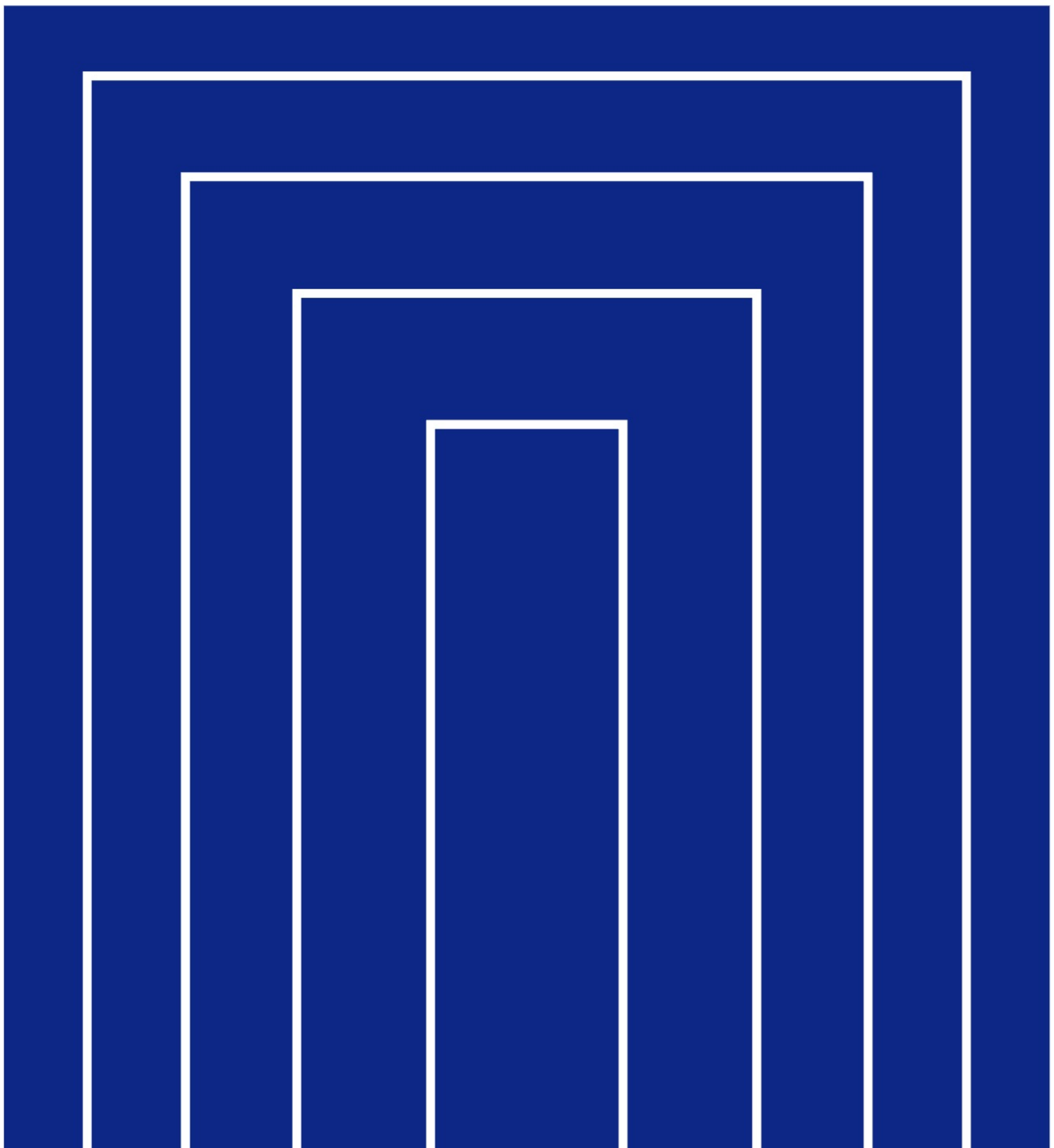
TOYOTA

B, 3B, 11B, 14B ENGINE

REPAIR MANUAL

Aug., 1988



Pub. No. RM132E

FOREWORD

This repair manual has been prepared to provide information covering general service repairs for the B, 3B, 11B, and 14B engines mounted on the TOYOTA LAND CRUISER, DYNA and COASTER.

Applicable models:
BJ60, 70, 73, 75 series
BU60, 61, 65, 66, 70, 76, 83, 84, 87, 88, 91, 94, 96 series
BY34, 43 series
BB21, 22, 23, 30, 32 series

All information in this manual is based on the latest product information at the time of publication. However specifications and procedures are subject to change without prior notice.

TOYOTA MOTOR CORPORATION

TOYOTA
B, 3B, 11B, 14B ENGINE
REPAIR MANUAL

INTRODUCTION IN
ENGINE MECHANICAL EM
FUEL SYSTEM FU
COOLING SYSTEM CO
LUBRICATION SYSTEM LU
STARTING SYSTEM ST
CHARGING SYSTEM CH
SERVICE SPECIFICATIONS A
STANDARD BOLT TORQUE SPECIFICATIONS B
SST AND SSM C

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INTRODUCTION

	Page
HOW TO USE THIS MANUAL	IN-2
IDENTIFICATION INFORMATION	IN-4
GENERAL REPAIR INSTRUCTIONS	IN-4
ABBREVIATIONS USED IN THIS MANUAL	IN-7

HOW TO USE THIS MANUAL

To assist in finding your way through this manual, the Section Title and major heading are given at the top of every page.

An **INDEX** is provided on the 1st page of each section to guide you to the item to be repaired.

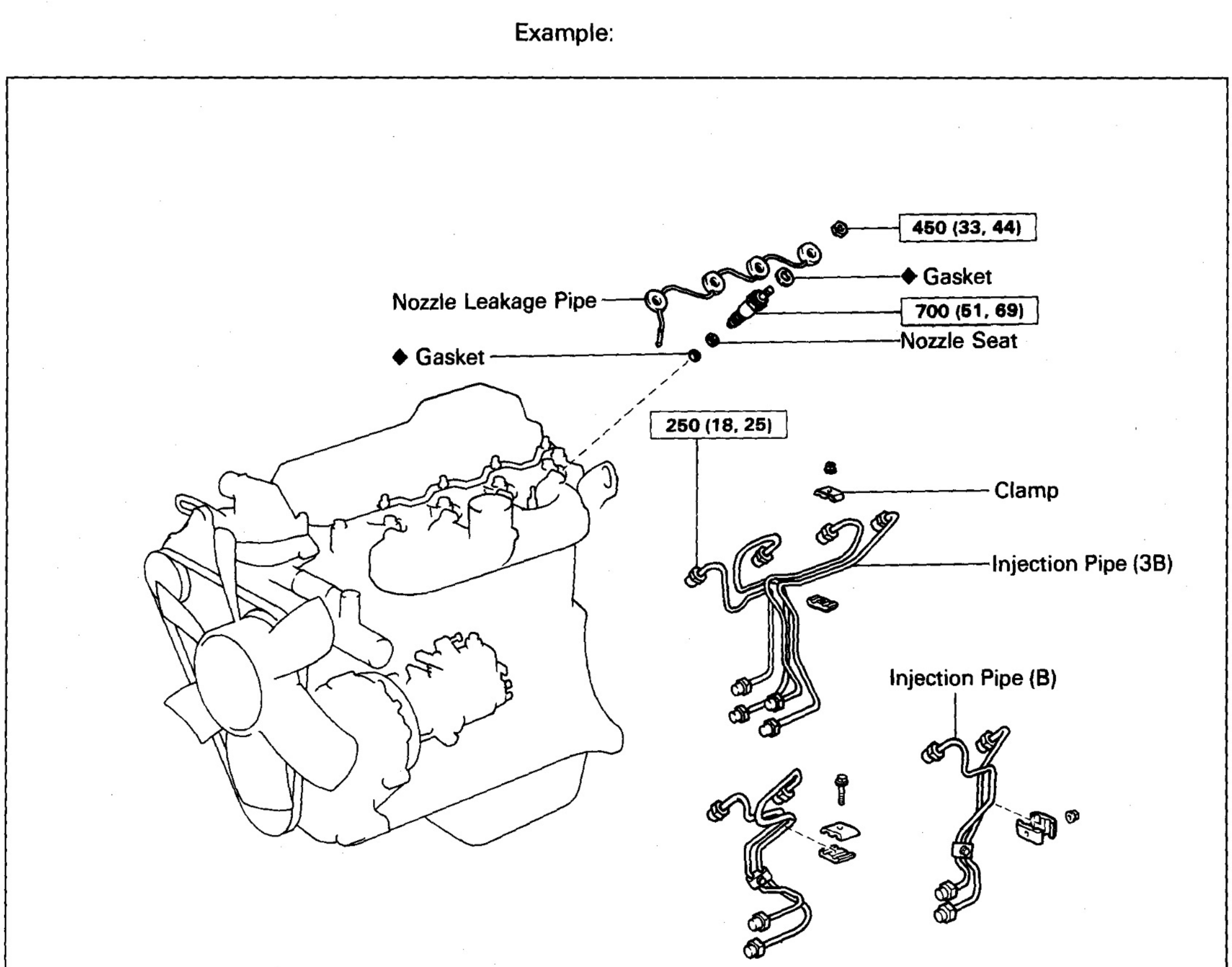
At the beginning of each section, **PRECAUTIONS** are given that pertain to *all* repair operations contained in that section. *Read these precautions before starting any repair task.*

TROUBLESHOOTING tables are included for each system to help you diagnose the system problem and find the cause. The repair for each possible cause is referenced in the remedy column to quickly lead you to the solution.

REPAIR PROCEDURES

Most repair operations begin with an overview illustration. It identifies the components and shows how the parts fit together.

Example:



The procedures are presented in a step-by-step format:

- The illustration shows *what* to do and *where* to do it.
- The task heading tells *what* to do.
- The detailed text tells *how* to perform the task and gives other information such as specifications and warnings.

Example:

Illustration:
what to do and where

Task heading: what to do

3. REMOVE INJECTION NOZZLES

Using SST, remove the four nozzles, seats and gaskets.

SST 09260-46013 (09268-46012)

Set part No. *Component part No.*

Install and torque the four nozzles. ← Detailed text: how to do task

Torque: 700 kg-cm (51 ft-lb, 69 N·m)

Torque Specifications

This format enables the experienced technician with a FAST TRACK to the information needed. The upper case heading can be read at a glance and only when necessary, the test below it provides detailed information. Important specifications and warnings always stand out in bold type.

REFERENCES

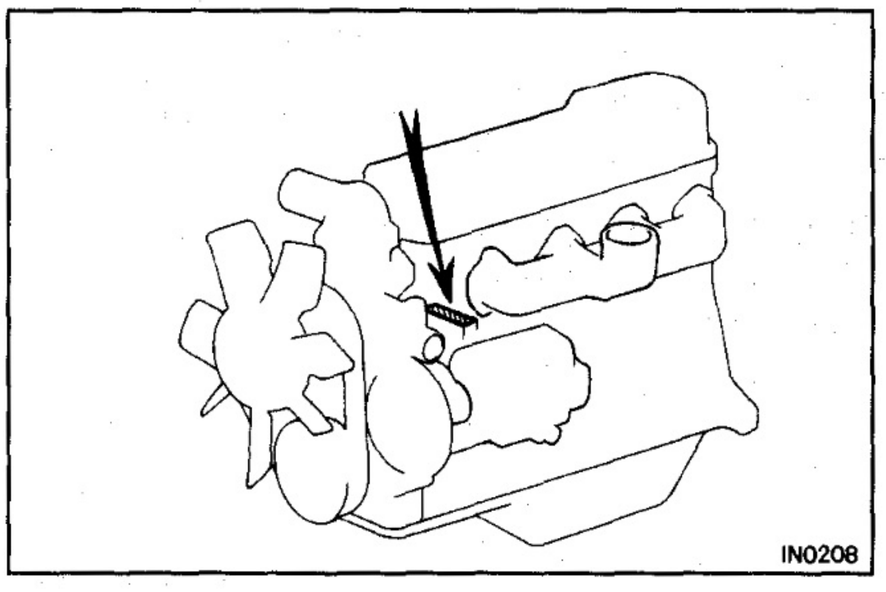
References have been kept to a minimum. However, when they are required, you are given the *page* to go to.

SPECIFICATIONS

Specifications are presented in bold type throughout the text in the applicable step. You never have to leave the procedure to look up your specs. All specifications are also found in Appendix A, specifications, for quick reference.

CAUTIONS, NOTICES, HINTS:

- CAUTIONS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- NOTICES are also presented in bold type and indicate there is a possibility of damage to the components being repaired.
- HINT are separated from the text but do not appear in bold. They provide additional information to help you efficiently perform the repair.



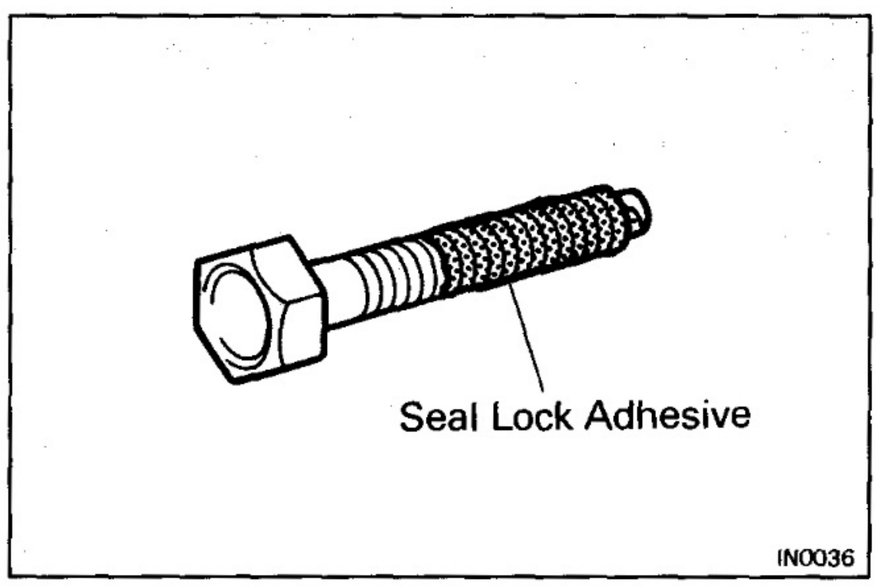
IDENTIFICATION INFORMATION

ENGINE SERIAL NUMBER

The engine serial number is stamped on the left side of the cylinder block.

GENERAL REPAIR INSTRUCTIONS

1. Use fender, seat and floor covers to keep the vehicle clean and prevent damage.
2. During disassembly, keep parts in order to facilitate re-assembly.
3. Observe the following:
   (a) Before performing electrical work, disconnect the negative cable from the battery terminal.
   (b) If it is necessary to disconnect the battery for inspection or repair, always disconnect the cable from the negative (–) terminal which is grounded to the vehicle body.
   (c) To prevent damage to the battery terminal post, loosen the terminal nut and raise the cable straight up without twisting or prying it.
   (d) Clean the battery terminal posts and cable terminal with a shop rag. Do not scrape them with a file or other abrasive object.
   (e) Install the cable terminal to the battery post with the nut loose, and tighten the nut after installation. Do not use a hammer to tap the terminal onto the post.
   (f) Be sure the cover for the positive (+) terminal is properly in place.
4. Check hose and wiring connectors to make sure they are securely and correctly connected.
5. Non-reusable parts
   (a) Always replace cotter pins gaskets, O-rings, oil seals, etc. with new ones.
   (b) Non-reusable parts are indicated in the component illustrations by the "◆" symbol.



6. Precoated Parts

Precoated parts are bolts and nuts, etc. Which are coated with a seal lock adhesive at the factory.

(a) If a precoated part is tightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.

(b) Recoating of Precoated Parts

(1) Clean off the old adhesive from the bolt, nut or installation part threads.

(2) Dry with compressed air.

(3) Apply the specified seal lock adhesive to the bolt or nut threads.

(c) Precoated parts are indicated in the component illustrations by the "★" symbol.

7. When necessary, use a sealer on gaskets to prevent leaks.

8. Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.

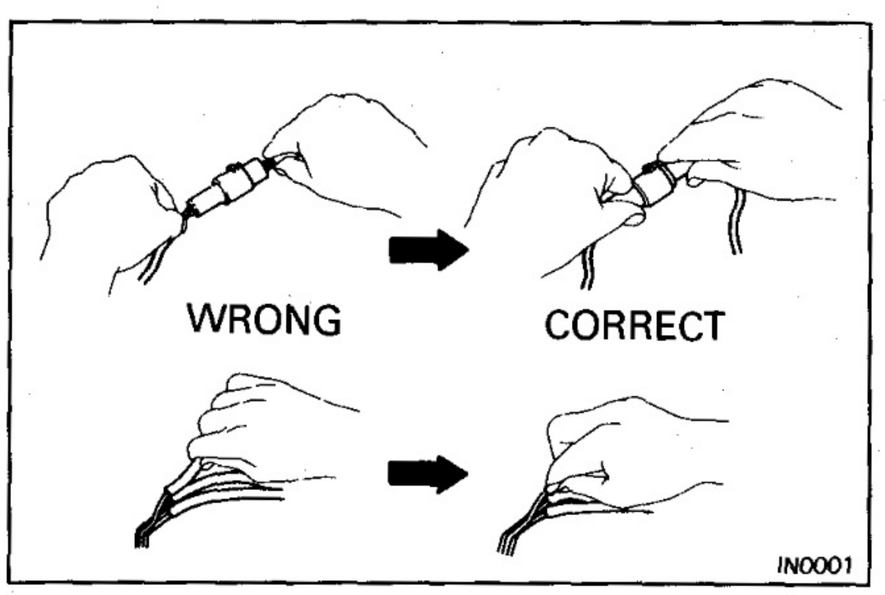
9. Use of special service tools (SST) and special service materials (SSM) may be required depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. A list of SST and SSM can be found at the back of this manual.

10. When replacing fuses, be sure the new fuse is the correct amperage rating. DO NOT exceed the fuse amp rating or use one of a lower rating.

11. Care must be taken when jacking up and supporting the vehicle. Be sure to lift and support the vehicle at the proper locations.

(a) If the vehicle is to be jacked up only at the front or rear end, be sure to block the wheels in order to ensure safety.

(b) After the vehicle is jacked up, be sure to support it on stands. It is extremely dangerous to do any work on the vehicle raised on a jack alone, even for a small job that can be finished quickly.



12. Observe the following precautions to avoid damage the parts:

(a) To disconnect vacuum hoses, pull on the end, not the middle of the hose.

(b) To pull apart electrical connectors, pull on the connector itself, not the wires.

(c) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.

(d) When steam cleaning an engine, protect the air filter and injection pump from water.

(e) Never use an impact wrench to remove or install thermo switches or tthermo sensors.

(f) When checking continuity at the wire connector, insert the tester probe carefully to prevent terminals from bending.

(g) When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step-down adapter instead. Once the hose has been stretched, it may leak.

13. After removing and reinstalling the inejction pump and fuel hoses, clean off the fuel on engine components. In particular, be sure to check the radiator hose and by-pass hose, because they deteriorate easily if they come into contact with fuel.

ABBREVIATIONS USED IN THIS MANUAL

ACSD	Automatic Cold Start Device
A/T	Automatic Transmission
ATDC	After Top Dead Center
BDC	Bottom Dead Center
BTDC	Before Top Dead Center
DP	Dash Pot
EX	Exhaust
Ex.	Except
HAC	High Altitude Compensator
IN	Intake
LST	Load Sensing Timer
MP	Multipurpose
M/T	Manual Transmission
O/S	Oversized
PCV	Positive Crankcase Ventilation
PS	Power Steering
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
TDC	Top Dead Center
U/S	Undersize
w/	With
w/o	Without

ENGINE MECHANICAL

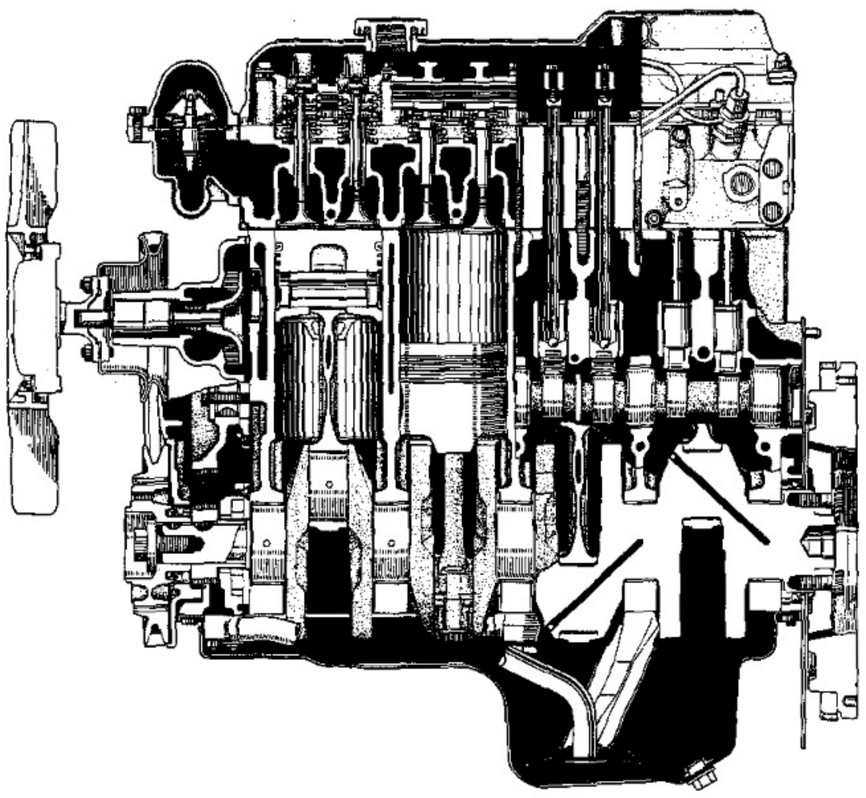
	Page
DESCRIPTION	EM-2
DIESEL ENGINE DIAGNOSIS	EM-4
DIESEL ELECTRICAL SYSTEM DIAGNOSIS [3B]	EM-13
DIESEL ELECTRICAL SYSTEM DIAGNOSIS [11B and 14B]	EM-16
ENGINE TUNE-UP	EM-19
COMPRESSION CHECK [B and 3B]	EM-27
COMPRESSION CHECK [11B and 14B]	EM-28
CYLINDER HEAD	EM-29
TIMING GEARS AND CAMSHAFT	EM-52
CYLINDER BLOCK	EM-67

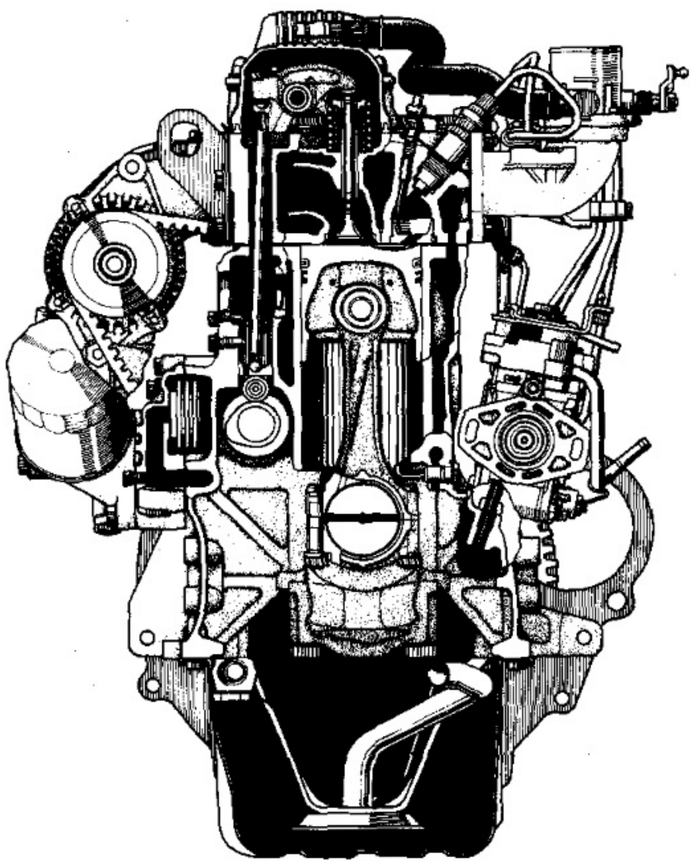
DESCRIPTION

B, 3B, 11B and 14B ENGINES

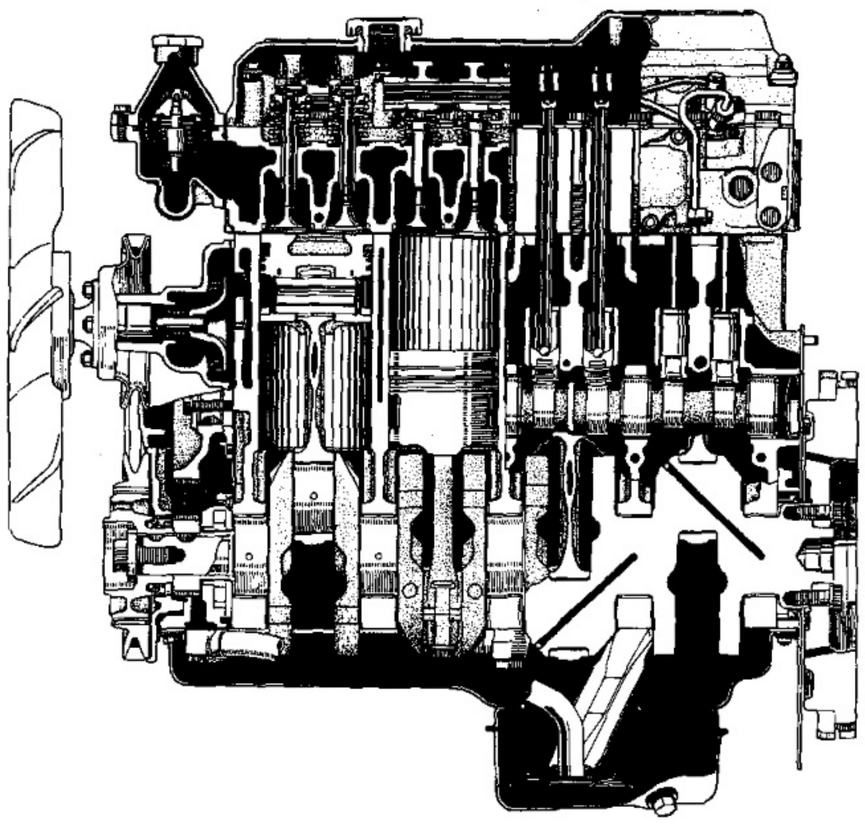
The B, 3B, 11B and 14B engines are in-line 4-cylinder OHV 8 valve engines with a capacity of 3.0 liters (B, 11B), 3.4 liters (3B) or 3.7 liters or (14B).

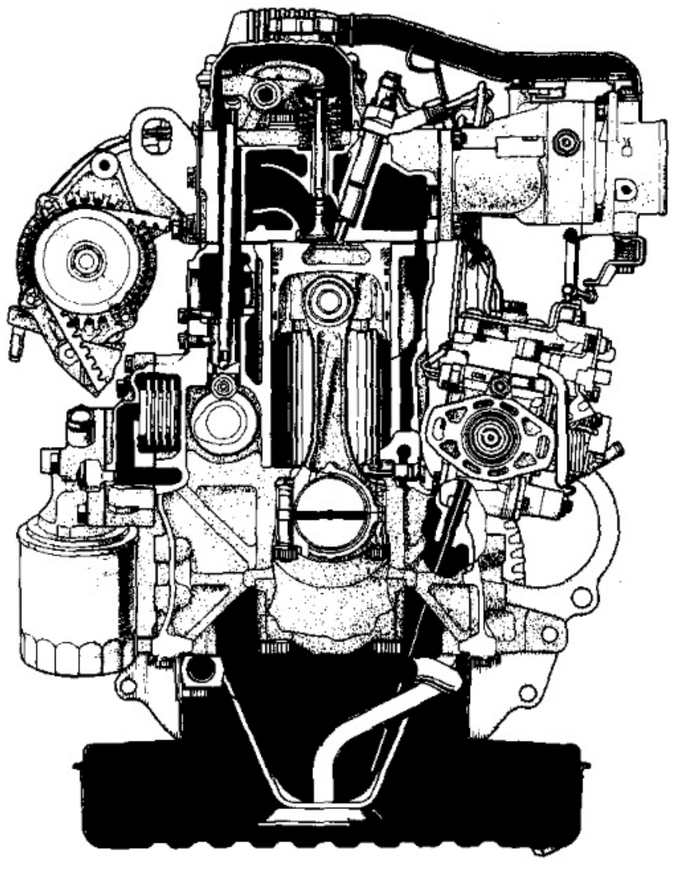
3B Engine (BJ)





14B Engine (BU)





HINT: For B and 3B engines, refer to the 3B (BJ) engine, and for 11B and 14B engines, refer to the 14B (BU) engine.

BS0115 BS0116
BS0161 BS0162

The B, 3B, 11B & 14B engines are in-line 4-cylinder engines with the cylinders numbered 1-2-3-4 from the front. The crankshaft is supported by 5 bearings inside the crankcase. These bearings are made of aluminum alloy.

The crankshaft is integrated with 8 weights which are cast with it for balancing. Oil holes are made in the center of the crankshaft to supply oil to the connecting rods, bearings, pistons and other components.

The ignition order is 1-3-4-2. The cylinder head is made of cast iron, with a cross flow type intake and exhaust layout. The combustion chambers are swirl chamber type for the B and 3B engines and direct injection type for the 11B and 14B engines.

An intake shutter is installed in the intake manifold to reduce intake noise.

Each intake and exhaust valve is equipped with an inner and outer spring made of special valve spring carbon steel, capable of following no matter what the engine speed.

The cam shaft is driven by a timing gear. The cam journal is supported at 5 places between the valve lifters of each cylinder and at the front and rear ends of the cylinder block. Lubrication of the cam and the cam journal is performed by oil supplied through the oiler port in each journal of the cylinder block.

The valve lifter is turned by the roller lifter for reduced friction and abrasion.

Adjustment of the vlave clearance is done by means of an adjusting screw on the rocker arm.

The timing gear cover is made of aluminum alloy. For the BU and BB series, the power steering pump is attached to timing gear cover.

Pistons are made of highly temperature-resistant aluminum alloy. As the 11B and 14B engines are the direct injection type, a deep combustion chamber has been provided. The No. 1 piston ring groove has been strengthened using a ceramic fiber alloy.

Piston pins are the full-floating type, with the pins fastened to neither the connecting rods nor the piston boss, but with a snap ring fitted to both ends of each pin to prevent it slipping out.

The No. 1 compression ring is made of steel and the No.2 compression ring is made of cast iron. The oil ring is made of a combination of steel and stainless steel. The outer diameter of each piston ring is slightly larger than the diameter of the piston and the flexibility of the rings allows them to hug the cylinder walls when they are mounted on the piston. Compression rings No.1 and No.2 work to prevent the leakage of gas from the cylinder and oil ring works to scrape oil off the cylinder walls to prevent it from entering the combustion chambers.

The cylinder block is made of cast iron. It has 4 cylinders which are approximately 2 times the length of the piston stroke. The top of the cylinders is closed off by the cylinder head and the lower end of the cylinders becomes the crankcase, in which the crankshaft is installed. In addition, the cylinder block contains a water jacket, through which coolant is pumped to cool the cylinders.

The oil pan is bolted onto the bottom of the cylinder block. The oil pan is an oil reservoir made of pressed steel sheet. A dividing plate is included inside the oil pan to keep sufficient oil in the bottom of the pan even when the vehicle is tilted. This dividing plate also allows the oil pump to maintain the oil supply when the vehicle stops suddenly and the oil forms waves.

DIESEL ENGINE DIAGNOSIS

1. GENERAL

Diesel engine problems are usually caused by the engine or fuel system. The injection pump is very rarely the cause of fuel system problems.

Before beginning fuel system tests, first check that the engine compression, valve timing and other major systems are within specifications.

2. PRELIMINARY CHECKS

(a) Before performing fuel system checks, insure that the engine is in good running condition. If necessary, first check the compression, timing and major components or systems.

(b) Check the air filter and clean or replace as necessary.

(c) Check for sufficient fuel in the tank.

(d) Check if the fuel is contaminated with gasoline or other foreign elements. Only high-quality diesel fuel should be used.

(e) Bleed air from the system by pumping the priming pump.

(f) Check for water in the sedimenter and fuel tank, and drain as necessary.

(g) If the engine will not crank or if it cranks slowly, troubleshoot the electrical system.

PRECAUTION:

1. The basic troubleshooting procedures for the diesel engine (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for a gasoline engine.
2. The repair of the injection pump required considerable skill and use of a special test bench.

ENGINE WILL NOT CRANK

(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	Check cables from battery to starter and make necessary repairs.
2. DISCHARGED BATTERY	Check the alternator output and the drive belt. Repair as necessary. (See page CH-5)
3. INOPERATIVE STARTER	Check for battery voltage at starter terminals 30 and 50. If Okay, see STARTING SYSTEM page (ST-12) for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

HINT: Minimum cranking speed: Cold M/T 100 rpm
A/T 110 rpm
Hot 150 rpm

(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	
2. DISCHARGED BATTERY	Refer to items 1 and 2 of ENGINE WILL NOT CRANK.
3. IMPROPER ENGINE OIL	Check engine oil If improper viscosity, drain and refill with oil of a viscosity recommended by manufacturer. (See page LU-5)

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)	(Check Procedure and Correction Method)
1. NOFUEL TO INJECTION NOZZLE	Loosen any one injection pipe union nut from its nozzle. Crank the engine for approx. 5 seconds while confirming that fuel is being discharged from the pipe. If fuel is coming out, begin diagnosis from item 4. If not, begin from item 2.
2. NO FUEL CUT SOLENOID OPERATION	With ignition switch turned ON, check for fuel cut solenoid operation noise (clicking sound) while repeatedly connecting and disconnecting fuel cut solenoid. If no noise, check if there is battery voltage to the solenoid when the starter switch is ON. If battery voltage is confirmed, fuel cut solenoid is faulty and should be replaced. If no voltage, refer to ELECTRICAL DIAGNOSIS and make necessary repairs.
3. NO FUEL INTO INJECTION PUMP	Disconnect inlet hoses to the fuel filter and feed clean fuel from separate container directly into pump. If engine starts, either the fuel filter or fuel line between the fuel tank and fuel filter is clogged and should be repaired. If the engine still does not start, check the fuel filter or line between fuel filter and injection pump. If normal, the injection pump is faulty and should be repaired. **HINT: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.**
4. FUEL LEAKAGE FROM INJECTION PIPE	Check for loose unions or cracks. If leaking, tighten to specified torque or, if necessary, replace pipe(s).
5. [B AND 3B] INOPERATIVE PRE-HEATING OPERATION	With the starter switch turned ON and the glow plug indicator light illuminated, check that there is voltage applied to the glow plug. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary. (See page EM-13)

6. [w/ INTAKE HEATER] INOPERATIVE PRE-HEATING OPERATION	With the ignition switch turned ON and the intake heater indicator light illuminated, check that there is voltage applied to the intake heater. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary. (See page EM-13)
7. [B AND 3B] FAULTY GLOW PLUG OPERATION	Check the glow plug for continuity. (See page ST-6) If no continuity, a broken wire is indicated and the glow plug should be replace.
8. [w/ INTAKE HEATER] FAULTY INTAKE HEATER OPERATION	Check the intake heater continuity. (See page ST-11) If no continuity, a broken wire is indicated and intake heater should be replaced.
9. IMPROPER INJECTION TIMING	Turn crankshaft pulley clockwise to where either No. 1 or No. 4 piston is at TDC and, after releasing cold start advance system (w/ ACSD), check plunger stroke with SST. (See page EM-22) SST 09275-54010 **Plunger stroke:** **B, 3B 1.27 — 1.33 mm (0.0450 — 0.0524 in.)** **11B 1.34 — 1.40 mm (0.0528 — 0.0551 in.)** **14B 1.31 — 1.37 mm (0.0516 — 0.0539 in.)** If not as specified, injection timing must be readjusted.
10. [w/ ACSD] IMPROPER COLD START ADVANCE AND FAST IDLE	Measure timer piston stroke and fast idle lever opening angle with injection pump tester when cold start advance is operated.
11. FAULTY INJECTION NOZZLE	Check the injection pressure with nozzle tester. (See page FU-9 or 15) **Opening pressure:** **B and 3B 105 — 125 kg/cm² (1,493 — 1,778 psi) (10,296 — 12,258 kPa)** **11B and 14B 180 — 210 kg/cm² (2,560 — 2,987 psi) (17,652 — 20,594 kPa)** It not within specification, nozzle adjustment is improper and pressure should be readjusted. If pressure cannot be adjust to specification, replace nozzle.

ROUGH IDLE WITH WARM ENGINE

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER ADJUSTMENT OF ACCELERATOR CABLE	With the accelerator pedal released, check that the adjusting lever is in contact with the idle adjusting screw. Also, check if the accelerator cable is catching on something. If necessary, adjust so lever is in contact with the screw, or make other required repairs.
2. IDLE SPEED TOO LOW	Check the idle speed as specified below. (See page EM-25) **Idle speed: M/T 600 — 700 rpm** **A/T 770 — 820 rpm** If not, adjust with the idle adjusting screw. **HINT: If less then specified, idling would normally be rough.**
3. FUEL LEAKAGE	Check for leaks in the injection pump connections, pump distributive head bolt, nozzle holder and delivery valve. Tighten any loose connections to specified torque or replace parts as necessary.
4. IMPROPER INJECTION TIMING	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.
5. IMPROPER OPERATION OF INJECTION NOZZLE OR DELIVERY VALVE	With the engine idling, loosen the injection pipe to each cylinder in order, and check if the idle speed changes. If no change, a faulty cylinder is indicated. Check according to the following procedure. ● Faulty Nozzle Check the nozzle with nozzle tester. (See page FU-9 or 15) **Opening pressure:** **B and 3B 105 — 125 kg/cm² (1,493 — 1,778 psi) (10,296 — 12,258 kPa)** **11B and 14B 180 — 210 kg/cm² (2,560 — 2,987 psi) (17,652 — 20,594 kPa)** If not within specification, the nozzle is faulty and injection pressure should be readjusted. ● Faulty Delivery Valve If injection pressure is within specification, the delivery valve is defective and should be replaced.

ENGINE SUDDENLY STOPS

(Possible Cause)	(Check Procedure and Correction Method)
1. ENGINE WILL NOT RE-START	Check to see if engine re-starts according to prescribed procedure. If not, refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and repair as necessary.
2. ROUGH IDLE	If idle is not stable, refer to ROUGH IDLE WITH WARM ENGINE and repair accordingly.
3. MALFUNCTION OF FUEL-CUT SOLENOID	Refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and check accordingly. **HINT: No operation noise from the fuel cut solenoid may be due to loose electrical connections, so check connectors before proceeding with further repairs.**
4. NO FUEL INTO INJECTION PUMP	Refer to item 3 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

LACK OF POWER

HINT:
1. First check that the air cleaner is not clogged or the engine overheating.
2. Not applicable if the customer desires an output power higher than specified for that vehicle. For accuracy, adjust with a chassis dynamo.

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER ACCELERATOR CABLE ADJUSTMENT	With accelerator fully depressed, check that the adjusting lever is in contact with the maximum speed adjusting screw. (See page EM-25) If not, adjust accordingly.
2. INSUFFICIENT MAXIMUM SPEED	Start engine, depress the accelerator pedal to the floor and check that maximum speed is as specified below. (See page EM-25) **Maximum speed: B, 3B 4,050 — 4,200 rpm** **11B, 14B 4,050 — 4,250 rpm** If not, adjust with the maximum speed adjusting screw.

3. INTERCHANGED OVERFLOW SCREW (OUT) AND INLET (NO MARK) FITTING	**HINT: Overflow screw is marked "OUT" and has an inner jet. Althogh both fittings are same size, they must not be interchanged.**
4. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
5. CLOGGED FUEL FILTER	Disconnect inlet hose to fuel filter and feed clean fuel directly into the pump. If the engine condition improves, the fuel filter is clogged and should be replaced. (See page FU-4) **HINT: When feeding fuel directly into the pump, keep container at same level as vehicle fuel tank.** If no increase in engine condition after replacing the fuel filter, check the priming pump or perform other necessary repairs.
6. IMPROPER INJECTION TIMING	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
7. FAULTY INJECTION NOZZLE	Refer to item 11 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

EXCESSIVE EXHAUST SMOKE

HINT:
1. Check that the air cleaner is not clogged.
2. Check with the customer whether or not oil consumption has been excessive.

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER INJECTION TIMING	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **HINT: Black smoke indicates advanced timing while white smoke indicates retarded timing. Adjustments should be made accordingly.**
2. CLOGGED FUEL FILTER	Refer to item 5 of LACK OF POWER. **HINT: At high speed (2,000 — 3,000 rpm), a clogged filter tends to make the exhaust smoke white.**
3. FAULTY INJECTION NOZZLE	Refer to item 11 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **HINT: Excessive exhaust smoke is often caused by nozzle pressure being too low.**

EXCESSIVE FUEL CONSUMPTION

HINT: Check whether the clutch slips, brakes grab, whether the tires are the wrong size or the air filter is clogged.

(Possible Cause)	(Check Procedure and Correction Method)
1. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
2. IDLE SPEED TOO HIGH	After sufficiently warming up engine, check that idle speed is as specified below. (See page EM-25) **Idle speed: M/T 600 — 700 rpm** **A/T 770 — 820 rpm** If not, adjust with the idle adjusting screw.
3. MAXIMUM SPEED TOO HIGH	Start engine, depress the accelerator pedal to the floor and check that maximum speed is as specified below. (See page EM-25) **Maximum speed: B, 3B 4,050 — 4,200 rpm** **11B, 14B 4,050 — 4,250 rpm** If not, adjust with maximum speed adjusting screw.
4. IMPROPER INJECTION TIMING	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
5. FAULTY INJECTION NOZZLE	Refer to item 11 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE NOISE WHEN WARM

(Cranking Noise with Excessive Vibration)

(Possible Cause)	(Check Procedure and Correction Method)
1. COOLANT TEMPERATURE TOO LOW	Check coolant temperature with water temp. gauge. If not sufficiently warm, thermostat is faulty and should be replaced.
2. IMPROPER INJECTION TIMING	Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
3. FAULTY INJECTION NOZZLE	Refer to item 11 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE WILL NOT RETURN TO IDLE

(Possible Cause)	(Check Procedure and Correction Method)
BINDING ACCELERATOR CABLE	Operate adjusting lever on side of injection pump and check if engine returns to idle. If so, the accelerator cable is binding or improperly adjusted and should be repaired accordingly. If engine does not return to idle, the injection pump is faulty and should be repaired.

ENGINE WILL NOT SHUT OFF WITH KEY

(Possible Cause)	(Check Procedure and Correction Method)
IMPROPER FUEL CUT-SOLENOID OPERATION	Disconnect connector on top of fuel cut solenoid and check if engine stops. If so, ignition switch is faulty and should be repaired as necessary or replaced. If engine does not stop, either fuel cut solenoid is faulty or there is interference by foreign particles. Repair as necessary.

DIESEL ELECTRICAL SYSTEM DIAGNOSIS [3B]

ENGINE DOES NOT START COLD

HINT:
1. **Battery voltage at least 12 volts (or 24 volts) — ignition switch OFF.**
2. **Engine cranks normally.**
3. **Fusbible link okay.**
4. **Check the voltage marked with an asterisk (*) just as the ignition switch is placed at ON because the voltage will change with elapse of time.**

1. Pre-heating System [Super Glow Type]

Check if indicator light lights up with ignition switch ON.
Coolant temp. Approx. 20°C (68°F): Approx. 2 seconds

→ No → Check ENGINE (BJ) or GAUGE (BB) fuse.

Fuse Blown → Check for short circuit and repair if necessary.

Fuse OK → Check indicator light bulb.

Bulb No Good → Replace bulb.

Bulb OK → Check for battery voltage to terminal 3 of pre-heating timer connector (on wire harness side).
If okay, pre-heating timer is faulty and should be replaced.

Yes → Ignition switch OFF.

→ * Check for battery voltage to terminal 1 of pre-heating timer with ignition switch ON.

No Voltage → Check that is 1 V between terminals 9 and 6.
If faulty, repair glow plug.
If okay, timer is faulty and should be replaced.

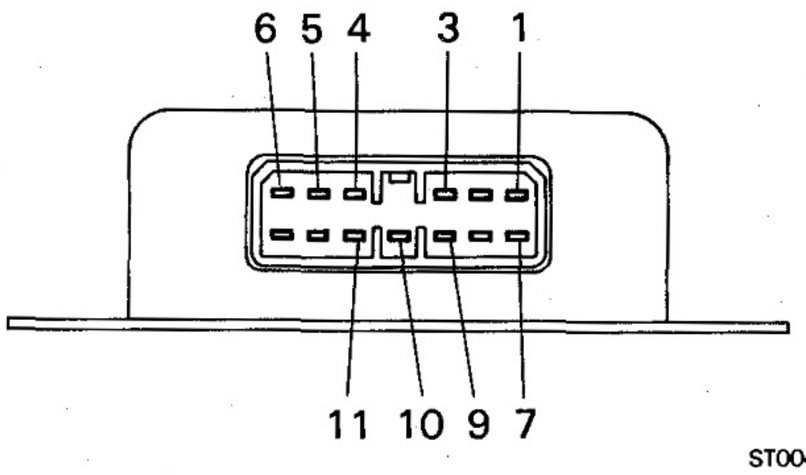
Voltage → Check if voltage to terminal 1 of pre-heating timer is terminated after engine is started.

No → Start the engine and check/if there is a voltage at terminal 9 of pre-heating timer.
If faulty, repair charging system as necessary.
If okay, timer is faulty and should be replaced.

Yes → Ignition switch OFF.

CONTINUED ON PAGE EM-14

Pre-heating Timer



ST0049

CONTINUED FROM PAGE EM-13

Place ignition switch at ON and check if current flow to terminal 5 of timer is in accordance with coolant temperature. (See Timer characteristics Diagram on page ST-3)

Pre-heating Duration Differs from the Specified Duration.

Timer is faulty and should be replaced.

OK

No Voltage

After completion of pre-heating, check for voltage at terminal 5 again when ignition switch is placed at ST.

No Voltage

Voltage

Ignition switch OFF.

Place ignition switch at ON and check for voltage to glow plug a few seconds later. Thereafter, voltage should drop approx. 1/2.

No Voltage at All

Check for battery voltage at plus side of glow plug.

If okay, replace glow plug.

If no voltage, No. 1 glow plug relay is faulty and should be replaced.

OK

Voltage Does not Drop by 1/2.

Check for battery voltage to plus side of resistor (Intake manifold side).

If okay, replace resistor.

If no voltage, No. 2 glow plug relay is faulty and should be replaced.

Measure glow plug resistance.

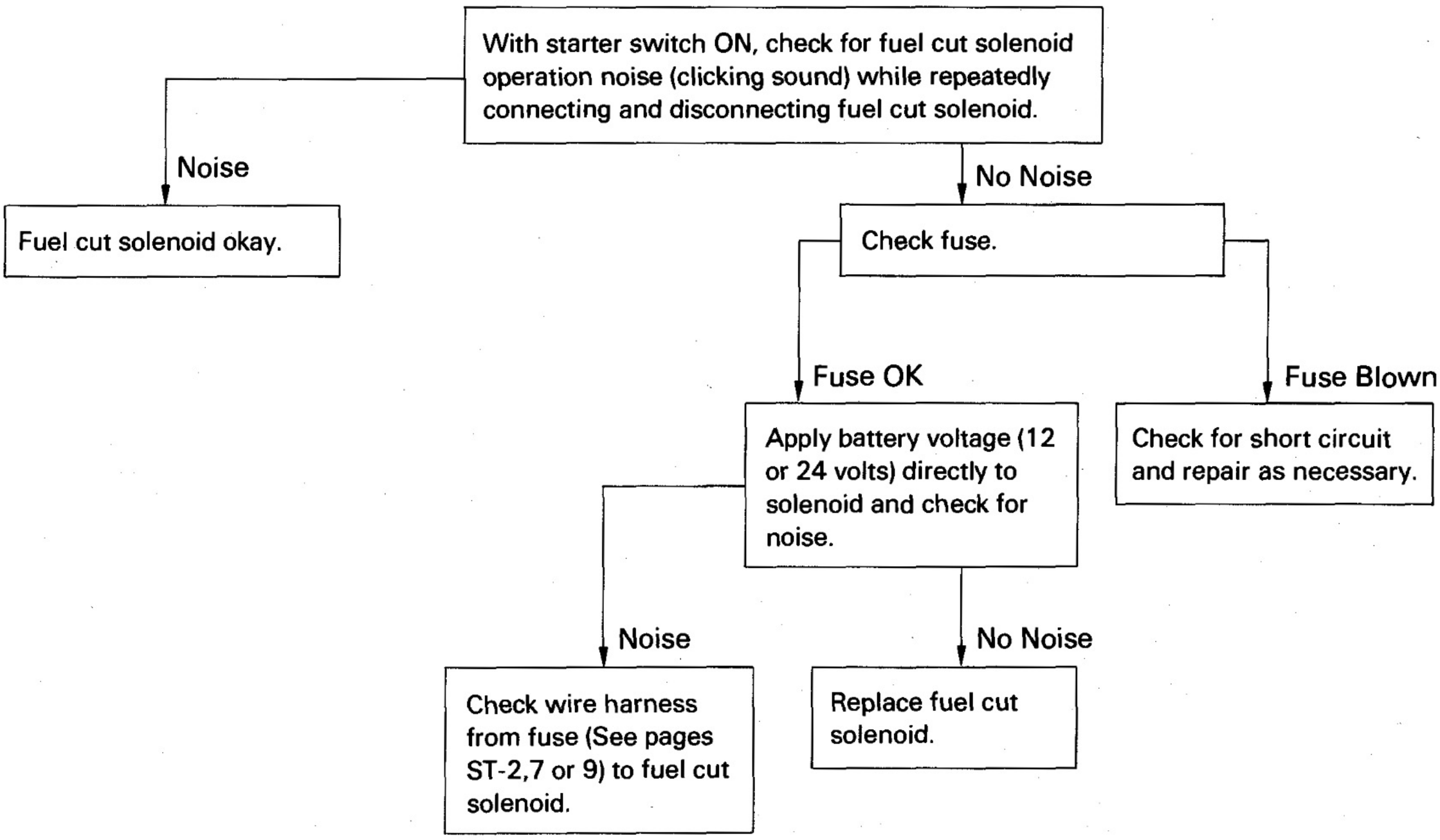
Infinity

Glow plug is faulty and should be replaced.

Approx. 0 Ω

Glow plug okay

2. Fuel Cut Solenoid



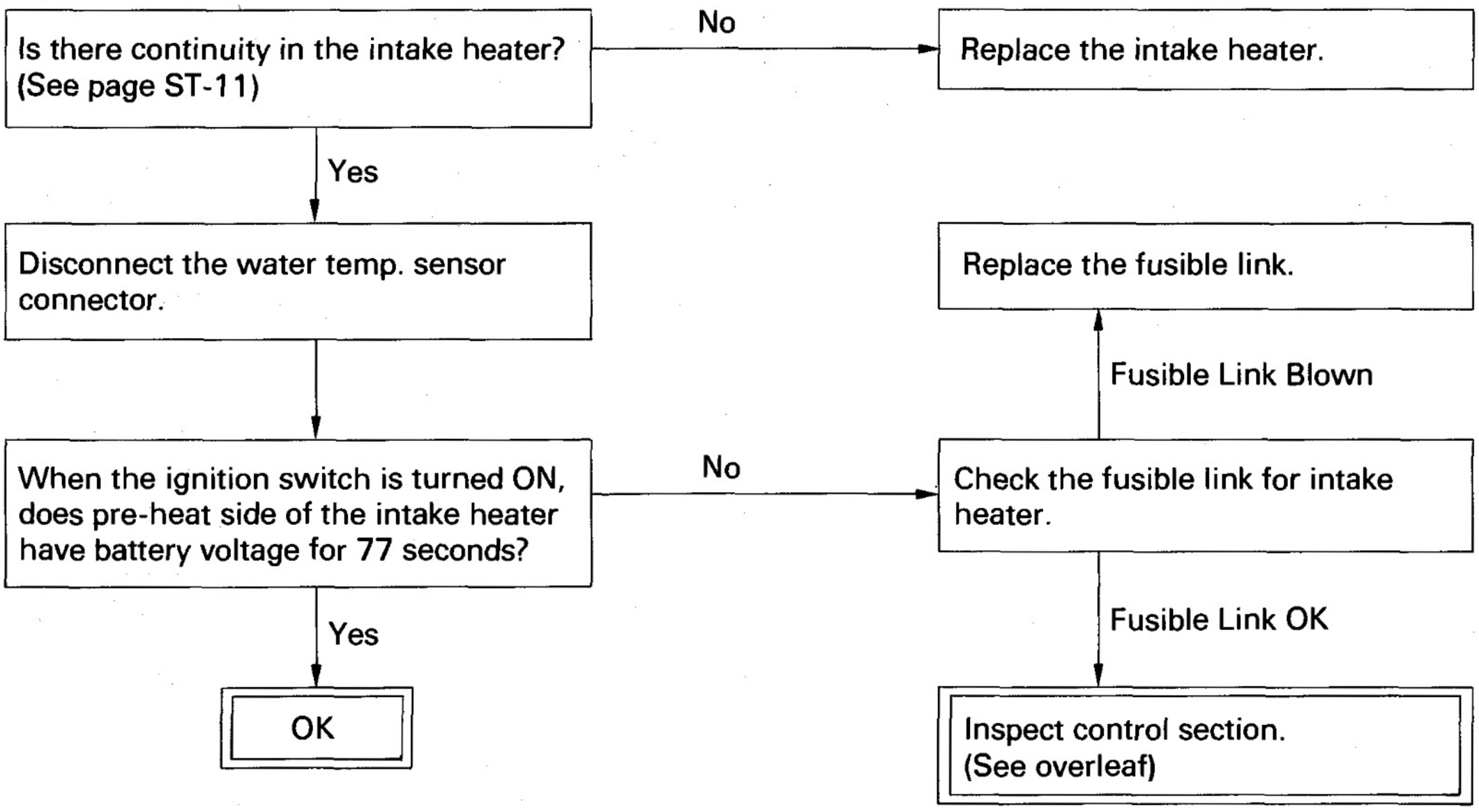
DIESEL ELECTRICAL SYSTEM DIAGNOSIS [11B AND 14B]

ENGINE DOES NOT START WHEN COLD

HINT: 1. Battery voltage at least 12 volts (or 24 volts) — ignition switch OFF.
2. Engine cranks normally.
3. Water temp. sensor okay. (See page ST-6)

1. Pre-heating System [w/ Intake Heater]

1. INSPECT POWER SUPPLY SECTION



2. INSPECTION CONTROL SECTION

HINT: Perform this inspection with the intake heater connector fully connected.

Disconnect the water temp. sensor connector.

When the ignition switch is turned ON, does the indicator light? (Measure the time lighted)

No → Is the GAUGE fuse Okay?

No → Replace the fuse.

Yes

Is the indicator light bulb Okay?

No → Replace the bulb.

Yes

Is terminal 6 of the pre-heating timer grounded?

No → Open circuit or ground faulty in wire harness between terminal 7 of the timer and body gound.

Yes

Is there battery voltage to terminal 8 of the timer (on wire harness side) ?

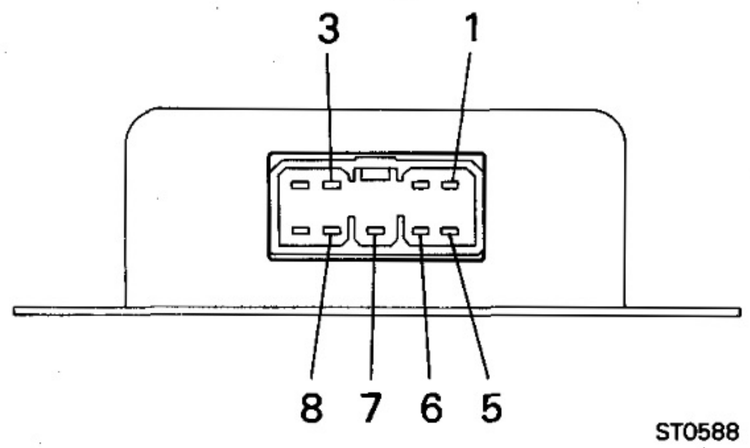
Yes → Replace the timer.

No

Open circuit in wire harness between terminal 8 of the timer and indicator light.

Yes

Pre-heating Timer



ST0588

Is the lighting time correct?
5 seconds [Below 0°C (32°F)]

No → Replace the timer.

Yes

CONTINUED ON PAGE EM-18

Yes

CONTINUED FROM PAGE EM-17

Is there battery voltage between terminal G of the intake heater relay and body ground for 5 seconds with the ignition switch ON?

No → Did intake heater relay check out okay? (See page ST-11)

No → Replace the intake heater relay.

Yes

When the ignition switch is turned ON, does terminal 1 of the intake heater timer have battery voltage for 5 seconds?

No → Replace the timer.

Yes

- Open circuit in wire harness between terminal 1 of the timer and terminal g of the intake heater relay.
- Open circuit or ground faulty in wire harness between terminal E of the intake heater relay and body ground.

Yes

Inspect power supply section. (See page EM-16)

HINT: Refer to ST-9 for intake heater relay terminal location.

2. Fuel Cut Solenoid

(See page EM-15)

ENGINE TUNE-UP

INSPECTION OF ENGINE COOLANT

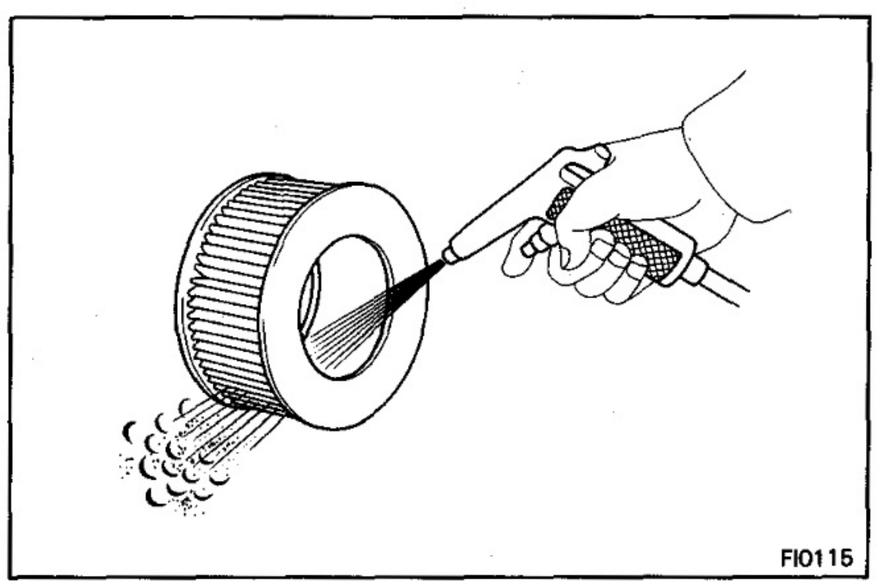
(See page CO-4)

INSPECTION OF ENGINE OIL

(See page LU-4)

INSPECTION OF BATTERY

(See page CH-5)

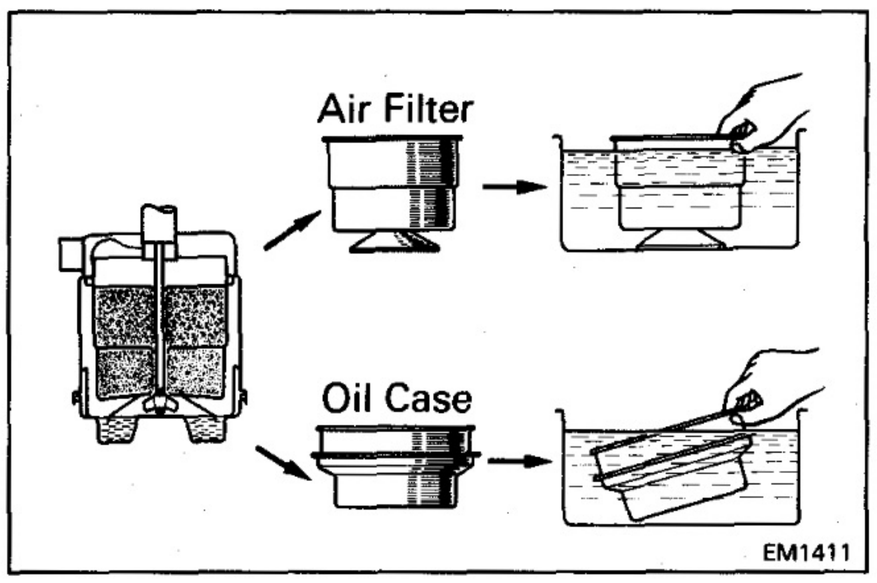


CLEANING OF AIR FILTER

[Paper Filter Type]

CLEAN AIR FILTER

Clean the element with compressed air.
First blow from the inside thoroughly. Then blow off the outside of the element.

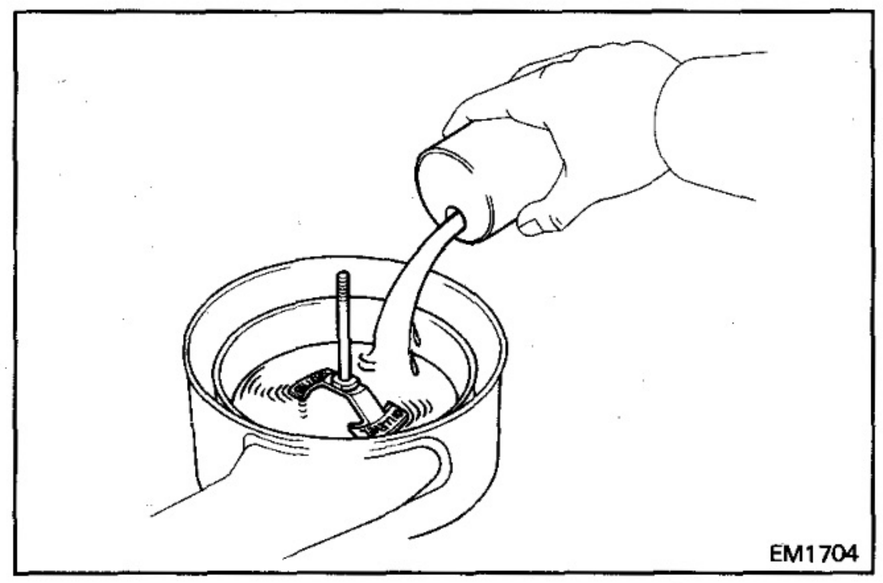


[Oil Bath Type]

CLEAN AIR FILTER

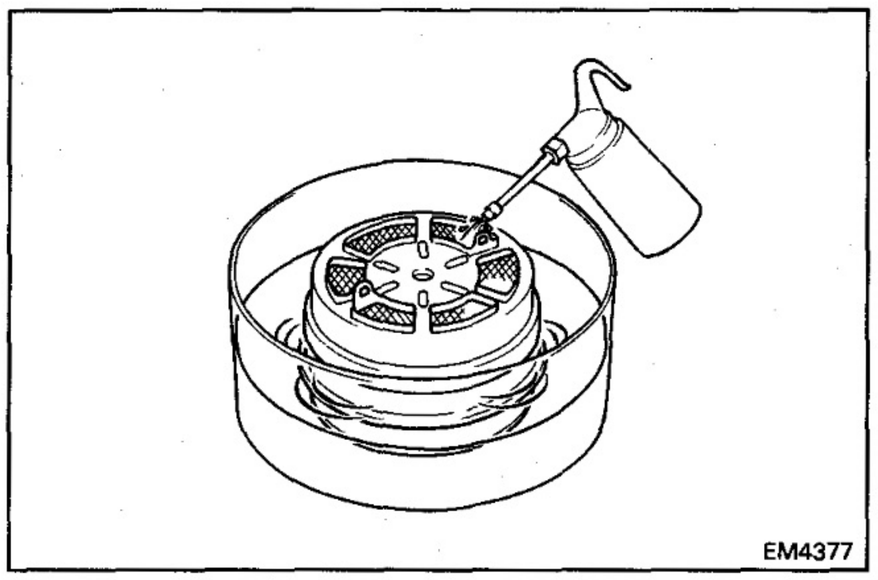
(a) Wash the oil case and air filter in kerosine by agitating and rubbing.

(b) Wipe the oil case and air filter with a clean rag.



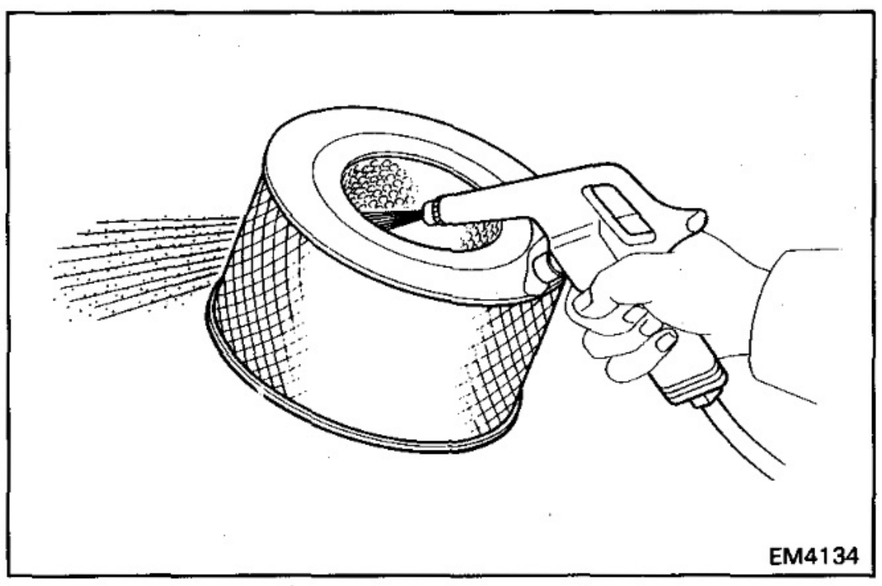
(c) Place the oil case on a level work stand.

(d) Pour in clean engine oil until it reaches the "OIL LEVEL" mark.



(e) Place the air filter on the tray.

(f) Staturate the air filter with clean engine oil.


EM4134

(Fabric Type)

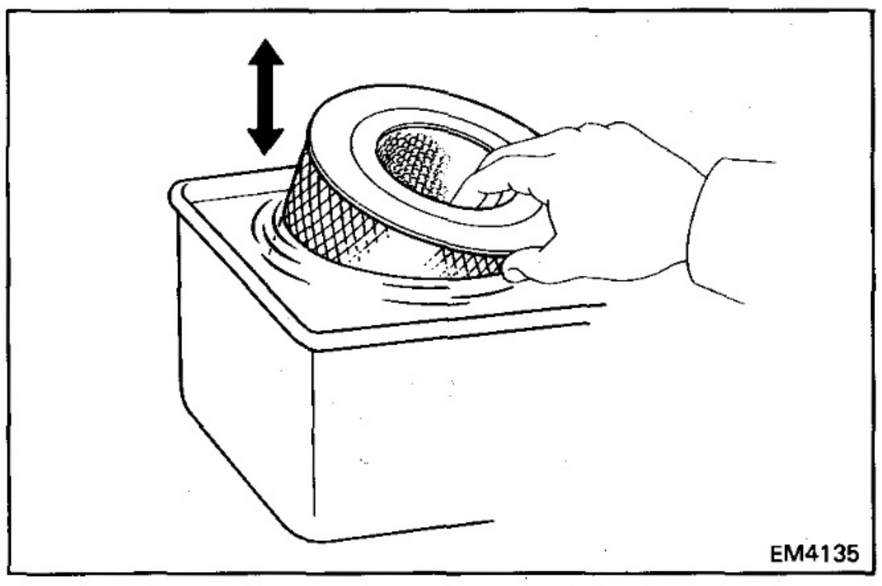
1. INSPECT AIR FILTER

Visually check that the air filter element is not excessively dirty, damaged or oily.

If the element is excessively dirty, damaged or oily, replace it.

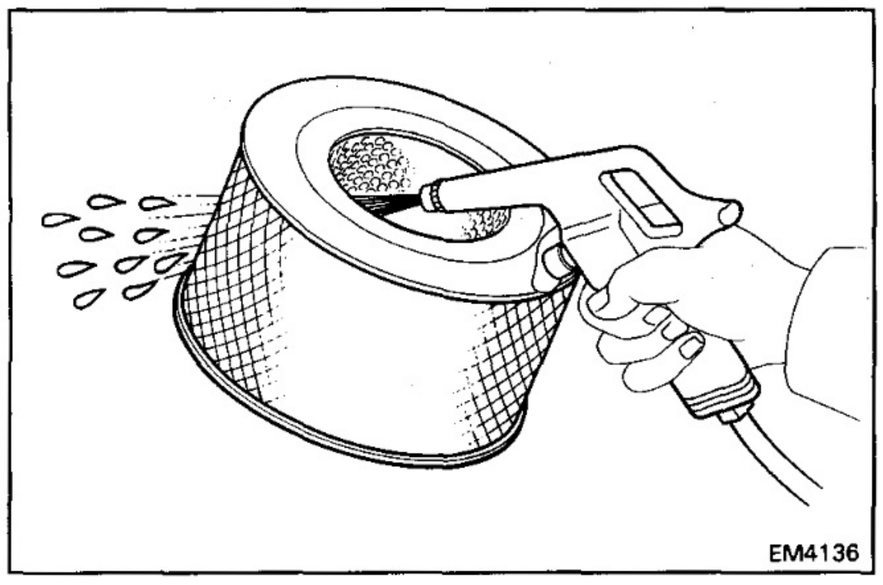
2. CLEAN AIR FILTER

(a) Blow dirt off in the element with compressed air from the inside.


EM4135

(b) Submerge the element in the water and agitate it up and down ten or more times.

(c) Repeat rinsing in clean water until rinse water is clear.


EM4136

(d) Remove excess water by shaking the element or blowing with compressed air.

NOTICE: Do not beat or drop filter element.

(e) Wipe off dust on the air cleaner case interior.

INSPECTION OF ALTERNATOR DRIVE BELT

(See page CH-5)

INSPECTION OF GLOW PLUGS [B and 3B]

(See page ST-6)

INSPECTION OF INTAKE HEATER [W/ INTAKE HEATER]

(See page ST-9)

INSPECTION OF INJECTION NOZZLES

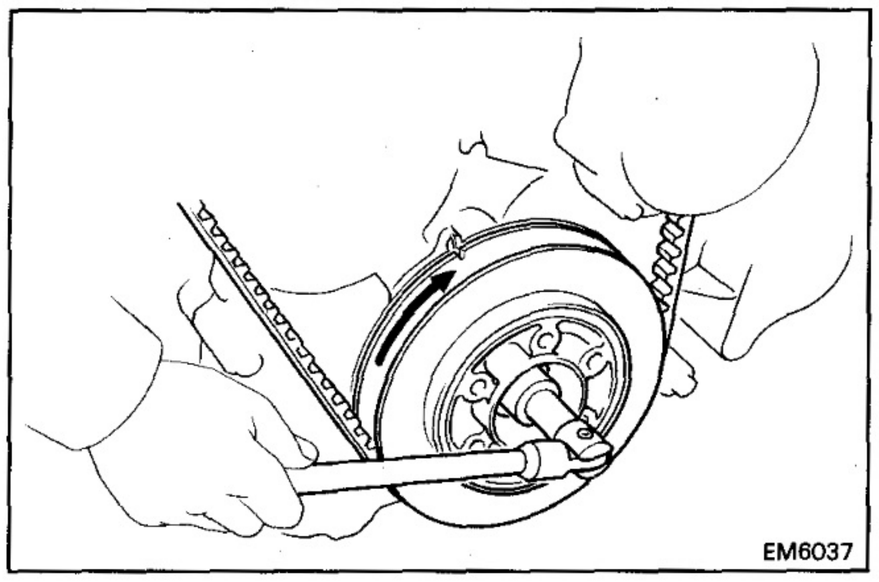
(See pages FU-8 and 9) B and 3B
(See pages FU-14 and 15) 11B and 14B

ADJUSTMENT OF VALVE CLEARANCES

1. WARM UP ENGINE

Allow the engine to reach normal operating temperature.

2. REMOVE CYLINCER HEAD COVER

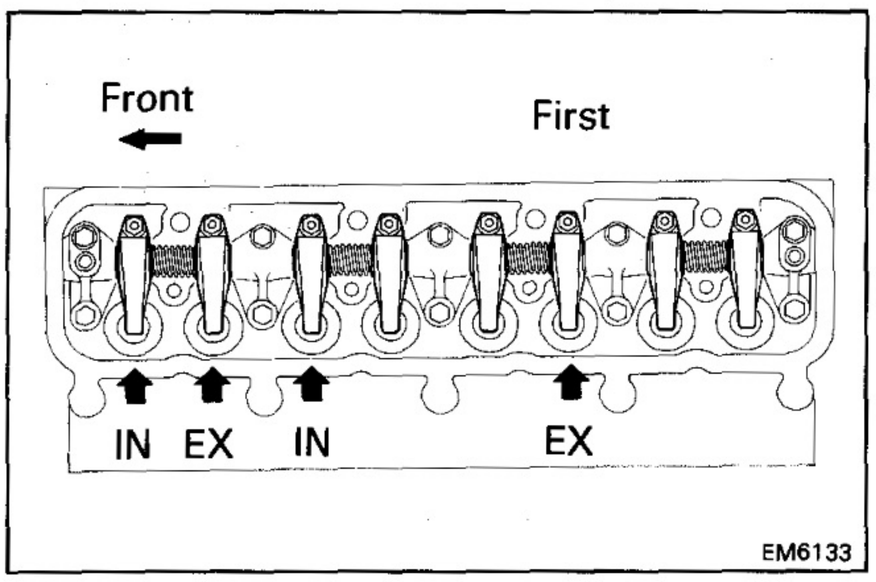


3. SET NO. 1 CYLINDER TO TDC/COMPRESSION

(a) Align the groove on the pulley with the timing gear cover groove by turning the crankshaft clockwise with a wrench.

(b) Check that the rocker arms on the No. 1 cylinder are loose and rocker arms on the No. 4 cylinder are tight.

If not, turn the crankshaft one revolution (360°) and align the mark as above.

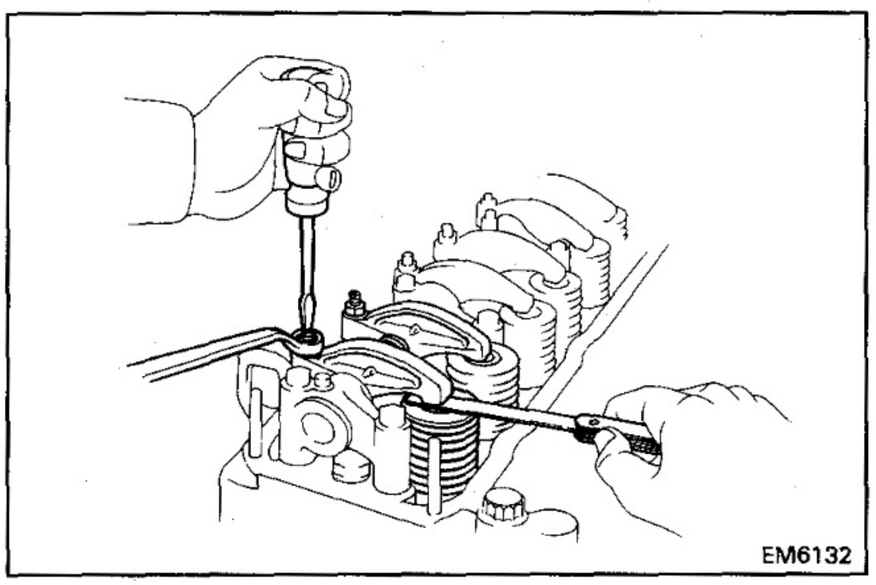


4. ADJUST VALVE CLEARANCES

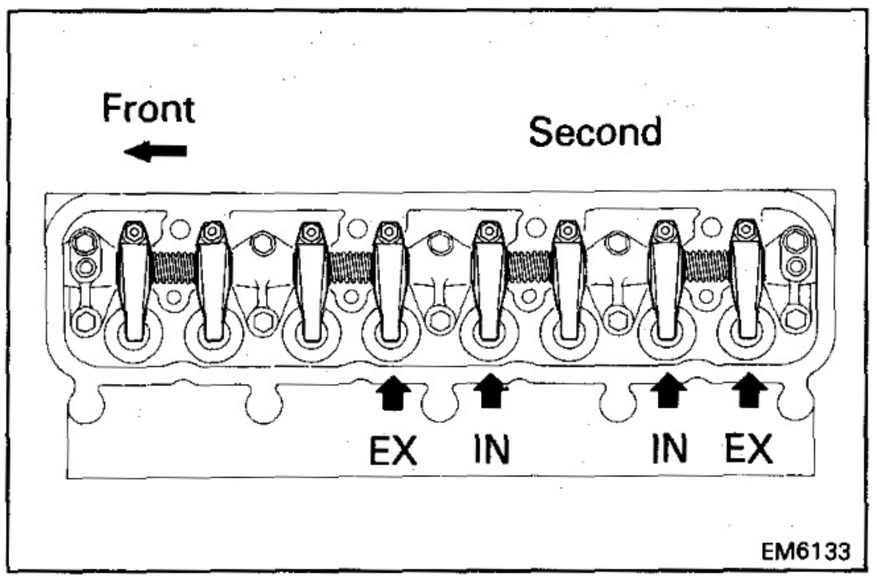
(a) Measure only those valves indicated by arrows.

Valve clearance (Hot):

Intake	**0.20 mm (0.008 in.)**
Exhaust	**0.36 mm (0.014 in.)**

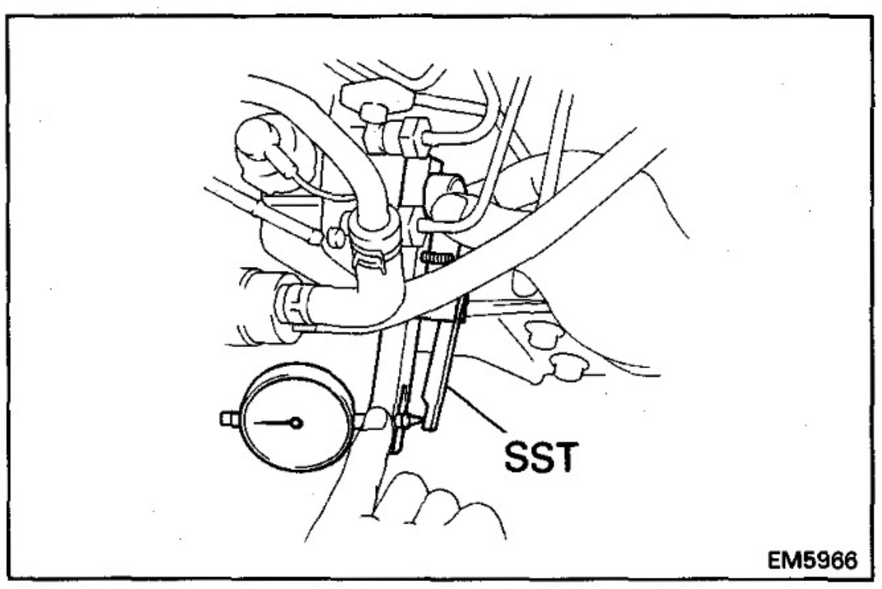


- Using a thickness gauge, measure the valve clearance between the valve stem cap and rocker arm. Loosen the lock nut and turn the adjusting screw to set the proper clearance. Hold the adjusting screw in position and tighten the lock nut.
- Recheck the valve clearance. The thickness gauge should slide with a very slight drag.



(b) Turn the crankshaft one revolution (360°) and align the mark as above.
Adjust only the valves indicated by arrows.

5. INSTALL CYLINDER HEAD COVER



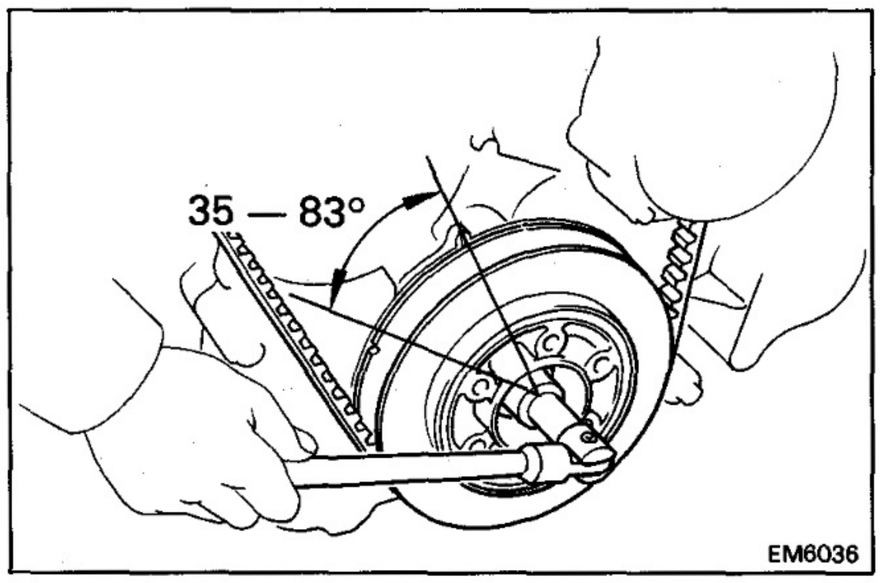
INSPECTION AND ADJUSTMENT OF INJECTION TIMING

1. INSTALL PLUNGER STROKE MEASURING TOOL (SST) AND DIAL INDICATOR

(a) Remove the distributive head plug bolt from the injection pump.

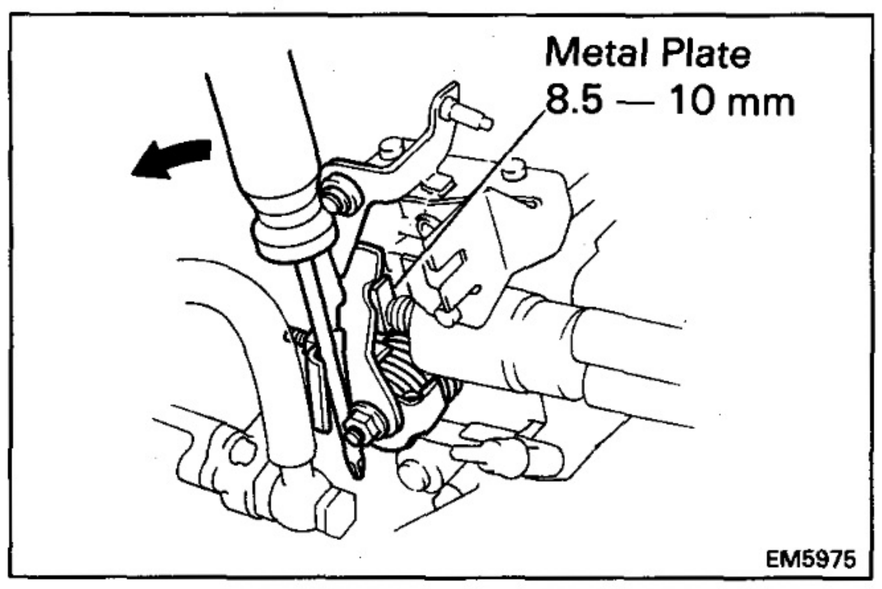
(b) Install SST and the dial indicator to the distributive head plug hole.

SST 09275-54010



2. SET NO. 1 OR NO. 4 CYLINDER TO APPROX. 35 — 83° BTDC/COMPRESSION

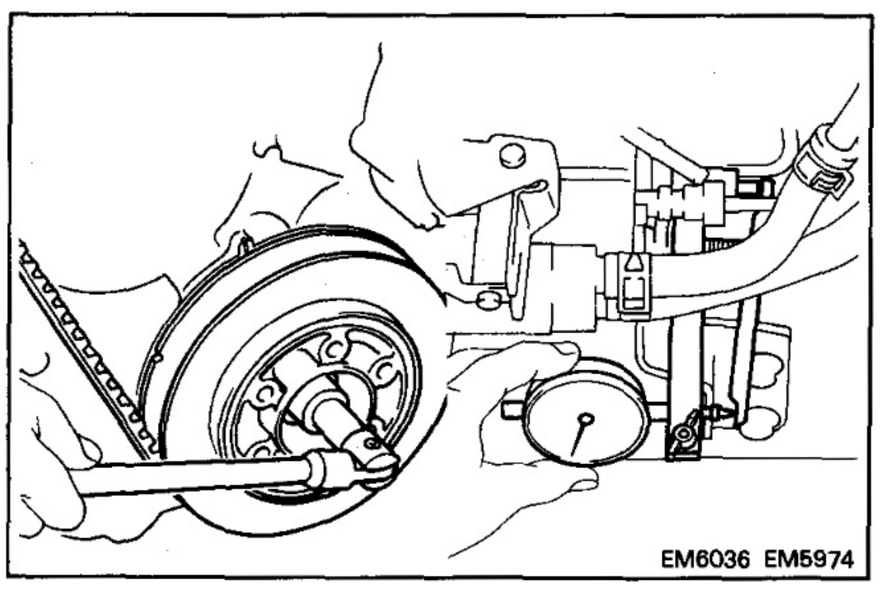
Turn the crankshaft pulley clockwise so the pulley groove is 35 — 83° from the timing gear cover groove.



3. (w/ ACSD) RELEASE COLD STARTING SYSTEM

(a) Using a screwdriver, turn the cold starting lever counterclockwise approx. 20° as shown.

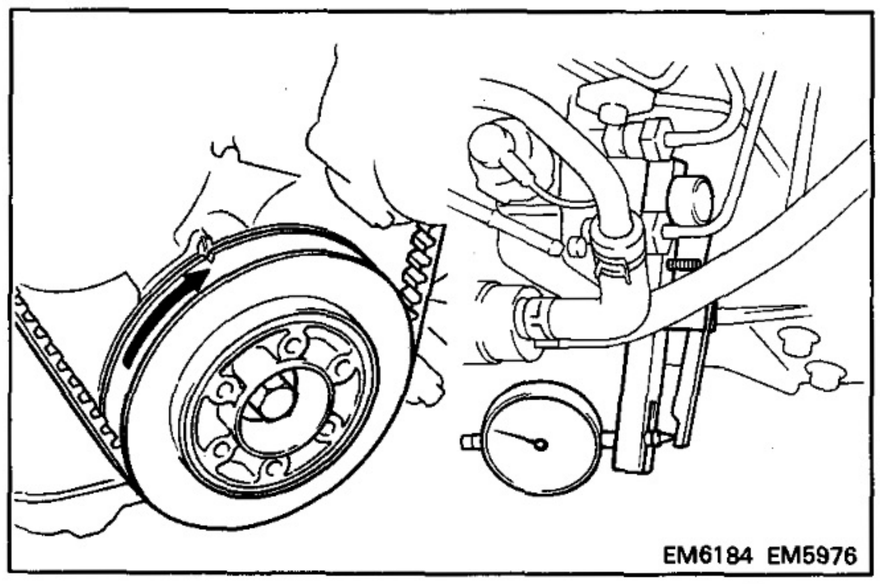
(b) Put a metal plate 8.5 — 10 mm (0.33 — 0.39 in.) thick between the cold starting lever and thermo wax plunger.



4. CHECK INJECTION TIMING

(a) Set the dial indicator at 0 mm (0 in.).

(b) Recheck to see that the dial indicator remains at 0 mm (0 in.) while rotating the crankshaft pulley slightly to the left and right.

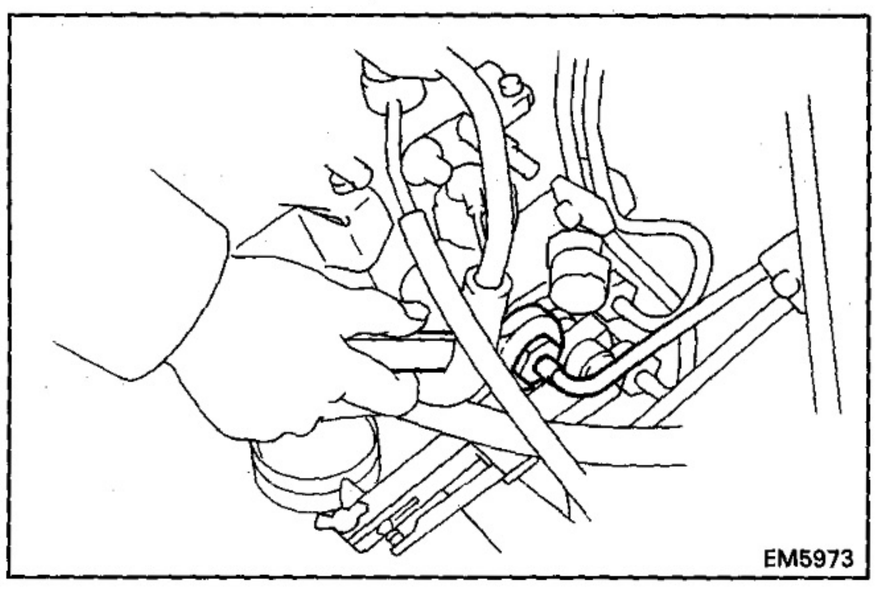


(c) Slowly rotate the crankshaft pulley clockwise until the pulley groove is aligned with the timing gear cover groove.

(d) Measure the plunger stroke

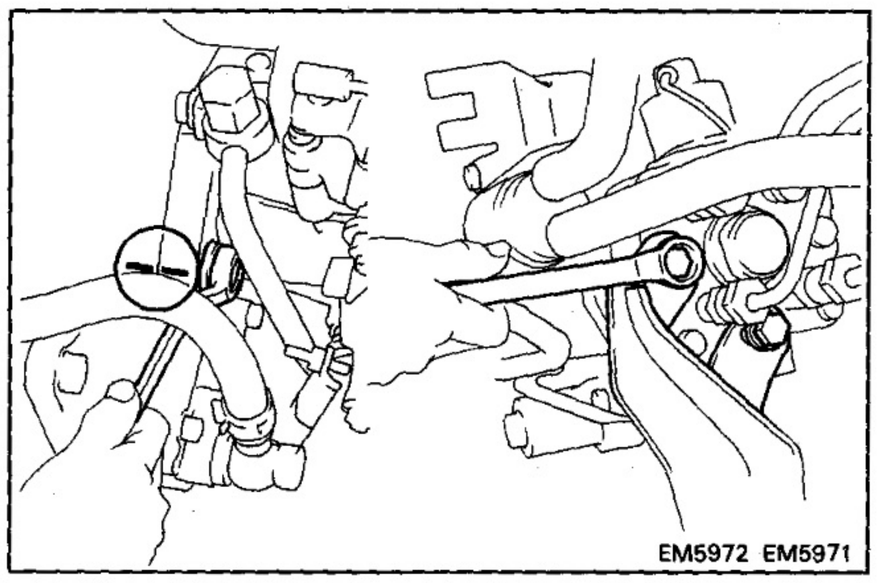
Plunger stroke:

B, 3B	**1.27 — 1.33 mm (0.0450 — 0.0524 in.)**
11B	**1.34 — 1.40 mm (0.0528 — 0.0551 in.)**
14B	**1.31 — 1.37 mm (0.0516 — 0.0539 in.)**

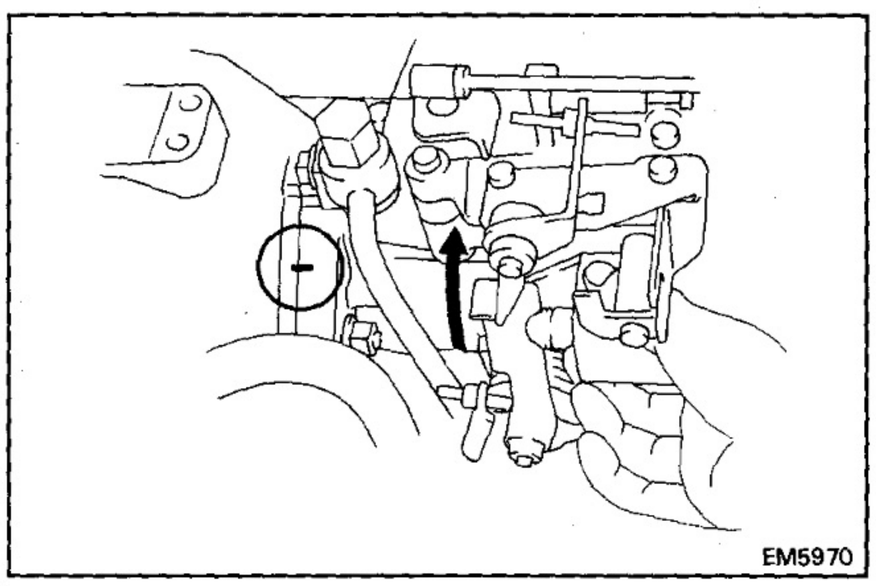


5. ADJUST INJECTION TIMING

(a) Loosen the four injection pipe union nuts on the pump side.



(b) Loosen the injection pump mounting bolt and nuts.



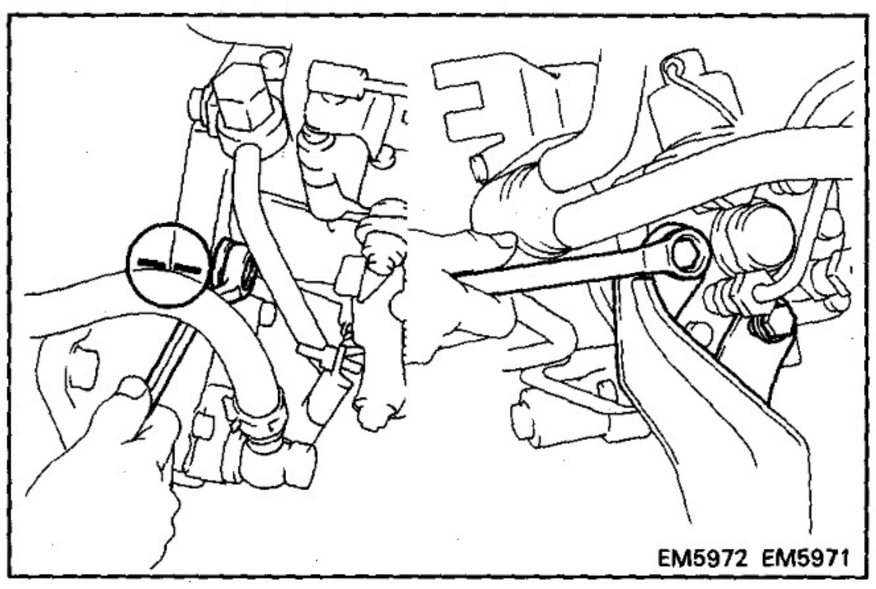
(c) Adjust the plunger stroke by slightly tilting the injection pump body.

If the stroke is less than specification, tilt the pump toward the engine.

If greater than specification, tilt the pump away from the engine.

Plunger stroke:

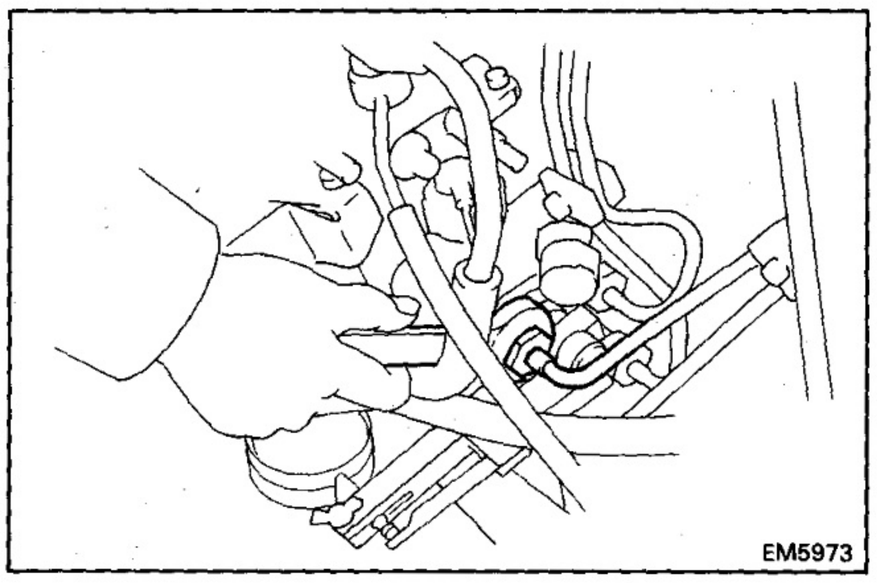
B, 3B	**1.27 — 1.33 mm (0.0450 — 0.0524 in.)**
11B	**1.34 — 1.40 mm (0.0528 — 0.0551 in.)**
14B	**1.31 — 1.37 mm (0.0516 — 0.0539 in.)**



(d) Tighten the injection pump mounting bolt and nuts. Torque the bolt and nuts.

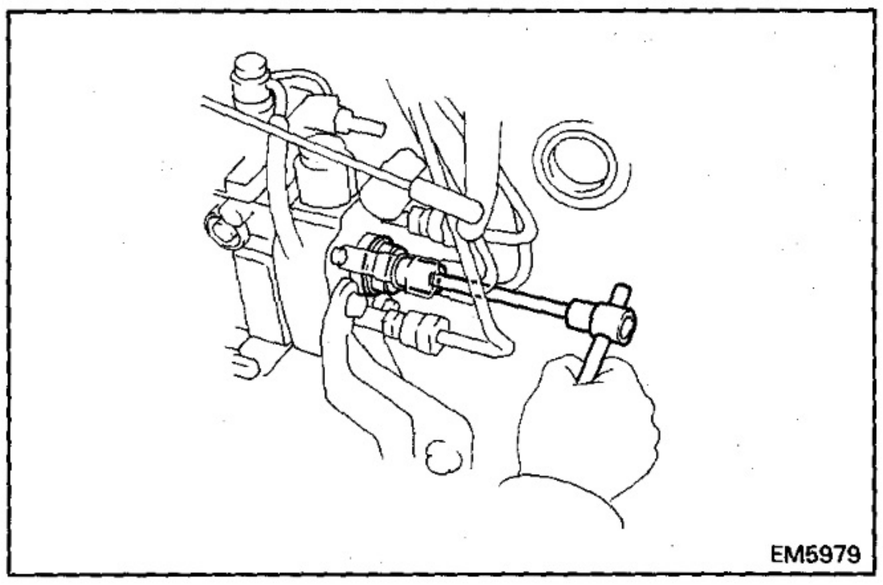
Torque: 185 kg-cm (13 ft-lb, 18 N·m)

(e) Recheck the plunger stroke.



(f) Tighten all union nuts on the injection pipes.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)



EM5979

6. REMOVE METAL PLATE FROM COLD STARTING LEVER

7. REMOVE SST AND DIAL INDICATOR

(a) Remove SST and dial indicator.

(b) Install the distributive head plug bolt with a new gasket. Torque the bolt.

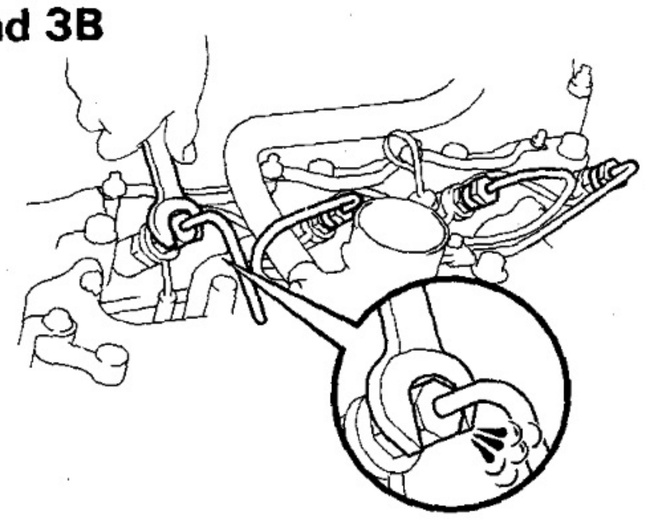
Torque: B, 3B 170 kg-cm (12 ft-lb, 17 N·m)
11B, 14B 260 kg-cm (19 ft-lb, 25 N·m)

8. BLEET AIR FROM FUEL LINE

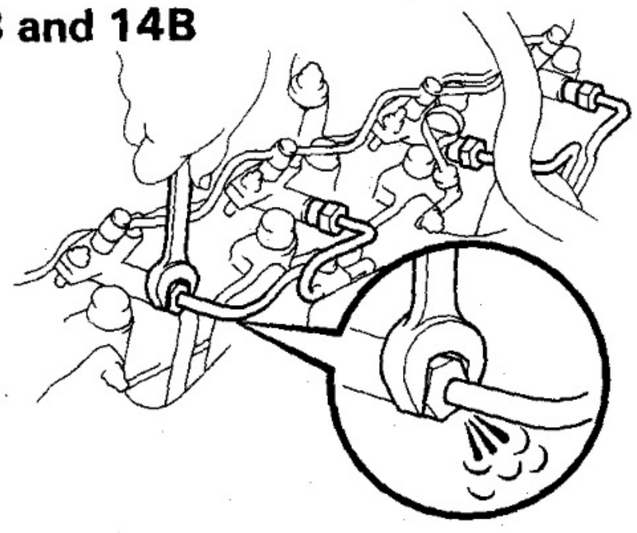
Bleed air from the injection pipe by activating the starter motor.

9. START ENGINE AND CHECK FOR LEAKS

B and 3B



11B and 14B



EM5981
EM5982

INSPECTION AND ADJUSTMENT OF IDLE AND MAXIMUM SPEED

1. INITIAL CONDITIONS:

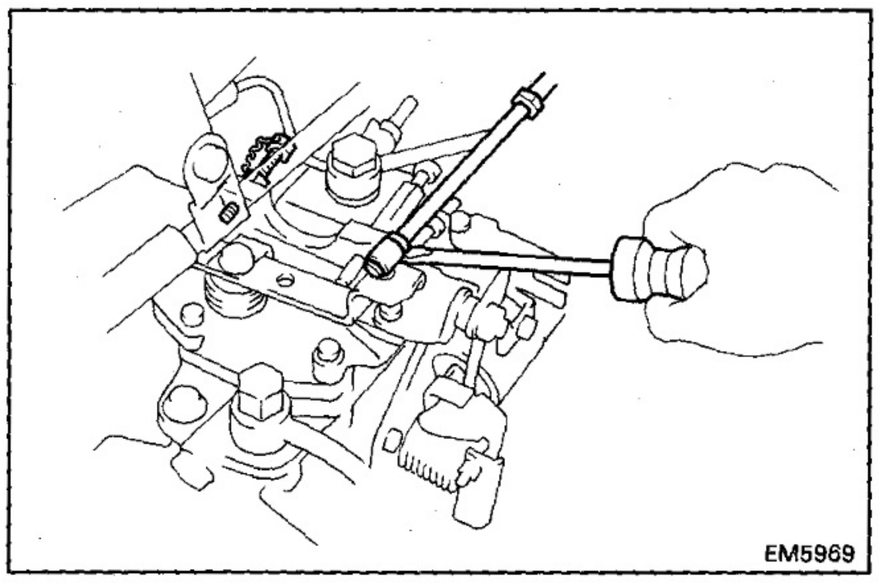
(a) Air cleaner installed

(b) Engine coolant normal operating temperature

(c) Accessories switched off

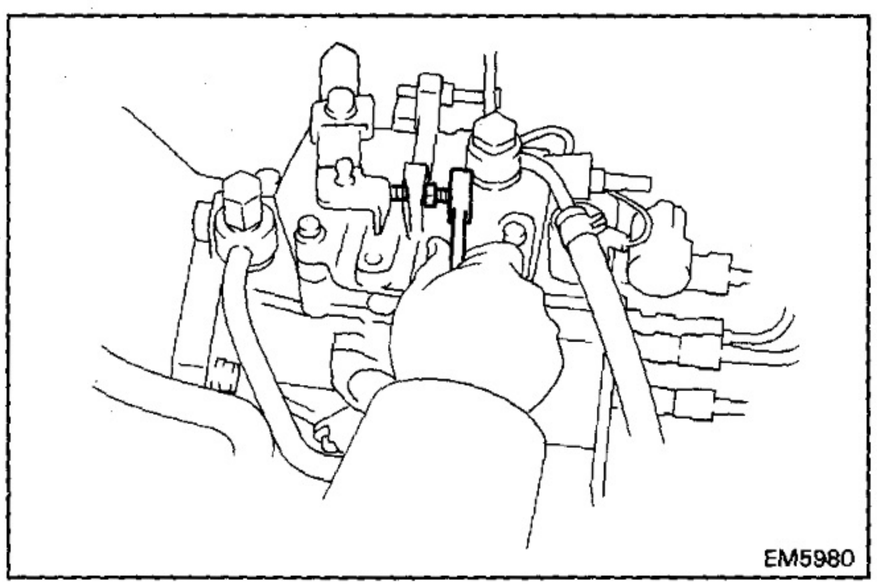
(d) Transmission in neutral

2. CONNECT TACHOMETER TO ENGINE


EM5969

3. DISCONNECT ACCELERATOR CONNECTING ROD

Disconnect the accelerator connecting rod from the injection pump.


EM5980

4. INSPECT AND ADJUST IDLE SPEED

(a) Check that the adjusting lever is in contact with the idle speed adjusting screw.

If not, check if the air conditioner switch is OFF or if engine is running at normal operating temperature.

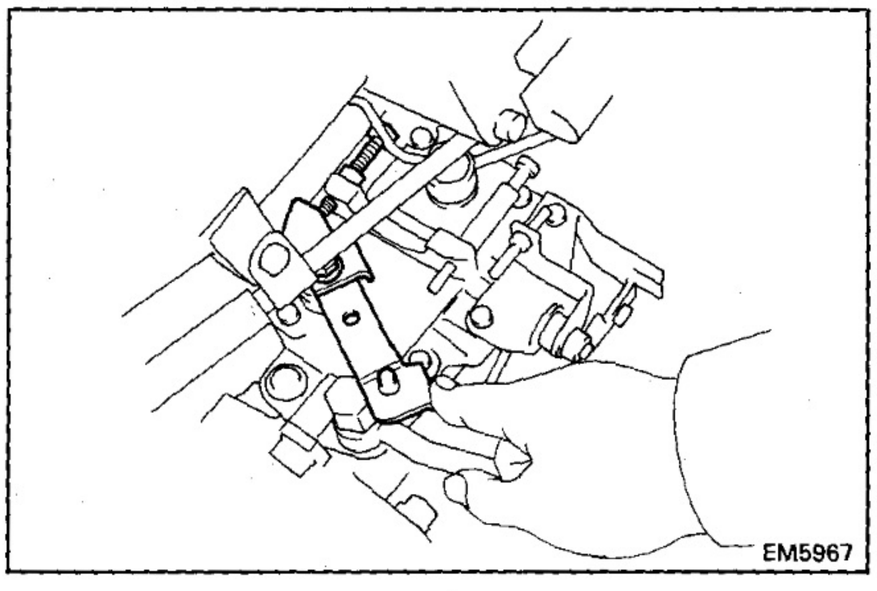
(b) Start the engine and check the idle speed.

Idle speed: M/T 600 — 700 rpm
A/T 770 — 820 rpm

HINT (w/ ACSD only): Make sure the idle up is not touching the adjusting lever.

(c) Loosen the lock nut and adjust by turning the idle adjusting screw.

(d) Securely tighten the lock nut and recheck the idle speed.

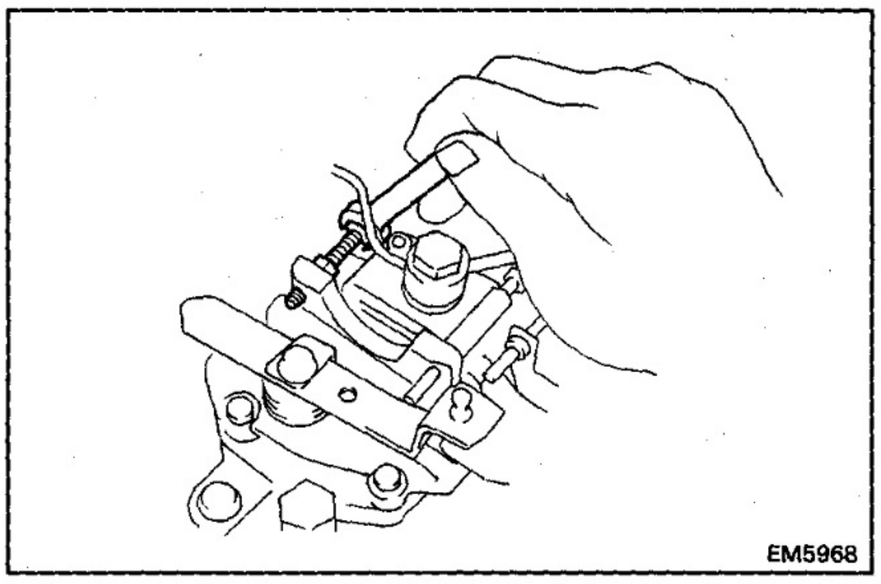

EM5967

5. INSPECT AND ADJUST MAXIMUM SPEED

(a) Inspect the engine maximum speed with the adjusting lever fully depressed.

Maximum speed: B, 3B 4,050 — 4,200 rpm
11B, 14B 4,050 — 4,250 rpm

NOTICE: This check should be performed in as short a time as possible.


EM5968

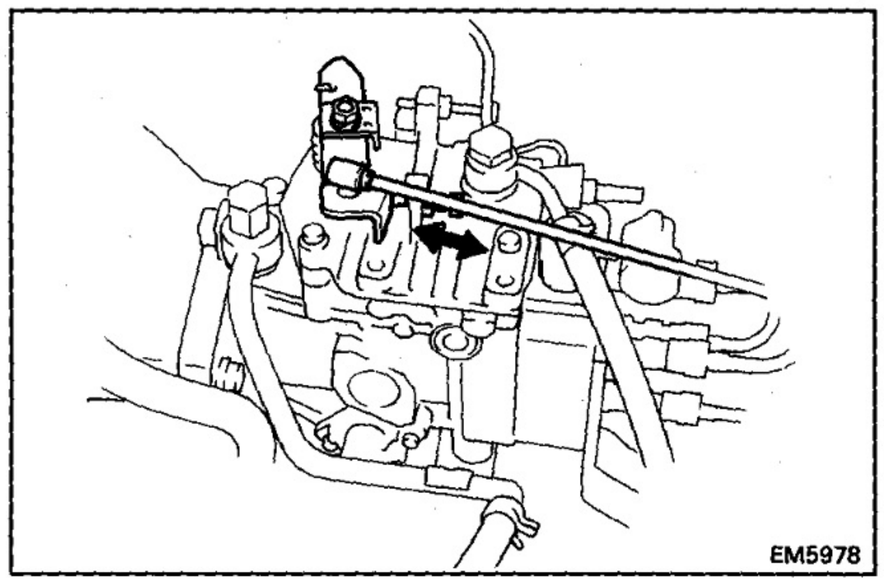
(b) Cut the maximum adjusting screw wire.

(c) Loosen the lock nut and adjust by turning the maximum speed adjusting screw.

NOTICE: Perform adjustment at low rpm, and then recheck at maximum speed.

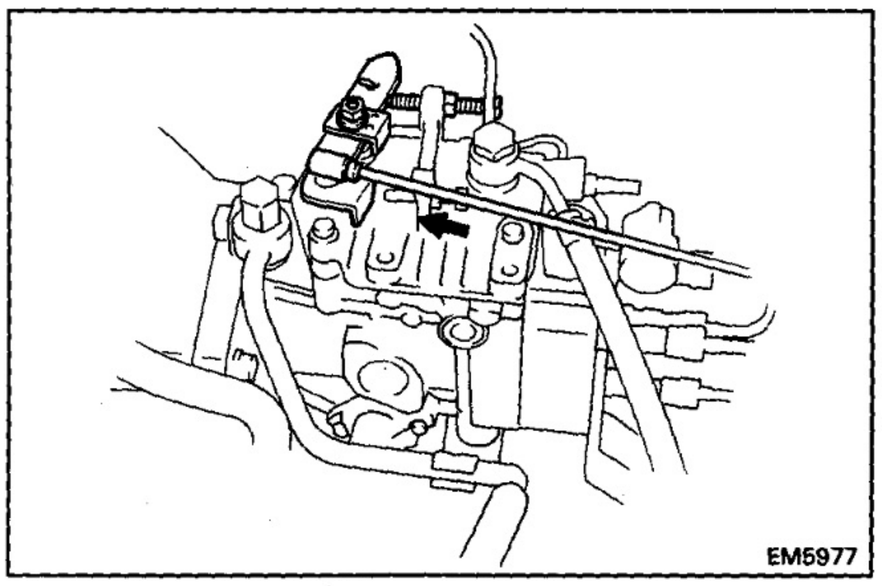
(d) Securely tighten the lock nut and recheck the maximum speed.

(e) Lock the maximum speed adjusting screw with the wire.


EM5978

6. CONNECT ACCELERATOR CONNECTING ROD

(a) Connect the accelerator connecting rod and adjust so there is no slack in it.


EM5977

(b) Inspect to see that adjusting lever is stopped by the maximum speed adjusting screw when the accelerator pedal is depressed all the way.

7. DISCONNECT TACHOMETER

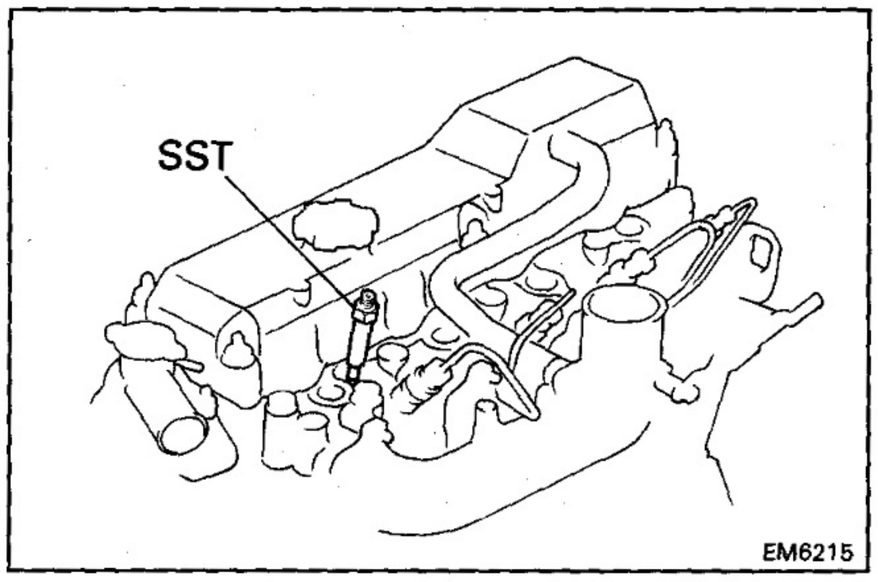
COMPRESSION CHECK [B and 3B]

HINT: If there is lack of power, excessive oil consumption or poor fuel economy, measure the cylinder compression pressure.

1. **WARM UP AND STOP ENGINE**

2. **REMOVE GLOW PLUGS (See page EM-31)**

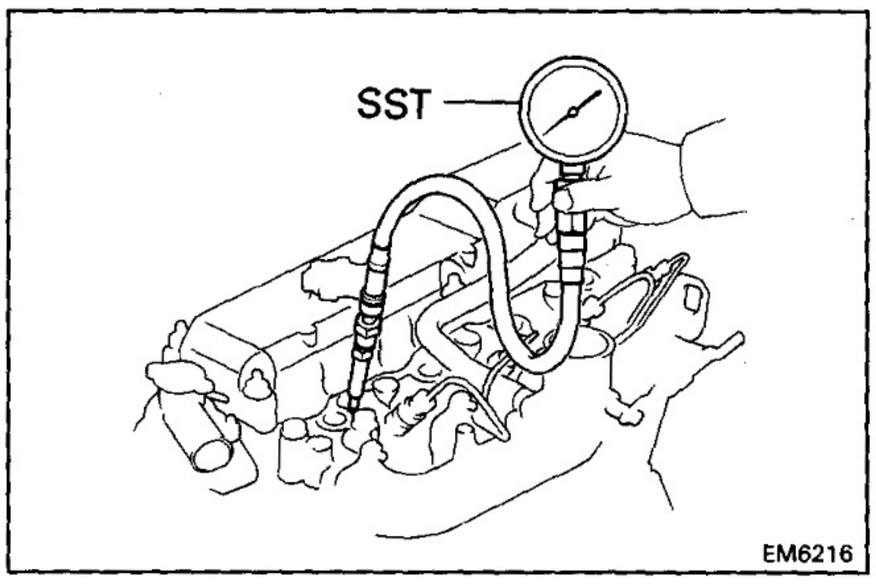
   NOTICE: Make sure the load wire is not grounded.



3. **CHECK CYLINDER COMPRESSION PRESSURE**

   (a) Install SST (gauge adapter) to the glow plug hole.

   SST 09992-00024



   (b) Connect SST (compression gauge) to SST (gauge adapter).

   SST 09992-00024

   (c) Fully open the throttle valve.

   (d) While cranking the engine with the starter, measure the compression pressure.

   HINT: Always use a fully charged battery to obtain engine revolutions of more than 250 rpm.

   (e) Repeat steps (a) through (d) for each cylinder.

   Compression pressure:
   30.0 kg/cm² (427 psi, 2,942 kPa) or more
   Minimum pressure:
   20.0 kg/cm² (284 psi, 1,961 kPa)
   Difference between each cylinder:
   2.0 kg/cm² (28 psi, 196 kPa) or less

   (f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the glow plug hole and repeat steps (a) through (d) for the cylinder with low compression.

   - If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
   - If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

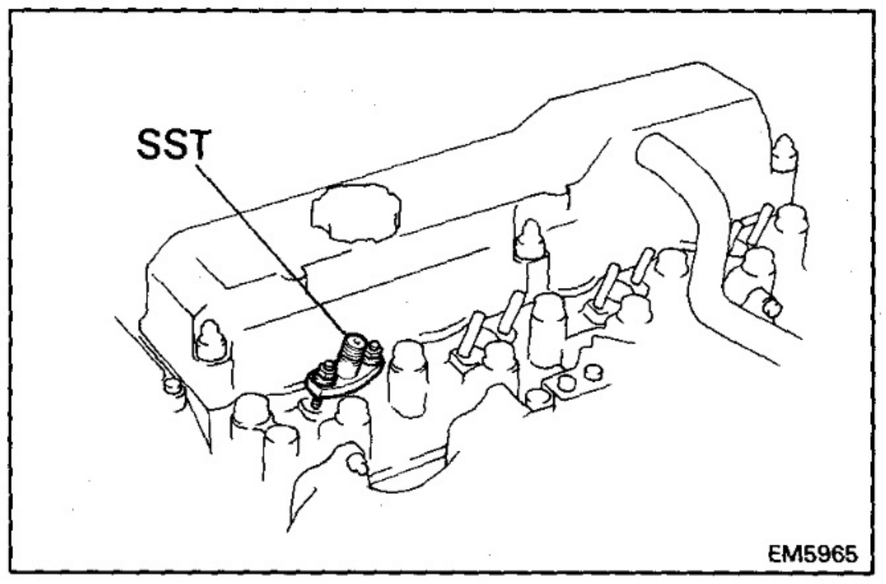
4. **INSTALL GLOW PLUGS (See page EM-50)**

COMPRESSION CHECK [11B and 14B]

HINT: If there is lack of power, excessive oil consumption or poor fuel economy, measure the cylinder compression pressure.

1. **WARM UP AND STOP ENGINE**

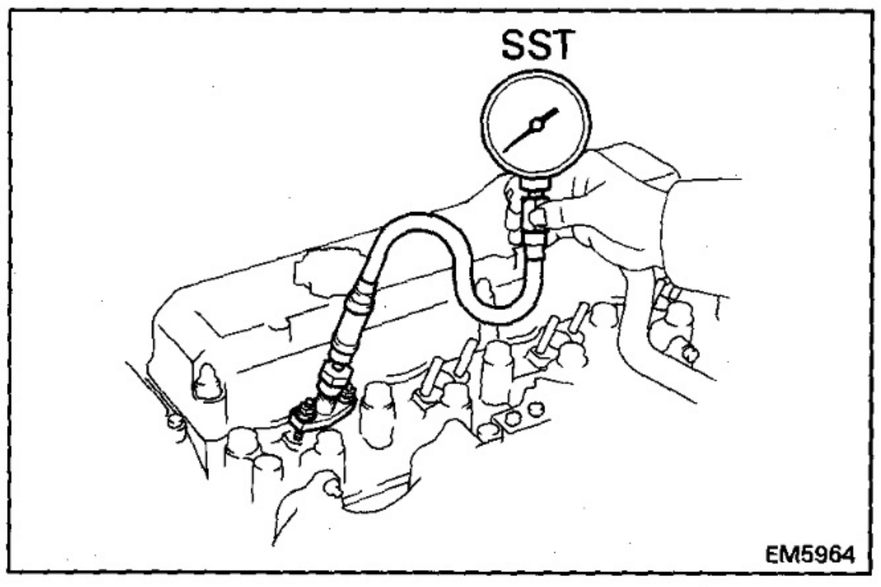
2. **REMOVE INJECTION NOZZLES (See page FU-14)**



3. **CHECK CYLINDER COMPRESSION PRESSURE**

(a) Install SST (gauge adapter) to the injection nozzle hole.

SST 09992-00024



(b) Connect SST (compression gauge) to SST (gauge adapter).

SST 09992-00024

(c) Fully open the throttle valve.

(d) While cranking the engine with the starter, measure the compression pressure.

HINT: Always use a fully charged battery to obtain engine revolutions of more than 250 rpm.

(e) Repeat steps (a) through (d) for each cylinder.

Compression pressure:
30.0 kg/cm² (427 psi, 2,942 kPa) or more
Minimum pressure:
20.0 kg/cm² (284 psi, 1,961 kPa)
Difference between each cylinder:
2.0 kg/cm² (28 psi, 196 kPa) or less

(f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the injection nozzle hole and repeat steps (a) through (d) for the cylinder with low compression.

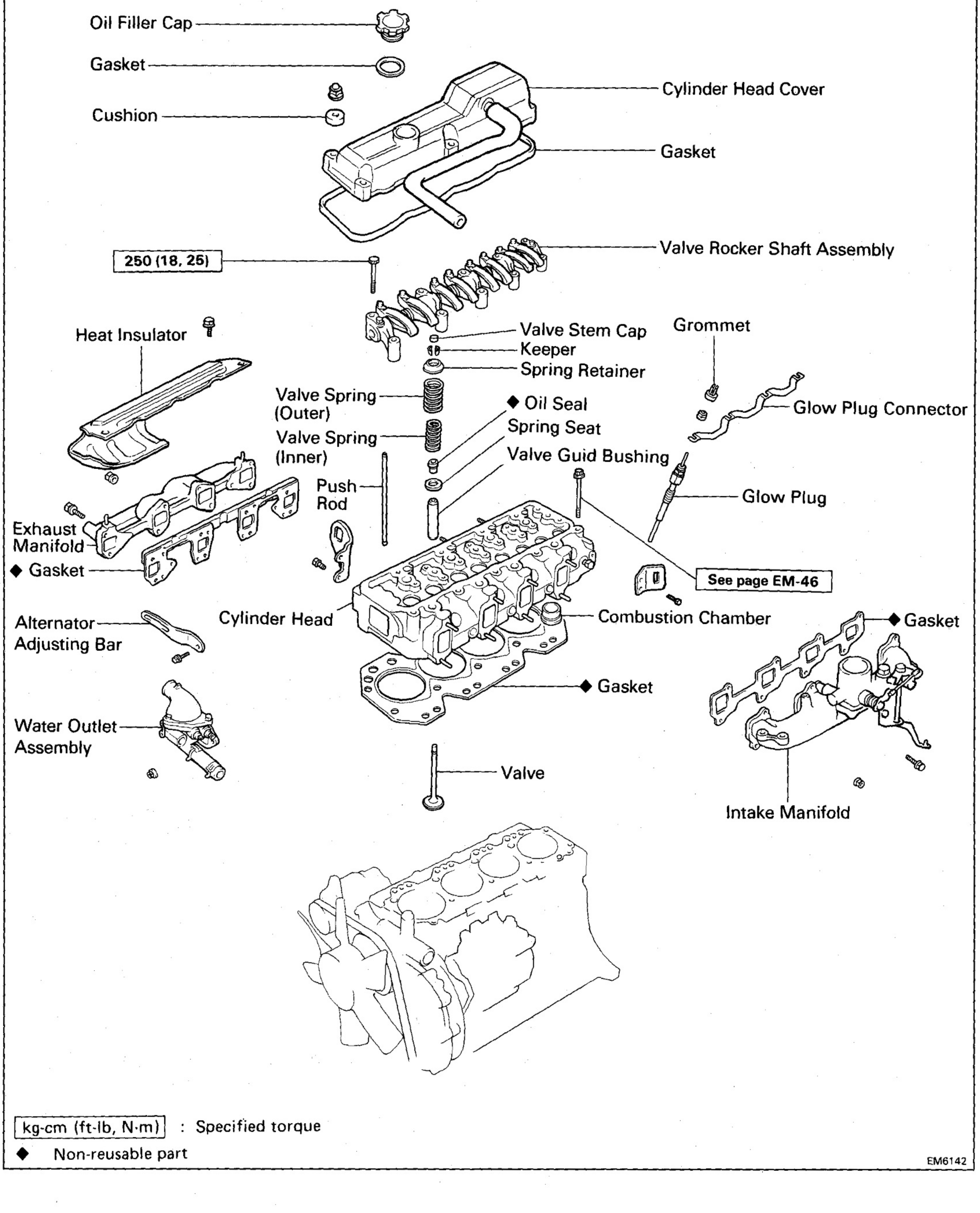
- If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
- If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

4. **INSTALL INJECTION NOZZLES (See page FU-19)**

CYLINDER HEAD

COMPONENTS

B and 3B



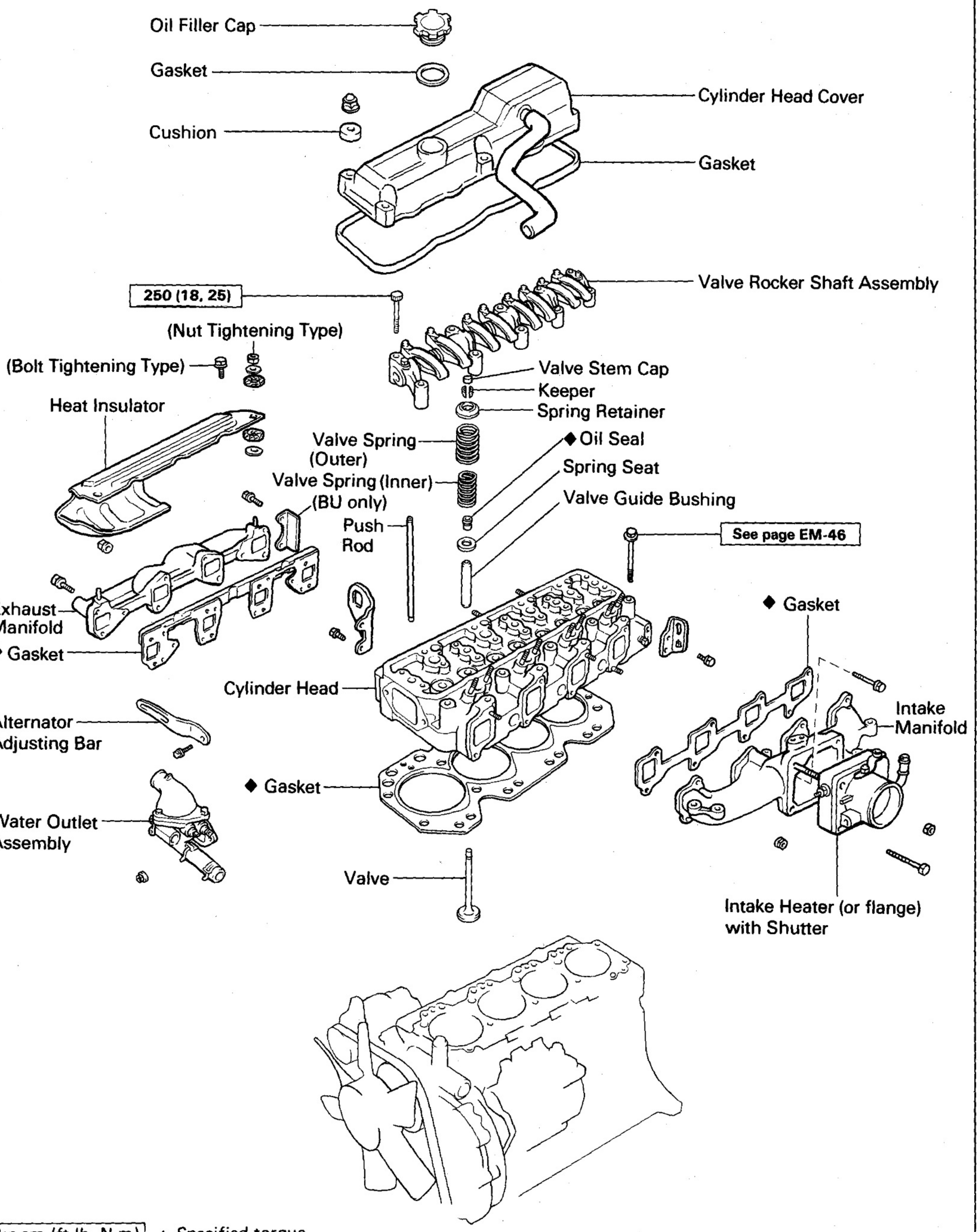
kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

EM6142

COMPONENTS (Cont'd)

11B and 14B



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

EM6143

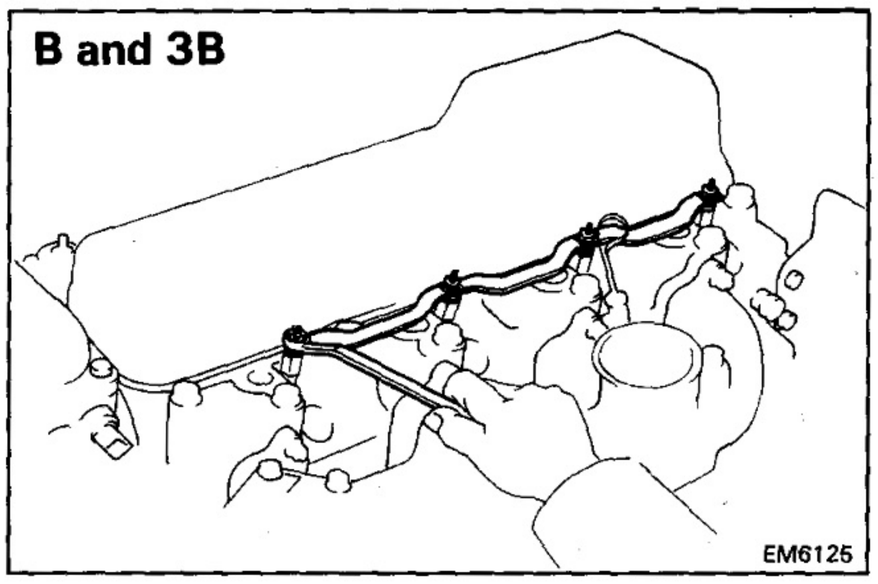
REMOVAL OF CYLINDER HEAD

(See page EM-29) B and 3B
(See page EM-30) 11B and 14B

1. DRAIN ENGINE COOLANT (See page CO-5)

2. REMOVE INJECTION NOZZLES
(See page FU-8) B and 3B
(See page FU-14) 11B and 14B

B and 3B



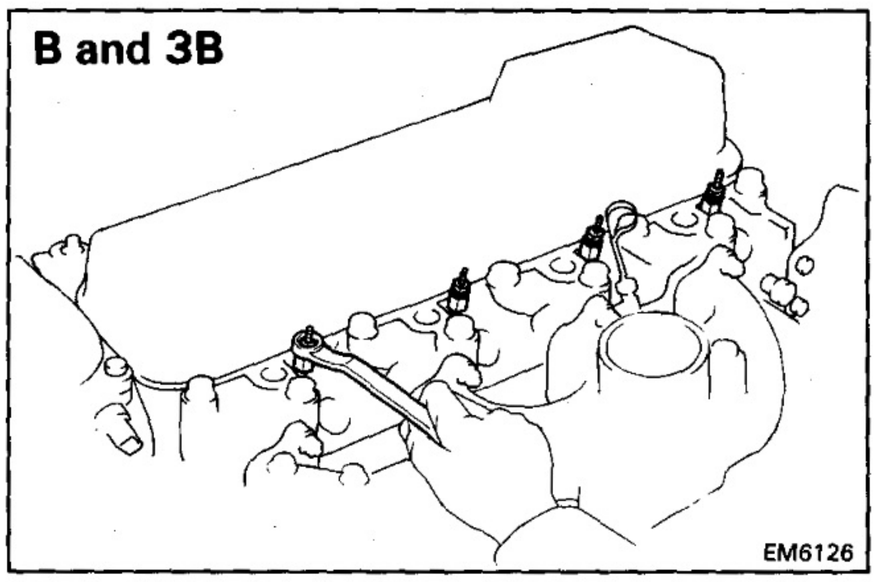
EM6125

3. [B AND 3B]
REMOVE GLOW PLUGS

(a) Remove the four screw grommets.

(b) Remove the four nuts and glow plug connector.

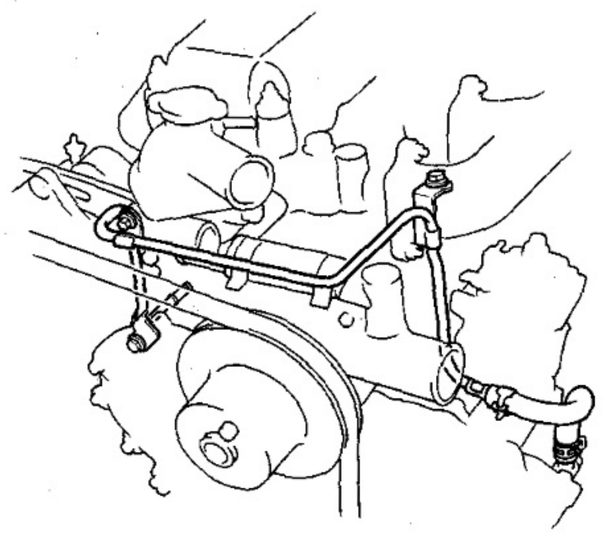
B and 3B



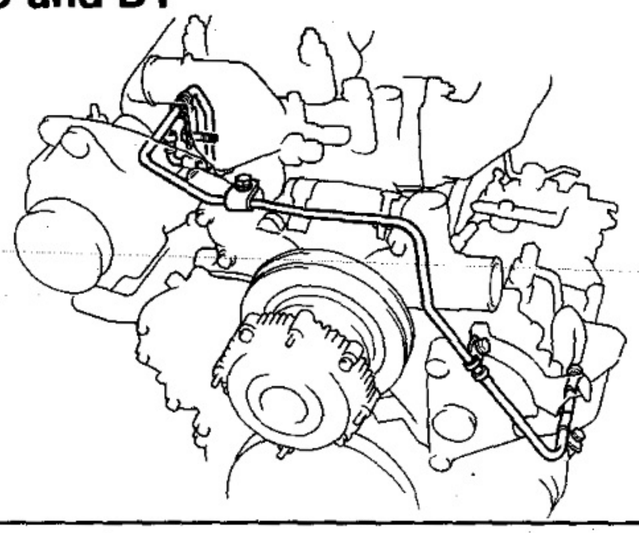
EM6126

(c) Remove the four glow plugs.

BJ

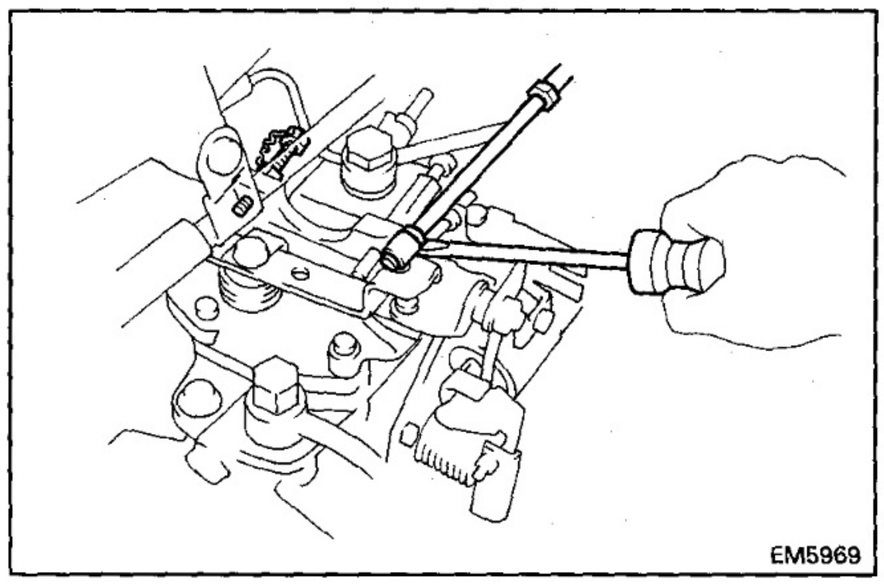


BU and BY

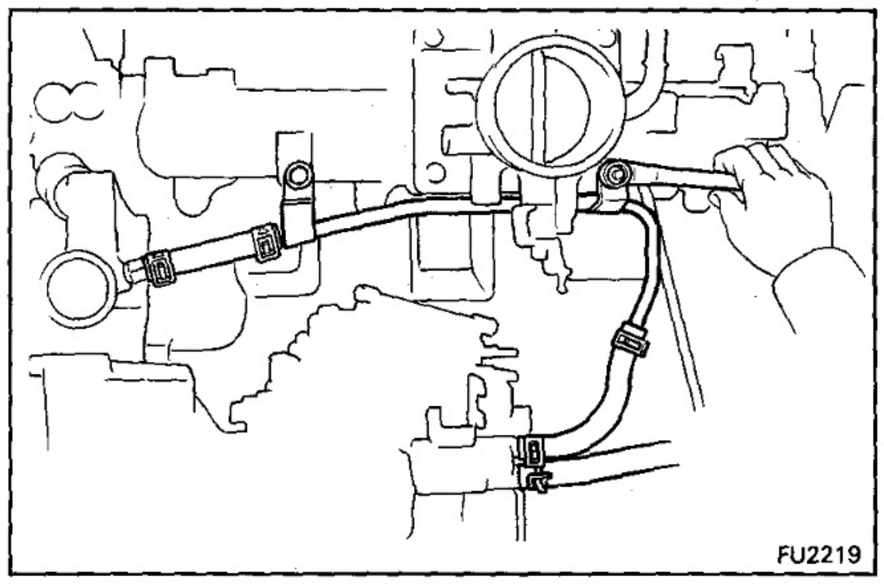


EM6130
EM6217

4. [BJ, BU AND BY]
REMOVE VACUUM PIPE

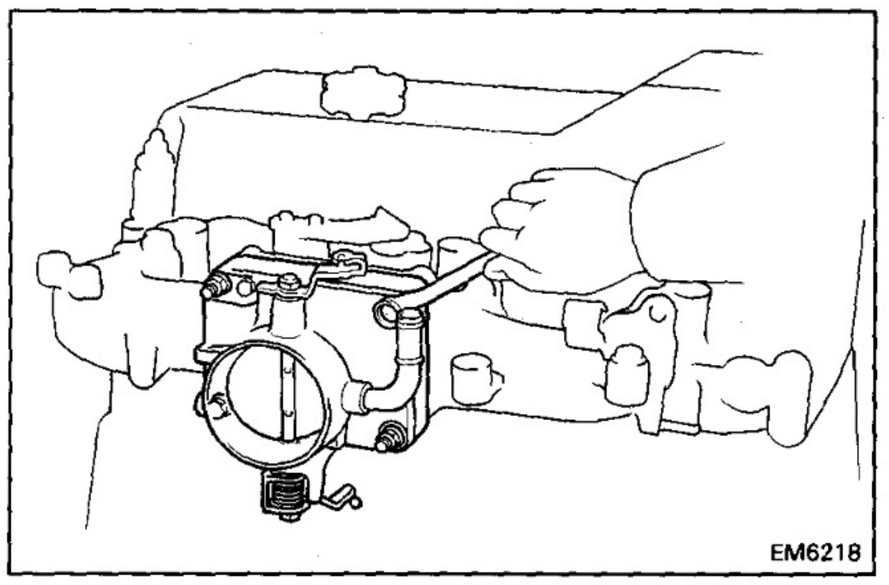


5. REMOVE ACCELERATOR CONNECTING ROD

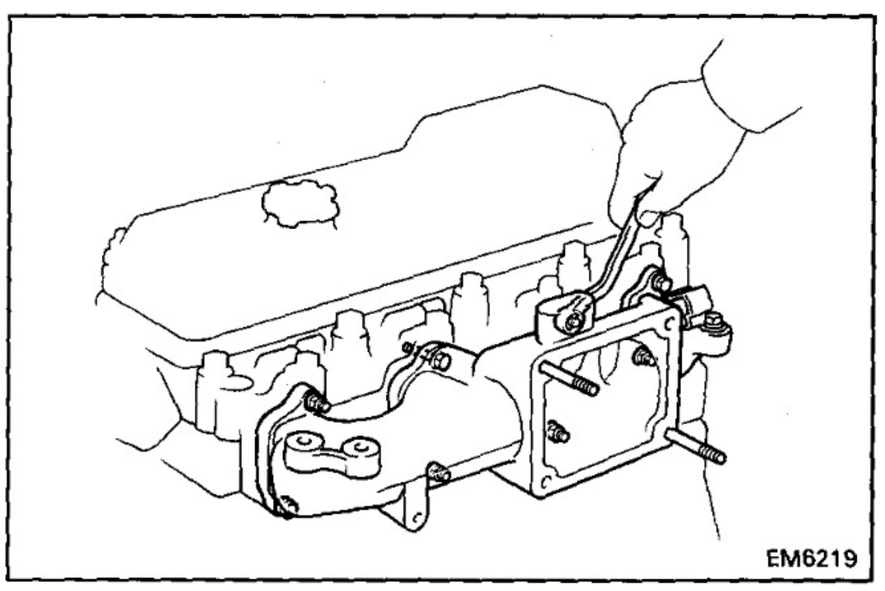


6. REMOVE INTAKE MANIFOLD

(a) (w/ ACSD)
Remove the No. 4 water by-pass pipe with hoses.

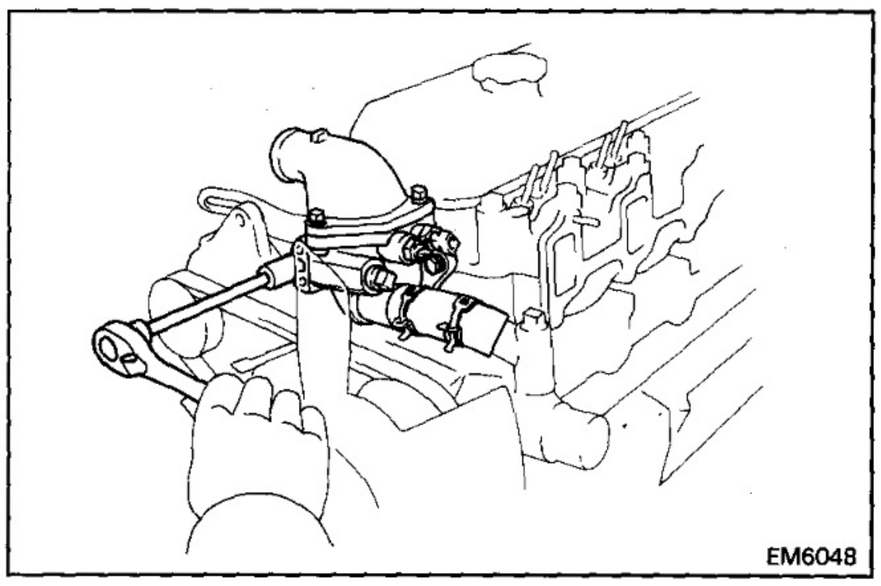


(b) (11B and 14B)
Remove the two bolts, nuts and intake heater or intake flange with intake shutter.



(c) Remove the five nuts and three bolts holding the dipstick clamp, and intake manifold from the cylinder head.

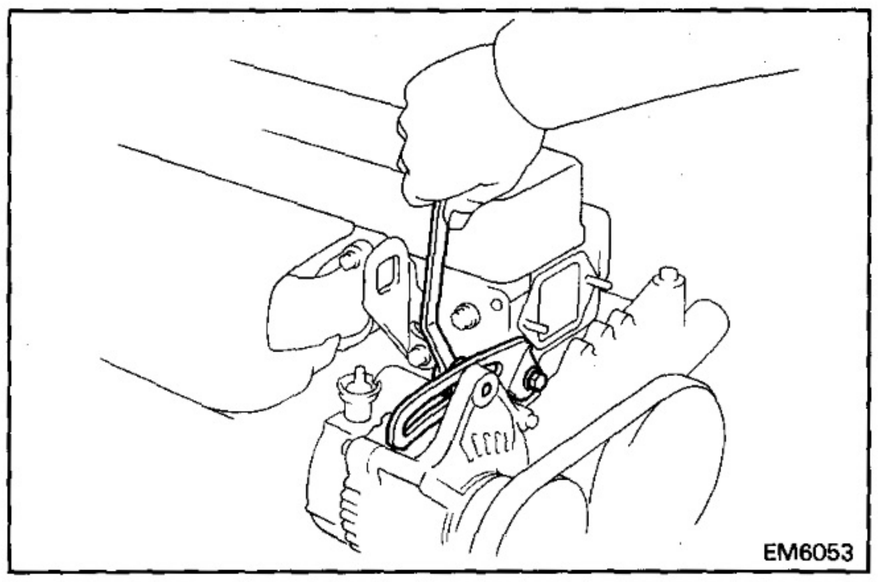
(d) Remove the intake manifold and gasket.



7. REMOVE WATER OUTLET ASSEMBLY

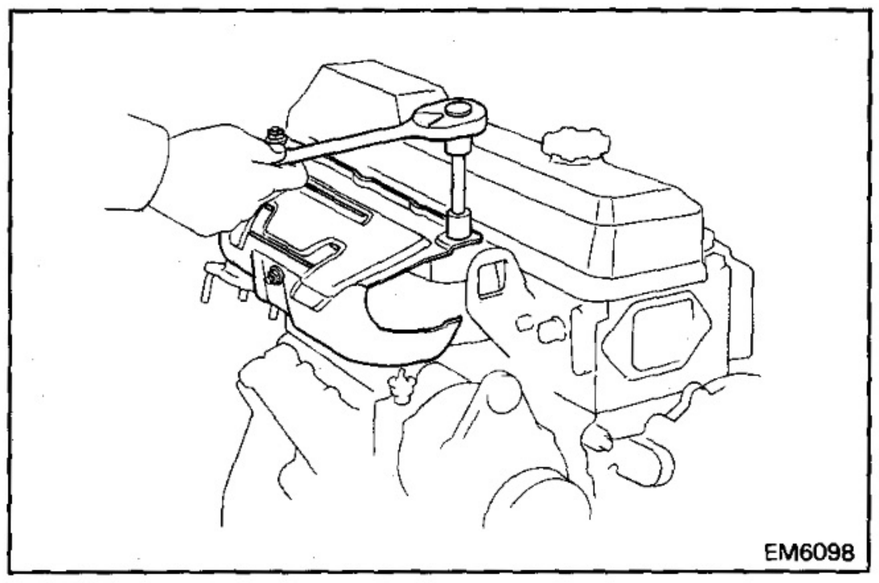
(a) Remove the two nuts holding the water outlet housing to the cylinder head.

(b) Disconnect the water by-pass hose from the water pump, and remove the water outlet assembly with the by-pass hose.



8. REMOVE DRIVE BELT ADJUSTING BAR

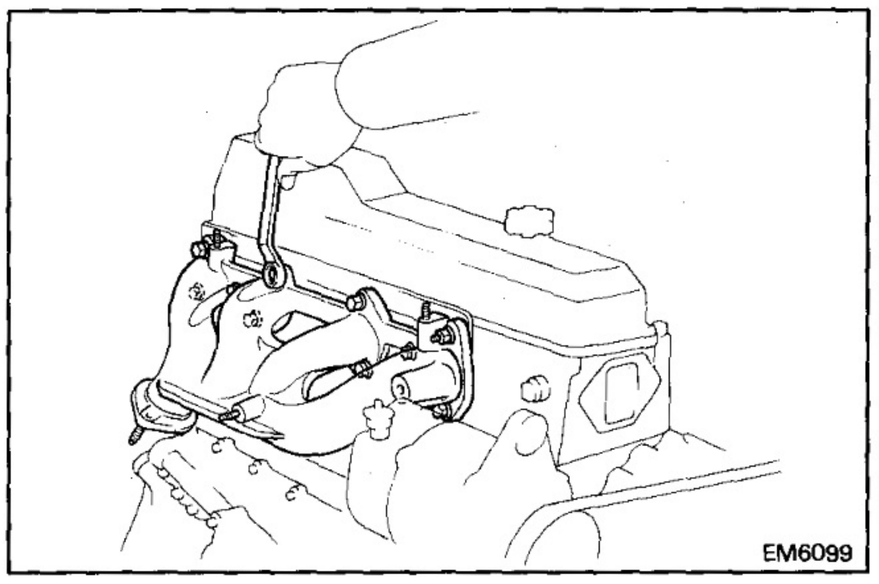
Remove the two bolts and adjusting bar.



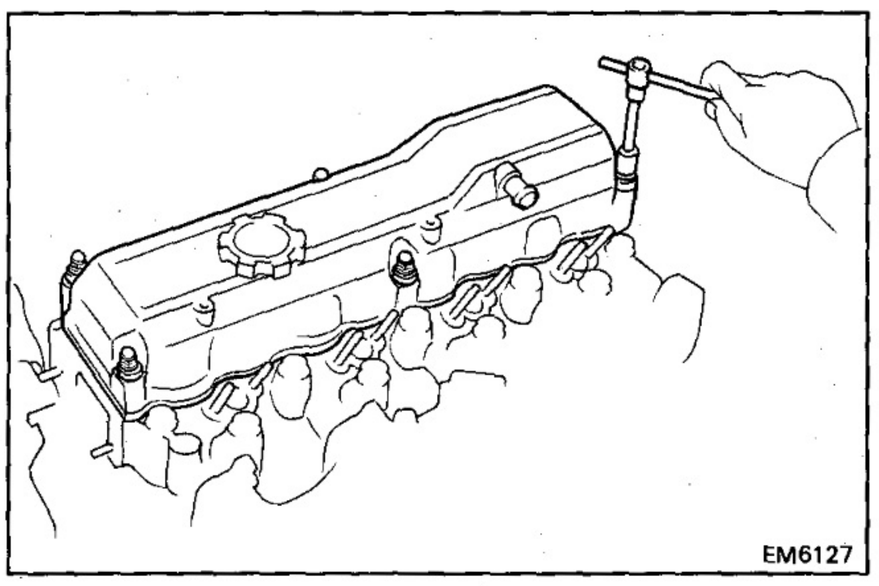
9. REMOVE EXHAUST MANIFOLD

(a) [B, 3B, 11B and 14B (Bolt tightening type)]
Remove the three bolts and heat insulator.

(b) [11B and 13B (Nut tightening type)]
Remove the three nuts, plate washers, heat insulator and six spacers.

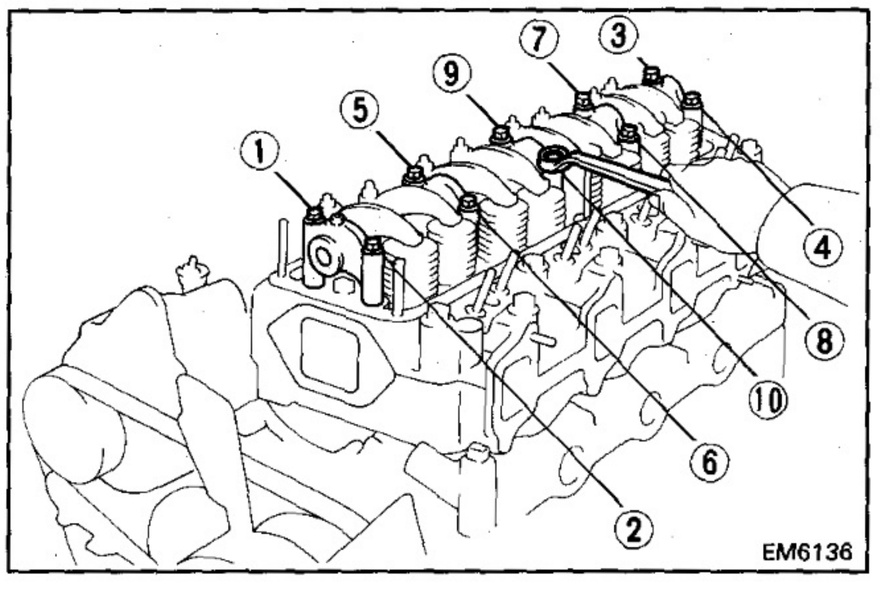


(c) Remove the eight bolts, two nuts, exhaust manifold, No. 2 heat insulator (BU) and gasket.



10. REMOVE CYLINDER HEAT COVER

Remove the six cap nuts, cushions, cylinder head cover and gasket.



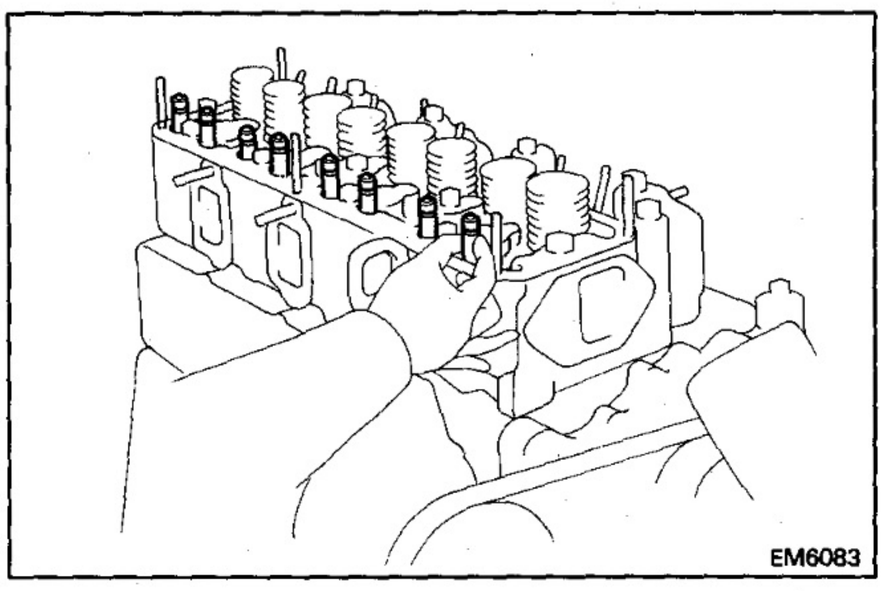
11. REMOVE VALVE ROCKER SHAFT ASSEMBLY

(a) Uniformly loosen and remove the ten bolts in several passes, in the sequence shown.

(b) Remove the rocker shaft assembly.

(c) Remove the valve stem caps.

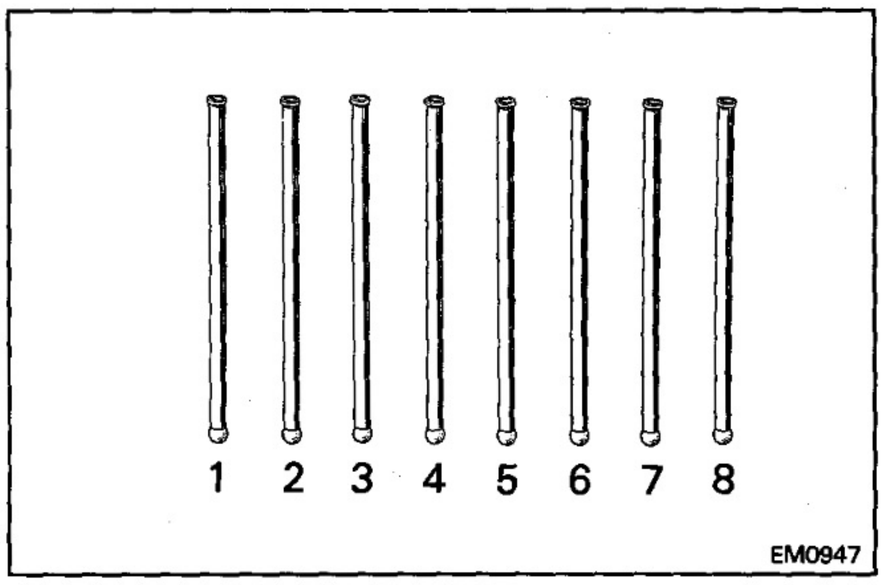
HINT: Arrange the stem caps in correct order.

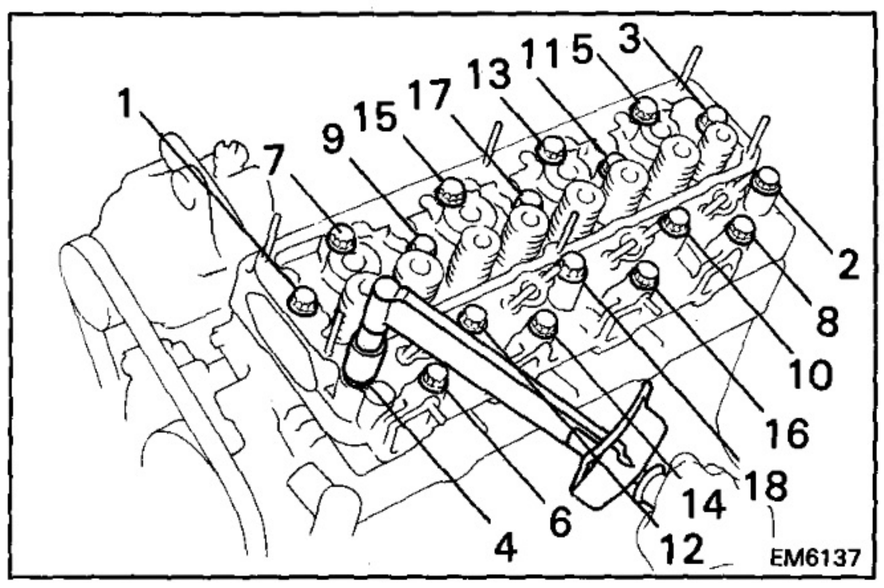


12. REMOVE PUSH RODS

Remove the eight push rods in order, beginning from the No. 1 push rod.

HINT: Arrange the push rods in correct order.

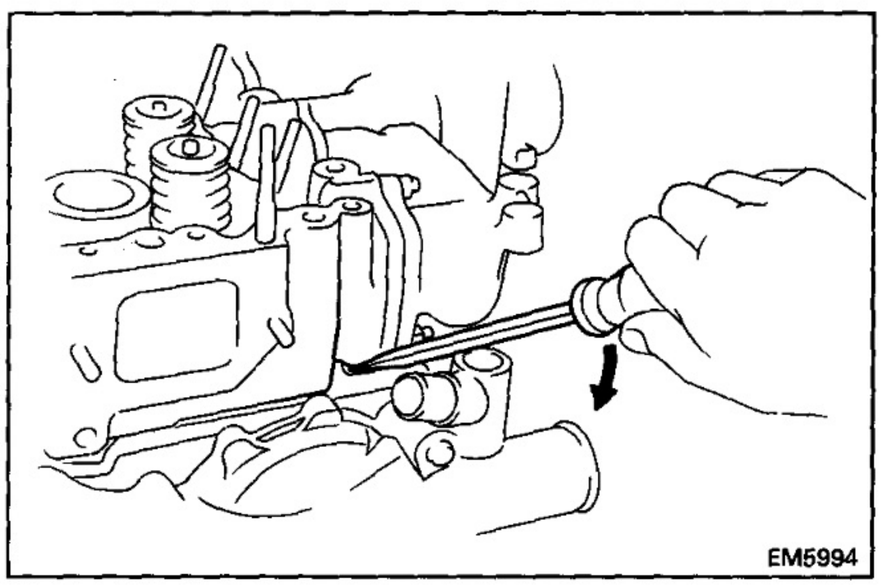




13. REMOVE CYLINDER HEAD

(a) Uniformly loosen and remove the eighteen head bolts in several passes, in the sequence shown.

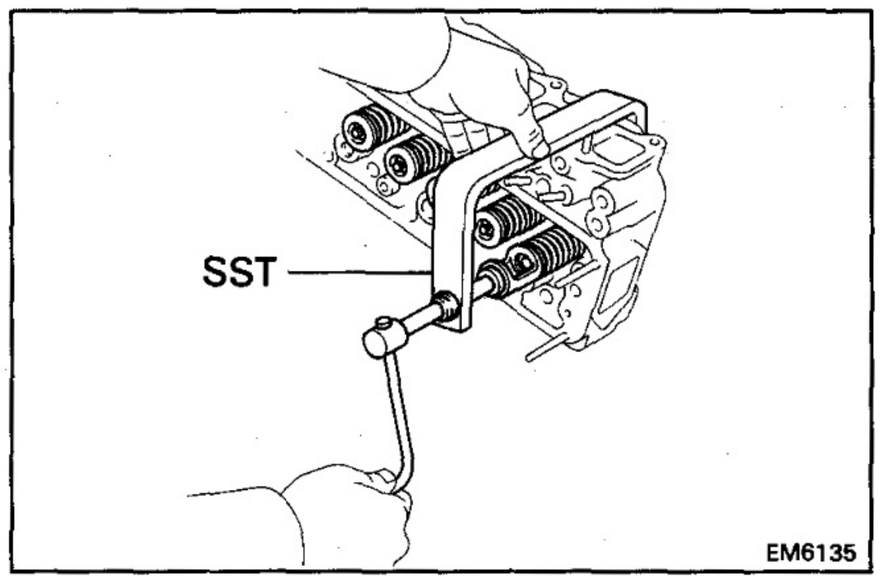
NOTICE: Head warpage or cracking could result from removing bolts in incorrect order.



(b) Lift the cylinder head from the dowels on the cylinder block and place the head on wooden blocks on a bench.

HINT: If the cylinder head is difficult to lift off, pry with a screwdriver between the cylinder head and block saliences.

NOTICE: Be careful not to damage the cylinder head and block surface on the cylinder and head gasket sides.



DISASSEMBLY OF CYLINDER HEAD

(See page EM-29) B and 3B
(See page EM-30) 11B and 14B

1. REMOVE VALVES

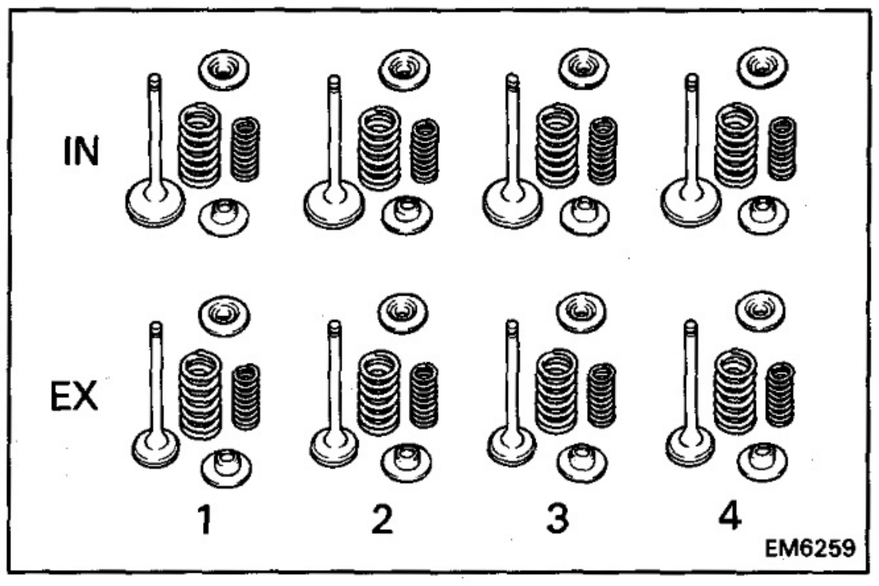
(a) Using SST, compress the valve spring and remove the two keepers.

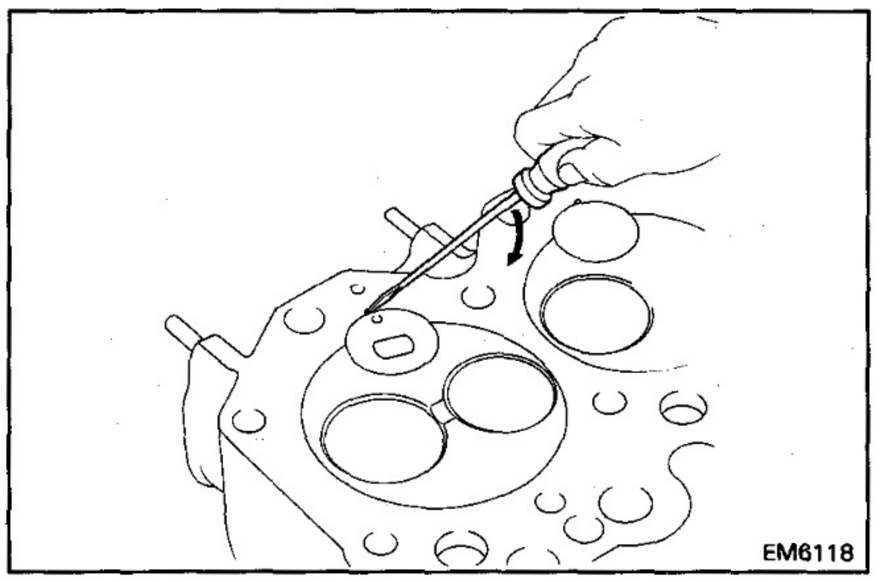
SST 09202-43013

(b) Remove the spring retainer, valve springs and valve.

(c) Remove the spring seat and oil seal.

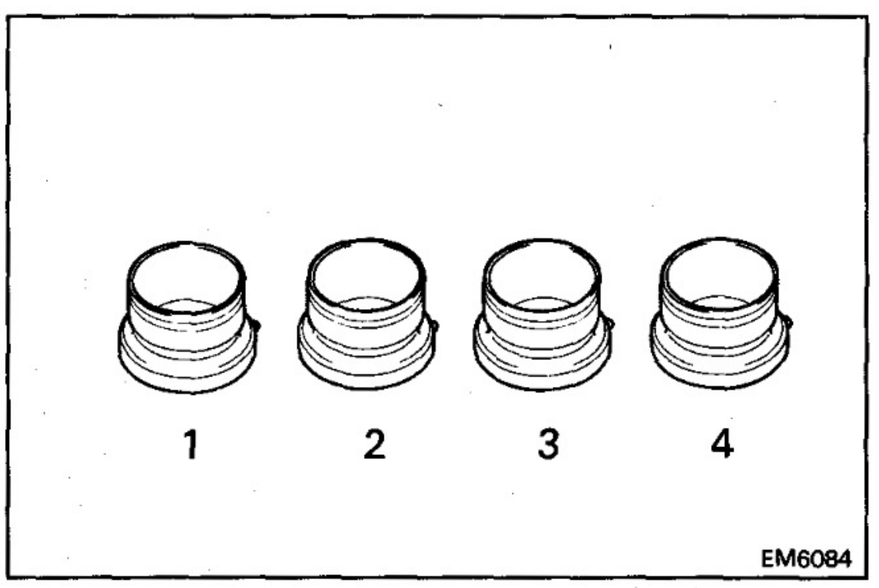
HINT: Arrange the valves, spring seats, springs and retainers in correct order.



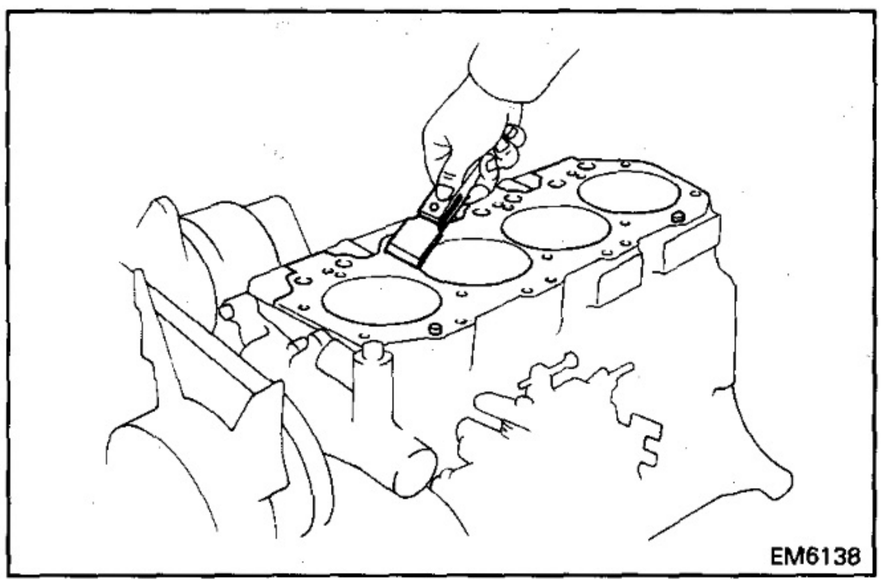


2. [B AND 3B] REMOVE COMBUSTION CHAMBERS

Using a screw driver, remove the four combustion chambers.



HINT: Arrange the combustion chambers in correct order.


EM6138

INSPECTION, CLEANING AND REPAIR OF CYLINDER HEAD COMPONENTS

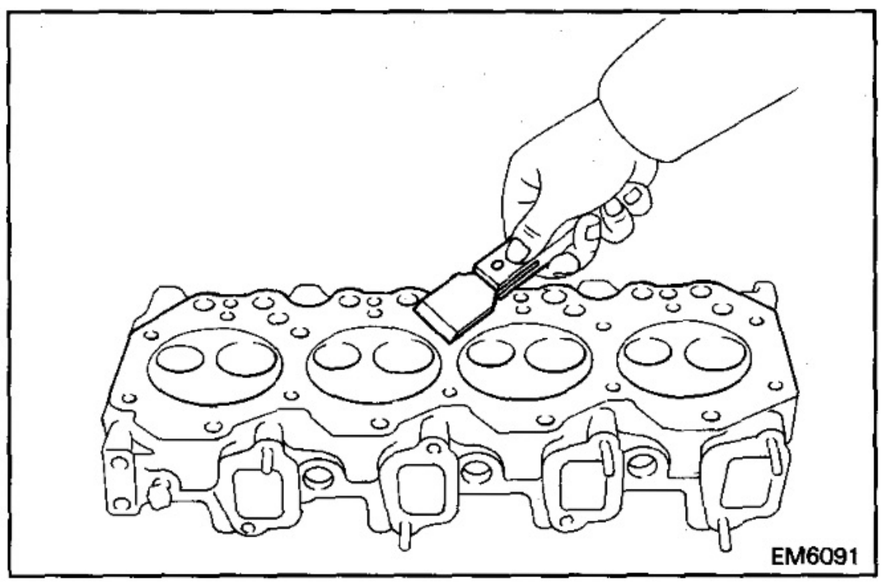
1. CLEAN TOP OF PISTONS AND TOP OF BLOCK

(a) Turn the crankshaft and bring each piston to top dead center. Using a gasket scraper, remove all the carbon from the piston top.

(b) Remove all the gasket material from the top of the block.

(c) Blow carbon and oil from the bolt holes.

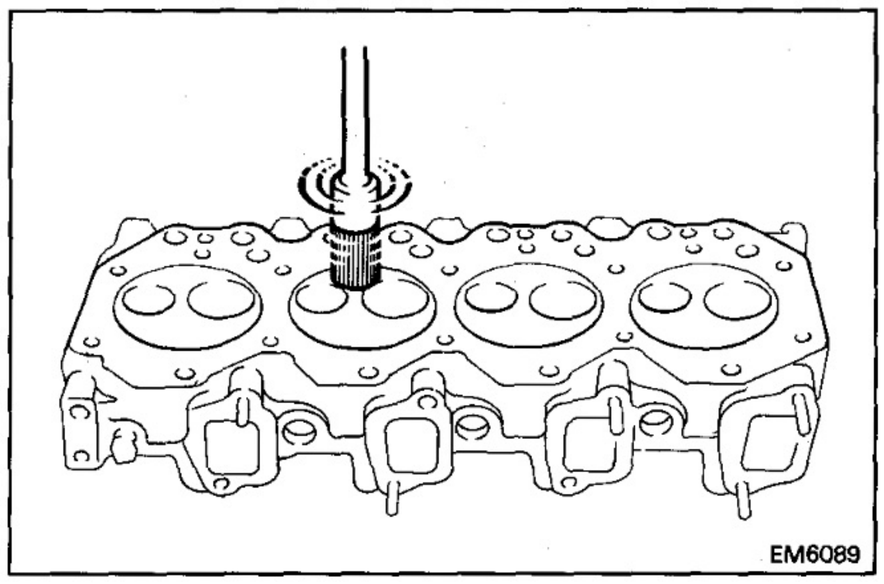
NOTICE: Protect your eyes when using high pressure air.


EM6091

2. REMOVE GASKET MATERIAL

Using a gasket scraper, remove all the gasket material from the manifold and head surface.

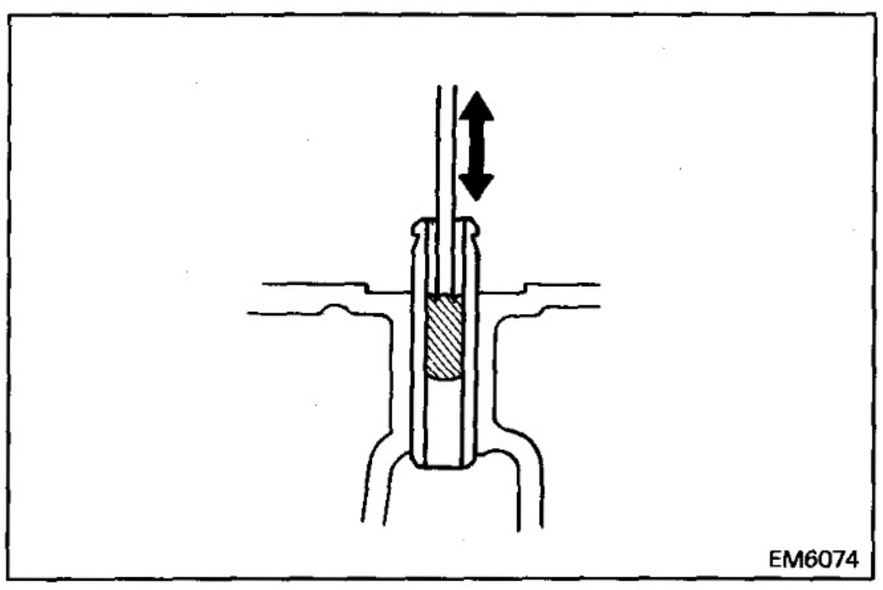
NOTICE: Be careful not to scratch the surfaces.


EM6089

3. CLEAN COMBUSTION CHAMBERS

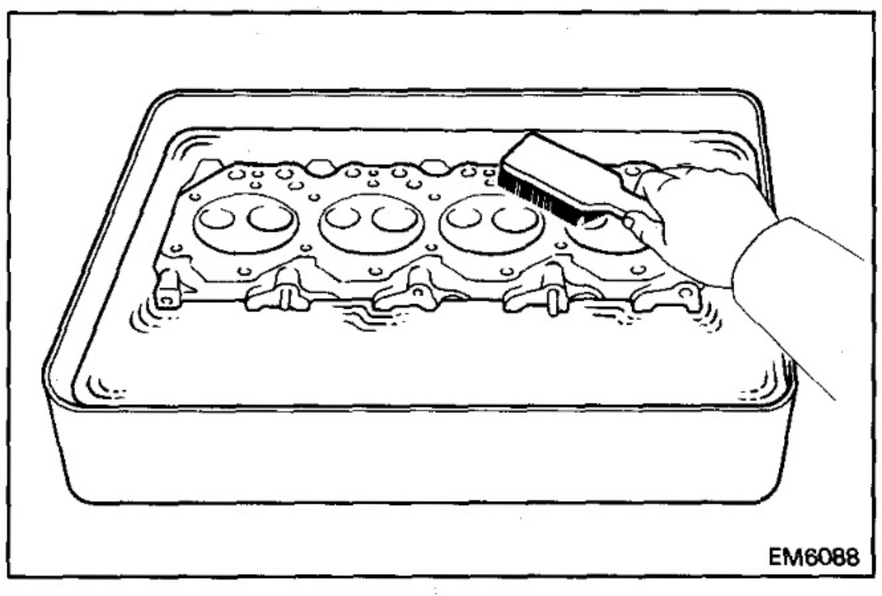
Using a wire brush, remove all the carbon from the combustion chambers.

NOTICE: Be careful not to scratch the head gasket contact surface.


EM6074

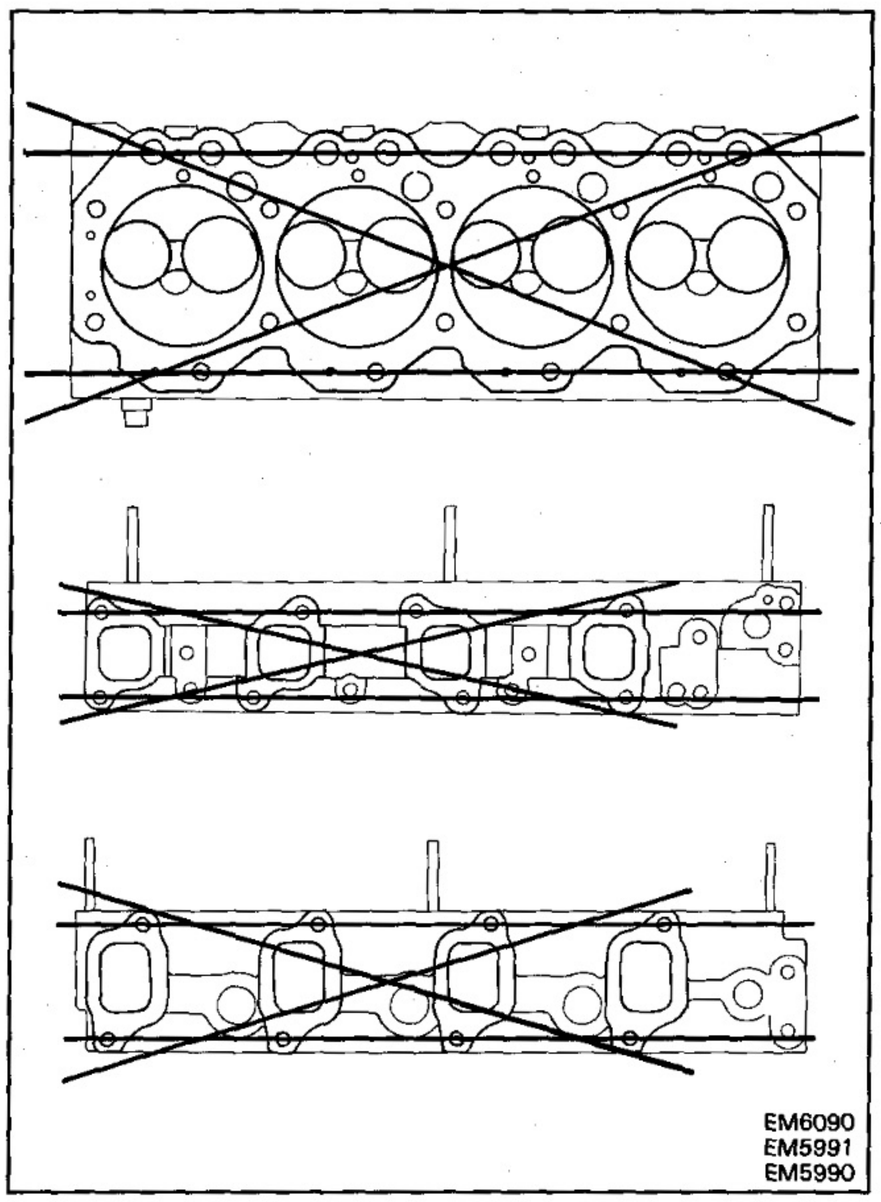
4. CLEAN VALVE GUIDE BUSHINGS

Using a valve guide busing brush and solvent, clean all the guide bushings.


EM6088

5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, thoroughly clean the head.



EM6090
EM5991
EM5990

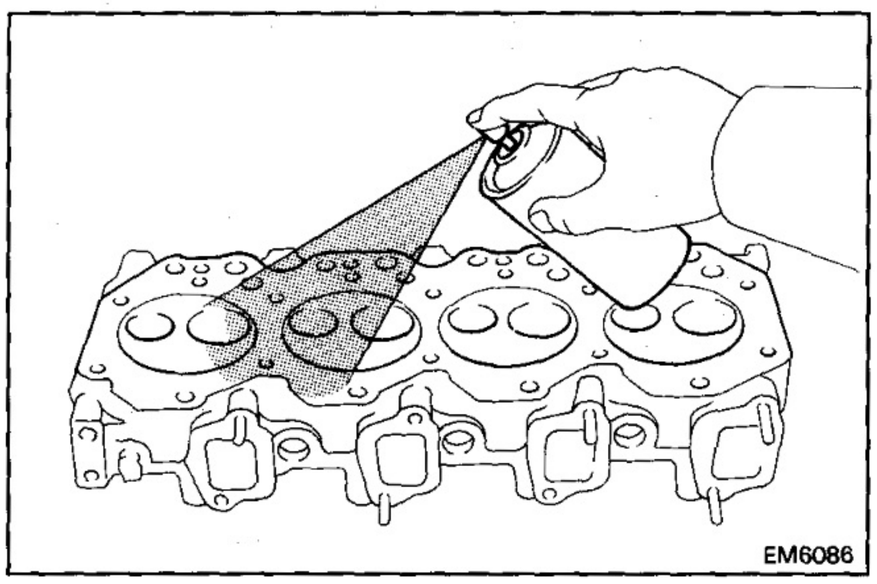
6. INSPECT CYLINDER HEAD FOR FLATNESS

Using a precision straight edge and thickness gauge, measure the surfaces contacting the cylinder block and manifolds for warpage.

Maximum warpage:

Cylinder block side	**0.20 mm (0.0079 in.)**
Manifold side	**0.20 mm (0.0079 in.)**

If warpage is greater than maximum, replace the head.

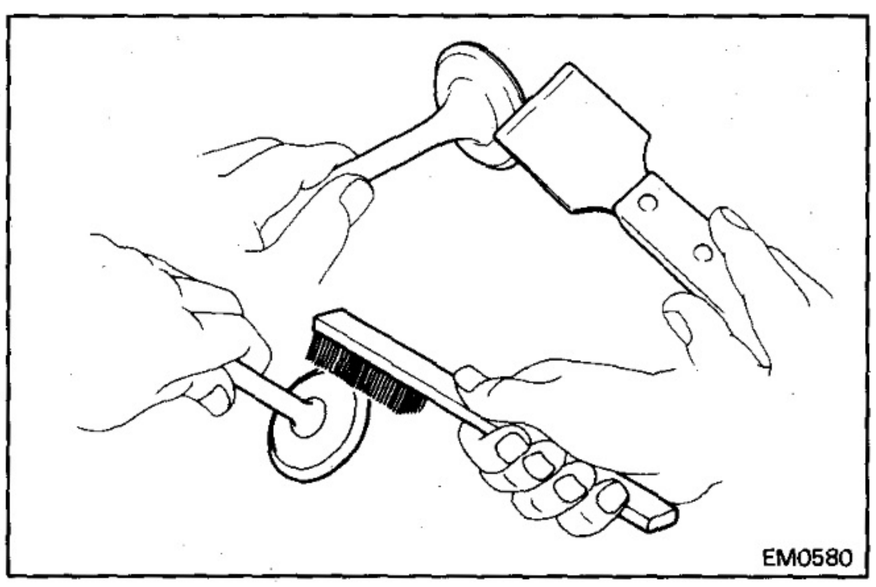


EM6086

7. INSPECT CYLINDER HEAD FOR CRACKS

Using a dye penetrant, check the combustion chamber, intake and exhaust ports, head surface and the top of the head for cracks.

If cracked, replace the head.

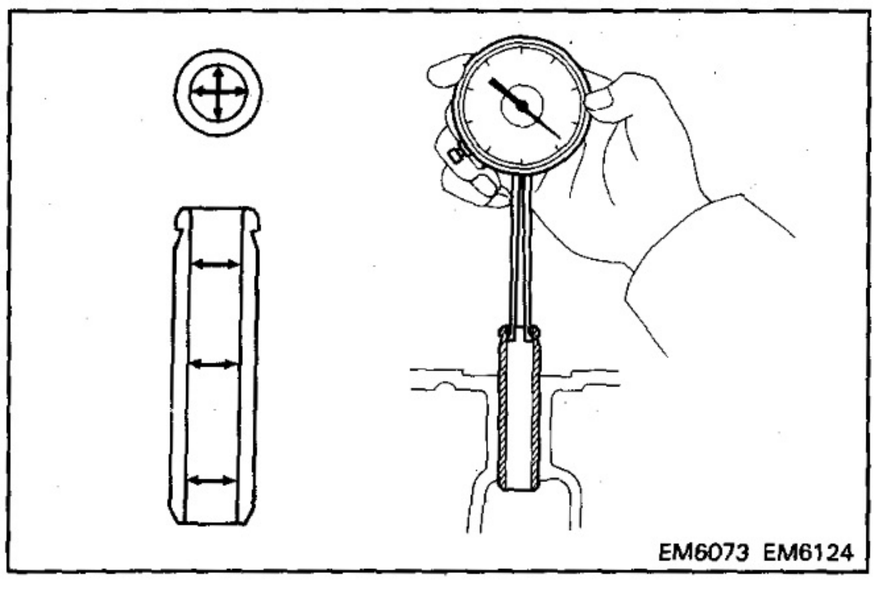


EM0580

8. CLEAN VALVES

(a) Using a gasket scraper, chip any carbon from the valve head.

(b) Using a wire brush, thoroughly clean the valve.



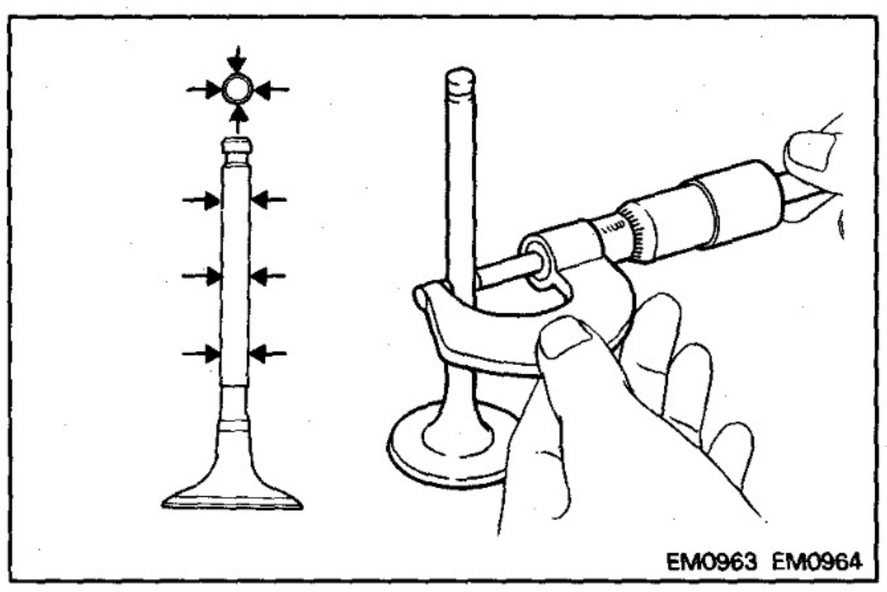
EM6073 EM6124

9. INSPECT VALVE STEM AND VALVE GUIDE BUSHING

(a) Using a caliper gauge or telescoping gauge, measure the inside diameter of the valve guide bushing.

Bushing inside diameter:

9.010 — 9.030 mm (0.3547 — 0.3555 in.)


EM0963 EM0964

(b) Using a micrometer, measure the diameter of the valve stem.

Stem diameter:

Intake	**8.968 — 8.984 mm (0.3531 — 0.3537 in.)**
Exhaust	**8.954 — 8.970 mm (0.3525 — 0.3531 in.)**

(c) Subtract the valve stem diameter measurement from the valve guide bushing inside diameter measurement.

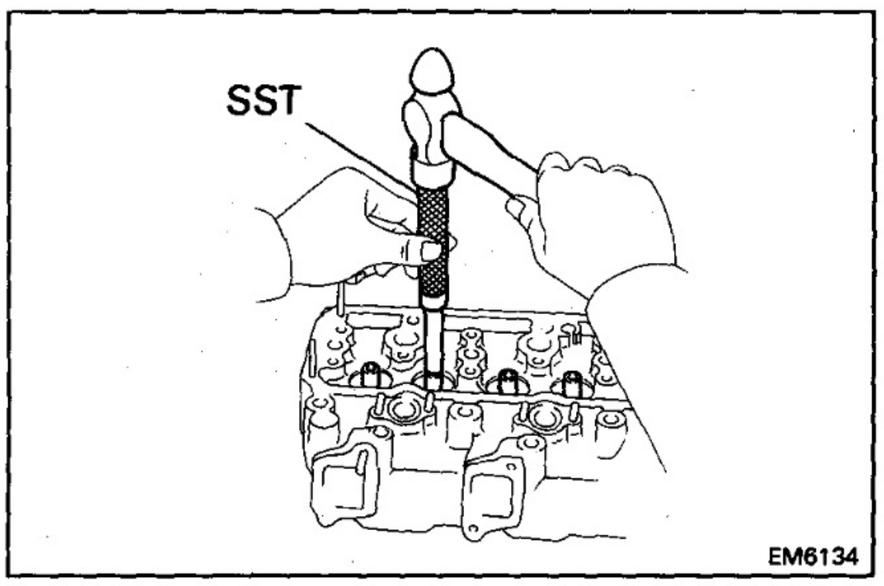
Standard oil clearance:

Intake	**0.026 — 0.062 mm (0.0010 — 0.0024 in.)**
Exhaust	**0.040 — 0.076 mm (0.0016 — 0.0030 in.)**

Maximum oil clearance:

Intake	**0.10 mm (0.039 in.)**
Exhaust	**0.12 mm (0.0047 in.)**

If the clearance is greater than maximum, replace the valve and guide bushing.

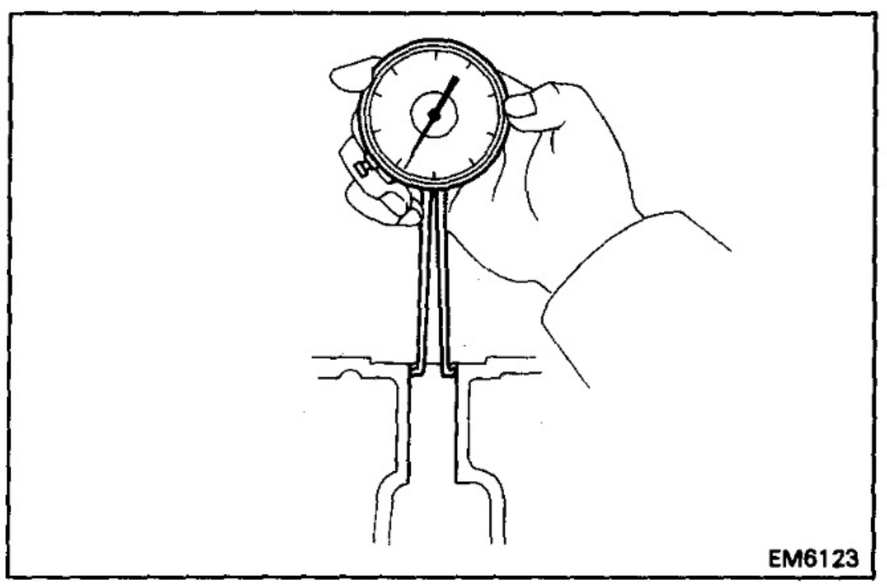


EM6134

10. IF NECESSARY, REPLACE VALVE GUIDE BUSHING

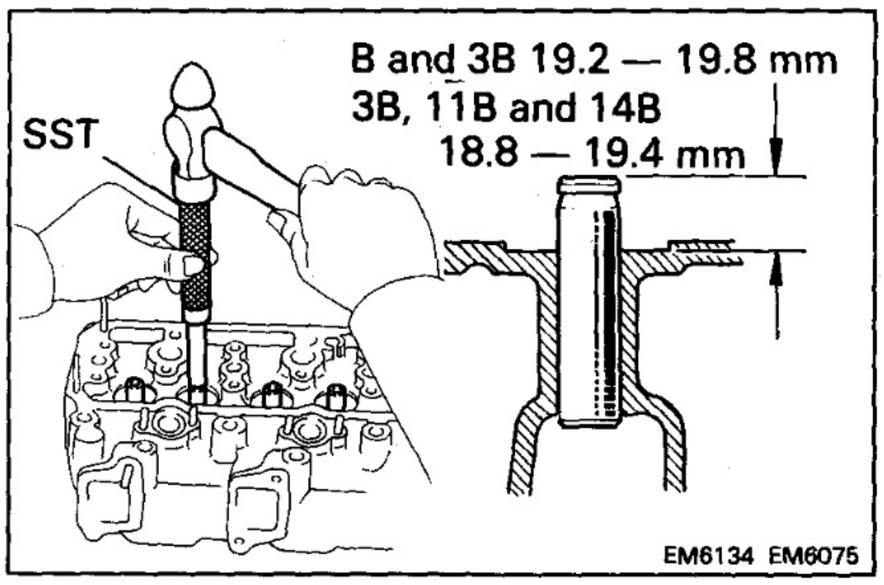
(a) Using SST and a hammer, tap out the valve guide bushing.

SST 09201-60011


EM6123

(b) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

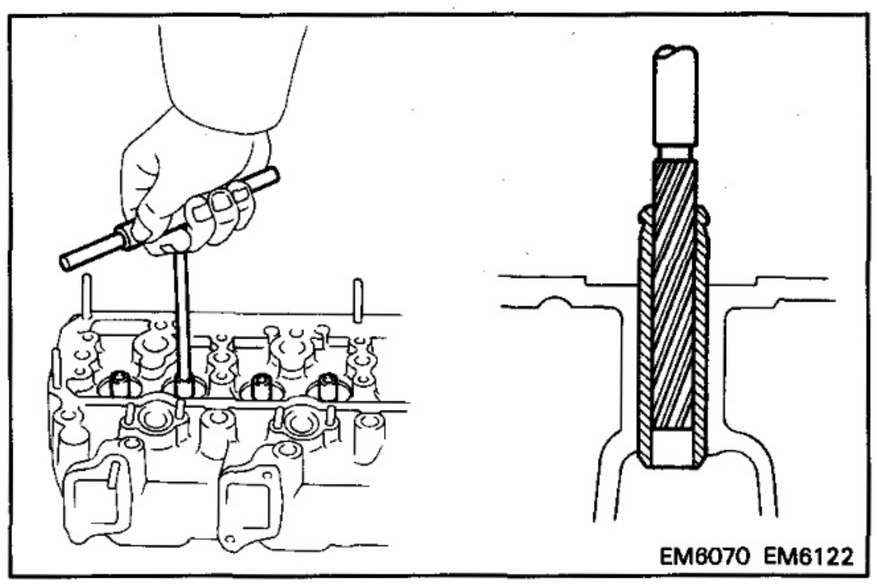
If the bushing bore diameter of cylinder head is more than 14.018 mm (0.5519 in.), replace the cylinder head.



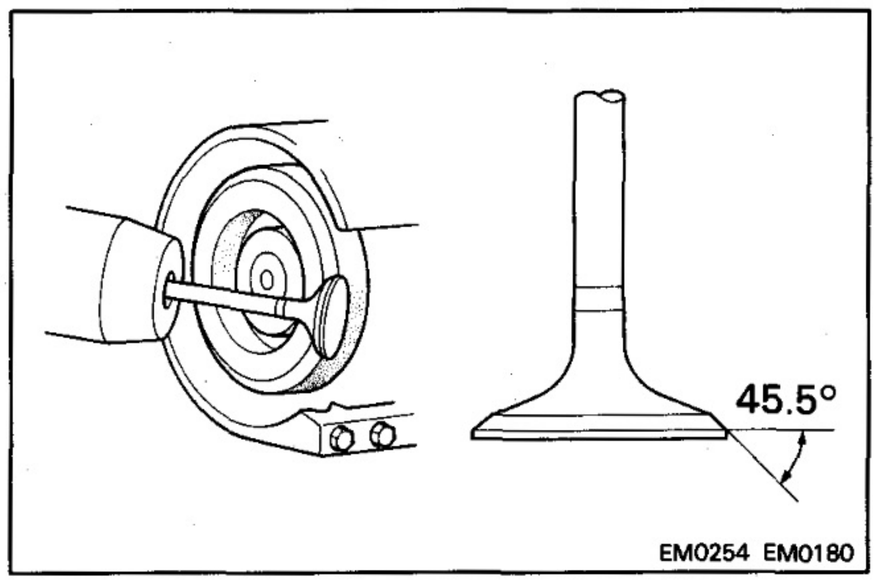
EM6134 EM6075

(c) Using SST and a hammer, drive in a new valve guide bushing to where there is 19.2 — 19.8 mm (0.756 — 0.780 in.) or 18.8 — 19.4 mm (0.740 — 0.764 in.) protruding from the cylinder head.

SST 09201-60011



(d) Using a sharp 9.0 mm reamer, ream the valve guide bushing to obtain the standard specified clearance (See page EM-38) between the valve guide bushing and new valve stem.

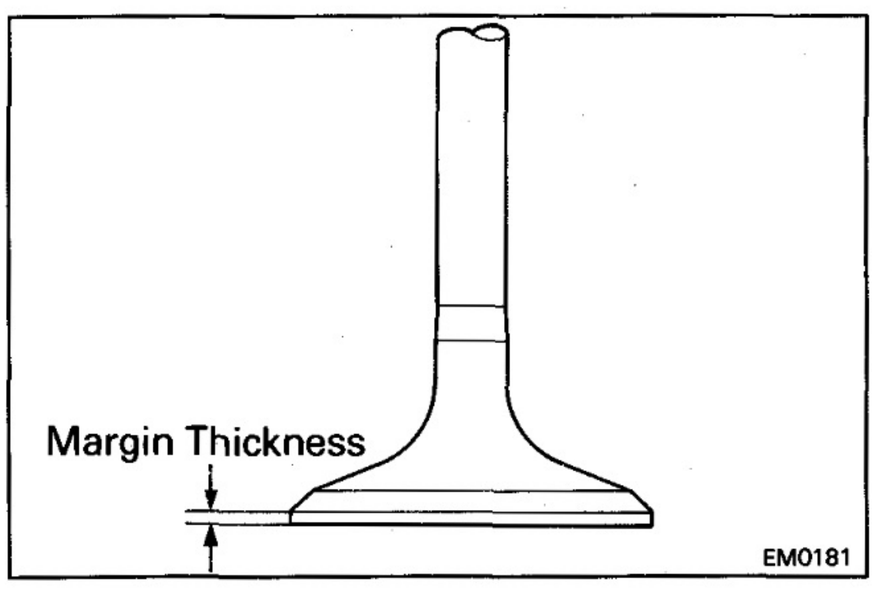


11. INSPECT AND GRIND VALVES

(a) Grind the valve only enough to remove pits and carbon.

(b) Check that the valve is ground to the correct valve face angle.

Valve face angle: 45.5°



(c) Check the valve head margin thickness.

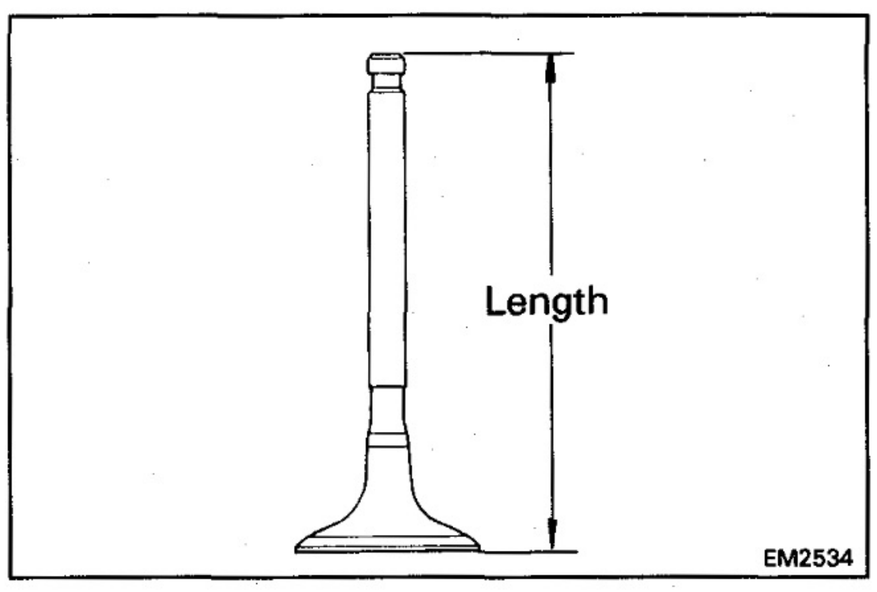
Standard margin thickness:

Intake	B and 3B	1.4 mm (0.055 in.)
	3B and 14B	1.1 mm (0.043 in.)
Exhaust	B and 3B	1.8 mm (0.071 in.)
	11B	1.4 mm (0.055 in.)
	14B	1.7 mm (0.067 in.)

Maximum margin thickness:

Intake		0.9 mm (0.035 in.)
Exhaust	B and 3B	1.3 mm (0.051 in.)
	11B	0.9 mm (0.035 in.)
	14B	1.2 mm (0.047 in.)

If the valve head margin thickness is less than minimum, replace the valve.



(d) Check the valve overall length.

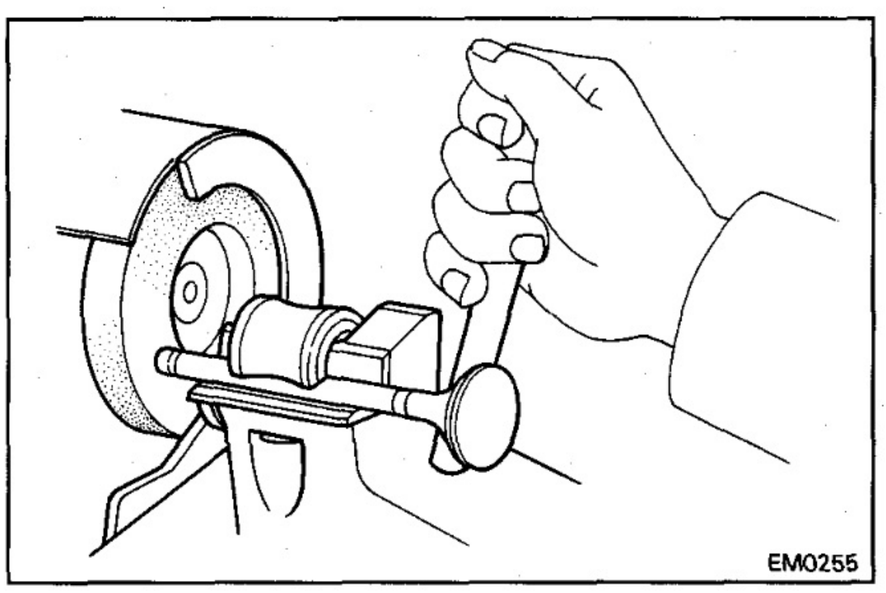
Standard overall length:

Intake	B	126.60 mm (4.9842 in.)
	3B, 11B, 14B	126.65 mm (4.9862 in.)
Exhaust	B	126.50 mm (4.9803 in.)
	3B	126.55 mm (4.9823 in.)
	11B, 14B	126.42 mm (4.9772 in.)

Minimum overall length:

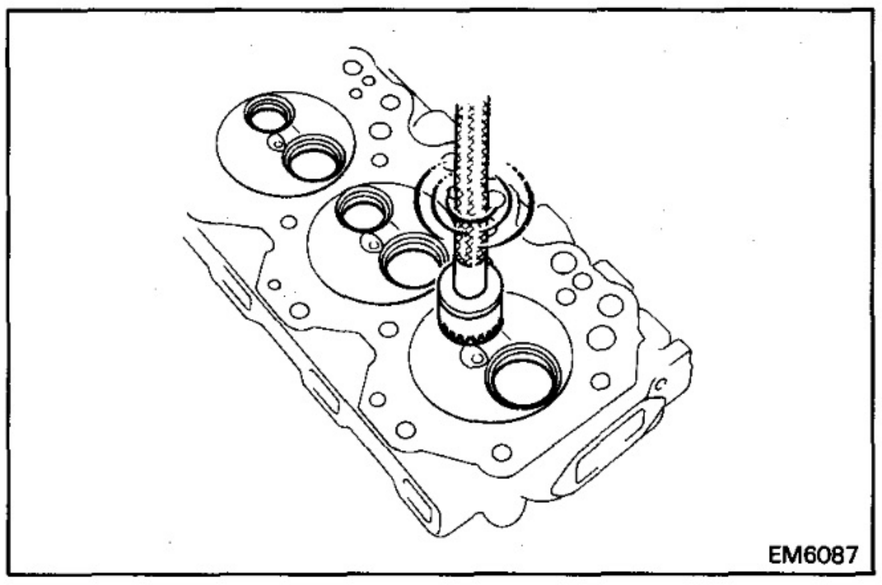
Intake	B	126.10 mm (4.9646 in.)
	3B, 11B, 14B	126.15 mm (4.9665 in.)
Exhaust	B	126.00 mm (4.9606 in.)
	3B	126.05 mm (4.9626 in.)
	11B, 14B	125.92 mm (4.9575 in.)

If the valve overall length is less than minimum, replace the valve.



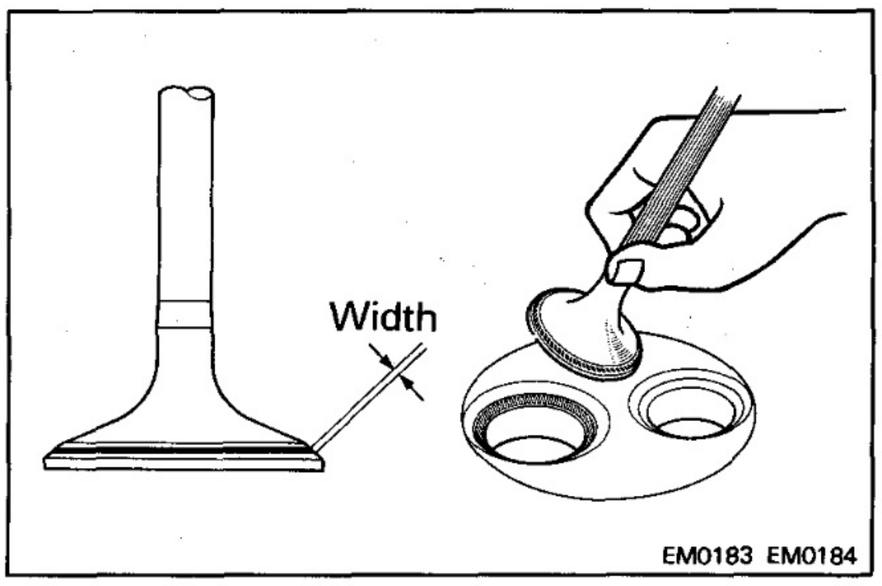
(e) If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

NOTICE: Do not grind off more than the minimum amount.



12. INSPECT AND CLEAN VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.



(b) Check the valve seating position.

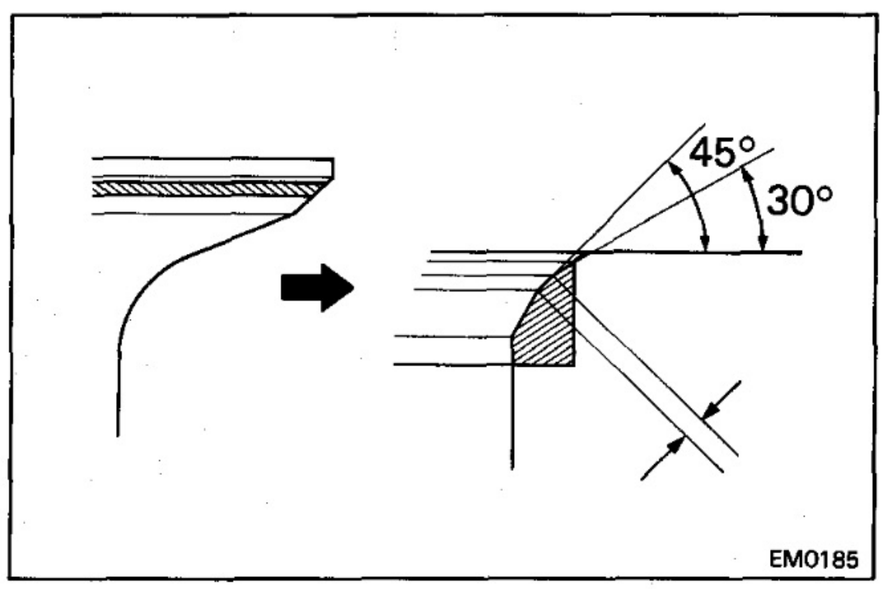
Apply a thin coat of prussian blue (or white lead) to the valve face. Install the valve. Lightly press the valve against the seat. Do not rotate the valve.

(c) Check the valve face and seat for the following:

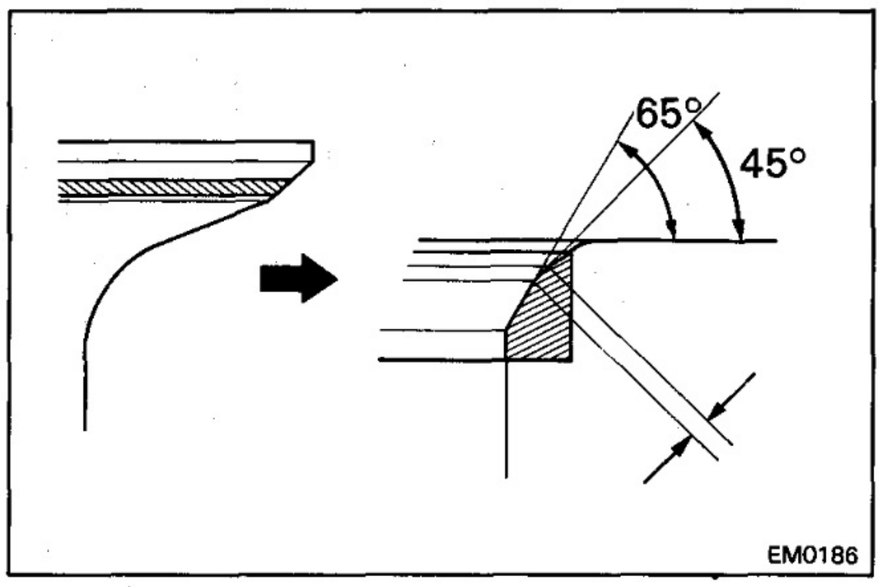
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and seat are concentric. If not, resurface the seat.
- Check that the seat contact is on the middle of the valve face with the following width:

1.9 — 2.3 mm (0.075 — 0.091 in.)

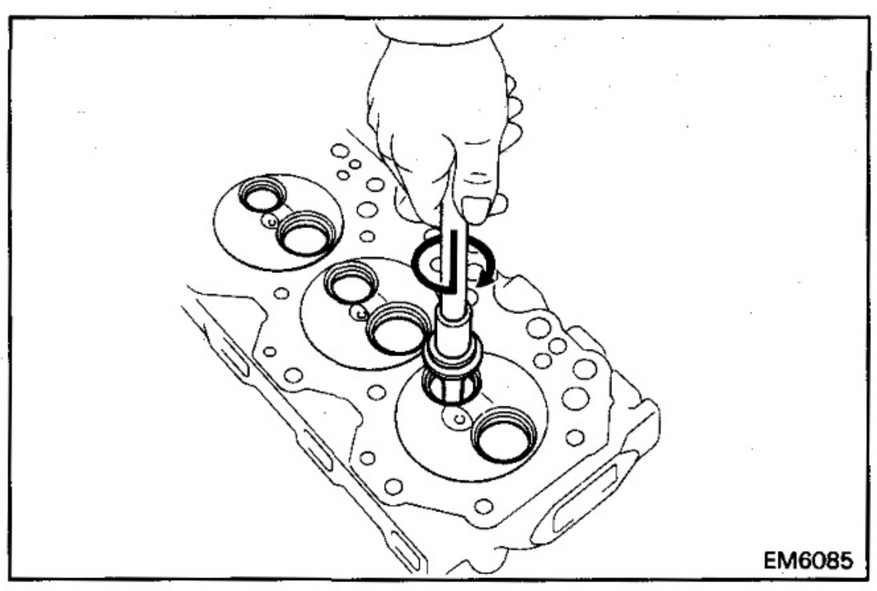
If not, correct the valve seat as follows:



(1) If the seating is too high on the valve face, use 30° and 45° cutters to correct the seat.

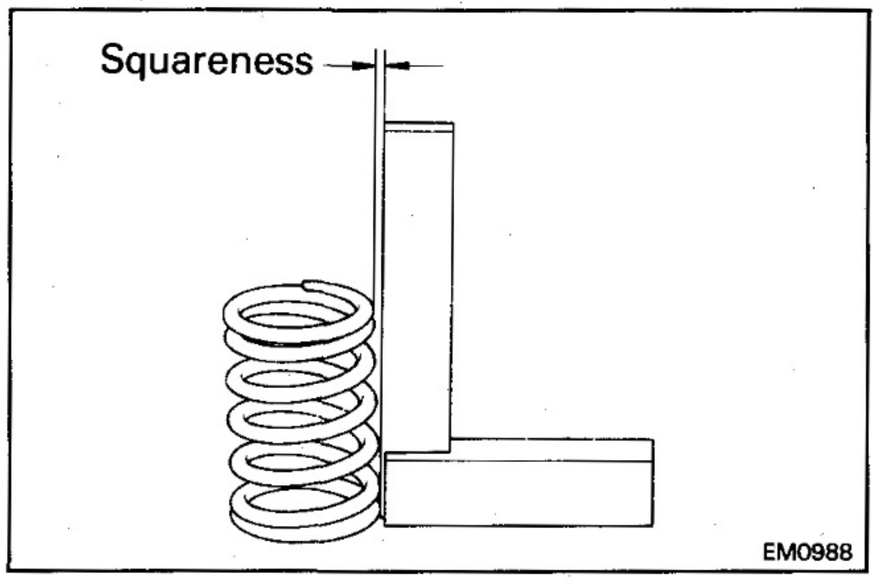


(2) If seating is too low on the valve face, use 65° and 45° cutters to correct the seat.



(d) Hand-lap the valve and valve seat with an abrasive compound.

(e) After hand-lapping, clean the valve and valve seat.

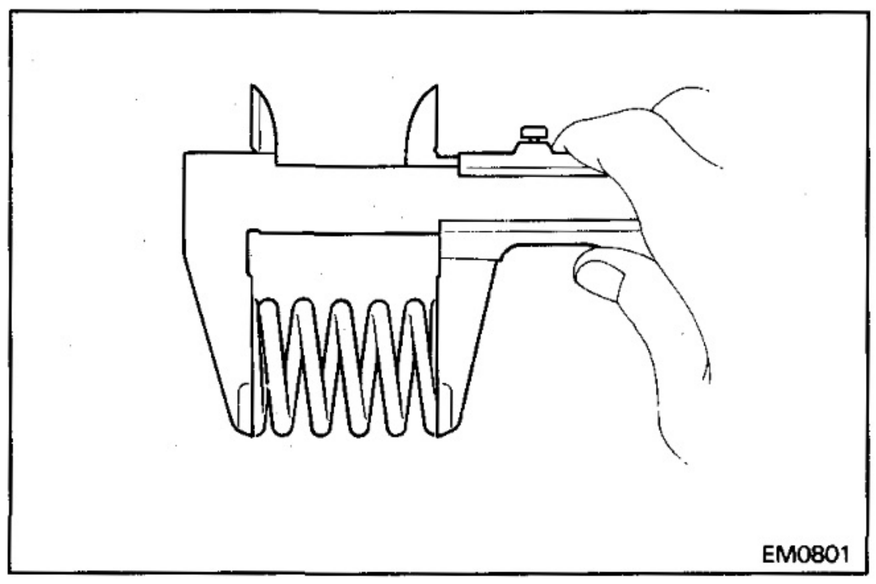


13. INSPECT VALVE SPRINGS

(a) Using a steel square, check the squareness of the valve spring.

Maximum squareness: 2.0 mm (0.079 in.)

If squareness is greater than maximum, replace the valve spring.

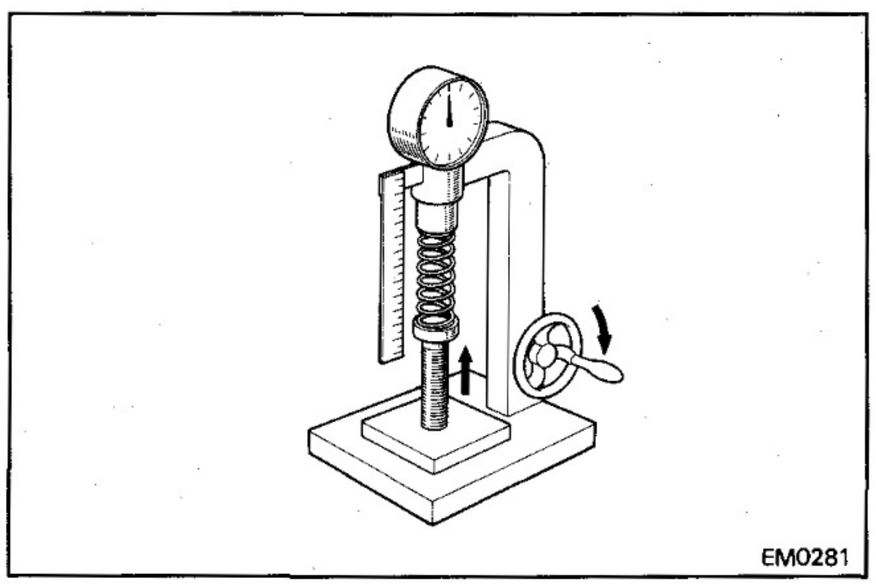


(b) Using calipers, measure the free length of the valve spring.

Free length:

Inner spring 45.28 mm (1.7827 in.)
Outer spring 50.73 mm (1.9973 in.)

If the free length is not as specified, replace the valve spring.

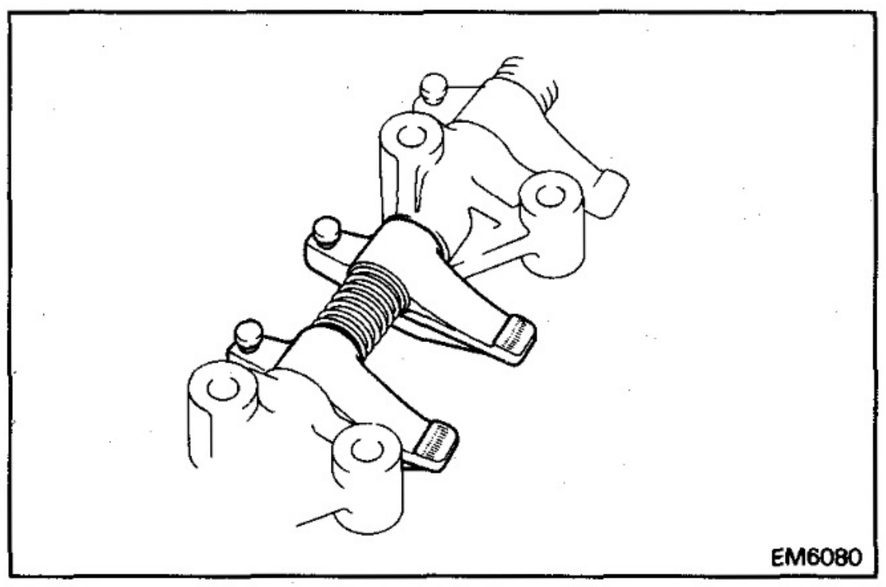


(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

Installed tension:

Inner spring
13.8 kg (30.4 lb, 135 N) at 38.19 mm (1.5035 in.)
Outer spring
28.3 kg (62.4 lb, 278 N) at 41.69 mm (1.6413 in.)

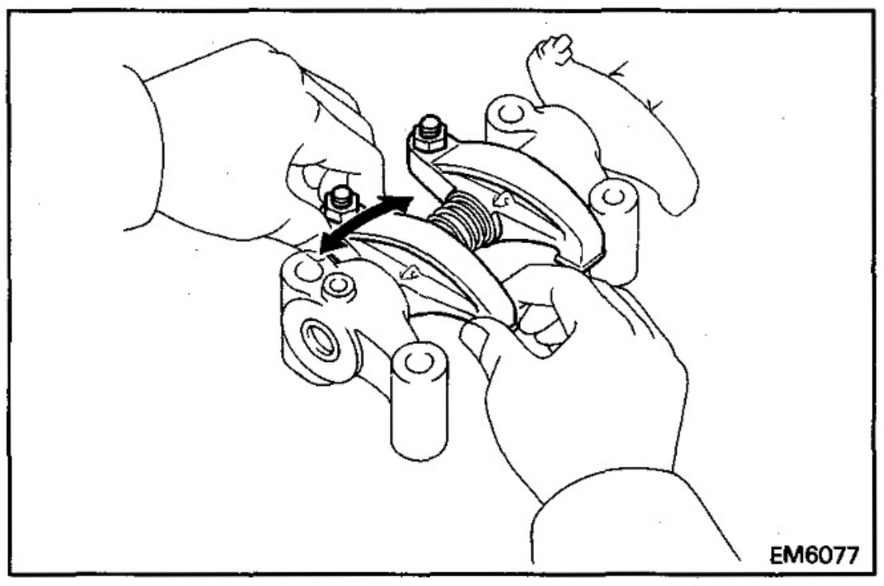
If the install tension is not as specified, replace the valve spring.


EM6080

14. INSPECT VALVE ROCKER SHAFT ASSEMBLY

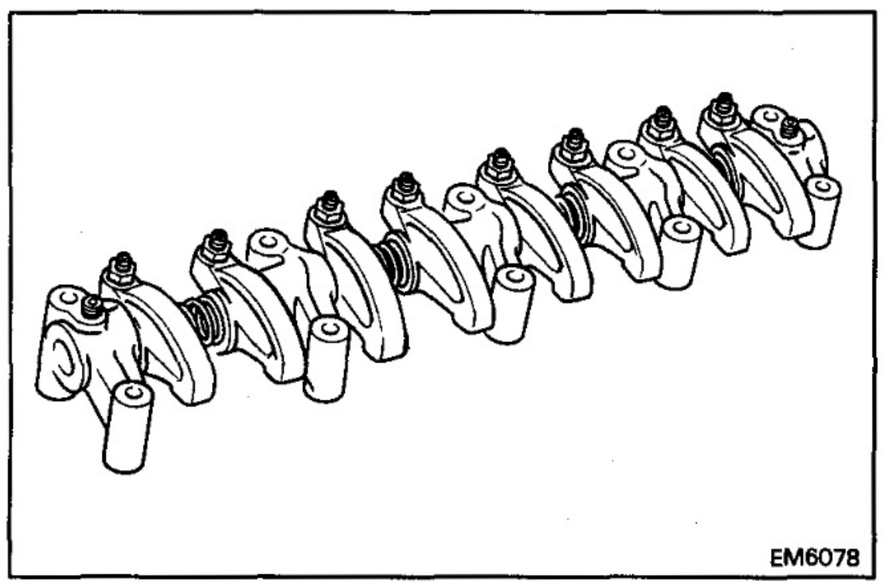
(a) Check the stem cap contacting surface of the rocker arm for wear.

If the stem cap contact surface is worn, disassemble and replace the rocker arm.


EM6077

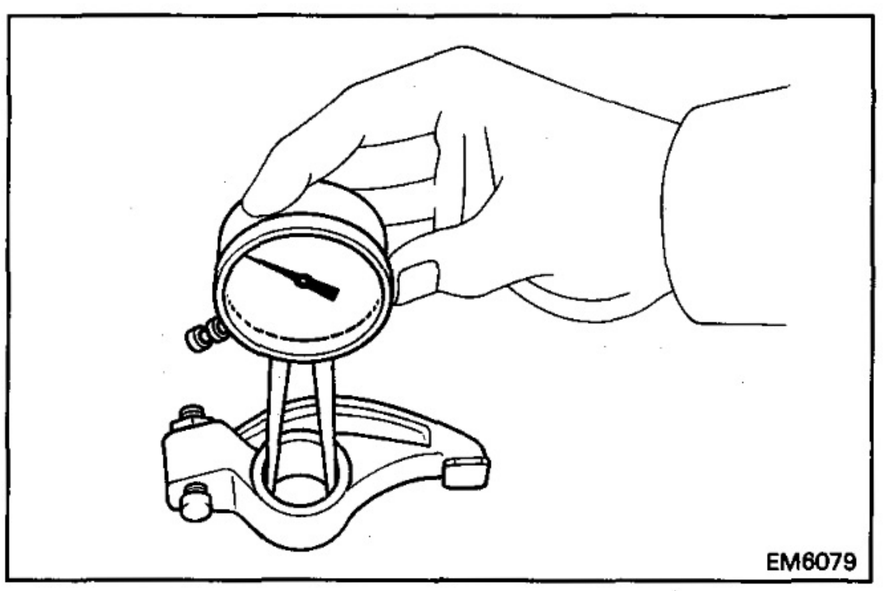
(b) Check the clearance between the rocker arms and shaft by moving the rocker arms as shown. Little or no movement should be felt.

If movement is felt, disassemble and check the oil clearance.


EM6078

(c) Disassemble the rocker shaft assembly.

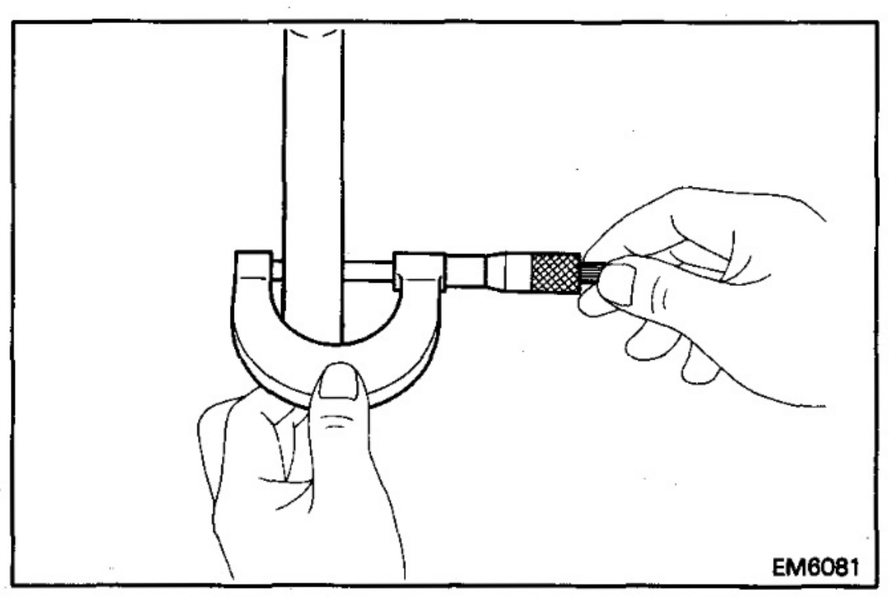
HINT: Arrange the rocker arms, spring and rocker supports in correct order.


EM6079

(d) Check the oil clearance between the rocker arm and shaft.

- Using a caliper gauge, measure the inside diameter of the rocker arm.

Rocker arm inside diameter:
18.512 — 18.533 mm (0.7288 — 0.7296 in.)


EM6081

- Using a micrometer, measure the diameter of the rocker shaft.

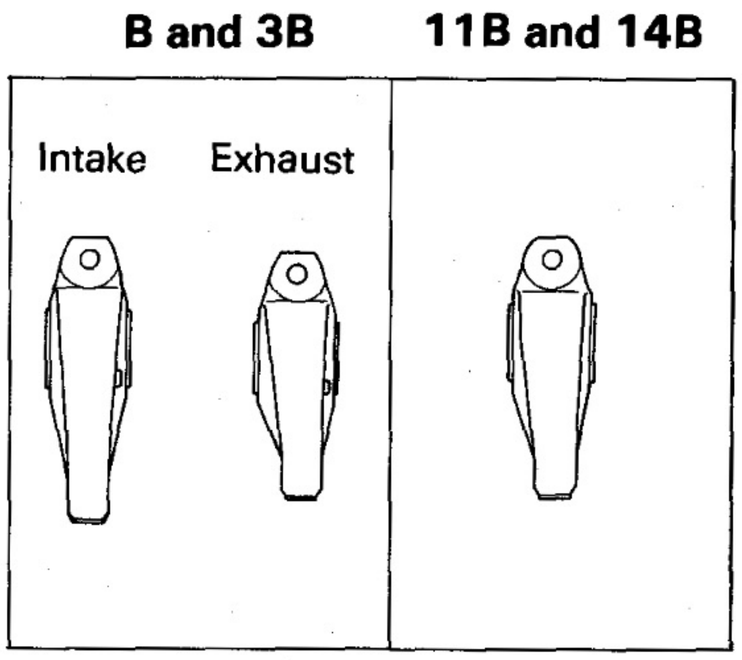
Rocker shaft diameter:
18.472 — 18.493 mm (0.7272 — 0.7281 in.)

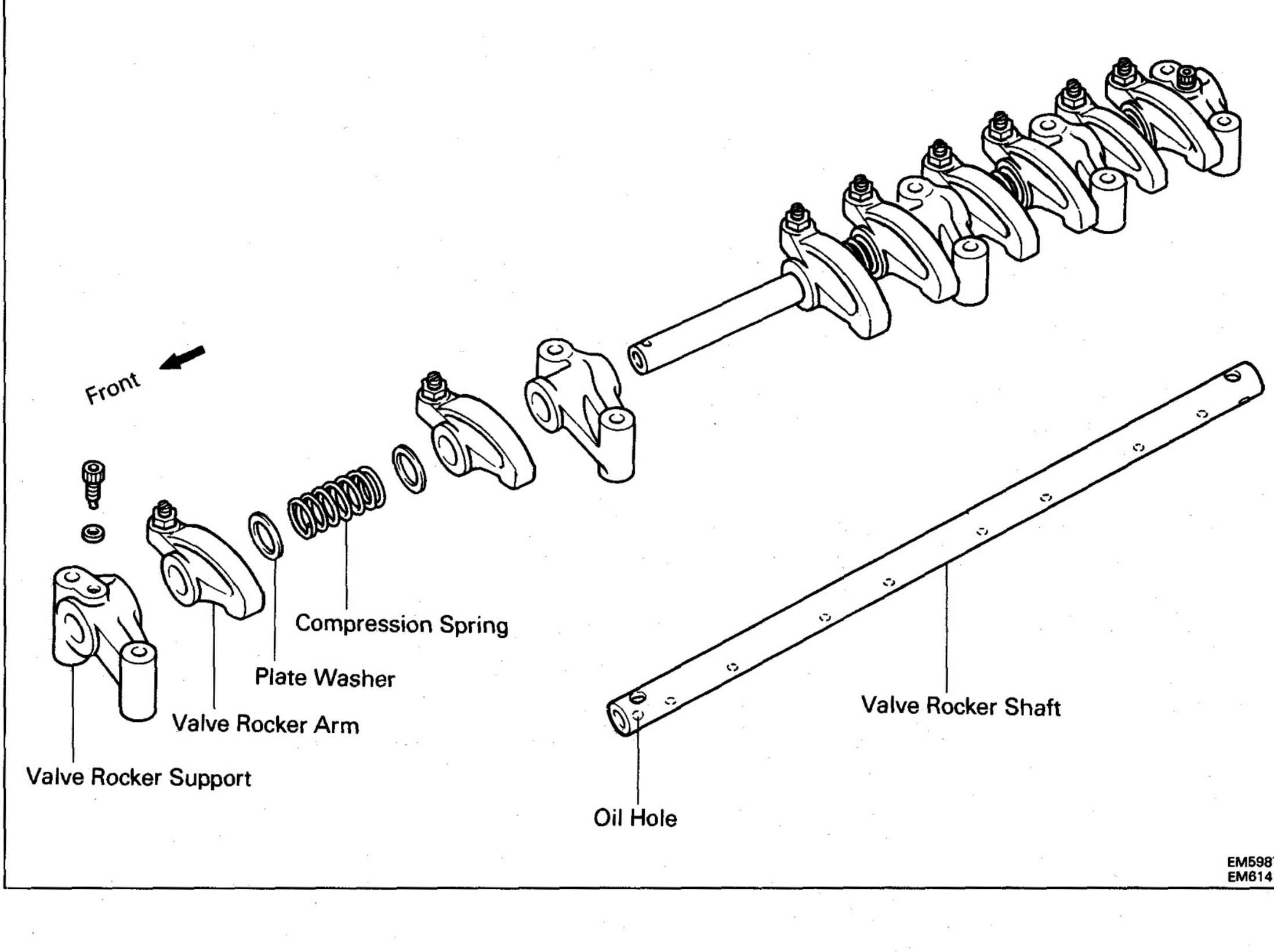
- Subtract the rocker shaft diameter measurement from the inside diameter measurement of the rocker arm.

Standard oil clearance: **0.019 — 0.061 mm (0.0007 — 0.0024 in.)**
Maximum oil clearance: **0.10 mm (0.0039 in.)**

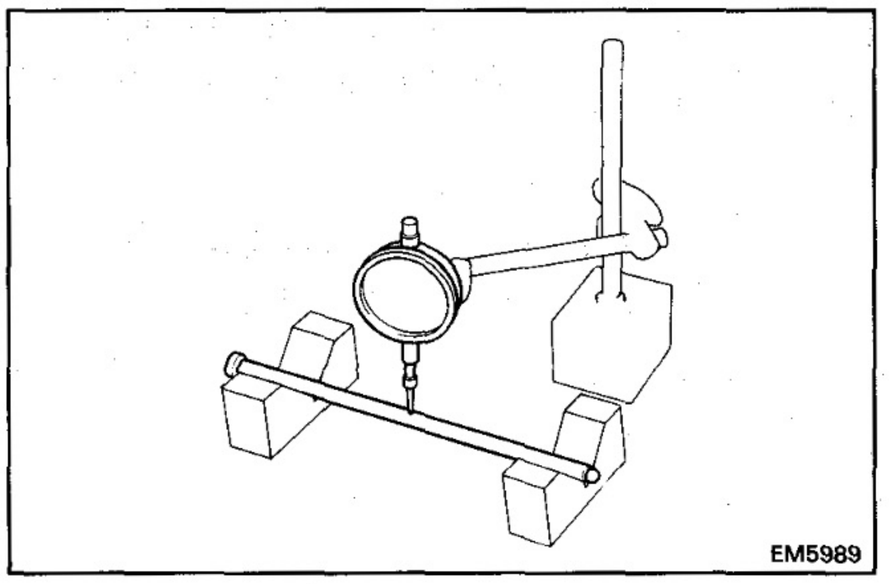
If the clearance is greater than maximum, replace the rocker arm and shaft.

(e) Assemble the valve rocker shaft assembly as shown.





EM5987
EM6141



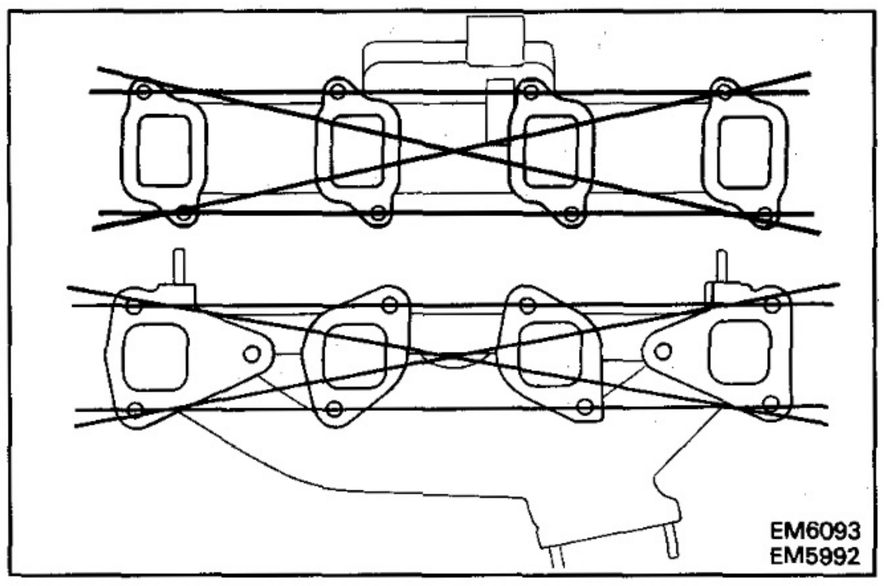
15. INSPECT PUSH RODS

(a) Place the push rod on V-blocks.

(b) Using a dial indicator, measure the circle runout at the center of the push rod.

Maximum circle runout: 0.50 mm (0.0197 in.)

If the circle runout is greater than maximum, replace the push rod.



16. INSPECT INTAKE AND EXHAUST MANIFOLDS

Using a precision straight edge and thickness gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

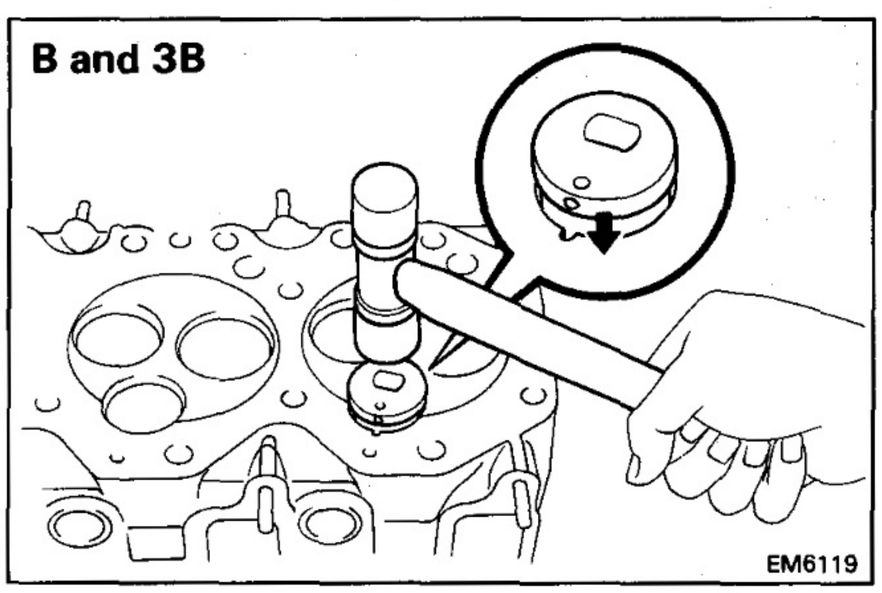
If warpage is greater than maximum, replace the manifold.

ASSEMBLY OF CYLINDER HEAD

(See page EM-29) B and 3B
(See page EM-30) 11B and 14B

HINT:

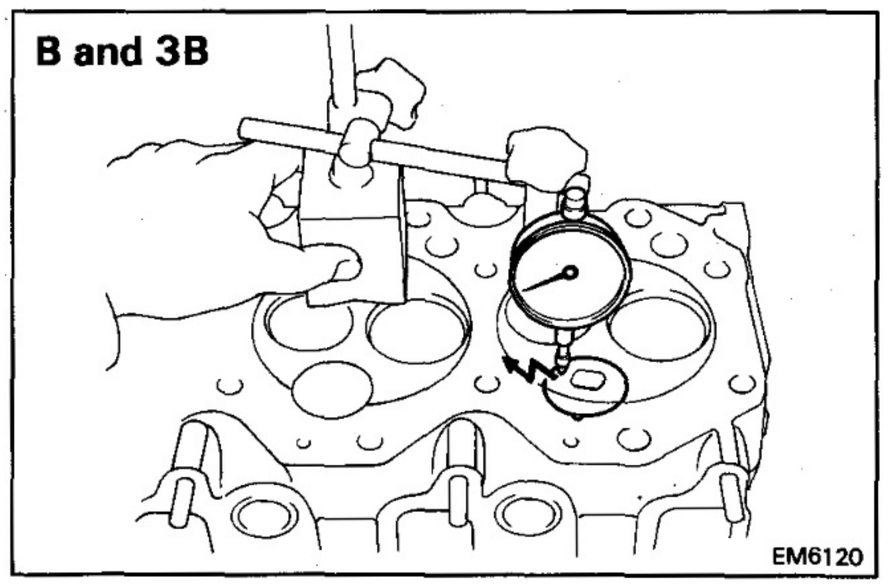
- Throughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seal with new ones.



1. [B AND 3B] INSTALL COMBUSTION CHAMBERS

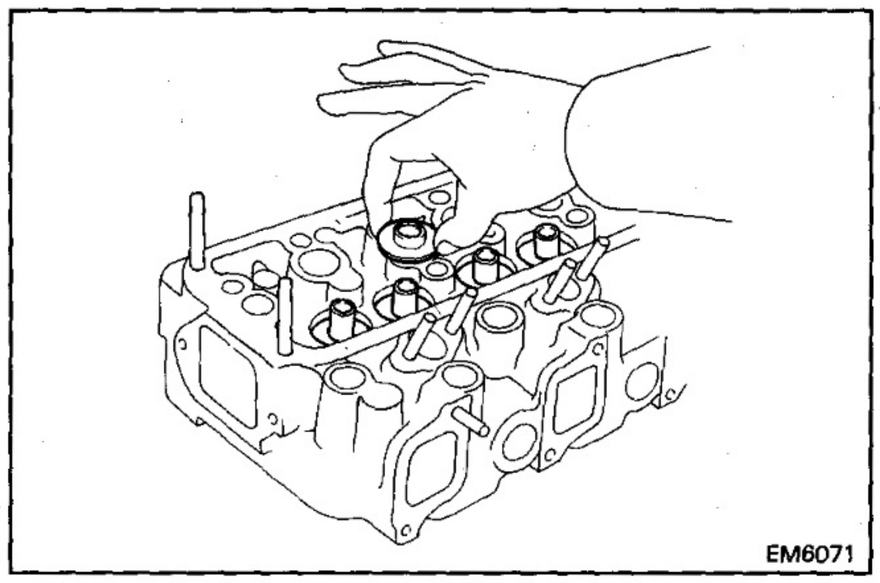
(a) Align the combustion chamber knock pin with the cylinder head notch.

(b) Using a plastic-faces hammer, tap in the combustion chamber.



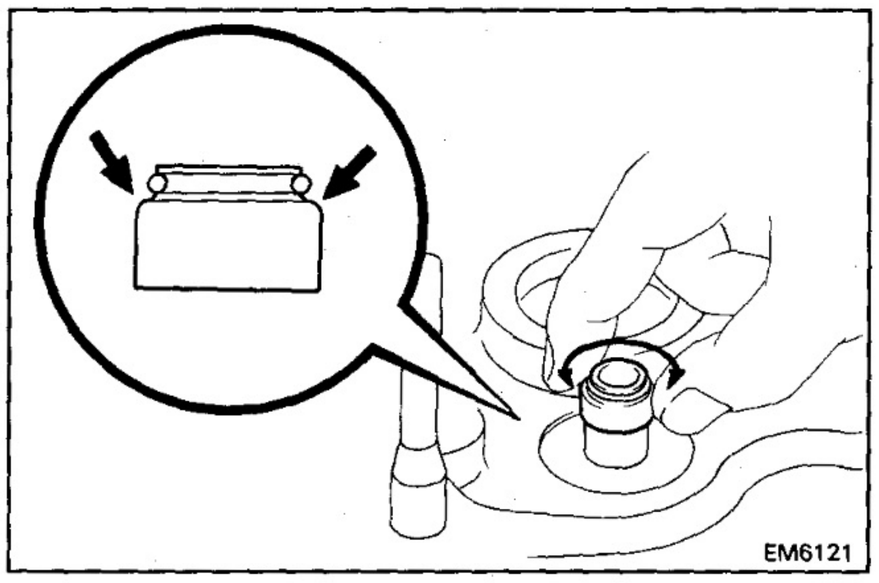
(c) Using a dial indicator, check the combustion chamber protrusion.

Combustion chamber protrusion:
Minus 0.05 — Plus 0.05 mm
(Minus 0.0020 — Plus 0.0020 in.)


EM6071

2. INSTALL VALVES

(a) Place the spring seat on the cylinder head.


EM6121

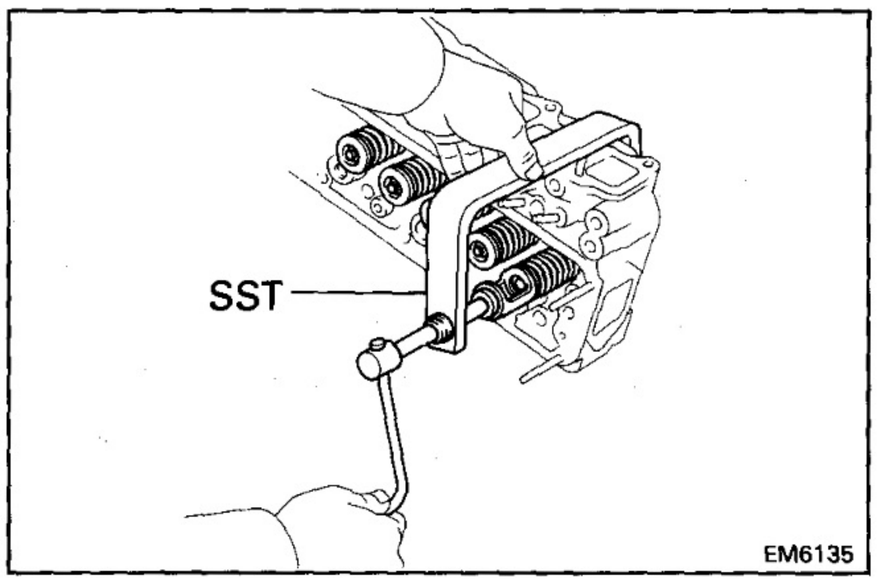
(b) Apply engine oil to a new oil seal lip.

(c) Install new oil seals on the valve guide bushings.

HINT: Pushing down at the places shown in the illustration.

(d) Rotate the oil seal to check that it is firmly installed.

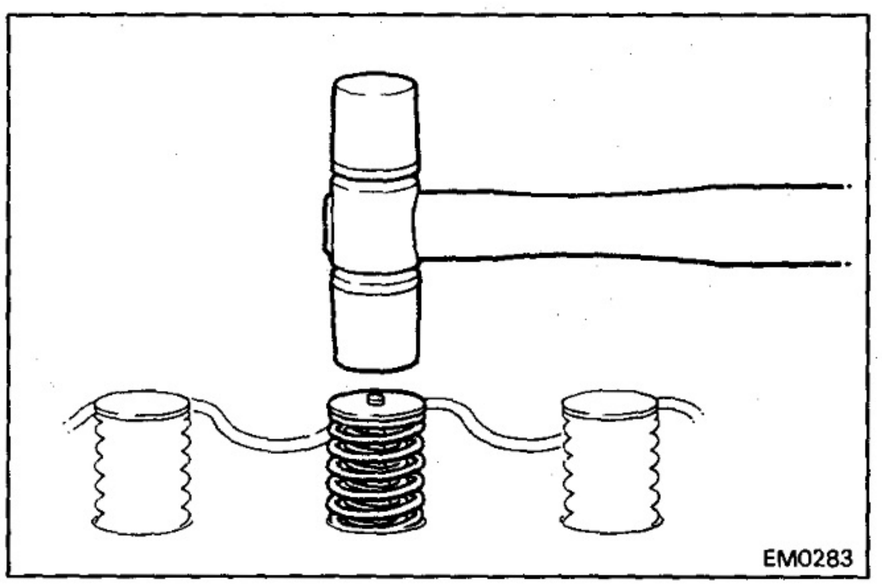
(e) Install the valve, valve springs and spring retainer.



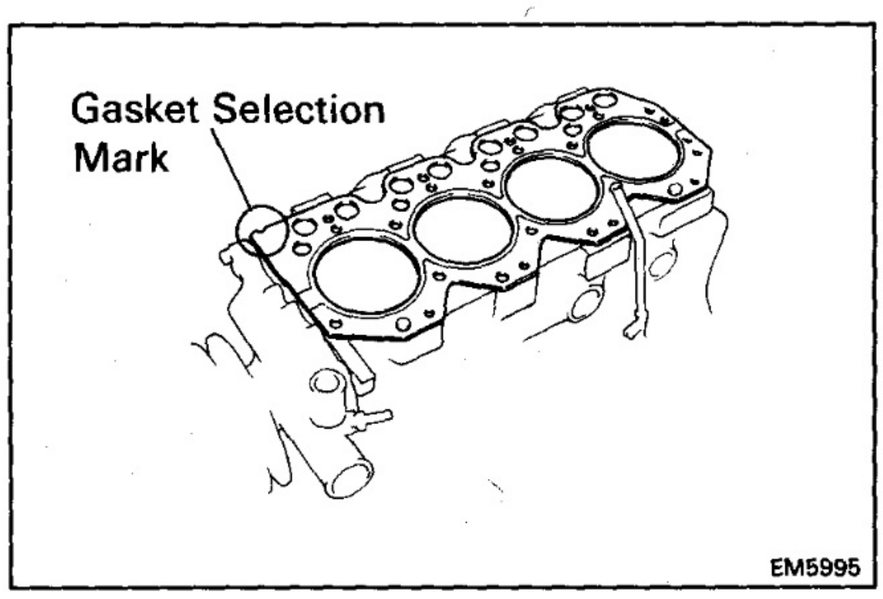
EM6135

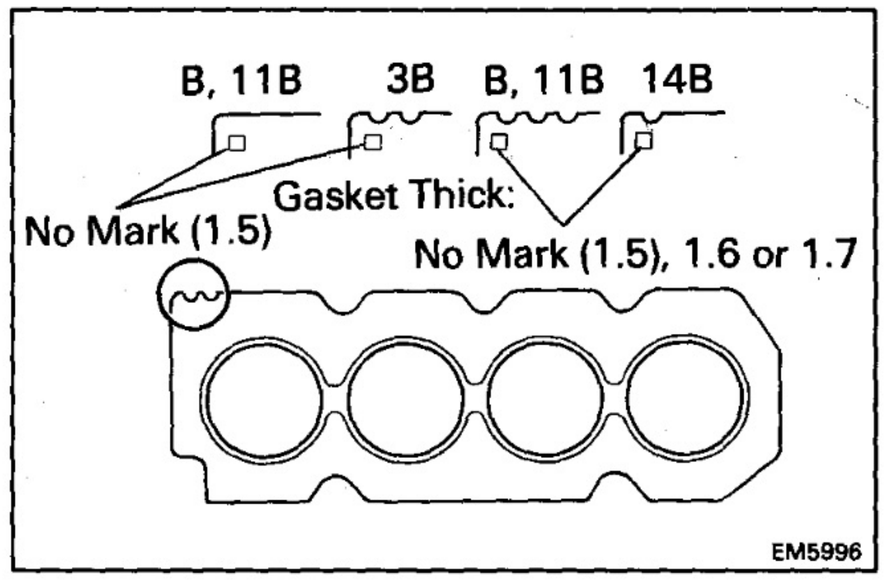
(f) Using SST, compress the valve springs and place the two keepers around the valve stem.

SST 09202-43013


EM0283

(g) Using a plastic-faced hammer, lightly tap the stem to assure proper fit.





INSTALLATION OF CYLINDER HEAD

(See page EM-29) B and 3B
(See page EM-30) 11B and 14B

1. INSTALL CYLINDER HEAD

(a) Place a new head gasket over dowels on the cylinder block.

NOTICE: Trouble will arise if the wrong cylinder head gasket is installed.

HINT:
(B, 3B, 11B and 14B)
Confirm that the new gasket is appropriate for the engine you are repairing by checking the number of cutouts.
(B and 3B)
Only one thickness of gasket exists for both these engines, gasket with no mark (1.5 mm/0.059 in.).
(B and 11B)
Gaskets with no cutout are used only in factory assembly and are not available as a supply part.
(11B and 14B)

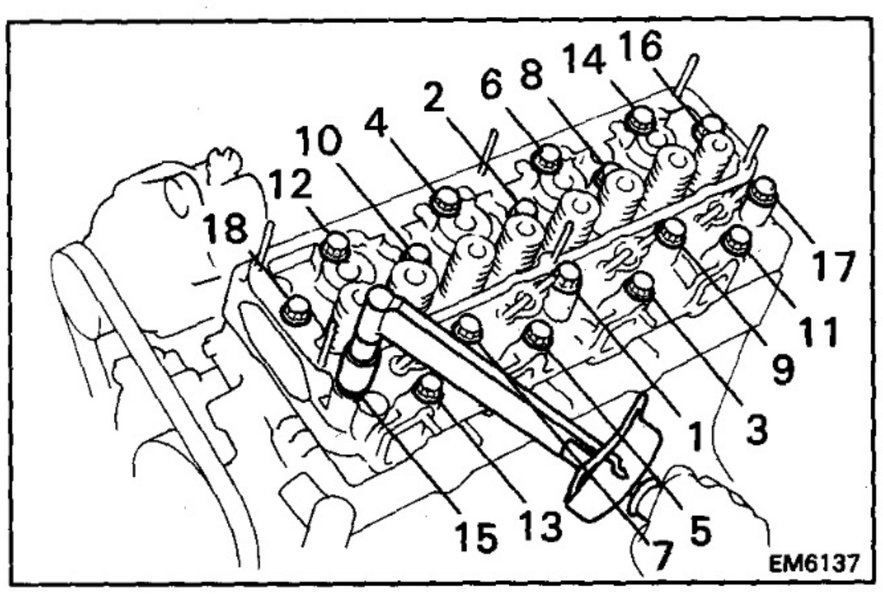
- There are three different thicknesses of gasket available [No mark = 1.5 mm (0.059 in.), 1.6 = 1.6 mm (0.063 in.), 1.7 = 1.7 mm (0.067 in.)].
- When replacing the gasket only, use a new gasket with the same thickness identification number as shown on the originally installed gasket.
  However, when replacing piston, crankshaft or connecting rod, select the appropriate cylinder head gasket according to the piston protrusion. (See page EM-96)

(b) Position the cylinder head over dowels on the block.

2. TORQUE CYLINDER HEAD BOLTS

HINT:

- The cylinder head bolts are tighten in three progressive steps.
- If any of the bolts break or deform, replace them.
- If the cylinder head bolts are to be replaced, use only cylinder head bolts with a 12-sided head.

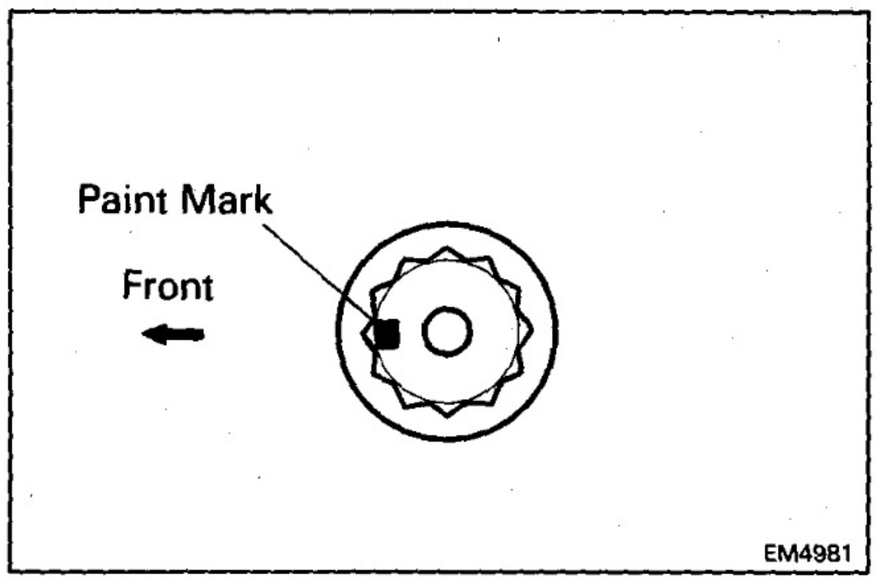


(a) Apply a light coat of engine oil on the threads and under the cylinder head bolts.

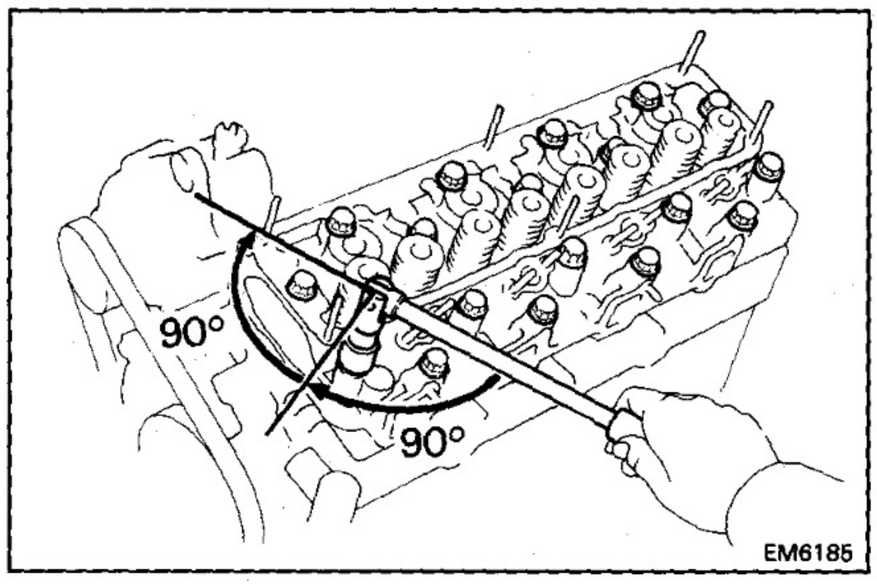
(b) First, uniformly torque the eighteen cylinder head bolts in several passes and in the sequence shown.

Torque: 500 kg-cm (36 ft-lb, 49 N·m)

If any one of the bolts does not meet the torque specification, replace the bolt.



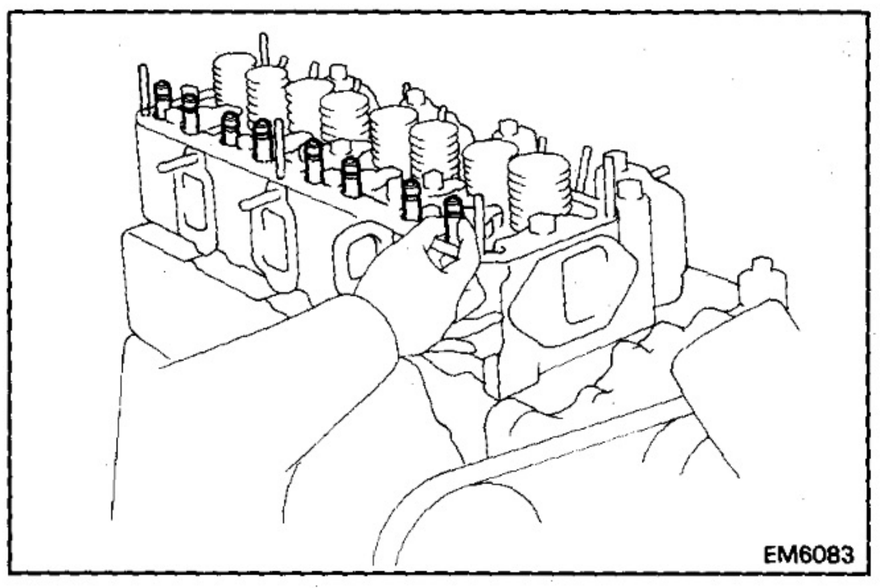
(c) Mark the front side of the top of bolt with paint.



(d) Tighten the eighteen head bolts 90° in the numerical order shown.

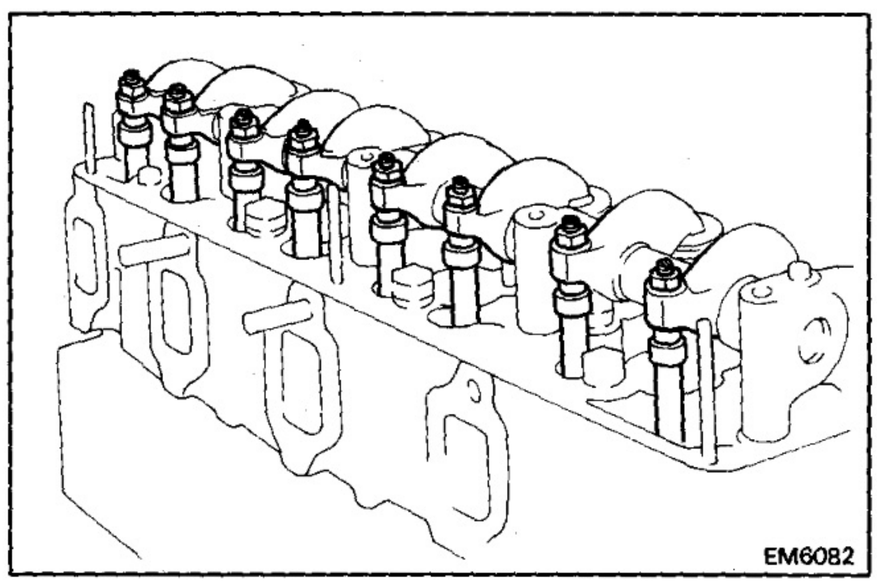
(e) Then tighten the bolts by an additional 90°.

(f) Check that the paint mark is now facing rearward.



3. INSTALL PUSH RODS

Install the eight push rods.

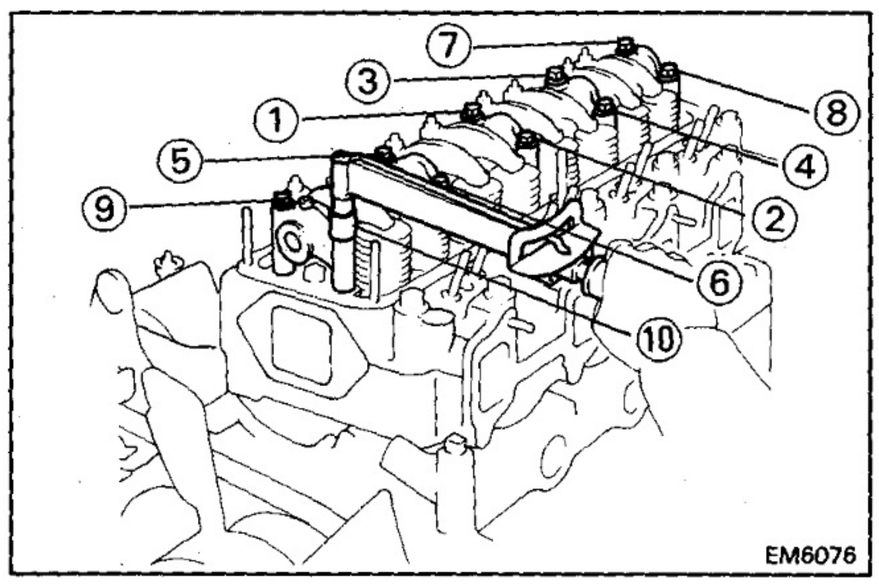


4. INSTALL VALVE ROCKER SHAFT ASSEMBLY

(a) Install the valve stem caps.

(b) Place the rocker shaft assembly on the cylinder head.

(c) Align the rocker arm adjusting screws with the heads of the push rods.



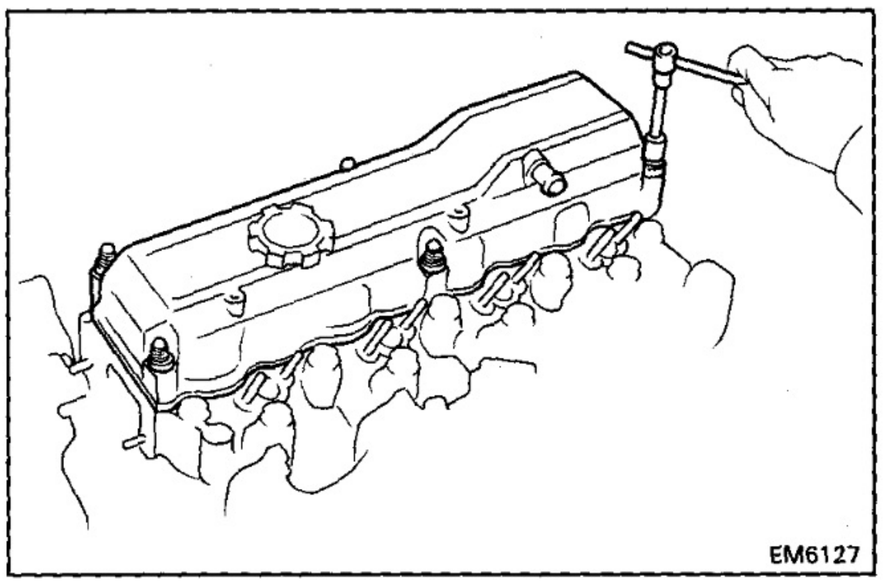
(d) Install and uniformly tighten the ten bolts in several passes, in the sequence shown.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

5. ADJUST VALVE CLEARANCES
(See steps 3 and 4 on page EM-21)

Valve clearance (Cold):

Intake	**0.25 mm (0.010 in.)**
Exhaust	**0.40 mm (0.016 in.)**

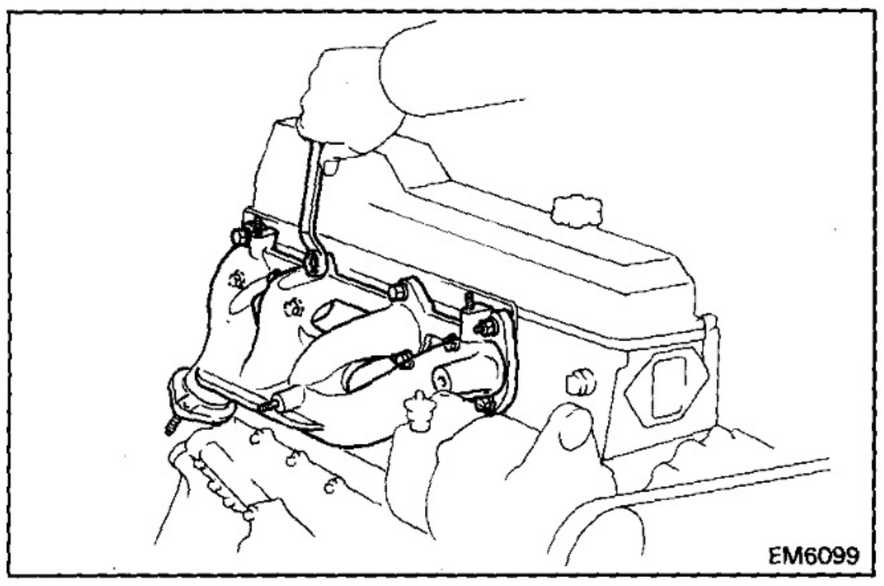


6. INSTALL CYLINDER HEAD COVER

(a) Install a new gasket to the cylinder head cover.

(b) Install the cylinder head cover with the six cushions and cap nuts.

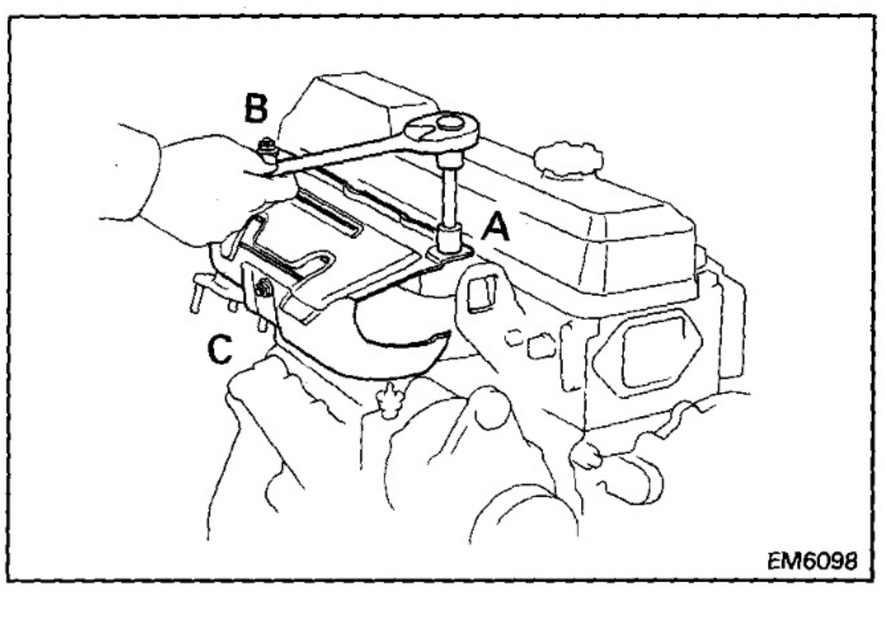
Torque: 105 kg-cm (8 ft-lb, 10 N·m)



7. INSTALL EXHAUST MANIFOLD

(a) Install a new gasket, the exhaust manifold and No. 2 heat insulator (BU) with the eight bolts and two nuts. Torque the bolts and nuts.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

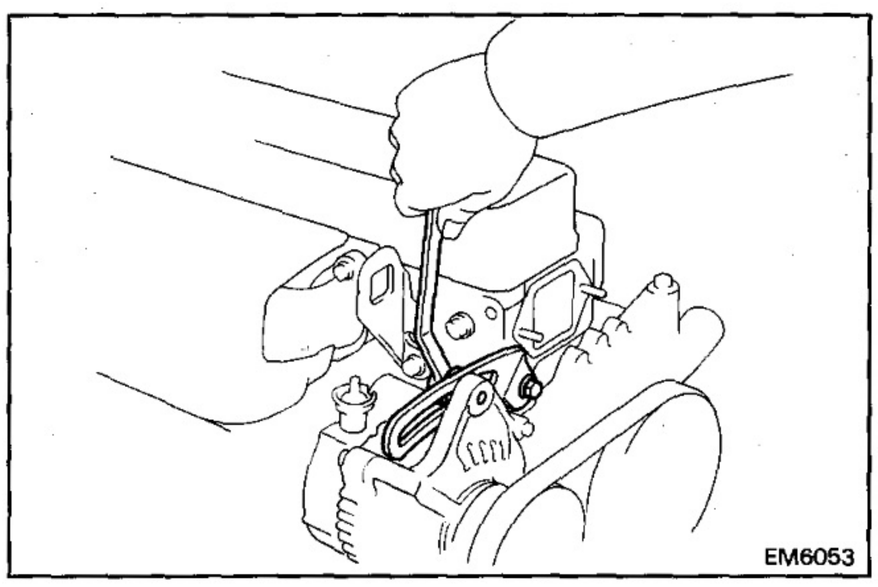


(b) [11B and 14B (Nut tightening type)]
Place the three spacers, heat insulator, three spacers and three plate washers on the exhaust manifold.

(c) [B, 3B, 11B and 14B (Bolt tightening type)]
Place the heat insulator on the exhaust manifold.

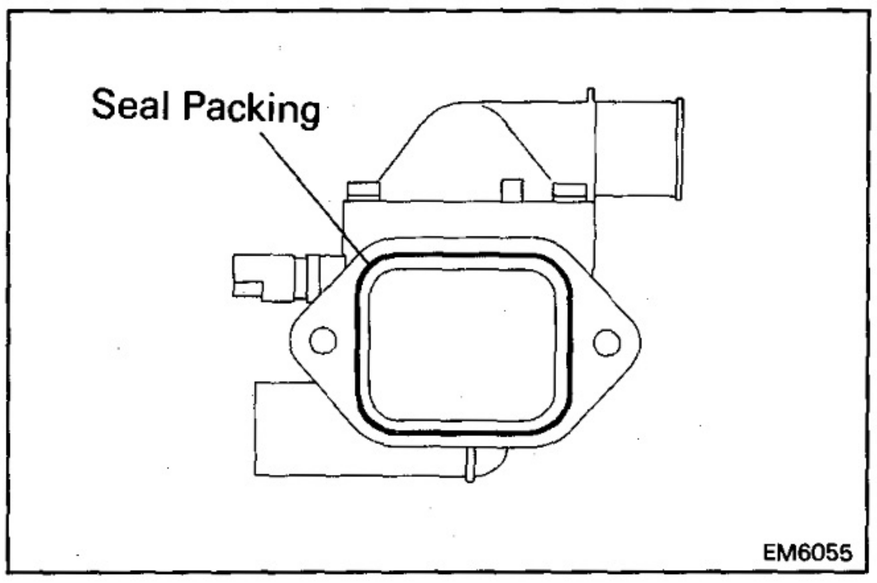
(d) Install and tighten the three nuts or bolts with the following order.
First, temporarily tighten nuts or bolts A and B. Then fully tighten nuts or bolts C, A and B.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)



8. INSTALL DRIVE BELT ADJUSTING BAR

9. ADJUST DRIVE BELT (See page CH-5)

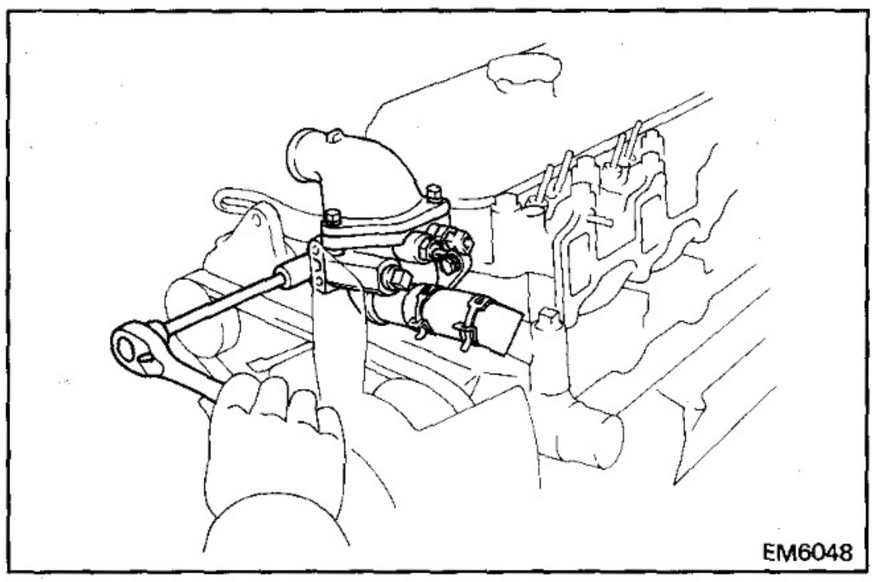


10. INSTALL WATER OUTLET ASSEMBLY

(a) Apply seal packing to the water outlet assembly.

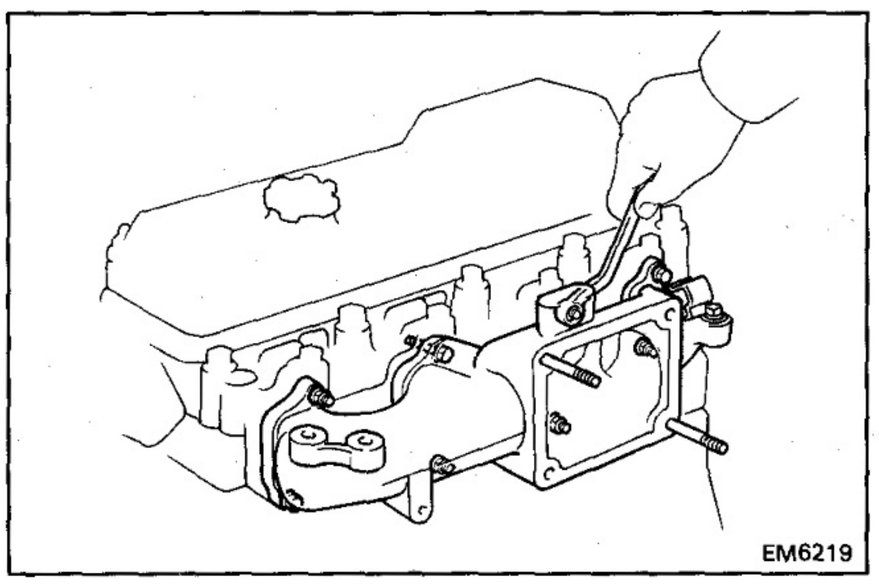
Seal packing: Part No. 08826-00100 or equivalent

HINT: Cleaning and application of seal packing to the installation surface. However, use a nozzle cut to 2 mm (0.08 in.).
(See page LU-14)



(b) Connect the water by-pass hose to the water pump, and install the water outlet assembly with the two nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)



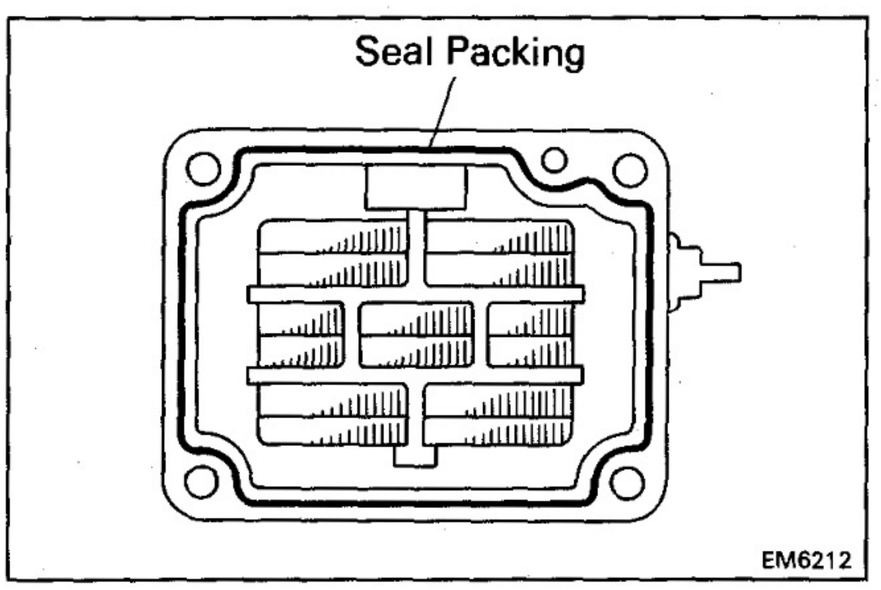
11. INSTALL INTAKE MANIFOLD

(a) Install a new gasket to the intake manifold.

(b) Install the intake manifold and dipstick clamp with the five nuts and three bolts. Torque the bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

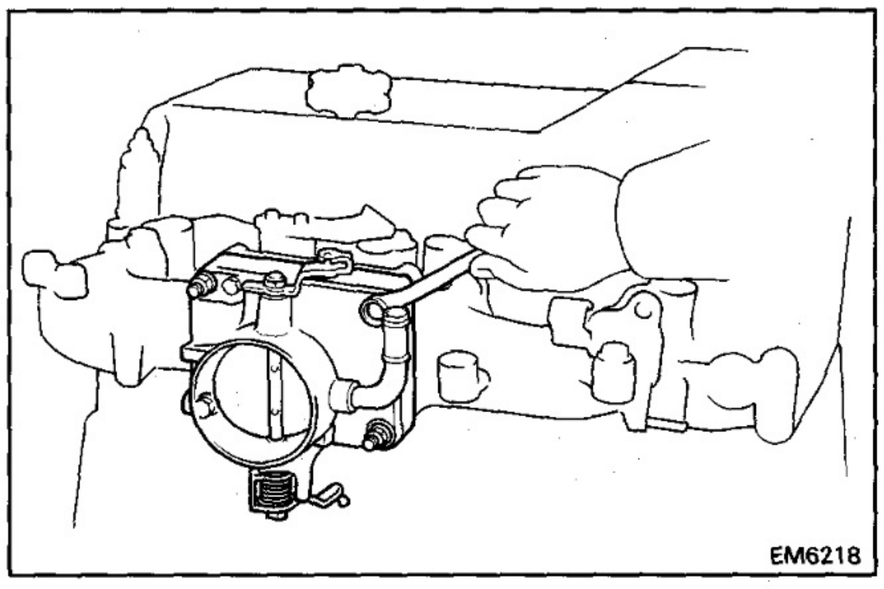
(c) Install the oil dipstick.



(d) (11B and 14B)
Apply seal packing to the intake heater or intake flange as shown in the figure.

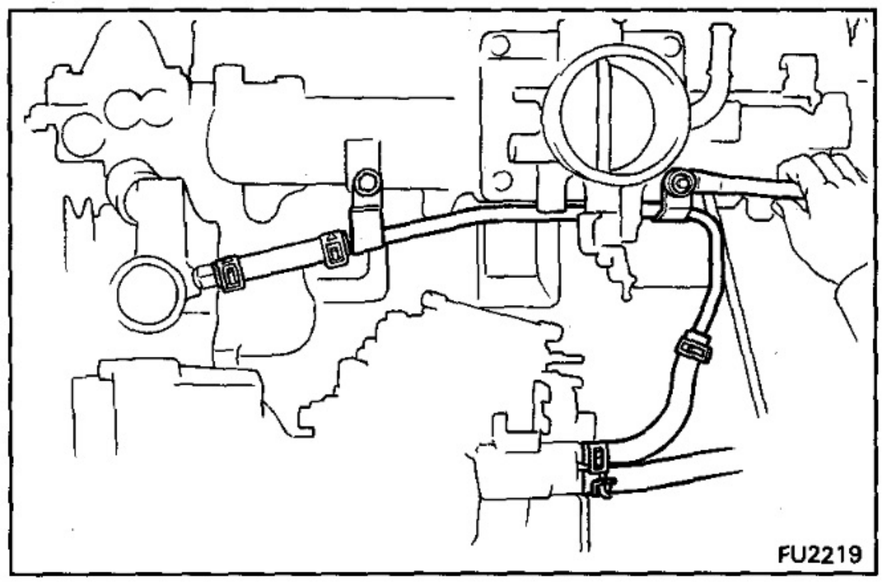
Seal packing: Part No. 08826-00080 or equivalent

HINT: Cleaning and application of seal packing to the installation surface. However, use a nozzle cut to 2 mm (0.08 in.).


EM6218

(e) Install the intake heater or intake flange to the intake manifold with the two bolts and nuts.

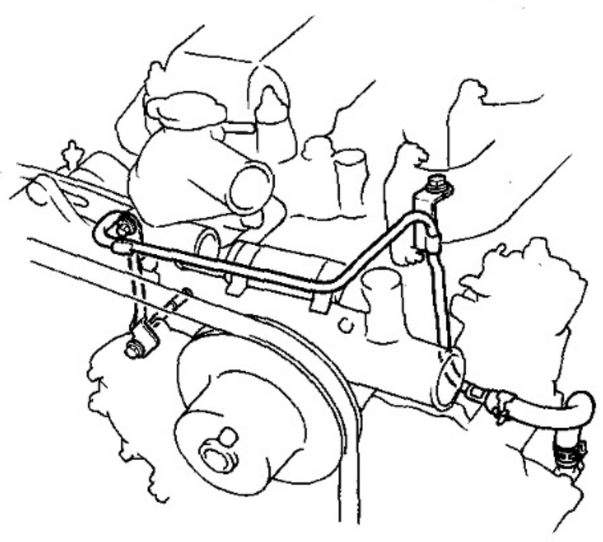
Torque: 185 kg-cm (13 ft-lb, 18 N·m)


FU2219

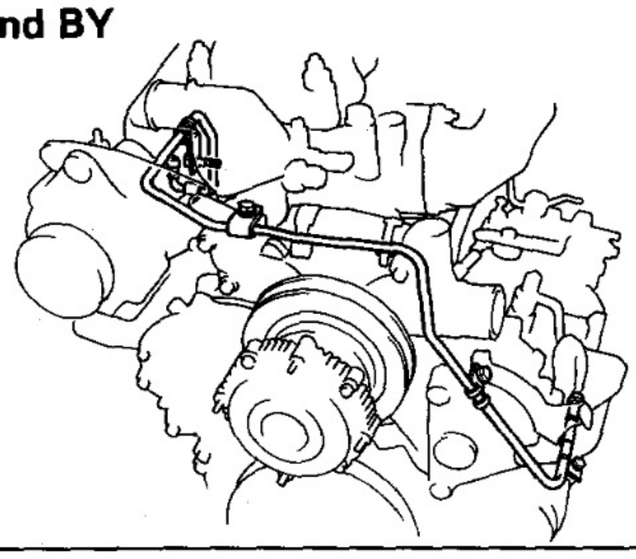
(f) (w/ ACSD)
Install the No. 4 water by-pass pipe with hoses.

12. INSTALL ACCELERATOR CONNECTING ROD

BJ

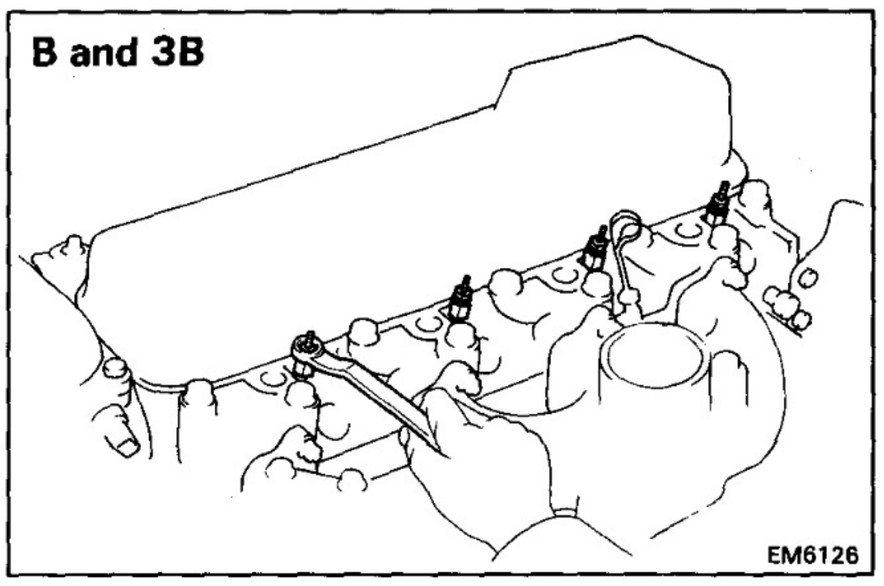


BU and BY


EM6130
EM6217

13. INSTALL VACUUM PIPE

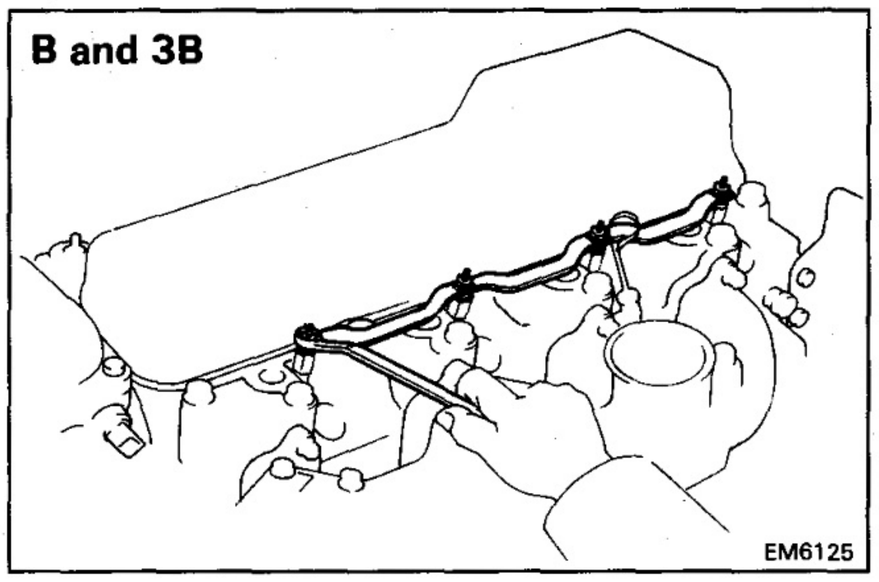
B and 3B


EM6126

14. [B AND 3B] INSTALL GLOW PLUGS

(a) Install the four glow plugs.

Torque: 125 kg-cm (9 ft-lb, 12 N·m)



(b) Install the glow plug connector with the four nuts.

(c) Install the four screw grommets.

15. INSTALL INJECTION NOZZLES
(See page FU-13) B and 3B
(See page FU-19) 11B and 14B

16. FILL WITH ENGINE COOLANT (See page CO-5)

17. START ENGINE AND CHECK FOR LEAKS

18. CHECK ENGINE OIL LEVEL (See page LU-4)

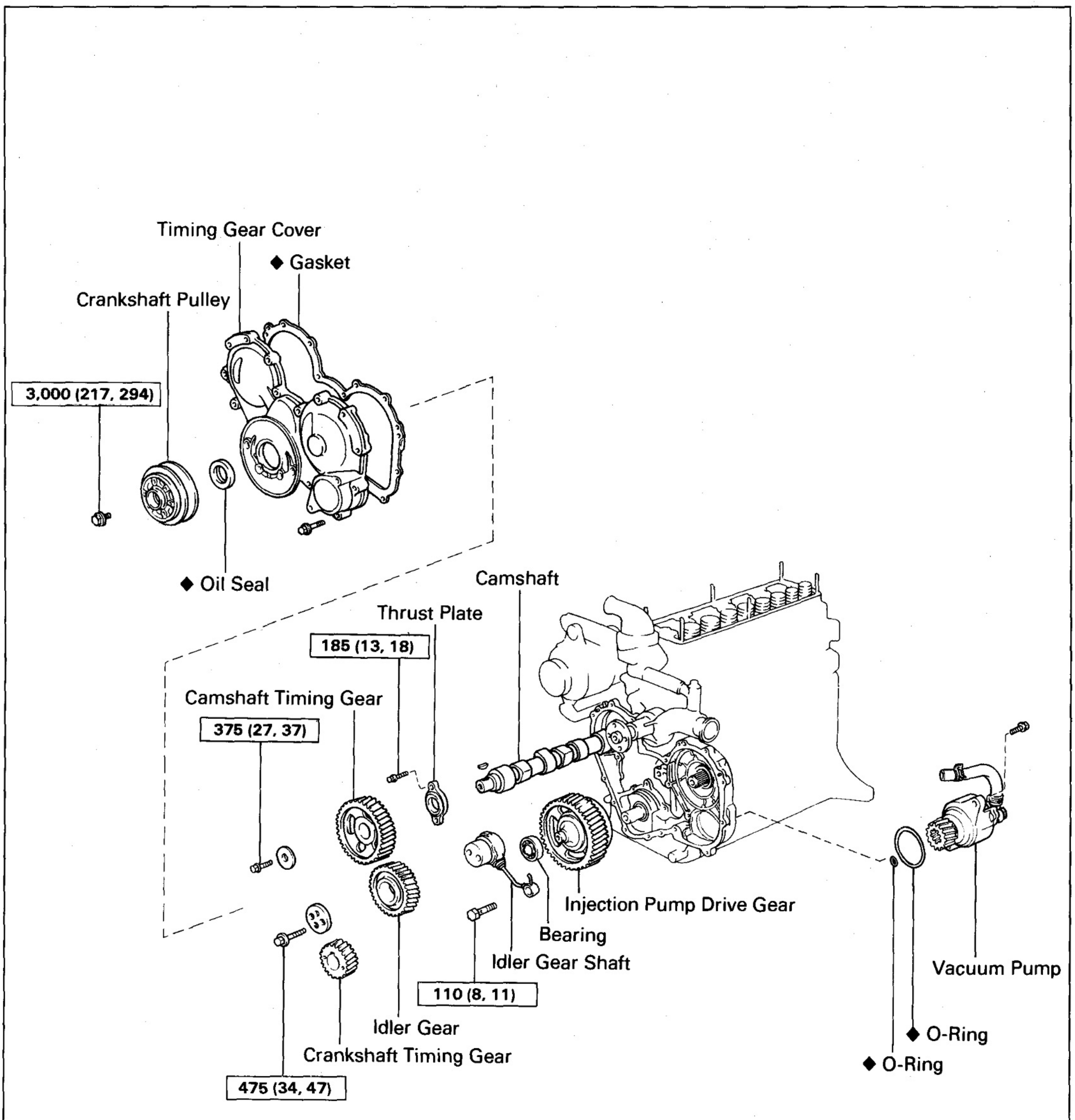
19. READJUST VALVE CLEARANCES (See page EM-21)

Valve clearance (Hot):

Intake	**0.20 mm (0.008 in.)**
Exhaust	**0.36 mm (0.014 in.)**

TIMING GEARS AND CAMSHAFT

COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

EM6038

REMOVAL OF TIMING GEARS AND CAMSHAFT

(See page EM-52)

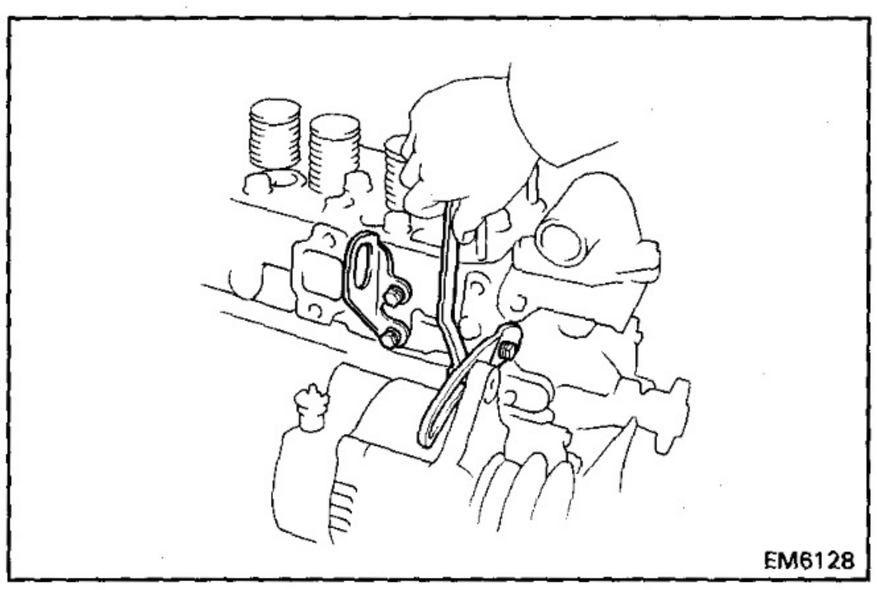
1. SET NO. 1 CYLINDER TO TDC/COMPRESSION
(See page EM-22)

2. REMOVE DRIVE BELT

3. REMOVE FAN AND WATER PUMP PULLEY
(See page CO-7)

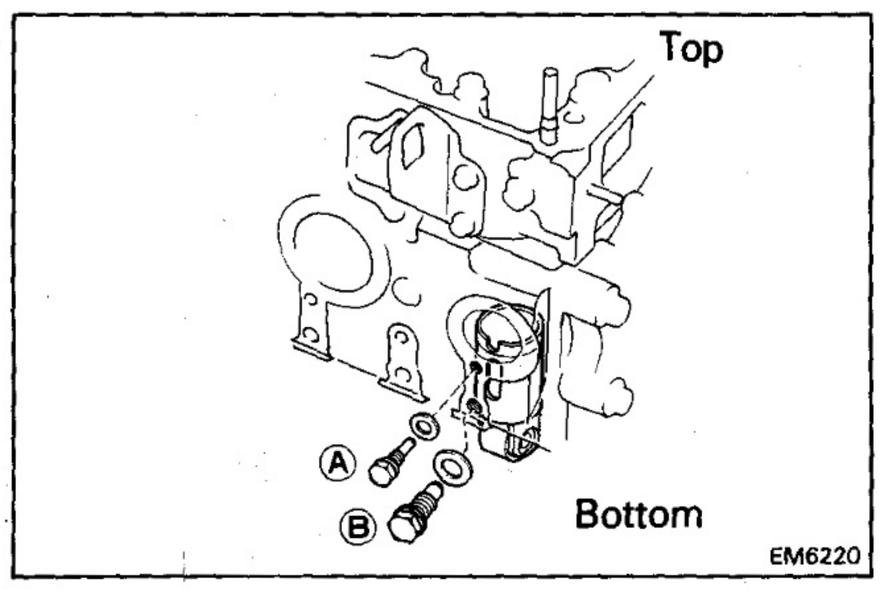
4. REMOVE VALVE ROCKER SHAFT ASSEMBLY
(See steps 10 to 12 on pages EM-33 and 34)

5. REMOVE EXHAUST MANIFOLD (See page EM-33)



EM6128

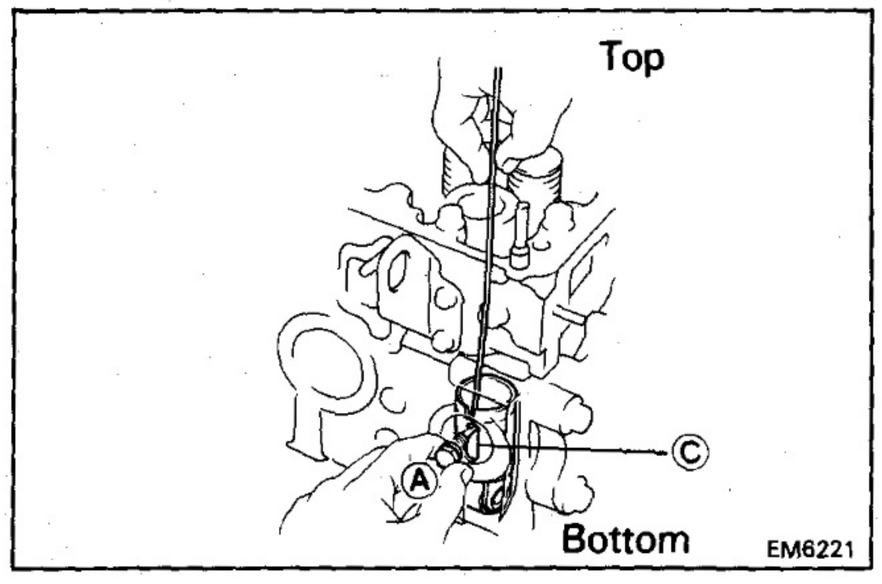
6. REMOVE NO. 1 ENGINE HANGER AND DRIVE BELT ADJUSTING BAR



EM6220

7. DISPLACE VALVE LIFTERS

(a) Remove bolts Ⓐ and Ⓑ .



EM6221

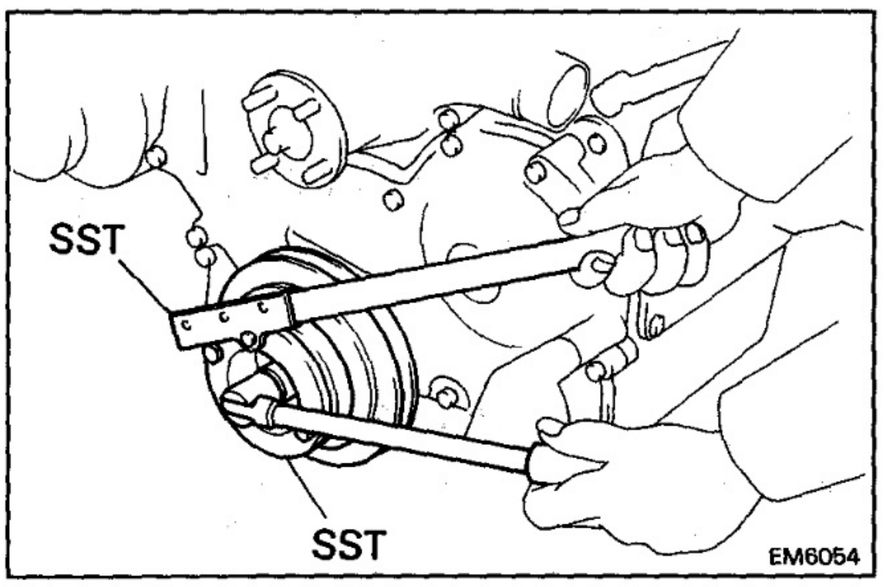
(b) Using a wire, lift up the valve litter until long hole Ⓒ of the valve lifter moves up to the position of the installation hole for bolt Ⓐ .

HINT: If the lifter is lifted up too high it may get out of position.

(c) Install bolt Ⓐ .

(d) Check that bolt Ⓐ prevents the valve lifter from falling.

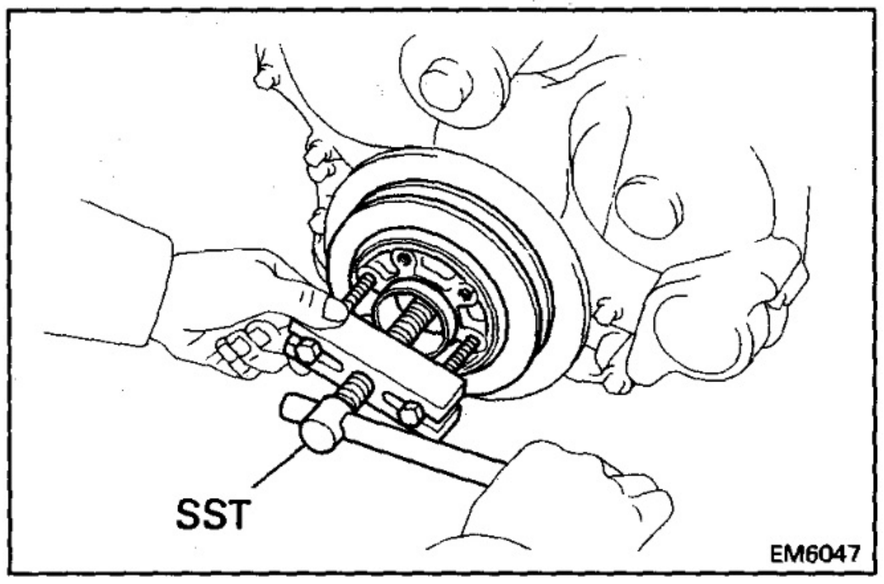
HINT: Be careful not to scratch the valve lifter.



8. REMOVE CRANKSHAFT PULLEY

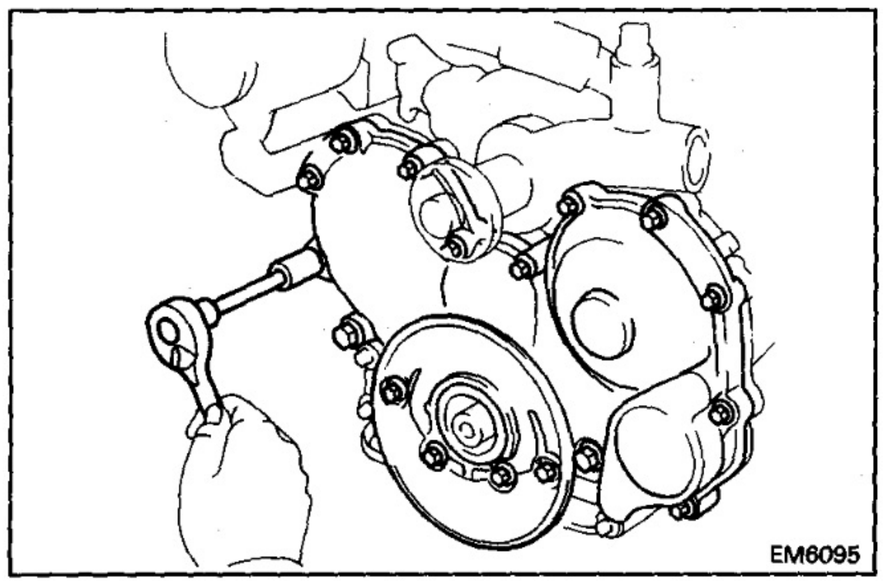
(a) Using SST, remove the mount bolts.

SST 09213-58011 and 09330-00021



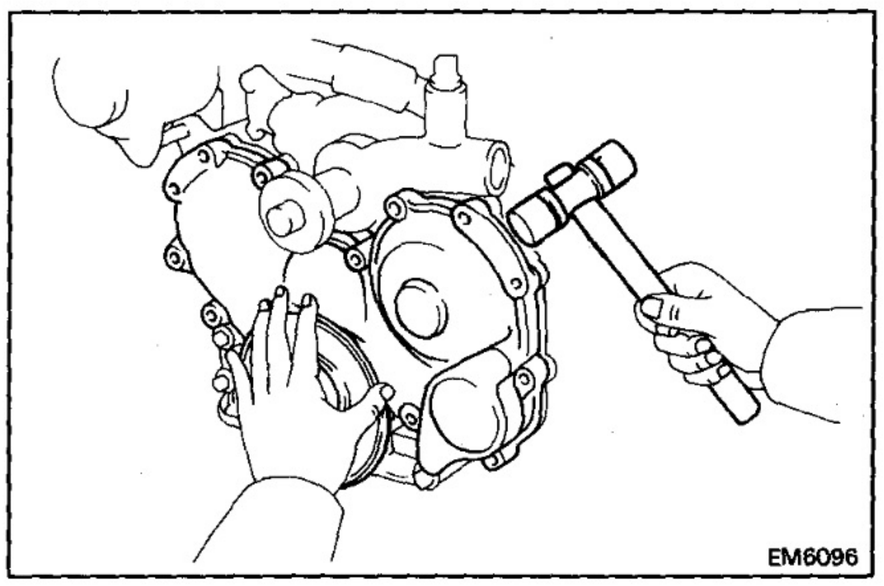
(b) Using SST, remove the pulley.

SST 09213-60017



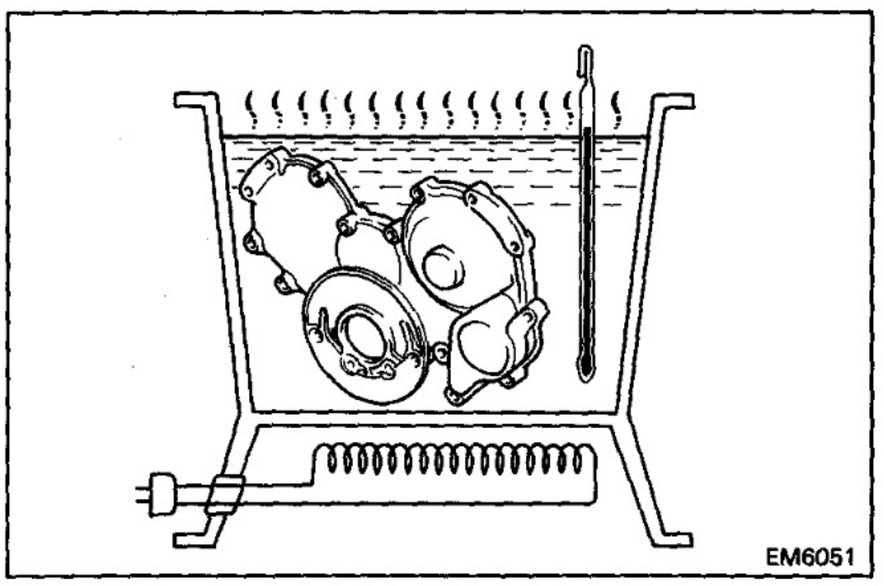
9. REMOVE TIMING GEAR COVER

(a) Remove the seventeen mount bolts.



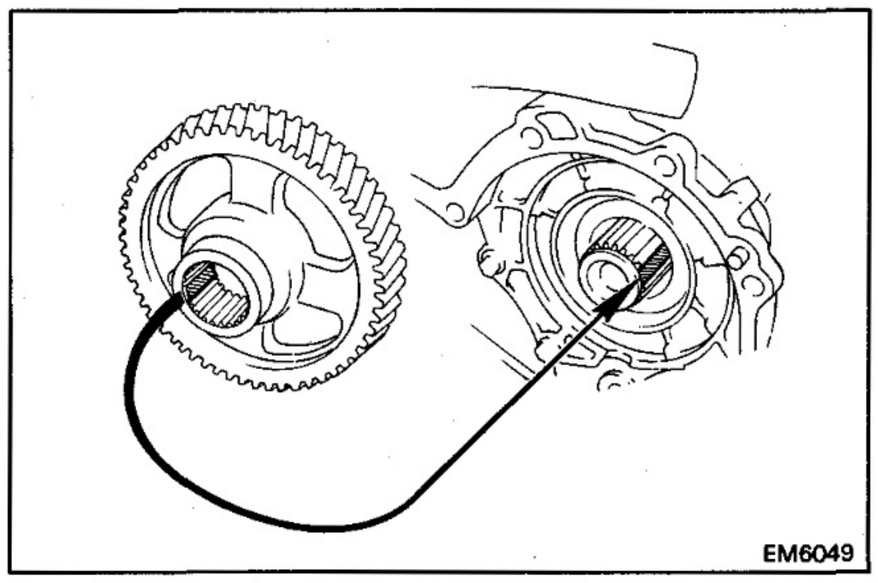
(b) Using a plastic-faced hammer, lightly tap out the gear cover.

(c) Remove the cover gasket.



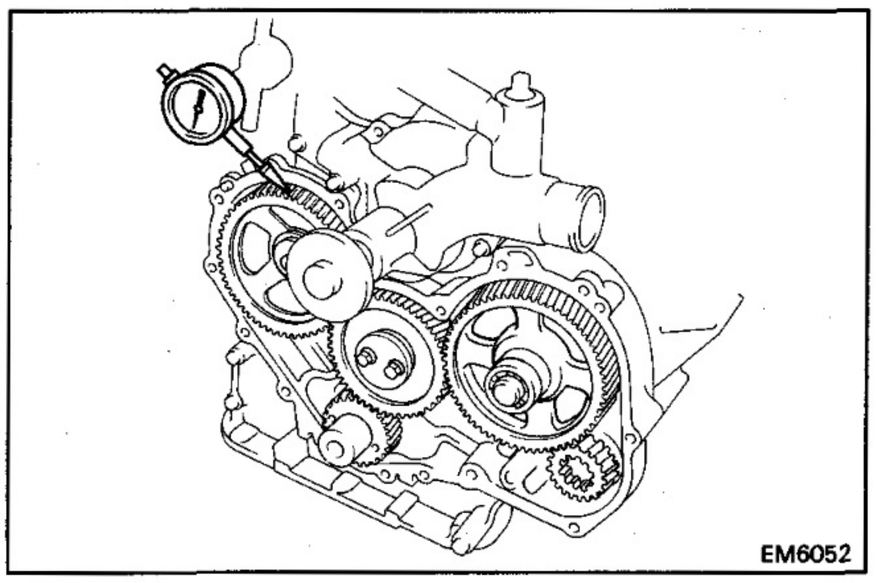
10. REMOVE INJECTION PUMP DRIVE GEAR FROM TIMING GEAR COVER

Heat the timing gear cover with the drive gear to approx. 60°C (140°F) and remove the drive gear.


EM6049

11. CHECK TIMING GEAR BACKLASH

(a) Align the spline toothless portions of the injection pump drive gear and injection pump, and install the drive gear.


EM6052

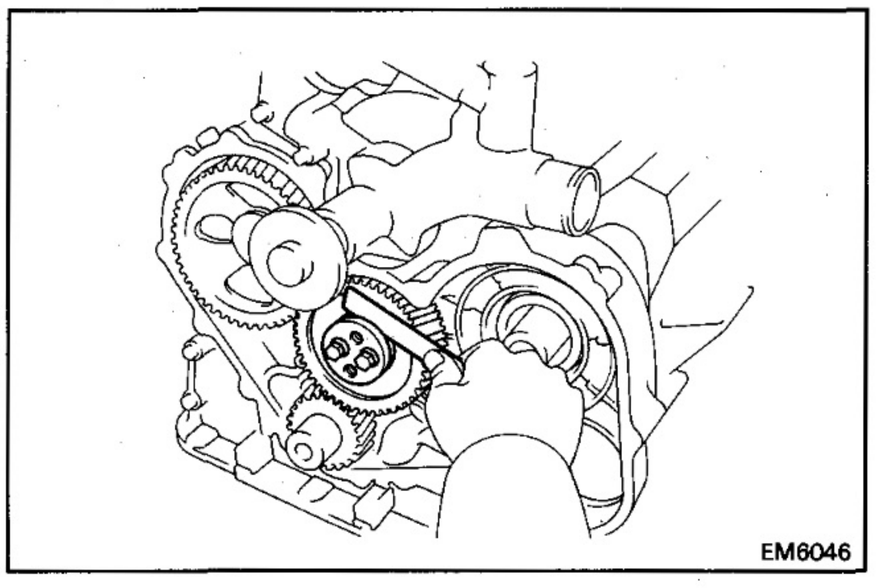
(b) Using a dial indicator, measure the backlash between each gear.

Standard backlash: **0.058 — 0.162 mm (0.0023 — 0.0064 in.)**
Maximum backlash: **0.30 mm (0.0118 in.)**

If the backlash is greater than maximum, replace the gears as a set.

(c) Remove the injection pump drive gear.

12. REMOVE VACUUM PUMP

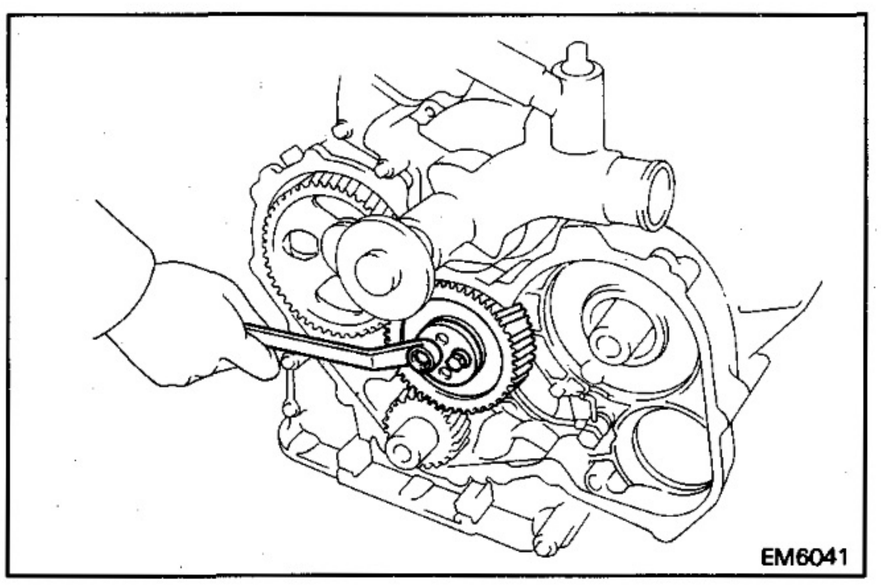

EM6046

13. CHECK IDLE GEAR THRUST CLEARANCE

Using a thickness gauge, measure the idle gear thrust clearance.

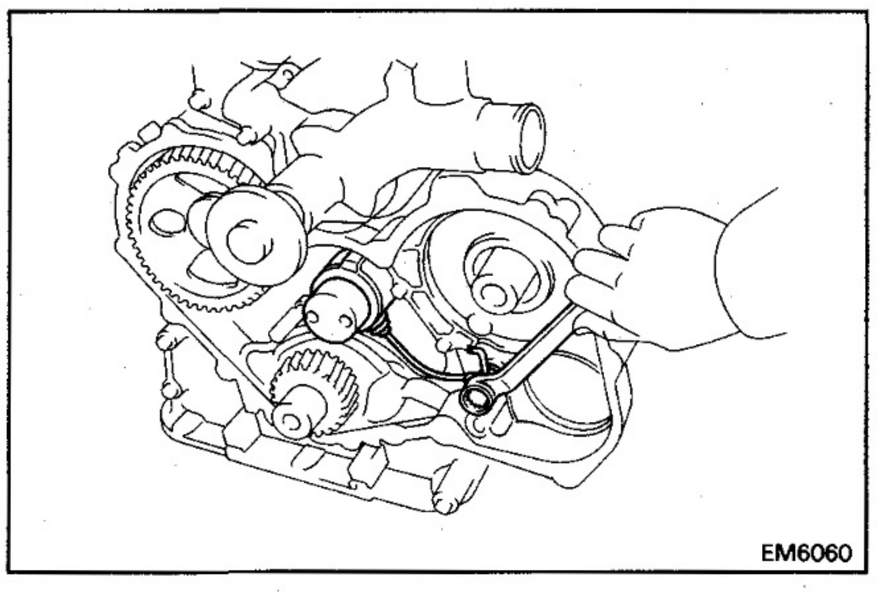
Standard thrust clearance: **0.06 — 0.17 mm (0.0024 — 0.0067 in.)**
Maximum thrust clearance: **0.30 mm (0.0118 in.)**

If the thrust clearance is greater than maximum, replace the thrust plate.


EM6041

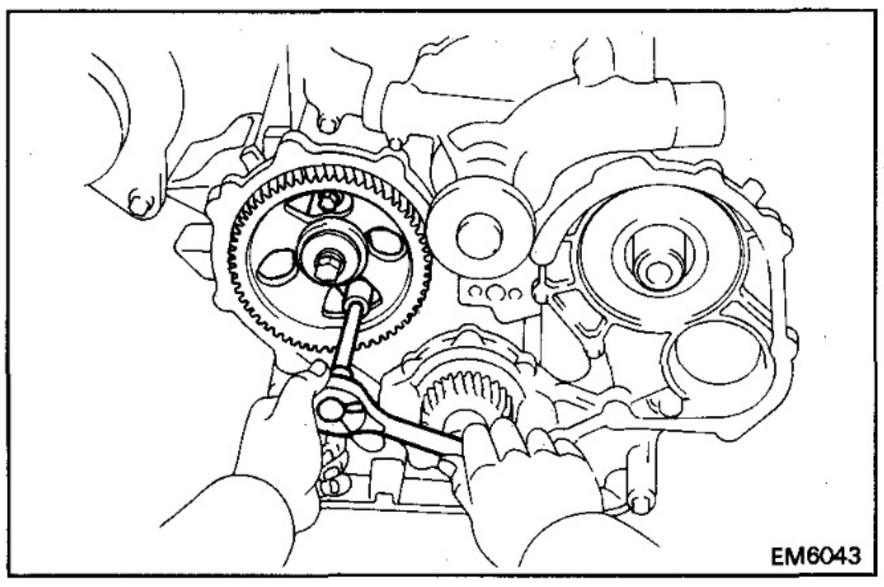
14. REMOVE IDLE GEAR

Remove the two bolts, trust plate and idle gear.


EM6060

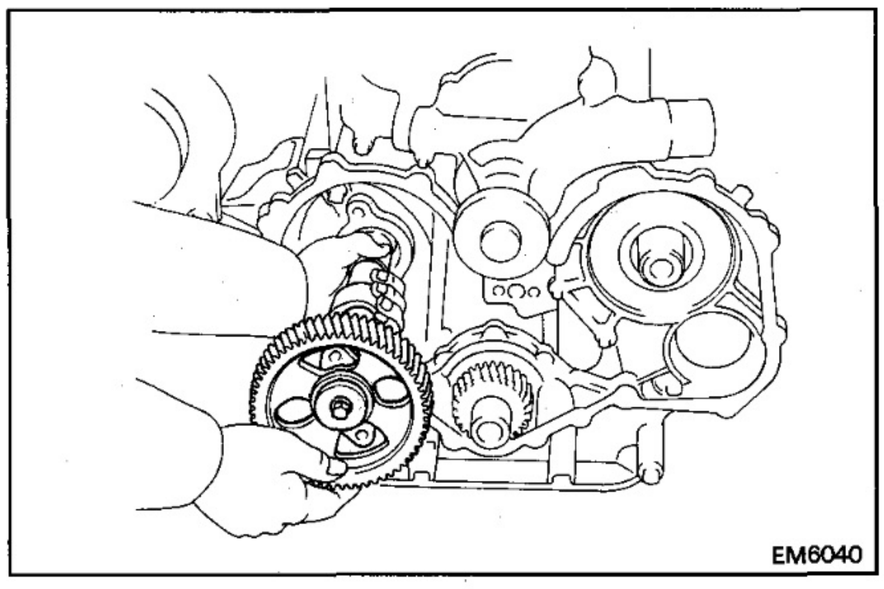
15. REMOVE IDLE GEAR SHAFT

Remove the union bolt and idle gear shaft.



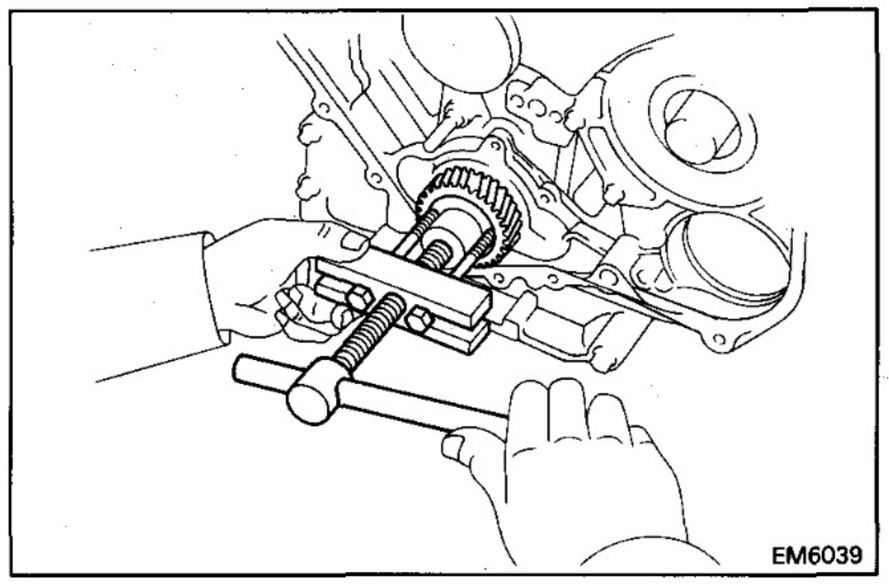
16. REMOVE CAMSHAFT TIMING GEAR AND CAMSHAFT ASSEMBLY

(a) Remove the two bolts holding the thrust plate to the cylinder block.



(b) Carefully pull out the camshaft and timing gear assembly.

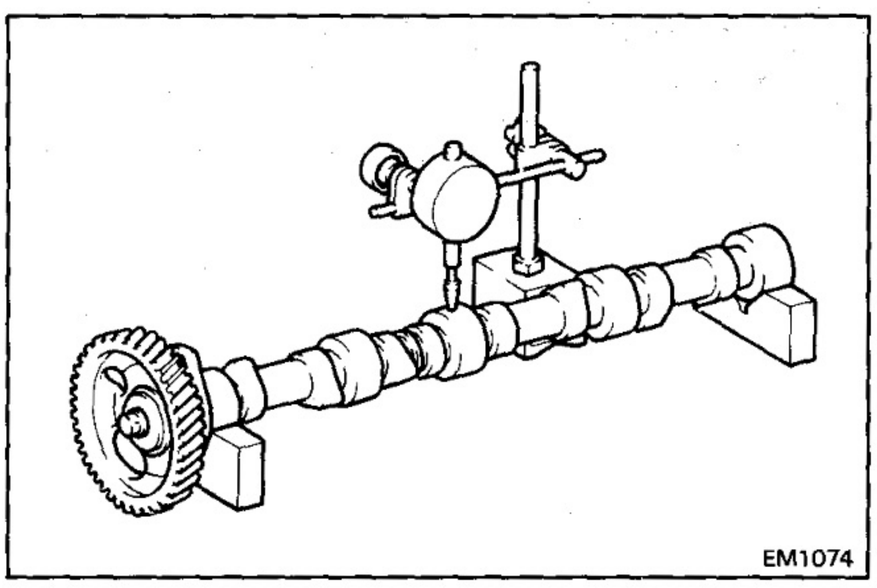
NOTICE: Be careful not to damage the camshaft bearings.

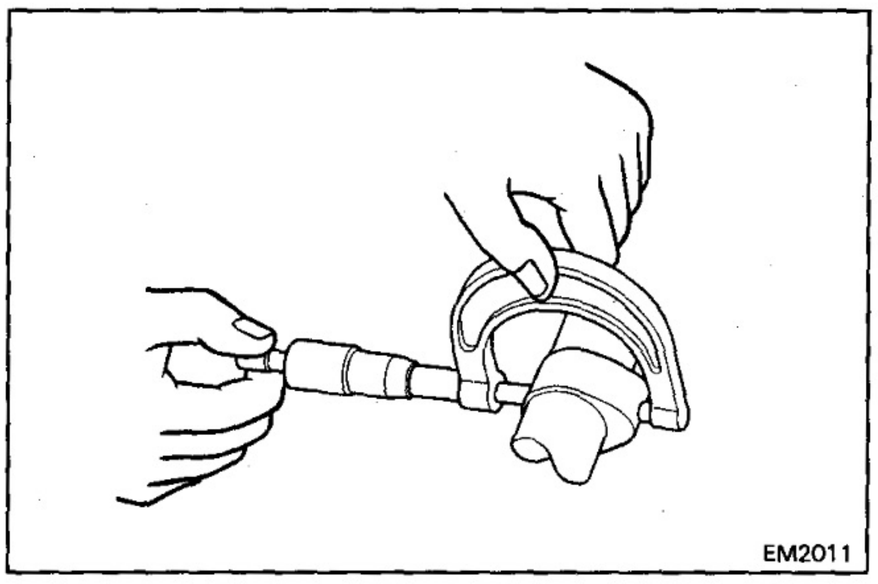


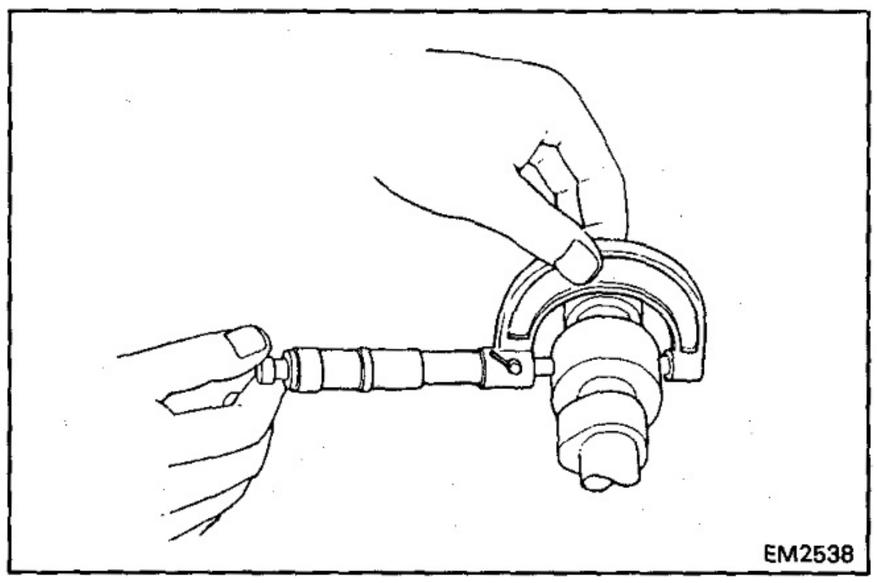
17. REMOVE CRANKSHAFT TIMING GEAR

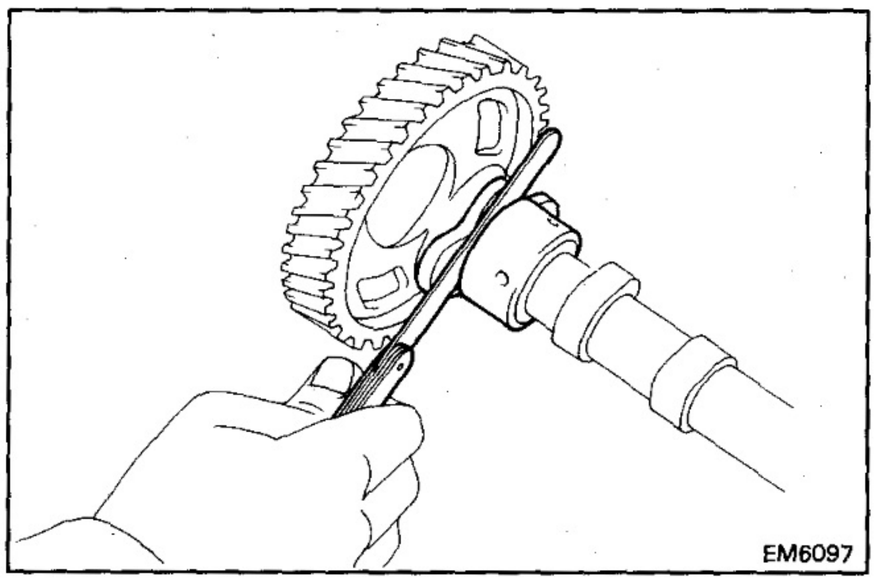
Using SST, remove the timing gear.

SST 09213-60017


EM1074


EM2011


EM2538


EM6097

INSPECTION OF TIMING GEARS AND CAMSHAFT

1. INSPECT CAMSHAFT

(a) Place the camshaft on V-blocks and, using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.06 mm (0.0024 in.)

If the circle runout is greater than maximum, replace the camshaft.

(b) Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake	**B, 3B**	**45.288 — 45,378 mm (1.7830 — 1.7865 in.)**
	11B, 14B	**44.879 — 44.969 mm (1.7669 — 1.7704 in.)**
Exhaust	**B, 3B**	**45.261 — 45.351 mm (1.7819 — 1.7855 in.)**
	11B, 14B	**45.050 — 45.140 mm (1.7736 — 1.7772 in.)**

Minimum cam lobe height:

Intake	**B, 3B**	**44.85 mm (1.7657 in.)**
	11B, 14B	**44.44 mm (1.7496 in.)**
Exhaust	**B, 3B**	**44.83 mm (1.7650 in.)**
	11B, 14B	**44.62 mm (1.7567 in.)**

If the lobe height is less than minimum, replace the camshaft.

(c) Using a micrometer, measure the journal diameter.

Journal diameter (from front side):

No. 1	**53.459 — 53.475 mm (2.1047 — 2.1053 in.)**
No. 2	**53.209 — 53.225 mm (2.0948 — 2.0955 in.)**
No. 3	**52.959 — 52.975 mm (2.0850 — 2.0856 in.)**
No. 4	**52.709 — 52.725 mm (2.0752 — 2.0758 in.)**
No. 5	**52.459 — 52.475 mm (2.0653 — 2.0659 in.)**

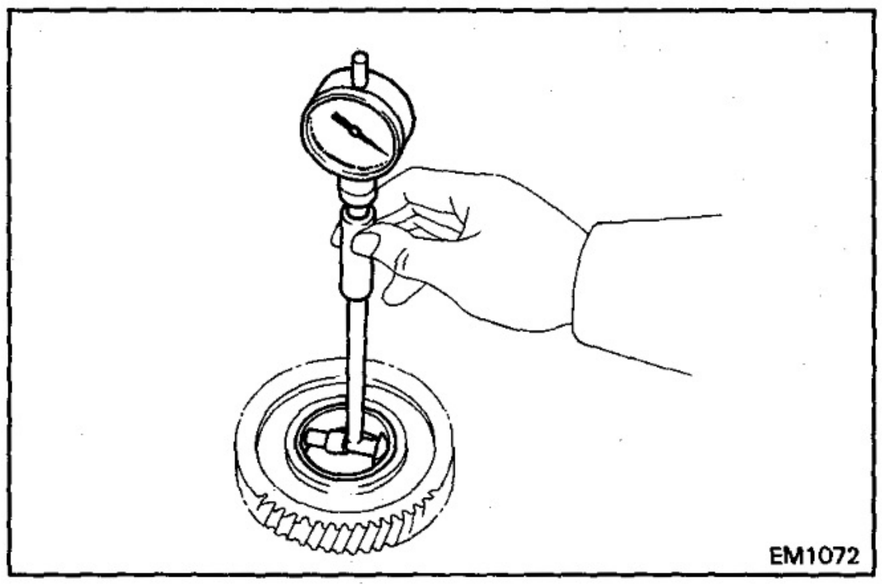
If the journal diameter is not within specification, check the oil clearance. (See page EM-88)

(d) Using a feeler gauge, measure the thrust clearance between the camshaft and thrust plate.

Standard clearance: 0.06 — 0.13 mm (0.0024 — 0.0051 in.)

Maximum clearance: 0.30 mm (0.0118 in.)

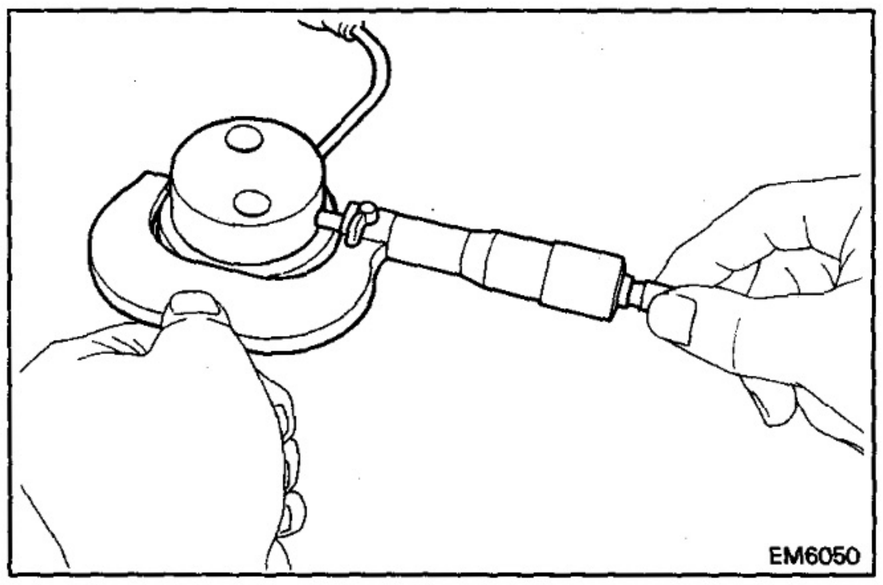
If the thrust clearance is greater than maximum, replace the thrust plate. If necessary, replace the camshaft.
(See page EM-59)


EM1072

2. INSPECT IDLE GEARS

(a) Using a cylinder gauge, measure the inside diameter of the idle gear.

Idle gear inside diameter: 44.969 — 44.995 mm (1.7704 — 1.7715 in.)


EM6050

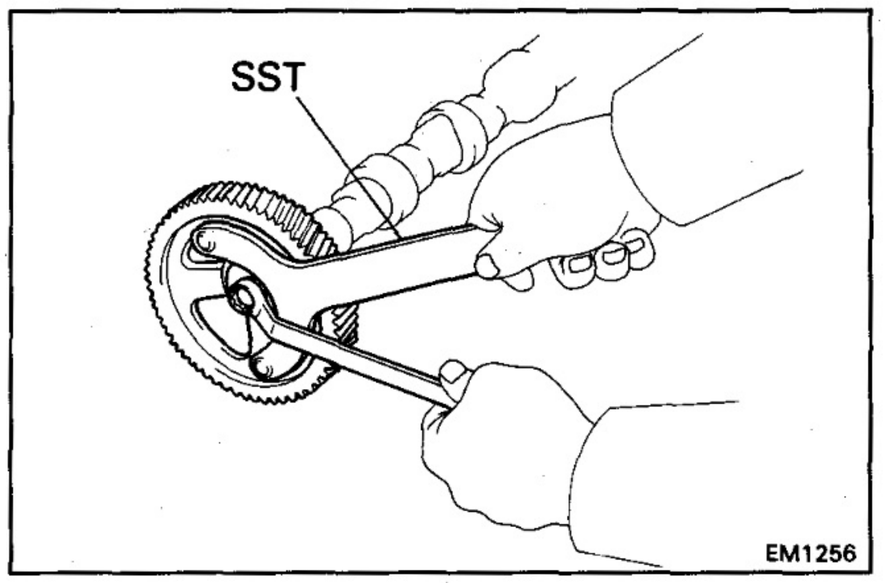
(b) Using a micrometer, measure the diameter of the idle gear shaft.

Idle gear shaft diameter: 44.935 — 44.955 mm (1.7691 — 1.7699 in.)

(c) Subtract the idle gear shaft diameter measurement from the idle gear inside diameter measurement.

Standard oil clearance: 0.045 — 0.090 mm (0.0018 — 0.0035 in.)
Maximum oil clearance: 0.18 mm (0.0071 in.)

If the clearance is greater than maximum, replace the gear and shaft.

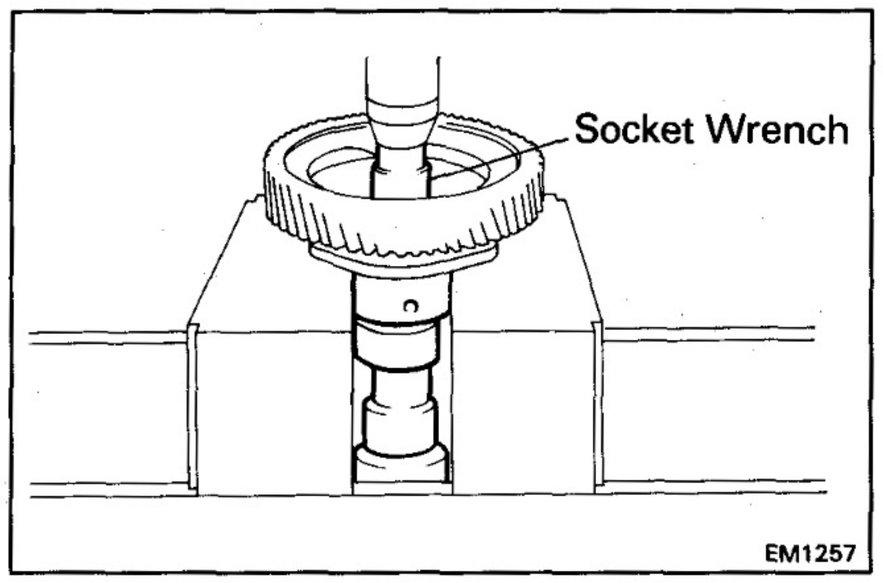


REPLACEMENT OF CAMSHAFT (OR CAMSHAFT TIMING GEAR)

1. REMOVE CAMSHAFT

(a) Using SST, remove the bolt and plate washer.

SST 09278-54012

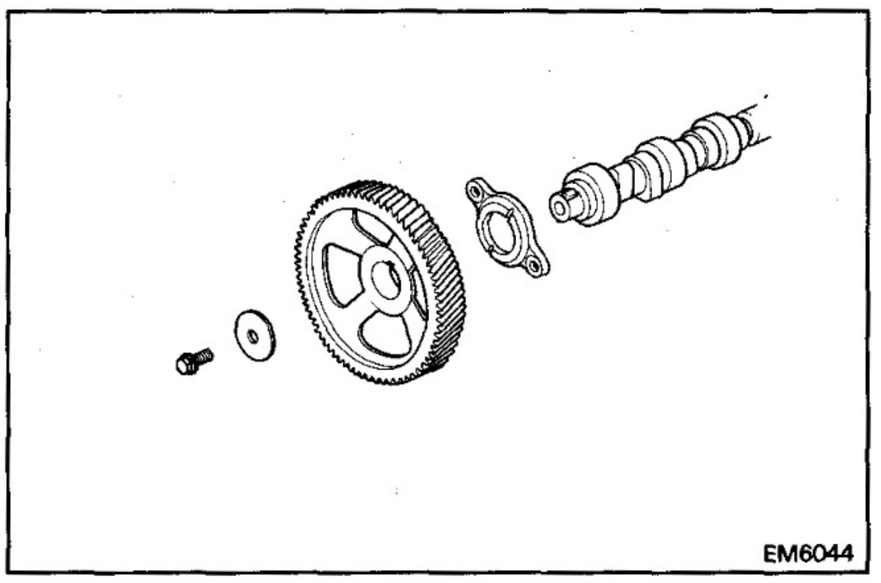


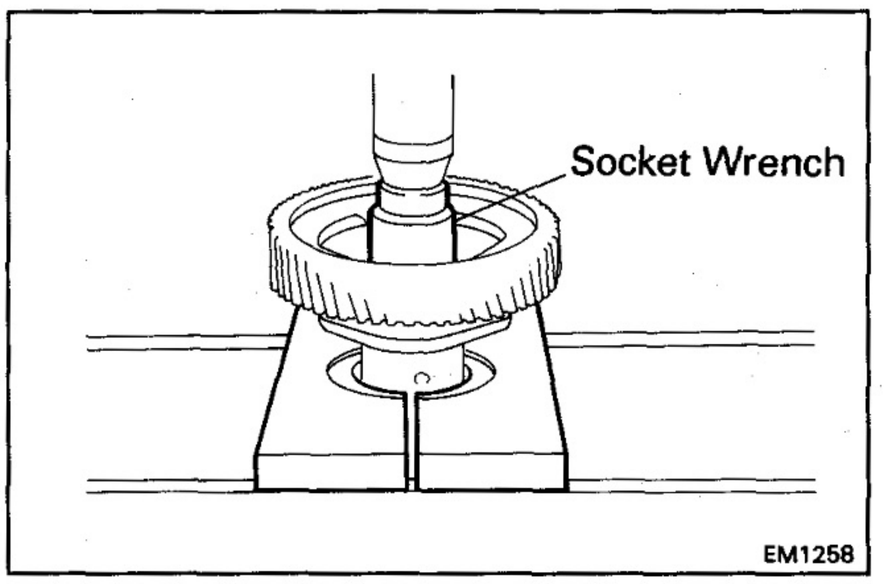
(b) Using a 19 mm socket wrench and press, press out the camshaft.

2. INSTALL NEW CAMSHAFT

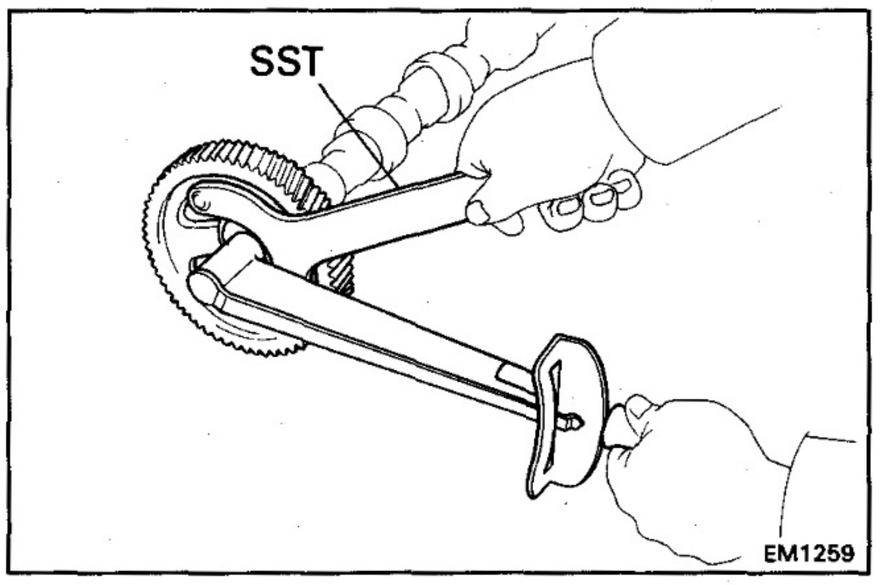
(a) Install the timing gear set key to the camshaft.

(b) Assembly the camshaft, thrust plate and timing gear as shown.





(c) Using a 29 mm socket wrench and press, align the timing gear set key with the key groove of the timing gear, and press in the camshaft timing gear.



(d) Using SST, install the plate washer and bolt. Torque the bolt.

SST 09278-54012

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

3. CHECK CAMSHAFT THRUST CLEARANCE

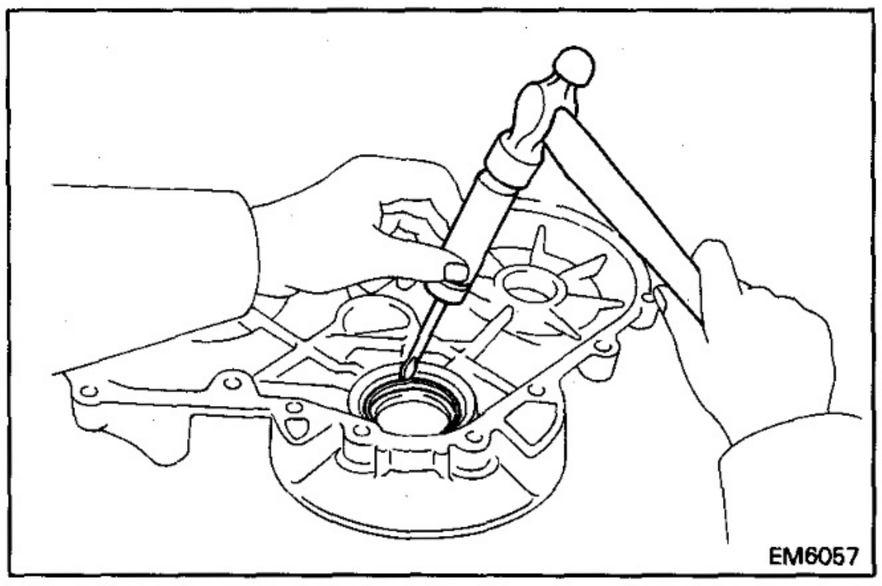
(See page EM-57)

Standard thrust clearance:	**0.06 — 0.13 mm (0.0024 — 0.0051 in.)**
Maximum thrust clearance:	**0.30 mm (0.0118 in.)**

REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL

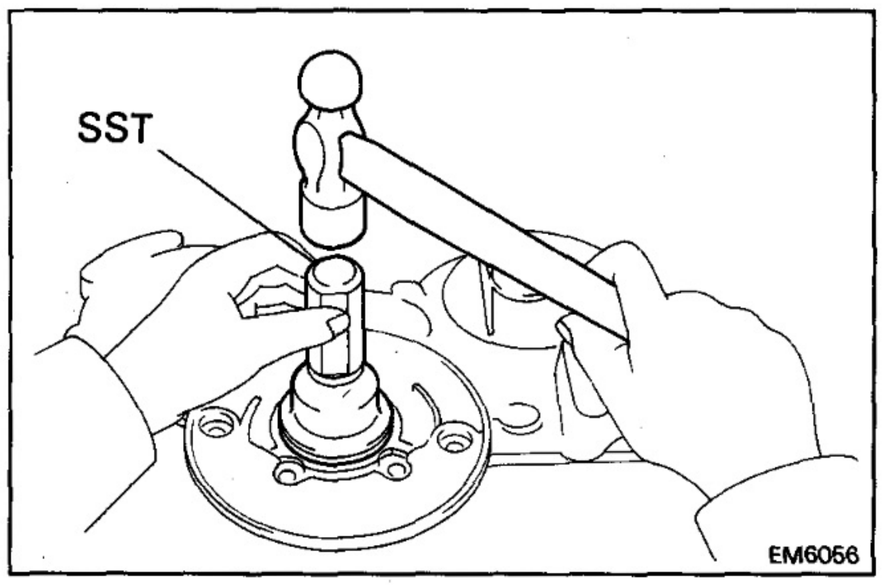
REPLACE CRANKSHAFT FRONT OIL SEAL

HINT: There are two methods (A and B) to replace the oil seal as follows.



A. If timing gear cover is removed from cylinder block:

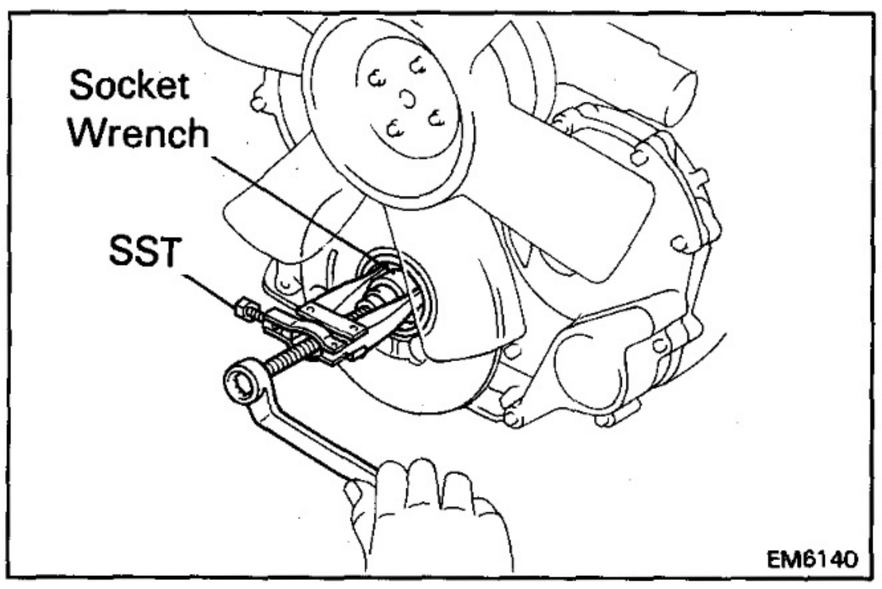
(a) Using a screwdriver and hammer, tap out the oil seal.



(b) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.

SST 09223-46011

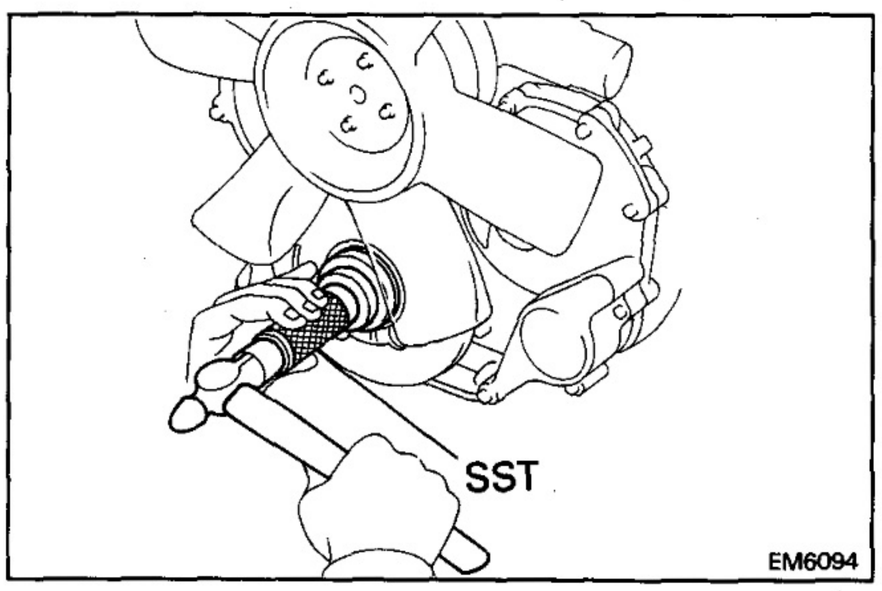
(c) Apply MP grease to the oil seal lip.



B. If timing gear cover is installed to cylinder block:

(a) Using SST and a socket wrench, remove the oil seal.

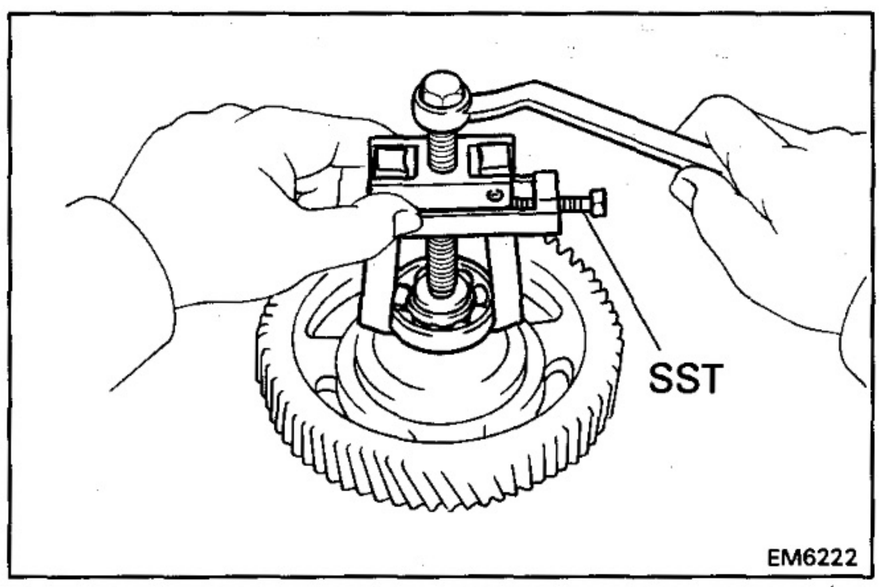
SST 09308-10010



(b) Apply MP grease to a new oil seal lip.

(c) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.

SST 09223-46011

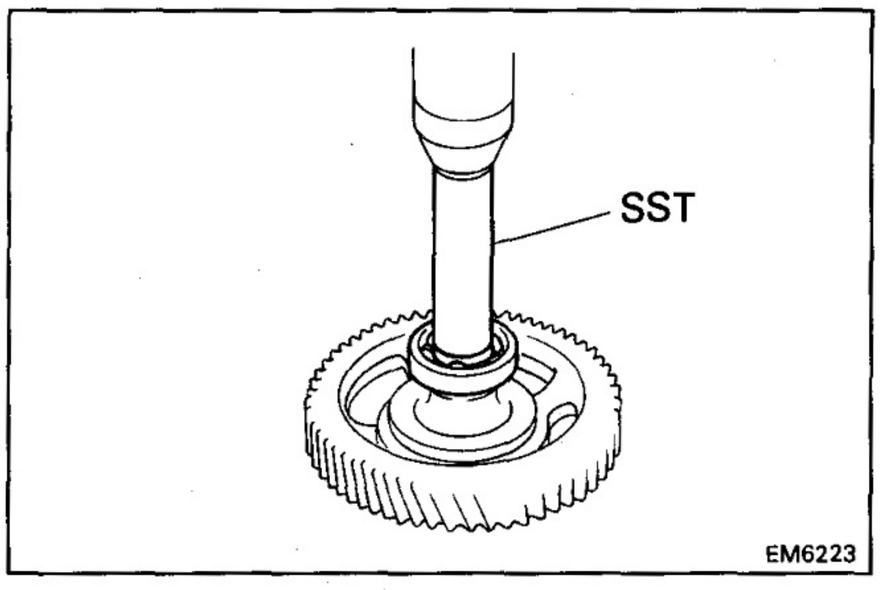


REPLACEMENT OF INJECTION PUMP DRIVE GEAR BEARING

1. REMOVE BEARING

Using SST, remove the bearing.

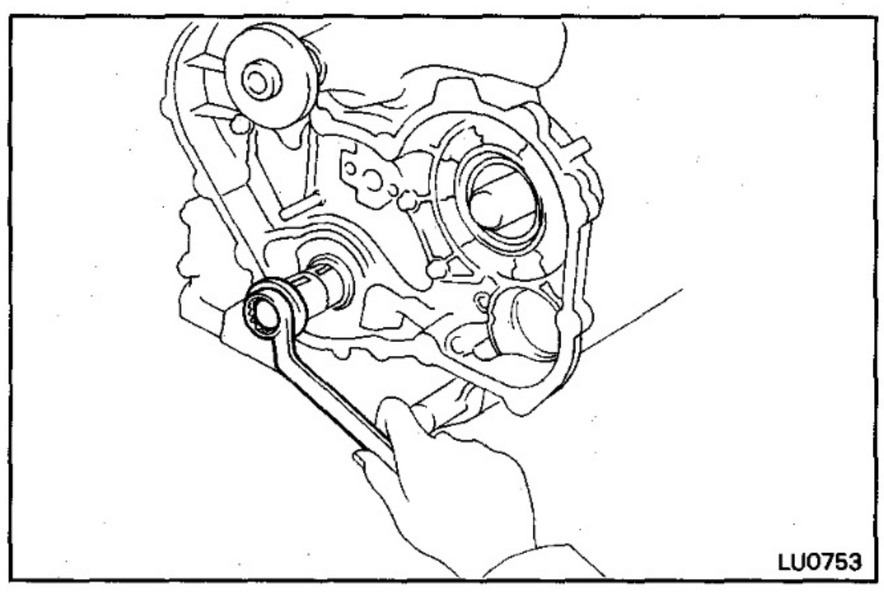
SST 09286-46011



2. INSTALL BEARING

Using SST and a press, press in the bearing.

SST 09260-58010 (09285-76020)



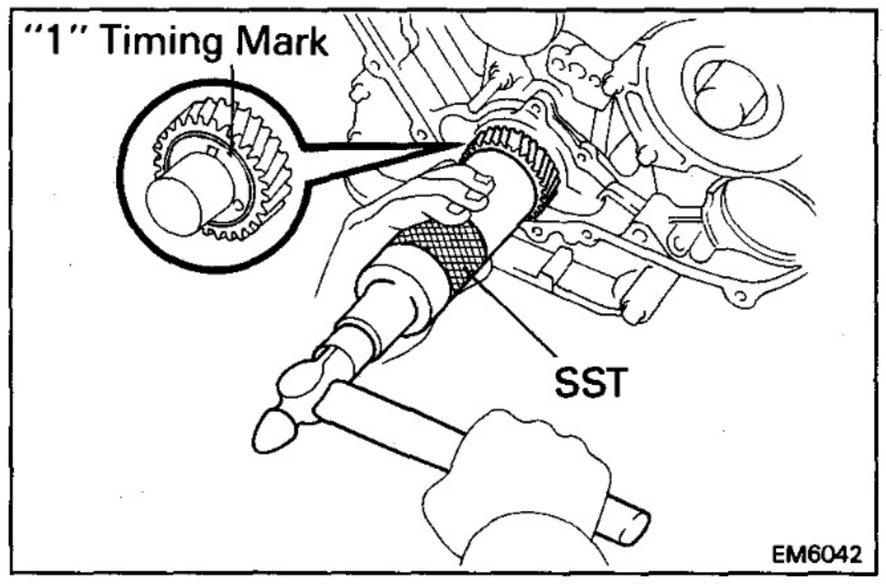
INSTALLATION OF TIMING GEARS AND CAMSHAFT

(See page EM-52)

1. INSTALL CRANKSHAFT TIMING GEAR

(a) Check the set key on crankshaft facing upward.

If not, then turn the crankshaft with a crankshaft pulley mount bolt.

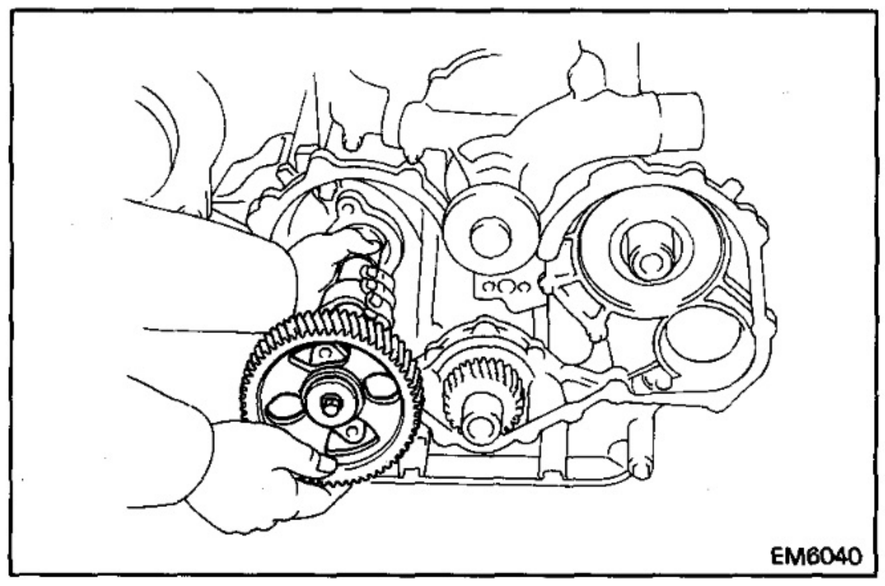


(b) Put the timing gear on the crankshaft with the "1" timing mark of the timing gear facing forward.

(c) Align the timing gear set key with the key groove of the timing gear.

(d) Using SST and a hammer, tap in the timing gear.

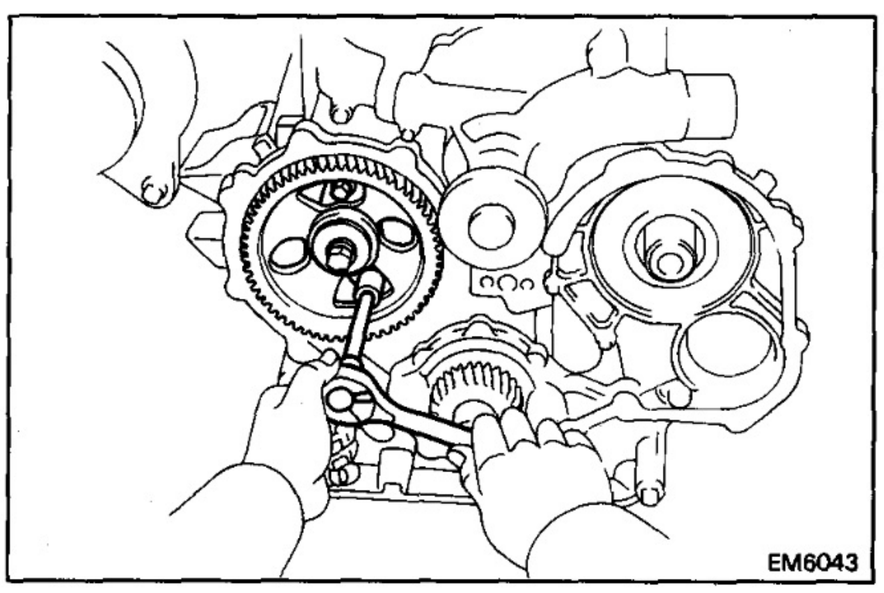
SST 09608-35014 (09608-06040)



2. INSTALL CAMSHAFT TIMING GEAR AND CAMSHAFT ASSEMBLY

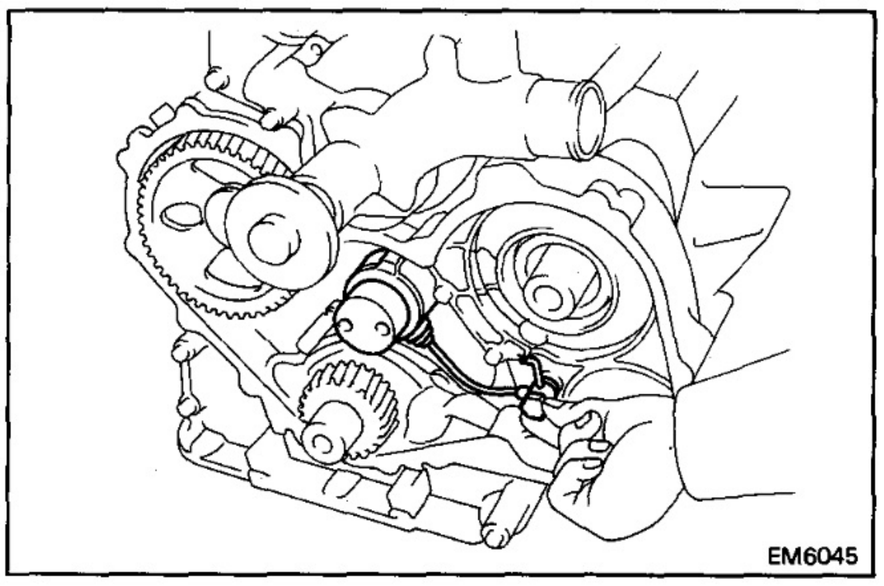
(a) Insert the camshaft into the cylinder block.

NOTICE: Be careful not to damage the camshaft bearings.



(b) Install and torque the two bolts.

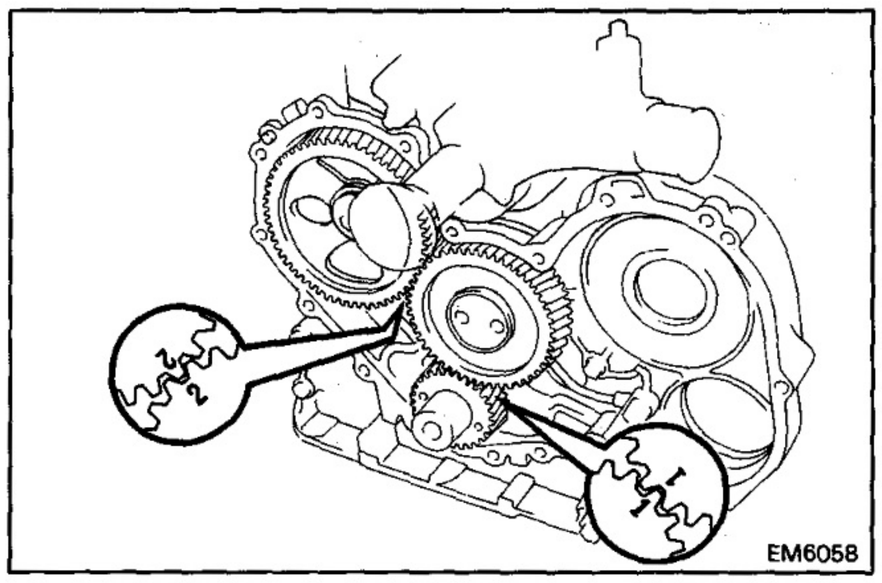
Torque: 185 kg-cm (13 ft-lb, 18 N·m)



3. INSTALL IDLE GEAR SHAFT

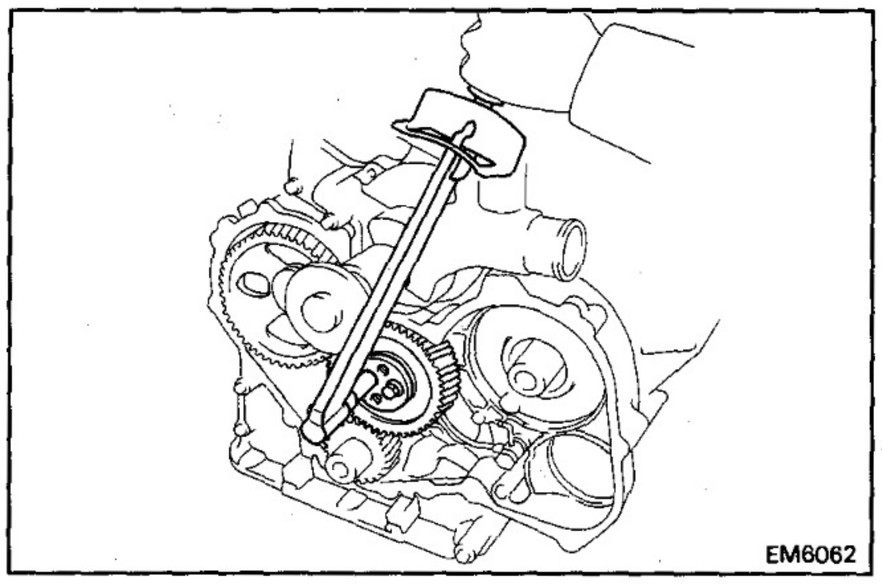
Temporarily install the idle gear shaft with the union bolt.

NOTICE: Do not tighten the union bolt.



4. INSTALL IDLE GEAR

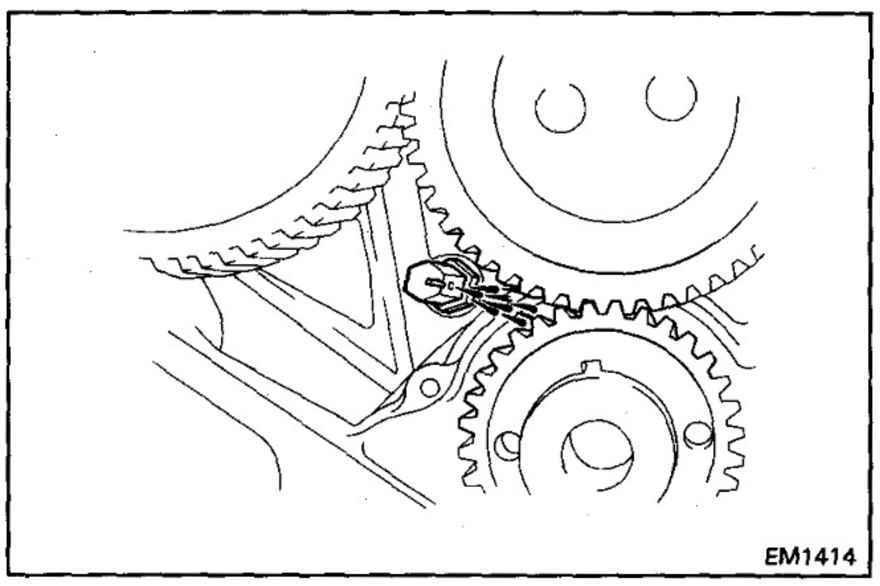
(a) Align the idle gear timing marks "1" and "2" with the crankshaft gear timing mark "1" and camshaft gear timing mark "2" respectively, and mesh the gears.



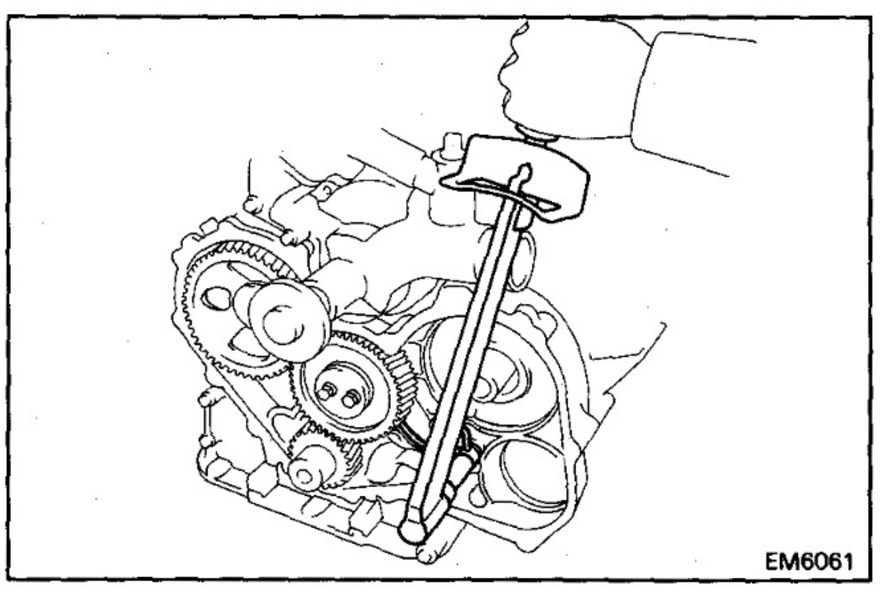
(b) Apply a light coat of engine oil on the threads and under the bolt heads.

(c) Install the thrust plate with the two bolts. Torque the bolts.

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

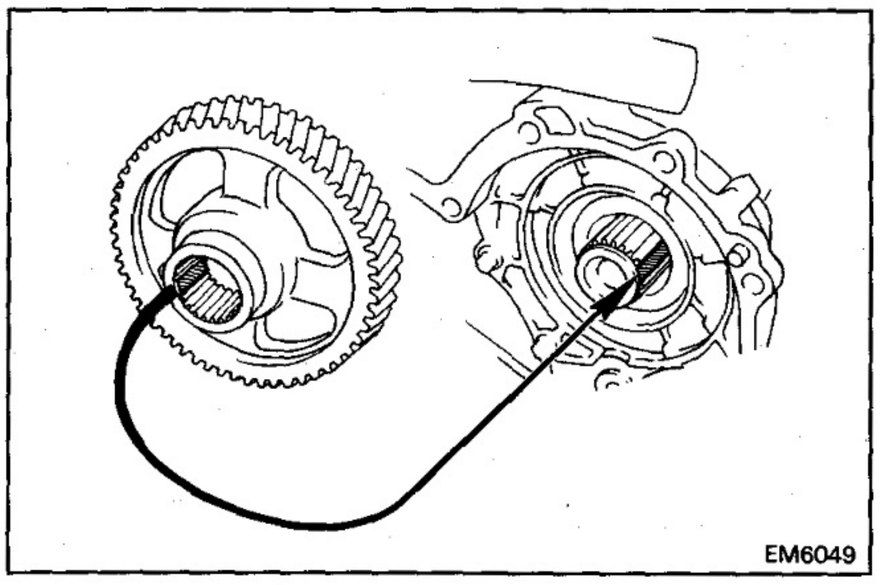


(d) Check that the oil nozzle is in the position shown.



5. TORQUE IDLE GEAR SHAFT UNION BOLT

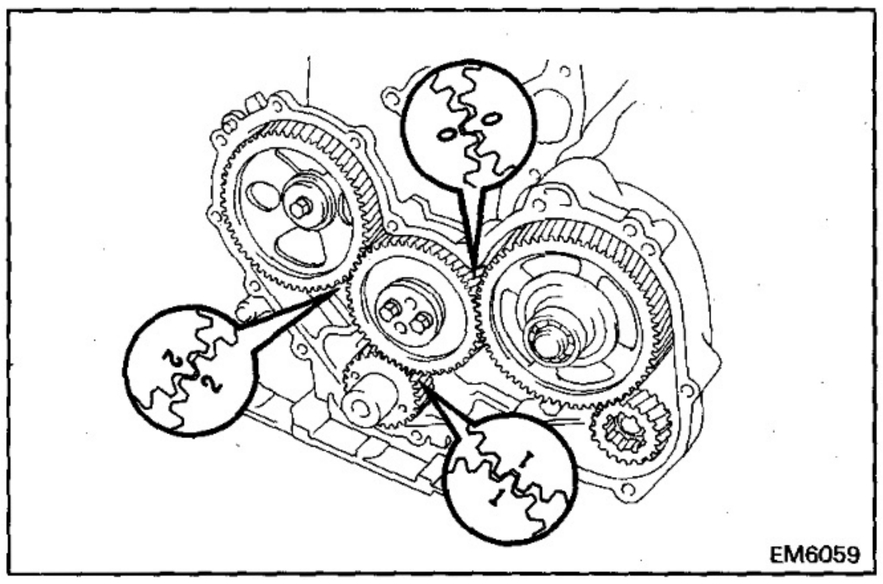
Torque: 110 kg-cm (8 ft-lb, 11 N·m)



6. INSTALL INJECTION PUMP DRIVE GEAR

(a) Apply MP grease to the drive gear spline, bearing and injection pump spline.

(b) Align the spline toothless portions of the injection pump drive gear and injection pump, and install the injection pump drive gear.



(c) Align the idle gear timing mark 0 with the injection pump drive gear timing mark 0, and mesh the gears.

7. INSTALL VACUUM PUMP

8. CHECK TIMING GEAR BACKLASH
(See page EM-55)

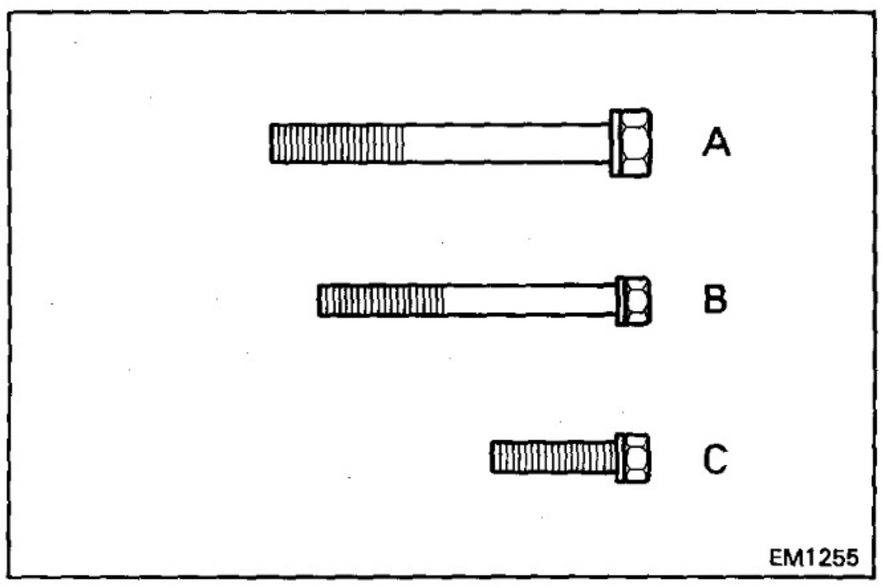
Standard backlash: **0.058 — 0.162 mm (0.0023 — 0.0064 in.)**
Maximum backlash: **0.30 mm (0.0118 in.)**

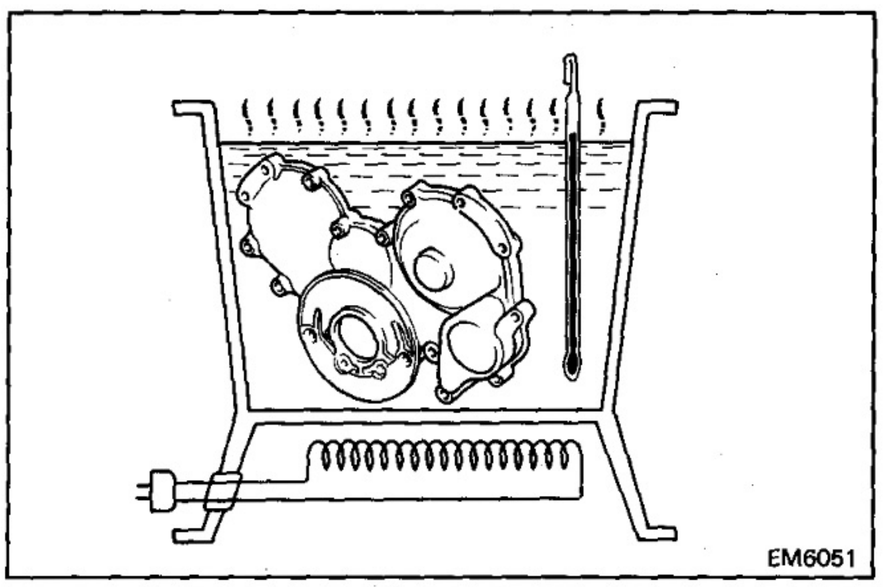
9. CHECK IDLE GEAR THRUST CLEARANCE
(See page EM-55)

Standard thrust clearance: **0.06 — 0.17 mm (0.0024 — 0.0067 in.)**
Maximum thrust clearance: **0.30 mm (0.0118 in.)**

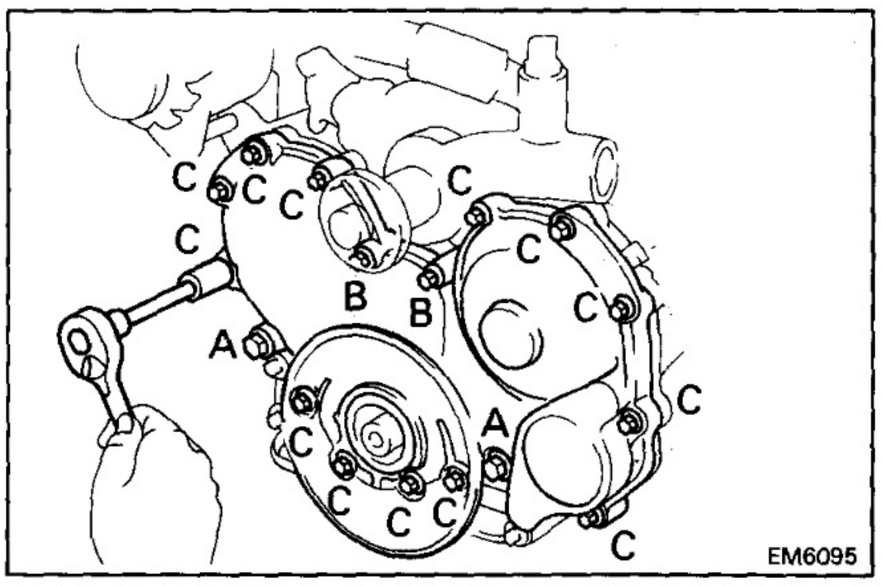
10. INSTALL TIMING GEAR COVER

HINT: Use the bolts indicated by A, B and C.



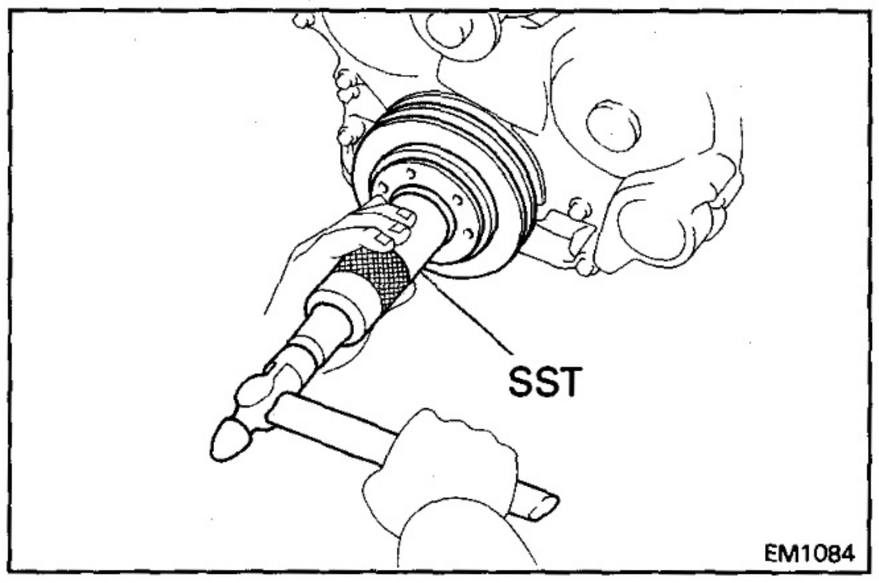


(a) Gradually heat the timing gear cover to approx. 60°C (140°F).



(b) Install a new gasket and the warmed gear cover with seventeen bolts.

Torque: **A** **375 kg-cm (27 ft-lb, 37 N·m)**
B and C **185 kg-cm (13 ft-lb, 18 N·m)**

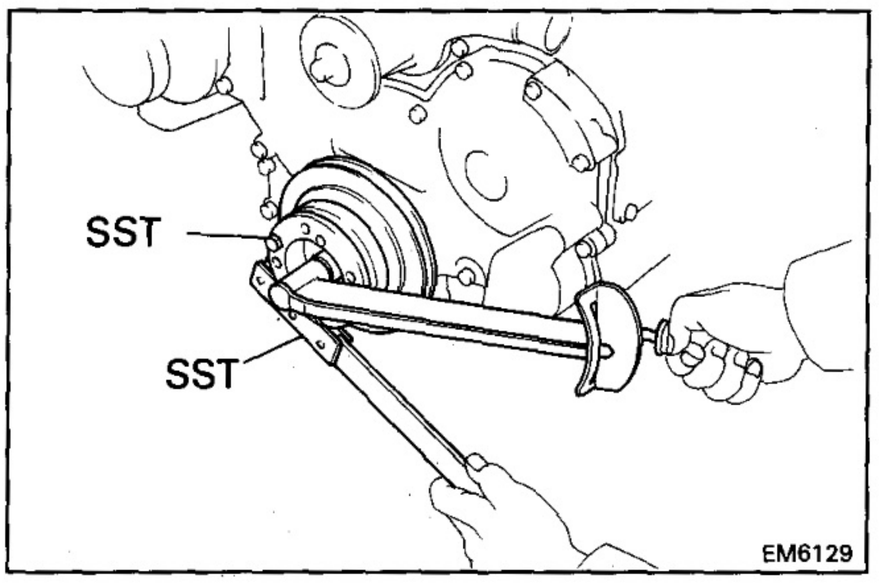


11. INSTALL CRANKSHAFT PULLEY

(a) Align the pulley set key with the key groove of the pulley.

(b) Using SST and a hammer, tap in the pulley.

SST 09608-35014 (09608-06040)

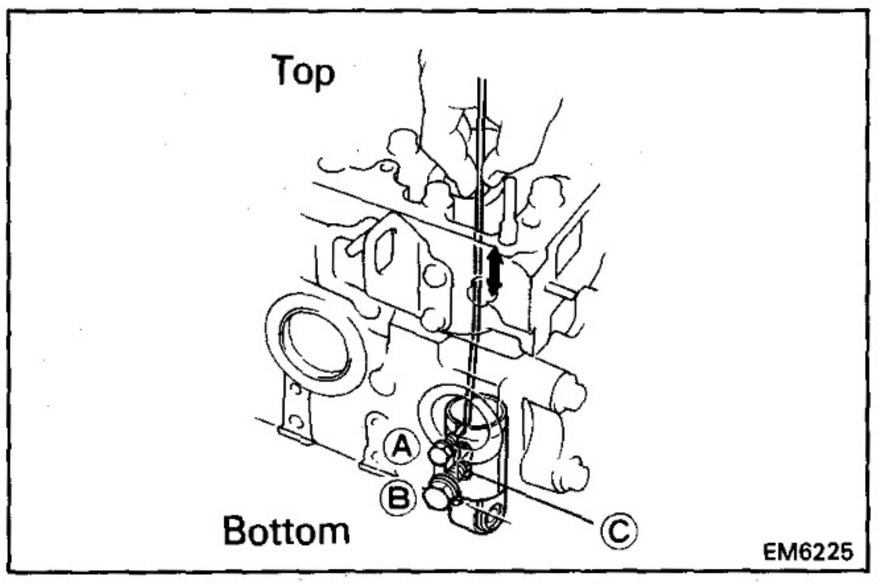


(c) Apply a light coat of engine oil on the threads and under the bolt head.

(d) Using SST, install and torque the pulley mount bolt.

SST 09213-58011 and 09330-00021

Torque: 3,000 kg-cm (217 ft-lb, 294 N·m)



12. DISPLACE VALVE LIFTERS

(a) Remove bolt Ⓐ and let the lifter slide down.

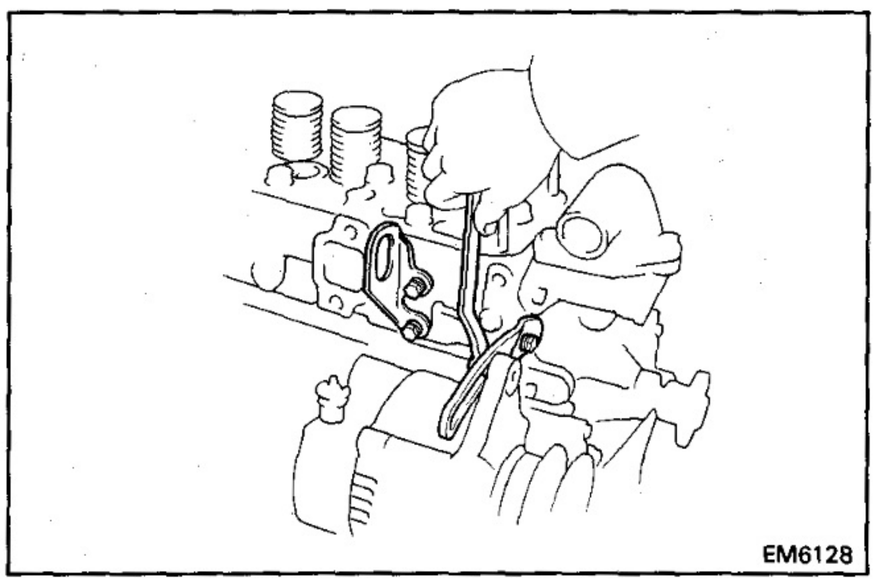
(b) Install bolts Ⓐ and Ⓑ with new gaskets.

Torque: Bolt Ⓐ 75 kg-cm (4.7 in.-lb, 7.4 N·m)
Bolt Ⓑ 375 kg-cm (28 ft-lb, 37 N·m)

HINT: When installing bolt Ⓑ, check that the hole for bolt Ⓑ is aligned with long hole Ⓒ of valve lifter.

(c) Check that the valve lifter can move up and down within the limits of long hole Ⓒ.

HINT: Be careful not to scratch the valve lifter.



13. INSTALL NO. 1 ENGINE HANGER AND DRIVE BELT ADJUSTING BAR

14. **INSTALL EXHAUST MANIFOLD (See page EM-48)**

15. **INSTALL VALVE ROCKER SHAFT ASSEMBLY (See steps 3 to 6 on pages EM-47 and 48)**

16. **INSTALL WATER PUMP PULLEY AND FAN (See page CO-12)**

17. **INSTALL AND ADJUST DRIVE BELT (See page CH-5)**

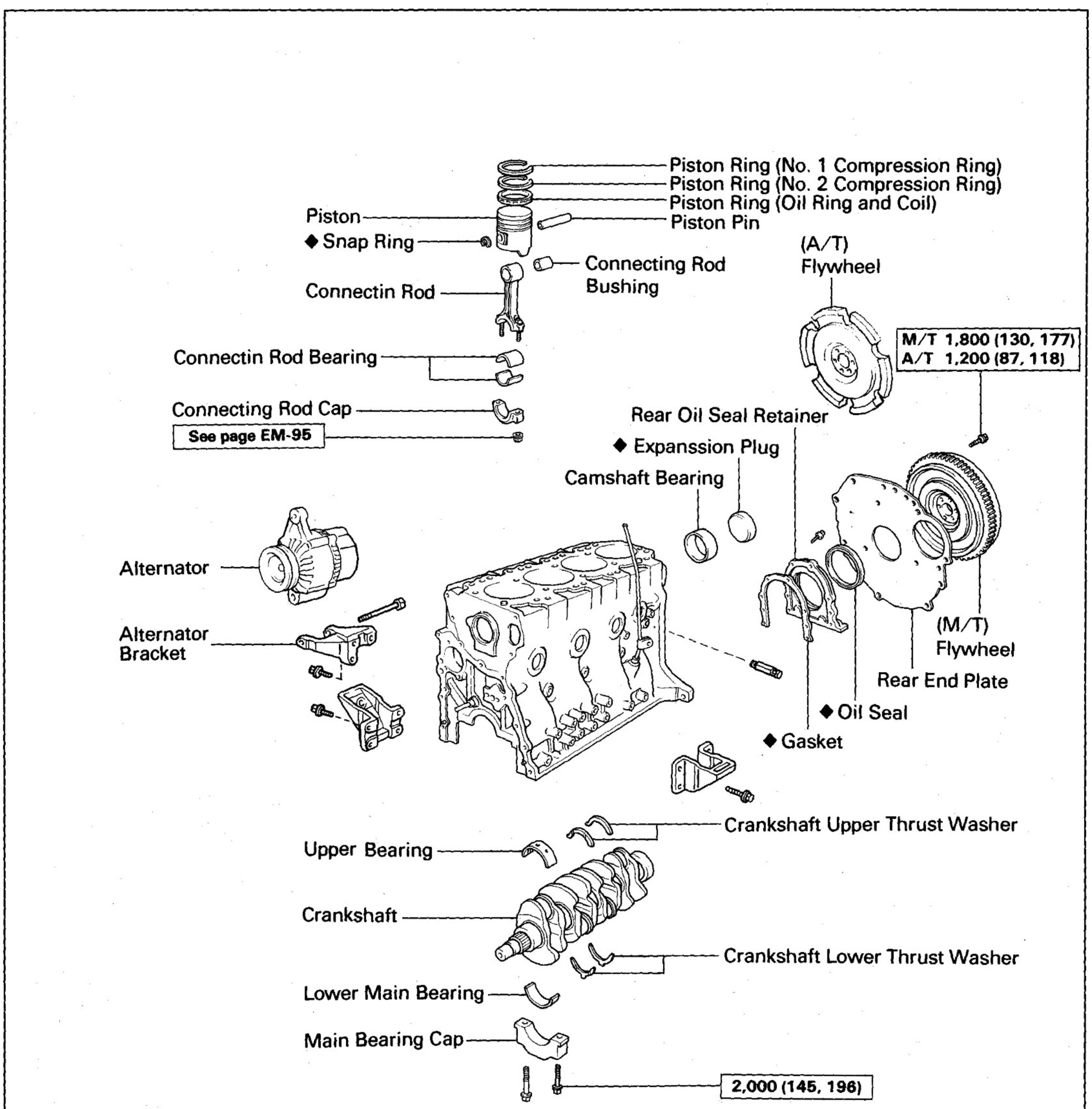
18. **START ENGINE AND CHECK FOR LEAKS**

19. **CHECK ENGINE OIL LEVEL (See page LU-4)**

20. **READJUST VALVE CLEARANCES (See page EM-22)**

CYLINDER BLOCK

COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

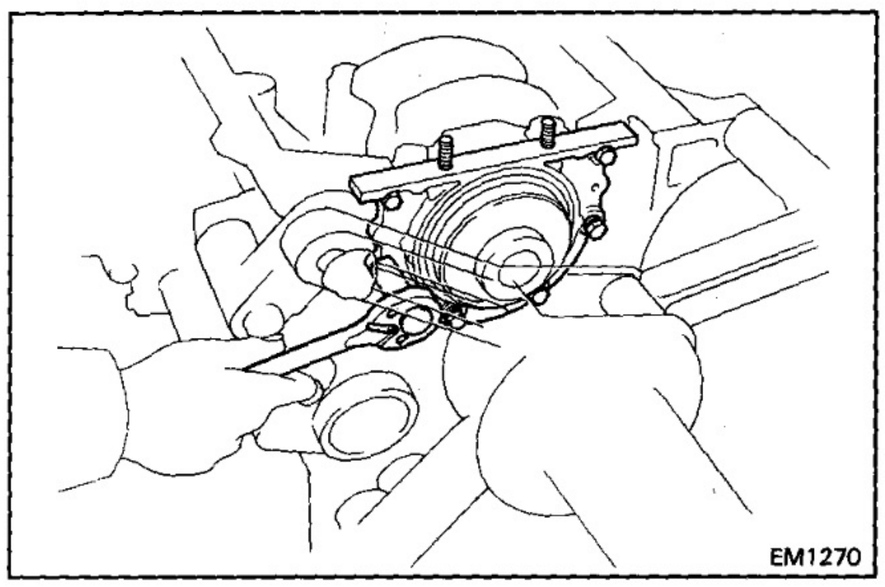
◆ Non-reusable part

EM6144

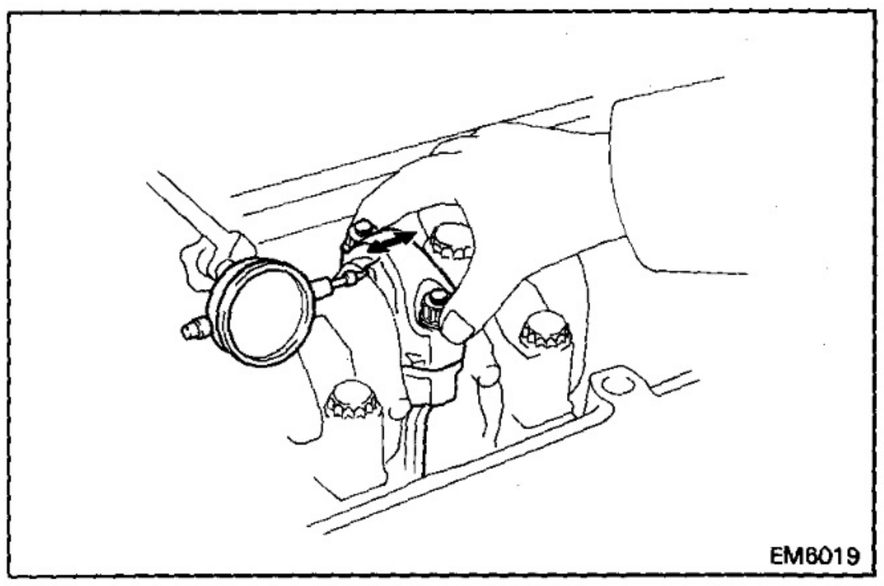
DISASSEMBLY OF CYLINDER BLOCK

(See page EM-67)

1. [M/T]
   REMOVE FLYWHEEL
2. [A/T]
   REMOVE SPACER, DRIVE PLATE AND FLYWHEEL
3. REMOVE REAR END PLATE
4. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
5. REMOVE INJECTION PIPES
   (See page FU-8) B and 3B
   (See page FU-14) 11B and 14B
6. REMOVE ALTERNATOR
7. REMOVE CYLINDER HEAD (See page EM-31)
8. REMOVE TIMING GEARS AND CAMSHAFT
   (See pages EM-53)
9. REMOVE INJECTION PUMP (See page FU-20)
10. REMOVE OIL PAN AND OIL PUMP (See page LU-8)



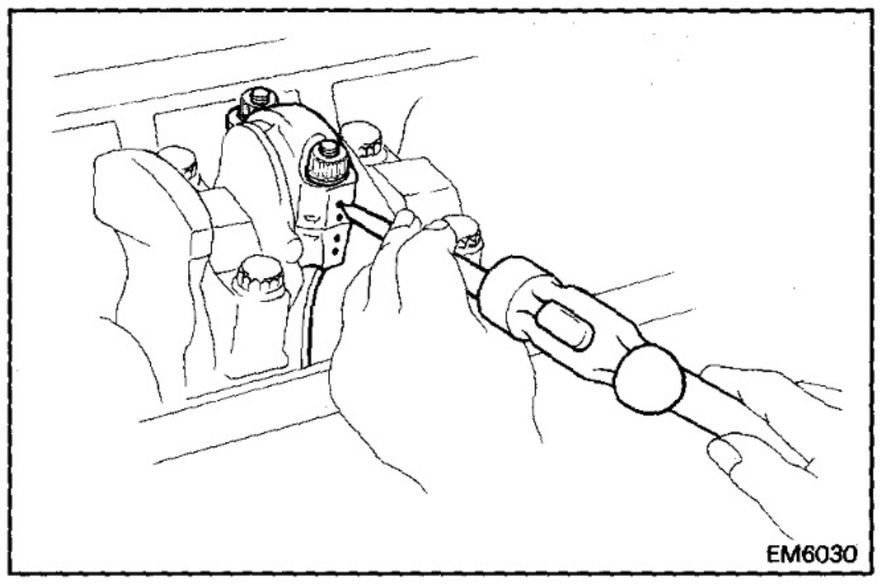
11. REMOVE REAR OIL SEAL RETAINER
    Remove the six bolts, retainer and gasket.



12. CHECK CONNECTING ROD THRUST CLEARANCE
    Using a dial indicator, measure the thrust clearance while moving the rod back and forth.

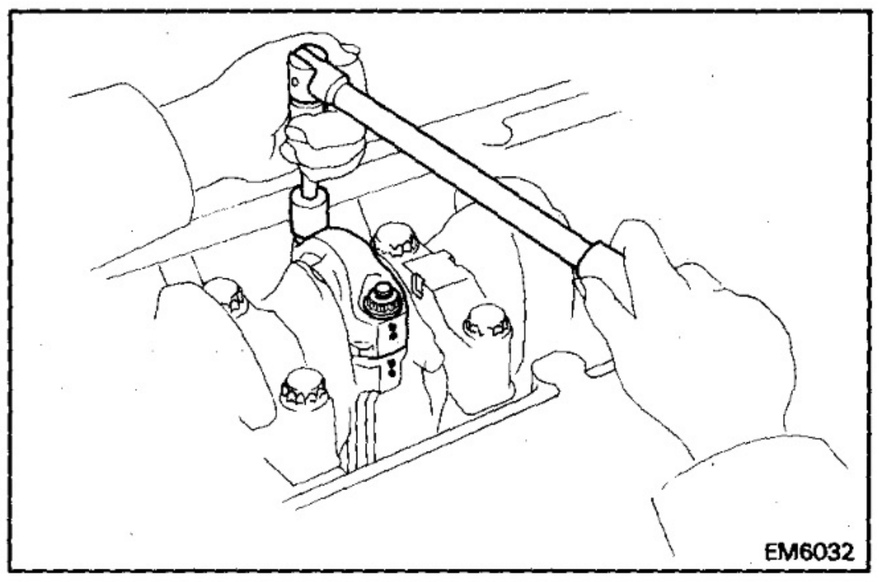
    Standard thrust clearance: **0.200 — 0.320 mm (0.0079 — 0.0126 in.)**
    Maximum thrust clearance: **0.40 mm (0.0157 in.)**

    If the clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.

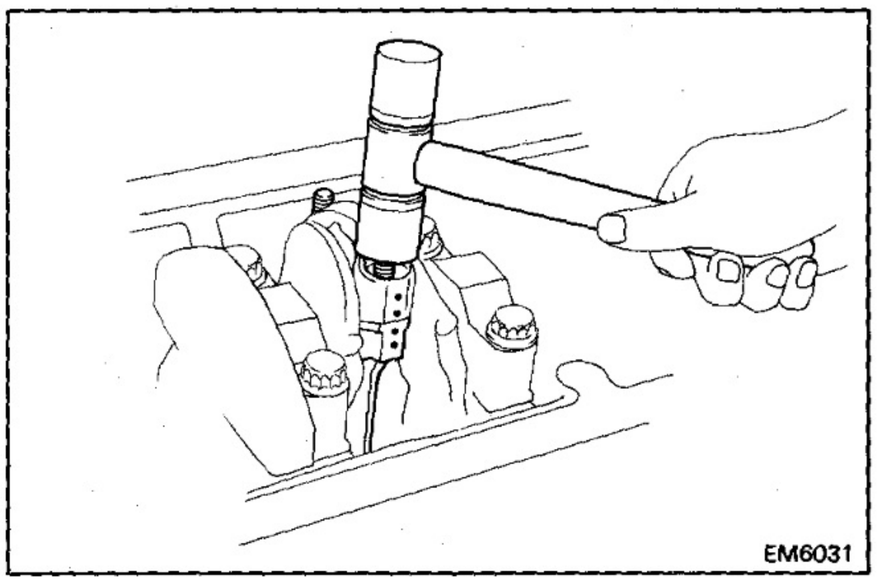

EM6030

13. REMOVE CONNECTIN ROD CAPS AND CHECK OIL CLEARANCE

(a) Using a punch or numbering stamp, place match-marks on the connecting rod and cap to ensure correct reassembly.

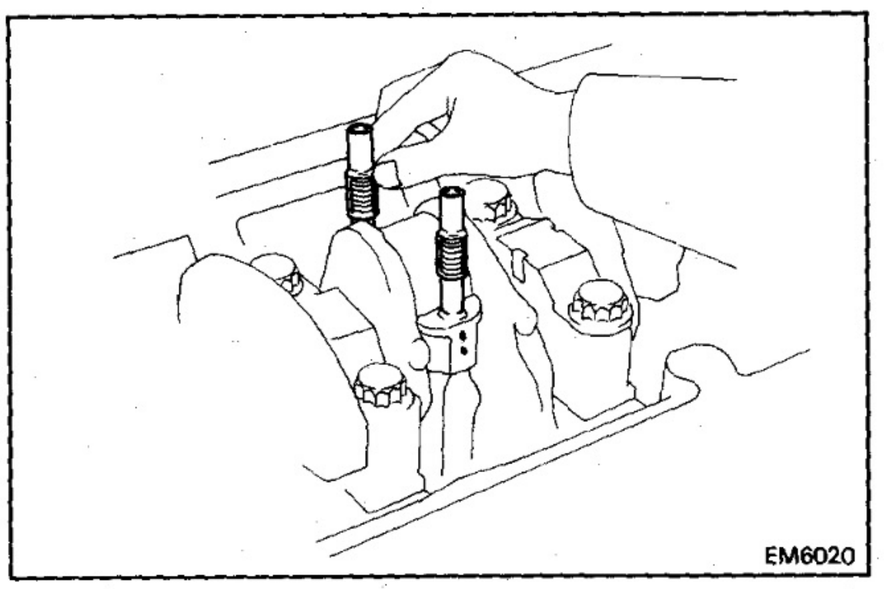

EM6032

(b) Remove the connecting rod cap nuts.

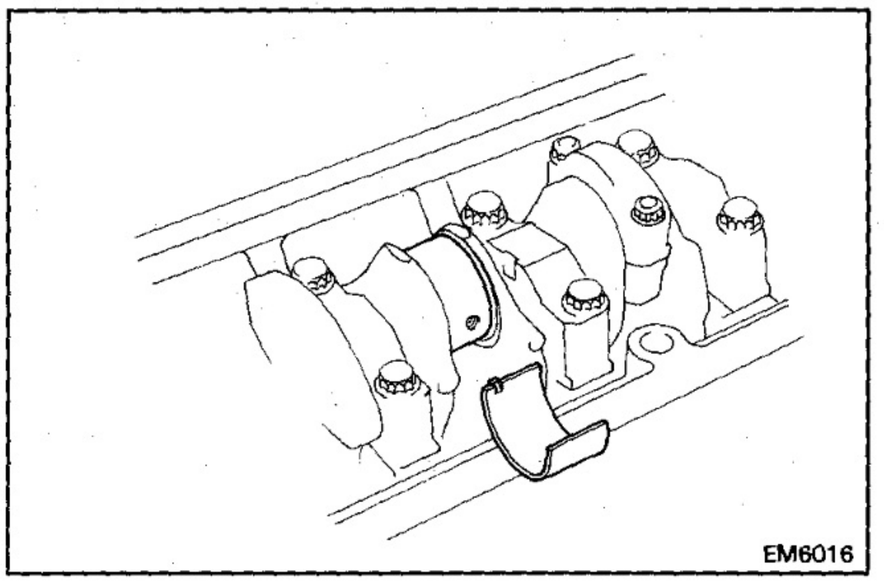

EM6031

(c) Using a plastic-faced hammer, lightly tap the connecting rod bolts and lift off the connecting rod cap.

HINT: Keep the lower bearing inserted with the connecting rod cap.


EM6020

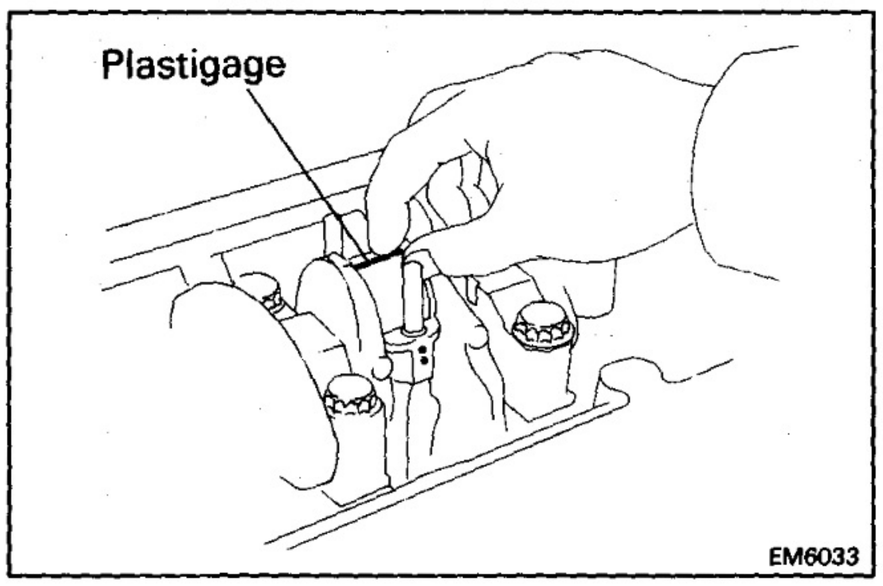
(d) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft from damage.


EM6016

(e) Clean the crank pin and bearing.

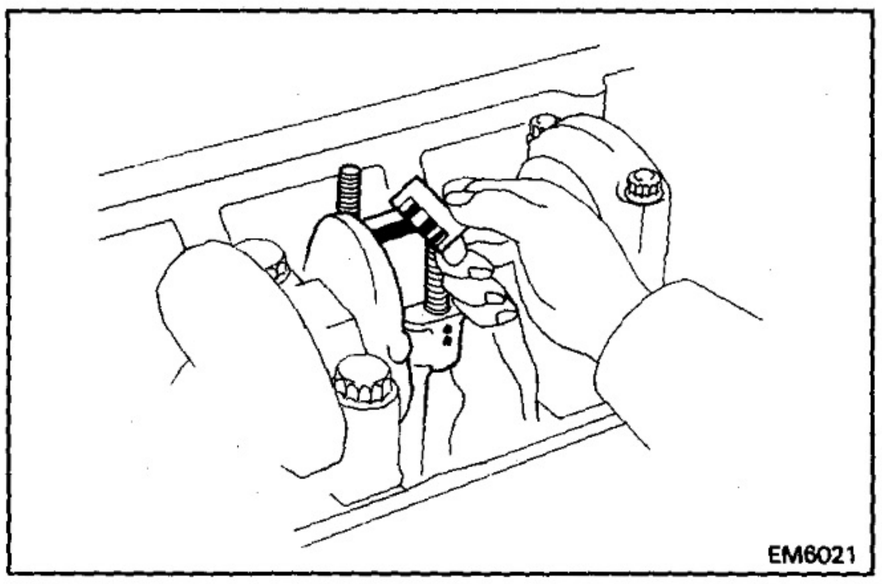
(f) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing are mamaged, replace the bearings. If necessary, grind or replace the crankshaft.



(g) Lay a strip of Plastigage across the crank pin.

(h) Install the connecting rod cap. (See page EM-95)



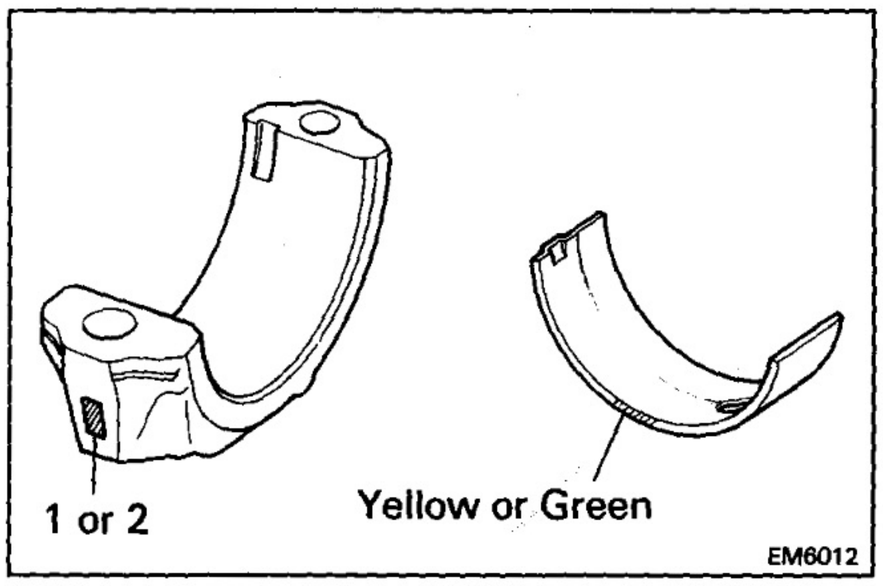
(i) Remove the connecting rod cap.

(j) Measure the Plastigage at its widest point.

Standard oil clearance: 0.030 — 0.070 mm (0.0012 — 0.0028 in.)

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the bearing. If necessary, grind or replace the crankshaft.



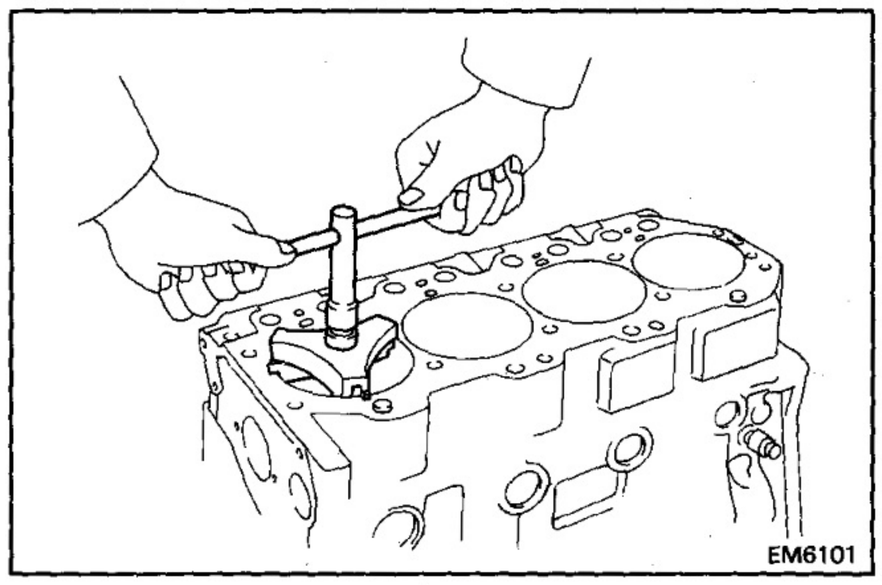
HINT: There are two sizes of standard bearings, colored yellow and green. If using a stadard bearing, select one having the color corresponding to the number on the bearing cap:

1 with Yellow
2 with Green

mm (in.)

Item	Size	Big end inner diameter	Crank pin diameter	Bearing center wall thickness
B	1 or Yellow	62.000 — 62.010 (2.4409 — 2.4413)	58.980 — 59.000 (2.3220 — 2.3228)	1.480 — 1.485 (0.0583 — 0.0585)
	2 or Green	62.011 — 62.020 (2.4414 — 2.4417)		1.486 — 1.490 (0.0585 — 0.0587)
	U/S 0.25	62.000 — 62.020 (2.4409 — 2.4417)	58.740 — 58.750 (2.3126 — 2.3130)	1.604 — 1.610 (0.0635 — 0.0634)
	U/S 0.50		58.490 — 58.500 (2.3028 — 2.3031)	1.729 — 1.735 (0.0681 — 0.0683)
	U/S 1.00		57.990 — 58.000 (2.2831 — 2.2835)	1.979 — 1.985 (0.0779 — 0.0781)
3B 11B 14B	1 or Yellow	64.000 — 64.010 (2.5197 — 2.5201)	60.980 — 61.000 (2.4008 — 2.4016)	1.480 — 1.485 (0.0583 — 0.0585)
	2 or Green	64.011 — 64.020 (2.5201 — 2.5205)		1.486 — 1.490 (0.0585 — 0.0587)
	U/S 0.25	64.000 — 64.020 (2.5197 — 2.5205)	60.740 — 60.750 (2.3913 — 2.3917)	1.604 — 1.610 (0.0635 — 0.0634)
	U/S 0.50		60.490 — 60.500 (2.3815 — 2.3819)	1.729 — 1.735 (0.0681 — 0.0683)
	U/S 1.00		59.990 — 60.000 (2.3618 — 2.3622)	1.979 — 1.985 (0.0779 — 0.0781)

(k) Completely remove the Plastigage.

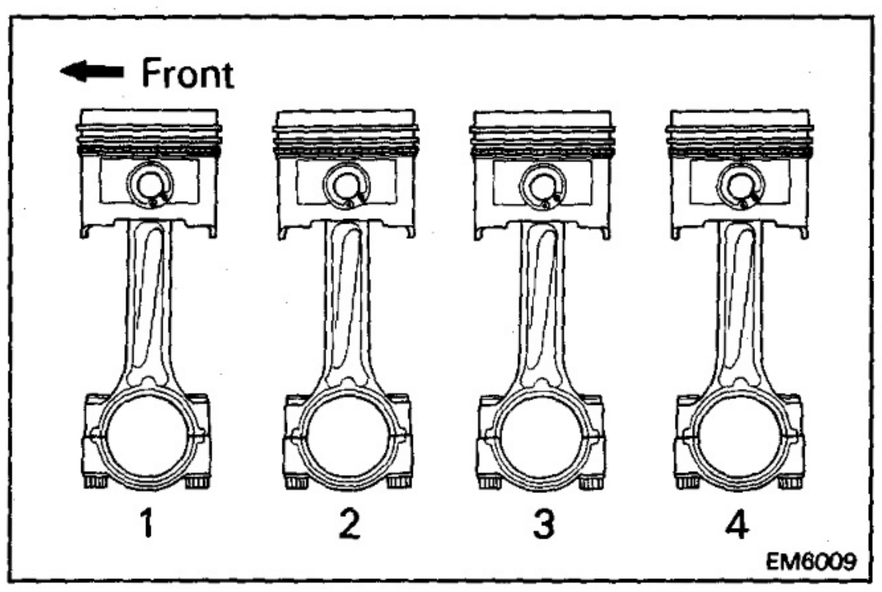


14. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(a) Remove all the carbon from the piston ring ridge.

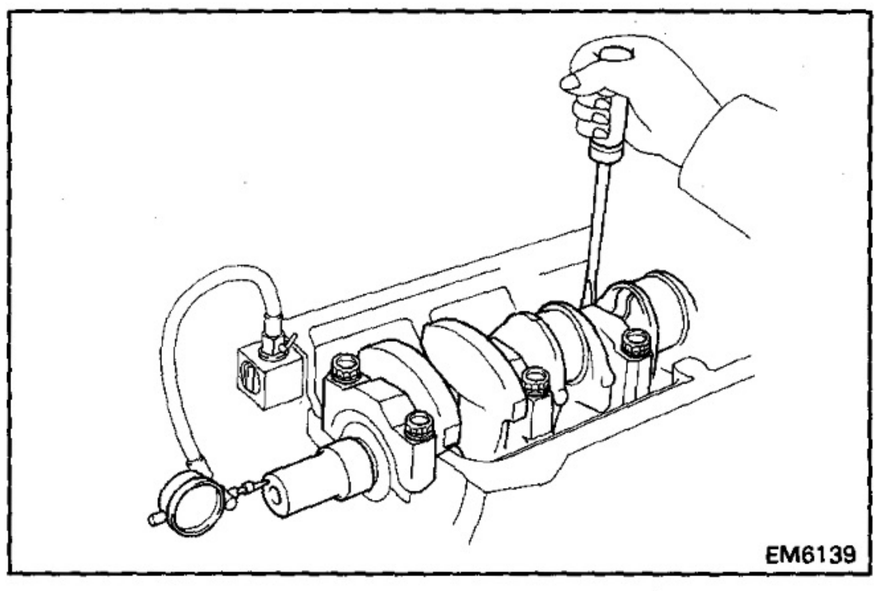
(b) Cover the connecting rod bolts. (See page EM-69)

(c) Push the piston, connecting rod assembly and upper bearing out through the top of the cylinder.



HINT:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in correct order.



15. CHECK CRANKSHAFT THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

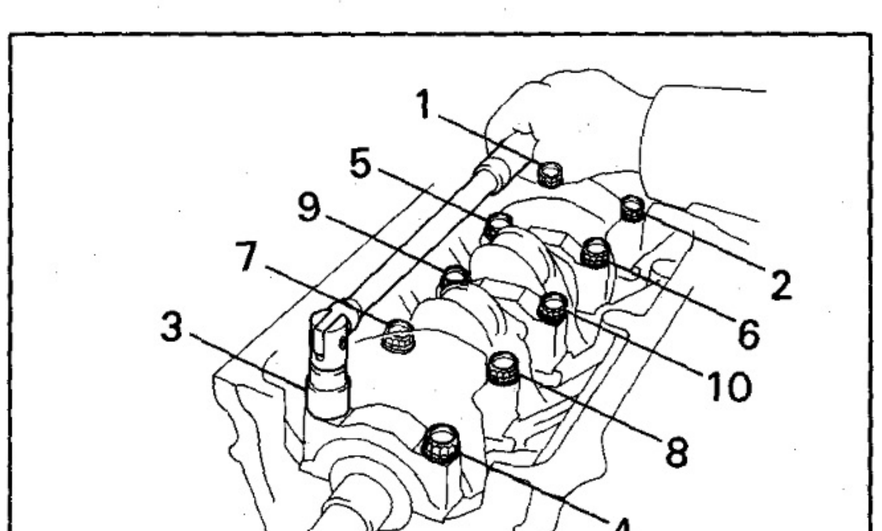
Standard thrust clearance: **0.040 — 0.250 mm (0.0016 — 0.0098 in.)**

Maximum thrust clearance: **0.40 mm (0.0157 in.)**

If the clearance is greater than maximum, replace the thrust washers as a set.

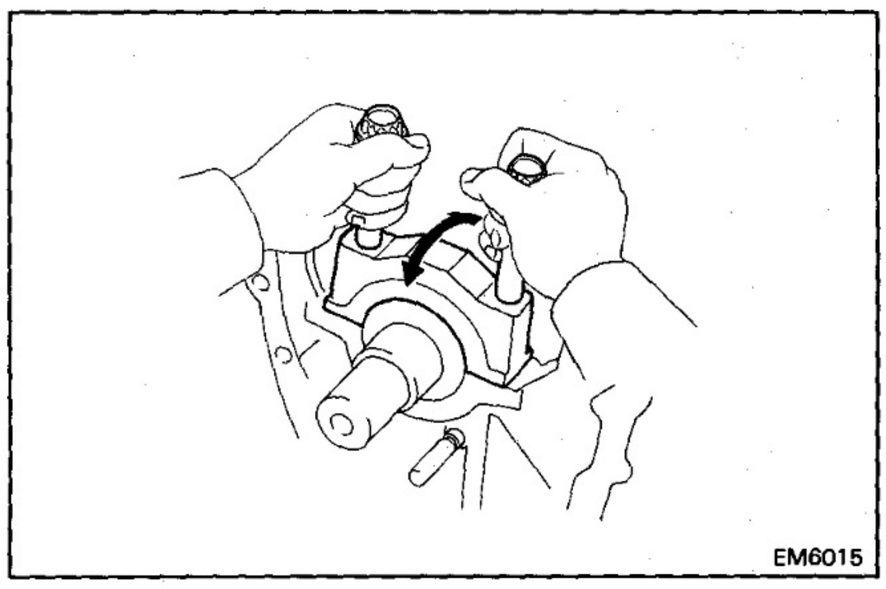
Thrust washer thickness:

STD size	**2.430 — 2.480 mm (0.0957 — 0.0976 in.)**
O/S 0.125	**2.493 — 2.543 mm (0.0981 — 0.1001 in.)**
O/S 0.250	**2.555 — 2.605 mm (0.1006 — 0.1026 in.)**



16. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Remove the main bearing cap bolts.

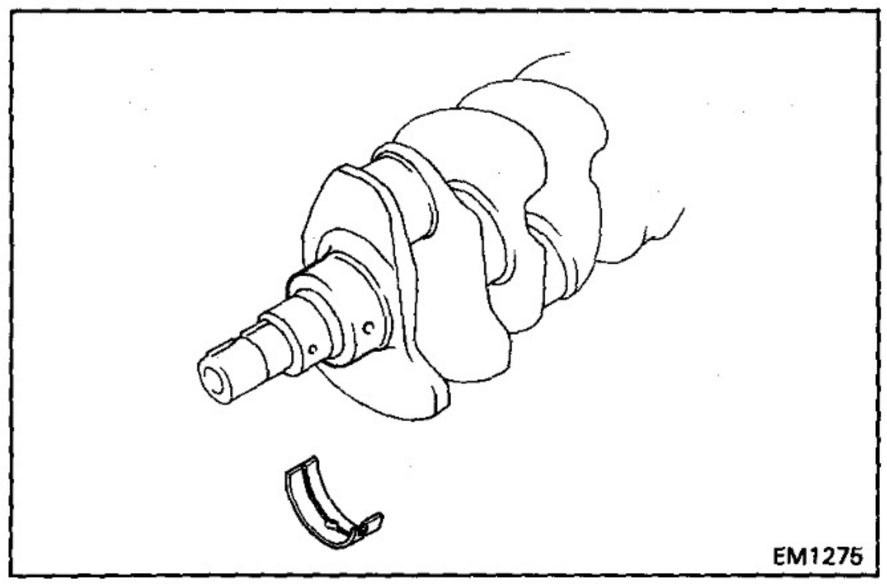


(b) Using the removed main bearing cap bolts, pry the cap back and forth, and remove the main bearing caps, lower bearings and lower thrust washers (No. 3 main bearing cap only).

HINT:
- Keep the lower bearing and main bearing cap together.
- Arrange the main bearing cap and lower thrust washers in correct order.

(c) Lift out the crankshaft.

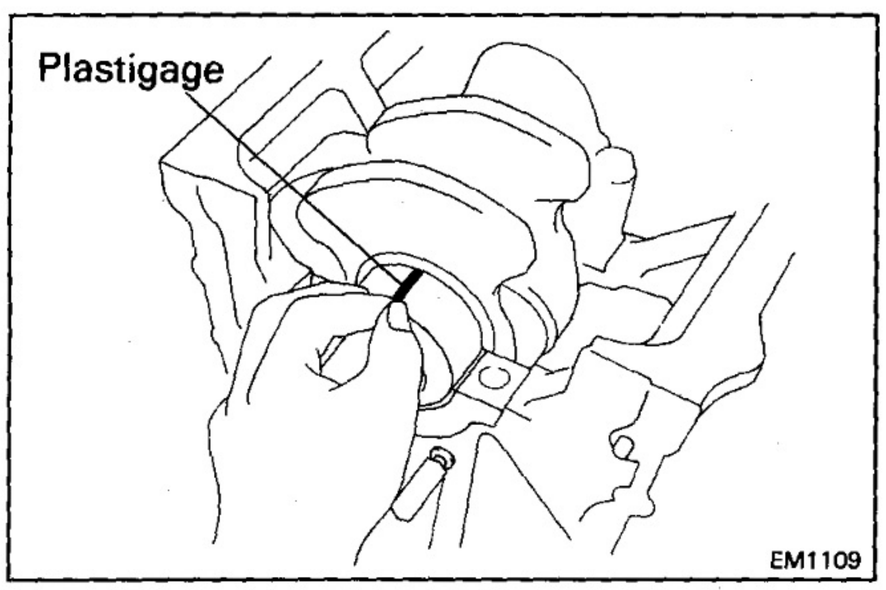
HINT: Keep the upper bearing and upper thrust washers together with the cylinder block.



(d) Clean each main journal and bearing.

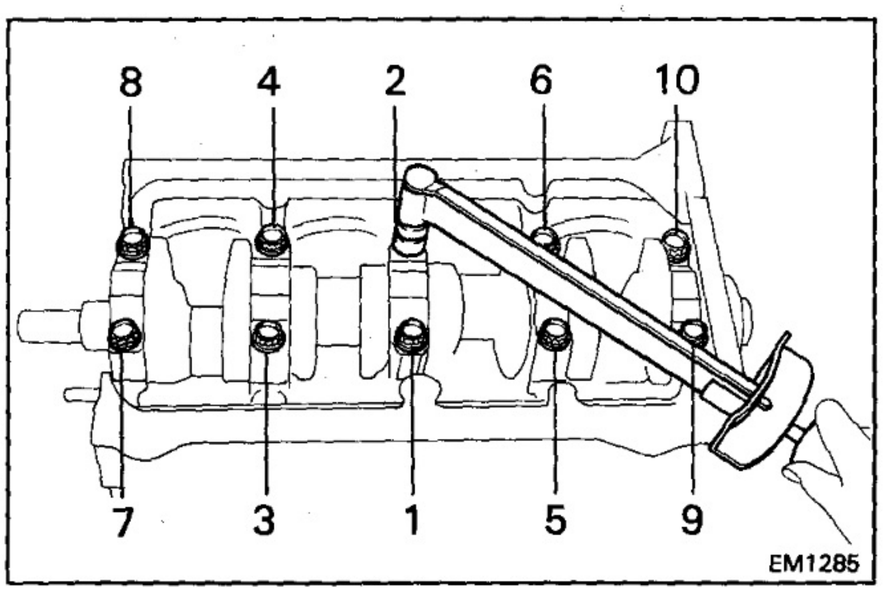
(e) Check each main journal and bearing for pitting and scratches.

If the journal or bearing are damaged, replace the bearing.
If necessary, grind or replace the crankshaft.



(f) Place the crankshaft on the cylinder block.

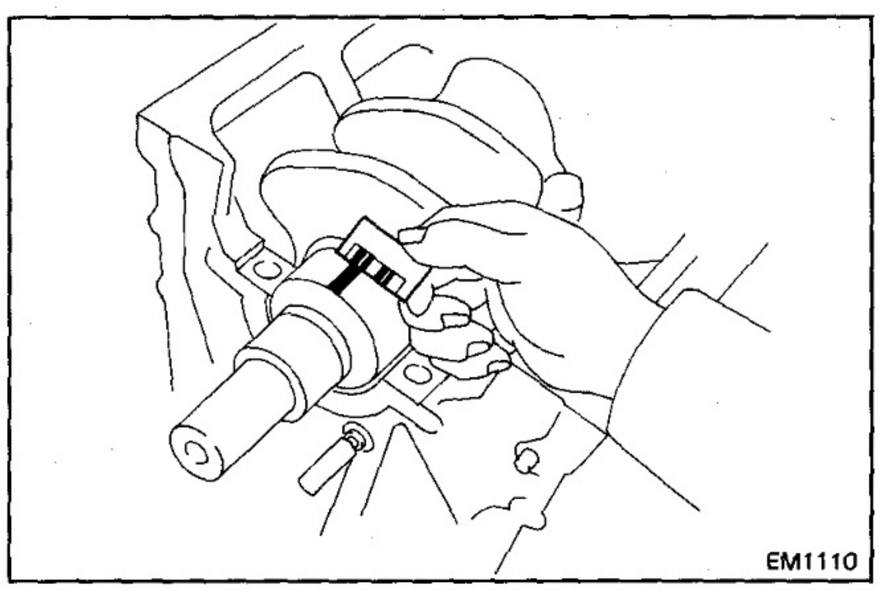
(g) Lay a strip of Plastigage across each of the main journal.



(h) Install the main bearing caps. (See page EM-94)

Torque: 2,000 kg-cm (145 ft-lb, 196 N·m)

HINT: Do not turn the crankshaft.



(i) Remove the main bearing caps.

(j) Measure the plastigage at its widest point.

Standard oil clearance:

No. 1, 2, 4 and 5 journal
0.030 — 0.074 mm
(0.0012 — 0.0029 in.)

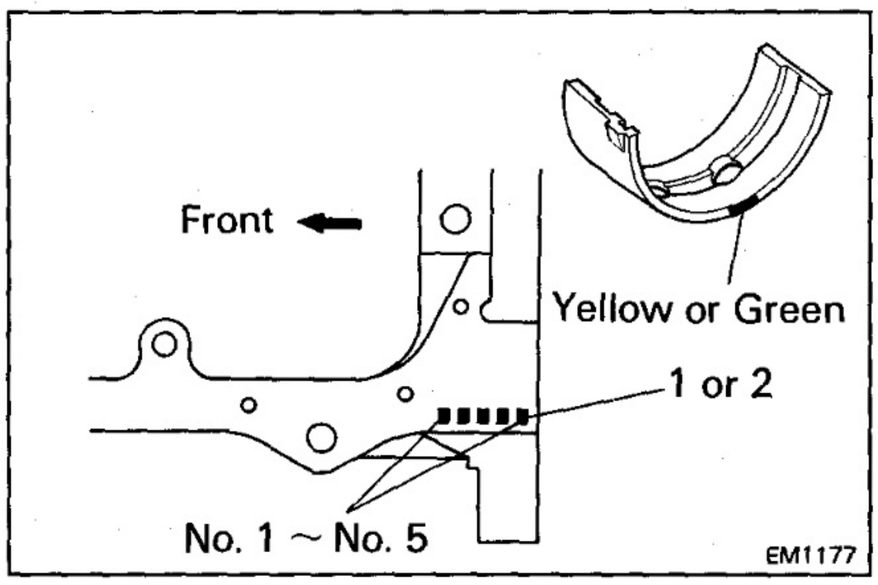
No. 3 journal **0.060 — 0.104 mm**
(0.0024 — 0.0041 in.)

Maximum oil clearance:

No. 1, 2, 4 and 5 journal
0.15 mm (0.0059 in.)

No. 3 journal **0.20 mm (0.0079 in.)**

If the clearance is greater than maximum, replace the main bearing. If necessary, grind or replace the crankshaft.



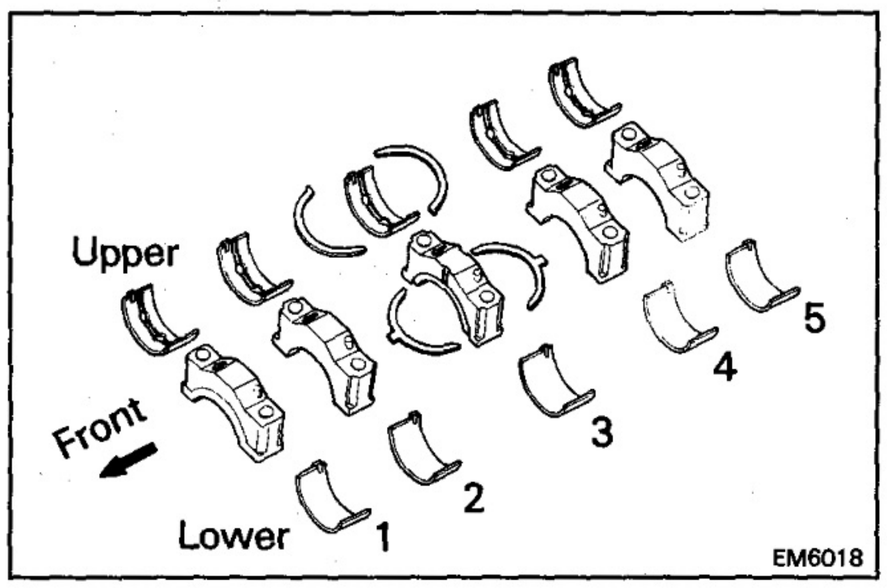
HINT: There are two sizes of standard bearings, colored yellow and green. If using a standard bearing, select one having the color corresponding to the number on the cylinder block:

1 with Yellow
2 with Green

mm (in.)

Size	Cylinder block main journal bore	Main journal diameter		Bearing center wall thickness
		No. 1, 2, 4 and 5 Journal	No. 3 Journal	
Yellow	75.000—75.012 (2.9528—2.9532)	69.980—70.000 (2.7551—2.7559)	69.950—69.970 (2.7539—2.7547)	2.480—2.485 (0.0976—0.0978)
Green	75.013—75.024 (2.9533—2.9537)			2.486—2.490 (0.0979—0.0980)
U/S 0.25	75.000—75.024 (2.9528—2.9537)	69.740—69.750 (2.7457—2.7461)		2.604—2.610 (0.1025—0.1028)
U/S 0.50		69.490—69.500 (2.7358—2.7362)		2.729—2.735 (0.1074—0.1077)
U/S 1.00		68.990—69.000 (2.7161—2.7165)		2.979—2.985 (0.1173—0.1175)

(k) Completely remove the Plastigage.

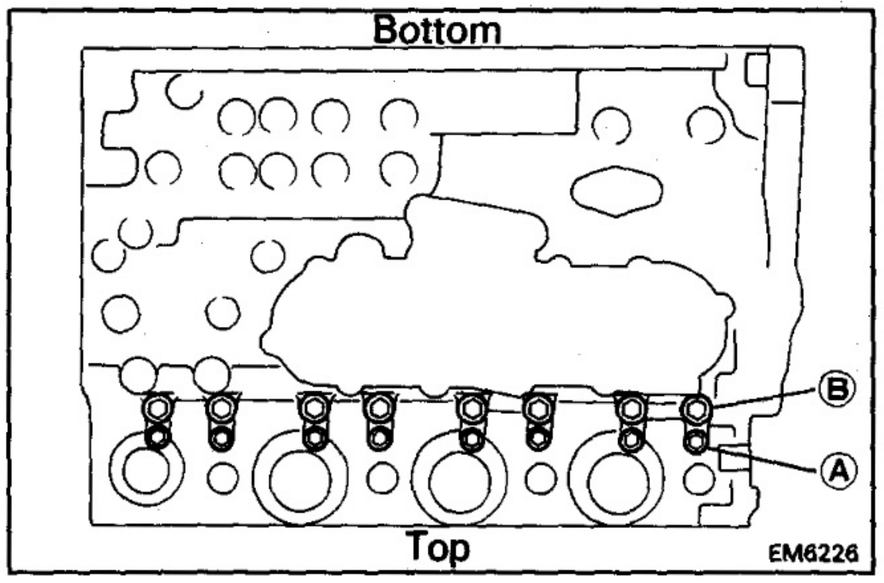


17. REMOVE CRANKSHAFT

(a) Lift out the crankshaft.

(b) Remove the upper bearings and upper thrust washers from the cylinder block.

HINT: Arrange the main bearing caps, bearings and thrust washers in correct order.



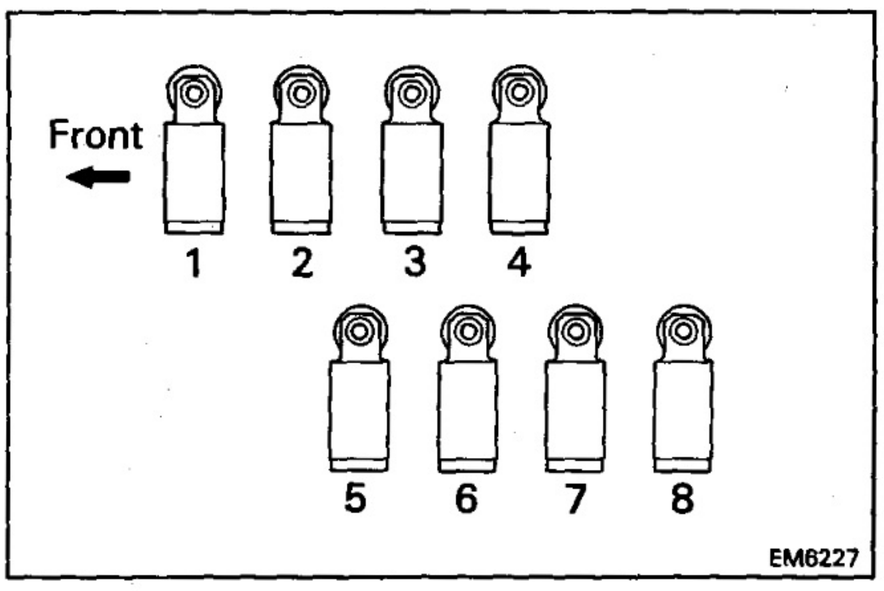
18. REMOVE VALVE LIFTERS

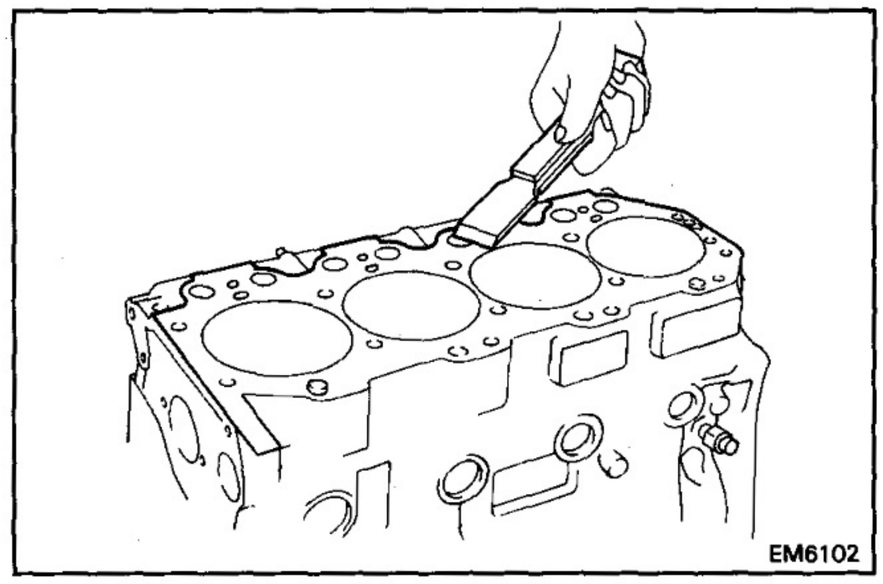
(a) Remove the eight Ⓑ bolts and pull out the valve lifters.

NOTICE: With the engine in the upside down position, the lifters will drop in the engine if the Ⓐ bolts are removed.

(b) Remove the eight Ⓐ bolts, if necessary.

HINT: Arrange the valve lifters in correct order.




EM6102

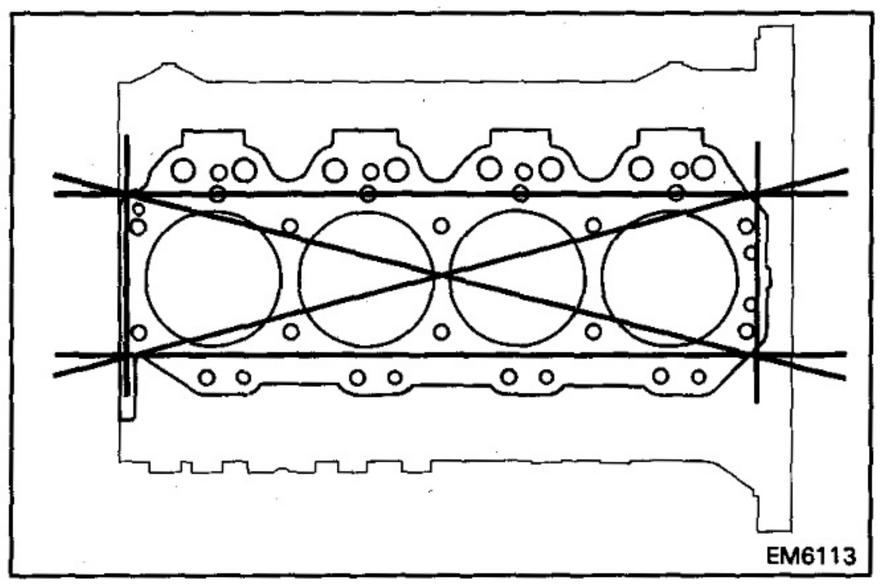
INSPECTION OF CYLINDER BLOCK

1. REMOVE GASKET MATERIAL

Using a gasket scraper, remove all the gasket material from the cylinder block surface.

2. CLEAN CYLINDER BLOCK

Using a soft brush and solvent, clean the block.

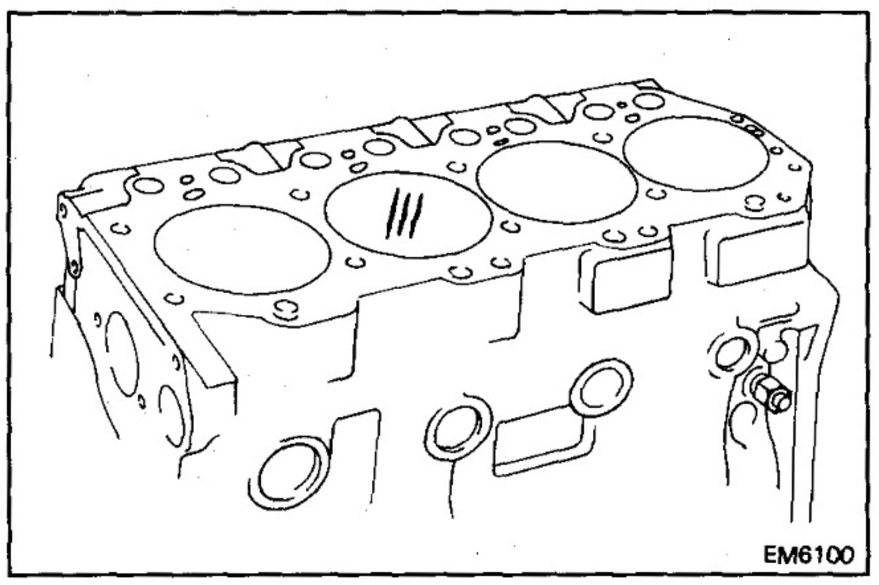

EM6113

3. INSPECT TOP OF CYLINDER BLOCK FOR FLATNESS

Using a precision straight edge and thickness gauge, measure the surfaces contacting the cylinder head gasket for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

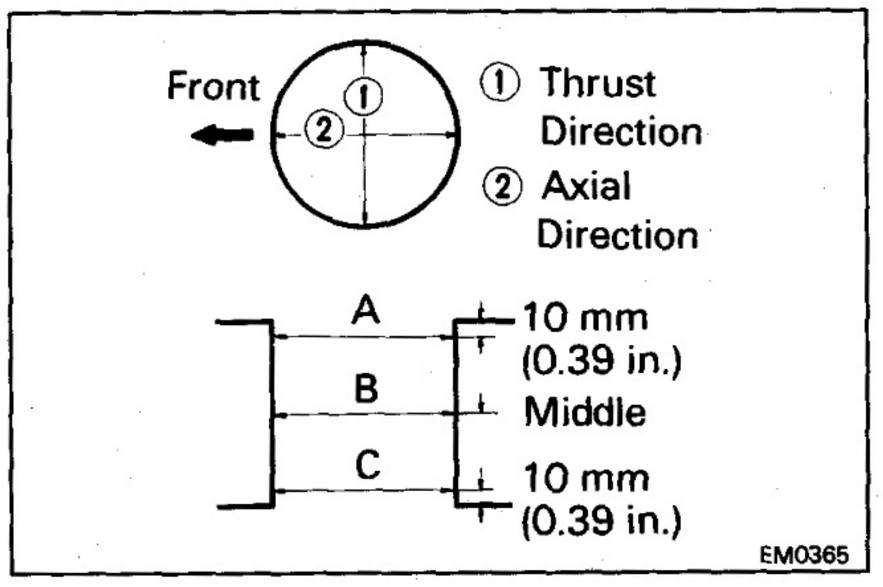
If warpage is greater than maximum, replace the cylinder block.


EM6100

4. INSPECT CYLINDER FOR VERTICAL SCRATCHES

Visually check the cylinder for vertical scratches.

If deep scratches are present, replace the cylinder block or rebore all four cylinder.



EM0365

5. INSPECT CYLINDER BORE DIAMETER

Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

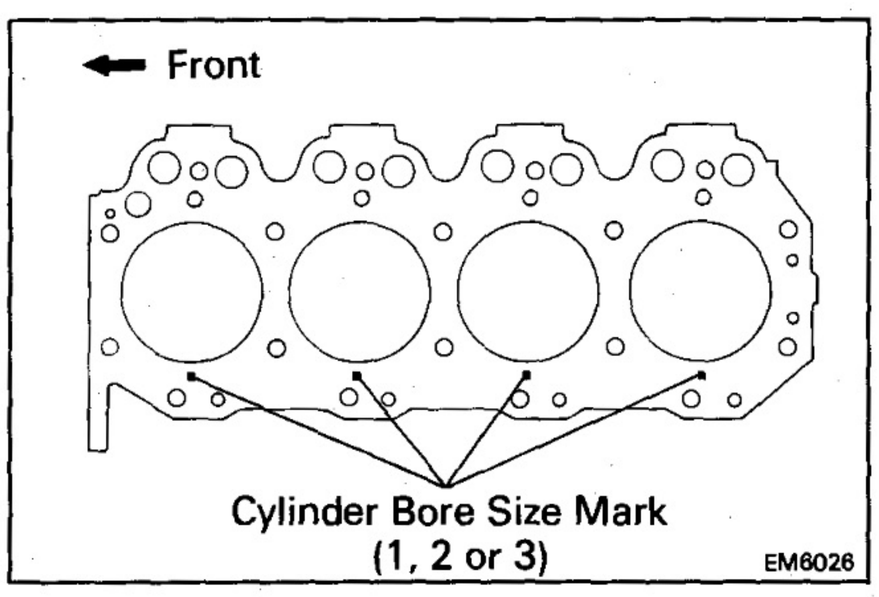
HINT: There are three sizes of the standard cylinder bore diameter, marked "1", "2", and "3", accordingly. The marked is stamped on the cylinder block.

Standard diameter:

B, 11B

STD

Mark "1"	**95.000 — 95.010 mm (3.7402 — 3.7405 in.)**
Mark "2"	**95.011 — 95.020 mm (3.7406 — 3.7409 in.)**
Mark "3"	**95.021 — 95.030 mm (3.7410 — 3.7413 in.)**
O/S 0.50	**95.500 — 95.530 mm (3.7598 — 3.7610 in.)**
0.75	**95.750 — 95.780 mm (3.7697 — 3.7709 in.)**
1.00	**96.000 — 96.030 mm (3.7795 — 3.7807 in.)**



EM6026

3B, 14B

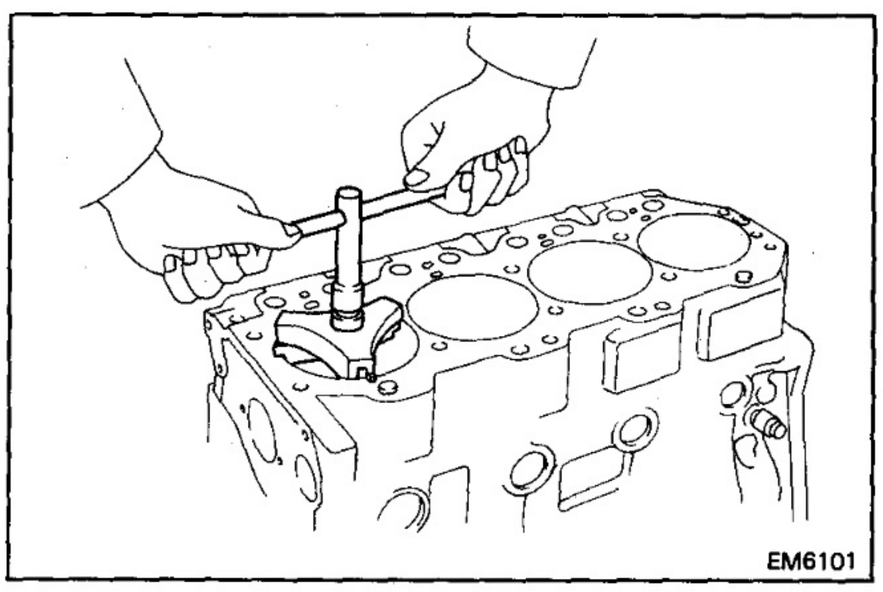
STD

Mark "1"	**102.000 — 102.010 mm (4.0157 — 4.0161 in.)**
Mark "2"	**102.011 — 102.020 mm (4.0162 — 4.0165 in.)**
Mark "3"	**102.021 — 102.030 mm (4.0166 — 4.0169 in.)**
O/S 0.50	**102.500 — 102.530 mm (4.0354 — 4.0366 in.)**
0.75	**102.75 — 102.78 mm (4.0453 — 4.0464 in.)**
1.00	**103.000 — 103.030 mm (4.0551 — 4.0563 in.)**

Maximum diameter:

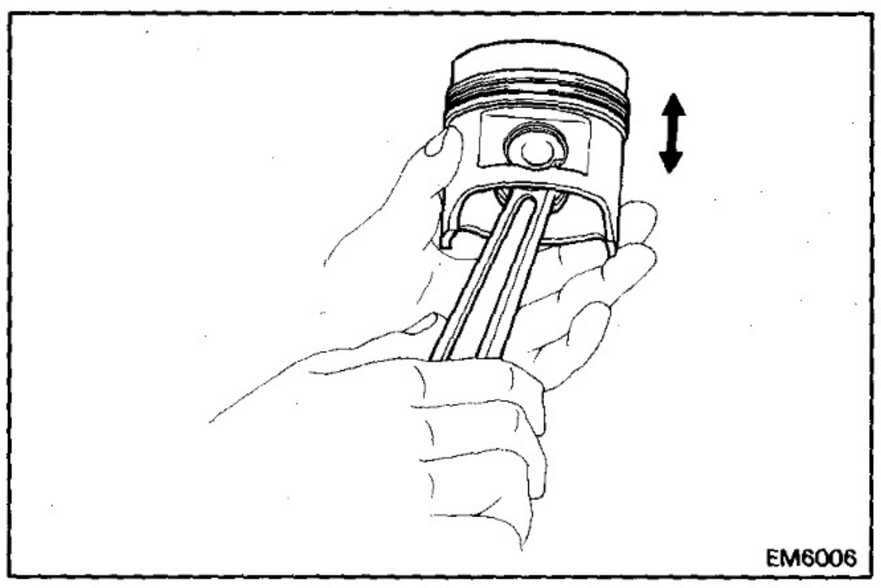
STD	**B, 11B**	**95.23 mm (3.7492 in.)**
	3B, 14B	**102.23 mm (4.0248 in.)**
O/S 0.50	**B, 11B**	**95.73 mm (3.7689 in.)**
	3B, 14B	**102.73 mm (4.0445 in.)**
0.75	**B, 11B**	**95.98 mm (3.7787 in.)**
	3B, 14B	**102.98 mm (4.0543 in.)**
1.00	**B, 11B**	**96.23 mm (3.7886 in.)**
	3B, 14B	**103.23 mm (4.0642 in.)**

If the diameter is greater than maximum, rebore all four cylinders, or replace the cylinder block.



6. REMOVE CYLINDER RIDGE

If the wear is less than 0.2 mm (0.008 in.), use a ridge reamer to machine the piston ring ridge at the top of the cylinder.

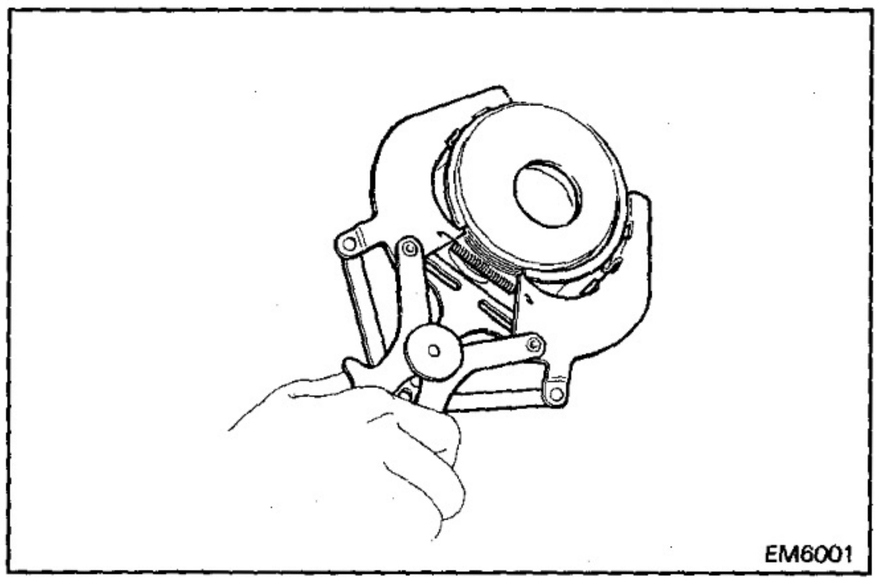


DISASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. CHECK FIT BETWEEN PISTON AND PIN

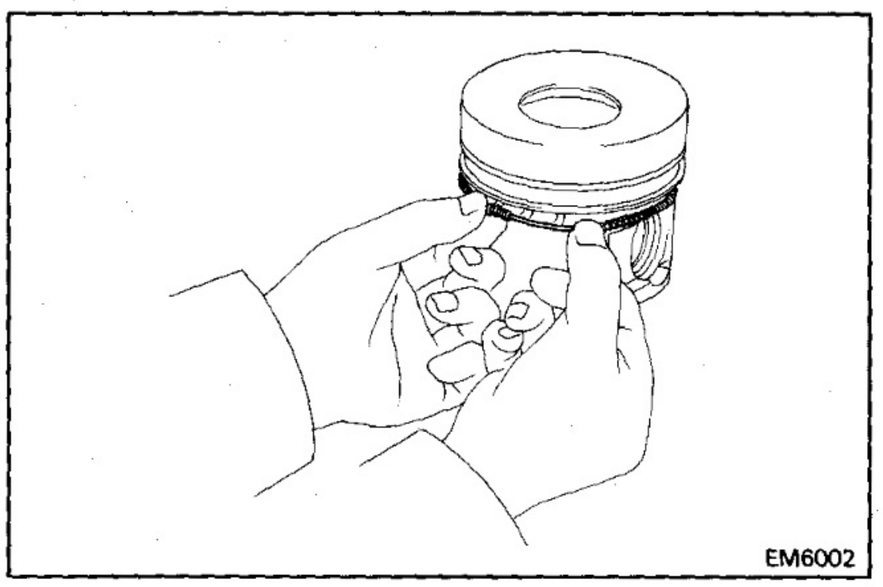
Try to move the piston back and forth on the piston pin.

If any movement is felt, replace the piston and pin as a set.



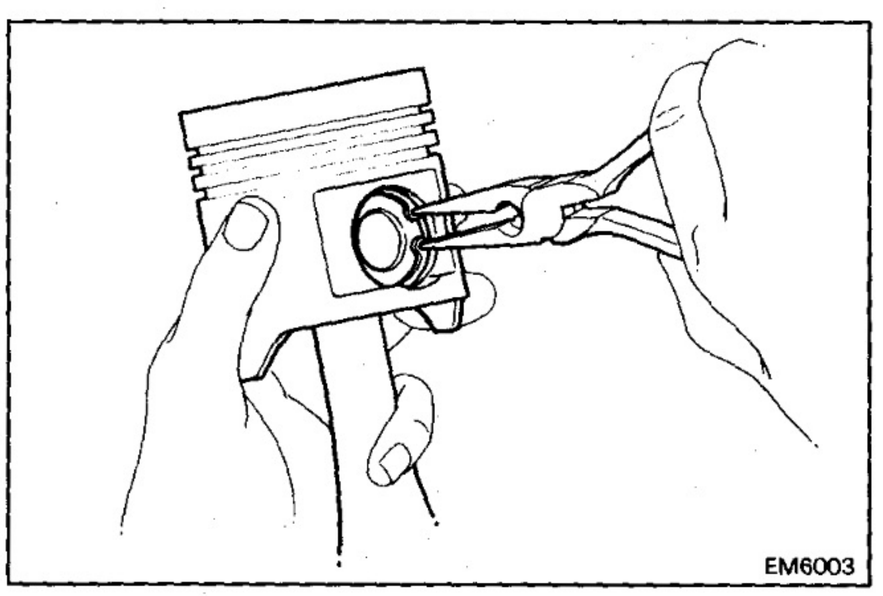
2. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the two compression rings.



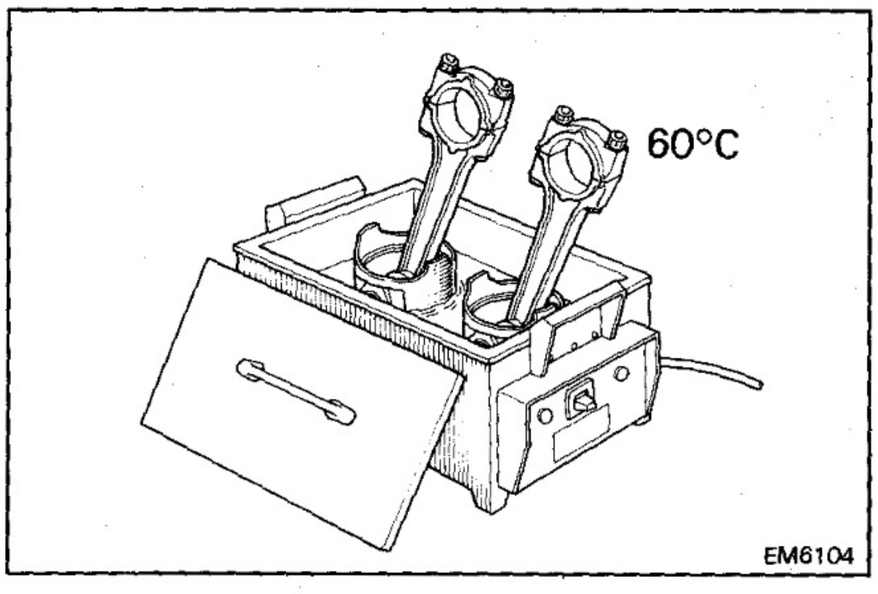
(b) Remove the oil ring and coil by hand.

HINT: Arrange the rings in correct order only.

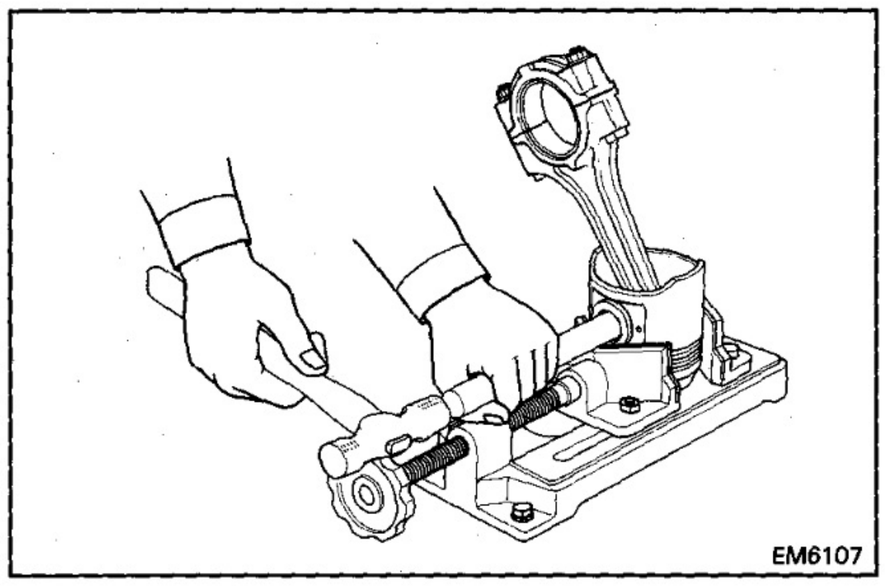


3. DISCONNECT CONNECTING ROD FROM PISTON

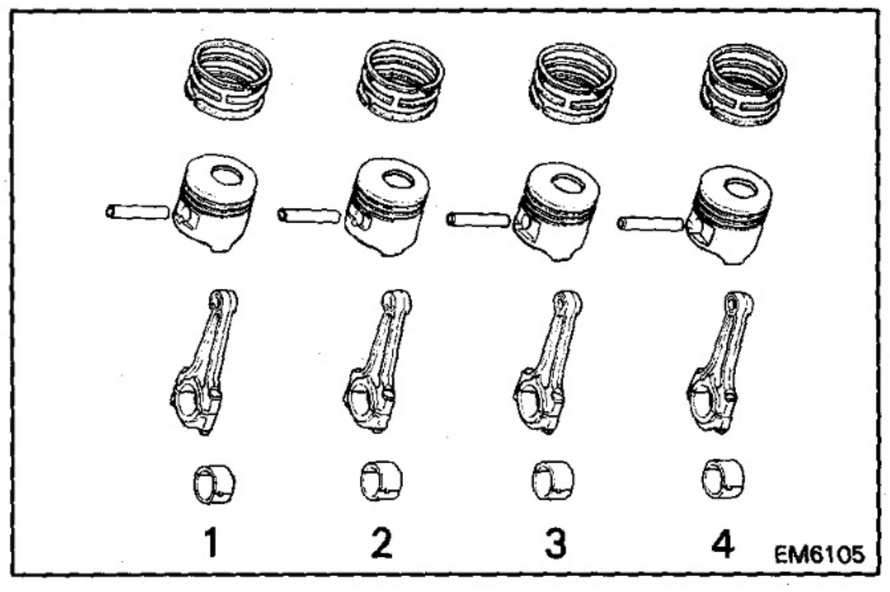
(a) Using needle-nose pliers, remove the snap rings.



(b) Gradually heat the piston to approx. 60°C (140°F).


EM6107

(c) Using a plastic-faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.



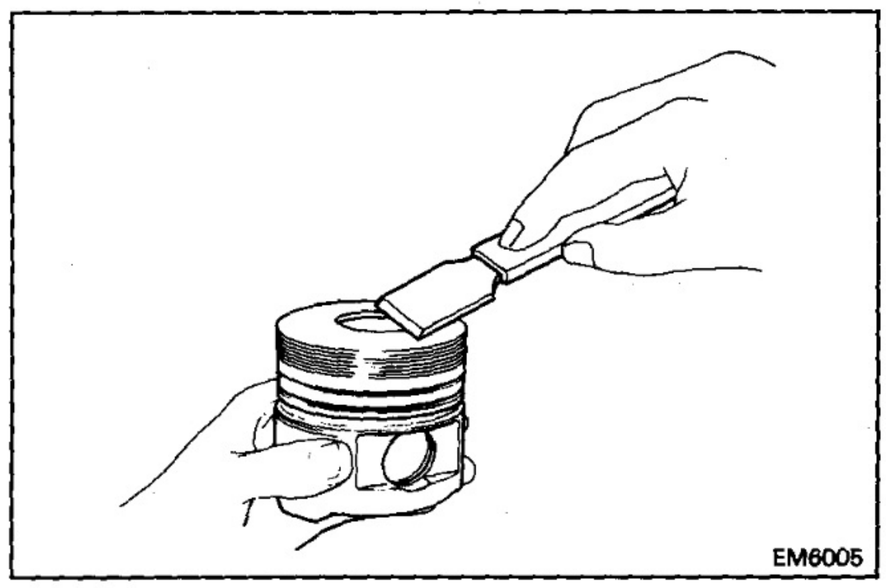
EM6105

HINT:

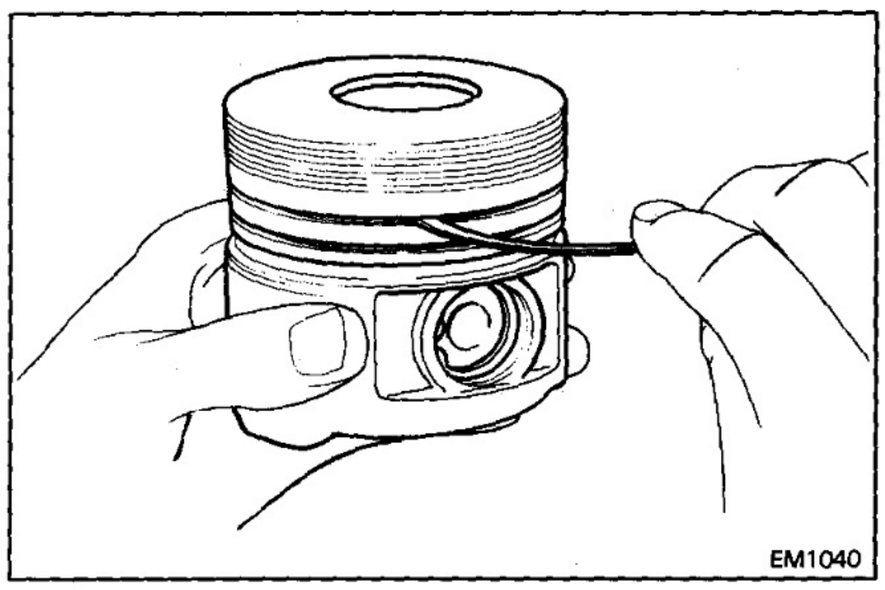
- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

INSPECTION AND REPAIR OF PISTON AND CONNECTING ROD ASSEMBLES

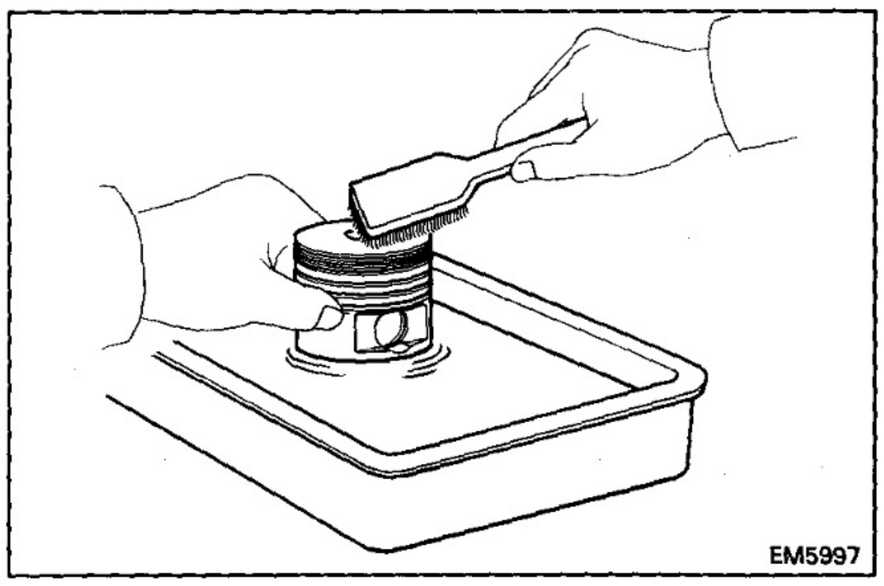
1. CLEAN PISTON


EM6005

(a) Using a gasket scraper, remove the carbon from the piston top.

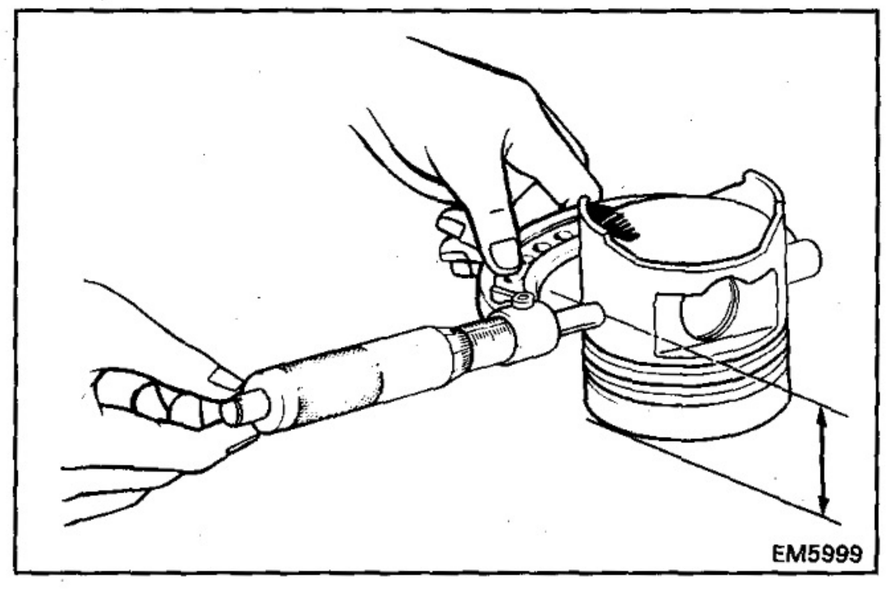

EM1040

(b) Using a groove cleaning tool or broken ring, clean the ring grooves.


EM5997

(c) Using solvent and a brush, thoroughly clean the piston.

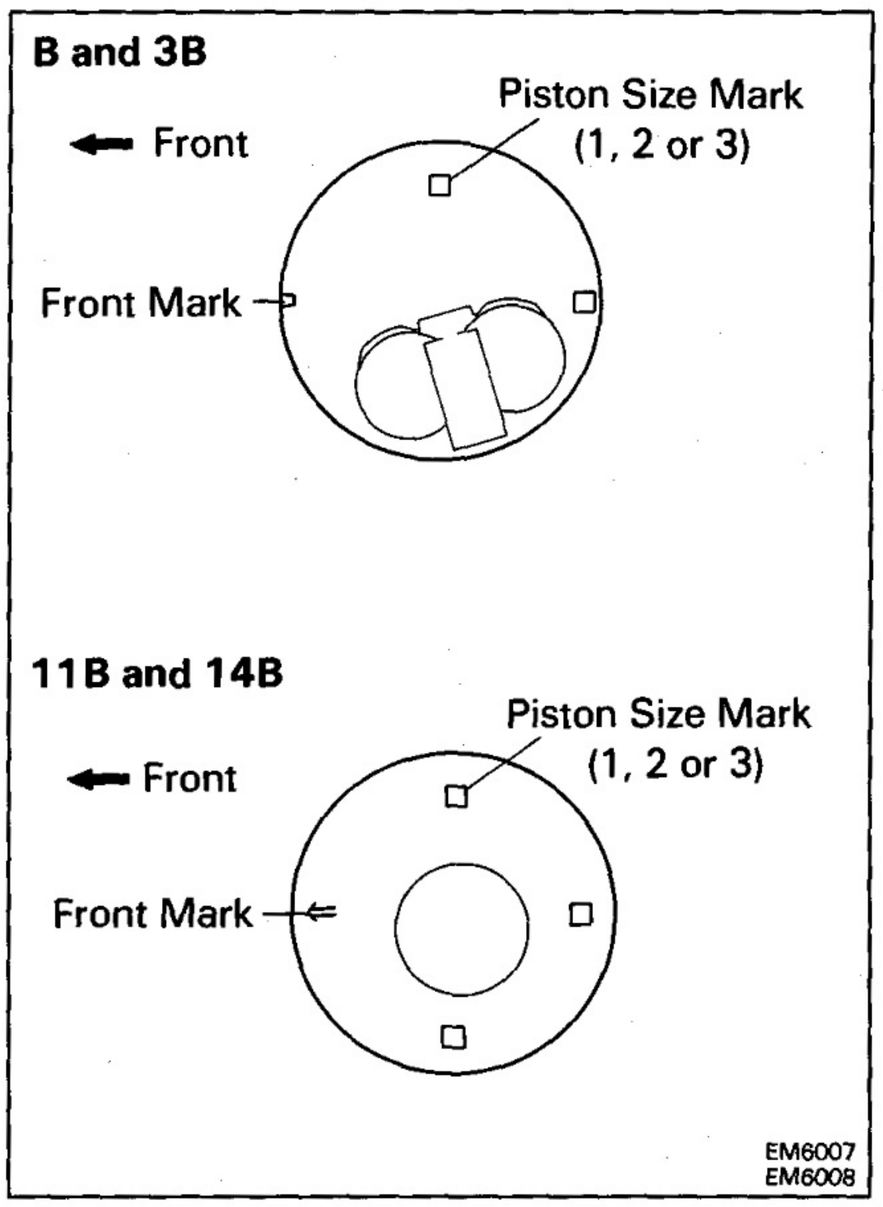
NOTICE: Do not use a wire brush.


EM5999

2. INSPECT PISTON DIAMETER AND OIL CLEARANCE

(a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line, the indicated distance from the piston head.

Distance:
B 49.20 mm (1.9370 in.)
3B 45.20 mm (1.7795 in.)
11B 38.33 mm (1.5091 in.)
14B 42.83 mm (1.6862 in.)



EM6007
EM6008

HINT: There are three sizes of the standard piston diameter, marked "1", "2", and "3", accordingly. The marked is stamped on the top of the piston.

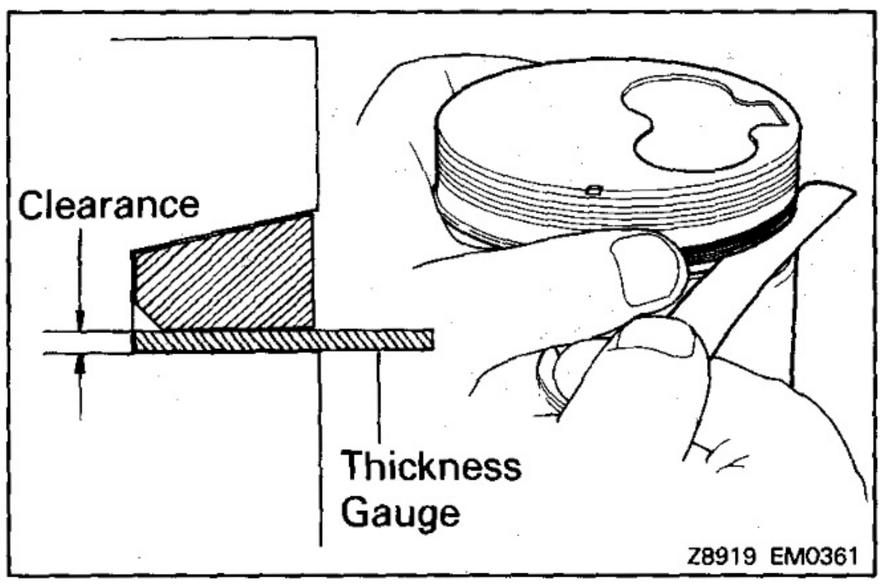
Piston diameter:

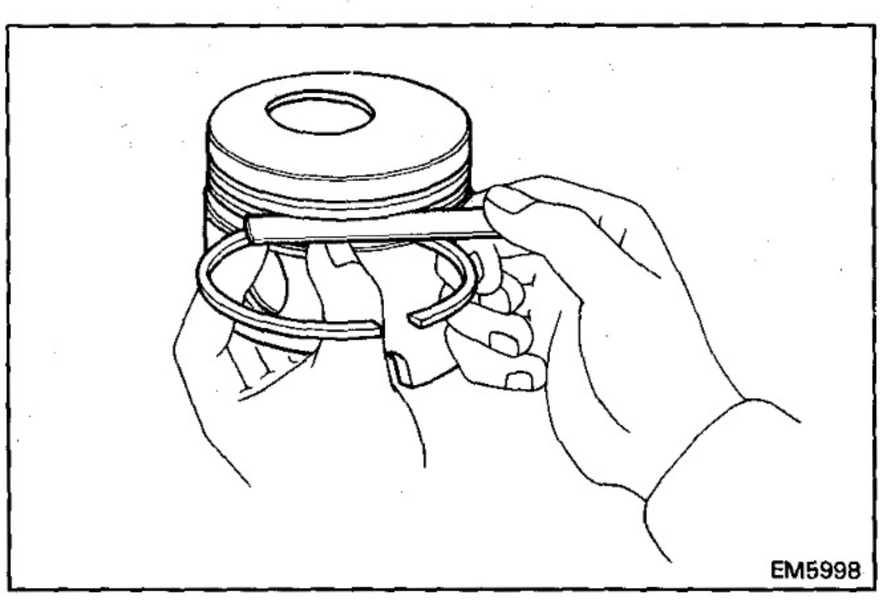
B STD
Mark "1" 94.845 – 94.855 mm (3.7370 – 3.7374 in.)
Mark "2" 94.855 – 94.865 mm (3.7374 – 3.7378 in.)
Mark "3" 94.865 – 94.875 mm (3.7378 – 3.7382 in.)
O/S 0.50 95.345 – 95.375 mm (3.7537 – 3.7549 in.)
O/S 0.75 95.595 – 95.625 mm (3.7636 – 3.7648 in.)
O/S 1.00 95.845 – 95.875 mm (3.7734 – 3.7746 in.)

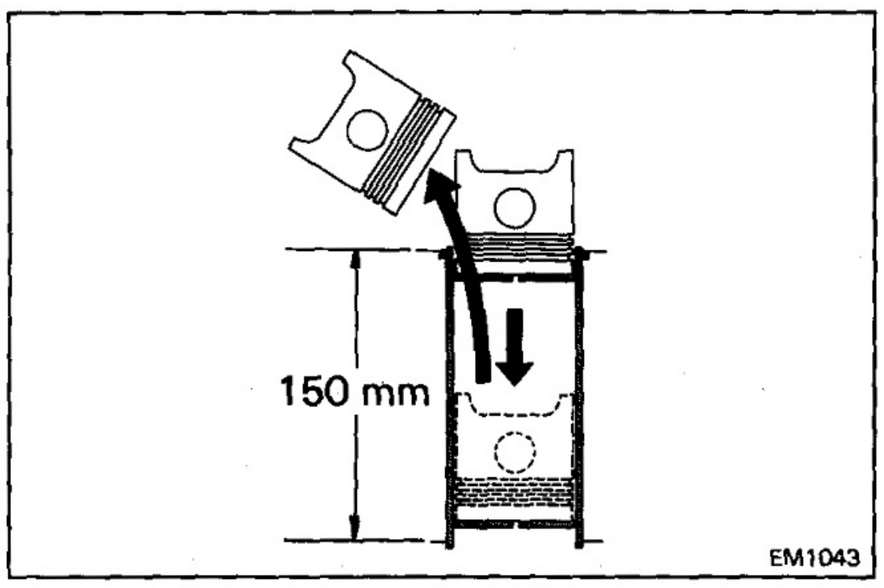
3B STD
Mark "1" 101.800 – 101.810 mm (4.0079 – 4.0083 in.)
Mark "2" 101.810 – 101.820 mm (4.0083 – 4.0087 in.)
Mark "3" 101.820 – 101.830 mm (4.0087 – 4.0090 in.)
O/S 0.50 102.300 – 102.330 mm (4.0276 – 4.0287 in.)
O/S 0.75 102.550 – 102.580 mm (4.0374 – 4.0386 in.)
O/S 1.00 102.800 – 102.830 mm (4.0472 – 4.0484 in.)

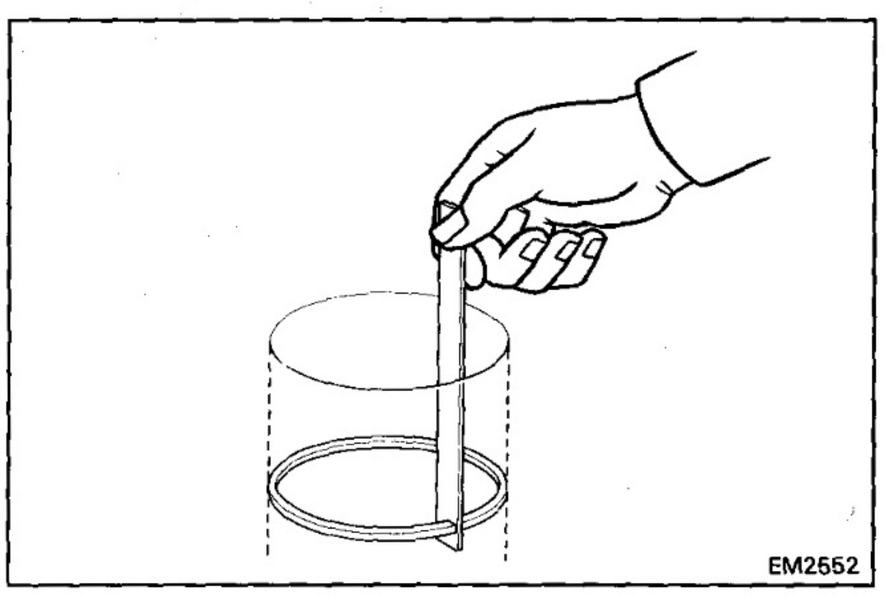
11B STD
Mark "1" 94.690 – 94.700 mm (3.7374 – 3.7378 in.)
Mark "2" 94.700 – 94.710 mm (3.7378 – 3.7382 in.)
Mark "3" 94.710 – 94.720 mm (3.7382 – 3.7386 in.)
O/S 0.50 95.190 – 95.220 mm (3.7476 – 3.7488 in.)
O/S 0.75 95.440 – 95.470 mm (3.7575 – 3.7587 in.)
O/S 1.00 95.690 – 95.720 mm (3.7673 – 3.7685 in.)

14B STD
Mark "1" 101.760 – 101.770 mm (4.0063 – 4.0067 in.)
Mark "2" 101.770 – 101.780 mm (4.0067 – 4.0071 in.)
Mark "3" 101.780 – 101.790 mm (4.0071 – 4.0075 in.)
O/S 0.50 102.260 – 102.290 mm (4.0260 – 4.0272 in.)
O/S 0.75 102.510 – 102.540 mm (4.0358 – 4.0370 in.)
O/S 1.00 102.760 – 102.790 mm (4.0457 – 4.0468 in.)









3. INSPECT CLEARANCE BETWEEN WALL OF PISTON RING GROOVE AND NEW PISTON RING

(a) Install a new No. 1 ring to the piston and, using a thickness gauge, measure the No. 1 ring clearance between the new piston ring and the ring land when the ring is flush with the piston surface.

No. 1 ring groove clearance:

B	**0.059 — 0.089 mm (0.0023 — 0.0035 in.)**
3B	**0.061 — 0.091 mm (0.0024 — 0.0036 in.)**
11B and 14B	**0.062 — 0.092 mm (0.0024 — 0.0036 in.)**

(b) Using a thickness gauge, measure the No. 2 ring or oil ring clearance between the new piston ring and the ring land.

No. 2 ring groove clearance:

B	**0.05 — 0.09 mm (0.0020 — 0.0035 in.)**
3B, 11B, 14B	**0.04 — 0.08 mm (0.0016 — 0.0031 in.)**

Oil ring groove clearance:

0.03 — 0.07 mm (0.0012 — 0.0028 in.)

If the clearance is greater than the maximum, replace the piston.

4. INSPECT PISTON RING END GAP

(a) Insert the piston ring into the cylinder bore.

(b) Using a piston, push the piston ring a little beyond the bottom of the ring travel, 150 mm (5.91 in.) from the top of the cylinder block.

(c) Using a thickness gauge, measure the end gap.

Standard end gap:

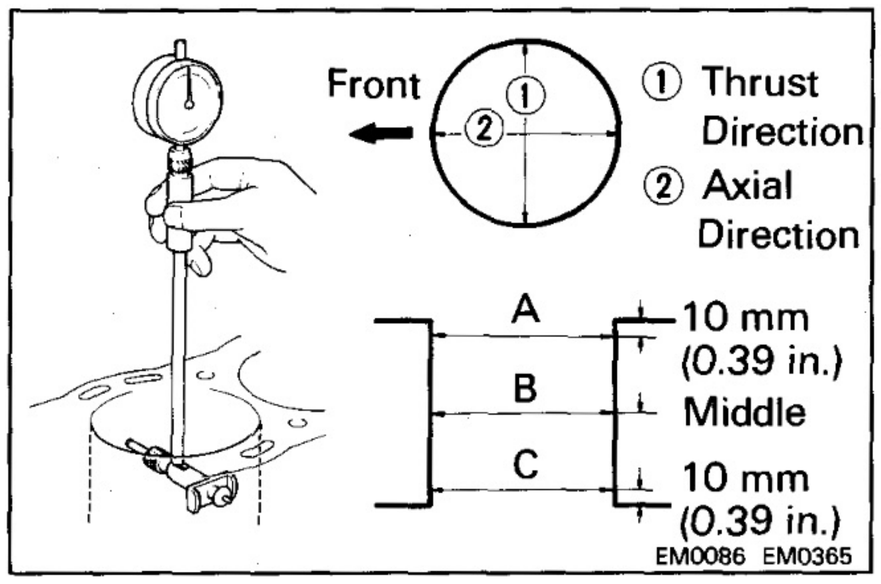
No. 1	**B and 11B**	**0.35 — 0.64 mm (0.0138 — 0.0252 in.)**
	3B and 14B	**0.30 — 0.54 mm (0.0118 — 0.0213 in.)**
No. 2	**B and 11B**	**0.35 — 0.64 mm (0.0138 — 0.0252 in.)**
	3B and 14B	**0.45 — 0.69 mm (0.0177 — 0.0272 in.)**
Oil	**B and 11B**	**0.35 — 0.64 mm (0.0138 — 0.0252 in.)**
	3B and 14B	**0.40 — 0.69 mm (0.0157 — 0.0272 in.)**

Maximum end gap:

No. 1	**B and 11B**	**1.44 mm (0.0567 in.)**
	3B and 14B	**1.34 mm (0.0528 in.)**
No. 2	**B and 11B**	**1.44 mm (0.0567 in.)**
	3B and 14B	**1.49 mm (0.0587 in.)**
Oil	**B and 11B**	**1.44 mm (0.0567 in.)**
	3B and 14B	**1.49 mm (0.0587 in.)**

If the gap is greater than maximum, replace the piston ring.

If the gap is greater than maximum, even with a new piston ring, replace the cylinder block.



(d) Measure the cylinder bore diameter in thrust directions (See page EM-75) and subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard piston oil clearance:

B	**0.145 — 0.165 mm (0.0057 — 0.0065 in.)**
3B	**0.19 — 0.21 mm (0.0075 — 0.0083 in.)**
11B	**0.30 — 0.32 mm (0.0118 — 0.0126 in.)**
14B	**0.23 — 0.25 mm (0.0091 — 0.0098 in.)**

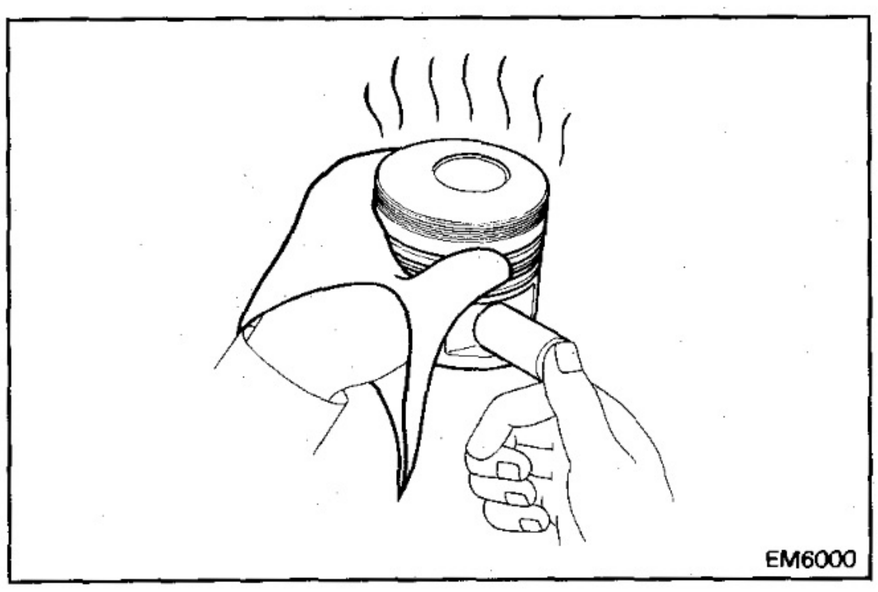
Maximum piston oil clearance:

B	**0.22 mm (0.0087 in.)**
3B	**0.26 mm (0.0102 in.)**
11B	**0.37 mm (0.0146 in.)**
14B	**0.30 mm (0.0118 in.)**

If the greater than maximum, replace all four pistons.

If necessary, rebore or replace the cylinder block.

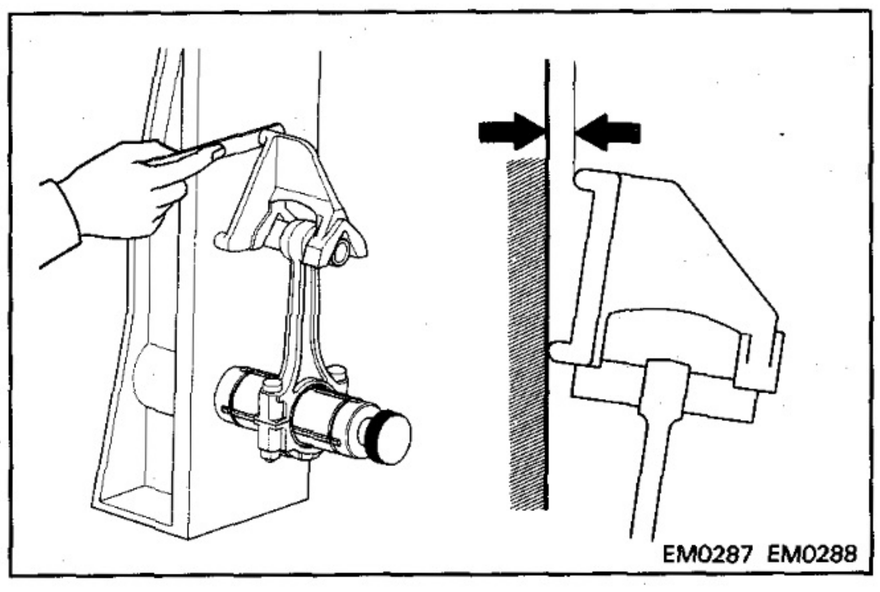
HINT: (Use cylinder block sub-assembly)
When installing a standard piston, install one with the same mark as the standard bore diameter mark on the cylinder block.



5. CHECK PISTON PIN FIT

At 60°C (140°F) you should be able to push the pin into the piston with thumb.

If the pin can be installed at a lower temperature, replace the piston and pin as a set.



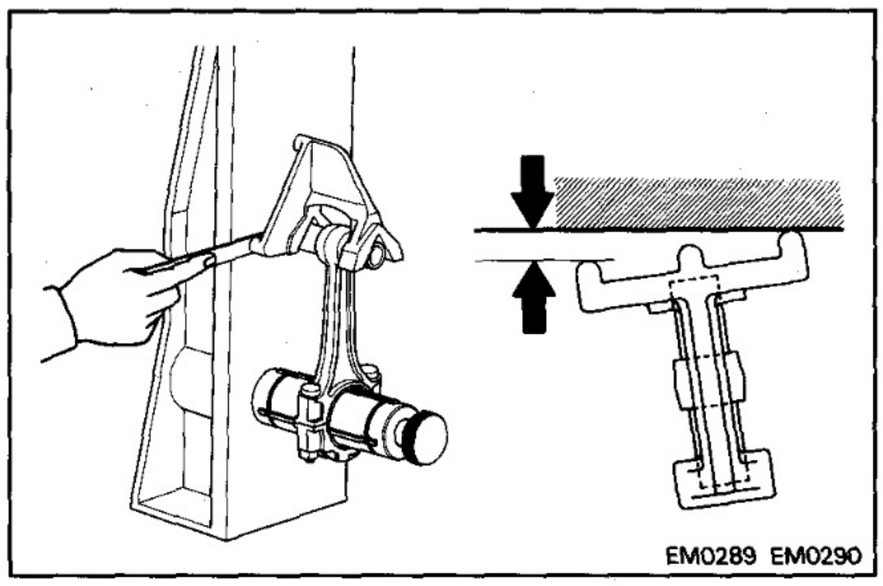
6. INSPECT CONNECTING RODS

(a) Using a rod aligner, check the connecting rod alignment.

- Check rod bend.

Maximum bend:
0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If bend is greater than maximum, replace the connecing rod assembly.

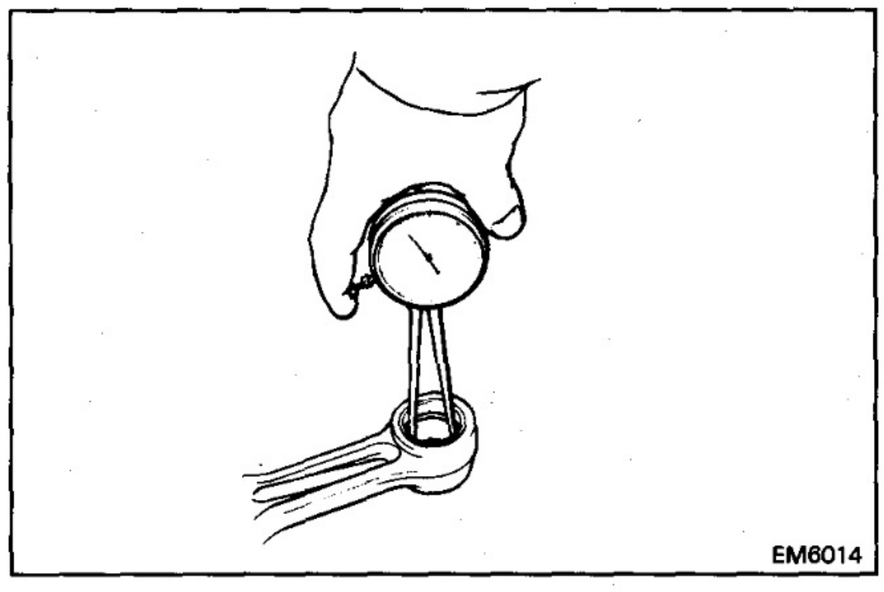

EM0289 EM0290

- Check for twist.

Maximum twist:

0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

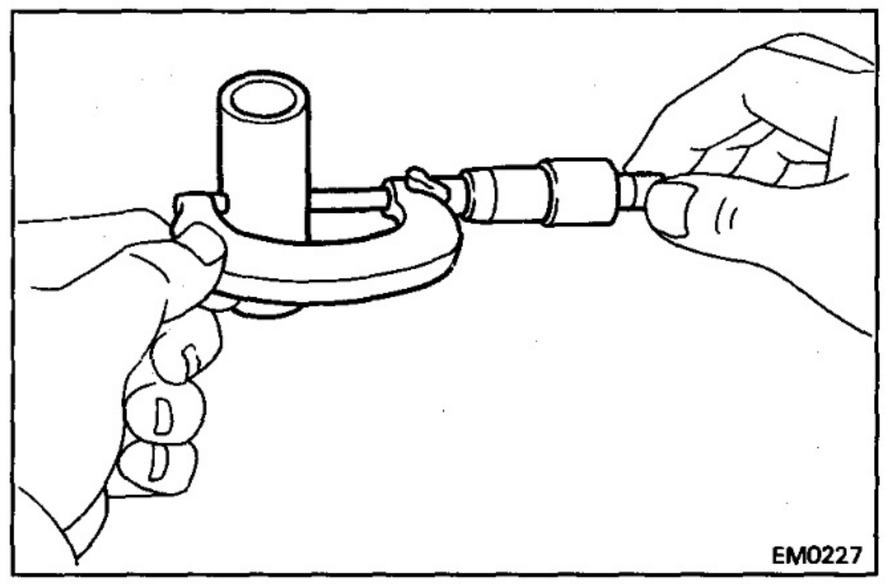
If twist is greater than maximum, replace the connecing rod assembly.


EM6014

(b) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

Bushing inside diameter:

B	**29.009 — 29.019 mm (1.1421 — 1.1425 in.)**
3B, 11B and 14B	**32.009 — 32.019 mm (1.2602 — 1.2606 in.)**


EM0227

(c) Using a micrometer, measure the diameter of the piston pin.

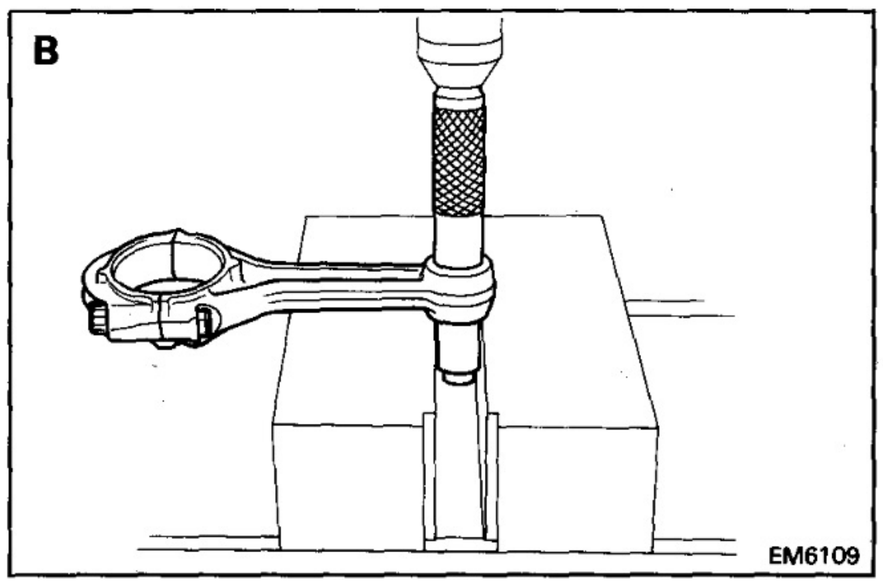
Piston pin diameter:

B	**29.000 — 29.010 mm (1.1417 — 1.1421 in.)**
3B, 11B and 14B	**32.000 — 32.010 mm (1.2598 — 1.2602 in.)**

(d) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

Standard oil clearance:	**0.004 — 0.014 mm (0.0002 — 0.0006 in.)**
Maximum oil clearance:	**0.05 (0.0020 in.)**

If the clearance is greater than maximum, replace the connecting rod bushing. If necessary, replace the piston and piston pin assembly.



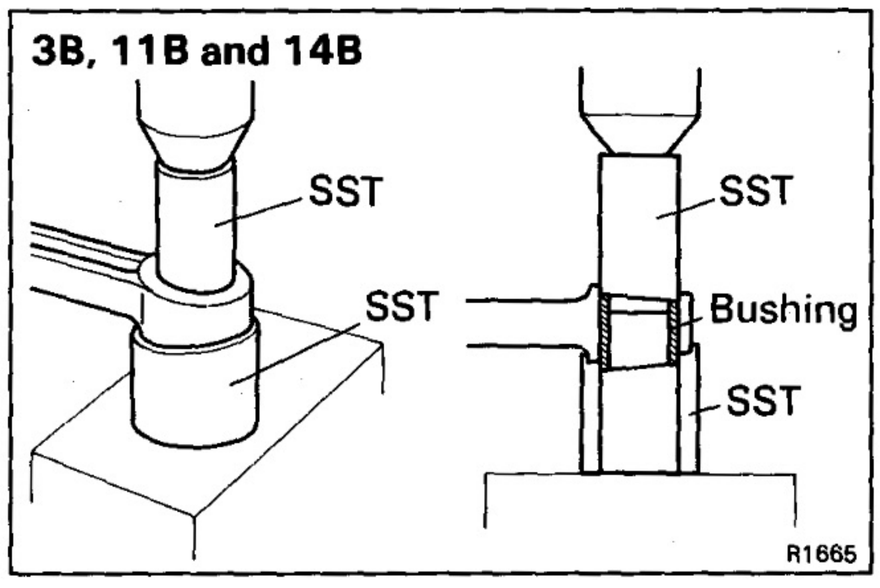
EM6109

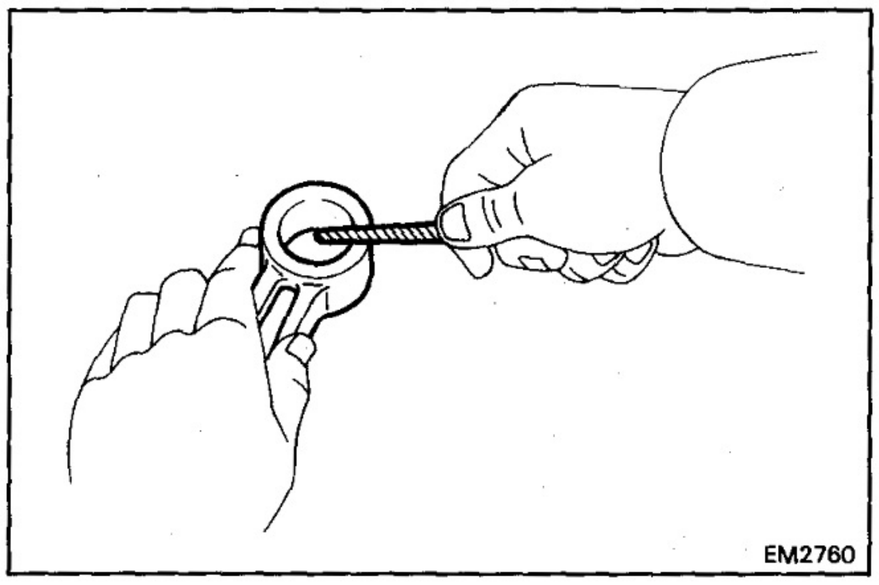
7. IF NECESSARY, REPLACE CONNECTING ROD BUSHINGS

A. Remove connecting rod bushing

Using SST and a press, press out the bushing.

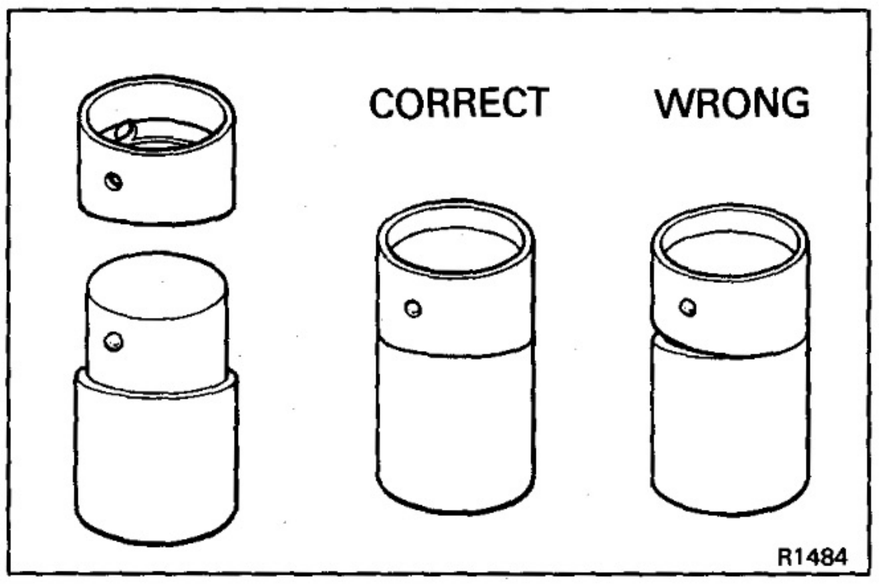
SST B 09222-66010
3B, 11B and 14B
09222-58020 (09222-04015, 09222-04025)





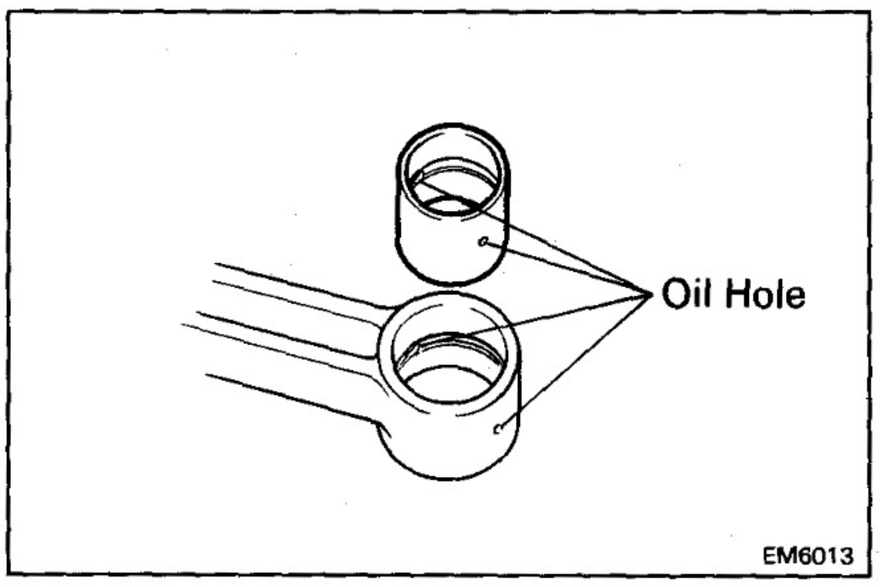
B. Install new connecting rod bushings

(a) Using a round file, lightly file off any roughness from the small end of the connecting rod as shown in the illustration.

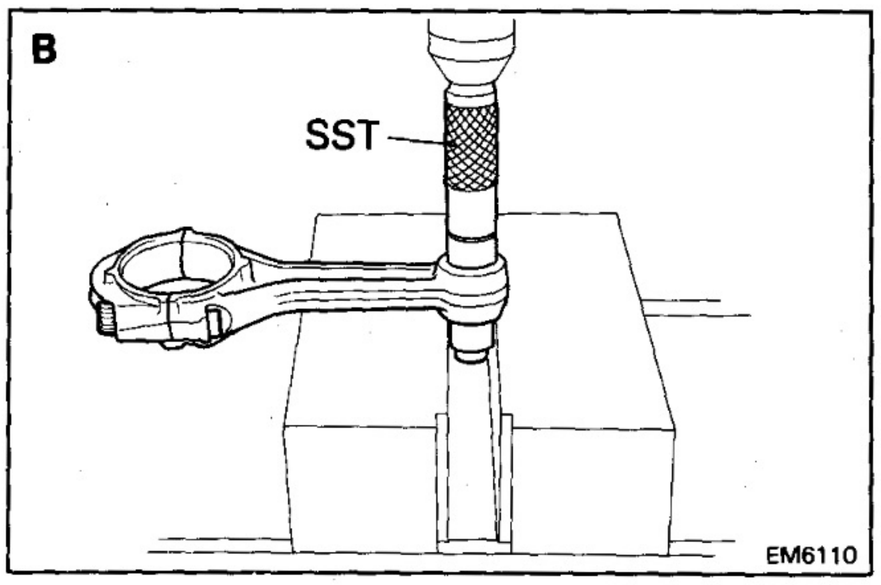


(b) (3B, 11B and 14B)
Attach the bushing to the SST with the ball of the SST inside the small oil hole of the bushing.

SST 09222-58020 (09222-04020)

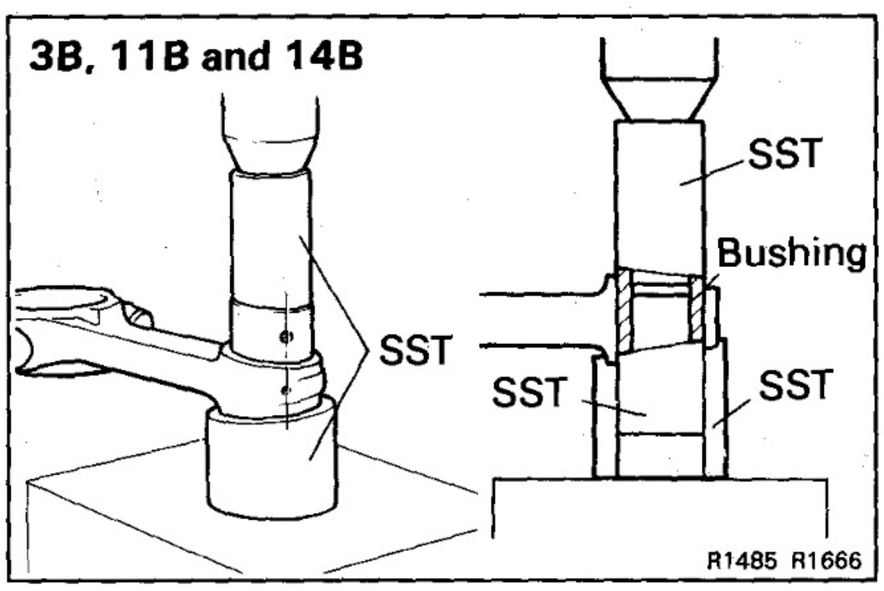


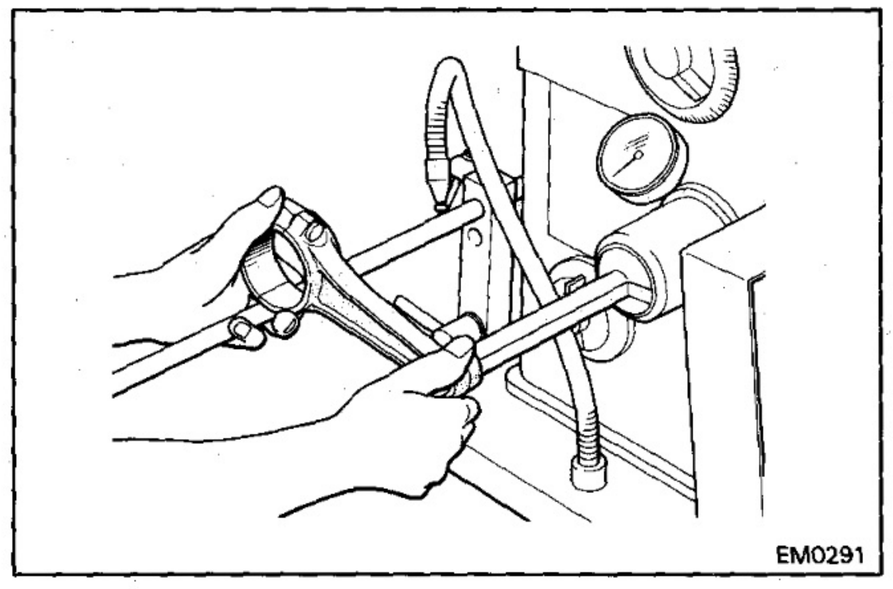
(c) Align the oil holes of the bushing and connecting rod.

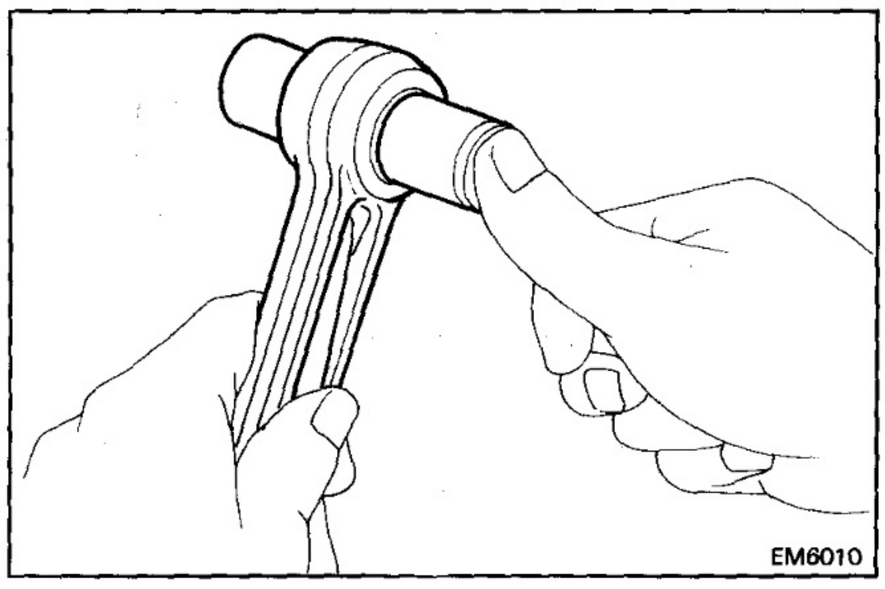


(d) Using SST and a press, press in the bushing.

SST B 09222-66010
3B, 11B and 14B
09222-58020 (09222-04015, 09222-04020, 09222-04025)







C. Hone connecting rod bushing and check piston pin fit in connecting rod

(a) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page EM-82) between the bushing and piston pin.

(b) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil and push it into the rod with your thumb.

BORING OF CYLINDERS

HINT:

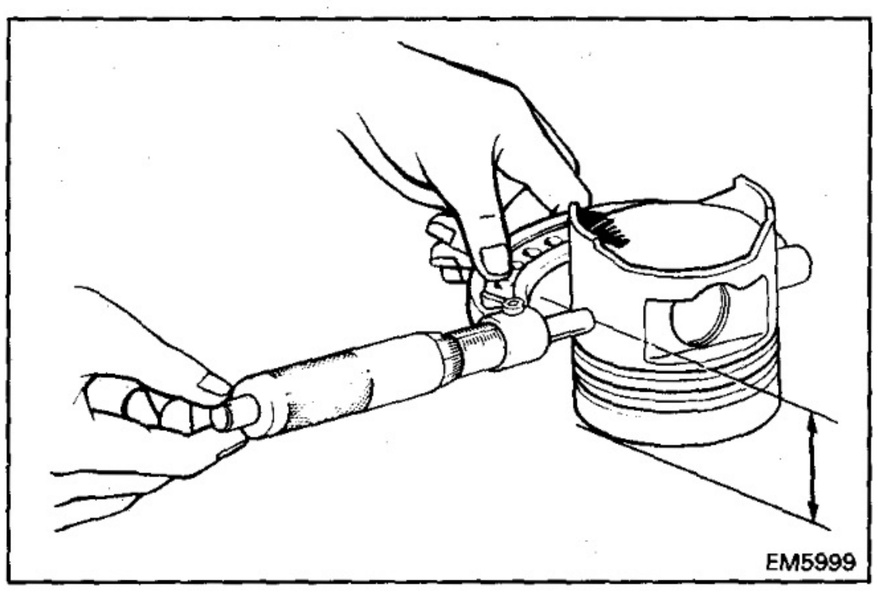
- Bore all four cylinders for the oversized piston outside diameter.
- Replace the piston rings with ones matching the pistons.

1. SELECT OVERSIZED PISTON

Oversized piston diameter:

mm (in.)

O/S	B	3B	11B	14B
0.50	95.345—95.375 (3.7537—3.7549)	102.300—102.330 (4.0276—4.0287)	95.190—95.220 (3.7476—3.7488)	102.260—102.290 (4.0260—4.0272)
0.75	95.595—95.625 (3.7636—3.7648)	102.550—102.580 (4.0374—4.0386)	95.440—95.470 (3.7575—3.7587)	102.510—102.540 (4.0358—4.0370)
1.00	95.845—95.875 (3.7734—3.7746)	102.800—102.830 (4.0472—4.0484)	95.690—95.720 (3.7673—3.7685)	102.760—102.790 (4.0457—4.0468)



2. CALCULATE DIMENSION TO BORE CYLINDERS

(a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line, the indicated distance from the piston head.

Distance:
B 49.20 mm (1.9370 in.)
3B 45.20 mm (1.7795 in.)
11B 38.33 mm (1.5091 in.)
14B 42.83 mm (1.6862 in.)

(b) Calculate the size each cylinder is to be rebored as follows:

Size to be rebored = P + C − H

P = piston diameter

C = piston clearance

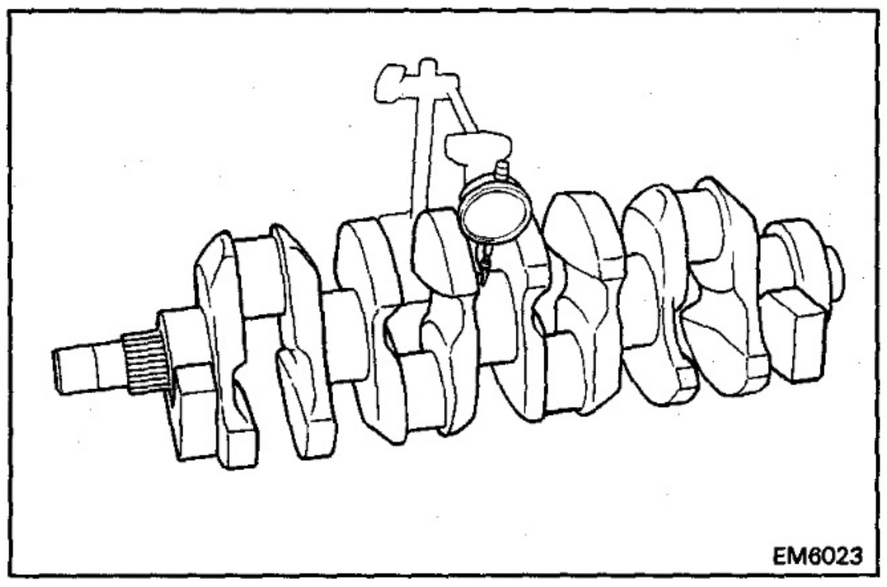
- B 0.145 — 0.165 mm (0.0057 — 0.0065 in.)
- 3B 0.19 — 0.21 mm (0.0075 — 0.0083 in.)
- 11B 0.30 — 0.32 mm (0.0118 — 0.0126 in.)
- 14B 0.23 — 0.25 mm (0.0091 — 0.0098 in.)

H = allowance for honing
Less than 0.02 mm (0.0008 in.)

3. BORE AND HONE CYLINDERS TO CALCULATED DIMENSIONS

Amount of honing: 0.02 mm (0.0008 in.) maximum

NOTICE: Excess honing will destroy the finished roundness.


EM6023

INSPECTION AND REPAIR OF CRANKSHAFT

1. INSPECT CRANKSHAFT FOR RUNOUT

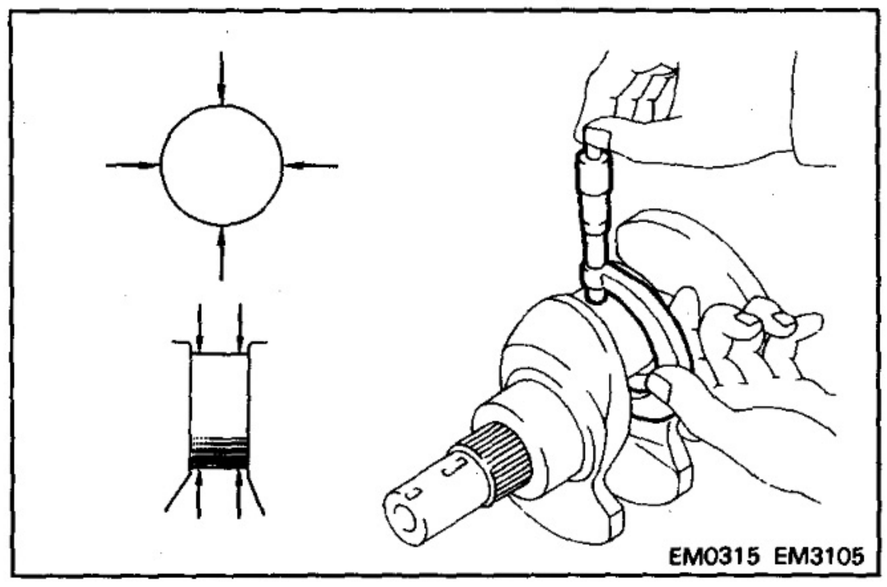
(a) Place the crankshaft on V-blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.

HINT: Use a long spindle on the dial indicator.

Maximum circle runout: 0.08 mm (0.0031 in.)

If the circle runout is greater than maximum, replace the crankshaft.


EM0315 EM3105

2. INSPECT MAIN JOURNALS AND CRANK PINS

(a) Using a micrometer, measure the diameter of the main journal and crank pin.

Main journal diameter:

No. 1, 2, 4 and 5 Journal

STD size	**69.98 — 70.00 mm (2.7551 — 2.7559 in.)**
U/S 0.25	**69.74 — 69.75 mm (2.7457 — 2.7461 in.)**
U/S 0.50	**69.49 — 69.50 mm (2.7358 — 2.7362 in.)**
U/S 1.00	**68.99 — 69.00 mm (2.7161 — 2.7165 in.)**

No. 3 Journal

STD size	**69.950 — 69.970 mm (2.7539 — 2.7547 in.)**
U/S 0.25	**69.710 — 69.720 mm (2.7445 — 2.7449 in.)**
U/S 0.50	**69.460 — 69.470 mm (2.7346 — 2.7350 in.)**
U/S 1.00	**68.960 — 68.970 mm (2.7150 — 2.7153 in.)**

Crank pin diameter:

B

STD size	**58.98 — 59.00 mm (2.3220 — 2.3228 in.)**
U/S 0.25	**58.74 — 58.75 mm (2.3126 — 2.3130 in.)**
U/S 0.50	**58.49 — 58.50 mm (2.3028 — 2.3031 in.)**
U/S 1.00	**57.99 — 58.00 mm (2.2831 — 2.2835 in.)**

3B, 11B and 14B

STD size	**60.98 — 61.00 mm (2.4008 — 2.4016 in.)**
U/S 0.25	**60.74 — 60.75 mm (2.3913 — 2.3917 in.)**
U/S 0.50	**60.49 — 60.50 mm (2.3815 — 2.3819 in.)**
U/S 1.00	**59.99 — 60.00 mm (2.3618 — 2.3622 in.)**

If the diameter is not within specification, check the oil clearance. If necessary, grind or replace the crankshaft.

(b) Check each main journal and crank pin for taper and out-of-round as shown.

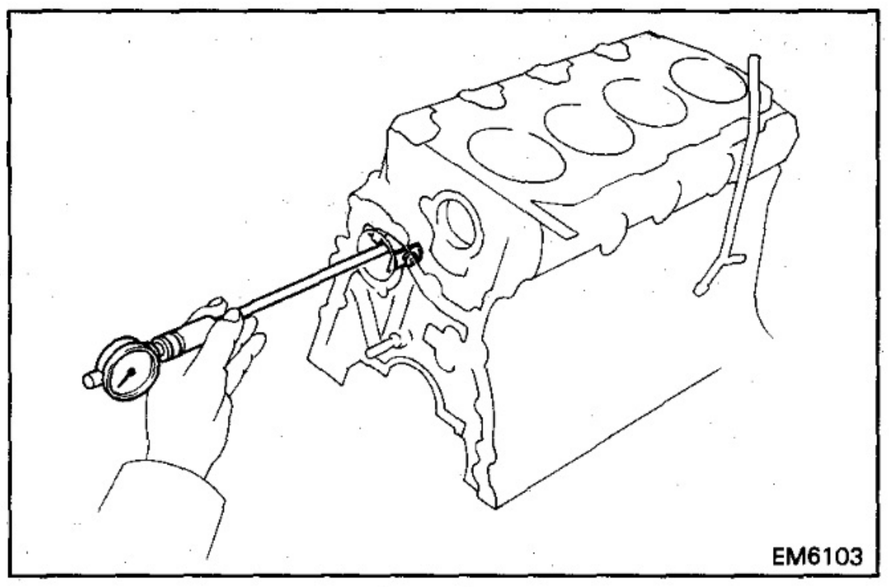
Maximum taper and out-of-round: 0.02 mm (0.0008 in.)

If taper and out-of-round is greater than maximum, replace the crankshaft.

3. IF NECESSARY, GRIND AND HONE MAIN JOURNALS AND/OR CRANK PINS

Grind and hone the main journals and/or crank pins to the undersized finished diameter. (See procedure step 2)

Install new main journal and/or crank pin undersized bearings.



INSPECTION AND REPAIR OF CAMSHAFT BEARINGS AND CAMSHAFT

1. INSPECT CAMSHAFT OIL CLEARANCE

(a) Using a cylinder gauge, measure the inside diameter of the camshaft bearing.

Bearing inside diameter (from front side):

No. 1	**53.500 — 53.525 mm (2.1063 — 2.1073 in.)**
No. 2	**53.250 — 53.275 mm (2.0965 — 2.0974 in.)**
No. 3	**53.000 — 53.025 mm (2.0866 — 2.0876 in.)**
No. 4	**52.750 — 52.775 mm (2.0768 — 2.0778 in.)**
No. 5	**52.500 — 52.525 mm (2.0669 — 2.0679 in.)**

(b) Subtract the journal diameter measurement (See page EM-57) from the bearing inside diameter measurement.

Standard oil clearance: **0.025 — 0.066 mm (0.0010 — 0.0026 in.)**

Maximum oil clearance: **0.10 mm (0.0039 in.)**

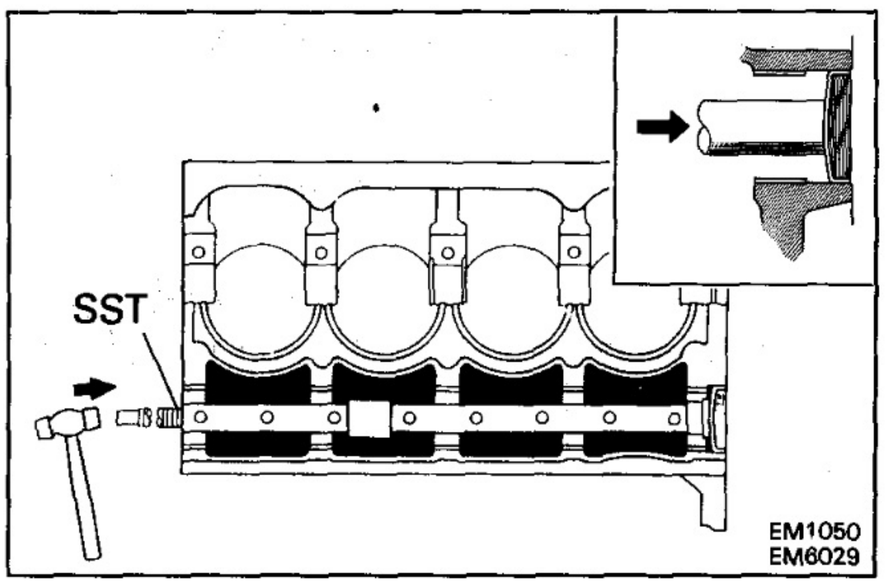
If the clearance is greater than maximum, replace the camshaft bearings. If necessary, replace the camshaft.

2. IF NECESSARY, REPLACE CAMSHAFT BEARINGS

A. Remove expansion plug

Using SST and a hammer, tap out the expansion plug.

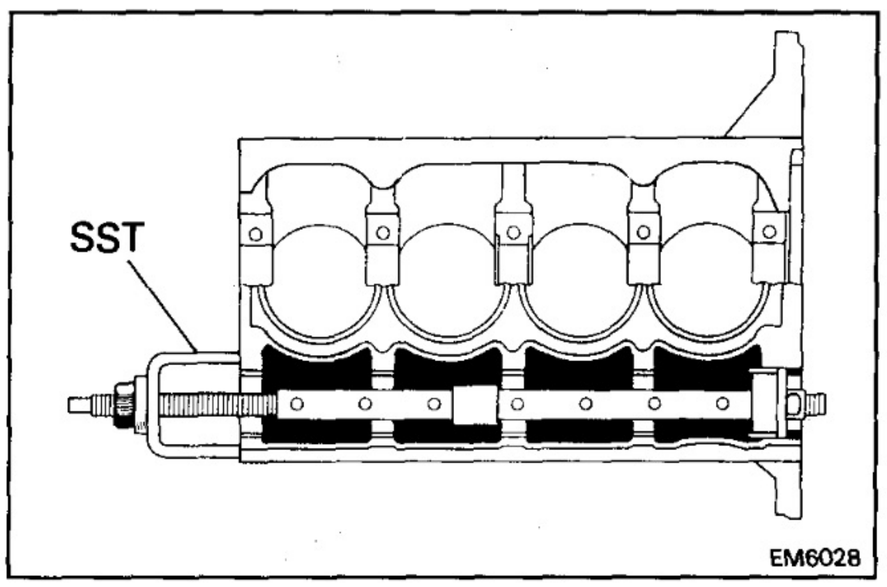
SST 09215-00100 (09215-00130, 09215-00150, 09215-00210)



B. Remove camshaft bearings

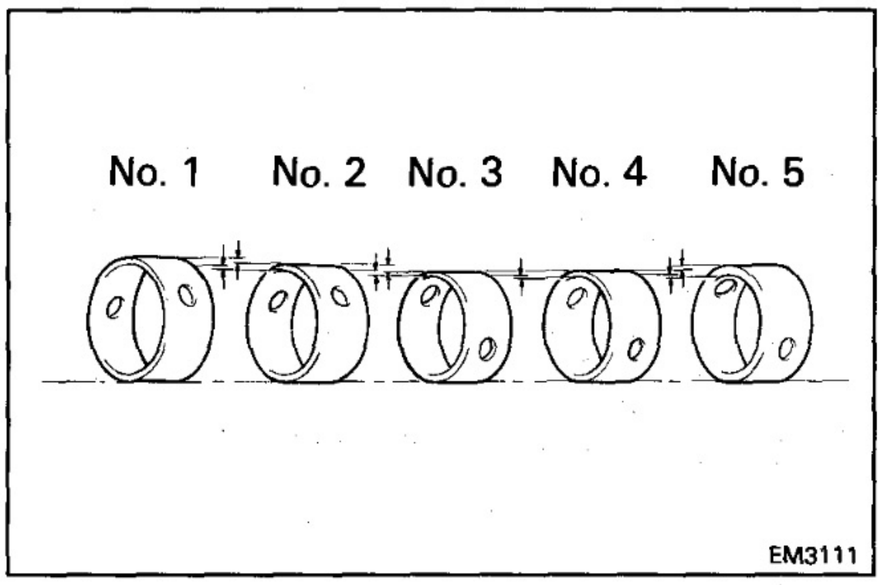
Using SST, remove the camshaft bearings.

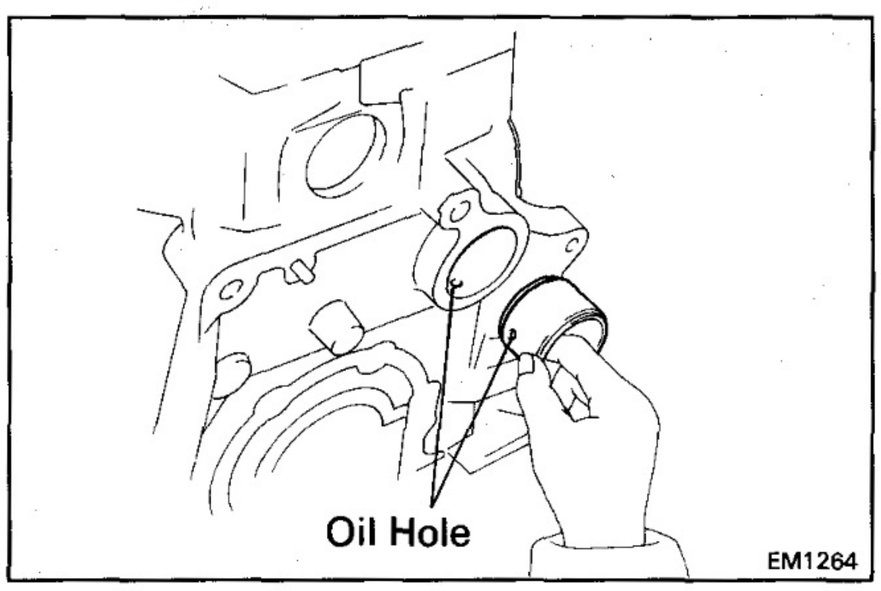
SST 09215-00012 (09215-00020, 09215-00440, 09215-00470) and 09215-00100 (09215-00130, 09215-00140, 09215-00150, 09215-00160)



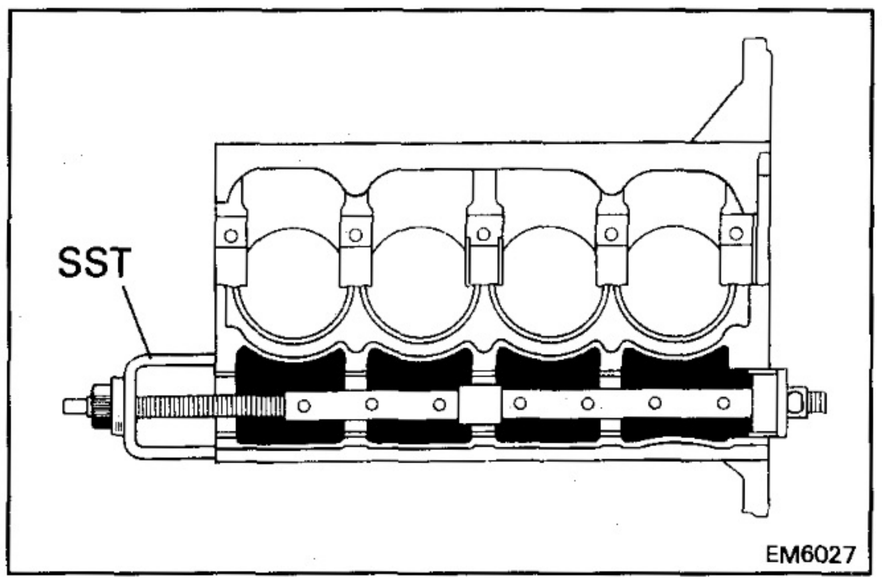
C. Install new camshaft bearings

(a) Install new bearings in their proper location.



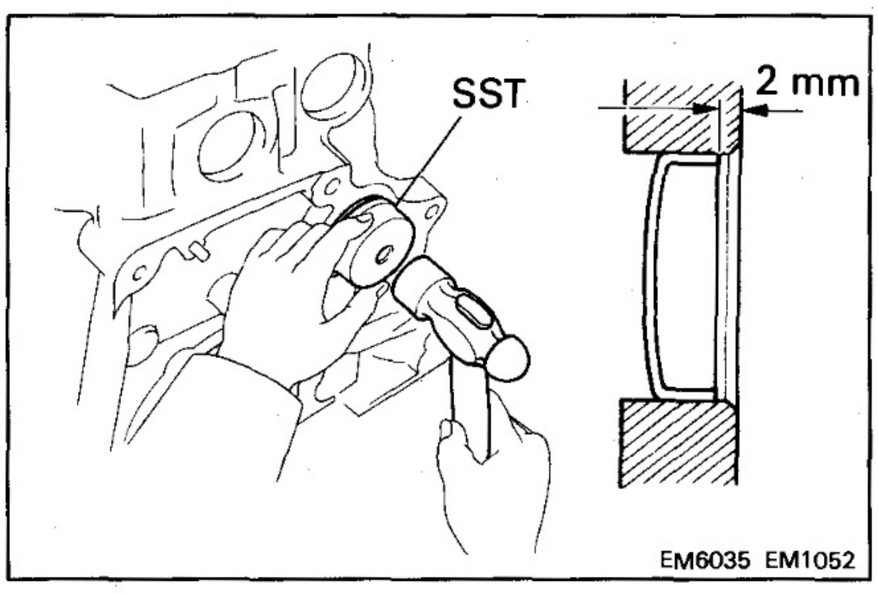


(b) Align the oil holes of the bearing and cylinder block.



(c) Using SST, install the camshaft bearings.

SST 09215-00012 (09215-00020, 09215-00440, 09215-00470) and
09215-00100 (09215-00130, 09215-00140, 09215-00150, 09215-00160)



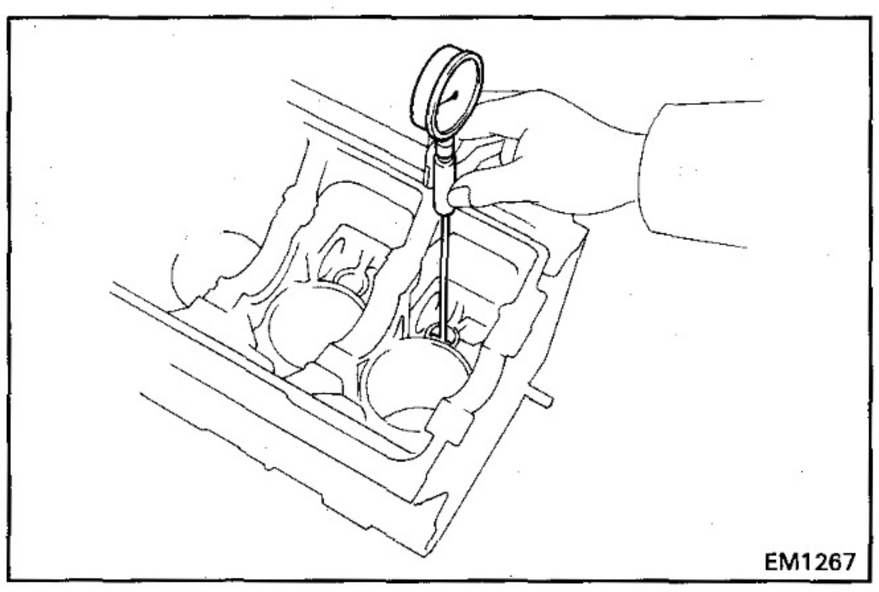
D. Check camshaft oil clearance (See page EM-88)

E. Install expansion plug

(a) Apply liquid sealer to the expansion plug surface of the cylinder block.

(b) Using SST and a hammer, drive in the expansion plug to a distance of 2 mm (0.08 in.) from the cylinder block edge.

SST 09215-00012 (09215-00470)

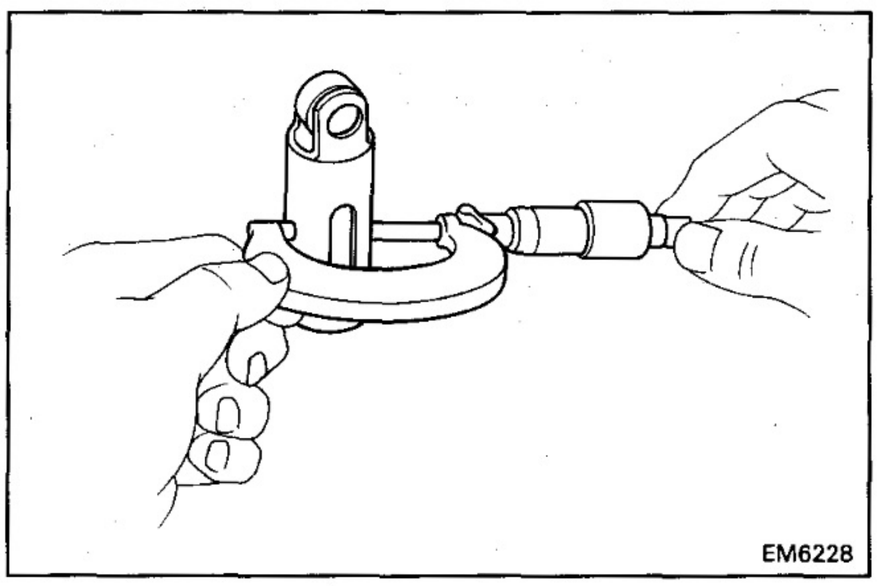


INSPECTION OF VALVE LIFTERS AND VALVE LIFTER BORES

INSPECT VALVE LIFTER OIL CLEARANCE

(a) Using a cylinder gauge, measure the valve lifter bore diameter.

Bore diameter: 27.010 — 27.030 mm (1.0634 — 1.0642 in.)



(b) Using a micrometer, measure the valve lifter diameter.

Lifter diameter: 26.955 — 26.975 mm (1.0612 — 1.0620 in.)

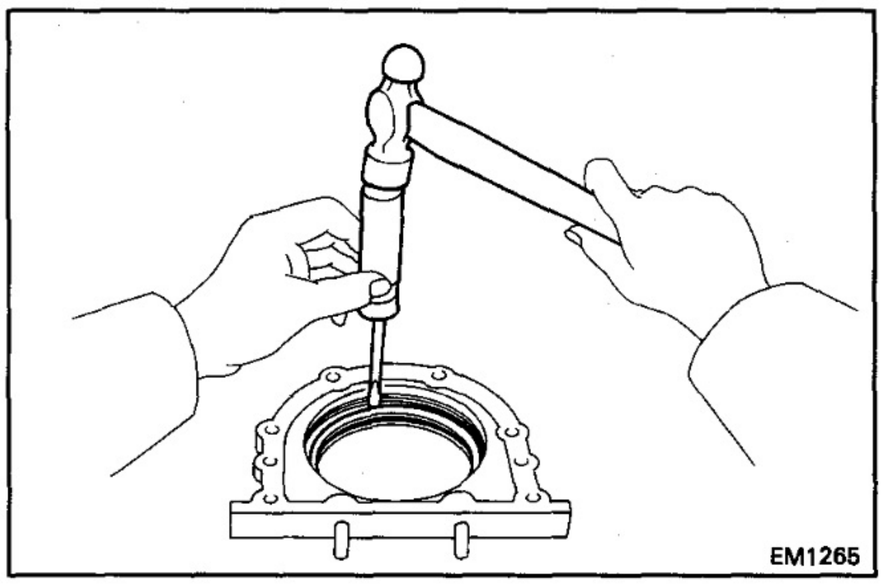
(c) Subtract the valve lifter diameter measurement from the valve lifter bore diameter measurement.

Standard oil clearance: 0.035 — 0.075 mm (0.0014 — 0.0030 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the valve lifters.

REPLACEMENT OF CRANKSHAFT REAR OIL SEAL

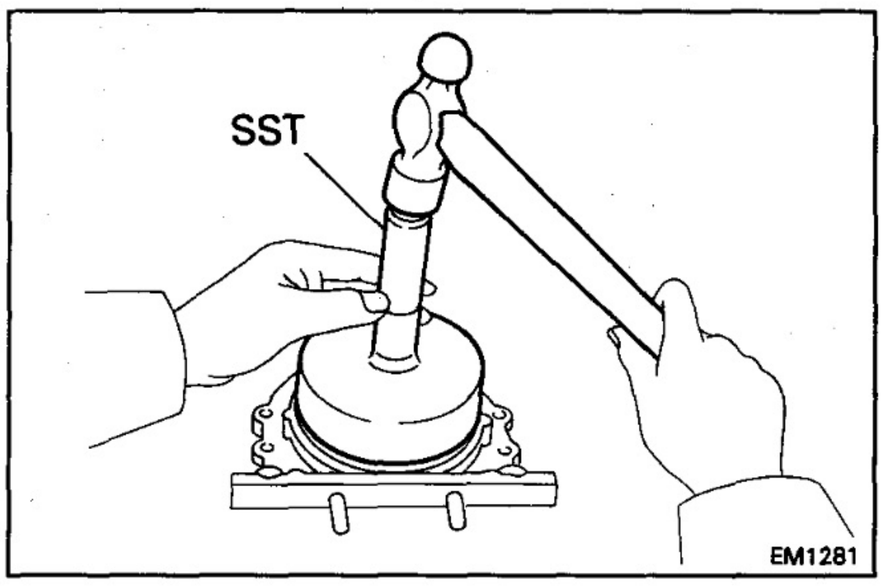
HINT: There are two methods (A and B) to replace the oil seal as follows.



REPLACE CRANKSHAFT REAR OIL SEAL

A. If rear oil seal retainer is removed from cylinder block:

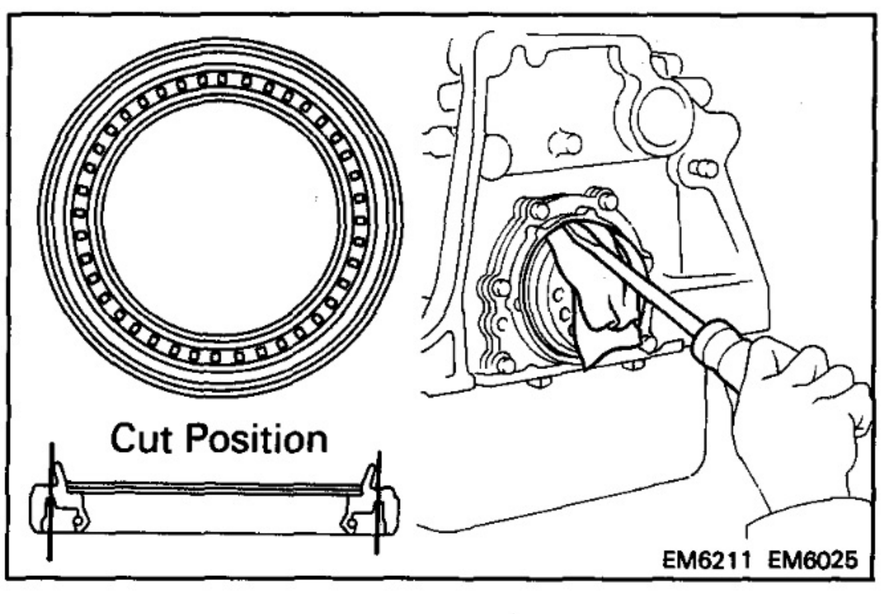
(a) Using a screwdriver and hammer, tap out the oil seal.



(b) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

SST 09223-56010

(c) Apply MP grease to a new oil seal.

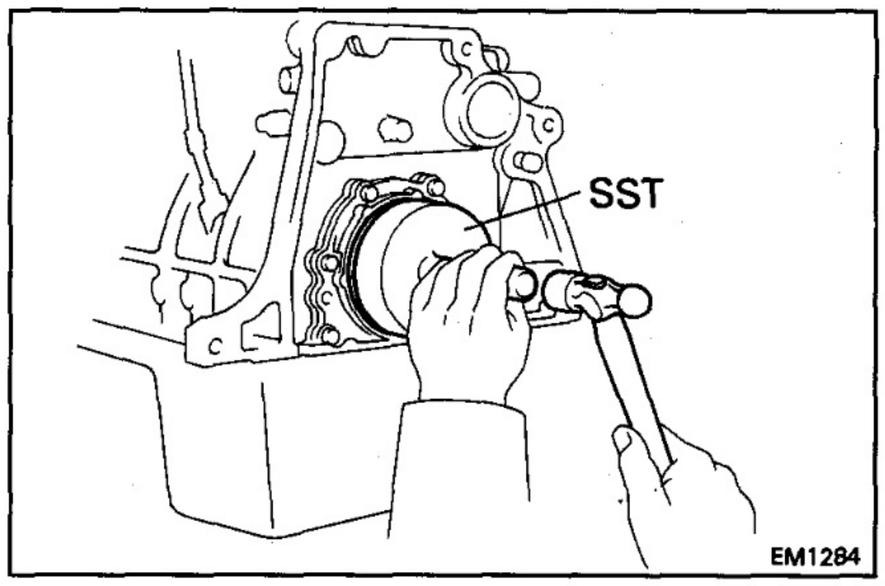


B. If rear oil seal retainer is installed to cylinder block:

(a) Using a knife, cut off the oil seal lip.

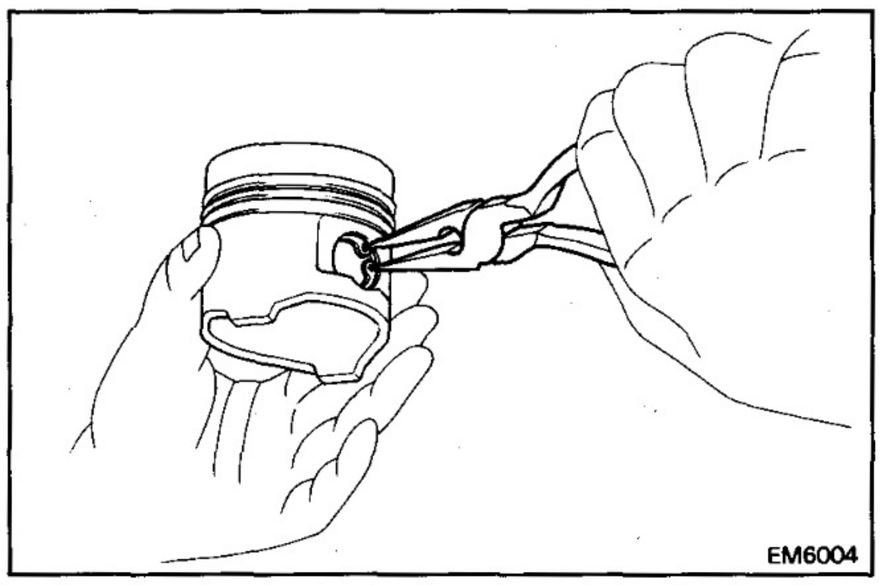
(b) Using a screwdriver, pry out the oil seal.

NOTICE: Be careful not to damage the crankshaft. Tape the screwdriver.



(d) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

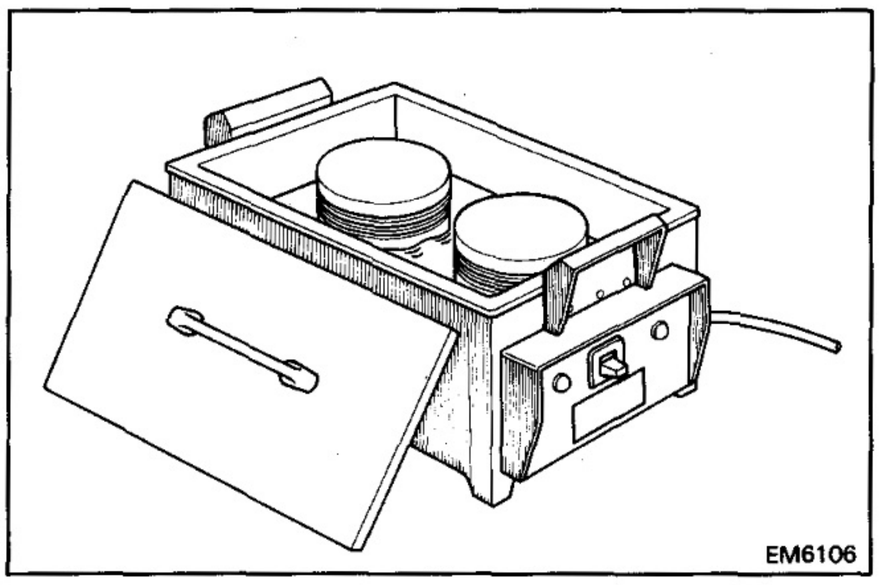
SST 09223-56010



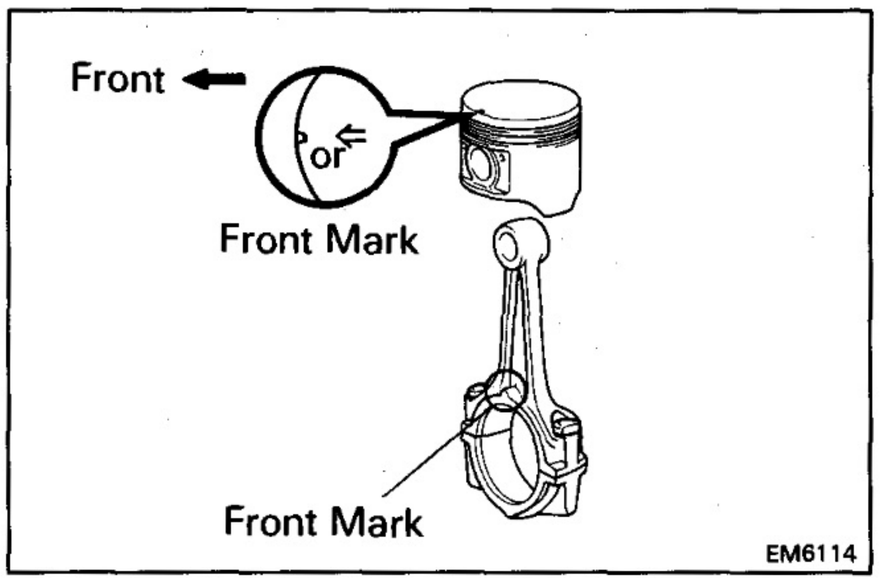
ASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. ASSEMBLE PISTON AND CONNECTING ROD

(a) Install a new snap ring on one side of the piston pin hole.

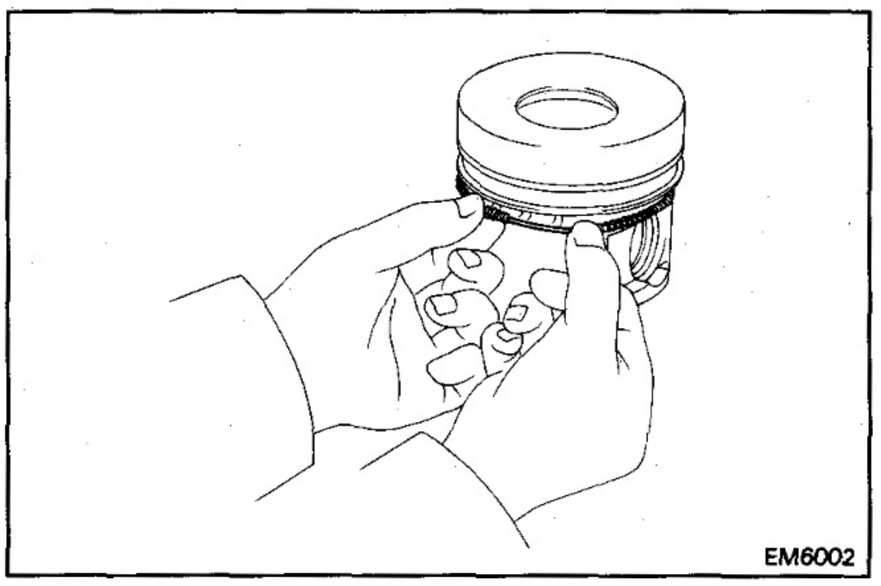


(b) Gradually heat the piston to about 60°C (140°F).



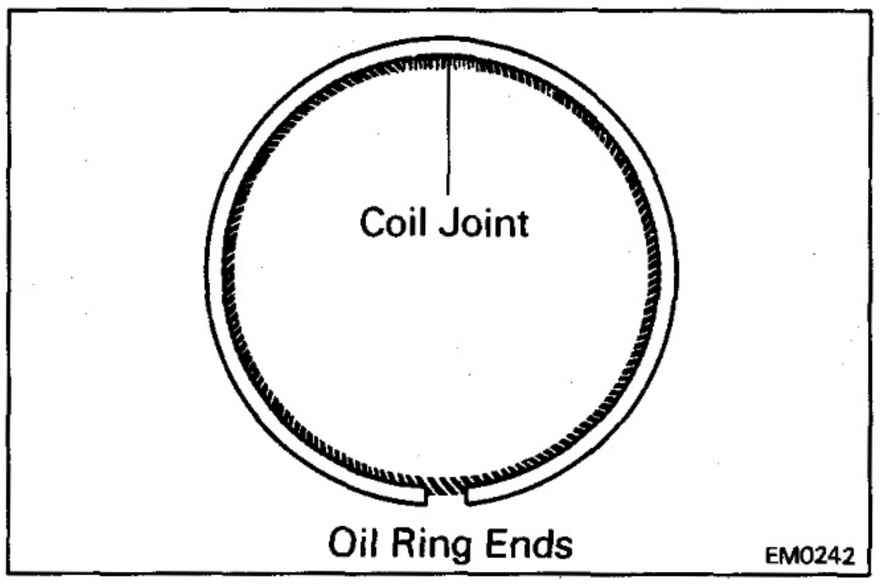
(c) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

(d) Install a new snap ring on the other side of the pin hole.

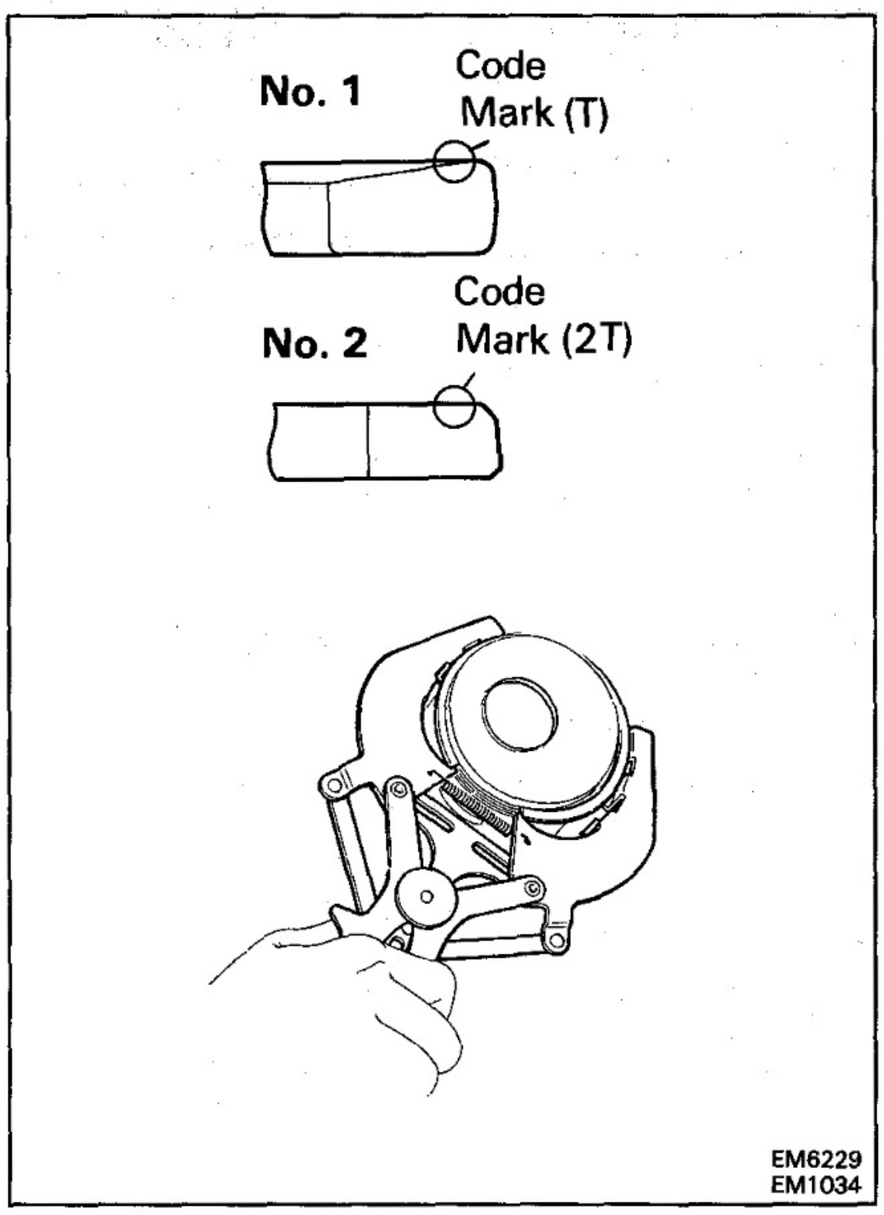


2. INSTALL PISTON RINGS

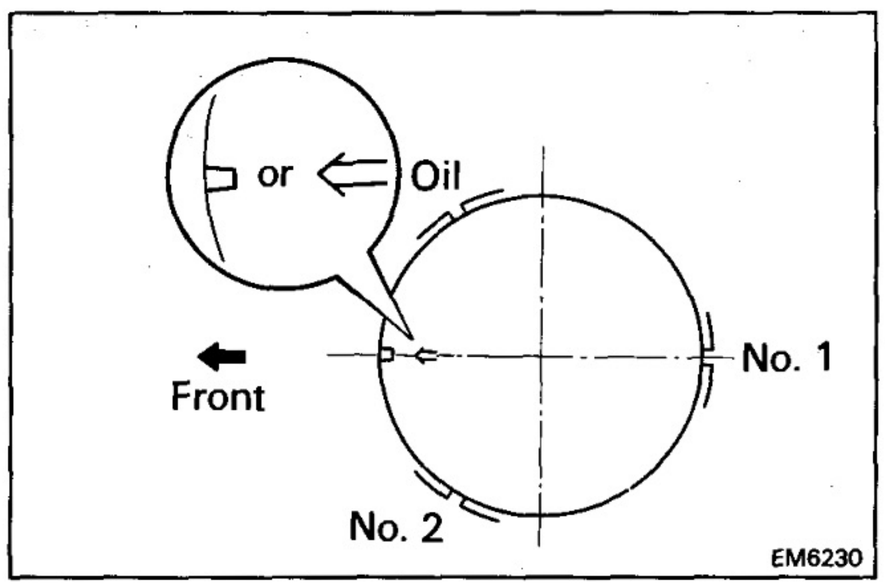
(a) Install the coil and oil ring by hand.



HINT: Face the end gap of the oil ring in the opposite direction of the coil joint.

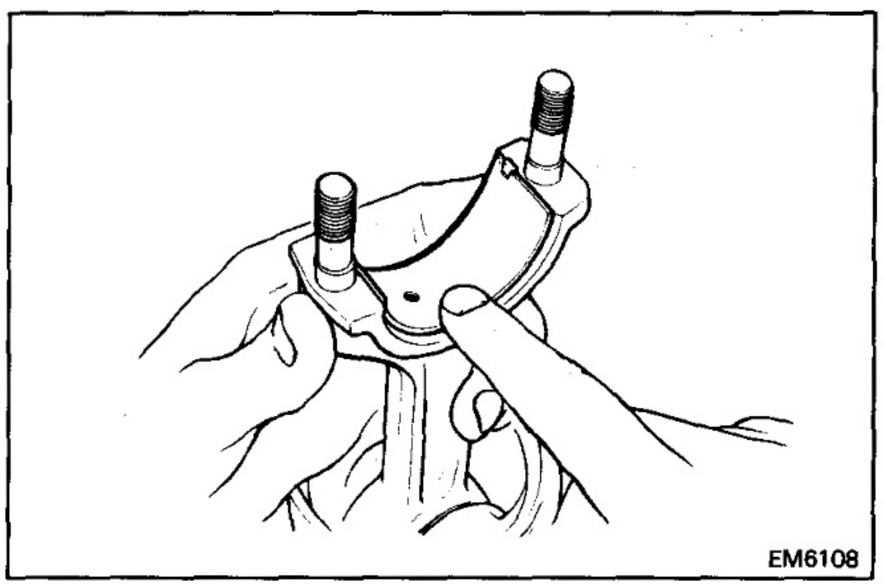


(b) Using a piston ring expander, install the two compression rings with the code mark facing upward.



(c) Position the piston rings so that the ring end gaps are as shown.

NOTICE: Do not align the end gaps.



3. INSTALL BEARINGS

(a) Align the bearing claw with the claw groove of the connecting rod or connecting rod cap.

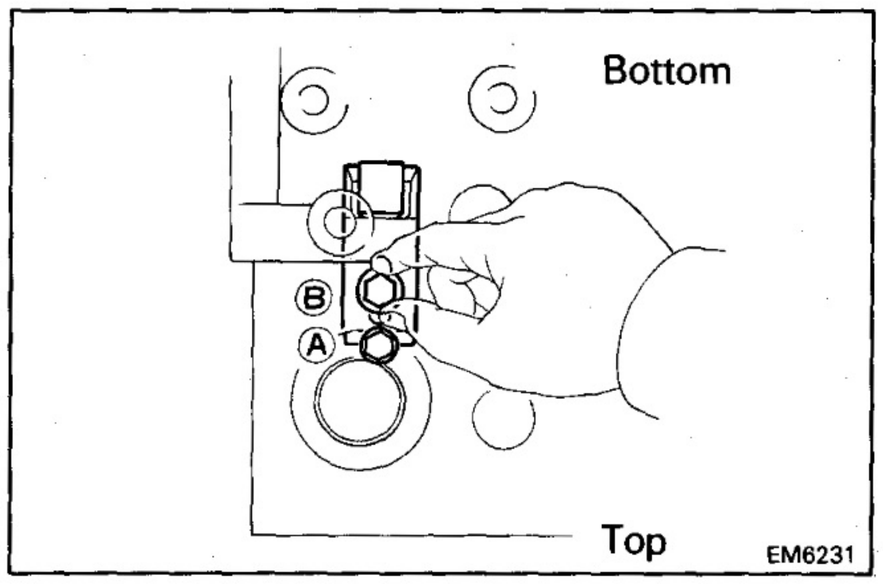
(b) Install the bearings in the connecting rod and connecting rod cap.

ASSEMBLY OF CYLINDER BLOCK

(See page EM-67)

HINT:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply new engine oil to all sliding and rotaing surfaces.
- Replace all gaskets, and oil seals with new parts.



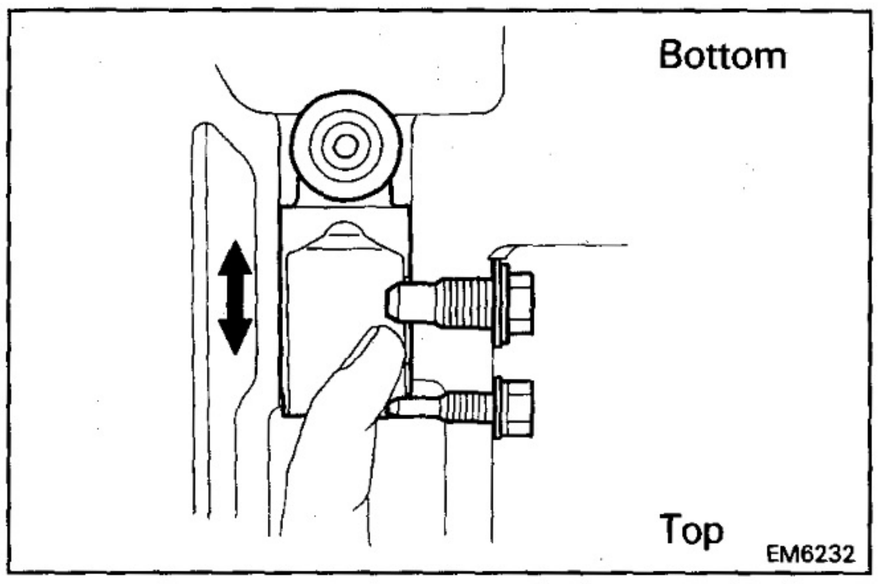
1. INSTALL VALVE LIFTERS

(a) Install bolt Ⓐ to the cylinder block with a new gasket.

Torque: 75 kg-cm (4.7 in.-lb, 7.4 N·m)

(b) Install the valve lifter so that the tip of bolt Ⓐ fits in the groove.

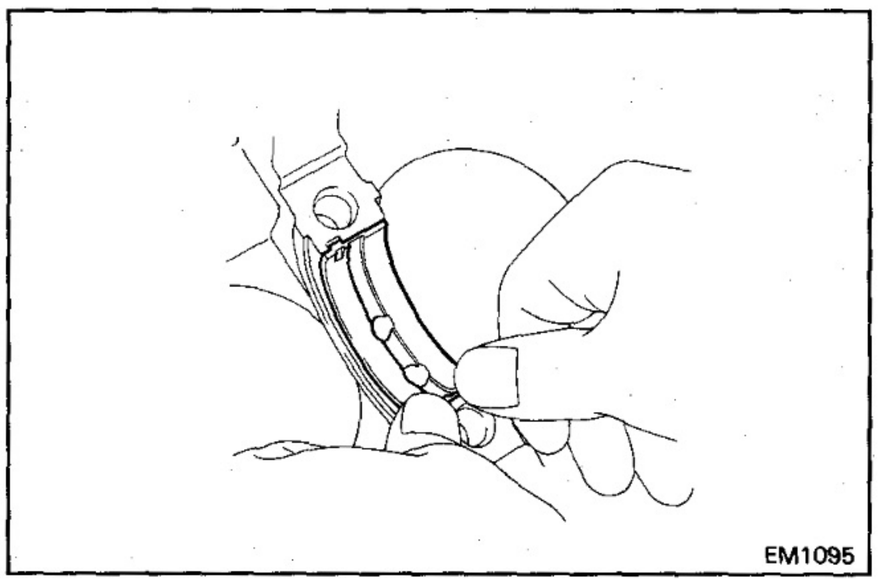
(c) Install bolt Ⓑ with a new gasket by hand, check that its tip is inside the long hole.



(d) Torque bolt Ⓑ .

Torque: 375 kg-cm (28 ft-lb, 37 N·m)

HINT: Check that the valve lifter moves smoothly up and down.

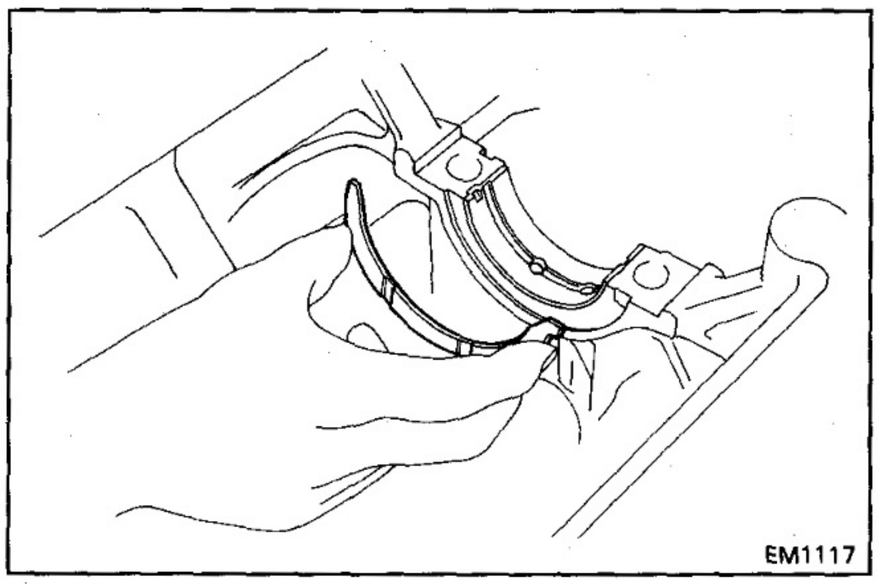


2. INSTALL MAIN BEARINGS

(a) Align the bearing claw with the claw groove of the main bearing cap or cylinder block.

(b) Install the bearing in the cylinder block and main bearing caps in the proper location.

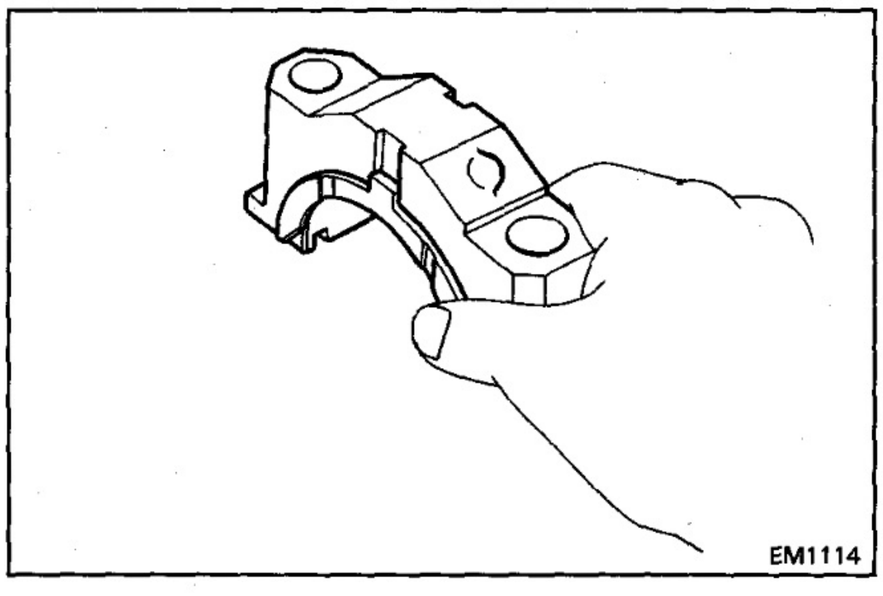
NOTICE: Install the bearing with the oil hole in the cylinder block.



3. INSTALL UPPER THRUST WASHERS

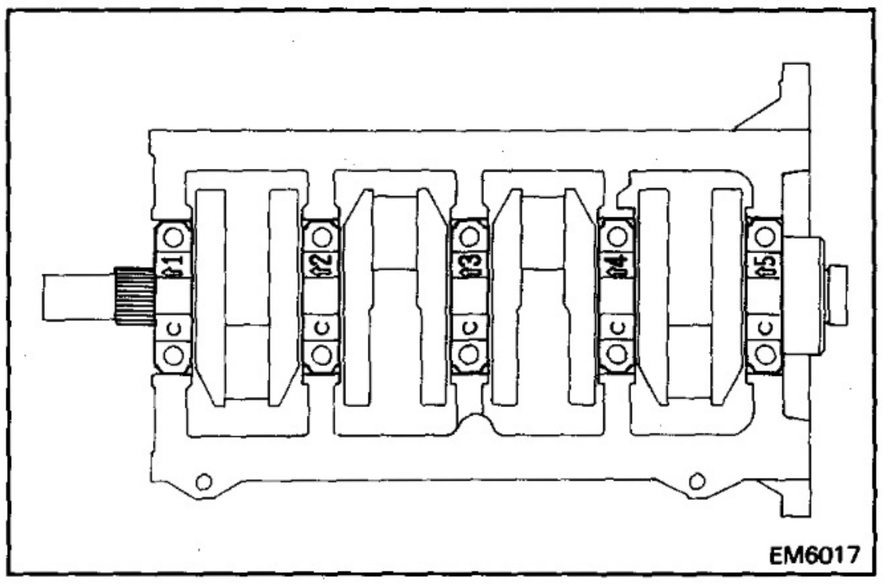
Install the thrust washers under the No. 3 main bearing cap position of the block with the oil grooves facing outward.

4. PLACE CRANKSHAFT ON CYLINDER BLOCK

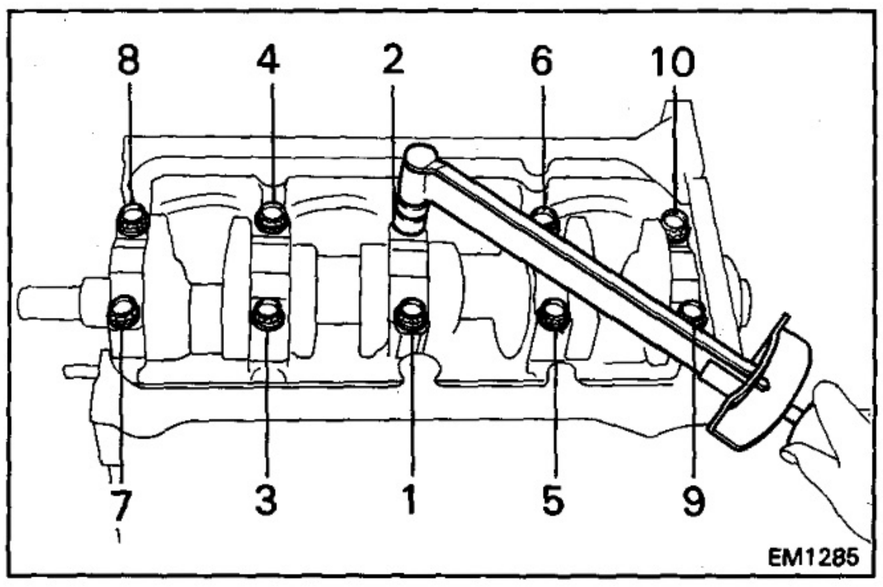


5. INSTALL MAIN BEARING CAPS AND LOWER THRUST WASHERS

(a) Install the lower thrust washers on the No. 3 main bearing cap with the oil grooves facing outward.



(b) Install the main bearing caps in their proper locations.



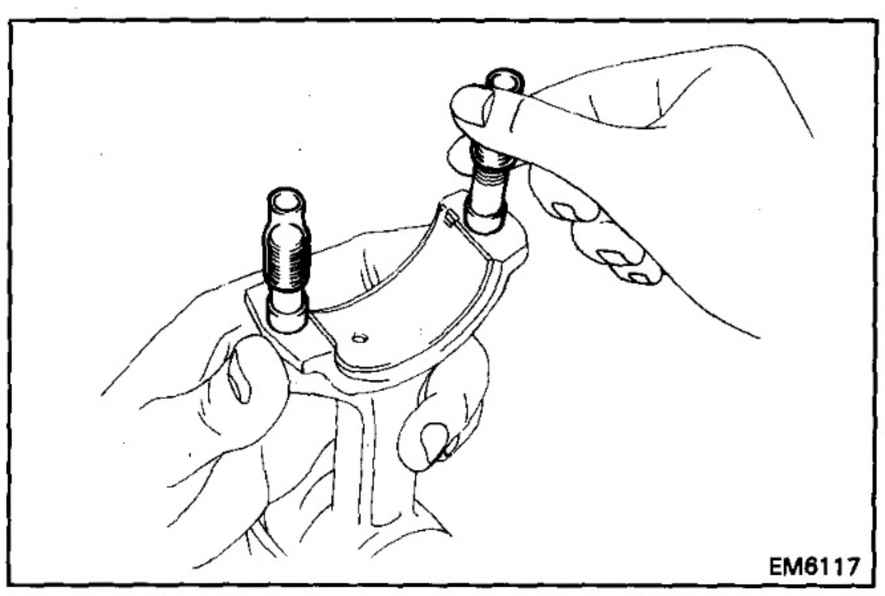
(c) Apply a light coat of the engine oil on the threads and under the bolt heads of the main bearing caps.

(d) Install and uniformly tighten the fourteen bolts of the main bearing caps in several passe, in the sequence shown.

Torque: 2,000 kg-cm (145 ft-lb, 196 N·m)

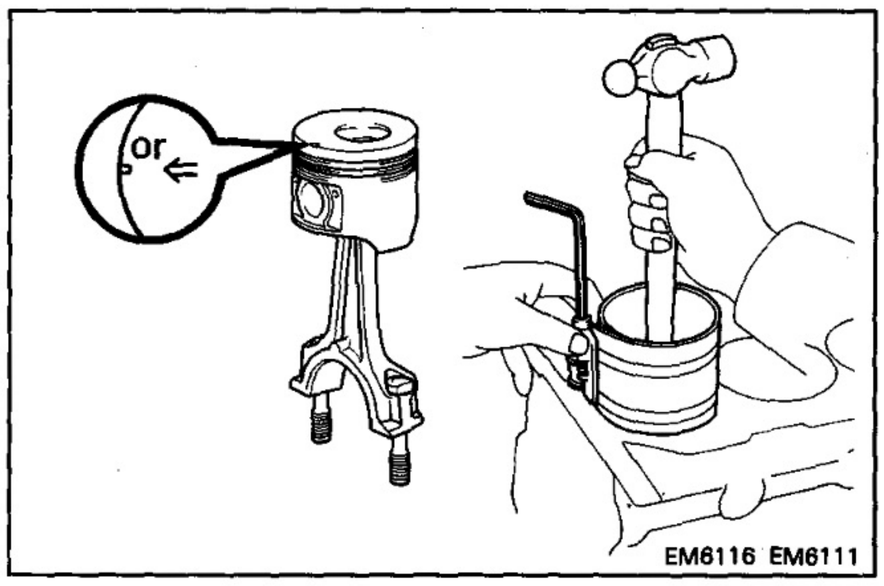
(e) Check that the cranshaft turns smoothly.

(f) Check the crankshaft thrust clearance.
(See page EM-71)

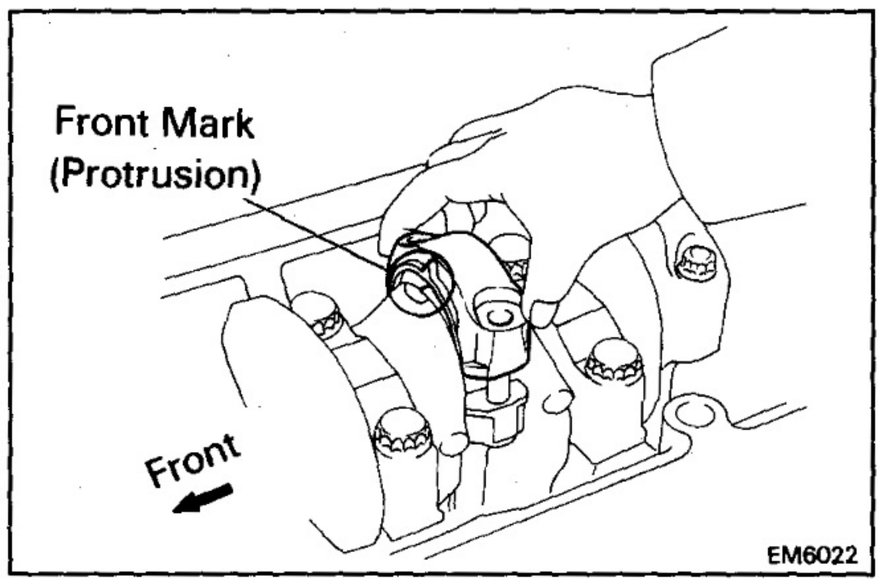


6. INSTALLATION PISTON AND CONNECTING ROD ASSEMBLIES

(a) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft and cylinder bore from damage.



(b) Using a piston ring compressor, push the correctly numbered piston and connecting rod assembly into the cylinder with the front mark of the piston facing forward.



7. INSTALL CONNECTING ROD CAPS

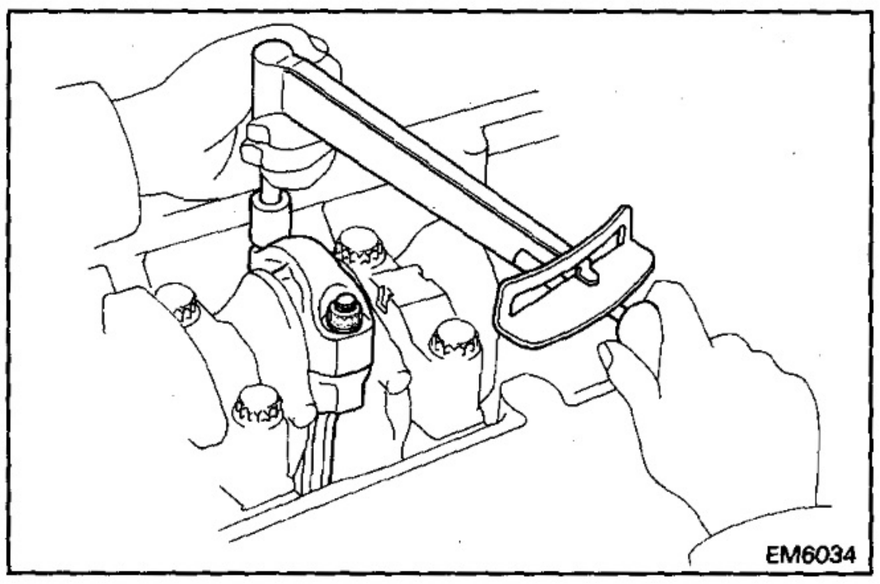
(a) Match the numbered cap with the numbered connecting rod.

(b) Install the connecting rod cap with the front mark facing forward.

8. TORQUE CONNECTING ROD CAP NUTS

HINT:

- The connecting rod cap nuts are tighten in two progressive steps.
- If any of the cap bolts break or deform, replace them.



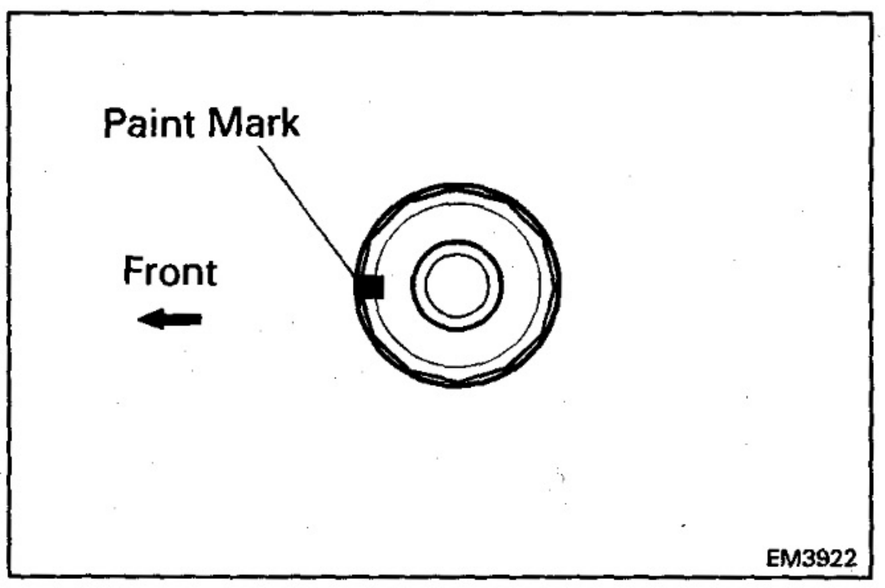
(a) Apply a light coat of the engine oil under the nuts.

(b) First, alternately torque the cap nuts in several passes.

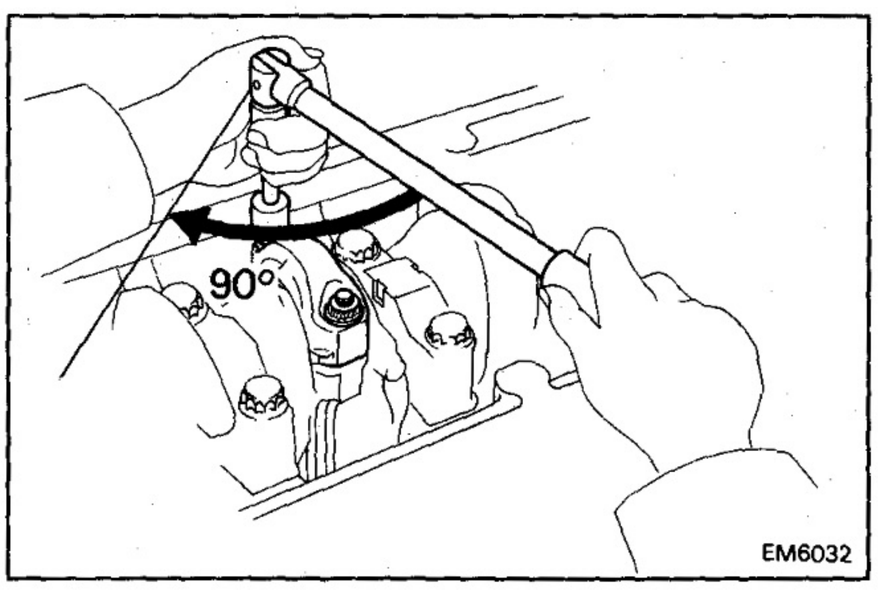
Torque:

B	**550 kg-cm (40 ft-lb, 54 N·m)**
3B, 11B and 14B	**700 kg-cm (51 ft-lb, 69 N·m)**

If any one of the nuts does not meet the torque specification, replace the bolt.



(c) Mark the front side of the top of cap nut with paint.

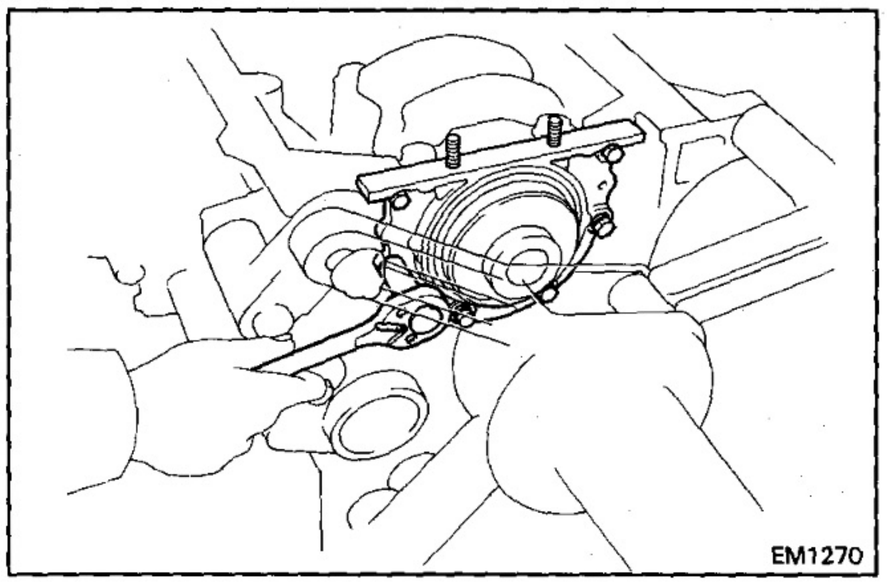


(d) Torque the cap nuts by an additional 90°.

(e) Check that the paint mark is now facing sideward.

(f) Check that the crankshaft turns smoothly.

(g) Check the rod thrust clearance.
(See step 12 on page EM-68)



9. INSTALL REAR OIL SEAL RETAINER

Install a new gasket and the retainer with the six bolts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

10. INSTALL OIL PUMP AND OIL PAN (See page LU-14)

11. INSTALL INJECTION PUMP (See page FU-60)

12. INSTALL TIMING GEARS AND CAMSHAFT (See page EM-62)

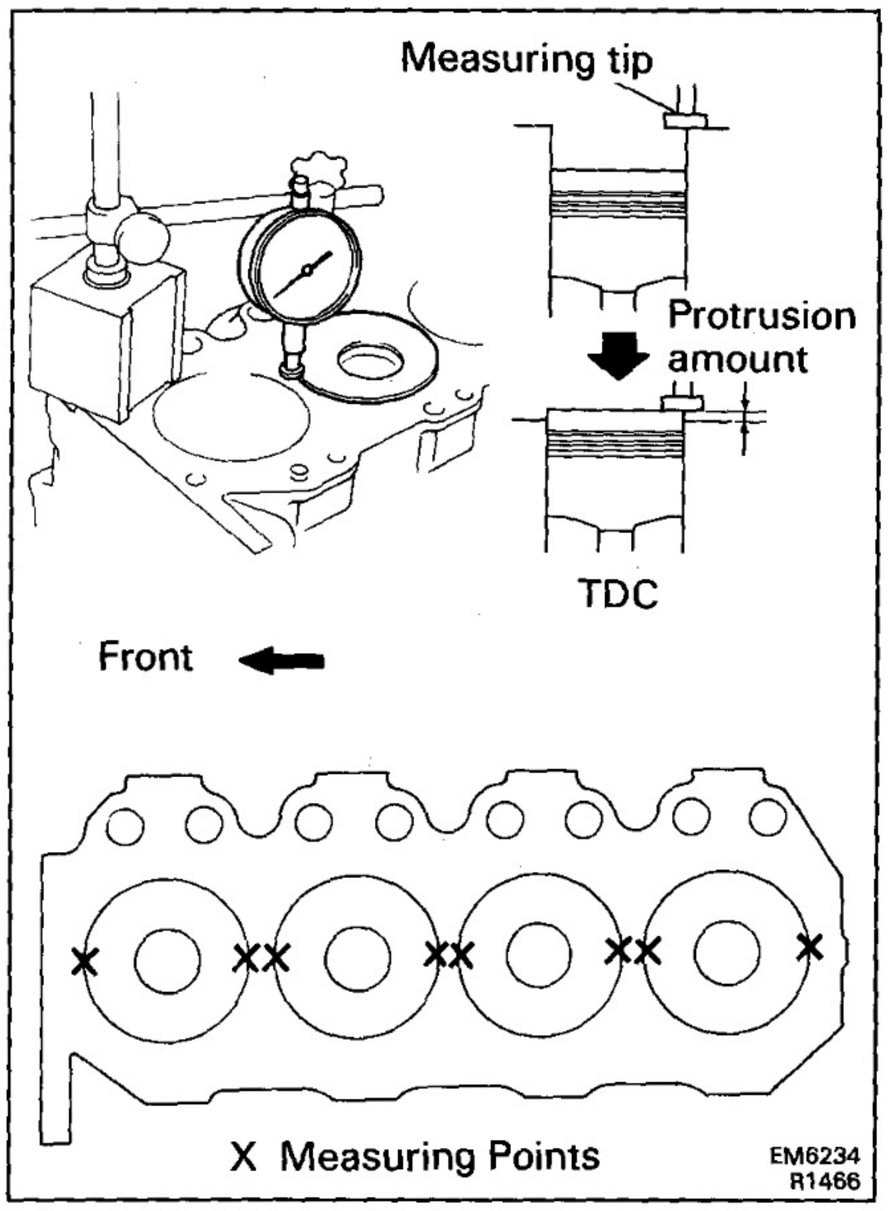
13. [11B and 14B] SELECT CYLINDER HEAD GASKET

HINT:

- If only replacing the gasket, use a gasket of the same thickness shown on the originally installed gasket.
- If replacing the cylinder block, pistons, connecting rods or crankshaft, use the following procedures to make the cylinder head gasket selection.
- (11B)
  Gaskets with no cutout are used only in factory assembly and are not available as a supply part.

(a) Clean the cylinder block solvent.

(b) Using a dial gauge measure the piston protrusion from the cylinder block gasket surface at two points on each piston while pistons are at TDC as shown in the illustration.

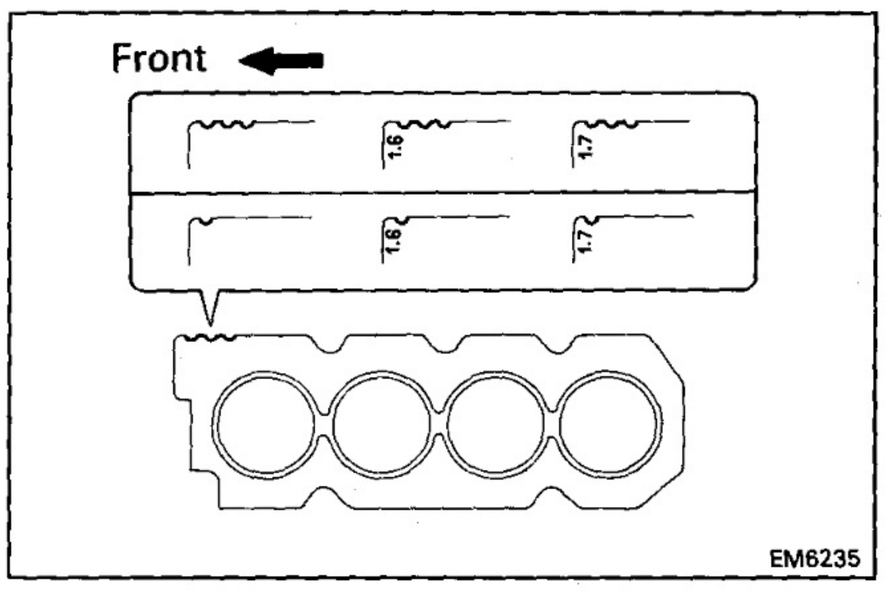


HINT:

- Use a dial gauge measuring tip as shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.
- Find where the piston head protrudes the most by slowly turning the crankshaft clockwise and counter-clockwise.

(c) From the piston protrusion measurements taken from eight measuring points, use the highest value and select the appropriate gasket using the table below.

Selection mark	Maximum piston protrusion value (mm)	Head gasket thickness (mm)
No mark	0.535 — 0.785 (0.0211 — 0.0309 in.)	1.5 (0.059 in.)
1.6	0.785 — 0.885 (0.0309 — 0.0348 in.)	1.6 (0.063 in.)
1.7	0.885 — 0.985 (0.0348 — 0.0388 in.)	1.7 (0.067 in.)



14. **INSTALL CYLINDER HEAD (See page EM-46)**

15. **INSTALL ALTERNATOR**

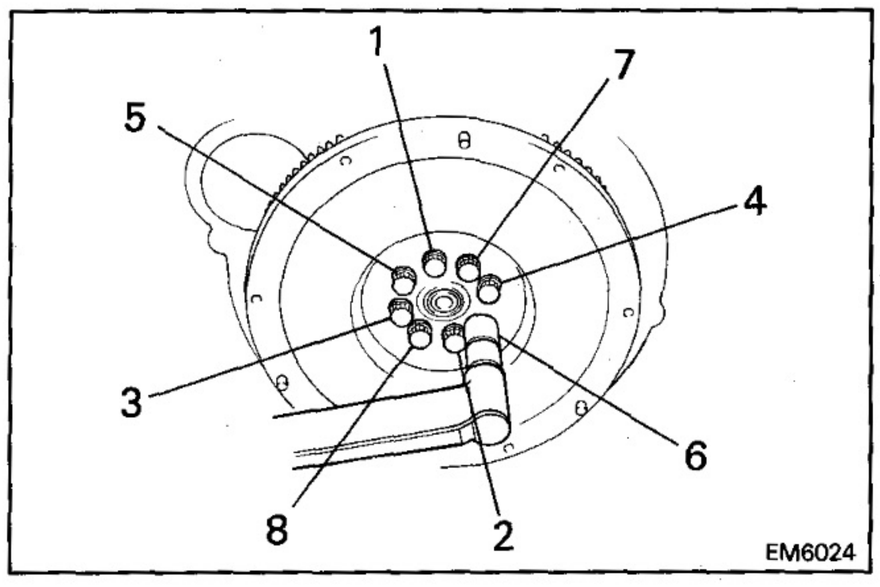
16. **INSTALL INJECTION PIPES**
    (See page FU-13) B and 3B
    (See page FU-19) 11B and 14B

17. **REMOVE ENGINE STAND**

18. **INSTALL REAR END PLATE**

19. **[M/T]**
    INSTALL FLYWHEEL
    (a) Apply a light coat of engine oil on the threads and under the bolt heads.
    (b) Install the flywheel on the crankshaft.
    (c) Install and uniformly tighten the six bolts in several passes, in the sequence shown.

    Torque: 1,800 kg-cm (130 ft-lb, 177 N·m)



20. **[A/T]**
    INSTALL FLYWHEEL, DRIVE PLATE AND SPACER
    (See procedure step 19)

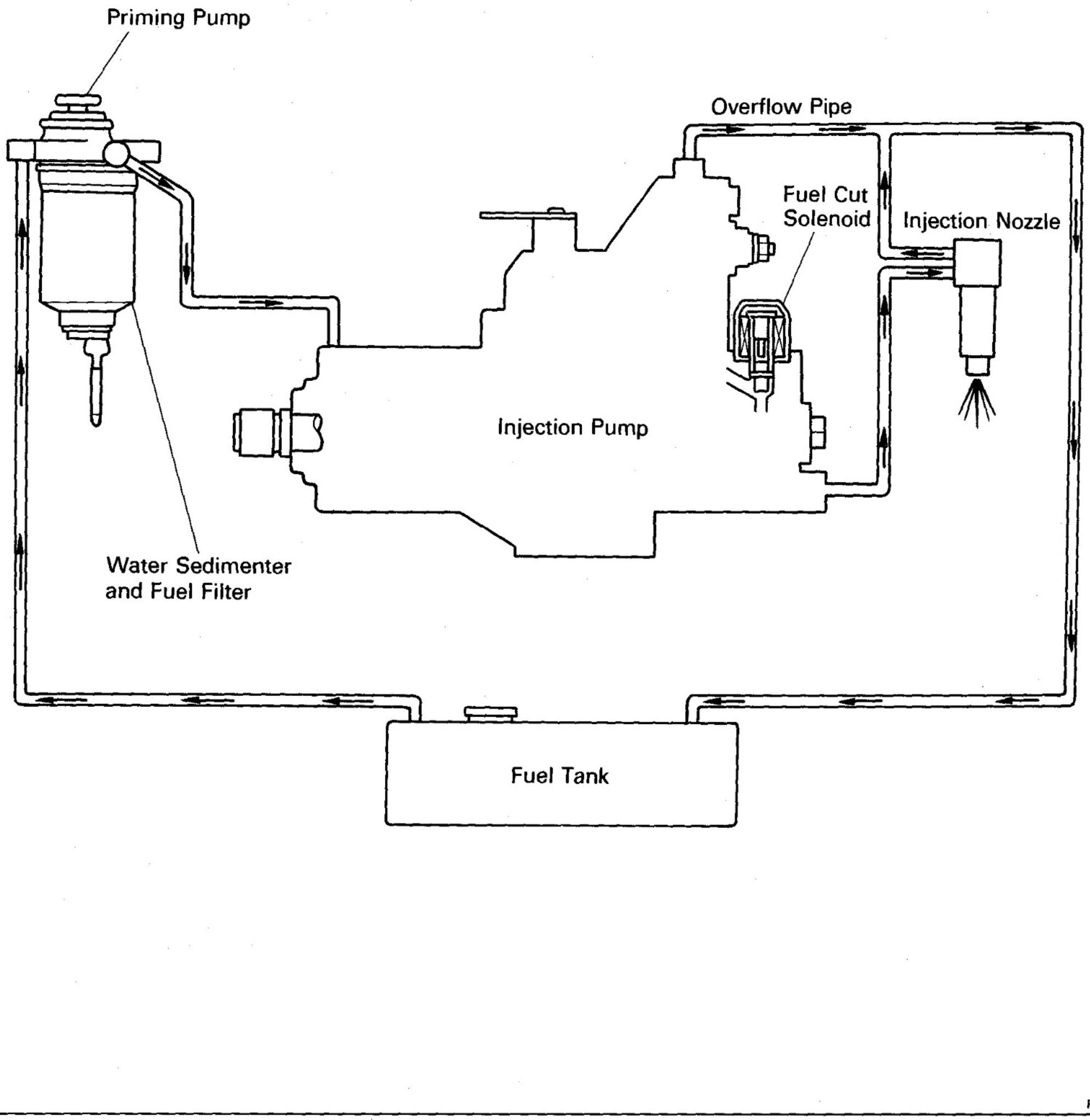
    Torque: 1,200 kg-cm (87 ft-lb, 118 N·m)

FUEL SYSTEM

NOTE: For troubleshooting procedures, refer to DIESEL ENGINE DIAGNOSIS (EM Section).

	Page
DESCRIPTION	FU-2
REPLACEMENT OF FUEL FILTER	FU-4
FUEL FILTER WARNING SWITCH	FU-5
FUEL HEATER	FU-6
INJECTION NOZZLES [B and 3B]	FU-8
INJECTION NOZZLES [11B and 14B]	FU-14
INJECTION PUMP	FU-20

DESCRIPTION

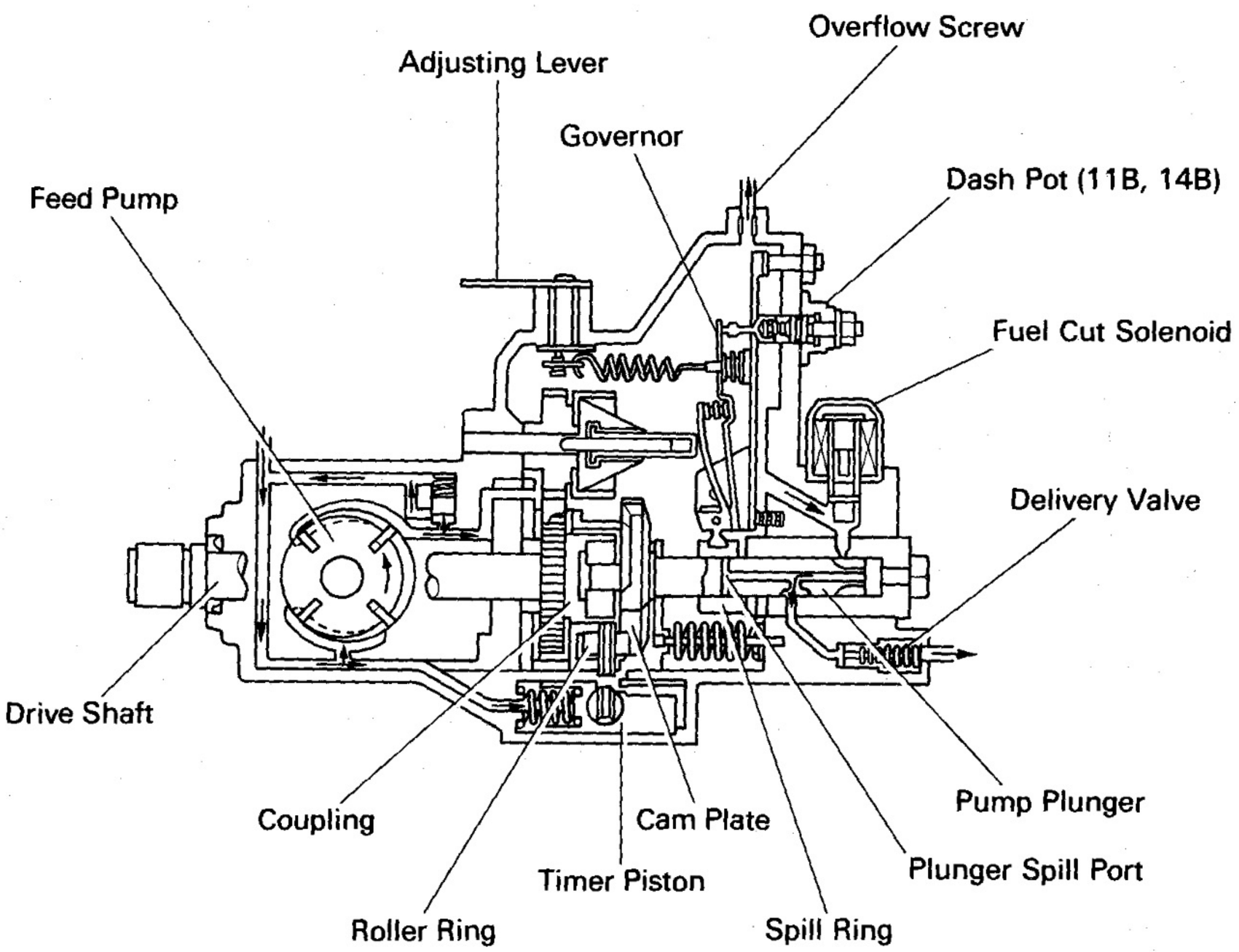


FU2222

FUEL SYSTEM

Fuel is drawn up from the fuel tank through the sedimenter and fuel filter by the feed pump built into the injection pump.
The fuel drawn up is then sent into the pump housing. Fuel compressed in the pump housing is distributed to the injection nozzles according to the injection order, and injected at high pressure into the fuel chamber. Excess fuel in the pump housing flows through the overflow valve and along the overflow pipe and returns to the fuel tank.
The fuel cycle provides both cooling and lubrication for the pump. The cycling of fuel through the pump chamber warms the fuel so that it is prevented from becoming wax-like at cold temperatures.

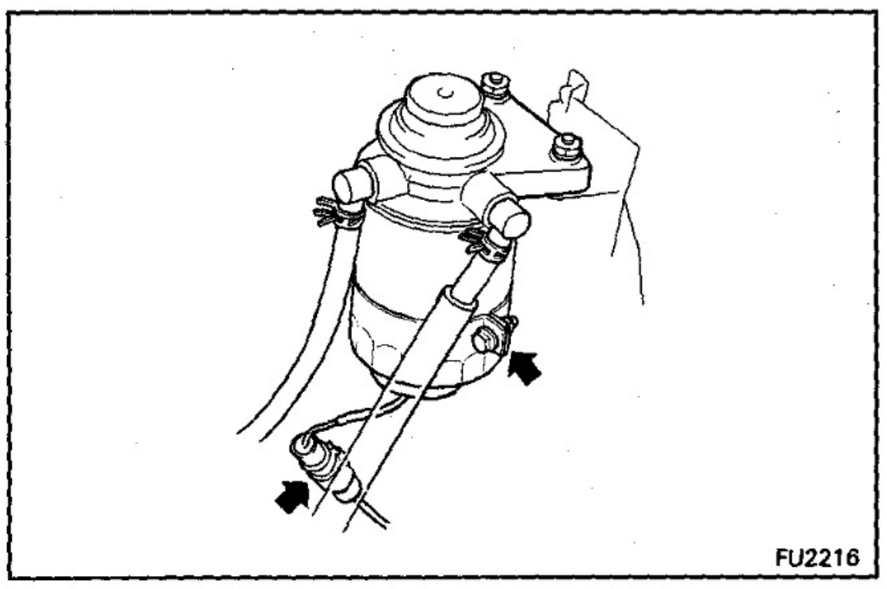
INJECTION PUMP (VE TYPE)



Operation

- The centrifugal force type feed pump takes up a fixed volume of fuel with each turn. The fuel expulsion pressure from the feed pump is controlled by operation of the pressure regulator valve.
- Fuel is sent from the outlet side of the feed pump, through the hole in the upper part of the feed pump cover and into the pump body.
- The pump plunger also rotates as it moves up and down. After the fuel is drawn in, it is distributed under pressure to the delivery valve of each cylinder according to the injection order.
- The centrifugal force type all speed governor installed in the upper part of the injection pump moves the spill ring obstructing the plunger spill port and controls the fuel injection volume.
- The hydraulic type timer installed in the lower part of the injection pump is operated by the fuel pressure of the pump housing, and movement of the roller ring by the timer advances the injection angle and controls the injection timing.
- The fuel cut solenoid is connected to the ignition switch IG circuit, and when the ignition switch is turned to OFF, the current is cut off, the solenoid is de-energized, fuel is cut off and the engine stops.
- High Altitude Compensation Device
  Due to the decrease in atmospheric pressure at high altitudes, the intake air volume decreases and the exhaust gas density increases. To prevent this, the device automatically reduces the fuel injection volume for full loads in response to the altitude.

REPLACEMENT OF FUEL FILTER

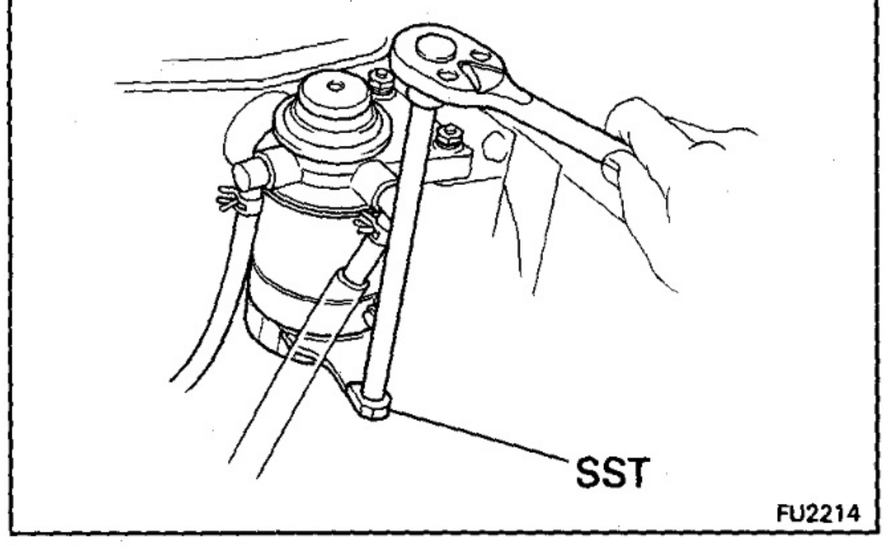

FU2216

1. DISCONNECT FUEL FILTER WARNING SWITCH CONNECTOR

2. LOOSEN FUEL FILTER CLAMP BOLT

3. DRAIN FUEL FROM FUEL FILTER

HINT: Put a suitable container or shop towel under the fuel filter.

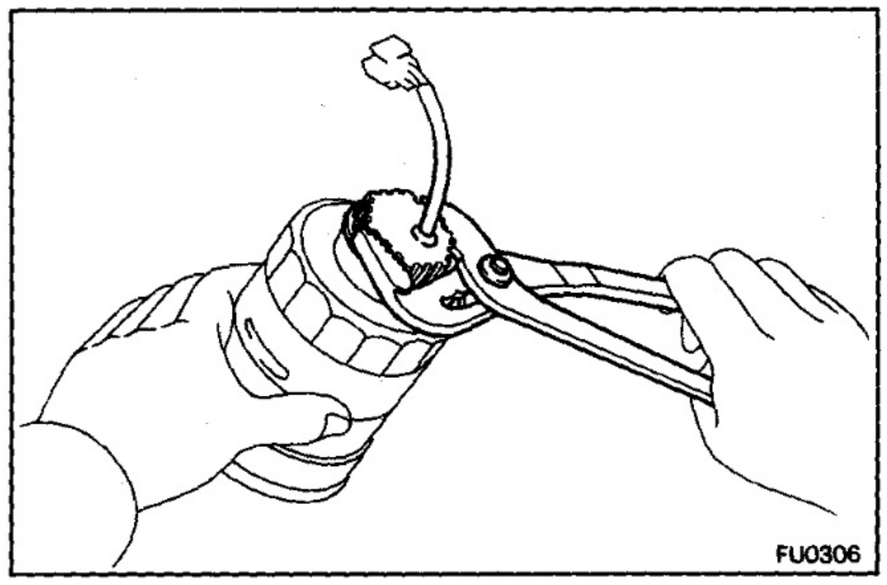


FU2214

4. REMOVE FUEL FILTER

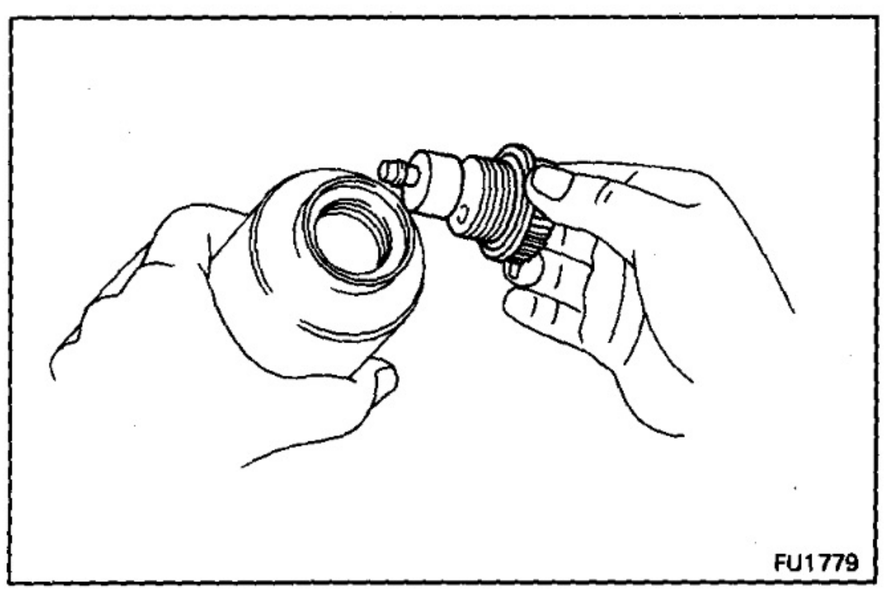
(a) Using SST, remove the fuel filter with the gasket.

SST 09228-64010


FU0306

(b) Using pliers, remove the fuel filter warning switch with the O-ring.

NOTICE: Be careful not to damage the warning switch.

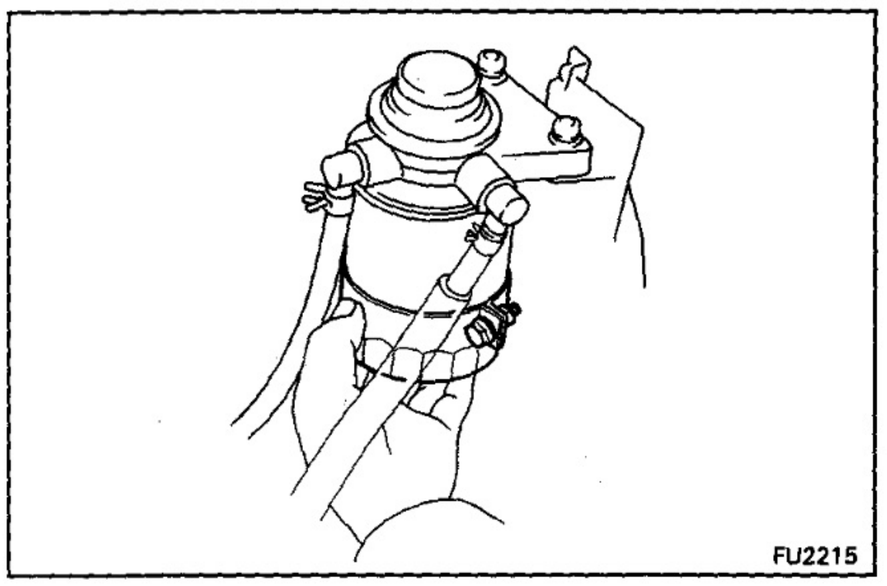

FU1779

5. INSTALL NEW FUEL FILTER

(a) Install a new O-ring to the fuel filter warning switch.

(b) Apply fuel to the O-ring of the fuel filter warning switch.

(c) Install the fuel filter warning switch to the fuel filter by hand.

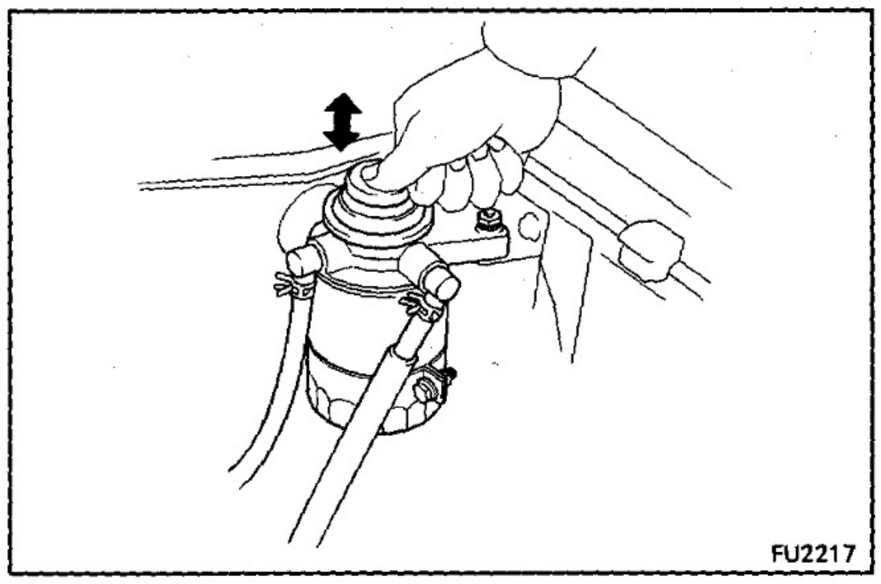

FU2215

(d) Apply fuel to the gasket of the new fuel filter.

(e) Install the fuel filter to the fuel filter bracket by hand.

6. TIGHTEN FUEL FILTER CLAMP BOLT

7. CONNECT FUEL FILTER WARNING SWITCH CONNECTOR



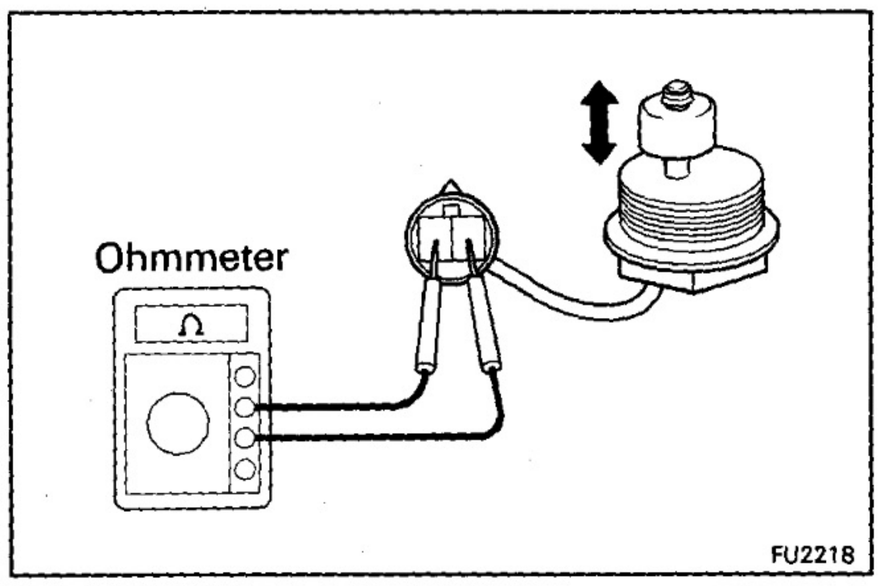
8. CHECK FOR FUEL LEAKS

Using a priming pump, fill with fuel and check for leaks.

FUEL FILTER WARNING SWITCH

INSPECTION OF FUEL FILTER WARNING SWITCH

1. REMOVE FUEL FILTER WARNING SWITCH
(See page FU-4)



2. INSPECT WARNING SWITCH

(a) Check that there is continuity between terminals when the warning switch is ON (float up).

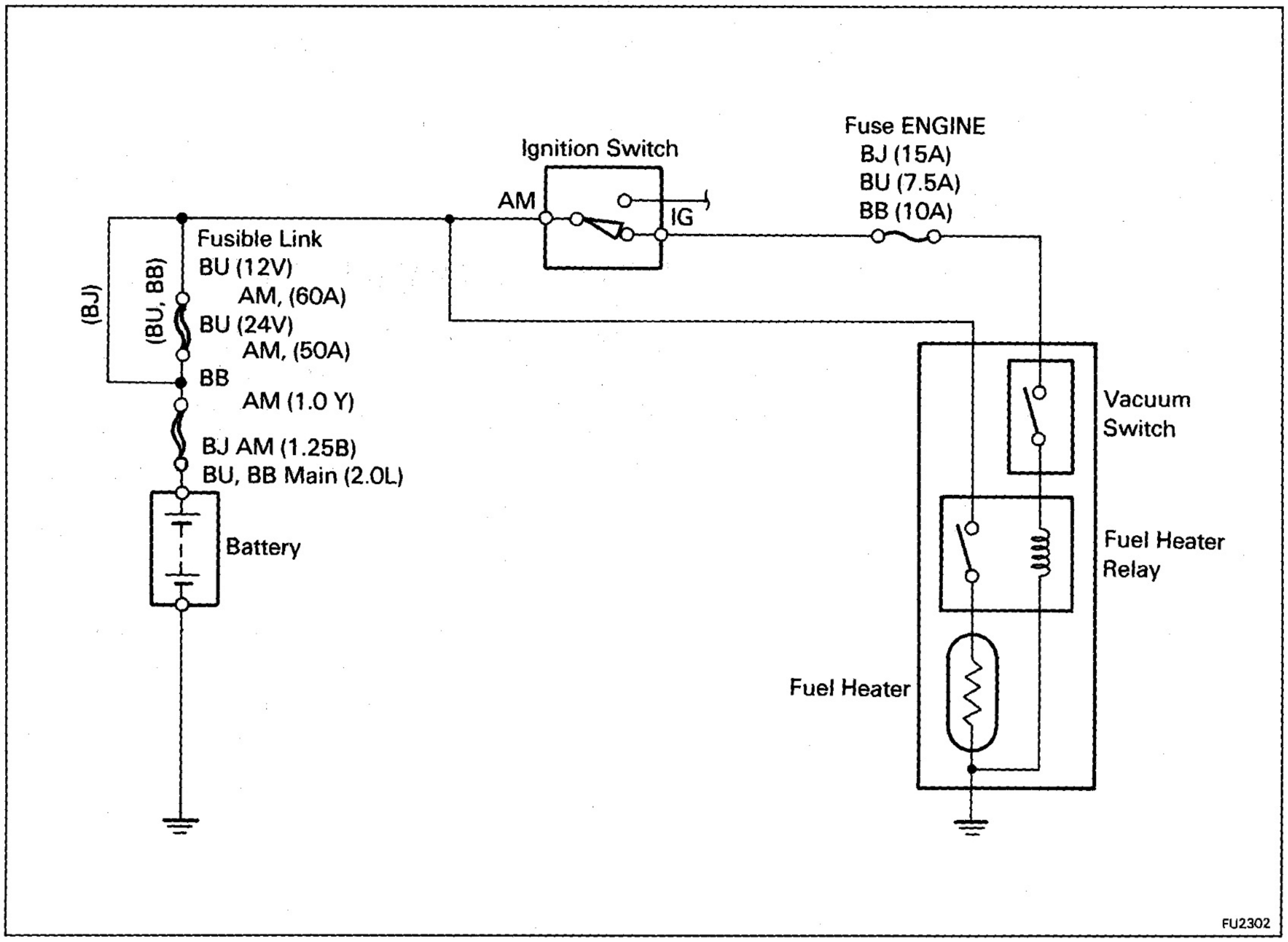
(b) Check that there is no continuity between terminals when the warning switch is OFF (float down).

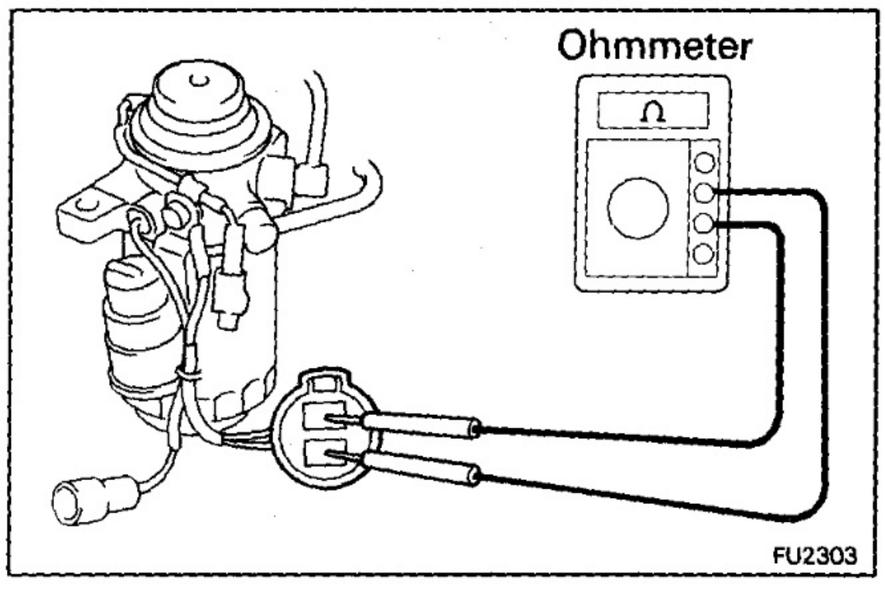
If operation is not as specified, replace the warning switch.

3. INSTALL FUEL FILTER WARNING SWITCH
(See page FU-4)

FUEL HEATER

SYSTEM CIRCUIT



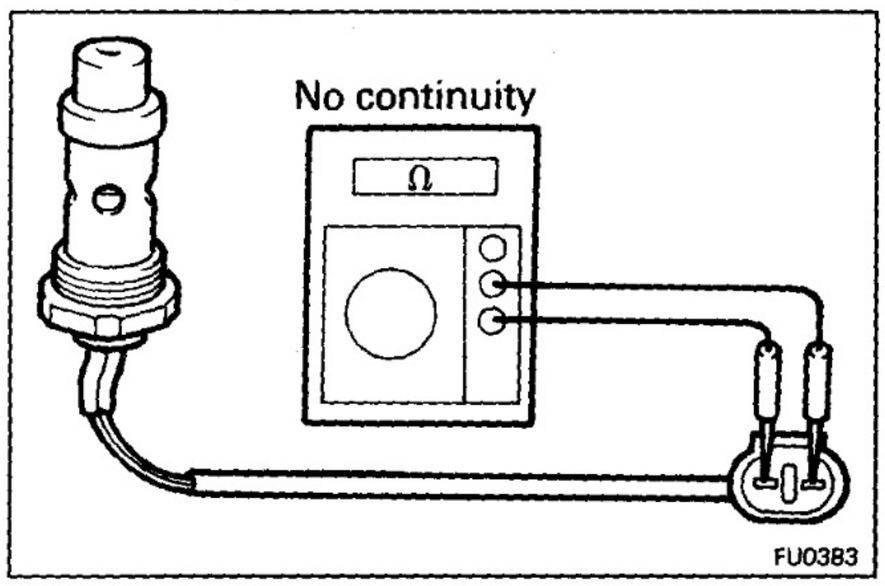


INSPECTION OF FUEL HEATER

1. INSPECT FUEL HEATER

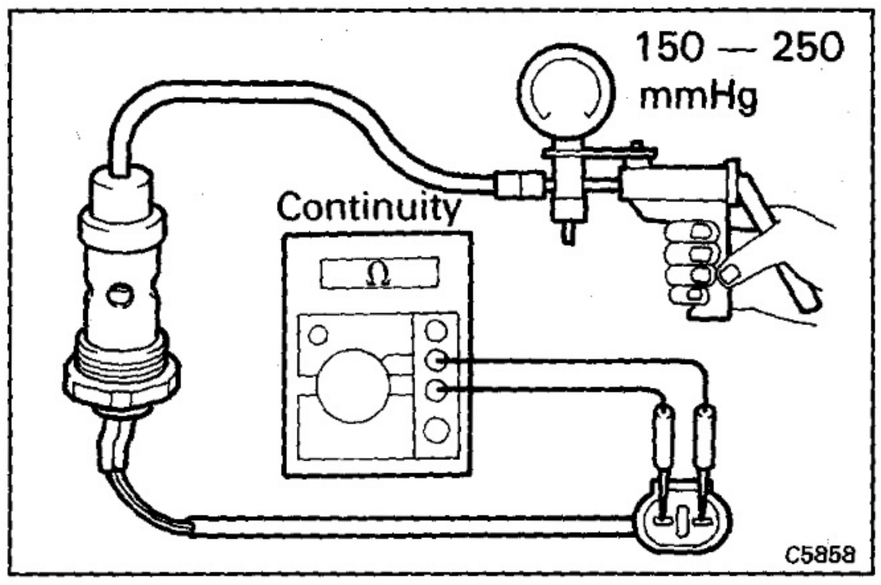
Using an ohmmeter, measure the resistance between the terminals.

Resistance: Approx. 0.7 Ω at 20°C (68°F)



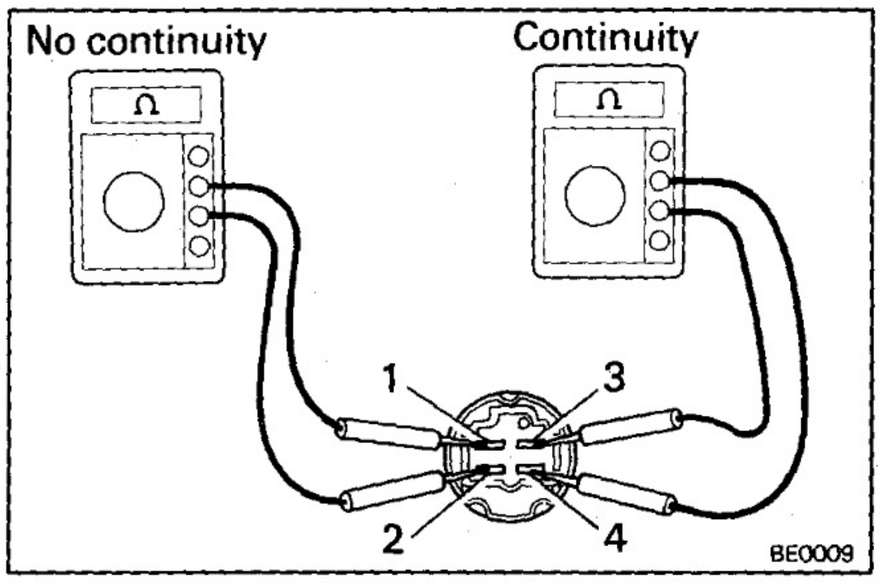
2. INSPECT VACUUM SWITCH

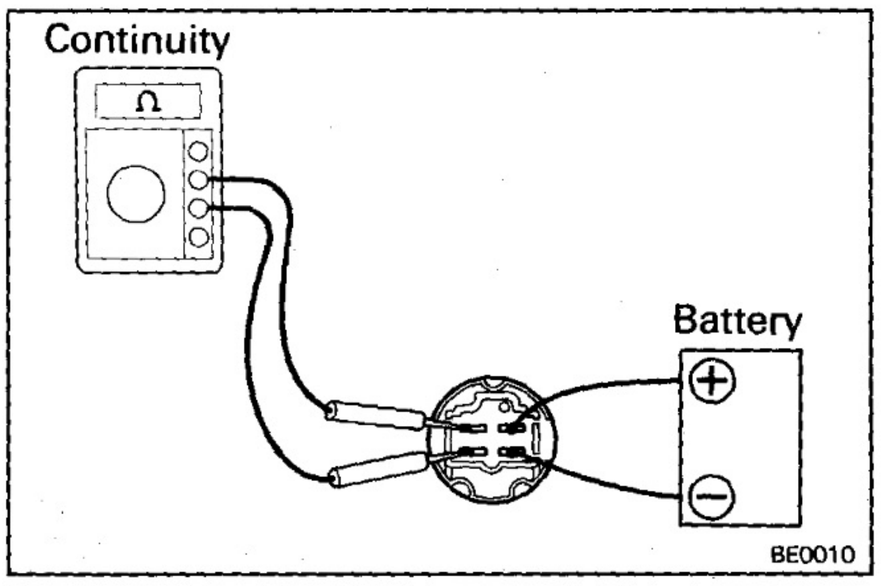
(a) Using an ohmmeter, check that there is no continuity between the switch terminal and switch body.



(b) With a vacuum of 200 ± 50 mmHg (7.87 ± 1.97 in.Hg, 26.7 ± 6.67 kPa) or above. Check that there is continuity between the switch terminal and switch body.

If continuity is not as specified, replace the switch.





3. INSPECT FUEL HEATER RELAY

LOCATION

BJ: On the fuel filter bracket
BU: Under the instrument panel on the passenger side.
BB: Inside wall adjacent to passenger door.

(a) Using an ohmmeter, check for continuity between the following terminals:

- **3 ⟷ 4 Continuity**
- **1 ⟷ 2 No continuity**

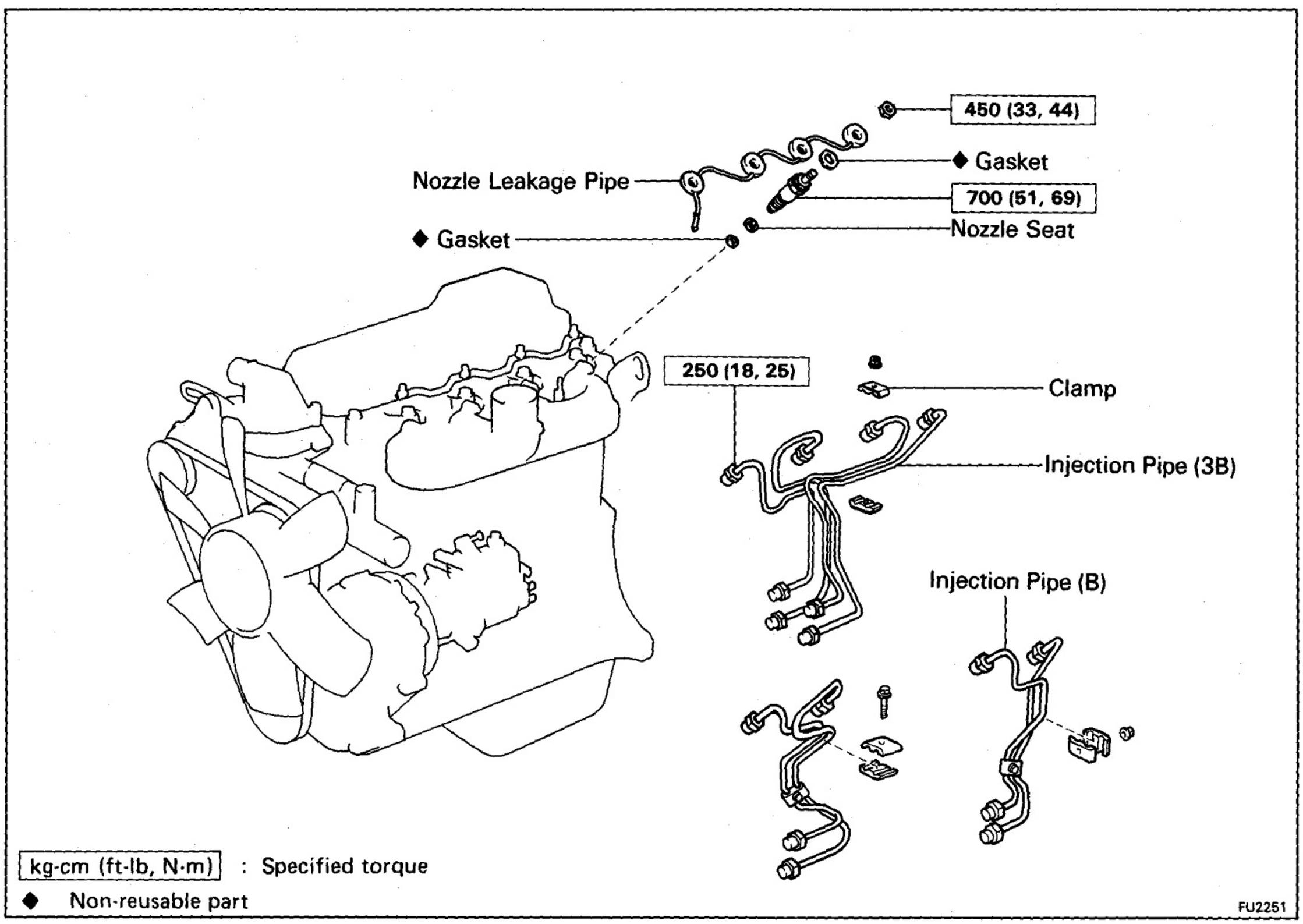
(b) Apply battery voltage between terminals 3 and 4.

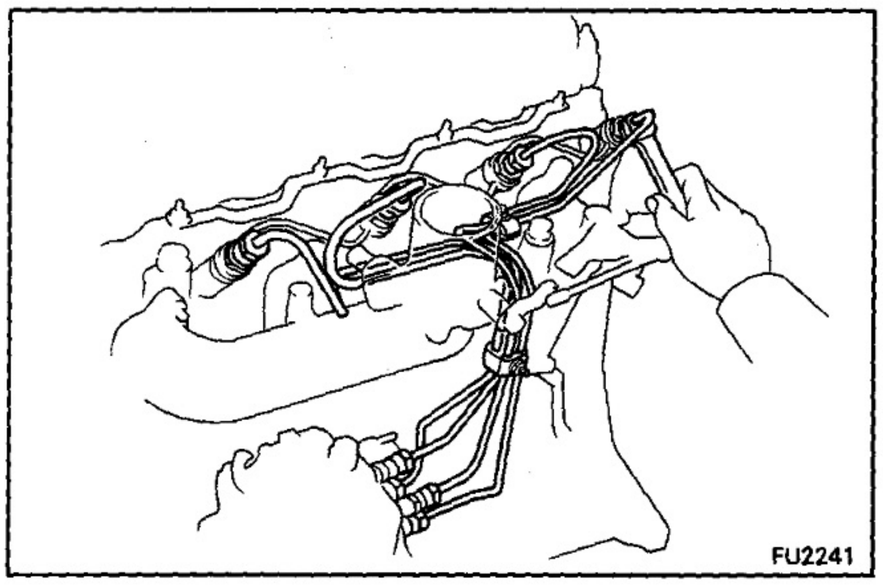
- **1 ⟷ 2 Continuity**

If continuity is not as specified, replace the relay.

INJECTION NOZZLES [B and 3B]

REMOVAL AND TEST OF INJECTION NOZZLES



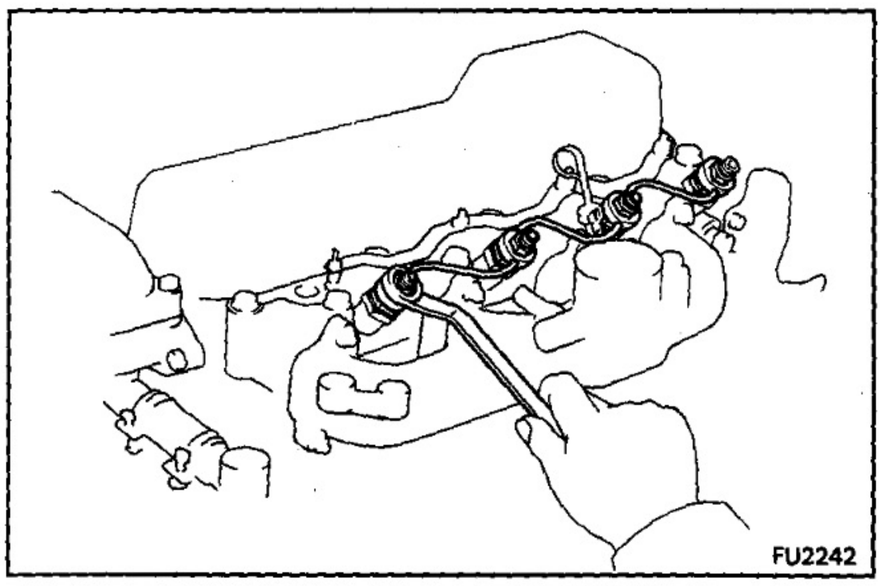


1. REMOVE INJECTION PIPES

(a) Loosen the union nuts of the four injection pipes.

(b) **(B)**
Remove the three bolts, nut, four injection pipes and clamps.

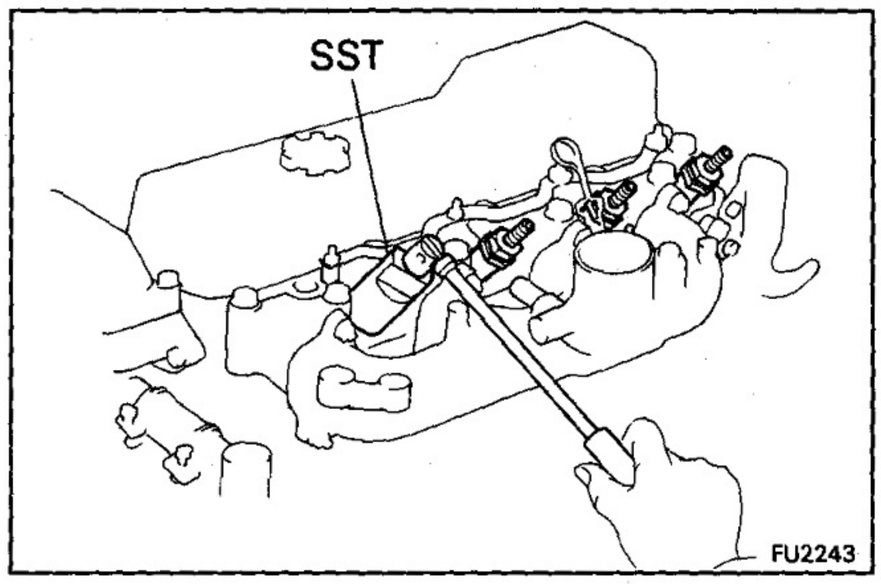
(3B)
Remove the four bolts, four injection pipes and clamps.



2. REMOVE NOZZLE LEAKAGE PIPE

(a) Disconnect the fuel hose from the leakage pipe.

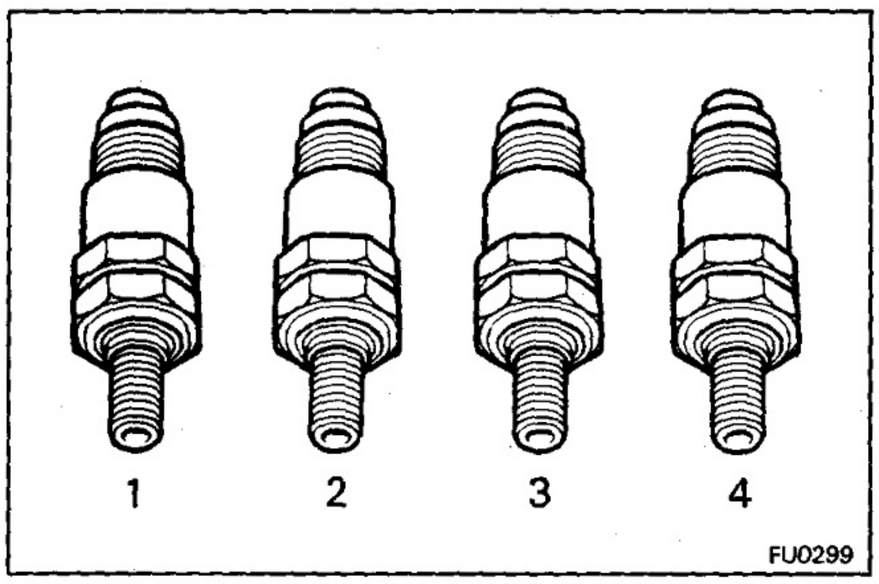
(b) Remove the four nuts, leakage pipe and four gaskets.



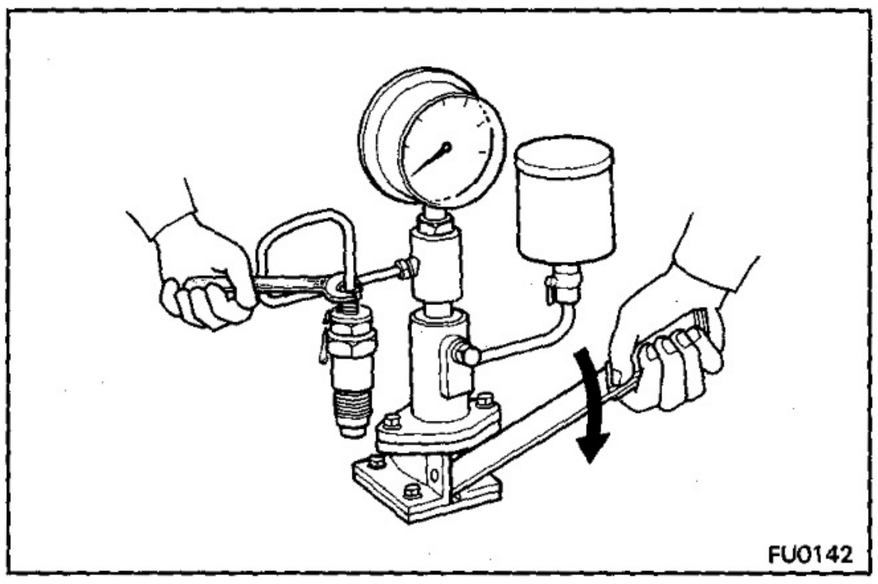
3. REMOVE INJECTION NOZZLES

Using SST, remove the four nozzles, seats and gaskets.

SST 09268-46012



HINT: Arrange the nozzles in correct order.

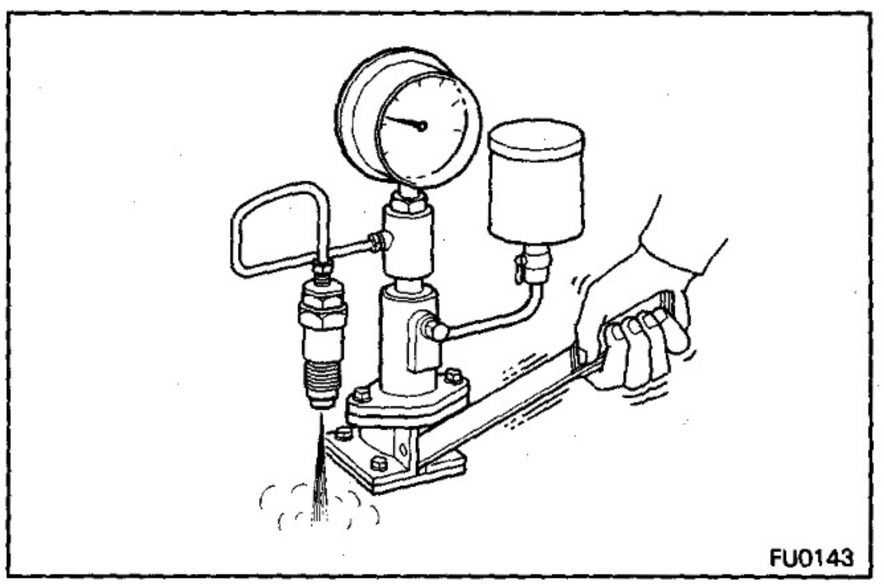


4. INJECTION PRESSURE TEST

(a) Install the nozzle to an injection nozzle hand tester and bleed the air from the union nut.

CAUTION: Do not place your finger over the nozzle injection hole.

(b) Pump the tester handle a few times as fast as possible by hand to discharge the carbon from the injection hole.



(c) Pump the tester handle slowly and observe the pressure gauge.

(d) Read the pressure gauge when the injection pressure just begins to drop.

Opening pressure:

New nozzle	**115 — 125 kg/cm² (1,636 — 1,778 psi) (11,278 — 12,258 kPa)**
Reused nozzle	**105 — 125 kg/cm² (1,493 — 1,778 psi) (10,296 — 12,258 kPa)**

HINT: Proper nozzle operation can be determined by a swishing sound.

If the opening pressure is no within specification, disassemble the nozzle and change the adjusting shim on the top of the pressure spring.

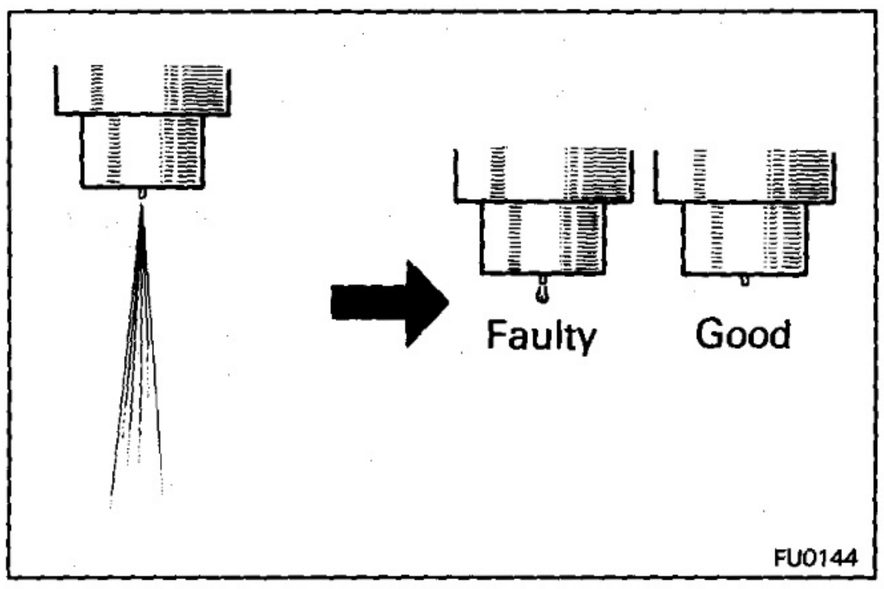
Adjusted opening pressure: 105 — 125 kg/cm² (1,493 — 1,778 psi) (10,296 — 12,258 kPa)

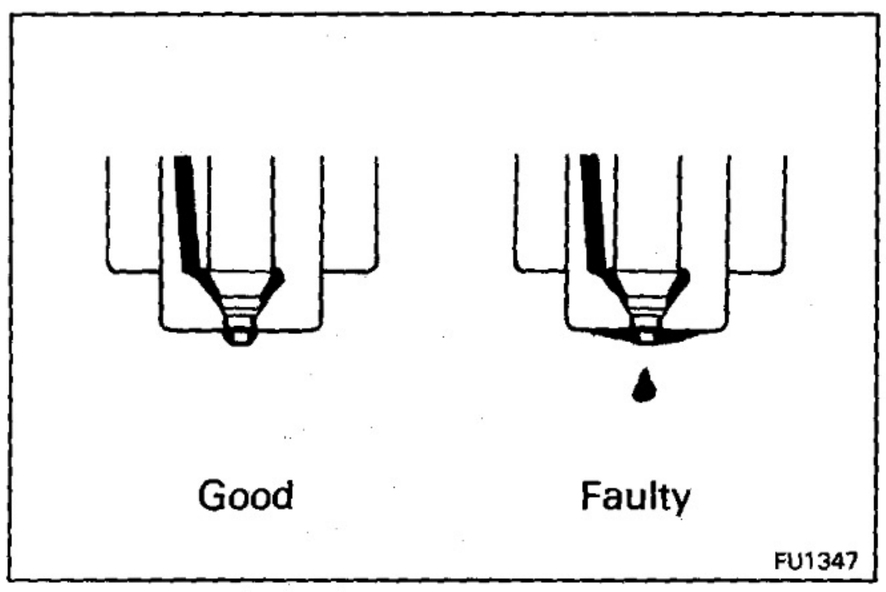
Adjusting shim thickness mm (in.)	
1.00 (0.0394)	1.50 (0.0591)
1.05 (0.0413)	1.55 (0.0610)
1.10 (0.0433)	1.60 (0.0630)
1.15 (0.0453)	1.65 (0.0650)
1.20 (0.0472)	1.70 (0.0669)
1.25 (0.0492)	1.75 (0.0689)
1.30 (0.0512)	1.80 (0.0709)
1.35 (0.0531)	1.85 (0.0728)
1.40 (0.0551)	1.90 (0.0748)
1.45 (0.0571)	1.95 (0.0768)

HINT:

- Varying the adjusting shim thickness by 0.05 mm (0.0020 in.) changes the injection pressure by about 6.4 kg/cm² (91 psi, 628 kPa).
- Only one adjusting shim should be used.

(e) There should be no dripping after injection.

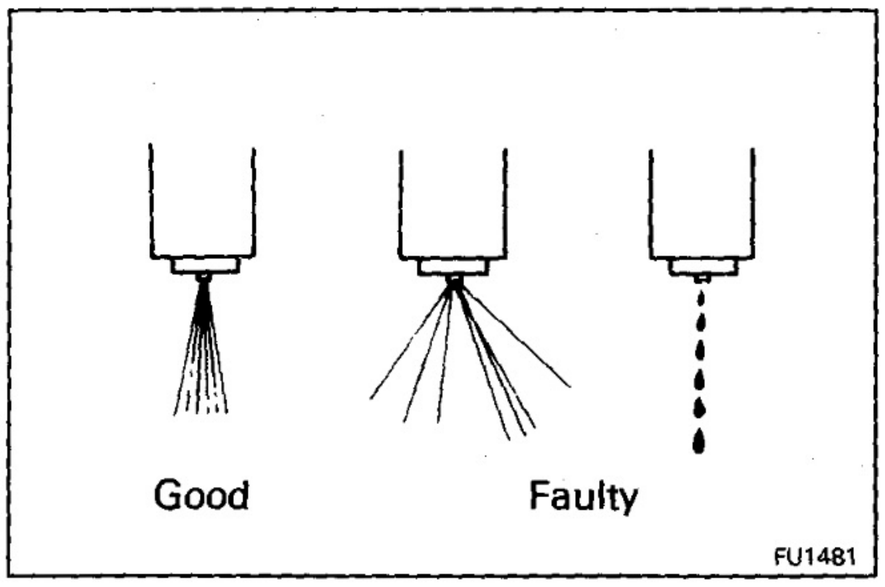




5. LEAKAGE TEST

While maintaining pressure at about 10.0 — 20.0 kg/cm² (142 — 284 psi, 981 — 1,961 kPa) below opening pressure (adjust by tester handle), check that there is no dripping for 10 seconds from the injection hole or around the retaining nut.

If the nozzle drips within 10 seconds, replace it or clean and overhaul the nozzle assembly.



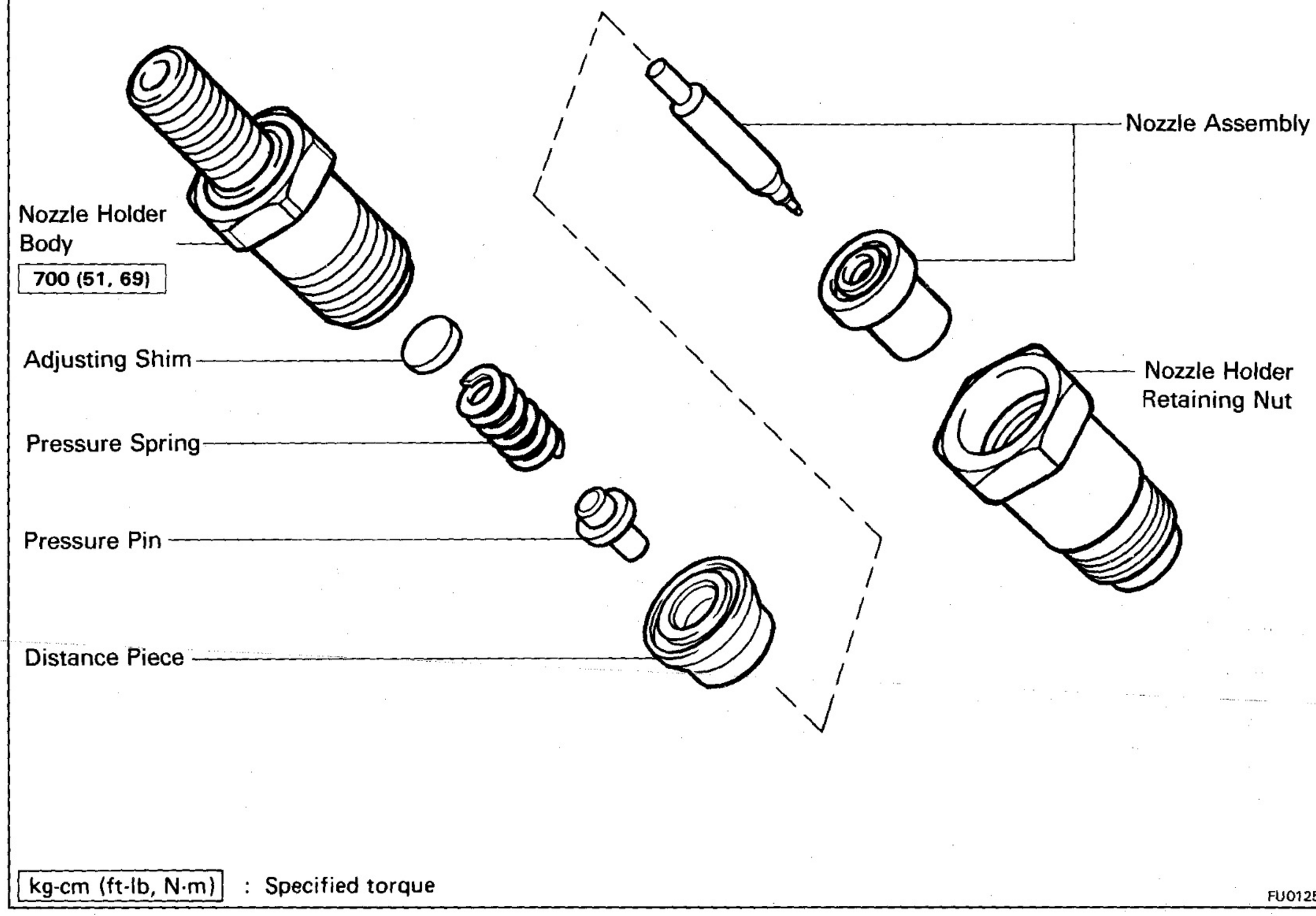
6. SPRAY PATTERN TEST

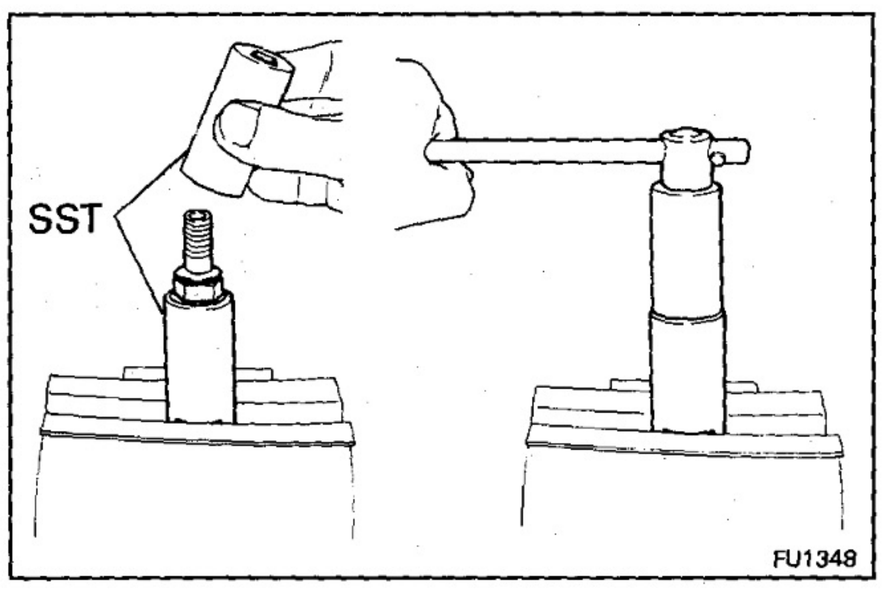
(a) The injection nozzle should shudder at a pumping speed between 15 — 60 times (old nozzle) or 30 —60 times (new nozzle) per minute.

(b) Check the spray pattern during shuddering.

If the spray pattern is not correct during shuddering, the nozzle must be replaced or cleaned.

COMPONENTS





DISASSEMBLY, CLEANING AND TEST OF INJECTION NOZZLE

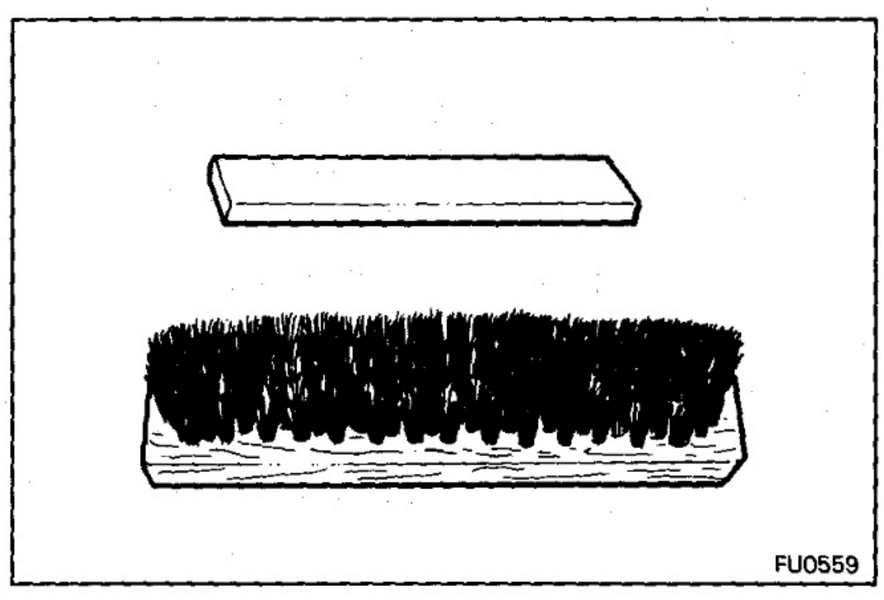
1. DISASSEMBLE INJECTION NOZZLE

(a) Using SST, unscrew the nozzle holder body.

SST 09268-46012, 09268-46021

NOTICE: When disassembling the nozzle, be careful not to drop the inner parts.

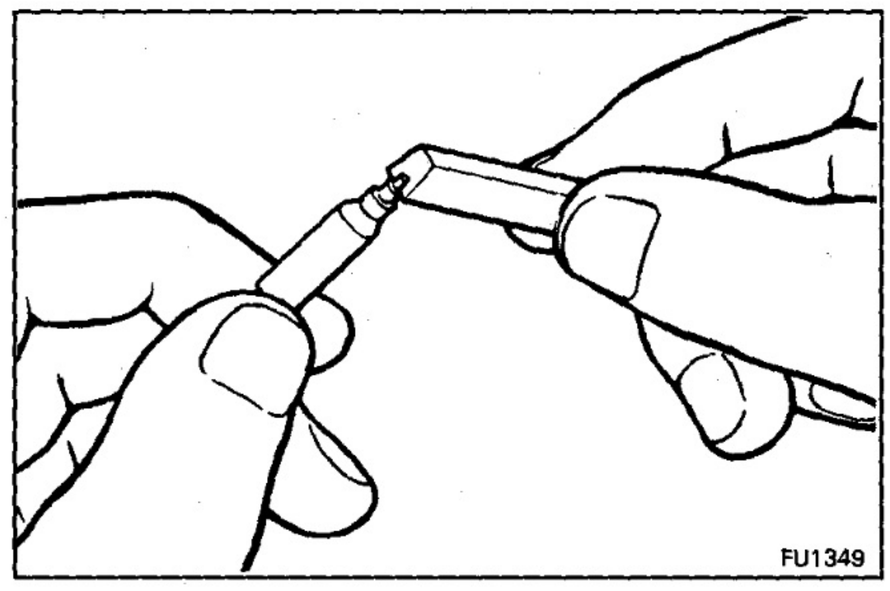
(b) Remove the adjusting shim, pressure spring, pressure pin, distance piece and the nozzle assembly.



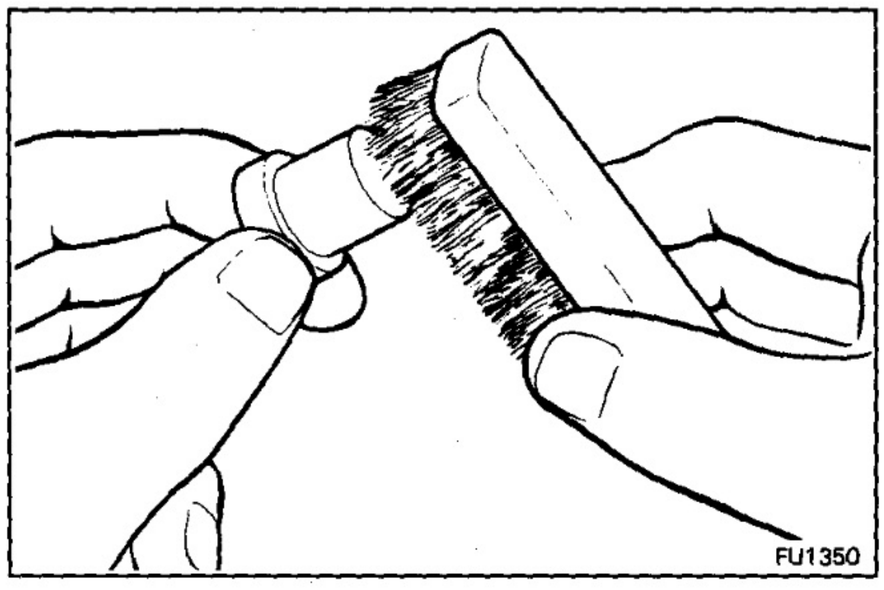
2. NOZZLE CLEANING

(a) To wash the nozzles, use a wooden stick and brass brush. Wash in clean diesel fuel.

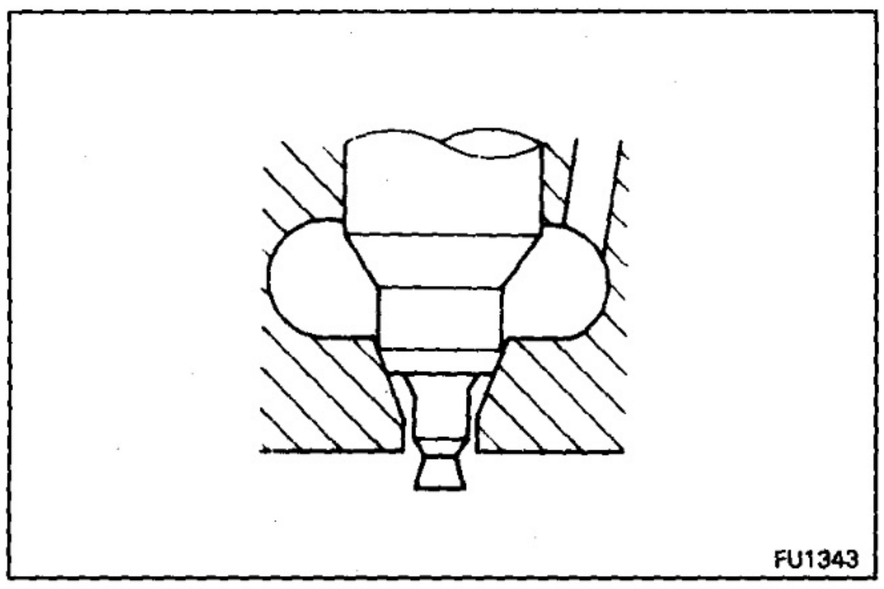
HINT: Do not touch the nozzle mating surfaces with your fingers.



(b) Using a wooden stick, remove the carbon adhering to the nozzle needle tip.



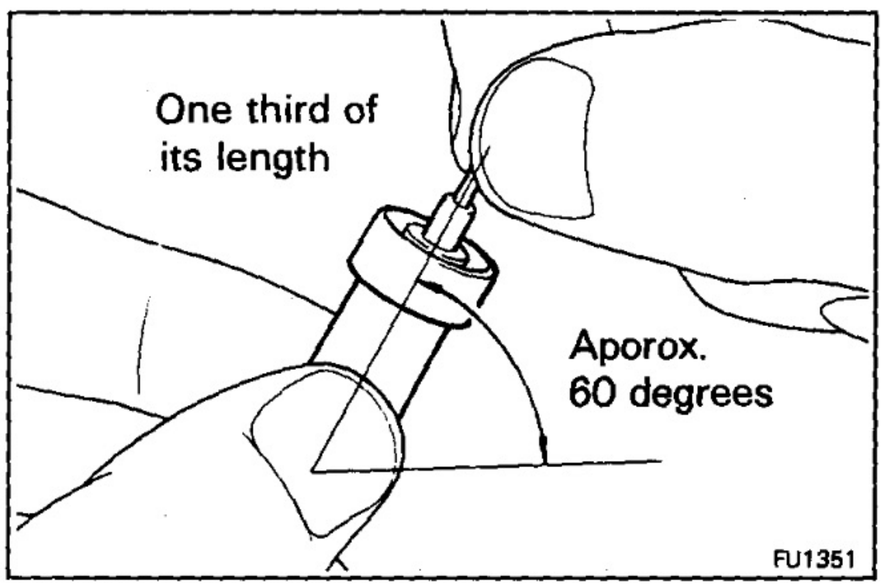
(c) Using a brass brush, remove the carbon from the exterior of the nozzle body.



(d) Check the seat of the nozzle body for burns or corrosion.

(e) Check the nozzle needle tip for damage or corrosion.

If any of these conditions are present, replace the nozzle assembly.

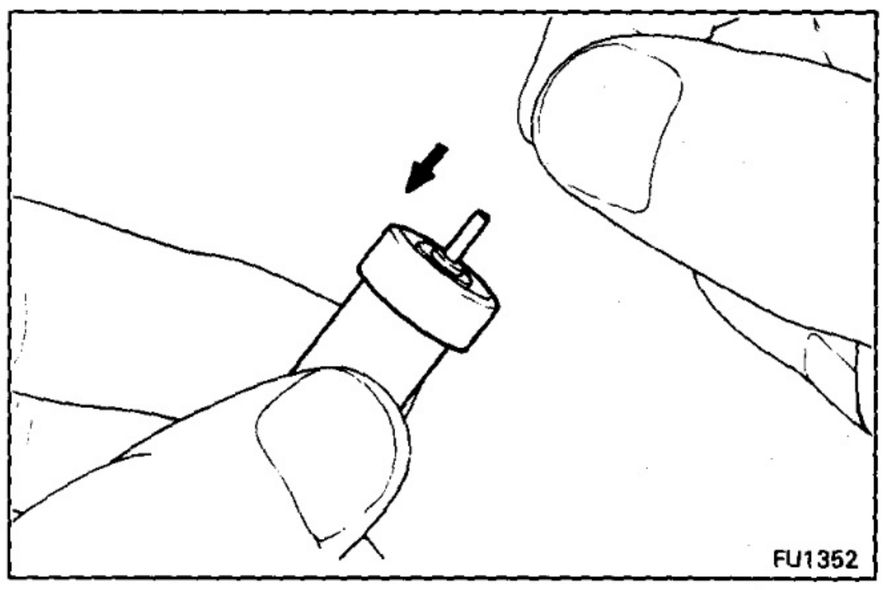


3. SINKING TEST

(a) Wash the nozzle in clean diesel fuel.

HINT: Do not touch the nozzle mating surfaces with your fingers.

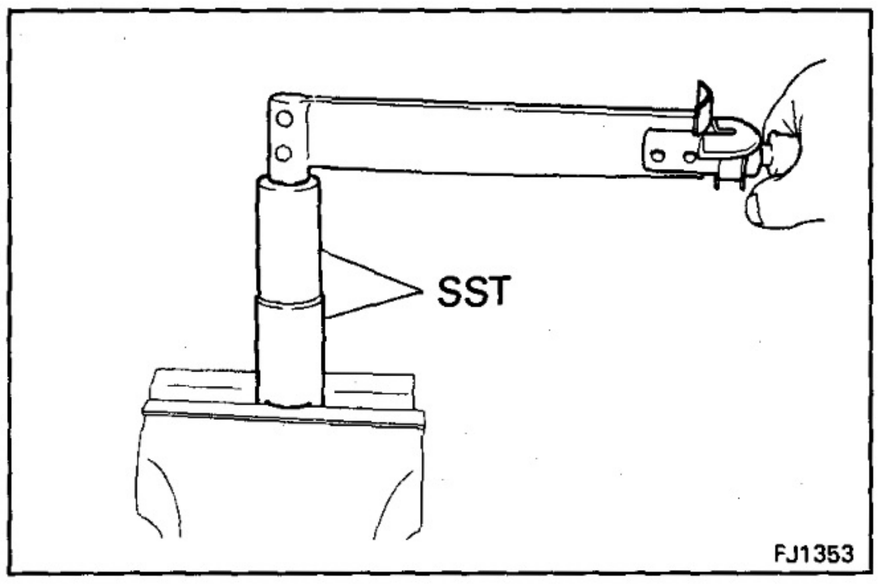
(b) Tilt the nozzle body approx. 60 degrees and pull the needle out about one third of its length.



(c) When released, the needle should sink down into the body vent smoothly by its own weight.

(d) Repeat this test, rotating the needle slightly each time.

If the needle does not sink freely, replace the nozzle assembly.



ASSEMBLY OF INJECTION NOZZLES

(See page FU-11)

1. ASSEMBLE INJECTION NOZZLES

(a) Assemble the nozzle holder body, the nozzle assembly, distance piece, pressure pin, pressure spring, adjusting shim and nozzle holder retaining nut, and finger tighten the nut.

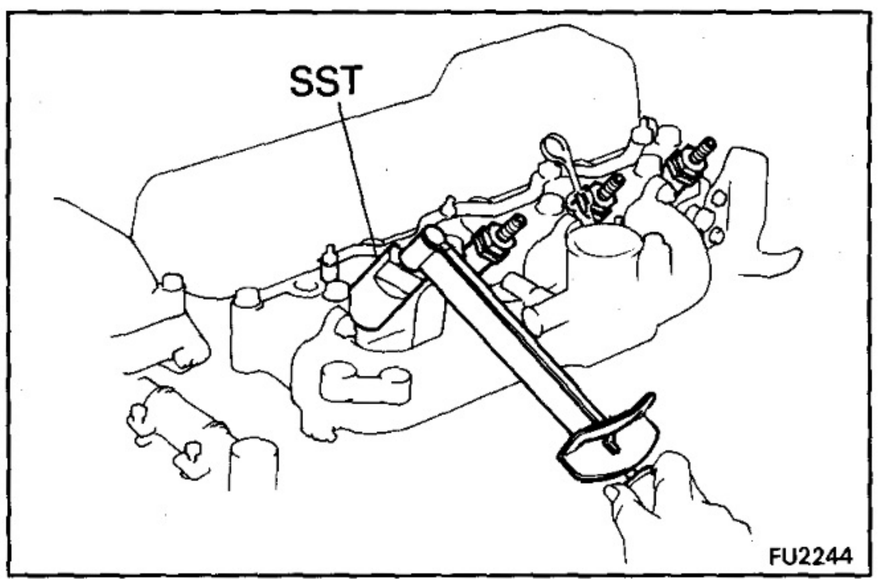
(b) Using SST, torque the nozzle holder body.

SST 09268-46012, 09268-46021

Torque: 700 kg-cm (51 ft-lb, 69 N·m)

2. PERFORM PRESSURE AND SPRAY PATTERN TEST

(See steps 4 to 6 on pages FU-9 and 10)



INSTALLATION OF INJECTION NOZZLES

(See page FU-8)

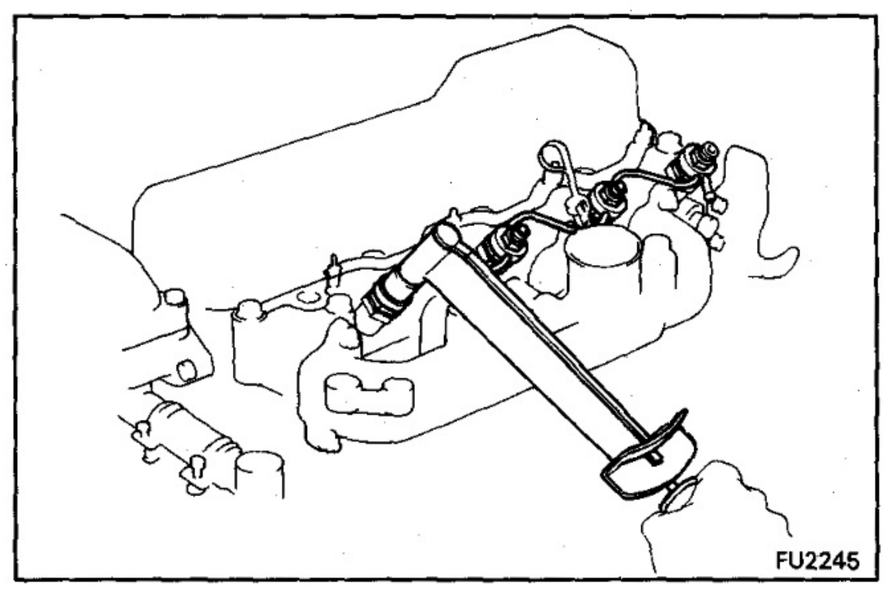
1. INSTALL INJECTION NOZZLES

(a) Place new four gaskets and the four nozzle seats in the cylinder head.

(b) Using SST, install and torque the four nozzles.

SST 09268-46012

Torque: 700 kg-cm (51 ft-lb, 69 N·m)

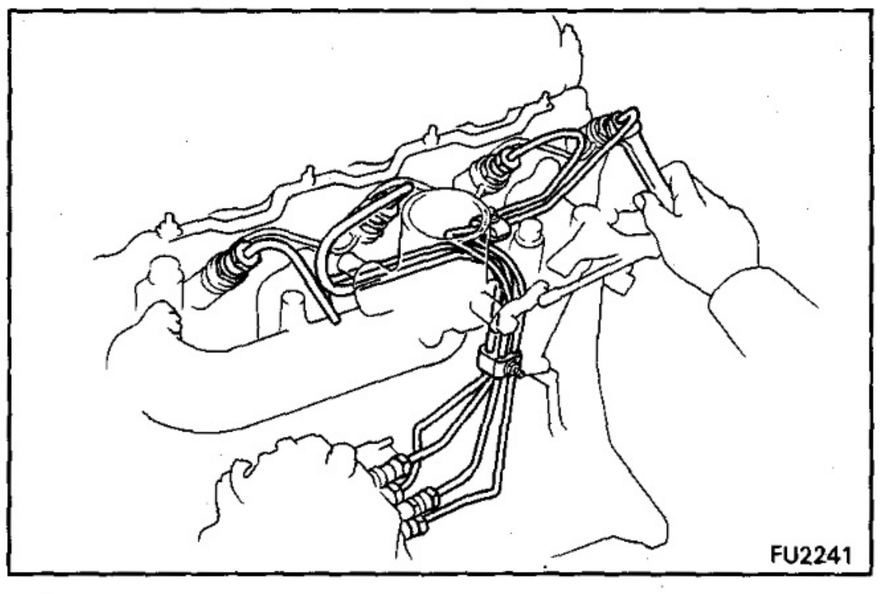


2. INSTALL NOZZLE LEAKAGE PIPE

(a) Install new four gaskets and the leakage pipe with the four nuts. Torque the nuts.

Torque: 450 kg-cm (33 ft-lb, 44 N·m)

(b) Connect the fuel hose to the leakage pipe.



3. INSTALL INJECTION PIPES

(a) Place the two lower clamps in position on the intake manifold.

(b) Install the four injection pipes. Torque the union nuts.

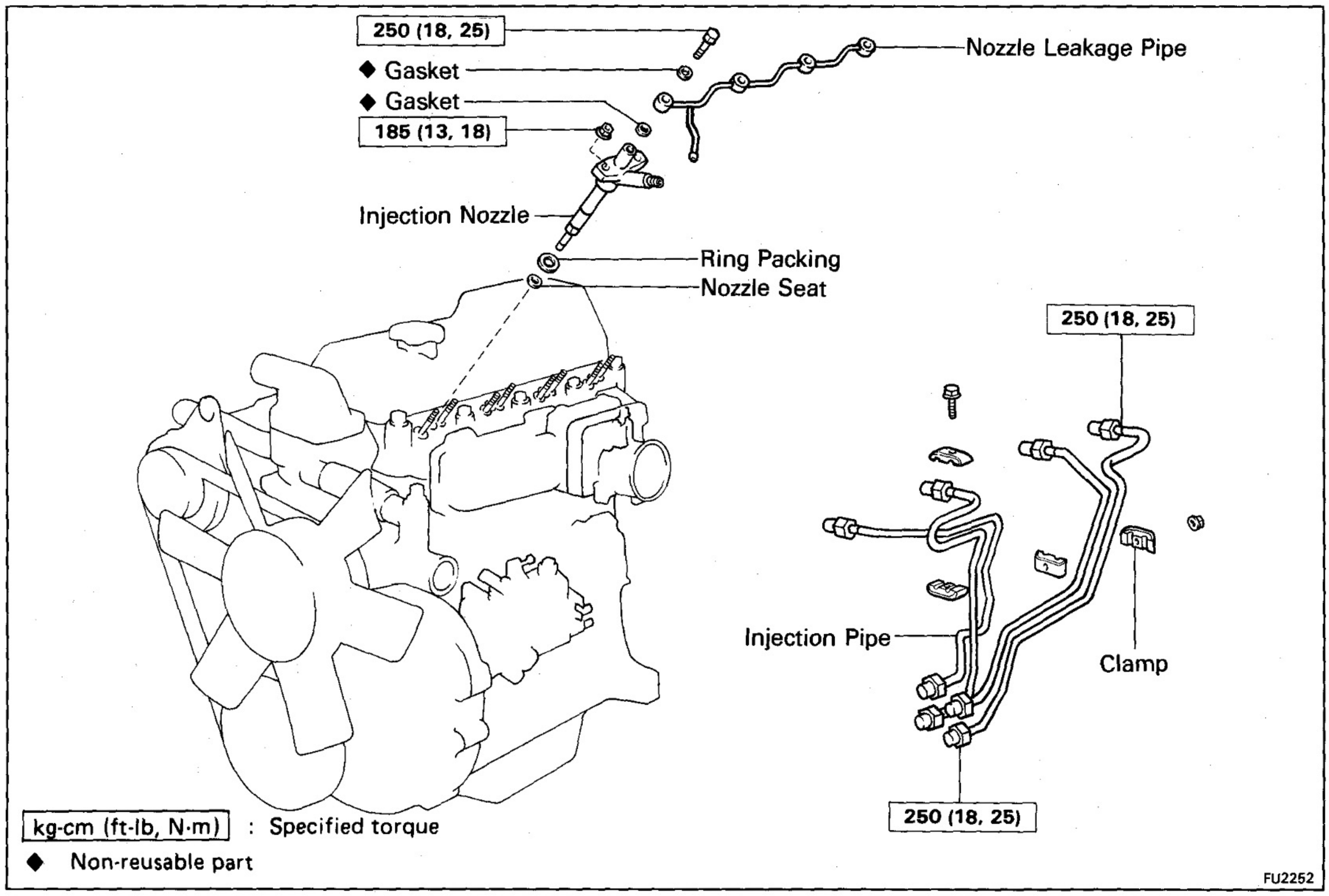
Torque: 250 kg-cm (18 ft-lb, 25 N·m)

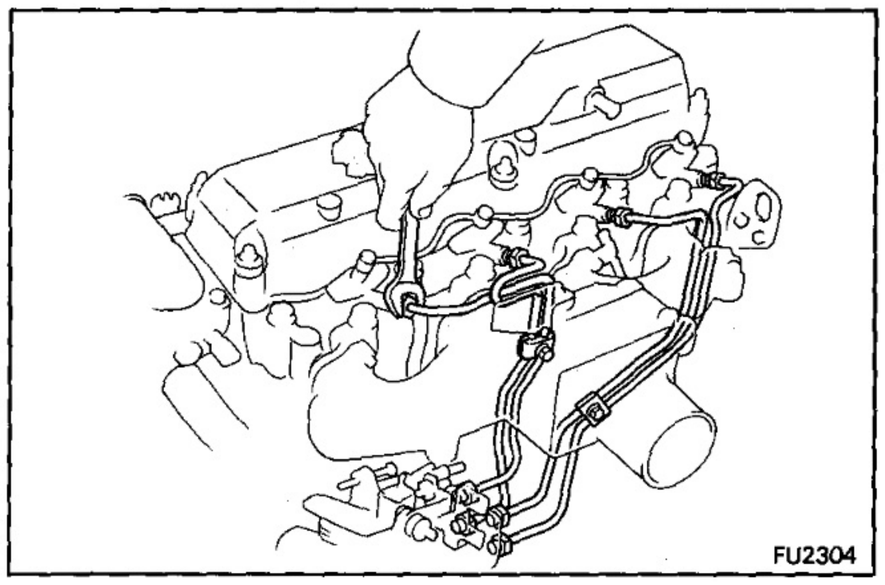
(c) Secure the injection pipes with the clamps, nut (B) and bolts.

4. START ENGINE AND CHECK FOR LEAKS

INJECTION NOZZLES [11B and 14B]

REMOVAL AND TEST OF INJECTION NOZZLES

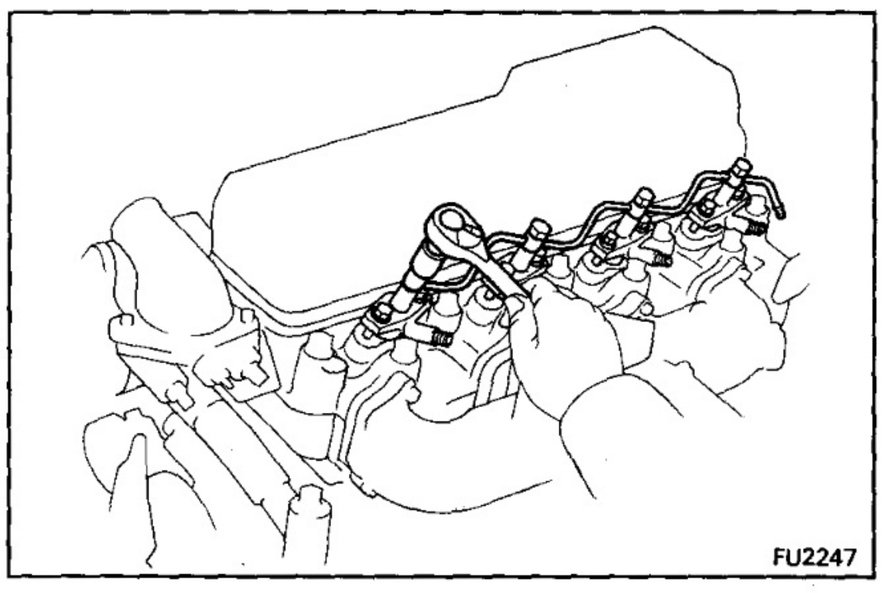




1. REMOVE INJECTION PIPES

(a) Loosen the union nuts of the four injection pipes.

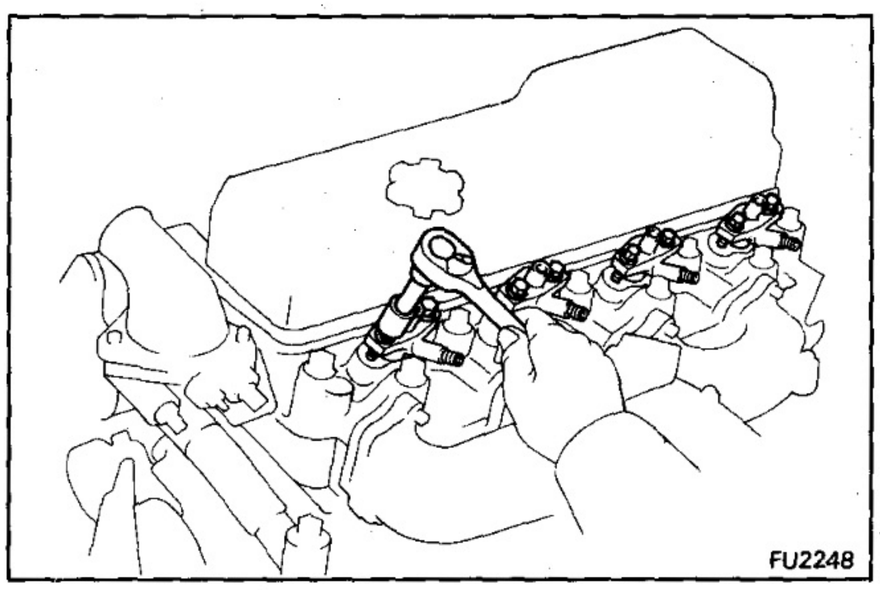
(b) Remove the three bolts, nut, four injection pipes and clamps.



2. REMOVE NOZZLE LEAKAGE PIPE

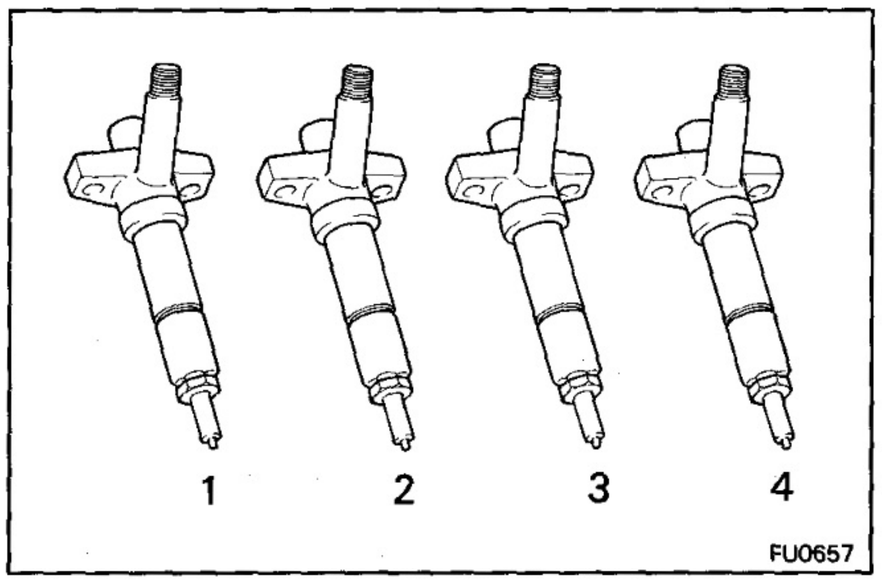
(a) Disconnect the fuel hose from the leakage pipe.

(b) Remove the four hollow bolts, leakage pipe and eight gaskets.

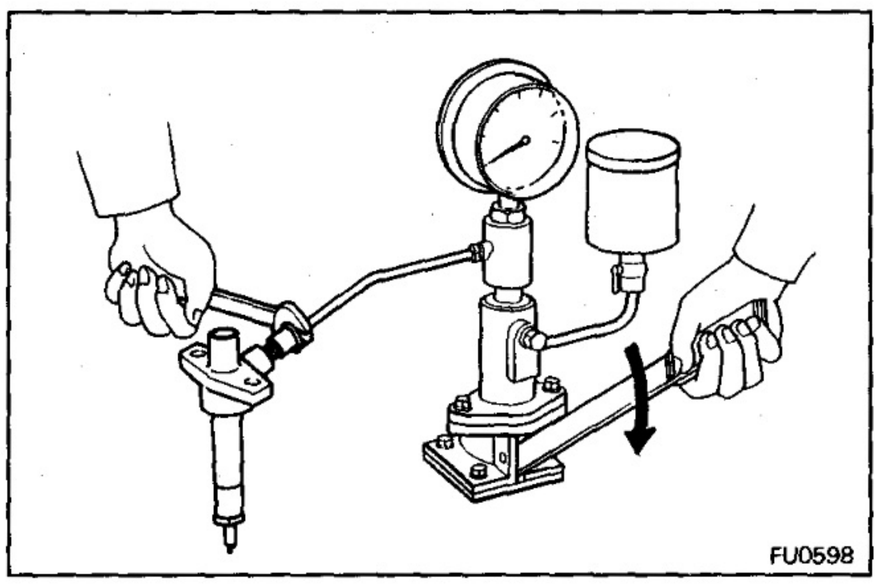


4. REMOVE INJECTION NOZZLES

Remove the two bolts, nozzle, ring packing and seat.
Remove the four nozzles.



HINT: Arrange the nozzles in correct order.



5. INJECTION PRESSURE TEST

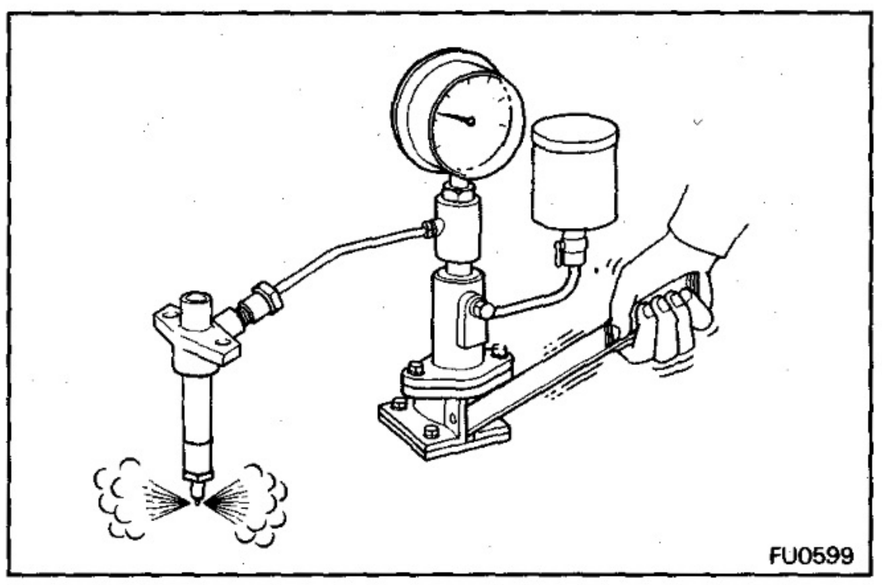
(a) Install the nozzle to an injection nozzle hand tester and bleed the air from the union nut.

NOTICE: Do not place your finger over the nozzle injection hole.

(b) Pump the tester handle a few times as fast as possible by hand discharge the carbon from the injection hole.

(c) Pump the tester handle slowly and observe the pressure gauge.

(d) Read the pressure gauge when the injection pressure just begins to drop.



Opening pressure:

New nozzle	**200 — 210 kg/cm² (2,845 — 2,987 psi) (19,613 — 20,594 kPa)**
Reused nozzle	**180 — 210 kg/cm² (2,560 — 2,987 psi) (17,652 — 20,594 kPa)**

HINT: Proper nozzle operation can be determined by a swishing sound.

If the opening pressure is not within specification, disassemble the nozzle and change the adjusting shim on the top of the pressure spring.

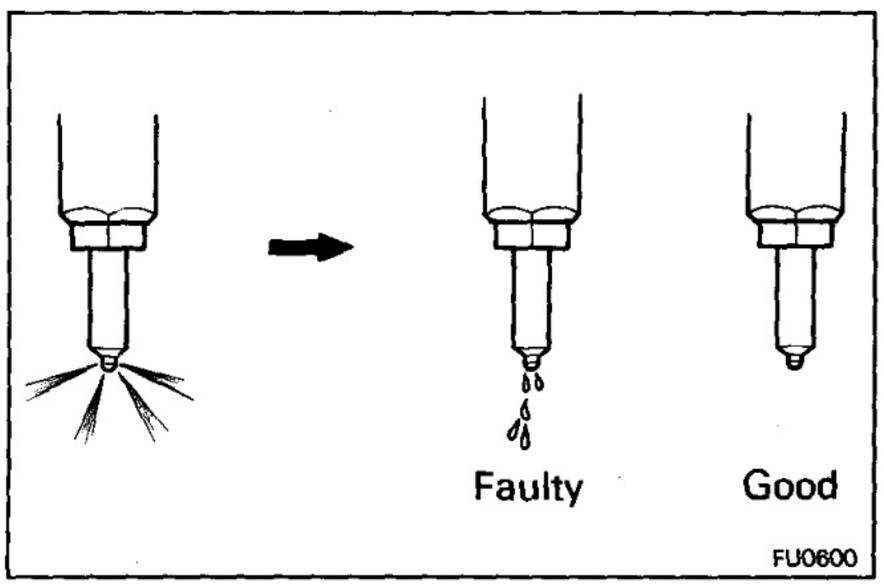
Adjusting opening pressure: 180 — 210 kg/cm² (2,560 — 2,987 psi) (17,652 — 20,594 kPa)

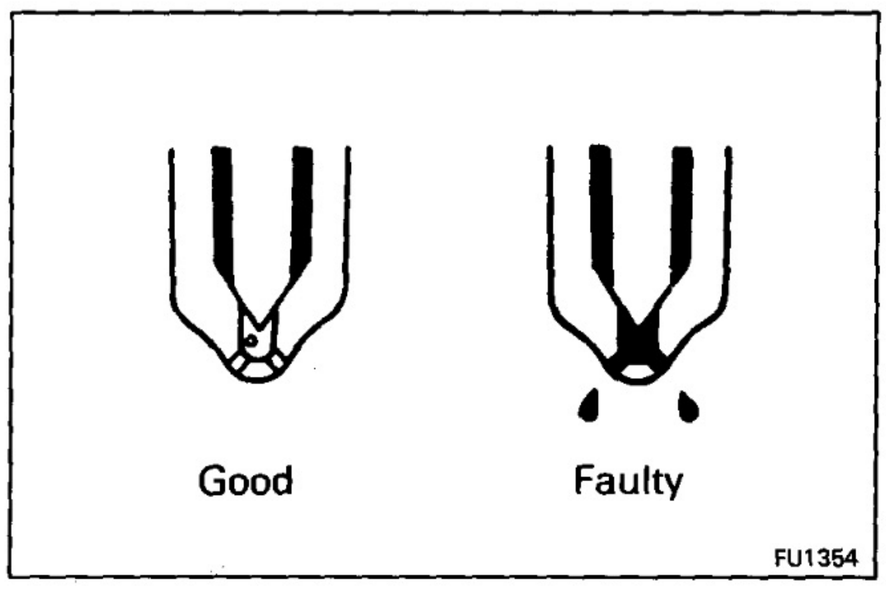
Adjusting shim thickness mm (in.)	
0.700 (0.0276)	1.250 (0.0492)
0.750 (0.0295)	1.275 (0.0502)
0.800 (0.0315)	1.300 (0.0512)
0.850 (0.0335)	1.325 (0.0522)
0.900 (0.0354)	1.350 (0.0531)
0.950 (0.0374)	1.375 (0.0541)
0.975 (0.0384)	1.400 (0.0551)
1.000 (0.0394)	1.425 (0.0561)
1.025 (0.0404)	1.450 (0.0571)
1.050 (0.0413)	1.475 (0.0581)
1.075 (0.0423)	1.500 (0.0591)
1.100 (0.0433)	1.550 (0.0610)
1.125 (0.0443)	1.600 (0.0630)
1.150 (0.0453)	1.650 (0.0650)
1.175 (0.0463)	1.700 (0.0669)
1.200 (0.0472)	1.750 (0.0689)
1.225 (0.0482)	1.800 (0.0709)

HINT:

- Varying the adjusting shim thickness by 0.025 mm (0.0010 in.) changes the injection pressure by about 3.8 kg/cm² (54 psi, 373 kPa).
- Only one adjusting shim should be used.

(e) There should be no dripping after injection.

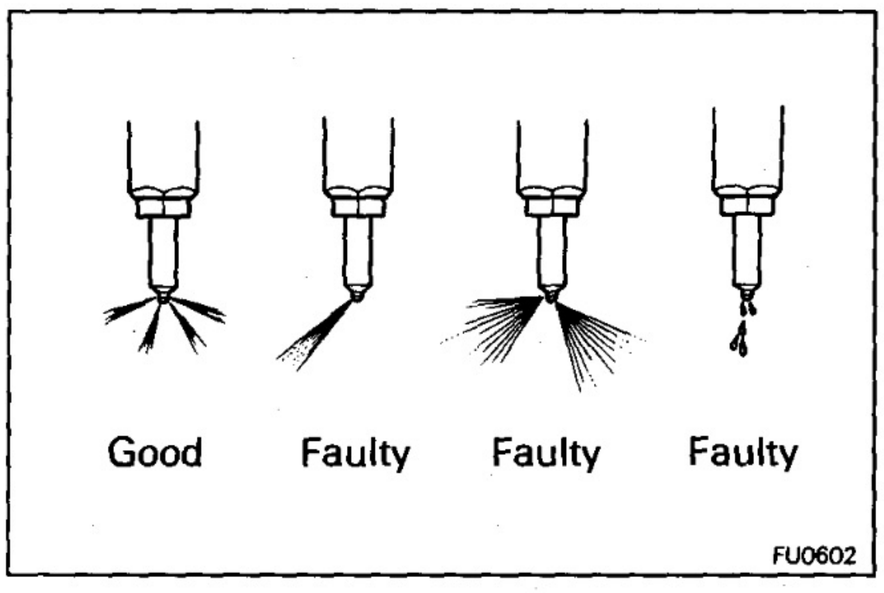




6. LEAKAGE TEST

While maintaining pressure at approx. 10.0 — 20.0 kg/cm² (142 — 284 psi, 981 — 1,961 kPa) below opening pressure (adjust by tester handle), check that there is no dripping for 10 seconds from the injection hole or around the retaining nut.

If the nozzle drips within 10 seconds, replace it or clean and overhaul the nozzle assembly.



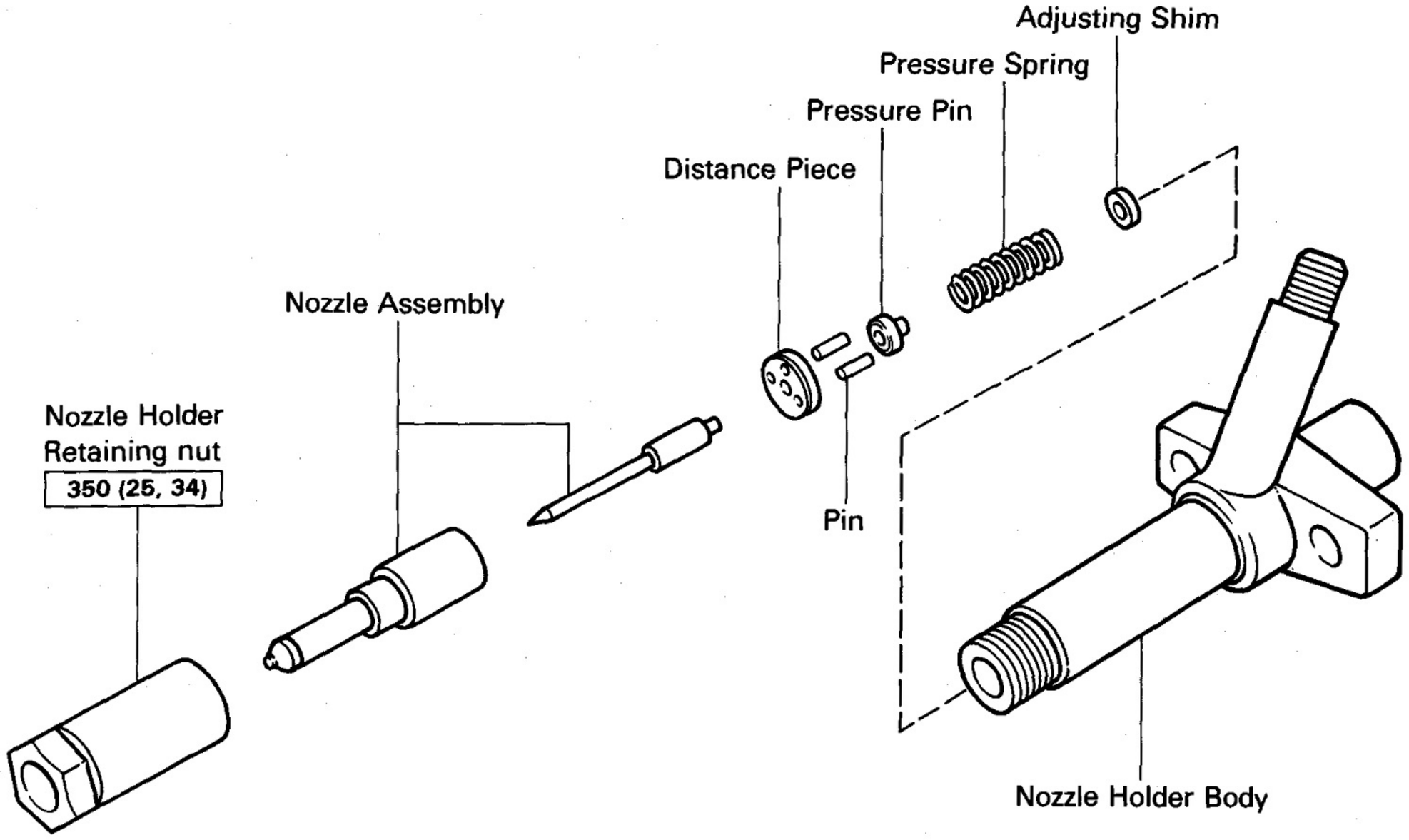
7. SPRAY PATTERN TEST

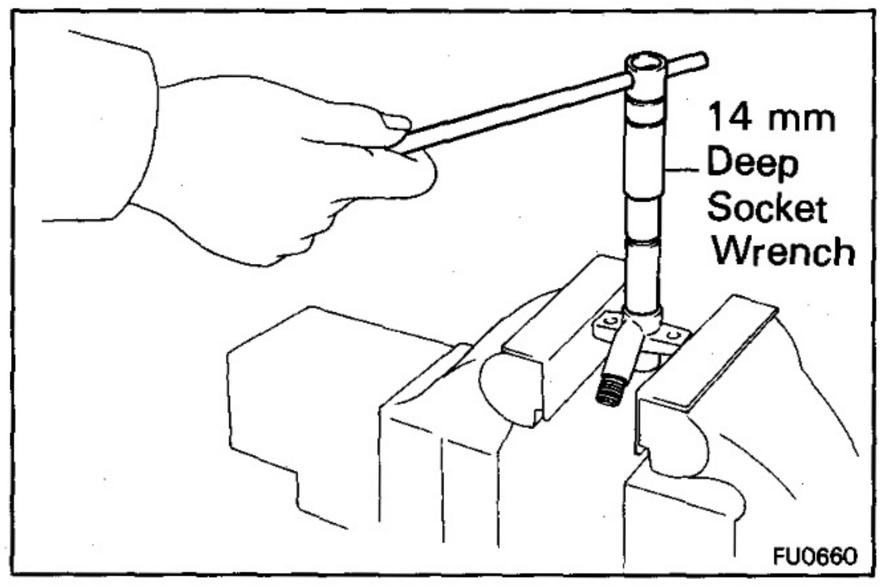
(a) The injection nozzle should shudder at a pumping speed between 15 — 60 times (old nozzle) or 30 —60 times (new nozzle) per minute.

(b) Check the spray pattern during shuddering.

If the spray pattern is not correct, the nozzle must be cleaned or replaced.

COMPONENTS





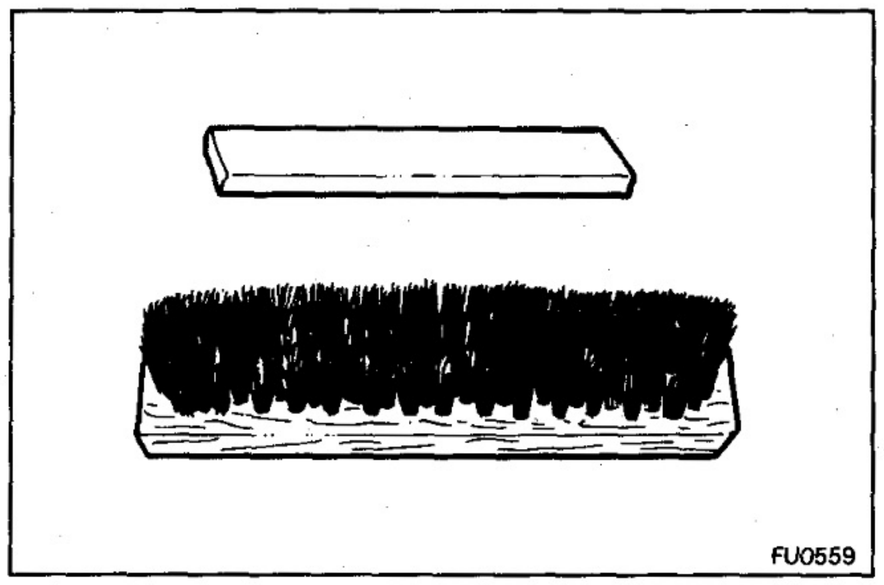
DISASSEMBLY, CLEANING AND TEST OF INJECTION NOZZLE

1. DISASSEMBLE INJECTION NOZZLE

(a) Using a 14 mm deep socket wrench, unscrew the nozzle holder retaining nut.

NOTICE: When disassembling the nozzle holder, be careful not to drop the inner parts.

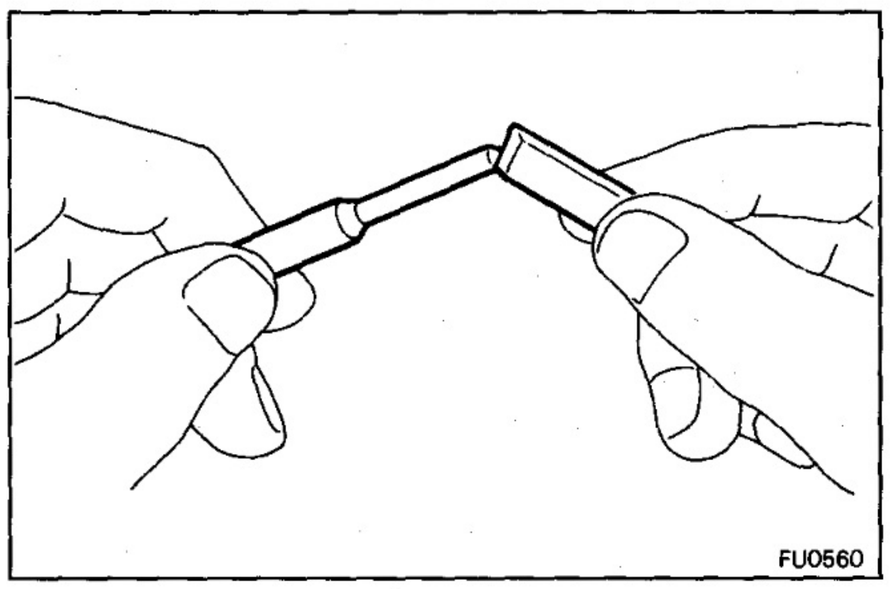
(b) Remove the pressure spring, adjusting shim, pressure pin, pin, distance piece and the nozzle assembly.



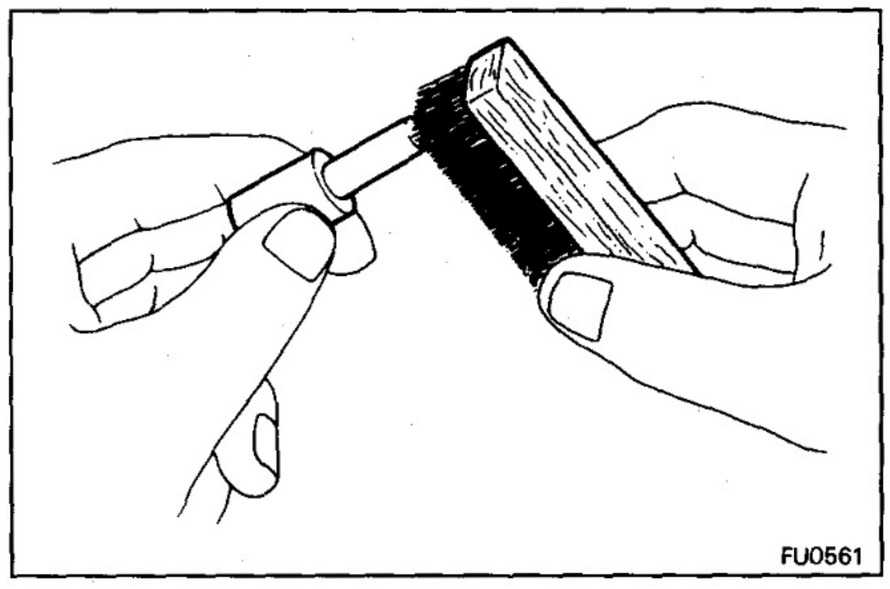
2. NOZZLE CLEANING

(a) To wash the nozzles, use a wooden stick and brass brush. Wash in clean diesel fuel.

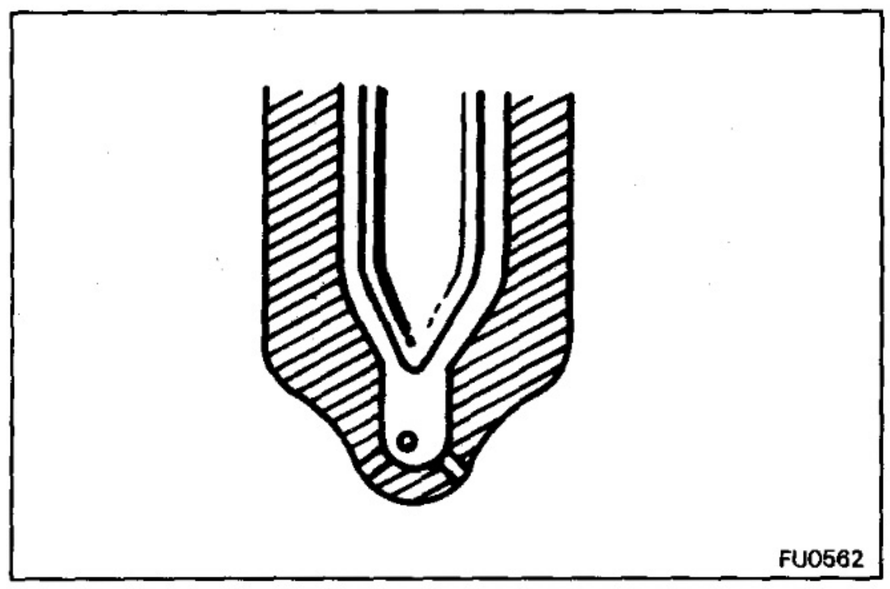
HINT: Do not touch the nozzle mating surfaces with your fingers.



(b) Using a wooden stick, remove the carbon adhering to the nozzle needle tip.



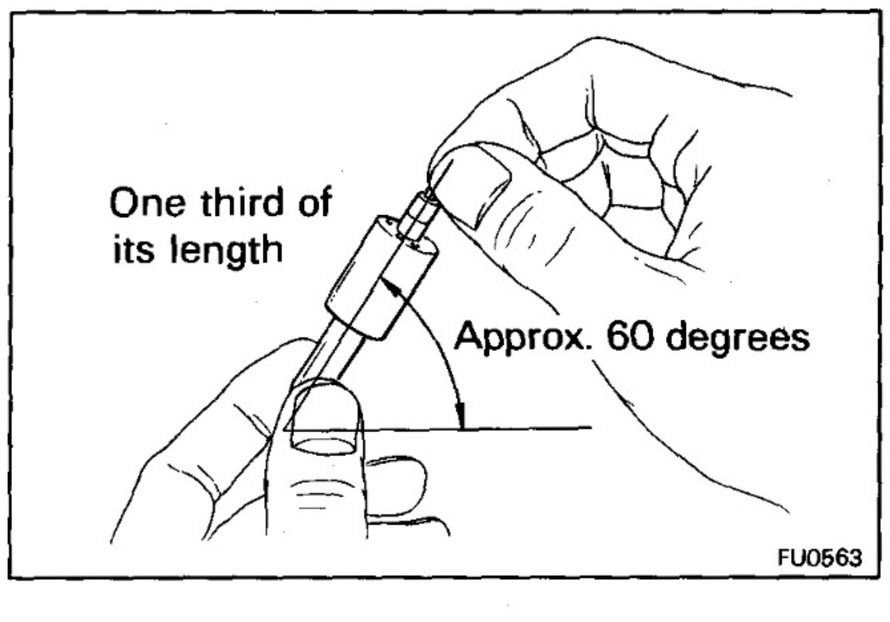
(c) Using a brass brush, remove the carbon from the exterior of the nozzle body.



(d) Inspect the nozzle body for burns or corrosion.

(e) Inspect the nozzle needle tip for damage or corrosion.

If any of these conditions are present, replace the nozzle assembly.

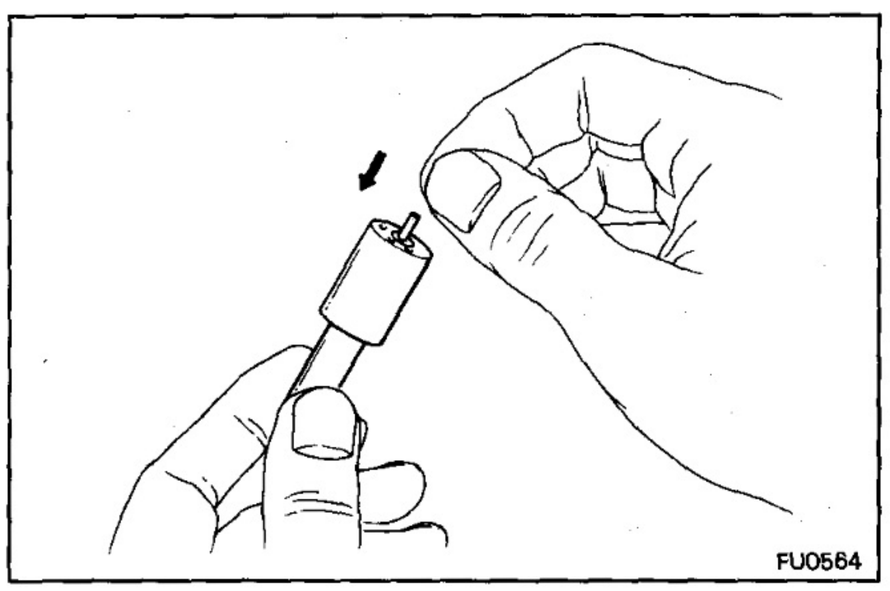


3. SINKING TEST

(a) Wash the nozzle in clean diesel fuel.

HINT: Do not touch the nozzle mating surfaces with your fingers.

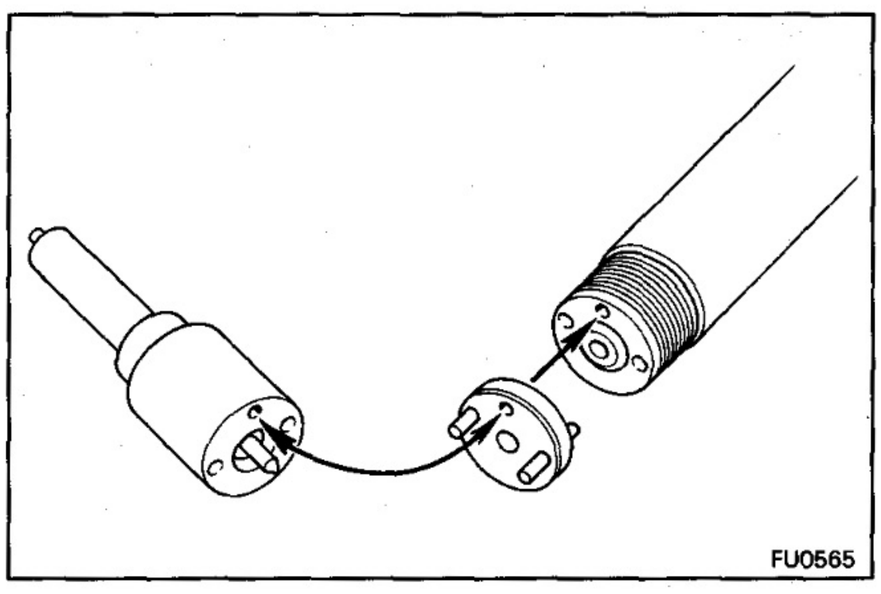
(b) Tilt the nozzle body approx. 60 degrees and pull the needle out about one third of its length.

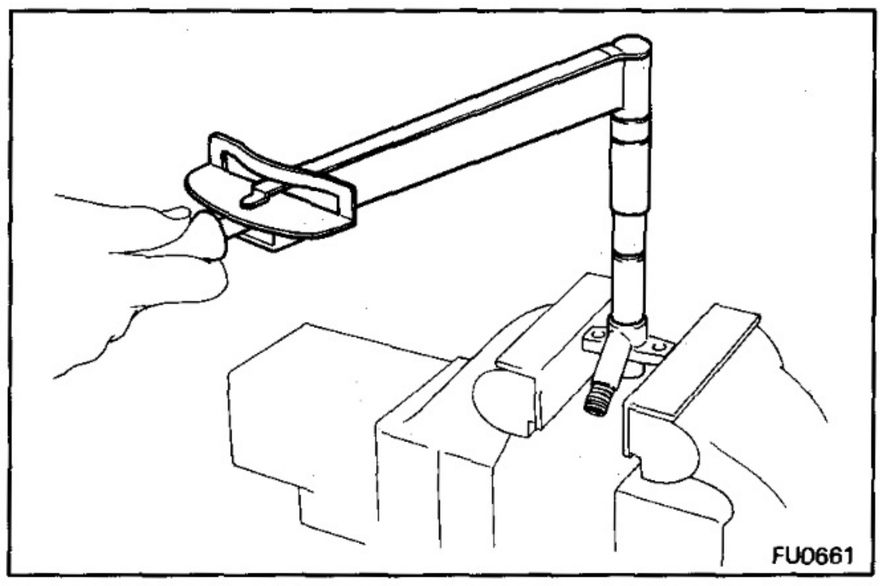


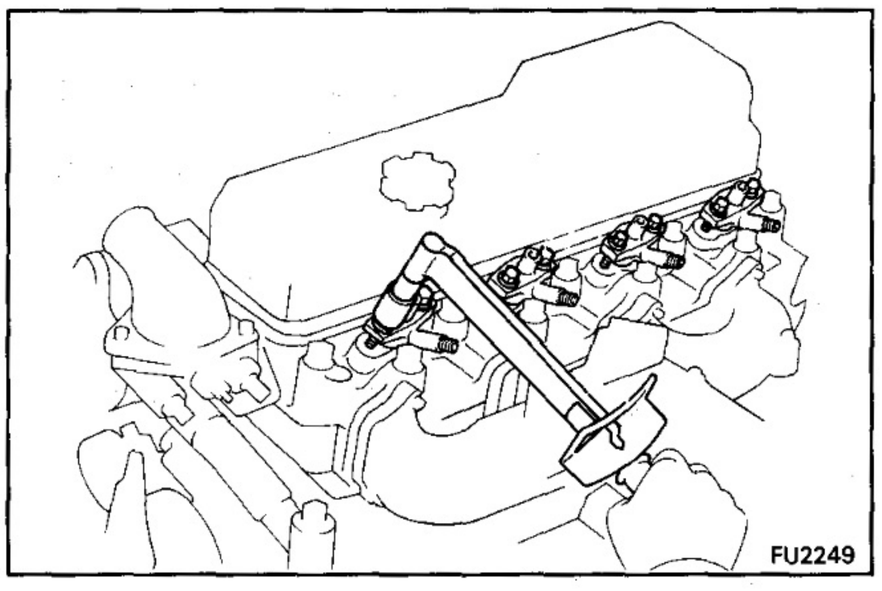
(c) When released, the needle should sink down into the body vent smoothly by its own weight.

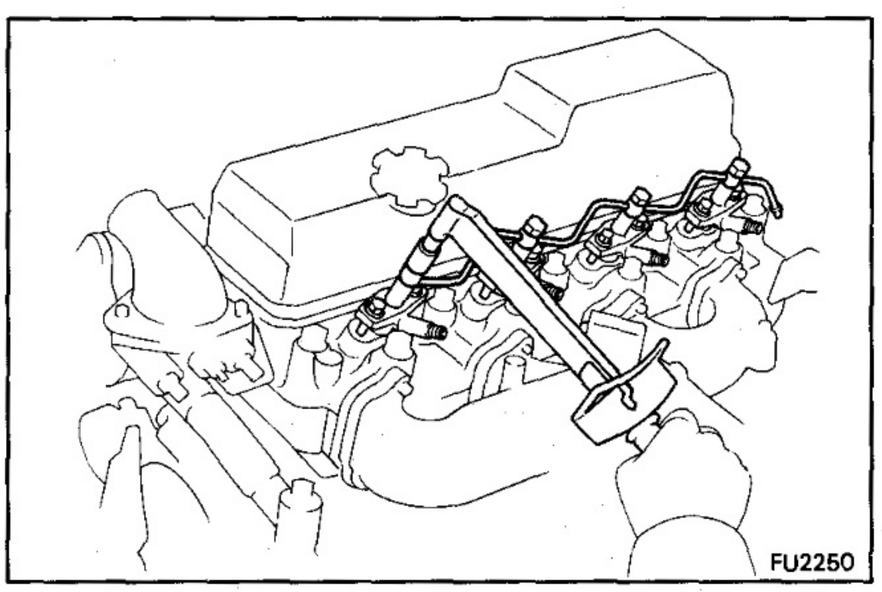
(d) Repeat this test, rotating the needle slightly each time.

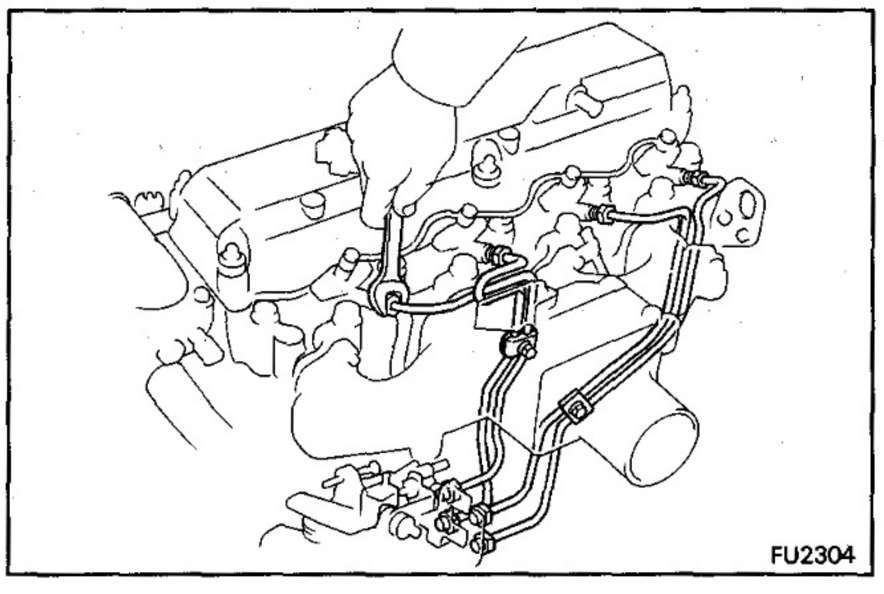
If the needle does not sink freely, replace the nozzle assembly.











ASSEMBLY OF INJECTION NOZZLES

(See page FU-17)

1. ASSEMBLE INJECTION NOZZLES

(a) Assemble the nozzle holder body, adjusting shim, pressure spring, pressure pin, distance piece, the nozzle assembly and nozzle holder retaining nut, and finger tighten the nut.

HINT: Align the holes of the nozzle body, distance piece and nozzle holder body.

(b) Using a 14 mm deep socket wrench, torque the retaining nut.

Torque: 350 kg-cm (25 ft-lb, 34 N·m)

2. PERFORM PRESSURE AND SPRAY PATTERN TEST

(See steps 5 to 7 on pages FU-15 and 16)

INSTALLATION OF INJECTION NOZZLES

(See page FU-14)

1. INSTALL INJECTION NOZZLES

Install the nozzle seat, ring packing and injection nozzle with the two nuts. Install the four injection nozzles. Uniformly torque the nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

2. INSTALL NOZZLE LEAKAGE PIPE

(a) Install new eight gaskets, and the leakage pipe with the four hollow bolts. Torque the hollow bolts.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

(b) Connect the fuel hose to the leakage pipe.

3. INSTALL INJECTION PIPES

(a) Place the two lower clamps in position of the intake manifold.

(b) Install the four injection pipes. Torque the union nuts.

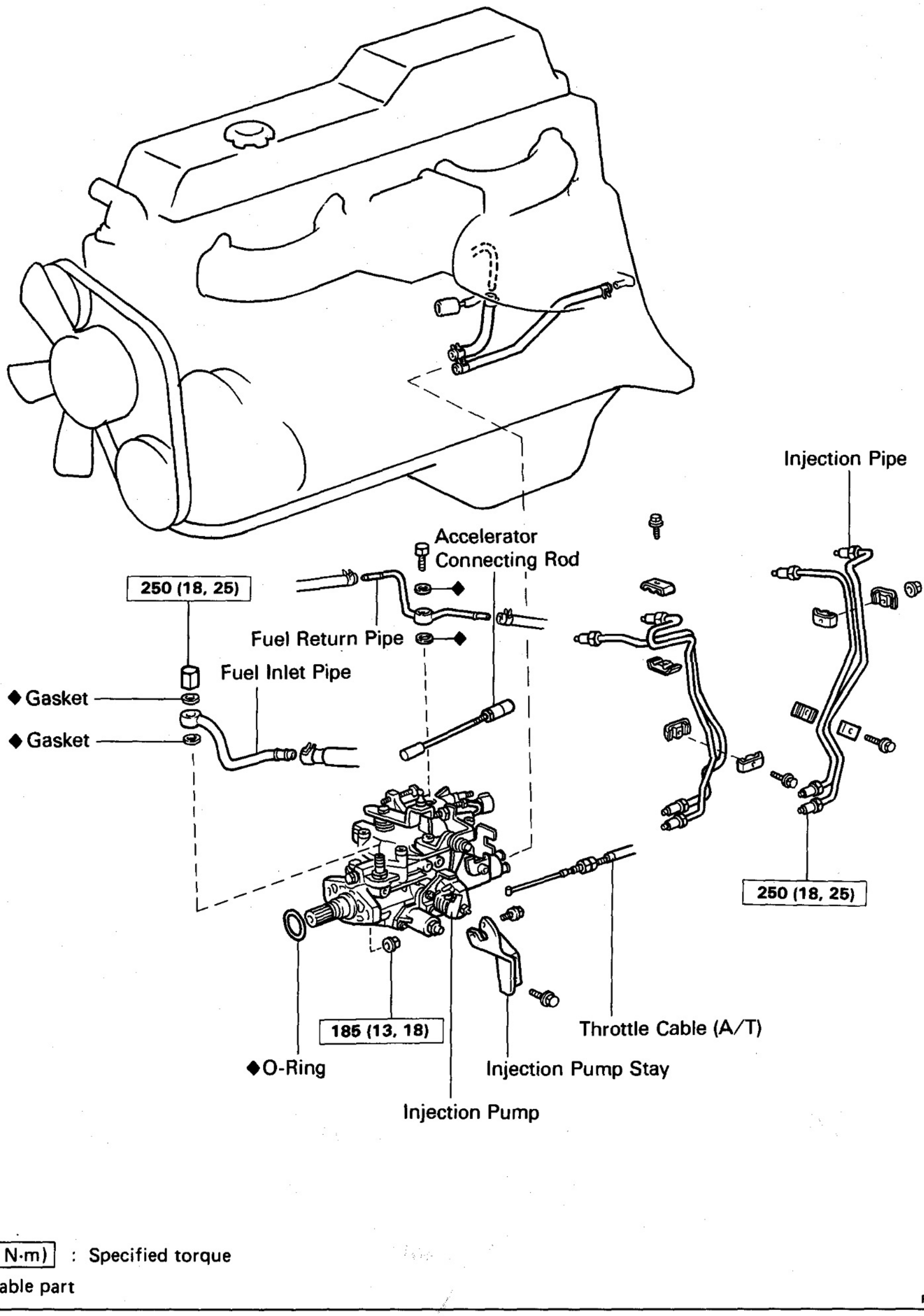
Torque: 250 kg-cm (18 ft-lb, 25 N·m)

(c) Secure the injection pipes with the clamps and bolts and nut.

4. START ENGINE AND CHECK FOR FUEL LEAKS

INJECTION PUMP

REMOVAL OF INJECTION PUMP

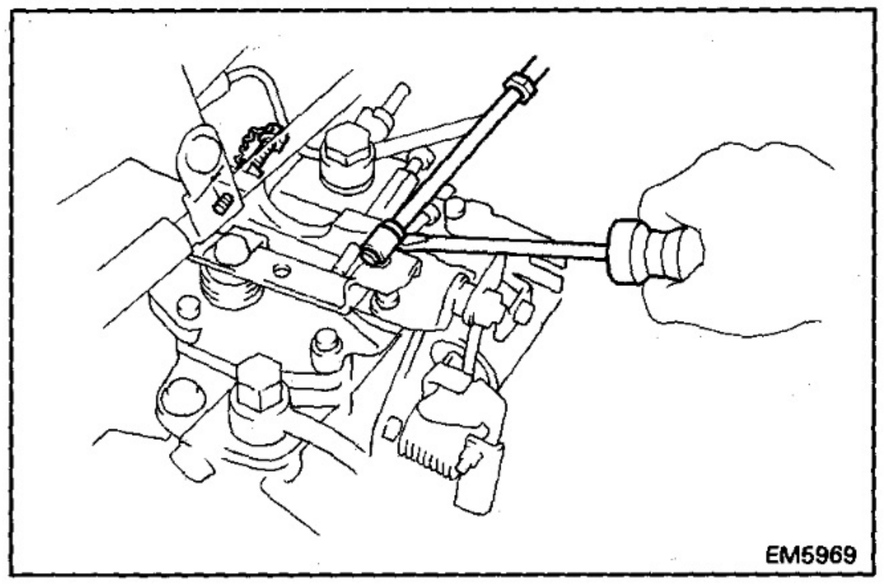


kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

FU2305

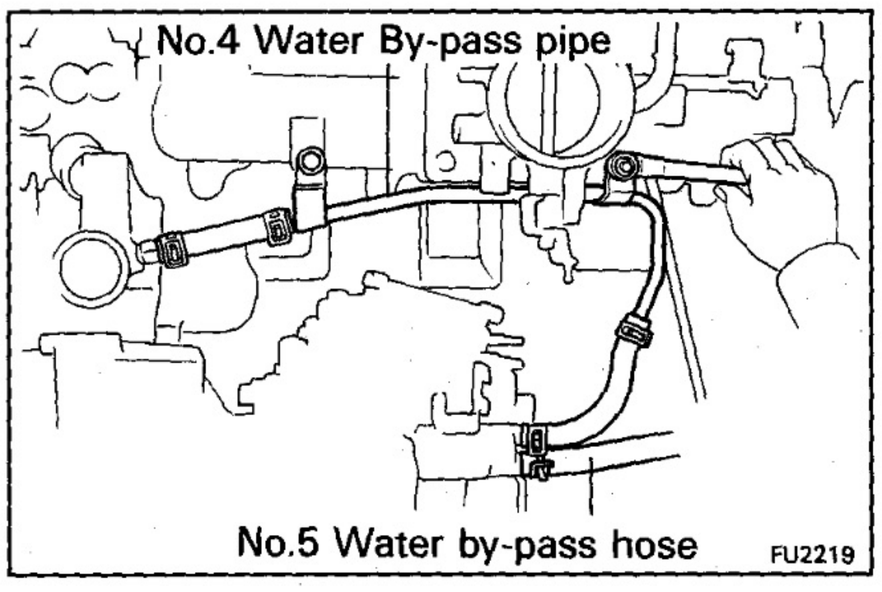
1. REMOVE INJECTION PIPES
(See step 1 on page FU-8) B and 3B
(See step 1 on page FU-14) 11B and 14B


EM5969

2. REMOVE PARTS

(a) Accelerator connecting rod

(b) (A/T)
Throttle cable

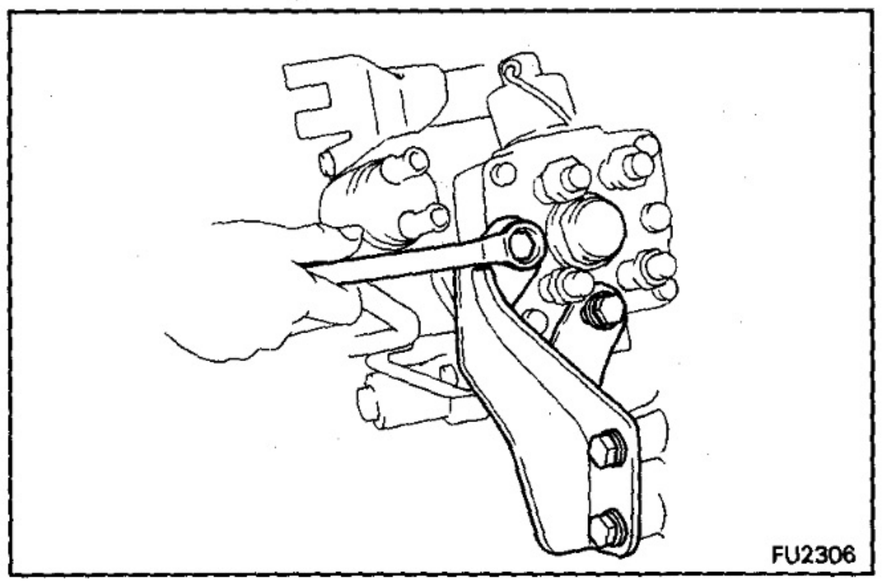


FU2219

(c) (w/ACSD)
No.4 water by-pass pipe with hoses

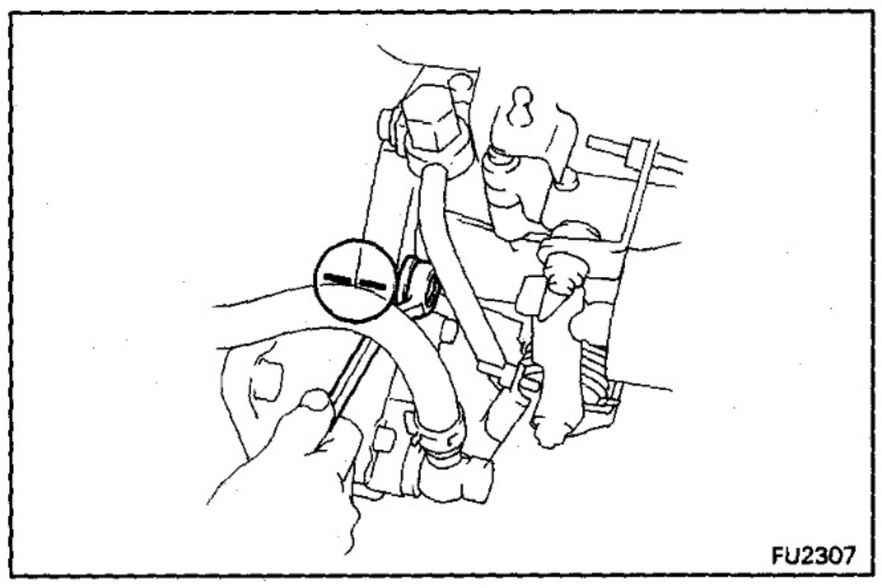
(d) (w/ACSD)
No.5 water by-pass hose

(e) Fuel return hose


FU2306

3. REMOVE INJECTION PUMP

(a) Remove the four bolts and injection pump stay.

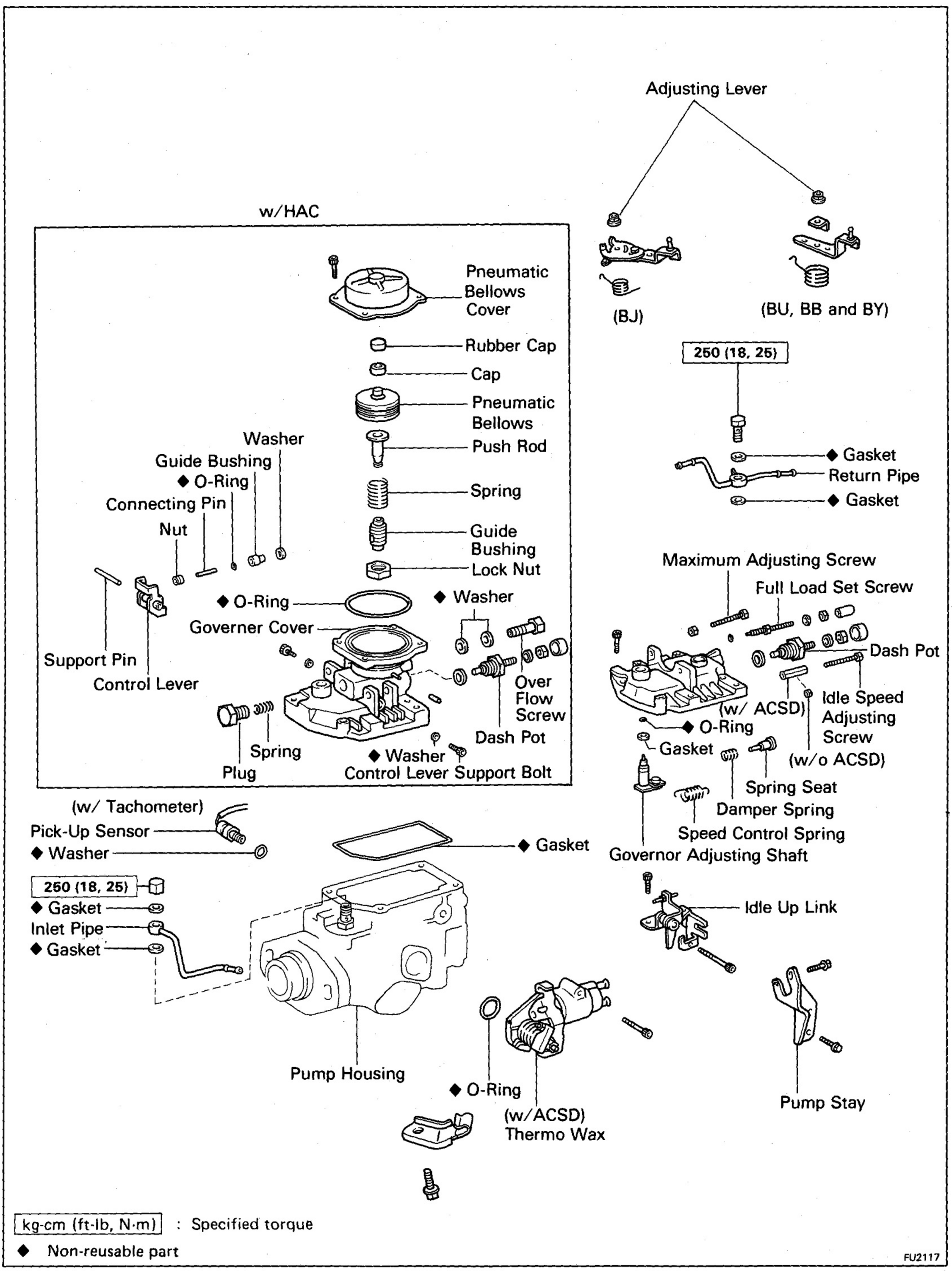

FU2307

(b) Before removing the injection pump, check if the matchmarks are aligned. If not, place new matchmarks for reinstallation.

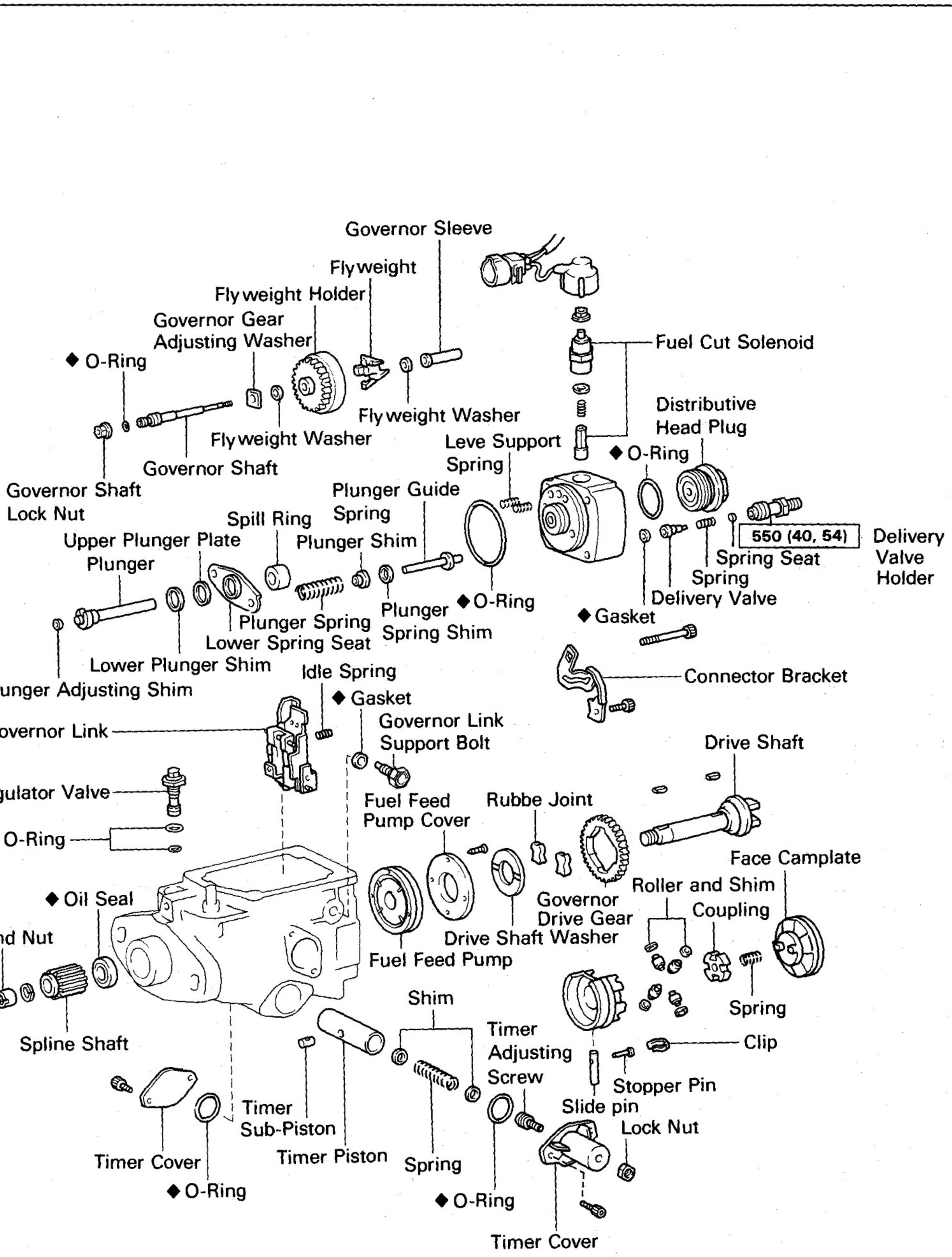
(c) Remove the two nuts and injection pump.

(d) Remove the O-ring from the injection pump flange.

COMPONENTS


w/HAC
Pneumatic Bellows Cover
Rubber Cap
Cap
Pneumatic Bellows
Push Rod
Spring
Guide Bushing
Lock Nut
Washer
Guide Bushing
◆ O-Ring
Connecting Pin
Nut
◆ O-Ring
Governer Cover
◆ Washer
Support Pin
Control Lever
Over Flow Screw
Dash Pot
Spring
Plug
◆ Washer
Control Lever Support Bolt
Adjusting Lever
(BJ)
(BU, BB and BY)
250 (18, 25)
◆ Gasket
Return Pipe
◆ Gasket
Maximum Adjusting Screw
Full Load Set Screw
Dash Pot
(w/ ACSD)
Idle Speed Adjusting Screw
(w/o ACSD)
◆ O-Ring
Gasket
Spring Seat
Damper Spring
Speed Control Spring
Governor Adjusting Shaft
(w/ Tachometer)
Pick-Up Sensor
◆ Washer
◆ Gasket
250 (18, 25)
◆ Gasket
Inlet Pipe
◆ Gasket
Idle Up Link
Pump Housing
◆ O-Ring
(w/ACSD) Thermo Wax
Pump Stay
kg-cm (ft-lb, N·m) : Specified torque
◆ Non-reusable part
FU2117

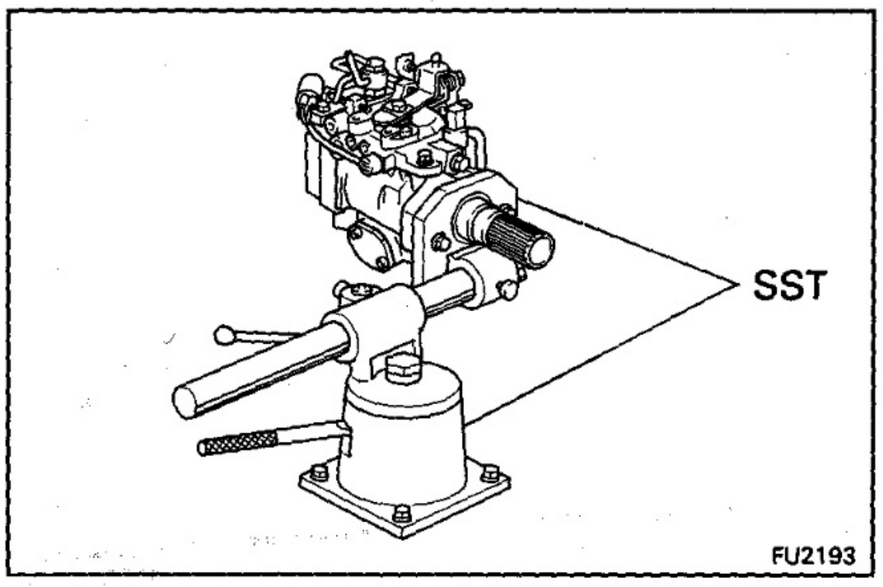
COMPONENTS (Cont'd)



kg-cm (ft-lb, N-m) : Specified torque

◆ Non-reusable part

FU2118

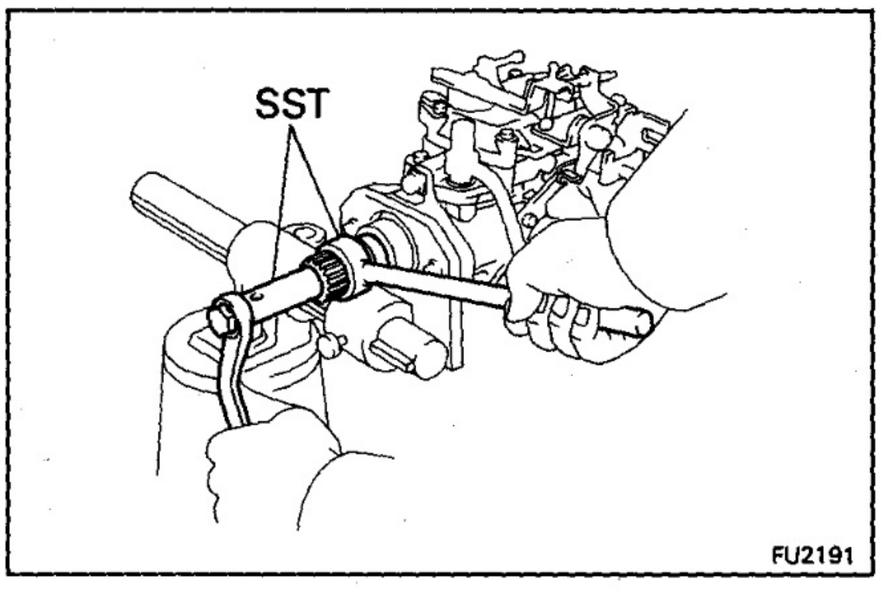


DISASSEMBLY OF INJECTION PUMP

(See pages FU-22 and 23)

1. MOUNT INJECTION PUMP TO STAND (SST) FOR DISASSEMBLY

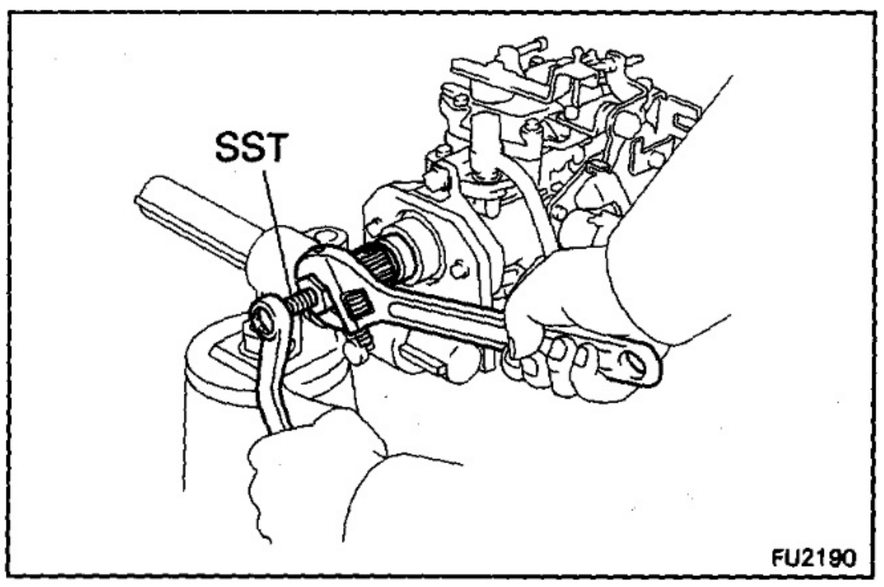
SST 09241-76022 and 09245-54010



2. REMOVE SPLINE SHAFT

(a) Using SST, remove the round nut and spring washer.

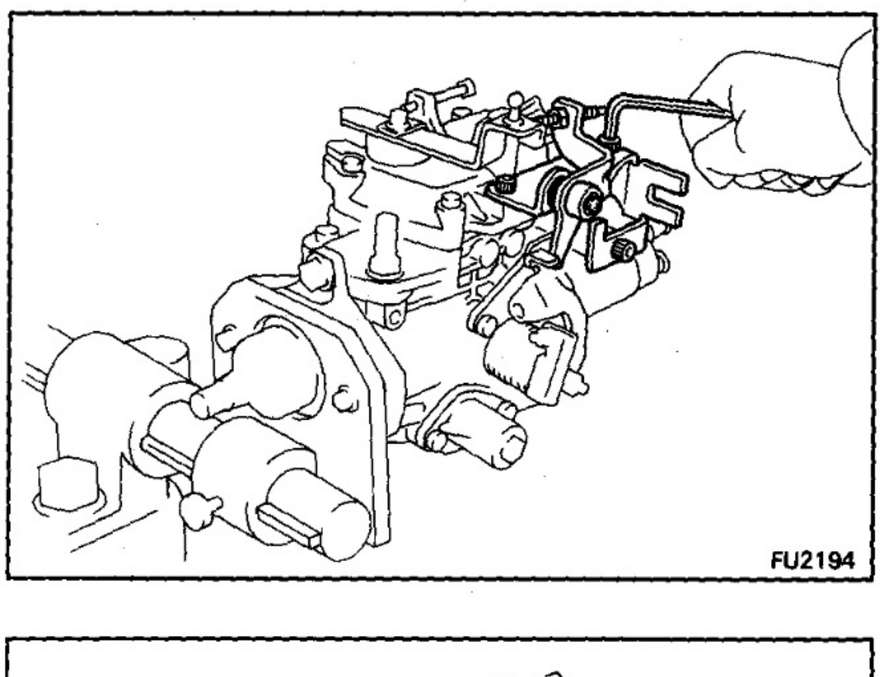
SST 09260-58010 (09266-76011, 09278-46020)



(b) Using SST, remove the spline shaft.

SST 09260-58010 (09267 -76011)

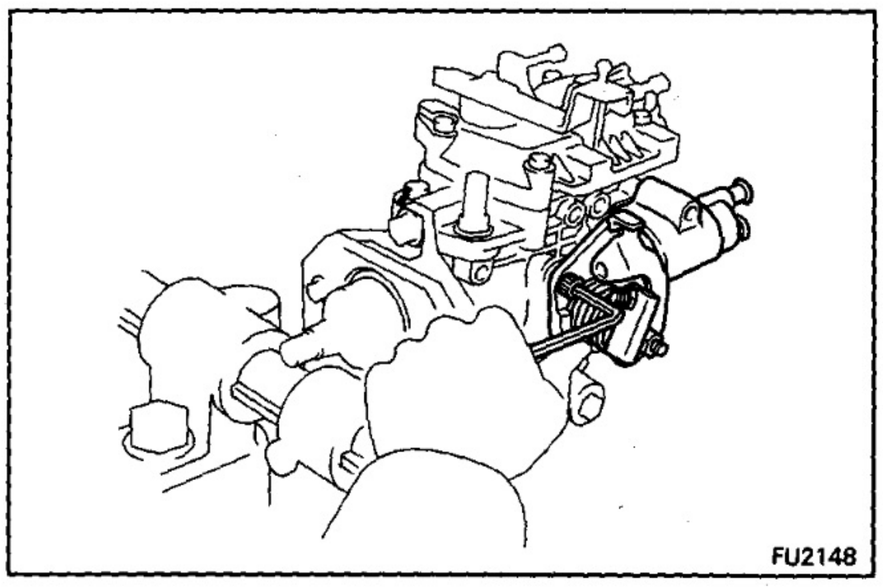
3. REMOVE TWO FUEL PIPES AND CLAMP



4. [w/ACSD]
REMOVE IDLE-UP

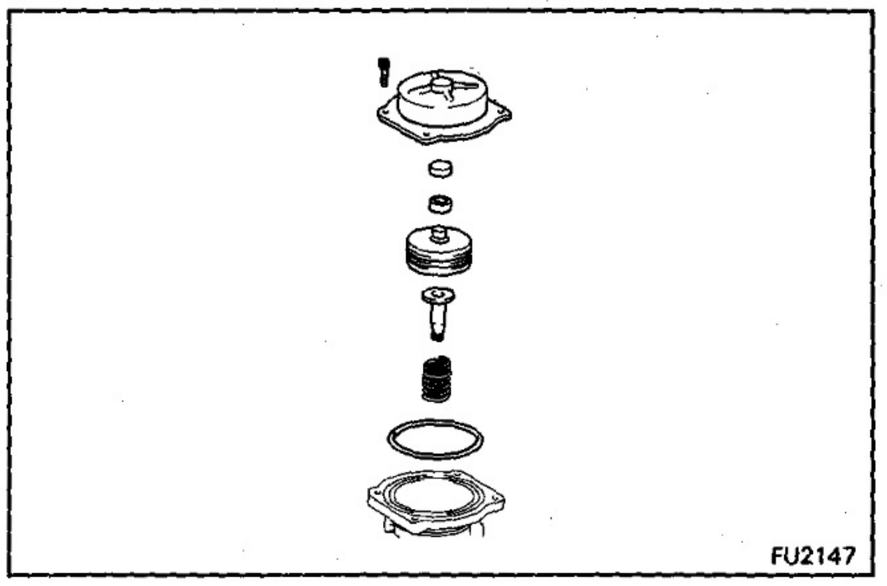
(a) Loosen the collar lock bolt and pull out the collar.

(b) Remove the three bolts and idle-up.



5. [w/ACSD]
REMOVE THERMO WAX

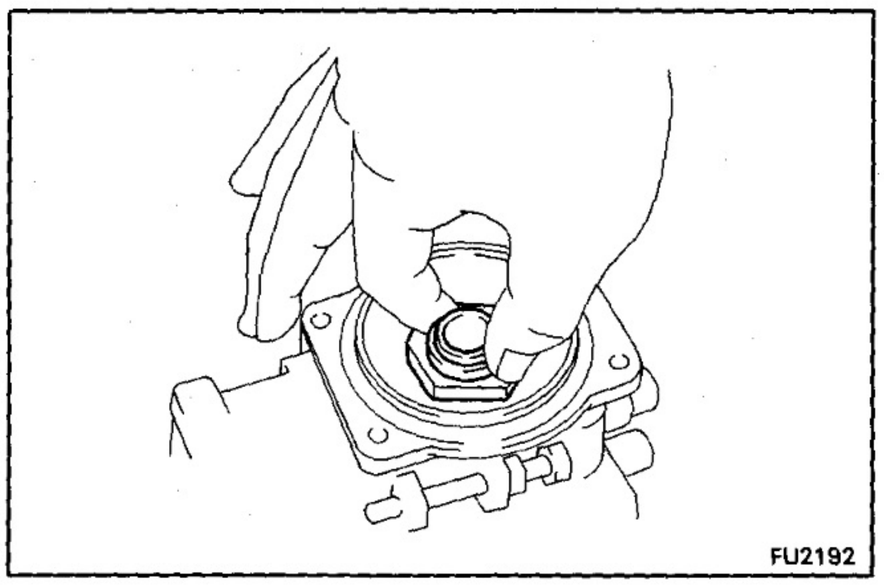
Remove the two bolts, thermo wax and O-ring.



6. [w/ HAC]
REMOVE PNEUMATIC BELLOWS

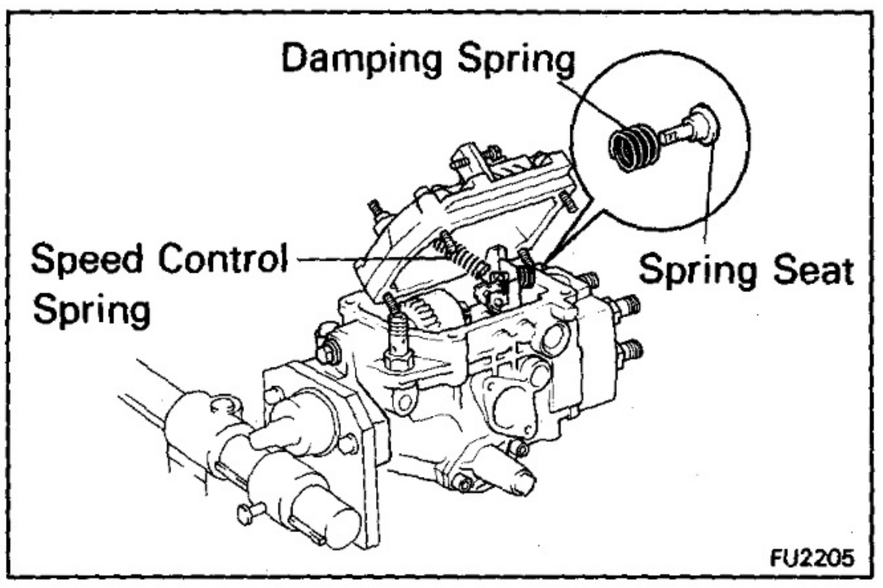
(a) Remove the four bolts, pneumatic bellows cover and o-ring.

(b) Remove the cap, bellows, push rod and spring.



(c) Turn the guide bushing counter-clockwise to remove it.

7. [11B and 14B]
REMOVE DASH POT

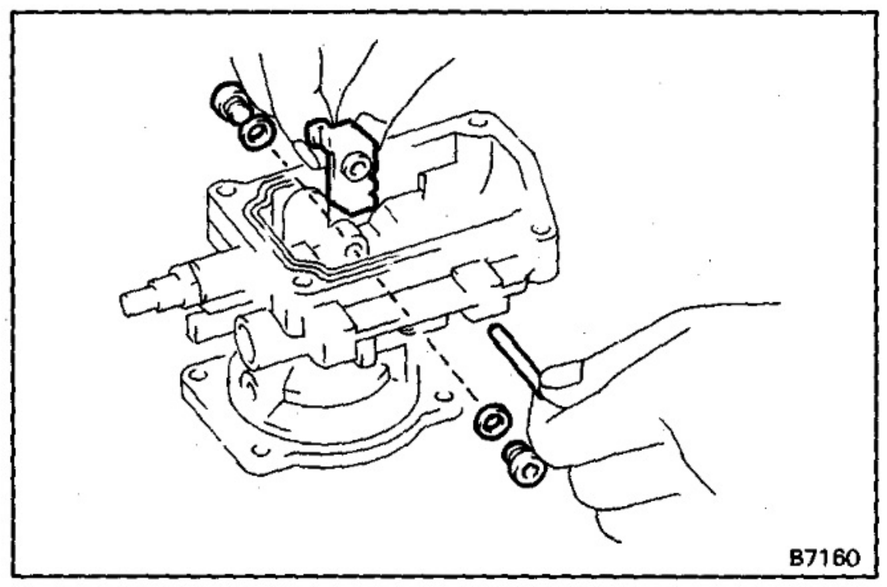


8. REMOVE GOVERNOR COVER

(a) Using an allen wrench remove the four bolts.

(b) Disconnect the speed control spring from the spring seat and then remove the spring seat and damper spring.

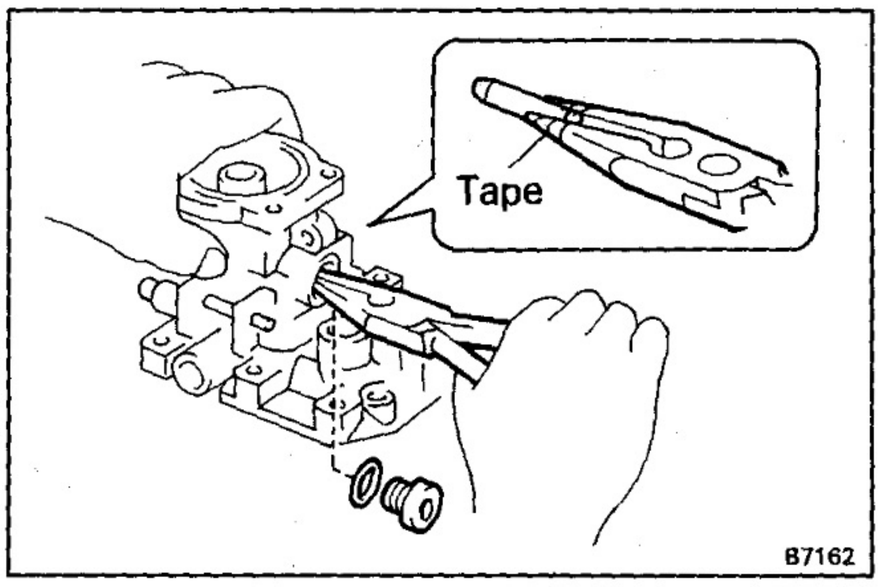
(c) Remove the governor cover with the gasket.



9. [w/HAC]
REMOVE CONTROL LEVER FROM GOVERNOR COVER

(a) Using an allen wrench, remove the two bolts and the gaskets.

(b) Remove the support pin and control lever.

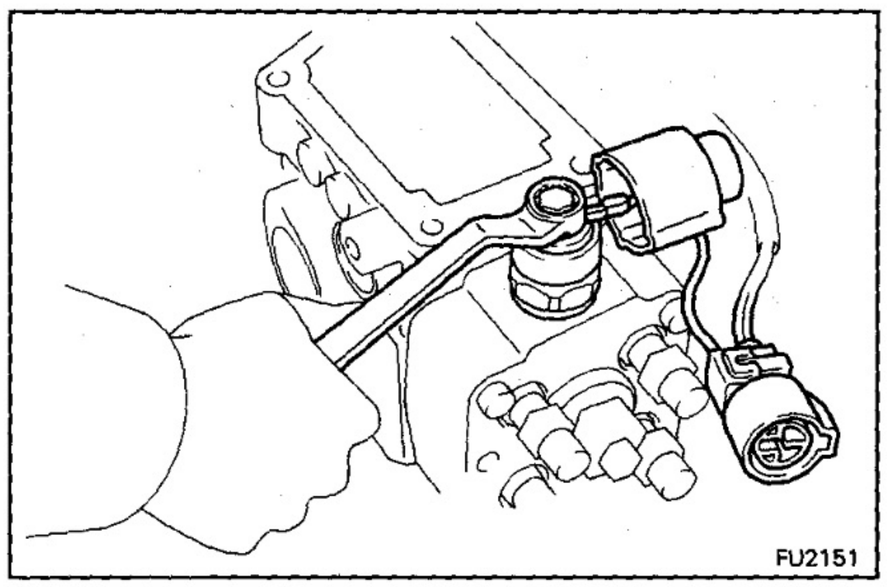


10. [w/HAC]
REMOVE CONNECTING PIN FROM GOVERNOR COVER

(a) Using an allen wrench, remove the screw plug with the gasket.

(b) Using pliers, pull out the connecting pin.

NOTICE: Tape the tip of the pliers, and be careful not damage the connecting pin.

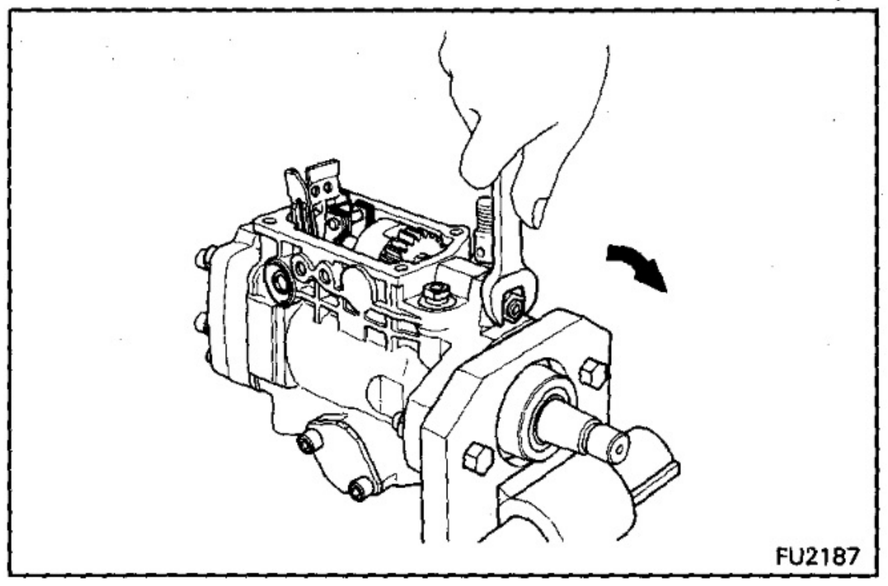


11. REMOVE FUEL CUT SOLENOID

(a) Disconnect the lead wire from the fuel cut solenoid.

(b) Remove the fuel cut solenoid, spring and valve.

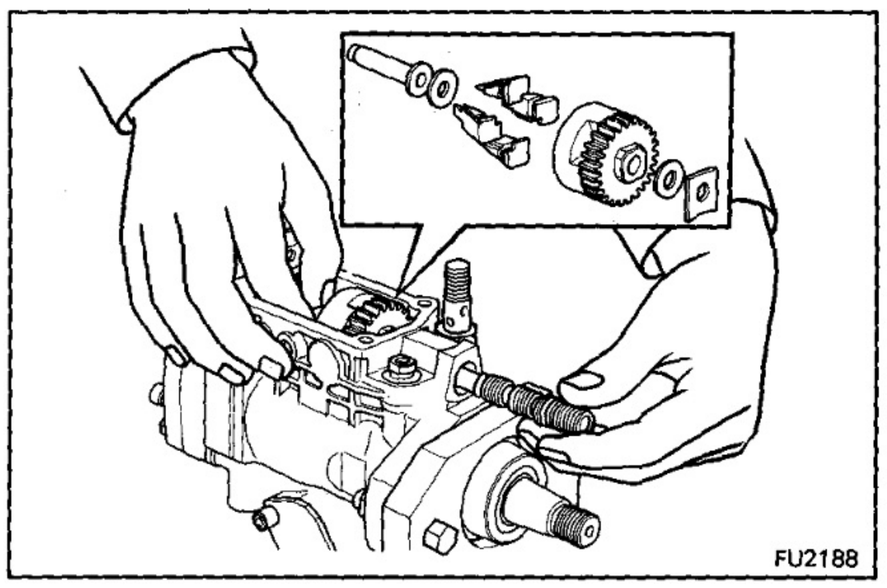
12. REMOVE PICK UP SENSOR
(w/Tachometer Vehicles)



13. REMOVE GOVERNOR SHAFT AND FLYWEIGHT HOLDER

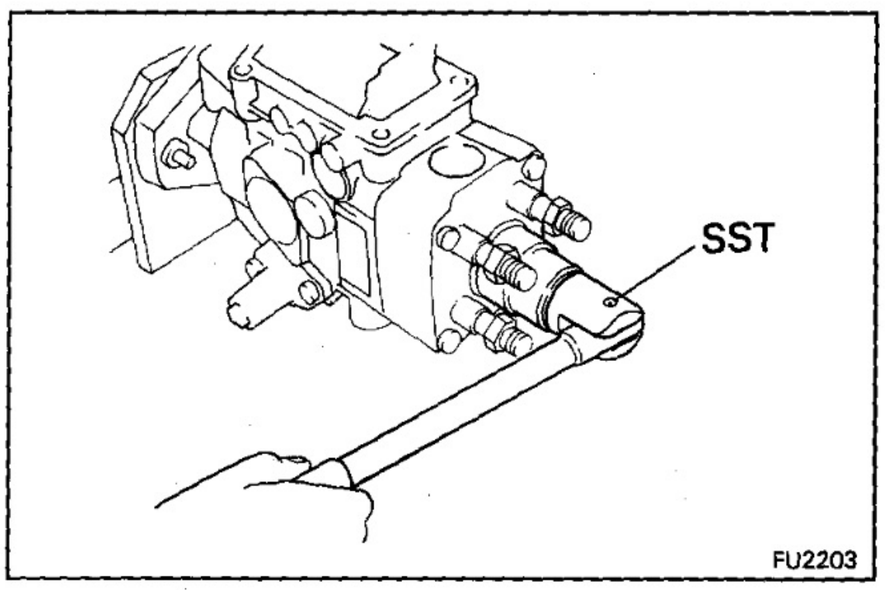
(a) Loosen the governor shaft lock nut by turning it clockwise.

NOTICE: The governor shaft and lock nut have LH threads.



(b) Hold the flyweight holder subassembly and screw out the governor shaft clockwise.

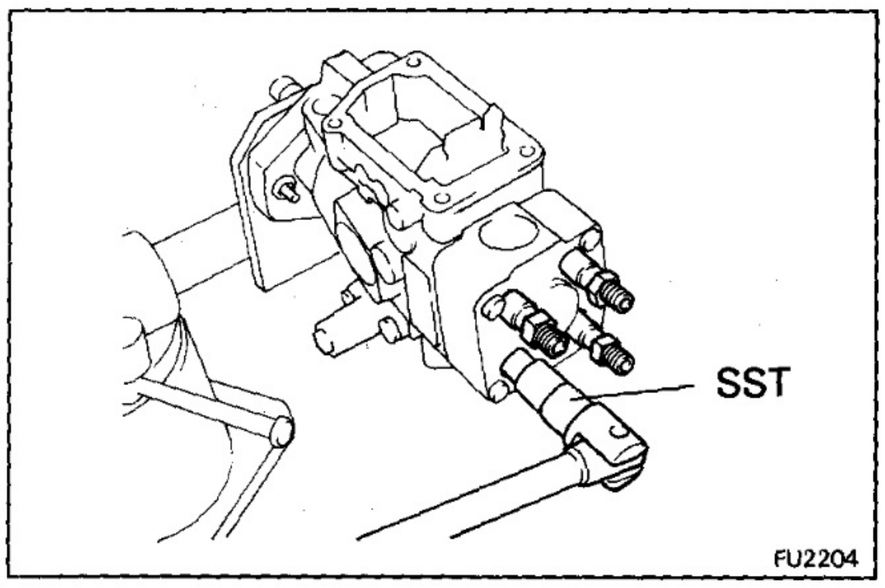
HINT: Be careful not to drop the two washers into the pump housing.



14. REMOVE DISTRIBUTIVE HEAD PLUG

Using SST, remove the distributive head plug.

SST 09260-54012 (09262-54010)

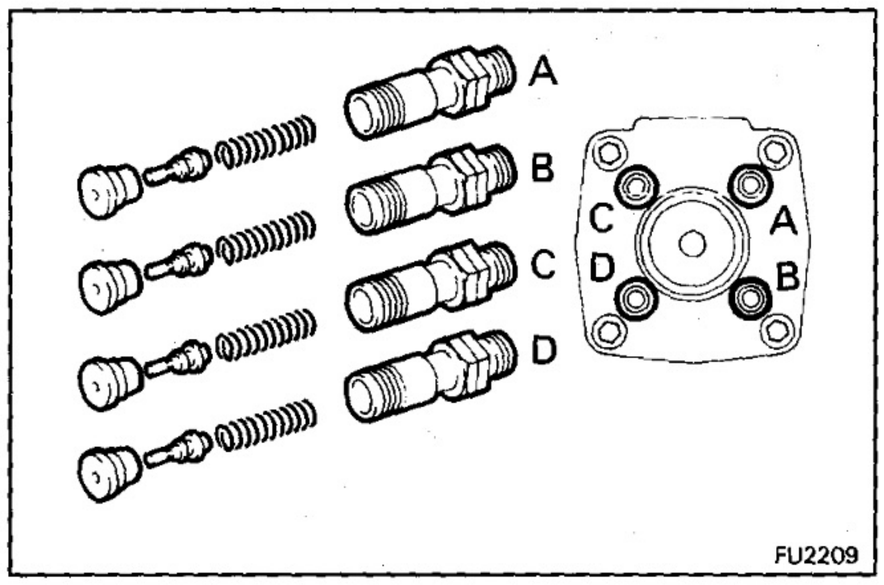


15. REMOVE FOUR DELIVERY VALVE HOLDERS

(a) Using SST, remove the four delivery valve holders, springs and spring seats.

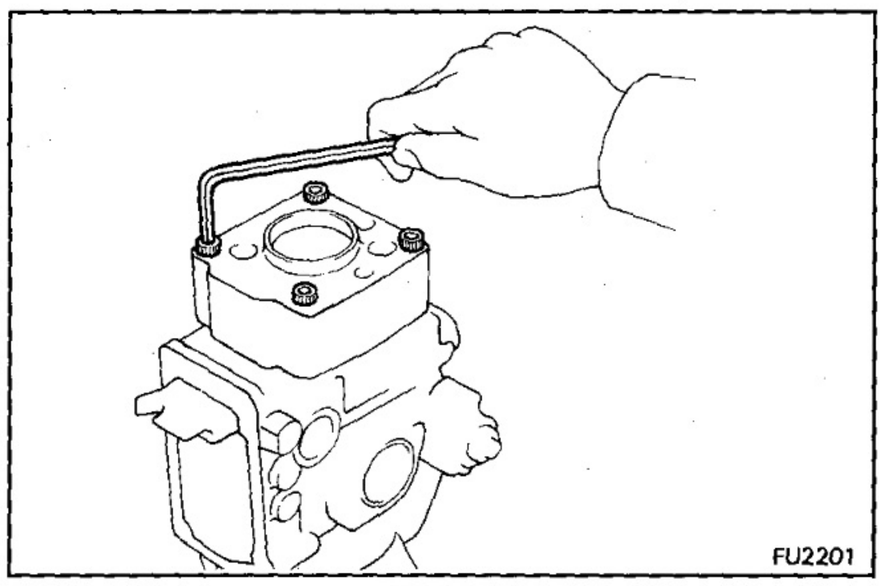
SST 09260-54012 (09269-54020)

(b) Remove four delivery valves and gaskets.



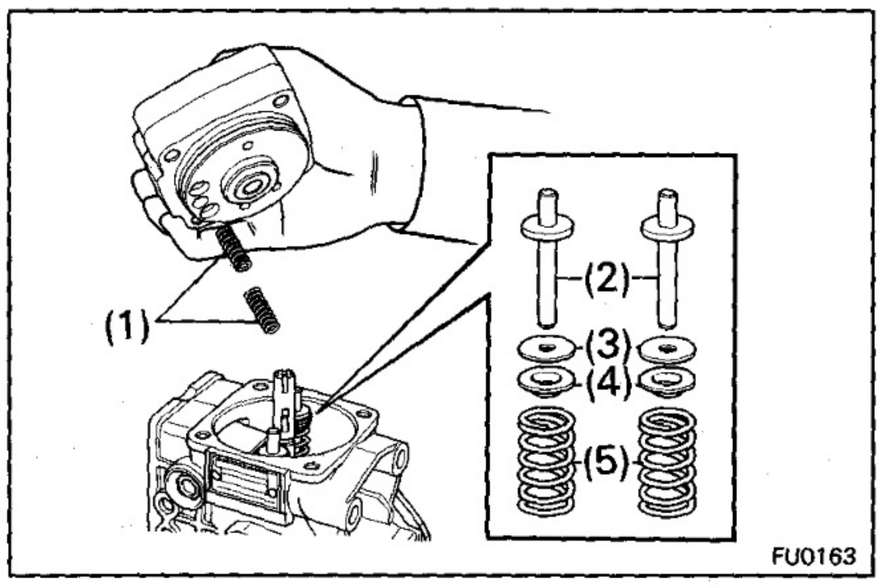
HINT:

- Do not touch the sliding surfaces of the delivery valve with your hand.
- Arrange the delivery valves, springs and holders in order.



16. REMOVE DISTRIBUTIVE HEAD BOLTS

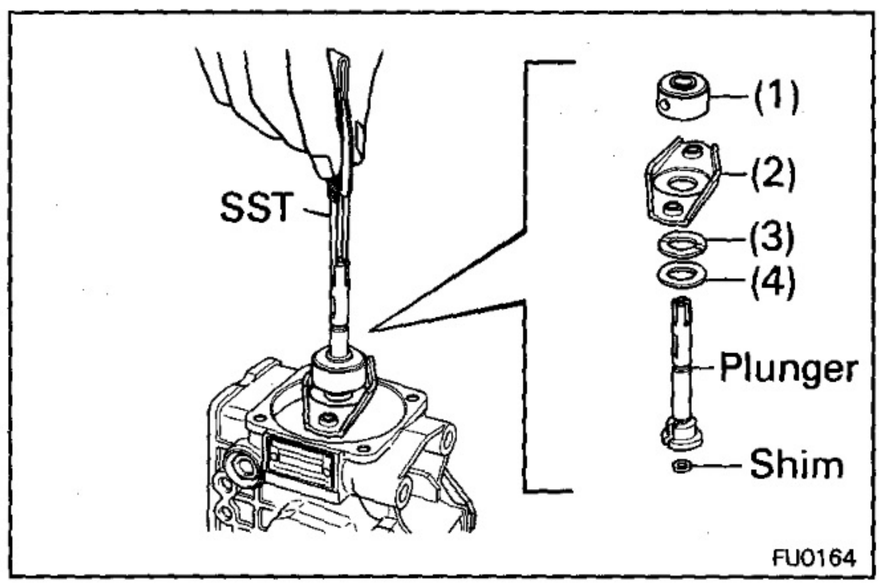
Using an allen wrench, remove the four head bolts.



17. REMOVE DISTRIBUTIVE HEAD

Remove the distributive head and following parts:

(1) Lever support springs
(2) Plunger spring guides
(3) Plunger spring shims
(4) Upper spring seats
(5) Plunger springs



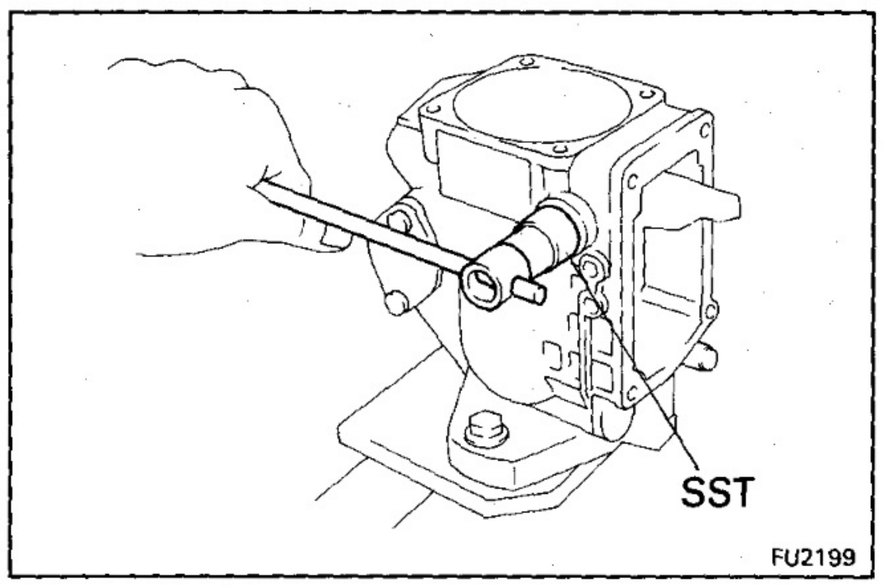
18. REMOVE PUMP PLUNGER

Using SST, remove the pump plunger and plunger adjusting shim with the following parts:

(1) Spill ring
(2) Lower spring seat
(3) Upper plunger plate
(4) Lower plunger plate

SST 09260-54012 (09269-54030)

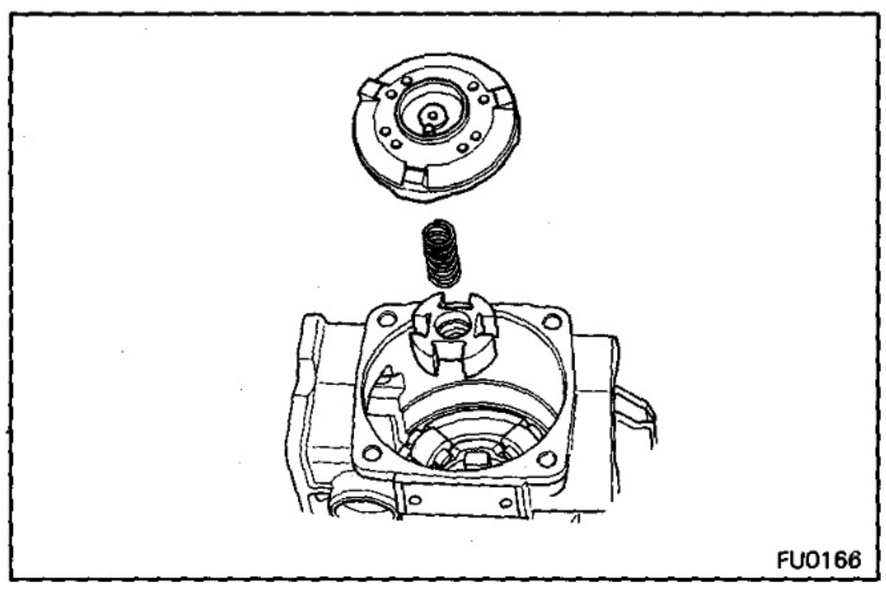
HINT: Do not touch the sliding surfaces of the pump plunger with your hand.



19. REMOVE GOVERNOR LINK

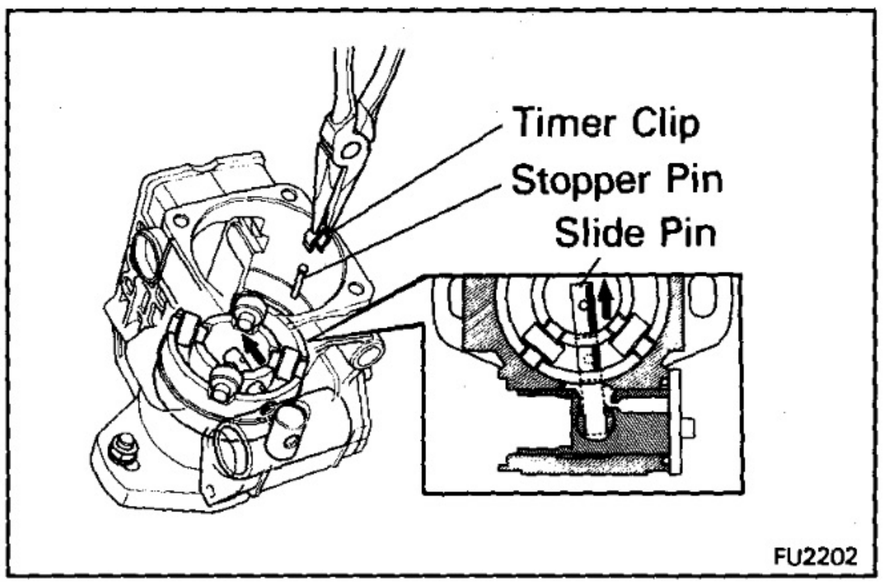
Using SST, remove the two support bolts and governor link.

SST 09260-54012 (09269-54040)


FU0166

20. REMOVE FACE CAMPLATE AND COUPLING

Remove the face camplate, spring and coupling.

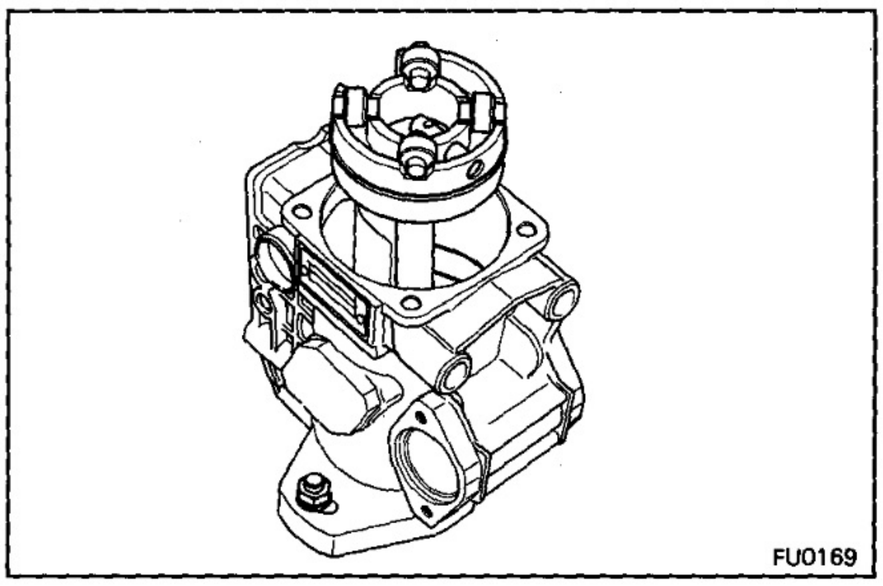


FU2202

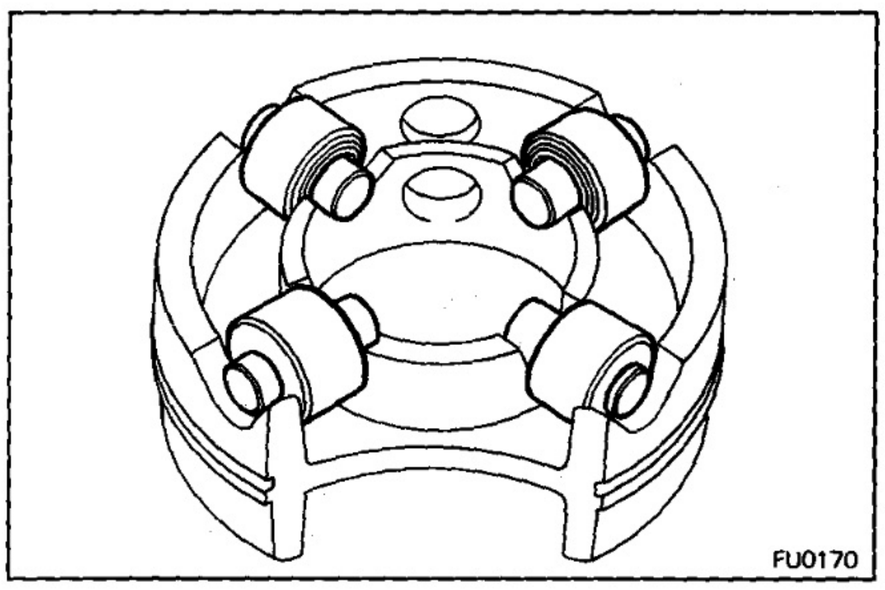
21. REMOVE ROLLER RING AND DRIVE SHAFT

(a) Remove the timer clip and stopper pin.

(b) Push on the slide pin as shown.

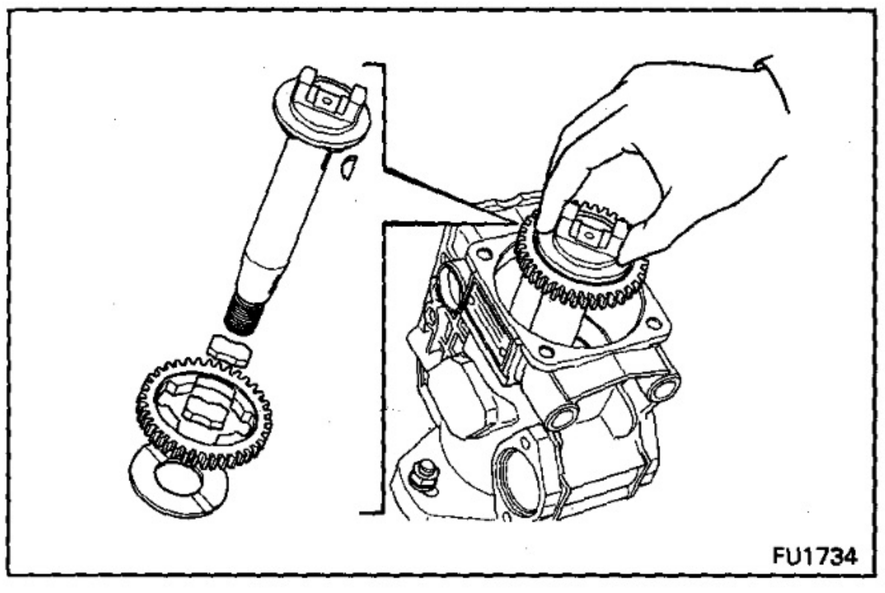

FU0169

(c) Push the drive shaft and remove the roller ring.


FU0170

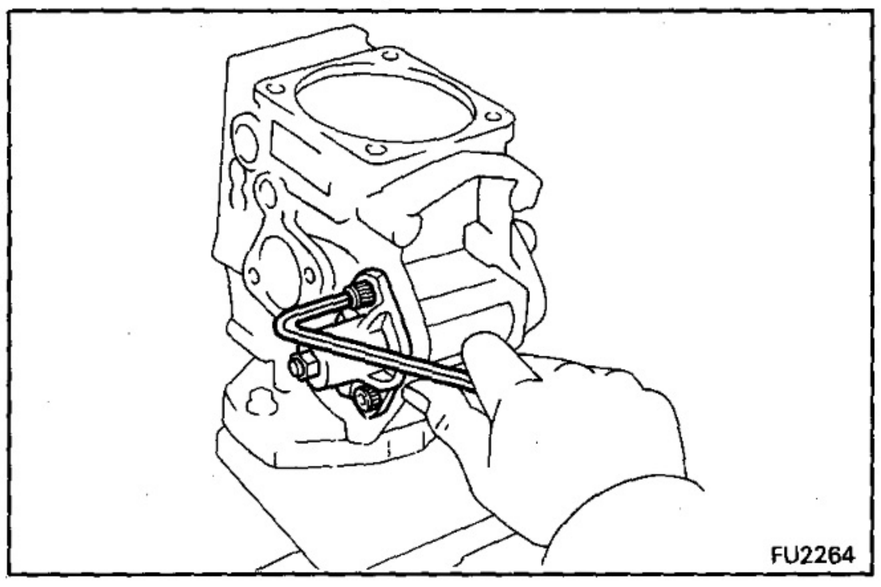
HINT:

- Be careful not to drop the rollers.
- Do not alter the position or assembly of the rollers.


FU1734

(d) Remove the drive shaft with the governor drive gear.

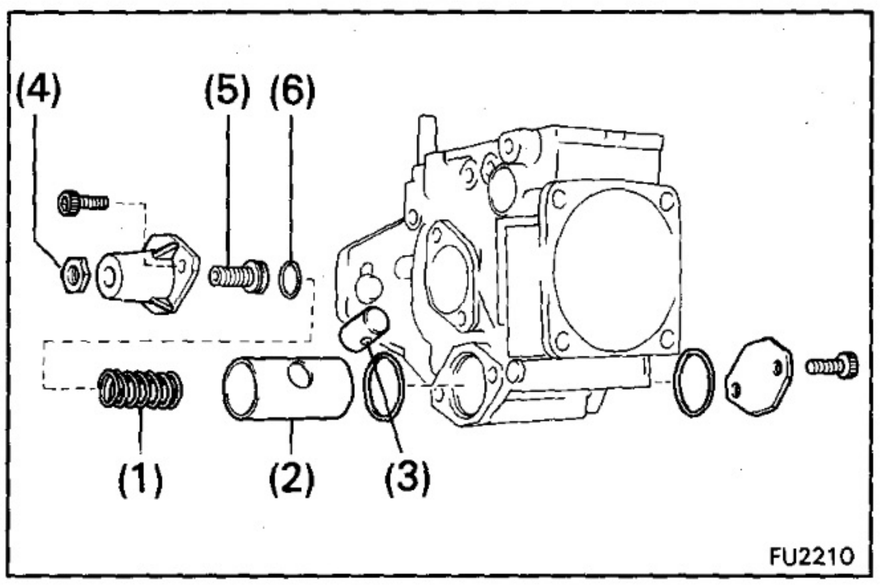
(e) Remove the drive shaft washer.



22. REMOVE TIMER

(a) Loosen the timer adjusting screw lock nut.

(b) Remove the two timer covers and O-rings.



(c) Remove the following parts:

(1) Spring

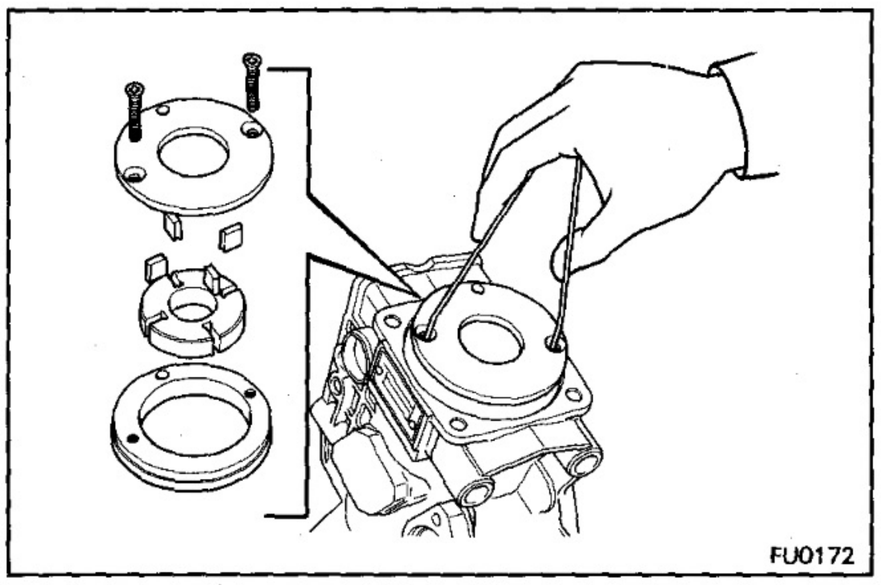
(2) Piston

(3) Sub-piston

(4) Timer adjusting screw lock nut

(5) Timer adjusting screw

(6) O-ring



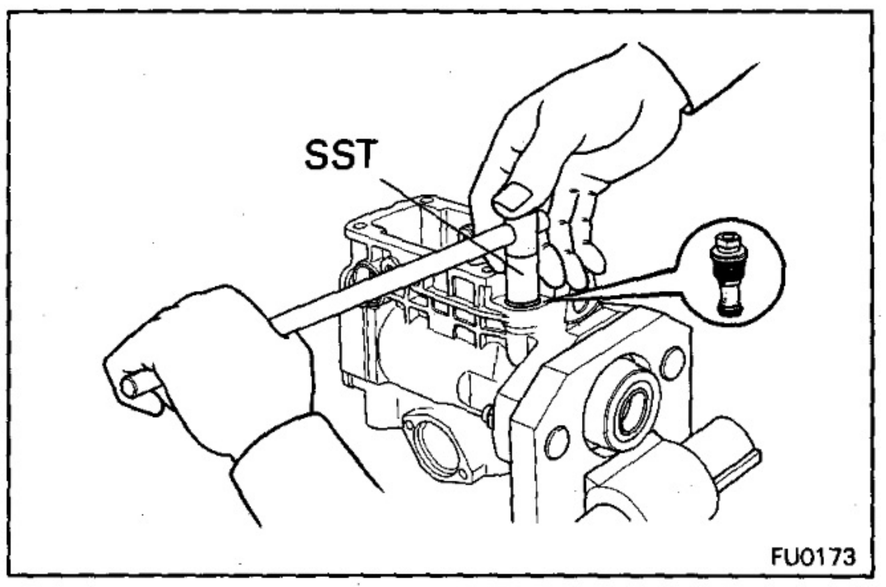
23. REMOVE FEED PUMP

(a) Remove the two screws.

(b) Using a piece of wire, remove the feed pump cover.

(c) Remove the feed pump rotor, four blades and liner.

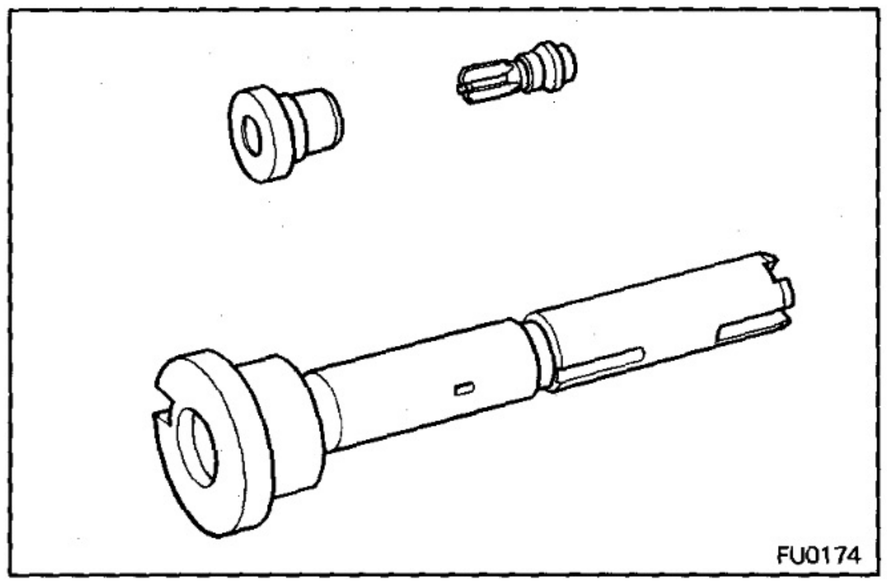
NOTICE: Be careful not to interchange the blade positions.



24. REMOVE REGULATOR VALVE

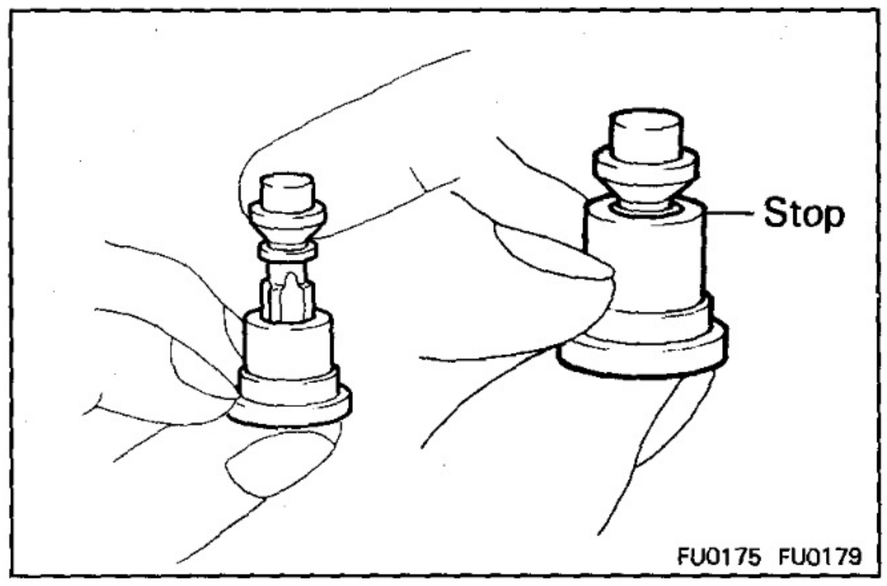
Using SST, remove the regulator valve.

SST 09260-54012 (09262-54020)


FU0174

INSPECTION OF INJECTION PUMP COMPONENTS

HINT: Do not touch the sliding surfaces of the pump plunger and delivery valves.

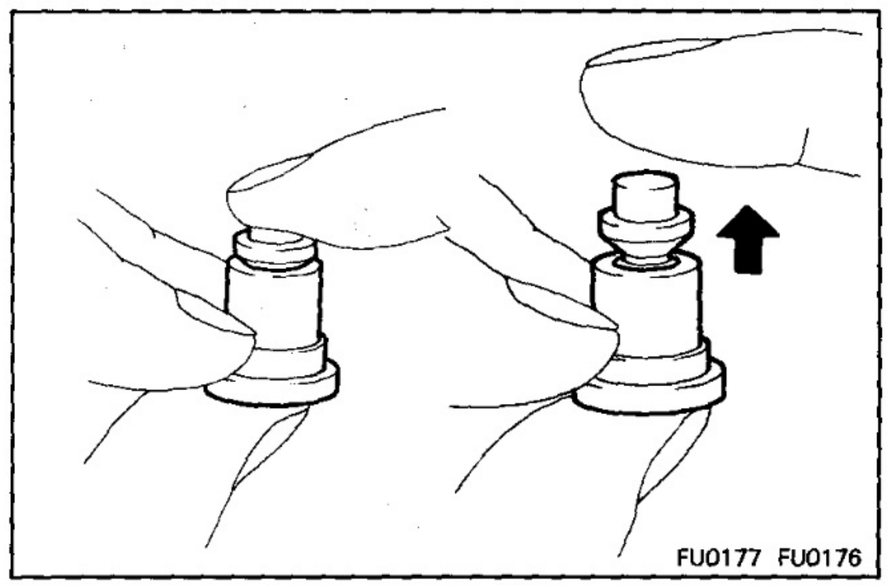


FU0175 FU0179

1. INSPECT DELIVERY VALVES

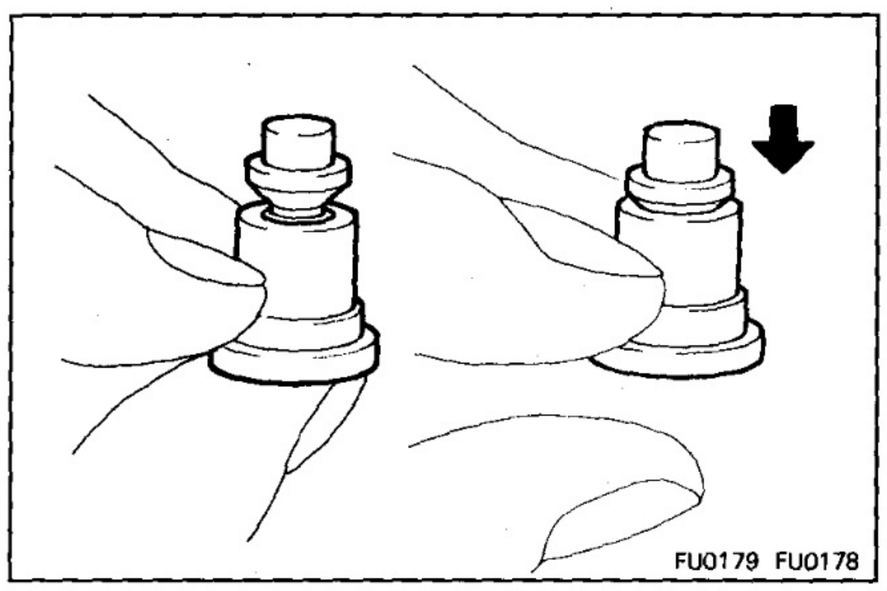
(a) Pull up the valve and close the hole at the valve seat bottom end with your thumb.
When the valve is released, it should sink down quickly and stop at the position where the relief ring closes the valce seat hole.

If defective, replace the valve as a set.


FU0177 FU0176

(b) Close the hole at the valve seat bottom end with your thumb.
Insert the valve into the valve seat and press down with your finger. When your finger is released, the valve should rise back to its original position.

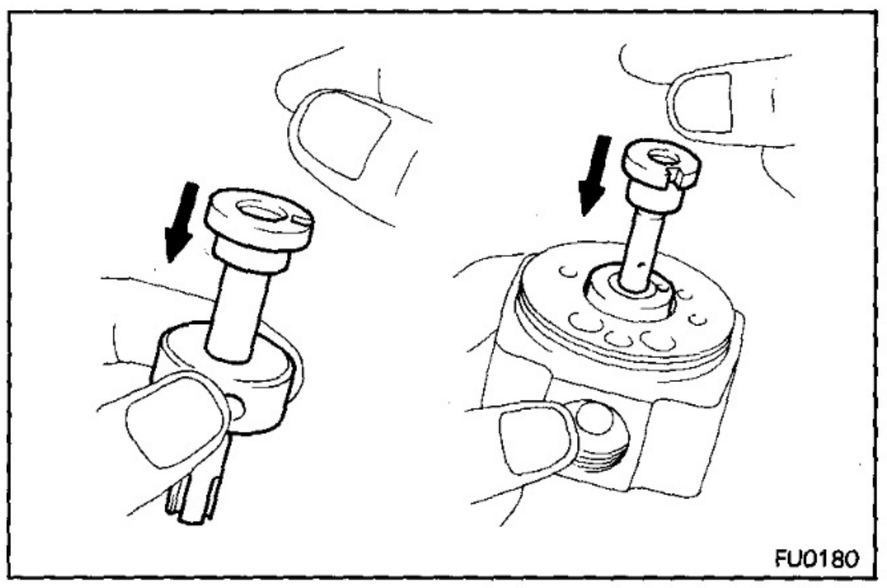
Replace if defective.


FU0179 FU0178

(c) Remove your thumb from the valve seat hole.
The valve should close completely by its own weight.

Replace if defective.

HINT: Before using a new valve set, wash off the rust prevention compound with light oil or gasoline.
Then re-wash with diesel fuel and perform the above tests.


FU0180

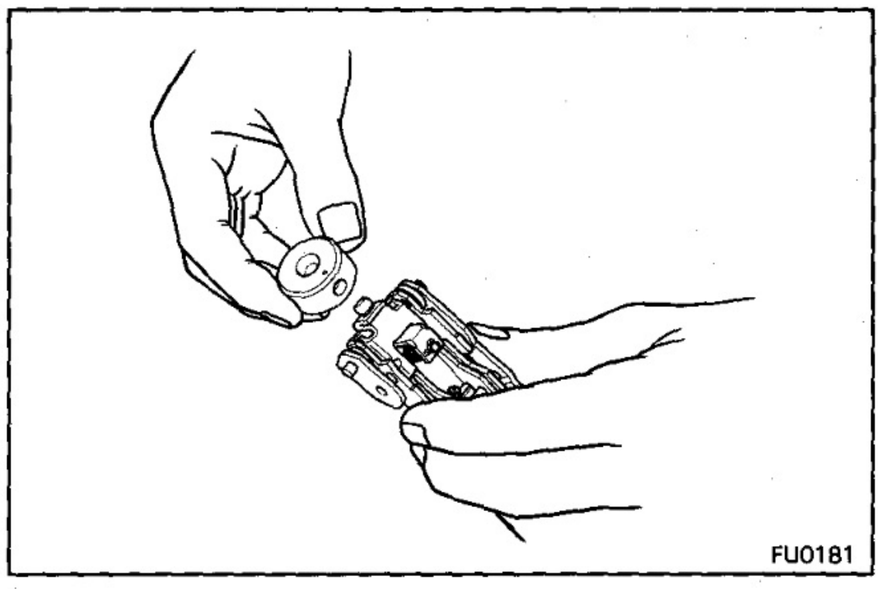
2. INSPECT PUMP PLUNGER, SPILL RING AND DISTRIBUTIVE HEAD

(a) Tilt the spill ring (distributive head) slightly and pull out the plunger.

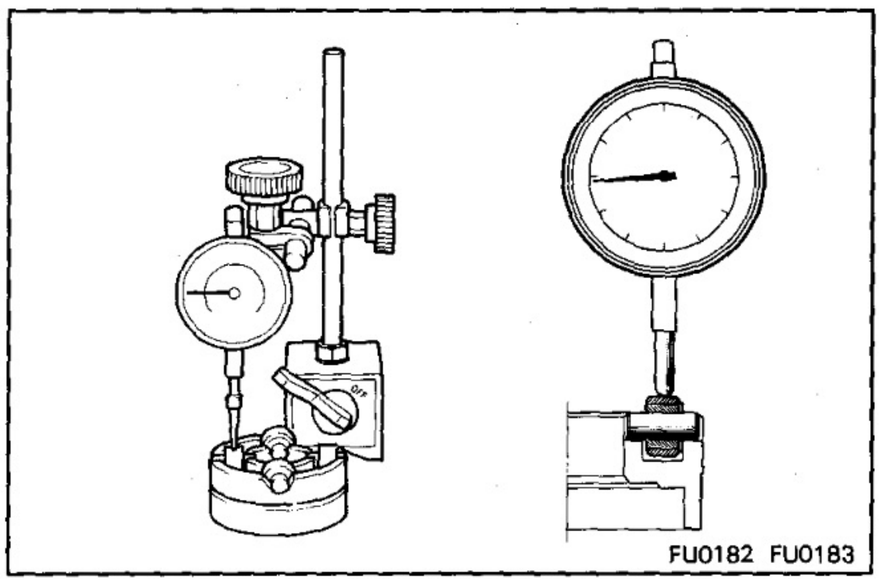
(b) When released, the plunger should sink down smoothly into the spill ring (distributive head) by its own weight.

(c) Rotate the plunger and repeat the test at various positions.

If the plunger sticks at any position, replace the parts as a set.


FU0181

(d) Insert the governor link ball pin into the spill ring and check that it moves smoothly without any play.

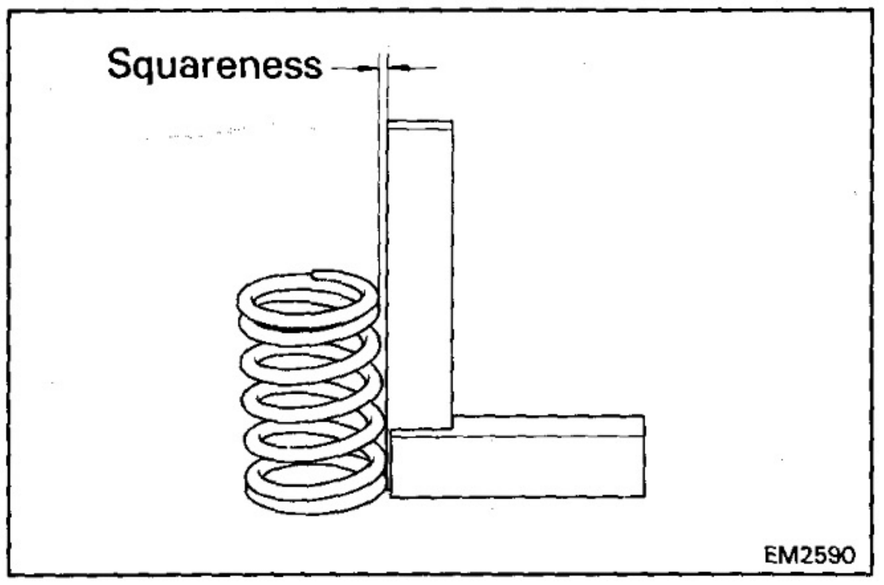

FU0182 FU0183

3. INSPECT ROLLER RING AND ROLLERS

Using a dial indicator, measure the roller height.

Roller height variation: 0.02 mm (0.0008 in.)

If not within specification, replace the roller ring and roller as a set.



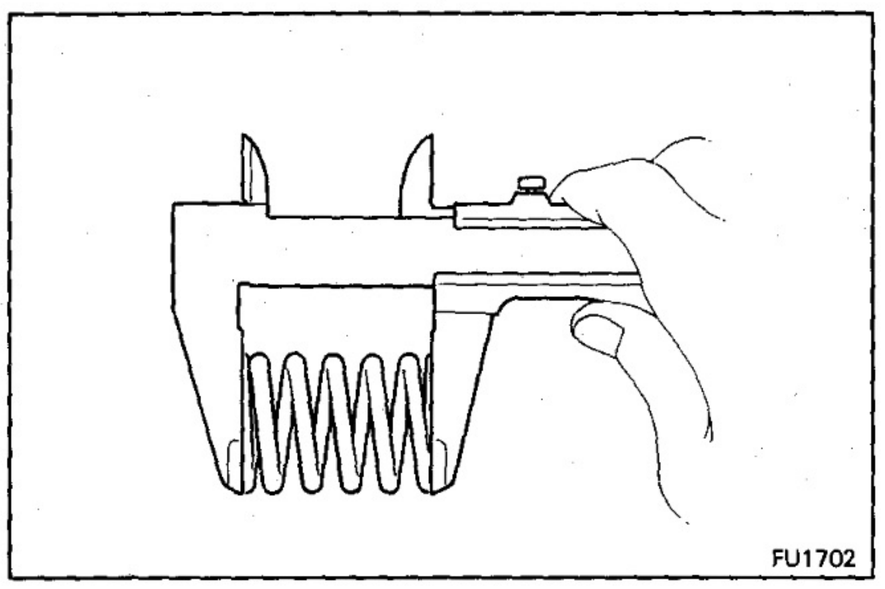
EM2590

4. INSPECT PLUNGER SPRINGS FOR SQUARENESS

Using a steel square, check the squareness of the plunger springs.

Maximum squareness: 2.0 mm (0.079 in.)

If one spring is out of square more than the maximum, replace both springs.


FU1702

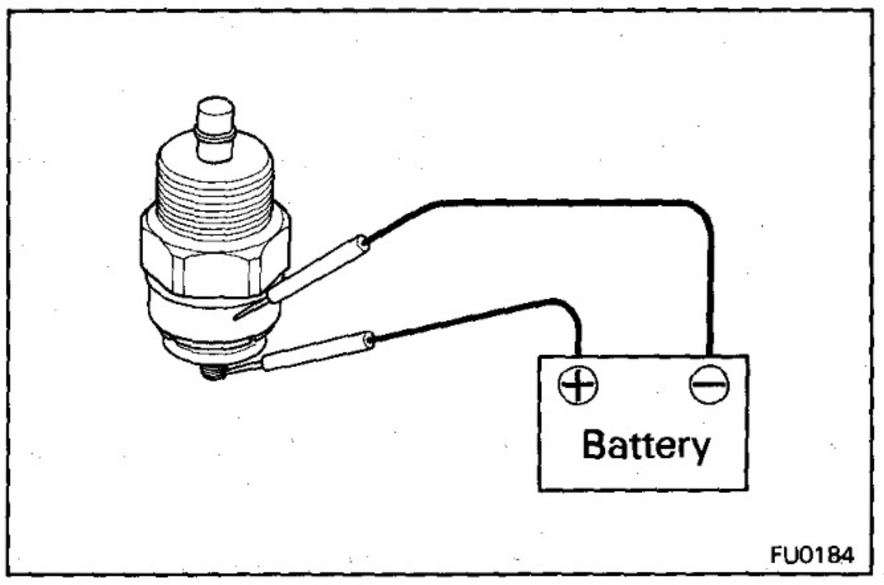
5. INSPECT SPRING LENGTH

Using calipers, measure the free length of each spring.

Spring length mm (in.)

	Delivery valve spring	Plunger spring
Standard	19.4 (0.764)	32.4 (1.276)
Minimum	18.5 (0.728)	31.9 (1.256)

If the length is less than minimum, replace the spring.



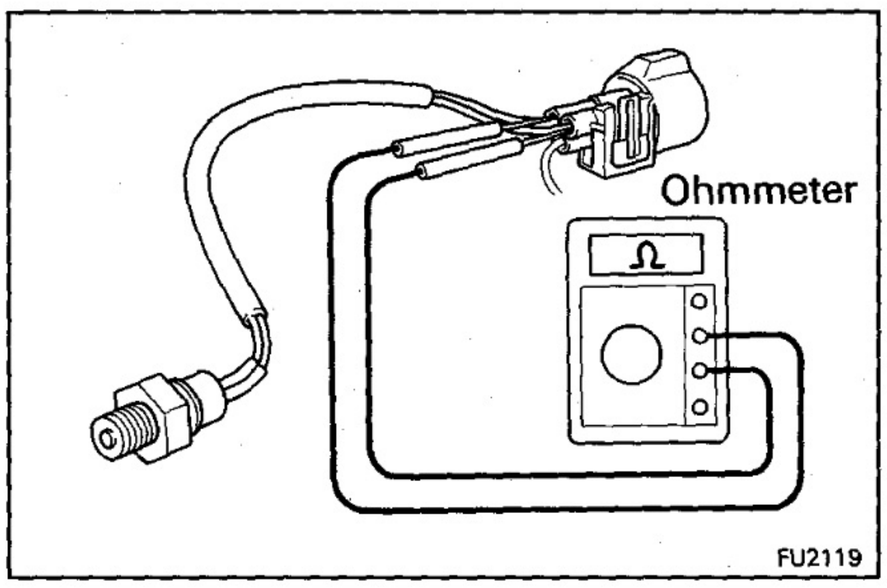
FU0184

6. INSPECT FUEL CUT SOLENOID

(a) Connect the solenoid valve body and terminal to the battery terminals.

(b) You should feel the click from the solenoid valve when the battery power is connected and disconnected.

If the solenoid valve is not operating properly, replace it.

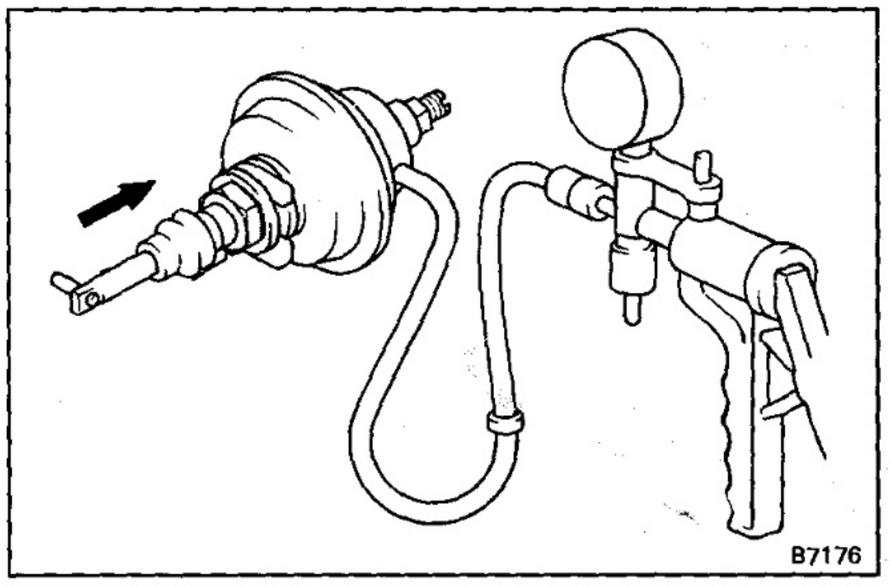


7. INSPECT PICKUP SENSOR

Using an ohmmeter, measure the resistance between terminals.

Resistance: 600 — 800 Ω

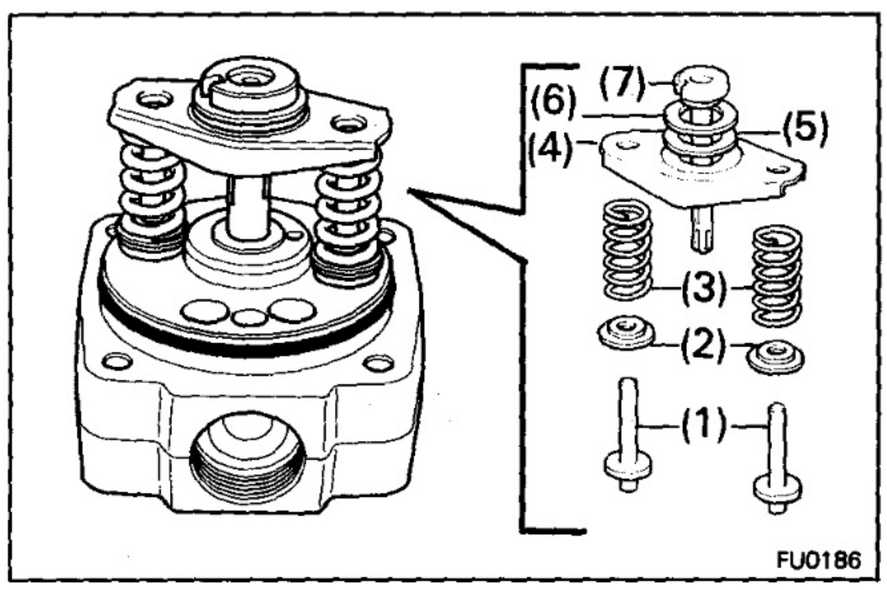
If not within specification, replace the sensor.



8. INSPECT ACTUATOR FOR IDLE-UP

Apply vacuum and check that the actuator rod moves.

If the actuator does not work, replace the actuator as necessary.



9. ADJUST PLUNGER SPRING SHIM

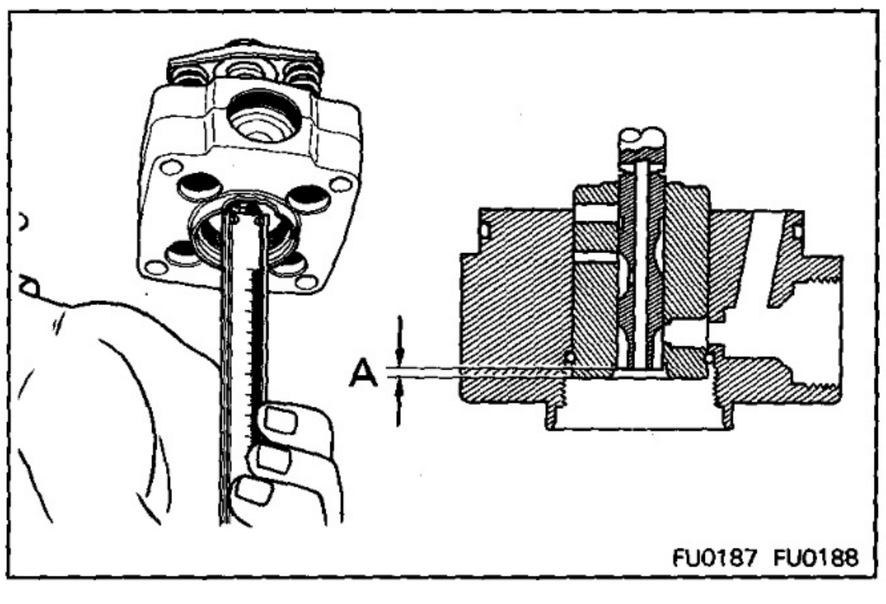
(a) Install the following parts to the distributive head.
- (1) Two plunger spring guides
- (2) Two upper spring seats
- (3) Two plunger springs
- (4) Lower spring seat
- (5) Upper plunger plate
- (6) Lower plunger plate
- (7) Pump plunger

HINT: Do not assemble the plunger spring shims at this time.

(b) Using calipers, measure clearance A indicated in the figure.

(c) Determine the shim size by using the following formula and chart.

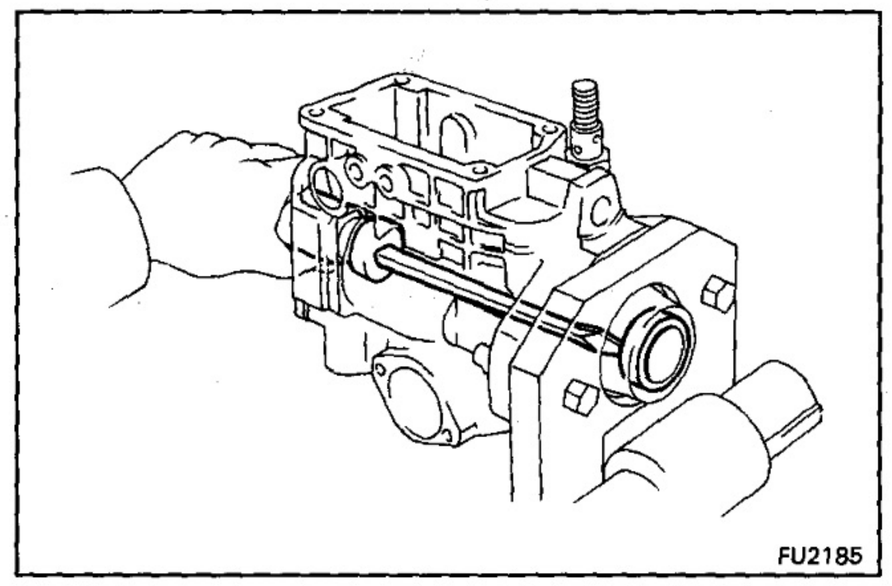
New shim thickness = 5.8 – A
A . . . . Plunger position measured



Shim selection chart mm (in.)

Measured clearance	Shim thickness	Measured clearance	Shim thickness
More than 5.3 (0.209)	0.5 (0.020)	4.3 — 4.5 (0.169 — 0.177)	1.5 (0.059)
5.0 — 5.2 (0.196 — 0.205)	0.8 (0.031)	4.0 — 4.2 (0.157 — 0.165)	1.8 (0.071)
4.8 — 4.9 (0.189 — 0.193)	1.0 (0.039)	Less than 3.9 (0.154)	2.0 (0.079)
4.6 — 4.7 (0.181 — 0.185)	1.2 (0.047)	—	—

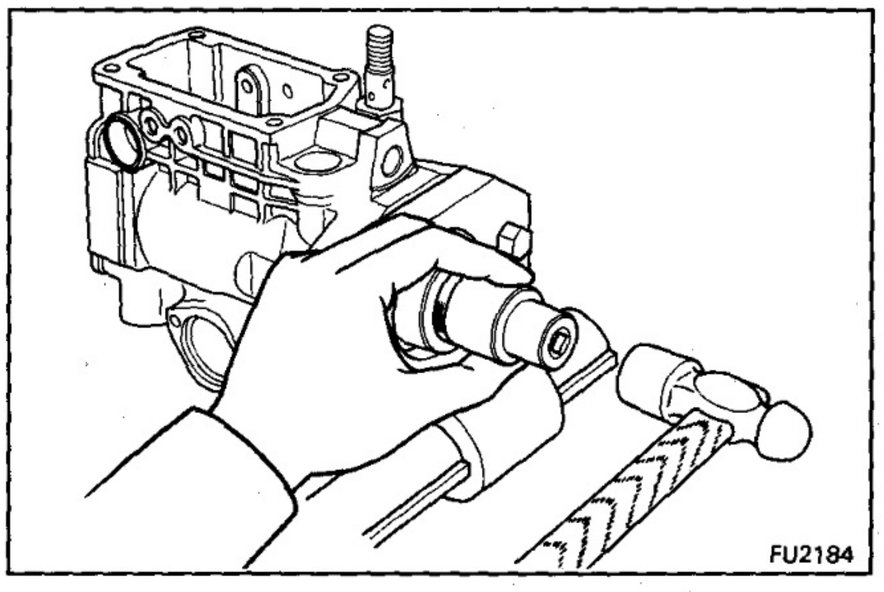
HINT:
- For a measurement between listed sizes, use the next larger size. Ex. If thickness is 1.1mm (0.043 in.) by calculation, use a 1.2 mm (0.047 in.) shim.
- Select two shims which have the same thickness.



10. IF NECESSARY, REPLACE OIL SEAL

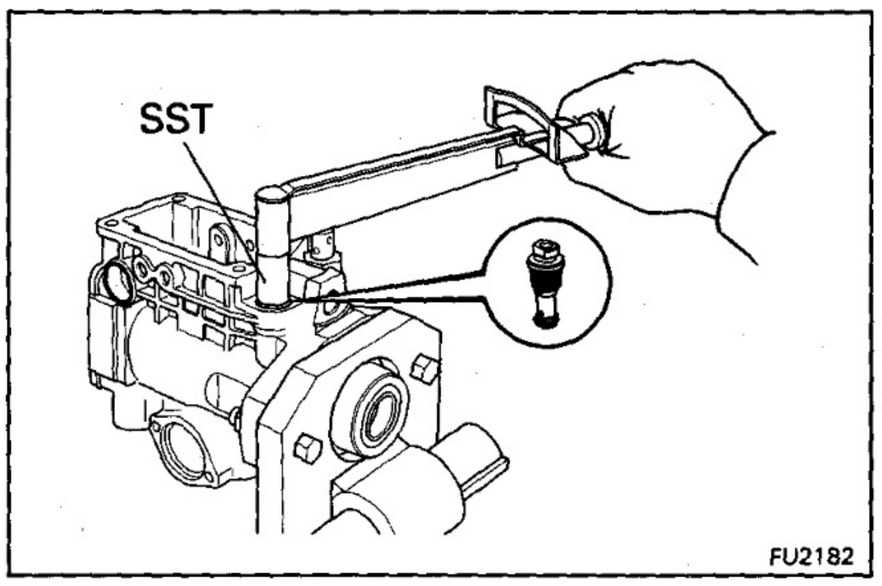
(a) Using a screwdriver, push out the oil seal.

NOTICE: Be careful not to damage to the pump body.



(b) Apply MP grease to the lip of a new oil seal.

(c) Using a socket wrench, drive in the oil seal until its surface is flush with the pump housing.



ASSEMBLY OF INJECTION PUMP

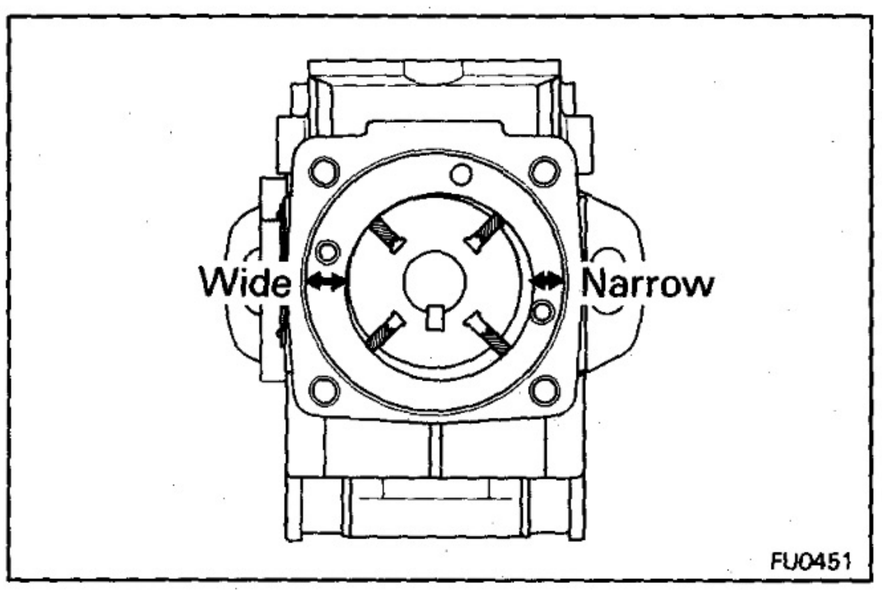
(See pages FU-22 and 23)

1. INSTALL REGULATOR VALVE

Using SST, install and torque the regulator valve.

SST 09260-54012 (09262-54020)

Torque: 90 kg-cm (78 in.-lb, 8.8 N·m)

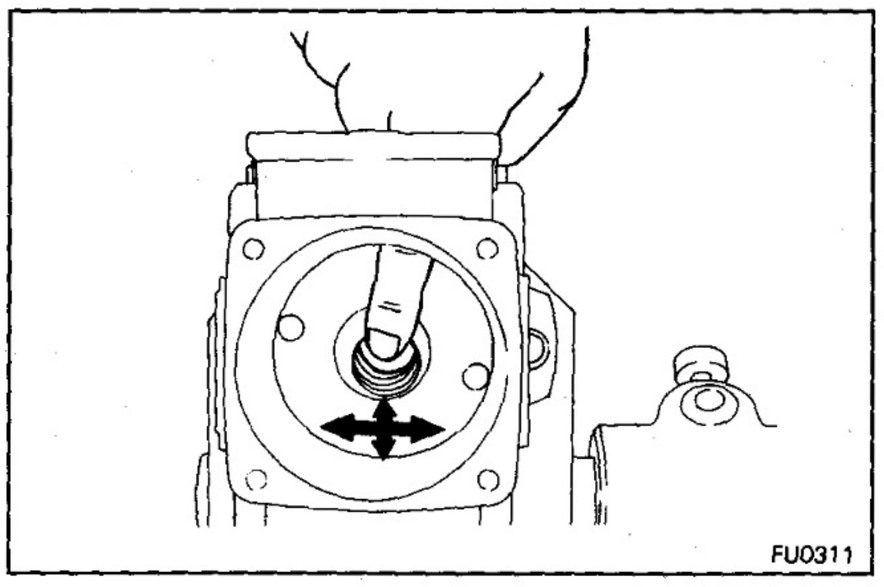


2. INSTALL FEED PUMP

(a) Install the liner, rotor and four blades.

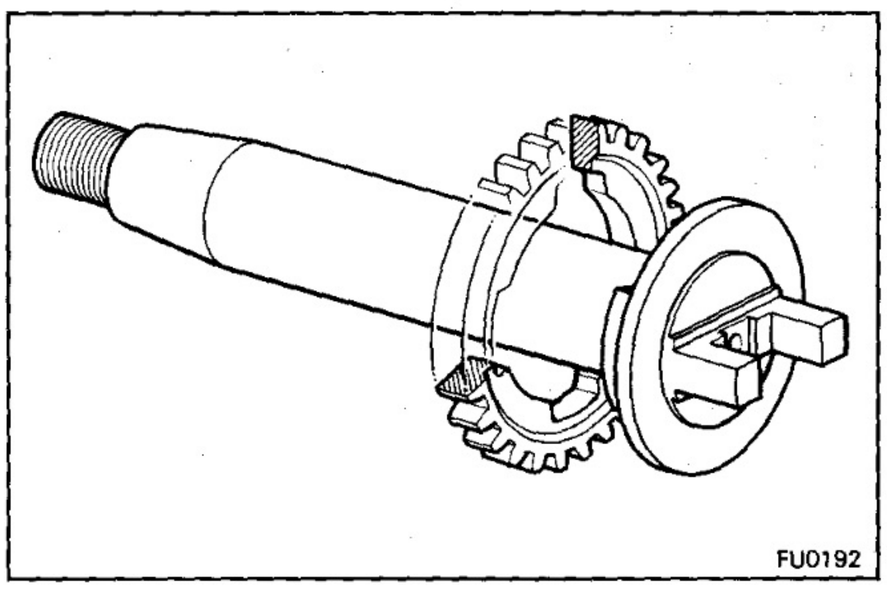
(b) Check that the liner and blades are facing in the correct direction, as shown.

(c) Check that the blades move smoothly.



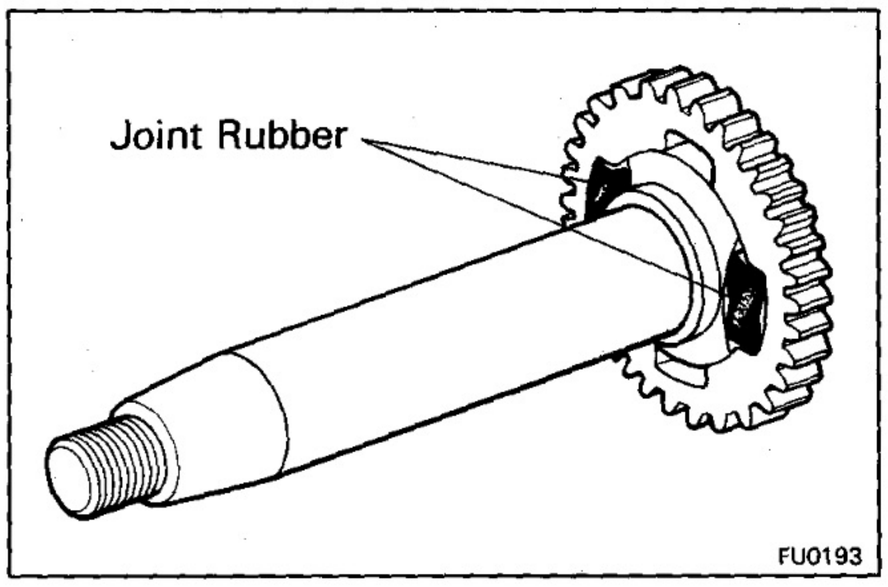
(d) Install the pump cover with the two screws and check that the rotor moves smoothly.

HINT: Check that the fuel outlet hole of the cover is aligned with the liner.


FU0192

3. INSTALL DRIVE SHAFT

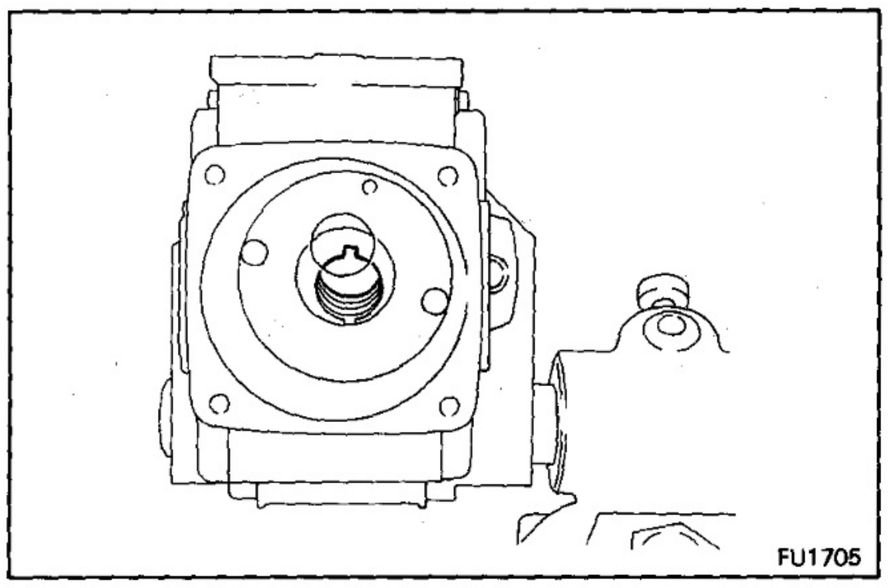
(a) Install the drive gear on the drive shaft as shown.



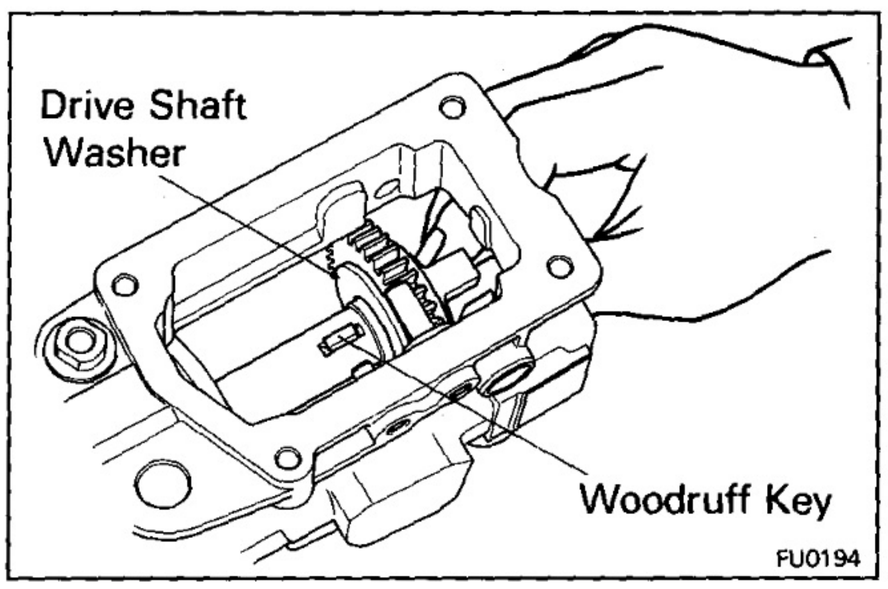
FU0193

(b) Install new two joint rubbers into the drive gear.

HINT: Replace the joint rubber when overhauling.

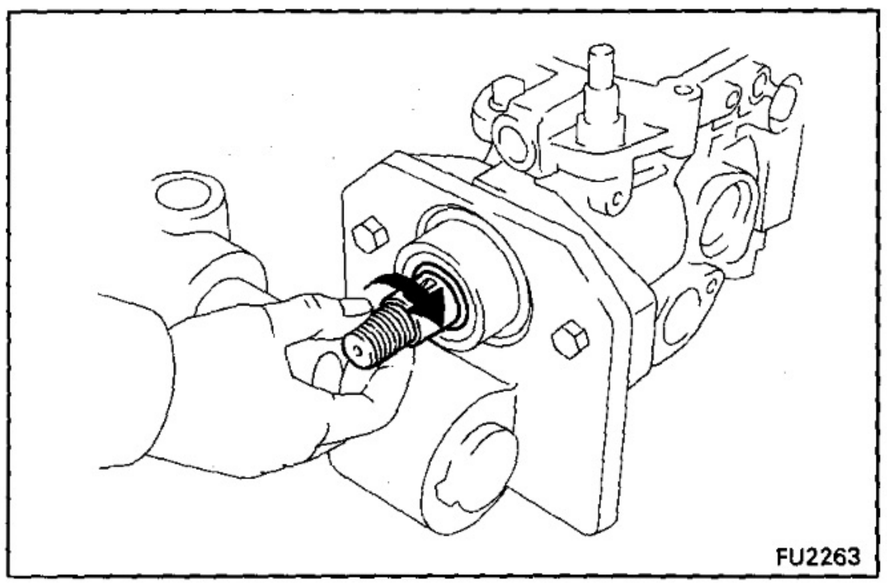

FU1705

(c) Position the notch of the feed pump rotor upward.

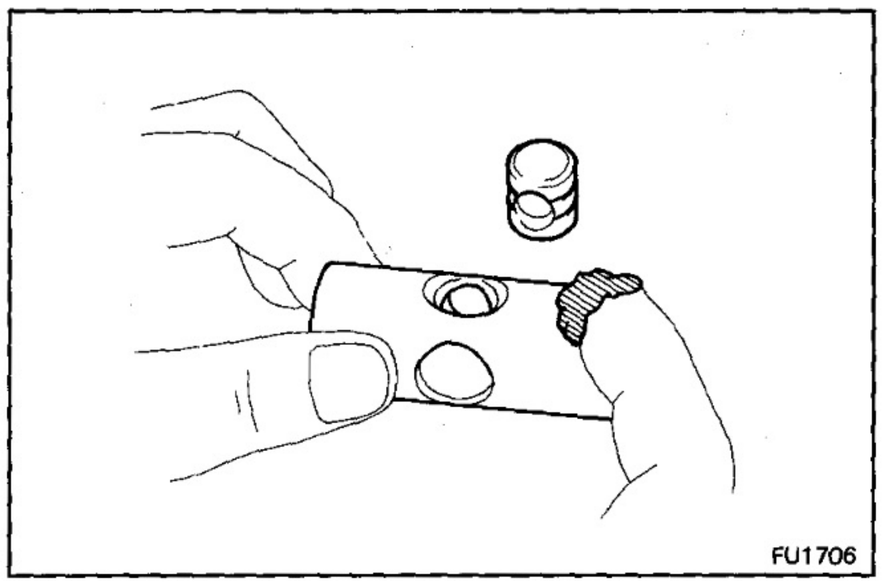


FU0194

(d) Install the woodruff key and drive shaft washer on the drive shaft and insert the drive shaft assembly into the pump housing.


FU2263

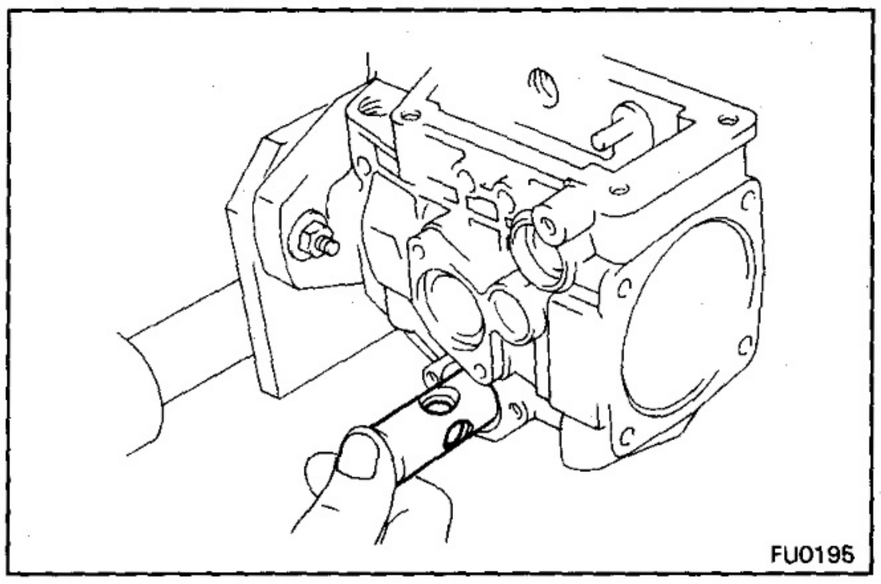
(e) Check that the drive shaft turns without catching.


FU1706

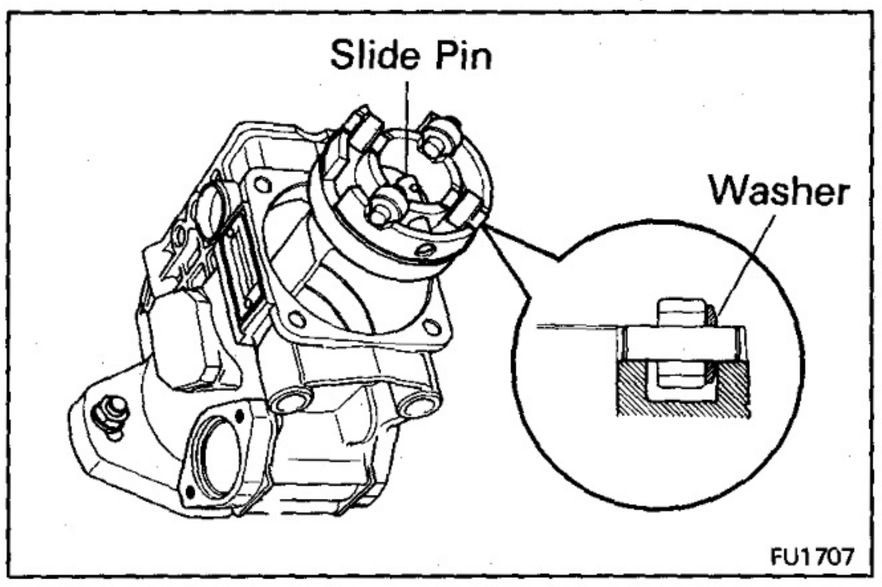
4. INSTALL TIMER PISTON

(a) Apply No. 50 Denso grease to the timer piston.

(b) Install the sub-piston in the timer piston.


FU0195

(c) Insert the timer piston into the pump housing.



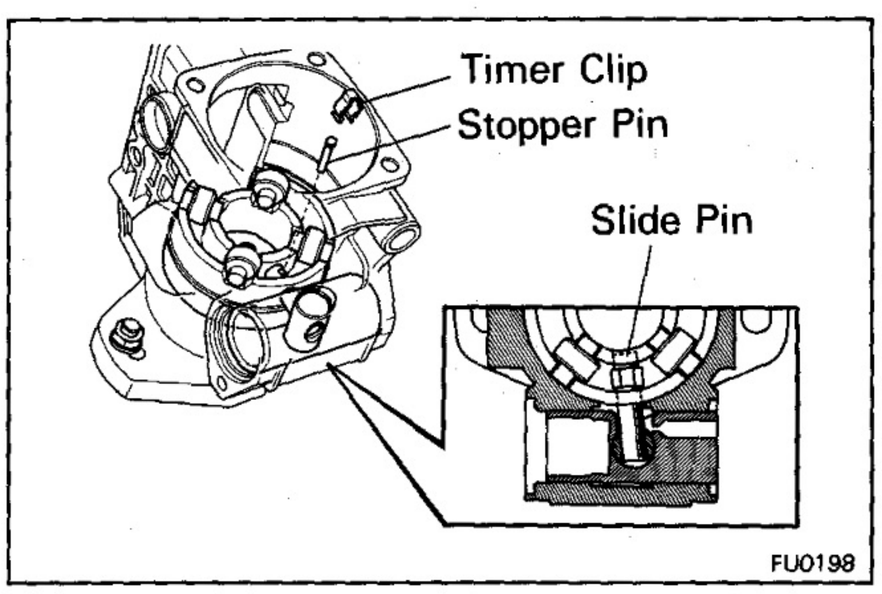
FU1707

5. INSTALL ROLLER RING

(a) Install the slide pin, four rollers and washers on the roller ring.

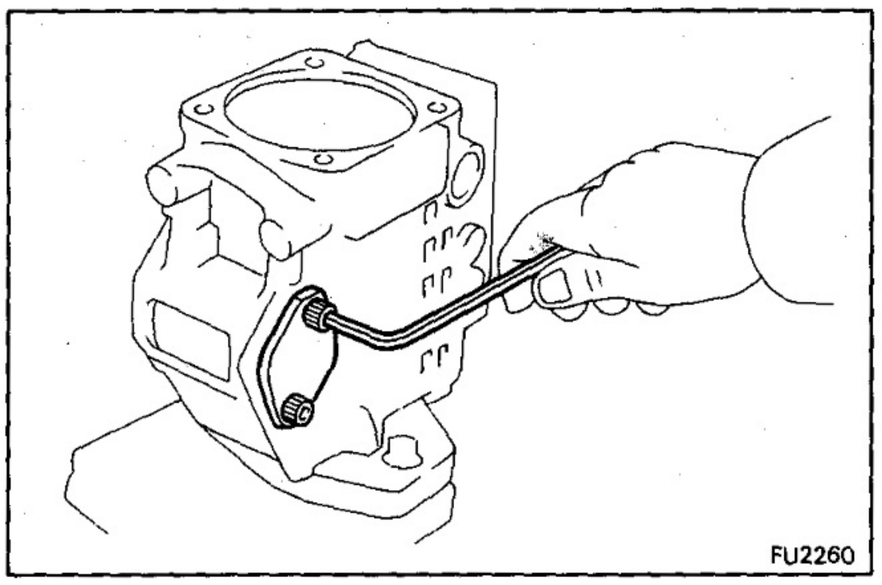
(b) Check that the roller is facing the flat surface of the washer.

(c) Install the roller ring in the pump housing.

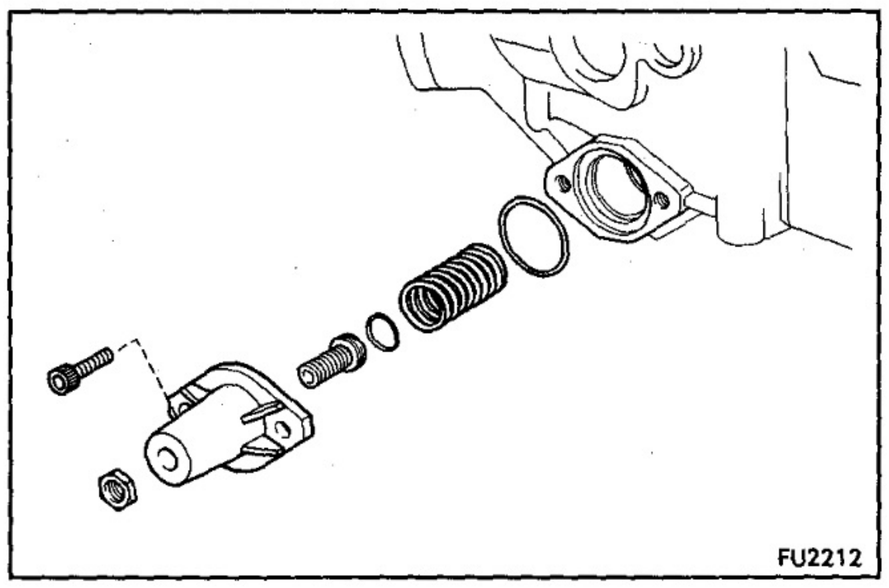


FU0198

(d) Carefully push down the slide pin and install the stopper pin and clip.

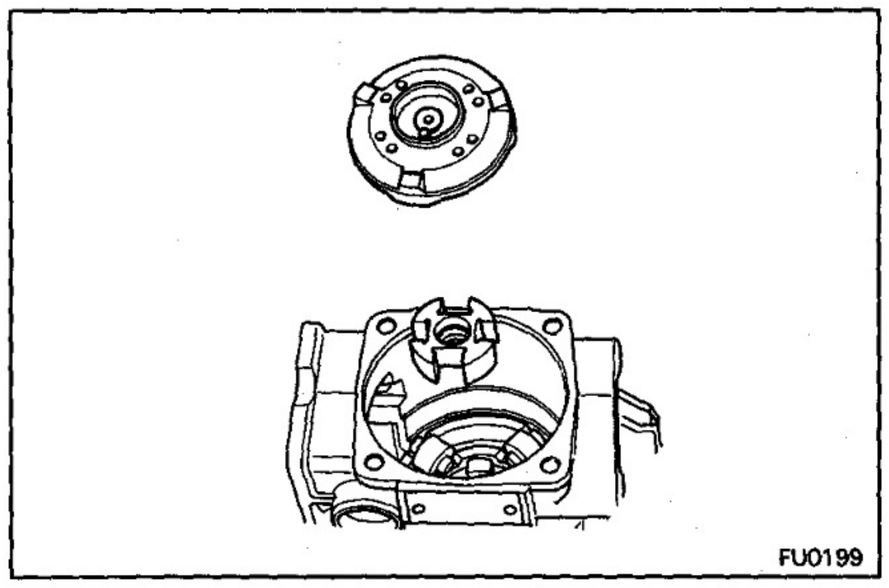

FU2260

(e) Install a new O-ring and the flat timer cover with the two bolts.



(f) Install a new O-ring and the timer adjusting screw.

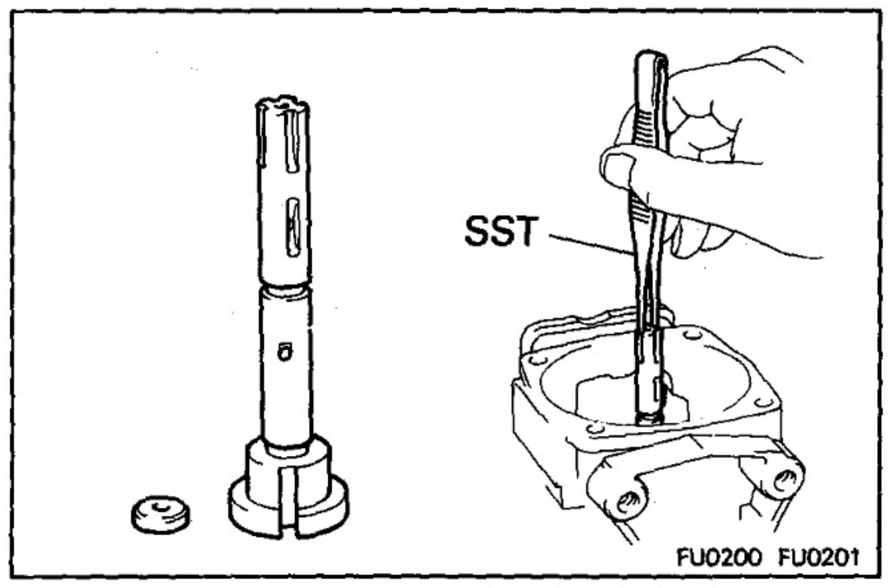
(g) Install a new O-ring, the spring and other timer cover, two bolts and adjusting screw lock nut.



6. ADJUST PLUNGER ADJUSTING SHIM

(a) Install the coupling and camplate.

HINT: Do not assemble the coupling spring.

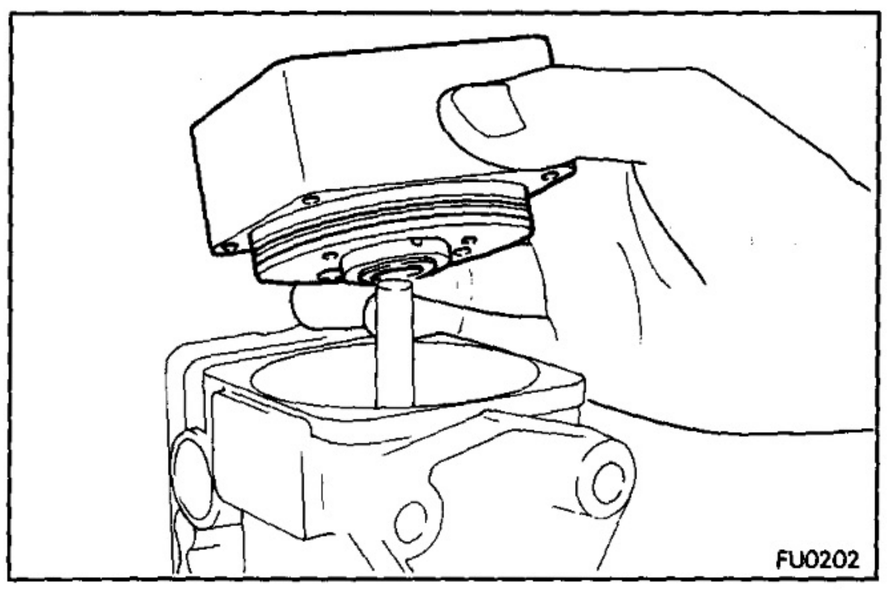


(b) Clean the adjusting shim and contacting surface area.

(c) Using SST, install the used adjusting shim and pump plunger.

SST 09260-54012 (09269-54030)

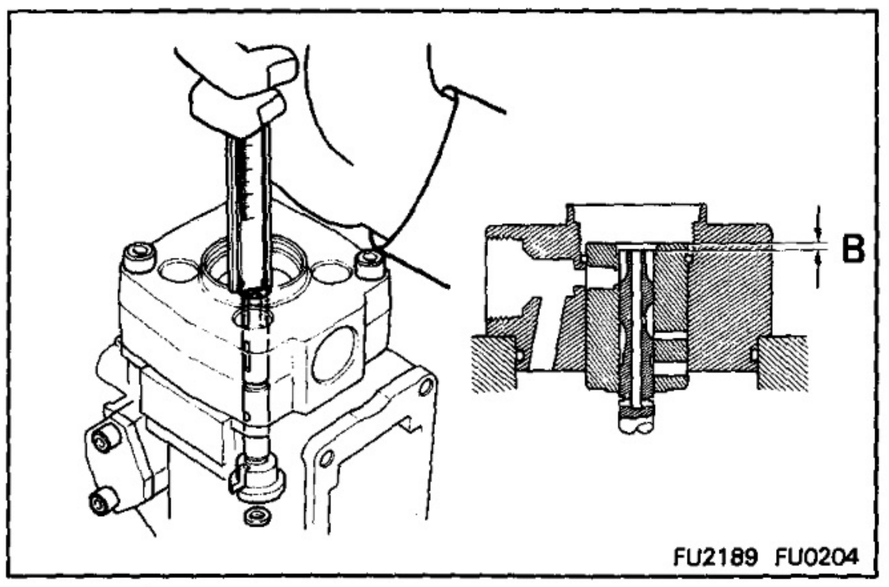
(d) Check that the notch on the pump plunger is aligned with the camplate pin.



(e) Install the distributive head with the four bolts. Torque the bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)

NOTICE: Be careful not to damage the pump plunger.



(f) Using calipers, measure clearance B indicated in the figure.

(g) Determine the shim size by using the following formula and chart.

New shim thickness = T + (B − 3.3)

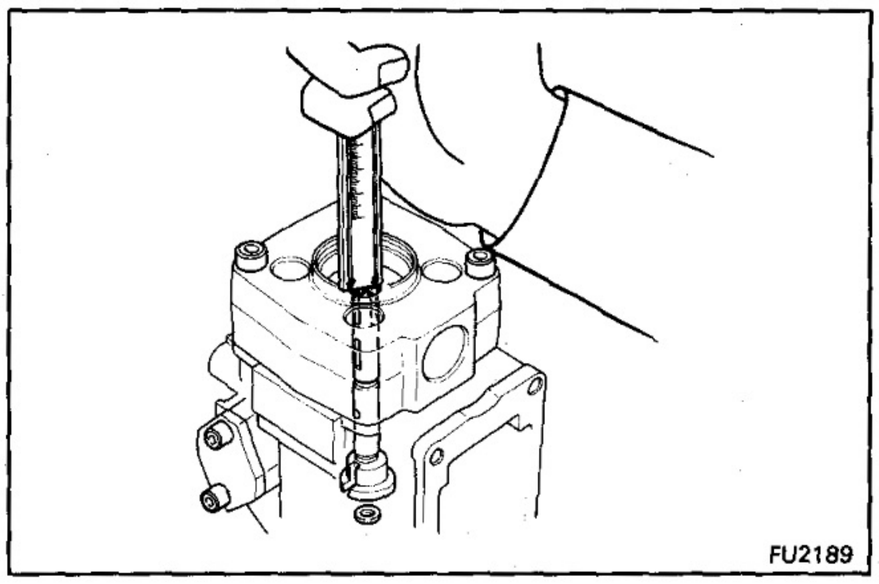
T . . . Thickness of shim used
B . . . Plunger position measured

Shim selection chart

Installed shim (mm) \ Measured clearance (mm)	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2 — 3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4
1.9											2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9
2.0									1.9		2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9	
2.1								1.9	1.9		2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.9		
2.2							1.9	1.9	2.0		2.4	2.5	2.6	2.7	2.8	2.9	2.9			
2.3						1.9	1.9	2.0	2.1		2.5	2.6	2.7	2.8	2.9	2.9				
2.4					1.9	1.9	2.0	2.1	2.2		2.6	2.7	2.8	2.9	2.9					
2.5				1.9	1.9	2.0	2.1	2.2	2.3		2.7	2.8	2.9	2.9						
2.6			1.9	1.9	2.0	2.1	2.2	2.3	2.4		2.8	2.9	2.9							
2.7		1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5		2.9	2.9								
2.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6		2.9									
2.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7											

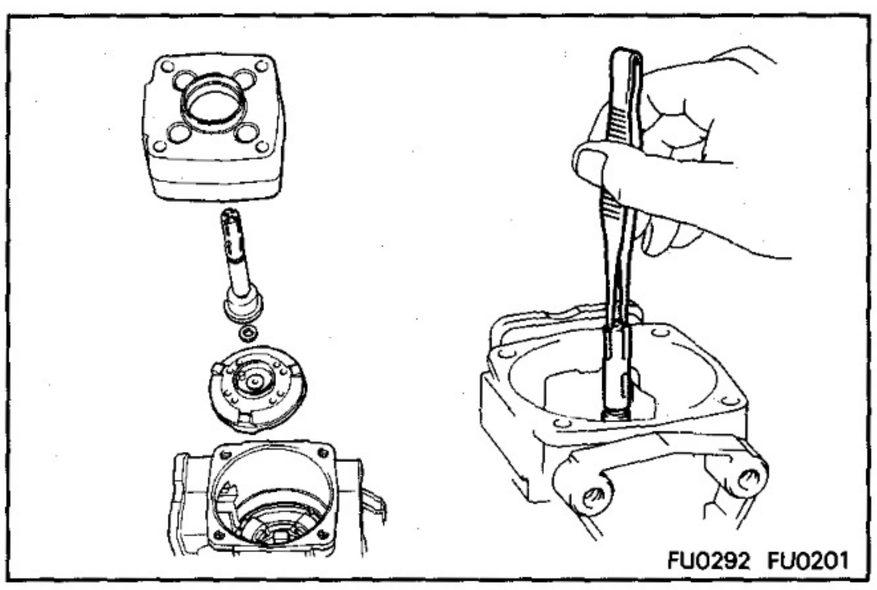
Example: 2.5 mm (0.098 in.) shim installed. Measured clearance is 3.0 mm (0.118 in.).
Replace with 2.2 mm (0.087 in.) shim.

Plunger adjusting shim thickness mm (in.)	1.9 (0.075)	2.0 (0.079)	2.1 (0.083)	2.2 (0.087)	2.3 (0.091)	2.4 (0.094)	2.5 (0.098)	2.6 (0.102)	2.7 (0.106)	2.8 (0.110)	2.9 (0.114)


FU2189

(h) Install a new shim and recheck clearance B.

B: 3.3 ± 0.1 mm (0.130 ± 0.0039 in.)


FU0292 FU0201

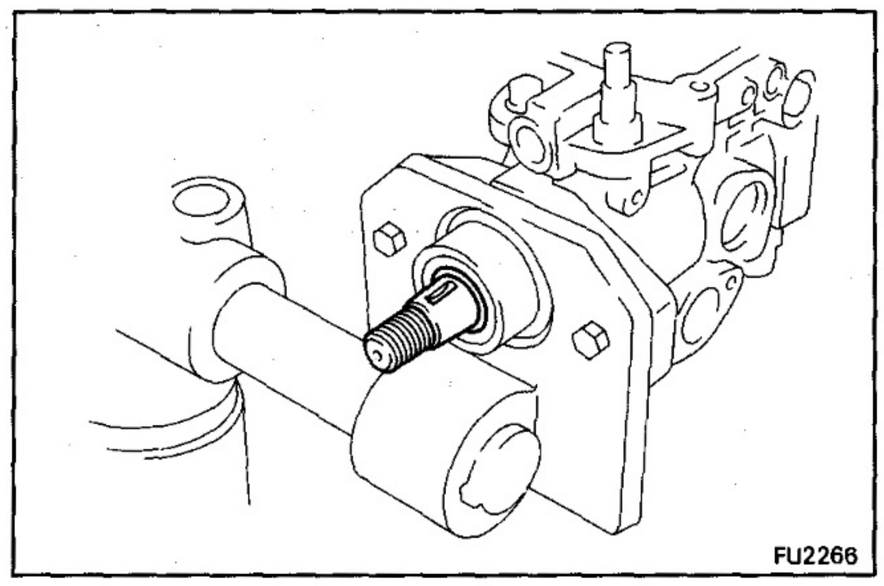
(i) Remove the distributive head and the following parts with SST:

(1) Pump plunger

(2) Plunger adjusting shim

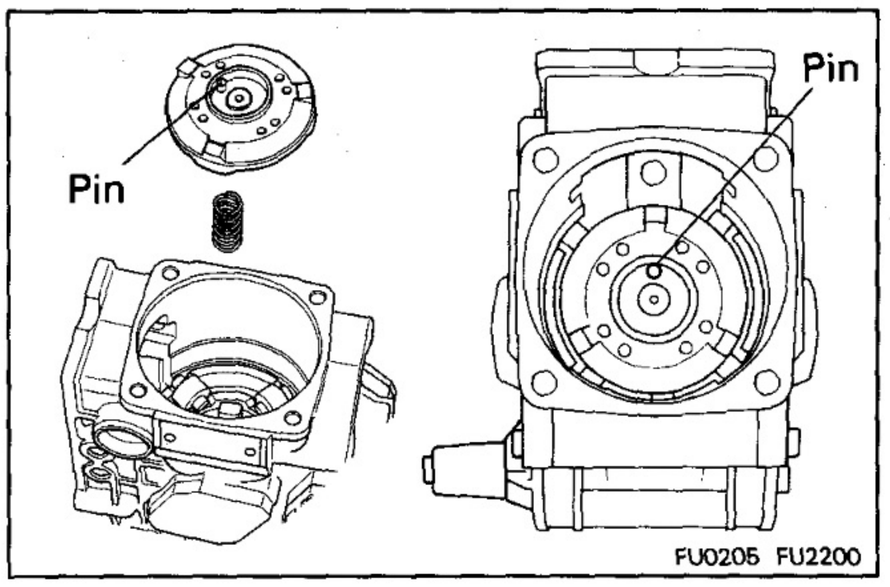
(3) Camplate

SST 09260-54012 (09269-54030)

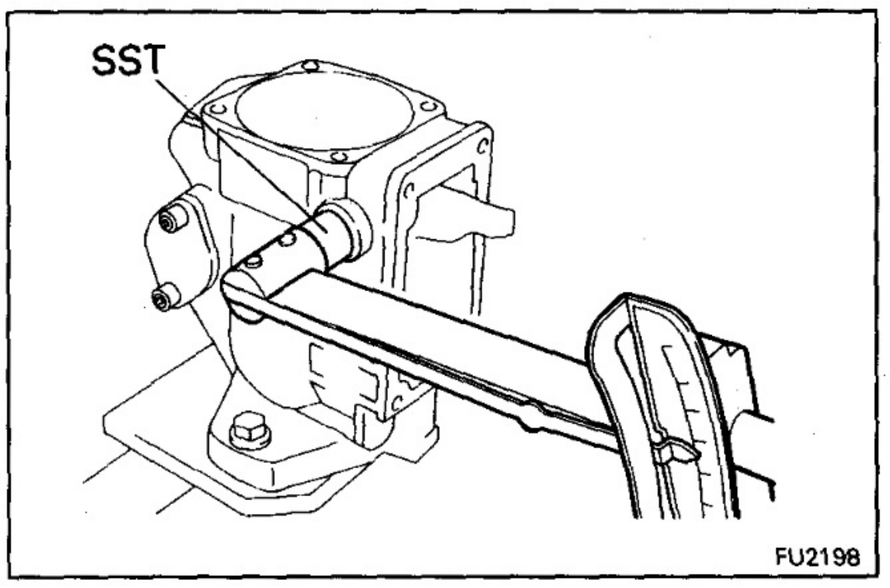

FU2266

7. INSTALL CAMPLATE

(a) Face the key groove of the drive shaft upward.



(b) Install the coupling spring and camplate with the complate pin facing toward the governor cover side.



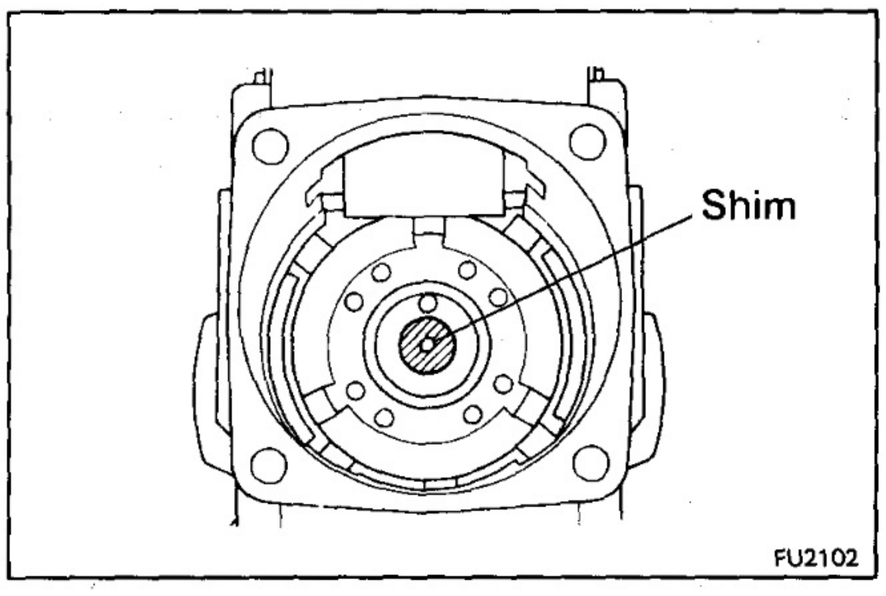
8. INSTALL GOVERNOR LINK

(a) Using SST, install the governor link with the two support bolts and gaskets. Torque the bolts.

Torque: 115 kg-cm (8 ft-lb, 11 N·m)

SST 09260-54012 (09269-54040)

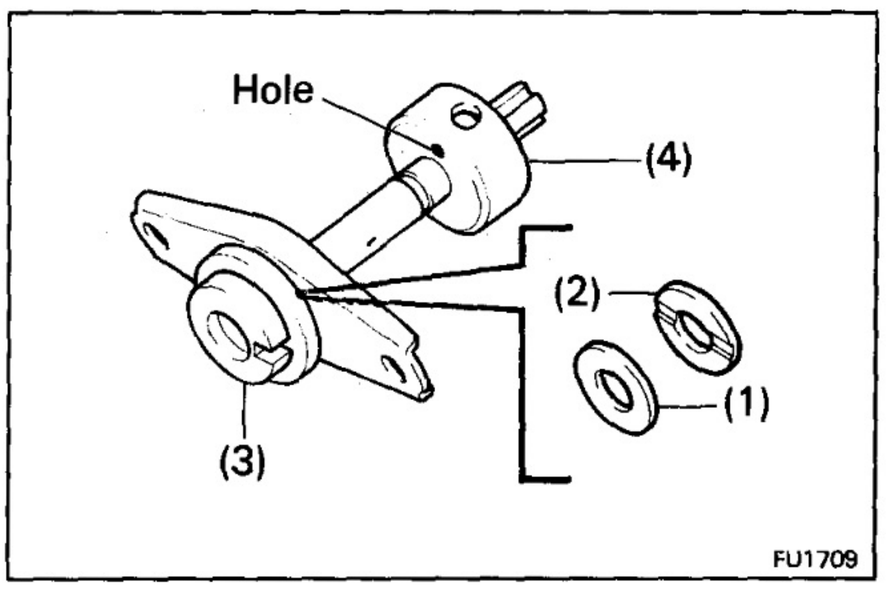
(b) Check that the governor link moves smoothly after assembly.



9. INSTALL PUMP PLUNGER

(a) Place the selected plunger adjusting shim on the center of the camplate.

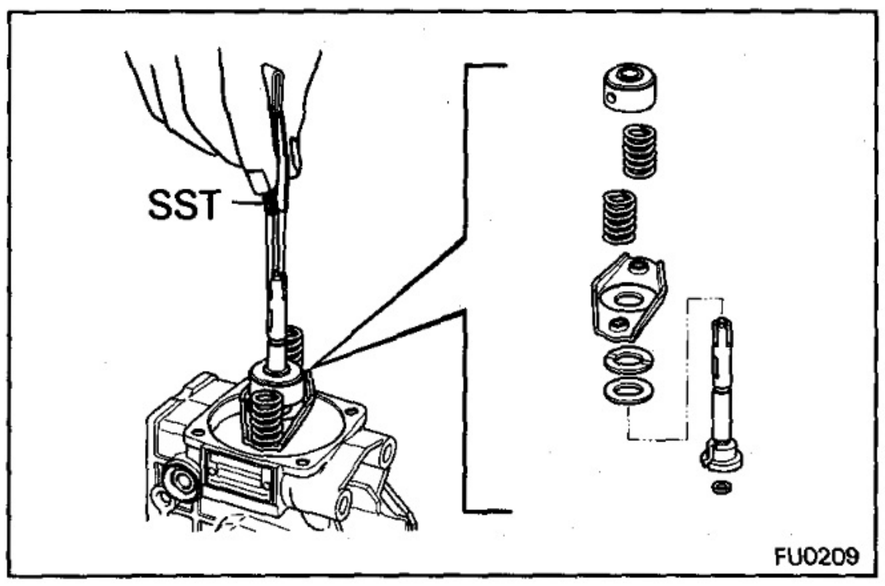
HINT: Do not apply grease to the shim.



(b) Install the following parts to the pump plunger:

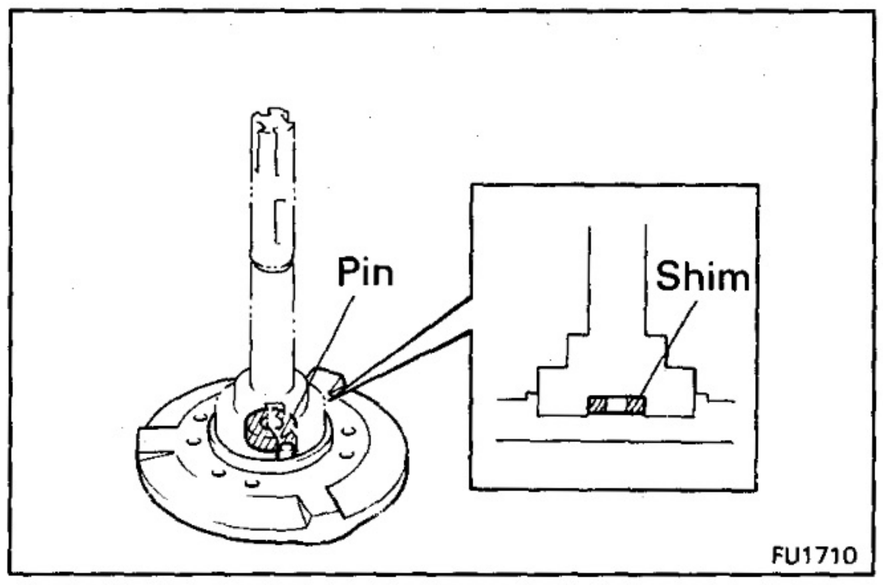
(1) Lower plunger plate
(2) Upper plunger plate
(3) Lower spring seat
(4) Spill ring

HINT: Face the spill ring with the hole side toward the lower seat.



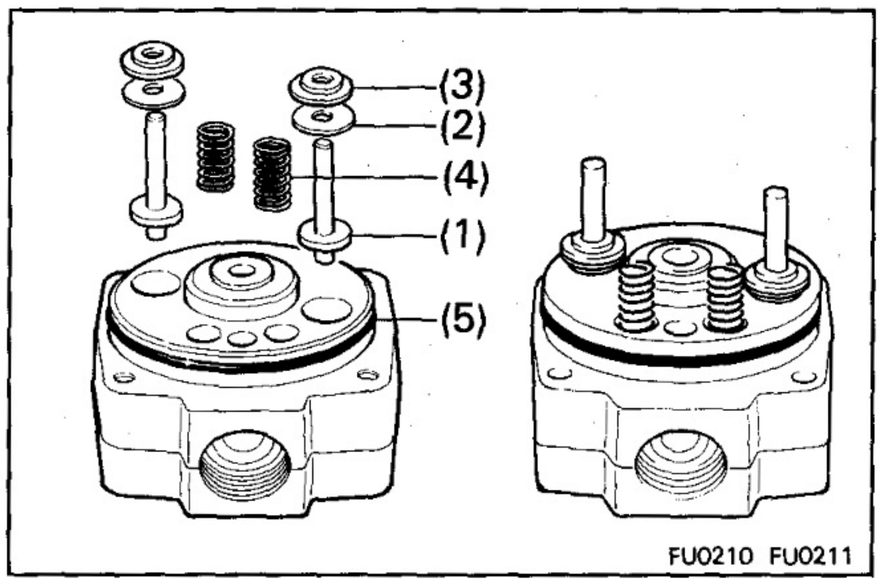
(c) Using SST, install the pump plunger and plunger springs.

SST 09260-54012 (09269-54030)



(d) Check that the cam plate pin and plunger notch are aligned.

(e) Check that the spill ring hole and governor link ball pin are aligned.



10. INSTALL DISTRIBUTIVE HEAD

(a) Apply No. 50 Denso grease to the following parts and install them to the distributive head:

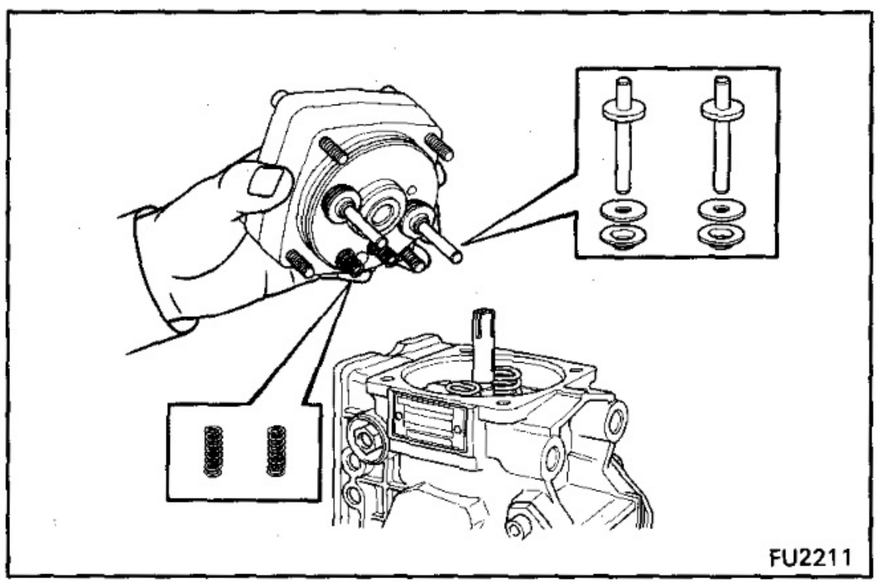
(1) Plunger spring guides

(2) Plunger spring shims

(3) Upper spring seats

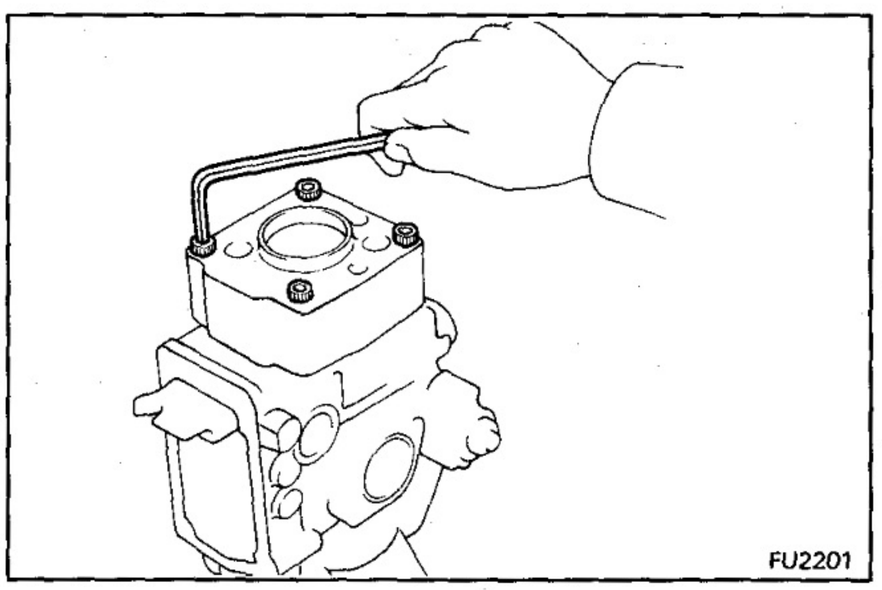
(4) Lever support springs

(5) New O-ring



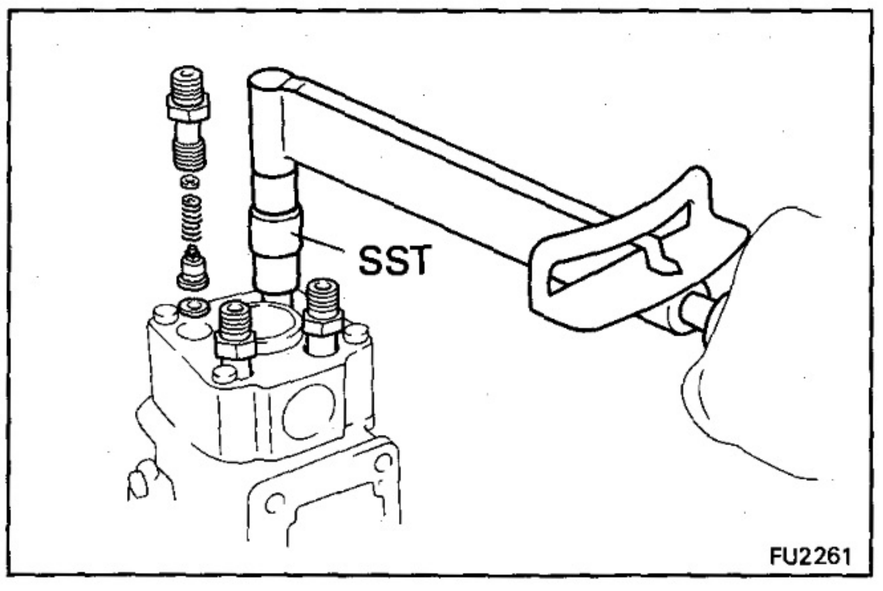
(b) Install the distributive head.

NOTICE: Be careful not to damage the pump plunger.



(c) Install and torque the four bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)



11. INSTALL FOUR DELIVERY VALCE HOLDERS

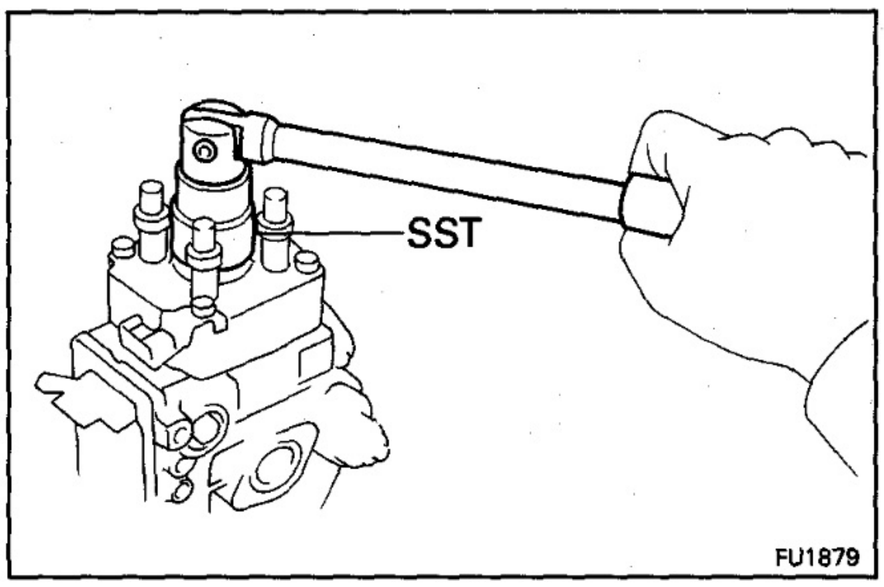
(a) Install four new gaskets and the valves into the distributive head.

(b) Install the spring seats and springs into the delivery valve holders.

(c) Using SST, install and torque the delivery valve holders.

SST 09260-54012 (09269-54020)

Torque: 550 kg-cm (40 ft-lb, 54 N·m)



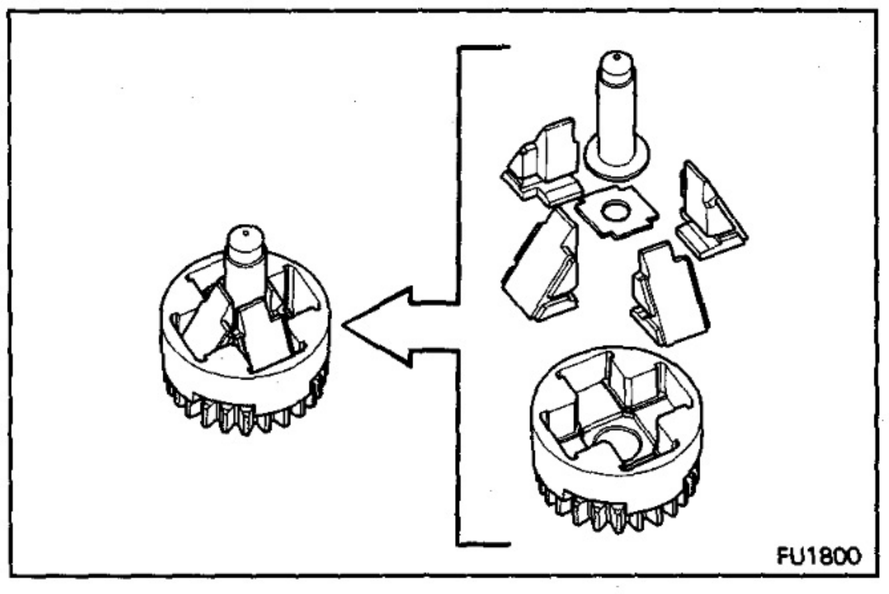
12. INSTALL DISTRIBUTIVE HEAD PLUG

(a) Install a new O-ring on the head plug.

(b) Using SST, install and torque the head plug.

SST 09260-54012 (09262-54010)

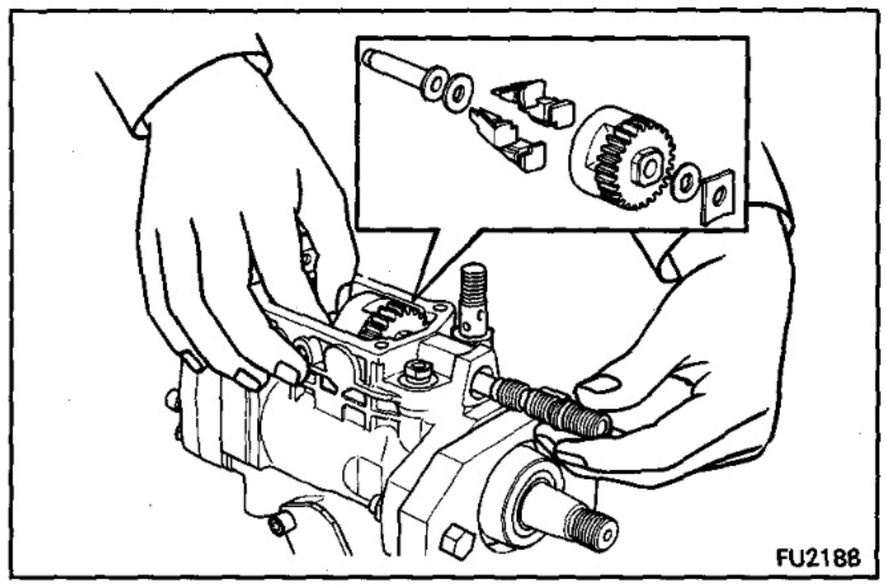
Torque: 700 kg-cm (51 ft-lb, 69 N·m)



13. INSTALL GOVERNOR SHAFT AND FLYWEIGHT HOLDER ASSEMBLY

(a) Install the four flyweights, flyweight washer and governor sleeve on the flyweight holder.

HINT: Replace the four flyweights as a set.



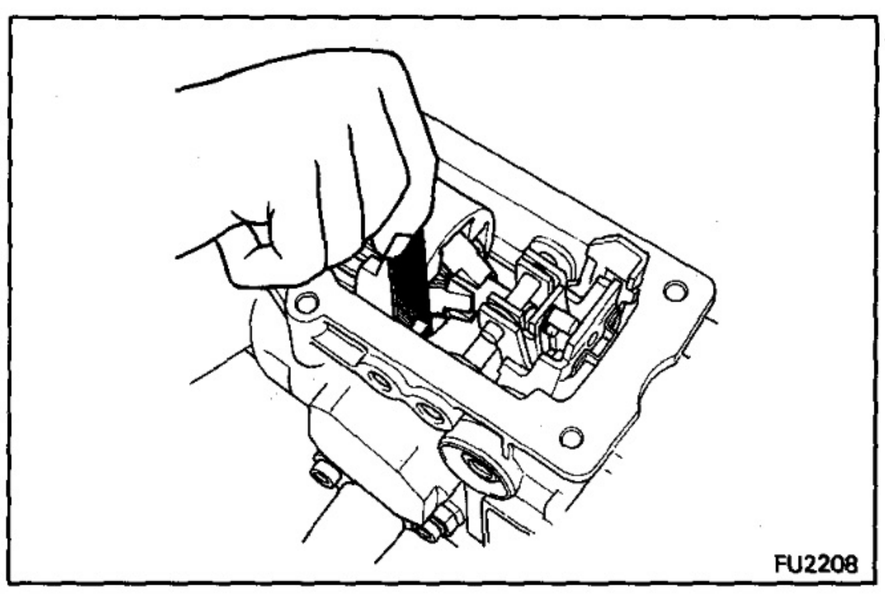
(b) Install a new O-ring to the governor shaft.

(c) Put the flyweight holder subassembly, flyweight washer and adjusting washer into the pump housing.

(d) Install the governor shaft through the adjusting washer, flyweight washer and flyweight holder subassembly.

(e) Turn the governor shaft counterclockwise with an allen wrench.

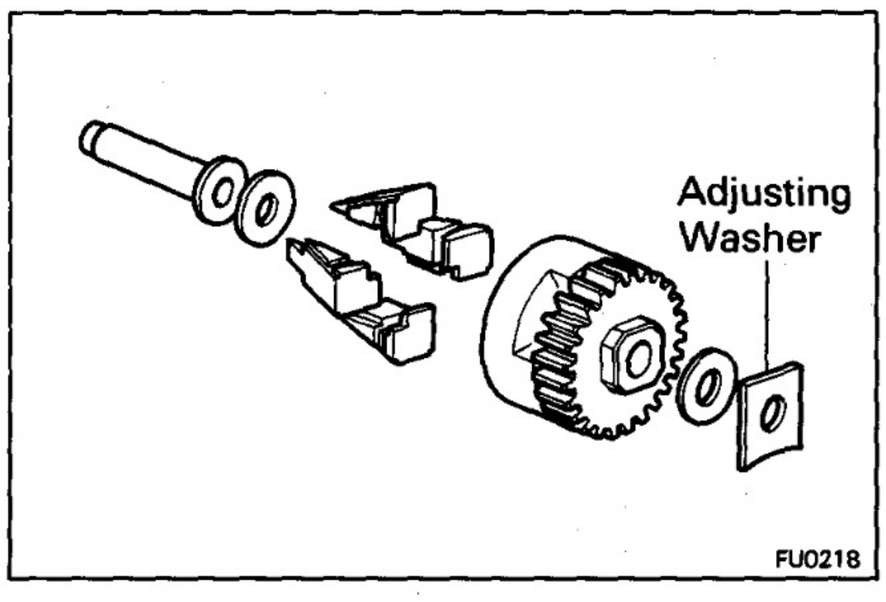
HINT: The governor shaft has LH threads.



14. CHECK FLYWEIGHT HOLDER THRUST CLEARANCE

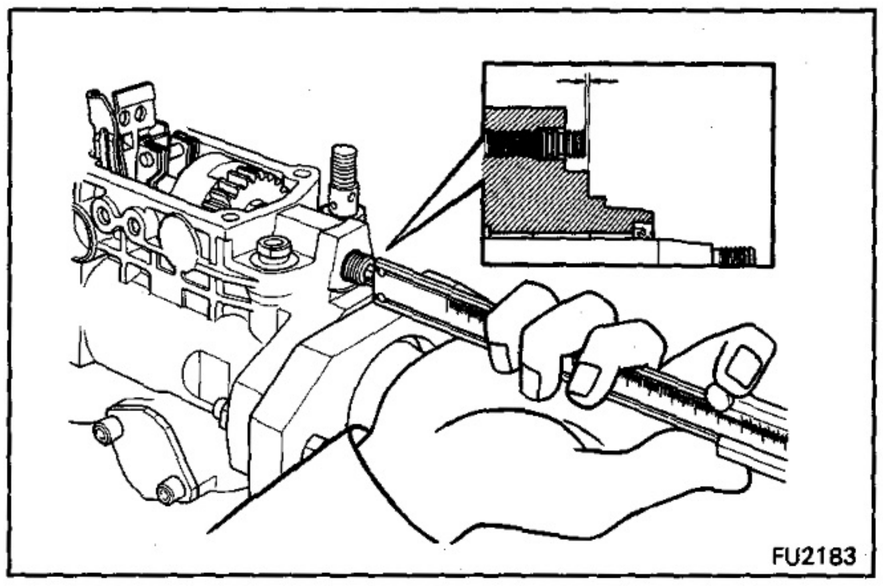
Using a feeler gauge, measure the flyweight holder thrust clearance.

Thrust clearance: 0.15 — 0.35 mm (0.0059 — 0.0138 in.)



If the thrust clearance is not within specification, adjust with an governor gear adjusting washer.

Governor gear adjusting washer thickness mm (in.)	
1.05 (0.0413) 1.25 (0.0492) 1.45 (0.0571)	1.65 (0.0650) 1.85 (0.0728)



15. ADJUST PROTRUSION OF GOVERNOR SHAFT

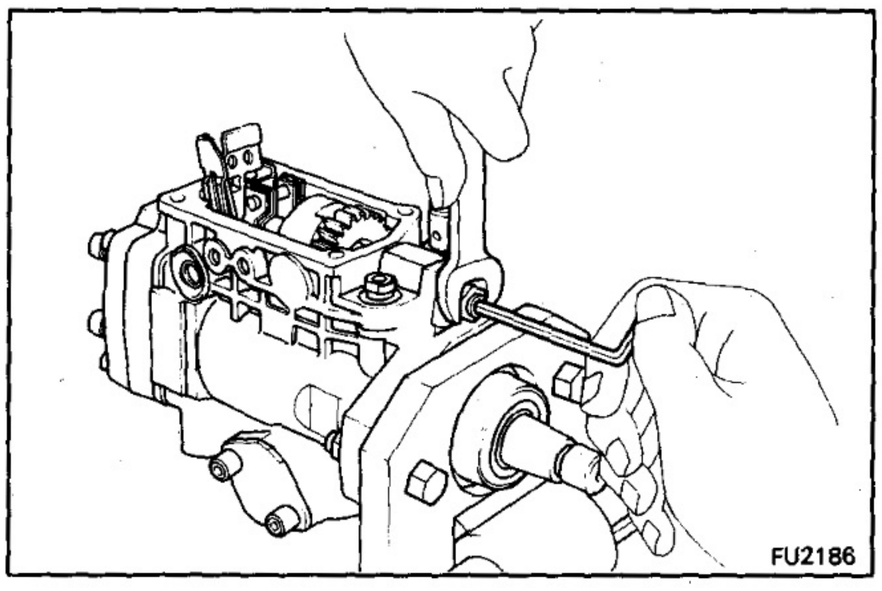
(a) Using calipers, measure the protrusion of the governor shaft.

Protrusion: 0.5 — 2.0 mm (0.02 — 0.079 in.)

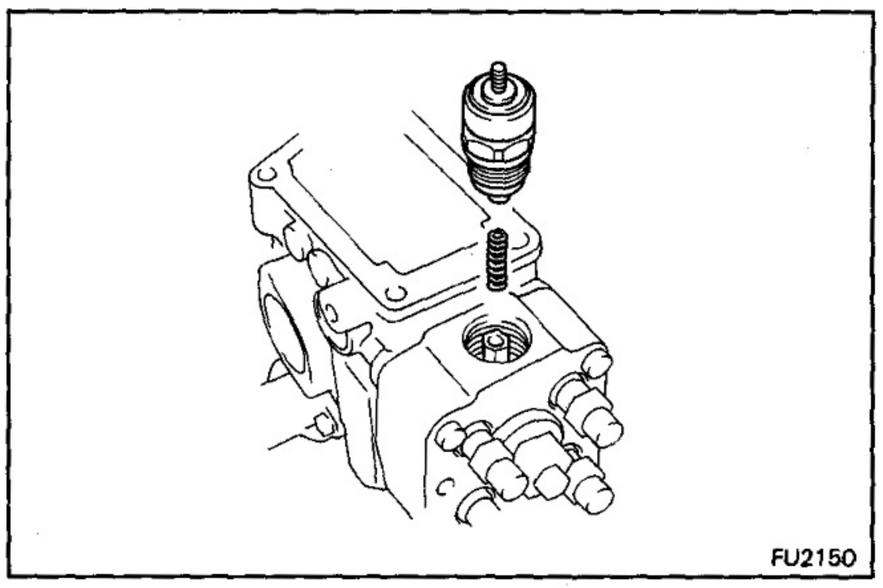
If the protrusion is not within specification, adjust by turning the governor shaft with an allen wrench.

HINT: The governor shaft has LH threads.

(b) Install and torque the lock nut while holding the governor shaft with an allen wrench.



16. INSTALL PICKUP SENSOR



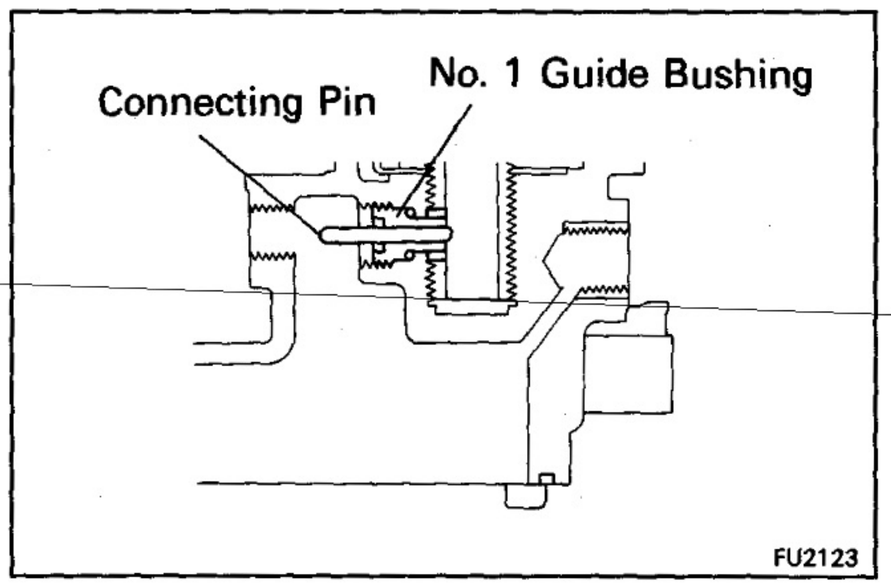
17. INSTALL FUEL CUT SOLENOID

(a) Install a new O-ring on the fuel cut solenoid.

(b) Insert the valve and spring to the distributive head.

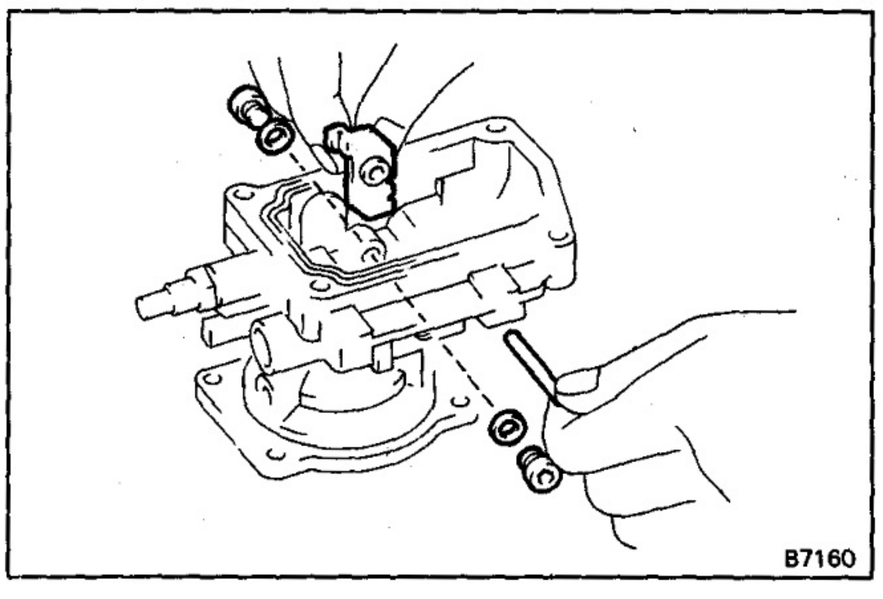
(c) Install the fuel cut solenoid.

(d) Connect the lead wire to the fule cut solenoid.



18. [w/ HAC] INSTALL CONNECTING PIN TO GOVERNOR COVER

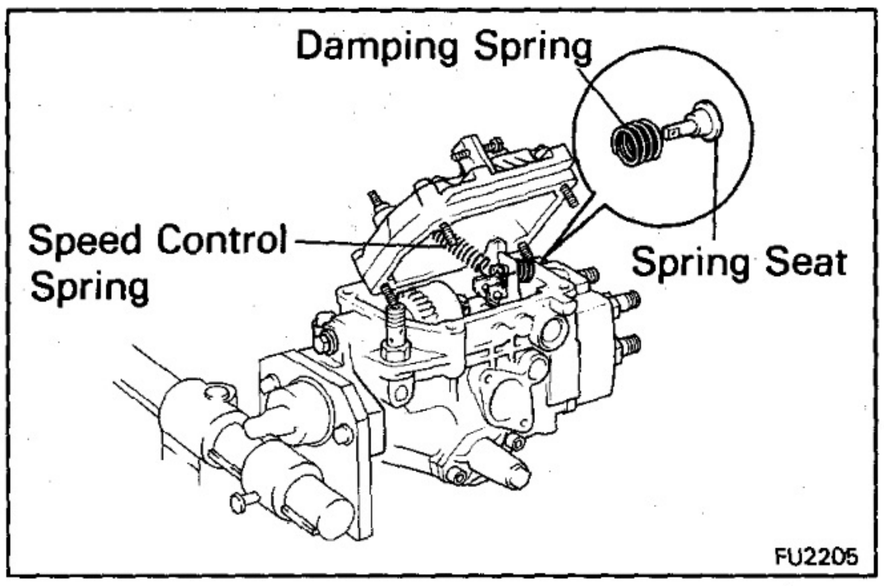
Insert the connecting pin into the No. 1 guide bushing.



19. [w/ HAC] INSTALL CONTROL LEVER TO GOVERNOR COVER

(a) Install the control lever and support pin.

(b) Using an allen wrench, install the two bolts with the gaskets.



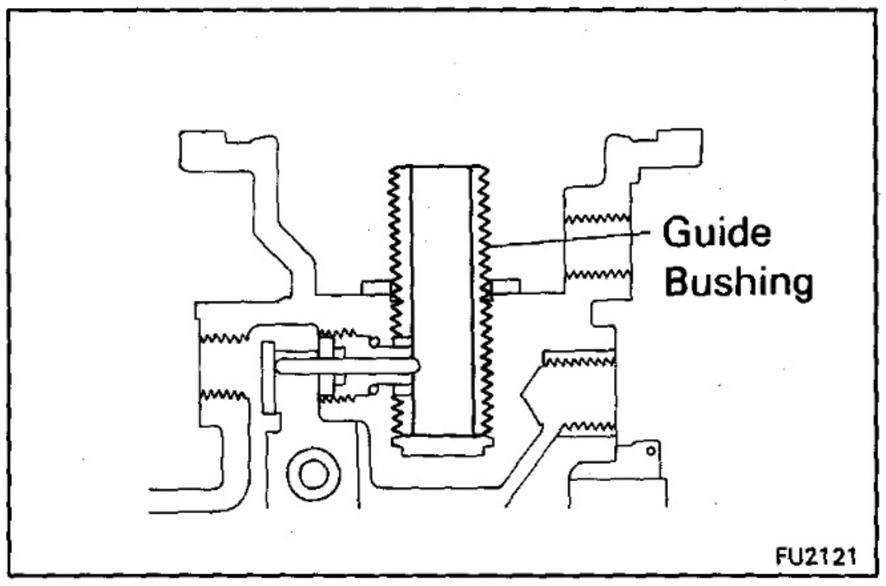
20. INSTALL GOVERNOR COVER

(a) Install a new gasket into the groove of the governor cover.

(b) Install the damper spring and spring seat, and connect them with the control spring.

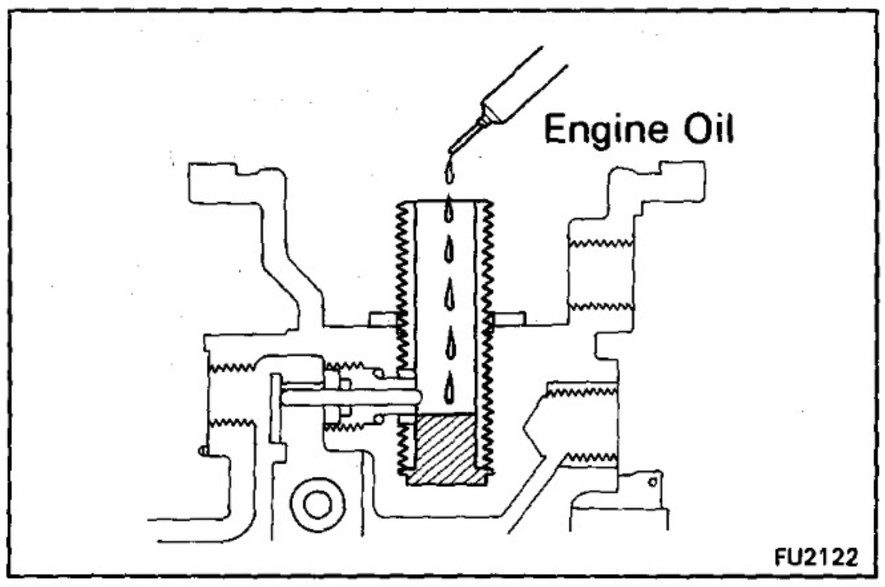
(c) Using an allen wrench, install the four bolts.

21. [11B and 14B]
INSTALL DASH POT



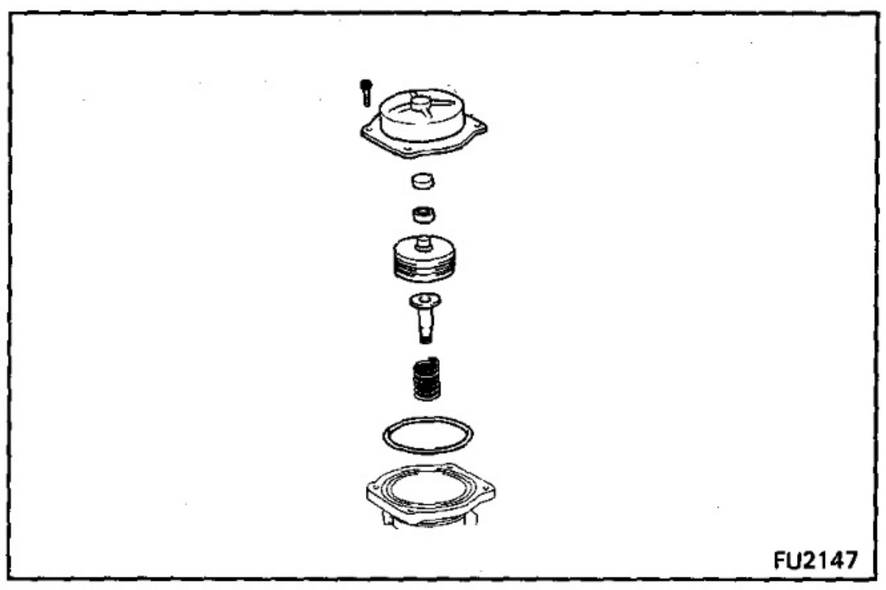
22. [w/ HAC]
INSTALL GUIDE BUSHING

Install and adjust the guide bushing as shown.



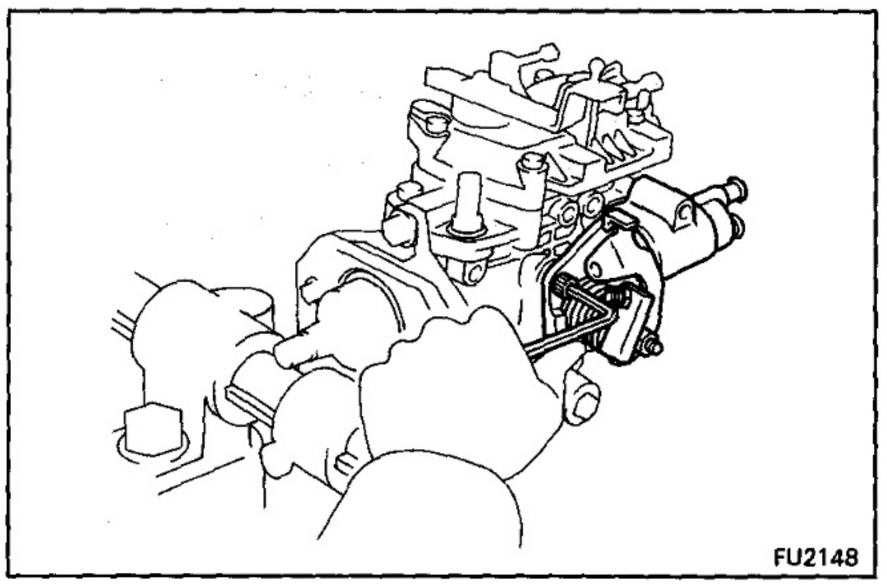
23. [w/ HAC]
INSTALL PNEUMATIC BELLOWS

(a) Insert 3 — 4 cc (0.18 — 0.24 cu in.) of engine oil into the guide bushing.



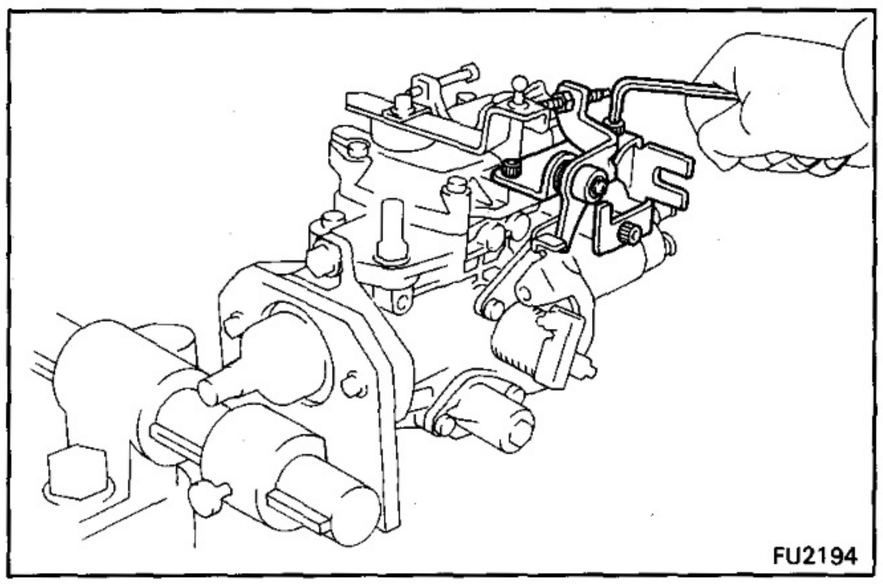
(b) Install the spring, push rod, bellows and cap.

(c) Install the pneumatic bellows cover.



24. [w/ ACSD]
INSTALL THERMO WAX

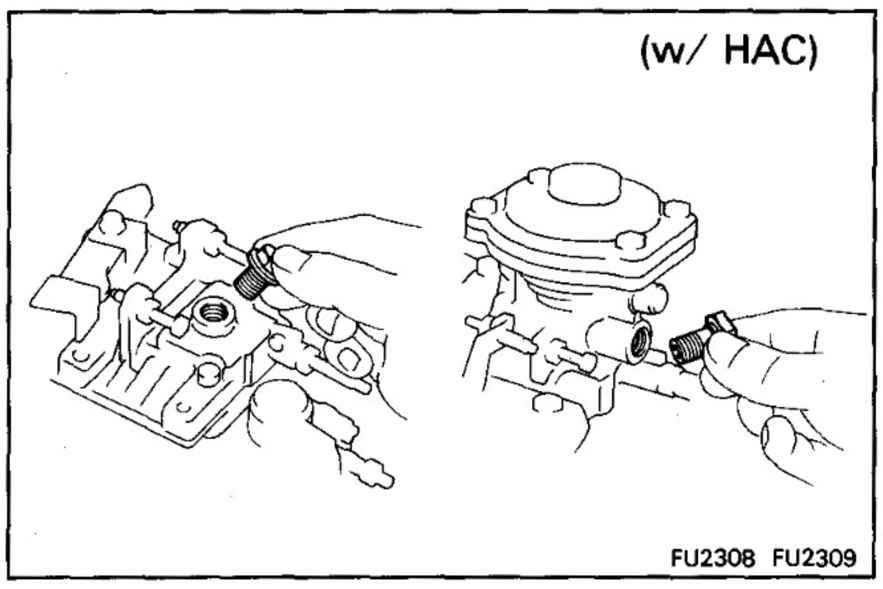
Install a new O-ring and thermo wax with two bolts.


FU2194

25. [w/ ACSD]
INSTALL IDLE-UP

Install the idle-up with three bolts.

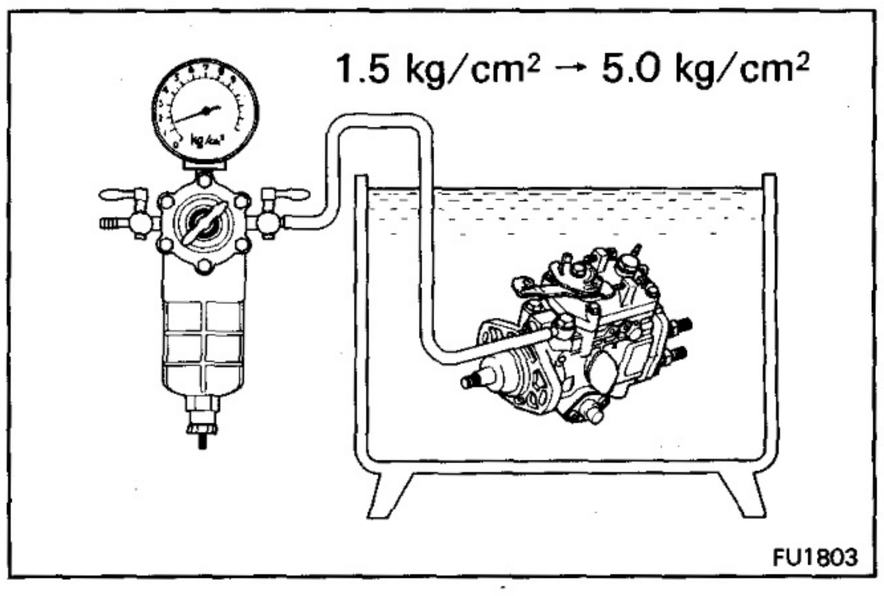
26. REMOVE INJECTION PUMP FROM STAND



FU2308 FU2309

27. PERFORM AIR TIGHT TEST

(a) Replace the overflow screw with a bolt.



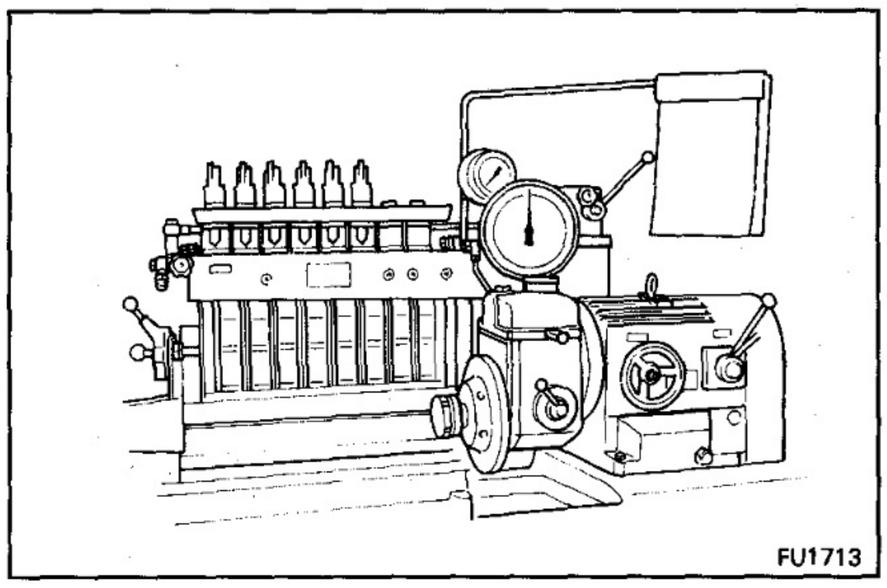
FU1803

(b) Connect an air hose to the fuel inlet hole and submerge the injection pump in diesel fuel.

(c) Apply 1.5 kg/cm² (21 psi, 147 kPa) of pressure and confirm that there are no leaks.

(d) Next check that there are no leaks with 5.0 kg/cm² (71 psi, 490 kPa) of pressure applied.

28. INSTALL WOODRUFF KEY ON DRIVE SHAFT

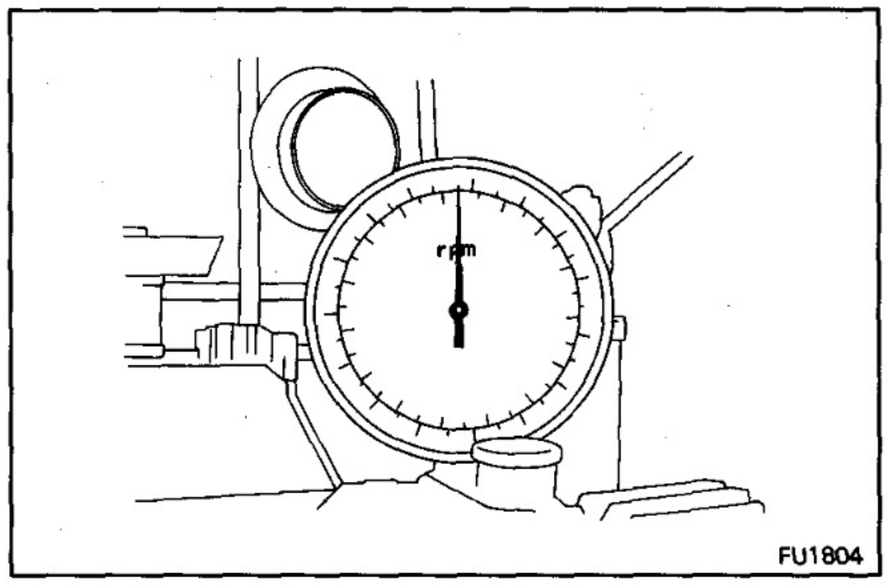

FU1713

ADJUSTMENT OF INJECTION PUMP

1. PRE-TEST CHECK AND PREPARATION

(a) The specifications for test nozzle and nozzle holders are as follows.

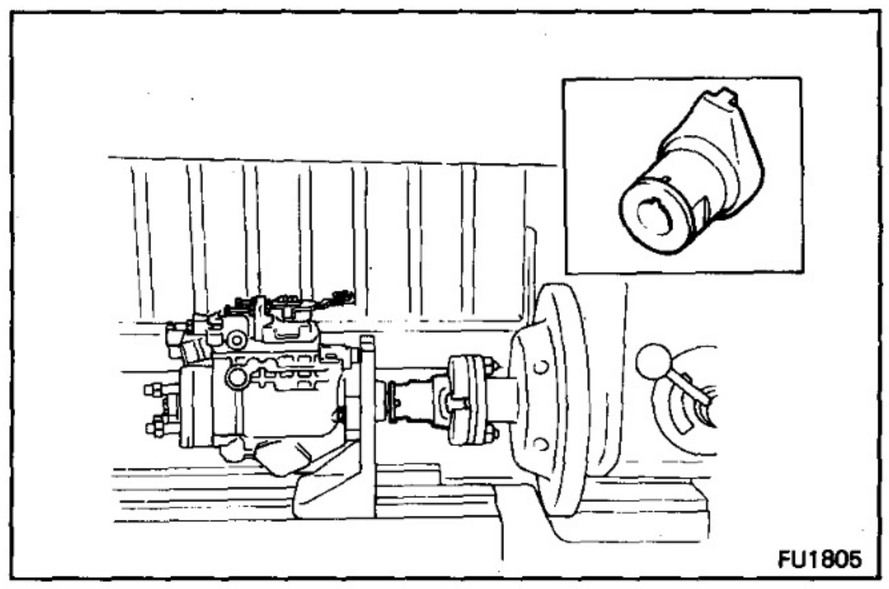
Test nozzle: DN 12 SD 12
Test nozzle holder valve opening pressure:
145 — 155 kg/cm² (2,062 — 2,205 psi, 14,220 — 15,200 kPa)



FU1804

(b) Check the accuracy of the tachometer.

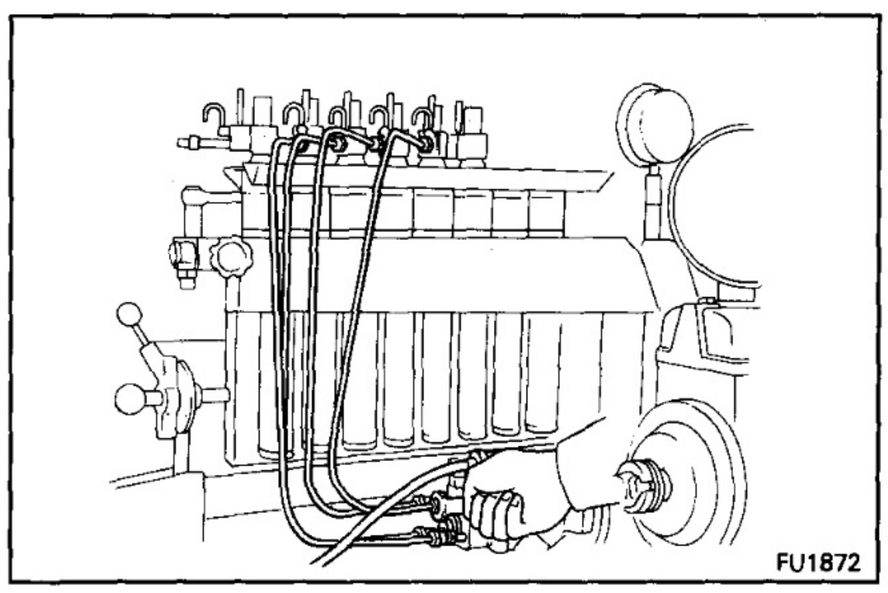
Allowable error: ± 40 rpm


FU1805

(c) Install the angle gauge stand.

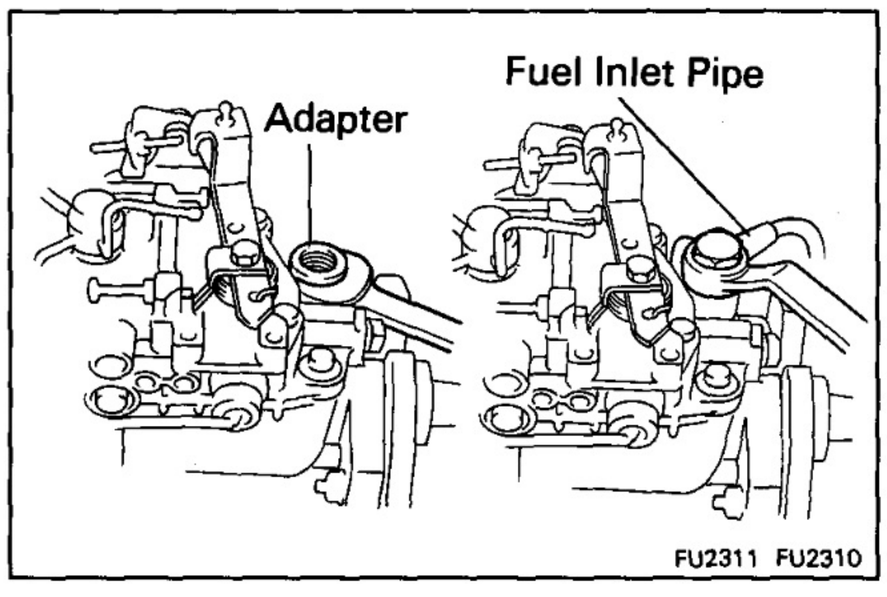
(d) Mount the injection pump body on the pump tester.

HINT: Place a mark on the key groove portion of the coupling.


FU1872

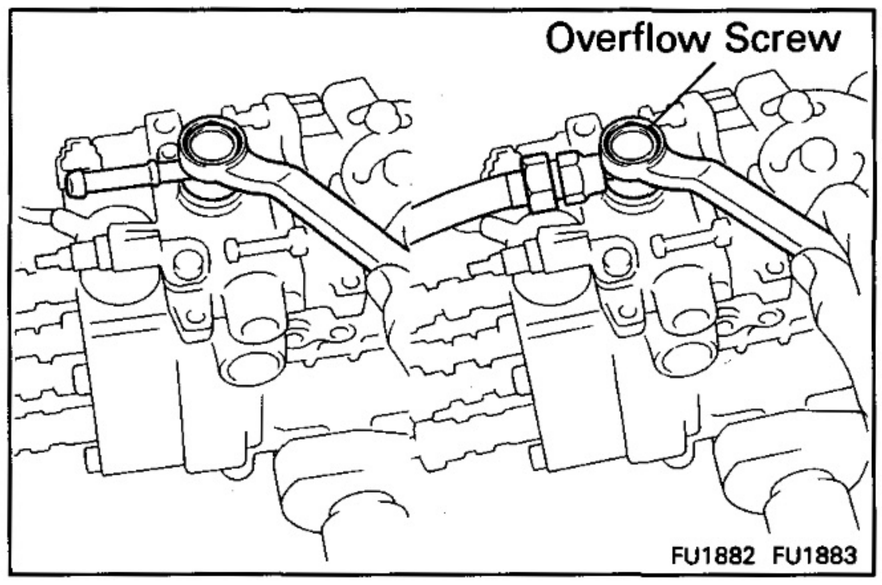
(e) Install an injection pipe with the following specifications.

Outer Diameter: 6.0 mm (0.236 in.)
Inner diameter: 2.0 mm (0.079 in.)
Length: 840 mm (33.07 in.)
Minimum bending radius: More than 25 mm (0.98 in.)



FU2311 FU2310

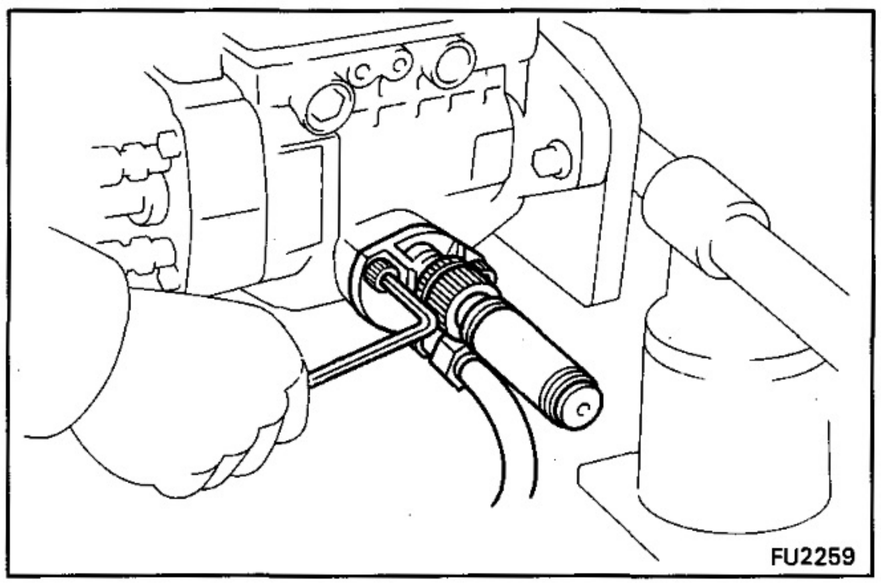
(f) Connect the fuel inlet pipe with an adapter.



(g) Remove the overflow screw and fuel return pipe.

(h) Install the overflow hose with the overflow screw.

HINT: Always use the overflow screw installed on the pump to be adjusted.

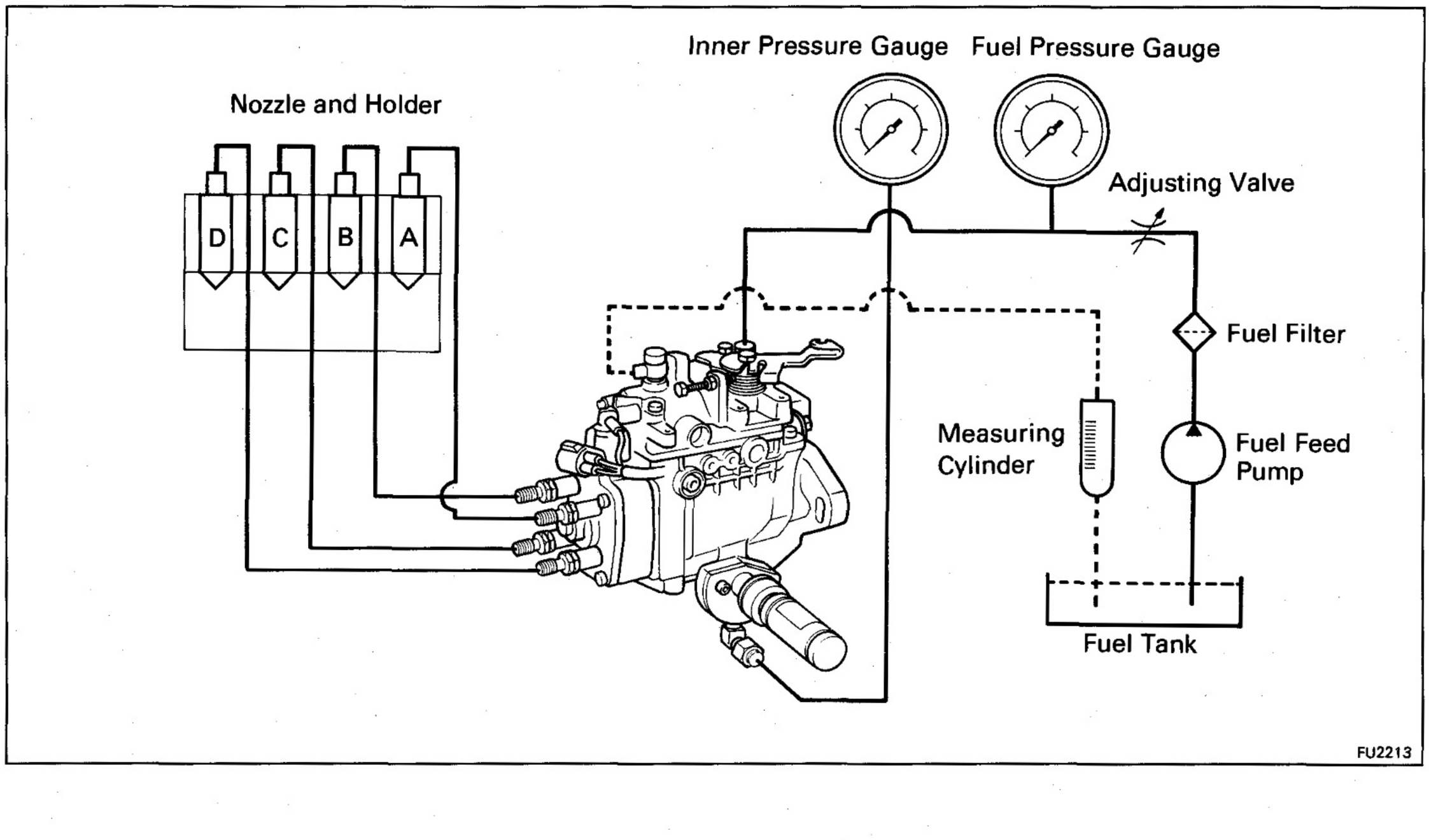


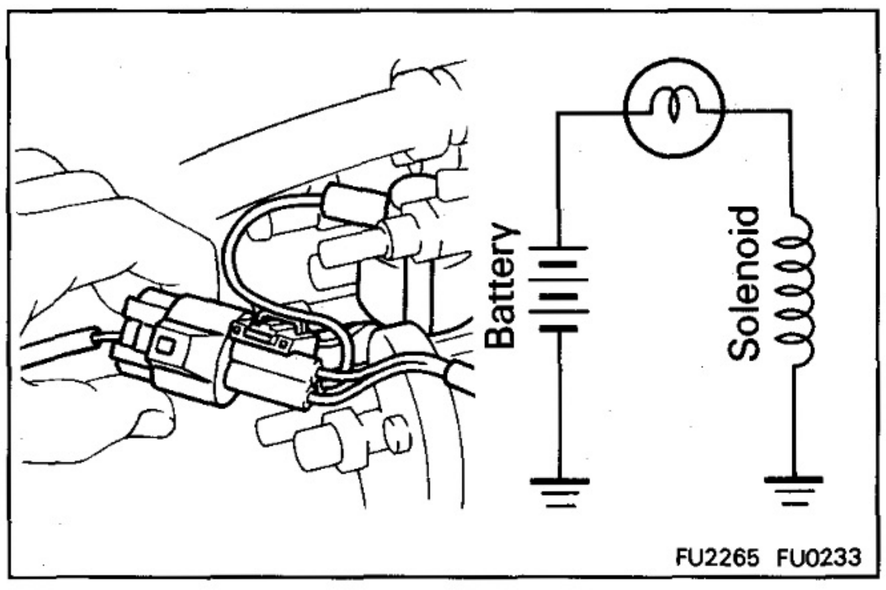
(i) Remove the timer cover with the two screws.

(j) Install the inner pressure gauge with the timer measuring device.

Part No. 95095-10220 and 95095-10231 (NIPPONDENSO)

HINT: Bleed the air by the air bleed screw.



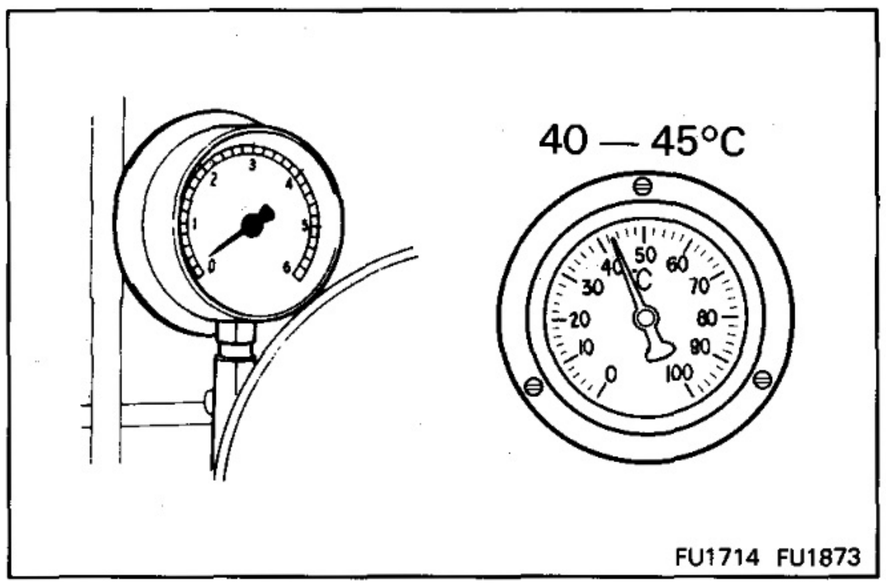


(k) Apply approx. 6 or 12 volts of DC power to the fuel cut solenoid.

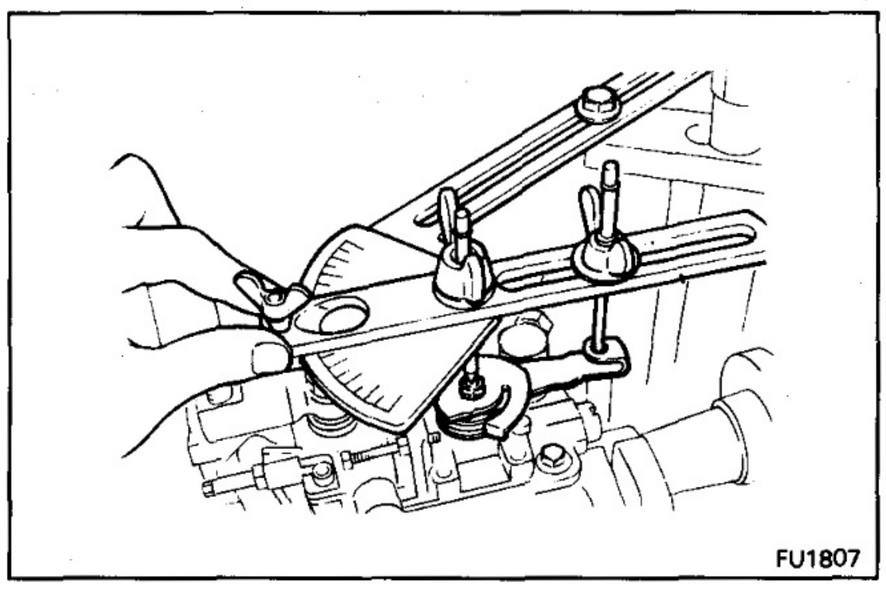
NOTICE:

1. **When applying voltage to the solenoid, position the battery as far away from the solenoid as possible so that a spark does not occur.**
2. **When connecting the battery cable, connect the solenoid side first.**

HINT: For a 12V or 24V battery, connect the battery through a 10 or 12W bulb.

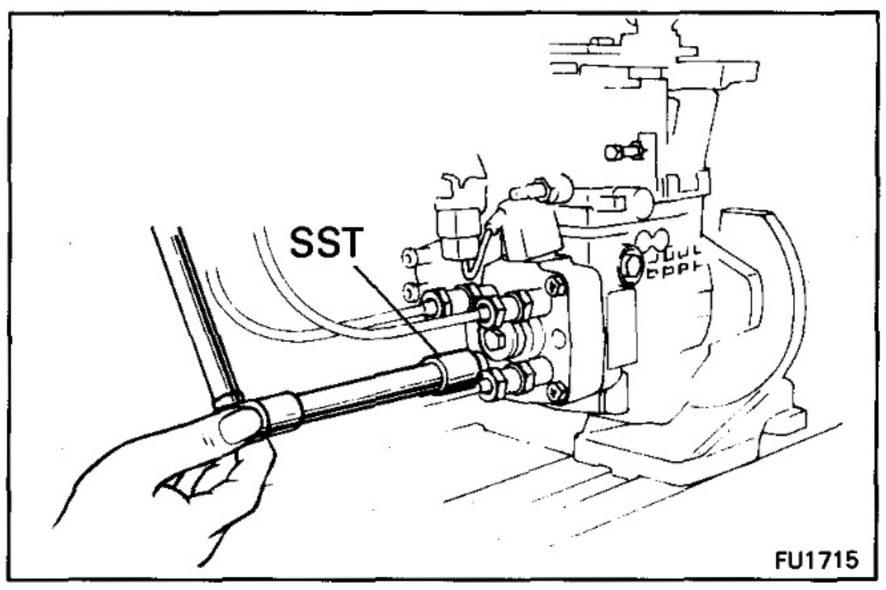


(l) The pressure for feeding fuel to the injection pump should be 0.2 kg/cm² (2.8 psi, 20 kPa).
The fuel temperature for pump testing should be 40 — 45°C (104 — 113°F).



(m) Install an angle gauge to the stand and set it to the adjusting lever.

(n) Secure the adjusting lever fully on the maximum speed side.

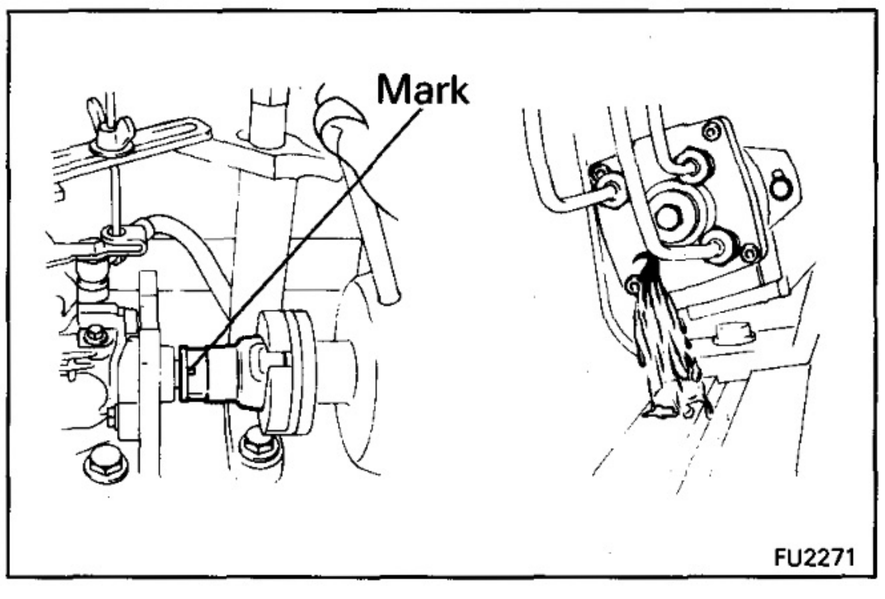


(o) Check the installation direction of the camplate.

(1) Disconnect the injection pipe from the position marked "C" on the distributive head.

(2) Using SST, remove the delivery valve holder.

SST 09260-54012 (09269-54020)

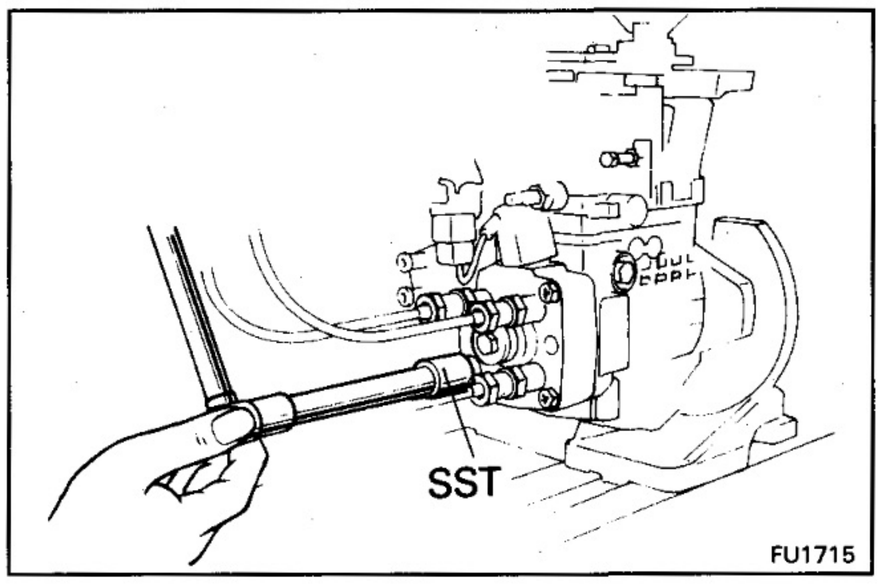


(3) Check that fuel is flowing out when the mark is in the position shown in the figure.

If not, it is improperly assembled.

(4) Disassemble and charge the camplate position 180° in the opposite direction.

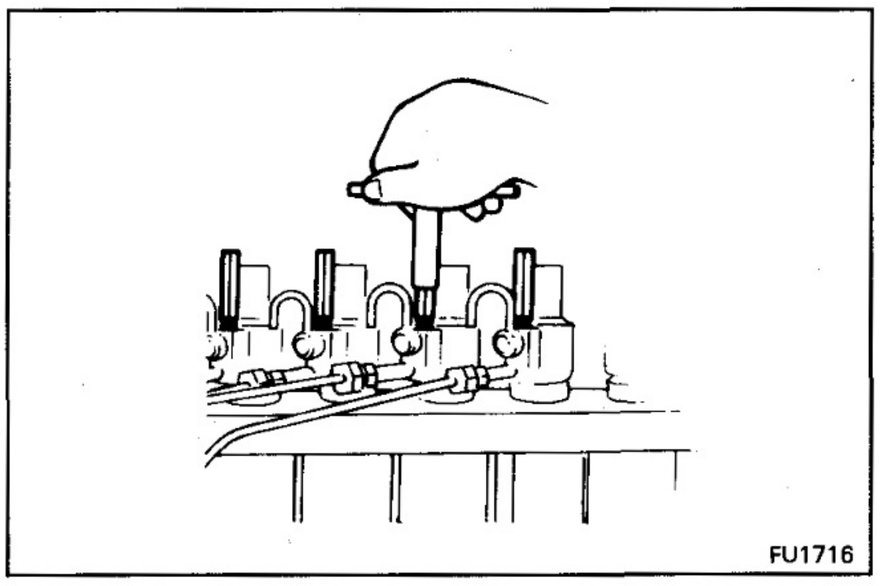
HINT: At this time, disconnect the fuel cut solenoid wire harness.



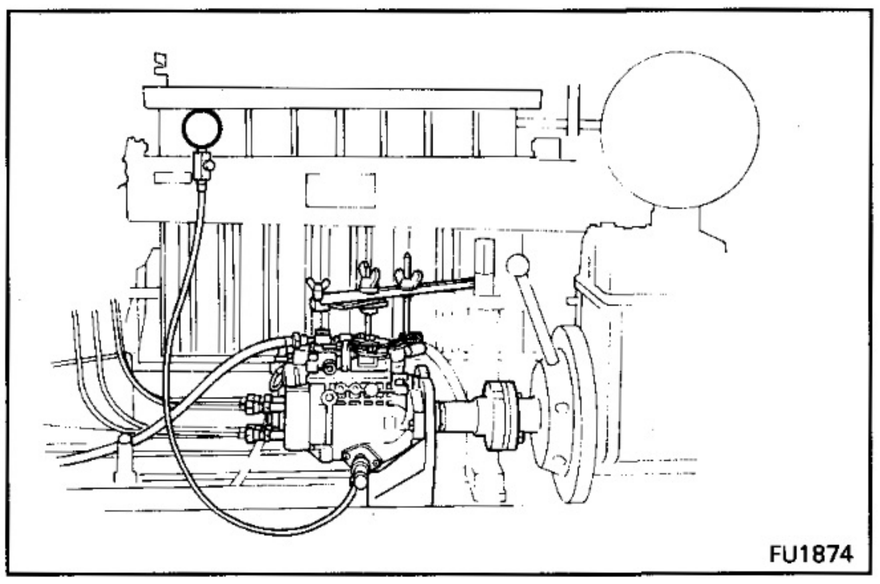
(5) Using SST, install the delivery valve holder.

SST 09260-54012 (09269-54020)

(6) Connect the injection pipe.

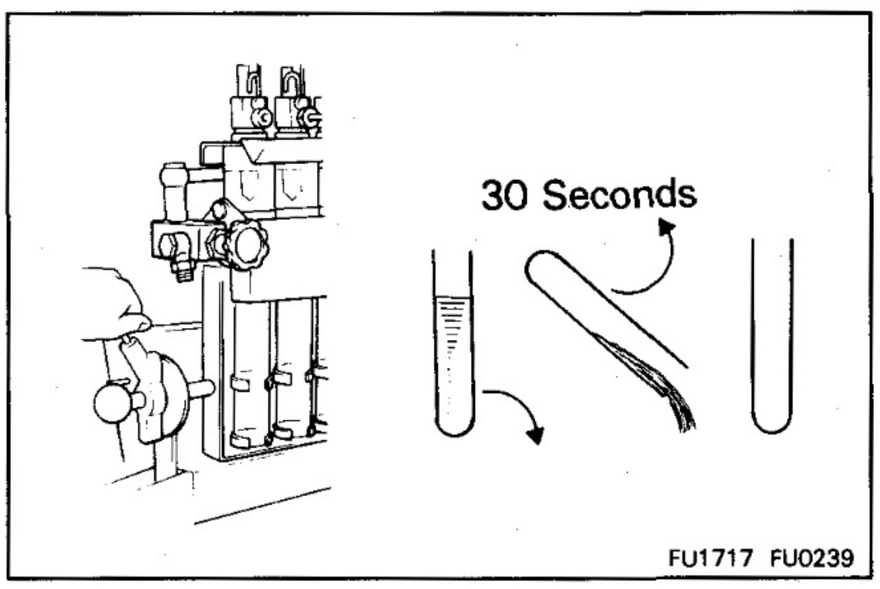


(p) Bleed the air from the injection pipes.



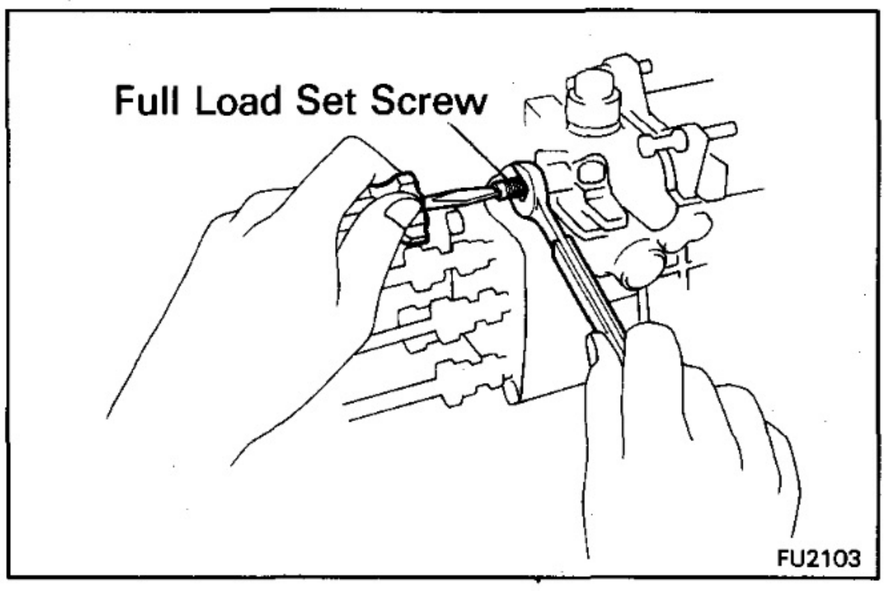
(q) Race the injection pump for 5 minutes at 2,000 rpm.

NOTICE: Check that there is no fuel leakage or abnormal noise.



HINT:

- Measure the volume of each injection cylinder with a measuring cylinder.
- Before measuring the injection volume, first hold the cylinder tilted for at least 30 seconds to discard all the fuel.



2. PRE-SETTING OF FULL LOAD INJECTION VOLUME

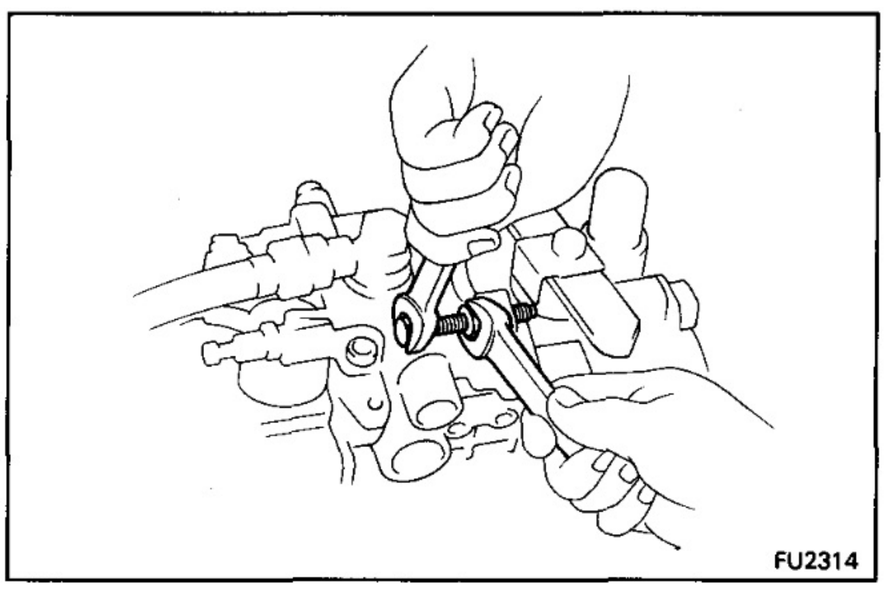
(a) Set the adjuisting lever to maximum position.

(b) Adjust the injection volume with the full load set screw.

Item		Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)
B	w/ HAC	1,100	200	8.95 — 9.25 (0.55 — 0.56)
	Others			9.35 — 9.65 (0.57 — 0.59)
3B	w/ HAC			10.45 — 10.75 (0.64 — 0.66)
	Europe			11.45 — 11.75 (0.70 — 0.72)
	Others			10.85 — 11.15 (0.66 — 0.68)
11B	w/ HAC			11.35 — 11.95 (0.69 — 0.73)
	Europe			11.75 — 12.35 (0.72 — 0.75)
	Others			11.95 — 12.55 (0.73 — 0.77)
14B	Hong Kong General BU China			13.75 — 14.15 (0.84 — 0.86)
	Australia A/T Europe Portugal			15.45 — 16.05 (0.94 — 0.98)
	w/ ACSD			13.15 — 13.75 (0.80 — 0.84)

(w/HAC)
Apply 730 ± 1.5 mmHg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

HINT: The injection volume will increase about 3 cc (0.18 cu in.) with each 1/2 turn of the screw.

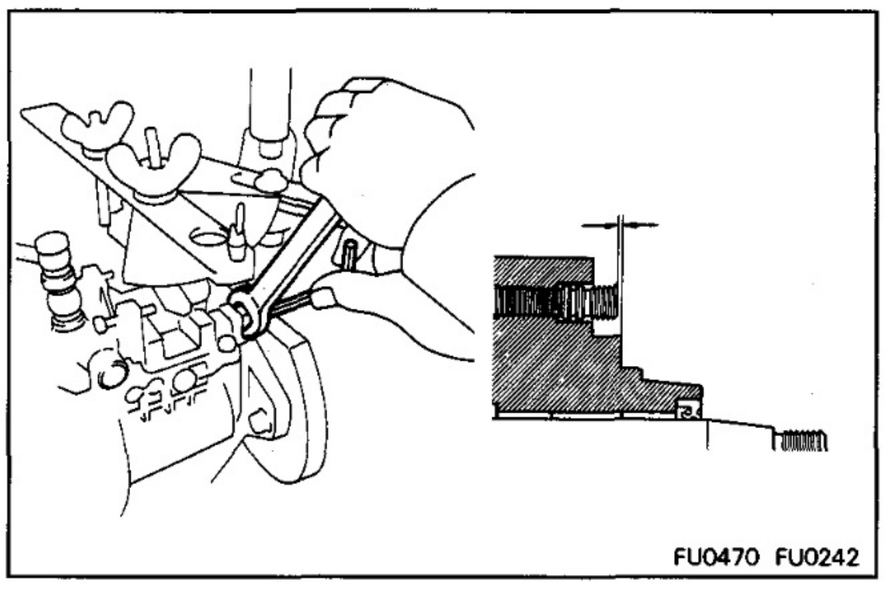


3. PRE-SETTING OF MAXIMUM SPEED

(a) Set the adjusting lever to maximum position.

(b) Adjust the injection volume with the maximum adjusting screw.

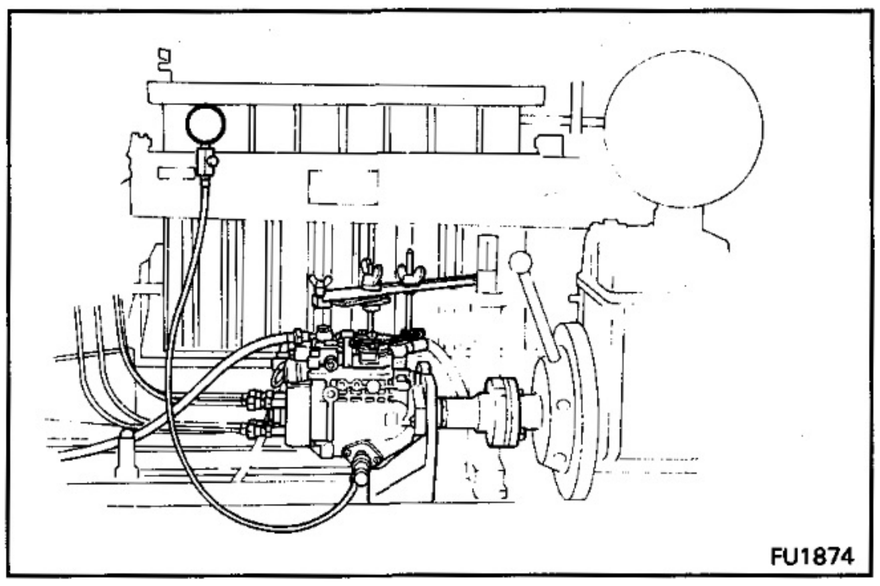
Item	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)
B	2,050	200	4.4 — 5.6 (0.27 — 0.34)
3B	2,050		3.5 — 4.9 (0.21 — 0.30)
11B, 14B	2,075		3.4 — 5.8 (0.21 — 0.35)

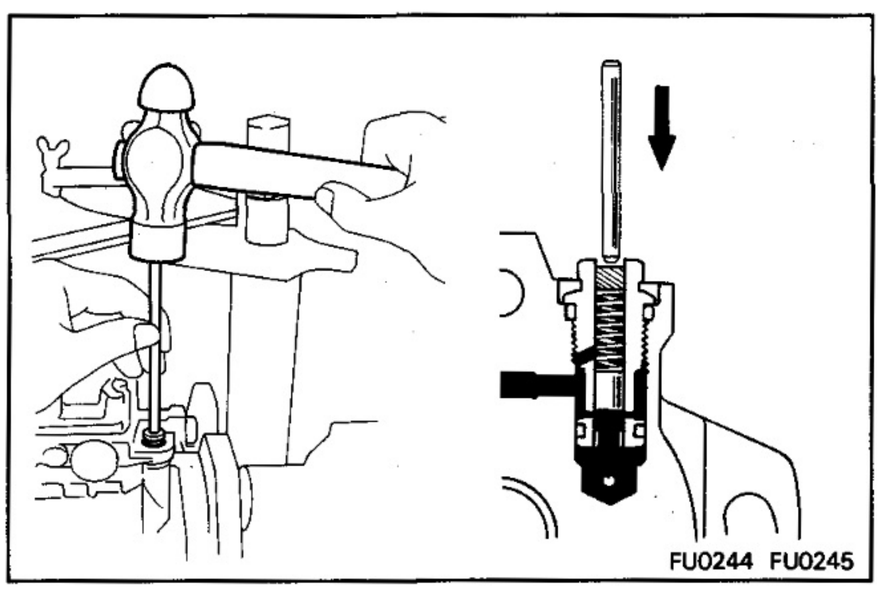


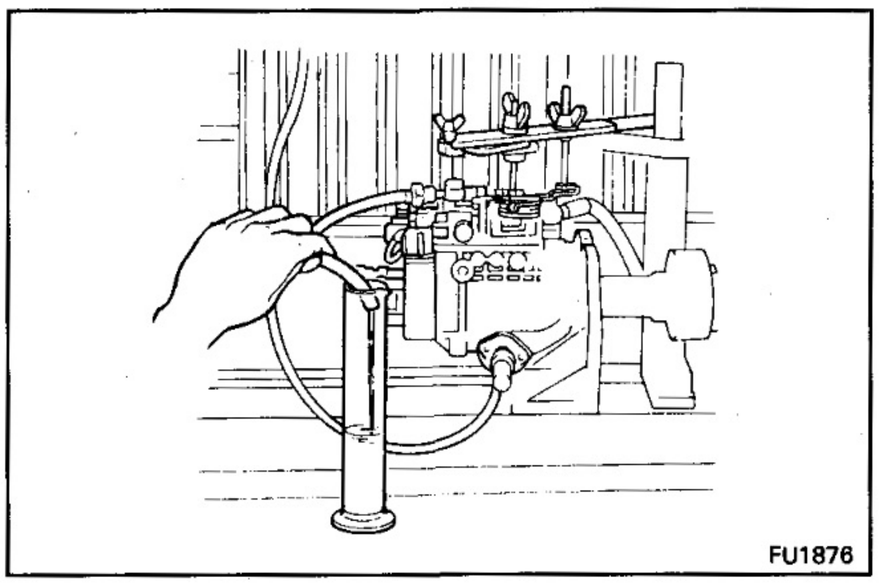
4. PRE-SETTING OF LOAD SENSING TIMER

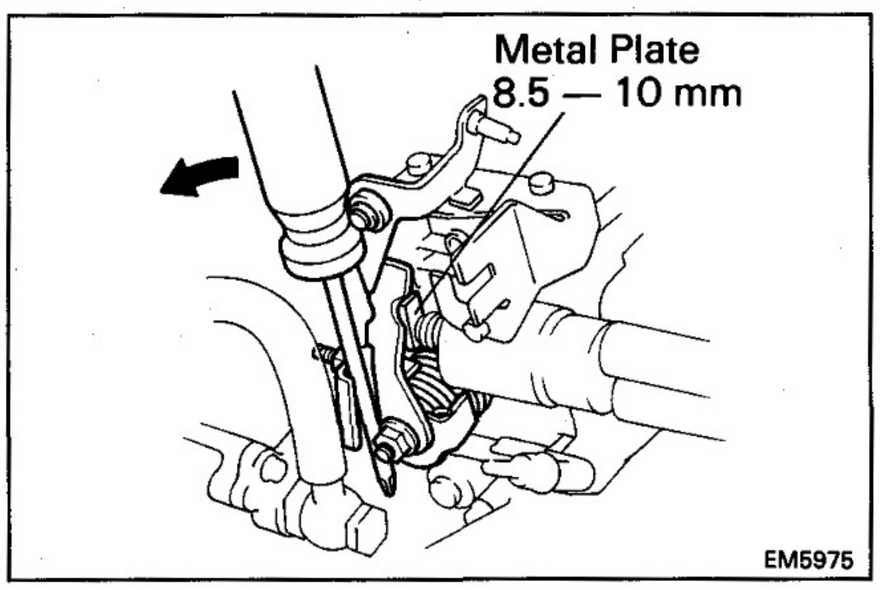
Using an allen wrench, adjust the protrusion of the governor shaft.

Protrusion: 0.5 — 2.0 mm (0.020 — 0.079 in.)

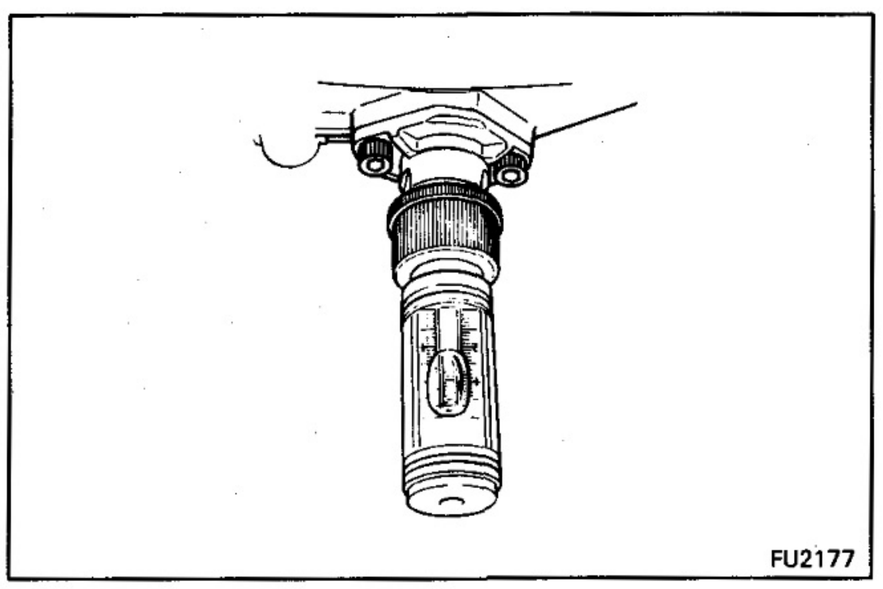

FU1874


FU0244 FU0245


FU1876



EM5975


FU2177

5. MEASURE PUMP INNER PRESSURE

Measure the pump inner pressure at the below-listed rpm.
Others

Item	Pump revolution (rpm)	Inner pressure kg/cm² (psi, kPa)
B, 3B	400	2.2 — 2.8 (31 — 40, 216 — 275)
	1,900	6.8 — 7.4 (97 — 105, 667 — 726)
11B, 14B	400	2.2 — 2.8 (31 — 40, 216 — 275)
	1,700	6.8 — 7.4 (97 — 105, 667 — 726)

- If the pressure is low, adjust by lightly tapping the regulator valve piston while watching the pressure gauge.
- If the pressure is too high or if the regulator valve was tapped in too far, the regulator valve must be replaced.

5. MEASURE OVERFLOW VOLUME

Measure the overflow volume at the below listed rpm.

Item	Pump revolution (rpm)	Overflow volume cc/min. (cu in./min.)
B, 3B	1,800	366 — 800 (22.3 — 48.8)
11B, 14B	400	250 — 683 (15.3 — 41.7)

HINT: Always use the overflow screw installed on the pump to be adjusted.

6. [w/ ACSD] RELEASE COLD STARTING SYSTEM FOR NEXT INSPECTIONS

Using a screwdriver, turn the cold start lever counter-clockwise and put a metal plate of 8.5 — 10 mm (0.33 — 0.39 in.) in thickness between the lever and thermo wax.

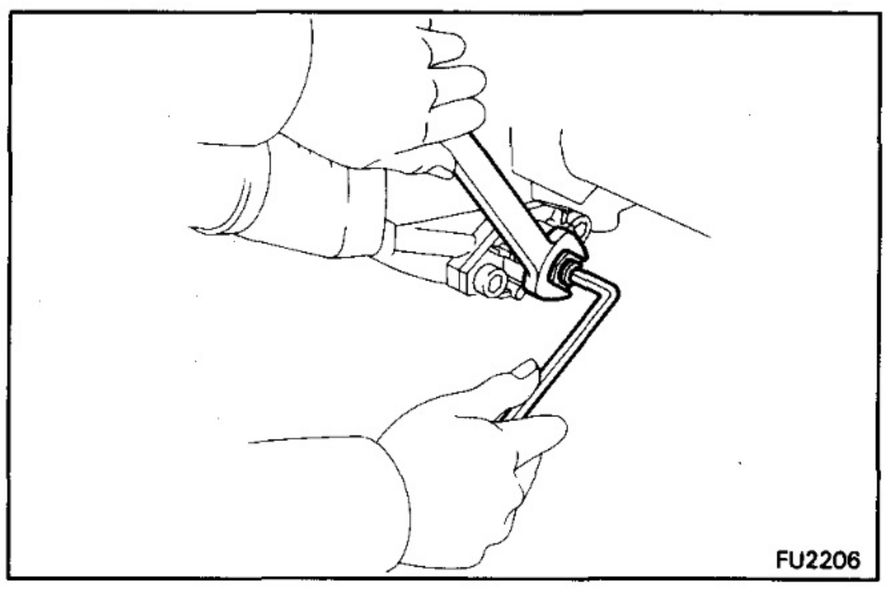
HINT: Keep the cold starting system released until all measurements and adjustments are finished.

7. CHECK AND ADJUST TIMER

(a) Set the timer measuring device at zero.

(b) Measure the piston stroke at the below listed rpms.

Item		Pump revolution (rpm)	Piston strokes mm (in.)
B		650	0.9 — 1.9 (0.035 — 0.075)
		1,100	3.5 — 4.5 (0.138 — 0.177)
		1,600	6.4 — 7.4 (0.252 — 0.291)
		1,900	7.3 — 8.3 (0.287 — 0.327)
3B		700	0.1 — 1.1 (0.004 — 0.043)
		1,100	2.7 — 3.7 (0.106 — 0.146)
		1,400	4.6 — 5.6 (0.181 — 0.220)
		1,900	6.9 — 7.9 (0.272 — 0.311)
11B	w/ LST	1,360	0.6 — 1.7 (0.024 — 0.067)
		1,560	3.1 — 4.2 (0.122 — 0.165)
		1,700	4.5 — 5.6 (0.177 — 0.220)
		2,000	4.5 — 5.6 (0.177 — 0.220)
	w/o LST	1,360	0.6 — 1.6 (0.024 — 0.063)
		1,560	3.1 — 4.1 (0.122 — 0.161)
		1,700	4.5 — 5.5 (0.177 — 0.217)
		2,000	4.5 — 5.5 (0.177 — 0.217)
14B	Europe	1,260	0.6 — 1.6 (0.024 — 0.063)
		1,460	3.1 — 4.1 (0.122 — 0.161)
		1,600	4.5 — 5.5 (0.177 — 0.217)
		1,900	4.5 — 5.5 (0.177 — 0.217)
	Australia	1,360	1.9 — 2.9 (0.075 — 0.114)
		1,460	3.1 — 4.1 (0.122 — 0.161)
		1,600	4.5 — 5.5 (0.177 — 0.217)
		1,900	4.5 — 5.5 (0.177 — 0.217)
	Others	1,000	0.3 — 1.3 (0.012 — 0.051)
		1,550	4.5 — 5.5 (0.177 — 0.217)
		1,700	5.5 — 6.5 (0.217 — 0.256)
		1,900	5.5 — 6.5 (0.217 — 0.256)

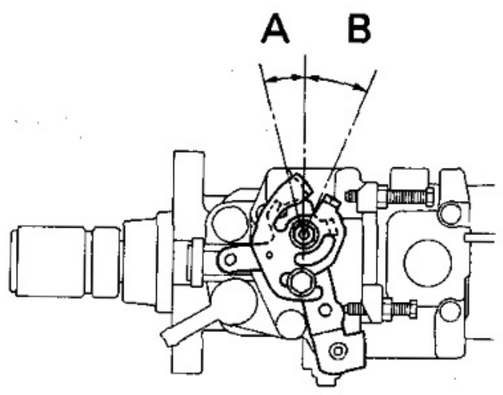

FU2206

HINT: Confirm that the hysteresis is within 0.3 mm (0.012 in.)

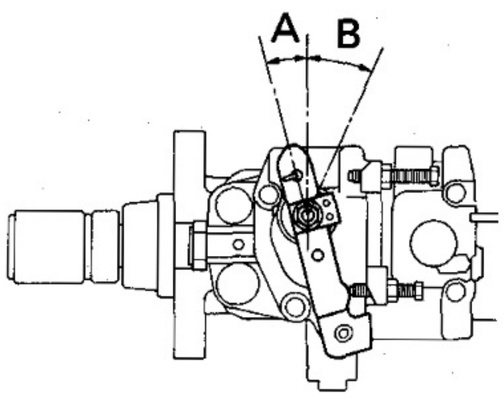
If any stroke is not within standard, adjust with the TIMER ADJUSTING SCREW.

HINT: The stroke will decrease with turn to clockwise and increase with turn to counterclockwise.

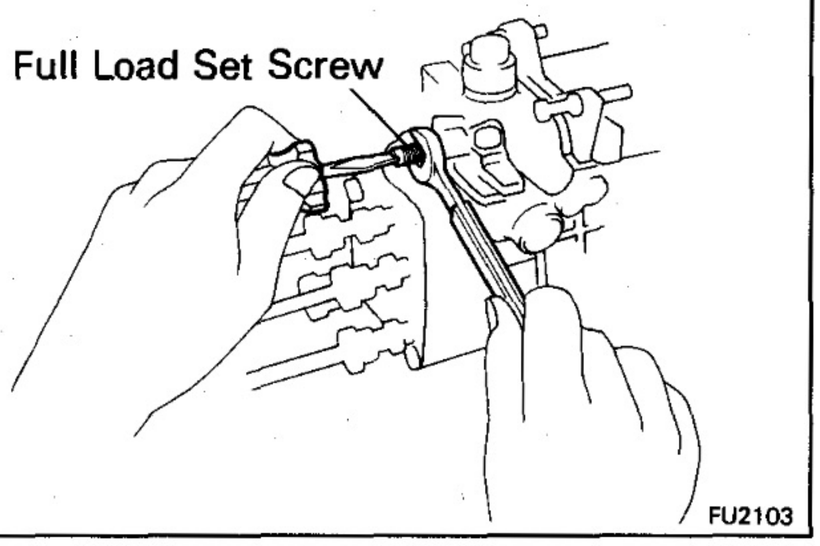
BJ



Others



FU2125
FU2124



FU2103

10. MEASURE AND ADJUST FULL LOAD INJECTION VOLUME

(a) The adjusting lever angle for the adjustment below should be as shown in the figure.

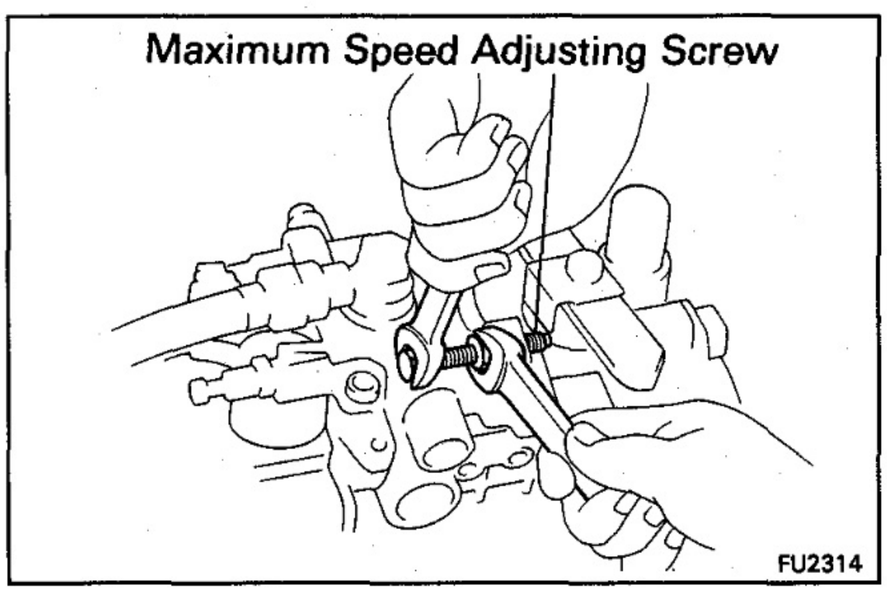
Adjusting lever angle	
A (Maximum speed side)	B (Idle speed side)
Plus 21 — 31°	Minus 12 — 22°

(b) Adjust the injection volume with the full load set screw.

Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)
B	w/ HAC	Plus 21-31°	1,100	200	8.95 — 9.25 (0.55 — 0.56)
	Others				9.35 — 9.65 (0.57 — 0.59)
3B	w/ HAC				10.45 — 10.75 (0.64 — 0.66)
	Europe				11.45 — 11.75 (0.70 — 0.72)
	Others				10.85 — 11.15 (0.66 — 0.68)
11B	w/ HAC				11.35 — 11.95 (0.69 — 0.73)
	Europe				11.75 — 12.35 (0.72 — 0.75)
	Others				11.95 — 12.55 (0.73 — 0.77)
14B	Hong Kong General BU China				13.75 — 14.15 (0.84 — 0.86)
	Australia A/T Europe Portugal				15.45 — 16.05 (0.94 — 0.98)
	w/ HAC				13.15 — 13.75 (0.86 — 0.84)

w/ HAC
Apply 730 ± 1.5 mmHg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

HINT: The injection volume will increase approx. 3 cc (0.18 cu in.) with each 1/2 turn of the screw.



11. ADJUST MAXIMUM SPEED

Adjust the injection volume with the maximum speed adjusting screw.

Item	Adjusting lever angle	Pump rmp	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
B	Plus 21 — 31°	2,050	200	4.4 — 5.6 (0.27 — 0.34)	Adjust
		2,200		Less than 1.2 (0.07)	—
3B		2,050		3.5 — 4.9 (0.21 — 0.30)	Adjust
		2,200		Less than 1.2 (0.07)	—
11B, 14B		2,075		3.4 — 5.8 (0.21 — 0.35)	Adjust
		2,400		Less than 1.2 (0.07)	—

w/ HAC Apply 730 ± 1.5 mmHg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

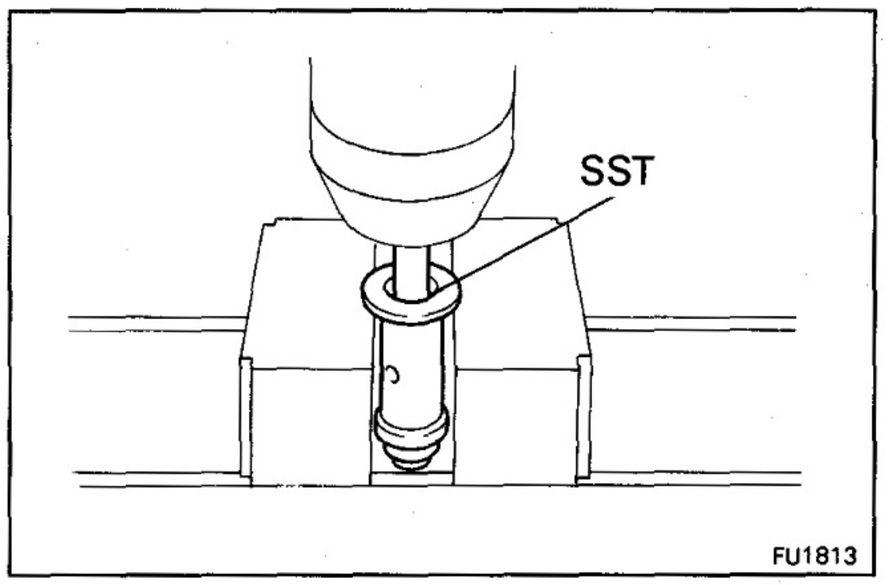
12. INSPECT INJECTION VOLUME

Measure the injection volume for each pump rpm.

Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cc in.)	Remarks
B	w/ HAC	Plug 21 — 31°	1,100	200	8.95 — 9.25 (0.55 — 0.56)	0.4 (0.02)	Basic full load injection volume
			100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
			400		8.3 — 10.7 (0.51 — 0.65)	—	—
			500		7.0 — 8.4 (0.43 — 0.51)	0.5 (0.03)	—
			1,800		7.95 — 9.45 (0.49 — 0.58)		
			1,950		7.1 — 10.0 (0.43 — 0.61)	—	—
	Others		1,100		9.35 — 9.65 (0.57 — 0.59)	0.4 (0.02)	Basic full load injection volume
			100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
			400		8.9 — 11.3 (0.54 — 0.69)	—	—
			500		7.6 — 9.0 (0.46 — 0.55)	0.5 (0.03)	—
			1,800		8.75 — 10.25 (0.53 — 0.63)		
			1,950		7.5 — 10.0 (0.46 — 0.61)	—	—
3B	w/ HAC		1,100		10.45 — 10.75 (0.64 — 0.66)	0.4 (0.02)	Basic full load injection volume
			100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
			400		9.8 — 12.2 (0.60 — 0.74)	—	—
			500		8.6 — 10.0 (0.52 — 0.61)	0.5 (0.03)	—
			1,750		9.2 — 10.8 (0.56 — 0.66)		
			1,950		7.3 — 10.1 (0.45 — 0.62)	—	—
	Europe		1,100		11.45 — 11.75 (0.70 — 0.72)	0.4 (0.02)	Basic full load injection volume
			100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
			400		11.4 — 13.4 (0.70 — 0.82)	—	—
			500		10.2 — 11.3 (0.63 — 0.69)	0.5 (0.03)	—
			1,750		10.5 — 11.7 (0.64 — 0.71)		
			1,950		8.3 — 10.1 (0.51 — 0.62)	—	—
	Others		1,100		10.85 — 11.15 (0.66 — 0.68)	0.4 (0.02)	Basic full load injection volume
			100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
			400		10.4 — 12.8 (0.63 — 0.78)	—	—
			500		9.2 — 10.6 (0.56 — 0.65)	0.5 (0.03)	—
			1,750		9.7 — 11.3 (0.59 — 0.69)		
			1,950		7.7 — 10.1 (0.47 — 0.62)	—	—
11B	w/ HAC		1,100		11.35 — 11.95 (0.70 — 0.73)	0.7 (0.04)	Basic full load injection volume
			100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
			350		9.0 — 13.0 (0.55 — 0.79)	—	—
			500		8.1 — 9.7 (0.49 — 0.59)	0.7 (0.04)	—
			700		9.1 — 10.7 (0.56 — 0.65)		—
			1,800		8.9 — 10.5 (0.54 — 0.64)		—

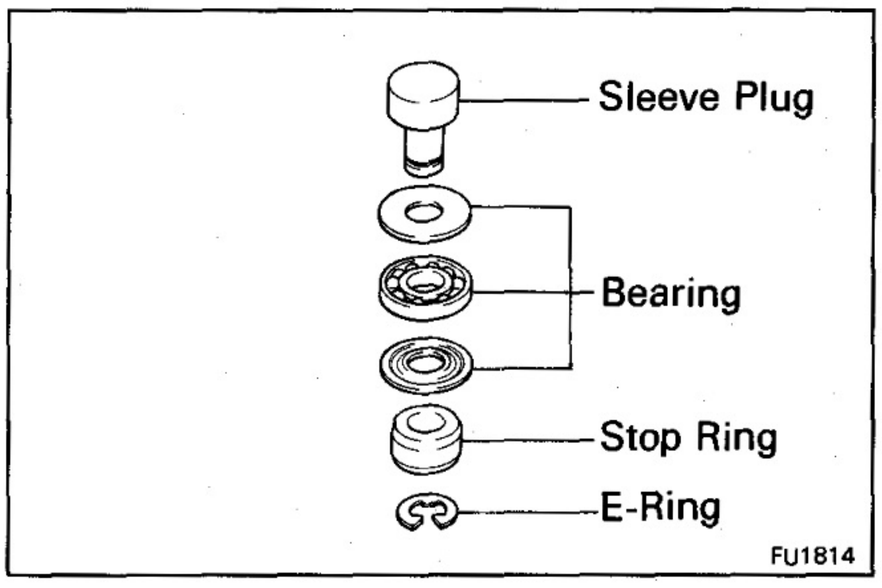
w/ HAC Apply 730 ± 1.5 mmHg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure

Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cc in.)	Remarks
11B	Europe	Plug 21 — 31°	1,100	200	11.75 — 12.35 (0.72 — 0.75)	0.7 (0.04)	Basic full load injection volume
			100		14.6 — 19.4 (0.89 — 1.18)	1.3 (0.08)	Volume during starting
			350		9.0 — 13.0 (0.55 — 0.79)	—	—
			500		8.0 — 9.2 (0.49 — 0.56)	0.7 (0.04)	—
			700		9.8 — 11.0 (0.60 — 0.67)		
			900		11.0 — 12.2 (0.67 — 0.74)		
			1,300		11.8 — 13.0 (0.72 — 0.79)		
			1,800		10.4 — 11.6 (0.63 — 0.71)		
	Others		1,100		11.95 — 12.55 (0.73 — 0.77)	0.7 (0.04)	Basic full load injection volume
			100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during staring
			350		9.4 — 13.4 (0.57 — 0.82)	—	—
			500		8.5 — 10.1 (0.52 — 0.62)	0.7 (0.04)	—
			700		9.6 — 11.2 (0.59 — 0.68)		
			1.800		9.4 — 11.0 (0.57 — 0.67)		
14B	Portugal		1,100		15.45 — 16.05 (0.94 — 0.98)	0.7 (0.04)	Basic full load injection volume
			100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
			500		11.1 — 12.3 (0.68 — 0.75)	0.7 (0.04)	—
			700		12.3 — 13.5 (0.75 — 0.82)		
			900		14.1 — 15.3 (0.86 — 0.93)		
			1,300		14.8 — 16.0 (0.90 — 0.98)		
			1,700		13.6 — 14.8 (0.83 — 0.90)		
	Hong Kong General		1,100		13.75 — 14.15 (0.84 — 0.86)	0.7 (0.04)	Basic full load injection volume
			100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
			500		11.2 — 12.4 (0.68 — 0.76)	0.7 (0.04)	—
			700		11.9 — 13.1 (0.73 — 0.80)		
			1,700		13.1 — 14.3 (0.80 — 0.87)		
	BU China		1,100		13.75 — 14.15 (0.84 — 0.86)	0.7 (0.04)	Basic full load injection volume
			100		16.6 — 21.4 (1.01 — 1.31)	1.3 (0.08)	Volume during starting
			500		11.2 — 12.4 (0.68 — 0.76)	0.7 (0.04)	—
			700		11.9 — 13.1 (0.73 — 0.80)		
			1,700		13.1 — 14.3 (0.80 — 0.87)		
	Australia A/T Europe		1,100		15.45 — 16.05 (0.94 — 0.98)	0.7 (0.04)	Basic full load injection volume
			100		16.6 — 21.4 (1.01 — 1.31)	1.3 (0.08)	Volume during starting
			500		11.1 — 12.3 (0.68 — 0.75)	0.7 (0.04)	—
			700		12.3 — 13.5 (0.75 — 0.82)		
			900		14.1 — 15.3 (0.86 — 0.93)		
			1,300		14.8 — 16.0 (0.90 — 0.98)		
			1,700		13.6 — 14.8 (0.83 — 0.90)		
	w/ HAC		1,100		13.15 — 13.75 (0.80 — 0.84)	0.7 (0.04)	Basic full load injection volume
			100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Vulume during starting
			500		10.4 — 12.0 (0.63 — 0.71)	0.7 (0.04)	—
			700		11.2 — 12.8 (0.68 — 0.78)		
			1,700		11.9 — 13.5 (0.73 — 0.82)		

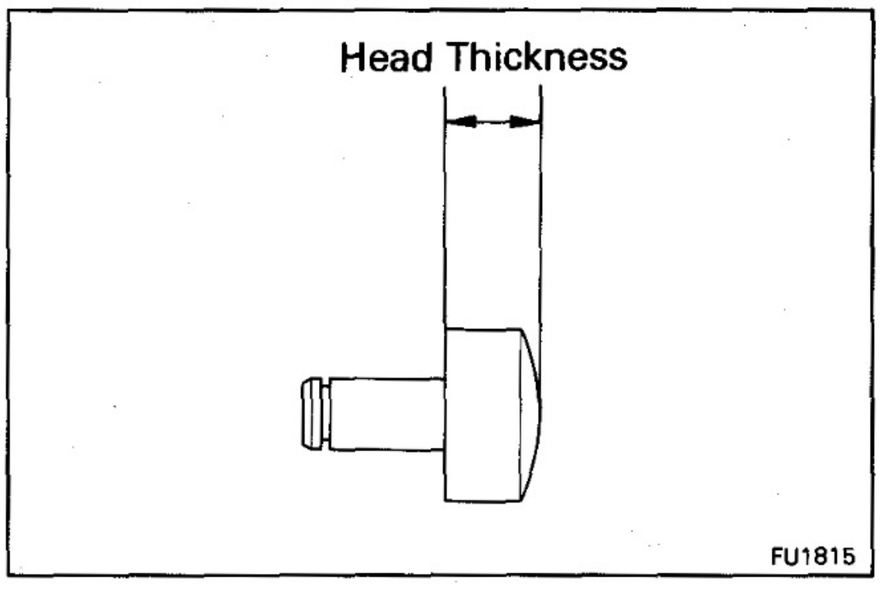


(1) Using SST and press, remove the sleeve plug subassembly.

SST 09236-00101 (09237-00070)



(2) Remove the E-ring, stop ring, bearing and sleeve plug.

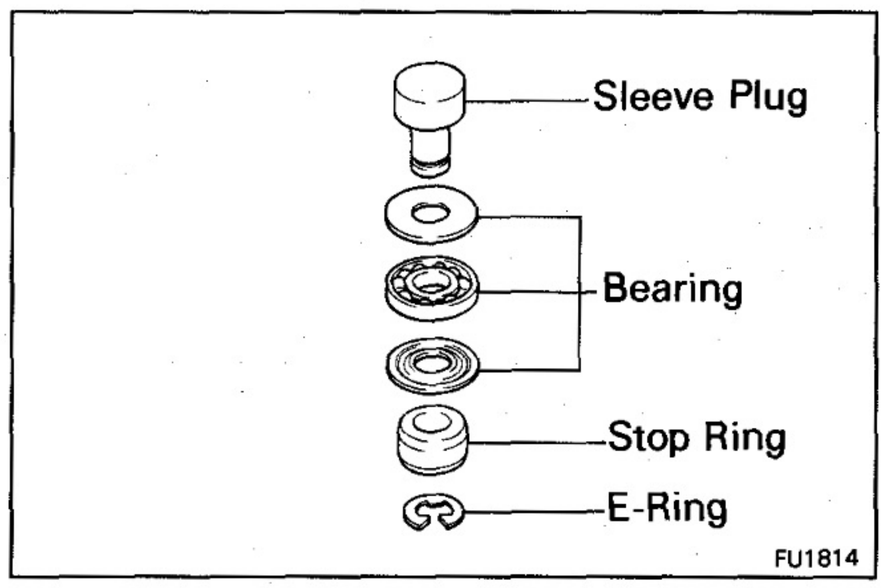


(3) Select the head thickness of the sleeve plug.

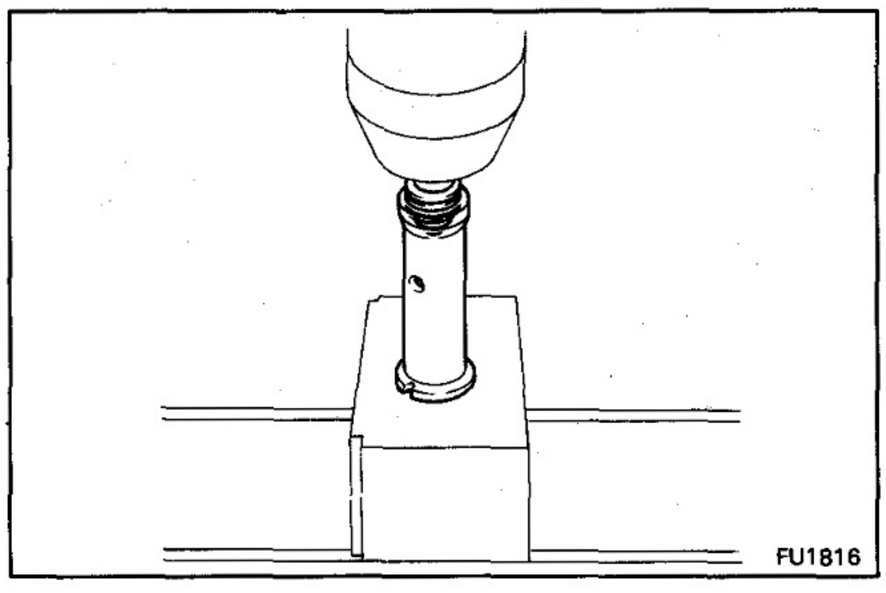
Governor sleeve plug head thickness mm (in.)	
3.0 (0.118)	3.7 (0.146)
3.1 (0.122)	3.8 (0.150)
3.2 (0.126)	3.9 (0.154)
3.3 (0.130)	4.0 (0.157)
3.4 (0.134)	4.1 (0.161)
3.5 (0.138)	4.2 (0.165)
3.6 (0.142)	

HINT: Lengthening the plug 0.1 mm (0.004 in.) will increase injection volume by 0.6 cc (0.04 cu in.).

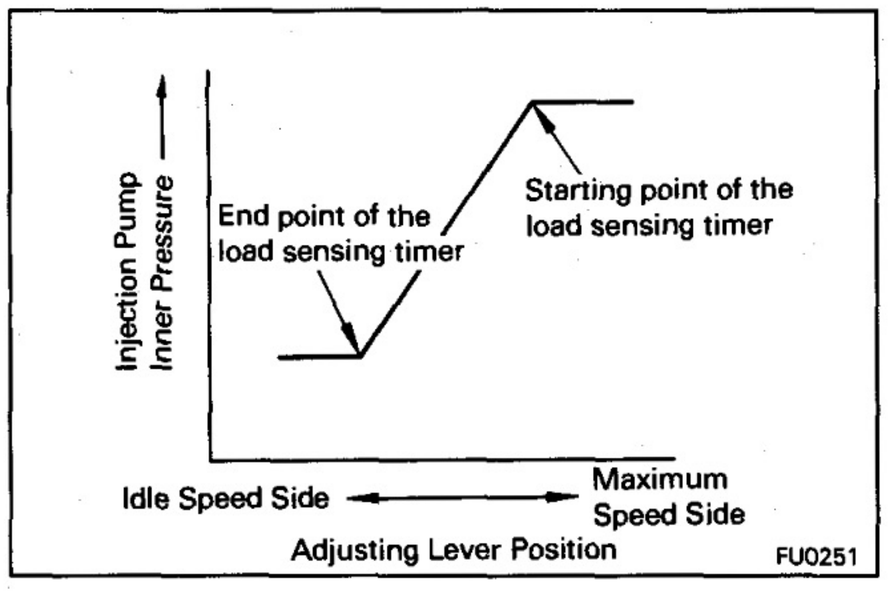
If the variation limit exceeds specification, replace the delivery valve.



(4) Install the sleeve plug, bearing, a new stop ring and a new E-ring.



(5) Using a hand press, install the sleeve plug subassembly.



13. ADJUST LOAD SENSING TIMER

(a) Adjusting the starting and end points of the load sensing timer with the governor shaft.

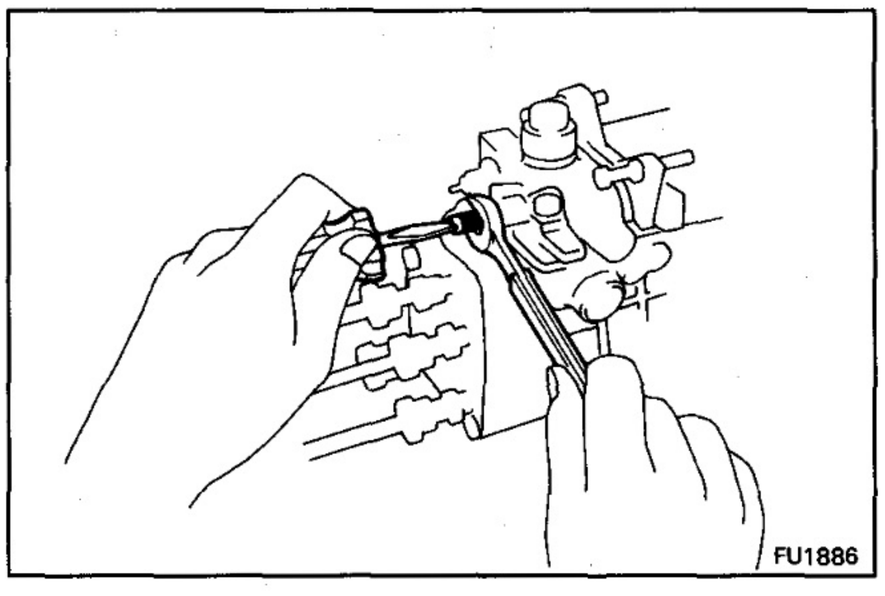
(b) Measure the injection volume.

Item	Adjusting lever position	Pump revolution (rpm)	No. of measuring strokes
B, 3B	Maximum speed side	1,400	200
11B, 14B		1,360	

(c) Slowly move the adjusting lever from the maximum speed side to the idle speed side, and secure it at the point where the pump inner pressure begins to drop.

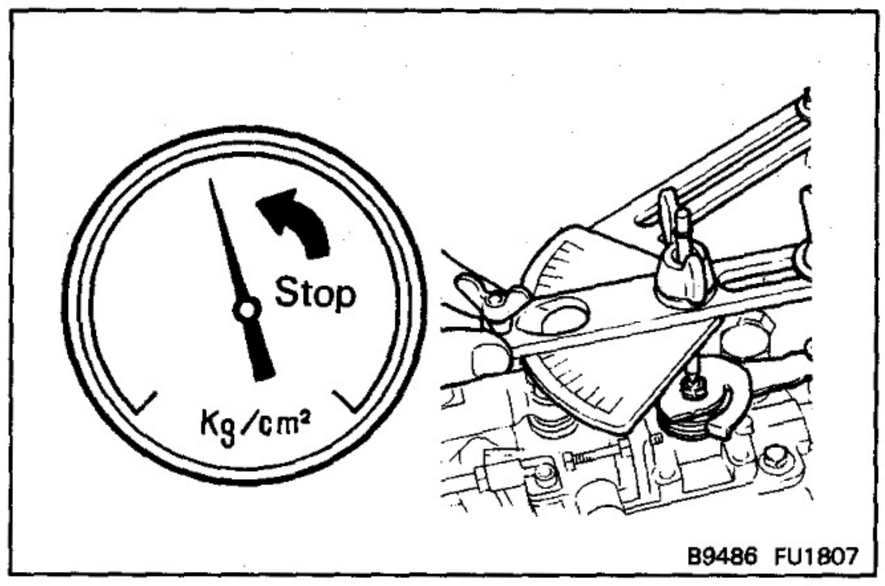
(d) Measure the injection volume at the drop point (starting point).

Item	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in.) Measured value at Step (b) minus
B	1,400	200	1.2 (0.07) ± 0.5 (0.03)
3B			1.2 (0.07) ± 0.6 (0.04)
11B	1,360		3.6 (0.22) ± 0.5 (0.04)
14B			1.0 (0.06) ± 0.5 (0.04)



If any injection volume is not at standard value, adjust with the governor shaft.

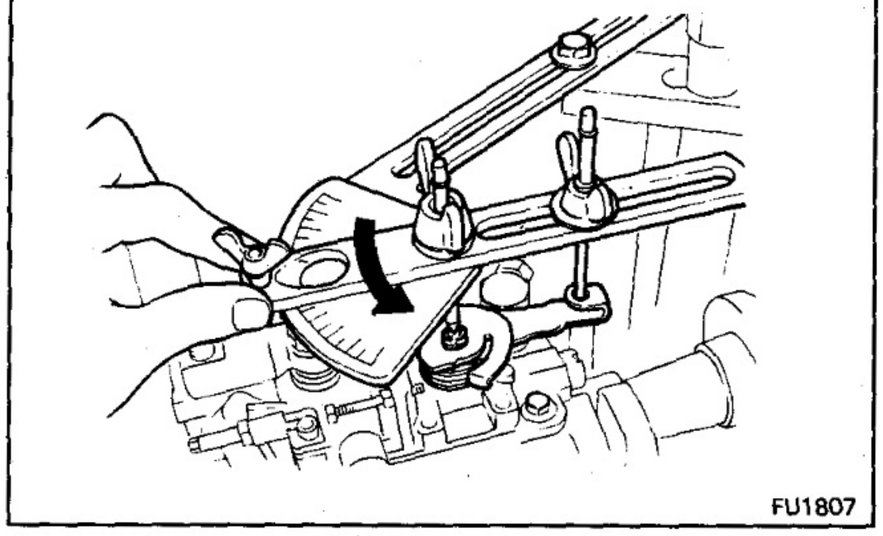
HINT: The injection volume will increase approx. 3 cc (0.18 cu in.) with each 1/2 turn of the screw.



B9486 FU1807

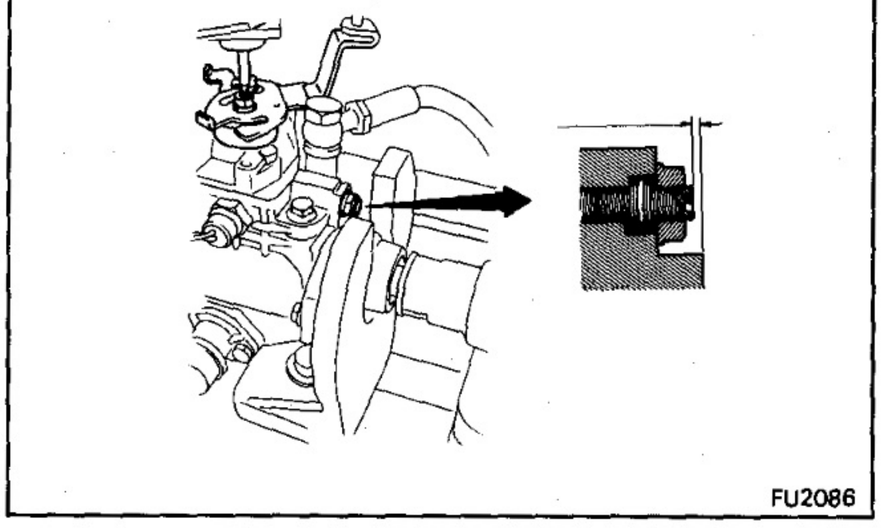
(e) Check the end point injection volume by slowly moving the adjusting lever from the maximum speed side to the idle speed side, and secure it at the point where the pump inner pressure stops dropping.

Item	Pump revolution (rpm)	Measuring strokes	Injection volume cc (cu in.)
B	1,400	200	5.7 — 6.1 (0.35 — 0.37)
3B			8.8 — 9.2 (0.54 — 0.56)
11B	1,360		8.0 — 8.4 (0.49 — 0.51)
14B			11.2 — 11.6 (0.68 — 0.71)


FU1807

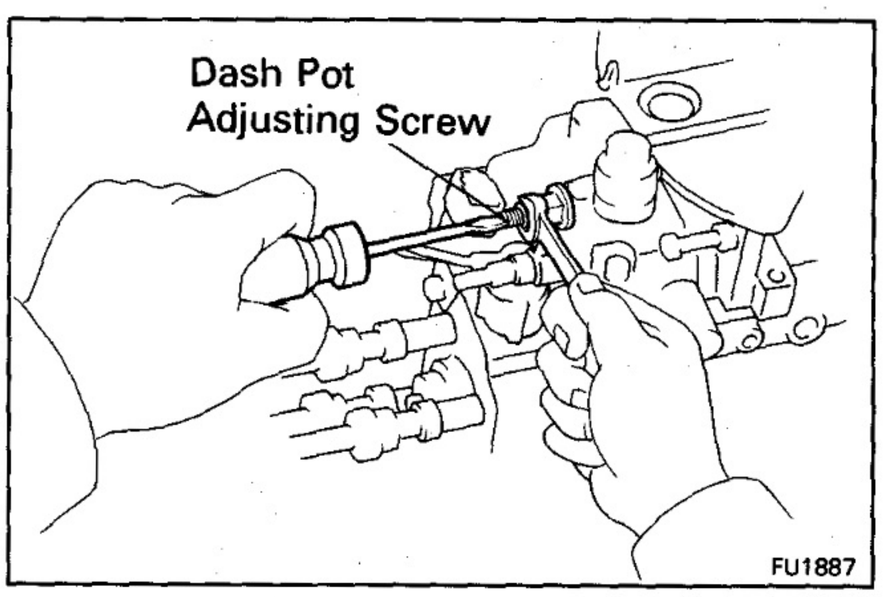
(f) Check the timer piston fluctuation when the adjusting lever is moved from the full side to the idle side.

Item	Pump rpm	Timer piston fluctuation mm (in.)
B	1,400	2.7 — 3.9 (0.106 — 0.154)
3B		2.2 — 2.8 (0.087 — 0.110)
11B	1,360	0.5 — 1.5 (0.020 — 0.059)
14B		1.1 — 1.8 (0.043 — 0.071)


FU2086

(g) Check the protrusion of the governor shaft.

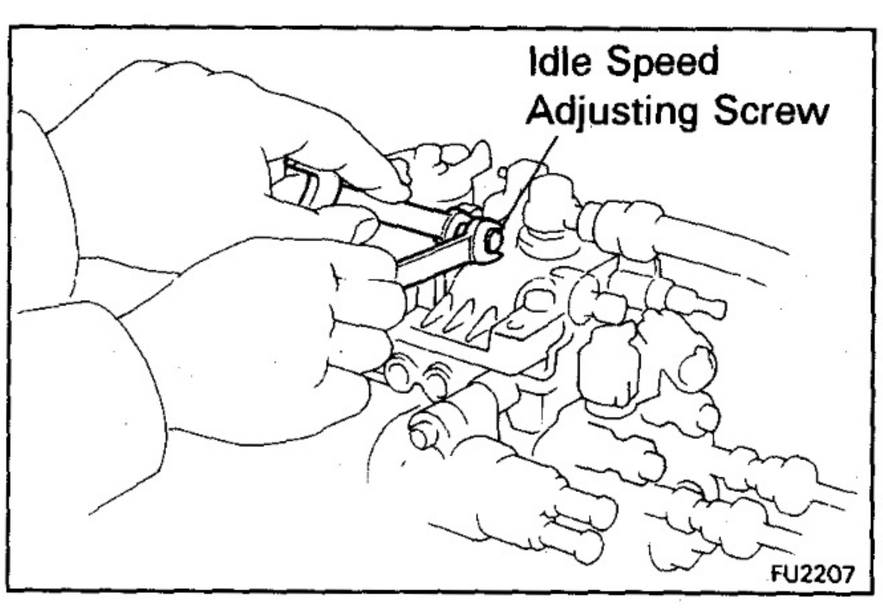
Protrusion: 0.5 — 2.0 mm (0.020 — 0.079 in.)



FU1887

14. ADJUST IDLE SPEED

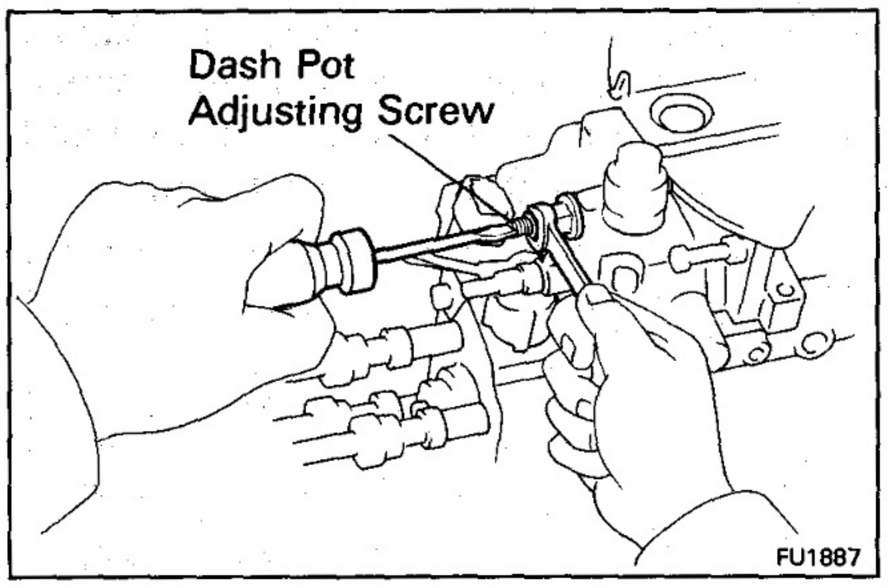
(a) (11B and 14B)
Loosen the dash pot adjusting screw fully.



FU2207

(b) (11B and 14B)
Adjust the injection volume with the IDLE SPEED ADJUSTING SCREW.

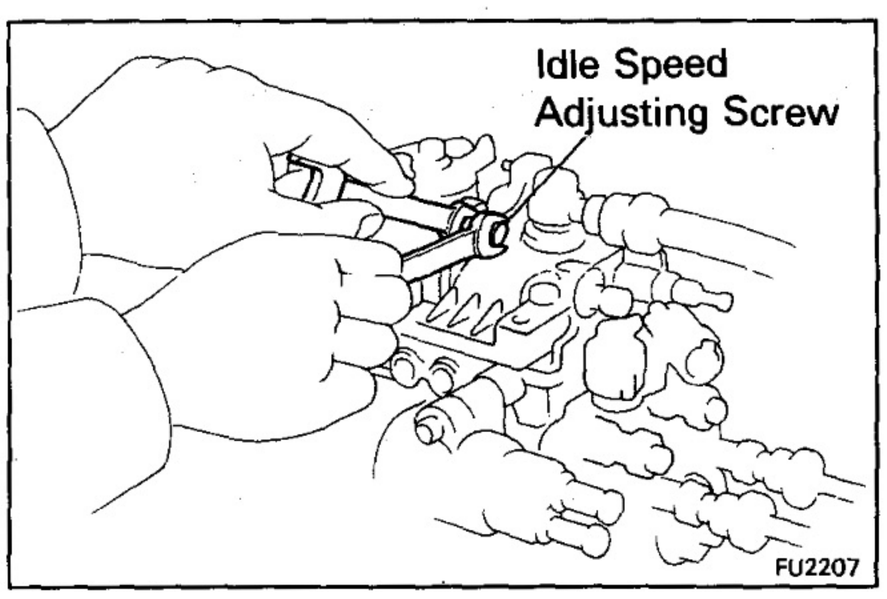
Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
Minus 12—22°	325	200	q=3.8—4.2 (0.23—0.26)	Lever set



(c) (11B and 14B)
Adjust the injection volume with the DASH POT ADJUSTING SCREW.

HINT: The stroke will decrease with turn to clockwise and increase with turn to counterclockwise.

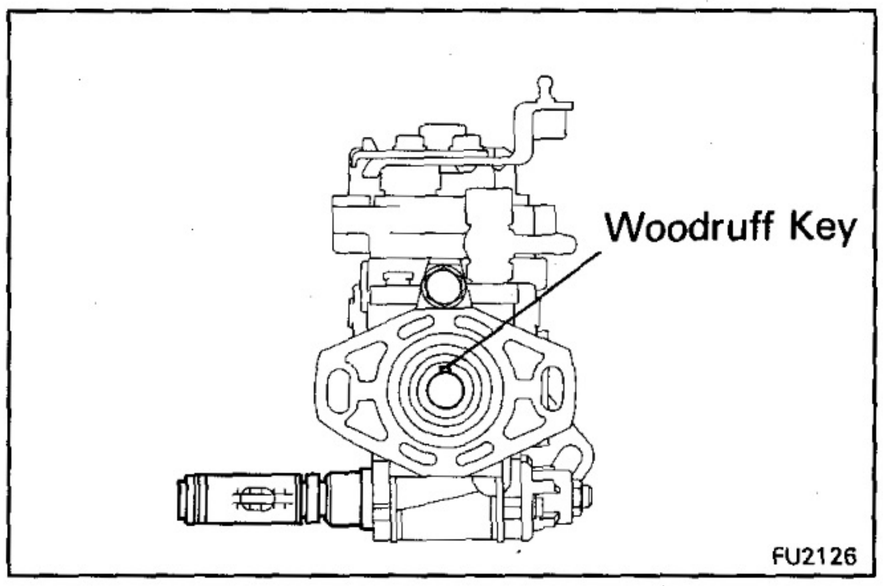
Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
Minus 12 — 22°	325	200	q plus 0.2—0.4 (0.01—0.02)	Dash pot set



(d) Adjust the injection volume with the idle speed adjusting screw.

Item	Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection vokume cc (cu in.)	Remarks
B	Minus 10.5 — 20.5°	325	1,000	9.25 — 13.25 (0.56 — 0.81)	—
		500		Less than 4 (0.24)	—
3B	Minus 12 — 22°	325		10 — 15 (0.61 — 0.92)	—
		500		Less than 4 (0.24)	—
11B, 14B		325	200	1.1 — 2.7 (0.07 — 0.16)	Lever set

w/ HAC Apply 730 ± 1.5 mmHg (28.74 ± 0.06 in. Hg, 97.3 ± 0.2 kPa) absolute pressure



15. [w/ ACSD]
ADJUST COLD STARTING SYSTEM

(a) Remove the overflow screw and check the fuel temperature in the fuel pump.

Fuel temperature: 15 — 35°C (59 — 95°F)

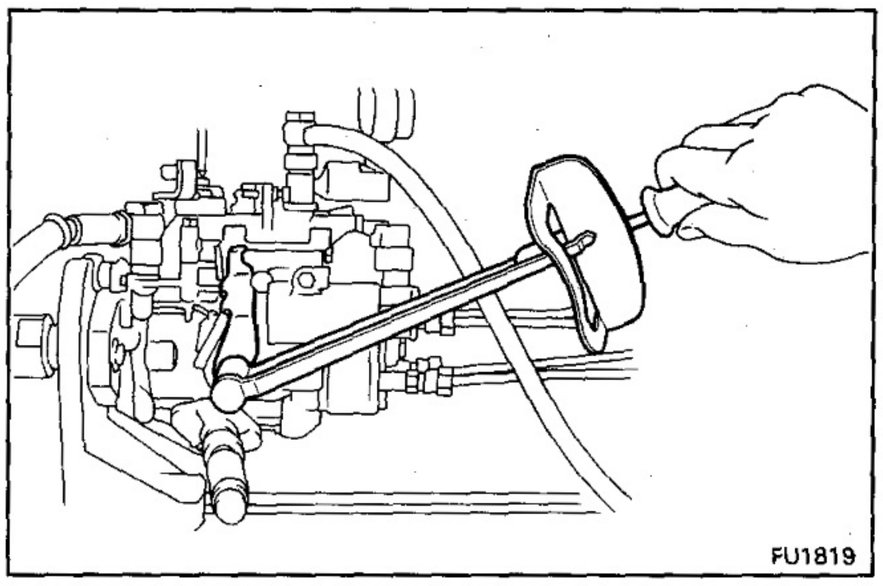
(b) Set the woodruff key on the pump drive shaft in a vertical or horizontal position.

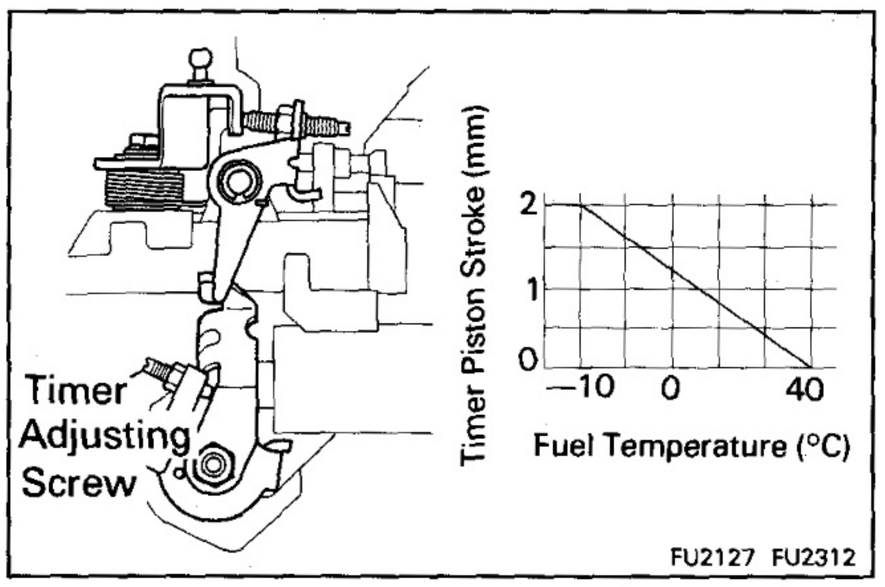
(c) Set the scale of the timer measuring device to zero.

(d) Check the adjusting lever opening angle and consider this angle as zero.

(e) Remove the metal plate put between the cold starting lever and thermo wax.

(f) Torque the cold starting lever clockwise to approx. 50 kg-cm (43 in.-lb, 4.9 N·m) and keep the lever tightened for about 10 seconds. Then release the torque.

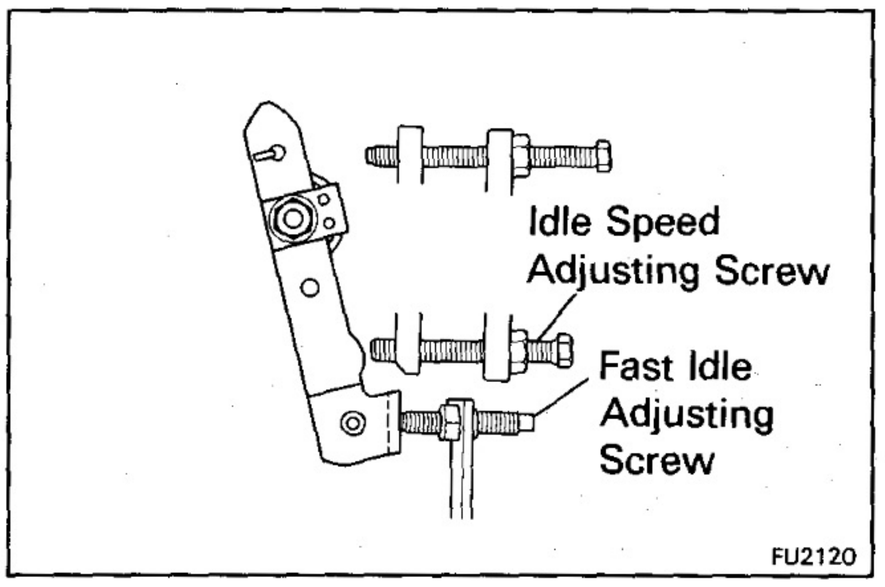




(g) Measure the timer piston stroke.

If not within specification, adjust with the timer adjusting screw.

HINT: Screw in for stroke decrease.

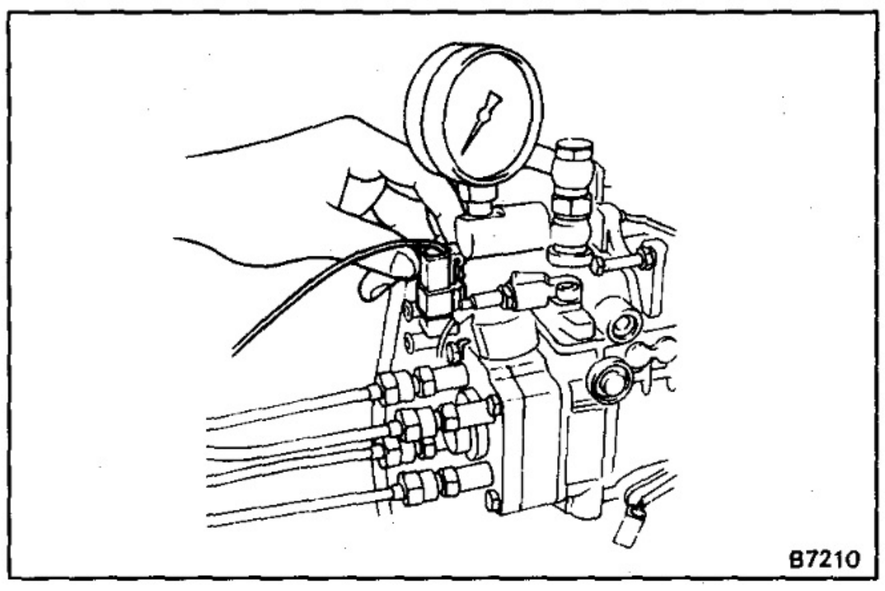


16. ADJUST FAST IDLE

(a) Measure the clearance between the adjusting lever and idle speed adjusting screw.

Fuel temperature	Clearance
15°C (59°F)	1.9 mm (0.075 in.)
40°C (104°F)	0 mm (0 in.)

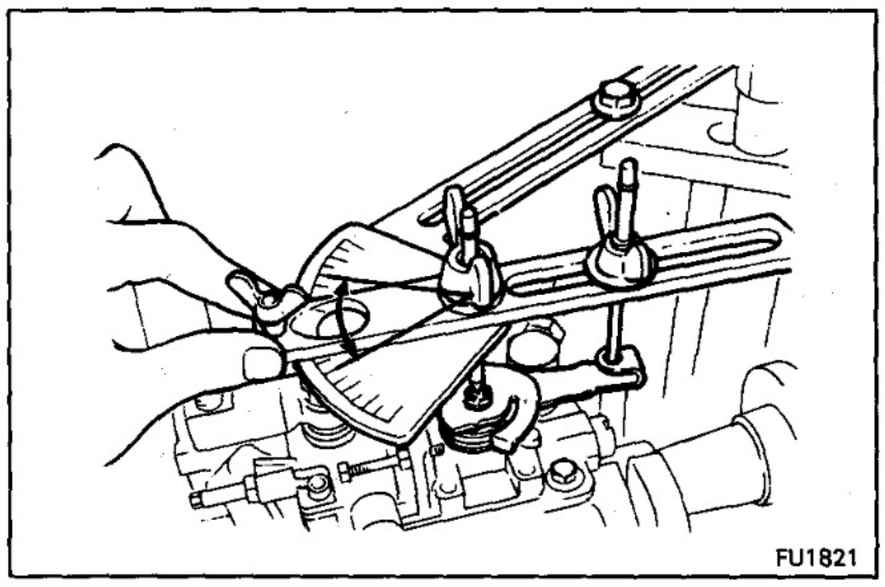
(b) Adjust the fast idle adjusting screw.


B7210

17. POST ADJUSTMENT CHECK

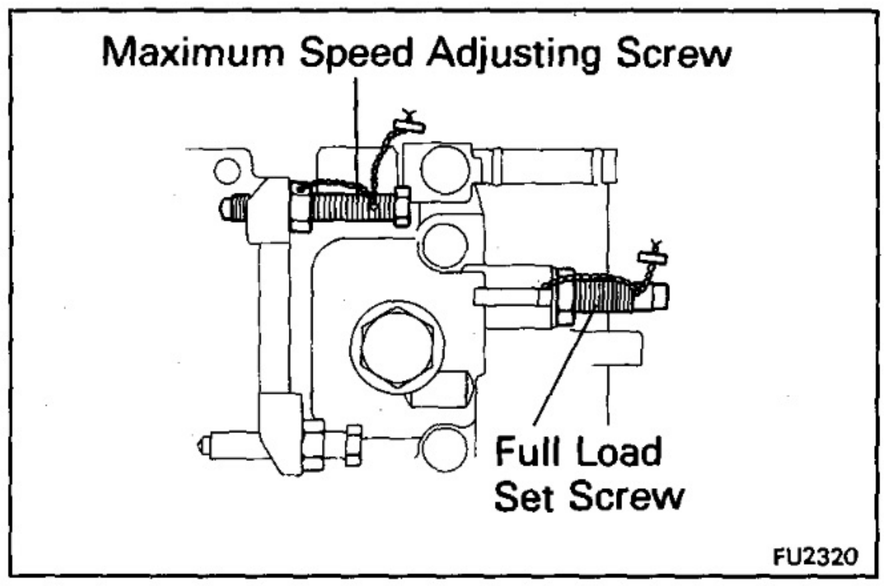
(a) Check that injection stops when the fuel cut solenoid harness is removed.

Pump revolution: **B, 3B 100 rpm**
11B, 14B 200 rpm


FU1821

(b) Check the adjusting lever movement.

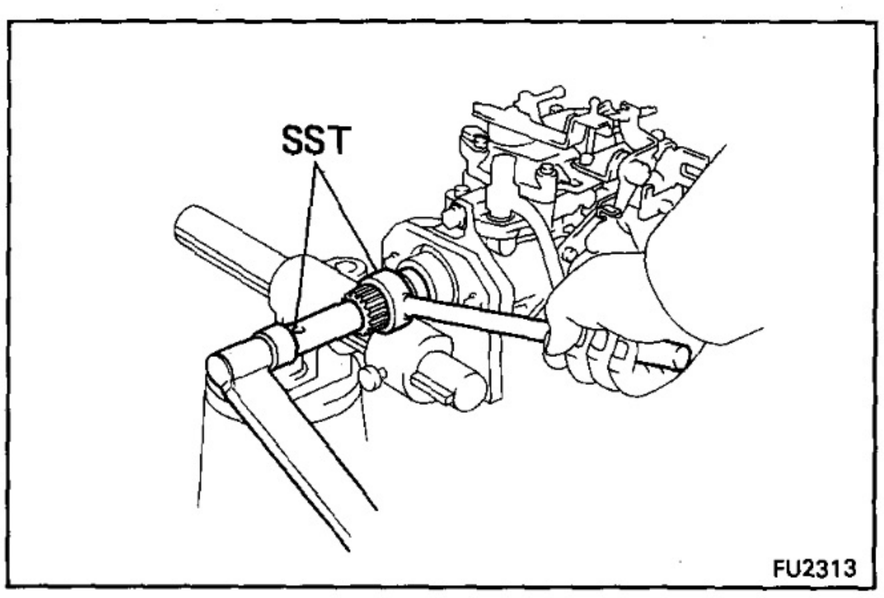
B	**36.5 — 46.5°**
3B, 11B, 14B	**38 — 48°**



FU2320

(c) Lock the maximum speed adjusting screw and full load set screw with the wires as shown in the figure.

18. INSTALL TWO FUEL PIPES AND CLAMP



FU2313

19. INSTALL SPLINE SHAFT

(a) Install the set key on the drive shaft.

(b) Align the set key groove of the spline shaft with the set key.

(c) Using SST, install the spline shaft with the spring washer and round nut.

SST 09260-58010 (09266-76011, 09278-46020)

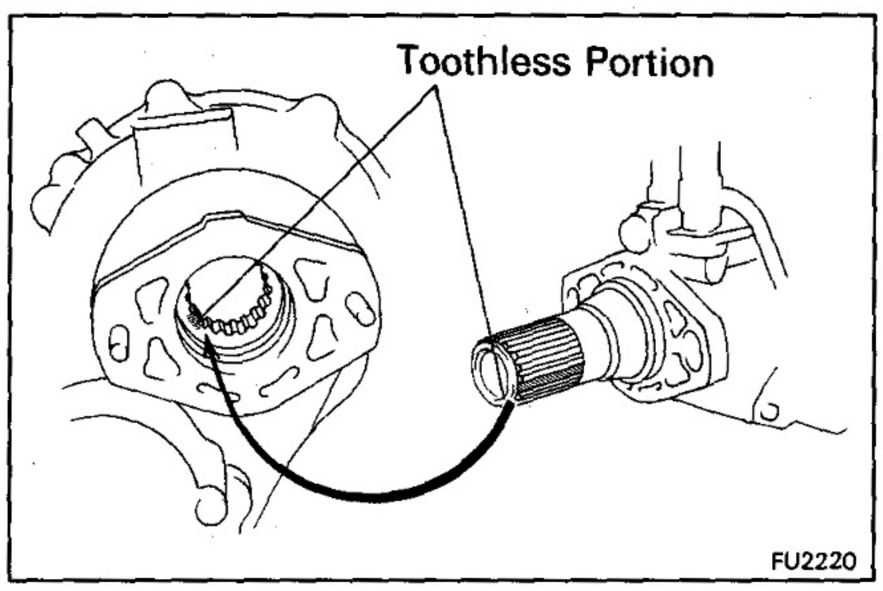
Torque: 550 kg-cm (40 ft-lb, 54 N·m)

INSTALLATION OF INJECTION PUMP

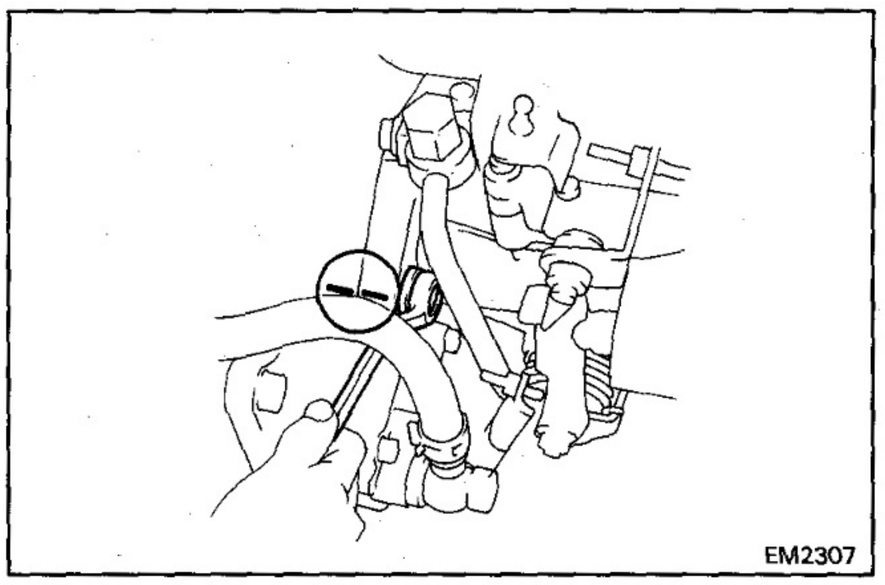
(See page FU-20)

1. INSTALL INJECTION PUMP

(a) Install a new O-ring to the injection pump flange.



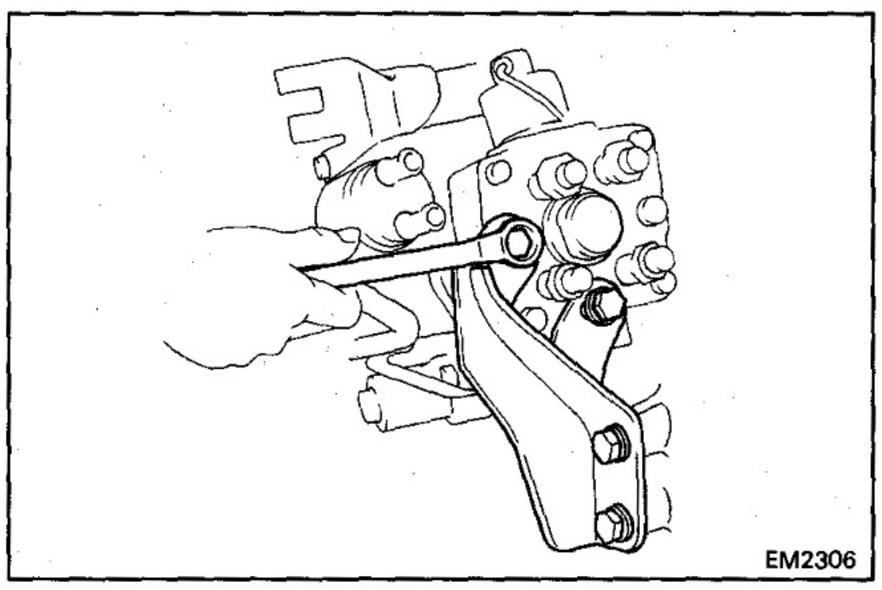
(b) Align the spline toothless portions of the injection pump and injection pump drive gear, and install the injection pump.



(c) Align the matchmark of the injection pump flange and timing gear case.

(d) Install the injection pump with the two nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

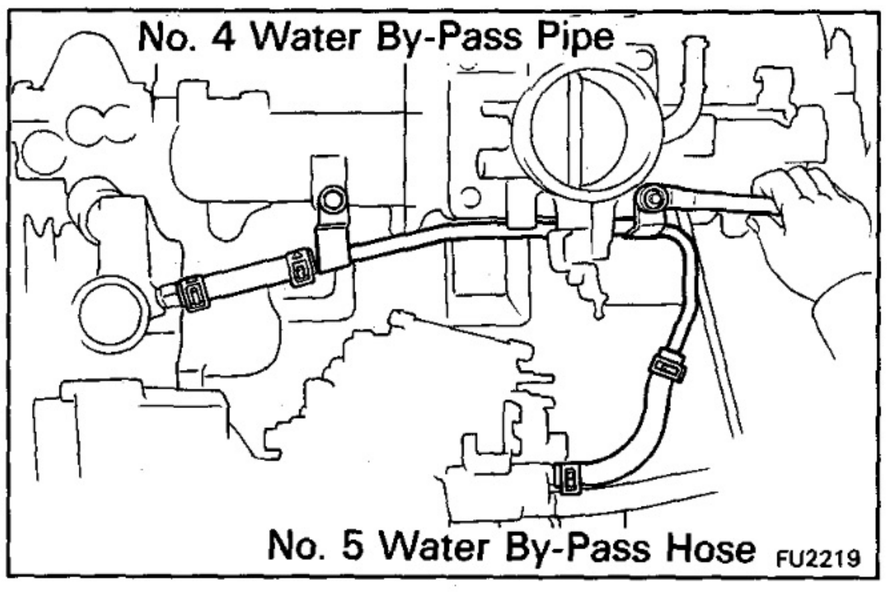


(e) Install the injection pump stay with the four bolts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

2. INSTALL PARTS

(a) Fuel return hose



(b) (w/ ACSD)
No.5 water by-pass hose

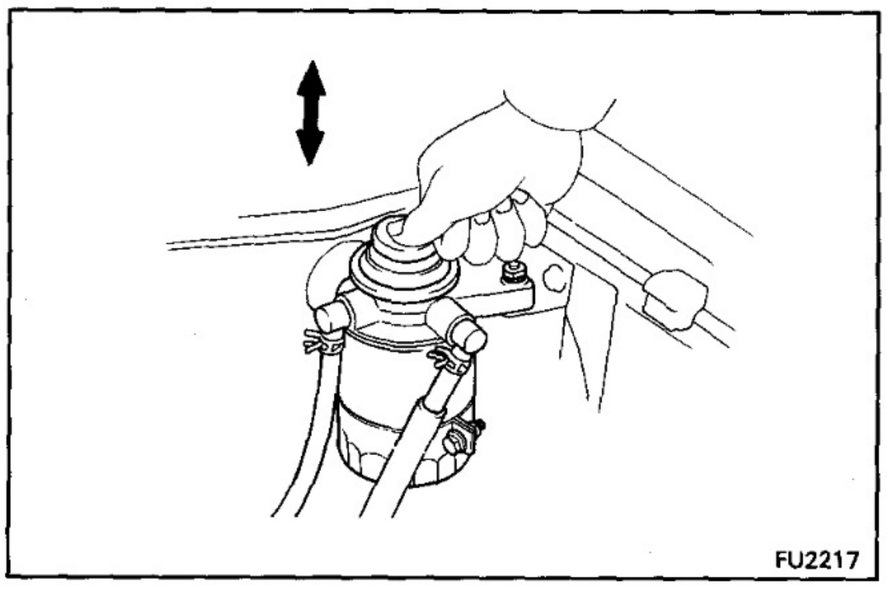
(c) (w/ ACSD)
No.4 water by-pass pipe with hoses

(d) Accelerator connecting rod

(e) (A/T)
Throttle cable

3. INSTALL INJECTION PIPES
(See step 3 on page FU-13) B and 3B
(See step 3 on page FU-19) 11B and 14B

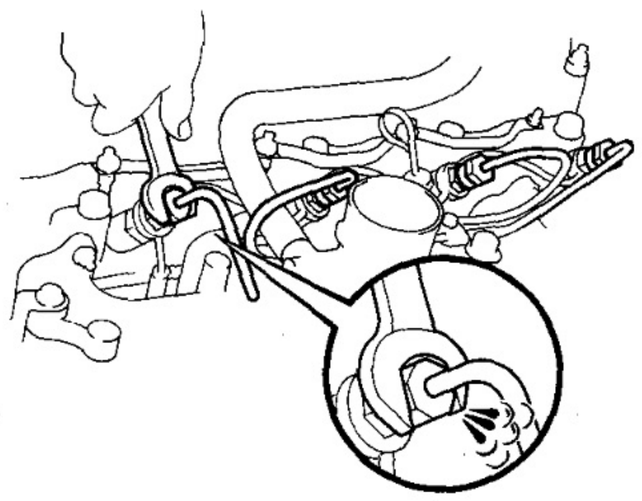
4. [w/ ACSD]
FILL WITH COOLANT
(See step 3 on page CO-5)



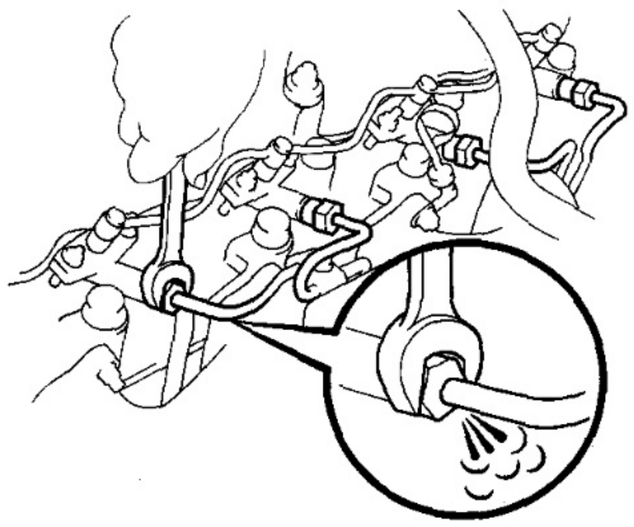
5. FILL INJECTION PUMP WITH FUEL

Operate the priming pump until you feel more resistance.

B and 3B



11B and 14B



6. BLEED INJECTION NOZZLES

(a) Loosen all union nuts of the injection pipe on the nozzle holder side.

(b) Crank the engine to bleed the air and force out the fuel from the injection pipe.

7. START ENGINE AND CHECK FOR FUEL LEAKS

8. CHECK ENGINE IDLE SPEED AND MAXIMUM SPEED (See page EM-25)

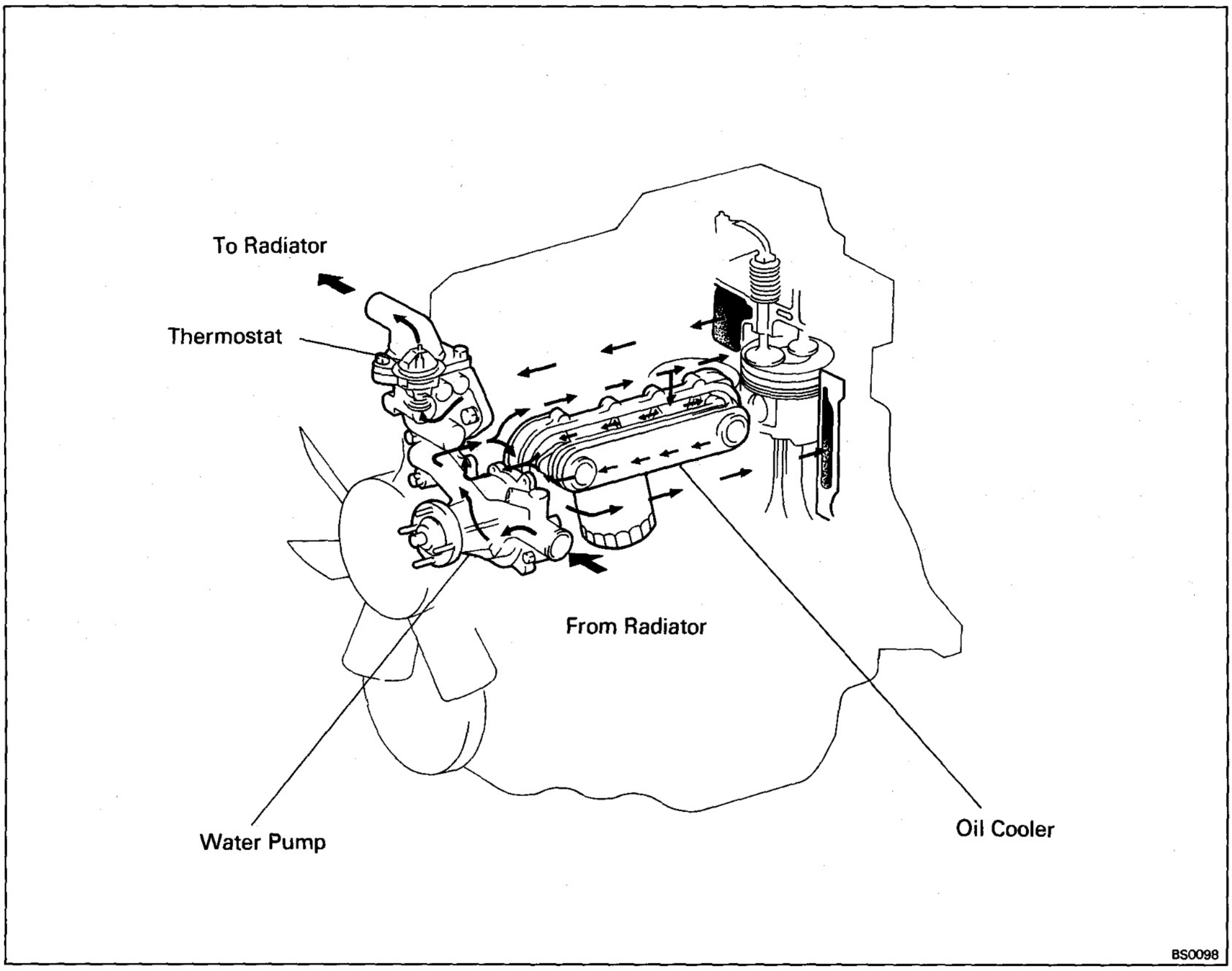
9. [w/ ACSD]
RECHECK COOLANT LEVEL

COOLING SYSTEM

	Page
DESCRIPTION	CO-2
TROUBLESHOOTING	CO-4
CHECK AND REPLACEMENT OF ENGINE COOLANT	CO-4
WATER PUMP	CO-6
THERMOSTAT	CO-8
RADIATOR	CO-10

DESCRIPTION

This engine utilizes a pressurized water forced circulation cooling system which includes a thermostat equipped with a bypass valve mounted on the outlet side.



The cooling system is composed of the water jacket (inside the cylinder block and cylinder head), radiator, water pump, thermostat, cooling fan, hoses and other components.

Coolant which is heated in the water jacket is pumped to the radiator, where the cooling fan and the vehicle airstream as it passes through. Coolant which has been cooled is then sent back to the engine by the water pump, where it cools the engine.

The water jacket is a network of channels in the shell of the cylinder block and cylinder head through which coolant passes. It is designed to provide adequate cooling of the cylinders and combustion chambers which become the hottest during engine operation.

RADIATOR

The radiator performs the function of cooling the coolant which has passed through the water jacket and become hot, and is mounted in the front of the vehicle. The radiator consists of an upper tank and lower tank, and a core which connects the two tanks. The upper tank contains the inlet for coolant from the water jacket and, depending on the model, a hole for replenishing water. It also has a hose attached through which excess coolant or steam can flow. The lower tank contains the outlet for coolant and the drain cock. The core contains many tubes through which coolant flows from the upper tank to the lower tank as well as cooling fins which radiate heat away from the coolant in the tubes. Coolant which has passed through the water jacket and become hot is cooled in this part by the air sucked in by the cooling fan and by the wind generated by the vehicle's travel. Models with automatic transmissions include an automatic transmission fluid cooler built into the lower tank of the radiator.

RADIATOR CAP

The radiator cap is a pressure type cap which seals the radiator, resulting in pressurization of the radiator as the coolant expands. The pressurization prevents the coolant from boiling even when the coolant temperature exceeds 100°C (212°F). A relief valve (pressurization valve) and a vacuum valve (negative pressure valve) are built into the radiator cap. The relief valve opens and lets steam escape through the overflow pipe when the pressure generated inside the cooling system exceeds the limit (coolant temperature: 110 — 120°C, 230 — 248°F, pressure: 0.75 — 1.05 kg/cm², 10.7 — 14.9 psi, 73.5 — 103.0 kPa). The vacuum valve opens to let in atomspheric air to alleviate the vacuum which develops in the coolant system after the engine is stopped and the coolant temperature drops.

RESERVOIR TANK

The reservoir tank is used to catch coolant which overflows the cooling system as a result of volumetric expansion when the coolant is heated. The coolant in the reservoir tank returns to the radiator when the coolant temperature drops, thus keeping the radiator full at all times and avoiding needless coolant loss. To find out if the coolant needs to be replenished, check the coolant level in the reservoir tank.

WATER PUMP

The water pump is used for forced circulation of coolant through the cooling system. It is mounted on the front of the cylinder block and driven by a V-ribbed belt.

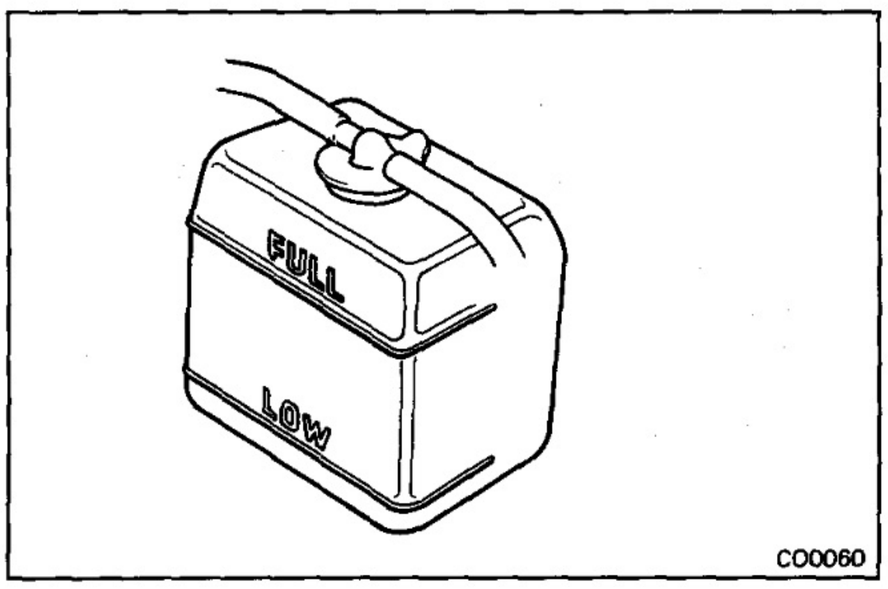
THERMOSTAT

The thermostat has a wax type bypass valve and is mounted in the water outlet housing. The thermostat is a type of automatic valve operated by fluctuations in the coolant temperature. This valve closes when the coolant temperature drops, preventing the circulation of coolant through the radiator. Because the bypass valve is open the coolant inside the engine circulates inside the engine only, thus permitting the engine to warm up rapidly. When the coolant temperature has risen, the thermostat valve opens and the bypass valve closes allowing the circulation of coolant through the engine and radiator. Wax inside the thermostat expands when heated and contracts when cooled. Heating the wax thus generates pressure which overpowers the force of the spring keeping the valve closed, thus opening the valve. When the wax cools, its contraction causes the force of the spring to take effect once more, closing the valve. In this engine two types of thermostat are used which operate at temperatures of 82°C (180°F) and 88°C (190°F) respectively.

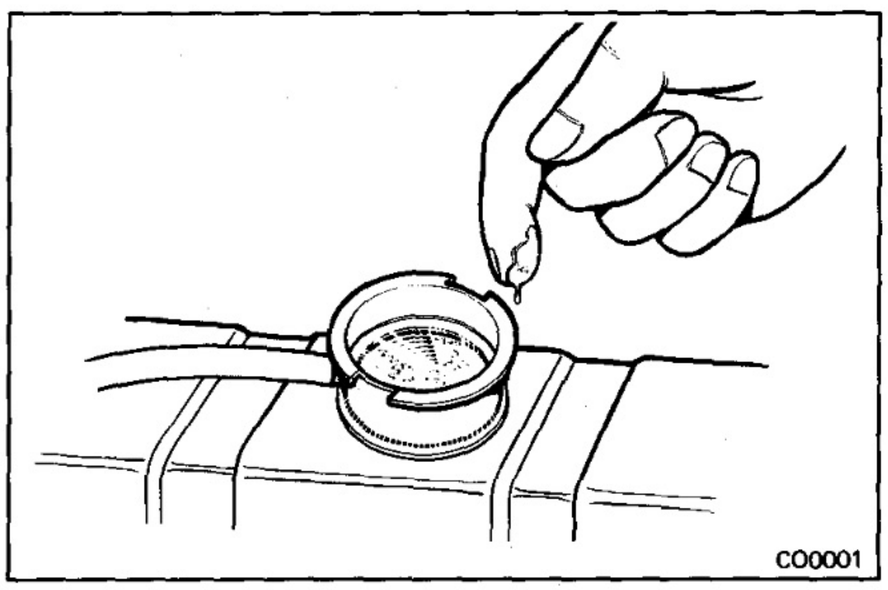
TROUBLESHOOTING

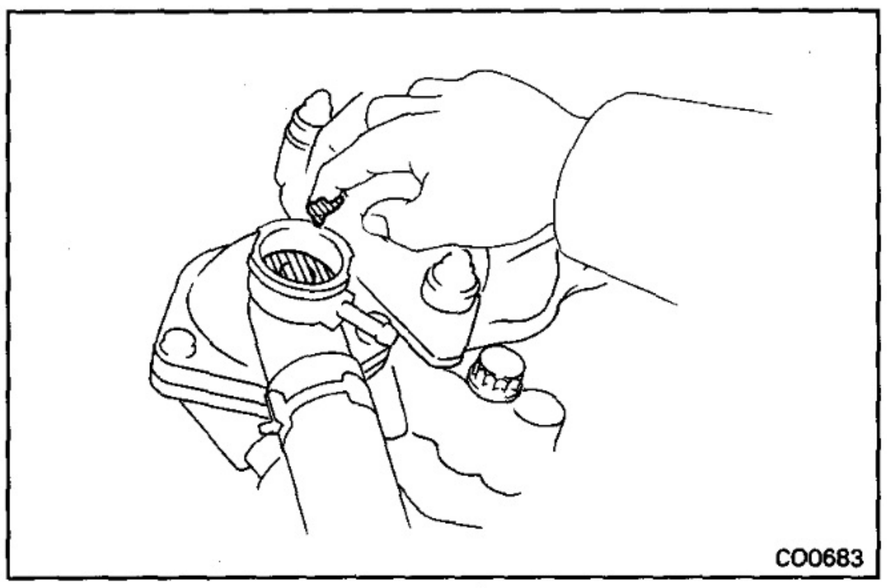
Problem	Possible cause	Remedy	Page
Engine overheats	Fan belt loose or missing	Adjust or replace belt	CH-5
	Dirt, leaves or insects in radiator or condenser	Clean radiator or condenser	CO-10
	Hoses, water pump, thermostat housing, radiator, heater, core plugs or head gasket leakage	Repair as necessary	
	Thermostat faulty	Check thermostat	CO-8
	Injection timing retarded	Adjust timing	EM-23
	Fluid coupling faulty	Replace fluid coupling	CO-6
	Radiator hose plugged or rotted	Replace hose	
	Water pump faulty	Replace water pump	CO-6
	Radiator plugged or cap faulty	Check radiator	CO-10
	Cylinder head or block cracked or plugged	Repair as necessary	

HINT: If the engine tends to overheat, removal of the thermostat will adversely effect cooling efficiency.



CO0060


CO0001


CO0683

CHECK AND REPLACEMENT OF ENGINE COOLANT

1. CHECK ENGINE COOLANT LEVEL AT RESERVE TANK

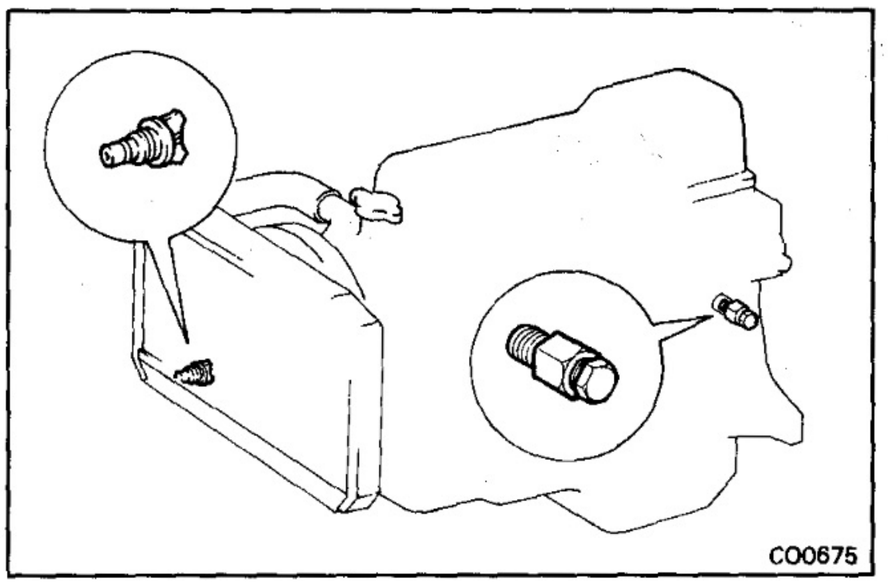
The coolant level should be between the "LOW" and "FULL" lines.

If low, check for leaks and add coolant up to the "FULL" line.

2. CHECK ENGINE COOLANT QUALITY

There should not be any excessive deposits of rust or scales around the radiator cap (water outlet cap) or radiator filler hole (water filler hole), and the coolant should be free from oil.

If excessively dirty, replace the coolant.



3. REPLACE ENGINE COOLANT

(a) Remove the radiator cap.

(b) Drain the coolant from radiator and engine drain cocks. (Engine drain cock is at left front of engine block.)

(c) Close the drain cocks.

(d) Fill the system with coolant.

Use a good brand of ethylene-glycol base coolant, mixed according to the manufacturer's directions.

Capacity (w/ Heater)

BB		**15.0 liters (15.9 US qts, 13.2 Imp. qts)**
BJ60		**13.3 liters (14.1 US qts, 11.7 Imp. qts)**
BJ70, 73, 75		**13.8 liters (14.6 US qts, 12.1 Imp. qts)**
BU	**Regular cab**	**12.5 liters (13.2 US qts, 11.0 Imp. qts)**
	Wide cab	**13.0 liters (13.7 US qts, 11.4 Imp. qts)**
BY (w/o Heater)		**11.6 liters (12.3 US qts, 10.2 Imp. qts)**

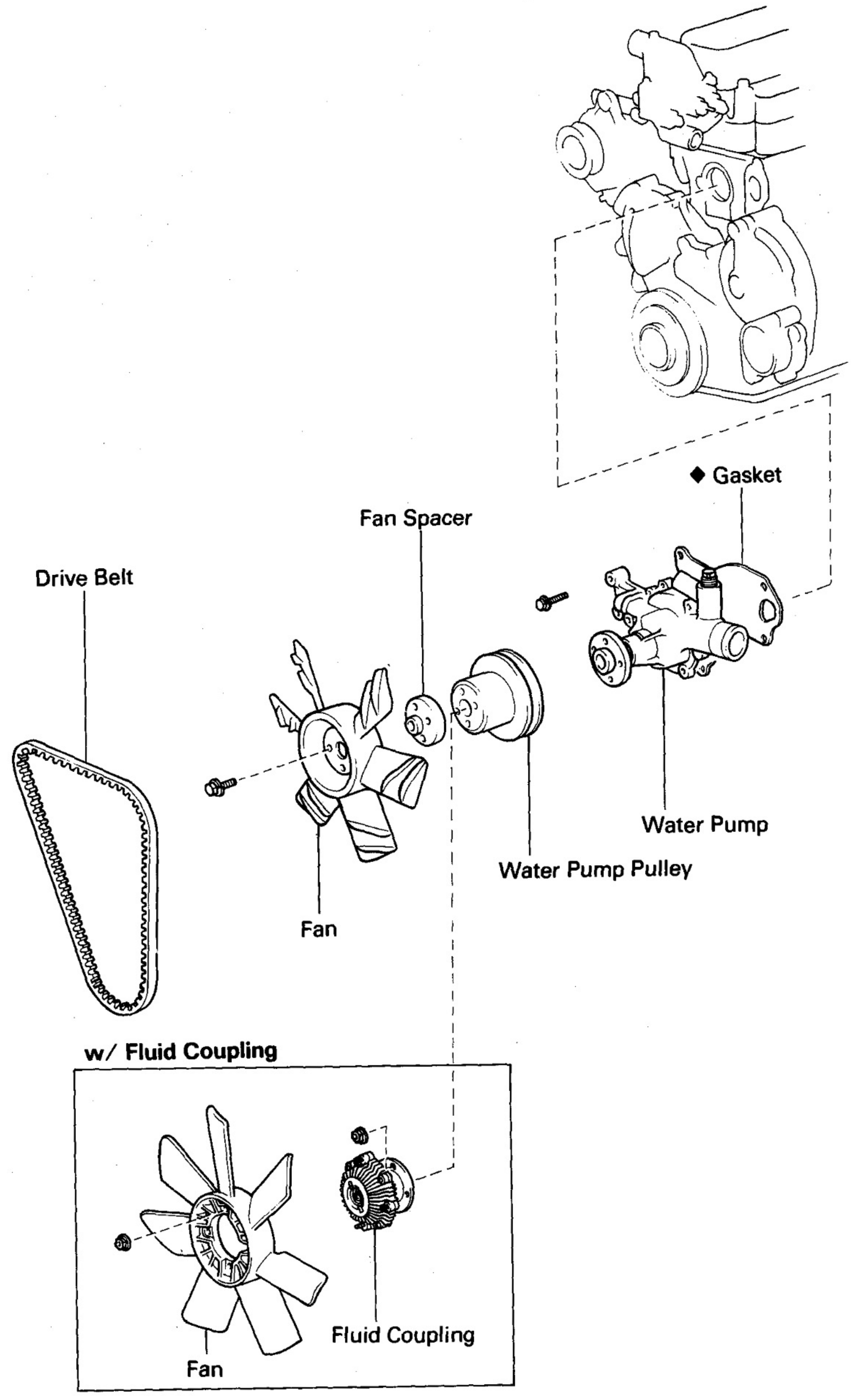
(e) Install the radiator cap (water outlet cap).

(f) Start the engine and check for leaks.

(g) Recheck the coolant level and refill as necessary.

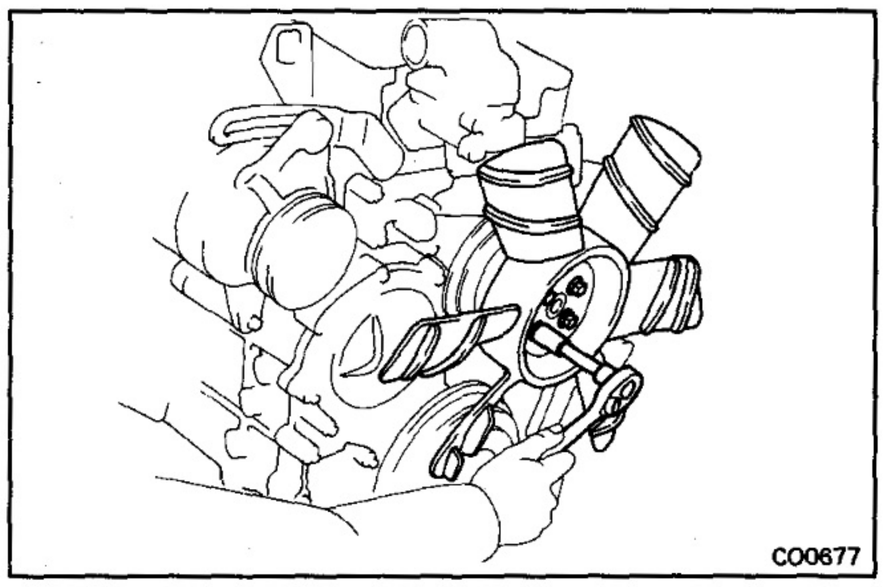
WATER PUMP

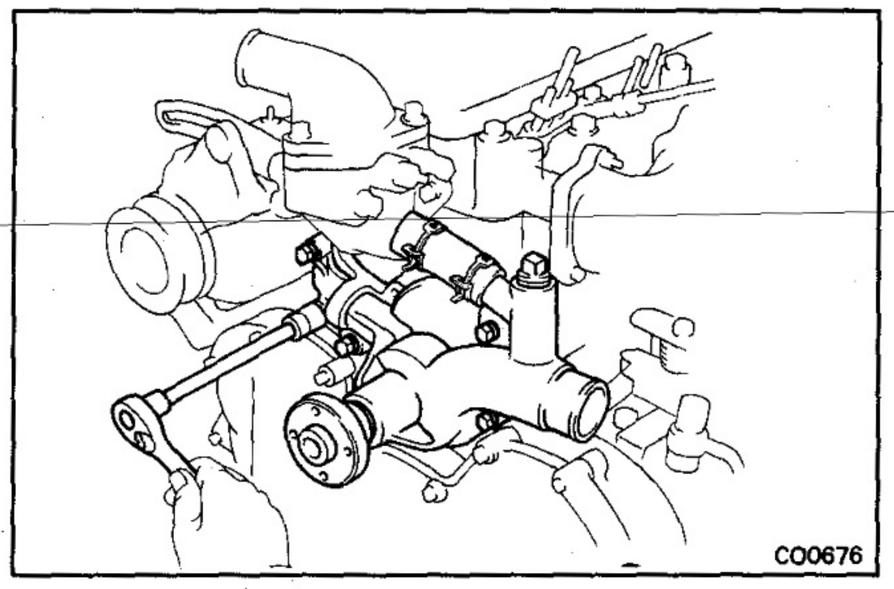
REMOVAL OF WATER PUMP

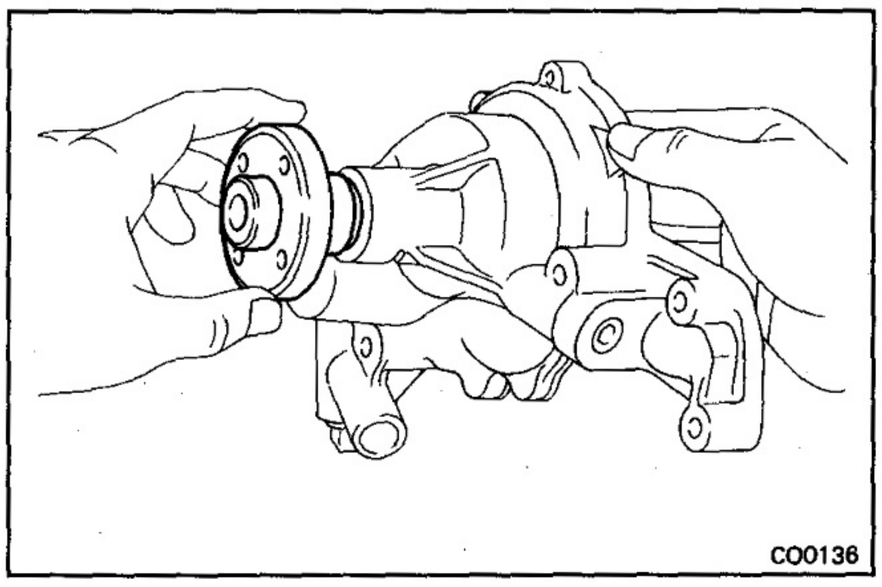


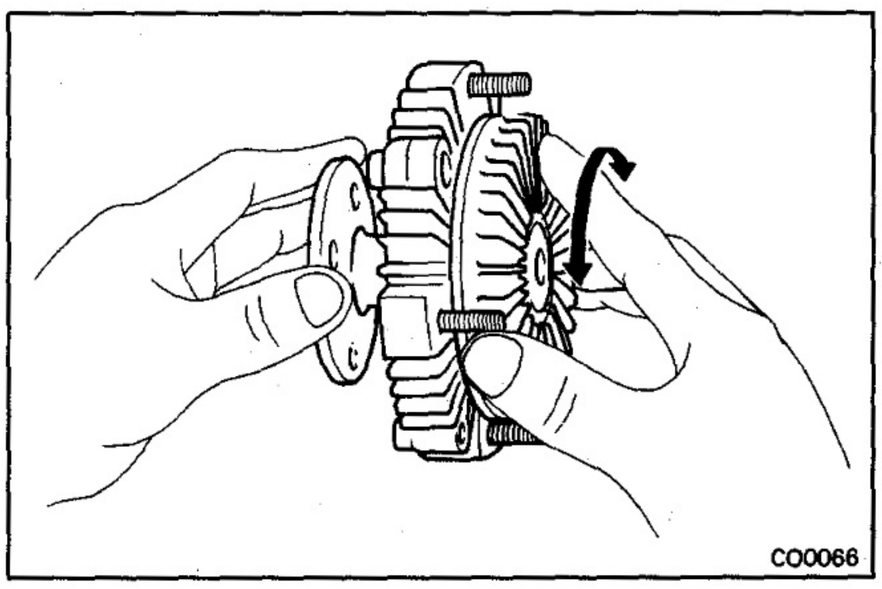
◆ Non-reusable part

CO0682


CO0677


CO0676


CO0136


CO0066

1. **DRAIN ENGINE COOLANT (See page CO-5)**

2. **REMOVE DRIVE BELT**

3. **REMOVE FAN AND WATER PUMP PULLEY**

[w/o Fluid Coupling]

Remove the four bolts holding the fan to the pulley seat, and remove the fan, fan spacer and pump pulley.

[w/ Fluid Coupling]

Remove the four nuts holding the fluid coupling to the pulley seat, and remove the fan and fluid coupling assembly and the pump pulley.

4. **REMOVE WATER PUMP**

(a) Remove the five bolts.

(b) Disconnect the water by-pass hose, and remove the water pump and gasket.

INSPECTION OF WATER PUMP COMPONENTS

1. **INSPECT WATER PUMP**

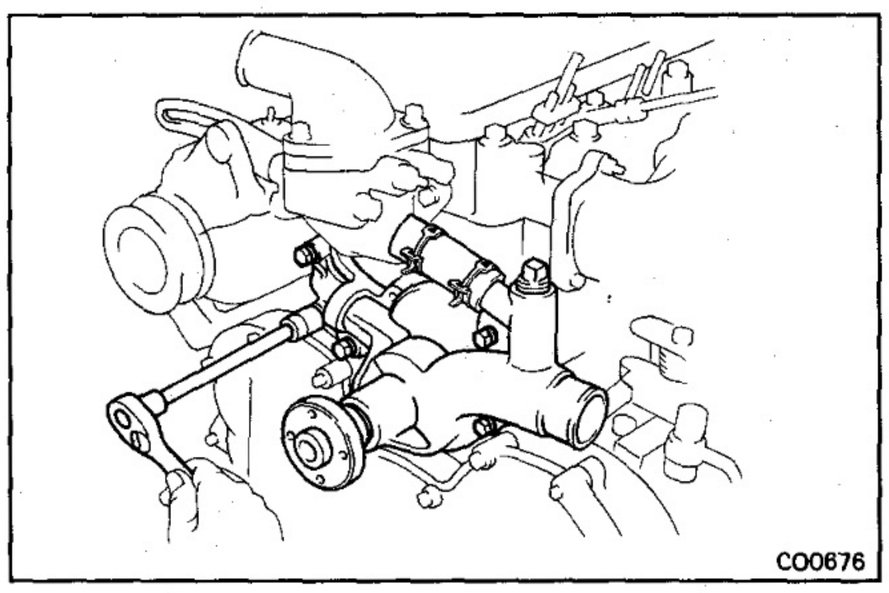
Turn the pulley seat and check that the water pump bearing moves smoothly and quietly.

If necessary, replace the water pump.

2. **INSPECT FLUID COUPLING**

Check that the fluid coupling for damage and silicon oil leakage.

If necessary, replace the fluid coupling.



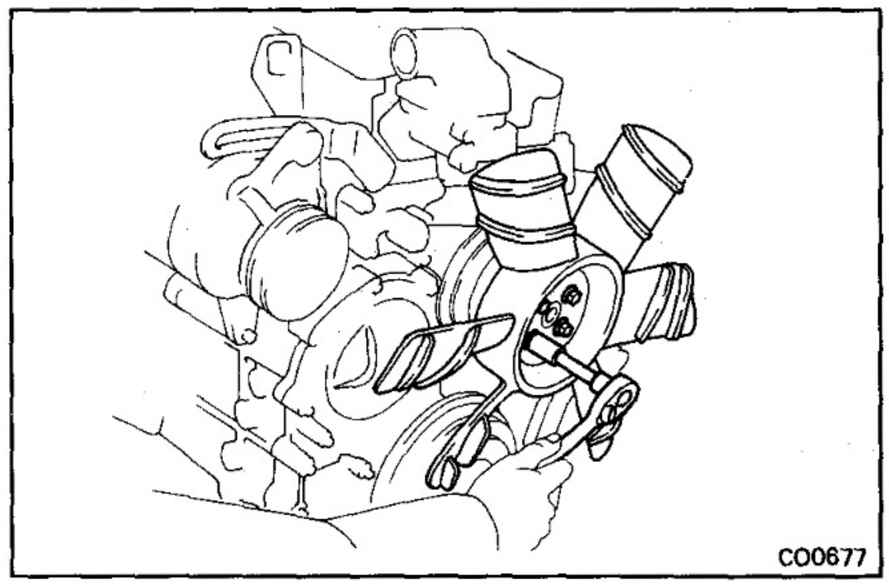
INSTALLATION OF WATER PUMP

(See page CO-6)

1. INSTALL WATER PUMP

Connect the water by-pass hose, install a new gasket and the water pump with the five bolts.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)



2. INSTALL WATER PUMP PULLEY AND FAN

[w/o Fluid Coupling]

Install the pump pulley and the drive shaft and fan assembly with the four bolts.

[w/ Fluid Coupling]

Install the pump pulley and the fluid coupling and fan assembly with the four nuts.

3. INSTALL AND ADJUST DRIVE BELT
(See page CH-5)

4. REFILL WITH COOLANT (See page CO-5)

5. START ENGINE AND CHECK FOR LEAKS

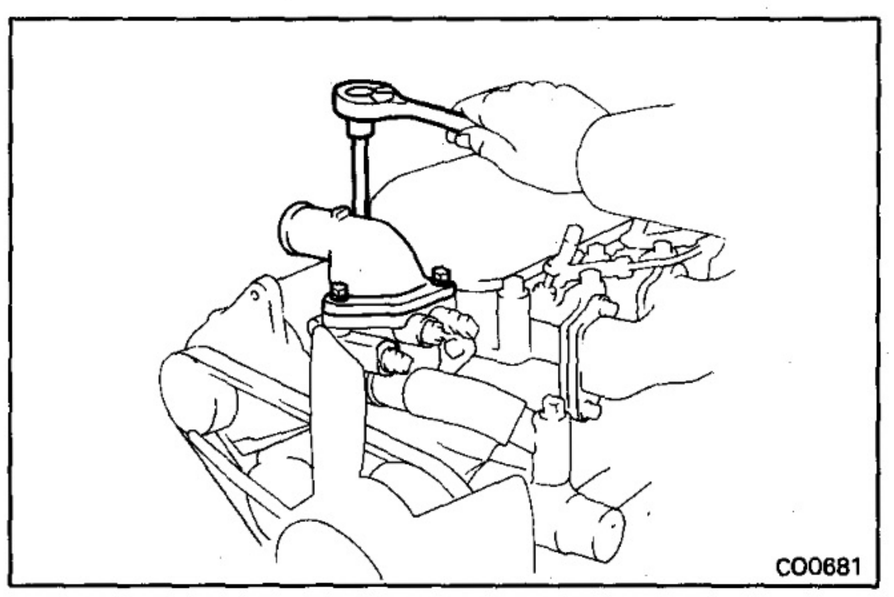
THERMOSTAT

REMOVAL OF THERMOSTAT

1. DRAIN ENGINE COOLANT (See page CO-5)

2. DISCONNECT RADIATOR INLET HOSE FROM WATER OUTLET

3. [WATER OUTLET CAP TYPE]
DISCONNECT COOLANT RESERVOIR HOSE AND WATER BY-PASS HOSE(S) FROM WATER OUTLET

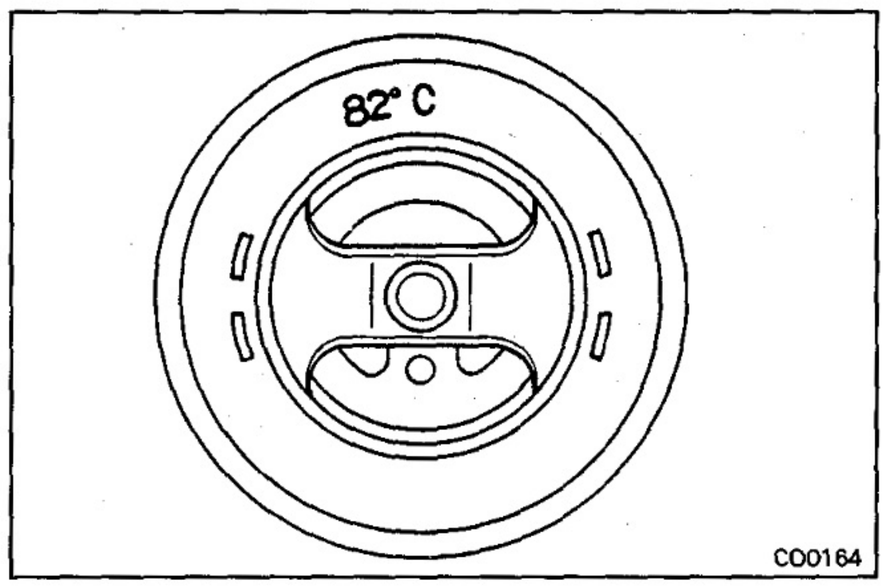


4. REMOVE WATER OUTLET

Remove the three bolts and water outlet.

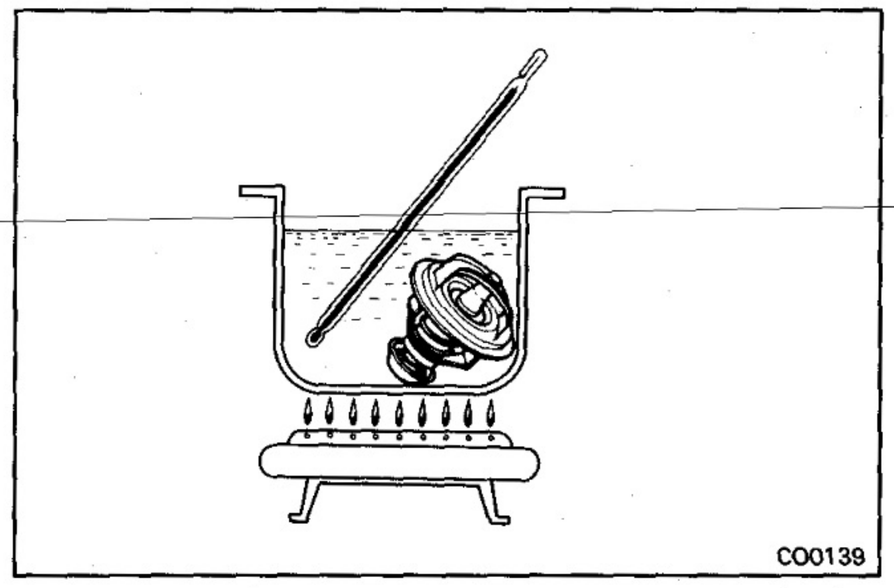
5. REMOVE THERMOSTAT

Remove the gasket from the thermostat.



INSPECTION OF THERMOSTAT

HINT: The thermostat is numbered with the valve opening temperature.

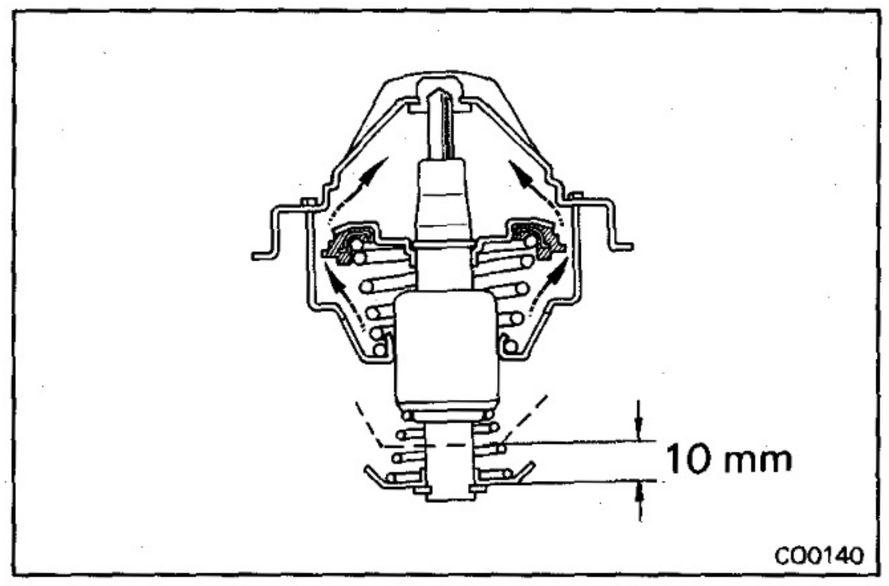


(a) Immerse the thermostat in water and gradually heat the water.

(b) Check the valve opening temperature.

Valve opening temperature:
82°C type 80 — 84°C (176 — 183°F)
88°C type 86 — 90°C (187 — 194°F)

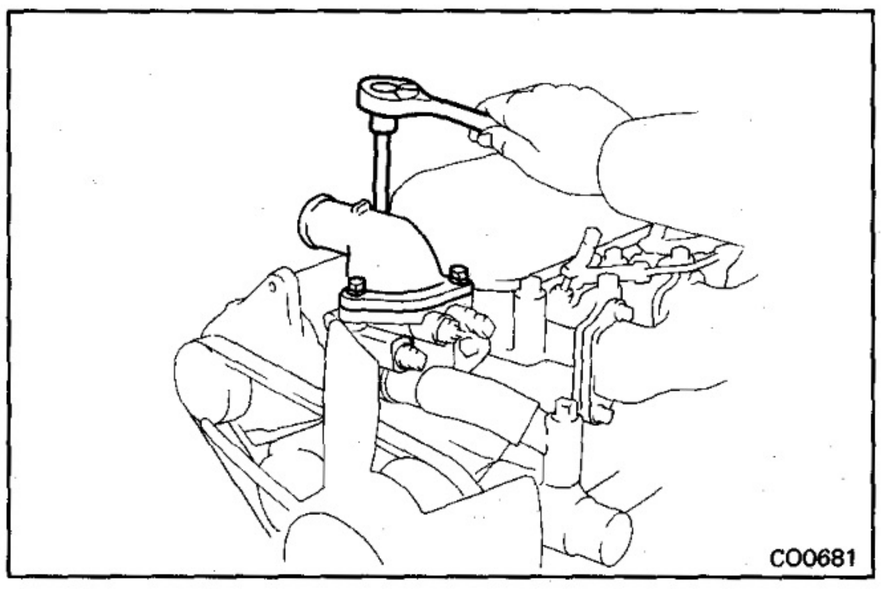
If the valve opening temperature is not within specification, replace the thermostat.



(c) Check the valve lift.

Valve lift:
82°C type
10 mm (0.39 in.) or more at 95°C (203°F)
88°C type
10 mm (0.39 in.) or more at 100°C (212°F)

If the valve lift is less than specification, replace the thermostat.



INSTALLATION OF THERMOSTAT

1. **PLACE THERMOSTAT IN WATER OUTLET HOUSING**

   Install a new gasket to thermostat.

2. **INSTALL WATER OUTLET**

   Install the water outlet with the three bolts. Torque the bolts.

   Torque: 185 kg-cm (13 ft-lb, 18 N·m)

3. **[WATER OUTLET CAP TYPE]**
   CONNECT COOLANT RESERVOIR HOSE AND WATER BY-PASS HOSE(S)

4. **CONNECT RADIATOR INLET HOSE**

5. **FILL ENGINE WITH COOLANT (See page CO-5)**

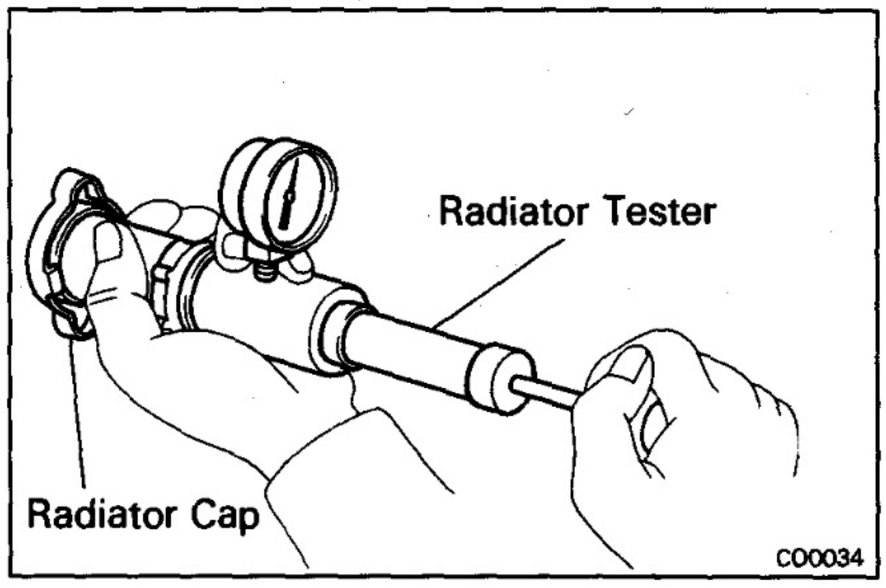
6. **START ENGINE AND CHECK FOR LEAKS**

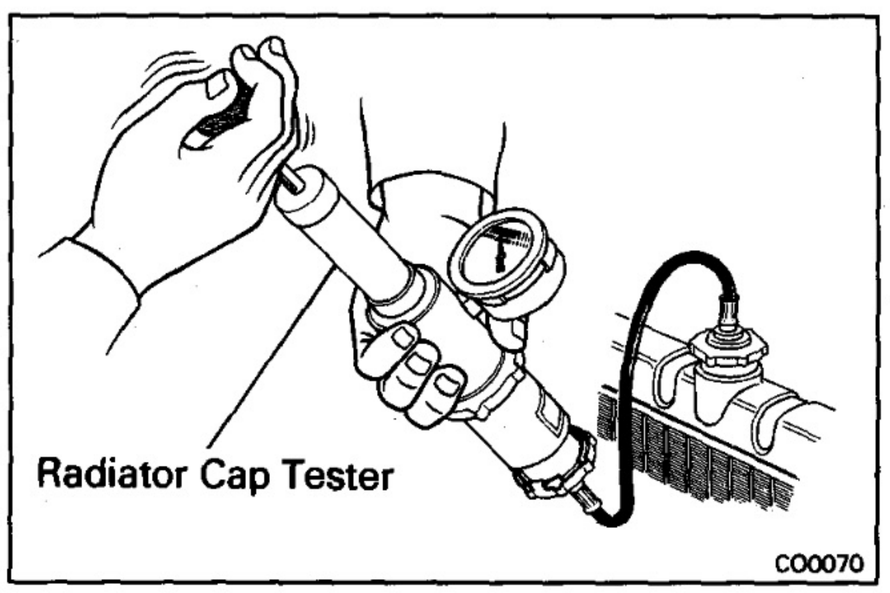
RADIATOR

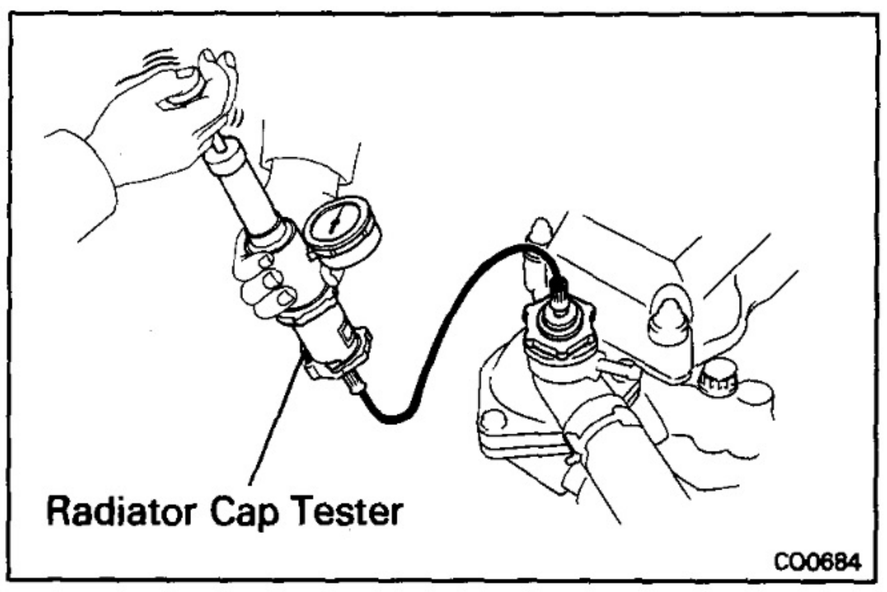
CLEANING OF RADIATOR

Using water or steam cleaner, remove any mud and dirt from the radiator core.

NOTICE: If using a high pressure type cleaner, be careful not to deform the fins of the radiator core. If the cleaner nozzle pressure is 30 — 35 kg/cm² (427 — 498 psi, 2,942 — 3,432 kPa), keep a distance of at least 40 — 50 cm (15.75 — 19.69 in.) between the radiator core and cleaner nozzle.







INSPECTION OF RADIATOR

1. INSPECT RADIATOR CAP OR WATER OUTLET CAP

Using a radiator cap tester, pump the tester until the relief valve opens. Check that the valve opens between 0.75 kg/cm² (10.7 psi, 74 kPa) and 1.05 kg/cm² (14.9 psi, 103 kPa).

Check that the pressure does not drop rapidly when pressure on the cap is below 0.6 kg/cm² (8.5 psi, 59 kPa).

If either check is not within limits, replace the cap.

2. INSPECT COOLING SYSTEM FOR LEAKS

(a) Fill the radiator with coolant and attach a pressure tester.

(b) Warm up the engine.

(c) Pump it to 1.2 kg/cm² (17 psi, 118 kPa), check that pressure does not drop.

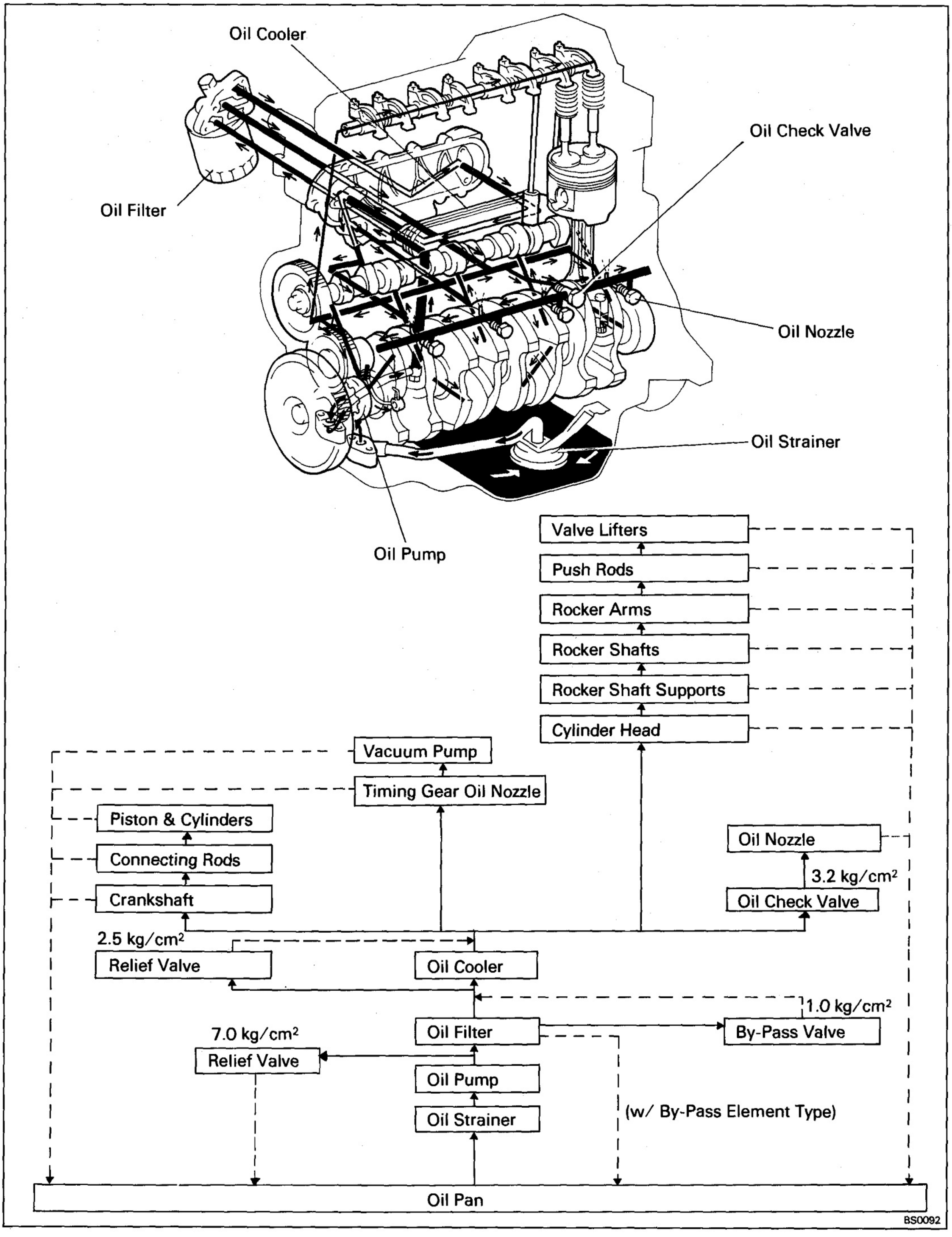
If the pressure drops, check for leaks from the hoses, radiator or water pump. If no external leaks are found, check the heater core, cylinder block and head.

LUBRICATION SYSTEM

	Page
DESCRIPTION	LU-2
TOUBLESHOOTING	LU-4
OIL PRESSURE CHECK	LU-4
REPLACEMENT OF ENGINE OIL AND OIL FILTER	LU-5
OIL PUMP	LU-7
OIL COOLER AND RELIEF VALVE	LU-17
OIL NOZZLES AND CHECK VALVE	LU-21

DESCRIPTION

A fully pressurized, fully filtered lubrication system has been adopted for this engine.



A pressure feeding lubrication system is used to supply oil to the moving parts of this engine. The lubrication system consists of an oil pan, oil pump, oil filter and oil cooler, etc. The oil circuit is shown in the illustration at the top of the previous page. Oil from the oil pan is pumped up by the oil pump. After it passes through the oil filter, it is cooled by the oil cooler and fed through the oil holes in the crankshaft and cylinder block. After passing through each part and performing its lubricating and cooling function, the oil is returned by gravity to the oil pan. A dip stick on the side of the cylinder block is provided to check the oil level.

OIL PUMP

The oil pump pumps up oil from the oil pan and sends it under pressure to each part of the engine. An oil strainer is mounted at the inlet to the oil pump to remove impurities. The oil pump itself is a trochoid type pump, inside of which is a drive rotor and a driven rotor. When the drive rotor rotates, the driven rotor rotates in the same direction, and since the axis of the drive rotor shaft is different from the center of the driven rotor, the space between the two rotors changes as they rotate. Oil is drawn in when the space is wide and is discharged when the space is narrow.

OIL PUMP RELIEF VALVE

A relief valve is installed on the oil pump to prevent a sudden increase in hydraulic pressure when the engine is started at a low engine temperature. When the hydraulic pressure is 7 kg/cm^2 (99.6 psi, 686.5 kPa) or less, the relief valve is kept closed by the coil spring, but when the hydraulic pressure exceeds 7 kg/cm^2 (99.6 psi, 686.5 kPa), it overcomes the force the spring, the valve opens and the oil passes along the relief passage to return to the oil pan.

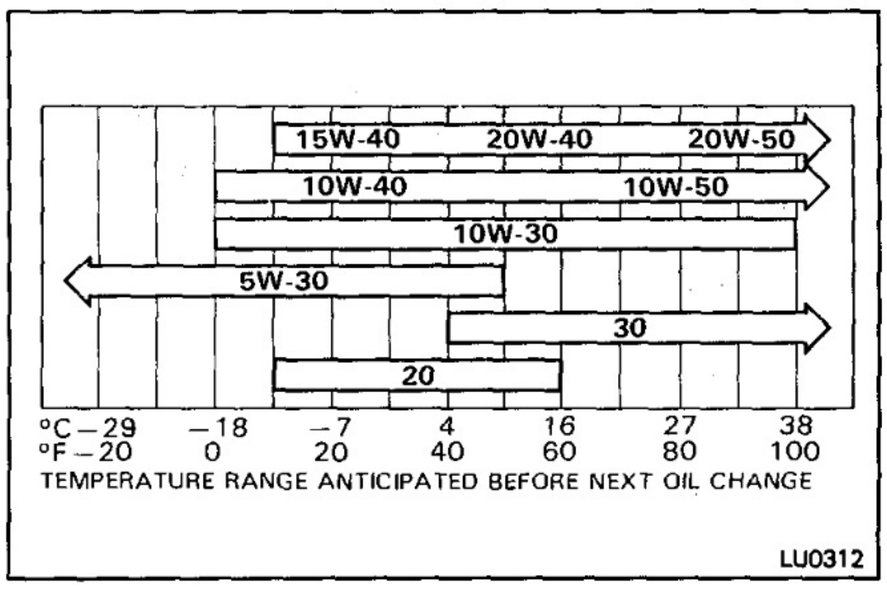
OIL FILTER

There are two types of oil filter, a full flow type and a twin element type with a bypass system.

Both types of filter have a paper filter element with a built-in relief valve. Particles of metal from wear, airborn dirt, carbon and other impurities can get in the oil during use and could cause accelerated wear or siezing if allowed to circulate through the engine. The oil filter, integrated into the oil line, removes these impurities as the oil passes through it. The filter is mounted outside the engine to simplify replacement of the filter element. A relief valve is also included before the filter element to relieve high oil pressure in case the filter element becomes clogged with impurities. The relief valve opens when the oil pressure overpowers the force of the spring. Oil passing through the relief valve bypasses the oil filter and flows directly into the main oil hole in the engine.

TROUBLESHOOTING

Problem	Possible cause	Remedy	Page
Oil leakage	Cylinder head, cylinder block or oil pump body damaged or cracked	Repair as necessary	
	Oil seal faulty	Replace Oil seal	EM-60 or EM-91
	Gasket faulty	Replace gasket	
Low oil pressure	Oil leakage	Repair as necessary	
	Relief valve faulty	Repair relief valve	LU-7
	Oil pump faulty	Repair oil pump	LU-7
	Engine oil poor quality	Replace engine oil	LU-5
	Crankshaft bearing faulty	Replace bearing	EM-71
	Connecting rod bearing faulty	Replace bearing	EM-69
	Oil filter clogged	Replace oil filter	LU-5
High oil pressure	Relief valve faulty	Repair relief valve	LU-7



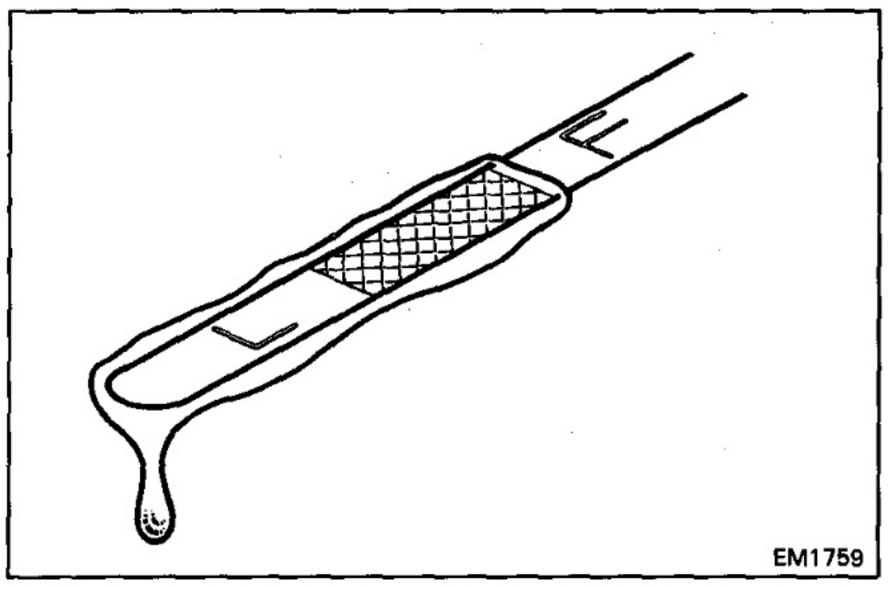
OIL PRESSURE CHECK

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If the quality is poor, replace the oil.

Use API grade CC, CD or better and recommended viscosity oil.



2. CHECK ENGINE OIL LEVEL

The oil level should be between the "L" and "F" marks on the level gauge.

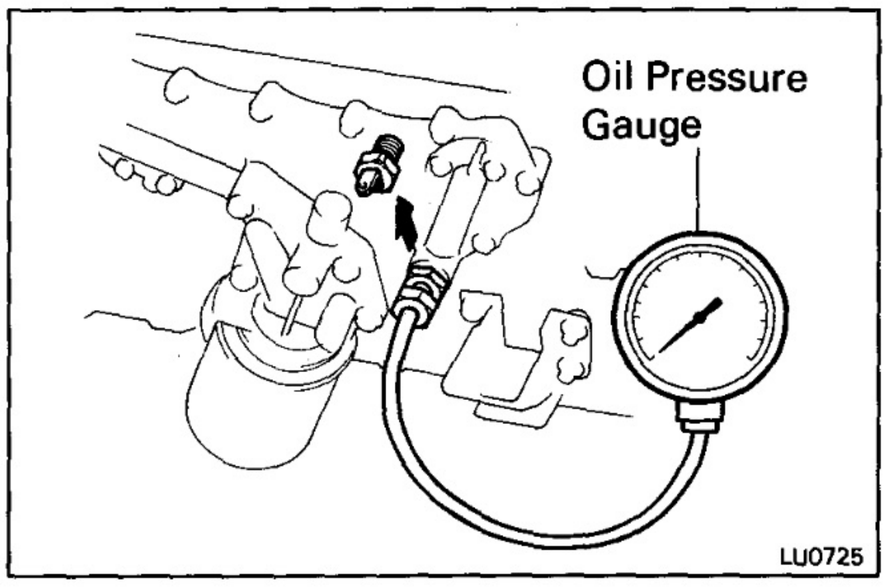
If low, check for leakage and add oil up to the "F" mark.

3. REMOVE OIL PRESSURE SWITCH OR SCREW PLUG

4. INSTALL OIL PRESSURE GAUGE

5. START ENGINE

Start the engine and warm it up to normal operating temperature.



6. CHECK OIL PRESSURE

Oil pressure:

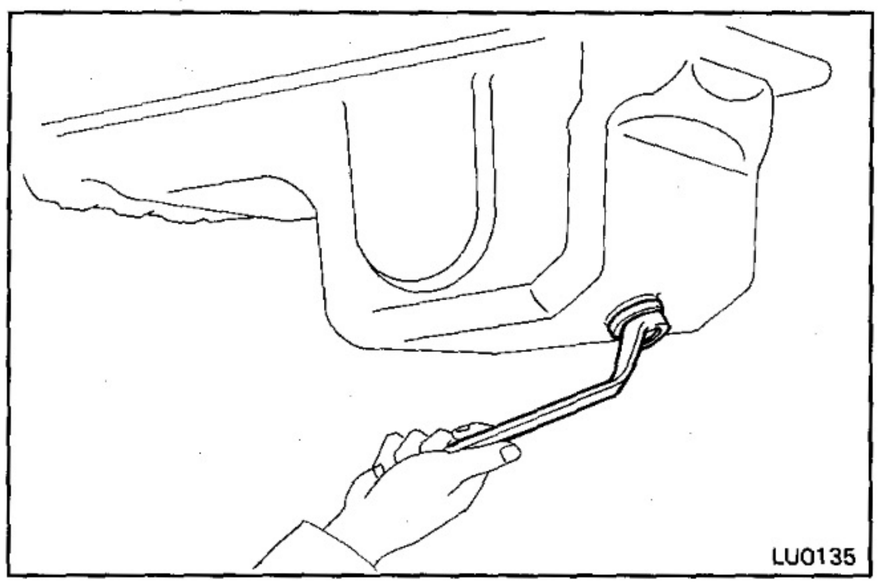
At idle	**0.3 kg/cm² (4.3 psi, 29 kPa) or more**
At 3,000 rpm	**2.5 — 6.0 kg/cm² (36 — 85 psi, 245 — 588 kPa)**

HINT: Check for oil leakage after reinstalling the pressure switch or screw plug.

REPLACEMENT OF ENGINE OIL AND OIL FILTER

NOTICE:

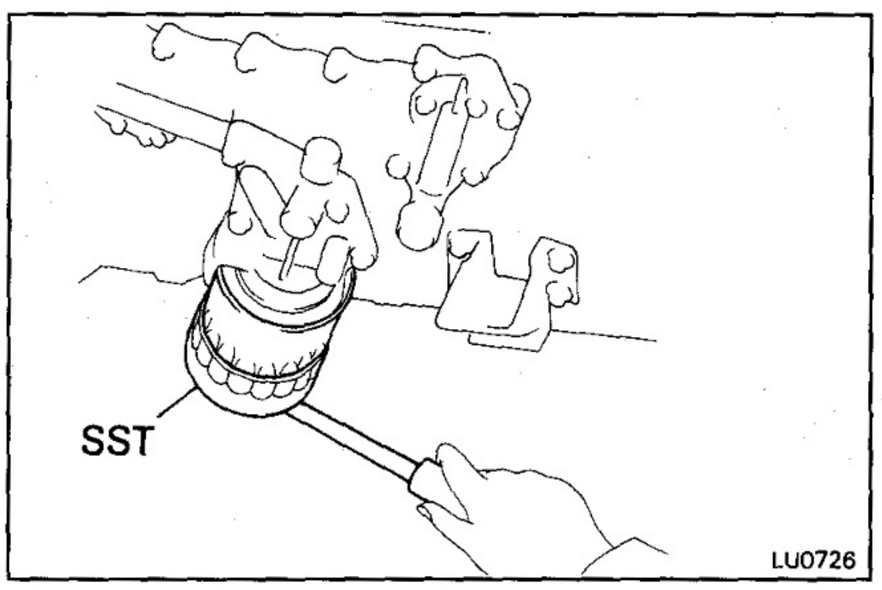
- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
  Adequate means of skin protection and washing facilities should be provided.
- **Care should be taken, therefore, when changing engine oil, to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves, that cannot be penetrated by oil, should be worn. The skin should be thoroughly washed with soap and water, or use waterless hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the enviroment, used oil must be disposed of only at designated disposal sites.**



1. DRAIN ENGINE OIL

(a) Remove the oil filler cap.

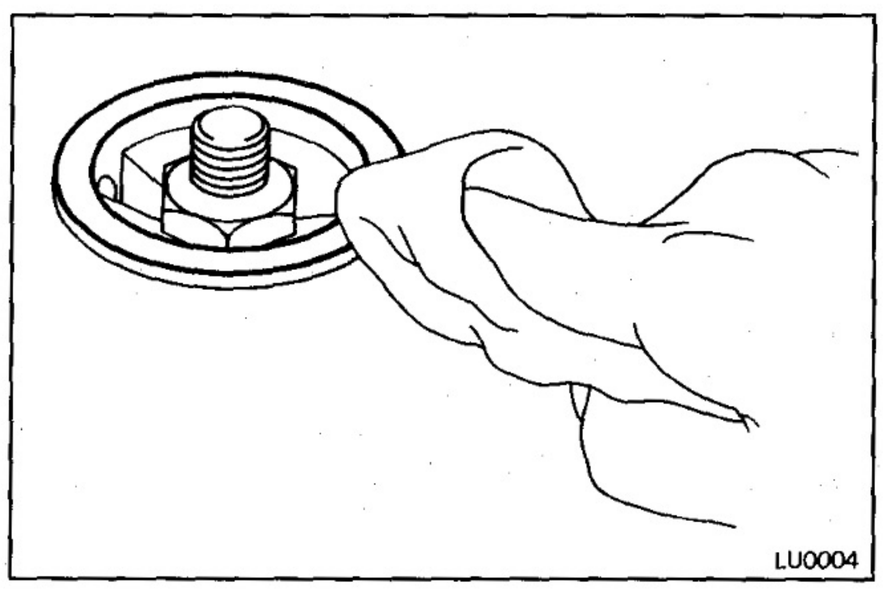
(b) Remove the oil drain plug and drain the oil into a container.



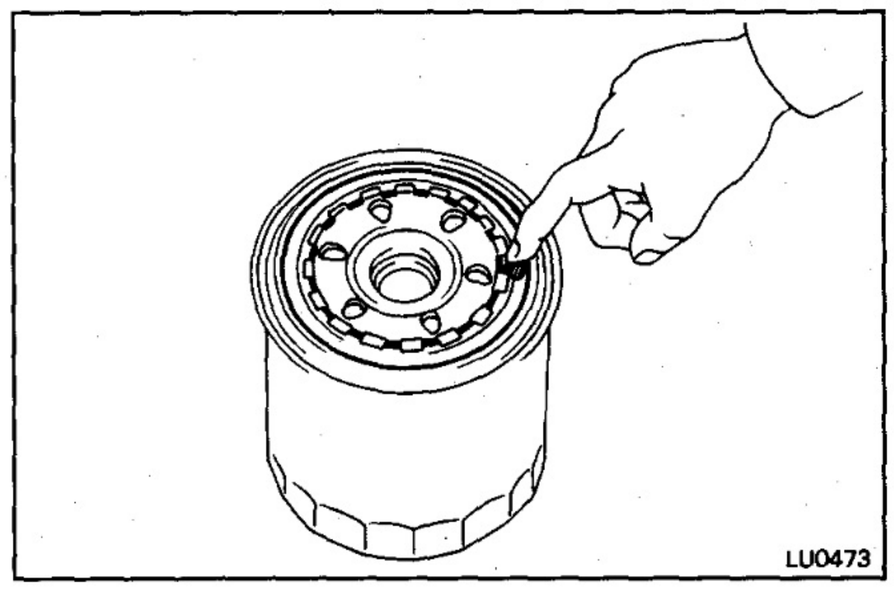
2. REPLACE OIL FILTER

(a) Using SST, remove the oil filter.

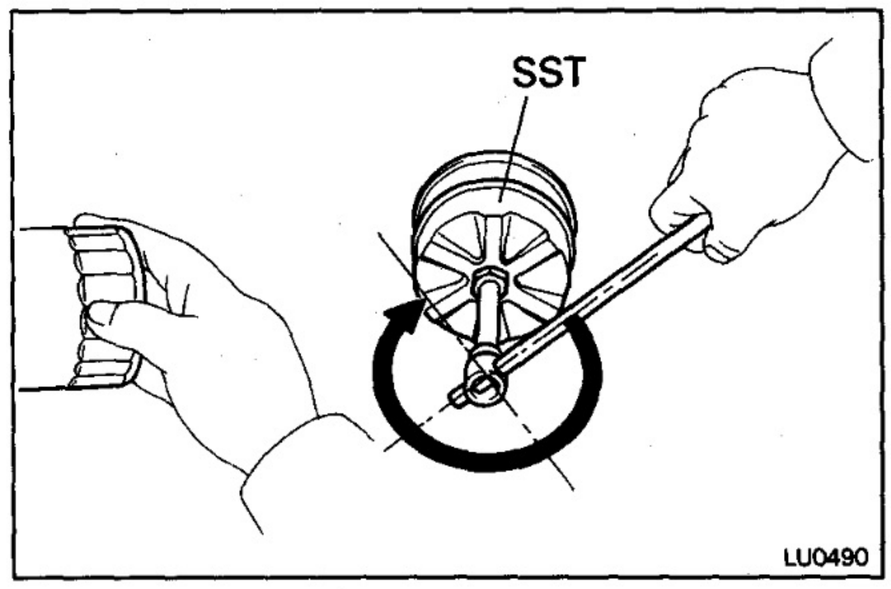
SST Full flow type	09228-44011
w/ By-Pass element type	09228-10001



(b) Inspect and clean the oil filter installation surface.



(c) Apply clean engine oil to the gasket of a new oil filter.



(d) Lightly screw in the oil filter until you feel resistance.

(e) Using SST, tighten the oil filter an extra 3/4 turn.

SST Full flow type 09228-44011
w/ By-Pass element type 09228-10001

3. FILL WITH ENGINE OIL

(a) Clean and install the oil drain plug with a new gasket. Torque the drain plug.

Torque: 350 kg-cm (25 ft-lb, 34 N·m)

(b) Fill the engine with new oil, API grade CC, CD or better.

Capacity:

liters (US qts, Imp. qts)

	w/o Oil filter change	w/ Oil filter change	Dri fill
BJ and BU (B, 11B)	6.4 (6.8, 5.6)	7.3 (7.7, 6.4)	7.9 (8.4, 7.0)
BU (14B) and BY	8.4 (8.9, 7.4)	9.3 (9.8, 8.2)	9.9 (10.5, 8.7)
BB	8.1 (8.6, 7.1)	9.0 (9.5, 7.9)	9.6 (10.1, 8.4)

(c) Install the oil filler cap with the gasket.

4. START ENGINE AND CHECK FOR LEAKS

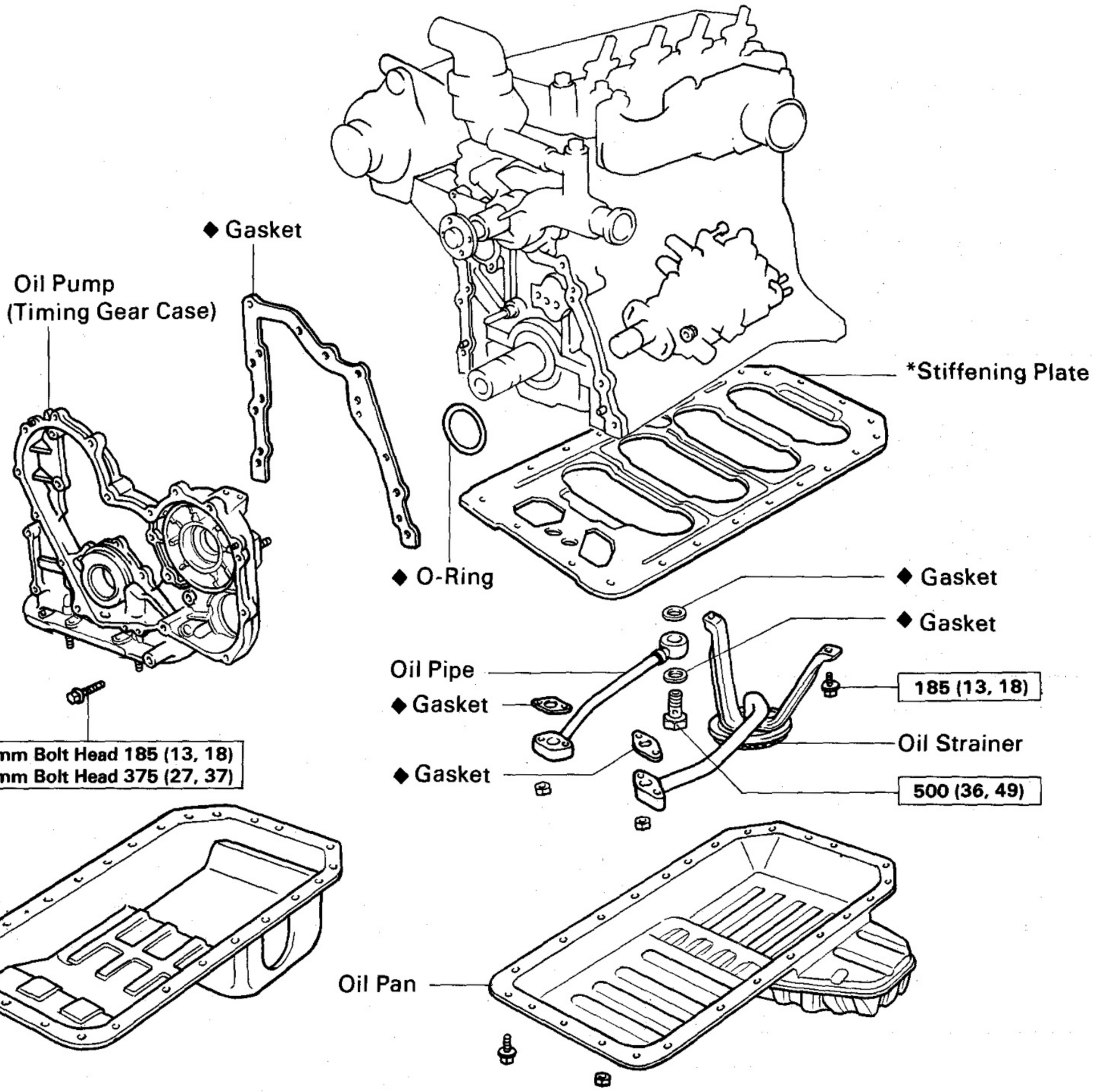
5. RECHECK OIL LEVEL

Recheck the engine oil level and refill as necessary.

OIL PUMP

REMOVAL OF OIL PUMP

HINT: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

LU0757

*: Europe and Australia (11B and 14B) only

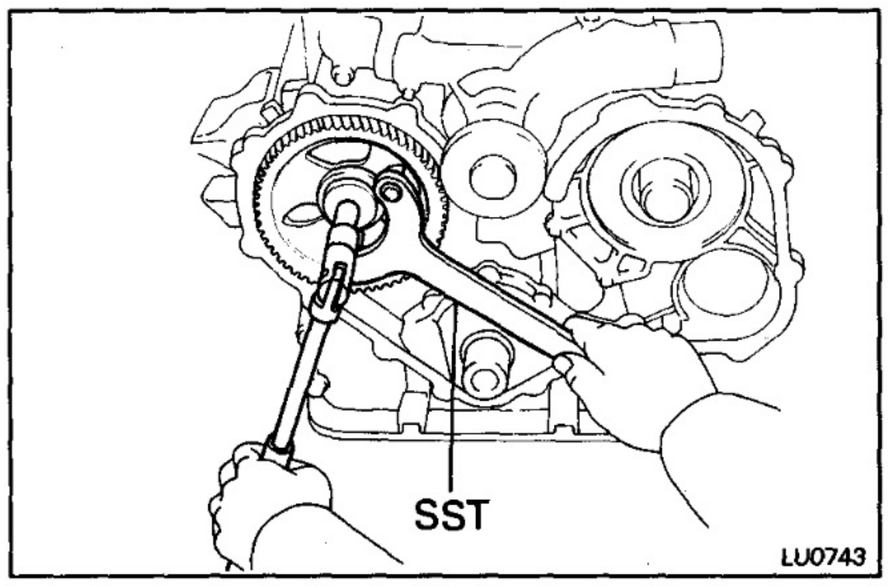
1. **SET NO. 1 CYLINDER TO TDC/COMPRESSION**
(See page EM-22)

2. **DRAIN ENGINE OIL (See page LU-5)**

3. **REMOVE DRIVE BELT**

4. **REMOVE FAN AND WATER PUMP PULLEY**
(See page CO-7)

5. **REMOVE CRANKSHAFT PULLEY AND TIMING GEAR COVER**
(See steps 8 to 10 on pages EM-54 and 55)



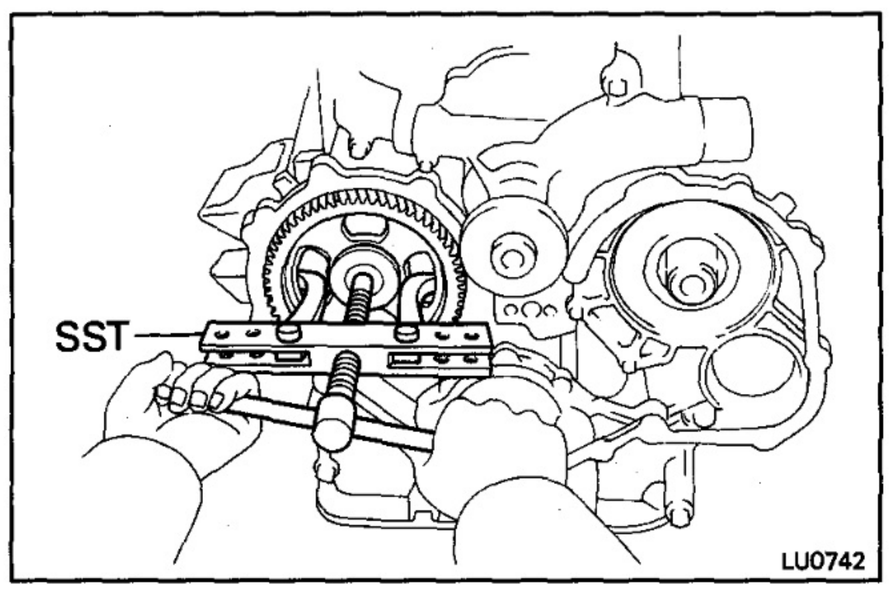
6. **REMOVE VACUUM PUMP**

7. **REMOVE IDLE GEAR AND CRANKSHAFT TIMING GEAR**
(See steps 14, 15 and 17 on pages EM-55 and 56)

8. **REMOVE CAMSHAFT TIMING GEAR**

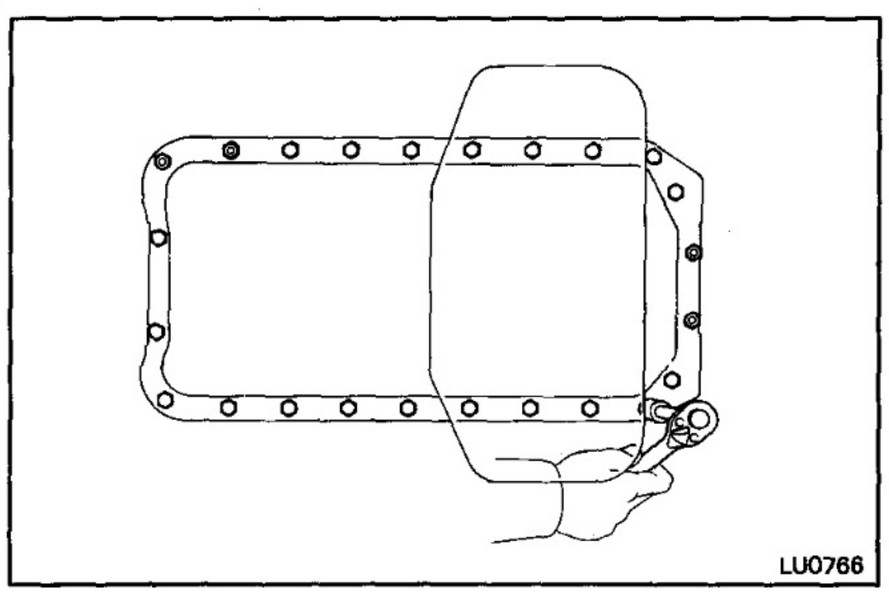
(a) Using SST, remove the mount bolt and plate washer.

SST 09278-54012



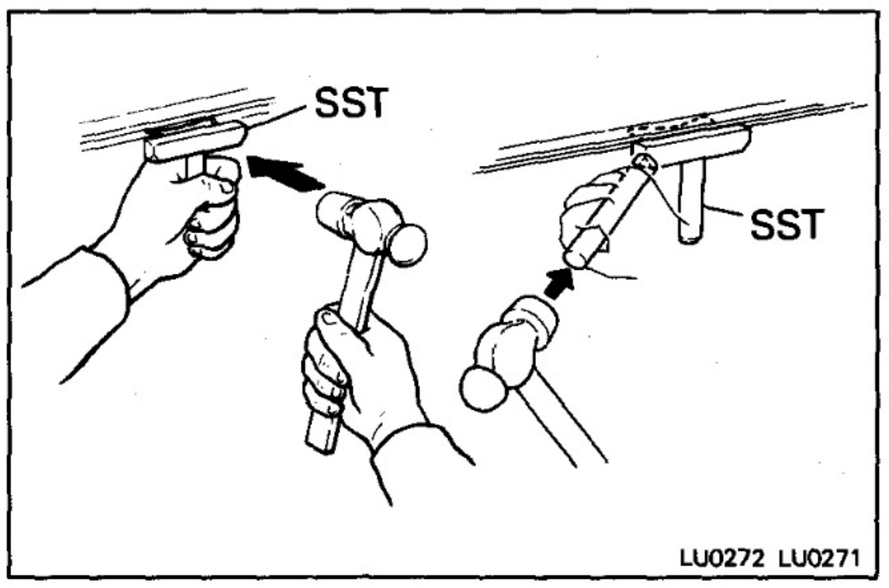
(b) Using SST, remove the timing gear.

SST 09950-20017



9. **REMOVE OIL PAN**

(a) Remove the twenty bolts and four nuts.

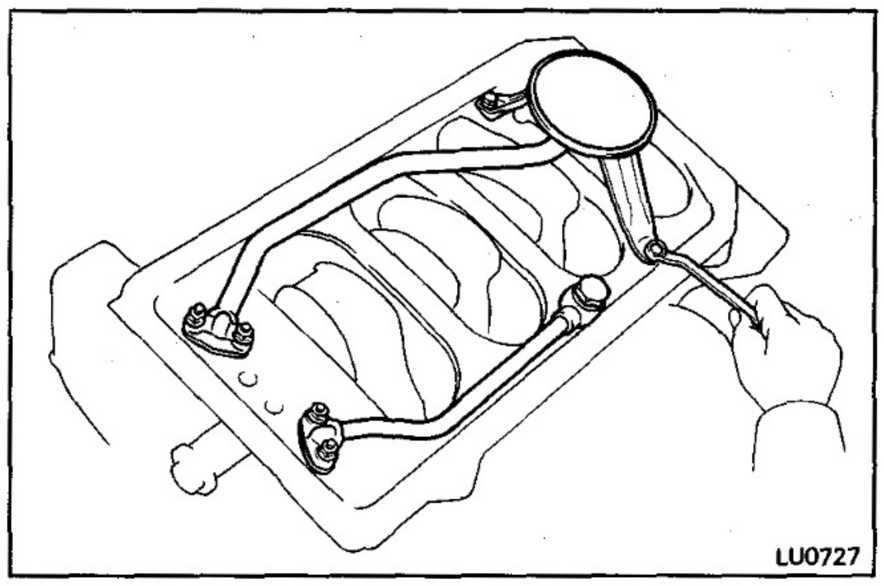


(b) Insert the SST blade between the cylinder block (or stiffening plate) and oil pan, cut off applied sealer and remove the oil pan.

SST 09032-00100

NOTICE:

- **Do not use SST for the timing gear case side and rear oil seal retainer side.**
- **Be careful not to damage the oil pan flange.**

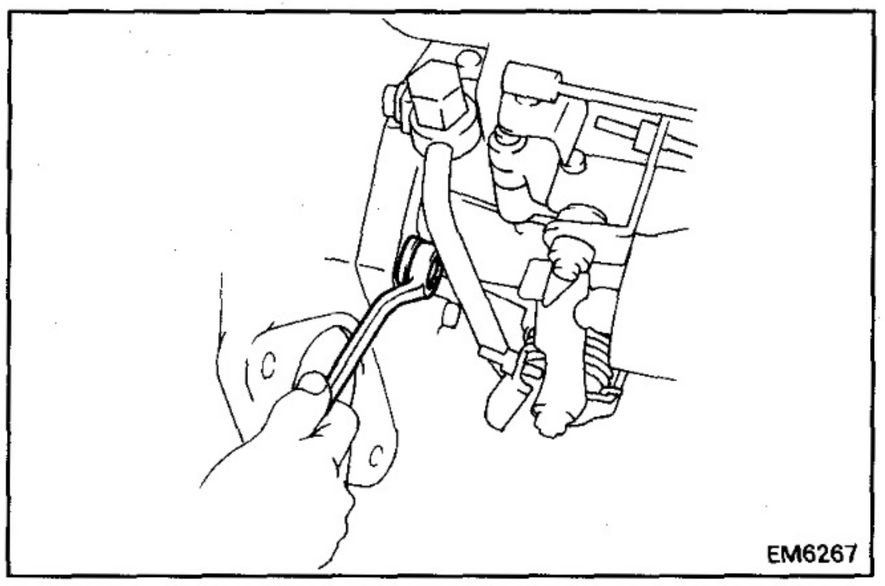


9. REMOVE OIL STRAINER AND OIL PIPE

(a) Remove the two bolts, two nuts, oil strainer and gasket.

(b) Remove the union bolt, two nuts, oil pipe and three gaskets.

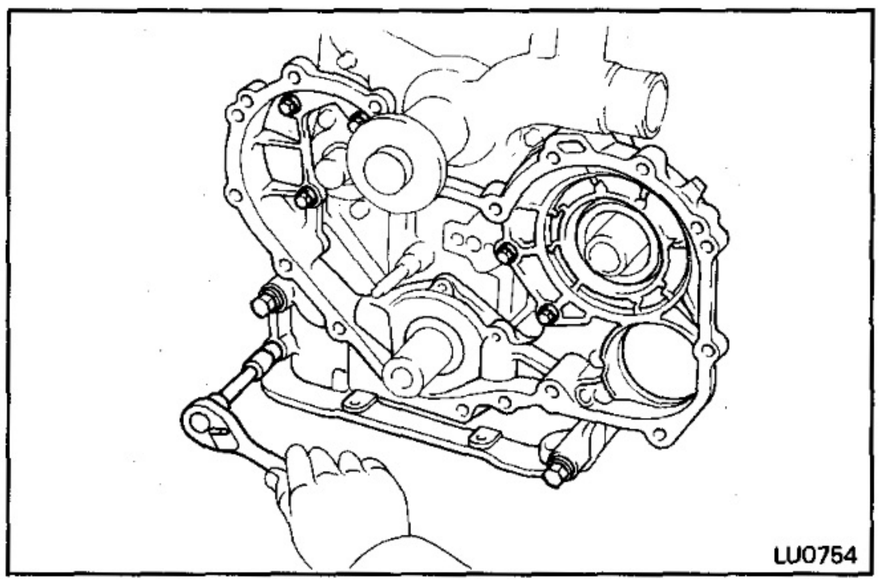
(c) [Europe and Australia (11B and 14B)]
Remove the stiffening plate.



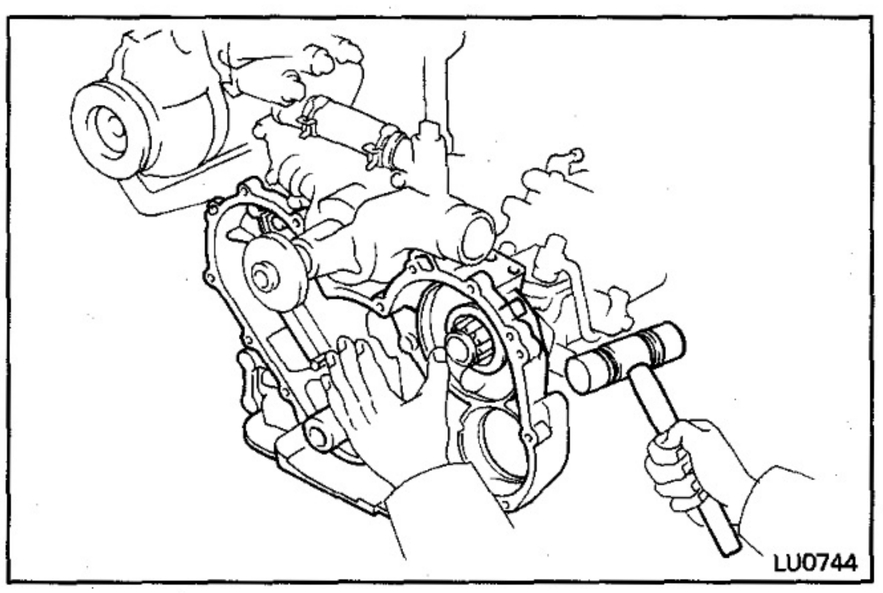
10. REMOVE OIL PUMP (TIMING GEAR CASE)

(a) Before removing the two nuts holding the injection pump flange to the timing gear case, check if the matchmarks are aligned. If not, place new matchmarks for reinstallation.

(b) Remove the two nuts.

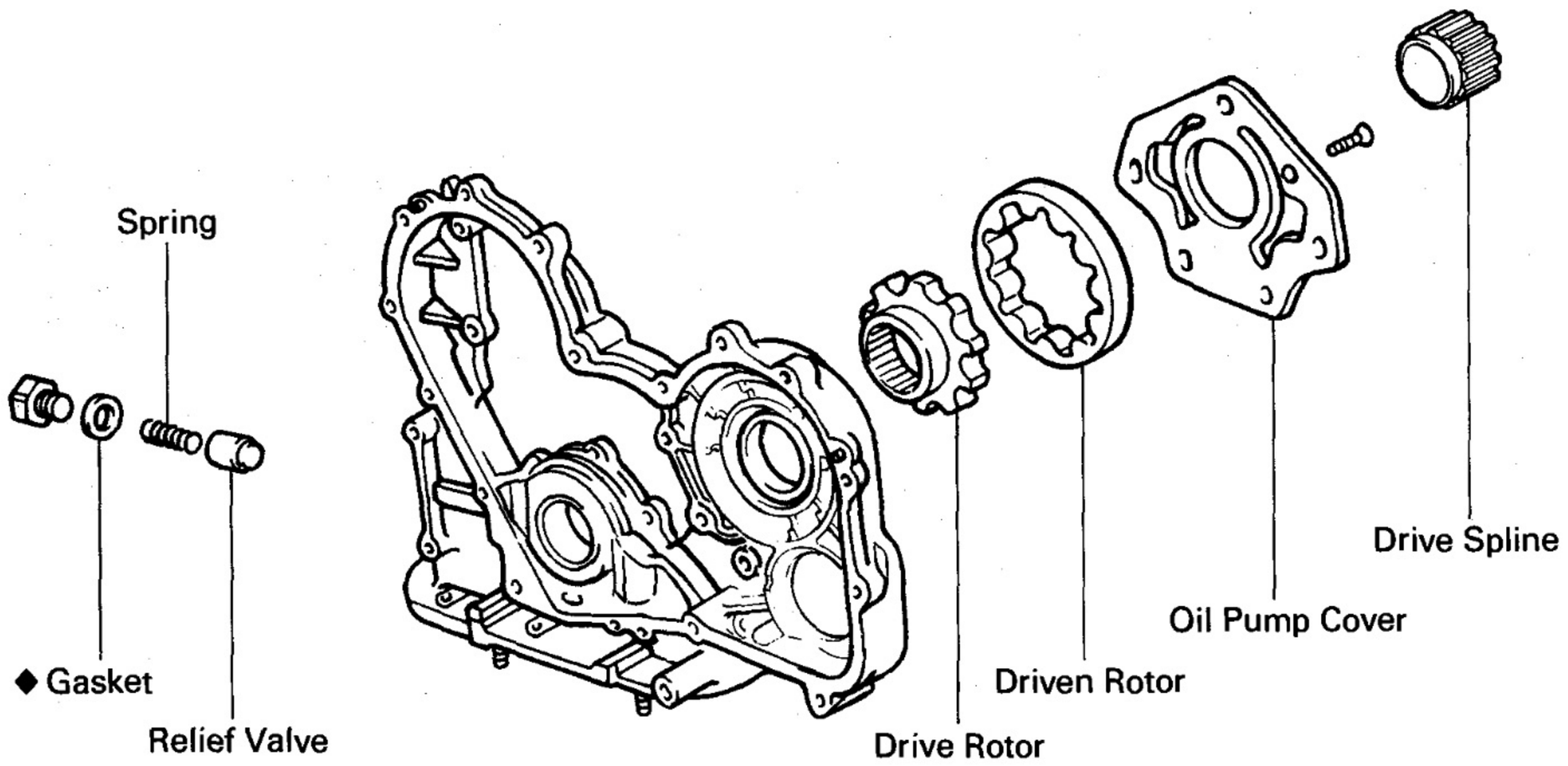


(c) Remove the eight bolts.



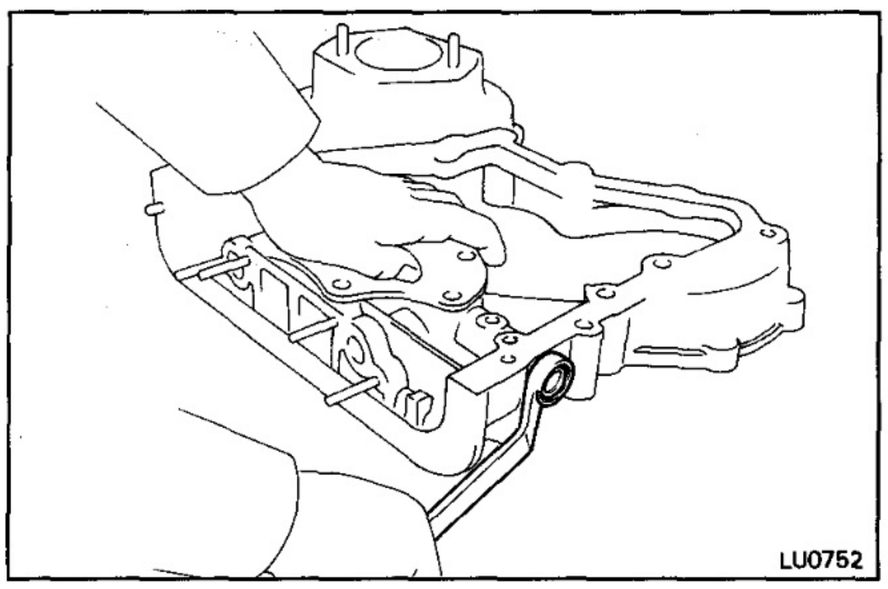
(d) Using a plastic-faced hammer, lightly tap out the timing gear case and gasket.

COMPONENTS



◆ Non-reusable part

LU0745

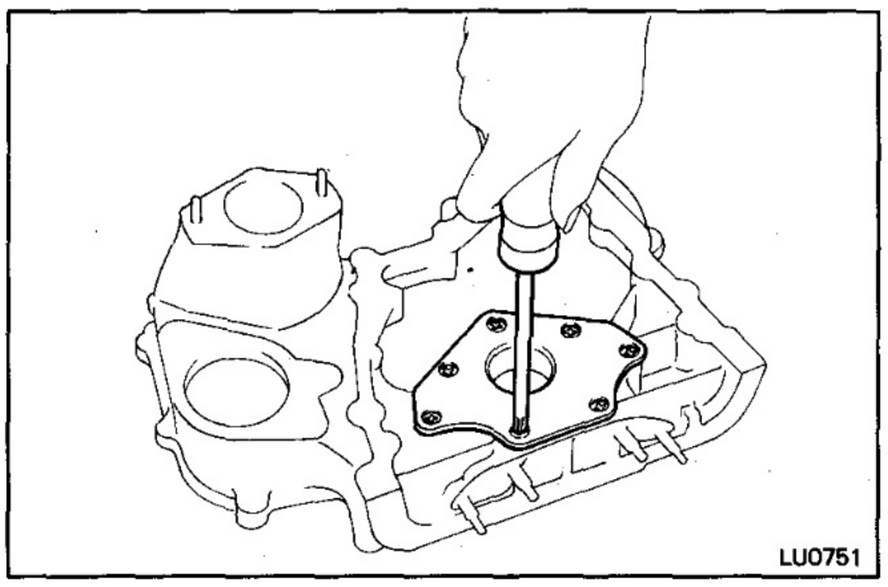


LU0752

DISASSEMBLY OF OIL PUMP

1. REMOVE RELIEF VALVE

Remove the plug, gasket, spring and relief valve.

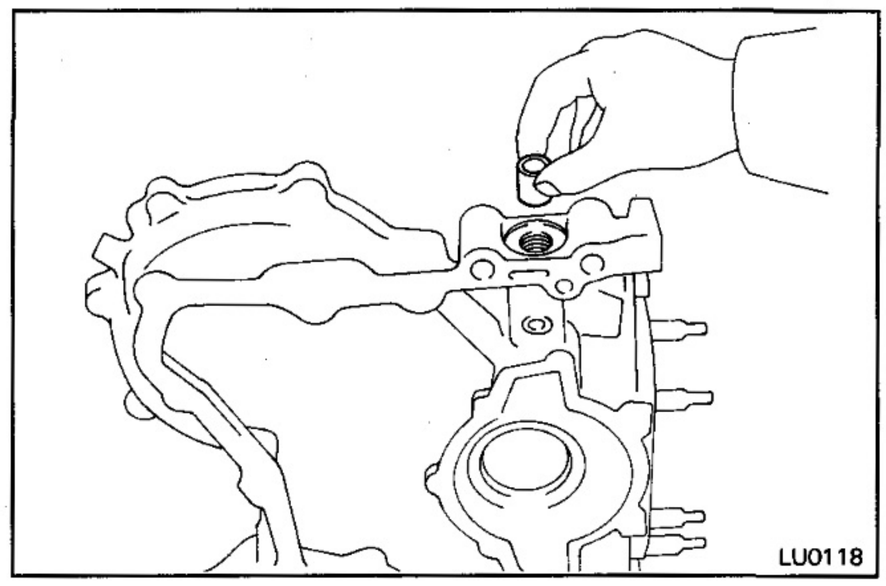


LU0751

2. REMOVE DRIVE AND DRIVEN ROTORS

(a) Remove the seven screws and oil pump cover.

(b) Remove the rotors.

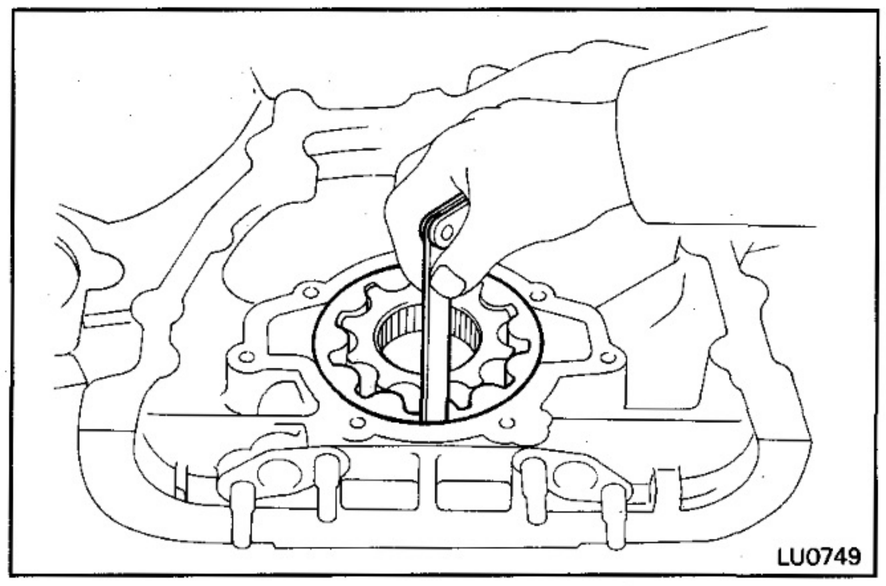


INSPECTION OF OIL PUMP

1. INSPECT RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If is not, replace the relief valve. If necessary, replace the oil pump assembly.



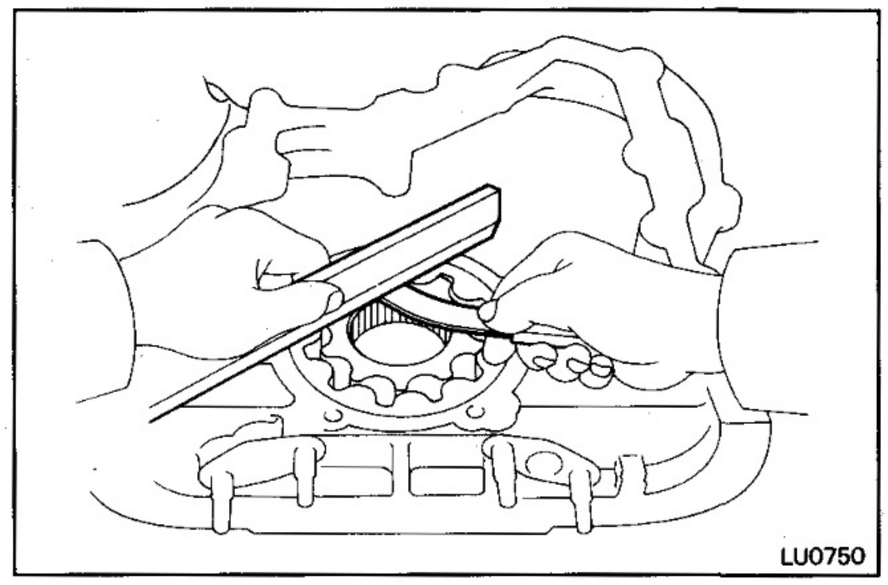
2. INSPECT DRIVE AND DRIVEN ROTORS

A. Inspect Rotor Body Clearance

Using a thickness gauge, measure the clearance between the driven rotor and body.

Standard body clearance: **0.140 — 0.220 mm (0.0055 — 0.0087 in.)**
Maximum body clearance: **0.40 mm (0.0157 in.)**

If the clearance is greater than maximum, replace rotors. If necessary, replace the oil pump assembly.

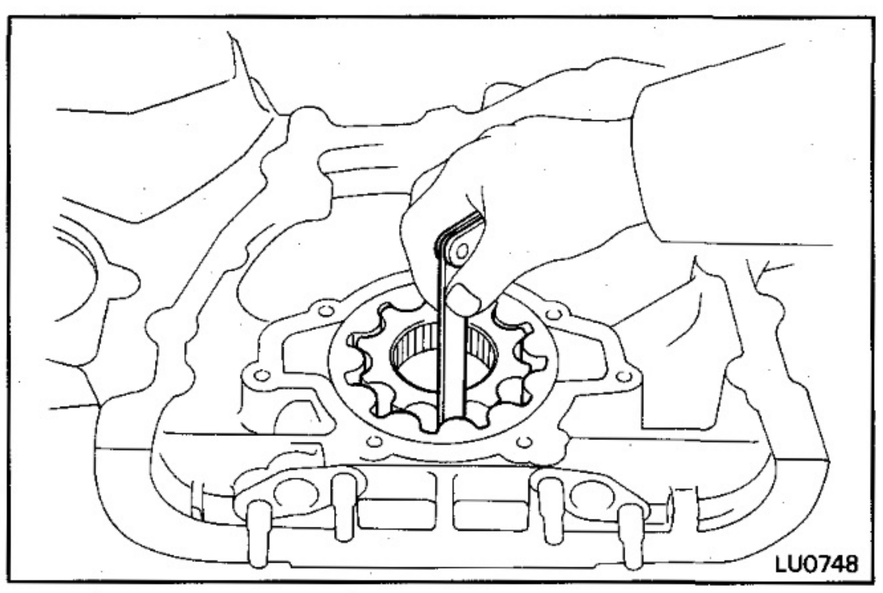


B. Inspect Rotor Side Clearance

Using a thickness gauge and precision straight edge, measure the clearance between the rotor and precision straight edge.

Standard side clearance: **0.035 — 0.090 mm (0.0014 — 0.0035 in.)**
Maximum side clearance: **0.15 mm (0.0059 in.)**

If the clearance is greater than maximum, replace the rotors. If necessary, replace the oil pump assembly.

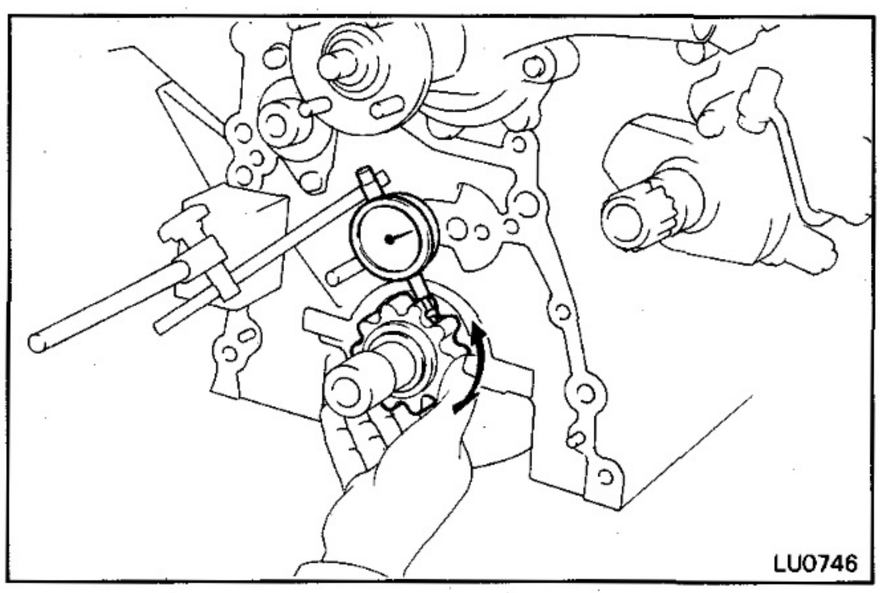


C. Inspect Rotor Tip Clearance

Using a thickness gauge, measure the clearance between the drive and driven rotors.

Standard tip clearance: **0.110 — 0.240 mm (0.0043 — 0.0094 in.)**
Maximum tip clearance: **0.30 mm (0.0118 in.)**

If the clearance is greater than maximum, replace the rotors.

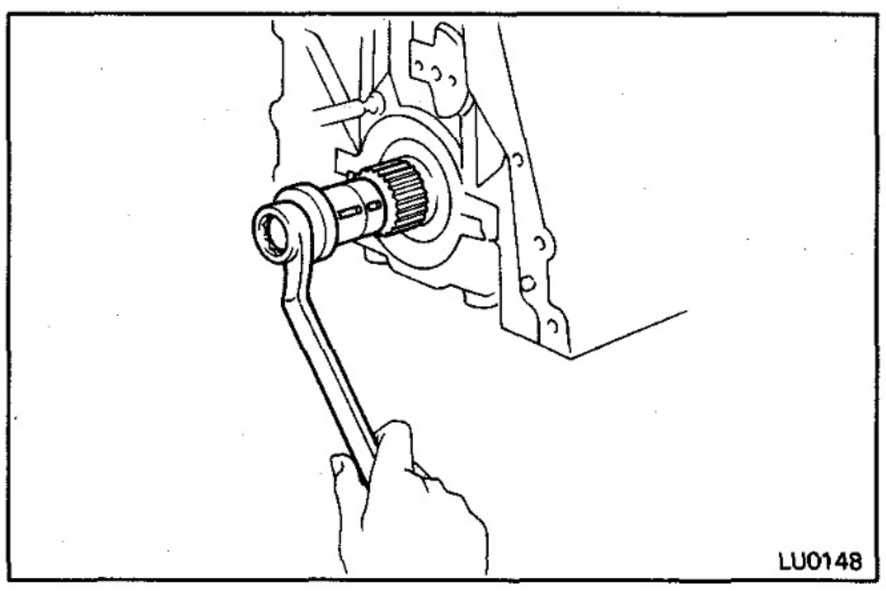


3. INSPECT DRIVE SPLINE

Using a dial indicator, measure the backlash while turning the drive rotor clockwise and counterclockwise in several places.

Standard backlash: **0.541 — 0.790 mm (0.0213 — 0.0311 in.)**
Maximum backlash: **1.00 mm (0.0394 in.)**

If the backlash is greater than maximum, replace the rotor and spline.



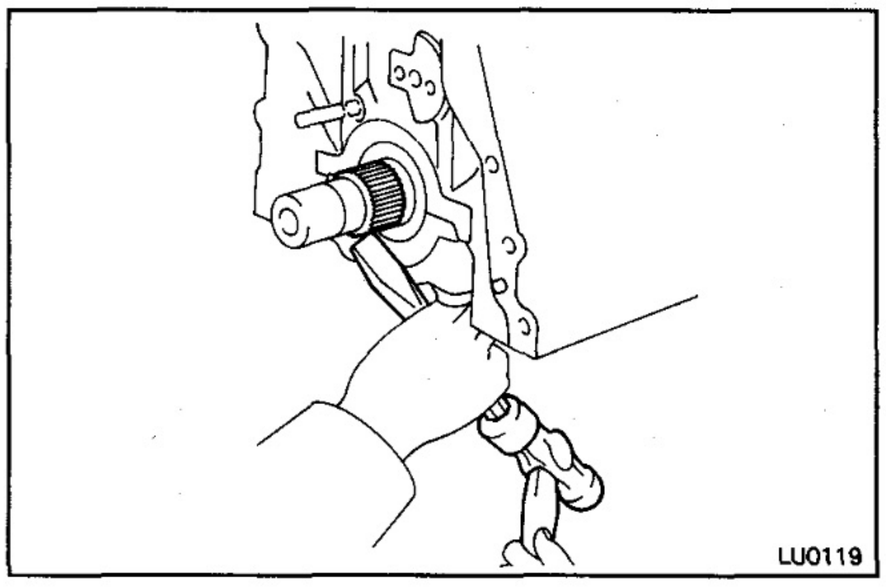
REPLACEMENT OF DRIVE SPLINE

1. REMOVE DRIVE SPLINE

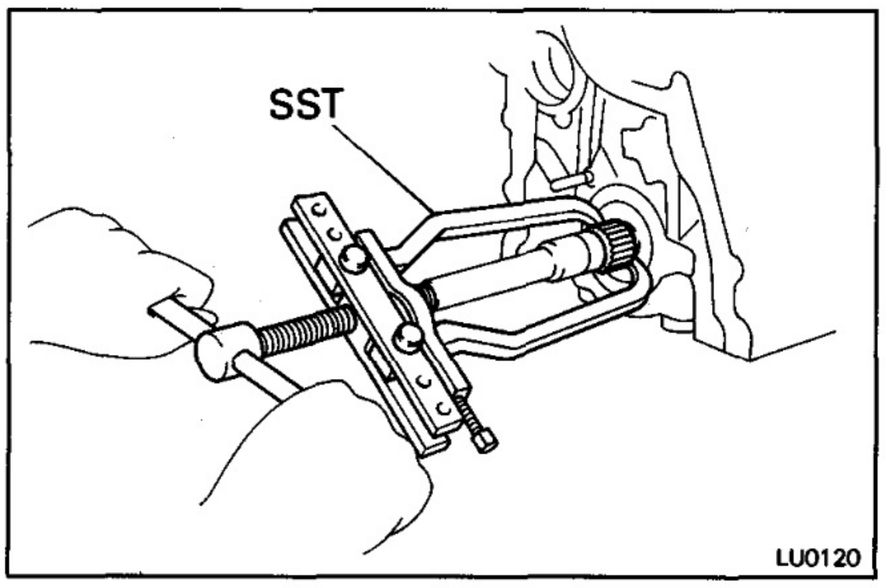
(a) Remove the two set keys.

(b) Set the drive spline with the hole facing downward by turning the crankshaft.

NOTICE: Do not turn the crankshaft more than 1/4 revolution.

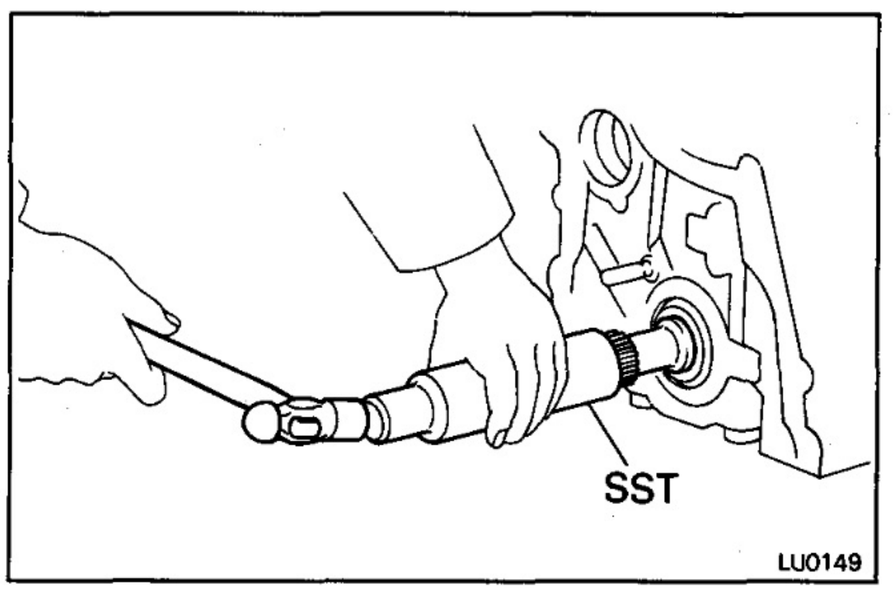


(c) Using a chisel and hammer, tap the drive spline out of the hole until SST can be hooked to spline's end.



(d) Using SST, remove the drive spline.

SST 09950-20017

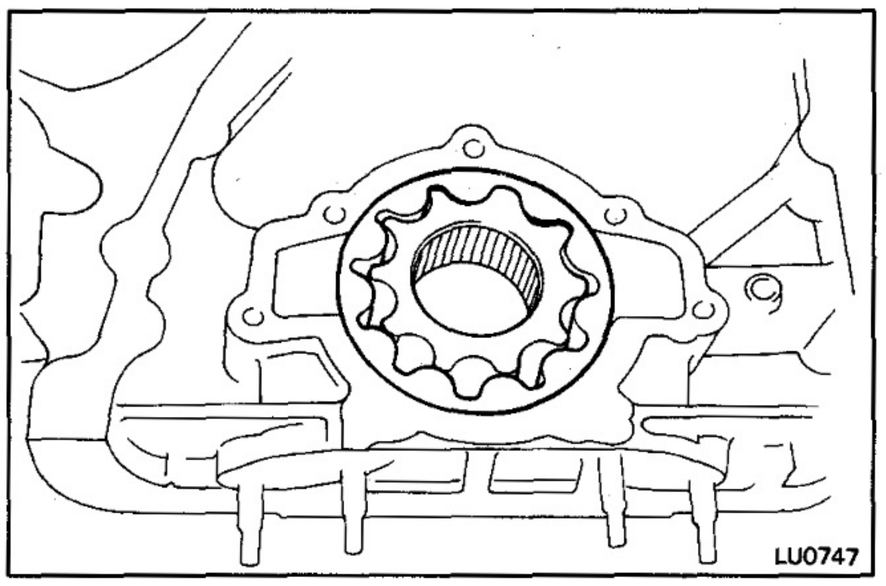


2. INSTALL NEW DRIVE SPLINE

(a) Using SST and a hammer,tap in the drive spline.

SST 09608-35014 (09608-06040)

(b) Install the two set keys.

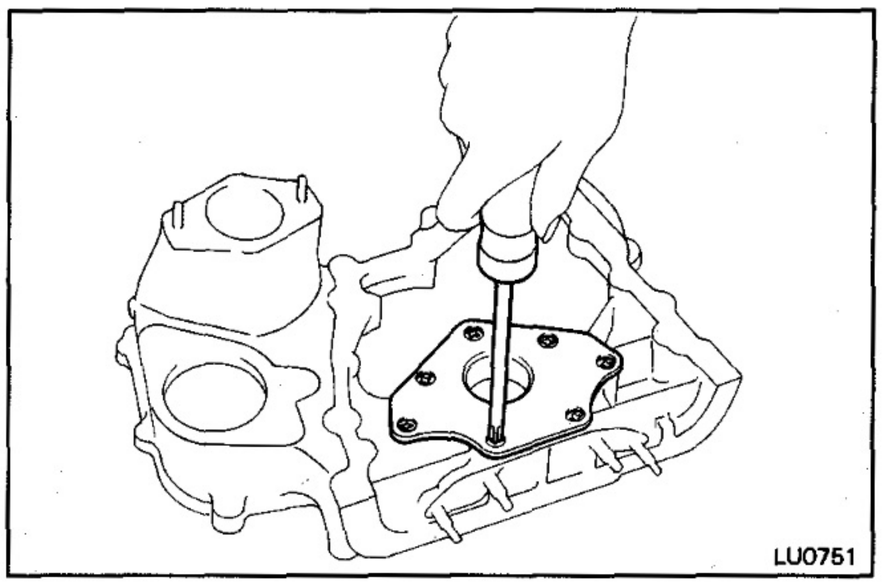


ASSEMBLY OF OIL PUMP

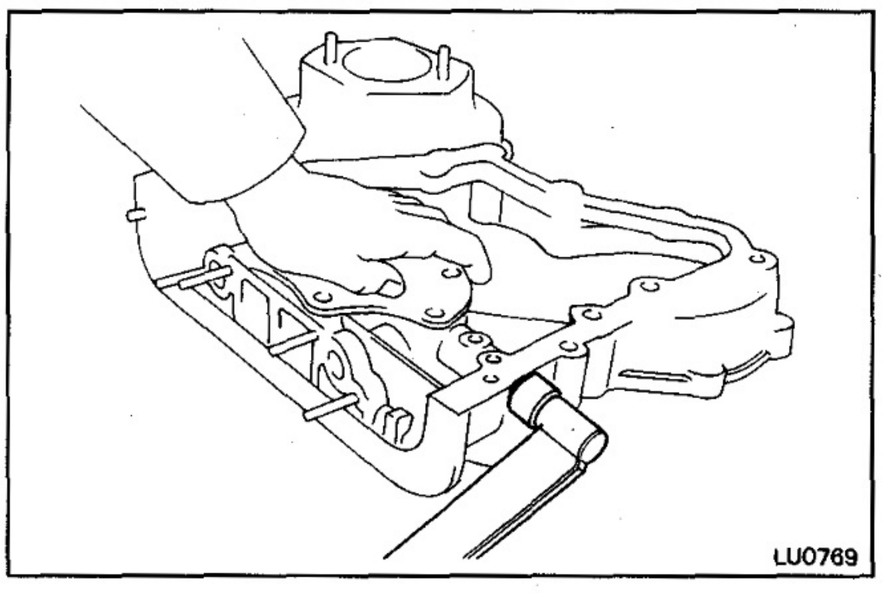
(See page LU-10)

1. INSTALL DRIVE AND DRIVEN ROTORS

(a) Insert the rotors into the oil pump body.



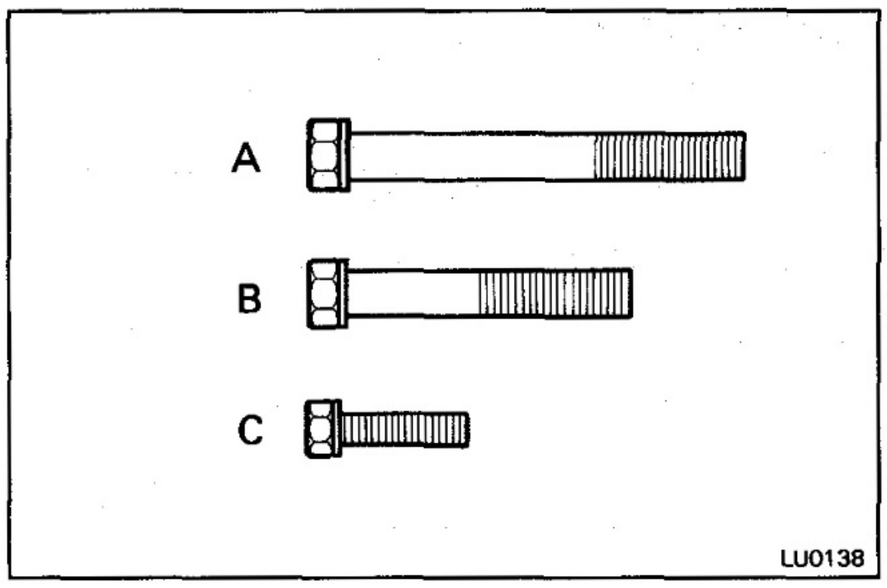
(b) Install the oil pump cover with the seven screws.



2. INSTALL RELIEF VALVE

Install the relief valve and spring with a new gasket and the plug.

Torque: 500 kg-cm (36 ft-lb, 49 N·m)

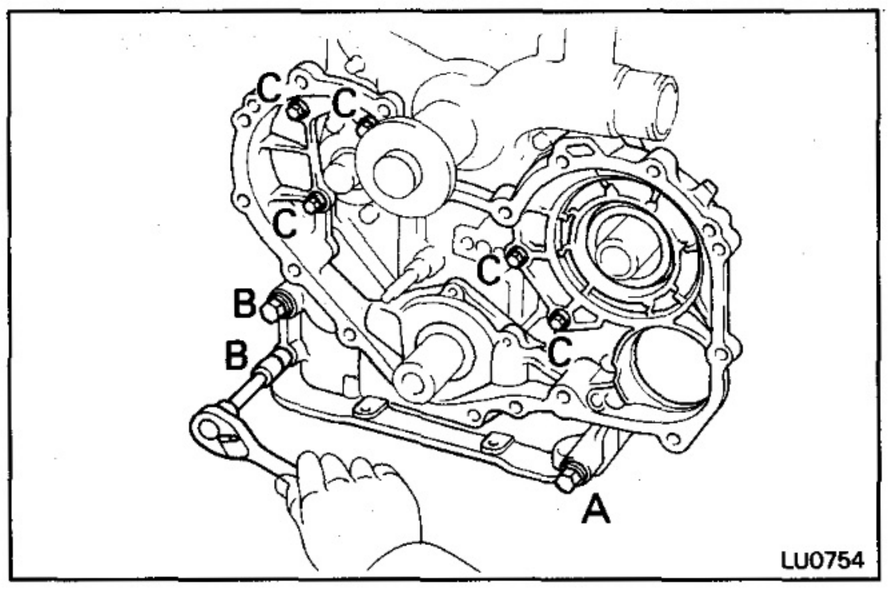


INSTALLATION OF OIL PUMP

(See page LU-7)

1. INSTALL OIL PUMP (TIMING GEAR CASE)

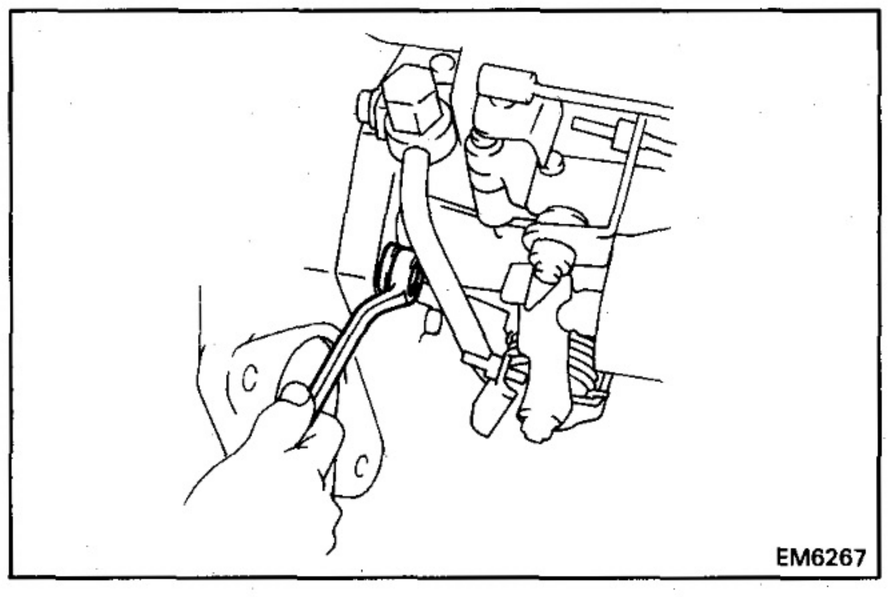
HINT: Use the bolts indicated "A" "B", and "C".



(a) Place a new gasket and the timing gear case in position.

(b) Install and uniformly tighten the eight bolts in several passes.

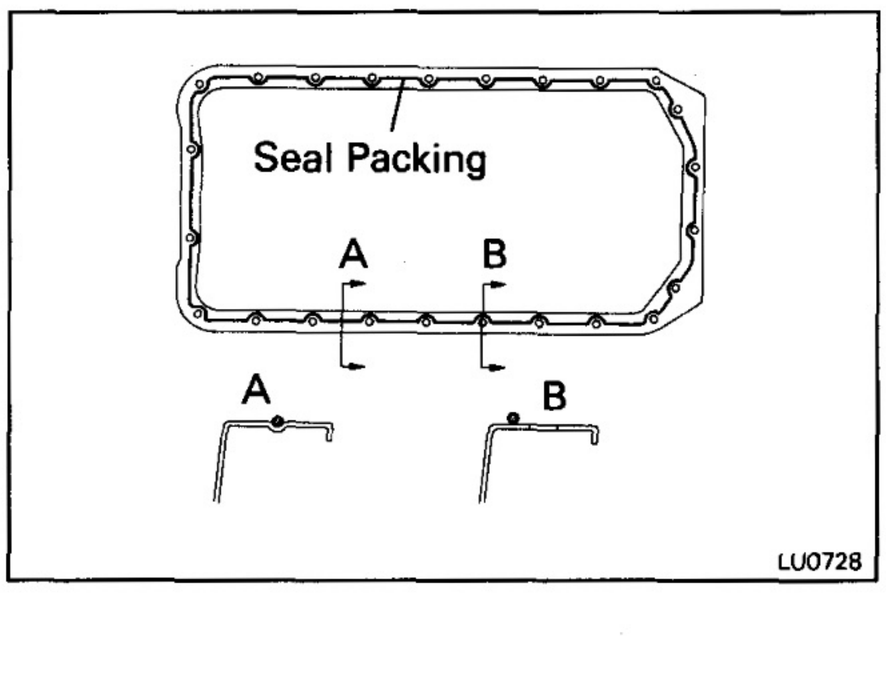
Torque: A and B 375 kg-cm (27 ft-lb, 37 N·m)
C 185 kg-cm (13 ft-lb, 18 N·m)



(c) Align the matchmarks on the injection pump and timing gear case.

(d) Install the two nuts holding the injection pump flange to the timing gear case.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



2. [Europe and Australia (11B and 14B)] INSTALL STIFFENING PLATE

(a) Remove any oil packing material and be careful not to drop any oil on the contacting surfaces of the stiffening plate and cylinder block.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Clean both sealing surfaces with a non-residue solvent.

NOTICE: Do not use a solvent which will affect the painted surfaces.

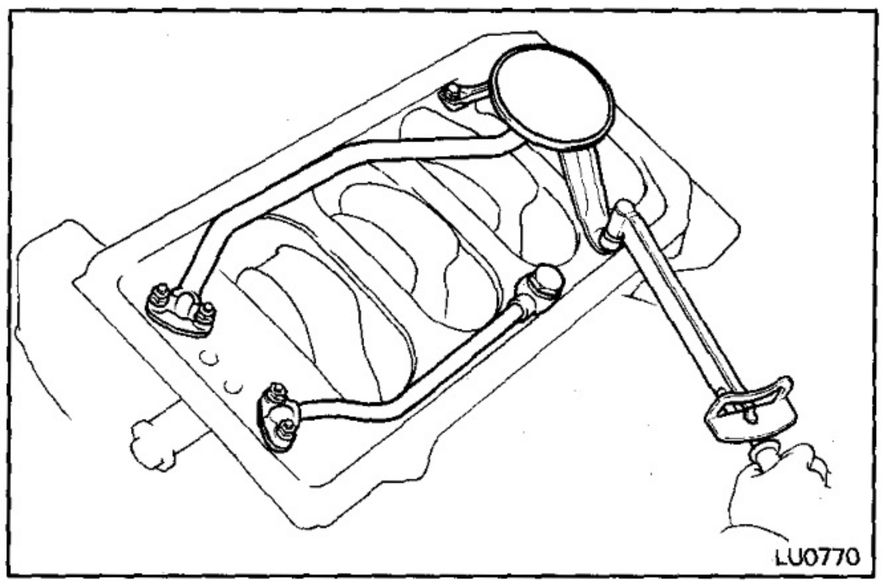
(b) Apply seal packing to the stiffening plate as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to the 4 mm (0.16 in.) opening.

HINT: Avoid applying an excess amount to the surface. Be especially careful near oil passages.

- Parts must be assembled within 15 minutes of application. Otherwise, the material must be removed and reapplied.
- Immediately remove nozzle from tube and reinstall cap.



3. INSTALL OIL STRAINER AND OIL PIPE

(a) Install a new gasket and oil strainer with the two bolts and two nuts. Torque the bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

(b) Install new three gaskets and oil pipe with the union bolt and two nuts. Torque the union bolt and nuts.

Torque:

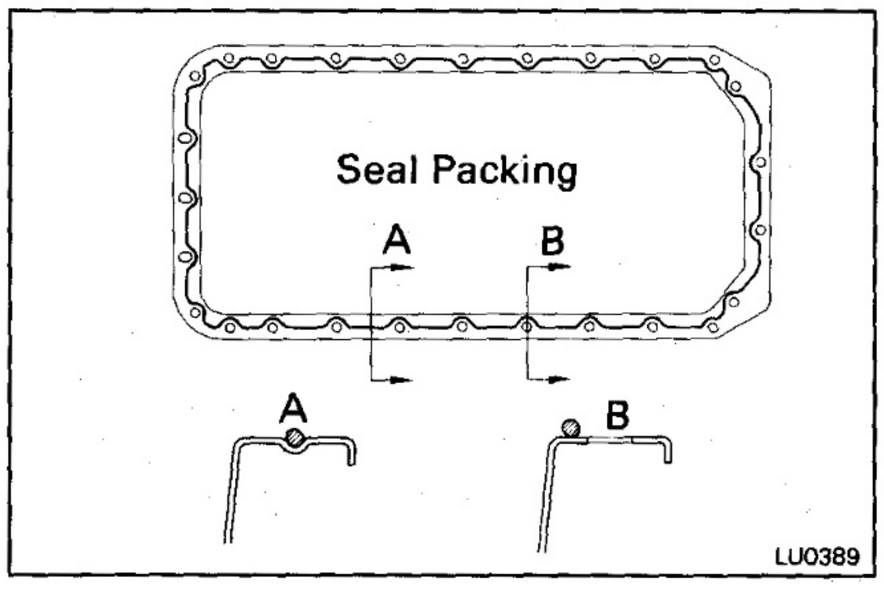
Union bolt	**500 kg-cm (36 ft-lb, 49 N·m)**
Nut	**185 kg-cm (13 ft-lb, 18 N·m)**

4. INSTALL OIL PAN

(a) Remove any oil packing material and be careful not to drop any oil on the contacting surfaces of the oil pan and stiffening plate.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Clean both sealing surfaces with a non-residue solvent.

NOTICE: Do not use a solvent which will affect the painted surfaces.



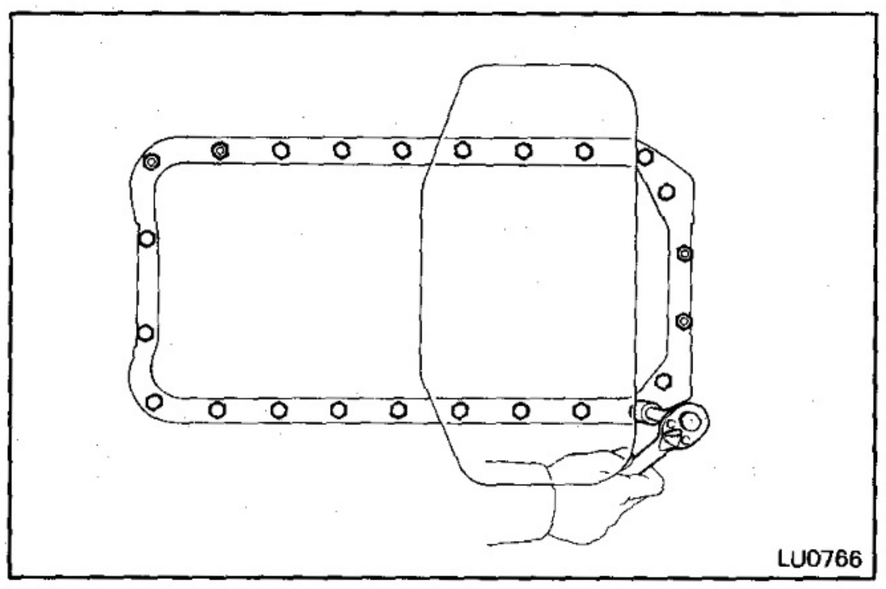
(b) Apply seal packing to the oil pan as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to the 4 mm (0.16 in.) opening.

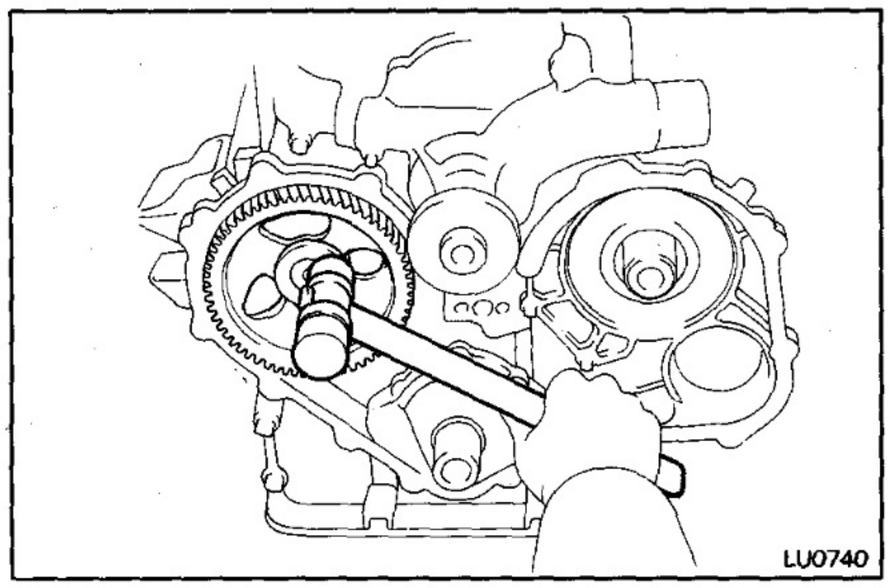
HINT: Avoid applying an excess amount to the surface. Be especially careful near oil passages.

- Parts must be assembled within 15 minutes of application. Otherwise, the material must be removed and reapplied.
- Immediately remove nozzle from tube and reinstall cap.



(c) Install the oil pan with the twenty bolts and four nuts.

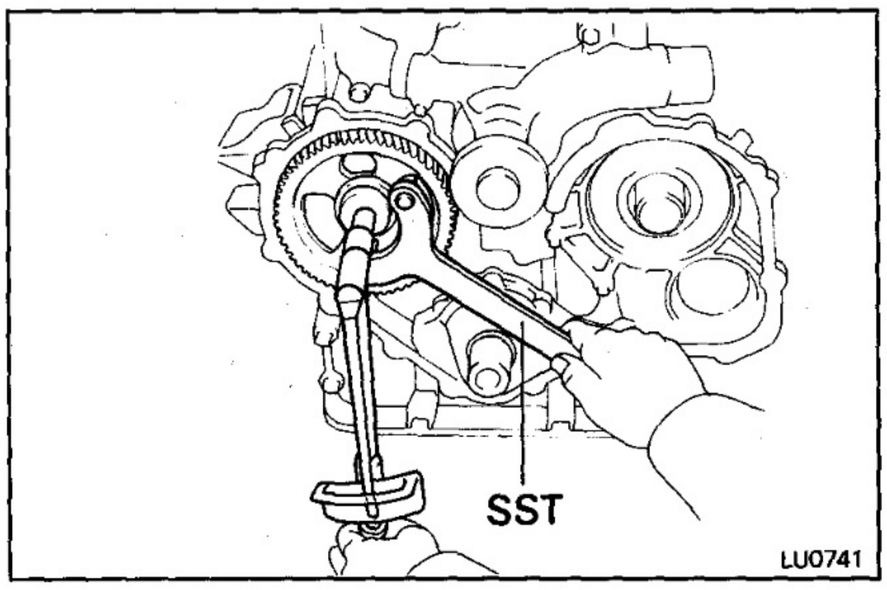
Torque: 185 kg-cm (13 ft-lb, 18 N·m)



5. INSTALL CAMSHAFT TIMING GEAR

(a) Align the timing gear set key with the key groove of the timing gear.

(b) Using a plastic-faced hammer, lightly tap in the timing gear.



(c) Using SST, install the plate washer and mount bolt. Torque the bolt.

SST 09278-54012

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

6. INSTALL CRANKSHAFT TIMING GEAR, IDLE GEAR AND INJECTION PUMP DRIVE GEAR

(See steps 1, 3 to 6 on pages EM-62 to 64)

7. INSTALL VACUUM PUMP

8. INSTALL TIMING GEAR COVER AND CRANKSHAFT PULLEY

(See steps 9 and 10 on pages EM-64 and 65)

9. INSTALL WATER PUMP PULLEY AND FAN

(See page CO-12)

10. INSTALL AND ADJUST DRIVE BELT

(See page CH-5)

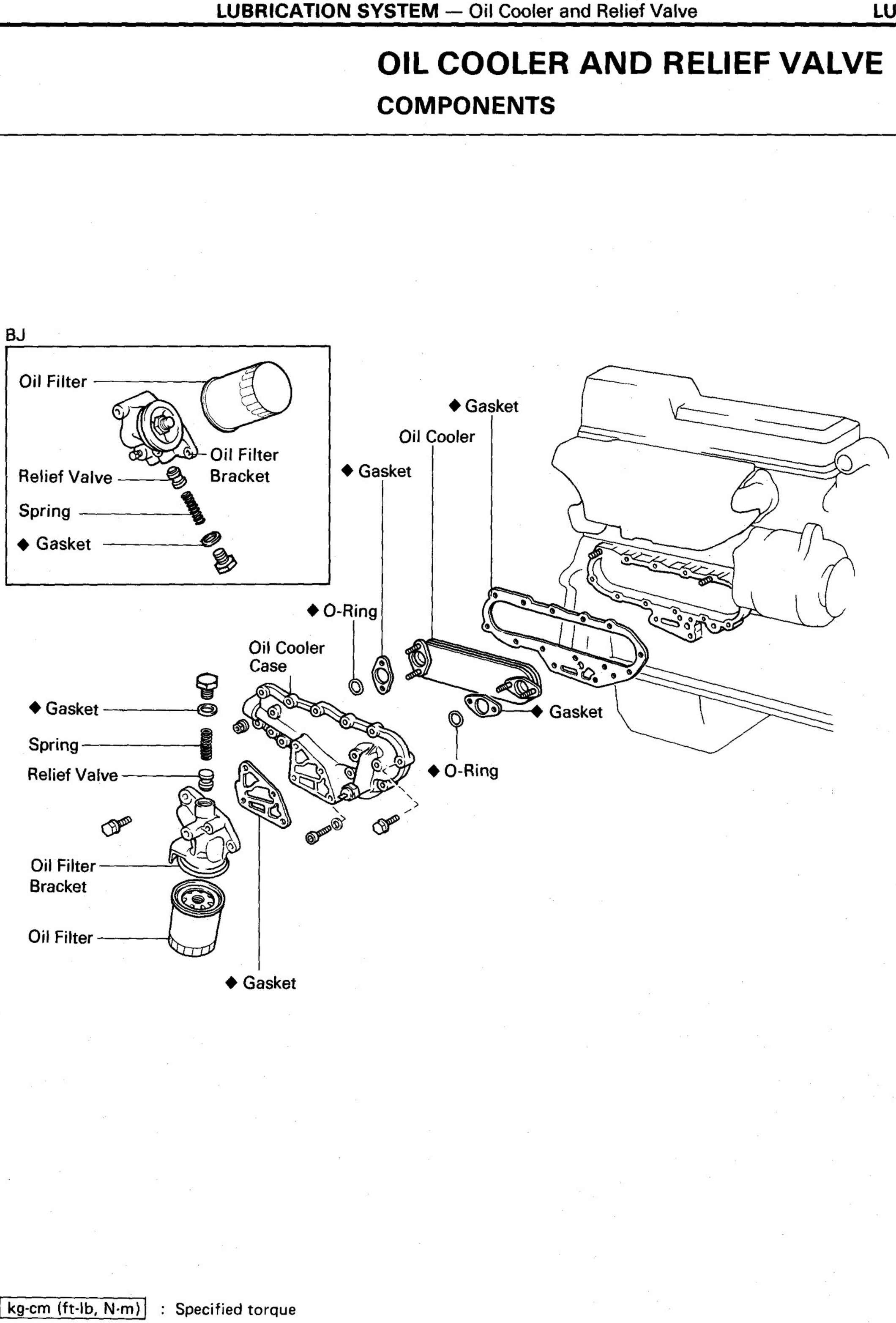
11. FILL WITH ENGINE OIL (See page LU-6)

12. START ENGINE AND CHECK FOR LEAKS

13. RECHECK ENGINE OIL LEVEL (See page LU-4)

OIL COOLER AND RELIEF VALVE

COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

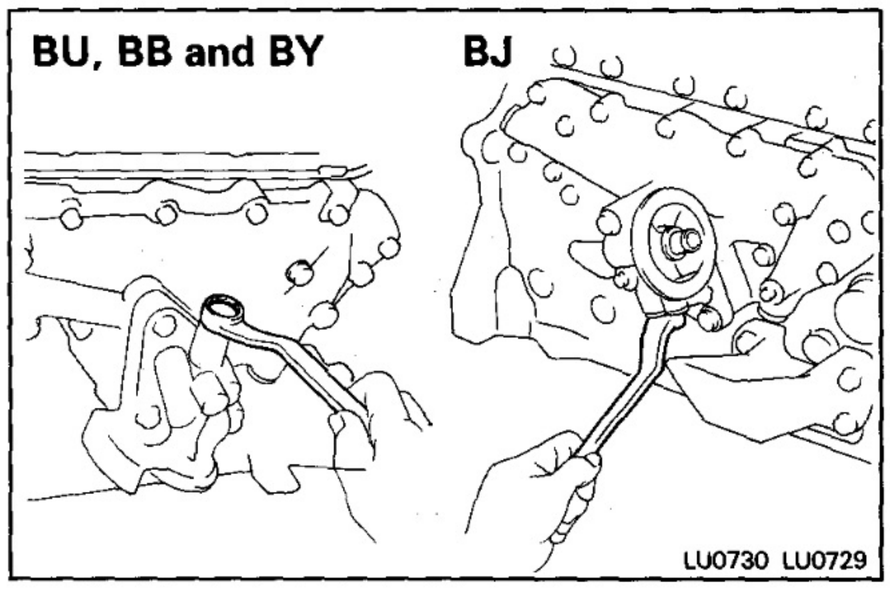
LU0758

REMOVAL OF OIL COOLER AND RELIEF VALVE

(See page LU-17)

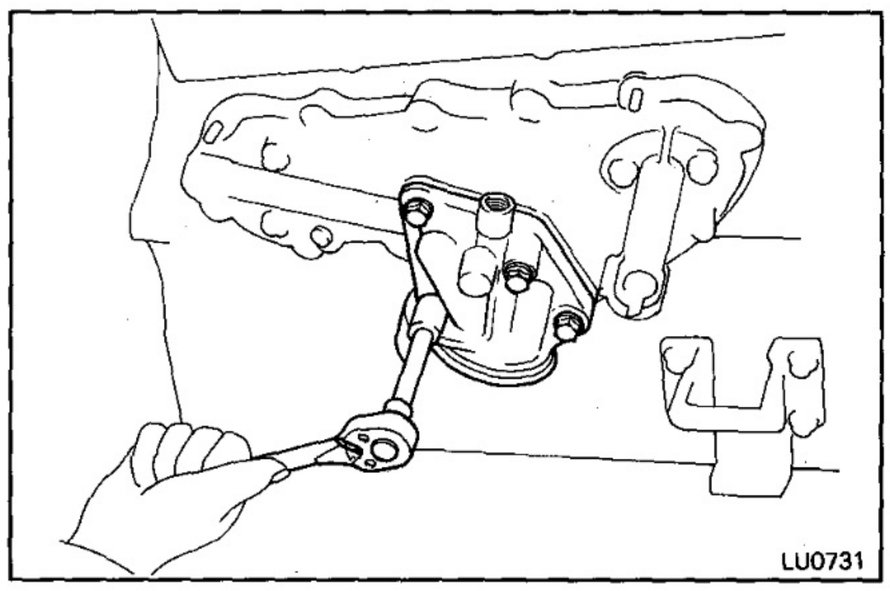
1. DRAIN ENGINE COOLANT (See page CO-5)

2. REMOVE OIL FILTER (See page LU-5)



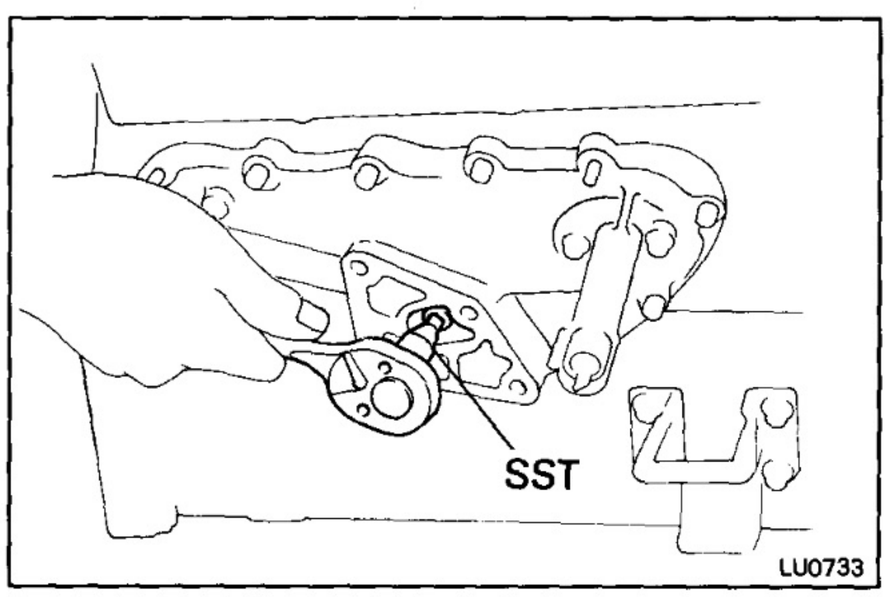
3. REMOVE RELIEF VALVE

Remove the plug, gasket, spring and relief valve.



4. REMOVE OIL FILTER BRACKET

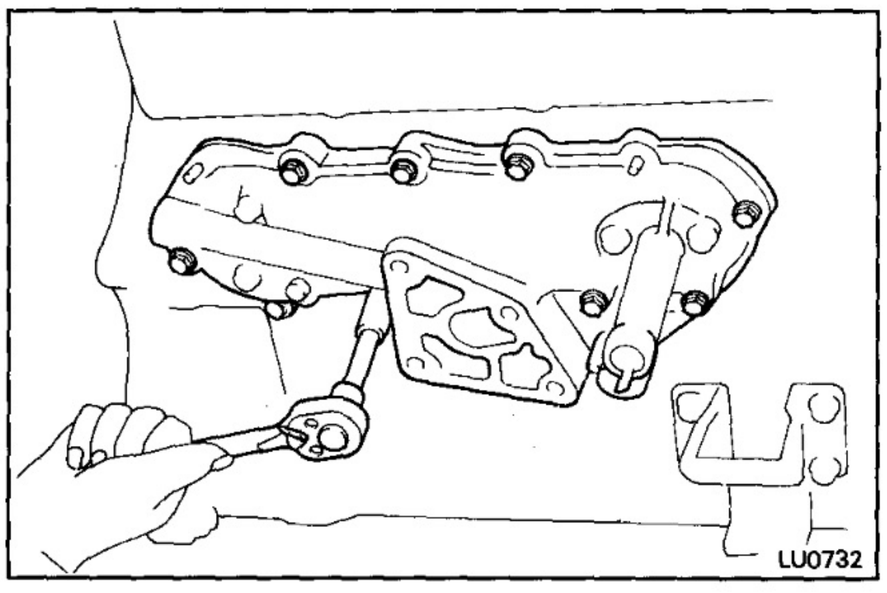
Remove the four bolts, bracket and gasket.



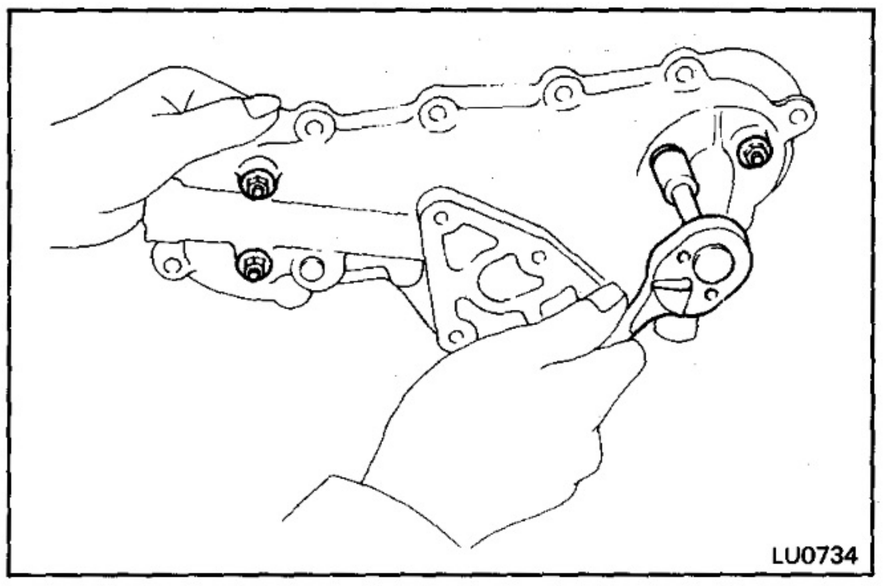
5. REMOVE OIL COOLER COVER WITH OIL COOLER

(a) Using SST, remove the bolt holding the oil cooler cover to cylinder block as shown.

SST 09313-30021

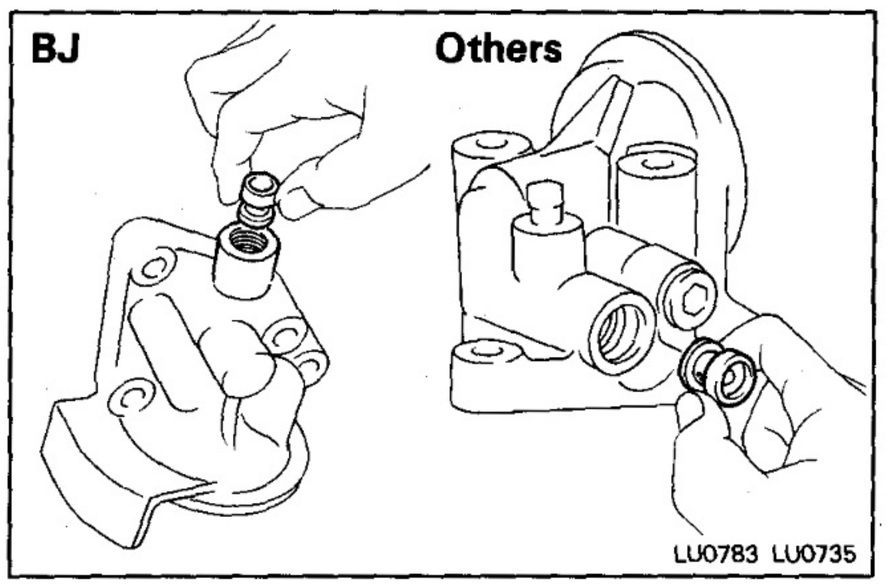


(b) Remove the nine bolts, two nuts, oil cooler cover with the oil cooler and gasket.



6. SEPARATE OIL COOLER AND OIL COOLER CASE

Remove the four nuts, oil cooler, two O-rings and gasket.

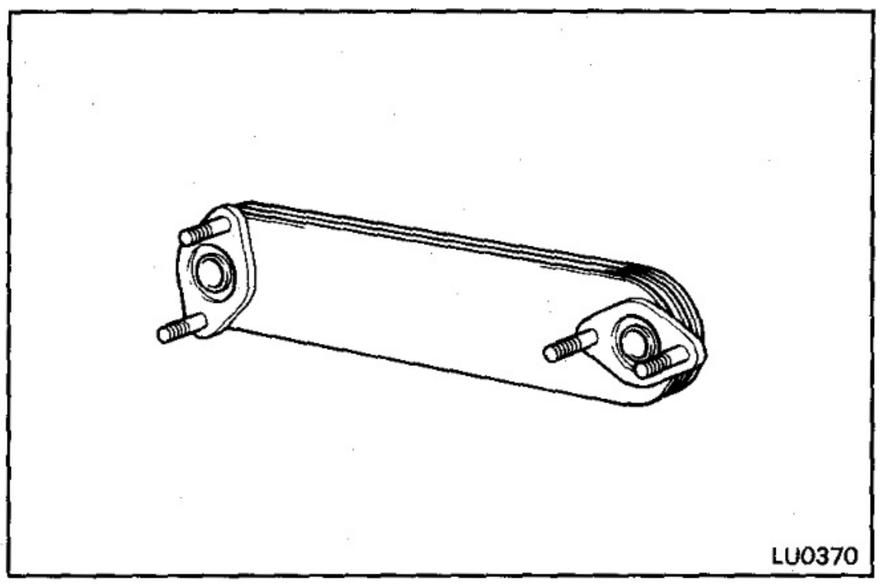


INSPECTION OF OIL COOLER AND RELIEF VALVE

1. INSPECT RELIEF VALVE

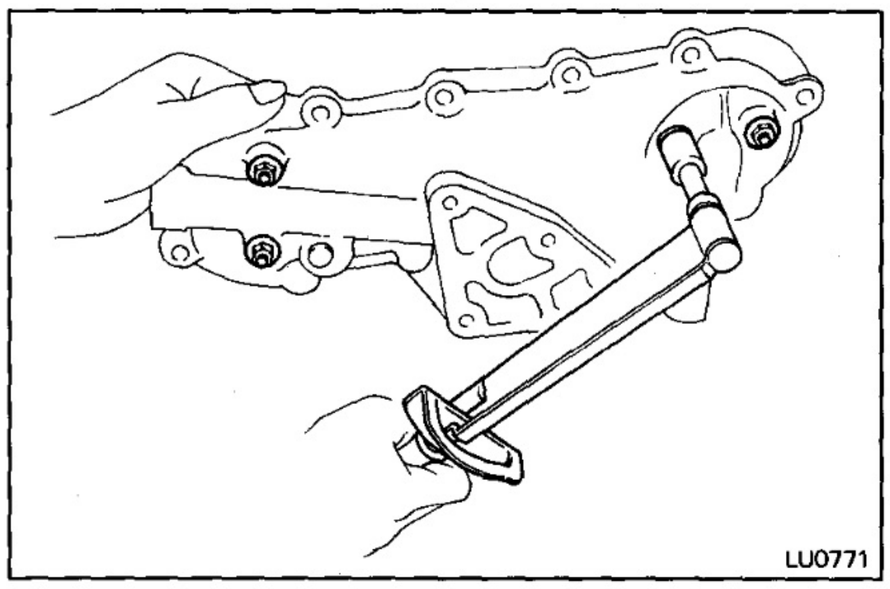
Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If is not, replace the relief valve. If necessary, replace the oil filter bracket.



2. INSPECT OIL COOLER

Check the oil cooler for damage or clogging.



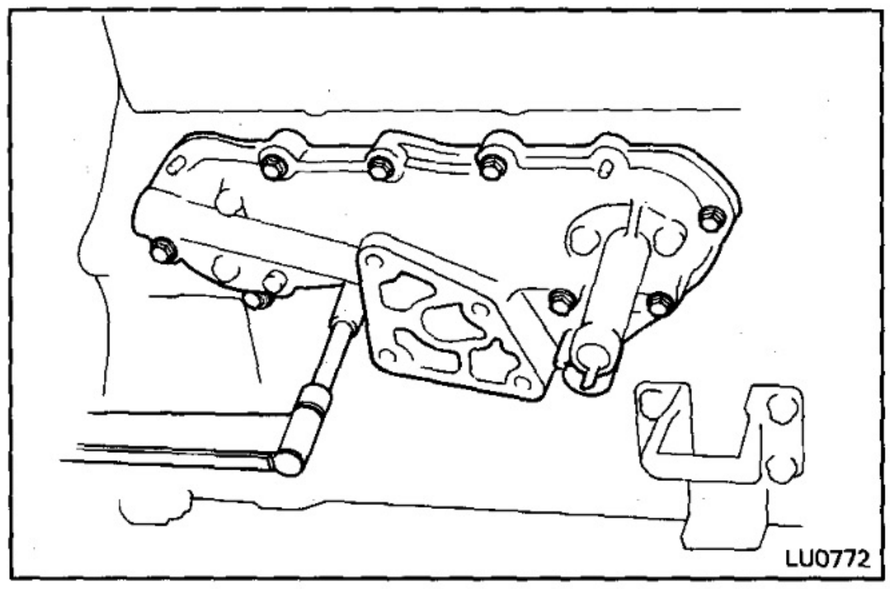
INSTALLATION OF OIL COOLER AND RELIEF VALVE

(See page LU-17)

1. ASSEMBLE OIL COOLER AND OIL COOLER CASE

Assemble the oil cooler and oil cooler case together with new two gaskets and O-rings. Install the four nuts.

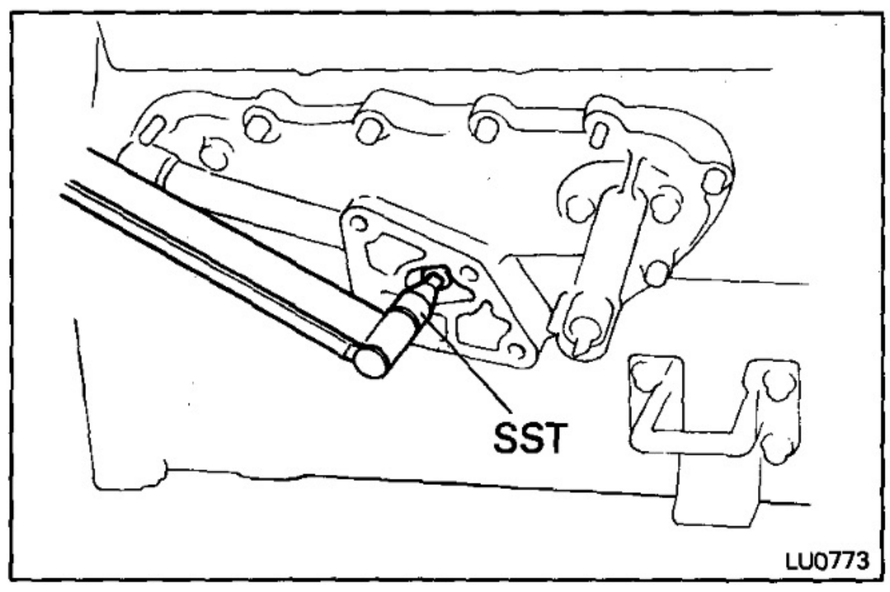
Torque: 145 kg-cm (10 ft-lb, 14 N·m)



2. INSTALL OIL COOLER CASE AND OIL COOLER ASSEMBLY

(a) Install a new gasket, the oil cooler case and oil cooler assembly with the nine bolts and two nuts.

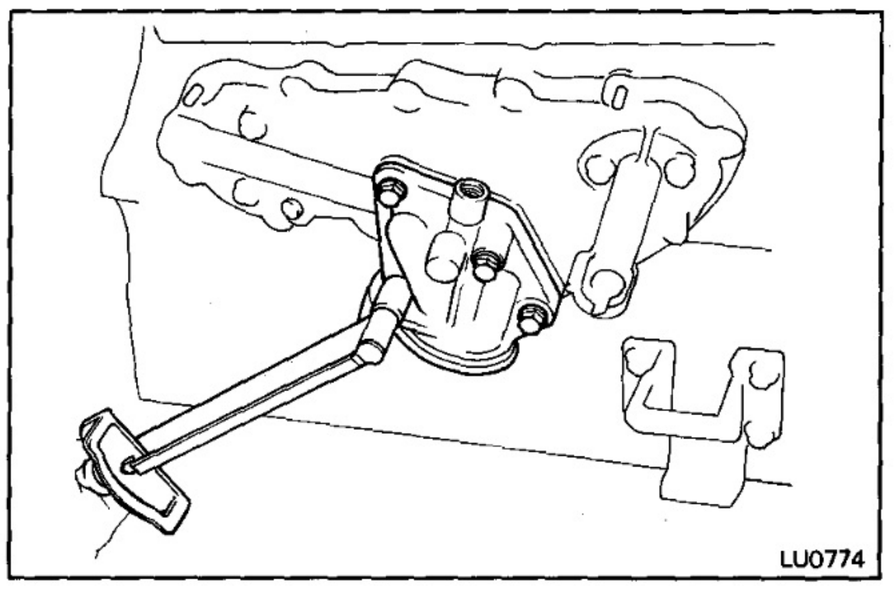
Torque: 185 kg-cm (13 ft-lb, 18 N·m)



(b) Using SST, install the bolt holding the oil cooler case to the cylinder block.

SST 09313-30021

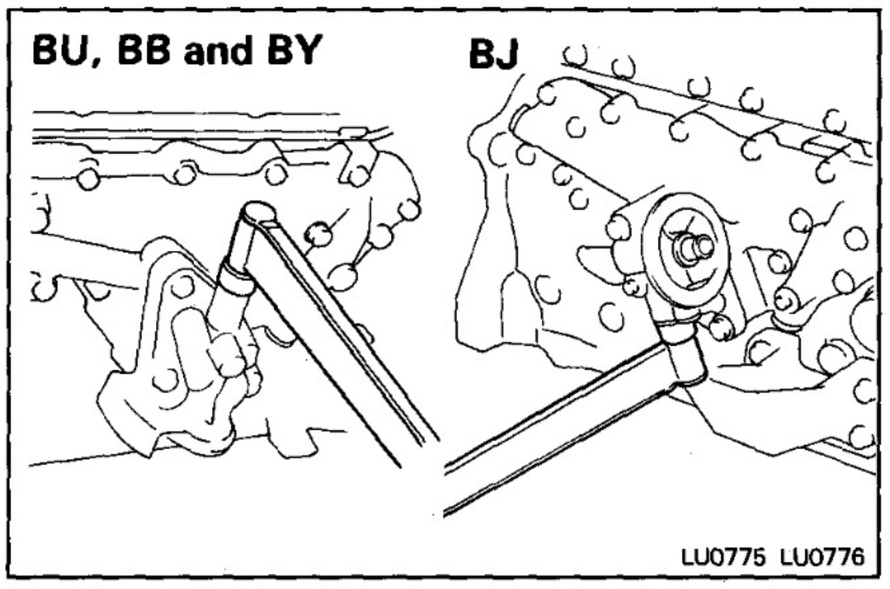
Torque: 185 kg-cm (13 ft-lb, 18 N·m)



3. INSTALL OIL FILTER BRACKET

Install a new gasket, the oil filter bracket with the four bolts.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



4. INSTALL RELIEF VALVE

Install the relief valve and spring with a new gasket and the plug.

Torque: 500 kg-cm (36 ft-lb, 49 N·m)

5. INSTALL OIL FILTER (See page LU-5)

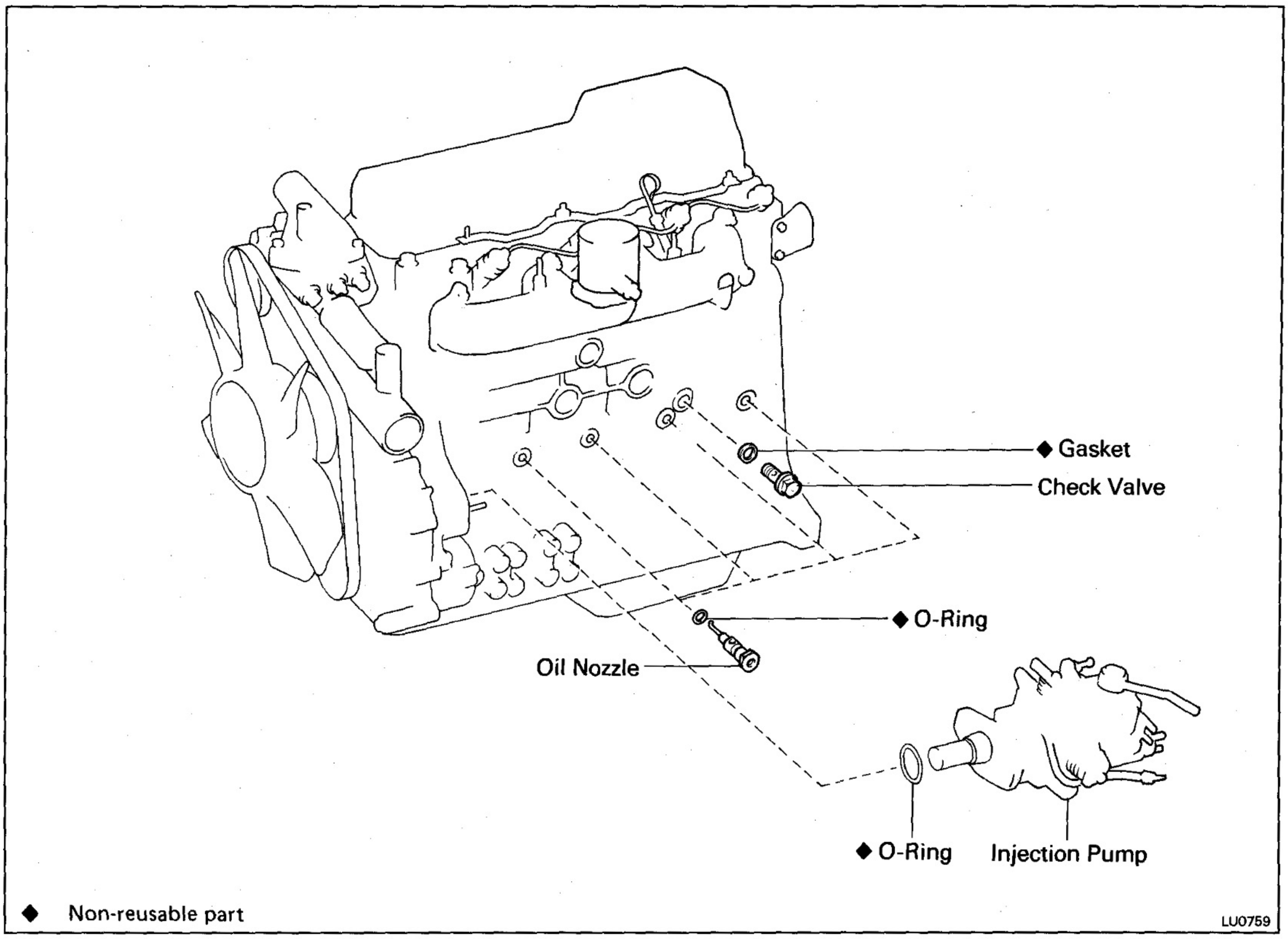
6. FILL WITH ENGINE COOLANT (See page CO-5)

7. START ENGINE AND CHECK FOR LEAKS

8. CHECK ENGINE OIL LEVEL (See page LU-4)

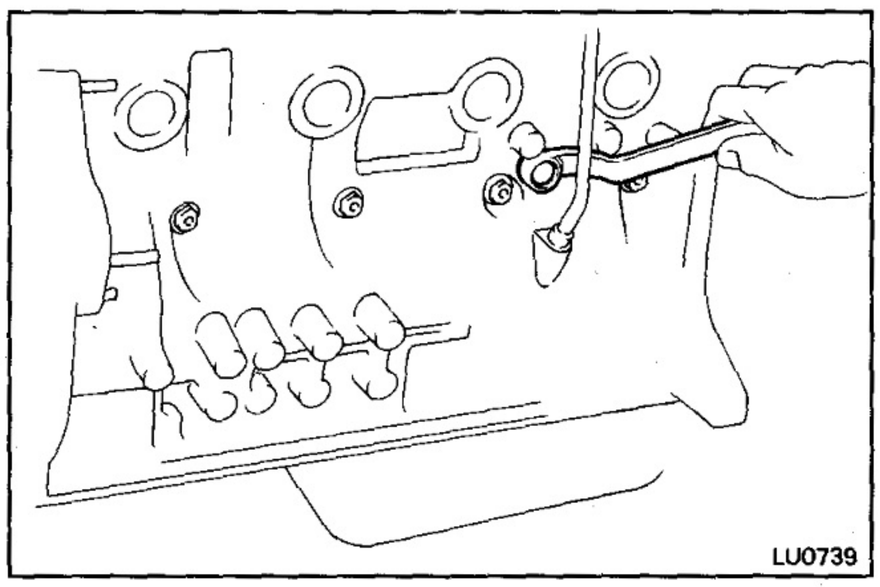
OIL NOZZLES AND CHECK VALVE

COMPONENTS



◆ Non-reusable part

LU0759

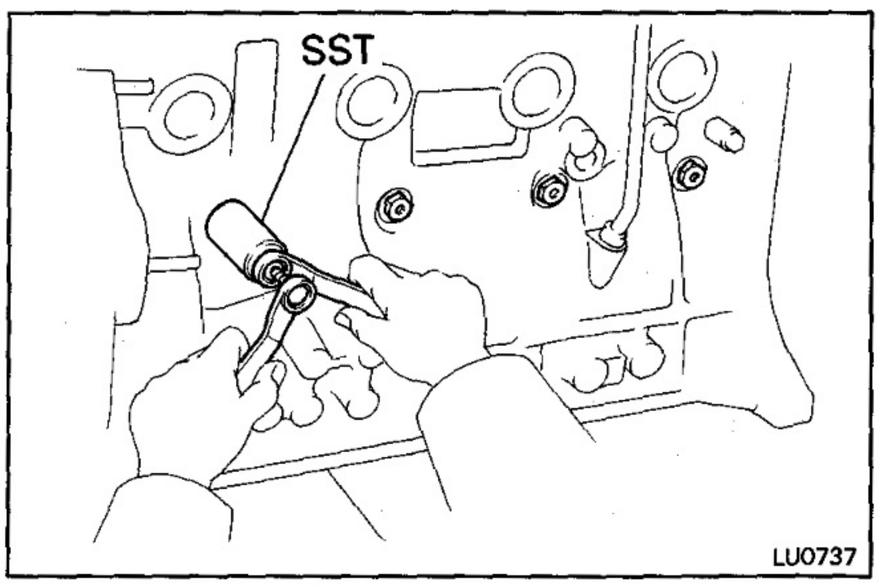


LU0739

REMOVAL OF OIL NOZZLES AND CHECK VALVE

1. **REMOVE INJECTION PUMP (See page FU-20)**

2. **REMOVE CHECK VALVE**

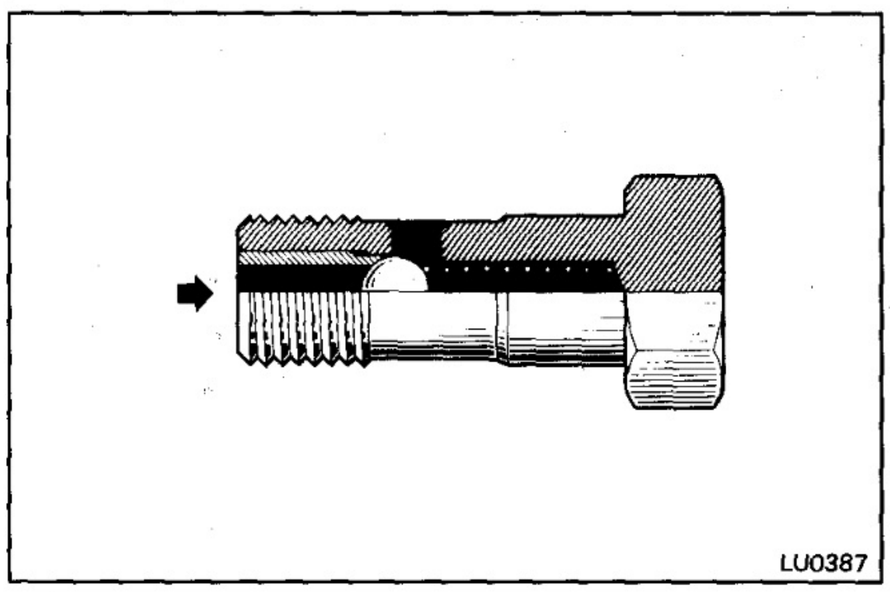


LU0737

3. **REMOVE OIL NOZZLES**

Using SST, remove the oil nozzles.

SST 09219-56010

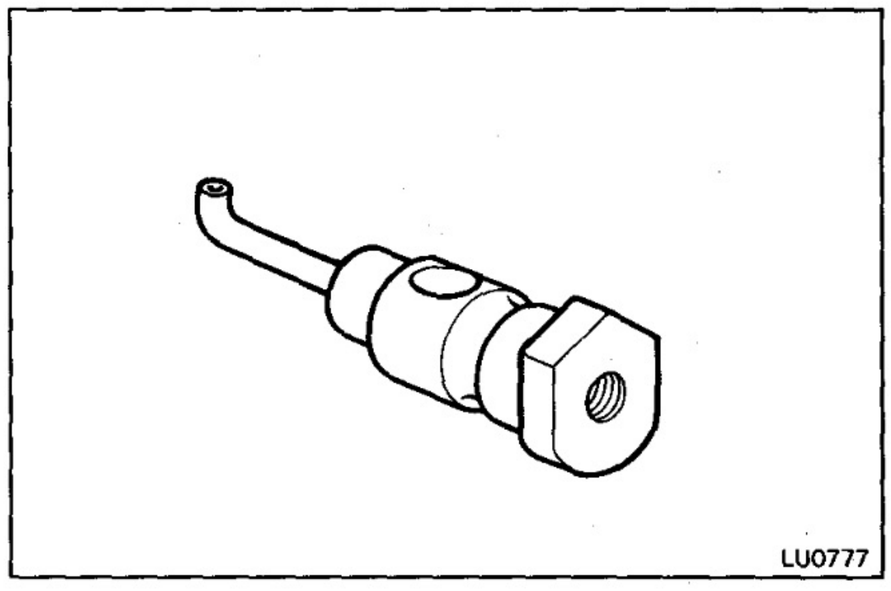


INSPECTION OF OIL NOZZLE AND CHECK VALVE

1. INSPECT CHECK VALVE

Push the valve with a wooden stick to check if it is stuck.

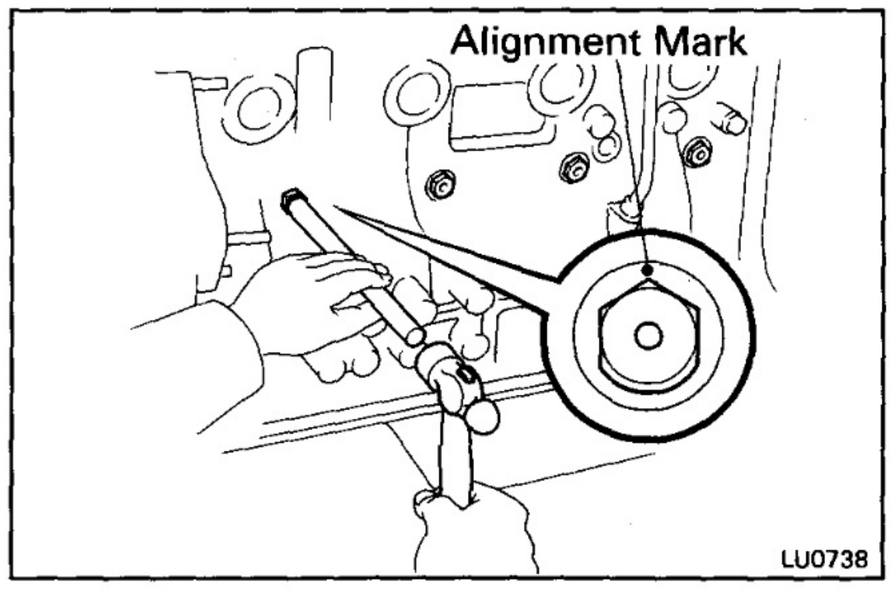
If stuck, replace the check valve.



2. INSPECT OIL NOZZLES

Check the oil nozzle for damage or clogging.

If damaged or clogging, replace the oil nozzle.



INSTALLATION OF OIL NOZZLES AND CHECK VALVE

(See page LU-21)

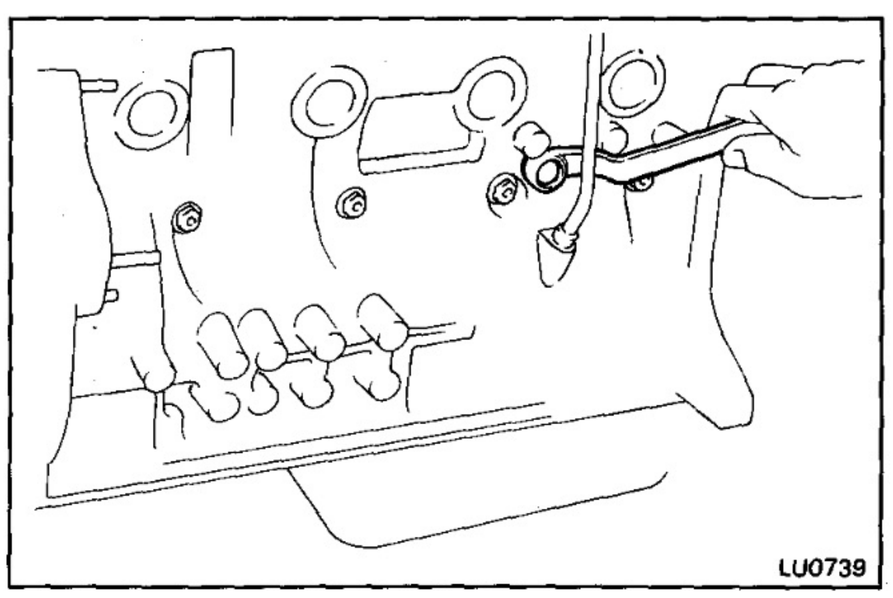
1. INSTALL OIL NOZZLES

(a) Install a new O-ring to the oil nozzle.

(b) Apply a light coat of engine oil on the O-ring.

(c) Align the head point of the oil nozzle with the alignment mark of the cylinder block.

(d) Using a brass bar and hammer, tap in the four nozzles.



2. INSTALL CHECK VALVE

Install a new gasket and the check valve.

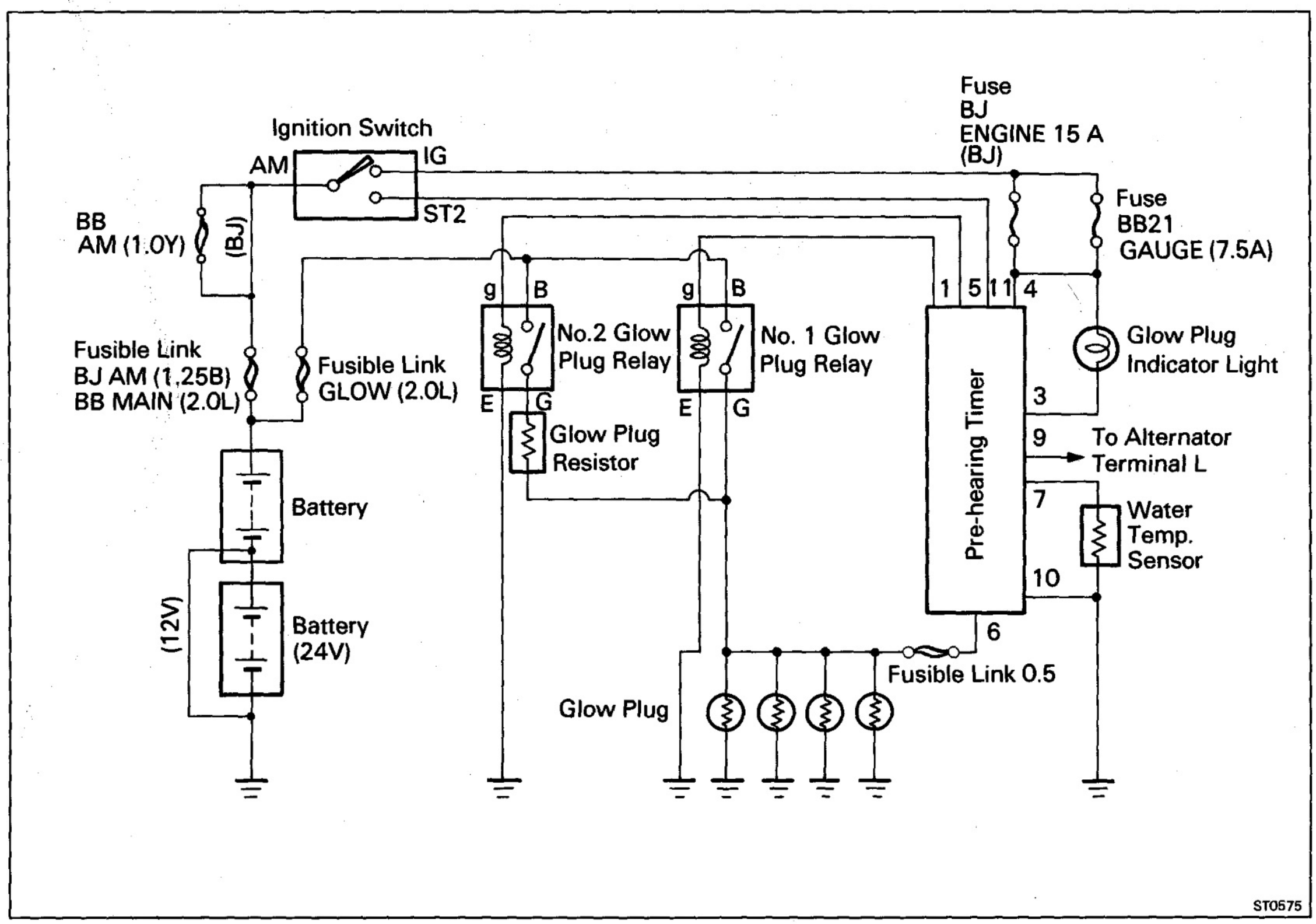
Torque: 350 kg-cm (25 ft-lb, 34 N·m)

STARTING SYSTEM

	Page
PRE-HEATING SYSTEM [B and 3B]	ST-2
PRE-HEATING SYSTEM [11B and 14B]	ST-9
TROUBLESHOOTING	ST-12
STARTING SYSTEM CIRCUIT	ST-12
STARTER	ST-13
STARTER RELAY [BB, BU and BY]	ST-22
STARTER RELAY [BJ]	ST-23

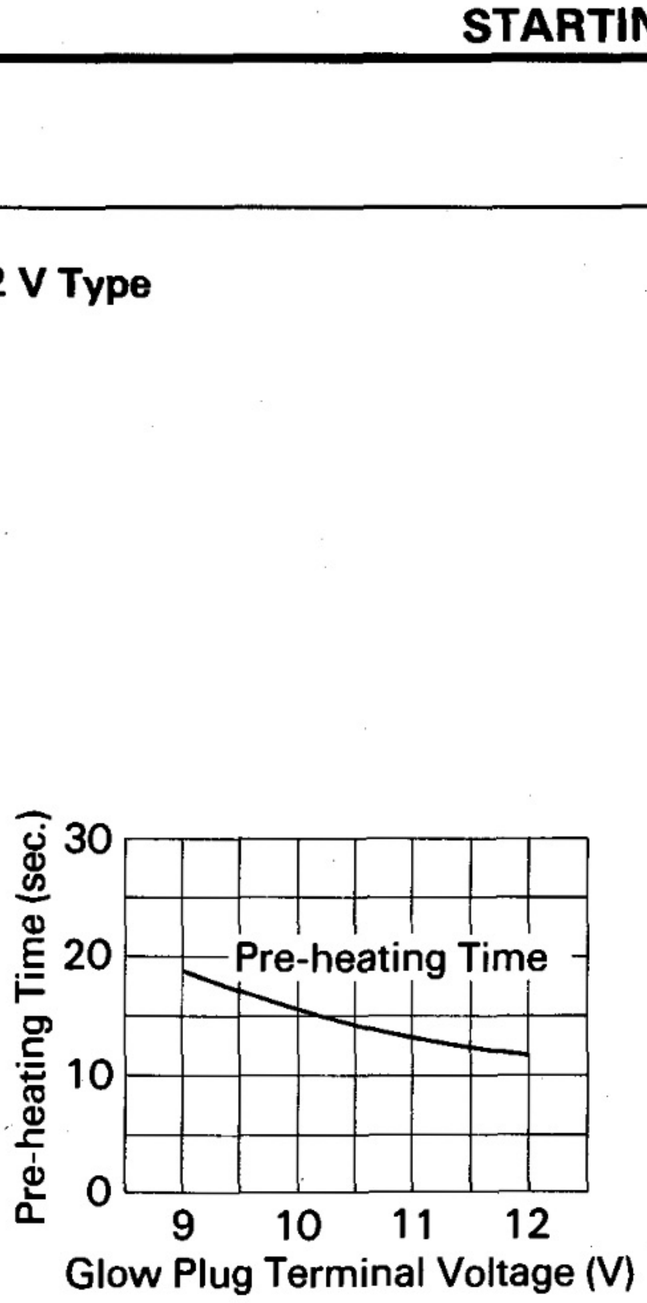
PRE-HEATING SYSTEM [B and 3B]
Super Glow Type

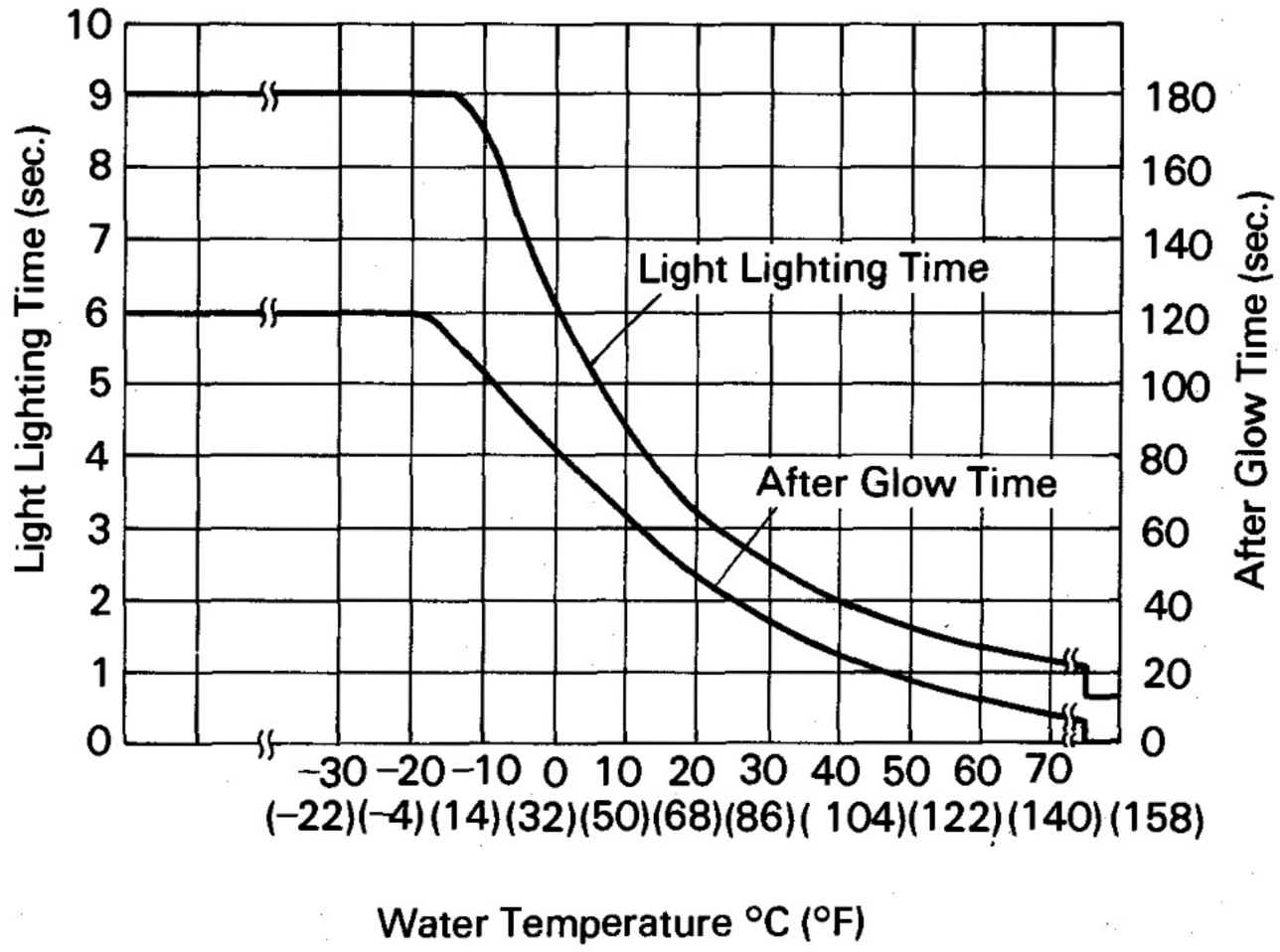
SYSTEM CIRCUIT



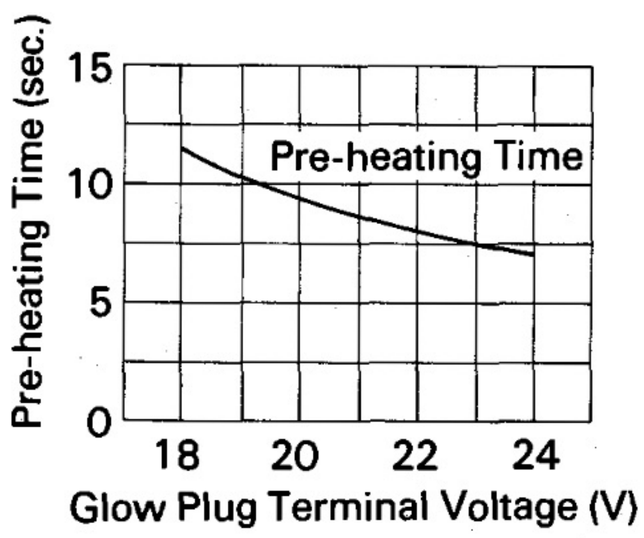
TIMER CHARACTERISTIC DIAGRAM

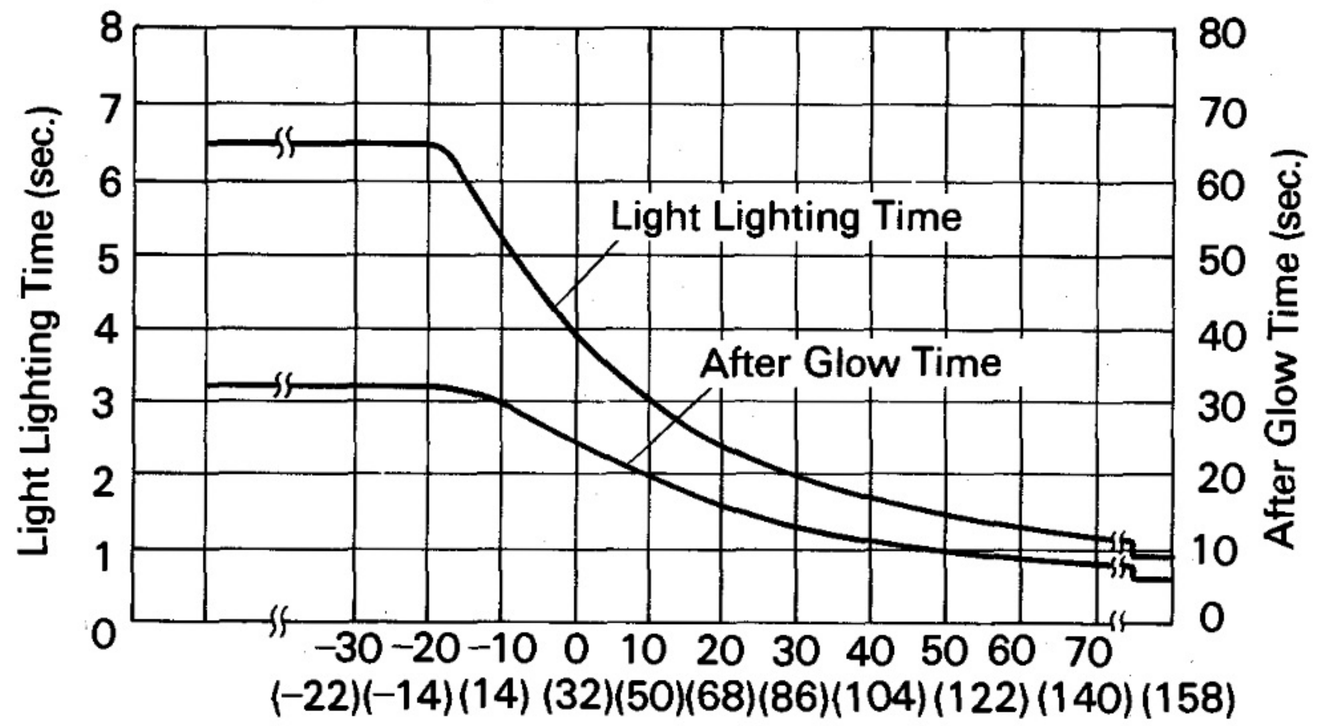
12 V Type



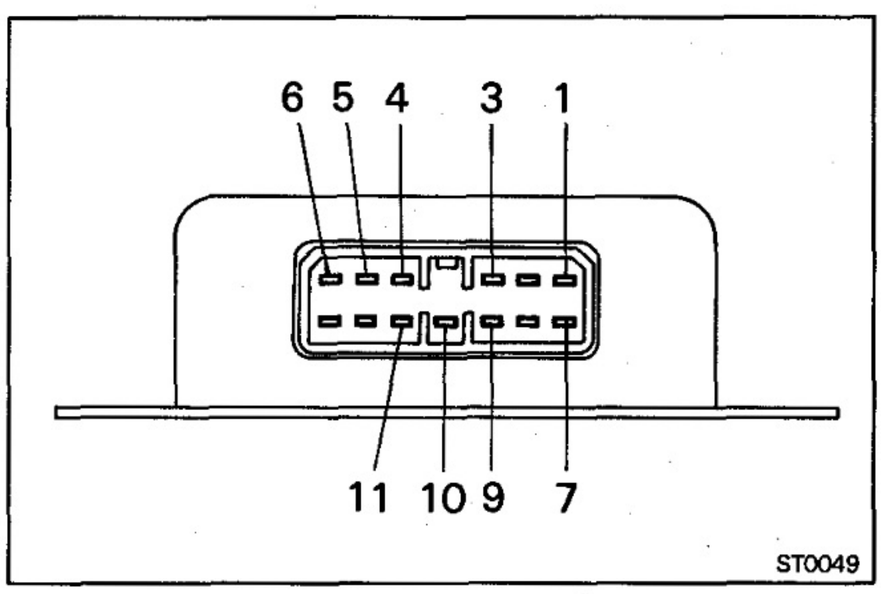


24 V Type





ST0585 ST0584
ST0586 ST0583



INSPECTION OF COMPONENTS

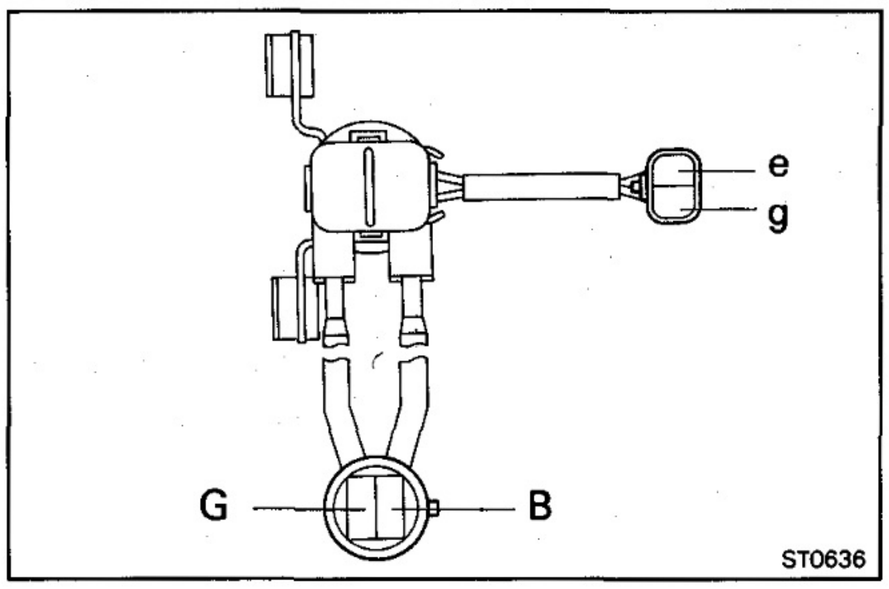
Pre-heating Timer

LOCATION

BJ: Under the instrument panel on the passenger side.

BB: Under the instrument panel center.

Refer to Diesel Electrical System Diagnosis for inspection procedures. (See page EM-13)

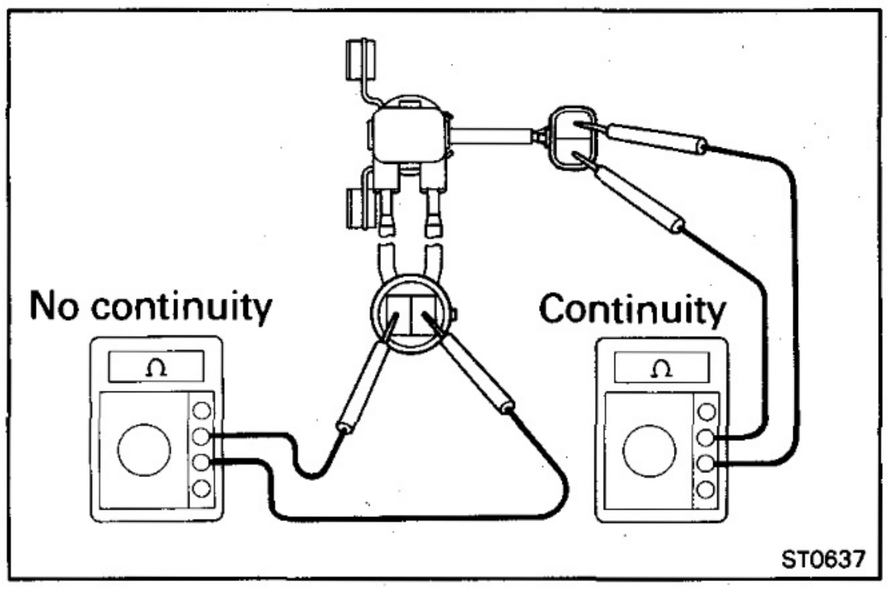


No. 1 Glow Plug Relay

LOCATION

BJ: On the fender apron in the engine compartment.

BB: Below the left fender apron.

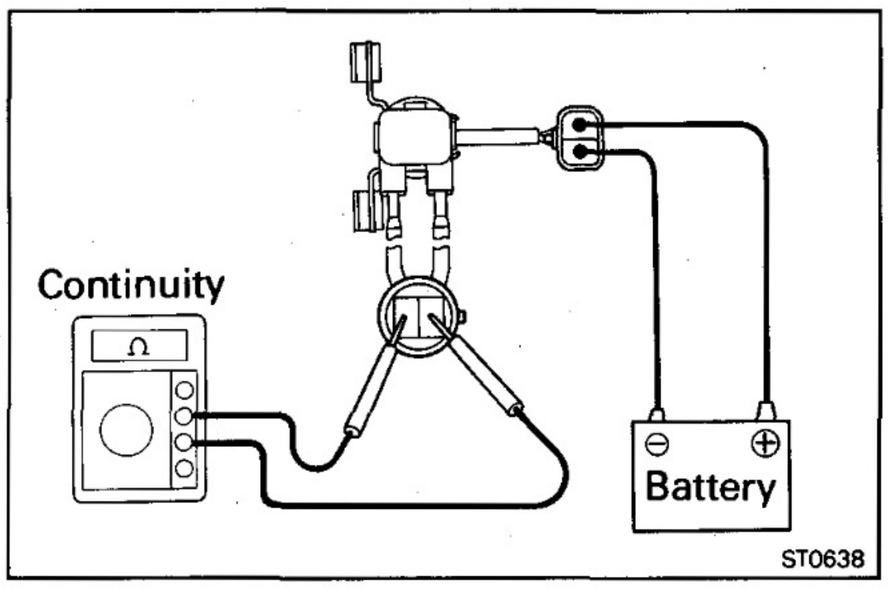


1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.

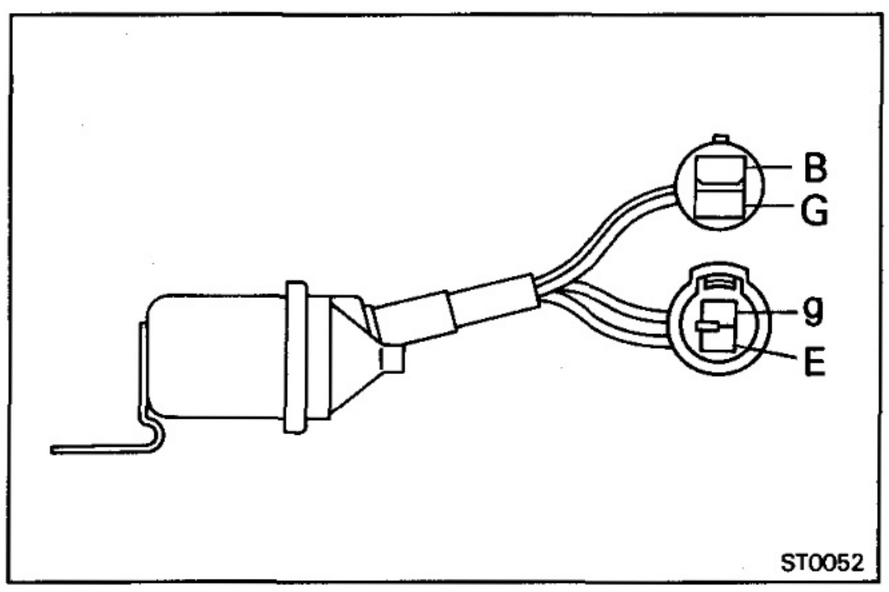


2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and g for no more than a few seconds.

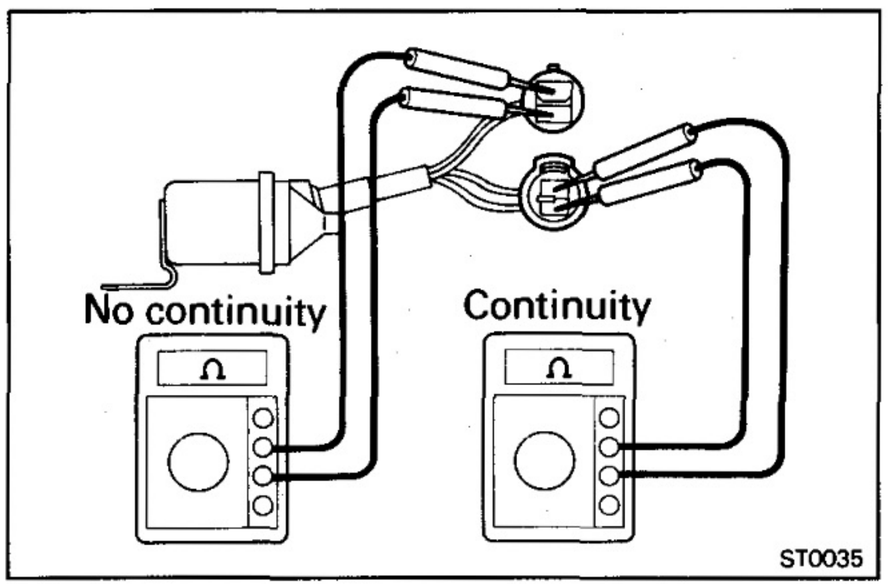
(b) Check that there is continuity between terminals B and G.

If operation is not as specified, replace the relay.



No. 2 Glow Plug Relay [BJ]

LOCATION: On the fender apron in the engine compartment.

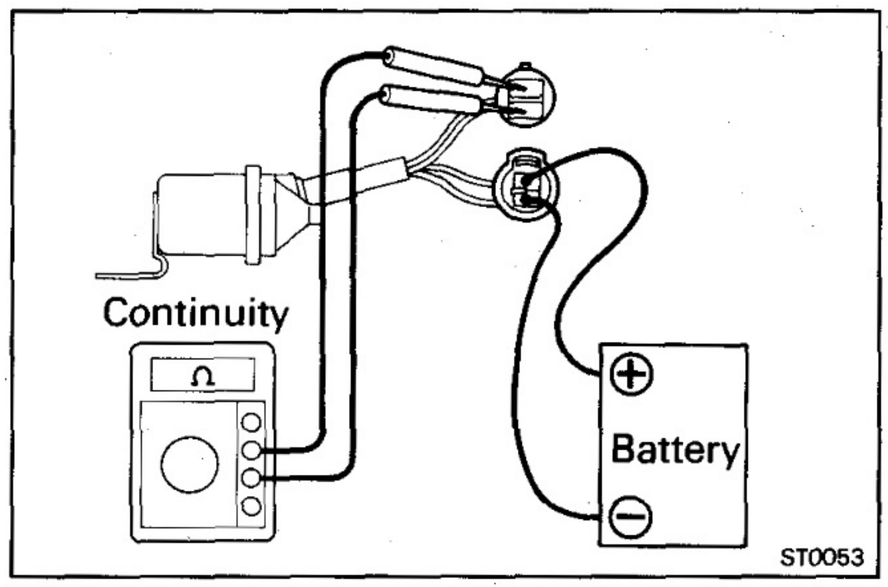


1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.

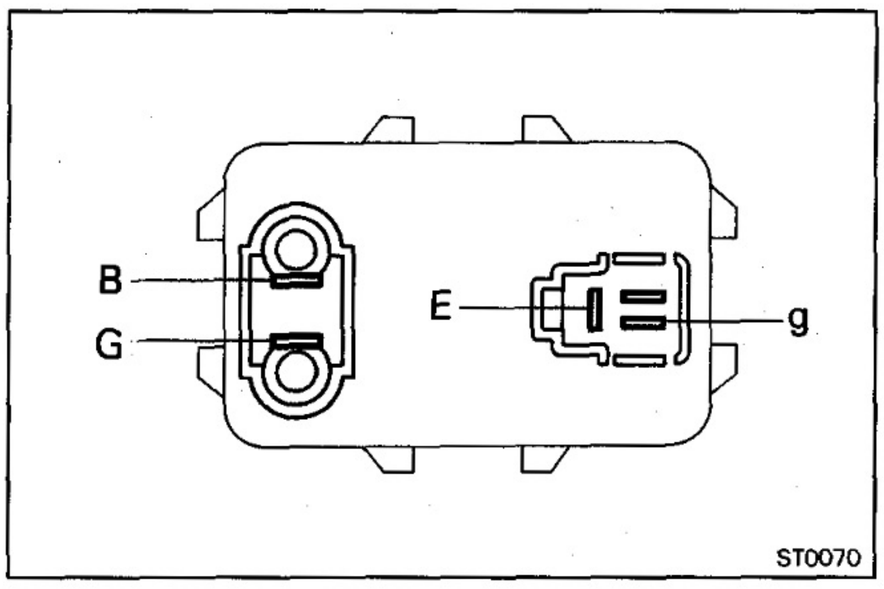


2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and g for no more than a few seconds.

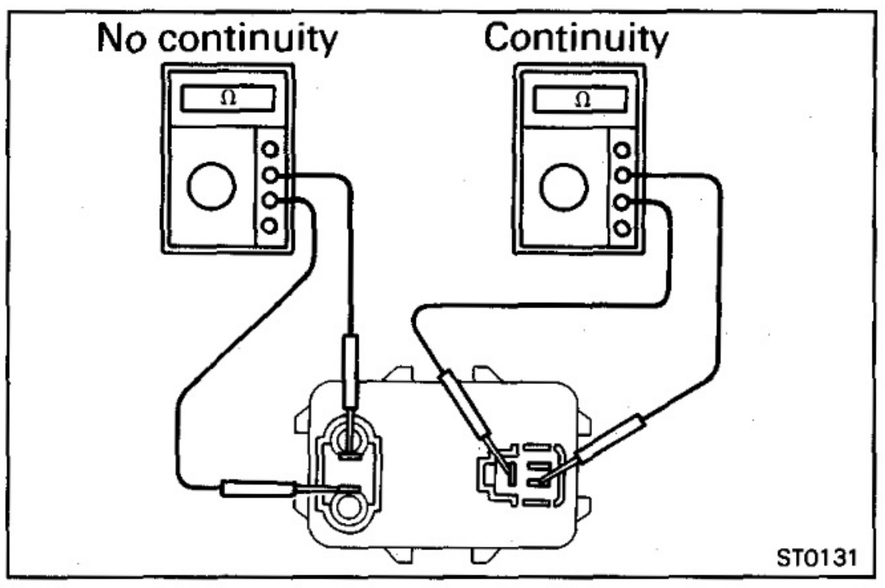
(b) Check that there is continuity between terminals B and G.

If operation is not as specified, replace the relay.



No. 2 Glow Plug Relay [BB]

LOCATION: Below the left tender apron.

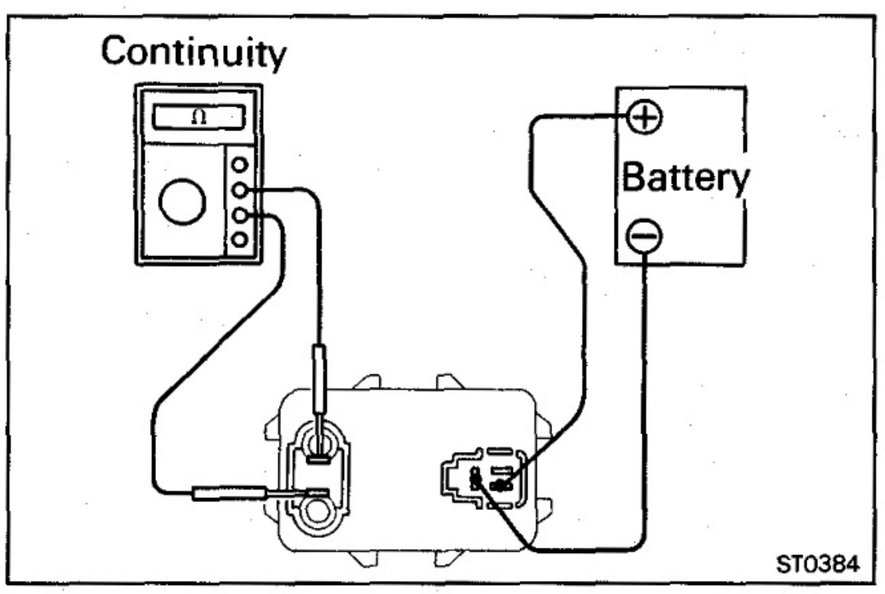


1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.

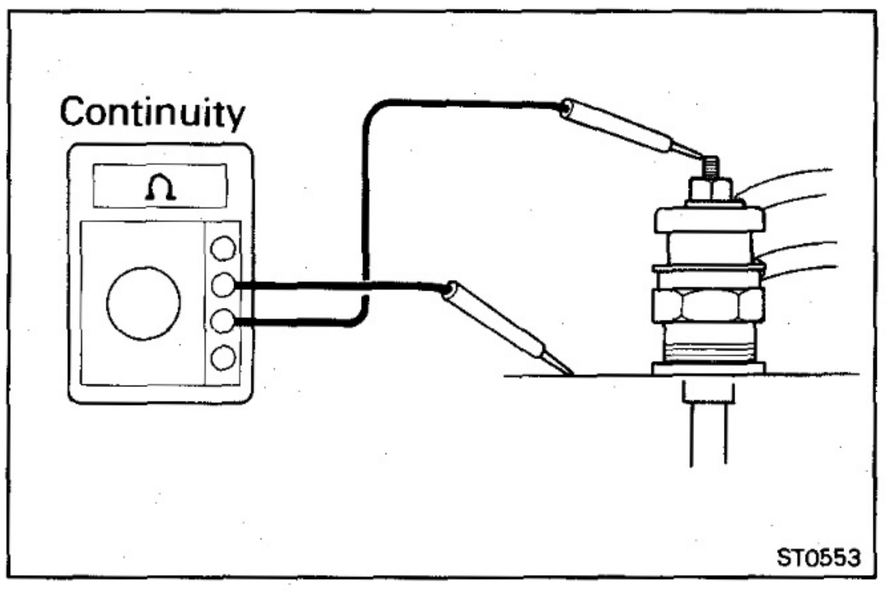


2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and g for no more than a few seconds.

(b) Check that there is continuity between terminals B and G.

If operation is not as specified, replace the relay.

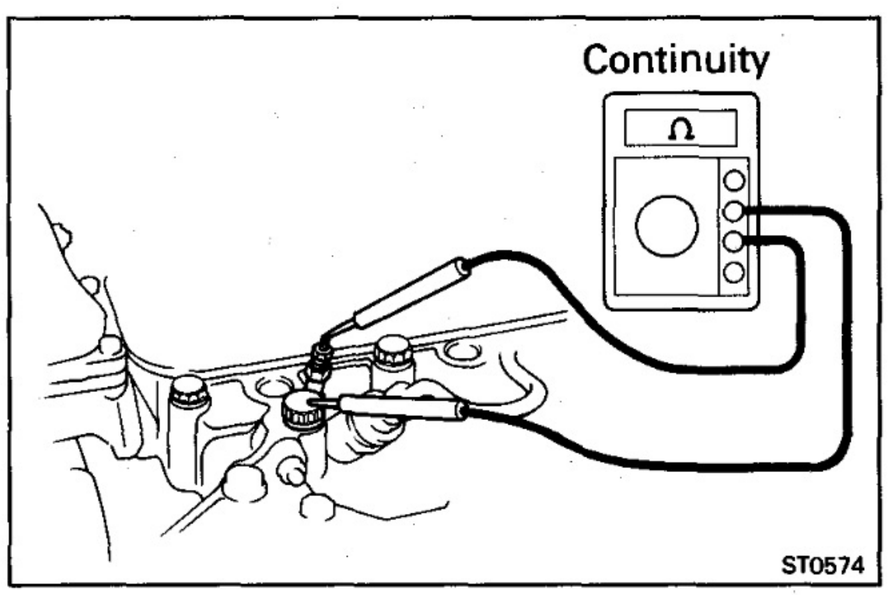


Glow Plug Resistor

INSPECT GLOW PLUG RESISTOR

Using an ohmmeter, check that there is no continuity between the resistor terminal and intake manifold.

If there is continuity, replace the resistor.



Glow Plug

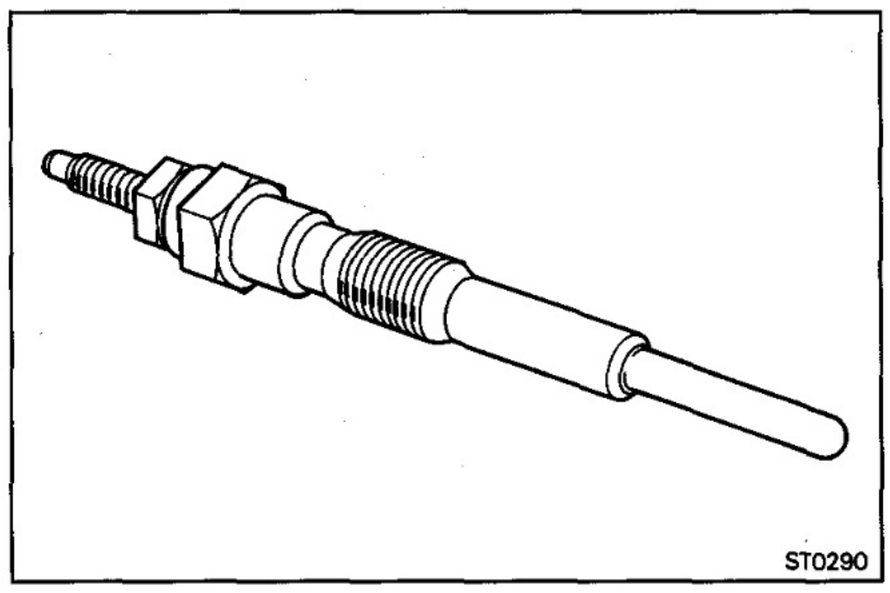
INSPECT GLOW PLUG

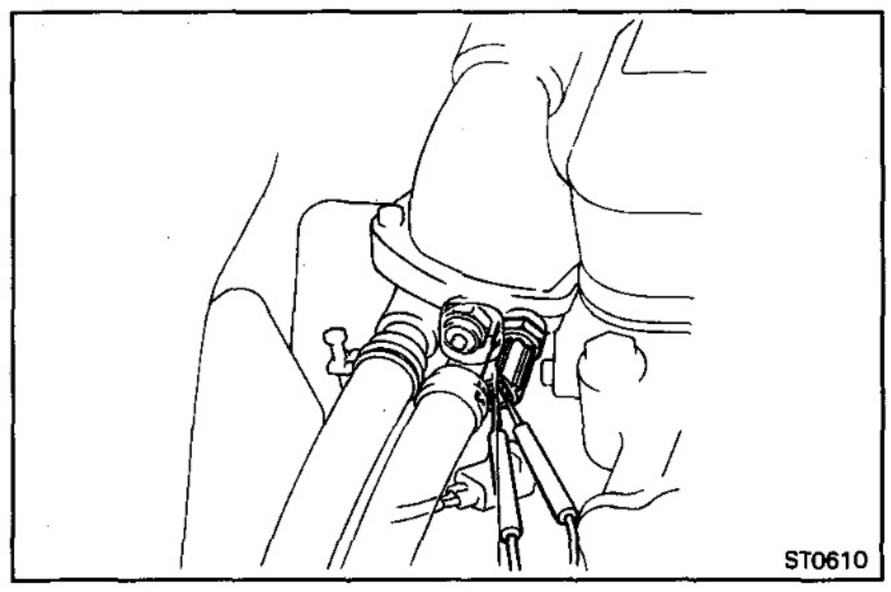
Using an ohmmeter, check that there is continuity between the glow plug terminal and ground.

If there is no continuity, replace the glow plug.

HINT:

- Be careful not to damage the glow plug pipes as it could cause an open circuit or shorten the life of the plugs.
- Avoid getting oil and gasoline on the glow plugs when cleaning.
- During inspection, use a cloth be sure to wipe any oil off the glow plug terminals and bakelite washer.
- Be careful not to apply more than 7 volts to the glow plug as it could cause an open circuit.





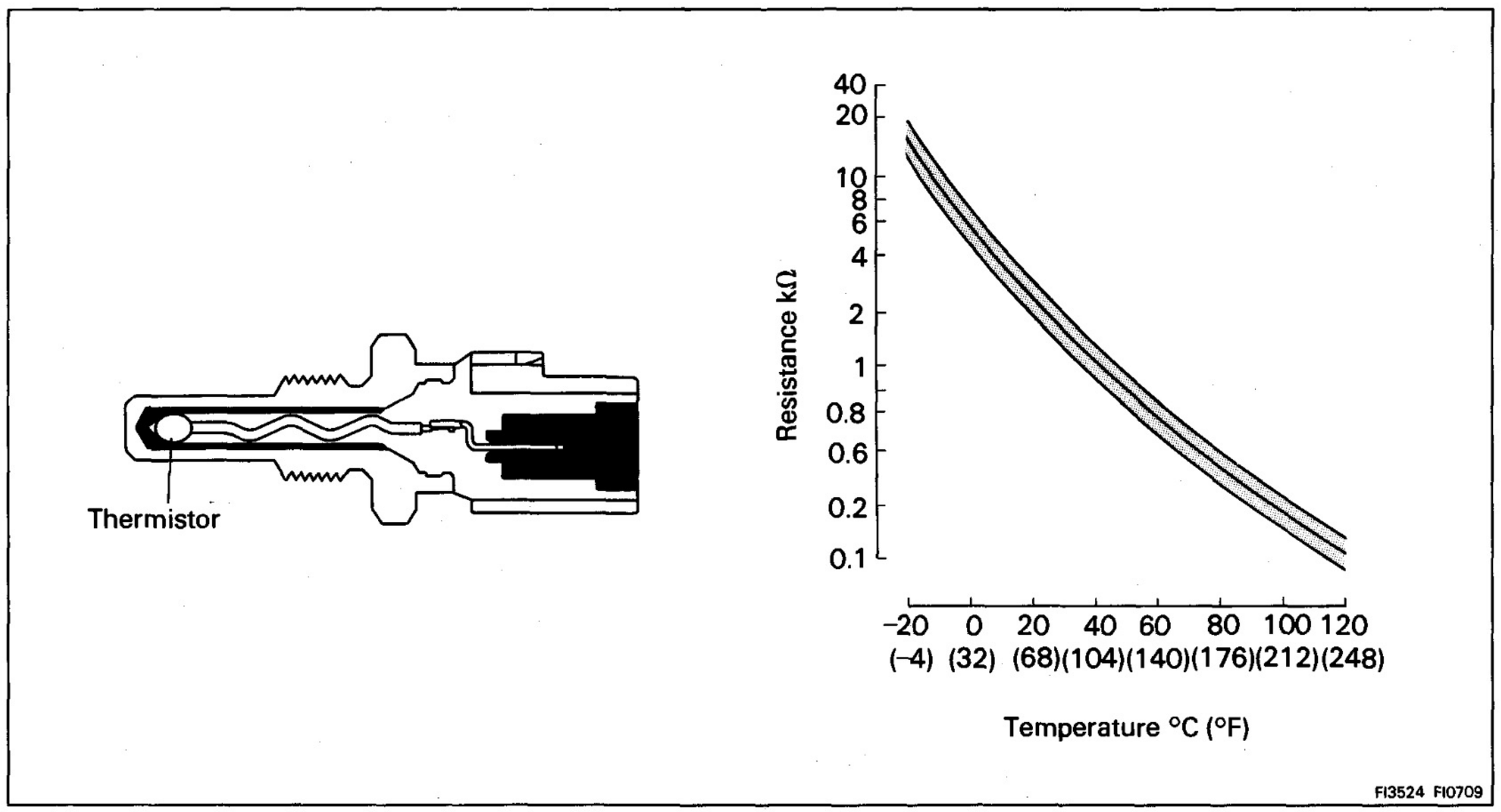
Water Temp. Sensor

INSPECT WATER TEMP. SENSOR

Using an ohmmeter, check the resistance between the water temp. sensor terminals.

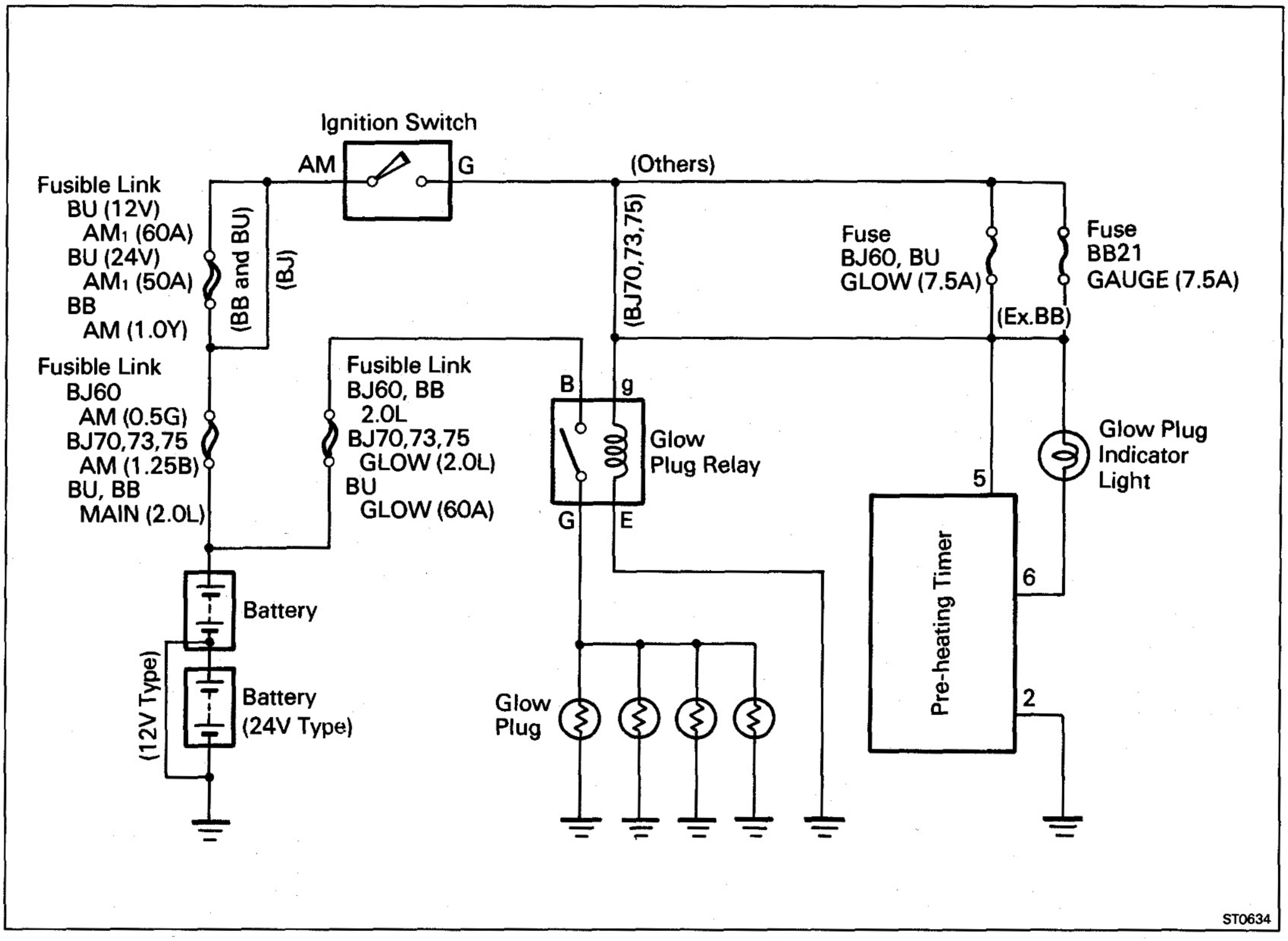
Resistance: *Refer to the chart.*

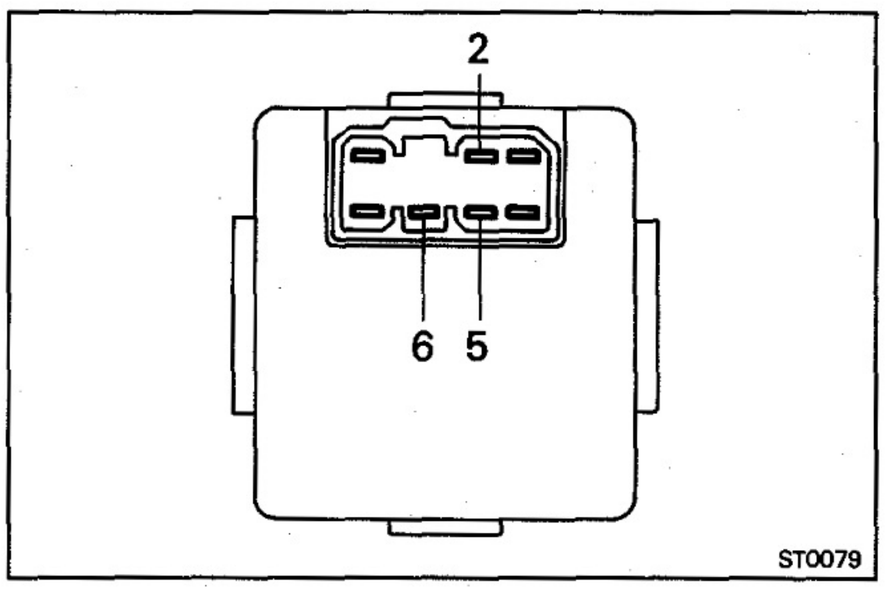
If the resistance is not as specified, replace the water temp. sensor.



Fixed Delay Type

SYSTEM CIRCUIT





INSPECTION OF COMPONENTS

Pre-Heating Timer

LOCATION

BB: Under the instrument panel center.

BJ60: In the cowl on the passenger side.

BJ73: Under the instrument panel on the passenger side.

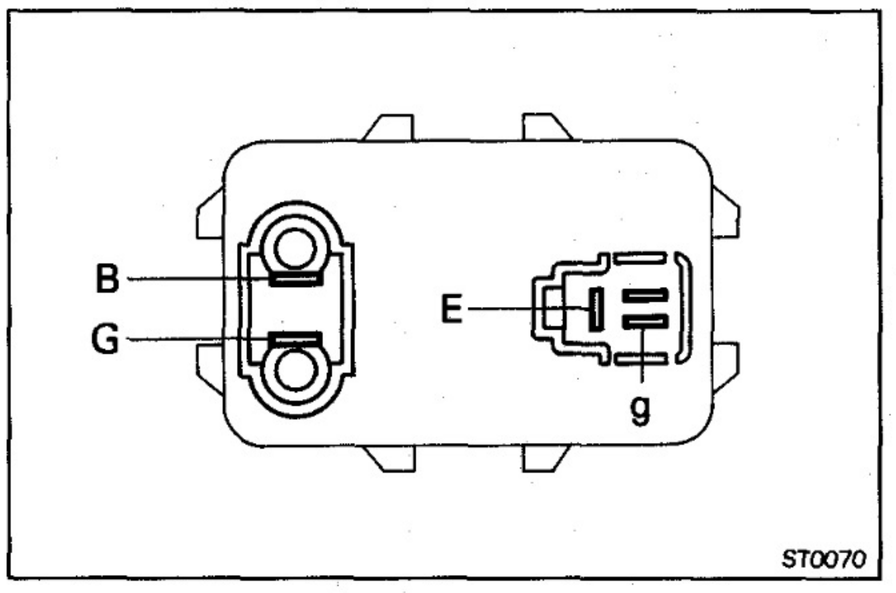
BU: Under the instrument panel on the driver's side.

INSPECT PRE-HEATING TIMER

(a) Turn the ignition switch to G and measure the lighting time of the glow indicator light.

Light lighting time: 15 — 19.5 seconds

(b) Check that there is voltage at terminal 5 of the preheating timer when the ignition switch is turned to G.

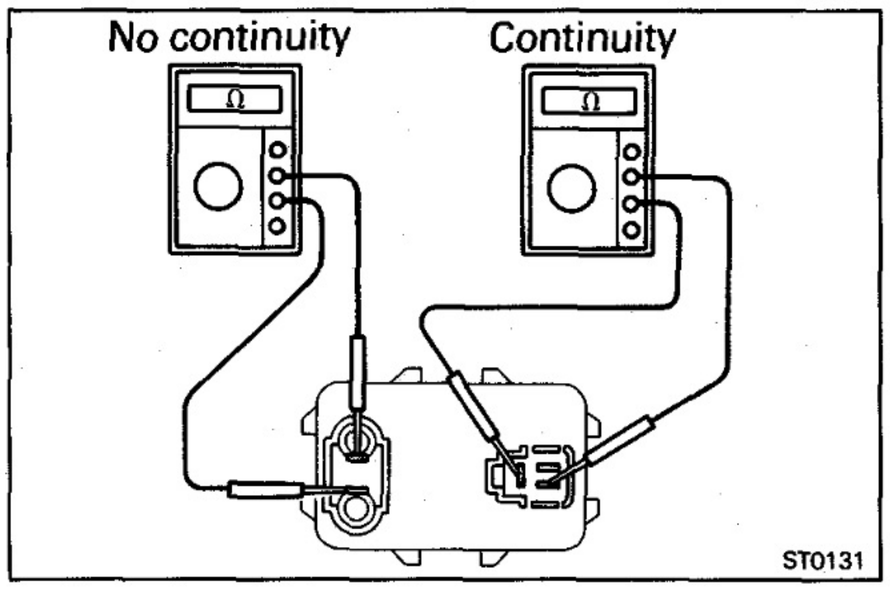


Glow Plug Relay [BB and BU]

LOCATION

BB: Below the left fender apron.

BU: In the cowl on the passenger side.

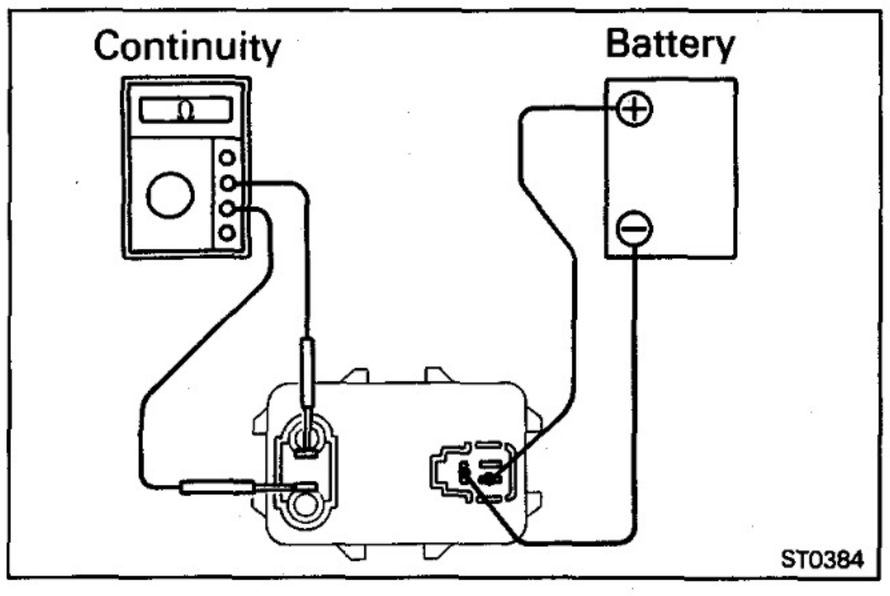


1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and g.

(b) Check that there is continuity between terminals B and G.

If operation is not as specified, replace the relay.

Glow Plug Relay [BJ]

(See No. 2 Glow Plug Relay on page ST-4)

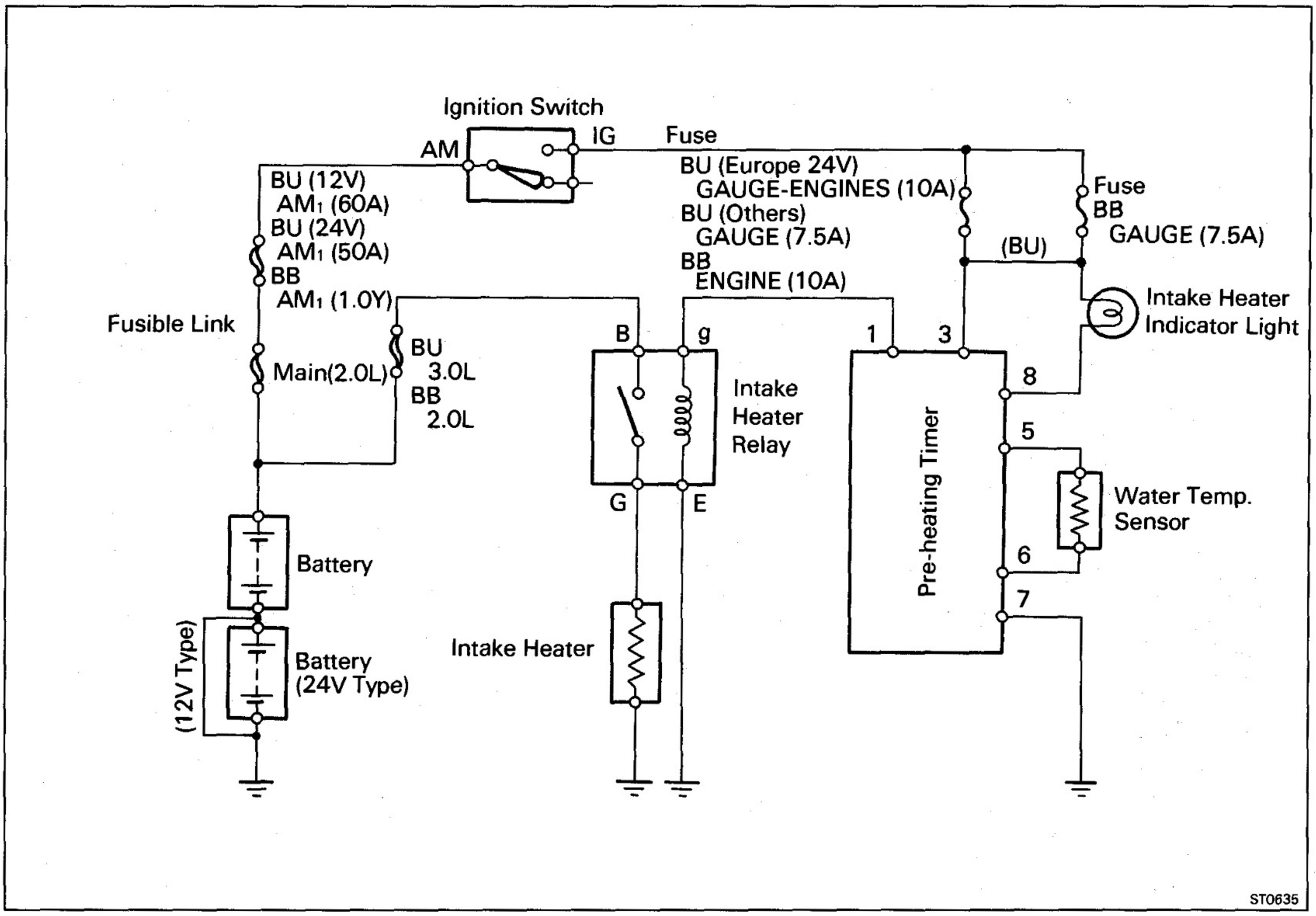
LOCATION: On the fender apron in the engine compartment.

Glow Plug

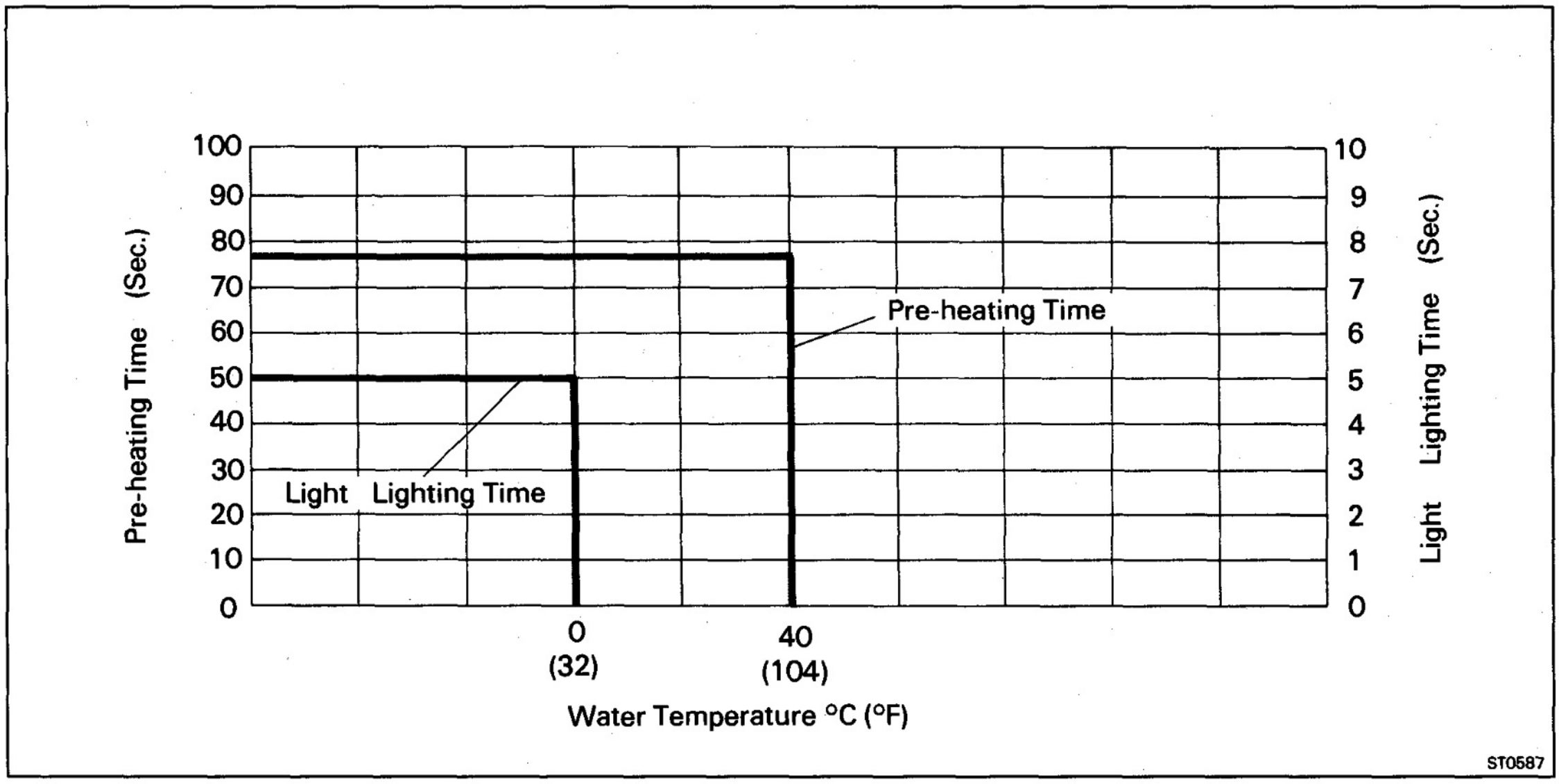
(See page ST-6)

PRE-HEATING SYSTEM [11B and 14B]

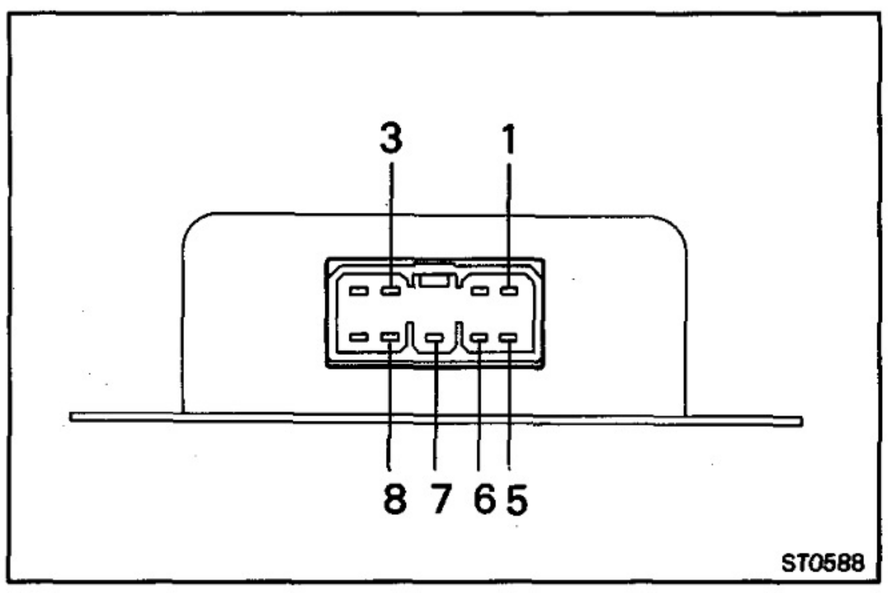
SYSTEM CIRCUIT



TIMER CHARACTERISTIC DIAGRAM



ST0587



ST0588

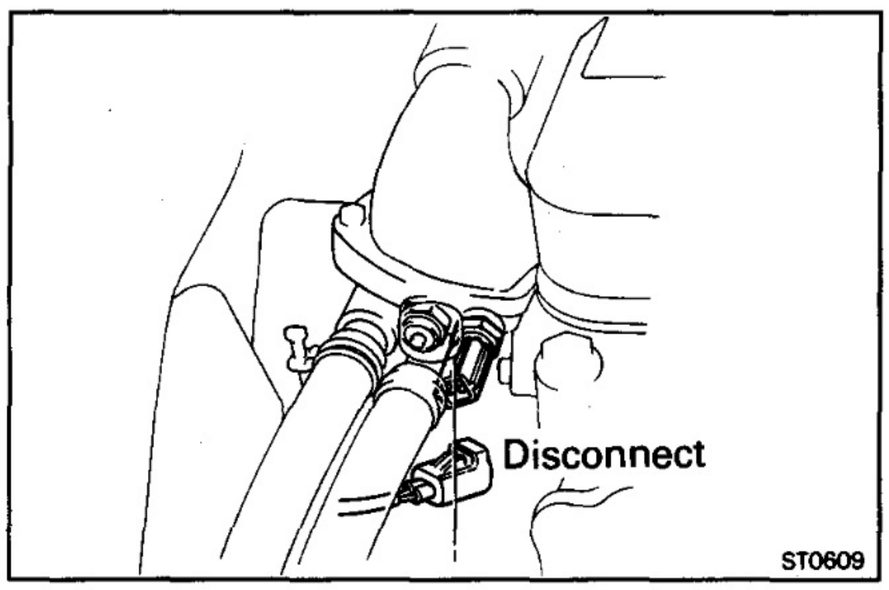
INSPECTION OF COMPONENTS

Pre-heating Timer

LOCATION

BB: Under the instrument panel center.

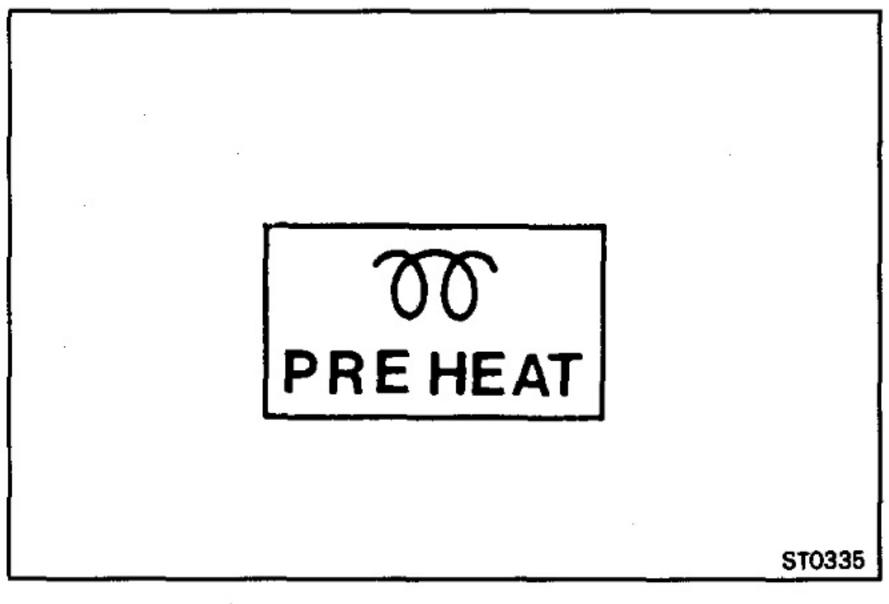
BU: Under the instrument panel on the driver's side.



ST0609

INSPECT PRE-HEATING TIMER

(a) Disconnect the water temp. sensor connector.

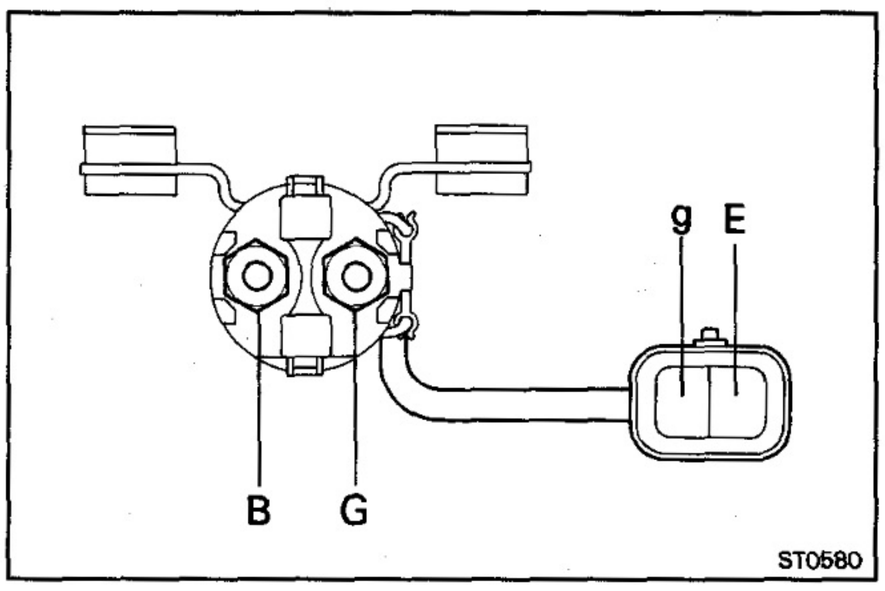


ST0335

(b) Turn the ignition switch to "ON," and measure the time the pre-heating indicator is lit.

Light lighting time [Below 0°C (32°F)]:
Approx. 5 seconds

NOTICE: Since power consumption is high, perform this check as few times as possible.

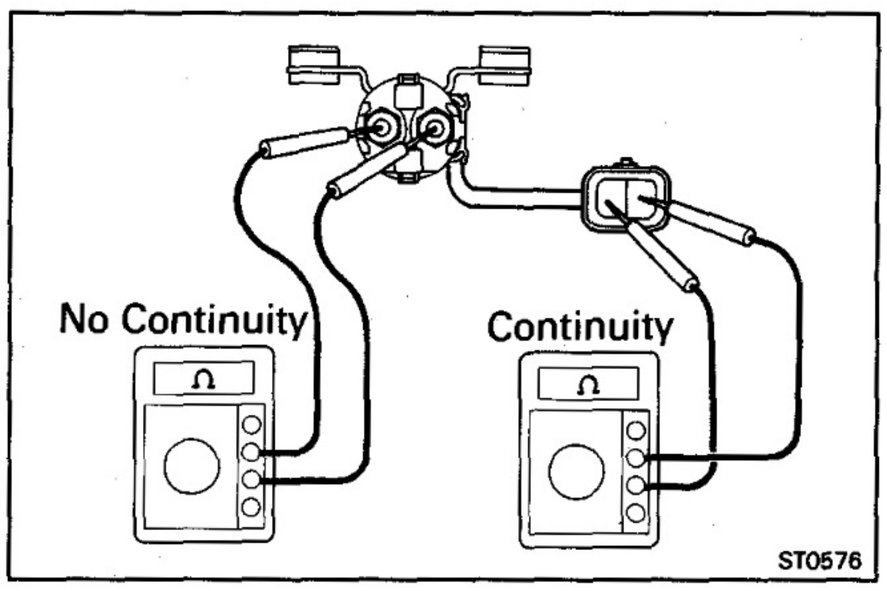


Intake Heater Relay

LOCATION

BB: Below the left fender apron.

BU: On the frame at the rear of the engine

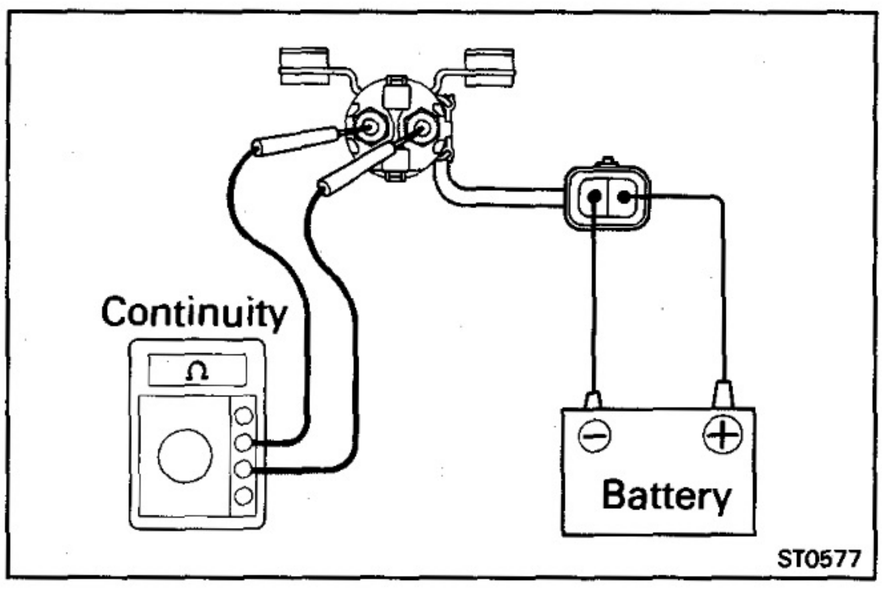


1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and g.

(b) Check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and g.

(b) Check that there is continuity between terminals B and G.

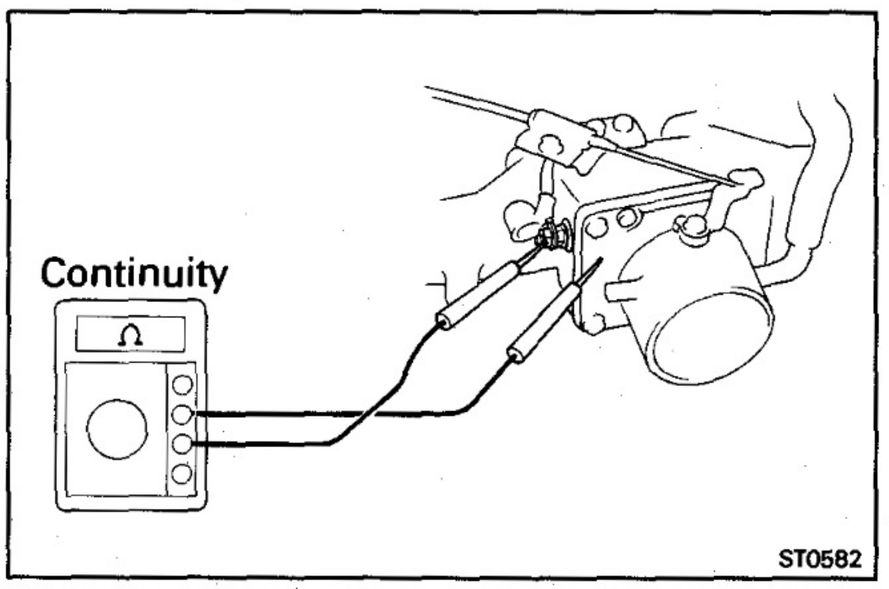
If operation is not as specified, replace the relay.

Intake Heater

INSPECT INTAKE HEATER

Using an ohmmeter, check that there is continuity between terminal of the intake heater and ground.

If there is no continuity, replace the intake heater.



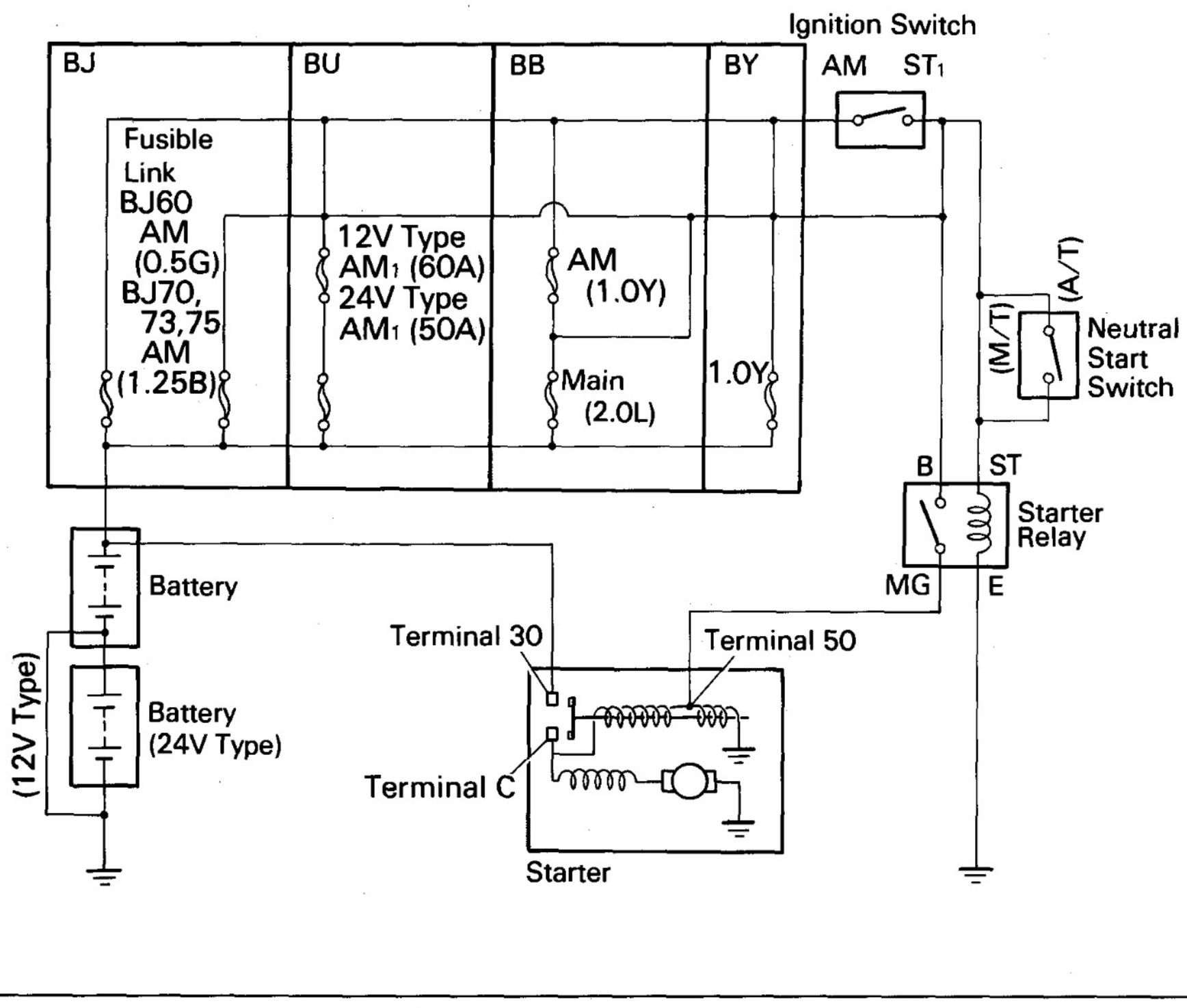
Water Temp. Sensor

(See page ST-6)

TROUBLESHOOTING

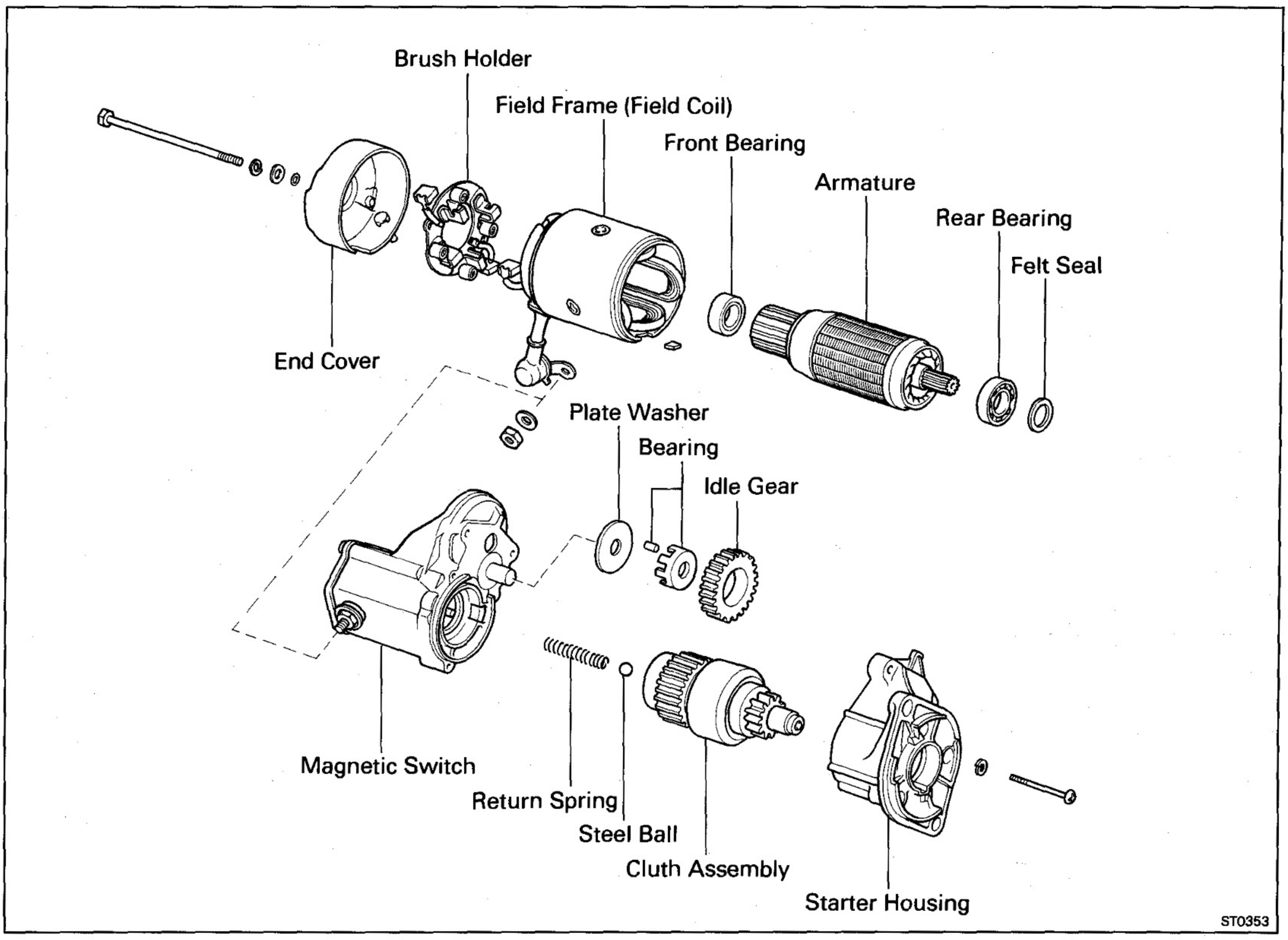
Problem	Possible cause	Remedy	Page
Engine will not crank	Battery charge low	Check battery specific gravity Charge or replace battery	CH-5
	Battery cables loose, corroded or worn	Repair or replace cables	
	Neutral start switch faulty (A/T only)	Replace switch	
	Fusible link blown	Replace fusible link	
	Starter faulty	Repair starter	ST-13
	Ignition switch faulty	Replace ignition switch	
Engine cranks slowly	Battery charge low	Check battery specific gravity Charge or replace battery	CH-5
	Battery cables loose, corroded or worn	Repair or replace cables	
	Starter faulty	Repair starter	ST-13
Starter keeps running	Starter faulty	Repair starter	ST-13
	Ignition switch faulty	Replace ignition switch	
	Short in wiring	Repair wiring	
Starter spins but engine will not crank	Pinion gear teach broken or faulty starter	Repair starter	ST-13
	Flywheel or drive plate teeth broken	Replace flywheel or drive plate	

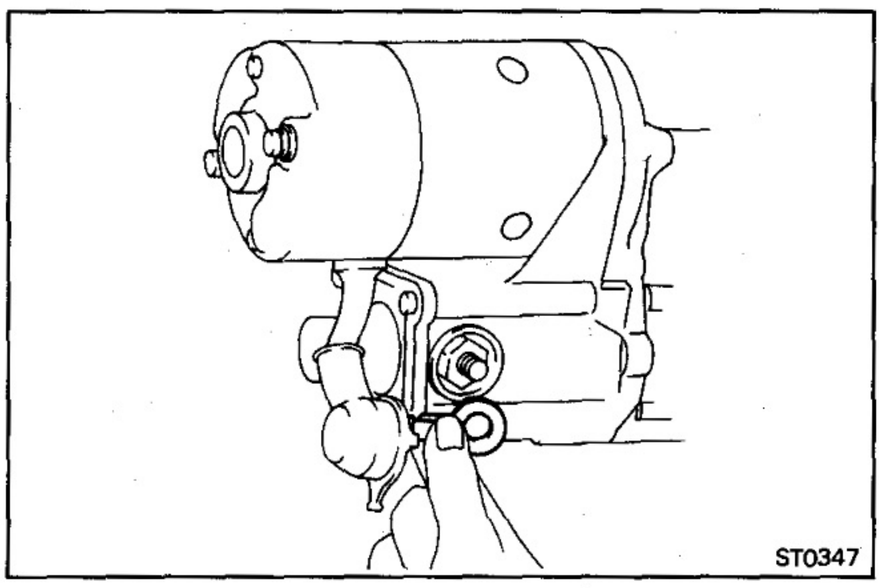
STARTING SYSTEM CIRCUIT



STARTER

COMPONENTS

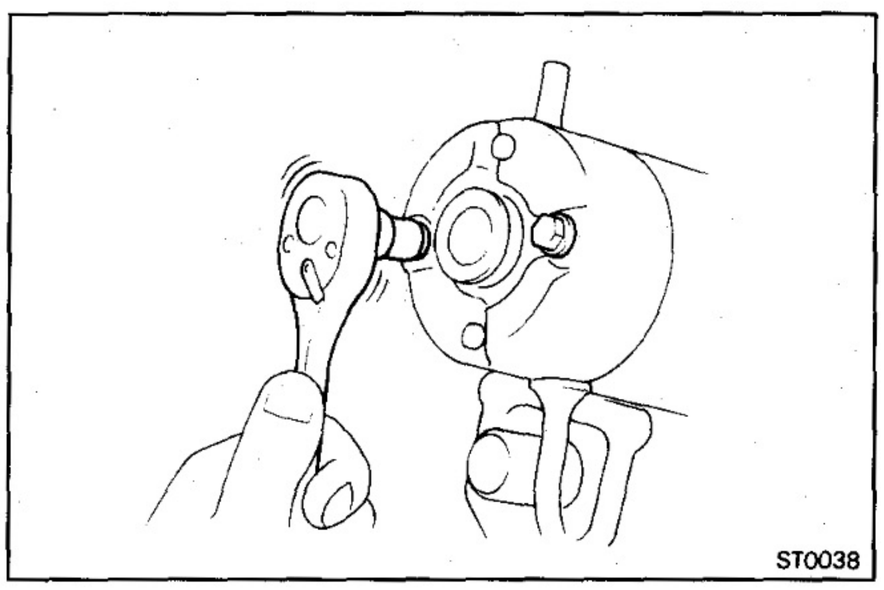




DISASSEMBLY OF STARTER

1. REMOVE FIELD FRAME AND ARMATURE ASSEMBLY

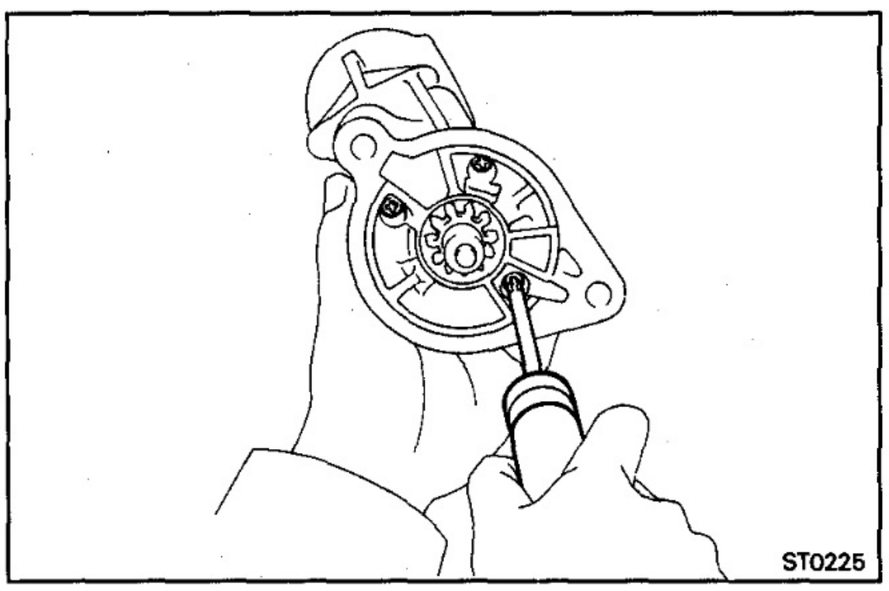
(a) Remove the nut and disconnect the lead wire from the magnetic switch terminal.



(b) Remove the two through bolts.

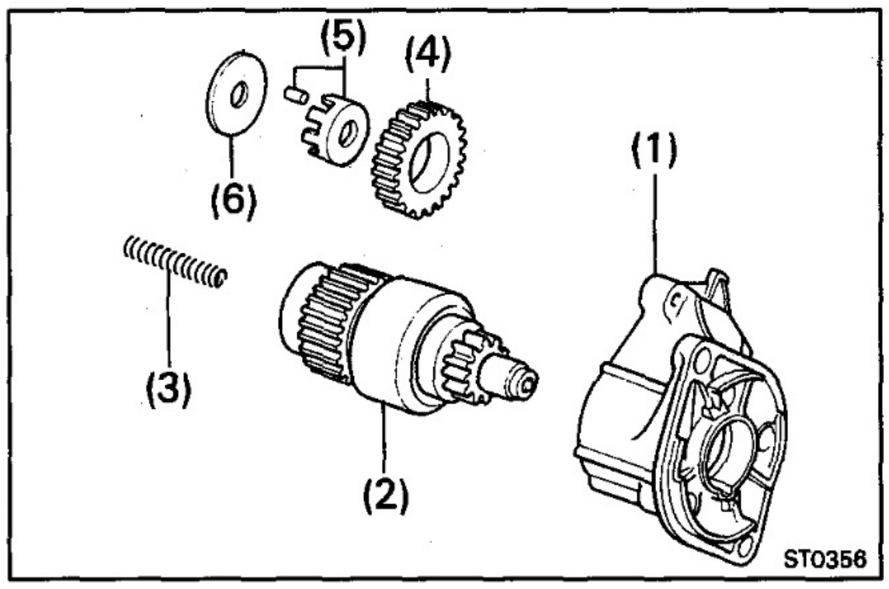
(c) Pull out the field frame together with the armature.

(d) Remove the felt seal and lock plate.



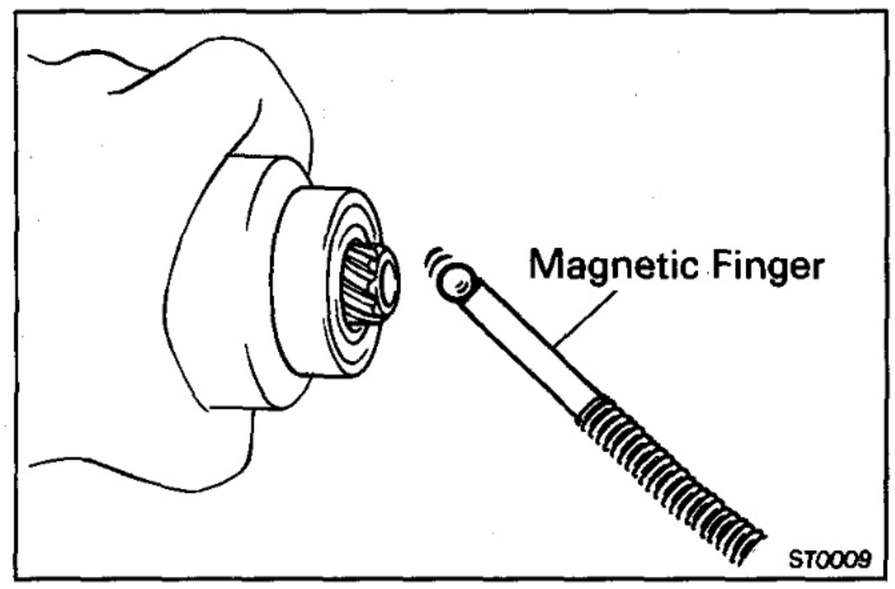
2. REMOVE STARTER HOUSING, CLUTCH ASSEMBLY AND GEAR

(a) Remove the three screws.



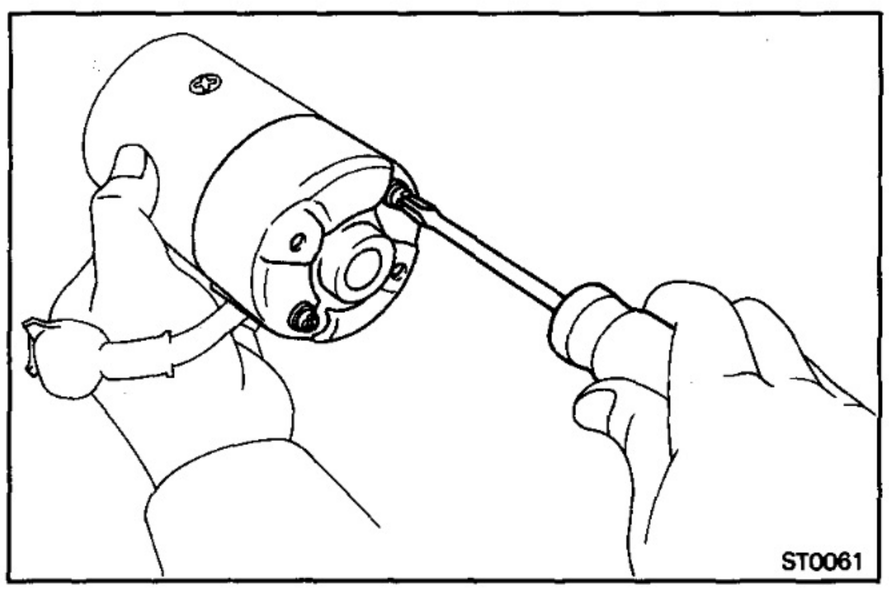
(b) Remove the following parts from the magnetic switch:

(1) Starter housing
(2) Clutch assembly
(3) Return spring
(4) Idle gear
(5) Bearing
(6) Plate washer



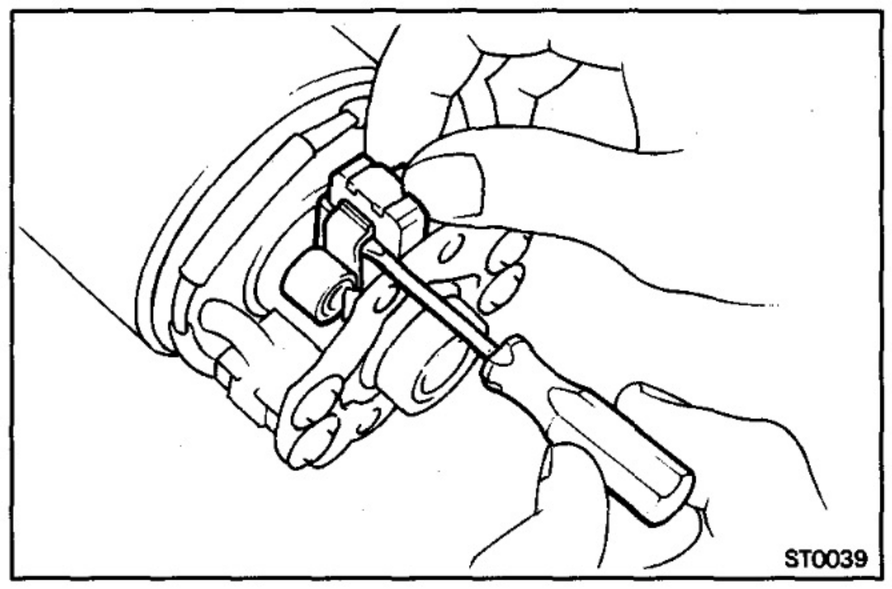
3. REMOVE STEEL BALL

Using a magnetic finger, remove the steel ball from the clutch shaft hole.



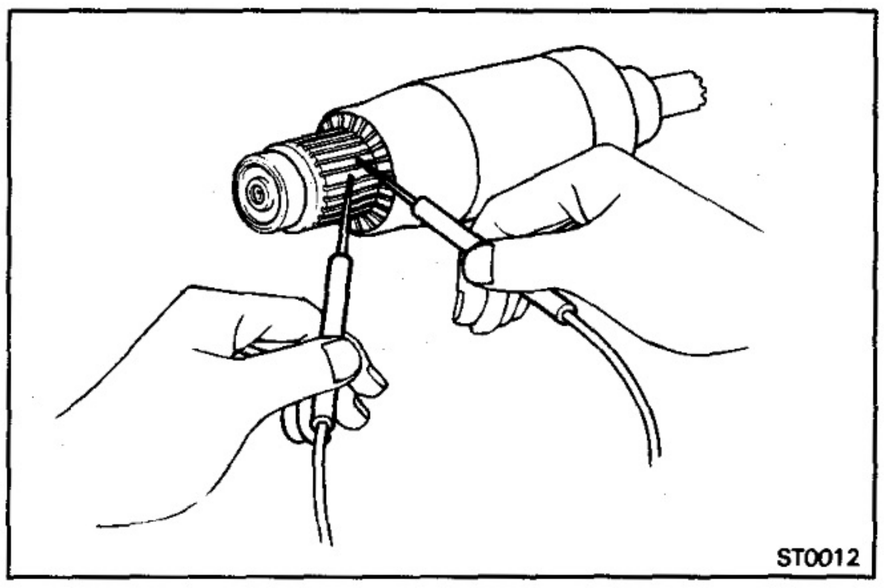
4. REMOVE BRUSH HOLDER

(a) Remove the two screws and end cover from the field frame.



(b) Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the four brushes and remove the brush holder.

5. REMOVE ARMATURE FROM FIELD FRAME



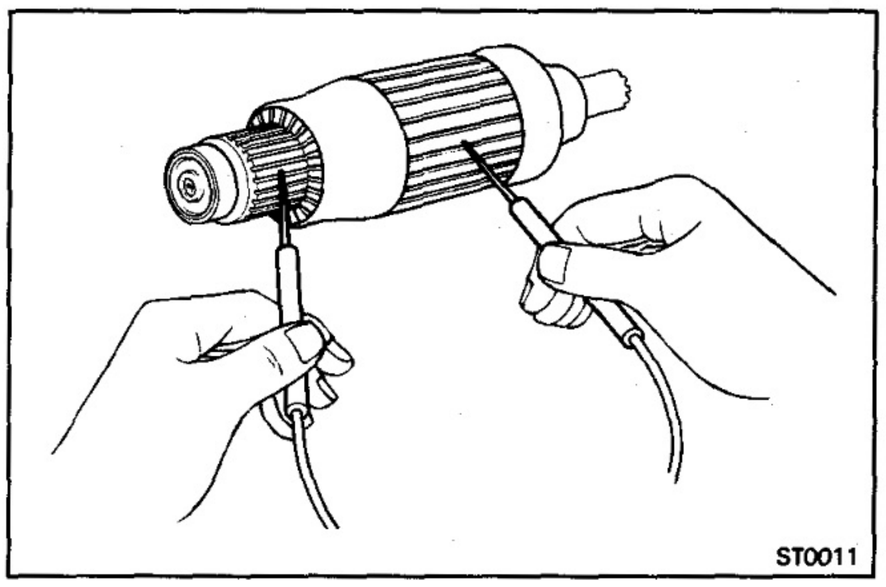
INSPECTION OF STARTER

Armature Coil

1. INSPECT COMMUTATOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the segments of the commutator.

If there is no continuity, replace the armature.



2. INSPECT COMMUTATOR FOR GROUND

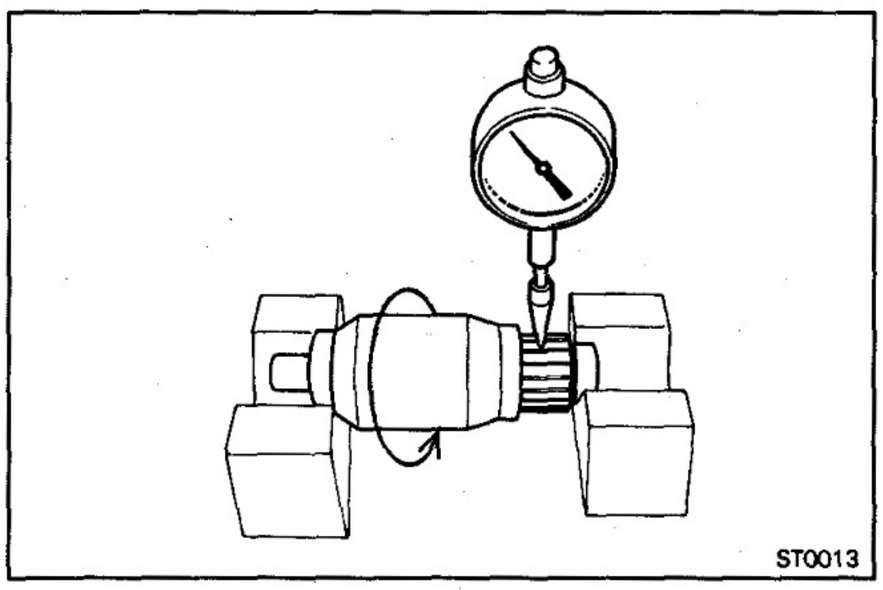
Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature.

Commutator

1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACE

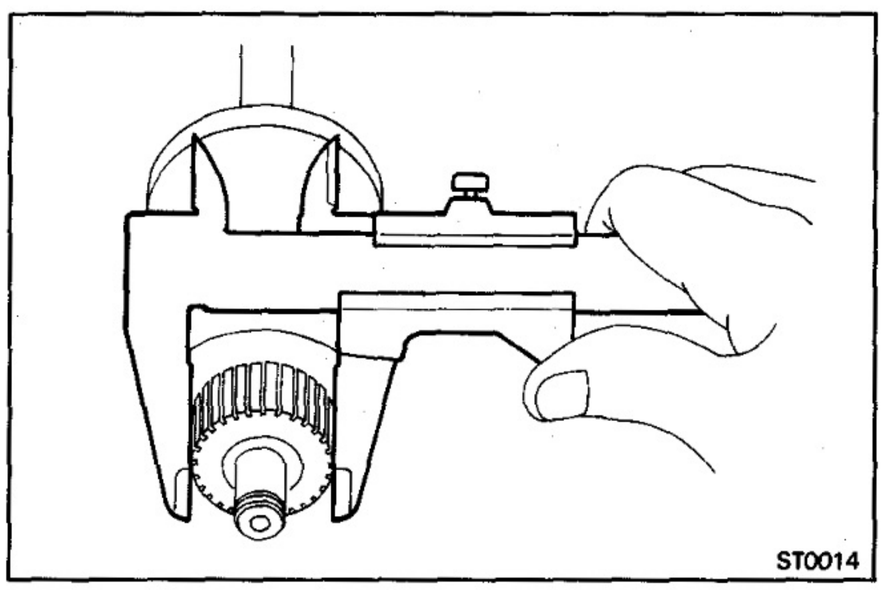
If the surface is dirty or brunt, correct with sandpaper (No. 400) or on a lathe.



2. INSPECT COMMUTATOR CIRCLE RUNOUT

Maximum circle runout: 0.05 mm (0.0020 in.)

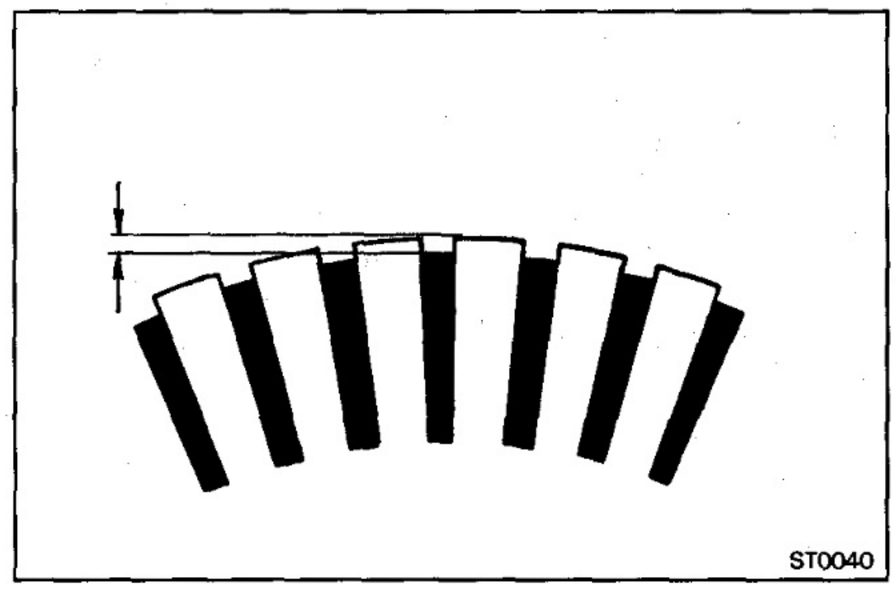
If the circle runout is greater than maximum, correct on a lathe.



3. INSPECT DIAMETER OF COMMUTATOR

Standard diameter: 36 mm (1.42 in.)
Minimum diameter: 35 mm (1.38 in.)

If the diameter is less than minimum, replace the armature.

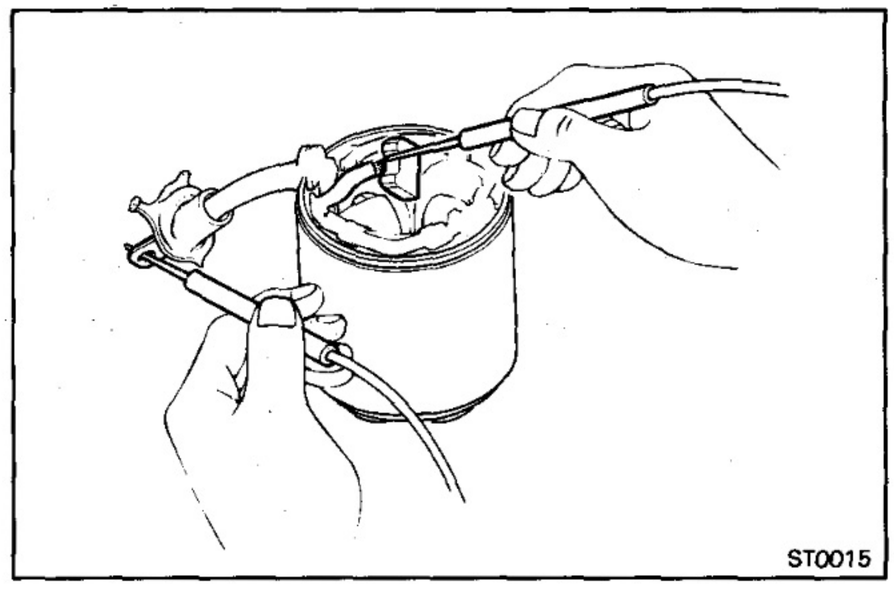


4. INSPECT UNDERCUT DEPTH

Check that the undercut depth is clean and free of foreign material. Smooth out the edge.

Standard undercut depth: 0.7 mm (0.028 in.)
Minimum undercut depth: 0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade.

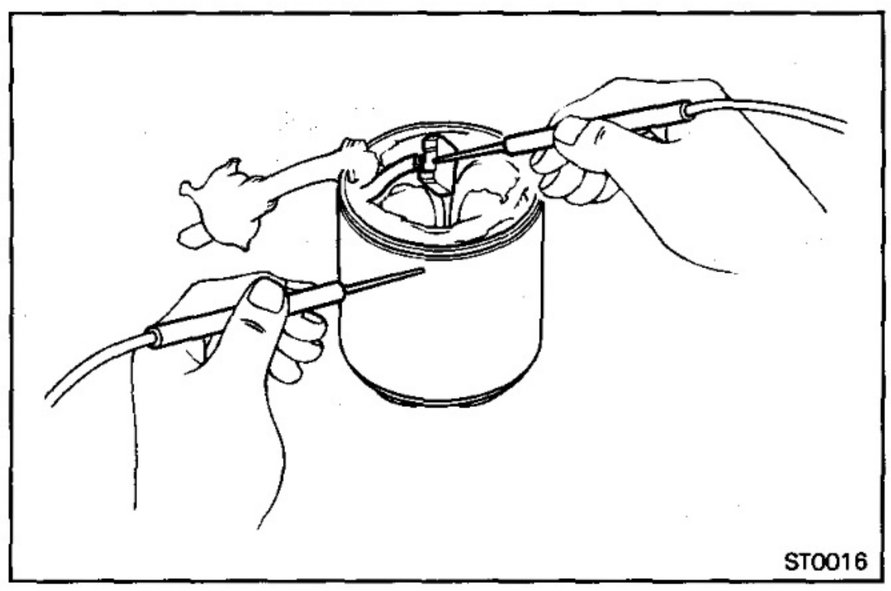


Field Coil (Field Frame)

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

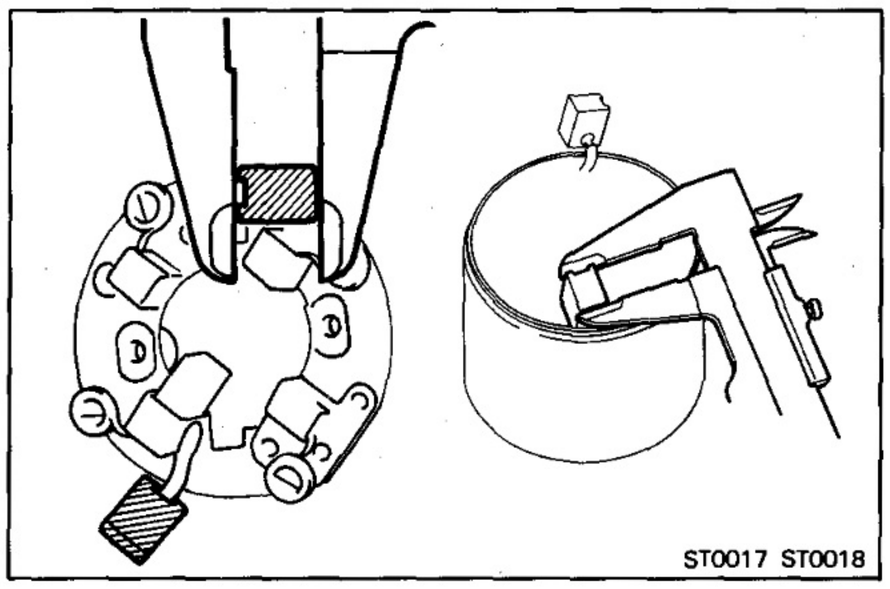
If there is no continuity, replace the field frame.



2. INSPECT FIELD COIL FOR GROUND

Using an ohmmeter, check that there is no continuity between the field coil end and field frame.

If there is continuity, repair or replace the field frame.



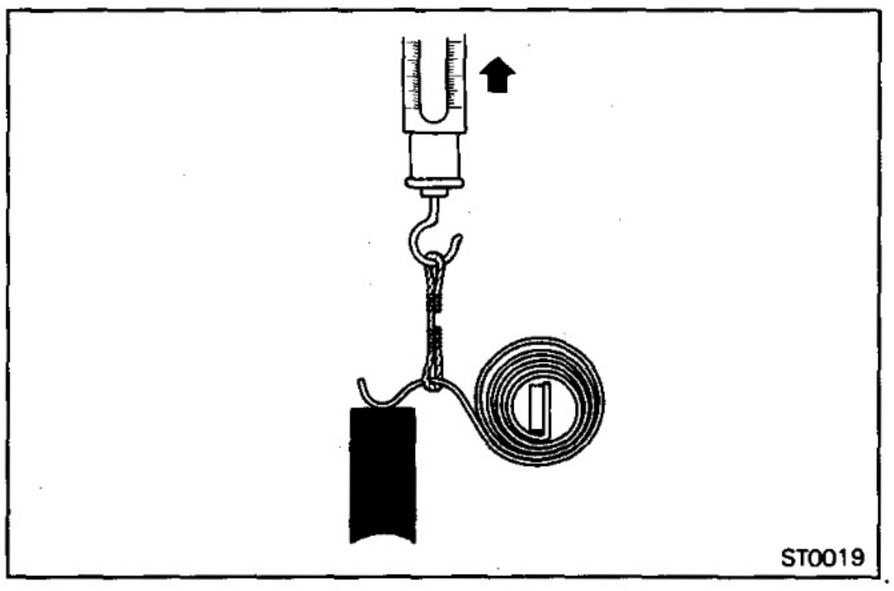
Brushes

INSPECT BRUSH LENGTH

Using calipers, measure the brush length.

Standard length: 20.5 mm (0.807 in.)
Minimum length: 13.0 mm (0.512 in.)

If the length is less than minimum, replace the brush holder and field frame.



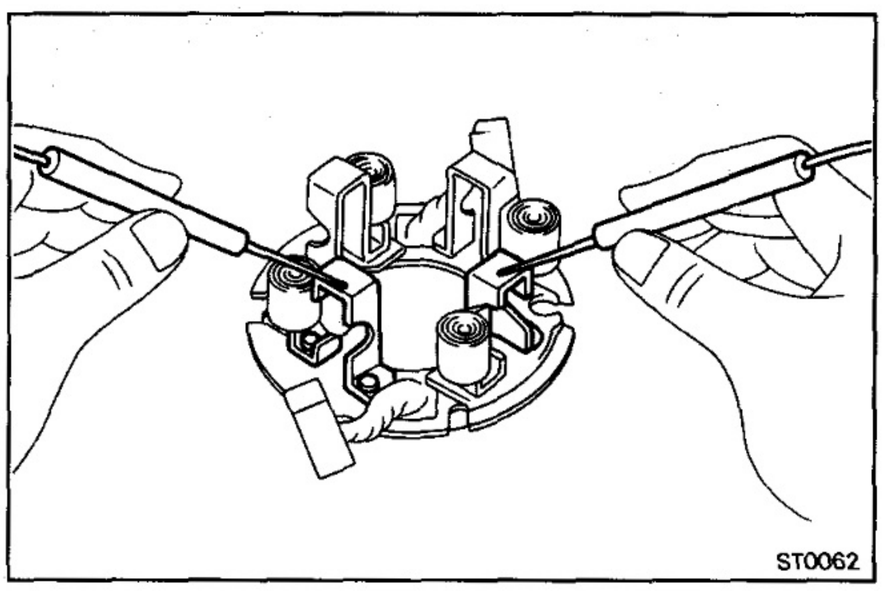
Brush Springs

INSPECT BRUSH SPRING LOAD

Take the pull scale reading the instant the brush spring separates from the brush.

Spring installed load:
3.2 — 4.0 kg (7.1 — 8.8 lb, 31 — 39 N)

If the reading is not within specification, replace the brush springs.



Brush Holder

INSPECT INSULATION OF BRUSH HOLDER

Using an ohmmeter, check that there is no continuity between the positive (+) and negative (–) brush holders.

If there is continuity, repair or replace the brush holder.

Clutch and Gears

1. INSPECT GEAR TEETH

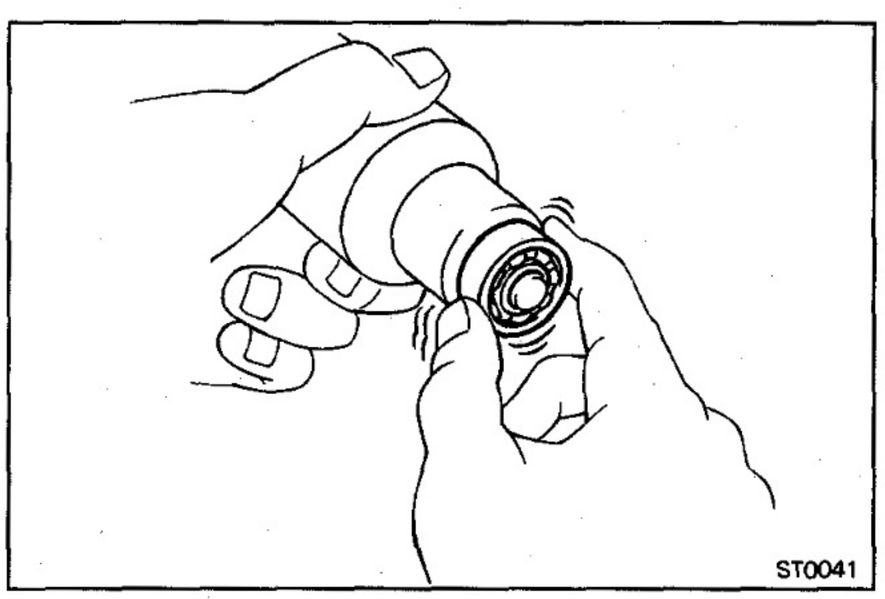
Check the gear teeth on the pinion gear, idler gear and clutch assembly for wear or damage. Replace if damaged.

If damaged, also check the flywheel ring gear for wear or damage.

2. INSPECT CLUTCH PINION GEAR

Rotate the pinion gear clockwise and check that it turns freely. Try to rotate the pinion gear counterclockwise and check that it locks.

If necessary, replace the clutch assembly.

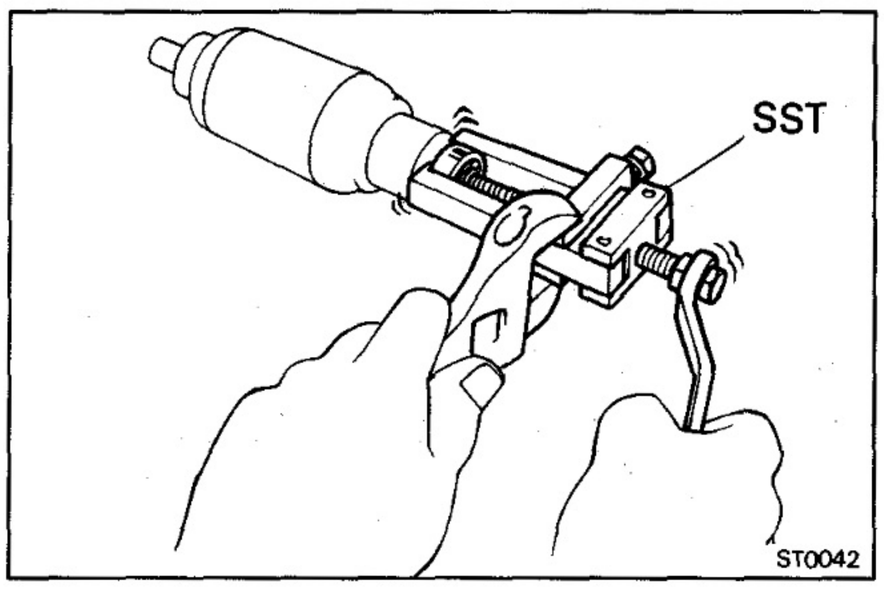


Bearings

1. INSPECT BEARINGS

Turn each bearing by hand while applying inward force.

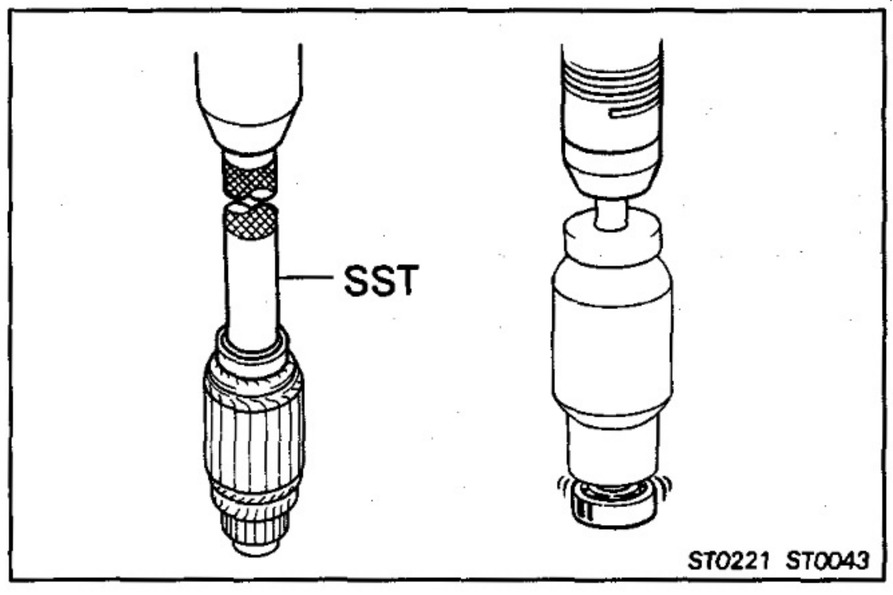
If resistance is felt or if the bearing sticks, replace the bearing.



2. IF NECESSARY, REPLACE BEARINGS

(a) Using SST, remove the bearing.

SST 09286-46011

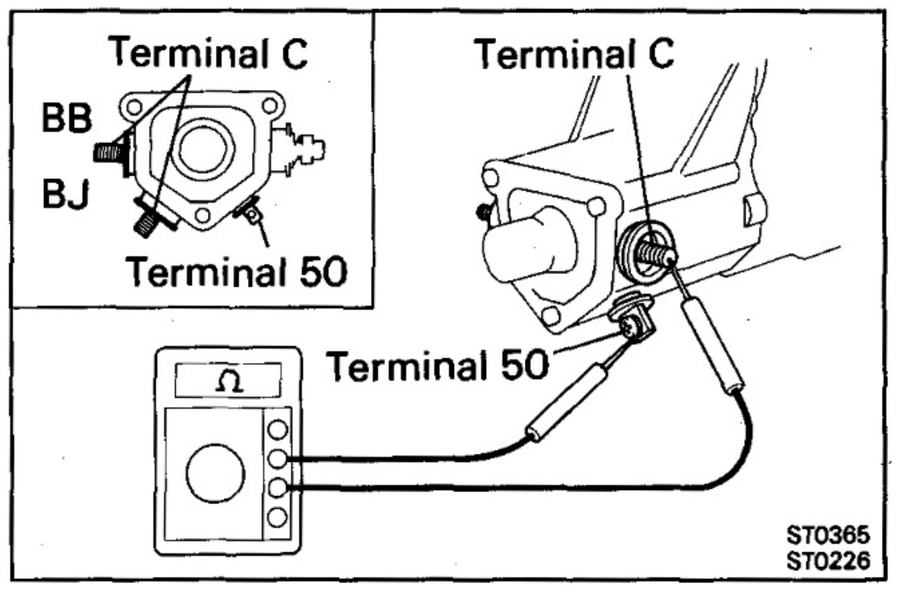


(b) Using SST and a press, press in a new front bearing.

SST 09285-76010

(c) Using a press, press in a new rear bearing.

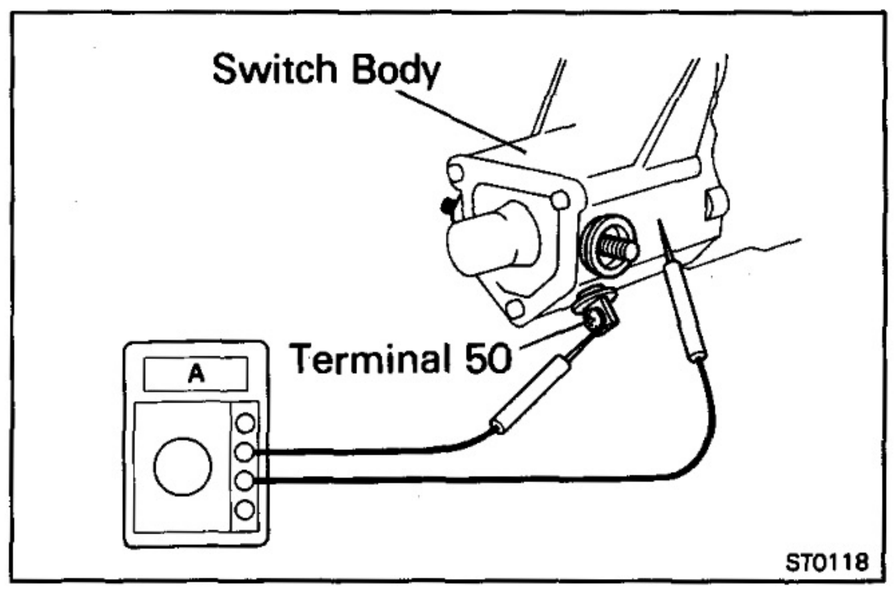
Magnetic Switch



1. PERFORM FULL-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminals 50 and C.

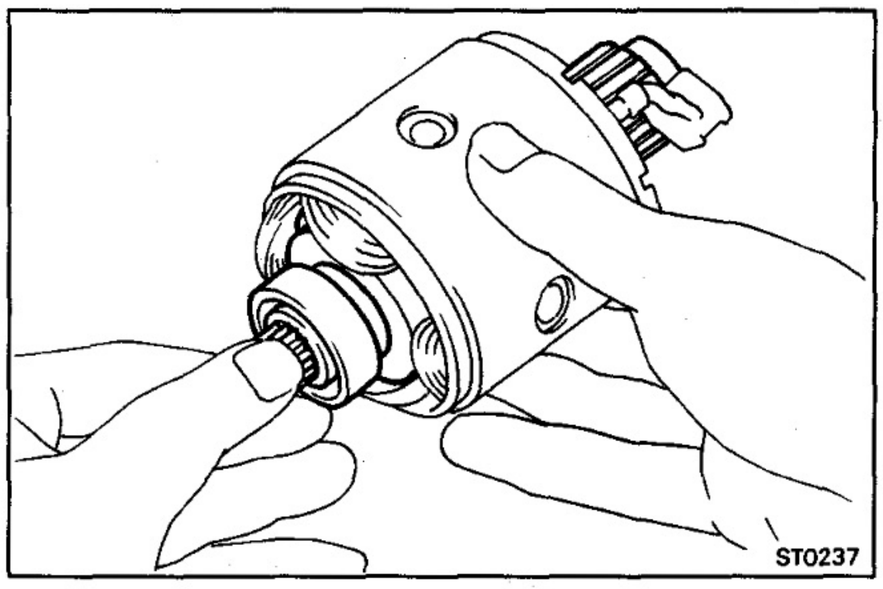
If there is no continuity, replace the magnetic switch.



2. PERFORM HOLD-IN COIL OPEN CIRCUIT TEST

Using an ohmmeter, check that there is continuity between terminal 50 and the switch body.

If there is no continuity, replace the magnetic switch.



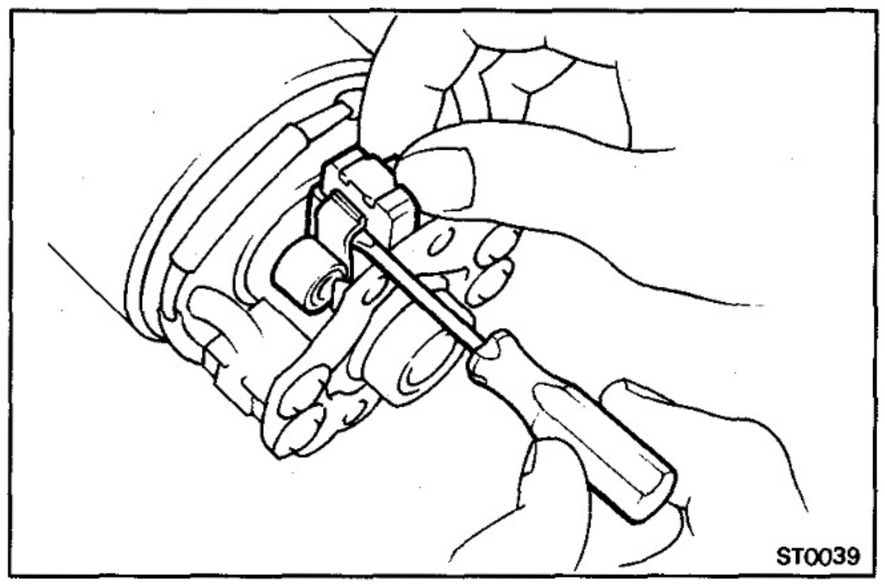
ASSEMBLY OF STARTER

(See page ST-13)

HINT: Use high-temperature grease to lubricate the bearings and gears when assembling the starter.

1. PLACE ARMATURE INTO FIELD FRAME

Apply grease to the armature bearings and insert the armature into the field frame.

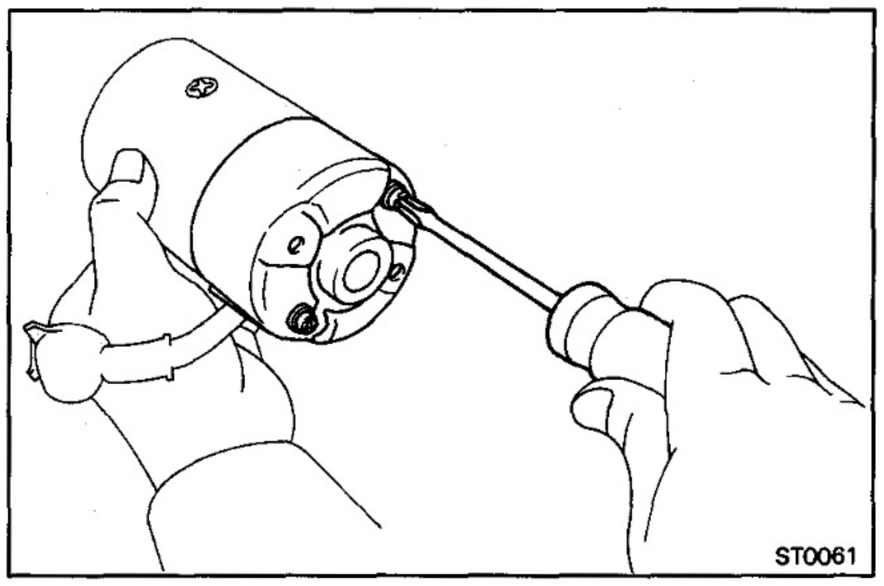


2. INSTALL BRUSH HOLDER

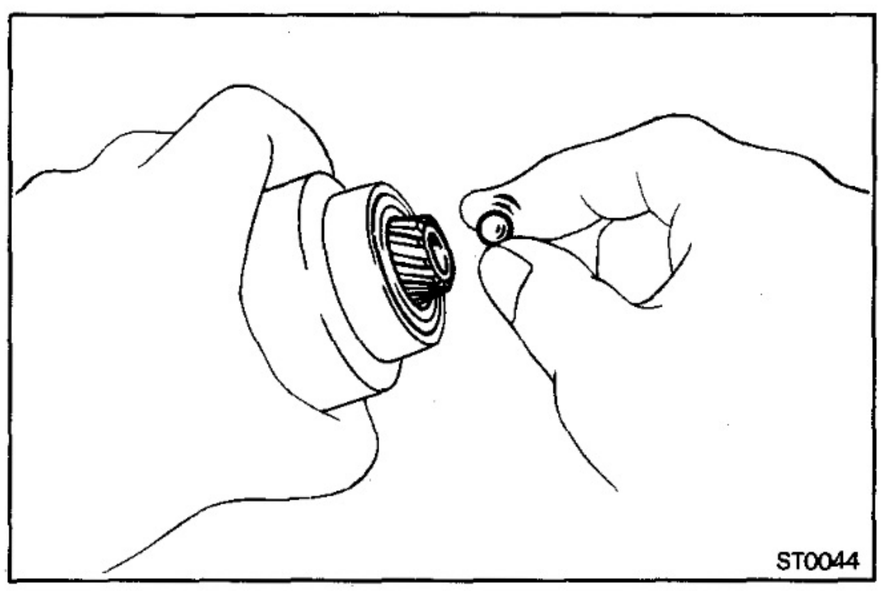
(a) Place the brush holder on the armature.

(b) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the four brushes.

HINT: Check that the positive (+) lead wires are not grounded.



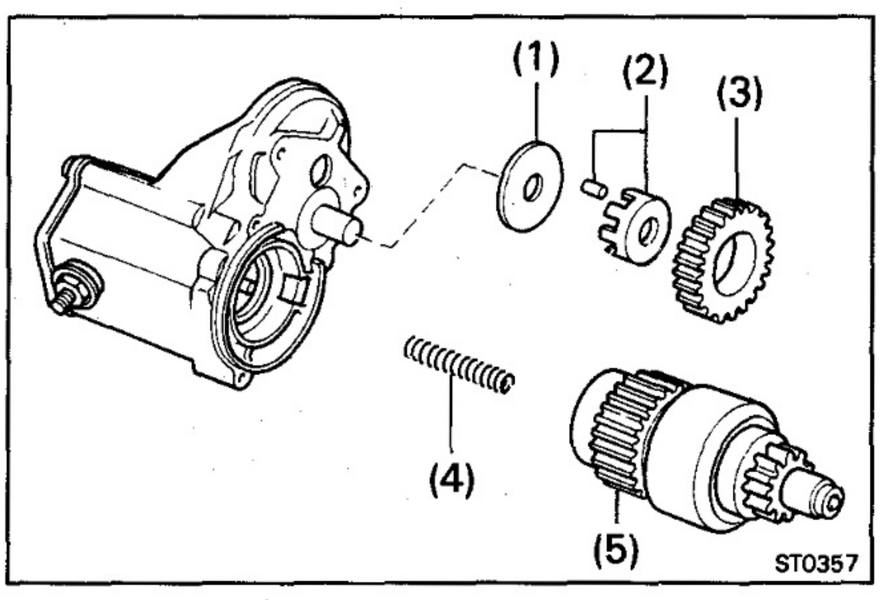
(c) Install the end cover with the two screws.



3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

(a) Apply grease to the steel ball.

(b) Insert the steel ball into the clutch shaft hole.



4. INSTALL CLUTCH ASSEMBLY AND GEAR

(a) Place the following parts in position on the magnetic switch:

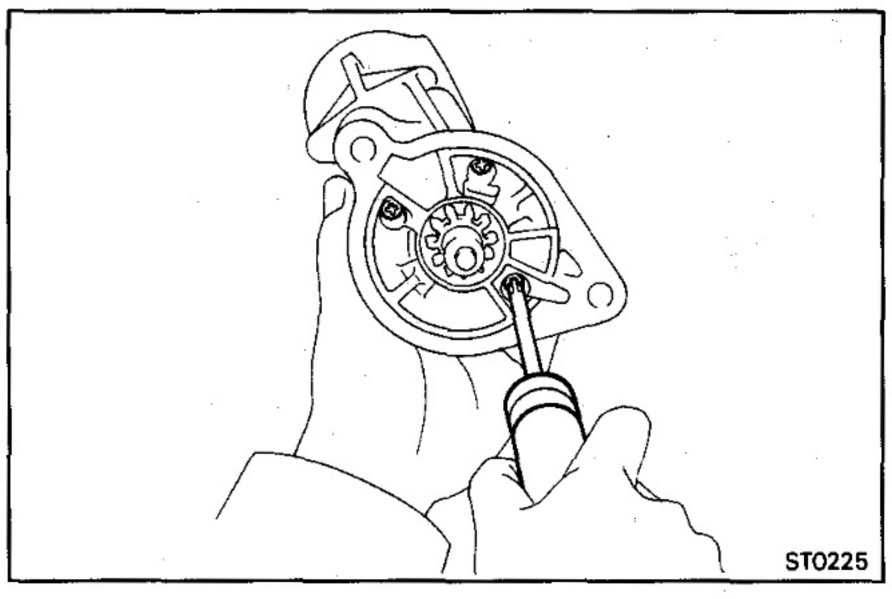
(1) Plate washer

(2) Bearing

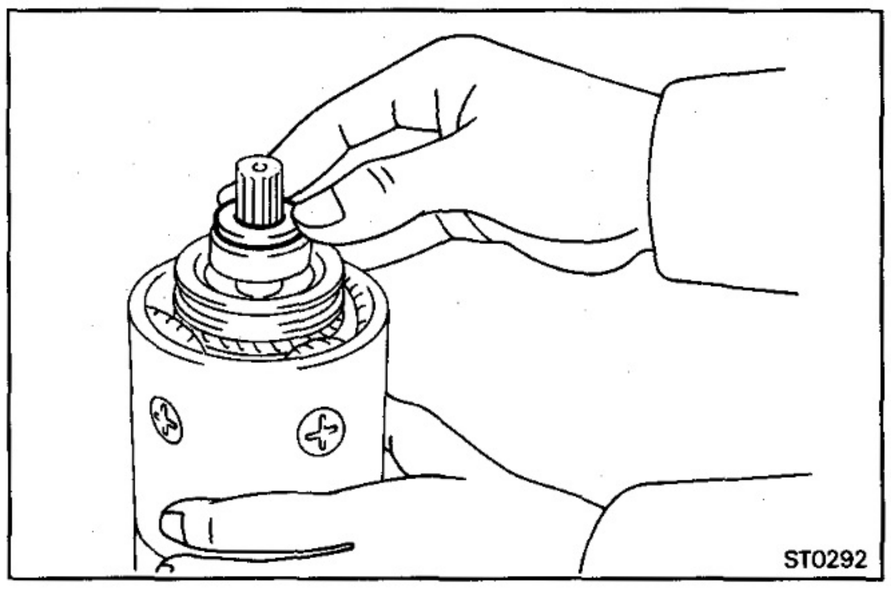
(3) Idle gear

(4) Return spring

(5) Clutch assembly

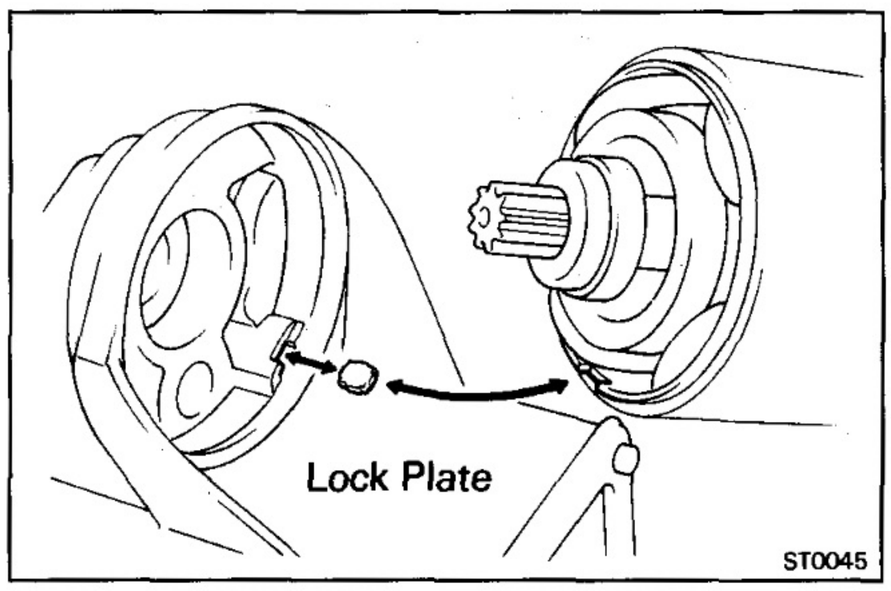


(b) Assemble the starter housing and magnetic switch with the three screws.

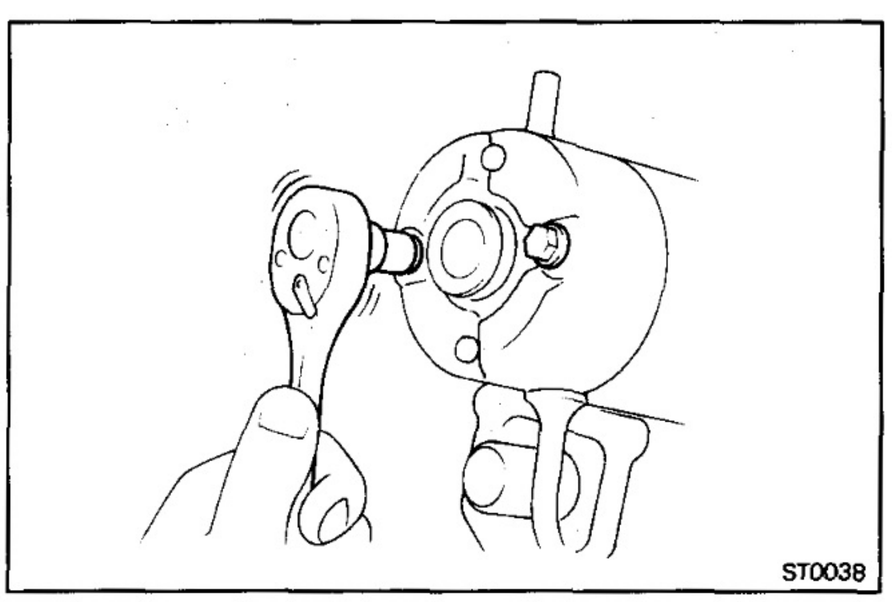


5. INSTALL FIELD FRAME AND ARMATURE ASSEMBLY

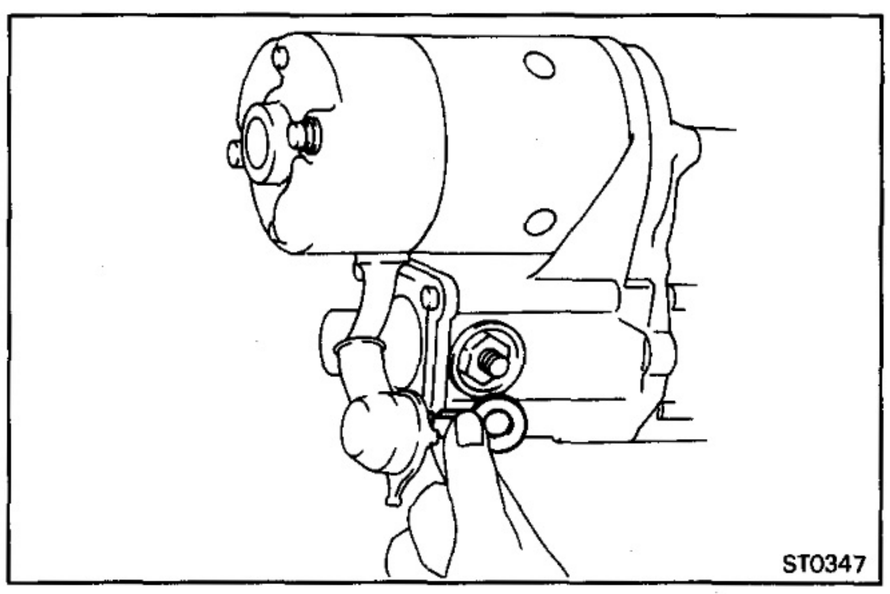
(a) Place the felt seal in position on the armature shaft.



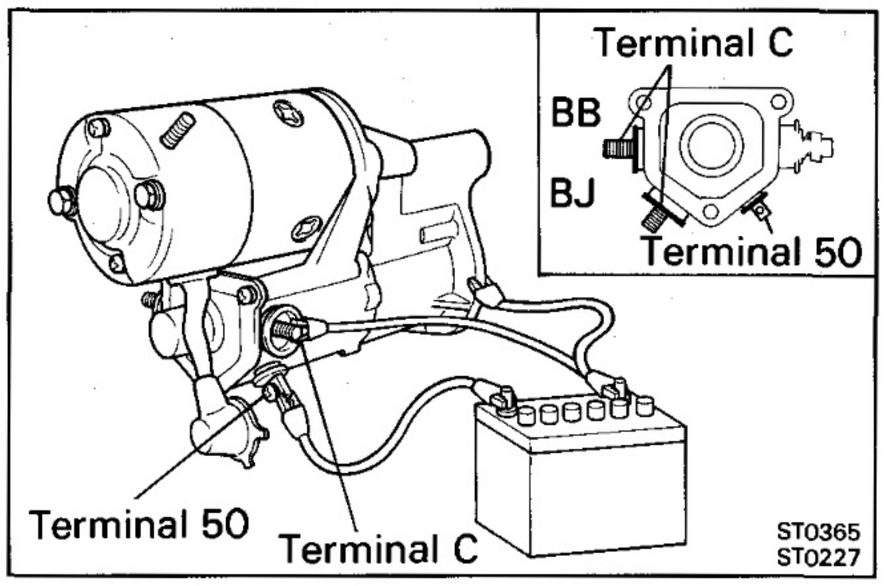
(b) Align the lock plate with the notch on the field frame.



(c) Install the field frame and armature assembly with the two throught bolts.



(d) Connect the lead wire to the magnetic switch terminal, and install the nut.



PERFORMANCE TEST OF STARTER

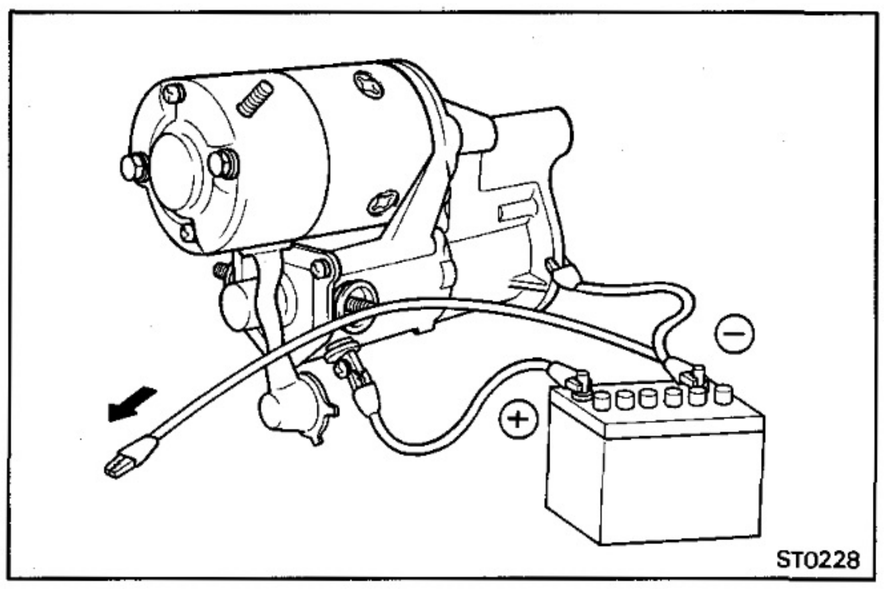
NOTICE: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

1. PERFORM PULL-IN TEST

(a) Disconnect the field coil lead from terminal C.

(b) Connect the battery to the magnetic switch as shown. Check that the pinion gear moves outward.

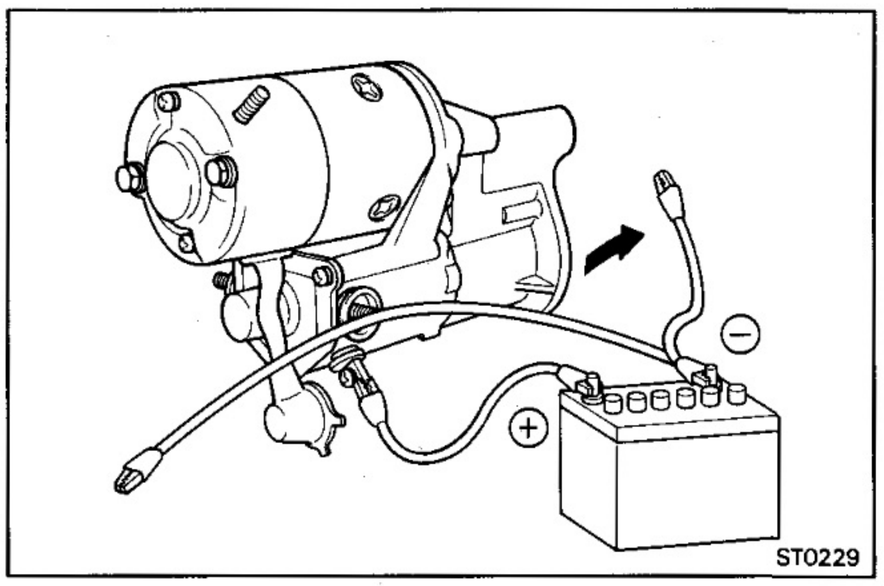
If the pinion gear does not move, replace the magnetic switch assembly.



2. PERFORM HOLD-IN TEST

While connected as above with the pinion gear out, disconnect the negative (–) lead from terminal C. Check that the pinion gear remains out.

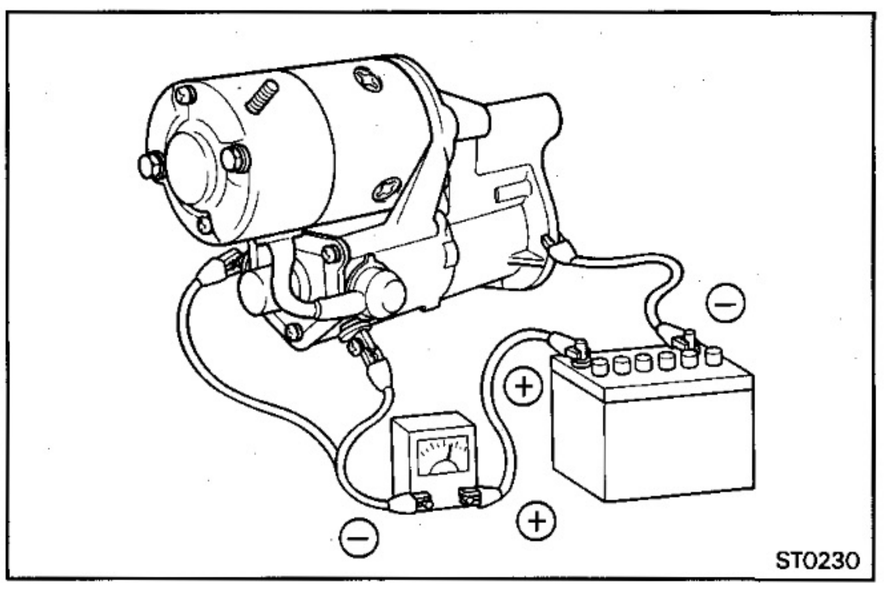
If the pinion gear returns inward, replace the magnetic switch assembly.



3. INSPECT PLUNGER RETURN

Disconnect the negative (–) lead from the switch body. Check that the pinion gear returns inward.

If the pinion gear does not return, replace the magnetic switch assembly.



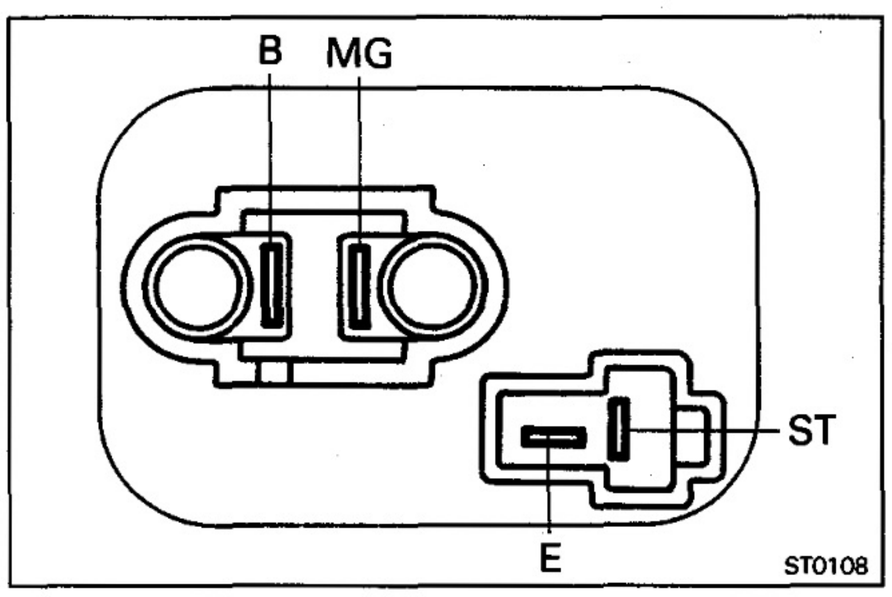
4. PERFORM NO-LOAD PERFORMANCE TEST

(a) Connect the battery and ammeter to the starter as shown.

(b) Check that the starter rotates smoothly and steadily with the pinion gear moving cut. Check that the ammeter reads the specified current.

Specified current:

12V Type	**180 A or less at 11 V**
24V Type	**90 A or less at 23V**



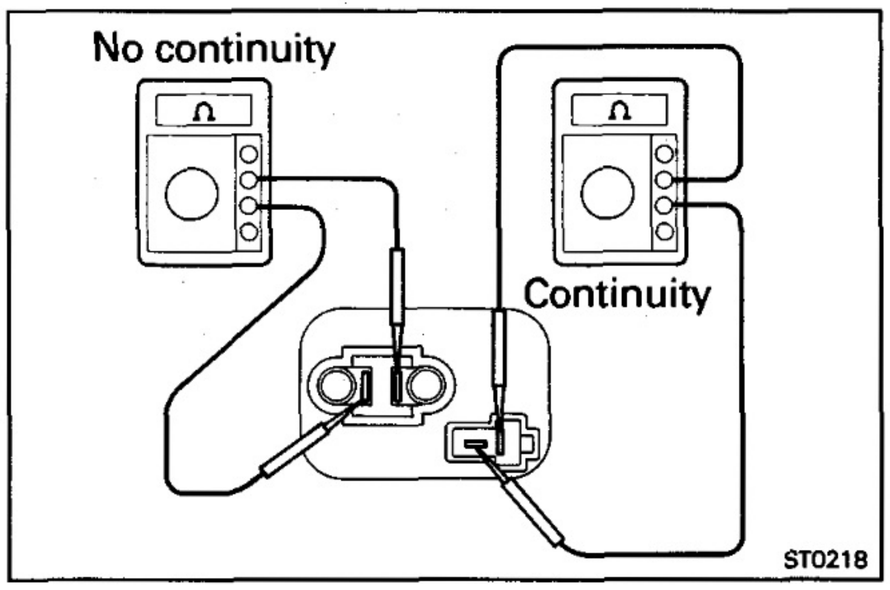
STARTER RELAY [BB, BU and BY]

LOCATION:

BY: Under the instrument panel on the driver's side.

BU: Under the instrument panel center.

BB: Inside wall adjacent to passenger door.



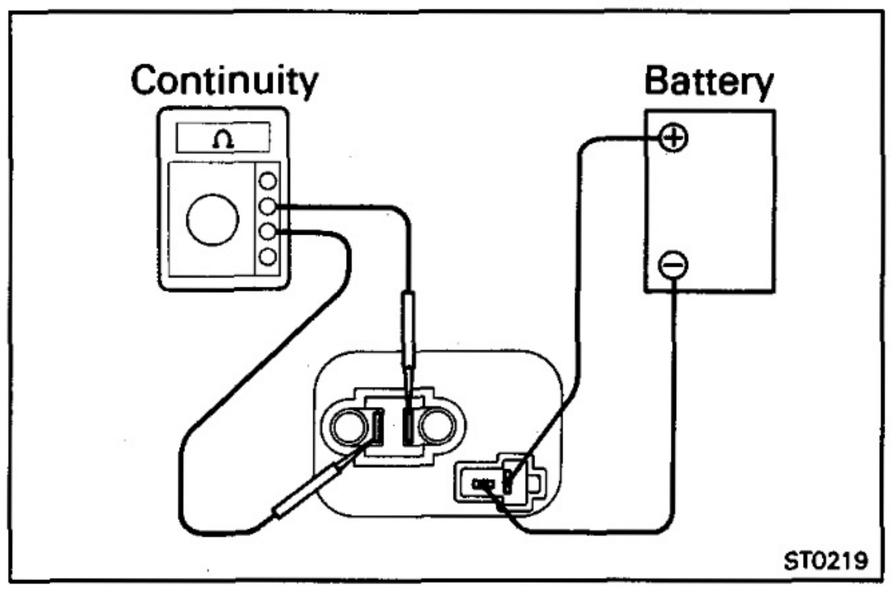
INSPECTION OF STARTER RELAY

1. INSPECT RELAY CONTINUITY

(a) Check that there is continuity between terminals E and ST.

(b) Check that there is no continuity between terminal B and MG.

If continuity is not as specified, replace the relay.

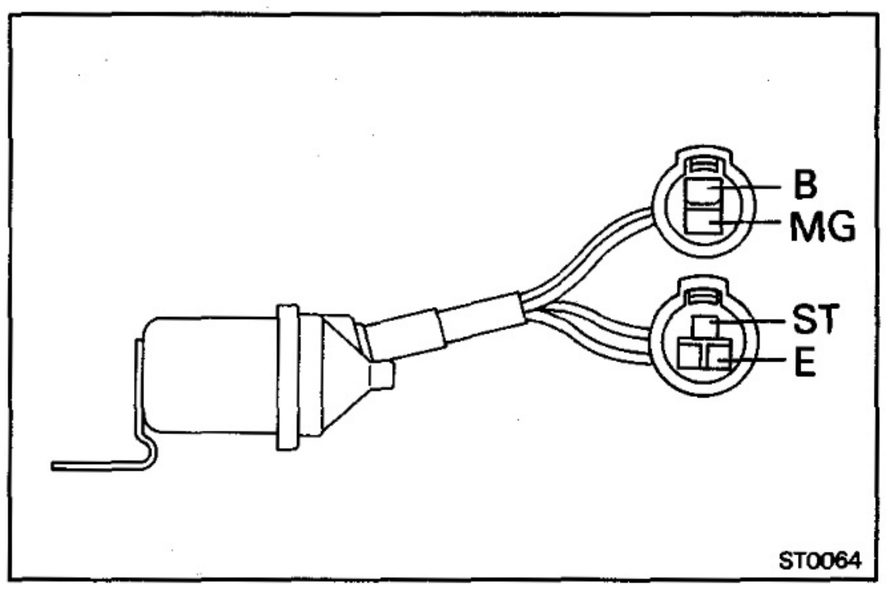


2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and ST.

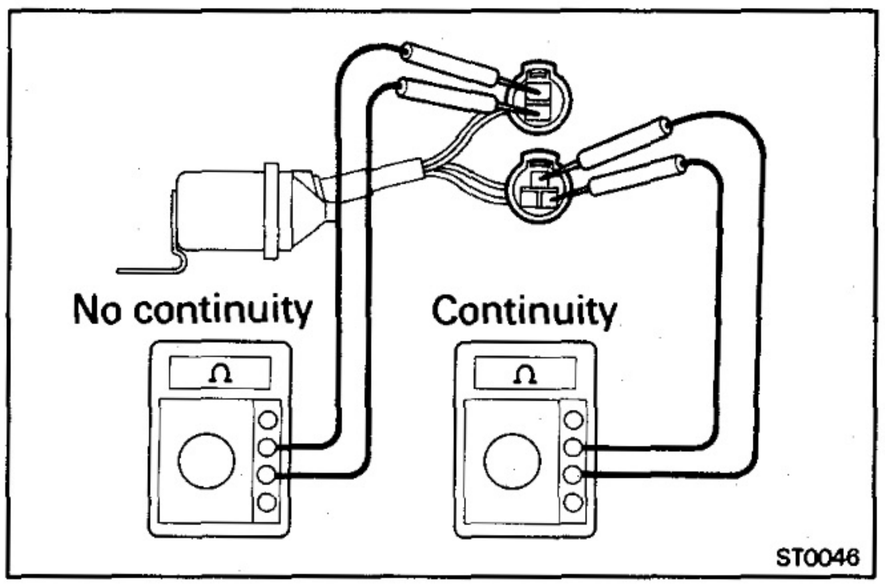
(b) Check that there is continuity between terminals B and MG.

If operation is not as specified, replace the relay.



STARTER RELAY [BJ]

LOCATION: On the fender apron in the engine compartment.



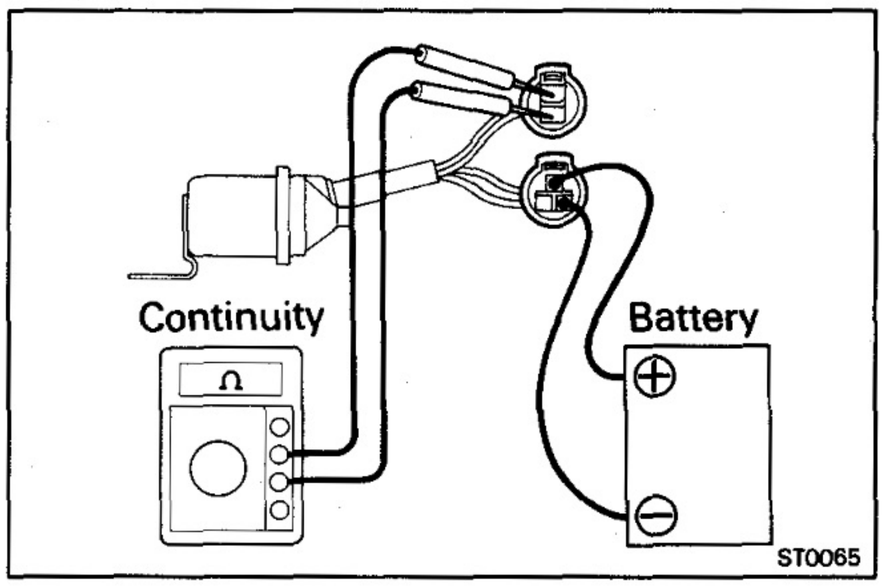
INSPECTION OF STARTER RELAY

1. INSPECT RELAY OPERATION

(a) Check that there is continuity between terminals E and ST.

(b) Check that there is no continuity between terminals B and MG.

If operation is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals E and ST.

(b) Check that there is continuity between terminals B and MG.

If operation is not as specified, replace the relay.

CHARGING SYSTEM

	Page
PRECAUTIONS	CH-2
TROUBLESHOOTING	CH-2
CHARGING SYSTEM CIRCUIT	CH-3
ON-VEHICLE INSPECTION	CH-5
ALTERNATOR	CH-9

PRECAUTION

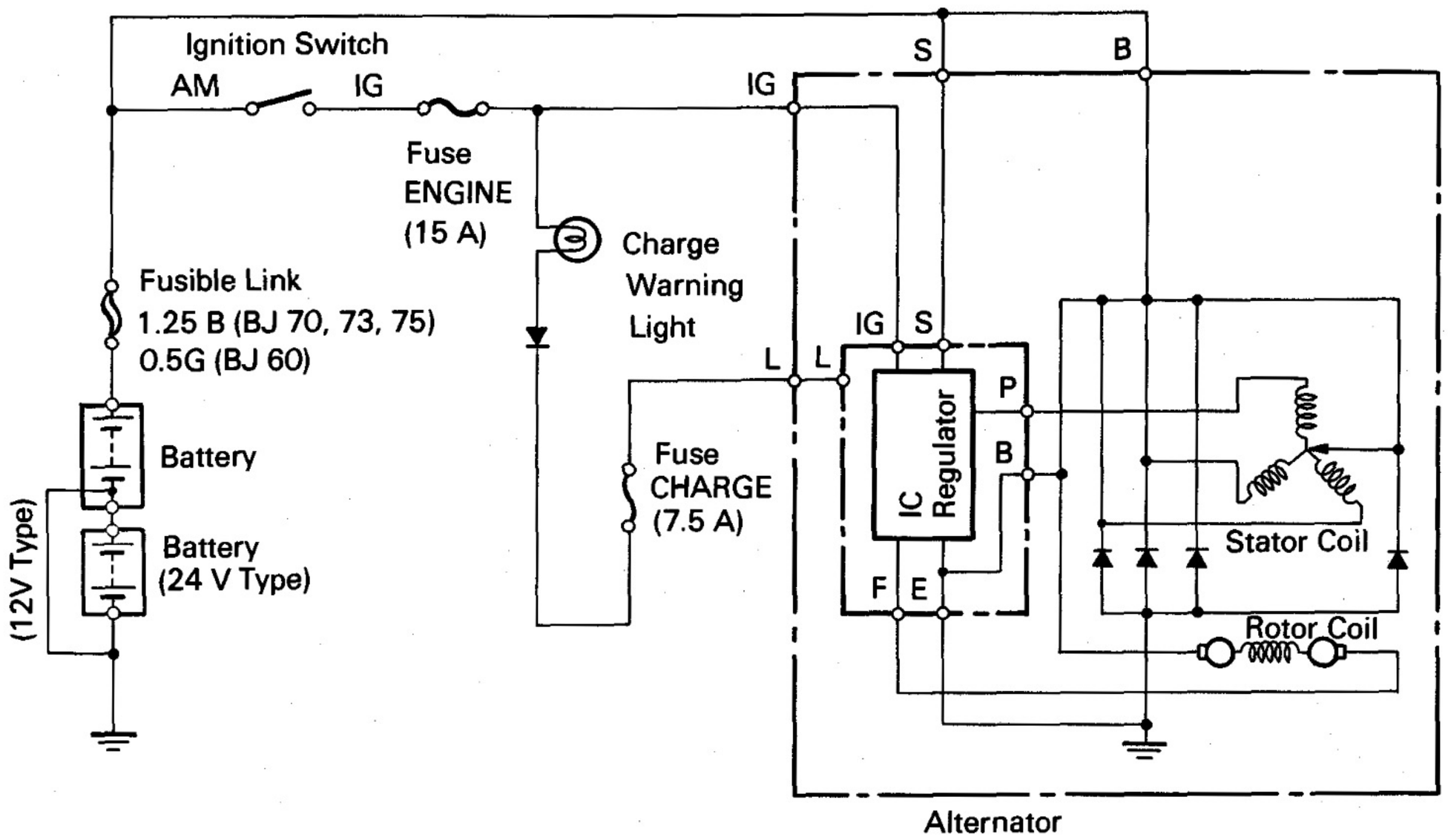
1. **Check that the battery cables are connected to the correct terminals.**
2. **Disconnect the battery cables when the battery is given a quick charge.**
3. **Do not perform tests with a high voltage insulation resistance tester.**
4. **Never disconnect the battery while the engine is running.**

TROUBLESHOOTING

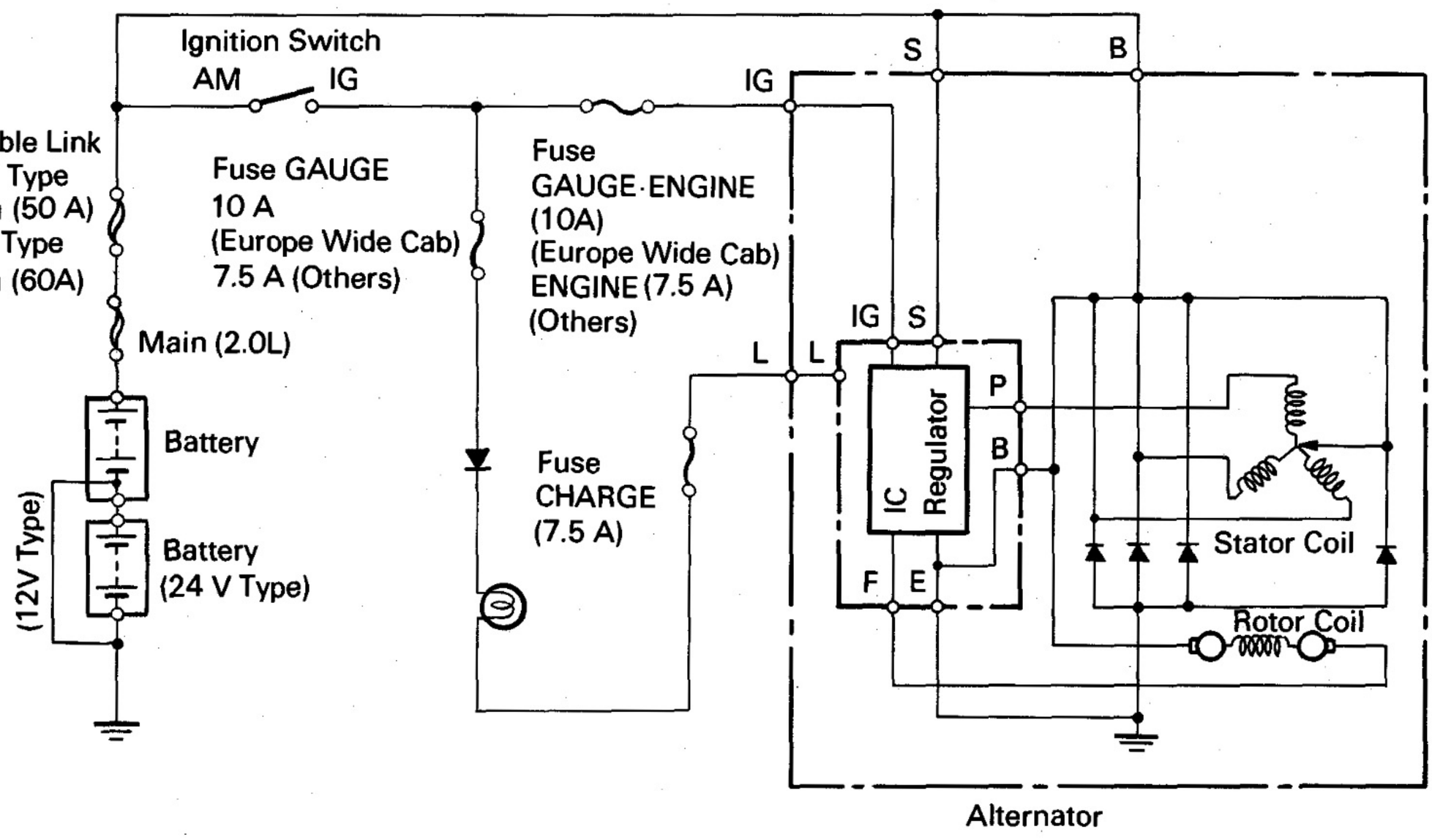
Problem	Possible cause	Remedy	Page
Discharge warning light does not light with starter switch at "ON" and engine not running	Fuse blown	Check fuses	
	Light burned out	Replace light	
	Wiring connection loose	Tighten loose connection	
	IC regulator faulty	Replace IC regulator	CH-9
Discharge warning light does not go out with engine running (battery requires frequent recharging)	Drive belt loose or worn	Adjust or replace drive belt	CH-5
	Battery cables loose, corroded or worn	Repair or replce cables	
	Fuse blown	Check fuse	
	Fusible link blown	Replace fusible link	
	IC regulator or alternator faulty	Check charging system	CH-9
	Wiring faulty	Repair wiring	

CHARGING SYSTEM CIRCUIT

BJ



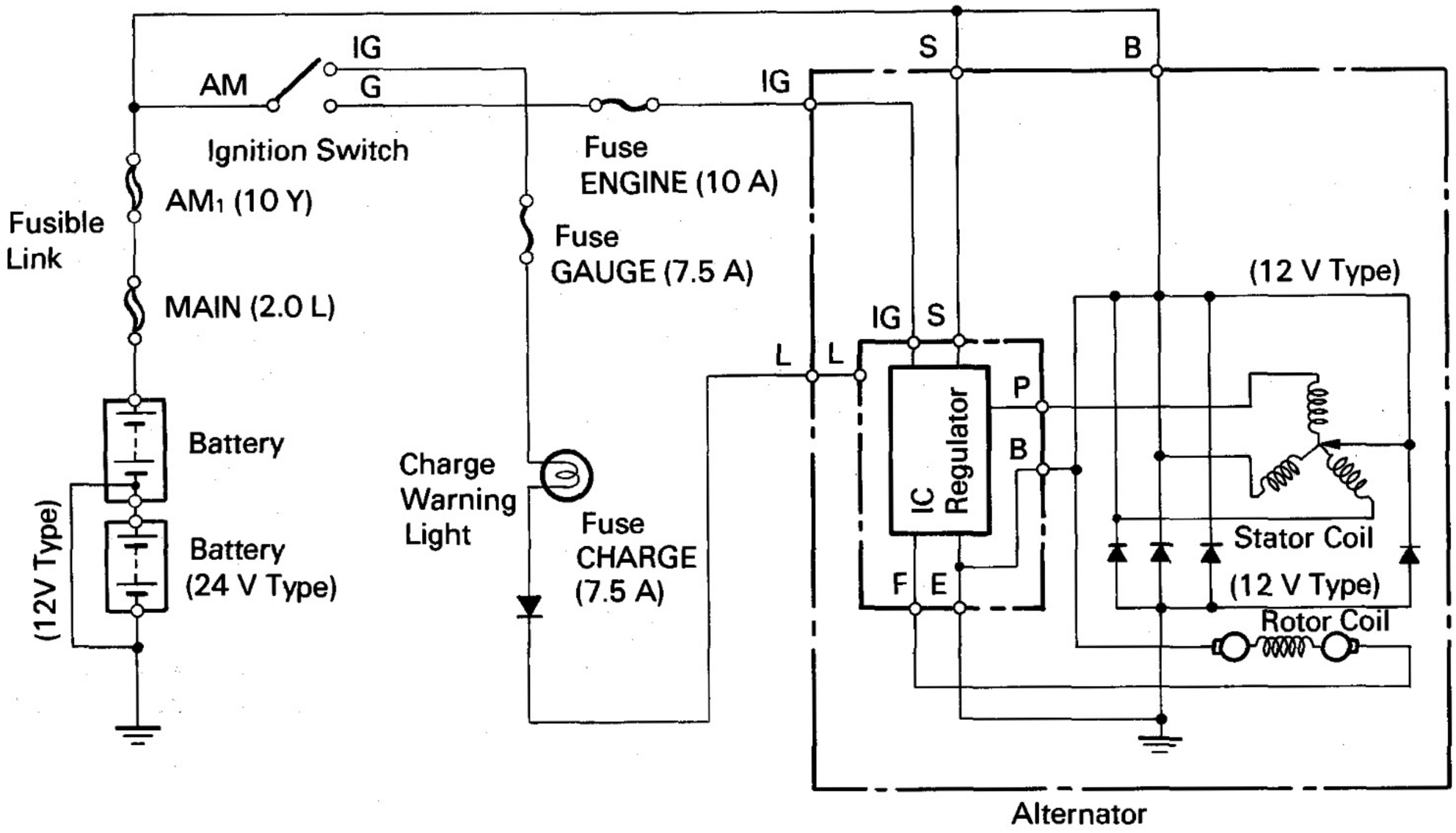
BU



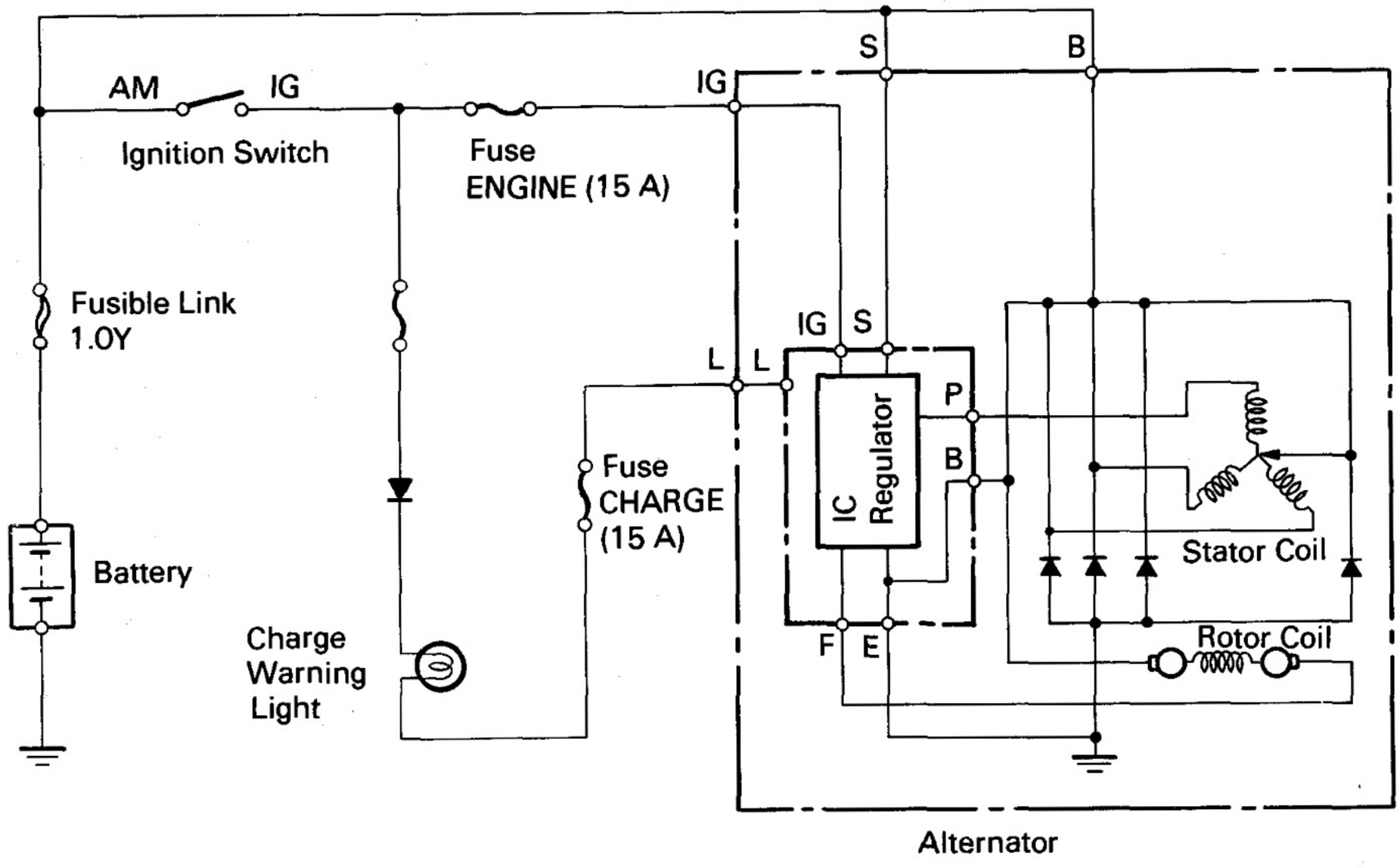
CH0705
CH0706

CHARGING SYSTEM CIRCUIT (Cont'd)

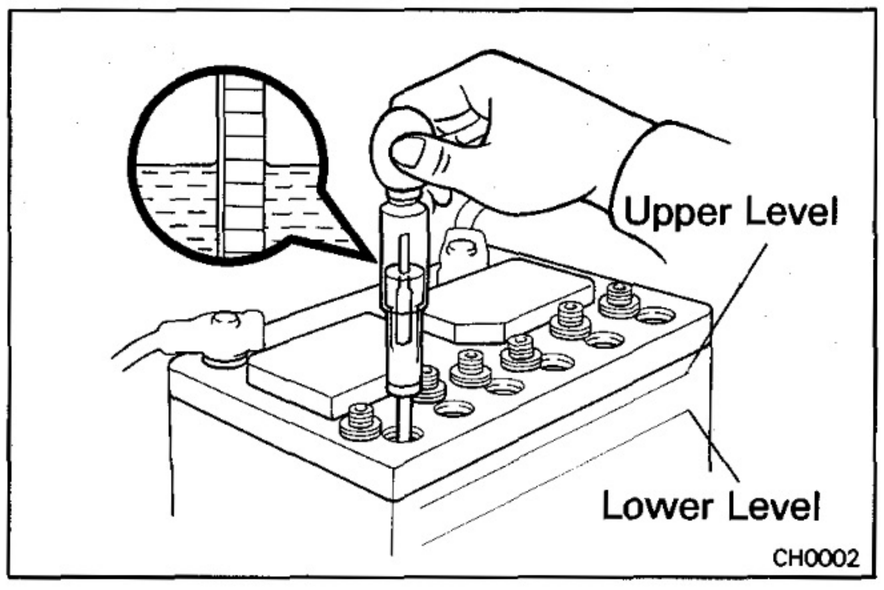
BB



BY



CH0707
CH0708



ON-VEHICLE INSPECTION

1. CHECK BATTERY SPECIFIC GRAVITY

(a) Check the specific gravity of each cell.

Standard specific gravity:

80D26R, 95D31R

1.27 — 1.29 when fully charged at 20°C (68°F)

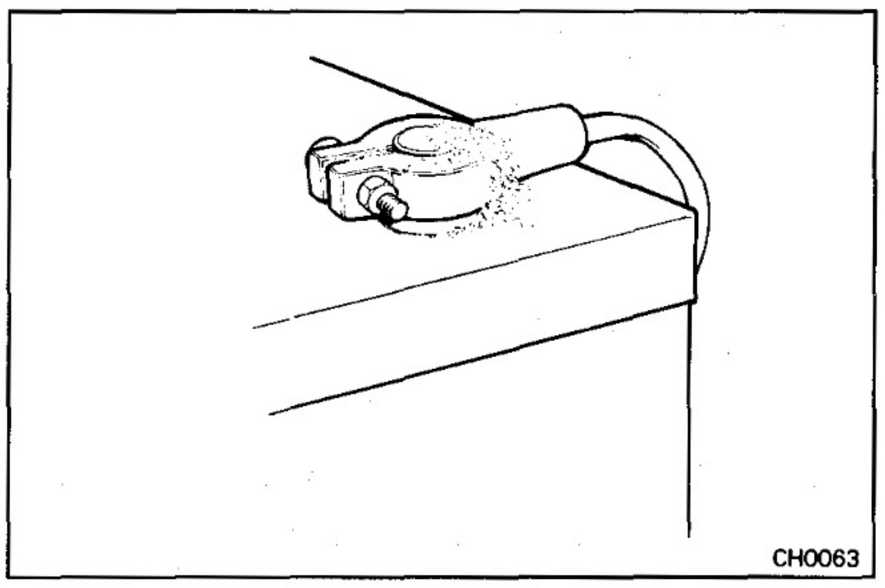
Others

1.25 — 1.27 when fully charged at 20°C (68°F)

If not within specifications, charge the battery.

(b) Check the electrolyte quantity of each cell.

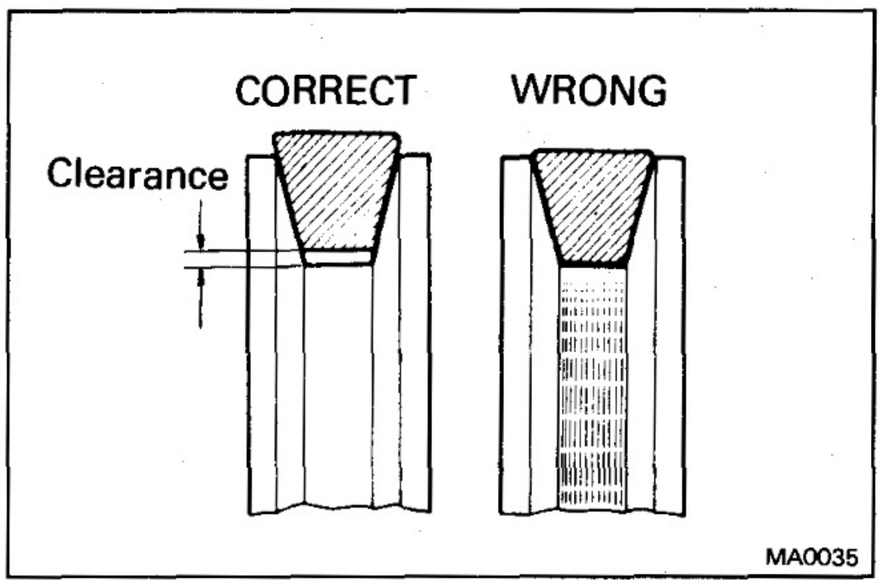
If insufficient, refill with distilled (or purified) water.



2. CHECK BATTERY TERMINALS, FUSIBLE LINKS AND FUSES

(a) Check that the battery terminals are not loose or corroded.

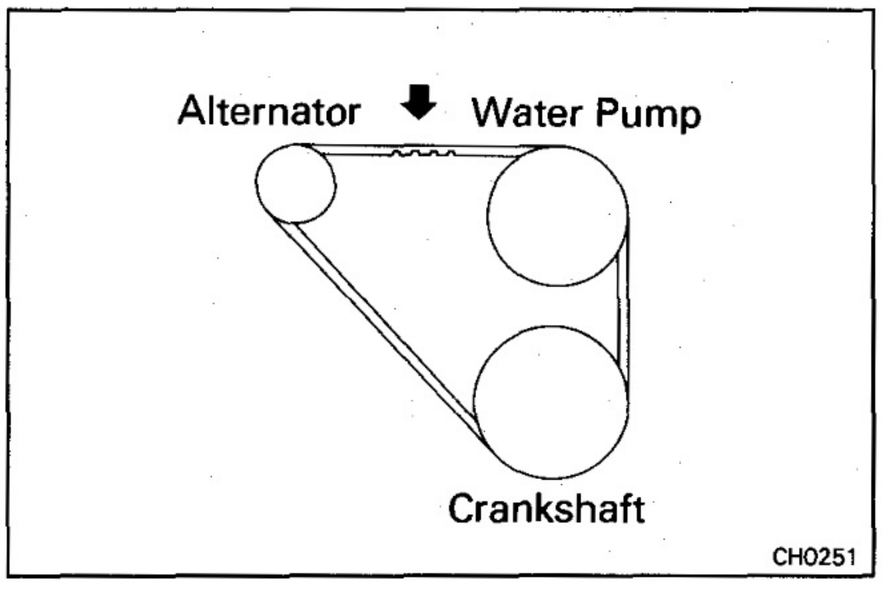
(b) Check the fusible link and fuses for continuity.



3. INSPECT DRIVE BELT

(a) Visually check the drive belt for cracks, oiliness or wear. Check that the belt does not touch the bottom of the pulley groove.

If necessary, replace the drive belt.



(b) Check the drive belt deflection by pressing on the belt at the points indicated in the figure with 10 kg (22.0 lb, 98 N) of pressure.

Drive belt deflection:

Single belt type

New belt 7.5 — 11 mm (0.30 — 0.43 in.)

Used belt 11 — 15.5 mm (0.43 — 0.61 in.)

Double belt type

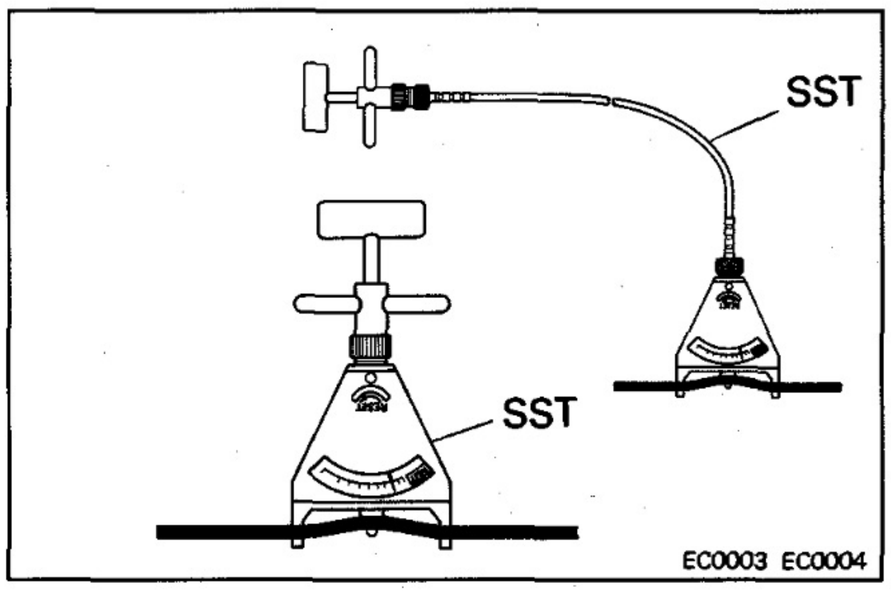
New belt 12 — 15 mm (0.47 — 0.59 in.)

Used belt 14 — 20 mm (0.55 — 0.79 in.)

If the belt deflection is not within specification, adjust it.

HINT:

- "New belt" refers to a belt which has been used less than 5 minutes on a running engine.
- "Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.
- After installing a new belt, run the engine for approx. 5 minutes and recheck the deflection.



(c) [Reference]
Using SST, check the drive belt tension.

SST 09216-00020 and 09216-00030

Drive belt tension:

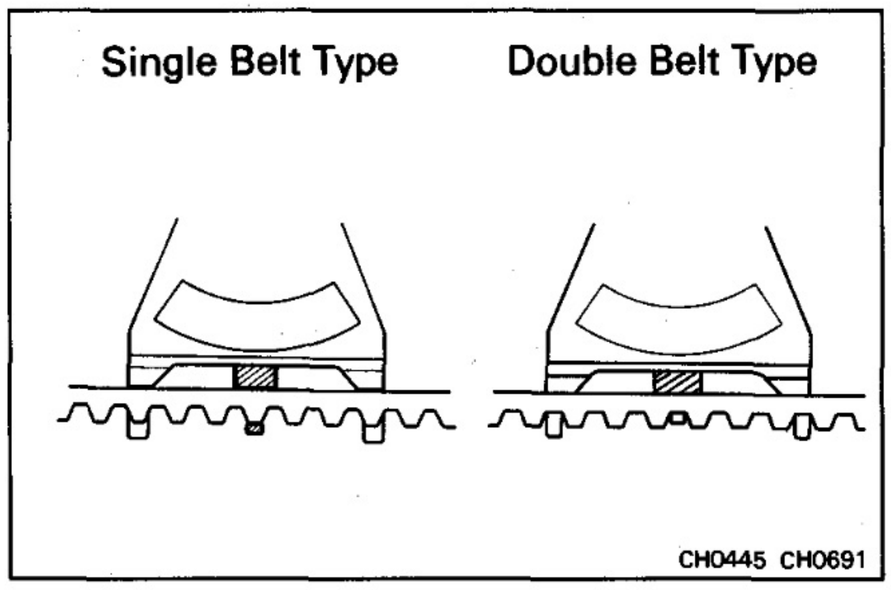
Single belt type

New belt 45 — 65 kg
Used belt 25 — 45 kg

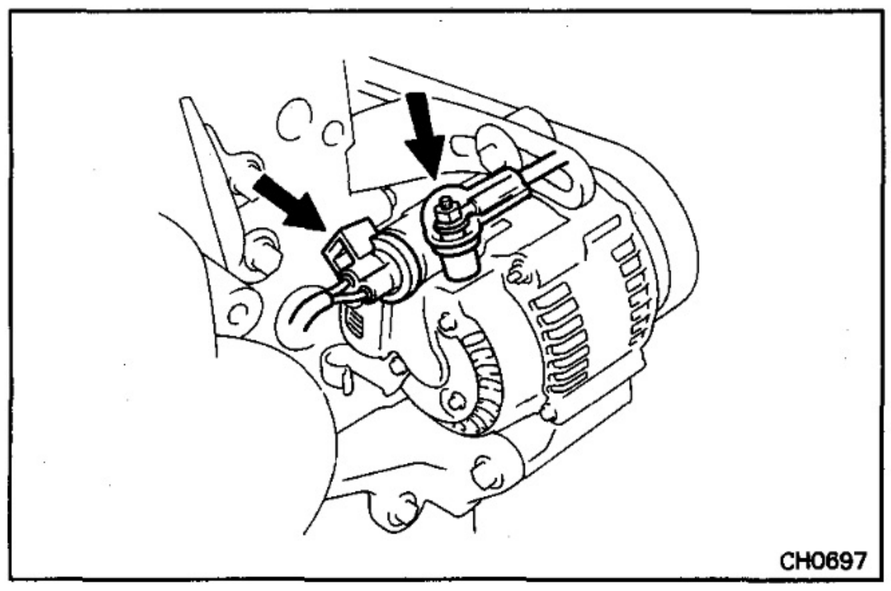
Double belt type

New belt 30 — 50 kg
Used belt 20 — 40 kg

If the belt tension is not within specification, adjust it.



HINT: When checking the tension, be sure the gauge is on the belt protrusion (single belt type) or belt groove (double belt type).



4. VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES

(a) Check that the wiring is in good condition.

(b) Check that there are no abnormal noises from the alternator while the engine is running.

5. INSPECT CHARGE WARNING LIGHT CIRCUIT

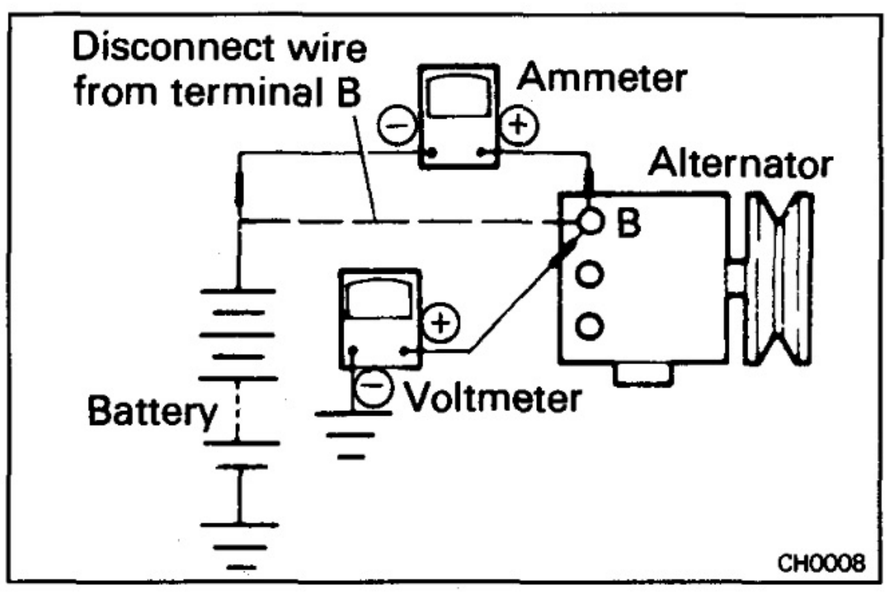
(a) Warm up the engine and then turn it off.

(b) Trun off all accessories.

(c) Turn the starter switch to "ON." Check that the charge warning light is lit.

(d) Start the engine. Check that the light goes out.

If the light does not operate as specified, troubleshoot the warning light circuit.



6. CHECK CHARGING CIRCUIT WITHOUT LOAD

HINT: If a battery/alternator tester is available, connect the tester to the charging circuit as per the manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter to the charging circuit as follows:

- Disconnect the wire from terminal B of the alternator and connect it to the negative (–) probe of the ammeter.
- Connect the test probe from the positive (+) terminal of the ammeter to terminal B of the alternator.
- Connect the positive (+) probe of the voltmeter to terminal B of the alternator.
- Ground the negative (–) probe of the voltmeter.

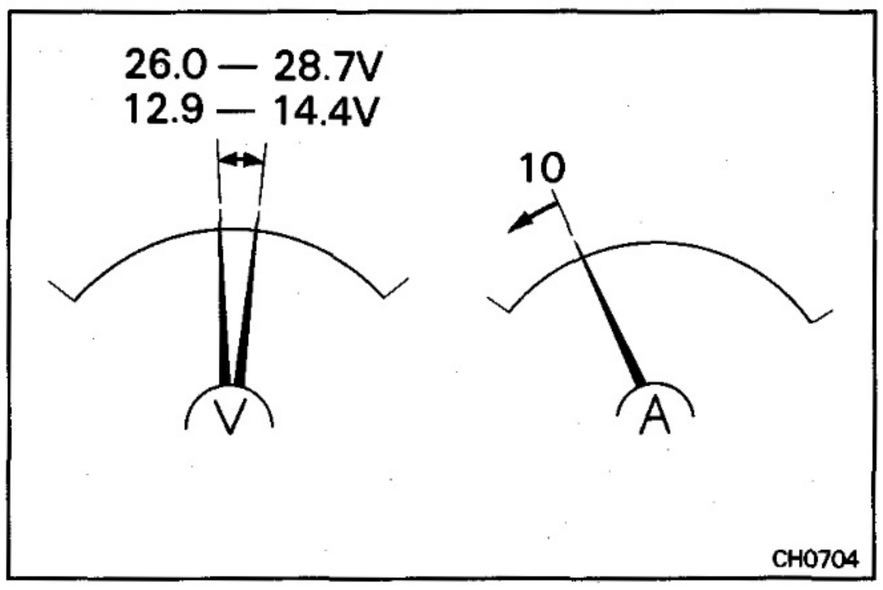
(b) Check the charging circuit as follows:

With the engine running from idle to 2,000 rpm, check the reading on the ammeter and voltmeter.

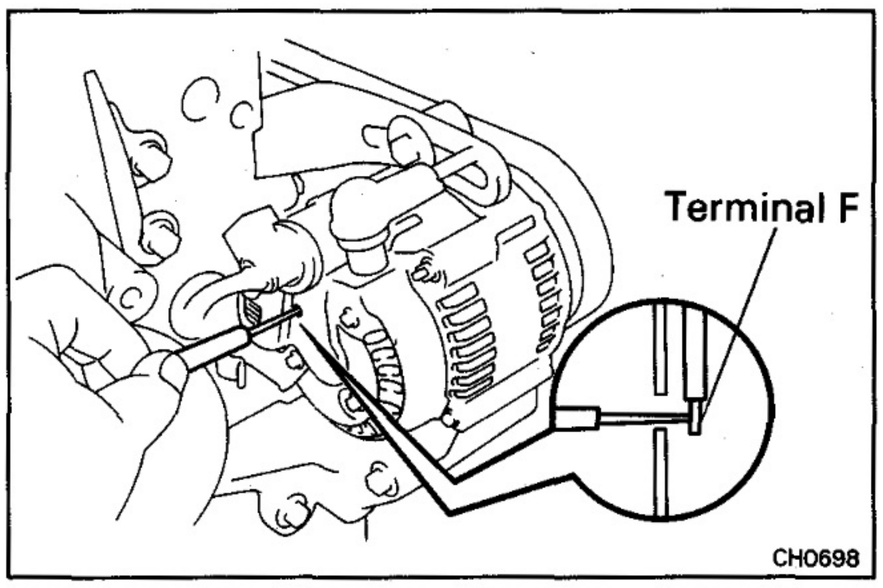
Standard amperage: 10 A or less

Standard voltage:

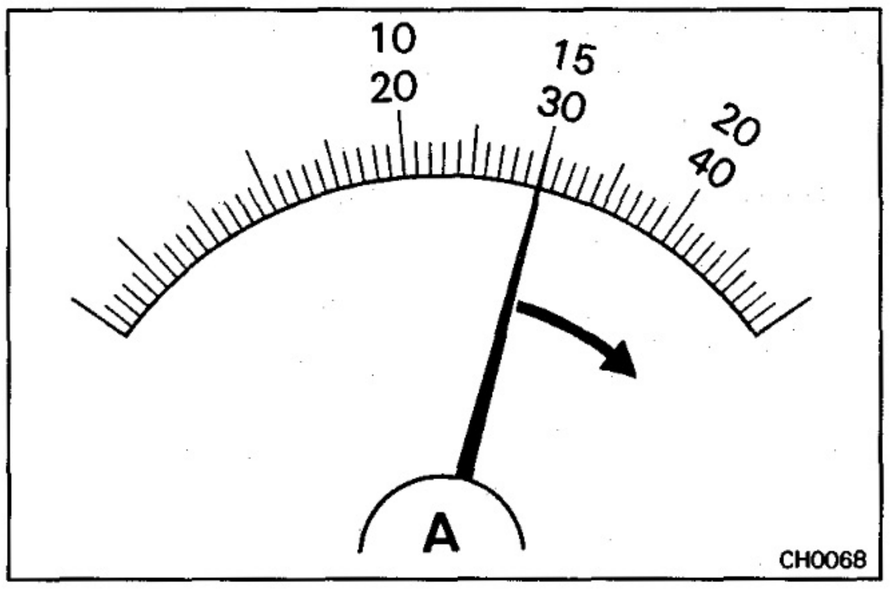
12V type	**13.8 — 14.4 V at 25°C (77°F)**
	12.9 — 14.4 V at 135°C (275°F)
24V type	**27.7 — 28.7 V at 25°C (77°F)**
	26.0 — 28.7 V at 135°C (275°F)



- If the voltage reading is greater than standard voltage, replace the IC regulator.



- If the voltage is less than standard voltage, check the IC regulator and alternator as follows:
  With terminal F grounded, start the engine and check the voltage reading of terminal B.
- If the voltage reading is greater than standard, replace the IC regulator.
- If the voltage reading is less than standard, check the alternator.



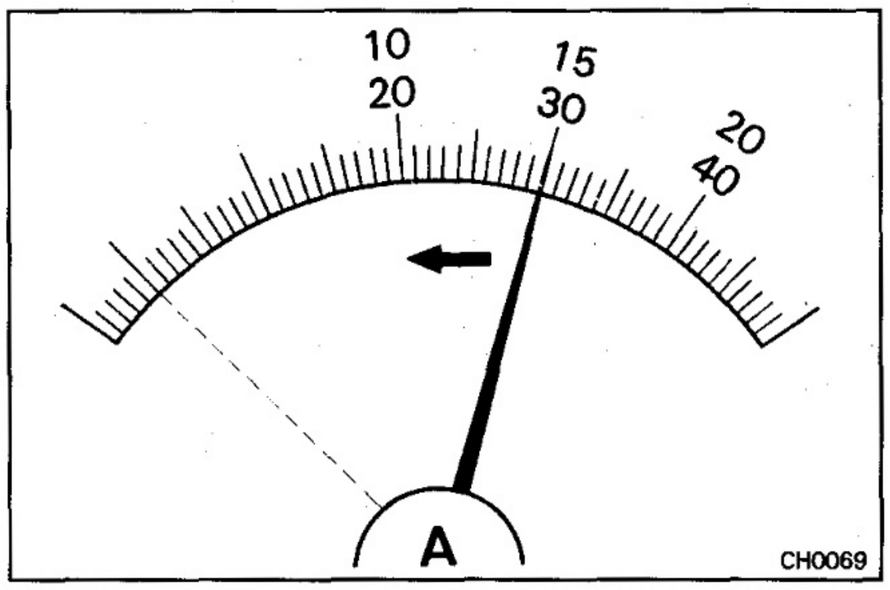
7. CHECK CHARGING CIRCUIT WITH LOAD

(a) With the engine running at 2,000 rpm, turn on the high beam headlights and place the heater fan control switch at "H".

(b) Check the reading on the ammeter.

Standard amperage:

12V type	**30 A or more**
24V type	**15 A or more**



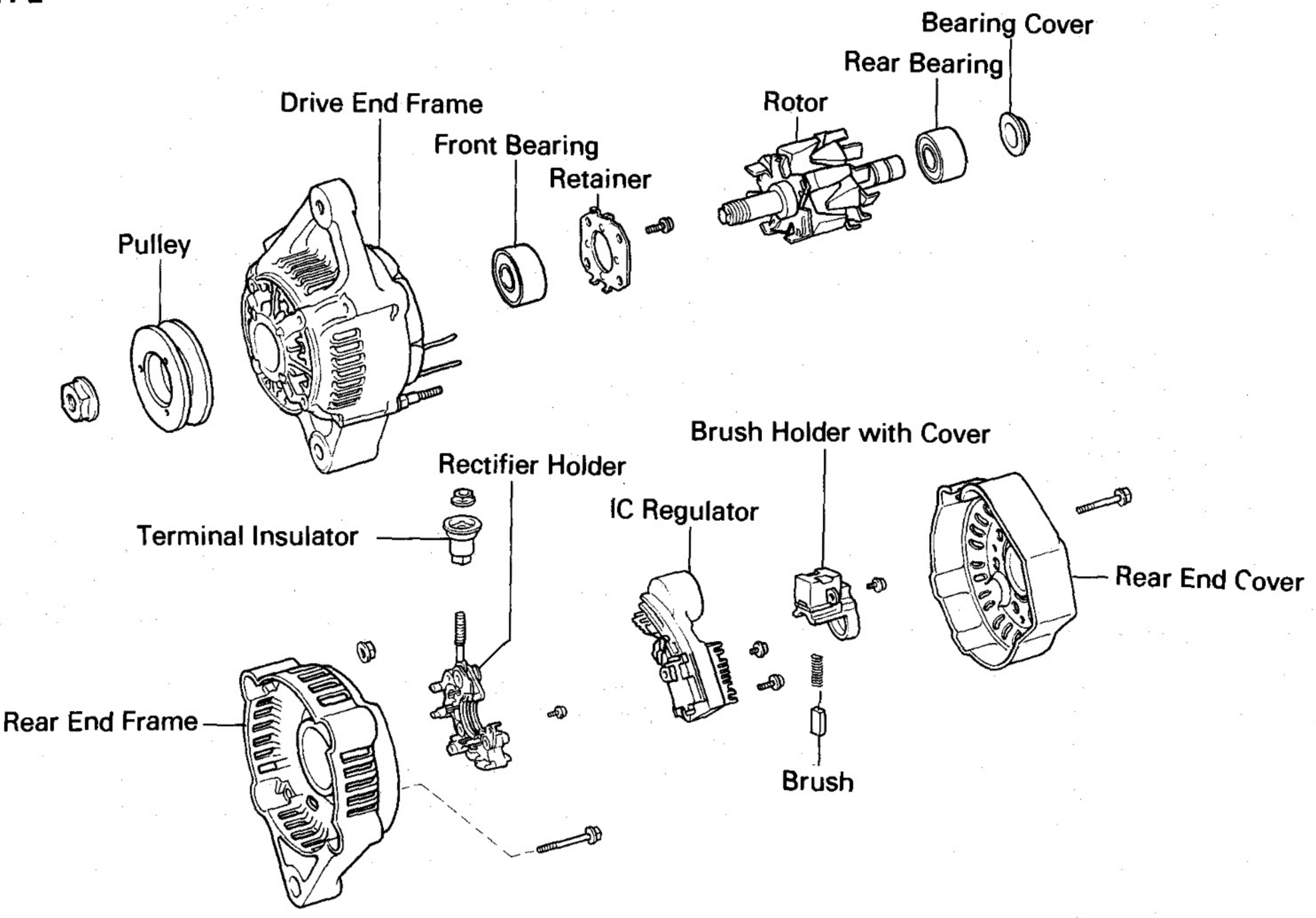
If the ammeter reading is less than standard amperage, repair the alternator. (See page CH-9)

HINT: If the battery is fully charged, the indication will sometimes be less than standard amperage.

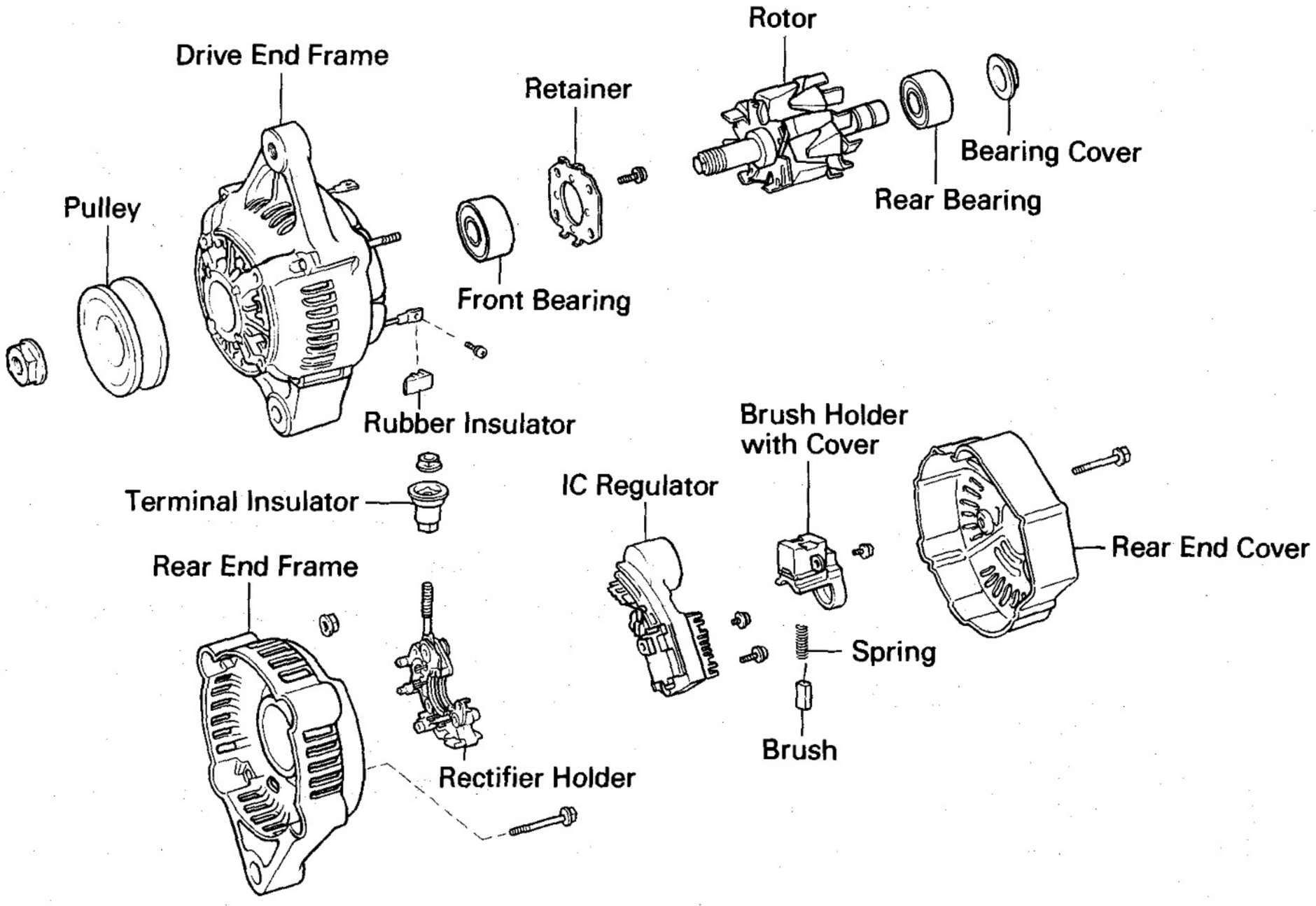
ALTERNATOR

COMPONENTS

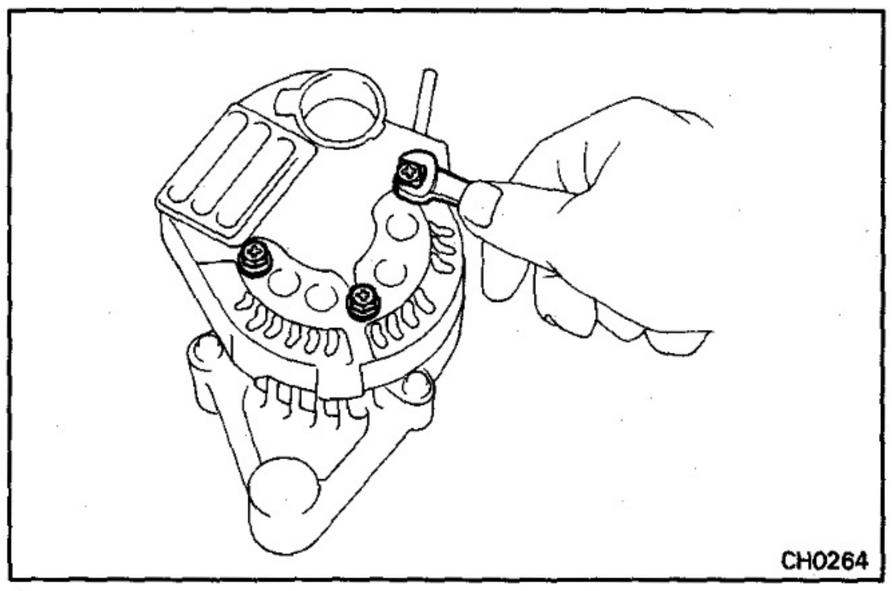
45A TYPE



25A, 30A, 55A and 60A TYPE



CH0709
CH0710



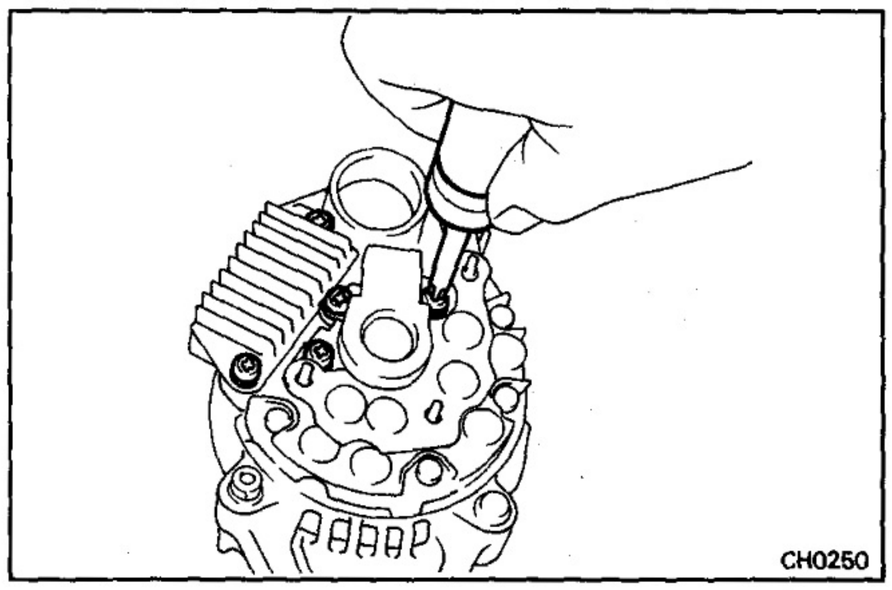
DISASSEMBLY OF ALTERNATOR

(See page CH-9)

1. REMOVE REAR END COVER

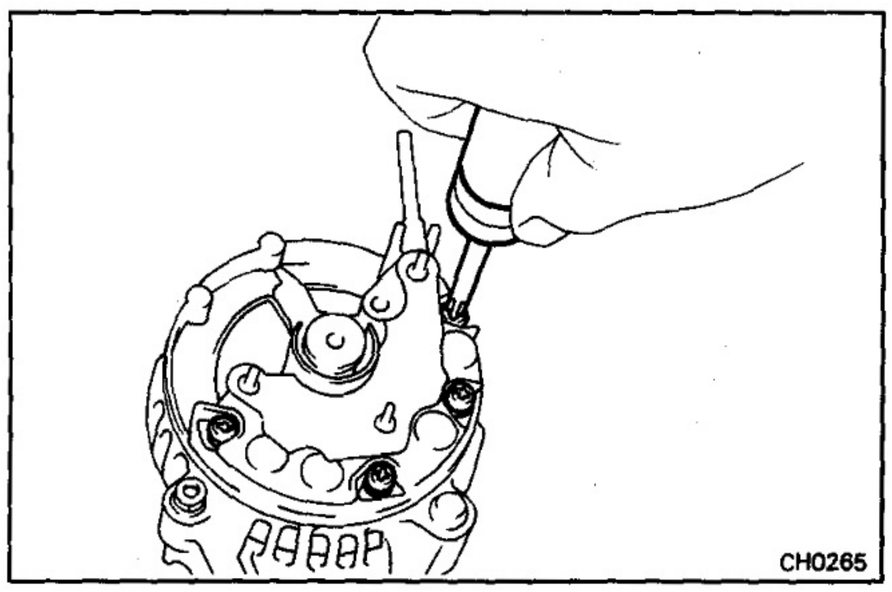
(a) Remove the nut and terminal insulator.

(b) (45 A type)
Remove the three bolts and end cover.
(Others)
Remove the three nuts and end cover.



2. REMOVE BRUSH HOLDER AND IC REGULATOR

Remove the five screws, brush holder and IC regulator.

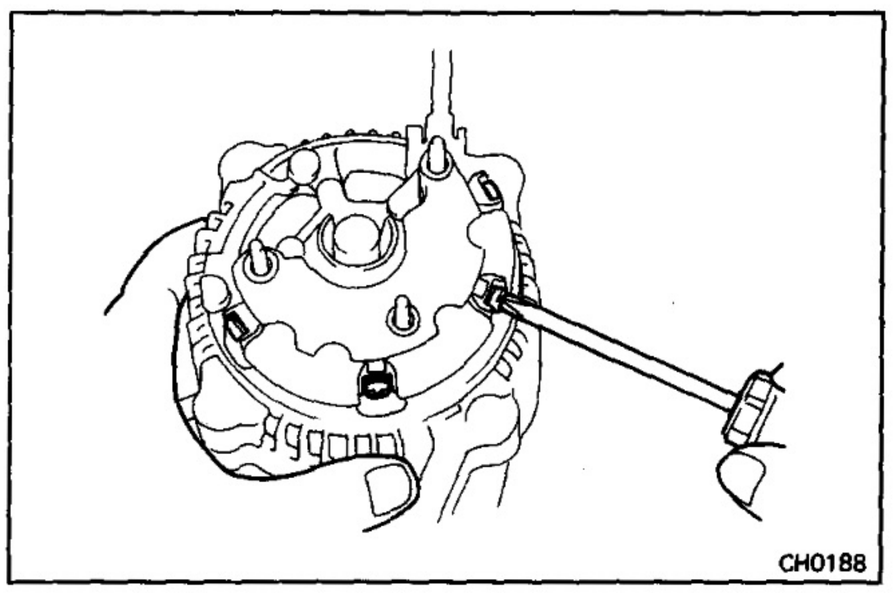


3. REMOVE RECTIFIER HOLDER (45 A TYPE)

(a) Remove the four screws.

(b) Using pliers, straighen the stator lead wire.

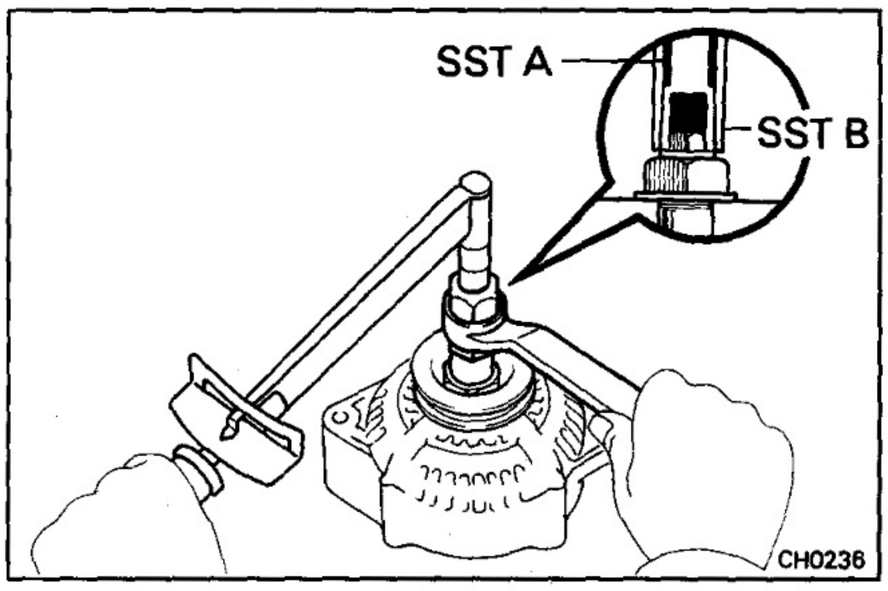
(c) Remove the rectifier holder.



(Others)

(a) Remove the four screws and rectifier holder.

(b) Remove the four rubber insulators.



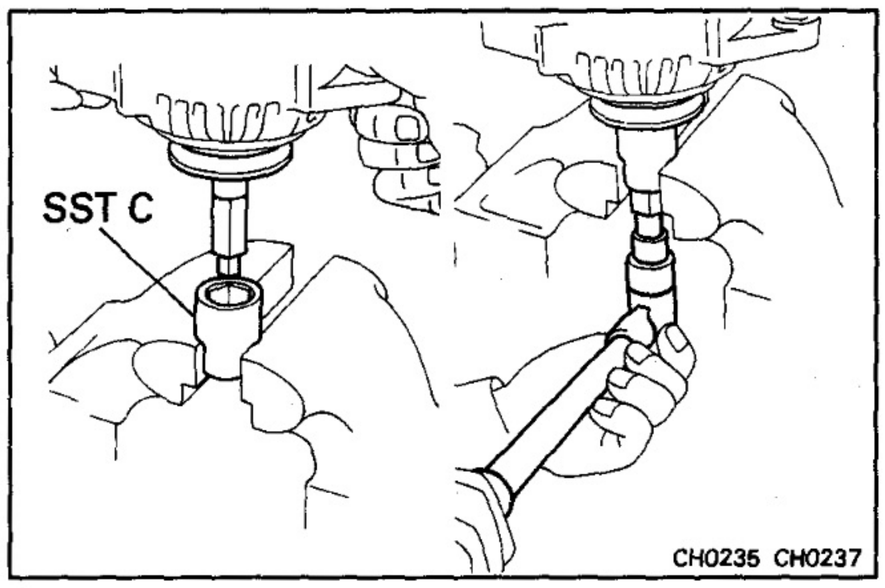
4. REMOVE PULLEY

(a) Hold SST A with a torque wrench, and tighten SST B clockwise to the specified torque.

SST 09820-63010

Torque: 400 kg-cm (29 ft-lb, 39 N·m)

(b) Check that SST A is secured to the rotor shaft.



(c) As shown in the figure, mount SST C in a vise, and install the alternator to SST C.

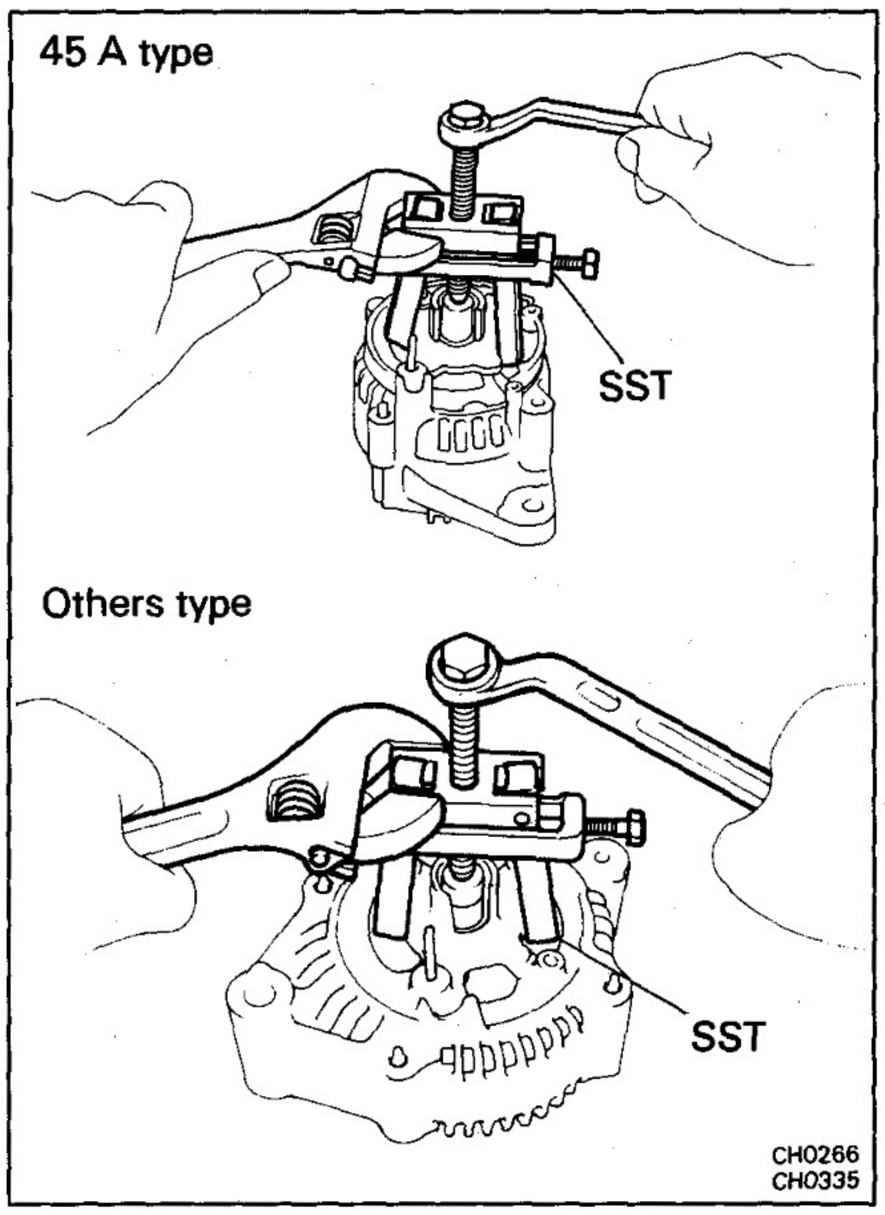
(d) To loosen the pulley nut turn SST A in the direction shown in the figure.

NOTICE: To prevent damage to the rotor shaft, do not loosen the pulley nut more that one-half of a turn.

(e) Remove the alternator from SST C.

(f) Turn SST B and remove SSTs A and B.

(g) Remove the pulley nut and pulley.



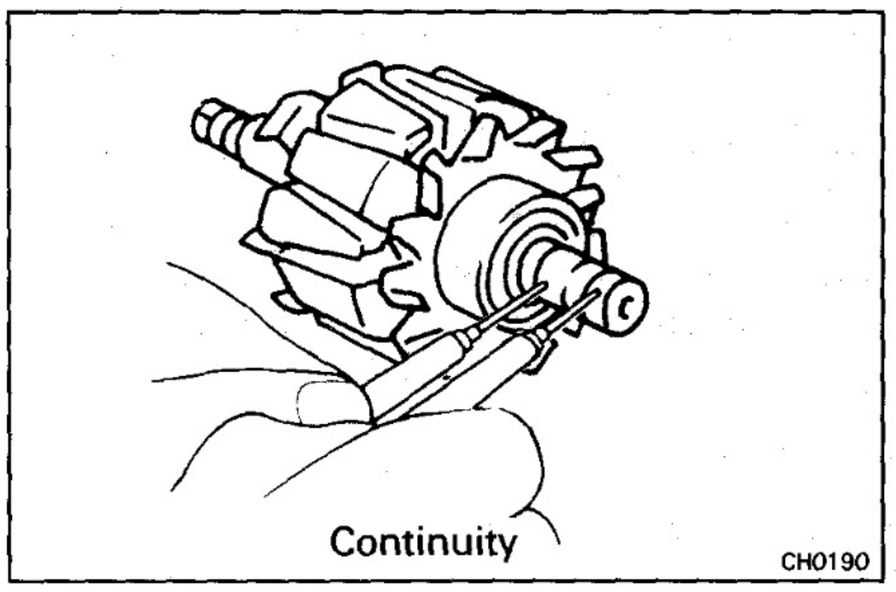
5. REMOVE RECTIFIER END FRAME

(a) (45 A type)
Remove the two nuts and bolts.
(Others)
Remove the four nuts.

(b) Using SST, remove the rectifier end frame.

SST	45 A type	09820-00021
	Others	09286-46011

6. REMOVE ROTOR FROM DRIVE END FRAME



INSPECTION AND REPAIR OF ALTERNATOR

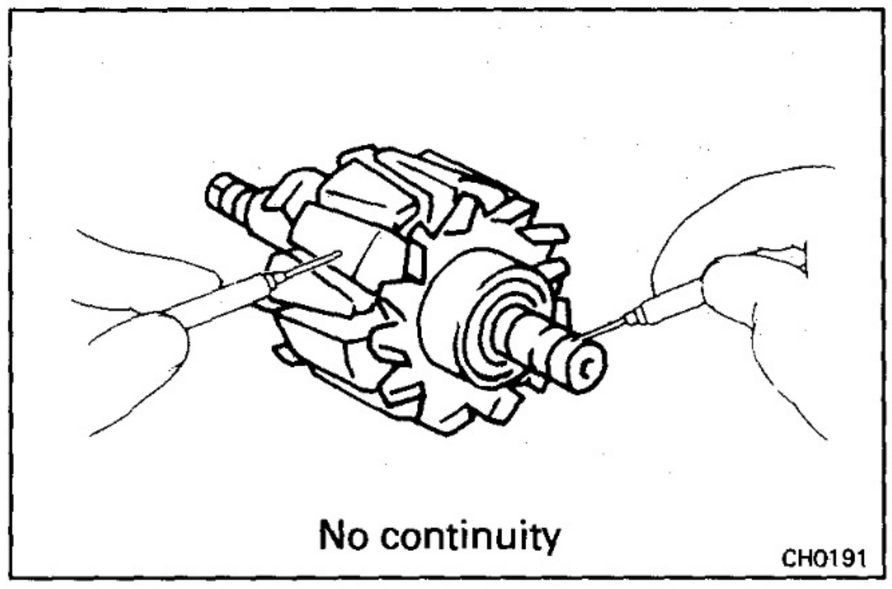
Rotor

1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance (cold): 2.8 — 3.0 Ω

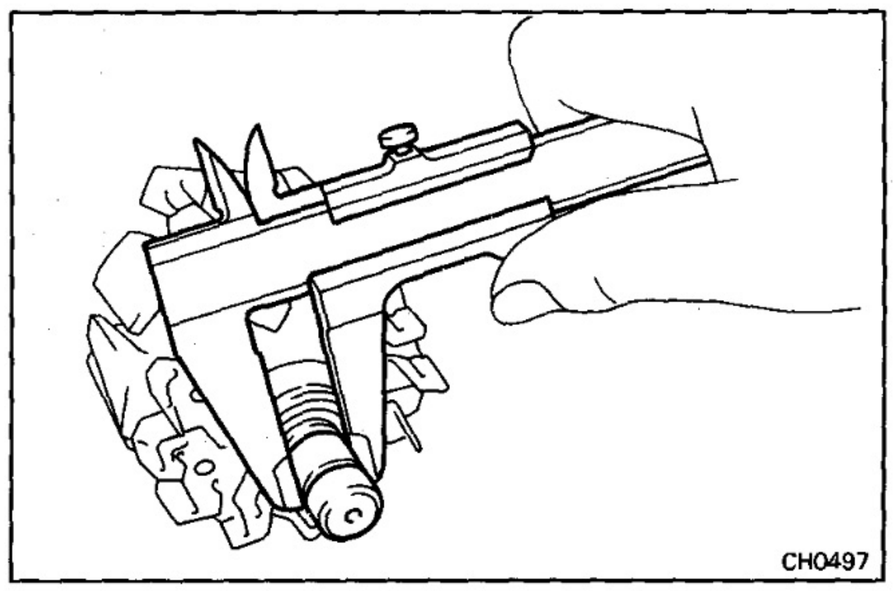
If there is no continuity, replace the rotor.



2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and the rotor.

If there is continuity, replace the rotor.



3. INSPECT SLIP RINGS

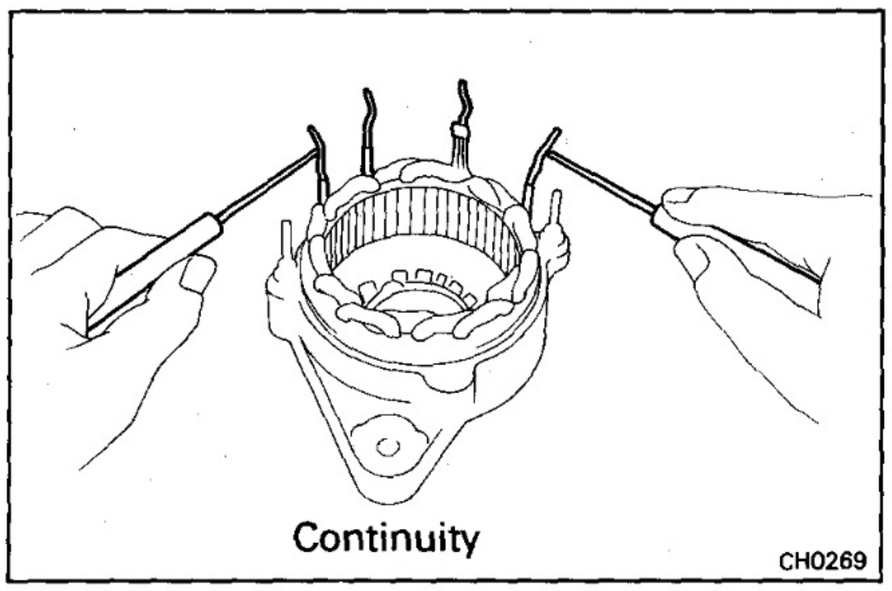
(a) Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.

(b) Using calipers, measure the slip ring diameters.

Standard diameter: 14.4 mm (0.567 in.)
Minimum diameter: 12.8 mm (0.504 in.)

If the diameter is less than minimum, replace the rotor.

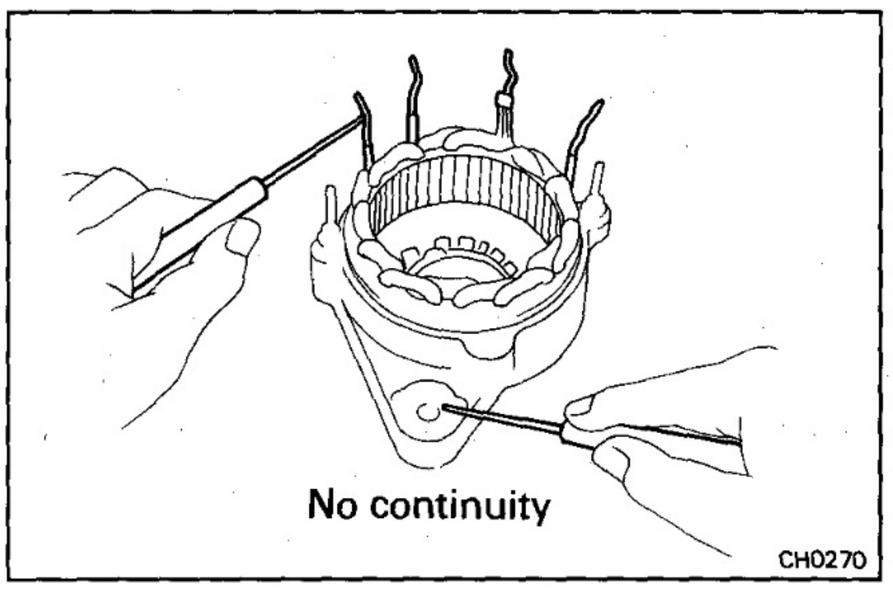


Stator

1. INSPECT STATOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the coil leads.

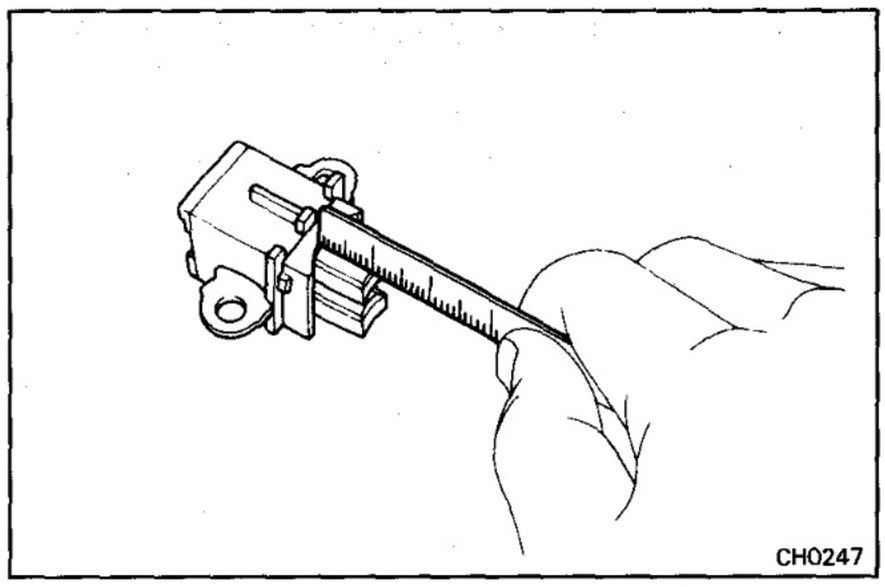
If there is no continuity, replace the drive end frame assembly.



2. INSPECT STATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the coil leads and drive end frame.

If there is continuity, replace the drive end frame assembly.

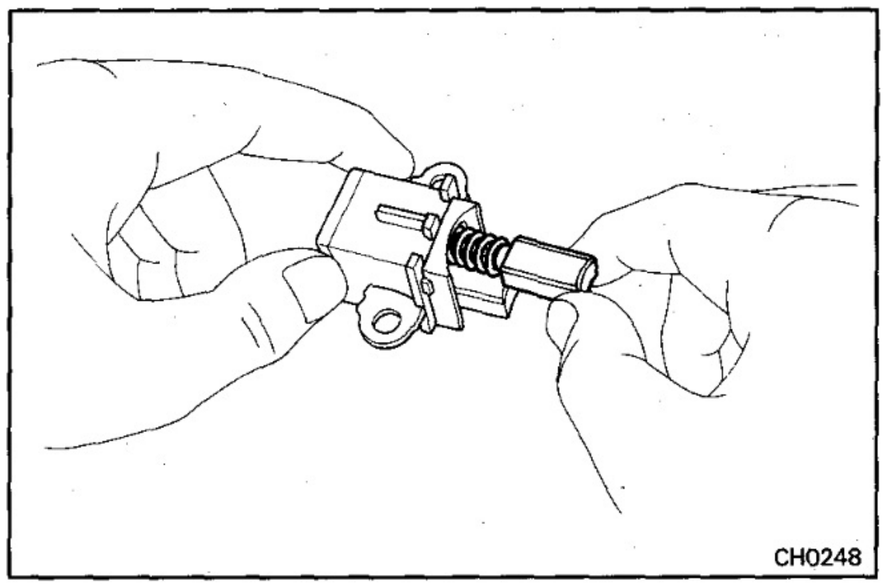


Brushes

1. MEASURE EXPOSED BRUSH LENGTH

Minimum exposed length: 1.5 mm (0.059 in.)

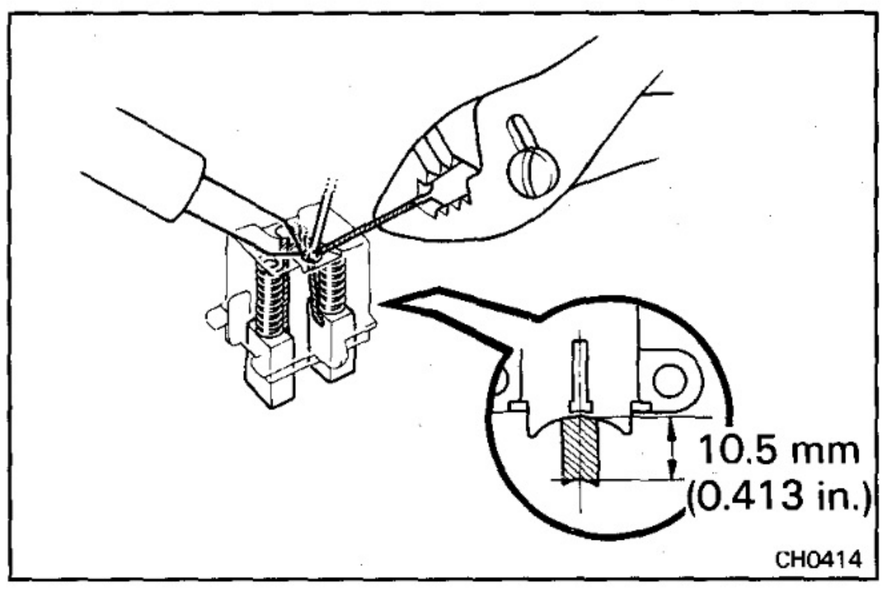
If the brush length is less than minimum, replace the brushes.



2. IF NECESSARY, REPLACE BRUSHES

(a) Unsolder and remove the brush and spring.

(b) Run the wire of the brush through the hole in the brush holder, and insert the spring and brush into the brush holder.



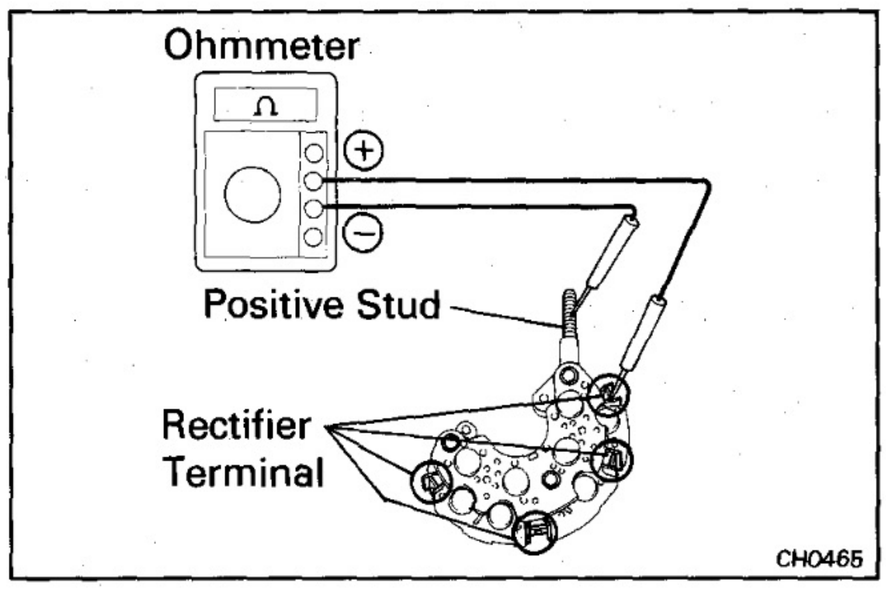
(c) Solder the brush wire to the brush holder at the exposed length.

Exposed length: 10.5 mm (0.413 in.)

(d) Check that the brush moves smoothly in the brush holder.

(e) Cut off the excess wire.

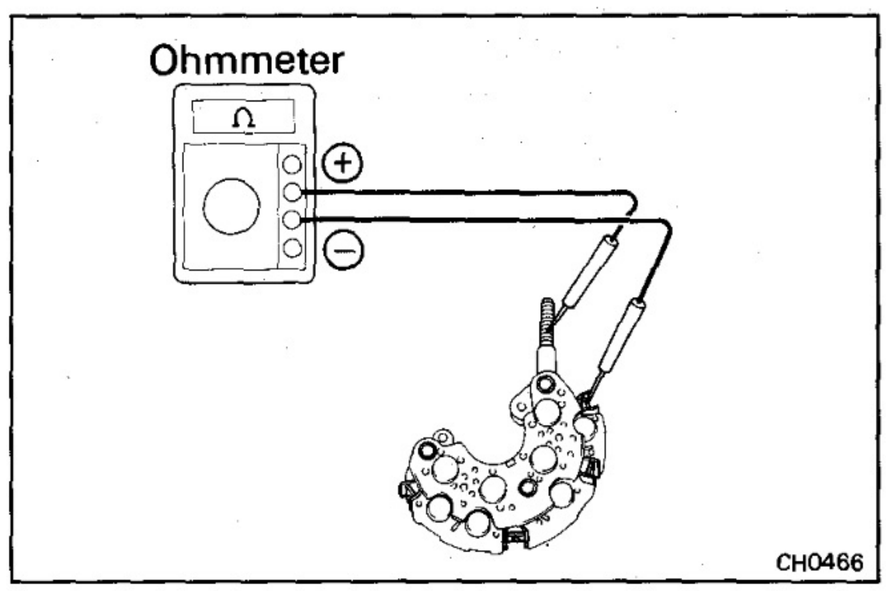
(f) Apply insulation paint to the soldered point.



Rectifier

1. INSPECT POSITIVE SIDE RECTIFIER

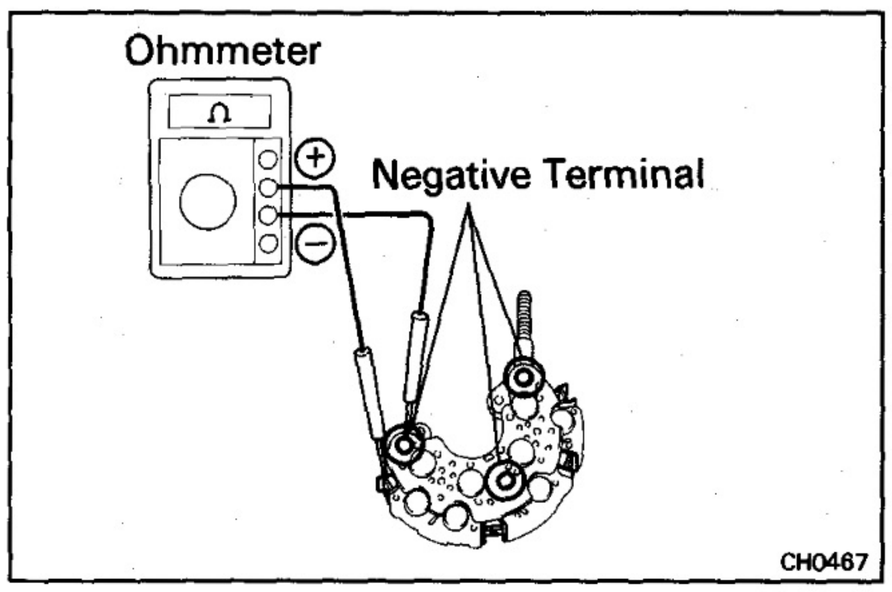
(a) Using an ohmmeter, connect one tester prove to the positive stud and the other to each rectifier terminal.



(b) Reverse the polarity of the tester probes.

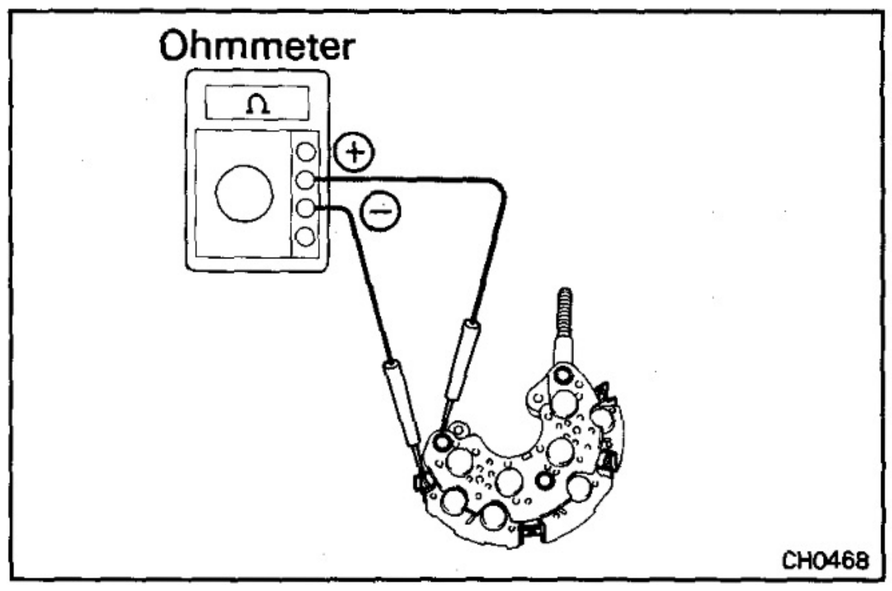
(c) Check that one shows continuity and the other shows no continuity.

If not, replace the rectifier holder.



2. INSPECT NEGATIVE SIDE RECTIFIER

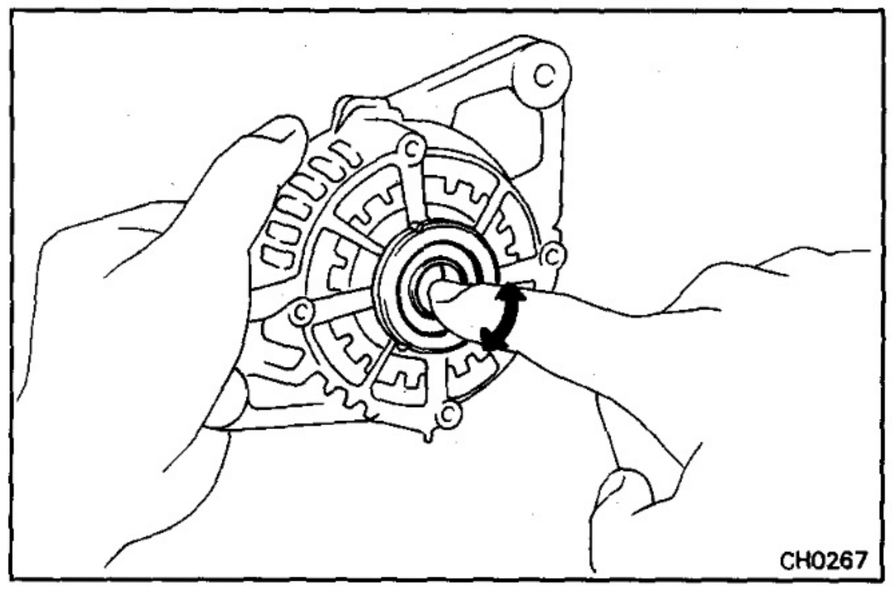
(a) Connect one tester probe to each rectifier terminal and the other to each rectifier negative terminal.



(b) Reverse the polarity of the tester probes.

(c) Check that one shows continuity and the other shows no continuity.

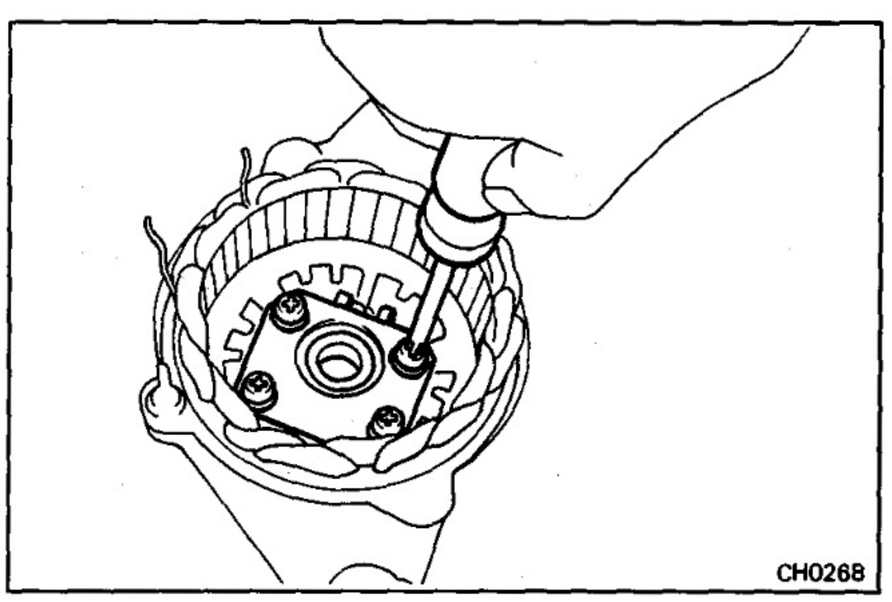
If not, replace the rectifier holder.



Bearings

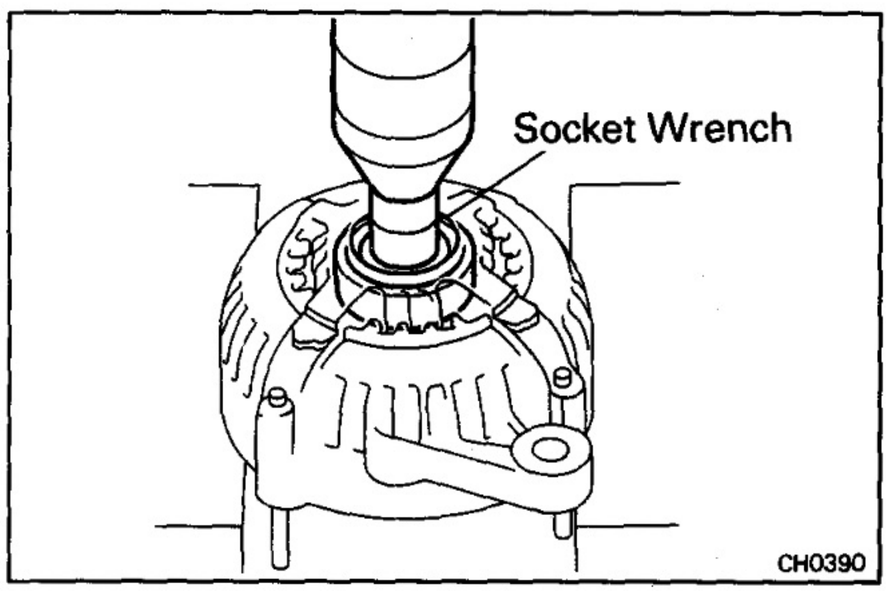
1. INSPECT FRON BEARING

Check that the bearing is not rough or worn.

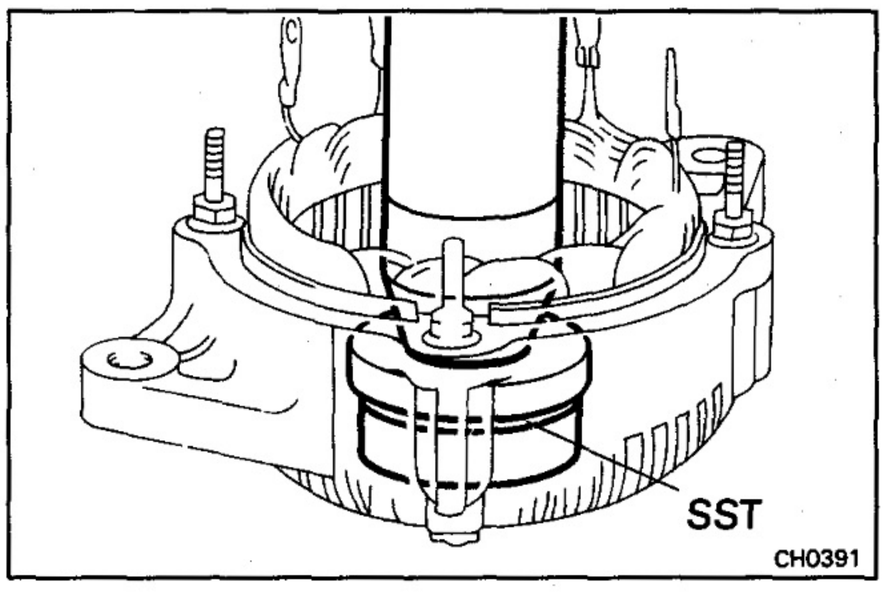


2. IF NECESSARY, REPLACE FRONT BEARING

(a) Remove the four screws and bearing retiner.



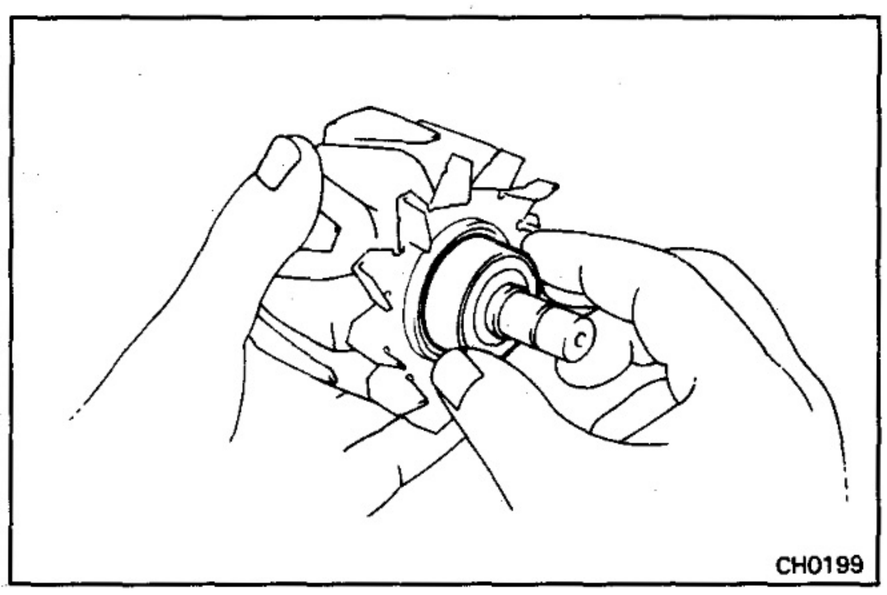
(b) Using a press and socket wrench, press out the front bearing.



(c) Using SST and a press, press the front bearing into the drive end frame.

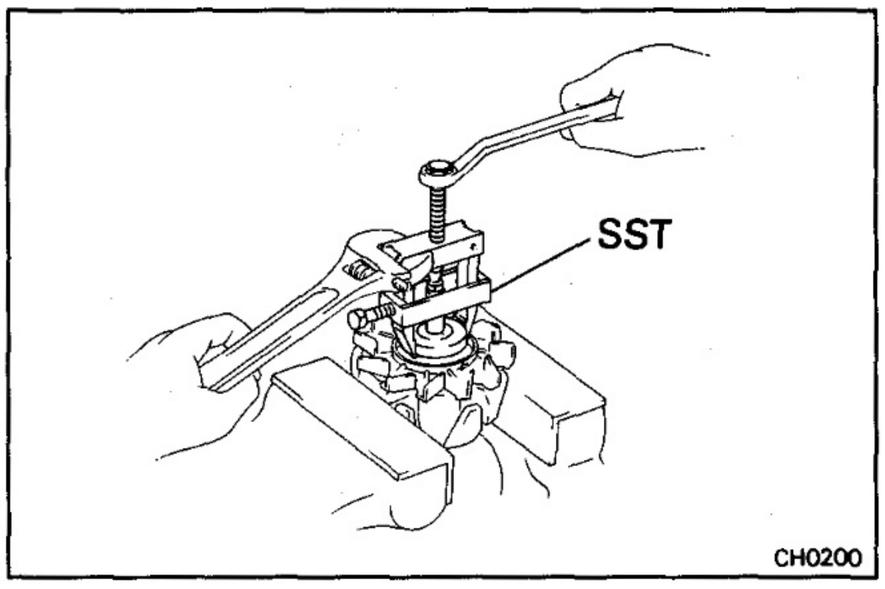
SST 09608-20012 (09608-00030)

(d) Install the bearing retainer with the four screws.



3. INSPECT REAR BEARING

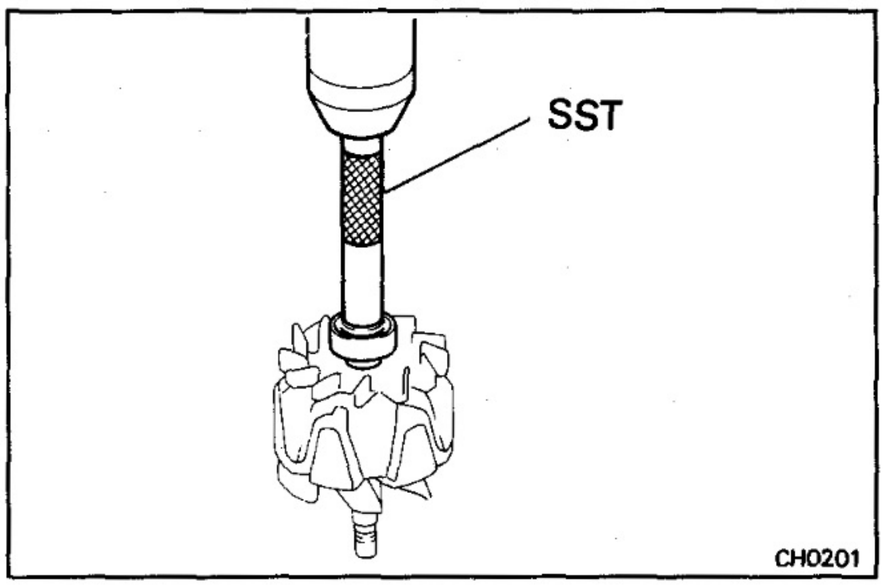
Check that the bearing is not rough or worn.



4. IF NECESSARY, REPLACE REAR BEARING

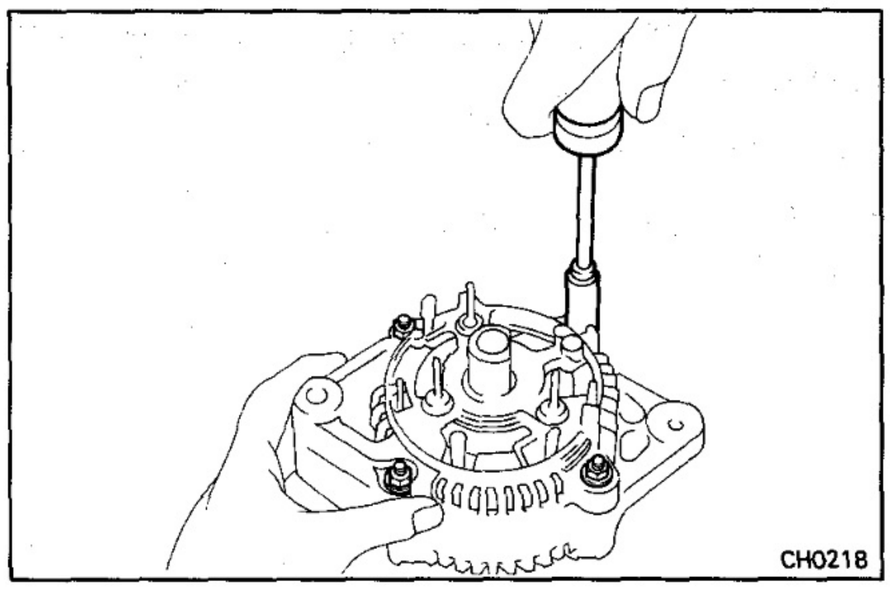
(a) Using SST, remove the bearing cover and bearing.

SST 09820-00021



(b) Using SST and a press, press in a new bearing and the bearing cover.

SST 09285-76010



ASSEMBLY OF ALTERNATOR

(See page CH-9)

1. INSTALL ROTOR TO DRIVE END FRAME

2. INSTALL RECTIFIER END FRAME

(a) Using a plastic-faced hammer, lightly tap in the end frame.

(b) (45 A type)
Install the two nuts and bolts.
(Others)
Install the four nuts.

3. INSTALL PULLEY

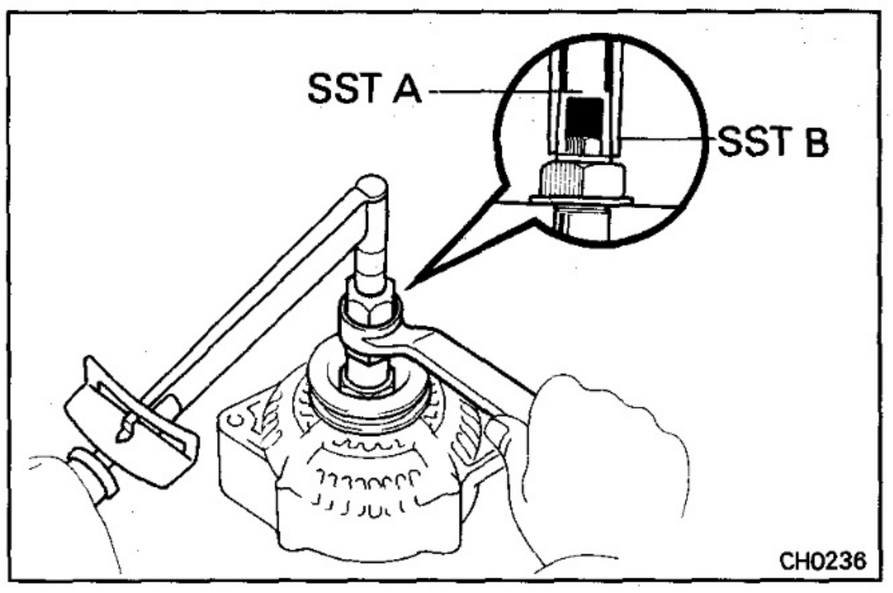
(a) Install the pulley to the rotor shaft by tightening the pulley nut by hand.

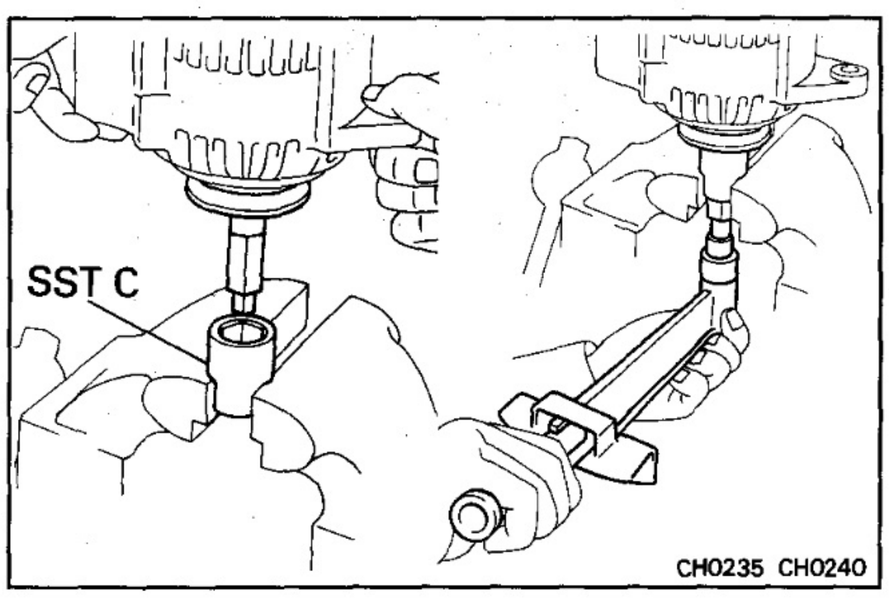
(b) Hold SST A with a torque wrench, and tighten SST B clockwise to the specified torque.

SST 09820-63010

Torque: 400 kg-cm (29 ft-lb, 39 N·m)

(c) Check that SST A is secured to the pulley shaft.





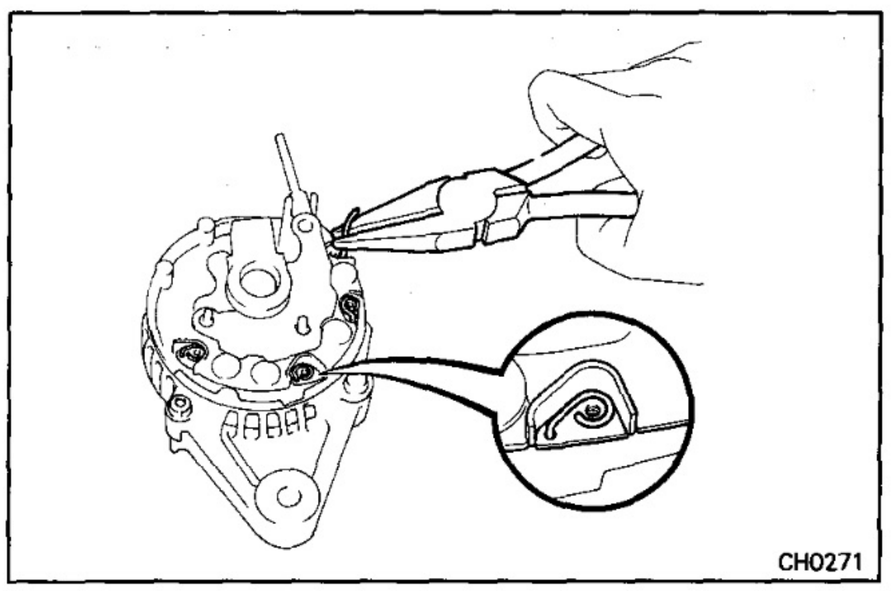
(d) As shown in the figure, mount SST C in a vise, and install the alternator to SST C.

(e) To torque the pulley nut turn SST A in the direction shown in the figure.

Torque: 1,125 kg-cm (81 ft-lb, 110 N·m)

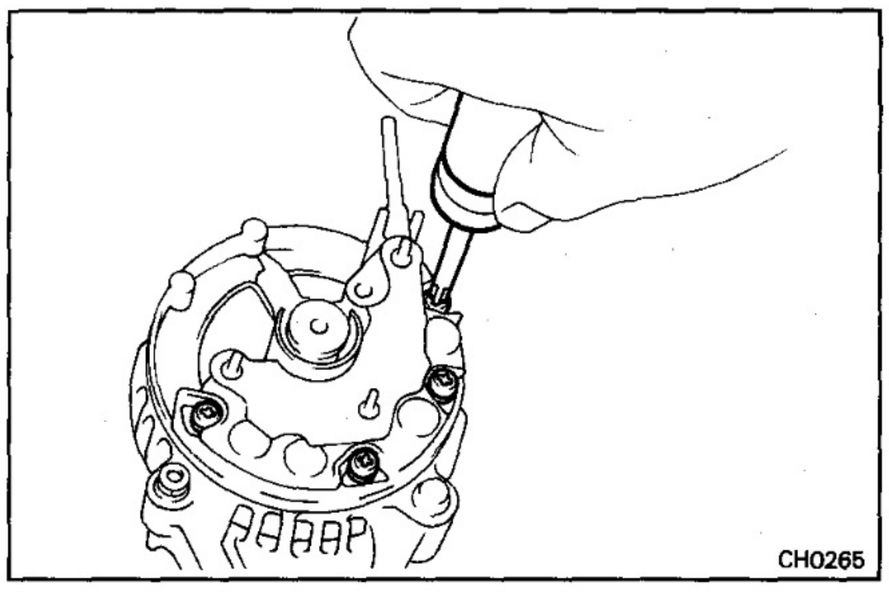
(f) Remove the alternator from SST C.

(g) Turn SST B and remove SSTs A and B.

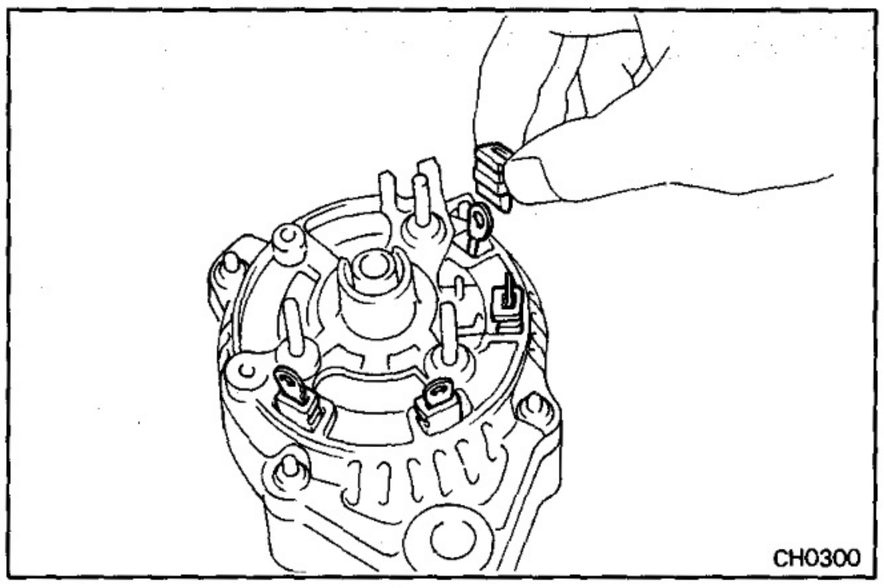


4. INSTALL RECTIFIER HOLDER (45 A type)

(a) Install the rectifier and bend lead wires as shown.

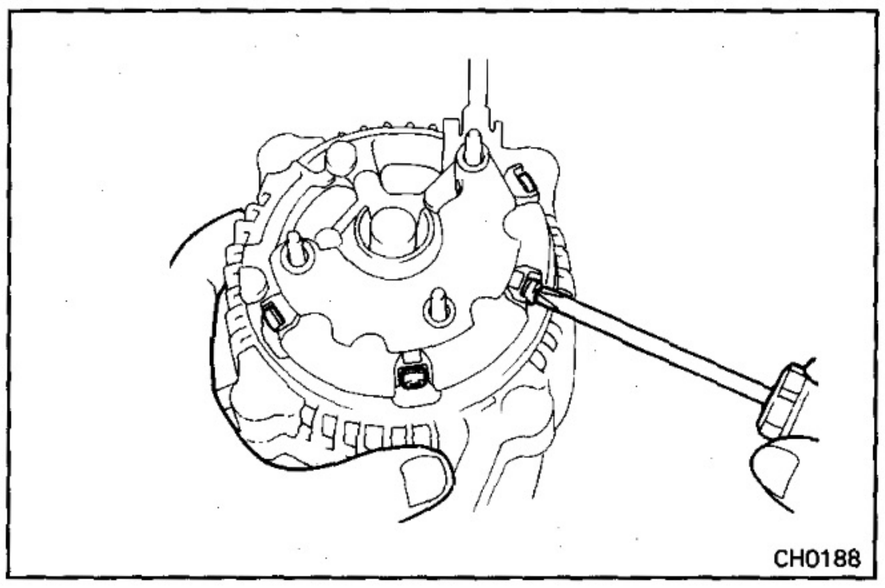


(b) Install the four screws.

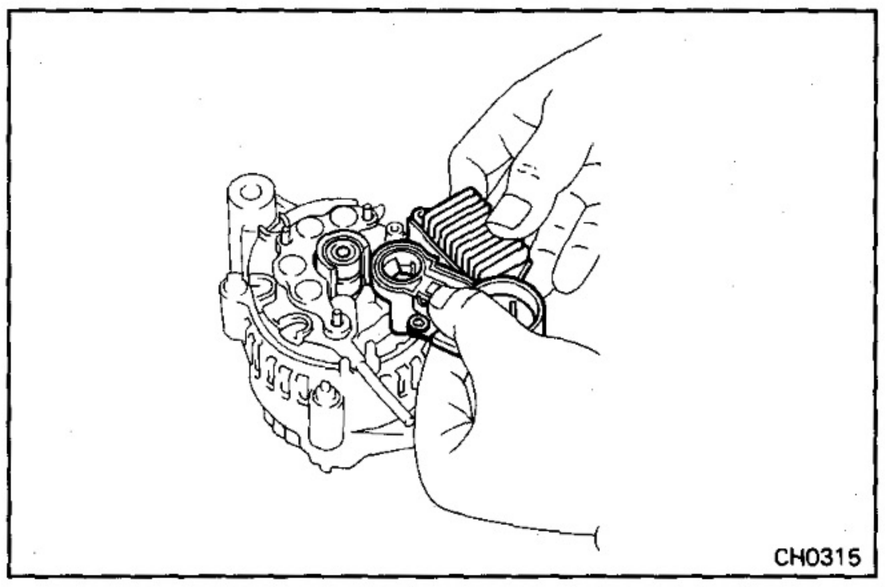

CH0300

(Others type)

(a) Install the four rubber insulators on the lead wires.


CH0188

(b) Install the rectifier with the four screws.

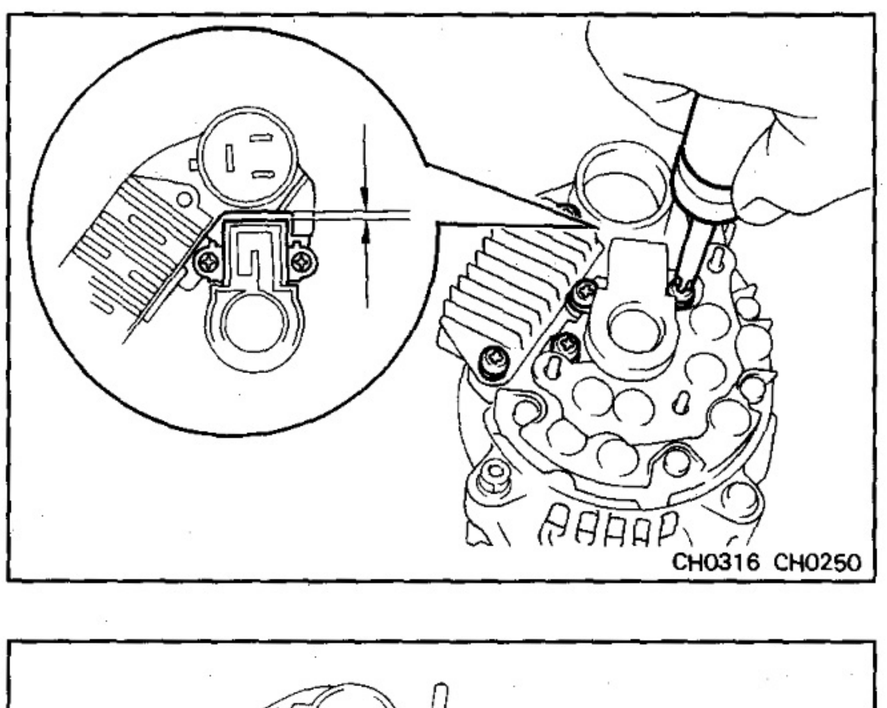

CH0315

5. INSTALL BRUSH HOLDER AND IC REGULATOR

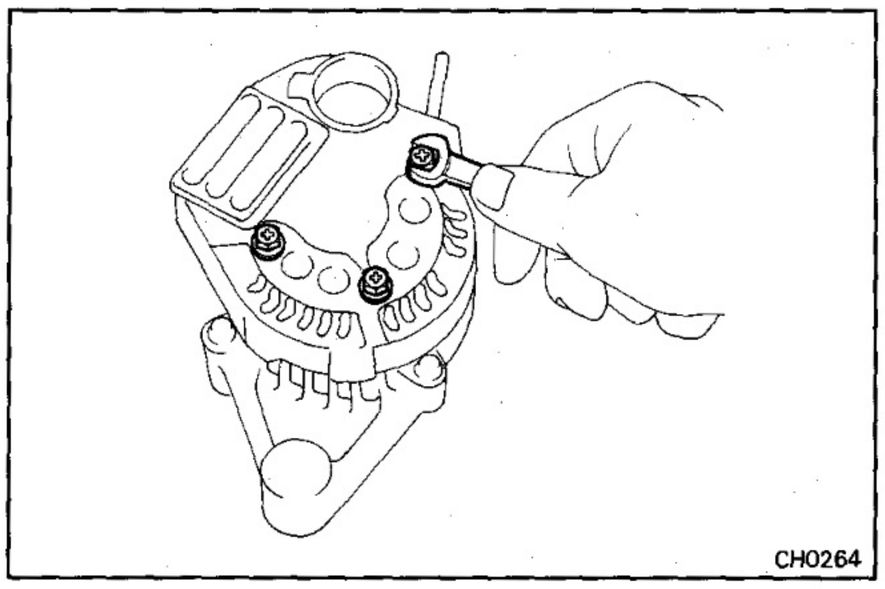
(a) Place the brush holder cover to the brush holder.

(b) Install the IC regulator and brush holder to the rear end frame horizontally as shown in the figure.

HINT: Make sure the brush holder's cover doesn't slip to one side during installation.


CH0316 CH0250

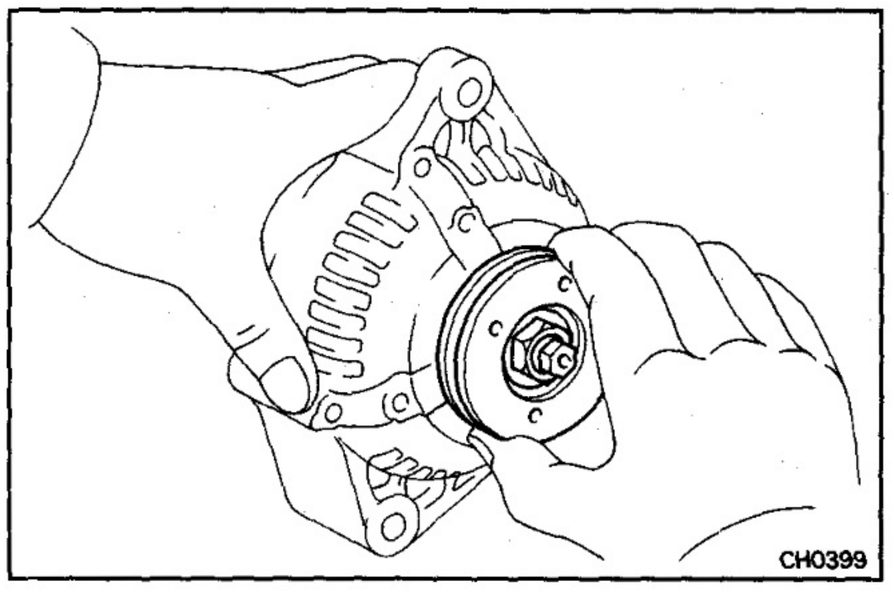
(c) Tighten the five screws until there is a clearance of at least 1 mm (0.04 in.) between the brush holder cover and connector.


CH0264

6. INSTALL REAR END COVER

(a) (45 A type)
Install the end cover with the three bolts.
(Others)
Install the end cover with the three nuts.

(b) Install the terminal insulator with the nut.



7. MAKE SURE ROTOR ROTATES SMOOTHLY

SERVICE SPECIFICATIONS

	Page
ENGINE MECHANICAL	A-2
FUEL SYSTEM	A-8
COOLING SYSTEM	A-17
LUBRICATION SYSTEM	A-17
STARTING SYSTEM	A-18
CHARGING SYSTEM	A-18

ENGINE MECHANICAL

Specifications

Engine tune-up	Engine coolant capacity (w/ Heater)			
	BJ60	13.3 liters	14.1 US qts	11.7 Imp. qts
	BJ70, 73, 75	13.8 liters	14.6 US qts	12.1 Imp. qts
	BU Regular cab	12.5 liters	13.2 US qts	11.0 Imp. qts
	Wide cab	13.0 liters	13.7 US qts	11.4 Imp. qts
	BB	15.0 liters	15.9 US qts	13.2 Imp. qts
	BY (w/o Heater)	12.2 liters	12.9 US qts	10.7 Imp. qts
	Engine oil capacity			
	Drain and refill			
	w/o oil filter change			
	BJ and BU (B, 11B)	6.4 liters	6.8 US qts	5.6 Imp. qts
	BU (14B) and BY	8.4 liters	8.9 US qts	7.4 Imp. qts
	BB	8.1 liters	8.6 US qts	7.1 imp. qts
	w/ Oil filter change			
	BJ and BU (B, 11B)	7.3 liters	7.7 US qts	6.4 Imp. qts
	BU (14B) and BY	9.3 liters	9.8 US qts	8.2 Imp. qts
	BB	9.0 liters	9.5 US qts	7.9 Imp. qts
	Battery specific gravity			
	80D26R and 95D31R	1.27 — 1.29 when fully charged at 20°C (68°F)		
	Others	1.25 — 1.27 when fully charged at 20°C (68°F)		
	Drive belt			
	Deflection			
	Single belt New belt	7.5 — 11 mm	0.30 — 0.43 in.	
	Used belt	11 — 15.5 mm	0.43 — 0.61 in.	
	Double belt New belt	12 — 15 mm	0.47 — 0.59 in.	
	Used belt	14 — 20 mm	0.55 — 0.79 in.	
	Tension (Reference)			
	Single belt New belt	45 — 65 kg		
	Used belt	25 — 45 kg		
	Double belt New belt	30 — 50 kg		
	Used belt	20 — 40 kg		
	Injection nozzle opening pressure			
	B and 3B New nozzle	115 — 125 kg/cm² (1,636 — 1,778 psi, 11,278 — 12,258 kPa)		
	Reused nozzle	105 — 125 kg/cm² (1,493 — 1,778 psi, 10,297 — 12,258 kPa)		
	11B and 14B New nozzle	200 — 210 kg/cm² (2,845 — 2,987 psi, 19,613 — 20,594 kPa)		
	Reused nozzle	180 — 210 kg/cm² (2,560 — 2,987 psi, 17,652 — 20,594 kPa)		
	Valve clearance (Hot) IN	0.20 mm	0.008 in.	
	EX	0.36 mm	0.014 in.	
	Injection timing	0°		
	At B and 3B 1.27 — 1.33 mm (0.0450 — 0.0524 in.)			
	11B 1.34 — 1.40 mm (0.0528 — 0.0551 in.)			
	14B 1.31 — 1.37 mm (0.0516 — 0.0539 in.)			
	Injection order	1 — 3 — 4 — 2		

Specifications (Cont'd)

Engine tune-up (cont'd)	Idle speed	M/T	600 — 700 rpm	
		A/T	770 — 820 rpm	
	Maximum speed	B and 3B	4,125 rpm	
		11B and 14B	4,150 rpm	
Compression pressure	Engine revolution at 250 rpm			
		STD	30.0 kg/cm² (427 psi, 2,942 kPa) or more	
		Limit	20.0 kg/cm²	284 psi 1,961 kPa
	Difference of pressure between each cylinder		2.0 kg/cm² (28 psi, 196 kPa) or less	
Cylinder head	Cylinder head surface warpage			
		Limit	0.20 mm	0.0079 in.
	Manifold side warpage	Limit	0.20 mm	0.0079 in.
	Valve seat			
	Refacing angle		30°, 45°, 65°	
	Contacting angle		45°	
	Contacting width		1.9 — 2.3 mm	0.075 — 0.091 in.
Valve guide bushing	Inner diameter		9.010 — 9.030 mm	0.3547 — 0.3555 in.
	Outer diameter		14.023 — 14.041 mm	0.5521 — 0.5528 in.
Valve	Valve overall length			
	STD IN	B	126.60 mm	4.9842 in.
		3B, 11B and 14B	126.65 mm	4.9862 in.
	EX	B	126.50 mm	4.9803 in.
		3B	126.55 mm	4.9823 in.
		11B and 14B	126.42 mm	4.9772 in.
	Limit IN	B	126.10 mm	4.9646 in.
		3B, 11B and 14B	126.15 mm	4.9665 in.
	EX	B	126.00 mm	4.9606 in.
		3B	126.05 mm	4.9626 in.
		11B and 14B	125.92 mm	4.9575 in.
	Valve face angle		45.5°	
	Stem diameter IN		8.968 — 8.984 mm	0.3531 — 0.3537 in.
	EX		8.954 — 8.970 mm	0.3525 — 0.3531 in.
	Stem oil clearance			
	STD IN		0.026 — 0.062 mm	0.0010 — 0.0024 in.
	EX		0.040 — 0.076 mm	0.0016 — 0.0030 in.
	Limit IN		0.10 mm	0.0039 in.
	EX		0.12 mm	0.0047 in.
	Margin thickness			
	STD IN	B and 11B	1.4 mm	0.055 in.
		3B and 14B	1.1 mm	0.043 in.
	EX	B and 3B	1.8 mm	0.071 in.
		11B	1.4 mm	0.055 in.
		14B	1.7 mm	0.067 in.
	Limit IN		0.9 mm	0.035 in.
	EX	B and 3B	1.3 mm	0.051 in.
		11B	0.9 mm	0.035 in.
		14B	1.2 mm	0.047 in.

Specifications (Cont'd)

Valve spring	Free length	STD	Inner	45.28 mm	1.7827 in.
			Outer	50.73 mm	1.9972 in.
	Installed tension		Inner	13.8 kg (30.4 lb, 135 N) at 38.19 mm 1.5035 in.)	
			Outer	28.3 kg (62.4 lb, 278 N) at 41.69 mm (1.6413 in.)	
	Squareness			2.0 mm	0.079 in.
Rocker arm and shaft	Rocker arm inside diameter			18.512 — 18.533 mm	0.7288 — 0.7296 in.
	Rocker shaft diameter			18.472 — 18.493 mm	0.7272 — 0.7281 in.
	Rocker arm to shaft oil clearance				
		STD		0.019 — 0.061 mm	0.0007 — 0.0024 in.
		Limit		0.10 mm	0.0039in.
Push rod	Circle runout			0.50 mm	0.0197 in.
Intake and exhaust manifold	Manifold surface warpage				
		Limit		0.20 mm	0.0079 in.
Combustion chamber (B, 3B)	Protrusion			Minus 0.05 — Plus 0.05 mm	Minus 0.0020 — Plus 0.0020 in.
Camshaft	Circle runout	Limit		0.06 mm	0.0024 in.
	Cam lobe height				
		STD	IN	B and 3B	45.288 — 45.378 mm	1.7830 — 1.7865 in.
				11B and 14B	44.879 — 44.969 mm	1.7669 — 1.7704 in.
			EX	B and 3B	45.261 — 45.351 mm	1.7819 — 1.7855 in.
				11B and 14B	45.050 — 45.140 mm	1.7736 — 1.7772 in.
		Limit	IN	B and 3B	44.85 mm	1.7657 in.
				11B and 14B	44.44 mm	1.7496 in.
			EX	B and 3B	44.83 mm	1.7650 in.
				11B and 14B	44.62 mm	1.7567 in.
	Journal diameter		No. 1		53.459 — 53.475 mm	2.1047 — 2.1053 in.
			No. 2		53.209 — 53.225 mm	2.0948 — 2.0955 in.
			No. 3		52.959 — 52.975 mm	2.0850 — 2.0856 in.
			No. 4		52.709 — 52.725 mm	2.0752 — 2.0758 in.
			No. 5		52.459 — 52.475 mm	2.0653 — 2.0659 in.
	Bearing inside diameter		No. 1		53.500 — 53.525 mm	2.1063 — 2.1073 in.
			No. 2		53.250 — 53.275 mm	2.0965 — 2.0974 in.
			No. 3		53.000 — 53.025 mm	2.0866 — 2.0876 in.
			No. 4		52.750 — 52.775 mm	2.0768 — 2.0778 in.
			No. 5		52.500 — 52.525 mm	2.0669 — 2.0679 in.
	Journal oil clearance		STD		0.025 — 0.066 mm	0.0010 — 0.0026 in.
			Limit		0.10 mm	0.0039 in.
	Thrust clearance		STD		0.06 — 0.13 mm	0.0024 — 0.0051 in.
			Limit		0.30 mm	0.0118 in.

Specifications (Cont'd)

Timing gear	Gear backlash (each gear)		STD	0.058 — 0.162 mm	0.0023 — 0.0064 in.
			Limit	0.30 mm	0.0118 in.
	Idle gear thrust clearance		STD	0.06 — 0.17 mm	0.0024 — 0.0067 in.
			Limit	0.30 mm	0.0118 in.
	Idle gear shaft diameter			44.935 — 44.955 mm	1.7691 — 1.7699 in.
	Idle gear inside diameter			45.000 — 45.025 mm	1.7717 — 1.7726 in.
	Idle gear oil clearance		STD	0.045 — 0.090 mm	0.0018 — 0.0035 in.
			Limit	0.18 mm	0.0071 in.
Valve lifter	Valve lifter diameter			26.955 — 26.975 mm	1.0612 — 1.0620 in.
	Valve lifter bore diameter			27.010 — 27.030 mm	1.0634 — 1.0642 in.
	Oil clearance		STD	0.035 — 0.075 mm	0.0014 — 0.0030 in.
			Limit	0.10 mm	0.0039 in.
Cylinder block	Cylinder block surface warpage				
			Limit	0.20 mm	0.0079 in.
	Cylinder bore diameter				
	STD	B and 11B	STD 1	95.000 — 95.010 mm	3.7402 — 3.7405 in.
			2	95.011 — 95.020 mm	3.7406 — 3.7409 in.
			3	95.021 — 95.030 mm	3.7410 — 3.7413 in.
			O/S 0.50	95.500 — 95.530 mm	3.7598 — 3.7610 in.
			O/S 0.75	95.750 — 95.780 mm	3.7697 — 3.7709 in.
			O/S 1.00	96.000 — 96.030 mm	3.7795 — 3.7807 in.
		3B and 14B	STD 1	102.000 — 102.010 mm	4.0157 — 4.0161 in.
			2	102.011 — 102.020 mm	4.0162 — 4.0165 in.
			3	102.021 — 102.030 mm	4.0166 — 4.0169 in.
			O/S 0.50	102.500 — 102.530 mm	4.0354 — 4.0366 in.
			O/S 0.75	102.750 — 102.780 mm	4.0453 — 4.0464 in.
			O/S 1.00	103.000 — 103.030 mm	4.0551 — 4.0563 in.
	Limit	B and 11B	STD	95.23 mm	3.7492 in.
			O/S 0.50	95.73 mm	3.7689 in.
			O/S 0.75	95.98 mm	3.7787 in.
			O/S 1.00	96.23 mm	3.7886 in.
		3B and 14B	STD	102.23 mm	4.0248 in.
			O/S 0.50	102.73 mm	4.0445 in.
			O/S 0.75	102.98 mm	4.0543 in.
			O/S 1.00	103.23 mm	4.0642 in.
	Main journal bore		STD 1	75.000 — 75.012 mm	2.9528 — 2.9532 in.
			2	75.013 — 75.024 mm	2.9533 — 2.9537 in.
			U/S 0.25, 0.50, 1.00	75.000 — 75.024 mm	2.9528 — 2.9537 in.
Piston and piston ring	Piston diameter	B	STD 1	94.845 — 94.855 mm	3.7340 — 3.7344 in.
			2	94.855 — 94.865 mm	3.7344 — 3.7348 in.
			3	94.865 — 94.875 mm	3.7348 — 3.7352 in.
			O/S 0.50	95.345 — 95.375 mm	3.7537 — 3.7549 in.
			0.75	95.595 — 95.625 mm	3.7636 — 3.7648 in.
			1.00	95.845 — 95.875 mm	3.7734 — 3.7746 in.
		3B	STD 1	101.800 — 101.810 mm	4.0079 — 4.0083 in.
			2	101.810 — 101.820 mm	4.0083 — 4.0087 in.
			3	101.820 — 101.830 mm	4.0087 — 4.0090 in.
			O/S 0.50	102.300 — 102.330 mm	4.0276 — 4.0287 in.
			0.75	102.550 — 102.580 mm	4.0374 — 4.0386 in.
			1.00	102.800 — 102.830 mm	4.0472 — 4.0484 in.

Specifications (Cont'd)

Piston and piston ring (Cont'd)	Piston diameter	11B	STD 1	94.690 — 94.700 mm	3.7279 — 3.7283 in.
			2	94.700 — 94.710 mm	3.7283 — 3.7287 in.
			3	94.710 — 94.720 mm	3.7287 — 3.7291 in.
			O/S 0.50	95.190 — 95.220 mm	3.7476 — 3.7488 in.
			0.75	95.440 — 95.470 mm	3.7575 — 3.7587 in.
			1.00	95.690 — 95.720 mm	3.7673 — 3.7685 in.
		14B	STD 1	101.760 — 101.770 mm	4.0063 — 4.0067 in.
			2	101.770 — 101.780 mm	4.0067 — 4.0071 in.
			3	101.780 — 101.790 mm	4.0071 — 4.0075 in.
			O/S 0.50	102.260 — 102.290 mm	4.0260 — 4.0272 in.
			0.75	102.510 — 102.540 mm	4.0358 — 4.0370 in.
			1.00	102.760 — 102.790 mm	4.0457 — 4.0468 in.
	Piston oil clearance				
	STD	B		0.145 — 0.165 mm	0.0057 — 0.0065 in.
		3B		0.190 — 0.210 mm	0.0075 — 0.0083 in.
		11B		0.300 — 0.320 mm	0.0118 — 0.0126 in.
		14B		0.230 — 0.250 mm	0.0091 — 0.0098 in.
	Limit	B		0.22 mm	0.0087 in.
		3B		0.26 mm	0.0102 in.
		11B		0.37 mm	0.0146 in.
		14B		0.30 mm	0.0118 in.
	Piston ring groove clearance				
		No. 1	B	0.059 — 0.089 mm	0.0023 — 0.0035 in.
			3B	0.061 — 0.091 mm	0.0024 — 0.0036 in.
			11B and 14B	0.062 — 0.092 mm	0.0024 — 0.0036 in.
		No. 2	B	0.05 — 0.09 mm	0.0020 — 0.0035 in.
			3B, 11B and 14B	0.04 — 0.08 mm	0.0016 — 0.0031 in.
		Oil		0.03 — 0.07 mm	0.0012 — 0.0028 in.
	Piston ring end gap				
	STD	No. 1	B and 11B	0.35 — 0.64 mm	0.0138 — 0.0252 in.
			3B and 14B	0.30 — 0.54 mm	0.0118 — 0.0213 in.
		No. 2	B and 11B	0.35 — 0.64 mm	0.0138 — 0.0252 in.
			3B and 14B	0.45 — 0.69 mm	0.0177 — 0.0272 in.
		Oil	B and 11B	0.35 — 0.64 mm	0.0138 — 0.0252 in.
			3B and 14B	0.40 — 0.69 mm	0.0157 — 0.0272 in.
	Limit	No. 1	B and 11B	1.44 mm	0.0567 in.
			3B and 14B	1.34 mm	0.0528 in
		No. 2	B and 11B	1.44 mm	0.0567 in.
			3B and 14B	1.49 mm	0.0587 in.
		Oil	B and 11B	1.44 mm	0.0567 in.
			3B and 14B	1.49 mm	0.0587 in.
Connecting rod	Thrust clearance		STD	0.200 — 0.320 mm	0.0079 — 0.0126 in.
			Limit	0.40 mm	0.0157 in.
	Bushing inside diameter		B	29.009 — 29.019 mm	1.1421 — 1.1425 in.
			3B, 11B and 14B	32.009 — 32.019 mm	1.2602 — 1.2606 in.
	Piston pin diameter		B	29.000 — 29.010 mm	1.1417 — 1.1421 in.
			3B, 11B and 14B	32.000 — 32.010 mm	1.2598 — 1.2602 in.
	Piston pin oil clearance			0.004 — 0.014 mm	0.0002 — 0.0006 in.
				0.05 mm	0.0020 in.
	Big end inner diameter				
	B		STD 1	62.000 — 62.010 mm	2.4409 — 2.4413 in.
			2	62.011 — 62.020 mm	2.4414 — 2.4417 in.
			U/S 0.25, 0.50, 1.00	62.000 — 62.010 mm	2.4409 — 2.4413 in.

Specifications (Cont'd)

Connecting rod (Cont'd)	3B, 11B and 14B	STD	1	64.000 — 64.010 mm	2.5197 — 2.5201 in.
			2	64.011 — 64.020 mm	2.5201 — 2.5205 in.
			U/S 0.25, 0.50, 1.00	64.000 — 64.020 mm	2.5197 — 2.5205 in.
	Bend	Limit per 100 mm (3.94 in.)		0.05 mm	0.0020 in.
	Twist	Limit per 100 mm (3.94 in.)		0.15 mm	0.0059 in.
Crankshaft	Thrust clearance		STD	0.040 — 0.250 mm	0.0016 — 0.0098 in.
			Limit	0.40 mm	0.0157 in.
	Thrust washer thickness		STD	2.430 — 2.480 mm	0.0957 — 0.0976 in.
			O/S 0.125	2.493 — 2.543 mm	0.0981 — 0.1001 in.
			O/S 0.250	2.555 - 2.605 mm	0.1006 — 0.1026 in.
	Main journal diameter				
	No. 1, 2, 4 and 5 journal		STD	69.98 — 70.00 mm	2.7551 — 2.7559 in.
			U/S 0.25	69.74 — 69.75 mm	2.7457 — 2.7461 in.
			U/S 0.50	69.49 — 69.50 mm	2.7358 — 2.7362 in.
			U/S 1.00	68.99 — 69.00 mm	2.7161 — 2.7165 in.
	No. 3 journal		STD	69.95 — 69.97 mm	2.7539 — 2.7547 in.
			U/S 0.25	69.71 — 69.72 mm	2.7445 — 2.7449 in.
			U/S 0.50	69.46 — 69.47 mm	2.7346 — 2.7350 in.
			U/S 1.00	68.96 — 68.97 mm	2.7150 — 2.7153 in.
	Main journal oil clearance				
	No. 1, 2, 4 and 5 journal		STD	0.030 — 0.074 mm	0.0012 — 0.0029 in.
			Limit	0.15 mm	0.0059 in.
	No. 3 journal		STD	0.060 — 0.104 mm	0.0024 — 0.0041 in.
			Limit	0.20 mm	0.0079 in.
	Main bearing center wall thickness				
		STD	Yellow	2.480 — 2.485 mm	0.0976 — 0.0978 in.
			Green	2.486 — 2.490 mm	0.0979 — 0.0980 in.
		U/S	0.25	2.605 — 2.615 mm	0.1026 — 0.1030 in.
			0.50	2.730 — 2.740 mm	0.1075 — 0.1079 in.
			1.00	2.980 — 2.990 mm	0.1173 — 0.1177 in.
	Crank pin diameter				
	B	STD		58.980 — 59.000 mm	2.3220 — 2.3228 in.
		U/S	0.25	58.740 — 58.750 mm	2.3126 — 2.3130 in.
			0.50	58.490 — 58.500 mm	2.3028 — 2.3031 in.
			1.00	57.990 — 58.000 mm	2.2831 — 2.2835 in.
	3B, 11B and 14B	STD		60.980 — 61.000 mm	2.4008 — 2.4016 in.
		U/S	0.25	60.740 — 60.750 mm	2.3913 — 2.3917 in.
			0.50	60.490 — 60.500 mm	2.3815 — 2.3819 in.
			1.00	59.990 — 60.000 mm	2.3618 — 2.3622 in.
	Crank pin oil clearance	STD		0.030 — 0.070 mm	0.0012 — 0.0028 in.
		Limit		0.10 mm	0.0039 in.
	Crank pin (connecting rod) bearing center wall thickness				
		STD	Yellow	1.480 — 1.485 mm	0.0583 — 0.0585 in.
			Green	1.486 — 1.490 mm	0.0585 — 0.0587 in.
		U/S	0.25	1.605 — 1.615 mm	0.0632 — 0.0636 in.
			0.50	1.730 — 1.740 mm	0.0681 — 0.0685 in.
			1.00	1.980 — 1.990 mm	0.0780 — 0.0783 in.
	Circle runout		Limit	0.08 mm	0.0031 in.
	Taper and out-of round				
	Main journal and crank pin		Limit	0.02 mm	0.0008 in.

Torque Specifications

Part tightened		kg-cm	ft-lb	N·m
Cylinder head × Cylinder block	1st	500	~ 36	49
	2nd	90°		
	3rd	90°		
Cylinder block × Main bearing cap		2,000	145	196
Cylinder block × Timing gear case	12 mm bolt head	185	13	18
	14 mm bolt head	375	27	37
Cylinder block × Camshaft thrust plate		185	13	18
Cylinder block × Idle gear		475	34	47
Cylinder block × Oil Strainer		185	13	18
Cylinder block × Oil outlet pipe		500	36	49
Cylinder block × Oil jet (for timing gear)		130	9	13
Timing gear case × No. 1 oil pipe		110	8	11
Timing gear case × Oil Strainer		185	13	18
Timing gear case × Oil outlet pipe		185	13	18
Connecting rod × Connecting rod cap				
1st	B	550	40	54
	3B, 11B and 14B	700	51	69
2nd		90°		
Crankshaft × flywheel	M/T	1,800	130	177
	A/T	1,200	87	118
Camshaft × Camshaft timing gear		375	27	37
Rocker arm × Adjusting screw		185	13	18
Rocker arm support × Rocker arm shaft		75	65 in.-lb	7.4

FUEL SYSTEM

Specifications

Injection nozzle (B, 3B)	Nozzle type	ND-DN 4 SDND 142	
	Nozzle opening pressure	See page A-2	
	Pressure adjusting shim thickness	1.00 mm	0.0394 in.
		1.05 mm	0.0413 in.
		1.10 mm	0.0433 in.
		1.15 mm	0.0453 in.
		1.20 mm	0.0472 in.
		1.25 mm	0.0492 in.
		1.30 mm	0.0512 in.
		1.35 mm	0.0531 in.
		1.40 mm	0.0551 in.
		1.45 mm	0.0571 in.
		1.50 mm	0.0591 in.
		1.55 mm	0.0610 in.
		1.60 mm	0.0630 in.
		1.65 mm	0.0650 in.
		1.70 mm	0.0669 in.
		1.75 mm	0.0689 in.
		1.80 mm	0.0709 in.
		1.85 mm	0.0728 in.
		1.90 mm	0.0748 in.
		1.95 mm	0.0768 in.

FUEL SYSTEM

Specifications

Injection nozzle 11B, 14B	Nozzle type	11B	ND-DLLA 150P61	
		14B	ND-DLLA150P59	
	Nozzle opening pressure		See page A-2	
	Pressure adjusting shim thickness		0.700 mm	0.0276 in.
			0.750 mm	0.0295 in.
			0.800 mm	0.0315 in.
			0.850 mm	0.0335 in.
			0.900 mm	0.0354 in.
			0.950 mm	0.0374 in.
			0.975 mm	0.0384 in.
			1.000 mm	0.0394 in.
			1.025 mm	0.0404 in.
			1.050 mm	0.0413 in.
			1.075 mm	0.0423 in.
			1.100 mm	0.0433 in.
			1.125 mm	0.0443 in.
			1.150 mm	0.0453 in.
			1.175 mm	0.0463 in.
			1.200 mm	0.0472 in.
			1.225 mm	0.0482 in.
			1.250 mm	0.0492 in.
			1.275 mm	0.0502 in.
			1.300 mm	0.0512 in.
			1.325 mm	0.0522 in.
			1.350 mm	0.0531 in.
			1.375 mm	0.0541 in.
			1.400 mm	0.0551 in.
			1.425 mm	0.0561 in.
			1.450 mm	0.0571 in.
			1.475 mm	0.0581 in.
			1.500 mm	0.0591 in.
			1.550 mm	0.0610 in.
			1.600 mm	0.0630 in.
			1.650 mm	0.0650 in.
			1.700 mm	0.0669 in.
			1.750 mm	0.0689 in.
			1.800 mm	0.0709 in.

FUEL SYSTEM

Injection pump	Direction of rotation		Clockwise as seen from drive side	
	Injection order		1 — 3 — 4 — 2 (A — B — C — D)	
	Adjusting lever moving angle		42 — 52°	
	Roller height variation		0.02 mm	0.0008 in.
	Plunger spring			
	Free length	STD	30.0 mm	1.181 in.
		Limit	29.5 mm	1.161 in.
	Squareness	Limit	2.0 mm	0.079 in.
	Delivery valve spring			
	Free length	STD	24.4 mm	0.961 in.
		Limit	23.5 mm	0.925 in.
	Governor shaft protrusion		2.0 — 2.5 mm	0.079 — 0.098 in.
	Flyweight holder thrust clearance		0.15 — 0.35 mm	0.0059 — 0.0138 in.
	Plunger spring shim thickness		0.5 mm	0.020 in.
			0.8 mm	0.031 in.
			1.0 mm	0.039 in.
			1.2 mm	0.047 in.
			1.5 mm	0.059 in.
			1.8 mm	0.071 in.
			2.0 mm	0.079 in.
	Plunger adjusting shim thickness		1.9 mm	0.075 in.
			2.0 mm	0.079 in.
			2.1 mm	0.083 in.
			2.2 mm	0.087 in.
			2.3 mm	0.091 in.
			2.4 mm	0.094 in.
			2.5 mm	0.098 in.
			2.6 mm	0.102 in.
			2.7 mm	0.106 in.
			2.8 mm	0.110 in.
			2.9 mm	0.114 in.
	Governor gear adjusting washer thickness		1.05 mm	0.0413 in.
			1.25 mm	0.0492 in.
			1.45 mm	0.0571 in.
			1.65 mm	0.0650 in.
			1.85 mm	0.0728 in.
	Governor sleeve plug head thickness		3.0 mm	0.118 in.
			3.1 mm	0.122 in.
			3.2 mm	0.126 in.
			3.3 mm	0.130 in.
			3.4 mm	0.134 in.
			3.5 mm	0.138 in.
			3.6 mm	0.142 in.
			3.7 mm	0.146 in.
			3.8 mm	0.150 in.
			3.9 mm	0.154 in.
			4.0 mm	0.157 in.
			4.1 mm	0.161 in.
			4.2 mm	0.165 in.

Injection Pump Adjustment and Test

Preparations of pump tester	Test nozzle type			DN 12 SD 12	
	Test nozzle opening pressure			145 — 155 kg/cm² (2,062 — 2,205 psi, 14,220 — 15,200 kPa)	
	Injection pipe	Outer diameter		6.0 mm	0.236 in.
		Inner diameter		2.0 mm	0.079 in.
		Length		840 mm	33.07 in
		Minimum bending radius		More than 25 mm (0.98 in.)	
	Fuel temperature			40 — 45°C	104 — 113°F
	Fuel feeding pressure			0.2 kg/cm²	2.8 psi 20 kPa
	Fuel cut solenoid voltage			12V or 24V	

Pre-setting	Full load injection volume	Item		Pump revolution (rpm)	No. of measuring stroke	Injection volume cc (cu in.)
		B	w/ HAC	1,100	200	8.95 — 9.25 (0.55 — 0.56)
			Others			9.35 — 9.65 (0.57 — 0.59)
		3B	w/ HAC			10.45 — 10.75 (0.64 — 0.66)
			Europe			11.45 — 11.75 (0.70 — 0.72)
			Others			10.85 — 11.15 (0.66 — 0.68)
		11B	w/ HAC			11.35 — 11.95 (0.69 — 0.73)
			Europe			11.75 — 12.35 (0.72 — 0.75)
			Others			11.95 — 12.55 (0.73 — 0.77)
		14B	Hong Kong General BU China			13.75 — 14.15 (0.84 — 0.86)
			Australia A/T Europe Portugal			15.45 — 16.05 (0.94 — 0.98)
			w/ HAC			13.15 — 13.75 (0.80 — 0.84)
	Maximum speed	Item		Pump revolution (rpm)	No. of measuring stroke	Injection volume cc (cu in.)
		B		2,050	200	4.5 — 5.6 (0.27 — 0.34)
		3B		2,050		3.5 — 4.9 (0.21 — 0.30)
		11B, 14B		2,075		3.4 — 5.8 (0.21 — 0.35)
	Pump inner pressure	Item		Pump revolution (rpm)	Inner pressure kg/cm² (psi, kPa)	
		B, 3B		400	2.2 — 2.8 (31 — 40, 216 — 275)	
				1,900	6.8 — 7.4 (97 — 105, 667 — 726)	
		11B, 14B		400	2.2 — 2.8 (31 — 40, 216 — 275)	
				1,700	6.8 — 7.4 (97 — 105, 667 — 726)	

Injection Pump Adjustment and Test (Cont'd)

Pre-setting (cont'd)	Overflow volume	Item	Pump revolution (rpm)	Overflow volume cc/min. (cu in./min.)
		B, 3B	1,800	366 — 800 (22.3 — 48.8)
		11B, 14B	400	250 — 683 (15.3 — 41.7)

Automatic timer	Item		Pump revolution (rpm)	Piston strokes mm (in.)
	B		650	0.9 — 1.9 (0.035 — 0.075)
			1,100	3.5 — 4.5 (0.138 — 0.177)
			1,600	6.4 — 7.4 (0.252 — 0.291)
			1,900	7.3 — 8.3 (0.287 — 0.327)
	3B		700	0.1 — 1.1 (0.004 — 0.043)
			1,100	2.7 — 3.7 (0.106 — 0.146)
			1,400	4.6 — 5.6 (0.181 — 0.220)
			1,900	6.9 — 7.9 (0.272 — 0.311)
	11B	w/ LST	1,360	0.6 — 1.7 (0.024 — 0.067)
			1,560	3.1 — 4.2 (0.122 — 0.165)
			1,700	4.5 — 5.6 (0.177 — 0.220)
			2,000	4.5 — 5.6 (0.177 — 0.220)
		w/o LST	1,360	0.6 — 1.6 (0.024 — 0.063)
			1,560	3.1 — 4.1 (0.122 — 0.161)
			1,700	4.5 — 5.5 (0.177 — 0.217)
			2,000	4.5 — 5.5 (0.177 — 0.217)
	14B	Europe	1,260	0.6 — 1.6 (0.024 — 0.063)
			1,460	3.1 — 4.1 (0.122 — 0.161)
			1,600	4.5 — 5.5 (0.177 — 0.217)
			1,900	4.5 — 5.5 (0.177 — 0.217)
		Australia	1,360	1.9 — 2.9 (0.075 — 0.114)
			1,460	3.1 — 4.1 (0.122 — 0.161)
			1,600	4.5 — 5.5 (0.177 — 0.217)
			1,900	4.5 — 5.5 (0.177 — 0.217)
		Others	1,000	0.3 — 1.3 (0.012 — 0.051)
			1,550	4.5 — 5.5 (0.177 — 0.217)
			1,700	5.5 — 6.5 (0.217 — 0.256)
			1,900	5.5 — 6.5 (0.217 — 0.256)

Injection Pump Adjustment and Test (Cont'd)

Full load injection volume	Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)
	B	w/ HAC	Plus 21-31°	1,100	200	8.95 — 9.25 (0.55 — 0.56)
		Others				9.35 — 9.65 (0.57 — 0.59)
	3B	w/ HAC				10.45 — 10.75 (0.64 — 0.66)
		Europe				11.45 — 11.75 (0.70 — 0.72)
		Others				10.85 — 11.15 (0.66 — 0.68)
	11B	w/ HAC				11.35 — 11.95 (0.69 — 0.73)
		Europe				11.75 — 12.35 (0.72 — 0.75)
		Others				11.95 — 12.55 (0.73 — 0.77)
	14B	Hong Kong General BU China				13.75 — 14.15 (0.84 — 0.86)
		Australia A/T Europe Portugal				15.45 — 16.05 (0.94 — 0.98)
		w/ HAC				13.15 — 13.75 (0.86 — 0.84)

Maximum speed	Item	Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
	B	Plus 21-31°	2,050	200	4.4 — 5.6 (0.27 — 0.34)	Adjust
			2,200		Less than 1.2 (0.07)	—
	3B		2,050		3.5 — 4.9 (0.21 — 0.30)	Adjust
			2,200		Less than 1.2 (0.07)	—
	11B, 14B		2,075		3.4 — 5.8 (0.21 — 0.35)	Adjust
			2,400		Less than 1.2 (0.07)	—

Injection Pump Adjustment and Test (Cont'd)

Injection volume	Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
	B	w/ HAC	Plus 21-31°	1,100	200	8.95 — 9.25 (0.55 — 0.56)	0.4 (0.02)	Basic full load injection volume
				100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
				400		8.3 — 10.7 (0.51 — 0.65)	—	—
				500		7.0 — 8.4 (0.43 — 0.51)	0.5 (0.03)	—
				1,800		7.95 — 9.45 (0.49 — 0.58)		
				1,950		7.1 — 10.0 (0.43 — 0.61)	—	—
		Others		1,100		9.35 — 9.65 (0.57 — 0.59)	0.4 (0.02)	Basic full load injection volume
				100		12.7 — 1.65 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
				400		8.9 — 11.3 (0.54 — 0.69)	—	—
				500		7.6 — 9.0 (0.46 — 0.55)	0.5 (0.03)	—
				1,800		8.75 — 10.25 (0.53 — 0.63)		
				1,950		7.5 — 10.0 (0.46 — 0.61)	—	—
	3B	w/ HAC		1,100		10.45 — 10.75 (0.64 — 0.66)	0.4 (0.02)	Basic full load injection volume
				100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
				400		9.8 — 12.2 (0.60 — 0.74)	—	—
				500		8.6 — 10.0 (0.52 — 0.61)	0.5 (0.03)	—
				1,750		9.2 — 10.8 (0.56 — 0.66)		
				1,950		7.3 — 10.1 (0.45 — 0.62)	—	—
		Europe		1,100		11.45 — 11.75 (0.70 — 0.72)	0.4 (0.02)	Basic full load injection volume
				100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
				400		11.4 — 13.4 (0.70 — 0.82)	—	—
				500		10.2 — 11.3 (0.63 — 0.69)	0.5 (0.03)	—
				1,750		10.5 — 11.7 (0.64 — 0.71)		
				1,950		8.3 — 10.1 (0.51 — 0.62)	—	—
		Others		1,100		10.85 — 11.15 (0.66 — 0.68)	0.4 (0.02)	Basic full load injection volume
				100		12.7 — 16.5 (0.78 — 1.01)	1.2 (0.07)	Volume during starting
				400		10.4 — 12.8 (0.63 — 0.78)	—	—
				500		9.2 — 10.6 (0.56 — 0.65)	0.5 (0.03)	—
				1,750		9.7 — 11.3 (0.59 — 0.69)		
				1,950		7.7 — 10.1 (0.47 — 0.62)	—	—
	11B	w/ HAC		1,100		11.35 — 11.95 (0.70 — 0.73)	0.7 (0.04)	Basic full load injection volume
				100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
				350		9.0 — 13.0 (0.55 — 0.79)	—	—
				500		8.1 — 9.7 (0.49 — 0.59)	0.7 (0.04)	—
				700		9.1 — 10.7 (0.56 — 0.65)		
				1,800		8.9 — 10.5 (0.54 — 0.64)		
		Europe		1,100		11.75 — 12.35 (0.72 — 0.75)	0.7 (0.04)	Basic full load injection volume
				100		14.6 — 19.4 (0.89 — 1.18)	1.3 (0.08)	Volume during starting
				350		9.0 — 13.0 (0.55 — 0.79)	—	—
				500		8.0 — 9.2 (0.49 — 0.56)	0.7 (0.04)	—
				700		9.8 — 11.0 (0.60 — 0.67)		
				900		11.0 — 12.2 (0.67 — 0.74)		
				1,300		11.8 — 13.0 (0.72 — 0.79)		
				1,800		10.4 — 11.6 (0.63 — 0.71)		

Injection Pump Adjustment and Test (Cont'd)

Injection volume (cont'd)	Item		Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cu in.)	Remarks
	11B	Others	Plus 21-31°	1,100	200	11.95 — 12.55 (0.73 — 0.77)	0.7 (0.04)	Basic full load injection volume
				100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
				350		9.4 — 13.4 (0.57 — 0.82)	—	—
				500		8.5 — 10.1 (0.52 — 0.62)	0.7 (0.04)	—
				700		9.6 — 11.2 (0.59 — 0.68)		
				1,800		9.4 — 11.0 (0.57 — 0.67)		
	14B	Portugal		1,100		15.45 — 16.05 (0.94 — 0.98)	0.7 (0.04)	Basic full load injection volume
				100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
				500		11.1 — 12.3 (0.68 — 0.75)	0.7 (0.04)	—
				700		12.3 — 13.5 (0.75 — 0.82)		
				900		14.1 — 15.3 (0.86 — 0.93)		
				1,300		14.8 — 16.0 (0.90 — 0.98)		
				1,700		13.6 — 14.8 (0.83 — 0.90)		
		Hong Kong General		1,100		13.75 — 14.15 (0.84 — 0.86)	0.7 (0.04)	Basic full load injection volume
				100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
				500		11.2 — 12.4 (0.68 — 0.76)	0.7 (0.04)	—
				700		11.9 — 13.1 (0.73 — 0.80)		
				1,700		13.1 — 14.3 (0.80 — 0.87)		
		BU China		1,100		13.75 — 14.15 (0.84 — 0.86)	0.7 (0.04)	Basic full load injection volume
				100		16.6 — 21.4 (1.01 — 1.31)	1.3 (0.08)	Volume during starting
				500		11.2 — 12.4 (0.68 — 0.76)	0.7 (0.04)	—
				700		11.9 — 13.1 (0.73 — 0.80)		
				1,700		13.1 — 14.3 (0.80 — 0.87)		
		Australia A/T Europe		1,100		15.45 — 16.05 (0.94 — 0.98)	0.7 (0.04)	Basic full load injection volume
				100		16.6 — 21.4 (1.01 — 1.31)	1.3 (0.08)	Volume during starting
				500		11.1 — 12.3 (0.68 — 0.75)	0.7 (0.04)	—
				700		12.3 — 13.5 (0.75 — 0.82)		
				900		14.1 — 15.3 (0.86 — 0.93)		
				1,300		14.8 — 16.0 (0.90 — 0.98)		
				1,700		13.6 — 14.8 (0.83 — 0.90)		
		w/ HAC		1,100		13.15 — 13.75 (0.80 — 0.84)	0.7 (0.04)	Basic full load injection volume
				100		12.6 — 17.4 (0.77 — 1.06)	1.3 (0.08)	Volume during starting
				500		10.4 — 12.0 (0.63 — 0.71)	0.7 (0.04)	—
				700		11.2 — 12.8 (0.68 — 0.78)		
				1,700		11.9 — 13.5 (0.73 — 0.82)		

Injection Pump Adjustment and Test (Cont'd)

Load sensing timer	Item	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
	B	1,400	200	Full injection volume minus 1.2 (0.07) ± 0.5 (0.03)	Set to starting point
	3B			Full injection volume minus 1.2 (0.07) ± 0.6 (0.04)	
	11B	1,360		Full injection volume minus 3.6 (0.22) ± 0.5 (0.03)	
	14B			Full injection volume minus 1.0 (0.06) ± 0.5 (0.04)	
	B	1,400		5.7 — 6.1 (0.35 — 0.37)	Confirm end point
	3B			8.8 — 9.2 (0.54 — 0.56)	
	11B	1,360		8.0 — 8.4 (0.49 — 0.51)	
	14B			11.2 — 11.6 (0.68 — 0.71)	
	Item	Pump revolution (rpm)	Timer piston fluctuation		Remarks
	B	1,400	2.7 — 3.9 mm 0.106 — 0.154 in.		Confirm
	3B		2.2 — 2.8 mm 0.087 — 0.110 in.		
	11B	1,360	0.5 — 1.5 mm 0.020 — 0.059 in.		
	14B		1.1 — 1.8 mm 0.043 — 0.071 in.		

Idle speed set	Item	Adjusting lever angle	Pump revolution (rpm)	No. of measuring strokes	Injection volume cc (cu in.)	Remarks
	B	Minus 10.5 — 20.5°	325	1,000	9.25 — 13.25 (0.56 — 0.81)	—
			500		Less than 4 (0.24)	
	3B	Minus 12 — 22°	325		10 — 15 (0.61 — 0.92)	—
			500		Less than 4 (0.24)	
	11B		325	200	q = 3.8 — 4.2 (0.23 — 0.26)	Lever Set
			325		q Plus 0.2 — 0.4 (0.01 — 0.02)	Dash Pot Set
			325		1.1 — 2.7 (0.07 — 0.16)	Lever Set
	14B		325		q = 9.2 — 10.8 (0.56 — 0.66)	Lever Set
			450		q Minus 4.2 — 6.6 (0.26 — 0.40)	
			325		q = 3.8 — 4.2 (0.23 — 0.26)	Lever Set
			325		q Plus 0.2 — 0.4 (0.01 — 0.02)	Dash Pot Set
			325		1.1 — 2.7 (0.07 — 0.16)	Lever Set

Torque Specifications

Part tightened		kg-cm	ft-lb	N·m
Cylinder head × Injection nozzle	B and 3B	700	51	69
	11B and 14B	185	13	18
Injection pump × Injection pipe		250	18	25
Injection pump × Fuel pipe		250	18	25
Injection pump × No. 2 leakage pipe		250	18	25
Injection nozzle × No. 1 leakage pipe	B and 3B	450	33	44
	11B and 14B	250	18	25
Injection nozzle × Injection pipe		250	18	25
Injection pump × Distributive head bolt	B and 3B	170	12	17
	11B and 14B	260	19	25
Injection pump × Delivery holder		550	40	54

COOLING SYSTEM

Specifications

Engine coolant capacity		See page A-2	
Thermostat	Valve opening temperature		
	82°C type	80 — 84°C	176 — 183°F
	88°C type	86 — 90°C	187 — 194°F
	Valve opening travel		
	82°C type at 95°C (203°F)	10 mm (0.39 in.) or more	
	88°C type at 100°C (212°F)	10 mm (0.39 in.) or more	
Radiator	Relief valve opening pressure		
	STD	0.75 — 1.05 kg/cm² (10.7 — 14.9 psi, 74 — 103 kPa)	
	Limit	0.6 kg/cm²	8.5 psi 59 kPa

LUBRICATION SYSTEM

Specifications

Engine oil capacity		See page A-2	
Oil pressure	at idle	0.3 kg/cm² (4.3 psi, 29 kPa) or more	
	at 3,000 rpm	2.5 — 6.0 kg/cm² (36 — 85 psi, 245 — 588 kPa)	
Oil Pump	Rotor body clearance STD	0.144 — 0.220 mm	0.0057 — 0.0087 in.
	Limit	0.40 mm	0.0157 in.
	Rotor side clearance STD	0.035 — 0.090 mm	0.0014 — 0.0035 in.
	Limit	0.15 mm	0.0059 in.
	Rotor tip clearance STD	0.110 — 0.240 mm	0.0043 — 0.0094 in.
	Limit	0.30 mm	0.0118 in.
	Drive spline to rotor backlash	0.541 — 0.790 mm	0.0213 — 0.0311 in.
		1.00 mm	0.0394 in.

STARTING SYSTEM

Pre-heating system	Light lighting time 3B (Super glow type) 12 V 24 V B and 3B (Fixed delay type) 11B and 14B (at below 0°C (32°F))			Approx. 3.3 seconds Approx. 2.5 seconds 15 — 19.5 seconds 5 seconds
Starter	Rated voltage and output power		12 V 2.5 kw	24 V 4.5 kw
	No-load characteristic	Ampere rpm	180 A or less at 11 V 3,500 rpm or more	90 A or less at 23 V ←
	Brush length	STD Limit	20.5 mm 0.807 in. 13.0 mm 0.512 in.	← ←
	Spring installed load	STD	3.2 — 4.0 kg (7.1 — 8.8 lb, 31 — 39 N)	←
	Commutator Outer diameter	STD Limit	36 mm 1.42 in. 35 mm 1.38 in.	← ←
	Undercut depth	STD Limit	0.7 mm 0.028 in. 0.2 mm 0.008 in.	← ←
	Circle runout	Limit	0.05 mm 0.0020 in.	←

CHARGING SYSTEM

Battery specific gravity			See page A-2	
Drive belt tension or deflection			See page A-2	
Alternator	Rated output		12 V 45 A, 12 V 60 A, 24 V 30 A	
	Rotor coil resistance		2.8 — 3.0 Ω	
	Slip ring diameter	STD Limit	14.4 mm 14.0 mm	0.567 in. 0.551 in.
	Brush exposed length	STD Limit	10.5 mm 4.5 mm	0.413 in. 0.177 in.
Alternator regulator	Regulating voltage 12 V type	at 25°C (77°F) at 135°C (275°F)	13.8 — 14.4 V 12.9 — 14.4 V	
	24 V type	at 25°C (77°F) at 135°C (275°F)	27.7 — 28.7 V 26.0 — 28.7 V	

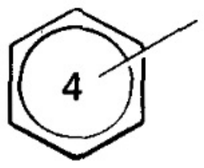
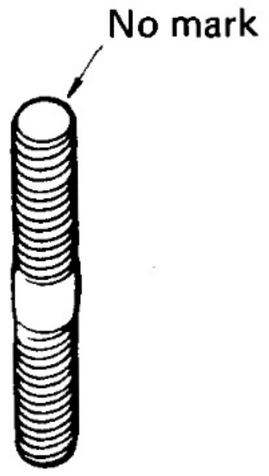
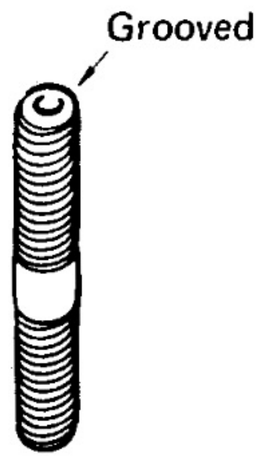
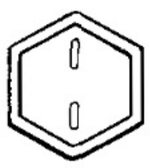
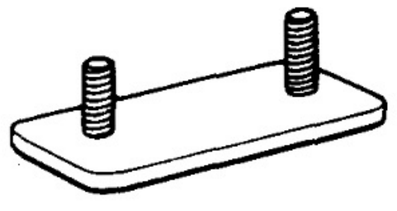
STANDARD BOLT TORQUE SPECIFICATIONS

Page

STANDARD BOLT TORQUE SPECIFICATIONS . . . B-2

STANDARD BOLT TORQUE SPECIFICATIONS

HOW TO DETERMINE BOLT STRENGTH

	Mark		Class		Mark	Class
Hexagon head bolt		Bolt head No. 4– 5– 6– 7–	4T 5T 6T 7T	Stud bolt		4T
		No mark	4T			
Hexagon flange bolt w/ washer hexagon bolt		No mark	4T			6T
Hexagon head bolt		Two protruding lines	5T			
Hexagon flange bolt w/ washer hexagon bolt		Two protruding lines	6T	Welded bolt		4T
Hexagon head bolt		Three protruding lines	7T			

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt			Hexagon flange bolt		
			kg-cm	ft-lb	N·m	kg-cm	ft-lb	N·m
4T	6	1	55	48 in.-lb	5.4	60	52 in.-lb	5.9
	8	1.25	130	9	13	145	10	14
	10	1.25	260	19	25	290	21	28
	12	1.25	480	35	47	540	39	53
	14	1.5	760	55	75	850	61	83
	16	1.5	1,150	83	113		–	
5T	6	1	65	56 in.-lb	6.4		–	
	8	1.25	160	12	16		–	
	10	1.25	330	24	32		–	
	12	1.25	600	43	59		–	
	14	1.5	930	67	91		–	
	16	1.5	1,400	101	137		–	
6T	6	1	80	69 in.-lb	7.8	90	78 in.-lb	8.8
	8	1.25	195	14	19	215	16	21
	10	1.25	400	29	39	440	32	43
	12	1.25	730	53	72	810	59	79
	14	1.5		–		1,250	90	123
7T	6	1	110	8	11	120	9	12
	8	1.25	260	19	25	290	21	28
	10	1.25	530	38	52	590	43	58
	12	1.25	970	70	95	1,050	76	103
	14	1.5	1,500	108	147	1,700	123	167
	16	1.5	2,300	166	226		–	

SST AND SSM

	Page
SST (SPECIAL SERVICE TOOLS)	C-2
SSM (SPECIAL SERVICE MATERIALS)	C-7

SST (SPECIAL SERVICE TOOLS)

HINT: Classification

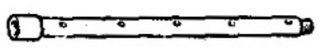
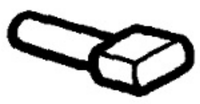
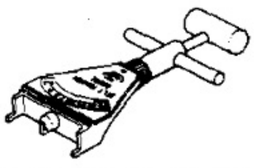
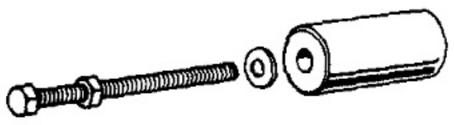
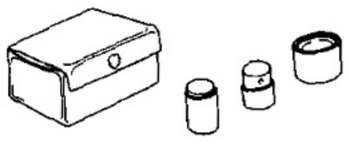
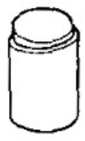
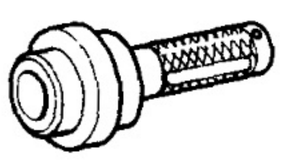
A = SST required for vehicle inspections and minor repairs and multipurpose SST.

B = SST required for major repairs involving disassembly of components.

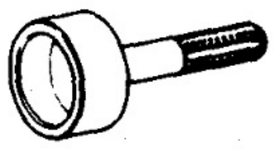
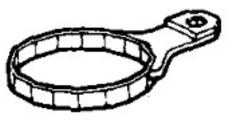
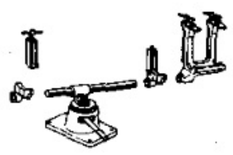
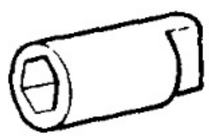
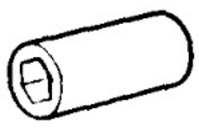
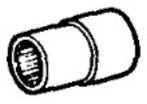
C = SST required for rather special, less frequent work not of classifiable as either A or B.

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH	Note
	09032-00100	(Oil Pan Seal Cutter)	A	●			●			
	09201-60011	(Valve Guide Bushing Remover & Replacer)	A	●						
	09202-43013	(Valve Spring Compressor)	A	●						
	09213-58011	(Crankshaft Pulley Holding Tool)	A	●						
	09213-60017	(Crankshaft Pulley & Gear Pulley Set)	A	●						
	09215-00012	(Camshaft Bearing Remover & Replacer Set)	C	●						
	(09215-00020)	(Gate "B")		●						
	(09215-00440)	(Camshaft Bearing Remover & Replacer)		●						
	(09215-00470)	(Camshaft Bearing Remover & Replacer)		●						
	09215-00100	(Camshaft Bearing Remover & Replacer)	C	●						
	(09215-00130)	(Bolt)		●						

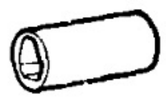
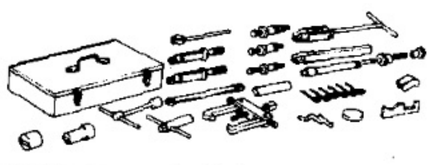
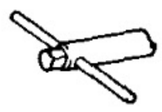
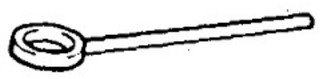
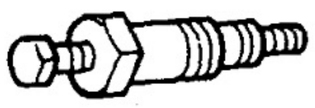
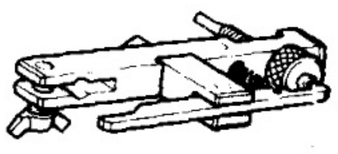
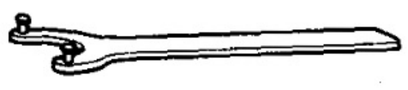
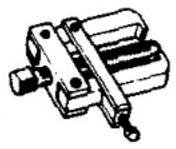
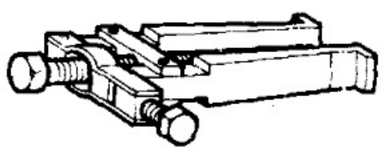
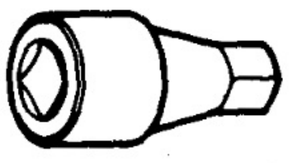
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH	Note
	(09215-00140)	(Nut)		●						
	(09215-00150)	(Shaft "A")		●						
	(09215-00160)	(Pin)		●						
	(09215-00210)	(Remover & Replacer)		●						
	09216-00020	(Belt Tension Gauge)	A	●					●	
	09216-00030	(Belt Tension Cable)	A	●					●	
	09219-56010	(Piston Cooler Remover)	B				●			
	09222-58020	(Connecting Rod Bushing Remover & Replacer)	B	●						3B, 11B and 14B only
	(09222-04015)	(Remover & Replacer)		●						
	(09222-04020)	(Guide)		●						
	(09222-04025)	(Base)		●						
	09222-66010	(Connecting Rod Bushing Remover & Replacer)	B	●						B only
	09223-46011	(Crankshaft Front Oil Seal Replacer)	B	●						

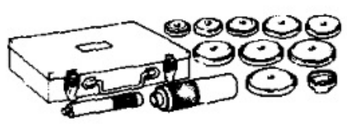
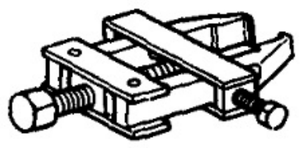
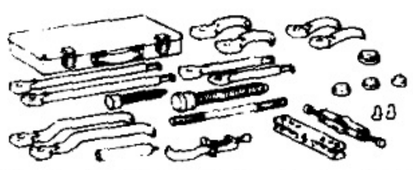
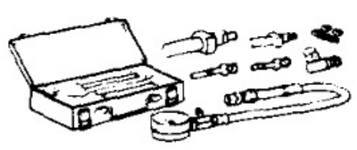
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH	Note
	09223-56010	(Crankshaft Rear Oil Seal Replacer)	B	●						
	09228-10001	(Oil Filter Wrench)	A				●			w/ By-pass element type
	09228-44011	(Oil Filter Wrench)	A				●			
	09228-64010	(Oil Filter Wrench)	A		●					
	09241-76022	(Injection Pump Stand Set)	C		●					
	09245-54010	(Injection Pump Stand Arm)	C		●					
	09268-46012	(Nozzle Holder Body Wrench)	A		●					B, 3B only
	09268-46021	(Nozzle Holder Retaining Nut Wrench)	A		●					B, 3B only
	09260-54012	(Injection Pump Tool Set)	C							
	(09262-54010)	(Distributor Head Plug Wrench)			●					
	(09262-54020)	(Regulator Valve Wrench)			●					
	(09269-54020)	(Socket 14 mm)			●					
	(09269-54030)	(Tweezers)			●					

SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH	Note
	(09269-54040)	Governor Lever Support Bolt Wrench			●					
	09260-58010	Injection Pump Tool Set	C		●					
	(09266-76011)	Automatic Timer Set Nut Wrench			●					
	(09278-46020)	Spline Shaft Holding Tool			●					
	(09267-76011)	Automatic Timer Extractor			●					Injection pump spline shaft
	09275-54010	Plunger Stroke Measuring Tool	A	●						
	09278-54012	Drive Shaft Holding Tool	A	●			●			Camshaft timing gear
	09285-76010	Injection Pump Camshaft Bearing Cone Replacer	C					●	●	
	09286-46011	Injection Pump Spline Shaft puller	C	●				●	●	
	09308-10010	(Oil Seal Puller)	A	●						
	09313-30021	Detent Ball Plug Socket	A				●			
	09330-00021	Companion Flange Holding Tool	A	●						
	09506-35010	Differential Drive Pinion Rear Bearing Replacer	B			●				

SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH	Note
	09608-20012	Front Hub & Drive Pinion Bearing Tool Set	B						●	
	(09608-00030)	(Replacer)							●	
	09608-35014	Axle Hub & Drive Pinion Bearing Tool Set	B	●			●			
	(09608-06040)	Front Hub Inner Bearing Cone Replacer		●			●			Crankshaft timing gear crankshaft pulley Oil pump drive spline
	09820-00021	Alternator Rear Bearing Puller	B						●	
	09820-63010	Alternator Pulley Set Nut Wrench Set	B						●	
	09950-20017	(Universal Puller)	A				●			
	09992-00024	Cylinder Compression Check Gauge Set	A	●						

SSM (SPECIAL SERVICE MATERIALS)

Part Name	Part No.	Sec.	Use etc.
Seal packing or equivalent	08826-000080	EM	Intake manifold Intake heater or flange
		LU	Oil pan Stiffening plate
	08826-00100	EM	Water outlet housing