SECTION 4 BRAKE SYSTEM

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SECTION 4 BRAKE SYSTEM

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.

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

The differential contains annular brake piston and double sided disk.

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.

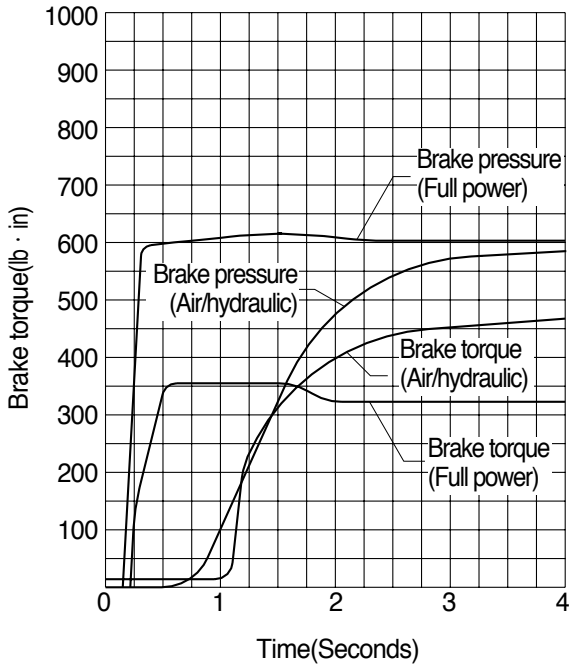
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

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.

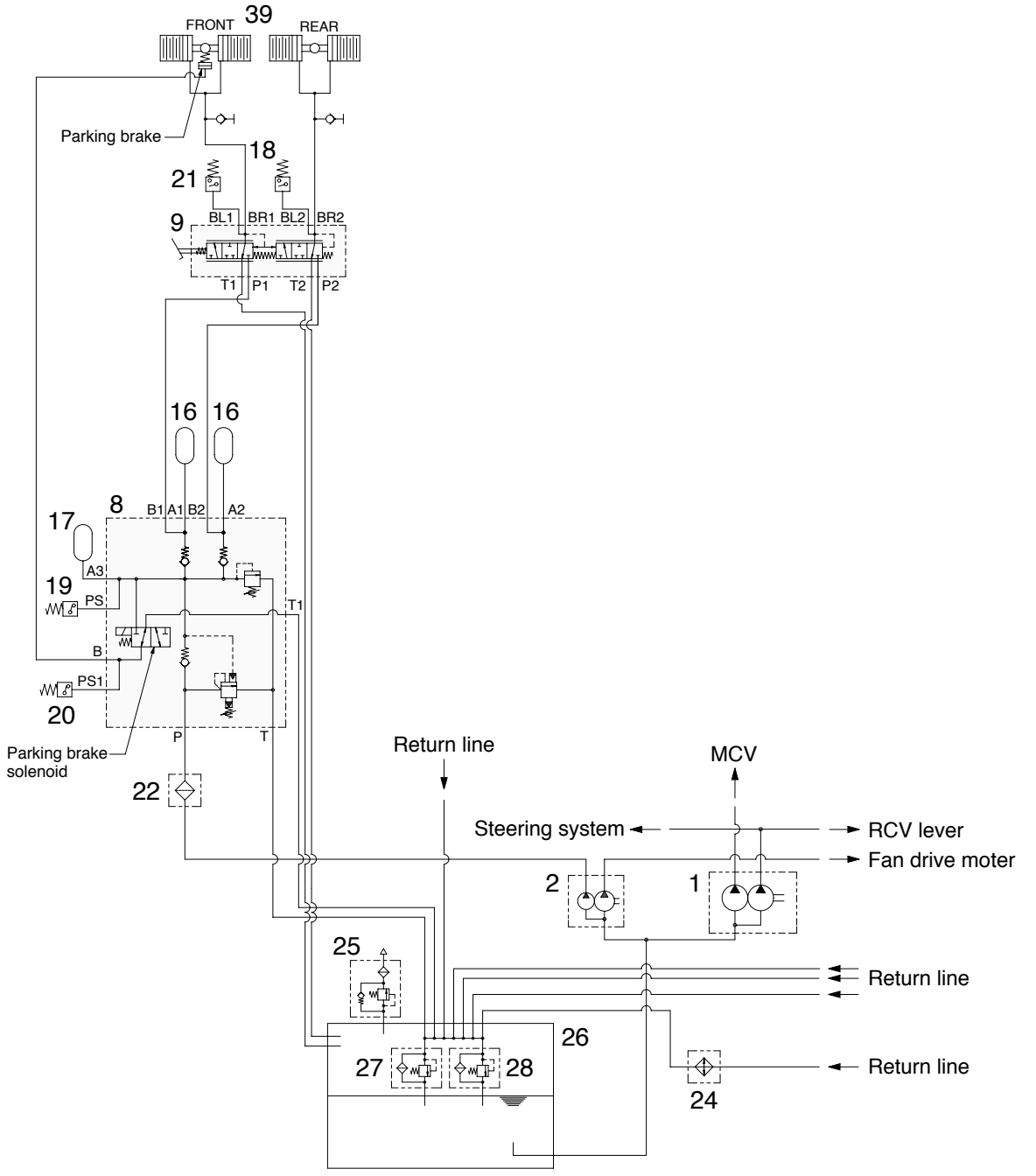
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the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

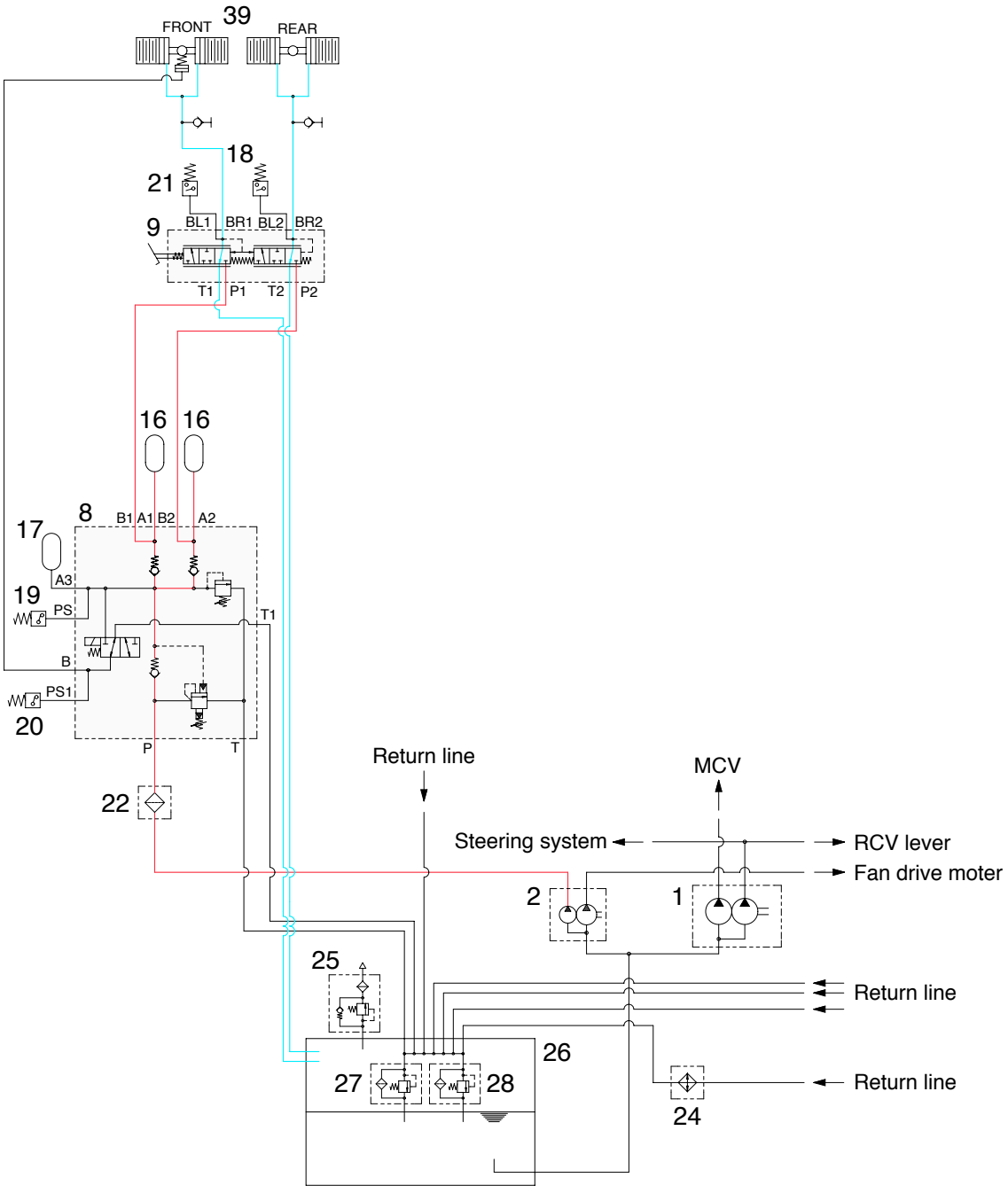


2. HYDRAULIC CIRCUIT



2	Brake & fan pump	19	Pressure switch	25	Air breather
8	Cut off valve	20	Pressure switch	26	Hydraulic tank
9	Brake valve	21	Pressure switch	27	Return filter
16	Accumulator	22	Line filter	28	Bypass valve
17	Accumulator	24	Oil cooler	39	Axle
18	Pressure switch				

1) SERVICE BRAKE RELEASED

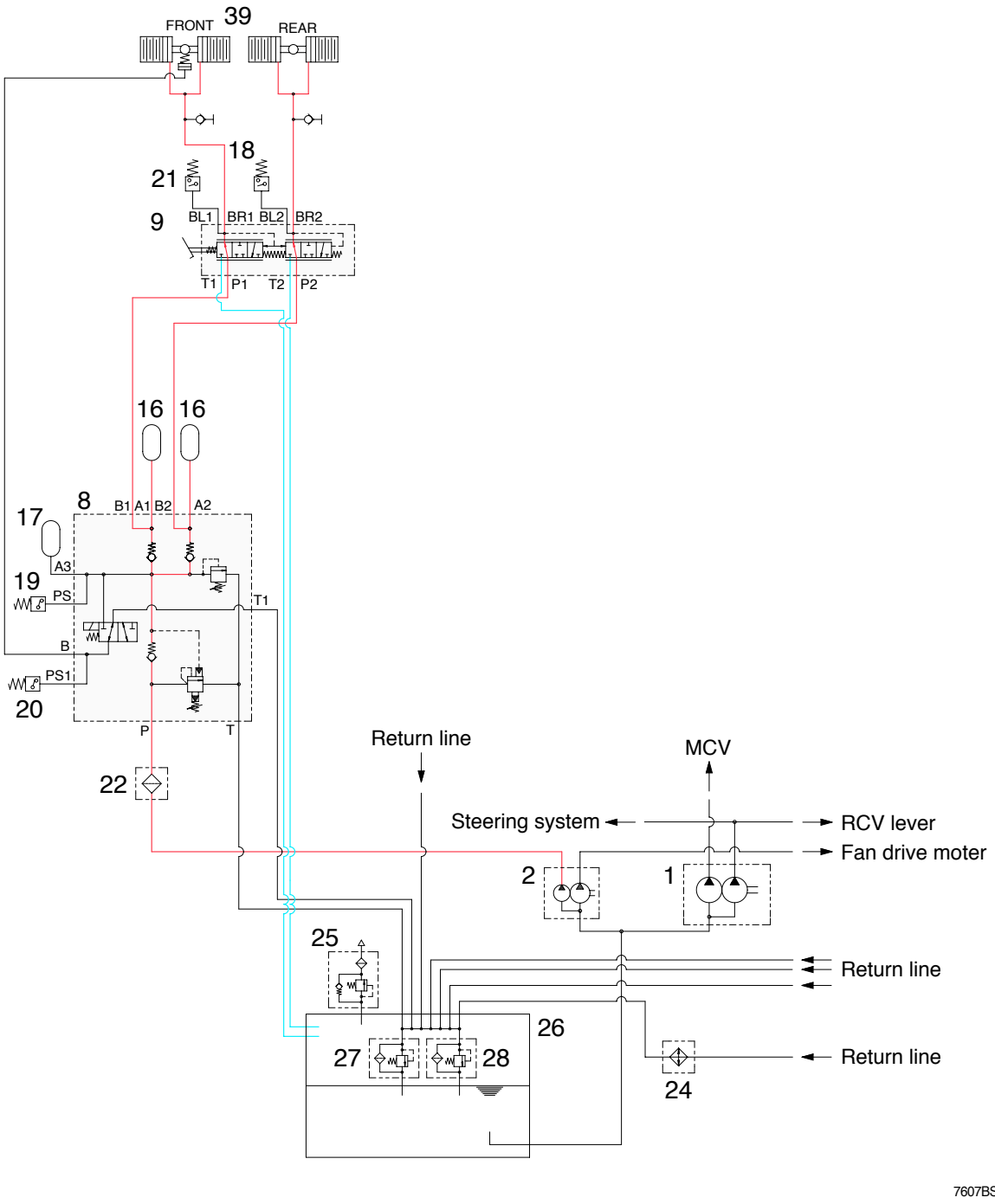


When the pedal of brake valve(9) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank(26).

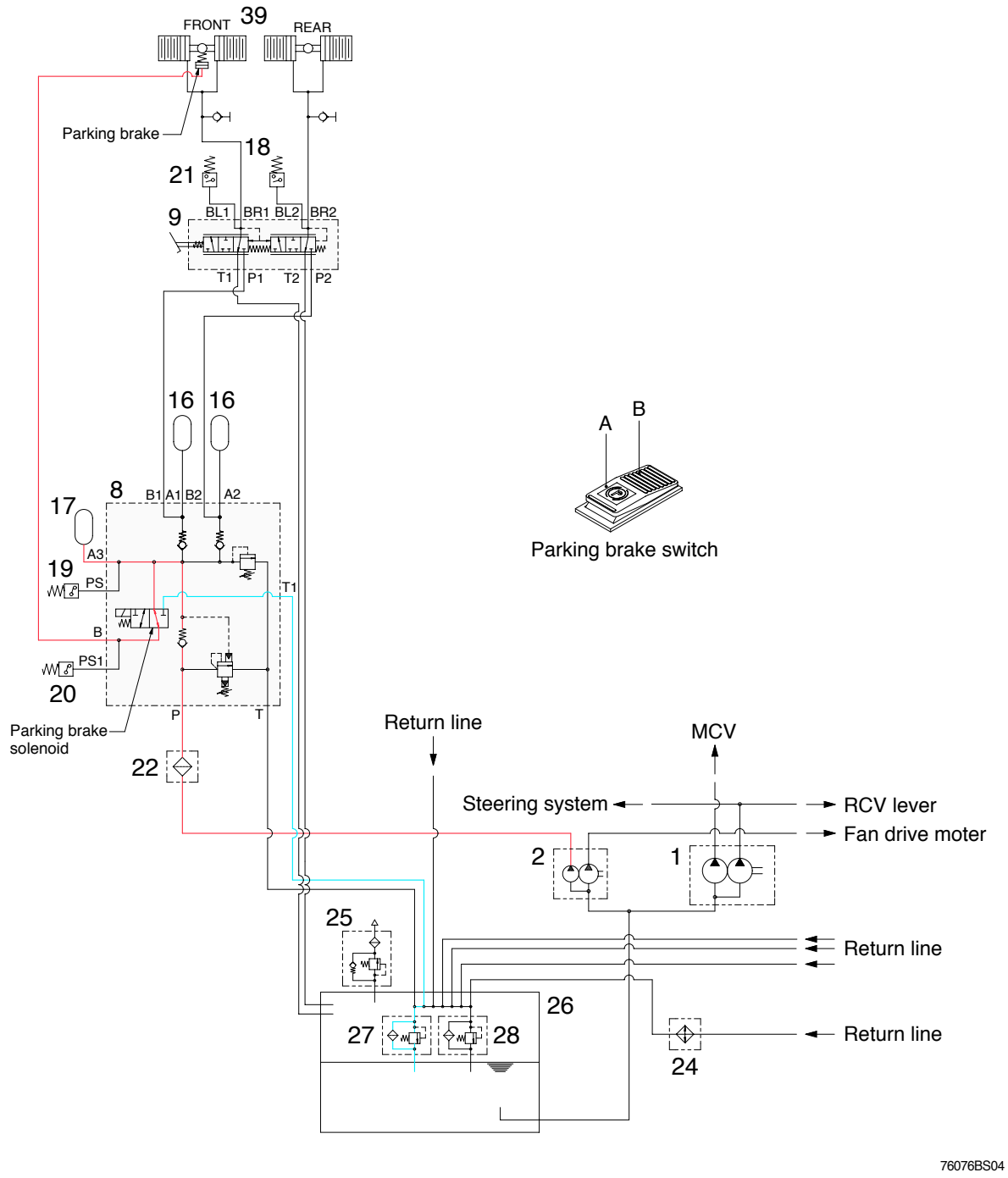
Therefore, the service brake is kept released.

2) SERVICE BRAKE OPERATED



When the pedal of brake valve(9) 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(8) enters the piston in the front and rear axles. Therefore, the service brake is applied.

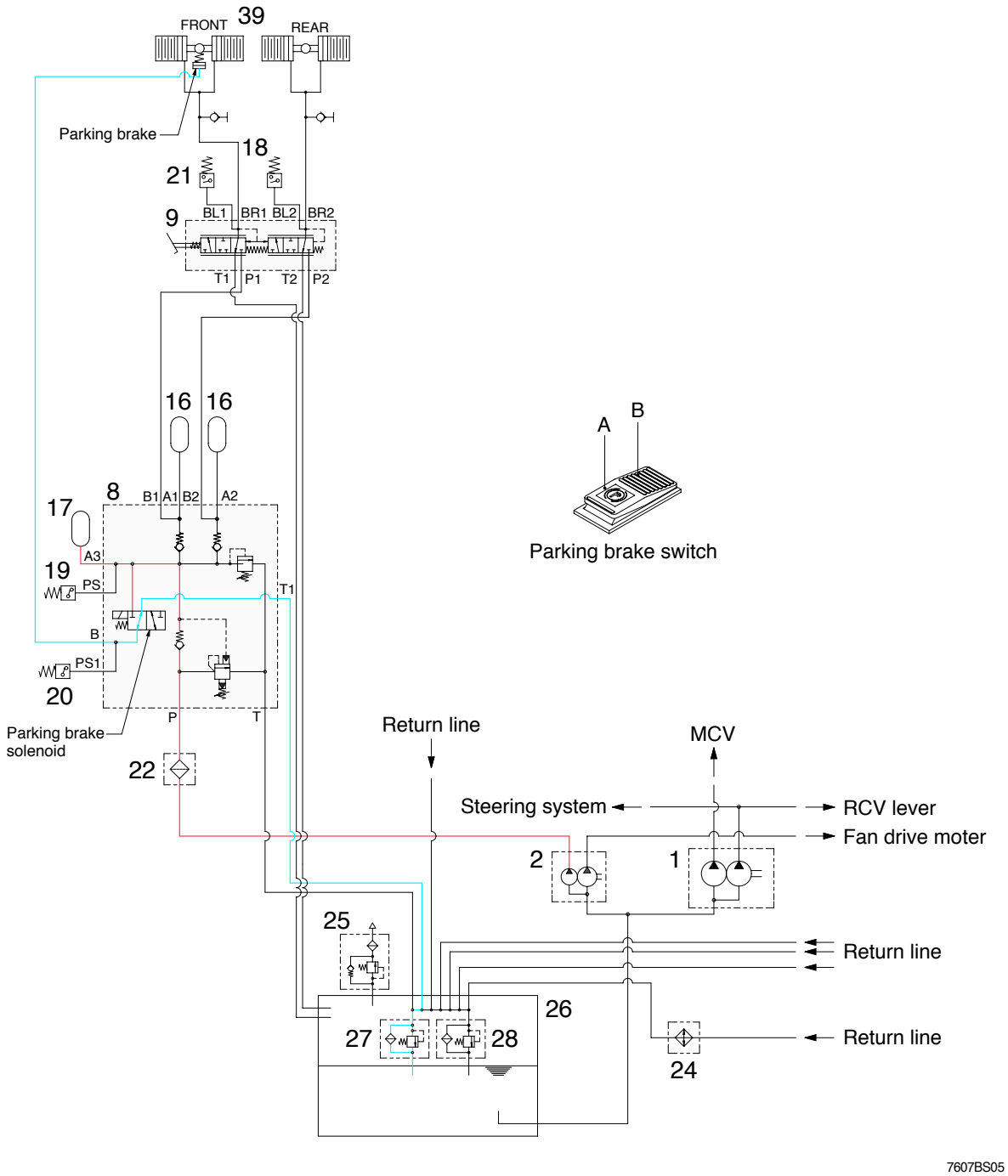
3) PARKING BRAKE RELEASED



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 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



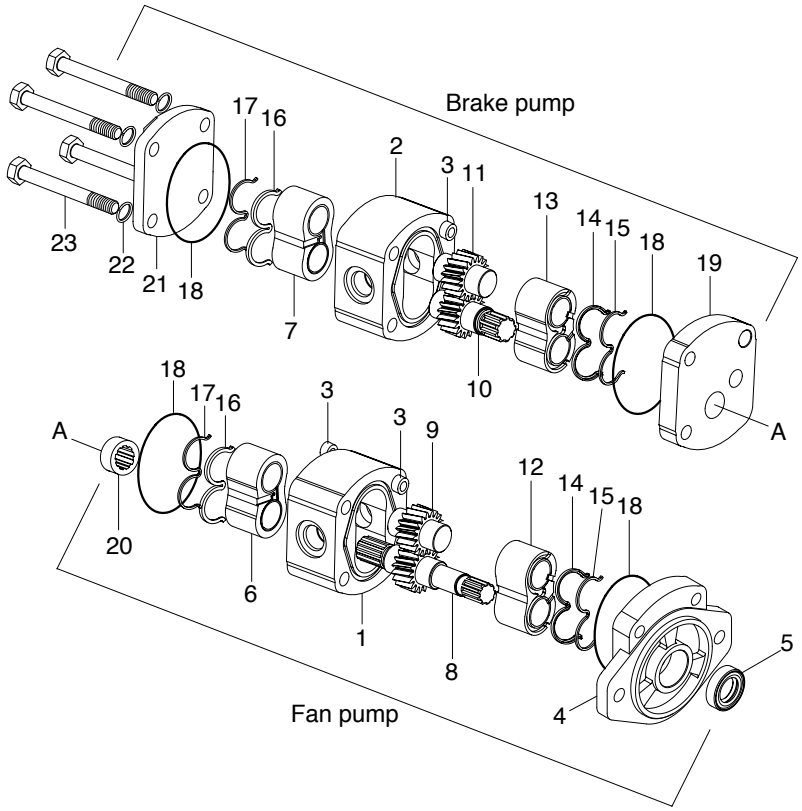
When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

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(+FAN PUMP)

1) STRUCTURE



7707BS19

1	Body	9	Driven gear	17	Backing ring
2	Body	10	Driver gear	18	Body O-ring
3	Dowel pin	11	Driven gear	19	Intermediate plate
4	Front cover	12	Bushing	20	Coupling
5	Shaft seal	13	Bushing	21	Rear cover
6	Bushing	14	Bushing seal	22	Spring washer
7	Bushing	15	Backing ring	23	Screw
8	Driver gear	16	Bushing seal		

This gear pump have a maximum delivery pressure of 150kgf/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.

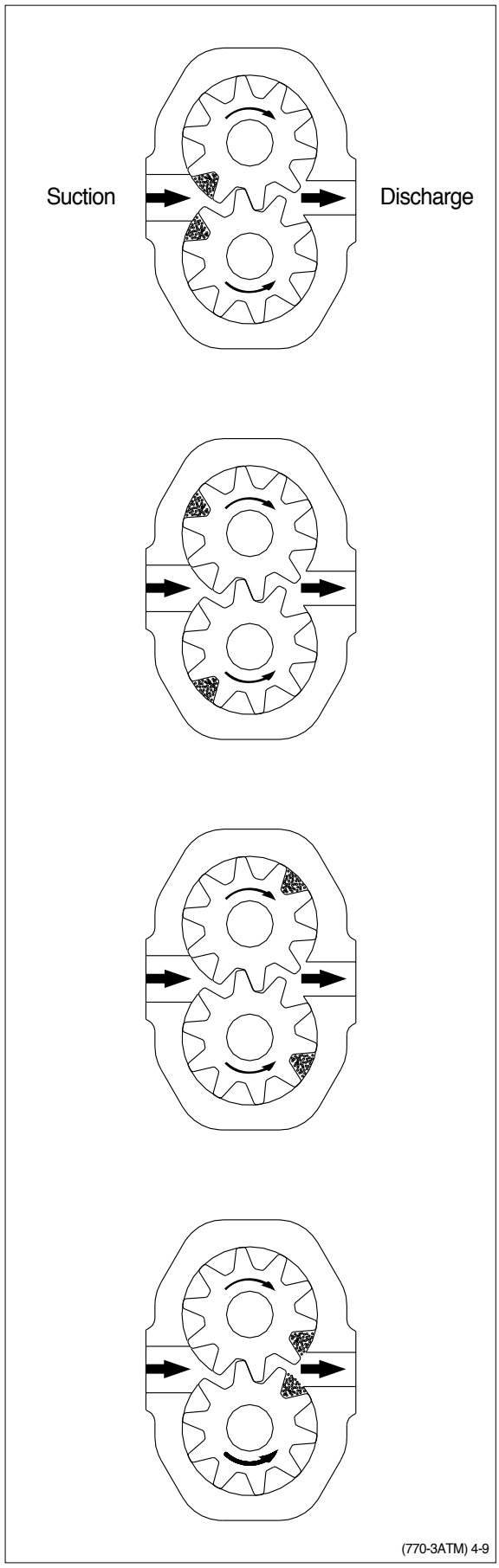
The amount of discharge increases with the speed of rotation of the gear.

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.



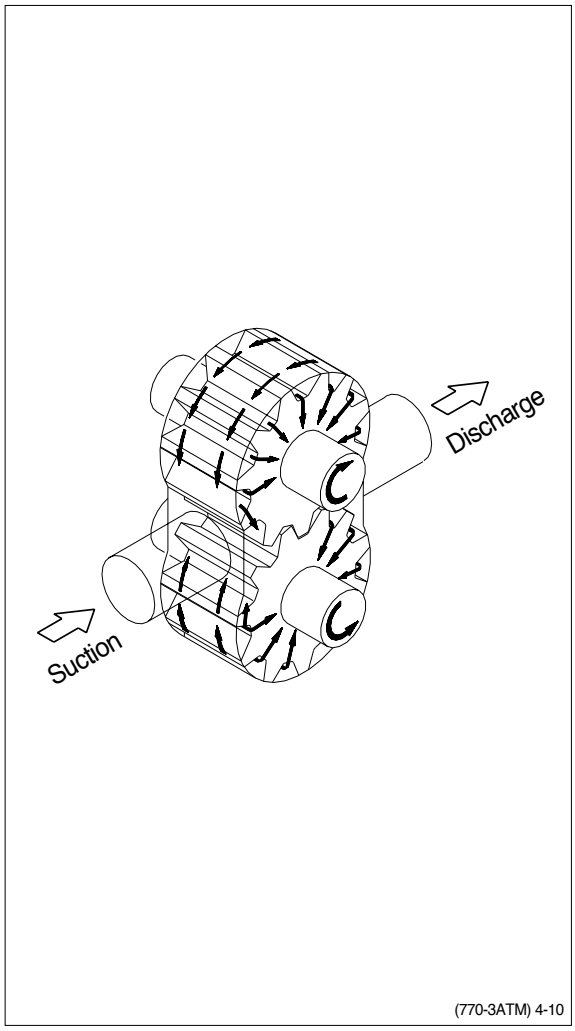
(2) Internal oil leakage

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.

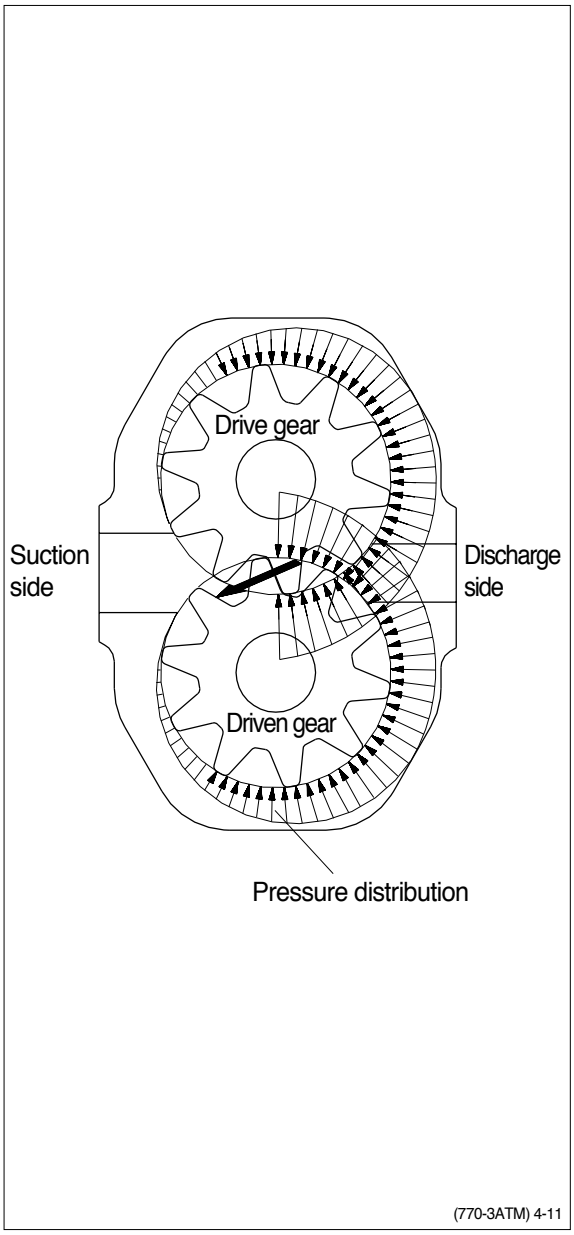
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

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

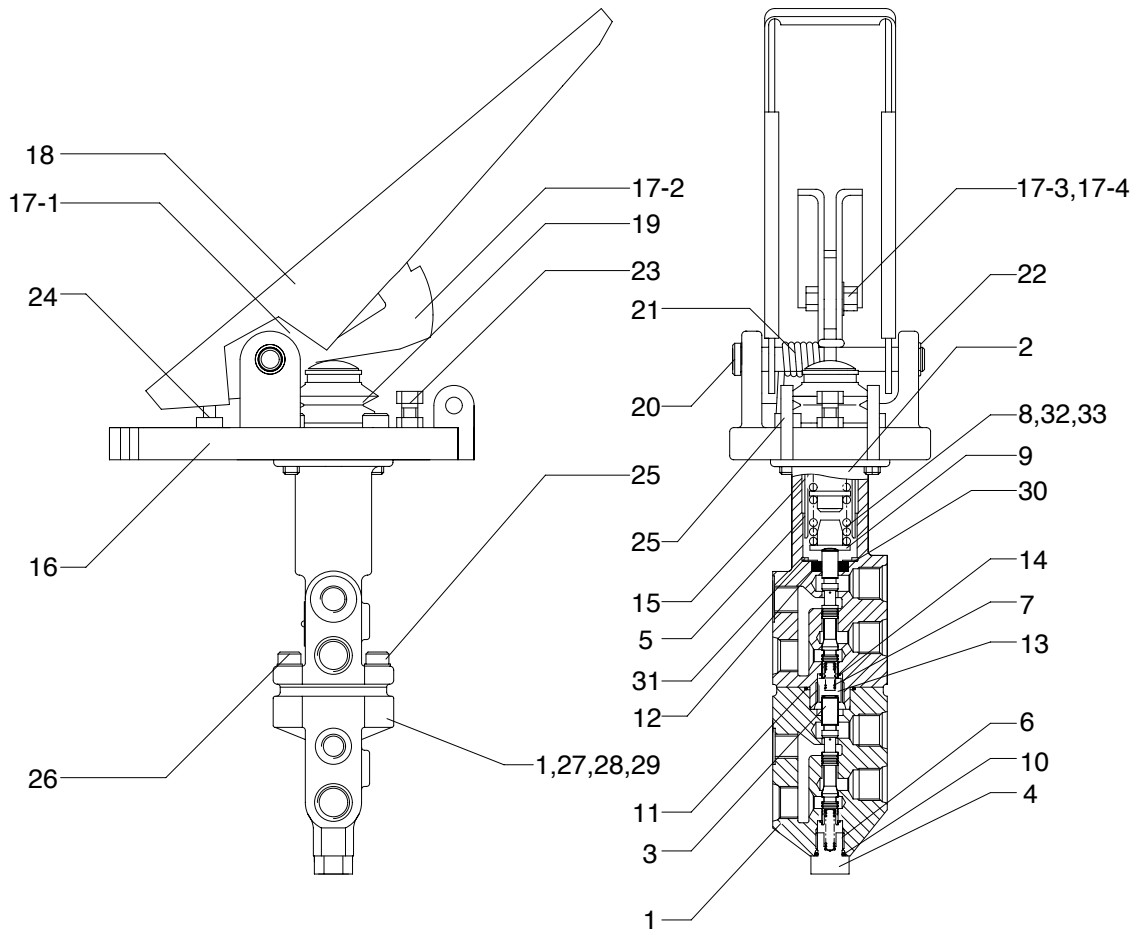
These forces pushing the gears toward the suction side are received by the bearings. Since the gears are pressed toward the suction side by these forces, the radial clearance becomes smaller on the suction side in the case. In some pumps, the clearance may become zero, thus allowing the gear teeth and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

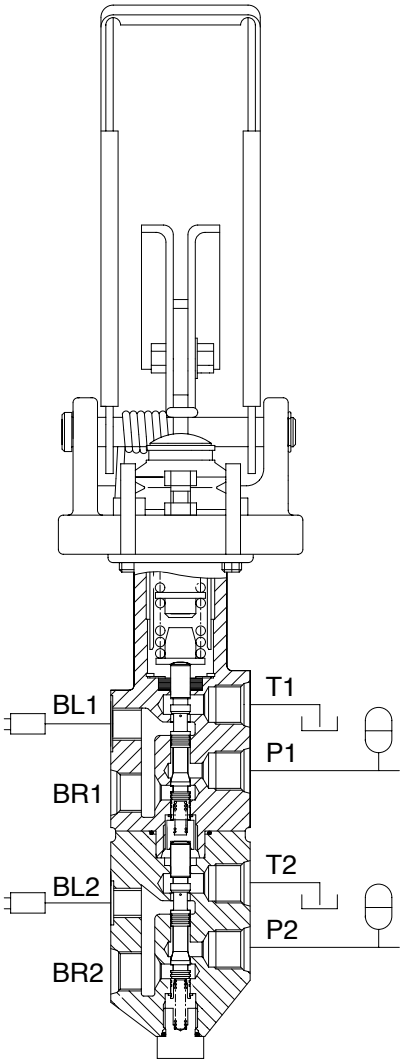
1) STRUCTURE

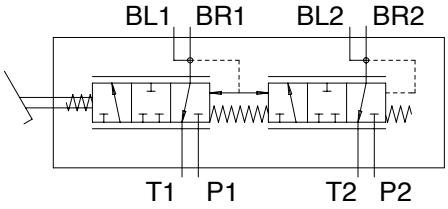


7707BS21

1	Lower body	13	Spring guide	22	Stop ring
2	Upper body	14	Stop ring	23	Hexagon bolt
3	Spool	15	Bushing	24	Hexagon nut
4	Plug	16	Pedal plate	25	Bolt
5	Holder	17-1	Pedal	26	Spring washer
6	Lower spring	17-2	Lock plate	27	Plastic plug
7	Upper spring	17-3	Hexagon bolt	28	Name plate
8	Main spring 1	17-4	Plain washer	29	Screw
9	Spring retainer 1	18	Rubber	30	Plain washer
10	O-ring	19	Cover	31	Stop ring
11	O-ring	20	Lock pin 1	32	Spring retainer 2
12	Oil seal	21	Torsion spring 1	33	Main spring 2

2) OPERATION





Hydraulic circuit

Porte	Port name	Port size
P1, P2	Port	PF3/8
T1, T2	Drain port	PF3/8
BR1, BR2	Brake cylinder port	PF3/8
BL1	Pressure switch port	PF1/4
BL2	Pressure switch port	M12×1.5

7707BS22

(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

When the braking system is ready for operation, its accumulator pressure acts directly on ports (P1, P2) of the brake valve. A connection is established between ports(BR1, BR2) and ports(T1, T2) so that the wheel brakes ports(BR1, BR2) are pressureless via the returns ports(T1, T2).

(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 spring assembly(8) beneath base plate(16) 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 upper spool is mechanically actuated via spring assembly(8), and the lower spool is actuated hydraulically by spool. As spools(3) move downward, they will first close returns(T1, T2) via the control edges, thus establishing a connection between accumulator ports(P1, P2) and ports(BR1, BA2) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spools(3) are held in the control position by the force applied(Spring assembly above the spools and the hydraulic pressure below the spool(Balance of forces).
After output of the braking pressure, spools(3) are in a partial braking position, causing ports(P1, P2) and ports(T1, T2) to close and holding the pressure in ports(BR1, BR2).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports(P1, P2) and brake cylinder ports(BR1, BR2). Returns(T1, T2) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports(BR1, BR2) and return ports(T1, T2), closing accumulator ports(P1, P2).

The arrangement of spools in the valve ensures that even if one braking circuit fails the other remains fully operational. This is achieved by means of the mechanical actuation of both spools and requires slightly more pedal travel.

(5) Limiting the braking pressure

Pedal restriction bolt(23) on base plate below pedal is used to limit the braking pressure.

(6) Failure of a circuit

In the event of the lower circuit failing, the upper circuit will remain operational. Spring assembly (8) will mechanically actuate spool(28). In the event of the upper circuit failing, the lower circuit will remain operational since the lower spool(31) is mechanically actuated by spring assembly(21) and spool(28).

(7) Installation requirements

Return lines(T1, T2) must be connected directly to the tank.
The connecting lines must be installed is such a way as to permit proper bleeding.

(8) 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.**

(9) 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.

(10) Replacing the pedal cover

Pedal cover(18) is simply pulled of by hand. The new pedal cover is pushed over pedal(17) and tightened manually. Fasten the bellows with the strap retainers.

(11) Replacing the complete actuating mechanism

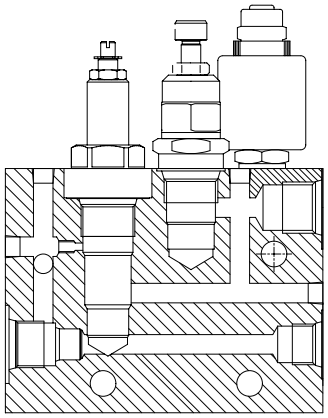
Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the four bolts. Make sure that spring assembly(8) does not fall out. When installing the new actuating mechanism, make sure that spring assembly(8) is fitted in the right order. Tighten the four bolts(25).

(12) Replacing the bellows

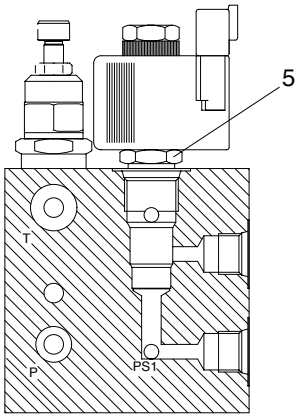
To change bellows(19) it is advisable to remove pedal(17). For this purpose, loosen retaining ring (22) and knock out pin(20) using a mandrill. When knocking out the bolt, make sure that the mandrill is applied to the side of the bolt without a knurl. Remove pedal(17) and bellows(19).
Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston(5), its lower portion to base plate(1) secure the bellows using clamps.

5. CUT-OFF VALVE

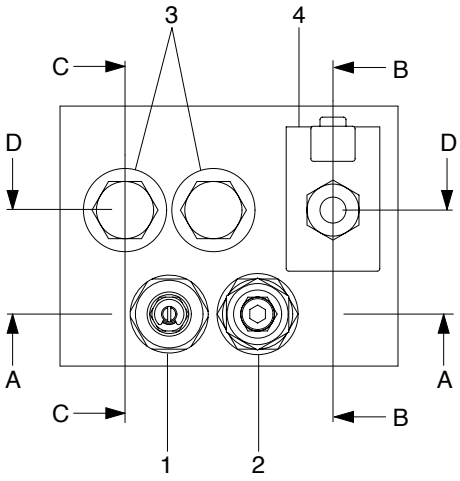
1) STRUCTURE

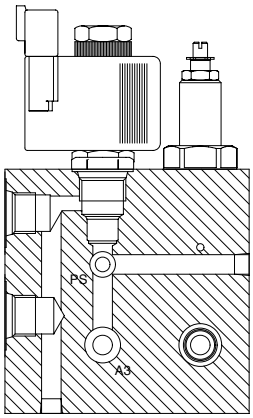


SECTION A - A

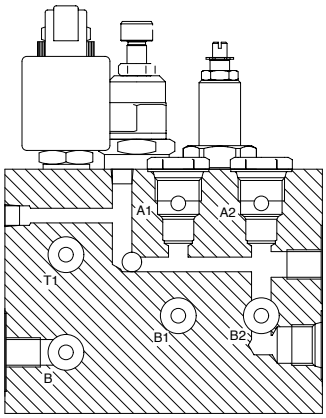


SECTION B - B



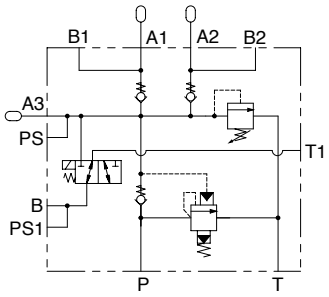


SECTION C - C



SECTION D - D

HYDRAULIC SYMBOL



7707BS06

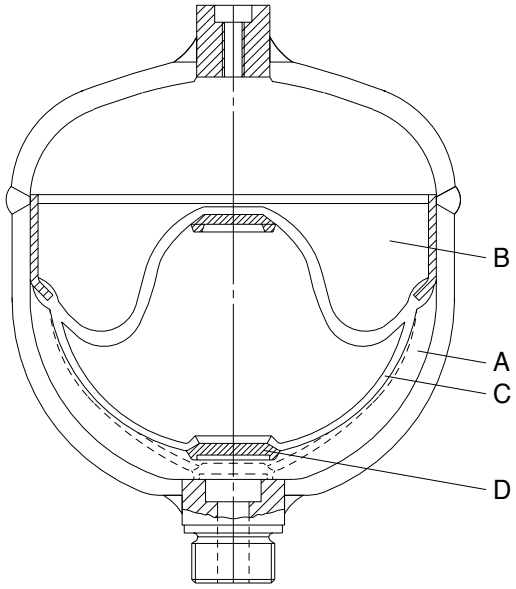
1 Cut-off valve
2 Relief valve
3 Check valve
4 Coil
5 Solenoid valve

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 150bar, the cut off valve(1) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120bar 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



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Item	81L1-0004 (Item16)	81L1-0003 (Item17)
Diameter	121mm	136mm
Mounting height	146mm	160mm
Norminal volume	0.75m^3	1.0m^3
Priming pressure	50kgf/cm^2	50kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 210kgf/cm^2	Max 200kgf/cm^2
Thread	M18×1.5	M18×1.5
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

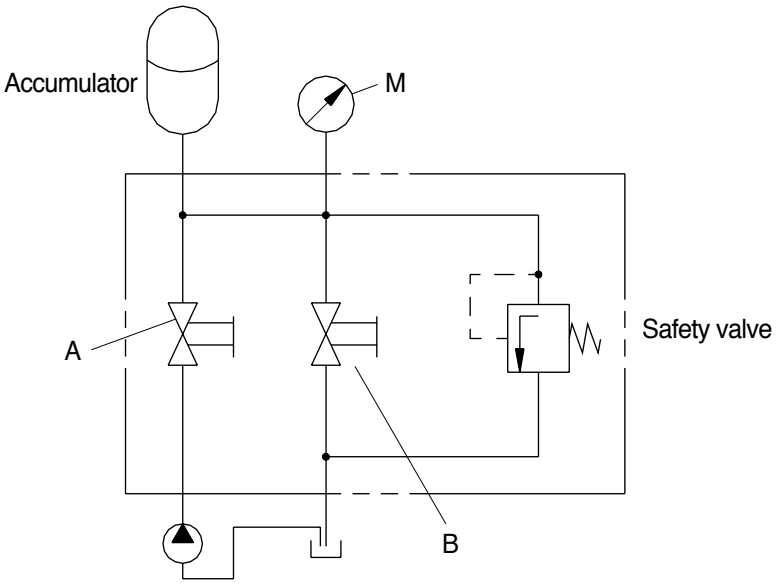
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber(B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ **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.**



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(7) Repair work

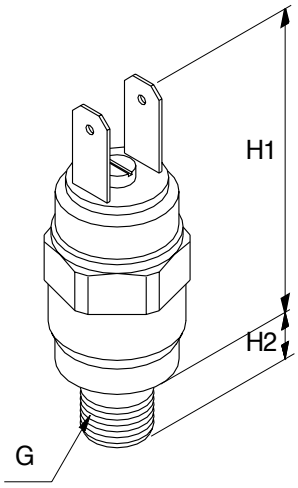
△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.

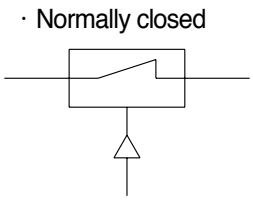
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

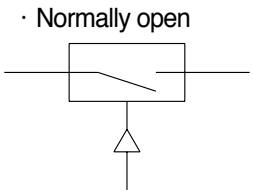
△ For safety reasons the accumulators need to be replaced as a whole if damaged.

7. PRESSURE SWITCHES

1) STRUCTURE







(770-3ATM) 4-25

· **Technical data**

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Adjusting pressure kgf/cm²	Voltage V
Parking	NC	Oil	M12×1.5	55	9	20 ~ 50	21 ± 2	Max 42
Charging	NC	Oil	M12×1.5	55	9	50 ~ 150	100 ± 10	Max 42
Brake stop	NO	Oil	M12×1.5	55	9	1 ~ 10	5 ± 1	Max 42
Clutch cut-off	NO	Oil	PF 1/4"	55	9	20 ~ 50	24 ± 2	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.**

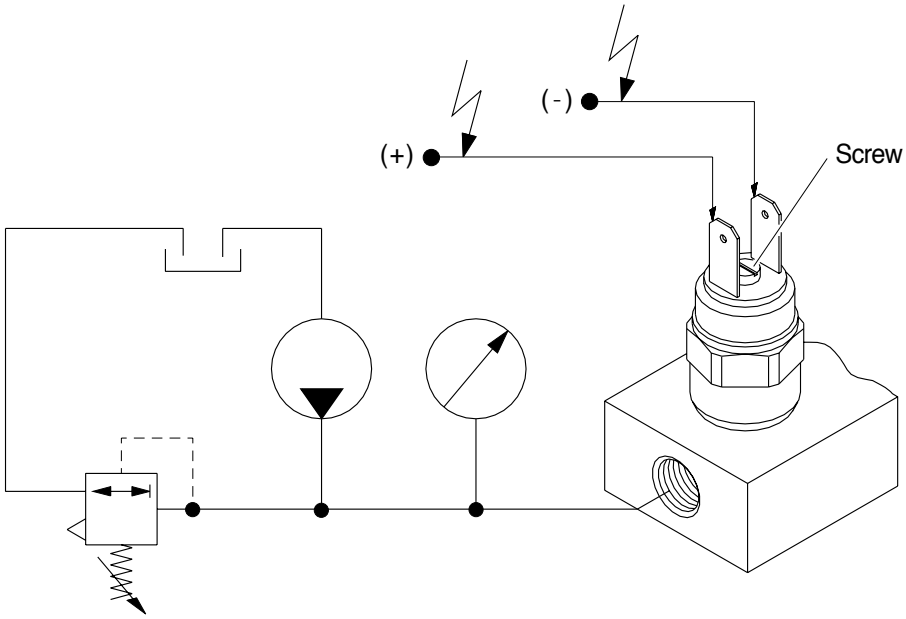
※ **When doing repair work, make sure your environment is very clean.**
Immediately close all open ports on the components and on pipes using plugs.

※ **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.



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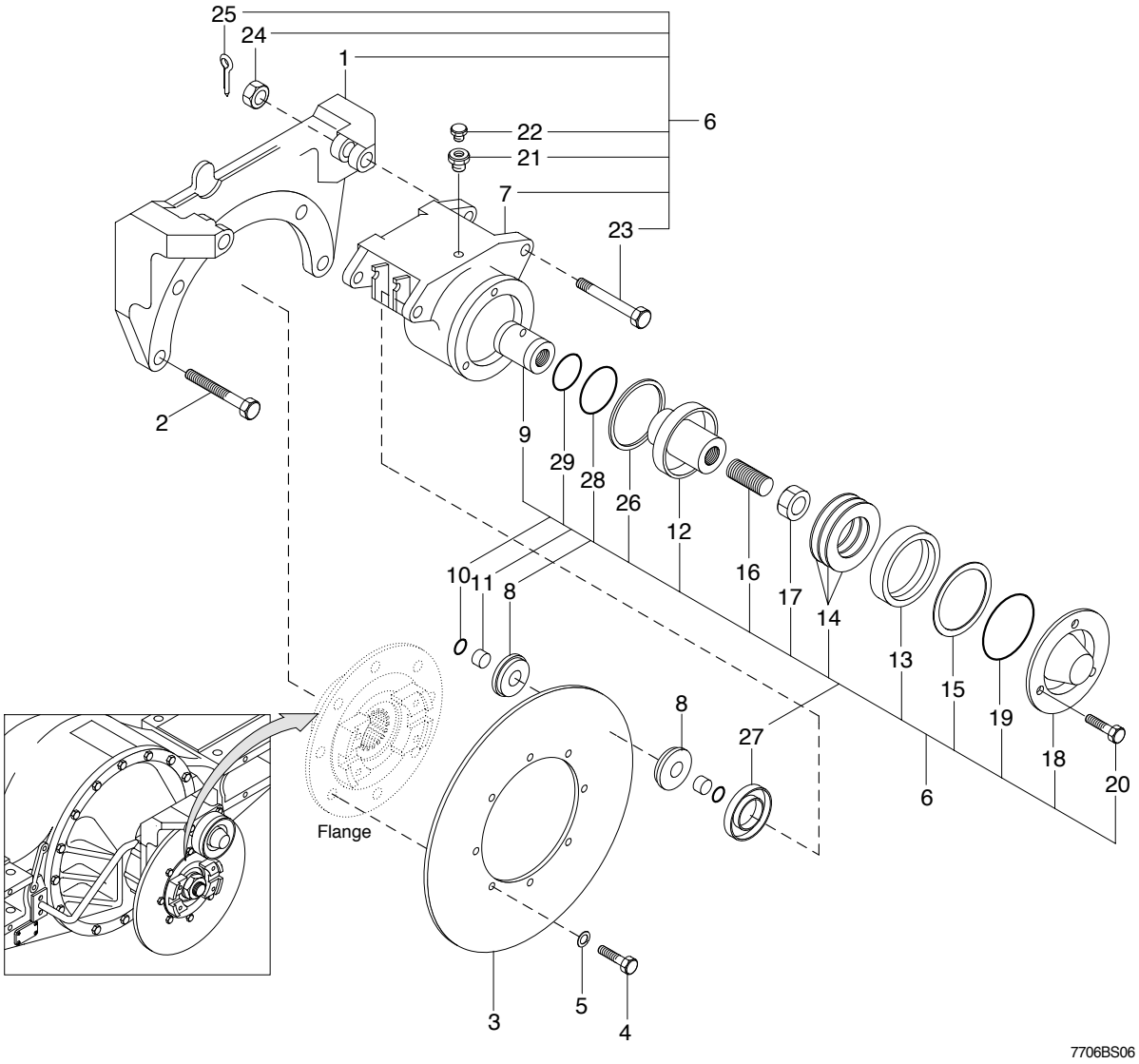
8. PARKING BRAKE



1	Caliper bracket	11	Magnet	21	Breather
2	Bolt	12	Piston	22	Cap
3	Disc	13	Ring	23	Bolt
4	Bolt	14	Plate ring	24	Nut
5	Spring washer	15	Lock plate	25	Split pin
6	Brake caliper	16	Pin	26	Ring
7	Body	17	Nut	27	Seal
8	Pad	18	Cover	28	Ring
9	Shuttle	19	O-ring	29	O-ring
10	Ring	20	Bolt		

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.

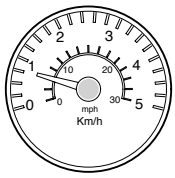
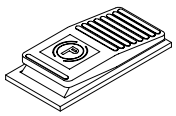
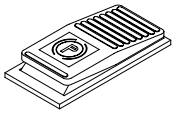
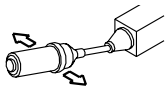
The engine and all other major components must be at operating temperature for some checks.

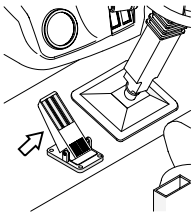
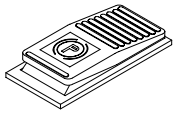
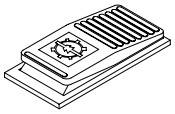
Locate system check in the left column and read completely, following the sequence from left to right. Read each check completely before performing.

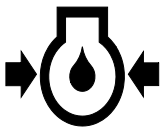
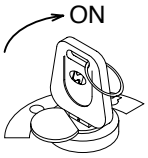
At the end of each check, if no problem is found(OK), that check is complete or an additional check is needed. If problem is indicated(NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

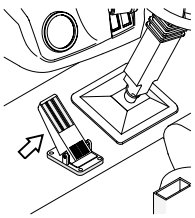
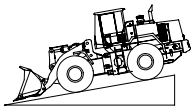
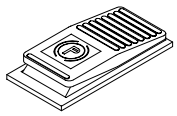
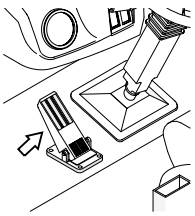
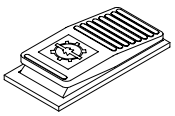
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※Hydraulic oil must be at operating temperature for these checks(Refer to page 6-50).

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. Go to brake pump flow test, in section 3.
Service brake capacity check Engine running.	Turn clutch cut-off 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, see group 3.

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 in group 3. **NOT OK** If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator, group 3.
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 bucket 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. 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, 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. Go to brake pressure test on group 3.
Clutch cut-off check	 Place clutch cut-off switch in ON position. 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 pressure switch can be adjusted to operator preference to match your loading needs.	**OK** Check completed. **NOT OK** Adjust clutch cut-off switch, see group 3.

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

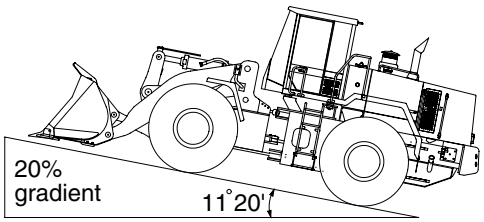
1) MEASUREMENT CONDITION

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



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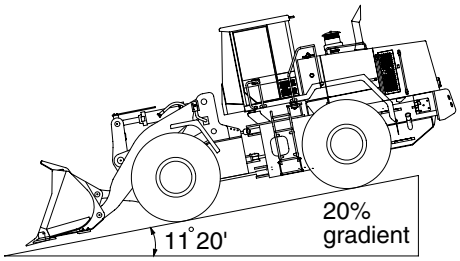
2) MEASURING PROCEDURE

(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.**

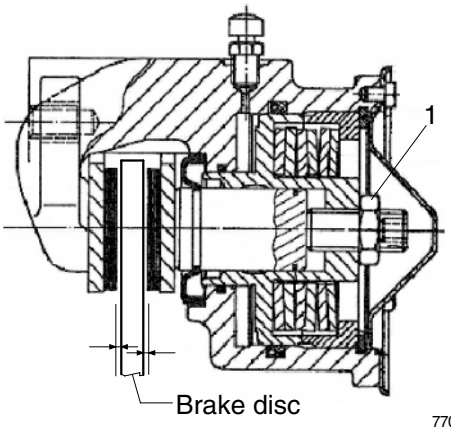


7707BS17

2. EXTERNAL BRAKE INSPECTION

Inspect for wear of brake pad.

Adjust the gap(each 0.125~0.25㎜) by adjust nut(1).



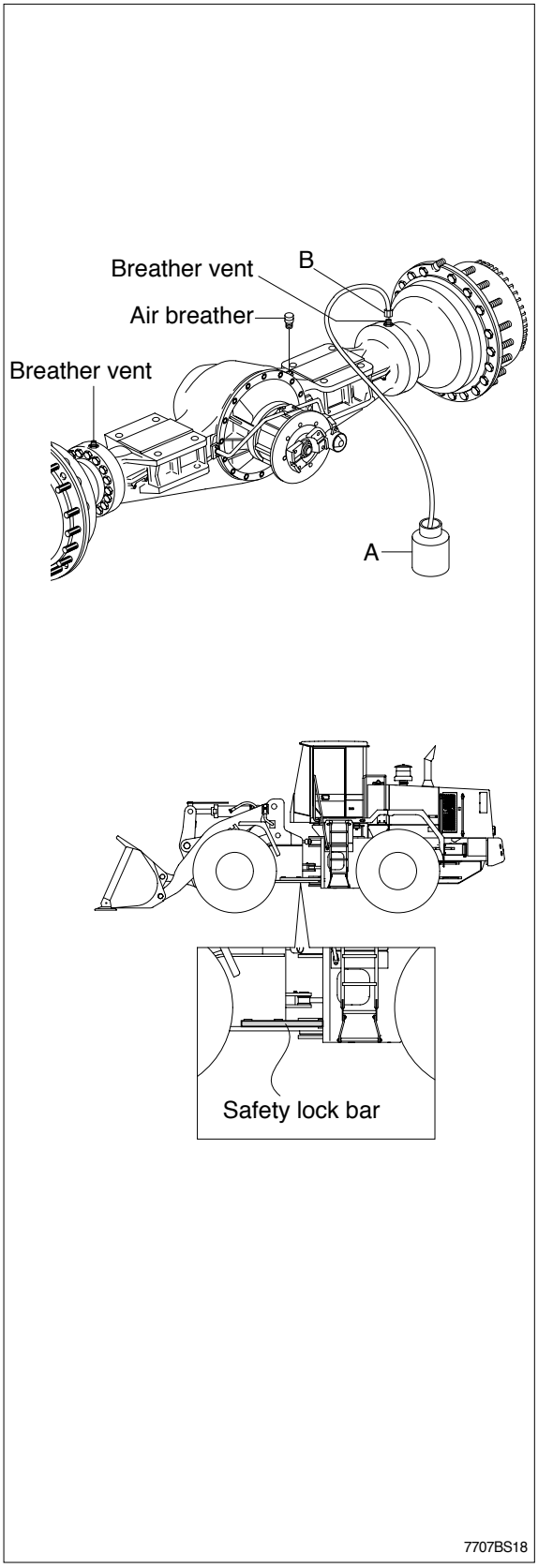
7707BS26

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.

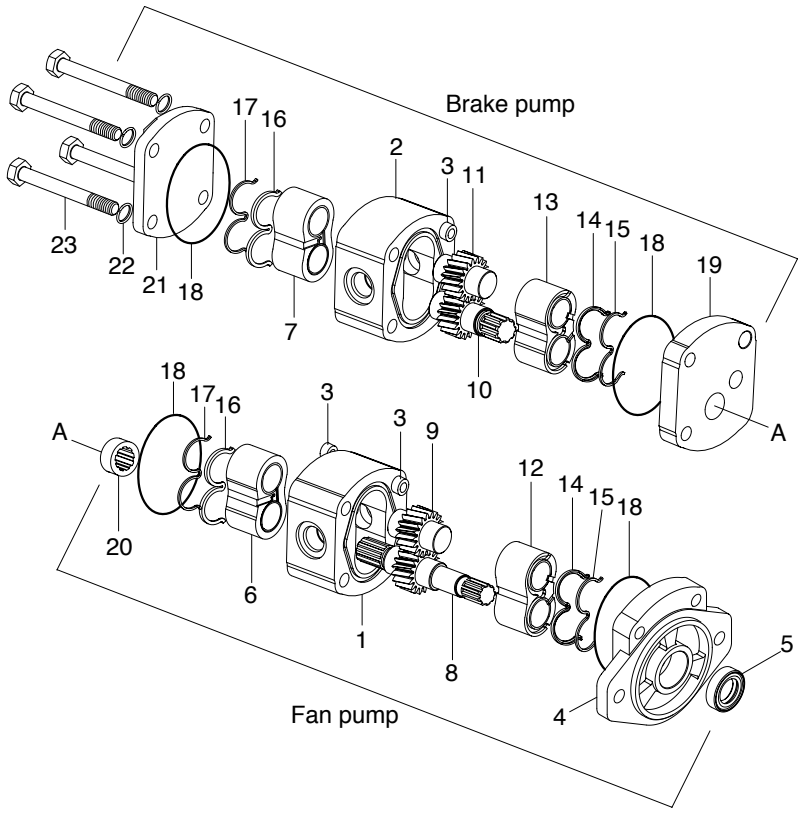
※ **If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.**
Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.
Two people are required to bleed brake system oil,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



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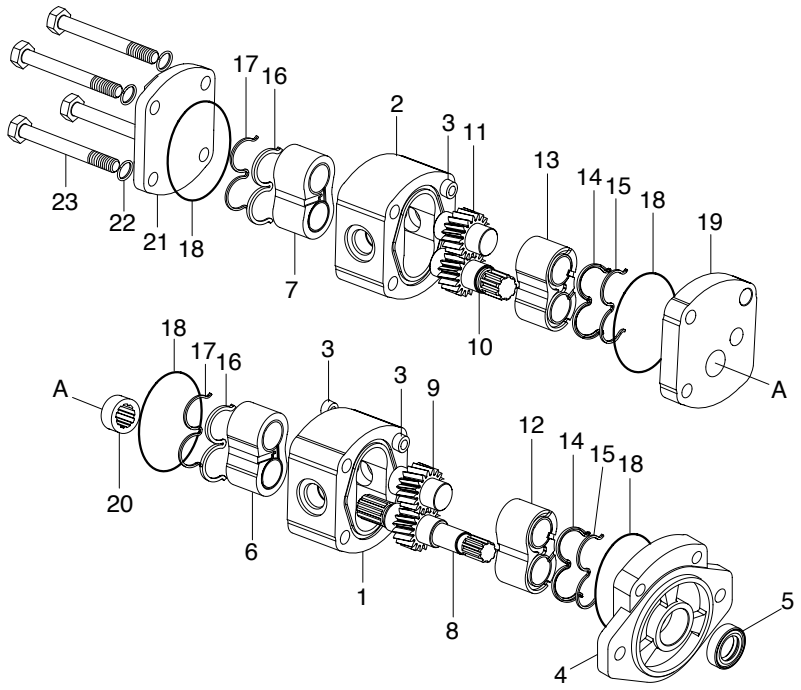
1	Body	9	Driven gear	17	Backing ring
2	Body	10	Driver gear	18	Body O-ring
3	Dowel pin	11	Driven gear	19	Intermediate plate
4	Front cover	12	Bushing	20	Coupling
5	Shaft seal	13	Bushing	21	Rear cover
6	Bushing	14	Bushing seal	22	Spring washer
7	Bushing	15	Backing ring	23	Screw
8	Driver gear	16	Bushing seal		

2) DISASSEMBLY



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※ Before disassembling ensure that the unit itself, bench and tools are thoroughly clean.

(1) Lightly mark the rear cover(21), body(2) and plate(19) to ensure reassembly in the correct position.

(2) Remove the bolts(23) and separate the brake pump unit from the fan pump using a soft faced hammer.

(3) Remove splined coupling(20).

(4) Remove the plate(19) from the body(2), free from plate using a soft faced hammer.

(5) Remove the backing ring(15), the seal element(14) and the body O-ring(18).

(6) Remove the rear cover(21) from the body(2).

(7) Remove the backing ring(17), the seal element(16) and the body O-ring(18).

※ Before removing the internal components each bushing(7, 13) must be marked to denote its location within the body. On the plain area of the bush away from the seal location, lightly mark.

(8) With the unit laying on its side grasp hold of the drive shaft(10) and pull it squarely out of the body(2) bringing the bushing(13) with it.

(9) Remove the driven gear(11) and the remaining bushing(7).

3) INSPECTION AND REPAIR

(1) Assessment

Each components should be thoroughly cleaned, carefully examined and assessed for suitability re-use. Below is a guide for inspecting the various components.

(2) Body

① Inspect the body bore cut-in where both gears wipe into the body.

② The body can only be re-used if the **cut-in** is bright and polished in appearance and the depth does not exceed 0.15㎜(0.006").

③ The body should be replaced if the surface is scored, has a matt appearance or shows signs that the tip of the gears have dug in and torn away the surface material.

④ The body should be inspected to ensure that there is no superficial damage which may adversely effect performance or sealing. Pay particular attention to the port threads and body O-ring seal recesses.

(3) Plate and cover

① The inner surfaces should be inspected to ensure that there is no unusual wear or scoring in the regions where the body O-rings and backing rings contact, which result in external leakage.

② Check the shaft seal recess for scoring or damage that could result in oil leakage around the outer diameter of the shaft seal. Replacement shaft seals can be refitted with Loctite hydraulic sealant to overcome slight damage in this area.

(4) Bushes

① The side faces which abut the gears should be perfectly flat showing no sign of scoring. Characteristically there are bright polished areas on this surface caused by loading against the gear side faces, which is often more pronounced on the low pressure side. The bush should be replaced if there is any general scoring or fine scoring with a matt appearance or tearing of the surface material. Often there is a witness where the tips of the opposing gears have wiped an overlap reassembling a half moon shape. There must be no noticeable wear step as it is critical that the bush side face is completely flat to the gear side face.

② The bearing liners are acceptable providing that they are not scored or show other damage. The general outside area of the bush should not show any prominent signs of wear.

(5) Gears

① The gear side faces should be examined for bruising or scoring. Often operation on contaminated fluid shows scoring between the root of the gear and the journal undercut, which leaves a wear step. If a wear step can be felt, coincidental with the root diameter, by drawing a sharp pointed tool across the surface from the undercut outwards towards the tip of the gear, then the gear is unserviceable.

② The gear teeth should then be carefully examined to ensure that there are no signs of bruising or pitting.

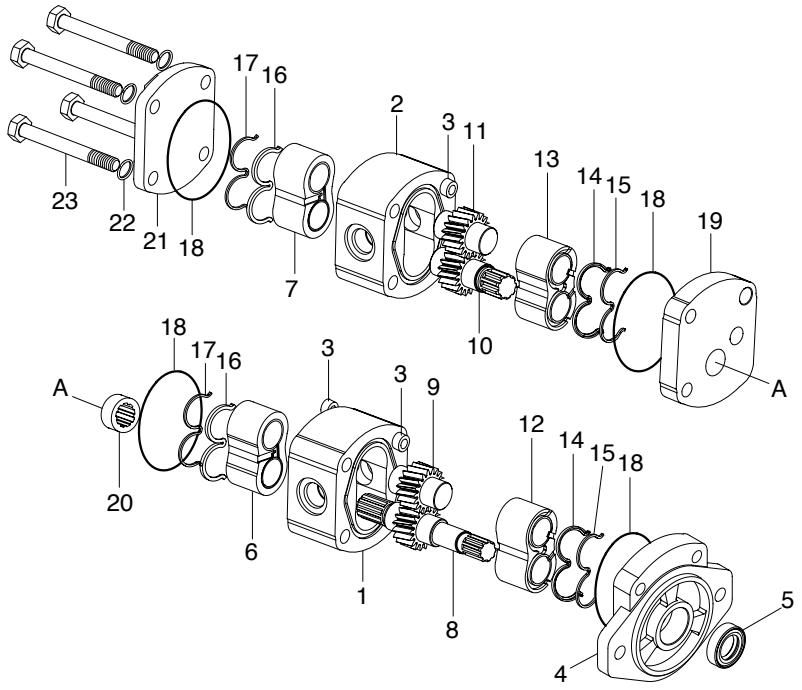
③ The journal bearing surfaces should be completely free from scoring or bruising. The surface should appear highly polished and smooth to touch.

④ Examine the area where the shaft seal lips run on the drive shaft, this shows up as a polished ring or rings. If a noticeable groove can be felt or there is scoring the shaft should be replaced.

⑤ Provided the drive shaft is not damaged from the drive-coupling and the gears have not been harmed as described above, then the gears can be re-used. If, however, the gears are damaged they must be replaced as a matched pair.

⑥ As a matter of good practice, when pumps have been disassembled, all the seals should be replaced. It is most important that only the genuine seals are used.

4) ASSEMBLY



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※ Ensure that all parts are perfectly clean and lightly lubricate the bushes and gears with hydraulic oil(Ensure body O-ring recess and end faces remain free from oil). This will assist with their assembly when they are later fitted into the body.

(1) Refit the bushing(7) into the undowelled end of the body(2) from where they were removed.

(2) Place the rear cover(21) against the body(2) and then stand the assembly on the cover so that the hollow dowels are uppermost, i.e. the bushing should be at the bottom with the bushings against the cover.

(3) Fit the drive shaft(10) and driven gear(11) back into their original positions in the body(2).

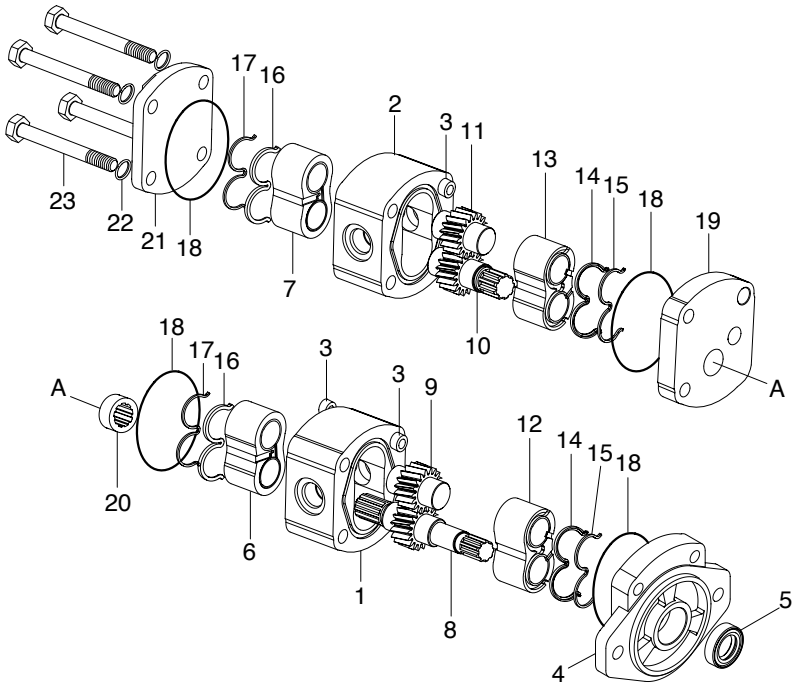
(4) Refit the plate bushing(13) into their original bores.

(5) Fit the new body O-ring(18).

(6) Fit the new seal element(14) and backing ring(15) to the bushing.

(7) Carefully refit the plate(19) to the body(2). If the plate(19) is not fitted squarely the backup seal(14) may become misplaced and trapped, resulting in internal damage if the unit is run in this condition.

ASSEMBLY



7707BS25

(8) Fit coupling(20) to the plate(19).

(9) Holding the whole unit together carefully turn it over, making sure it is supported on the spacer plate(19) not the shaft.

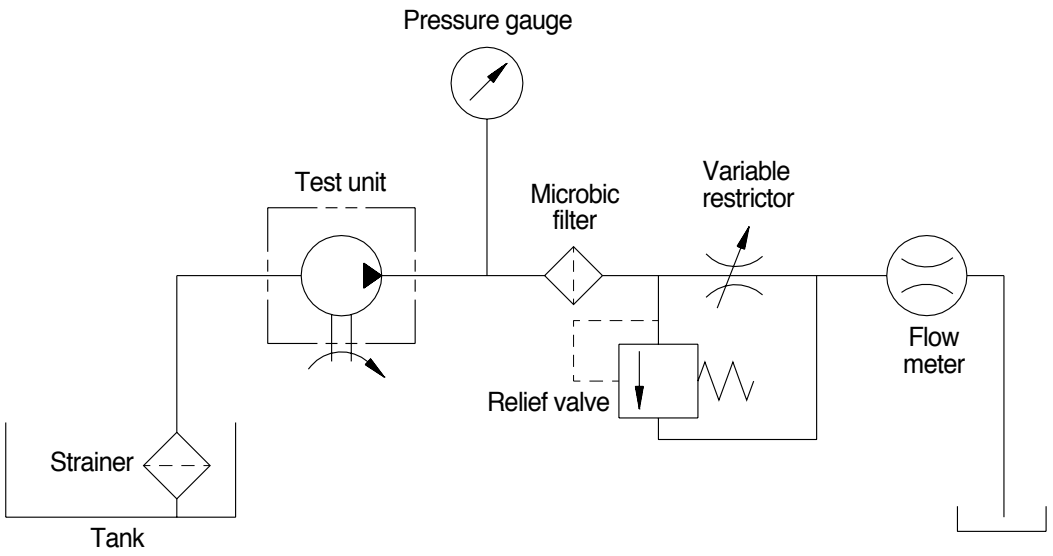
(10) Slide off the rear over and fit seals as in(5) and (6) above.

(11) Fit the rear cover(21), taking care not to dislodge the backup seal(16) and bolt(23) the unit together.

· Tightening torque : 4.8kgf · m(35lbf · ft)

※ Pour a small amount of oil into a port and check that the shaft can be rotated without undue force using a smooth jawed hand wrench hooked around the shaft or a suitable half coupling locked against the key.

5) 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 1500rpm, initially, at zero pressure for one minute then in stages with the pressure increased by 500psi 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 ℃. If the temperature exceeds the system or unit specification the test must be delayed and operated off-load until acceptable temperatures are obtained.