SECTION 4 BRAKE AND FAN SYSTEM

SECTION 4 BRAKE AND FAN SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

The variable displacement piston pump supplies the hydraulic oil that is required in order to operate the brake and the hydraulic fan system. Oil flows from pump to the cut-off valve.

The cut-off valve controls the flow of oil from the pump to the brake accumulators and also controls the flow of oil to the hydraulic fan motor.

The cut-off valve contains a priority valve. The brake system has priority. The oil flows to the brake accumulators while the accumulators are charged. After the accumulators are fully charged, the oil then flows to the hydraulic fan system.

The accumulator has pre-charged gas and an inlet check valve to maintain a pressurized volume of oil for reserving brake system.

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

The front and rear brakes will operate simultaneously with only one brake pedal depressed.

The hydraulic fan system is used to meet the cooling requirements. The hydraulic fan system controls the fan speed through the pump output pressure. The desired pressure level can be set by varying the solenoid current.

The hydraulic fan system contains directional valve that reverses the direction of fan.

The brake and hydraulic fan system contains the following components :

- Fan & brake pump
- Cut-off valve
- Brake valve
- Accumulators
- Pressure sensors and switch
- Fan motor
- Directional valve

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.

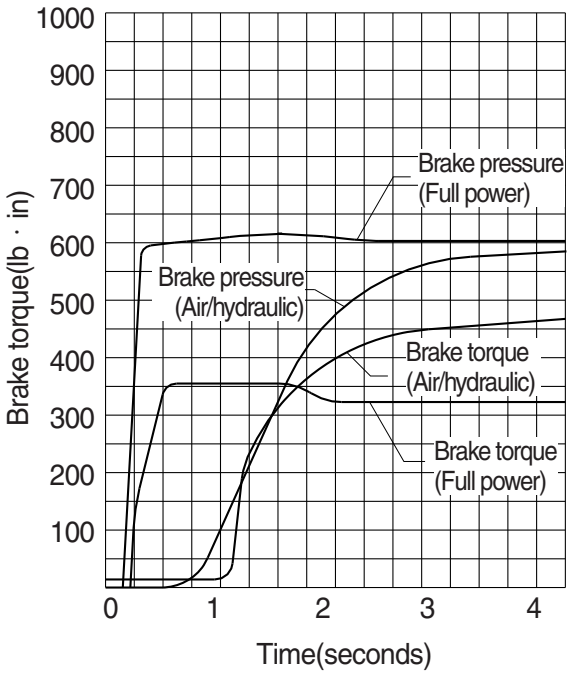
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

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.

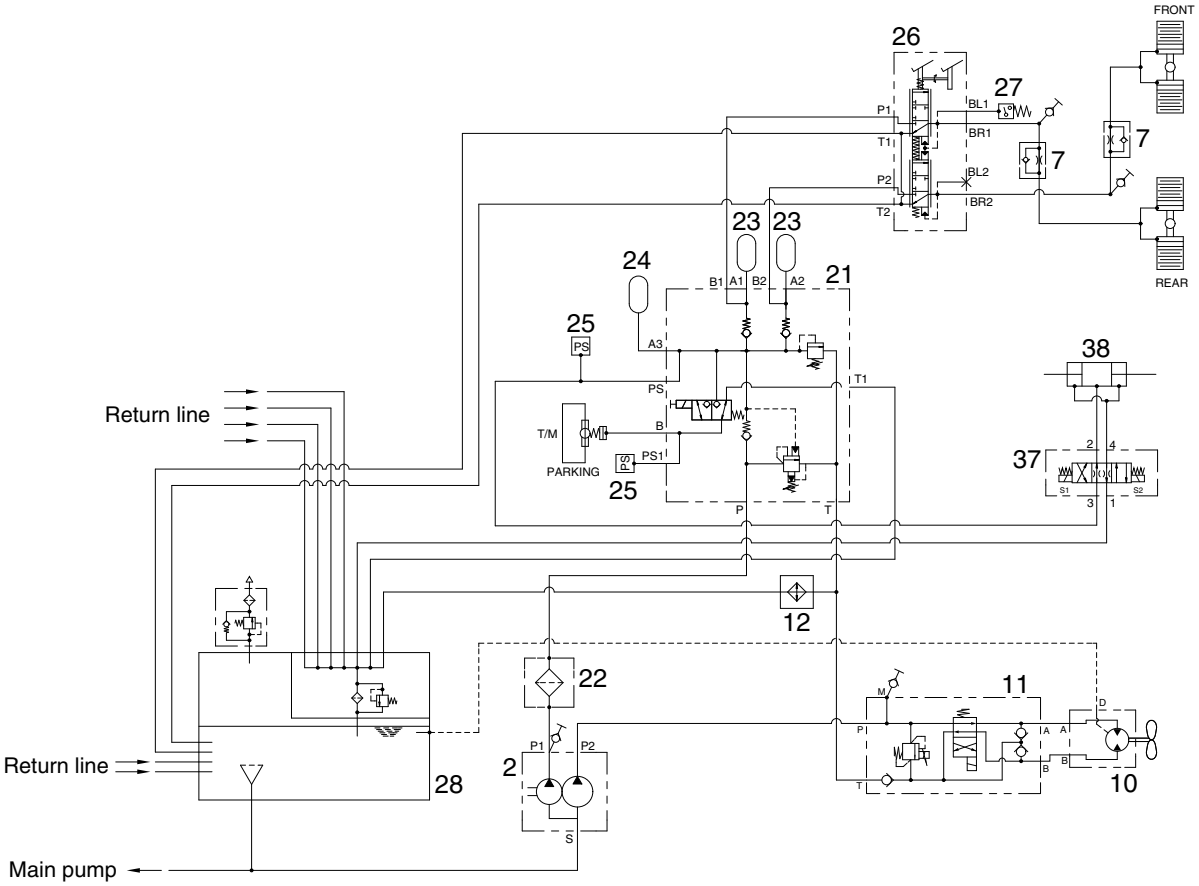
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the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

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



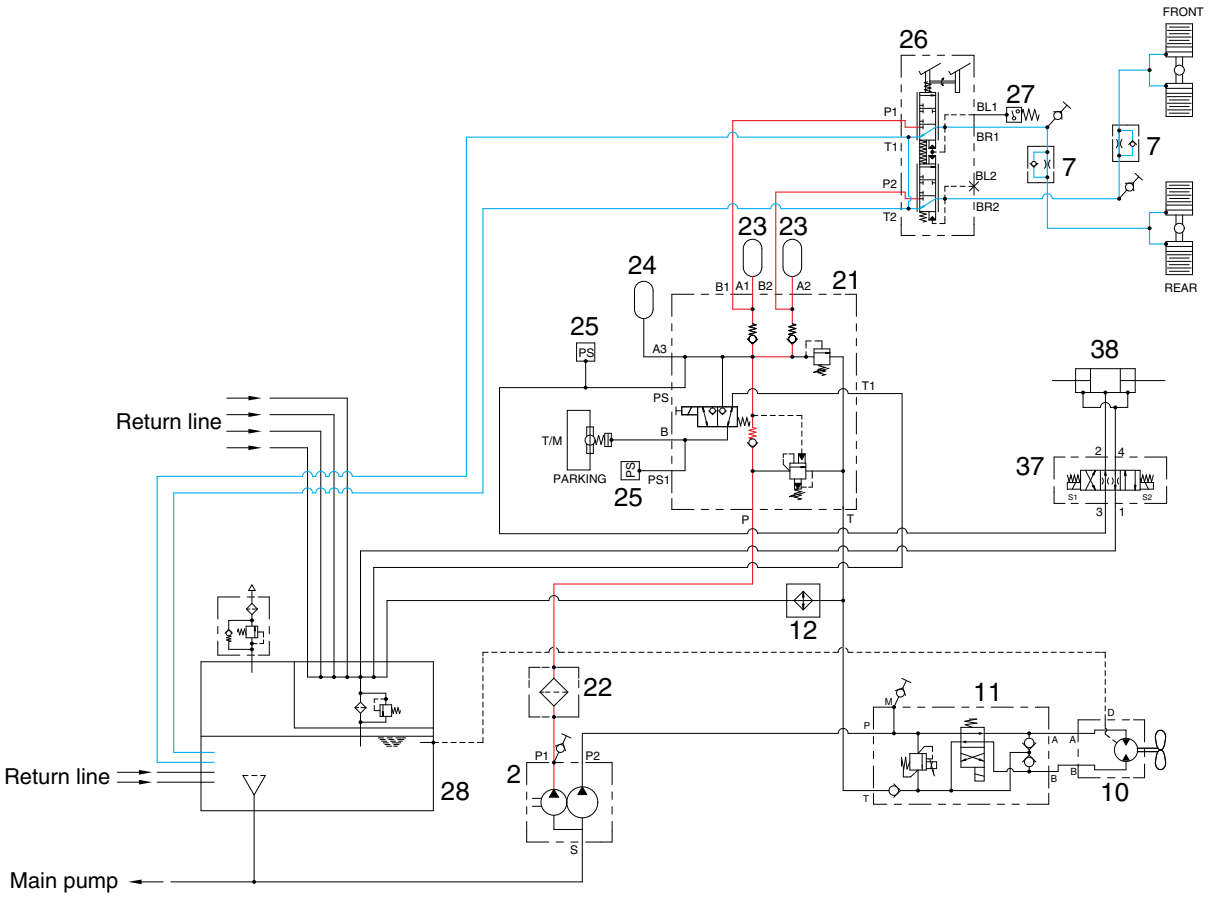
2. HYDRAULIC CIRCUIT



930A4BS01

2	Fan & brake pump	21	Cut-off valve	26	Brake valve
7	Orifice check valve	22	Line filter	27	Pressure switch
10	Fan motor	23	Accumulator	28	Hydraulic tank
11	Directional valve	24	Accumulator		
12	Oil cooler	25	Pressure sensor		

1) SERVICE BRAKE RELEASED



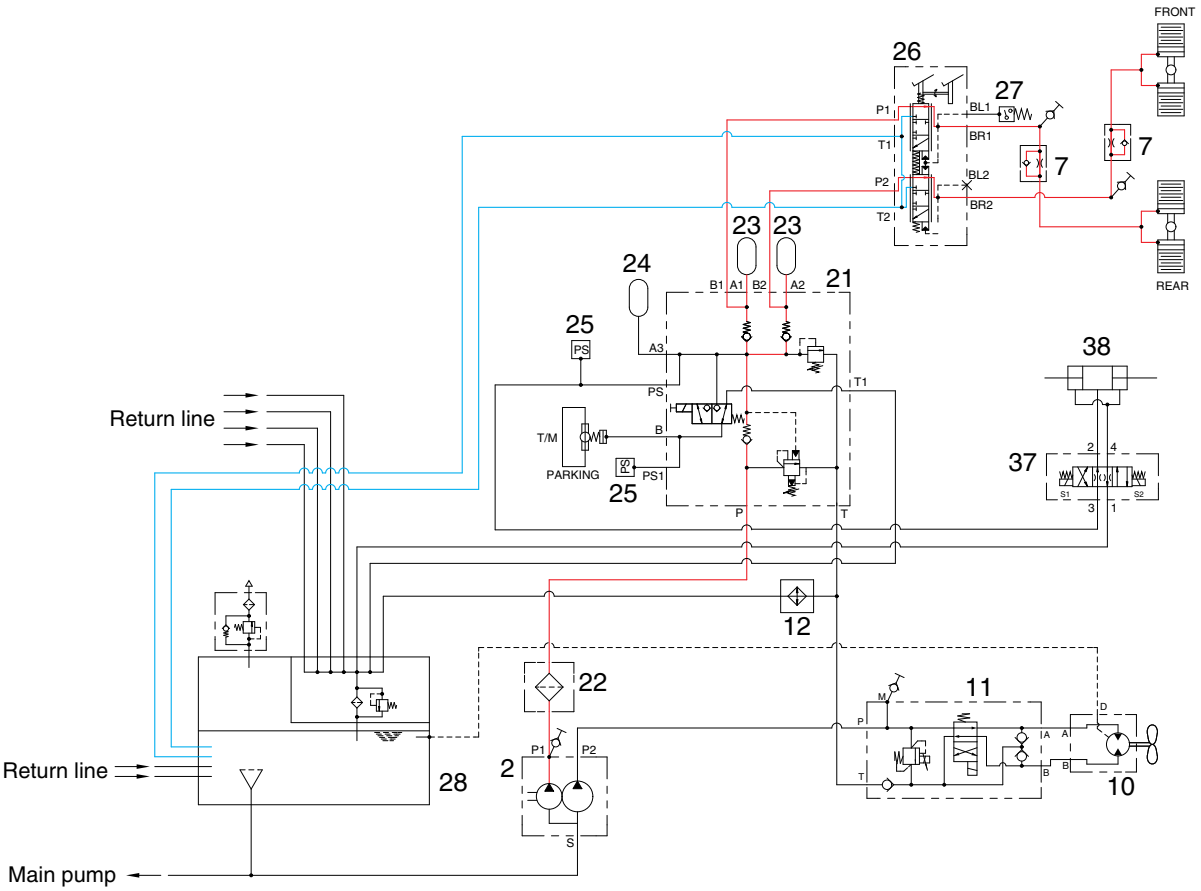
940A4BS023

When the pedal of brake valve (26) 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 (28).

Therefore, the service brake is kept released.

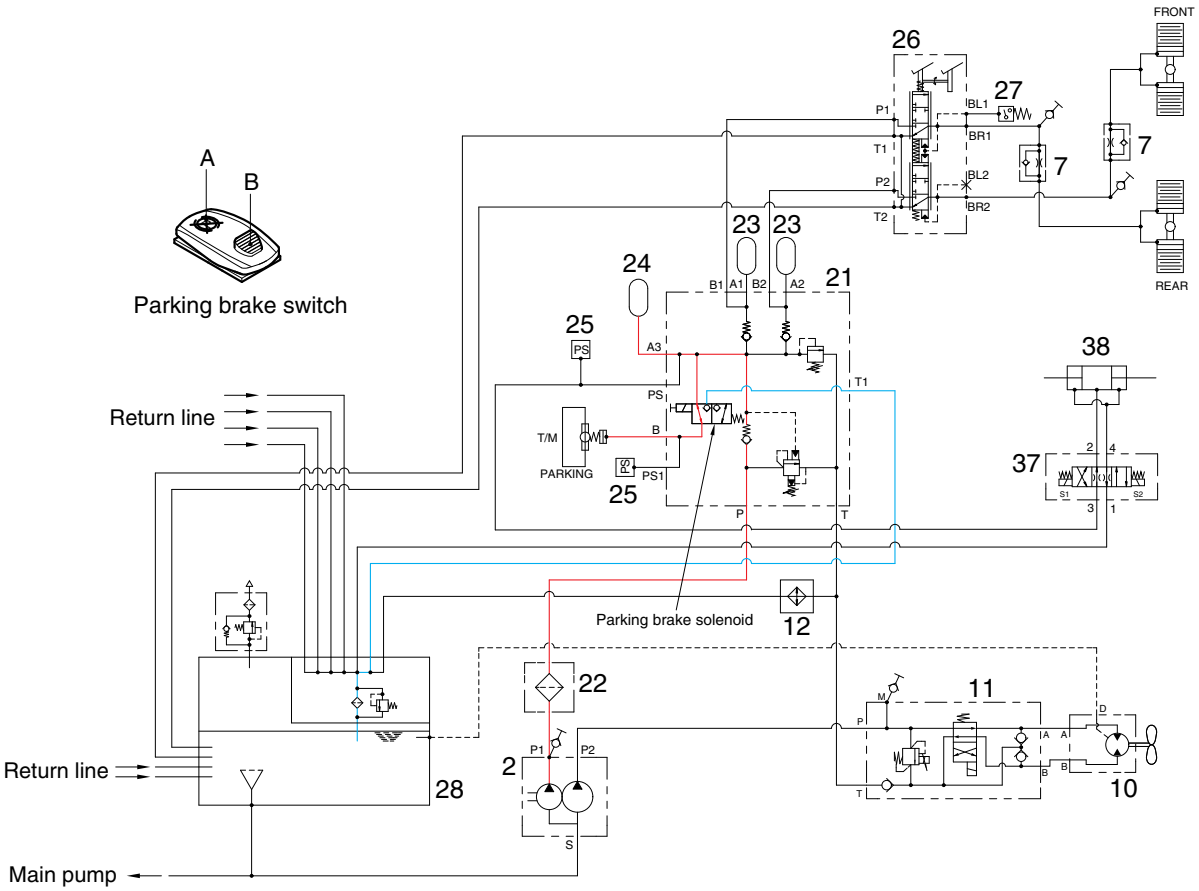
2) SERVICE BRAKE OPERATED



930A4BS03

When the pedal of brake valve (26) 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 (21) enters the piston in the front and rear axles. Therefore, the service brake is applied.

3) PARKING BRAKE RELEASED

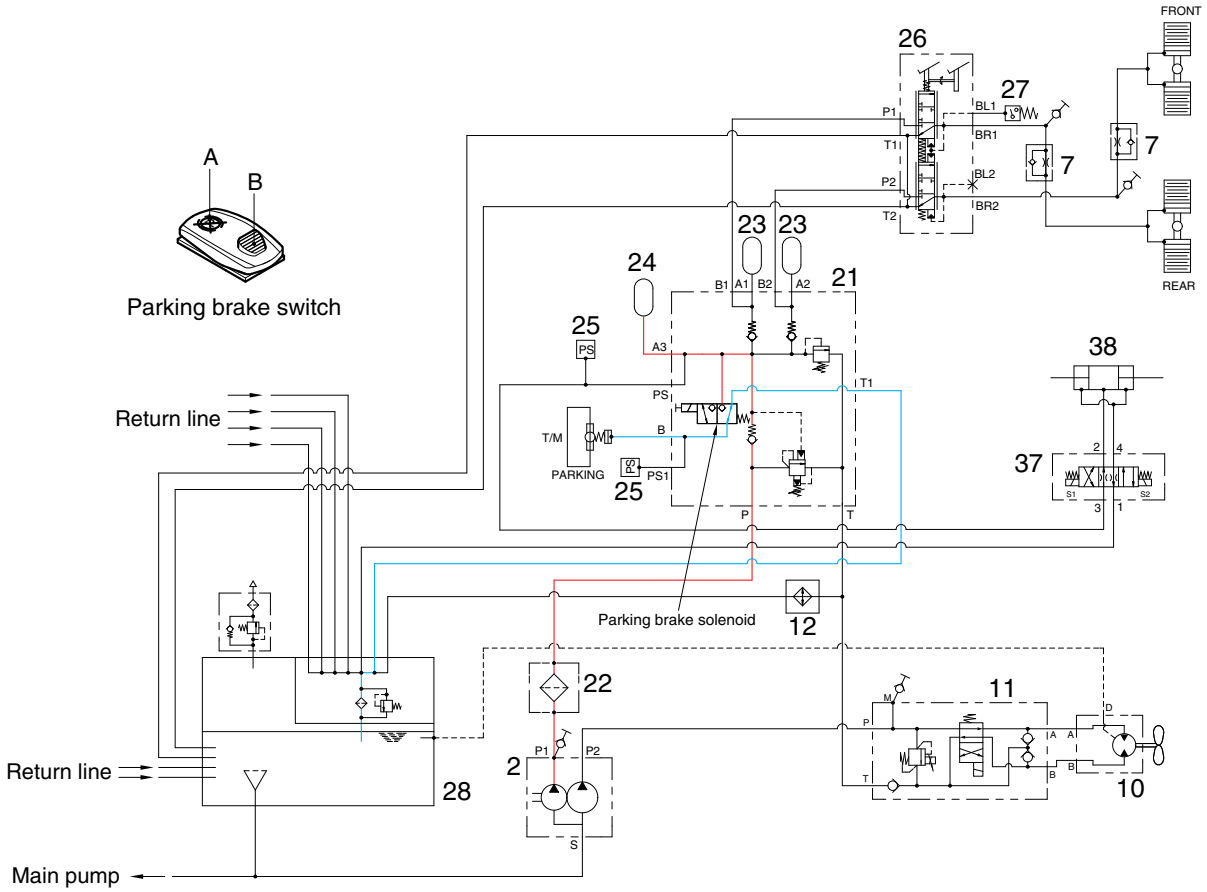


930A4BS04

When the parking brake switch is pressed A position, the solenoid valve is energized and the hydraulic oil controlled the pressure level by the cut-off valve 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

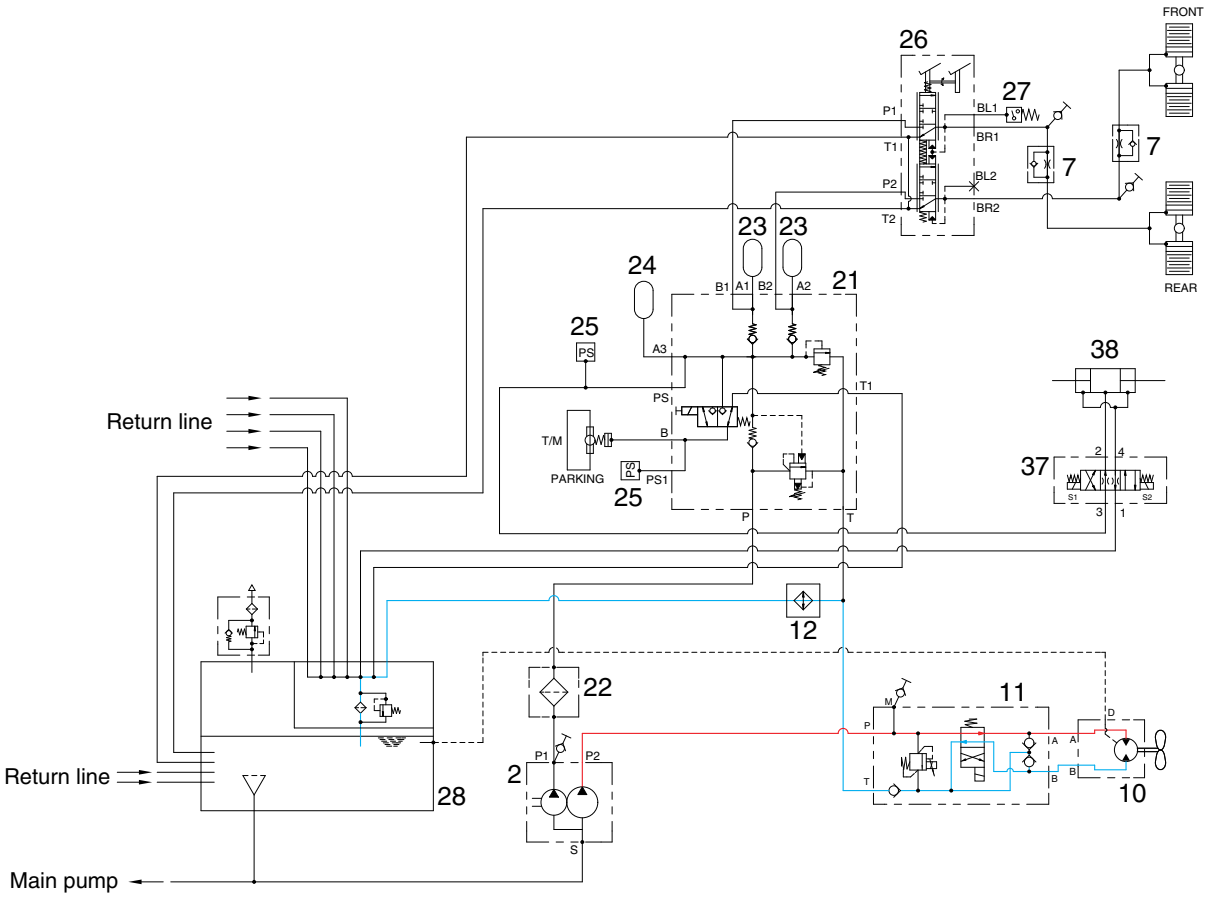


930A4BS05

When the parking brake switch is pressed B 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.

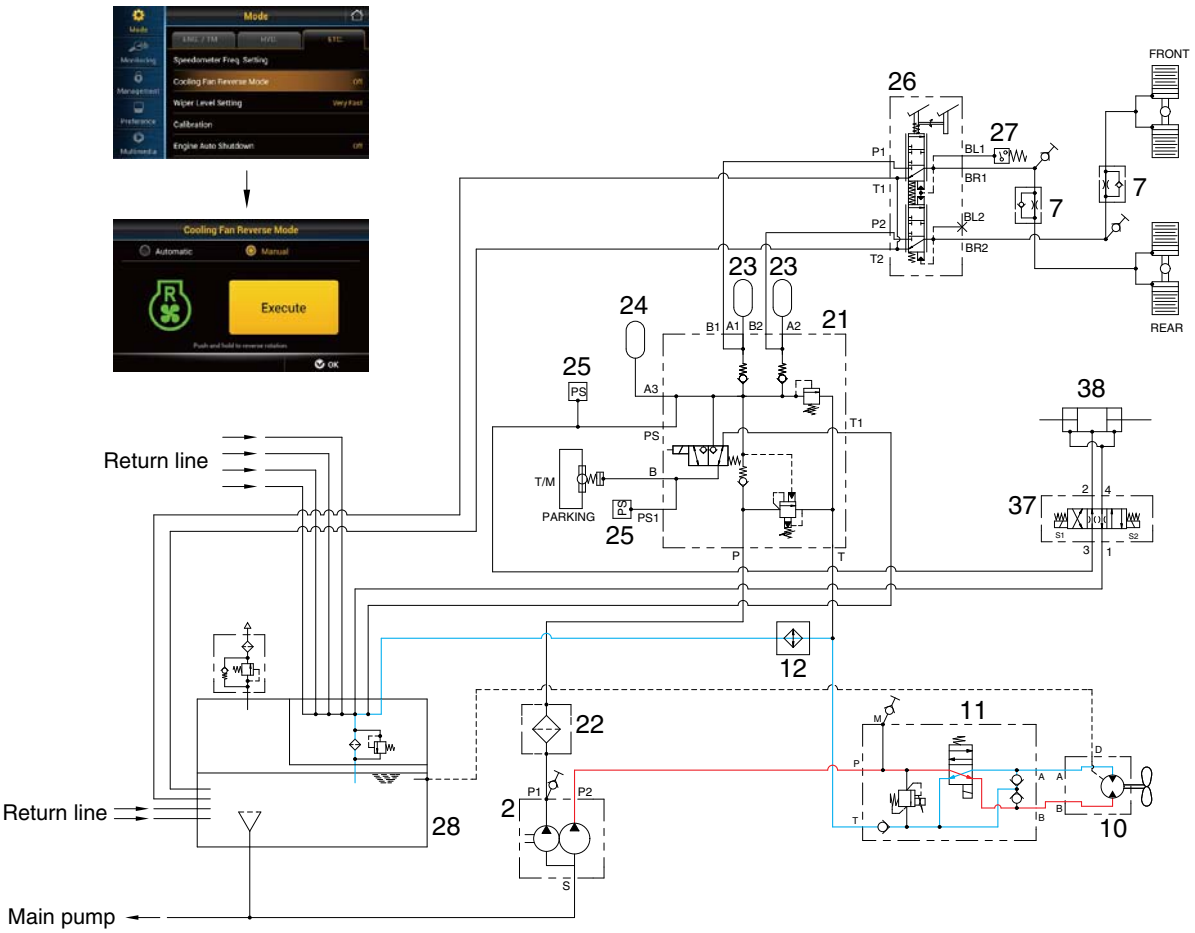
5) FAN MOTOR OPERATED



930A4BS06

When the brake accumulators are fully charged, the priority valve switches position and the oil is directed to hydraulic fan motor through directional valve (11). The flow of the oil causes fan motor (10) to rotate the fan blade. The rotation of the fan forces cool air to flow through the cooler.

6) DIRECTIONAL VALVE OPERATED

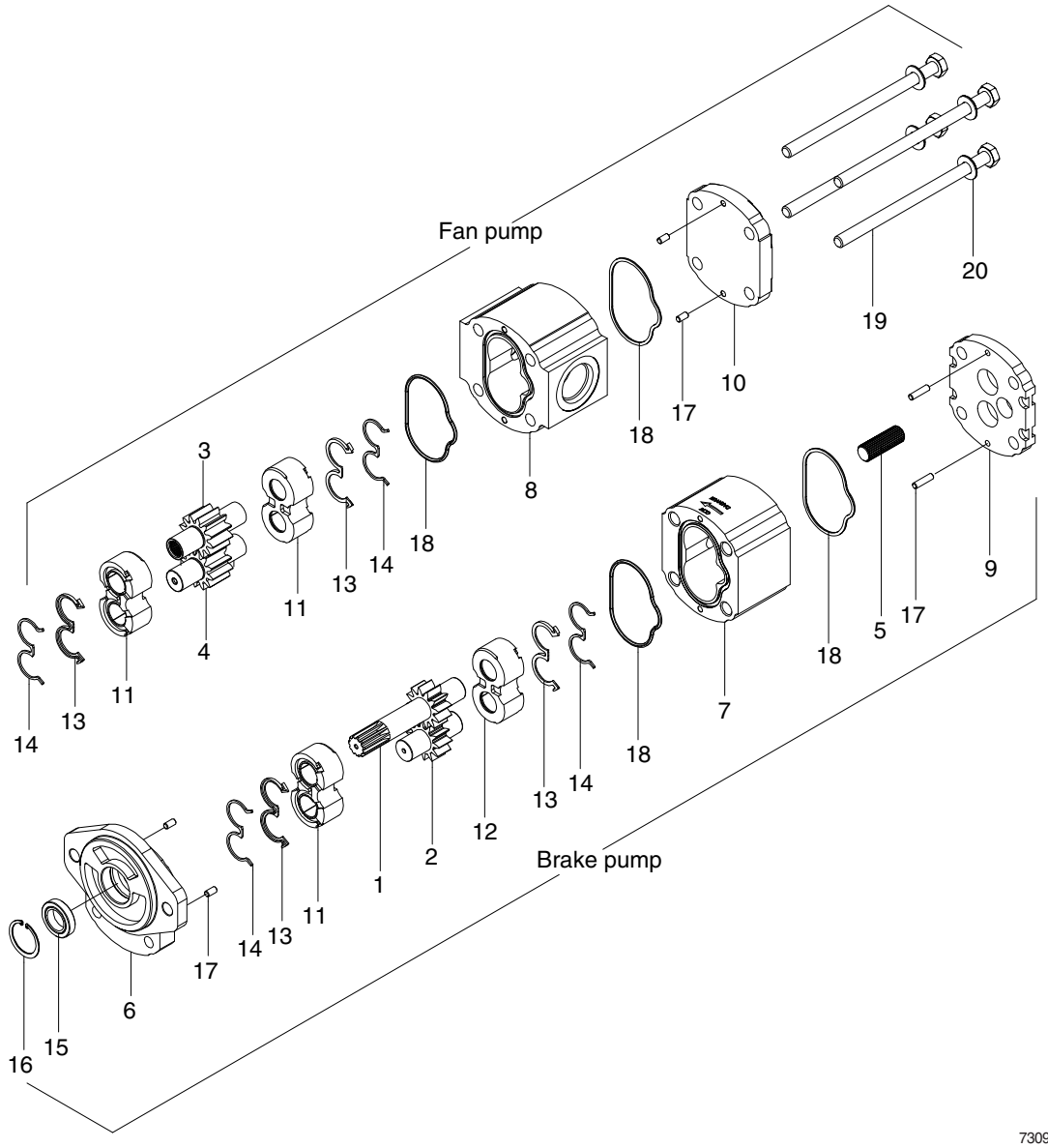


930A4BS07

When the fan control switch is pressed Automatic or Manual position, the solenoid valve in the directional valve (11) is energized and the flow of the oil is changed. The rotation of the fan is reversed to clear the radiators.

3. BRAKE PUMP (+FAN PUMP)

1) STRUCTURE



7309A4BS20

1	Shaft gear	8	Pump housing	15	Retainer seal
2	Driven gear	9	Multi spacer	16	Snap ring
3	Joint drive gear	10	Rear cover	17	Dowel pin
4	Driven gear	11	Block bushing	18	D-ring
5	Connector	12	DU bushing	19	Bolt
6	Front cover	13	Channel seal	20	Washer
7	Front housing	14	Back up seal		

This gear pump have a maximum delivery pressure of 150 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.

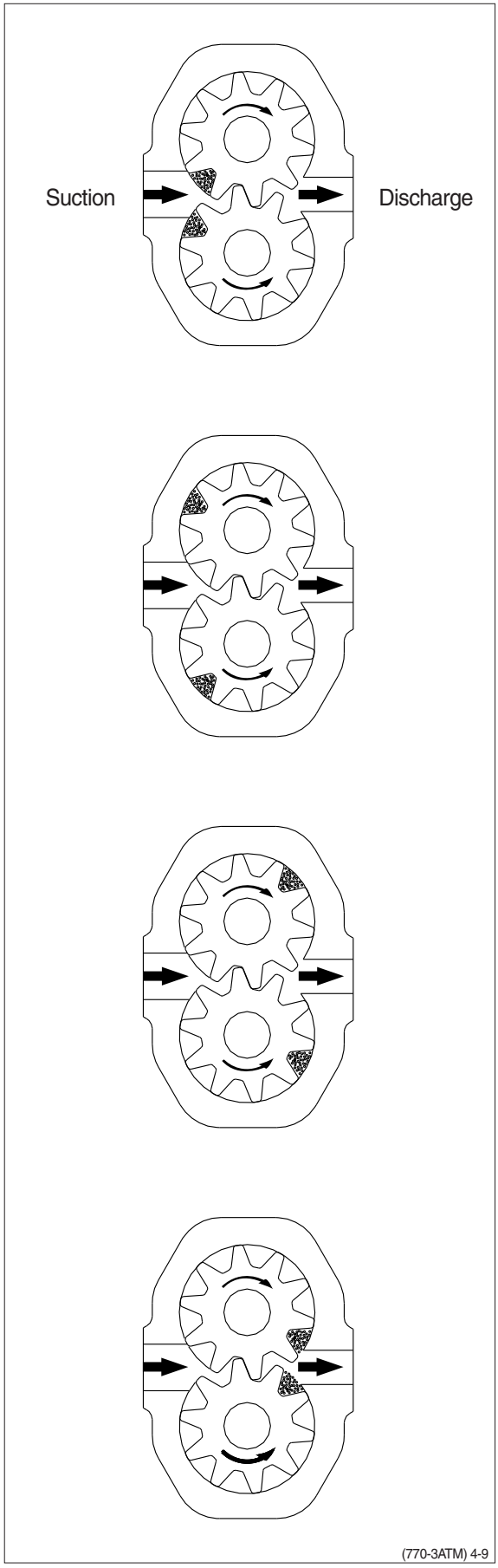
The amount of discharge increases with the speed of rotation of the gear.

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.



(770-3ATM) 4-9

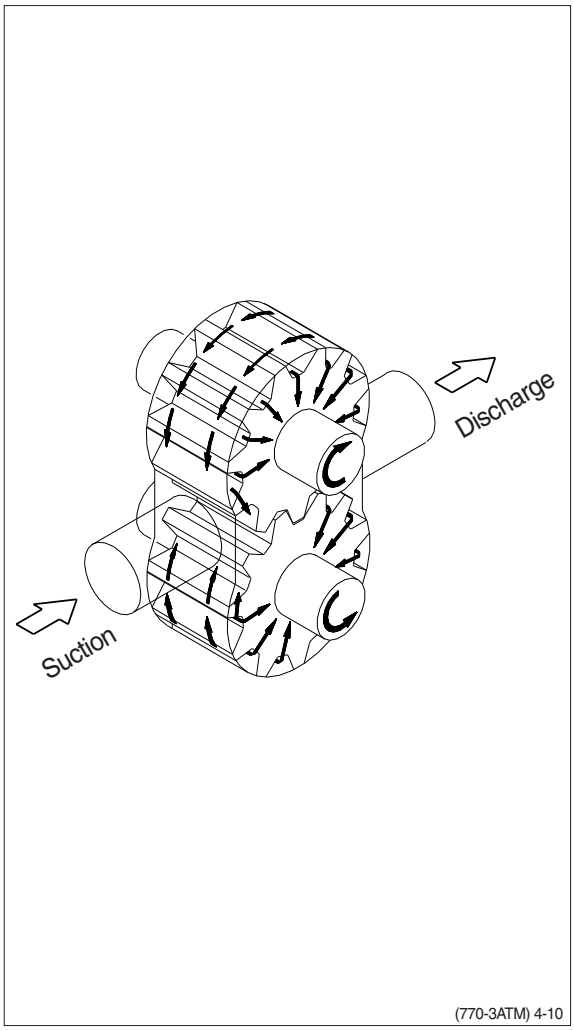
(2) Internal oil leakage

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.

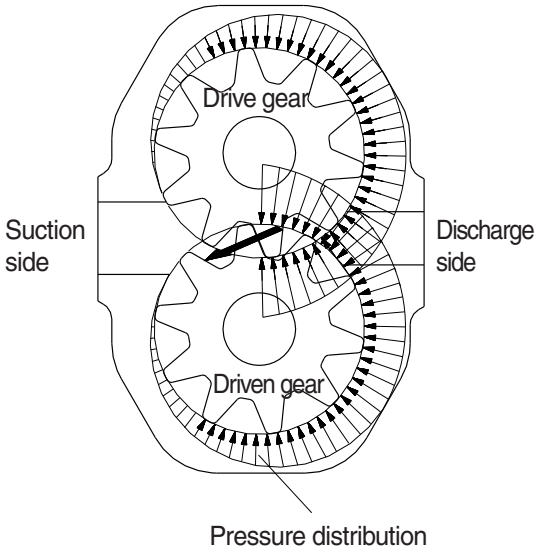
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

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.

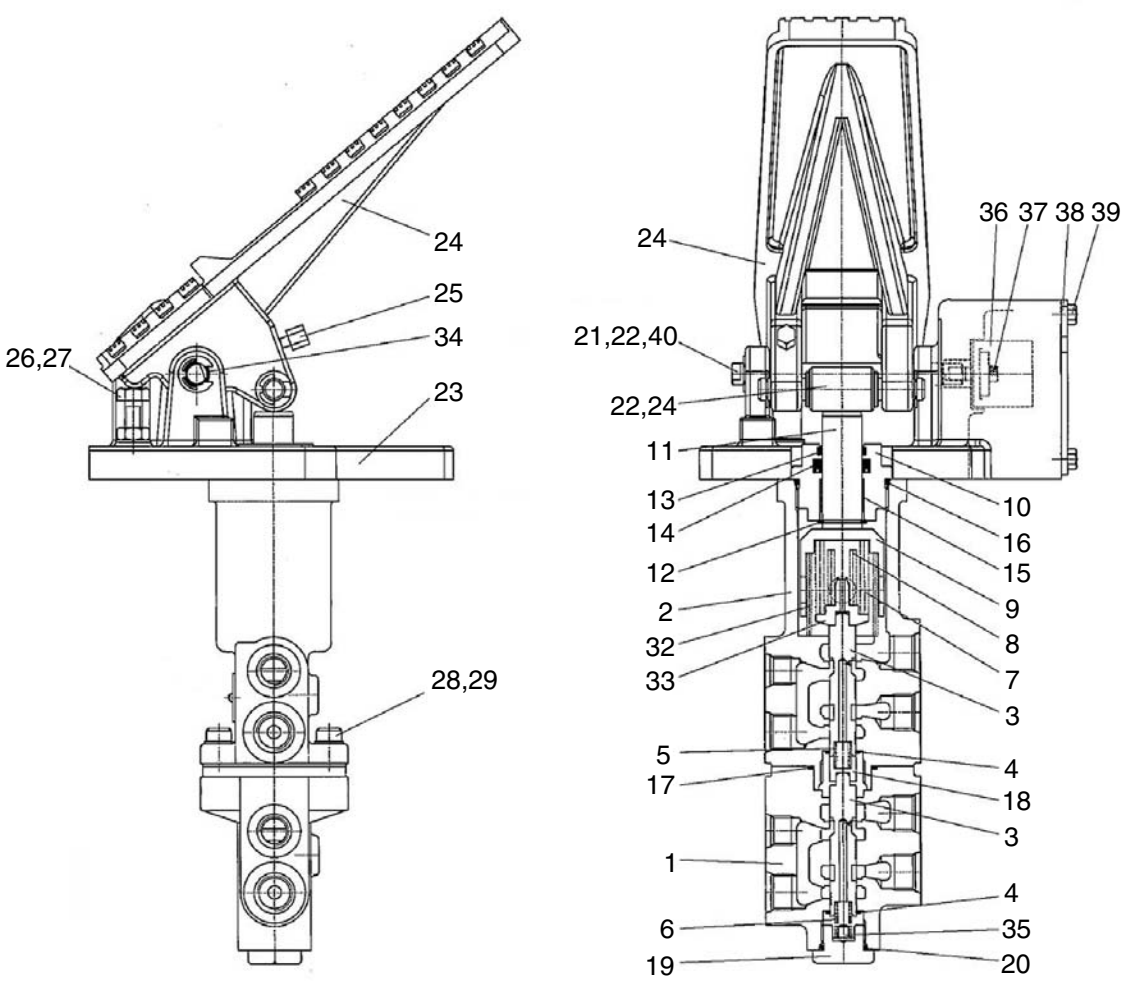
For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



(770-3ATM) 4-11

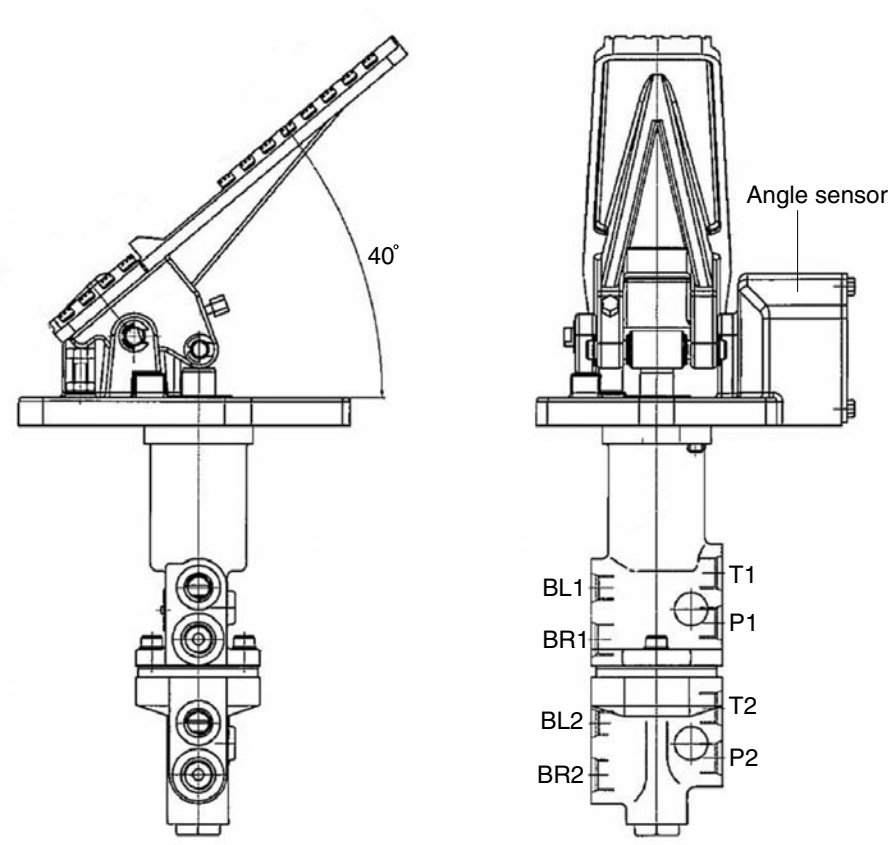
4. BRAKE VALVE

1) STRUCTURE

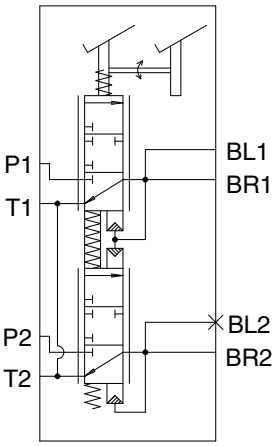


930A4BS11

1	Lower body	13	Spacer	25, 26	Bolt
2	Upper body	14	Rod packing	27,28	Nut, Bolt
3	Spool	15	Bushing	29	Spring washer
4	Stop ring	16	O-ring	32	Return spring
5	Upper Spring	17	O-ring	33	Spring retainer
6	Lower Spring	18	Spring guide	34	Bushing
7	Main Spring	19	Plug	35	Spacer
8	Main Spring	20	O-ring	36	Angle sensor
9	Stopper	21	Lock pin	37	Bolt
10	Retainer	22	Stop ring-E	38	Cover
11	Push rod	23	Pedal plate	39	Bolt
12	Stop ring	24	Pedal assy	40	Torsion spring



Port	Port size
P1, P2	PF 3/8
T1, T2	PF 3/8
BR1, BR2	PF 3/8
BL1, BL2	PF 1/4



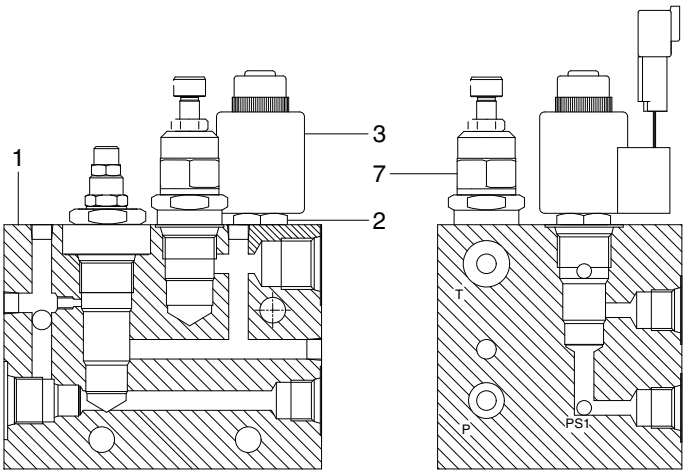
75794BS08

Hydraulic circuit

· Brake pressure specification : 72 bar (1040 psi)

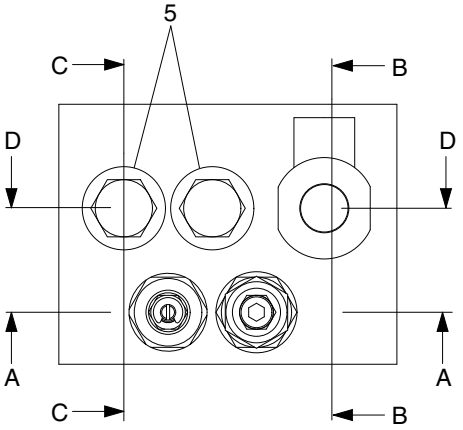
5. CUT-OFF VALVE

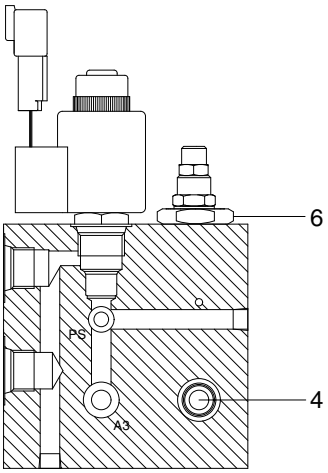
1) STRUCTURE



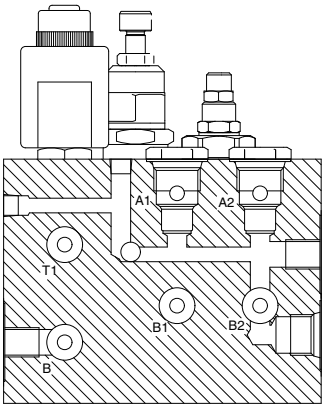
SECTION A - A

SECTION B - B

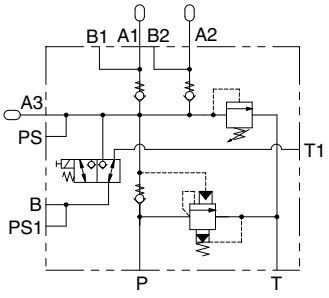




SECTION C - C



SECTION D - D



Hydraulic circuit

75794BS20

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

Port name	Port size
P, T	PF 1/2
A1, A2, A3, B, B1, B2, T1	PF 3/8
PS, PS1	PF 1/4

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.

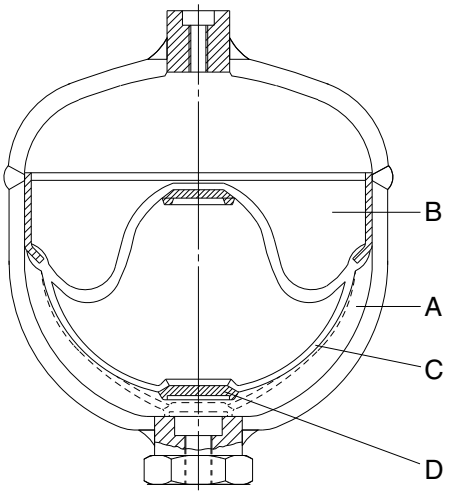
As the pressure on P line rises to 150bar, the cut off valve (6) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120 bar by the minute leakage from valve and other factors.

At this pressure, the cut-off valve starts cut-ining.

This process is repeated in the regular period of 30~40 seconds.

6. BRAKE ACCUMULATOR

1) STRUCTURE



75794BS09

Item	31LL-40020 (item 24)	31AC-10030 31LC-80030★ (item 23)
Diameter	167 mm	136 mm
Mounting height	219 mm	159 mm
Norminal volume	2.0 ℓ	1.0 ℓ
Priming pressure	50 kgf/cm²	50 kgf/cm²
Operating medium	Oil	Oil
Operating pressure	Max 210 kgf/cm²	Max 200 kgf/cm²
Thread	M22×1.5	M22×1.5
Priming gas	Nitrogen	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

★ : Cold region

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

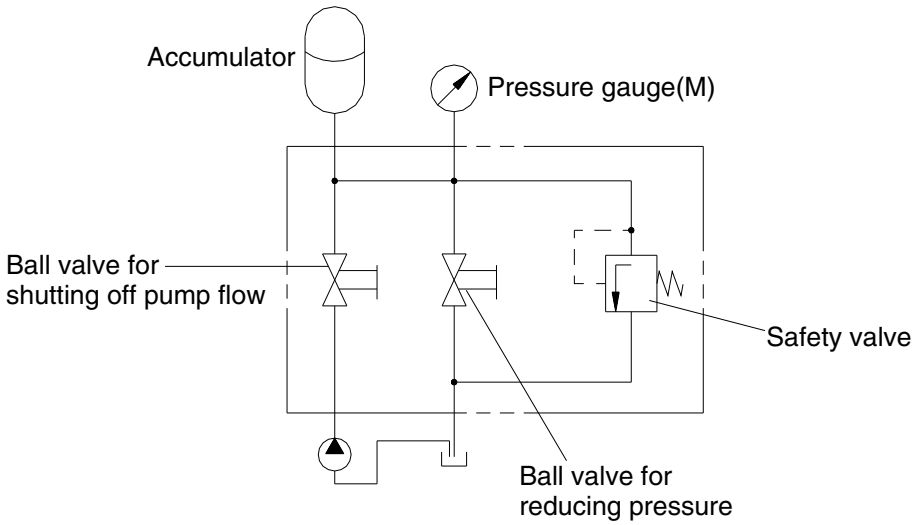
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber (B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ 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**.



75794BS10

(7) Repair work

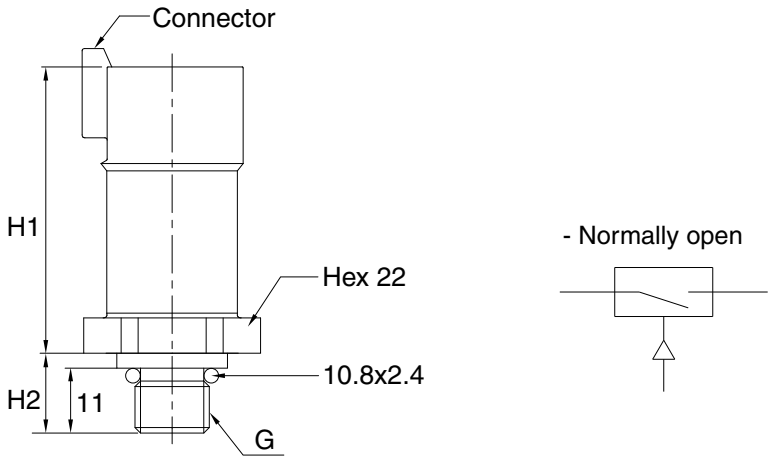
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.

※ 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.

7. PRESSURE SENSOR AND SWITCH

1) STRUCTURE



7609A4BS12

2) TECHNICAL DATA

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Actuating pressure kgf/cm²	Voltage V
Parking pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Charging pressure sensor	-	Oil	PF 1/4"	45	12.5	0 ~ 200	100 ± 5	Max 30
Brake stop pressure switch	NO	Oil	PF 1/4"	45	12.5	0 ~ 100	5 ± 1	Max 30

NO : Normally open

3) Tightening torque : 3.5 kgf · m (25.3 lbf · ft)

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

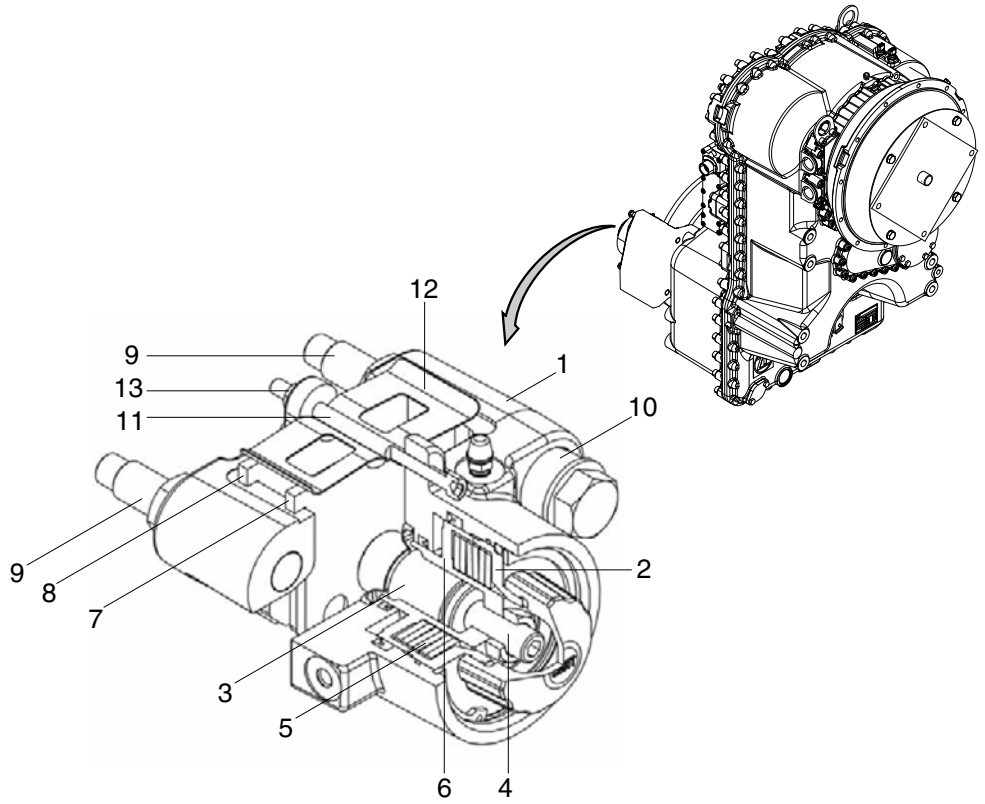
⚠ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

※ 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.

8. PARKING BRAKE SYSTEM

1) STRUCTURE



7609A4BS21

1	Housing	6	Piston	11	Adjusting screw
2	Pressure ring	7	Lining pad	12	Lining spring
3	Pressure bolt	8	Lining pad	13	Counter nut
4	Setting screw	9	Guiding pin		
5	Plate spring pack	10	Rubber buffer		

2) OPERATION

The two identical lining pads (7, 8) slide on the guide surfaces on the top of the housing and are held in position by a lining spring (12). The brake itself is directly fixed on the gearbox with the two guide pins (9).

The brake is positioned axially using the rubber buffers (10) between the brake housing (1) and the guide pins (9), and the setting screw (11).

When the brake is actuated (= closed) a clamping force is created on the lining pads (7, 8) which is transmitted to the brake disc. Under the force of the plate spring pack (5), the piston (6), together with the adjusting screw (4), the pressure bolt (3) and the lining pad (7) are moved towards the brake disc. When the lining pad (7) comes into contact with the brake disc, the reaction force displaces the brake on the guide pins (9), against the spring force of the rubber buffers (10), until the second lining pad (8) is also pressed against the brake disc.

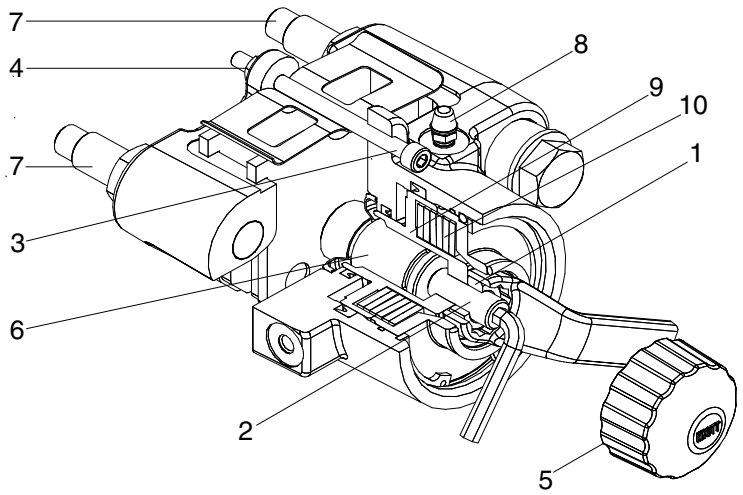
The braking effect (braking torque) is dependent upon the frictional values of the brake linings.

The brake is released by complete pretensioning of the plate spring pack (5). The piston (6) is moved back by the required minimum release pressure to the stop on the pressure ring (2).

During this process the brake positions itself, depending upon the setting, by the two rubber buffers (10) up to contact with the setting screw (11). An equal air gap must be guaranteed on both sides of the brake disc when set correctly.

The clamping force is reduced by wear of the lining pads (7, 8) and the brake disc.
The brake must then be readjusted.

3) FITTING AND SETTING INSTRUCTIONS



7609A4BS22

1	Lock nut	5	Screw cap	9	Piston
2	Setting screw	6	Pressure bolt	10	Spring pack
3	Adjusting screw	7	Guiding bolt		
4	Counter nut	8	Bleeding screw		

※ The fitting or adjusting must always be carried out when the brake is cold.

(1) Fitting the brake

① Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
② Release the lock nut (1) and turn the adjusting screw (2) counter-clockwise until the pressure bolt (6) contacts the piston (9) with the flat surface.
③ Slide the brake over the brake disc in this condition.
④ Screw the two guide pins (7) into the gearbox.
⑤ Connect the pressure.
⑥ Apply the required release pressure (min. 130 bar) to the brake in order to pre-tension the plate spring pack (10) completely, up to the stop.
⑦ Carry out bleeding of the brake using the bleed valve (8) .

(2) Clearance adjusting

① Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.

※ **The thickness of the setting gauge must be adjusted to the desired air gap.**

Clearance		Setting gauge
Min.	0.5 mm	0.25 mm
Nominal clearance	1.0 mm	0.50 mm
Max.	1.5 mm	0.75 mm

② Turn the adjusting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.

③ Hold the adjusting screw (2) in position and lock using the lock nut (1).

※ **The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.**

④ Release the counter nut (4) and then turn the setting screw (3) in a clockwise direction until the end surface of the setting screw (3) is in contact with the surface provided for setting.

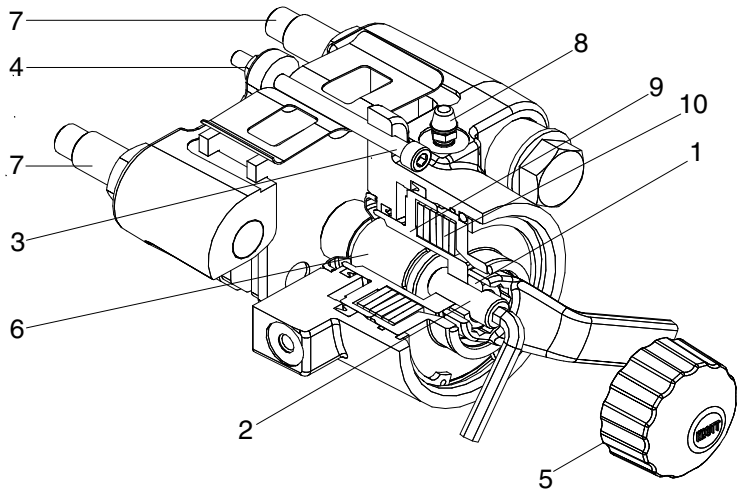
⑤ Hold the setting screw (3) in position and lock using the counter nut (4).

⑥ Remove the setting gauges from both sides of the brake disc.

※ **The fitting procedure for the brake and the setting of the desired air gap is now complete. The brake is ready for use.**

⑦ Turn the screw cap (5) in a clockwise direction and tighten hand-tight.

※ **The brake should be actuated and released several times to check that it is functioning properly.**



7609A4BS22

(3) Adjusting instructions

① Place the machine on flat ground and secure against rolling away.

② Release the parking brake by application of the required release pressure (min. 130 bar).

③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.

④ Release the lock nut (1) of the setting screw (2).

⑤ Insert a setting gauge on both sides between the brake lining carrier and brake disc and hold them in position.

※ The setting gauge must be selected in accordance with the table under (2) "Clearance adjusting".

⑥ Turn the setting screw (2) in a clockwise direction until the two setting gauges are clamped between the brake lining carriers and the brake disc.

⑦ Apply the lock nut (1) to the setting screw (2).

※ The application pressure for clamping the setting gauges must be selected so that both gauges can be removed using a small amount of force after locking in position.

⑧ Release the counter nut (4) and then turn the adjusting screw (3) in a clockwise direction until the end surface of the adjusting screw (3) is in contact with the surface provided for setting.

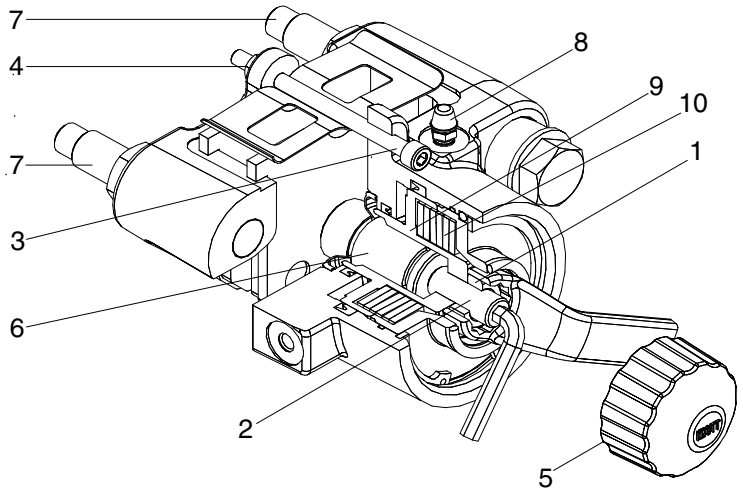
⑨ Hold the adjusting screw (3) in position and lock using the counter nut (4).

⑩ Remove the setting gauge from both sides of the brake disc.

※ The adjustment of the desired air gap is now complete. The brake is ready for use.

⑪ Turn the screw cap (5) in a clockwise direction and tighten hand-tight.

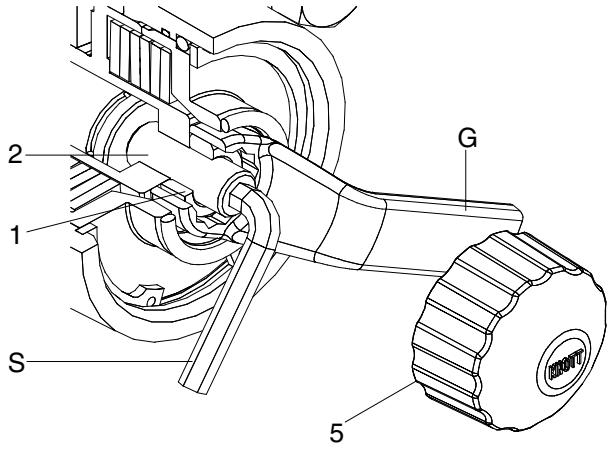
※ Actuate the brake valve several times and check the holding effect of the parking brake on a suitable incline or a suitable gradient.



7609A4BS22

4) EMERGENCY RELEASE OF THE PARKING BRAKE

In the event of a failure in pressure supply the parking brake can be released mechanically in the following way :



7609A4BS23

1 Lock nut
2 Setting screw
5 Screw cap
S Peg spanner
G Ring spanner

(1) Secure the machine against rolling away.
(2) Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.
(3) Release the lock nut (1) and unscrew it back to the end of the setting screw (2).
(4) Rotate the setting screw (2) in a clockwise direction until the brake disc is completely free.

※ **For emergency release a torque of min 7.1 kgf·m (51.6 lbf·ft) is required on the setting screw (2).**

(5) Screw on the lock nut (1) up to contact with the piston and apply a slight locking force to the setting screw (2).
(6) Screw on the screw cap (5) in a clockwise direction by a few threads. (dirt ingress protection)

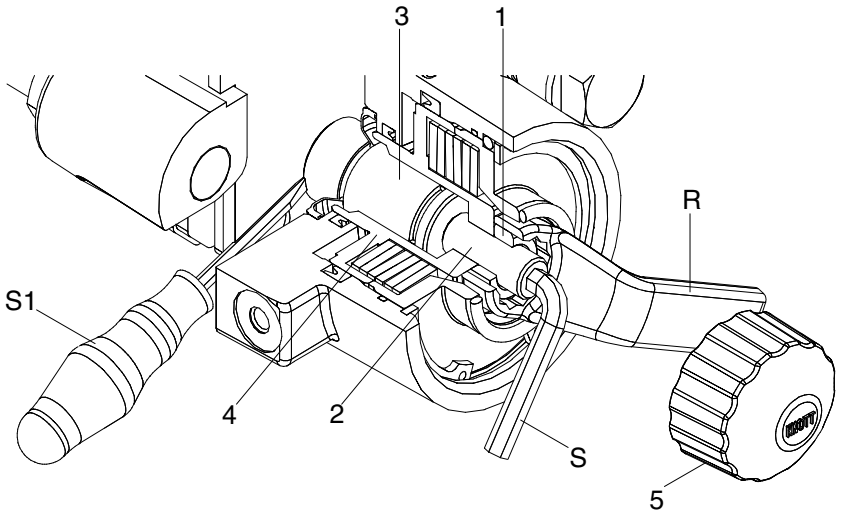
※ **In this condition the machine has no parking brake facility and thus must be protected from rolling away by different means. The brake must be adjusted before recommissioning.**

5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and replacement of the lining pads

The brake, particularly the brake lining carriers, must be visually inspected at regular intervals. If the remaining lining thickness is too thin, these intervals must be reduced accordingly to prevent extensive damage to the brake or the brake disc.

Once the minimum remaining lining thickness of 1.0 ~ 1.5 ㎜ per brake lining carrier is reached, the brake lining carrier must be replaced in accordance with the following instructions :



7609A4BS24

1	Lock nut	5	Screw cap
2	Setting screw	S	Peg spanner
3	Pressure bolt	S1	Screwdriver
4	Piston	R	Ring spanner

① Place the machine on flat ground and secure against rolling away.

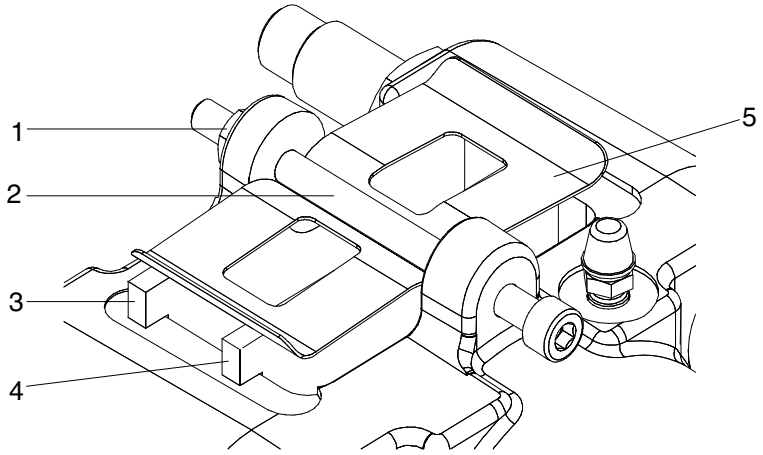
② Release the parking brake by application of the required release pressure (min. 130 bar).

③ Rotate the screw cap (5) in a counter-clockwise direction and unscrew it.

④ Release the lock nut (1) of the setting screw (2).

⑤ Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (3) can be pushed completely into the piston (4) .

⑥ Unscrew (lever) the pressure bolt (3) with a suitable screwdriver until it contacts the piston (4).



7609A4BS25

1 Counter nut
2 Adjusting screw
3 Lining pad
4 Lining pad
5 Lining spring

⑦ Release the counter nut (1) and unscrew the adjusting screw (2) from the brake housing.

※ **The lining spring (5) is pre-tensioned. The lining spring (5) must be held in position with a suitable tool whilst removing the adjusting screw (2).**

⑧ Remove the lining spring (5).

⑨ Remove the two lining pads (3, 4) from the lining compartment in the brake housing.

※ **If there is no possibility of changing the brake lining carriers (3, 4) as described above (not enough space), the brake must be removed completely.**

※ **Check the pressure line. A pressure line which is too short must be unscrewed in order to permit removal of the brake.**
An emergency release of the parking brake must be carried out before releasing the pressure line.

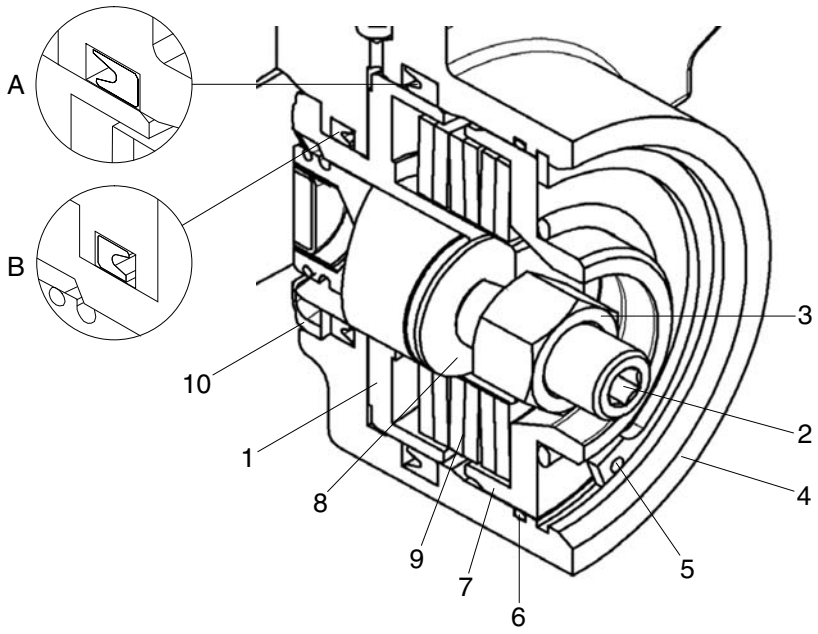
⑩ Replace the lining pads (3, 4).

⑪ The lining spring (5) must be pushed in position with a suitable tool whilst screwing in the adjusting screw (2).

※ **If you removed the brake completely because of a lack of space you must carry out fitting of the brake.**

※ **After changing the lining pads (3, 4), or repair to them, the brake must be adjusted in accordance with 3) FITTING AND SETTING INSTRUCTION.**

(2) Replacing the seals



7609A4BS26

1	Piston	5	Circlip	9	Plate spring pack
2	Setting screw	6	Sealring	10	Dust protection cap
3	Lock nut	7	Pressure ring	A	Detail sealring
4	Housing	8	Pressure bolt	B	Detail sealring

Leaking seals must be replaced in accordance with the following instructions :

① Place the machine on flat ground and secure against rolling away.
② Release the parking brake by application of the required release pressure (min. 130 bar).

※ If the brake cannot be pressurised with the required release pressure (min. 130 bar) because of excessive leaks, the parking brake MUST be released using the emergency procedure. See 4) Emergency release of the parking brake.

③ Rotate the screw cap in a counter-clockwise direction and unscrew it.
④ Release the lock nut (3) of the setting screw (2).
⑤ Rotate the setting screw (2) in an counter-clockwise direction until the pressure bolt (8) can be pushed completely into the piston (1).
⑥ Unscrew (lever) the pressure bolt (8) with a suitable screwdriver until it contacts the piston (1).
⑦ Actuate the brake valve and dissipate the existing release pressure down to 0 bar.

※ The plate spring pack (9) is now fully de-tensioned.

⑧ Unscrew the pressure line and remove the brake completely.
⑨ Remove the circlip (5) and remove the pressure ring (7) from the housing (4).
⑩ Remove the plate spring pack (9) and the piston (1).
⑪ Always replace both the seals (A, B).

※ **Observe the fitting direction of the grooved rings and use a suitable fitting needle with rounded edges to fit the new grooved rings. Take care - there is a danger of injury.**

※ **Carry out re-fitting of the individual parts into the brake in reverse order. Apply a light coat of fitting fluid lubricant to the sliding and sealing surfaces of the piston when fitting.**

⑫ If necessary, also replace the dust protection cap (10).

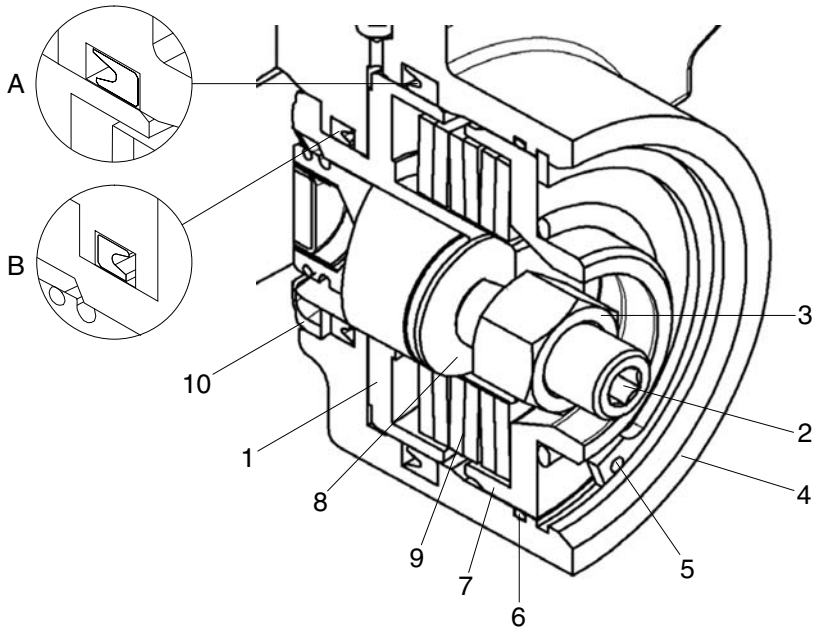
※ **The dust protection cap (10) has a vulcanised-in steel ring which is used to press it into the opening in the brake housing (4).**

In order to replace this you will need to "lever it out" with a suitable tool and then replace with a fitting fixture by pressing it into the housing (4).

⑬ Fit the brake onto gearbox in accordance with the fitting instructions.

(3) General instructions

Any faults or damage detected on parts not listed here must, of course, be rectified or replaced by genuine parts.



7609A4BS26

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.

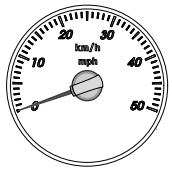
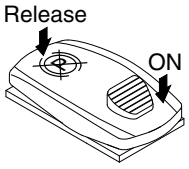
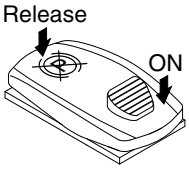
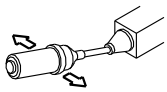
The engine and all other major components must be at operating temperature for some checks.

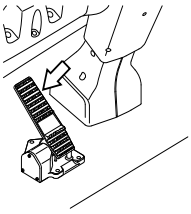
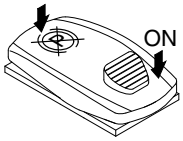
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

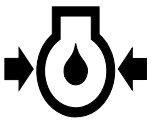
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

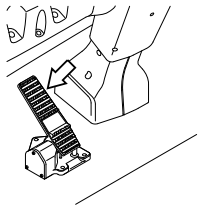
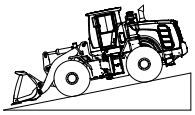
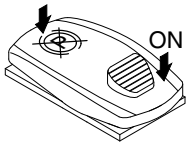
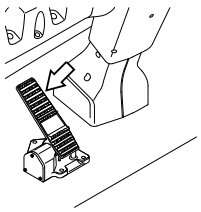
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks (refer to page 6-51).

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 4 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.	OFF  Release  ON Select clutch cut-off mode to 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. **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 in 1~5 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.
Service and parking brake system drag checks Engine running	  Position machine on gradual slope. Lower bucket approximately 50 mm (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. Drive machine at high speed for about 5 minutes. Brake drag is indicated if brake areas in differential case are hot. **NOTE** : Observe parking brake. If disk is hot, parking brake drag is indicated.	**OK** Check completed. **NOT OK** Adjust park brake. **NOT OK** Check floor mat interference to pedal or debris build-up. **IF OK** Check for brake pressure when brake is released. Go to brake pressure test.
Clutch cut-off check	 Select clutch cut-off mode to L mode. Release parking brake. Run engine at half speed in 1st forward.  Firmly depress brake pedal. **FEEL** : Transmission must disengage when brake pedal is depressed at 30% of pedal stroke. **NOTE** : Clutch cut-off mode can be selected to operator preference to match your loading needs.	**OK** Check completed. **NOT OK** Adjust clutch cut-off mode.

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.
	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

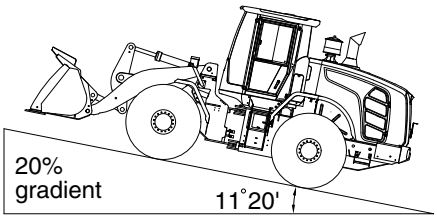
1) MEASUREMENT CONDITION

(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 valve
Parking brake performance	Keep machine on 20% (11˚20') gradient



740F4BS17

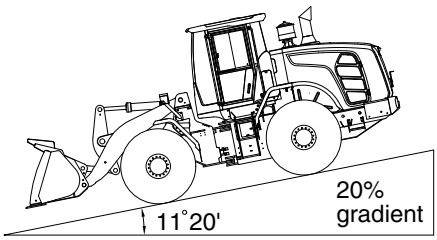
2) MEASURING PROCEDURE

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



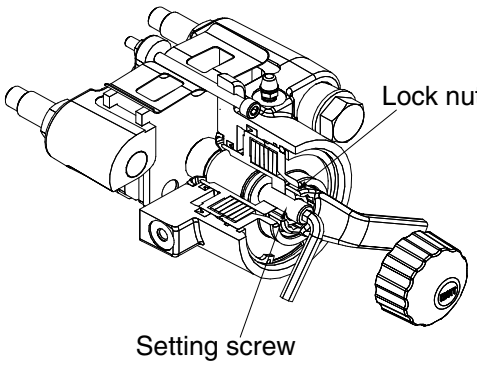
740F4BS18

2. ADJUSTMENT OF PARKING BRAKE

(1) External brake inspection

· Inspect for wear of brake pad

(2) Refer to the PARKING BRAKE SYSTEM on the page 4-22.



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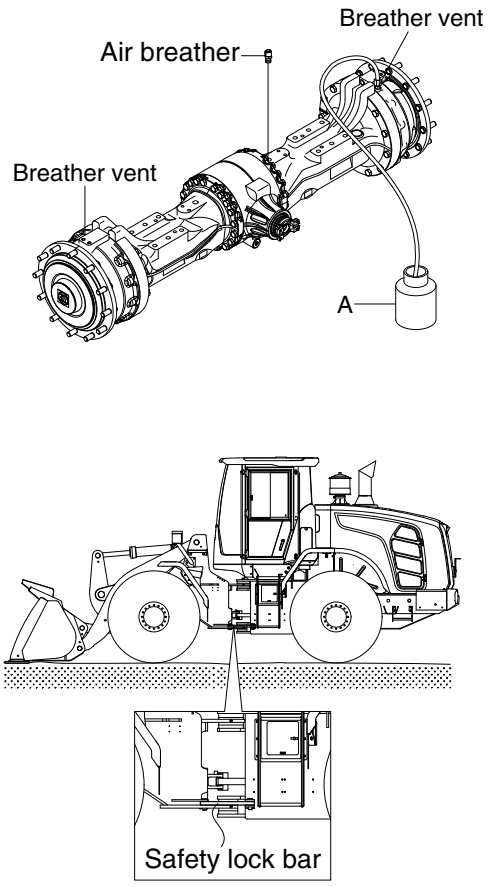
3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ **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.

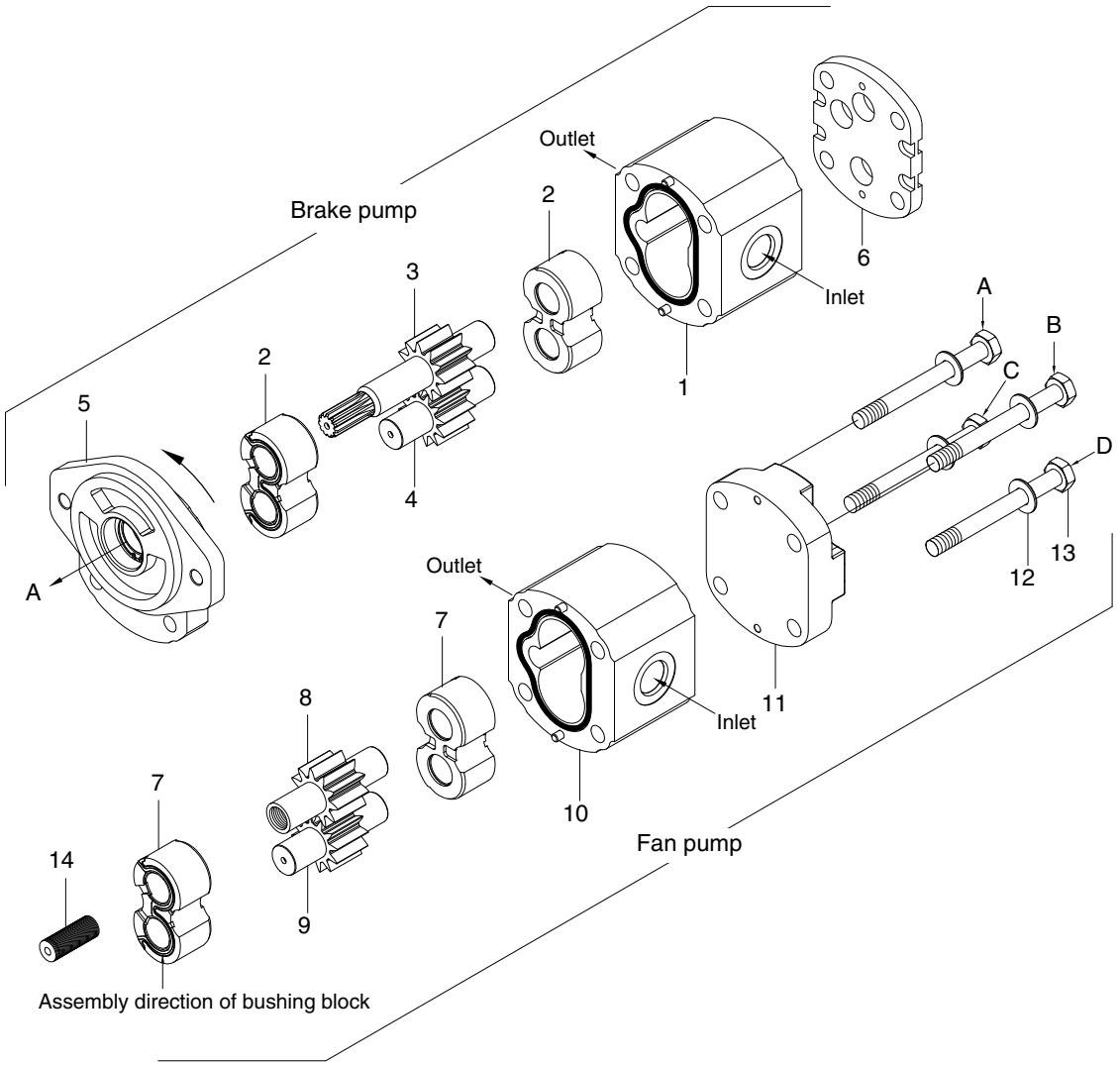
1) Install frame locking bar. Engage parking brake.
2) Put a clear plastic tube on bleed screw to route low to hydraulic oil tank filler tube or container (A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.
※ If bubbles continue for 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.



740F4BS19

1. BRAKE PUMP

1) MAIN ASSEMBLY



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1	Housing sub assy	6	Multi spacer	11	Rear cover
2	Bushing block sub assy	7	Bush block sub assy	12	Washer
3	Shaft gear	8	Joint drive gear	13	Bolt
4	Driven gear	9	Driven gear	14	Connector
5	Front cover sub assy	10	Housing sub assy		

(1) Prepare all parts and clean it.

(2) Prepare M10 torque wrench, oil pump and 1, 2, 5, 7, 10 sub assembly status.

(3) When you assemble, front cover sub assy (5) is based on a front view.

(4) Main assembly order

① Front cover sub assy (5) is based on a front view in drawing, check sense of rotation (CW) and assembling shaft gear's upper direction.

② At first, one of bushing block sub assy (2) point to same position of figure. After you assemble drive gear (3) and driven gear (4), you assemble bushing block sub assy (2).

③ Put oil on the assembled parts (2, 3, 4), lubrication for the gear to rotate and assemble front cover sub assy (5) to A direction.

④ Check the outlet port based on housing sub assy (1) drawing and contamination of part's inside. Coated oil parts are assembled in the direction vertical and horizontal.

⑤ Assemble multi spacer(6) as shown in the figure and connector (14) put in joint drive gear's(8) hole.

⑥ One of bush block sub assy(7) point to same position of figure.
After you assemble joint drive gear(8) and driven gear(9), you assemble bush block sub assy.

⑦ Put oil on the assembled parts (7,8,9), lubrication for the gear to rotate assemble multi spacer(6) to A axis direction.

⑧ Check the outlet port based on housing sub assy(10) drawing and contamination of part's inside. Coated oil parts are assembled in the direction verticcal and horizontal.

⑨ Assemble rear cover(11) as shown in the figure.

⑩ Washer(12) put in bolt(13), assemble in order of **A-D-B-C** and tighten bolts same order using toque wrench

· Tightening torque : 4.6±0.5 kgf · m (33.3±3.7 lbf · ft)

(5) Complete assembly.

(6) Dissembly is assembly's order in reverse.

(7) You proceed running-in using performance test device.

(8) Install it, and use.

2) SUB ASSEMNLY

※ Beware of scratches, damages and foreign materials.

※ Grease must have good lubricity and viscosity.

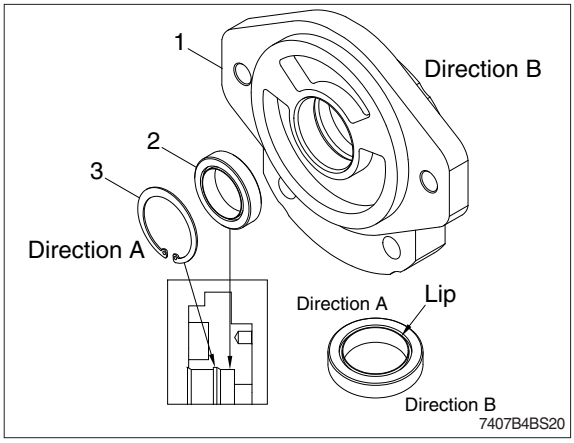
※ You must prepare snap ring tool and retainal seal special tool.

(1) Front cover assy

① After enough grease on the surface of retainal seal (2). It is assembled front cover (1) using retainal seal special tool.

※ Lip's direction toward A direction should be assembled and because of the risk of damage should be used only special tool.

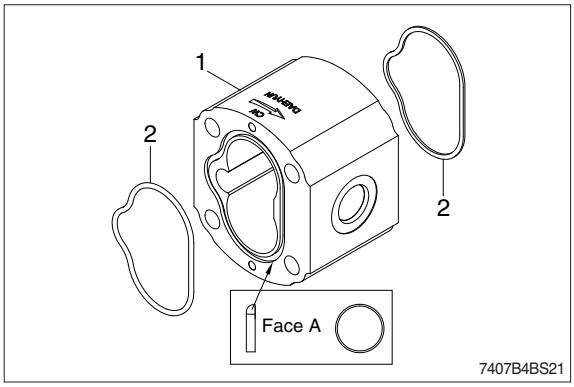
② After you put snap ring tool in 2 holes of snap ring (3), grasp it and snap ring (3) is assembled front cover's (1) groove using snap ring tool.



(2) Housing assy

① After enough grease on the surface of D-rings (2), those should be assembled grooves of housing's (1) both sides closely.

※ A side of D-ring (2) should be assembled side of housing (1) closely.



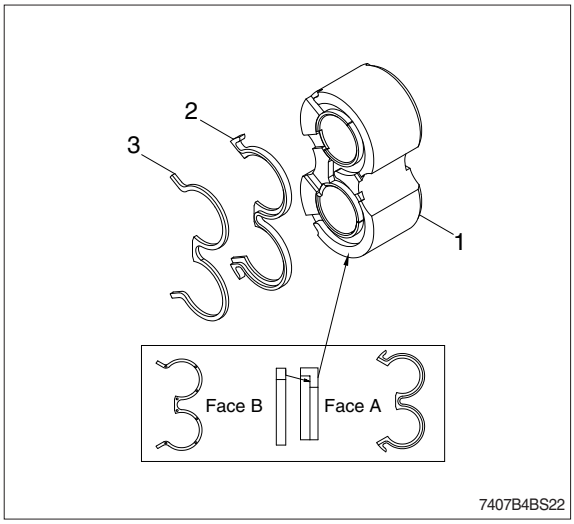
(3) Bushing block assy

① After enough grease on the surface of channel seal (2), it should be assembled groove of bushing block (1).

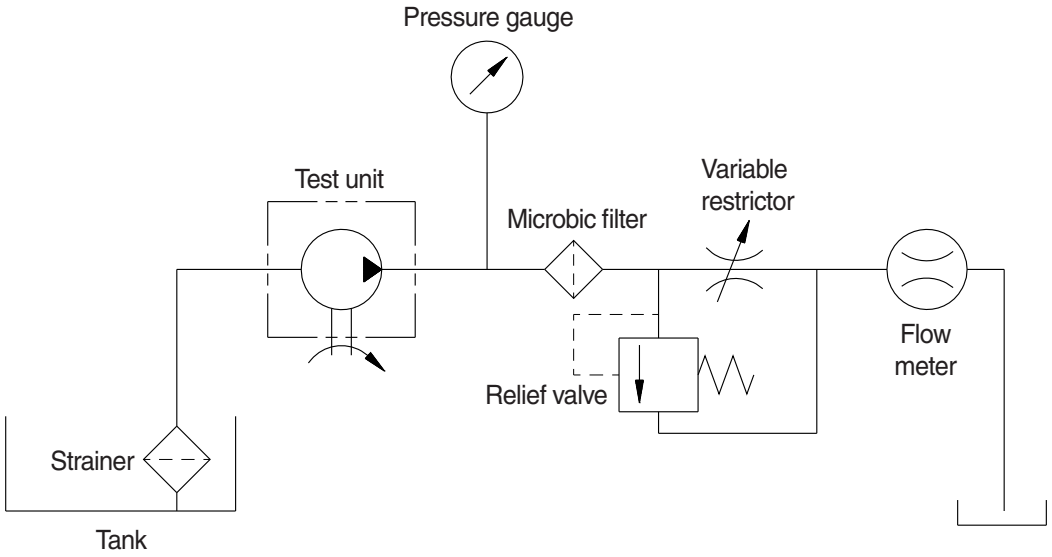
※ A side of channel seal(2) should be assembled side of bushing block (1) closely.

② After enough grease on the surface of back-up seal (3), it should be assembled groove of channel seal (2).

※ A side of back-up seal (3) should be assembled inside of channel seal (2) closely.



3) RUNNING-IN



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(1) A unit which has been re-assembled with either new gears, bushes or body, must be carefully run-in before it is subjected to full working conditions.

(2) Ideally this should be done on a test rig (see figure) where pressure can be gradually applied and any wipings from the body cut-in arrested by filters.

(3) It is recommended that the unit is run-in at 1500 rpm, initially, at zero pressure for one minute then in stages with the pressure increased by 500 psi every minute, until maximum rated pressure has been attained. Frequently check the system temperature, ensuring that it does not exceed the maximum permissible figure of 80˚C. If the temperature exceeds the system or unit specification the test must be delayed and operated off-load until acceptable temperatures are obtained.