

SECTION 4 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The dozer hydraulic system is an open centered manually operated system. The hydraulic system controls the operation of the dozer blade.

The dozer hydraulic system components are :

- Hydraulic pump
- Main control valve
- Lift cylinders
- Angle cylinders
- Tilt cylinder
- Attachment control lever
- Hydraulic oil tank

Hydraulic pump is a gear pump. Hydraulic pump draws oil from hydraulic oil tank.

The oil from pump flows to the inlet port of five blocks type main control valve.

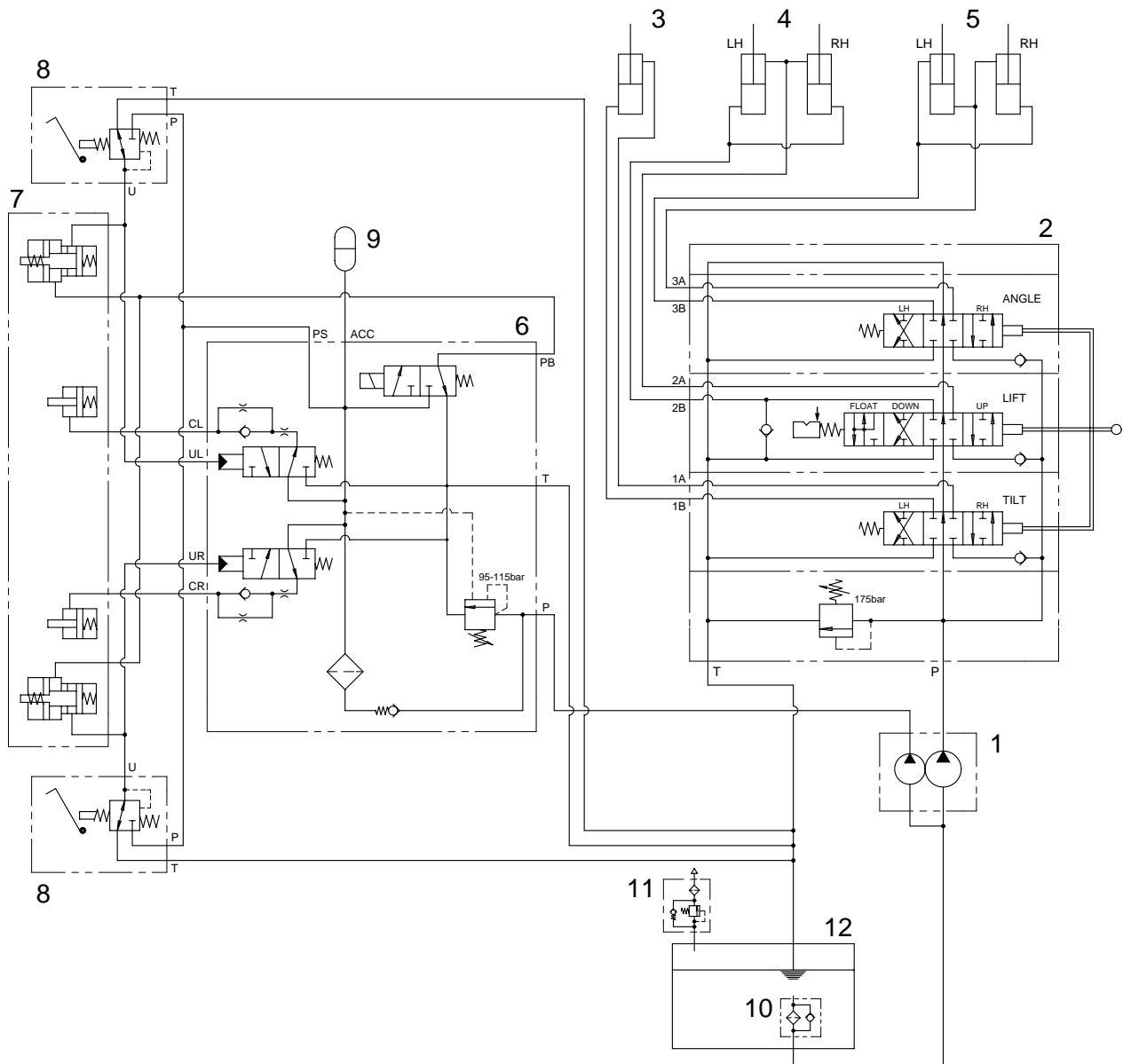
The main control valve is a parallel circuit type, open center valve which routes flow to the lift, angle or tilt cylinders when the respective spools are shifted by mechanical system of attachment control lever.

Attachment control lever is connected to the valve spools in control valve.

The relief valve setting is approximately 175kgf/cm²(2500psi).

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

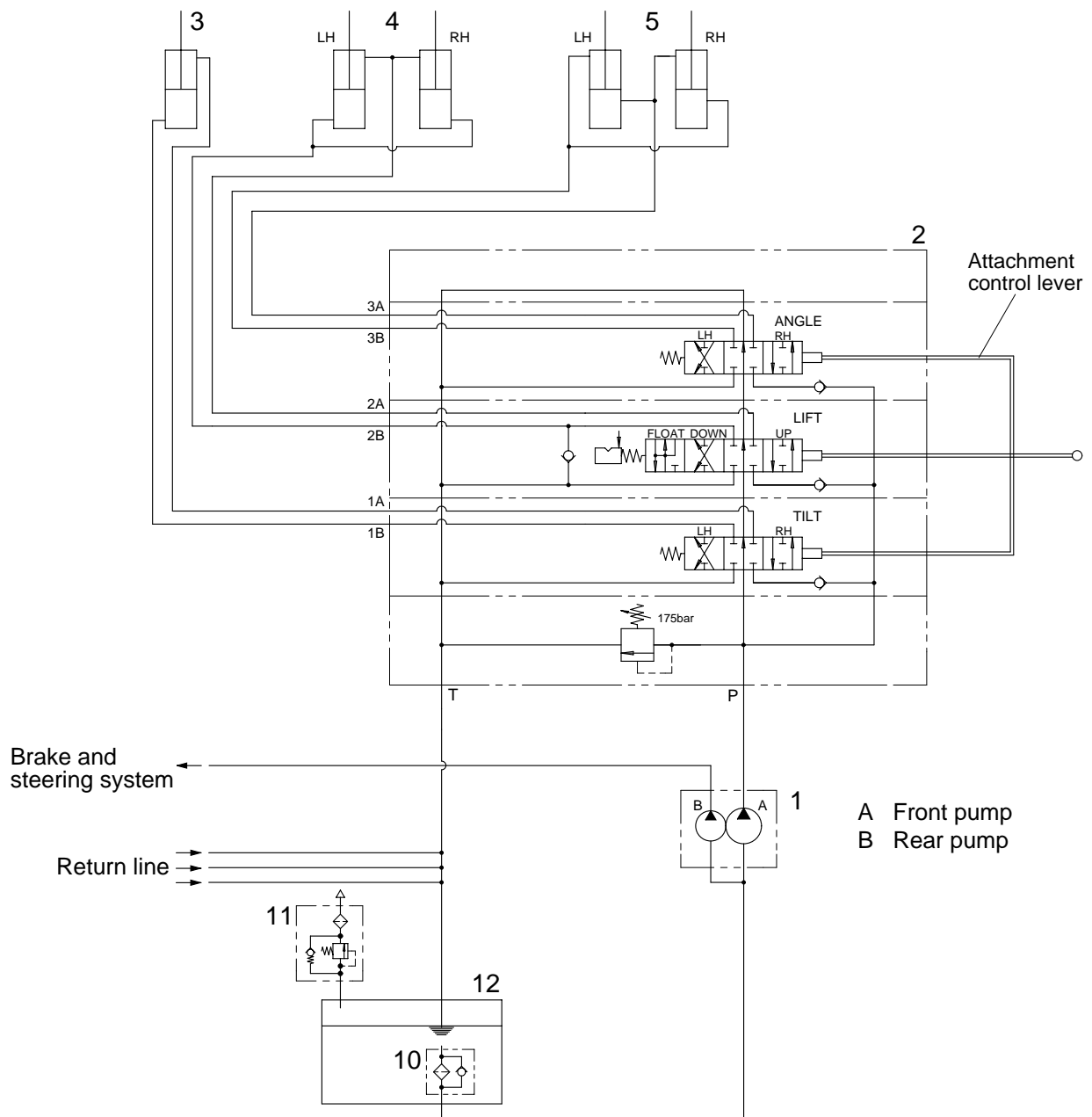
2. HYDRAULIC CIRCUIT



- 1 Hydraulic pump
- 2 Main control valve
- 3 Tilt cylinder
- 4 Lift cylinders
- 5 Angle cylinders
- 6 Clutch/Brakes control assy

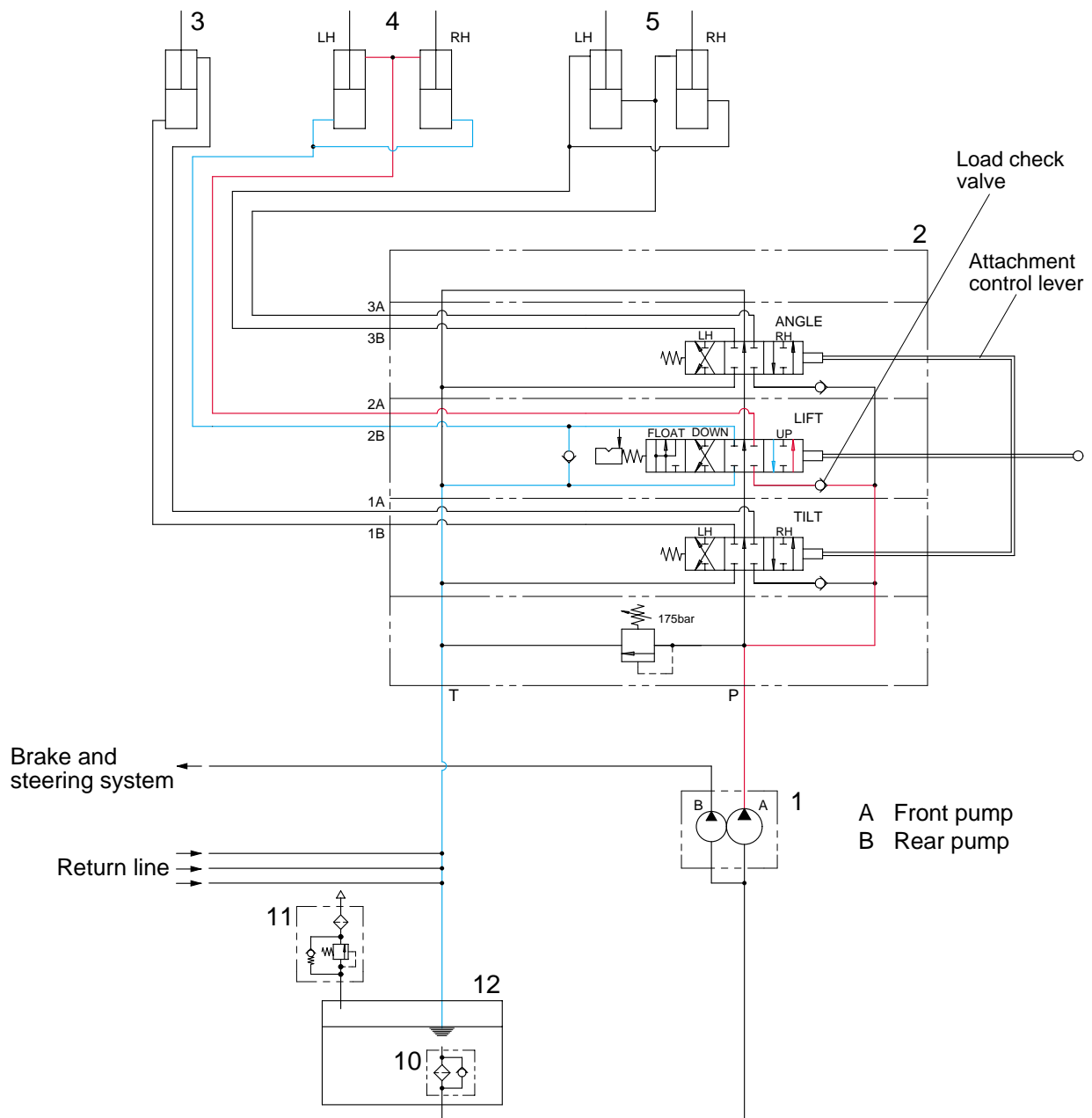
- 7 Axle unit
- 8 Foot valve assy
- 9 Accumulator
- 10 Hydraulic oil filter
- 11 Air breather
- 12 Hydraulic oil tank

3. WORK EQUIPMENT HYDRAULIC CIRCUIT



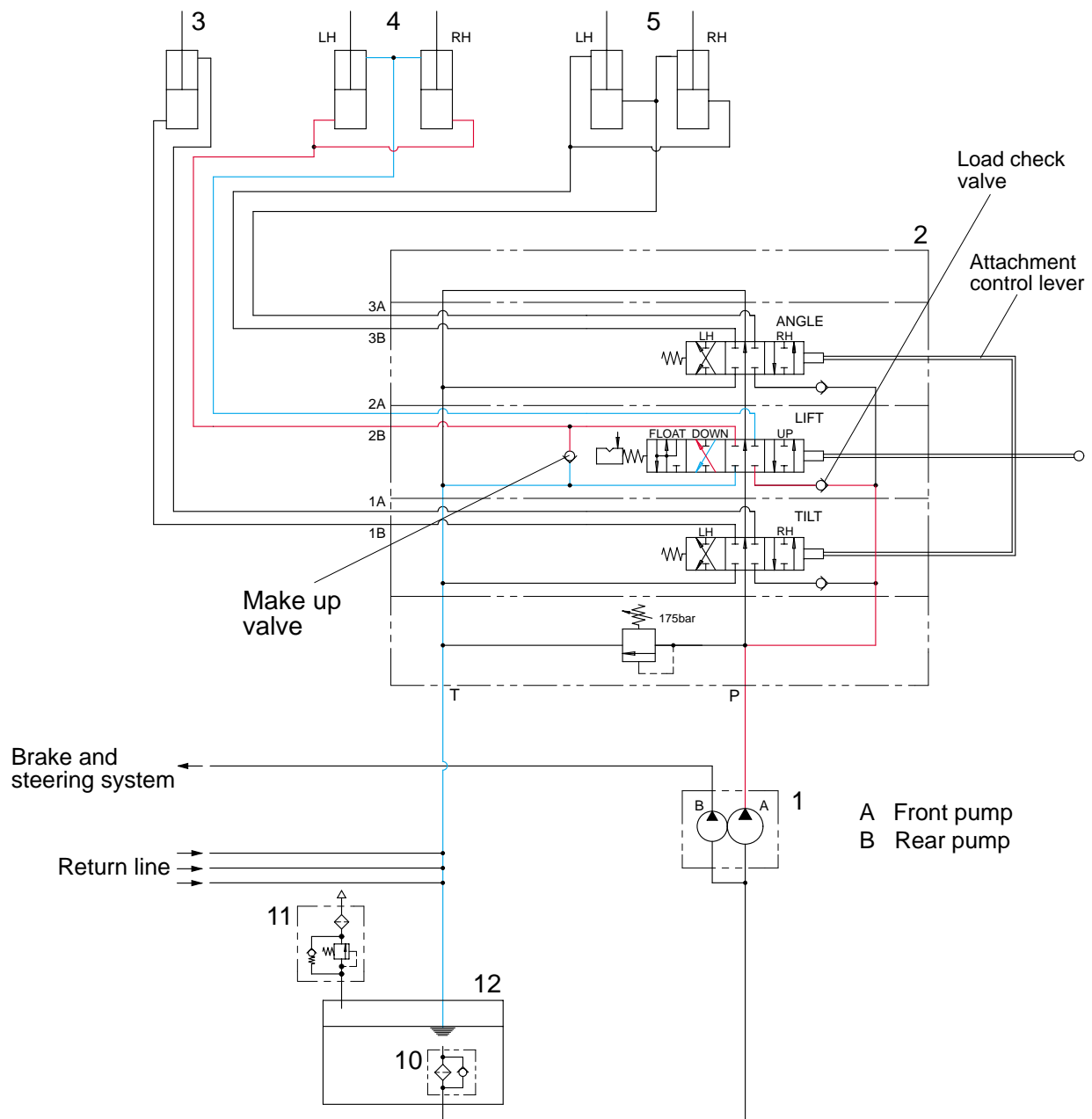
- | | | | |
|---|--------------------|----|----------------------|
| 1 | Hydraulic pump | 5 | Angle cylinders |
| 2 | Main control valve | 10 | Hydraulic oil filter |
| 3 | Tilt cylinder | 11 | Air breather |
| 4 | Lift cylinders | 12 | Hydraulic oil tank |

1) WHEN THE CONTROL LEVER IS IN THE UP POSITION



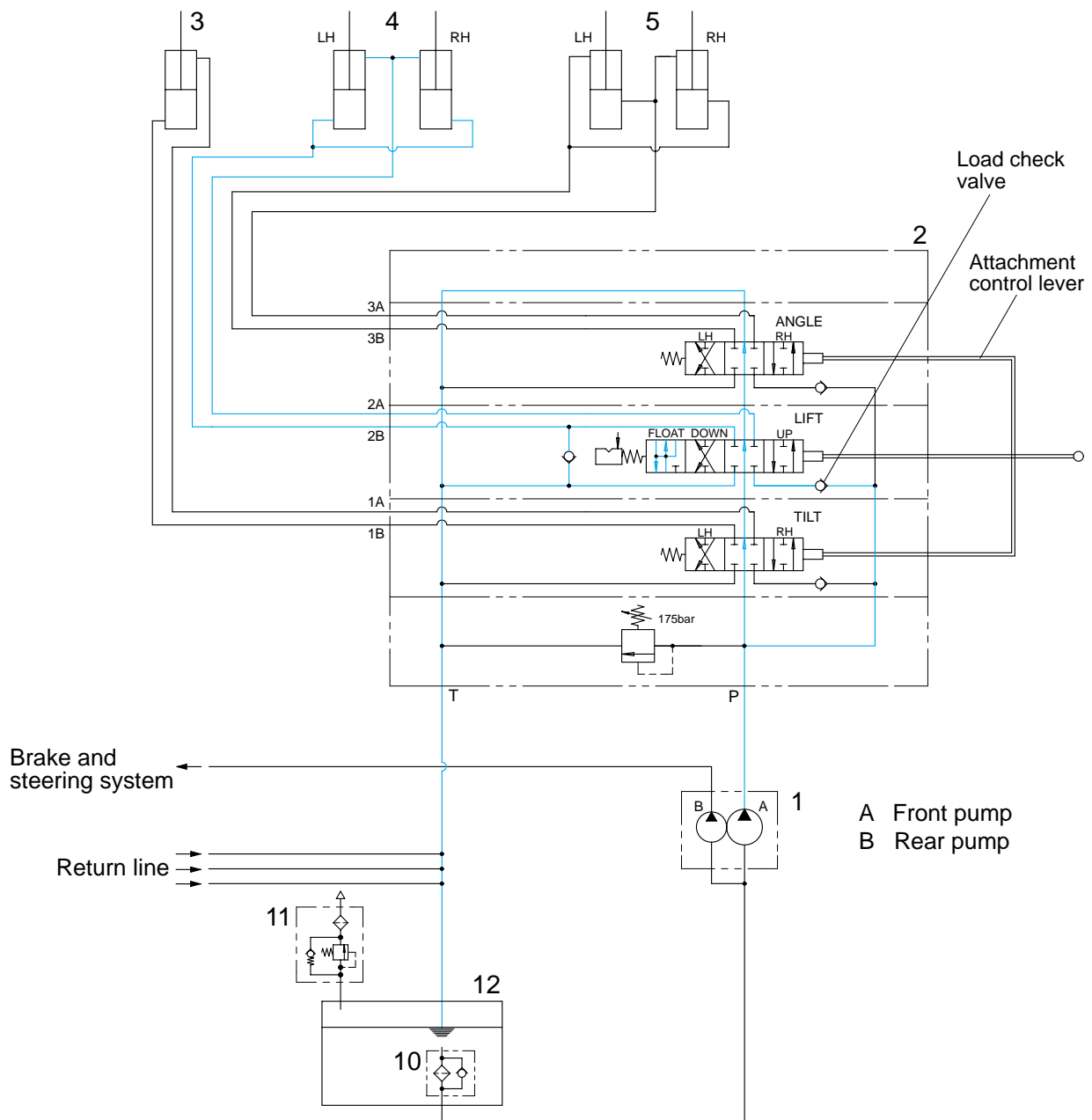
- When the attachment control lever is pulled back, the spool of lift valve section is moved to up position.
- The oil from hydraulic pump(1) flows into main control valve(2) and then goes to the small chamber of lift cylinder(4) by pushing the load check valve of the lift valve section.
- The oil from the large chamber of lift cylinder(4) returns to hydraulic oil tank(12) through the lift valve section at the same time.
- When this happens, the dozer blade goes up.

2) WHEN THE CONTROL LEVER IS IN THE DOWN POSITION



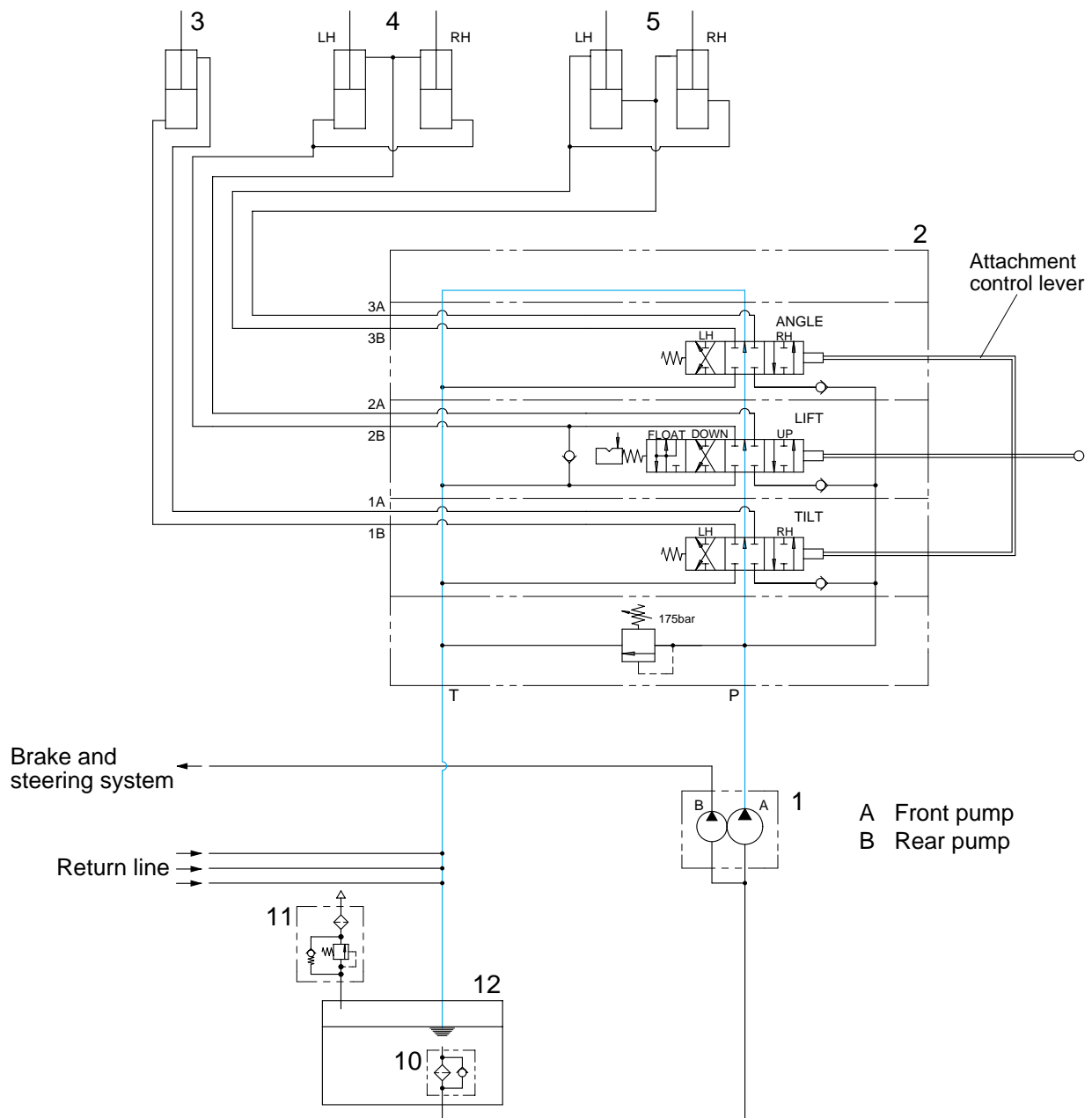
- When the attachment control lever is pushed forward, the spool of lift valve section is moved to down position.
 - The oil from hydraulic pump(1) flows into main control valve and then goes to large chamber of lift cylinder(4) by pushing the load check valve of the lift valve section.
 - The oil returned from small chamber of lift cylinder(4) returns to hydraulic oil tank(12) through the lift valve section at the same time.
 - When the lowering speed of blade is faster, the return oil from the small chamber of lift cylinder combines with the oil from the pump through the makeup valve, and flows into the large chamber of the cylinder.
- This prevents cylinder cavitation by the negative pressure when the pump flow cannot match the dozer blade down speed.

3) WHEN THE CONTROL LEVER IS IN THE FLOAT POSITION



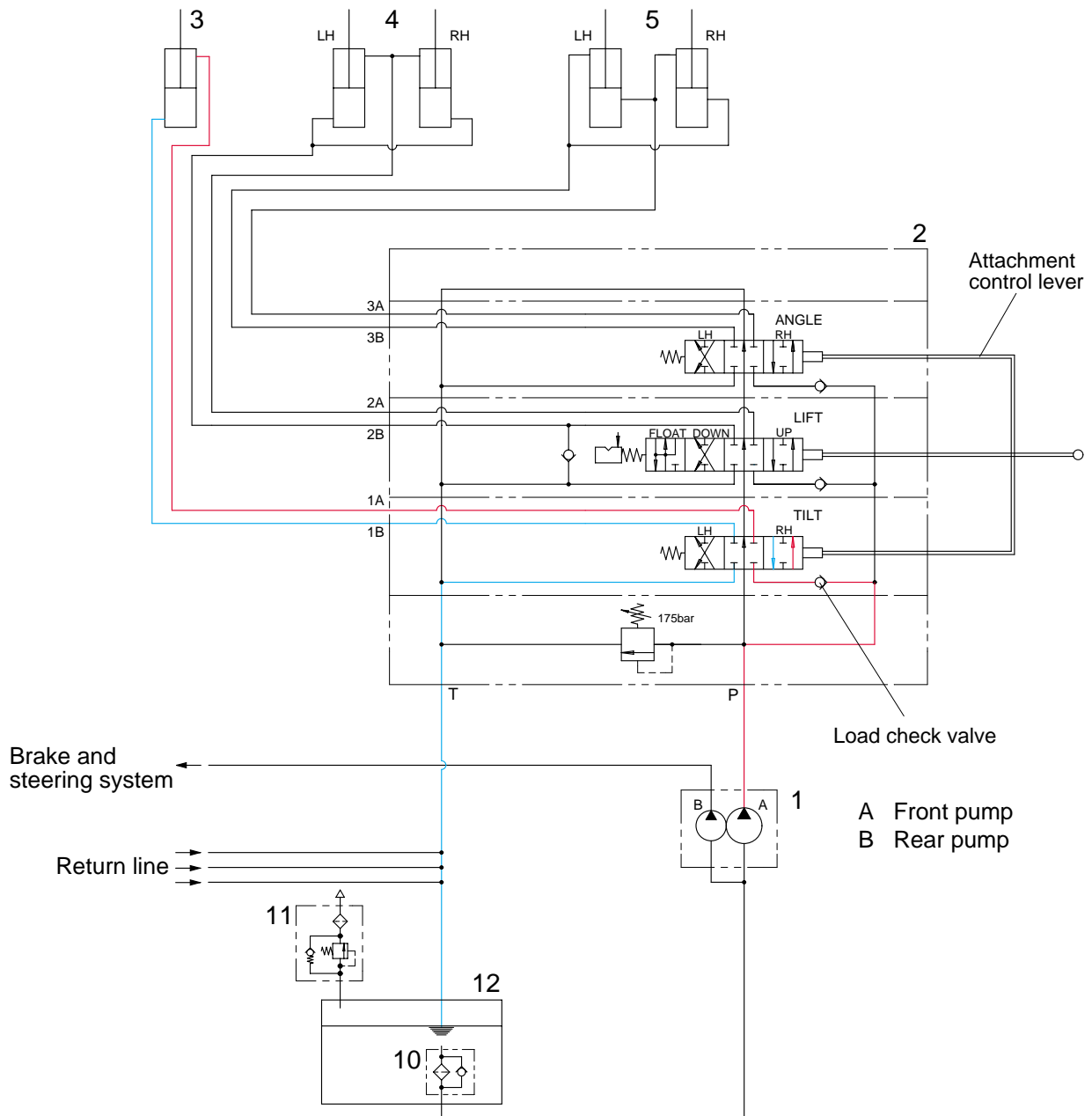
- When the control lever is pushed further forward into detent, for FLOAT position, the spool of lift valve section is moved to floating position.
- The work ports(2A), (2B) and the small chamber and the large chamber are connected to the return passage, so the dozer blade will be lowered due to it's own weight.
- In this condition, when the dozer blade is in contact with the ground, it can be move up and down in accordance with the shape of the ground.

4) WHEN THE CONTROL LEVER IS IN THE HOLD POSITION



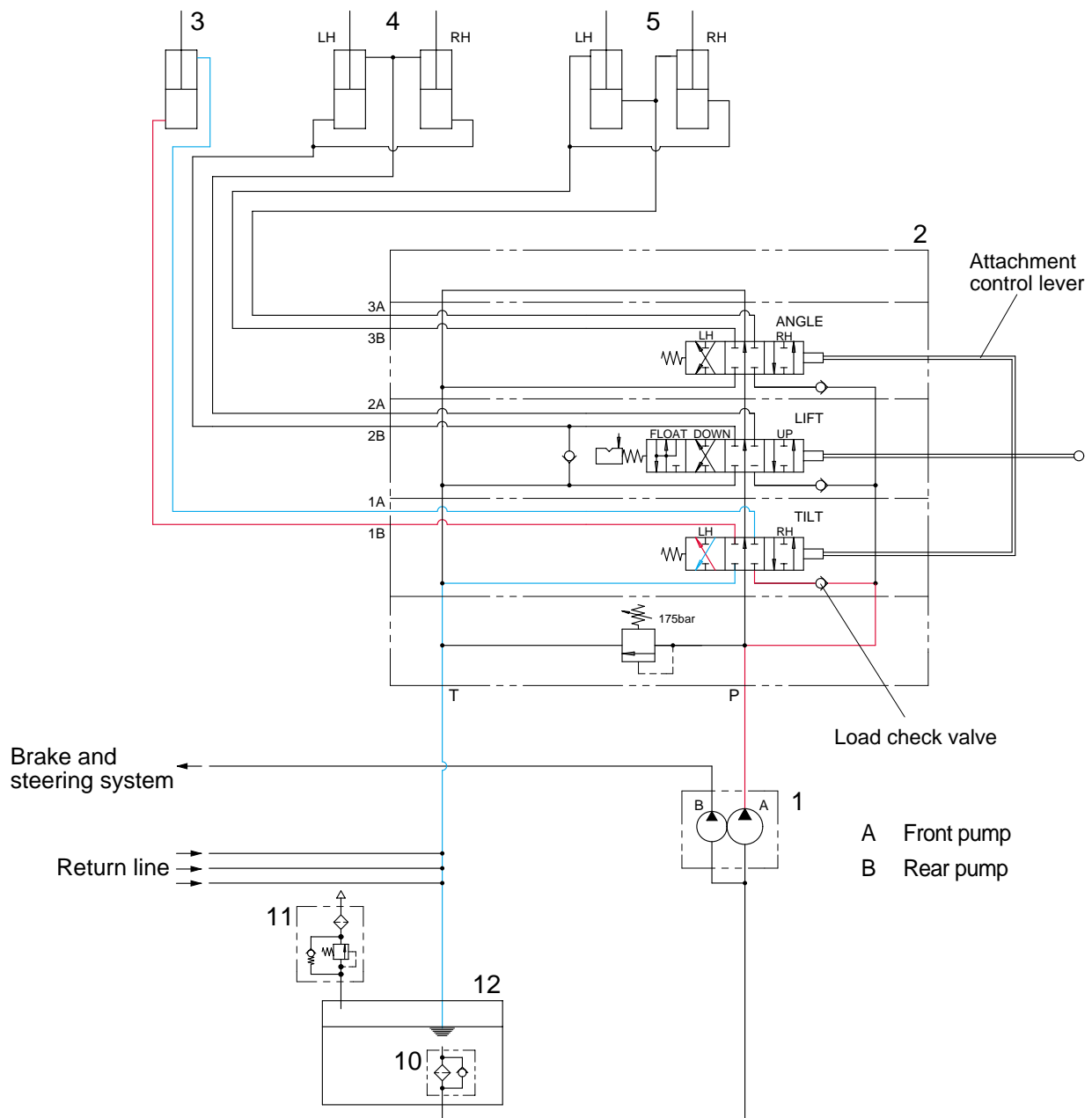
- The oil from hydraulic pump(1) flows into main control valve(2).
- In this time, the spool of tilt and angle valve sections are in neutral position, then the oil supplied to main control valve(2) returns into hydraulic tank(12) through center bypass circuit of each spool.
- In this condition, each cylinder keeps the hold position, so the dozer blade is held.

5) WHEN THE CONTROL LEVER IS IN THE TILT RIGHT POSITION



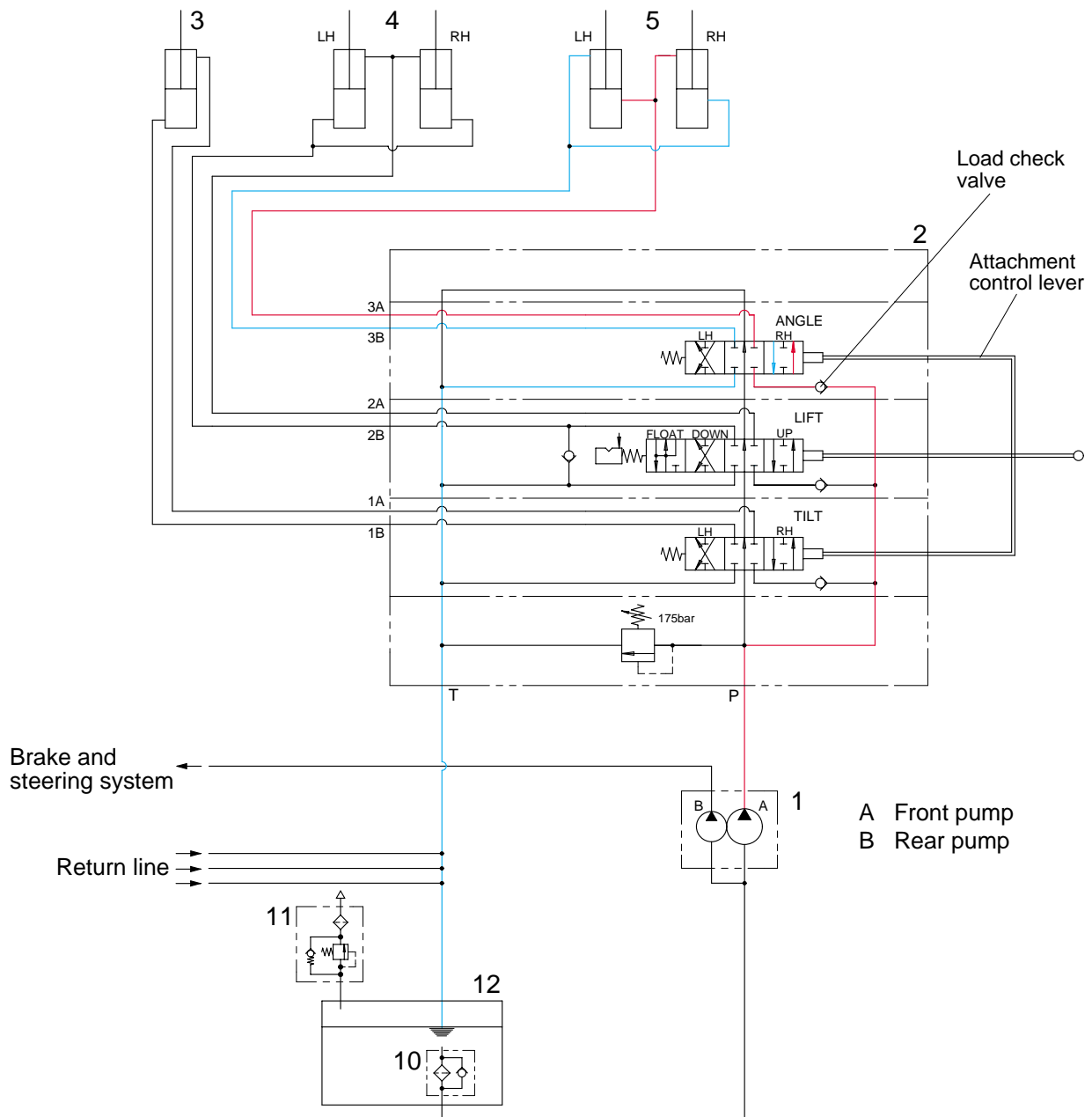
- If the control lever is pushed right, the spool of tilt valve section is moved to tilt right position.
- The oil from hydraulic pump(1) flows into main control valve(2) and then goes to the small chamber of tilt cylinder(3) by pushing the load check valve of the tilt valve section.
- The oil at the large chamber of tilt cylinder(3) returns to hydraulic oil tank(12) through the tilt valve section.
- When this happens, the dozer blade is tilt right.

6) WHEN THE CONTROL LEVER IS IN THE TILT LEFT POSITION



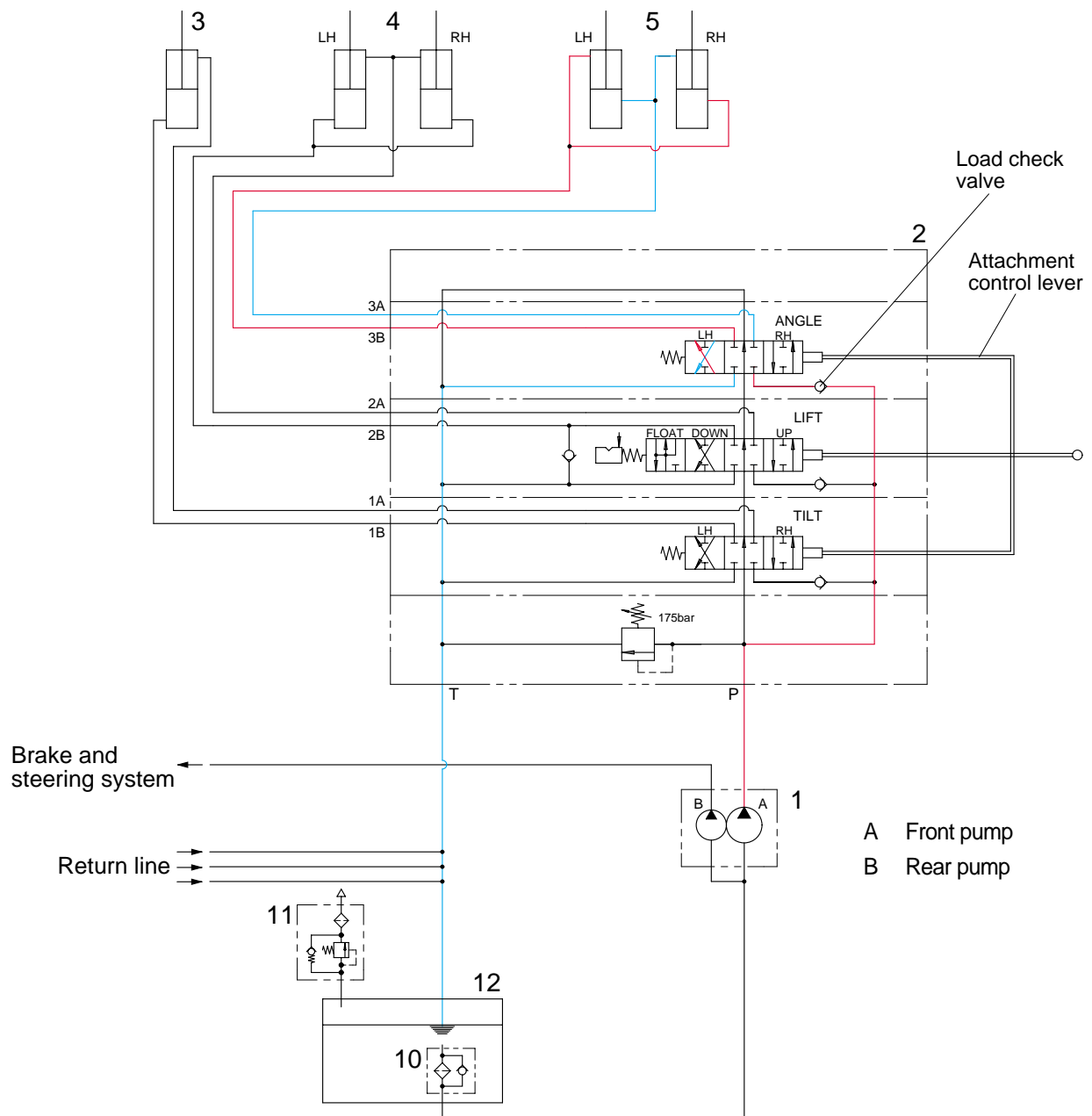
- If the control lever is pulled left, the spool of tilt valve section is moved to tilt left position.
- The oil from hydraulic pump(1) flows into main control valve(2) and then goes to the large chamber of tilt cylinder(3) by pushing the load check valve of the tilt valve section.
- The oil at the small chamber of tilt cylinder(3) returns to hydraulic tank(12) through the tilt valve section.
- When this happens, the dozer blade is tilt left.

7) WHEN THE CONTROL LEVER IS IN THE ANGLE RIGHT POSITION



- If the control lever is rotated right, the spool of angle valve section is moved to angle right position.
- The oil from hydraulic pump(1) flows into main control valve(2) and then goes to the small chamber of right side cylinder and large chamber of left side angle cylinder(5) by pushing the load check valve of the angle valve section.
- The oil at the large chamber of right side cylinder and small chamber of left side cylinder(5) returns to hydraulic tank(12) through the angle valve section.
- When this happens, the dozer blade is angle right.

8) WHEN THE CONTROL LEVER IS IN THE ANGLE LEFT POSITION



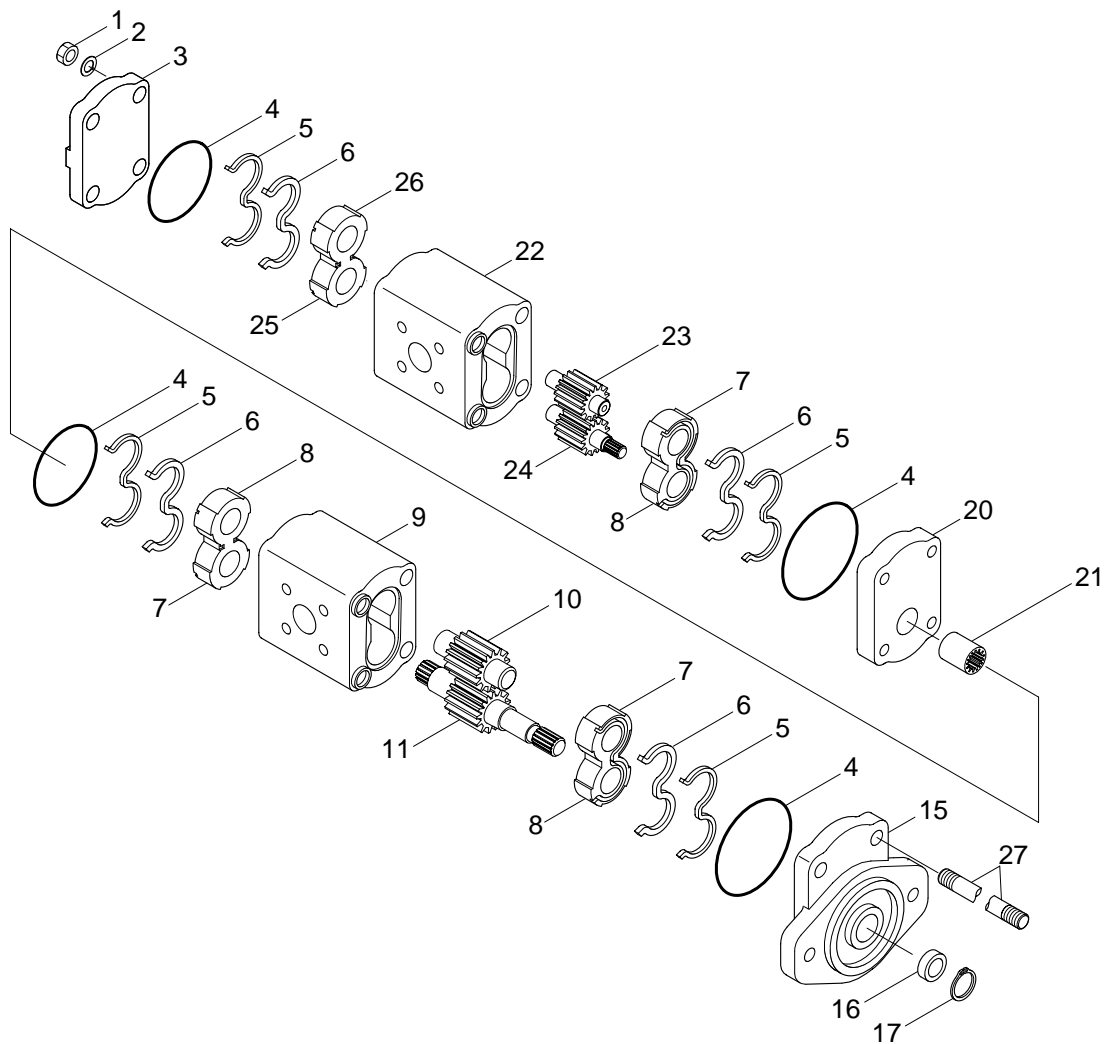
- If the control lever is rotated left, the spool of angle valve section is moved to angle left position.
- The oil from hydraulic pump(1) flows into main control valve(2) and then goes to the large chamber of right side cylinder and small chamber of left side angle cylinder by pushing the load check valve of the angle valve section.
- The oil at the small chamber of right side cylinder and large chamber of left side cylinder(5) returns to hydraulic tank(12) through the angle valve section.
- When this happens, the dozer blade is angle left.

3. HYDRAULIC PUMP

1) STRUCTURE

These units comprise of 2 basic unidirectional pump sizes designated 1PX and 1PX which can be supplied in tandem arrangements.

These units comprise of an end cover, a body housing a matched gear pair, bushes and a mounting flange bolted together with through bolts. The gear journals are supported in plain bearings within pressure balanced bushes to give high volumetric and mechanical efficiencies.



- 1 Nut
- 2 Spring washer
- 3 End cover
- 4 O-ring
- 5 Back up seal
- 6 Bush seal
- 7 Bushing
- 8 Bushing

- 9 Front body
- 10 Driven gear
- 11 Driveshaft and gear
- 15 Flange
- 16 Shaft seal
- 17 Circlip
- 20 Spacer plate
- 21 Splined coupling

- 22 Rear body
- 23 Driven gear
- 24 Driveshaft and gear
- 25 Bushing
- 26 Bushing
- 27 Stud

2) OPERATION

The hydraulic pump is a fixed displacement gear type pump. The pump is drive at transmission speed. The pump shafts are supported by bushings(7, 8, 25, 26) in the flange(15), front body(9), rear body(22) and end cover(3).

As the drive shaft and gear(11, 24) turns the driven gears(10, 23), the gear teeth come out of mesh. Oil flows from the hydraulic tank through the inlet port into the cavity between the gear teeth. As the gears continue to rotate, the oil becomes trapped between the gear teeth and the bushings(7, 8, 25, 26).

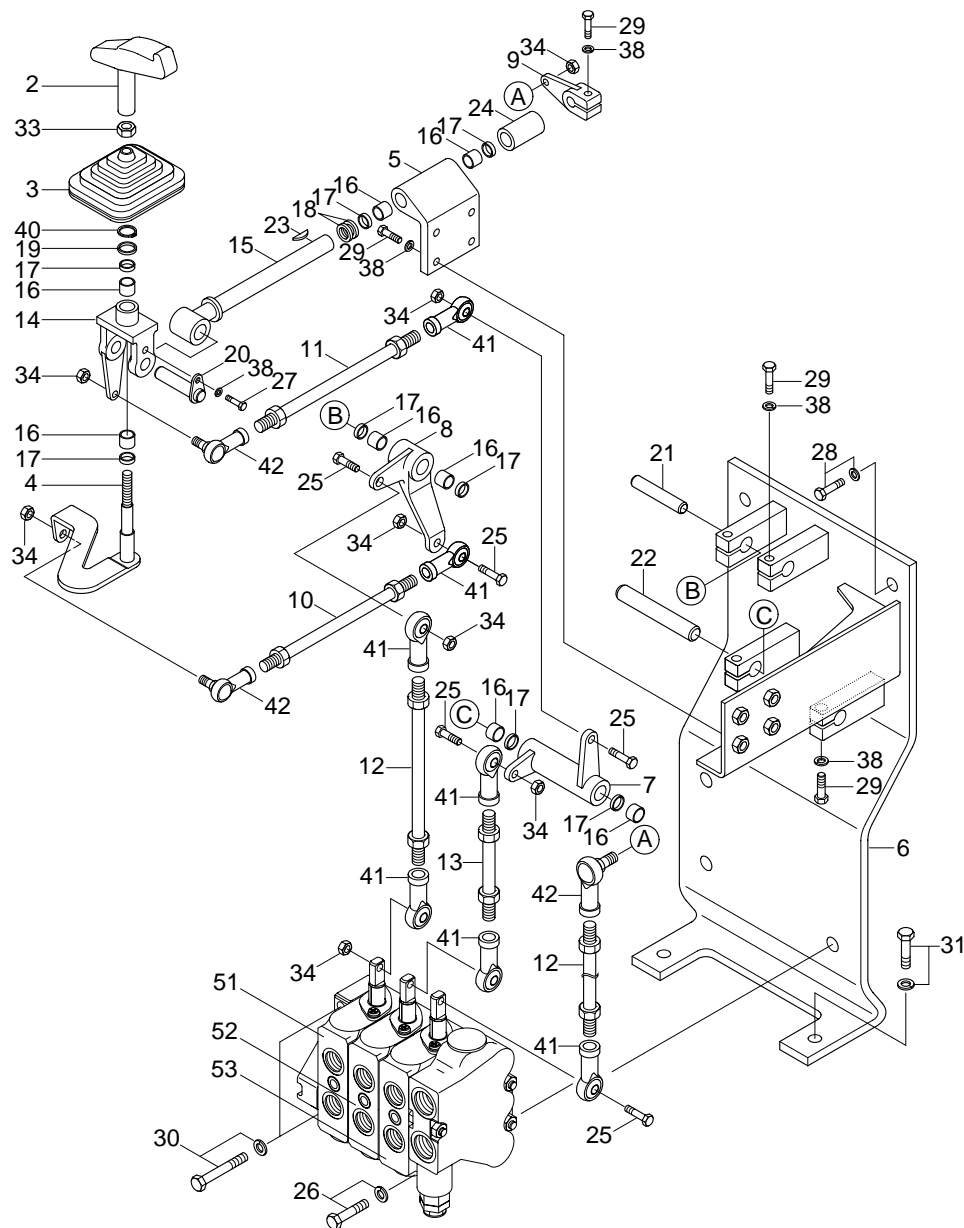
The trapped oil is then carried to the pump outlet. Oil is forced out the outlet to supply the hydraulic function. As the gears re-mesh, they form a seal to prevent oil from flowing between the gears and back to the inlet.

The pump uses outlet pressure oil to load the bushings(7, 8, 25, 26) against the gear faces. This controls internal leakage to maintain pump displacement.

Outlet pressure fills the area bounded by the seals(5, 6) to force the pressure plate against the high pressure area or the gear faces. Pump shaft lubrication is achieved by routing outlet pressure oil into the area between the gear shafts and the bushings. The oil is collected at the end of the shafts in the hollow areas in the port and flange plates and routed back to return.

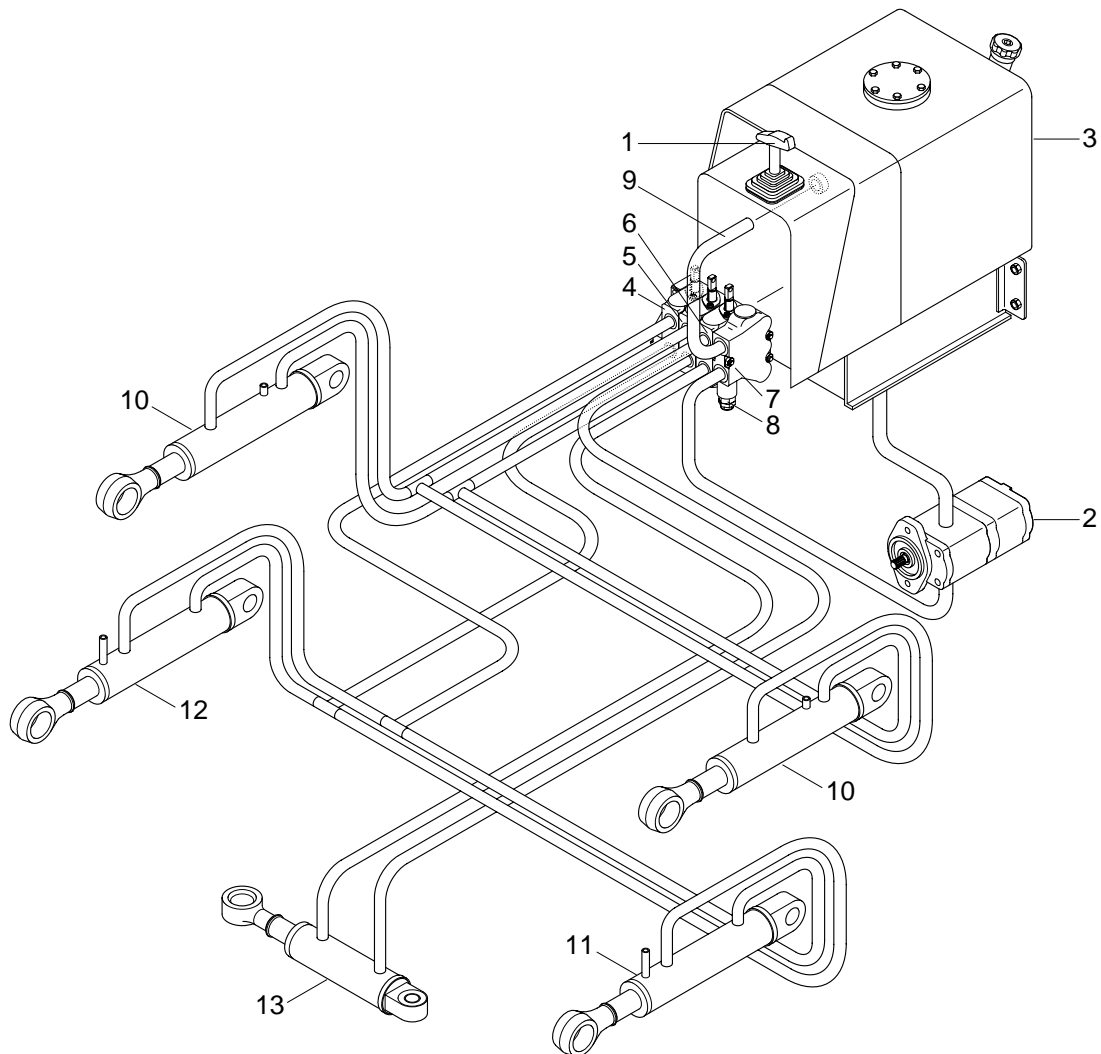
4. HYDRAULIC CONTROL LINKAGE

1) STRUCTURE



2	Knob	16	Roller bearing	30	Bolt
3	Boot	17	Seal	31	Bolt-w/washer
4	Lever	18	Shim	32	Rod end
5	Support	19	Shim	33	Nut
6	Bracket	20	Shaft	34	Self knocking nut
7	Support	21	Shaft	38	Hardened washer
8	Support	22	Shaft	40	Retainer ring
9	Support	23	Woodruff key	41	Rod end
10	Rod assembly	24	Boss	42	Rod end
11	Rod assembly	25	Hex bolt	51	Valve section(Angle)
12	Rod assembly	26	Hex bolt	52	Valve section(Lift)
13	Rod assembly	27	Hex bolt	53	Valve section(Tilt)
14	Yoke	28	Bolt-w/washer		
15	Shaft	29	Bolt		

2) OPERATION



Control lever(1) is connected to the valve spools in valve sections(4), (5) and (6). Move the lever backward or forward to move the valve spool in valve section(5). Move the lever from side to side to move the valve spool in valve section(6). Twist the lever to move the valve spool in section(4).

When control lever(1) is in UP position, the oil from pump(2) flows through inlet section(7), valve section(6), and then into valve section(5). The oil in valve section(5) now flows to the rod end of the lift cylinders, moves the rod into the cylinders, and the dozer blade up. The oil from the head end of the cylinders flows through valve section(5), valve section(6), inlet section(7), line(9), and to the hydraulic tank.

When control lever(1) is moved to the TILT LEFT position, the oil in valve section(6) now flows to the head end of cylinder(13), moves the rod out of the cylinder and the right corner of the cutting edge rises. The oil from the rod end of the cylinder flows through valve section(6), inlet section(7), line(9), and to the hydraulic tank(3).

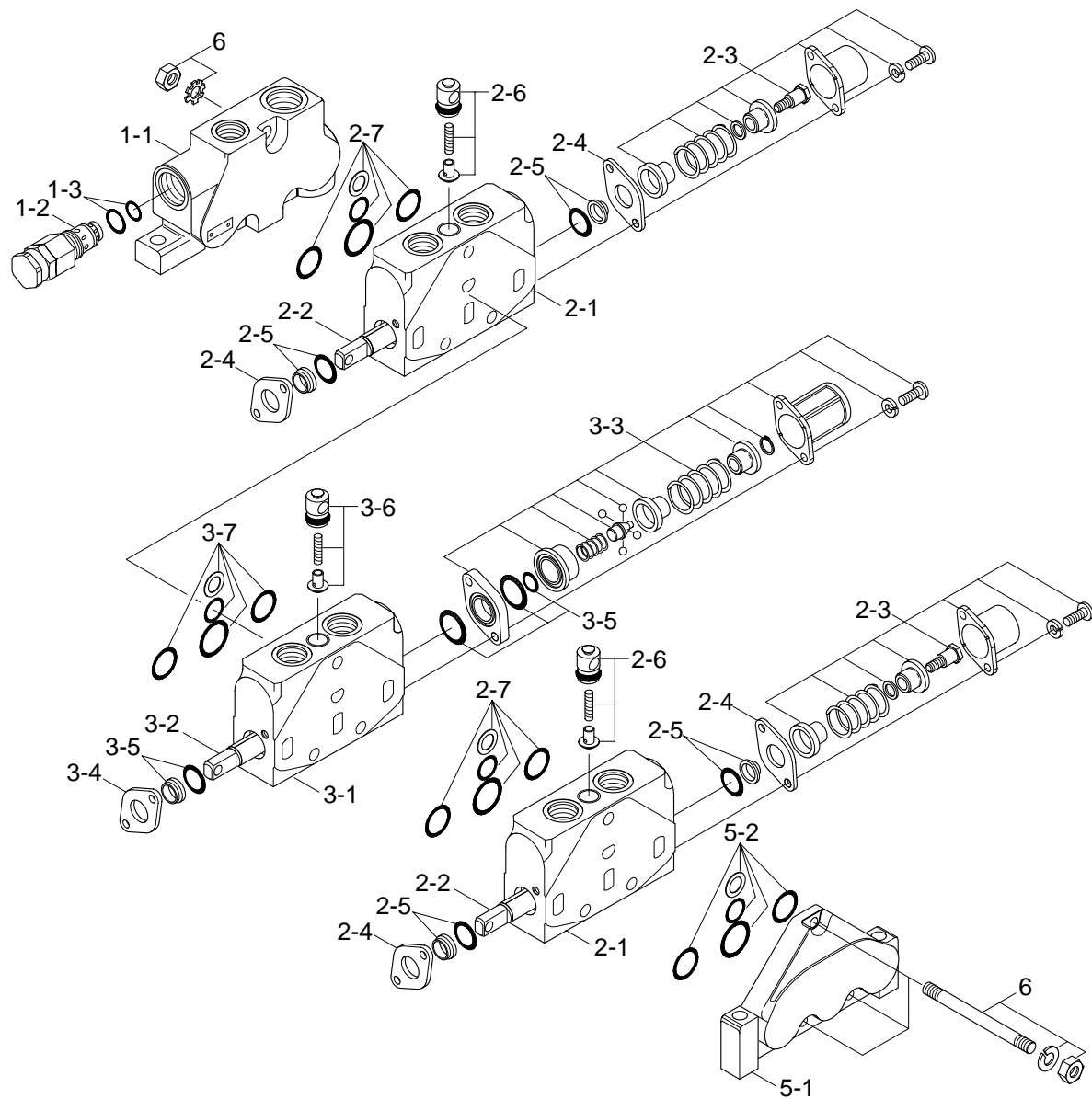
When control lever(1) is moved to the ANGLE RIGHT position, the oil from valve section(4) flows to the head end of cylinder(11) and rod end of cylinder(12). The movements of the rods, in cylinders(11) and (12), turns the dozer blade to the right.

When control lever(1) is moved to the ANGLE LEFT position, the oil in valve section(4) flows into the head end of cylinder(12) and rod end of cylinder(11). The rod in cylinder(12) moves out, which moves cylinder(11) rod in and the dozer blade turns to the left on the angling frame assembly.

Relief valve(8) is in the oil passage to all of the valve sections(4, 5 and 6) and to all of the cylinders(10, 11, 12 and 13). The relief valve is part of inlet section(7). The relief valve setting is approximately 175kgf/cm²(2500psi).

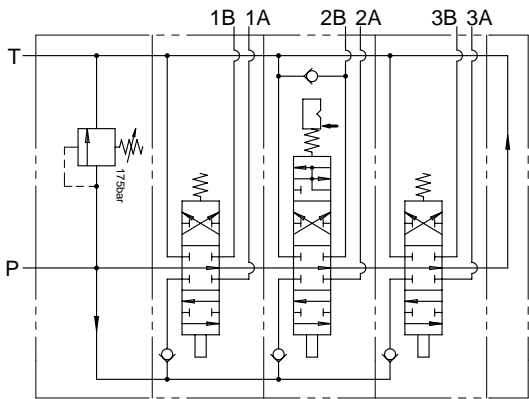
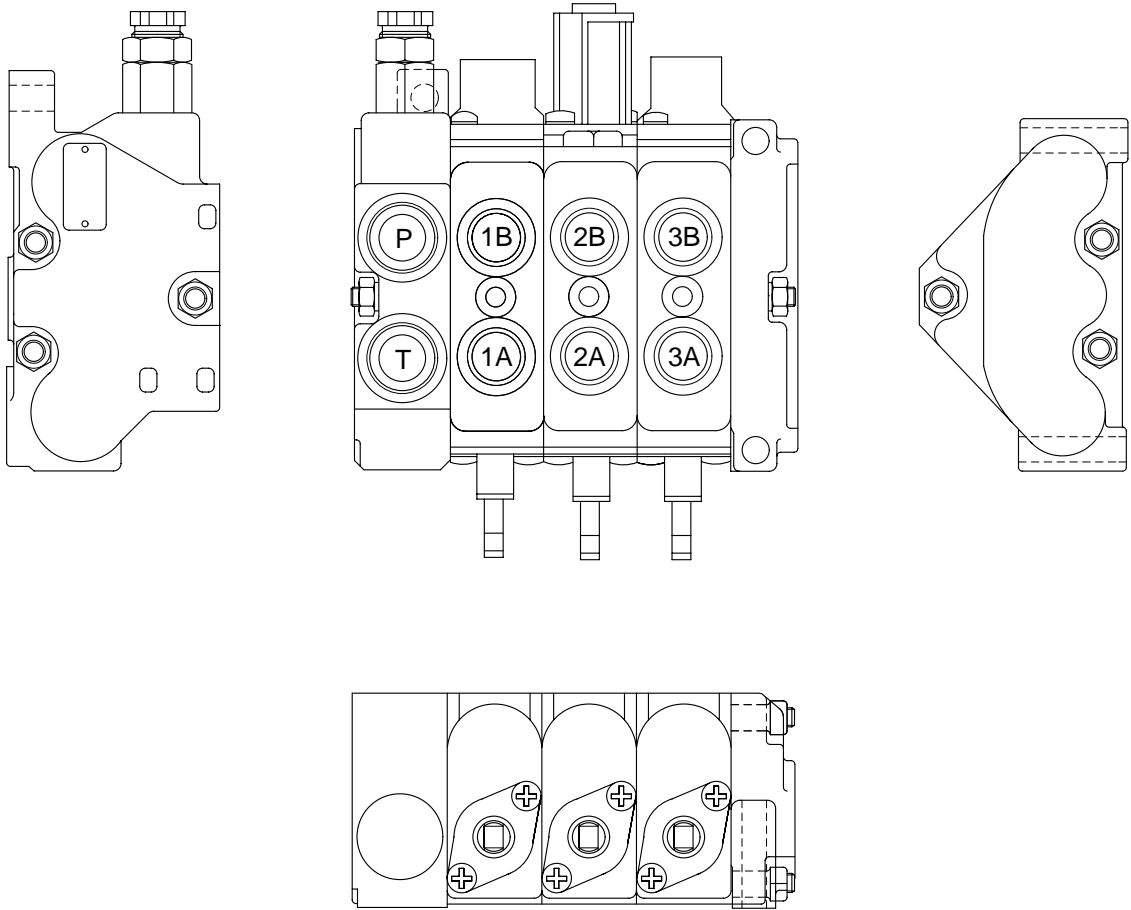
5. MAIN CONTROL VALVE

1) STRUCTURE



1-1	Inlet cover	2-5	Spool seal kit	3-5	Spool seal kit
1-2	Relief valve assembly	2-6	Check valve	3-6	Check valve
1-3	Seal kit	2-7	Interface seal kit	3-7	Interface seal kit
2-1	Housing	3-1	Housing	5-1	Housing
2-2	Spool	3-2	Spool	5-2	Interface seal kit
2-3	Mechanism kit	3-3	Mechanism kit	6	Stud assembly
2-4	Seal retainer	3-4	Seal retainer		

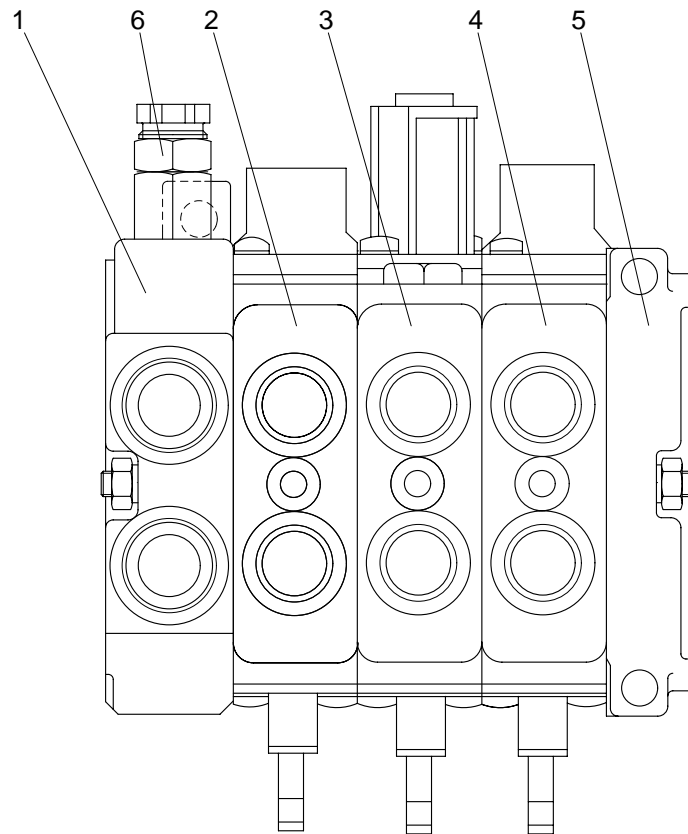
STRUCTURE



Hydraulic circuit

Port	Port name	Port size
P	From main pump	1 1/16-12UNF
T	To hydraulic tank	1 1/16-12UNF
1A, 1B	To tilt cylinder port	7/8UNF
2A, 2B	To lift cylinder port	7/8UNF
3A, 3B	To angle cylinder port	7/8UNF

2) OPERATION



- | | | | | | |
|---|--------------------------|---|---------------------------|---|----------------------|
| 1 | Inlet manifold | 3 | Dozer lift valve section | 5 | Housing(End) section |
| 2 | Dozer tilt valve section | 4 | Dozer angle valve section | 6 | Main relief valve |

The main control valve is located in the compartment to the right of the operator's seat. The main control valve includes inlet manifold(1) ; From three valve sections(2), (3), and (4) ; Housing(End section)(5), and main relief valve(6).

Linkage rods connect the valve sections to the attachment control lever. The attachment control lever controls dozer up and down, tilt right and left, and angle.

The control valve consists of individual valves stacked together using three tie rods. O-rings are used between the valves. Pump pressure is seen by all valves in parallel.

All sections have manual actuation. All sections have open centered directional stems. The dozer tilt, and angle stems have three positions ; EXTEND, HOLD and RETRACT. The dozer lift has four positions ; UP, HOLD, DOWN and FLOAT. The FLOAT position is the only one detented.

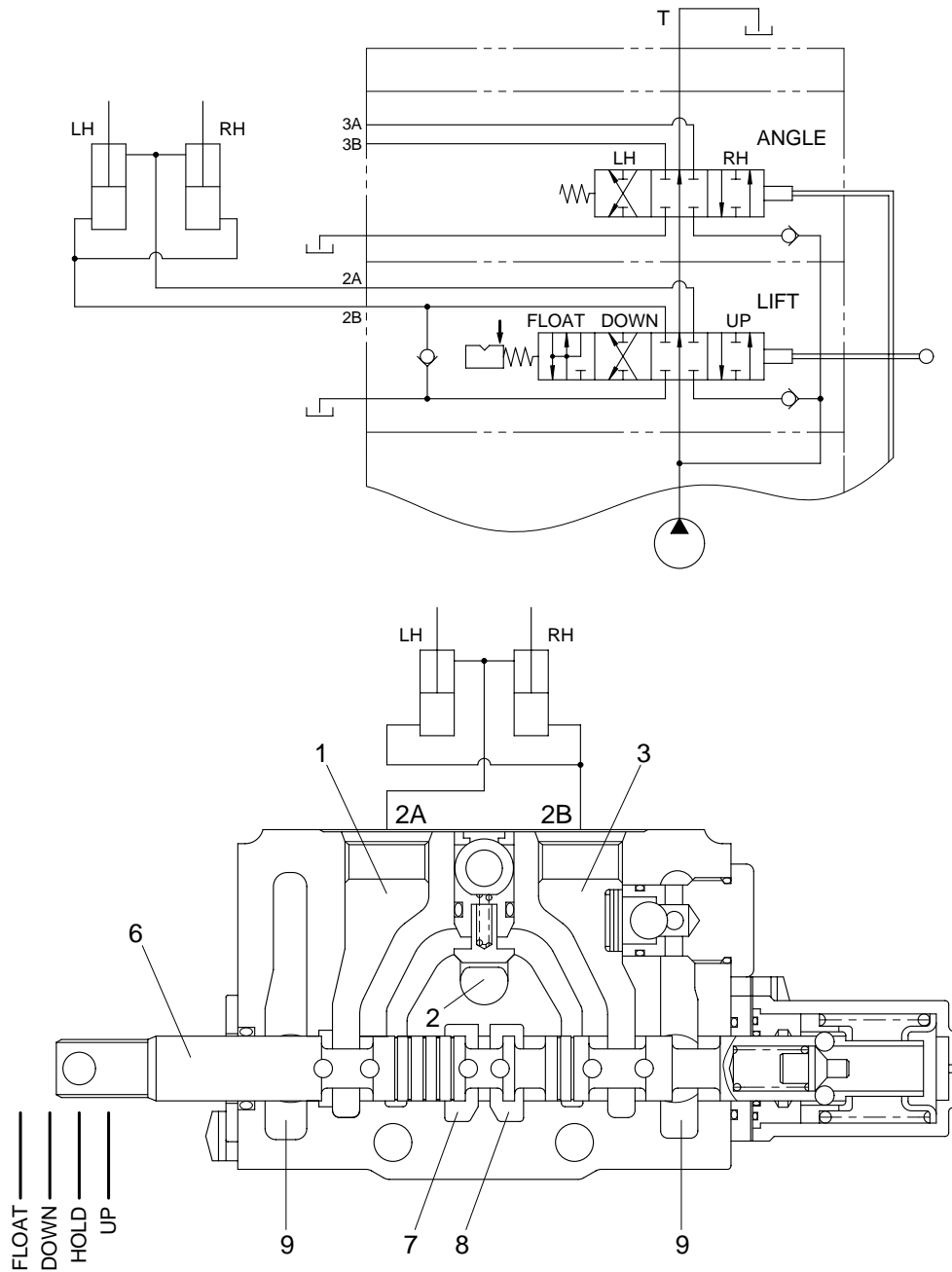
A spring on the end of the valve spool in each valve section moves the valve spool and the control lever to the HOLD position when the control lever is released.

All valve sections have load check valves that prevent the implement from dropping when the valve is shifted from HOLD position and the pump pressure is less than the pressure in the implement cylinder.

The dozer lift section has a makeup valve to reduce pause time. The pause time is caused by the weight of the blade forcing the oil out of the rod end faster than the pump can fill the head end. The void in the head of the cylinder causes the pressure in the cylinder passage to be less than in the tank passage, causing oil to flow from the tank to head end of the cylinder.

3) DOZER LIFT SECTION OPERATION

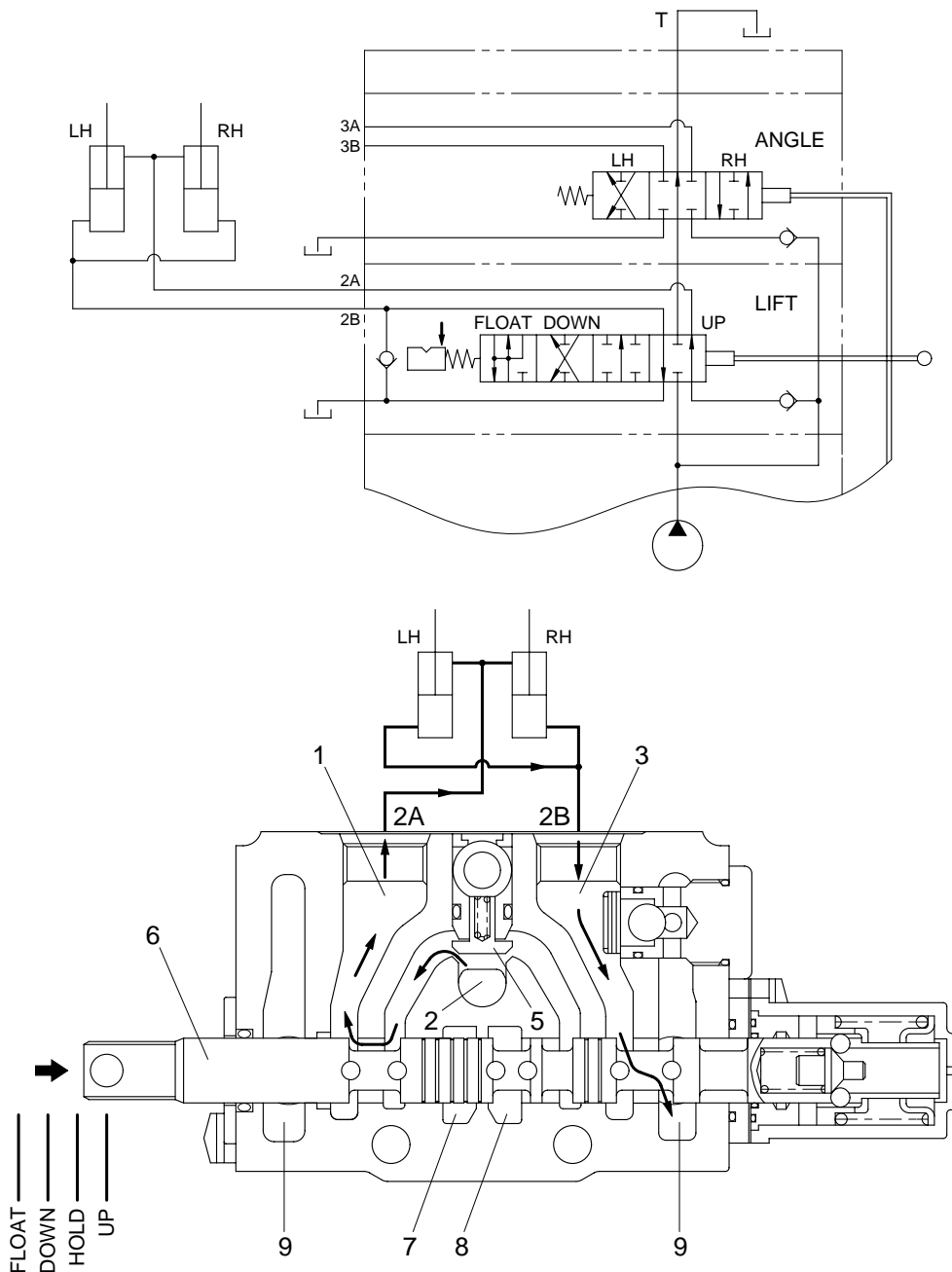
(1) Dozer hold position



The oil flow from the inlet section goes into passage(2) which is a common passage through all valve sections. The oil also flows into passages(7) and (8). Passages(7) and (8) do not go through the valve section. When valve spool(6) is in the HOLD position, the oil in passages(7) and (8) flows around valve spool(6) into the next control valve section.

If the other valve sections are in HOLD position, the oil flows through the other valve sections, and then flows through common passage(9) to the tank. The HOLD position of valve spool(6) stops the oil in passages(3) and (1). When oil flow stops, the lift cylinders can not move until the control lever, and valve spool(6), are moved to either the UP, DOWN, or FLOAT position.

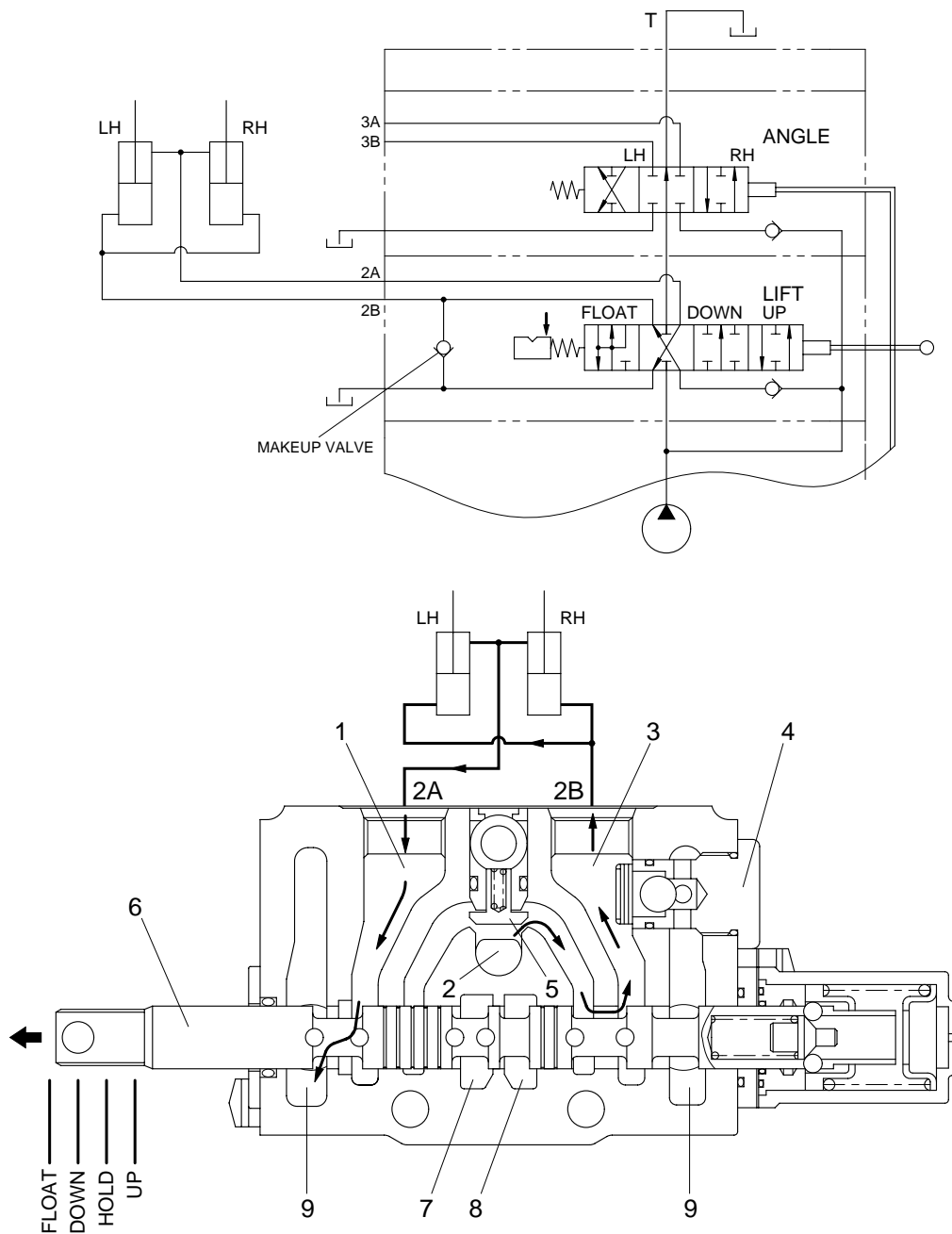
(2) Dozer up position



When the control lever moves valve spool(6) to the UP position, the pump oil in passages(7) and (8) through the next valve sections and through passage(9) to the tank. With no outlet for the oil, the oil in passage(2) increases in pressure which opens check valve(5). The oil from passage(2) flows through the open check valve(5) into passage(1) and to the rod end of the lift cylinders.

The oil flowing into the rod end of the cylinders moves the pistons and rods which moves the C-frame assembly to lift the blade. The oil from the head end of the cylinders flows through passage(3), and then through passage(9) to the tank. The location of the relief valve, for the circuit to lift the dozer, is in the inlet section of the control valve assembly.

(3) Dozer down position

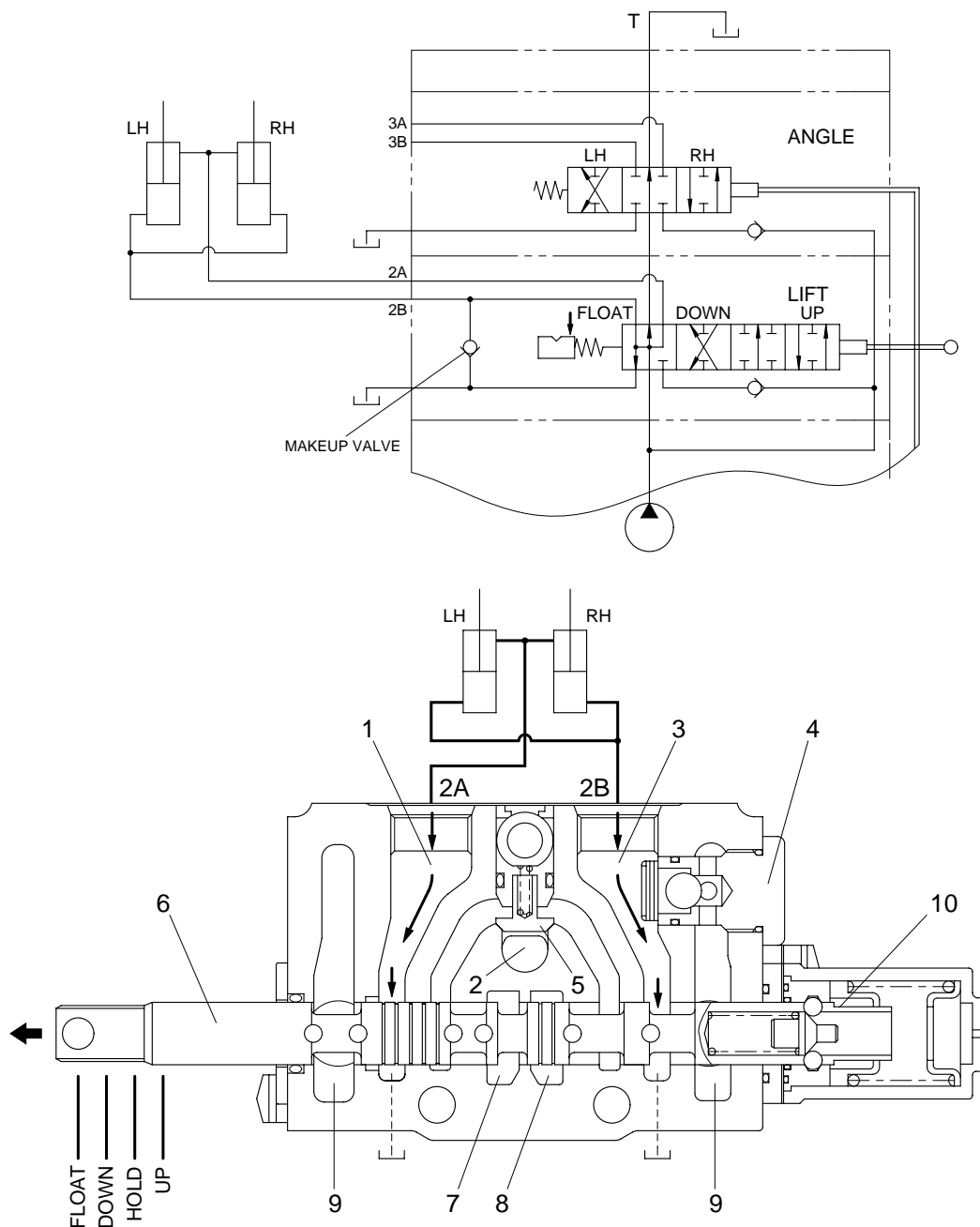


When the valve spool(6) is in the DOWN position, the oil in passage(2) opens check valve(5) and oil flows to passage(3) to the head end of the lift cylinders.

The flow of oil to the head end of the cylinders moves the piston and rod toward the rod end of the cylinders, which in moves the C-frame assembly down. The oil from the rod end of the cylinders flow through passage(1), through passage(9), and on to the tank. The relief valve for the circuit is the relief valve in the inlet section.

The makeup valve(4) is in passage(2) to the head end of the lift cylinders. The purpose of the makeup valve is to prevent cavitation when the dozer rapidly lowered.

(4) Dozer float position



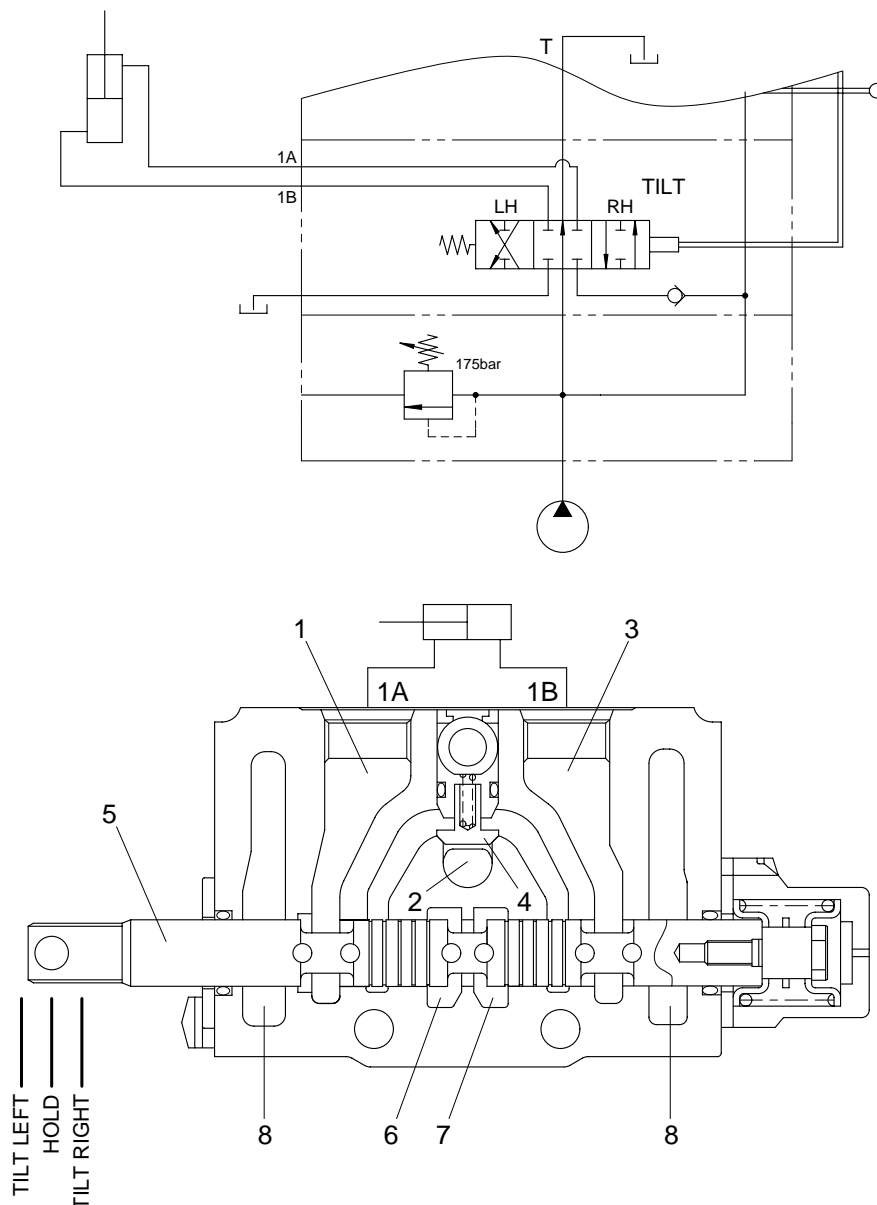
A detent(10) on the end of valve spool(6) holds the valve spool in the FLOAT position. The operator must move the lever forward to engage the detent. The operator must pull the lever backward to get valve spool(6) out of the detent for the FLOAT position.

When valve spool(6) is in FLOAT position, the oil flows through passages(7) and (8) through the next valve sections to passage(9). The position of valve spool(6) allows the oil in passage(9) flow to both passage(1) and (3), to the rod end and head end of the lift cylinders. With the oil in both ends of the lift cylinders at the same pressure, and passages(3) and (1) open to the tank through passage(9), the vertical position of the dozer is controlled by gravity and the weight of the dozer itself.

With the control lever and valve spool(6) in FLOAT position, the weight of the dozer is the only force that controls the vertical position of the dozer.

4) DOZER TILT SECTION OPERATION

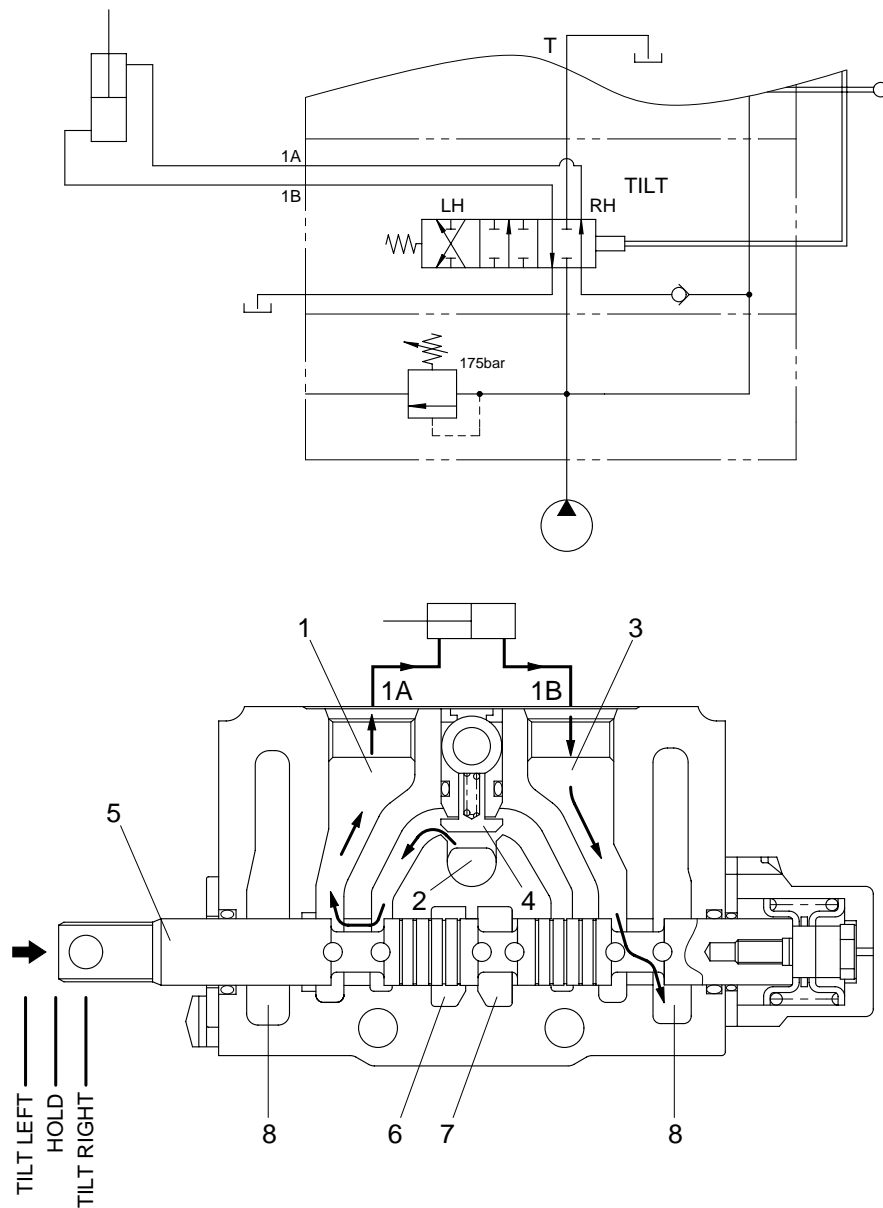
(1) Dozer hold position



The oil from the inlet section of the control assembly flows into passage(2). Passage(2) is a common passage through all of the valve sections. The oil from the inlet section also flows to passages(6) and (7). Passages(6) and (7) are open on only one side of the valve section. When valve spool(5) is in HOLD position, the oil in passages(6) and (7) flow around valve spool(5) to the tank.

The HOLD position of valve spool(5) and check valve(4) stops the flow of oil in passages(1) and (3). When the oil flow stops, the cylinders can not move until a control lever is moved, which moves valve spool(5) away from the HOLD position.

(2) Dozer tilt right position

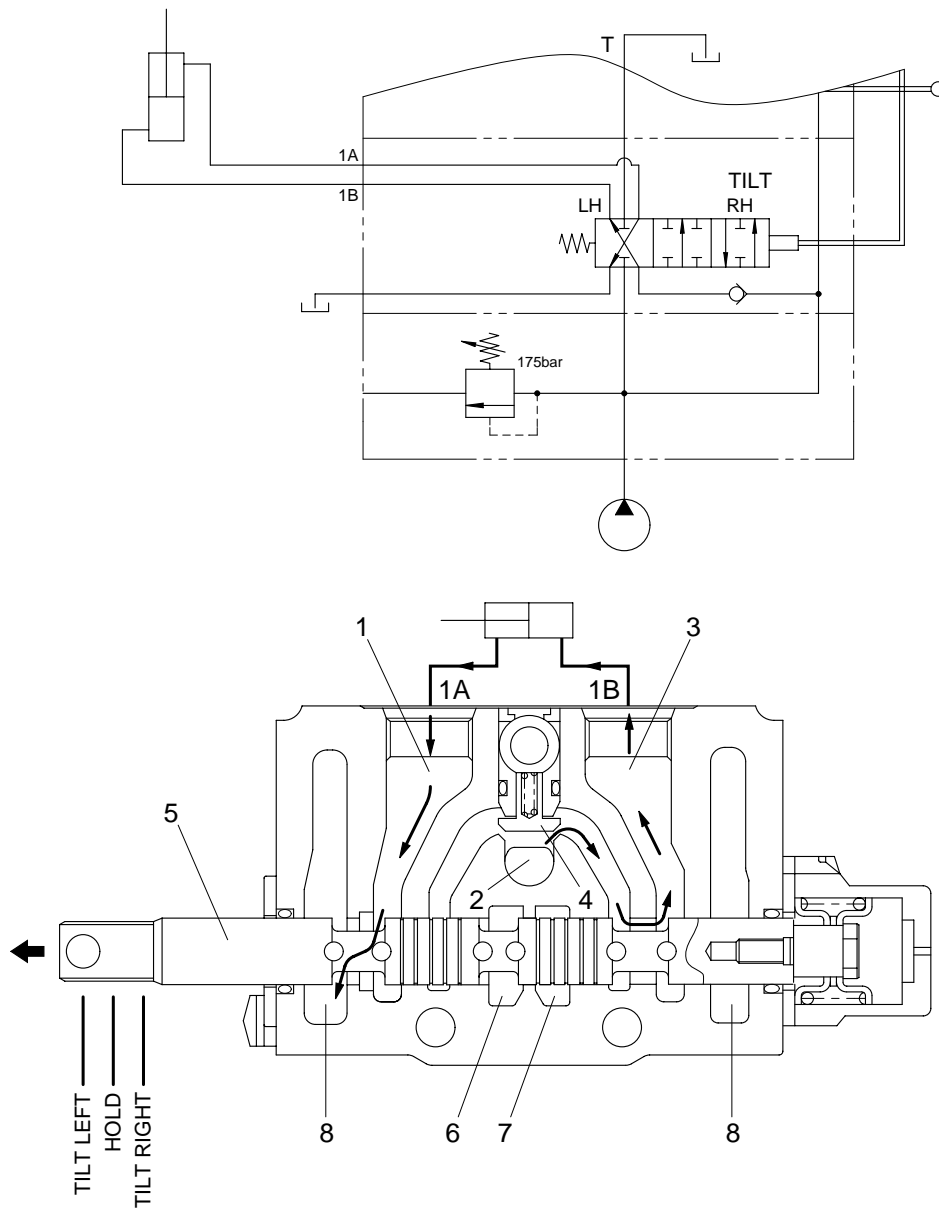


When valve spool(5) is in the TILT RIGHT position, the oil in passages(6) and (7) can not flow to passage(8) and the oil pressure in the valve section increases.

The increase of oil pressure in passage(2) opens check valve(4). The oil flows through the open check valve, through passage(1), and to the rod end of the tilt cylinder. The oil in the rod end pushes the rod into the tilt cylinder which moves the right side of the blade down.

The oil from the head end of the tilt cylinder flows through passage(3), through passage(8), and to the tank.

(3) Dozer tilt left position



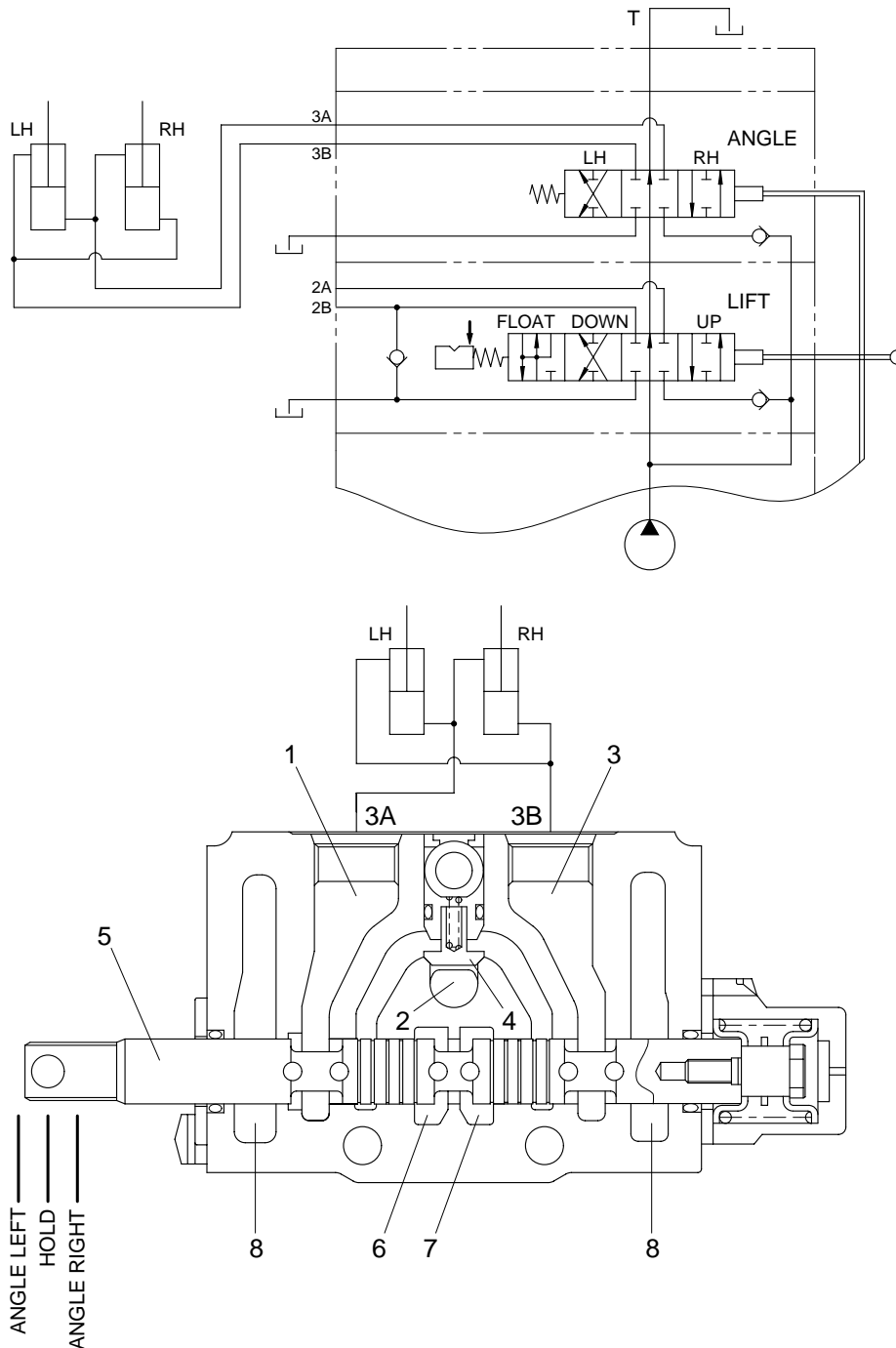
When valve spool(5) is in the TILT LEFT position, the oil in passages(6) and (7) can not flow to passage(8) and the oil pressure in the valve section increases.

The increase of oil pressure in passage(2) opens check valve(4). The oil flows through the open check valve, through passage(1), and to the head end of the tilt cylinder. The oil in the head end pushes the rod out of the tilt cylinder which moves the right side of the blade up.

The oil from the rod end of the tilt cylinder flows through passage(1), through passage(8), and to the tank.

5) DOZER ANGLE SECTION OPERATION

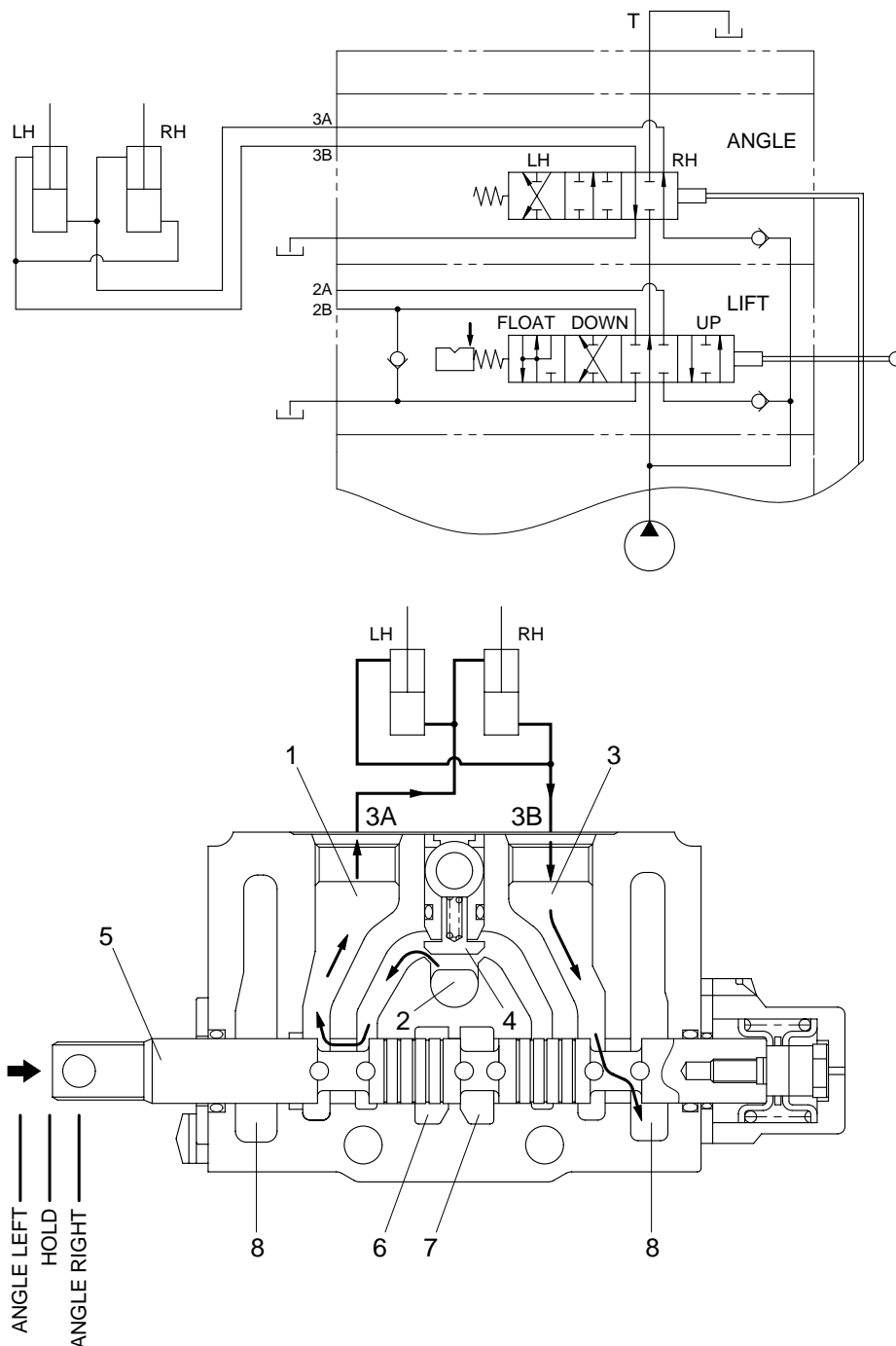
(1) Dozer hold position



The oil from the inlet section of the control assembly flows into passage(2). Passage(2) is a common passage through all of the valve sections. The oil from the inlet section also flows to passages(6) and (7). Passages (6) and (7) are open on only one side of the valve section. When valve spool(5) is in HOLD position, the oil in passage(6) and (7) flow around valve spool(5) to the tank.

The HOLD position of valve spool(5) and check valve(4) stops the flow of oil in passages(1) and (3). When the oil flow stops, the cylinders can not move until a control lever is moved, which moves valve spool(5) away from the HOLD position.

(2) Dozer angle right position

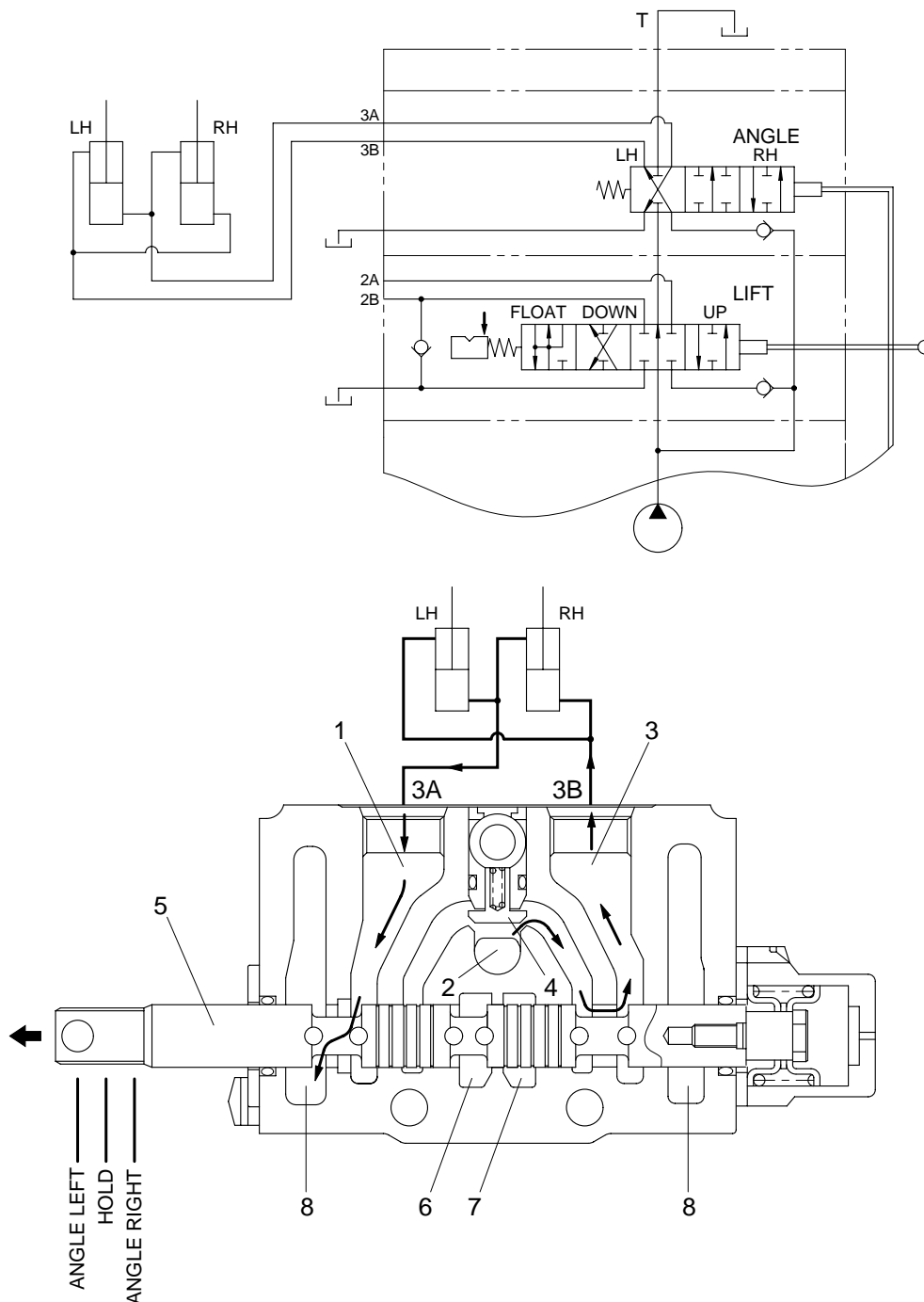


When control lever is moved to the ANGLE RIGHT position, the oil in the passage(6) and (7) can not flow to passage(8) and the oil pressure in the valve section increases. The increase of oil pressure in passage(2) opens check valve(4).

The oil flows through the open check valve, through passage(1) and to the head end of left side cylinder and rod end of right side cylinder.

The rod of the left side cylinder moves out and the rod on the right side cylinder moves in at the same time. The cylinder movement turns the blade on the C-frame for ANGLE RIGHT. The oil from the head end of the right side cylinder and rod end of left side of cylinder flows through passage(3), through passage(8), and to the tank.

(3) Dozer angle left position



When control lever is moved to the ANGLE LEFT position, the oil in the passage(6) and (7) can not flow to passage(8) and the oil pressure in the valve section increases. The increase of oil pressure in passage(2) opens check valve(4).

The oil flows through the open check valve, through passage(3), and to the rod end of left side cylinder and head end of right side cylinder.

The rod in the right side cylinder moves out and the rod in the left side cylinder moves in at the same time. The movement of the left side and right side cylinders turns the blade on the C-frame to the ANGLE LEFT position. The oil from the head end of the left side cylinder and rod end of right side of cylinder flows through passage(1), through passage(8), and to the tank.

6) MAIN RELIEF VALVE

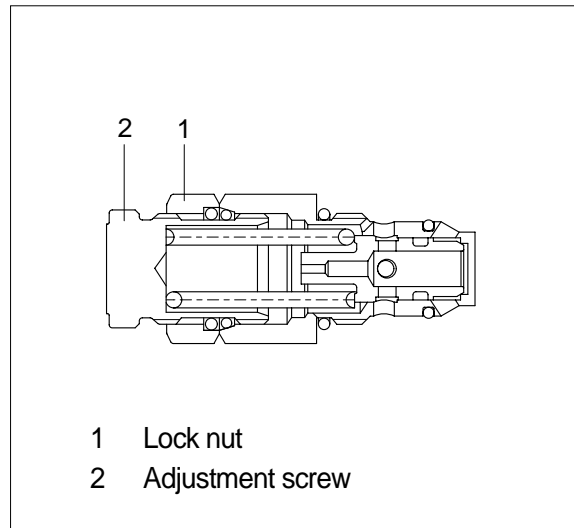
- (1) Setting pressure
175kgf/cm²(2500psi)

(2) Adjustment

Loosen the lock nut(1).

Turn the adjustment screw(2) either clockwise for an increase or counterclockwise for a decrease in the pressure setting of the relief valve.

Tighten lock nut(1) after the adjustment is made and test again for the pressure setting.



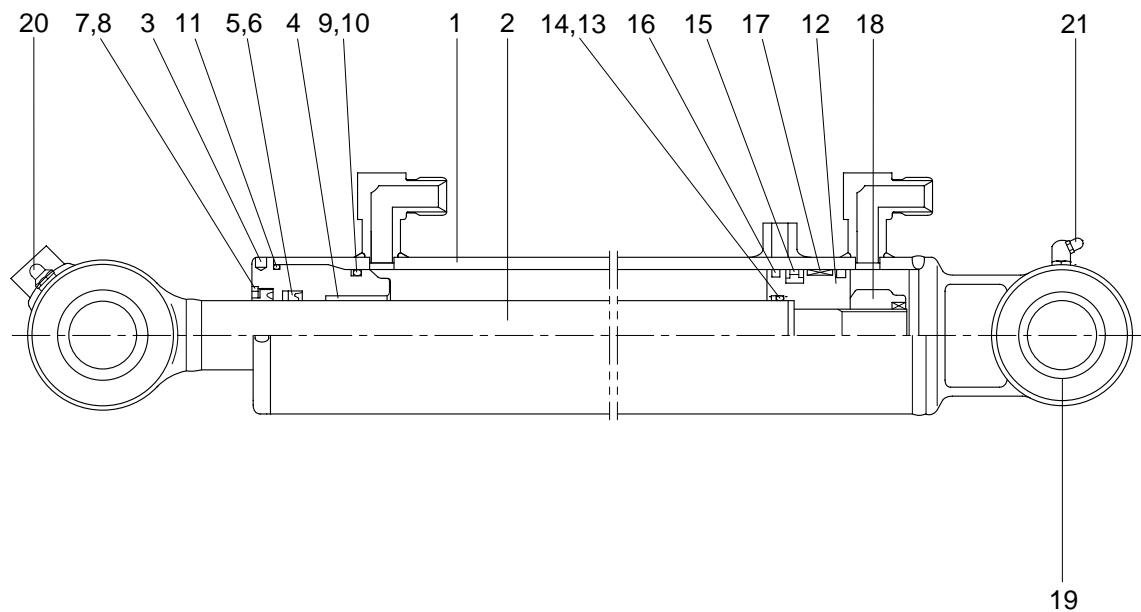
6. CYLINDERS

The lift cylinders are two unit. The piston(12) threads on to the rod(2) and is retained by a nylon nut(18).

The piston seals against the tube(1) with piston seal(15). The wear ring(17) and dust rings(16) are located on each side of the piston seal.

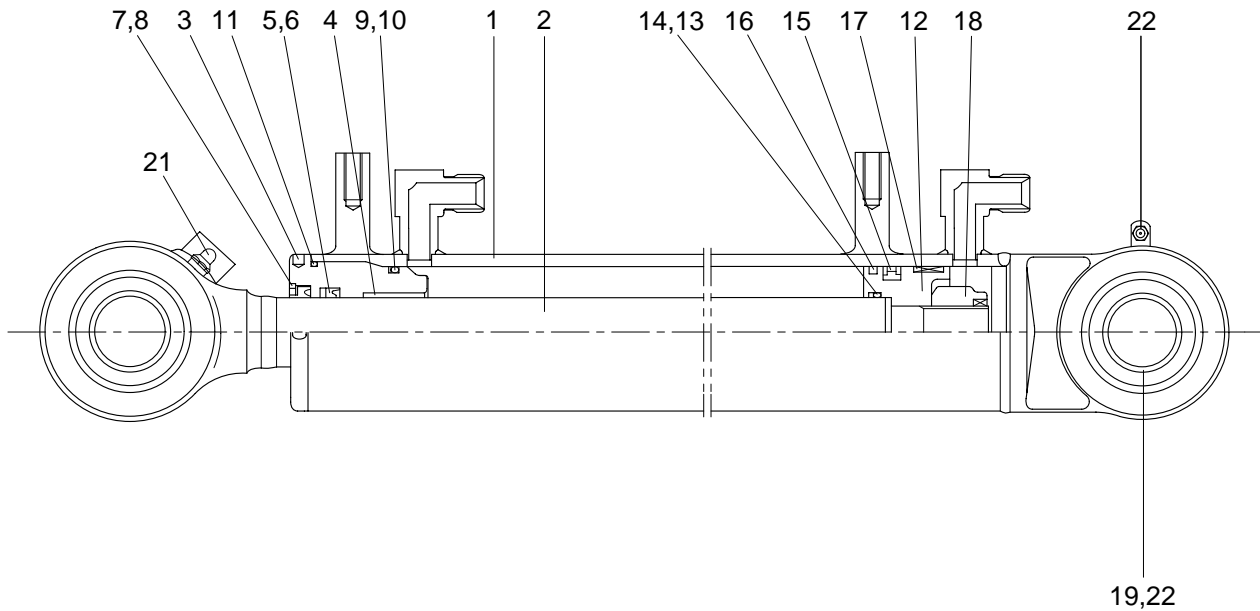
The gland(3, the rod guide) seals against the tube with an O-ring(9). The cylinder thread seals against the rod with a rod seal(5). A dust wiper(7) cleans the rod when it is retracted.

1) LIFT CYLINDER



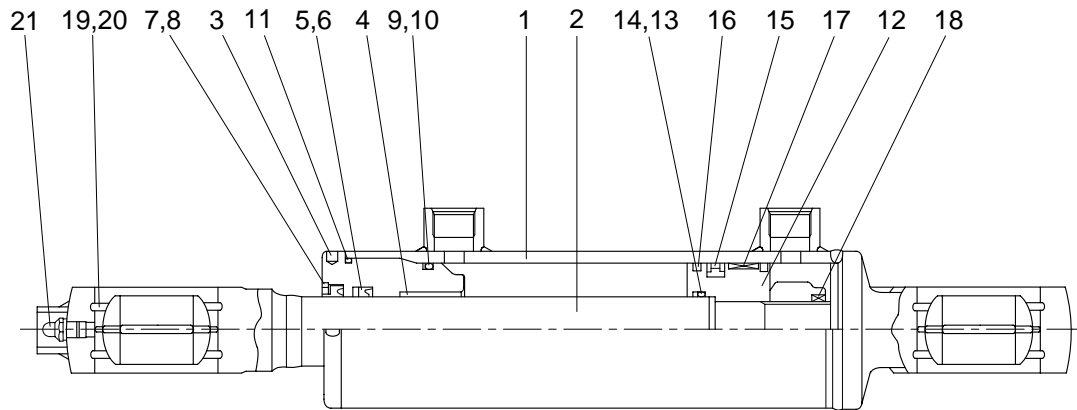
1	Tube assy	8	Snap ring	15	Piston seal
2	Rod assy	9	O-ring	16	Dust ring
3	Gland	10	Back up ring	17	Wear ring
4	Bushing	11	O-ring	18	Nylon nut
5	Rod seal	12	Piston	19	Bushing
6	Back up ring	13	O-ring	20	Grease nipple
7	Dust wiper	14	Back up ring	21	Grease nipple

2) ANGLE CYLINDER



- | | | | | | |
|---|--------------|----|--------------|----|-------------------|
| 1 | Tube assy | 9 | O-ring | 17 | Wear ring |
| 2 | Rod assy | 10 | Back up ring | 18 | Nylon nut |
| 3 | Gland | 11 | O-ring | 19 | Spherical bearing |
| 4 | Bushing | 12 | Piston | 20 | Retainer ring |
| 5 | Rod seal | 13 | O-ring | 21 | Grease nipple |
| 6 | Back up ring | 14 | Back up ring | 22 | Grease nipple |
| 7 | Dust wiper | 15 | Piston seal | | |
| 8 | Snap ring | 16 | Dust ring | | |

3) TILT CYLINDER



- | | | | | | |
|---|--------------|----|--------------|----|-------------------|
| 1 | Tube assy | 9 | O-ring | 17 | Wear ring |
| 2 | Rod assy | 10 | Back up ring | 18 | Nylon nut |
| 3 | Gland | 11 | O-ring | 19 | Spherical bearing |
| 4 | Bushing | 12 | Piston | 20 | Retainer ring |
| 5 | Rod seal | 13 | O-ring | 21 | Grease nipple |
| 6 | Back up ring | 14 | Back up ring | | |
| 7 | Dust wiper | 15 | Piston seal | | |
| 8 | Snap ring | 16 | Dust ring | | |

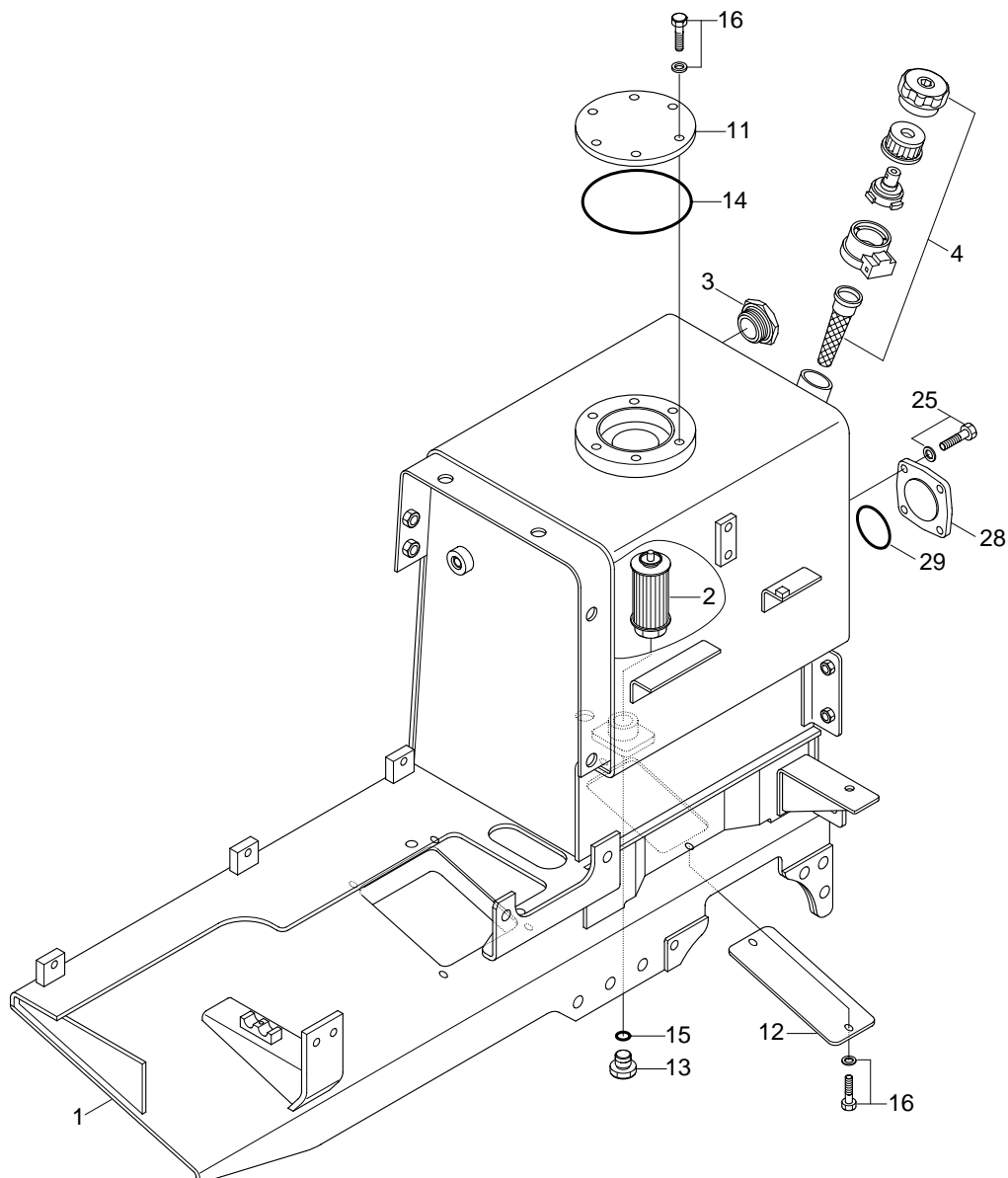
7. HYDRAULIC OIL TANK

1) STRUCTURE

The oil from the hydraulic tank is sent from the pump through control valve to the cylinders.

In the return circuit, the oil from various parts merges.

If the hydraulic return hydraulic oil filter becomes clogged, return filter bypass valve acts to allow the oil to return directly to the hydraulic tank(1). This prevents damage to the hydraulic filter(8). The bypass valve is also actuated when negative pressure is generated in the circuit.



- | | | | | | |
|----|----------------------|----|---------------|----|---------------|
| 1 | Hydraulic tank | 12 | Cover | 25 | Bolt-w/washer |
| 2 | Hydraulic oil filter | 13 | Plug | 28 | Cover |
| 3 | Sight gauge | 14 | O-ring | 29 | O-ring |
| 4 | Air breather | 15 | O-ring | | |
| 11 | Cover | 16 | Bolt-w/washer | | |

2) AIR BREATHER

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

(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 poppet 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.

