SECTION 4 BRAKE SYSTEM

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.

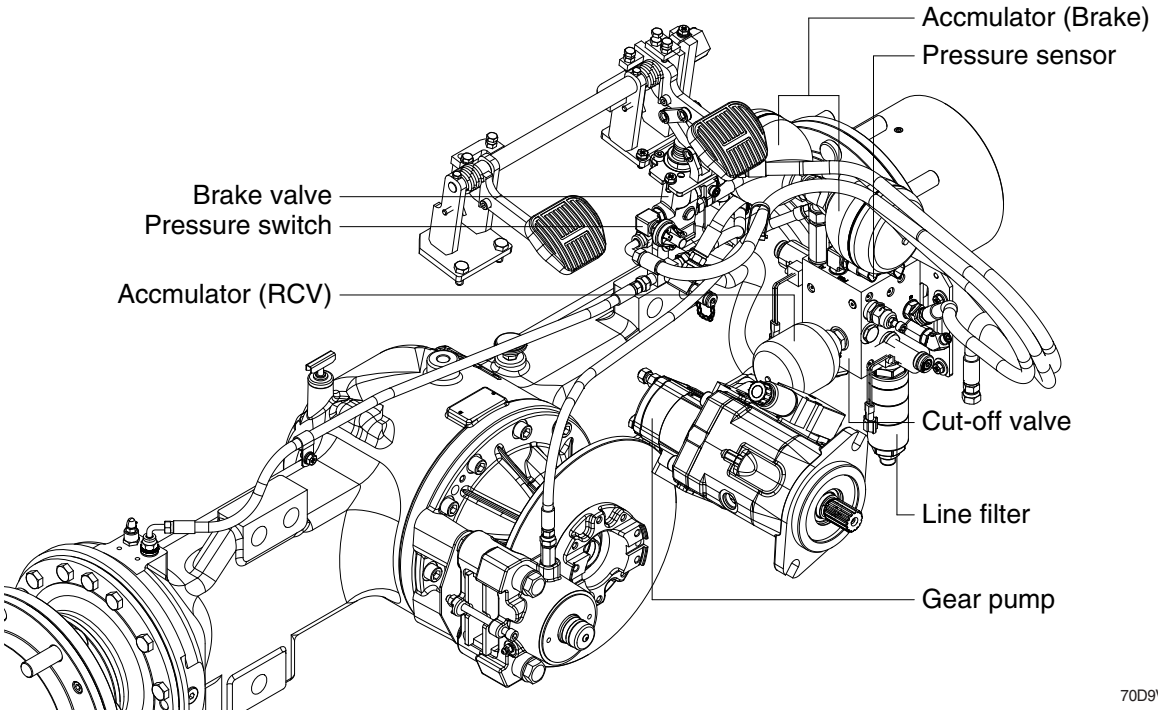
1) SERVICE BRAKE SYSTEM

The fixed displacement brake pump supplies flow to the cut-off valve for service brake circuit. It flows to two 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, single circuit operated by a pedal. The brake system contains the following components:

- Gear pump
- Cut-off valve, Line filter, Accumlators, Prssure sensor
- Brake valve, Prssure switch

2) PARKING BRAKE SYSTEM

In the parking brake system, turn parking brake switch ON, the parking brake solenoid valve in the cut off solenoid valve is de-energized 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 is returned by the force of the spring, the parking brake is applied.



70D9V5BS01

3) 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.

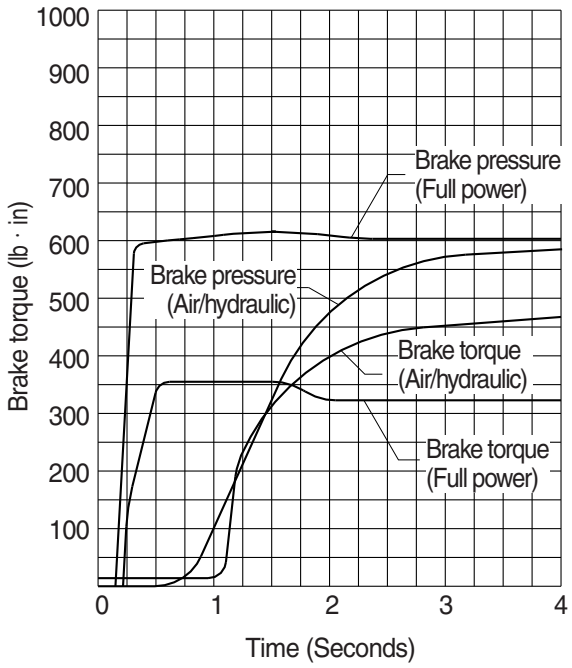
Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated. This is referred to as brake pressure modulation.

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.

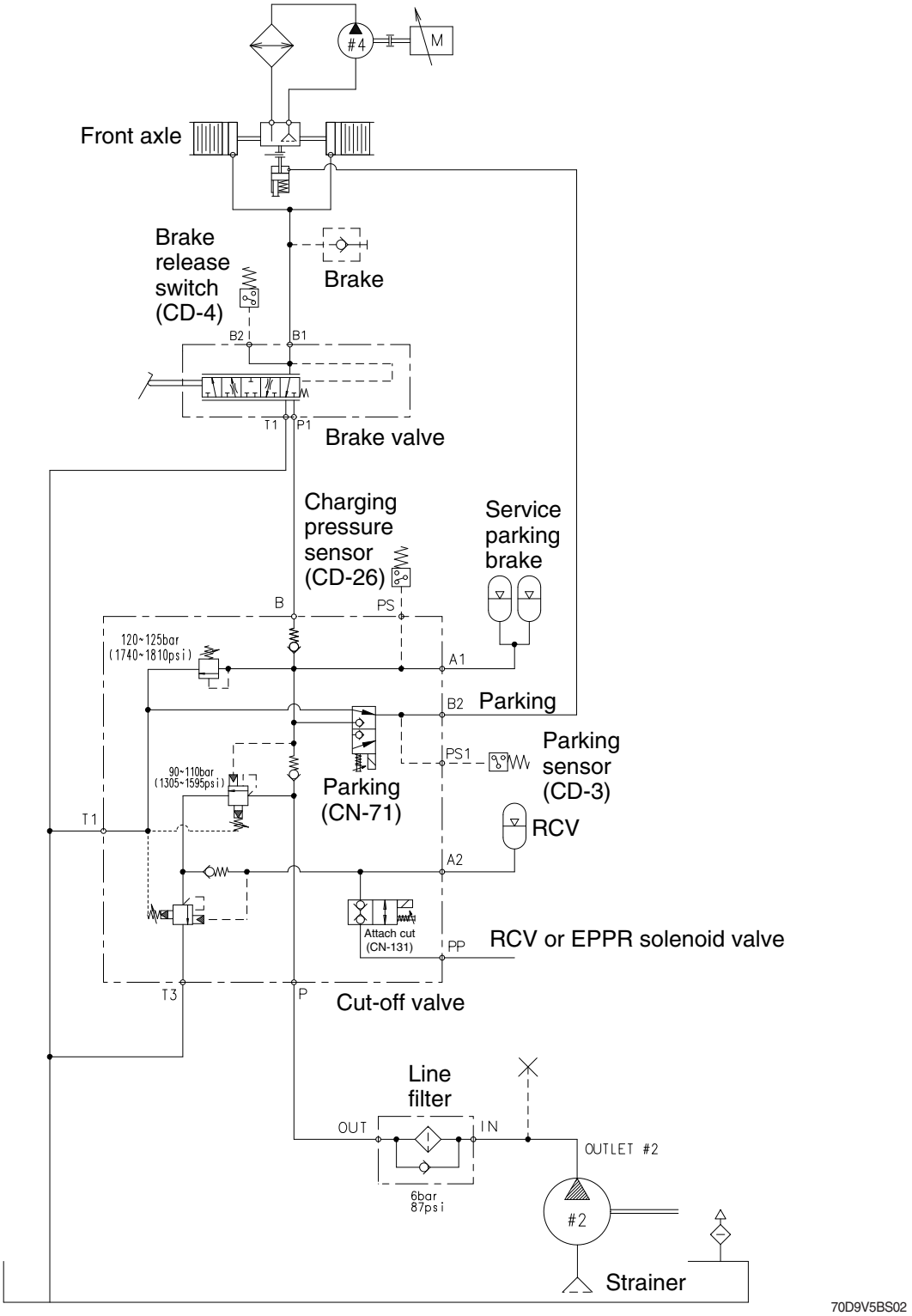
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the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

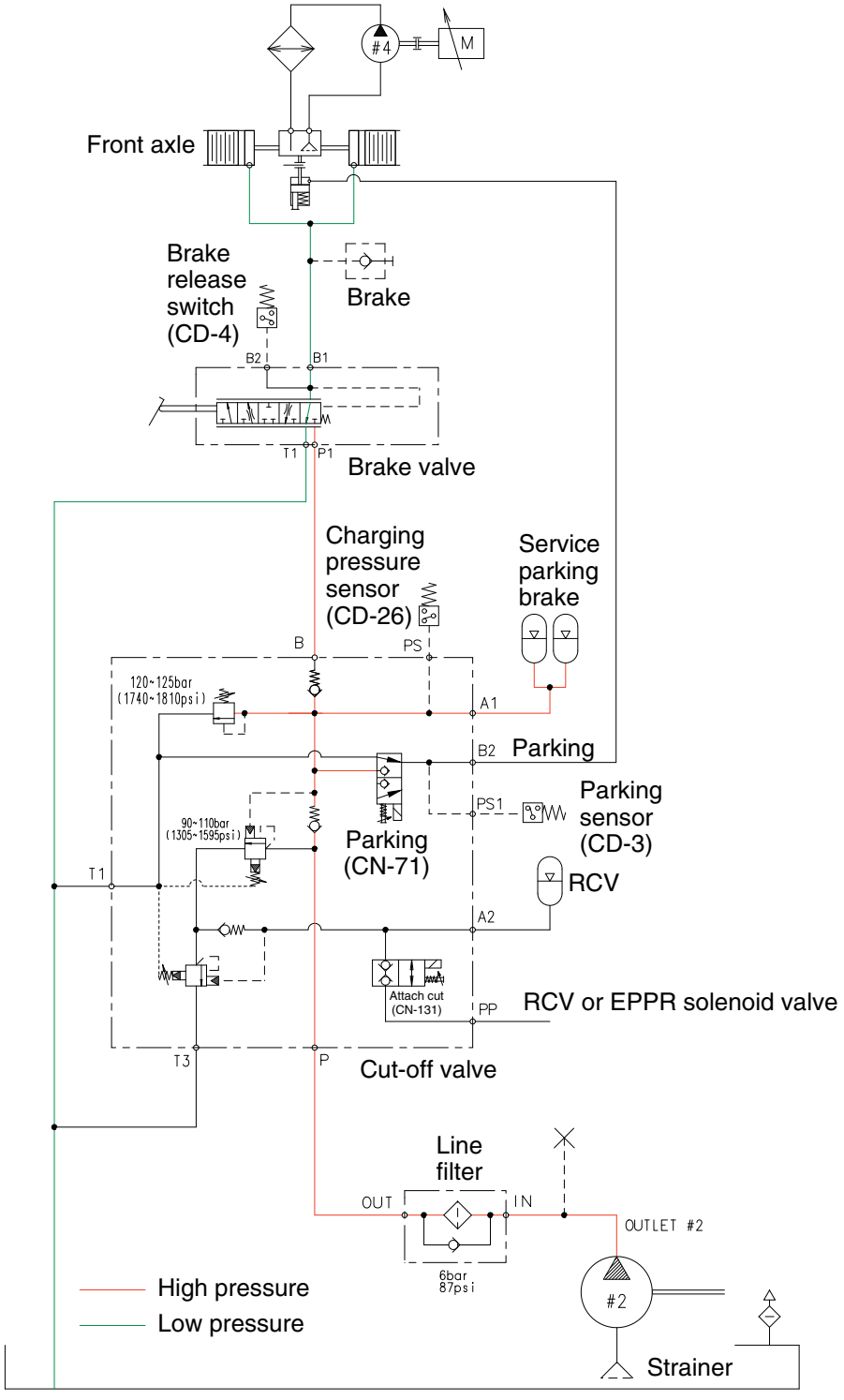
Response time
Full power brake actuation VS
Air/Hydraulic brake actuation



2. HYDRAULIC CIRCUIT



1) SERVICE BRAKE RELEASED



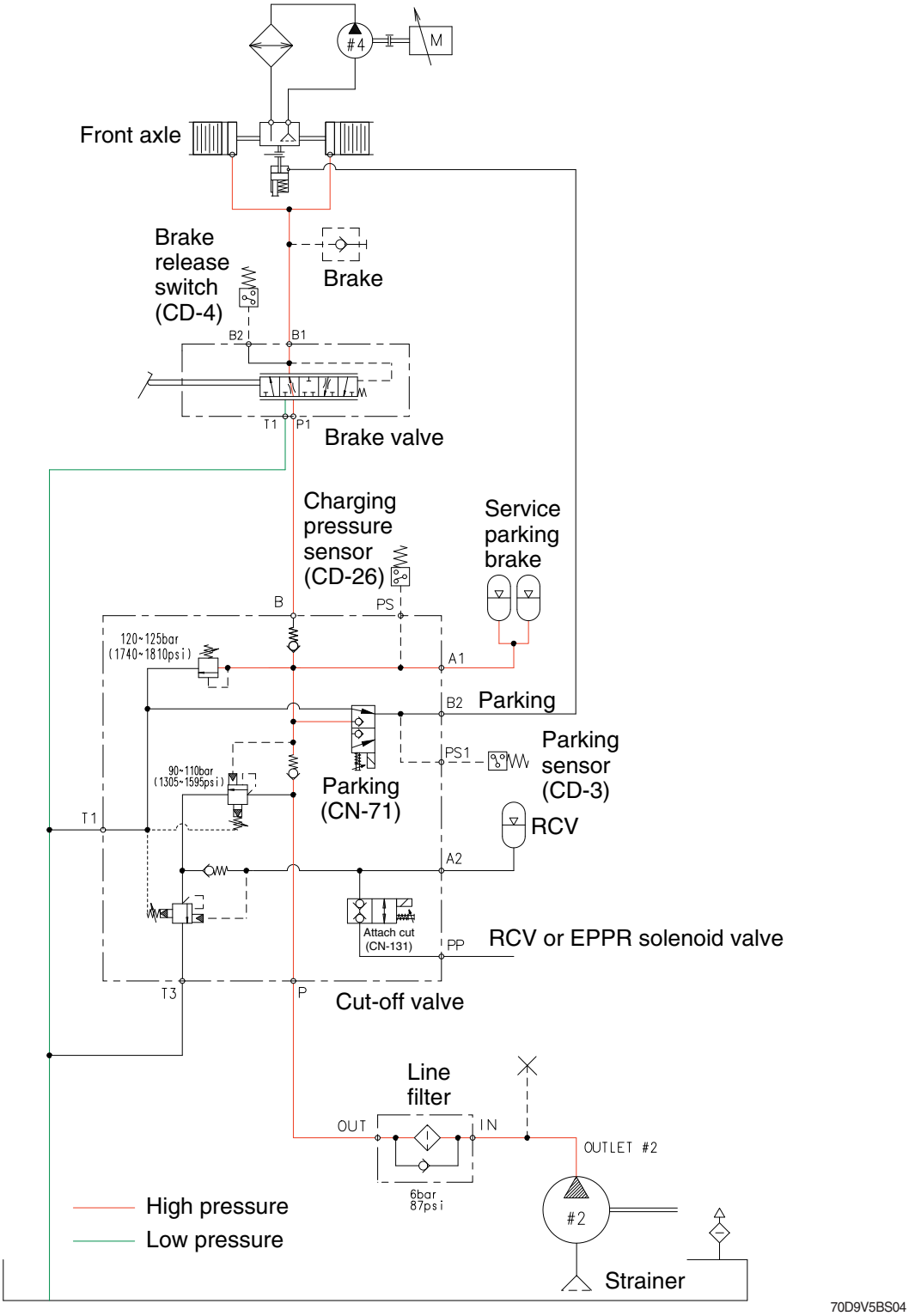
70D9V5BS03

When the pedal of brake valve 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.

Therefore, the service brake is kept released.

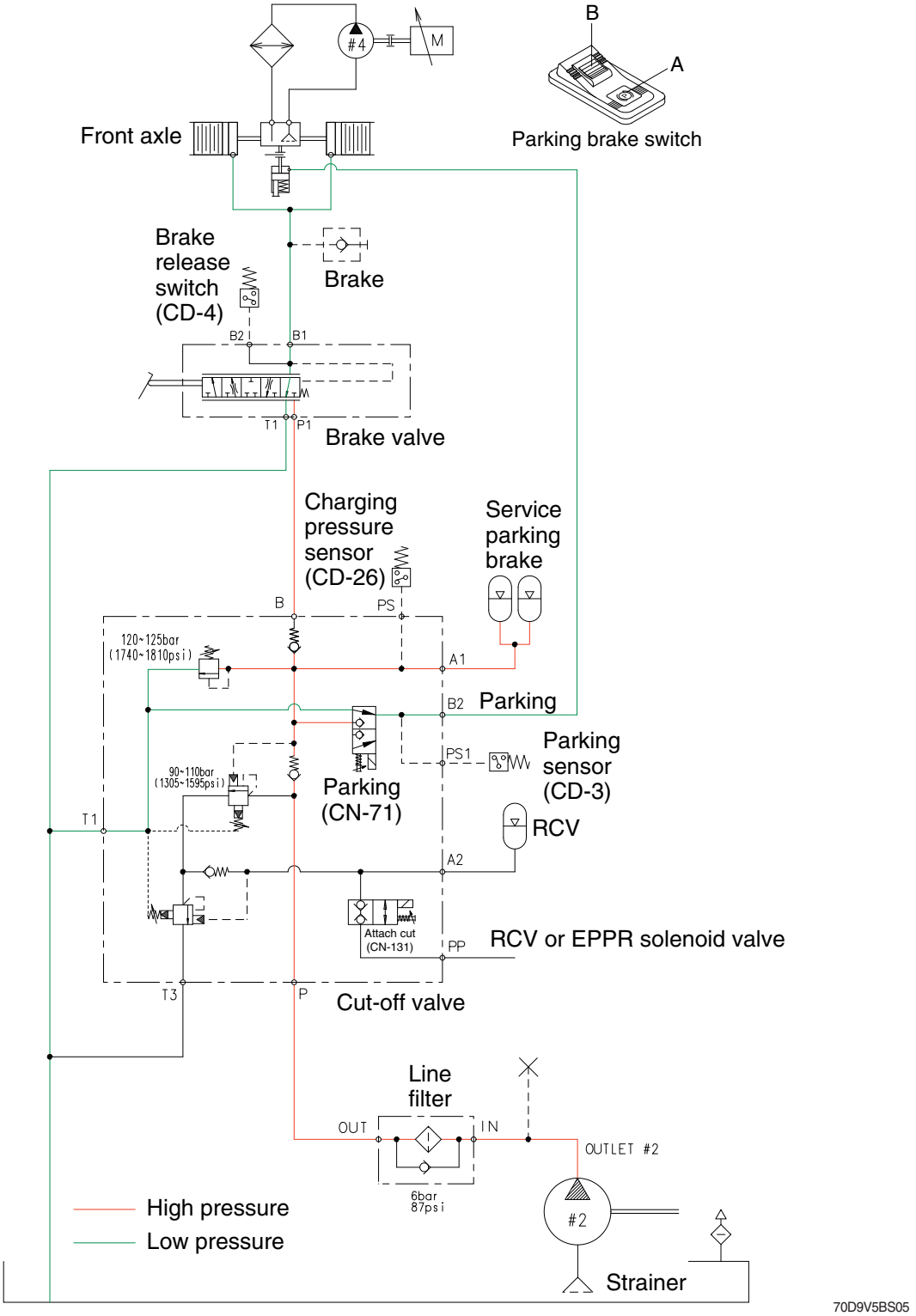
2) SERVICE BRAKE OPERATED



70D9V5BS04

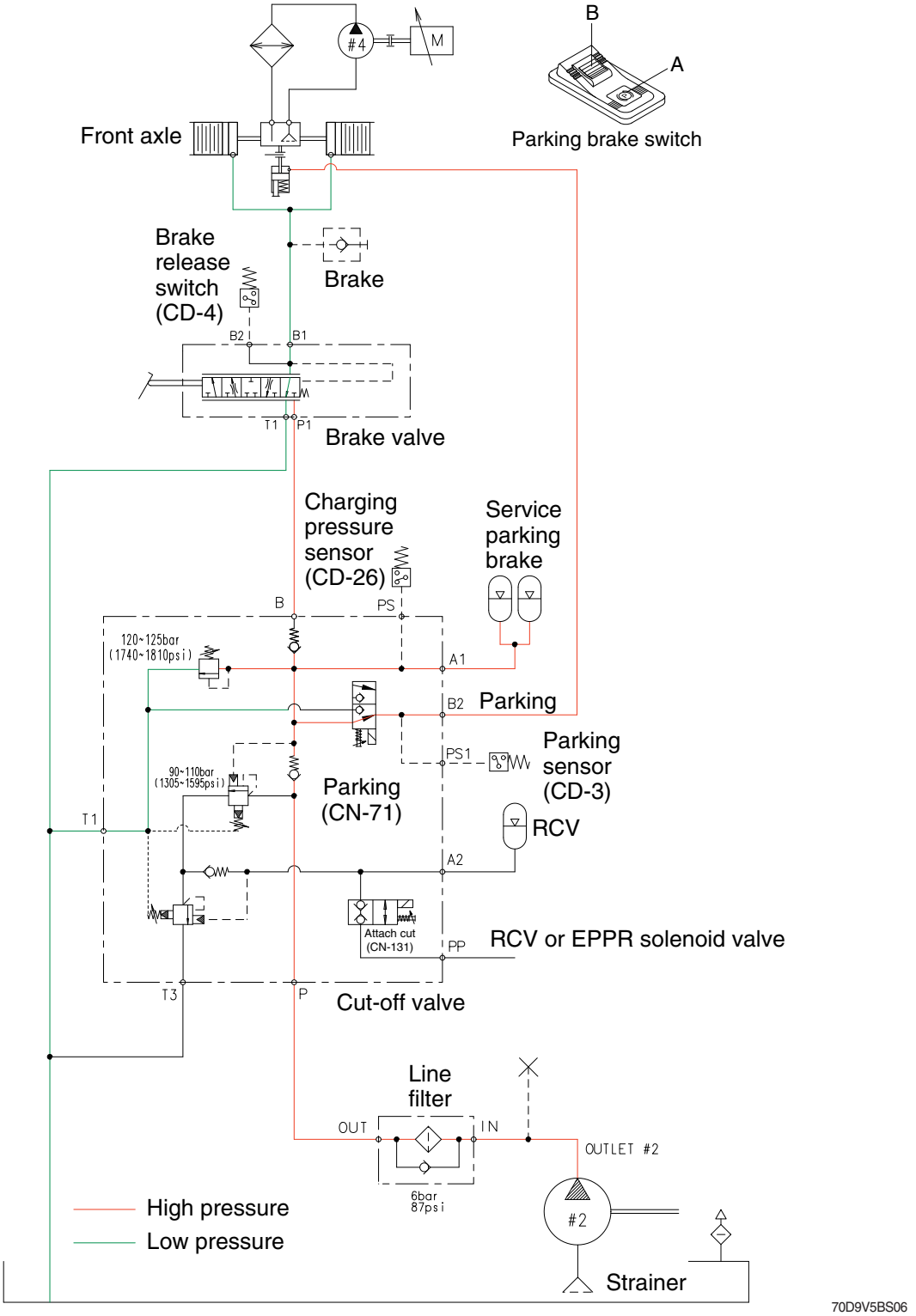
When the pedal of brake valve is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve enters the piston in the front 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 parking brake piston. This releases the parking 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 de-energized 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 is returned by the force of the spring, the parking brake is applied.

5) DO AEB WORK

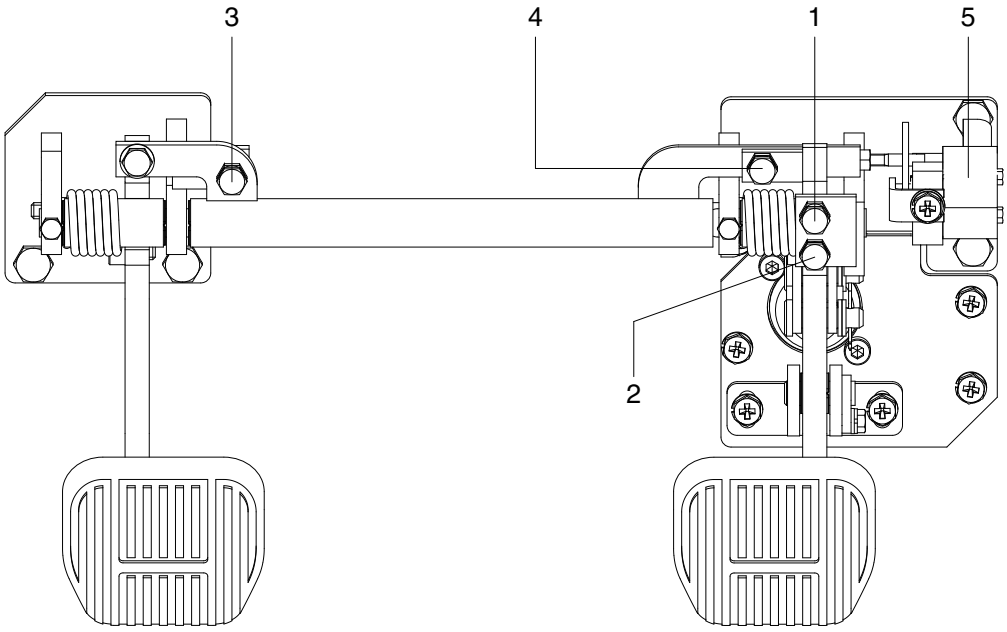
(1) Start engine after parking the machine on flat floor and blocking wheels.
(2) Release parking brake.
(3) With stepping on the service brake, operate T/M STALL (3 stage).
(To avoid defect of clutch pack, repeat 10 sec of operation and 10 sec of placing neutral)
(4) When the T/M oil temperature reaches 75~80˚C, lock the parking brake and then shift gear to neutral position to keep the machine at LOW RPM.
(5) Connect the AEB STARTER to T/M controller.
(6) Push AEB STARTER over 3 seconds.
(7) Confirm the status of AEB from the DISPLAY.
- Normal operation shows "ST, KR, KV, KC, KD, KE" orderly for 3~5 minutes.
- After the successful completion, it displays "OK".
- With a new controller, it may display "F6" error code before AEB, but after AEB, it will disappear.

(8) In case of abnormal running, it may display "STOP" with the appropriate error code.
(9) After troubleshooting, start the machine again to repeat above.

※ As the STALL operation has to be done, the SERVICE BRAKE must be locked perfectly to avoid the fatal accident.

3. INCHING PEDAL AND LINKAGE

The brake pedal serves to actuate the hydraulic brakes on the front axle. At the beginning of the pedal stroke, the inching spool of the transmission control valve is actuated to shift the hydraulic clutch to neutral and turn off the driving force. By treading the pedal further, the brake is applied.



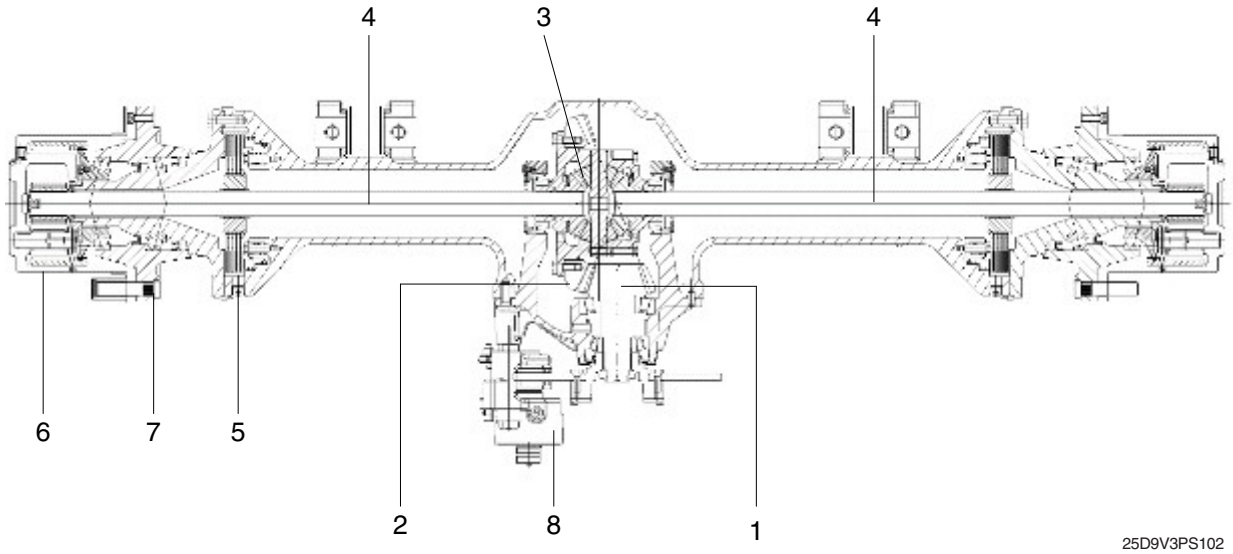
1	Brake stopper bolt	3	Inching stopper bolt	5	Inching sensor
2	Brake storke limit bolt	4	Brake&inching pedal interlock bolt		

1) INITIALIZING THE INCHING SENSOR

Refer to the page of the cluster setting.

4. DISK BRAKE

1) STRUCTURE

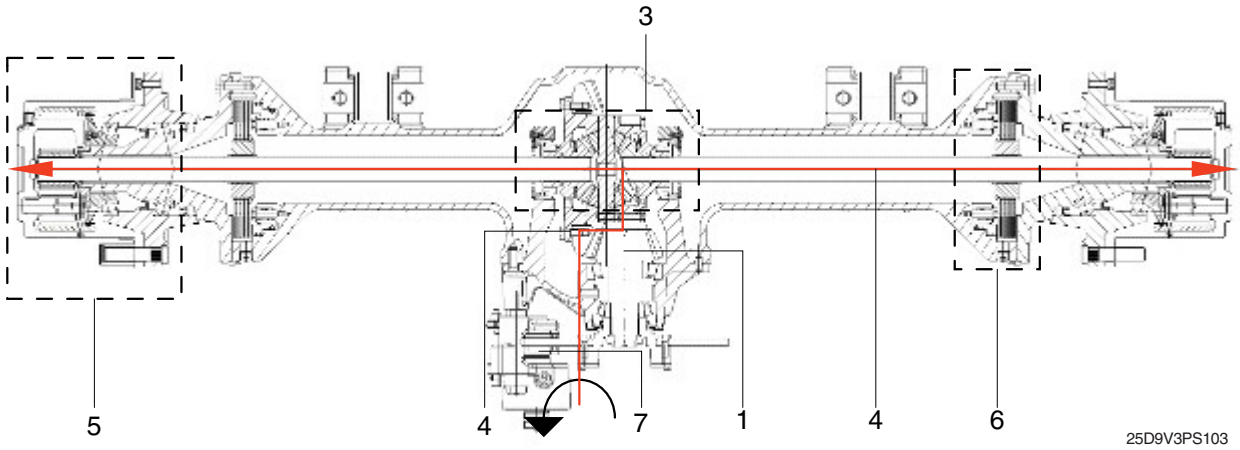


25D9V3PS102

1	Pinion shaft	4	Axle shaft	7	Hub
2	Ring gear	5	Service brake	8	Parking brake
3	Differential device	6	Hub reduction		

2) OPERATION

The drive axle is connected with the transmission output gear by drive shaft assembly. The power transferred by the drive shaft assembly is connected to the pinion shaft of drive axle, the pinion shaft delivers the power to the differential device through the ring gear. The differential device deliver the power to hub reduction through axle shaft.

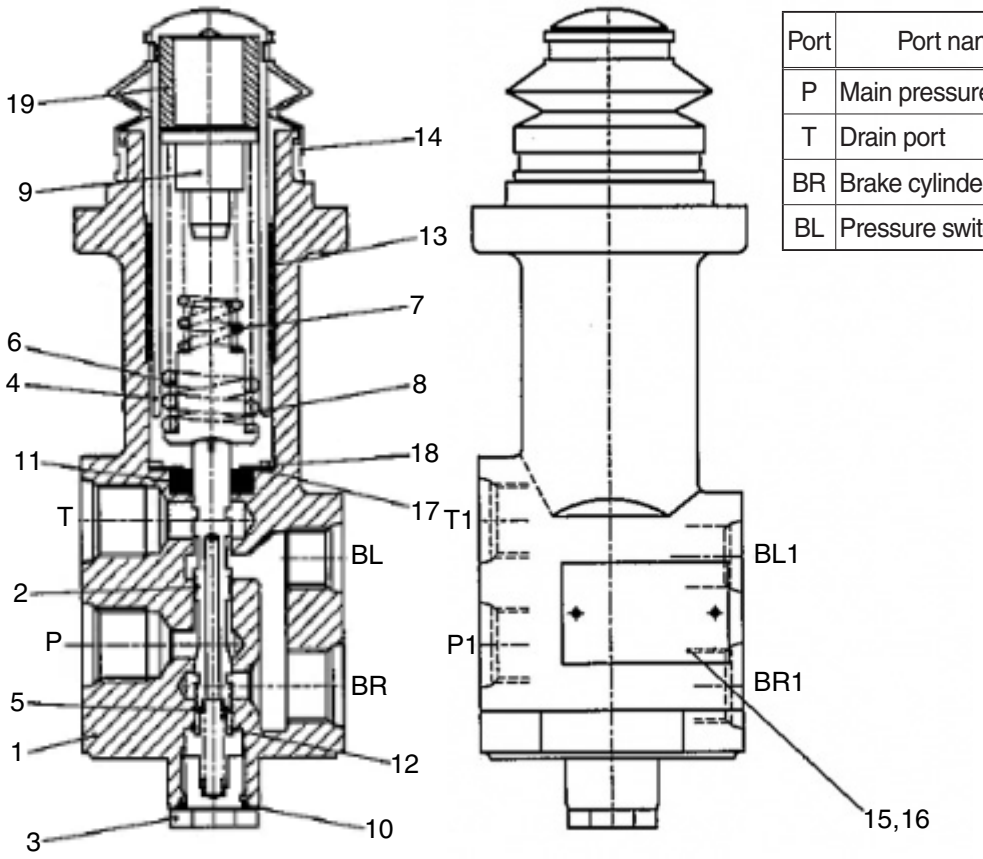


25D9V3PS103

1	Pinion shaft	4	Axle shaft	7	Parking brake
2	Ring gear	5	Hub reduction		
3	Differential device	6	Service brake		

5. BRAKE VALVE

1) STRUCTURE



Port	Port name	Port size
P	Main pressure port	PF 3/8
T	Drain port	PF 3/8
BR	Brake cylinder port	PF 3/8
BL	Pressure switch port	PF 1/4

70D9V5BS07

1	Body	8	Retainer spring	15	Name plate
2	Spool	9	Retainer spring	16	Drive screw
3	Plug	10	O-ring	17	Plate washer
4	Brake holder	11	Oil seal	18	Snap ring
5	Lower spring	12	Snap ring	19	Spacer
6	Main spring	13	Du bushing		
7	Reatiner spring	14	Rubber cover		

(1) Purpose

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

(2) Ready position

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

(3) Partial braking

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

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

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

(4) Full braking position

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

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

(5) Installation requirements

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

(6) 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).

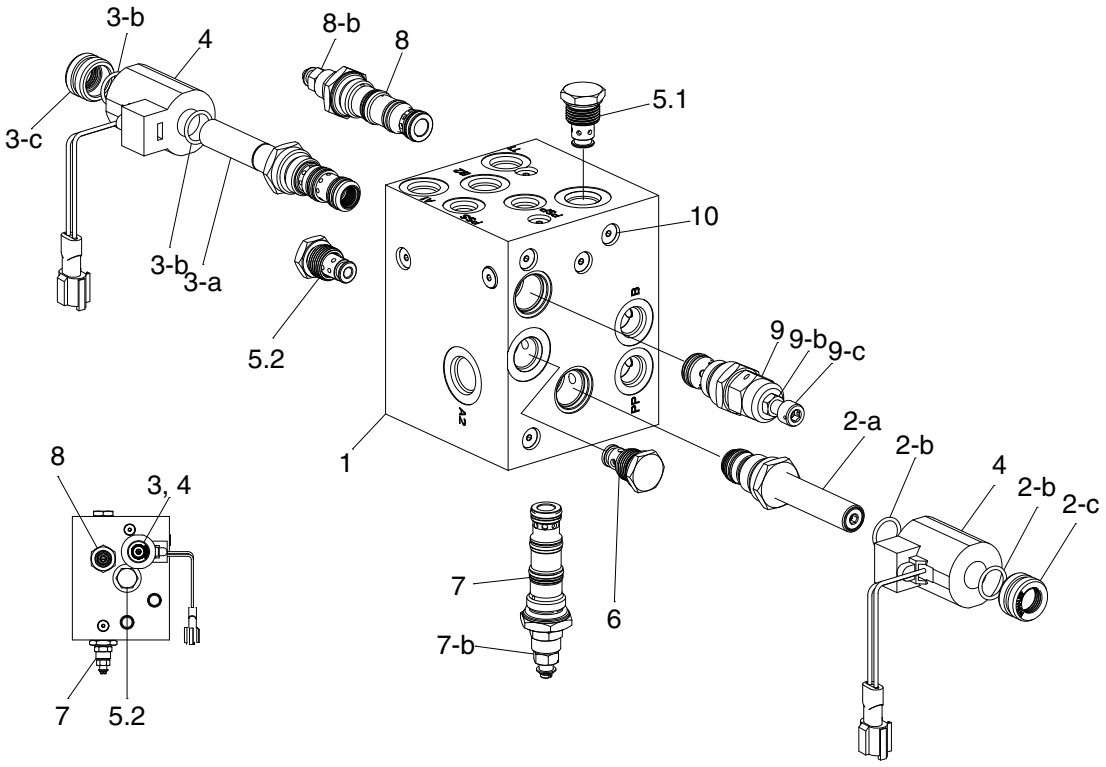
△ **For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.**

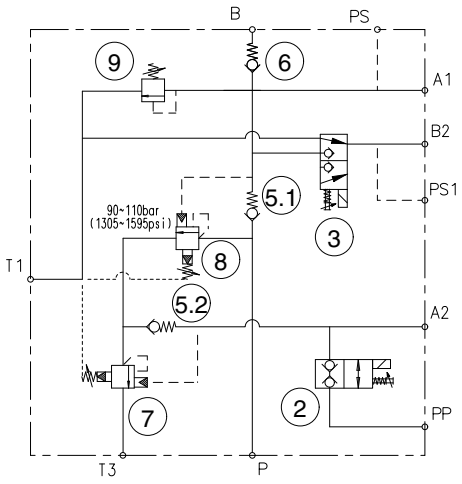
(7) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine 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.

6. CUT-OFF VALVE

1) STRUCTURE





Hydraulic circuit

Port	Thread	Tightening torque	
		kgf·m	lbf·ft
A2	PF 1/2	6.1	44.1
P, A1, B, B2, T1, T3	PF 3/8	5	36.2
PS, PS1	9/16-18 UNF	3	21.7

70D9V4BS08

No.		Part name	Hex. (mm)	Tightening torque		Remark (bar)
				kgf·m	lbf·ft	
1		Manifold	-	-		-
2	a	Solenoid valve (RCV)	27	5.0 ± 0.6	36.9 ± 4.4	Attach (RCV)
	b	O-Ring (2 EA)	-	-		
	c	Cap		0.6 ± 0.1	4.4 ± 0.7	
3	a	Solenoid valve (parking)	27	5.0 ± 0.6	36.9 ± 4.4	Parking
	b	O-Ring (2 EA)	-	-		
	c	Cap	-	0.6 ± 0.1	4.4 ± 0.7	
4		12V Coil (2 EA)	-	-		12V
5		Check valve (2 EA)	22	3.8 ± 0.25	28 ± 1.8	-
6		Check valve	22	3.8 ± 0.25	28 ± 1.8	-
7	a	Cut-off valve (RCV)	27	4.8 ± 0.25	35.4 ± 1.8	Set pressure (OFF : 40 ~ 45, ON : 25 ~ 30)
	b	Lock nut	13	1.0 ± 0.1	7.4 ± 0.7	
8	a	Cut-off valve (brake)	27	4.8 ± 0.25	35.4 ± 1.8	Set pressure (OFF : 105 ~ 110, ON : 90 ~ 95)
	b	Lock nut	13	1.0 ± 0.1	7.4 ± 0.7	
9	a	Relief valve	27	4.8 ± 0.25	35.4 ± 1.8	System (120 ~ 125)
	b	Lock nut	13	1.0 ± 0.1	7.4 ± 0.7	
	c	Screw	SW 6	-		-
10		Plug (M7, 18 EA)	3	0.6 ± 0.1	4.4 ± 0.7	-

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 A1 port.

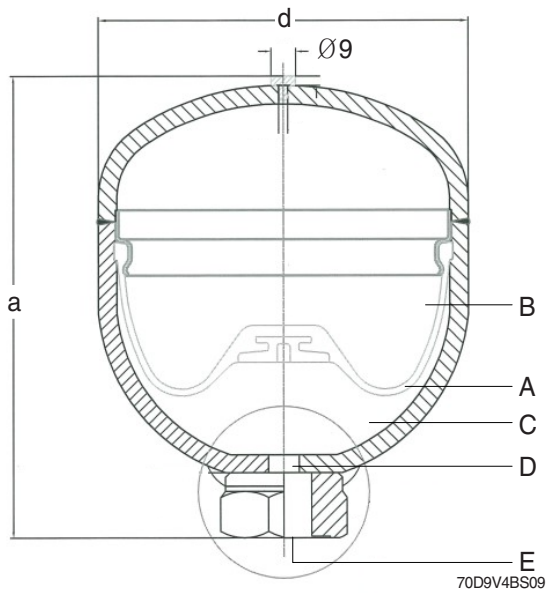
As the pressure on P line rises to 95 bar, the cut off valve (7) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 80 bar by the minute leakage from valve and other factors.

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

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

7. BRAKE ACCUMULATOR

1) STRUCTURE



Item	Brake (2 EA)	RCV (1 EA)
Diameter (d)	122 mm	90 mm
Mounting height (a)	145 mm	120 mm
Nominal volume	0.75 ℓ	0.35 ℓ
Priming pressure	50 bar	15 bar
Operating medium	Oil	Oil
Operating pressure	Max. 210 bar	Max. 170 bar
Thread	M18×1.5	PF 1/2
Priming gas	Nitrogen	Nitrogen

A Fluid portion C Diaphragm E Flat port
B Gas portion 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. 3 mm 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.**

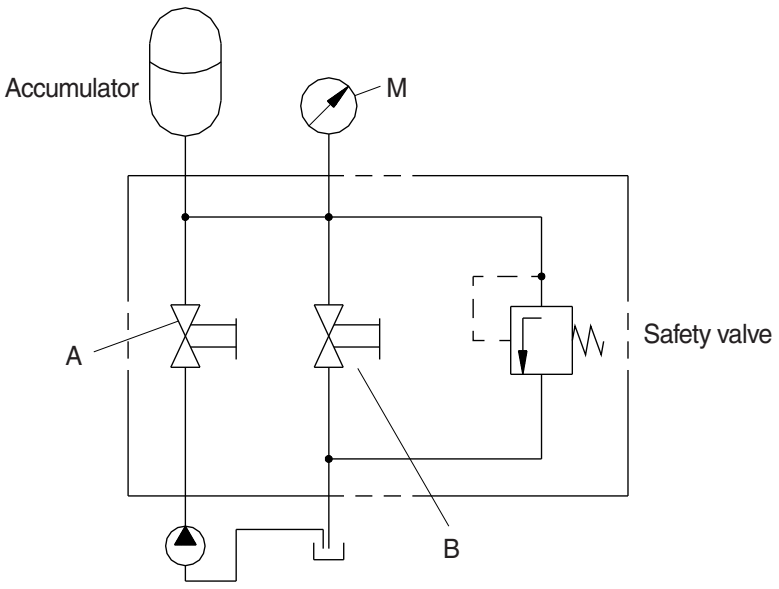
The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If 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.**

(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.**



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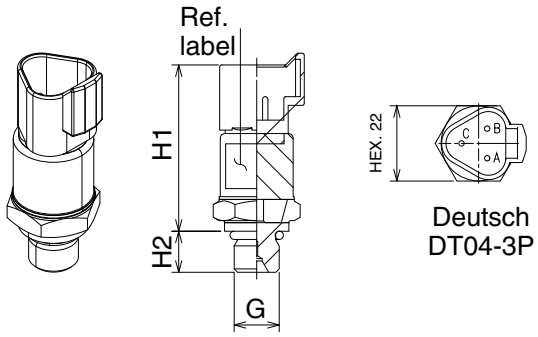
8. PRESSURE SENSOR AND SWITCH

1) PRESSURE SENSOR

(1) Structure



· Tightening torque : 2.5 ~ 3.0 kgf·m
(18 ~ 21.7 lbf·ft)

Pin map	Function
A	+ Supply
B	- Supply
C	Output

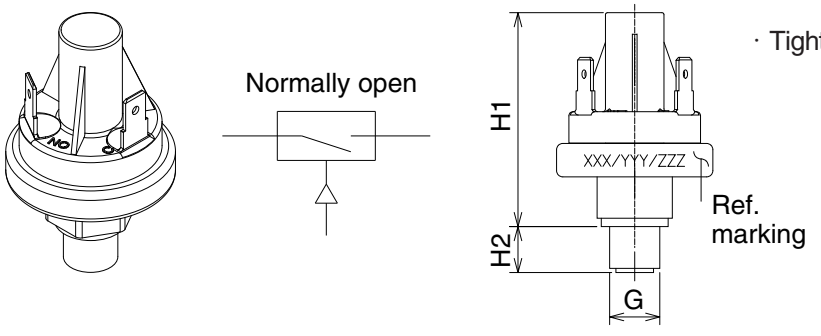
70D9V4BS10

Item	Medium	Thread (G)	H1 (mm)	H2 (mm)	Measuring range (bar)	Cut-off actuating pressure	Voltage (V)	Electircal connections
Charging pressure sensor (PS or PSS)	Oil	9/16-18 UNF	49	12	0 ~ 350	90 ~ 95 bar (1.52 ~ 1.58 V)	Max. 30	CD-3
Parking pressure sensor (PS1 or PSP)	Oil	9/16-18 UNF	49	12	0 ~ 350	90 ~ 95 bar (1.52 ~ 1.58 V)	Max. 30	CD-26

※ O-ring (S611-012001) : 11.89×1.98 (AS568-906, NBR Hs90)

2) PRESSURE SWITCH

(1) Structure



· Tightening torque : 2.5 ~ 3.0 kgf·m
(18 ~ 21.7 lbf·ft)

70D9V4BS11

Item	Type	Medium	Thread (G)	H1 (mm)	H2 (mm)	Measuring range (bar)	Actuating pressure	Supply voltage	Electrical connections
Brake lamp pressure switch (B2 or BL)	Normally open	Oil	1/2-20 UNF	49	11	1 ~ 10	5 ± 1 bar (0.56 V)	Max. 45 V	Slip on CD-4

※ O-ring (S611-011001) : 10.52×1.82 (AS568-905, NBR Hs90)

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.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

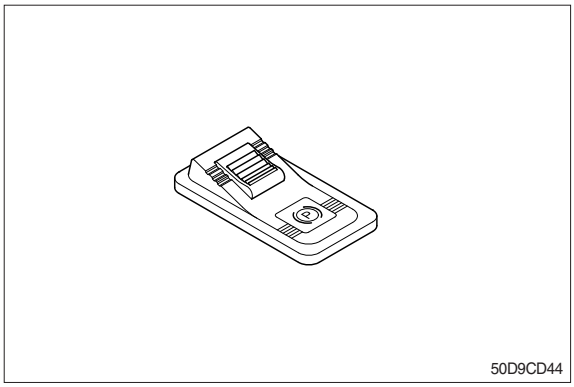
1. OPERATIONAL CHECKS

1) BRAKE PIPING

(1) Check pipes, hoses and joints for damage, oil leakage or interference.
(2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

2) PARKING BRAKE

(1) Check that parking brake can hold machine in position when loaded on 20% slope. If there is no slope available, travel at low speed and check braking effect of parking brake.



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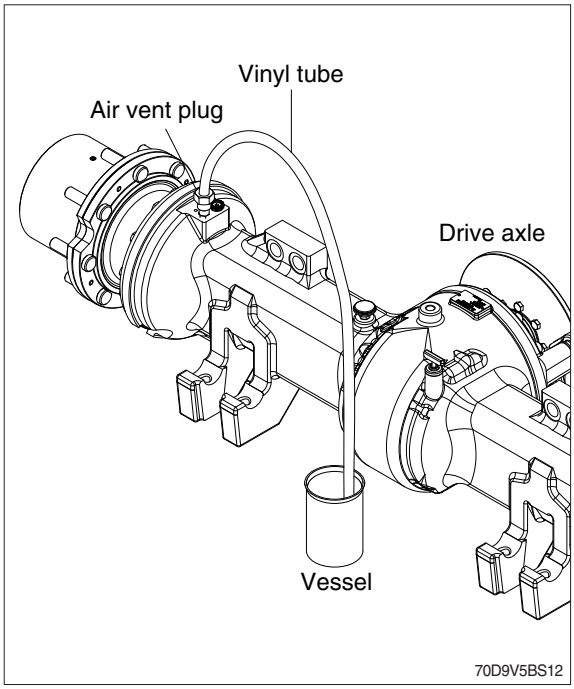
2. TROUBLESHOOTING

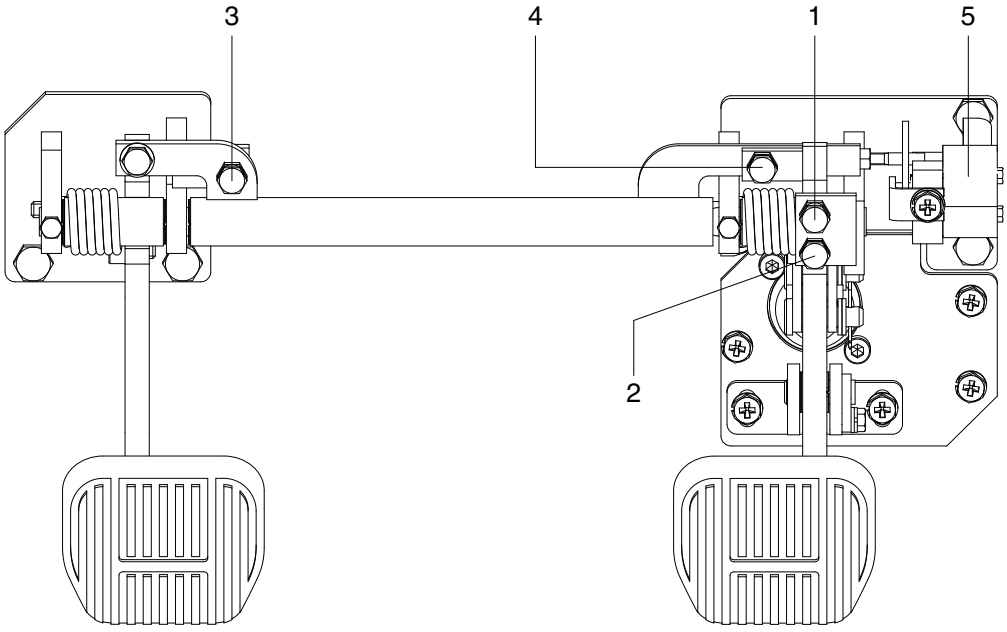
Problem	Cause	Remedy
Insufficient braking force	· Hydraulic system leaks oil. · Hydraulic system leaks air. · Disk worn. · Brake valve malfunctioning. · Hydraulic system clogged.	· Repair and add oil. · Bleed air. · Replace. · Repair or replace. · Clean.
Brake acting unevenly. (Machine is turned to one side during braking.)	· Tires unequally inflated. · Brake out of adjustment. · Disk surface roughened. · Wheel bearing out of adjustment. · Hydraulic system clogged.	· Adjust tire pressure. · Adjust. · Repair by polishing or replace. · Adjust or replace. · Clean.
Brake trailing.	· Pedal has no play. · Piston cup faulty. · Brake valve return port clogged. · Hydraulic system clogged. · Wheel bearing out of adjustment.	· Adjust. · Replace. · Clean. · Clean. · Adjust or replace.
Brake chirps	· Brake trailing. · Piston fails to return. · Disk worn. · Disk surface roughened.	· See above. Brake trailing. · Replace. · Replace. · Repair by polishing or replace.
Brake squeaks	· Disk surface roughened. · Disk worn. · Excessively large friction between disk plate.	· Repair by polishing or replace. · Replace. · Clean and apply brake grease.
Large pedal stroke	· Brake out of adjustment. · Hydraulic line sucking air. · Oil leaks from hydraulic line, or lack of oil. · Disk worn.	· Adjust. · Bleed air. · Check and repair or add oil. · Replace.
Pedal dragging.	· Twisted push rod caused by improperly fitted brake valve. · Brake valve seal faulty.	· Adjust. · Replace.

1. AIR BLEEDING OF BRAKE SYSTEM

1) Air bleeding should be performed by two persons :
   One rides on truck for depressing and releasing brake pedal : the other person is on the ground and removes cap from air vent plug on wheel cylinder.
2) Block the front wheel securely and apply parking brake.
3) Start the engine.
4) Attach a vinyl tube to air vent plug and immerse other end of tube into a vessel filled with hydraulic oil.
5) Loosen air vent plug by turning it 3/4 with a wrench. Depress brake pedal to drain oil mixed with air bubbles from plug hole.
6) Depress brake pedal until no air bubbles come out of air vent plug hole.
7) After completion of air bleeding, securely tighten air vent plug. Install cap on plug.
8) Same way for the opposite side.



2. ADJUSTMENT OF PEDALS



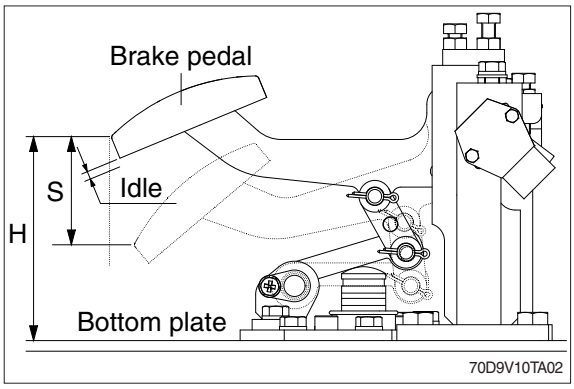
1	Brake stopper bolt	3	Inching stopper bolt	5	Inching sensor
2	Brake storke limit bolt	4	Brake&inching pedal interlock bolt		

1) Brake pedal

- Adjust the brake stopper bolt (1) so that pedal height is "H".
- Adjust the brake storke limit bolt (2) so that pedal stroke is "S"

Unit : mm

H	S	IDLE
116±5	62±5	0

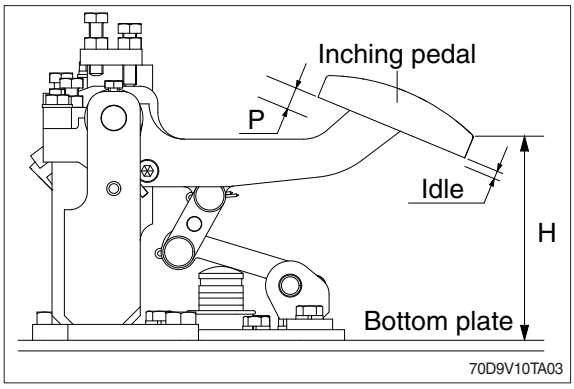


2) Inching pedal

- Adjust inching stopper bolt (3) so that pedal height is "H".
- Adjust rod of inching cable so that inching pedal play is idle stroke when pedal height is "H".
- Adjust the brake and inching pedal interlock bolt (4) so that brake pedal interconnects with inching pedal at inching pedal stroke "P".

Unit : mm

H	P	IDLE
116±5	10	3

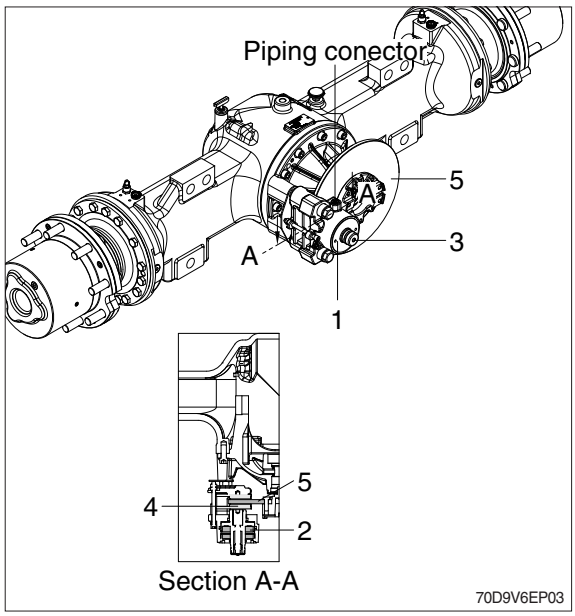


3. PARKING BRAKE RELEASE

In case of malfunction of transmission, it is hard to supply pressure at parking brake.
Using function of parking force release at carrier sub assembly of drive axle, it is possible to tow the truck.

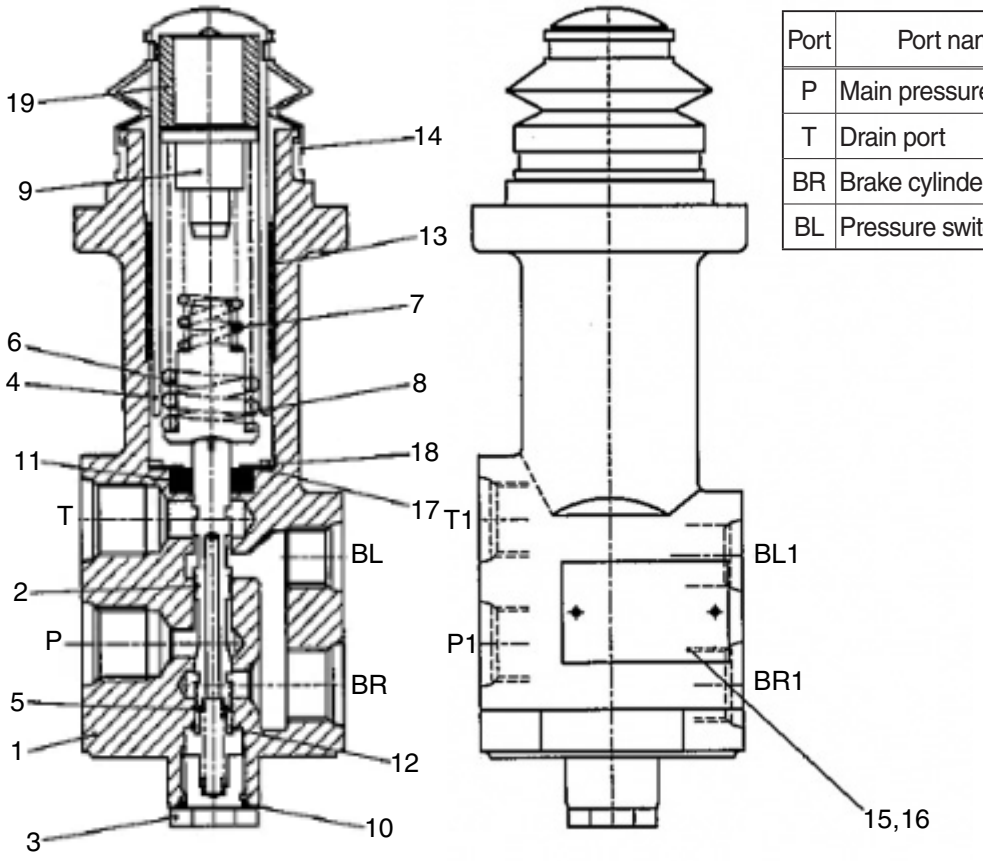
※ After the start switch OFF, perform this procedure.

1) Loosen the cover (1) by using a spanner wrench ( ).
2) Remove the disc spring (2).
3) Pull the piston (3) until the lining (4) is unforced.
   Check the parking disc (5) is driven.
4) The assembly is the reverse of the release
5) procedure. After the assembly, conect the parking brake piping and check the parking disc (5) is not driven.



1. BRAKE VALVE

1) STRUCTURE



Port	Port name	Port size
P	Main pressure port	PF 3/8
T	Drain port	PF 3/8
BR	Brake cylinder port	PF 3/8
BL	Pressure switch port	PF 1/4

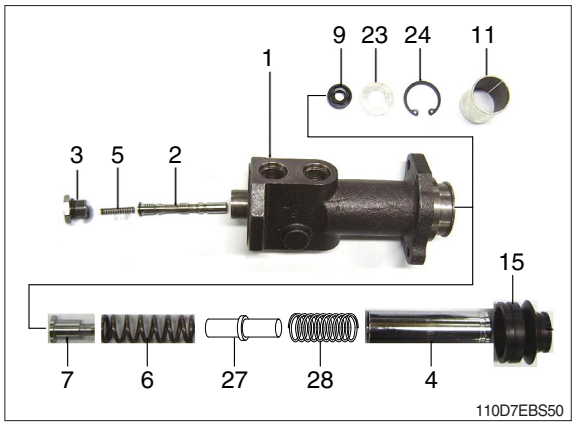
70D9V5BS07

1	Body	8	Retainer spring	15	Name plate
2	Spool	9	Retainer spring	16	Drive screw
3	Plug	10	O-ring	17	Plate washer
4	Brake holder	11	Oil seal	18	Snap ring
5	Lower spring	12	Snap ring	19	Spacer
6	Main spring	13	Du bushing		
7	Reatiner spring	14	Rubber cover		

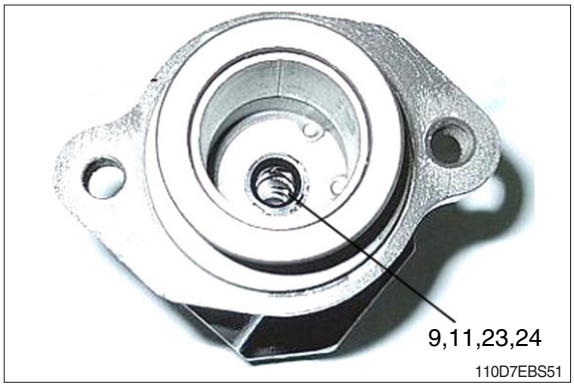
2) REASSEMBLY

(1) Body assembly

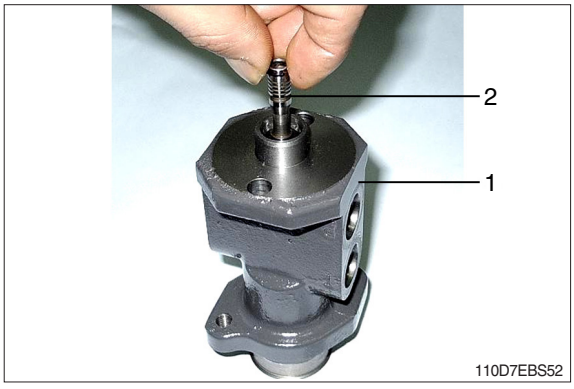
1 Body
2 Spool
3 Plug
4 Holder
5 Spring
6 Main spring 1
7 Spring retainer 1
9 Oil seal
11 DU bushing
15 Rubber cover
23 Plain washer
24 Stop ring
27 Spring retainer 2
28 Main spring 2



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



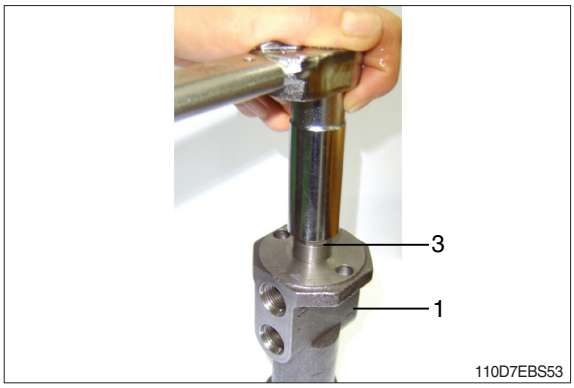
② Install spool (2) into body (1).



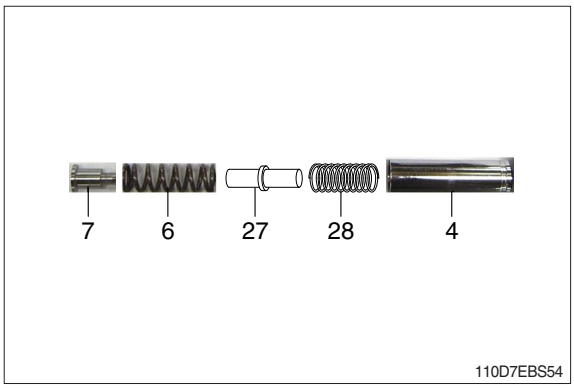
③ Tighten plug (3)
- Tool : 19 mm spanner
- Tightening torque : 14.0~16.5 kgf · m

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

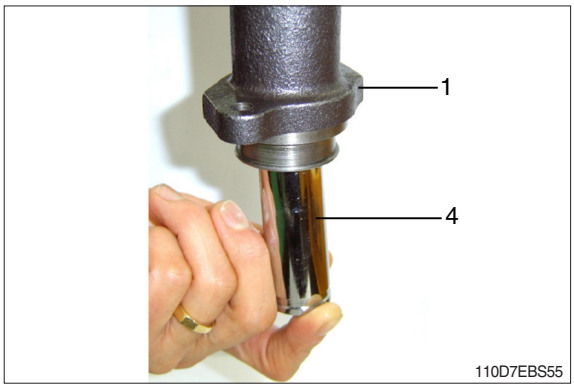
⚠ **Be careful of dust and scrap after washing the parts.**



④ Spring retainer (7, 27), main spring (6, 28) and holder (4).



⑤ Holder (4) → Body (1)



⑥ Rubber cover (15)