YANMAR

SERVICE MANUAL

CRAWLER CARRIER

MODEL C30R-2

1. GENERAL CAUTIONS FOR MAINTENANCE WORK

1. General Cautions for Maintenance Work

1-1 Correct Work

Correct work means the quickest possible completion of according to the correct procedures and the specified standards.

It is important when conducting certain operations always to bear in mind the equipment, tools, gauges, materials, oil and grease, etc. that you must have ready, as well as items to be checked, adjusted, or disassembled, and cautions to watch out for.

1-2 Safety Precautions

(1) Never attempt servicing while engine is running or immediately after stopping operation.
(2) Wear work cloths, safety shoes and helmet.
(3) Check the equipment and tools before use. Especially, be sure to check the crane, lifting equipment and tools.
(4) When working together with other persons, allocate everyone's share of job, arrange the signals and act in concert with the other persons.
(5) The operation of the crane and slinging work must be performed by qualified persons.
(6) Do not enter or pass under the raised load.
(7) Lift and support the massive parts by crane before removing the installation bolts.
(8) Disconnect cables from battery before repairing the electric system.
(9) Remove the battery when welding the machine.

1-3 Preparations

(1) Check the service record of the machine. (That is, check how many months or hours the machine has been used since the preceding overhaul, what was the trouble then and what parts were replaced.)
(2) Have all servicing tools ready, i.e., tools, measuring devices (which have received periodic maintenance), containers, oil & grease, etc.
(3) Have the service literature (operation manual, parts catalog, etc.) ready.

1-4 Cautions for Disassembly and Reassembly

(1) Clean the machine before disassembly.
(2) Check and record the condition of the machine before disassembly :
  • Model, machine number, operation hours
  • Reasons for repair, history of repair
  • Contamination of filters
  • Fuel and oil condition
  • Damage to parts, etc.
(3) Place alignment marks on the necessary parts to facilitate reassembly.
(4) Clean all the removed parts and new replacement parts and put them in order.
(5) Use new seals, split pins, etc. for reassembly.

1-10 Air Release Procedure for H.S.T. System

When operating the machine after disassembly or parts replacement of the hydraulic equipment, piping, etc., be sure to release air from the hydraulic system. This is necessary to prevent seizure and cavitation of the hydraulic equipment. If the air is left in the hydraulic system, the air is compressed or expanded depending on the load, having an adverse effect on the smooth operation of the hydraulic equipment and shortening the service life.

1. Air release of H.S.T. (Piston pump & motor)

1) Check that all the pipings are connected correctly and that the joints are not loosened.
2) Put a specified volume of hydraulic oil into the hydraulic oil tank.

Notes :

• Set the vehlcle at the oll level check posltlon.

• Keep the oll supply cap ol the hydraullc oll tank removed.

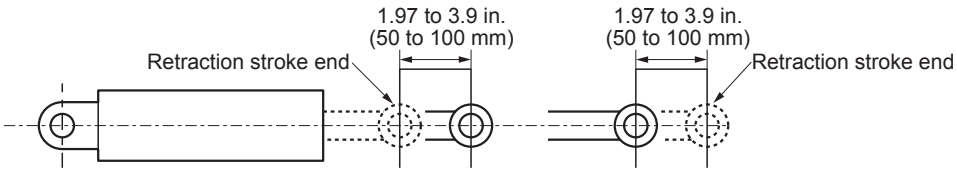
3) Check the oil level after running the engine at low idling range for 5 to 10 seconds.
4) If the oil level is lower than the specified level, stop the engine to supply hydraulic oil.
5) Run the engine at low idling range again for 2 to 3 minutes.
6) Check the oil level. If the oil quantity is not sufficient, supply oil. Then, install the oil supply cap.

2. Air release of each hydraulic equipment

Run the engine at medium speed and operate the respective circuits for about 10 to 15 minutes.

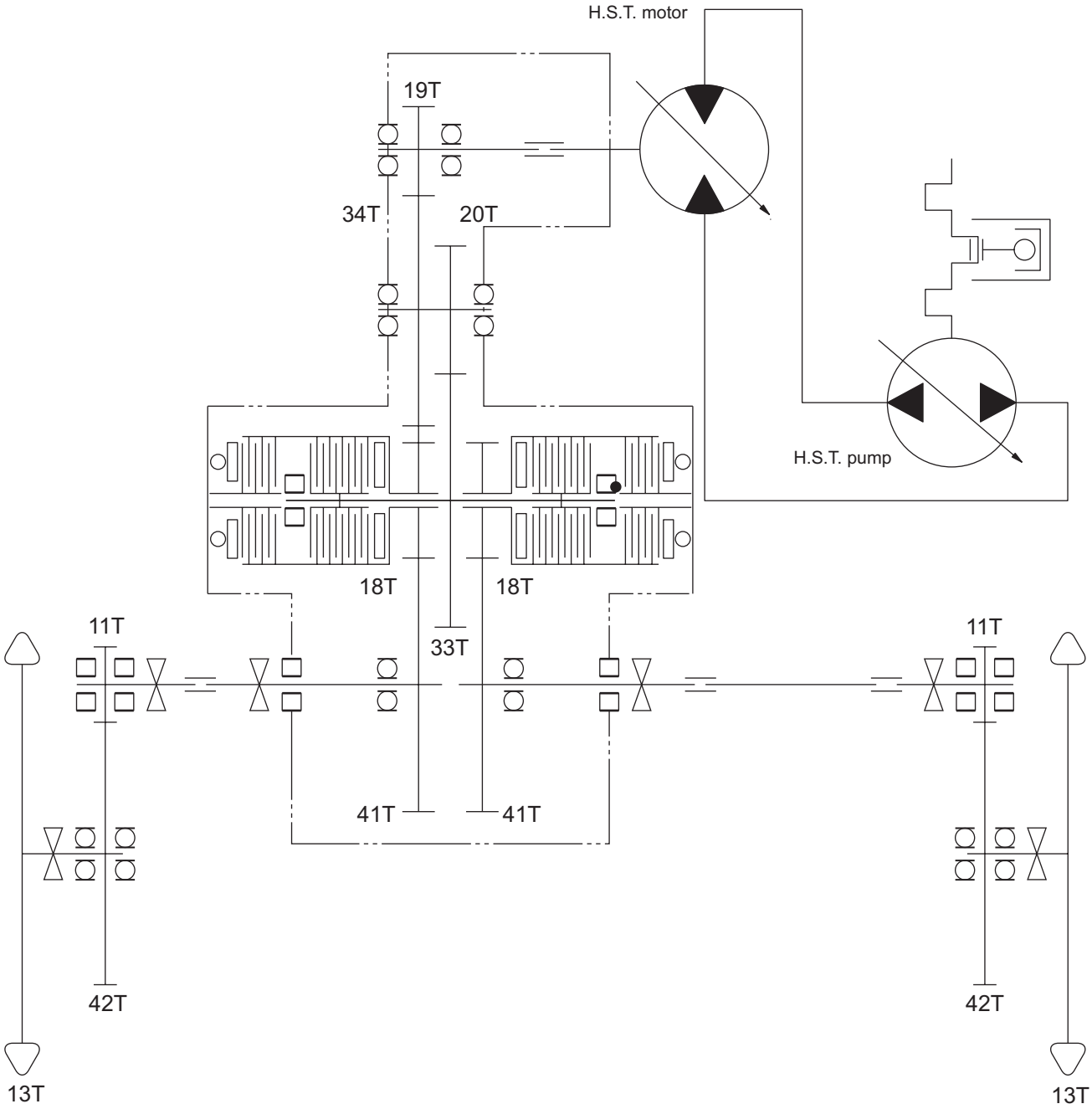
3. Air release of hydraulic cylinder

1) Set the engine speed at low idling range.
2) Extend and retract the cylinder up to about 1.97 to 3.9 in. (50 to 100 mm) from either stroke end slowly 4 to 5 times.



3) Then, extend and retract the cylinder to either stroke end 3 to 4 times.

2-3 Power Transmission Mechanical Diagram



Type	: 3TNV88-FFW
Engine output	: 32.9 HP (24.6 kW) / 3000 rpm
Max. revs.	: 3185 to 3235 rpm

3-2 Engine

Applicable model				3TNV88-FFW	
Item			Unit	Standard	Wear limit
Cylinder head					
Cylinder head distortion			in. (mm)	0.0020 (0.05) or less	0.0059 (0.15)
Valve seat angle	Intake		degrees (°)	120	–
	Exhaust			90	–
Valve seat width	Intake		in. (mm)	–	–
	Exhaust			–	–
Intake valve	Stem outside dia.		in. (mm)	0.313 to 0.314 (7.955 to 7.975)	0.311 (7.90)
	Guide inside dia.			0.315 to 0.316 (8.010 to 8.025)	0.319 (8.10)
	Oil clearance			0.0014 to 0.0028 (0.035 to 0.070)	0.071 (0.18)
Exhaust valve	Stem outside dia.		in. (mm)	0.313 to 0.314 (7.955 to 7.970)	0.311 (7.90)
	Guide inside dia.			0.316 to 0.317 (8.015 to 8.030)	0.319 (8.10)
	Oil clearance			0.0018 to 0.0030 (0.045 to 0.075)	0.071 (0.18)
Valve guide projection			in. (mm)	579 to 591 (14.7 to 15.0)	–
Valve sinkage	Intake		in. (mm)	0.012 to 0.020 (0.30 to 0.50)	0.031 (0.8)
	Exhaust			0.012 to 0.020 (0.30 to 0.50)	
Valve head thickness	Intake		in. (mm)	0.049 to 0.057 (1.24 to 1.44)	0.031 (0.8)
	Exhaust			0.053 to 0.061 (1.35 to 1.55)	
Intake valve operating timing	Open	b. TDC	degrees (°)	10 to 20	–
	Close	a. BDC		40 to 50	–
Exhaust valve operating timing	Open	b. BDC	degrees (°)	51 to 61	–
	Close	a. TDC		13 to 23	–
Valve spring	Free length		in. (mm)	1.654 (42.0)	1.634 (41.5)
	Inclination		in. (mm)	–	0.055 (1.4)
	Tension [1 mm compressed]		lbs. (kg)	5.20 (2.36) Irregular pitch / 6.84 (3.101)	–
Intake / exhaust valve clearance			in. (mm)	0.0059 to 0.0098 (0.15 to 0.25)	–
Cylinder block					
Cylinder bore dia.			in. (mm)	3.4646 to 3.4657 (88.000 to 88.030)	3.4724 (88.200)
Cylinder bore dia.		L mark		3.4654 to 3.4657 (88.020 to 88.030)	
		M mark		3.4650 to 3.4654 (88.010 to 88.020)	
		S mark		3.4646 to 3.4650 (88.000 to 88.010)	
Roundness of cylinder				0.0000 to 0.0004 (0.00 to 0.01)	0.0012 (0.03)
Cylindricity of cylinder				0.0000 to 0.0004 (0.00 to 0.01)	0.0012 (0.03)

3-8 List of Tightening Torque

3-8-1 Machine

Unit : ft•lbf (N•m)

Applicable model:			C30R-2		
Equipment No.		Tightening part	Thread size	Tightening torque	Adhesive
Engine / Electrical equipment					
	1	Reflector	M5	2.9 to 4.3 (3.9 to 5.9)	
	2	Engine mount vibroisolating rubber	Nut M12	33 to 43 (45 to 58)	
	3	Engine × Engine mount	M10 × 30 (10.9T)	48 to 54 (64 to 73)	Three Bond 1324
	4	Engine × Engine mount	M12 × 30	80 to 94 (108 to 128)	Three Bond 1324
	5	Air cleaner	M8 × 20	15 to 16 (20 to 22)	
	6	Air cleaner intake hose	Hose clip 70	1.9 to 2.5 (2.5 to 3.4)	
	7	Air cleaner intake hose	Hose clip 80	1.9 to 2.5 (2.5 to 3.4)	
	8	Sub tank	M6 × 20	1.1 to 1.4 (1.5 to 2.0)	
	9	CW hose	Hose band 38	1.9 to 2.1 (2.5 to 2.9)	
	10	Fuel level gauge unit	M5 × 12 (Pan head screw)	0.9 to 1.0 (1.2 to 1.5)	
	11	Fuel tank holding band (Band side)	M8 × 80	1.9 to 2.1 (2.5 to 2.9)	
	12	Fuel tank holding band (Lock nut)	Nut M8	9.4 to 12 (13 to 16)	
	13	Battery holding rod	Nut M6	2.9 to 4.3 (3.9 to 5.9)	Lock nut 3.7 to 6.5 (0.5 to 0.9)
	14	Safety switch	Nut M14	7.2 (9.8)	
	15	Safety switch	Nut M16	21.7 (29.4)	
Power transmission					
	1	SB valve spool	Flat head set screw 6 × 8	7.3 to 8.6 (9.8 to 11)	Three Bond 1322
	2	Reduction gear × Bracket (Front)	M12 × 30	58 to 72 (79 to 98)	Three Bond 1324
	3	Reduction gear × Bracket (Rear)	M12 × 30	58 to 72 (79 to 98)	Three Bond 1324
	4	Reduction gear × Bracket (Rear)	M12 × 110	58 to 72 (79 to 98)	Three Bond 1324
	5	Reduction gear × Frame (Front)	M12 × 30	58 to 72 (79 to 98)	Three Bond 1324
	6	Reduction gear × Frame (Rear)	M14 × 40	116 to 151 (157 to 205)	Three Bond 1324
	7	Final case	Stud bolt M16	123 to 151 (167 to 205)	Three Bond 1324
	8	Final case × Frame	M16 × 40	123 to 151 (167 to 205)	Three Bond 1324

4-1-5 Exhaust Gas Emission Regulation

The engines in this manual have been certified by the US EPA, California ARB and/or the 97/68/EC Directive.

California

Proposition 65 Warning

Diesel engine exhaust and some of its constitutions are known to the State of California to cause cancer, birth defects, and other reproductive harm.

California

Proposition 65 Warning

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm.

1) The Emission Standard in USA

(1) EPA Nonroad Diesel Engine Emission Standards

g/kW•hr (g/bhp•hr)

Engine Power	Tier	Model Year	NOx	HC	NMHC + NOx	CO	PM
kW < 8 (hp < 11)	Tier 1	2000	-	-	10.5 (7.8)	8.0 (6.0)	1.0 (0.75)
	Tier 2	2005	-	-	7.5 (5.6)	8.0 (6.0)	0.80 (0.60)
8 <= kW < 19 (11 <= hp < 25)	Tier 1	2000	-	-	9.5 (7.1)	6.6 (4.9)	0.80 (0.60)
	Tier 2	2005	-	-	7.5 (5.6)	6.6 (4.9)	0.80 (0.60)
19<= kW < 37 (25 <= hp < 50)	Tier 1	1999	-	-	9.5 (7.1)	5.5 (4.1)	0.80 (0.60)
	Tier 2	2004	-	-	7.5 (5.6)	5.5 (4.1)	0.60 (0.45)
37 <= kW < 75 (50 <= hp < 100)	Tier 1	1998	9.2 (6.9)	-	-	-	-
	Tier 2	2004	-	-	7.5 (5.6)	5.0 (3.7)	0.40 (0.30)
	Tier 3	2008	-	-	4.7 (3.5)	5.0 (3.7)	
75 <= kW < 130 (100 <= hp < 175)	Tier 1	1997	9.2 (6.9)	-	-	-	-
	Tier 2	2003	-	-	6.6 (4.9)	5.0 (3.7)	0.30 (0.22)
	Tier 3	2007	-	-	4.0 (3.0)	5.0 (3.7)	

Notes :

- *The EPA emission regulation under 130 kW is mentioned below.*
- *As for Model year, the year which a regulation is applicable to is shown.*

Engine classification	Transient smoke standards % opacity (acceleration/lug/peak modes)
Constant speed engine	Not regulated
Variable speed engine	20/15/50 or less

(2) California ARB Emission Regulation

The ARB emission standard is based on that of the EPA.

4-3 Inspection and Adjustment

4-3-1 Oil Inspection

• Standard

The level shall be between the upper and lower limit lines on the dipstick.

Total volume	7.1 Qts. (6.7 L)
Effective volume	3.0 Qts. (2.8 L)

(1) The oil shall not be contaminated heavily and have appropriate viscosity. No cooling water or diesel gas oil shall be mixed.
(2) Insert the dipstick fully and check the oil level.

Notice :

The oil should not be overfilled to exceed the upper limit line.

Otherwise, oil may jet out from the breather or the engine may become faulty.

4-3-2 Cooling Water Inspection

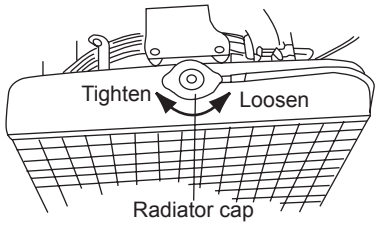
• Standard

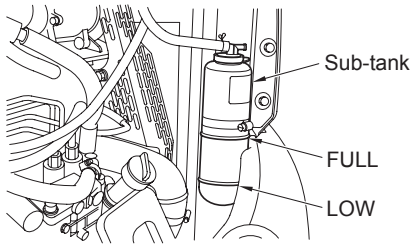
Engine : The radiator shall be filled up.

Sub-tank : The water level shall be between the upper and lower limit lines.

Capacity	Engine	4.4 Qts. (4.2 L)
	Sub-tank	0.32 Qts. (0.3 L)

(1) The cooling water shall be checked when the engine is cold.
(2) If the water level is normal in the sub-tank but low in the radiator, check loosened clamping of the rubber hose between the radiator and sub-tank or tear in the hose.

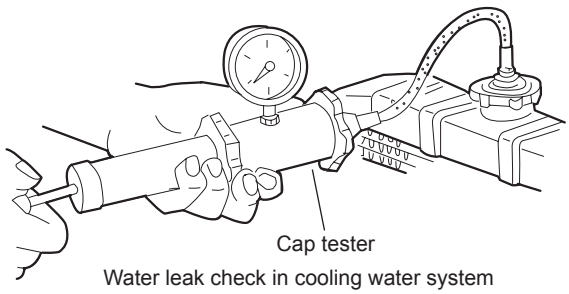




4-3-3 Inspecting Water Leak from Cooling Water System and Radiator

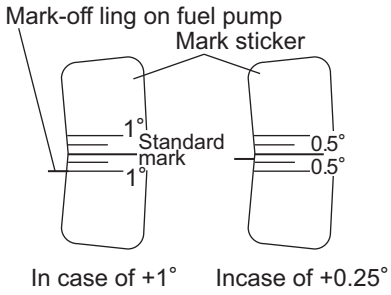
1) Water Leak Check in Cooling Water System

(1) Fill cooling water to the normal level in the radiator, and install the cap tester on the radiator.
(2) Operate the manual pump to set the pressure to 10.7 to 14.9 PSI (73.6 to 103.0 kPa). If the cap tester pressure gage reading drops then, water is leaking from the cooling water system. Check the water leaking point.



Water leak check in cooling water system

[7] Adjust the injection angle difference, calculated in the above 5), at 0.25° in the unit in the installation angle of the fuel pump while reading the mark (minimum 0.5° and cam angle) of the adjustment sticker.

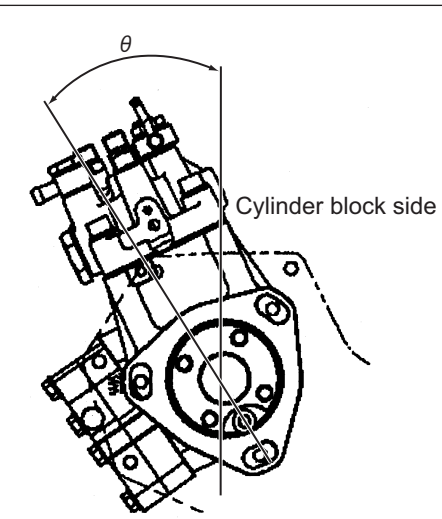


Injection angle adjustment

Notice :

Push down the fuel pump in the outside direction of the cylinder block at +1 degree when a injection angle difference is +1 degree. And, push it down to the cylinder block side when a difference is –1 degree.

[8] Tighten the fuel pump installation nuts.



Fuel pump installation angle

(Supplementary explanation 1)

The installation angle of the fuel pump is as follows.

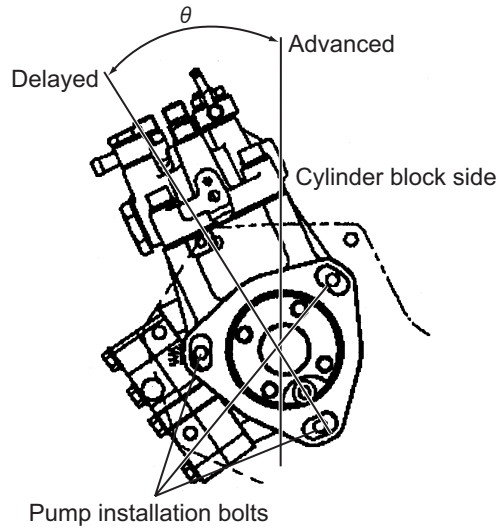
Model	Installation angle θ (deg.)
4TNV94L/98/106 (T)	25

(Supplementary explanation 2)

When fuel injection timing is advanced or delayed, the installation angle of the fuel pump is adjusted.

When fuel injection timing is advanced for example at 2 degrees, loosen the nuts, which fix the fuel pump on the gear case, and turn the fuel pump body in the outside direction of the cylinder block at 1 degree, and tighten the pump installation nuts.

And, when fuel injection timing is delayed, a pump is turned in that reverse direction.

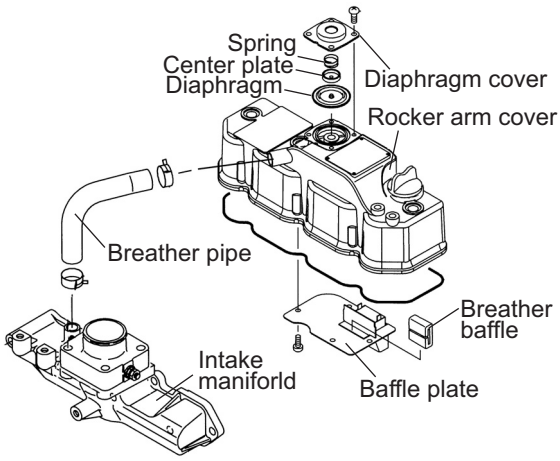


Injection timing adjustment

Point 6

Breather system (A redactor to intake air system of blowby gas)

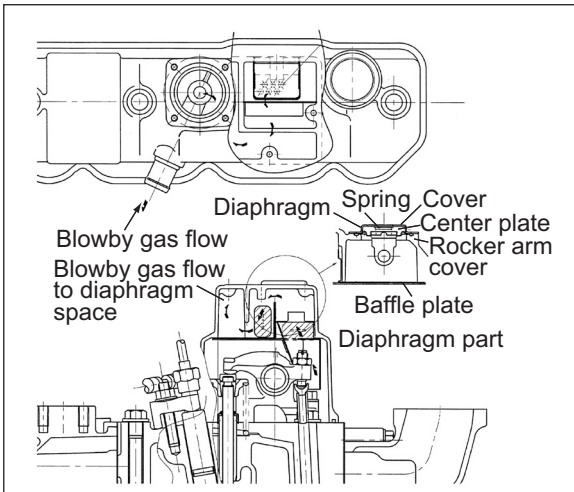
Emitting blowby gas is harmful to natural environment. Therefore blowby gas redactor is adopted to the engine. Some of the combustion gas passes through the clearance between the cylinder and the piston, piston ring, and flows to the crankcase. This is said as blowby gas. While it passes into the cylinder head and the rocker arm cover, the blowby gas mixes with splash oil, and becomes oil mist-blowby gas mixes with splash oil, and becomes oil mist-blowby gas it passing through the baffle plate inside a rocker arm cover. And it passes through a diaphragm assy, and a intake manifold, and is reduced in the combustion chamber. Pressure inside a crankcase is controlled by the function of the diaphragm assy, and suitable amount of blowby gas is reduced in intake air system.



Breather system componert

Disassemble :

- When a rocker arm cover is taken off, check whether oil or the like enter the diaphragm space from a small hole on the side of a diaphragm cover or not without disassembling the diaphragm.



Blowby gas flow

Notice :

- *When a diaphragm is damaged, pressure control inside the crankcase becomes insufficient, and troubles occur. When the internal pressure of the crankcase decreases too much due to the damage of a spring, much blowby gas containing oil is reduced in intake air system, and it may cause the combustion defect by the early dirt of the intake valve or the urgent rotation of the engine by the oil burning.*

  When pressure progresses in the crank case too much due to the wrong operation of the diaphragm and so on, it is considered that oil leakage from the joint of a oil pan, a oil seal and so on will occur. When a diaphragm is damaged, blowby is discharged from the breathing hole on the side of diaphragm cover, and not reduced in the intake manifold. Therefore, be careful of the diaphragm trouble.
- *At lubricating oil replacement or lube oil supply*

  The amount of lubricating oil isn't to be beyond the standard upper limit (in the engine horizontally, the upper limit mark of the dip stick). Since the blowby gas redactor is adopted, be careful that the amount of oil mist may be inducted in the combustion chamber and the oil hammer sometimes may occur, when the lubricating oil quantity is beyond the upper limit or an engine is operated beyond the allowable maximum angle of an engine.

Reassemble :

- Replace the diaphragm with new one, when it is damaged.

5) Parts Inspection and Measurement

(1) Camshaft

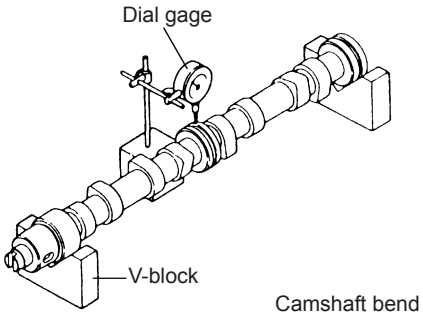
Mainly check the contact between the tappet and cam contact surface, bearing seizure and wear, and gear damage.

[1] Shaft bend measurement

Support the camshaft with V blocks. Rotate the camshaft and measure the runout at the center of the camshaft and at each journal with a dial gage. Half of the runout is the bend.

in. (mm)

	Standard	Limit
Bend	0 to 0.0008 (0 to 0.02)	0.0020 (0.05)

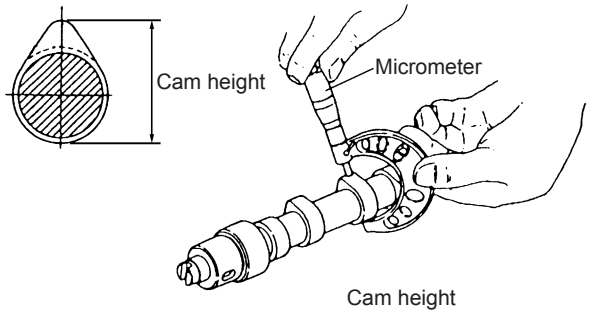


Camshaft bend

[2] Intake/exhaust cam height measurement

in. (mm)

	Standard	Limit
Cam height	1.520 to 1.528 (38.600 to 38.800)	1.510 (38.350)



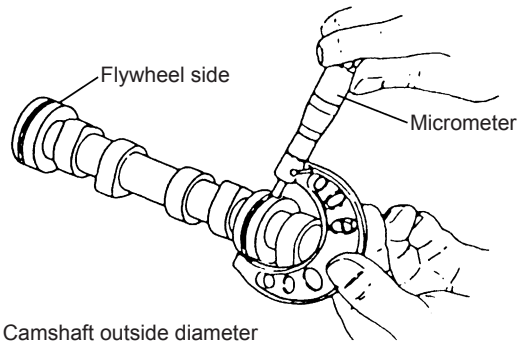
Cam height

[3] Camshaft outside diameter and bearing hole diameter measurement

Measure the camshaft outside diameter with a micrometer. The oil clearance shall be calculated by subtracting the measured camshaft outside diameter from the camshaft bushing inside diameter after insertion to the cylinder measured with a cylinder gage.

in. (mm)

		Standard	Limit
Gear side	Camshaft O.D.	1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
	Bushing I.D.	1.7713 to 1.7738 (44.990 to 45.055)	1.7768 (45.130)
	Oil clearance	0.0016 to 0.0051 (0.040 to 0.130)	0.0094 (0.240)
Intermediate position	Camshaft O.D.	1.7681 to 1.7691 (44.910 to 44.935)	1.7667 (44.875)
	Bushing I.D.	1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
	Oil clearance	0.0026 to 0.0045 (0.065 to 0.115)	0.0089 (0.225)
Wheel side	Camshaft O.D.	1.7687 to 1.7697 (44.925 to 44.950)	1.7673 (44.890)
	Bushing I.D.	1.7717 to 1.7726 (45.000 to 45.025)	1.7756 (45.100)
	Oil clearance	0.0020 to 0.0039 (0.050 to 0.100)	0.0083 (0.210)



Camshaft outside diameter

(3) Thrust metal inspection

Inspect any damage or wear.

[1] Thickness

in. (mm)

	Standard	Limit
Thickness	0.0760 to 0.0780 (1.930 to 1.980)	0.0728 (1.850)

[2] Side gap

in. (mm)

	Standard	Limit
Side gap	0.0055 to 0.0087 (0.14 to 0.22)	0.0110 (0.28)

If the side gap is exceeded, use an oversized thrust metal.

0.25 OS	129150-02940
Standard thickness	0.0809 to 0.0829 in. (2.055 to 2.105 mm)

(4) Piston

Especially clean the combustion surface, circumference, ring grooves and piston pin bosses, and check after removing any carbon deposit. Any burr at a ring groove or snap ring groove shall be removed. If crack is suspected, inspect by color check.

[1] Piston outside diameter measurement

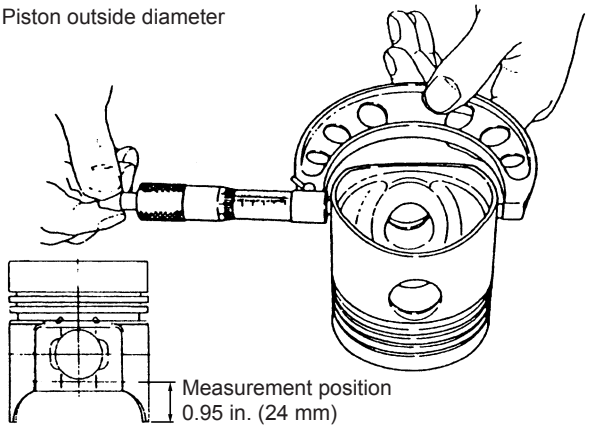
Measure the long diameter at 0.95 in. (24 mm) from the bottom end of the piston of the oval hole in the vertical direction to the piston pin hole.

in. (mm)

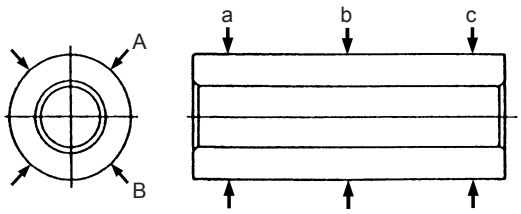
		Standard	Limit
Long diameter		3.4622 to 3.4634 (87.940 to 87.970)	3.4604 (87.895)
Clearance between piston and cylinder	Min.	0.0018 (0.045)	0.0016 (0.040)
	Max.	0.0030 (0.075)	0.0028 (0.070)

If the clearance between piston and cylinder exceeds the limit, use an oversized piston.

Piston outside diameter



Measure at positions a, b and c in directions A and B.



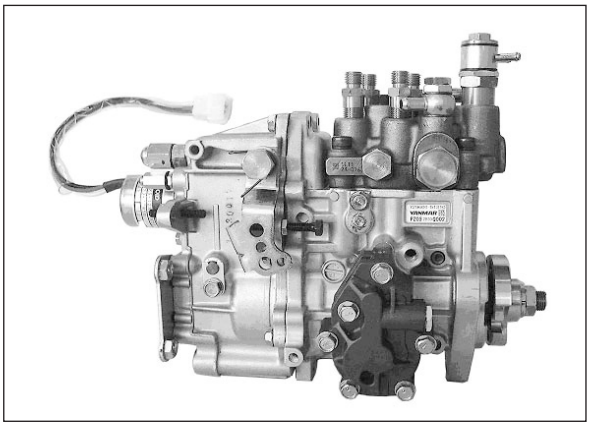
Piston pin outside diameter

0.25 OS	Piston ass'y code (incl./Piston ring ass'y)	Piston ring ass'y code	Boring dimension in. (mm)
	129005-22900	129005-22950	Ø3.4744 to Ø3.4756 (Ø88.250 to Ø88.280)

4-7 Fuel Injection Pump / Governor

Only the outline of the MP fuel pump is explained in this chapter. Refer to the MP pump service manual of the separate volume for the disassembly and assembly.

4-7-1 Introduction



It is described about the features of the fuel injection pump, YDP-MP, manufactured by Yanmar, disassembly, assembly and adjustment procedure.

Fuel injection pump is the most important equipment, which is enable to make the sensitive adjustment according to the variable load of the engine.

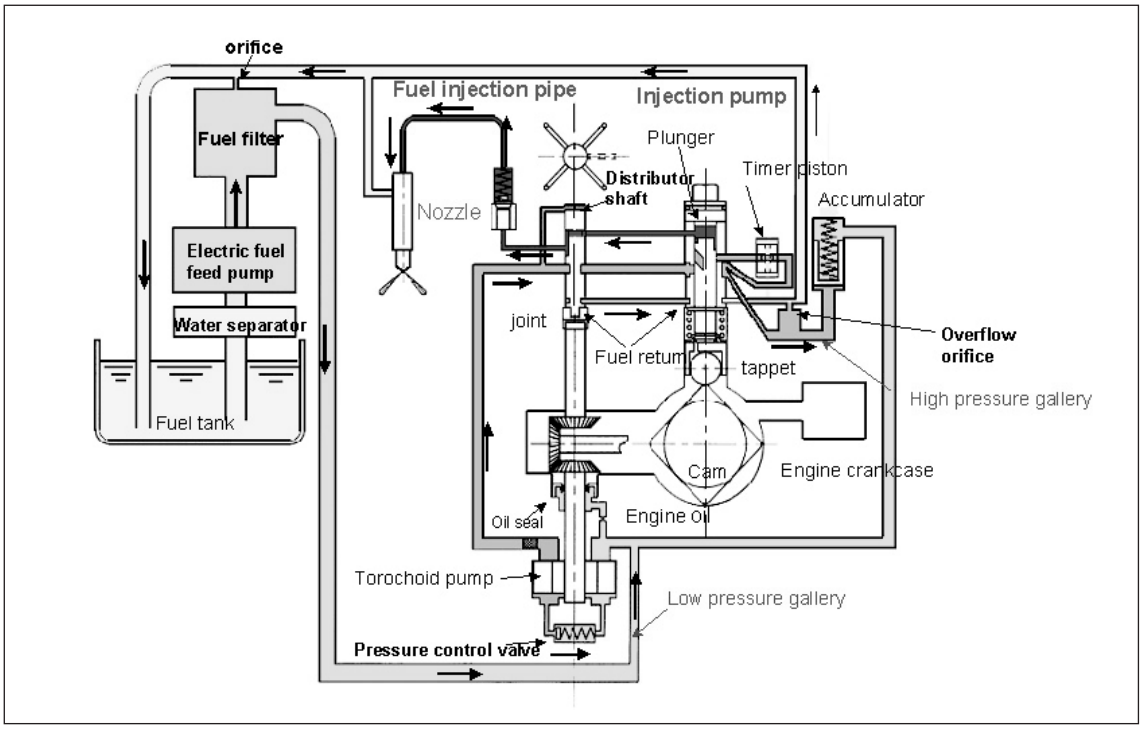
Therefore all of the parts are required not only very precise machining but also finest, assembling with top level.
The careful arrangement of keeping off the dust and the rust when disassemble, adjustment and reassemble of the fuel injection pump is made in the market.

Yanmar YDP-MP Pump is a distributor type pump which is unified of Mono-plunger, a distributing shaft, a hydraulic head which equipped the delivery valve for each cylinder, pump housing which has a cam shaft internally and governor.
The fuel, which is pressurized by the up and down movement of the plunger driven by the cam-rotation, is supplied through the distributor shaft, which is rotating accordingly.

There are a model YDP-MP2 and a model YDP-MP4, and plunger diameter and fuel cam speed are different.

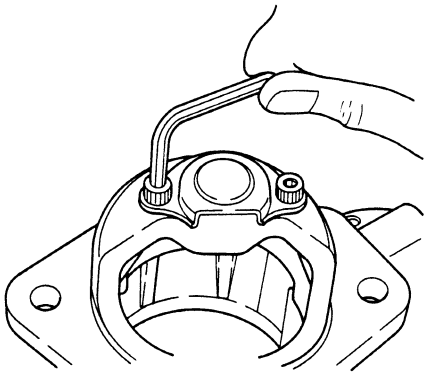
4-7-2 Fuel Injection Pump

1) Fuel System Diagram

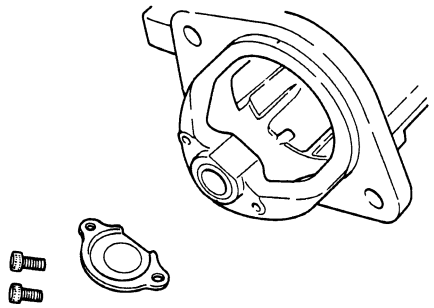


7) Removal of Gear Case Dust Cover

Remove the two M5 bolts (using 0.16 in. (4 mm) hexagon wrench) to disassemble the dust cover from the gear case.



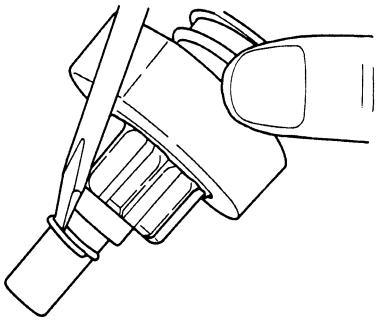
Removing M5 bolt



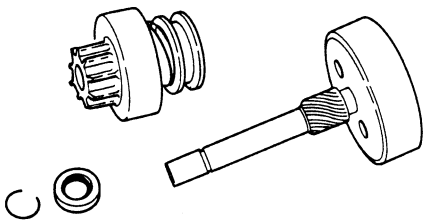
Disassembling the dust cover

8) Removal of Pinion

Slide the pinion stopper towards the pinion and remove the pinion stopper clip using a (–) screwdriver.



Removing pinion stopper clip

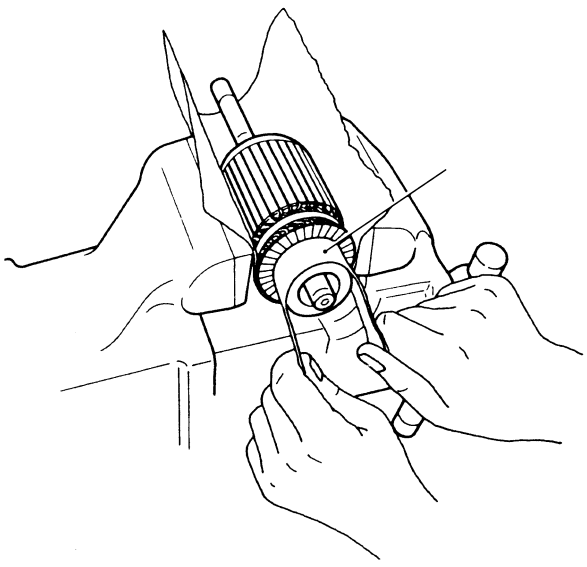


After disassembly of pinion

4-8-6 Inspection and Maintenance

1) Armature

(1) Check the commutator for rough surface. If so, smooth the surface using #500 to #600 emery cloth. If the outside periphery of the commutator has been deflected over 0.008 in. (0.2 mm), repair by a lathe.



Standing commutator surface

CHAPTER 5

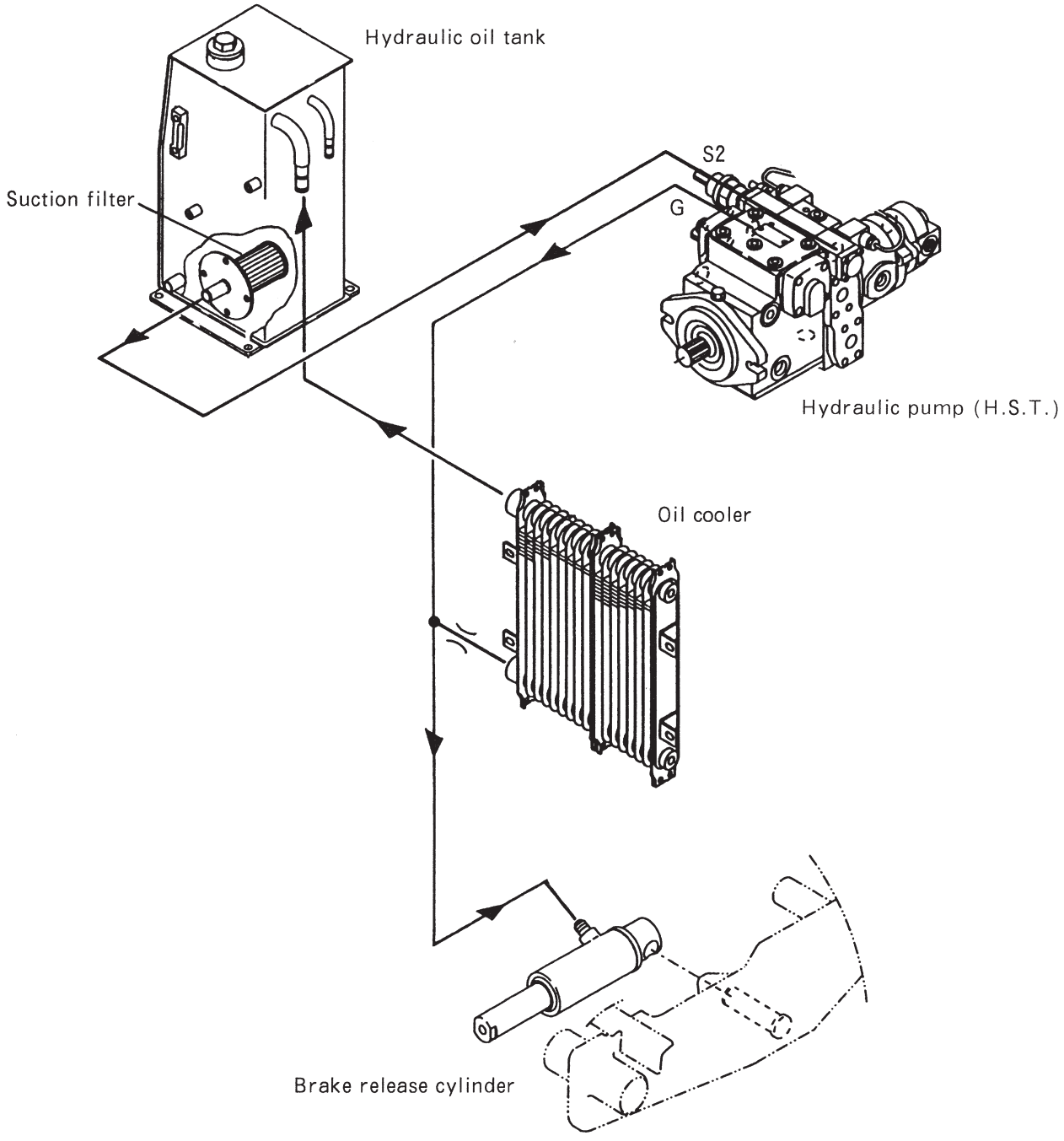
STRUCTURE AND OPERATION

5-5 Auxiliary Equipment for Brake

1. Outline

This vehicle is equipped with auxiliary equipment for the brake. With the auxiliary equipment, the brake is kept applied while the engine is stopped and it is released when the engine is started.

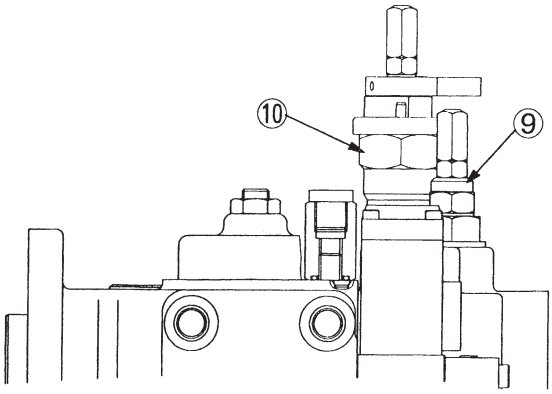
2. Hydraulic piping for brake release

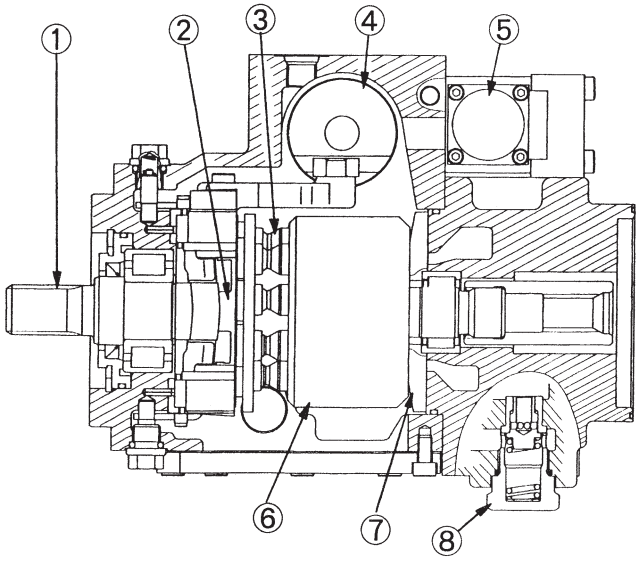


1. Operation of piston pump

<Transmission>

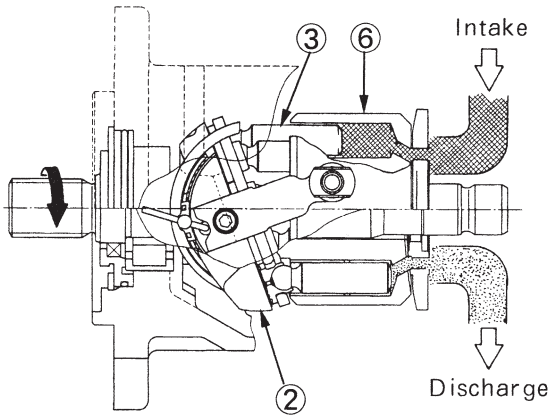
- The piston pump is connected to the coupling installed to a flywheel of the engine.
- The power from the engine is transmitted to the piston pump through the coupling.
- The piston pump has the F/R switching valve **5** and the inclination piston **4**. When the F/R lever is moved to the forward or reverse position, the F/R switching valve **5** is operated and the swash plate of the piston pump **2** is inclination to change the oil flow direction.
- Nine pistons **3** are installed in the pump. The cylinder barrel **6** and the pistons **3** rotate together with the drive shaft **1**.



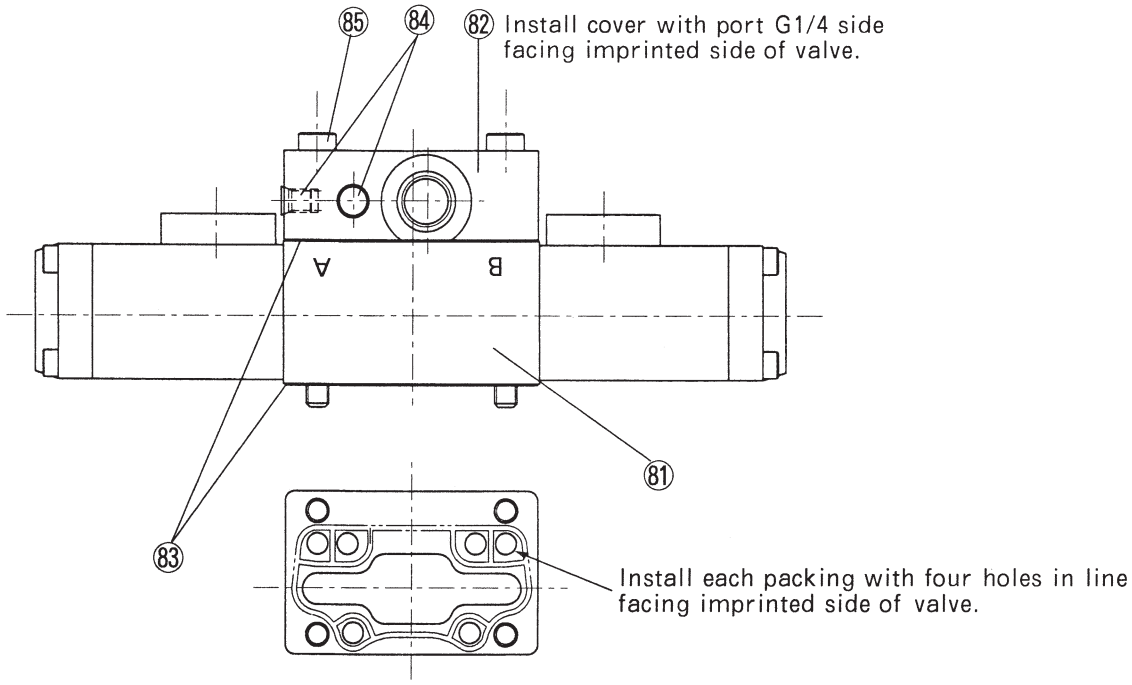


<Intake and discharge of oil>

- When the swash plate **2** is inclination, the pistons **3** contacted with the swash plate are reciprocated and work as a pump. This pumping operation causes the oil to be sucked in into the cylinder block **6** and discharged from it continuously.
- The discharged oil becomes a high-pressure oil flow in a certain direction and flows to the piston motor.
- The stroke of the piston is changed by making the inclination angle of the swash plate **2** larger or smaller, so that the travel speed can be controlled.
- When the inclination of the swash plate **2** is changed to the opposite, the intake and discharge of the oil are reversed and the direction of the oil flow is also reversed.
- Besides, the oil in the low pressure circuit (the circuit where the oil returns to the pump from the motor) becomes insufficient due to the oil leak from the piston pump, the piston motor, the control valve and others. To make up the shortage of oil, additional oil is supplied through the DA valve **10** and the check valve of the high pressure relief valve **9** from the charge pump.



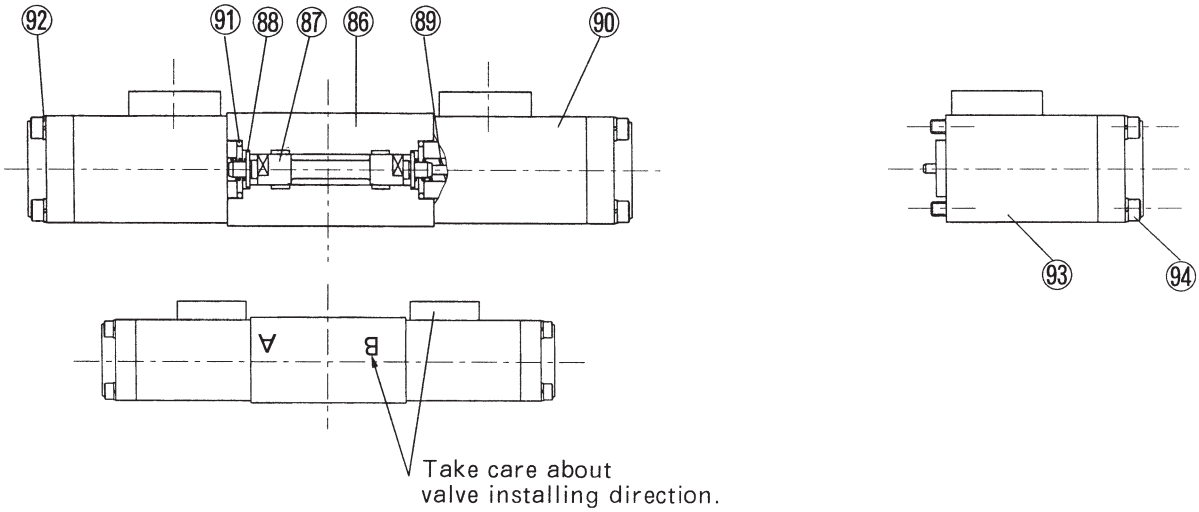
4) Control section



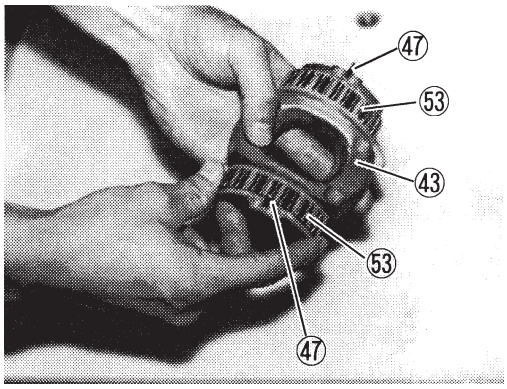
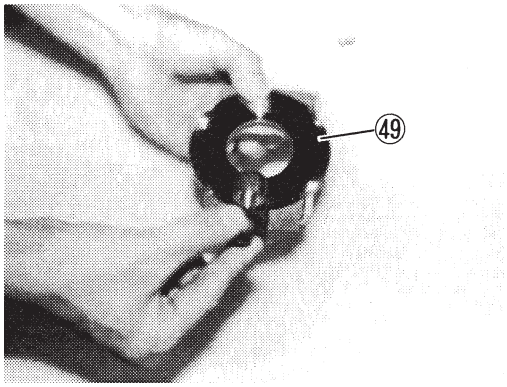
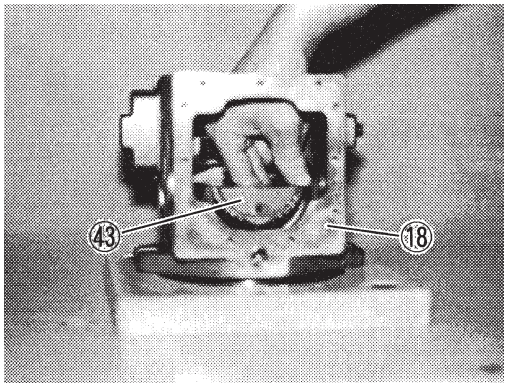
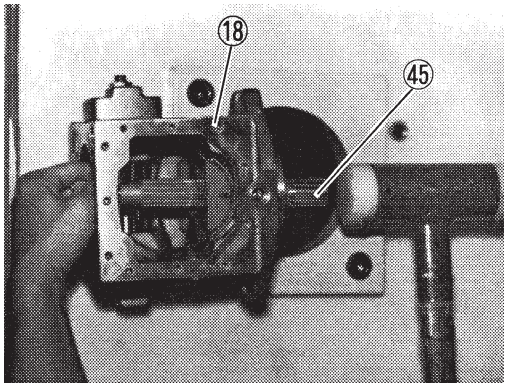
No.	Part	Q'ty
81	Directional selecting valve	1
82	Cover	1
83	Packing	2
84	Plug	1
85	Hexagon socket head bolt M6×65	4

4-1) Directional selecting valve **81**

4-2) Magnet section **90**



No.	Part	Q'ty	No.	Part	Q'ty
86	Body	1	91	O-ring (NBR, HS70)	2
87	Spool	1	92	Spring washer (2)	8
88	Spring seat	2	93	Solenoid	1
89	Spring	2	94	Hexagon socket head bolt M4×65	4
90	Magnet section	2			

Procedure	
(5) After installing two pins **47** into hangar **43**, put the pins through two bearings **53** with pins and install the bearings on hanger using grease.	
(6) Install guide **49** on hanger **43**.	
(7) Install hanger **43** into housing **18** with guide **49** fit into the slit of piston **42**.	
(8) Install shaft **45** into housing **18** by tapping the end face of it lightly with a plastic hammer.	

2. HAL regulator

<Outline>

- The HAL regulator is installed at the rear of the piston motor and controls the inclination of the control plate to regulate the output of the motor to the external load of it, by the pressure difference between the oil from the high pressure circuit and that from the F/R switching valve of the piston pump.

<Operation>

- The HAL regulator controls the inclination of the control plate by using the pressure at the port A or the port B, which is higher, selected by the shuttle valve. Normally priority is given to a large inclination, and the regulator automatically controls the inclination of the control plate by the pilot pressure through the switching of the solenoid valve and by the fluctuation in load.

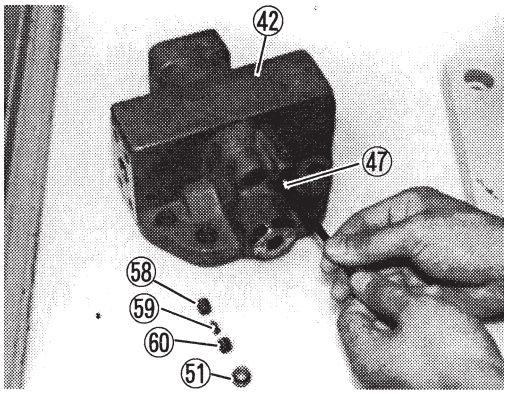
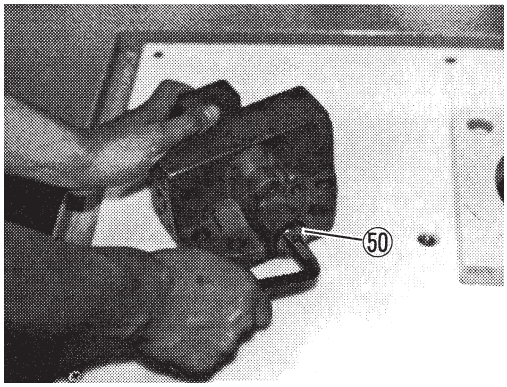
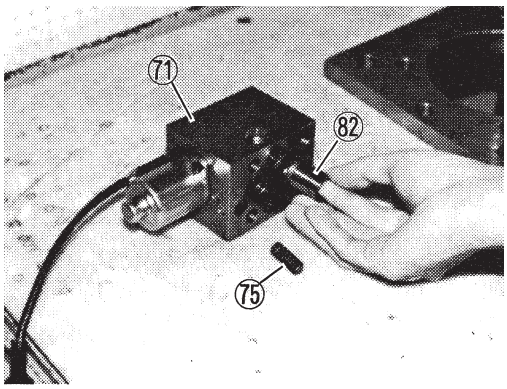
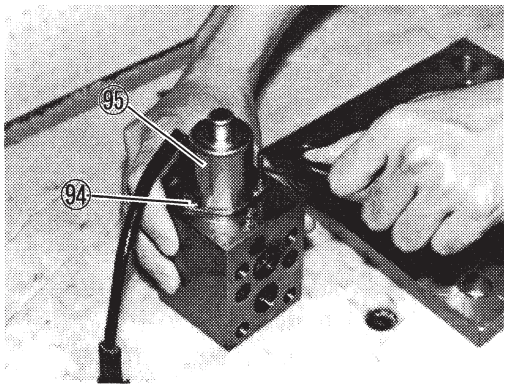
- When the servo spool is in neutral, the control oil pressure PC applied to the larger diameter side of the control piston is balanced with the main circuit pressure PH applied to the smaller diameter side of it, so that the inclination of the control plate is kept.

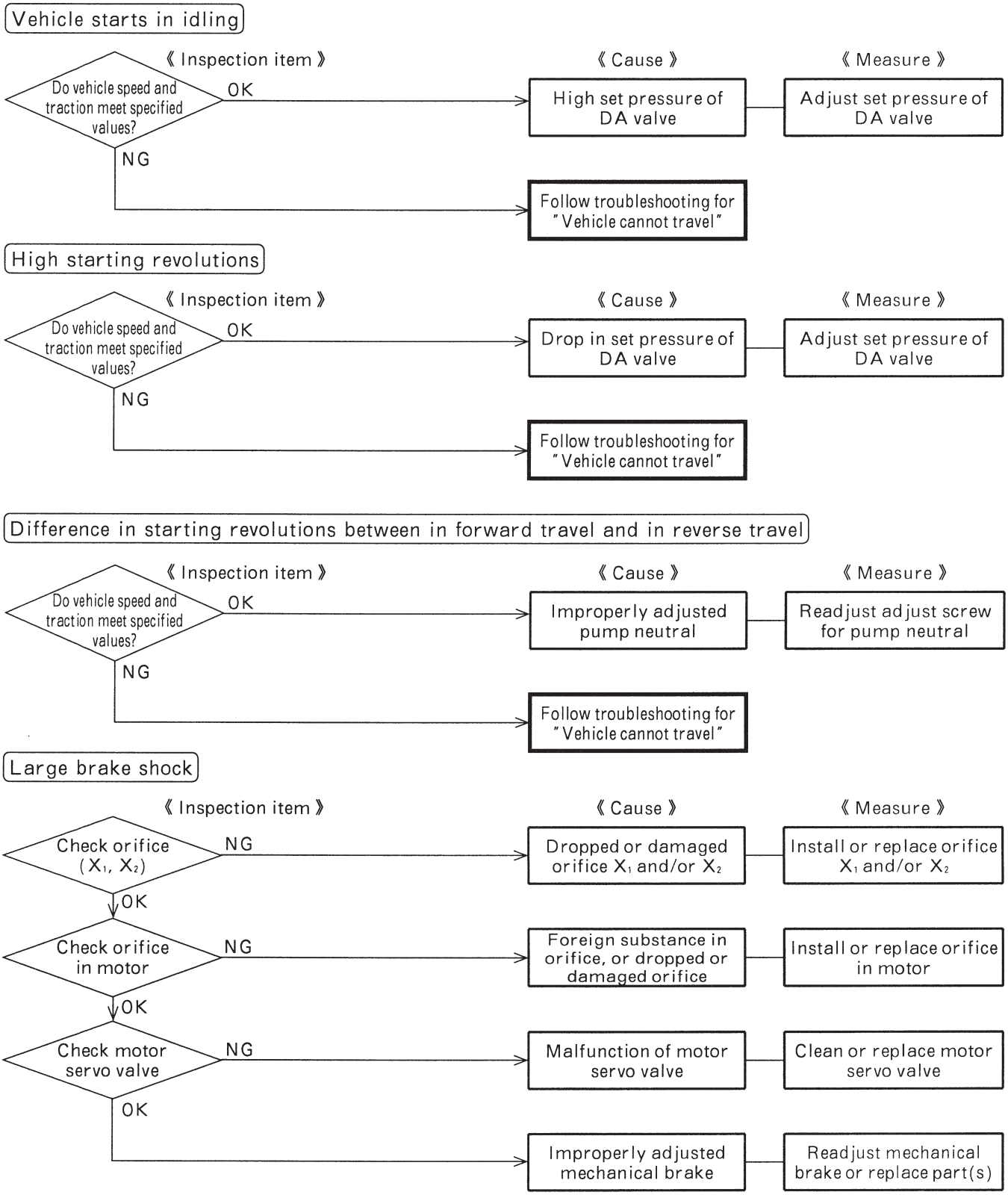
- When the opposed spring force Ft applied to the servo spool is smaller than the total force of the adjusting spring force FAJ and the oil pressure, the pressure PC is equal to the pressure in the tank (in the housing) and the control piston is moved to the direction "q max". When the opposed spring force Ft is larger than the total force of the adjusting spring force FAJ and the oil pressure, the pressure PC is equal to the main circuit pressure PH and the control piston is moved to the direction "q min".

  - Neutral (q : held) : $F_t = P_H \cdot B + F_{AJ}$
  - Inclination (to " q min") : $F_t > P_H \cdot B + F_{AJ}$
  - Inclination (to " q max") : $F_t < P_H \cdot B + F_{AJ}$

- When the solenoid valve is not excited, i.e., "OFF", the inclination of the control plate is normally the maximum because no pilot pressure is applied to the opposing piston, in order to prevent the vehicle from slipping down on a slope or the similar place.

- When the solenoid valve is excited, i.e., "ON", the pilot pressure is applied to the opposing spring.
  If the load is small, the inclination of the control plate is also small and the vehicle can be operated at high speed.
  If larger load is applied, the control plate is moved to the maximum inclination and large torque is generated though the operating speed is low.

Procedure	
(9) After removing plug **51**, remove guide **60**, orifice **59**, guide **58** and orifice **47**.	
(10) Remove plug **50**.	
(11) Remove spring **75** and piston **82** from cover **71** of the control unit.	
(12) After removing two hexagon socket head bolts **94**, remove solenoid **95**.	

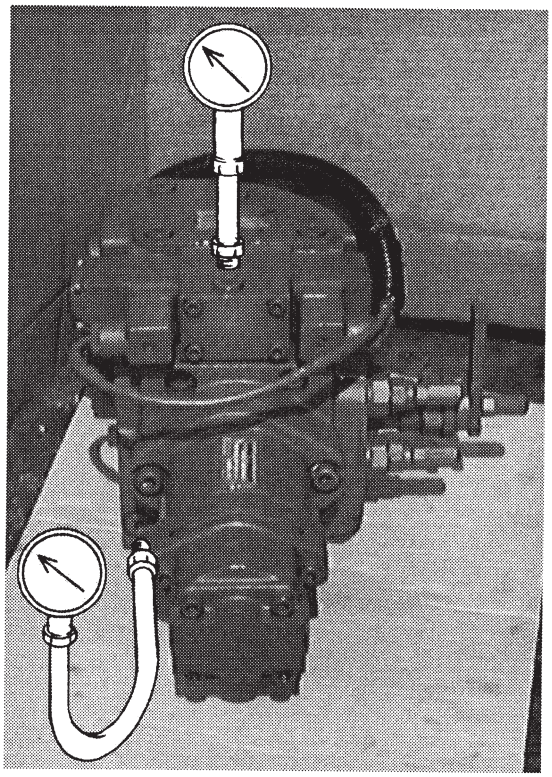

Vehicle starts in idling
《 Inspection item 》
《 Cause 》
《 Measure 》
Do vehicle speed and traction meet specified values?
OK
High set pressure of DA valve
Adjust set pressure of DA valve
NG
Follow troubleshooting for "Vehicle cannot travel"
High starting revolutions
《 Inspection item 》
《 Cause 》
《 Measure 》
Do vehicle speed and traction meet specified values?
OK
Drop in set pressure of DA valve
Adjust set pressure of DA valve
NG
Follow troubleshooting for "Vehicle cannot travel"
Difference in starting revolutions between in forward travel and in reverse travel
《 Inspection item 》
《 Cause 》
《 Measure 》
Do vehicle speed and traction meet specified values?
OK
Improperly adjusted pump neutral
Readjust adjust screw for pump neutral
NG
Follow troubleshooting for "Vehicle cannot travel"
Large brake shock
《 Inspection item 》
《 Cause 》
《 Measure 》
Check orifice (X1, X2)
NG
Dropped or damaged orifice X1 and/or X2
Install or replace orifice X1 and/or X2
OK
Check orifice in motor
NG
Foreign substance in orifice, or dropped or damaged orifice
Install or replace orifice in motor
OK
Check motor servo valve
NG
Malfunction of motor servo valve
Clean or replace motor servo valve
OK
Improperly adjusted mechanical brake
Readjust mechanical brake or replace part(s)

6-5-2 H.S.T.

1. Pressure gauge installation position

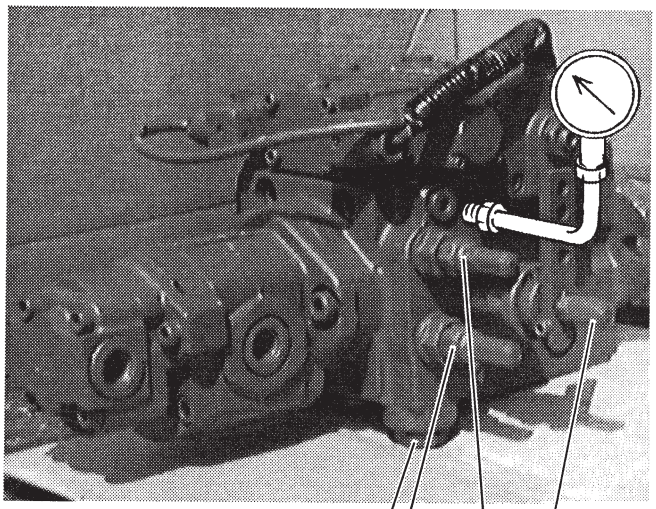
After removing the plug (PF1/4) of the port, install the gauge.

DA valve port



High pressure relief port (for reverse)

High pressure relief port (for forward)



2. Pressure adjustment

Adjust any of the relief valves shown in the above photos, as required.

- DA valve
  Measure the pressure with the engine speed changed based on the valve characteristics.
  The F/R lever should be in neutral.
  - Number of engine revolutions : 1500 rpm
    0.49 to 0.69 MPa (5 to 7 kgf/cm^2)
  - Number of engine revolutions : 2700 rpm
    1.52 to 1.72 MPa (15.5 to 17.5 kgf/cm^2)
- High pressure relief valve
  In measurement, the pressure of the low pressure relief valve is added as back pressure to that of the high pressure relief. The pressure gauge shows the total value.

Example :

Pressure on gauge = Set pressure + Back pressure

29.4 MPa	27.44 MPa	1.96 MPa
(300 kgf/cm^2)	(280 kgf/cm^2)	(20 kgf/cm^2)

2) Alarm sensor operation

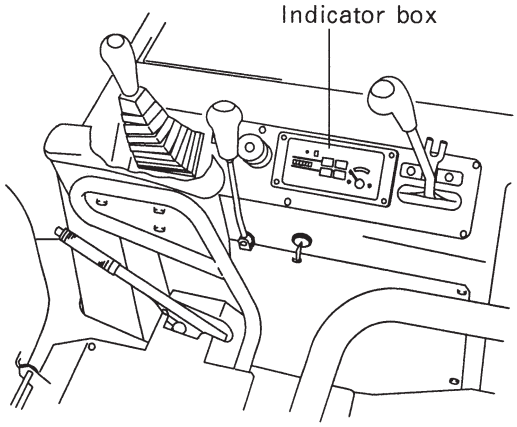
- All the lamps should go on and be kept on for 2 to 3 seconds when the engine is started.
- All the lamps should be off when the engine is running.
- The engine oil pressure and battery charge alarm lamps should go on when the engine is stopped.
- The buzzer should sound when a lamp goes on while the engine is running.

Note :

The above items are not applied to the parking lamp.

Structure

(1) Panel

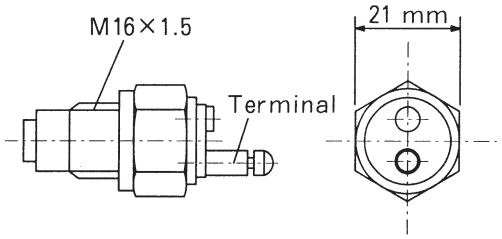


(2) Overheating sensor (C.W. switch)

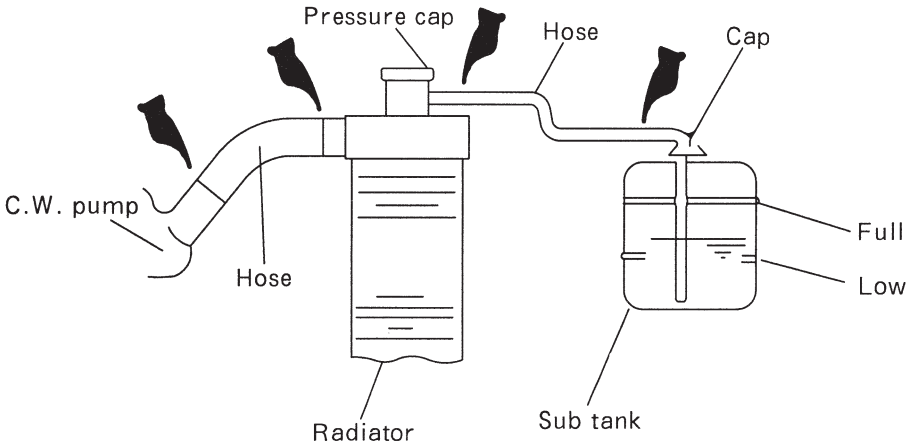
Turned on Hydraulic oil temp. : 107 to 113°C

Turned off Hydraulic oil temp. : Below 100°C

Installation position C.W. pump on engine



The water volume in the tank changes before operation (low water temp.) and after operation (high water temp.). Check the water level. If there is no change in the water level, check for water leakage at the illustrated points and tighten the clamp.

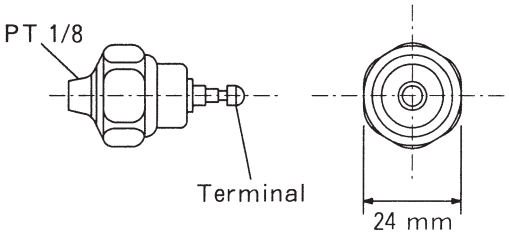


(3) Lube oil pressure drop monitoring (L.O. switch)

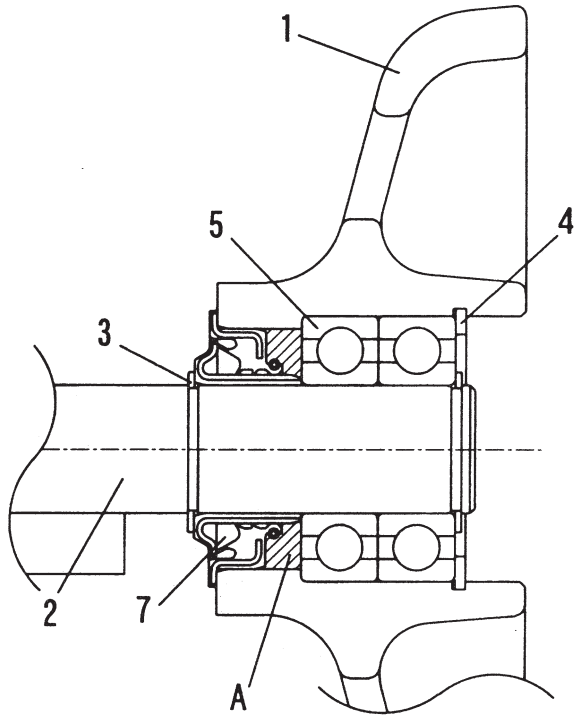
The switch monitors the lube oil pressure drop of the engine and causes the engine oil pressure alarm lamp to go on and the alarm buzzer to sound.

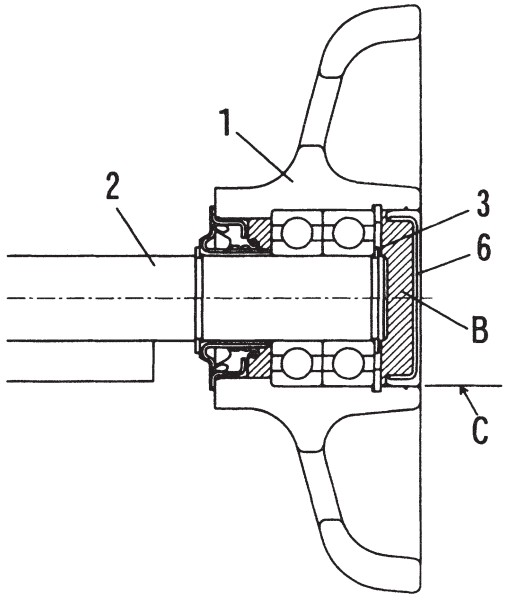
Working pressure : 0.4 to 0.6 kgf/cm^2

Installation position : Engine block

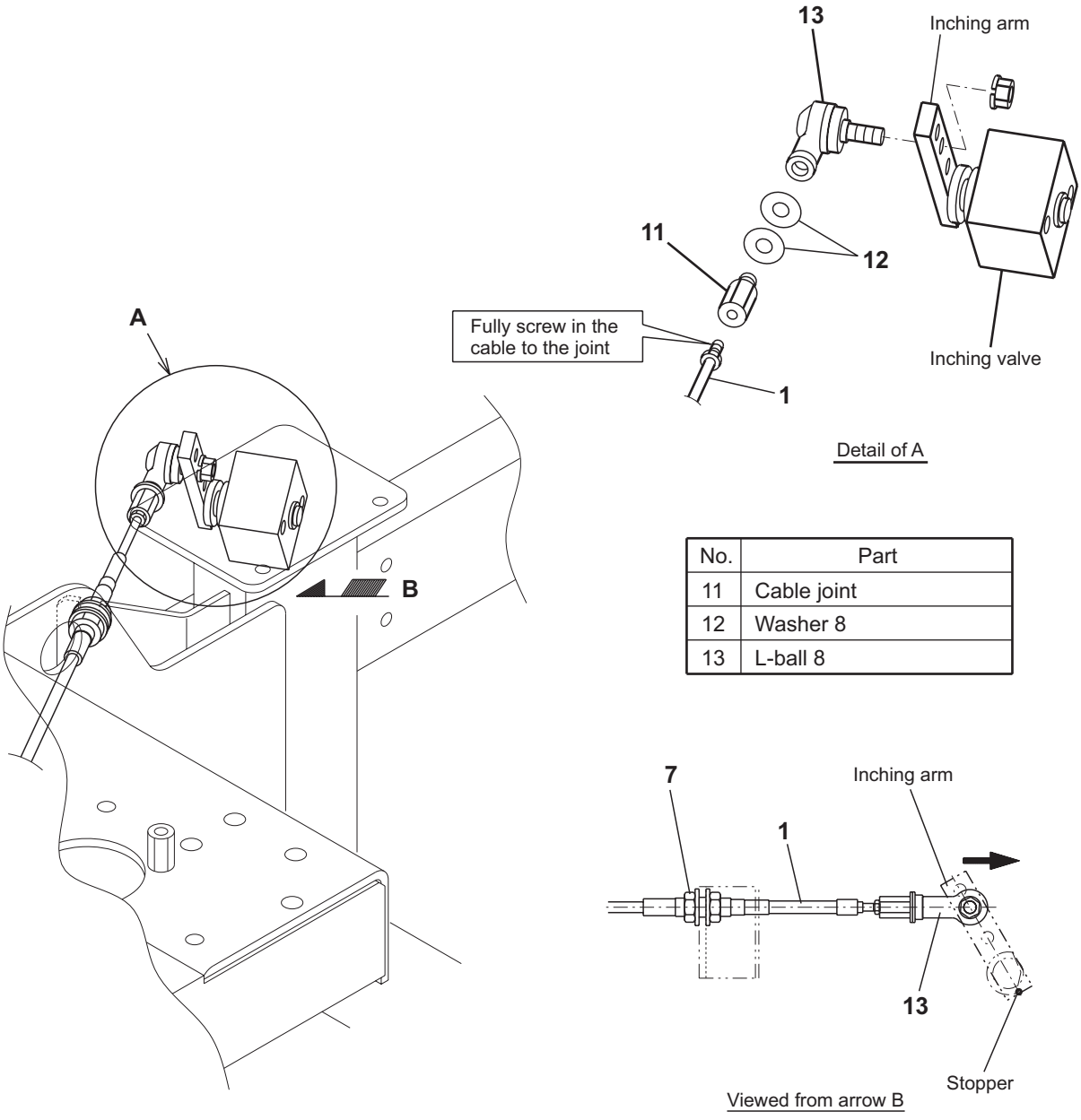


4) Reassembly

Procedure	
(1) Install external snap ring 25 **3** onto carrier roller shaft **2**. (2) Install two ball bearings 6205 **5** and internal snap ring 52 **4** into carrier roller **1**. (3) After filling the part A (shown in the figure) of oil seal **7** with grease, press-fit it into the carrier roller. (Grease : Multipurpose grease) ***Note :*** *Check that there is no grease on the outside surface of the oil seal.*	

(4) Press-fit carrier roller shaft **2** and install external snap ring 25 **3**. (5) After filling the part B (shown in the figure) of plug 52 **6** with grease, press-fit it. (Grease : Multipurpose grease) ***Note :*** *Check that there is no grease on the outside surface of plug 52 **6** or on the inside surface of the boss of the carrier roller **1**. If there is some grease on the surfaces, the plug may come off.* (6) Check After reassemble, check that the carrier roller rotates smoothly. (7) Reassemble the other side in the same way, too.	

(5) Install the cable joint **11**, washer 8, **12** and L-ball 8, **13** on the inching cable **1** and connect the L-ball **13** to the second position of the inching arm. (Do not move the inching arm when installing the inching cable.)



No.	Part
11	Cable joint
12	Washer 8
13	L-ball 8

(6) Start engine and adjust the inching cable **1** for the inching arm to contact the stopper with the adjusting nut **7**, then fix it. (Make sure if the inching arm has no play when it is pulled in the direction of the arrow.)

(7) After installation, test the following with the engine running.

[1] Machine stops when the brake pedal is fully moved.

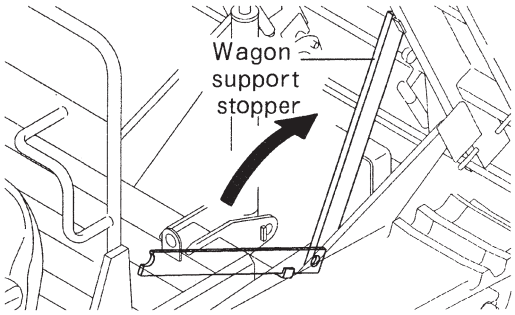
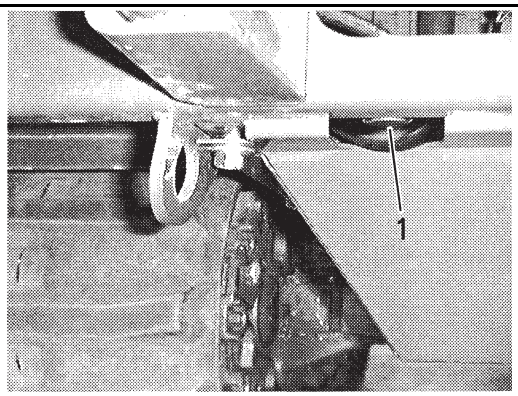
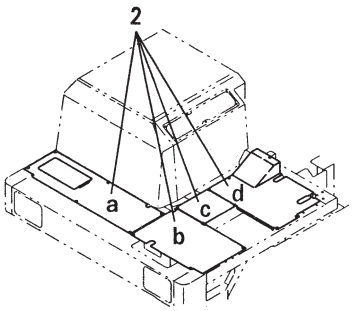
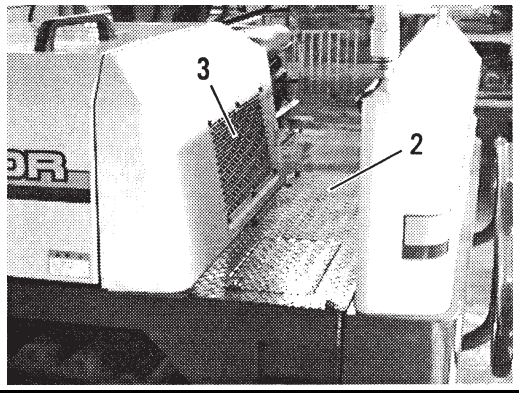
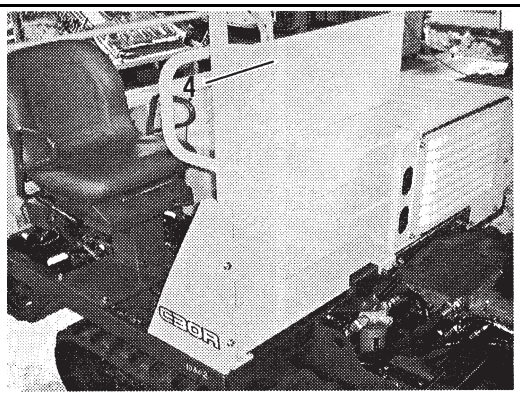
[2] Machine runs fast enough when the brake pedal is not moved.

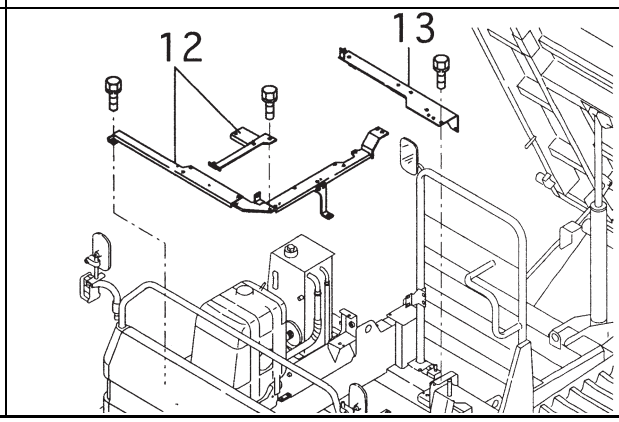
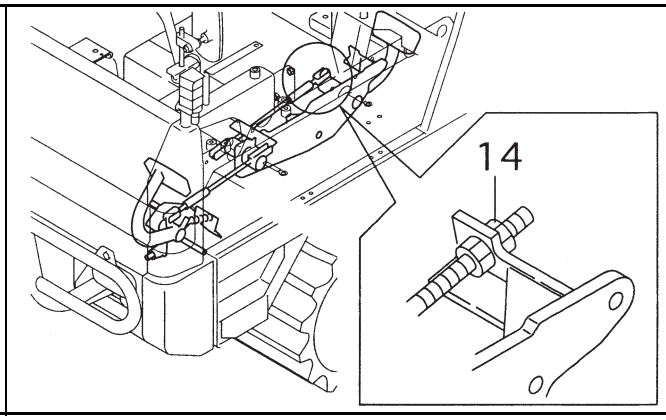
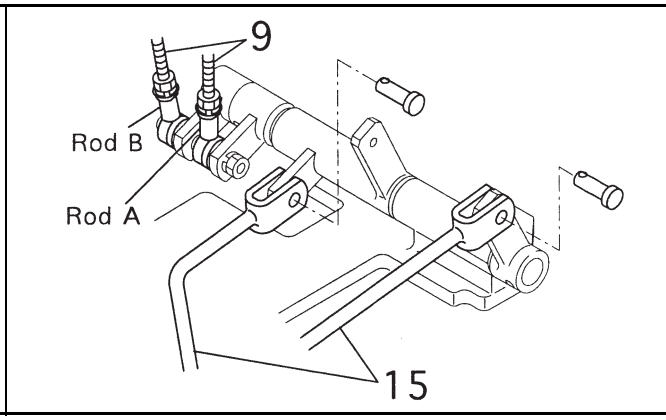
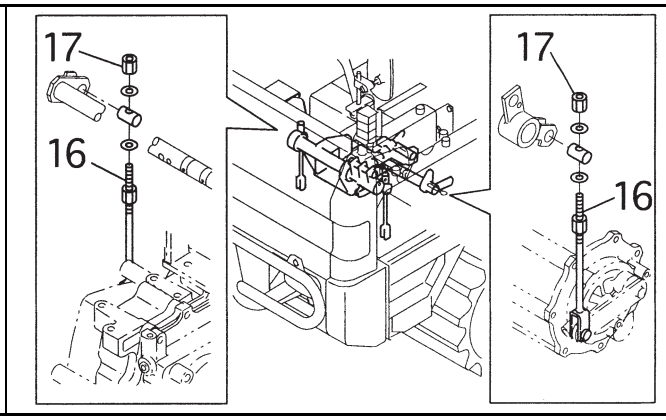
[3] Traveling speed changes according to the brake pedal movement.

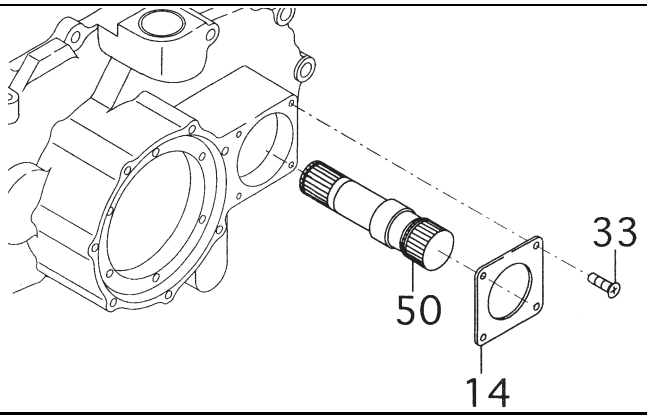
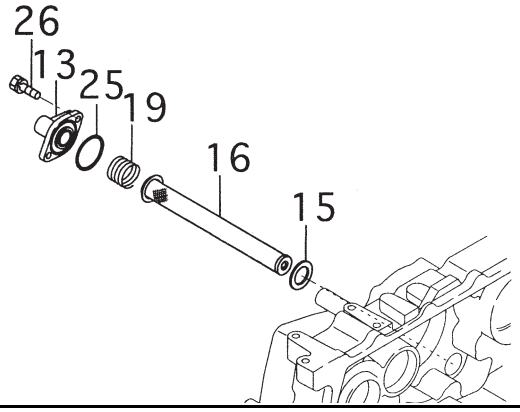
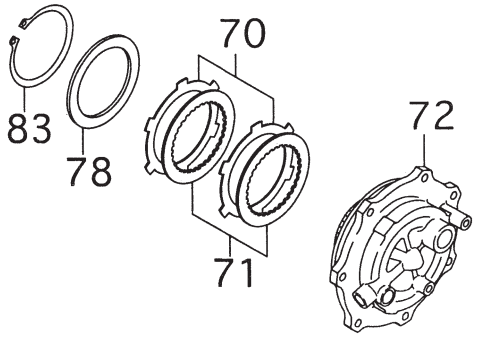
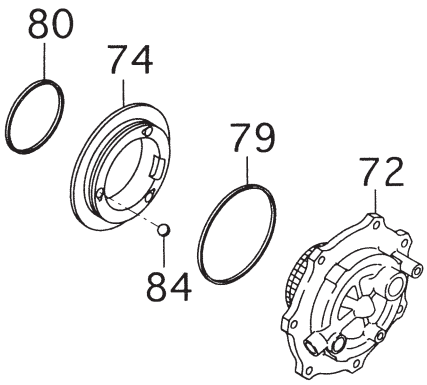
7-4 Power Transmission

7-4-1 Removal and Installation of Engine

1) Removal

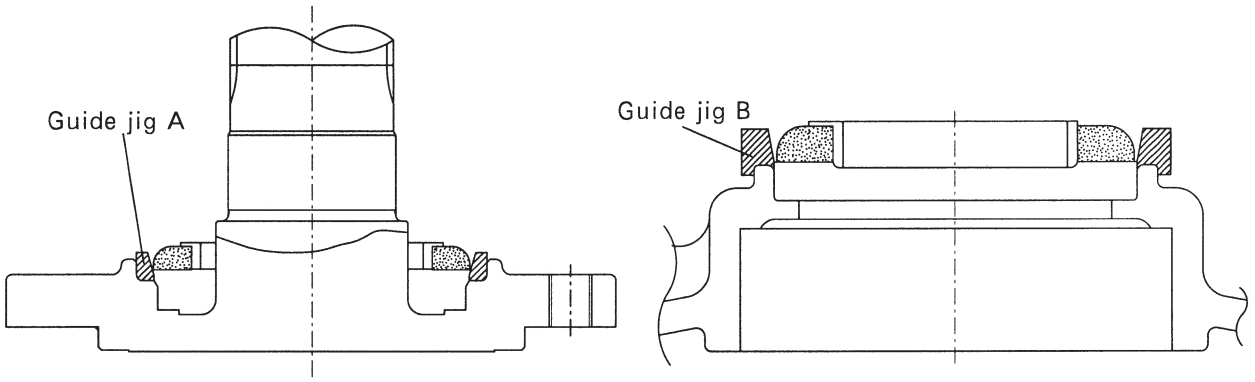
Procedure	
(1) Raise wagon and hold it with wagon support stopper.	
(2) Loosen drain plug **1** of radiator to drain water. ***Note :*** *Put a container (with a capacity of 4.5 L or more) under drain plug **1**.*	
(3) Remove four steps **2** and engine hood grill **3**. a : Step FR b : Step L c : Step CE d : Step R 	
(4) Remove safety guard **4**.	

Procedure	
(10) Remove two step brackets **12** and cross member **13**.	
(11) Loosen nut 10 **14** of brake spring rod.	
(12) Remove steering rods A and B **9** and steering rods **15**.	
(13) Remove nuts **17** from side brake rods **16** (L and R).	

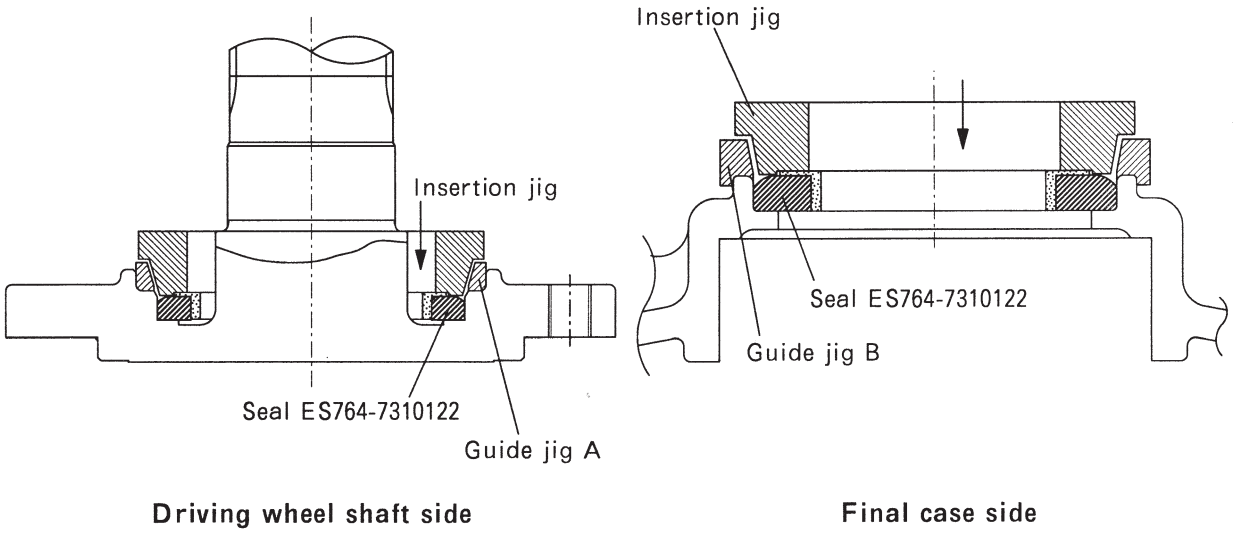
Procedure	
(9) After removing four cross recessed head screws **33**, remove shaft 4 cover **14** and shaft 4 **50**.	
(10) After removing two hexagon head bolts **26**, remove flange **13** (with O-ring **25**), spring **19** and strainer **16** (with packing **15**).	
(11) After removing external snap ring 82 **83** from brake case L **72**, remove pressure plates **78**, steel plates **70** and friction plates **71** (7 pcs. each).	
(12) Remove actuator L **74**, three steel balls **84** and seal rings **79** and **80** from brake case L **72**. (13) Remove brake case R assembly as the same procedure as the above.	

4. Installation of floating seal

(1) After installing the packing in the floating seal, check that it is not twisted or does not come off.
(2) Apply oil lightly to the outside surface of the packing.
(3) Set guide jigs on the driving wheel shaft and the final case.
(4) Put the floating seal assembly on the guide jig with its sliding surface up. At that time, take care not to incline the floating seal much, because the insertion jig can not be set.



(5) After putting the insertion jig on the floating seal, press it until it contacts with the guide jig.



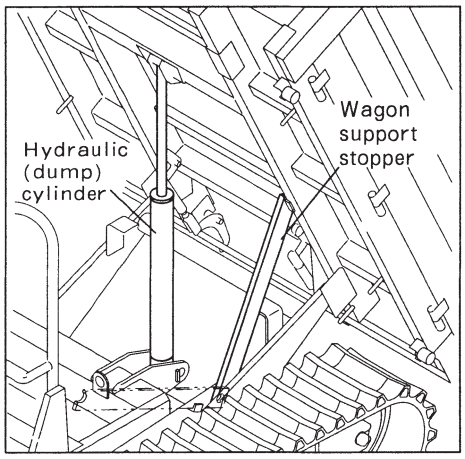
7-5-3 Hydraulic Cylinder

1. Removal and installation of hydraulic cylinder

1) Removal of cylinder

⚠ • To remove or install the hydraulic (dump) cylinder, raise the wagon and install the wagon support stopper.
• Release residual pressure before removing the hose.

(1) Raising the wagon to install the wagon support stopper.
(2) Remove the pin on the rod side.
(3) Start the engine and retract the piston rod.
(4) Remove the hose.
(5) Remove the pin on the bottom side.



2) Installation of cylinder

⚠ When aligning the holes for the pin, never insert the finger into the holes.

(1) Install the cylinder in the reverse order of the removal procedure.
(2) For air release, refer to the section 1-10 "Air Release Procedure for Hydraulic Equipment".

CHAPTER 8

PERIODIC INSPECTION AND SERVICING

10. Troubleshooting

10-1 Non-breakdowns

The following phenomena are not breakdowns:

1) Change in travel speed due to dump operation

Phenomenon:

The travel speed of the vehicle is changed when the wagon is dumped during the traveling of the vehicle.

Reason:

- The travel circuit (with the DA valve) and the dump circuit are connected in tandem.
- The dump operation during traveling causes difference in the quantity of the oil which is supplied to the travel circuit between at the bottom end and the rod end of the cylinder. This difference, i.e., difference in oil volume has an affect on the travel speed of the vehicle, especially at low speed.

Examples:

When the wagon is raised, the travel speed will be slower.

When the wagon is lowered, the travel speed will be faster.

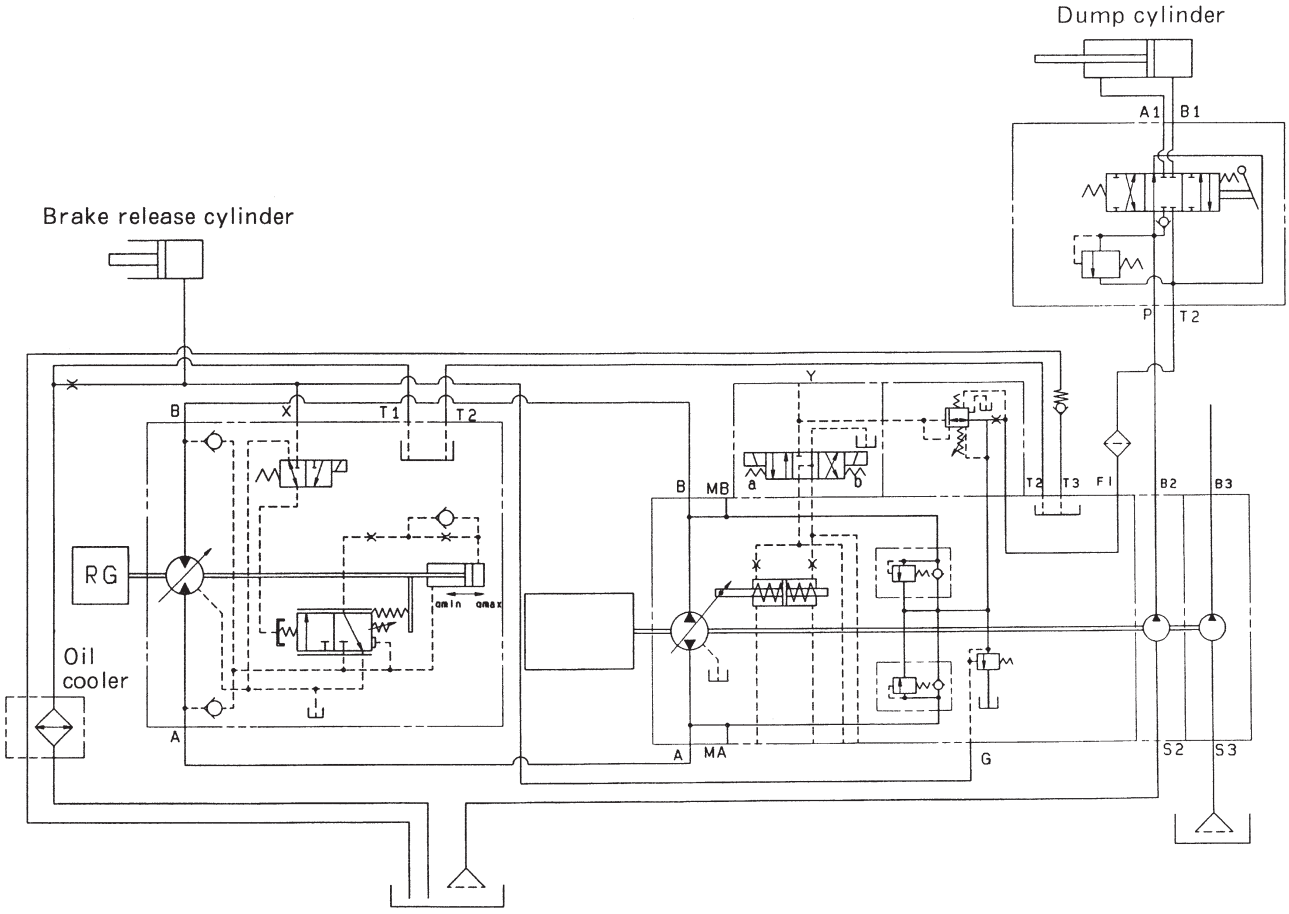
2) Play of brake pedal

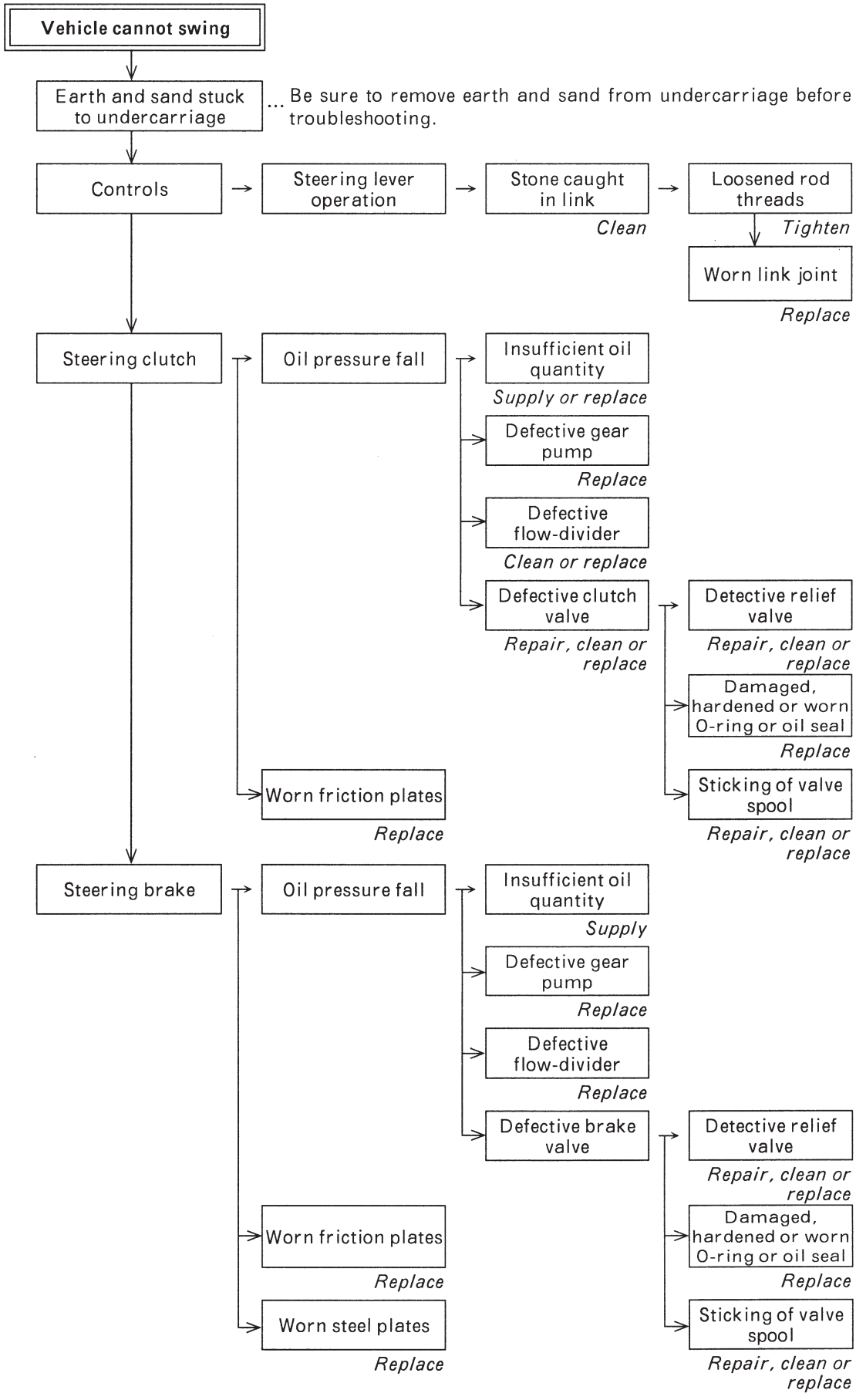
Phenomenon:

There occurs some play in the brake pedal when the engine is stopped.

Reason:

When the engine is stopped, the auxiliary equipment for the brake works and the brake is applied. Accordingly, there occurs some play in the brake pedal.




Vehicle cannot swing
Earth and sand stuck to undercarriage
... Be sure to remove earth and sand from undercarriage before troubleshooting.
Controls
Steering lever operation
Stone caught in link
Clean
Loosened rod threads
Tighten
Worn link joint
Replace
Steering clutch
Oil pressure fall
Insufficient oil quantity
Supply or replace
Defective gear pump
Replace
Defective flow-divider
Clean or replace
Defective clutch valve
Repair, clean or replace
Detective relief valve
Repair, clean or replace
Damaged, hardened or worn O-ring or oil seal
Replace
Sticking of valve spool
Repair, clean or replace
Worn friction plates
Replace
Steering brake
Oil pressure fall
Insufficient oil quantity
Supply
Defective gear pump
Replace
Defective flow-divider
Replace
Defective brake valve
Detective relief valve
Repair, clean or replace
Damaged, hardened or worn O-ring or oil seal
Replace
Sticking of valve spool
Repair, clean or replace
Worn friction plates
Replace
Worn steel plates
Replace