SERVICE MANUAL

TRACKED TRUCTOR MOTOR

MITSUBISHI DIESEL ENGINE

6D22-T

for LD1000

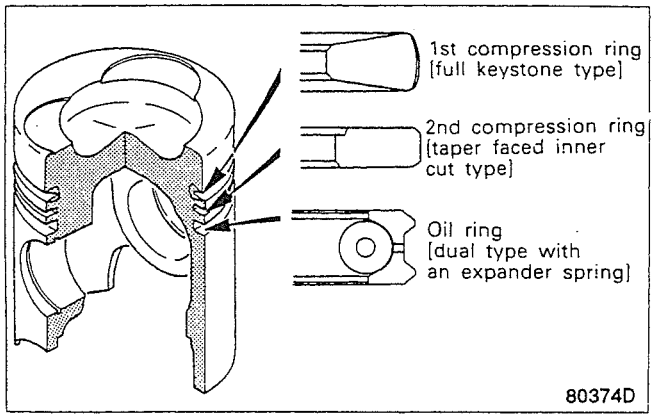
MITSUBISHI HEAVY INDUSTRIES, LTD.

1. MAJOR SPECIFICATIONS

Item			LD1000
Engine model			6D22-T (with turbocharger)
Type			Diesel, 4-cycle, water-cooled
Combustion method			Direct injection
No. and arrangement of cylinders			6 in-line
Cylinder bore x stroke, mm (in.)			130 x 140 (5.12 x 5.51)
Total displacement, cc (cu in.)			11149 (680)
Engine dimensions, mm (in.)		Overall length	1522 (59.9)
		Overall width	816 (32.1)
		Overall height	1241 (48.9)
Service weight, kg (lb)			995 (2194)
Performance	Maximum output, PS/rpm		260/2200
	Maximum torque, kgf·m (lbf·ft) [N·m]/rpm		101 (731) [990]/1400
	No-load minimum speed, rpm		500 to 550
	No-load maximum speed, rpm		2600

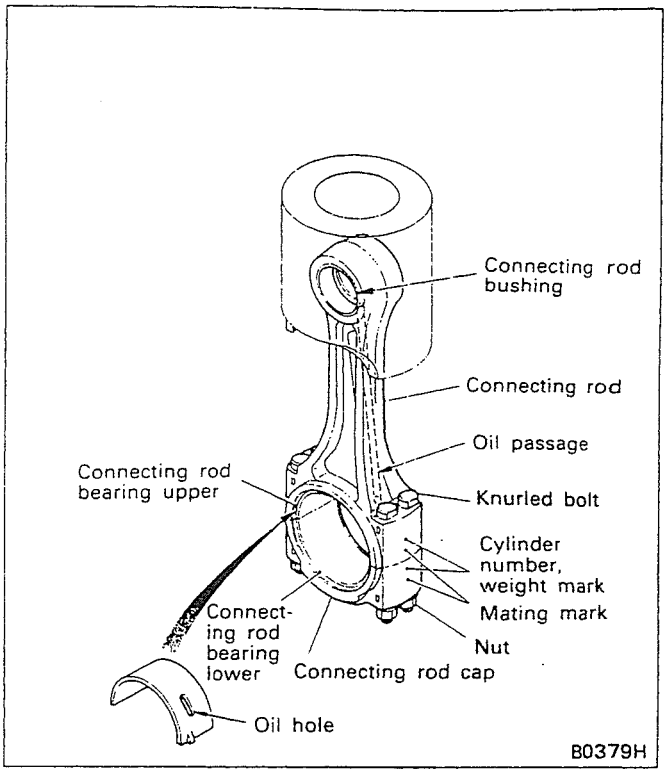
A Niresist piston ring insert is cast into the 1st piston ring groove to increase durability.
Stamped on the top surface of the piston are a size mark (or oversize dimension on oversize pistons) for selection fit with the cylinder liner, a piston weight mark, part number, identification mark, and the "F" with an arrow for the front mark showing the piston installing direction.
Piston pin for connecting piston to connecting rod is of full-floating type and is prevented from moving out by means of a snap ring installed on each end of the pin ends.

(b) Piston ring



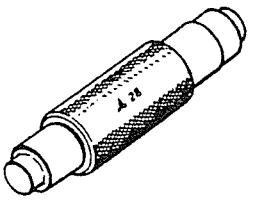
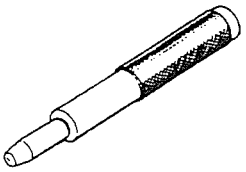
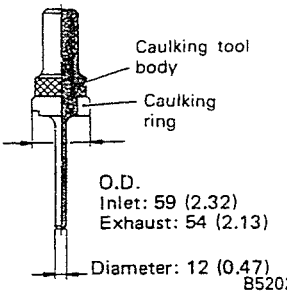
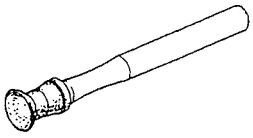
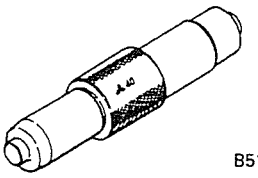
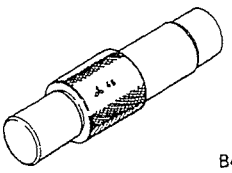
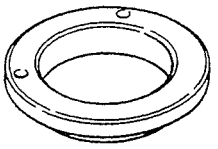
There are three piston rings installed: two compression rings and one oil ring.
The piston rings are shaped as shown in the figure.

(5) Connecting Rod and Connecting Rod Bearing



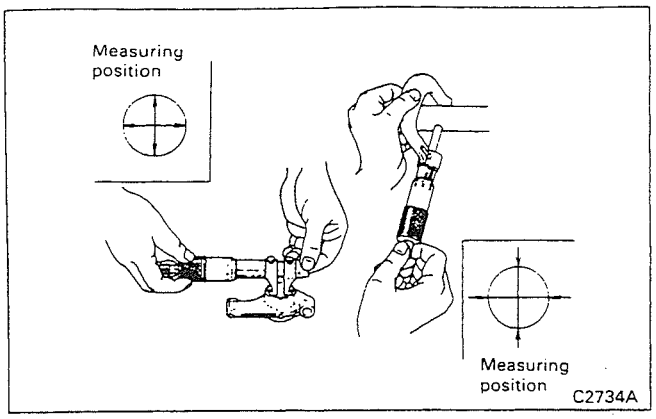
The connecting rod is a die forging of I cross section providing high rigidity. A lead bronze bushing is press-fitted onto the small end. The connecting rod bearing of the big end is a split type plain bearing. Through the stem of connecting rod, an oil passage is provided obliquely to lubricate the small end bushing. The connecting rod and connecting rod cap are coupled with four bolts.

Unit: mm (in.)

Tool name	Part No.	Shape	Use
Rocker bushing puller	MH061236	 B5311A	Removal and installation of rocker bushing
Valve guide puller	30091-08100	 B5111A	Removal and installation of valve guide
Valve seat insert caulking tool	Caulking tool body MH061360 Caulking ring inlet MH061650 Caulking ring exhaust MH061651	 B5202A	Installation and caulking of valve seat insert
Valve lapper	30091-07500	 B5261A	Lapping of valve
Idler gear bushing puller	MH061228	 B5121A	Removal and installation of idler gear bushing (Idler gear "A")
	MH062046	 B4384A	Removal and installation of idler gear bushing (Idler gear "C")
Crankcase table	MH061889	 B1480A	Measurement of flatness of cylinder liner flange supporting surface on crankcase

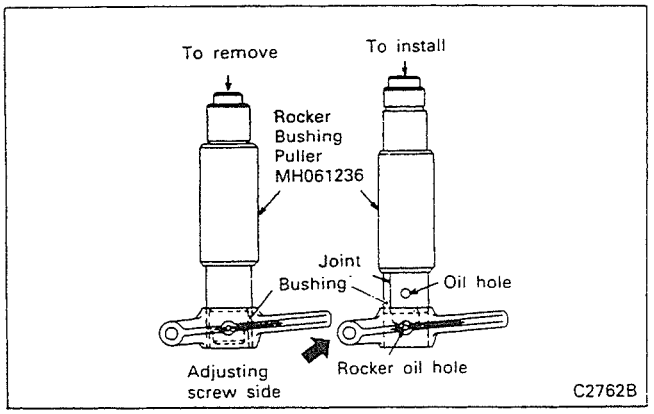
Inspection Procedure

(1) Rocker to Rocker Shaft Clearance



If the limit is exceeded, replace the bushing in the rocker.

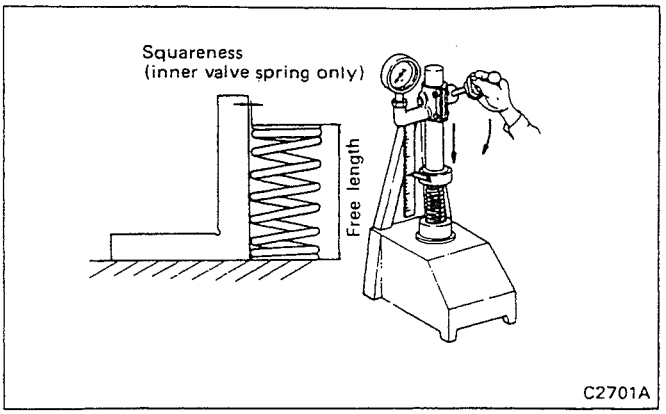
(2) Replacement of Rocker Bushing



NOTE:

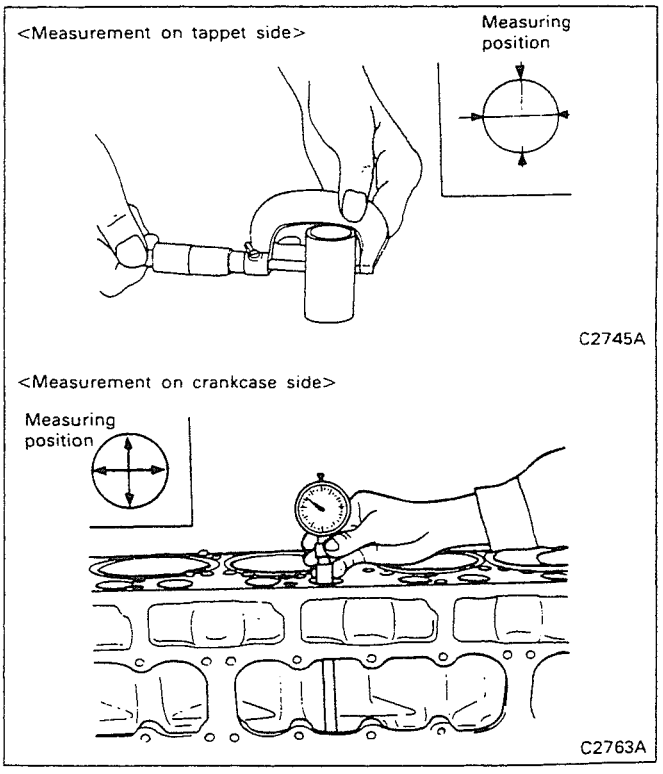
1. **Align the bushing and rocker oil holes.**
2. **Face the bushing joint toward the adjusting screw.**

(3) Inspection of Valve Spring



Mesure the free length and installed load of the spring and replace if the measurement exceeds the limit. For the inner valve spring, check also for squareness.

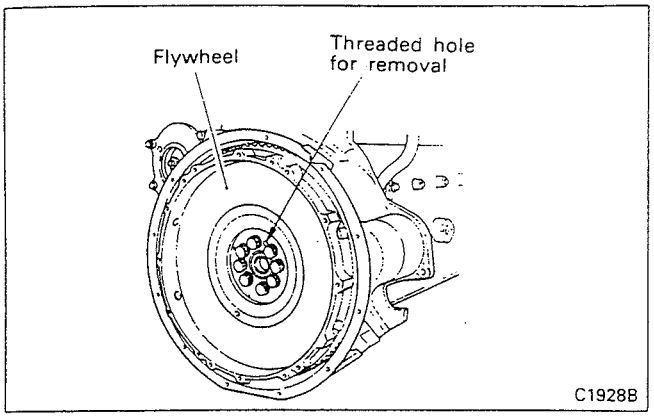
(4) Tappet to Crankcase Clearance



If the limit is exceeded, replace the tappet.

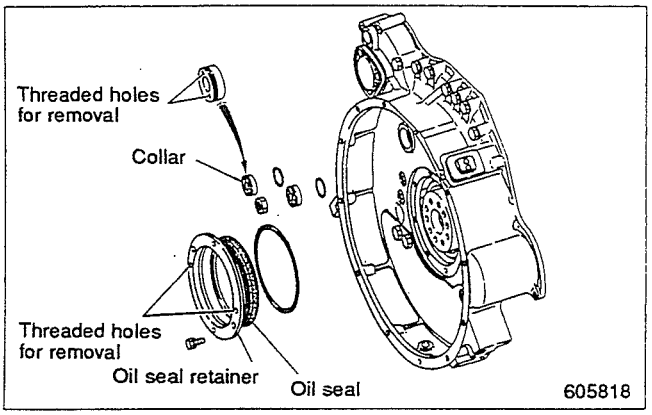
Disassembly Procedure

(1) Removal of Flywheel



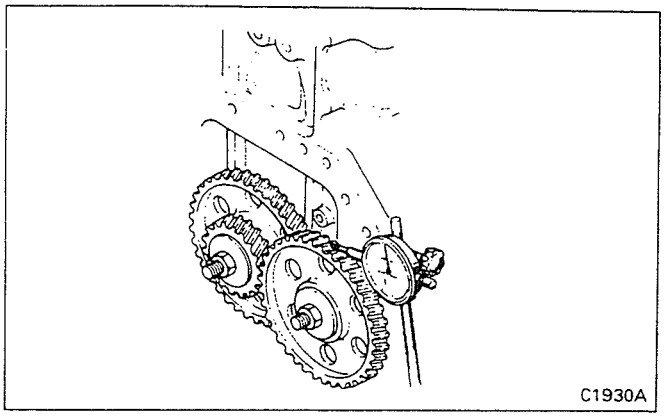
Thread the mounting bolt into the removing threaded hole to remove the flywheel.

(2) Removal of Oil Seal Retainer and Coller



- To remove the oil seal retainer, turn down the attaching bolts into the removing threaded holes evenly, while making sure that the oil seal retainer does not have eccentricity, remove the retainer with the oil seal attached.
- Remove the collar by screwing M4 x 0.7 bolts into the removing threaded holes.

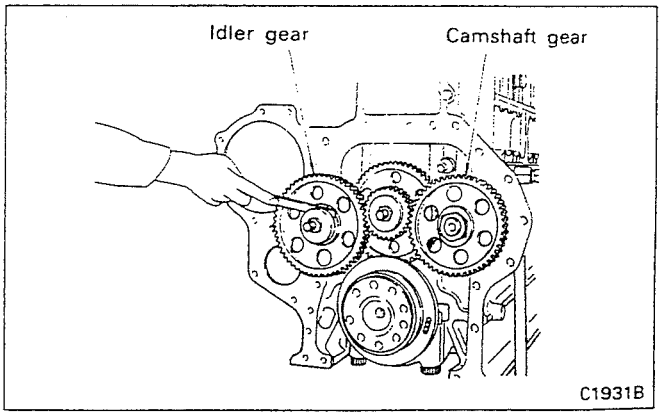
(3) Measurement of Gear Backlash



If the backlash exceeds the limit, check idler gear bushing and gears and replace parts as necessary.

NOTE:
For a pair of gears, the backlash should be measured at more than three points to determine whether it is acceptable.

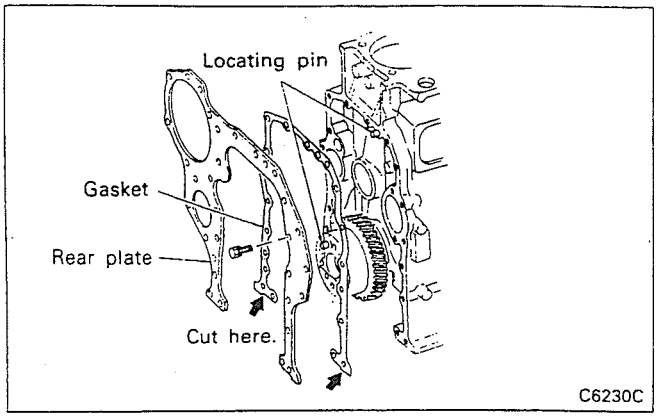
(4) Measurement of End Play in Idler Gear and Camshaft Gear



If the end play exceeds the limit, replace the thrust plate.

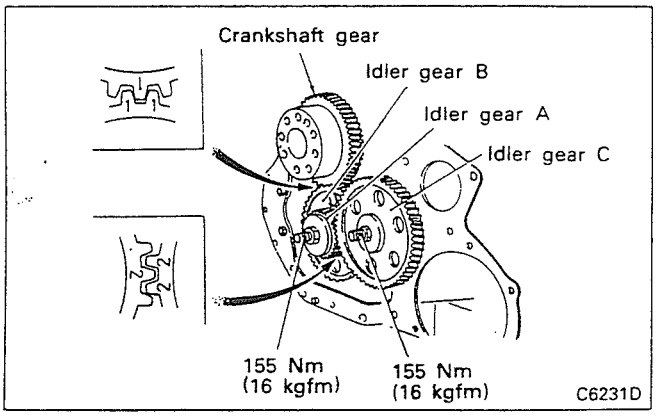
Reassembly Procedure

(1) Installation of Rear Plate



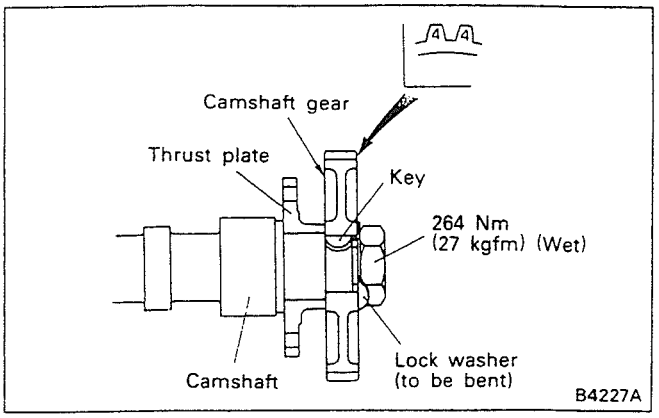
The bottom of gasket installed between the rear plate and crankcase will protrude. After the flywheel housing has been installed, cut away the protruding portion.

(2) Installation of Idler Gears



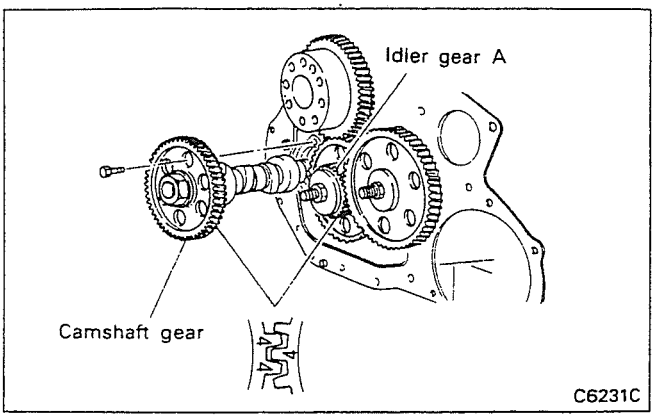
Then, install the idler gear B so that its alignment mark "1" is aligned with the alignment mark "1" on the crankshaft gear.
Next, install idler gears A and C so that their alignment marks "2" are aligned.

(3) Installation of Camshaft Gear



Install the camshaft gear so that the side having stamped numbers "4" faces front.

(4) Installation of Camshaft



Install the camshaft so that the alignment mark "4" on the camshaft gear is aligned with the alignment mark "4" on idler gear A.

NOTE:
When the camshaft is inserted, take care not to damage the camshaft bushing.

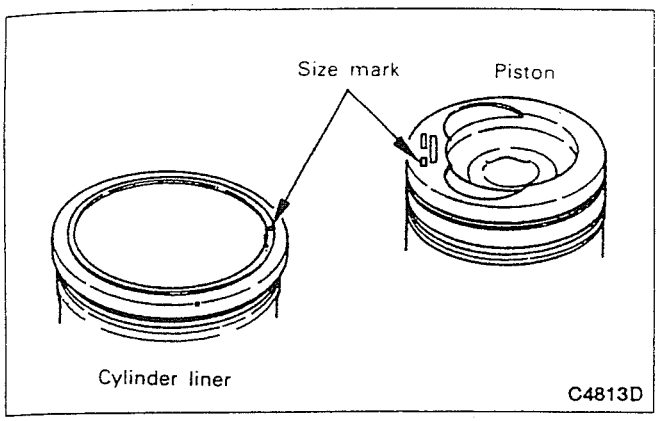
(5) Check camshaft gear and idler gear for correct end play.

[Refer to Section 5.3.1 (4)]

(6) Check backlash in gears.

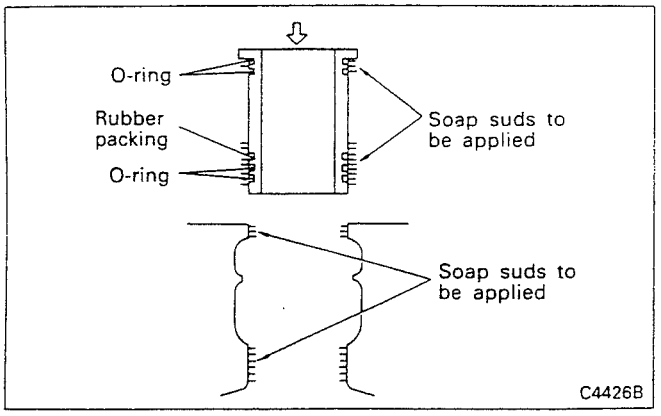
[Refer to Section 5.3.1 (3)]

(b) Installation

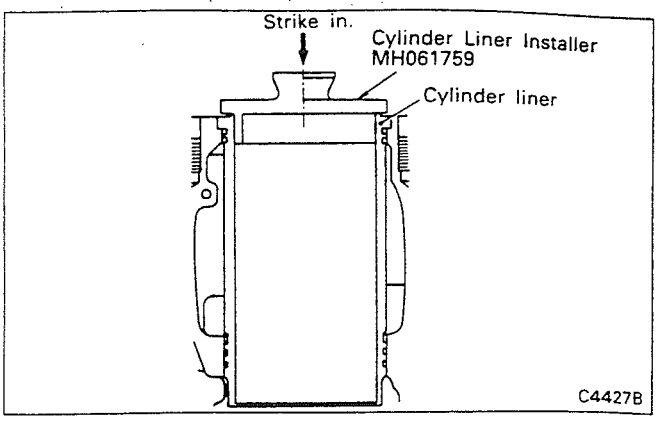


1) When replacing the cylinder liner, use a cylinder liner with the same size mark as that of the piston to be selected.

Size mark of piston	A	B	C
Size mark of cylinder liner	A	B	C



2) After a new rubber packing and O-ring have been installed to the cylinder liner, slowly insert the cylinder liner into the crankcase.

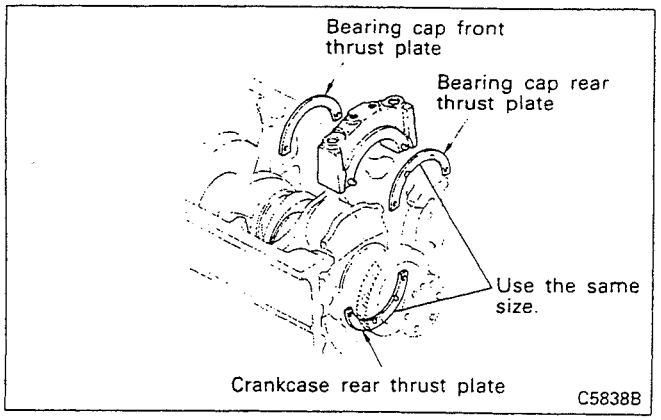


3) Securely seat the cylinder liner on the crankcase by lightly striking the flange portion, using Cylinder Liner Installer (special tool).

NOTE:

1. **Apply soap suds to the crankcase and cylinder liner fitting portions and make sure that the rubber packing and O-ring are not twisted when inserted.**
2. **After installation, conduct the leak test to verify air-tightness. Apply thrust force to cylinder liner flange.**

(c) Only to both sides of the rearmost main bearing cap, install the thrust plates facing their oil grooveless side toward the cap.



NOTE:

If an oversize thrust plate is used, use the bearing cap rear thrust plate of the same size as that of the thrust plate in the crankcase rear end [Refer to Item (3)]. Note, however, that the bearing cap front and rear thrust plates may be of different sizes.

(d) Install the main bearing caps, making sure that the side with the lug groove placed on the right-hand side of the engine and they are installed in the order of embossed numbers from the front of engine.

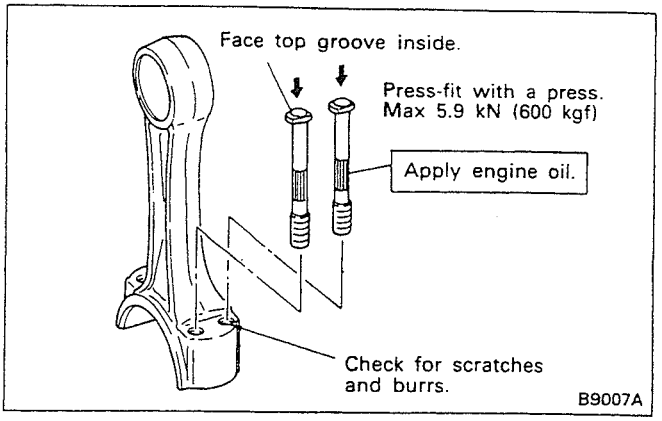
(e) Tighten main bearing cap bolts to specified torque. Then, tighten main bearing cap side bolts to specified torque.

After the bolts are tightened, make sure that the crankshaft is free to rotate by hand.

(f) Check to see if the end play of the crankshaft is within nominal value.

[Refer to Item (6), Section 5.4.1.]

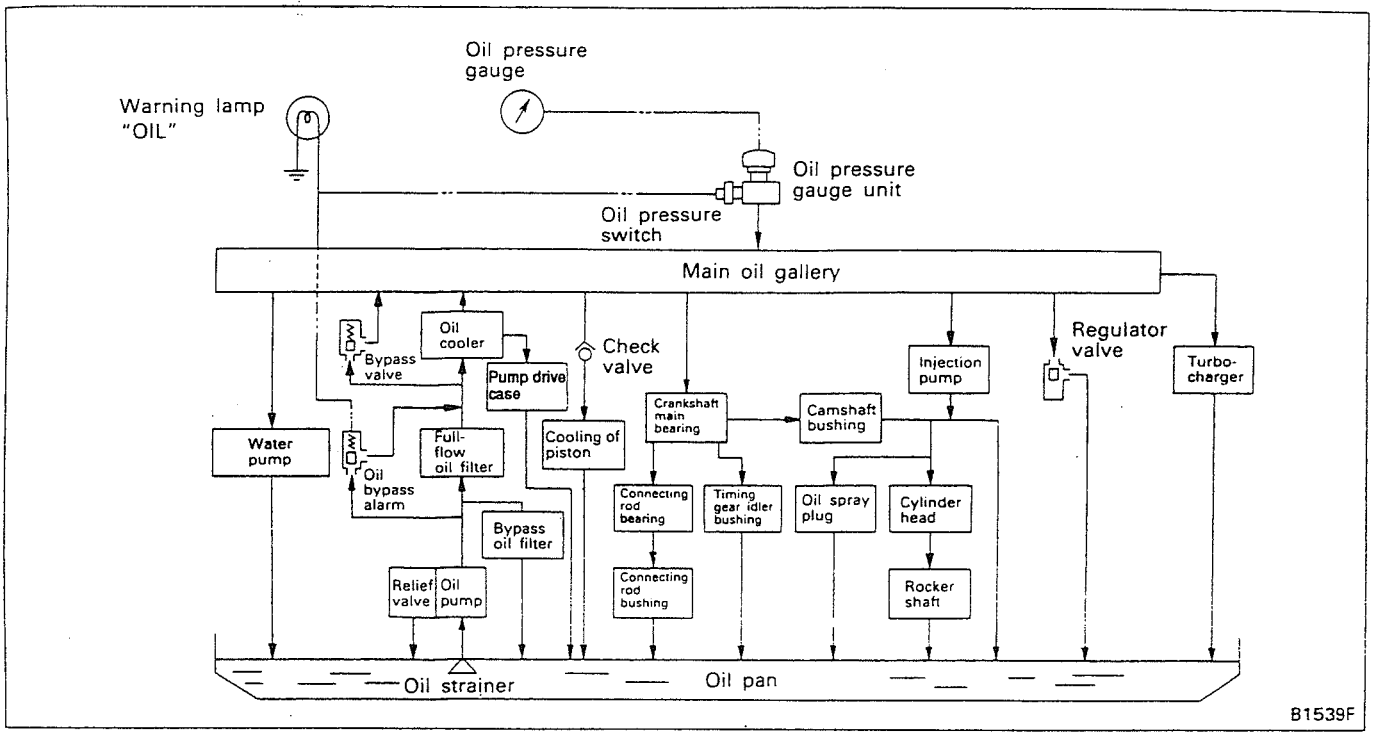
(8) Installation of Connecting Rod Bolt



After checking the connecting rod for damage and burr in the bolt hole, apply engine oil to the connecting rod bolt and press-fit it into the connecting rod.

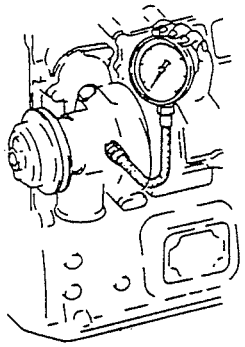
1. GENERAL

Engine lubrication is accomplished by forced lubrication system using gear pump. The engine oil in the oil pan is drawn up through the oil strainer by the oil pump and force-fed to the oil filter and oil cooler to lubricate all parts.



4. SERVICE PROCEDURES

Hydraulic Pressure Measurement



At idle	
NV	145 kPa (1.5 kgf/cm²) or more
L	49 kPa (0.5 kgf/cm²)
At maximum speed	
NV	295 to 490 kPa (3 to 5 kgf/cm²)
L	195 kPa (2 kgf/cm²)

NV ... Nominal Value
L ... Limit

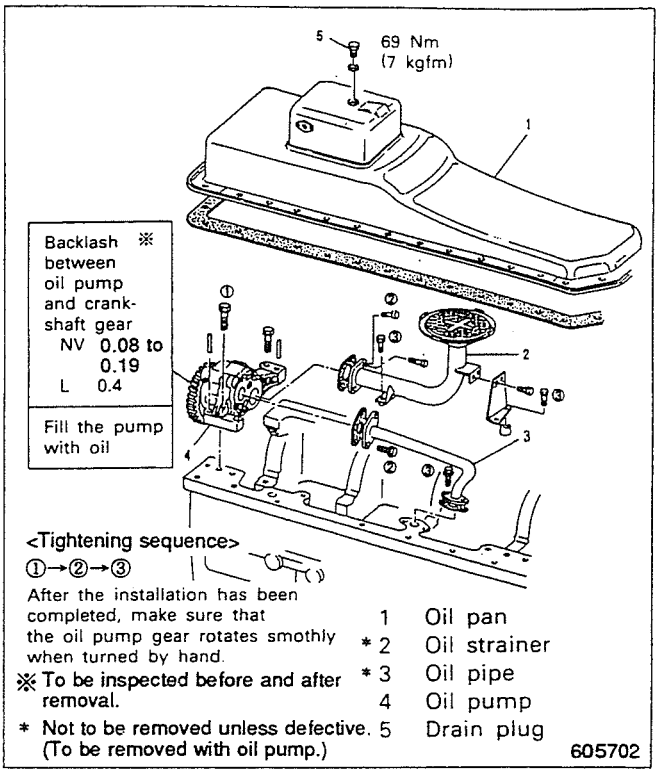
B9016A

(1) Remove the oil pressure switch, and set up a pressure gauge. Start the engine and run it until the oil temperature is 70°C to 90°C (158°F to 194°F).

(2) Measure the hydraulic pressure at idling speed and at maximum speed. If the measurements are below the limits, overhaul the lubrication system.

4.1 Oil Pump

4.1.1 Removal and Installation



Backlash ※ between oil pump and crankshaft gear
NV 0.08 to 0.19
L 0.4

Fill the pump with oil

<Tightening sequence>
①→②→③

After the installation has been completed, make sure that the oil pump gear rotates smothly when turned by hand.

※ To be inspected before and after removal.

* Not to be removed unless defective. (To be removed with oil pump.)

	1	Oil pan
*	2	Oil strainer
*	3	Oil pipe
	4	Oil pump
	5	Drain plug

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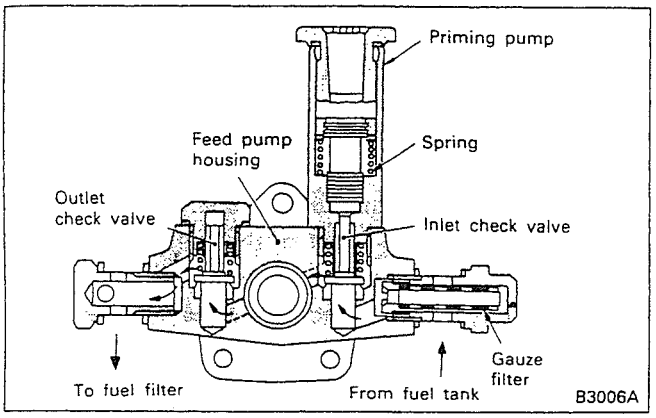
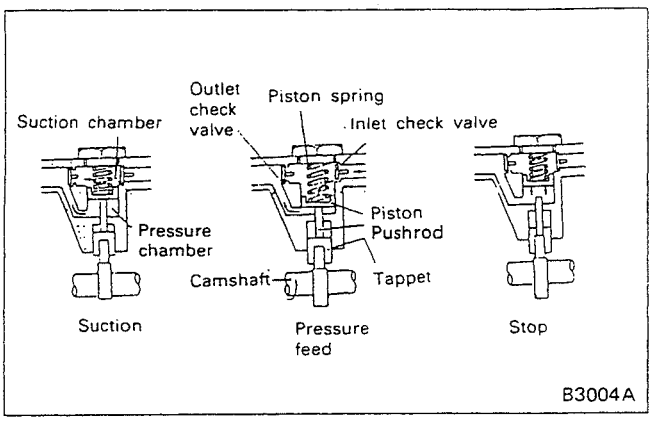
GROUP 4 FUEL SYSTEM AND ENGINE CONTROL

(3) Feed Pump



Supply of fuel to the injection pump proper is accomplished by the feed pump mounted to the side of the injection pump proper and driven by the cam of the injection pump camshaft provided for the purpose.

The priming pump mounted to the feed pump makes it possible to lift fuel manually when the engine is stationary.



The feed pump feeds fuel under pressure as follows. When the piston is pushed up by the cam of the camshaft, the fuel in the suction chamber opens the outlet check valve, so most of the fuel is forced out and drawn into the pressure chamber. When the cam is moved away by rotation of the camshaft, the piston is pushed back by the pressure of the piston spring. At the time, the outlet check valve closes and the inlet check valve opens. So fuel is drawn into the suction chamber, whereas the fuel in the pressure chamber is forced out.

When the pressure of the pressure chamber or the delivery pressure exceeds specification, the piston cannot be brought back by the pressure of the piston spring, so the pump action stops and the fuel pressure in the fuel filter does not rise more than necessary.

(4) Automatic Timer

The interval between fuel injection into the cylinder and its ignition is called the ignition delay interval. The ignition delay interval is constant regardless of the engine speed. If the ignition timing is always constant, changes in the engine speed will vary the relation between the piston position and ignition timing, making it impossible to obtain the best engine performance. To maintain the relation between the piston position and ignition timing constant at all times, the injection timing must be changed to match the engine speed.

The automatic timer is a device which automatically changes the injection timing according to the engine speed.

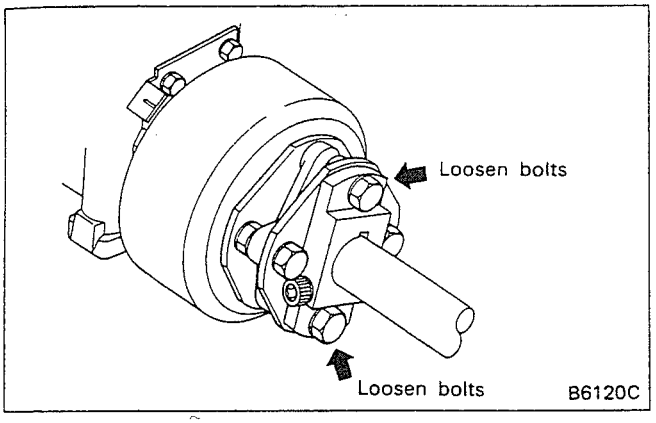
5. SERVICE PROCEDURES

5.1 REMOVAL AND INSTALLATION OF INJECTION PUMP ASSEMBLY

(1) Removal Procedure

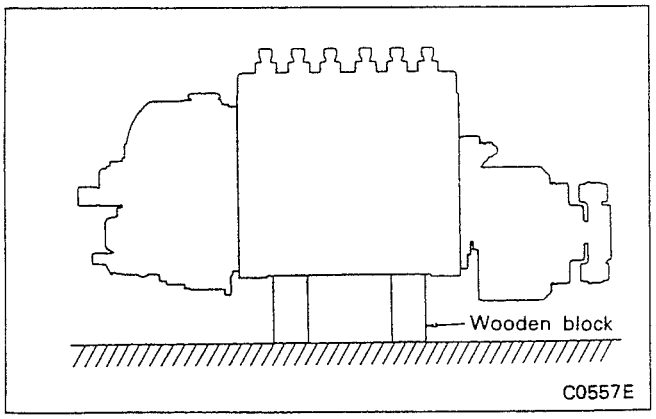
(a) Prepare a container for catching fuel and oil flowing out of the engine and rag for cleaning up spillage.

(b) Disconnect the pipes and harnesses that stand in the way of injection pump removal.



(c) First loosen bolts indicated by arrows in figure from coupling.

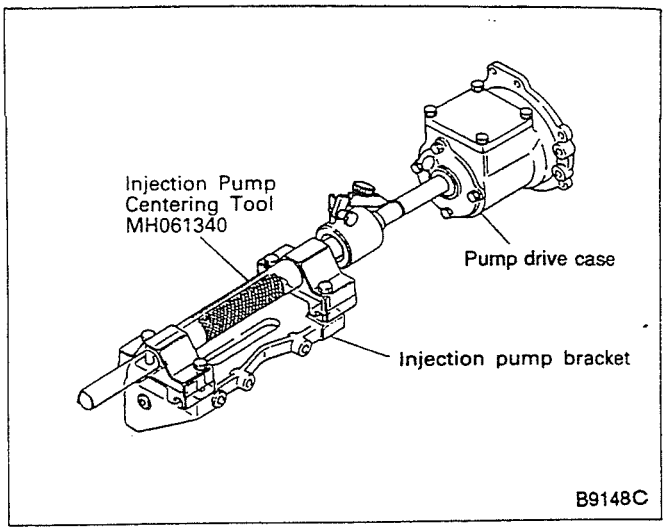
(d) Remove the injection pump from the pump bracket. Use a wood block to store injection pump lest excess force might be applied to timer.



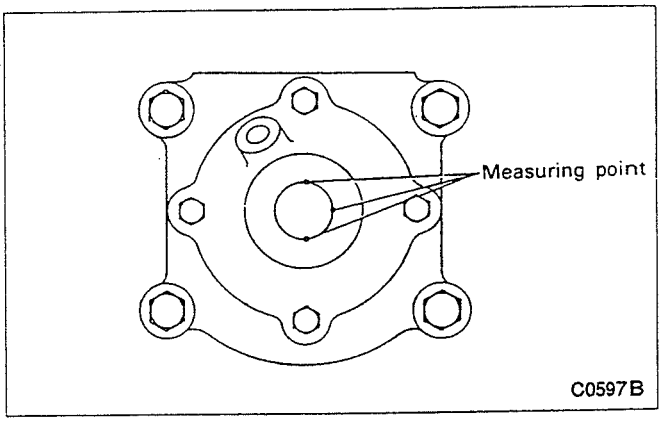
(e) Do not attempt to remove the pump bracket if it is cracked.

(2) Installation Procedure

(a) Adjustment of injection pump bracket

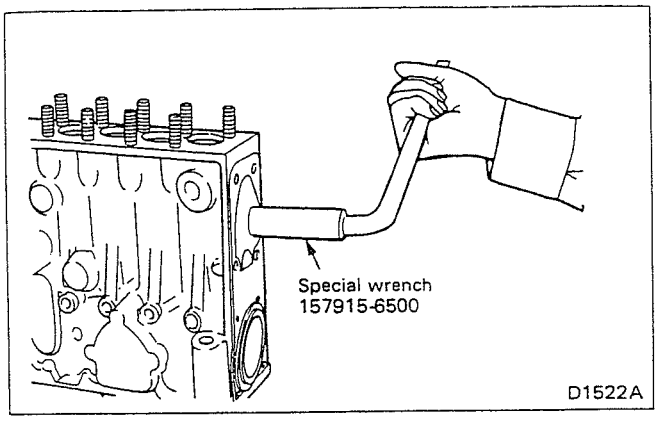


1) Place Injection Pump Centering Tool (special tool) on the injection pump bracket, hold a dial indicator to the mandrel of the centering tool, and perform O-point adjustment.



2) Slide the dial indicator of the centering tool toward the pump case and measure the positions of the pump drive shaft shown in the illustration with the dial indicator.

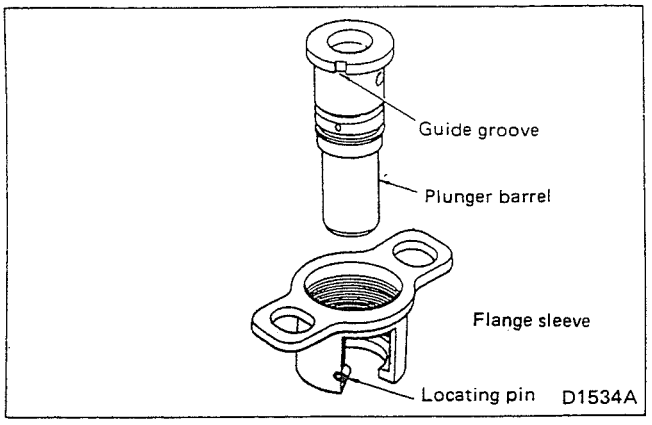
Reassembly Procedure



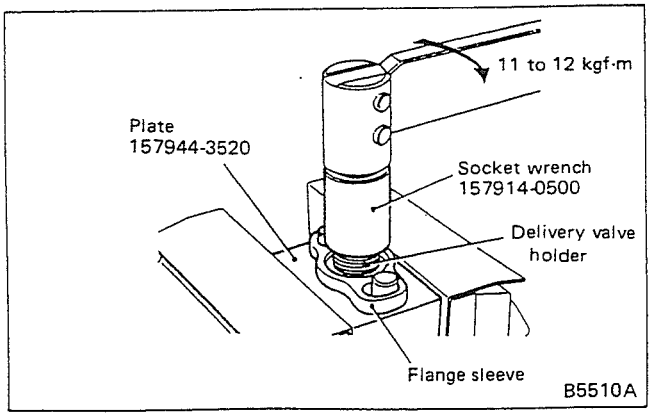
(1) Hole the pump housing in Universal Vise (special tool). [Refer to Section 5.2.1.] Install the control rod, pin and screw bushing. To install the bushing, use Special Wrench (special tool). Make sure that the control rod moves smoothly.

(2) Reassembly of plunger block assemblies

(a) Installation of plunger barrels

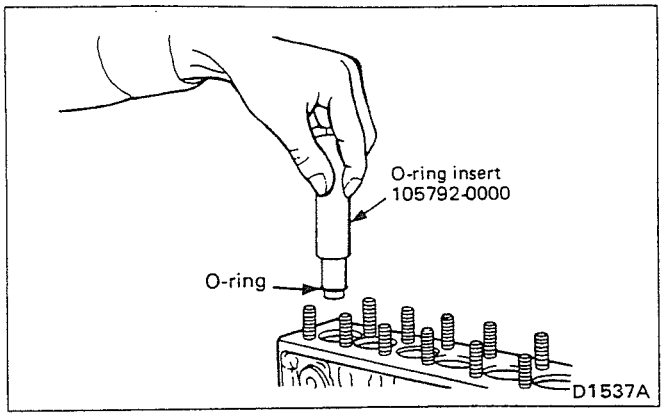


Install the barrel by aligning its guide groove with the locating pin of the flange sleeve.



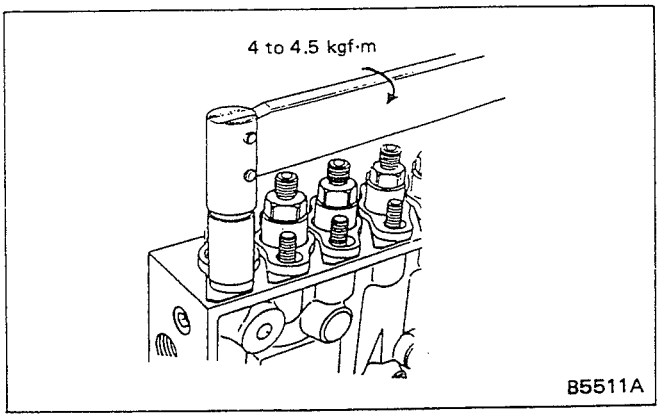
(b) Installation of delivery valve holders

(3) Installation of plunger block assemblies



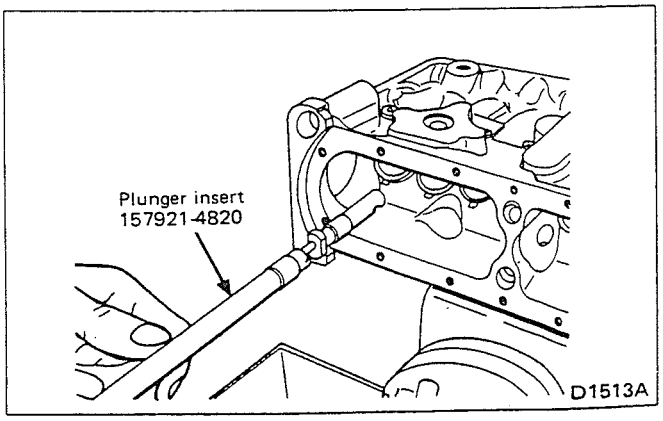
(a) Put the upper-side O-ring on the plunger barrel. Put the lower-side O-ring in the pump housing with O-ring Insert (special tool).

NOTE:
Do not put the lower-side O-ring on the plunger barrel and slide it into the pump housing.



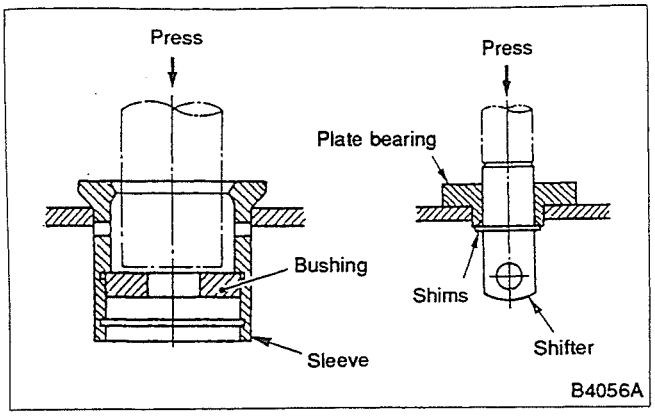
(b) Tighten two plunger block assembly lock nuts equally to the specified torque.

(4) Installation of plungers

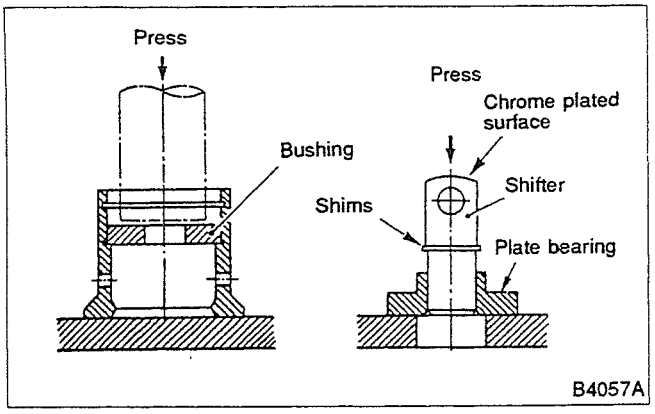


Using Plunger Insert (special tool), insert the plunger into the pump housing.

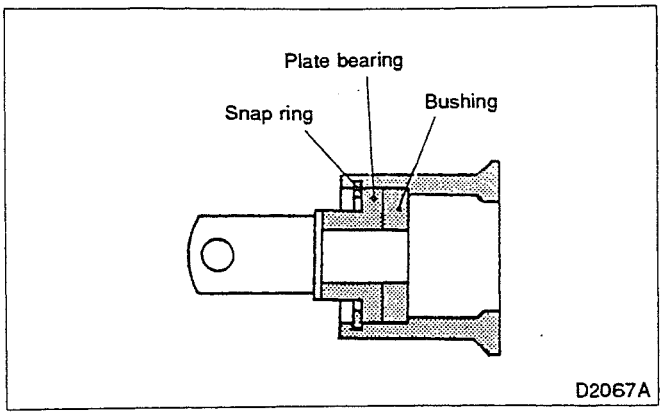
(3) Replacement of sleeve and guide lever assembly



(a) Remove the snap ring from inside the sleeve and separate the sleeve from the shifter portion of the guide lever assembly.
(b) Remove the sleeve from the sleeve with a press. Remove the shifter of guide lever from the plate bearing.



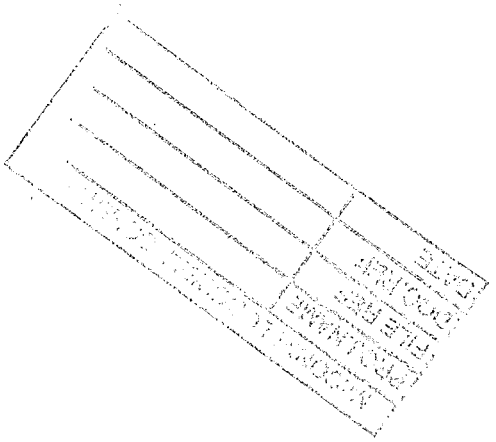
(c) Press the bushing into the sleeve. Press the shifter portion of the guide lever assembly into the plate bearing.
NOTE:
1. **Do not attempt to remove the shims.**
2. **Be careful not to damage the chrome plated surface of the shifter portion of guide lever assembly during removal or installation.**



(d) Press the plate bearing until it comes in full face contact with the bushing and install the snap ring. Make sure the sleeve rotates smoothly.

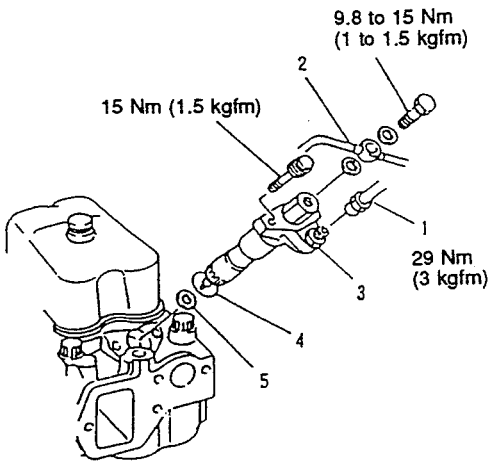
5.4.2 Testing

Item	Nominal value	Remarks
Airtightness	0 cc/min	Under air pressure of 2 kgf/cm^2 (28 psi) [196 kPa]
Delivery test (minimum)	See 3.1 SERVICE STANDARD TABLE.	Amount of delivery for 15 seconds Test conditions Fuel pipe: O.D. 10 mm (0.39 in.), I.D. 8 mm (0.31 in.), length 2000 mm (78.7 in.) Cam lift: 4 mm (0.16 in.) (double cam)
Suction test	25 strokes or less	No. of priming pump strokes operated at a rate of 60 to 100 strokes/min for lifting fuel 1 m (3.3 ft) Test conditions Same as delivery test



5.9 INJECTION NOZZLE

5.9.1 Removal and Installation



1 Injection pipe
2 Leak-off pipe
3 Injection nozzle
4 Dust seal
5 Nozzle tip gasket

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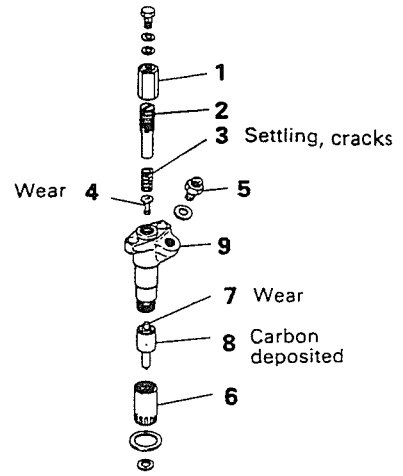
5.9.2 Disassembly



1 Cap nut
2 Adjusting screw
3 Spring
4 Push rod
5 Inlet connector
6 Retaining nut
7 Needle valve
8 Nozzle
9 Nozzle holder

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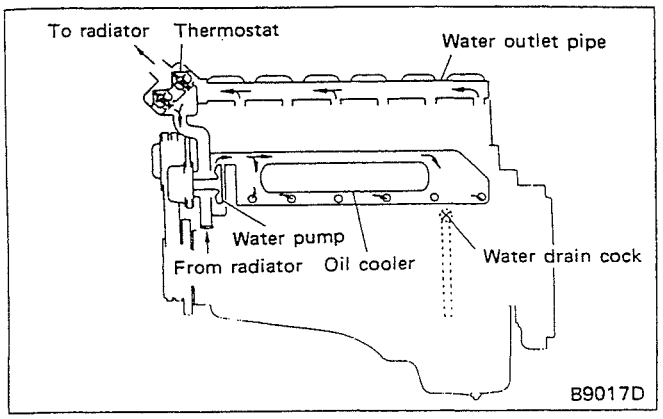
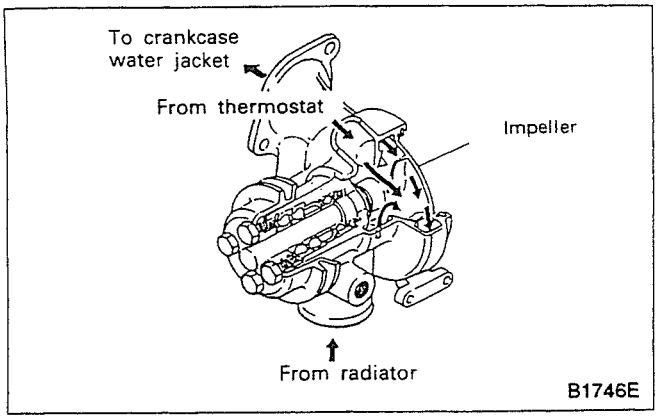
1. GENERAL

The engine is cooled by forced circulation of coolant by the water pump. The illustration below shows the coolant flow.



(1) Water Pump

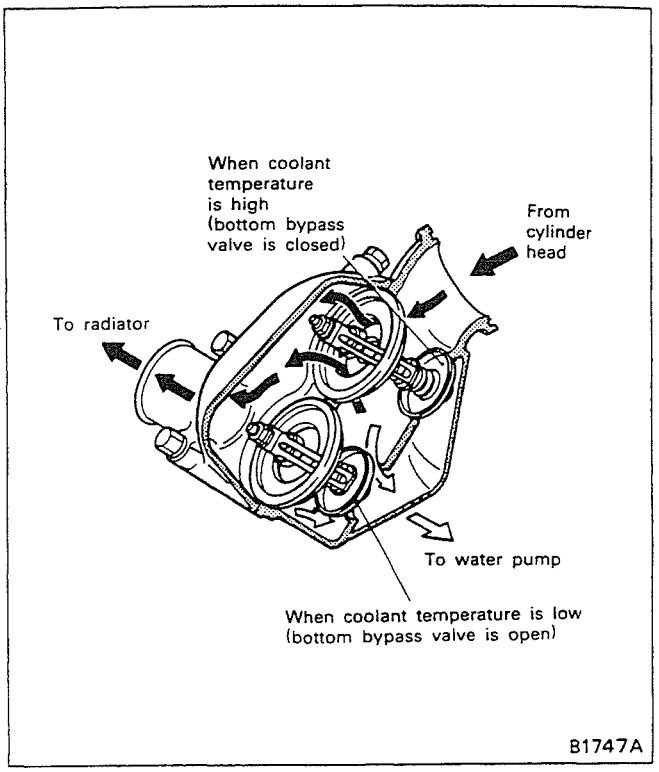


The water pump is a centrifugal pump. Mounted on the left side of the crankcase, the pump is driven by the crankshaft pulley via a V-belt.

An impeller having a blade is mounted at one end of the water pump shaft and coolant is sealed off by a unit seal.

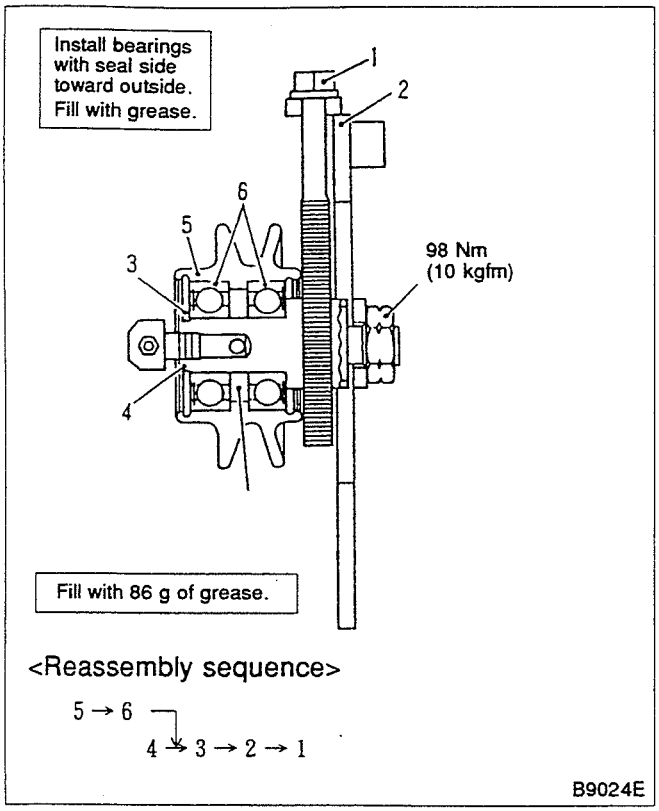
For lubrication of the water pump, refer to "Group 3 Lubrication System".

(2) Thermostat



The thermostat is a bottom bypass type with a special wax enclosed in a pellet. When the wax is heated, it changes from solid to liquid and its volume also changes. This change in volume changes the opening of the valve and changes the quantity of coolant flowing into the radiator and water pump (bypass side), thereby controlling the coolant temperature.

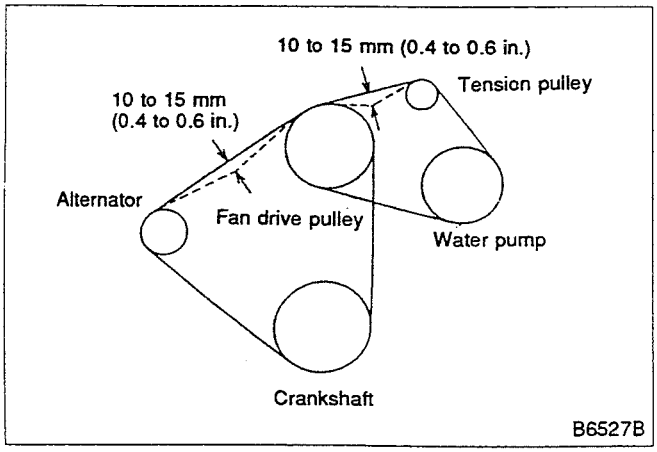
5.6.2 Reassembly



5.7 V-BELTS

5.7.1 Inspection

Push the V-belt inward with 10 kgf (22 lbf) [98 N] pressure exerted midway between the pulleys and check the deflection.

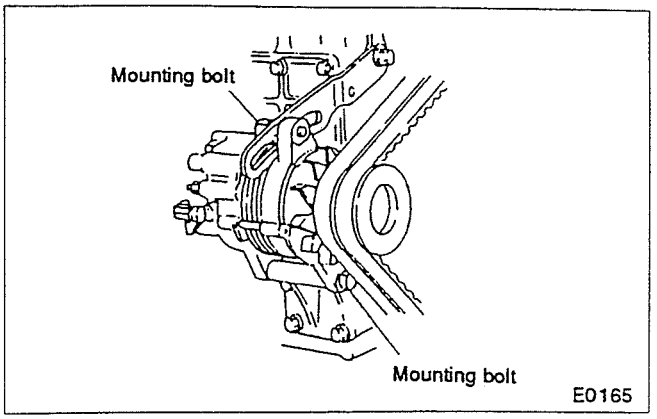


NOTE:

1. **If the belts are too loose, they will slap against the pulleys, causing unnecessary wear to the belts and possibly slipping to the extent that the engine will overheat.**
2. **If the belts are too tight, unnecessary stresses are placed upon the bearings and belts, which might shorten the life of both.**

5.7.2 Adjustment

(1) Alternator

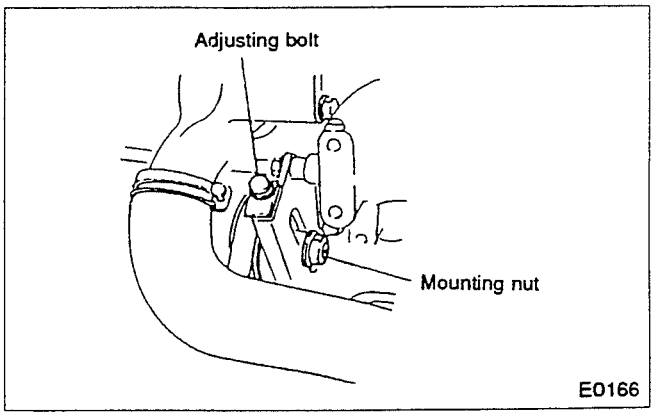


Loosen the mounting bolts, upper and lower, and move the alternator away from, or toward, the crankcase with a wrench handle.

NOTE:

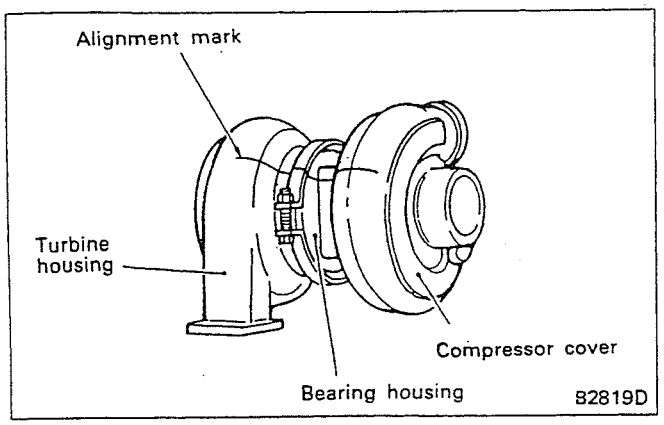
When moving the alternator, be careful not to damage the stator coil and through bolt.

(2) Tension pulley



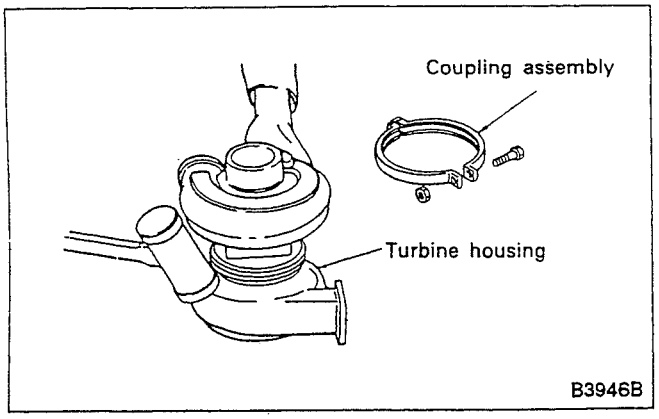
Loosen the idler pulley mounting nut and move the idler pulley with the adjusting bolt.

Disassembly Procedure



(a) Before disassembling the turbocharger, make alignment marks on the compressor cover, bearing housing, and turbine housing so that they can be properly reassembled.

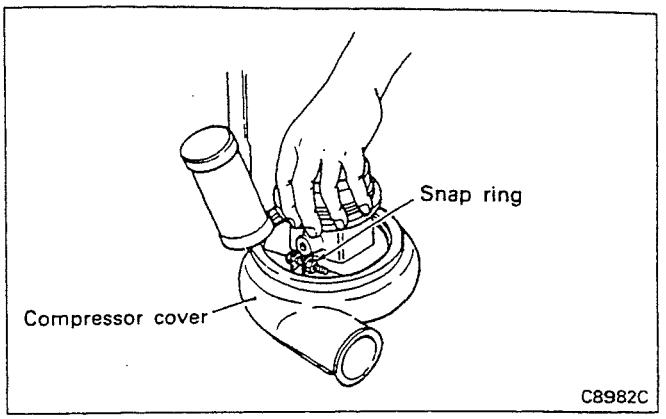
(b) Removal of turbine housing



To remove the turbine housing, remove the coupling assembly and tap the housing with a plastic hammer or similar tool to prevent damage to it.

NOTE:
The turbine wheel blades are easy to bend. Use care not to damage them.

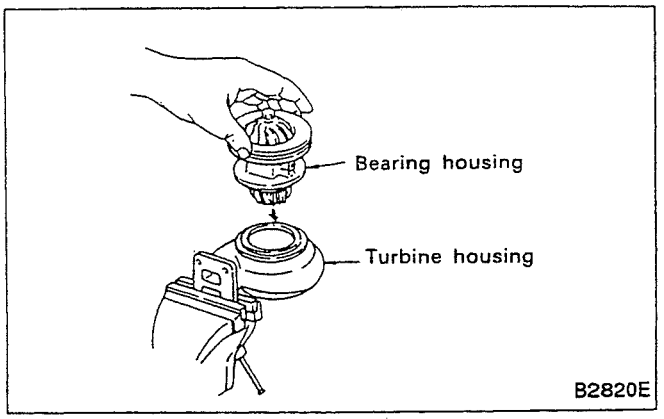
(c) Removal of compressor cover



Remove the compressor cover by tapping it with a plastic hammer with the snap ring loosened.

NOTE:
Use care not to damage the compressor wheel during the removal procedure.

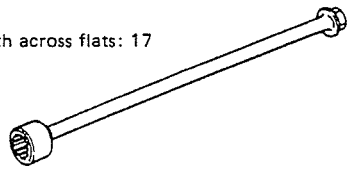
(d) Removal of compressor wheel



1) Fit the bearing housing into the turbine housing which is clamped in a vise.

GROUP 7 ELECTRICAL SYSTEM

4. SPECIAL TOOL

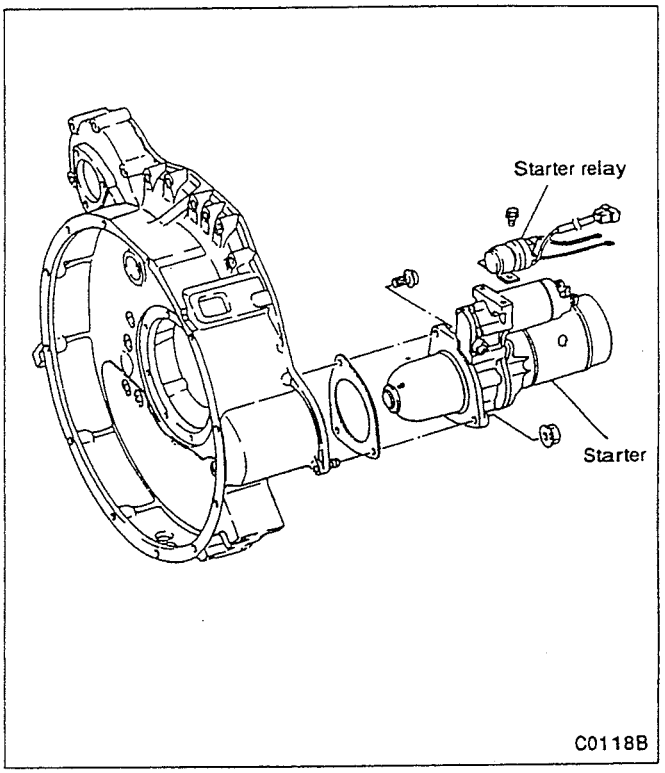
Tool name	Part No.	Shape	Use
Socket	31191-06100	Width across flats: 17  B5021A	Removal and installation of starter

5. SERVICE PROCEDURES

NOTE:
Whenever removing electrical parts from the vehicle, be sure to place the battery switch in OFF position, disconnect the negative battery cable, and wind the cable end with vinyl insulation tape.

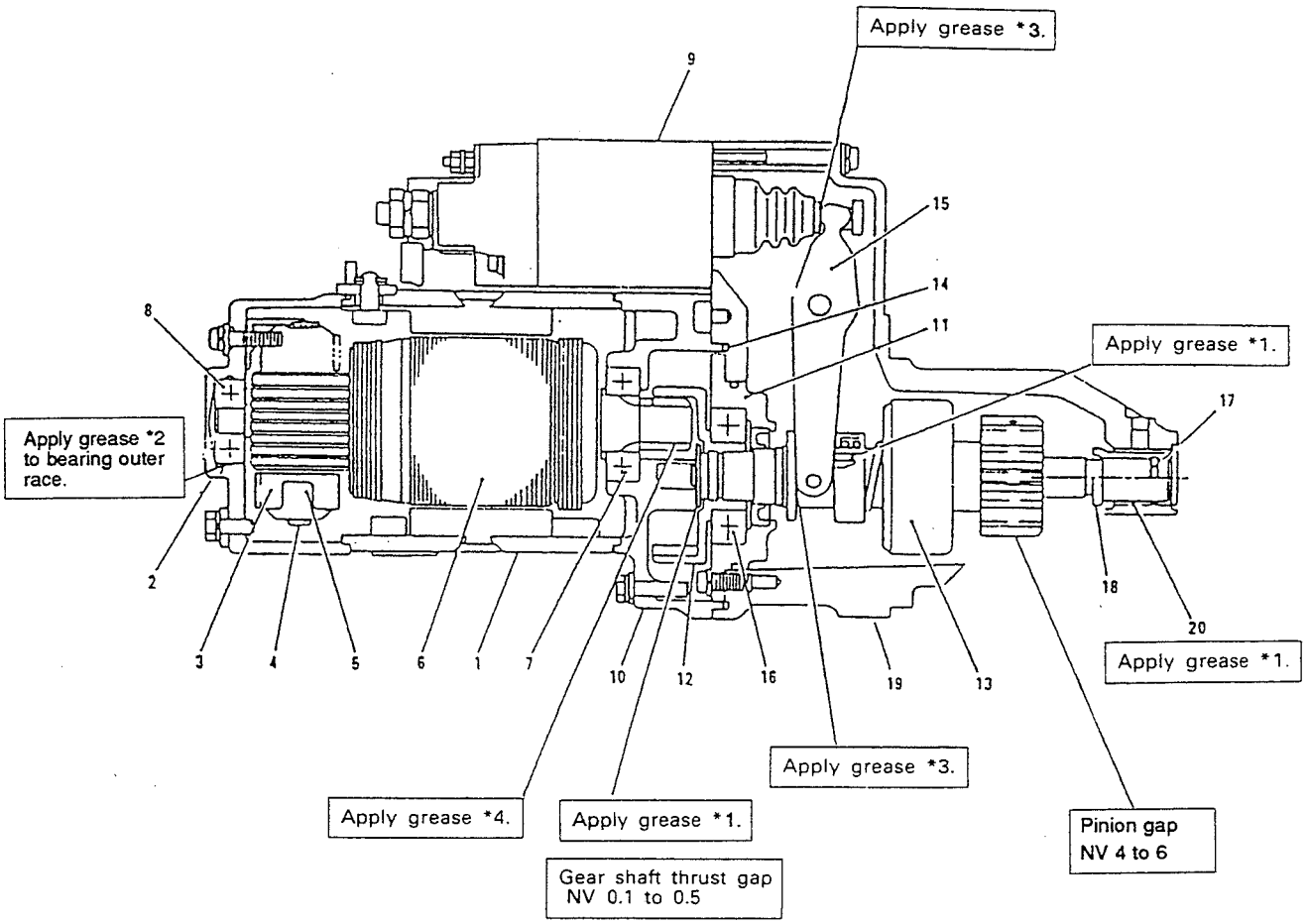
5.1 STARTER

5.1.1 Removal and Installation



The starter mounting bolt on the inner side (crankcase side) can be easily mounted or removed by use of the special tool (Socket: 31191-06100).

5.1.4 Reassembly



NV ... Nominal Value

(Recommended grease)
*1: MULTEMP MS-2 or equivalent
*2: MULTEMP HD-2 or equivalent
*3: Mystik JT-6 or equivalent
*4: MOLYCOAT AS-19 or equivalent

<Assembly sequence>

⑫→16→⑪→⑬→⑱→⑰→⑮ → 19→20 → 14 →10→⑨ → 6→7→8 → 3→4→5→① → 2

For parts with an encircled number, refer to Reassembly Procedure that follows.

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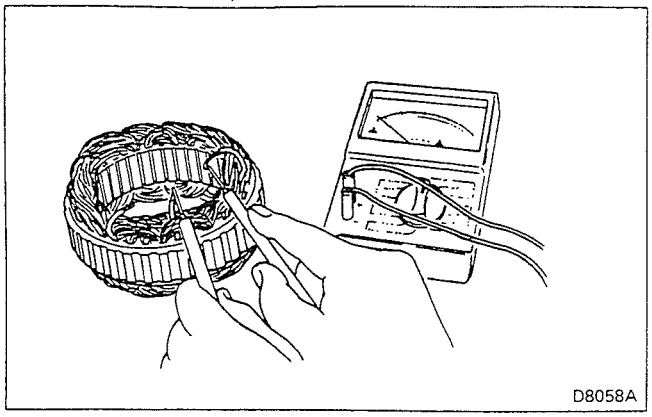
Inspection Procedure

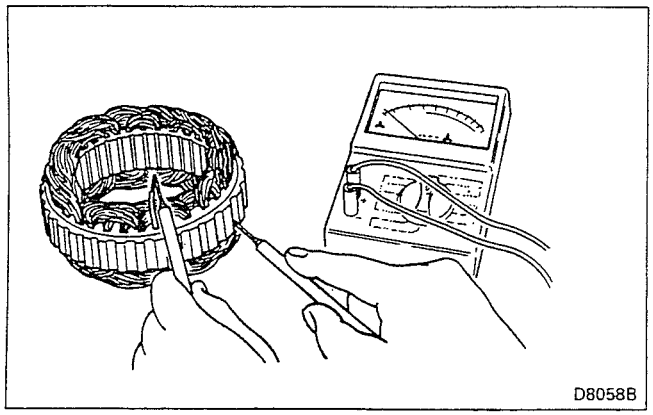
(1) Inspection of Stator

(a) Continuity across leads



Check that there is continuity across stator leads. If there is no continuity indicating a broken wire, replace the stator.

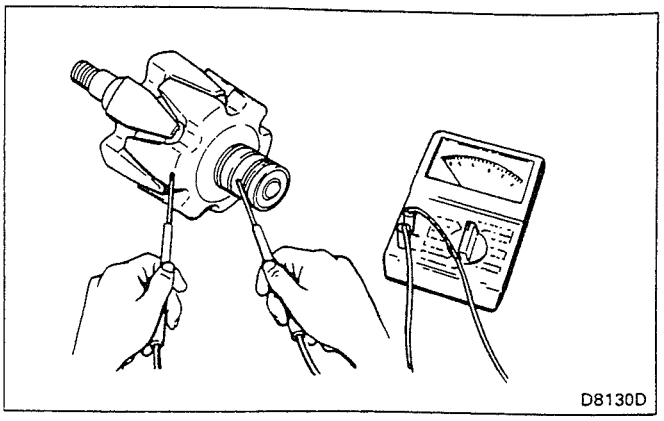
(b) Continuity across stator leads and core



Check that there is continuity across the stator leads and core.
If there is, replace the stator as it is grounded.

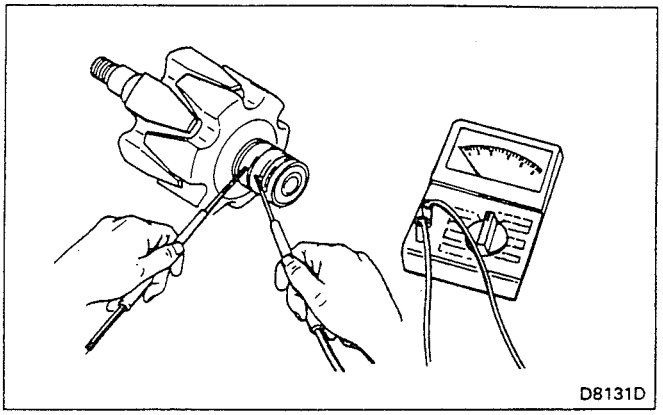
(2) Inspection of Rotor

(a) Continuity between slip ring and core



Check that there is no continuity between the slip ring and core.
If there is, replace the rotor as it is grounded.

(b) Field coil resistance



Measure the resistance across slip rings. Replace the rotor if the resistance is not within the specification.