

GENERAL PRECAUTIONS

Some recommended and standard maintenance services for your engine are mentioned in this section.

When performing maintenance on your engine be careful not to get injured by improper work.

Improper or incomplete work can cause a malfunction of the engine which may result in personal injury and/or property damage.

WARNING

When working on your engine, observe the following general precautions to prevent personal injury and/or property damage in addition to the particular NOTES or WARNINGS.

Most threaded fasteners are metric.

Be careful not to mix with threaded fasteners using the inch system.

- Always wear safety glasses or goggles to protect your eyes.
- Remove rings, watches, ties, loose hanging jewelry and loose clothing before starting work on the engine.
- Bind long hair securely behind the head.
- To avoid serious burns, keep yourself away from hot metal parts such as the engine, exhaust manifold, radiator, muffler, exhaust pipe and tail pipe.
- Keep yourself, your clothing and your tools away from moving parts such as the cooling fan and V-belts when the engine is running.
- Always stop the engine by pulling out the engine stop knob. Leave the knob pulled out as long as the engine is stopped. And turn off the starter switch, unless the operation requires the engine running. Removing the key from the switch is recommended.
- Run the engine only in a well-ventilated area to avoid inhaling of carbon monoxide.
- Do not smoke while working on the engine since fuel and gases from the battery are flammable.
- Take utmost care when working on the battery. It contains corrosive sulfuric acid.
- Large electric current flows through the battery cable and starter cable. Be careful not to cause a short which can result in personal injury and/or property damage.
- Be careful not to leave any tool in the engine compartment. The tool may be hit by moving parts and can cause personal injury.

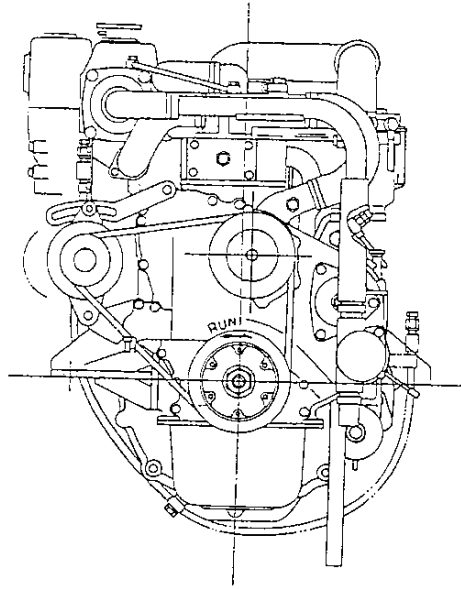
- **EQUIPMENT**

- **ENGINE**

1. Flywheel housing	SAE No. 3
2. Flywheel	SAE 11½
3. Fuel injection pump	BOSCH "A" type with all speed governor
4. Fuel filter	Paper element type
5. Water separator	Equipped
6. Lube oil pump	Full forced pressure feed by gear pump
7. Lube oil filter	Paper element type (Full flow)
8. Lube oil cooler	Multi plate type, Fresh water cooled
9. Fresh water pump	Forced-circulation by volute pump
10. Raw water pump	Self priming, Rubber impeller type
11. Intake manifold	Inlet position at rear, with air cleaner
12. Exhaust manifold	Fresh water-cooled exhaust manifold, integrated heat exchanger with expansion tank
13. Starter	12V, 2.5 KW
14. Alternator	12V, 50A, with built-in voltage regulator
15. Engine stop solenoid	Equipped
16. Emergency stop relay	Equipped
17. Starter block relay	Equipped
18. Glow plug	Equipped
19. Rigid mount bracket	Equipped
20. Exhaust riser	Cooled by raw water

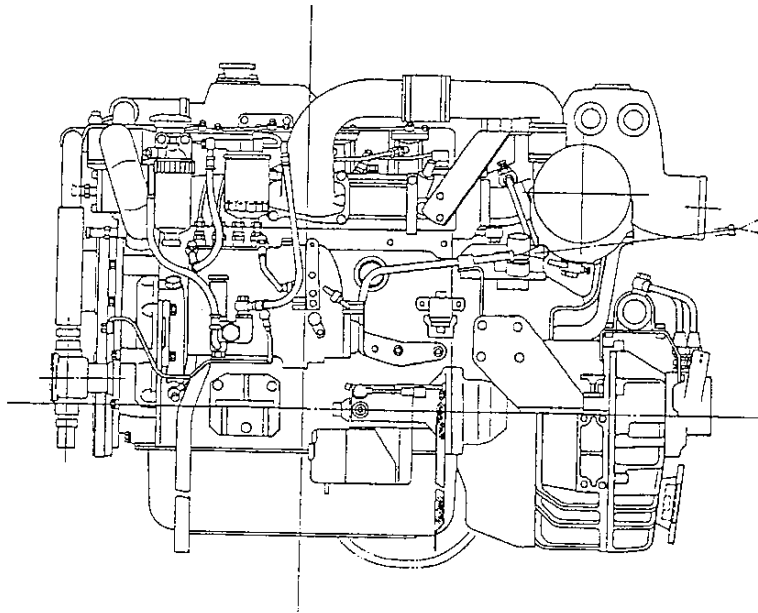
- **INSTRUMENT PANEL**

1. Battery switch
2. Starter switch with key
3. Instrument panel lamp switch
4. Tachometer (with hourmeter and trip meter)
5. Coolant temperature gauge
6. Oil pressure gauge
7. Fuel gauge
8. Volt meter
9. Pre-heater indicator lamp
10. Coolant temperature warning lamp
11. Charge warning lamp
12. Oil pressure warning lamp



FRONT VIEW

F226



LEFT SIDE VIEW

F227

NOTE: These specifications are subject to change without notice.

- EQUIPMENT

- ENGINE

1. Flywheel housing	SAE No. 3
2. Flywheel	SAE 11½
3. Fuel injection pump	BOSCH "AD" type with all speed governor
4. Fuel filter	Paper element type
5. Water separator	Equipped
6. Lube oil pump	Full forced pressure feed by gear pump
7. Lube oil filter	Paper element type (Full flow)
8. Lube oil cooler	Multi plate type, Fresh water cooled
9. Fresh water pump	Forced-circulation by volute pump
10. Raw water pump	Self priming, Rubber impeller type
11. Intake manifold	Inlet position at rear
12. Exhaust manifold	Fresh water-cooled exhaust manifold, integrated heat exchanger with expansion tank
13. Turbocharger	Cooled by fresh water, with air cleaner
14. Intercooler	Cooled by raw water
15. Starter	12V, 2.5 KW
16. Alternator	12V, 50A, with built-in voltage regulator
17. Engine stop solenoid	Equipped
18. Emergency stop relay	Equipped
19. Starter block relay	Equipped
20. Glow plug	Equipped
21. Rigid mount bracket	Equipped
22. Exhaust riser	Cooled by raw water
23. Marine gear	Equipped

- INSTRUMENT PANEL

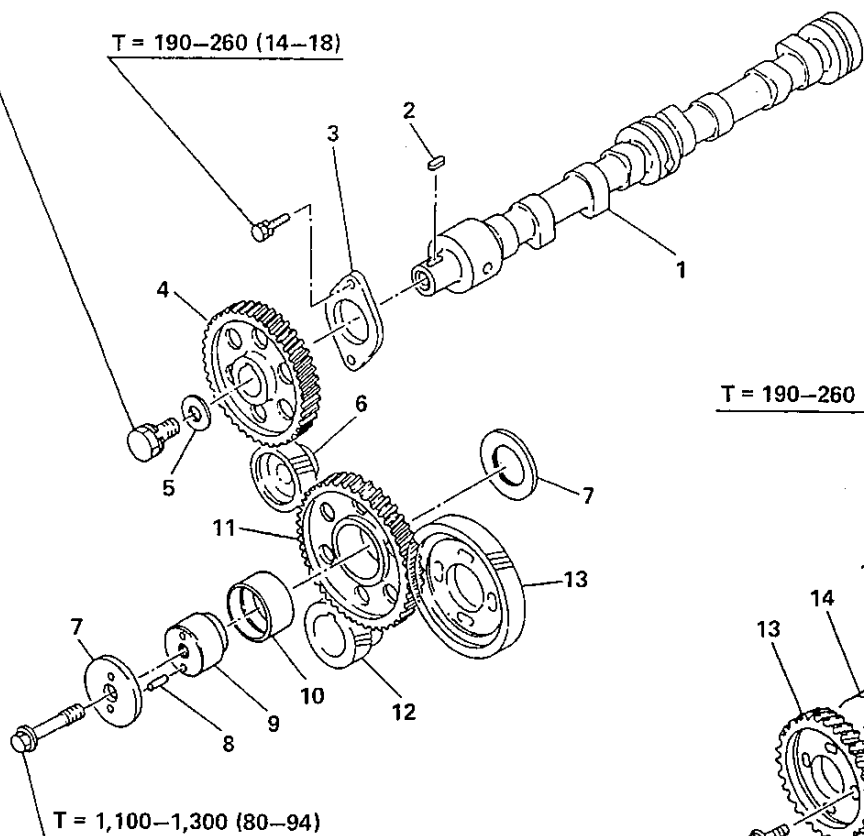
1. Battery switch
2. Starter switch with key
3. Instrument panel lamp switch
4. Tachometer (with hourmeter and trip meter)
5. Coolant temperature gauge
6. Oil pressure gauge
7. Fuel gauge
8. Volt meter
9. Pre-heater indicator lamp
10. Coolant temperature warning lamp
11. Charge warning lamp
12. Oil pressure warning lamp

<u>Symptom</u>	<u>Possible cause</u>	<u>Remedy/Prevention</u>
Difficulty starting engine	Electrical system	
	• Discharged battery	Charge battery.
	• Defective wiring in starter circuit	Repair wiring of starter.
	• Loose or open-circuit battery cable	Tighten battery terminal connections or replace battery cable.
	• Breakdown of starter	Replace starter.
	• Break of glow plug or intake air heater (if so equipped)	Replace
	Injection pump	Refer to CHAPTER IP, FUEL INJECTION PUMP.
	Air cleaner	
	• Clogged element	Clean the element or replace the element.
	Fuel system	
	• No fuel in tank	Supply fuel and bleed air from fuel system.
	• Clogged fuel line	Clean fuel line.
	• Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
	• Clogged fuel filter	Replace element.
	• Loose connection in high-pressure line	Tighten sleeve nut of high pressure line.
• Water in fuel	Drain and clean fuel system	
Difficulty starting engine	Nozzles	
	• Seized nozzle	Replace nozzle.
	• Broken or fatigued nozzle spring	Replace spring.
	Oil system	
	• Oil viscosity too high	Use proper viscosity oil, or install an oil immersion heater and warm up oil.
	Other problems	
	• Seized piston	Replace piston, piston rings, and liner.
	• Seized bearing	Replace bearing and/or crankshaft.
	• Reduced compression pressure	Overhaul engine.
	• Ring gear damaged or worn	Replace the ring gear and/or starter pinion.
• Improperly adjusted or broken accelerator cable	Adjust or replace the accelerator cable.	

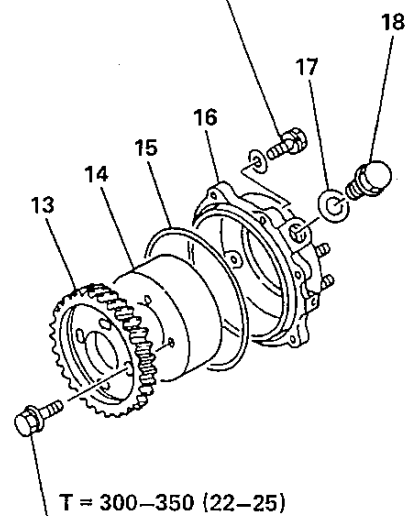
OVERHAUL

T = 1,100–1,300 (80–94)

T = 190–260 (14–18)



T = 190–260 (14–18)

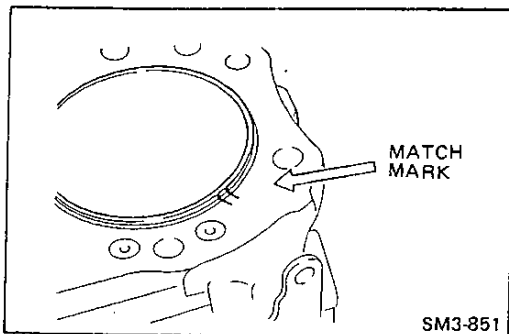


T = Tightening torque: kg-cm (lb.ft)

1. Camshaft
2. Key
3. Thrust bearing
4. Camshaft gear
5. Thrust washer
6. Oil pump drive gear

7. Idler gear thrust plate
8. Straight pin
9. Idler gear shaft
10. Bearing
11. Idler gear
12. Crankshaft gear

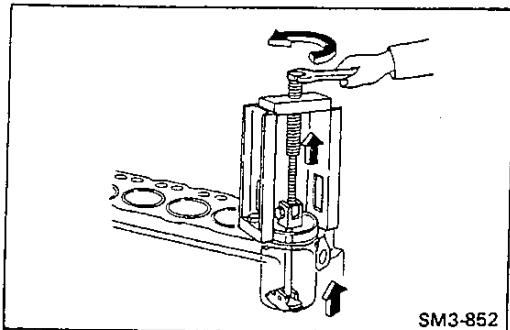
13. Injection pump drive gear
14. Coupling flange
15. O-ring
16. Timer cover
17. Soft washer
18. Plug



REMOVE THE CYLINDER LINER.

1. Place the match marks with a pen on the cylinder block and liner flange, before removing the cylinder liners.

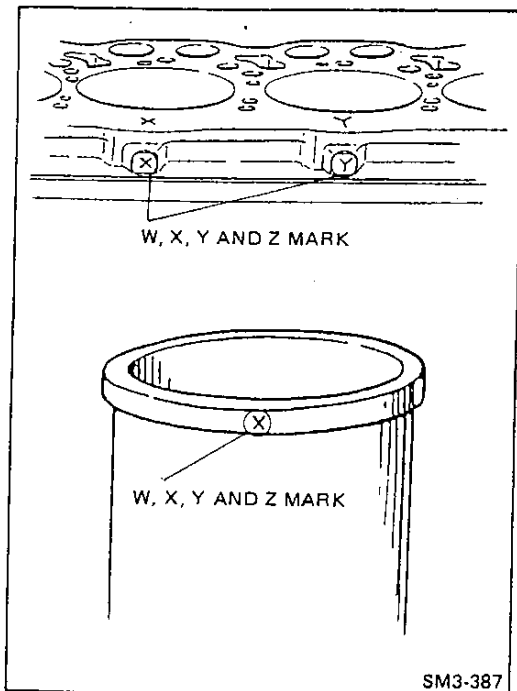
NOTE: Do not put the match marks with a punch.



2. Using a special tool, remove the cylinder liners.

Special Tool: Cylinder Liner Puller (09420-1460)

NOTE: After removing the cylinder liners, put numbers on their periphery or arrange them in sequence.

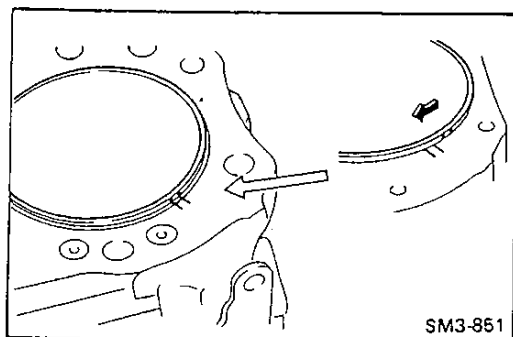


IMPORTANT POINTS – ASSEMBLY

INSERT THE CYLINDER LINER INTO THE CYLINDER BLOCK.

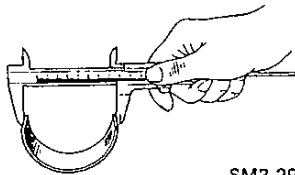
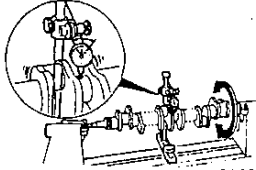
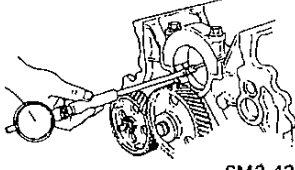
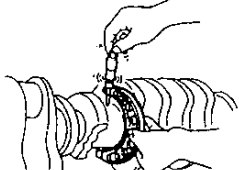
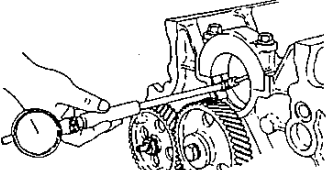
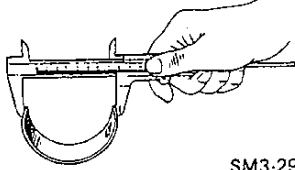
1. When a new cylinder liner is used, make sure that the liner has the same mark as the mark on the cylinder block.

NOTE: ○ There are 4 different liner and cylinder block matches. The flange section of each liner has a marking any, W, X, Y, Z, or indicating the size of the outer diameter of the liner on which it is stamped. The markings W, X, Y and Z, indicating the inner diameter of the cylinder bore supporting the liner on the sides and top of the cylinder block (the boss section for attaching the coolant gallery cover), are inscribed on each cylinder.



2. When reusing a liner, insert the liner its original position aligning the marking marked before disassembly.

Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Connecting Rod Bearing Spread Dimension	67.05–67.55 (2.6398–2.6594)	–	Replace	 SM3-298
Crankshaft bearing spread dimension	79.00–79.60 (3.1102–3.1339)	–		
Crankshaft Bend	–	0.04 (0.0015)	Repair or replace	 SM3-861
Crankshaft Main Bearing Cap Inside Diameter (Without Bearing)	77.985–78.000 (3.0703–3.0709)	–	Replace	 SM3-436
Crankshaft Journal Diameter	72.94–72.96 (2.8717–2.8724)	–0.20 (–0.0078)	Regrind and use undersize bearing	 SM3-860
		71.76 (2.8521)	Replace crankshaft	
Clearance between Crankshaft Journal and Main Bearing	0.039–0.090 (0.0016–0.0035)	0.13 (0.0051)	Replace bearing	 SM3-436
Crankshaft Main Bearing Spread Dimension	79.00–79.06 (3.1103–3.1125)	–	Replace	 SM3-298

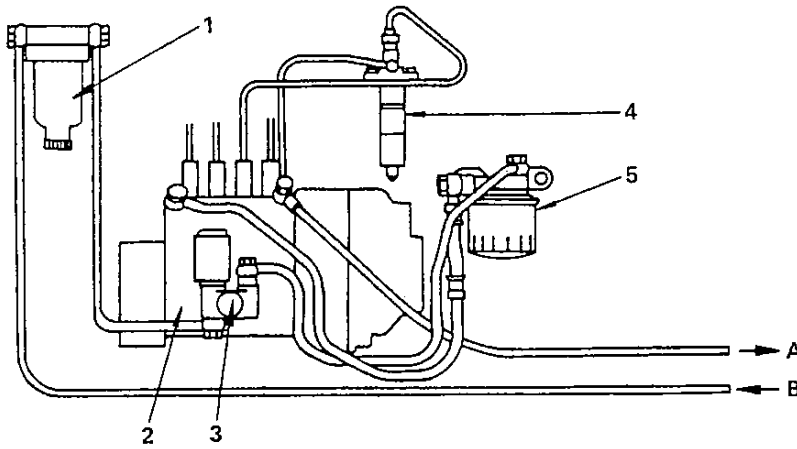
FUEL SYSTEM

DATA AND SPECIFICATIONS

Injection nozzle

Type Multi-hole nozzle type
 Opening pressure 220 kg/cm² (3,129 lb/sq.in)

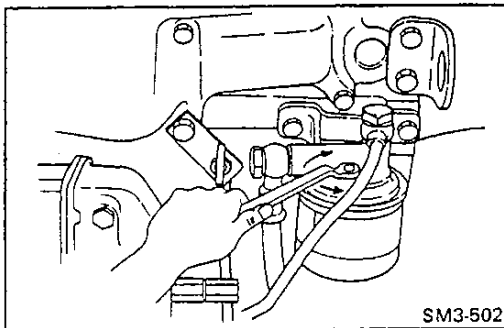
FUEL SYSTEM DIAGRAM



1. Water separator
(If so equipped)
2. Fuel injection pump
3. Fuel feed pump
4. Injection nozzle
5. Fuel filter
- A. To fuel tank
- B. From fuel tank

NOTE: Figure illustrates 4-cylinder engine.

SM3-227A

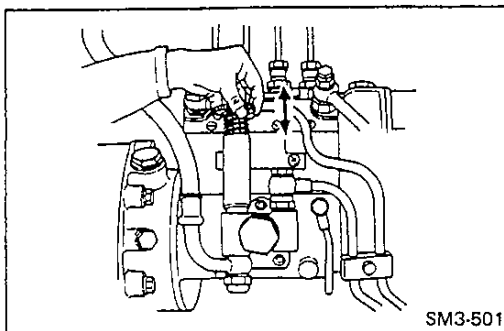


AIR BLEEDING FROM FUEL SYSTEM.

1. Loosen the bleeder plug on the fuel filter.
2. Loosen the priming pump knob.
3. Operate the priming pump knob until the air will not come out from the bleeder plug.
4. Tighten the bleeder plug.

Tightening Torque: 40–60 kg-cm (3–4 lb.ft)

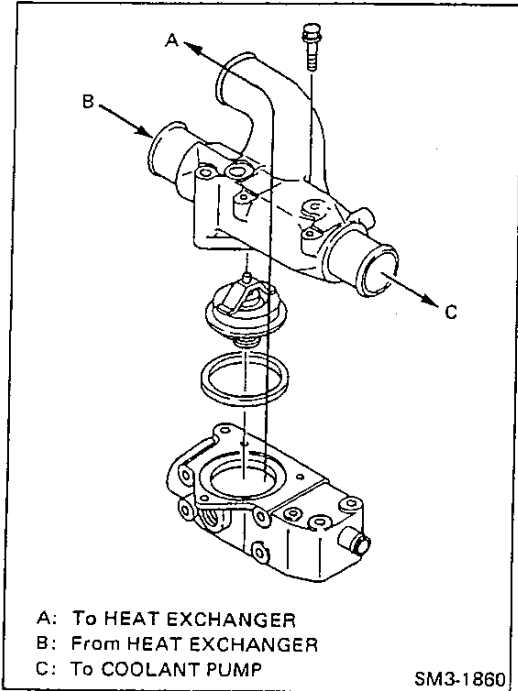
NOTE: The bleeder plug should be tightened while the priming pump knob is operated.



5. Once again, operate the priming pump knob several times.
6. Push back the priming pump knob and tighten it.

NOTE: Wipe off any splashed fuel.

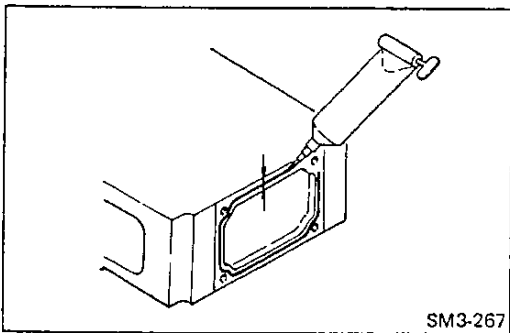
THERMOSTAT



IMPORTANT POINT – ASSEMBLY

INSTALL THE THERMOSTAT.

1. Remove water and dirt adhering to the thermostat case.
2. Replace the gasket without fail if it is corroded, damaged or flattened.
3. Before installing the thermostat, apply sealing compound to the hose installation portion of the coolant manifold.
4. Assemble the thermostat, gasket, case and coolant manifold as shown.



IMPORTANT POINT – MOUNTING

INSTALL THE THERMOSTAT CASE.

1. Clean the faces.
2. Apply the liquid gasket as shown and install the thermostat case on the cylinder head within 20 minutes.

NOTE: If leaving it more than 20 minutes, clean the liquid gasket completely and reapply the liquid gasket.

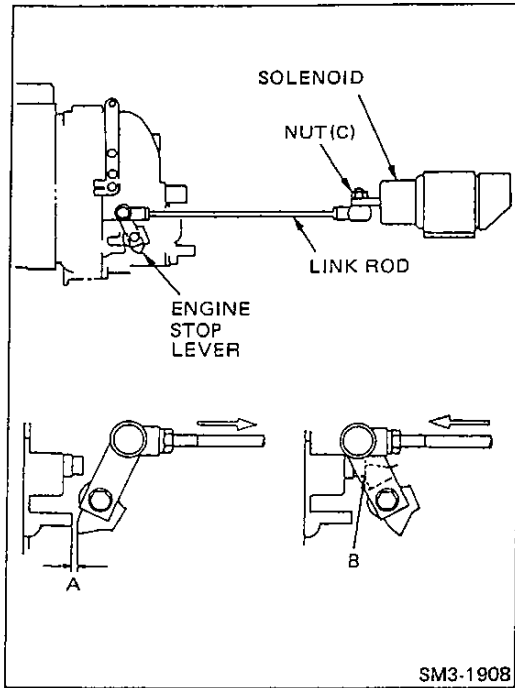
Coating Width: 1.5–2.5 mm (0.06–0.10 in)

INSPECTION AND REPAIR

Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Thermostat Valve Opening Temperature	74.5–78.5°C (166–173°F)	—	Replace thermostat	<p>STIRRING ROD THERMOMETER THERMOSTAT SUPPORTER THERMOSTAT HEATER</p>
Thermostat Valve Lift	At least 10 (0.4) at 90°C (194°F)	—		
Thermostat Closing Condition	Fully opened valve should close completely within 5 minutes when thermostat is immersed in water of normal temperature.	—		

SM3-888



ENGINE CONTROL

ADJUST THE SOLENOID (ENGINE STOP) LINK ROD.

1. Adjust the link rod length so that the clearance between the stopper of the governor case and the engine stop lever becomes "A" when the solenoid plunger is fully pushed in.

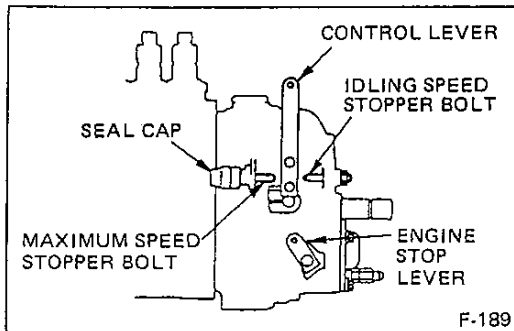
Assembly Standard "A": 2–3 mm (0.08–0.11 in)

NOTE: ○ Install the link rod with the nut(c) at the top.

- If the clearance adjustment is unsatisfactory or the action of the solenoid is sluggish, solenoid seizure, insufficient output or engine stoppage may result.

2. After the above adjustment is over, move the link rod by hand and make sure that it moves lightly.
3. When the engine is running, the clearance between the engine stop lever and the stopper becomes "B".

Assembly Standard "B": 0 mm (0 in)



ADJUST THE ENGINE IDLING SPEED.

When straight drive navigation is not smoothly made at the time of a sea trial in engine at idle, adjust it according to the following procedures.

1. Disconnect the throttle control cable from engine port (left) side and the starboard (right) side.
2. Loosen the idling speed stopper bolt lock nut.
3. Adjust through varying the engine speed using the idling speed stopper bolt on the injection pump so that straight drive navigation is made.

NOTE:

Increase in engine speed: Turn the idling speed stopper bolt clockwise.

Decrease in engine speed: Turn the idling speed stopper bolt counter-clockwise.

Engine Idling Speed: Refer to section DATA AND SPECIFICATIONS.

4. Upon completion of adjustment of engine idling speed, lock the stopper bolt with nut and apply paint on the stopper bolt and nut.

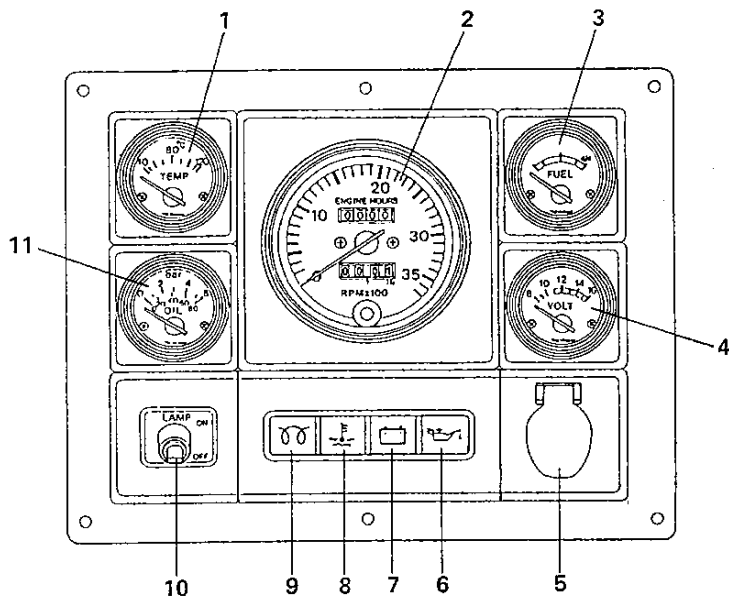
NOTE: When adjusting the all adjusting devices on the fuel injection pump governor, except the idling speed stopper bolt, refer to CHAPTER GV, INJECTION PUMP GOVERNOR.

DATA AND SPECIFICATIONS

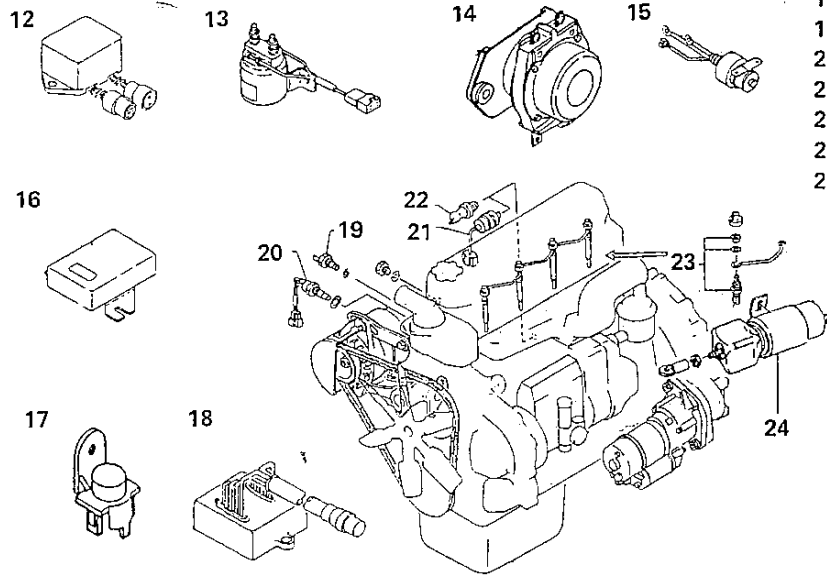
Electrical system

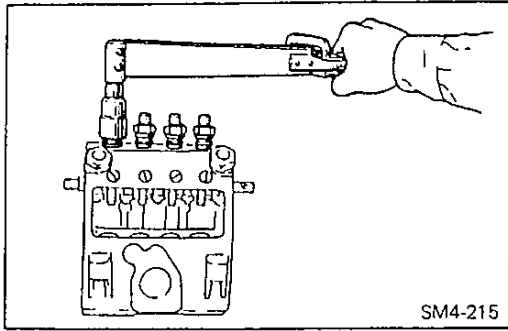
Voltage	Direct current 12 volts or 24 volts
Ground	Negative (-) ground
Warning and indicator lamp	1.4W 4 pieces
Gauge illumination lamp	1.7W 4 pieces
Tachometer illumination lamp	3.4W 2 pieces

LOCATION OF ELECTRICAL EQUIPMENT



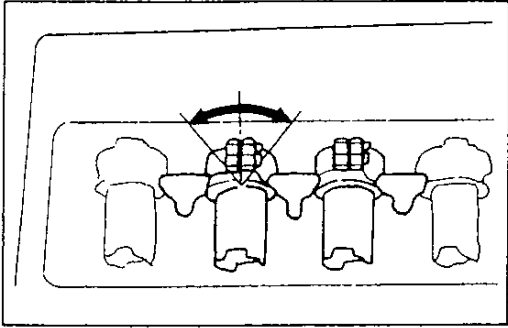
1. Water temperature receiver gauge
2. Engine tachometer
3. Fuel receiver gauge
4. Volt-meter
5. Starter switch
6. Oil pressure warning lamp
7. Battery charge warning lamp
8. Water temperature warning lamp
9. Intake air heater indicator lamp
10. Illumination lamp switch
11. Oil pressure receiver gauge
12. Emergency stop relay
13. Intake air heater relay
14. Battery main relay
15. Starter block relay
16. Intake air heater timer
17. Relay
18. Sensor amplifier
19. Water temperature switch
20. Water temperature sender gauge
21. Oil pressure sender gauge
22. Oil pressure switch
23. Glow plug
24. Solenoid





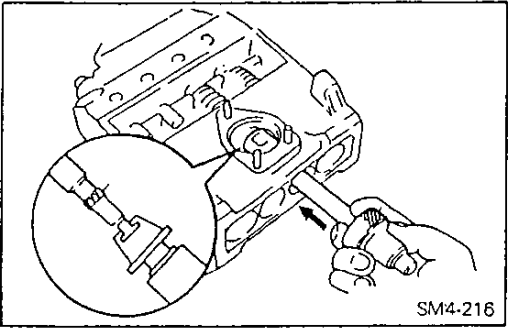
2. Install the gasket, spring, shim and stopper on the delivery valve.
3. Provisionally tighten the delivery valve holder with a new O-ring by hand.

NOTE: Tighten the delivery valve holder after installing the plunger.



INSTALL THE CONTROL SLEEVES ON THE BARRELS.

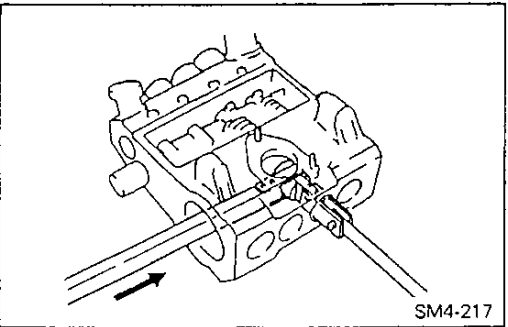
NOTE: Make sure that the control sleeve swings evenly right and left when the control rack is moved to the right and left.



INSTALL THE PLUNGER AND TAPPET.

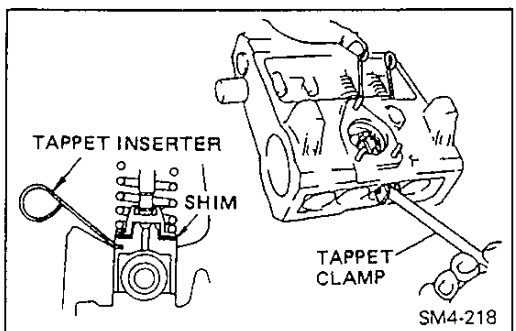
1. Assemble the plunger and spring lower seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).

Special Tool: Plunger Clamp (09512-1360)



2. Install the tappet to the pump housing with the adjusting shim.

Special Tool: Tappet Roller Clamp (09512-1130)
Tappet Clamp (09512-1120)

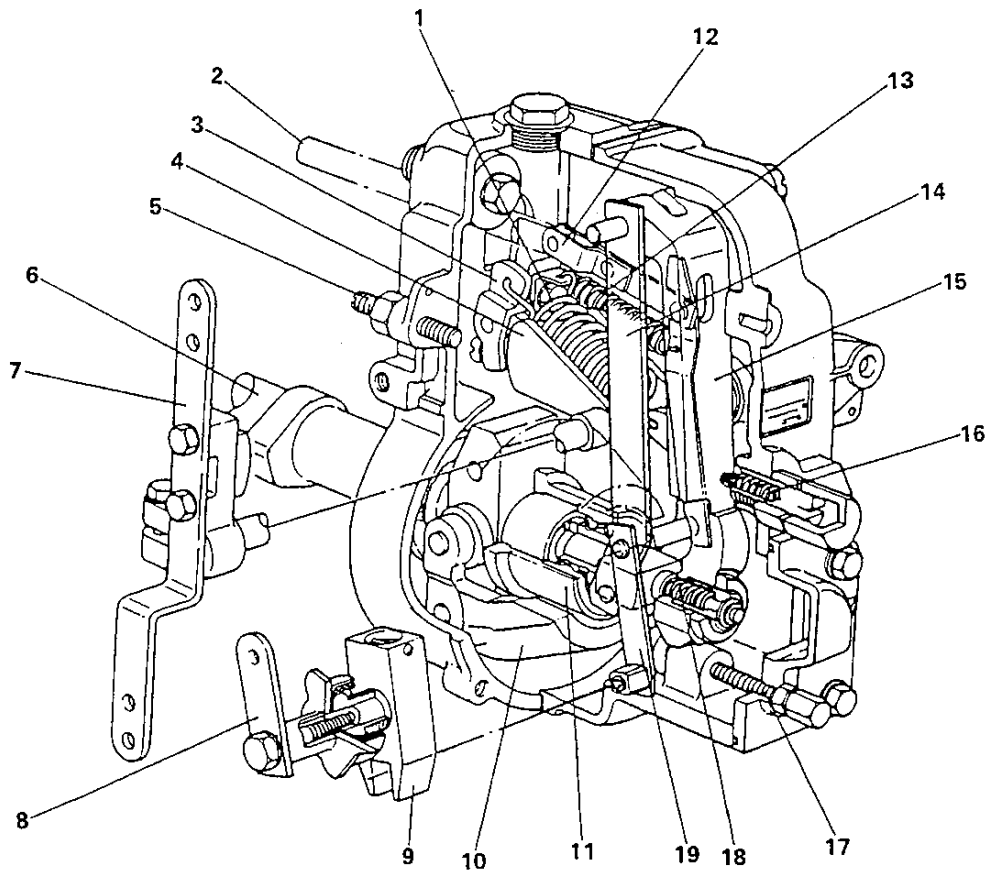


3. Using the tappet roller clamp to press in the tappet and hold it in with the tappet inserter.

Special Tool: Tappet Inserter (09512-1380)

DESCRIPTION

[MODEL: RSV]

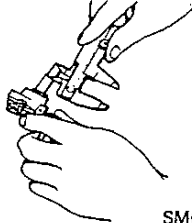
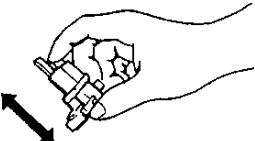
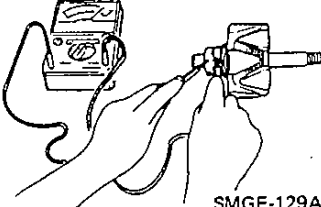
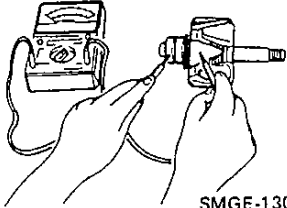
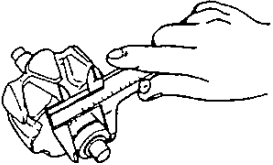
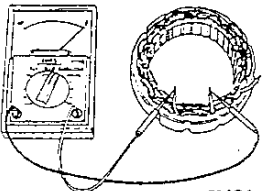
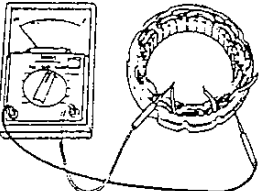


[Representative model]

- | | |
|-------------------------------|----------------------------|
| 1. Governor spring | 11. Sleeve |
| 2. Control rod | 12. Link |
| 3. Knuckle | 13. Start spring |
| 4. Swivel lever | 14. Guide lever |
| 5. Maximum speed stopper bolt | 15. Tension lever |
| 6. Camshaft | 16. Idle sub spring |
| 7. Control lever | 17. Full load stopper bolt |
| 8. Stop lever | 18. Idle spring |
| 9. Supporting lever | 19. Floating lever |
| 10. Flyweight | |

INSPECTION AND REPAIR

Unit: mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Brush length	20.0 (0.787)	5.5 (0.217)	Replace	 <p>SMGE-127</p>
Function of the brush holder	-	-	Replace, if necessary.	<p>Visual check</p>  <p>SMGE-128</p>
Checking of the rotor coil.	About 2.9 Ω	-	Replace.	 <p>SMGE-129A</p>
Insulation between the slip ring and the core.	-	-	If continuity replace the rotor.	 <p>SMGE-130A</p>
Diameter of the slip ring.	32.5 (1.280)	32.1 (1.264)	Replace.	 <p>SMGE-131A</p>
Checking of the stator coil	-	-	If not continuity, replace the stator coil.	 <p>SM21-037</p>
Insulation of the stator coil.	-	-	If not continuity, replace the stator coil.	 <p>SM21-038</p>