TCM®

TCM WHEEL LOADER
SHOP MANUAL

MODEL 850
860
870

TOYO UMPANKI CO., LTD.

Tires (front and rear)	20.5 x 25 – 12PR, L–2 (OR), tubeless
Rims (front and rear)	17.00 x 25 – 1.7

Brake System

Service Brake	
Type	Front-rear wheel separate braking, wet disc, air-over hydraulic
Number of fluid lines	2
Parking Brake	
Type	Front axle input braking, disk brake with spring cylinder
Emergency Brake	Combined with parking brake

Steering System

Type	Frame articulation

Loading System

Type	Inverted-Z-shaped link
Bucket Blade Edge	I-shaped

Hydraulic System

Boom Cylinders	Double-acting piston type, 2 units
Bucket Cylinder	Double-acting piston type, 1 unit
Main Pump (serving also as steering pump)	
Name	KP50112C
Type	Gear type
Charging Pump	
Name	2P3146AR
Type	Gear type
Control Valve	
Name	4502
Type	2-spool sliding type

01.3 NOTES AND CAUTIONS ON MAINTENANCE

1. Correct decisions are required in maintenance.

Prior to starting to service the machine, carefully check the current conditions of the machine to form correct judgement on the basis of the checking. The maintenance job can thereby be efficiently performed.

To grasp the current conditions of the machine, it is necessary not only to ask the operator and other persons concerned but to operate the machine yourself and inspect the machine from the outside while letting the operator operate it.

During maintenance, it is desirable to use testers and instruments besides your perception and experience to have objective decisions.

2. ⚠ For hoisting a unit or other heavy object, be sure to use a wire rope having much larger allowable load capacity than the weight to be lifted and make sure of safety around.

When installing or removing the axle, drive unit, engine or other heavy component, pay full attention to the footing to assure safety operation.

When using a crane or other lifting means, check the weight of load to be lifted, then employ wire rope and hooking means both of which are strong enough to lift the load.

Safety factor of sling rope = 6 or above

Load acts on a wire rope dynamically when lifted so that a much heavier weight than the actual weight of the load will be applied, though momentarily, to the wire rope. Moreover, the wire rope may be subjected to the bending force and concentrated stress, depending upon the way of using the lifting equipment. With these points taken into consideration, the safety factor of the sling rope should be 6 or over.

$$\text{Safety factor} = \frac{\text{breaking load of wire rope used}}{\text{tension load applied to single rope}} = 6 \text{ or over}$$

This means that lifting any object with a wire rope requires the wire rope to have breaking load six or more times larger than the weight of the object to be lifted.

3. ⚠ Before removing unit components by using power, make sure the bolts, nuts, tubes, wire harnesses, etc. are all removed.

Get familiar with how the machine is constructed, and follow the standard removing and disassembling procedures provided for each model so as to save you the trouble of repeating the same work.

4. ⚠ When jacking the machine up, safety measures should be taken against hazard by using a stand, blocks or other supporting means.

Before inspecting or servicing the hydraulic system, lower the bucket down to the groung and shut off the engine.

When jacking up the machine for maintenance work, securely support the machine with a stand, blocks or other appropriate means. Removed components which are easy to fall down or roll should be doubly supported or blocked.

5. ⚠ Do not let the engine run continuously in all ill-vented place (such as indoors).

03.2 GREASE-UP POINTS

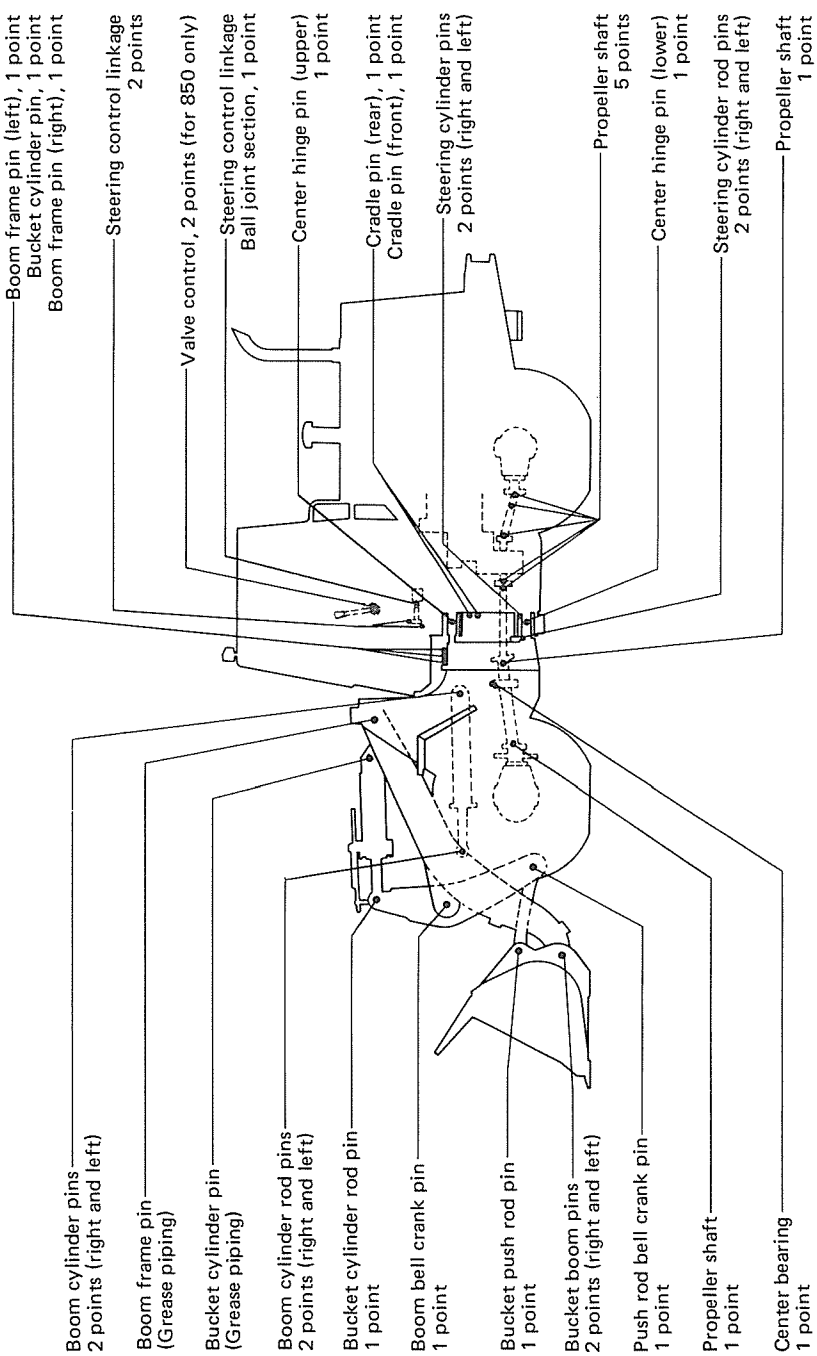


Fig. 03.2 Grease-up Points

5. DECREASED ENGINE POWER

Note:

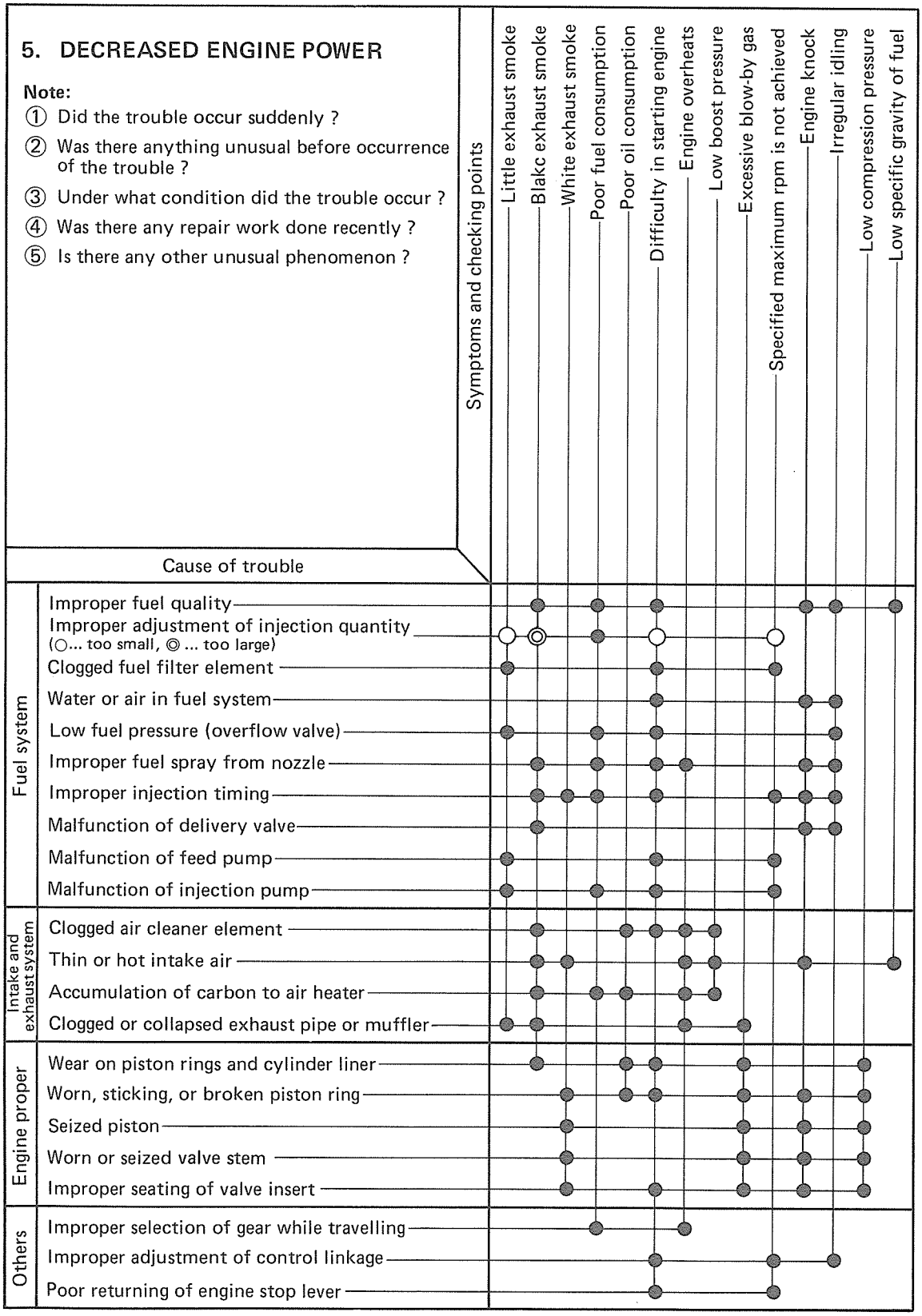
① Did the trouble occur suddenly ?

② Was there anything unusual before occurrence of the trouble ?

③ Under what condition did the trouble occur ?

④ Was there any repair work done recently ?

⑤ Is there any other unusual phenomenon ?



5. Removal of Water Pump

① Remove the water pump hose.

② Remove the three water pump mounting bolts.

Note: Two of the three mounting bolts are used to fasten the pump along with the front cover.

③ Remove the water pump from the front cover.

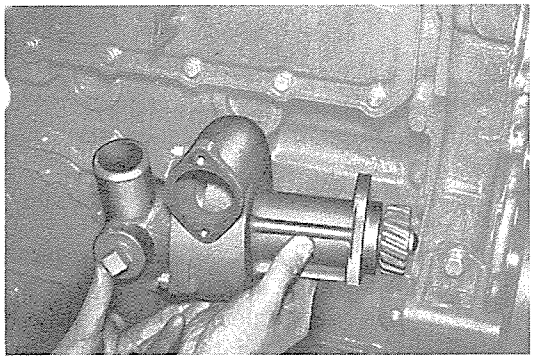


Fig. 11A.14 Water Pump Removal

6. Removal of Nozzle Holder

① Remove the nozzle holder connector bolt and remove the fuel spill tube.

② Remove the nozzle pipe clamp and loosen the nozzle pipe flared nut. Then remove the nozzle pipe assembly.

Note: Clean the flared nut of the nozzle pipe.

③ Loosen the two nozzle holder mounting bolts. Holding the nozzle holder with a wrench, remove the nozzle holder assembly from the cylinder head. Remove the remaining nozzle holders in the same manner.

Note: Care should be exercised as not to drop the copper gasket.

④ After removing the pipe, cover the joint with waste cloth to prevent dust or other foreign matter from getting into the injection pump.

7. Removal of Fuel Filter and Strainer

① Drain fuel from the filter case through the drain plug.

② Disconnect the fuel tube connected to the filter from the injection pump.

③ Remove the two fuel filter mounting bolts and remove the fuel filter.

④ Open the drain cock of the strainer to drain off fuel from the strainer.

⑤ Disconnect the fuel hose from the feed pump side.

⑥ Remove the two bolts securing the strainer and remove the strainer.

8. Removal of Intake Manifold

① Remove the air hose leading to the compressor.

② Remove the 12 mounting nuts from the intake manifold and remove the intake manifold.

9. Removal of Injection Pump

① Remove the oil tube.

② Remove the engine stop solenoid rod from the ball joint.

③ Remove the two coupling bolts.

④ Remove the four injection pump mounting bolts and remove injection pump by drawing it a little rearward.

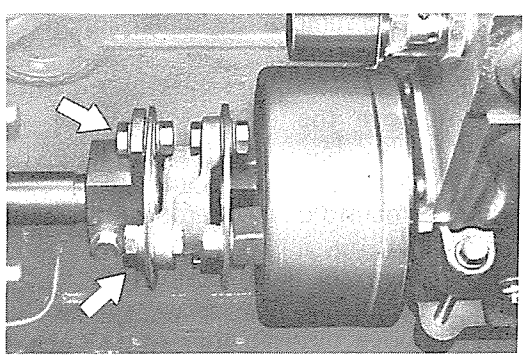


Fig. 11A.15 Coupling Bolt Removal

5. Removal of Timing Gear

① Remove the 18 front cover mounting bolts and remove the front cover from the gear case.

② Remove the oil slinger, collar and key from the crank shaft.

③ Temporarily install the injection pump drive gear and water pump gear.

④ Measure and record the backlash of each gear.

Note: For backlash measurement, put two fuse wires (spaced 180° apart) between both gears and measure the thickness of the fuses collapsed.

⑤ Measure the end plays of the idler gears A, B, and C, and record.

⑥ Remove the two end plate mounting bolts of the idler gear A and remove the idler gear A.

⑦ Remove the idler gear B in the same manner.

⑧ Remove the mounting bolts (left-hand screw) of the idler gear C and remove the idler gear C.

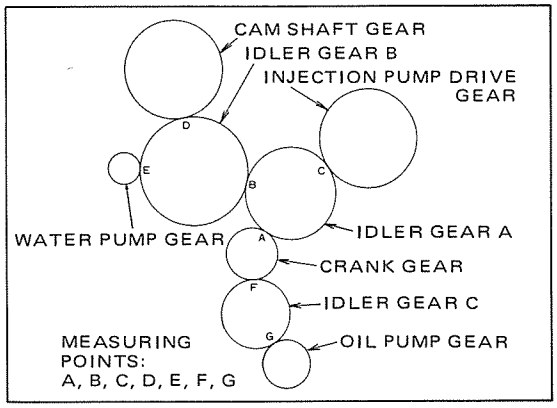


Fig. 11A.28 Gear Train Backlash

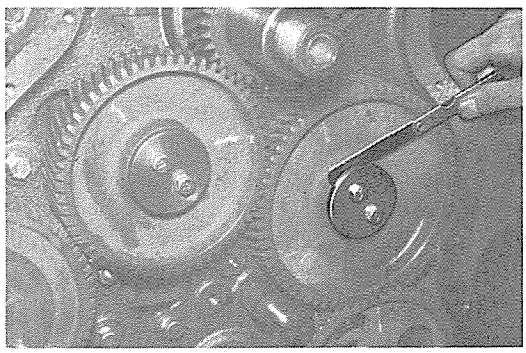


Fig. 11A.29 Idler Gear End Play Measurement

⑨ Remove the two cam shaft plate mounting bolts and remove the cam shaft and gear as an assembly.

⑩ Remove the temporarily installed injection pump drive gear and water pump gear.

⑪ Remove the 13 gear case mounting bolts and remove the gear case from the cylinder block.

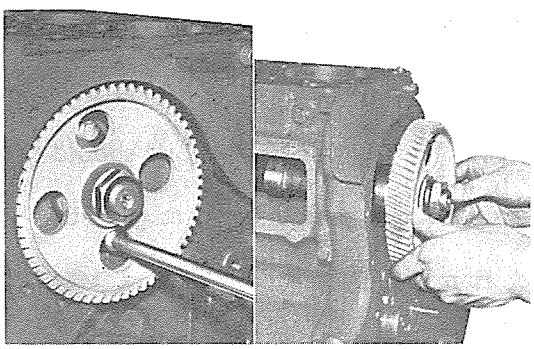


Fig. 11A.30 Removal of Cam Shaft and Gear

6. Removal of Flywheel and Housing

① Remove the 9 flywheel mounting bolts.

Note: Block the crank shaft with pieces of wood between the cylinder block and the crank shaft and remove the bolts.

② Screw three puller bolts into the flywheel and remove the flywheel from the crank shaft.

③ Remove the 10 flywheel housing mounting bolts and remove the flywheel housing from the cylinder block.

④ Remove the oil slinger from the crank shaft.

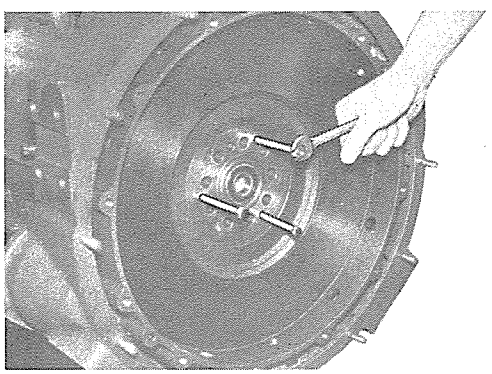


Fig. 11A.31 Flywheel Removal

Item	Boring size (mm)
0.5 mm OVERSIZE	125.5 – 125.53
0.75 mm OVERSIZE	125.75 – 125.78

② After boring, measure the liner inside diameter, and make sure that the roundness and taper meet the maintenance standard (see Paragraph 1. Items ③ and ④ of "11A.5.3 INSPECTION").

③ Use the piston and piston ring of 0.5 mm or 0.75 mm oversize.

3. Replacement of Cam Shaft Bushing

① With a special tool (bushing replacer), the No. 1, 2, 3 and 4 cam shaft bushings in that order toward the front side of the engine.

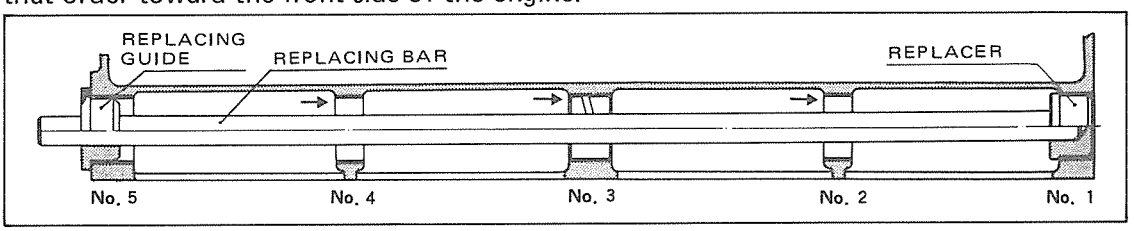


Fig. 11A.54 Cam Shaft Bushing Removal

② Drive the No. 5 cam shaft bushing toward the rear side of the engine.

③ Press-fit the cam shaft bushings in the sequence reverse to the removal using a special tool (bushing replacer): Fit the Nos. 4, 3, 2 and 1 cam shaft bushings in that order from the front side and then the No. 5 bushing from the rear side.

Notes 1: When fitting the cam shaft bushings, their chamfered areas should be pointed toward the front side with the notch placed in the horizontal position.

2: Fit the No. 1 and 5 bushings in the correct positions indicated in Figure 11A.55.

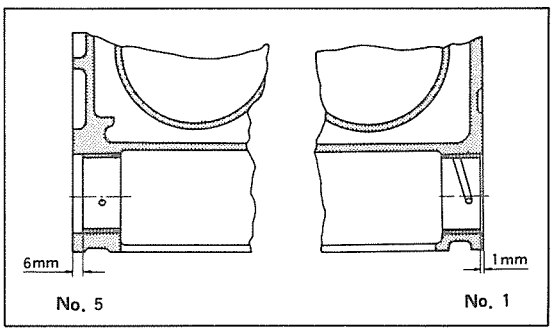


Fig. 11A.55 Cam Shaft Bushing Fitting Positions

4. Correction of Crank Shaft

(1) Correction of clearance between main bearing and journal

① If the journal is not worn so much, replace the main bearing with a standard or 0.07 mm undersized one so that the clearance between the bearing and journal is within the repair limit (see Paragraph 3. Item ④ of "11A.5.3 "INSPECTION").

② If the journal is worn greatly, or if the roundness of the journal is beyond the repair limit, machine the journal to the specified size and use an undersized bearing shell.

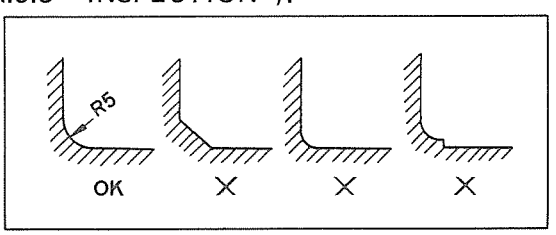


Fig. 11A.56 Crank Shaft Correction

Notes 1: When machining the journal, care should be exercised as not to widen the width and correctly finish the radius at both corners referring to in Figure 11A.56.

2: The roundness and taper should meet the maintenance standard (see Paragraph 3. Item 3 of "11A.5.3 INSPECTION").

⑨ Measure the runout of the rocker shaft and record. If the measurement is beyond the repair limit, repair or replace.

Item	Maintenance standard (mm)	Repair limit (mm)
ROCKER SHAFT RUNOUT	0.03 or less	0.05

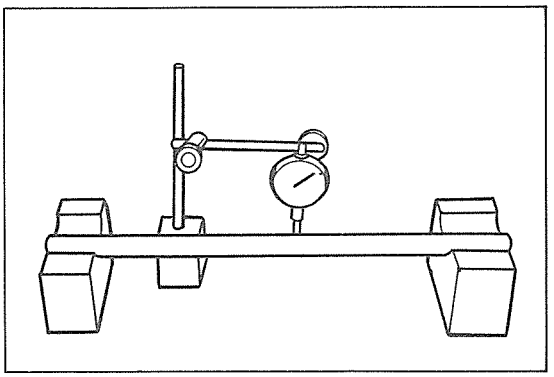


Fig. 11A.74 Measurement of Rocker Shaft Runout

⑩ Check the rocker shaft bracket for deformation, cracks or clogging of the oil groove and if unsatisfactory, replace.
⑪ Check the adjusting screw in the push rod contact area and the threaded area for cracks and excessive wear. If unsatisfactory, replace the adjusting screw.
⑫ Measure the runout of the push rod. If the measurement is beyond the repair limit, repair or replace.

Item	Maintenance standard (mm)	Repair limit (mm)
PUSH ROD DEFLECTION	0.30 or less	0.50

⑬ Check the spherical areas at both ends of the push rod for damage, cracks or excessive wear and if unsatisfactory, replace the push rod.
⑭ Check the inner and outer surfaces of the cam follower for damage or wear and if unsatisfactory, replace.
⑮ Measure the cam follower outer diameter (A), roller outer diameter (B), clearance (C) between the roller bushing and pin, and side clearance (D) of the roller and record. If any measurement is beyond the wear limit, replace the cam follower.

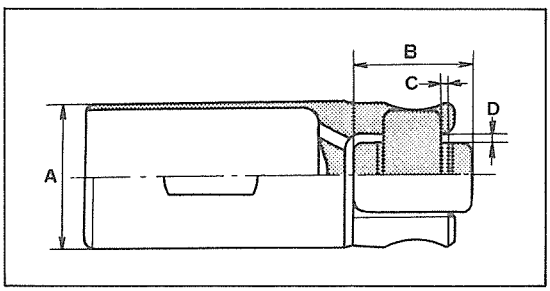


Fig. 11A.75 Cam Follower Measurement

Item	Nominal size (mm)	Maintenance standard (mm)	Repair limit (mm)	Wear limit (mm)
CAM FOLLOWER OUTER DIAMETER (A)	27	26.92 – 26.98	—	26.85
ROLLER OUTER DIAMETER (B)	23	22.98 – 23.02	—	22.4
CLEARANCE (C) BETWEEN ROLLER BUSHING AND PIN	—	0.02 – 0.04	0.5	1.0
SIDE CLEARANCE OF ROLLER (D)	—	0.35 – 0.60	—	0.8

⑯ Measure the diameter of the cam follower hole in the cylinder block and record. Calculate the clearance from the cam follower hole diameter in the cylinder block and the cam follower outer diameter previously measured (see Item ⑮ above) and if the clearance is beyond the repair limit, replace the cam follower.

Item	Maintenance standard (mm)	Repair limit (mm)
CYLINDER BLOCK HOLE-TO-CAM FOLLOWER CLEARANCE	0.02 – 0.07	0.20

11A.8.1 GENERAL DESCRIPTION

The engine cooling system is of water-cooled forced-circulation type using a gear-driven centrifugal water pump.

Cooling water is drawn up by the water pump from the radiator's bottom tank and flows through the engine oil cooler to enter the water jackets from the center of the cylinder block (right side), cooling the outer surfaces of the cylinders, and makes its way to the top of the cylinder block. The water threafter flows through the water jackets insersed under the cylinder heads to cool the valve seats and injection nozzles and it returns to the top tank of the radiator from the upper part of the cylinder heads via the water manifold and the thremostat. If the cooling water temperature is not high enough to open the thermostat, the water flows into the water pump via the bypass pipe.

11A.8.2 WATER PUMP

Note: The water pump should not generally be disassembled. Check the exterior of the water pump and if unsatisfactory, proceed as follows:

1. Appearance Check and Correction

① If any water leak is found around the bottom hole of the housing, check the seal and seat. If any defect is found, replace the seal and seat as a set.

② If any oil leak is found at the bottom hole of the housing, check the oil seal. If unsatisfactory, replace.

③ Turn the water pump gears to check to see if the impeller does not interfere with the water inlet. If unsatisfactory, replace the ball bearings as a set.

2. Disassembly

① Remove the water inlet.

② Remove the water pump gears and keys with a special tool (water pump gear wrench).

③ Remove the snap ring and shims and remove the shaft from the impeller side with a press.

④ Remove the ball bearing and spacer from the shaft with a press.

⑤ Remove the seal, slinger and oil seal from the housing.

⑥ Remove the seat from the impeller.

3. Cleaning and Inspection

① Clear away deposit and rust from the pump housing, water inlet and impeller and wash all parts except rubber parts by cleaning oil. After that, wash by water and dry.

② Check the impeller for rust, corrosion or damage of the threaded area and if unsatisfactory, replace.

③ Check the pump housing and the water inlet for rust, corrosion or damage of threaded area and if unsatisfactory, replace the housing or water inlet.

④ Check the water pump gear teeth and the keyways for damage or wear and if unsatisfactory, replace the water pump gears.

⑤ Check the shaft for bend, wear, or damage of the threaded area and if unsatisfactory, replace the shaft.

⑥ Check the oil seal, seal and seat for damage and if unsatisfactory, replace.

Note: When reassembling, use new oil seal, seal and seat.

5. Adjustment

① Loosen the cap nut.

② With a loose adjusting screw, install the nozzle on the nozzle tester. Move the hand lever vigorously two or three times to let the nozzle inject fuel so that dust or foreign matter inside the nozzle is removed.

③ Actuate the hand lever of the tester at a rate of 60 times per minute and read the injection pressure.

④ Tighten the adjusting screw to adjust the injection pressure.

Item		Maintenance standard (kg/cm²)
INJECTION PRESSURE	E	200

⚠ **Caution: Never catch the fuel injected from the nozzle with hand.**

⑤ While adjusting the injection pressure according to the reading of the nozzle tester, check injection hole for clogging, injection pattern and oil leaks from the injection hole. If unsatisfactory, repair or replace the nozzle assembly.

⑥ After tightening the cap nut, make sure that the injection pressure and injection pattern are proper.

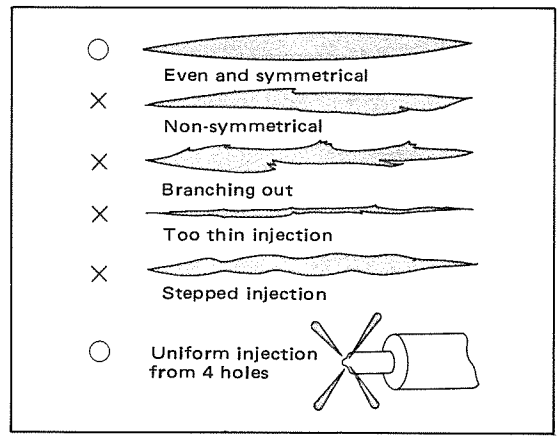


Fig. 11A.99 Nozzle Injection Pattern

11A.9.6 REPLACEMENT OF DELIVERY VALVE GASKET

1. Removal

① Remove the injection pump cover.

② Loosen the delivery valve holder and remove the stopper, spring and gasket.

2. Installation

Reassemble the delivery valve in the sequence opposite to disassembly.

Note: The "O"-ring should be replaced with a new one and coated with grease before installation.

DELIVERY VALVE HOLDER TIGHTENING TORQUE = 11.0 – 12.0 kg-m (79.6 – 86.8 ft-lbs)

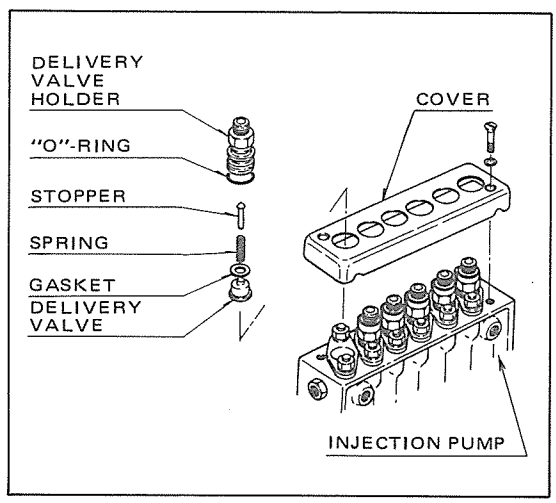


Fig. 11A.100 Replacement of Delivery Valve Gasket

11A.9.7 INJECTION PUMP, GOVERNOR AND TIMER

Check the injection interval, injection volume, injection uniformity and injection start timing and if unsatisfactory, ask the suppliers of the respective components for adjustment or overhaul.

③ Using a tester (3.0 V), measure the resistance between the terminals and if unsatisfactory, disassemble and repair.

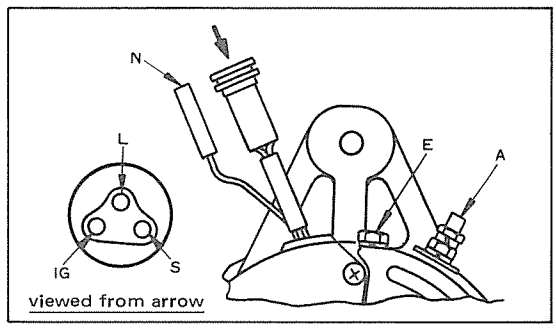


Fig. 11A.115 Measurement of Resistance Between Terminals

④ Measurement of output current:
1) Close the switches SW1 and SW2 and raise the speed of the generator up to about the rated rpm (5000 rpm).
2) Set the resistance of the variable resistor to its maximum. Then close the switch SW3 and open the switch SW2.
3) With the generator operating at the rated rpm, adjust the resistance of the variable resistor to measure the output current obtained when the generator terminal voltage is set to the rated voltage.

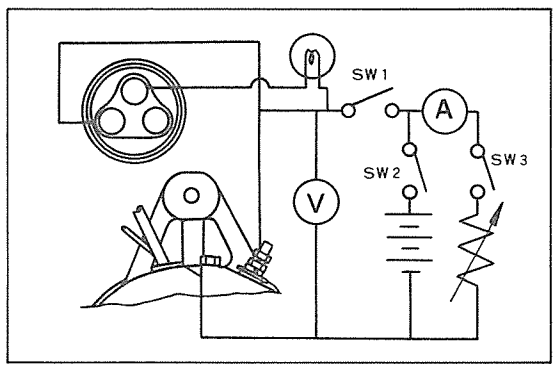


Fig. 11A.116 Measurement of Output Current

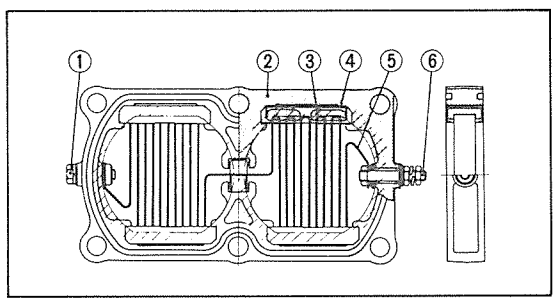
11A.11.3 AIR HEATER

1. Removal and Installation

See "REMOVAL AND INSTALLATION OF ALLIED PARTS" (Section 11A.4).

2. Inspection

① Check for the installation and breakage of wiring.
② Check the heating element for accumulation of carbon and if excessive carbon is found, clean.
③ Check the heating element for breakage or short-circuit and if unsatisfactory, replace the air heater as assembly.



1	MINUS TERMINAL (GROUND)	4	SPRING
2	FRAME	5	HEATING ELEMENT (RIBBON)
3	INSULATION BLOCK	6	PLUS TERMINAL

Fig. 11A.117 Air Heater Construction

Unit: mm

Division	Item	Nominal size	Maintenance st'd	Repair limit	Wear limit	Remarks
Timer	Airtightness	Feed air press. of 0.5 kg/cm² in timer and make sure no air leaks from oil seal, "O"-ring and other areas.				
Feed pump	O.D. of roller	15	14.973 – 15.000	—	14.6	
	Clearance between roller and roller pin	—	0.04 – 0.08	0.15	—	
	Air tightness	Close discharge port and apply an air press. of 2 kg/cm² from intake port. Air leaks should be less than 30 cc/min when immersed in light oil.				
	Pumping pressure	Time required to achieve a pumping press. of 1.8 kg/cm² with pump running at 600 rpm should be 30 seconds or less.				Suction pipe: 10 φ x 1 t x 2m, Cam lift: 10 mm
	Pumping amount	With pump running at 600 rpm, pumping amount for 15 seconds should be more than 300 cc.				
	Suction capacity (priming pump)	Actuate priming pump at a rate of 60 to 100 strokes per minute and make sure fuel begins to be sucked before the number of pump rotation is 30.				
Nozzle	Injection start pressure (kg/cm²)	—	200	—	—	
	Oil tightness between needle and seat	When pressurized to 170 kg/cm², no oil leaks from seat should be present.				

11A.16 ENGINE CONTROL

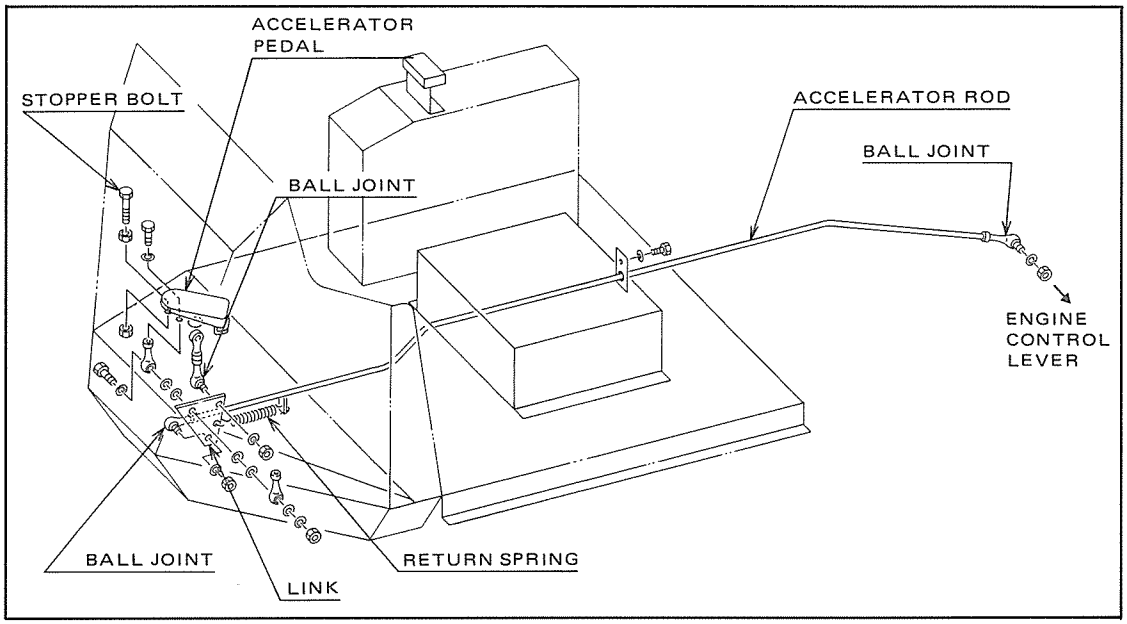


Fig. 11A.122 Engine Control Equipment

11A.16.1 GENERAL DESCRIPTION

1. Accelerator Pedal

The engine speed is controlled by operating the accelerator pedal. The accelerator pedal is connected to the injection pump governor control lever via the link and accelerator rod. Pressing the accelerator pedal actuates the governor control lever so that the engine rpm responds to the accelerator pedal effort.

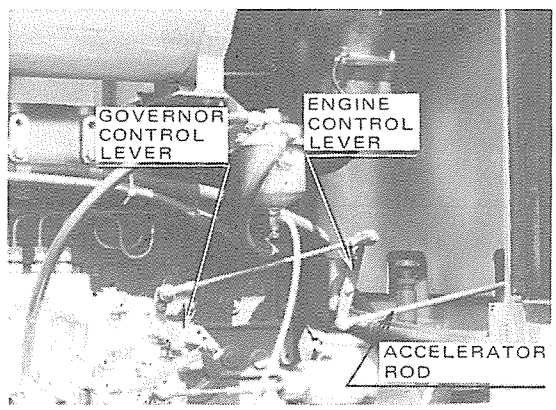


Fig. 11A.123 Engine Control

2. Engine Stop Solenoid

The engine is stopped with the starter switch. The governor stop lever is actuated by operation of the engine stop solenoid. When the starter switch is put to the OFF position, the engine stop solenoid operates to stop the engine.

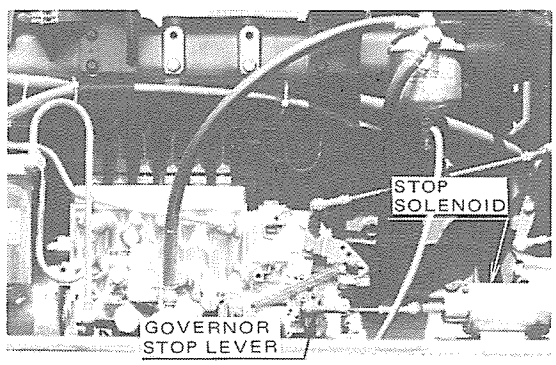


Fig. 11A.124 Engine Stop Solenoid

1. DIFFICULT ENGINE STARTING

Note: ① Did the truble occur suddenly ?

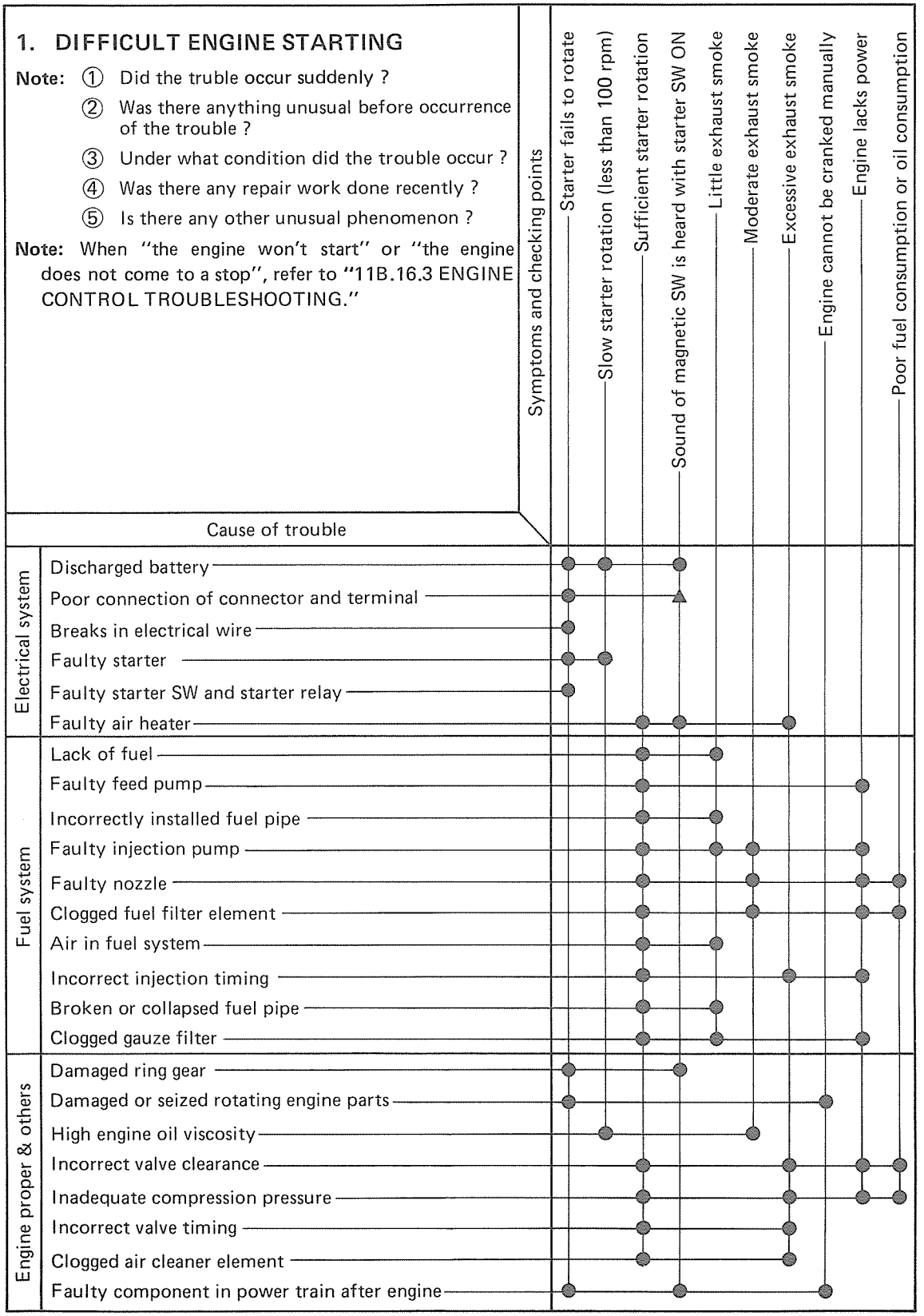
② Was there anything unusual before occurrence of the trouble ?

③ Under what condition did the trouble occur ?

④ Was there any repair work done recently ?

⑤ Is there any other unusual phenomenon ?

Note: When "the engine won't start" or "the engine does not come to a stop", refer to **"11B.16.3 ENGINE CONTROL TROUBLESHOOTING."**



⑧ Remove all wires, tubings and links connected to the right side of the engine:

a. Air vacuum switch wiring.
b. Engine heater wiring and clip.
c. Engine stop solenoid wiring.
d. Starter motor wiring (including ground wire).
e. Accelerator link rod.
f. Two brake air compressor tubes.
g. Two fuel hoses and clips.

(For their locations, see Figure 11B.8. The figure shows the model PE6T. The location of its wirings and tubings is the same as the PE6.)

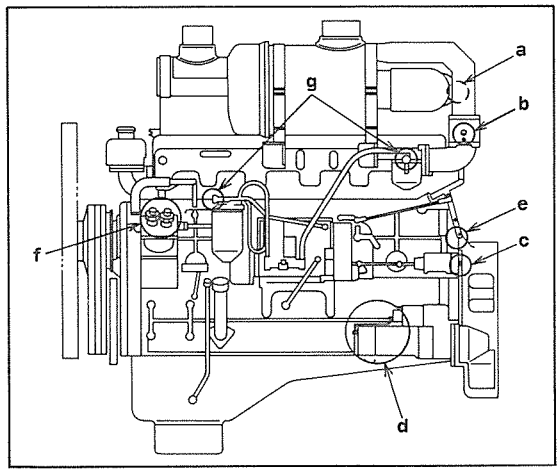


Fig. 11B.8 PE6T Engine

⑨ With the two hoses kept connected, remove the compressor for the air-conditioner along with the bracket and put it aside.

Note: Do not remove the two hoses from the air-conditioner compressor; otherwise freon will escape.

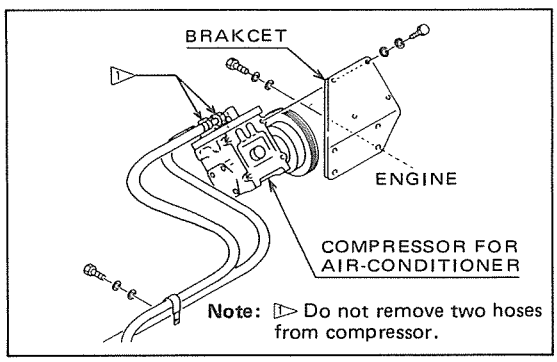


Fig. 11B.9 Removal of Compressor for Air-Conditioner

⑩ Pass wire rope through the two hooks of the engine and lift up the engine by a crane or hoist

⑪ Remove the 12 mount nuts from the joint of the engine flywheel and the drive unit.

⑫ Remove the mounting bolts (bracket thru frame) of the mount brackets at the right and left of the fan side.

⑬ Remove the eight stud bolts securing the mount brackets at the right and left of the flywheel side.

Note: Remove the nuts and lock washers from the stud bolt and install double nuts on the stud bolt. Then remove the stud bolt along with the double nuts from the flywheel housing.

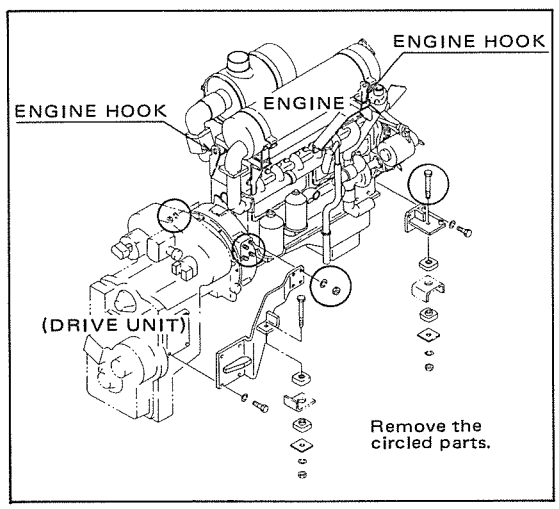


Fig. 11B.10 Removal of Engine

⑭ Lift the engine a little and swing it toward the rear of the machine to separate from the drive unit. Then slowly lift the engine off the machine.

Note: After lifting the engine a little, make sure all wires and tubes are removed.

⑮ Place the dismounted engine onto the engine stand. To replace the coupling gear, remove it from the flywheel.

⑥ In an engine which has been just reassembled, there is likely to be poor fit in the rotating parts and sliding parts. Prior to testing for performance, run the engine under a light load for fitting.

Note: Check the valve clearances after letting the engine run at idle for 10 minutes. After making sure the valve clearances are correct, perform running in for about two hours, gradually increasing the engine rpm and load.

⑦ During running in, check the following items when the engine is run at respective speeds.

Item			Maintenance st'd
OIL PRESSURE	(kg/cm^2)	at idling rpm	Over 1.0
		at 2200 rpm	Over 3.5
COOLING WATER TEMP. AT OUTLET	(°C)		70 – 80
LUBRICANT TEMP.	(°C)		70 – 100
WATER, OIL AND FUEL LEAKS			Check thoroughly. No leaks allowed.
UNUSUAL SOUNDS			Excessive noise from gear, etc. not allowed.

⑧ After running in the engine, retighten the cylinder head bolts and check the valve clearances and adjust, if needed.

8. Gear Train

① Check each timing gear for damage or wear and if unsatisfactory, repair or replace.

② If the backlash measured during disassembly is beyond the repair limit, replace (see 2. ④ of "11B.5.1 DISASSEMBLY").

Item		Maintenance standard (mm)	Repair limit (mm)
BACKLASH OF EACH GEAR	A thru E	0.07 – 0.14	0.30
	F & G	0.12 – 0.26	

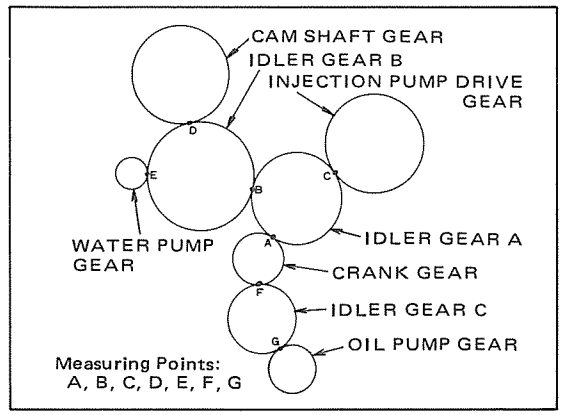


Fig. 11B.58 Backlash in Gear Train

③ Measure the inner diameter of the bushing and the outer diameter of the idler gear shaft and calculate the clearance between the bushing and the idler gear shaft. If the clearance is beyond the repair limit, replace the bushing.

Item		Maintenance standard (mm)	Repair limit (mm)
CLEARANCE BETWEEN BUSHING AND IDLER GEAR SHAFT	Idler gears A, B	0.03 – 0.06	0.20
	Idler gear C	0.02 – 0.05	

④ If the end play measured during disassembly is beyond the repair limit, replace the idler gear or idler gear plate (see 2. ⑤ of "11B.5.1 DISASSEMBLY").

Item		Maintenance standard (mm)	Repair limit (mm)
IDLER GEAR END PLAY	Idler gears A, B	0.05 – 0.12	0.30
	Idler gear C	0.04 – 0.12	

11B.5.4 CORRECTION AND REPLACEMENT

1. Replacement of Cylinder Liner

① Using the special tool (cylinder liner tool), remove the cylinder liner and fit a new one.

Note: Before fitting a new cylinder liner, thoroughly clean the cylinder block inside wall and the cylinder liner peripheral area and apply a thin coat of engine oil.

② When fitting the cylinder liner, select the liner, matching the mark (0 or 1) on the cylinder block upper surface with the mark of the skirt area of the cylinder liner periphery.

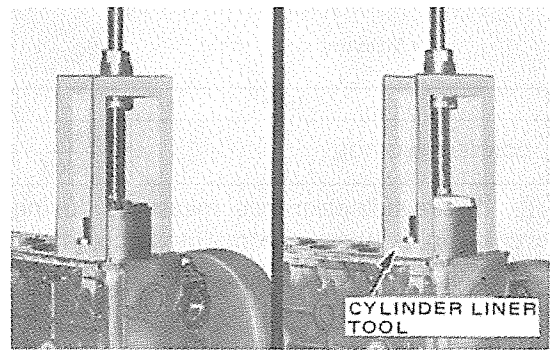


Fig. 11B.59 Replacement of Cylinder Liner

③ After fitting the cylinder liner, make sure that the inner diameter, roundness, taper and projecting amount of the flange are within the maintenance standard values (see 1. ③ and 1. ④ of "11B.5.3 INSPECTION").

11B.6.3 INSPECTION

1. Cylinder Head

① Measure the deformation of the cylinder head fitting surface. If the measurement is beyond the repair limit, repair or replace. After grinding, if the height of the cylinder head is lower than the wear limit, replace.

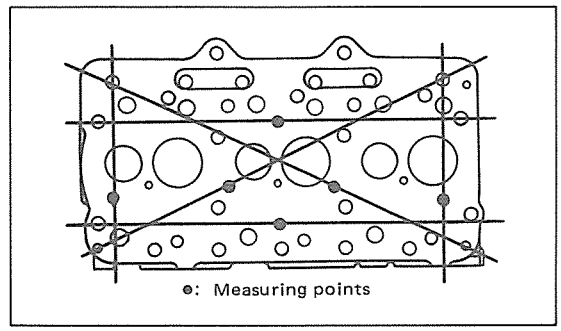


Fig. 11B.88 Measuring Points of Cylinder Head Flatness

Item		Maintenance standard (mm)	Repair limit (mm)	Wear limit (mm)
DEFORMATION OF CYLINDER HEAD	Axial direction	0.05 or less	0.15	—
	Right angle direction	0.02 or less		
HEIGHT OF CYLINDER HEAD		—	—	109.5

② Check the cylinder head bottom surface for cracks and if found, replace.

③ Perform water pressure test (test standard: 4 kg/cm^2) and check the water jacket of the cylinder head for leaks.

④ Check the valve insert contact width and contact pattern with the valve. If unsatisfactory, replace the valve or valve insert and perform lapping.

Item		Nominal size (mm)	Repair limit (mm)	Remarks
CONTACT WIDTH BETWEEN VALVE AND VALVE INSERT	Intake valve	2.2	3.0	PE6T
		2.1	3.0	PE6
	Exhaust valve	2.1	3.0	PE6T & PE6

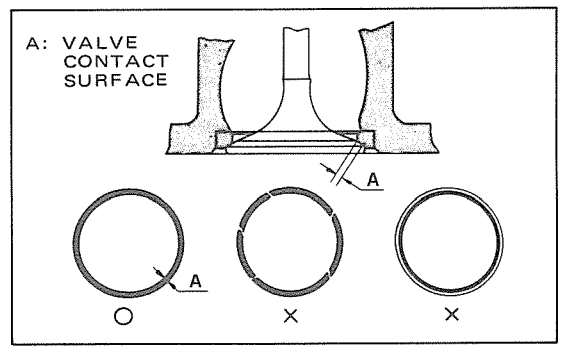


Fig. 11B.89 Contact of Valve Seat Surface

⑤ Check the water jacket and water jet for fur or rust and if found, clean or replace the cylinder head.

2. Valve Mechanism

① Check the valve spring for damage and if unsatisfactory, replace.

② Check the spring for inclination and measure the free length and record. Also using a spring tester, measure the spring tension and record. If the measurement is beyond the wear limit, replace.

Item			Maintenance standard (mm)	Wear limit (mm)	Remarks
INCLINATION	Valve spring		1.0 or less	1.4	Both outer and inner springs
FREE LENGTH	Valve spring	Outer	—	56.0	
		Inner		54.0	
	Inside spring			—	
TENSION (kg)	Valve spring	Outer	24.8 – 27.4	22.0	Measured length: 46 mm
		Inner	10.6 – 11.8	9.5	Measured length: 44 mm
	Inside spring		2.0 – 3.0	1.7	Measured length: 57 mm

① Install the pump gears in the case and make sure that the clearances and backlashes are within the repair limit (see Paragraph 1. Items ③ , ④ and ⑤ and Paragraph 2. Item ②).
② Install the oil pump drive gear, aligning the key with the key groove.
OIL PUMP DRIVE GEAR MOUNTING NUT TIGHTENING TORQUE = 7.4 – 10.4 kg-m (53.5 – 75.2 ft-lbs)
③ Install the relief valve, valve spring and spring seat and shims. Install the cover.

11B.7.3 OIL COOLER

1. Disassembly
Remove the short valve (steel ball) and valve spring from the already removed oil cooler adaptor.

2. Cleaning and Inspection
① Clean the short valve and the adapter with cleaning oil. Then wash them with water and dry.
② Remove deposit with a caustic soda solution from the inside of the housing and outside of the element. Wash them with water and dry.
③ Clean carbon sludge from the oil passage of the element.
④ Check the housing and the adaptor for cracks or damage and if unsatisfactory, replace the housing or adaptor.
⑤ Check the contacting surfaces of the short valve and the valve seat and if unsatisfactory, replace the short valve.
⑥ Check the valve spring for breakage or damage and if unsatisfactory, replace.
⑦ Perform the water pressure test of the element and if any defect is found, replace.

Item	Test standard
WATER PRESSURE TEST OF ELEMENT	No water leaks should be caused by the water pressure of 10 kg/cm^2

3. Assembly
Install the short valve (steel ball) and the valve spring in the oil cooler adaptor and install the screw plug with a gasket.
Note: When reassembling, all the gaskets, rubber rings, and "O"-rings should be replaced with new ones.

11B.7.4 OIL FILTER

1. Disassembly
① Remove the drain plug and drain off oil from the filter.
② Loosen the center bolts of both the full-flow and bypass oil filters and remove the filter case, element and filter body from each filter.
③ Remove the alarm switch from the full-flow oil filter and remove the valve spring, connector case, connector, connector spring and short valve.

3. Inspection

① Check the contacting surface of the check valve seat and if any defect is found, replace the housing.
② Check the push rod hole for wear and if found excessive, replace the housing.
③ Check the oil seal for deformation or damage and if unsatisfactory, replace the oil seal.
④ Check the contact surface of the check valve and if unsatisfactory, replace.
⑤ Inspect the check valve spring for breakage or deterioration and if unsatisfactory, replace.
⑥ Check the piston for damage or wear and if unsatisfactory, replace.
⑦ Check the piston spring for breakage or deterioration and if unsatisfactory, replace.
⑧ Check the tappet for damage or wear and if unsatisfactory, replace.
⑨ Measure the clearance between the tappet roller and the pin and record. If measurement is beyond the repair limit, replace both.

Item	Maintenance standard (mm)	Repair limit (mm)
CLEARANCE BETWEEN TAPPET ROLLER AND PIN	0.04 – 0.08	0.15

4. Assembly

With a new gasket, reassemble the feed pump in the sequence opposite to disassembly.

11B.9.3 FUEL FILTER

1. Disassembly

① Remove the drain plug and drain off fuel from the fuel filter.
② Remove the center bolt and remove the filter case, element and filter cover.

2. Inspection

① Check the element for clogging and damage and if unsatisfactory, replace. If the element has been used beyond serviceable duration, replace.
② Check the overflow valve spring for breakage or deterioration and if unsatisfactory, replace.
③ Perform an air tightness test on the overflow valve and if unsatisfactory, replace.
④ Check the cover and case for cracks or damage and if unsatisfactory, replace.
⑤ Check for clogging of the center bolt and if unsatisfactory, clean.
⑥ Check the specific gravity of fuel removed from the fuel filter during disassembly. Check also for the presence of water in it.

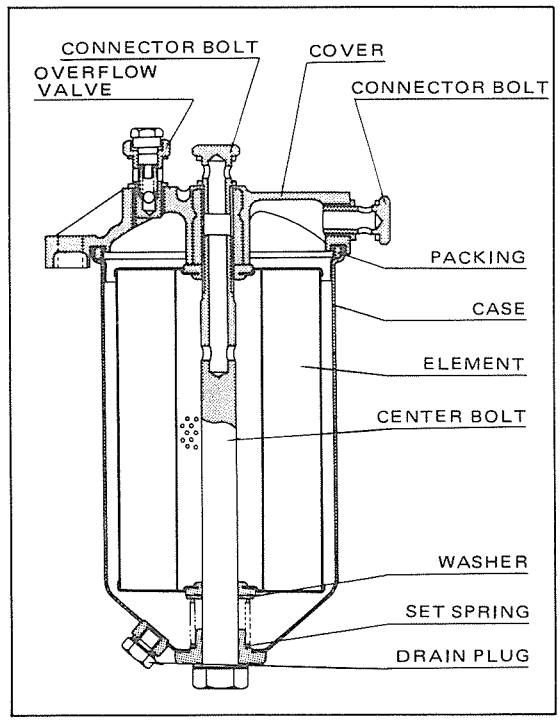


Fig. 11B.114 Fuel Filter Construction

3. Assembly

With a new packing, reassemble the fuel filter in the sequence opposite to disassembly.

④ Measure the thrust bushing groove width (indicated by C in Figure 11B.133) and oil thrower seal ring groove width (as indicated by D) and record. If worn beyond the wear limit, replace.

Item	Maintenance standard (mm)	Wear limit (mm)
THRUST BUSHING GROOVE WIDTH	5.08 – 5.10	5.11
OIL THROWER SEAL RING GROOVE WIDTH	1.65 – 1.67	1.75

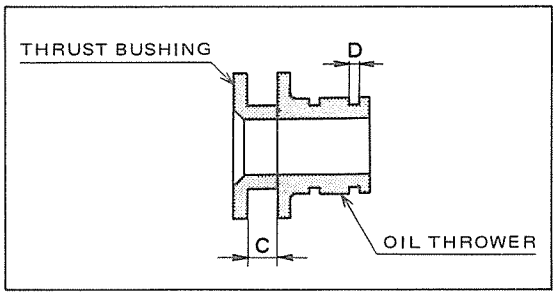


Fig. 11B.133 Measurement of Thrust Bushing and Oil Thrower

⑤ Measure the inner and outer diameters of the journal bearing and record. If the wear limit is exceeded, replace.

Item		Maintenance standard (mm)	Wear limit (mm)
JOURNAL BEARING	Inner dia.	14.03 – 14.05	14.07
	Outer dia.	19.99 – 20.01	19.97

⑥ Measure the inner diameter (indicated with E in Figure 11B.134) of the bearing sleeve and the inner diameter (F) of the center housing in the piston ring sliding area and record. Replace the center housing assembly if worn beyond the wear limit.

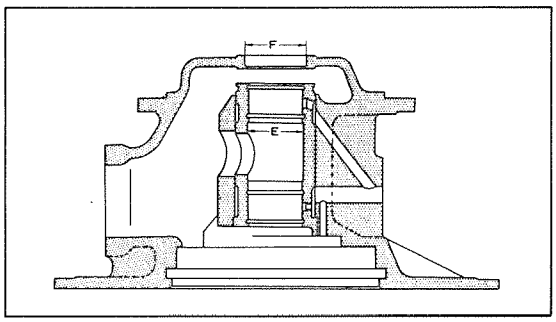


Fig. 11B.134 Measurement of Center Housing

Item	Maintenance standard (mm)	Wear limit (mm)
BEARING SLEEVE INNER DIA.	20.09 – 20.11	20.12
INNER DIA. OF CENTER HOUSING IN PISTON RING SLIDING AREA	22.40 – 22.42	22.45

⑦ Measure the air seal chamber inside diameter (as indicated by G in Figure 11B.135) and record. If worn beyond the wear limit, replace.

Item	Maintenance standard (mm)	Wear limit (mm)
AIR SEAL CHAMBER INSIDE DIAMETER	15.99 – 16.02	16.05

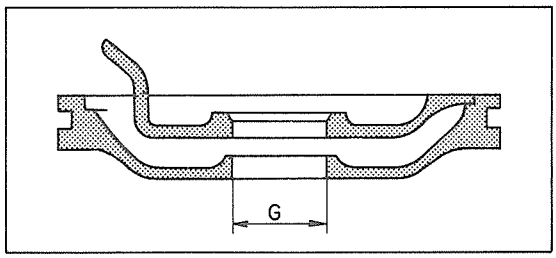


Fig. 11B.135 Measurement of Air Seal Chamber

⑧ If the end play of the shaft wheel obtained before disassembly is beyond the wear limit, replace the thrust bearing or thrust bushing.

If the radial play is beyond the wear limit, replace the journal bearing, center housing assembly or shaft wheel (see Items ② and ③ of 3. (1)).

Item	Maintenance standard (mm)	Wear limit (mm)
SHAFT WHEEL END PLAY	0.075 – 0.110	0.12
SHAFT WHEEL RADIAL PLAY	0.117 – 0.200	0.24

11B.11.2 STARTER MOTOR AND GENERATOR

The descriptions here concerning the starter motor and the generator cover only their inspection procedures. If anything unusual is found, ask the supplier of each component for adjustment or overhaul.

1. Removal and Installation

See "REMOVAL AND INSTALLATION OF ALLIED PARTS" (Section 11B.4) for the removal and installation of the starter motor and generator.

2. Inspection of Starter Motor

① Check the pinion gear for wear or breakage and if unsatisfactory, replace.

② Connect the battery to the starter motor and measure the no-load current and no-load rpm.

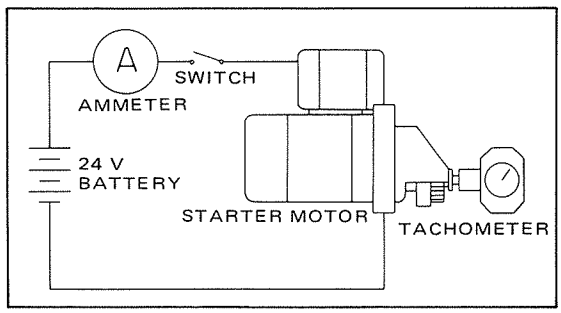


Fig. 11B.150 No-Load Test

③ Connect the starter motor and the switch to the battery and turn the switch on and off to check that the pinion gear smoothly pops out and in. If the pinion gear does not operate smoothly, disassemble it and if found defective, replace.

④ Measure the minimum voltage required for the pinion gear to pop out: Initially set the resistor to a high resistance so that a low voltage is applied to the starter motor. Gradually decrease the resistance step by step to measure the voltage with which the pinion gear begins to pop out.

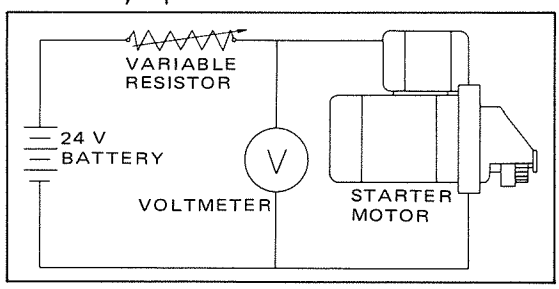


Fig. 11B.151 Voltage of Pinion Gear Pop-Out

3. Inspection of Generator

① Check the pulley for wear, damage or cracks and if unsatisfactory, replace.

② Check each terminal for corrosion or breakage and if unsatisfactory, repair or replace.

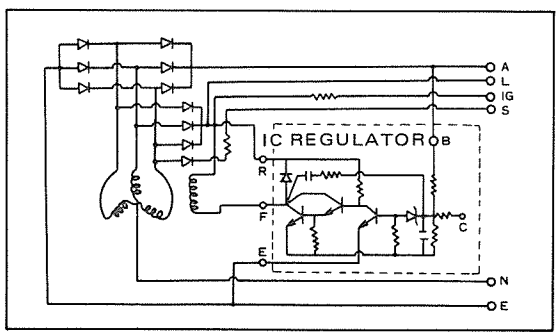


Fig. 11B.152 Wiring Diagram of Generator

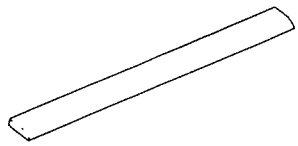
Unit: mm

Division	Item		Nominal size	Maintenance standard	Repair limit	Wear limit	Remarks
Oil cooler	Short valve opening pressure (kg/cm²)		3.3	3.1 – 3.5	—	—	
	Short valve spring	Free length	93.7	—	—	—	
		Tension (kg)	—	4.65 – 5.13	—	—	when compressed to 75.3 mm
Regulator valve	Valve opening pressure (kg/cm²)		3.5	3.27 – 3.72	—	—	
	Valve spring	Free length	41.0	—	—	—	
		Tension (kg)	—	5.16 – 5.62	—	—	when compressed to 27.0 mm
Piston cooling oil jet	Valve opening pressure (kg/cm²)		2.0	1.8 – 2.2	—	—	
	Valve spring	Free length	18.5	—	—	—	
		Tension (kg)	—	0.73 – 0.81	—	—	when compressed to 15.5 mm

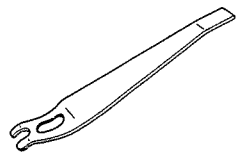
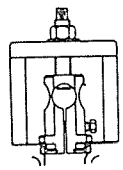
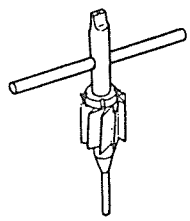
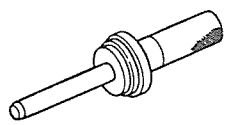
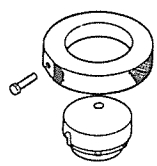
4. Cooling System

Unit: mm

Division	Item		Nominal size	Maintenance standard	Repair limit	Wear limit	Remarks
Water pump	Housing-to-impeller clearance		—	0.8 – 2.1	—	—	
	Clearance between water pump inlet & impeller		—	0.47 – 2.11	—	—	
	Fitting allowance between shaft & impeller		—	0.04T – 0.07T	—	—	T: Tight
Thermostat	Valve opening temp. (°C)		76.5	75.0 – 78.0	—	below 71.5 over 81.5	
			82.0	80.5 – 83.5	—	below 77.0 over 87.0	
	Valve lift (mm/°C)	76.5° C	—	over 8/90	—	below 7/90	
		82.0° C	—	over 8/95	—	below 7/95	
Radiator	Cap operating press. (kg/cm²)	Opening press.	—	0.35 – 0.65	—	—	
		Vacuum press.	—	0 – 0.046	—	—	

Part No. and Part Name	Application	Shape
99645 Z5001 Straight edge	For measuring flatness of cylinder block and cylinder head gasketed surfaces	

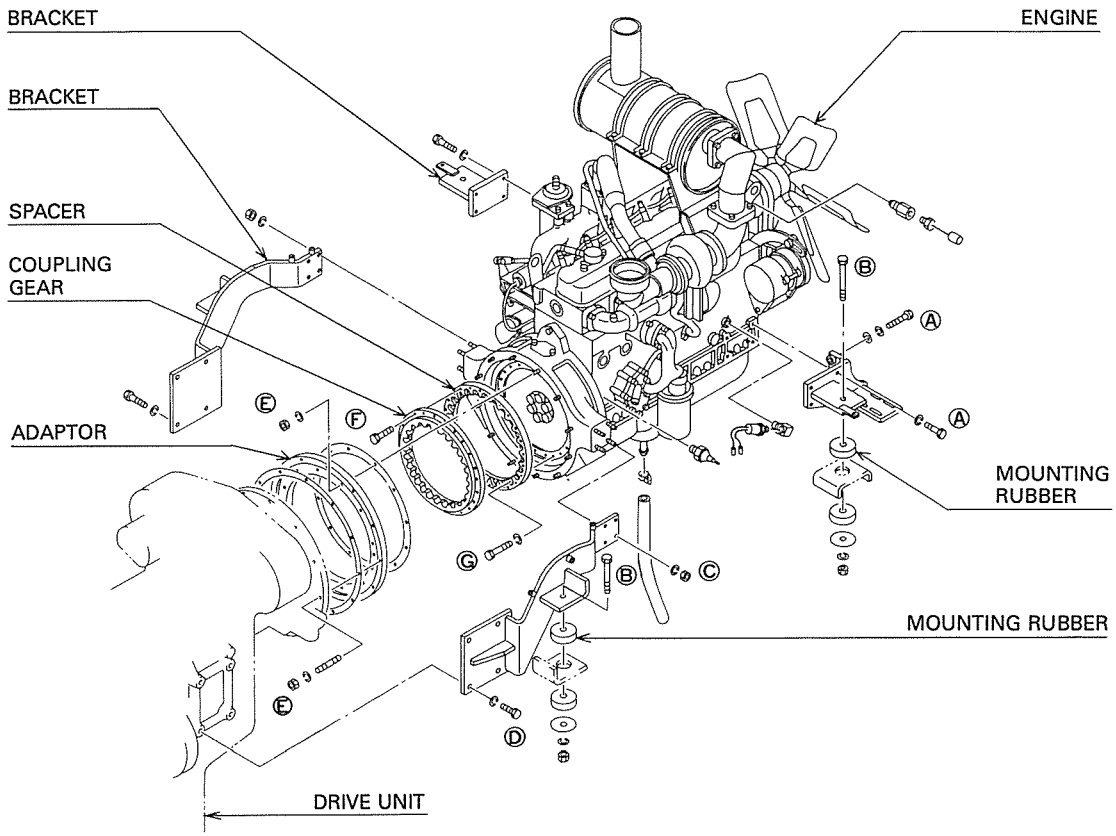
2. Cylinder Head and Valve Mechanism

Part No. and Part Name	Application	Shape
99624 Z5001 Split collar tool	For removal and installation of split collar	
99660 96001 Valve insert remover ass'y	For removal of valve insert	
99661 96000 Cutter	Used to remachine the inside diameter of the exhaust valve fitting part to the standard dimensions when replacing with the 0.5 or 1.0 mm oversized exhaust valve insert. Refer to the table for remachining dimensions and precision.	
99665 96000 Valve insert replacer	For installation of valve insert (cold fitting)	
99670 96000 Valve insert caulking	For caulking valve insert	

NOTE

2. Engine Mount

The engine is coupled to the drive unit and mounted on the rear frame through mounting rubber materials.



Notes 1. Tightening torque kg-m (ft-lbs)

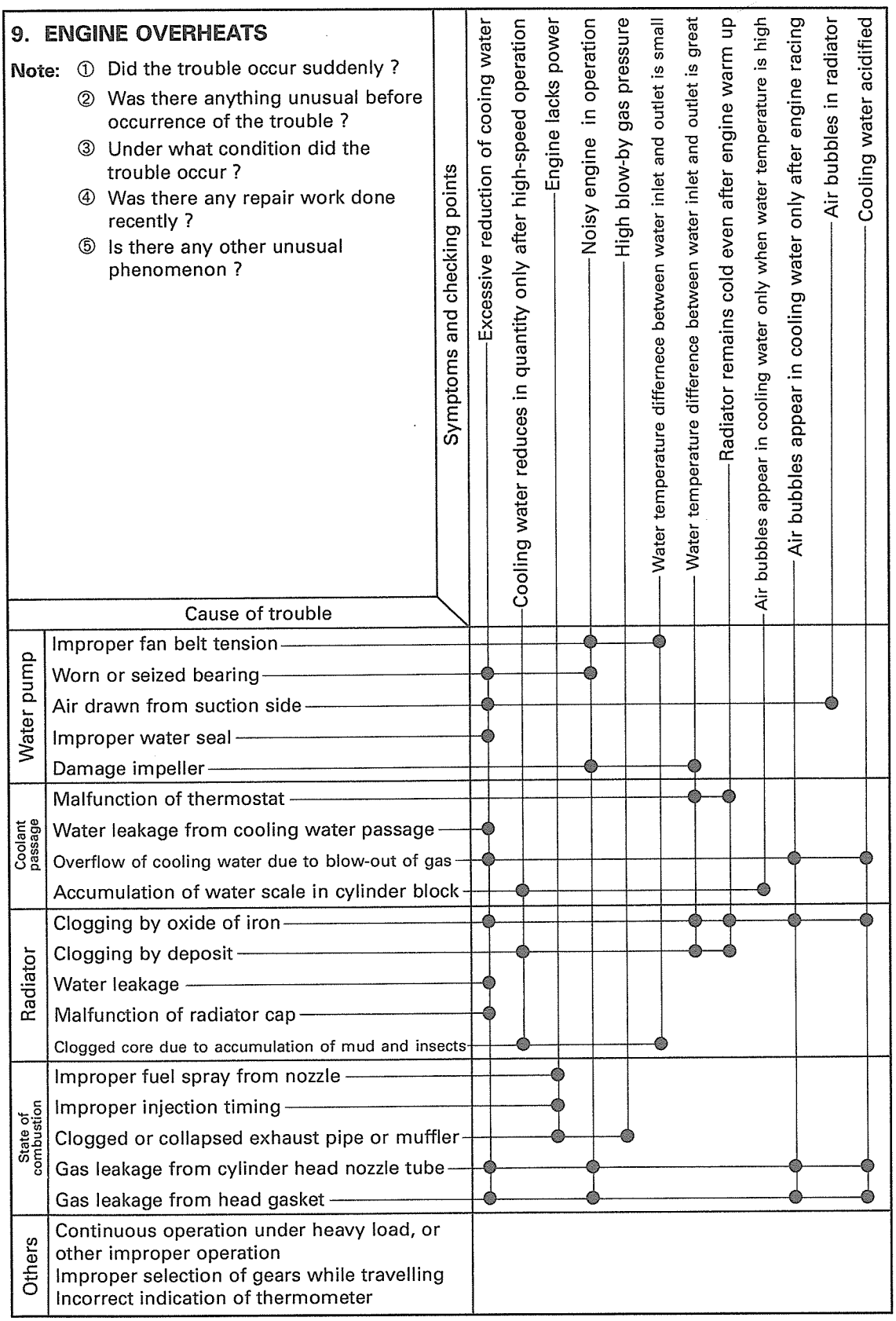
Ⓐ 3.8 (27.5) Ⓑ 22.8 (165) Ⓒ 6.7 (48.5)
Ⓓ 33.4 (242) Ⓔ 3.1 (22.4)
Ⓕ 4.5 (32.5) Apply LOCTITE #262 on threaded area.
Ⓖ 5.1 (36.9) Apply LOCTITE #262 on threaded area.

2. Reassembly of engine and drive unit
   ① Install adapter and gasket on engine flywheel housing.
   ② Remove dirt and antirust agent from spacer fitting surface by solvent.
   ③ Install spacer on flywheel.
   ④ Install coupling gear on spacer.
   ⑤ Lift drive unit with a hoist. Keeping drive unit at a level of flywheel fitting area, mate converter housing to flywheel housing by pushing with hand.
   ⑥ After making sure converter housing fits in flywheel housing completely, tighten converter housing nuts.

Fig. 11C.2 Engine Mount

9. ENGINE OVERHEATS

Note:
① Did the trouble occur suddenly ?
② Was there anything unusual before occurrence of the trouble ?
③ Under what condition did the trouble occur ?
④ Was there any repair work done recently ?
⑤ Is there any other unusual phenomenon ?



④ Remove the timing gear case.

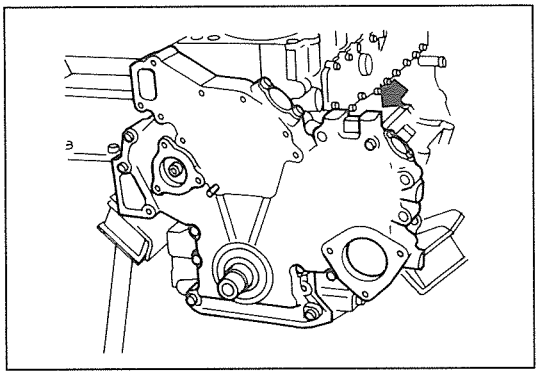


Fig. 11C.32

⑤ Measure the front gear train backlash and record.

Note: When the air compressor was removed, reinstall it and make measurement. After measurement, remove the air compressor.

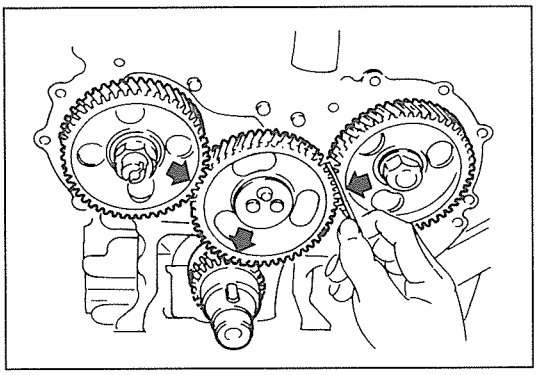


Fig. 11C.33 Backlash Measurement

⑥ Remove the flywheel housing.

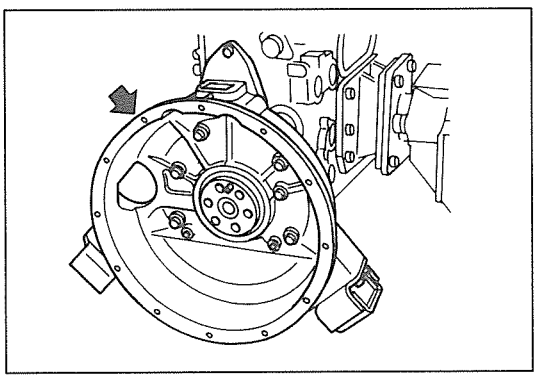


Fig. 11C.34

⑦ Measure the side clearance at the large end of each connecting rod.

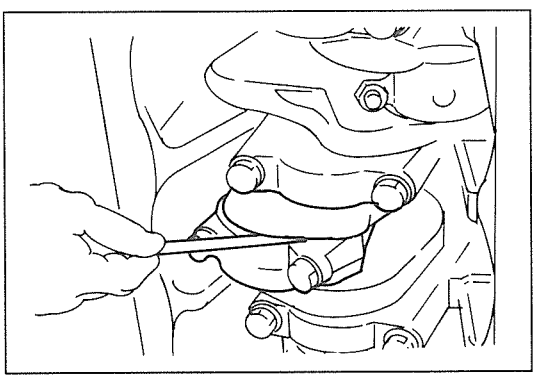


Fig. 11C.35 Side Clearance Measurement

3. Main Bearing Shell

Clearance between main bearing shell and crankshaft journal

Install the main bearing shell on the cylinder block, tighten the main bearing cap to the specified torque of 17.0 – 17.5 kg-m (123 – 127 ft-lbs), and measure the inside diameter of the shell. Calculate the clearance between that value and the outside diameter of the crankshaft journal [see 2.(1)].

Maintenance standard (mm)	Useful limit (mm)
0.03 – 0.09	0.15

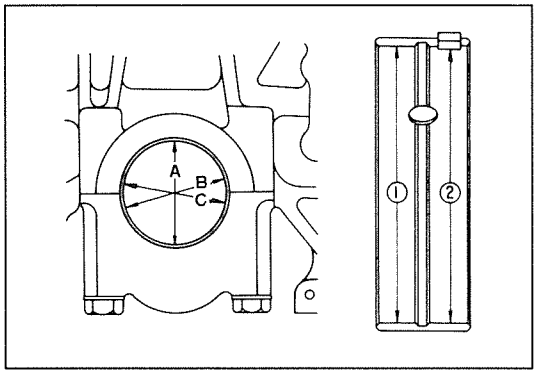


Fig. 11C.54

4. Cylinder Liner

(1) Inside diameter, roundness and taper

With the cylinder liner attached to the cylinder block, measure the inside diameter of the cylinder liner.

	Maintenance standard (mm)	Useful limit (mm)
INSIDE DIA.	108.00 – 108.03	108.23
ROUNDNESS	below 0.02	—
TAPER	below 0.02	—

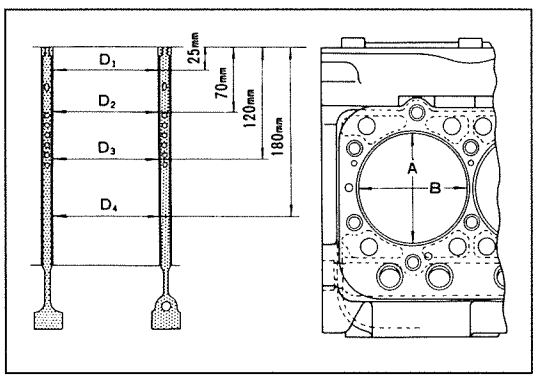


Fig. 11C.55

(2) Protrusion of flange

Maintenance standard (mm)	Useful limit (mm)
0 – 0.07	—

(3) Gap between adjoining cylinders (in protrusion of flange)

Maintenance standard (mm)	Useful limit (mm)
0.03	—

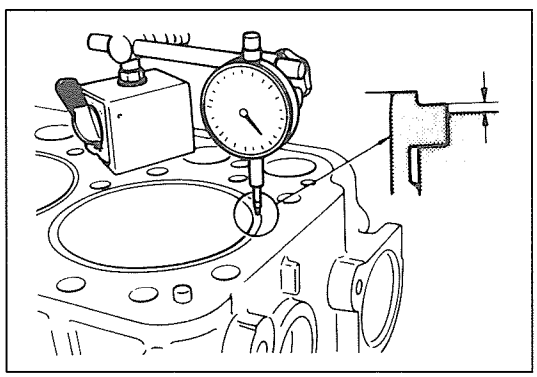


Fig. 11C.56

6. Replacement of Idler Gear Bushing

① Press fit the idler gear bushing until its end is flush with the boss on the front side of the engine.

Note: When the bushing is flush with the boss on the front side of the engine, dimension "H" indicated in the figure will be 1.5 mm at the rear side.

② After press-fitting the bushing, finish the inside diameter of the bushing so that the clearance between the bushing and the idler gear shaft is within the maintenance standard.

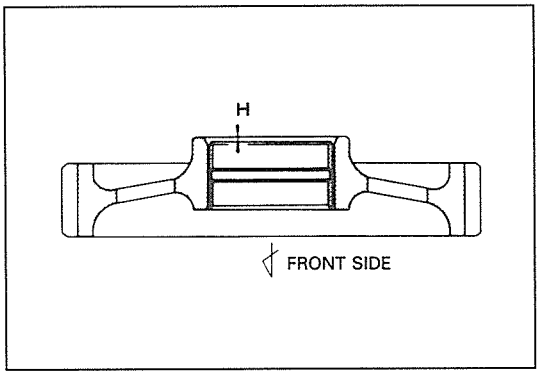


Fig. 11C.82

Item	Maintenance standard (mm)	Useful limit (mm)
CLEARANCE BETWEEN IDLER GEAR SHAFT AND BUSHING	0.02 – 0.06	—

7. Replacement of Oil Seal Collar

① Remove the oil seal collar after warming it.

② Using a collar replacer, press-fit the oil seal collar until it butts up against the crank gear.

Note: When press-fitting the collar, make sure the grooved surface faces upward.

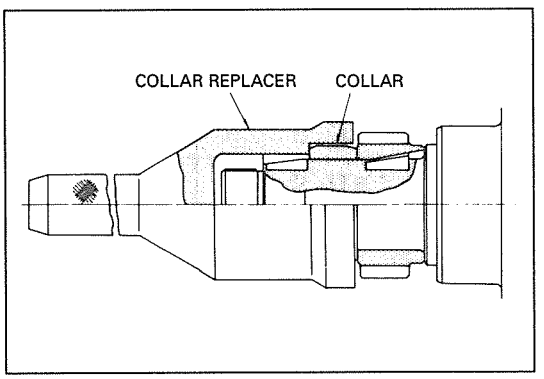


Fig. 11C.83 Installation

8. Replacement of Crank Gear

① Remove the crank gear after warming it.

② Warm the crank gear in an oil bath of about 200°C and fit it onto the crankshaft, aligning the keyway properly.

Note: Use caution not to have the wrong side of the gear.

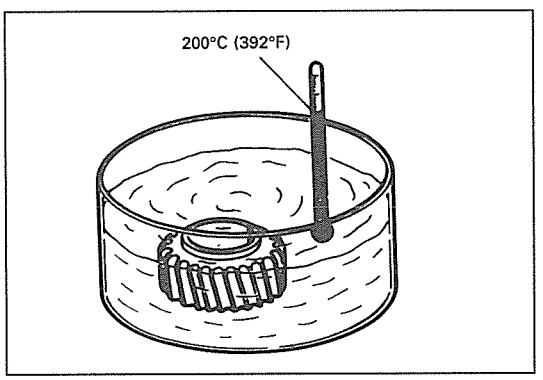


Fig. 11C.84

9. Replacement of Injection Pump Bracket

Whenever the cylinder block or injection pump bracket is replaced, it is necessary to center the injection pump bracket.

③ After fitting the valve insert, caulk the exhaust valve insert at four positions with use of a valve insert caulking tool.

Note: When using a pressing tool, do not allow the pressure to exceed 1,500 kg. Do not caulk the insert at the same point as before.

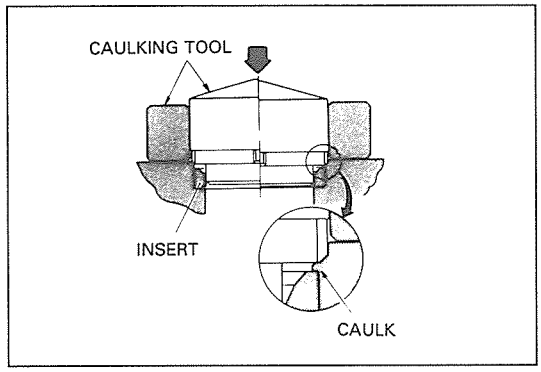


Fig. 11C.112

4. Lapping The Valve

Whenever any valve or valve insert is repaired or replaced with a new one, perform valve lapping.

① Apply the lapping compound sparingly to the valve seating surface.

② Apply engine oil to the valve stem and insert it into the valve guide. With a lapping bar contacted to the valve head, perform lapping by lightly tapping the insert while slowly rotating the valve.

③ After completing the lapping operation, wash the lapping compound away and apply engine oil to the seating surface, and perform lapping with oil.

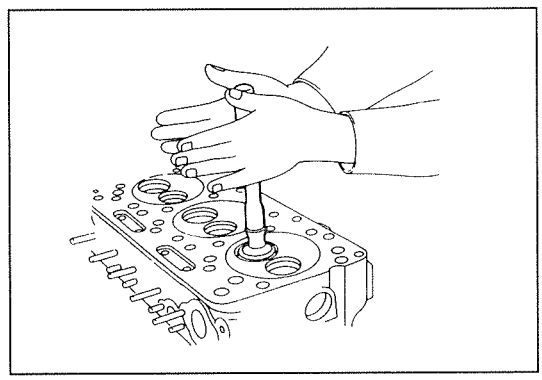


Fig. 11C.113

④ After lapping with oil, apply lead to the valve insert contacting surface to check for contact. If the contact pattern obtained is unsatisfactory, perform lapping again.

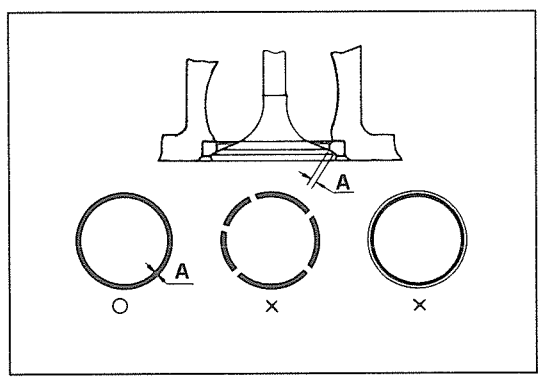


Fig. 11C.114 Contact on Valve Seating Surface

Item		Maintenance standard (mm)	Useful limit (mm)
CONTACT WIDTH BETWEEN VALVE AND VALVE INSERT	Intake	2.2 – 2.4	3.5
	Exhaust	2.0 – 2.3	3.5

Note: Generally, the water pump should not be disassembled. Should external examination indicates any abnormality, however, proceed as follows.

1. External Examination and Correction

① If any sign of water leakage is found around the bore underside of the housing, check the seal and impeller. Replace any parts which are found to be faulty as a set.
② If any sign of oil leakage is found around the bore underside of the housing or from the pulley side, replace the ball bearing at the leaking side.
③ If there is interference between the impeller and housing, or there is too great axial looseness of the ball bearings due to worn ball bearings, replace the ball bearings as a set.

2. Disassembly

① Using a pulley hub puller, remove the flange.
② Remove the snap ring. Using a drive shaft remover at the impeller side, drive out the shaft assembly.
③ Remove the impeller.
④ Using a bearing replacer, drive out the ball bearing together with the spacer and washer.
⑤ Using a water seal replacer, drive out the water seal.

3. Inspection

Item	Maintenance standard (mm)	Useful limit (mm)	Remarks
O.D. OF SHAFT IN IMPELLER FITTING AREA	13.03 – 13.05	—	
FITTING TOLERANCE BETWEEN IMPELLER AND SHAFT	0.03T – 0.06T	—	T: Tight

4. Reassembly

① Set the drive shaft guide on the pump body. Insert the drive shaft assembly.
② Install a washer, and press fit the ball bearing at the impeller side with use of a bearing replacer.
Note: Apply grease on the rotating surface of the bearing.
③ Install the spacer, and press fit the ball bearing at the flange side with use of a bearing replacer.
Note: Apply grease on the rotating surface of the bearing.
④ Install the snap ring.
⑤ Using a fan pulley hub replacer, press fit the flange onto the drive shaft.
⑥ Apply bonding agent on the outer periphery of the water seal. Using a water seal replacer, press fit the water seal onto the pump body.

⑨ Remove the back plate from the center housing.

Note: When the back plate cannot be removed by hand, tap the center housing lightly with a wooden mallet and then remove.

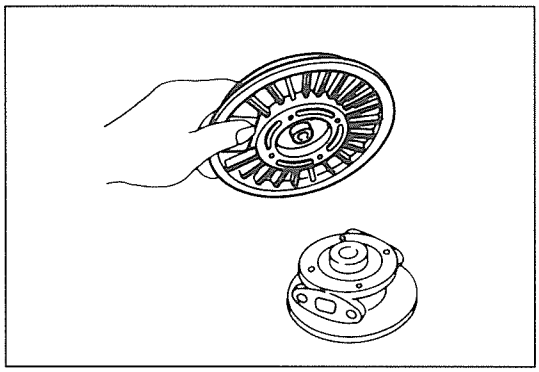


Fig. 11C.150

⑩ Pull out the thrust spacer from the back plate, and remove the piston ring.

⑪ Remove the thrust collar, thrust bearing, and seal ring.

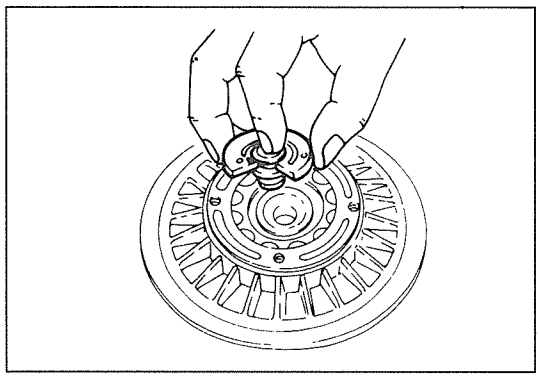


Fig. 11C.151

⑫ Detach the retaining ring from the center housing, then remove the journal bearing.

Note: Care should be exercised as not to damage the center housing and not to allow the retaining ring to drop when removing the retaining ring.

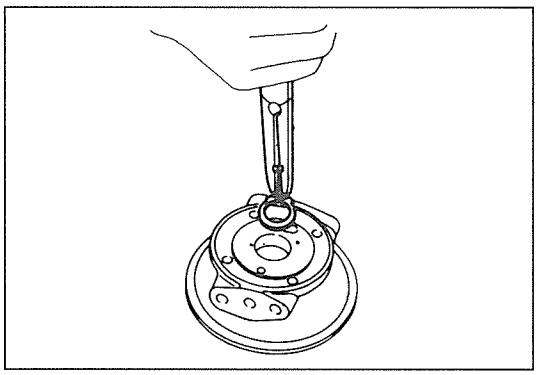


Fig. 11C.152

3. Inspection

① Visually inspect the following components, and if unsatisfactory, replace.

Component	Inspection item
Compressor housing	1) Scratches caused by interference with impeller 2) Scratches on contact surfaces with back plate and on hose connector 3) Cracks or dents

7. Other General-Purpose Bolts and Nuts

Note: When tightening the bolts, nuts or tube connectors whose tightening torque is not specified, refer to the standard tightening torques listed given below.

(1) Bolts and nuts

Size	Pitch (mm)	Torque kg-m (ft-lbs)			Remarks
		4T*	7T*	9T*	
M3	0.5	0.05 (0.36)	0.09 (0.65)	0.13 (0.94)	* Bolt material The material is sculptured or imprinted on the bolt head as follows:
M4	0.7	0.12 (0.87)	0.20 (1.4)	0.30 (2.2)	
M5	0.8	0.24 (1.7)	0.40 (2.9)	0.57 (4.1)	
M6	1.0	0.41 (3.0)	0.68 (4.9)	0.99 (7.2)	
M8	1.25	0.88 (6.4)	1.6 (12)	2.3 (17)	
M10	1.5	1.9 (14)	3.1 (22)	4.5 (33)	
	1.25	1.9 (14)	3.3 (24)	4.7 (34)	
M12	1.75	3.3 (24)	5.5 (40)	7.9 (57)	
	1.25	3.5 (25)	5.8 (42)	8.4 (61)	
M14	1.5	5.5 (40)	9.1 (66)	13 (94)	
M16	1.5	8.3 (60)	14 (100)	20 (140)	
M18	1.5	12 (87)	20 (140)	29 (210)	
M20	1.5	17 (120)	28 (200)	40 (290)	
M22	1.5	23 (170)	38 (270)	54 (390)	
M24	2.0	28 (200)	47 (340)	68 (490)	
	1.5	29 (210)	49 (350)	70 (510)	

Material	Symbol
4T	4 or 40
7T	7 or 70
9T	9 or 90

(2) Tube connector

Item			Torque kg-m (ft-lbs)	Remarks
Flare nut	Tube diameter (mm)	4.76	1.3 – 1.8 (9.4 – 13)	
		6.35	1.6 – 2.4 (12 – 17)	
		8	3.0 – 4.0 (22 – 29)	
		10	4.0 – 5.0 (29 – 36)	
		12	6.0 – 8.0 (43 – 58)	
		15	7.0 – 9.0 (51 – 65)	
Nipple nut			2.1 – 2.9 (15 – 21)	
Eye connector			4.3 – 5.8 (31 – 42)	

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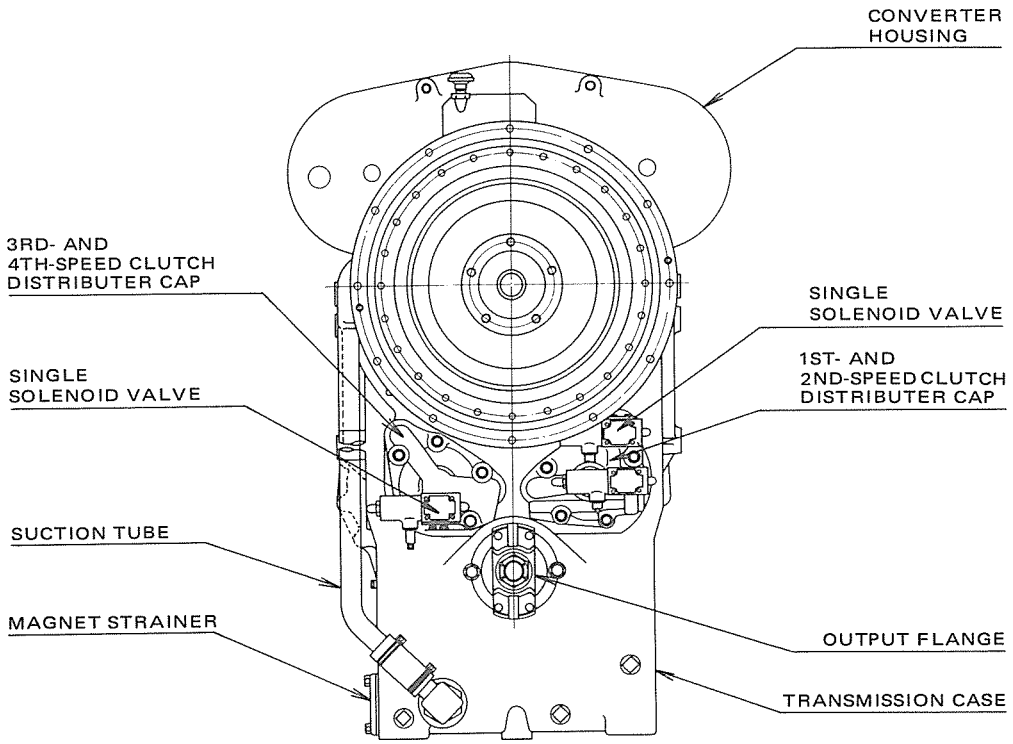


Fig. 21.2 Front side of Drive Unit

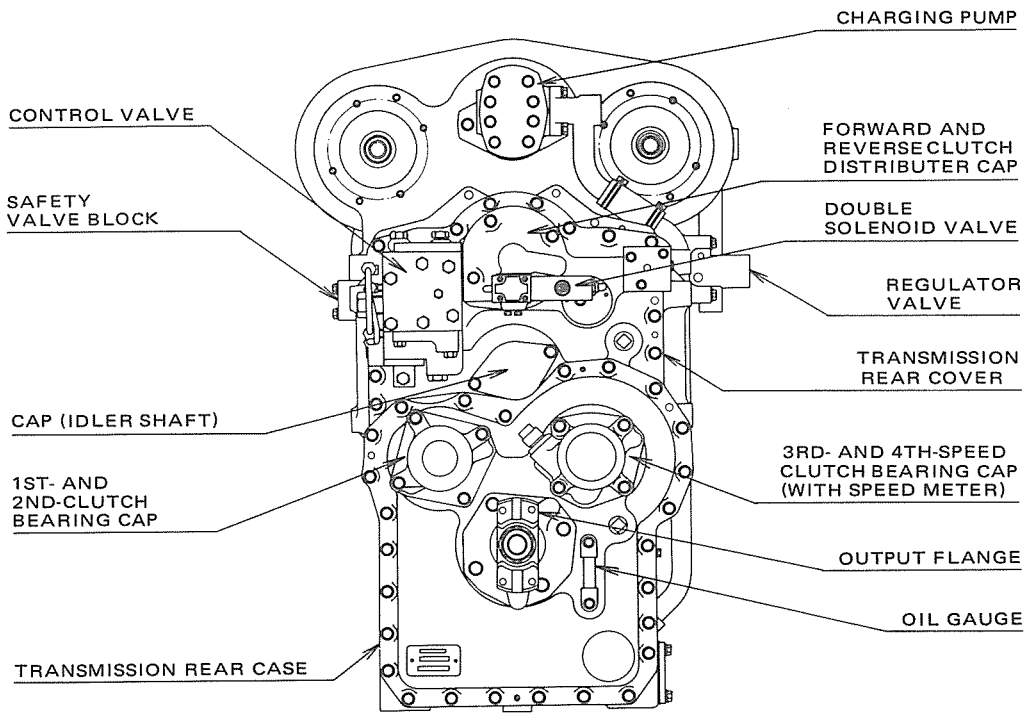


Fig. 21.3 Rear Side of Drive Unit

21.5 INSPECTION AFTER INSTALLATION OF DRIVE UNIT

Whenever the drive unit overhauled or reconditioned is reinstalled to the machine, the oil flow circuit cleaning shall be performed along with several inspections.

21.5.1 CLEANING OF OIL FLOW CIRCUIT

Clean the oil flow circuits of the drive unit, oil cooler, and line filter, referring to "25.3.1 FLUSHING OF OIL FLOW CIRCUIT".

21.5.2 INSPECTION

1. Inspection of Oil Pressure

Inspect the oil flow circuit for oil pressure and leakage, referring to "25.3.2 INSPECTION OF OIL PRESSURE". Measure and record the following oil pressures:

- Transmission clutch oil pressure
- Oil cooler "IN" pressure
- Oil cooler "OUT" pressure
- Transmission lubricating oil pressure

And also check for excessive or abnormal noise.

2. Inspection of Stall Speed

Measure and record the engine stall speed.

21.6 INSPECTION OF ENGINE SPEED AND ITS STALL SPEED

21.6.1 OUTLINE

The engine and torque converter act as a unit to deliver power to the transmission. So if the machine cannot develop the rated power, the engine, drive unit or hydraulic system must be checked.

The engine conditions may be checked by measuring the speeds as follows; the maximum speed under no load condition when the accelerator is fully depressed, the stall speed when the load is applied only to the torque converter, and the stall and relief speeds when the load is applied to both the torque converter and the main hydraulic system.

The drive unit conditions may be checked by measuring the working pressure, oil flow rate and oil leakage. (See "25.3.2 INSPECTION OF OIL PRESSURE".)

21.6.2 INSPECTION OF ENGINE SPEED

1. Inspection of Low Idle Speed

① Check the oil level of engine and drive unit, and fill the oil appropriately if the level is excessively low.

② Install a tachometer on the engine.

③ Keep the torque converter oil temperature within the range of 60 to 80°C.

Note: To increase the oil temperature, run the machine or stall the machine according to the following procedures:

1) Block all wheels completely.
2) Shift the speed change lever into Forward 4th-speed.
3) Depress the right brake pedal, and stall the torque converter for approx. 30 seconds when the engine speed comes to 1500 rpm.

22.2 DISASSEMBLY, INSPECTION, AND REASSEMBLY OF TORQUE CONVERTER

Note: Disassembly, inspection, and reassembly of torque converter are discussed based on the torque converter for the 860. However, the standard maintenance values and tightening torque are listed for all models.

22.2.1 DISASSEMBLY, INSPECTION AND REASSEMBLY OF TORQUE CONVERTER

Note: It is recommended to disassemble or reassemble the torque converter on the unit repair stand for efficient and safe work.

1. Disassembly

(1) Removal of pumps

① Remove four main and steering pump mounting bolts and remove the main steering pump from the converter housing.

② Remove the pump drive sleeve from the pump drive gear.

③ Remove two assist pump mounting bolts and remove the assist pump from the pump adapter.

④ Remove four pump adapter mounting bolts and remove the pump adapter from the converter housing. Then, remove the pump drive sleeve.

⑤ Remove two charging pump mounting bolts and remove the charging pump from the converter housing. Then, remove the pump drive sleeve.

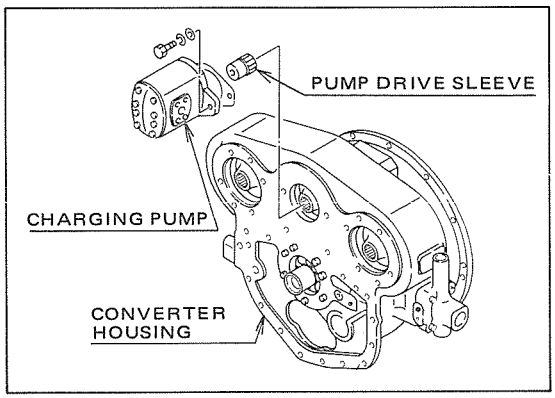


Fig. 22.9 Removal of Charging Pump

Note: Pump removing procedures vary with different models. See Figs. 22.4 through 6.

(2) Removal of regulator valve and safety valve

① Remove four regulator valve mounting bolts and remove the regulator valve from the converter housing.

② Remove four safety valve block mounting bolts and remove the safety valve block from the converter housing.

③ Remove the plunger and spring of the safety valve from the converter housing.

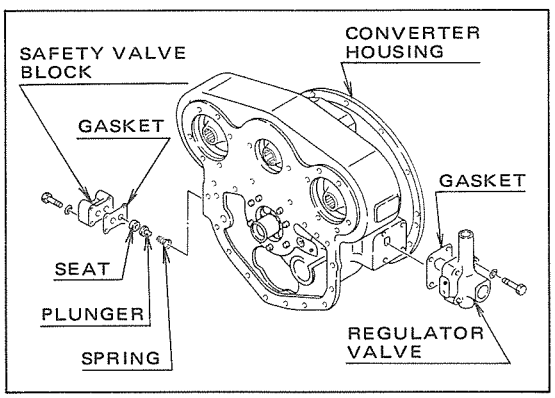
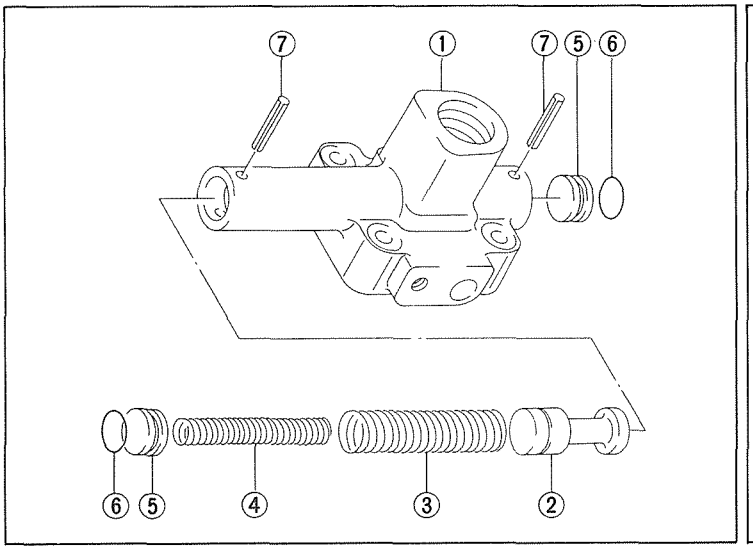


Fig. 22.10 Removal of Valve

22.2.3 DISASSEMBLY, INSPECTION AND REASSEMBLY OF REGULATOR VALVE



1	VALVE BODY
2	PISTON
3	OUTER REGULATOR SPRING
4	INNER REGULATOR SPRING
5	SPRING RETAINER
6	"O"-RING
7	ROLLING PIN

Fig. 22.23 Component Parts of Regulator Valve

1. Disassembly

① Holding the spring retainer, remove the roll pins.

⚠ **Caution: Care must be exercised when removing the roll pins since the spring retainer will pop out.**

② Remove the outer regulator spring, inner regulator spring, and piston from the valve body.

2. Inspection

① Inspect the valve body bore and piston for scores or scracthes. Install the piston in the valve body to check for fitness. If unsatisfactory, repair or replace.

② Inspect the reuglator spring for damage or breakage, and if unsatisfactory, replace.

③ Measure the tension of the regulator spring, and if tension is excessively low, replace.

Item		St'd value (kg)	Useful limit (kg)	Remarks
REGULATOR SPRING TENSION	Outer	9.8 – 11.6		Measured length: 96.8 mm
	Inner	3.1 – 3.9		Measured length: 96.8 mm

3. Reassembly

Reassemble the regulator valve in the sequence opposite to removal.

Note: Replace all "O"-rings with new ones and apply grease prior to installing them to the spring retainer.

23.2 DISASSEMBLY, INSPECTION, AND REASSEMBLY

23.2.1 DISASSEMBLY (See Fig. 23.1)

1. Removal of Input Shaft

① Remove the snap ring from the input shaft.
② Remove the spacer and input shaft gear from the input shaft.
③ Reinstall the spacer and snap ring on the input shaft.

Note: This prevents the input shaft from slipping when removing.

④ Expanding the snap ring on the input shaft bearing circumference, remove the input shaft together with the bearing.

Note: To remove the input shaft, remove the snap ring on the transmission side of the output shaft, then drive in the output shaft to force the input shaft out of the case.

⑤ Remove the snap ring and bearing from the input shaft.

2. Removal of Idler Shaft

① Remove the snap ring on the torque converter side of the idler shaft.
② Using a press, remove the idler shaft together with the bearing (one with the larger diameter) toward the transmission side.
③ Remove the snap ring and bearing from the idler shaft.
④ Remove idler shaft gears (30T and 33T) and two spacers from the gear case.
⑤ Remove the remaining bearing from the gear case.

3. Removal of Output Shaft

① Remove the snap ring securing the output shaft gear on the output shaft.
② Using a press, remove the output shaft together with the spacer and bearing toward the transmission side.
③ Remove the needle roller bearing, snap ring, bearing and spacer from the output shaft.
④ Remove the output shaft gear from the gear case.
⑤ Remove the snap ring from the gear case.

23.2.2 CLEANING AND INSPECTION

1. Cleaning

See "Cleaning of Disassembled Parts of Torque Converter" of subsection 22.2.1-2 for cleaning of the disassembled parts.

2. Inspection

(1) Gears

① Inspect all gears for wear, scratches, or nicks on teeth, and if unsatisfactory, replace.
② Inspect gear splines for damage, torsion, or wear, and if unsatisfactory, replace. Also inspect the spline engagement with the mating member.

(2) Shafts

① Inspect the shafts for deformation, bend, or torsion of splines, and if unsatisfactory, replace.
② Inspect the shafts for deformation, bend, or torsion of splines, and if unsatisfactory, replace the shaft together with the bearing.
③ Using a flaw detector or flow detecting agent, inspect the shafts for flaws, and if any flaw is found, replace.

24.2 OPERATION

24.2.1 CLUTCH OPERATION

Pressure oil for clutch operation is sent from the transmission control valve through the oil passages in the transmission case or the tubes inside the transmission case to the solenoid valves on the distributer caps. When the operator shifts the shift lever into one of the shift positions, the corresponding solenoid valve is selected by the electric circuit to send the pressure oil from the solenoid valve through the distributer cap and the oil passage inside the clutch drum shaft to the gap between the clutch drum and the clutch piston. The oil then pushes the clutch piston toward the backing plate side locking up the inner discs and the outer discs. The clutch drum shaft and the clutch hub thereby rotate as a one piece to transmit the power. When the clutch is in disengagement, the clutch piston is pushed to the drum side by the return spring. This causes a gap between the inner and outer discs, so that the power is not transmitted.

24.2.2 Control Valve Operation

Control valve adjusts the pressures of transmission clutch and master clutch hydraulic oil. It also offers full modulation in changing the travel direction and speed range.

When the brake pedal is pressed, the inching air pressure works on the control valve to disengage the torque converter master clutch, cutting off power transmission from the engine. This is called inching operation.

The control valve adjusts the pressure of hydraulic oil sent via the line filter from the charging pump and sends this oil to the forward/reverse clutch solenoid valve, the three speed change clutch solenoid valves, and master clutch.

Excess oil is sent to the torque converter as torque converter hydraulic oil.

1. Modulate Operation

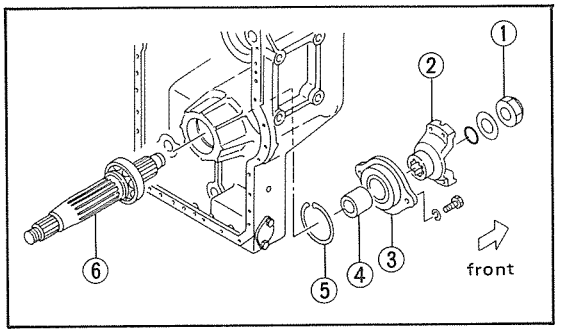
The pressure oil from the charging pump to the control valve is regulated by the clutch pressure relief valve and sent to the master clutch booster valve and transmssion clutch booster valve. The oil relieved from the clutch pressure relief valve is directed to the torque converter.

The master clutch booster valve is connected through the inching valve to the torque converter master clutch. The transmission clutch booster valve is connected to both the forward/reverse clutch solenoid valve and speed range clutch solenoid valves.

Transmission clutch booster valve and master clutch booster valve are a kind of reducing valve, and close the oil passage as the secondary pressure exceeds the spring force, and open it by the spring force as the secondary pressure drops. The flow sensing valve operates on differential pressure ($P_1 - P_2$) across the throttle "A".

12. Removal of Output Shaft

① Remove the locknut, washer and "O"-ring from the output shaft flange (front side).
② Remove the output flange from the output shaft.
③ Remove two oil seal retainer mounting bolts and remove the oil seal retainer from the transmission case.
④ Remove the "O"-ring, oil seal and dust seal from the oil seal retainer.
⑤ Remove the snap ring and spacer from the output shaft bearing (front side), and remove the output shaft together with the bearing toward the rear of the transmission case.
⑥ Remove the bearing from the output shaft.



1	LOCKNUT	4	SPACER
2	OUTPUT FLANGE	5	SNAP RING
3	OIL SEAL RETAINER (with oil seal)	6	OUTPUT SHAFT (with bearing)

Fig. 24.24 Removal of Output Shaft

13. Removal of Magnet Strainer

Remove two magnet strainer mounting bolts and remove the magnet strainer from the transmission case.

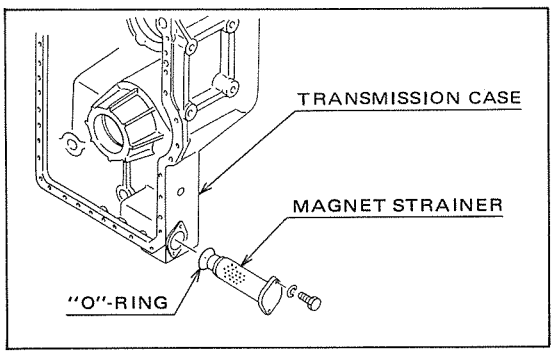


Fig. 24.25 Removal of Magnet Strainer

24.3.2 CLEANING AND INSPECTION

1. Cleaning

See "2. Cleaning of Disassembled Parts of Torque Converter" (22.2.1), for cleaning procedure.

2. Inspection

(1) Bearing

① Inspect the bearing for wear, damage, rust or chipping as well as rotating condition, and make sure the bearing can be re-used. If unsatisfactory, replace.
② Inspect the inner race inner circumference and outer race outer circumference of the bearing for seizing or slipping, and if unsatisfuactory, replace.

(2) Gears

① Inspect all gears for worn, damaged, chipped, cracked or broken teeth. If teeth were broken or chipped, or excessively worn, replace the gear. Repair damage with oil stone if damage is slight.

(4) Clutch hub and gear

① Inspect the gears for worn, damaged, chipped, cracked, or broken teeth. If cracks, wear, or chipping is found, replace the gear. If defect is insignificant, repair with an oil-stone.

② Inspect the clutch hub splines, and if excessive distortion or uneven wear is found, replace the clutch hub. Also inspect looseness between the clutch hub splines and the clutch inner disk.

③ Inspect the bearing fittings area for slipping, seizing, or wear. If unsatisfactory, replace the hub together with the bearing.

(5) Clutch piston

① Inspect the outer seal ring groove for damage, enlargement, or seizing, and if unsatisfactory, replace.

Measure the ring groove width, and if worn excessively, replace.

Item	Standard size (mm)	Useful limit (mm)
WIDTH OF OUTER SEAL RING GROOVE IN PISTON	3.30 – 3.40	

② Blow air to the piston bleed valve to check for proper valve (ball) operation. If leak or malfunction is found, replace.

③ Inspect the piston for worn teeth surface, and if excessive wear is found, replace.

④ Inspect the inner seal ring sliding surface on the piston's inner circumference, and if excessive damage or wear is found, replace.

Item	Standard size (mm)	Useful limit (mm)
INSIDE DIAMETER OF CLUTCH PISTON IN INNER SEAL RING SLIDING AREA (FOR CLUTCH PISTON)	63.50 – 63.55	

(6) Seal ring (for clutch piston)

① Inspect the appearance of the inner and outer seal rings for breakage, damage, or seizing, and if unsatisfactory, replace.

② Measure the width and thickness of the inner and outer seal rings, and if excessively worn, replace.

Item		Standard size (mm)	Useful limit (mm)
INNER SEAL RING (FOR CLUTCH PISTON)	width (axial)	3.10 – 3.20	
	thickness (radial)	3.30 – 3.40	
OUTER SEAL RING (FOR CLUTCH PISTON)	width (axial)	3.15 – 3.25	
	thickness (radial)	6.65 – 6.75	

③ Install the inner seal ring to the clutch piston, and if the joint gap of the seal ring is excessively large, replace.

④ Install the outer seal ring to the clutch drum, and if the joint gap is excessively large, replace.

2. DSS turned on in fwd 2nd

When the downshift switch is pressed with the gears in fwd 2nd, the relay inside the downshift control box changes the electric current from the 2nd speed solenoid valve to the 1st speed solenoid valve so that the gears are shifted into forward 1st.

Even if the finger is removed from the downshift switch, the circuit to the 1st solenoid valve is held by operation of the relay of the downshift control box.

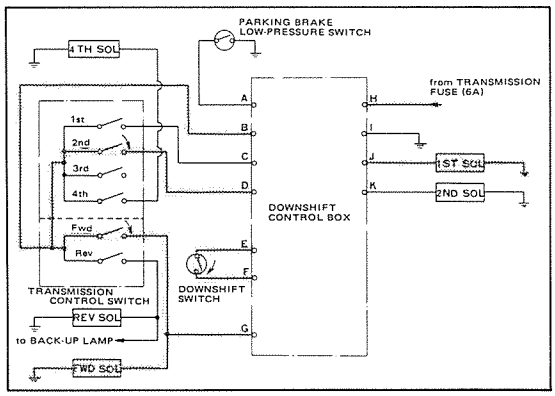


Fig. 24.43 Downshift Switch turned ON

3. Shifting Change Lever in Reverse

By placing the change lever in reverse, the forward switch of the transmission control switch is turned off and reverse switch turned on.

When the forward switch is turned off, the electric current from the 2nd speed switch is changed from the 1st speed solenoid to the 2nd speed one. The forward solenoid valve is deenergized to turn on the reverse switch, energizing the reverse solenoid valve. The machine thus travels in reverse 2nd speed.

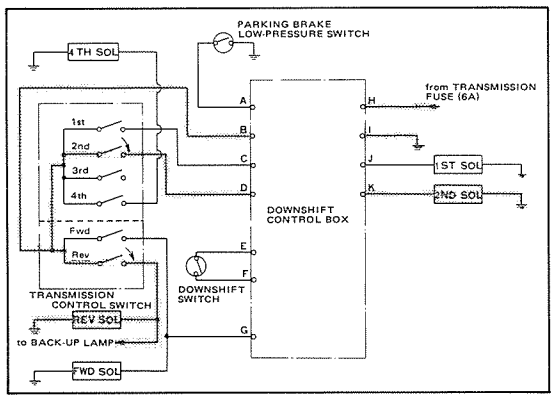


Fig. 24.44 Shifted to Reverse

24.7.3 TRANSMISSION CUT-OFF MECHANISM

The transmission control system is equipped with the transmission cut-off mechanism interlocked with the parking (emergency) brake.

In the parking brake line between the hand valve and quick release valve is the low-pressure switch wired to the downshift control box. When the parking brake is applied, the low-pressure switch is turned on so that the electric current does not flow to the transmission control switch due to the operation of the relay. That is, the machine won't start even if the change lever is actuated, when the parking brake or emergency brake is being applied.

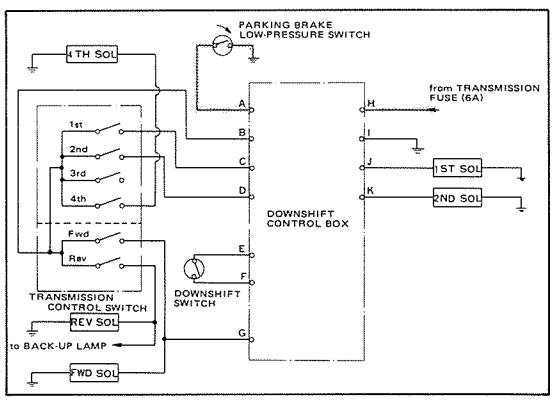


Fig. 24.45 Transmission Cut-off

24.9 MAINTENANCE SERVICE DATA

Division	Item		Standard size (mm)	Useful Limit (mm)	Remarks
Clutch Group	Inside diameter of distributor cap in clutch shaft seal ring sliding area (FWD/REV, 1st/2nd, 3rd/4th)		40.13–40.16		
	Inner seal ring (for clutch piston) (FWD/REV, 1st/2nd, 3rd/4th)	Width	3.10–3.20		
		Thickness	3.30–3.40		
	Groove width for inner seal ring (for clutch piston) (FWD/REV, 1st/2nd, 3rd/4th)		3.25–3.33		
	Inside diameter of clutch piston in inner seal ring sliding area (for clutch piston) (FWD/REV, 1st/2nd, 3rd/4th)		63.50–63.55		
	Outer seal ring (for clutch piston) (FWD/REV, 1st/2nd, 3rd/4th)	Width	3.15–3.25		
		Thickness	6.65–6.75		
	Groove width of piston outer seal ring (FWD/REV, 1st/2nd, 3rd/4th)		3.30–3.40		
	Inside diameter of clutch drum in outer seal ring sliding area (for clutch piston) (FWD/REV, 1st/2nd, 3rd/4th)		148.59–148.84		
	Seal ring (for distributor cap) (FWD/REV, 1st/2nd, 3rd/4th)	Width	3.10–3.20		
		Thickness	2.15–2.25		
	Groove width of seal ring (for distributor cap) (FWD/REV, 1st/2nd, 3rd/4th)		3.25–3.33		
	Inner clutch disk thickness (FWD/REV)		2.92–3.07		
	Inner clutch disk thickness (1st/2nd, 3rd/4th)		2.82–2.97		
	Outer clutch disk thickness (FWD/REV)		1.72–1.80		
	Outer clutch disk thickness (1st/2nd, 3rd/4th)		1.74–1.86		
	Return spring (FWD/REV, 1st/2nd, 3rd/4th)	Free length	46.8		
		Tension (kg)	45		Measured length: 28.9 mm

4. Inspection of Transmission

(1) Clutch oil pressure inspection

① Remove the control valve check port plug (PT 1/8) located at the front of the transmission and install an oil pressure gauge (25 kg/cm^2).

② Check that the oil temperature is within the range from 75 to 85°C.

③ Start the engine and run it at low idling speed.

④ Place the transmission change lever in forward 1st speed, and read the oil pressure gauge after completing modulate operation and record. Check that the measurement is within the standard range.

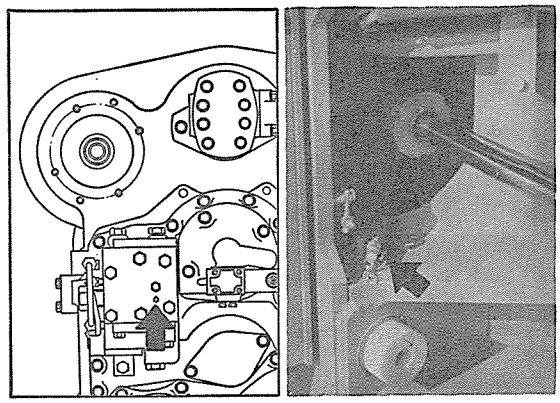


Fig. 25.9 Clutch Oil Pressure Measuring Point

Item	Standard value (kg/cm^2)	Useful limit (kg/cm^2)
TRANSMISSION CLUTCH OIL PRESSURE	17 – 20	17

⑤ In the same manner as above, measure and check the clutch oil pressure at each of forward 2nd, 3rd and 4th speeds.

⑥ Check the clutch oil pressure at each of reverse speeds in the same procedures as forward speeds.

Note: Clutch oil pressure check must be performed for each speed.

⑦ Calculate the clutch pressure difference between one speed and another.

(2) Inspection of transmission lubricating oil pressure

① Remove the check port plug (PT 1/8) of the adapter located at the front of the transmission (where oil returns from the oil cooler) and install an oil pressure gauge (10 kg/cm^2).

② Put the transmission change lever in neutral.

③ Make sure that the oil temperature is within the range from 75 to 85°C.

④ Start the engine and run it at high idling speed.

⑤ Read the pressure indicated by the pressure gauge.

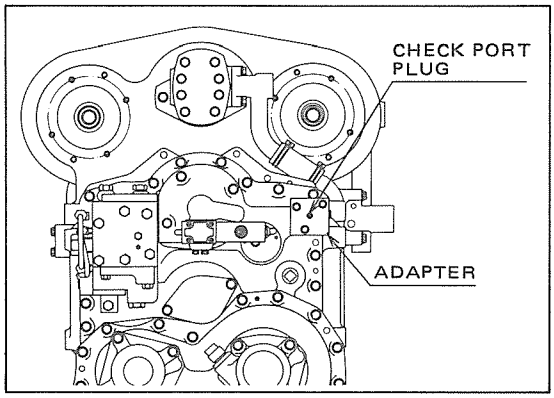
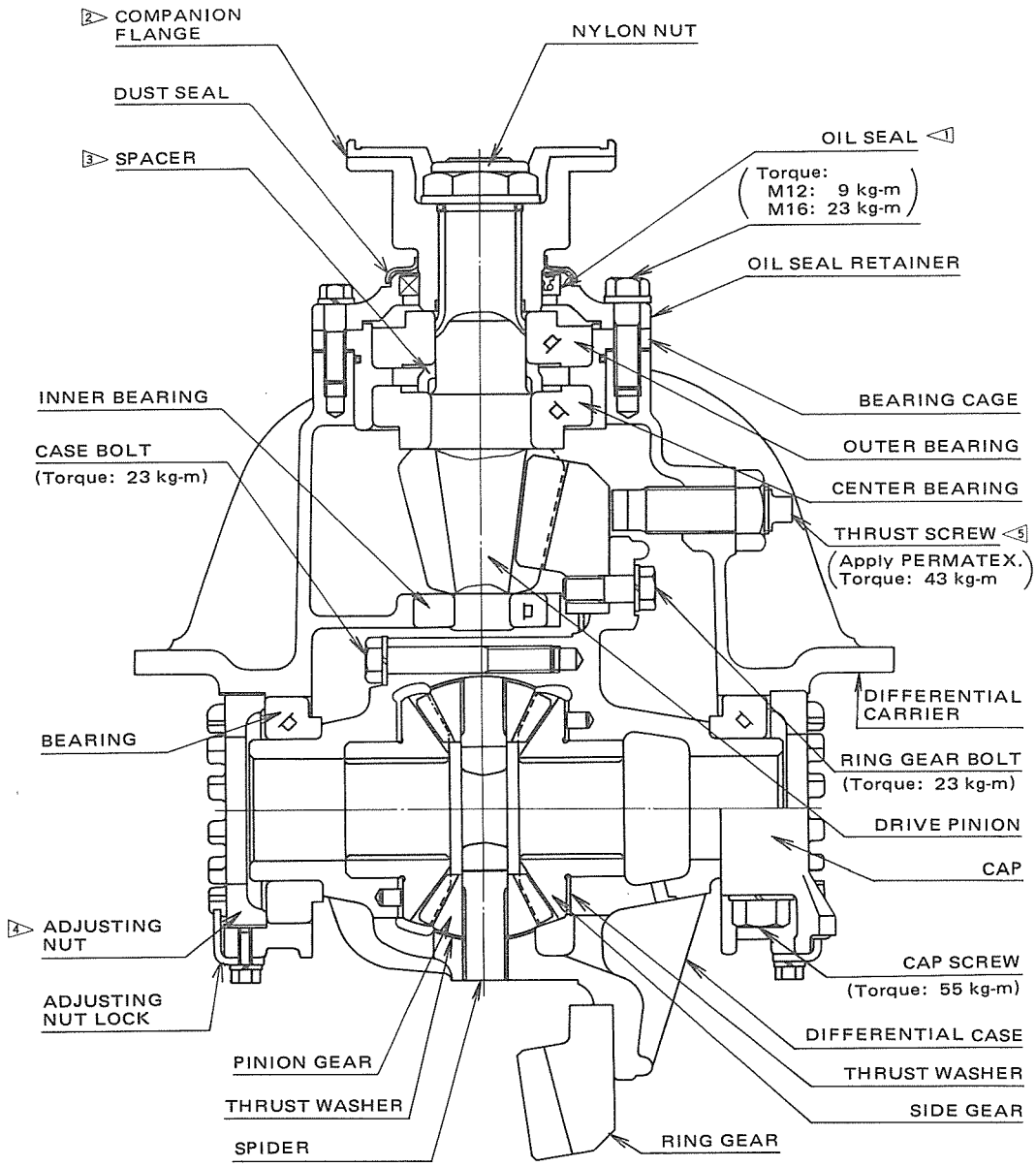


Fig. 25.10 Transmission Oil Pressure Measuring Point



Note 1:

1 PERMATEX No. 2 (equivalent to LOCTITE #241) is applied to the outer ring of the seal and grease to its lip.

2 Grease is applied to chamferred sections and seal sliding section.

3 After mounting pinion to carrier, choose a spacer which gives a pinion bearing resisting torque of 0.15 to 0.26 kg-m (oil seal resisting torque excluded).

4 Adjust so that bearing has no play. The diameter across these bosses should be 390.53 mm or less after final adjustment.

5 The clearance between ring gear and the thrust screw should be 0.51 to 0.64 mm.

Note 2:
Backlash between side gear and pinion gear should be 0.23 to 0.33 mm.

Note 3:
Backlash between ring gear and drive pinion should be 0.25 to 0.36 mm.

Note 4:
LOCTITE #262 should be applied to bolts.

Fig. 26.8 Structure of Rear Differential **(860, 870)**

5. Removal of Drive Pinion (Rear Differential)

① Remove the locknut from the companion flange.

② Using a gear puller or other appropriate means, remove the companion flange from the drive pinion shaft.

③ Remove the eight oil seal retainer mounting bolts and remove the oil seal retainer together with the oil seal.

④ Remove the oil seal from the oil seal retainer.

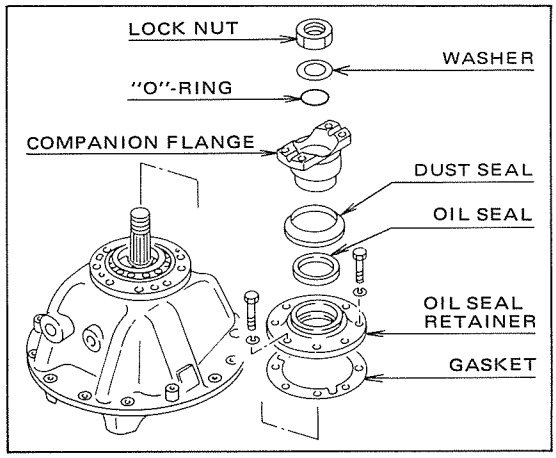


Fig. 26.18 Companion Flange Removal

⑤ Install the puller bolts (two) in the threaded puller holes.

Note: The size of the puller bolt is M10 x 1.5 with the thread length of 60 mm.

⑥ Tighten the two puller bolts equally and pull the bearing cage out of the differential carrier.

⑦ Remove the drive pinion, bearing cage, and inner bearing as an assembly from the differential carrier.

⑧ Remove the shims from the bearing cage.

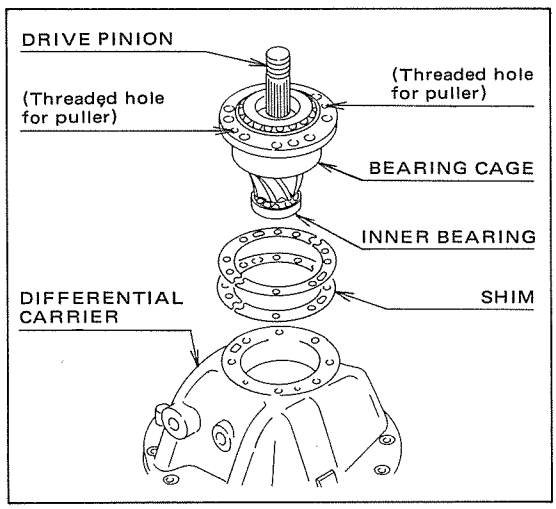


Fig. 26.19 Drive Pinion Removal

6. Disassembly of Drive Pinion (Removal of Bearings)

① Press the drive pinion shaft end to remove the bearing cage from the drive pinion.

② Remove the outer bearing cone and spacer from the bearing cage.

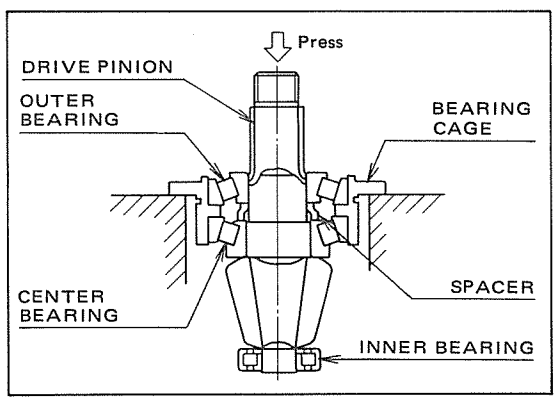


Fig. 26.20 Bearing Cage Removal

26.4 DISASSEMBLY, INSPECTION AND REASSEMBLY OF FINAL DRIVE AND BRAKE ASSEMBLY

Note: The descriptions in this section treat the Model 860 final drive and brake assembly as a standard model. The maintenance service data and the tightening torques, however, covers all the models.

26.4.1 DISASSEMBLY

1. Removal of Brake Housing

① Remove the disk hub and the cooling plate from the brake disk.

② Put a matchmark on each of the brake housing and the gear housing.

③ Remove the 12 gear housing mounting bolts and install four puller bolts each in the puller bolt hole (M16 x 1.5).

Note: To remove the gear housing of Model 850, remove the 14 mounting bolts and four stud nuts and install the four puller bolts.

④ Tighten the puller bolts equally and remove the gear housing from the brake housing.

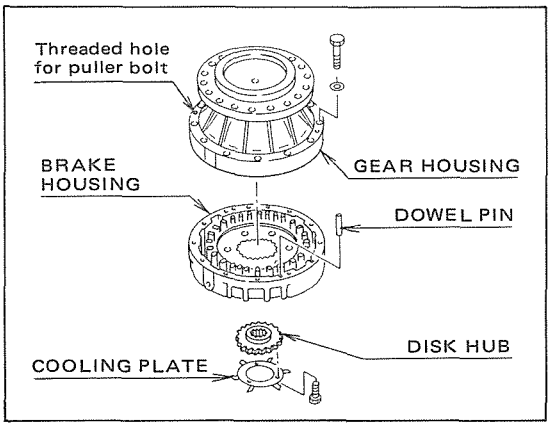


Fig. 26.42 Brake Housing Removal

Note: It is not necessary to remove the two dowel pins.

2. Disassembly of Brake Housing

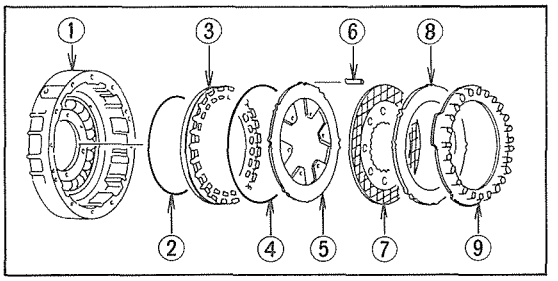
① Remove the end plate, brake ring, brake disk and brake ring from the brake housing in that order.

Note: Exercise care not to lose any of the eight parallel pins.

② Install the six puller bolts each in the six puller bolts holes (M6) of the brake piston, and pull out the brake piston.

Note: Due care should be exercised not to bend the brake piston.

③ Remove the outer and inner "O"-rings from the brake piston.



1	BRAKE HOUSING	6	PARALLEL PIN
2	INNER "O"-RING	7	BRAKE DISK
3	BRAKE PISTON	8	OUTER BRAKE
4	OUTER "O"-RING		RING
5	INNER BRAKE RING	9	END PLATE

Fig. 26.43 Brake Housing Disassembly

26.7 MAIN BOLT TORQUE DATA

Division	Item			Torque kg-m (ft-lbs)	Remarks
Differential	Drive pinion lock nut		850	60 (434.0)	
			860, 870	85 (614.8)	
	Brake disk mounting bolt			5 (36.2)	
	Brake carrier mounting bolt	850	M12	8 (57.9)	
			M14	13 (94.0)	
		860, 870		15 (108.5)	
	Brake adapter mounting bolt	860, 870	M12	9 (65.1)	
			M16	23 (166.4)	
	Oil seal retainer mounting bolt (for rear differential)		M12	9 (65.1)	
			M14	13 (94.0)	
			M16	23 (166.4)	
	Carrier cap mounting bolt			55 (397.8)	
	Differential case mounting bolt		850	15 (108.5)	
			860, 870	23 (166.4)	
	Ring gear mounting bolt		850	15 (108.5)	
			860, 870	23 (166.4)	
	Thrust screw lock nut			43 (311.0)	
Drive axle	Gear housing mounting bolt			23 (166.4)	
	Wheel hub hold bolt		850	111 (802.9)	
			860, 870	162 (1171.7)	
	Final drive and brake assembly mounting bolt			23 (166.4)	
	Differential carrier mounting bolt		850	9 (65.1)	Apply LOCTITE #572
			860, 870	15 (108.5)	
	Return pipe clamp mounting bolt		850	9 (65.1)	
			860, 870	15 (108.5)	
	Front axle mounting bolt		870	180 (1302)	
	Rear axle mounting bolt		860	88 (636.5)	
			870	180 (1302)	
	Wheel bolt			88 (636.5)	

Note: Unless otherwise specified, the bolts should be coated with LOCTITE 262.

b. Utilization of drum pump

Fill a drum can with the solution, connect a hose to the discharge port of a drum pump, and then send compressed air of about 5 kg/cm^2 from an air compressor to the drum pump.

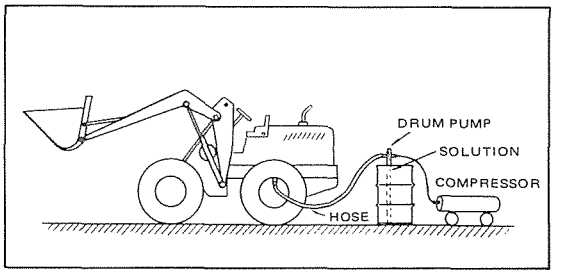


Fig. 28.3

c. Utilization of water tap

When using water as liquid ballast, connect the injector hose directly to a tap, and inject water by making use of the water pressure.

(3) Liquid injection procedures

a. Air valve and air-and-water valve

① Jack the wheel up and separate it from the ground. Then, turn the tire so that the valve comes up to its highest position.

② Remove the core of the air valve or the core housing of the air-and-water valve to remove air from the tire.

③ Connect the specified injector to the valve and inject the liquid.

④ For the air valve, remove the injector's socket several times during liquid injection to remove air from the tire.

Note: For the air-and-water valve, air automatically comes out from the injector used.

⑤ Stop injecting the liquid when the liquids comes up to the valve position and install the core of the air valve or the valve core housing of the air-and-water valve.

⑥ Fill the tire with air then and adjust the inflation pressure as specified.

b. Water valve

① Set the valve to its highest position in the same manner as the air valve, and remove air from the tire by removing the core of the air valve.

② Remove the plug of the water valve, connect a given injector, then inject the liquid until it comes up to the water valve position.

③ Install the air valve core and the water valve plug.

④ Fill the tire with air then and adjust the inflation pressure as specified.

(4) Liquid draining procedures

a. Air valve and air-and-water valve

① Jack the wheel up to separate it from the ground and turn the tire so that the valve comes down to its lowest position.

② Remove the valve core to drain the liquid. For the air-and-water valve, removing the core housing accelerates draining the liquid.

⚠ **Caution: Due care should be taken when allowing the liquid to discharge since it ejects strongly especially at the initial stage.**

③ After draining off the liquid, install the valve core, fill the tire with air, and adjust the inflation pressure as specified.

Note: The liquid left in the tire can be used as part of air inflation.

31.3.2 REMOVAL AND INSTALLATION

1. Removal

(1) Removal of brake valve

① Apply the parking brake and block the wheels.
② Open the drain cocks of the two air tanks to discharge compressed air.
③ Remove the tubes from the brake valve.

Note: Before removing the tubes, mark the positions of the valve body and tubes.

④ Remove the plug and switch located at each port of the brake valve.
⑤ Remove the three bolts securing the valve mounting plate to the floor board and remove upward the brake valve and pedal as an assembly.

Note: The inlet/exhaust valve can be removed without removing the tubing and brake valve in this way: Remove the retaining ring located at the bottom of the brake valve and pull out the inlet/exhaust valve.

(2) Removal of brake valve ass'y

① Remove the clip pin of the brake pedal mounting bracket and remove the roll pin.
② Remove the full-clam pin and remove the brake pedal assembly.
③ Remove the three brake valve mounting bolts and remove the mounting plate.

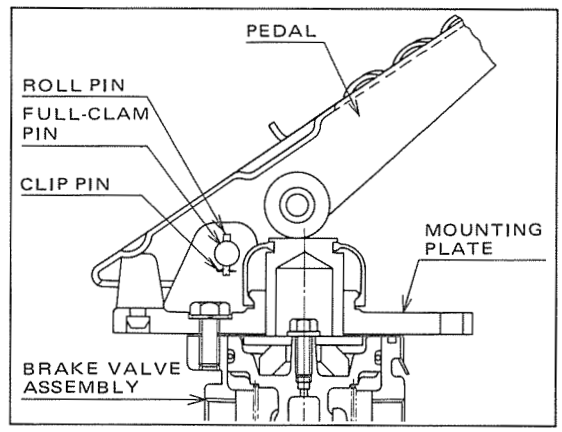


Fig. 31.10

2. Installation

Clean the fitting areas and ports of the brake valve and reinstall in the sequence opposite to removal.

31.3.3 DISASSEMBLY, INSPECTION AND ASSEMBLY

1. Disassembly

(1) Removal of piston assembly

① Press down the spring seat the remove the retainer from the body.
② Remove the piston assembly and return spring from the body.
③ Remove the bolt of the piston assembly and remove the washer, spring seat and rubber spring.
④ Remove the "O"-ring from the piston.

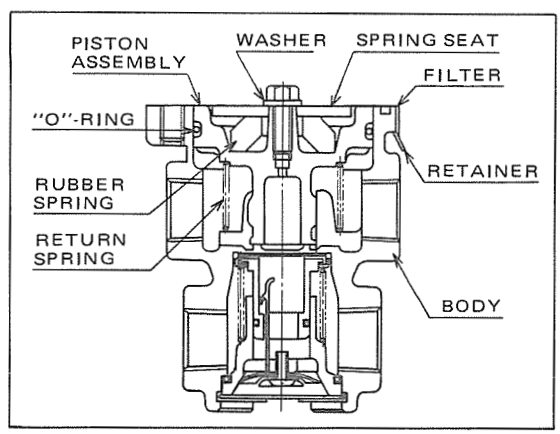


Fig. 31.11

31.6A AIR COMPRESSOR
(APPLICABLE MODEL: 850)

Model:	M10
No. of cylinders – dia. x stroke:	1 – 85 mm x 60 mm
Driving method:	Gear train direct-coupling drive
Cooling method:	Air cooling
Lubrication method:	Forced circulation

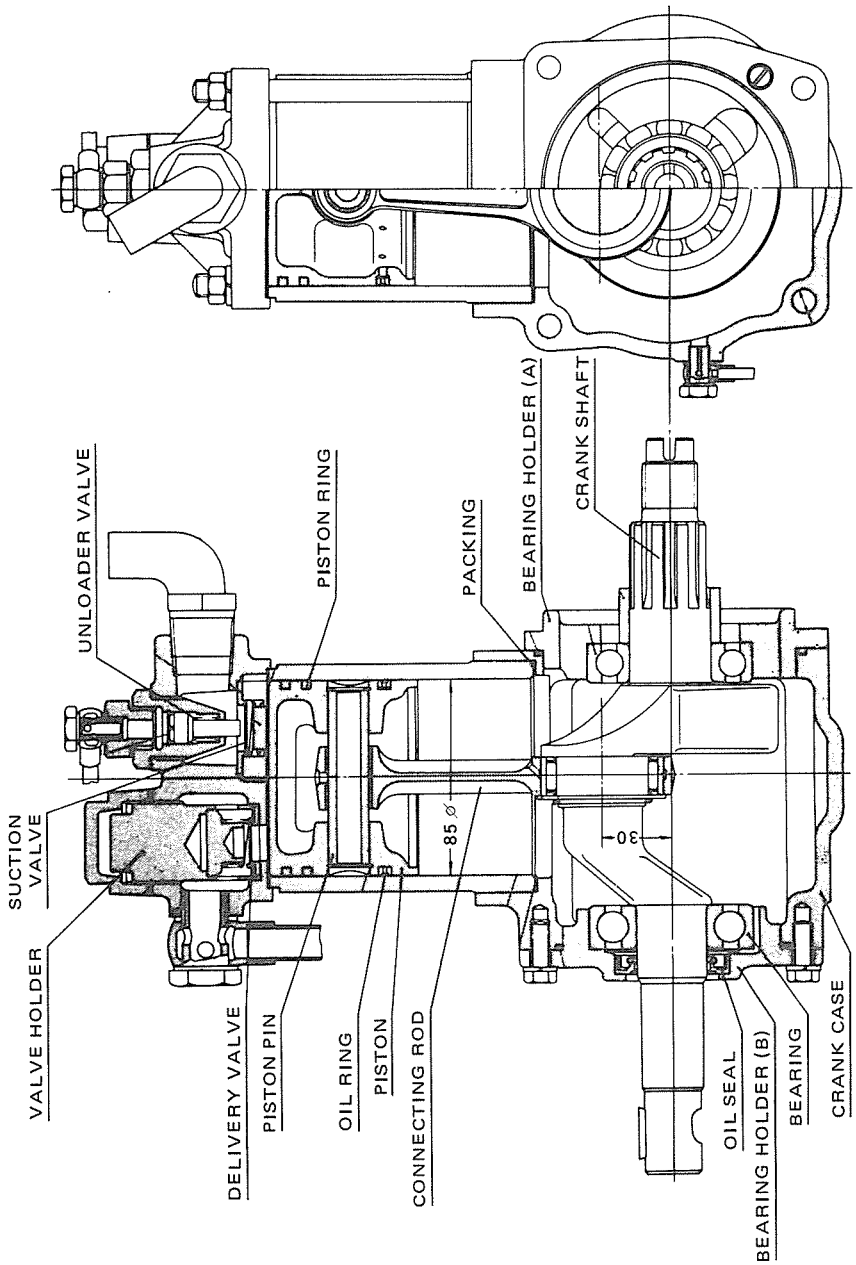


Fig. 31.23 Structure of Air Compressor

(3) Removal of crank shaft

① Remove the two bearing holder mounting screws and remove the bearing holder, tapping the edge of the bearing holder with a soft hammer.
② Remove the packing of the bearing holder.
③ Remove the crank shaft from the crank case, tapping the end of the crank shaft.
④ Using a bearing puller, remove the two ball bearings from the crank shaft.
⑤ Remove the oil seal from the crank case.

(4) Disassembly of cylinder head

① Remove the delivery valve holder. Then remove the spring holder, valve spring, delivery valve, valve seat and two "O"-rings from the cylinder head.
② Remove the unloader valve holder from the cylinder head and disassemble the unloader valve.
③ Using a valve holder tool (special tool), remove the suction valve holder from the cylinder head. Then, remove the valve spring, suction valve, valve seat and packing from the cylinder head.

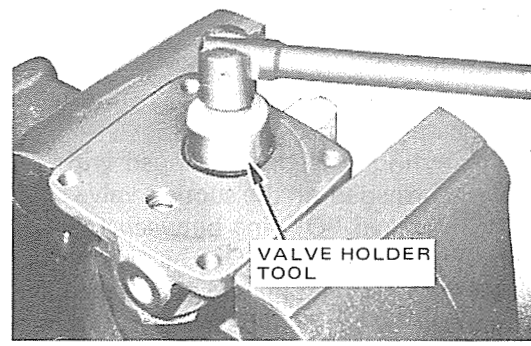


Fig. 31.32 Removal of Suction Valve

2. Cleaning

Clean all disassembled parts with cleaning oil except for rubber parts and dry them by blowing air.

3. Inspection

(1) Piston and cylinder

① Inspect the outer side surface of the piston and the inside wall of the cylinder for damage. If found damaged, repair or replace.
② Measure the piston outer diameter and the cylinder inside diammeter and from these measurements, calculate the clearance. If the clearance is beyond the repair limit, replace the piston or cylinder.

Item		Maintenance standard (mm)	Repair limit (mm)
PISTON-TO-CYLINDER CLEARANCE	Top	0.18 – 0.25	0.28
	Skirt	0.09 – 0.16	0.18

③ Check the piston ring for damage or uneven wear and if unsatisfactory, replace.
④ Measure the gap between the compression ring and ring groove and if the measurement is beyond the repair limit, replace the piston or compression ring.

Item	Maintenance standard (mm)	Repair limit (mm)
GAP BETWEEN COMPRESSION RING AND RING GROOVE	0.01 – 0.04	0.08

31.9.2 INSPECTION OF OIL TIGHTNESS IN OIL LINE

① Start the engine and raise the air pressure to the specified level. Stop the engine.
② Press the brake pedal and hold it for 1 minute.
③ If the indicator of the chamber-and-cylinder assembly comes forward, oil is leaking from the disk brake, master cylinder of chamber-and-cylinder assembly, piping, or joint. or joint.
④ If the piping is defective, replace it. If the joint is the cause of leaks, retighten. If retightening does not stop air leaks, replace the joint. Check also the disk brake and chamber-and-cylinder assembly and if unsatisfactory, repair or replace.

31.9.3 INSPECTION OF BRAKE VALVE OPERATION

① Install an air pressure gauge between the double check valve and the quick release valve.
② Start the engine and increase the air pressure to the specified level.
③ Press the left brake valve to several stages throughout the total stroke to check the brake valve discharge pressure at each stage. Make sure from the measurements that the brake valve discharge pressure increases in proportaion to the increase of the brake pedal pressing angle.
④ Also make sure that the brake valve discharge pressure is almost the same as the air pressure in the air tank when the brake valve is fully pressed and that it is zero when the brake valve is released.
⑤ Check the right brake valve for operation in the same way.

3. Inspection

① Inspect the diaphragm for cracks, breakage or excessive wear and if unsatisfactory, replace.

② Check the spring for breakage, deterioration or deformation and if unsatisfactory, replace.

③ Check other parts for damage or cracks and if unsatisfactory, replace.

4. Reassembly

① Place the pressure plate on a level stand with the threaded are of the push rod upward and install the spring and non-pressure plate over the push plate.

② Install the adapter (special jig) on the push rod and tighten the nut to the push rod to compress the spring (See Figure 32.7).

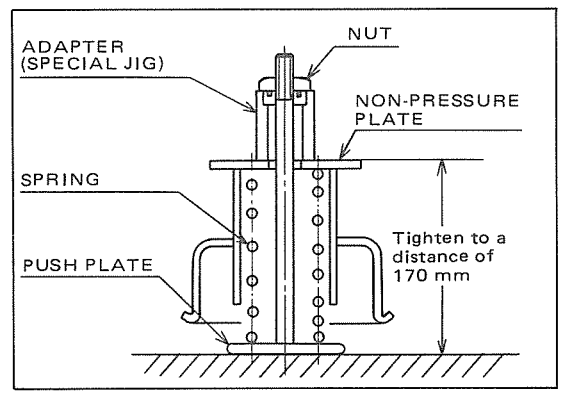


Fig. 32.7

③ Widen the clamp ring and install on the flange of the non-pressure plate.

Note: The clamp ring should be aligned with the mark made before disassembly.

④ Put the diaphragm and pressure plate over the non-pressure plate.

⑤ Widen the clamp ring and install it on the flange of the pressure plate.

Note: The pressure plate should be aligned with the mark made before disassembly.

⑥ After making sure that the diaphragm is installed in position, secure the clamp ring with two sets of bolts and nuts.

CLAMP BOLT & NUT TIGHTENING TORQUE = 1.5 – 2.0 kg-m (11 – 14 ft-lbs)

Note: Adapter (Special jig):

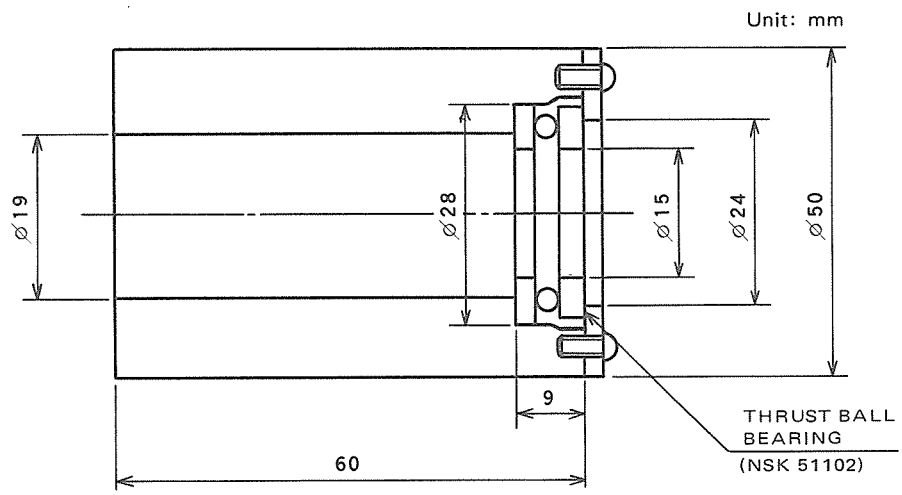


Fig. 32.8 Adapter (Special Jig)

TCM
東洋運搬機 TOYO UMPANKI CO., LTD.

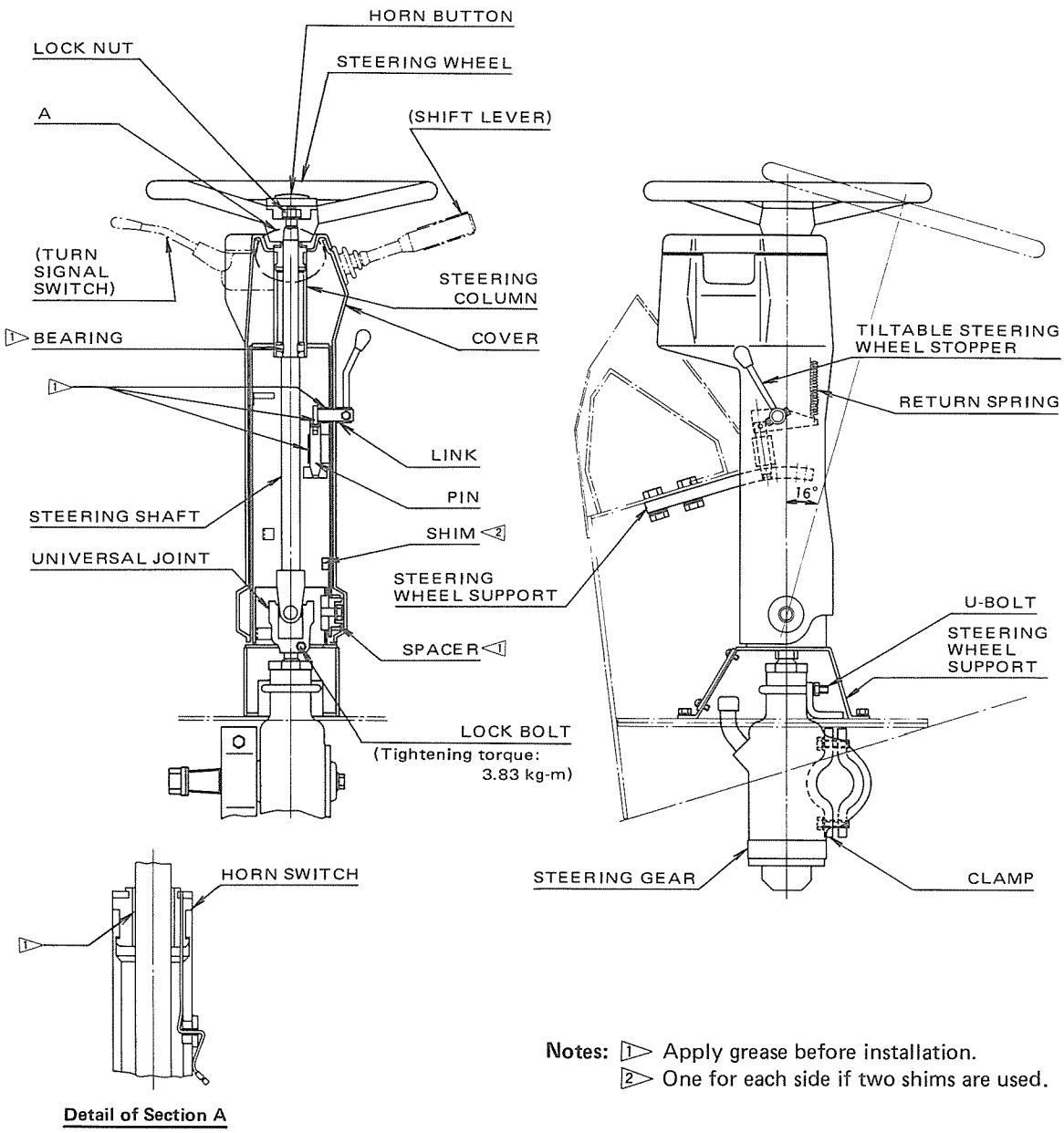


Fig. 41.5 Structure of Steering Wheel

41.4.2 OPERATION

1. In Neutral

When the steering wheel is placed to the straight-travel position (neutral position), the pressure oil from the steering pump flows not only into chamber (b) thru the orifice of the carry-over plunger but also into chamber (a) thru a notch of the plunger and a small opening, because ports (A) and (B) to the steering cylinders are blocked up by the steering spool. However, since chamber (a) is open to the load check valve inside the steering spool via the small opening and the oil hole in the steering spool, the oil opens the load check valve to flow into the low-pressure oil passage when the pressure of hydraulic oil from the steering pump rises.

The pressure in chamber (b) thereby becomes higher than that in chamber (a), so that the carry-over plunger overcomes the spring tension and moves to the right to open the carry-over port to the pump port. Therefore, hydraulic oil sent from the steering pump all flows into the main circuit by way of the carry-over port.

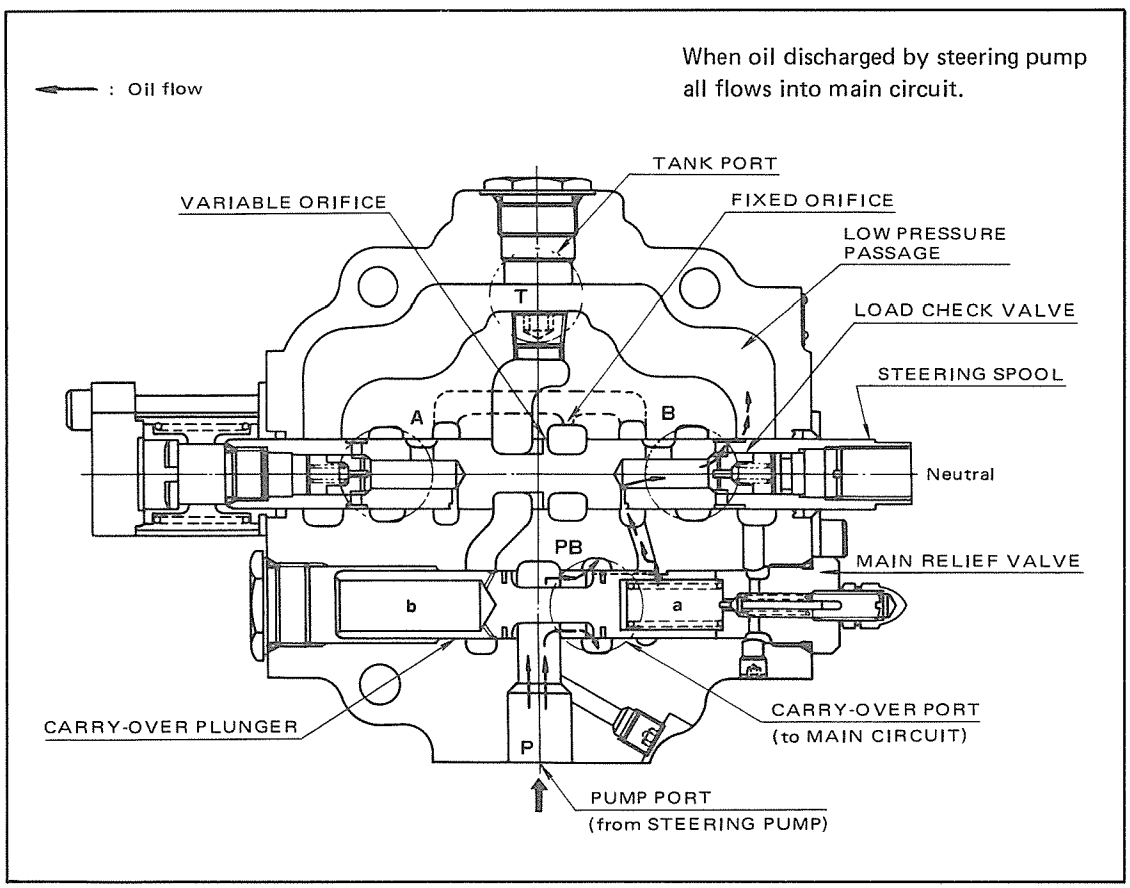


Fig. 41.19 Neutral State (Engine Started)

Turning angle change of the steering wheel changes the angles made by the sector shaft and the pitman arm. The amount of positional change of the link is thereby controlled. The turning radius of the machine accordingly corresponds to the turning angle of the steering wheel.

The steering wheel turning speed, on the other hand, controls the operating speed of the linkage, whereby the opening area of the oil passages to the cylinder ports is also controlled. So that turning the steering wheel slowly results in slow steering speed and turning it rapidly is followed by speedy steering.

(2) Feedback operation of linkage

When the steering wheel is held after turned clockwise, the screw shaft and the ball nut stop their movement and the sector shaft and the pitman arm are locked to stop the movement of the rod coupled with the link. However, the steering cylinder keeps the front frame turning to the right because the steering spool is kept drawn out.

This rightwise turning of the front frame works on the link through the front frame pivot so that the link is turned to the rear frame side with the joint between the link and the rod as a pivot. The push rod is thereby moved to push the steering spool in and the steering valve is put back in the neutral position. The machine therefore continues turning with the once-made steering angle kept till the steering wheel is operated again.

The bending of the machine frame is thus fed back to the steering valve by the linkage so that the turning radius corresponding to the turning angle of the steering wheel is maintained.

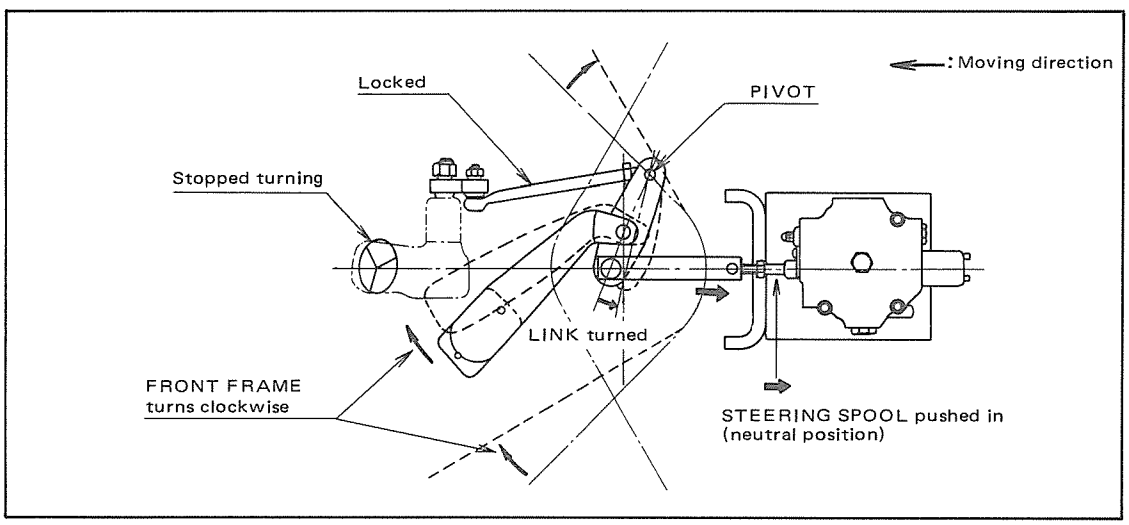


Fig. 41.33 Feedback Operation of Linkage

3. With Steering Wheel Turned Left

When the steering wheel is turned counterclockwise, the steering gear, pitman arm, rod, and link respectively operate in the directions opposite the right turning of the steering wheel and the steering spool is therefore pushed in. Hydraulic oil then flows in the direction opposite to the direction taken by oil to flow when the machine turns to the right so that the front frame turns to the left.

For feedback operation, the linkage operates in the manner opposite the linkage operation performed when the steering wheel is turned right, so that the steering spool resumes its neutral position.

41.7 STEERING CYLINDER

Type:	Double-acting piston type
Quantity:	2
Weight (per piece):	32 kg

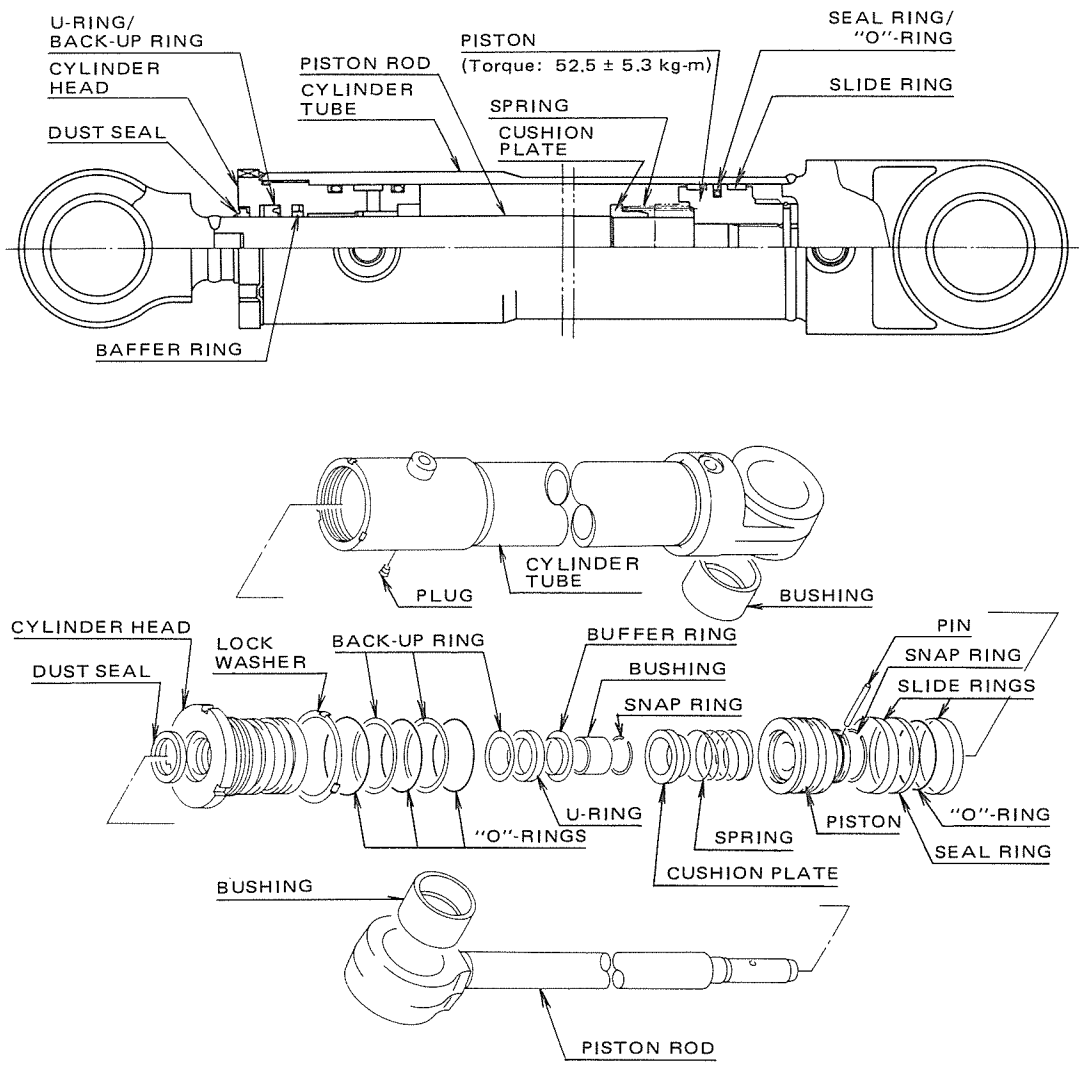


Fig. 41.47 Steering Cylinder Construction & Component Parts

Trouble	Probable Cause	Check	Remedy
Unusual sound heard	Pin or bushing of steering cylinder worn	Manipulate and listen	Replace
	Anchor bolt hole of steering cylinder deformed	Manipulate and listen	Repair
	Steering cylinder piston rod bent or cut	Disassemble and check	Repair or replace
	Steering cylinder and cradle improperly installed	Manipulate and listen	Adjust by spacer
Oil leaks	Packing or "O"-ring of steering gear damaged	Check visually	Replace
	Bearing support mounting bolt of steering gear loose	Check tightening torque	Tighten to specified torque
	Packing, seal or "O"-ring of steering valve damaged	Check visually	Replace
	Packing, seal or "O"-ring of steering cylinder head damaged	Check visually	Replace
	Loosened tube connection in steering circuit or damaged hose or tube	Check visually	Retighten or repair

Note: At the hinge section used is the double-row taper roller bearing which makes it unnecessary to perform preload adjustment. The shim is used for prevention of water and mad entry and deformation due to tightening. Therefore, be sure to use a thinner shim than the clearance so that a clearance of below 0.25 mm be secured.

⑧ Remove the upper and lower caps and insert the selected shim. Then install the upper and lower caps again.

CAP MOUNTING BOLT TIGHTENING TORQUE: (850, 860) = 9.0 kg-m (65.1 ft-lbs)
(870) = 22.8 kg-m (164.9 ft-lbs)

⑨ Assemble the bearing and the cap of the lower hinge in the same manner as the upper hinge.

⑩ Insert the upper bushing in the lower hinge.

2. Installation of Hinge Pins

① Move the frame so that the upper and lower hinge pin holes of the front and rear frames are aligned.

② Insert the upper hinge pin and secure it by the set bolt.

UPPER HINGE PIN SET BOLT TIGHTENING TORQUE (850, 860 & 870) = 8.54 kg-m (61.77 ft-lbs)

Note: Apply grease to the upper hinge pin.

③ Insert the lower hinge pin.

Note: Coat the lower hinge pin with grease.

④ Install the lower bushing on the lower hinge pin and temporarily install the washer and the center bolt.

LOWER HINGE PIN CENTER BOLT TEMPORARY TIGHTENING TORQUE:
(850, 860) = 30 kg-m (217.0 ft-lbs)
(870) = 45 kg-m (325.5 ft-lbs)

WASHER MOUNTING BOLT TEMPORARY TIGHTENING TORQUE:
(850, 860) = 4 kg-m (28.9 ft-lbs)
(870) = 9 kg-m (65.1 ft-lbs)

⑤ Measure the clearance between the washer and the rear frame and select a shim so that the clearance be below 0.25 mm.

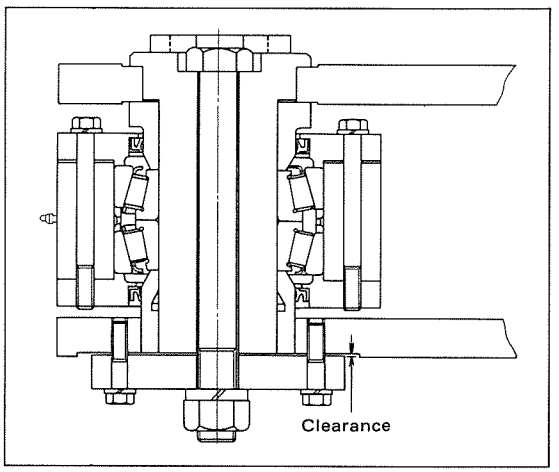


Fig. 51.7 Shim Selection (Clearance Measurement)

⑥ Remove the temporarily installed washer and center bolt and insert the shim selected. Then install the washer and the center bolt again.

LOWER HINGE PIN CENTER BOLT TIGHTENING TORQUE: (850, 860) = 103 kg-m (745.0 ft-lbs)
(870) = 154 kg-m (1113.9 ft-lbs)

WASHER MOUNTING BOLT TIGHTENING TORQUE: (850, 860) = 9.0 kg-m (65.1 ft-lbs)
(870) = 22.8 kg-m (164.9 ft-lbs)

61A.4 RUNNING-IN OF PUMP

1. Running-in

When the pump is replaced with a new one or overhauled, it should be run in. The optimal way of running in the pump is to use a special test stand. However if the test stand is not available, install the pump on the machine for running-in.

If the pump has been seized or unusually worn inside (that is, unusual wear of the gear plate circumference, bearing, gear or other), be sure to perform flushing throughout the circuit and to replace not only hydraulic oil in the oil tank but the filter element (see "65A.3 FLUSHING OF OIL CIRCUIT"). Proceed thereafter with running in the pump in the following procedures:

2. Running-in Procedures

① In order to measure the main relief pressure in the hydraulic circuit, install an oil pressure gauge (250 kg/cm^2) on the machine (see "65A.2.1 MAIN RELIEF PRESSURE CHECK AND ADJUSTMENT").

② Put the control valve in the neutral position and run the engine (pump) at the speed of 500 to 1000 rpm for about 10 minutes.

Note: The oil pressure gauge reads 10 kg/cm^2 or below when the control valve is in the neutral position.

③ Increase the engine (pump) operating speed up to 1500 to 2000 rpm, and keep it running at that speed for some 10 minutes also unloaded. If the pump shows any trouble at this stage, immediately stop operating it. Then inspect after disassembling it.

④ With the engine (pump) running at 1500 to 2000 rpm, operate the pump for about 5 minutes at each circuit pressure which should be raised by 20 to 30 kg/cm^2 until the maximum working pressure is reached.

Notes 1: Adjust the circuit pressure either by changing the main relief valve set pressure or by applying appropriate load to the load handling system.

2: Pay attention to the oil temperature, the pump surface temperature, and unusual sound if any, while operating the pump under high pressure. If the oil temperature or pump surface temperature rises unusually high, unload the pump and resumes the operation after the temperature goes down.

3: Touch your hand to the pump body to check the pump surface temperature. If the pump surface remains too hot to touch by hand even after the pump is kept operating at one pressure stage for some 1 minute while the oil tank's exterior temperature is low enough to touch by hand (i.e. below 50°C), the pump has some trouble. If so, immediately stop operating the pump and inspect it after disassembling.

The surface temperature somewhat goes up when the pressure is raised, but goes down to the previous level after the pump is kept operating at that pressure for 1 minute or so if the pump is normal.

⑤ Put the main relief valve to the specified pressure setting, and put each circuit in operation for about 5 minutes. Then replace the return filter element with a new one.

⑥ Check the discharge of the pump.

Note: Check that the loading system operates at the proper speeds (boom raising time and dump time) before checking the discharge from the pump (see "71.5 INSPECTION OF LOADING SYSTEM").

(5) Suction operation

When the pressure at the cylinder port side becomes lower due to a cavitation than that at the return passage side, the check valve poppet ④ is moved by the difference in area between ① (diameter A) and ⑪ (diameter C) to open the passage, allowing the oil to flow from the return passage to the cylinder port side to remove the cavitation.

The combination valve used as the port relief valve also offers such an anticavitation function as mentioned above.

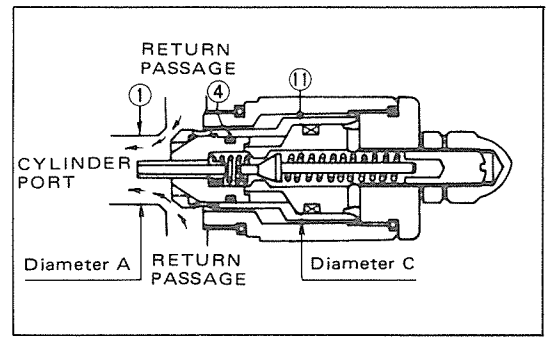


Fig. 62A12 Suction Operation of Port Relief Valve

62A.3.2 MAIN RELIEF VALVE

The main relief valve is installed at the control valve pump port and protects the whole hydraulic circuit of the loading system as well as controls the hydraulic control operating pressure. It is set to the maximum pressure of the circuit within the range of its pressure setting.

The main relief valve operates as follows: the hydraulic oil led from the steering valve flows through the center oil hole in the piston poppet into the chamber Ⓑ at any time. As the pressure in the hydraulic circuit exceeds the preset value, the pressure oil in the chamber Ⓑ opens the pilot poppet and flows to the return oil passage, lowering the pressure in the chamber Ⓑ. This produces the pressure difference between the chambers Ⓐ and Ⓑ, shifting the relief poppet. The pressure oil from the steering valve therefore flows through the oil holes in the sleeve and return oil passage to the oil tank.

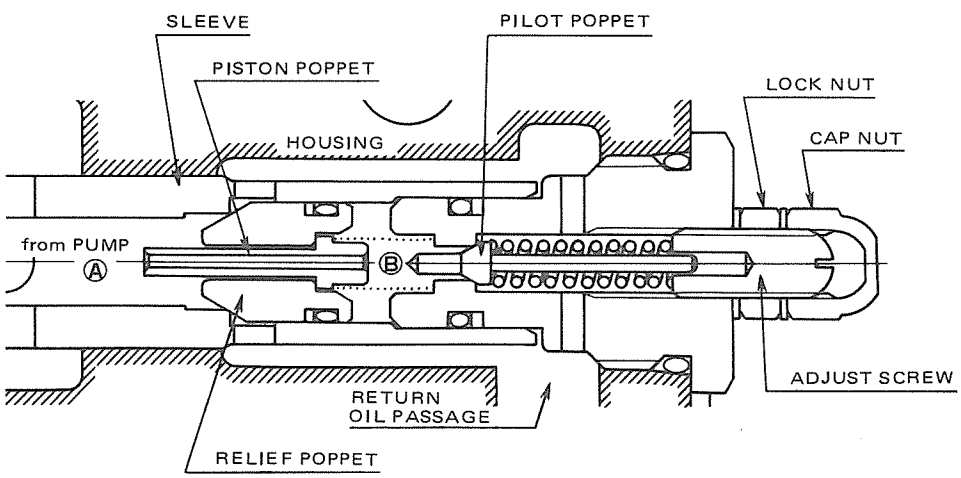


Fig. 62A.13 Main Relief Valve

NOTE

NOTE

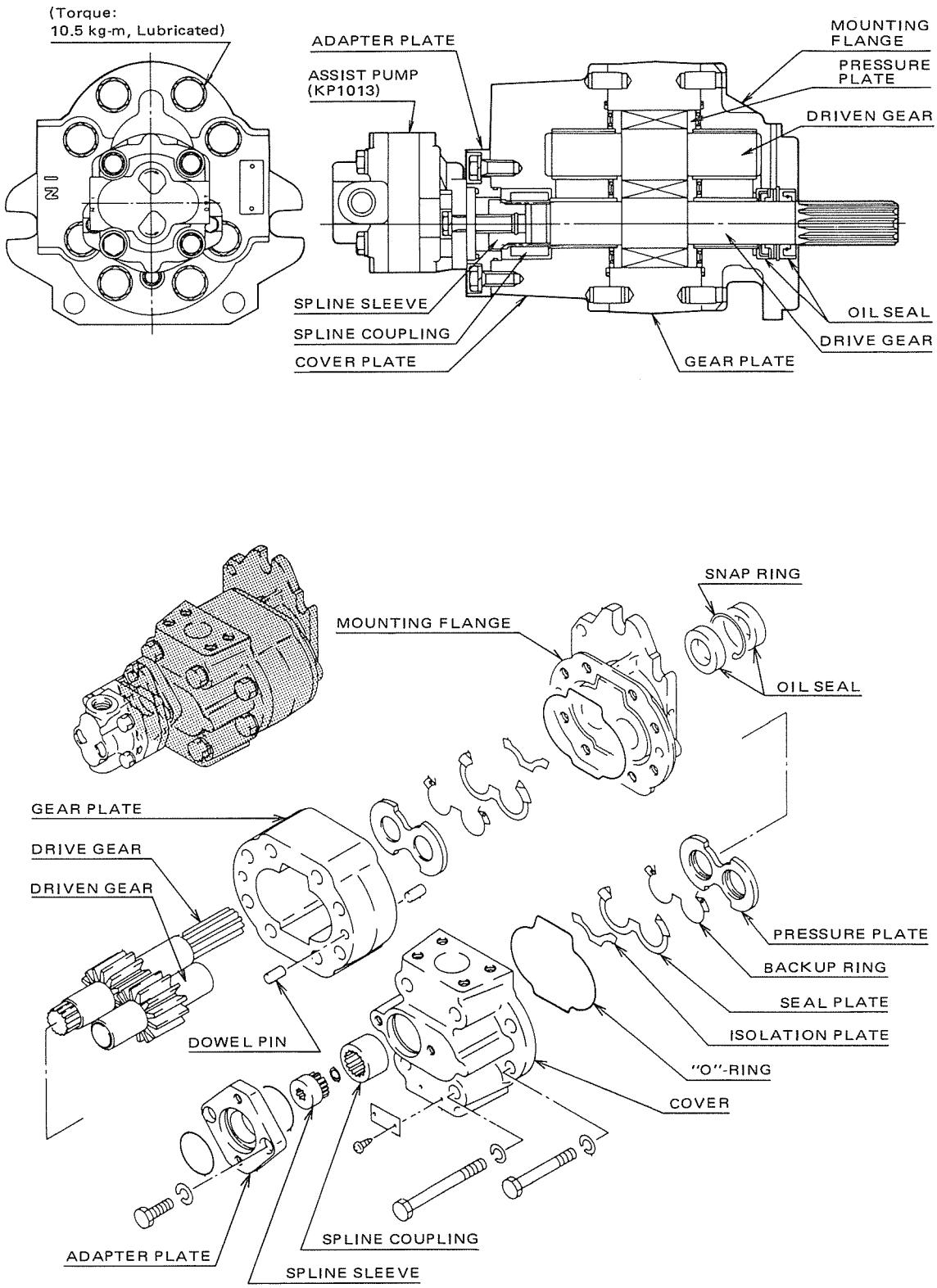


Fig. 61B.2 Main Pump Construction and Component Parts (870)

2. Disassembly

Notes 1: It is necessary to clean the pump before repairing or overhauling it. Block therefore the ports of the pump with clean waste cloth to prevent dust and other foreign matters from entering the pump, then clean the exterior of the pump by steam or other appropriate wears.

2: Carefully handle the disassembled parts so as not to give them scars, dents and other damages. Also, arrange them on clean paper or cloth so that they be not mistaken for one another when reassembled.

① With the cover side upward, hole the flange of the pump in a vise.
② Remove the four cover mounting bolts.
③ Remove the cover from the gear plate.

Note: The cover should be pulled straight in the axial direction. If hard to remove, tap it lightly with a soft hammer.

④ Remove the "O"-ring from the cover.
⑤ Remove the side plate (B) from the gear plate.
⑥ Remove the drive gear and driven gear from the gear plate.

Note: Put a matchmark on each shaft end of the drive and driven gears by oil stone for later alignment of their teeth.

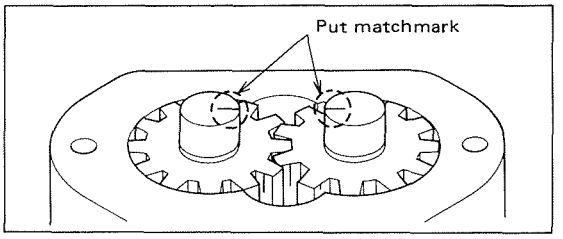


Fig. 61B.18

⑦ Remove the side plate (A) from the bottom of the gear plate.

Note: When removing the side plate, care should be exercised so as not to pull it askew. If it becomes askew and unremovable, insert the drive gear into the gear plate and gently push down the side plate to its original position. Then try to remove the side plate again.

⑧ Remove the gaskets (A and B) and balance seal from the flange.

Note: The balance seal can easily be removed by prying it with a screwdriver.

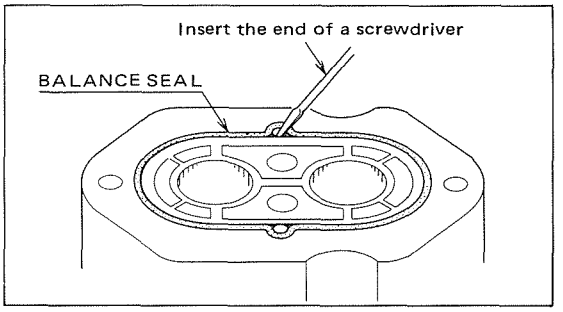


Fig. 61B.19

⑨ When replacing the oil seal, remove the flange from the vise and remove the snap ring. Then remove the oil seal.

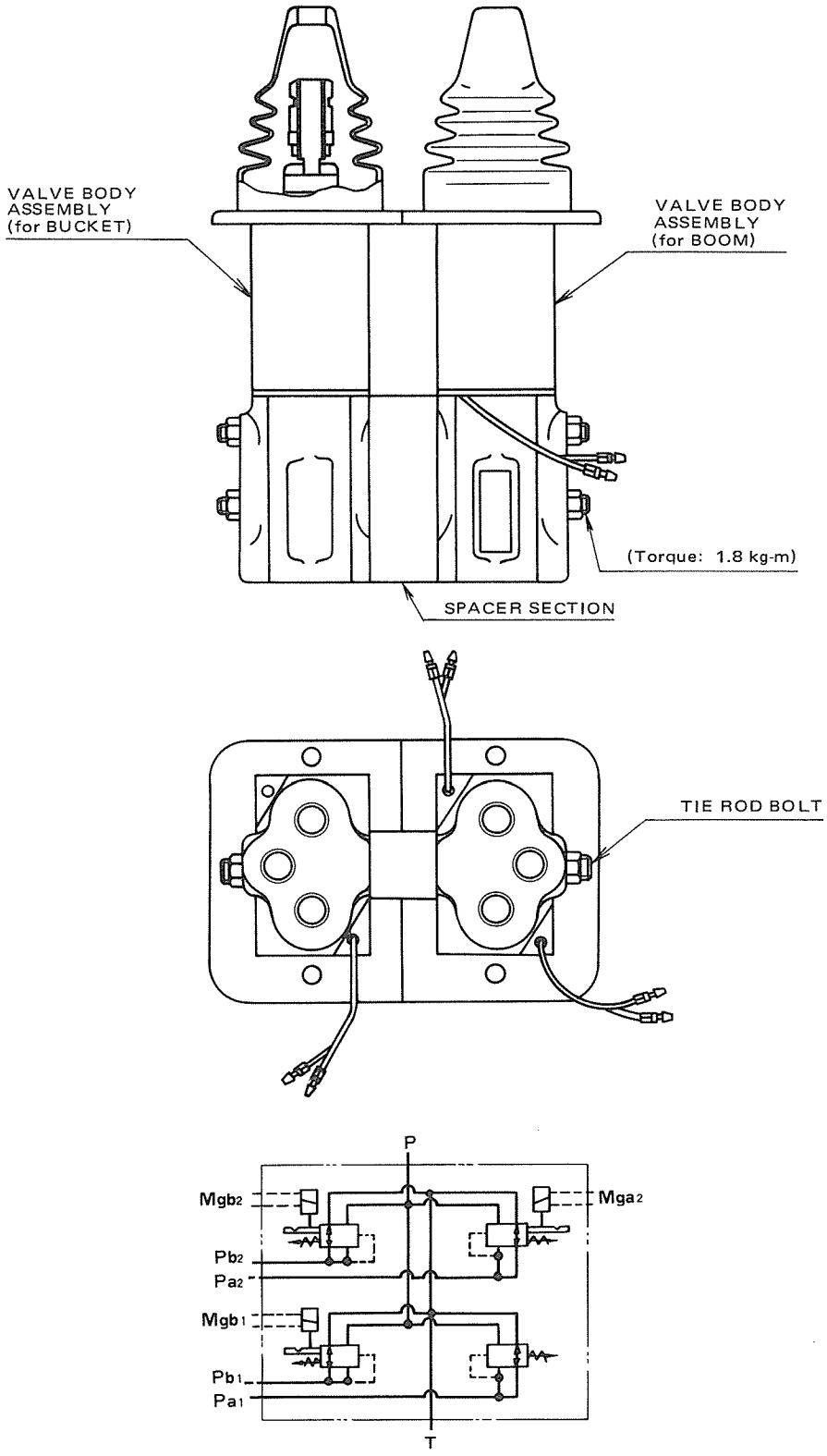


Fig. 62B.2 Pilot Valve

(3) Float (See Fig. 62B.11)

The boom lever is provided with a "float" position.

When the boom lever is operated forward to the stroke end, the plunger ④ gets into contact with the shuttle ⑦ and the spring seats ⑨ and ⑩ contact each other. The plate ① thereby receives the force of the spring ⑪ so that the operator feels different in lever operation from in other lever positions. The boom lever is now in the "float" position.

2. Operation at Electromagnetic Detent Section (See Fig. 62B.12)

As the plate ① is further tilted, the plunger ②′ and the plate ③′ are moved by the force of the spring ⑫ wheel keeping in contact with the plate ① . When the loading lever reaches its stroke end, the plate ③′ is attracted to the coil assembly ⑬ . This is the detent operation. In this state, the discharge port (OUT) is open to the pump port (P) so that the oil pressures at these ports are kept equal.

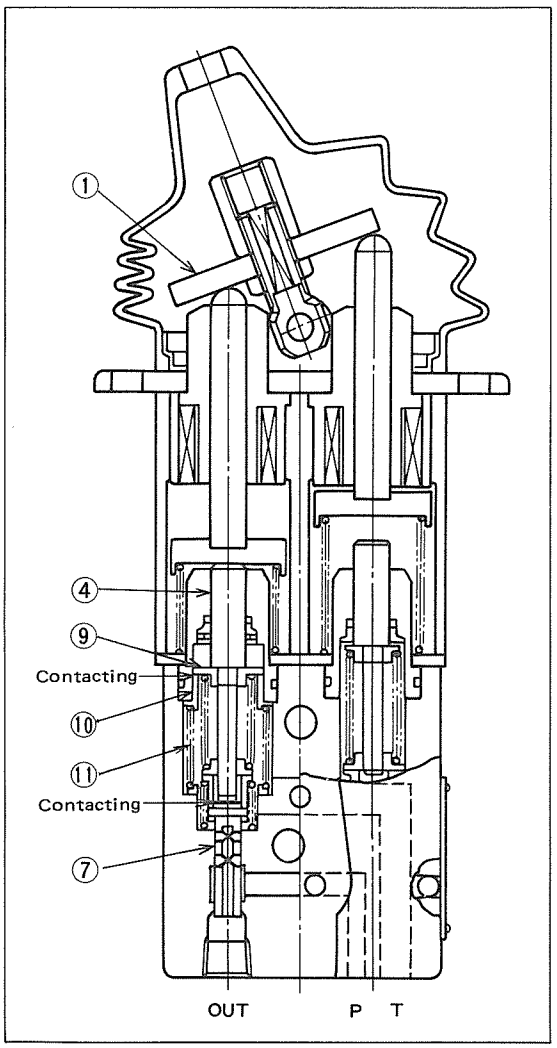


Fig. 62B.11 Float

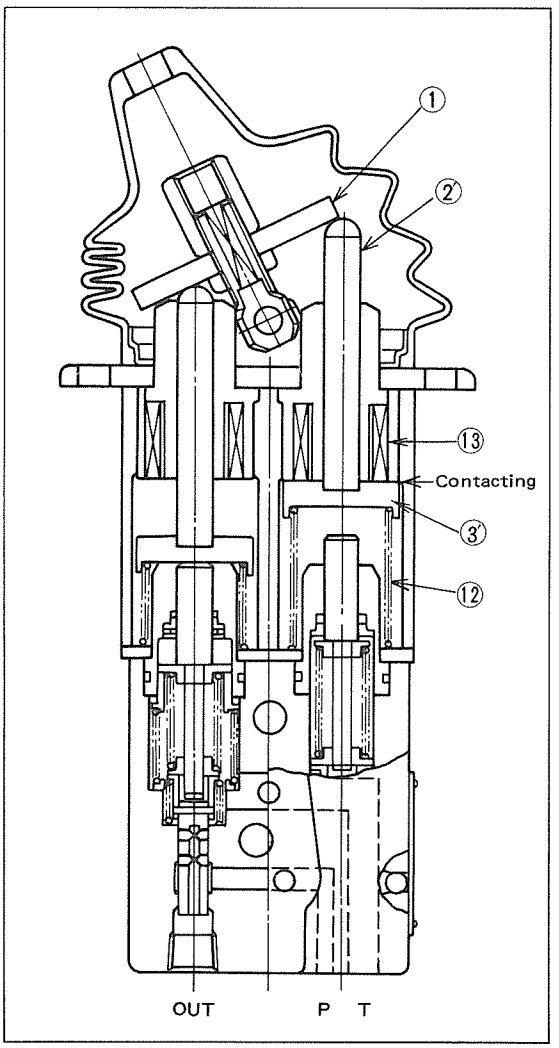


Fig. 62B.12 Electromagnetic Detent Operation

⑤ Remove the plate from the lower body. Pull the two plunger assemblies out of the lower body.

Note: For disassembly and reassembly of the plunger assembly, see (2) of "4. Notes on Disassembly and Reassembly".

⑥ Remove the spring seat, spring, and spring seat from the boom lowering port body in that order.

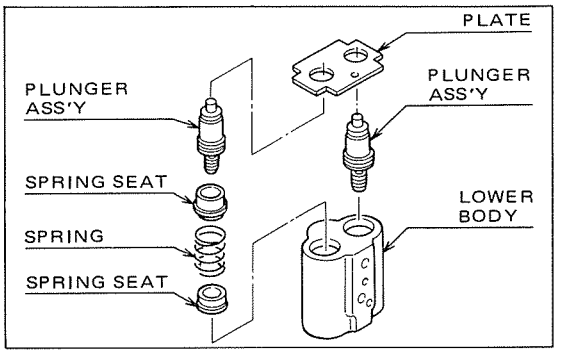


Fig. 62B.36

⑦ Put the end of an L-shaped metal hook (made by reshaping a zem clip or other appropriate thin hard wire) in the spring seat hole and pull up the shuttle vertically out of the lower body.

Note: Do not apply such excess force as to damage or bend the shuttle.

⑧ Remove the spring from the lower body.

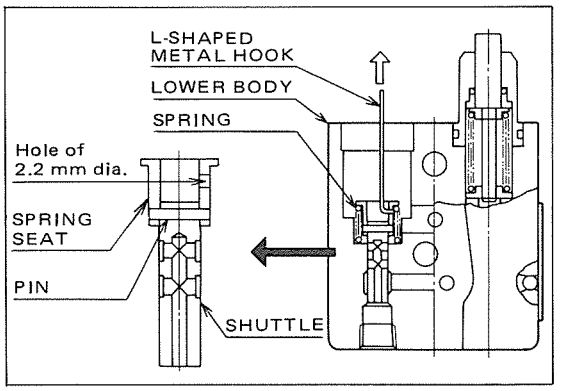


Fig. 62B.37

2. Cleaning and Inspection

① Clean all disassembled parts with cleaning oil or kerosene. Dry by air blow.

② Check all the parts for burrs, scratches, cuts, and others in their surfaces. Remove burrs by oil stone or lapping.

③ Make sure that each sliding area smoothly moves.

④ Check each spring for breakage and deterioration. Replace if necessary.

⑤ Check that there is no dust or other foreign materials found in the oil passages of any housing. If found, remove by air blow.

⑥ The "O"-rings and seals should all be replaced.

3. Reassembly

① If the tie rod bolts that secure the respective sections are removed, align the lower bodies: Place the lower bodies on a surface plate with their port sides upward for alignment, then fix them with the two tie rod bolts.

TIE ROD BOLT TIGHTENING NUT TORQUE
= 1.8 kg-m (13.0 ft-lbs) (Apply hydraulic oil)

Note: Exercise care not to tighten too much. Otherwise, the discharge port pressure may show unusual fluctuation.

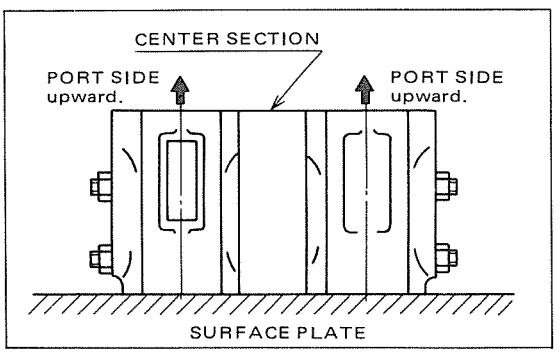


Fig. 62B.38

(2) Reassembly

Assembly the stop valve in the sequence opposite to disassembly with the following observed:

① The wiper seals and the "O"-rings should be replaced. Apply grease to new wiper seals and "O"-rings before installing them.

② Supply the detent section with grease.

③ Tightening torques:

PIN TORQUE = 2.1 kg-m (15.2 ft-lbs)

CAP MOUNTING HEXAGON SOCKET HEAD BOLT TORQUE = 1.0 kg-m (7.2 ft-lbs)

SEAL PLATE MOUNTING SCREW TORQUE = 0.28 kg-m (2.0 ft-lbs)

65B.3.2 OPERATION

Hydraulic oil flowing into the reducing valve from the IN port runs through the passage formed by the sleeve and the shuttle and then out of the valve thru the OUT port. The OUT port oil pressure works on the left end of the shuttle so that the shuttle stays at the position where the OUT port pressure balances with the spring force applied to the right of the shuttle. When the OUT port pressure rises, the shuttle shuts off hydraulic oil supplied through the IN port. When it falls, hydraulic oil resumes flowing thru the IN port. The OUT port pressure is thus regulated.

The RET port is provided for oil drained from the valve.

65B.3.3 DISASSEMBLY AND REASSEMBLY

1. Disassembly

① Remove the cap from the body.

Note: Removal of the cap also removes the cap nut, lock nut, and adjuster as one with the cap.

② Take the spool, spring, and spring seat out of the body.

③ Remove the tying wire from the other side of the body. Then, remove the plug.

④ Remove the spring, shuttle, and sleeve.

Note: The shuttle and the sleeve are select fit. They should be replaced, if necessary, as an assembly.

2. Reassembly

① Assemble the shuttle and the sleeve into an assembly. Next, install the spring on that assembly and insert into the valve.

② Install a new "O"-ring on the plug. Tighten the plug into the body.

PLUG TIGHTENING TORQUE = 5.5 kg-m (39.8 ft-lbs)

③ Install the tying wire to the plug and the body to secure the plug.

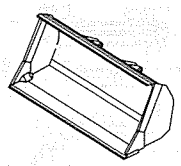
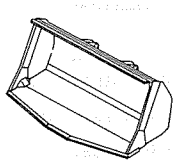
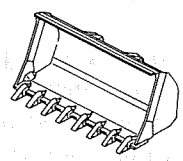
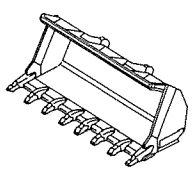
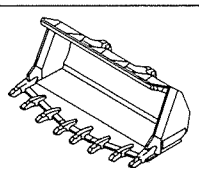
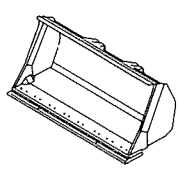
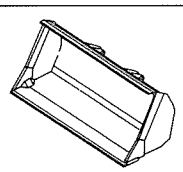
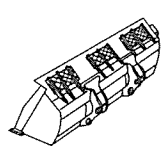
④ Insert the spring seat and the spring into the body through the other side of the body.

⑤ Install a new "O"-ring on the cap. Put the spool in the cap. Then, install the cap on the body.

CAP TIGHTENING TORQUE = 9 kg-m (65.1 ft-lbs)

71.3 BUCKET

71.3.1 BUCKET TYPES AND HOW TO MAKE SELECTION

Type	Shape	Structure & Features	Working Conditions	Material to be Handled
I-type bucket		A straight edge with no teeth. A basic bucket type. Also called a standard bucket.	Used to load earth, sand, and gravels (of merchandize) smashed by a crushter. Plane edge markes this type bucket suitable also for leveling of ground.	Loose stock pile γ: Below 1.6
II-type bucket		A bucket having an angular edge in place of straight edge so that the edge can easily shove into pile or other to be handled. The structure is the same as that of the I-type except for the edge.	Mainly used for loading processed material. Currently not popular because this type is unsuitable for ground leveling operation.	Stock pile γ: Below 1.6
III-type bucket		A toothed I-type bucket. The teeth make the edge more easily shove into pile or other to be handled. They also protect the edge to ensure longer life.	Suited to handle massive or lumped objects or such object mixture.	Stock pile γ: Below 1.6
III-type rock bucket		A bucket reinforced by making the bucket sheet, spill guard, end plate, thicker and adding reinforcement plate to areas which are easily worn. This bucket is also provided with teeth on the straight edge.	This type is provided for loading blasted rocks suitable for heavy-duty operations.	Bulky blasted rocks γ: Below 1.8
IV-type rock bucket		An angular-edged rock bucket, suitable for heavy-duty digging.	This type is provided for loading blasted rocks suitable for heavy-duty operations.	Bulky blasted rocks γ: Below 1.8
Double edge bucket		The same bucket as the III-type for the edge which is equipped with an extra edge in place of teeth. For extra edge installation, the tooth mounting holes are used.	Suited to handle processed material, sand, and earth. This type is also capable of ground leveling and now widely used.	Loose stock pile γ: Below 1.6
Light load bucket		Structurally the same as the I-type bucket, though the bucket capacity is larger than the I-type. Designed for light load handling and not provided with teeth.	Usef for handling relatively light loads such as coke, coal, grain, etc.	Loose stock pile γ: Below 1.0
Chip bucket		The capacity and width are made larger. The spill guard is meshed to provide unlimited front view.	Dedicatedly used for chip loading.	γ: Below 0.8

Note: For used paper handling the III-type bucket is suitable. However, please place a special order for a large-mesh radiator, in order to prevent the radiator from clogging.

2. Bucket DUMP Time

① Park the machine on a level ground and apply the parking brake. Check the oil level in the oil tank and raise the hydraulic oil temperature to 55 to 65°C.

② Raise the boom and operate the bucket cylinder several times to its stroke end to discharge air from the cylinder.

③ With the bucket unloaded, raise the boom up to its highest position and rotate the bucket to its maximum backward position.

④ Keep the engine running at high idling speed.

⑤ Operate the bucket lever and measure the time required for the bucket to move from the maximum backward position to the maximum forward (DUMP) position.

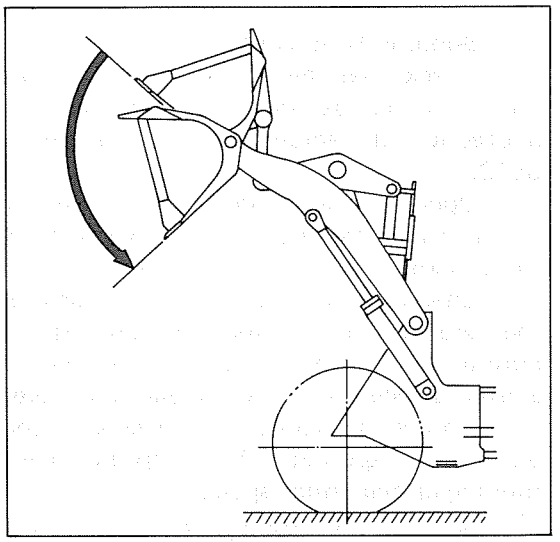


Fig. 71.21 Bucket DUMP Time Measurement

Item	Model	Standard (sec.)	Useful limit (sec.)
BUCKET DUMP TIME	850	1.8	—
	860	1.7	—
	870	1.7	—

⑥ If the dump time measured is longer than the useful limit, there exists trouble within the hydraulic circuit. Check therefore the hydraulic hose and tubing for oil leaks, the control valve for the main relief pressure and overload relief pressure, the bucket cylinder for oil leaks, the main pump for the discharge amount, and the steering valve. Repair or replace if anything unsatisfactory is found.

3. Reassembly

(1) Installation of bushing

① If replacing the bushing, press-fit the new bushing in the tail of the cylinder tube.
② Install the dust seal on each side of the bushing.

(2) Assembling cylinder cap

① If replacing the sleeve, press-fit the new sleeve into the cylinder cap and secure it by the stop ring.
② Install the U-packing and back-up ring inside the cylinder cap.

Note: Coat the U-packing lip with grease and install the U-packing with the lip pointing toward the cylinder tail.

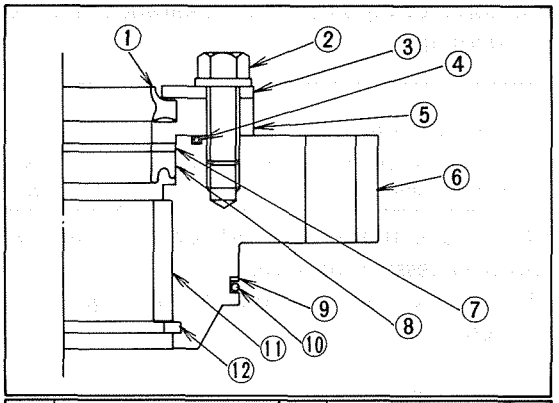
③ Install the "O"-ring and back-up ring outside the cylinder cap.

Note: Be sure to install the "O"-ring at the pressurized side.

④ Install the "O"-ring to the upper part of the cylinder cap.
⑤ Install the dust seal on the flange.

Note: Coat the dust seal lip with grease.

⑥ Install the flange and the retainer plate on the cylinder cap.



1	DUST SEAL	7	BACK-UP RING
2	BOLT	8	U-PACKING
3	RETAINER PLATE	9	BACK-UP RING
4	"O"-RING	10	"O"-RING
5	FLANGE	11	SLEEVE
6	CYLINDER CAP	12	STOP RING

Fig. 72.14 Cylinder Cap Assembly

RETAINER PLATE MOUNTING BOLT TIGHTENING TORQUE

(850 and 860) = 7.2 – 10.8 kg-m (52.1 – 78.1 ft-lbs)
(870) = 18 – 27 kg-m (130.2 – 195.3 ft-lbs)

(3) Assembling piston

① Install the piston seal and the two wear rings on the piston.
② Install the "O"-ring inside the piston.

(4) Assembling piston rod

① Install the cylinder cap assembly and the piston on the piston rod and temporarily tighten with lock nut.
② With the piston rod mounted on a hydraulic cylinder repair stand, tighten the lock nut with a specified torque and secure with the cotter pin.

PISTON LOCK NUT TIGHTENING TORQUE (850, 860, 870) = 140 ± 14 kg-m (1012.6 ± 101.3 ft-lbs)

(5) Installation of piston rod

① Apply hydraulic oil on the piston and insert the piston rod assembly into the cylinder tube.
② Tighten the 6 cylinder cap mounting bolts and nuts.

CYLINDER CAP MOUNTING BOLT & NUT TIGHTENING TORQUE

(850 and 860) = 44.5 kg-m (321.9 ft-lbs)
(870) = 77.0 kg-m (556.9 ft-lbs)

NOTE

81.2.2 SWITCHES

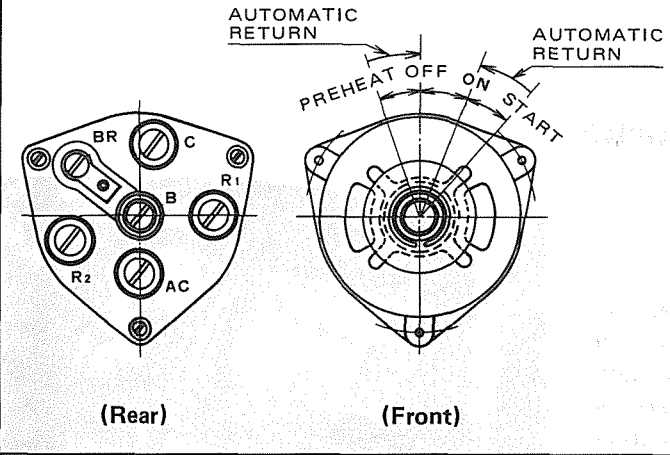
1. Starter Switch

The starter switch is a water-proof type, installed with a ring nut beneath the instrument panel.

The starter switch has four positions: ON, OFF, START and PREHEAT. The switch automatically returns from PREHEAT to OFF or from START to ON when released.

When the starter switch is in the ON position, the electric circuit is closed. When it is put in the OFF position, the engine is shut down by engine stop solenoid operation.

For starter switch circuit test, use a circuit tester to check there is conduction between the respective terminals with the key at each position. If the starter switch is malfunctioning, replace as follows: Remove the ring nut of the starter switch, then remove the starter switch toward the rear of the instrument panel.



Terminal / Position	B	R_1	AC	R_2	C	BR
OFF	○					
PREHEAT	○	○				○
ON	○		○			○
START	○			○	○	○

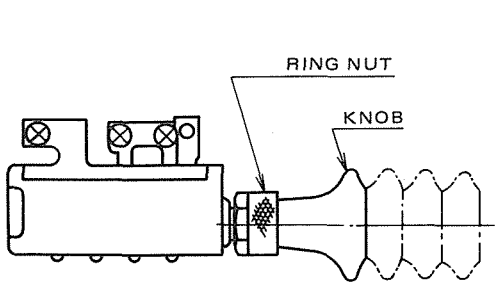
(Terminal Connections)

Fig. 81.9 Starter Switch

2. Lighting Switch

The lighting switch is installed with a ring nut beneath the instrument panel. Pulling out the lighting switch lets electric current run from the battery through the fuse and terminals of the lighting switch to turn on the head lights and other lights.

Check the lighting switch at each of its positions by using a circuit tester to make sure there is conduction between the respective terminals. If it malfunctions, replace as follows: Remove the lighting switch knob and ring nut, then remove the lighting toward the rear of the instrument panel.



Terminal / Position	B	ST	P	D	H	I
OFF	○	○				
FIRST	○	○	○			○
SECOND	○	○		○	○	○
THIRD	○	○		○	○	○

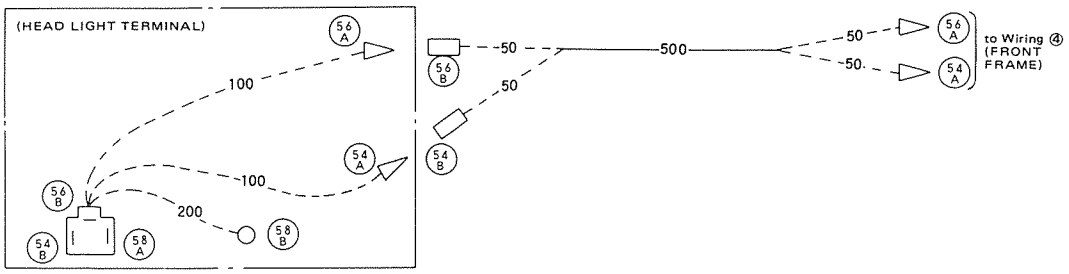
(Terminal Connections)

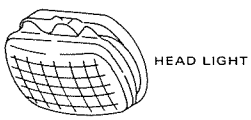
Fig. 81.10 Lighting Switch

Continuation of Wiring ① (INSTRUMENT PANEL)

No.	Cord size	Cord color	Connecting procedure	
154	AV1.25	WY	A. Radiator water temp. lamp	B. Monitor control box
158	AV1.25	GL	A. Brake oil temp. lamp	B. Monitor control box
161	AV1.25	R	A. Lamp power source (130)	B. Lamps (Brake air press., battery)
162	AV1.25	L	A. Brake air press. lamp	B. Monitor control box
165	AV1.25	RY	A. Battery voltage lamp	B. Monitor control box
167	AV1.25	B	A. Monitor control box terminal E	B. Grounding

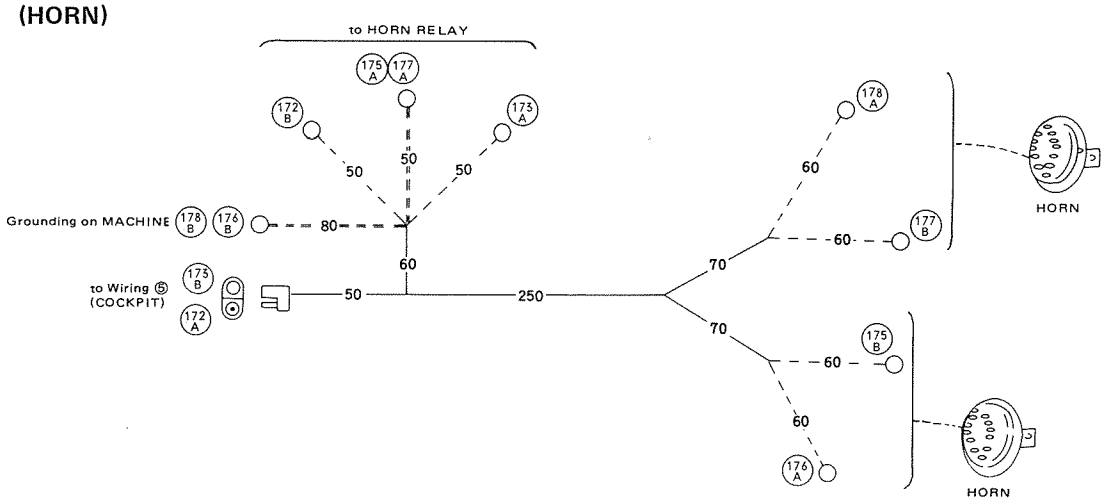
② (HEAD LIGHT FEED)





No.	Cord size	Cord color	Connecting procedure
54	AV1.25	LR	A. Flasher dimmer switch B. Head light main
56	AV1.25	P	A. Flasher dimmer switch B. Head light dimmer

③ (HORN)



No.	Cord size	Cord color	Connecting procedure	
172	AV1.25	YR	A. Fuse	B. Horn relay terminal B
173	AV1.25	YG	A. Horn relay terminal S	B. Horn switch
175	AV1.25	Y	A. Horn relay terminal H	B. Horn
176	AV1.25	B	A. Horn	B. Grounding
177	AV1.25	Y	A. Horn relay terminal H	B. Horn
178	AV1.25	B	A. Horn	B. Grounding