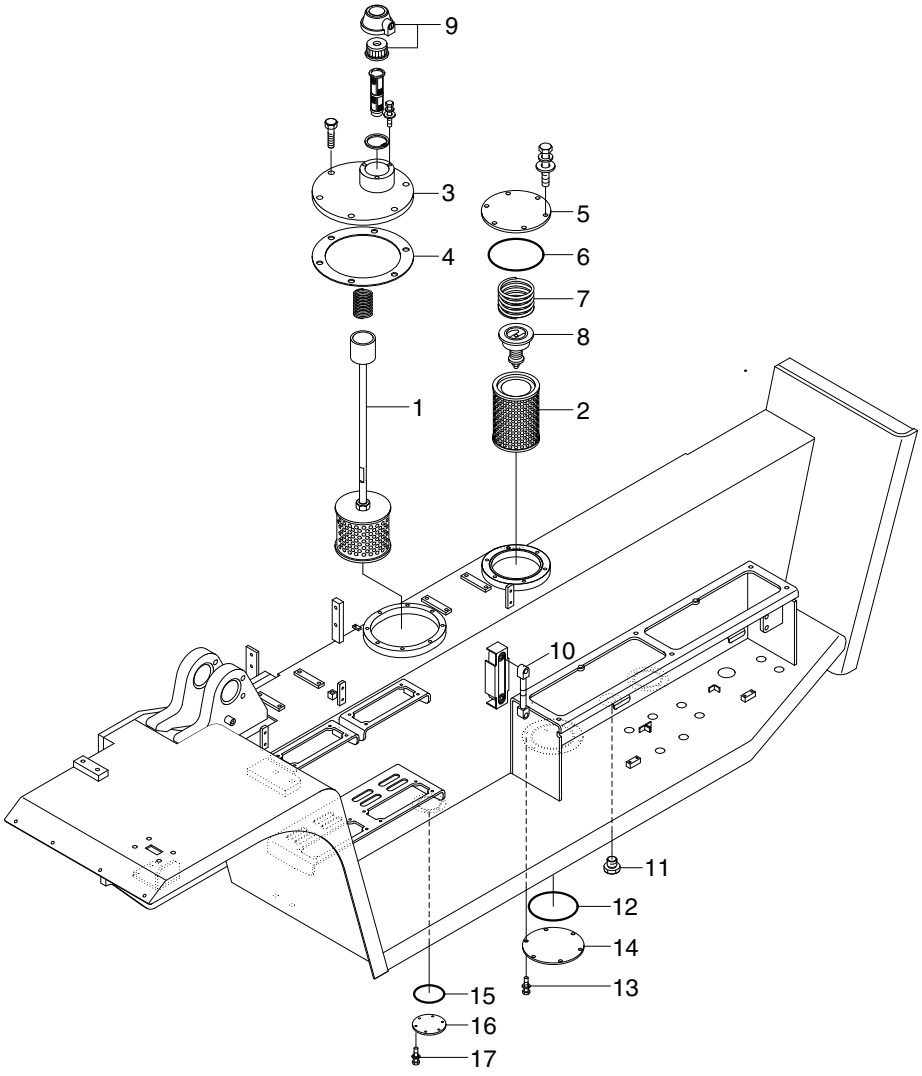


1	Tube assembly	9	Rod cover	16	Plug
2	Rod assembly	10	U-packing	17	O-ring
3	Piston	11	Back up ring	18	Dust cap
4	Check valve	12	Dust wiper	19	O-ring
5	Retaining ring	13	Retaining ring	20	O-ring
6	Seal slipper	14	O-ring		
7	Wear ring	15	Back up ring		

10. HYDRAULIC OIL TANK

1) STRUCTURE

- The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.
- A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank.



180D9HS13

1	Suction strainer	7	Spring	13	Bolt with washer
2	Return filter	8	Bypass valve	14	Cover
3	Cover	9	Air breather filter	15	O-ring
4	Gasket	10	Level gauge	16	Cover
5	Cover	11	Magnet plug	17	Bolt with washer
6	O-ring	12	O-ring		

2) AIR BREATHER

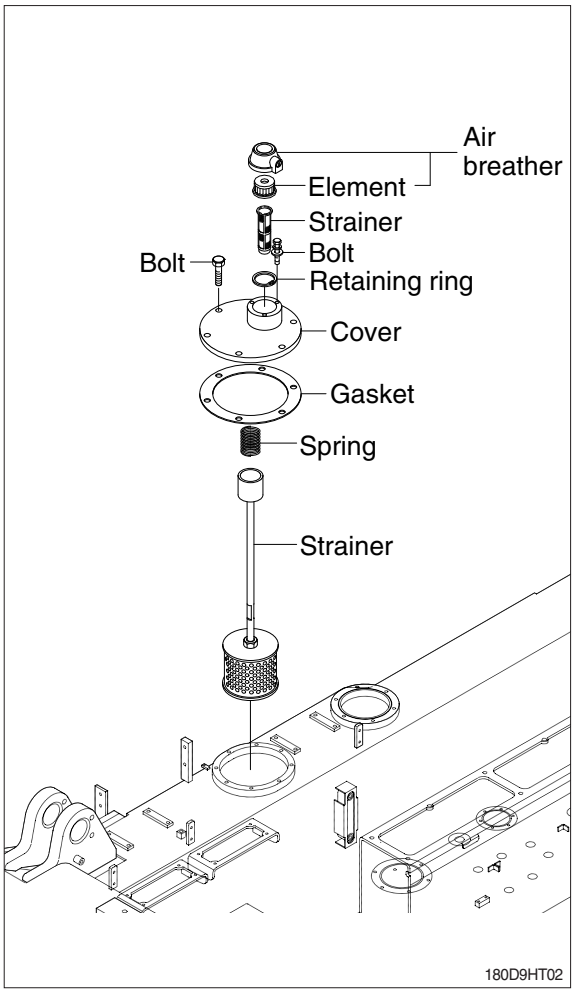
The air breather is equipped with the capacity to perform two functions simultaneously-as an air filter and as a breathing valve.

(1) Preventing negative pressure inside the tank

The tank is a pressurized sealed type, so negative pressure is formed inside the hydraulic tank when the oil level drops during operations. When this happens, the difference in pressure between the tank and the outside atmospheric pressure opens the puppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

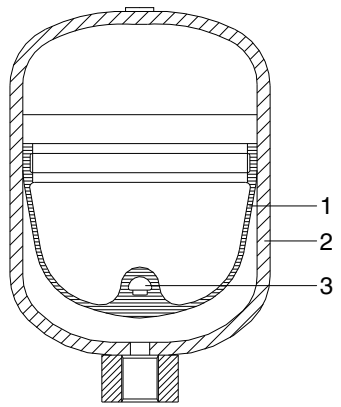
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



11. ACCUMULATOR

The accumulator is installed at the cut off valve. When the mast is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas (N_2)
Volume of gas	0.35 ℓ (0.1 U.S.gal)
Charging pressure of gas	15 kg/cm^2 (213 psi)
Max actuating pressure	170 kg/cm^2 (2420 psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

(1) Check visually for deformation, cracks or damage of rod.

(2) Set mast vertical and raise 1 m from ground. Wait for 10 minutes and measure hydraulic drift (amount forks move down and amount mast tilts forward).

· **Check condition**

- Hydraulic oil : Normal operating temp
- Mast substantially vertical.
- Rated capacity load.

· **Hydraulic drift**

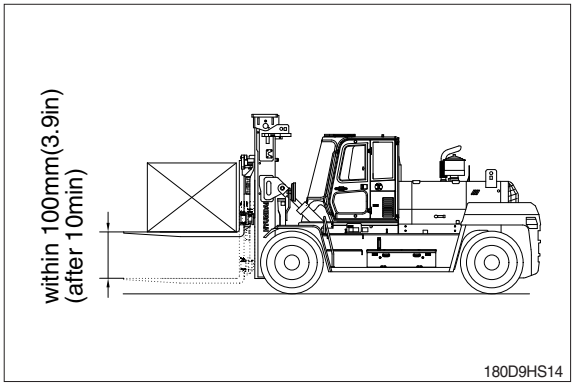
- Down (Downward movement of forks)
  : Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
  : Within 5°

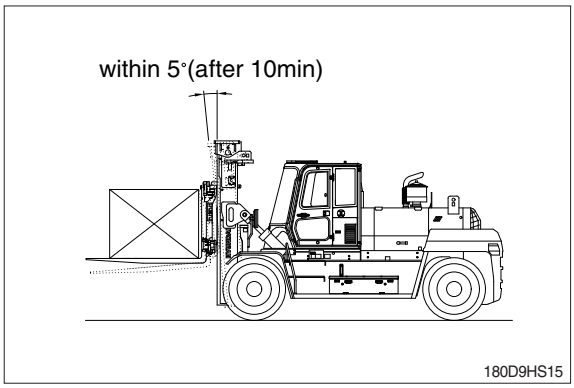
(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)

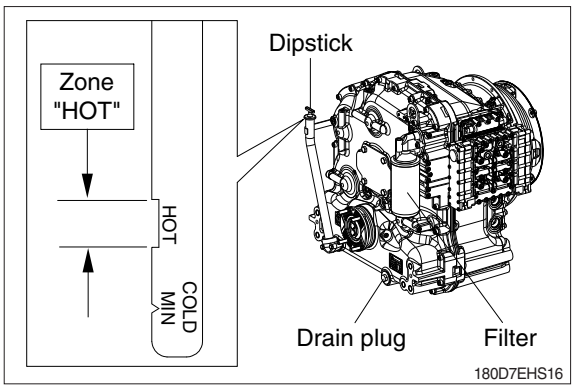




2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, and oil if necessary.

(2) When changing hydraulic oil, clean suction strainer (screwed into outlet port pipe) and line filter (screwed into inlet pipe). Line filter uses paper element, so replace periodically (every 6 months or 1200 hours)



3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.

Check that oil pressure is 240 kgf/cm^2.

(3410 psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast.	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting.	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to SAE10W, class CF engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds.	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to SAE10W, class CF engine oil. · Clean filter.

Problem	Cause	Remedy
Actuator (cylinder or motor) works slowly or does not operate.	· Shortage of oil in oil tank. · Decrease of relief valve pressure. · Spool got stuck. · Shortage of oil flow to the valve.	· Check the oil level in the oil tank. · Install pressure gauge on the circuit, and check the pressure with it by handling the lever. · Check that manual lever moves smoothly. · Check that lever stroke is enough. · Check that oil flow of the pump is within specified rate.
Cylinder lowers considerably under normal circumstance.	· Internal leakage of cylinder happens frequently. · Excessive leakage from spool of the valve. · Spool got stuck. · Leakage in a part of the circuit.	· Fit the stop valve on the pipe between valve and cylinder, observe the internal leakage of cylinder. · Check the oil viscosity is not too low. · Check that manual lever moves smoothly. · Check the circuit. · Observe leakage from pipes.
Pressure does not increase sufficiently.	· Defect of relief valve. · Leakage in a part of the circuit.	· Check the relief valve. · Check the circuit. · Observe leakage from pipes.
Temperature rising of the hydraulic oil.	· Working with higher pressure than rated pressure. · Low viscosity of oil. · Leakage from a part of the circuit. · Oil leakage in the pump. · Insufficient suction of the pump.	· Check the flow pressure. · Check the sort of oil and viscosity. · Check if the circuit is relieved at all times. · Check if the temperature of pump surface higher 30˚C than oil tempera-ture. · Check the oil tank volume. · Check if the suction strainer is blocked.
Steering force is heavy.	· Defect of steering relief valve.	· Check the steering relief valve.

2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	· System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out.	· Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty. · Suction strainer clogged.	· Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	· Oil too thick. · Oil filter plugged. · Suction line plugged or too small.	· Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil.	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between puppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

★ A good pressure gauge must be installed in the line which is in communication with the main relief. A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

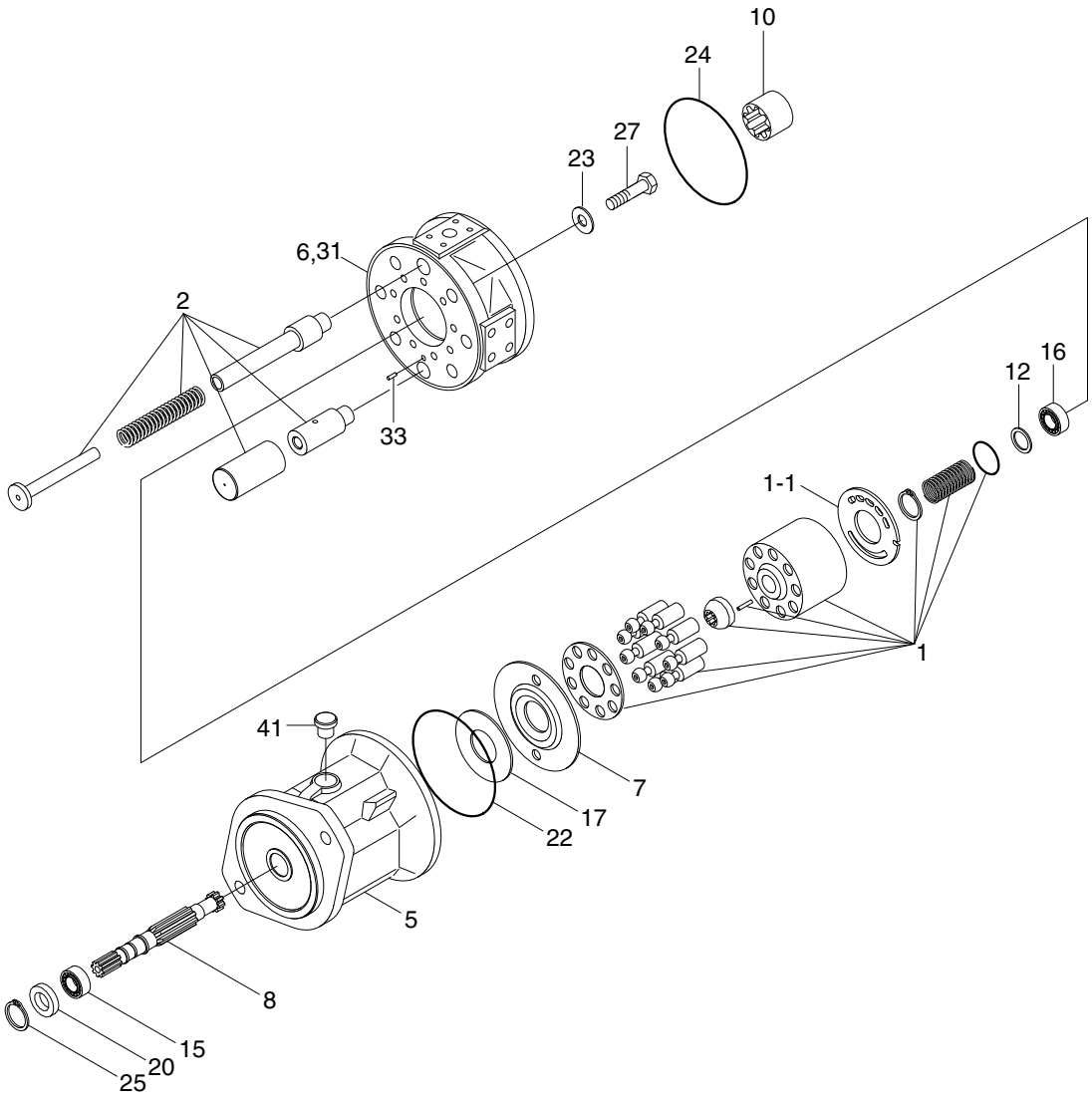
- Loosen lock nut.
- Set adjusting nut to desired pressure setting.
- If desired pressure setting cannot be achieved, add or remove shims as required.
- Tighten lock nut.
- Retest in similar manner as above.

4) CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland through rod.	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube. · Unallowable score on the inner surface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear (clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

1. MAIN PUMP

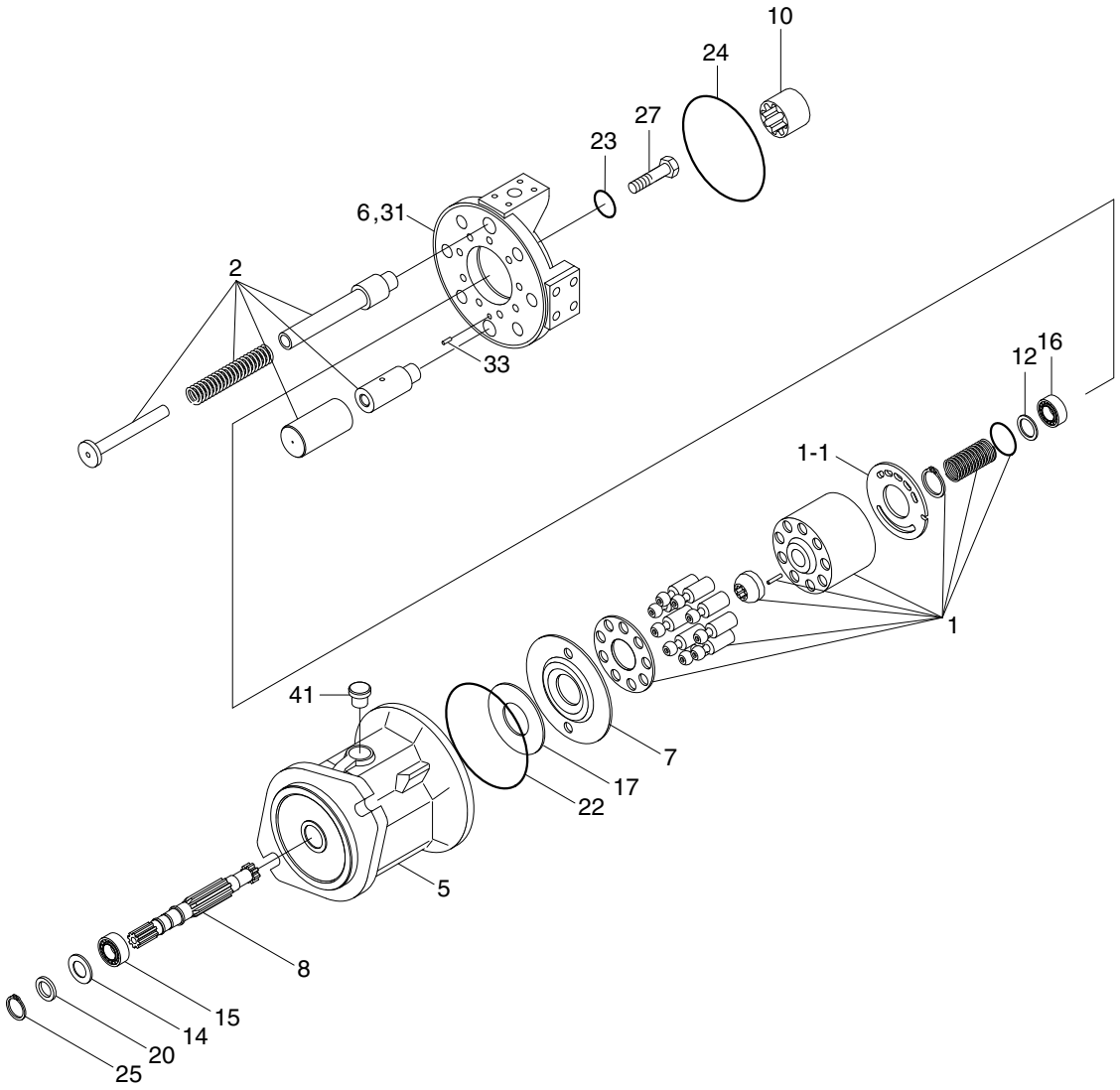
1) STRUCTURE (front)



180D7EMP01

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Splined hub	23	O-ring		

STRUCTURE (rear)



180D9MP02

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Spline hub	23	O-ring		

2) GENERAL REPAIR GUIDE LINES

※ Observe the following guidelines when carrying out repairs on hydraulic pumps.

(1) Close off all openings of the hydraulic unit.

(2) Replace all of the seals.
Use only original spare parts.

(3) Check all sealing and sliding surfaces for wear.

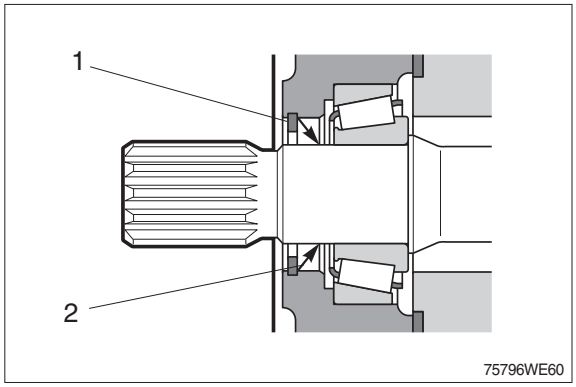
※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

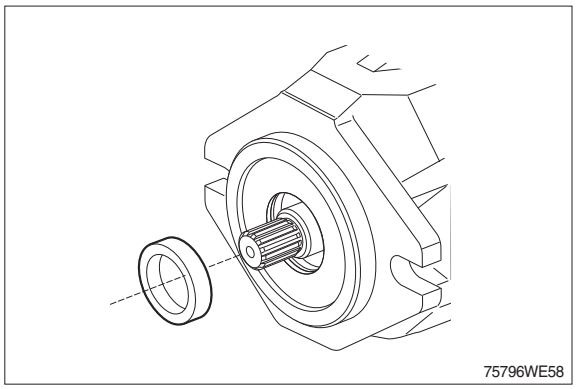
3) SEALING THE DRIVE SHAFT

(1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

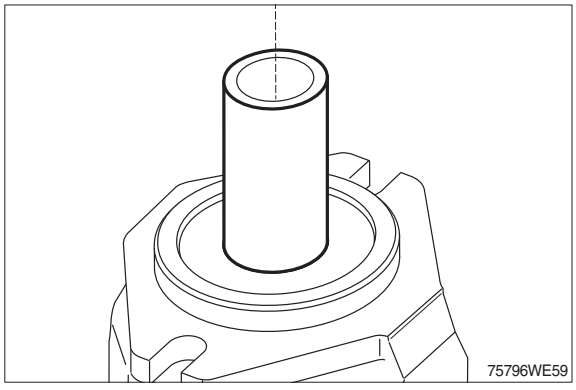
1 Circlip 2 Shaft seal



(2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



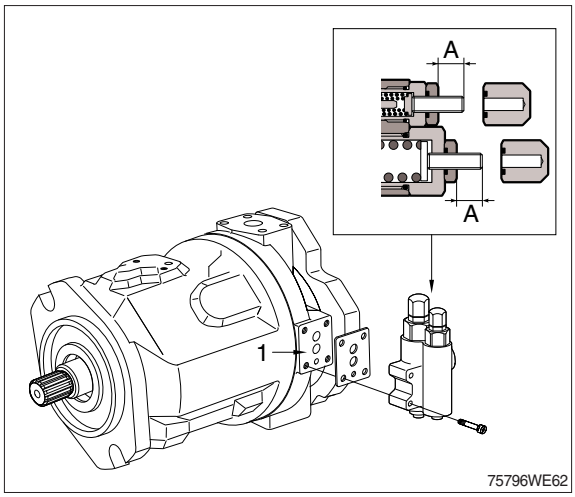
(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.



4) SEALING / CLEANING THE CONTROL VALVE

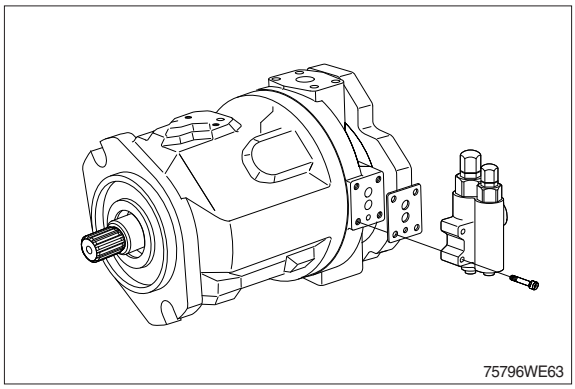
(1) Disassemble the control valve.

※ Measure dimension A and note down. Check sealing surface (1).

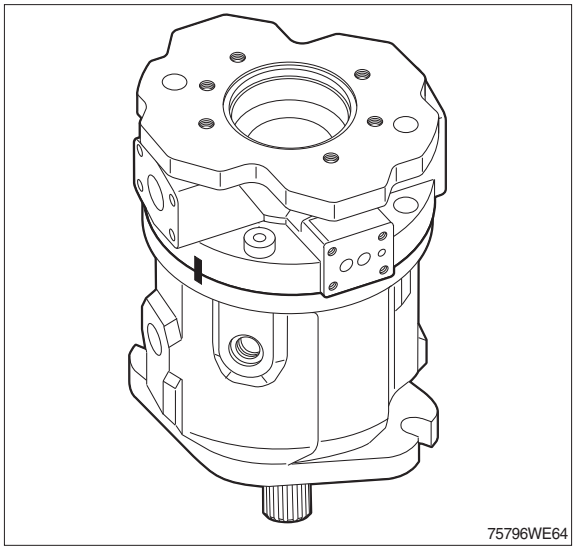


5) DISASSEMBLE THE PUMP

(1) Remove the control valve.

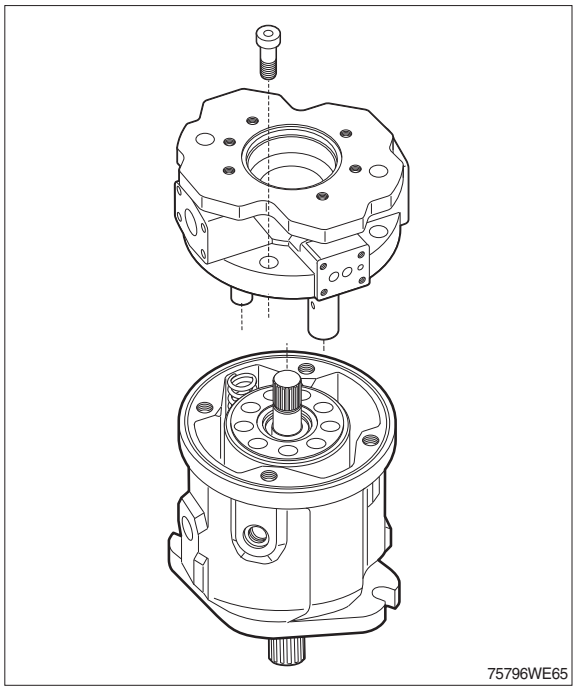


(2) Mark the location of the connection plate on the housing.



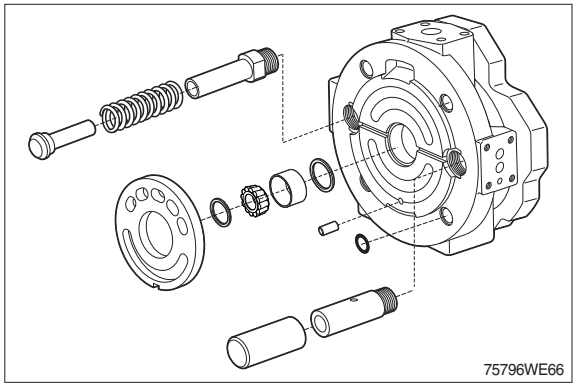
(3) Remove the connection plate fixing bolts and the connection plate.

※ Distributor plate and adjustment piston can drop down.

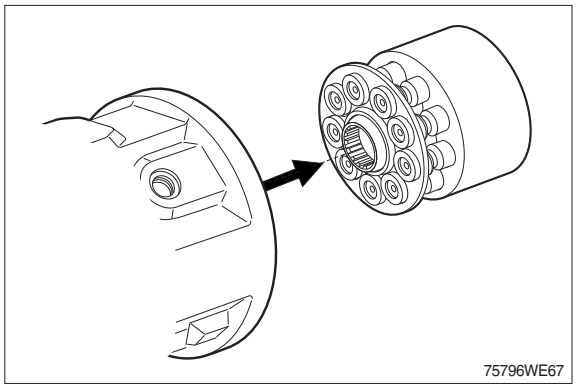


(4) Remove distributor plate.
Take note of the orientation.

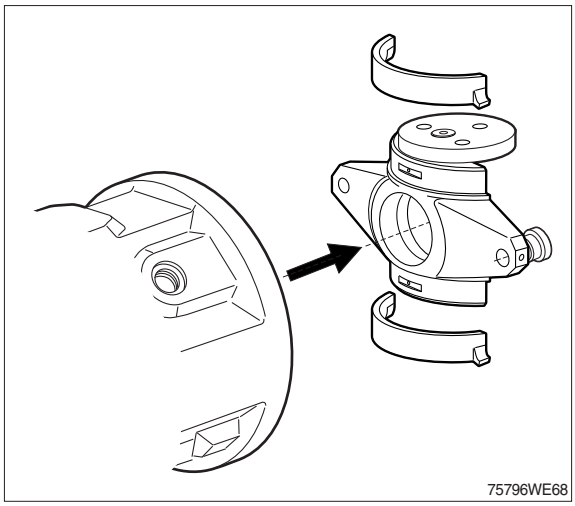
※ Remove bearing with withdrawal tool.
Do not damage the sealing surface.



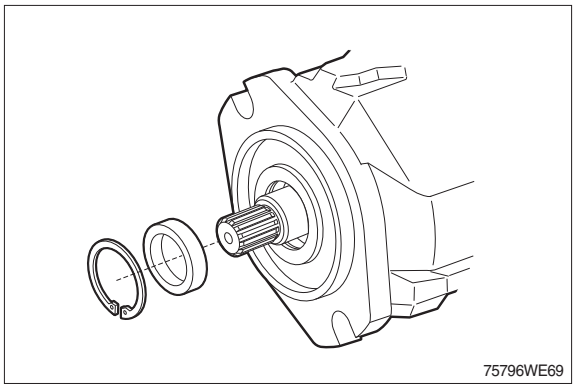
(5) Remove the rotary group in a horizontal position.



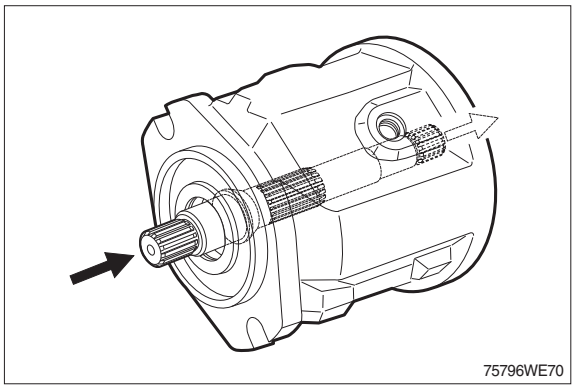
(6) Remove swash plate and bearing shells.



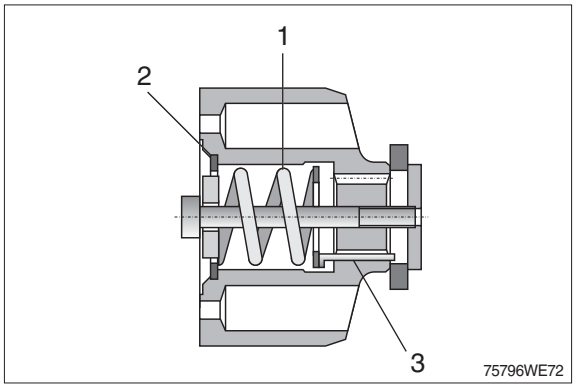
(7) Remove the circlip and the shaft seal.



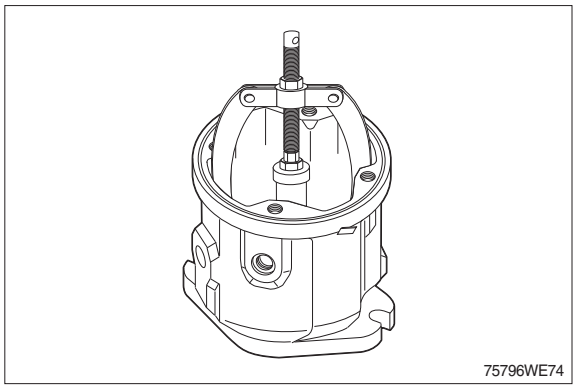
(8) Remove the drive shaft through rear side.



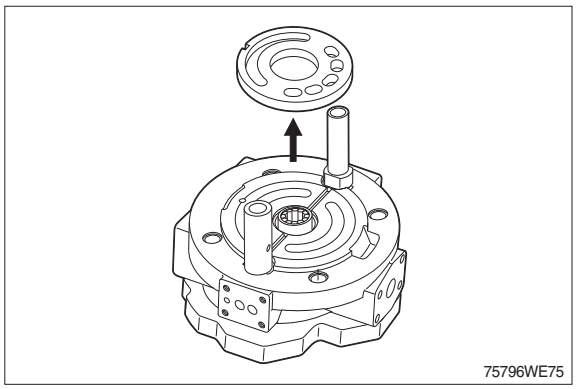
(9) Pre-tension the spring (1) using a suitable device.
Remove circlip (2).
Remove spring (1) and pressure pins (3).



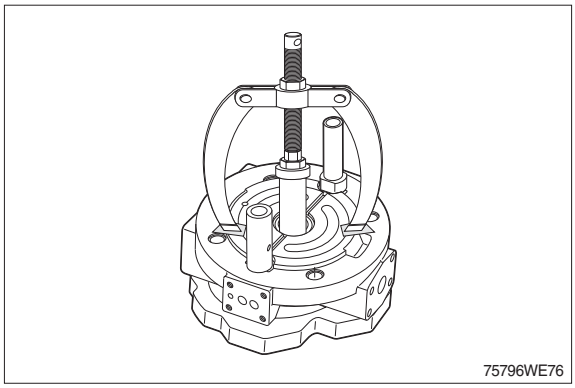
(10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



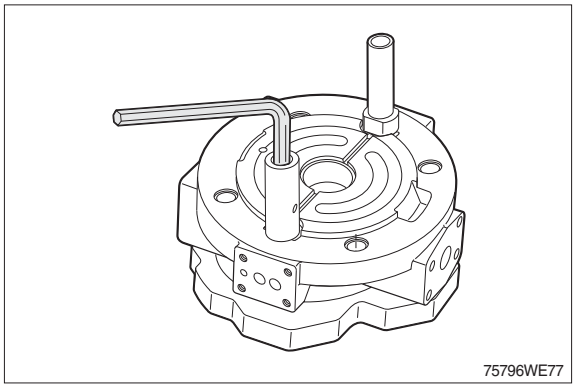
(11) Remove the control plate.



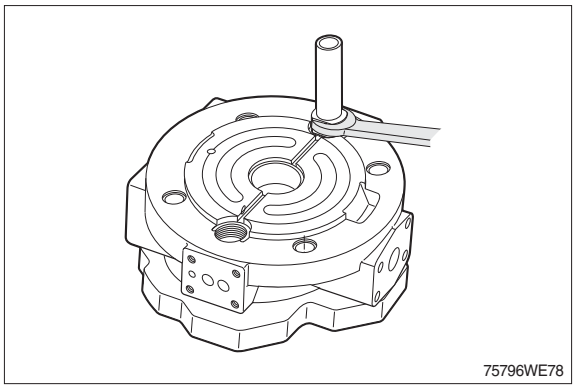
(12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



(13) Disassemble the guide of control piston (Mounting position: pilot valve side).

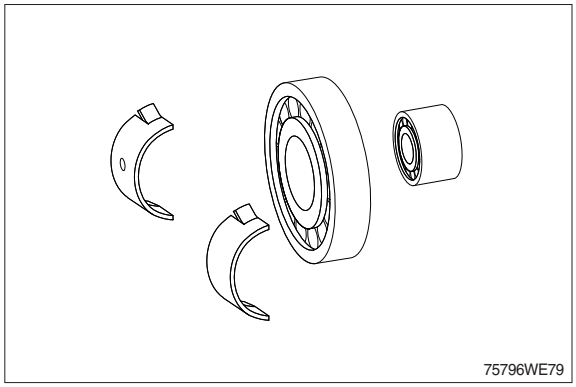


(14) Disassemble the guide of the opposite piston.

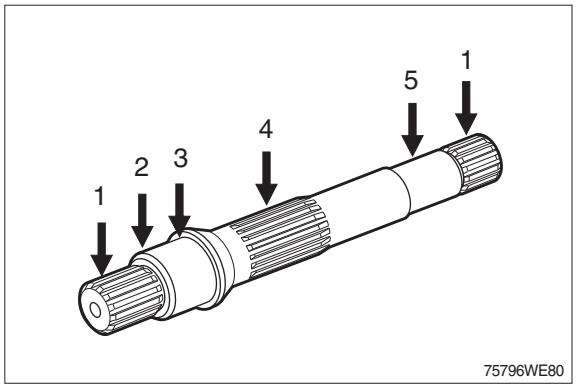


6) INSPECT HINTS

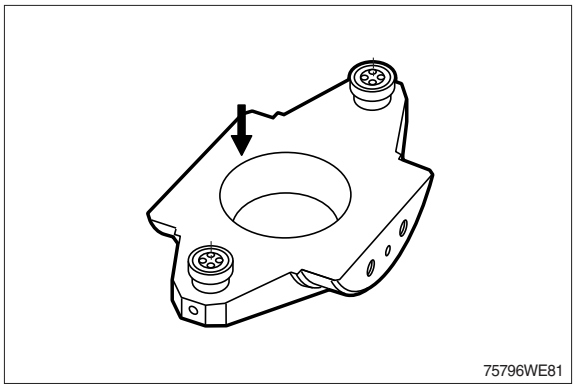
(1) Renew all bearings.



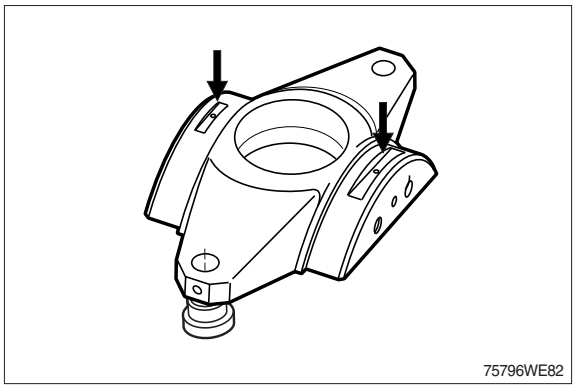
(2) Check :
1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



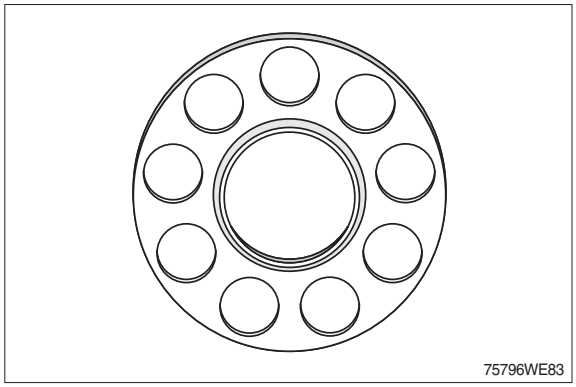
(3) Check :
Sliding surface free of grooves.



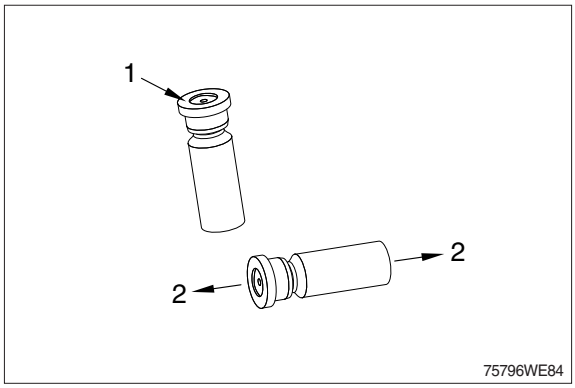
(4) Check :
Bearing surfaces.



(5) Check :
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.

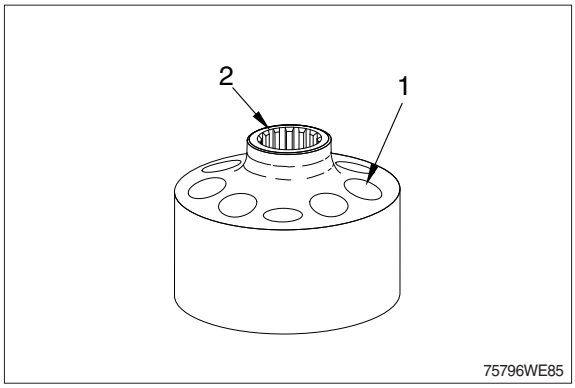


(6) Check :
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

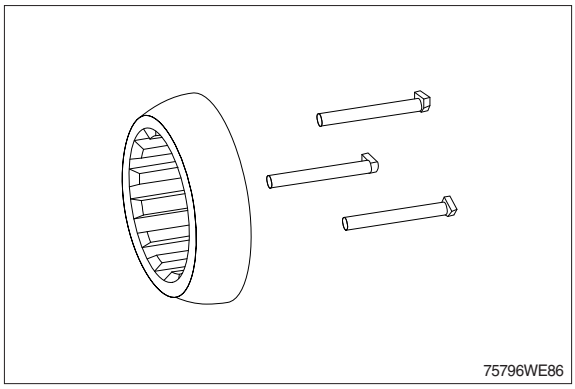


(7) Check :

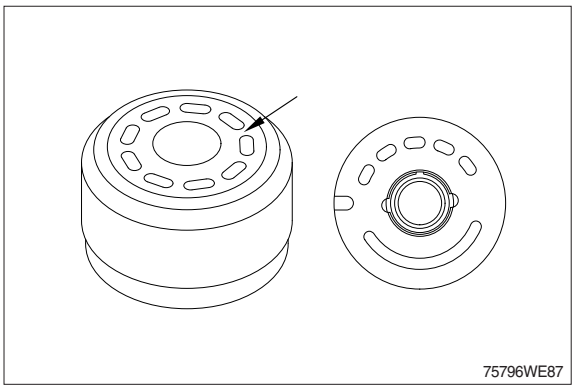
1 Cylinder bores
2 Splines



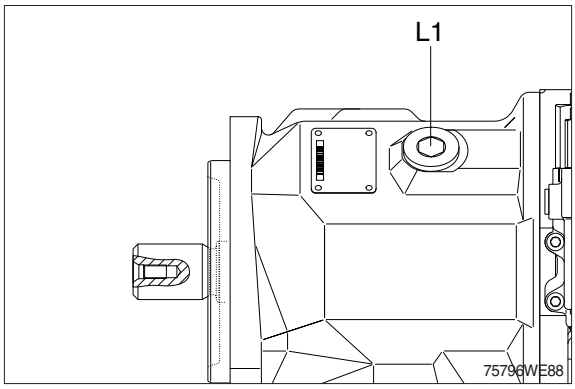
(8) Free of grooves, no signs of wear.



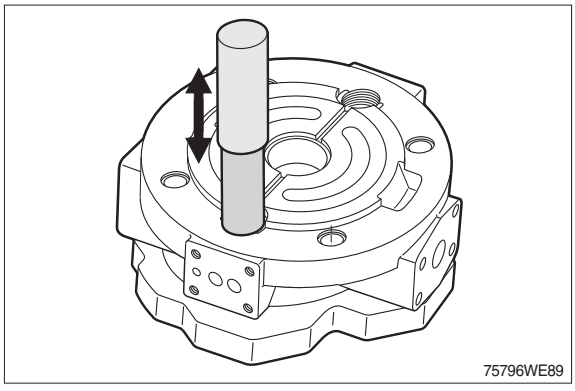
(9) Check :
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



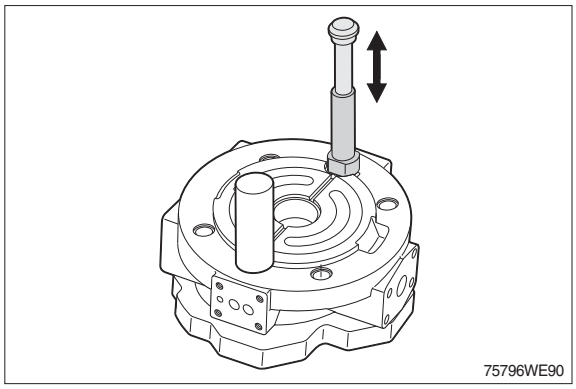
(10) Check :
Mounting surface - control plate undamaged.



(11) Check :
Check running conditions of the control piston.

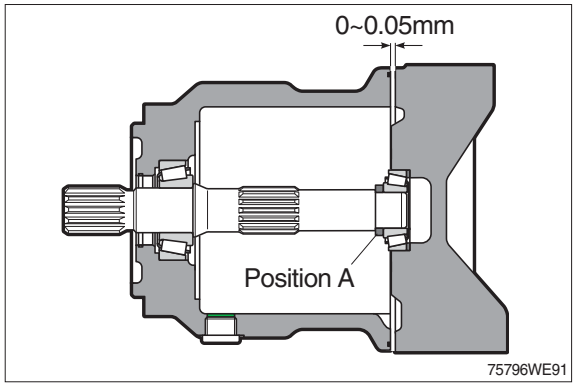


(12) Check :
Check running conditions of the opposite piston.



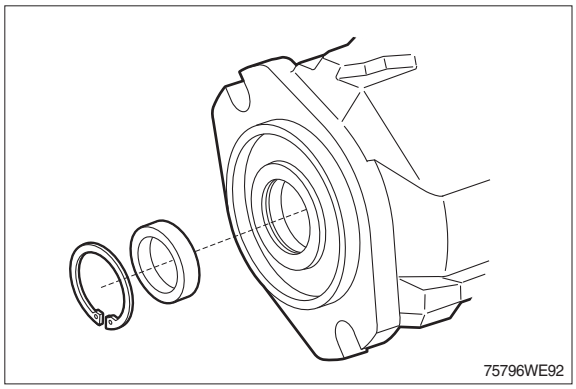
7) ADJUSTMENT OF TAPER ROLLER BEARING SET

(1) Cast iron housing must have initial tension of the bearings: 0~0,05 mm, grind position A if necessary.

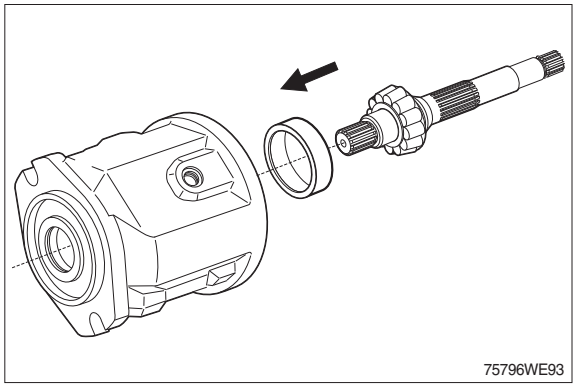


8) PUMP ASSEMBLY

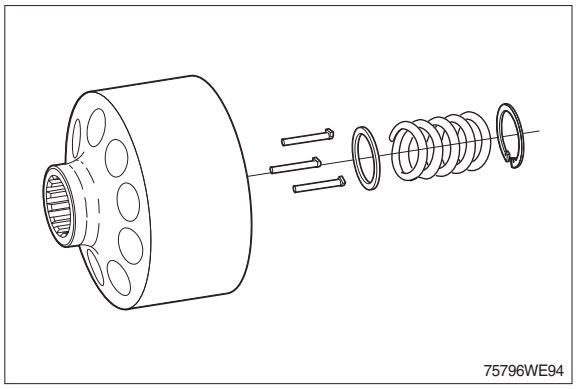
(1) Fit the seal into the housing.
Fit the circlip.



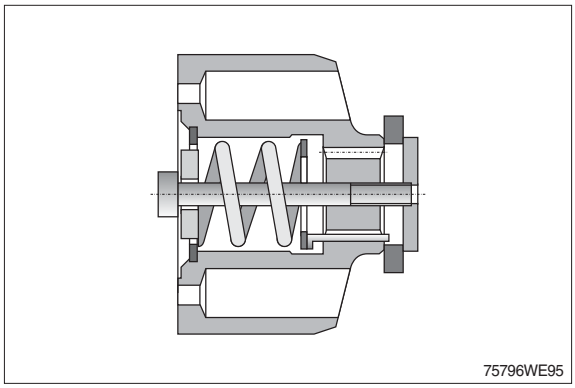
(2) Fit the drive with bearing from rear end.
※ Do not touch seal lip with edge of keyway or spline.



(3) Fit pressure pins using an assembly aid.

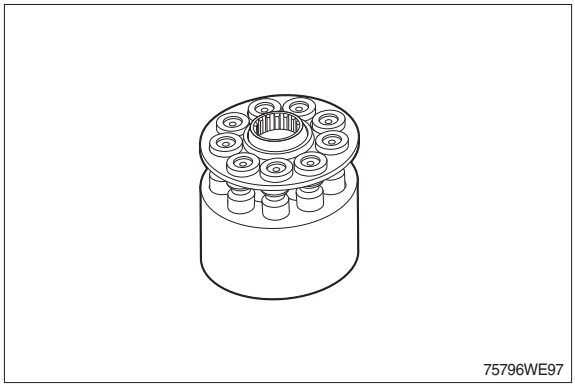


(4) Pre-tension the spring using a suitable device.



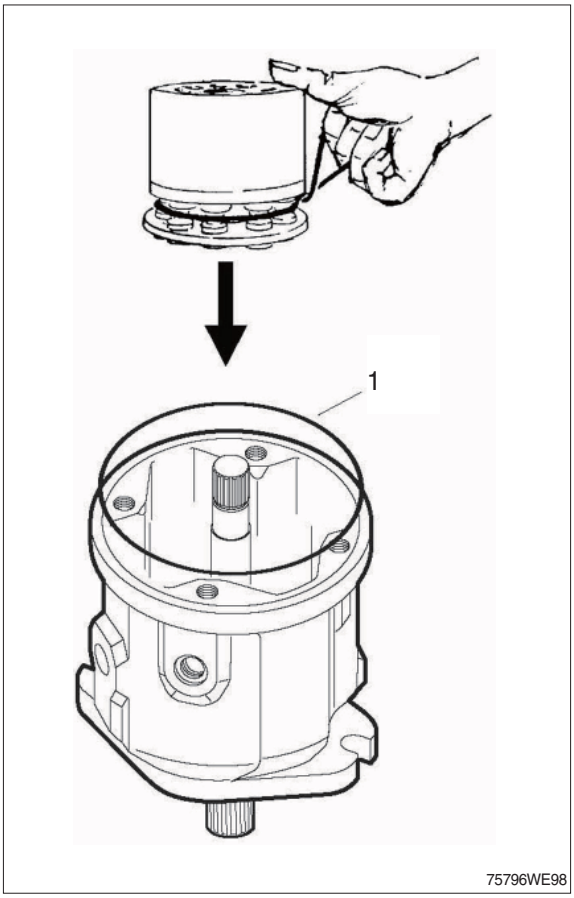
(5) Assemble piston with retaining plate.

※ Oil piston and slipper pad.



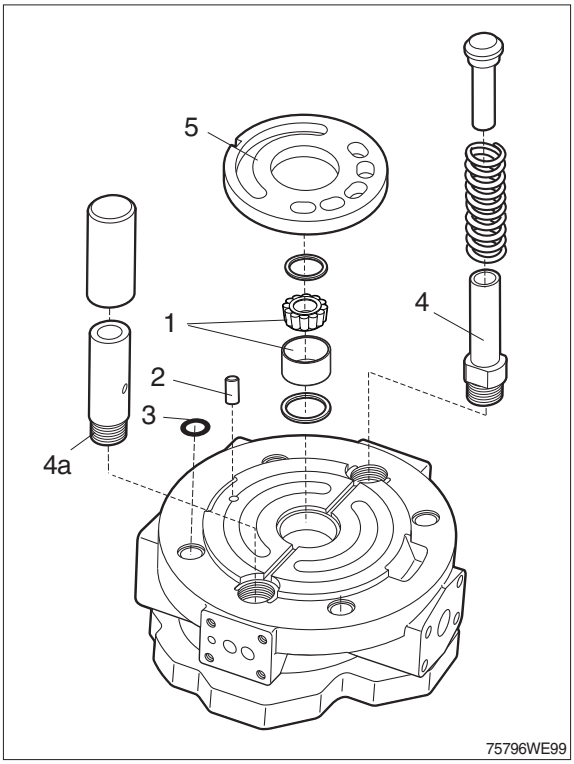
(6) Fit rotary group.

※ Hold the piston by using an O-ring.
Fit O-ring (1).



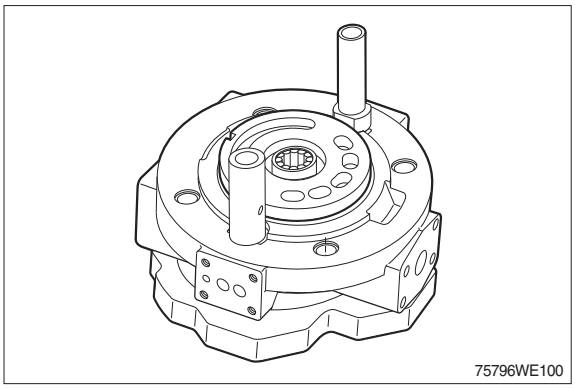
(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).
Fit distributor plate (5) (direction of rotation dependent)

※ Assembly.
Hold the components in place with grease.

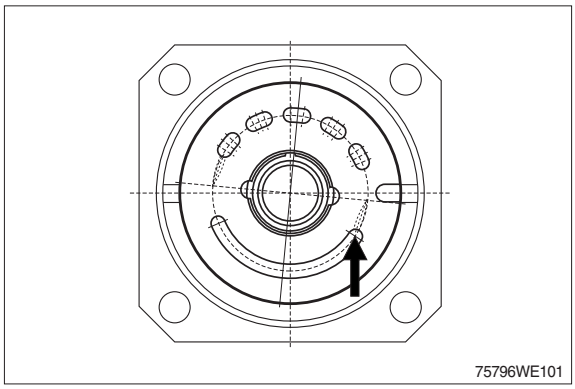


(8) Fit distributor plate.

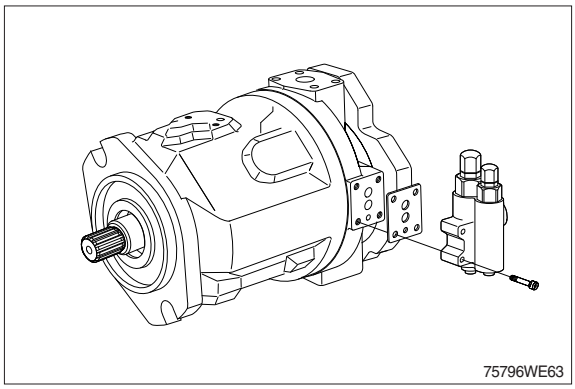
※ Assembly aid : Grease



(9) For clockwise rotation pumps the distributor plate is off-set by 4˚ to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).

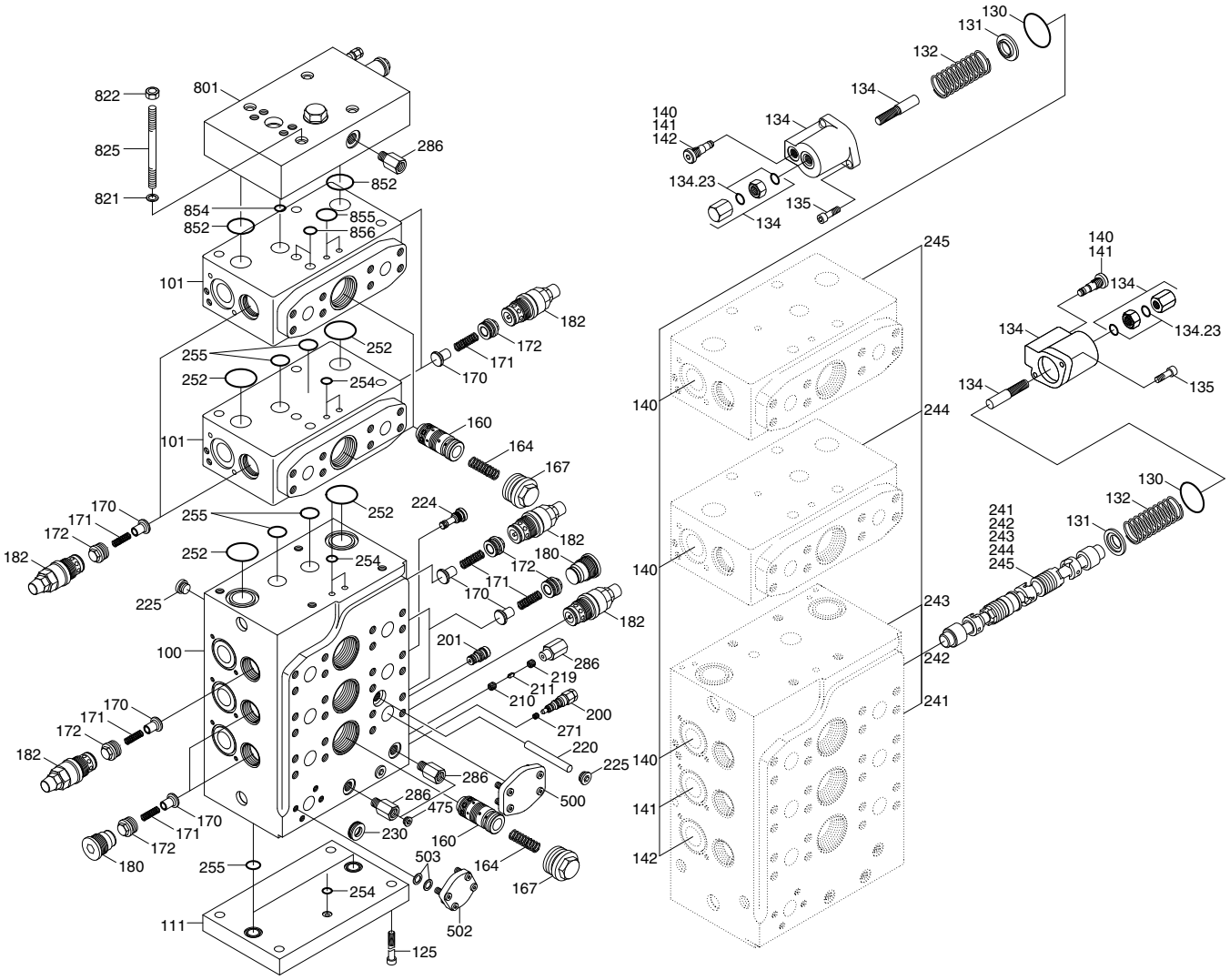


(10) Fit connection plate and control valve.



2. MAIN CONTROL VALVE

1) STRUCTURE



180D7EMCV01

100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE12 (1" 1/16-12UNF) & SAE16 (1" 5/16-12UNF) is 4.3 kgf · m (31 lbf · ft) and SAE6 (9/16-18UNF) is 2.5 kgf · m (18 lbf · ft).
(2) Care must be taken not to damage the seals by excess temperature or spatter of welding, when welding near by the valve.
(3) During the installation, care must be taken not to damage spool. It might cause defect of operation such as the spool getting stuck in valve body.
(4) Fit the rubber hosepipe for the machine, which expected vibration.
(5) Until piping, don't remove the blinds from each port.

4) PRECAUTION FOR OPERATION

(1) Max input pressure range should be less than 315 bar (4630 psi).
(2) Back pressure of tank port should be less than 25 bar (367 psi).
(3) The oil temperature should be between -20 ~ 80˚C. And ambient temperature should be from -40 ~ 60˚C. because that very high viscosity of oil will be cause defect of spool operation, warm up the machine to avoid it.
(4) 15/12- ISO4406 level of filtration is required in the hydraulic circuit for long life cycle of each components without mechanical trouble.

5) SPECIAL TOOL

(1) 3, 8, 5, 12 mm wrench.
(2) 17, 30, 36 mm spanner.
(3) Torque wrench adjustable from 0.9 ~ 4.3 kgf · m (7 ~ 31 lbf · ft).

6) INSTRUCTION FOR DISASSEMBLY AND REASSEMBLY

Before disassembly, visually inspect for leakage of oil and for part that have damage and clean the valve up. Preparation for assembly put the tag on each part to prevent wrong assembly and clean the parts completely. Inspect the parts if there is any scratch or dent, and check the movement. In assembly process, follow the tightening torque specification.

(1) Operation

Warm-up is very important before operation.

Be careful operating control valve when oil and valve temperature is low, to avoid stick by spool heat shock.

Not doing continual operates of main relief valve and port relief valve, warm valve uniformly by circulating oil to each cylinder.

Not doing neither inching operating nor multiple operation in low temperature to avoid heating locus of control.

(2) Relief valve

Exchanging complete relief valve is recommended. Therefore do not disassemble if there is any defect in the relief valve.

(3) Mounting

Be careful not to affect extreme force to control valve by hydraulic hose.

Tighten up all mounting blots in same torque.

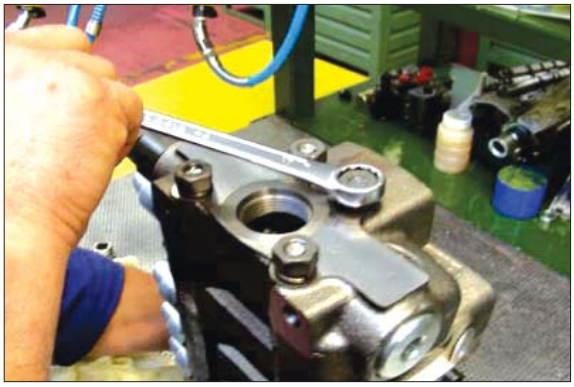
It is possible that seals are damaged by heat weld slag in which case of welding near the control valve.

To prevent contamination entering control valve, do not take off the shipping plug until install hydraulic hose.

6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen tightening two bolts with 17 ㎜ spanner.



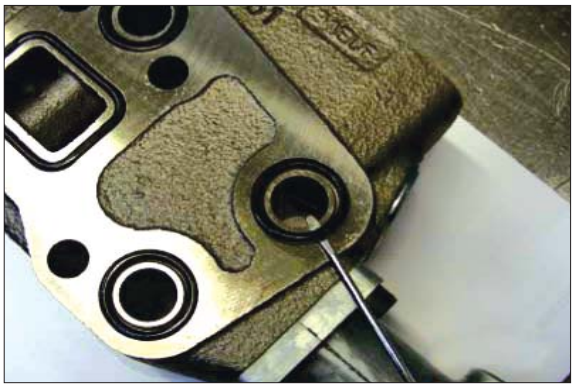
100D7MCV01

Taking out working section one by one.

100D7MCV02

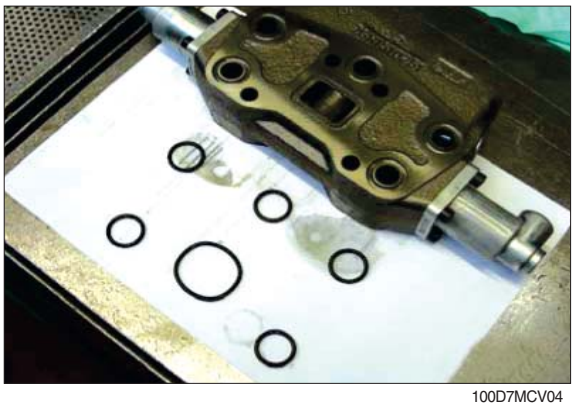
Remove O-rings on the surface of working section properly.

Pay special attention not to give any scratch on the surface.



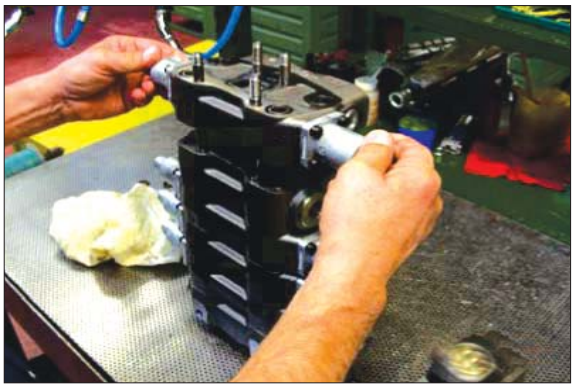
100D7MCV03

Prepare two sizes of O-rings.
And fix the O-rings on the right positions with some grease in order to avoid separation from the surface while moving.



100D7MCV04

Locate new or repaired working section in right position according to the order of functions.



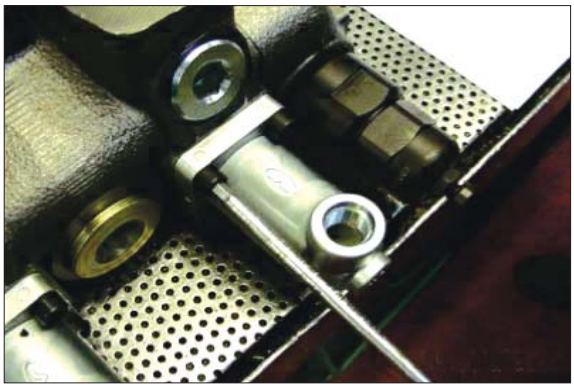
100D7MCV05

Tighten four nuts (M17) in a crisscross pattern with proper assembling torque of 4.3 kgf · m (31 lbf · ft).

100D7MCV06

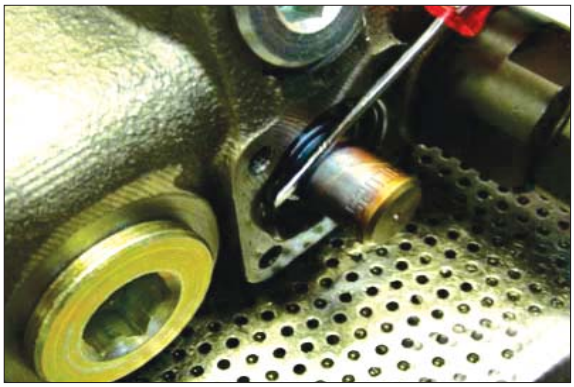
(2) Replacing spool & control kit

Loosen 4 screws holding aluminum kits to the body with 5 mm wrench.



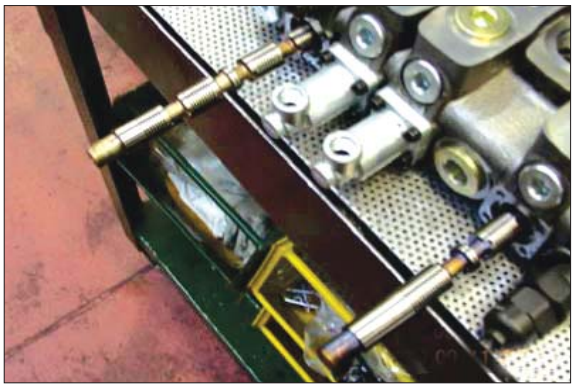
100D7MCV07

Take off all components and O-ring, valve inside, with attention not to give any damage to it.
Don't use anything with sharp edge.



100D7MCV08

Take out the spool, as straight as possible. Even very little force on the spool while disassembling & assembling could make deformation on the spool.



100D7MCV09

Prepare all components before starting reassembling spool control kit.

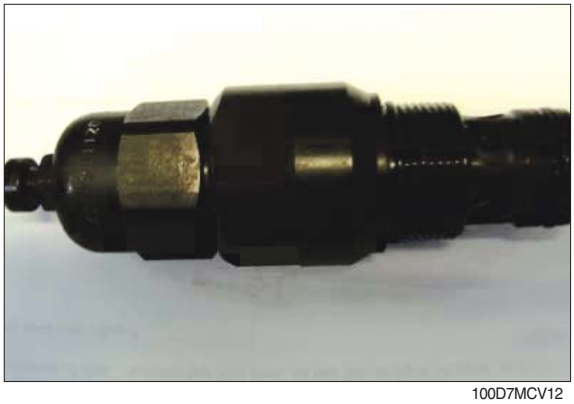
100D7MCV10

Fit aluminum kit to the body with 5 ㎜ wrench by 1.0 kgf · m (7.2 lbf · ft).

100D7MCV11

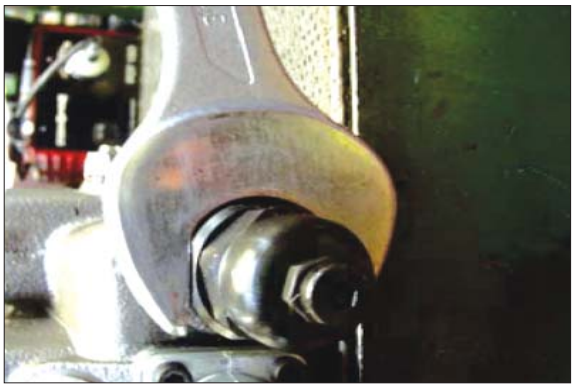
(3) Replacing relief valve

Prepare a new relief valve.



100D7MCV12

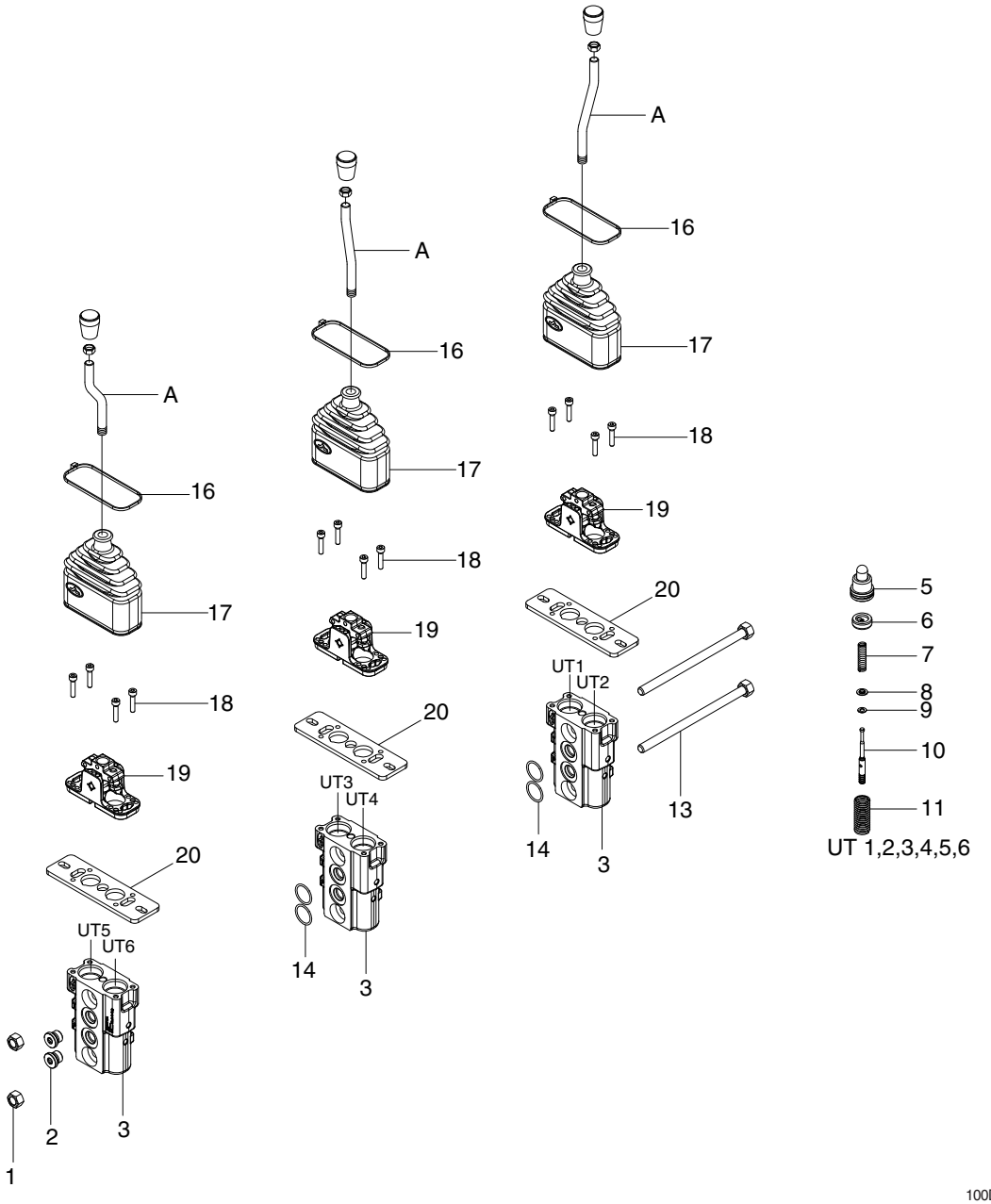
Replace old relief valve with new one.
Relief valve should be fitted with proper tool, 36 mm spanner, with 4.3 kgf · m (31 lbf · ft) torque.



100D7MCV13

3. REMOTE CONTROL VALVE

1) STRUCTURE



100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellow
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE 4 (7/16-20UNF) is 1.0 kgf · m (7.2 lbf · ft).
(2) Care must be taken not to damage the seals by excess temperature or spatter of welding, when welding near by the valve.
(3) During the installation, care must be taken not to damage spool. It might cause defect of operation such as the spool getting stuck in valve body.
(4) Fit the rubber hosepipe for the machine, which expected vibration.
(5) Until piping, don't remove the blinds from each port.

4) PRECAUTION FOR OPERATION

(1) Max input pressure range should be less than 30 ~ 100 bar (435 ~ 1450 psi).
(2) Back pressure of tank port should be less than 3 bar (43.5 psi).
(3) The oil temperature should be between -10 ~ 80˚C. And ambient temperature should be from -40 ~ 60˚C. because that very high viscosity of oil will be cause defect of spool operation, warm up the machine to avoid it.
(4) 15/12- ISO4406 level of filtration is required in the hydraulic circuit for long life cycle of each components without mechanical trouble.

5) SPECIAL TOOL

(1) 3 mm wrench.
(2) 13 mm socket spanner.
(3) Torque wrench adjustable from 1.02 ~ 3.06 kgf · m (7.4 ~ 22.1 lbf · ft).

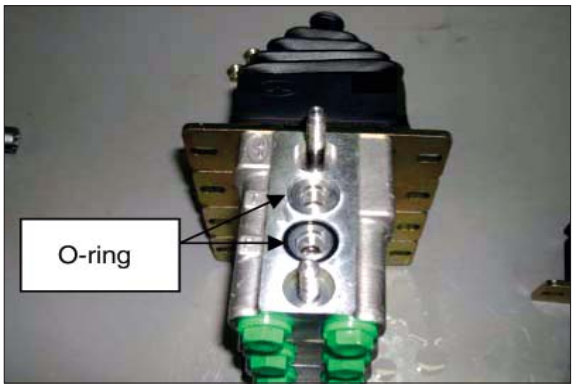
6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen two tightening bolts with 13 mm spanner.

100D7RCV02

Taking out the damaged section and insert new one. Pay attention 2 O-rings on the internal passage to be in right position.



100D7RCV03

Tight M13 nut with proper torque 3.06 kgf · m (22.1 lbf · ft).

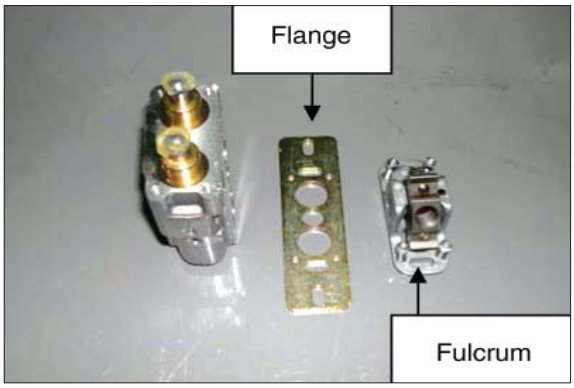
100D7RCV04

(2) Replacing pilot pressure spool

Loosen 4 screws holding upper part to the body with 3 mm wrench holding mounting plate no to spring up by return springs inside.

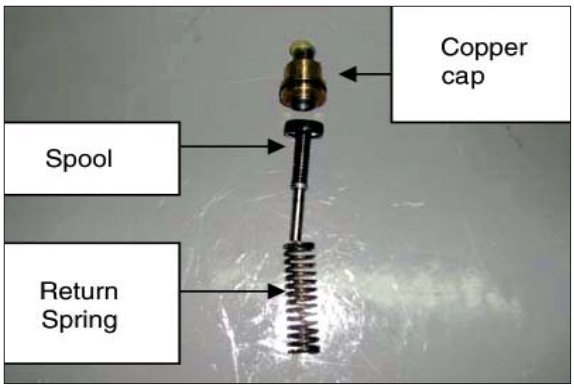
100D7RCV05

Take off the fulcrum and mounting flange very carefully keeping all components in their own positions.



100D7RCV06

Take out the spool, return spring from the body. And replace any component if it is needed.



100D7RCV07

Reassemble the spool in opposite order mentioned above.
Insert spool as straight as possible not to give any damaged on it while inserting it into body.


100D7RCV08

Prepare copper cap in clean.
Apply some clean grease around the O-ring on the copper cap, in order to avoid any damage of O-ring while fitting it into body.


100D7RCV09

Hold tightly mounting flange and lay fulcrum on the flange and screw in clamp bolts in a crisscross pattern.
Clamp torque is 0.67 kgf · m (4.9 lbf · ft).

100D7RCV10