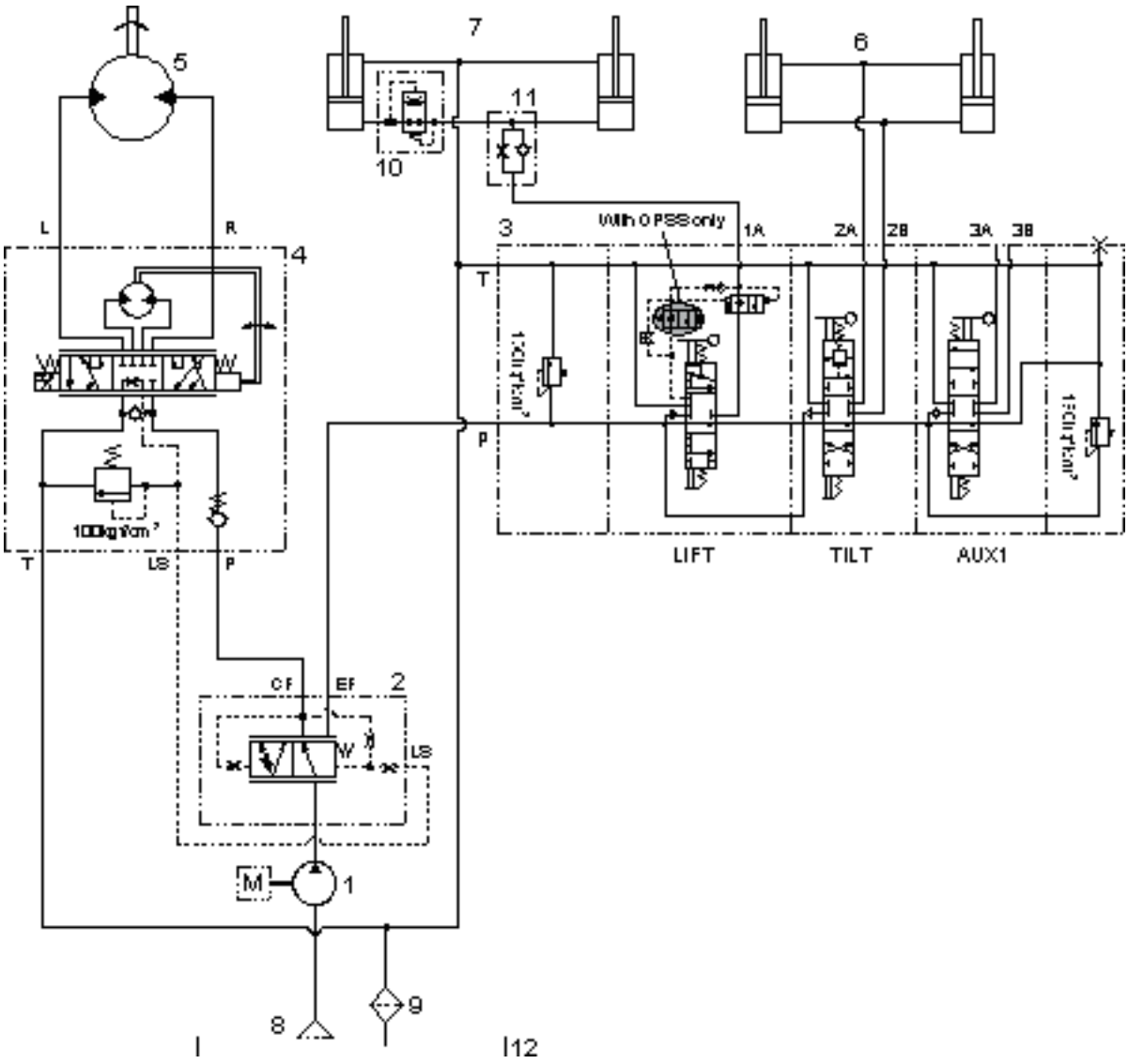
SECTION 6 HYDRAULIC SYSTEM

1. HYDRAULIC CIRCUIT

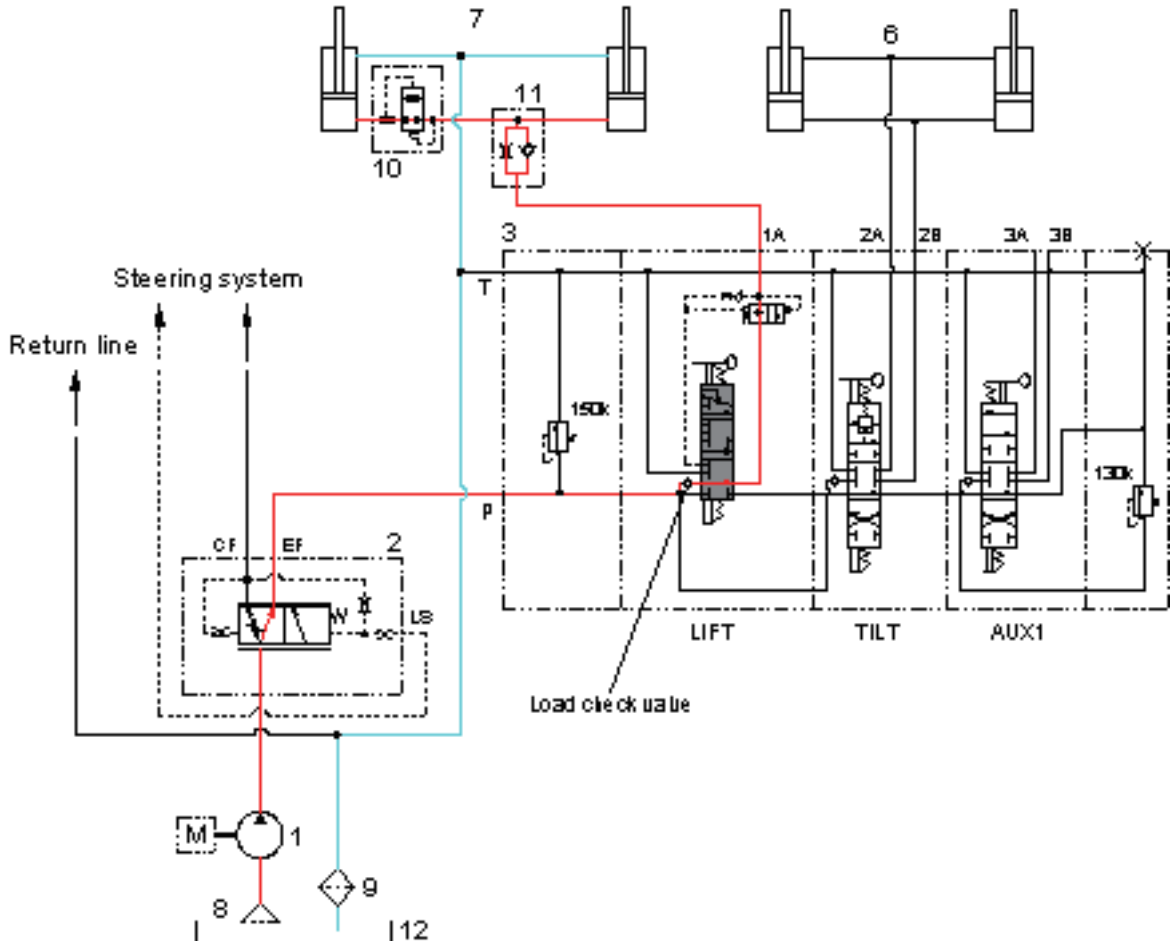


10BTR9HS01

1	Hydraulic gear pump	7	Lift cylinder
2	Priority valve	8	Suction strainer
3	Main control valve	9	Return filter
4	Steering unit	10	Down safety valve
5	Hydraulic motor	11	Down control valve
6	Tilt cylinder	12	Hydraulic oil tank

※ 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

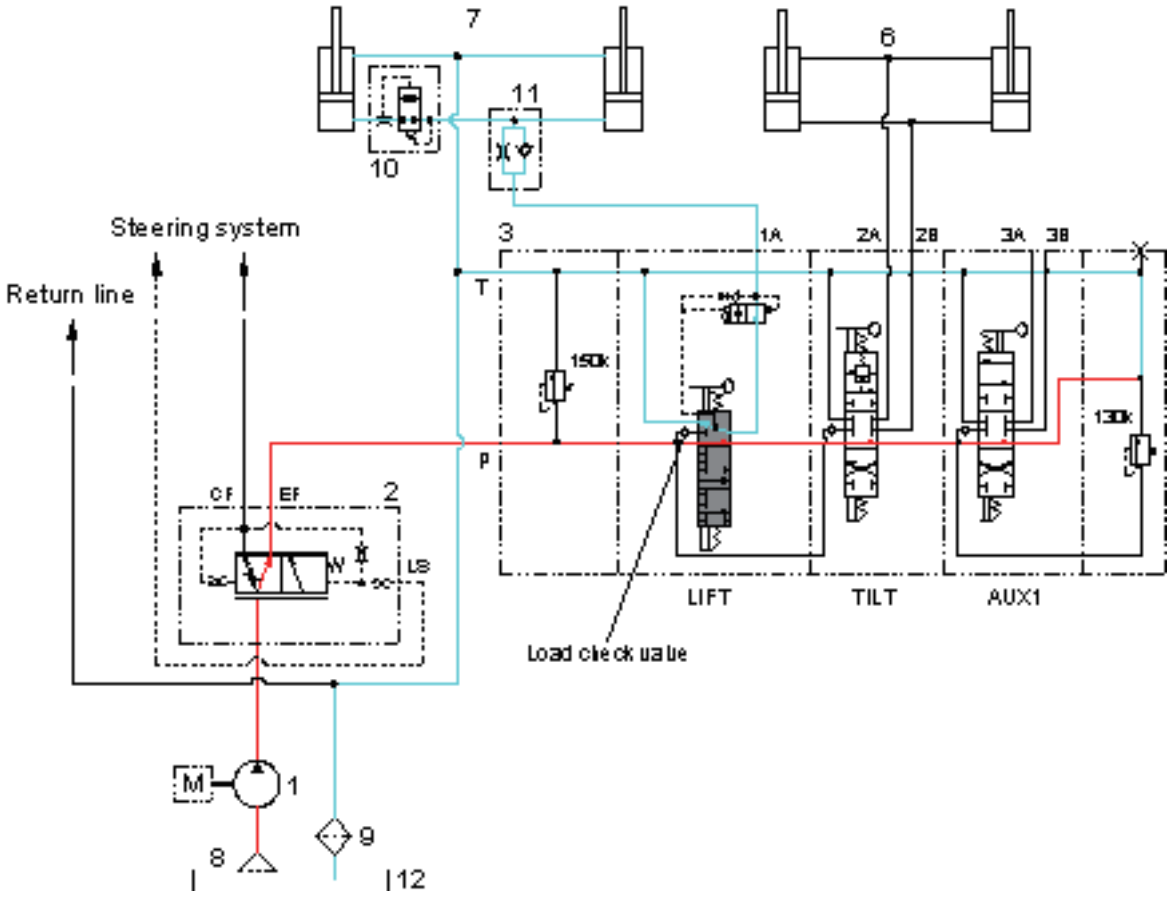


10BTR9HS02

When the lift control lever is pulled back, the spool on the first block is moves to lift position.
The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the large chamber of lift cylinder(7) by pushing the load check valve of the spool.
The oil from the small chamber of lift cylinder(7) returns to hydraulic oil tank(12) 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

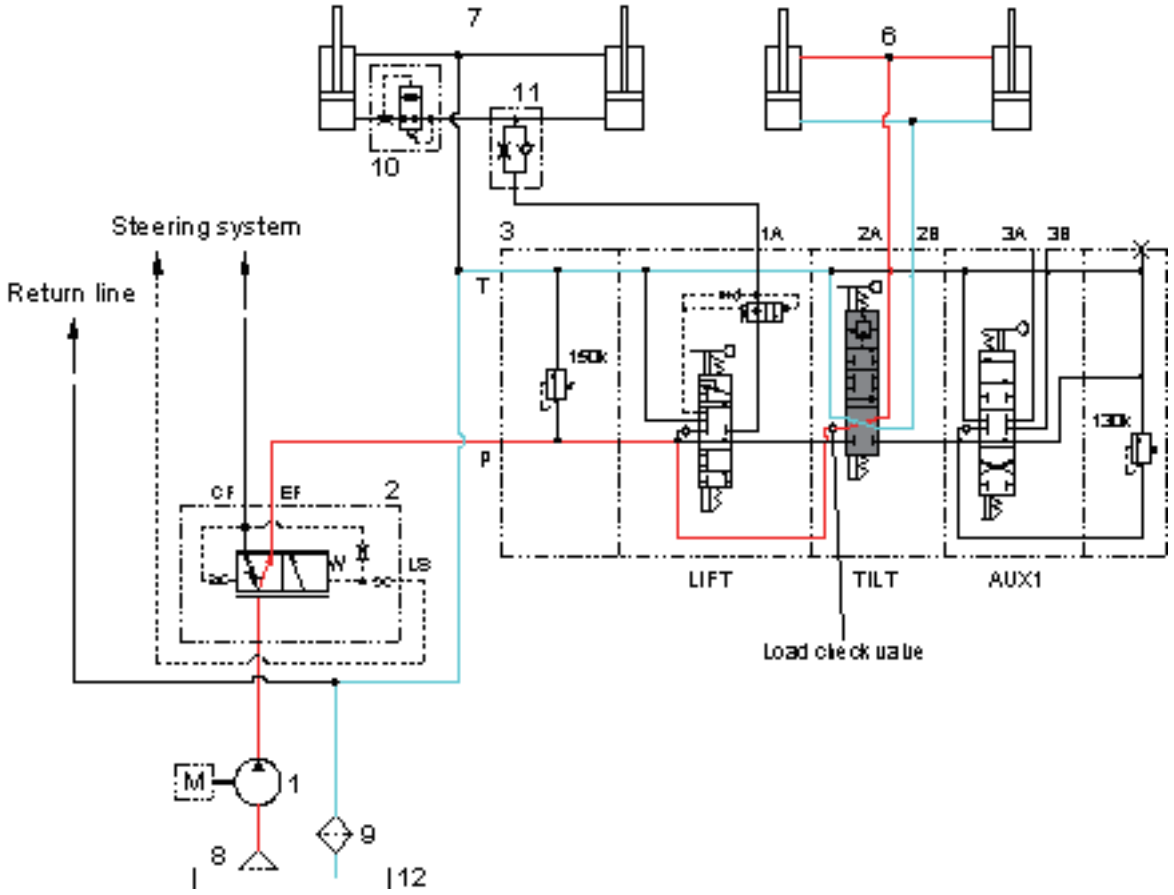


10BTR9HS03

When the lift control lever is pushed forward, the spool on the first block is moved to lower position. The work port(1A) and the small chamber and the large chamber are connected to the return passage, so the forks 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



10BTR9HS04

When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.

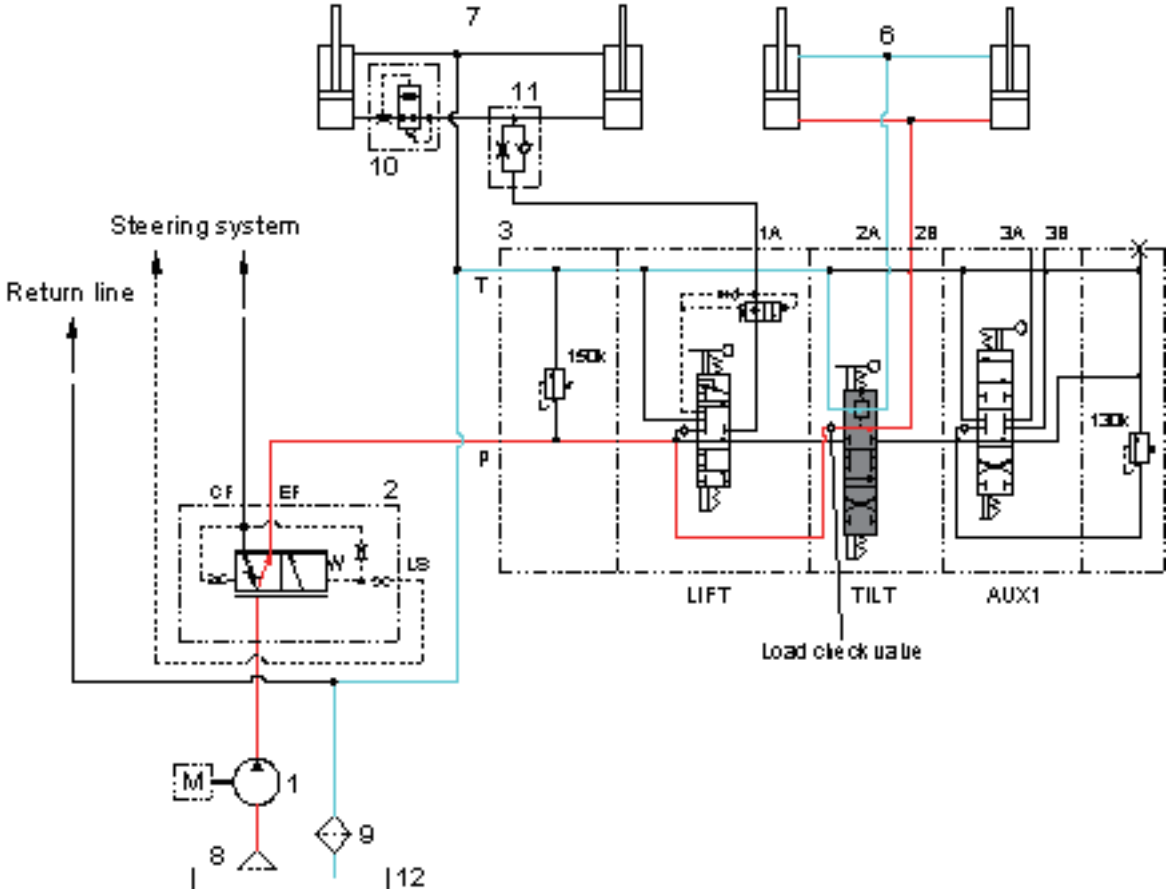
The oil from hydraulic gear pump(1) flows into main control valve (3) and then goes to the large chamber of tilt cylinder(6) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder(6) returns to hydraulic tank(12) 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



10BTR9HS05

When the tilt control lever is pulled back, the spool on the second block is moved to tilt backward position.

The oil from hydraulic gear pump(1) flows into main control valve(3) and then goes to the small chamber of tilt cylinder(6) by pushing the load check valve of spool.

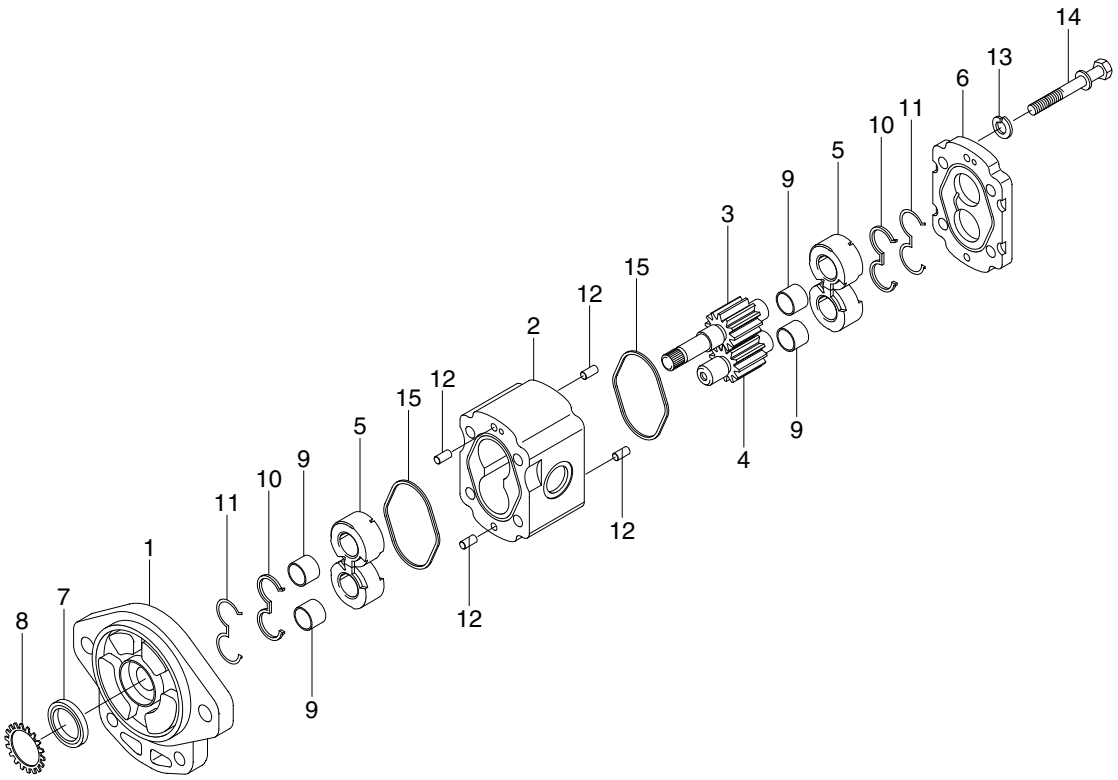
The oil at the large chamber of tilt cylinder(6) returns to hydraulic tank(12) at the same time.

When this happens, the mast tilt backward.

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

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



10BTR9HS19

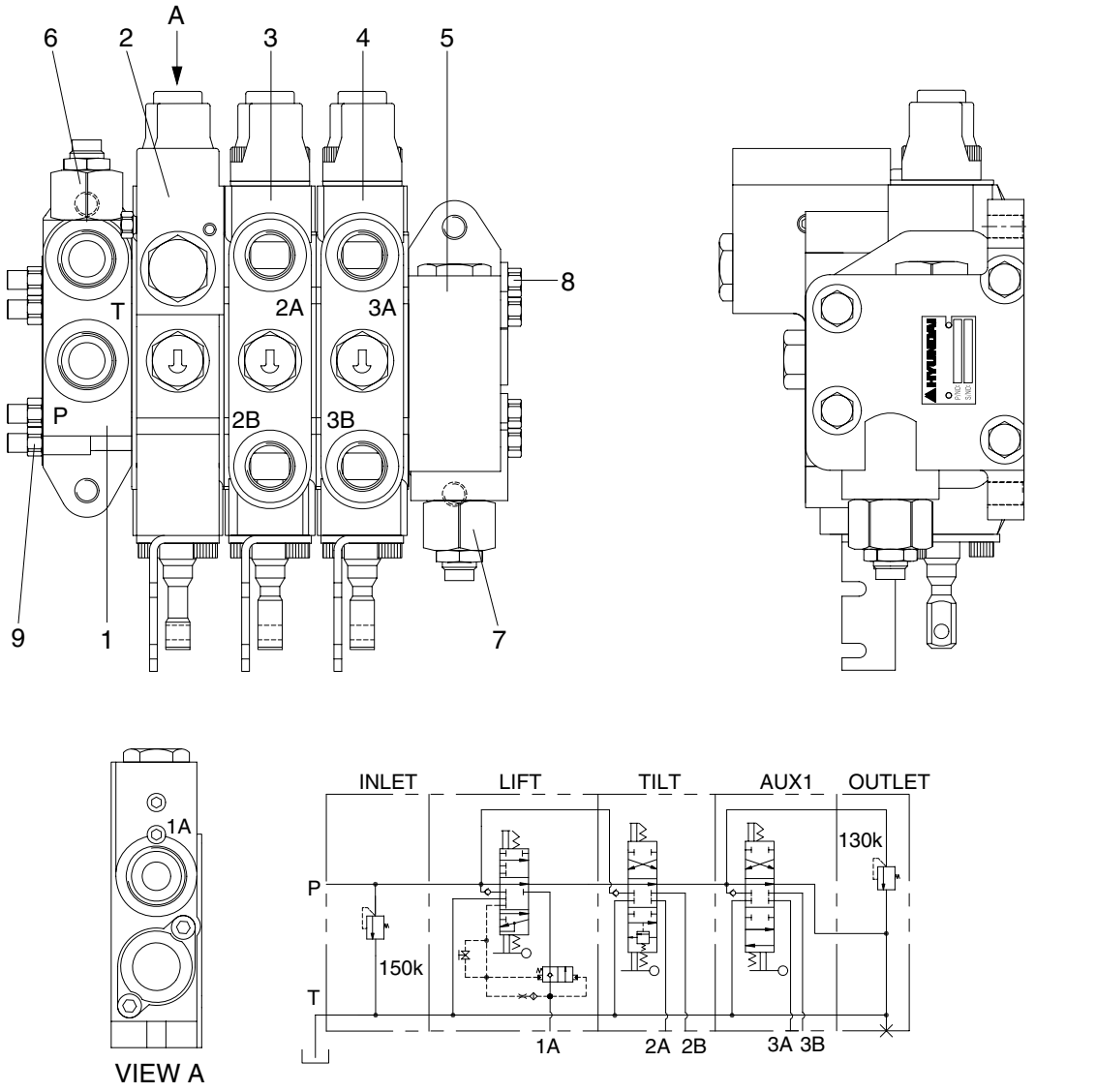
1	Housing assy	6	Rear cover	11	E-back up ring
2	Body	7	Oil seal	12	Pin-S
3	Drive gear	8	Snap ring	13	Wahser
4	Idler gear	9	Bushing	14	Bolt
5	Side plate assy	10	E-seal	15	Square seal

2) OPERATION

This pump comprises of an rear cover, a body, bushings and a housing bolted together with bolts. The gear journals are supported in side plate within pressure balanced bushings to give high volumetric and mechanical efficiencies.

3. MAIN CONTROL VALVE (without OPSS)

1) STRUCTURE (3 Spool)

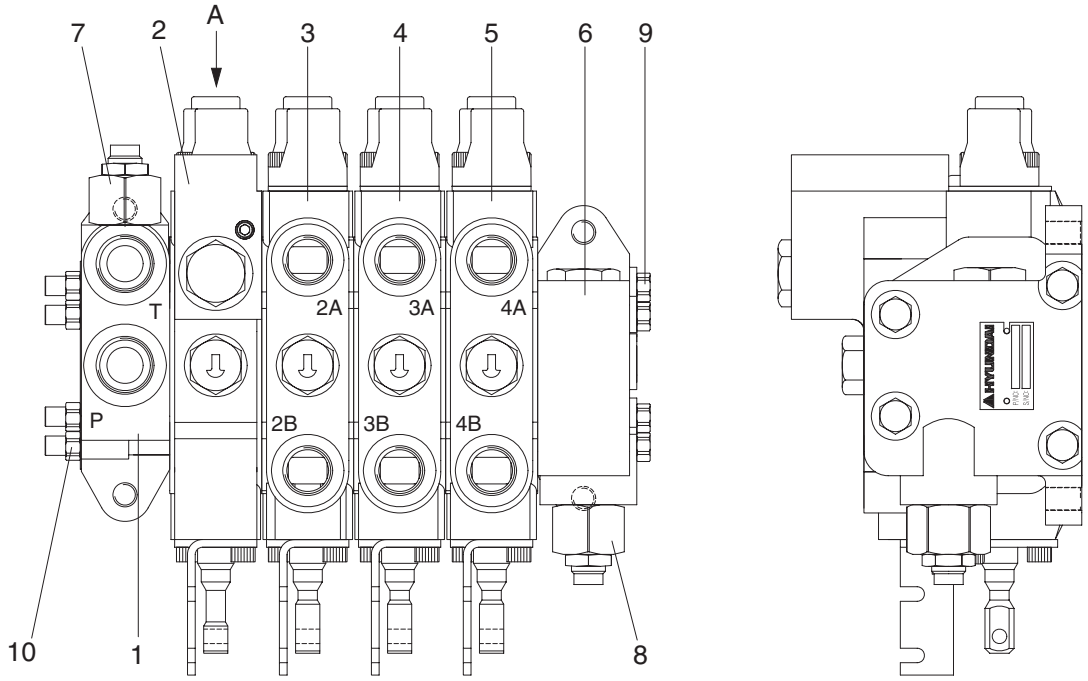


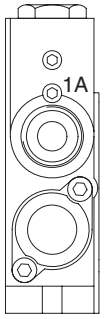
10BTR9HS07A

Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B

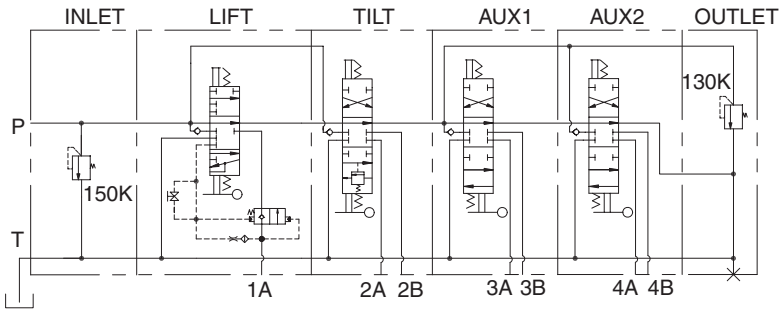
1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Outlet block assy
6 Main relief valve assy
7 Auxiliary relief valve assy
8 Long bolt
9 Nut

2) STRUCTURE (4 Spool)





VIEW A



Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

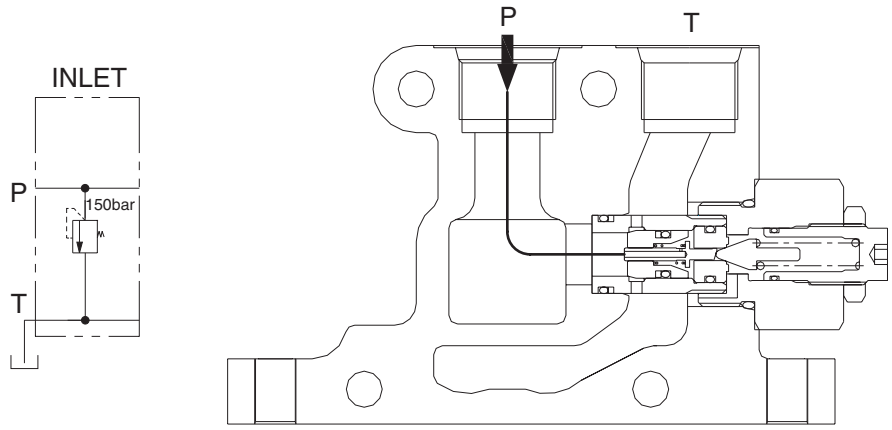
10BTR9HS07B

1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Aux 2 block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut

3) INLET SECTION

(1) Operation

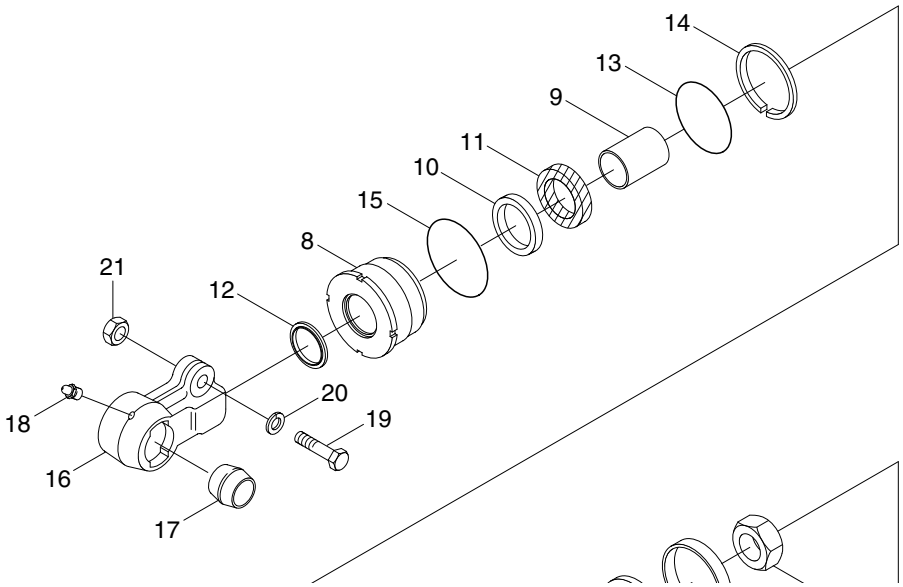
The inlet section contains the pump inlet connection and main relief valve.



10BTR9HS09

(2) Operation of relief valve at setting pressure

When the pressure at inlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the outlet tank.



10BTR9HS10

4) LIFT SECTION

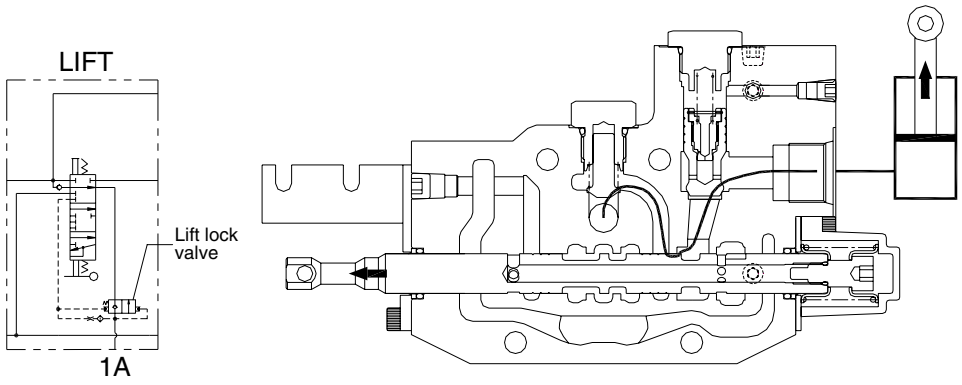
(1) Operation

The lift section has a single work port to direct flow to the lift cylinder. Only one work port is used, because the lift cylinder is single-acting(gravity returns the mast to the lowered position).

The lift section also contains part of the components which comprise the safety features. There is a lift lock check valve. At the neutral position, pressures in the lock valve are equalized across the lift lock poppet. In this manner, the spring bias keeps the lift lock valve closed and prevents lowering of the mast.

① Lifting

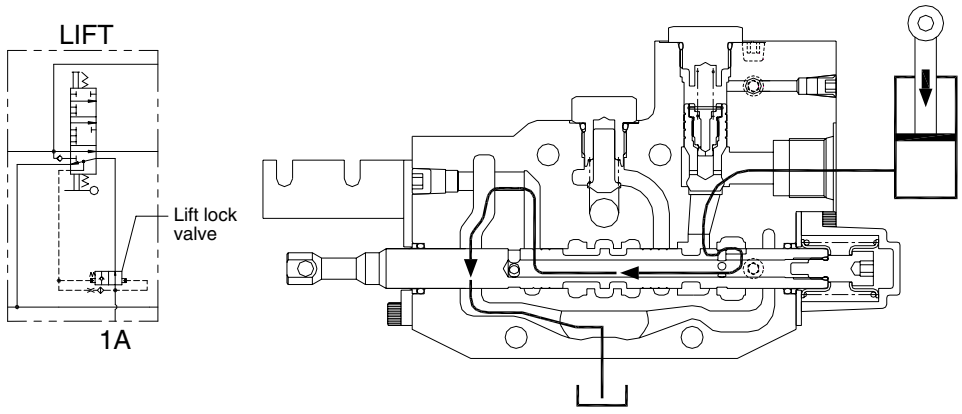
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and to the head side of the lift cylinder.



22B7HS11

② Lowering

When the seated operator shifts the lever forwards, the spool retracts into the valve, and the oil is directed from the cylinder, past the lift lock check valve, past the spool metering notches, and to the common tank cavity.



22B7HS12

Pressure is limited by the main relief valve.

5) TILT SECTION

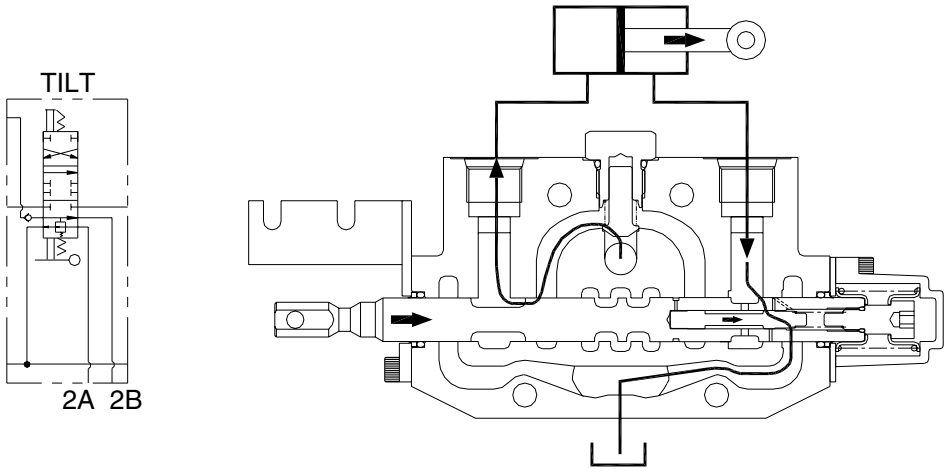
(1) Operation

The tilt spool contains an internal plunger which acts to stop tilt forward actuation when the battery power is off.

① Tilt forward

When the seated operator shifts the lever forward, pressure is applied to the head of the tilt cylinder, and the forks tilt forward. Oil is directed from the high pressure parallel passage past the load check valve, past the spool metering notches, and towards the cylinder head.

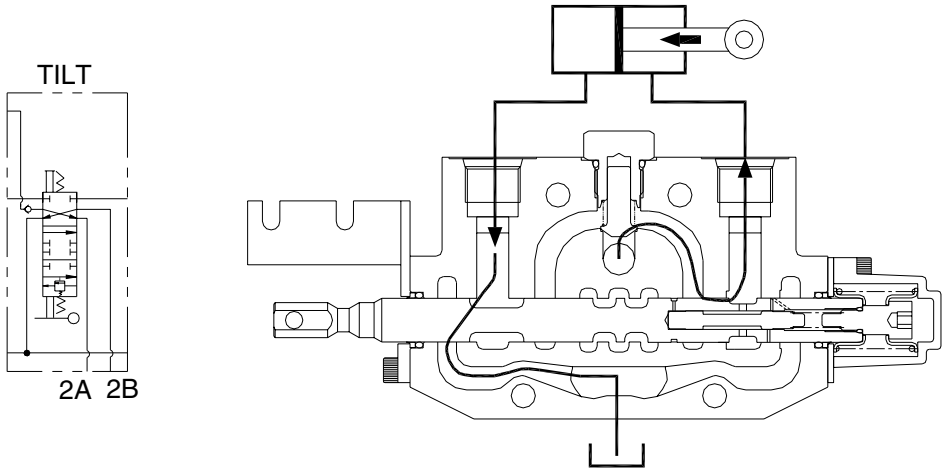
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



22B7HS13

② Tilt back

When the seated operator shifts the lever back, the high pressure oil from the parallel passage is directed past the load check valve, past the spool metering notches, and to the rod side of the cylinder. Exhaust oil from the head side of the cylinder is directed past the spool metering notches to tank.



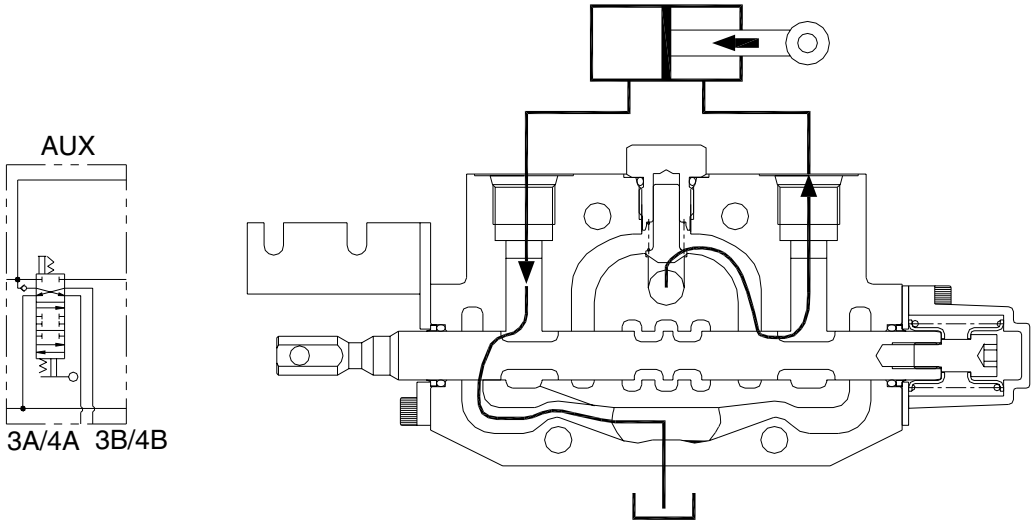
22B7HS14

Pressure is limited by the main relief valve.

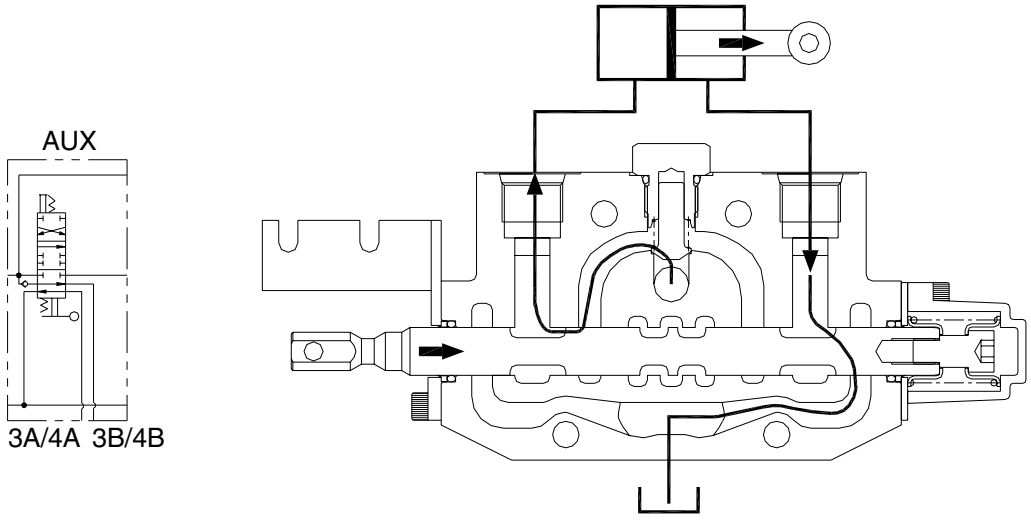
6) AUXILIARY SECTIONS

(1) Operation

Many different functions can be controlled by the auxiliary spool sections. In general, one work port is pressurized by high pressure oil from the parallel passage, past the load check valve, past the metering notches, and to the cylinder. Simultaneously, oil from the other work port is directed across the spool metering notches to tank.



22B7HS15



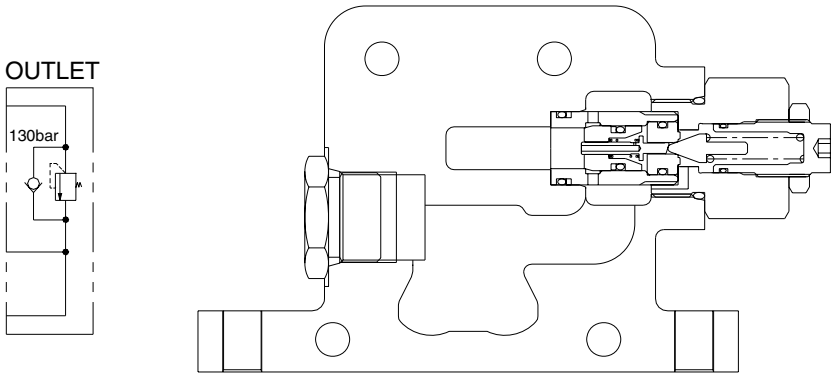
22B7HS16

Pressure is limited by the secondary main relief valve.

7) OUTLET SECTION

(1) Operation

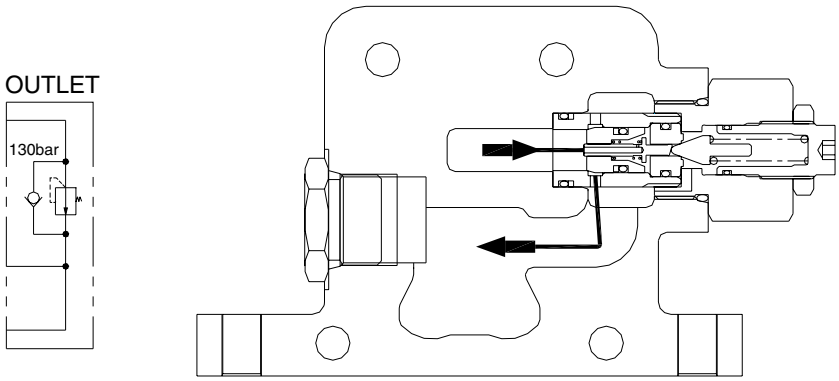
The outlet section contains the tank port and the secondary relief valve(with built-in anti-cavitation feature).



22B7HS17

(2) Operation of relief valve at setting pressure

When the pressure at outlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the tank line.

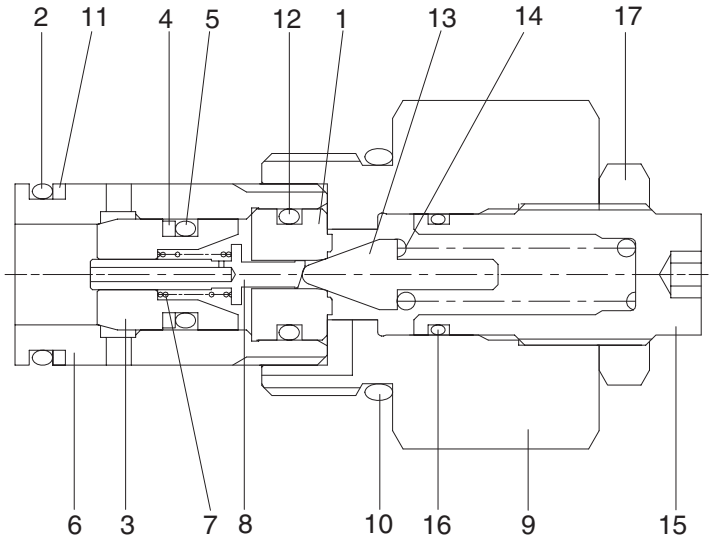


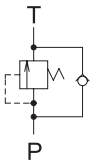
22B7HS18

8) MAIN RELIEF VALVE

This valve is a type of pilot piston to prevent hydraulic components and pipes from being broken by high pressure so, it keeps under pressure limited.

Relief valve pressure varies by 130kgf/cm² in accordance with 1 revolution of adjust bolt.





· Main relief valve : 150 kgf/cm^2

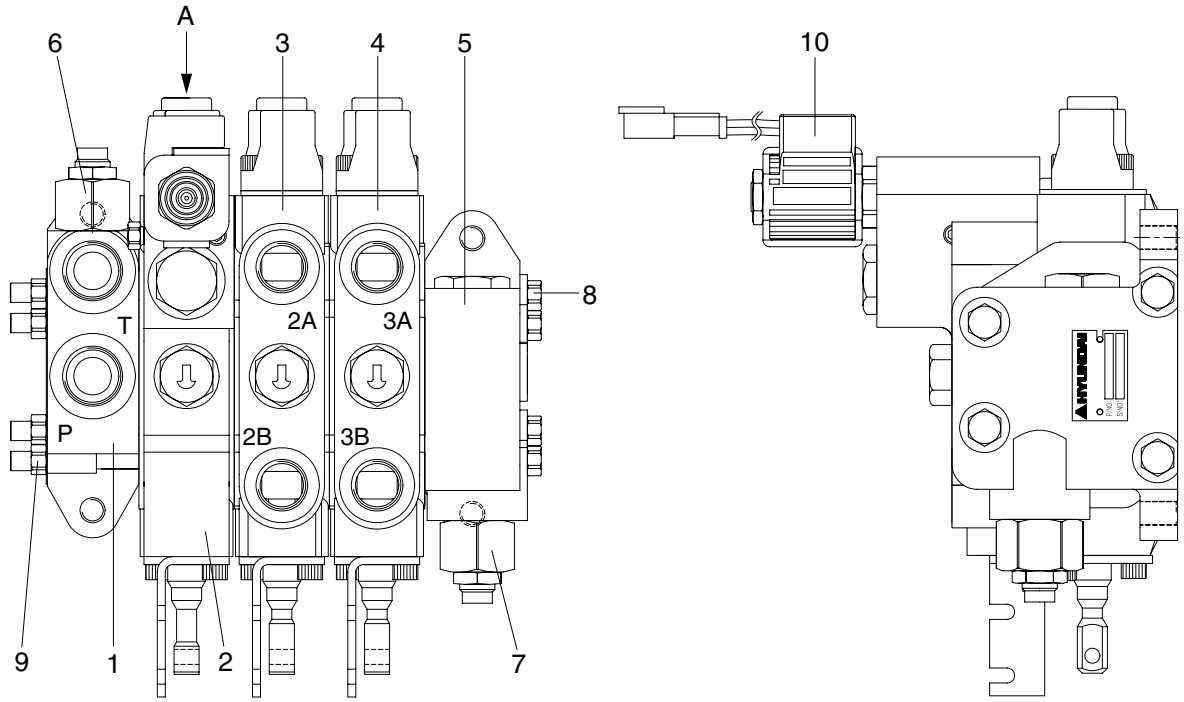
· Auxiliary relief valve : 130 kgf/cm^2
(For 3,4 spool only)

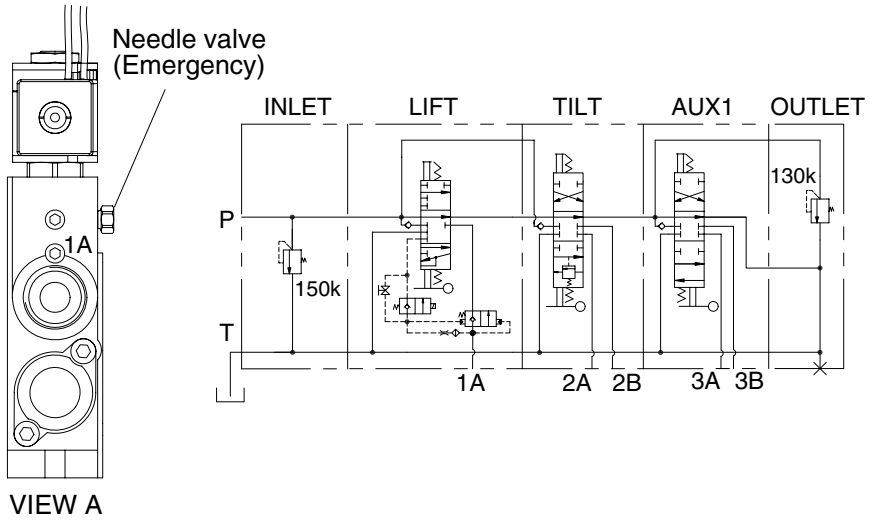
10BTR9HS20

1	Pilot seat	7	Main spring	13	Pilot poppet
2	O-ring	8	Piston	14	Pilot spring
3	Main poppet	9	Body	15	Adjust screw
4	Back up ring	10	O-ring	16	O-ring
5	O-ring	11	Back up ring	17	Lock nut
6	Socket	12	O-ring		

MAIN CONTROL VALVE (with OPSS)

1) **STRUCTURE** (3 Spool)



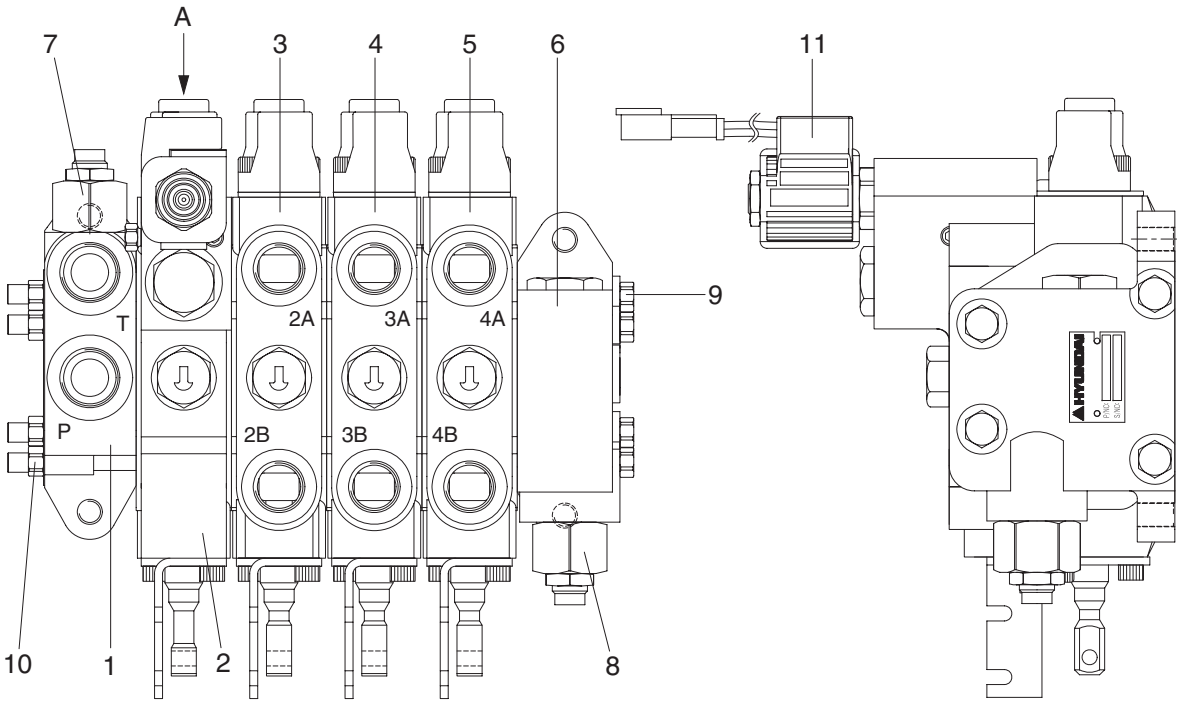


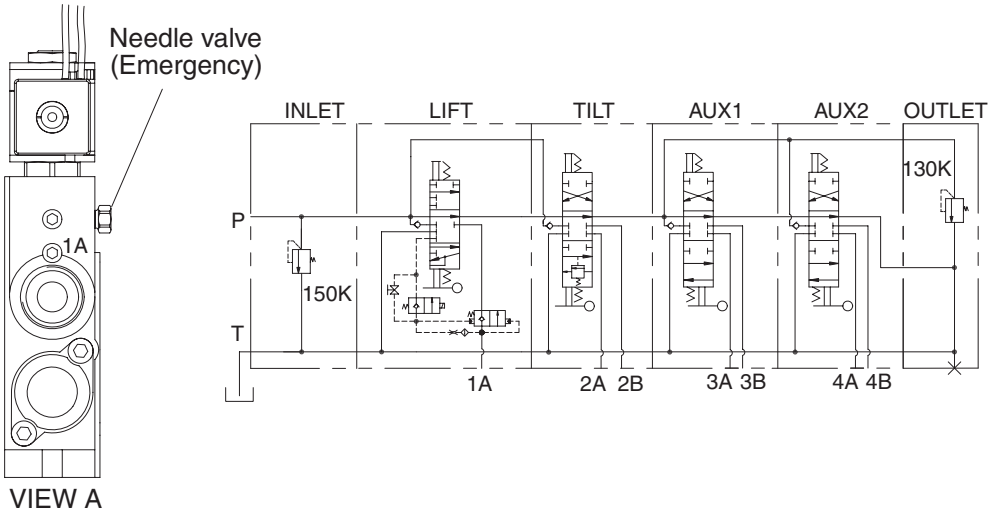
Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B

15BT9HS08

1	Inlet block assy	6	Main relief valve assy
2	Lift block assy	7	Auxiliary relief valve assy
3	Tilt block assy	8	Long bolt
4	Aux 1 block assy	9	Nut
5	Outlet block assy	10	Solenoid valve

2) STRUCTURE (4 Spool)





Port name	Size	Port
Inlet port	7/8-14UNF	P
Outlet port	7/8-14UNF	T
Work port	7/8-14UNF	1A
Work port	3/4-16UNF	2A, 2B, 3A, 3B, 4A, 4B

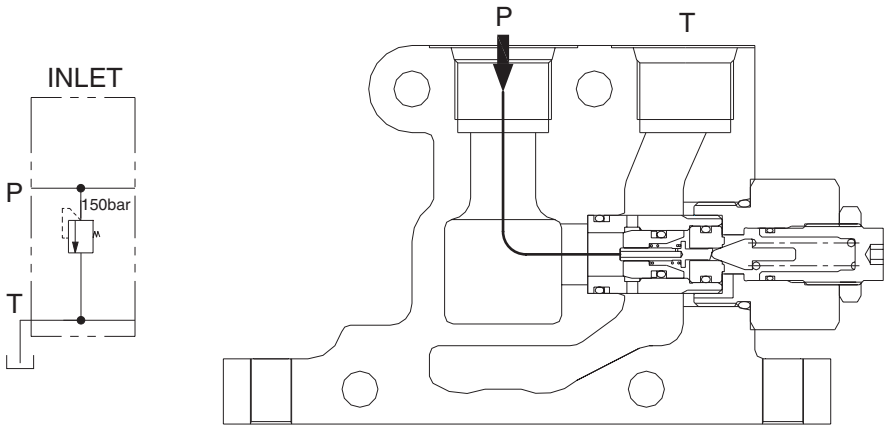
10BTR9HS08A

1 Inlet block assy
2 Lift block assy
3 Tilt block assy
4 Aux 1 block assy
5 Aux 2 block assy
6 Outlet block assy
7 Main relief valve assy
8 Auxiliary relief valve assy
9 Long bolt
10 Nut
11 Solenoid valve

3) INLET SECTION

(1) Operation

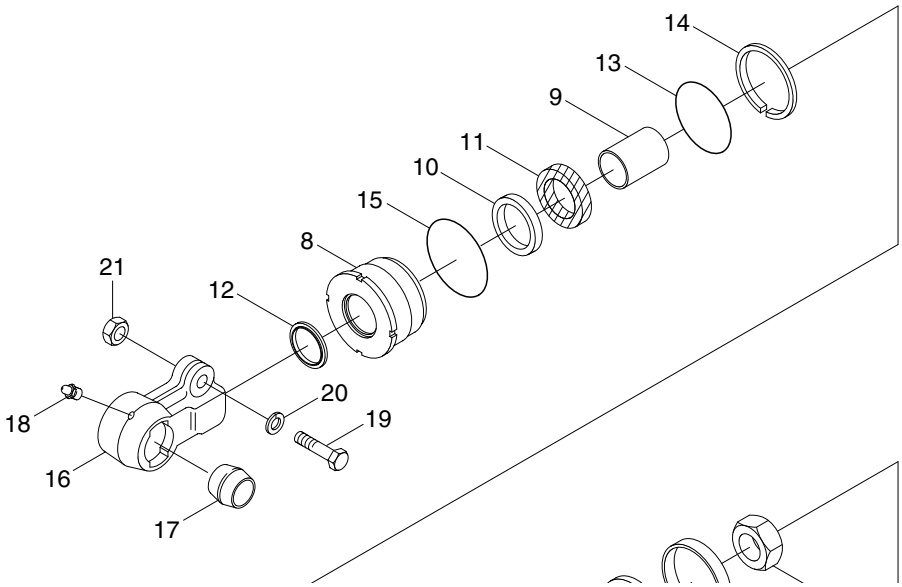
The inlet section contains the pump inlet connection and main relief valve.



10BTR9HS09

(2) Operation of relief valve at setting pressure

When the pressure at inlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the outlet tank.



10BTR9HS10

4) LIFT SECTION

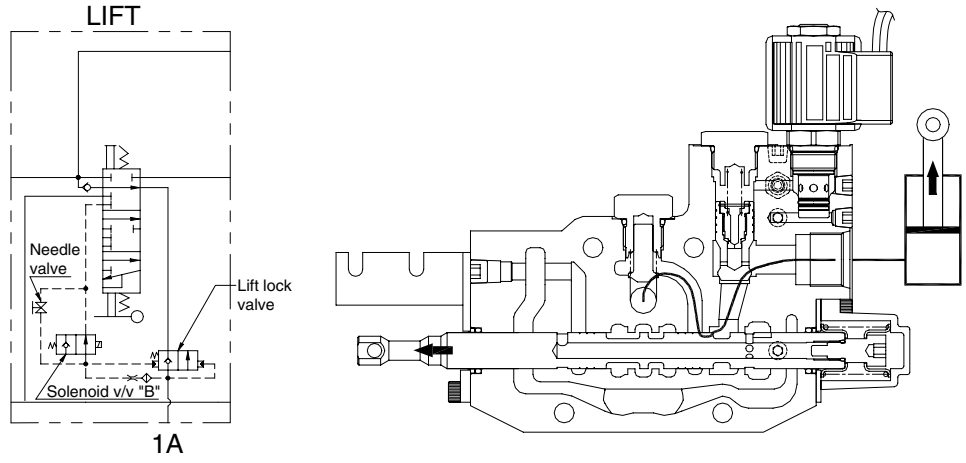
(1) Operation

The lift section has a single work port to direct flow to the lift cylinder. Only one work port is used, because the lift cylinder is single-acting(gravity returns the mast to the lowered position).

The lift section also contains part of the components which comprise the safety features. There is a lift lock check valve. At the neutral position, pressures in the lock valve are equalized across the lift lock poppet. In this manner, the spring bias keeps the lift lock valve closed and prevents lowering of the mast.

① Lifting

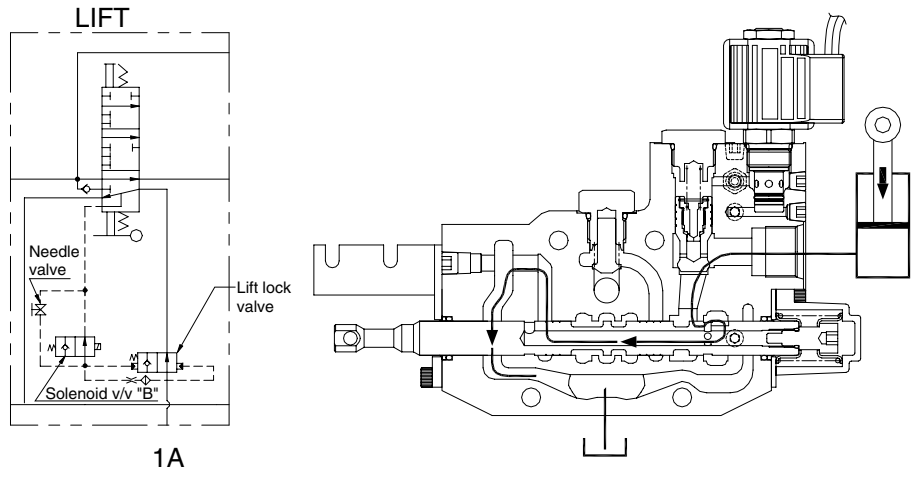
When the operator shifts the lever backwards, the spool is extended out of the valve, and this opens the internal fluid passages that lift the mast. Oil flows through the high pressure parallel cavity, past the load check valve, through the spool metering notches, past the lift lock check valve, and to the head side of the lift cylinder.



22B7HS11S

② Lowering

When the seated operator shifts the lever forwards, the spool retracts into the valve, and the oil is directed from the cylinder, past the lift lock check valve, past the spool metering notches, and to the common tank cavity.



22B7HS12S

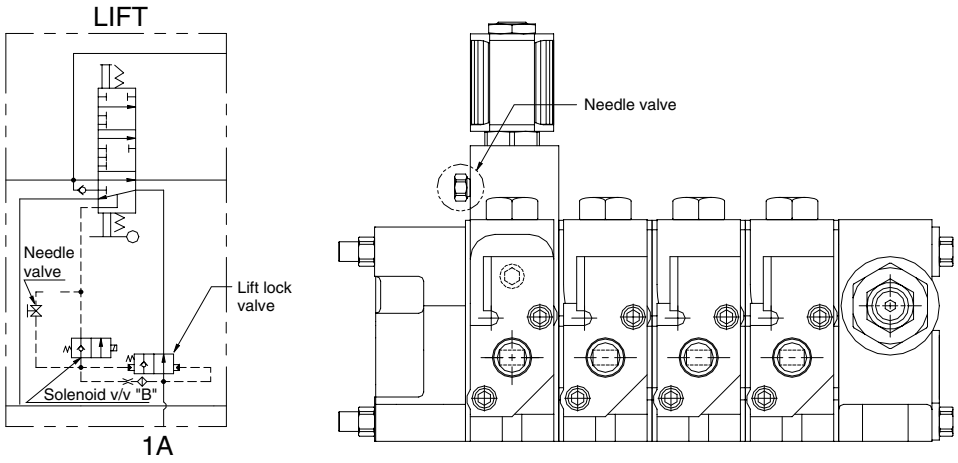
Pressure is limited by the main relief valve.

③ **Secondary lowering method** : A secondary lowering method is available in the event of the loss of battery power that is needed to energize the normally closed solenoid valve.

Important note : Before opening the secondary needle valve, make sure personnel and equipment are safely positioned to avoid accidents. Be careful to operate this secondary valve slowly, as heavy loads may be suspended.

A manual valve(needle valve) is located on the lift section, and it can be operated by opening the vehicle cowling and rotating the manual valve(needle valve) counterclockwise with a wrench.

Open the manual valve (needle valve) approximately 2 turn (do not rotate more than 3 turns). Then shift the lift spool slowly for controlled lowering. This should be just enough for slow, controlled movement of the mast.



22B7HS12AS

Pressure is limited by the main relief valve.

5) TILT SECTION

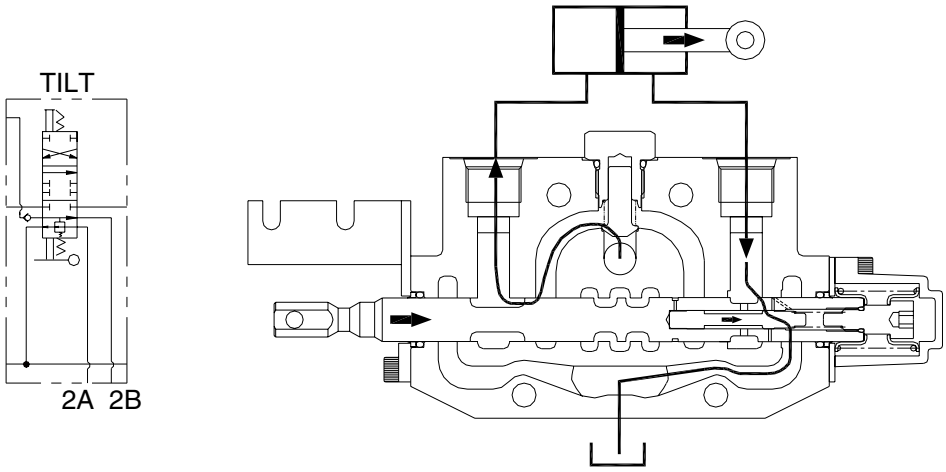
(1) Operation

The tilt spool contains an internal plunger which acts to stop tilt forward actuation when the battery power is off.

① Tilt forward

When the seated operator shifts the lever forward, pressure is applied to the head of the tilt cylinder, and the forks tilt forward. Oil is directed from the high pressure parallel passage past the load check valve, past the spool metering notches, and towards the cylinder head.

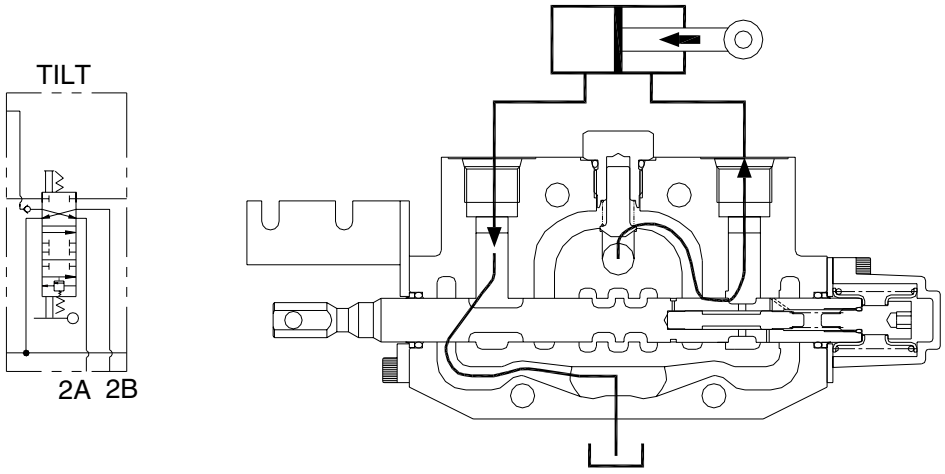
Simultaneously, the high pressure acts upon the end of the tilt lock plunger to move it towards the spring end of the spool. This plunger movement opens additional spool metering notches which control oil flow from the rod end of the cylinder to the tank return line.



22B7HS13

② Tilt Back

When the seated operator shifts the lever back, the high pressure oil from the parallel passage is directed past the load check valve, past the spool metering notches, and to the rod side of the cylinder. Exhaust oil from the head side of the cylinder is directed past the spool metering notches to tank.



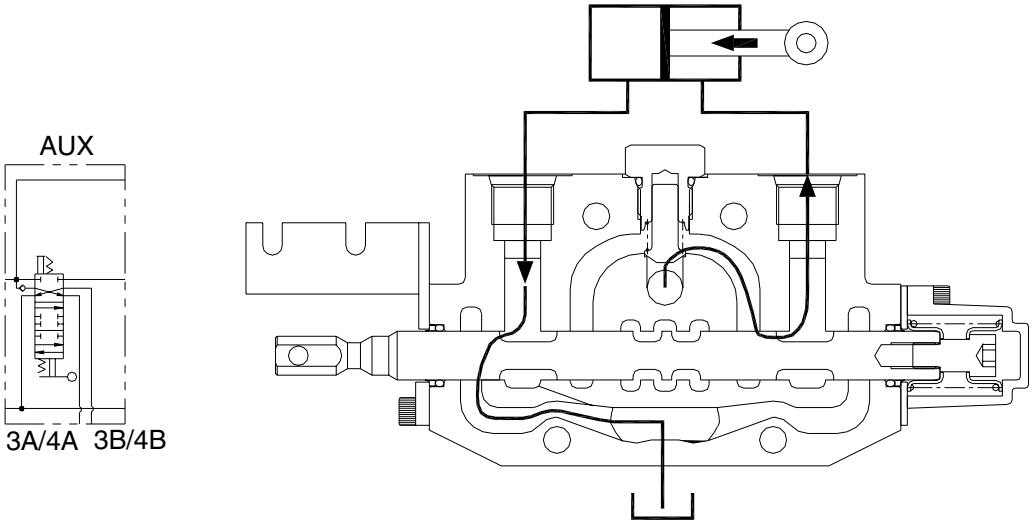
22B7HS14

Pressure is limited by the main relief valve.

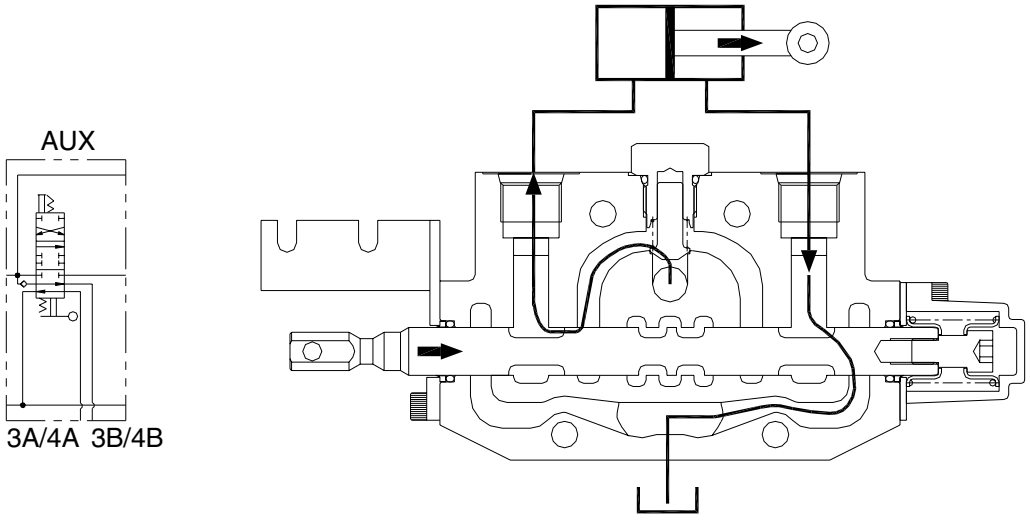
6) AUXILIARY SECTIONS

(1) Operation

Many different functions can be controlled by the auxiliary spool sections. In general, one work port is pressurized by high pressure oil from the parallel passage, past the load check valve, past the metering notches, and to the cylinder. Simultaneously, oil from the other work port is directed across the spool metering notches to tank.



22B7HS15



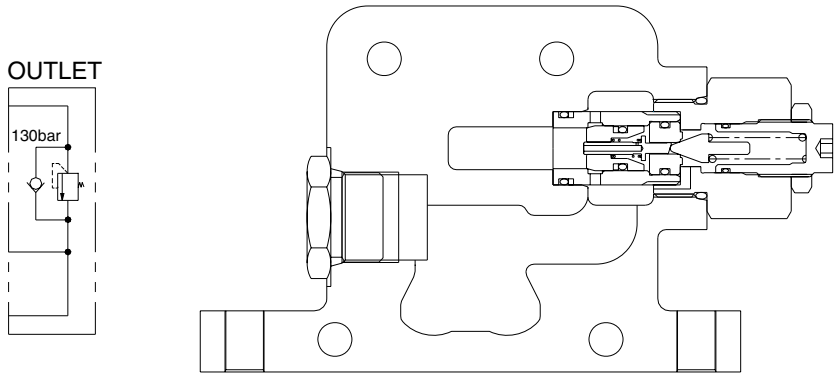
22B7HS16

Pressure is limited by the secondary main relief valve.

7) OUTLET SECTION

(1) Operation

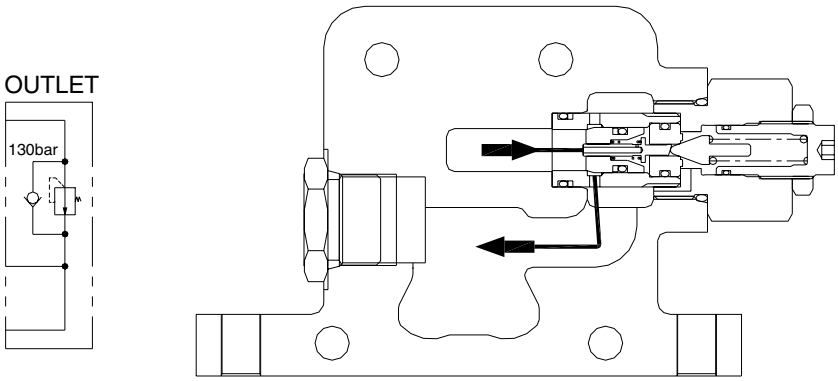
The outlet section contains the tank port and the secondary relief valve(with built-in anti-cavitation feature).



22B7HS17

(2) Operation of relief valve at setting pressure

When the pressure at outlet reaches to setting pressure, the pilot poppet which is in the main relief valve is opened by pressure. At this condition the flow divert from the pump directly to the tank line.

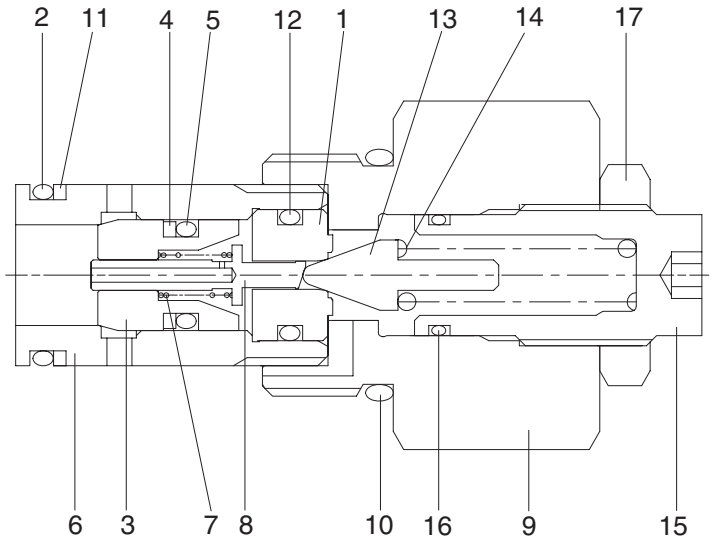


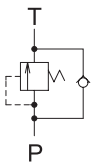
22B7HS18

8) MAIN RELIEF VALVE

This valve is a type of pilot piston to prevent hydraulic components and pipes from being broken by high pressure so, it keeps under pressure limited.

Relief valve pressure varies by 130kgf/cm² in accordance with 1 revolution of adjust bolt.





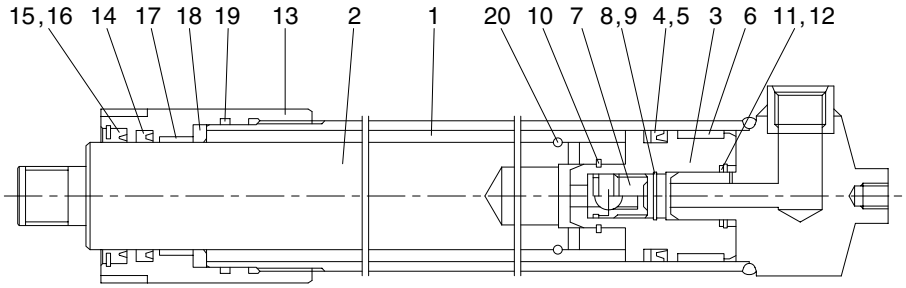
· Main relief valve : 150 kgf/cm²

· Auxiliary relief valve : 130 kgf/cm²
(For 3,4 spool only)

10BTR9HS20

1	Pilot seat	7	Main spring	13	Pilot poppet
2	O-ring	8	Piston	14	Pilot spring
3	Main poppet	9	Body	15	Adjust screw
4	Back up ring	10	O-ring	16	O-ring
5	O-ring	11	Back up ring	17	Lock nut
6	Socket	12	O-ring		

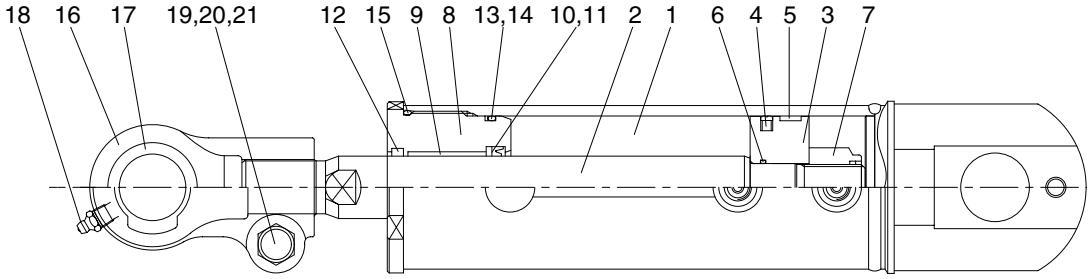
4. LIFT CYLINDER



10BTR9HS18

1	Tube assembly	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Rod bush
4	U-packing	11	Cushion seal	18	Spacer
5	Back up ring	12	Retaining ring	19	O-ring
6	Wear ring	13	Rod cover	20	Stop ring
7	Check	14	U-packing		

5. TILT CYLINDER



10BTR9HS07

1	Tube assembly	8	Rod cover	15	O-ring
2	Rod	9	Rod bush	16	Eye
3	Piston	10	U-packing	17	Spherical bearing
4	Piston seal	11	Back up ring	18	Grease nipple
5	Wear ring	12	Dust wiper	19	Hex bolt
6	O-ring	13	O-ring	20	Spring washer
7	Hex nylon nut	14	Back up ring	21	Lock nut

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

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

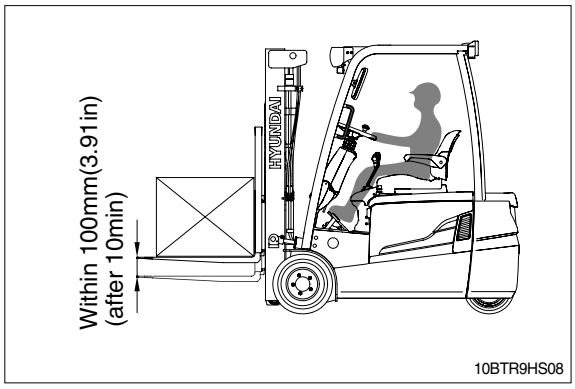
(2) Set mast vertical and raise 1m from ground. Wait for 10 minutes and measure hydraulic drift(amount forks move down and amount mast tilts forward).

· **Check condition**

- Hydraulic oil : Normal operating temp (50°C)
- Mast substantially vertical.
- Rated capacity load.

· **Hydraulic drift**

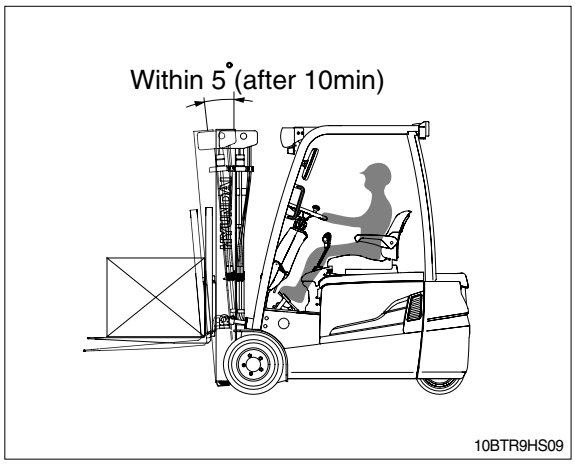
- Down(Downward movement of forks)
: Within 100mm (3.9in)
- Forward(Extension of tilt cylinder)
: Within 5°



(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)

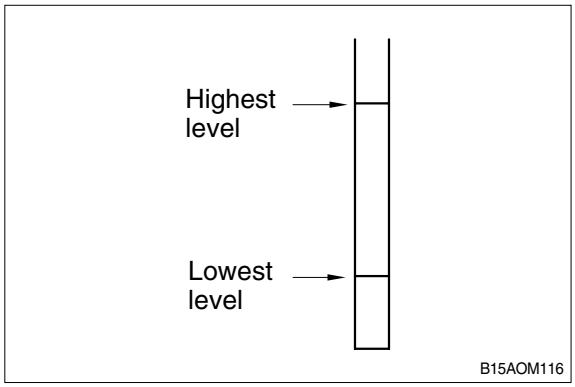
Standard	Under 0.6 (0.02)



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 1000 hours)



3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.
Check that oil pressure is 150kgf/cm^2.
(2130psi)

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 ISO VG46. · 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 ISO VG46. · Clean filter.

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 D, E or K stuck open or contamination under seat.	· Check for foreign matter between poppets D, E or K and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged. · Poppet C sticking in D.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See *Test of main control valve.
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) LIFT CYLINDER

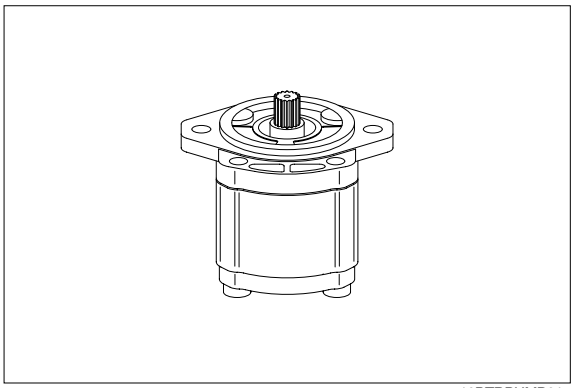
Problem	Cause	Remedy
Oil leaks out from rod cover through rod	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder rod cover thread	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract	· Scores on inner surface of tube. · Unallowable score on the inner suface 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.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

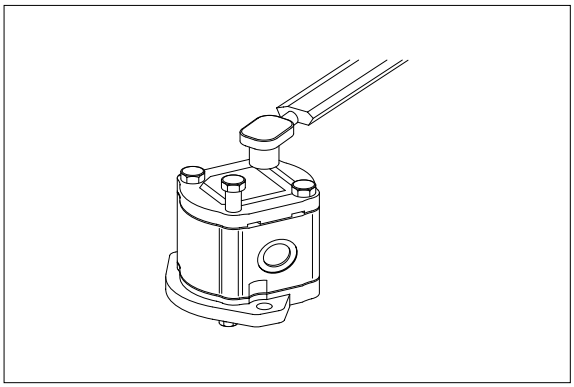
1) DISASSEMBLY

(1) Throughly clean the outside of the pump so that it can not remain the foreign material on the pump.



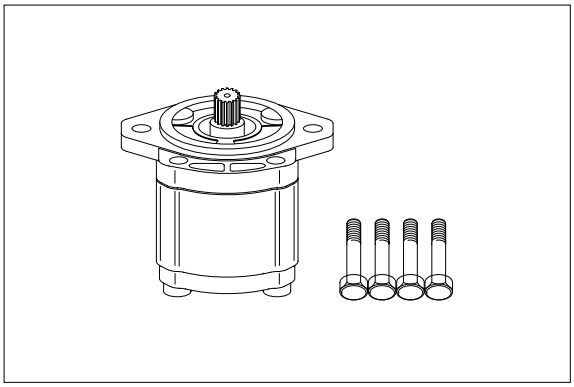
10BTRPUMP01

(2) Loosen and remove the bolts (4EA) from the pump cover.



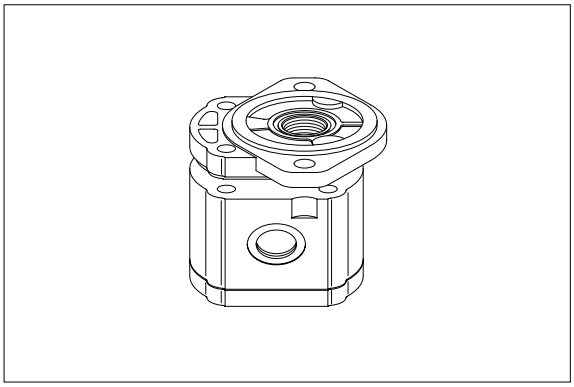
10BTRPUMP02

(3) Remove the sharp edge of the drive shaft and smear a clean grease on the shaft end to prevent any damage from the lip of the oil seal when removing the housing. (It should be carried out above work when it is necessary for replacing the oil seal)



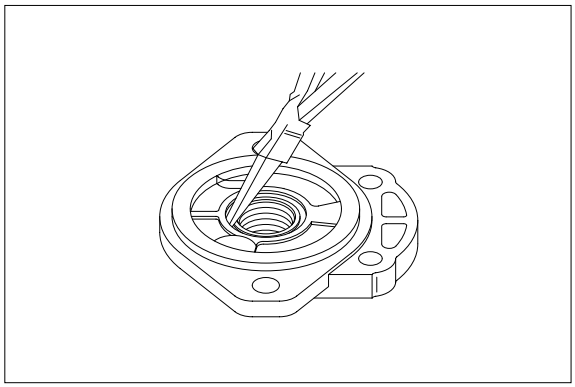
10BTRPUMP03

(4) Disassemble the housing to take care of keeping the shaft as straight as possible during removal.
If the housing is stuck to the drive shaft, tap around the edge with the rubber hammer in order to break away from the body.
At this time, it should be kept to remain assembly position for the shaft and other components while removing the mounting flange.



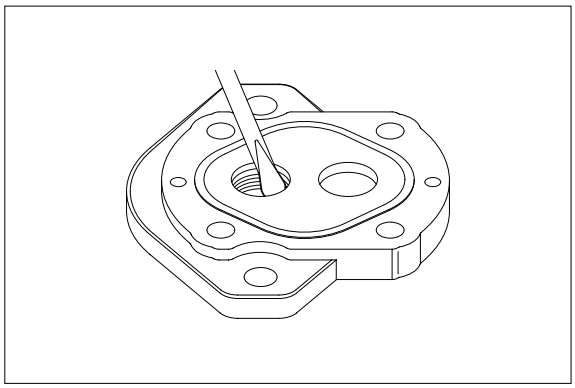
10BTRPUMP04

(5) Take off the snap ring using the proper tool. (If should be carried out above work when it is necessary for replacing the oil seal)



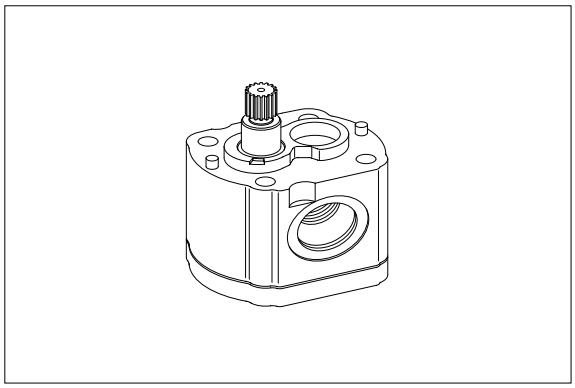
10BTRPUMP05

(6) Remove the oil seal from the cover to pay keen attention to do not damaging the surface of the shaft hole. (It should be carried out above work when it is necessary for replacing the oil seal)



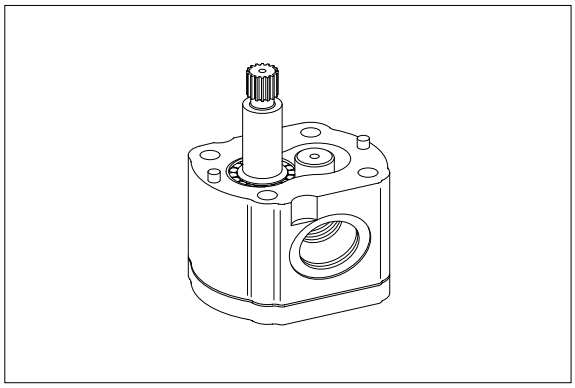
10BTRPUMP06

(7) Remove the side plate after lifting up the drive gear so that it can remove easily the side plate to the upward.



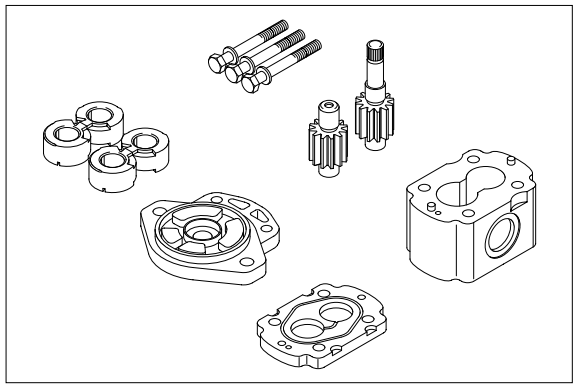
10BTRPUMP07

(8) Disassemble the drive gear and the idle gear. At this time, pay keen attention to keep as straight as possible for the gear shaft to the hole of the housing.



10BTRPUMP08

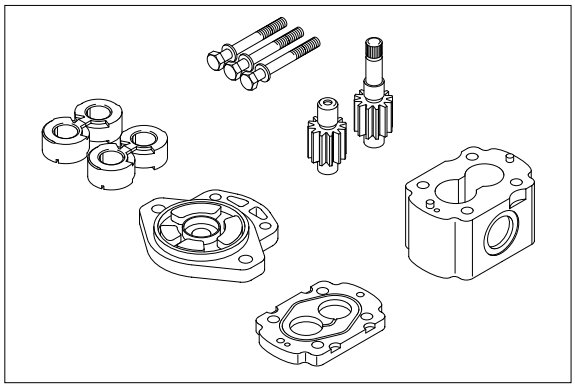
(9) Disassemble the rear cover and side plate of the lower side from the pump housing.



10BTRPUMP09

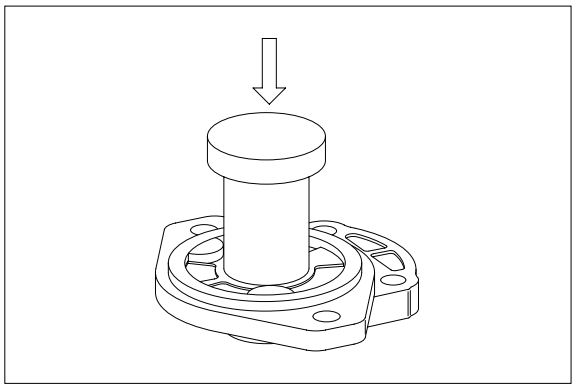
2) ASSEMBLY

(1) Throughly clean the components of the pump so that it can not remain the foreign material on the components.



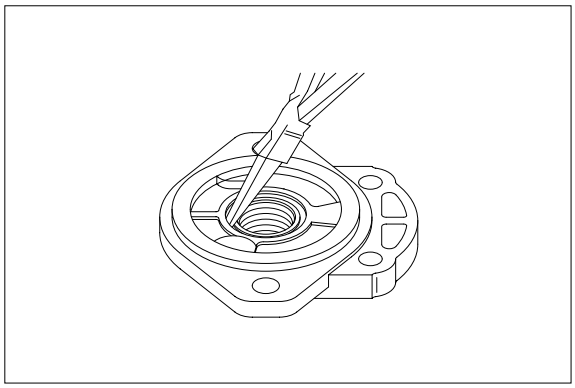
10BTRPUMP09

(2) Insert the oil seal carefully and fix it inside of the mounting flange using the proper tool.



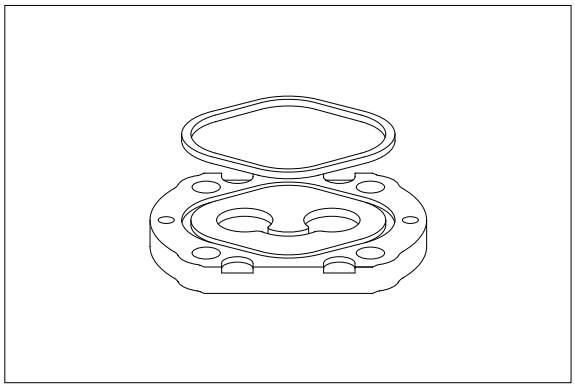
10BTRPUMP10

(3) Fit the snap ring in pre-arranged position using the proper tool.



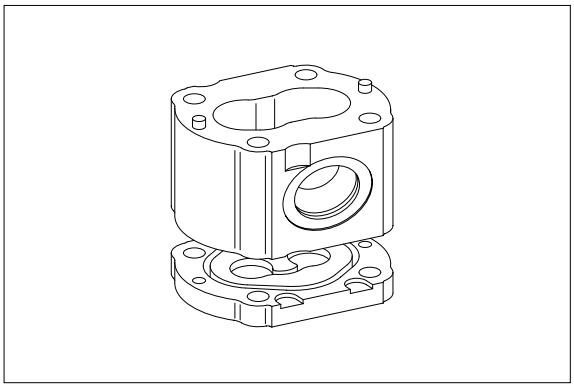
10BTRPUMP05

(4) Insert the square seal in the right position of the rear cover.
Smear clean grease on the square seal to prevent it from taking off the rear cover when it is assembled.



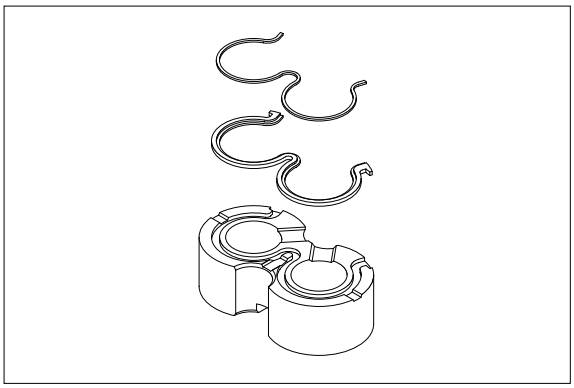
10BTRPUMP11

(5) Insert the pin in pre-arranged position of the rear cover after fitting the pin in the bottom side of the body.



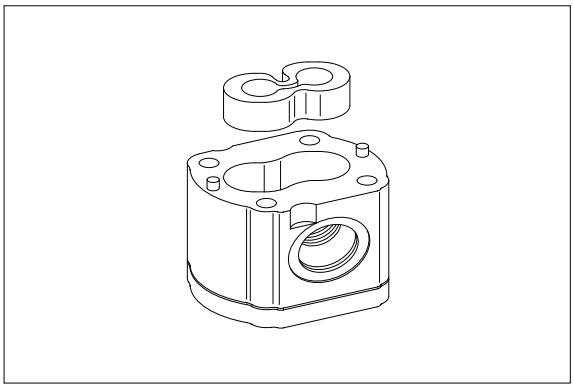
10BTRPUMP12

(6) Insert the E-seal in the right position of the side plate.
After that, fit the back up ring in the groove of the E-seal.
Apply clean grease on the E-seal. (It is same as the side plate and back up ring.)



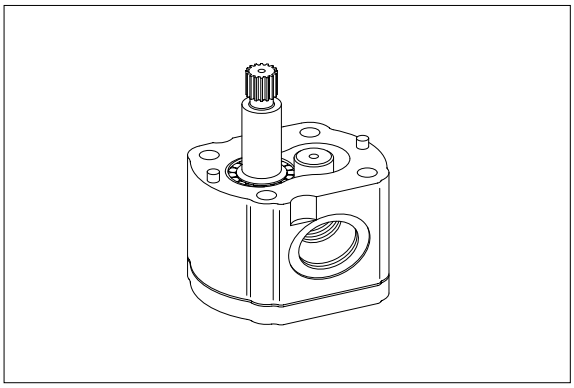
10BTRPUMP13

(7) Insert side plate assembly in the body to keep as straight as possible.
When assembling the side plate assembly, it should be assembled the seal side to the rear cover that is the opposite side to the gear.
Take care to the direction of the seal.



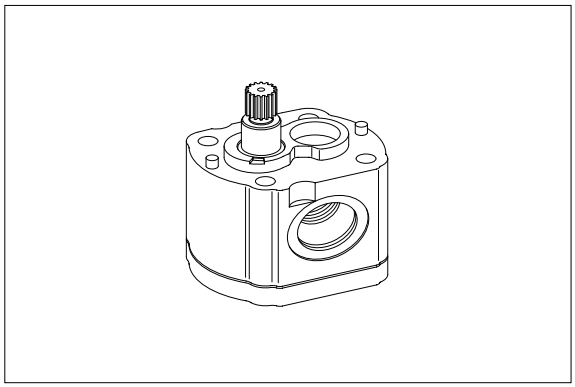
10BTRPUMP14

(8) Insert the drive gear and the idle gear in the pump housing.



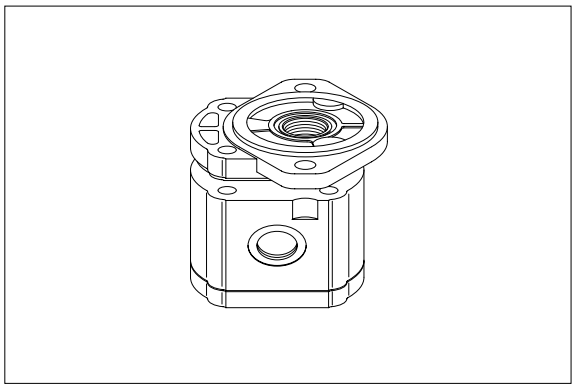
10BTRPUMP08

(9) Insert the side plate in the body to take care of direction of the side plate.



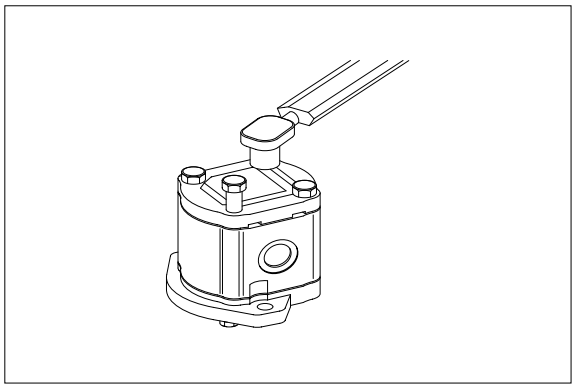
10BTRPUMP07

(10) Assemble the cover on the pump housing.



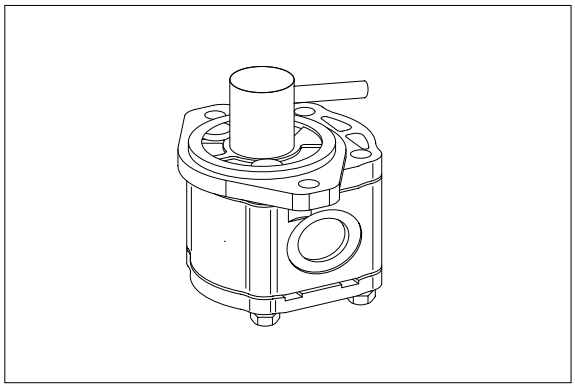
10BTRPUMP04

(11) Tighten alternately the bolts one after another in a diagonal direction order with 45~48Nm torque value after inserting the washer.



10BTRPUMP02

(12) When turning the drive shaft by hand, make sure that it can be rotated freely.
If it is not, it could be pinched E-seal between the shaft of drive gear and side plate by taking the E-seal from the groove of the side plate.



10BTRPUMP15

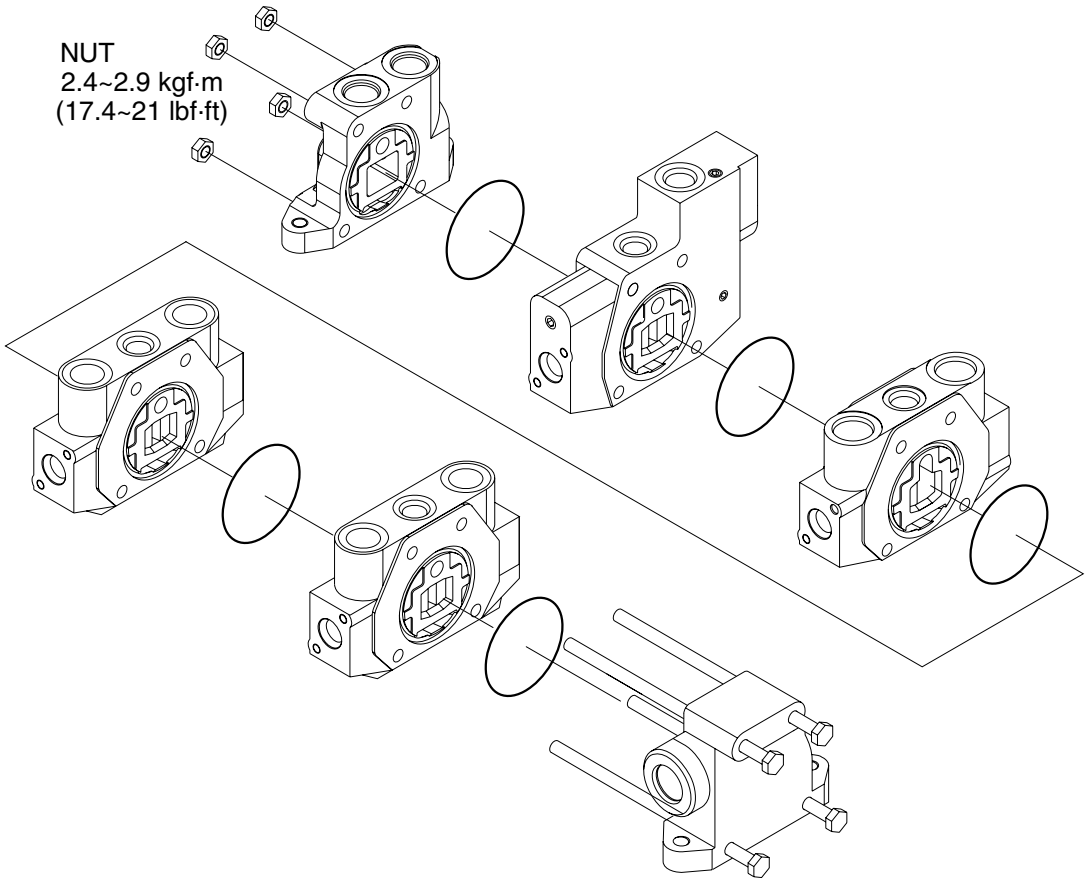
2. MAIN CONTROL VALVE (with OPSS)

1) ASSEMBLY

(1) General

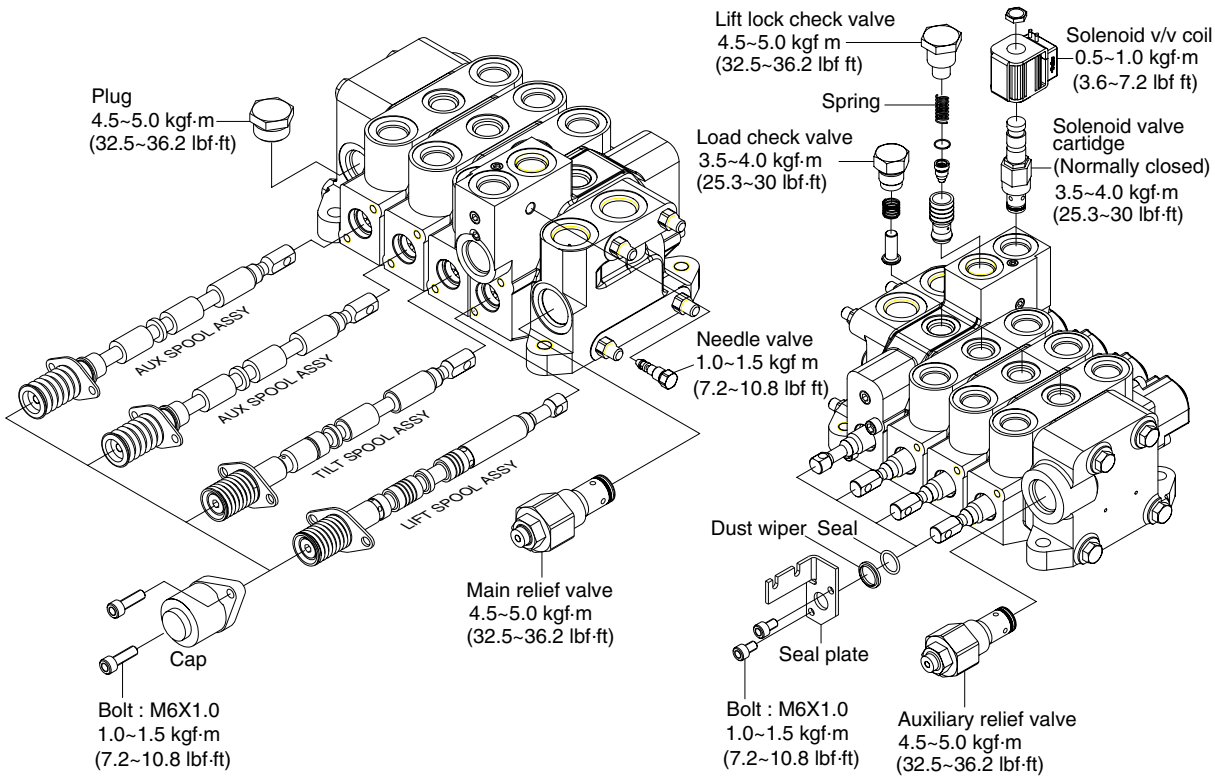
① Ensure that the assembly area will be clean and free of contamination.
② Use a flat(within 0.2㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.
④ Additional auxiliary valve sections may be added to the main control valve in a similar manner as indicated below.

(2) Block subassembly



22B7HS21

① Attach all the O-rings to the appropriate grooves between the spool sections.
② Stack the valve sections such that all the work ports are facing up, the spool ends are all in the same direction, and they are resting on a flat(within 0.2㎜), uniform surface.
③ Insert all the tie rods through the drilled holes in each of the housings.
④ Press the sections together, being carefully not to damage sealing surfaces or seals.
⑤ Install nuts to both ends of all tie rods and progressively torque in a circular pattern until reaching a torque of 2.4~2.9㎏f · ㎝(17.4~21㏈f · ft) on all tie rods. Periodically, make sure that the valve remains flat while applying torque.



15BT9HS25S

(3) Inlet section

① Install the main relief valve assembly into the lower side cavity of the inlet section, as illustrated. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft).

② Install the plug assembly in the tank port of the inlet section. Torque to 4.5~5.0kgf · m (32.5~36.2lbf · ft)

(4) Lift section

① The spool assembly should already consist of the lift spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

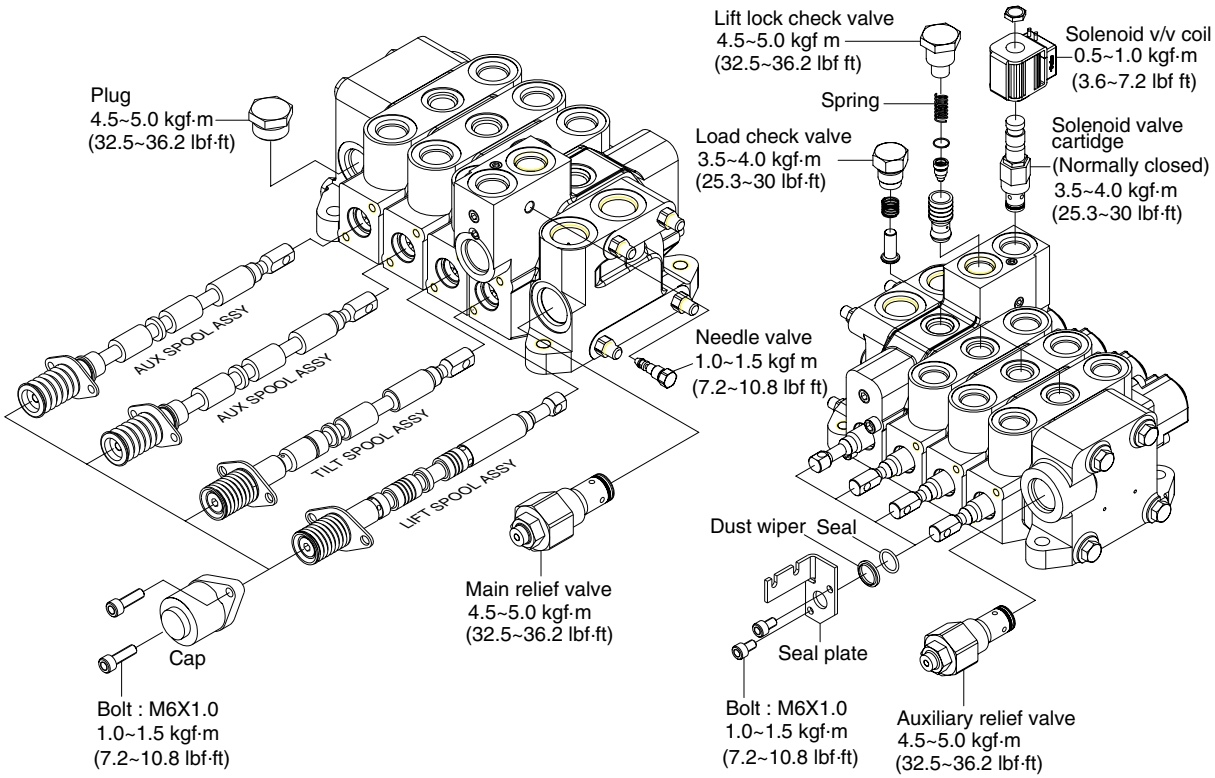
③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft)

⑤ The normally closed solenoid is installed in the rightmost cavity on the top of the section. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft)

⑥ Install the lift lock check valve assembly in the remaining open cavity in the top of the housing. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft)

⑦ Install the needle valve subassembly in the cavity on the inlet-facing surface of the housing. Torque to 1.0~1.5kgf · m (7.2~10.8lbf · ft)



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(5) Tilt section

① The spool assembly should already consist of the tilt spool(with tilt plunger and spring inserted into the bore on the spring end), the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

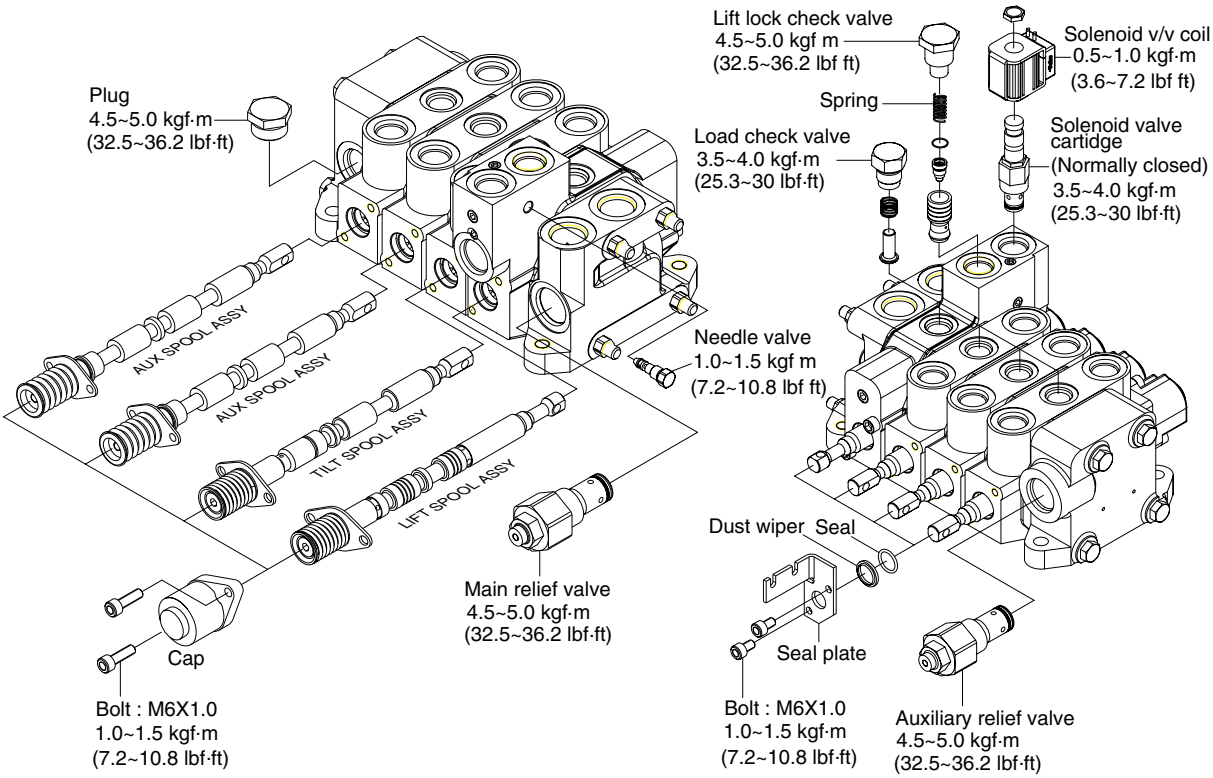
② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).

⑤ Install the anti-cavitation check valve in the housing cavity on the clevis end directly above the spool assembly. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft).

⑥ Install the plug in the housing cavity above the spool assembly. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).



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(6) Auxiliary section

※ Same procedure for all aux sections, but spool assembly components may vary.

① The spool assembly should already consist of the proper aux spool, the return spring, one spring seat on either end of the spring, the seal plate, a spool seal, and a dust wiper. All of these are assembled on the end of the spool opposite the clevis.

② Insert the clevis end of the spool into the right-hand side of the spool bore(the tallest end of the housing). Place the spool cap over the spool and spring assembly and connect the cap to the housing using two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m (7.2~10.8lbf · ft) is reached on both bolts.

③ Install the second spool seal and dust wiper over the clevis end of the spool and retain with a seal plate and two bolts. Torque both bolts alternatively until a torque of 1.0~1.5kgf · m(7.2~10.8lbf · ft) is reached on both bolts.

④ The load check assembly is inserted into the top center cavity. Torque to 3.5~4.0kgf · m (25.3~30lbf · ft).

(7) Outlet section

① Install the secondary main relief valve into the cavity on the clevis end of the housing. Torque to 4.5~5.0kgf · m(32.5~36.2lbf · ft)

2) DISASSEMBLY

(1) General

① Subassemblies (such as relief valves, check valves, and spools) may be removed without having to loosen the tie rods and disassembling the entire valve.

② Disassemble the valve sections on a flat working surface.

③ Ensure that the disassembly area will be clean and free of contamination.

④ Keep the disassembly area neat to avoid loss or damage of parts.

(2) Disassembly

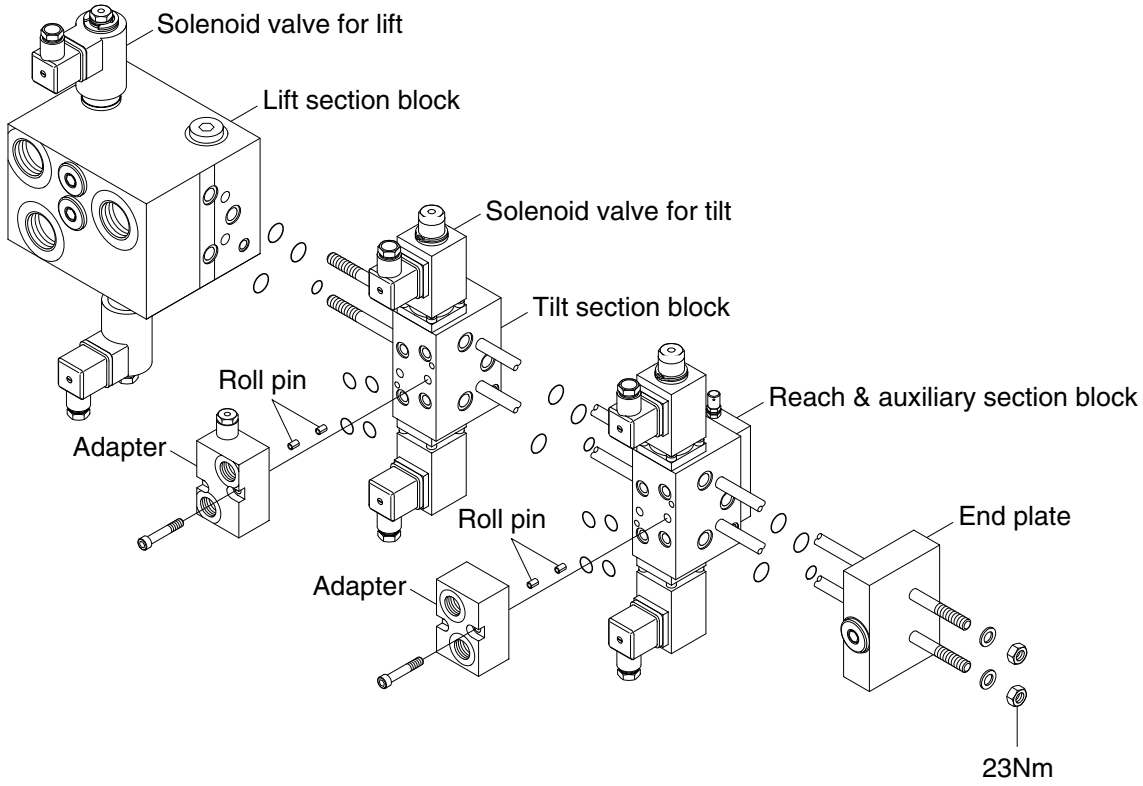
① Loosen the tie rod nuts and remove the tie rods from the valve sections.

② Remove O-rings between valve sections and set aside to avoid damage.

③ Spools, relief valves, load check valves, lift lock poppet, solenoid valves, and plugs can all be removed from the valve sections. Refer to the associated assembly procedures, above, for specific torque and handling details. Inspect and repair or replace the assemblies as complete units, as may be necessary.

④ Valve components are precision items, and care must be taken when handing them to avoid damage or the introduction of contamination that could adversely affect performance.

3. MAIN CONTROL VALVE



15BT9HS34

1) ASSEMBLY INSTRUCTION

(1) General

① Ensure that the assembly area will be clean and free of contamination.
② Use a flat(within 0.5㎜) work surface when bolting the valve sections together.
③ Use calibrated torque wrenches and instrumentation.

(2) Block subassembly

① Attach all the O-rings to the appropriate grooves between the spool sections.
② Stack the valve sections as below picture on a flat surface.
③ Insert all the tie rods through the drilled holes in each of the housings.
④ Press the sections together being careful not to damage sealing surfaces or seals.
⑤ Install nuts to tie rods and progressively torque in a circular pattern until reaching a torque of 2.3 kgf · cm^2(23Nm) on all tie rods.

(3) Lift block solenoid assembly

① The solenoide is installed upper side and below side cavities in lift block. Torque to 4.1kgf · cm^2
② (40Nm)
③ Install the O-ring, coil, O-ring and washer to the assemblied cartridge.
Insert the lock washer to the groove of the cartridge.

(4) Tilt & Auxiliary section assembly

① The solenoid is installed upper side and below side in tilt & auxiliary block with bolts.
Torque to 1kgf · m (10Nm)
② Install the coil, O-ring and washer to the assemblied cartridge.
③ Insert the snap ring to the groove of the cartridge.
④ Insert the roll pin to the pin hole on the front side of each block.
⑤ Place the O-rings in the O-ring grooves.
⑥ Insert the ancillary blocks to the each body with bolts.

2) DISASSEMBLY INSTRUCTION

(1) General

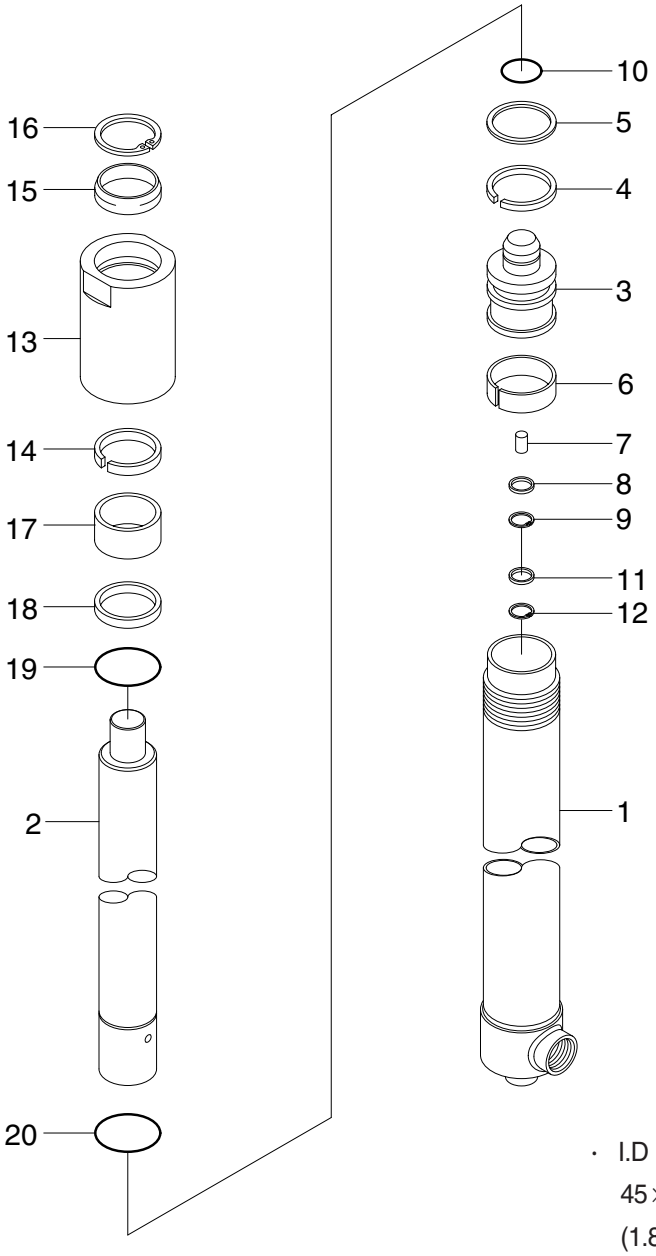
① Disassemble the valve sections on a flat working surface.
② Ensure that the disassembly area will be clean and free of contamination.
③ Keep the disassembly area neat to avoid loss or damage of parts.

(2) Perform the assembly in reverse order

① Remove the solenoid valves and ancillary blocks from the main blocks.
② Loosen the tie-rods from the valve section.
③ Remove the seals between valve section.
④ Valve components are precision items, and care must be taken when handing them to avoid damage or the introduction of contamination that could adversely affect performance.

4. LIFT CYLINDER

1) STRUCTURE



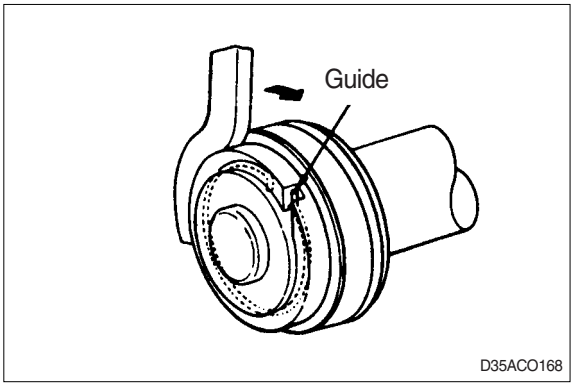
- I.D × O.D × Stroke (standard)
  45 × 55 × 1495mm
  (1.8 × 2.2 × 58.9 in)
- Rod O.D : 35mm (1.4 in)

15BT9HS14

1	Tube assy	8	Spacer	15	Dust wiper
2	Rod	9	Retaining ring	16	Retaining ring
3	Piston	10	Stop ring	17	Rod bush
4	U-packing	11	Cushion seal	18	Spacer
5	Back up ring	12	Retaining ring	19	O-ring
6	Wear ring	13	Rod cover	20	Stop ring
7	Check valve	14	U-packing		

2) DISASSEMBLY

(1) Hold the cylinder tube in a vice, loosen the cylinder head and remove it.
Remove the spacer from the cylinder tube and knock out the bushing. Hook a wrench in the hole in the retainer at the piston end and turn. Lever up the edge of the guide, then turn the guide in again and the guide can be removed.



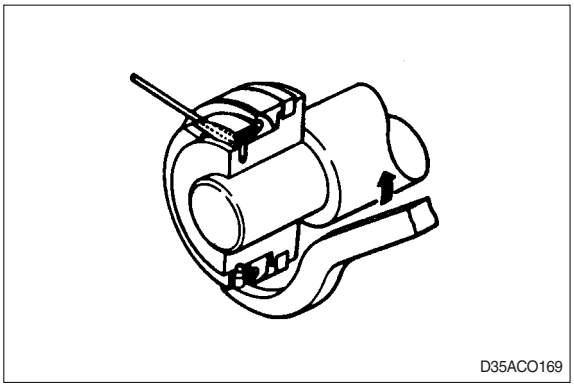
3) CHECK AND INSPECTION

mm(in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between piston ring & tube	0.05~0.030 (0.002~0.012)	0.5 (0.020)	Replace piston ring

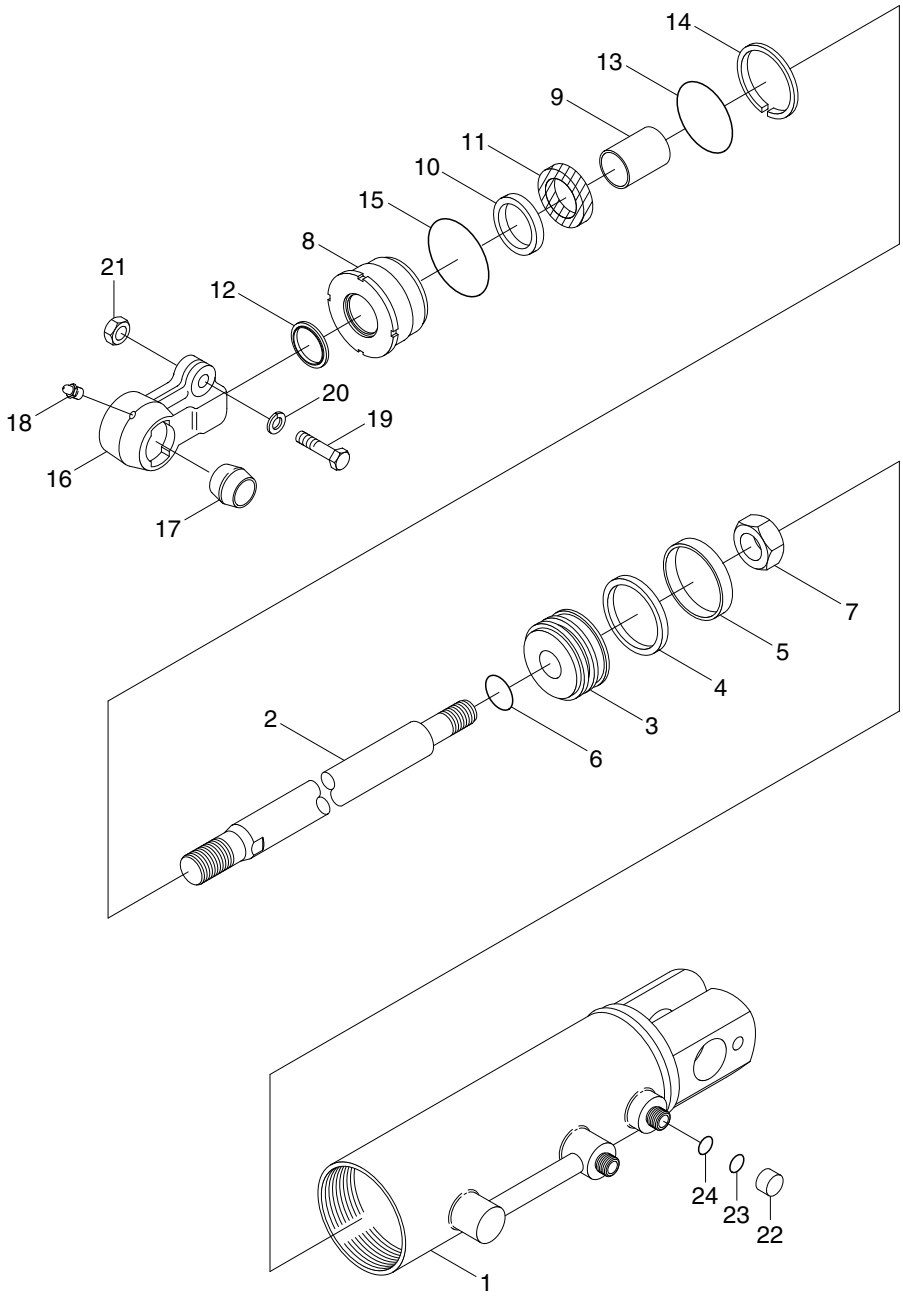
4) ASSEMBLY

(1) Soak the piston ring in hydraulic oil at a temperature of 40 to 50°C, expand the inside diameter and assemble on the piston. Install a piston seal.
Bend the edge of the guide and rotate it to install the guide completely.



5. TILT CYLINDER

1) STRUCTURE



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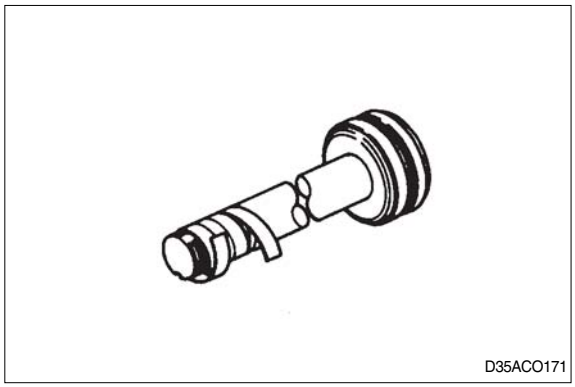
1	Tube assy	9	Bushing	17	Spherical bearing
2	Rod	10	Rod seal	18	Grease nipple
3	Piston	11	Back up ring	19	Hexagon bolt
4	Piston seal	12	Dust wiper	20	Spring washer
5	Wear ring	13	O-ring	21	Hexagon nut
6	O-ring	14	Back up ring	22	Dust cap
7	Nylon nut	15	O-ring	23	O-ring
8	Gland	16	Rod eye	24	O-ring

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.
When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.



3) CHECK AND INSPECTION

mm(in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing