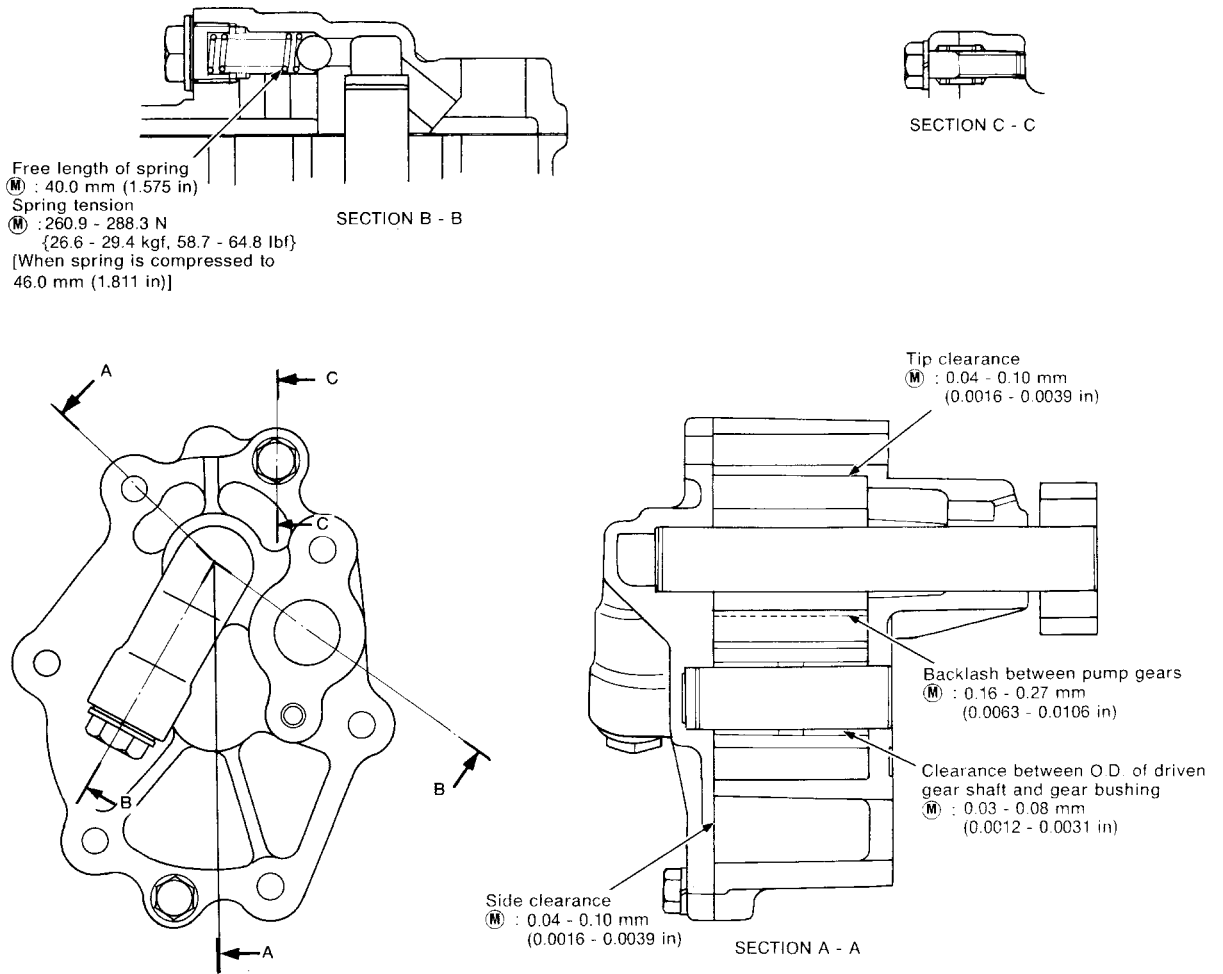


HOW TO USE THIS MANUAL

- ▶ **A quick reference index**, a black tab is provided on the first page, so you can quickly find the first page of each chapter by mating it to the chapter's black tab.
- ▶ **The contents** are listed on the first page of each chapter.
- ▶ **Construction illustration:**
The assembled unit is indicated. The construction illustration includes the names of the major components, items requiring adjustment after reassembling and their maintenance standards.

[EXAMPLE]



Ⓜ : Maintenance standard

WLB045A

SPECIFICATIONS

SPECIFICATIONS

ENGINE SPECIFICATIONS

Engine models FE6A and FE6B

| Item | | Engine model | | | |
|--|----------------------------------|--|-----------------------------------|-----------------|-----------------|
| | | FE6A | FE6B | | |
| Max. gross output (JIS) | | kW {PS}/rpm | | | |
| | | 118 {160}/3,000 | 119 {162}/3,000 132 {180}/3,000 | | |
| Type | | Diesel | | | |
| Cooling method | | Water cooled | | | |
| Number of cylinders and cylinder arrangement | | 6, in-line | | | |
| Stroke cycle | | 4 | | | |
| Combustion chamber | | Direct fuel injection | | | |
| Valve mechanism | | Overhead valve | | | |
| Cylinder liner | | Dry | | | |
| Bore x stroke | | mm (in) | | | |
| | | 108 x 126 (4.25 x 4.96) | | | |
| Compression ratio | | 18.0 | | | |
| Cylinder compression | | kPa {kgf/cm ² , psi}/rpm | | | |
| | | 2,942 {30, 427}/200 | | | |
| Idling speed | | 600 | | | |
| Valve timing | | Intake | Open (B.T.D.C.) | 15° | |
| | | | Closed (A.B.D.C.) | 40° | |
| | | Exhaust | Open (B.B.D.C.) | 53° | |
| | | | Closed (A.T.D.C.) | 9° | |
| Valve clearance mm (in) | | Intake | 0.3 - 0.4 (0.012 - 0.016) | | |
| | | Exhaust | 0.3 - 0.4 (0.012 - 0.016) | | |
| Lubrication system | Lubrication system | | Forced-circulation type | | |
| | Oil pump | | Gear pump | | |
| | Oil filter | | Cartridge type | | |
| | Oil cooler | | Water cooled flat tube type | | |
| | Regulator valve opening pressure | | kPa {kgf/cm ² , psi} | | |
| | | 422 - 461 {4.3 - 4.7, 61 - 67} | | | |
| Cooling system | Cooling system | | Forced-circulation type | | |
| | Radiator type | | Corrugated fin | | |
| | Cooling fan | Outside diameter - Number of fins mm (in) | 480 (18.90) - 6 | 485 (19.09) - 8 | 510 (20.08) - 6 |
| | | | 485 (19.09) - 8 | | 510 (20.08) - 7 |
| | | | 530 (20.87) - 6 | | 530 (20.87) - 6 |
| Water pump | | Centrifugal, belt-driven type | | | |
| Thermostat | | Wax pellet type | | | |

PRECAUTIONS

CLEANING AND INSPECTION

CLEANING

The parts will be coated with dirty oil and sludge. Cleaning is mandatory. Suitable cleaning methods include steam cleaning, light oil cleaning, acidic or alkaline solution cleaning, neutral agent cleaning, trichloroethylene steam cleaning, and magnus solution cleaning. The cleaning process may reveal damage. So check closely while the cleaning is in process.

METAL PARTS

Light oil

Unlike some other solvents, light oil has little penetrating or dissolving power with respect to sludge. Unless the surface is precision finished, use a wire brush or other tool to dislodge the sludge. Follow this up with two washings.

Alkaline solution

Do not use an alkaline solution if the parts are made from an alloy. However, an alkaline solution cleans steel and cast iron parts quite well.

NOTE

- **If an alkaline cleaning solution is to be used, prepare and keep on hand a neutralizing agent (such as boric acid solution), since the alkaline solution must be immediately washed from the skin or eyes in the event of contact.**

RUBBER PARTS

Do not use mineral oils. Wash in alcohol or merely wipe away dirt with a clean cloth.

OIL PASSAGES

Pass a wire through oil passages to make sure that they are free. Clean the oil passages with solvent that is injected under pressure from a nozzle.

PROTECTION AGAINST CORROSION

After removing all traces of old oil and grease from the surfaces of the parts, apply a coat of clean oil to them to prevent corrosion.

INSPECTION

Parts should be inspected using designated measuring instruments or tools. Whether the parts are suitable for further use should be determined by consulting the specified Maintenance Standards chart. Faulty parts should be corrected or replaced as required. If one of the mating parts is found to be worn to such an extent that the specified clearance is exceeded, replace it and/or its mate as the occasion demands.

Parts which are still within the repair or wear limit should sometimes be replaced before they exceed the limit from preventive maintenance viewpoint.

All parts should be checked carefully by looking at their appearance or by using the "red" (penetration) method, whichever is designated. If inspection of the exterior appearance reveals any of the following abnormalities, the affected part(s) should be repaired or replaced, as required.

All rubber parts, such as O-rings, oil seals, gaskets, etc. should be discarded after they have been removed.

Abnormalities

- Uneven wear
- Graded wear
- Scratches
- Cracks
- Deformity
- Fatigue or weakness (for springs and rubbers, etc.)
- Bends
- Loose fit
- Unusual noise (for bearings)
- Discoloration or jamming
- Rust formation
- Deterioration (for brake linings, etc.)

MAINTENANCE PROCEDURE

10. Shut the drain cocks and fill the cooling system with plain water. Start the engine and run it at a moderate speed in the same manner as described in step 8.
11. Stop the engine. Open the drain cocks and drain the rinsing water.
12. Repeat rinsing procedure 2 or 3 times until the discharged rinsing water appears clean.
13. Drain the coolant from the coolant reservoir tank as necessary.
14. Close the drain cocks and remove the drain hose from the radiator drain cock.

To fill up the cooling system (with coolant)

Use the following refill procedure to remove air from the system and provide proper coolant level.

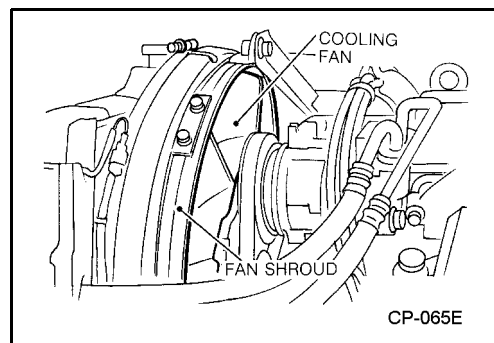
1. Fill the radiator slowly with the proper coolant solution up to the filler opening.
Add coolant solution up to the HIGH level of the coolant reservoir tank.
The cooling system holds approximately 22 liters (4-7/8 Imp gal) of coolant solution.
Then properly close the radiator filler cap and the reservoir tank cap.
2. Operate the engine at a slightly higher than normal idling speed with the engine idling control button until the coolant temperature indicator points the middle region of the gauge. Run the engine an additional 10 minutes to allow the air to escape from the engine cooling system.
3. Stop the engine. After the engine has completely cooled down, remove the radiator filler cap and check the coolant level in the radiator. If low, add coolant to the radiator filler opening.
Reinstall the radiator filler cap.
4. Check the coolant level in the coolant reservoir tank. If the level is between the LOW and HIGH lines, it is normal. If it is below the LOW level, add coolant solution up to the HIGH level.
5. If the added coolant solution is more than 500 milliliter (17.6 Imp fl oz), check and correct for any sign of leakage, then repeat steps 1 to 4.
6. Check the drain cock for leaks.

COOLING FAN AND FAN SHROUD

Check the cooling fan and fan shroud for proper installation, cracks or damage. Replace faulty parts.

WARNING

- Never get your hand near the fan, when the engine is operated.
 - If fan clutch is equipped, the fan rotating speed may seem to slow when the coolant is cool, but never try to touch the fan and other rotating parts while the engine is running.
-



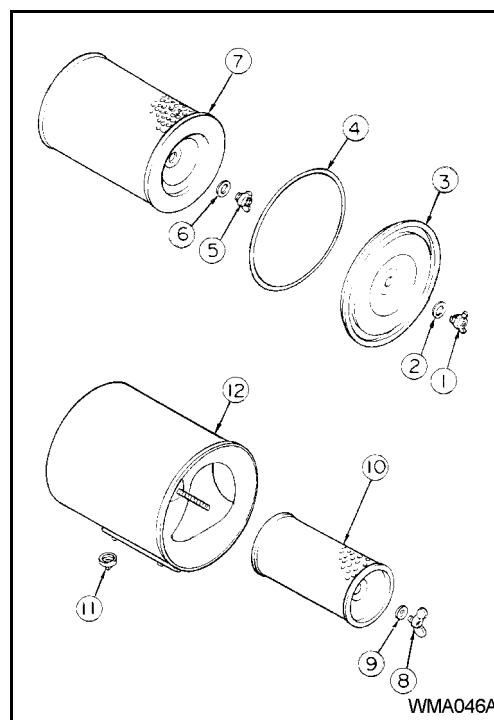
MAINTENANCE PROCEDURE

<FE6T 151 kW {205 PS}/162 kW {220 PS} and FE6TA>

Disassembly sequence (Reassembly sequence is in the reverse order of disassembly.)

- | | |
|-------------------|---------------------|
| 1. Wing nut | 7. Outer element |
| 2. Packing | 8. Wing nut |
| 3. Cover assembly | 9. Packing |
| 4. Packing | 10. Inner element |
| 5. Wing nut | 11. Evacuator valve |
| 6. Packing | 12. Body assembly |

1. Loosen the wing nut and remove the cover assembly.
2. Loosen the wing nut securing the outer element and remove the outer element.



WMA046A

3. Check the outer element and packing, and replace if broken or deformed.
If there is dirt or dust on the outer element, clean it by blowing compressed air at 196 to 294 kPa {2.0 to 3.0 kgf/cm², 28 to 43 psi} from inside.



ECJ-035

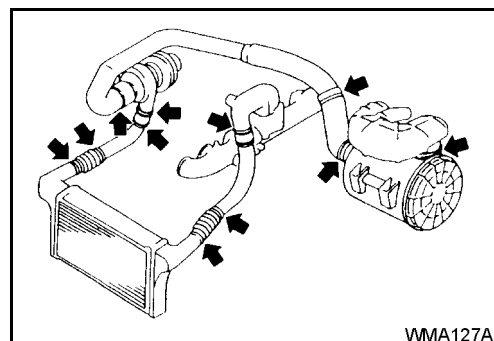
4. First remove the wing nut and then the inner element.

NOTE

- Do not remove the inner element until the specified replacement time. In other words, the inner element need not be checked between replacements.

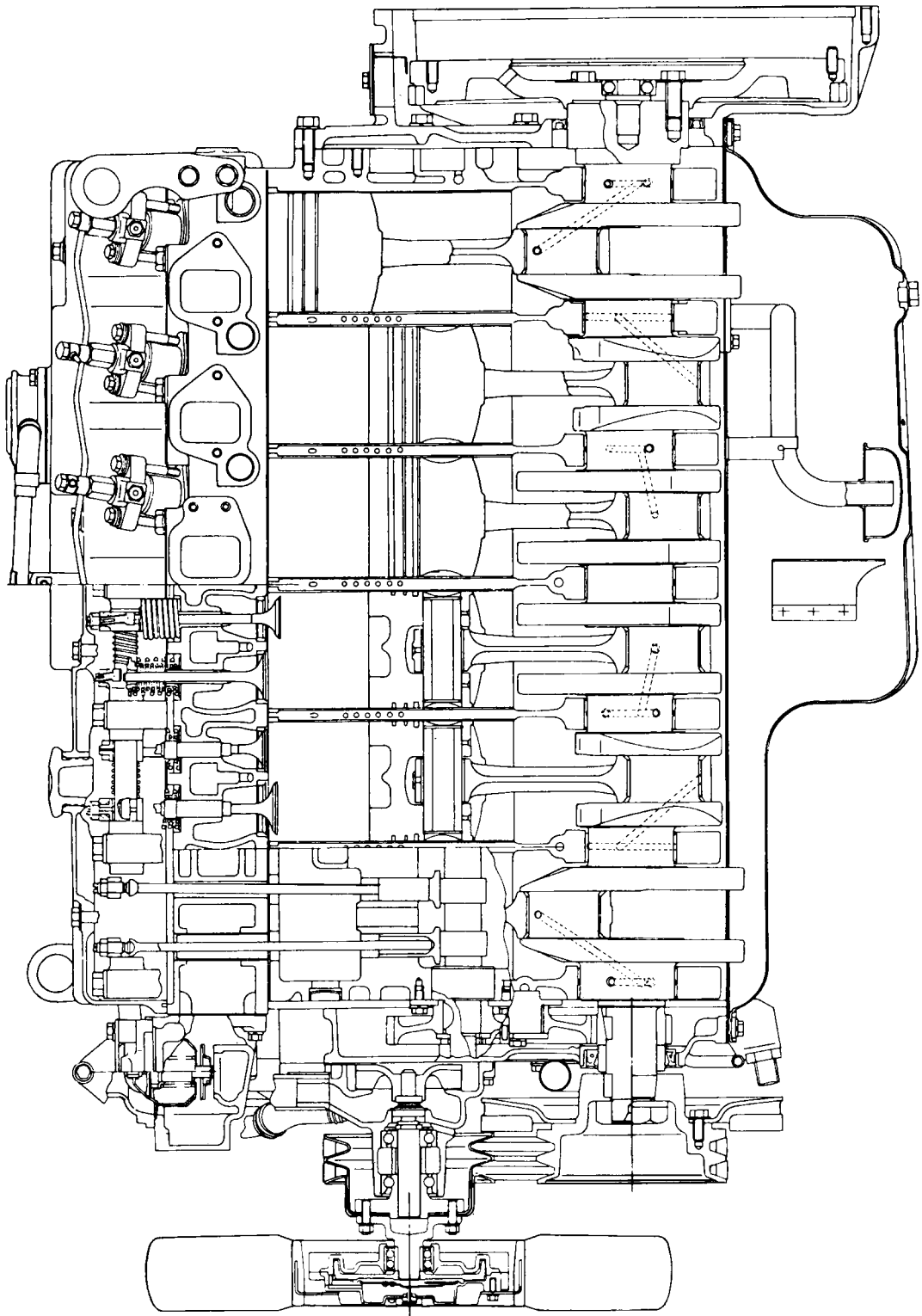
AIR INTAKE SYSTEM (DUCT, HOSE AND CLAMP)

Check the air intake duct connections for loose clamps or cracked hoses. Check the connection between the air cleaner and air intake manifold especially. Tighten loose clamps, if any.



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CONSTRUCTION



ZDR006A

DR-3-4

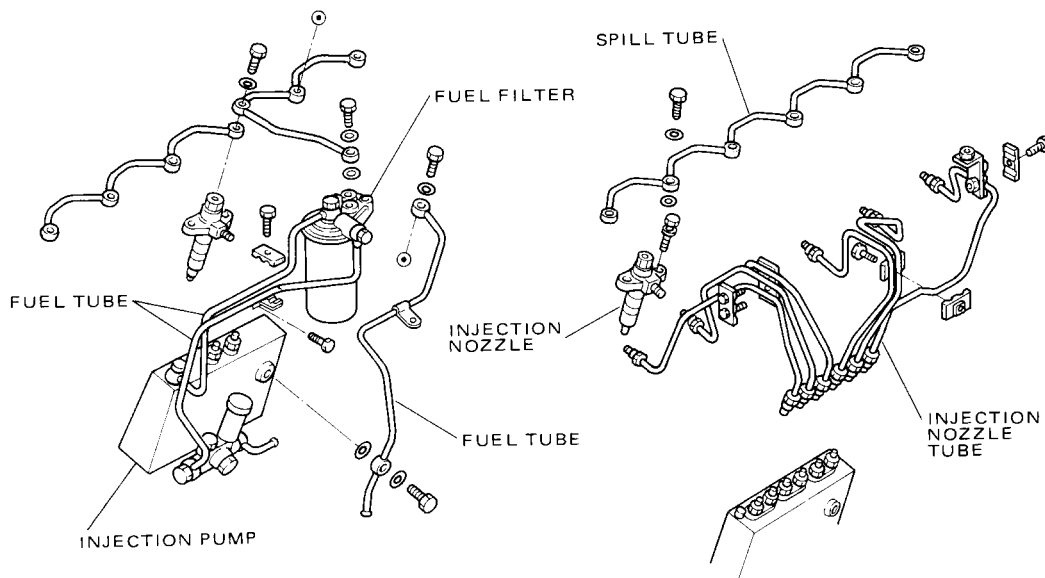
REMOVAL

REMOVAL

1. Remove the following parts:
 - Fuel tubes
 - Fuel filter assembly and bracket as a unit
 - Injection nozzle tubes and spill tubes
 - Injection nozzles

NOTE

- Use a container to catch fuel. Wipe up any fuel spilled on the exterior of the engine with a rag.



EHV3004A

2. Remove the rocker shaft assembly and push rods.

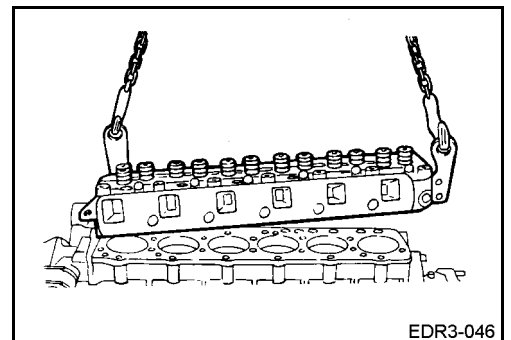
NOTE

- Loosen the rocker shaft assembly mounting bolts, starting with the outer bolts and moving toward the center.

3. Remove the cylinder head assembly. Attach chains or cables to the engine lifter and lifters and lift the cylinder head away from the cylinder block using a hoist.

NOTE

- Loosen the head bolts diagonally, starting with the outer one and moving toward the center.



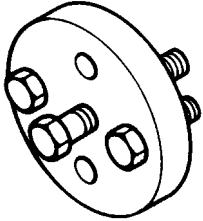
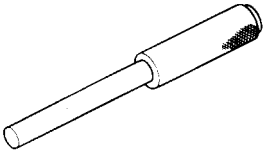
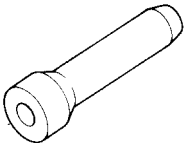
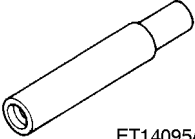
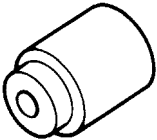
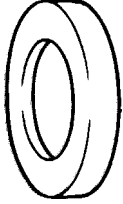
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TOOLS

TOOLS

WATER PUMP

Type I

| Tool name and number | Description | Shape |
|--|---|---|
| Pulley hub puller 99749 Z5503 | Used to remove flange and impeller |  <p>ET14093B</p> |
| Drive shaft remover 99758 Z5500 | Used to remove drive shaft |  <p>ET14-129</p> |
| Bearing replacer 99759 Z5503 | Used to remove and install ball bearing |  <p>ET14-130</p> |
| Water seal replacer 99759 Z5504 | Used to remove water seal |  <p>ET14095A</p> |
| Drive shaft guide 99789 Z5500 | Used to install drive shaft |  <p>ETL3-024</p> |
| Fan pulley hub replacer 99788 Z5501 | Used to drive flange into place |  <p>ET14-132</p> |

Key point of reassembly

Before assembling the fuel injection pump, clean parts thoroughly and apply a thin coat of engine oil to rotating and sliding parts.

35 Control rack

Tilt the pump housing onto its side and set the punch mark at both sides of the control rack to the same dimension from the ends of the pump housing.

32 Plunger assembly

Install the plunger to the special tool plunger insert (157921-5620) and assemble to the barrel.

At this time, the lower spring seat must be installed to the plunger.

NOTE

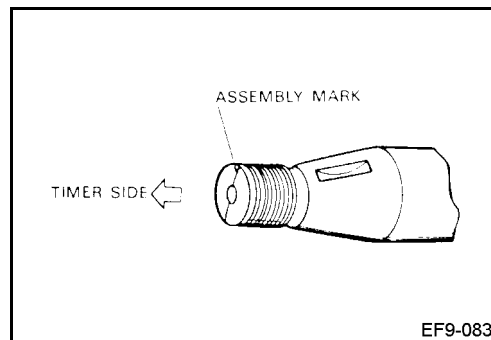
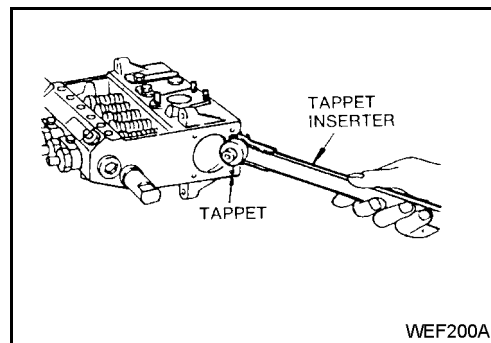
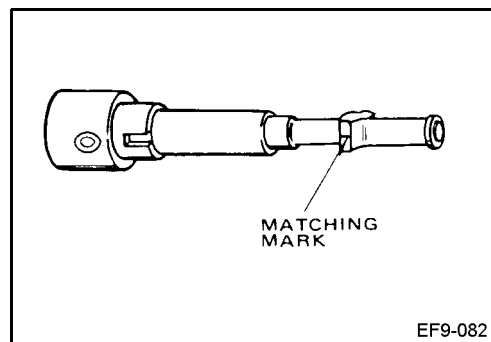
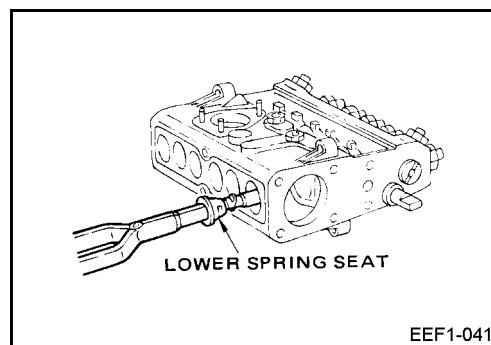
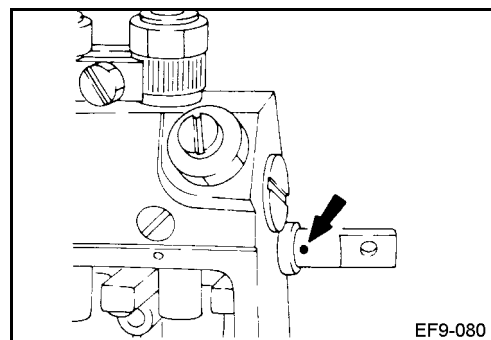
- Since the plunger and barrel are precision manufactured as pair, they must not be matched with those of another cylinder.
- Assemble the plunger with the matching mark facing the front (cover side) of the pump housing.

19 Tappet assembly

Assemble the tappet to the pump housing using the tappet inserter (157931-6120) and tappet insert (157921-0120) the same as when disassembling. Push the tappet itself forcefully and install the tappet holder.

13 Camshaft

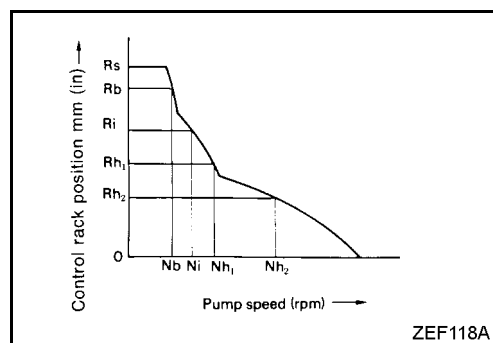
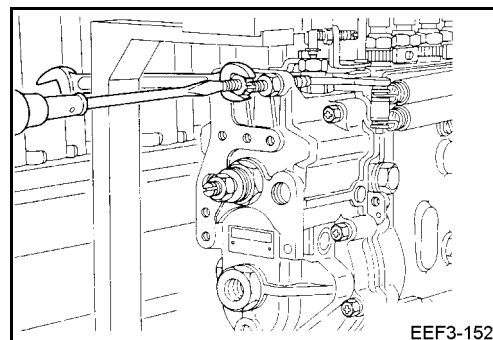
1. Install the camshaft, together with the center bearing, to the pump housing so that the "assembly mark" is at the timer side. (This work can be facilitated by coating the center bearing with a small amount of grease and sticking it to the camshaft.)



1. Locking the control rack
 At this time it is necessary to fix the control rack. Normally, injection timing adjustment and fuel injection quantity adjustment are performed before governor adjustment.
 Fix the control rack according to the following procedure: Increase the pump speed to 500 to 600 rpm with the control lever held at the idling position, then shift the lever to the maximum-speed position. Next, set the control rack 3 mm (0.12 in) beyond the full-speed position using the full-load setting bolt. Various adjustments can now be made with the control rack locked in the specified position.
2. Control lever operation
 Before shifting the control lever to the maximum-speed position, increase the pump speed to 500 to 600 rpm while the control lever is held at the idling position.
3. The performance of the governor depends on the engine specifications.
 The performance chart given above is typical of this governor.

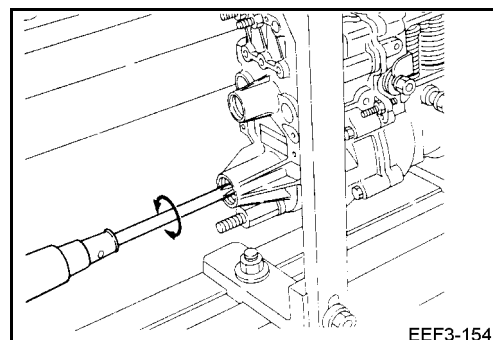
Idling adjustment

1. With the pump speed maintained at 80 to 100 rpm, temporarily set the control lever so that the control rack position is R_s mm (in).



2. Maintain pump speed at N_b rpm and screw in the idling spring assembly. When the rack position is R_b mm (in), tighten the locknut.

T: 18 - 22 N·m {1.8 - 2.2 kgf·m, 13 - 16 ft·lbf}



REASSEMBLY

To reassemble, reverse the order of the above removal procedures. Observe the following:

NOTE

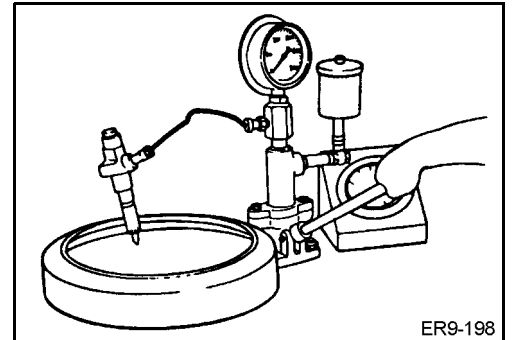
- Clean the mating surfaces of the nozzle and nozzle holder and the retaining nut in clean diesel fuel before installation.
- Use new gaskets.

ADJUSTMENT

1. Loosen the adjusting screw and install the nozzle on a nozzle tester (105785-0960). Operate the hand lever forcefully two or three times to remove foreign matter.
2. Adjust fuel valve opening pressure using the adjusting screw.

Unit: kPa {kgf/cm², psi}

| Item | Maintenance standard | Service limit |
|---|--|---------------|
| Valve opening pressure (Regulated pressure) | Z, D2, A5, A6, C1, F4 20,104 - 20,595 {205 - 210, 2,915 - 2,986} | — |
| | D3, F4 22,066 - 22,556 {225 - 230, 3,200 - 3,271} | — |



WARNING

- Be extremely careful not to direct fuel spray to hand while adjusting fuel injection. It may penetrate into blood vein to the skin and cause toxic symptoms.

3. After adjusting injection pressure to specifications, install the cap nut. Recheck injection pressure.

Z, D2, D3, A5 and A6

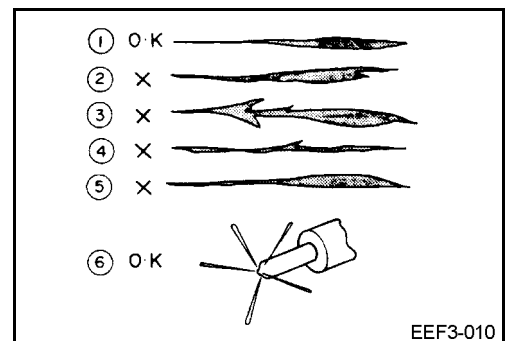
T: 39 - 49 N·m {4.0 - 5.0 kgf·m, 29 - 36 ft·lbf}

C1 and F4

T: 29 - 39 N·m {3.0 - 4.0 kgf·m, 22 - 29 ft·lbf}

4. While adjusting injection pressure, check the spray pattern. Also check for signs of fuel leakage or obstruction. If inspection reveals slight wear on the seating surfaces of the nozzle body and needle, lap both using lapping compound. If either part requires replacement, replace both parts as a unit.

- | | |
|--|-----------------------------------|
| 1. Equal, symmetrical fuel spray pattern | 4. Lean fuel spray pattern |
| 2. Asymmetrical fuel spray pattern | 5. Stepped fuel spray pattern |
| 3. Incorrect fuel spray pattern | 6. Equal fuel spray (from 5 jets) |

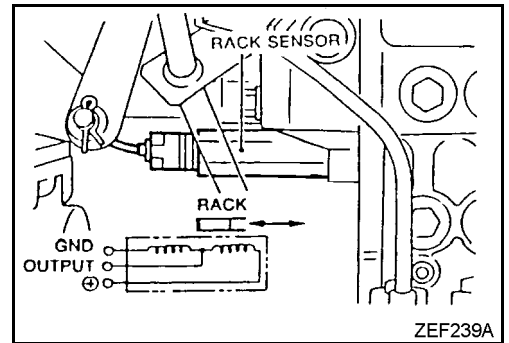


“MD-TICS” SYSTEM

Rack Sensor

The rack sensor is a non-contact displacement meter that acts to send the movement of the control rack of the injection pump to the control unit.

The rack sensor sends out an alternating wave current (sine wave) from the OSC terminal (oscillation terminal) of the control unit. It detects the position of the rack from the MDL (middle) signal generated by the change in the impedance (self-induction) between the two coils, and sends this to the control unit.

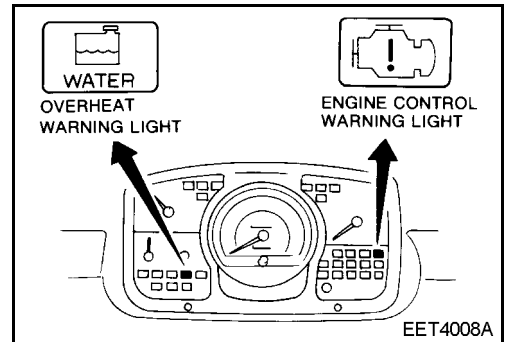


Diagnostic Switch

The diagnostic switch is the switch used to carry out trouble-shooting of the electronic control system.

The diagnostic switch consists of one pair of male and female terminals. These are normally connected; they are disconnected only when carrying out trouble-shooting.

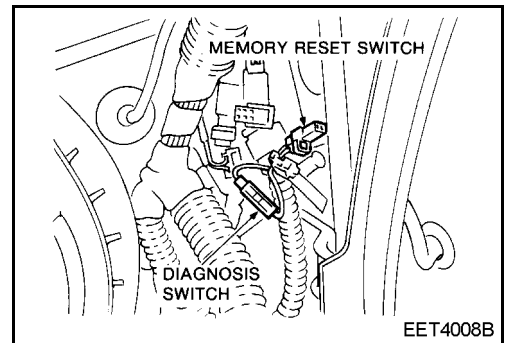
The diagnostic switch is installed behind the electrical unit board and labeled with a “DIAGNOSIS” tag.



Memory Reset Switch

This switch is used to delete the control unit trouble data from memory. To delete the data, short circuit the connector terminals for about ten seconds.

The memory reset switch is installed behind the electrical unit board and labeled with a “MEMORY” tag.



CHECK (1) Check fuse

1. Check that the power fuse for the pre-stroke actuator is not blown.
2. Measure the voltage at the fuse portion.

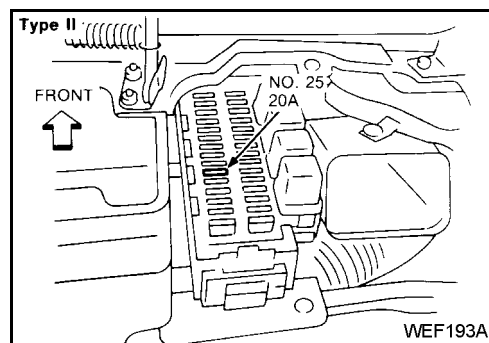
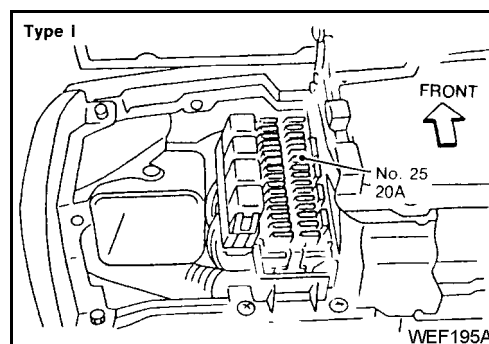
Value for power source voltage

Unit: V

| Measurement location | Standard value |
|---|----------------|
| Power source fuse for pre-stroke actuator | 20 - 28 |

3. Judgement

- Fuse is blown (voltage is normal) → after finding cause, replace fuse
- Fuse is normal → go to CHECK (2).
- Voltage is not as specified → disconnection in harness between battery and fuse, battery abnormal → repair harness or check battery



CHECK (2) Check harness between unit and power source for pre-stroke actuator system

1. Remove all harness connectors from the control unit, turn the ignition key switch ON, then measure the voltage the body(-end) and between terminal (2) (+end) of connector U-12.

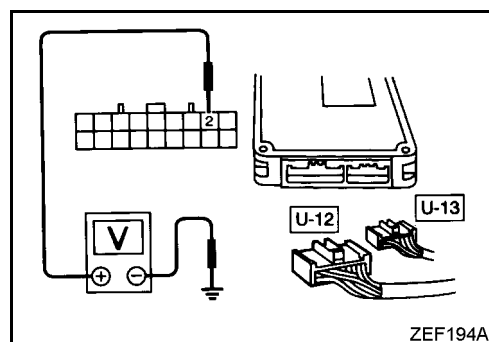
Value for power source voltage

Unit: V

| Measurement location | Standard value |
|--|----------------|
| Connector U-12, (2) (+end) - body (-end) | 20 - 28 |

2. Judgement

- Voltage is as specified → control unit abnormal → replace control unit
- Voltage is not as specified → abnormality in power harness between power harness connectors, or pre-stroke cut relay abnormal → repair or replace harness, or replace pre-stroke cut relay



INSTALLATION

Key point of installation

1. Install the turbocharger assembly on the exhaust manifold using a gasket.

NOTE

- **Mounting nuts are heat-resistant types. Do not confuse them with conventional nuts.**

2. Install the exhaust connector, connector support and seal plate.

NOTE

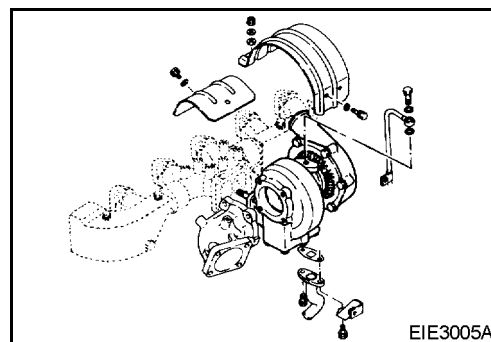
- **Mounting nuts or bolts are heat-resistant types. Do not confuse them with conventional nuts or bolts.**

3. After installing the turbocharger assembly, crank the engine using the sub-starter switch. Crank for approximately 10 to 20 seconds while pulling the engine stop lever out. Crank the engine until the oil pressure gauge activates, since oil is not distributed to the oil line.

NOTE

- **Do not crank the engine for more than 20 seconds at a time; otherwise, the starter motor may be damaged. Repeat cranking several times.**

4. Start the engine. Check that no oil leaks.



SERVICE DATA

SERVICE DATA

SPECIFICATIONS

STARTING MOTOR

| | | |
|--------|---------------|---------------|
| Model | 0350 502 0310 | 0350 502 0321 |
| Type | Shift | |
| Output | V-kW | 24-4.5 |

ALTERNATOR

| | | | | | | | |
|-------------------|--------------------------|---------------|---------------------|---------------|---------------------|---------------|---------------|
| Model | 0202 152 | | | | 0201 152 | | 0201 222 |
| | 0202 152 0310 | 0202 152 0311 | 0202 152 0220 | 0202 152 0221 | 0201 152 0420 | 0201 152 0421 | 0201 222 0273 |
| | With vacuum pump | | | | Without vacuum pump | | |
| Output | V-A | 24-50 | | | | | 24-80 |
| Type of regulator | IC transistor (Built-in) | | | | | | |
| Vacuum pump model | 1290 011 00 (VD-120) | | 1290 009 00 (VD-30) | | — | | |

AIR HEATER

| | | |
|---------------|--------|--------------|
| Type | Ribbon | |
| Rated current | V-A | 22-85 |
| Rated time | Second | Less than 50 |

SERVICE DATA

STARTING MOTOR

Models 0350 502 0310 and 0350 502 0321

Unit: mm (in)

| Item | | Maintenance standard | Service limit | Remarks |
|----------------------|-----------------------------------|------------------------------|----------------------------|--------------------|
| Commutator | Outside diameter | 36.0 (1.417) | 34.0 (1.339) | |
| | Runout | Less than 0.09 (0.0035) | More than 0.10 (0.0039) | |
| | Undercut depth | 0.5 - 0.8 (0.020 - 0.031) | 0.2 (0.008) | |
| Brush | Brush height | 18.0 (0.709) | 13.0 (0.512) | |
| | Brush spring tension N {kgf, lbf} | 29.4 {3.0, 6.6} | 20.6 {2.1, 4.6} | When spring is set |
| Magnetic switch | Continuity test | Pull coil resistance Ω | 0.70 - 0.86 | — |
| | | Hold coil resistance Ω | 0.85 - 1.05 | — |
| Gear shaft | Shaft runout | Less than 0.09 (0.0035) | More than 0.10 (0.0039) | |
| | Thrust gap | 0.1 - 0.5 (0.004 - 0.020) | — | |
| Armature, field coil | Insulation resistance MΩ | More than 1.0 | 0.5 | |
| Brush holder | Insulation resistance MΩ | More than 1.0 | 0.5 | |