SECTION 4 BRAKE SYSTEM

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GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

※ The brakes are operated by a pressure compensated, closed center hydraulic system.
Flow is supplied by a fixed displacement, gear type brake pump.

BRAKE SYSTEM

The fixed displacement brake pump supplies flow to the cut-off valve for service brake circuit and park brake circuits. It flows to three accumulator. The accumulator has a gas precharge and an inlet check valve to maintain a pressurized volume of oil for reserve brake applications.

Oil through the accumulator flows to the brake valves. The brake valve is a closed center design, dual circuit operated by a pedal.

Brake pump flow also goes to the parking brake solenoid valve in cut off valve.

The brake system contains the following components:

- Brake pump
- Parking brake solenoid valve in cut off valve.
- Cut-off valve
- Brake valve
- Accumulators
- Pressure switches

FULL POWER HYDRAULIC BRAKE SYSTEM

ADVANTAGES - The full power hydraulic brake system has several advantages over traditional brake actuation systems. These systems are capable of supplying fluid to a range of very small and large volume service brakes with actuation that is faster than air brake systems. Figure represents a time comparison between a typical air/ hydraulic and full power hydraulic brake actuation system.

Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated.

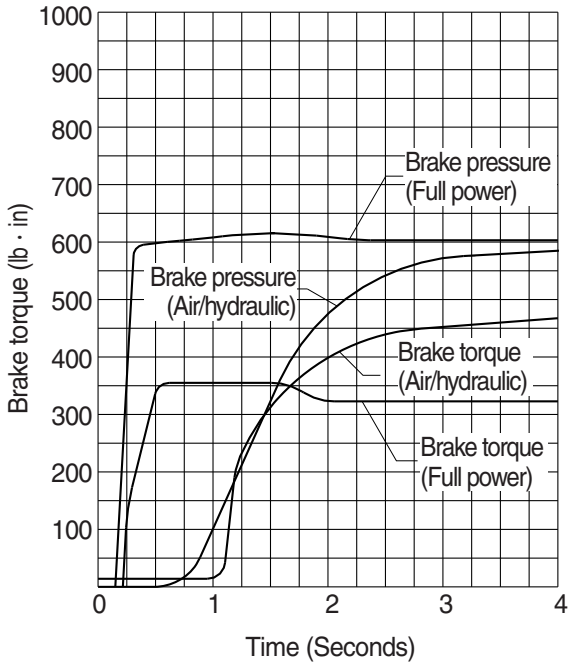
This is referred to as brake pressure modulation.

Another key design feature of full power systems is the ability to control maximum brake line pressure. In addition, because these systems operate with hydraulic oil, filtration can be utilized to provide long component life and low maintenance operation.

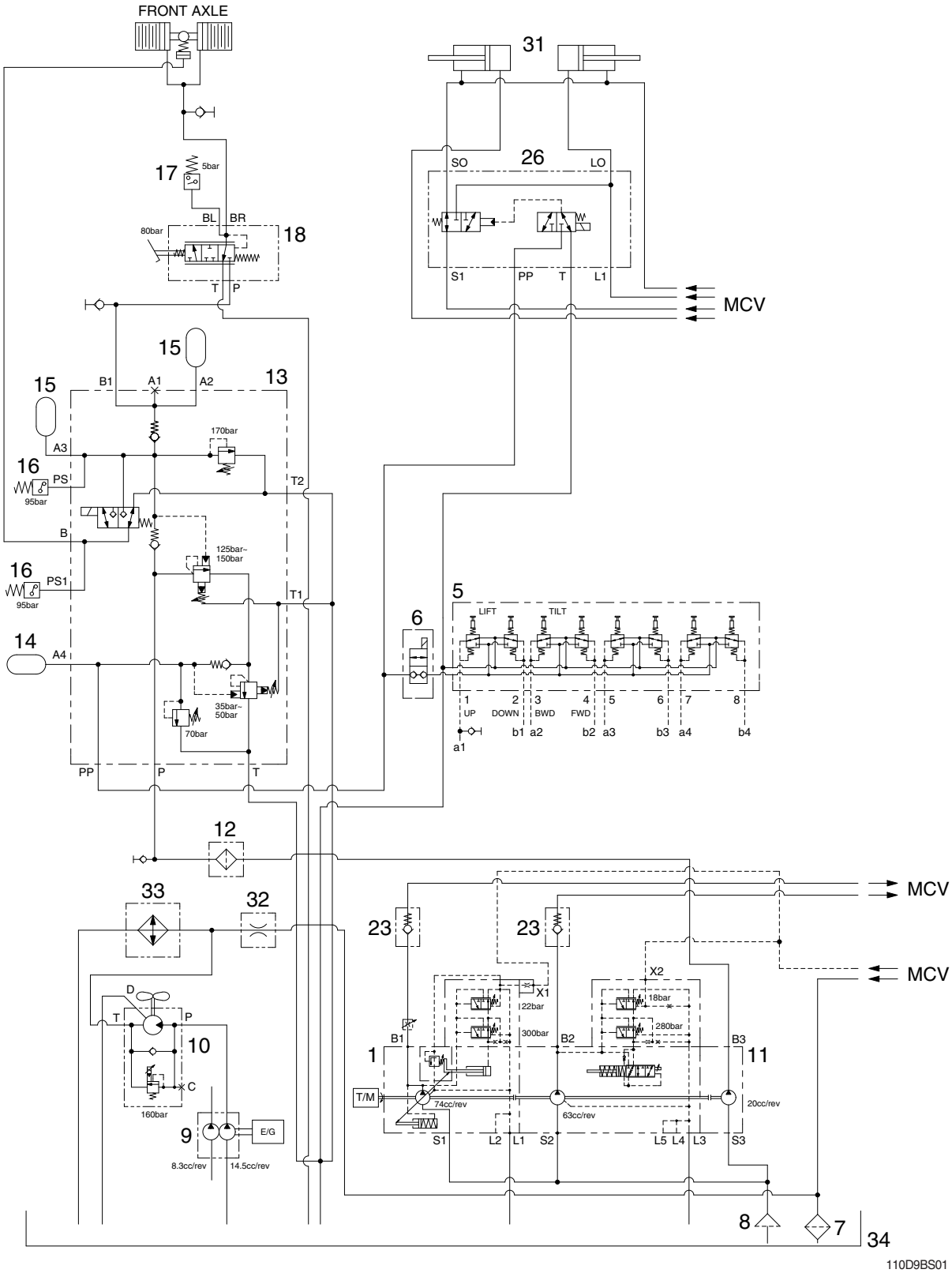
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the pump supplies the demands of the brake system as well as some secondary down stream hydraulic devise.

Another important note is that all seals within these system must be compatible with the fluid medium being used.

Response time
Full power brake actuation VS
Air/Hydraulic brake actuation



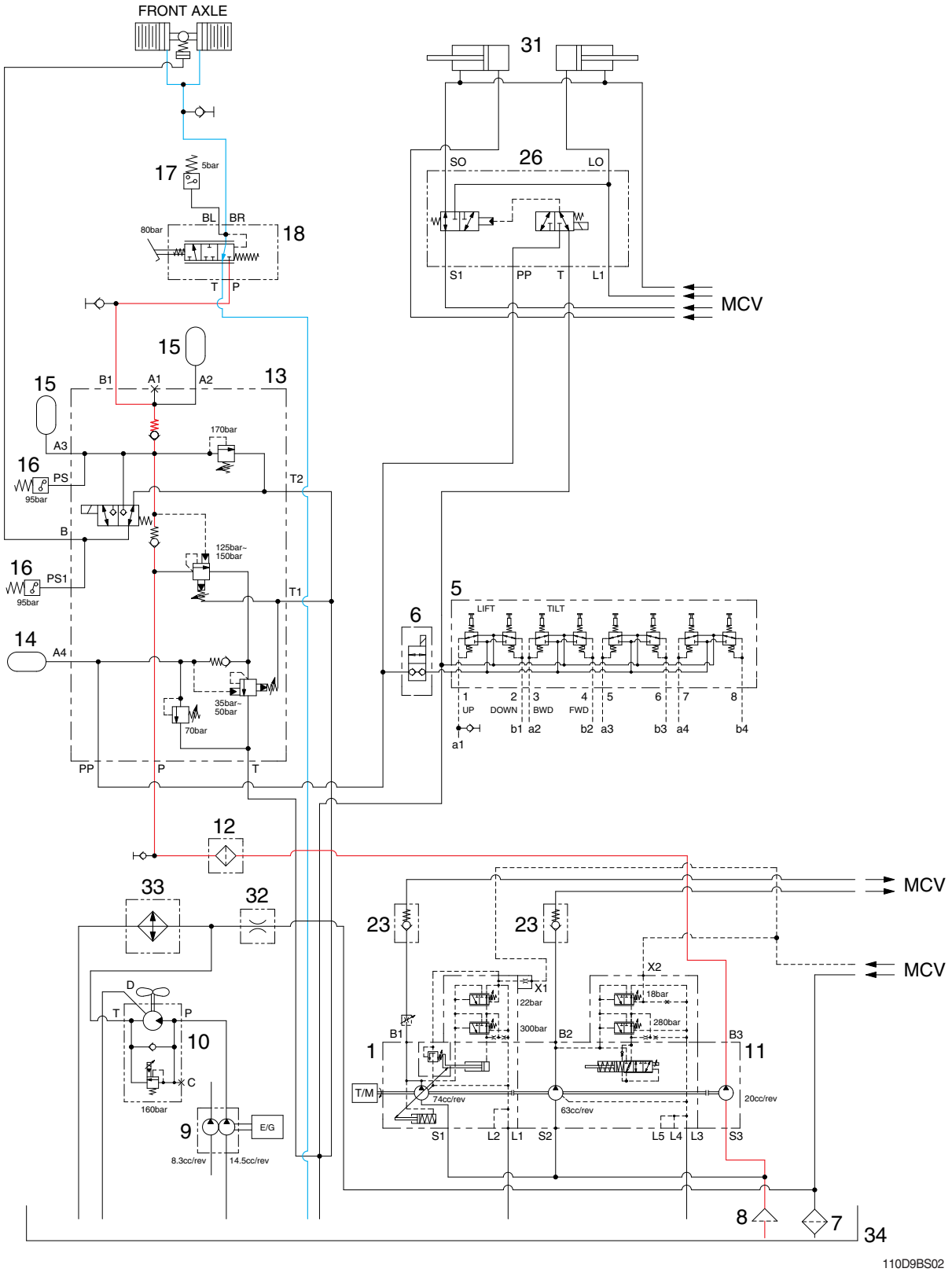
2. HYDRAULIC CIRCUIT



110D9BS01

1	Main pump	10	Fan drive motor	16	Pressure switch
5	RCV	11	Brake pump	17	Pressure switch
6	OPSS solenoid valve	12	Line filter	18	Brake valve
7	Return filter	13	Cut-off valve	26	Side shift solenoid valve (160D-9 only)
8	Suction strainer	14	Accumulator		
9	Fan drive pump	15	Accumulator	34	Hydraulic oil tank

1) SERVICE BRAKE RELEASED



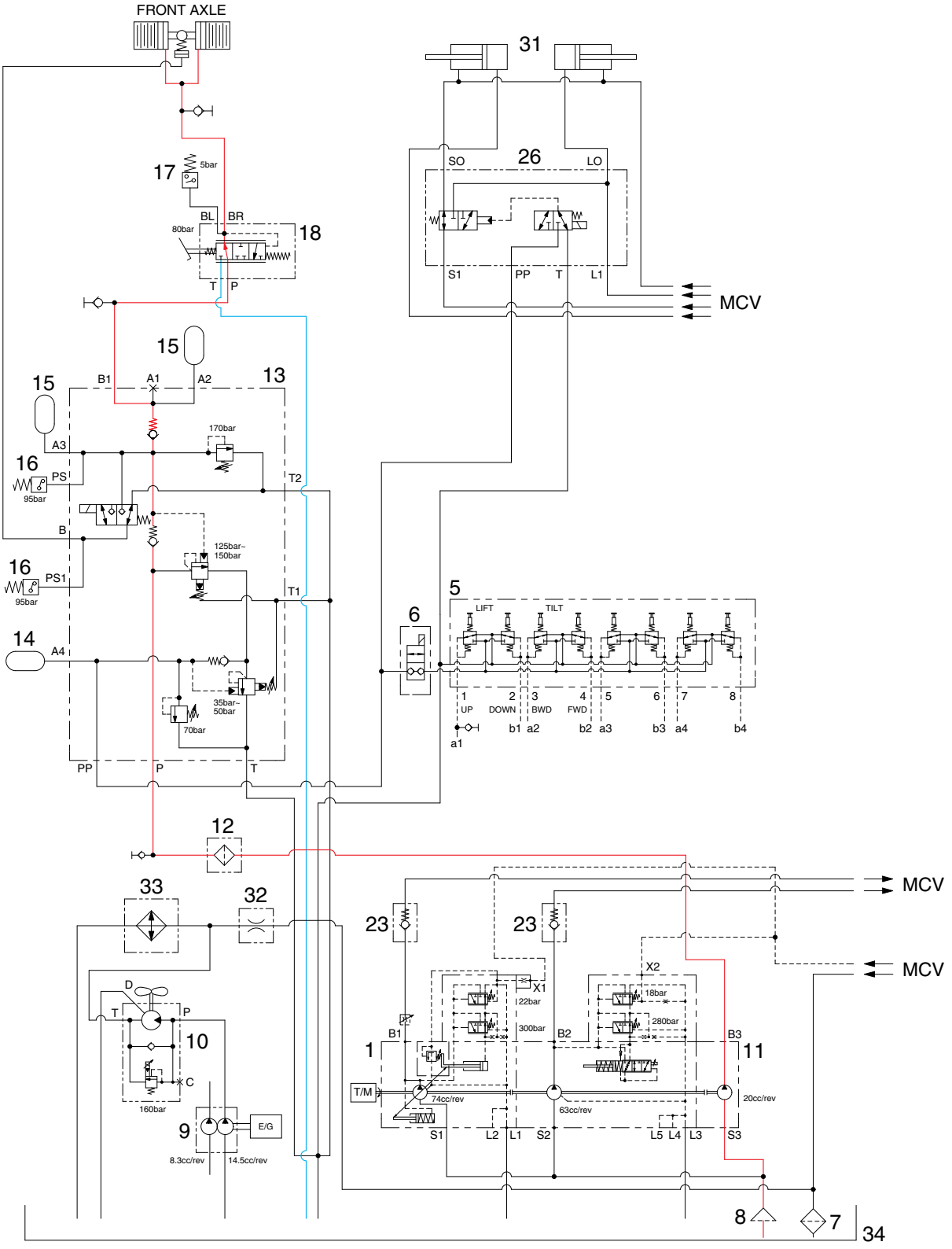
110D9BS02

When the pedal of brake valve (18) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank (34).

Therefore, the service brake is kept released.

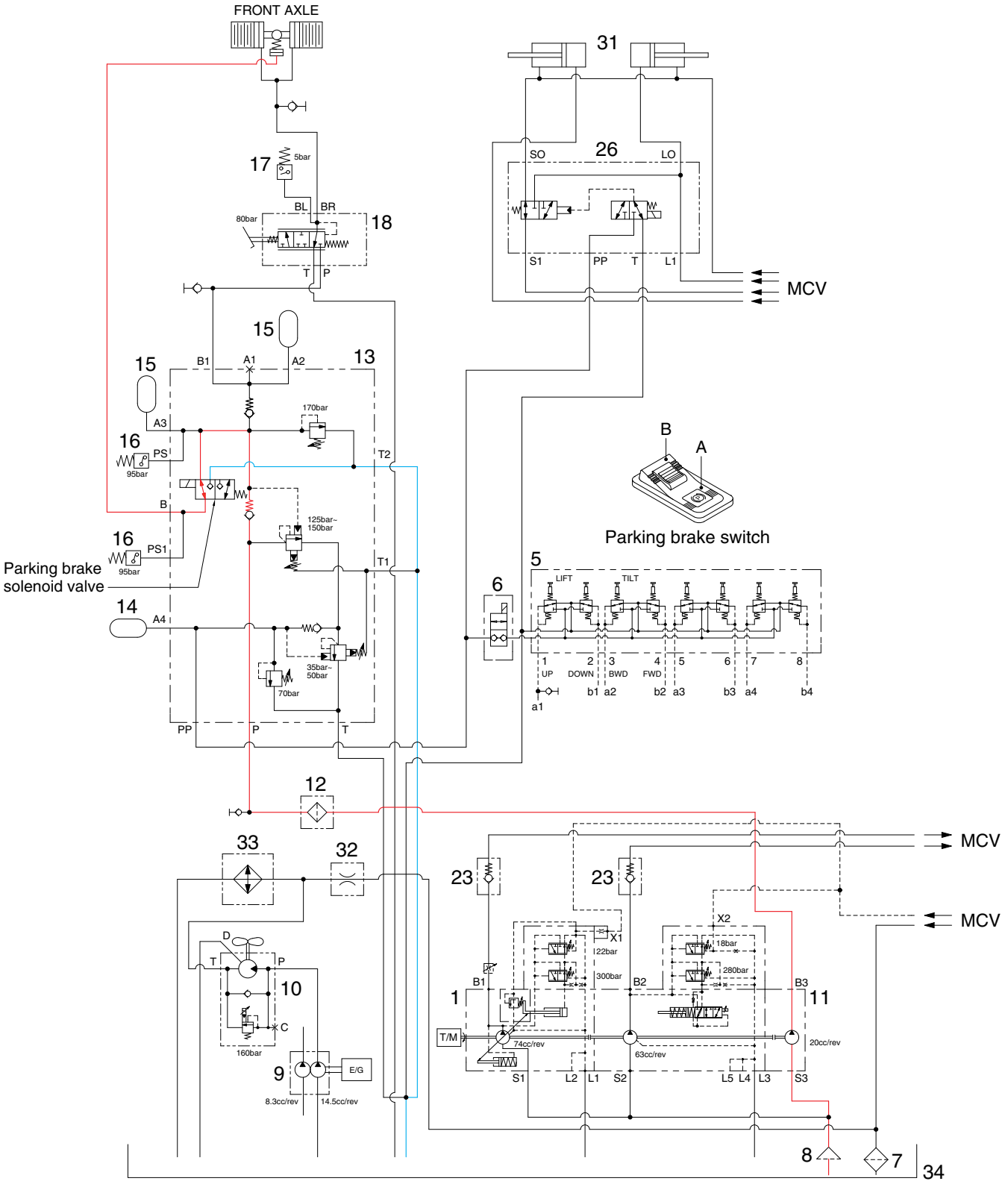
2) SERVICE BRAKE OPERATED



110D9BS03

When the pedal of brake valve (18) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve (13) enters the piston in the drive axles. Therefore, the service brake is applied.

3) PARKING BRAKE RELEASED

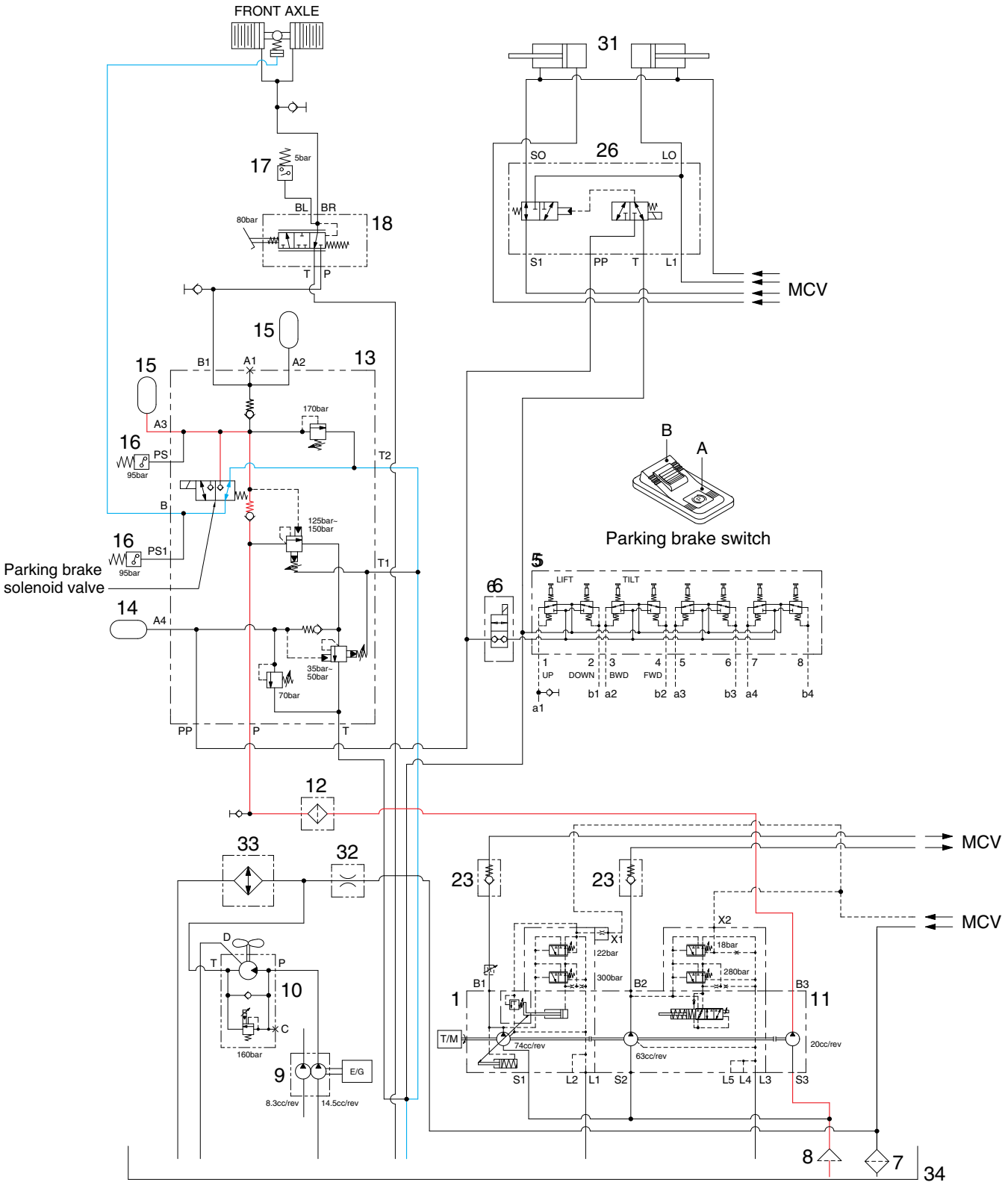


110D9BS04

When the parking brake switch is pressed B position, the solenoid valve is energized and the hydraulic oil controlled the pressure level by the cut-off valve (13) enters the parking brake. It overcomes the force of the spring and pushes the piston rod. This releases the brake.

Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

4) PARKING BRAKE OPERATED



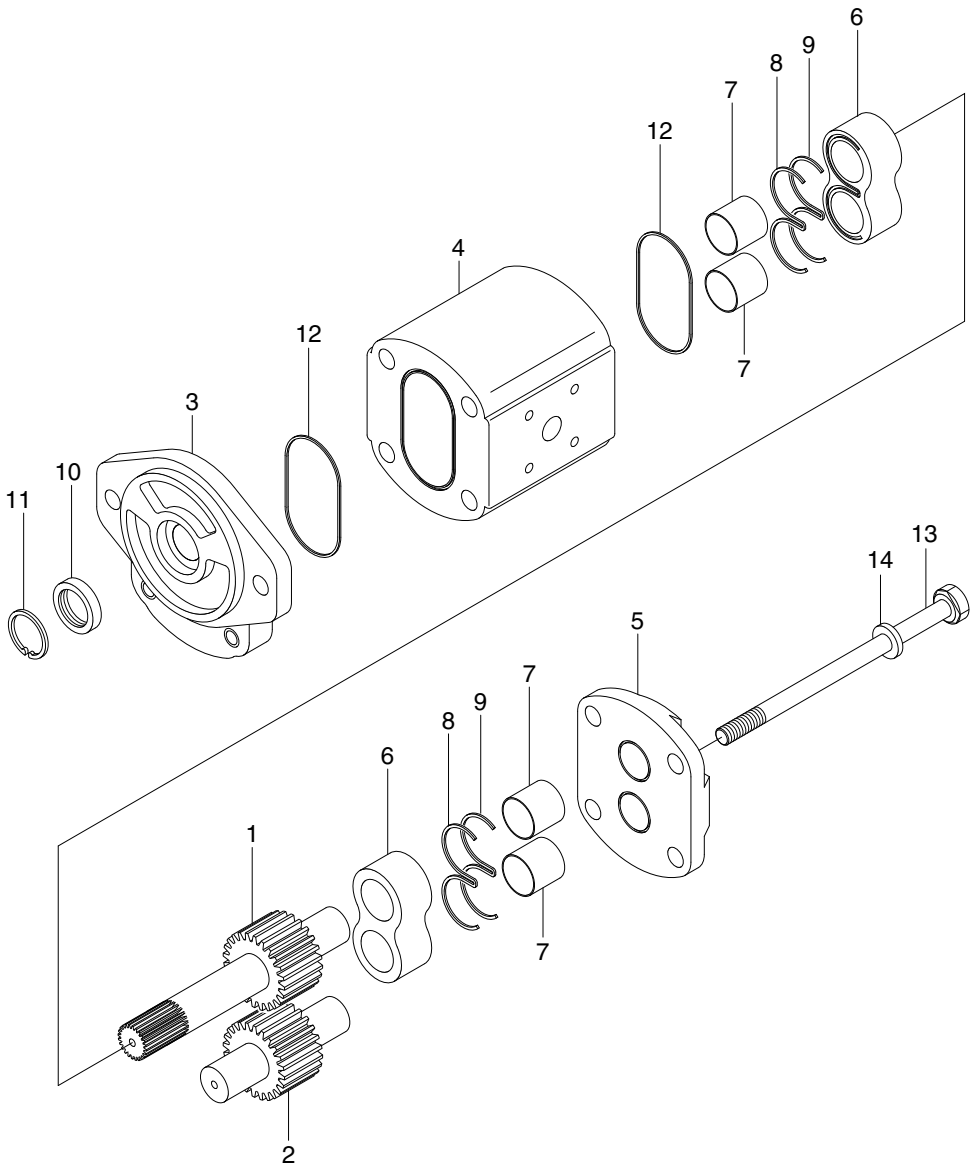
110D9BS05

When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

At the same time, the hydraulic oil in the parking brake return to the tank through the solenoid valve. When the piston rod is returned by the force of the spring, the parking brake is applied.

3. BRAKE PUMP

1) STRUCTURE



180D7EBS06

1	Shaft gear	8	Seal
2	Driven gear	9	Back up seal
3	Front cover	10	Retainer seal
4	Gear housing	11	Snap ring
5	Rear cover	12	O-ring
6	Bush block	13	Bolt
7	Bush	14	Spring washer

This gear pump have a maximum delivery pressure of 200 kgf/cm^2.
The pressure loaded type gear pump is designed so that the clearance between the gear and the bushing can be automatically adjusted according to the delivery pressure. Therefore, the oil leakage from the bushing is less than that in the case of the fixed bushing type under a high discharge pressure. Consequently, no significant reduction of the pump delivery occurs, even when the pump is operated under pressure.

2) PRINCIPLE OF OPERATION

(1) Mechanism for delivering oil

The drawing at right shows the operational principle of an external gear pump in which two gears are rotating in mesh.

The oil entering through the suction port is trapped in the space between two gear teeth, and is delivered to the discharge port as the gear rotates.

Except for the oil at the bottom of the gear teeth, the oil trapped between the gear teeth, is prevented from returning to the suction side with the gears in mesh.

Since the gears are constantly delivering oil, the oil delivered to the discharge port is forced out of the port.

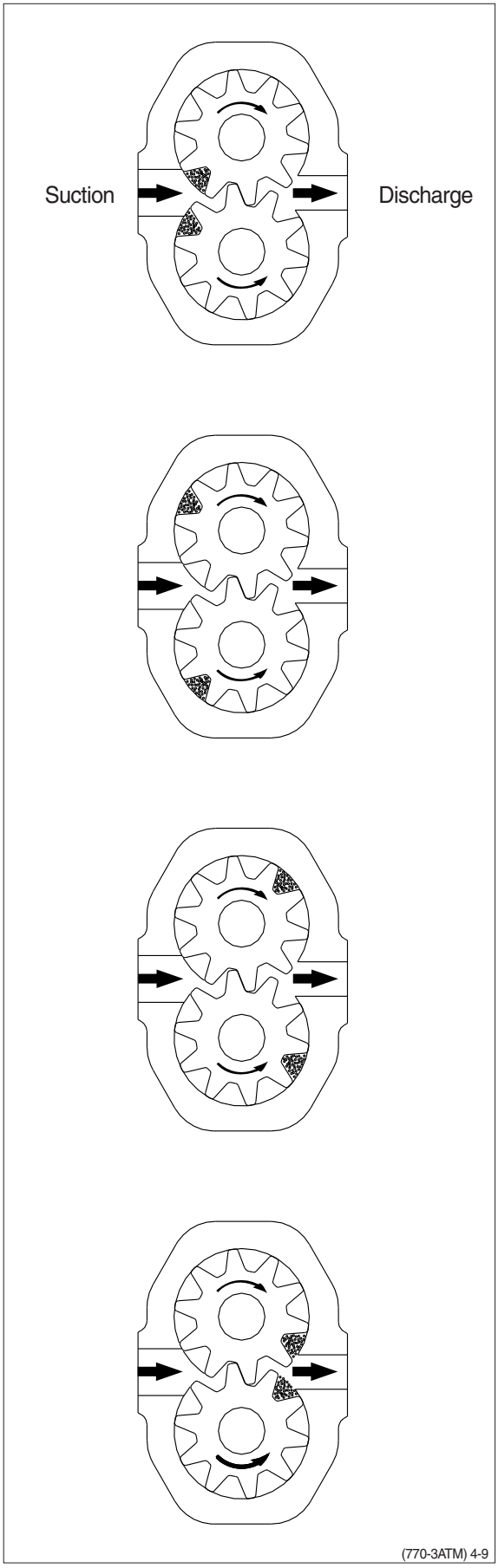
The amount of discharge increases with the speed of rotation of the gear.

If there is no resistance in the oil passage into which the discharged oil flows, the oil merely flows through the passage, producing no increase in pressure.

If however, the oil passage is blocked with something like a hydraulic cylinder, there will be no other place for the oil to flow, so the oil pressure will rise. But the pressure which rises in this way will never go higher, once the hydraulic cylinder piston starts moving because of the oil pressure.

As described earlier, the pump produces the oil flow, but not the oil pressure. We can therefore conclude that pressure is a consequence of load.

In other words, the pressure depends on a counterpart.



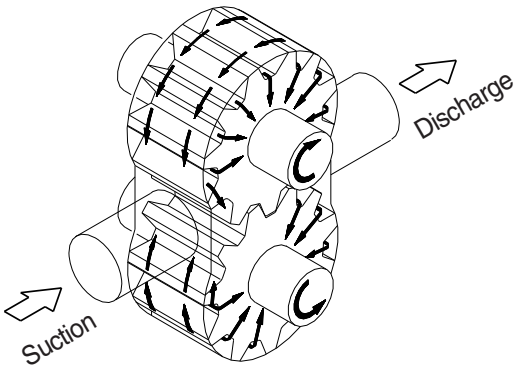
(2) Internal oil leakage

Oil leaks from a place under higher pressure to a place under lower pressure, provided that a gap or a clearance exists in between.

In the gear pump, small clearances are provided between the gear and the case and between the gear and the side plate to allow the oil to leak out and to serve as a lubricant so that the pump will be protected from seizure and binding.

The drawing at right shows how the leaked oil flows in the pump. As such, there is always oil leakage in the pump from the discharge side (under higher pressure) to the suction side. The delivery of the pump is reduced by an amount equal to the pump discharge.

In addition, the delivery of the pump will also decrease as the amount of oil leakage increases because of expanded radial clearance resulting from the wear of pump parts, the lower oil viscosity resulting from increases in the oil temperature, and the initial use of low viscosity oil.



(770-3ATM) 4-10

(3) Forces acting on the gear

The gear, whose outer surface is subjected to oil pressure, receives forces jointing towards its center.

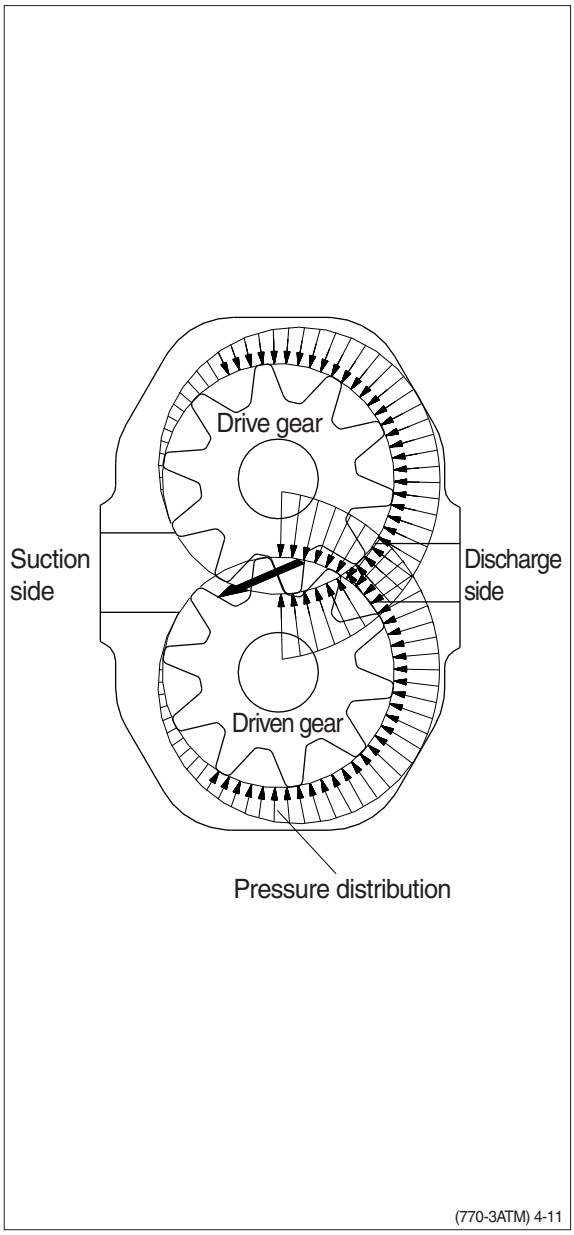
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

In addition, the gears in mesh will receive interacting forces.

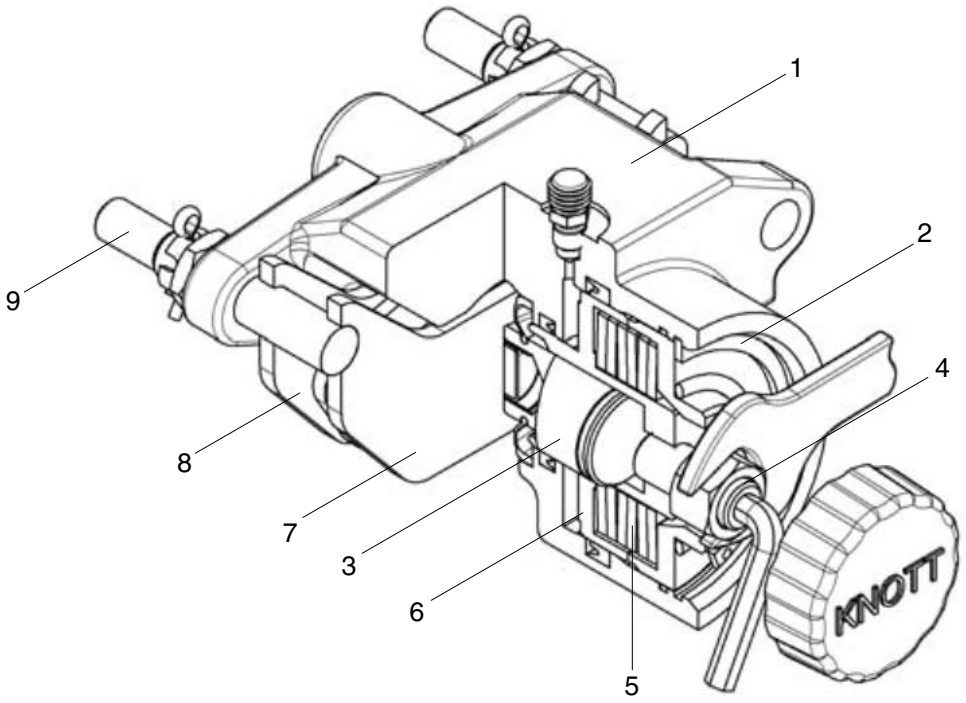
These forces pushing the gears toward the suction side are received by the bearings. Since the gears are pressed toward the suction side by these forces, the radial clearance becomes smaller on the suction side in the case. In some pumps, the clearance may become zero, thus allowing the gear teeth and the case to come into light contact.

For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



4. PARKING BRAKE SYSTEM (KESSLER)

1) STRUCTURE



100D7BS111

1	Housing	4	Adjust screw	7	Lining pad
2	Pressure ring	5	Bank of cup springs	8	Lining pad
3	Thrust bolt	6	Piston	9	Gliding bolt

2) OPERATION

The two identical brake pads and slide freely on the guide bolt, which is fastened in the housing. The guide bolts are guided in an additional brake anchor plate which in turn is screwed onto the vehicle, i.e. its axle.

On actuation, the brake generates a clamping force at the brake lining pads, which cause a tangential force/braking moment to be generated at the brake disk, the extent of which depends on the coefficients of friction generated by the linings.

The clamping force is generated by the bank of cup springs, during which the piston is moved together with the adjusting screw, the thrust bolt and the brake pad towards the brake disk.

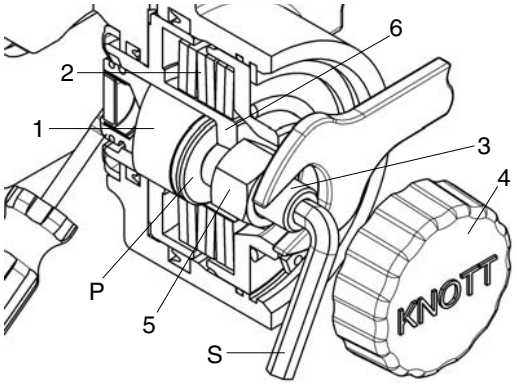
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

The brake is released by complete pre-tensioning of the bank of cup springs. Du-ring this process, through application of the necessary release pressure after overcoming the cup spring force, the piston must move back until it comes to rest against the pressure ring.

The clamping force diminishes with wear of the brake lining and brake disk. The brake must be adjusted at the latest at the times indicated by the adjusting specification followings.

3) MOUNTING AND BASIC SETTING REGULATIONS

Basic brake setting is required after mounting new brake lining plates or brake disks, as well as during all repair stages and in the event of insufficient braking performance.



100D7BS112

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

※ **All mounting and basic setting work must be carried out on the brake when cold.**

(1) Mounting the brake

① Stand the vehicle on an even surface and secure against rolling away.

② Release the screw cap.

③ Release the lock nut (size 24 or 30) and turn the adjusting screw anticlockwise using a size 8 or 10 socket wrench until the pressure bolt comes to rest against the even surface of the piston. In this status, the brake can be mounted onto the brake disk and fastened.

④ Mount the pressure connection again.

Apply the necessary release pressure to the brake until the bank of cup springs is completely pre-tensioned. Following carry out the following page basic setting regulation.

(2) BASIC SETTING REGULATION

① Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

② Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Model	Adjusting screw	Clearance (㎜)		Turns
110/130/160D-9	M16 (SW 8)	Min.	0.5	1/4
		Clearance	1.0	1/2
		Max.	1.5	3/4

③ Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

④ Mount the screw cap and tighten as far as possible manually.

⑤ Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

(3) ADJUSTING REGULATIONS

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

① Stand the vehicle on an even surface and secure against rolling away.

② Release the parking brake by using the required release pressure.

③ Release the screw cap and unscrew.

④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

⑤ Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

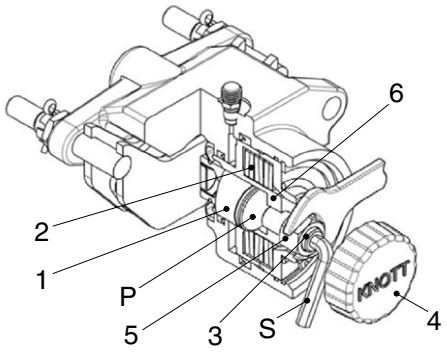
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

⑦ Mount the screw cap and tighten as far as possible manually.

※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

4) EMERGENCY RELEASE OF THE PARKING BRAKE

After the failure of the pressure release the parking brake by using following manual procedure.



100D7BS117

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

(1) The vehicle has to be secured against rolling away.
(2) Release the screw cap and unscrew
(3) Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter-clockwise until the brake disc is free.

⚠ **For the emergency release is an actuation torque of 40Nm respectively 70Nm required.**

(4) Mount the lock nut and the screw cap and tighten both as far as possible manually. (protection against dirt)

⚠ **Now, the vehicle do not have any brake function. The vehicle must be secured against moving away with proper means. Before putting the vehicle into operation again, the brake has to be adjusted again. Refer to previous page. "Assembly and basic setting regulations".**

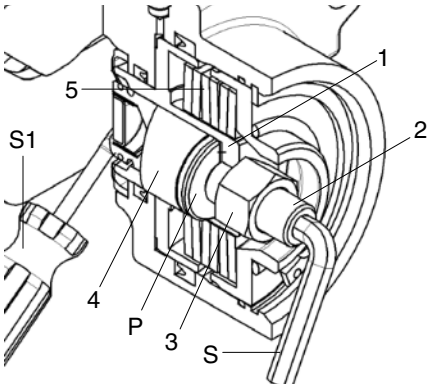
5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and exchange of brake pads

The brake pads themselves are maintenance free. All that is required here is a check for damaged parts, as well as inspection to ensure that the brake disk remains easy running.

The thickness of the brake lining must be subjected to a visual inspection at regular intervals, which depend on vehicle usage, but every six months at the latest. In the event of a minimal residual lining thickness, these intervals must be reduced accordingly in order to avoid major damage to the brake or disk.

Min. residual thickness 1.0 mm per lining pad (6 mm carrier plate thickness).

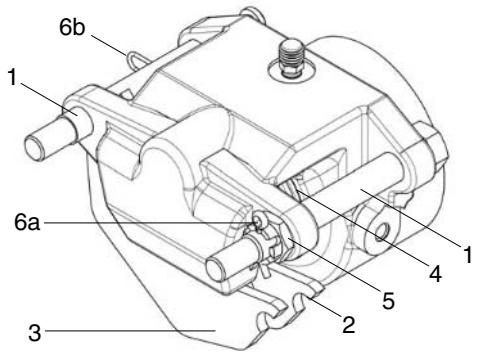


180D7EBS113

1	Piston	5	Bank of cup spring
2	Adjusting screw	S	Socket wrench
3	Lock nut	S1	Screwdriver
4	Thrust bolt	P	Inside of the piston

※ Only original spare lining plates may be used. If any other spare parts are used, no warranty claims will be accepted either for the brakes or their functional characteristics.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the required release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until it lies flush with the inside of the piston.
⑤ Press back the thrust bolt using a suitable screwdriver until it has contact with the piston.



100D7BS114

1	Guide bolt	5	Castellated nut
2	Lining pad	6a	Safety splint
3	Lining pad	6b	Safety clip
4	Permanent magnet		

⑥ Depending on the free space available, release one of the two guide bolts, removing the safety splint, unscrewing the castellated nut and pulling the guide bolt out of the brake anchor plate. Now, the brake lining pads can be removed tangentially to the brake disk.

※ In the event of minimal clearance, i.e. it is not possible for space reasons to exchange the brake lining plate in accordance with these instructions, the brake must be removed completely. To do this, pull both guide bolts out of the brake anchor plate.

⚠ Check the pressure hose. If the pressure hose is to short, it must be unscrewed to remove the brake. Before the pressure hose can be released the brake must be emergency released.

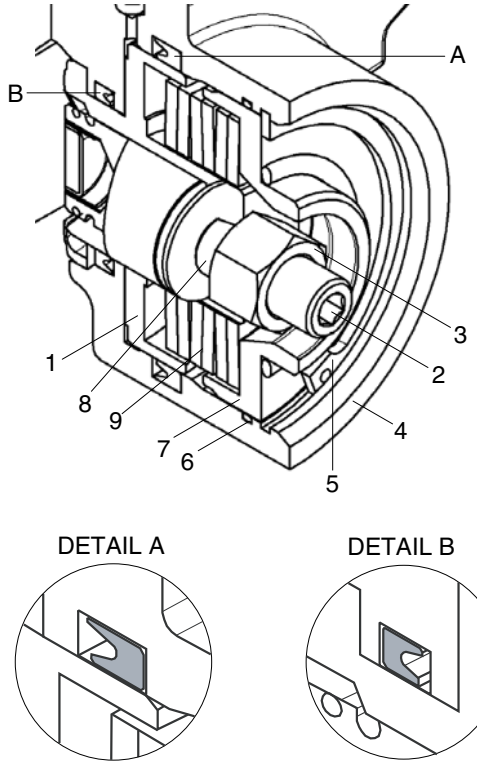
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

⑧ Check both permanent magnets if they still have sufficient magnetic force to hold the brake lining plates. Should this not be the case, the permanent magnets must also be changed by using a suitable screw driver.

⑨ Secure the guide bolt with the castellated nut and the safety splint respective safety clip.

⚠ After mounting new brake lining plates or their repair, the brake must be correctly set in accordance with the instructions "Adjusting regulations".

(2) Changing the seal



100D7BS115

1	Piston	5	Circlip	9	Bank of cup spring
2	Adjusting screw	6	Seal	A	Detail of the seal
3	Lock nut	7	Guide bolt	B	Detail of the seal
4	Housing	8	Thrust bolt		

※ Faulty seals must be exchanged in accordance with the instructions below.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the necessary release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter clockwise until the adjuster screw is flush with the inner side of the piston.
⑤ Push back the thrust bolt until it has contact with the piston. Following actuate the hand brake valve (No pressure must be in the piston chamber). The bank of cup springs is now completely depressurized.
⑥ Unscrew the pressure hose and remove the brake.
⑦ Release the circlip and remove the pressure ring of the housing.
⑧ Release the bank of cup spings and the piston.

⚠ Pay attention to the mounting direction of the seal rings, otherwise leaks can occur.

⚠ Use for mounting the new seal rings a suitable mounting needle with rounded edge. Be careful.

⑨ Change all seals and mount the parts of the brake in other way round order. By mounting the piston, the sliding and sealing surfaces must be greased lightly using lubricating grease to DIN 51825. The dust protection cap is fitted with a vulcanized-in steel ring which is used to press it through the locating hole. For exchanging, "lever out" the ring using a suitable tool. The new dust protection cap must be pressed in with the aid of a suitable mounting ring and screw clamps or a lever press.

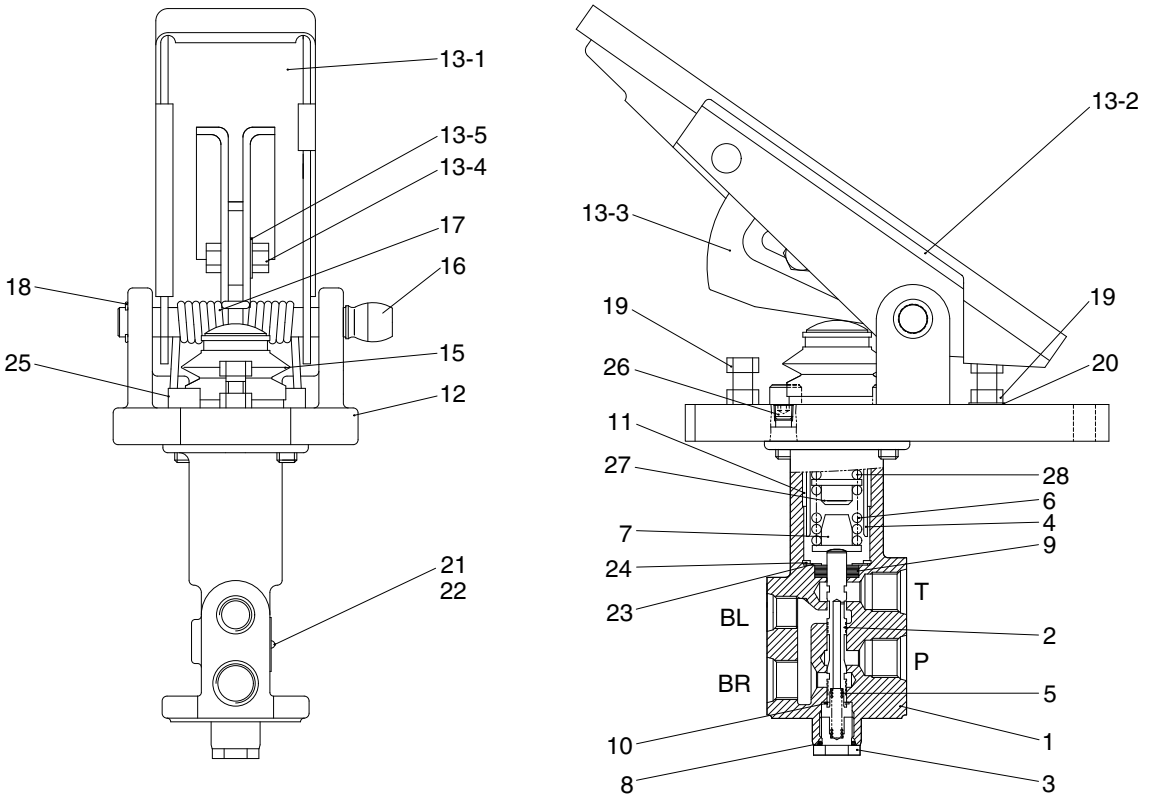
(2) General

Any discovered defects or damage to parts not listed here must naturally be repaired or replaced using original parts.

For any other information not contained in these instructions or for more detailed instructions, please contact Hyundai dealer.

5. BRAKE VALVE

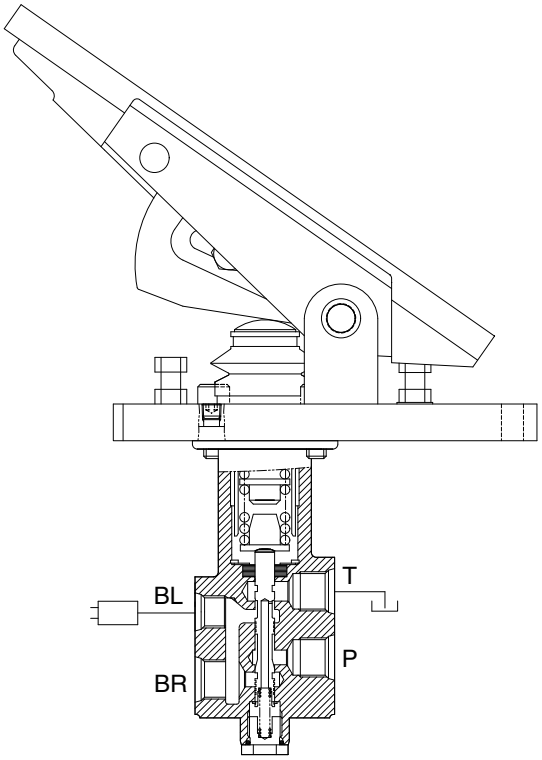
1) STRUCTURE

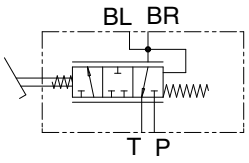


160D7ABS07

1	Body	12	Pedal plate	19	Hexagon bolt
2	Spool	13	Pedal assembly	20	Hexagon nut
3	Plug	13-1	Pedal	21	Name plate
4	Holder	13-2	Pedal rubber	22	Drive screw
5	Lower spring	13-3	Lock plate	23	Plain washer
6	Main spring 1	13-4	Hexagon bolt	24	Snap ring
7	Spring retainer 1	13-5	Plate washer	25	Socket bolt
8	O-ring	15	Bellows	26	Taper plug
9	Oil seal	16	Lock pin 1	27	Spring retainer 2 (DIC axle)
10	Snap ring	17	Torsion spring	28	Main spring 2 (DIC axle)
11	DU bushing	18	Snap ring		

2) OPERATION





Hydraulic circuit

Port	Port name	Port size
P	Main pressure port	PF3/8
T	Drain port	PF3/8
BR	Brake cylinder port	PF3/8
BL	Pressure switch port	PF1/4

160D7ABS08

(1) Purpose

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

(2) Ready position

A connection is established between ports (BR) and ports (T) so that the wheel brakes ports (BR) are pressureless via the returns ports (T).

(3) Partial braking

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

The main spring (6) beneath pedal plate (12) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the spool (2) is mechanically actuated via main spring (6). As spool (2) move downward, they will first close returns (T) via the control edges, thus establishing a connection between accumulator ports (P) and ports (BR) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spool (2) is held in the control position by the force applied (Spring assembly above the spool).
After output of the braking pressure, spool (2) is in a partial braking position, causing ports (P) and ports (T) to close and holding the pressure in ports (BR).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports (P) and brake cylinder ports (BR). Returns (T) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports (BR) and return ports (T), closing accumulator ports (P).

(5) Limiting the braking pressure

Pedal restriction bolt (19) on base plate below pedal is used to limit the braking pressure.

(6) Installation requirements

Return lines (T) must be connected directly to the tank.
The connecting lines must be installed is such a way as to permit proper bleeding.

(7) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the machine, please make sure that the water jet is not aimed directly at the brake valve (To prevent damaging the bellows).

△ **For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.**

(8) Repair work

△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

(9) Replacing the pedal cover

Pedal cover (13-2) is simply pulled of by hand. The new pedal cover is pushed over pedal (13-1) and tightened manually. Fasten the bellows with the strap retainers.

(10) Replacing the complete actuating mechanism

Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the four bolts. Make sure that main spring (6) does not fall out. When installing the new actuating mechanism, make sure that main spring (6) is fitted in the right order.

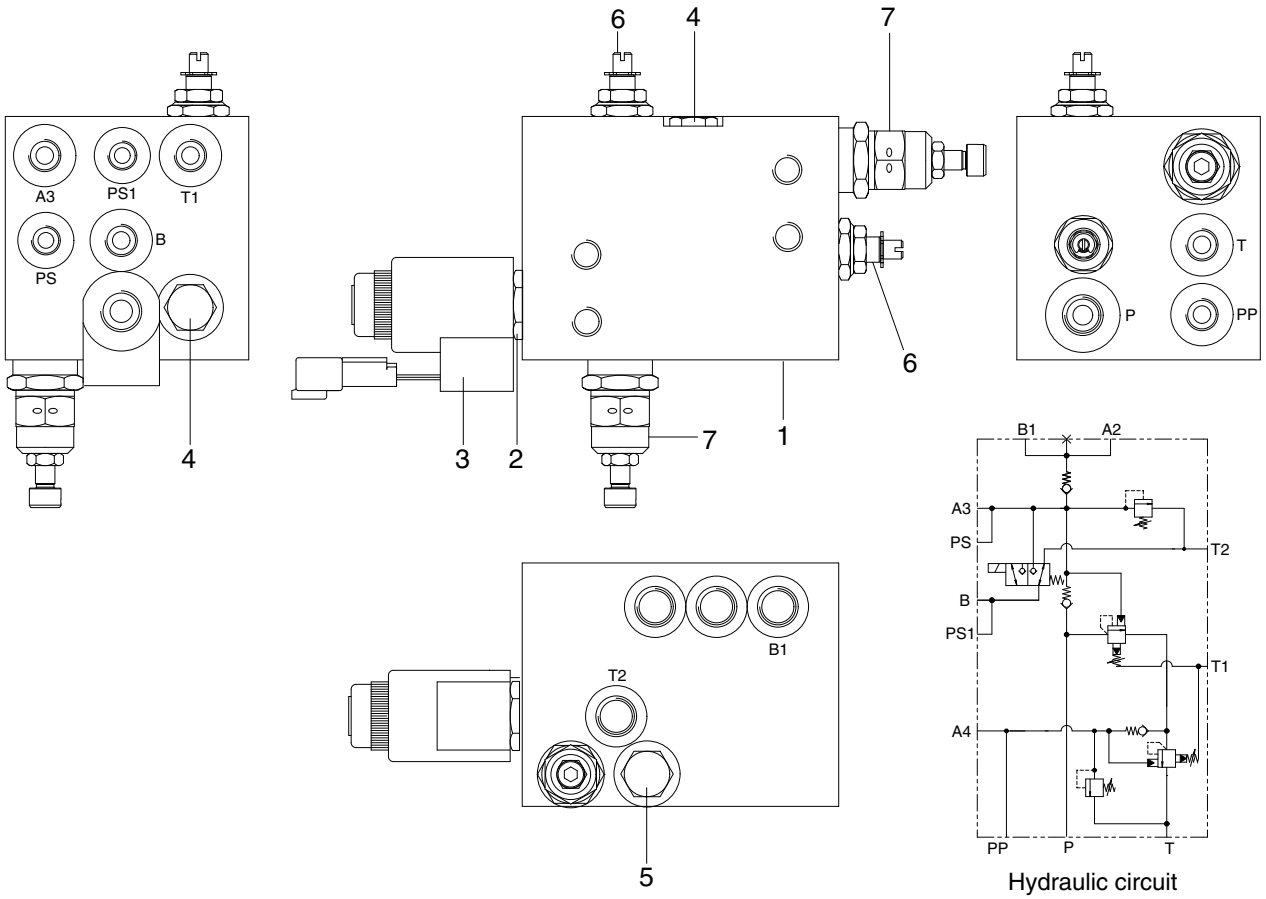
(11) Replacing the bellows

To change bellows (15) it is advisable to remove pedal (13). For this purpose, loosen retaining ring (18) and knock out pin 1 (16) using a mandrill. When knocking out the bolt, make sure that the mandrill is applied to the side of the bolt without a knurl. Remove pedal (13) and bellows (15).

Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston (4), its lower portion to pedal plate (12) secure the bellows using clamps.

6. CUT-OFF VALVE

1) STRUCTURE



110D9BS35

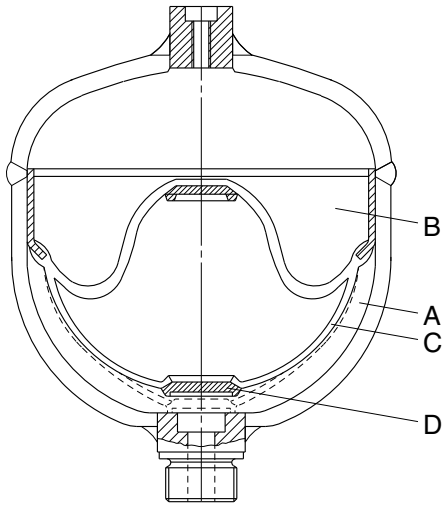
1 Manifold
2 Solenoid valve
3 Coil
4 Check valve
5 Check valve
6 Cut-off valve
7 Relief valve

2) OPERATION

When the pump works, the oil under the pressure flows into P port.
The oil in P port is stored in the accumulator on A3 port.
As the pressure on P line rises to 150 bar, the cut off valve (6) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120 bar by the minute leakage from valve and other factors.
At this pressure, the cut-off valve starts cuting.
This process is repeated in the regular period of 30~40 seconds.

7. BRAKE ACCUMULATOR

1) STRUCTURE



110D9BA01

Item	81L1-0003	31E3-3187
Diameter	138 mm	90 mm
Mounting height	187 mm	140 mm
Nominal volume	1.0 ℓ	0.35 ℓ
Priming pressure	50 kgf/cm^2	15 kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 150 kgf/cm^2	Max 170 kgf/cm^2
Thread	M22 × 1.5	PF1/2
Priming gas	Nitrogen	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion (A) and a gas portion (B) with a diaphragm (C) as a gas-tight dividing element. The fluid portion (A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk (D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible.

Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30%(Please refer to **Performance testing and checking of the accumulator**).

(5) Disposal of the accumulator

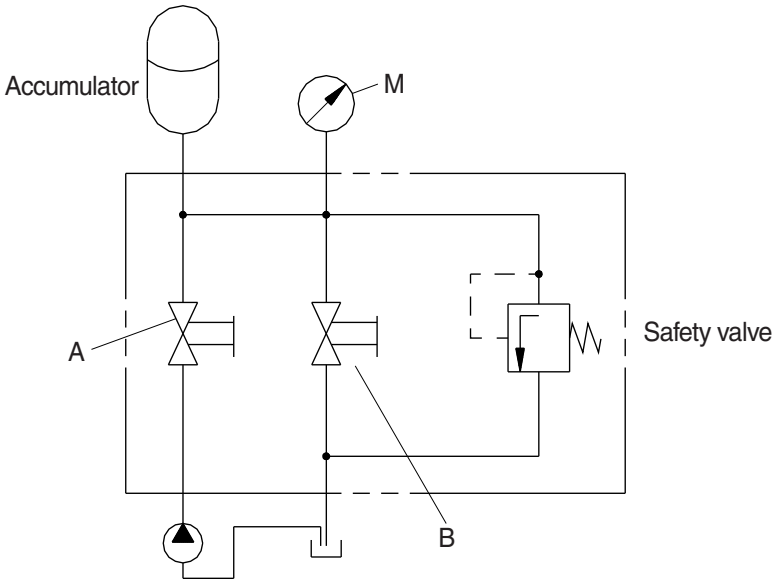
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ Wear safety goggles when doing this job.

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge **M**. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under **Disposal of the accumulator**.

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for **at least one** of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under **Disposal of the accumulator.**



(770-3ATM) 4-23

(7) Repair work

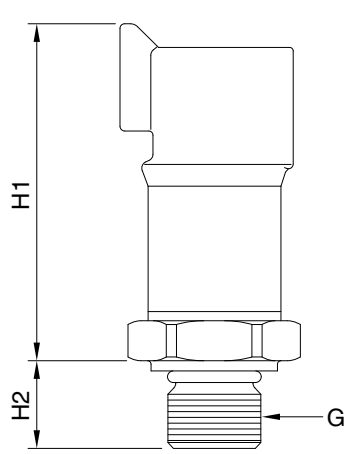
△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.**

※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

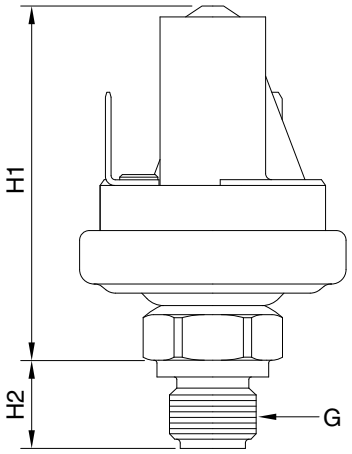
△ **For safety reasons the accumulators need to be replaced as a whole if damaged.**

8. PRESSURE SWITCHES

1) STRUCTURE



Parking and charging



Brake stop

110D9BS20

· **Technical data**

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Adjusting pressure kgf/cm²	Voltage V
Parking	NC	Oil	PF 1/4	49.4	12.5	50 ~ 150	95 ± 5	Max 42
Charging	NC	Oil	PF 1/4	49.4	12.5	50 ~ 150	95 ± 5	Max 42
Brake stop	NO	Oil	PF 1/4	-	-	1~10	5 ± 1	Max 42

NC : Normally closed NO : Normally open

2) OPERATION

(1) Purpose

The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

(2) Make contact / circuit closer

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on an absorption area within the switch, making an electrical contact as the pressure on that area is increased. The resulting current is used to activate a warning facility, for instance.

(3) Break contact / circuit breaker

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on a absorption area within the switch, breaking an electrical contact as the pressure on that area is increased. The current is now broken, e.g. to deactivate a warning facility.

(4) Installation requirements

No special measures need to be taken.

(5) Maintenance of the pressure switch

No special maintenance beyond the legal requirements is necessary.
When using high-pressure cleaners on the vehicle, please make sure that the water jet is not directed at the pressure switch (Corrosion of contacts).

(6) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**

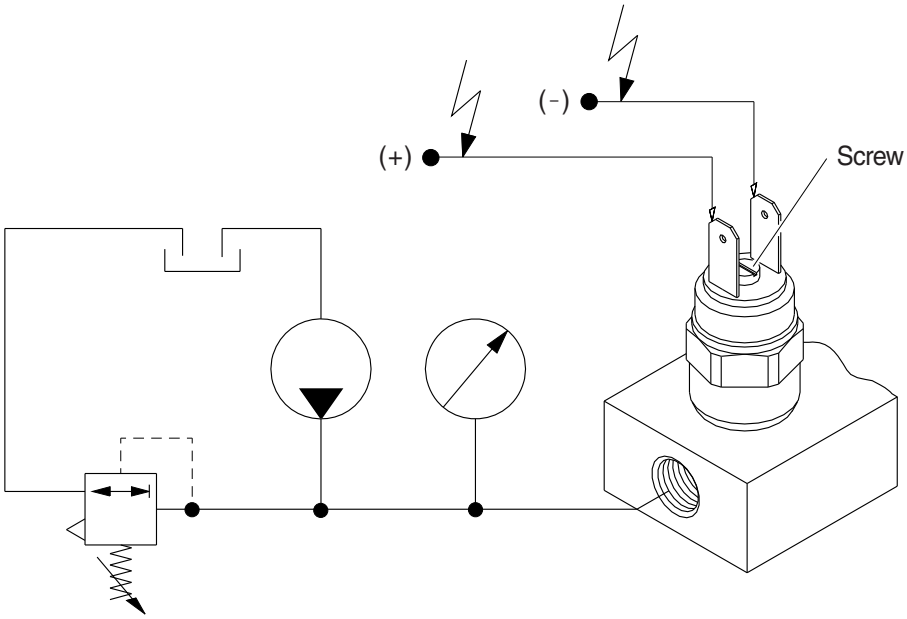
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

※ For safety reasons the pressure switch needs to be replaced as a whole if damaged.

(7) Adjusting and testing pressure switch

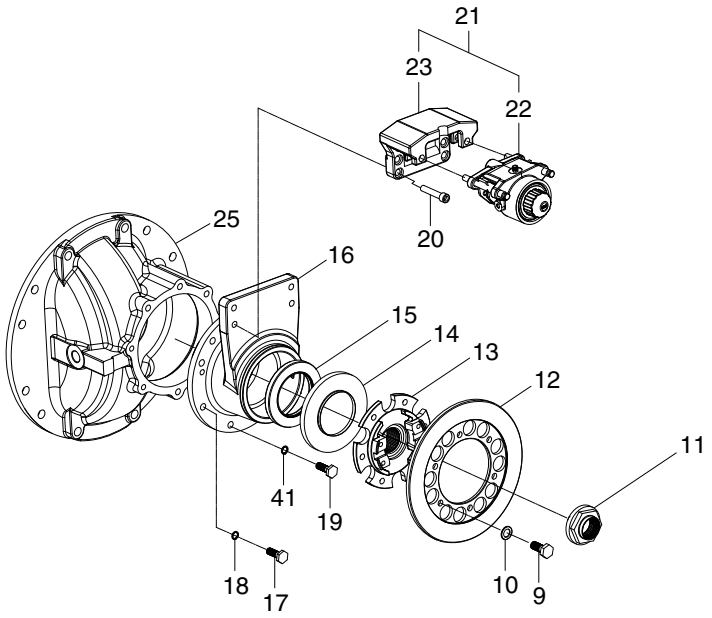
The adjusting screw located between the two contact plugs can be set to the desired value within a certain range. For adjusting range, please refer to the table **Technical data** on the previous page.

After making the adjustment, the adjusting screw should be secured using wax or a similar material.



(770-3ATM) 4-25

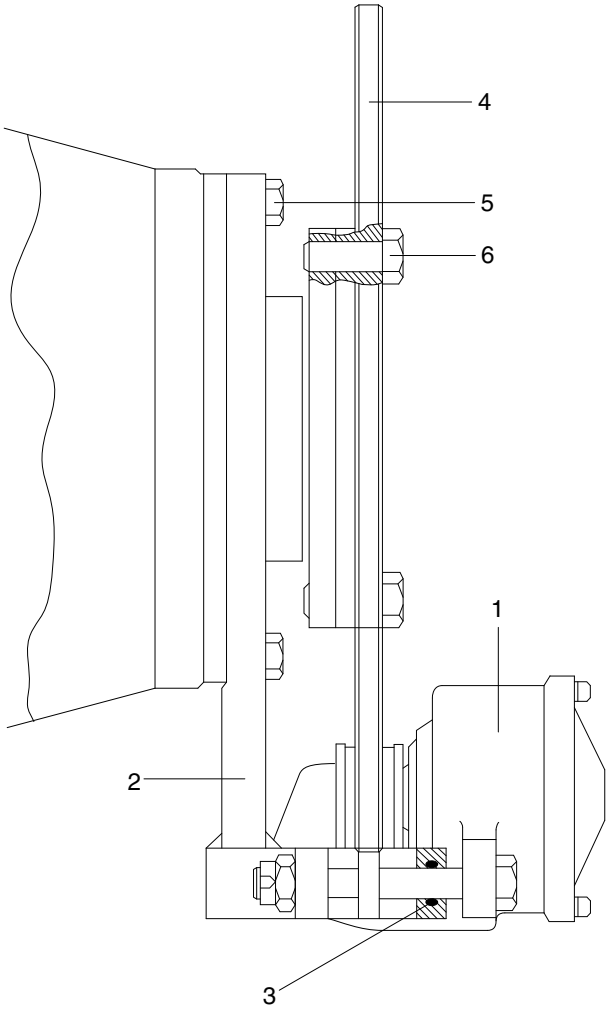
8. PARKING BRAKE (DIC)



110D9DA01

9	Hexagon bolt	18	Washer
10	Washer	19	Hexagon bolt
11	Lock nut	20	Socket bolt
12	Parking disc	21	Parking brake assy
13	Yoke	22	Parking brake
14	Dust cover	23	Parking brake support
15	Oil seal	25	Differential carrier
16	Differential flange	41	Washer
17	Hexagon bolt		

PARKING BRAKE (KESSLER)



100D7BS109

1	Brake	4	Brake disk
2	Brake carrier	5	Hexagon screw
3	O-ring	6	Hexagon screw

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

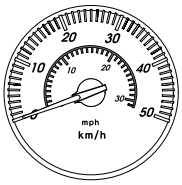
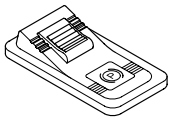
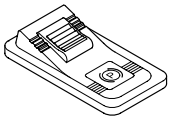
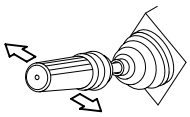
The engine and all other major components must be at operating temperature for some checks.

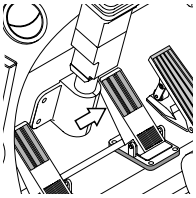
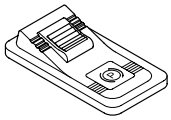
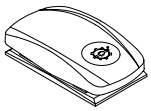
Locate system check in the left column and read completely, following the sequence from left to right.
Read each check completely before performing.

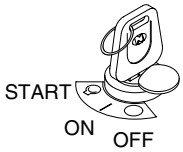
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

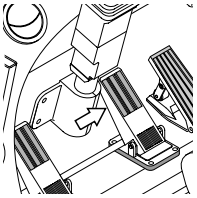
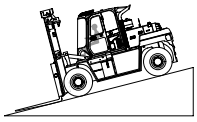
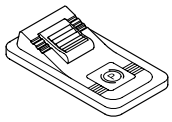
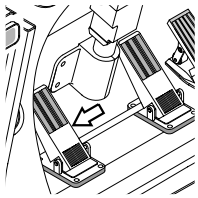
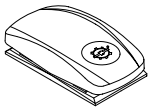
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ **Hydraulic oil must be at operating temperature for these checks.**

Item	Description	Service action
Parking brake capacity check Seat belt must be worn while doing this check to prevent possible injury when machine stops suddenly.	 Start engine. Fasten seat belt. Release parking brake and put transmission in 2nd gear forward. Drive machine at 8 km/hr and switch parking brake ON.  **LOOK/FEEL** : Machine must come to a stop within 2 meters(6 feet) when parking brake is engaged at 8 km/hr. Transmission must shift to neutral.	**OK** Check completed. **NOT OK** Inspect parking brake. Go to group 3.
Parking brake transmission lockout check Engine running.	 Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle.  **LOOK** : Machine must not move.	**OK** Check completed. **NOT OK** Go to transmission control circuit in section 3.

Item	Description	Service action
Service brake pump flow check ※ Hydraulic oil must be at operating temperature for the check. Engine OFF.	 Stop engine. Operate brake pedal approximately 20 times. Start engine and run at low idle. Record number of seconds required for low brake pressure indicator lamp to go out.  **LOOK** : Indicator lamp must go out in less than 10 seconds from time engine starts. **NOTE** : Indicator will not come on approximately 1 second after starting engine.	**OK** Check completed. **NOT OK** Check for brake circuit leakage. Go to next page. **IF OK** Install a cap on line connected to inlet of brake valve and repeat pump flow check. If time does not decrease, check for worn brake pump.
Service brake capacity check Engine running.	 Turn inching switch OFF. Apply service brakes, release park brake and put transmission in 2nd forward. Increase engine speed to high idle.  **LOOK** : Machine may not move or move at a very slow speed. Repeat check three times to ensure accurate results.	**OK** Check completed. **NOT OK** Check brake pressure in group 3. **IF OK** Inspect brake disk.

Item	Description	Service action
Brake accumulator precharge check ※ The axles and hydraulic oil must be at operating temperature for this check.	 Start and run engine for 30 seconds. Stop engine and turn start switch to ON and wait 5 seconds. **NOTE** : Engine oil pressure lamp will be on due to no engine oil pressure.  Count the number of times the brake pedal can be fully depressed before the low brake pressure warning lamp comes ON. **LOOK** : Warning lamp must come on over 20 times of applications. Start engine and operate at low idle. Observe cluster while applying brake pedal with maximum force. **LOOK/LISTEN** : Brake pressure indicator must not come ON.	**OK** Check completed. **NOT OK** Make sure brake pedal is not binding and keeping brakes partially engaged. Bleed brakes in group 3. Check brake system pressure. **NOT OK** If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator.
Brake system leakage check	 Start engine and wait 30 seconds. Stop engine. Wait 2 minutes. Turn start switch to ON and wait 5 seconds.  **LOOK** : Brake oil pressure warning lamp must not come on within 2 minutes after stopping engine.	**OK** Check completed. **NOT OK** If brake leakage is indicated with brakes released, check leakage at accumulator inlet check valve and brake valve. If brake leakage is indicated with brakes applied, check for leakage at brake valve and brake pistons. Check individual component leakage.

Item	Description	Service action
Service brake pedal check	 Slowly depress brake pedal. Listen for a hissing noise that indicates oil is flowing to brake pistons. **LISTEN/FEEL** : A hissing noise must be heard when pedal is depressed.	**OK** Check completed. **NOT OK** Inspect for debris under brake pedal. Inspect clutch cut-off linkage.
Service and parking brake system drag checks Engine running	 Position machine on gradual slope. Lower fork approximately 50mm(2 in) from ground. Release parking and service brakes. **LOOK** : Machine must move or coast.  **NOTE** : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals.	**OK** Check completed. **NOT OK** Adjust park brake, go to group 3. **NOT OK** Check floor mat interference to pedal or debris build-up. **IF OK** Check for brake pressure when brake is released.
Inching check	 Place inching switch in ON position. Release parking brake. Run engine at half speed in 1st forward. Depress inching pedal until machine stops with left foot. At this pedal angle, put on right foot on the brake pedal not to release. Release inching pedal.  **LOOK** : Machine must move.	**OK** Check completed. **NOT OK** Check inching sensor output voltage.

2. TROUBLESHOOTING

1) SERVICE BRAKE

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (See section 1)
Step 2. Operational checks (In this group)
Step 3. Troubleshooting
Step 4. Tests and adjustments (See group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low	Do brake accumulator check.
	Brake pump standby pressure low	Do brake pump standby pressure test.
	Brake pressure low	Do brake valve pressure test.
	Air in system	Bleed brakes.
	Worn brake surface material	Inspect brake surface material.
	Leakage in brake valve	Do brake valve leakage test.
	Leakage in brake piston seal	Check for an over filled differential. Apply brakes and check for leakage from check plug. ※ **It is normal for the oil level to be slightly above the check plug.**
Aggressive brakes	Internal restriction in circuit	Remove lines and components.
	Clutch cut-off switch out of adjustment	Adjust switch.
	Brake valve malfunction	Disassemble and inspect.
	Low oil level	Check oil level.
Brakes drag	Brake pedal not returning properly	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve	Do brake valve pressure test.
	Warped brake disk	Inspect brake disk.
	Stuck brake piston	Repair.
Brakes lock up	Brake valve malfunction	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system	Do brake bleed procedure.
	Worn brake surface material	Inspect brake surface material.
	Wrong oil in differential	Drain. Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston	Do brake system leakage test.
Brake pressure warning light will not go out or stays on excessively long after start-up	Malfunction in brake low pressure warning switch	Replace switch.
	Brake accumulator pressure too low	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block	Do pressure reducing valve manifold leakage test.
	Leakage in brake system	Do brake system components leakage tests.
	Worn brake pump	Do brake pump flow test.
	Leakage in parking brake solenoid	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly	Adjust parking brake.
	Malfunctioning parking brake solenoid	Inspect and replace.
	Worn brake disk and / or brake pads	Disassemble, inspect, repair.
	Brake piston hangs up in bore	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment	Adjust parking brake.
	Brake not released	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid	Check electric circuit.
	Restriction between brake valve and brake	Remove hose and inspect. Replace.

1. PARKING BRAKE PERFORMANCE

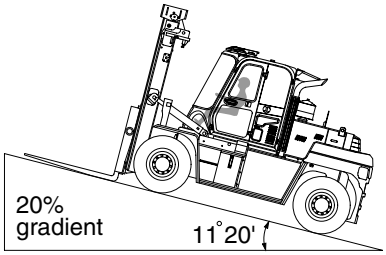
1) MEASUREMENT CONDITION

(1) Tire inflation pressure : Specified pressure

(2) Road surface : Flat, dry, paved surface with 1/5 (11˚20') gradient.

(3) Machine : In operating condition

Item	Standard value
Parking brake performance	Keep machine on 20% (11˚20') gradient



110D9BS33

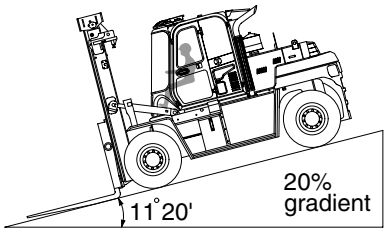
2) MEASURING PROCEDURE

(1) Start the engine and drive the machine straight up a 1/5 gradient with the fork unloaded.

(2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.

(3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.

※ The measurement must be made with the machine facing either up or down the slope.



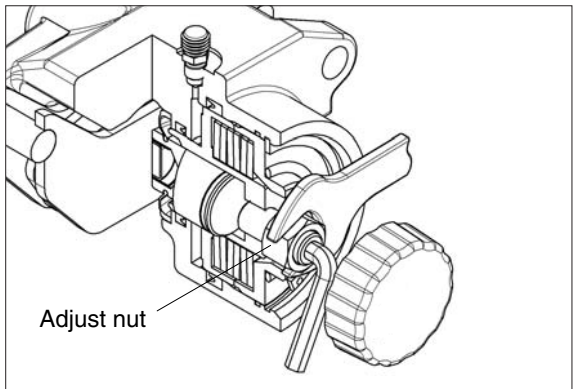
110D9BS32

2. ADJUSTMENT OF BRAKE

1) EXTERNAL BRAKE INSPECTION

(KESSLER)

· Inspect for wear of brake pad.



110DEBS39

2) BASIC SETTING REGULATION

(1) Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

(2) Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Model	Adjusting screw	Clearance (mm)		Turns
110D-9 130D-9 160D-9	M16 (SW 8)	Min.	0.5	1/4
		Clearance	1.0	1/2
		Max.	1.5	3/4

(3) Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

(4) Mount the screw cap and tighten as far as possible manually.

(5) Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

3) ADJUSTING REGULATIONS

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

(1) Stand the vehicle on an even surface and secure against rolling away.

(2) Release the parking brake by using the required release pressure.

(3) Release the screw cap and unscrew.

(4) Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

(5) Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

(6) Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

(7) Mount the screw cap and tighten as far as possible manually.

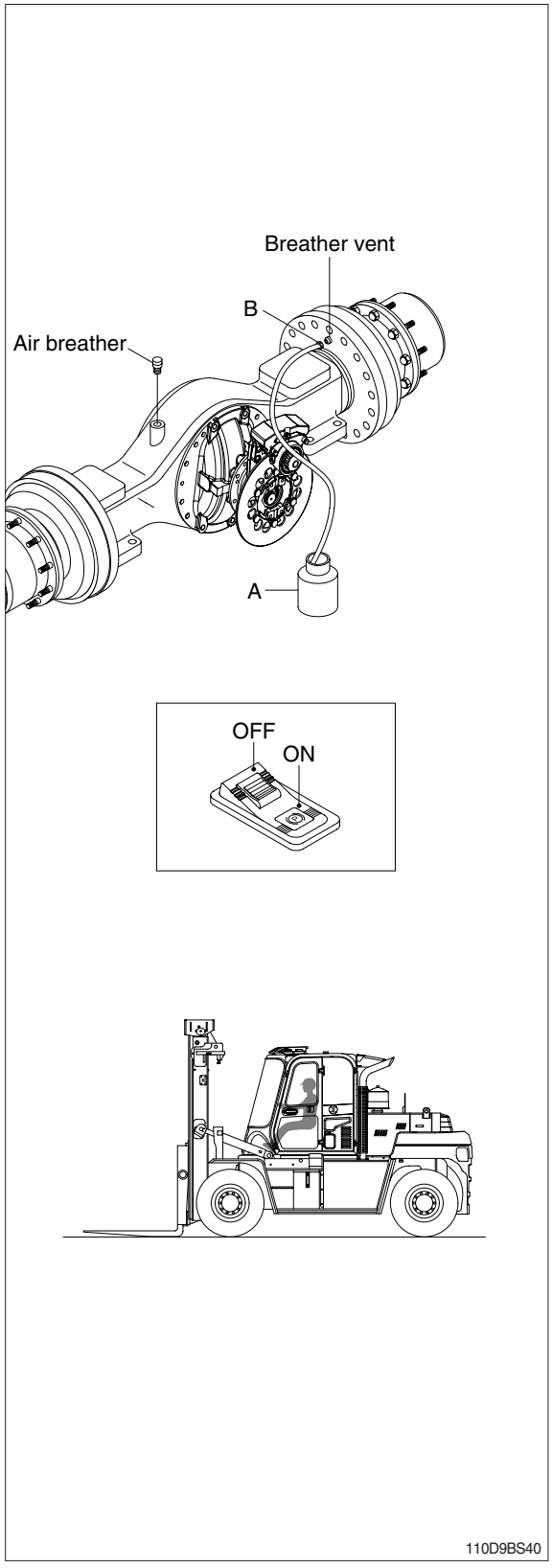
※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ **Escaping fluid under pressure can penetrate the skin causing serious injury.**
Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.
Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

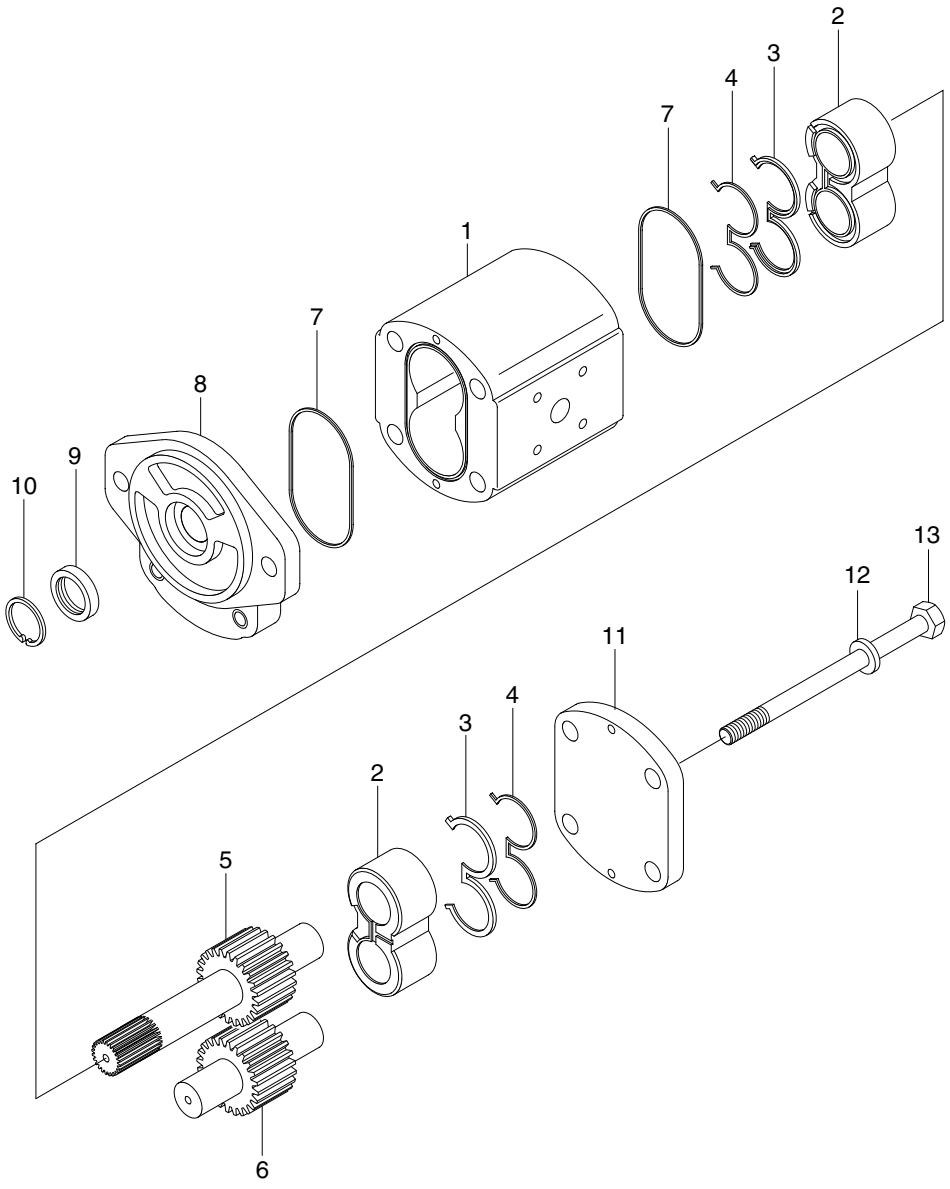
※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.
Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.
Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

1) Engage parking brake and block the tire.
2) Put a clear plastic tube on bleed screw (B) to route low to hydraulic reservoir filler tube or container (A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.
   ※ If bubbles continue for more than 2 minutes, stop bleeding procedure.
   Check for and correct problem, then continue.
5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
6) Repeat steps 1-5 for each bleed screw.
7) Push either brake pedal and hold down.
8) Check hydraulic oil level.



1. BRAKE PUMP

1) STRUCTURE



180D7EBP00

1	Housing	8	Front cover
2	Bush block	9	Retainer seal
3	Backup seal	10	Snap ring
4	Channel seal	11	Rear cover
5	Shaft gear	12	Washer
6	Driven gear	13	Bolt
7	O-ring		

2) GENERAL INSTRUCTION

(1) Always work in a clean environment.

(2) Wash all components in solvent and blow dry with compressed air before refitting.

(3) Take care not to damage rubber seals.

(4) Avoid damaging precision machined surfaces.

(5) Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.

(6) When hand pressure is insufficient, only use presses or rubber hammer to fit components.

(7) Never strike components with steel hammers.

(8) Steel bush must be fitted only with a suitable press.

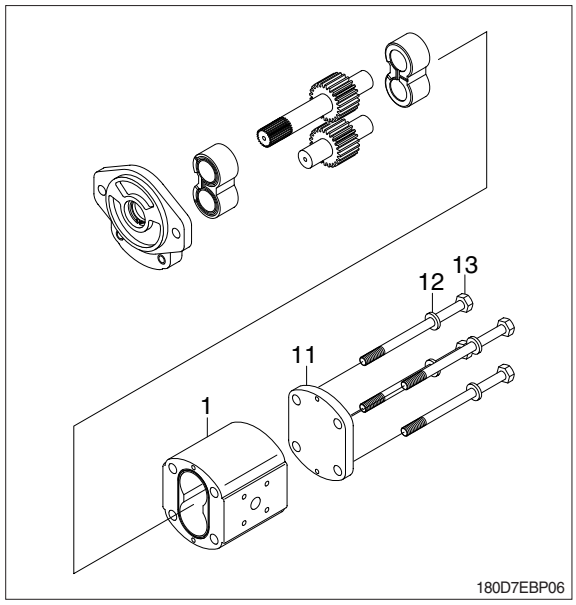
(9) Do not use hammers to fit bearings.

(10) Always respect the direction of rotation when assembling components.

3) DISASSEMBLY

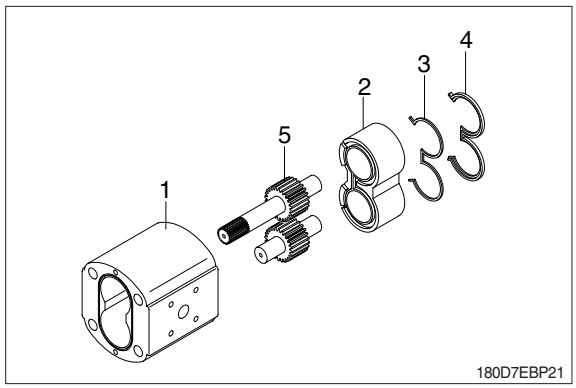
(1) Loosen and remove the bolts (13) with washers (12) from the rear cover (11).

(2) Remove the rear cover (11) from the housing (1).



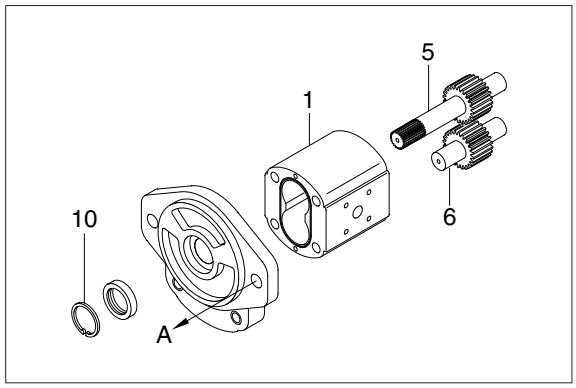
(3) Disassemble the channel seal (4), back up seal (3) and bush block (2), from the housing (1).

※ After removing the bush block (2) from the the housing (1), clean the contacting surface of the bush block (2) with the journal of the shaft gear (5) and the drive gear (1), inspect for excessive wear, scoring or crack.



(4) After removing the snap ring (10), take out the shaft gear (5) and the drive gear (6) from the housing (1).

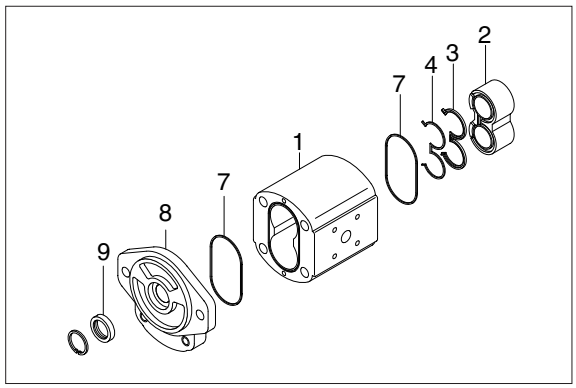
※ For the gear face of the shaft gear (5) and the driven gear (6), inspect for excessive wear, scoring or crack.



180D7EBP51

(5) Remove bush block (2), back up seal (3), channel seal (4) and O-ring (7) from the housing (1).

※ After removing the bush block (2) from the housing (1), inspect whether it is happened scratch or damage for inner surface of the housing (1).



180D7EBP52

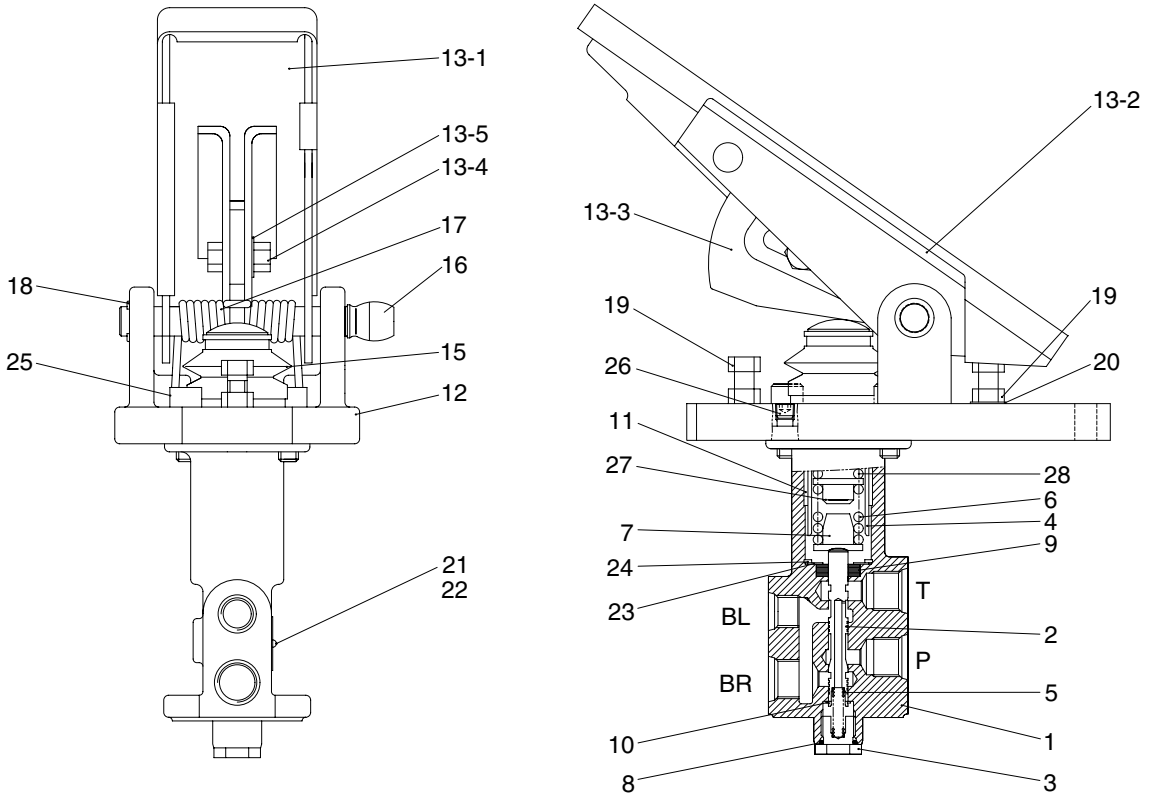
(6) Remove the retainer seal (9) from the front cover (8).

4) ASSEMBLY

Assembly procedure of the pump is the reverse order of the disassembly procedure.

2. BRAKE VALVE

1) STRUCTURE

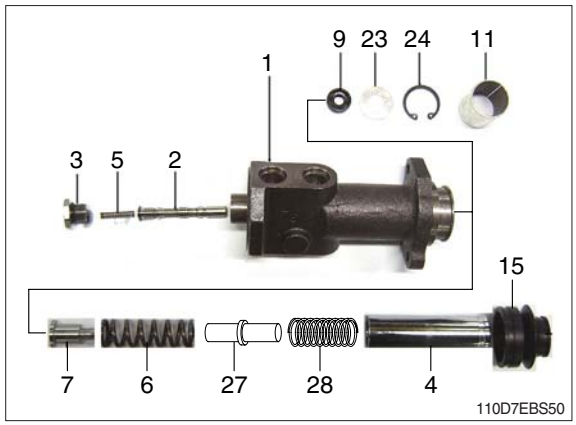


160D7ABS07

1	Body	12	Pedal plate	19	Hexagon bolt
2	Spool	13	Pedal assembly	20	Hexagon nut
3	Plug	13-1	Pedal	21	Name plate
4	Holder	13-2	Pedal rubber	22	Drive screw
5	Lower spring	13-3	Lock plate	23	Plain washer
6	Main spring 1	13-4	Hexagon bolt	24	Snap ring
7	Spring retainer 1	13-5	Plate washer	25	Socket bolt
8	O-ring	15	Bellows	26	Taper plug
9	Oil seal	16	Lock pin 1	27	Spring retainer 2 (DIC axle)
10	Snap ring	17	Torsion spring	28	Main spring 2 (DIC axle)
11	DU bushing	18	Snap ring		

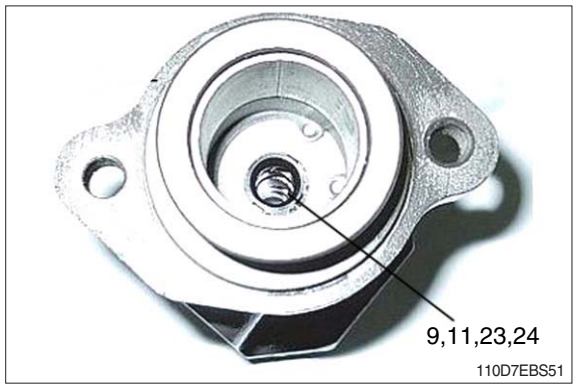
2) REASSEMBLY

(1) Body assembly

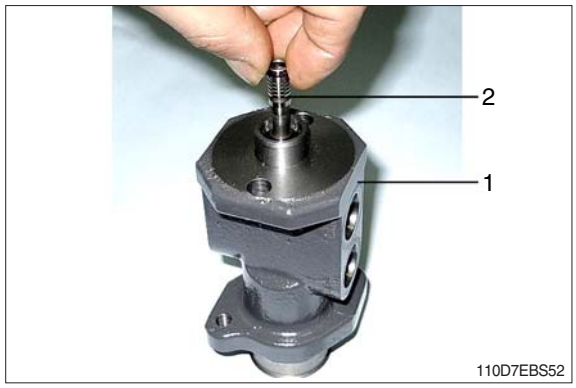


1 Body
2 Spool
3 Plug
4 Holder
5 Spring
6 Main spring 1
7 Spring retainer 1
9 Oil seal
11 DU bushing
15 Rubber cover
23 Plain washer
24 Stop ring
27 Spring retainer 2 (DIC axle)
28 Main spring 2 (DIC axle)

① Install oil seal (9), plain washer (23), stop ring (24), DU bushing (11).
- Tool : Jig for dry bearing, snap ring plier.



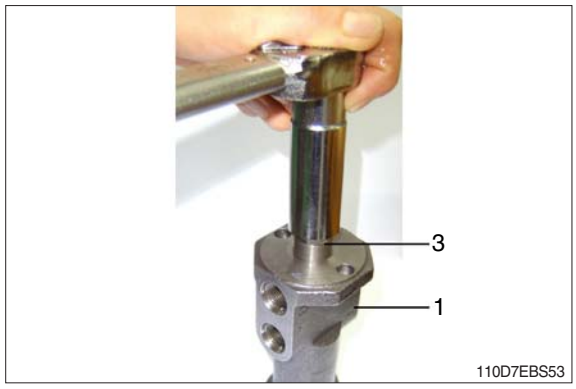
② Install spool (2) into body (1).



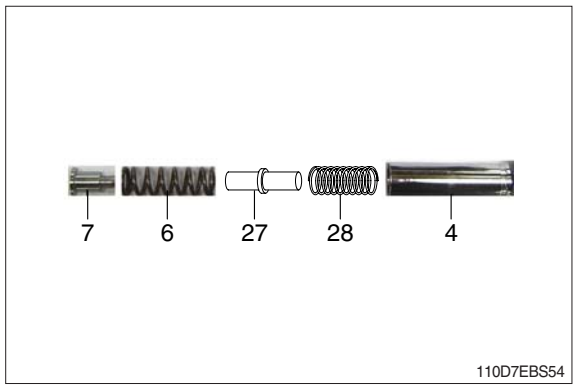
③ Tighten plug (3)
- Tool : 19㎜ spanner
- Tightening torque : 14.0~16.5 kgf · m

⚠ Press-in the DU bushing (11) with a exclusive jig.

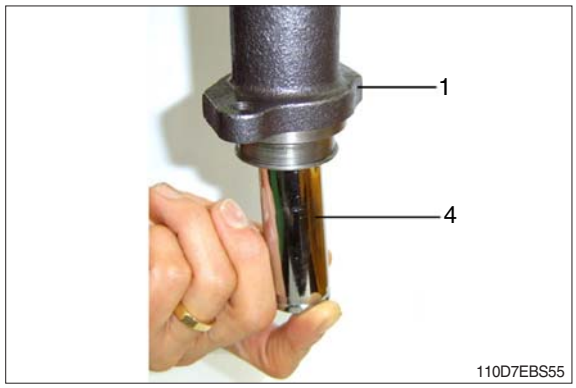
⚠ Be careful of dust and scrap after washing the parts.



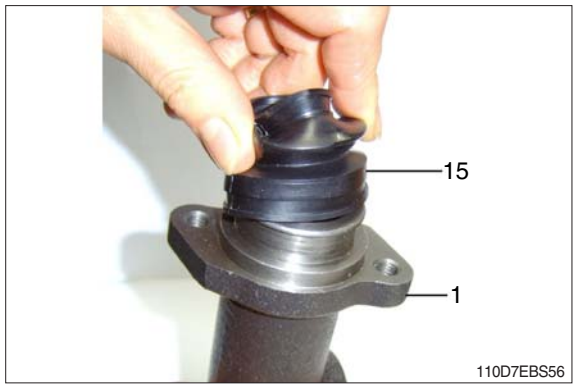
④ Spring retainer (7, 28), main spring (6, 28) and holder (4).



⑤ Holder (4) → Body (1)

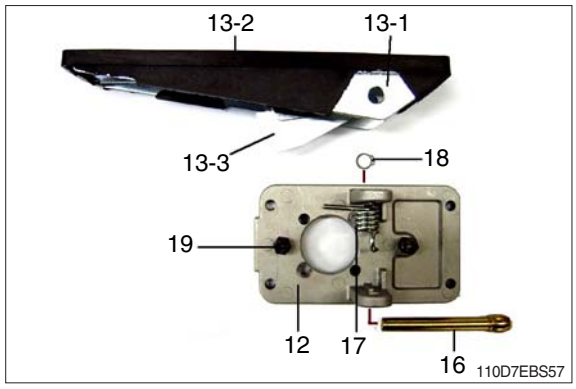


⑥ Rubber cover (15)

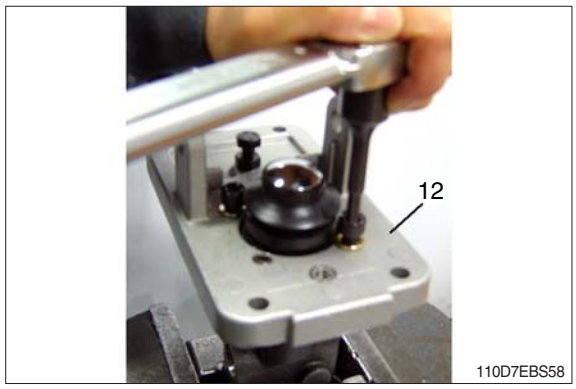


(2) Pedal plate assembly

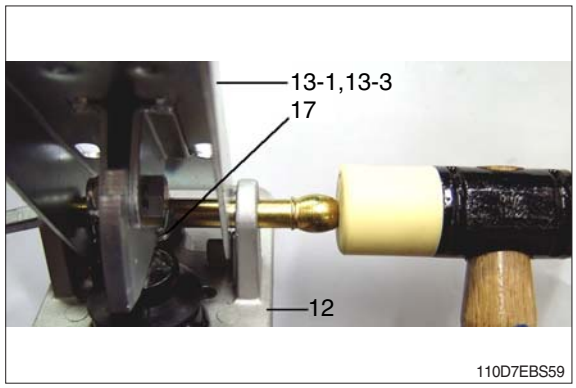
12	Pedal plate
13-1	Pedal
13-2	Pedal cover
13-3	Lock plate
16	Lock pin (pedal)
17	Torsion spring
18	Stop ring
19	Hexagon bolt



① Pedal plate (12) assembly
- Tool : 6 ㎜ torque wrench
- Tightening torque : 2.5~3.0 kgf · m

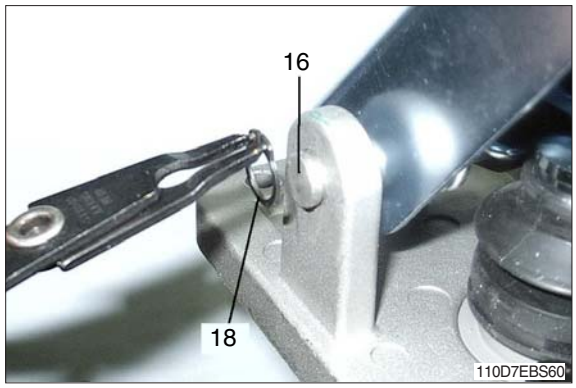


② Pre-assemble pedal assembly (13-1, 13-3) and torsion spring (17) on the pedal plate (12) with a bar of ø12 and then push the bar with a plastic hammer.
- Tool : ø12 bar, plastic hammer.

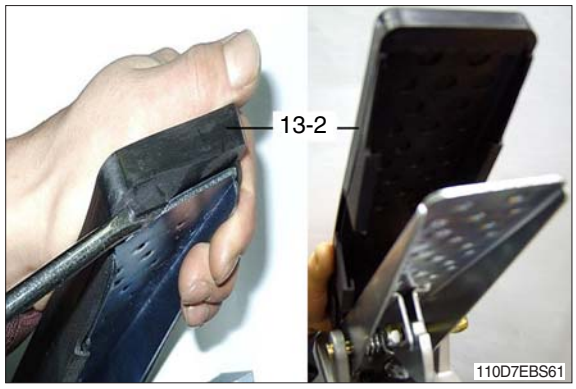


③ Lock pin (pedal) (16), stop ring (18).
- Tool : Snap ring plier for axis.

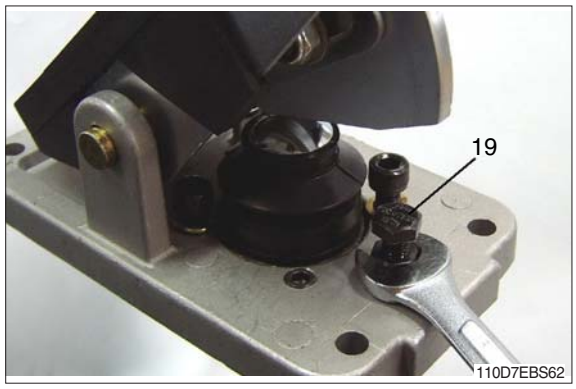
⚠ To prevent pedal plate from being damaged stop ring (18) must be removed before removing lock pin (16).



④ Rubber cover (13-2)



⑤ Hexagon bolt (19)
- Tool : 13 mm spanner
- Tightening torque : 2.0 kgf · m



⚠ Never remove the hexagon bolt.
(Pressure setting valve deviation occurs)