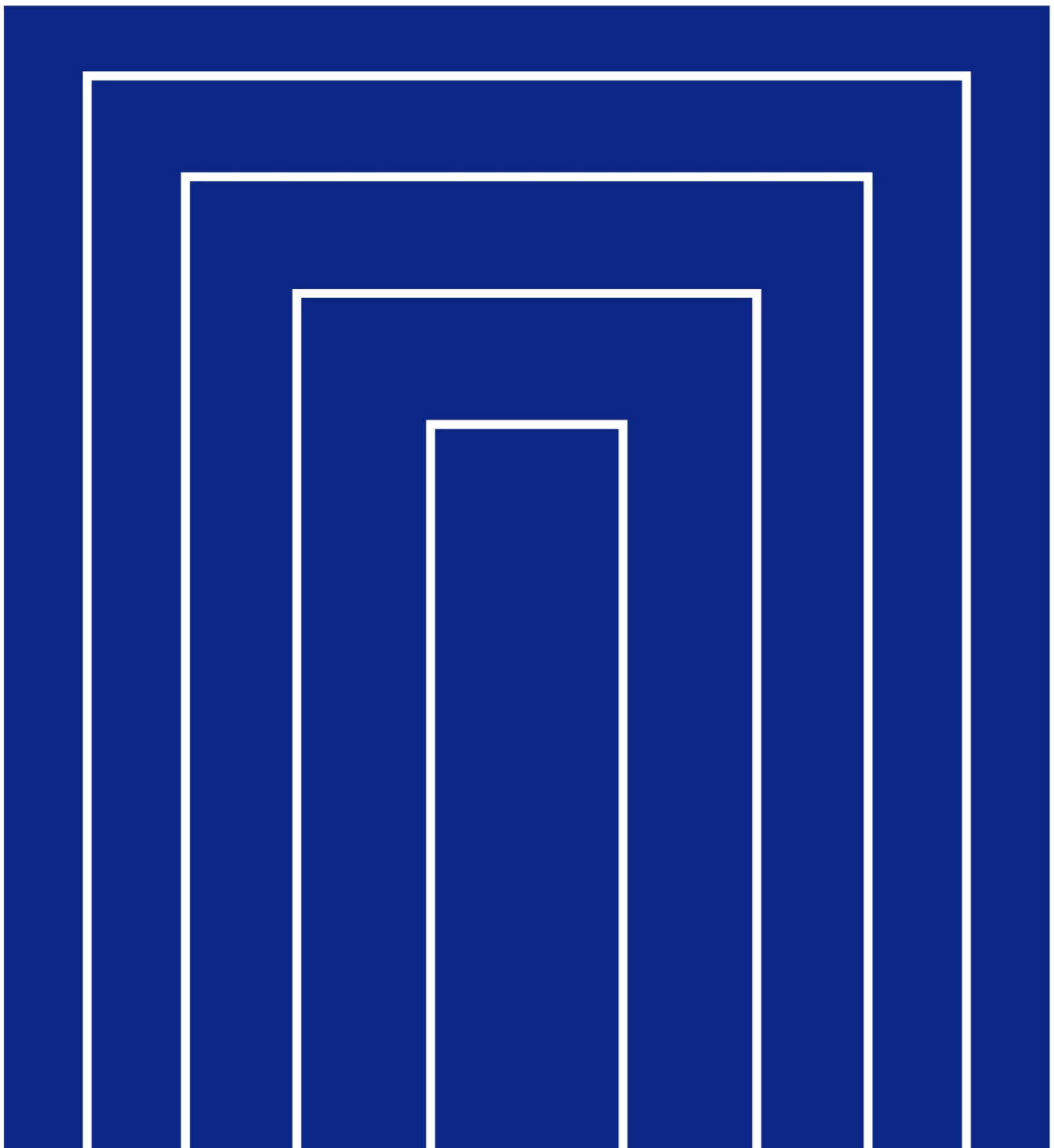
TOYOTA

11B, 13B, 13B-T ENGINE

REPAIR MANUAL

Nov, 1985



Pub. No. RM024E

FOREWORD

This repair manual has been prepared to provide information covering general service repairs for the 11B, 13B and 13B-T engines mounted on the LAND CRUISER, TOYOTA DYNA and COASTER.

Applicable models:
BJ71 series
BJ74 series
BY33 series
BY42 series
BU61 series
BU62 series
BU65 series
BU76 series
BU81 series
BU82 series
BU85 series
BU86 series
BB22 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
11B, 13B, 13B-T ENGINE
REPAIR MANUAL

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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

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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.

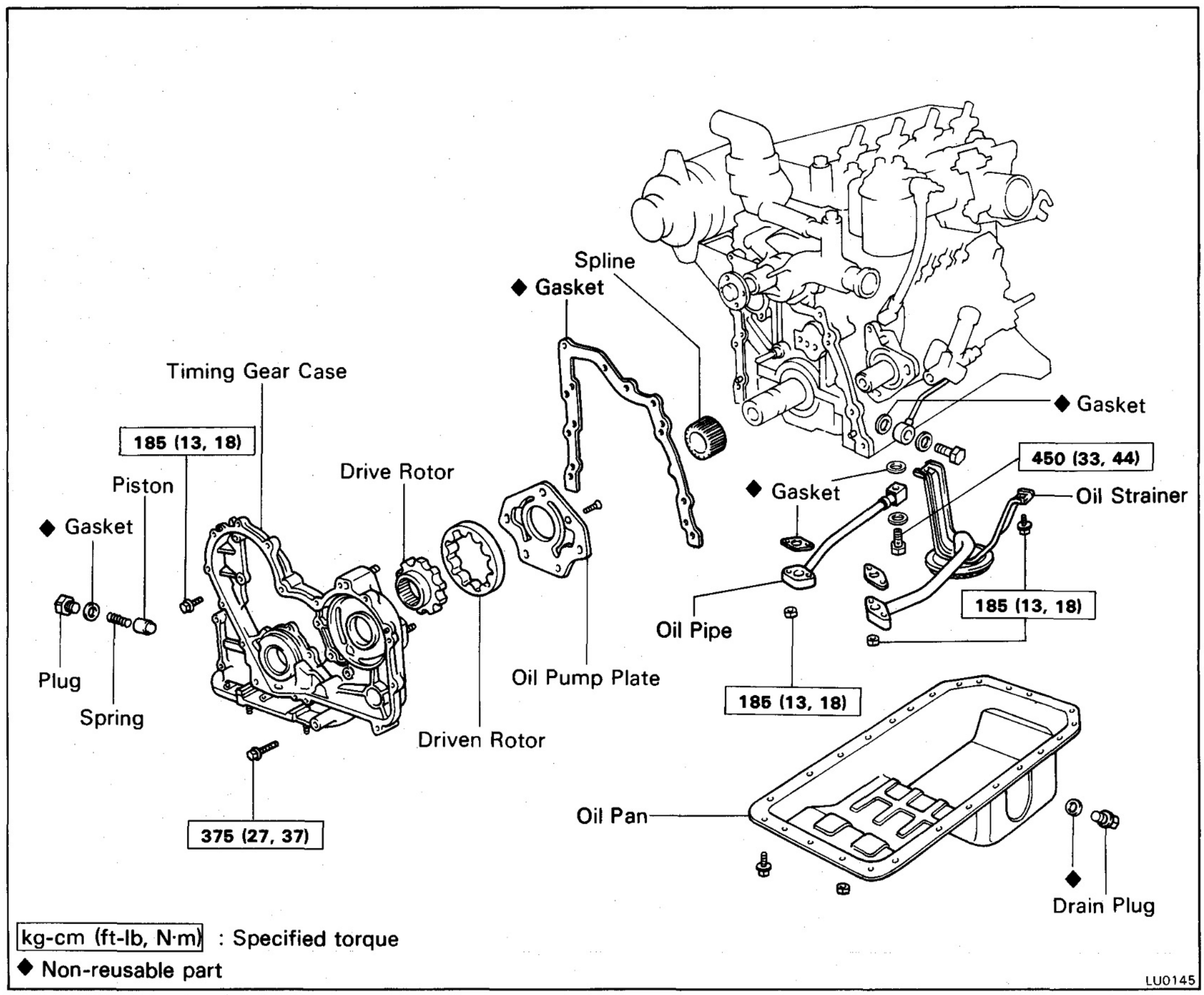
At the beginning of each section, **PRECAUTIONS** are given that pertain to *all* repair operations contained in that section. *Read these precautions before starting any repair task.*

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

4. REMOVE PULLEY SEAT

Using SST and a press, press the shaft of the bearing and remove the pulley seat.

SST 09236-00101 (09237-00010 and 09237-00050)

Set part No. *Component part No.*

Detail text: how to do it

(d) Install and tighten the rod nuts alternately and in two or three passes.

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

Torque Specification

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

REFERENCES

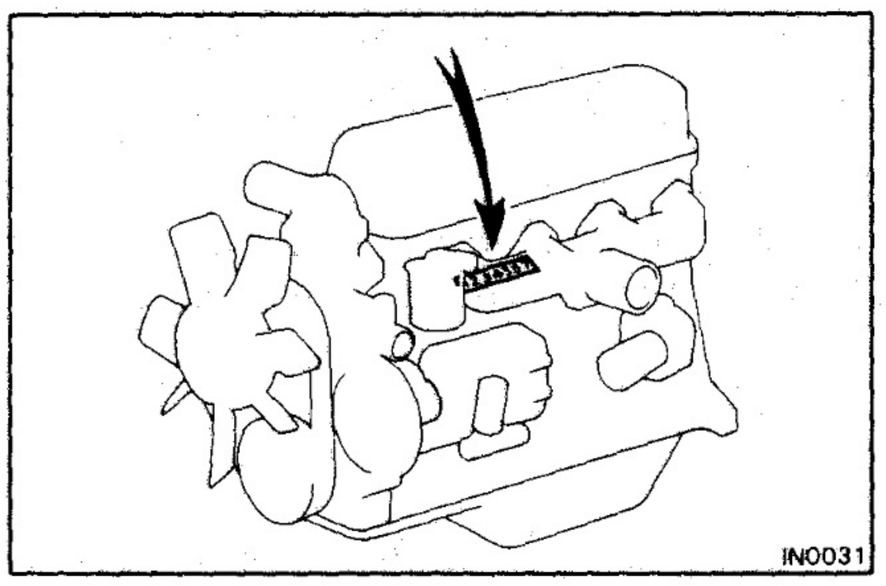
References have been kept to a minimum. However, when they are required you are given the *page* to go to.

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 specifications. All specifications are also found in Aplendix A, specifications, for quick reference.

WARNINGS, CAUTIONS, NOTES:

- WARNINGS are presented in bold type, and indicate the possibility of injury to you or other people.
- CAUTIONS are also presented in bold type and indicate there is a possibility of damage to the components being repaired.
- NOTES 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

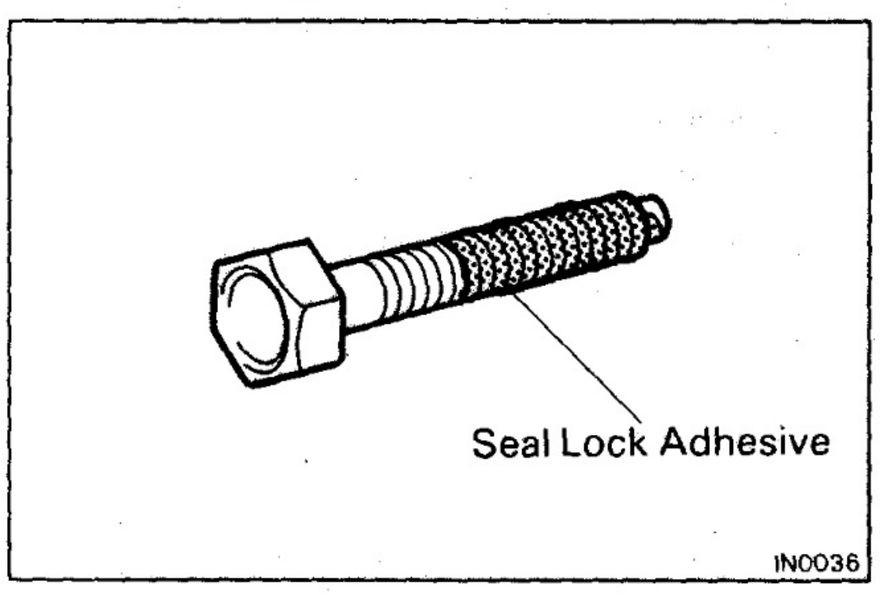
The engine serial number is stamped on the left side of the cylinder block.

GENERAL REPAIR INSTRUCTIONS

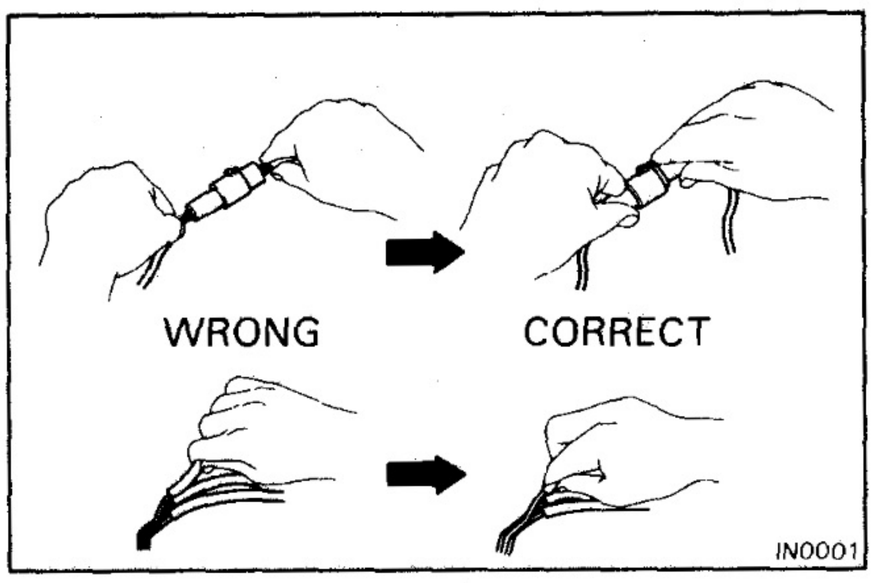
1. Use fender, seat and floor covers to keep the vehicle clean and prevent damage.
2. During disassembly, keep parts in order to facilitate reassembly.
3. Observe the following:
   (a) Before performing electrical work, disconnect the negative (–) cable from the battery terminal.
   (b) If it is necessary 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 terminals 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 that they are secure and correct.
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 the bolts, nuts, etc. which are coated with a seal lock adhesive at the factory.

   (a) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.
   (b) Recoating of Precoating 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 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. 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 one jack alone, even for a small job that can be finished quickly.



12. Observe the following precautions to avoid damaging the parts:
    (a) When disconnecting vacuum hoses, pull on the end of the hose, not the middle.
    (b) When separating 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 thermo 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 injection 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

Approx.	Approximate
A/T	Automatic Transmission
BDC	Bottom Dead Center
BTDC	Before Top Dead Center
DP	Dash Pot
EX	Exhaust
Ex.	Except
HAC	High Altitude Compensator
IN	Intake
MP	Multipurpose
M/T	Manual Transmission
O/S	Oversize
PCV	Positive Crankcase Ventilation
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
TDC	Top Dead Center
U/S	Undersize
VSV	Vacuum Switching Valve
w/	With
w/o	Without

ENGINE MECHANICAL

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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.

DIAGNOSIS

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 requires 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.
3. INOPERATIVE STARTER	Check for battery voltage at starter terminals 30 and 50. If Okay, see STARTING SYSTEM page (ST-9) for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

NOTE: 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-3)

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)	(Check Procedure and Correction Method)
1. NO FUEL TO INJECTION NOZZLE HOLDER	Loosen any one injection pipe union nut from its nozzle holder. Crank the engine for about 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 INTO INJECTION PUMP	Disconnect inlet hoses to the feed pump and feed clean fuel from separate container directly into feed pump. If engine starts, either the sedimenter or fuel line between the fuel tank and feed pump is clogged and should be repaired. If the engine still does not start, check the fuel filter or line between feed pump and injection pump. If normal, the feed pump or injection pump is faulty and should be repaired. **NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.**
3. FUEL LEAKAGE FROM INJECTION PIPE	Check for loose unions or cracks. If leaking, tighten to standard torque or, if necessary, replace pipe(s).
4. INOPERATIVE PRE-HEATING OPERATION (w/ PRE-HEATING SYSTEM)	With the starter switch turned ON and the pre-heat indicator light illuminated, check that there is voltage applied to the intake heater. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary.
5. FAULTY INTAKE HEATER OPERATION (w/ PRE-HEATING SYSTEM)	Check the intake heater continuity. (See page ST-6) If no continuity, a broken wire is indicated and intake heater should be replaced.
6. IMPROPER INJECTION TIMING	Check the injection timing. (See page EM-19) If not as specified, injection timing must be readjusted. **Injection timing: 11 ± 1°BTDC**

7. FAULTY INJECTION NOZZLE OR NOZZLE HOLDER	Check the injection pressure with nozzle tester. **Opening pressure: 200 – 210 kg/cm² (2,845 – 2,987 psi) (19,613 – 20,594 kPa)** If not within standard indicated above, nozzle adjustment is improper and pressure should be readjusted. If the pressure cannot be adjusted to standard, replace the nozzle holder assembly.

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-22) **Idle speed:** **11B, 13B M/T 625 – 675 rpm** **13B A/T 770 – 820 rpm** **13B-T M/T 625 – 675 rpm** **13B-T A/T 800 – 850 rpm** If not, adjust with the idle adjusting screw. **NOTE: If less than specified, idling would normally be rough.**
3. FUEL LEAKAGE	Check for leaks in the injection pump connections, feed pump, nozzle holder and delivery valve. Tighten any loose connections to specified torque or replace parts as necessary.
4. IMPROPER INJECTION TIMING	Refer to item 6 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 or Nozzle Holder Check the nozzle with nozzle tester. (See page FU-6) **Opening pressure: 200 – 210 kg/cm² (2,845 – 2,987 psi) (19,613 – 20,594 kPa)** If the pressure is 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. NO FUEL INTO INJECTION PUMP	Refer to item 2 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

LACK OF POWER

NOTE:
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-22) 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-22) **Maximum speed: 4,050 – 4,200 rpm** If not, adjust with the maximum speed adjusting screw.
3. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
4. CLOGGED FUEL FILTER	Disconnect the injection pump inlet hose and outlet pipe of the feed pump, and connect directly with a suitable pipe. Then pour clean fuel into the inlet side of the feed pump. If the engine condition improves, the fuel filter is clogged and should be replaced. (See page FU-2) **NOTE: 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 feed pump or perform other necessary repairs.
5. IMPROPER INJECTION TIMING	Refer to item 6 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
6. FAULTY INJECTION NOZZLE OR NOZZLE HOLDER	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

EXCESSIVE EXHAUST SMOKE

NOTE:
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 6 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **NOTE: Black smoke indicates advanced timing while white smoke indicates retarded timing. Adjustments should be made accordingly.**
2. CLOGGED FUEL FILTER	Refer to item 4 of LACK OF POWER. **NOTE: At high speed (2,000 – 3,000 rpm), a clogged filter tends to make the exhaust smoke white.**
3. FAULTY INJECTION NOZZLE HOLDER	Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START. **NOTE: Excessive exhaust smoke is often caused by nozzle pressure being too low.**

EXCESSIVE FUEL CONSUMPTION

NOTE: 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-22) **Idle speed:** **11B, 13B M/T 625 – 675 rpm** **13B A/T 770 – 820 rpm** **13B-T M/T 625 – 675 rpm** **13B-T A/T 800 – 850 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-22) **Maximum speed: 4,050 – 4,200 rpm** If not, adjust with maximum speed adjusting screw.

4. IMPROPER INJECTION TIMING	Refer to item 6 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
5. FAULTY INJECTION NOZZLE OR NOZZLE HOLDER	Refer to item 7 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 coolant temperature gauge. If not sufficiently warm, thermostat is faulty and should be replaced.
2. IMPROPER INJECTION TIMING	Refer to item 6 of ENGINE CRANKS NORMALLY BUT WILL NOT START.
3. FAULTY INJECTION NOZZLE HOLDER	Refer to item 7 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 INTAKE SHUTTER OPERATION	Close the intake shutter and check if engine stops. If it does, the intake shutter system is faulty and should be repaired. (See page EM-23)

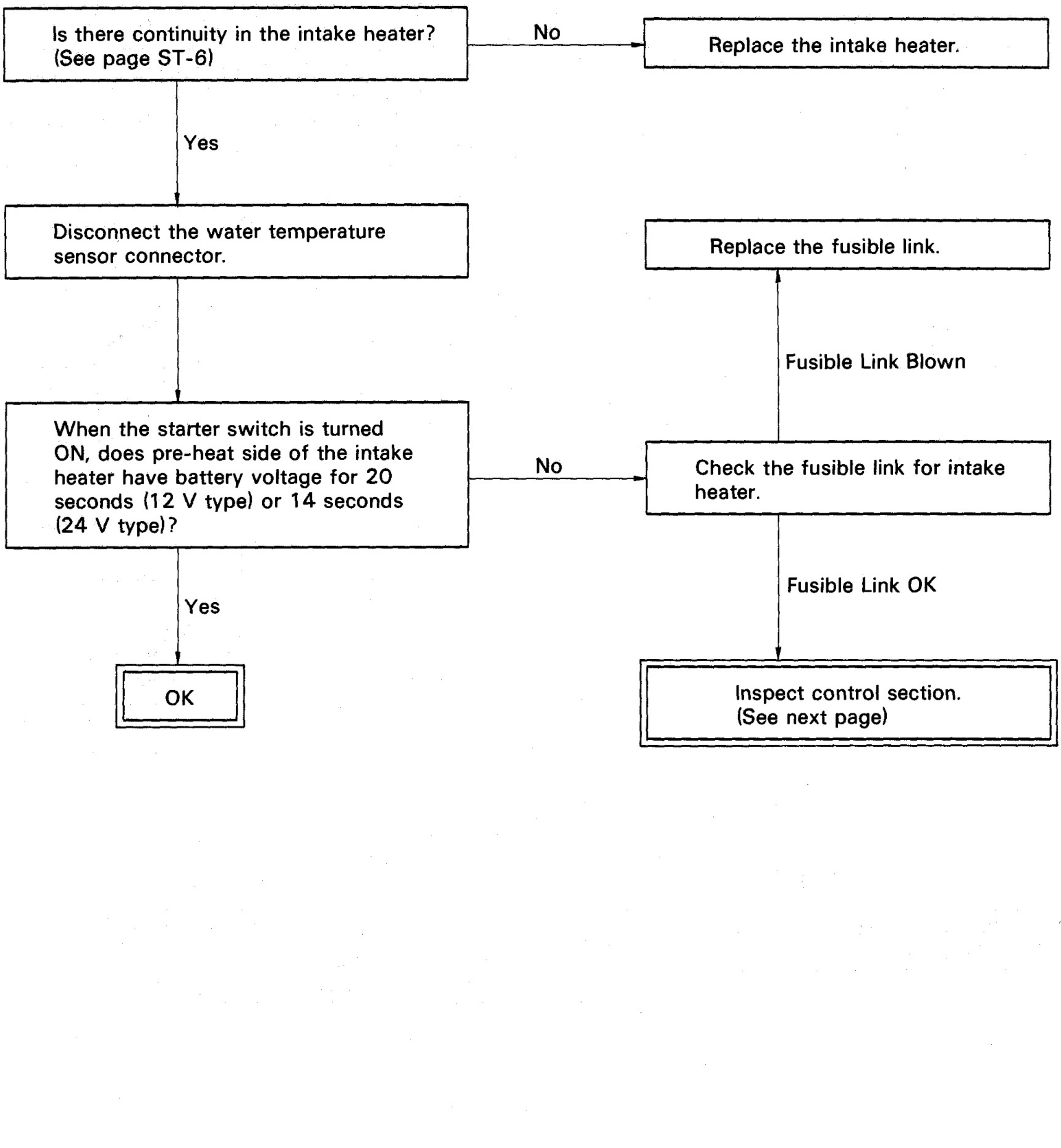
DIESEL ELECTRICAL SYSTEM DIAGNOSIS (w/ INTAKE HEATER)

ENGINE DOES NOT START WHEN COLD

NOTE: 1. Battery voltage is 12 volts (or 24 volts) when starter switch is OFF.
2. Engine cranks normally.
3. Water temperature sensor okay. (See page ST-7)

Pre-heating System

1. INSPECT POWER SUPPLY SECTION

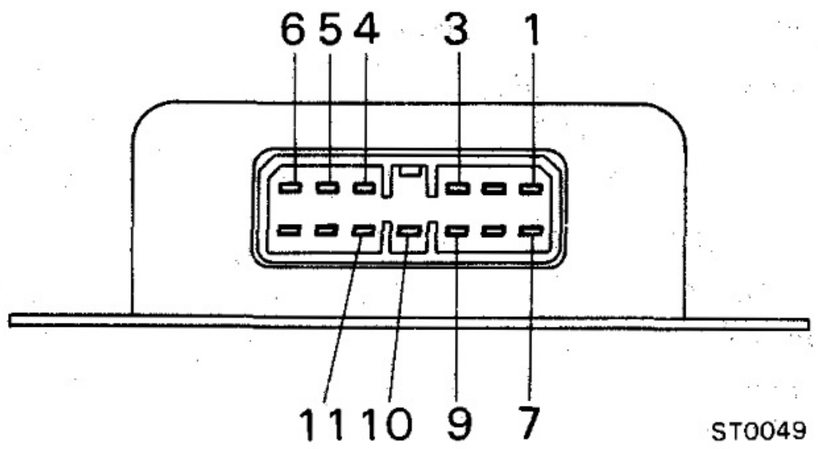


2. INSPECT CONTROL SECTION

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

Disconnect the water temperature sensor connector.

Intake Heater Timmer



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

No → Is the ENGINE (BJ) or GAUGE (BU, BB) fuse Okay?

No → Replace the fuse.

Yes

Yes → Is the indicator light bulb Okay?

No → Replace the bulb.

Yes → Is terminal 10 of the intake heater timer grounded?

No → Open circuit or ground faulty in wire harness between terminal 10 of the timer and body ground.

Yes → Is there battery voltage to terminal 3 of the intake heater connector (on wire harness side)?

No → Open circuit in wire harness between terminal 3 of the timer and pre-heat indicator light.

Yes → Replace the timer.

Yes → Is the lighting time correct?
12 V type: 20 seconds
24 V type: 14 seconds

No → Replace the timer.

Yes

CONTINUED ON PAGE EM-12

Yes

CONTINUED FROM PAGE EM-11

When the starter switch is turned ON, is voltage between terminals G_1 of the intake heater relay (BJ, BB) or terminal G of the No. 1 intake heater relay (BU) and body ground battery voltage for 20 seconds (12 V type) or 14 seconds (24 V type)?

No → Did intake heater relay (BJ, BB) or No. 1 intake heater relay (BU) check out okay? (See page ST-4 or 6)

No → Replace the intake heater relay (BJ, BB) or No. 1 intake heater relay (BU).

Yes

When the starter switch is turned ON, does terminal 1 of the intake heater timer have battery voltage for 20 seconds (12 V type) or 14 seconds (24 V type)?

No → Replace the timer.

Yes

- Open circuit in wire harness between terminal 1 of the timer and terminal g_1 of the intake heater relay (BJ, BB) or terminal g of the No. 1 intake heater relay (BU).
- Open circuit or ground faulty in wire harness between terminal e of the intake heater relay (BJ, BB) or terminal E of the No. 1 intake heater relay (BU) and body ground.

Yes

With the engine started, is there battery voltage between terminal G_2 of the intake heater relay (BJ, BB) or terminal G of the No. 2 intake heater relay (BU) and body ground? (Measure the time too)

No → Did intake heater relay (BJ, BB) or No. 2 intake heater relay (BU) check out okay? (See page ST-4 or 6)

No → Replace the intake heater relay (BJ, BB) or No. 1 intake heater relay (BU).

Yes

CONTINUED ON PAGE EM-13

NOTE: Refer to ST-4 or 6 for intake heater relay terminal location.

Yes CONTINUED FROM PAGE EM-12

Yes

With the engine started, does terminal 5 of the intake heater timer have battery voltage for 70 seconds?

Yes

No

Is terminal 9 of the intake heater timer grounded?

No

When the starter switch is turned ON, does the CHG indicator light light?

Yes

No

Yes

Replace the timer.

Open circuit in wire harness between terminal 9 of the timer and CHG light.

- Inspect CHARGE fuse.
- Inspect alternater regulator.

- Open circuit in wire harness between terminal 5 of the timer and terminal g_2 of the intake heater relay (BJ, BB) or terminal g of the No. 2 intake heater relay (BU).
- Open circuit or ground faulty in wire harness between terminal e of the intake heater relay (BJ, BB) or terminal E of the No. 2 intake heater relay (BU) and body ground.

Is time normal?
After heat time:
Approx. 70 seconds

No

Replace the timer.

Yes

Inspect power supply section.
(See page EM-10)

TURBOCHARGER DIAGNOSIS

NOTE: Before troubleshooting the turbocharger, first check the engine itself. (Valve clearance, engine compression, injection timing, etc.)

INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION

(Possible Cause)	(Check Procedure and Correction Method)
1. TURBOCHARGING PRESSURE TOO LOW	Check turbocharging pressure. (See page EM-45) **Turbocharging pressure: 0.42 — 0.56 kg/cm² (6.0 — 8.0 psi) (41 — 55 kPa)** If the pressure is below specification, begin diagnosis from item 2.
2. RESTRICTED INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-45)
3. LEAK IN INTAKE AIR SYSTEM	Check intake air system, and repair or replace parts as necessary. (See page EM-45)
4. RESTRICTED EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-45)
5. LEAK IN EXHAUST SYSTEM	Check exhaust system, and repair or replace parts as necessary. (See page EM-45)
6. ERRATIC TURBOCHARGER OPERATION	Check rotation of impeller wheel. If it does not turn or turns with a heavy drag, replace the turbocharger assembly. Check axial play of bearing shaft. (See page EM-49) **Axial play: 0.13 mm (0.0051 in.) or less** If not within specification, replace the turbocharger assembly.

ABNORMAL NOISE

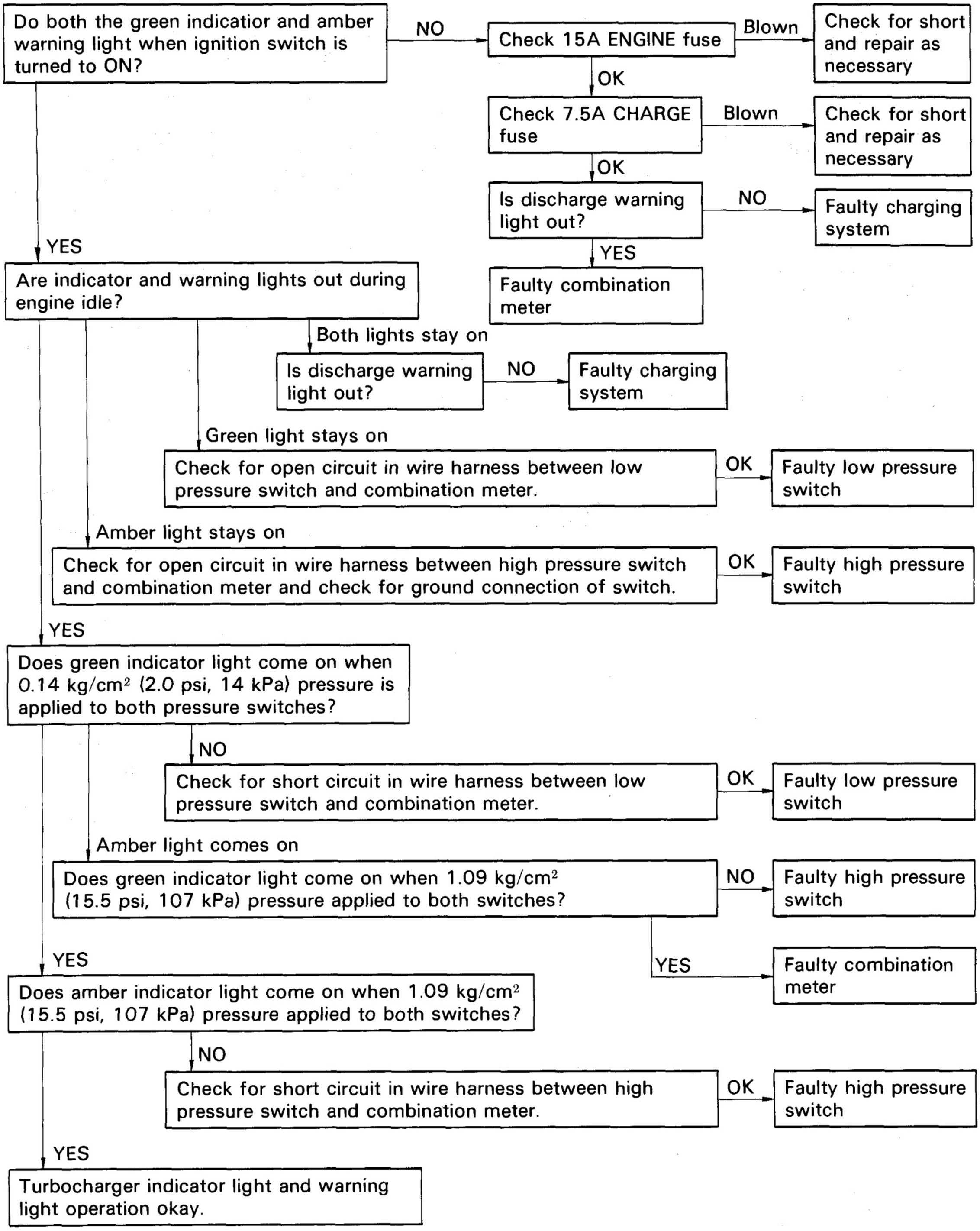
(Possible Cause)	(Check Procedure and Correction Method)
1. TURBOCHARGER INSULATOR RESONANCE	Check for loose, improperly installed or deformed insulator mount bolts, and repair or replace as necessary.
2. EXHAUST PIPE LEAKING OR VIBRATING	Check for exhaust pipe deformation, loose mount bolts or a damaged gasket, and repair or replace as necessary.
3. ERRATIC TURBOCHARGER OPERATION	Refer to item 6 of INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION.

EXCESSIVE OIL CONSUMPTION OR WHITE EXHAUST

(Possible Cause)	(Check Procedure and Correction Method)
1. FAULTY TURBOCHARGER OIL SEAL	Check for oil leakage in exhaust system. ● Remove the turbine elbow from the turbocharger and check for excessive carbon deposits on the turbine wheel. Excessive carbon deposits would indicate a faulty turbocharger. Check for oil leakage in intake air system. ● Check for axial play in impeller wheel, and replace the turbocharger if necessary. (See page EM-49) **Axial play: 0.13 mm (0.0051 in.) or less** **CAUTION: Do not mistakenly diagnose ordinary oil mist from the PCV in the blow by gas as an oil leak from the turbocharger.**

TURBOCHARGER ELECTRICAL SYSTEM DIAGNOSIS

Troubleshooting of Turbocharger Indicator Light and Warning Light Operation



ENGINE TUNE-UP

INSPECTION OF ENGINE COOLANT

(See page CO-2)

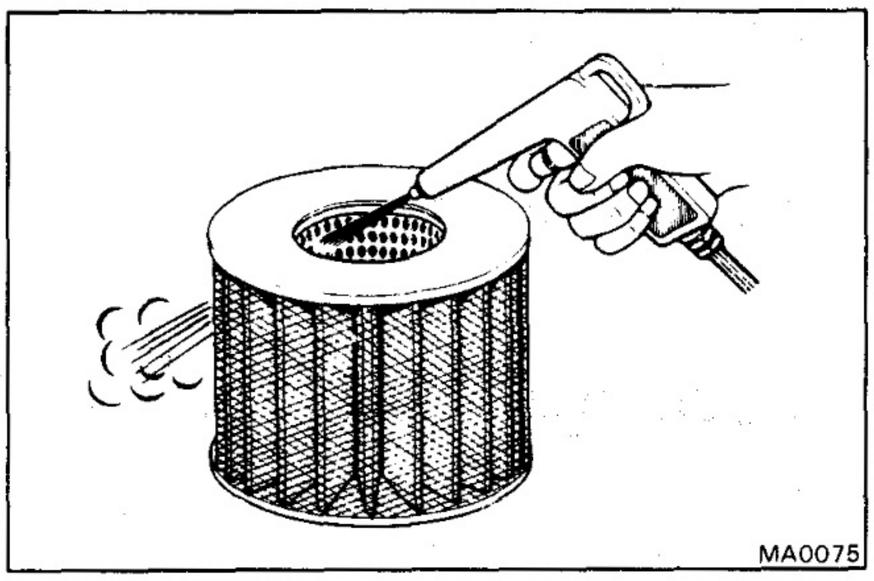
INSPECTION OF ENGINE OIL

(See page LU-2)

INSPECTION OF BATTERY SPECIFIC GRAVITY

(See page CH-4)

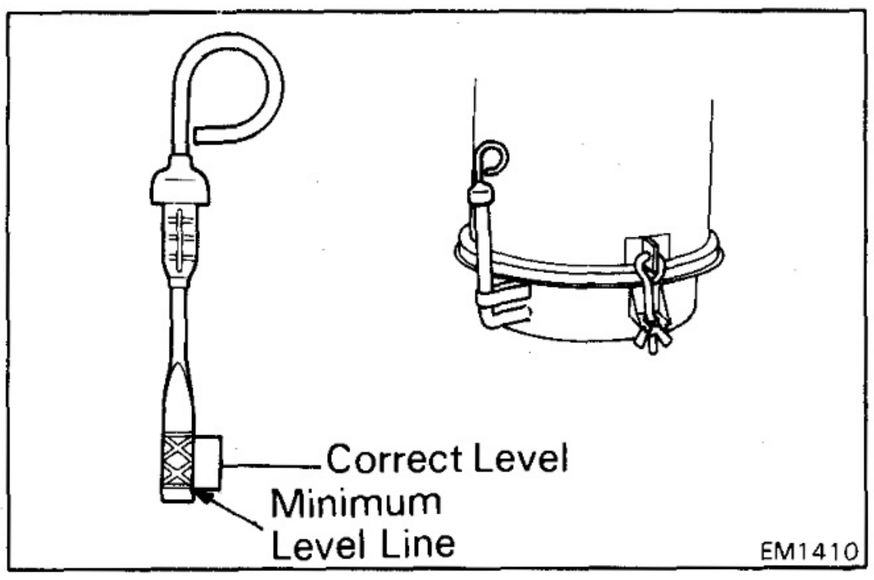
INSPECTION OF AIR FILTER



[Paper Element Type]

(a) Visually check that the air cleaner element is not excessively dirty, damaged or oily.

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



[Oil Bath Type]

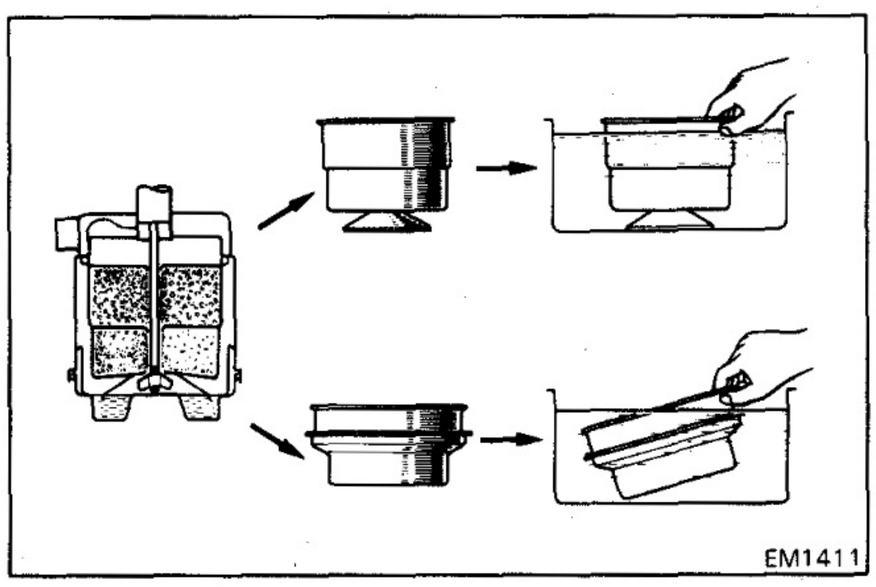
1. INSPECT AIR CLEANER OIL LEVEL

The oil level should be the correct level.

If the level is below the minimum level line, clean the air cleaner element.

NOTE:

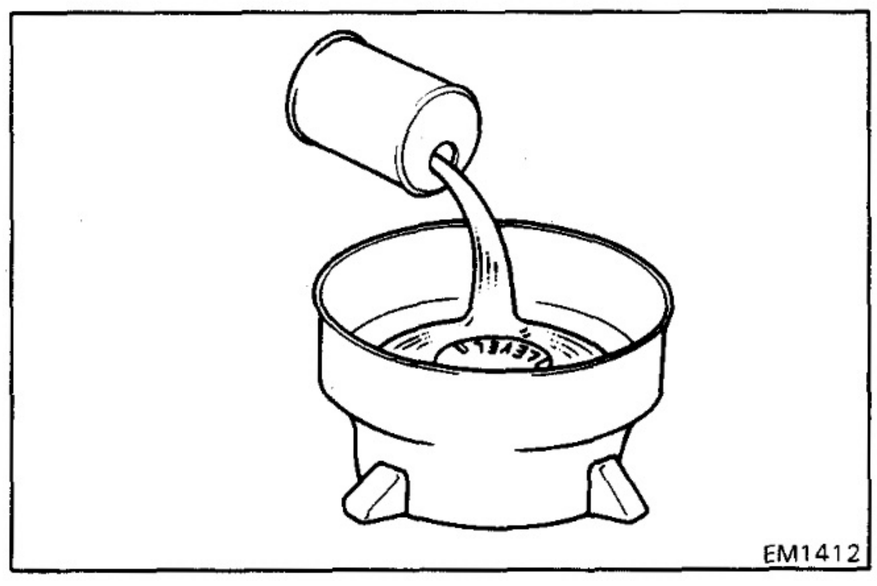
- To get a true reading, the vehicle should be on level ground with the engine turned off.
- If the engine is running, stop it and wait about 30 minutes.



2. CLEAN AIR CLEANER ELEMENT

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

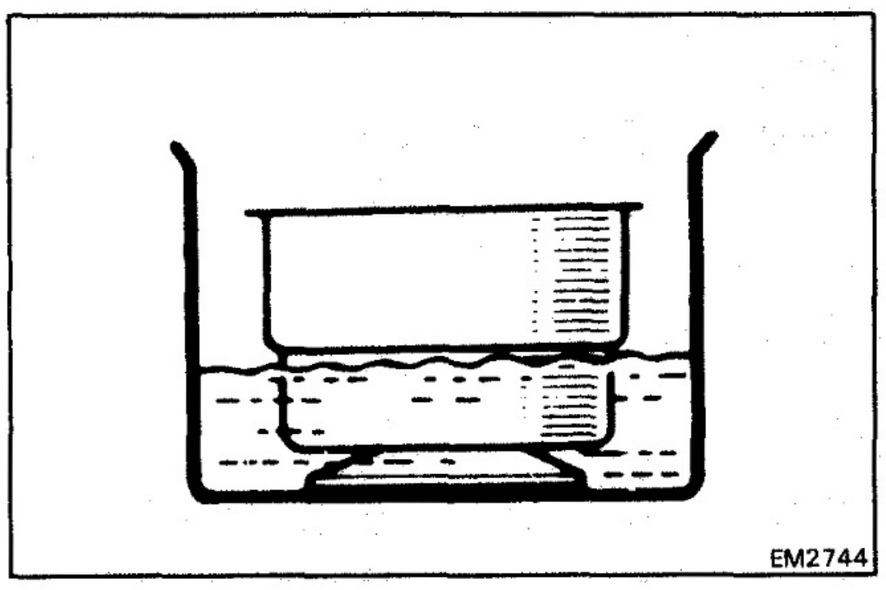
(b) Wipe the oil case and element with a clean rag.



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

(d) Pour in clean engine oil until the correct level is reached.

NOTE: The level is indicated inside the oil case.


EM2744

(e) Place the element on the tray.

(f) Saturate the element with clean engine oil.

INSPECTION OF DRIVE BELT

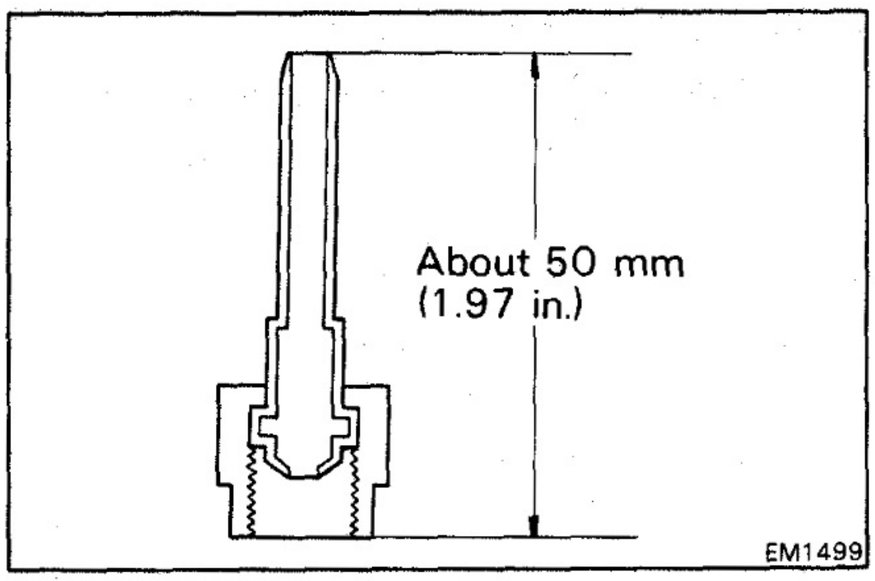
(See page CH-5)

INSPECTION OF INTAKE HEATER

(See page ST-6)

INSPECTION OF INJECTION PRESSURE TEST

(See page FU-6)

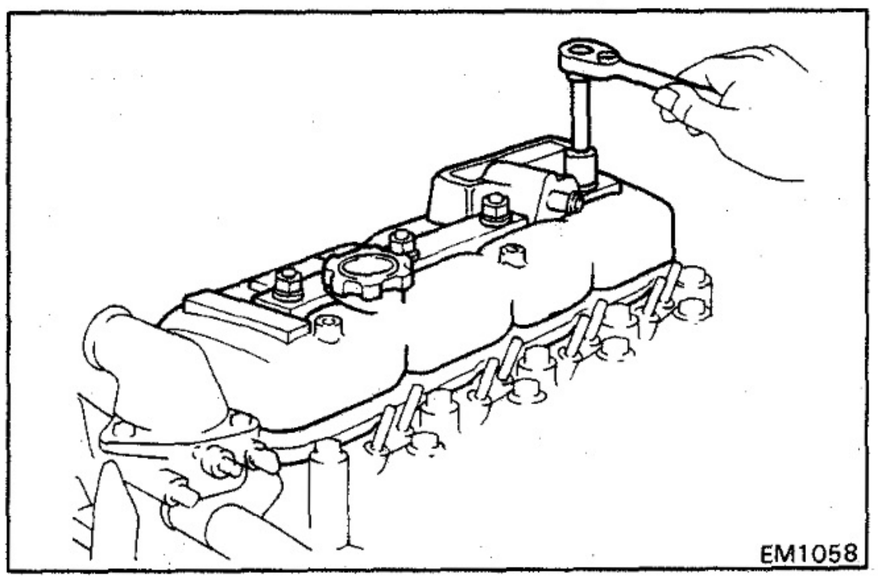


INSPECTION AND ADJUSTMENT OF INJECTION TIMING

1. [13B-T]
REMOVE INTAKE AIR CONNECTOR PIPE

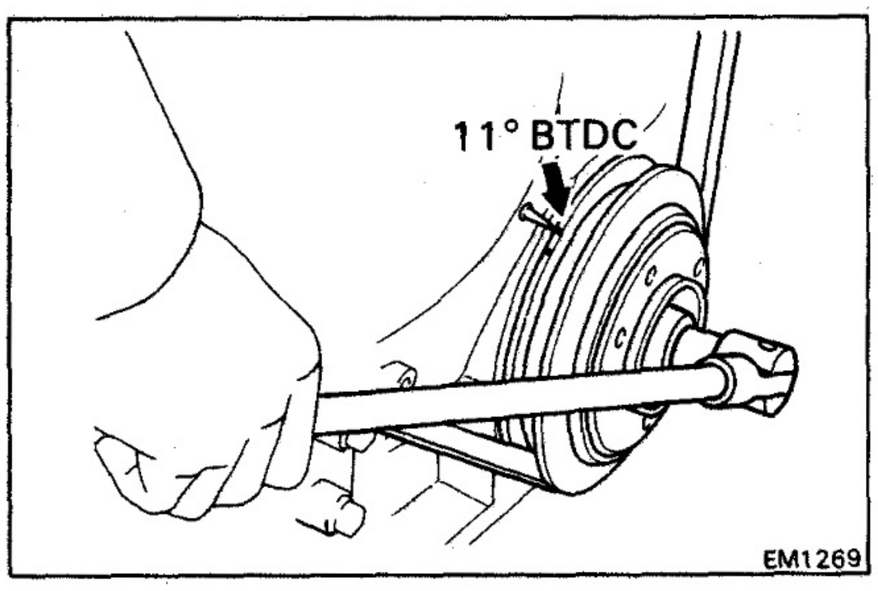
2. PREPARE INSPECTION PIPE

Make an inspection pipe with a injection pipe as shown.



3. REMOVE CYLINDER HEAD COVER

Remove the four cap nuts, seal washers, head cover and gasket.

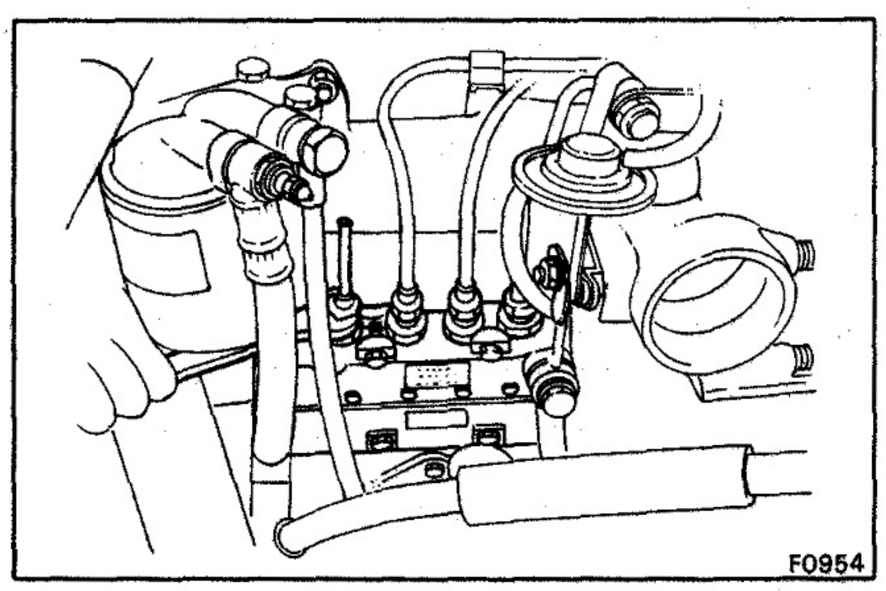


4. SET NO. 1 CYLINDER TO 11° BTDC/COMPRESSION

(a) Set the No. 1 cylinder to 11° BTDC/compression. Align the groove on the pulley with the timing pointer by turning the crankshaft clockwise with a wrench.

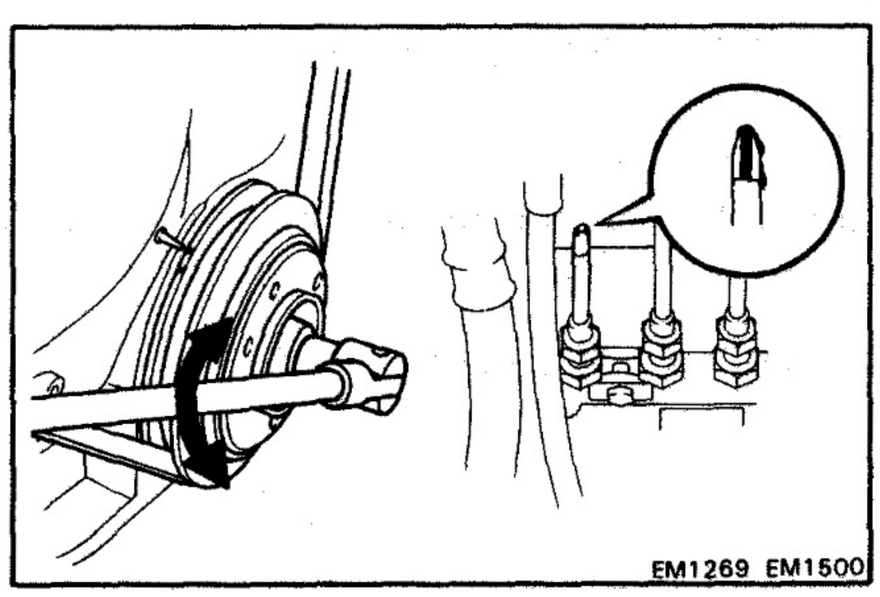
(b) Check that the rocker arms on the No. 1 cylinder are loose and rocker arms on the No. 4 cylinder are tight.

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



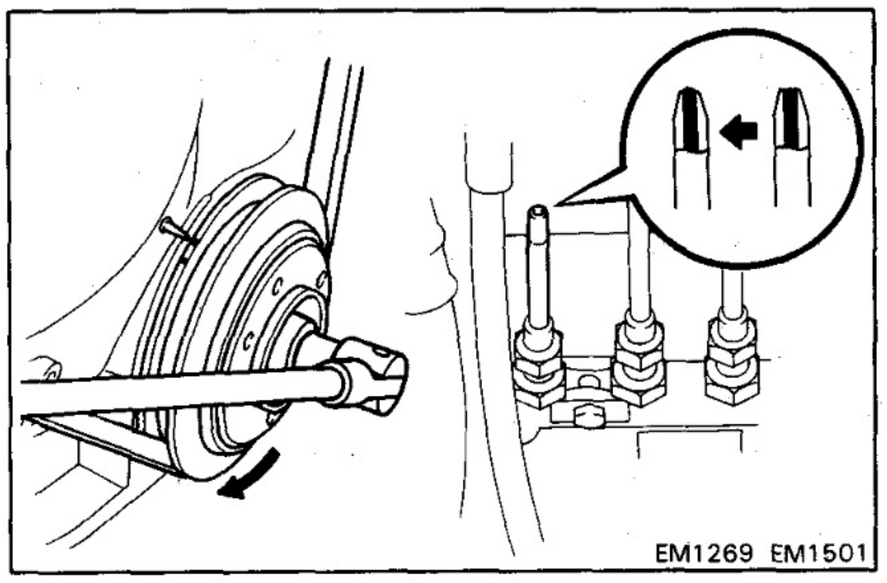
5. INSPECT AND ADJUST INJECTION TIMING

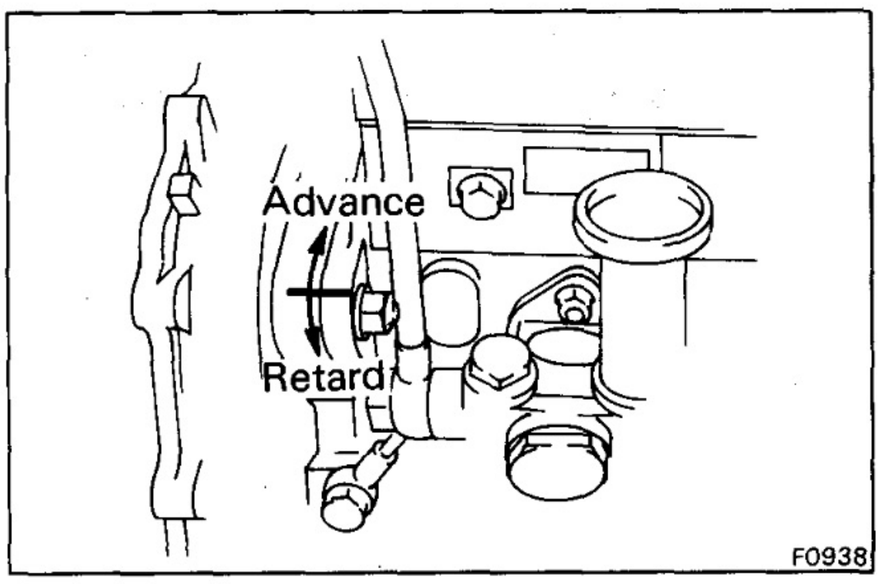
(a) Remove the No. 1 injection pipe and install the inspection pipe on the No. 1 delivery valve holder.



(b) Turn the crankshaft slightly to left and right until fuel surfaces from the inspection pipe.

(c) Turn the crankshaft counterclockwise, set the No. 1 cylinder just before the 11° BTDC/compression.





(d) Slowly turn the crankshaft clockwise.

(e) Check the crankshaft pulley position (injection timing position) when the fuel level in the inspection pipe rises.

Injection timing: 11 ± 1° BTDC

NOTE: This operation should be repeated at least two or three times.

(f) Loosen the other injection pipe union nuts, fuel pipe and oil pipe union bolt at the injection pump side.

(g) Loosen the three injection pump mounting nuts and pump stay mounting bolts and nut.

NOTE: If it is difficult to loosen the pump mounting nuts, remove the fuel filter.

(h) Adjust the injection timing by slightly tilting the injection pump body.

If the injection timing is retarded, advance it by tilting the pump toward the engine.

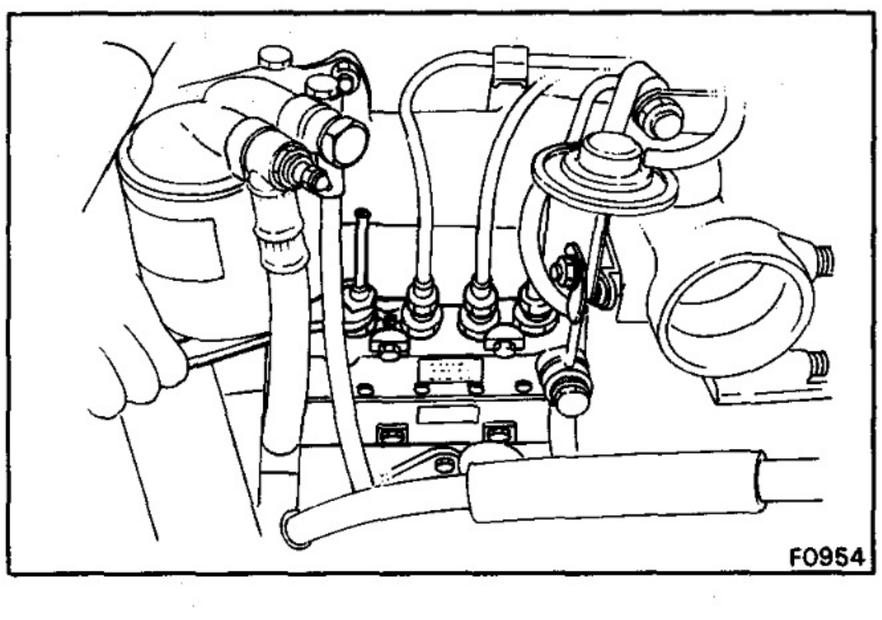
If the injection timing is advanced, retard it by tilting the pump away from the engine.

(i) Tighten the injection pump mounting nuts and pump stay mounting bolts and nut.

Torque:

Bolt	**375 kg-cm (27 ft-lb, 37 N·m)**
Nut	**185 kg-cm (13 ft-lb, 18 N·m)**

(j) Recheck the injection timing.



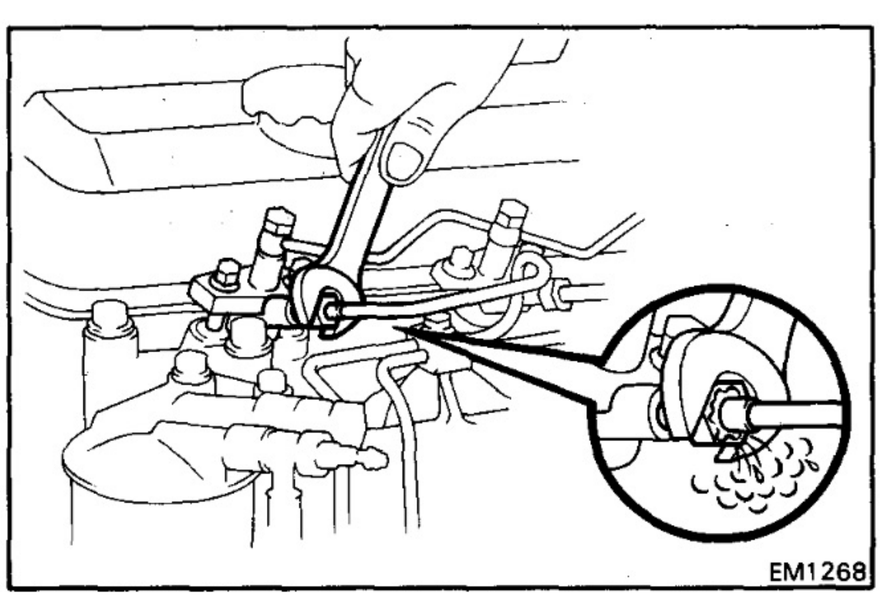
(k) Remove the inspection pipe and install the No. 1 injection pipe.

(l) Tighten the injection pipe union nuts, oil pipe union bolt and fuel pipe union bolt.

Torque:

Injection pipe	**250 kg-cm (18 ft-lb, 25 N·m)**
Oil pipe	**110 kg-cm (8 ft-lb, 11 N·m)**
Fuel pipe	**375 kg-cm (27 ft-lb, 37 N·m)**

6. INSTALL CYLINDER HEAD COVER

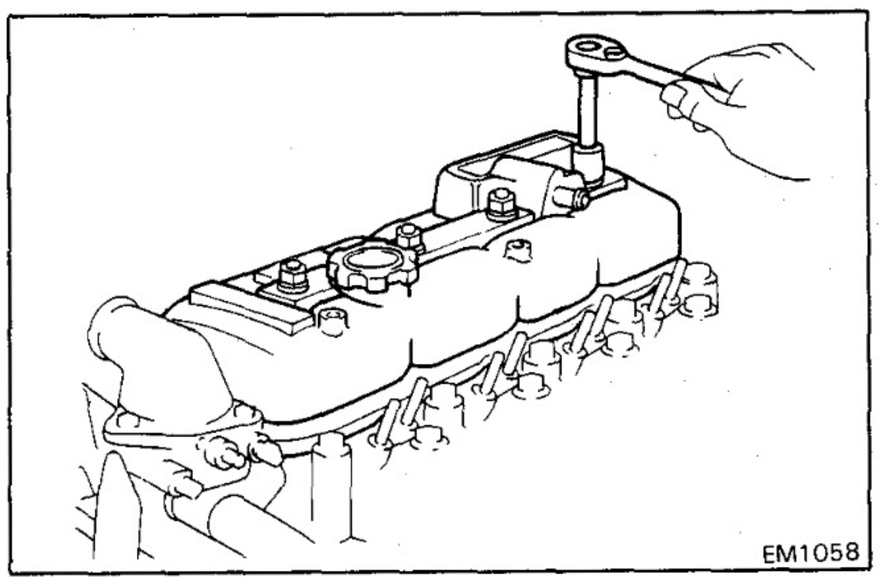


7. [13B-T]
INSTALL INTAKE AIR CONNECTOR PIPE

8. BLEED AIR FROM FUEL LINE

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

9. START ENGINE AND CHECK FOR LEAKS

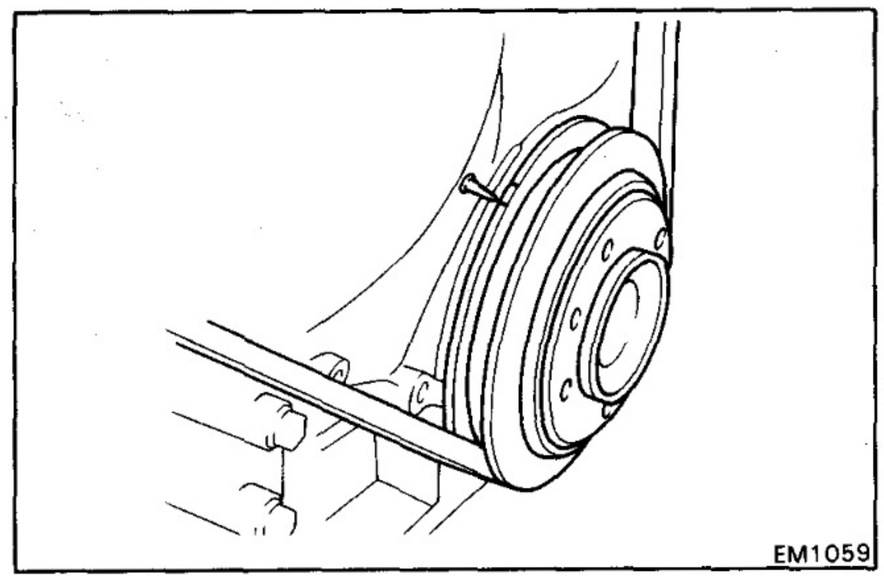


INSPECTION AND ADJUSTMENT OF VALVE CLEARANCES

NOTE: Inspect and adjust the valve clearance after engine has reached normal operating temperature.

1. **[13B-T]**
   REMOVE INTAKE AIR CONNECTOR PIPE

2. **REMOVE CYLINDER HEAD COVER**

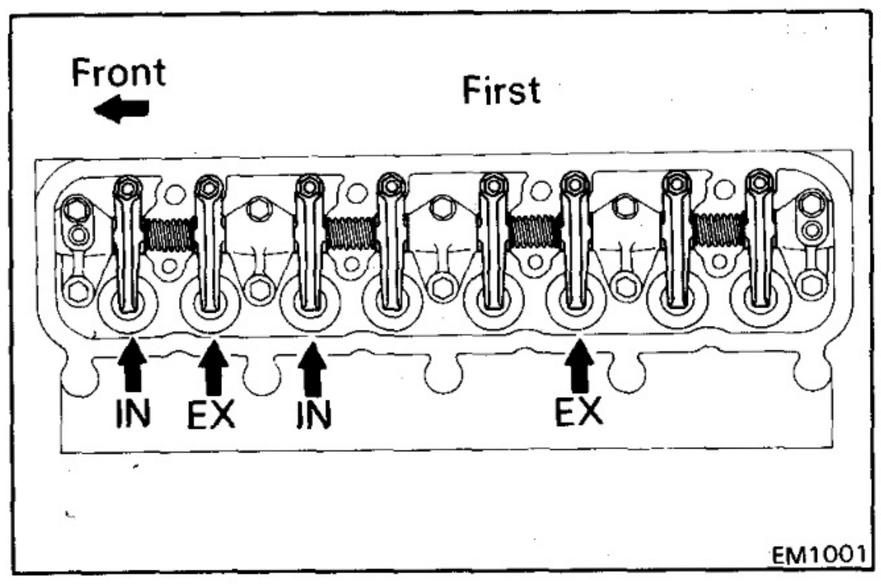


3. **SET NO. 1 CYLINDER TO TDC/COMPRESSION**

   (a) Set the No. 1 cylinder to TDC/compression.
   Align the groove on the pulley with the timing pointer 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.

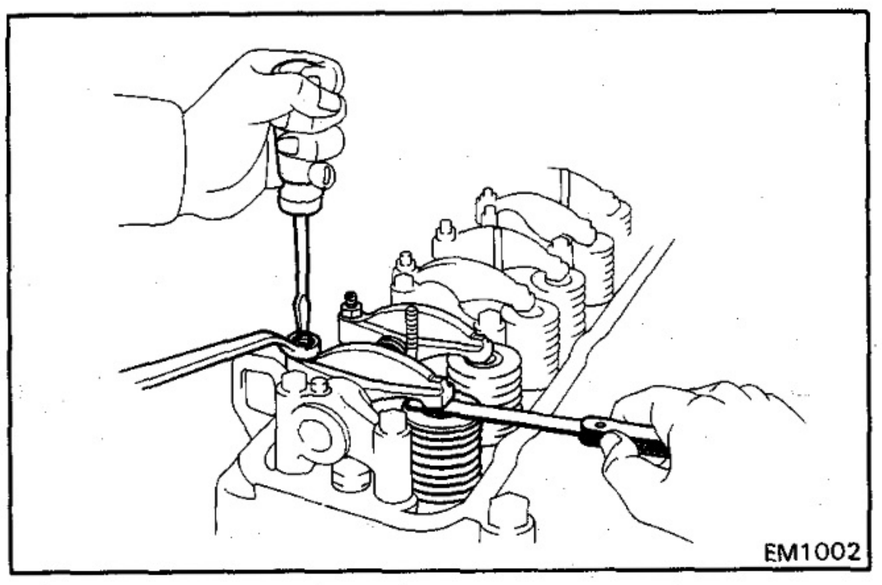
   If not, turn the crankshaft one revolution (360°) and align the mark as above.



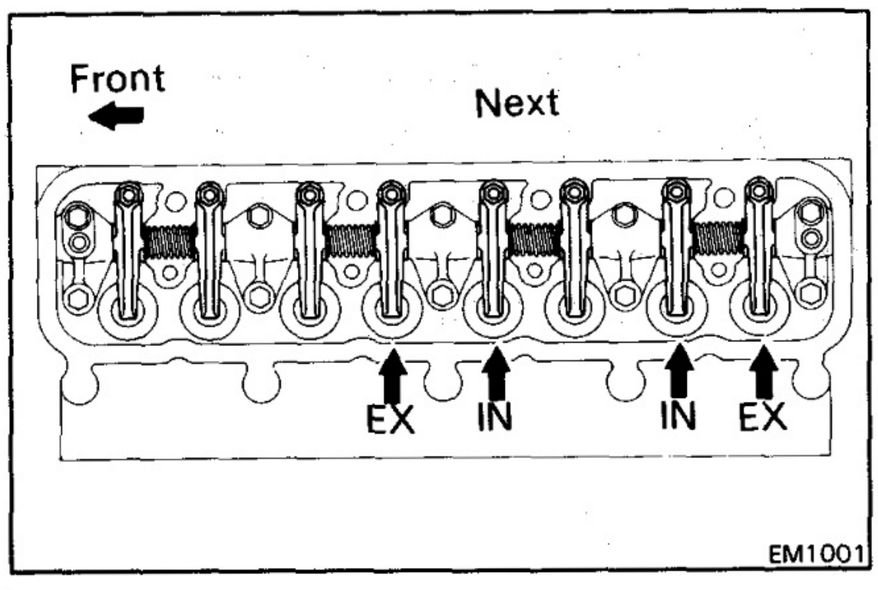
4. **INSPECT AND ADJUST VALVE CLEARANCE**

   (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 feeler gauge, measure the valve clearance between the valve stem 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 feeler gauge should slide with a very slight drag.



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

5. **INSTALL CYLINDER HEAD COVER**

6. **[13B-T]**
   INSTALL INTAKE AIR CONNECTOR PIPE

INSPECTION AND ADJUSTMENT OF IDLE AND MAXIMUM SPEEDS

1. INITIAL CONDITIONS:

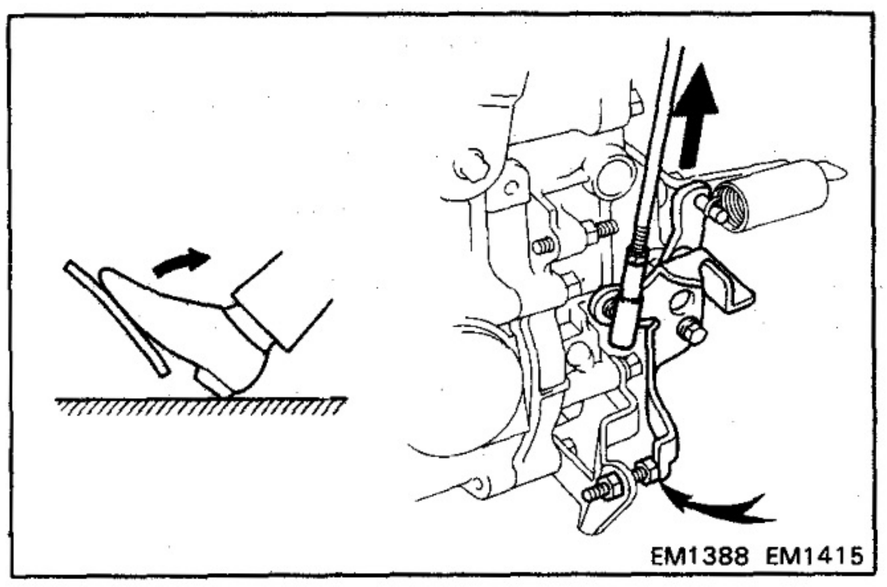
(a) Air cleaner installed

(b) Engine coolant normal operating temperature

(c) Accessories switched off

(d) Transmission in neutral

2. CONNECT TACHOMETER TO ENGINE

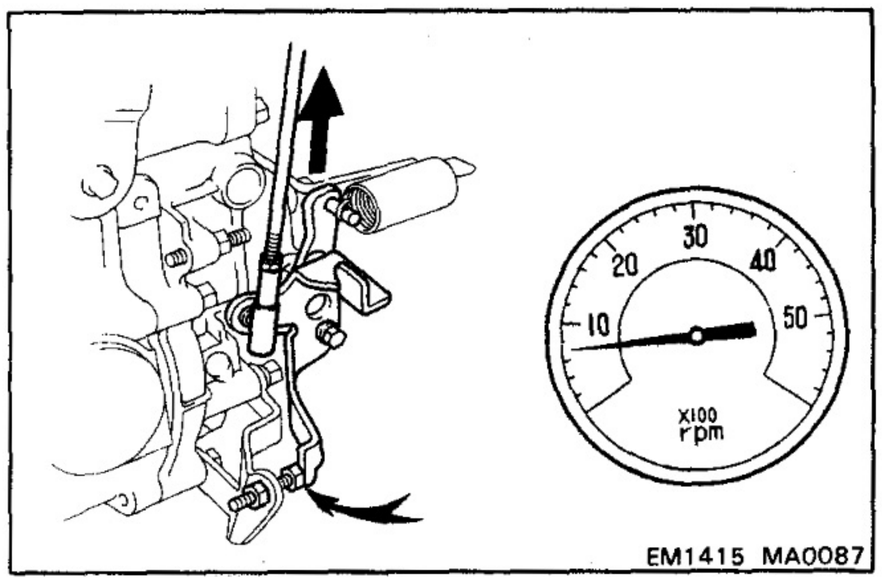


EM1388 EM1415

3. INSPECT AND ADJUST IDLE SPEED

(a) Check that the adjusting lever touches the idle speed adjusting screw when the accelerator pedal is released.

If not, adjust the accelerator linkage.



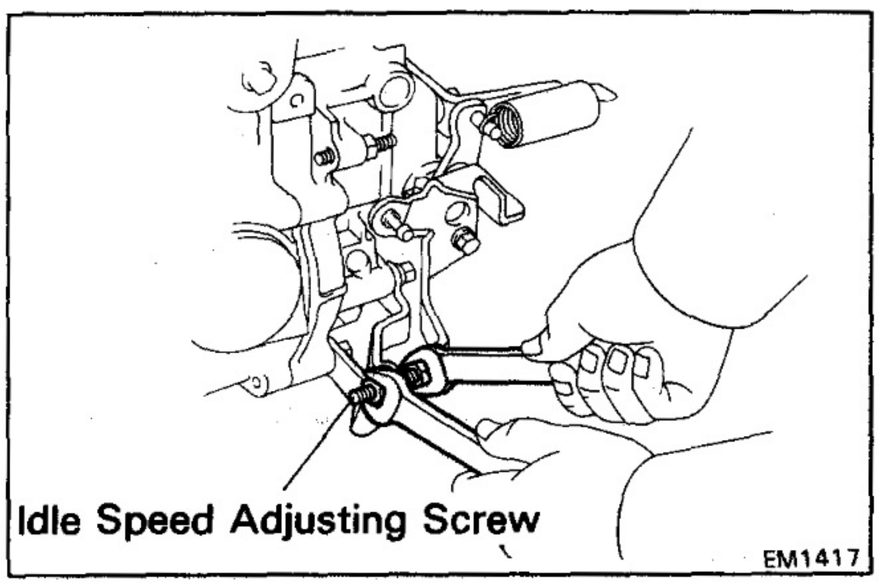
EM1415 MA0087

(b) Start the engine.

(c) Check the idle speed.

Idle speed:

11B, 13B	**M/T**	**625 – 675 rpm**
13B	**A/T**	**770 – 820 rpm**
13B-T	**M/T**	**625 – 675 rpm**
13B-T	**A/T**	**800 – 850 rpm**

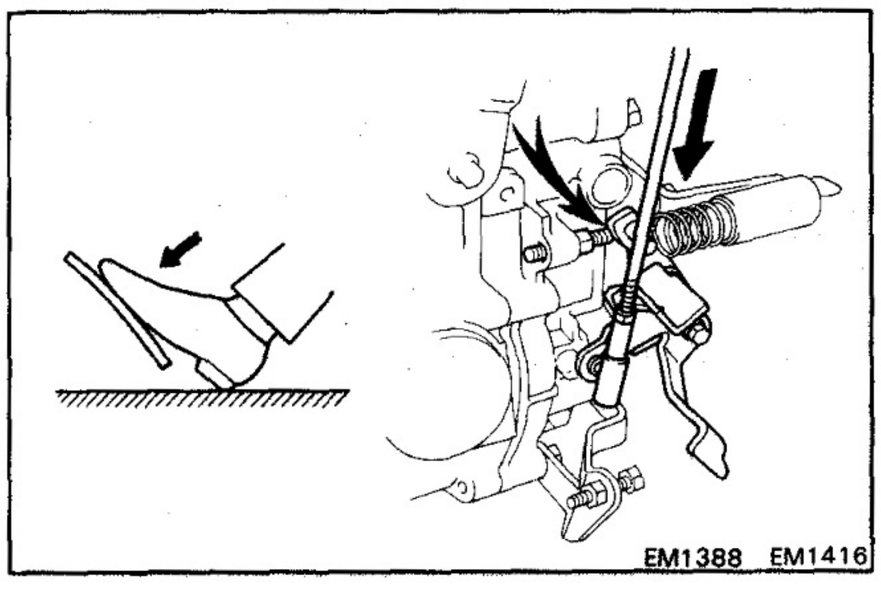


Idle Speed Adjusting Screw

EM1417

(d) Adjust the idle speed.

- Disconnect the accelerator linkage.
- Loosen the lock nut of the idle speed adjusting screw.
- Adjust the idle speed by turning the IDLE SPEED ADJUSTING SCREW.
- Securely tighten the lock nut and recheck the idle speed.
- Connect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.

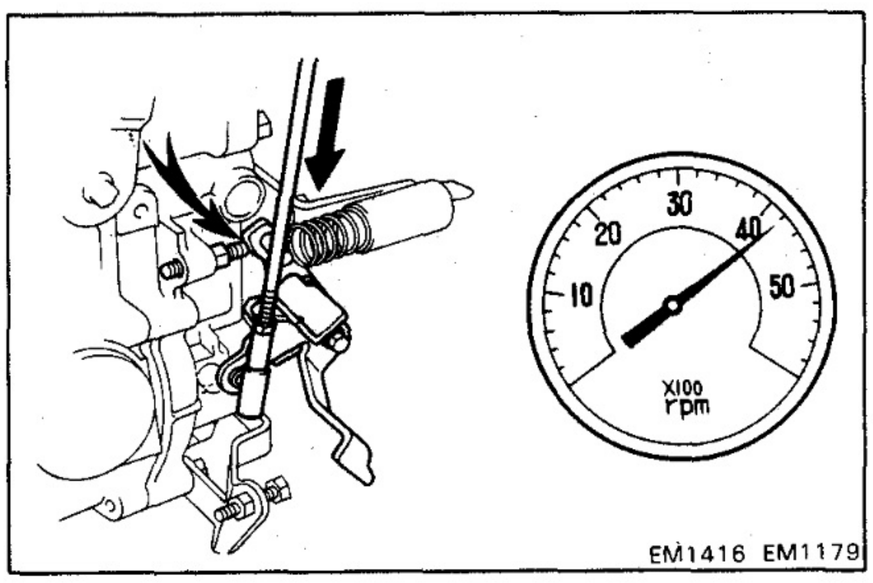


EM1388 EM1416

4. INSPECT AND ADJUST MAXIMUM SPEED

(a) Check that the adjusting lever touches the maximum speed adjusting screw when the accelerator pedal is depressed all the way.

If not, adjust the accelerator linkage.

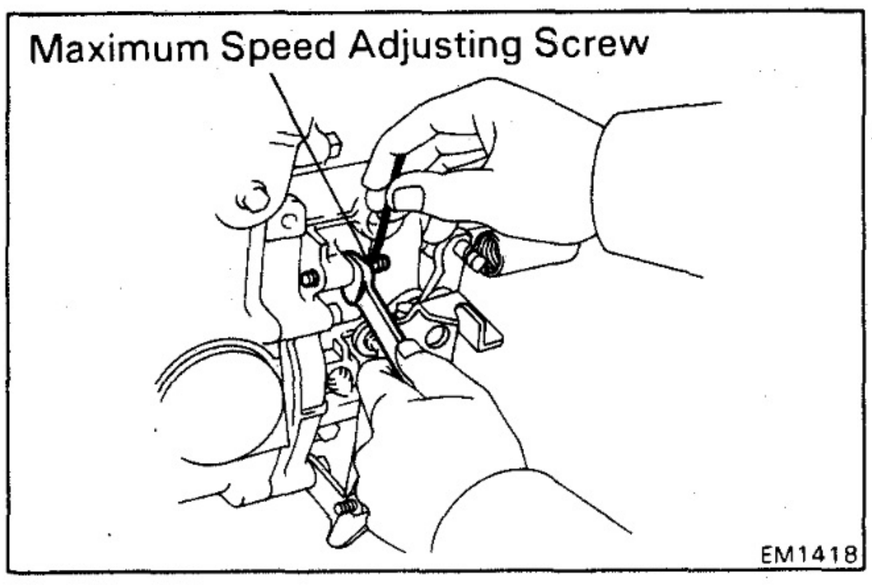


(b) Start the engine.

(c) Depress the accelerator pedal all the way.

(d) Check the maximum speed.

Maximum speed: 4,050 – 4,200 rpm

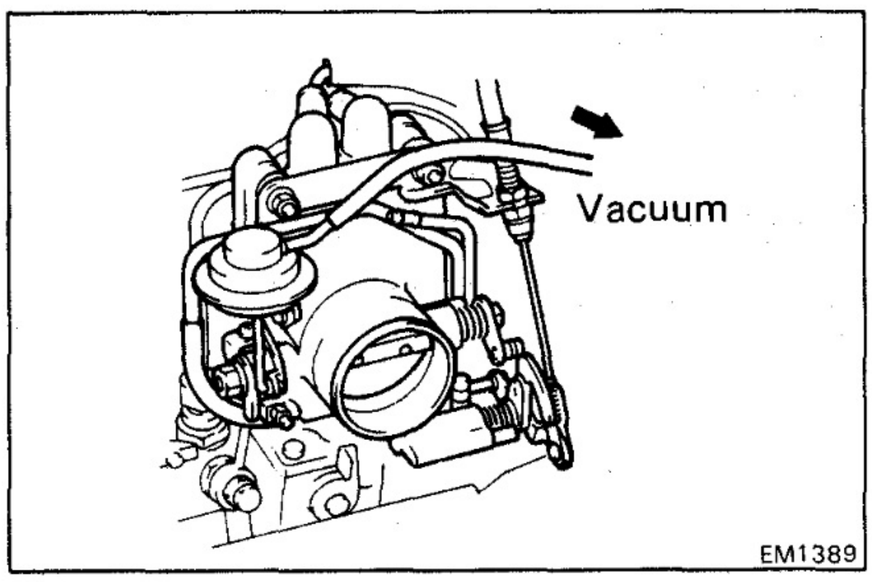


(e) Adjust the maximum speed.

- Disconnect the accelerator linkage.
- Cut out the maximum speed adjusting screw seal wire.
- Loosen the lock nut of the maximum speed adjusting screw.
- Adjust the maximum speed by the MAXIMUM SPEED ADJUSTING SCREW.

NOTE: Adjust at idle speed. Then, raise engine speed and recheck the maximum speed.

- Securely tighten the lock nut and recheck the maximum speed.
- Seal the maximum speed adjusting screw with a new seal wire.

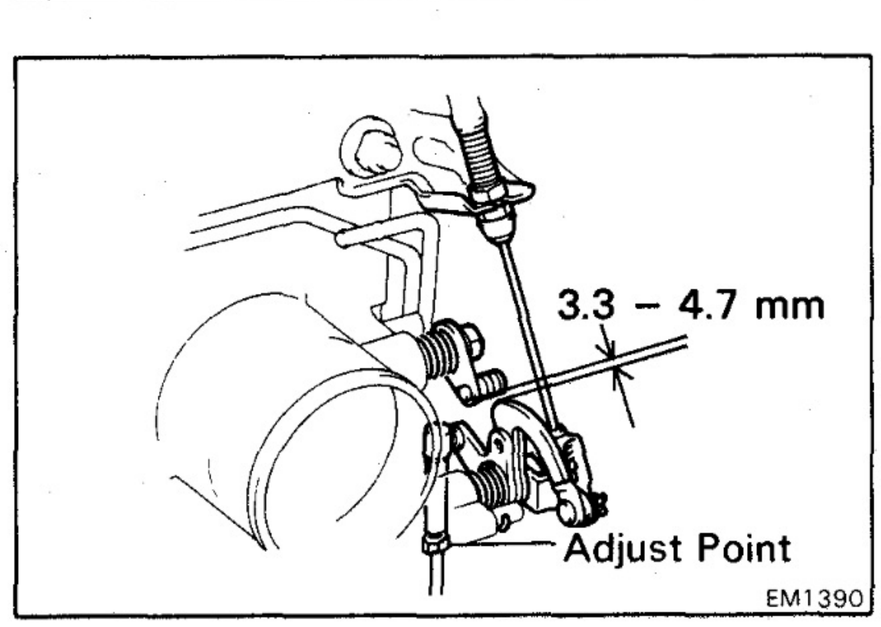


INSPECTION AND ADJUSTMENT OF INTAKE SHUTTER

1. INSPECT AND ADJUST INTAKE SHUTTER

(a) Apply at least 300 mmHg (11.81 in.Hg, 40.0 kPa) of vacuum to the actuator.

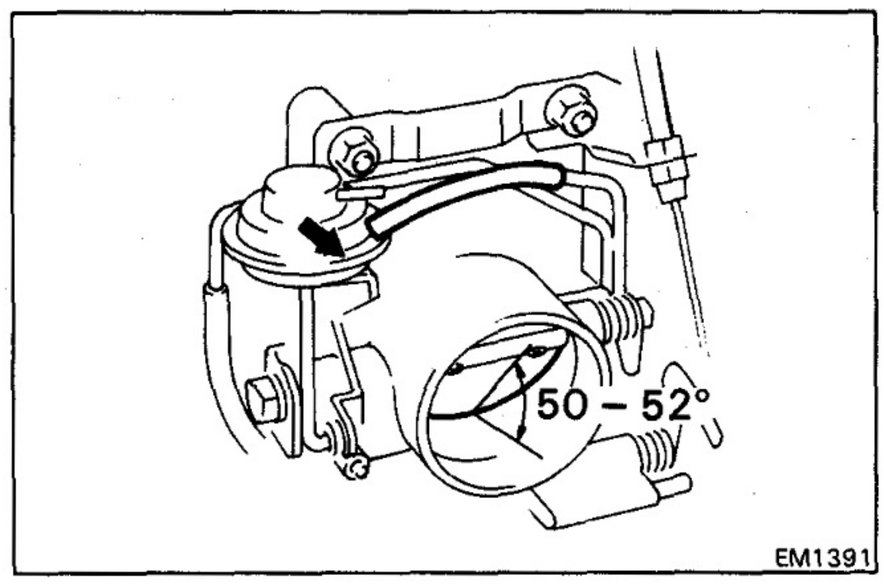
(b) Check that the throttle valve moves smoothly to the fully closed position.



(c) [11B, 13B]
Measure the clearance between the throttle lever and intake shutter lever.

Clearance: 3.3 – 4.7 mm (0.130 – 0.185 in.)

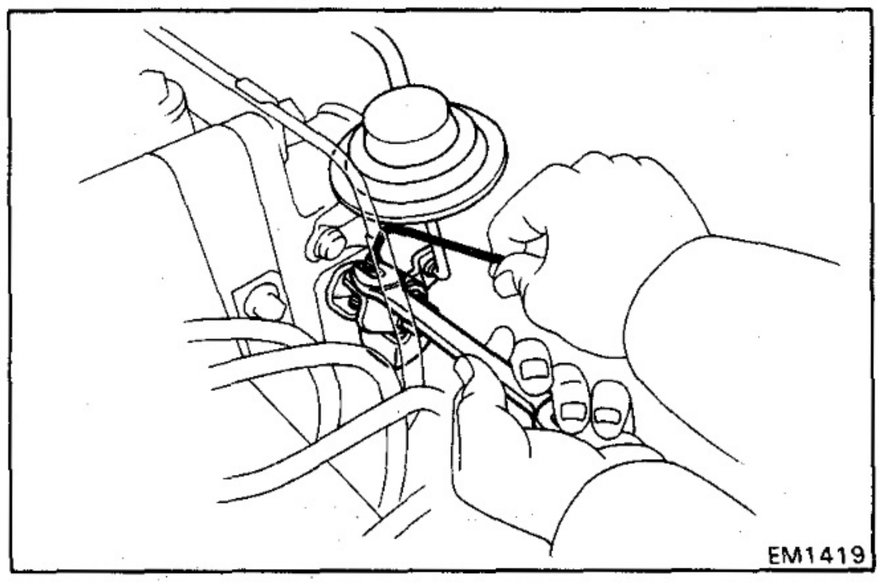
(d) [11B, 13B]
Adjust by turning the accelerator connecting rod.



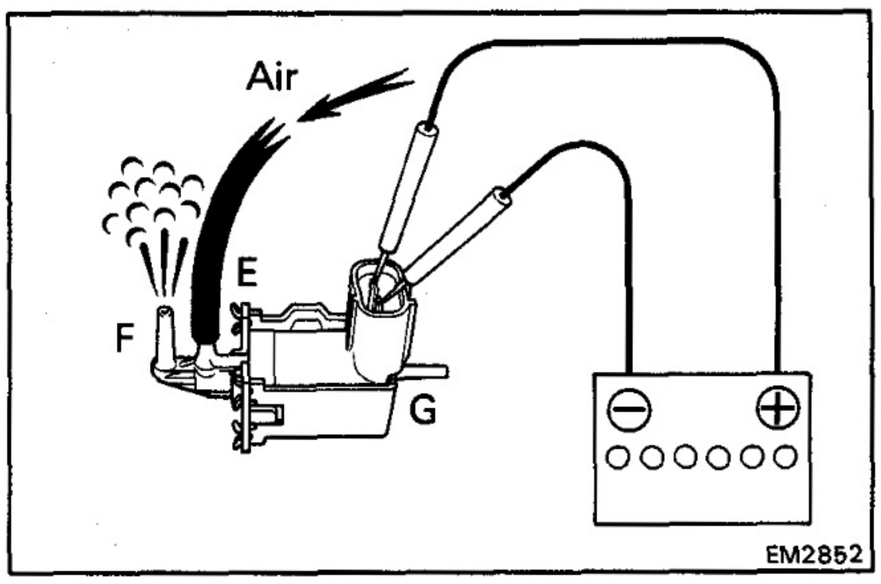
(e) [11B, 13B]
Disconnect the vacuum hose of the actuator.

(f) [11B, 13B]
Check the throttle valve angle.

Standard angle: 50 – 52° from horizontal



(g) [11B, 13B]
Using a hexagon wrench, adjust by turning the adjusting screw.

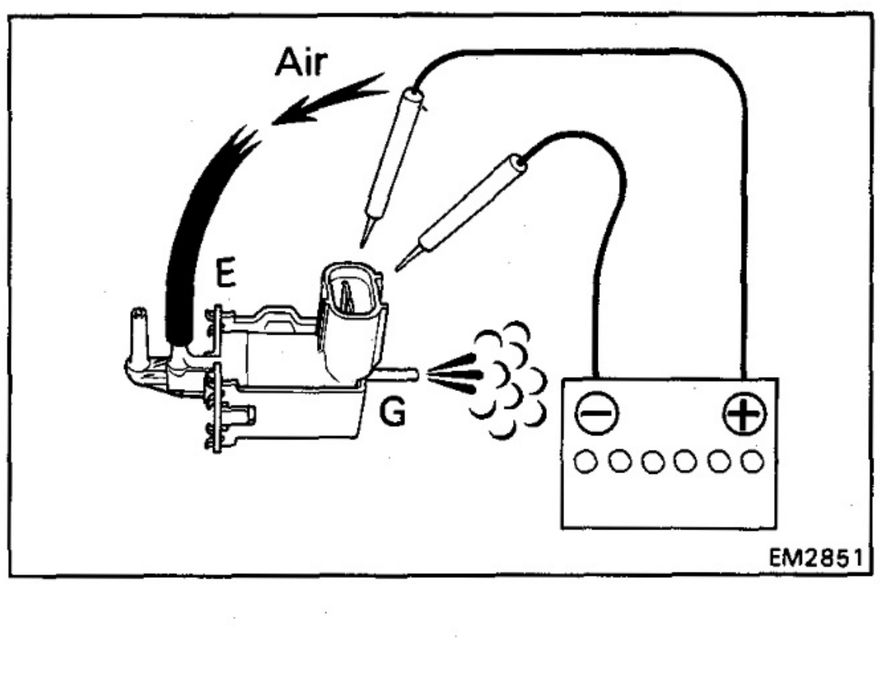


2. INSPECT VACUUM SWITCHING VALVE (VSV)

(a) Connect the VSV terminals to the battery terminals as shown.

CAUTION: There are two types of VSV, 12 V and 24 V, respectively; therefore, check the voltage before connecting.

(b) Blow into pipe E and check that air comes out of pipe F.



(c) Disconnect the battery.

(d) Blow into pipe E and check that air comes out of pipe G.

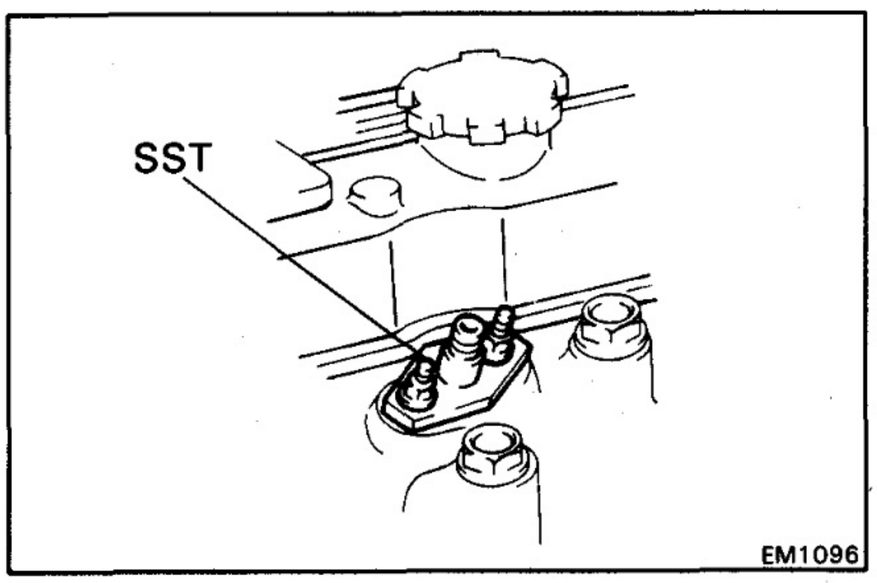
If a problem is found, replace the VSV.

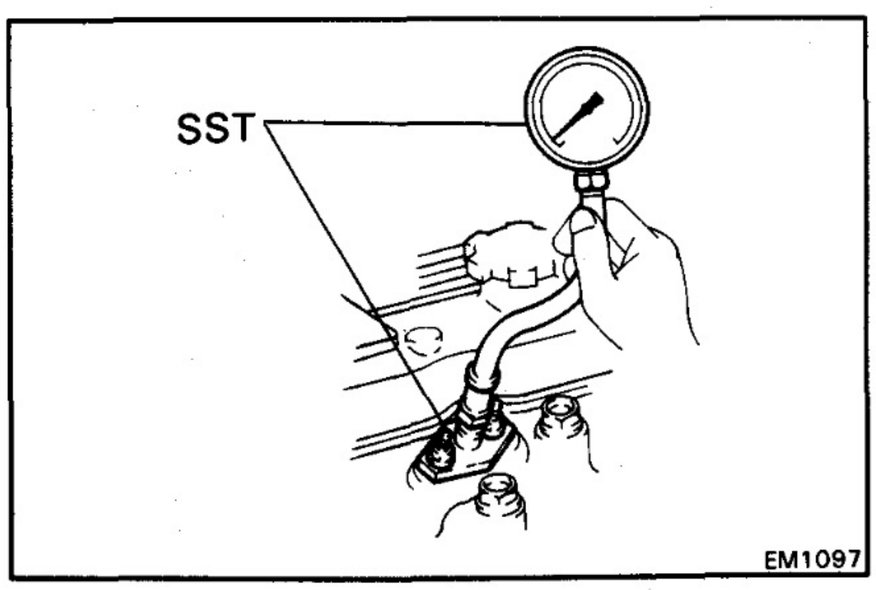
INSPECTION OF COMPRESSION PRESSURE

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

1. **WARM UP ENGINE**

2. **REMOVE INJECTION NOZZLES**
(See steps 1 to 4 on pages FU-5, 6)





3. **MEASURE CYLINDER COMPRESSION PRESSURE**

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

SST 09992-00023

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

SST 09992-00023

(c) Fully open the throttle valve.

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

NOTE: A fully charged battery is necessary to obtain engine revolution 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)
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

CAUTION: When cranking, crank with the injection pump stop lever pushed fully forward.

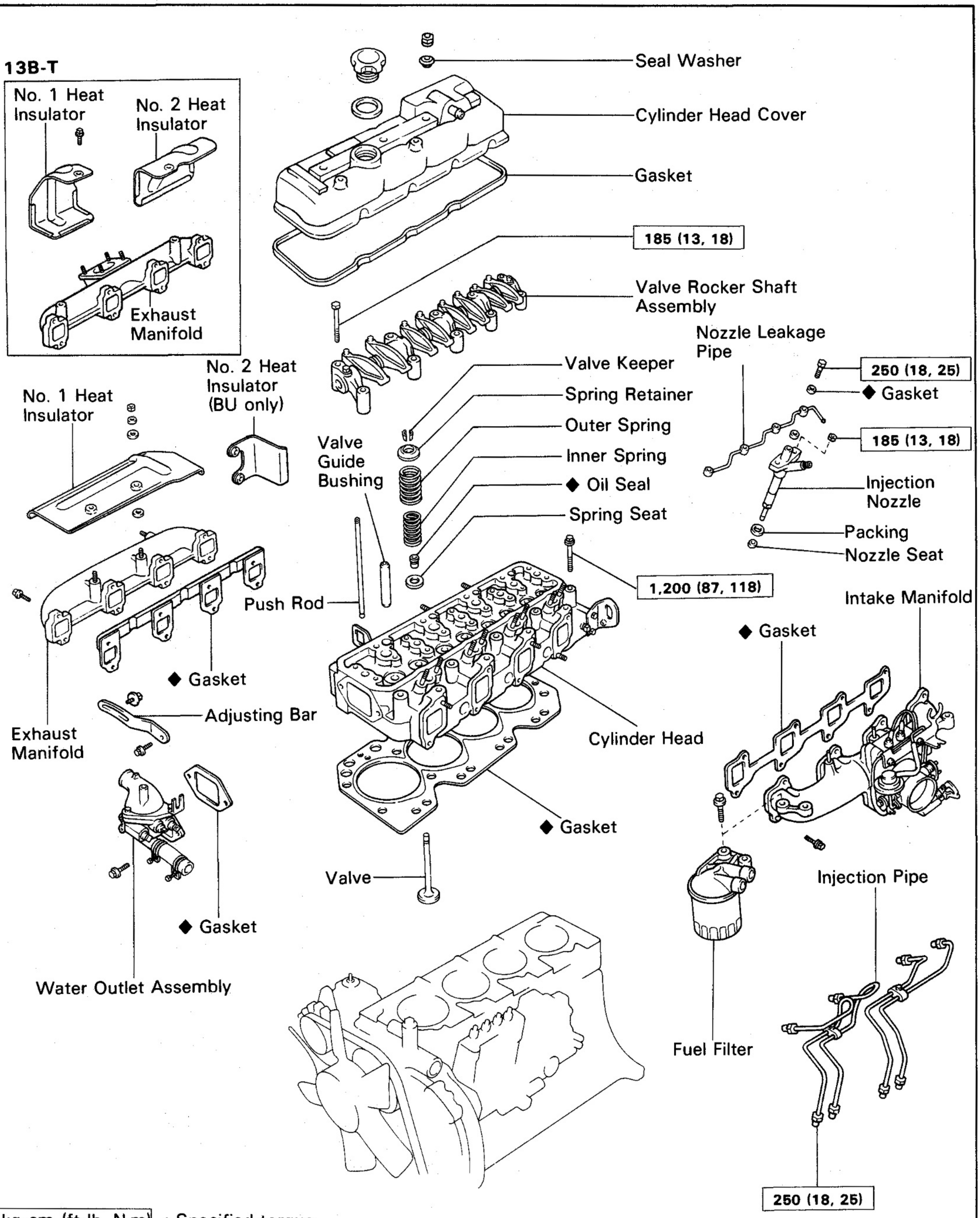
(f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the injection nozzle hole and repeat steps (a) through (d) for the cylinder with low compression.

- 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 leaking past the gasket.

4. **REINSTALL INJECTION NOZZLES**
(See steps 3 to 8 on page FU-10)

CYLINDER HEAD

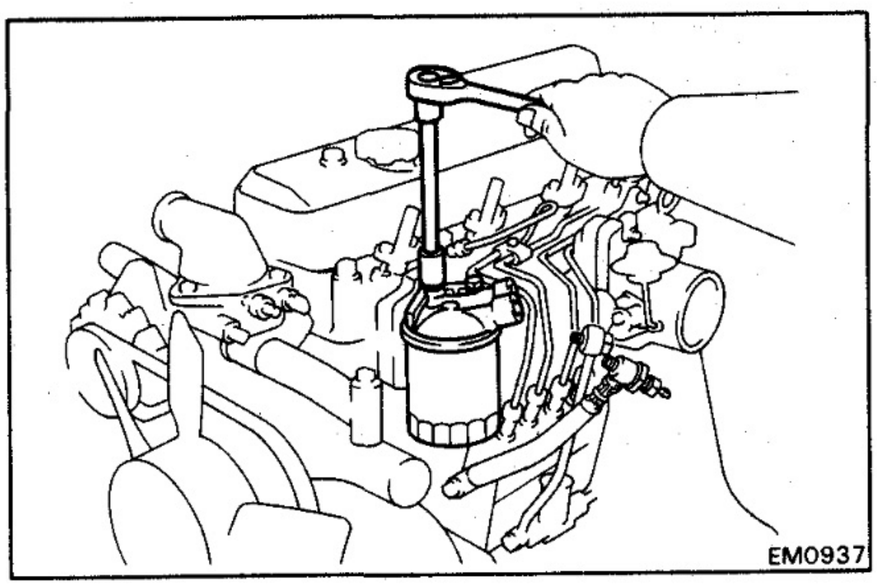
COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

EM2821



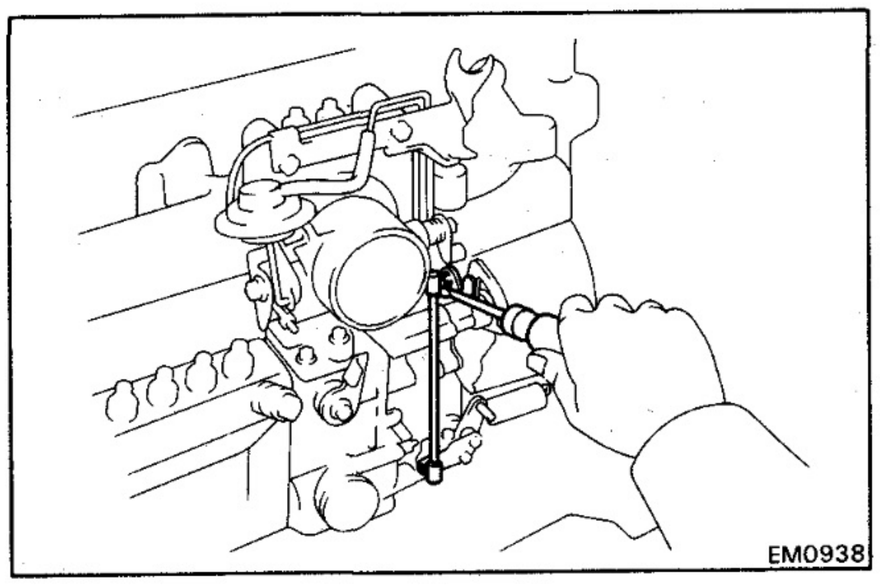
REMOVAL OF CYLINDER HEAD

(See page EM-26)

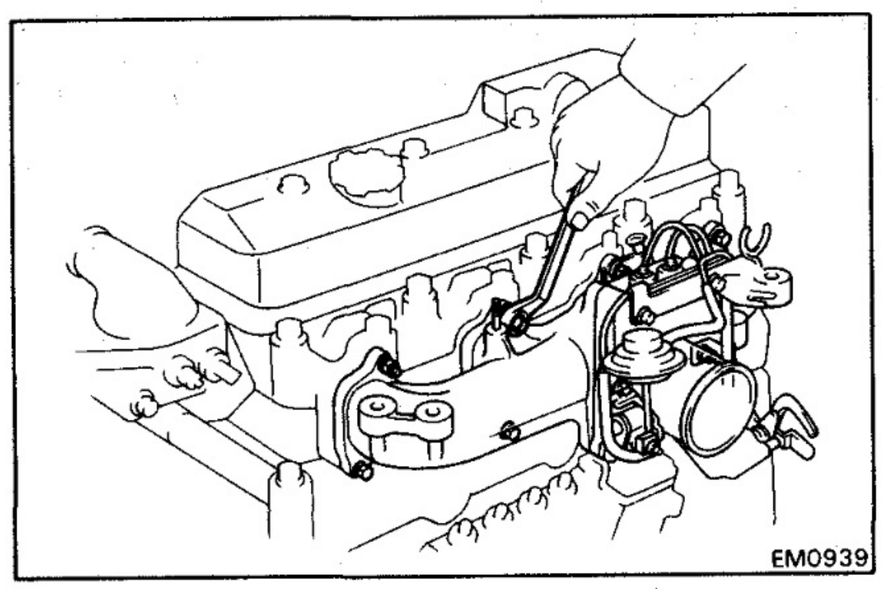
1. [13B-T]
   REMOVE TURBOCHARGER (See page EM-47)

2. REMOVE FUEL FILTER ASSEMBLY

3. REMOVE INJECTION NOZZLES
   (See page FU-5)



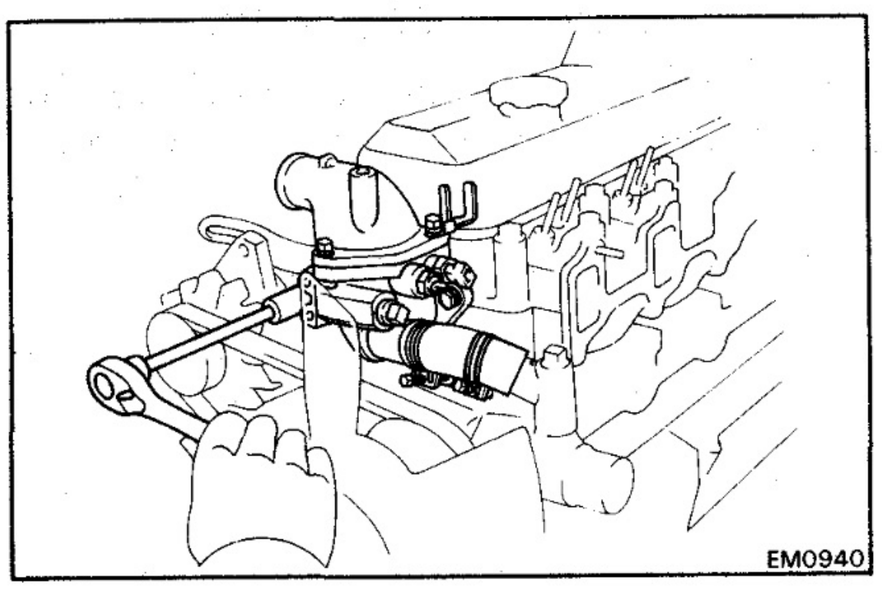
4. DISCONNECT ACCELERATOR CONNECTING ROD FROM ACCELERATOR LINK



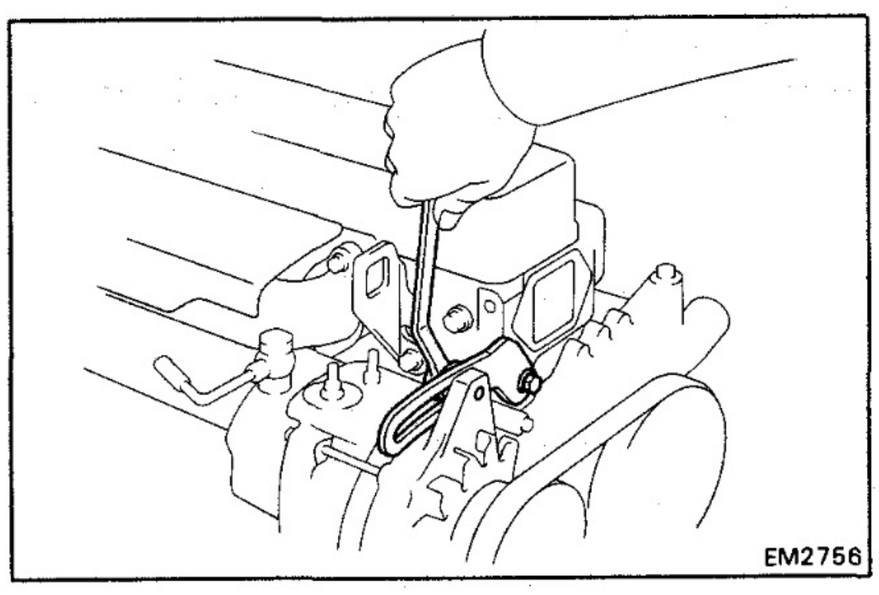
5. REMOVE INTAKE MANIFOLD
   (a) Remove the level gauge.
   (b) Disconnect the vacuum hoses from the intake manifold.
   (c) Remove the five bolts and three nuts holding the level gauge clamp, No. 2 leakage pipe clamps and intake manifold to the cylinder head.

NOTE: If necessary, remove the union bolt of the No. 2 leakage pipe.

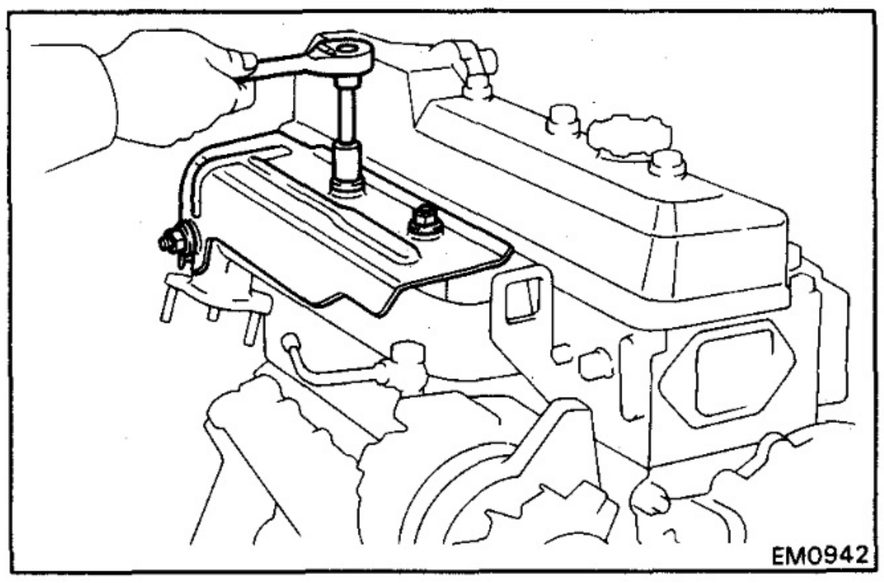
   (d) Remove the intake manifold and gasket.



6. REMOVE WATER OUTLET ASSEMBLY
   (a) [13B-T]
   Remove the bolt and disconnect the vacuum pipe clamp bolt.
   (b) Loosen the by-pass hose clamp on the water pump side.
   (c) Remove the two bolts holding the water outlet housing to the cylinder head.
   (d) Remove the water outlet assembly and gasket.



7. REMOVE DRIVE BELT ADJUSTING BAR
   Remove the two bolts and adjusting bar.



8. REMOVE EXHAUST MANIFOLD

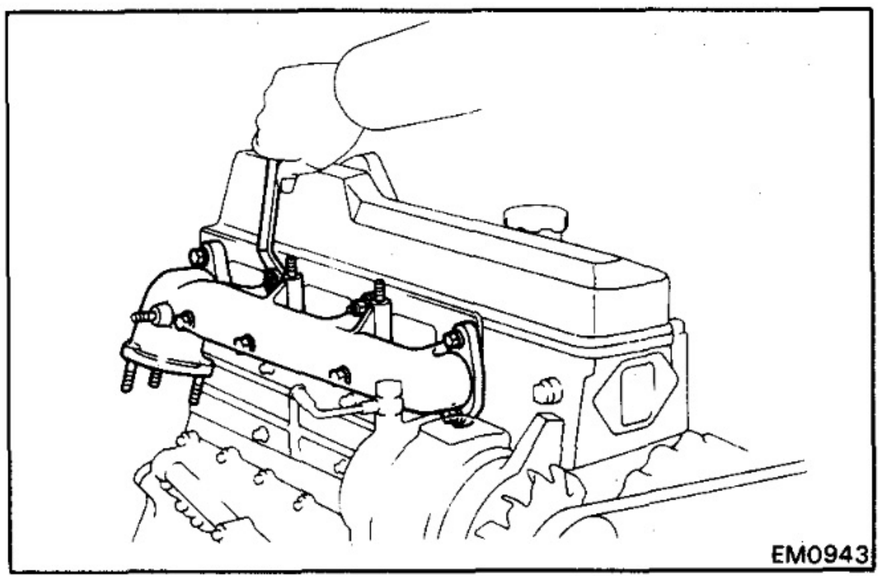
(a) [11B, 13B (Nut tightening type)]
Remove the three nuts, plate washers, No. 1 heat insulator and six spacers.

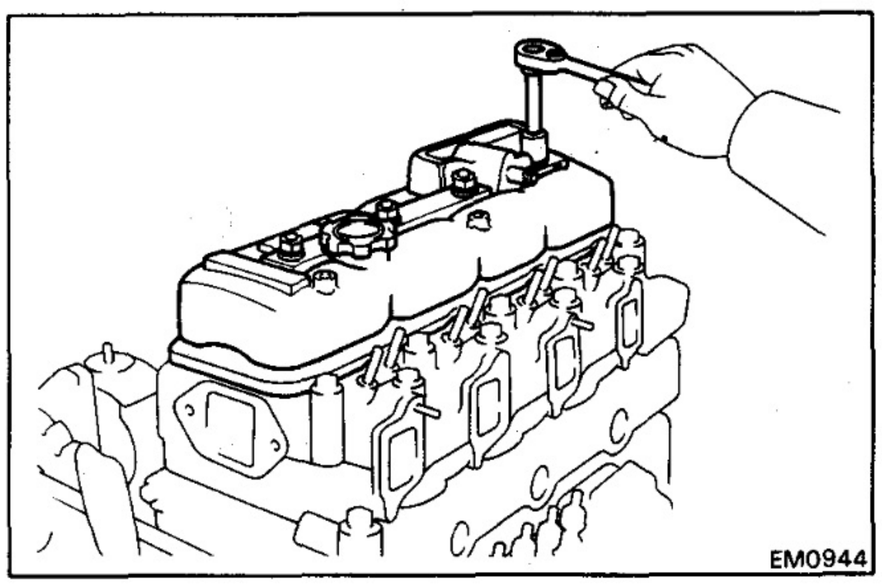
(b) [11B, 13B (Bolt tightening type)]
Remove the three bolts and No. 1 heat insulator.

(c) [13B-T]
Remove the three bolts, No. 1 heat insulator and No. 2 heat insulator.

(d) [13B-T]
Remove the two bolts, nuts and exhaust manifold stay.

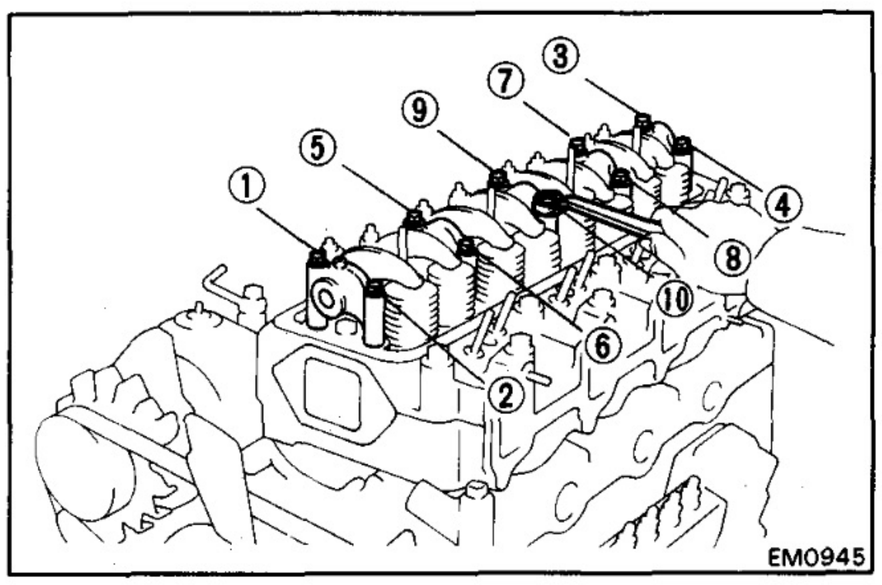
(e) Remove the six bolts, two nuts, exhaust manifold, No. 2 heat insulator (BU only) and gasket.





9. REMOVE CYLINDER HEAD COVER

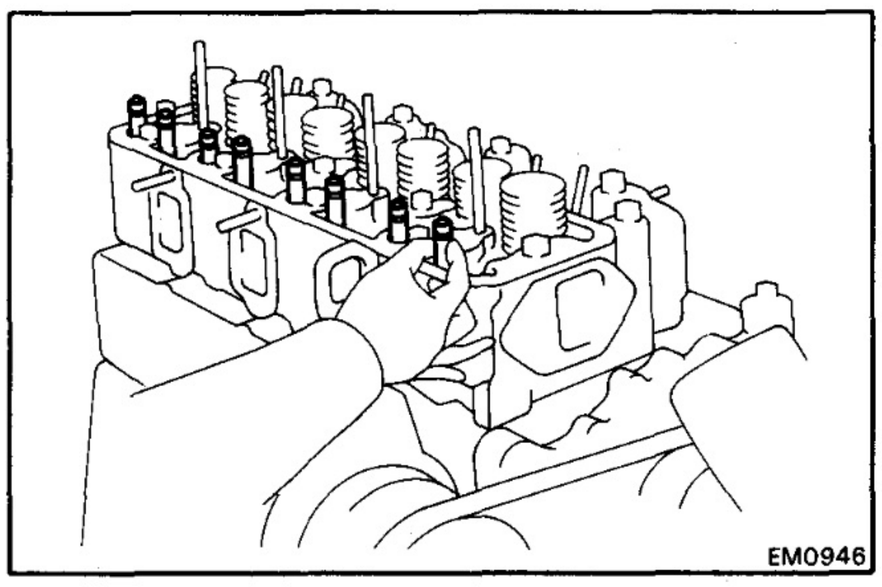
Remove the four cap nuts, seal washers, head cover and gasket.



10. REMOVE VALVE ROCKER SHAFT ASSEMBLY

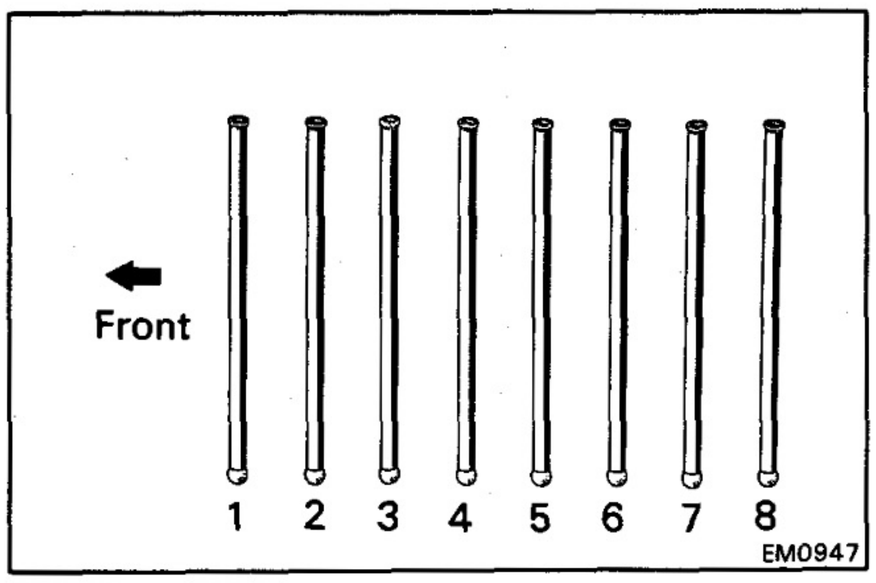
(a) Uniformly loosen and remove the valve rocker support bolts and plate washers in several passes, in the sequence shown.

(b) Remove the rocker shaft assembly.

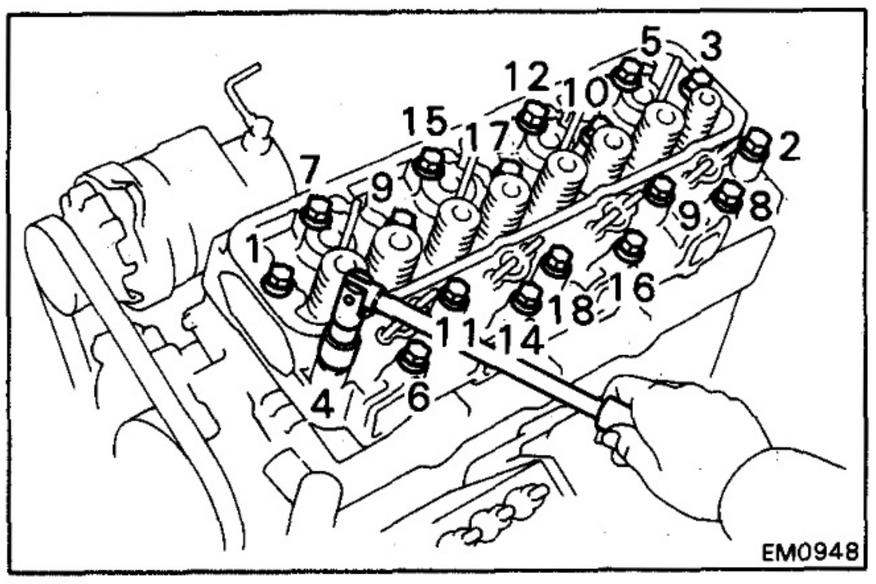


11. REMOVE PUSH RODS

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



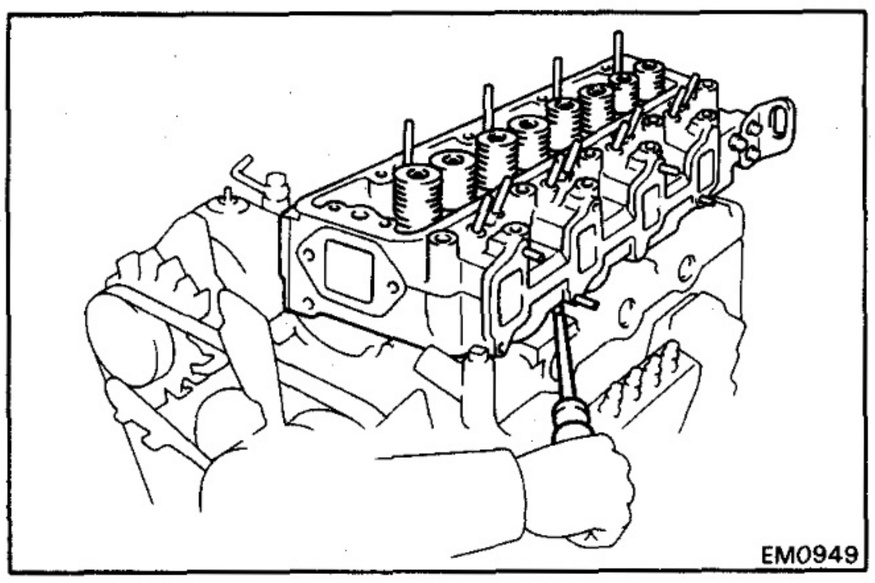
NOTE: Arrange the push rods in correct order.



12. REMOVE CYLINDER HEAD

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

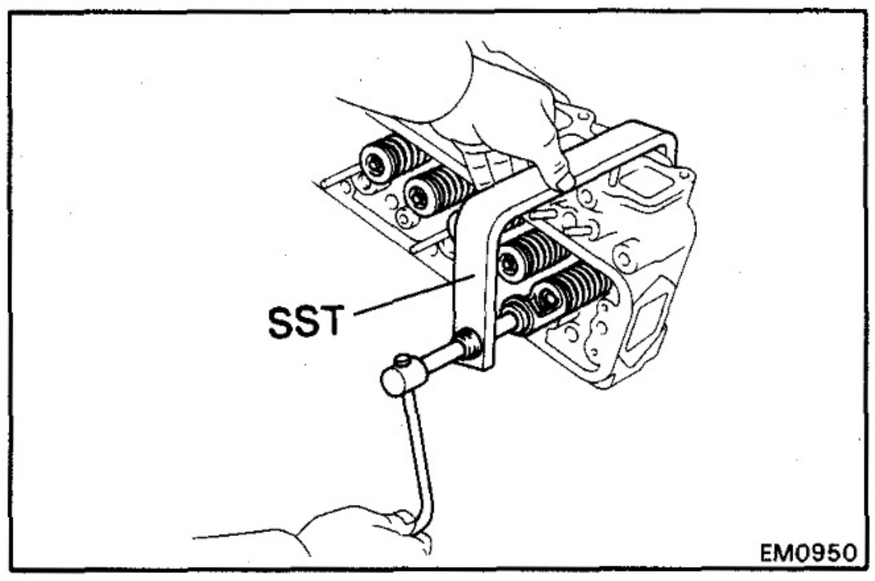
CAUTION: Head warpage or cracking could result from removing bolts out of order.



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

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

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



DISASSEMBLY OF CYLINDER HEAD

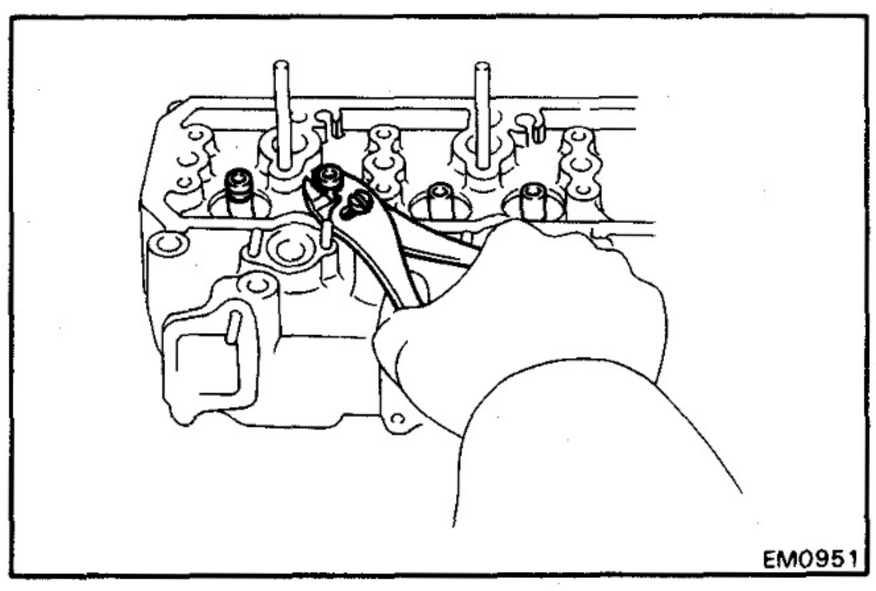
(See page EM-26)

REMOVE VALVES

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

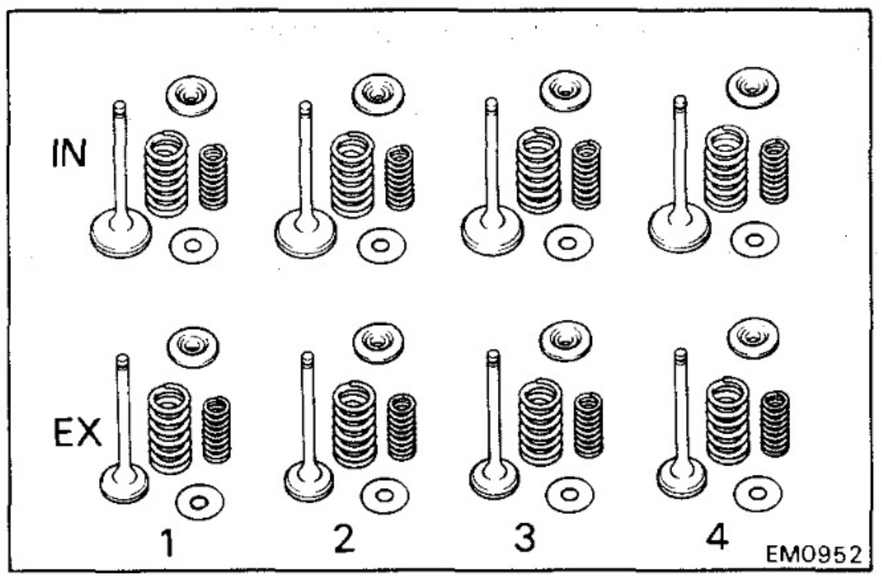
SST 09202-43013

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

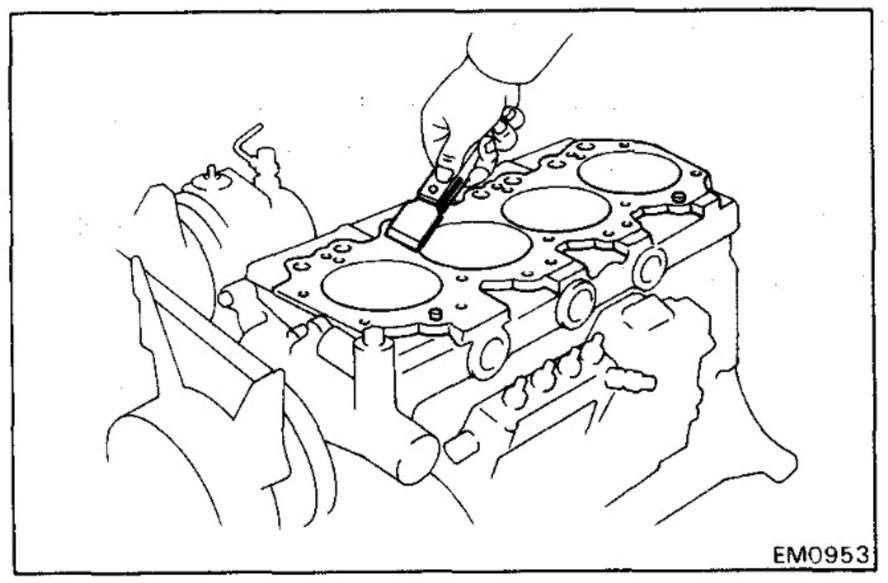


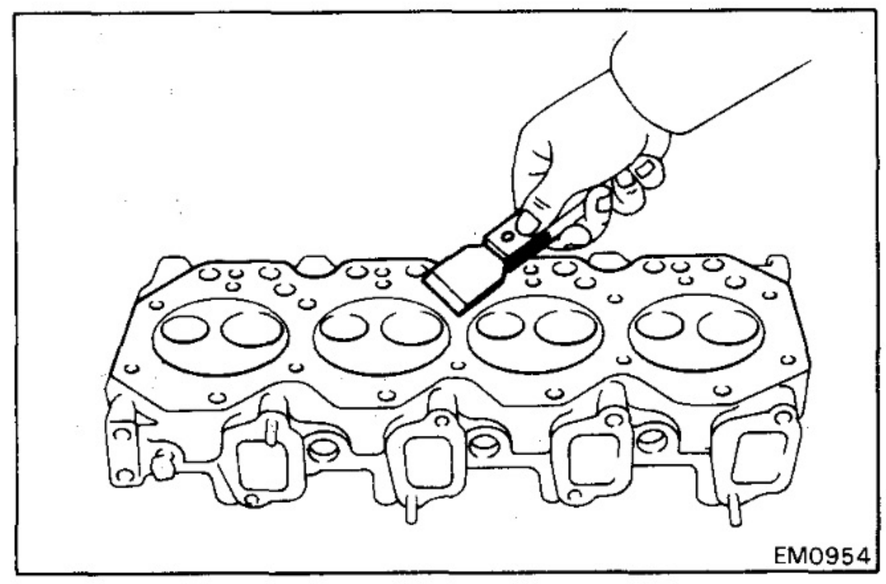
(c) Using pliers, pry out the oil seal.

(d) Remove the spring seat.



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





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 tops.

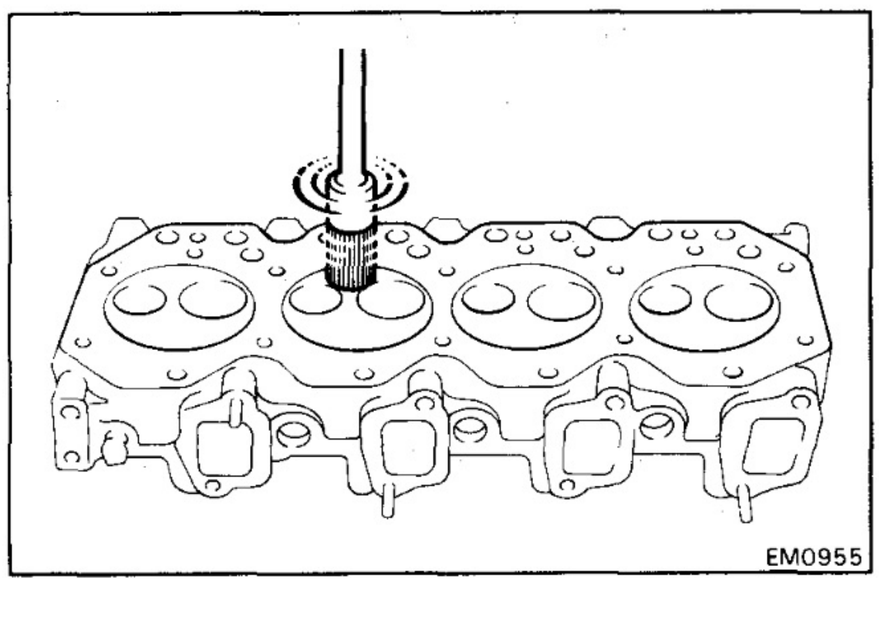
(b) Using a gasket scraper, remove all the gasket material from the top of the block. Blow any carbon, remaining gasket material or oil from the bolt hole.

WARNING: Protect your eyes when using high pressure air.

2. REMOVE GASKET MATERIAL

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

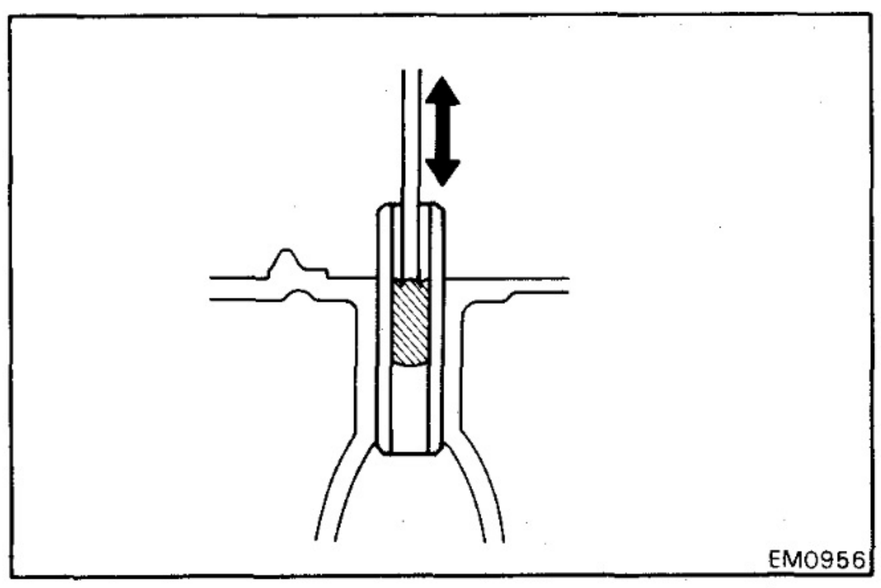
CAUTION: Be careful not to scratch the surfaces.



3. CLEAN COMBUSTION CHAMBERS

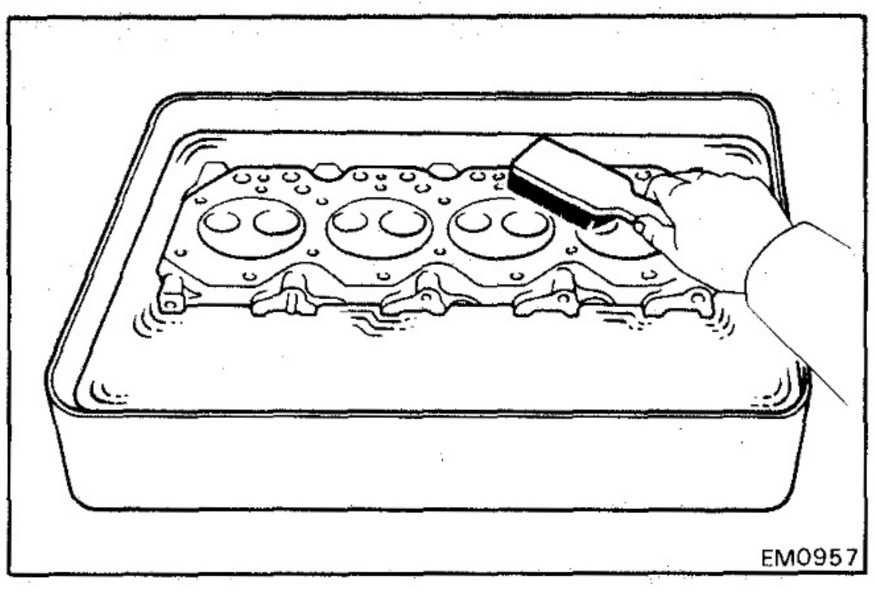
Using a wire brush, remove all the carbon from the combustion chambers.

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



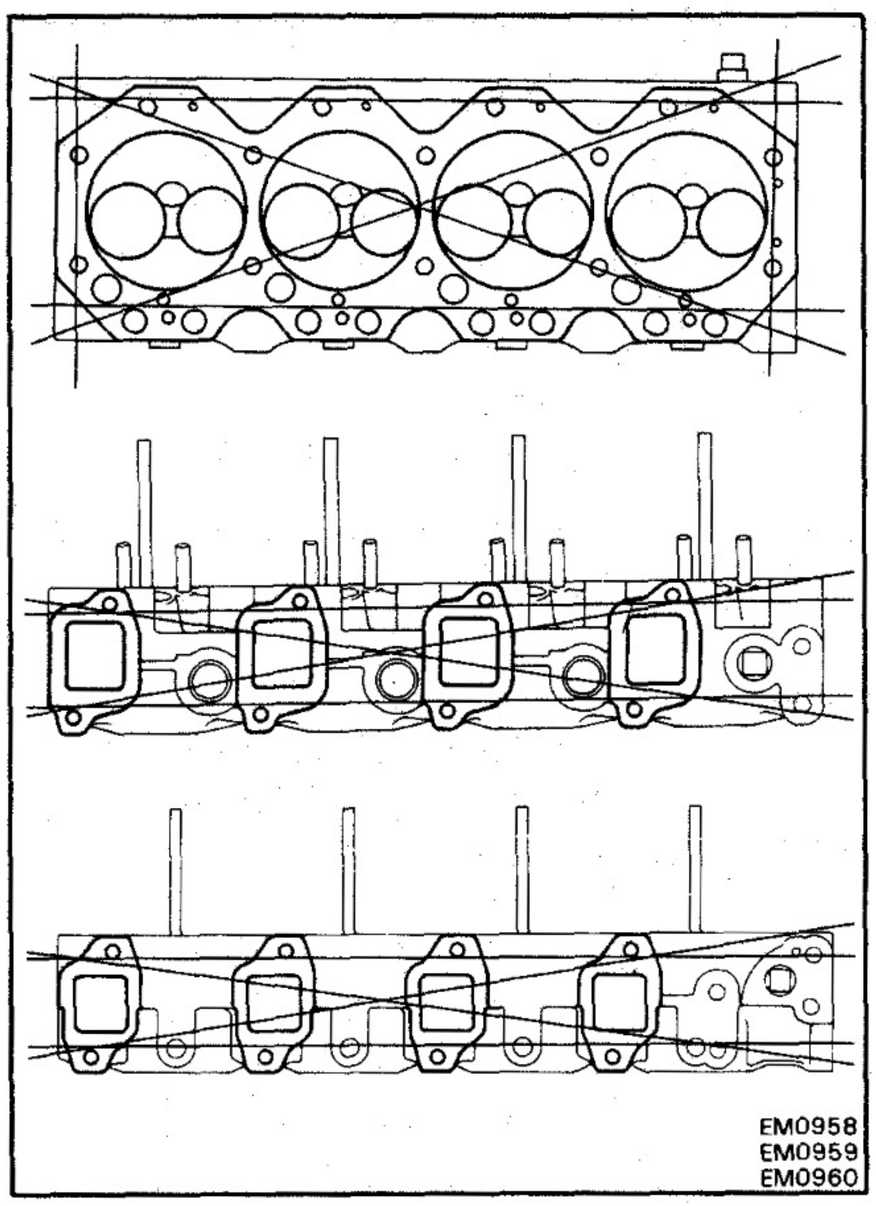
4. CLEAN VALVE GUIDE BUSHINGS

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



5. CLEAN CYLINDER HEAD

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

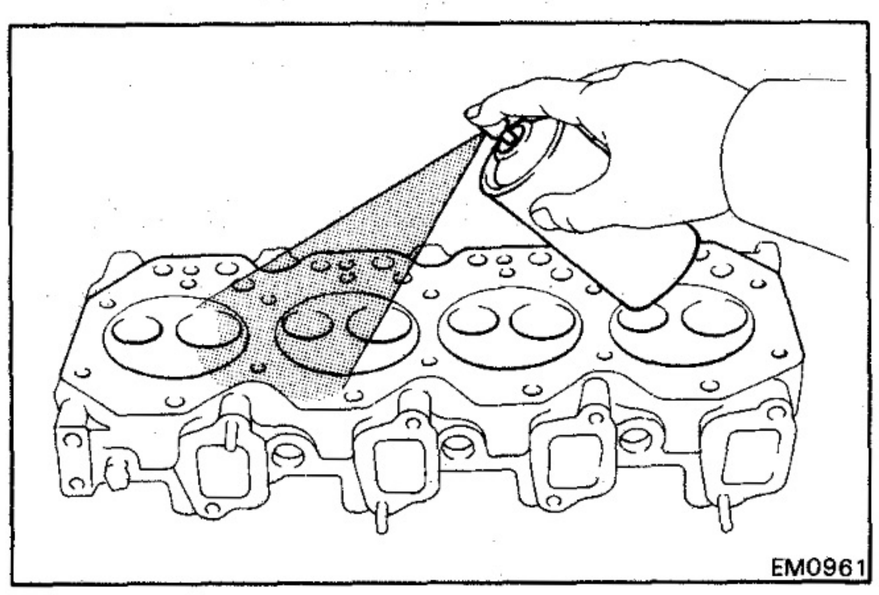


6. INSPECT CYLINDER HEAD FOR FLATNESS

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

Maximum warpage: 0.2 mm (0.008 in.)

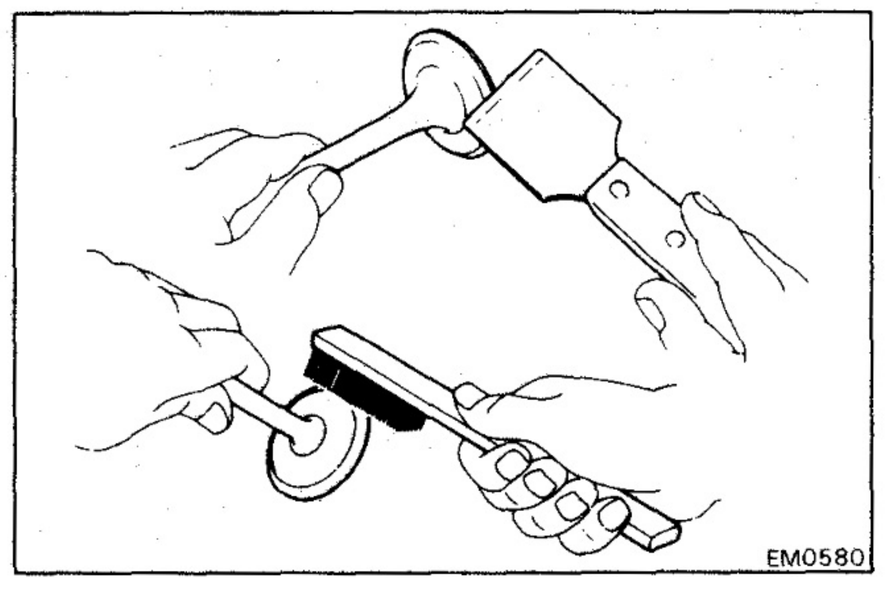
If warpage is greater than maximum, replace the cylinder head.



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.

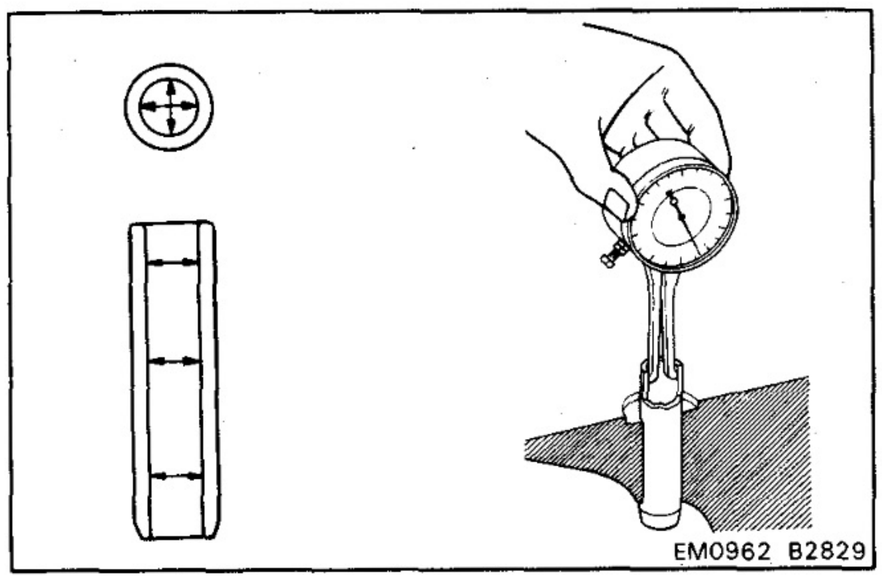
If cracked, replace the cylinder head.



8. CLEAN VALVES

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

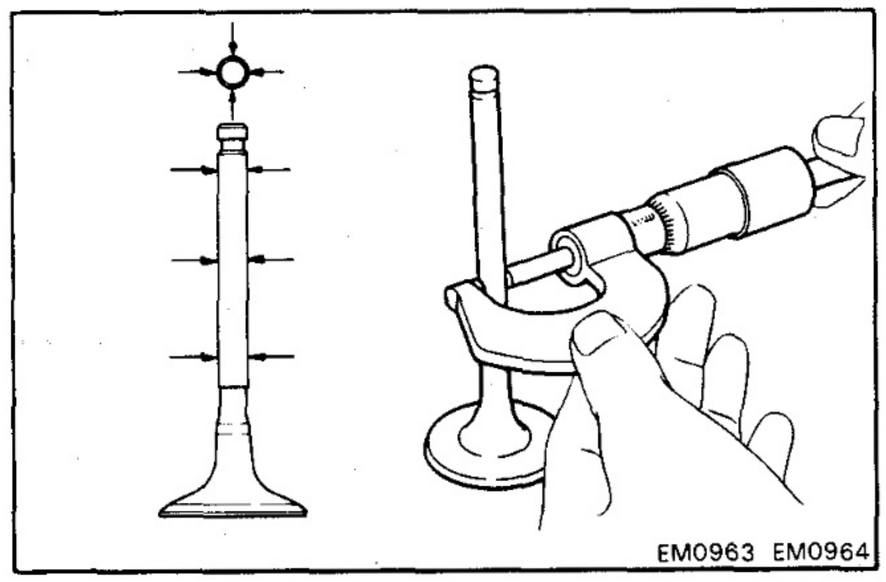
(b) Using a wire brush, thoroughly clean the valve.



9. INSPECT VALVE STEMS AND GUIDE BUSHINGS

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

Guide bushing inside diameter:
9.01 – 9.03 mm (0.3547 – 0.3555 in.)



(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	**11B, 13B**	**8.954 – 8.970 mm (0.3525 – 0.3531 in.)**
	13B-T	**8.940 – 8.956 mm (0.3520 – 0.3526 in.)**

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

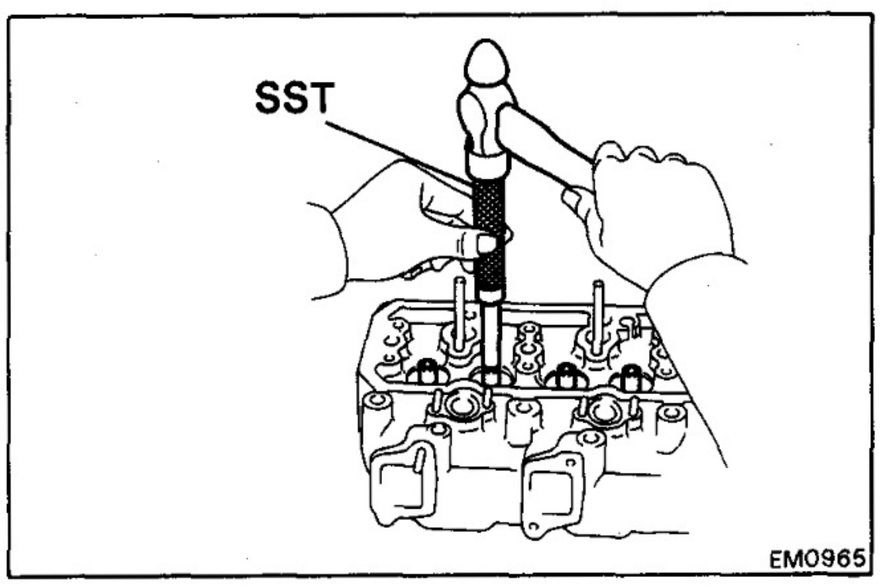
Standard oil clearance:

Intake		**0.026 – 0.062 mm (0.0010 – 0.0024 in.)**
Exhaust	**11B, 13B**	**0.040 – 0.076 mm (0.0016 – 0.0030 in.)**
	13B-T	**0.054 – 0.090 mm (0.0021 – 0.0035 in.)**

Maximum oil clearance:

Intake		**0.10 mm (0.0039 in.)**
Exhaust	**11B, 13B**	**0.12 mm (0.0047 in.)**
	13B-T	**0.13 mm (0.0051 in.)**

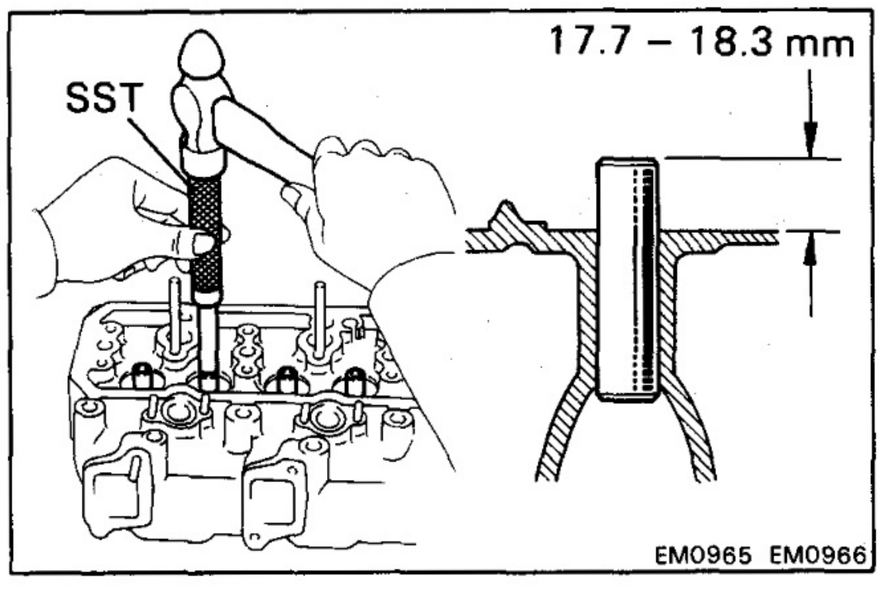
If the clearance is greater than maximum, replace the valve and guide bushing.



10. IF NECESSARY, REPLACE VALVE GUIDE BUSHINGS

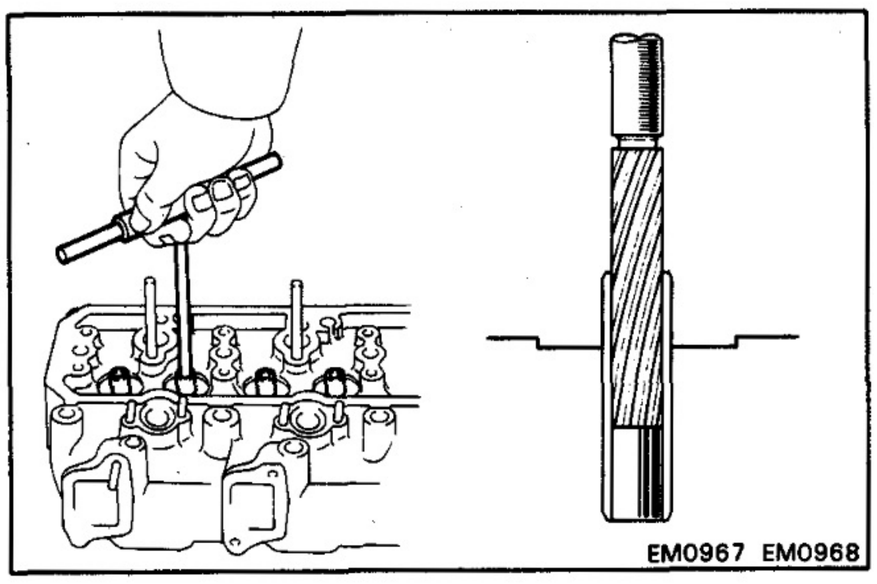
(a) Using SST and a hammer, drive out the valve guide bushing.

SST 09201-60011



(b) Using SST and a hammer, drive in a new valve guide bushing to where there is 17.7 – 18.3 mm (0.697 – 0.720 in.) protruding from the cylinder head.

SST 09201-60011


EM0967 EM0968

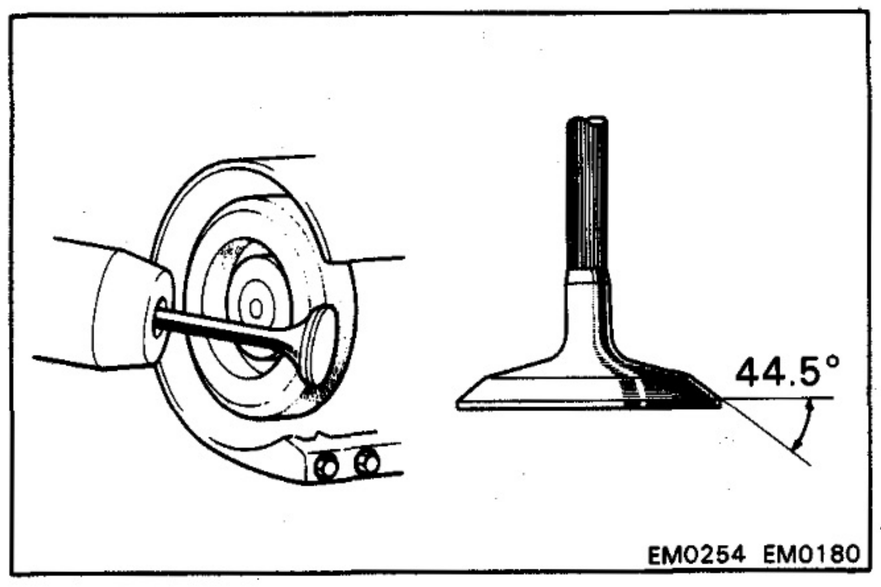
(c) Using a sharp 9 mm reamer, ream the valve guide bushing to obtain the standard specified clearance (See page EM-32) between the valve guide bushing and new valve stem.

11. INSPECT AND GRIND VALVES

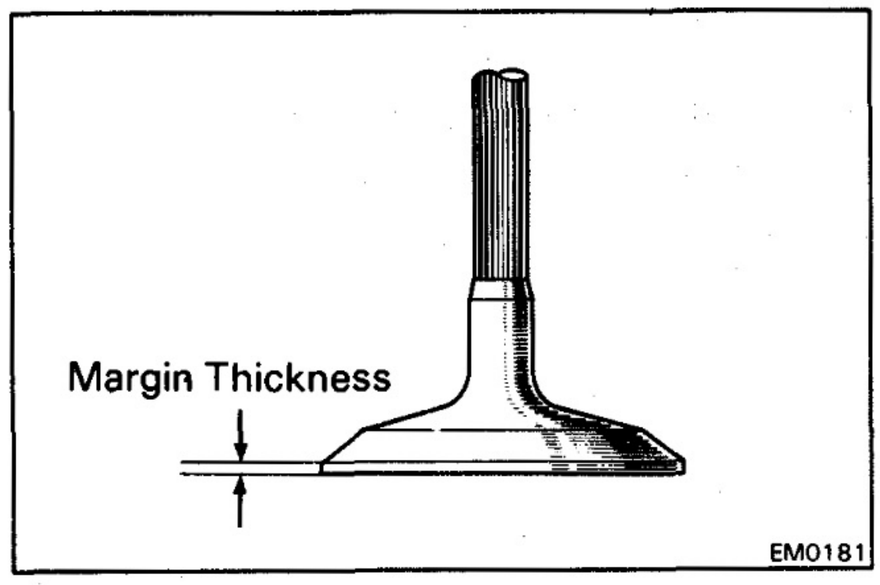
(a) Grind the valve only enough to remove pits and carbon.

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

Valve face angle: 44.5°



EM0254 EM0180



EM0181

(c) Check the valve head margin thickness.

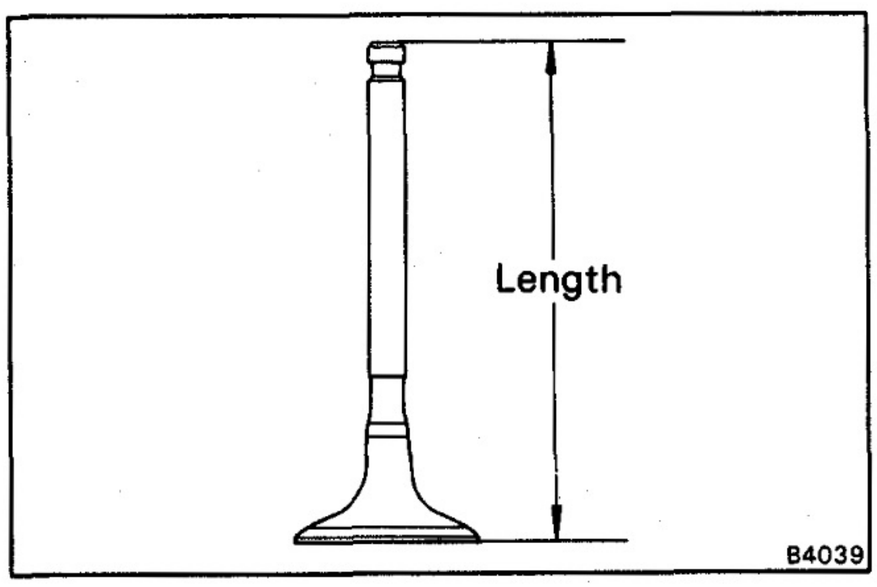
Standard margin thickness:

Intake		**1.4 mm (0.055 in.)**
Exhaust	**11B**	**1.3 mm (0.051 in.)**
	13B, 13B-T	**1.7 mm (0.067 in.)**

Minimum margin thickness:

Intake		**0.9 mm (0.035 in.)**
Exhaust	**11B**	**0.8 mm (0.031 in.)**
	13B, 13B-T	**1.2 mm (0.047 in.)**

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

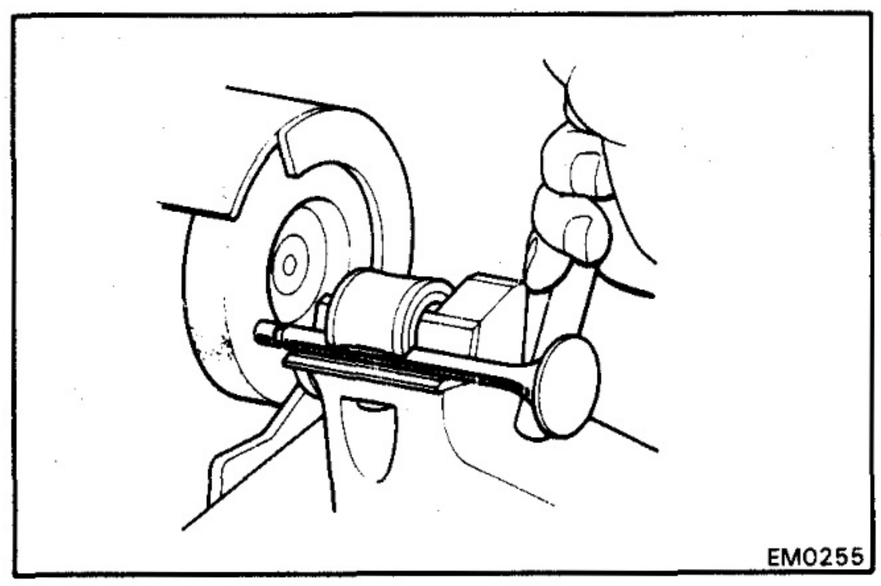


B4039

(d) Check the valve overall length.

Standard overall length: 127.95 mm (5.0374 in.)
Minimum overall length: 127.45 mm (5.0177 in.)

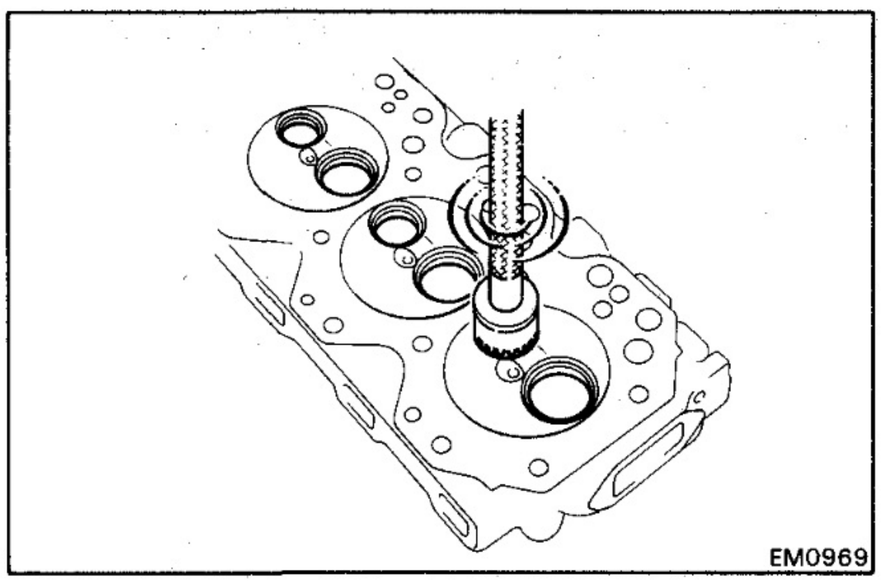
If the valve overall length is less than minimum, replace the valve.


EM0255

(e) Check the surface of the valve stem tip for wear.

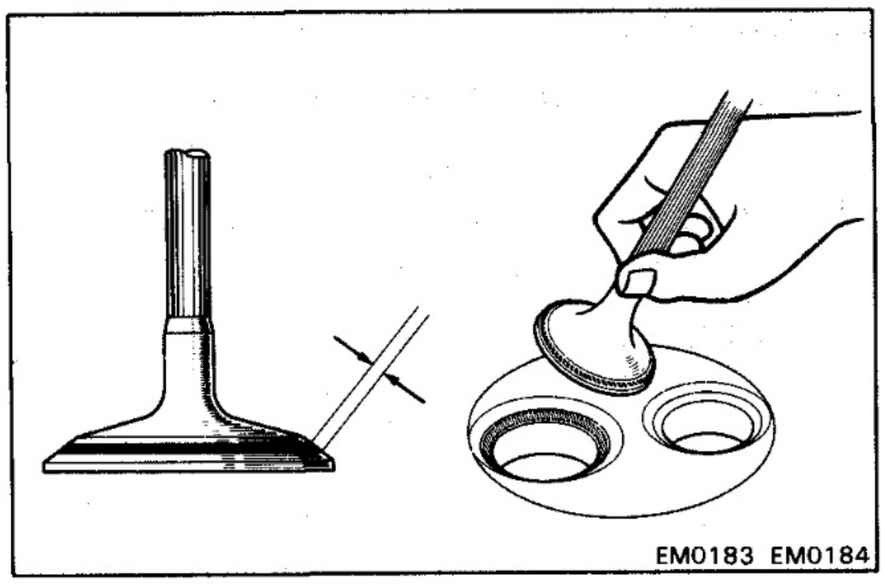
If the valve stem tip is worn, regrind the valve stem tip with a grinder. Replace the valve if necessary.

CAUTION: Do not grind off more than the minimum overall length.


EM0969

12. INSPECT AND CLEAN VALVE SEATS

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


EM0183 EM0184

(b) Check the valve seating position.

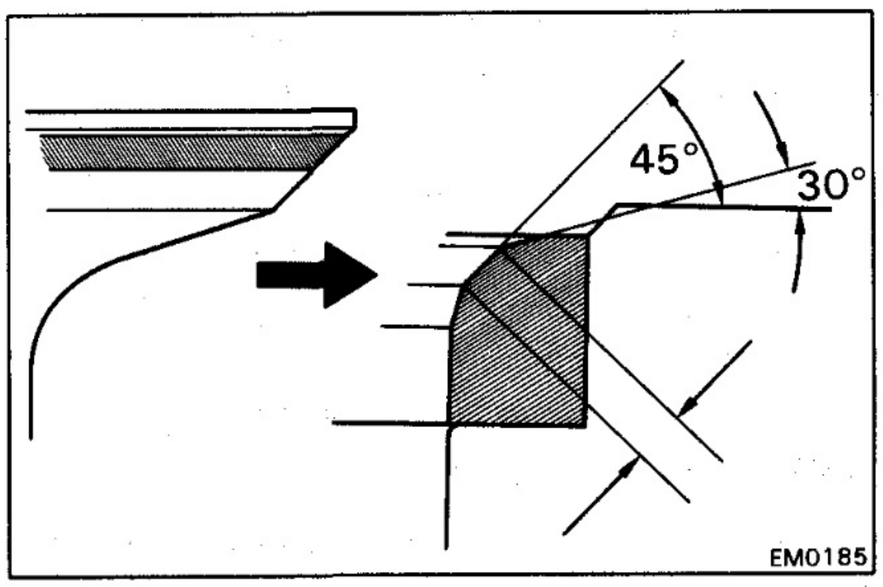
Apply a thin coat of prussian blue (or white lead) to the valve face. Install the valve. While applying light pressure to the valve, rotate the valve against the seat.

(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:

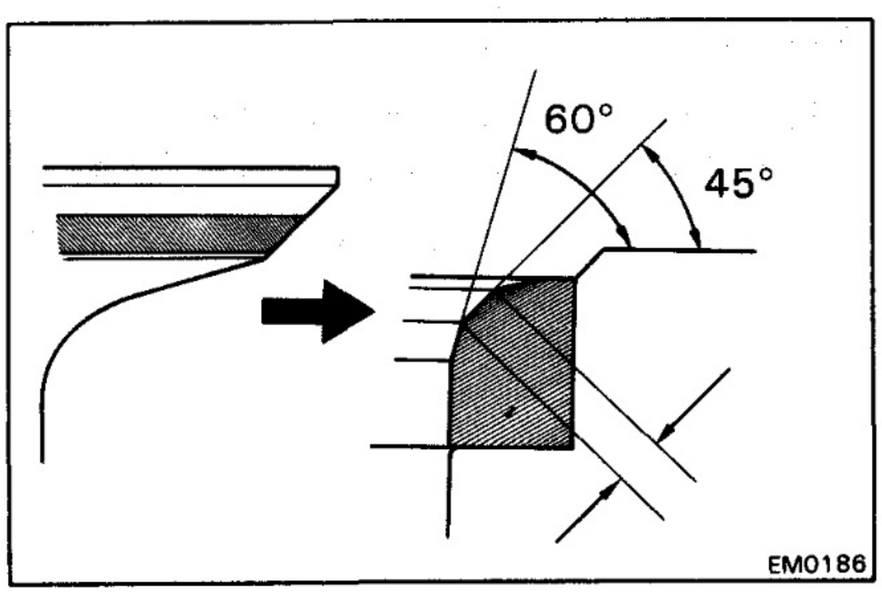
1.9 – 2.3 mm (0.075 – 0.091 in.)

If not, correct the valve seat as follows:



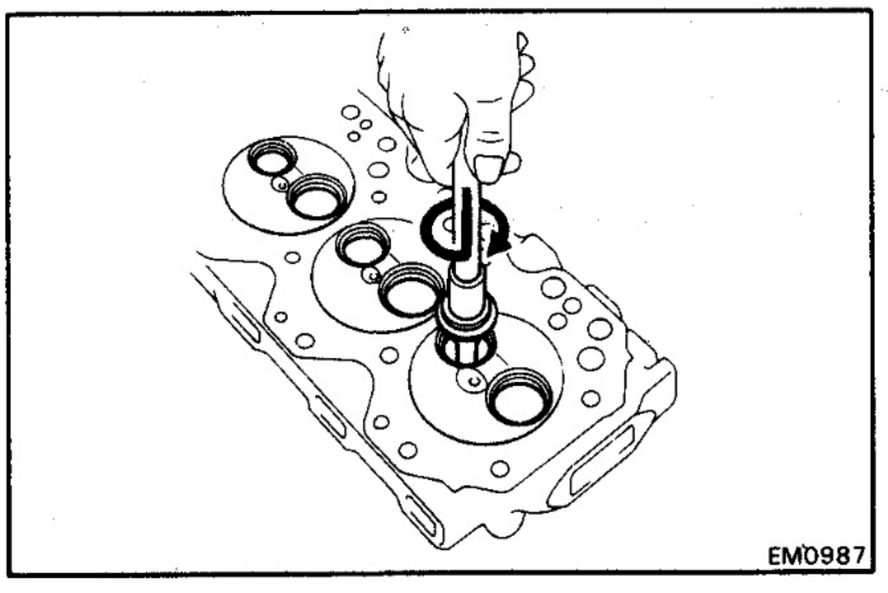
EM0185

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



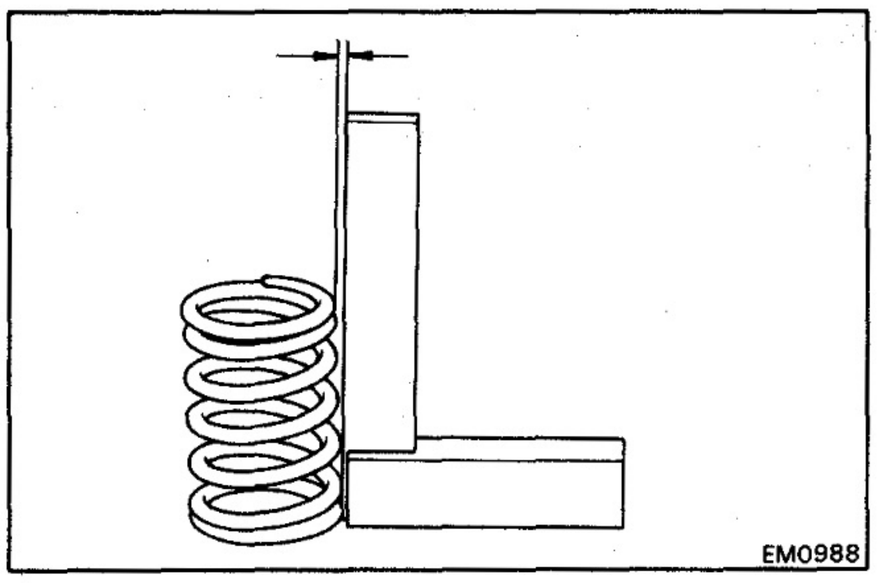
EM0186

(2) If seating is too low on the valve face, use 60° and 45° cutters to correct the seat.


EM0987

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

(e) Clean the valve and valve seat after hand-lapping.

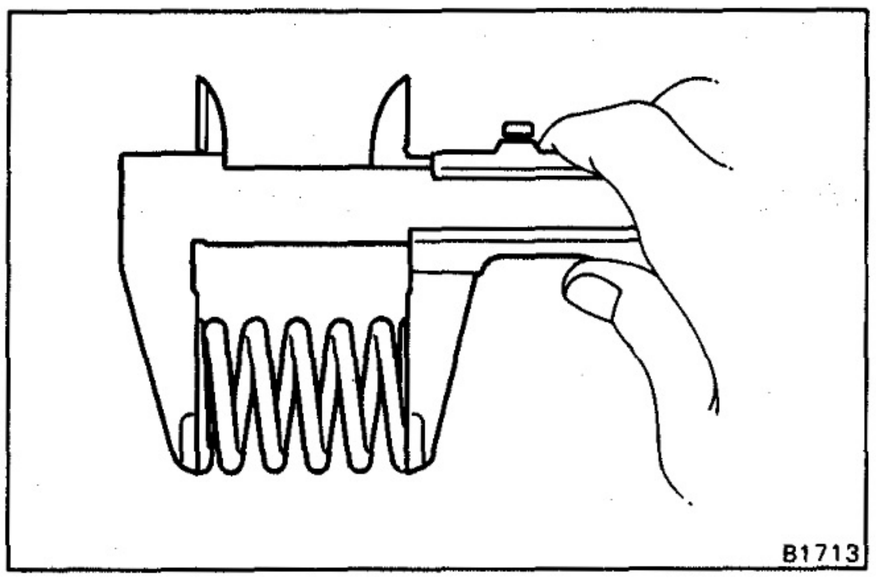


13. INSPECT VALVE SPRINGS

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

Maximum squareness: 2.0 mm (0.079 in.)

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

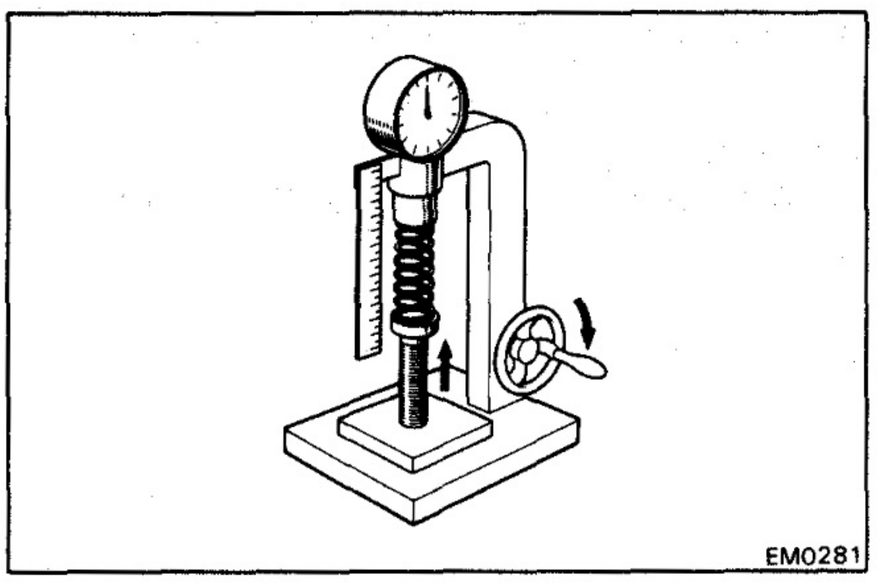


(b) Using calipers, measure the free length of the valve spring.

Standard free length:
Inner spring 54.84 mm (2.1591 in.)
Outer spring 58.30 mm (2.2953 in.)

Minimum free length:
Inner spring 52.80 mm (2.0787 in.)
Outer spring 56.30 mm (2.2165 in.)

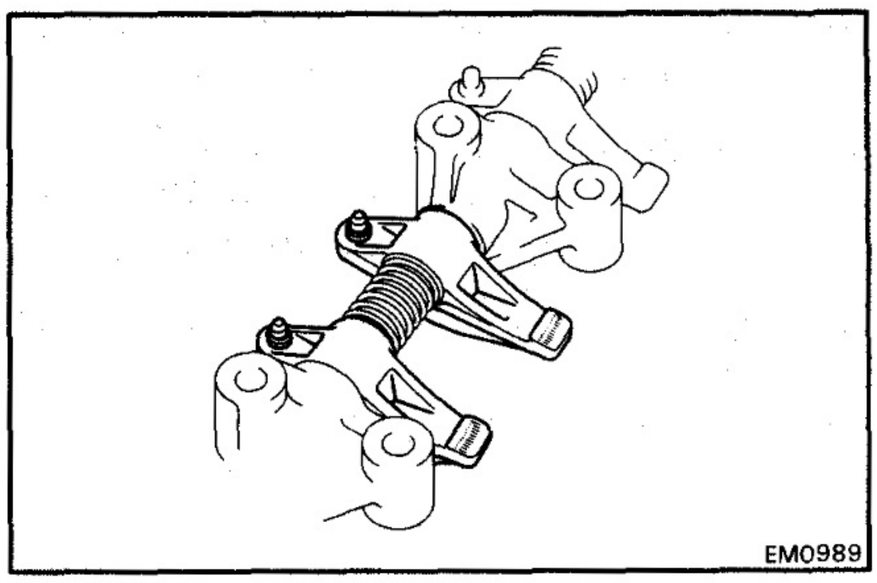
If the free length is less than minimum, replace the valve spring.



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

Installed tension:
Inner spring
14.2 kg (31.3 lb, 139 N) at
42.25 mm (1.6634 in.)
Outer spring
27.8 kg (61.2 lb, 273 N) at
44.75 mm (1.7618 in.)

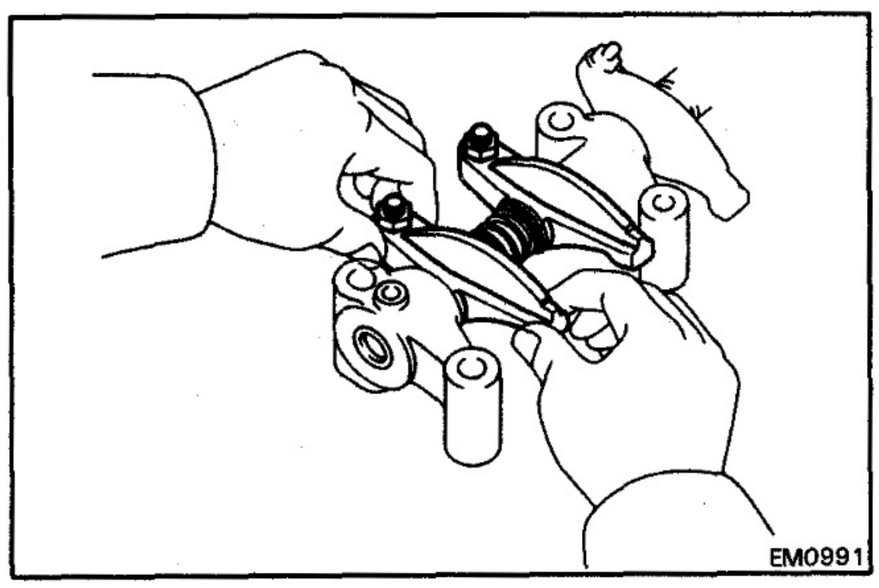
If the installed tension is not as specified, replace the valve spring.



14. INSPECT VALVE ROCKER SHAFT ASSEMBLY

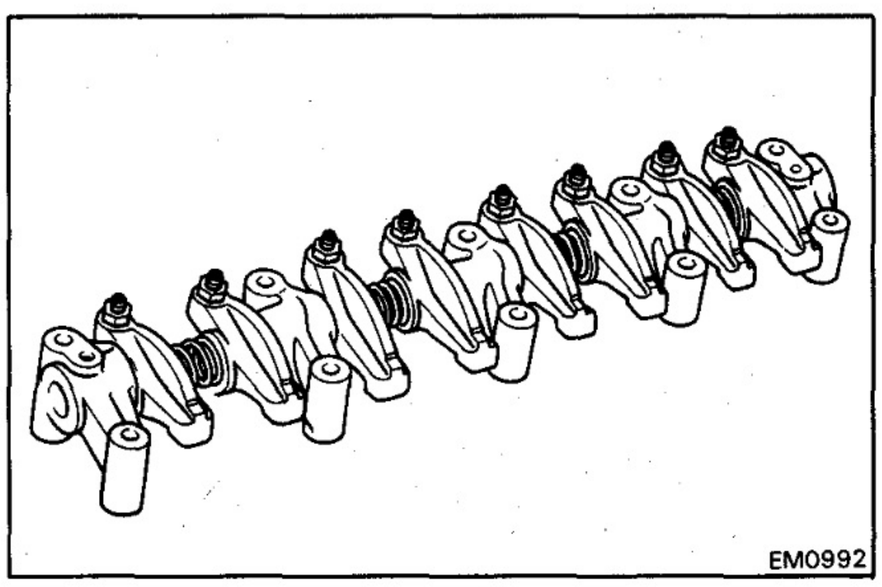
(a) Check the valve stem contacting surface of the rocker arm for wear.

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



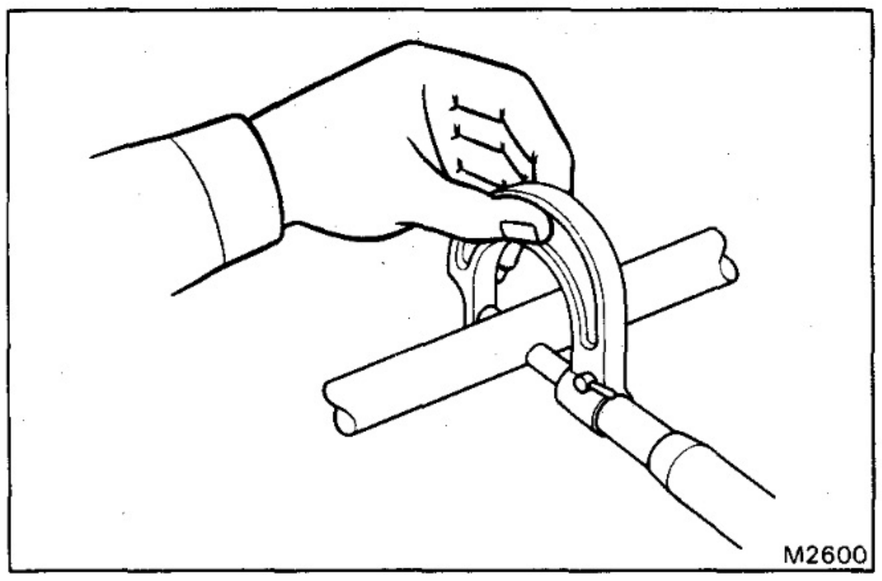
(b) Check the clearance between the rocker arms and shaft by moving the rocker arms as shown. Little or no movement should be felt.

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


EM0992

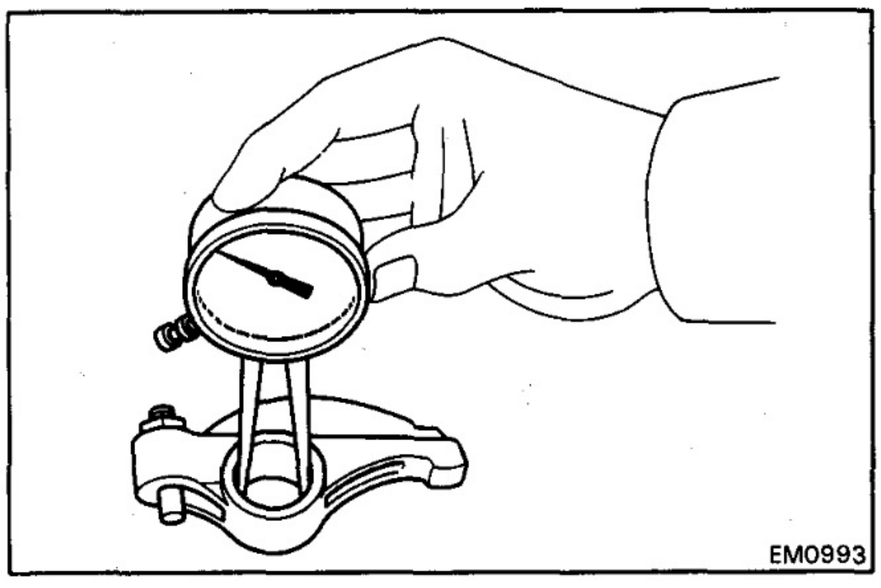
(c) Disassemble the rocker shaft assembly.

NOTE: Arrange the rocker arms, springs and rocker supports in correct order.


M2600

(d) Using a micrometer, measure the diameter of the valve rocker shaft.

Rocker shaft diameter:
18.472 — 18.493 mm (0.7272 — 0.7280 in.)


EM0993

(e) Using a caliper gauge, measure the inside diameter of the rocker arm.

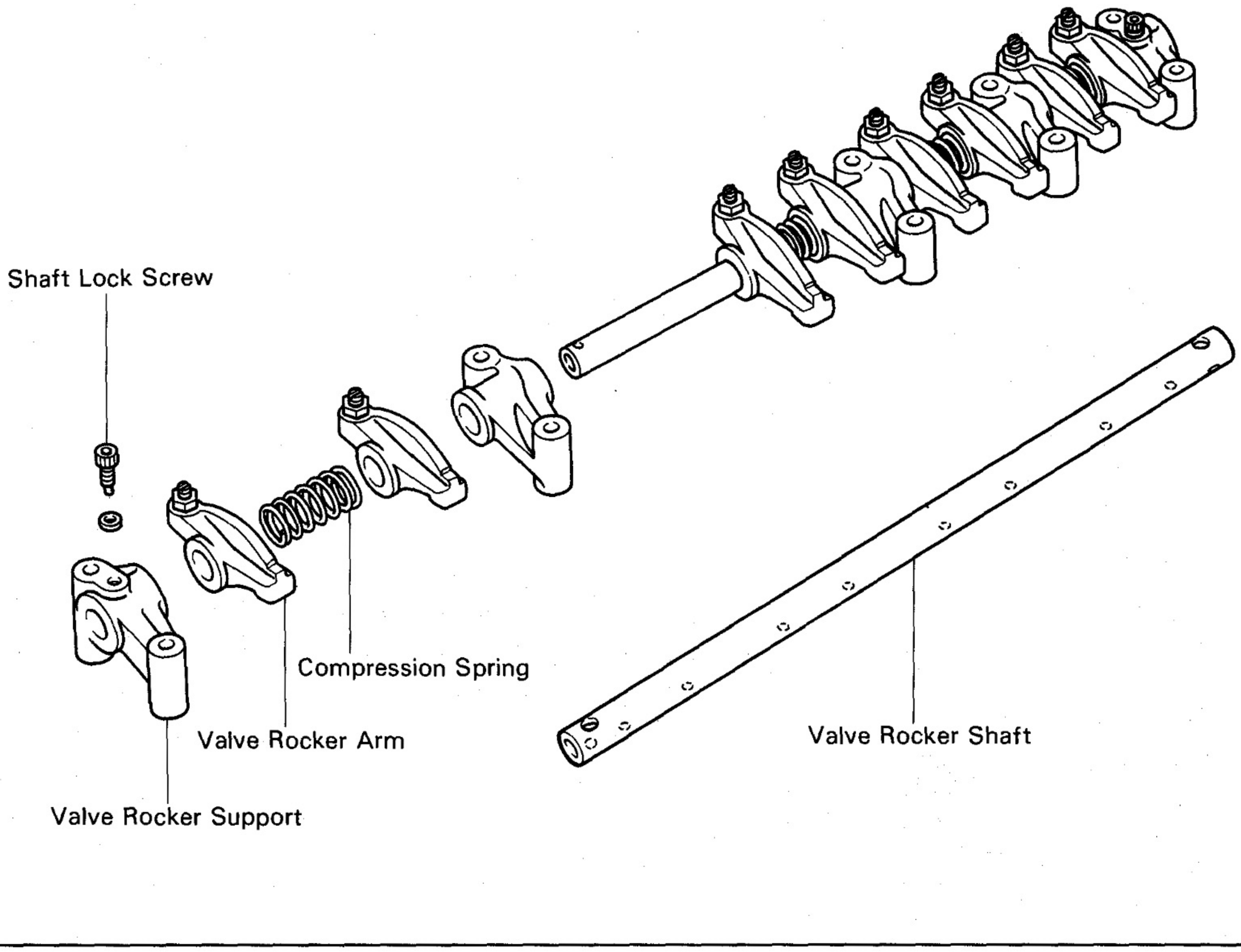
Rocker arm inside diameter:
18.512 — 18.533 mm (0.7288 — 0.7296 in.)

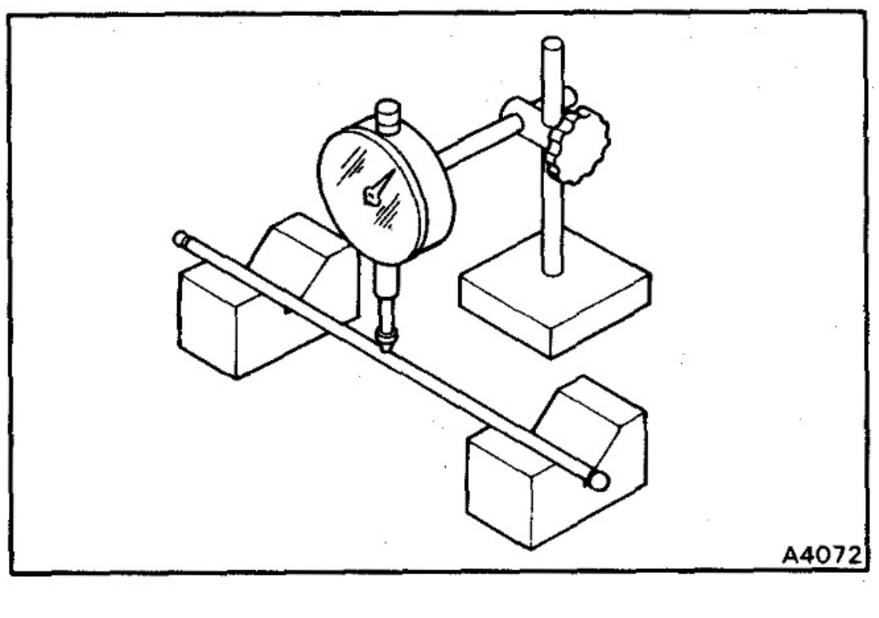
(f) Subtract the rocker shaft measurement from the rocker arm measurement.

Standard oil clearance: **0.019 — 0.061 mm (0.0007 — 0.0024 in.)**
Maximum oil clearance: **0.1 mm (0.004 in.)**

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

(g) Assemble the rocker shaft assembly as shown.



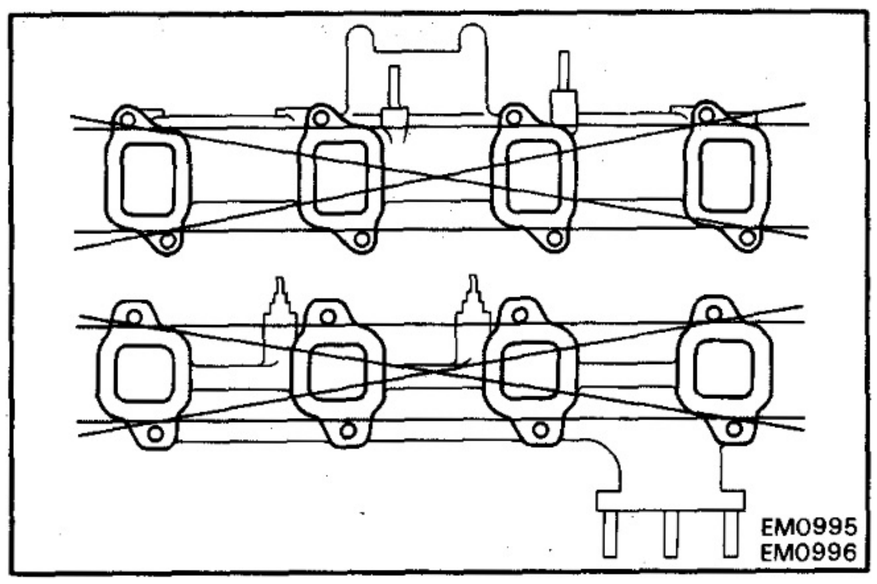


15. INSPECT PUSH RODS

Place the push rod on V-blocks and, using a dial indicator, measure the circle runout at the center of the push rod.

Maximum circle runout: 0.5 mm (0.020 in.)

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



16. INSPECT INTAKE AND EXHAUST MANIFOLDS

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

Maximum manifolds warpage: 0.4 mm (0.016 in.)

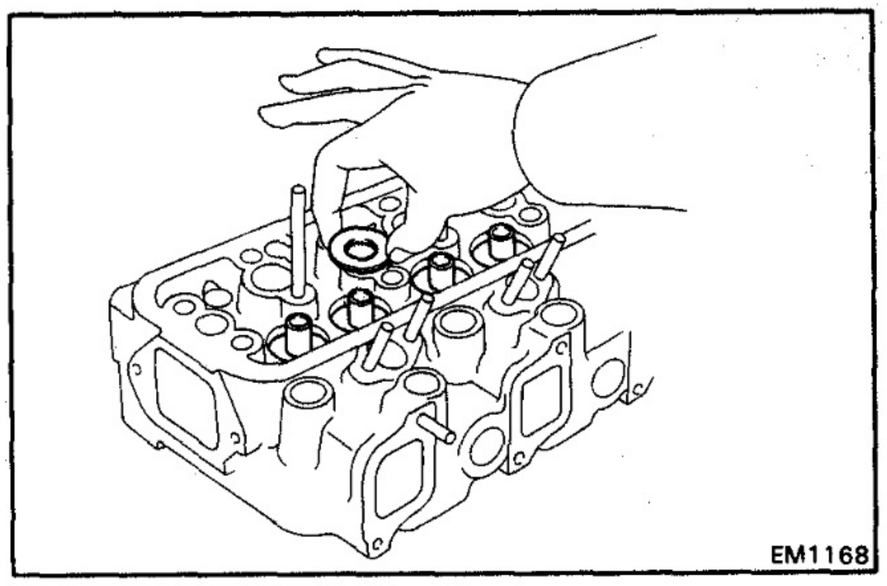
If warpage is greater than maximum, replace the manifold.

ASSEMBLY OF CYLINDER HEAD

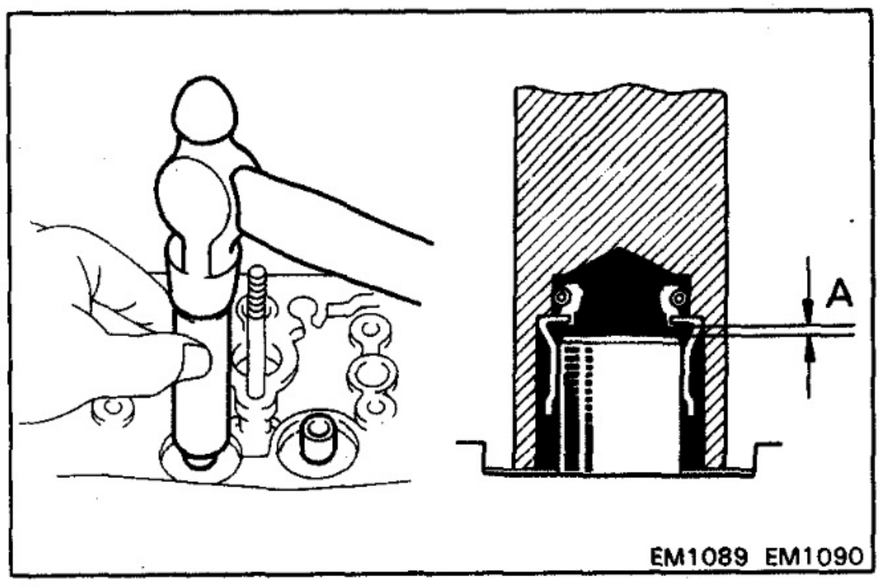
(See page EM-26)

NOTE:
- Thoroughly 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 seals with new ones.

INSTALL VALVES



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



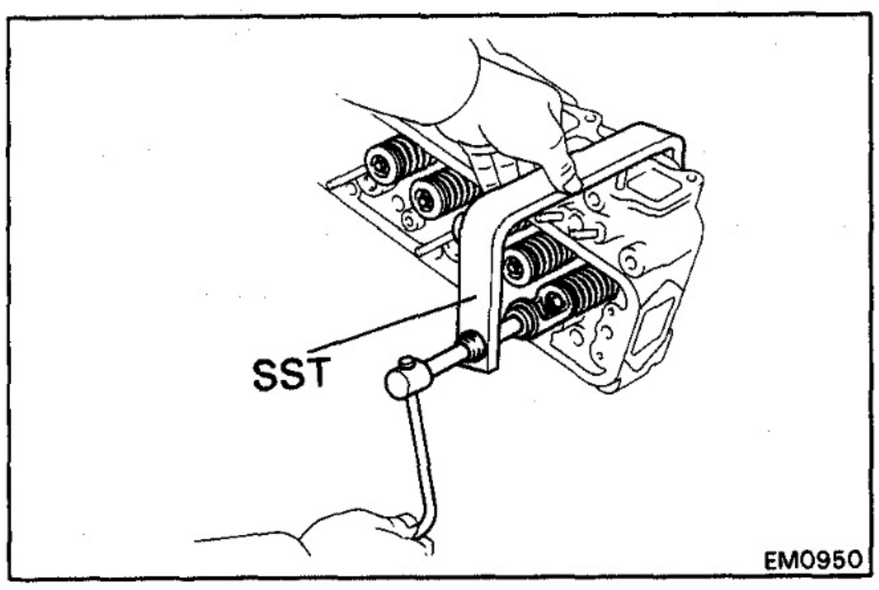
(b) Apply engine oil to a new oil seal lip.

(c) Using SST and a hammer, drive in a new oil seal.

SST 09201-58010

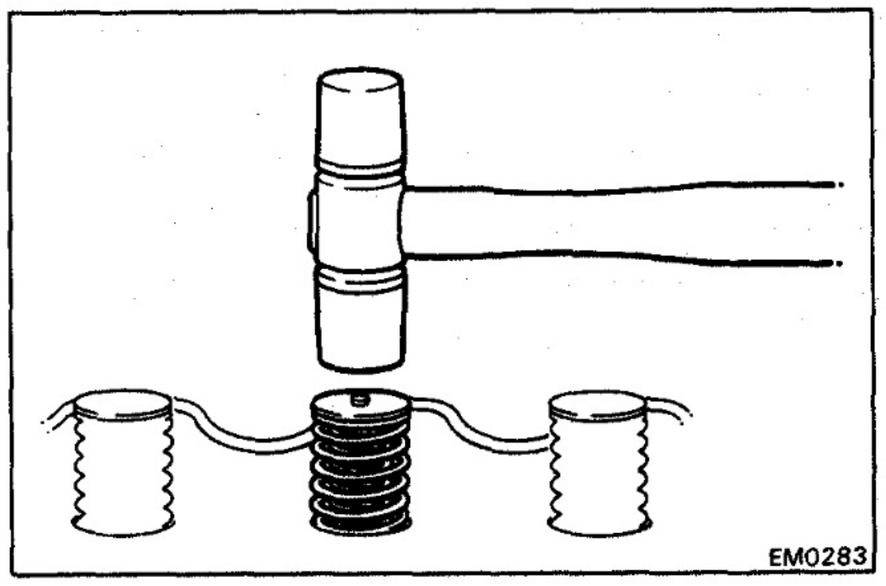
NOTE: There should be clearance A in the figure.

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

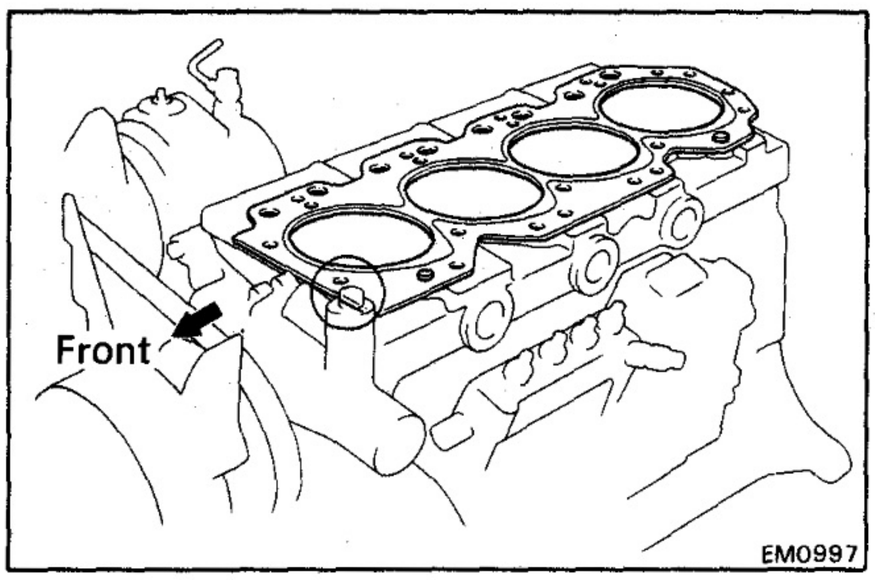


(e) Using SST, compress the valve springs and place the two keepers around the valve stem.

SST 09202-43013



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



INSTALLATION OF CYLINDER HEAD

(See page EM-26)

1. INSTALL CYLINDER HEAD

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

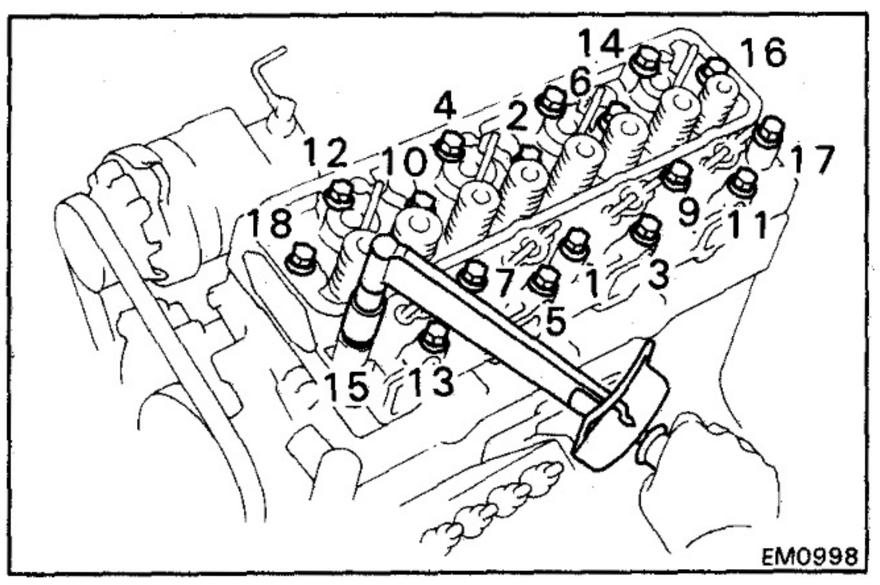
CAUTION: Be careful of the installation direction.

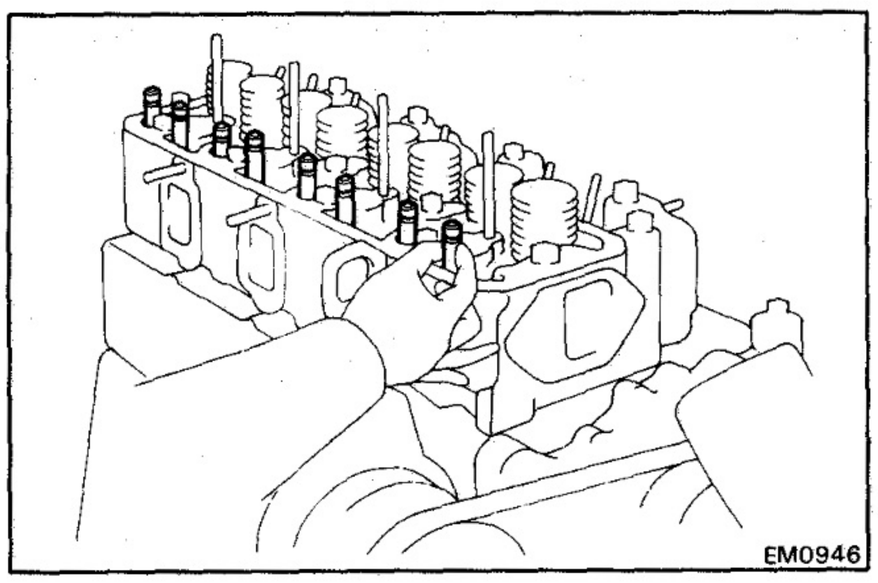
(b) Place the cylinder head on the cylinder head gasket.

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

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

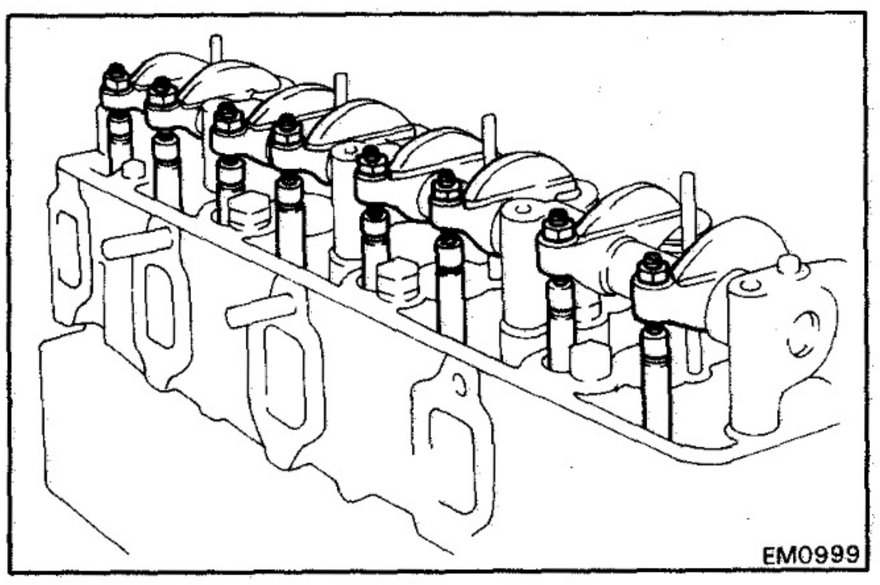
Torque: 1,200 kg-cm (87 ft-lb, 118 N·m)





2. INSTALL PUSH RODS

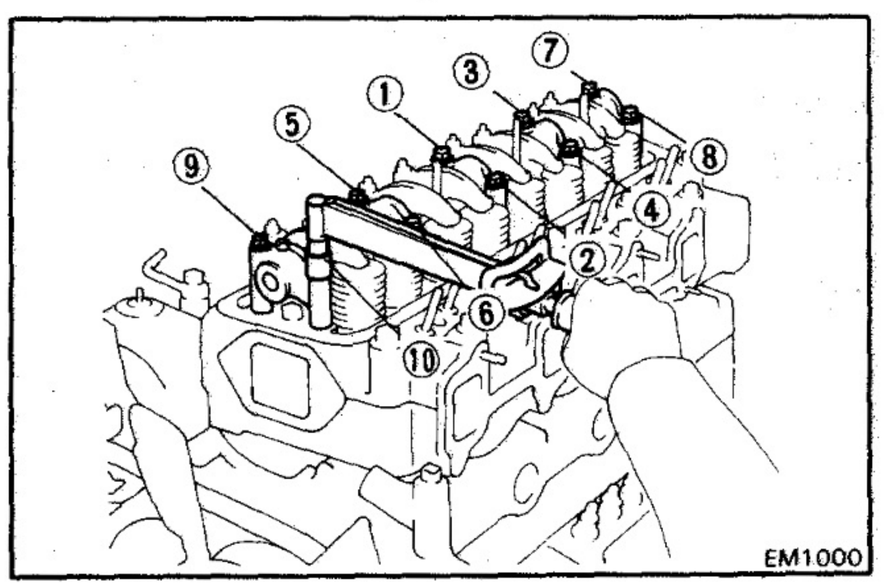
Install the eight push rods.



3. INSTALL VALVE ROCKER SHAFT ASSEMBLY

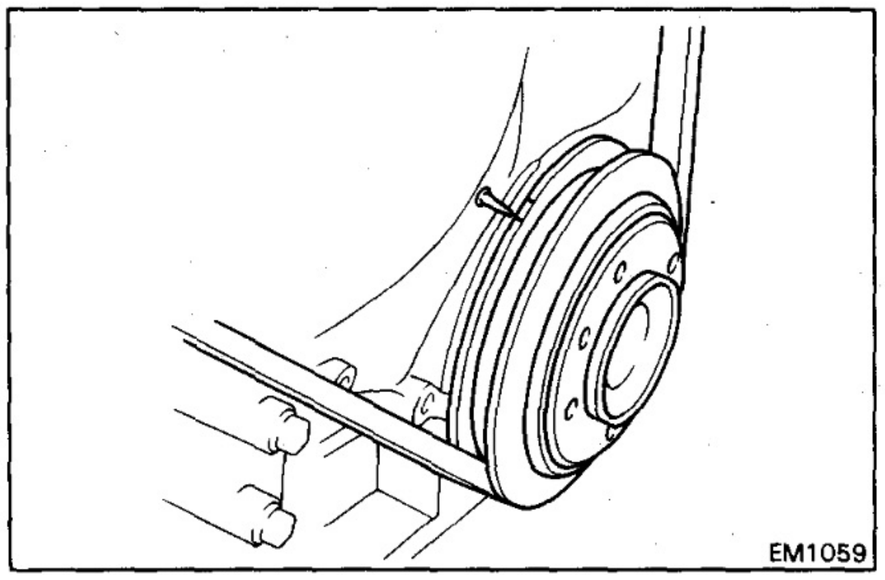
(a) Place the rocker shaft assembly on the cylinder head.

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



(c) Install and uniformly tighten the valve rocker support bolts and plate washers in several passes, in the sequence shown.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

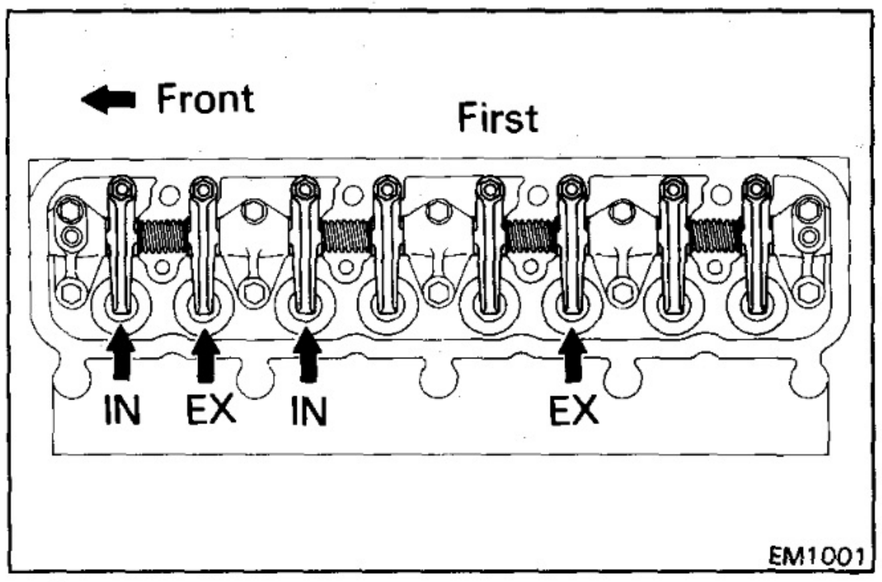


4. ADJUST VALVE CLEARANCE

(a) Set the No. 1 cylinder to TDC/compression.
Align the groove on the pulley with the timing pointer 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.

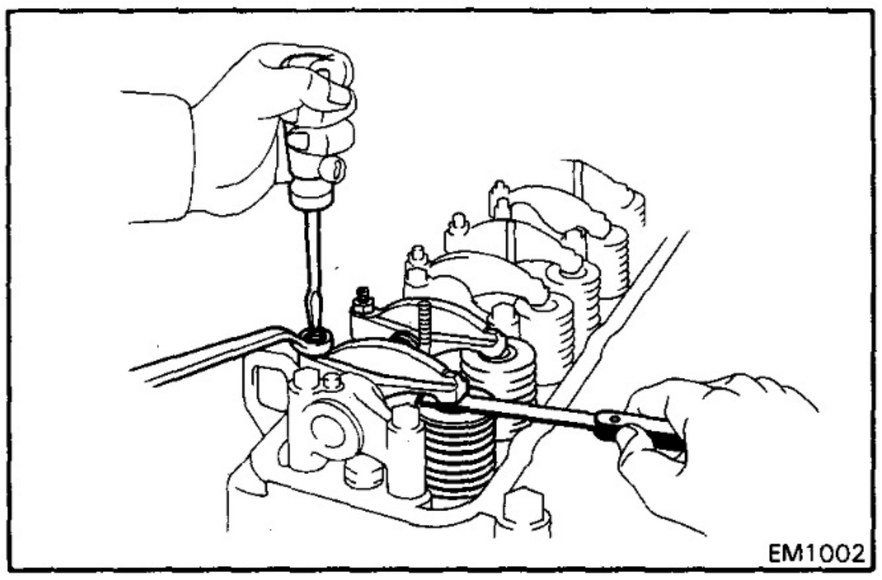


(c) Adjust only those valves indicated by arrows.

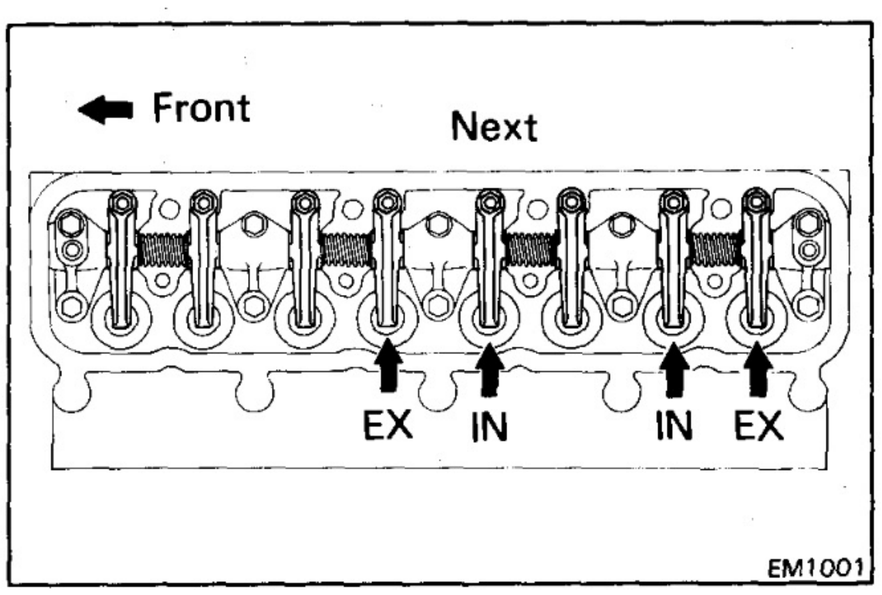
Valve clearance (Cold):

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

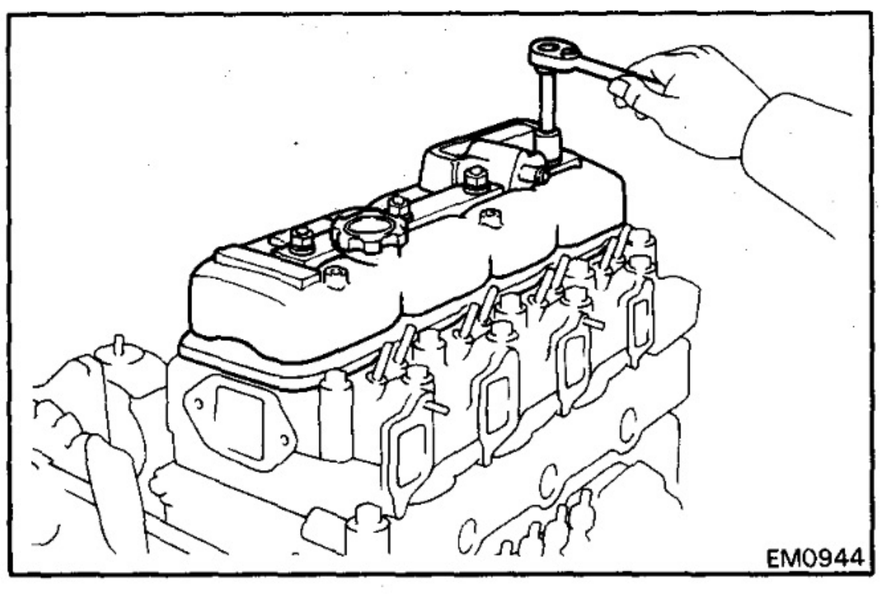
NOTE: After installing the engine, warm up the engine and readjust the valve clearance. (See page EM-21)



- Using a feeler gauge, measure the valve clearance between the valve stem 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 feeler gauge should slide with a very slight drag.



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

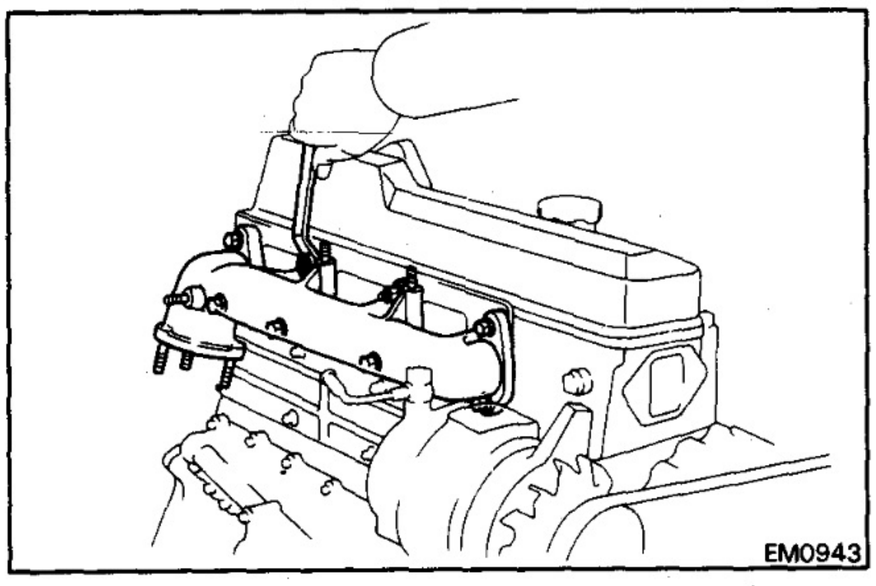


5. INSTALL CYLINDER HEAD COVER

(a) Install the gasket to the head cover.

(b) Install the head cover with the four seal washers and cap nuts.

Torque: 125 kg-cm (9 ft-lb, 12 N·m)

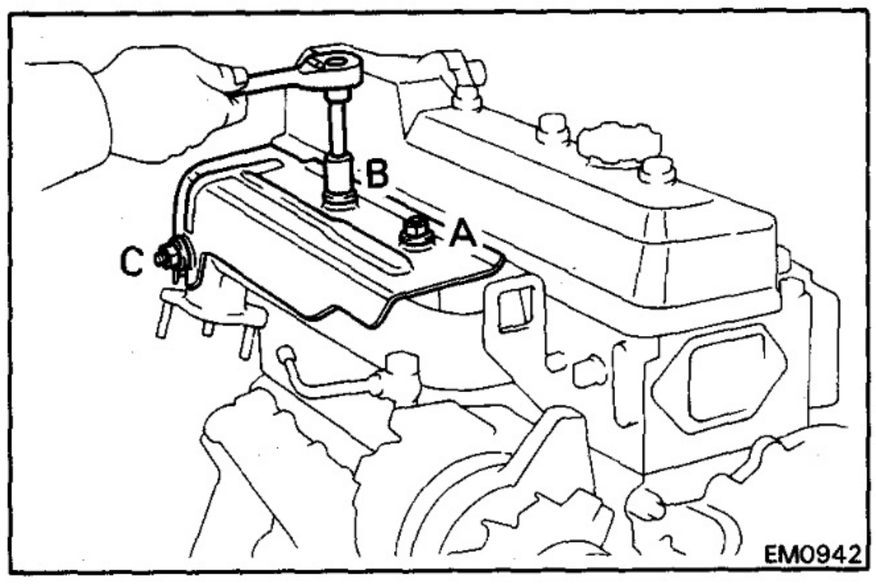


6. INSTALL EXHAUST MANIFOLD

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

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

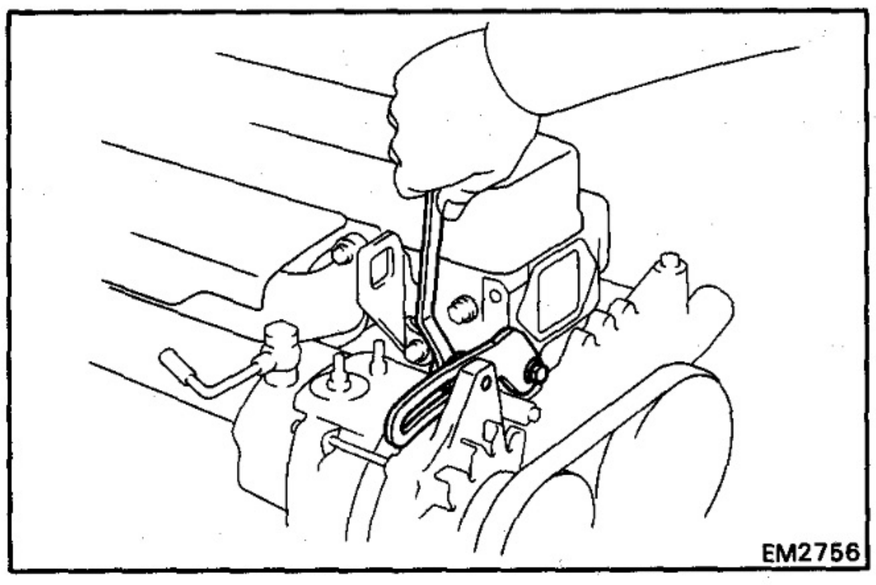
(b) [13B-T]
Install the exhaust manifold stay with the two bolts and nuts.



(c) [11B, 13B (Nut tightening type)]
Place the three spacers, No. 1 heat insulator, three spacers and three plate washers on the exhaust manifold.

(d) [11B, 13B (Bolt tightening type)]
Place the No. 1 heat insulator on the exhaust manifold.

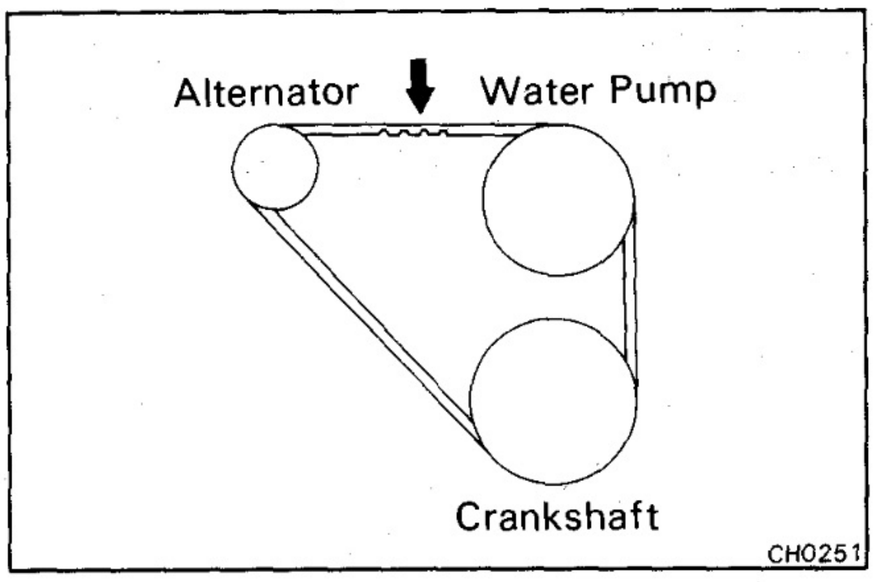
(e) Install and tighten the three nuts or bolts with the following order.
First, temporarily tighten nuts or bolts A and B. Then fully tighten nuts or bolts C, A and B.



(f) [13B-T]
Install the No. 1 and No. 2 heat insulators with the three bolts.

7. INSTALL DRIVE BELT ADJUSTING BAR

NOTE: Temporarily tighten the drive belt adjusting bolt.



8. ADJUST DRIVE BELT

Drive belt deflection at 10 kg (22.0 lb, 98 N):

Single belt type

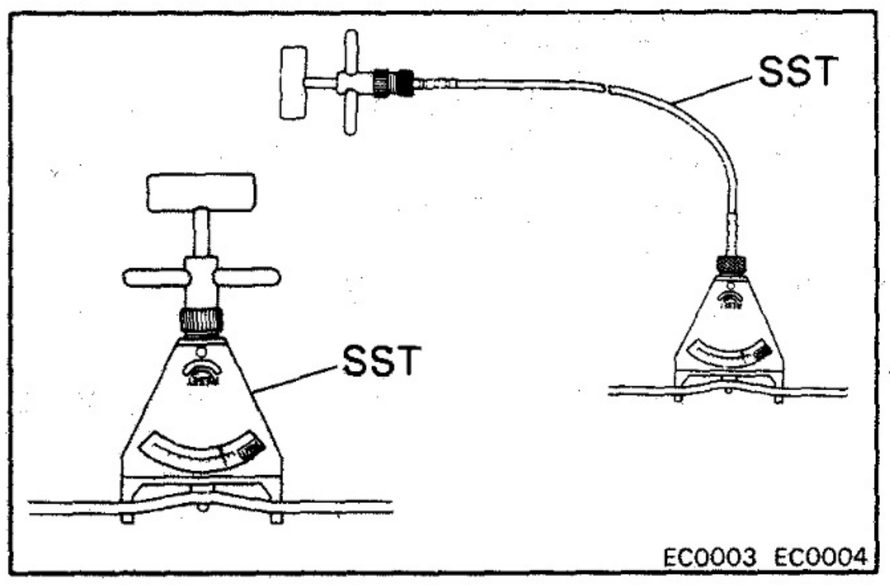
New belt	**8 – 12 mm (0.31 – 0.47 in.)**
Used belt	**11 – 16 mm (0.43 – 0.63 in.)**

Double belt type

New belt	**12 – 15 mm (0.47 – 0.59 in.)**
Used belt	**14 – 20 mm (0.55 – 0.79 in.)**

NOTE:

- "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 about 5 minutes and then recheck the deflection.



[Reference]

Using SST, check the drive belt tension.

SST 09216-00020 and 09216-00030

Drive belt tension:

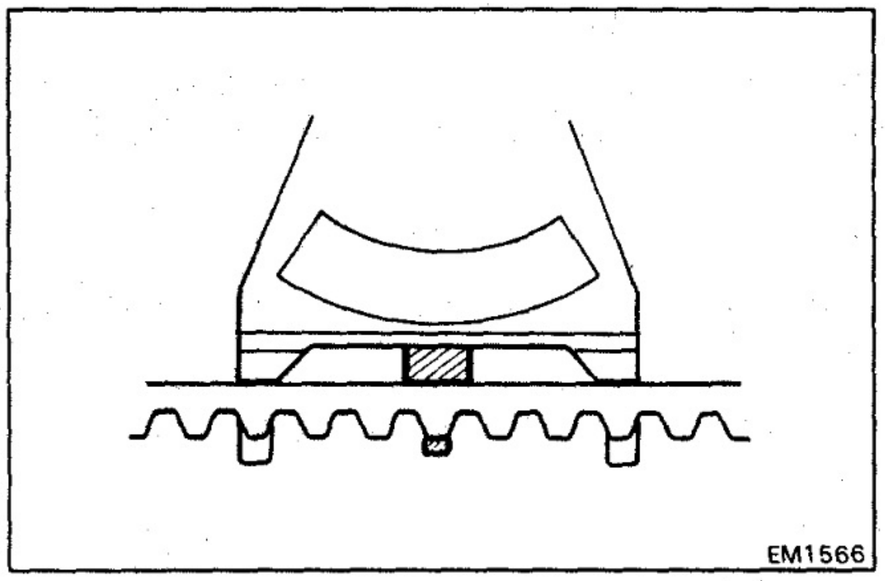
Single belt type

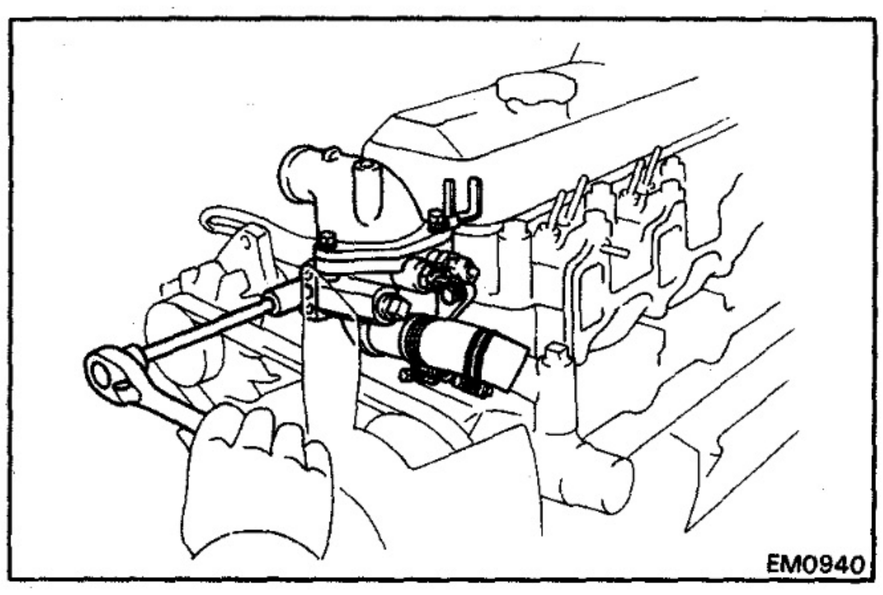
New belt 55 – 65 kg
Used belt 30 – 45 kg

Double belt type

New belt 45 – 55 kg
Used belt 20 – 35 kg

NOTE: When checking the tension, be sure the gauge is on the belt protrusion.





9. INSTALL WATER OUTLET ASSEMBLY

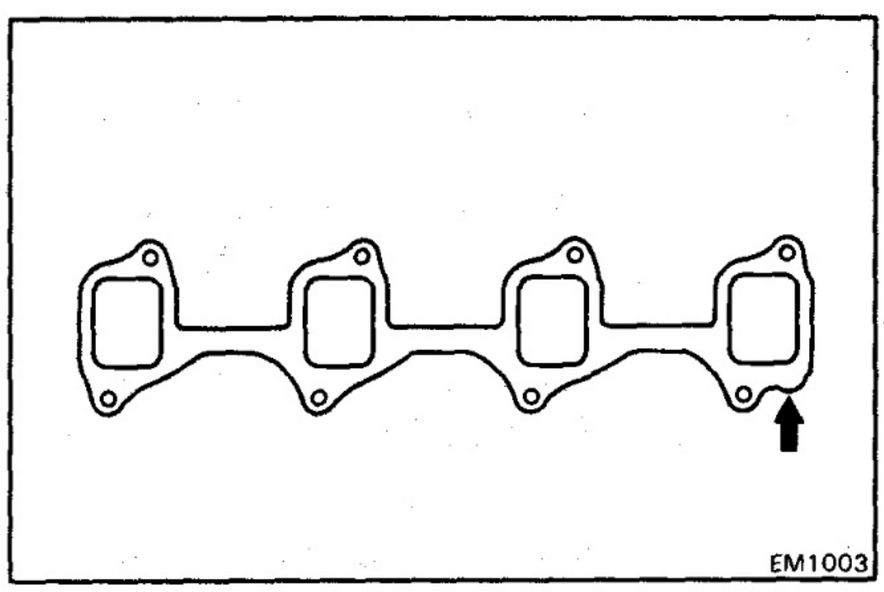
(a) Connect the by-pass hose to the water pump.

(b) Install a new gasket and the water outlet assembly with the two bolts.
Torque the bolts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

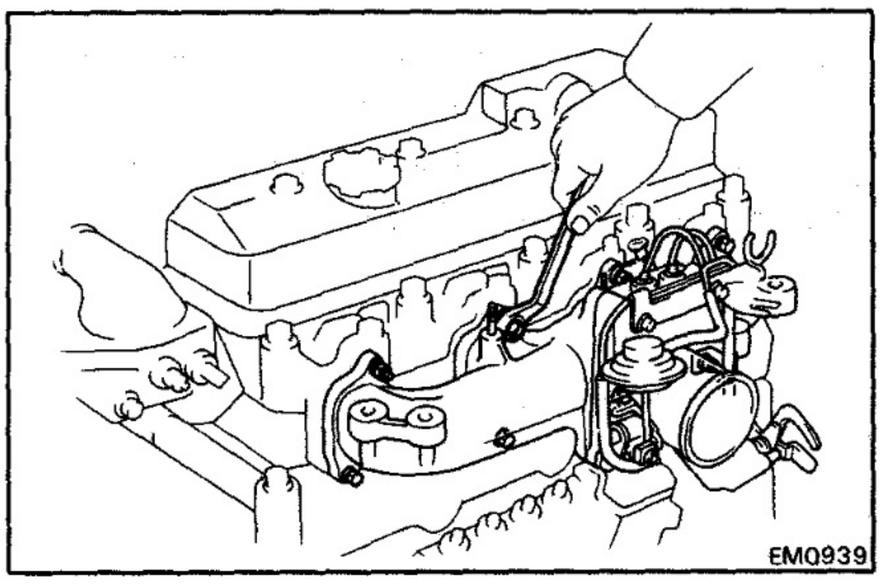
(c) Tighten the by-pass clamp.

(d) [13B-T]
Connect the vacuum pipe clamp with the bolt.



10. INSTALL INTAKE MANIFOLD

(a) Place a new gasket so the portion indicated by the arrow is at the lower rear of the cylinder head.



(b) Install the intake manifold, level gauge clamp and No. 2 leakage pipe clamps with the five bolts and three nuts. Torque the bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

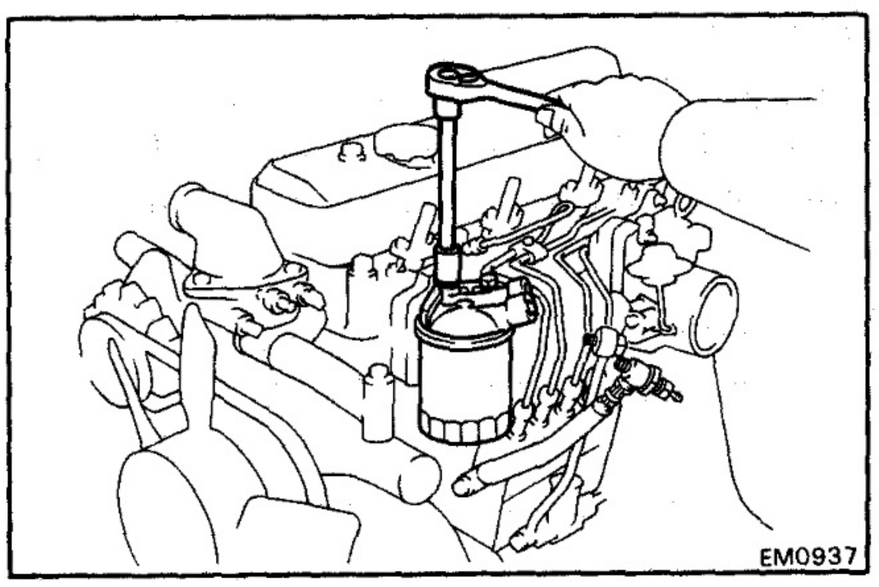
(c) Install and tighten the union bolt with new gaskets.

(d) Connect the vacuum hoses.

(e) Install the level gauge.

11. CONNECT ACCELERATOR CONNECTING ROD

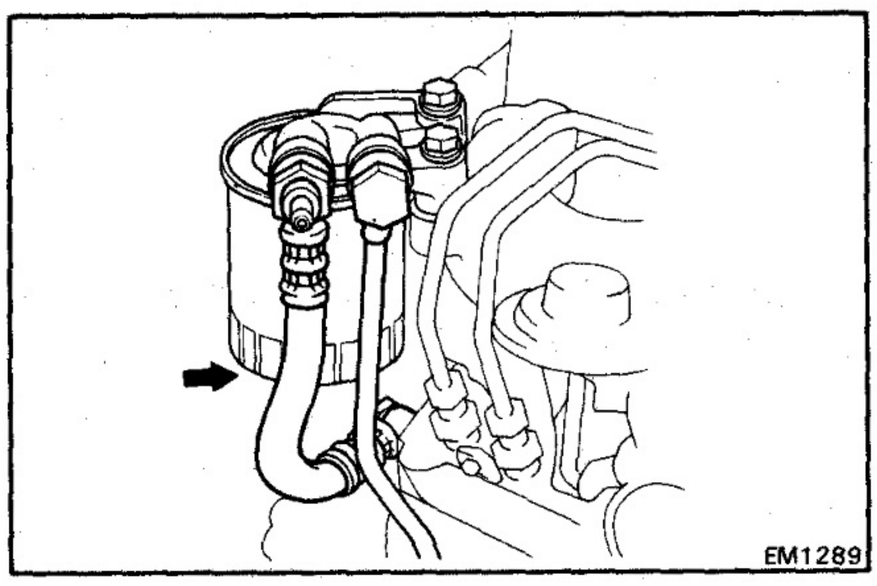
12. INSTALL INJECTION NOZZLES
(See page FU-10)



13. INSTALL FUEL FILTER ASSEMBLY

(a) Install the fuel filter assembly with the two bolts. Torque the bolts.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



(b) Install the fuel hose on the fuel pipe side so that it does not interfere with the pipe.

14. [13B-T]
INSTALL TURBOCHARGER (See page EM-49)

TURBOCHARGER

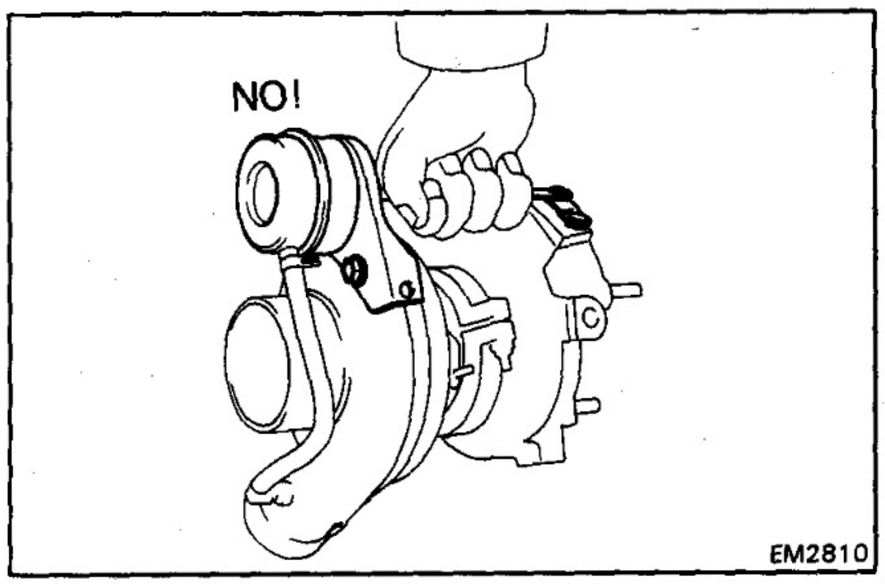
CAUTION:

- **Do not stop the engine immediately after pulling a trailer or high speed or uphill driving. Idle the engine 20 — 120 seconds, depending on the severity of the driving condition.**
- **Avoid sudden racing or acceleration immediately after starting a cold engine.**
- **If the engine is run with the air cleaner removed, foreign material entering will damage the wheels which run at extremely high speed.**
- **If the turbocharger is defective and must be replaced, first check for the cause of the defect in reference to the following items and replace parts if necessary:**

  Engine oil level and quality

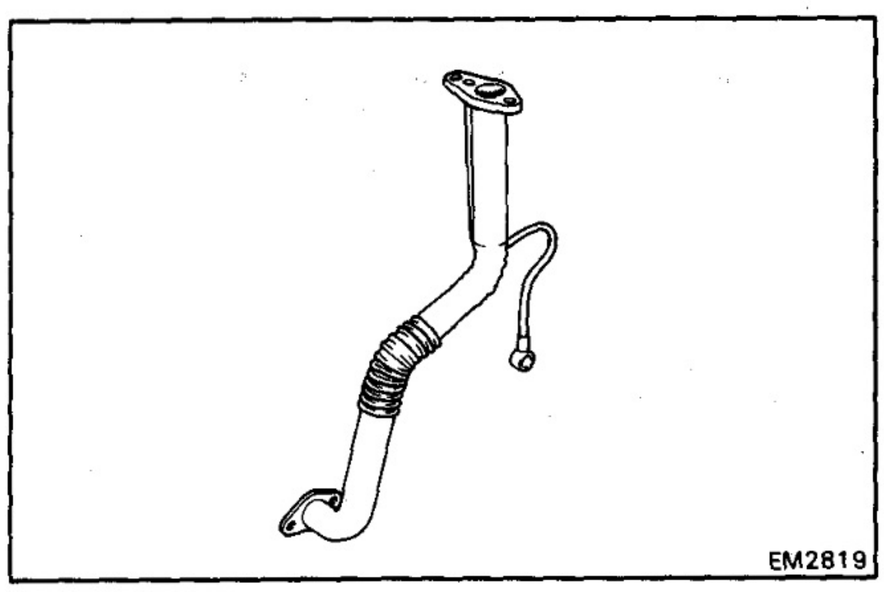
  Conditions under which the turbocharger was used

  Oil lines leading to the turbocharger

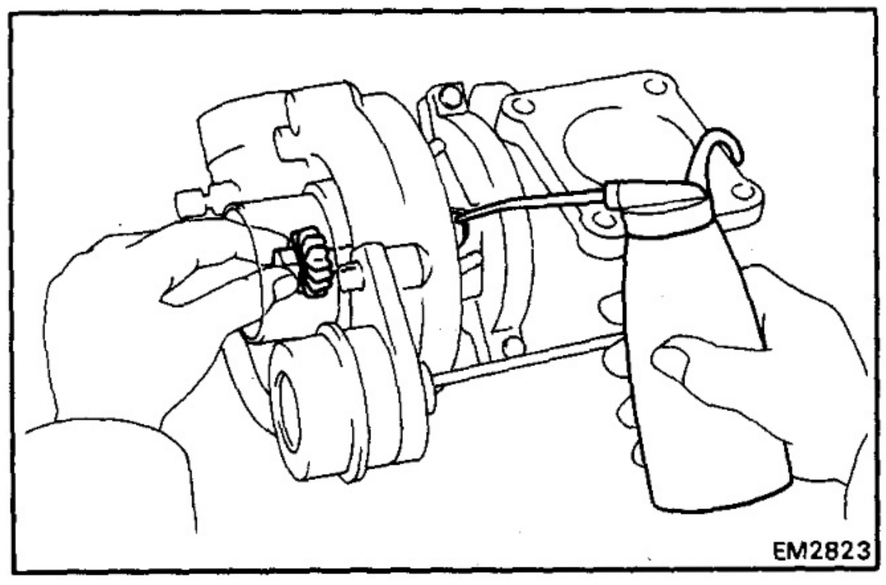


EM2810

- **Use caution when removing and reinstalling the turbocharger assembly. Do not drop it or bang it against anything or grasp it by easily-deformed parts, such as the actuator or rod, when moving.**
- **Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign material.**


EM2819

- **If replacing the turbocharger, check for accumulation of sludge particles in the oil pipes and, if necessary, replace the oil pipes.**
- **Completely remove the gaskets adhered to the lubrication oil pipe flange and turbocharger oil flange.**
- **If replacing bolts or nuts, do so only with the specified new ones to guard against breakage or deformation.**


EM2823

- **If replacing the turbocharger, put 20 cc (1.2 cu in.) of oil into the turbocharger oil inlet and turn the impeller wheel by hand to spread oil to the bearing.**
- **If overhauling or replacing the engine, cut the fuel supply after reassembly and crank the engine for 30 seconds to distribute oil throughout the engine. Then allow the engine to idle for 60 seconds.**

ON-VEHICLE INSPECTION OF TURBOCHARGER

1. INSPECT INTAKE AIR SYSTEM

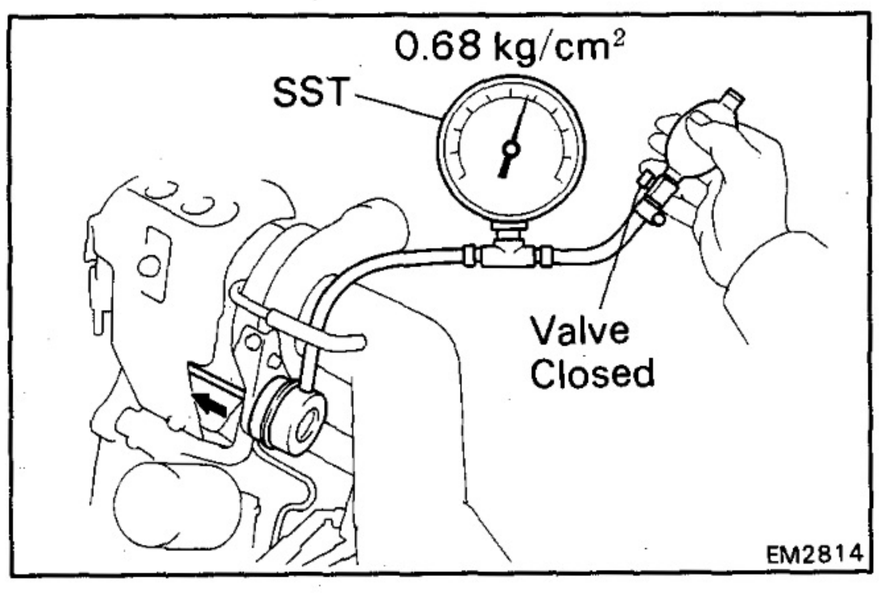
Check for leakage or clogging between the air cleaner and turbocharger inlet and between the turbocharger outlet and cylinder head.

- Clogged air cleaner ..... Clean or replace the element
- Hoses collapsed or deformed ..... Check each connection and repair
- Cracks in components ..... Check and replace

2. INSPECT EXHAUST SYSTEM

Check for leakage or clogging between the cylinder head and turbocharger inlet and between the turbocharger outlet and exhaust pipe.

- Deformed components ..... Repair or replace
- Foreign material in passages ..... Remove
- Leakage from components ..... Repair or replace
- Cracks in components ..... Check and replace



3. INSPECT OPERATION OF ACTUATOR AND WASTE GATE VALVE

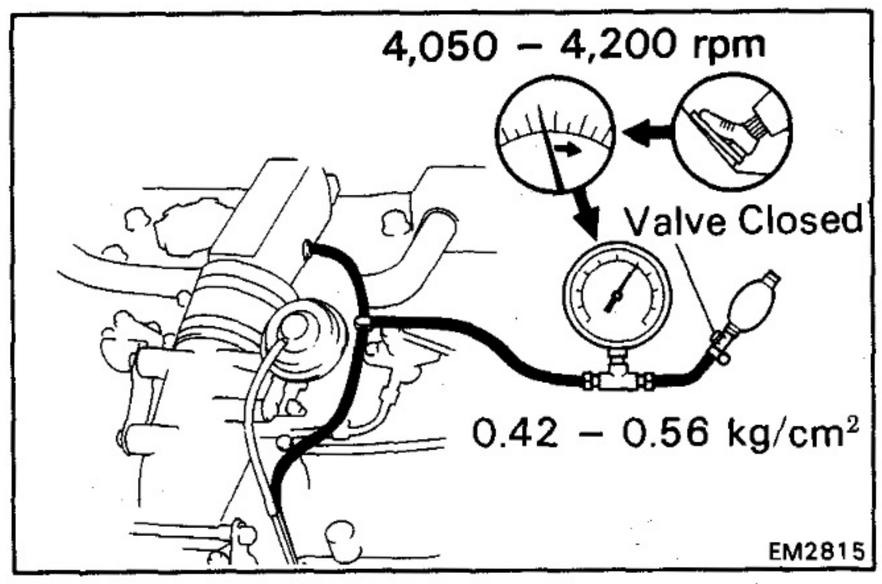
(a) Disconnect the actuator hose.

(b) Using SST (turbocharger pressure gauge), apply about 0.68 kg/cm² (9.7 psi, 67 kPa) of pressure to the actuator and check that the rod moves.

If the rod does not move, replace the turbocharger assembly.

SST 09992-00240

CAUTION: Never apply more than 0.8 kg/cm² (11.4 psi, 78 kPa) of pressure to the actuator.



4. CHECK TURBOCHARGING PRESSURE

(a) Warm up the engine.

(b) Using a 3-way union, connect SST (turbocharger pressure gauge) to the hose leading to the air intake connector.

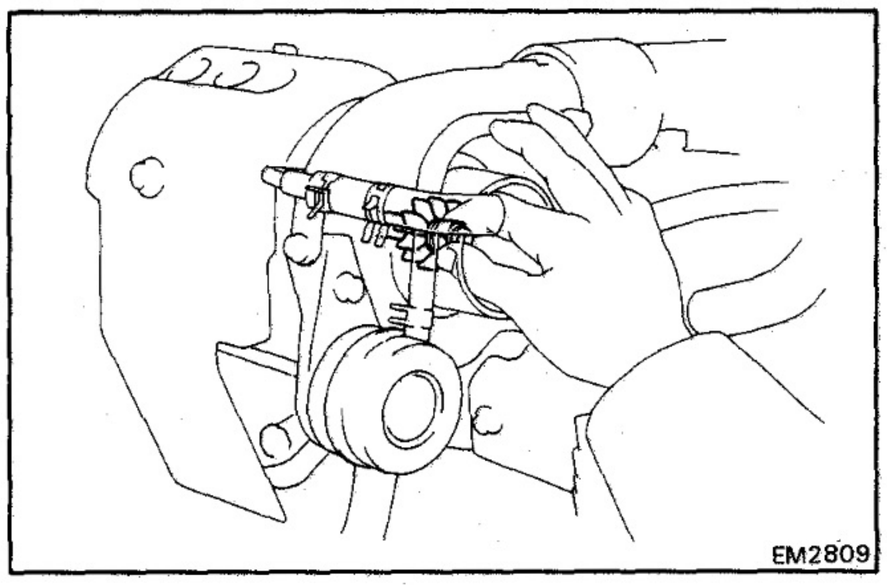
SST 09992-00240

(c) Press in the clutch pedal, then press the accelerator pedal down as far as it will go. Measure the turbocharging pressure at maximum speed (4,050 – 4,200 rpm).

Turbocharging pressure: 0.42 – 0.56 kg/cm² (6.0 – 8.0 psi, 41 – 55 kPa)

If the pressure is less than that specified, check the intake air and exhaust systems for leakage. If there is no leakage, replace the turbocharger assembly.

If the pressure is above specification, check if the actuator hose is disconnected or cracked. If not, replace the turbocharger assembly.



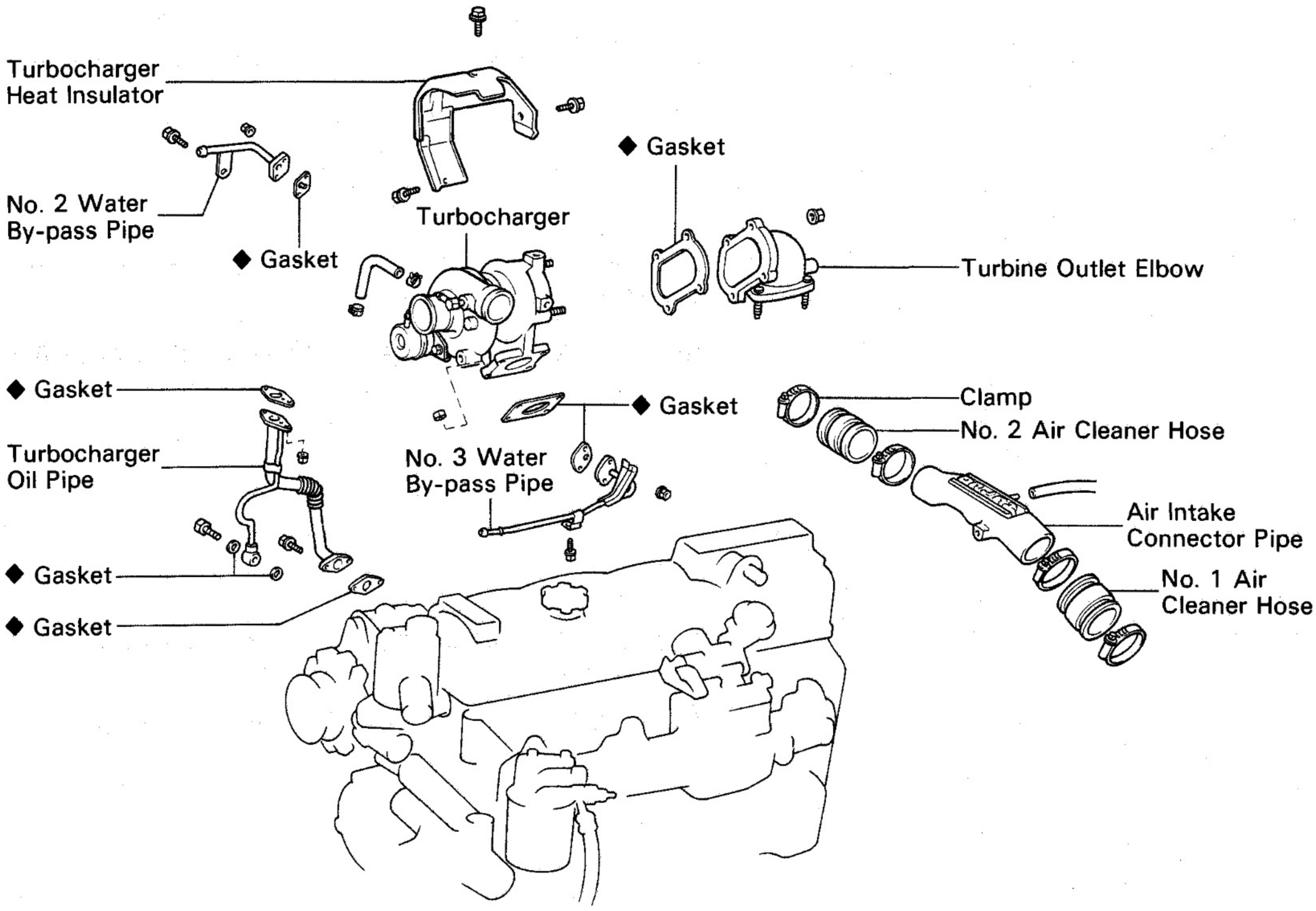
5. INSPECT IMPELLER WHEEL ROTATION

(a) Disconnect the air cleaner hose.

(b) Grasp the edge of the impeller wheel and turn it. Check that it turns smoothly.

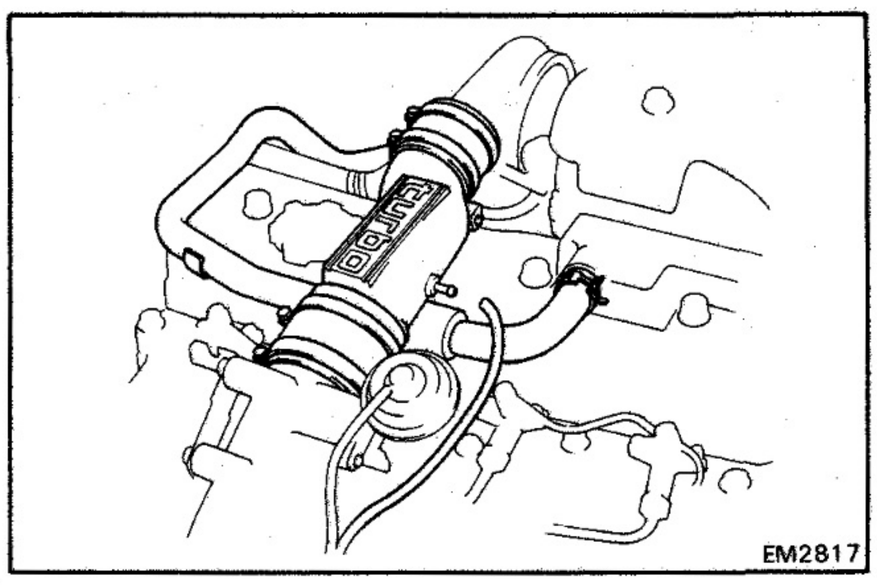
If it does not turn or if it turns with a drag, replace the turbocharger assembly.

COMPONENTS

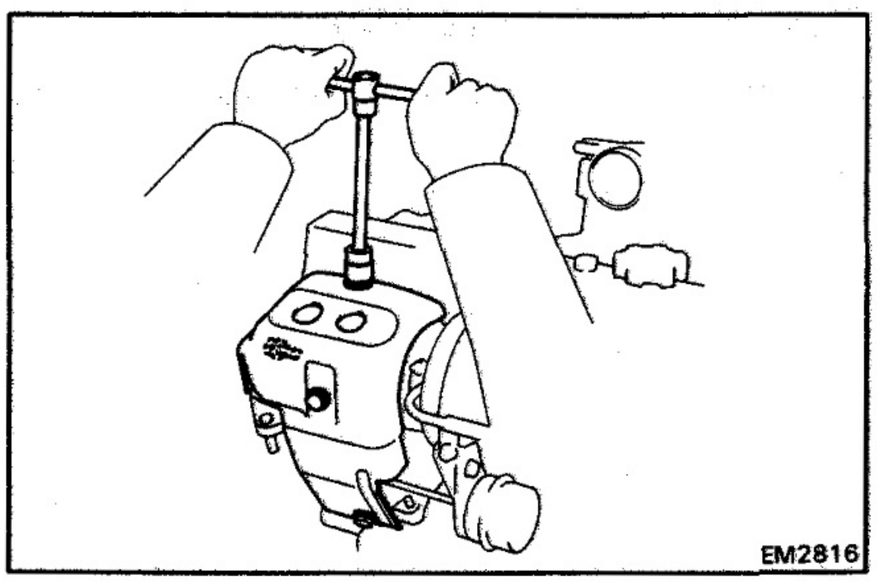


◆ Non-reusable part

EM2822



EM2817



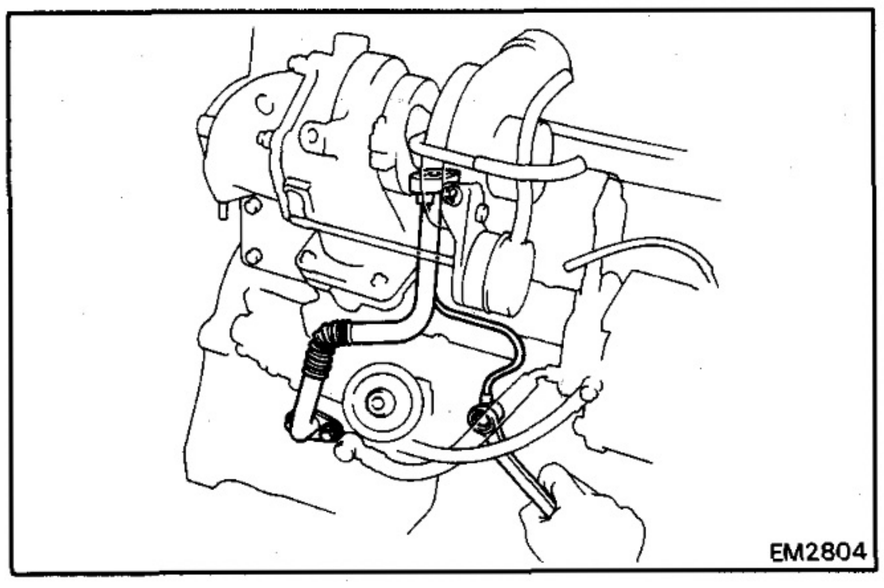
EM2816

REMOVAL OF TURBOCHARGER

1. **DRAIN ENGINE COOLANT (See page CO-3)**

2. **REMOVE POSITIVE CRANKCASE VENTILATION (PCV) HOSE AND INTAKE AIR CONNECTOR PIPE**
   (a) Disconnect the PCV hose from the cylinder head.
   (b) Disconnect the vacuum hose from the intake air connector.
   (c) Loosen the four clamps and remove the intake air connector pipe, No. 1 air cleaner hose, No. 2 air cleaner hose and PCV hose.

3. **REMOVE TURBOCHARGER HEAT INSULATOR**
   Remove the four bolts and heat insulator.

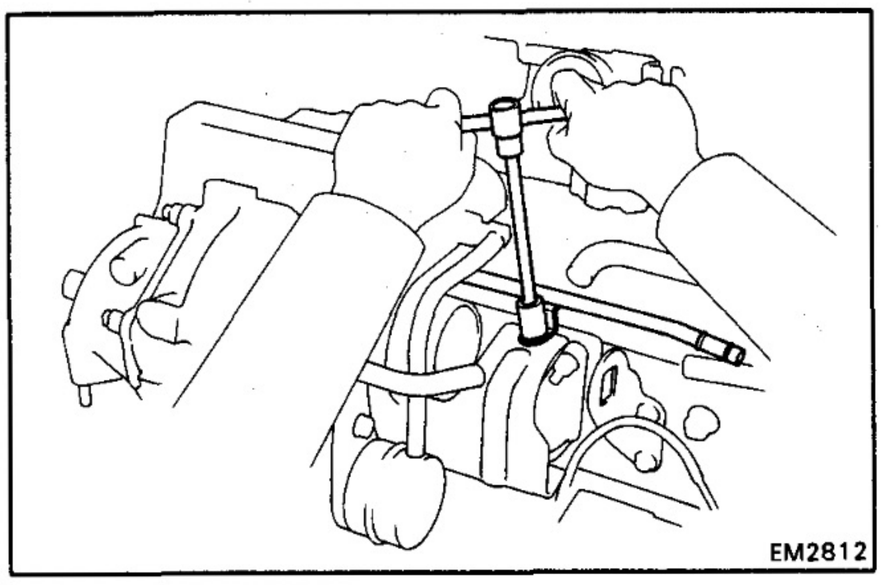


4. REMOVE OIL FILTER (See page LU-3)

5. REMOVE TURBOCHARGER OIL PIPE

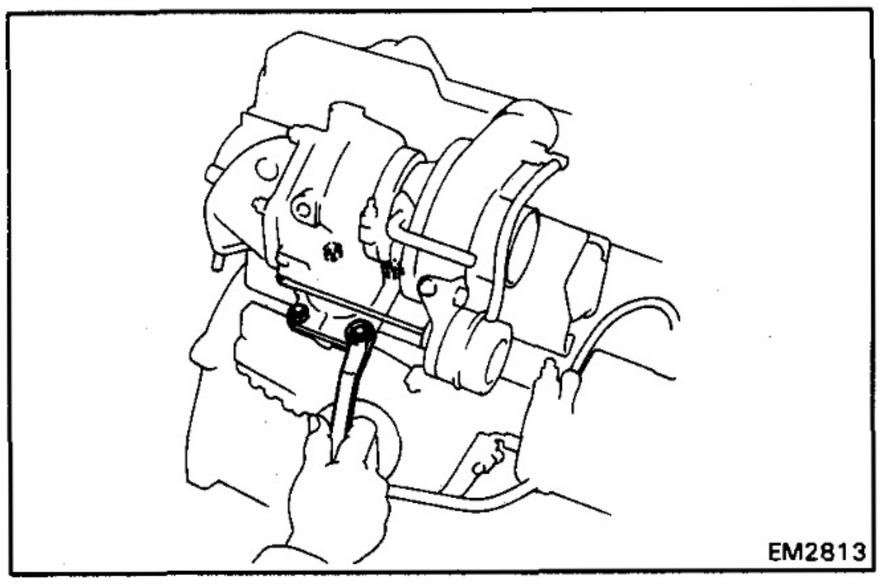
(a) Remove the union bolt and two gaskets from the oil cooler case.

(b) Remove the two bolts, two nuts, turbocharger oil pipe.



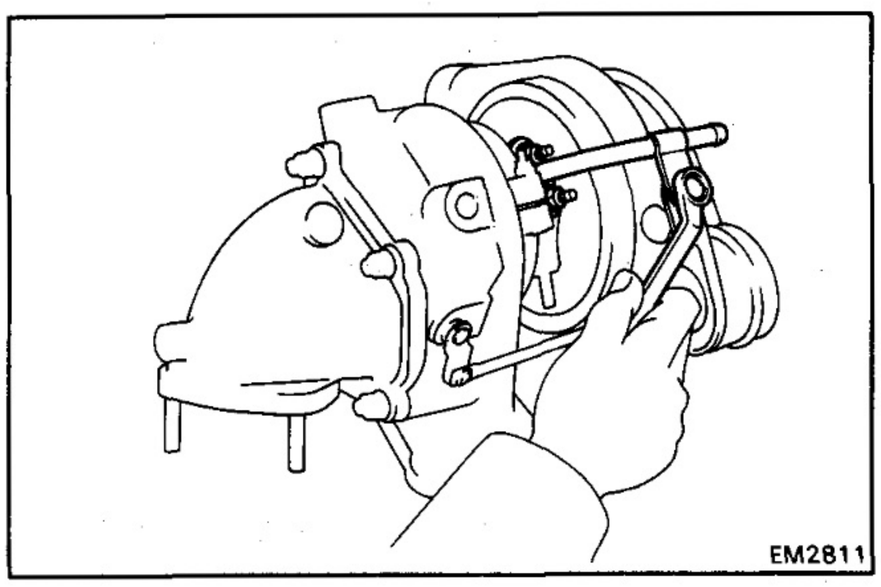
6. DISCONNECT WATER BY-PASS HOSE FROM NO. 3 WATER BY-PASS PIPE

7. REMOVE NO. 3 WATER BY-PASS PIPE CLAMP BOLT



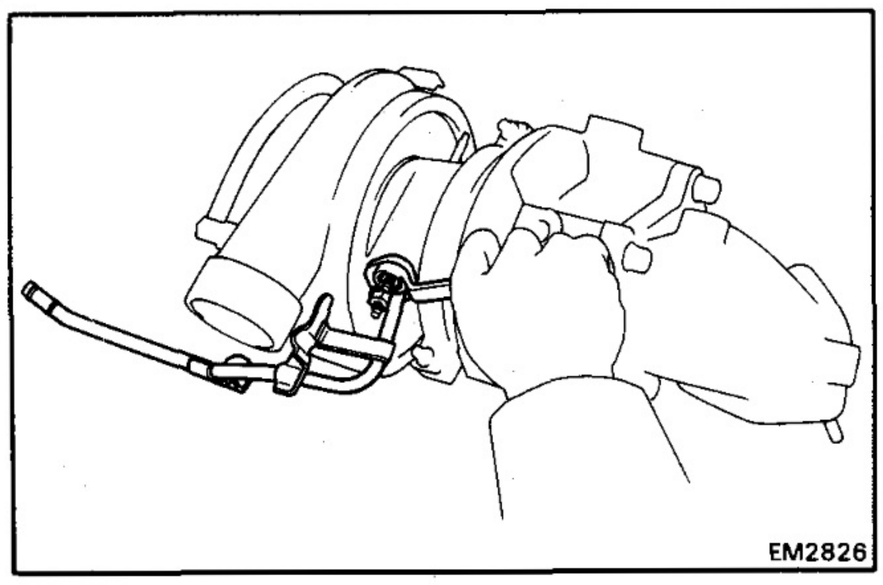
8. REMOVE TURBOCHARGER FROM EXHAUST MANIFOLD

Remove the four nuts, turbocharger and gasket.



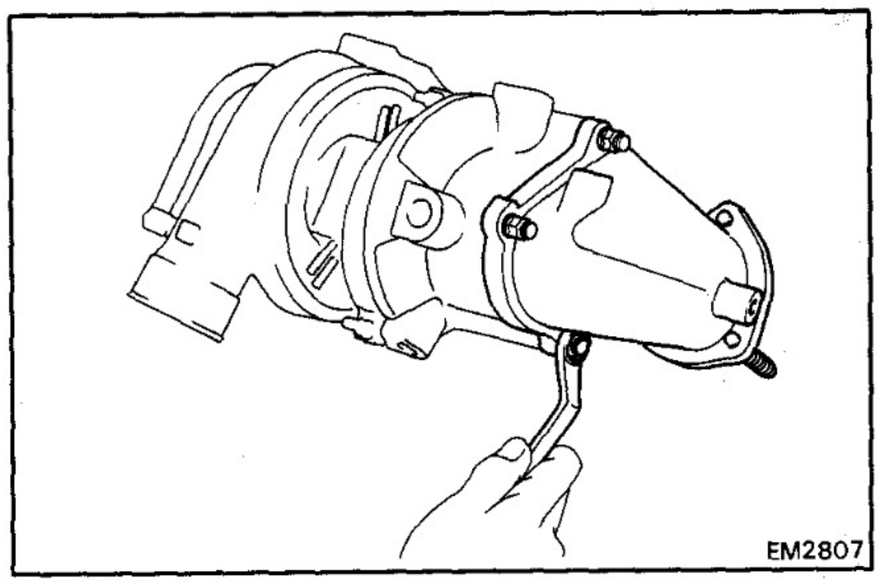
9. REMOVE NO. 2 WATER BY-PASS PIPE

Remove the bolt, two nuts, No. 2 water by-pass pipe and gasket.



10. REMOVE NO. 3 WATER BY-PASS PIPE

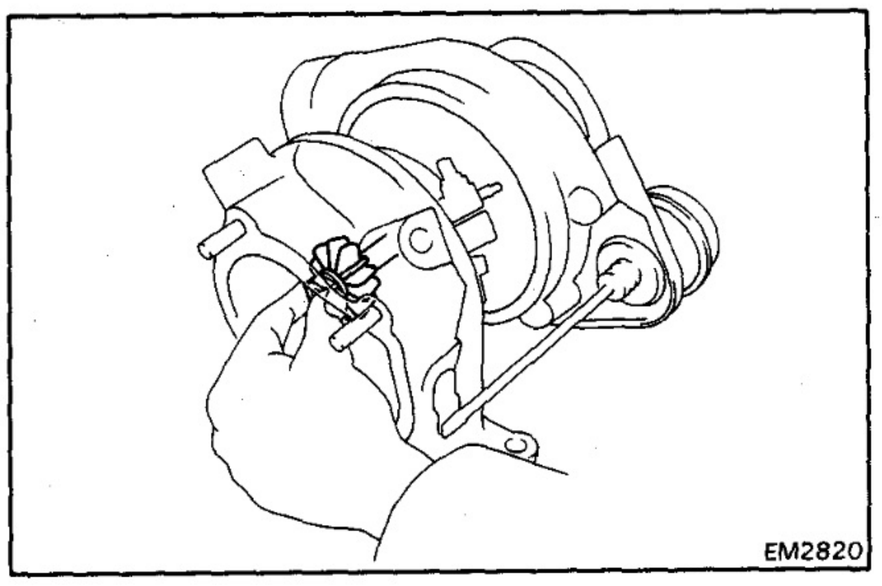
Remove the two nuts, No. 3 water by-pass pipe and gasket.



11. REMOVE TURBINE OUTLET ELBOW

Remove the four nuts, turbine outlet elbow and gasket.

12. REMOVE ACTUATOR HOSE

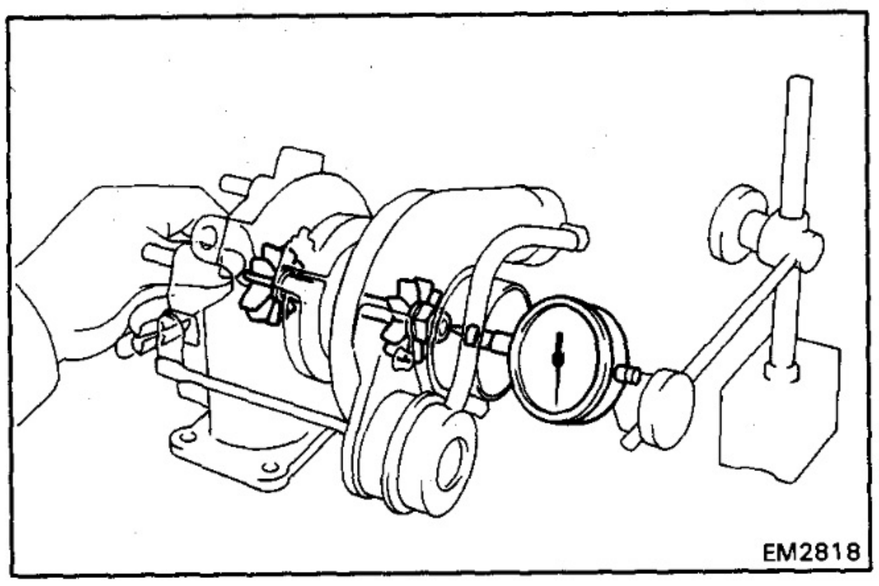


INSPECTION OF TURBOCHARGER

1. INSPECT IMPELLER WHEEL ROTATION

Grasp the edge of the turbine wheel and turn it. Check that the impeller wheel turns smoothly.

If the impeller wheel does not turn or if it turns with a drag, replace the turbocharger assembly.

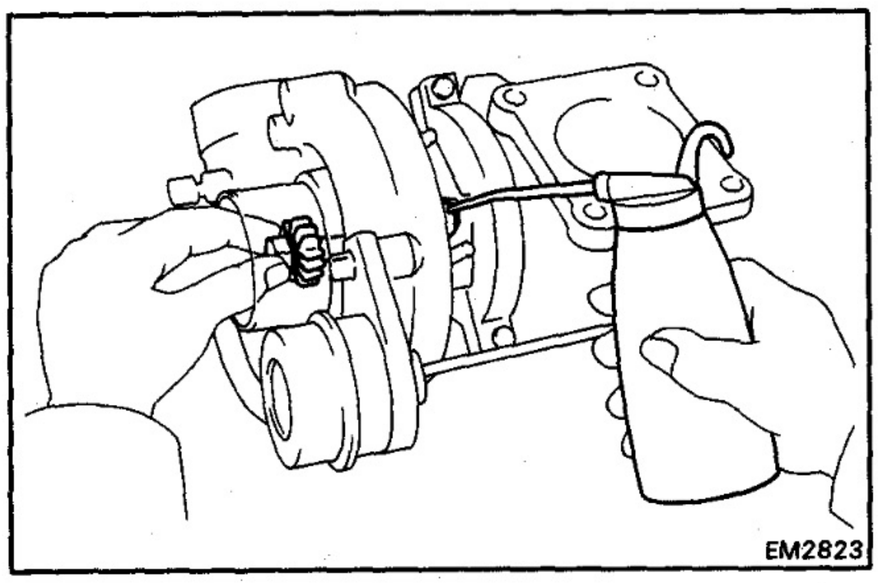


2. INSPECT AXIAL PLAY OF SHAFT BEARING

Insert a dial gauge into the intake side, hold the turbine wheel edge by hand and check the axial play.

Axial play: 0.13 mm (0.0051 in.) or less

If not within specification, replace the turbocharger assembly.

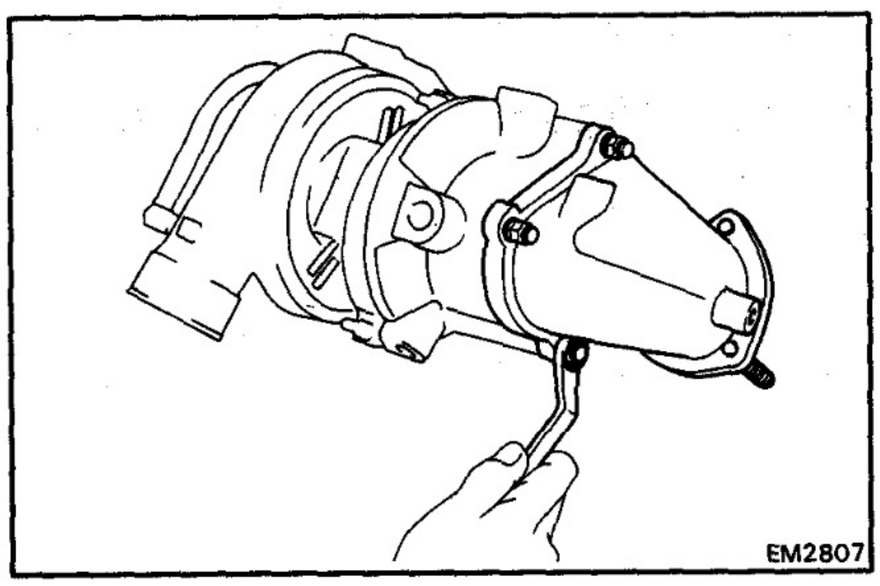


INSTALLATION OF TURBOCHARGER

(See page EM-47)

CAUTION: After replacing a turbocharger assembly, pour about 20 cc (1.2 cu in.) of new oil into the oil inlet and then turn the impeller wheel by hand to splash oil on the bearing.

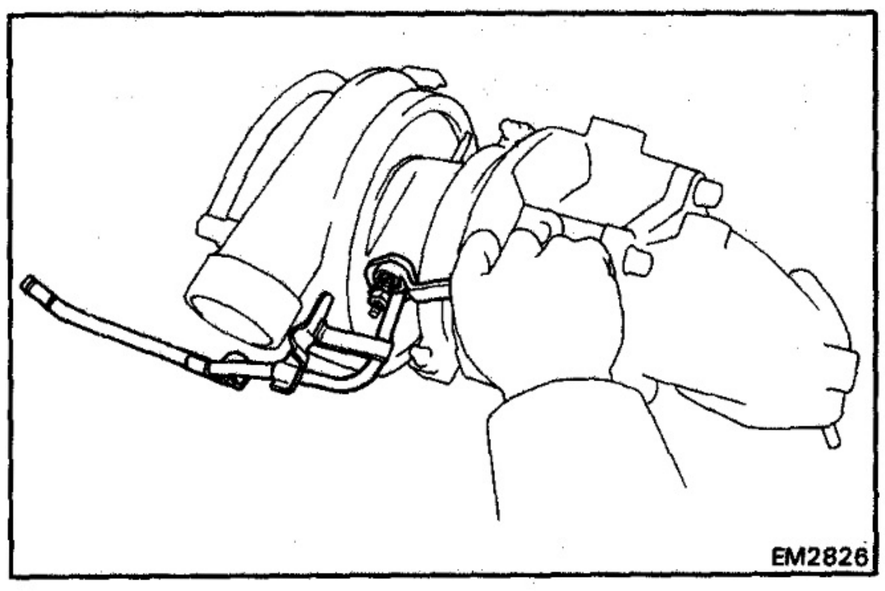
1. INSTALL ACTUATOR HOSE



2. INSTALL TURBINE OUTLET ELBOW

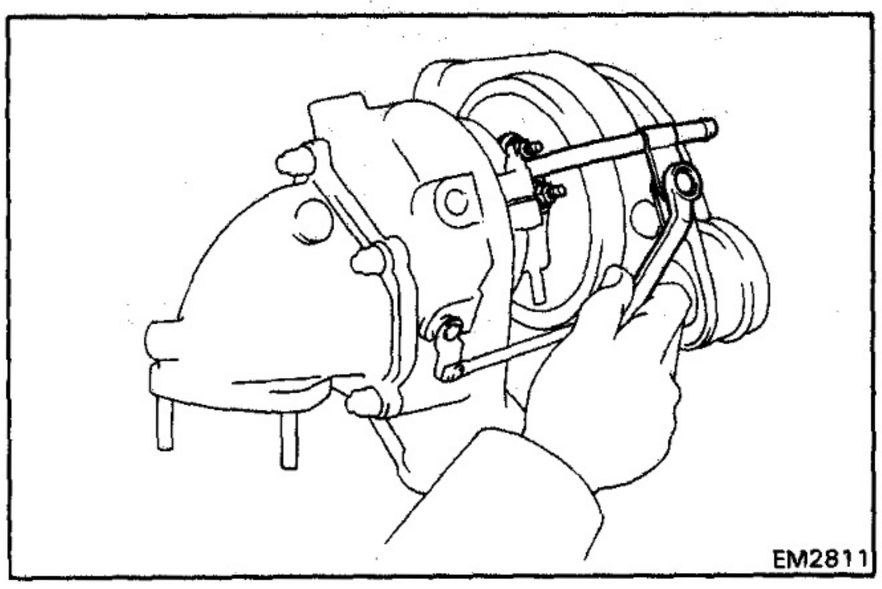
Install the gasket and turbine outlet elbow with the four nuts.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



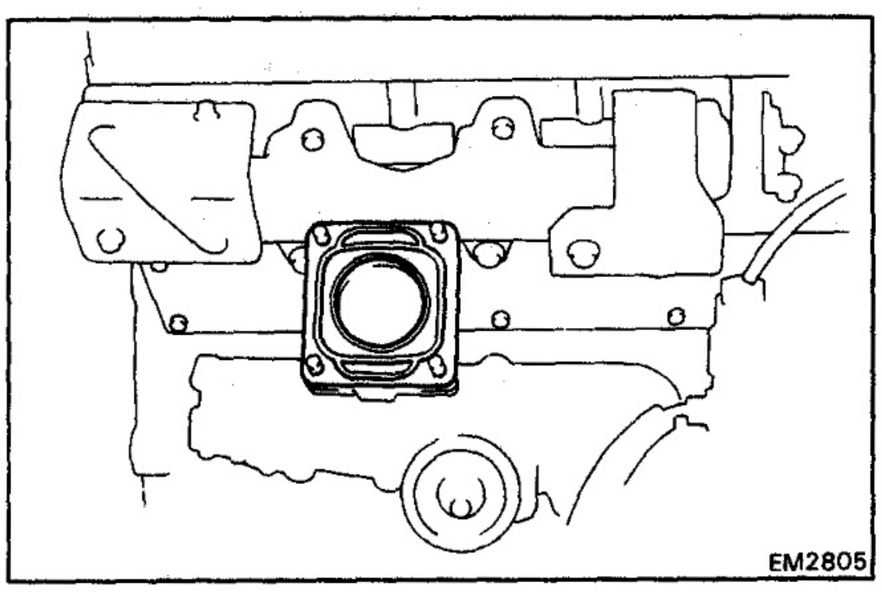
3. INSTALL NO. 3 WATER BY-PASS PIPE

Install a new gasket and No. 3 water by-pass pipe with the two nuts.



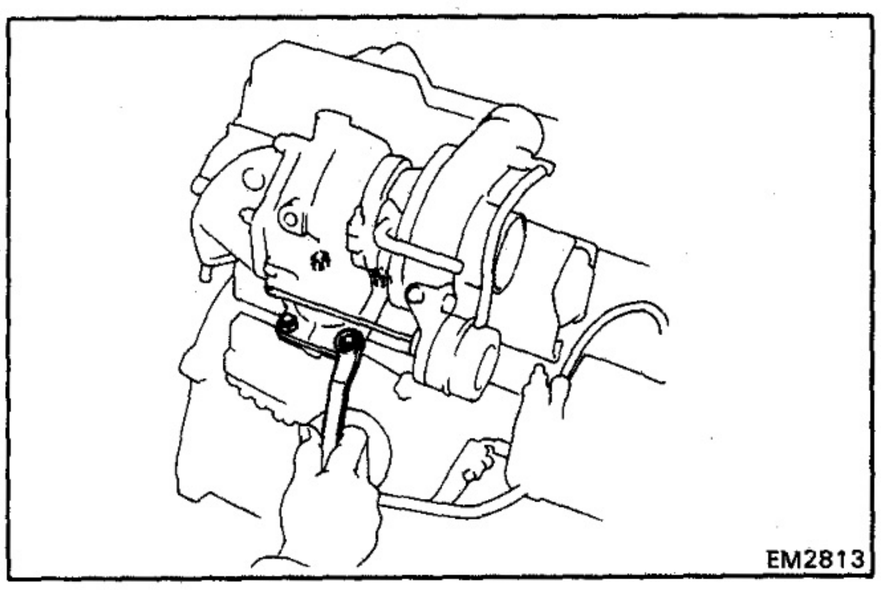
4. INSTALL NO. 2 WATER BY-PASS PIPE

Install a new gasket and No. 2 water by-pass pipe with the bolt and two nuts.



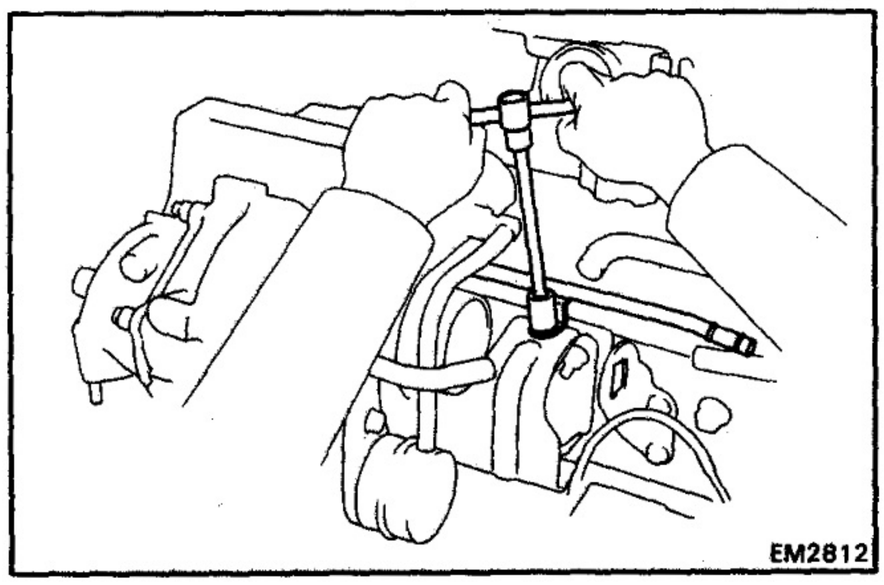
5. INSTALL TURBOCHARGER TO EXHAUST MANIFOLD

(a) Place a new gasket on the manifold with the groove of the gasket facing upward (turbocharger side).



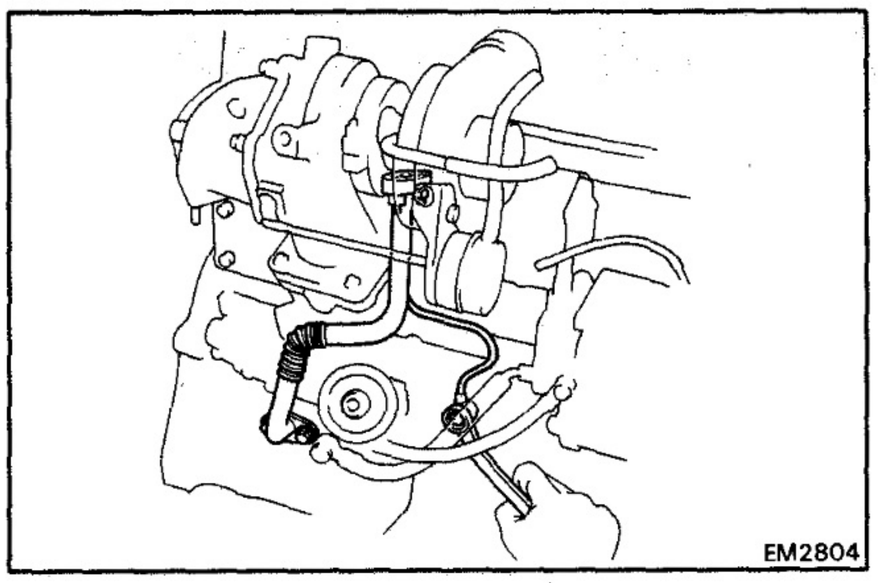
(b) Install the turbocharger with the four nuts.

Torque: 465 kg-cm (34 ft-lb, 46 N·m)



6. INSTALL NO. 3 WATER BY-PASS PIPE CLAMP BOLT

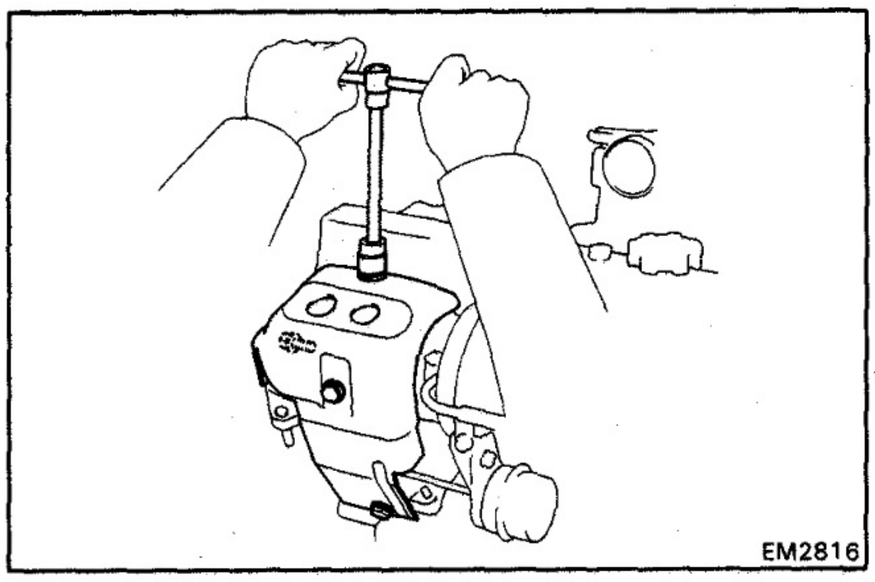
7. CONNECT WATER BY-PASS HOSE TO NO. 3 WATER BY-PASS PIPE



8. INSTALL TURBOCHARGER OIL PIPE

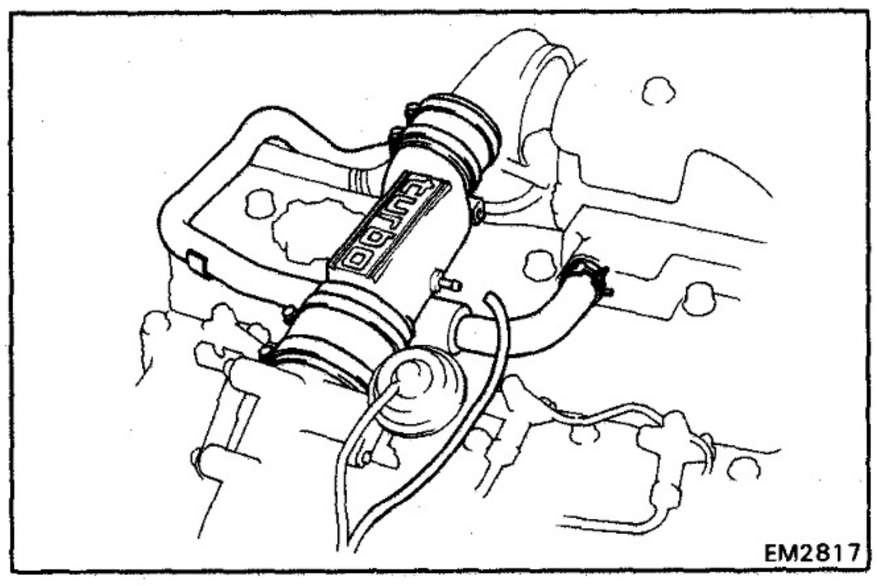
Install the turbocharger oil pipe with the two bolts, two nuts, union bolt and gaskets.

9. INSTALL OIL FILTER (See page LU-3)



10. INSTALL TURBOCHARGER HEAT INSULATOR

Install the turbocharger heat insulator with the four bolts.

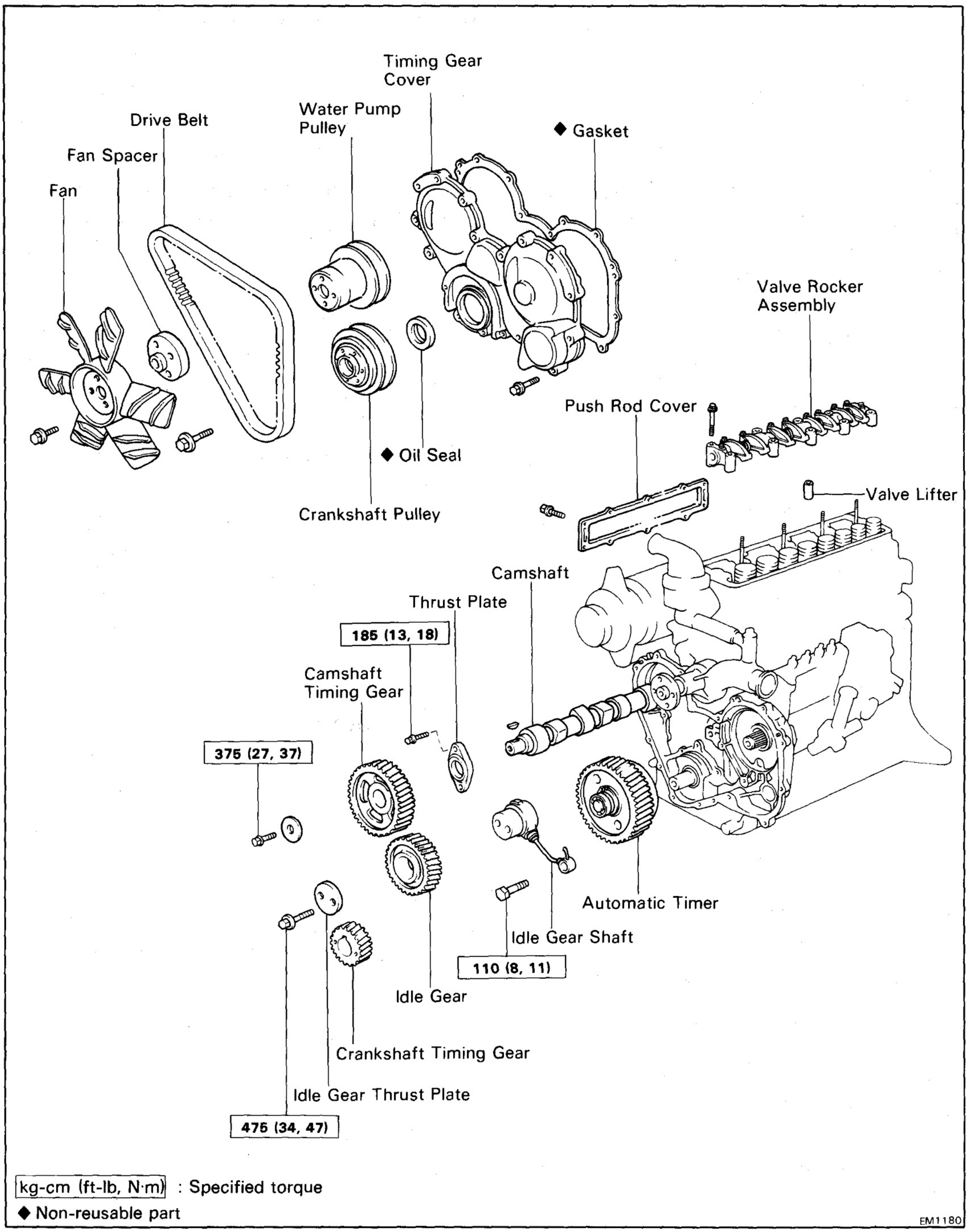


11. INSTALL POSITIVE CRANKCASE VENTILATION (PCV) HOSE AND INTAKE AIR CONNECTOR PIPE

12. FILL WITH COOLANT (See page CO-3)

TIMING GEARS AND CAMSHAFT

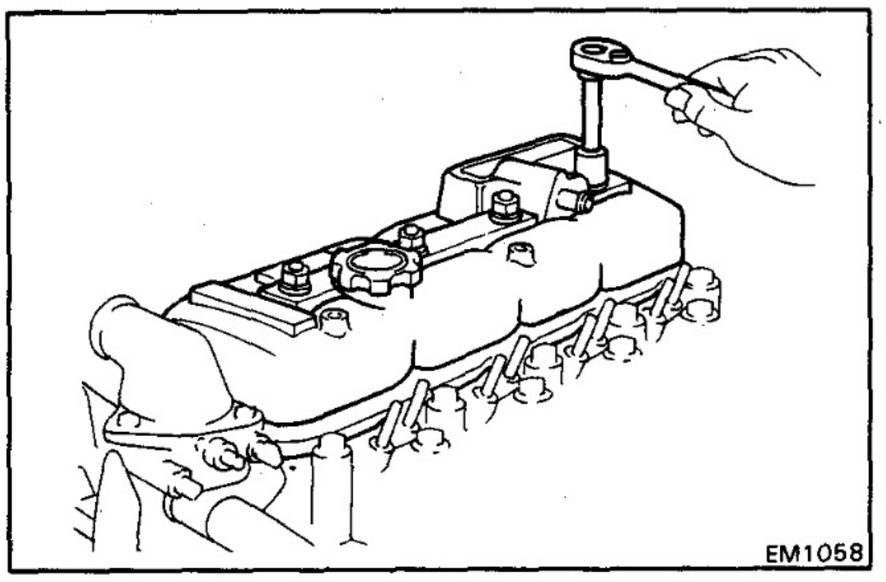
COMPONENTS

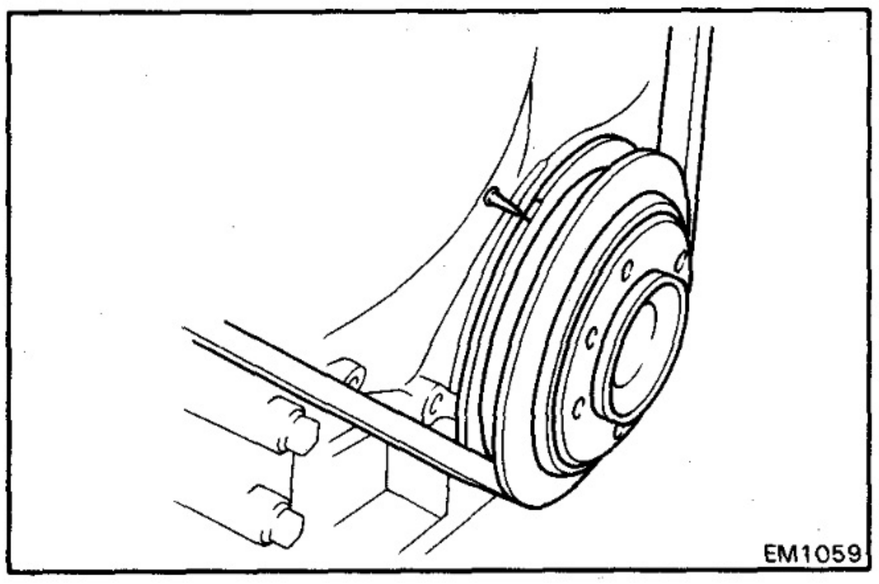


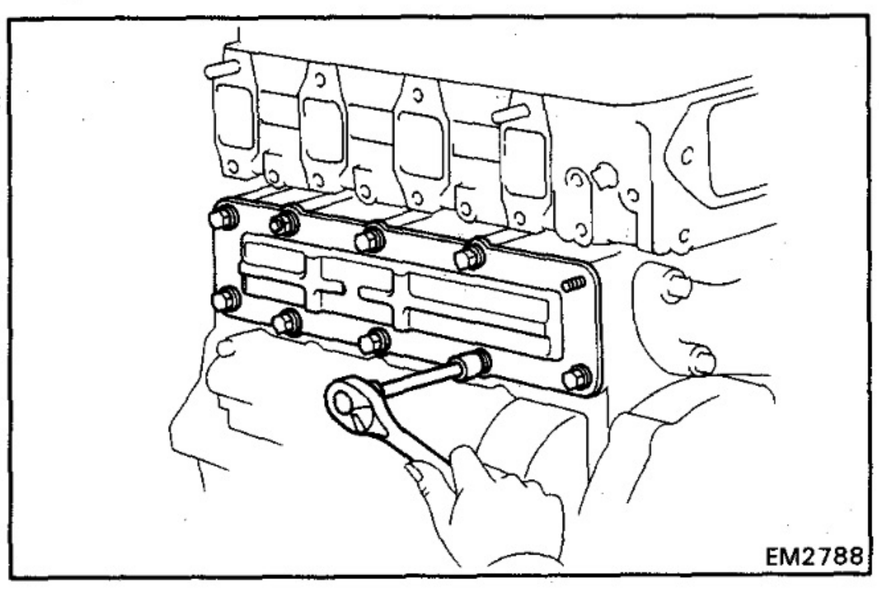
kg-cm (ft-lb, N·m) : Specified torque

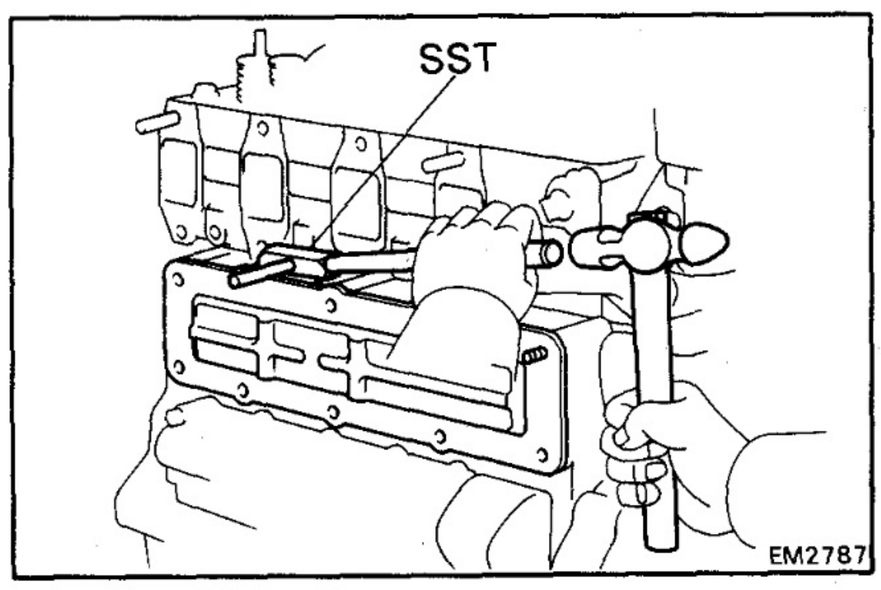
◆ Non-reusable part

EM1180


EM1058


EM1059


EM2788



EM2787

REMOVAL OF TIMING GEARS AND CAMSHAFT

(See page EM-52)

1. [13B-T]
   REMOVE TURBOCHARGER (See page EM-47)

2. REMOVE EXHAUST MANIFOLD
   (See step 8 on page EM-28)

3. REMOVE CYLINDER HEAD COVER

   Remove the four cap nuts, seal washers, head cover and gasket.

4. SET NO. 1 CYLINDER TO TDC/COMPRESSION

   (a) Set the No. 1 cylinder to TDC/compression.
   Align the groove on the pulley with the timing pointer 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.

5. REMOVE DRIVE BELT

6. SWING ALTERNATOR

   Swing the alternator away from the cylinder head.

7. REMOVE VALVE ROCKER SHAFT ASSEMBLY AND PUSH RODS (See steps 10, 11 on page EM-28)

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

9. REMOVE VACUUM TRANSMITTING PIPE

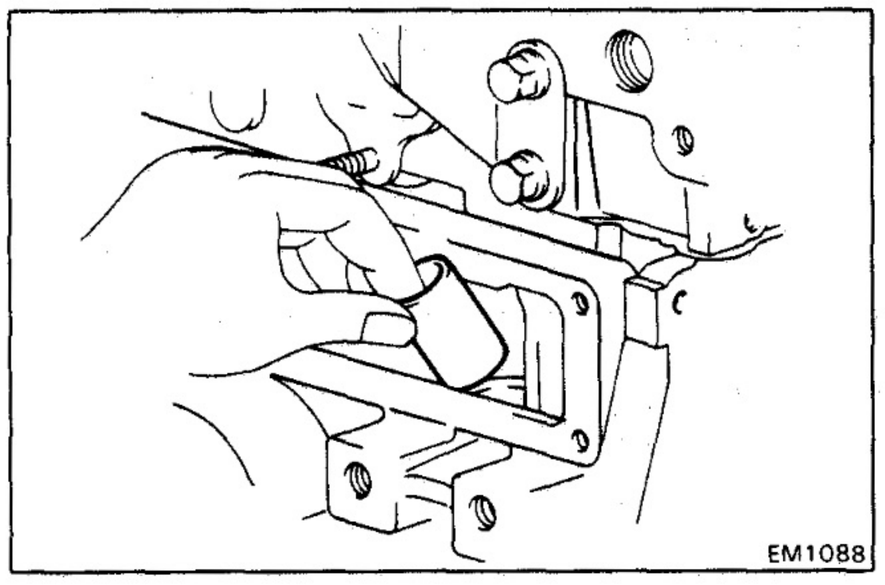
10. REMOVE PUSH ROD COVER

    (a) Remove the seven bolts and two nuts.

    (b) Insert the SST blade between the cylinder block and push rod cover, cut off applied sealer, and remove the push rod cover with a screwdriver.

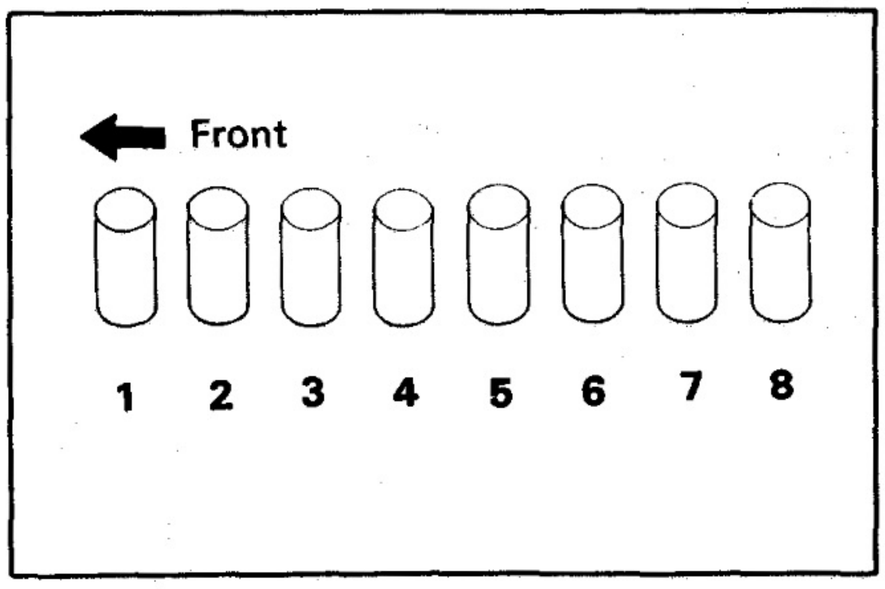
SST 09032-00100

NOTE: Be careful not to damage the flange of the push rod cover.

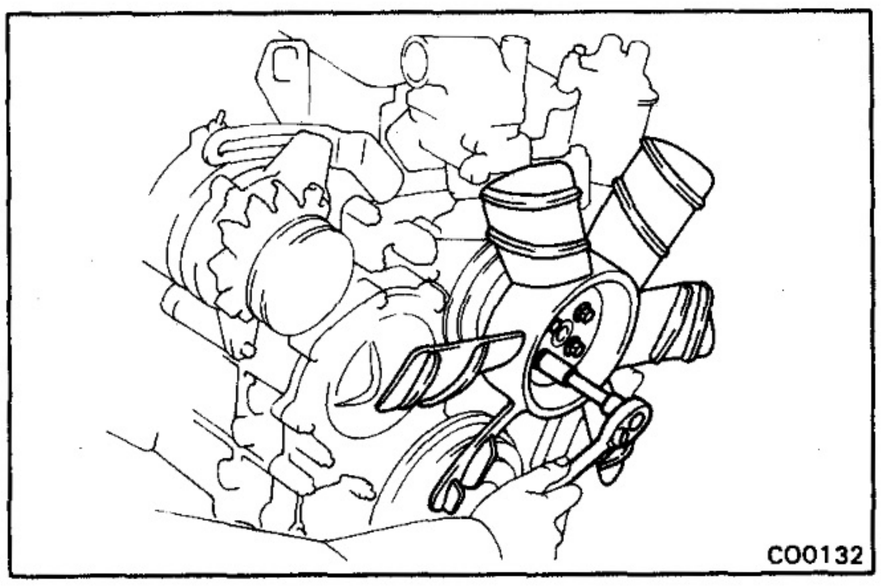


11. REMOVE VALVE LIFTERS

Remove the eight valve lifters in order, beginning from the No. 1 valve lifter.



NOTE: Arrange the valve lifters in correct order.



12. [w/o FLUID COUPLING] REMOVE FAN, FAN SPACER AND WATER PUMP PULLEY

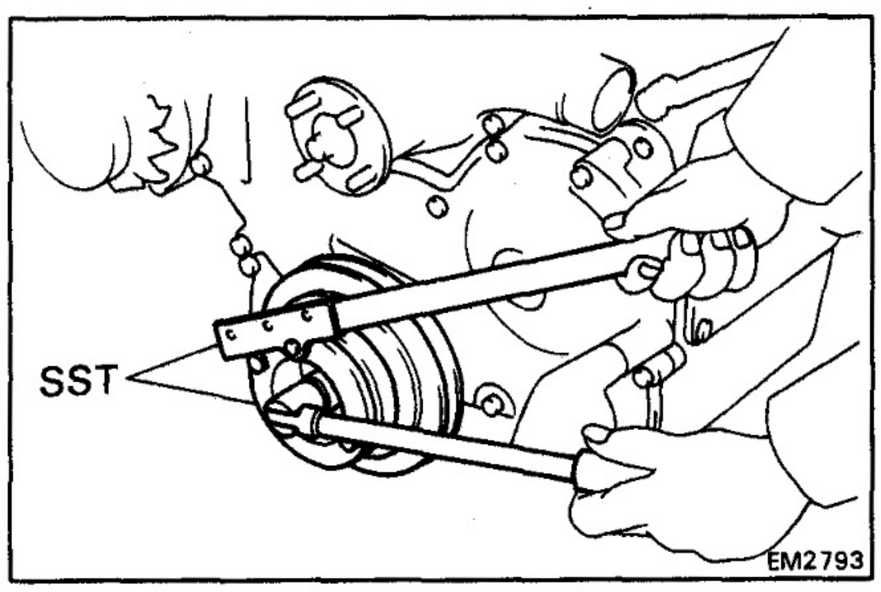
(a) Remove the four bolts mounting the fan to the pulley seat.

(b) Remove the fan, fan spacer and pulley.

[w/ FLUID COUPLING] REMOVE FAN, FLUID COUPLING AND WATER PUMP PULLEY

(a) Remove the four nuts mounting the fluid coupling to the pulley seat.

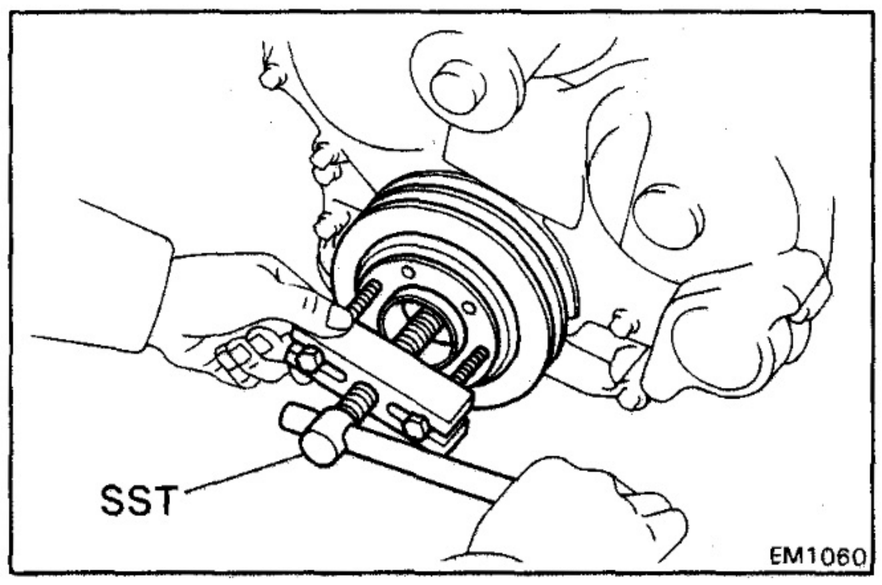
(b) Remove the fluid coupling with the fan assembly and pulley.



13. REMOVE CRANKSHAFT PULLEY

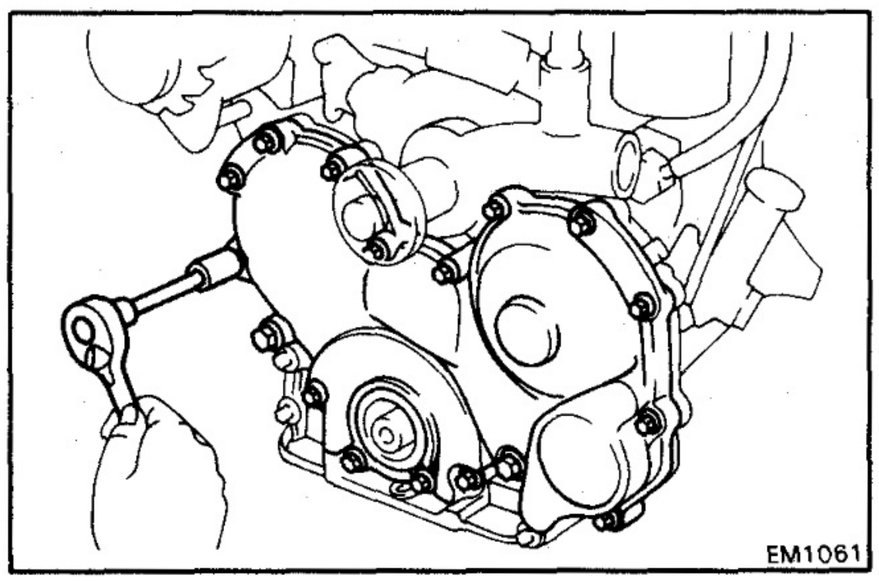
(a) Using SST, remove the mount bolts.

SST 09213-58011 and 09330-00021



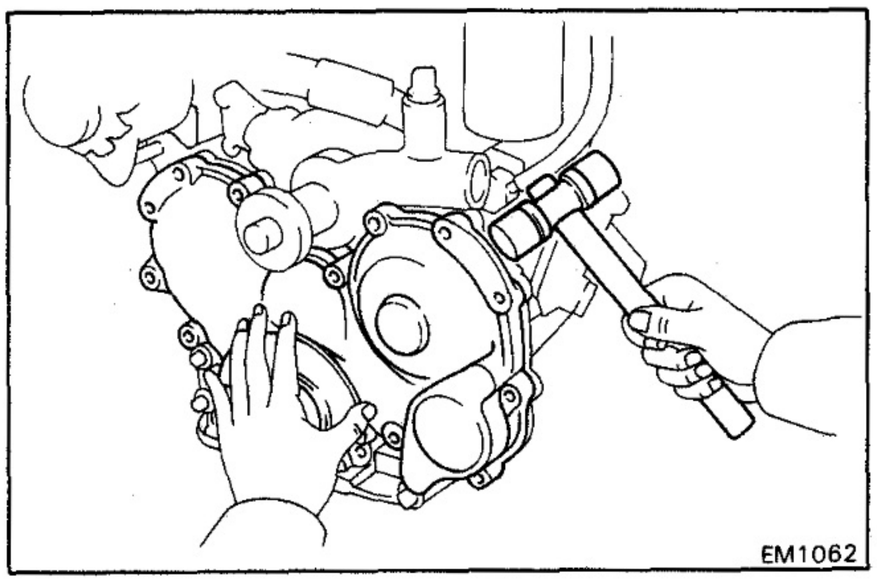
(b) Using SST, remove the pulley.

SST 09213-60017



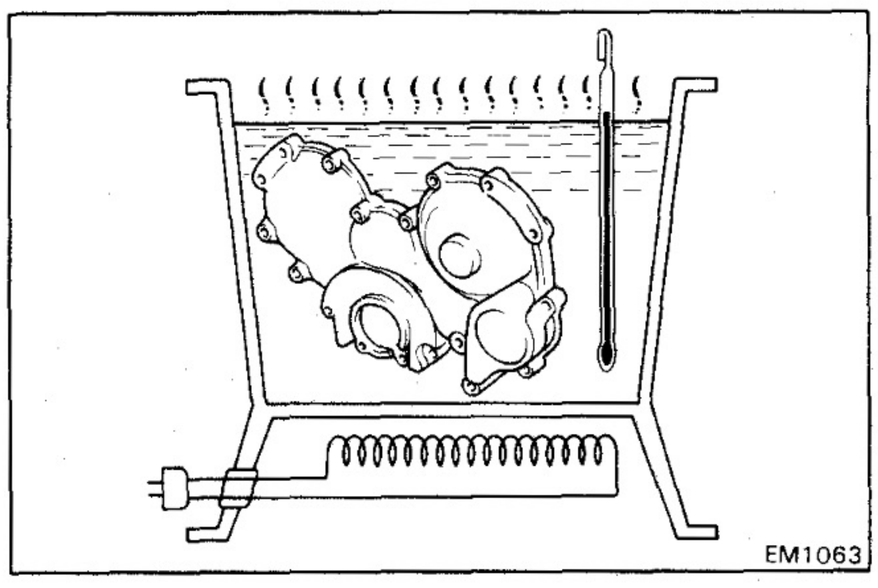
14. REMOVE TIMING GEAR COVER

(a) Remove the seventeen timing gear cover mount bolts.



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

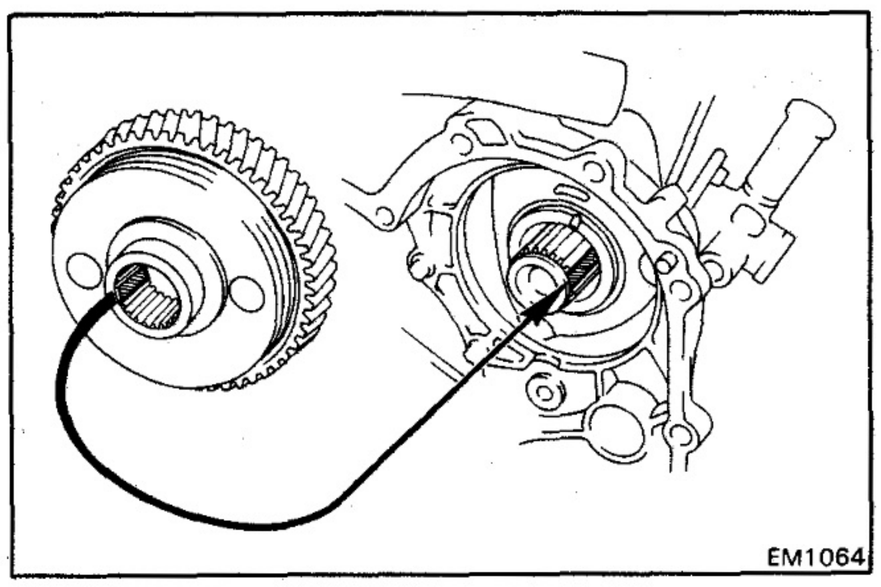
(c) Remove the cover gasket.



15. REMOVE AUTOMATIC TIMER FROM TIMING GEAR COVER

Heat the timing gear cover with automatic timer to about 60°C (140°F) and remove the timer.

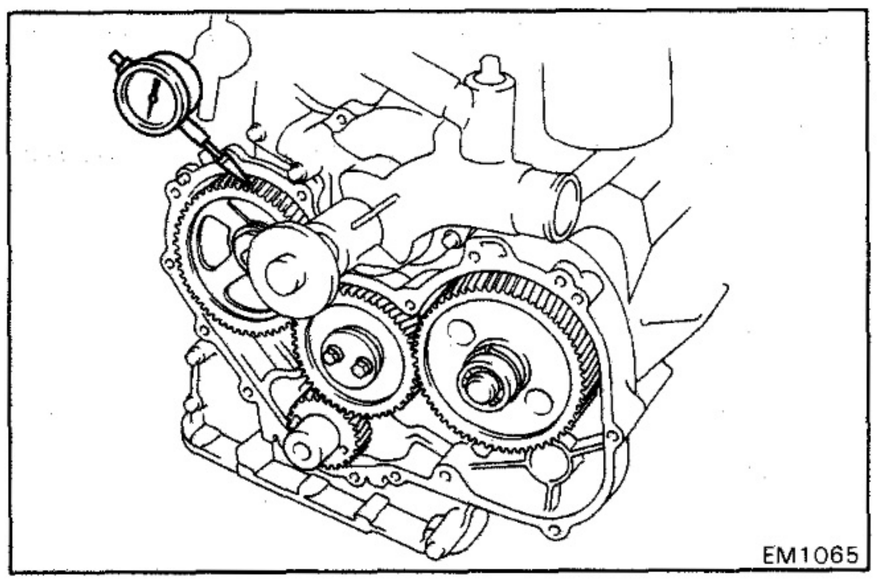
NOTE: For disassembly and assembly of the automatic timer, refer to the FUEL SYSTEM section.
(See page FU-16)



16. CHECK TIMING GEAR BACKLASHS

(a) Align the timer hub spline toothless portion with injection pump spline toothless portion.

(b) Install the automatic timer to the injection pump spline.

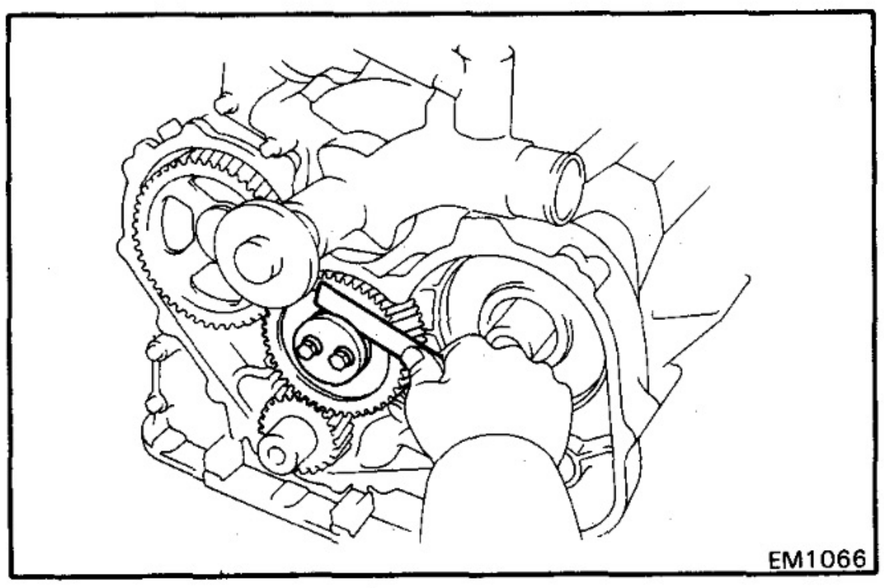


(c) Using a dial indicator, measure the backlash between each gear.

Standard backlash: **0.058 — 0.162 mm (0.0023 — 0.0064 in.)**
Maximum backlash: **0.3 mm (0.012 in.)**

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

(d) Remove the automatic timer.

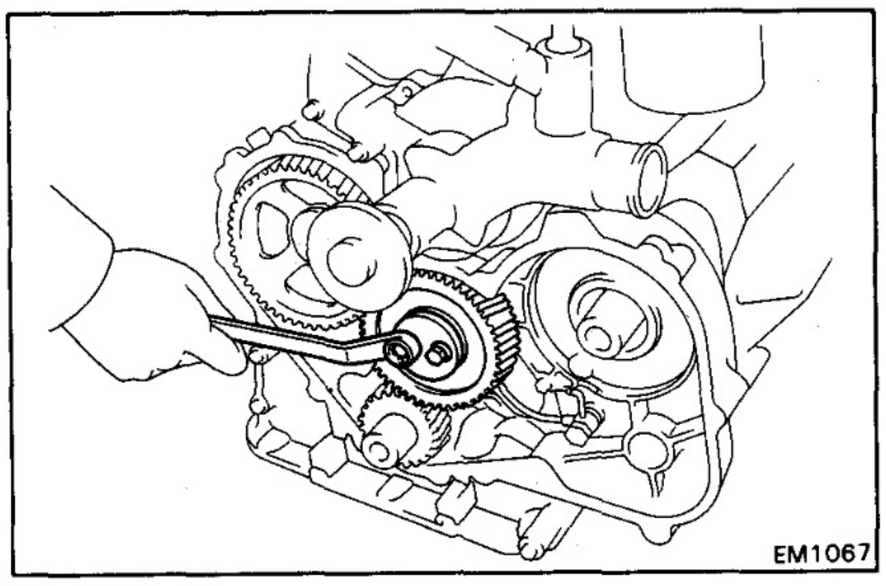


17. CHECK IDLE GEAR THRUST CLEARANCE

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

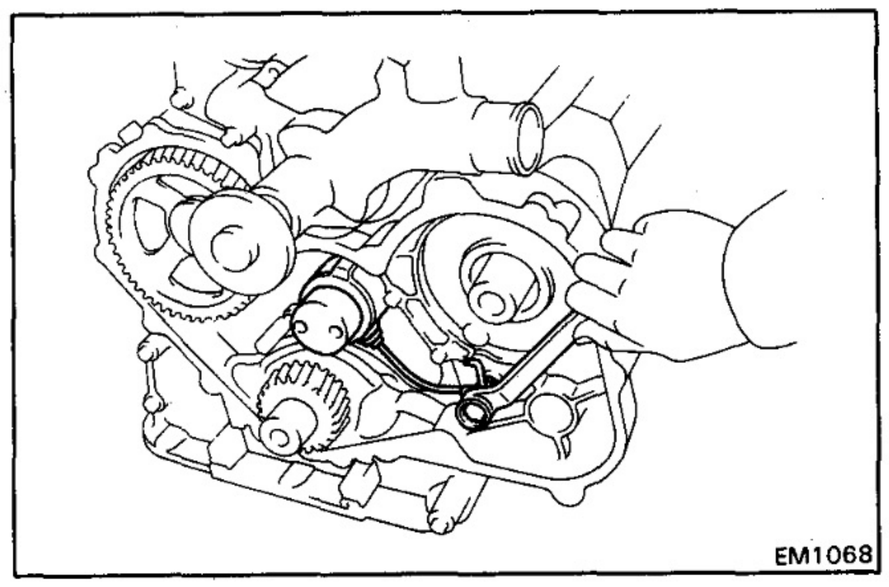
Standard thrust clearance: 0.06 – 0.17 mm (0.0024 – 0.0067 in.)
Maximum thrust clearance: 0.3 mm (0.012 in.)

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



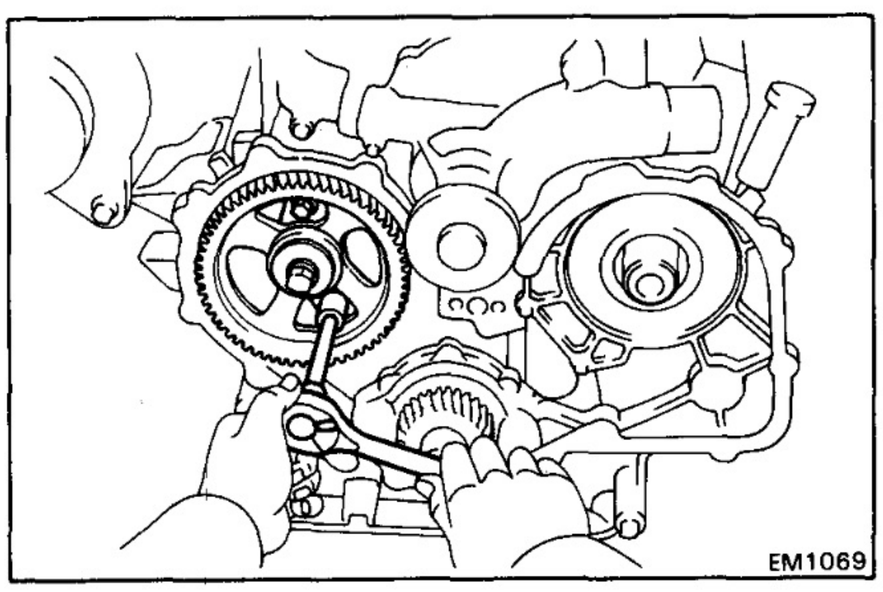
18. REMOVE IDLE GEAR

Remove the two bolts, thrust plate and idle gear.



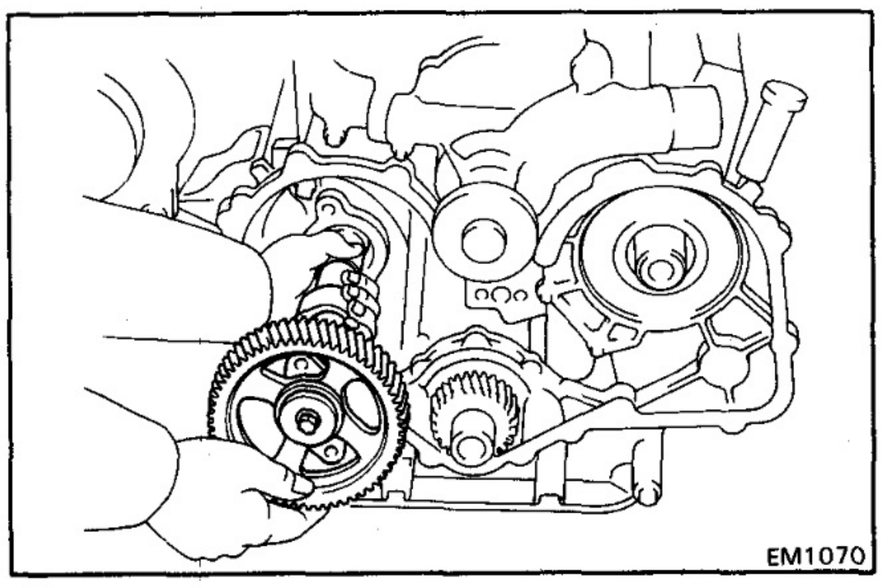
19. REMOVE IDLE GEAR SHAFT

Remove the union bolt and idle gear shaft.



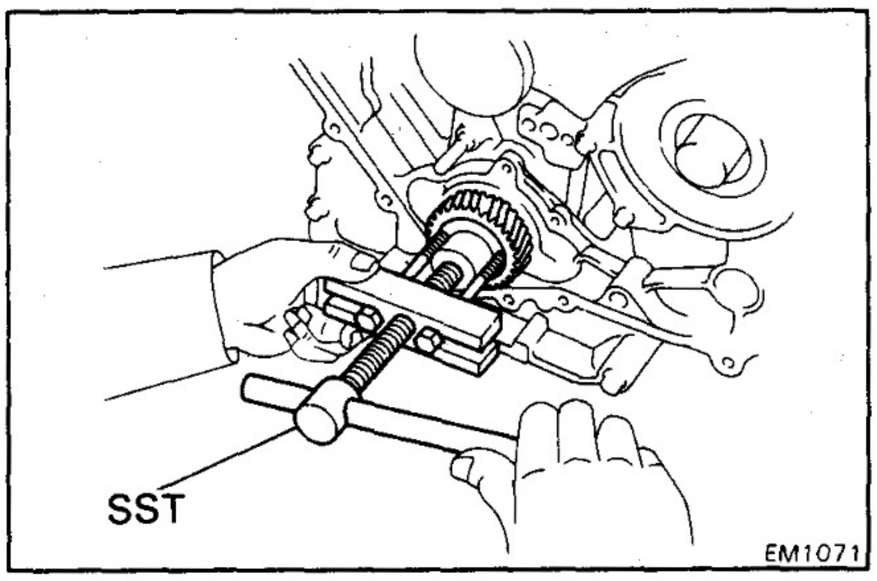
20. REMOVE CAMSHAFT TIMING GEAR AND CAMSHAFT ASSEMBLY

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



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

CAUTION: Be careful not to damage the camshaft bearings.



21. REMOVE CRANKSHAFT TIMING GEAR

Using SST, remove the timing gear.

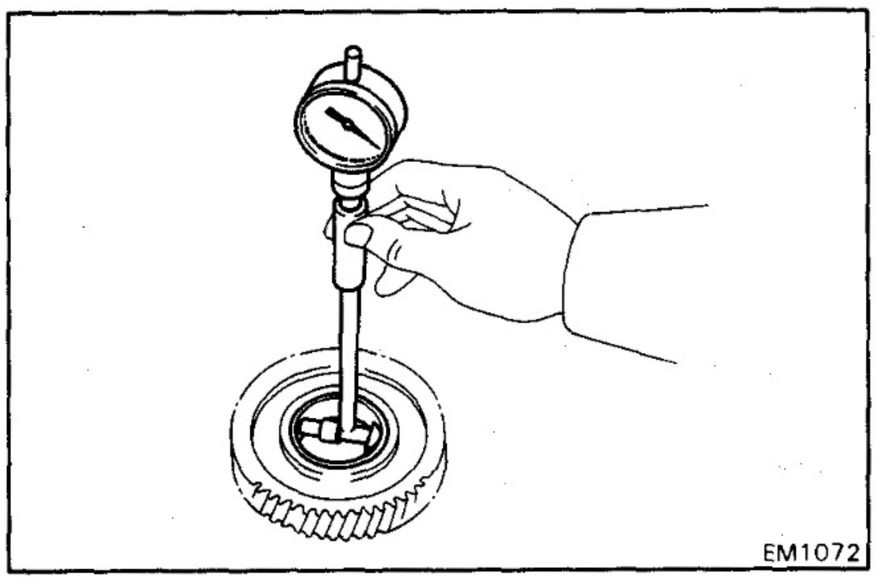
SST 09213-60017

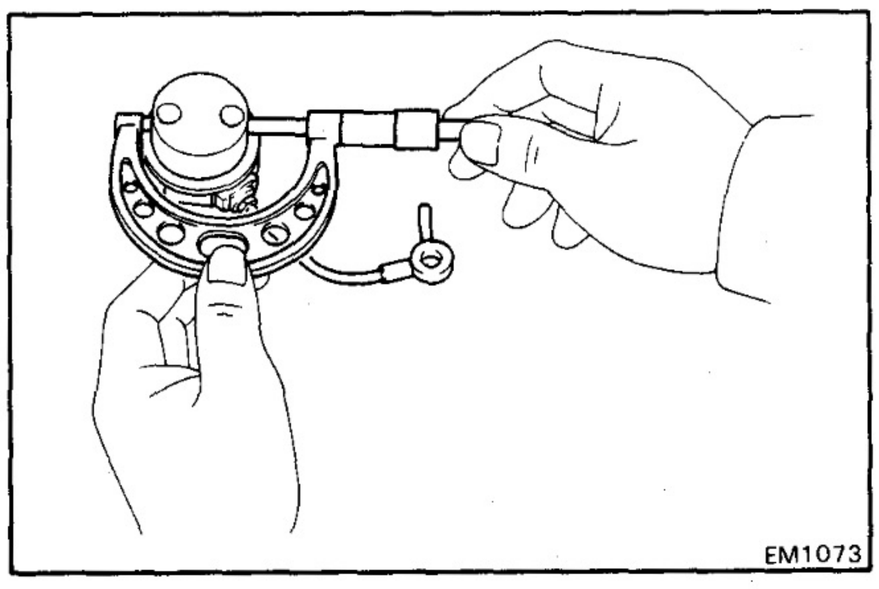
INSPECTION OF TIMING GEAR COMPONENTS

1. INSPECT IDLE GEAR

(a) Using a dial indicator, measure the inside diameter of the idle gear.

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





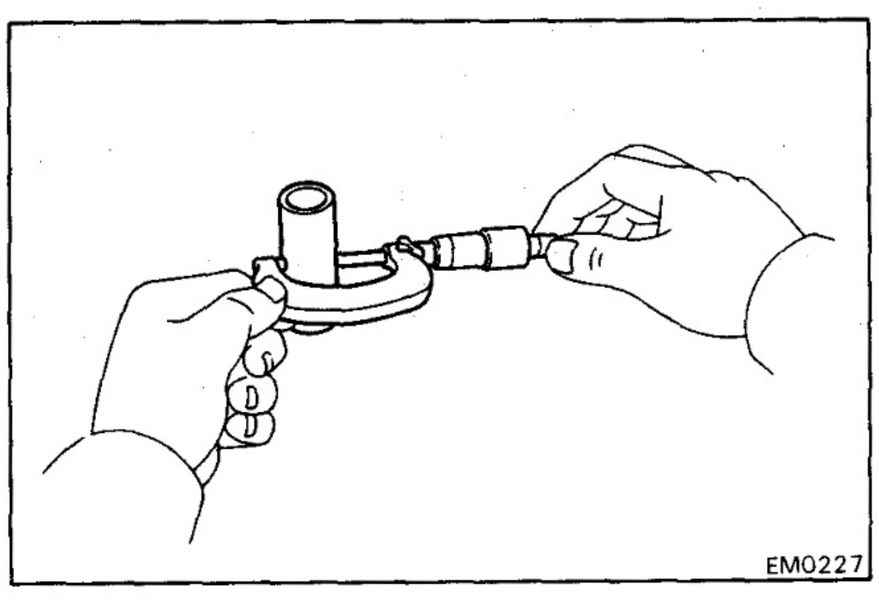
(b) Using a micrometer, measure the diameter of idle gear shaft.

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: **0.014 – 0.060 mm (0.0006 – 0.0024 in.)**
Maximum oil clearance: **0.2 mm (0.008 in.)**

If the oil clearance is greater than maximum, replace the idle gear and/or shaft.

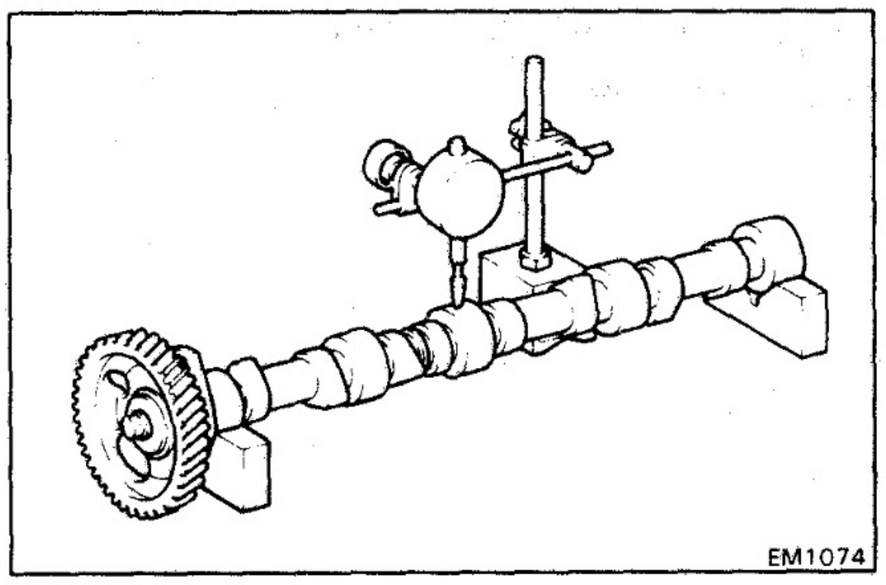


2. INSPECT VALVE LIFTERS

Using a micrometer, measure the valve lifter diameter.

Lifter diameter:
26.972 – 26.985 mm (1.0619 – 1.0624 in.)

If the diameter is not within specification, check the oil clearance. (See page EM-86)


EM1074

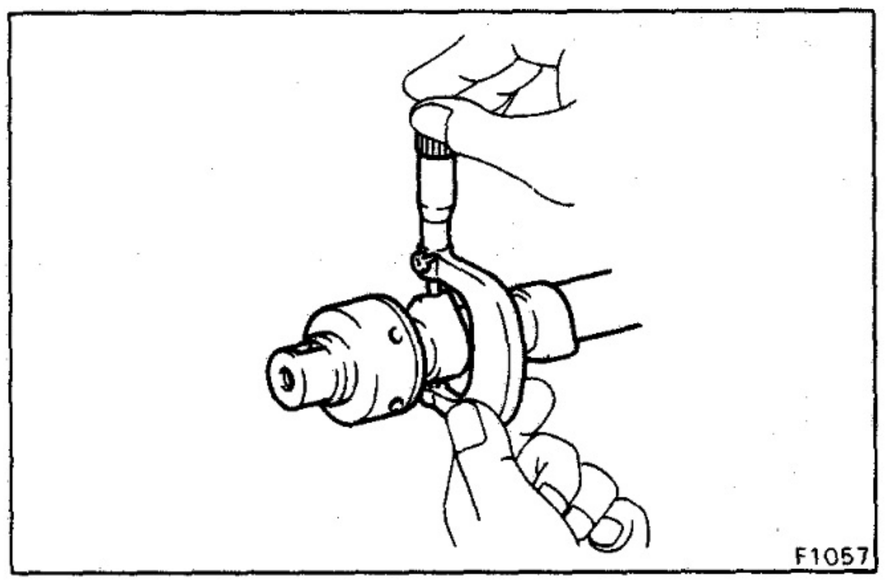
INSPECTION OF TIMING GEAR AND CAMSHAFT

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.


F1057

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

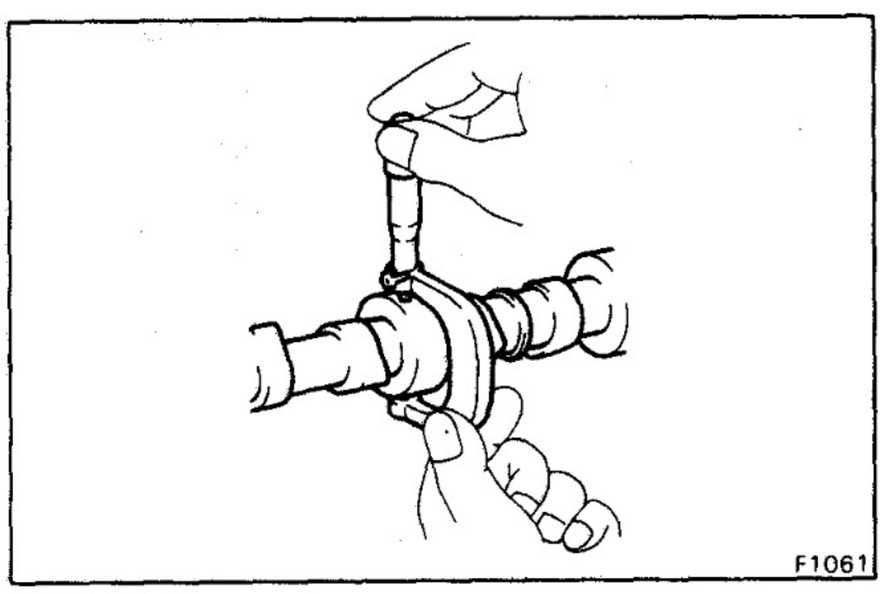
Standard cam lobe height:

Intake	**11B, 13B**	**44.705 – 44.795 mm (1.7600 – 1.7636 in.)**
	13B-T	**44.909 – 44.999 mm (1.7681 – 1.7716 in.)**
Exhaust		**44.774 – 44.864 mm (1.7628 – 1.7663 in.)**

Minimum cam lobe height:

Intake	**11B, 13B**	**44.27 mm (1.7429 in.)**
	13B-T	**44.47 mm (1.7508 in.)**
Exhaust		**44.34 mm (1.7457 in.)**

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

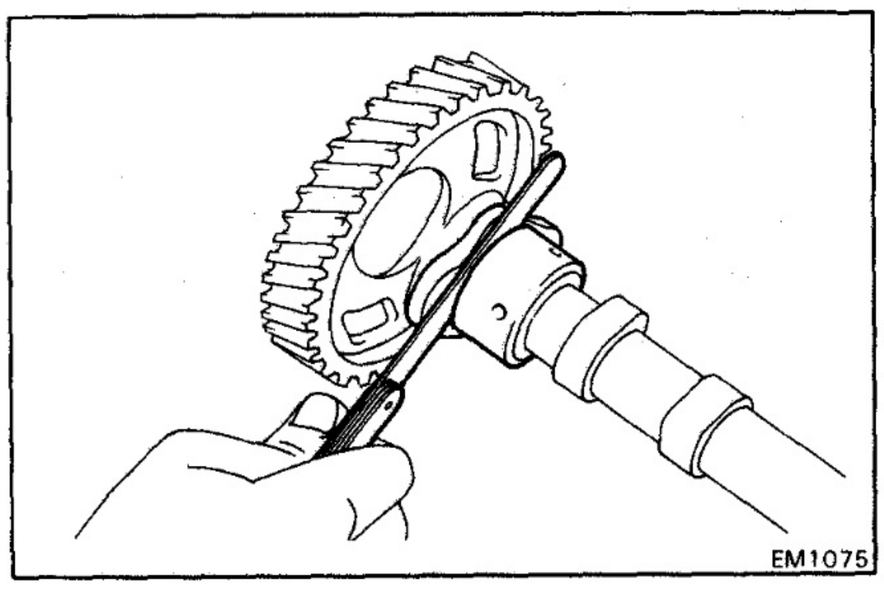

F1061

(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.)

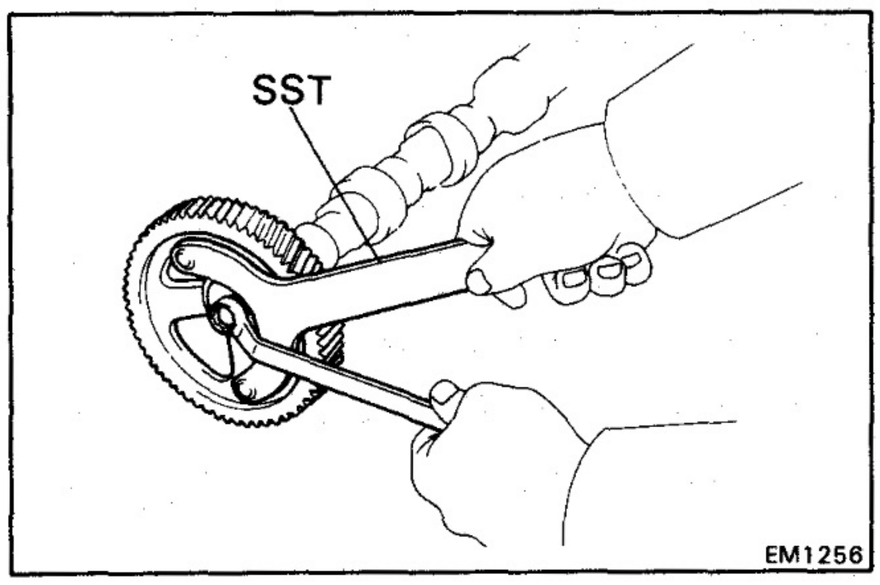
If the journal diameter is not within specification, check the oil clearance. (See page EM-84)


EM1075

(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: 0.3 mm (0.012 in.)

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

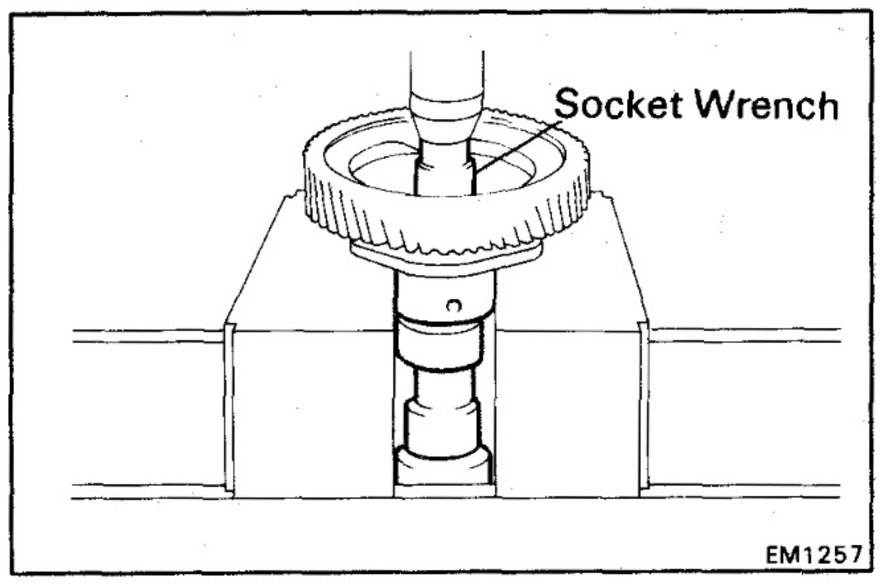


DISASSEMBLY AND ASSEMBLY OF CAMSHAFT AND CAMSHAFT TIMING GEAR

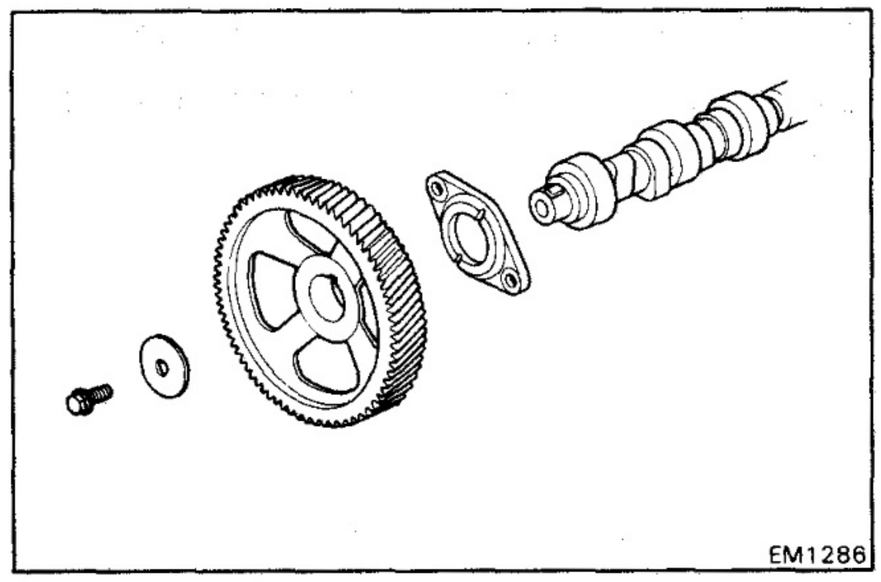
1. DISASSEMBLE CAMSHAFT AND CAMSHAFT TIMING GEAR

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

SST 09278-54012



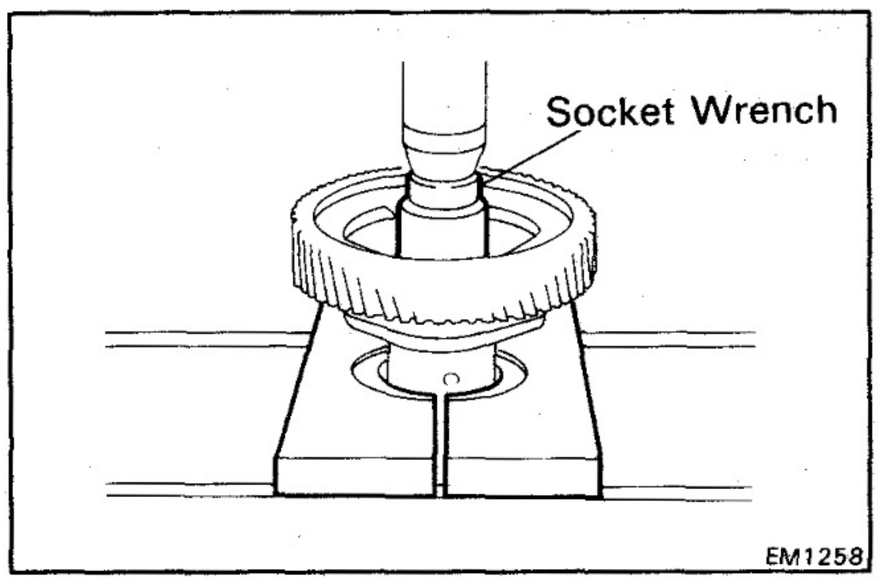
(b) Using a 19 mm socket wrench and press, press out the camshaft.



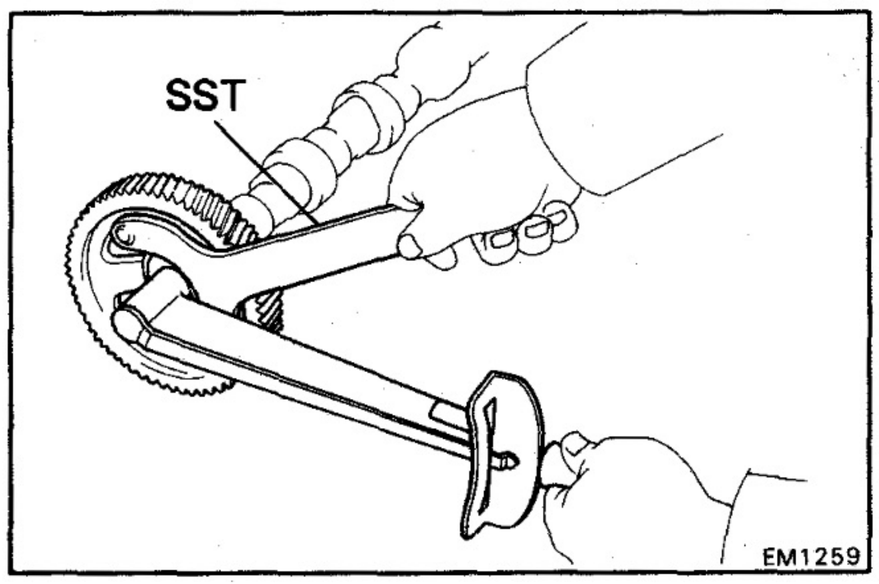
2. ASSEMBLE CAMSHAFT AND CAMSHAFT TIMING GEAR

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

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



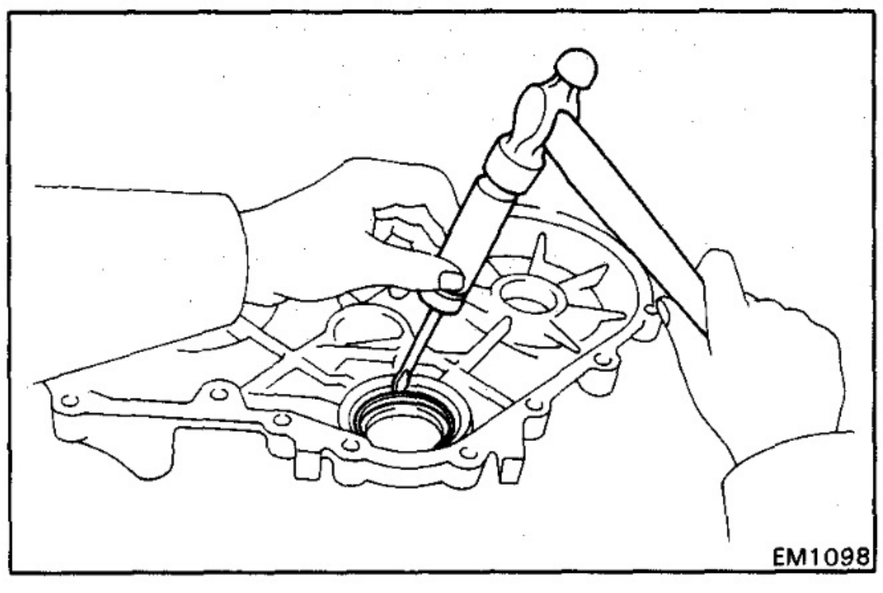
(c) Using a 29 mm socket wrench, align the timing gear set key with the key groove of the timing gear, and press in the timing gear.



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

SST 09278-54012

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



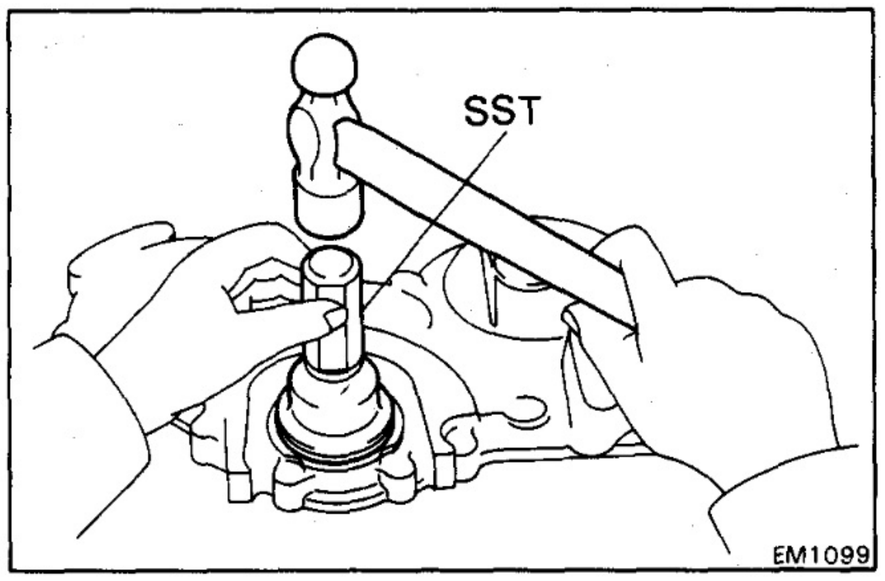
REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL

NOTE: There are two methods (A and B) of oil seal replacement.

REPLACE CRANKSHAFT FRONT OIL SEAL

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

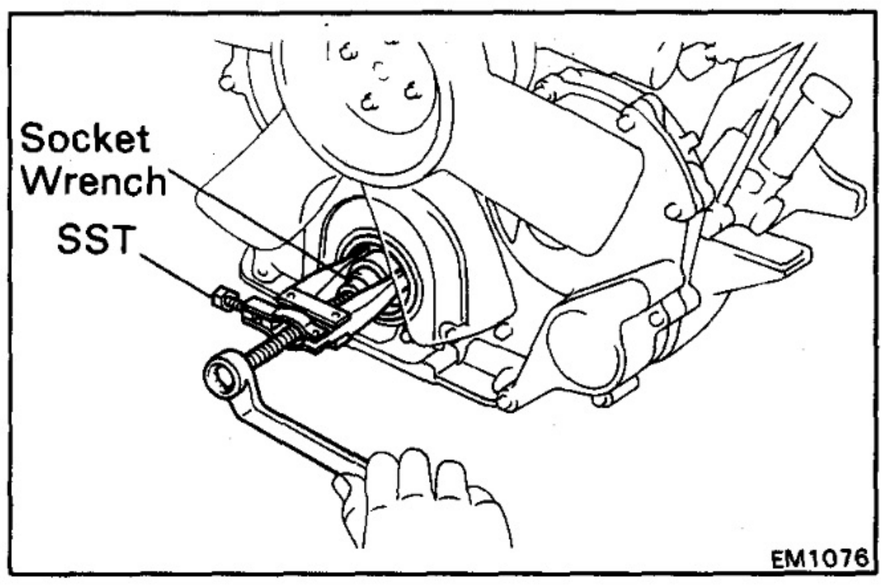
(a) Using a screwdriver and hammer, drive out the oil seal.



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

SST 09223-46011

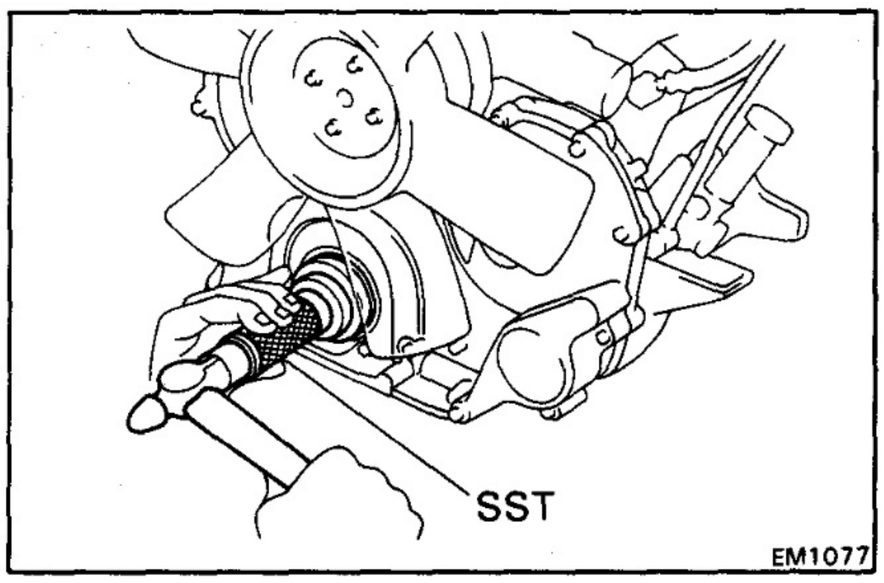
(c) Apply MP grease to the oil seal lip.



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

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

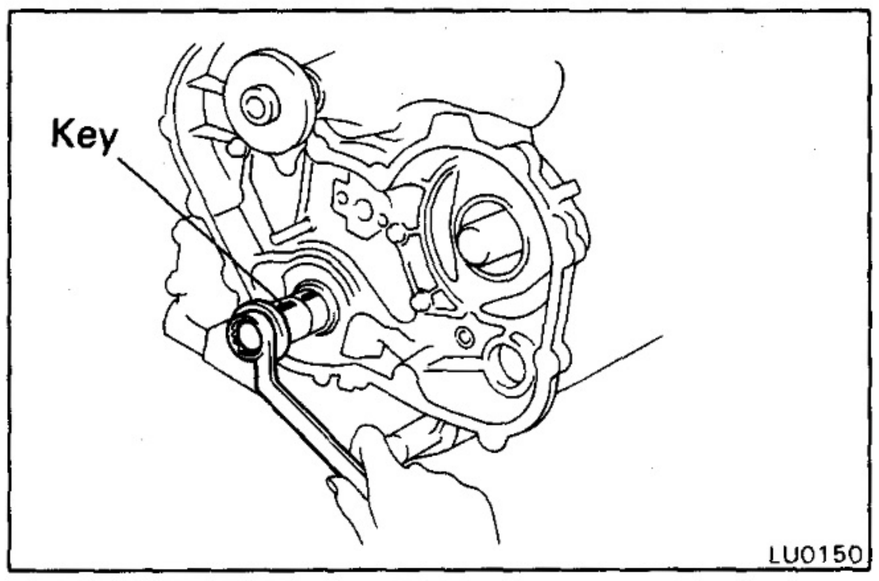
SST 09308-10010



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

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

SST 09223-46011



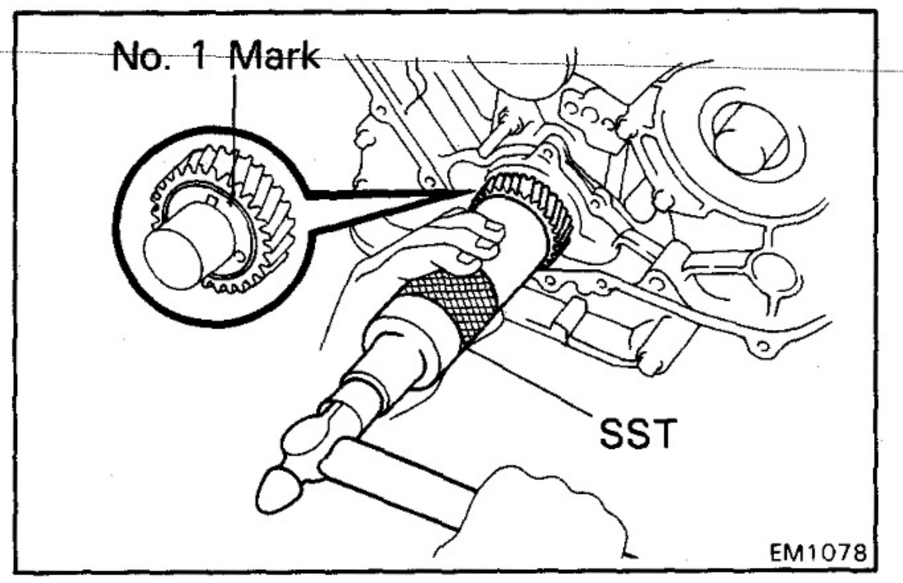
INSTALLATION OF TIMING GEARS AND CAMSHAFT

(See page EM-52)

1. INSTALL CRANKSHAFT TIMING GEAR

(a) Check the key on crankshaft facing upward.

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

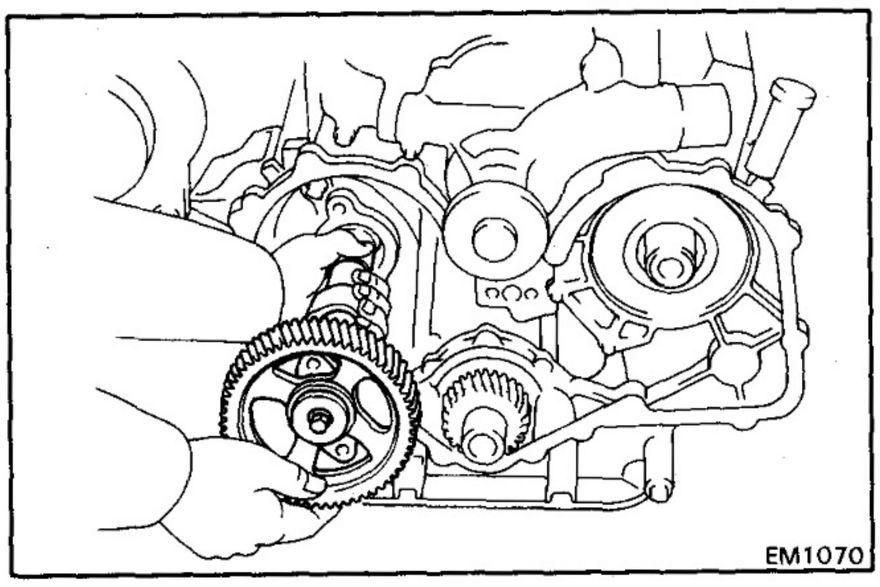


(b) Put the timing gear on the crankshaft with the No. 1 mark of the timing gear facing forward.

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

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

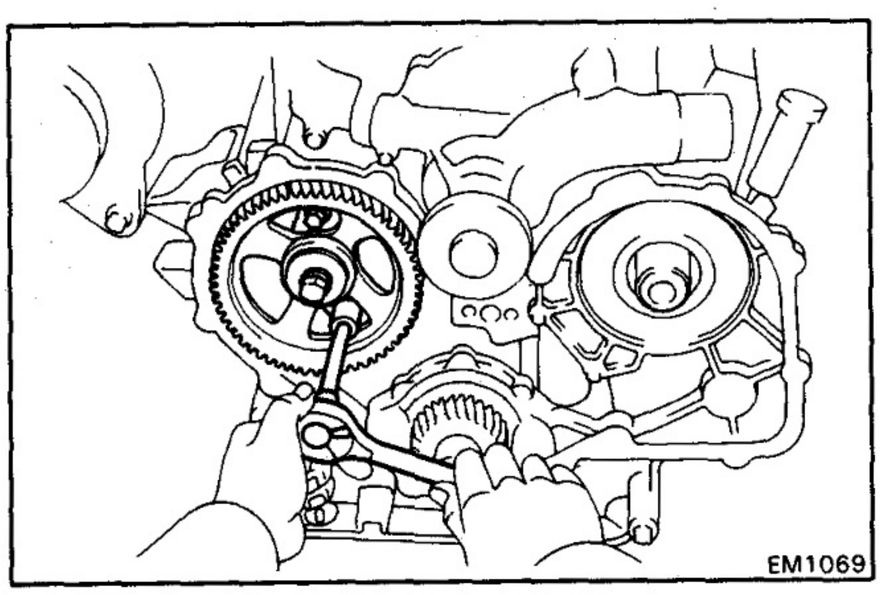
SST 09608-35014 (09608-06040)



2. INSTALL CAMSHAFT TIMING GEAR AND CAMSHAFT ASSEMBLY

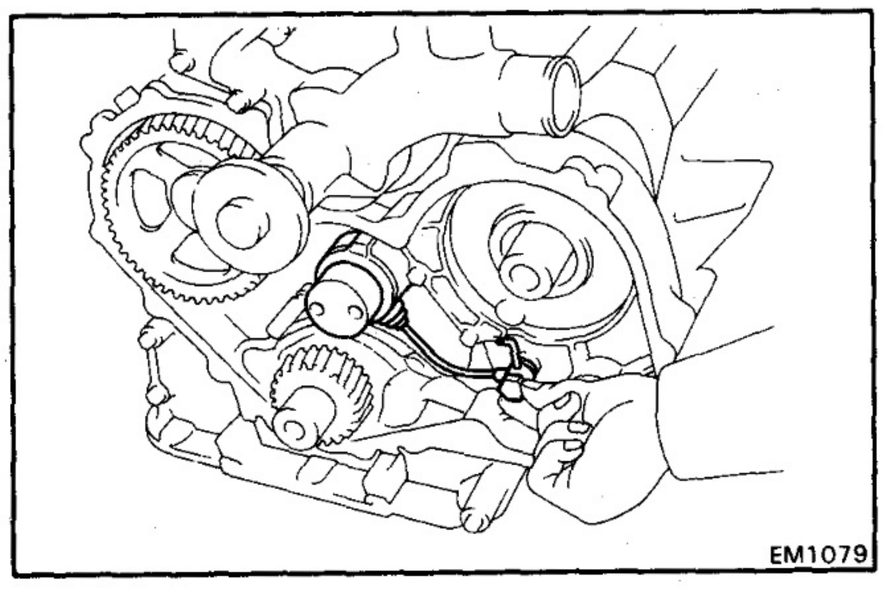
(a) Insert the camshaft into the cylinder block.

CAUTION: Be careful not to damage the camshaft bearings.



(b) Install the two bolts mounting the thrust washer to the cylinder block. Torque the bolts.

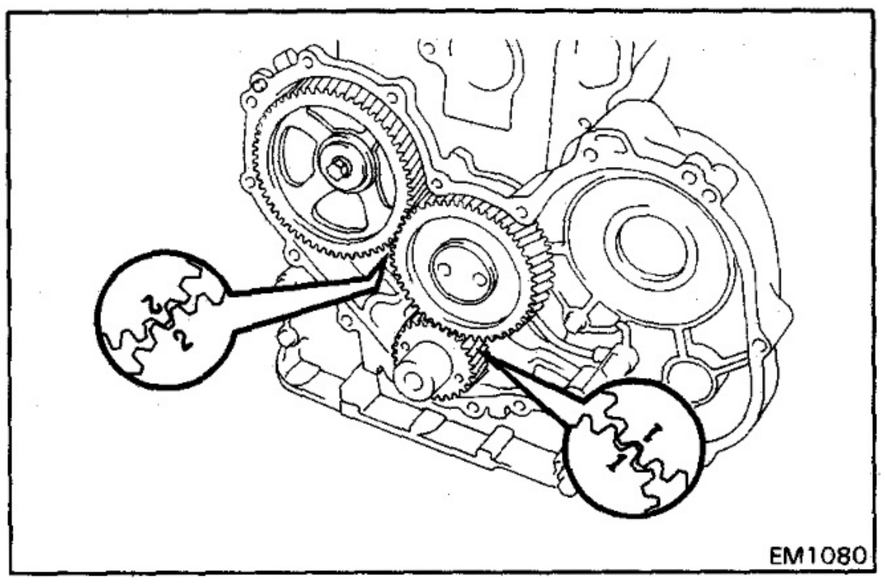
Torque: 185 kg-cm (13 ft-lb, 18 N·m)



3. INSTALL IDLE GEAR SHAFT

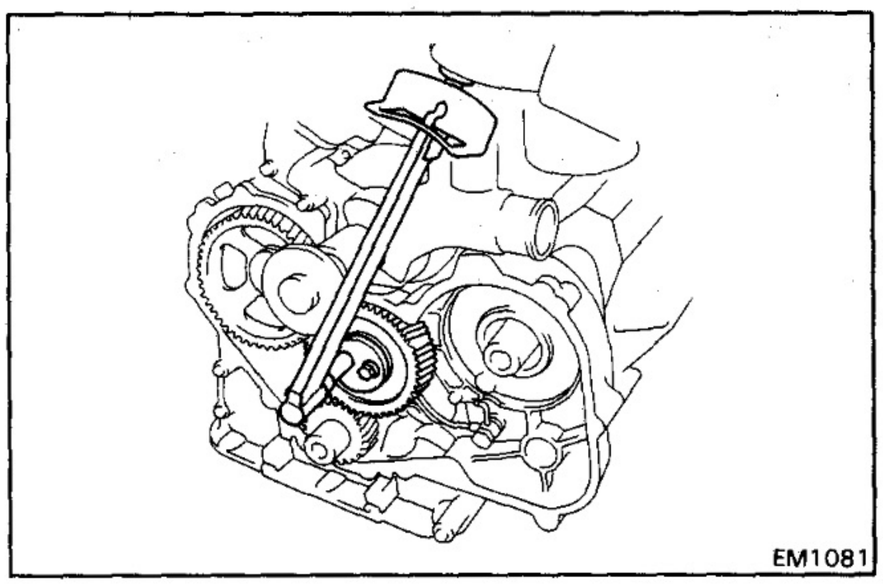
Temporarily install the idle gear with the union bolt.

CAUTION: Do not tighten the union bolt.



4. INSTALL IDLE GEAR

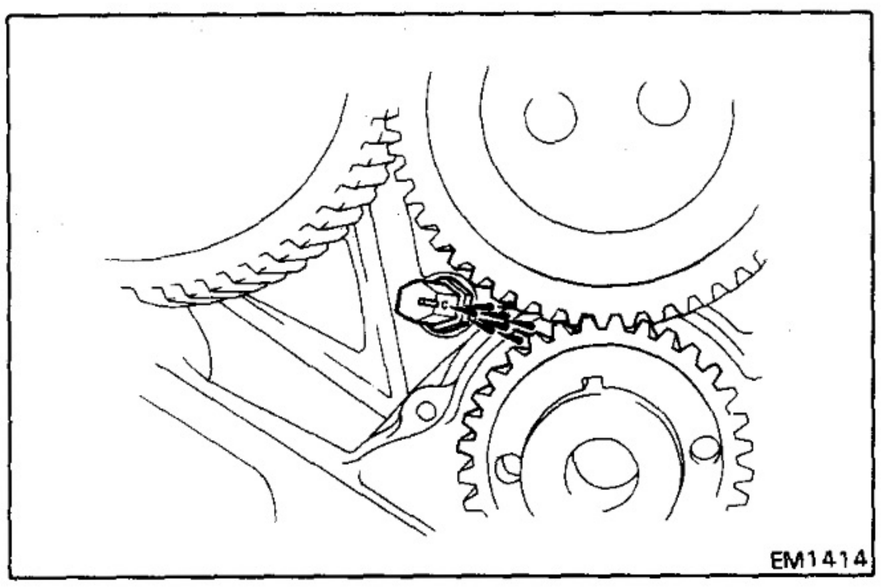
(a) Align the idle gear aligning marks 1 and 2 with the crankshaft gear aligning mark 1 and camshaft gear aligning mark 2 respectively, and mesh the gears.



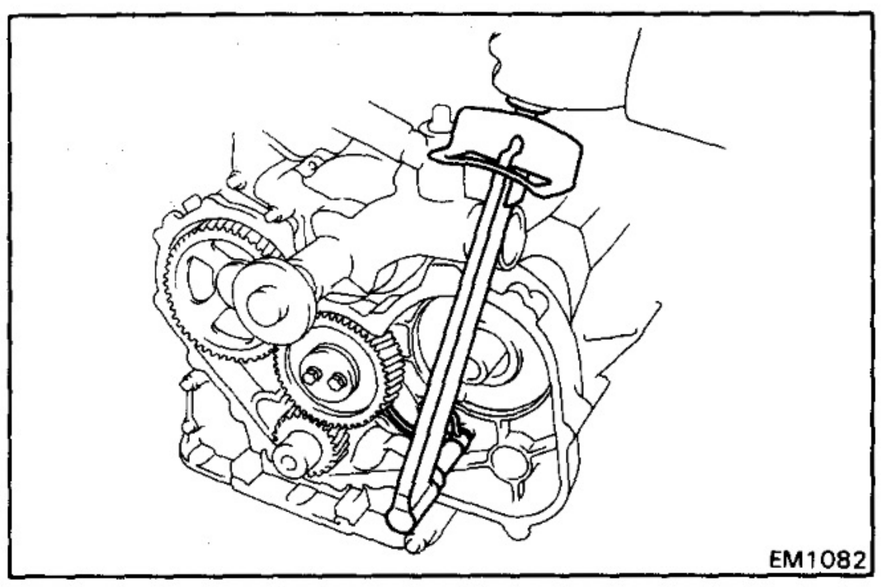
(b) Apply a light coat of engine oil on the threads and under the bolt heads.

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

Torque: 475 kg-cm (34 ft-lb, 47 N·m)

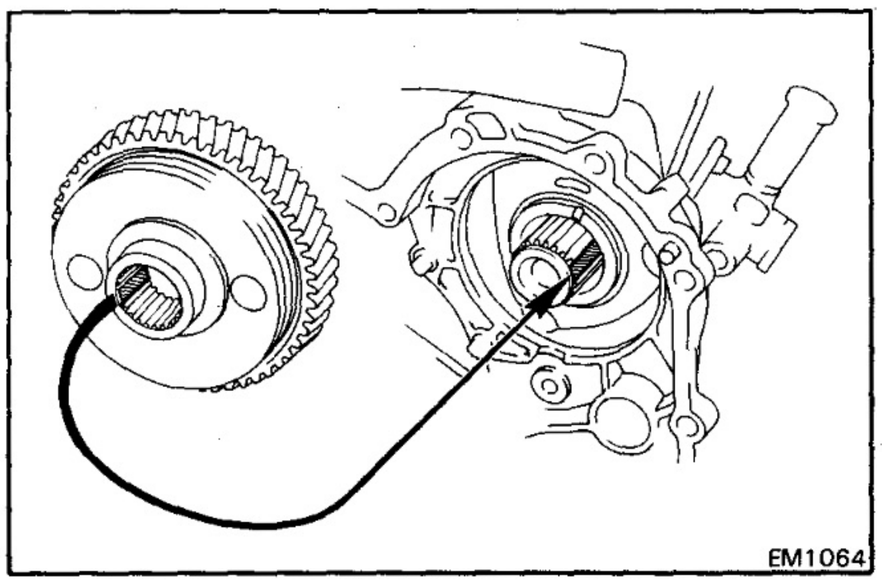


(d) Check that the oil nozzle is in the position shown.



5. TORQUE IDLE GEAR SHAFT UNION BOLT

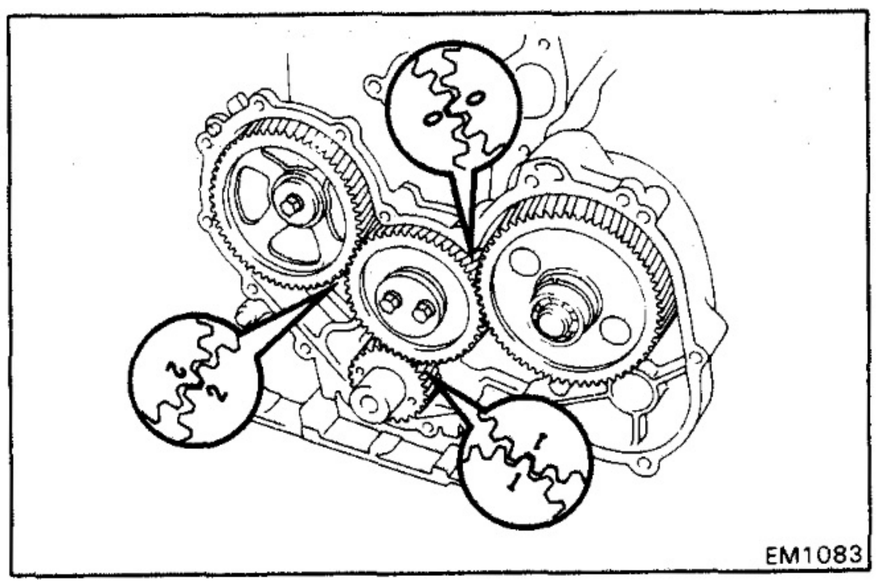
Torque: 110 kg-cm (8 ft-lb, 11 N·m)



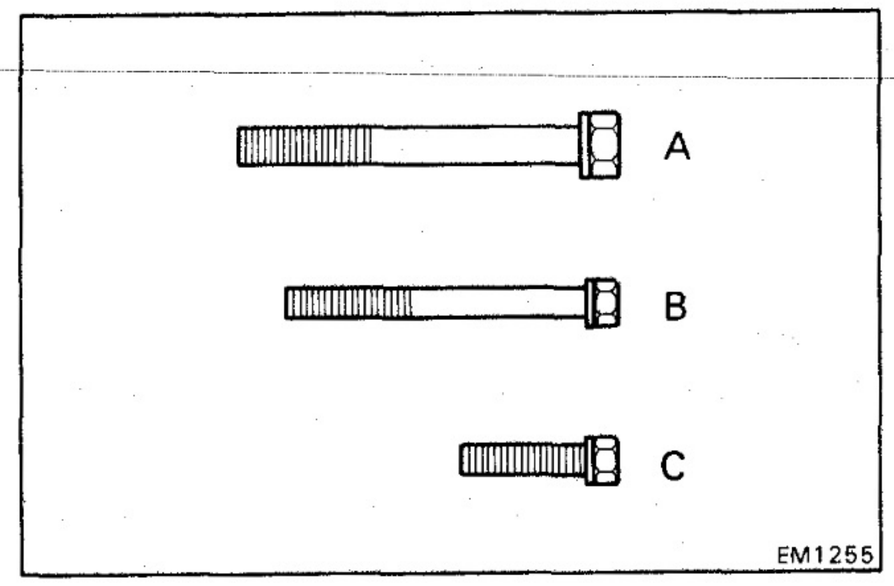
6. INSTALL AUTOMATIC TIMER

(a) Apply MP grease to the timer hub spline, bearing and injection pump spline.

(b) Align the timer hub spline toothless portion with injection pump spline toothless portion.

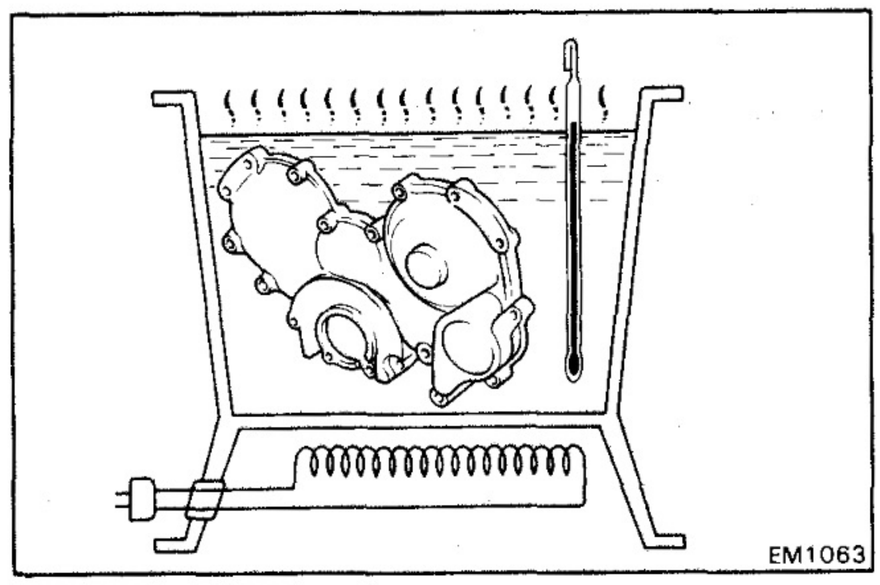


(c) Align the idle gear aligning mark 0 with the timer drive gear aligning mark 0, and mesh the gears.

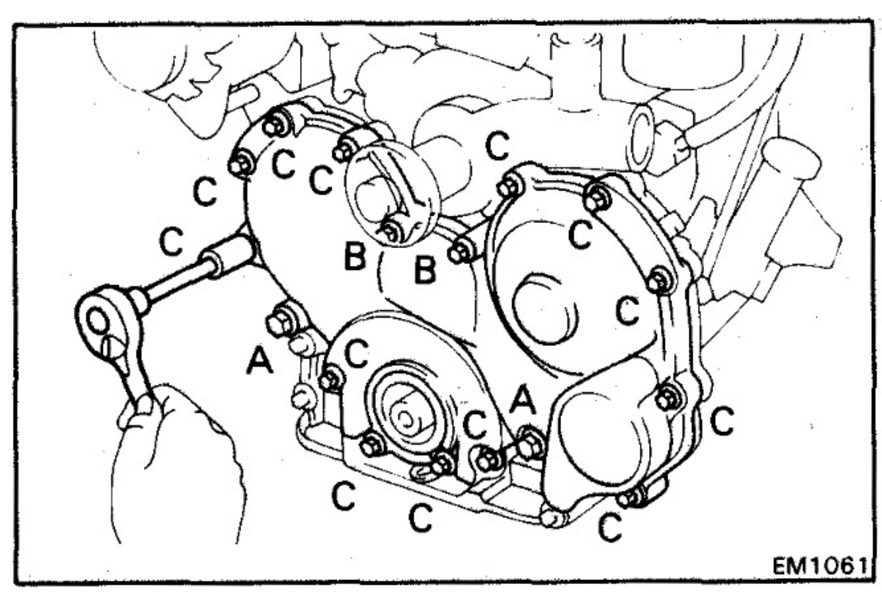


7. INSTALL TIMING GEAR COVER

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

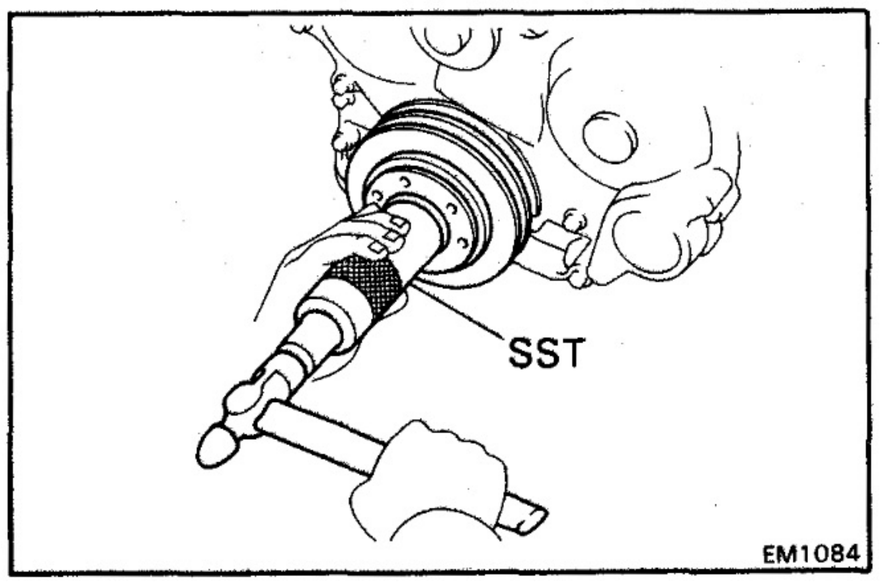


(a) Gradually heat the timing gear cover to about 60°C (140°F).



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

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

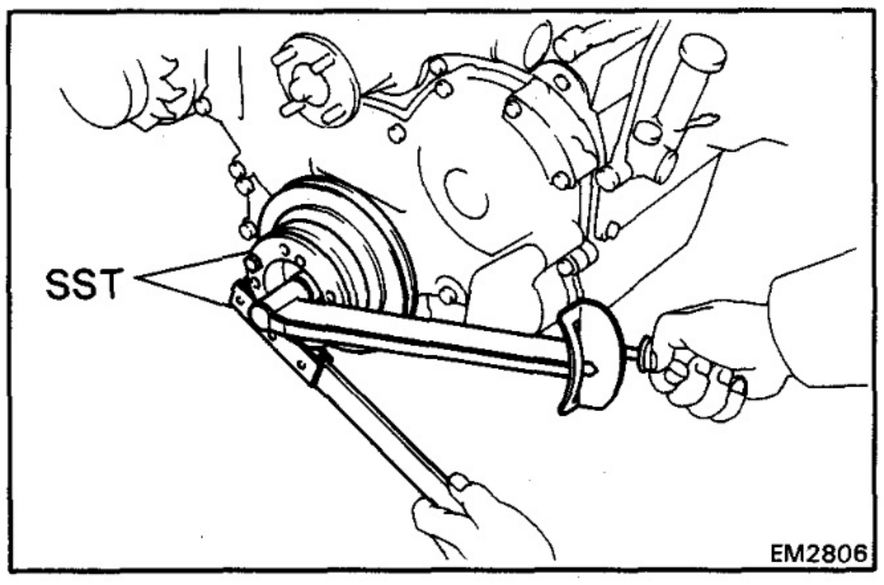


8. INSTALL CRANKSHAFT PULLEY

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

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

SST 09608-35014 (09608-06040)

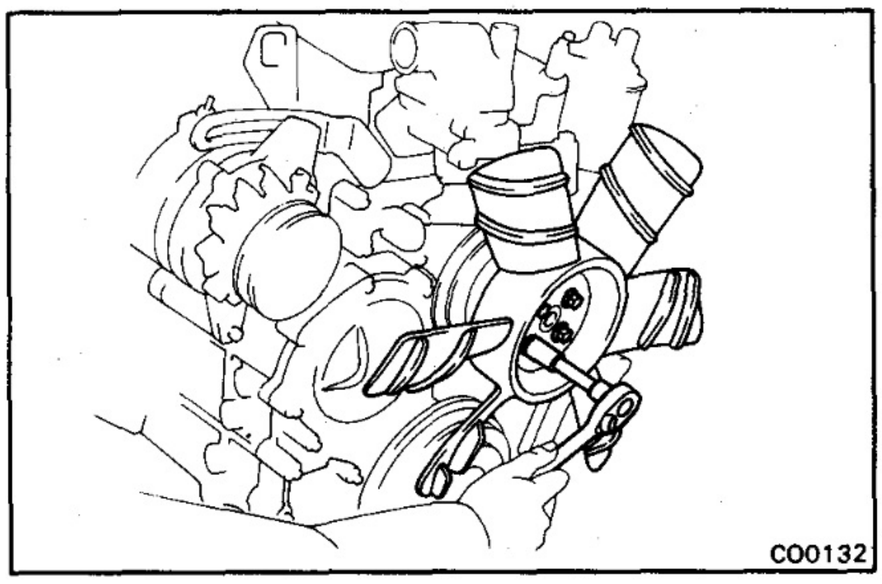


(c) Apply a light coat of engine oil on the threads and under the bolt head.

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

SST 09213-58011 and 09330-00021

Torque: 2,450 kg-cm (177 ft-lb, 240 N·m)

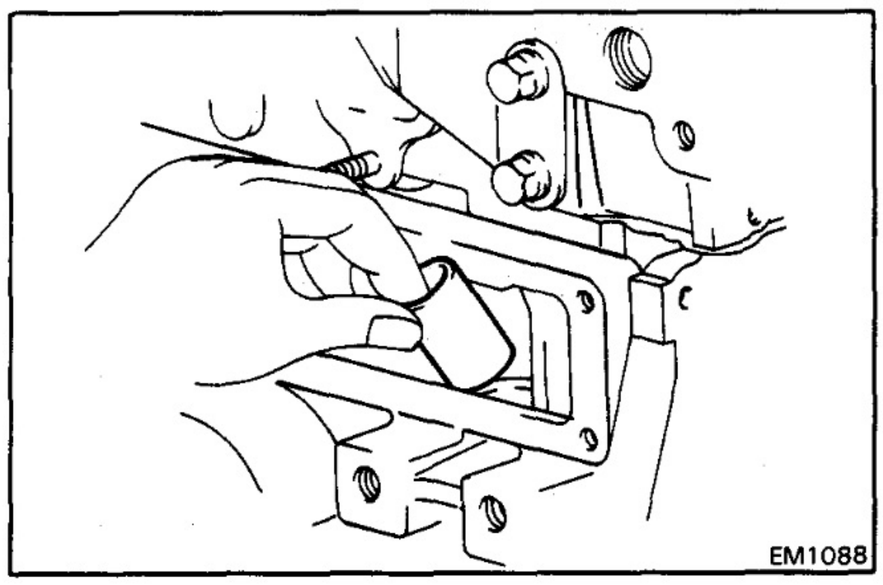


9. [w/o FLUID COUPLING]
INSTALL WATER PUMP PULLEY, FAN SPACER AND FAN

Install the water pump pulley, fan spacer and fan with the four bolts.

[w/ FLUID COUPLING]
INSTALL WATER PUMP PULLEY, FLUID COUPLING AND FAN

Install the water pump pulley, fluid coupling and fan with the four nuts.



10. INSTALL VALVE LIFTERS

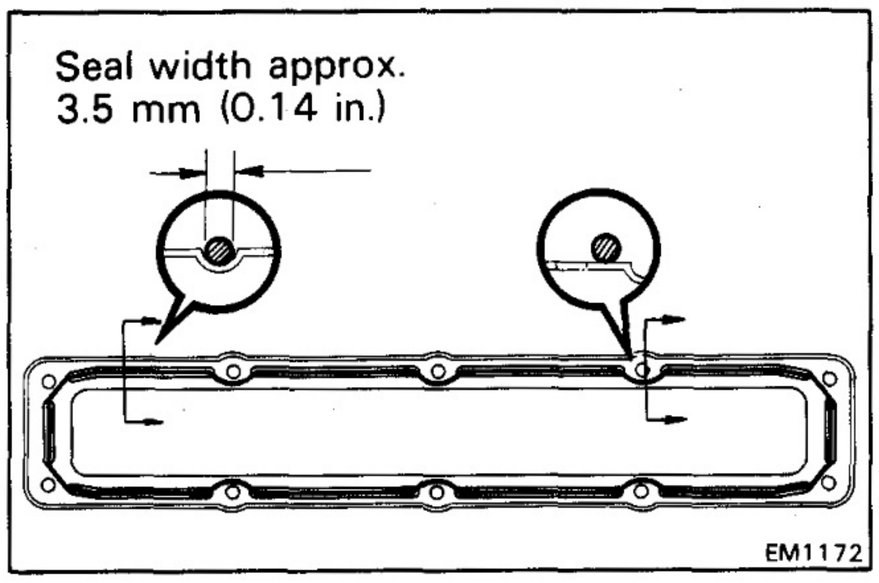
Carefully insert the eight lifters into the lifter bore.

11. INSTALL PUSH ROD COVER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the push rod cover and cylinder block.

- Using a razor blade and gasket scraper, remove all the residual 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.

CAUTION: Do not use a solvent which will affect the painted surfaces.



(b) Apply seal packing to the push rod cover as shown in the figure.

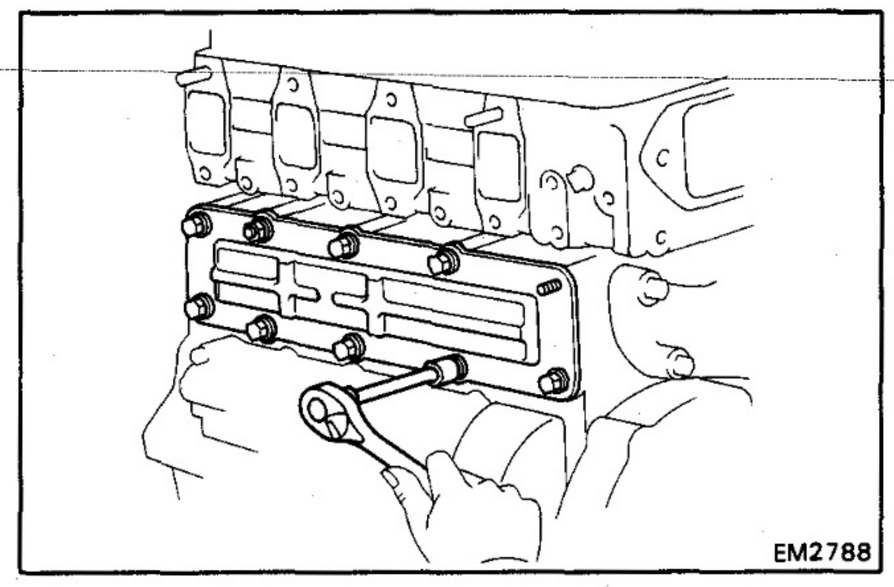
Seal packing: Part No. 08826-00080 or equivalent

- Install a nozzle that has been cut to a 3 mm (0.12 in.) opening.

NOTE: Avoid applying an excess amount to the surface.

- Parts must be assembled within 3 minutes of application. Otherwise, the material must be removed and reapplied.
- Immediately remove nozzle from tube and reinstall cap.

(c) Install the push rod cover with the seven bolts and two nuts.

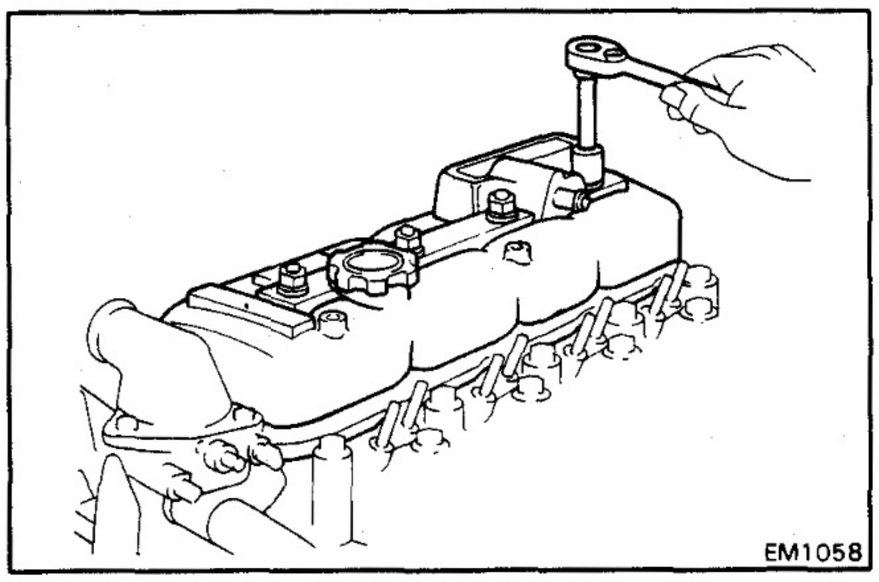


12. INSTALL VACUUM TRANSMITTING PIPE

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

14. INSTALL PUSH RODS AND VALVE ROCKER SHAFT ASSEMBLY
(See steps 2 to 4 on pages EM-39, 40)

15. INSTALL AND ADJUST DRIVE BELT
(See step 8 on page EM-41)



16. INSTALL CYLINDER HEAD COVER

(a) Install the gasket to the head cover.

(b) Install the head cover with the four seal washers and cap nuts.

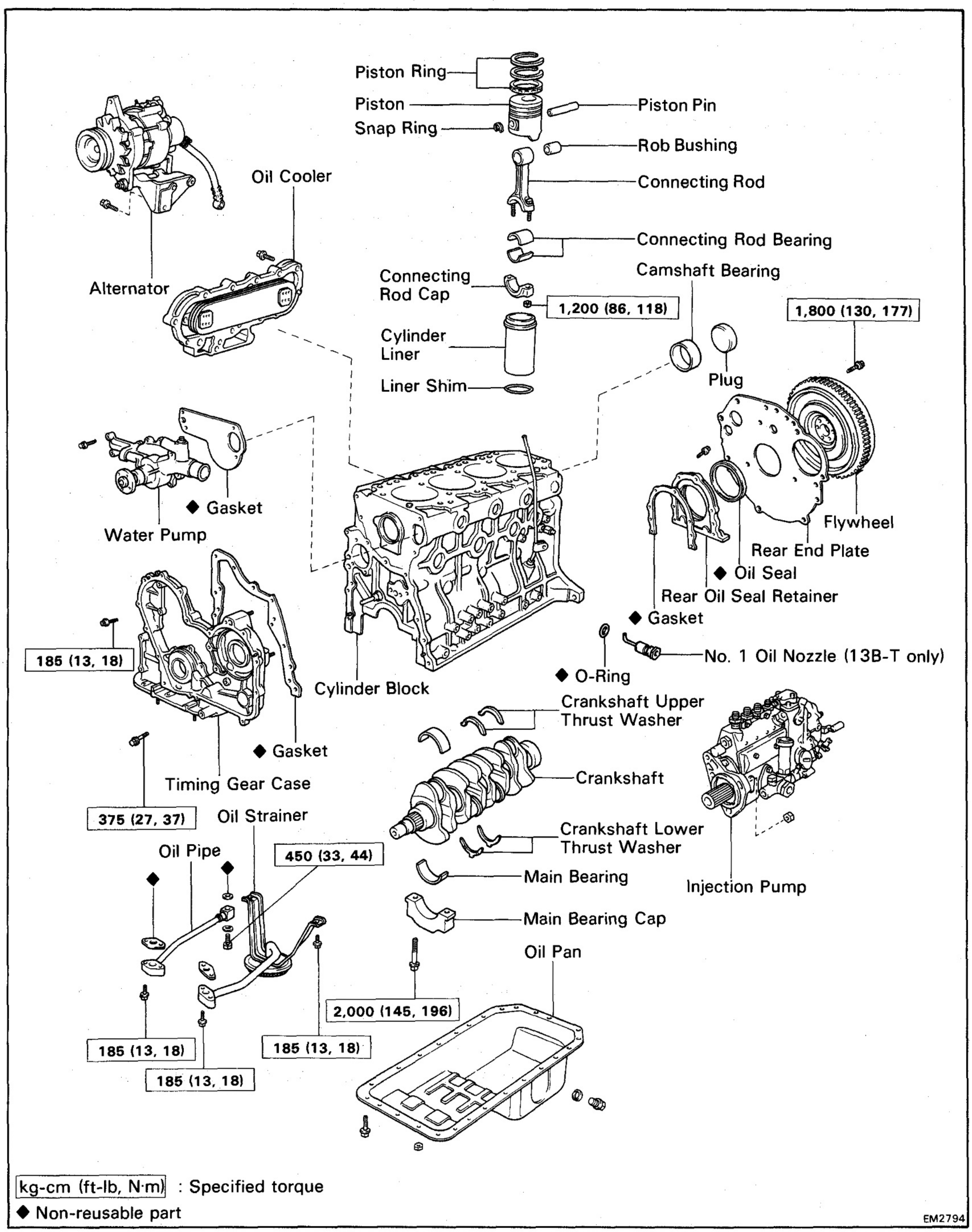
Torque: 125 kg-cm (9 ft-lb, 12 N·m)

17. INSTALL EXHAUST MANIFOLD
(See step 6 on page EM-41)

18. [13B-T]
INSTALL TURBOCHARGER (See page EM-49)

CYLINDER BLOCK

COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

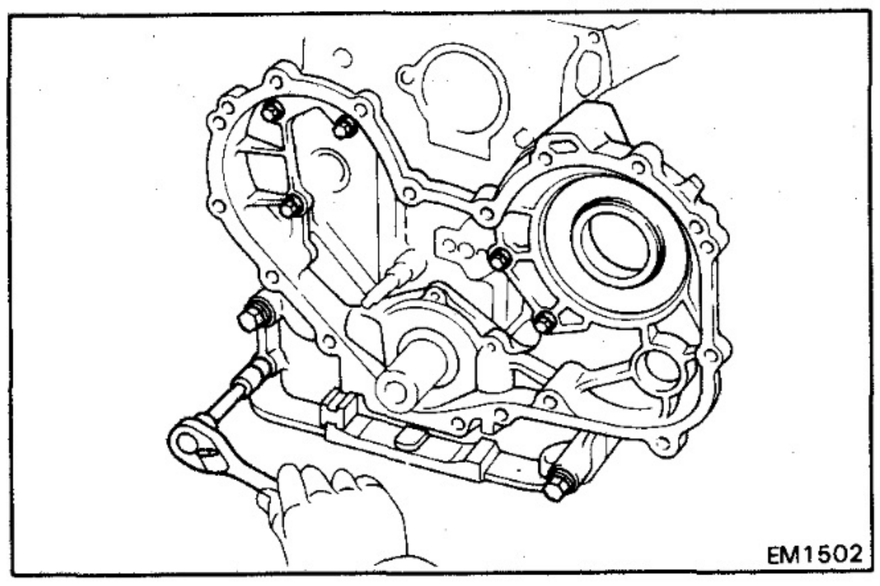
EM2794

DISASSEMBLY OF CYLINDER BLOCK

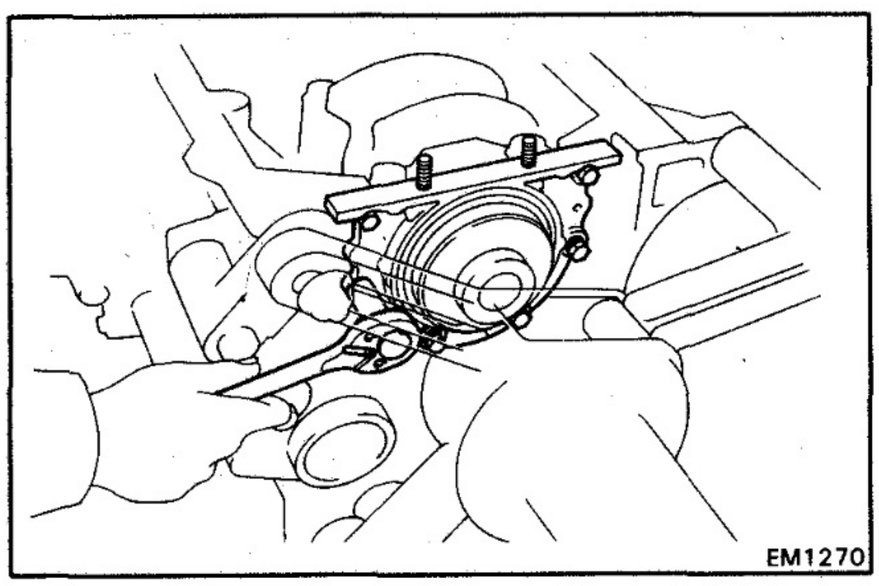
(See page EM-66)

1. REMOVE FLYWHEEL OR DRIVE PLATE
2. REMOVE REAR END PLATE
3. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
4. REMOVE INJECTION PUMP
   (See steps 1 to 8 on pages FU-21, 22)
5. REMOVE ALTERNATOR ASSEMBLY
6. REMOVE FUEL FILTER ASSEMBLY
7. REMOVE CYLINDER HEAD
   (See page EM-27)
8. REMOVE WATER PUMP (See page CO-4)
9. REMOVE TIMING GEARS AND CAMSHAFT
   (See steps 10, 11 and 13 to 21 on pages EM-53 to 57)
10. REMOVE OIL PAN, OIL STRAINER AND OIL PIPE
    (See steps 5, 6 on page LU-6)
11. REMOVE TIMING GEAR CASE

    Remove the eight bolts, timing gear case and gasket.

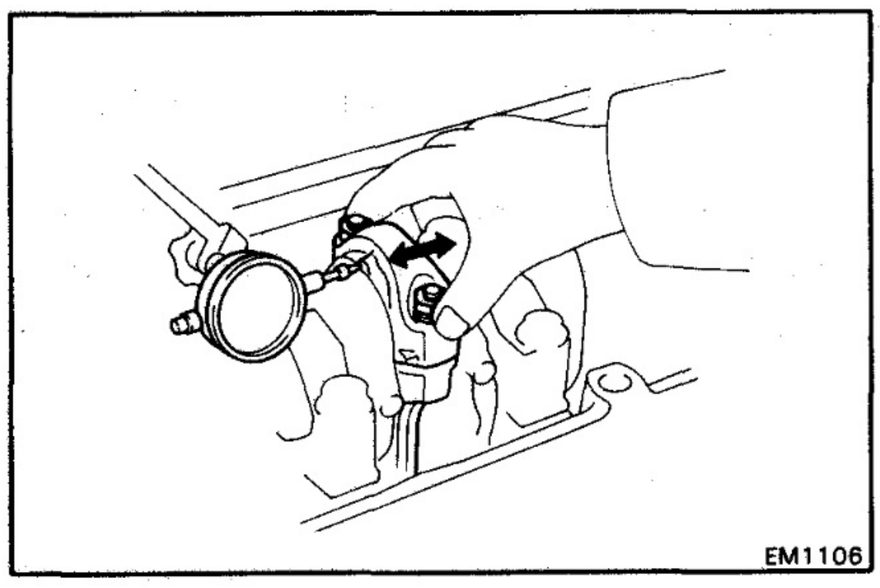

EM1502

12. REMOVE OIL COOLER CASE WITH OIL COOLER
    (See steps 1 to 7 on pages LU-14, 15)


EM1270

13. REMOVE REAR OIL SEAL RETAINER

    Remove the six bolts, retainer and gasket.

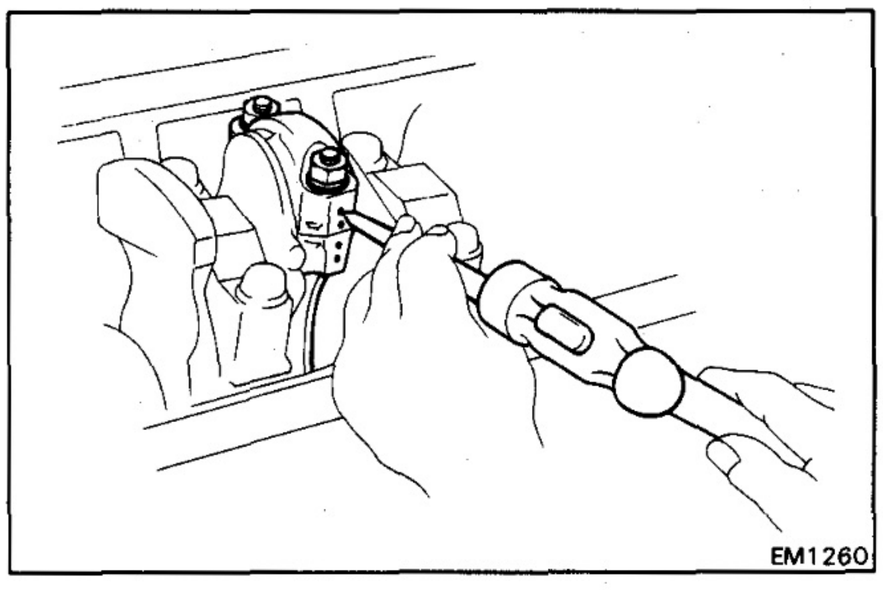

EM1106

14. CHECK CONNECTING ROD THRUST CLEARANCE

    Using a dial indicator, measure the thrust clearance while moving the rod back and forth.

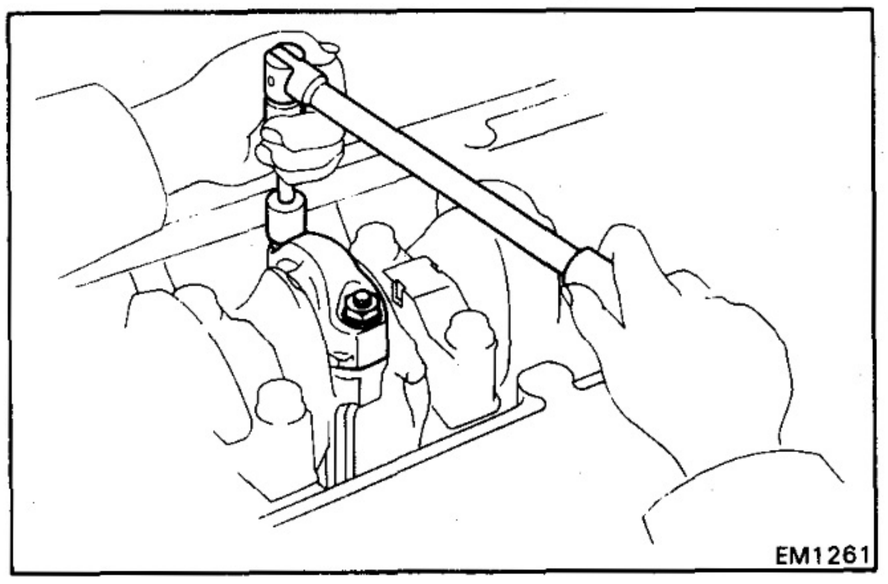
    Standard thrust clearance: **0.20 — 0.32 mm (0.0079 — 0.0126 in.)**
    Maximum thrust clearance: **0.4 mm (0.016 in.)**

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

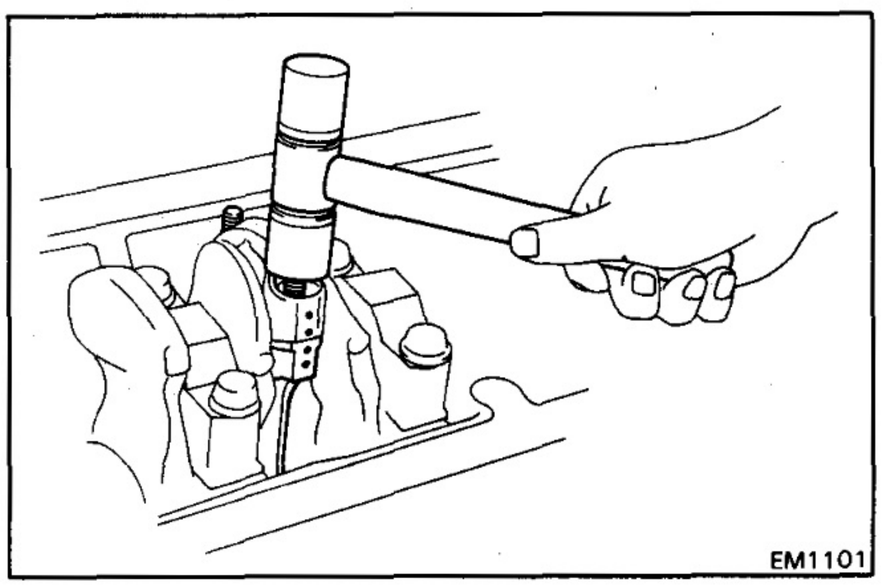


15. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

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

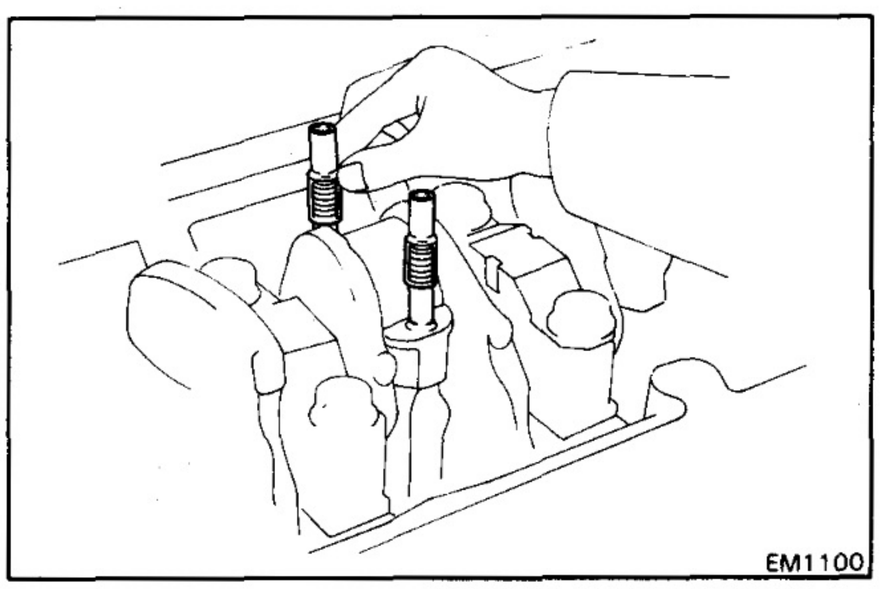


(b) Remove the connecting rod cap nuts.

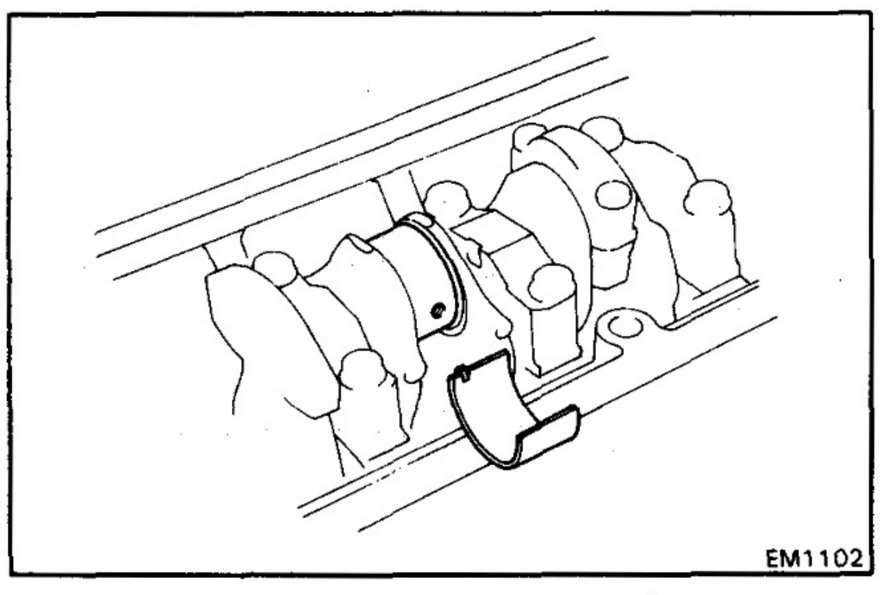


(c) Using a plastic-faced hammer, lightly tap the connecting rod bolt and lift off the connecting rod cap and lower bearing.

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



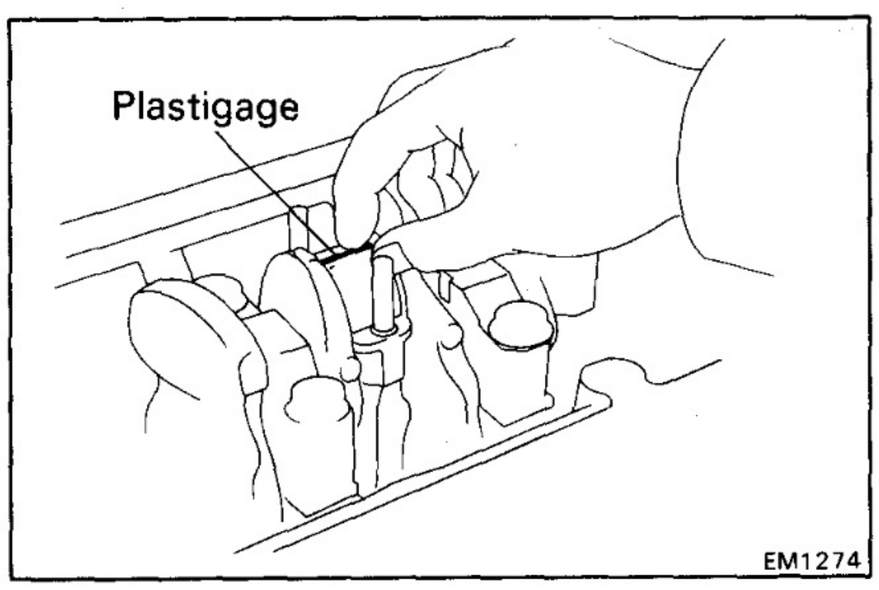
(d) Cover the rod bolts with a short piece of hose to protect the crankshaft from damage.



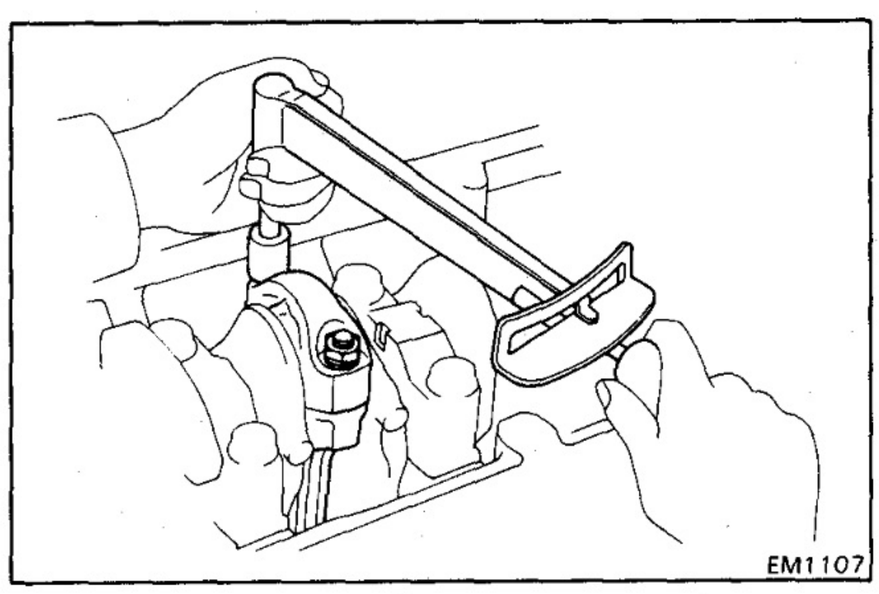
(e) Clean the crank pin and bearing.

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

If the crank pin or bearing is damaged, replace the bearings and/or regrind the crank pins. If necessary, replace the crankshaft.



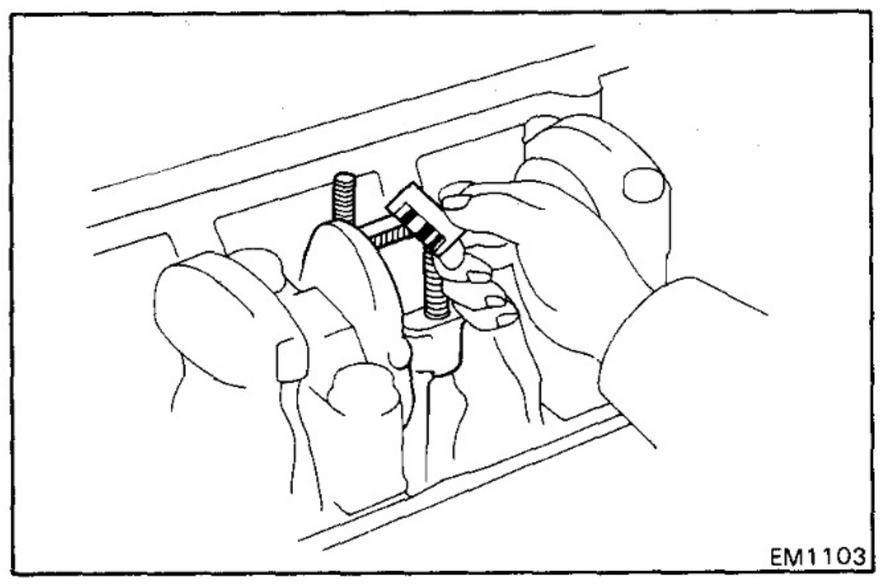
(g) Lay a strip of Plastigage across the crank pin.



(h) Install the connecting rod cap.
(See step 7 on page EM-90)

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

NOTE: Do not turn the crankshaft.



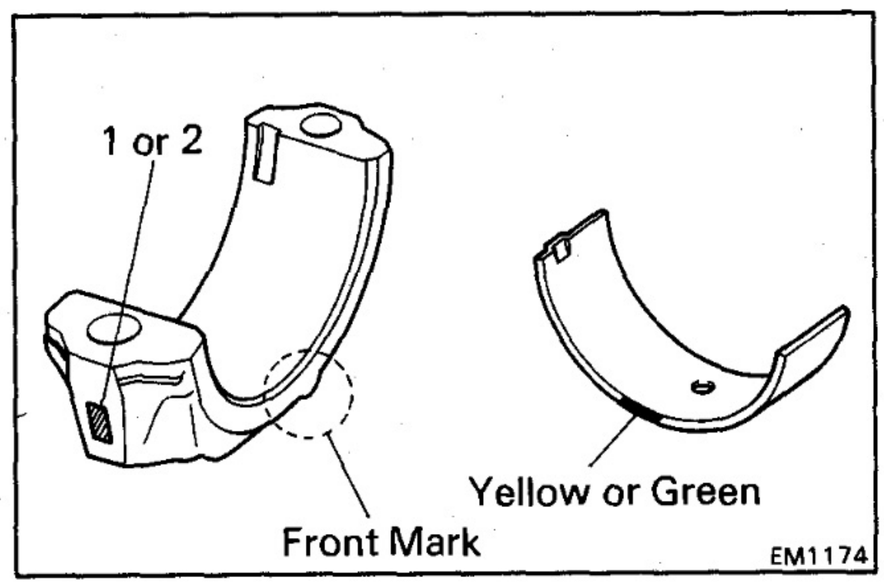
(i) Remove the connecting rod cap.

(j) Measure the crank pin oil clearance.

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

Maximum oil clearance: 0.1 mm (0.004 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, regrind or replace the crankshaft.



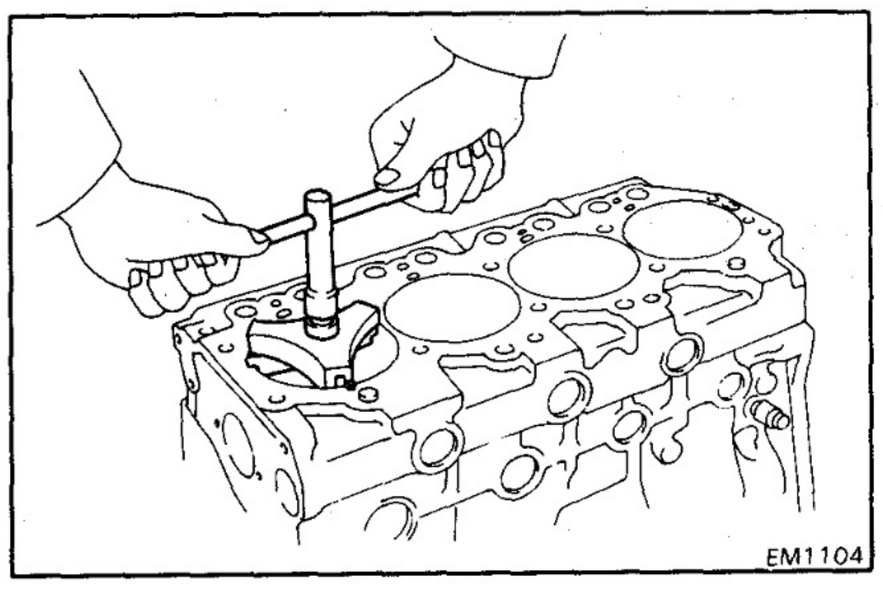
NOTE: There are two sizes of standard bearings, colored yellow and green. If using a standard bearing, select one having the color corresponding to the number on the bearing cap:

1 with Yellow

2 with Green

[Reference]

Mark	Color	Bearing center wall thickness mm (in.)
1	Yellow	1.480 – 1.485 (0.0583 – 0.0585)
2	Green	1.485 – 1.490 (0.0585 – 0.0587)



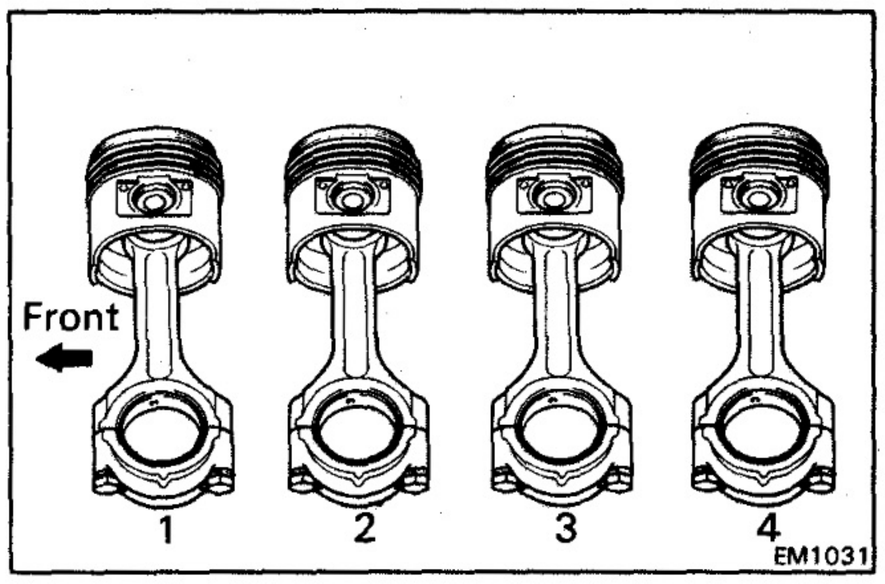
(k) Completely remove the Plastigage.

16. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

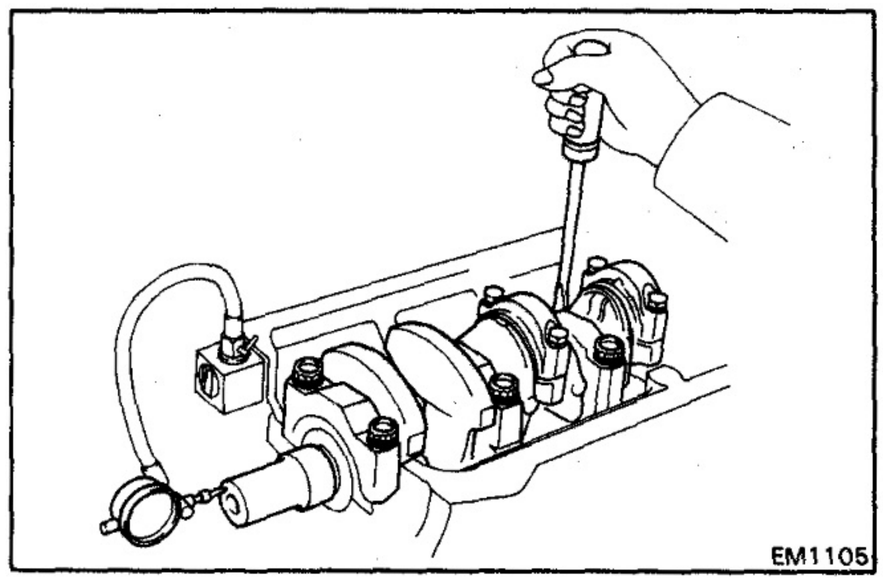
(a) Remove all the carbon from the piston ring ridge.

(b) Cover the connecting rod bolts. (See page EM-68)

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



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



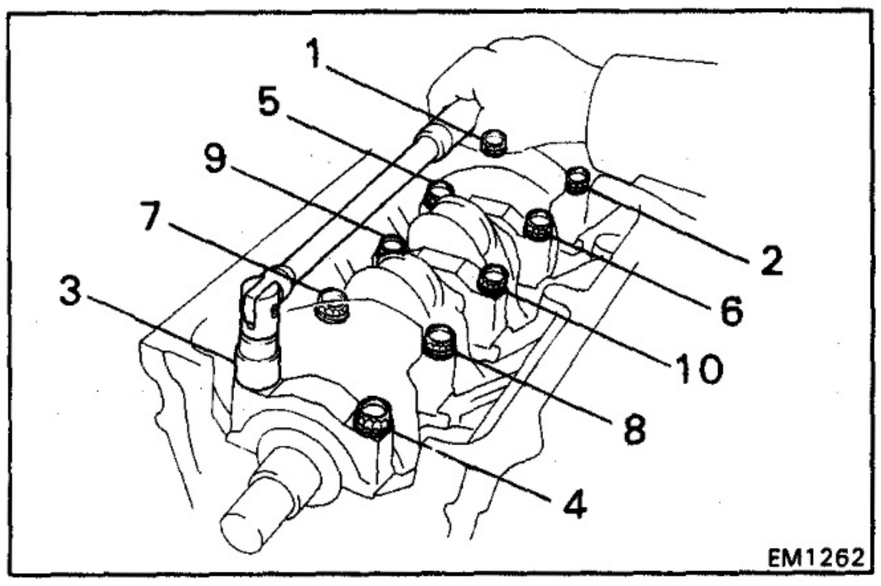
17. CHECK CRANKSHAFT THRUST CLEARANCE

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

Standard thrust clearance: 0.04 — 0.25 mm (0.0016 — 0.0098 in.)
Maximum thrust clearance: 0.3 mm (0.012 in.)

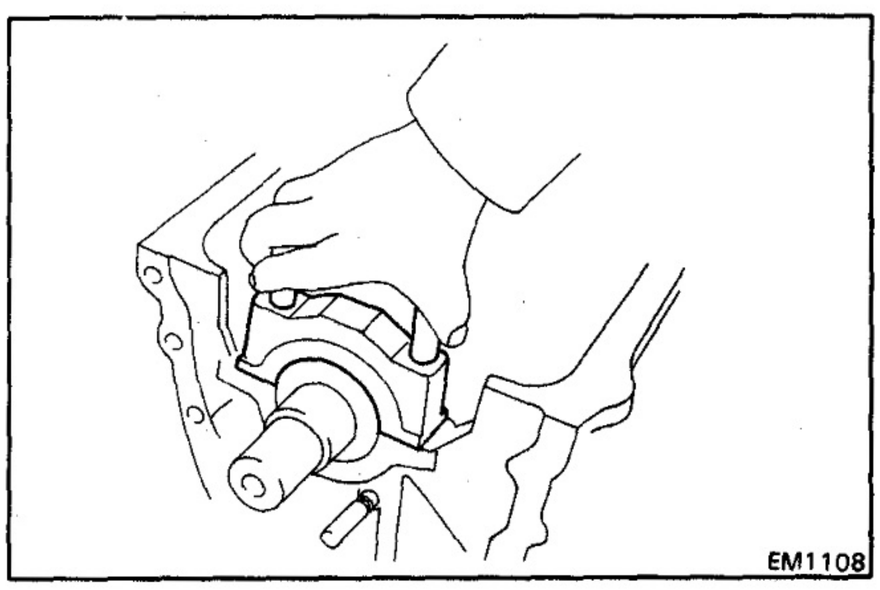
If the clearance is greater than maximum, replace the thrust washers as a set.

Thrust washer size: STD, O/S 0.125, O/S 0.250



18. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

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

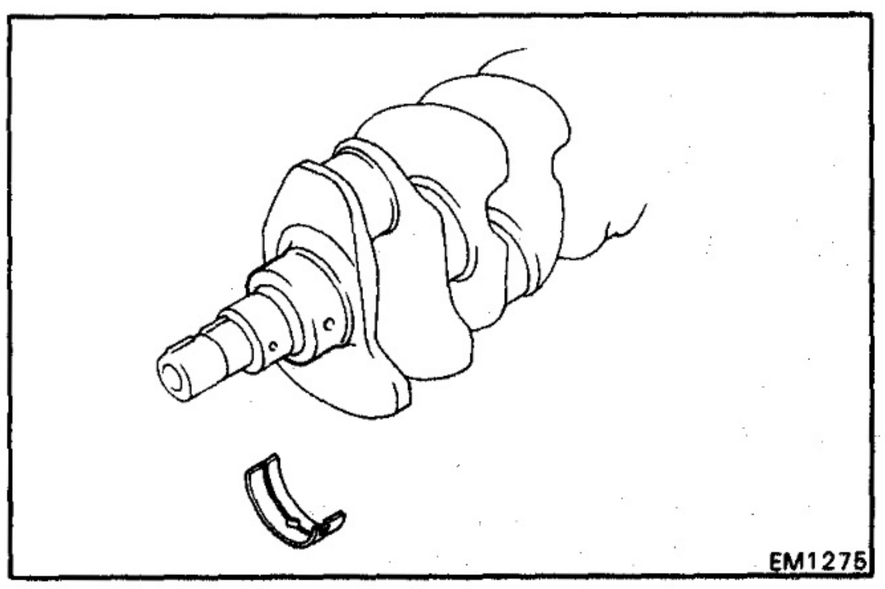


(b) Using the removed main bearing cap bolts, wiggle the cap back and forth, and remove the caps, lower bearings and lower thrust washers (No. 3 cap only).

NOTE:
- Keep the lower bearing inserted with the cap.
- Arrange the caps and lower thrust washers in correct order.

(c) Lift off the crankshaft.

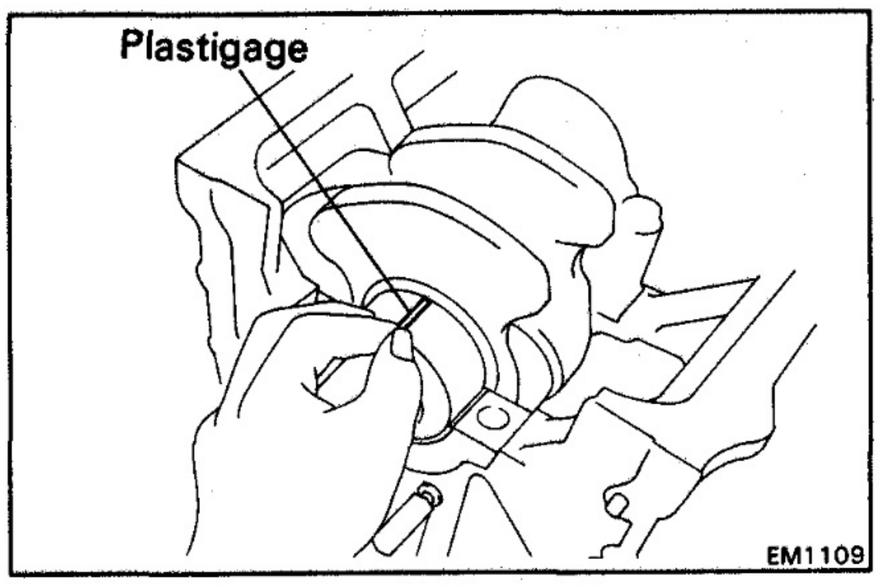
NOTE: Keep the upper bearings and upper thrust washers inserted with the cylinder block.



(d) Clean each journal and bearing.

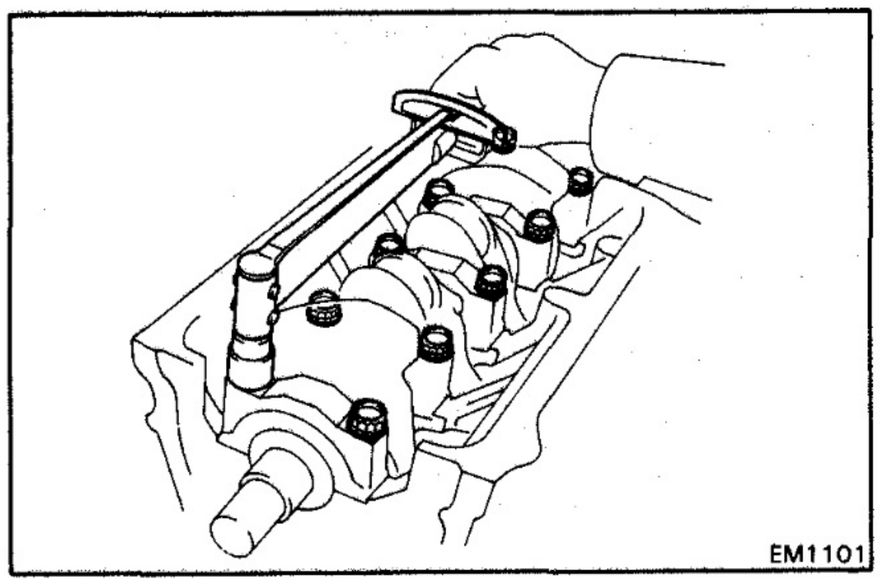
(e) Check each journal and bearing for pitting and scratches.

If the journal or bearing is damaged, replace the bearings and/or regrind the journals. If necessary, replace the crankshaft.



(f) Place the crankshaft on the cylinder block.

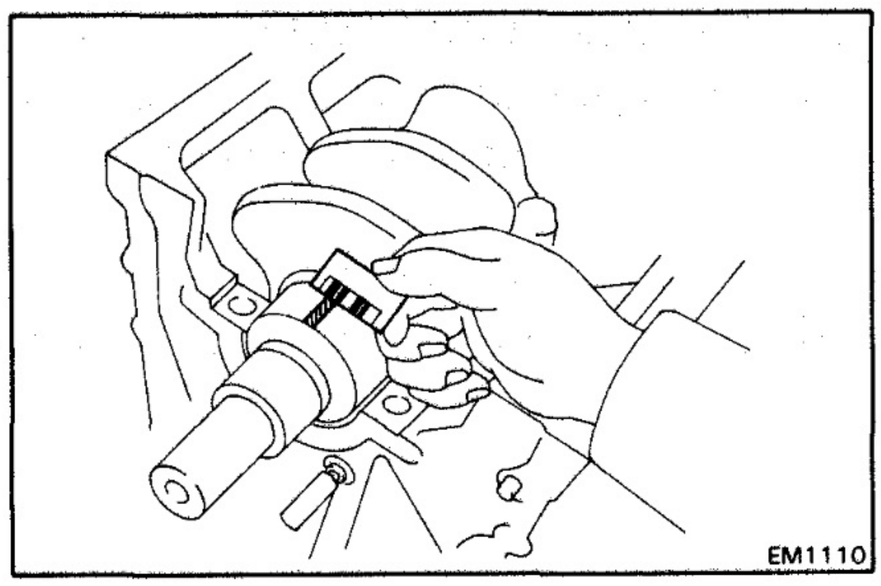
(g) Lay a strip of Plastigage across each journal.



(h) Install the main bearing caps.
(See step 5 on page EM-89)

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

NOTE: Do not turn the crankshaft.



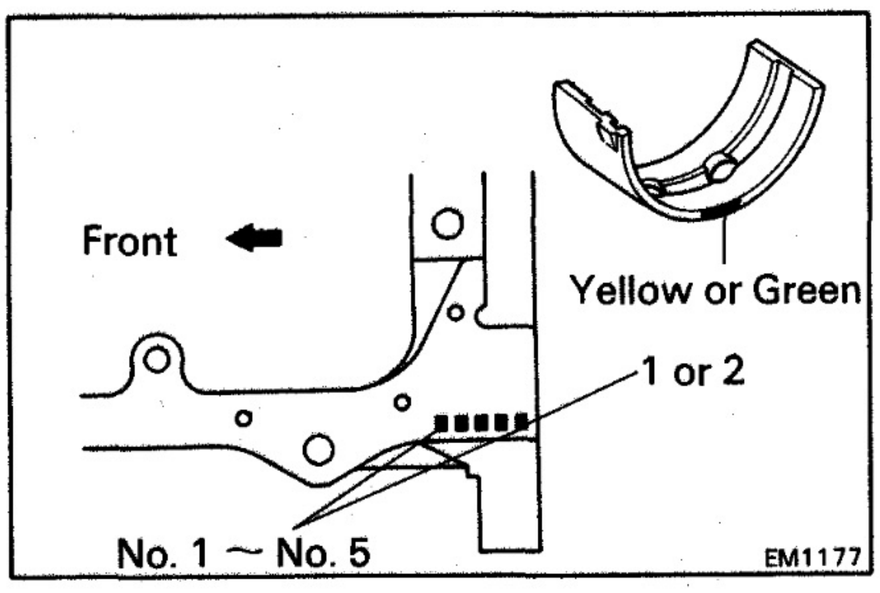
(i) Remove the main bearing caps.

(j) Measure the journal oil clearance.

Standard oil clearance: 0.030 – 0.074 mm (0.0012 – 0.0029 in.)

Maximum oil clearance: 0.1 mm (0.004 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, regrind or replace the crankshaft.



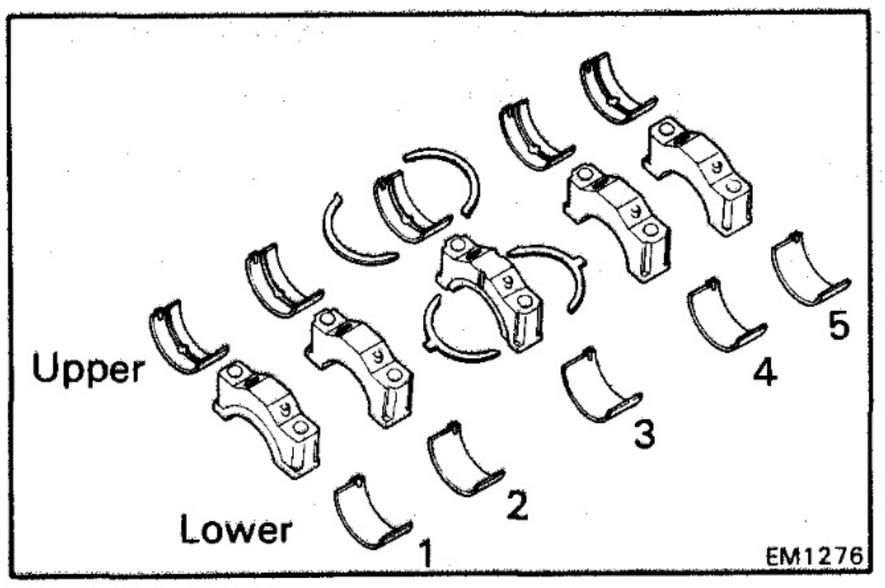
NOTE: There are two sizes of standard bearings, colored yellow and green. If using a standard bearing, select one having the color corresponding to the number on the cylinder block:

1 with Yellow

2 with Green

[Reference]

Mark	Color	Bearing center wall thickness mm (in.)
1	Yellow	2.480 – 2.485 (0.0976 – 0.0978)
2	Green	2.485 – 2.490 (0.0978 – 0.0980)



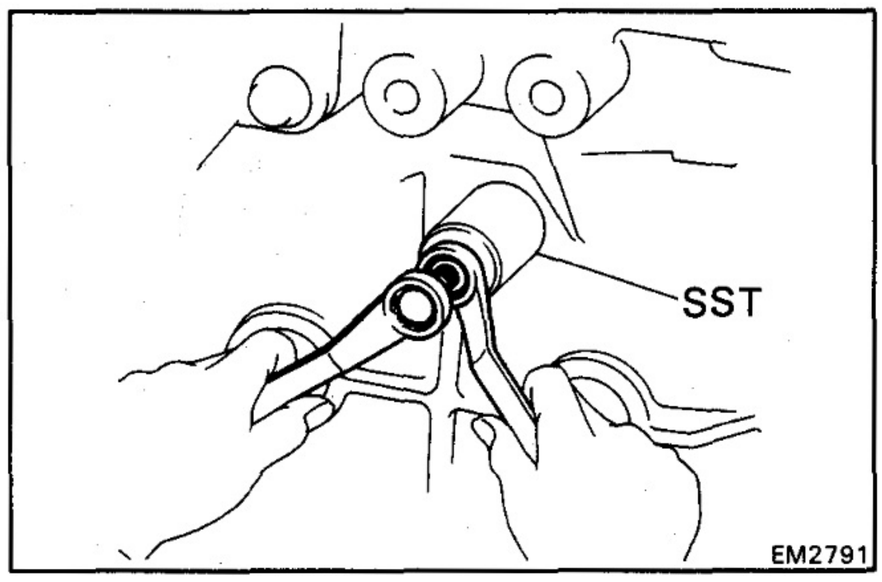
(k) Completely remove the Plastigage.

19. REMOVE CRANKSHAFT

(a) Lift off the crankshaft.

(b) Remove the upper bearings and upper thrust washers.

NOTE: Arrange the caps, bearings and thrust washers in correct order.

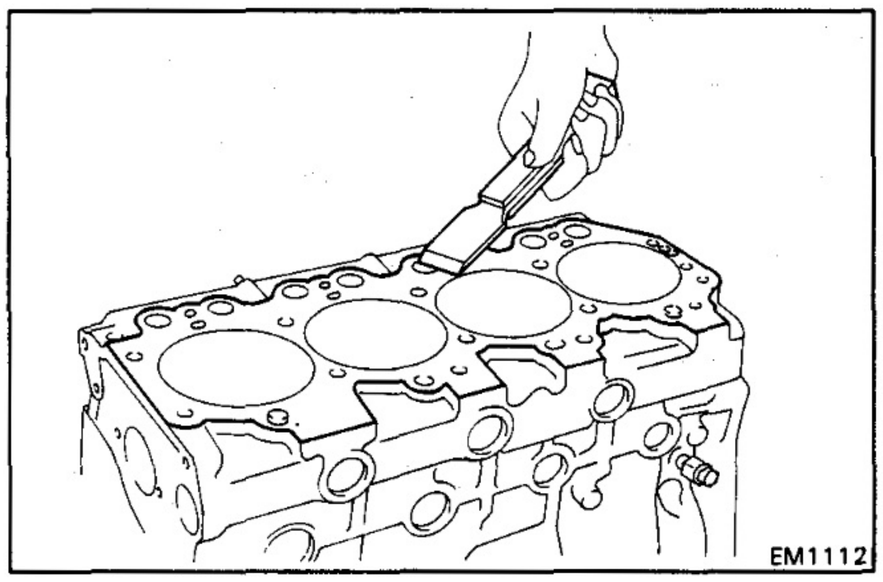


20. IF NECESSARY, REMOVE NO. 1 OIL NOZZLE

Using SST, remove the No. 1 oil nozzle.

SST 09219-56010

INSPECTION OF CYLINDER BLOCK

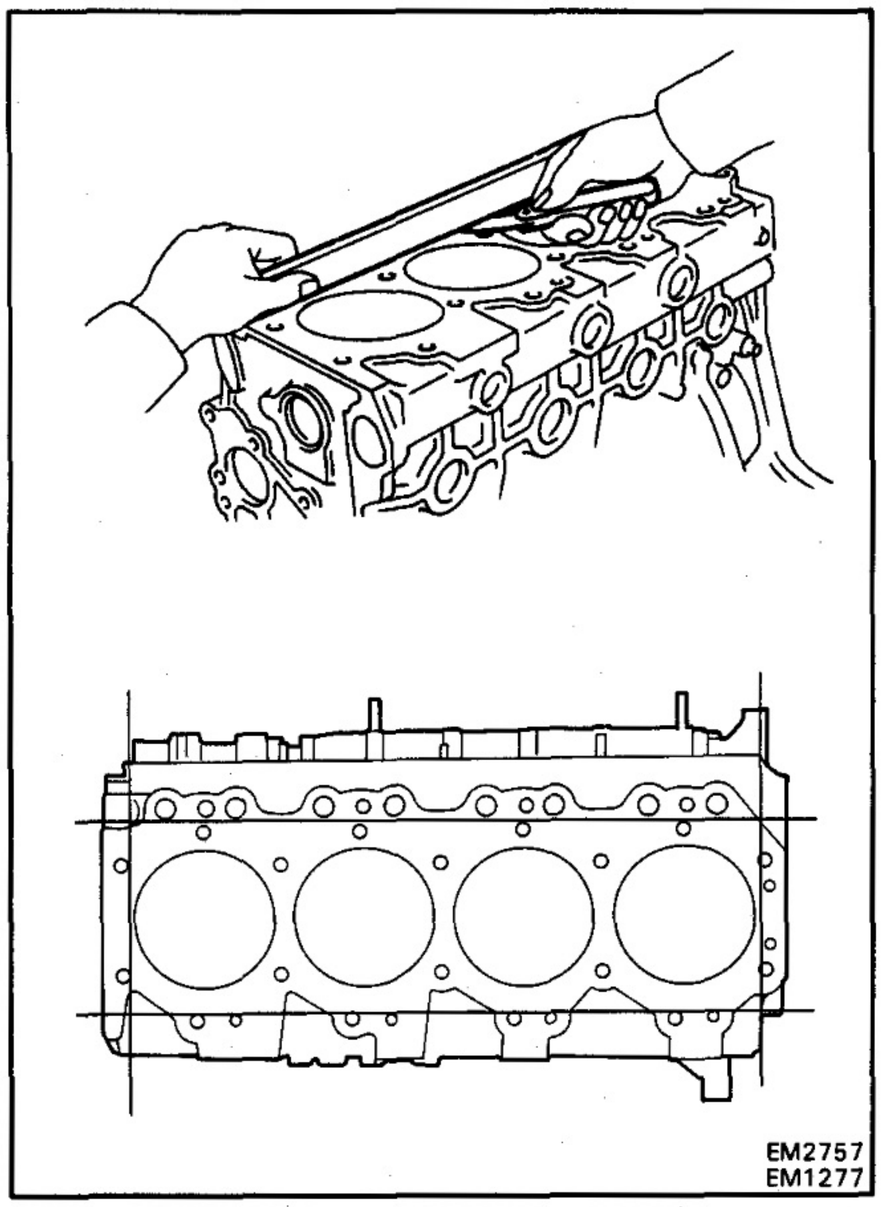


1. REMOVE GASKET MATERIAL

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.

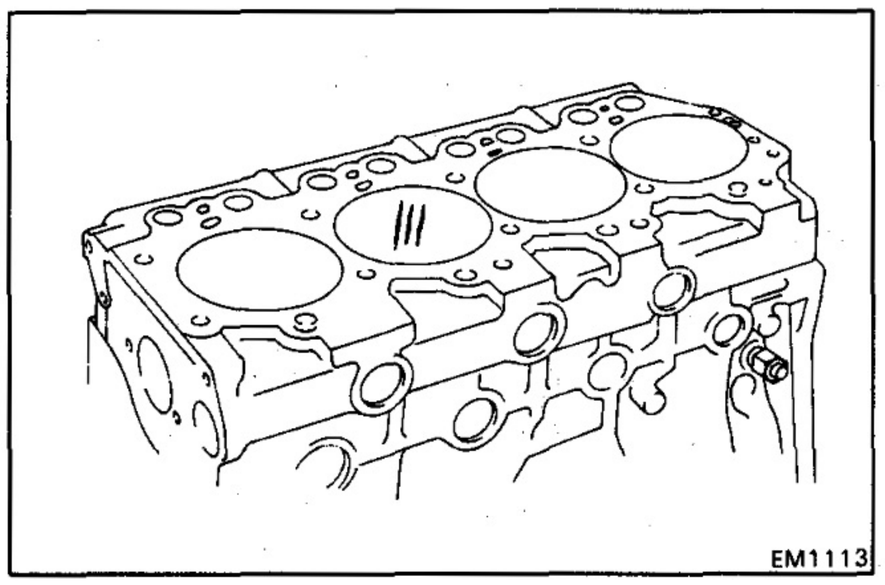


3. INSPECT TOP OF CYLINDER BLOCK FOR FLATNESS

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

Maximum warpage: 0.2 mm (0.008 in.)

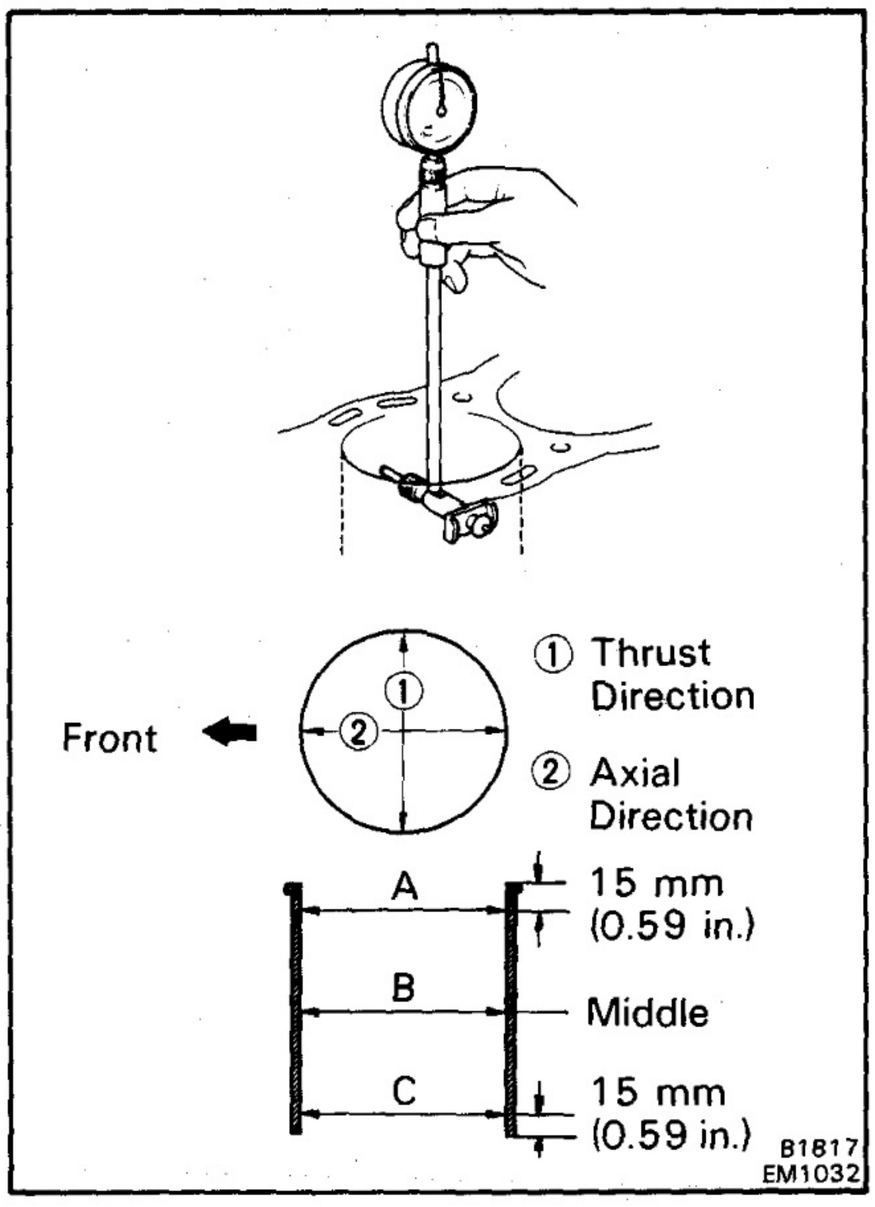
If warpage is greater than maximum, replace the cylinder block.



4. INSPECT CYLINDERS FOR VERTICAL SCRATCHES

Visually check the cylinder for vertical scratches.

If deep scratches are present, replace the cylinder liner.



5. INSPECT CYLINDER BORES

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

Standard diameter:

11B

95.00 – 95.03 mm (3.7402 – 3.7413 in.)

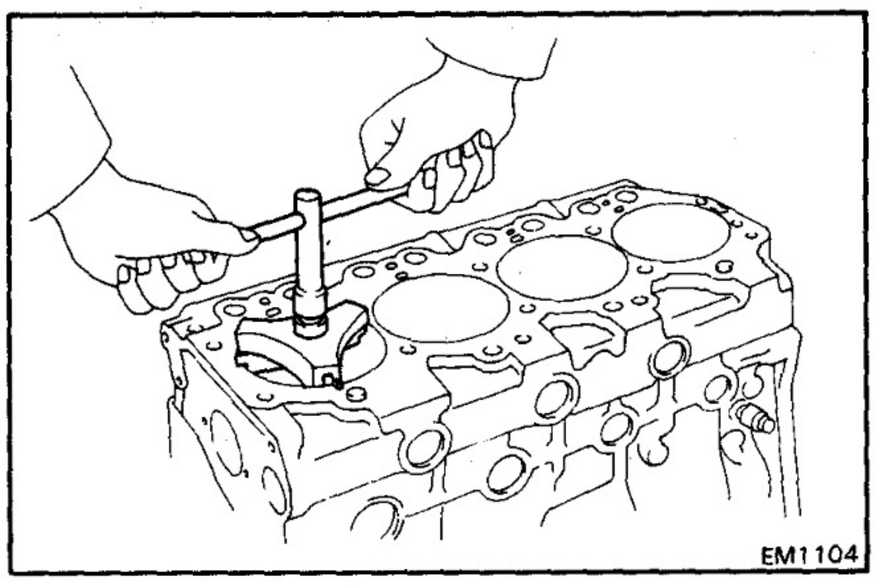
13B, 13B-T

102.00 – 102.03 mm (4.0157 – 4.0169 in.)

Maximum diameter:

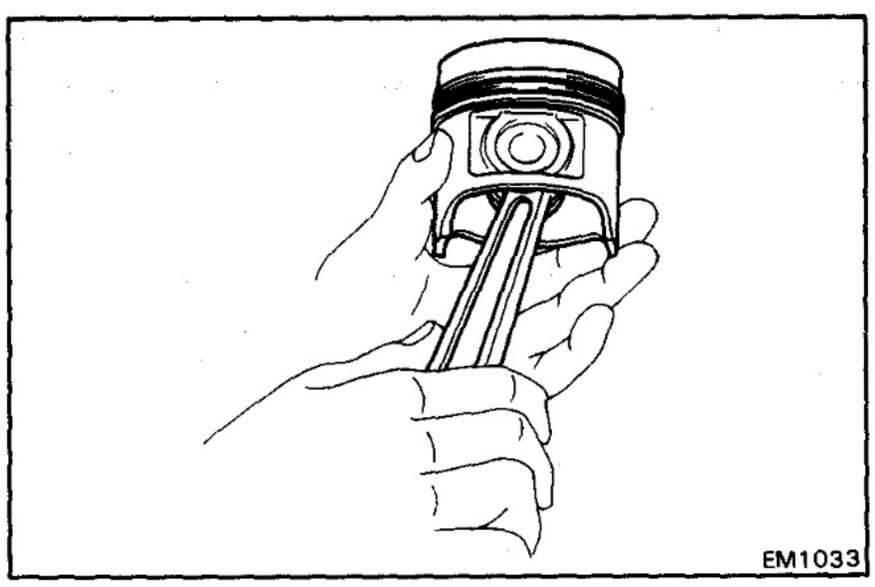
11B	**95.33 mm (3.7531 in.)**
13B, 13B-T	**102.33 mm (4.0287 in.)**

If the diameter is greater than maximum, replace the cylinder liner.



6. REMOVE CYLINDER RIDGES

If the wear is less than 0.3 mm (0.012 in.), use a ridge reamer to machine the piston ring ridge at the top of the cylinder.

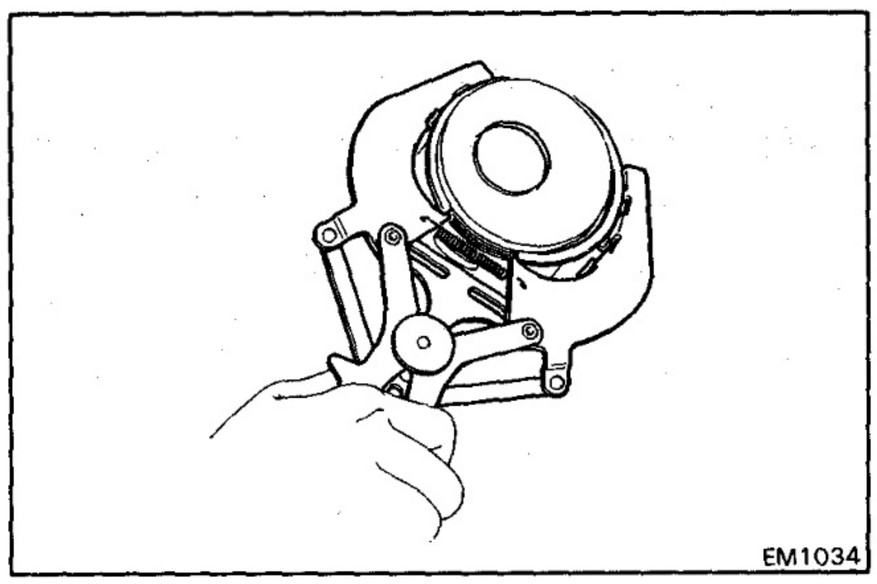


DISASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. CHECK FIT BETWEEN PISTON AND PIN

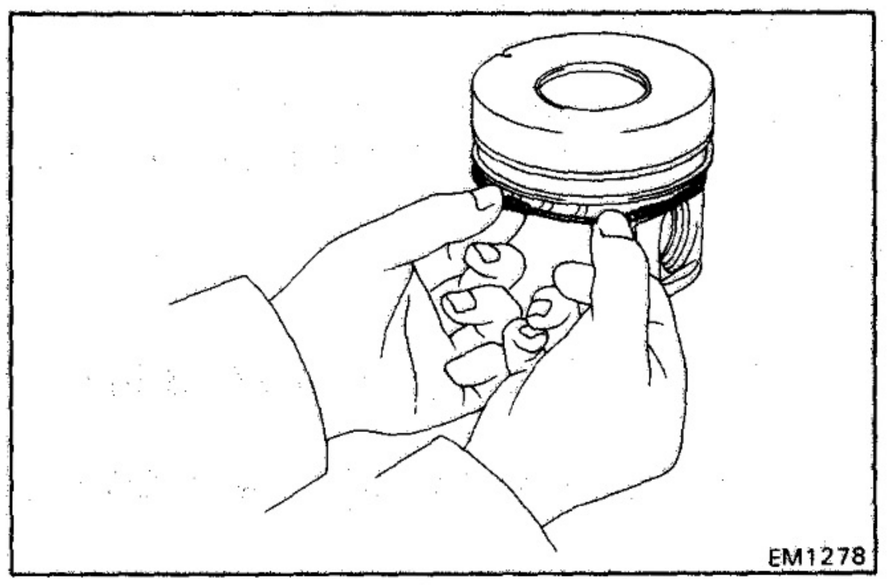
Try to move the piston back and forth on the piston pin.

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



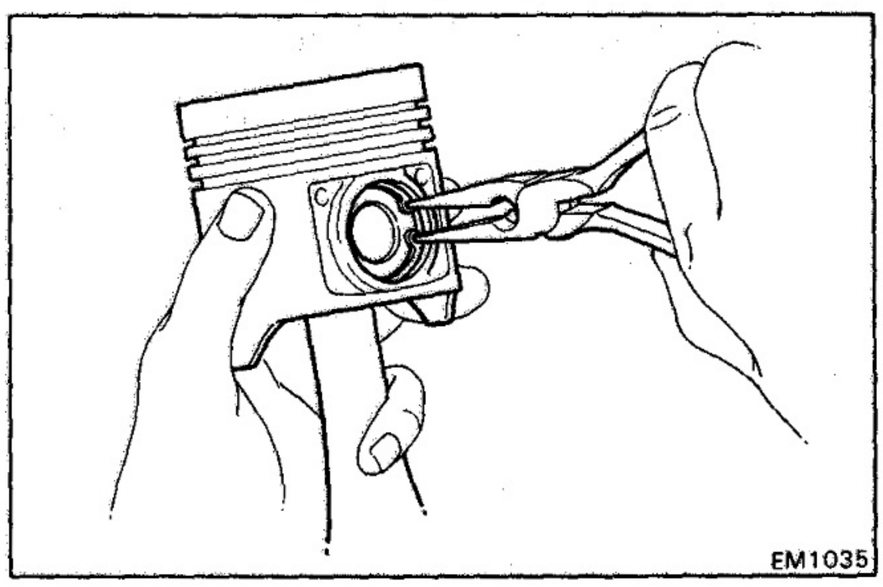
2. REMOVE PISTON RINGS

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



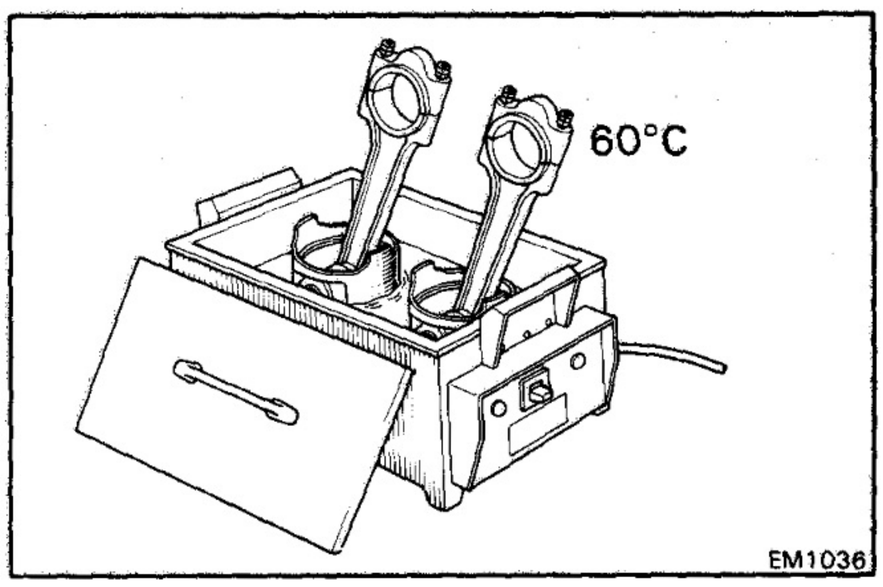
(b) Remove the oil expander coil by hand.

NOTE: Arrange the rings in correct order.

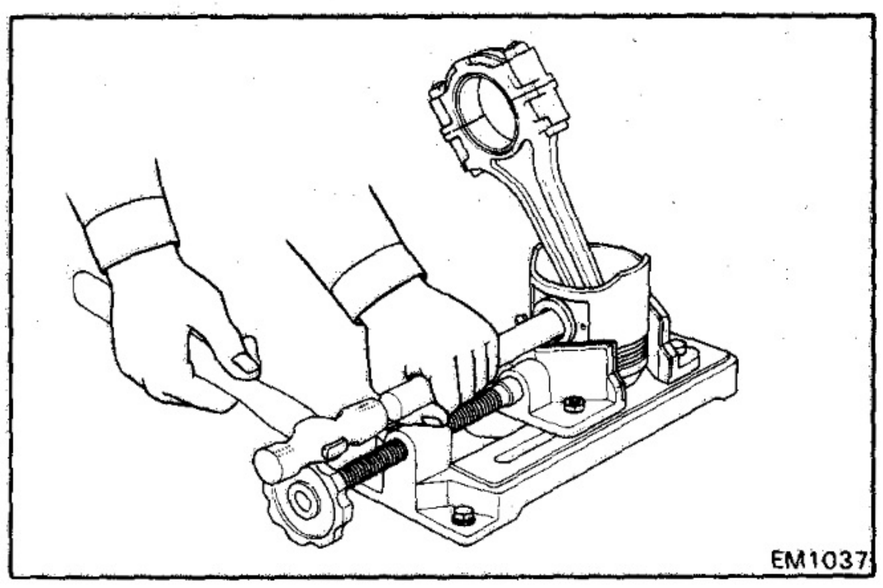


3. DISCONNECT CONNECTING ROD FROM PISTON

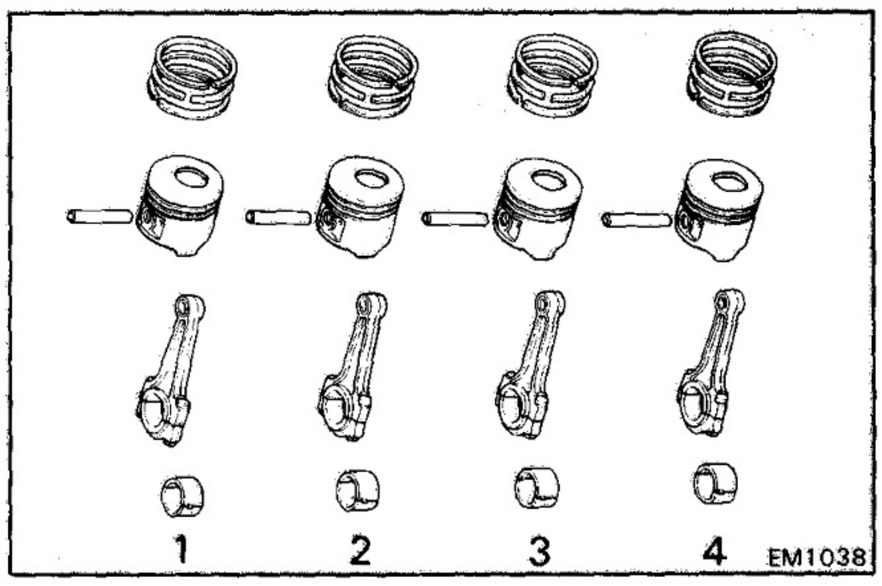
(a) Using needle-nose pliers, remove the snap rings.



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

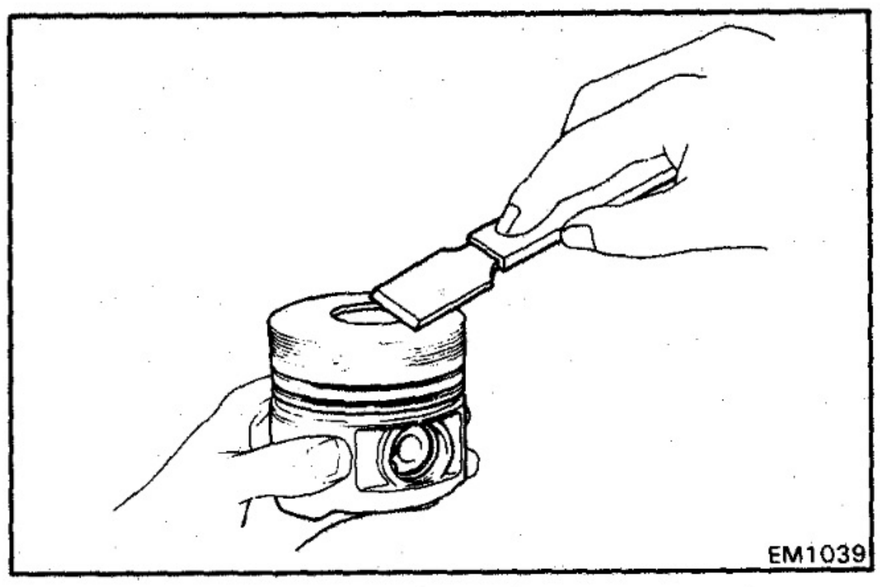


(c) Using a plastic-faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.



NOTE:

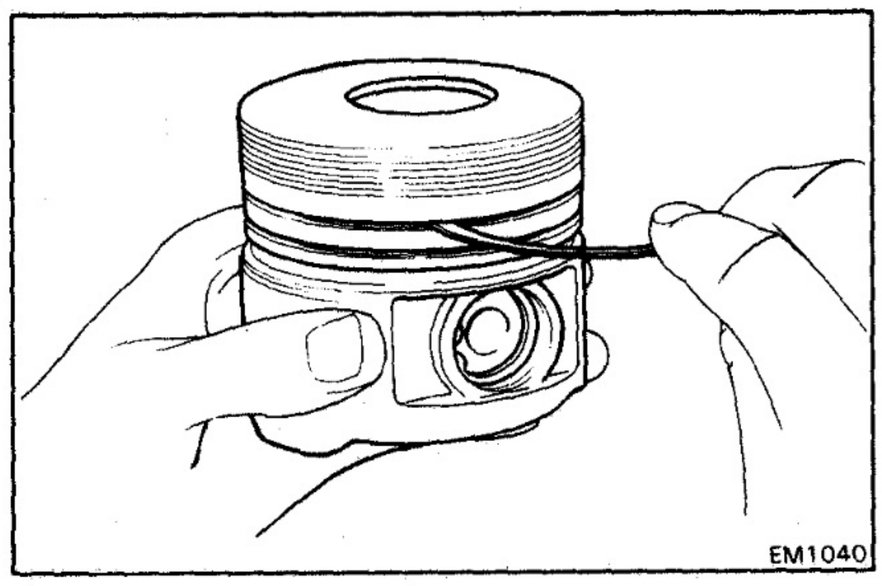
- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearing in correct order.


EM1039

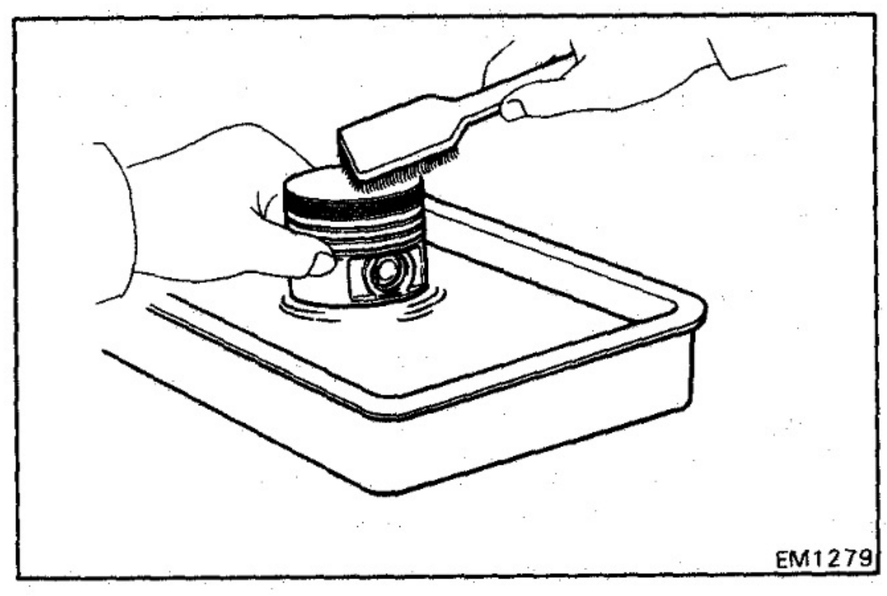
INSPECTION OF PISTON AND CONNECTING ROD ASSEMBLIES

1. CLEAN PISTONS

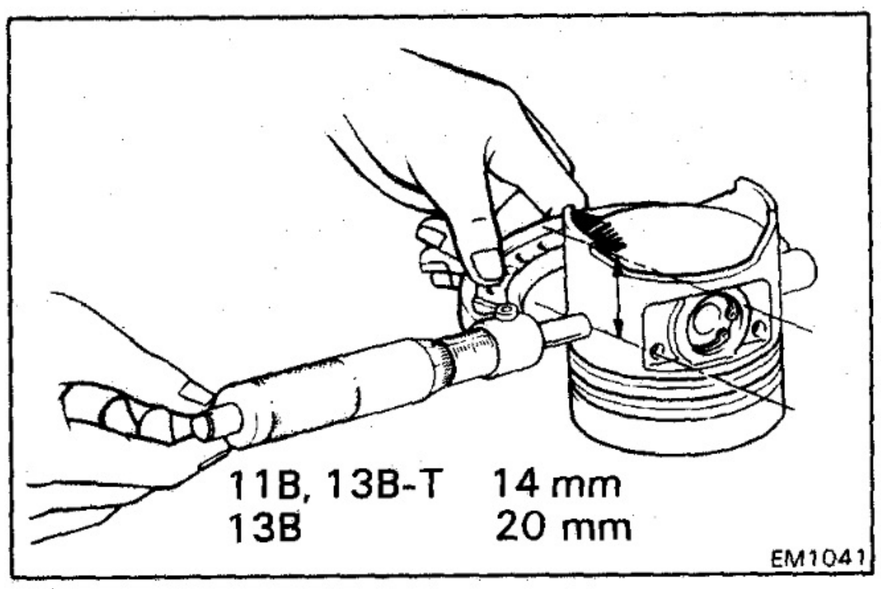
(a) Using a gasket scraper, remove the carbon from the piston top.


EM1040

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


EM1279

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



EM1041

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 below the skirt bottom edge.

Measure distance:

11B, 13B-T	**14 mm (0.55 in.)**
13B	**20 mm (0.79 in.)**

Piston diameter:

11B	**94.94 – 94.97 mm (3.7378 – 3.7390 in.)**
13B	**101.93 – 101.96 mm (4.0130 – 4.0142 in.)**
13B-T	**101.92 – 101.95 mm (4.0126 – 4.0138 in.)**

(b) Measure the cylinder bore diameter in the thrust directions (See page EM-73) and subtract the piston diameter measurement from the cylinder bore diameter measurement.

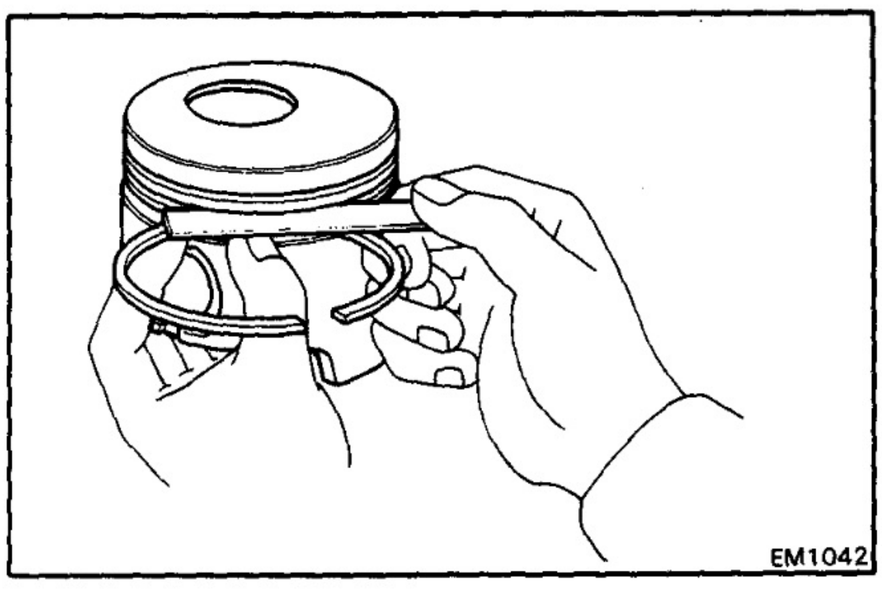
Standard oil clearance:

11B	**0.05 – 0.07 mm (0.0020 – 0.0028 in.)**
13B	**0.06 – 0.08 mm (0.0024 – 0.0031 in.)**
13B-T	**0.07 – 0.09 mm (0.0028 – 0.0035 in.)**

Maximum oil clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than maximum, replace the piston. If necessary, replace the cylinder liner.

(See page EM-81)



3. INSPECT PISTON RING GROOVE CLEARANCE

Using a feeler gauge, measure the clearance between the new piston ring and the ring land.

Piston ring groove clearance:

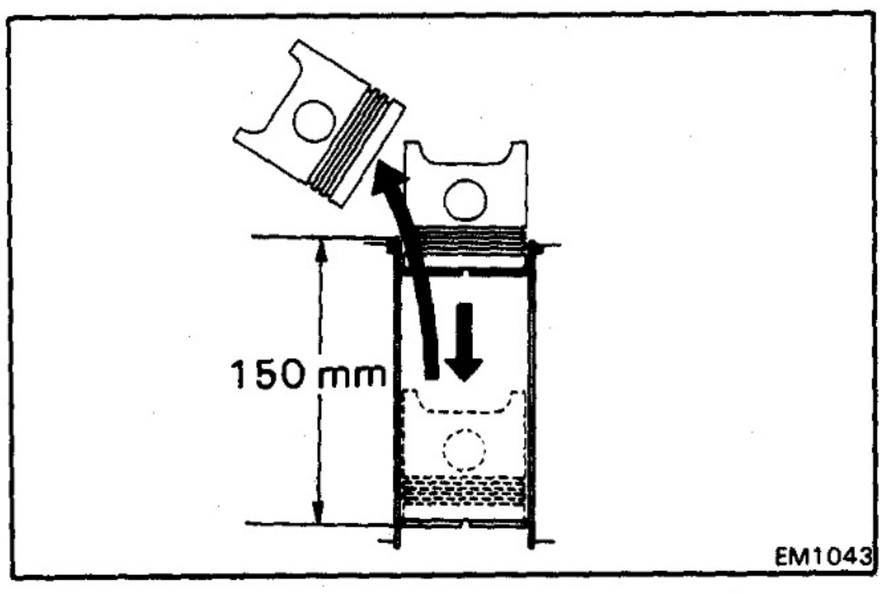
11B, 13B

No. 1 ring	**0.08 – 0.12 mm (0.0031 – 0.0047 in.)**
No. 2 ring	**0.04 – 0.08 mm (0.0016 – 0.0031 in.)**
Oil ring	**0.03 – 0.07 mm (0.0012 – 0.0028 in.)**

13B-T

No. 2 ring	**0.06 – 0.10 mm (0.0024 – 0.0394 in.)**
Oil ring	**0.03 – 0.07 mm (0.0012 – 0.0028 in.)**

If the clearance is not within specification, replace the piston.

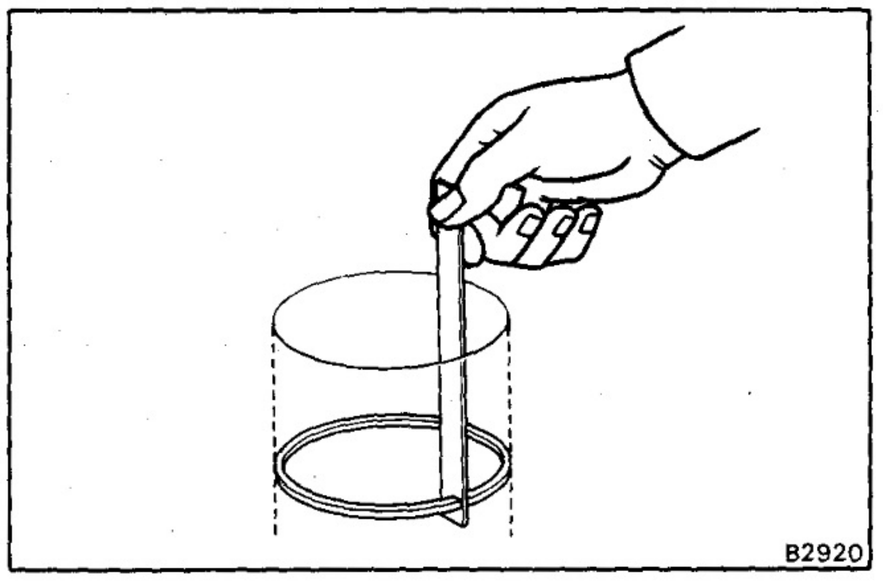


4. INSPECT PISTON RING END GAP

(a) Insert the piston ring into the cylinder.

(b) Using a piston, push the piston ring a little beyond the bottom of the ring travel.

[150 mm (5.91 in.) from top surface of cylinder block]



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

Standard piston ring end gap:

11B

No. 1 ring	**0.30 – 0.57 mm (0.0118 – 0.0224 in.)**
No. 2 ring	**0.35 – 0.67 mm (0.0138 – 0.0264 in.)**
Oil ring	**0.35 – 0.67 mm (0.0138 – 0.0264 in.)**

13B, 13B-T

No. 1 ring	**0.30 – 0.57 mm (0.0118 – 0.0224 in.)**
No. 2 ring	**0.45 – 0.72 mm (0.0177 – 0.0283 in.)**
Oil ring	**0.40 – 0.72 mm (0.0157 – 0.0283 in.)**

Maximum piston ring end gap:

11B

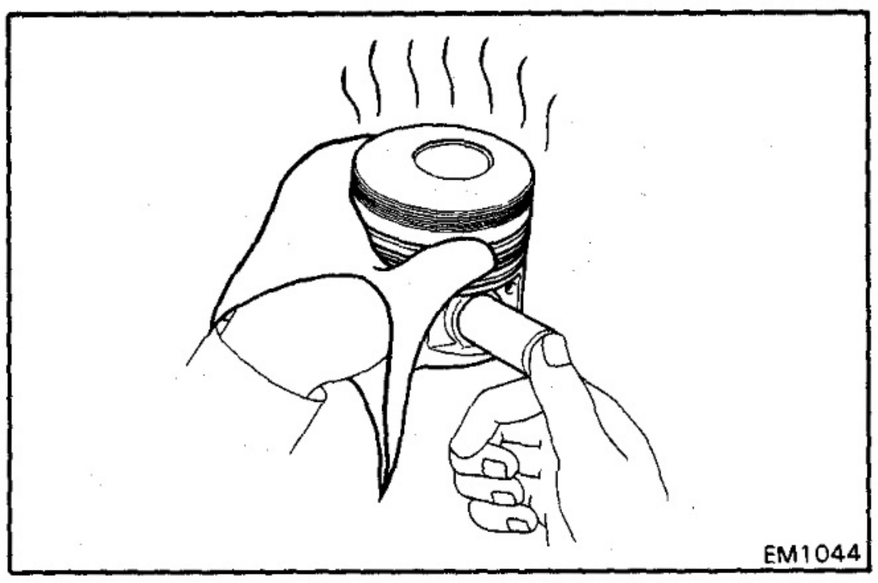
No. 1 ring	**1.37 mm (0.0539 in.)**
No. 2 ring	**1.47 mm (0.0563 in.)**
Oil ring	**1.47 mm (0.0579 in.)**

13B, 13B-T

No. 1 ring	**1.37 mm (0.0539 in.)**
No. 2 ring	**1.52 mm (0.0598 in.)**
Oil ring	**1.52 mm (0.0598 in.)**

If the gap exceeds the specified maximum, replace the piston ring.

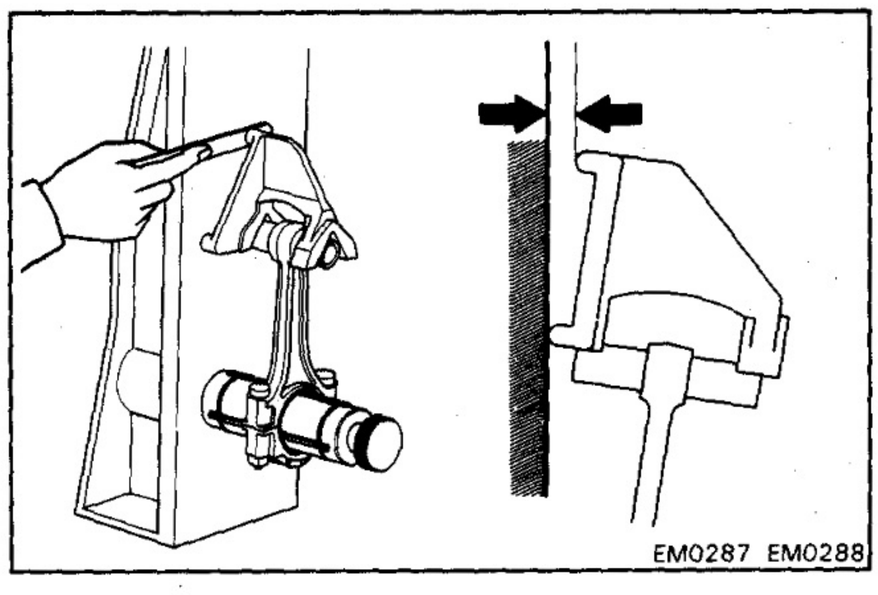
If the gap exceeds the specified maximum, even with a new piston ring, replace the cylinder liner.



5. CHECK PISTON PIN FIT

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

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



6. INSPECT CONNECTING RODS

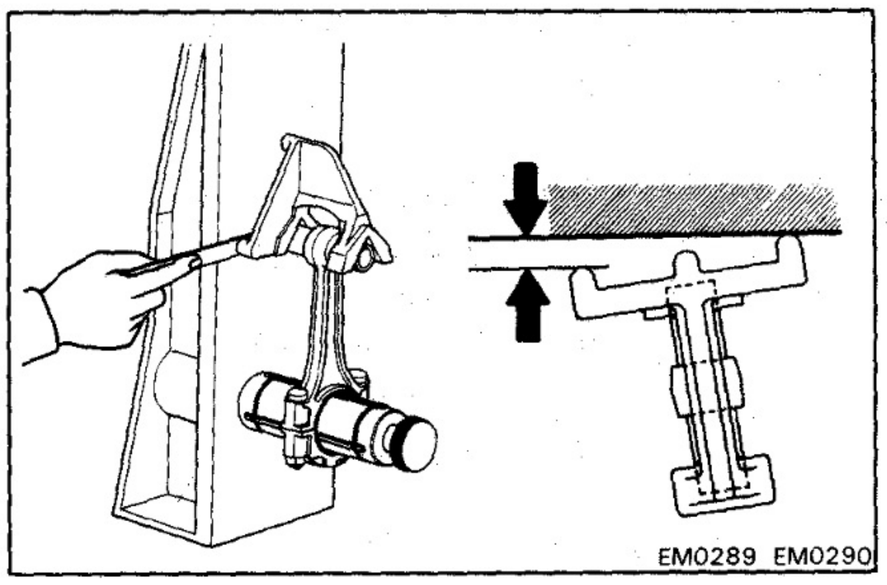
(a) Using a rod aligner, check the connecting rod alignment.

- Check for bend.

Maximum bend:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

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

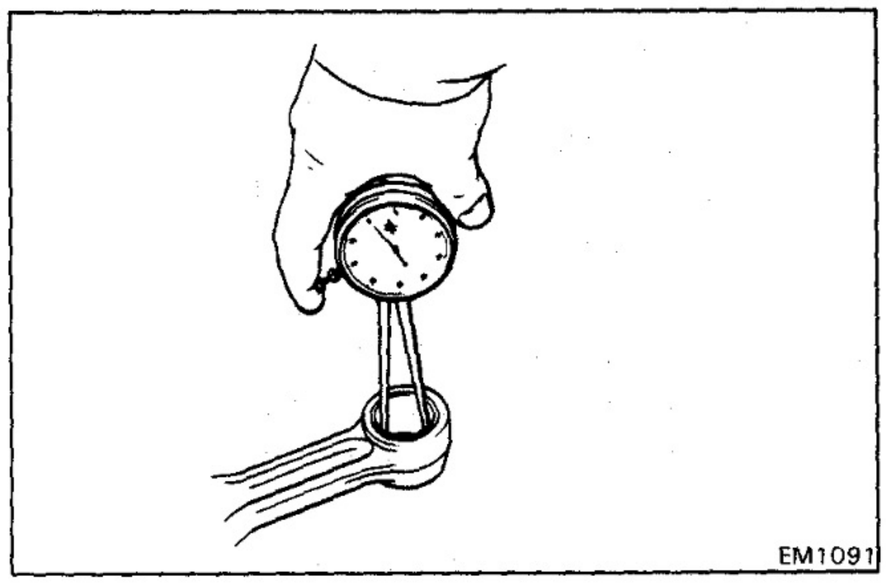

EM0289 EM0290

- Check for twist.

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

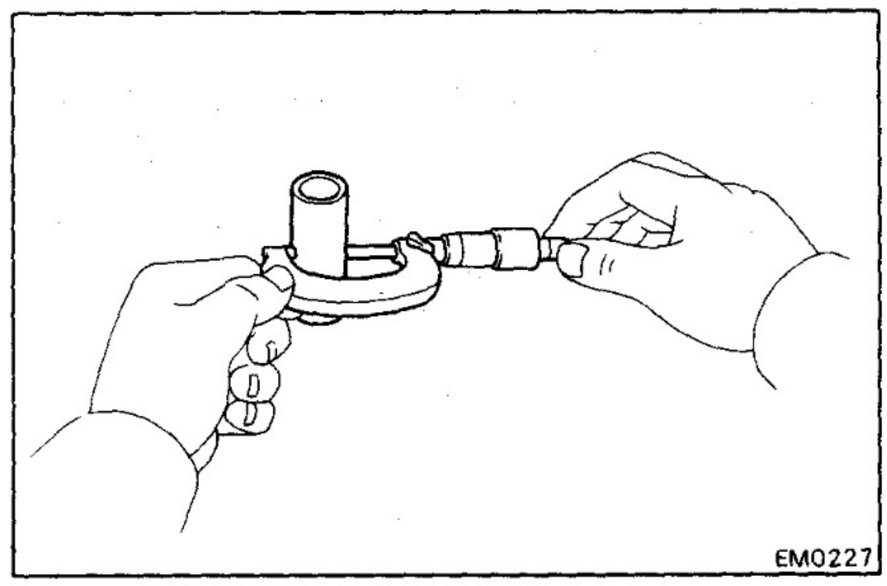
If twist is greater than maximum, replace the connecting rod assembly.

NOTE: If replacing the connecting rod, replace with bearings matching the number as is on the cap.
(See page EM-69)


EM1091

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

Bushing inside diameter:
34.009 – 34.019 mm (1.3389 – 1.3393 in.)


EM0227

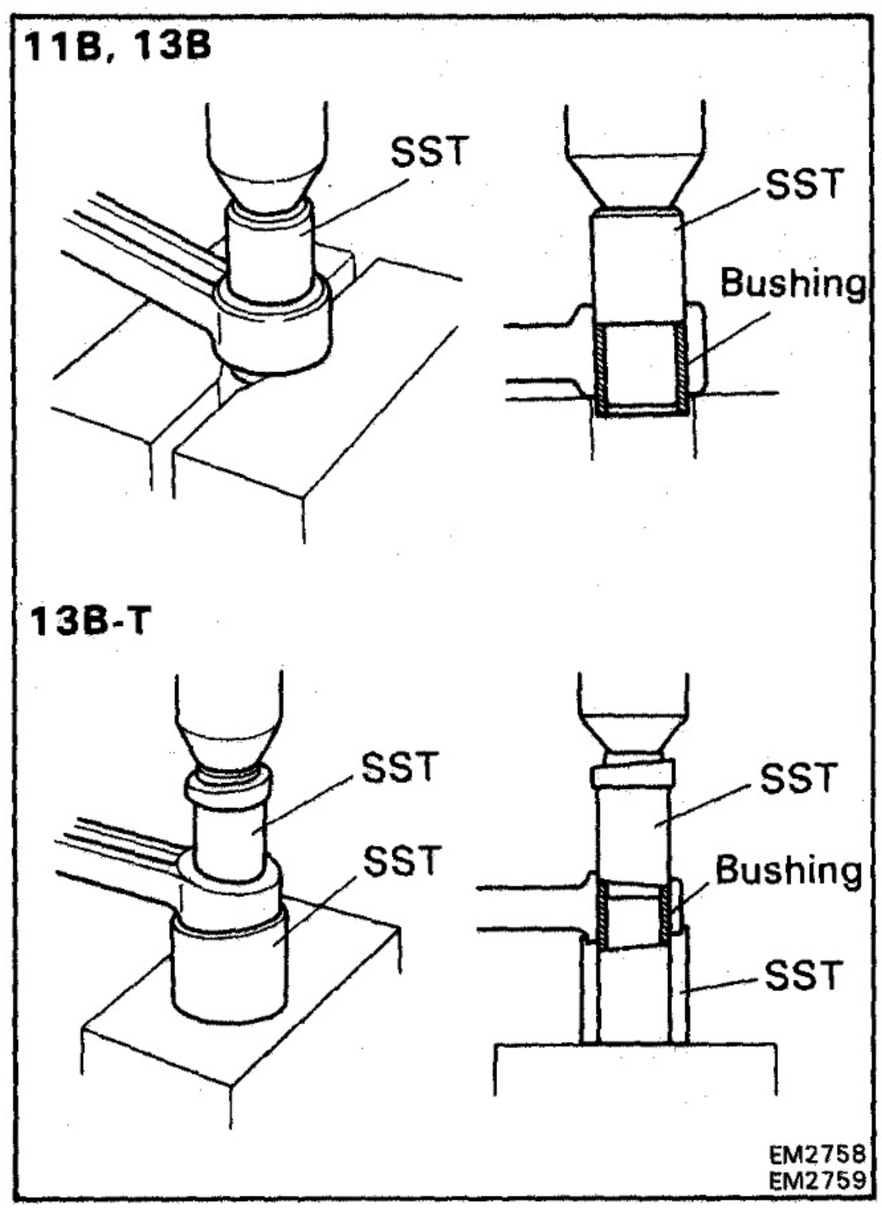
(c) Using a micrometer, measure the diameter of the piston pin.

Piston pin diameter:
34.000 – 34.010 mm (1.3386 – 1.3390 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 mm (0.0020 in.)**

If the oil clearance is greater than maximum, replace the rod bushing. If necessary, replace the piston assembly.

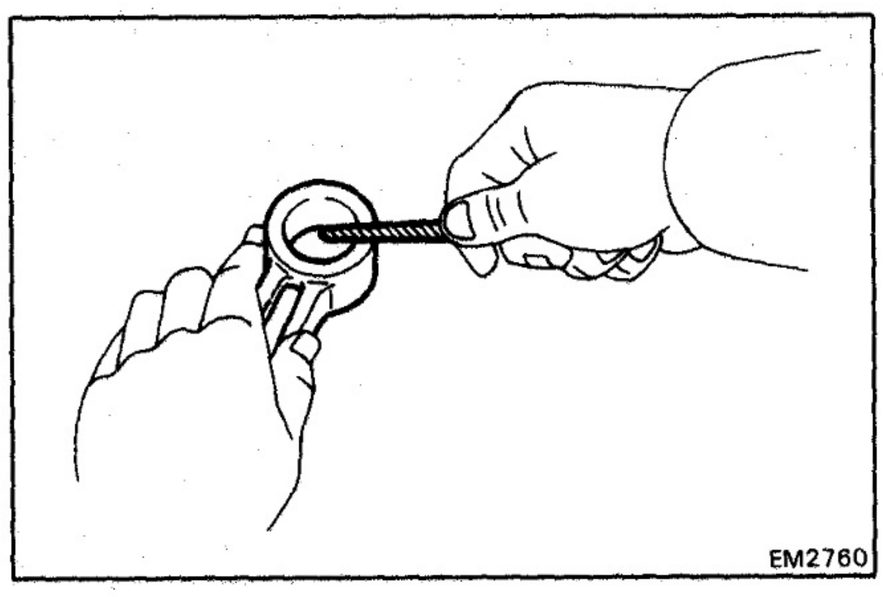


REPLACEMENT OF CONNECTING ROD BUSHINGS

1. REMOVE CONNECTING ROD BUSHING

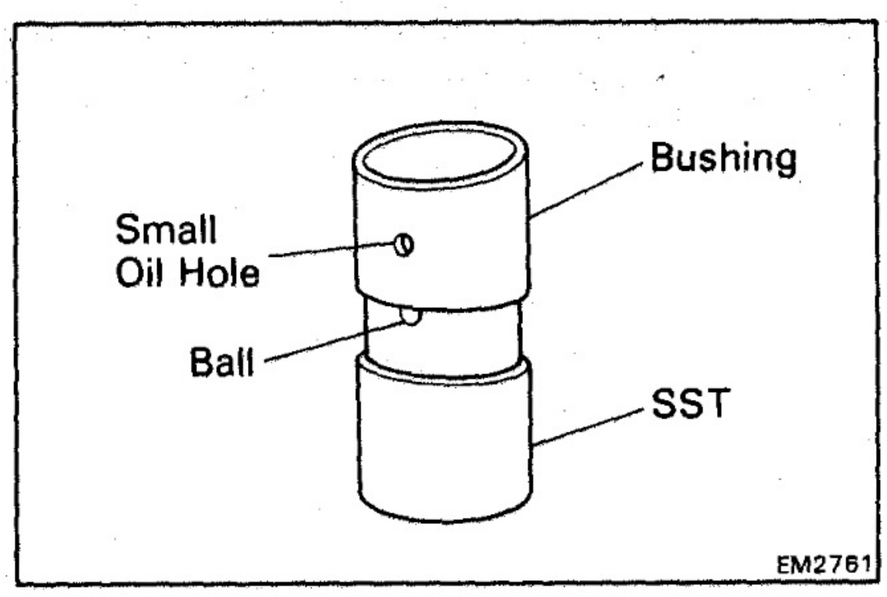
Using SST and a press, press out the bushing.

SST 11B, 13B 09222-76012
13B-T 09222-58010
(09222-01020 and 09222-01040)



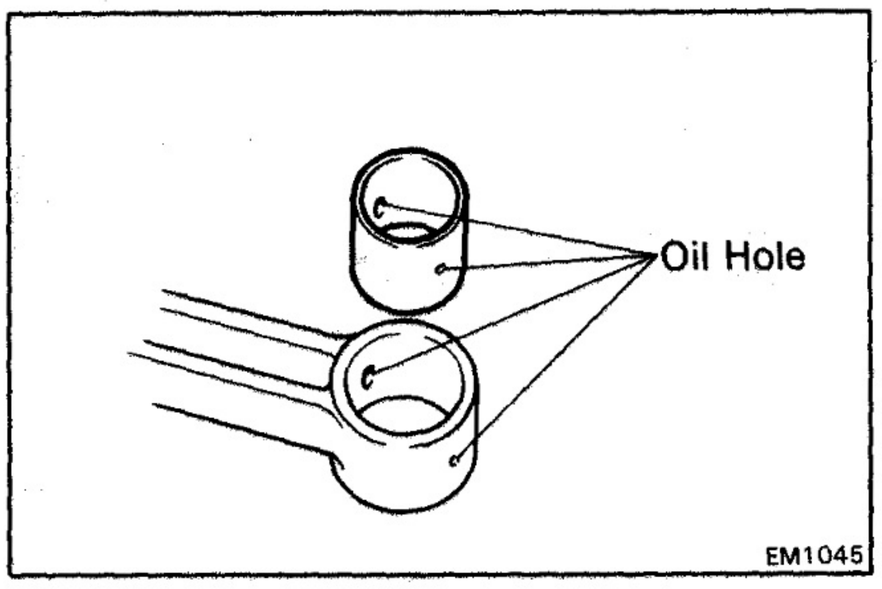
2. INSTALL NEW CONNECTING ROD BUSHING

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

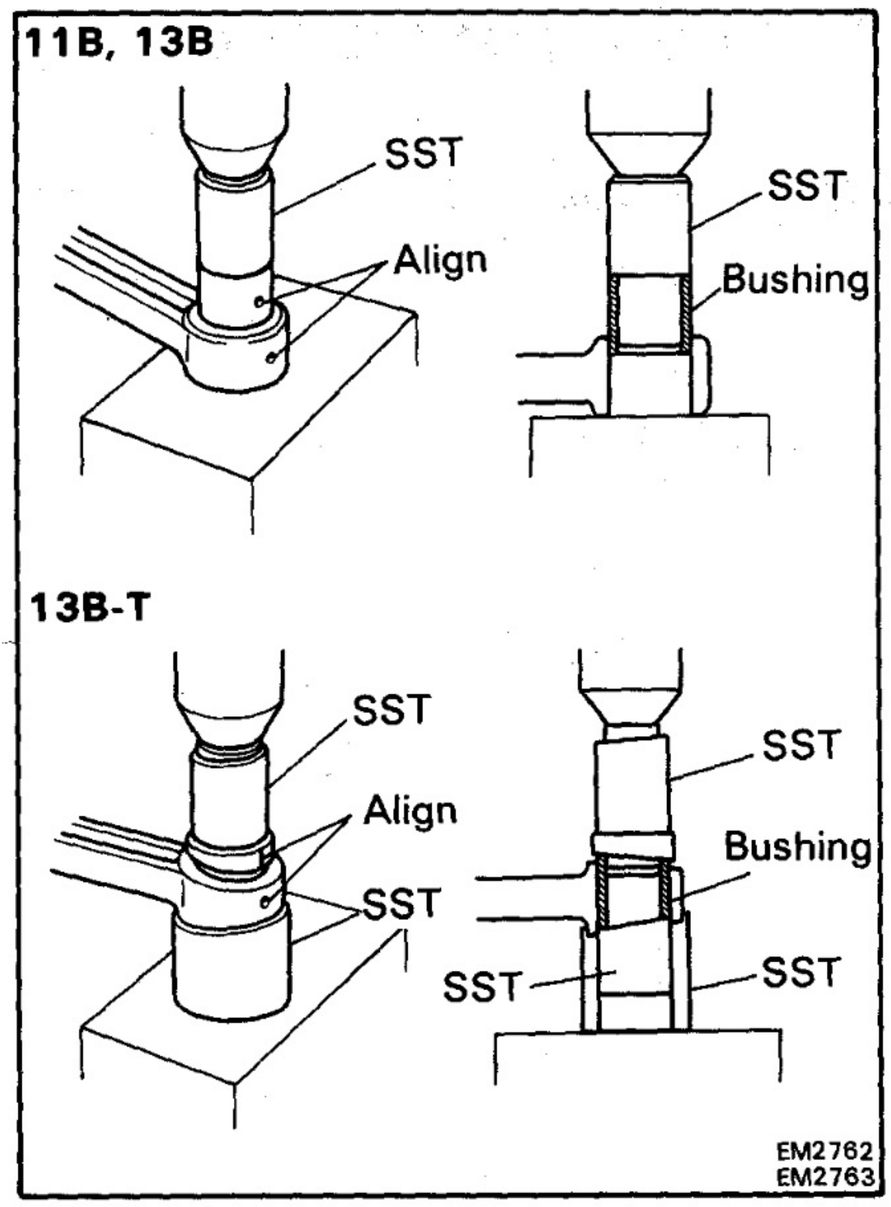


(b) [13B-T]
Attach the bushing to the SST with the ball of the SST inside the small oil hole of the bushing.

SST 09222-58010 (09222-01030)

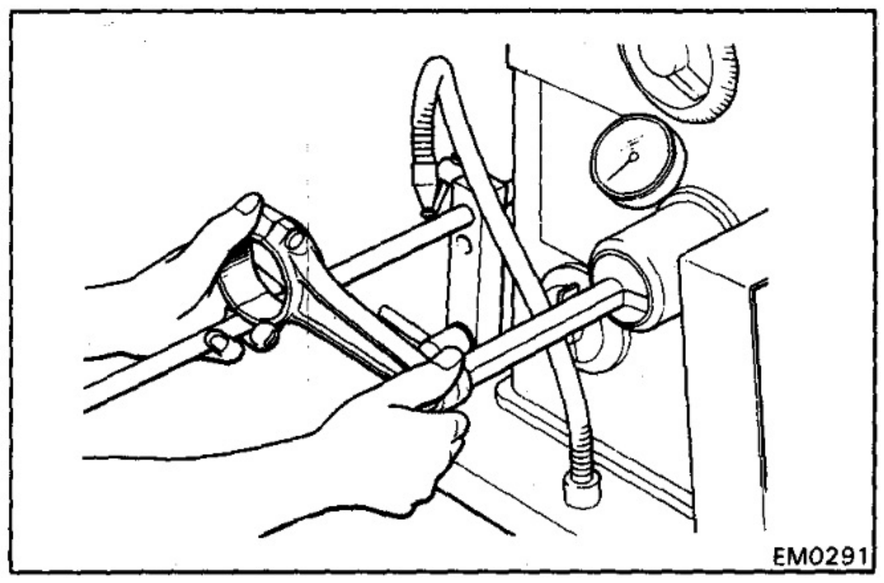


(c) Align the oil holes of the bushing and connecting rod.



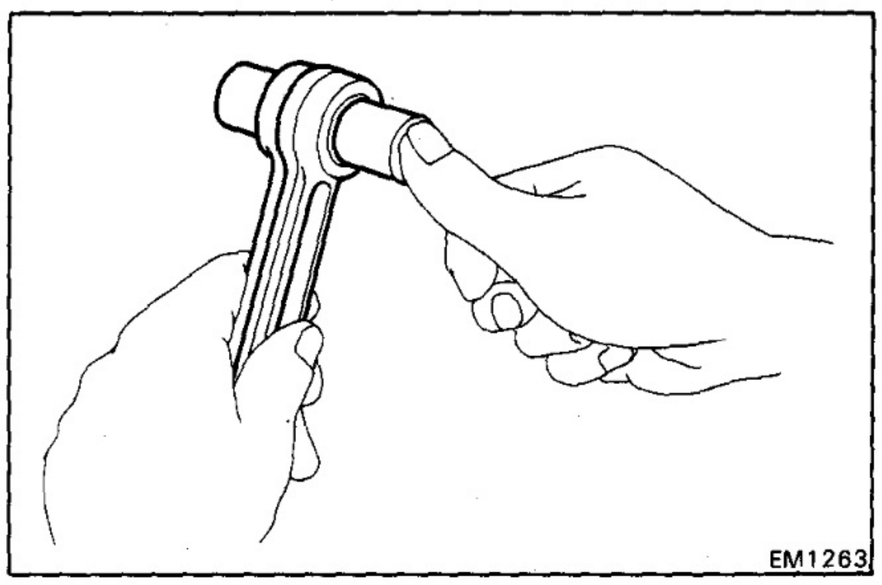
(d) Using SST and a press, press in the bushing as shown in the illustration.

SST 11B, 13B 09222-76012
13B-T 09222-58010 (09222-01020, 09222-01030 and 09222-01040)

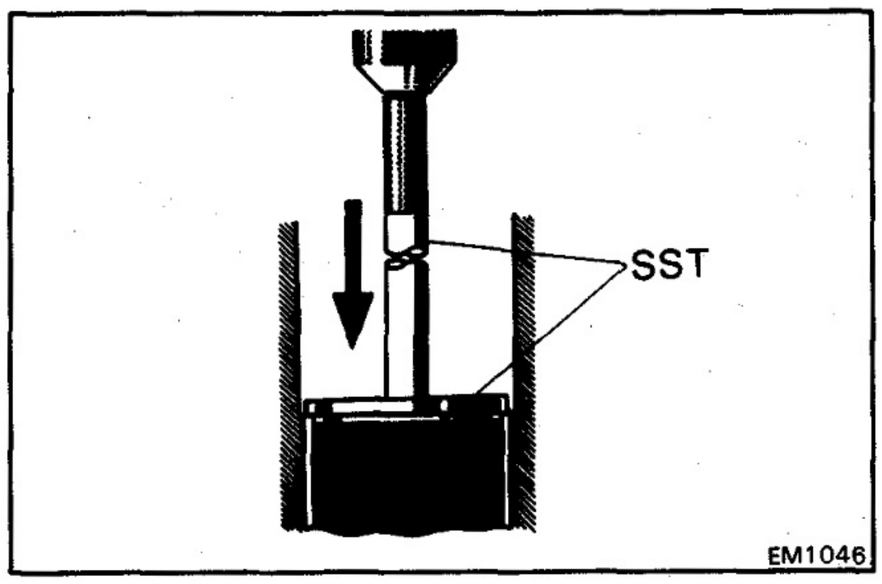


3. HONE CONNECTING ROD BUSHING AND CHECK PISTON PIN FIT IN CONNECTING ROD

(a) Using a pin hole grinder, hone the bushing and check that the oil clearance is within standard specification. (See page EM-78)



(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.

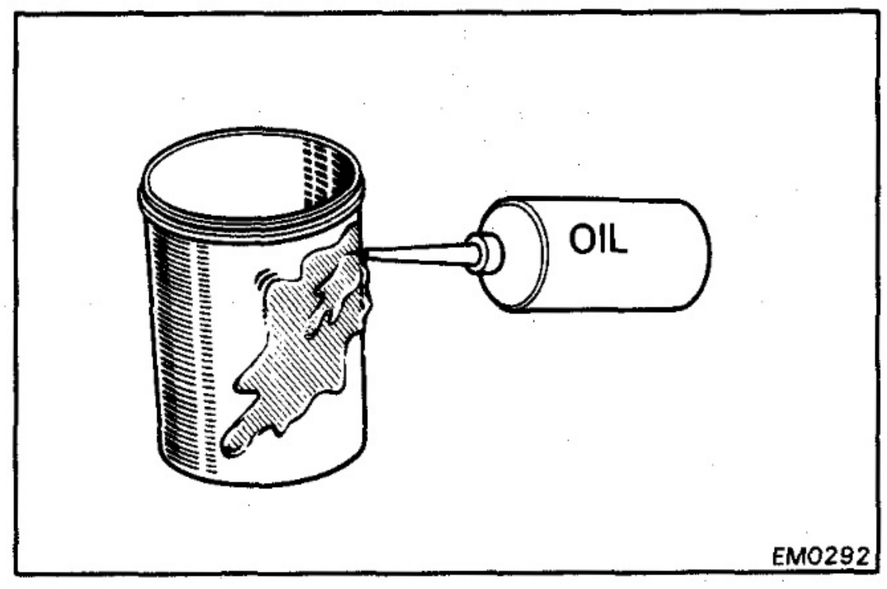


REPLACEMENT OF CYLINDER LINERS

1. REMOVE CYLINDER LINER

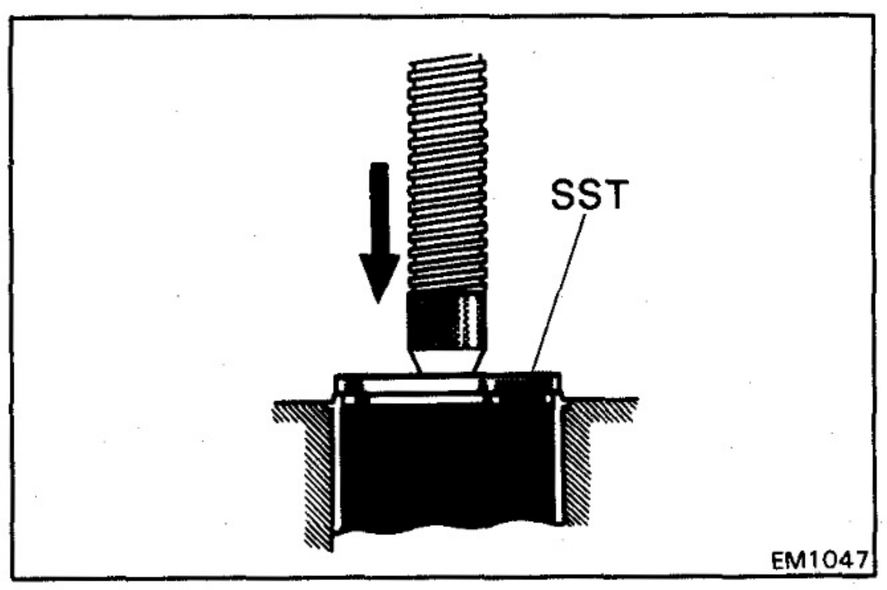
Using SST and a press, press out the liner with 2,500 kg (5,512 lb, 24,517 N) of pressure.

SST 11B 09218-56020 and
09608-12010 (09608-00020)
13B, 13B-T 09218-56030 and
09608-12010 (09608-00020)



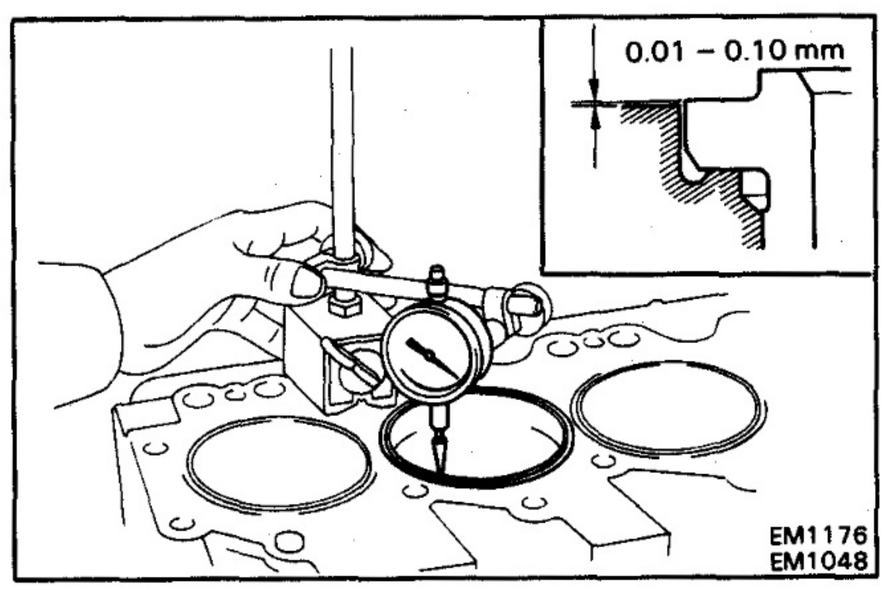
2. INSTALL NEW CYLINDER LINER WITH SHIM

(a) Apply engine oil to the outside surface of the cylinder liner.



(b) Using SST and a press, press in the cylinder liner with 2,500 kg (5,512 lb, 24,517 N) of pressure.

SST 11B 09218-56020
13B, 13B-T 09218-56030



3. CHECK CYLINDER LINER RIDGE PROTRUSION

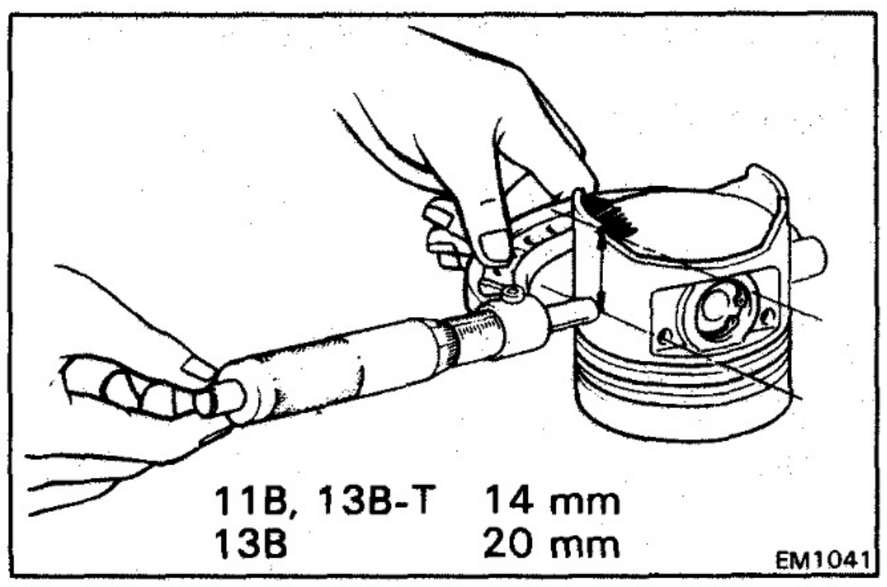
Using a dial indicator, measure the ridge protrusion of the cylinder liner.

Ridge protrusion: 0.01 – 0.10 mm (0.0004 – 0.0039 in.)

If the protrusion is not within specification, adjust it with a cylinder liner shim.

Cylinder liner shim thickness:
0.05 mm (0.0020 in.)
0.10 mm (0.0040 in.)

4. BORE CYLINDER LINER



BORING OF CYLINDER LINERS

1. CALCULATE AMOUNT TO BORE CYLINDER LINER

(a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line, the indicated distance below the skirt bottom edge.

Measure distance:

11B, 13B-T	**14 mm (0.55 in.)**
13B	**20 mm (0.79 in.)**

Piston diameter:

11B	**94.94 – 94.97 mm (3.7378 – 3.7390 in.)**
13B	**101.93 – 101.96 mm (4.0130 – 4.0142 in.)**
13B-T	**101.92 – 101.95 mm (4.0126 – 4.0138 in.)**

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

Size to be rebored = P + C – H
P = Piston diameter
C = Piston clearance

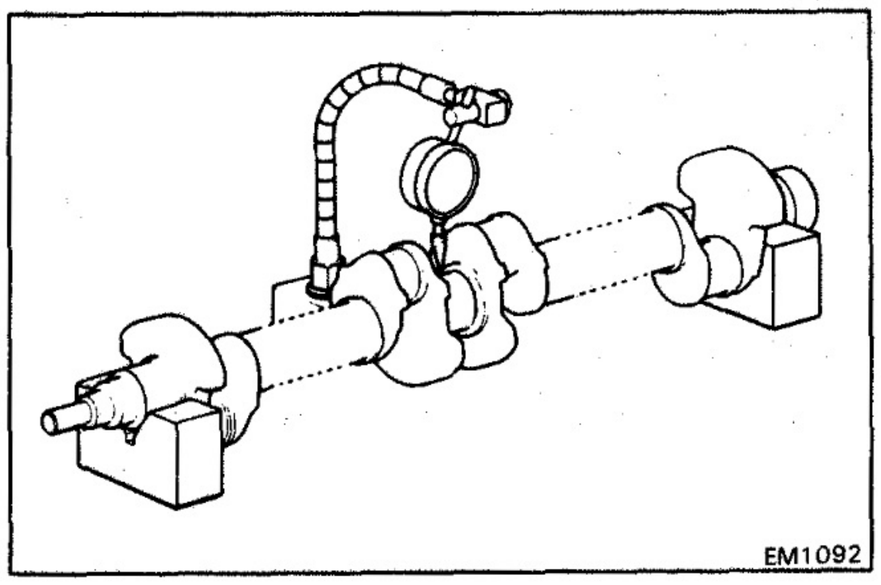
11B	**0.05 – 0.07 mm (0.0020 – 0.0028 in.)**
13B	**0.06 – 0.08 mm (0.0024 – 0.0031 in.)**
13B-T	**0.07 – 0.09 mm (0.0028 – 0.0035 in.)**

H = Allowance for honing
0.02 mm (0.0008 in.) or less

2. BORE AND HONE CYLINDER LINER TO CALCULATED DIMENSIONS

Maximum honing: 0.02 mm (0.0008 in.)

CAUTION: Excess honing will destroy the finished roundness.



INSPECTION AND REPAIR OF CRANKSHAFT

1. INSPECT CRANKSHAFT FOR RUNOUT

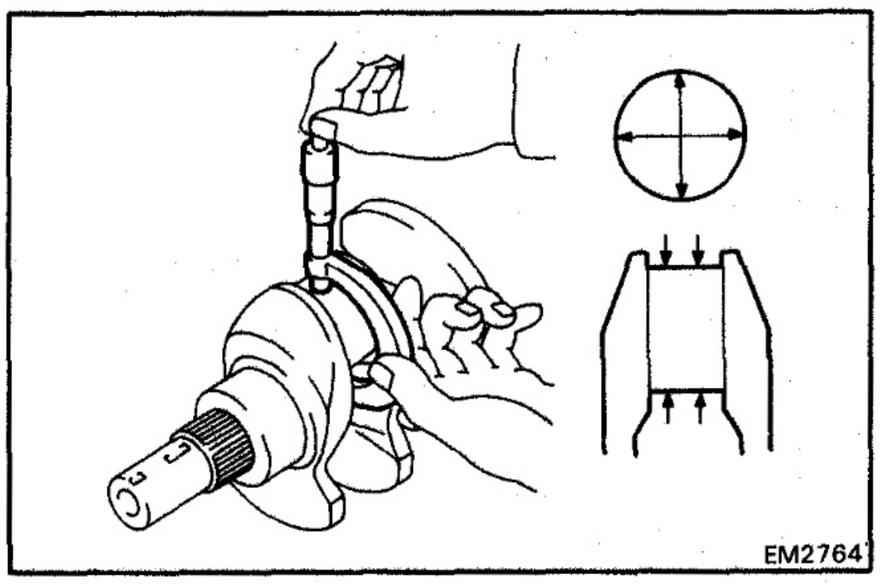
(a) Place the crankshaft on V-blocks.

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

NOTE: 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.



2. INSPECT MAIN JOURNALS AND CRANK PINS

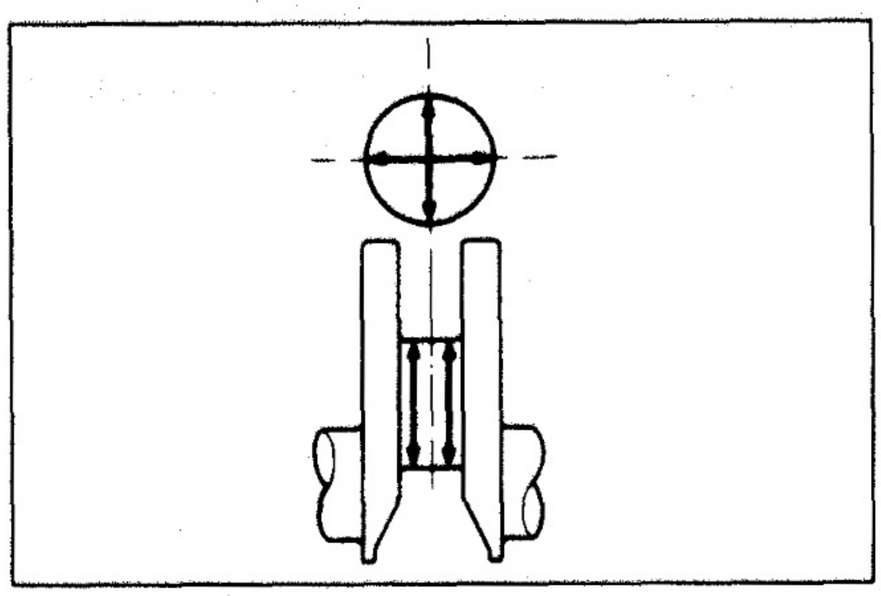
(a) Using a micrometer, measure the diameter of the main journal and crank pin.

Main journal diameter:
Standard 69.98 – 70.00 mm (2.7551 – 2.7559 in.)
U/S 0.25, 0.50 and 1.00
(See Main journal finished diameter)

Crank pin diameter:
Standard 60.98 – 61.00 mm (2.4008 – 2.4016 in.)
U/S 0.25, 0.50 and 1.00
(See Crank pin finished diameter)

If the diameter is not within specification, check the oil clearance.

If necessary, regrind or replace the crankshaft.



(b) Check the 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 are greater than maximum, regrind the crankshaft. If necessary, replace the crankshaft.

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

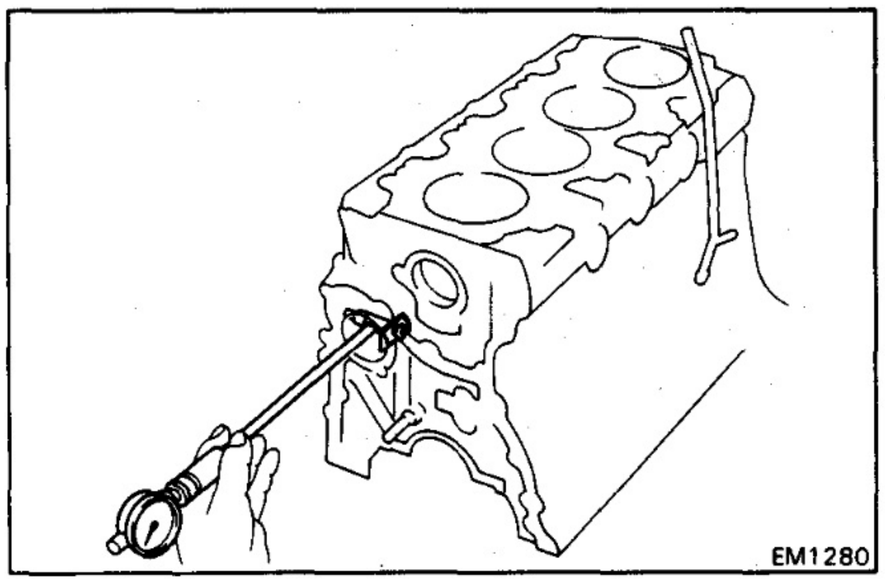
Grind and hone the main journals and/or crank pins to the undersized finished diameter.

Main journal finished diameter:
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.)

Crank pin finished diameter:

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.)**

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



INSPECTION OF CAMSHAFT AND CAMSHAFT BEARINGS

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.)**

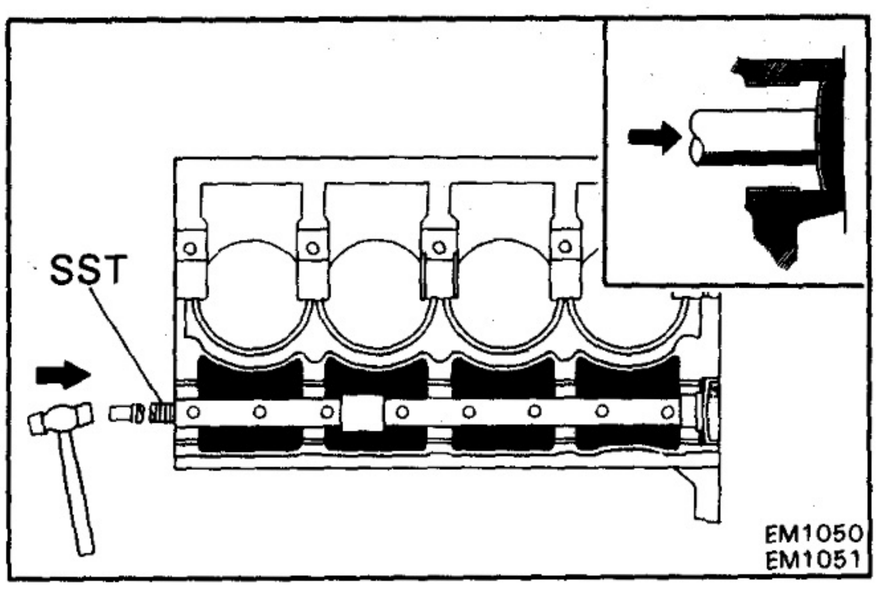
(b) Subtract the journal diameter measurement (See page EM-58) from the bearing inside diameter measurement.

Standard oil clearance:	**0.025 – 0.066 mm (0.0010 – 0.0026 in.)**
Maximum oil clearance:	**0.1 mm (0.004 in.)**

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

REPLACEMENT OF CAMSHAFT BEARINGS

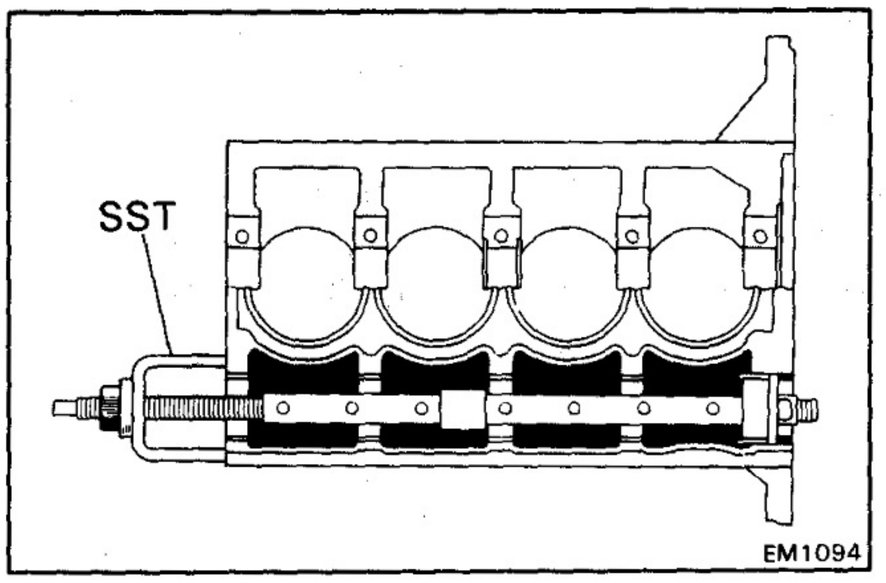
NOTE: The inner diameter varies with each bearing.



1. REMOVE EXPANSION PLUG

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

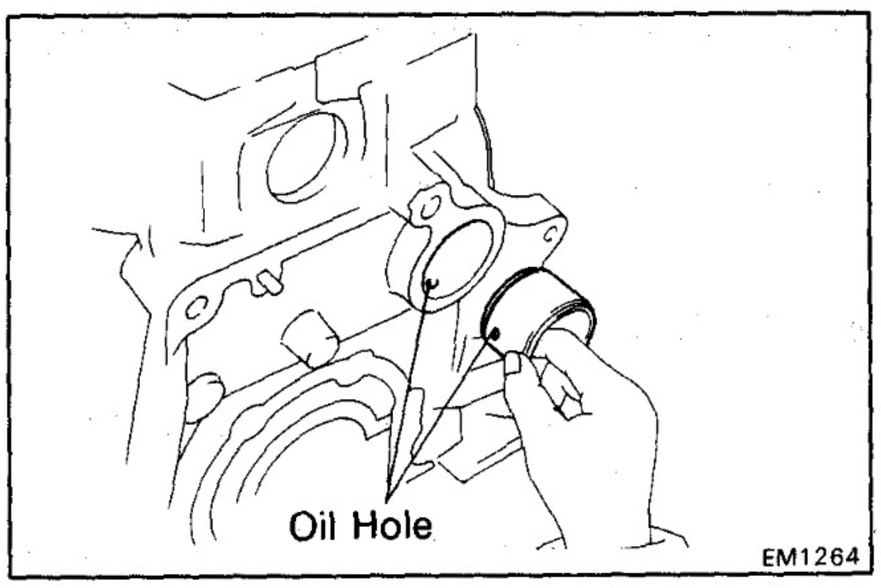
SST 09215-00100 (09215-00130, 09215-00150 and 09215-00210)



2. REMOVE CAMSHAFT BEARINGS

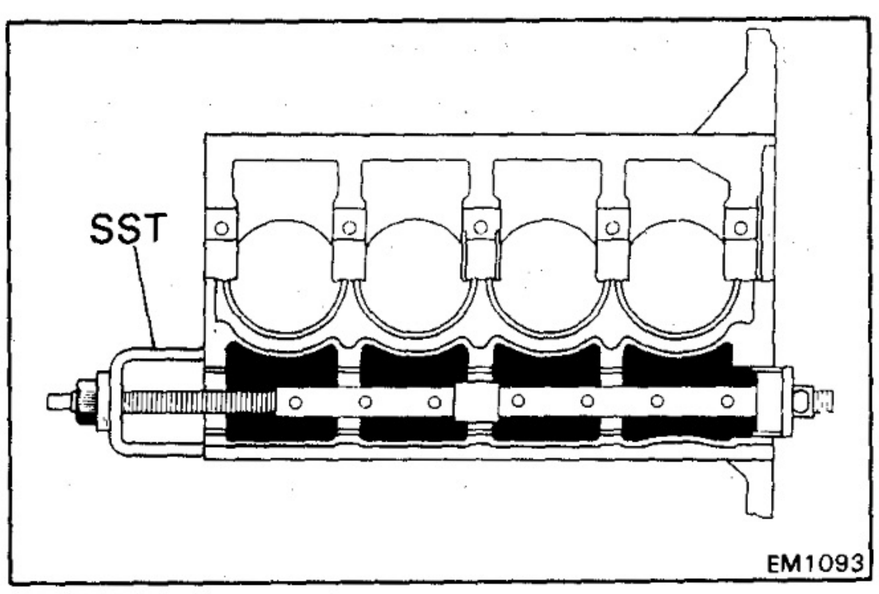
Using SST, remove the camshaft bearings.

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



3. INSTALL NEW CAMSHAFT BEARINGS

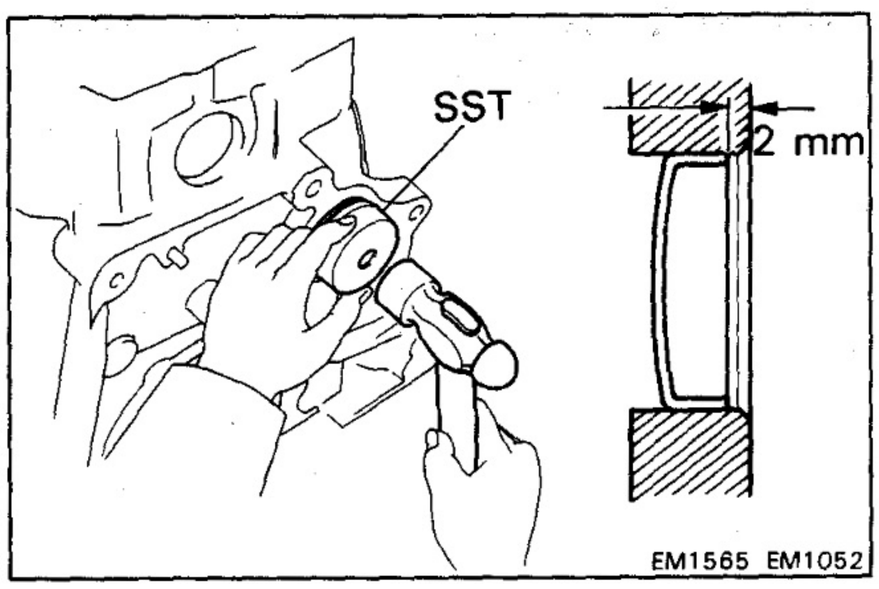
(a) Align the oil holes of the bearing and cylinder block.



(b) Using SST, install the camshaft bearings.

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

4. CHECK CAMSHAFT OIL CLEARANCE
(See page EM-84)

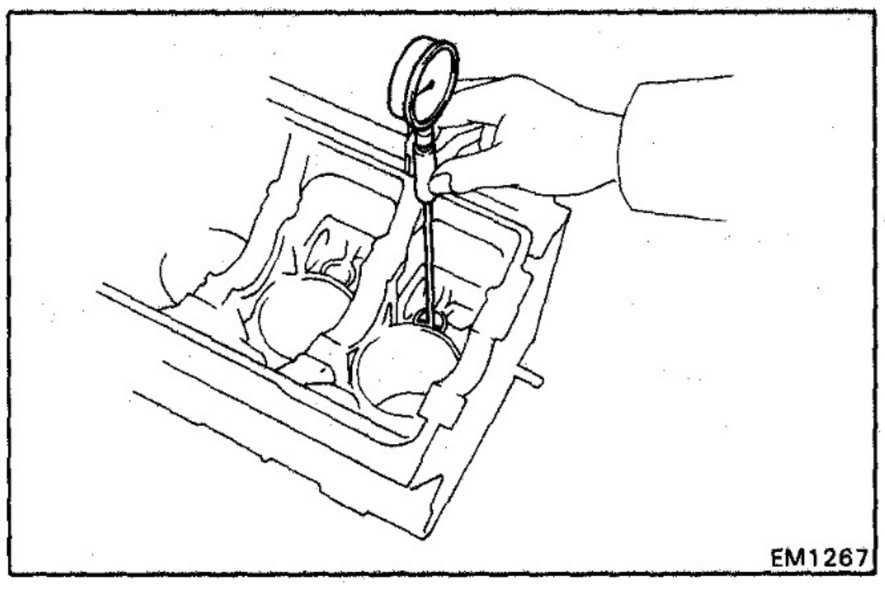


5. INSTALL EXPANSION PLUG

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

(b) Using SST and a hammer, drive in the expansion plug to a distance of 2 mm (0.079 in.) from the cylinder block edge.

SST 09215-00012 (09215-00470)


EM1267

INSPECTION OF VALVE LIFTERS AND VALVE LIFTER BORES

INSPECT VALVE LIFTER OIL CLEARANCE

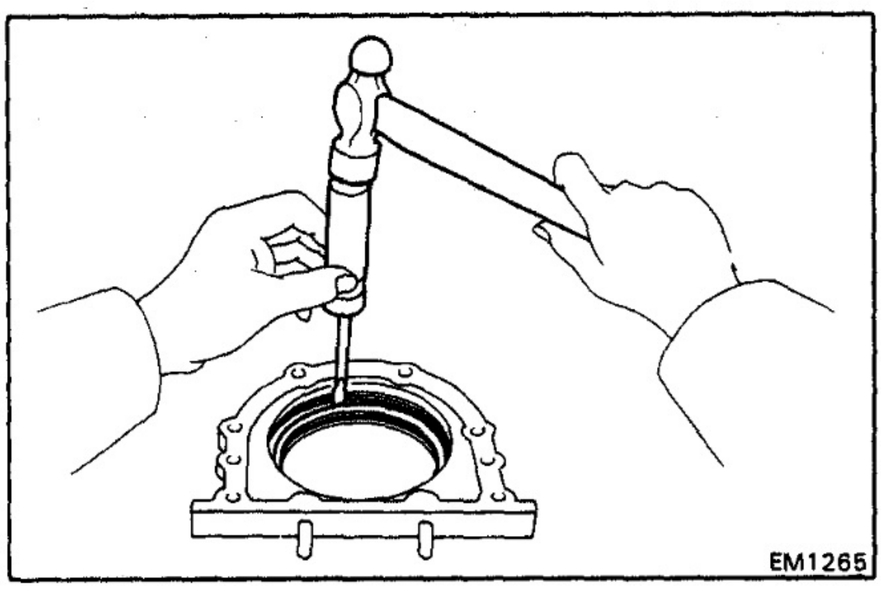
(a) Using a cylinder gauge, measure the valve lifter bore diameter.

Bore diameter: 27.01 – 27.03 mm (1.0634 – 1.0642 in.)

(b) Subtract the valve lifter diameter measurement (See page EM-57) from the valve lifter bore diameter measurement.

Standard oil clearance: 0.025 – 0.058 mm (0.0010 – 0.0023 in.)
Maximum oil clearance: 0.1 mm (0.004 in.)

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


EM1265

REPLACEMENT OF CRANKSHAFT REAR OIL SEAL

NOTE: There are two methods (A and B) of oil seal replacement.

REPLACE CRANKSHAFT OIL SEAL

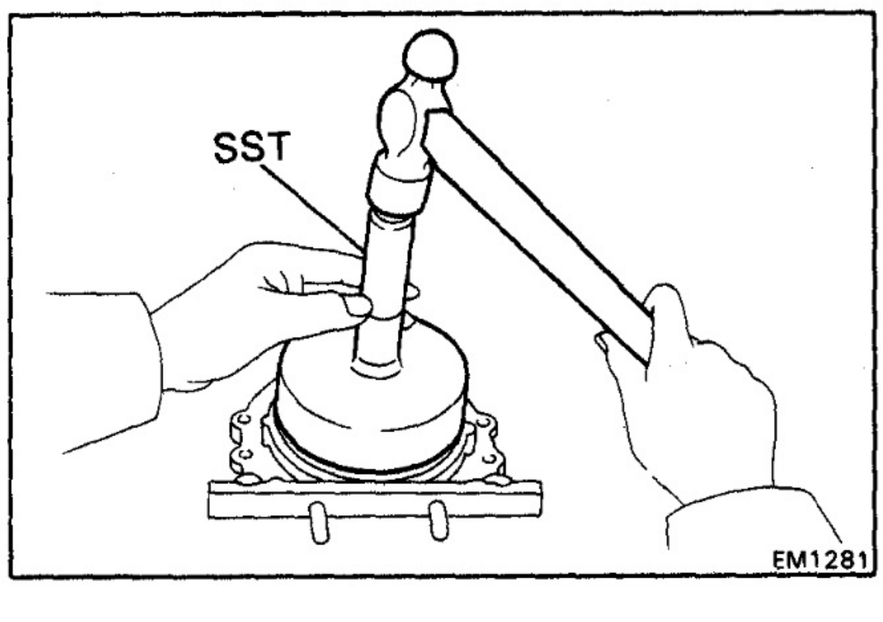
A. If the rear oil seal retainer is removed from the cylinder block:

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

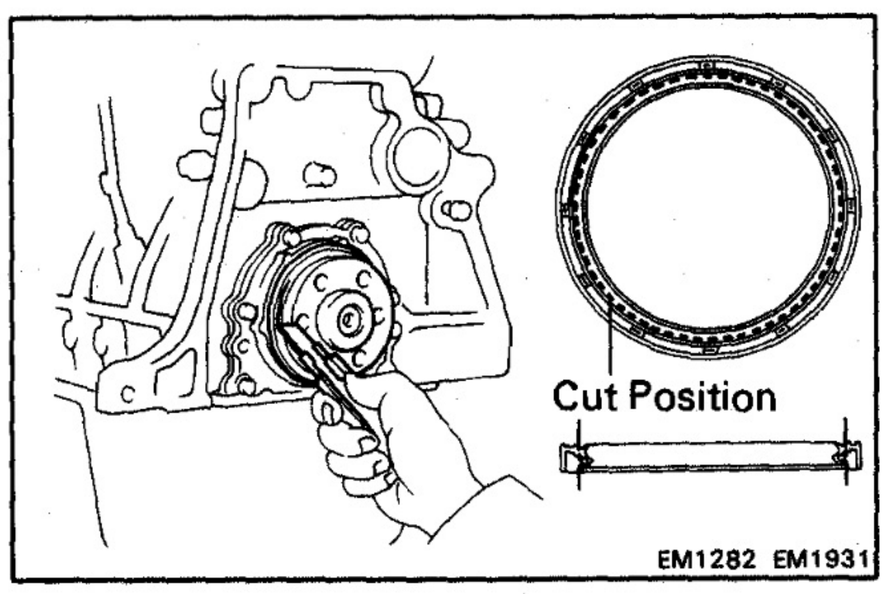
(b) Using SST and a hammer, drive in a new oil seal until its surface is flush with the rear oil seal retainer.

SST 09223-56010

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



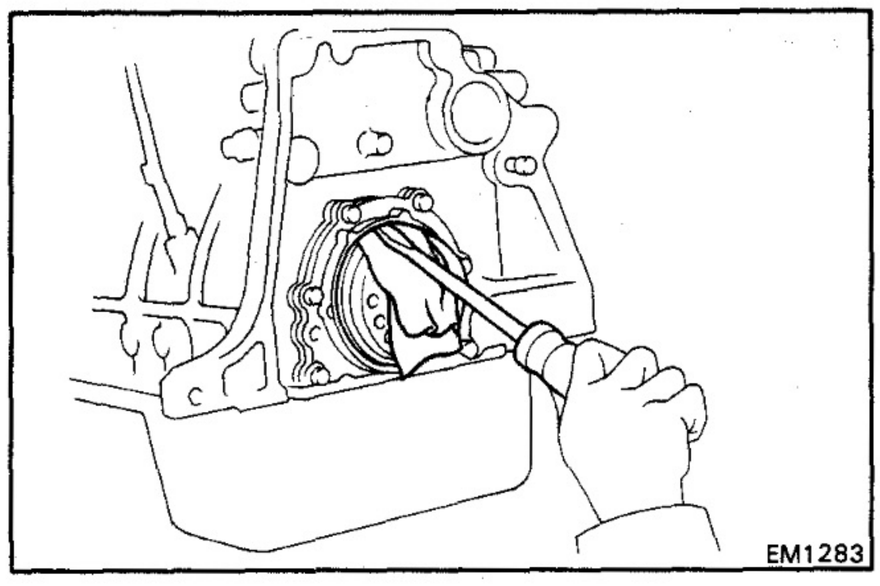
EM1281



EM1282 EM1931

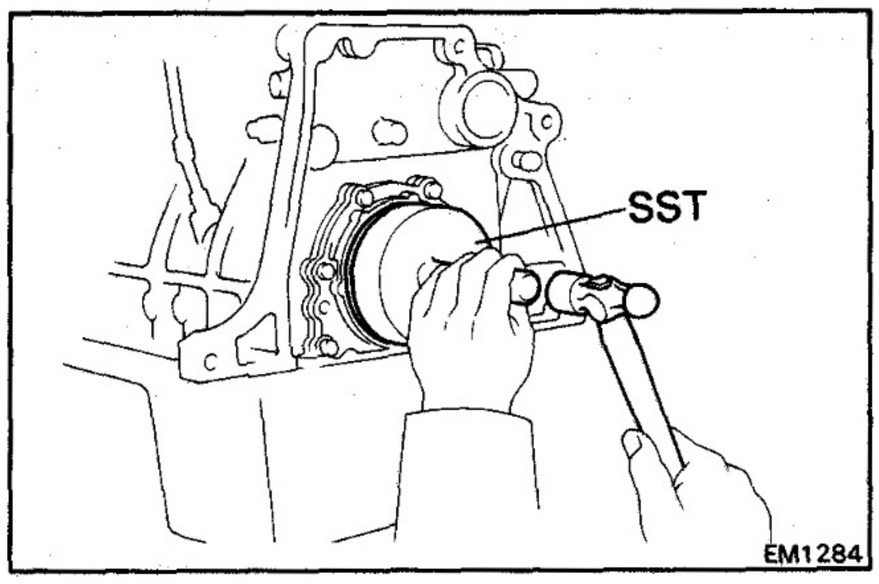
B. If rear oil seal retainer is installed to cylinder block:

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



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

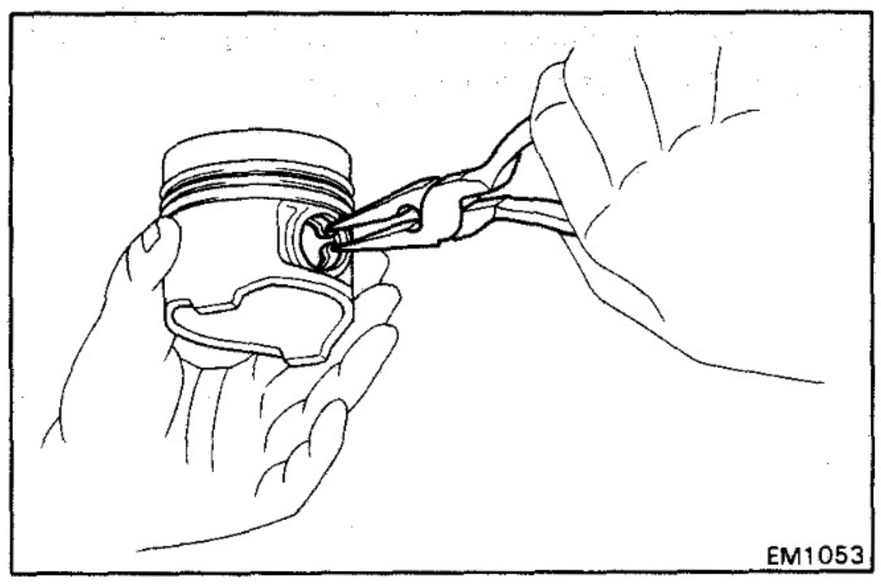
CAUTION: Be careful not to damage the crankshaft. Tape the screwdriver.



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

SST 09223-56010

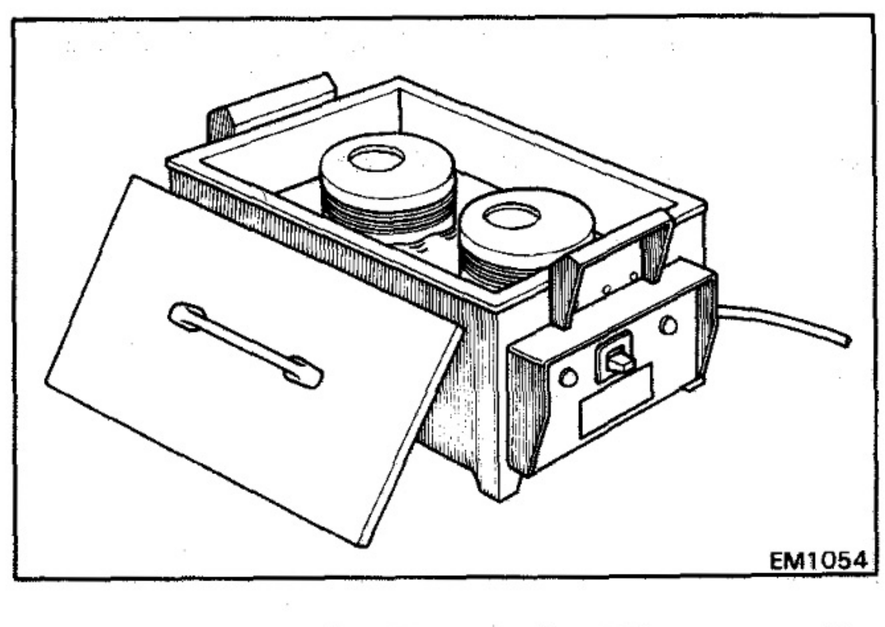
(d) Using SST and a hammer, drive in the oil seal until its surface is flush with the rear oil seal retainer edge.



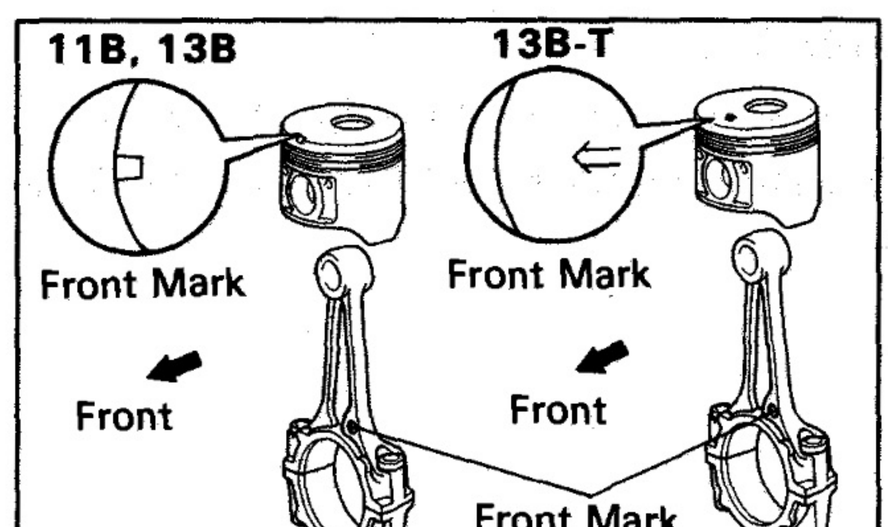
ASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. ASSEMBLE PISTON AND CONNECTING ROD

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

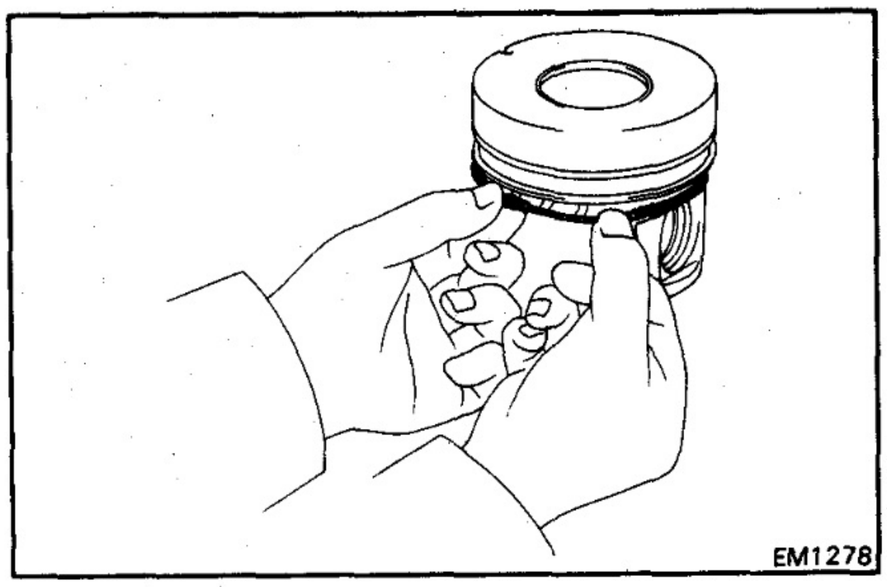


(b) Gradually heat the piston to about 60°C (140°F).



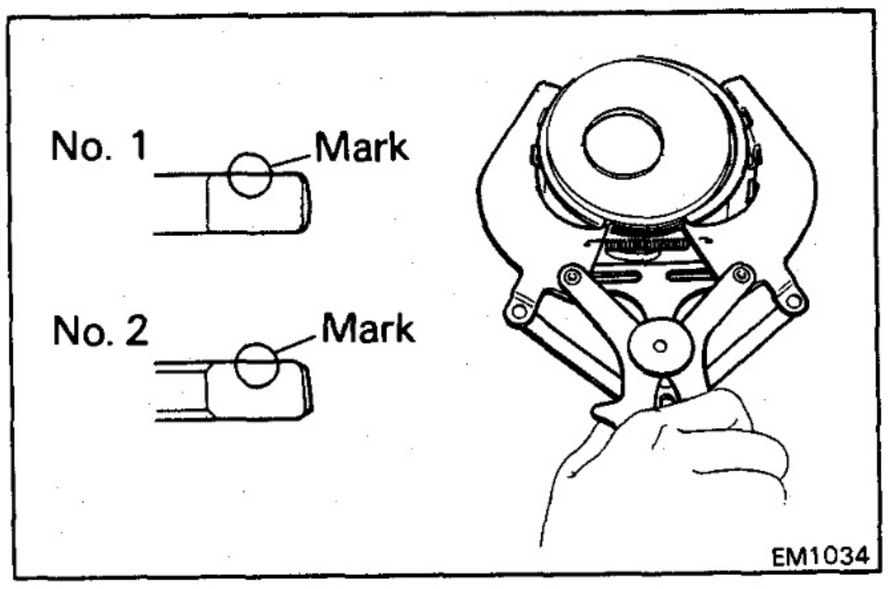
(c) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

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

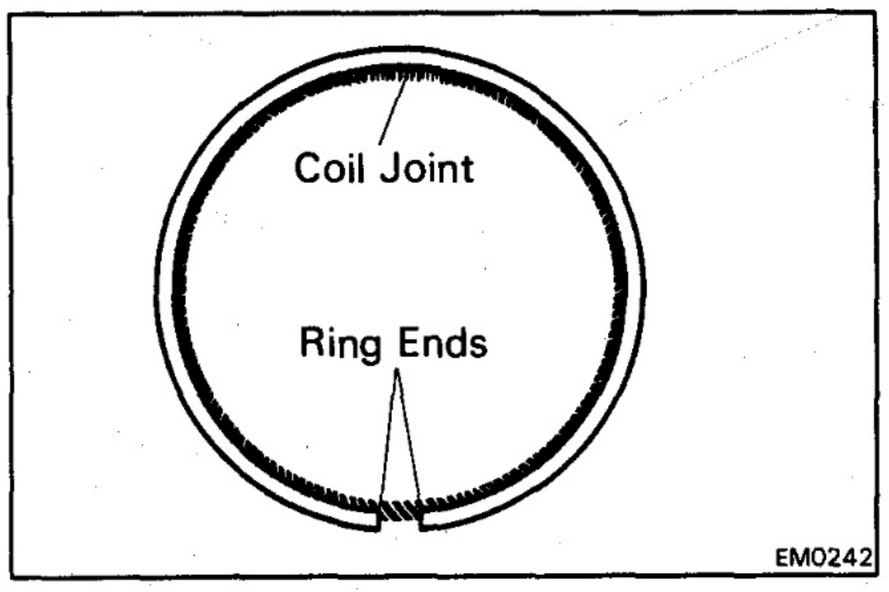


2. INSTALL PISTON RINGS

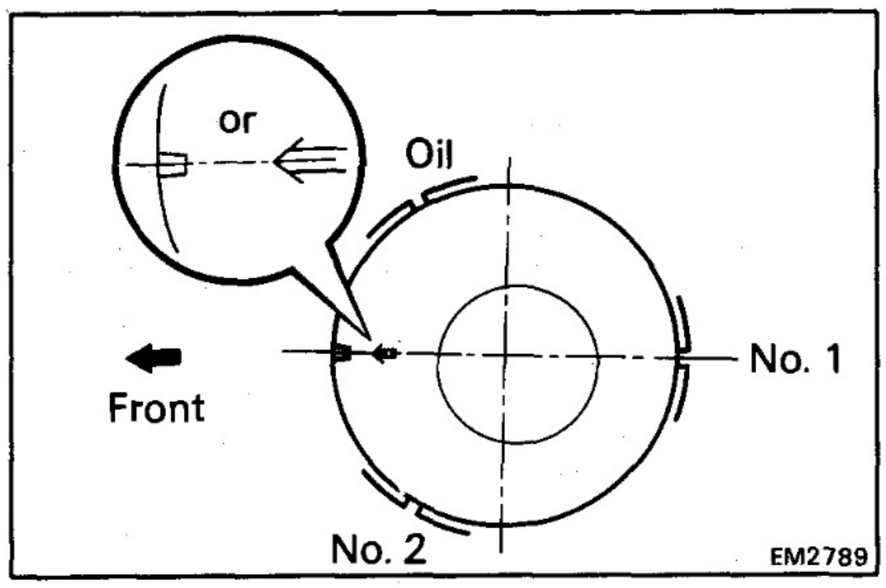
(a) Install the oil expander coil by hand.



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

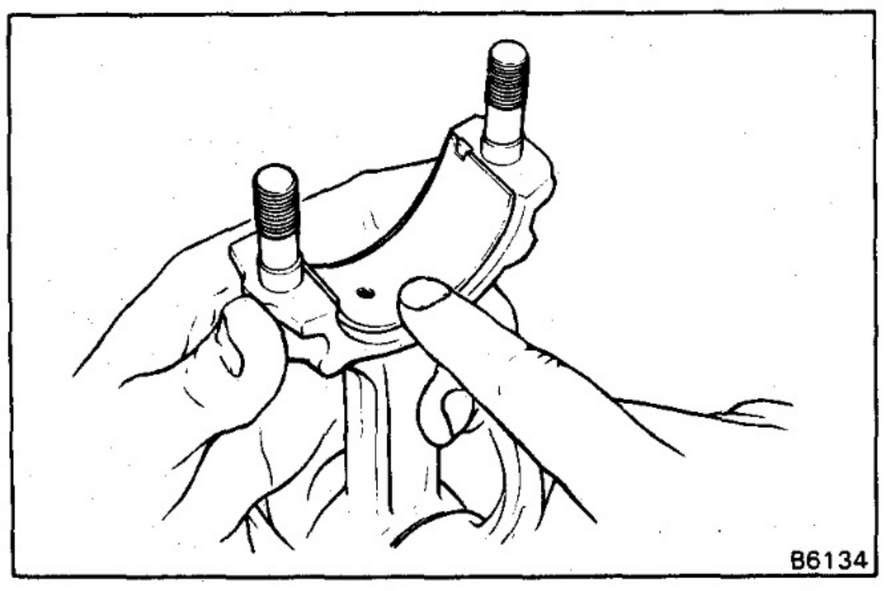


CAUTION: Face the end gap of the oil expander ring in the opposite direction of the coil joint.



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

CAUTION: Do not align the end gaps.



3. INSTALL BEARINGS

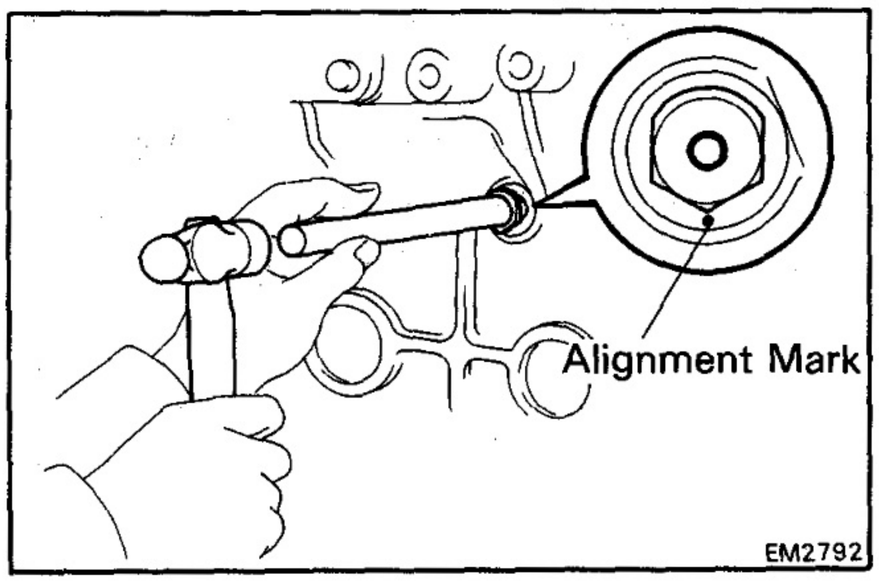
Install the bearing in the connecting rod and rod cap.

CAUTION: Install the bearing with the oil hole in the connecting rod.

ASSEMBLY OF CYLINDER BLOCK

(See page EM-66)

NOTE:
- Thoroughly 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 seals with new parts.



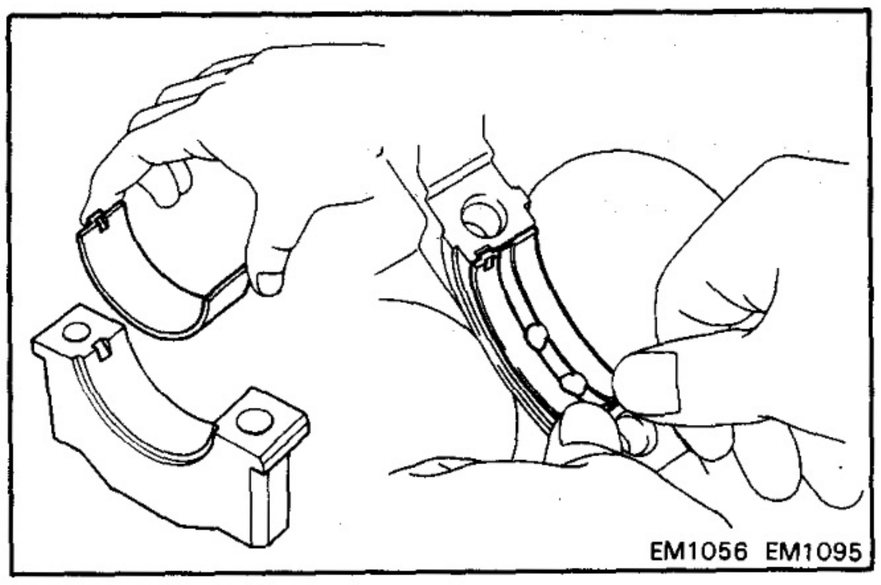
1. INSTALL NO. 1 OIL NOZZLES

(a) Check that the oil nozzles is not clogged.

(b) Install a new O-ring on the No. 1 oil nozzle.

(c) Apply light coat of engine oil to the O-ring.

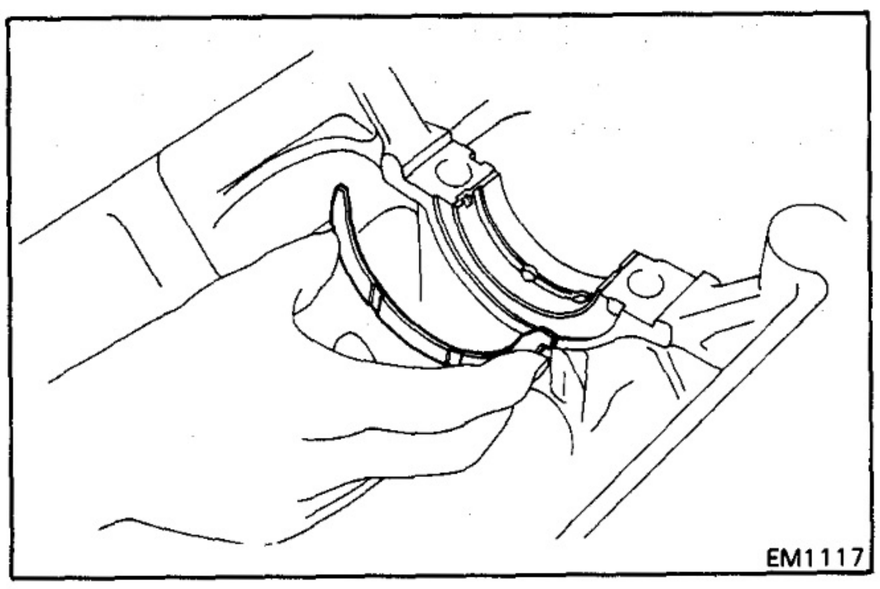
(d) Using a brass bar and hammer, tap in the nozzle facing its pointed end toward the alignment mark of the cylinder block as shown in the illustration.



2. INSTALL MAIN BEARINGS

Install the bearings in the cylinder block and main bearing caps.

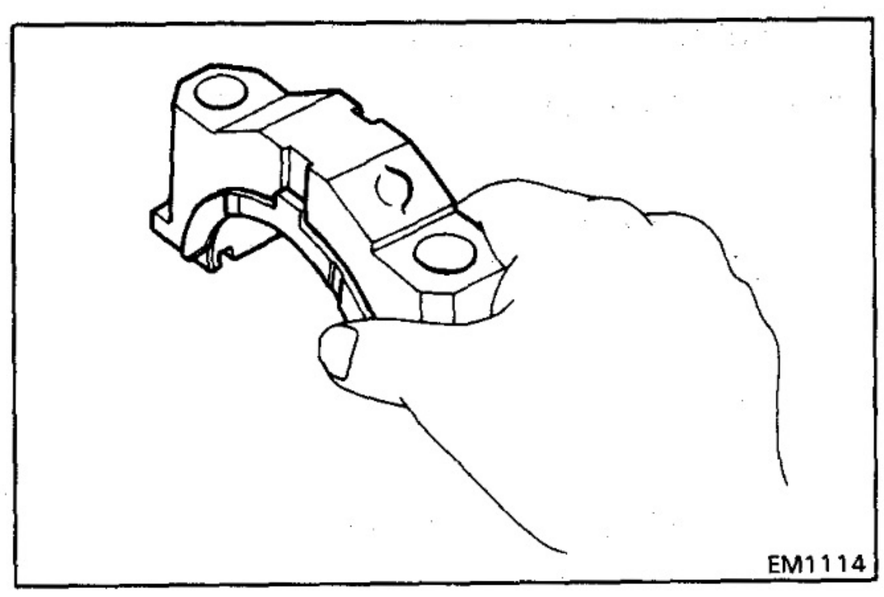
CAUTION: Install the bearing with the oil hole in the block.



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.

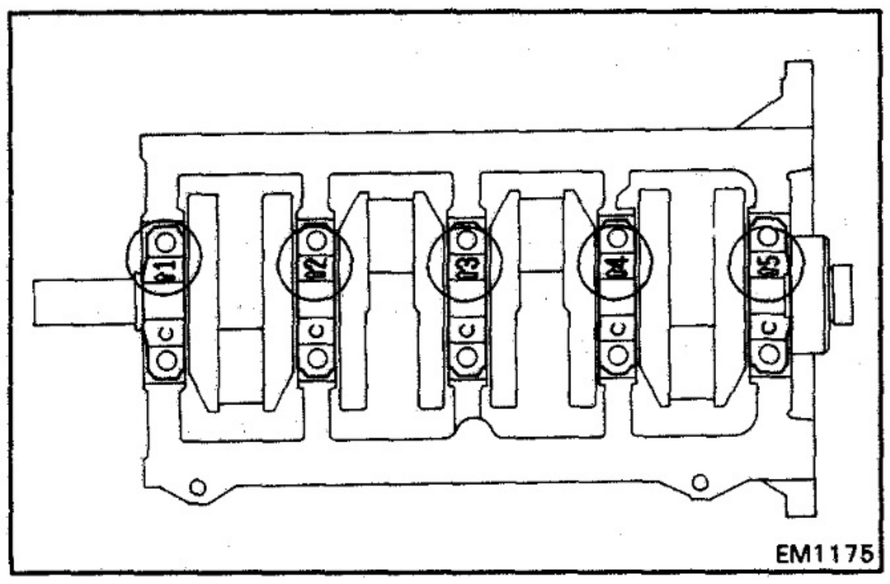
4. PLACE CRANKSHAFT ON CYLINDER BLOCK



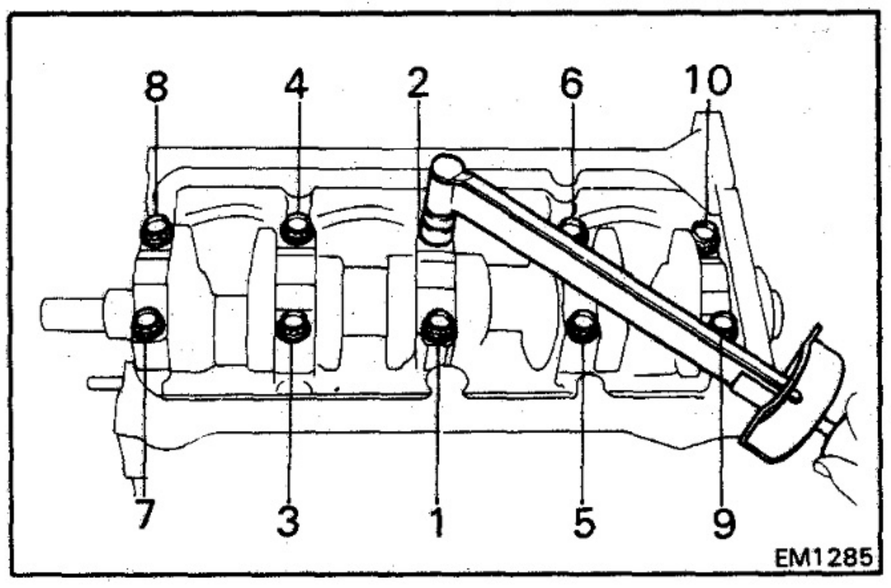
5. INSTALL MAIN BEARING CAPS AND LOWER THRUST WASHERS

NOTE: Each bearing cap is numbered and front mark.

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



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



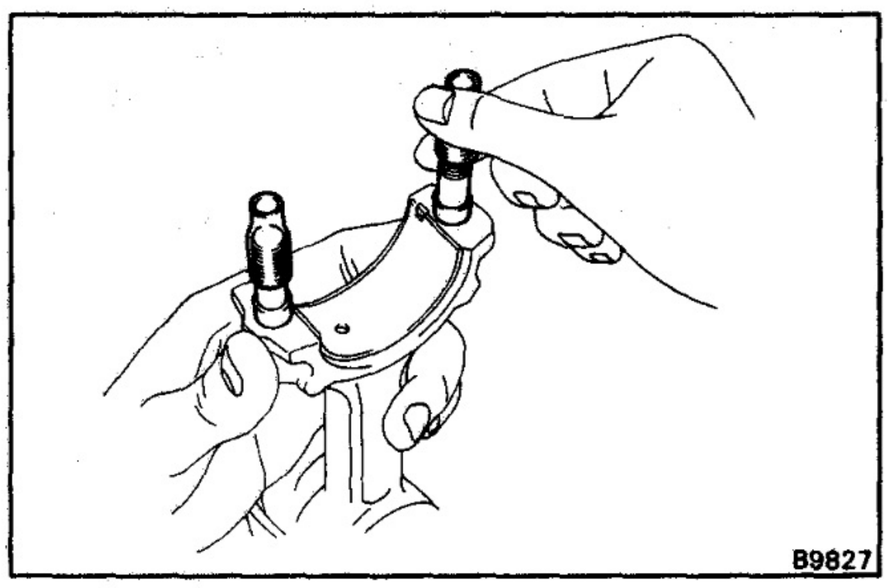
(c) Apply a light coat of engine oil on the threads and under the cap bolt heads.

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

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

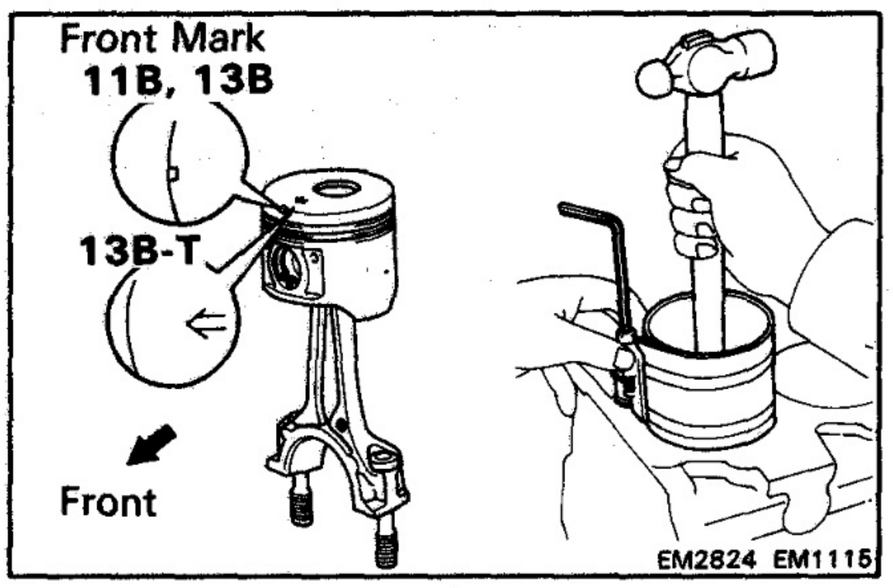
(e) Check that the crankshaft turns smoothly.

(f) Check the crankshaft thrust clearance.
(See page EM-70)

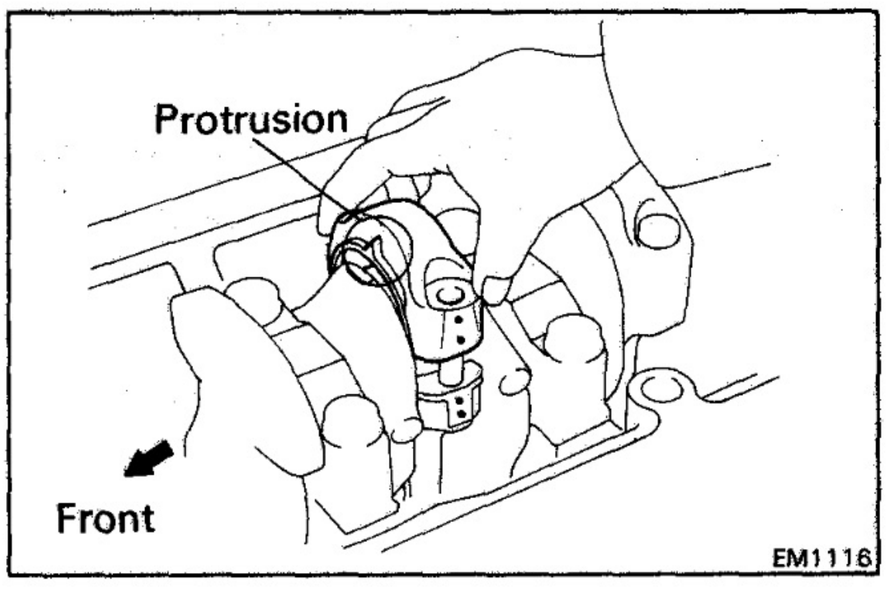


6. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES

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



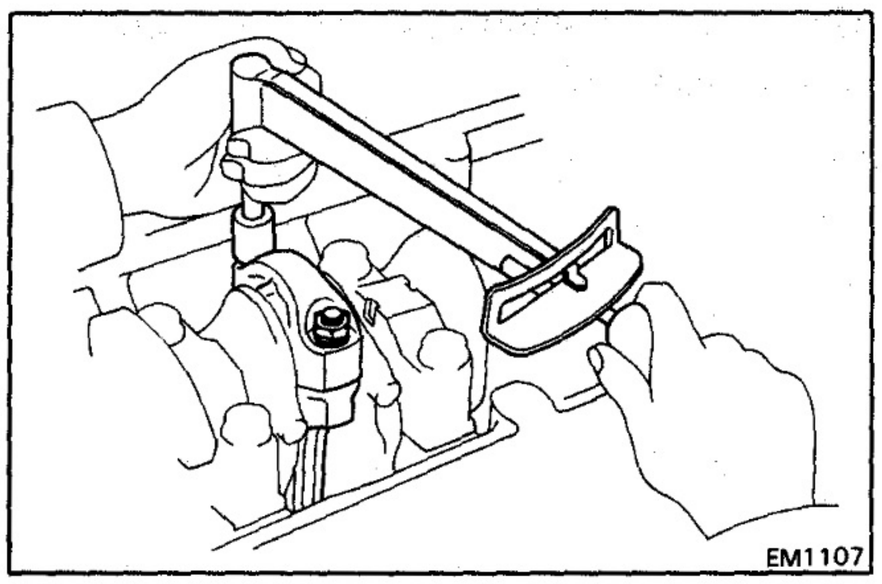
(b) Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.



7. INSTALL CONNECTING ROD CAPS

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

(b) Install the cap with the protrusion facing forward.



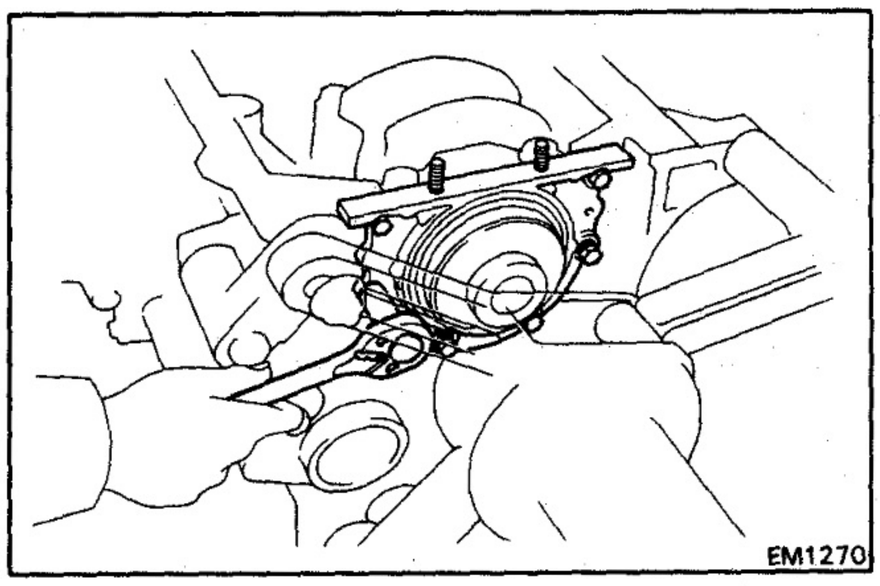
(c) Apply a light coat of the engine oil on the threads and under the cap nuts.

(d) Install and tighten the rod nuts alternately in two or three passes.

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

(e) Check that the crankshaft turns smoothly.

(f) Check the rod thrust clearance.
(See page EM-67)

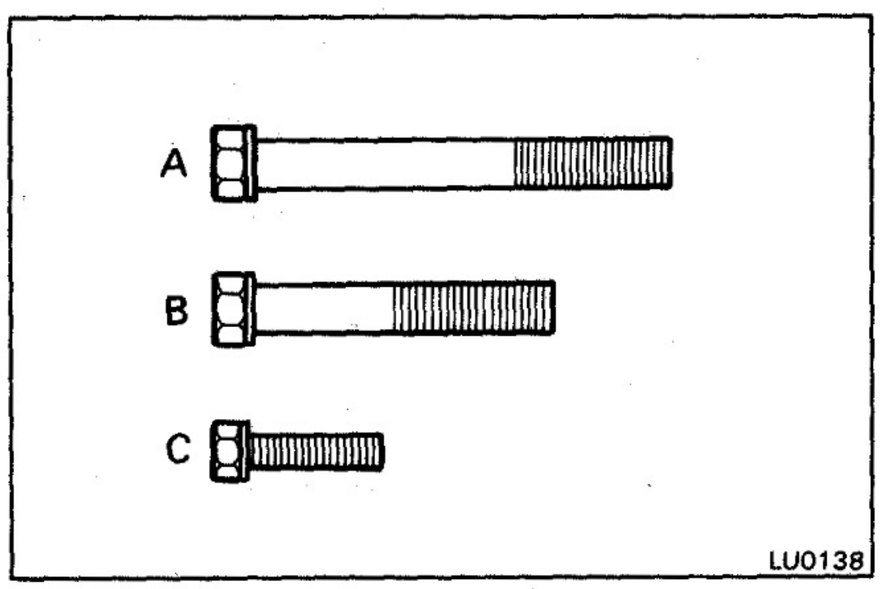


8. INSTALL REAR OIL SEAL RETAINER

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

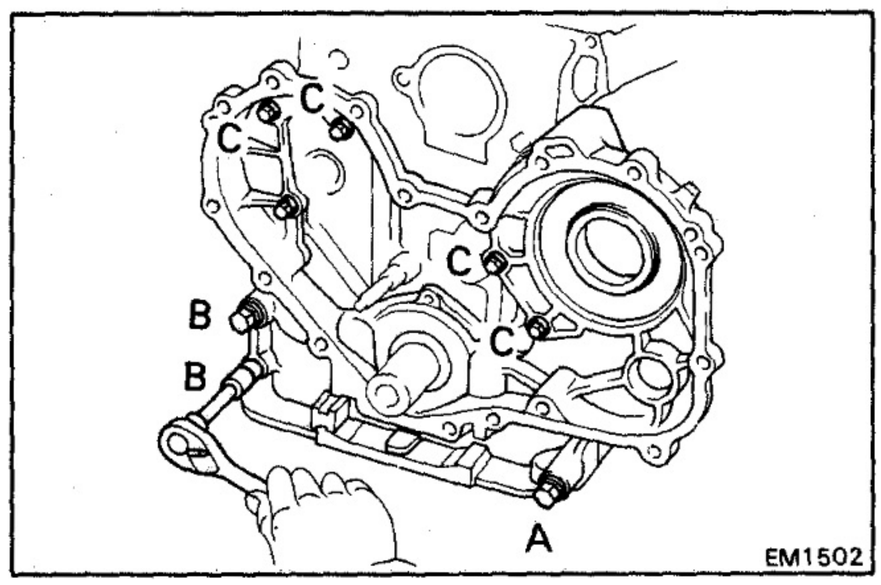
Torque: 185 kg-cm (13 ft-lb, 18 N·m)

9. INSTALL OIL COOLER CASE WITH OIL COOLER
(See steps 2 to 8 on pages LU-16, 17)



10. INSTALL TIMING GEAR CASE

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



Install a new gasket and timing gear case with the eight bolts.

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

11. INSTALL OIL PIPE, OIL STRAINER AND OIL PAN
(See steps 9, 10 on page LU-13)

12. INSTALL TIMING GEARS AND CAMSHAFT
(See steps 1 to 11 on pages EM-61 to 64)

13. INSTALL WATER PUMP
(See page CO-9)

14. INSTALL CYLINDER HEAD
(See page EM-39)

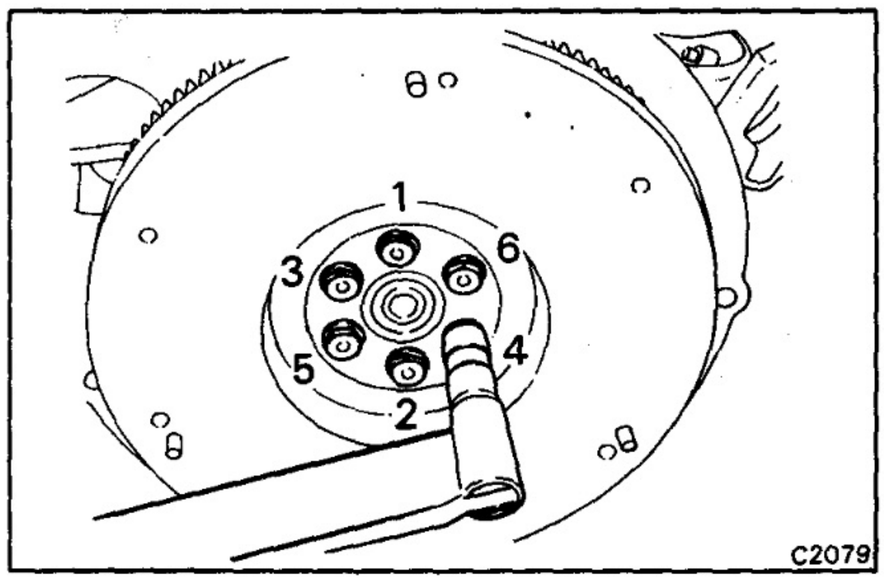
15. INSTALL FUEL FILTER ASSEMBLY

16. INSTALL ALTERNATOR ASSEMBLY

17. INSTALL INJECTION PUMP
(See page FU-73)

18. REMOVE ENGINE FROM ENGINE STAND

19. INSTALL REAR END PLATE



20. INSTALL FLYWHEEL OR DRIVE PLATE

(a) Pace the flywheel or drive plate on the crankshaft.

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

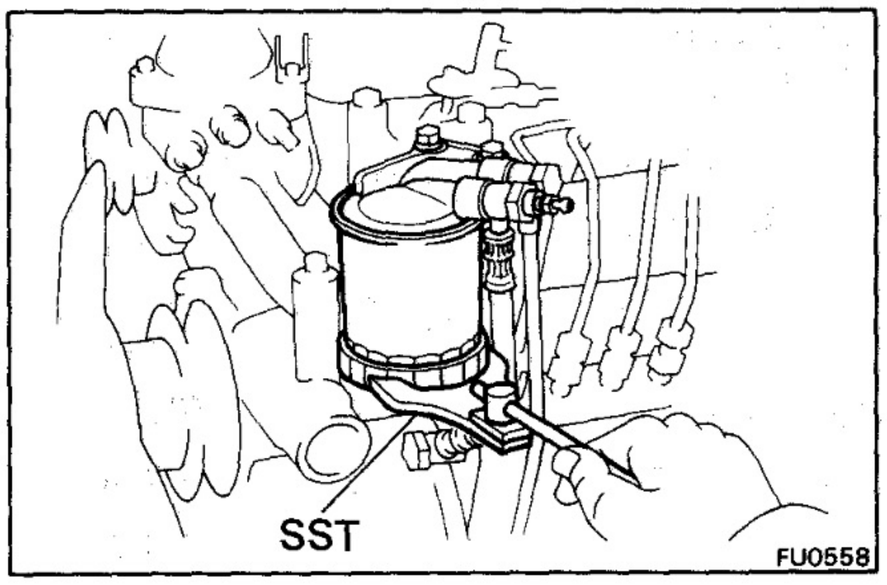
(c) Install and tighten the bolts in several passes, in the sequence shown.

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

FUEL SYSTEM

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

	Page
REPLACEMENT OF FUEL FILTER	FU-2
WATER LEVEL WARNING SWITCH	FU-4
INJECTION NOZZLES	FU-5
FUEL FEED PUMP	FU-11
AUTOMATIC TIMER	FU-16
INJECTION PUMP	FU-20
Removal of Injection Pump	FU-20
Components	FU-23
Disassembly of Injection Pump	FU-26
Inspection and Repair of Injection Pump	FU-40
Assembly of Injection Pump (Pump Body)	FU-45
Adjustment of Injection Pump (Pump Body)	FU-48
Assembly of Injection Pump (Governor)	FU-54
Adjustment of Injection Pump (Governor)	FU-63
Installation of Injection Pump	FU-71

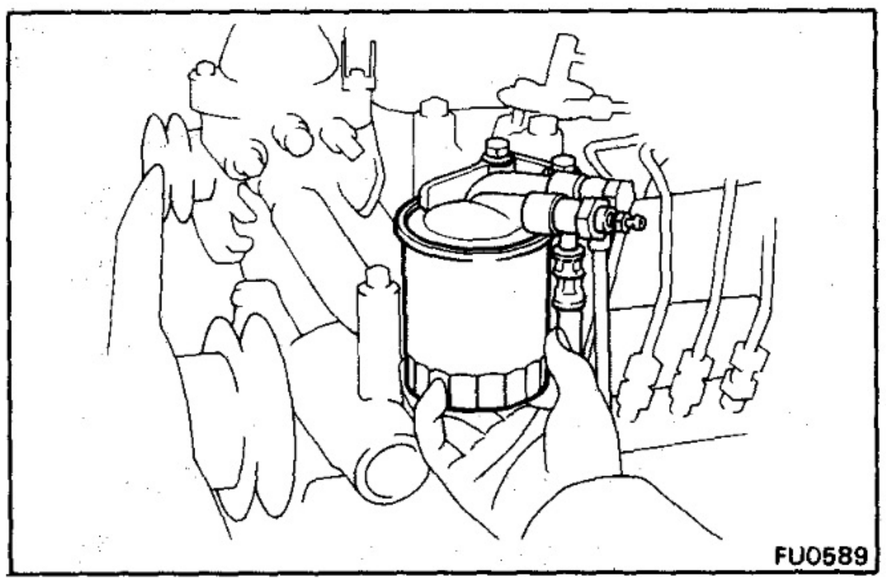


REPLACEMENT OF FUEL FILTER

1. REPLACE FUEL FILTER [CARTRIDGE TYPE]

(a) Using SST, remove the fuel filter and O-ring.

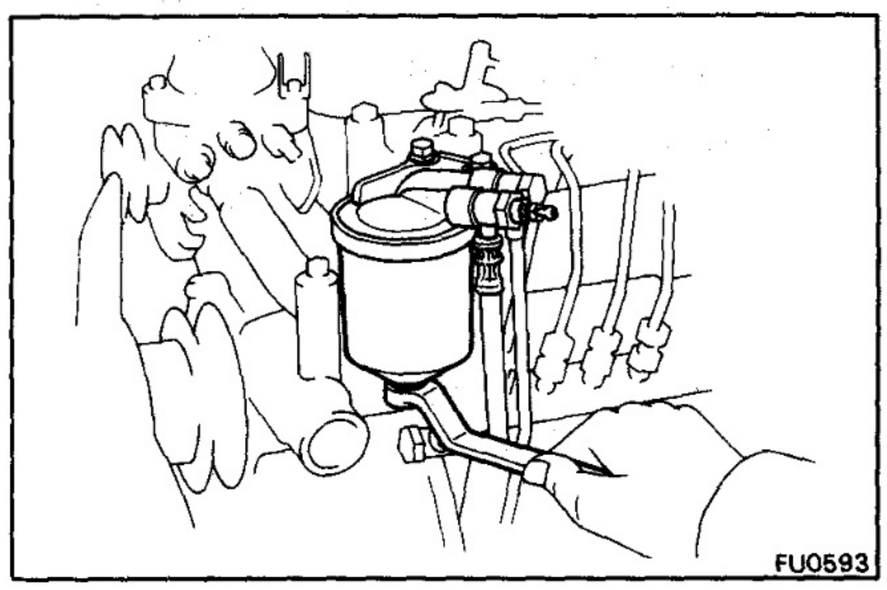
SST 09228-34010



(b) Install a new fuel filter with a new O-ring.

- Put a light coat of fuel on the O-ring.
- Hand tighten only. DO NOT use SST to tighten the filter.

[ELEMENT TYPE]

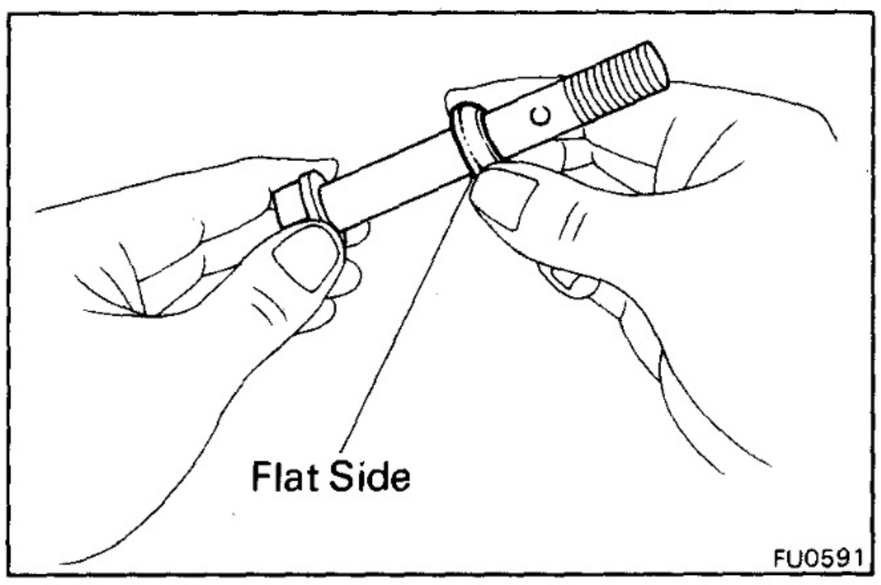


(a) Loosen the center bolt and remove the bolt with the fuel filter lower body assembly.

(b) Remove the upper body gasket from the fuel filter upper body.

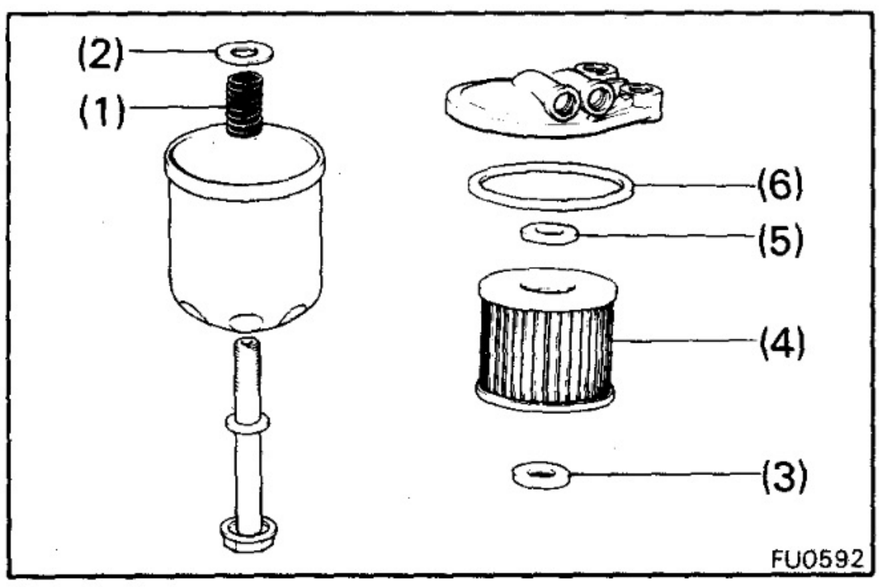
(c) Remove the rubber gaskets, element, spring plate and spring from the lower body.

(d) Remove the O-ring from the center bolt.



(e) Install a new O-ring facing its flat side toward the center bolt head.

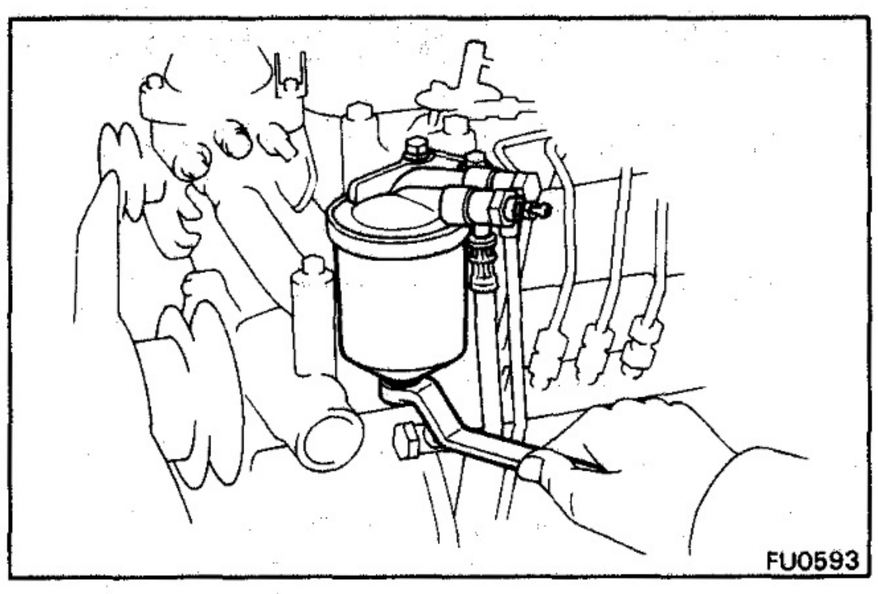
- Put a light coat of fuel on the O-ring.



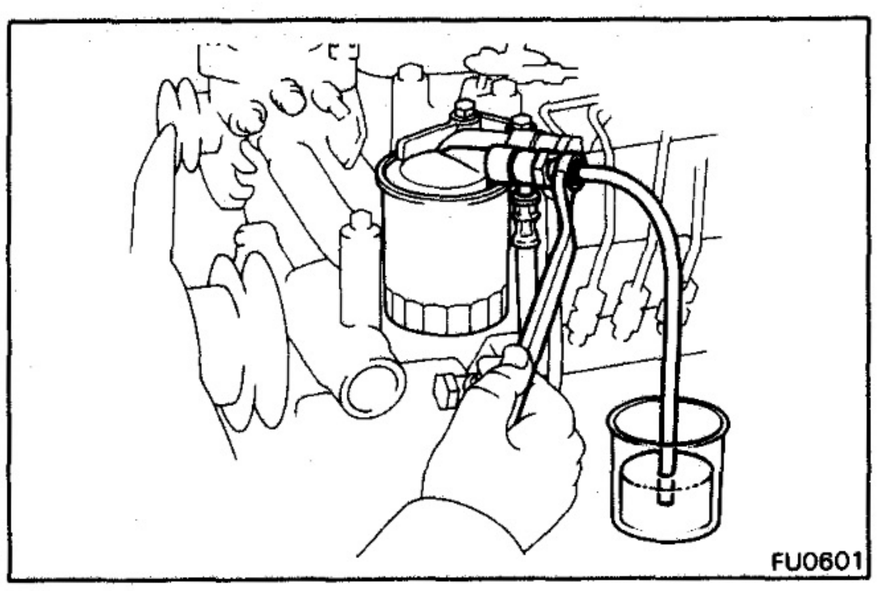
(f) Install the spring (1), spring plate (2), a new rubber gasket (3), a new element (4) and a new rubber gasket (5) to the lower body.

(g) Install a new upper body gasket (6) to the upper body.

- Put a light coat of fuel on the body gasket.



(h) Install the fuel filter lower body assembly with the center bolt.

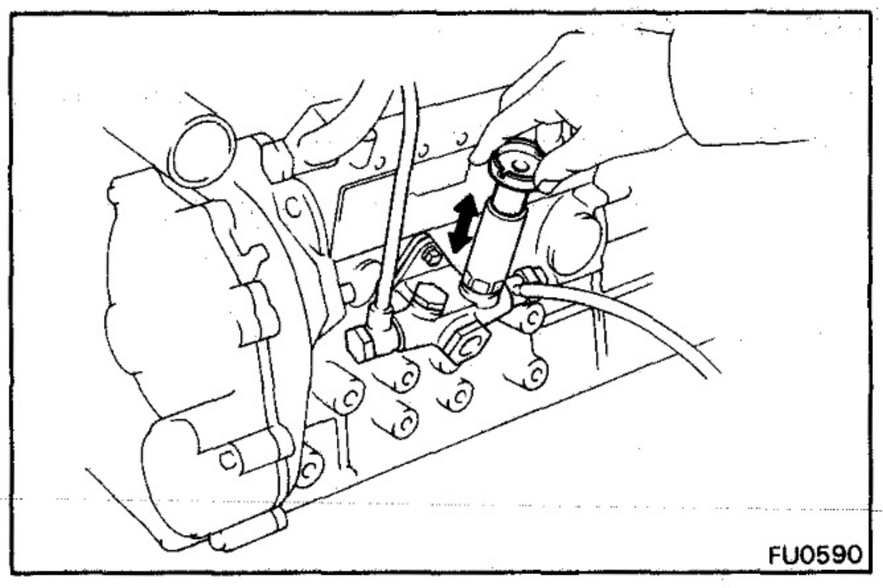


2. BLEED FUEL FILTER

(a) Connect a vinyl tube to the fuel filter bleeder plug.

(b) Insert other end of the tube in a container of fuel.

(c) Loosen the fuel filter bleeder plug.



(d) Turn the priming pump handle counterclockwise to free it.

(e) Operate the priming pump handle until there are no air bubbles emitted from the fuel filter bleeder plug.

(f) Turn the priming pump handle clockwise and tighten it.

(g) Tighten the fuel filter bleeder plug.

3. START ENGINE AND CHECK FOR FUEL LEAKS

WATER LEVEL WARNING SWITCH

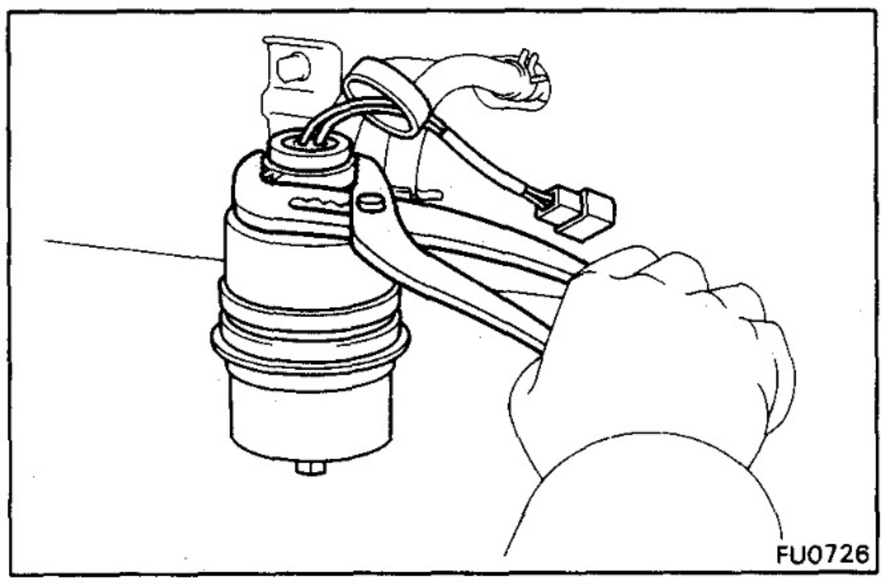
INSPECTION OF WATER LEVEL WARNING SWITCH

1. DISCONNECT WARNING SWITCH CONNECTOR

2. DRAIN FUEL FROM SEDIMENTER

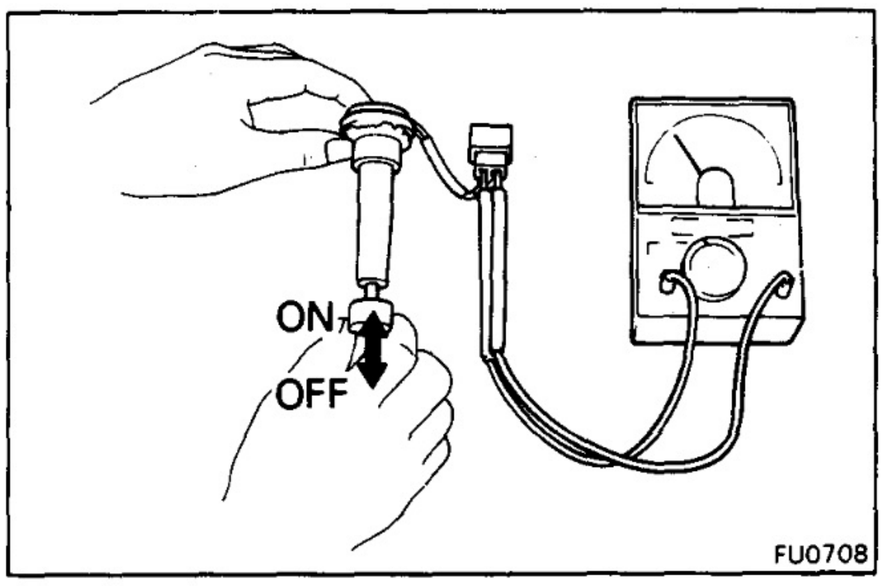
Remove the air vent plug and drain plug.

NOTE: Put a suitable container or shop towel under the sedimenter.



3. REMOVE WARNING SWITCH FROM SEDIMENTER

Using pliers, remove the warning switch.

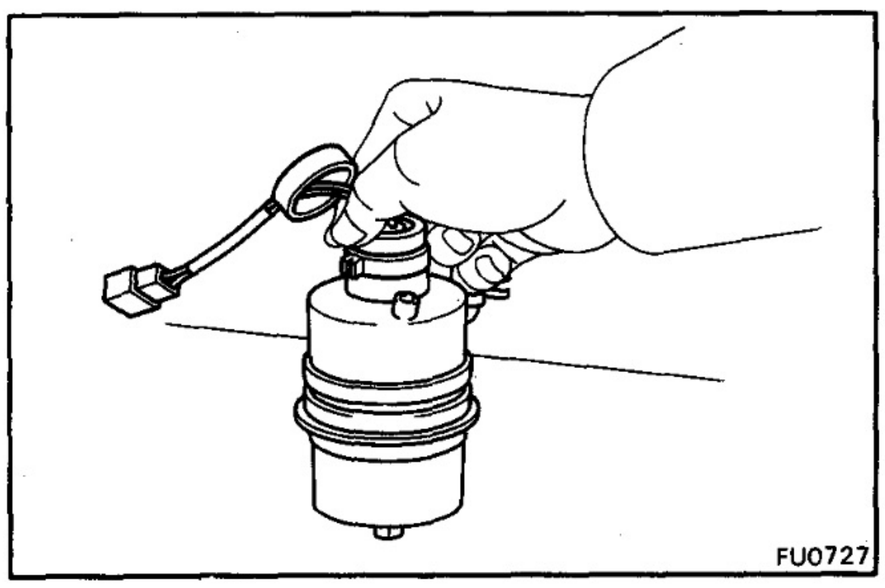


4. INSPECT WARNING SWITCH

(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.



5. INSTALL WARNING SWITCH

Install the warning switch with a new O-ring.

- Put a light coat of fuel on the O-ring.
- Hand tighten only. DO NOT use pliers to tighten the filter.

6. INSTALL DRAIN PLUG AND AIR VENT PLUG WITH NEW GASKETS

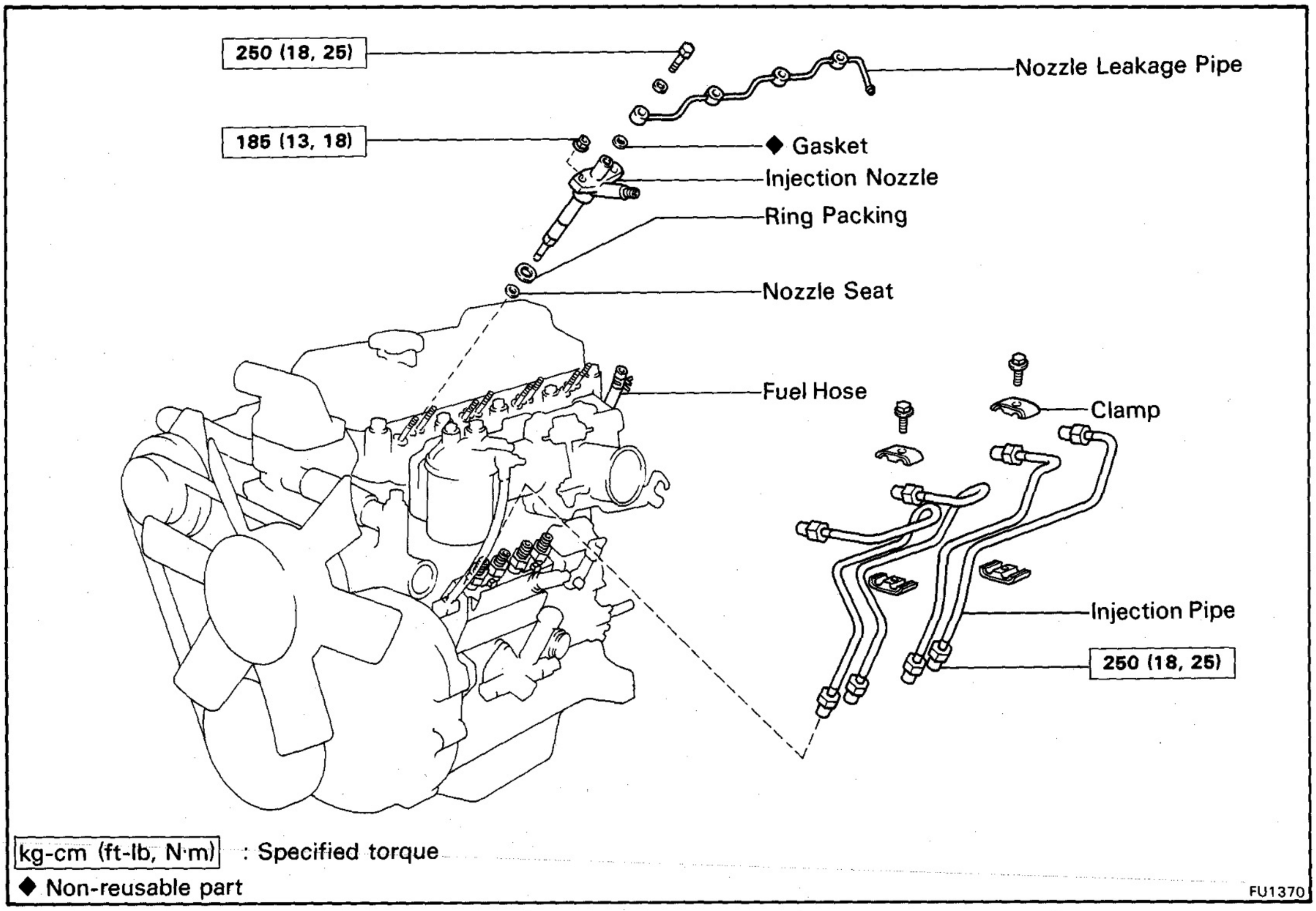
7. CONNECT WARNING SWITCH CONNECTOR

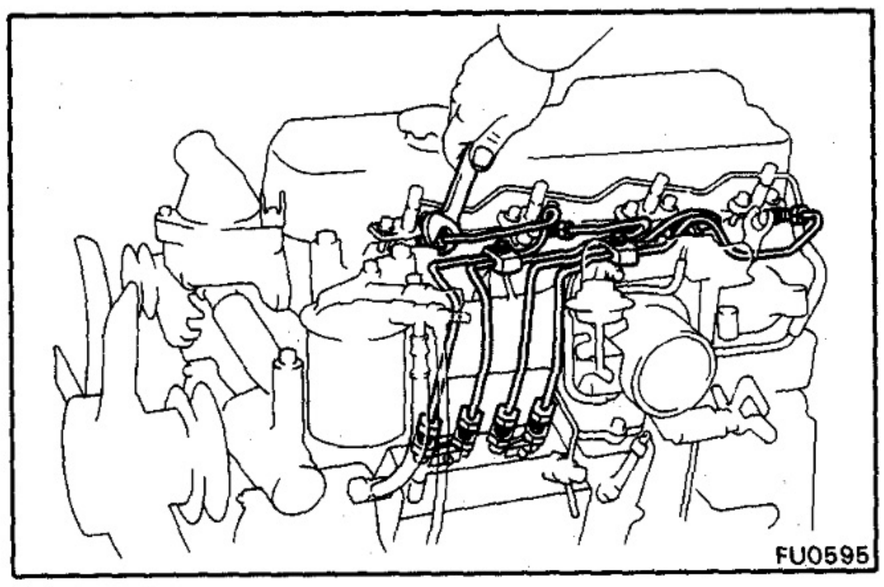
8. BLEED AIR IN SEDIMENTER FROM FUEL FILTER
(See step 2 on page FU-3)

9. START ENGINE AND CHECK FOR FUEL LEAKS

INJECTION NOZZLES

REMOVAL AND TEST OF INJECTION NOZZLES



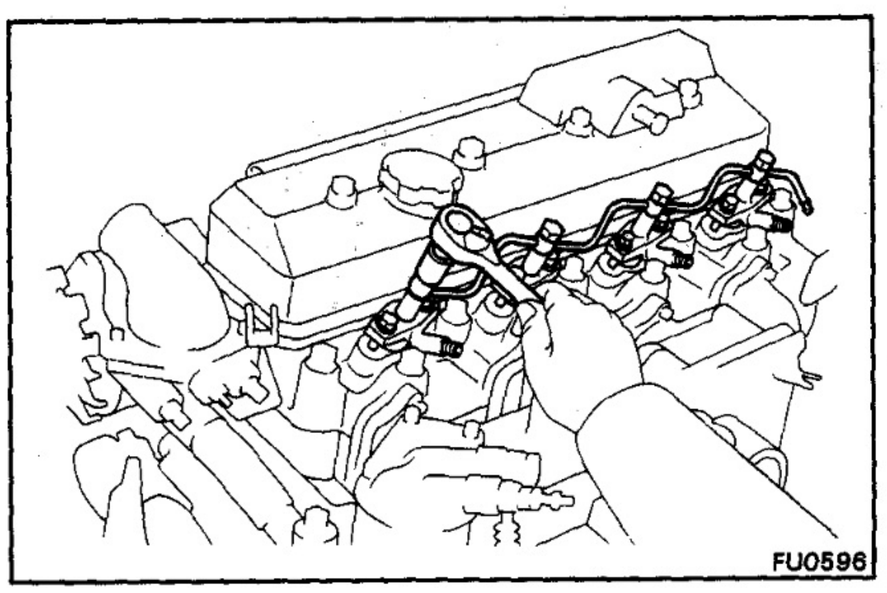


1. [13B-T]
REMOVE INTAKE AIR CONNECTOR PIPE

2. REMOVE INJECTION PIPES

(a) Remove the two bolts holding the four injection pipes to the intake manifold and remove the two upper clamps.

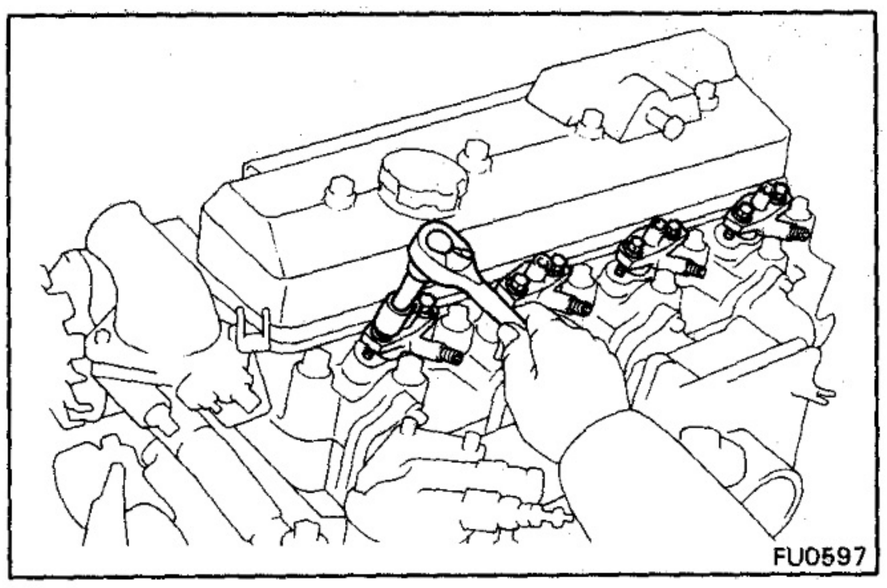
(b) Remove the four injection pipes and two lower clamps.



3. REMOVE NOZZLE LEAKAGE PIPE

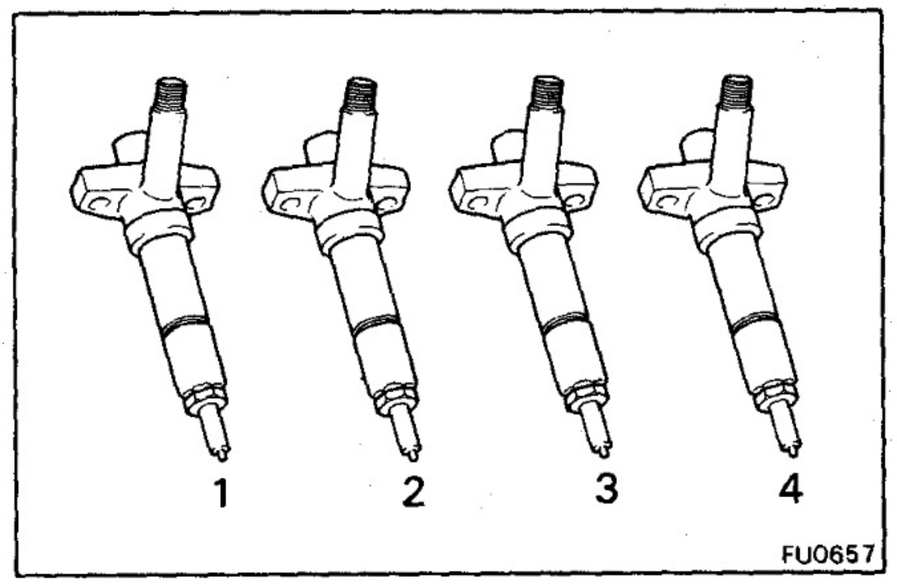
(a) Disconnect the fuel hose from the leakage pipe.

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

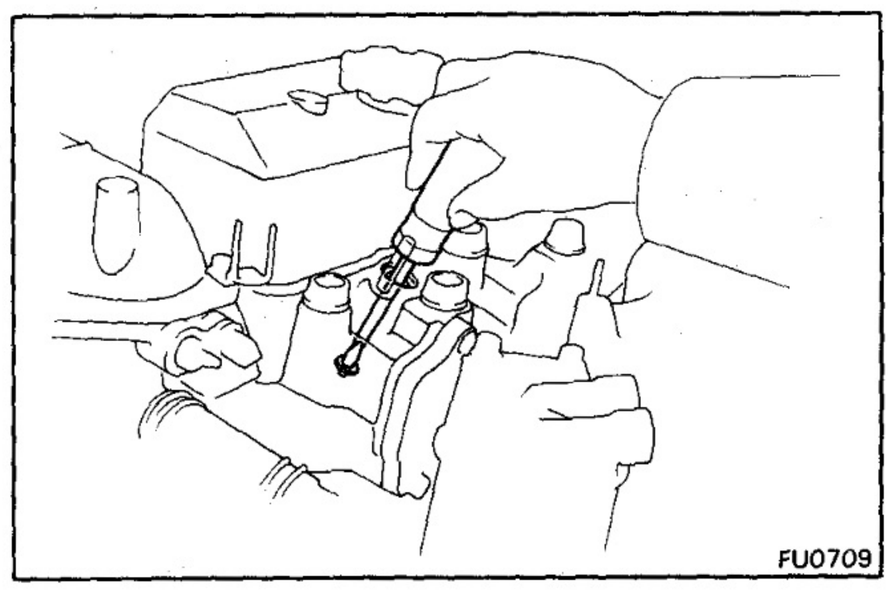


4. REMOVE INJECTION NOZZLES

Remove the holding nuts, nozzle and ring packing.

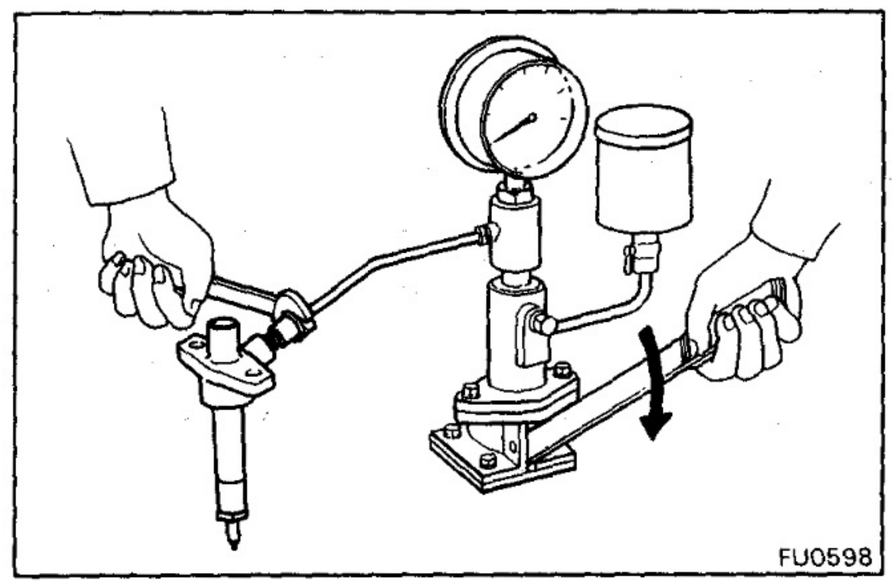


NOTE: Arrange the nozzles in order.



5. IF NECESSARY, REMOVE FOUR NOZZLE SEATS

Using a screwdriver, remove the nozzle seat.



6. INJECTION PRESSURE TEST

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

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

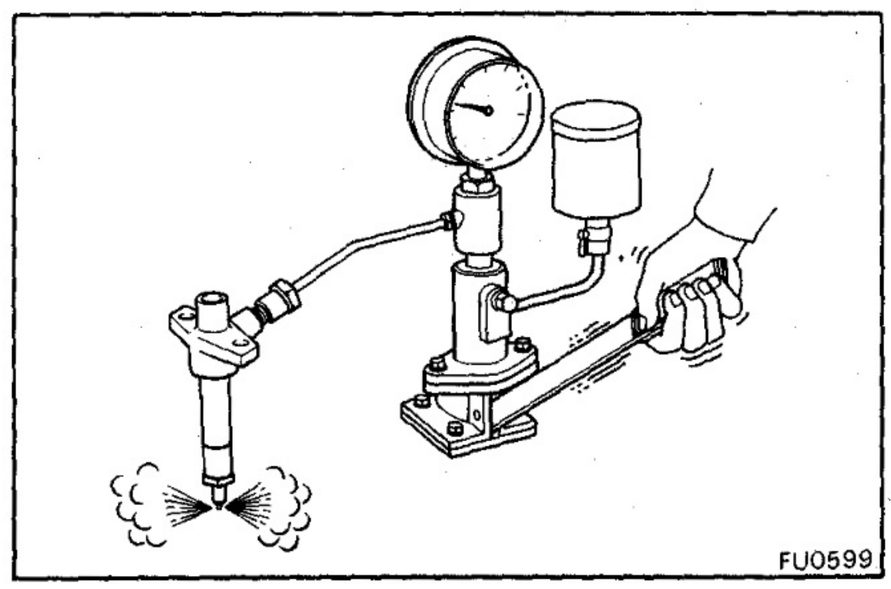
(b) Pump the tester handle a few times as fast as possible by hand to discharge the carbon from the injection hole.

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

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

Opening pressure: 200 – 210 kg/cm² (2,845 – 2,987 psi) (19,613 – 20,594 kPa)

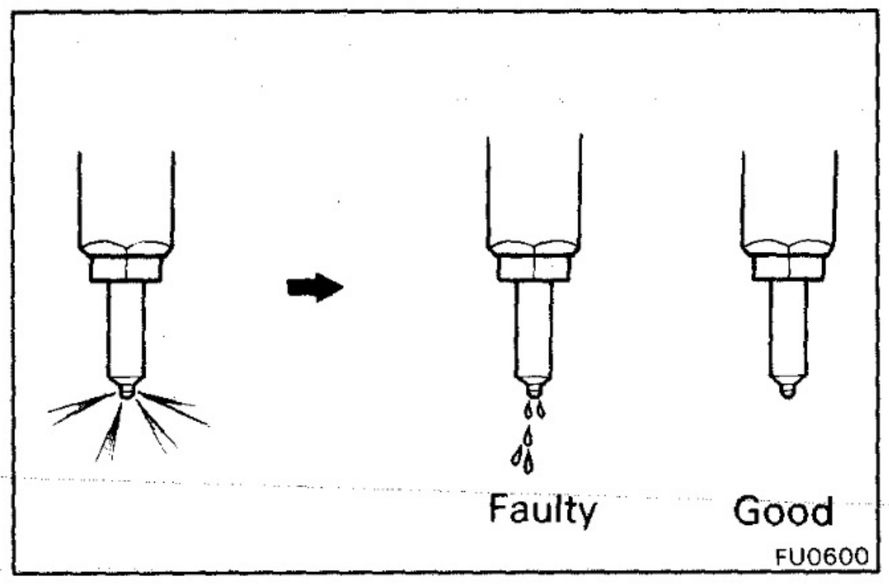
NOTE: Proper nozzle operation can be determined by a "swishing" sound.



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

If the below the specified value, use a thicker washer. If above, use a thinner washer.

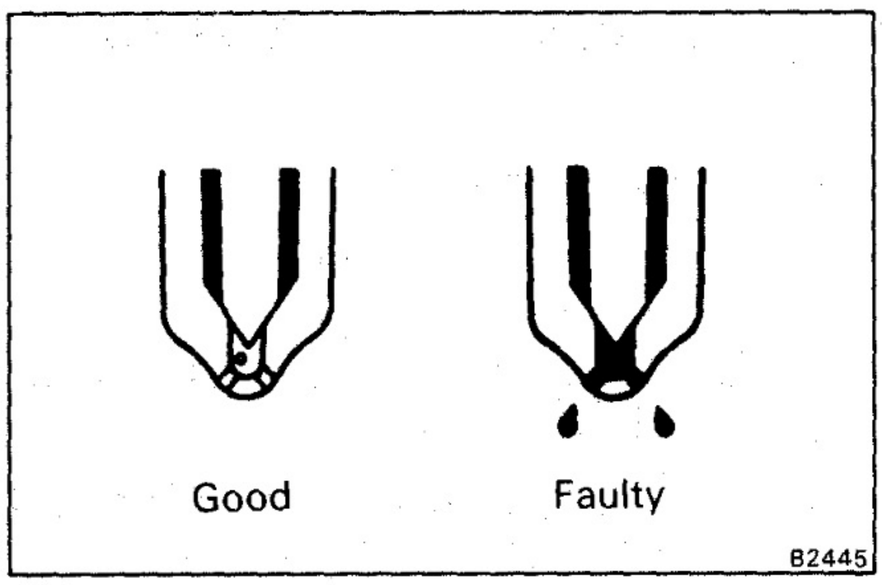
Adjusting shim thickness mm (in.)	
0.700 (0.0276)	1.250 (0.0492)
0.750 (0.0295)	1.275 (0.0502)
0.800 (0.0315)	1.300 (0.0512)
0.850 (0.0335)	1.325 (0.0522)
0.900 (0.0354)	1.350 (0.0531)
0.950 (0.0374)	1.375 (0.0541)
0.975 (0.0384)	1.400 (0.0551)
1.000 (0.0394)	1.425 (0.0561)
1.025 (0.0404)	1.450 (0.0571)
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)



NOTE:

- 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.

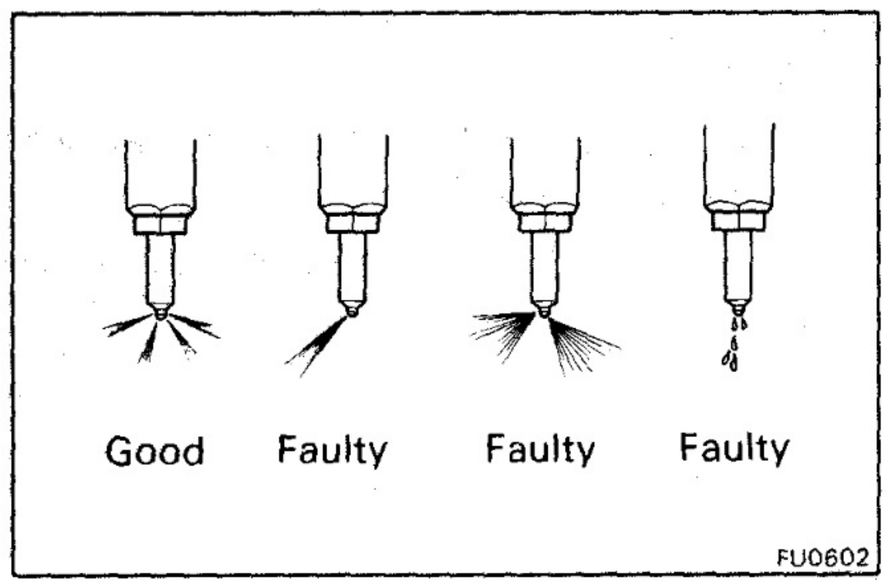
(e) There should be no dripping after injection.



7. 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.



8. SPRAY PATTERN TEST

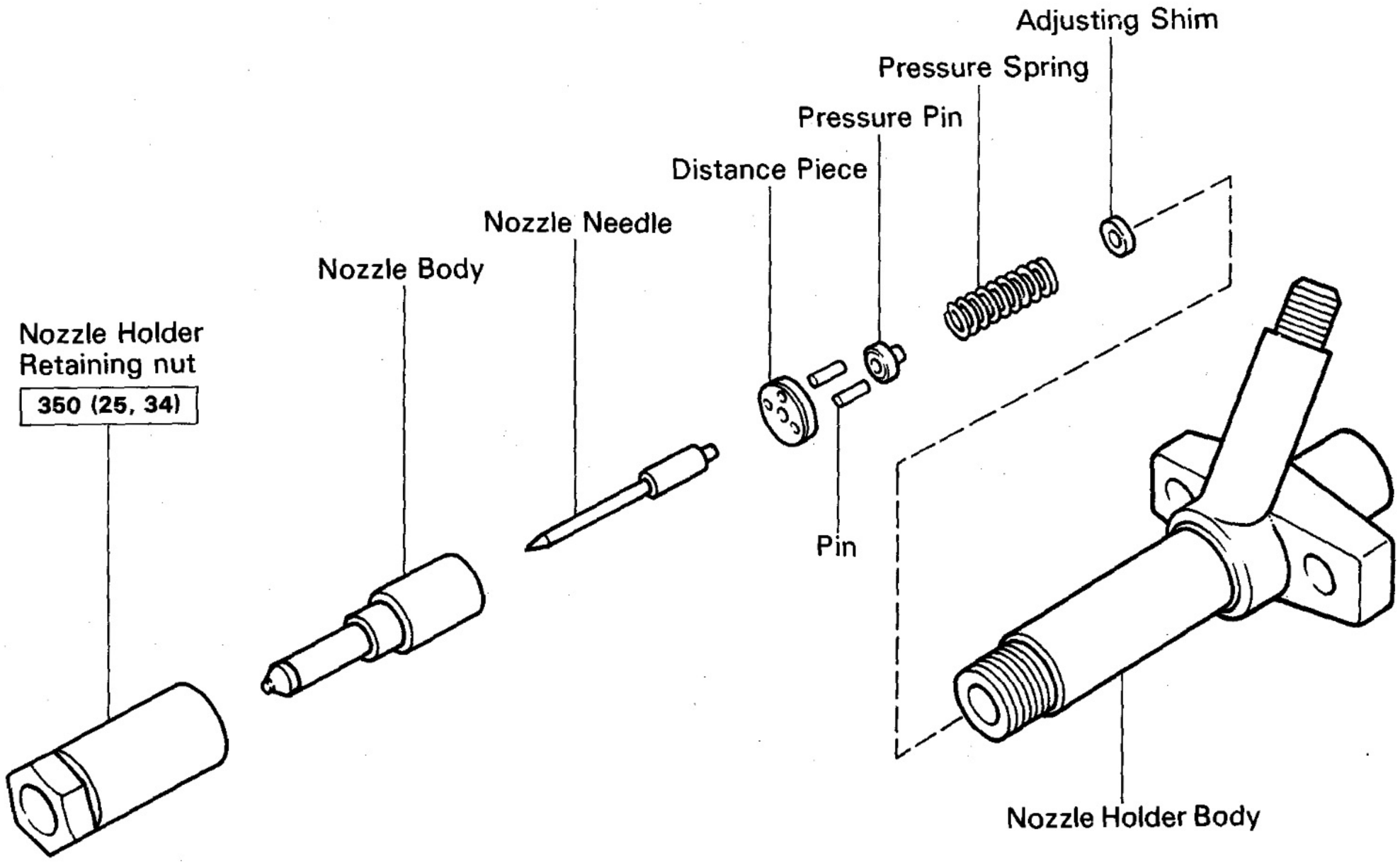
(a) The injection nozzle should shudder at a pumping speed between 15 – 60 times (old nozzle) or 30 – 60 times (new nozzle) per minute.

(b) Check the spray pattern during shuddering.

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

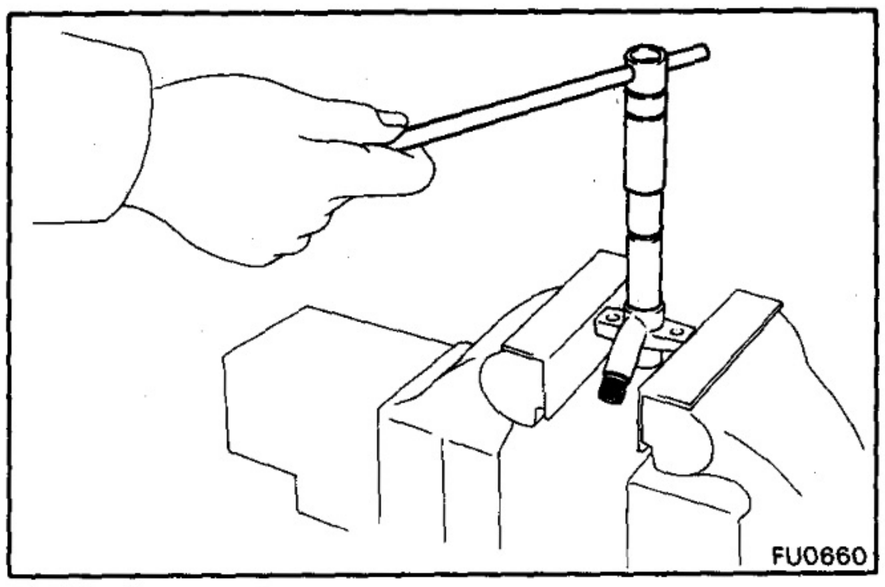
NOTE: The 11B engine has 5 spray orifices and the 13B and 13B-T engines have 4 spray orifices.

COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

FU1369



FU0660

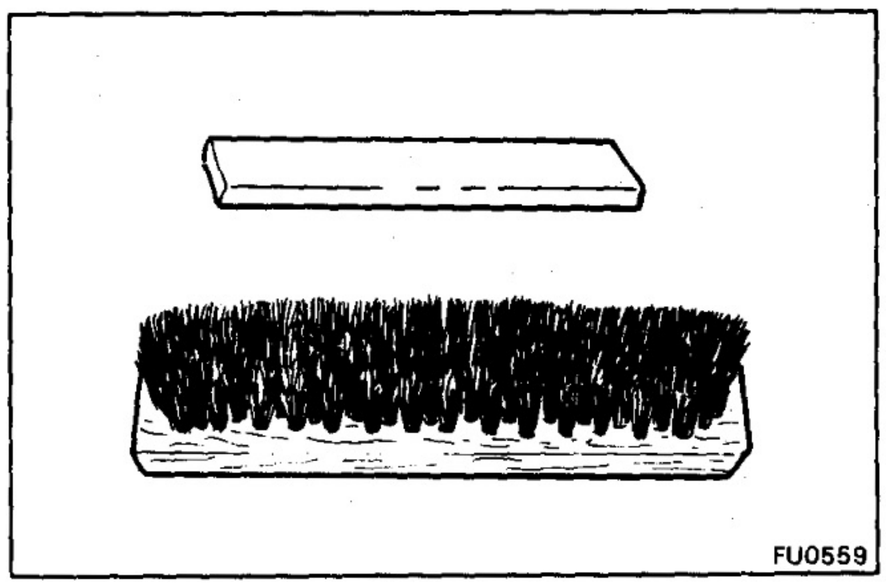
DISASSEMBLY, CLEANING AND TEST OF INJECTION NOZZLE

1. DISASSEMBLE INJECTION NOZZLE

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

CAUTION: 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 nozzle assembly.

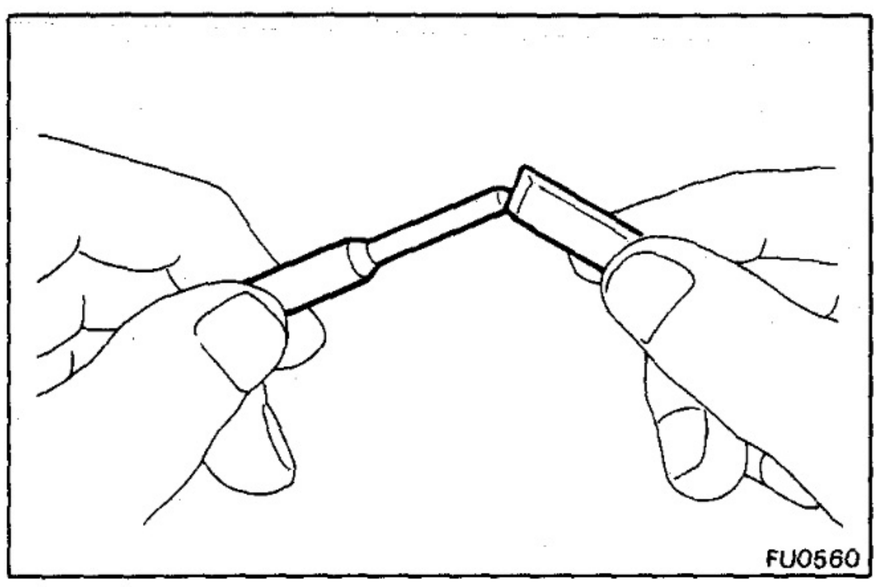


FU0559

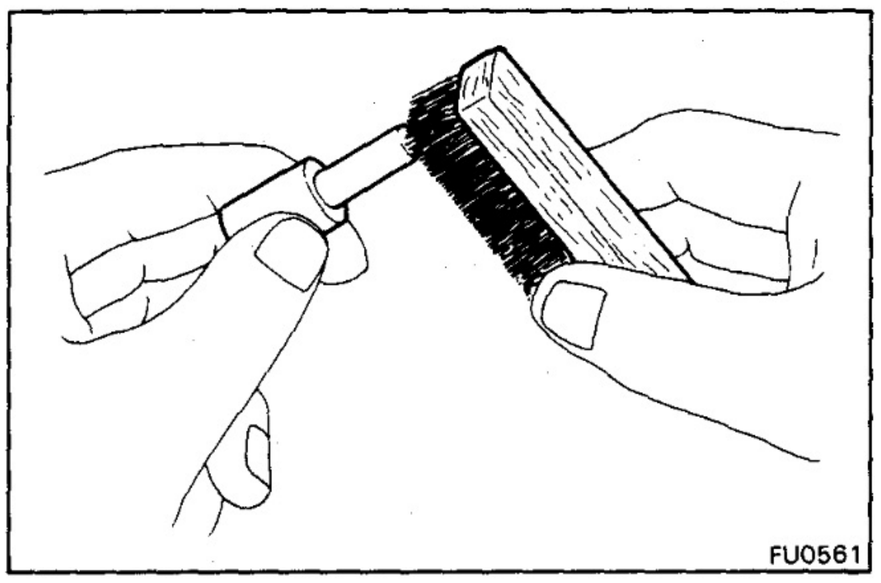
2. NOZZLE CLEANING

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

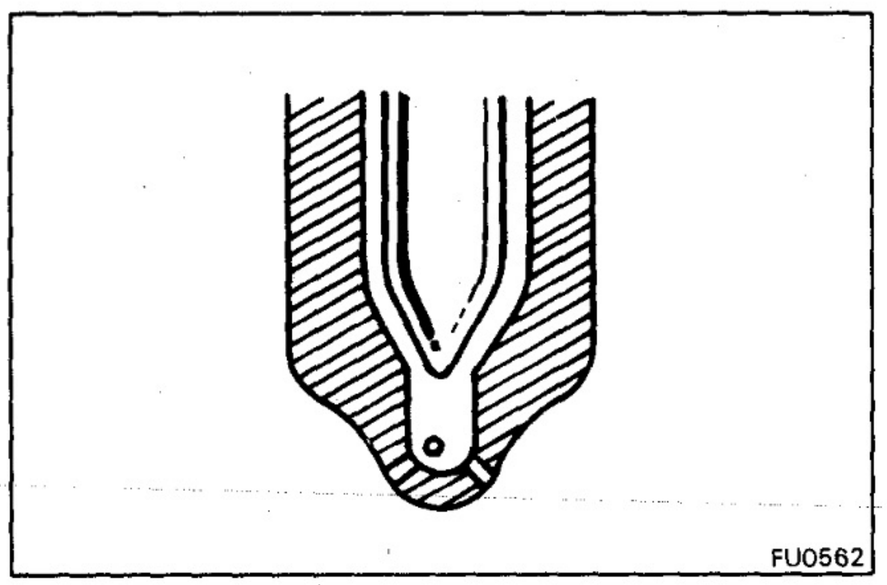
NOTE: Do not touch the nozzle mating surfaces with your fingers.


FU0560

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


FU0561

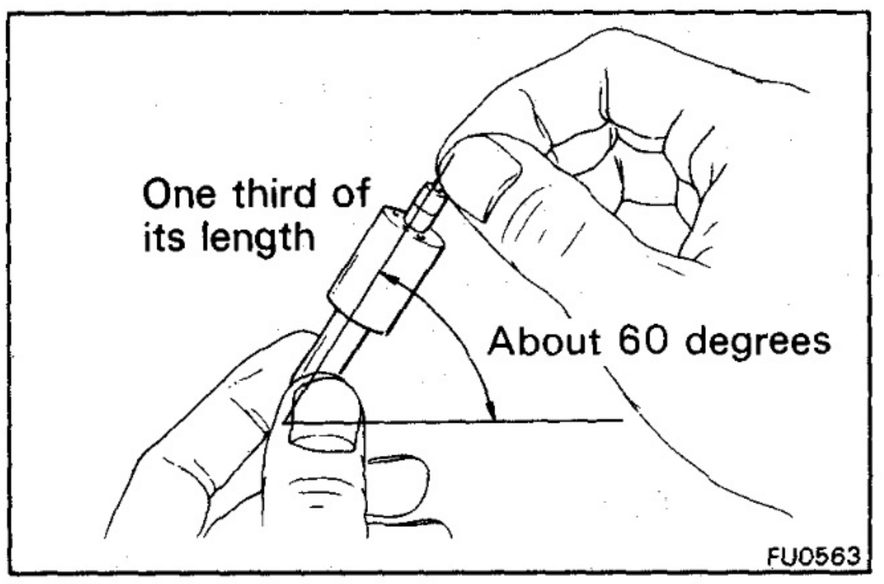
(c) Using a brass brush, remove the carbon from the exterior of the nozzle body.


FU0562

(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.



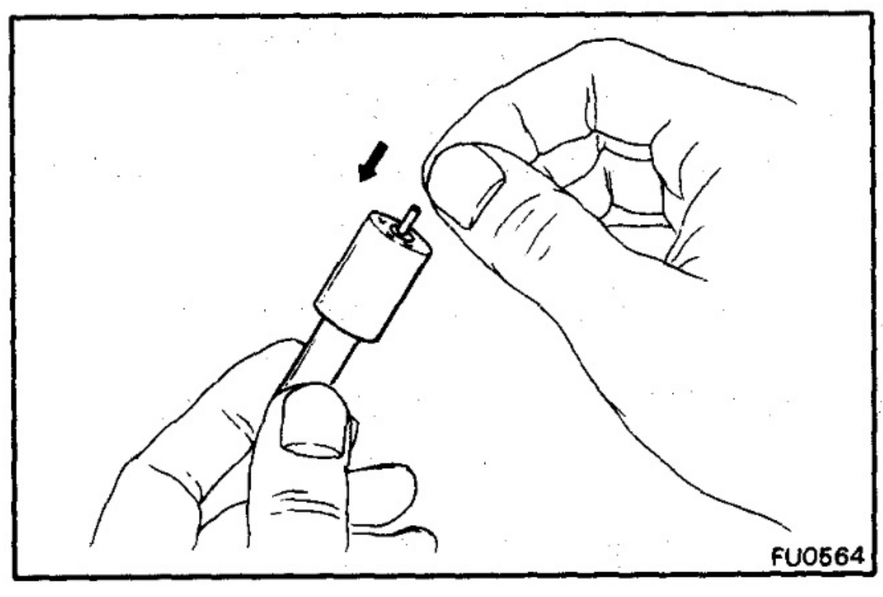
FU0563

3. SINKING TEST

(a) Wash the nozzle in clean diesel fuel.

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

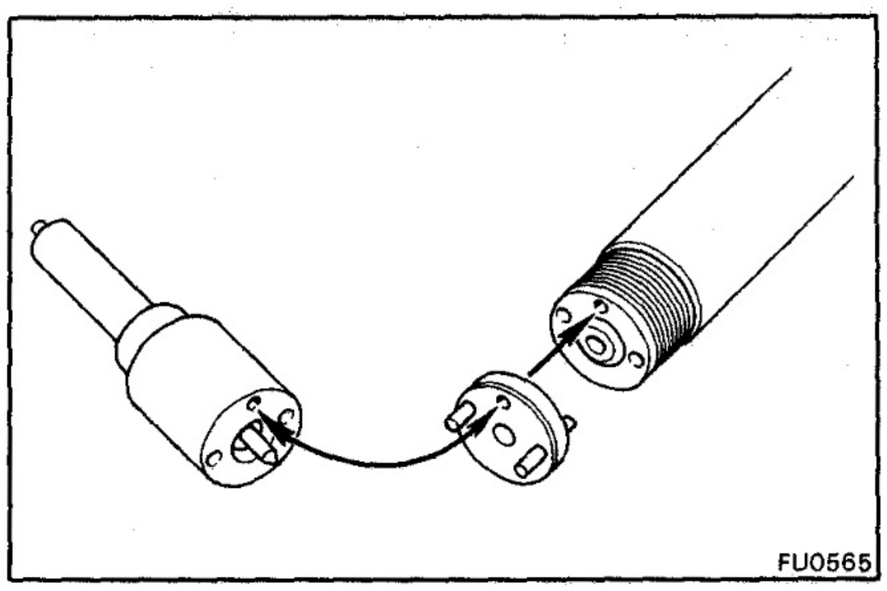
(b) Tilt the nozzle body about 60 degrees and pull the needle out about one third of its length.

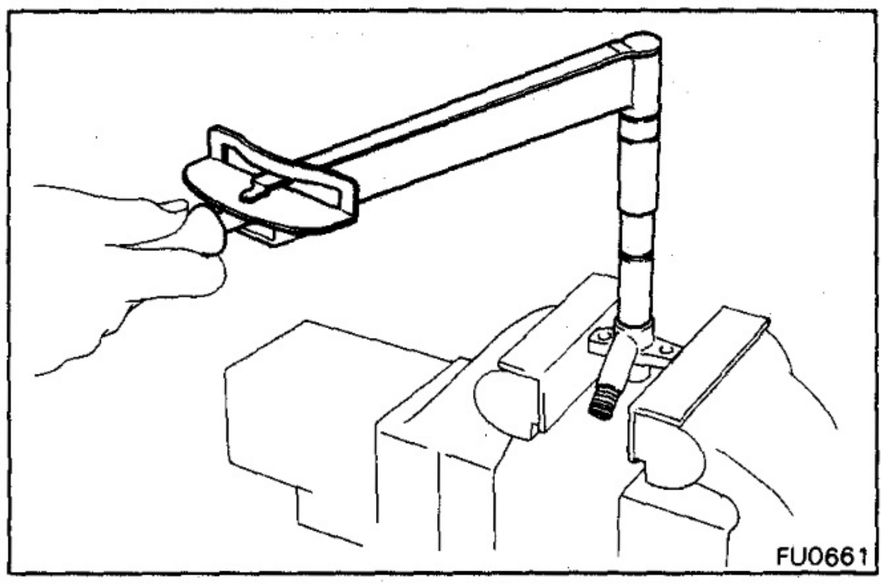

FU0564

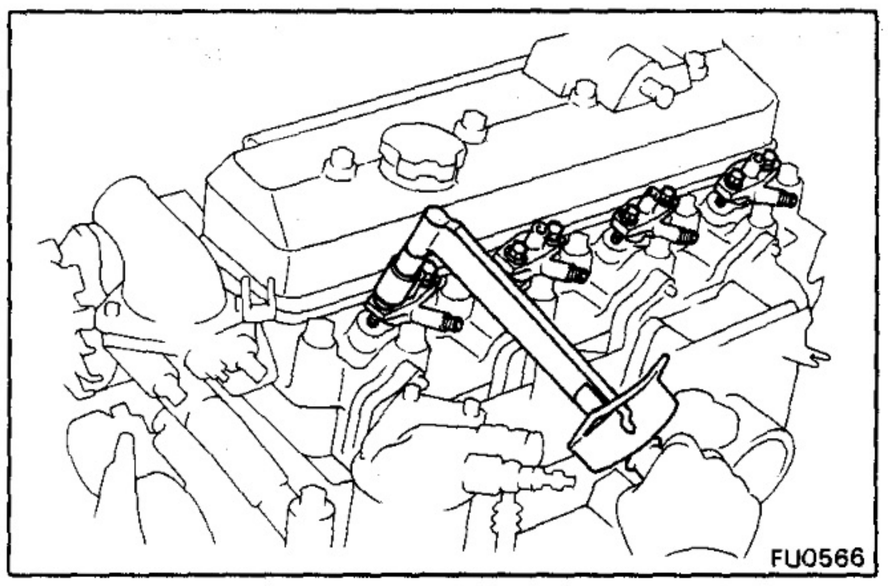
(c) When released, the needle should sink down into the body vent smoothly by its own weight.

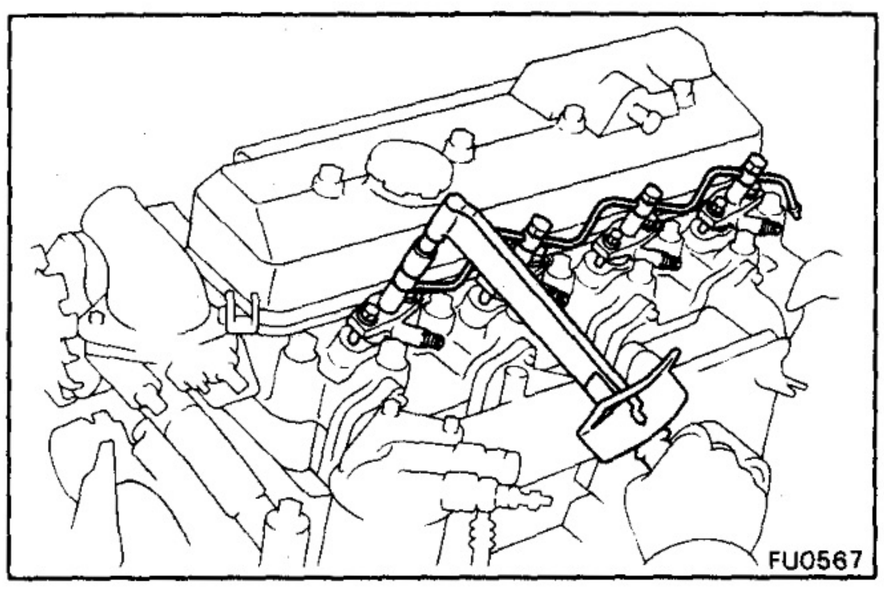
(d) Repeat this test, rotating the needle slightly each time.

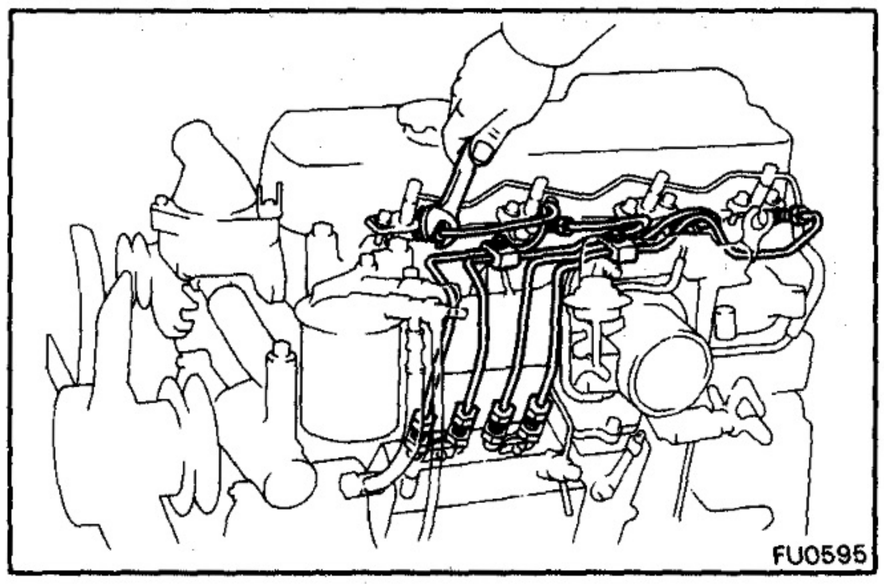
If the needle does not sink freely, replace the nozzle assembly.


FU0565


FU0661


FU0566


FU0567


FU0595

ASSEMBLY AND INSTALLATION OF INJECTION NOZZLE

(See page FU-8)

1. ASSEMBLE INJECTION NOZZLE

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

NOTE: 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 6 to 8 on pages FU-6, 7)

3. INSTALL INJECTION NOZZLES

(a) Install the ring packing to the nozzle.

(b) Place the four nozzle seats and nozzles in the cylinder head.

(c) Install and tighten the nuts alternately in two or three passes.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

4. INSTALL NOZZLE LEAKAGE PIPE

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

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

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

5. INSTALL INJECTION PIPES

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

(b) Install and torque the four injection pipes.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

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

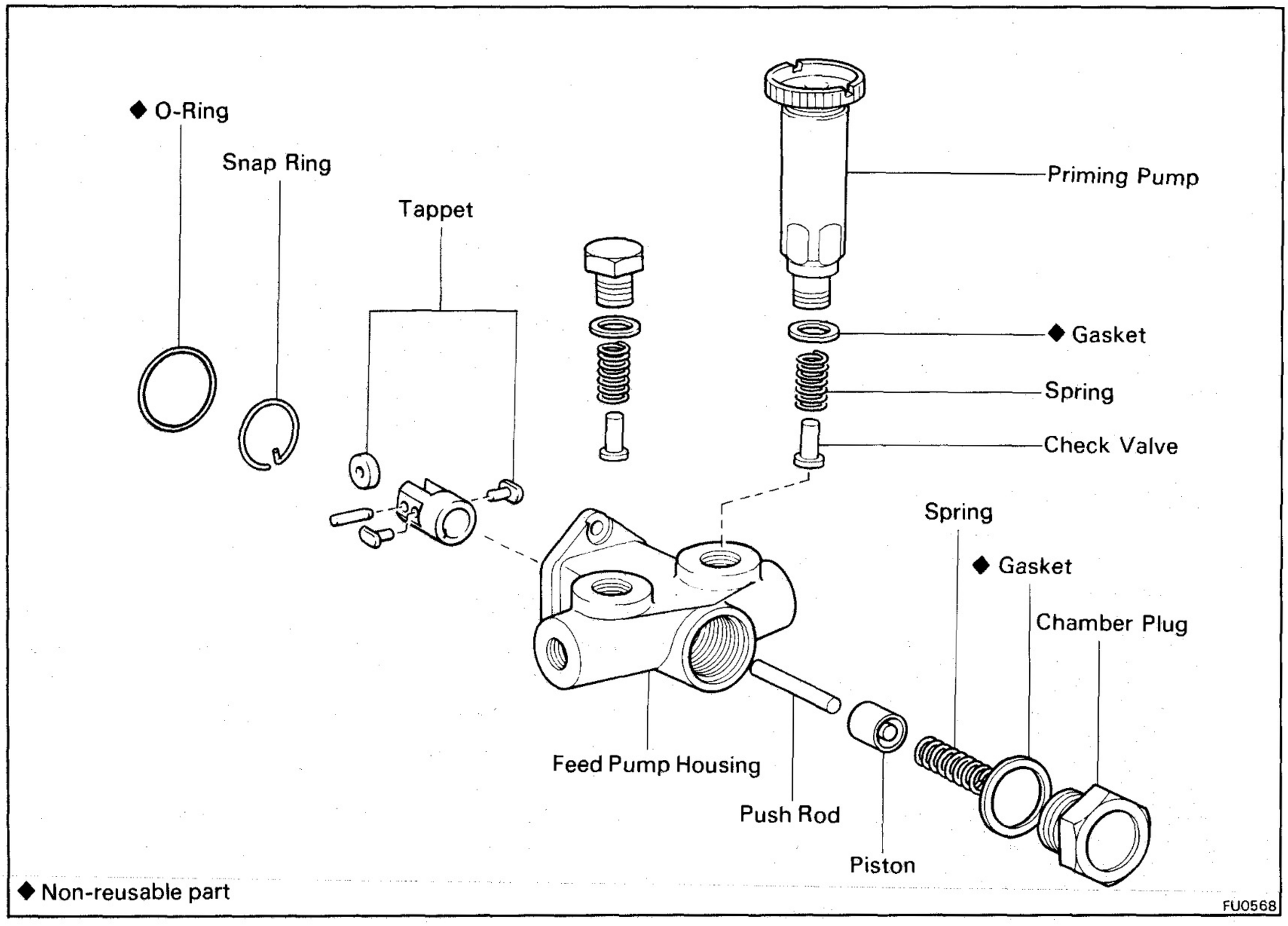
6. BLEED FUEL LINE (See step 10 on page FU-71)

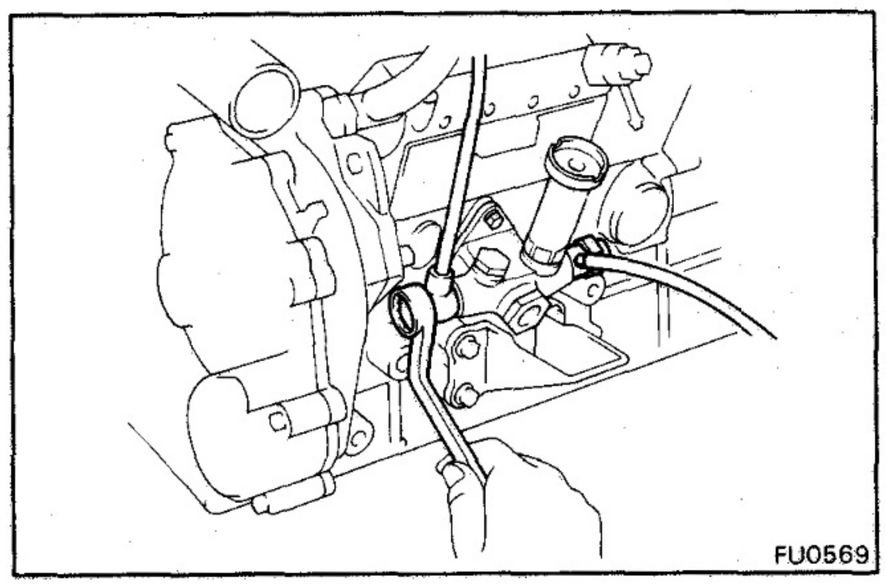
7. START ENGINE AND CHECK FOR FUEL LEAKS

8. [13B-T] INSTALL INTAKE AIR CONNECTOR PIPE

FUEL FEED PUMP

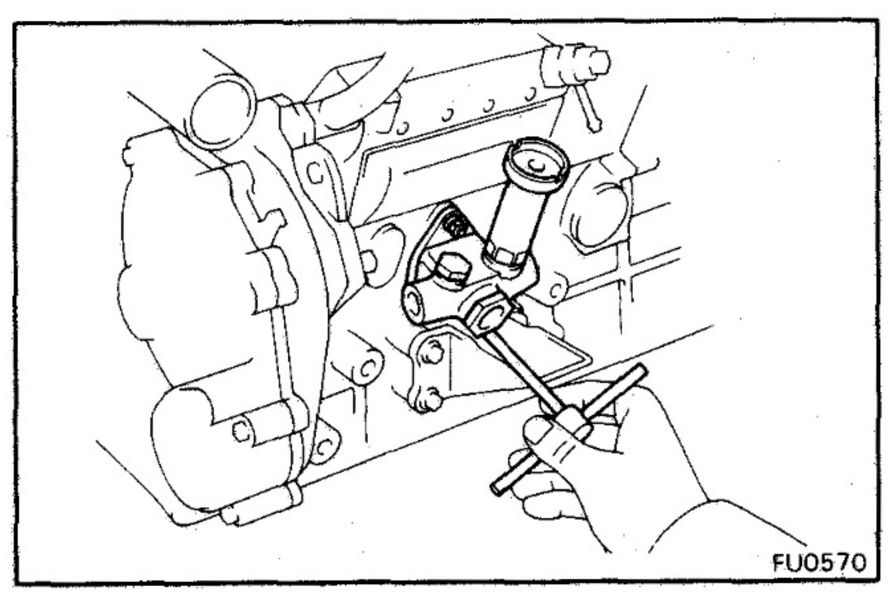
COMPONENTS





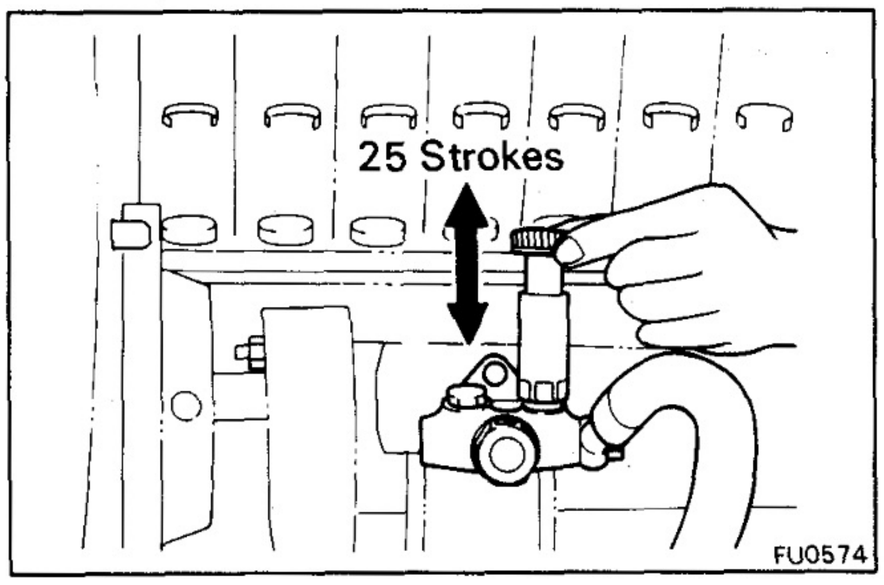
REMOVAL AND TEST OF FUEL FEED PUMP

1. DISCONNECT INLET AND OUTLET FUEL PIPES FROM FUEL FEED PUMP



2. REMOVE FUEL FEED PUMP FROM INJECTION PUMP

Remove the three nuts, spring washers and feed pump.



3. SUCTION TEST

(a) Mount the feed pump on the pump tester.

(b) Connect a suction pipe with the following specifications:

Pipe inner diameter: **8 mm (0.31 in.)**
Pipe length: **2 m (78.7 in.)**
Suction height: **1 m (39.4 in.)**

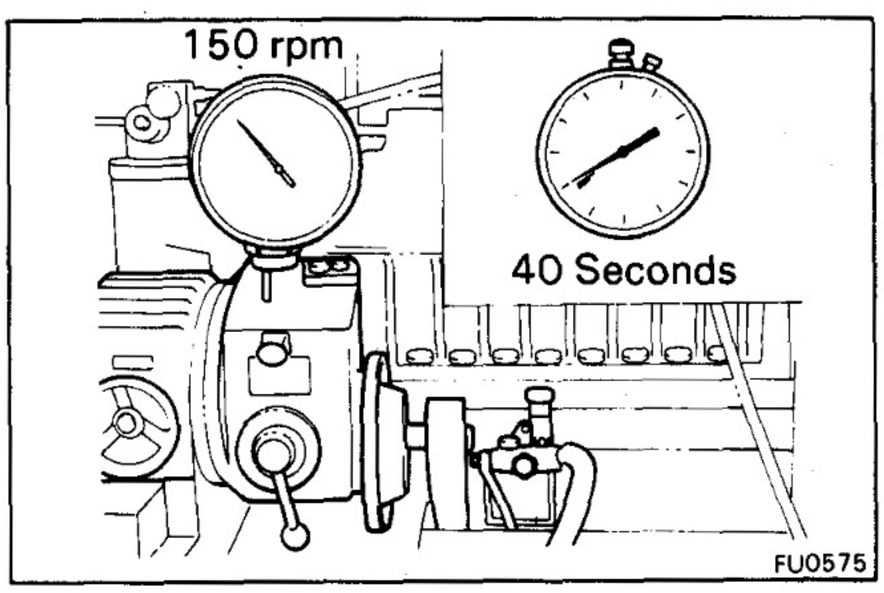
(c) Operate the priming pump 60 strokes per minute and count the number of strokes before fuel is discharged.

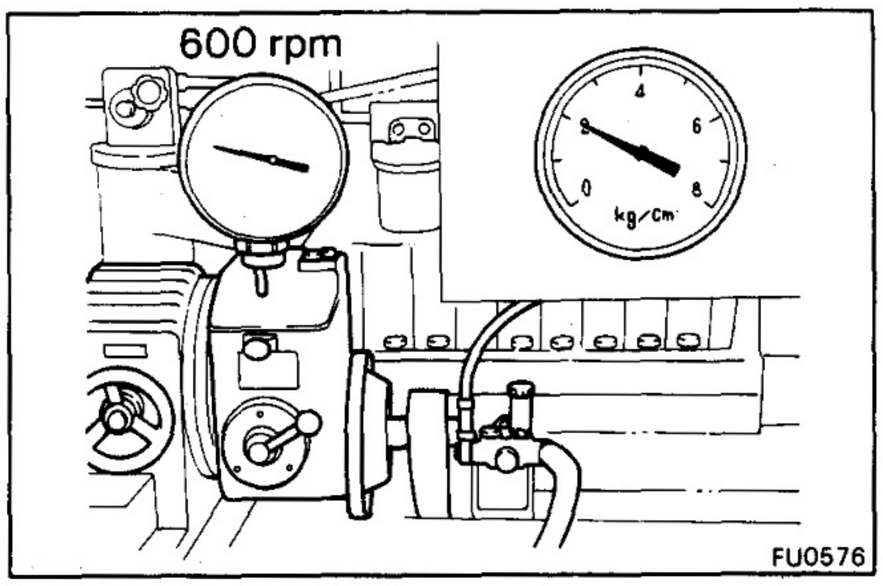
Fuel must discharge within 25 strokes

(d) Drain any fuel from the feed pump.

(e) Operate the feed pump at 150 rpm and check the amount of time until fuel is discharged.

Fuel must discharge within 40 seconds



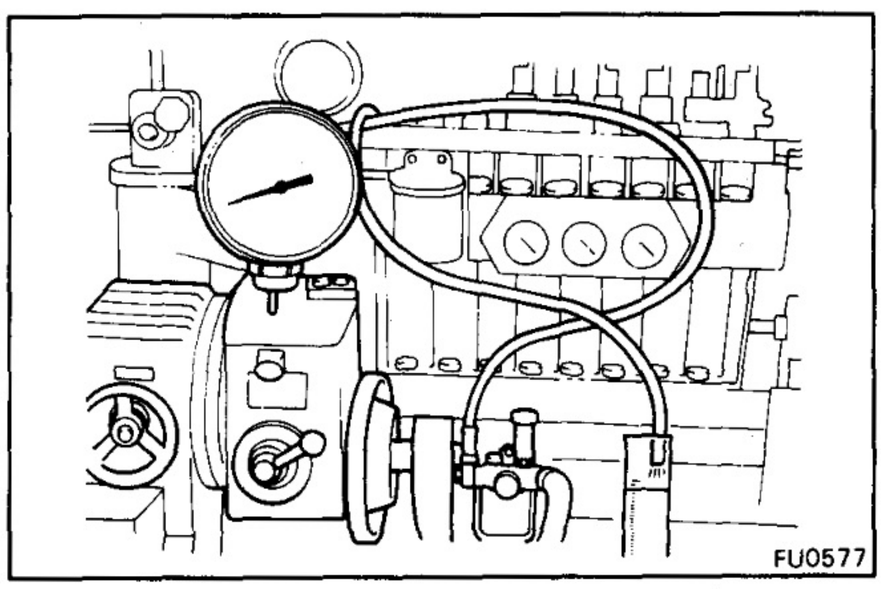


4. DISCHARGE TEST

(a) Install the pressure gauge to the feed pump discharge side.

(b) Operate the feed pump at 600 rpm and check the discharge pressure.

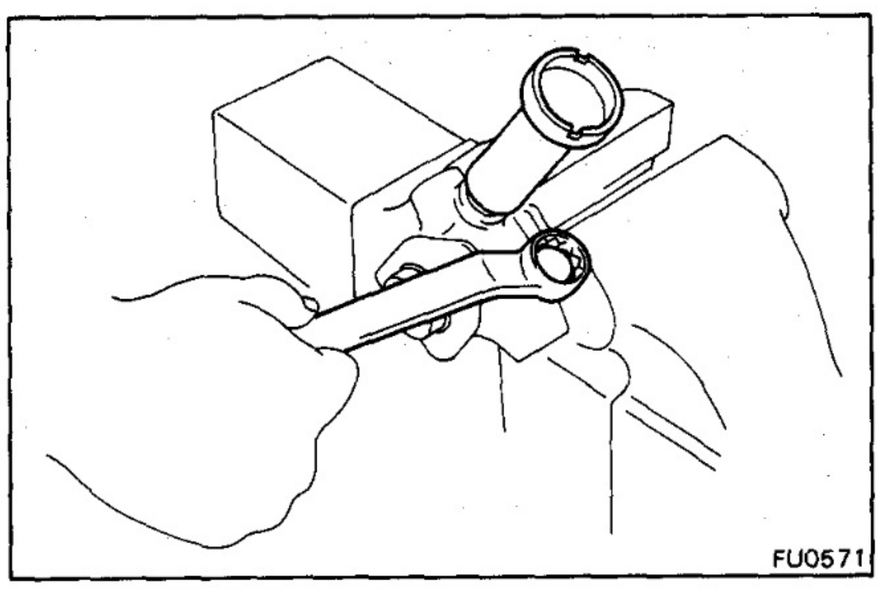
Discharge pressure:
1.8 – 2.2 kg/cm² (26 – 31 psi, 177 – 216 kPa)



(c) Install a 1.54 mm (0.0606 in.) nozzle to the feed pump discharge side.

(d) Operate the feed pump at 1,000 rpm, and measure discharge volume.

Discharge volume:
900 cc/min. (54.9 cu in./min.) or more



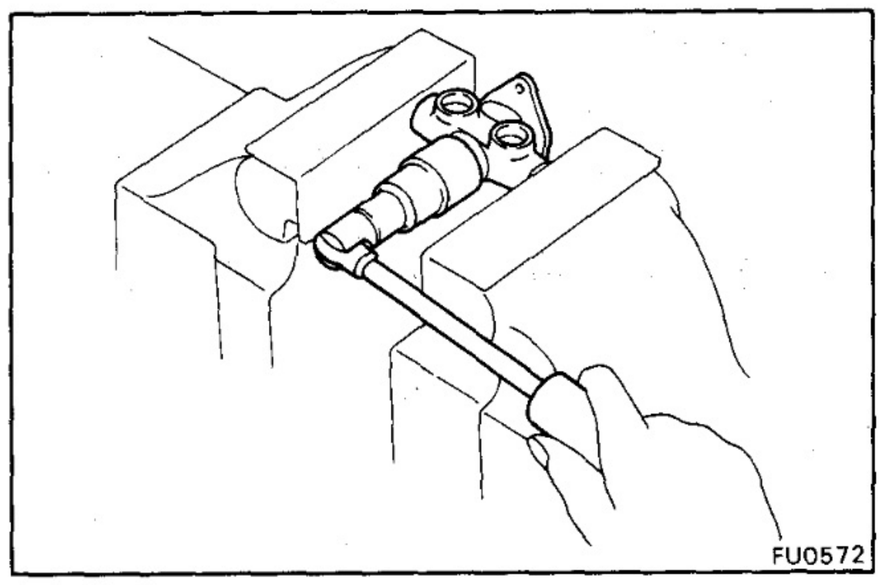
DISASSEMBLY OF FUEL FEED PUMP

(See page FU-11)

1. REMOVE PRIMING PUMP AND CHECK VALVES

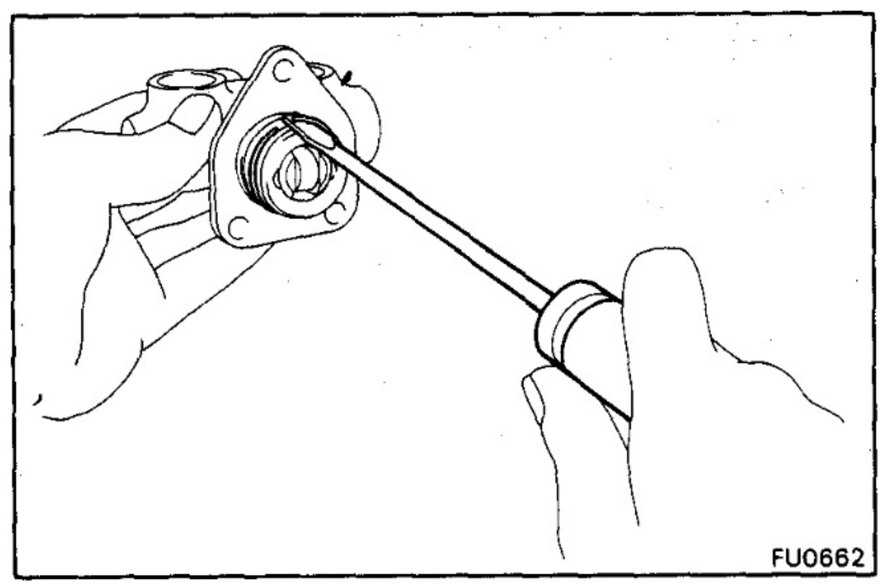
(a) Remove the plug, gasket, spring and check valve.

(b) Remove the priming pump, gasket, spring and check valve.



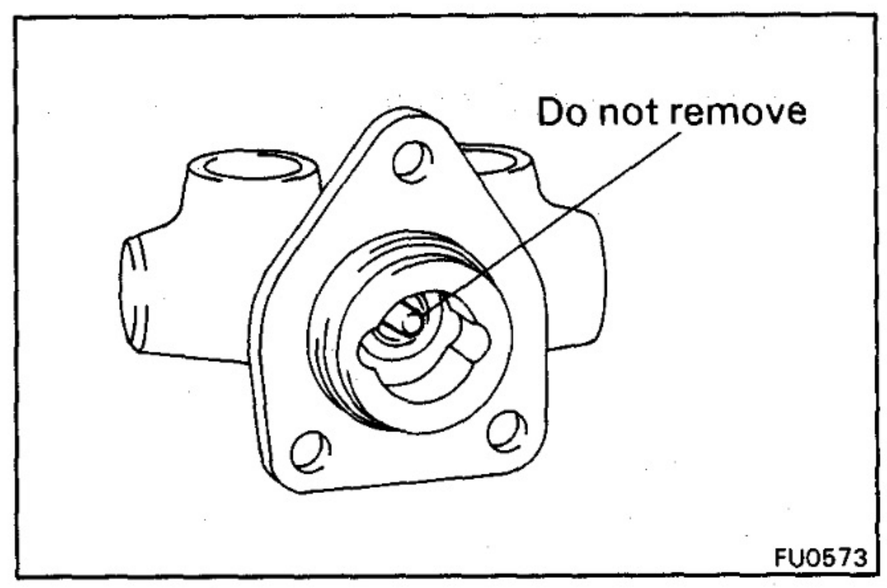
2. REMOVE FEED PUMP PISTON

Remove the chamber plug, gasket, spring and piston.



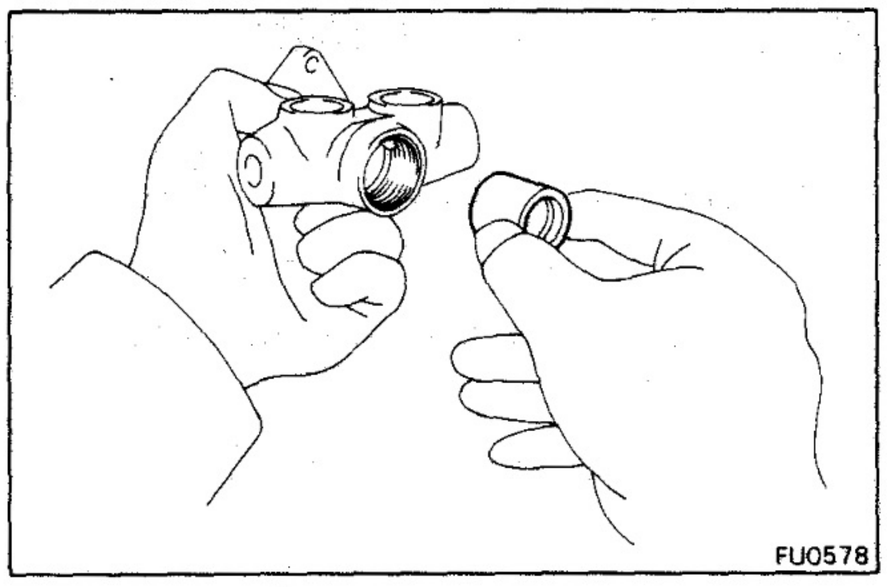
3. REMOVE FEED PUMP TAPPET

Remove the snap ring, and pull out the tappet.



NOTE: Since the push rod is precisely fitted into the feed pump housing, do not remove the rod unless necessary.

If removed, be sure to confirm assembly direction.

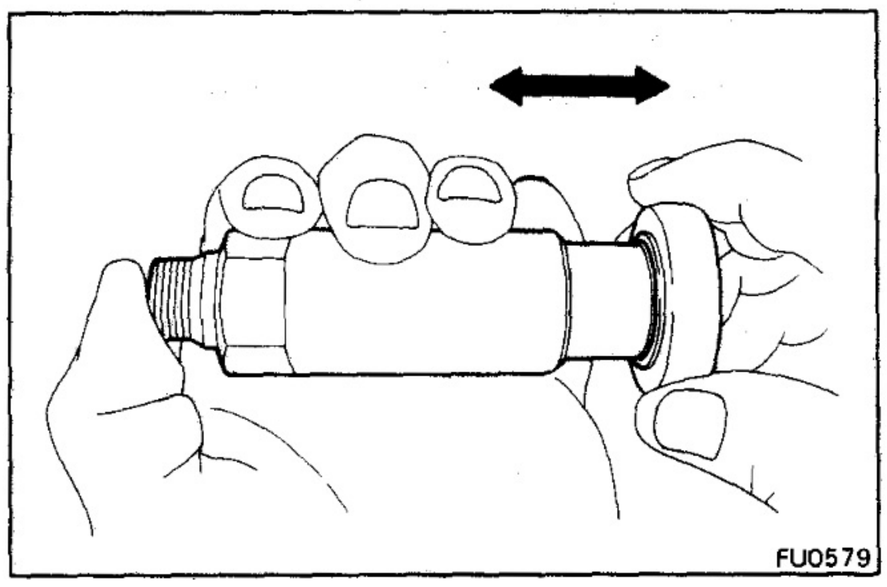


INSPECTION OF FUEL FEED PUMP

1. INSPECT FEED PUMP PISTON

Check the piston, push rod and housing for scoring or wear.

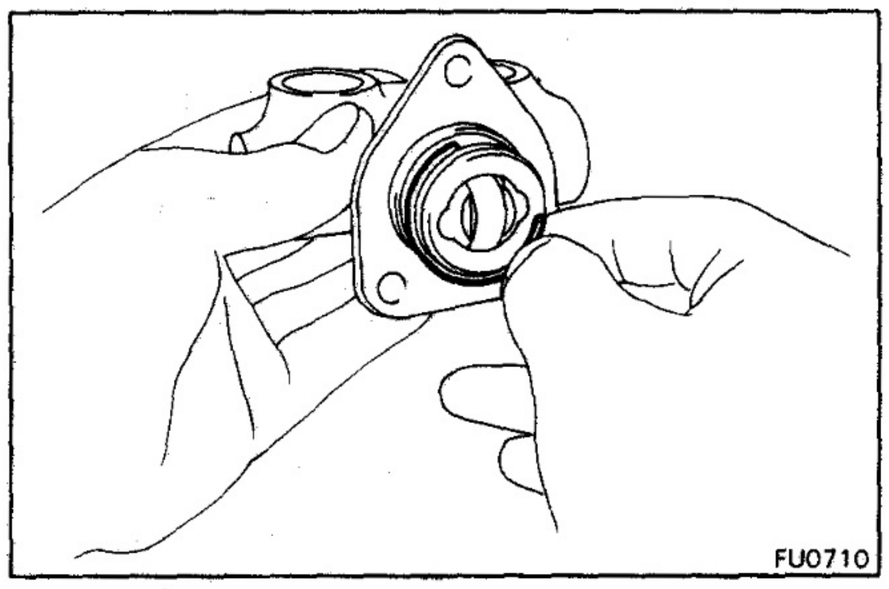
If necessary, replace the piston or pump assembly.



2. INSPECT PRIMING PUMP

Firmly block the priming pump inlet port with your finger and check that pressure and vacuum are created when the pump is operated.

If necessary, replace the priming pump.

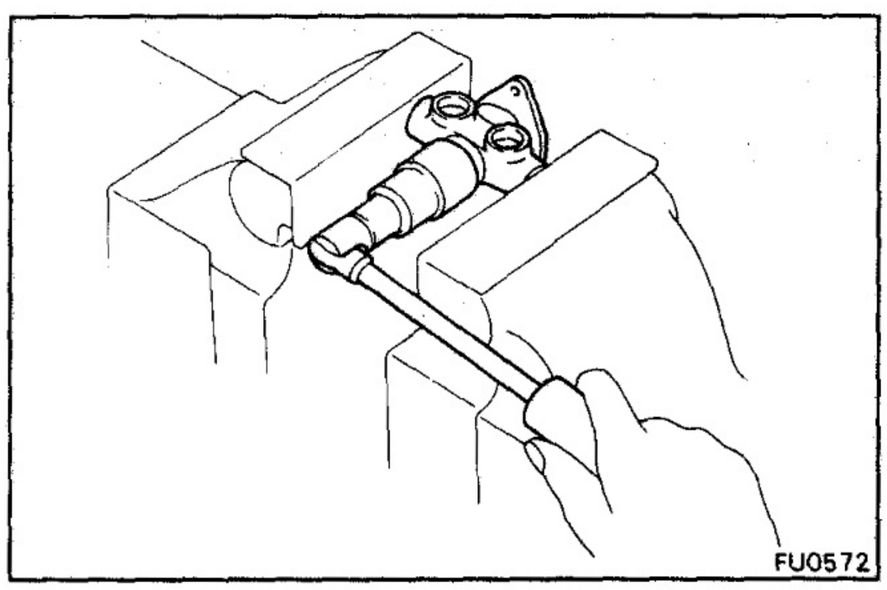


ASSEMBLY OF FUEL FEED PUMP

(See page FU-11)

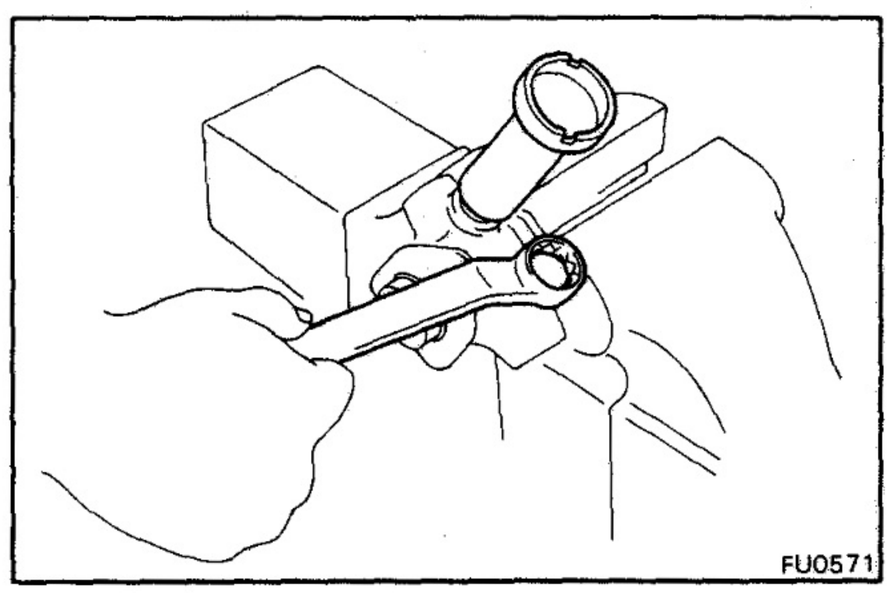
1. INSTALL FEED PUMP TAPPET

Insert the tappet in the housing, and secure it with the snap ring.



2. INSTALL FEED PUMP PISTON

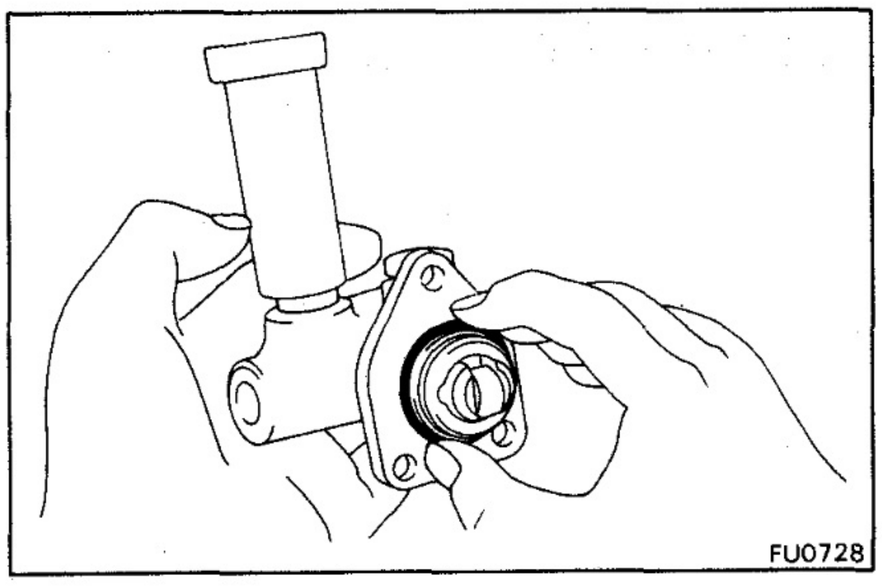
Install the piston, spring, new gasket and chamber plug.



3. INSTALL PRIMING PUMP AND CHECK VALVES

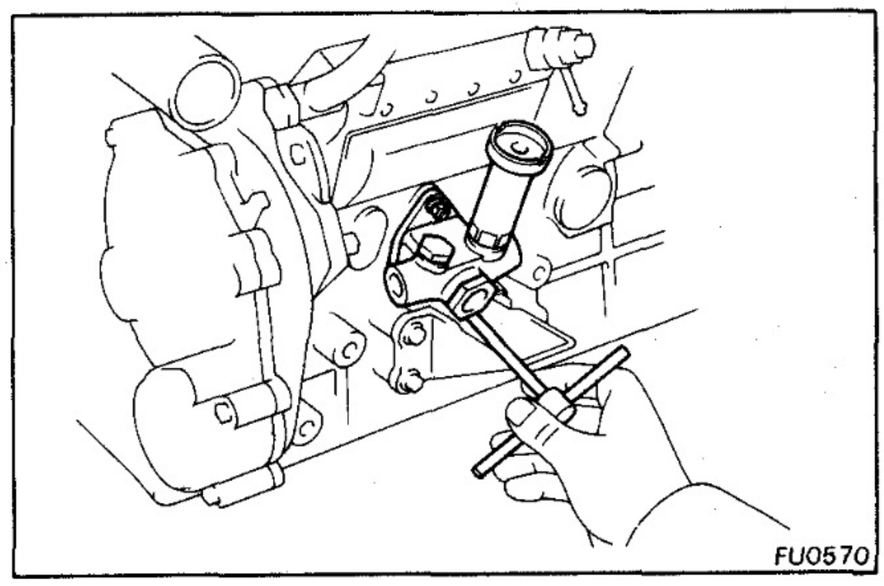
(a) Install the check valve, spring, new gasket and priming pump.

(b) Install the check valve, spring, new gasket and plug.



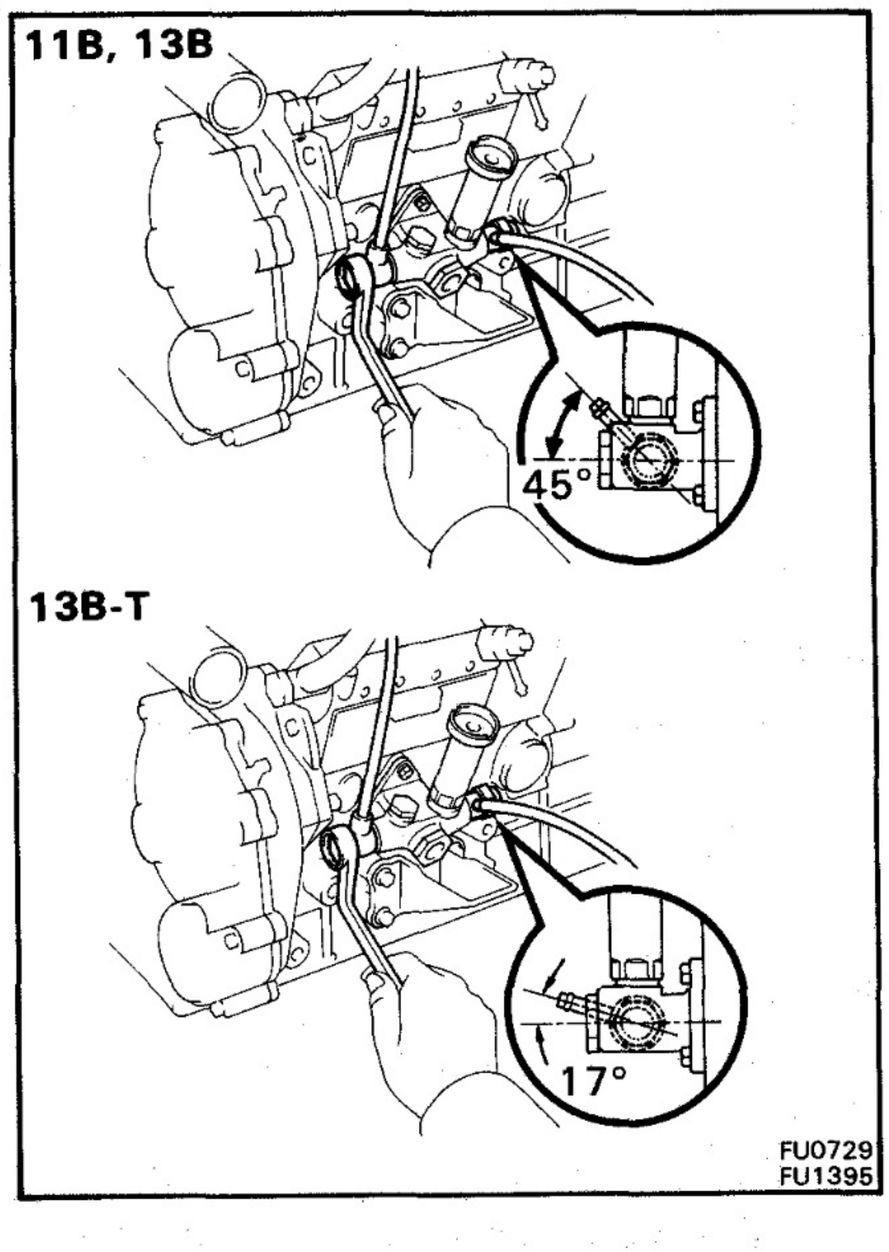
INSTALLATION OF FUEL FEED PUMP

1. INSTALL NEW O-RING TO FUEL FEED PUMP HOUSING



2. INSTALL FUEL FEED PUMP ON INJECTION PUMP

Install the feed pump with the three nuts and spring washers.



3. CONNECT INLET AND OUTLET FUEL PIPES

(a) Before installing the union bolt (inlet side), clean the filter inside the union bolt.

(b) Install the inlet pipe at the angle shown in the figure.

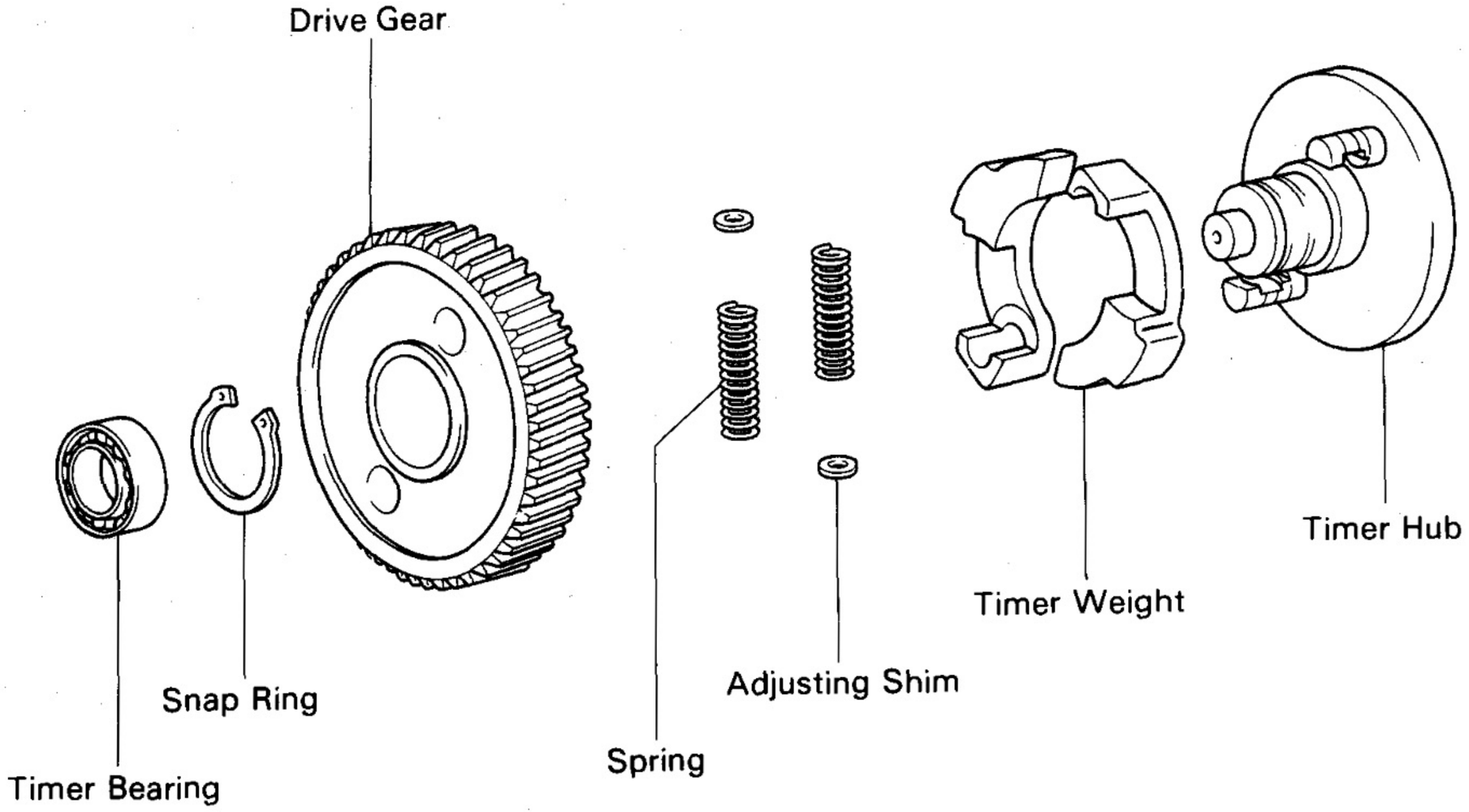
Torque: 375 kg-cm (27 ft-lb, 37 N·m)

4. BLEED FUEL FEED PUMP (See step 2 on page FU-3)

5. START ENGINE AND CHECK FOR FUEL LEAKS

AUTOMATIC TIMER

COMPONENTS



REMOVAL OF AUTOMATIC TIMER

(See steps 3, 4 and 12 to 15 on pages EM-53 to 55)

INSPECTION OF AUTOMATIC TIMER ADVANCE ANGLE

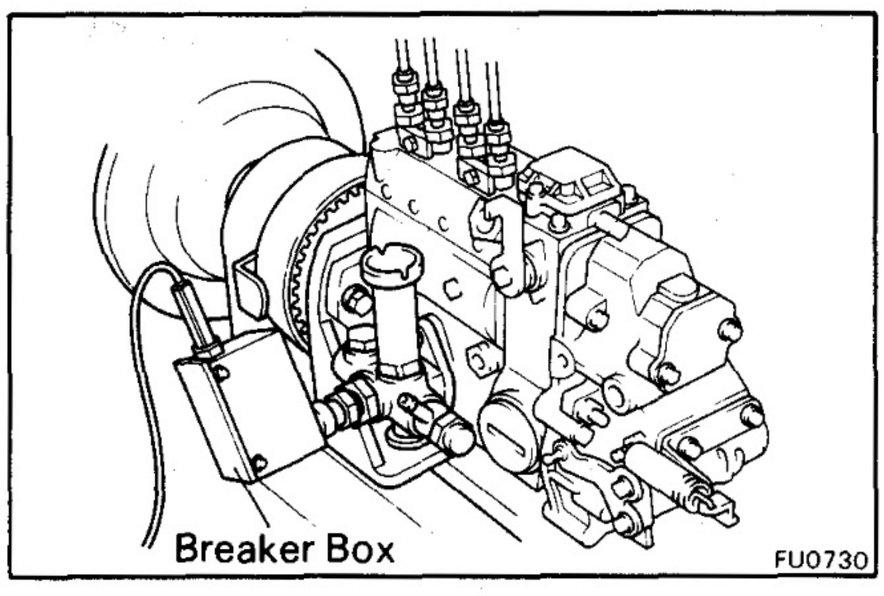
INSPECT ADVANCE ANGLE

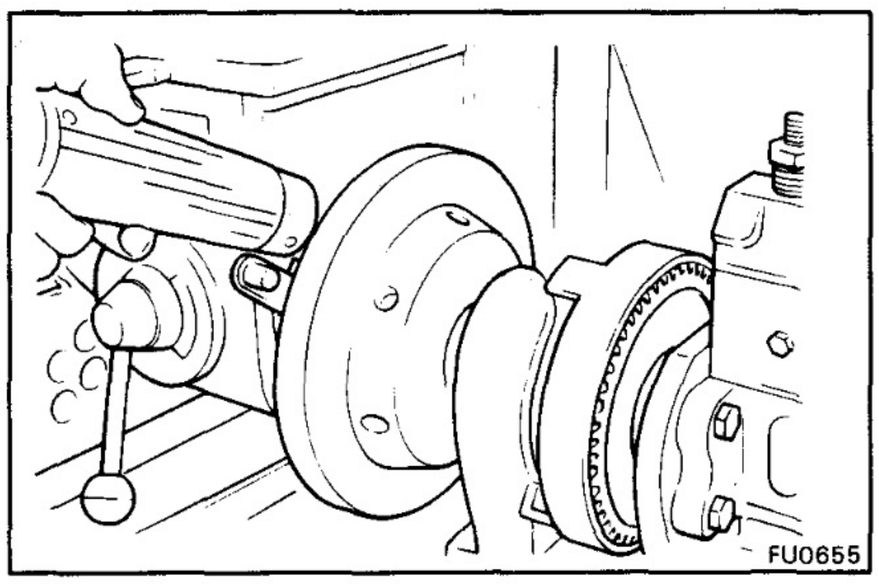
(a) Remove the injection pump from the engine.
(See page FU-20)

(b) Install the automatic timer on the pump spline shaft and mount the injection pump on the pump tester.

(c) Fill the pump camshaft chamber with engine oil.

(d) Install the timer breaker box to the piston bore of the feed pump.




FU0655

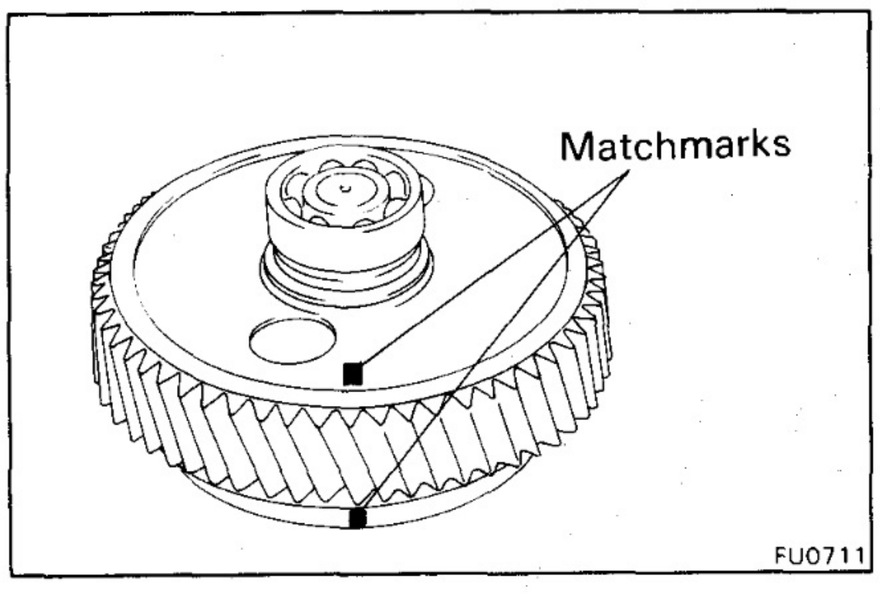
(e) Using a timing light, check the advance angle.

Item	Pump rpm	Timer advance angle
11B w/o HAC	1,450	Advance begins (≦ 0.5°)
	1,750	3.5 – 4.5°
13B w/o HAC	1,400	Advance begins (≦ 0.5°)
	1,700	4.5 – 5.5°
11B, 13B w/ HAC	1,000	Advance begins (≦ 0.5°)
	1,700	3.0 – 4.0°
13B-T	1,400	Advance begins (≦ 0.5°)
	1,700	3.5 – 4.5°

If any advance angle is not within specification, adjust by changing the timer spring shim.

Timer adjusting shim thickness mm (in.)	
0.5 (0.020) 0.6 (0.024) 0.7 (0.028)	0.8 (0.031) 0.9 (0.035) 1.0 (0.039)

NOTE: The advance angle will advance with a reduction in shim thickness and retard with an increase.

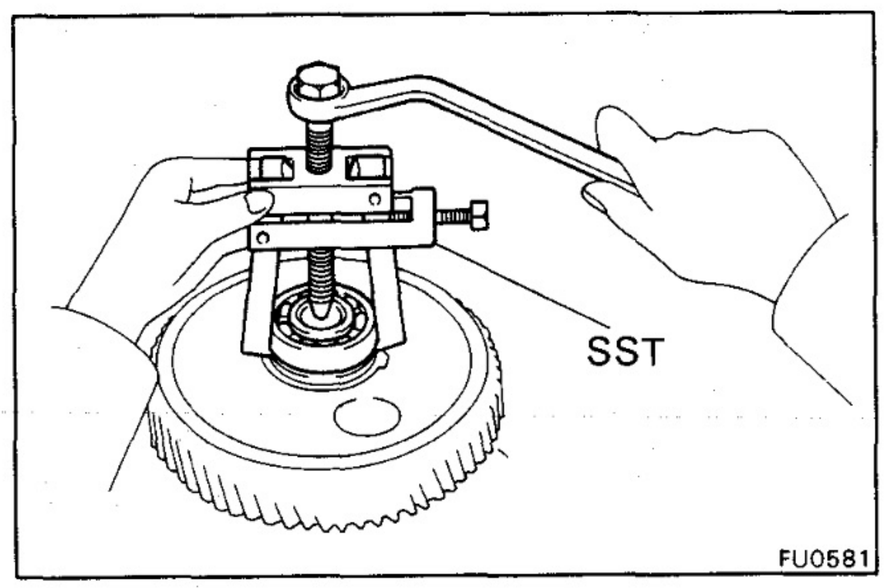


FU0711

DISASSEMBLY OF AUTOMATIC TIMER

(See page FU-16)

1. PLACE MATCHMARKS ON TIMER HUB AND DRIVE GEAR

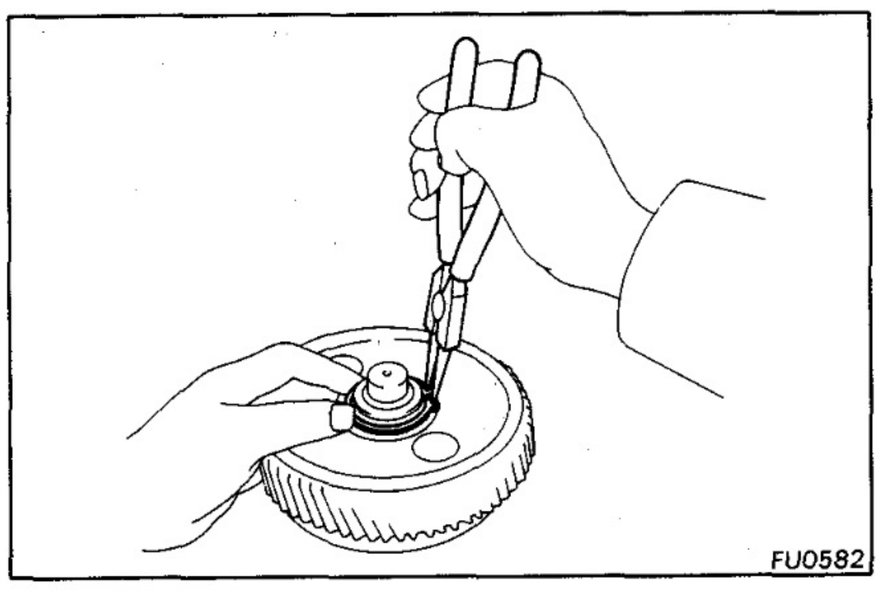


FU0581

2. REMOVE TIMER BEARING

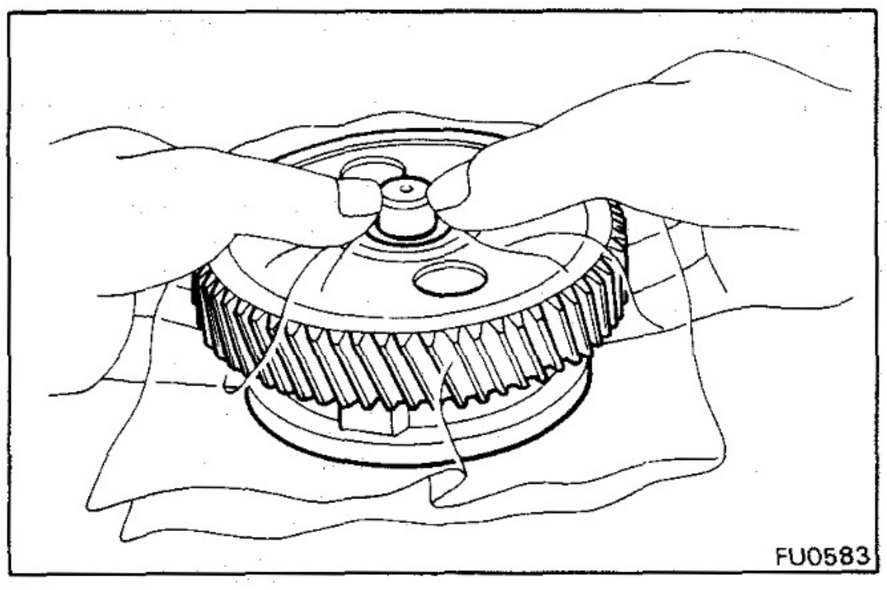
Using SST, remove the timer bearing.

SST 09286-46011


FU0582

3. REMOVE DRIVE GEAR

(a) Using snap ring pliers, remove the snap ring.

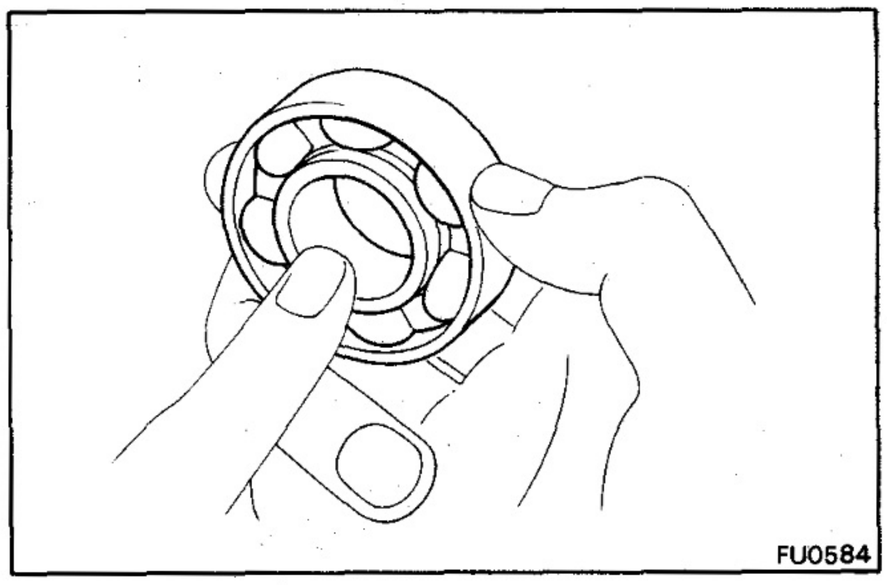


(b) Cover the timer with a shop towel to prevent the springs and spring seats from flying out.

(c) Pull up the drive gear.

(d) Remove the springs and adjusting shims.

(e) Remove the timer weight from the timer hub.

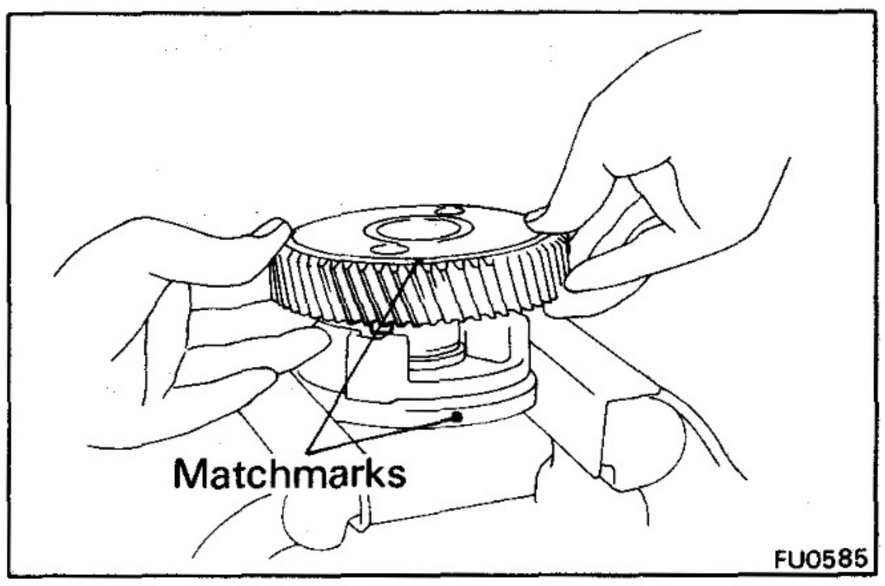


INSPECTION OF COMPONENTS

INSPECT TIMER BEARING

Check that the timer bearing operation is not rough or noisy.

If necessary, replace the timer bearing.



ASSEMBLY OF AUTOMATIC TIMER

(See page FU-16)

1. INSTALL DRIVE GEAR

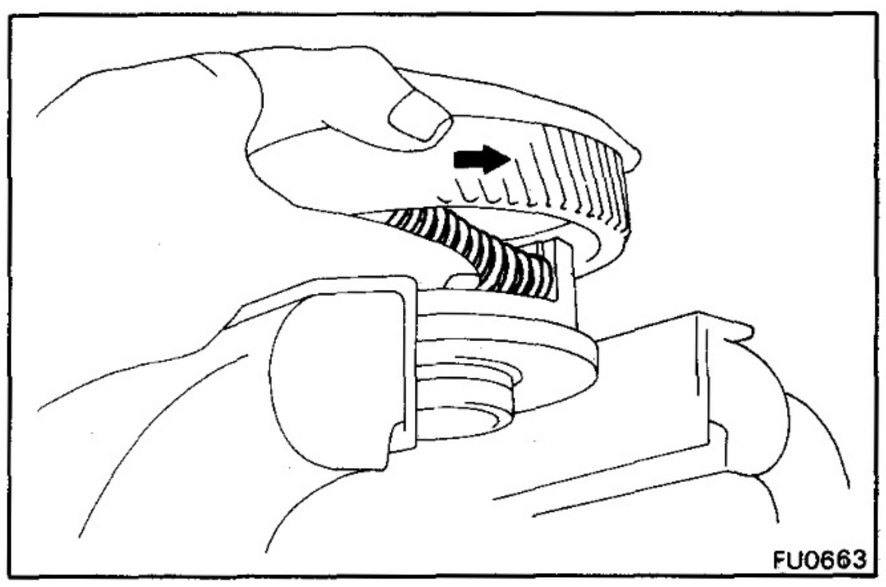
(a) Mount the timer hub in a vise.

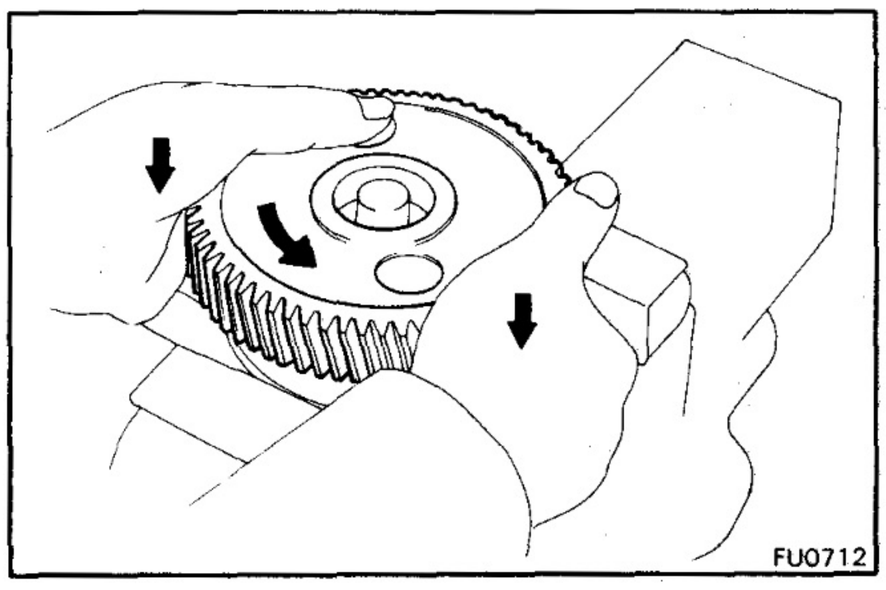
(b) Install the timer weight to the timer hub.

(c) Install the adjusting shims to the drive gear.

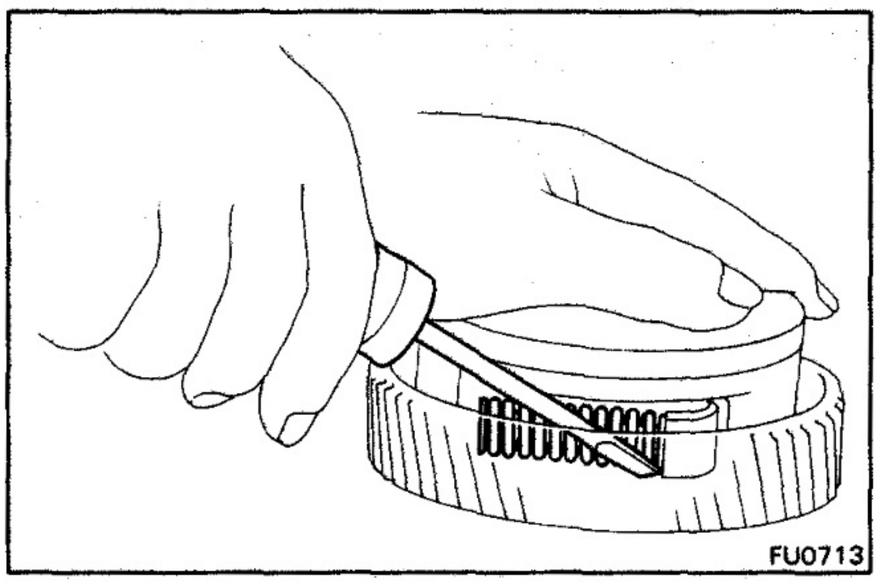
(d) During assembly, position the drive gear on the timer weight so that the matchmarks of the drive gear and timing hub align as shown.

(e) Slightly turn the drive gear counterclockwise, and install the springs.

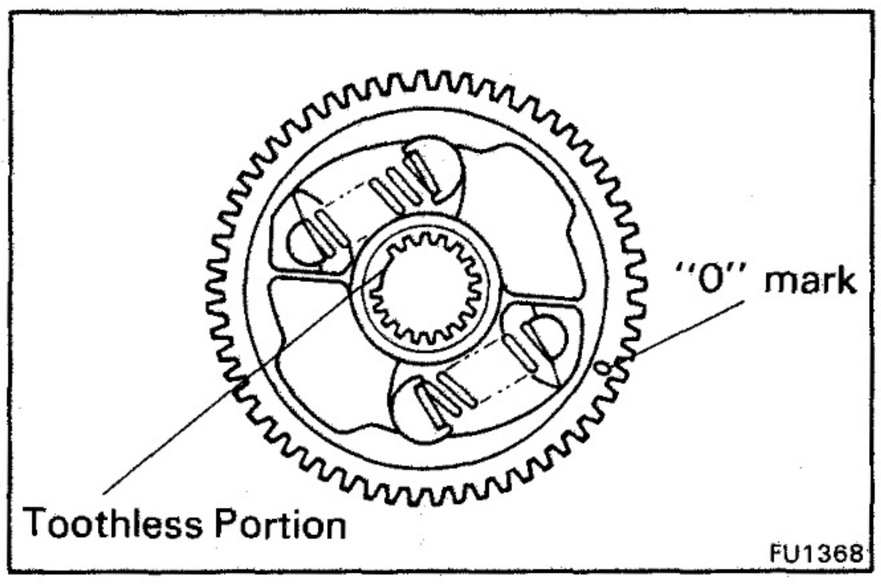




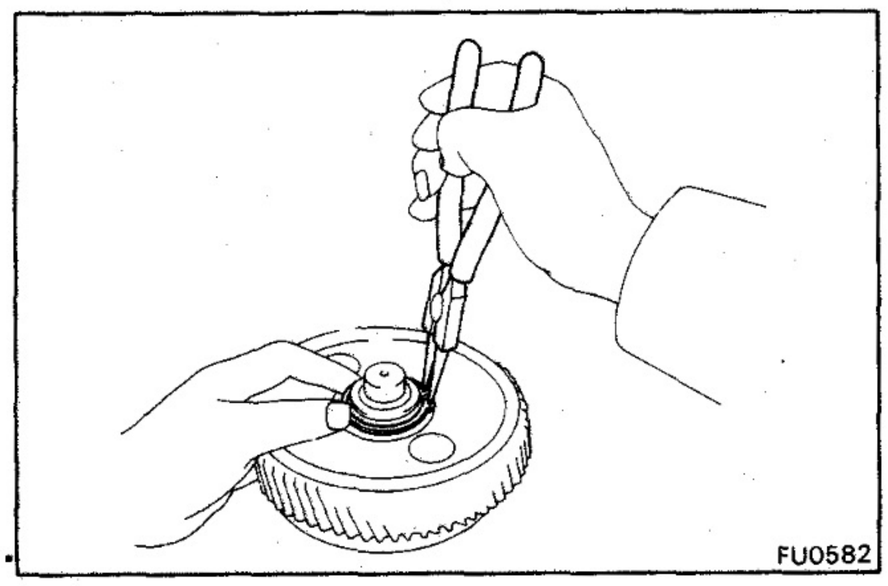
(f) While pressing the drive gear, turn it onto the hub.



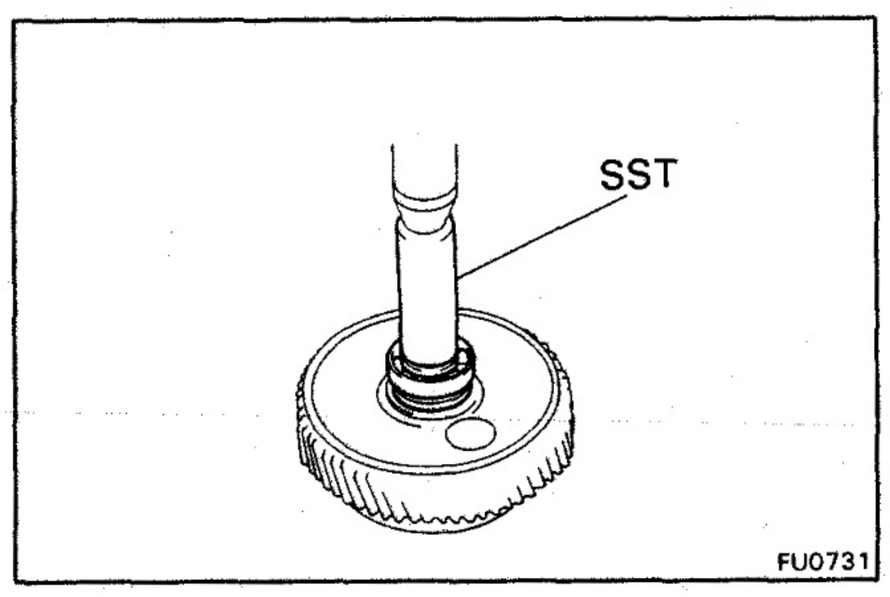
(g) Using a screwdriver, snugly seat the timer springs.



(h) Check that the "0" mark of the drive gear and toothless portion of the timer hub are as shown in the illustration.



(i) Using snap ring pliers, install the snap ring.



2. INSTALL TIMER BEARING

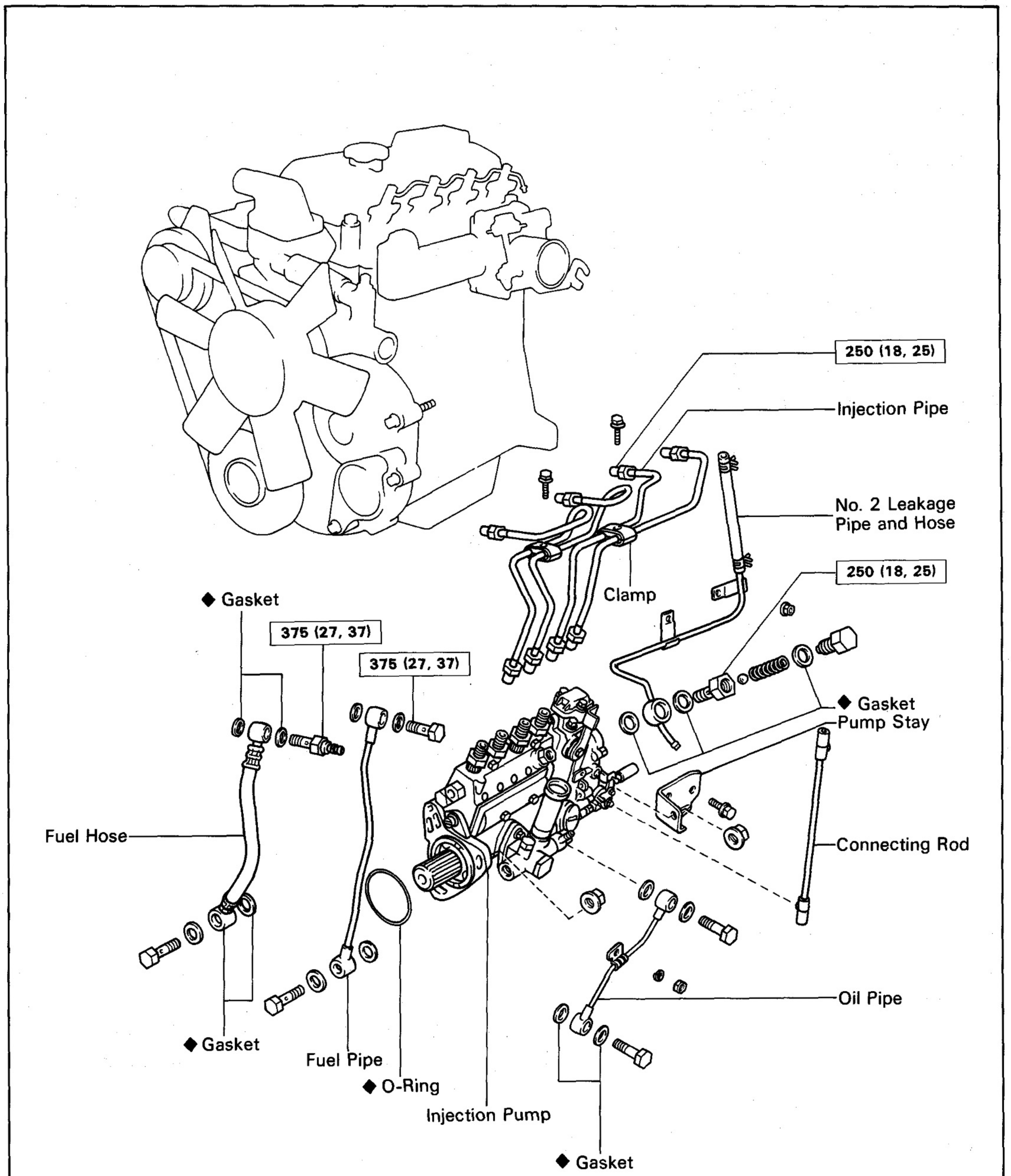
Using SST and a press, press in the bearing.
SST 09260-58010 (09285-76020)

INSTALLATION OF AUTOMATIC TIMER

(See steps 6 to 9 and 15 on pages EM-62 to 65)

INJECTION PUMP

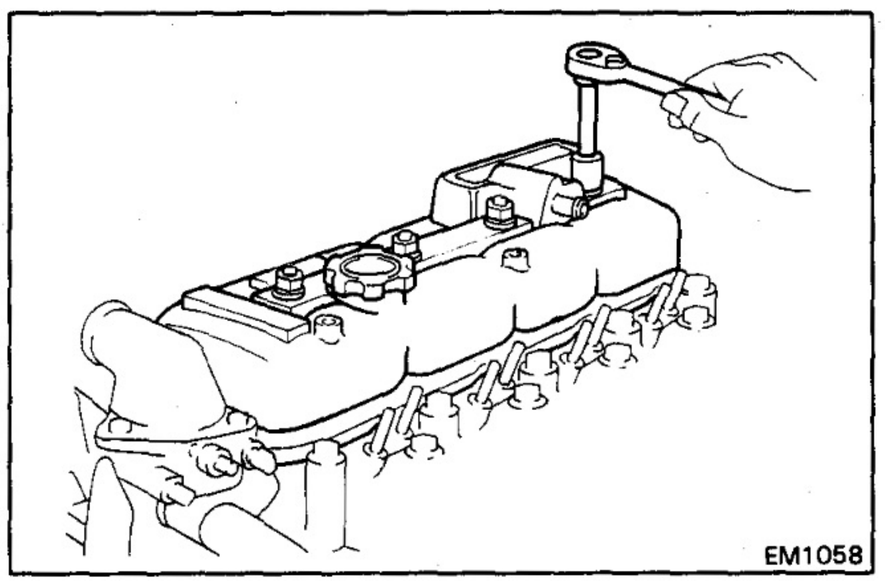
REMOVAL OF INJECTION PUMP



kg-cm (ft-lb, N·m) : Specified torque

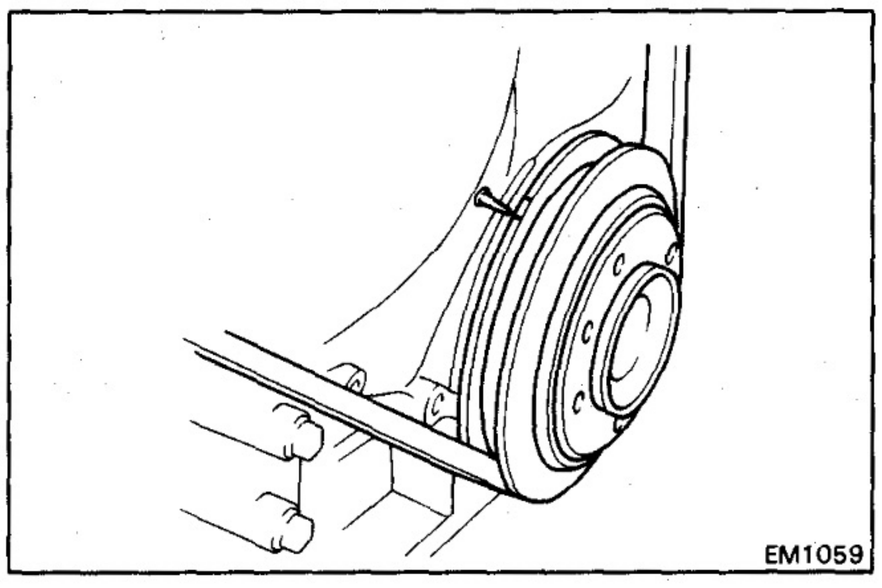
◆ Non-reusable part

FU0586



1. REMOVE CYLINDER HEAD COVER

Remove the four cap nuts, seal washers, head cover and gasket.

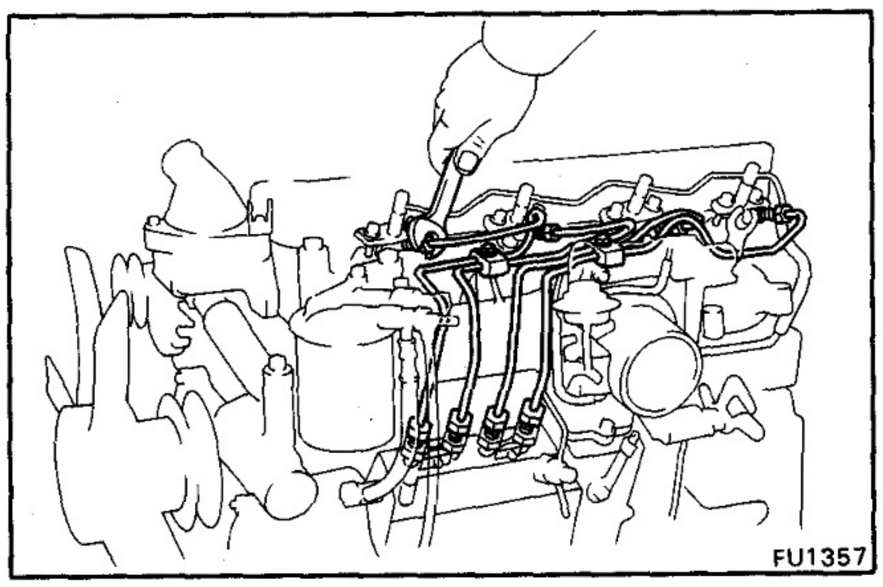


2. SET NO. 1 CYLINDER TO TDC/COMPRESSION

(a) Set the No. 1 cylinder to TDC/compression.
Align the groove on the pulley with the timing pointer 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.



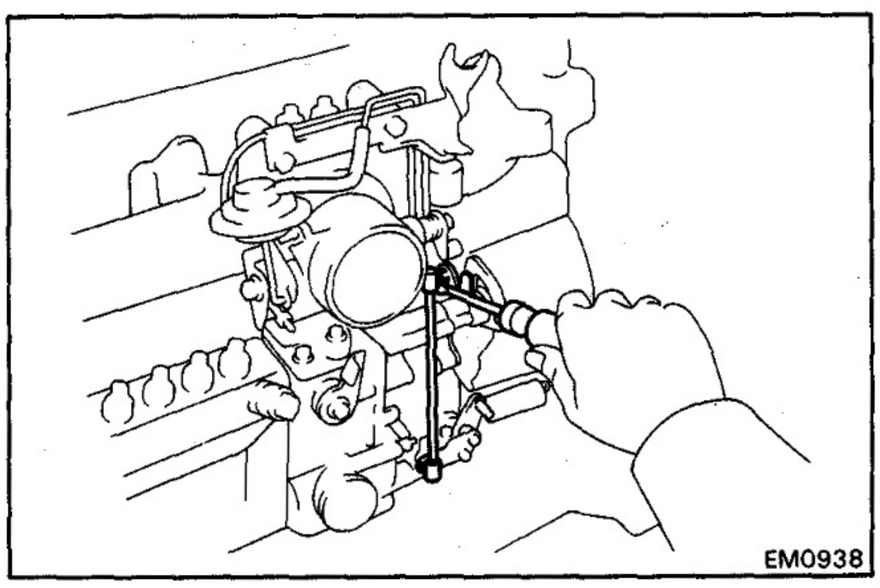
3. REMOVE INJECTION PIPES

(a) Remove the bolt holding the No. 1 and No. 2 injection pipes to the intake manifold and remove the upper clamp.

(b) Remove the No. 1 and No. 2 injection pipes and lower clamp.

(c) Remove the bolt holding the No. 3 and No. 4 injection pipes to the intake manifold and remove the upper clamp.

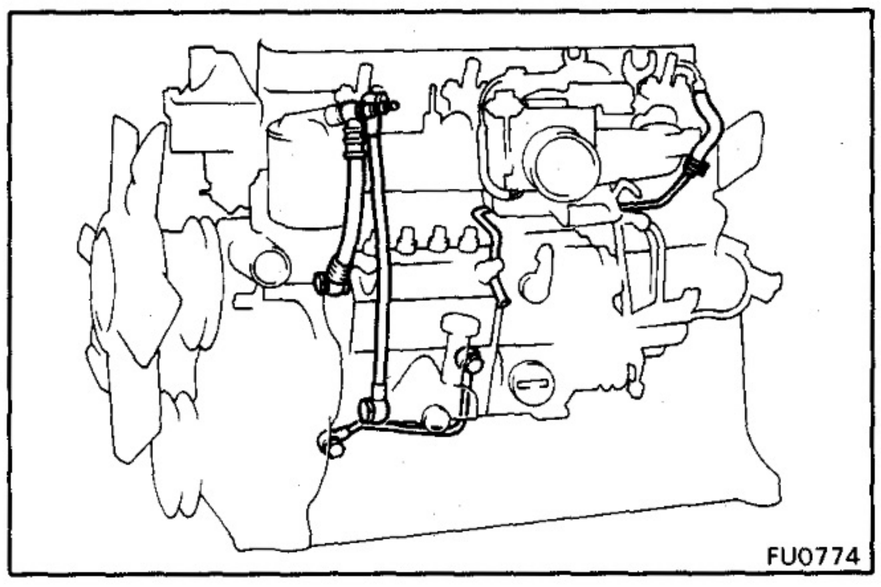
(d) Remove the No. 3 and No. 4 injection pipes and lower clamp.



4. REMOVE ACCELERATOR CONNECTING ROD

**5. [13B-T]
DISCONNECT BOOST COMPENSATOR VACCUM HOSE**

**6. [13B-T A/T]
DISCONNECT DASH POT (DP) VACUUM HOSE**



7. REMOVE FOLLOWING HOSES AND PIPES:

(a) Fuel pipe and hose (For fuel filter)

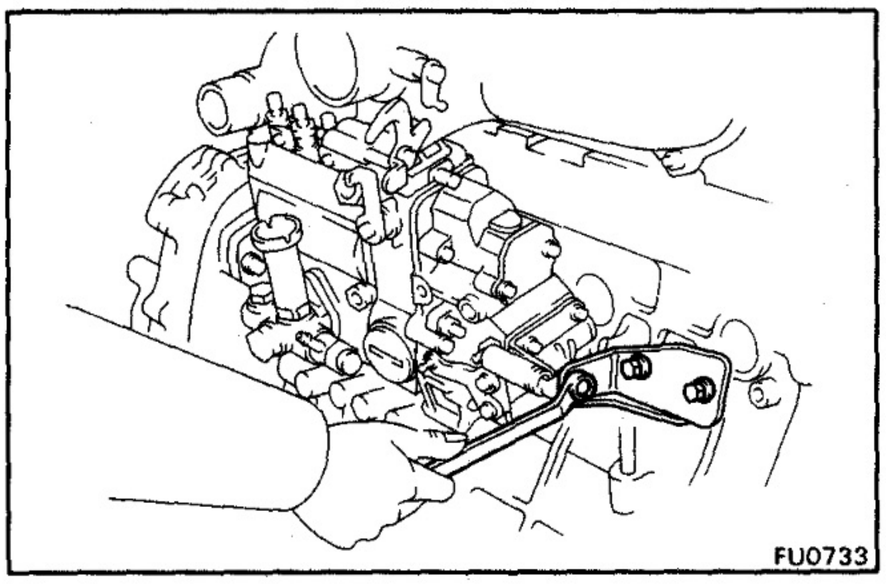
(b) No. 2 leakage pipe with hose

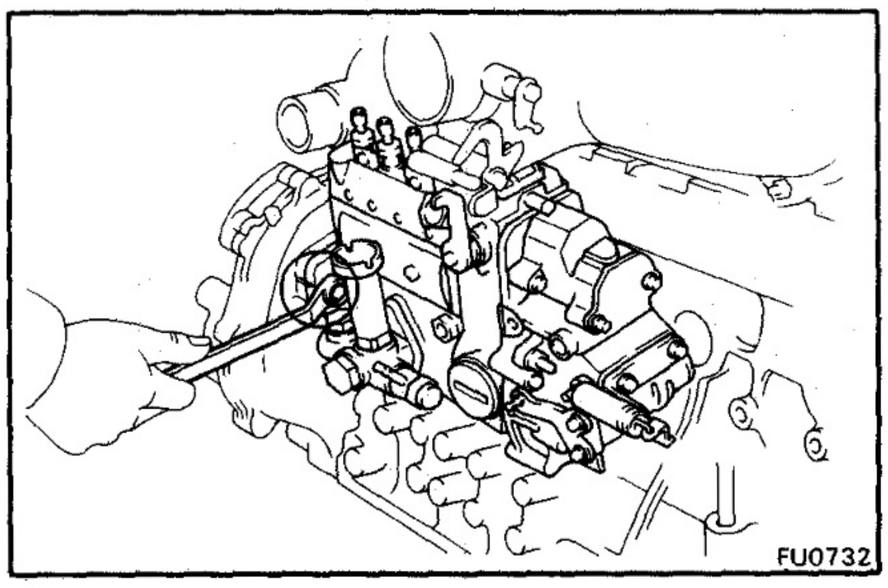
(c) Fuel return hose

(d) Fuel inlet hose

(e) Oil pipe

8. REMOVE FUEL FILTER ASSEMBLY





9. REMOVE INJECTION PUMP

(a) Remove the nut, two bolts and pump stay.

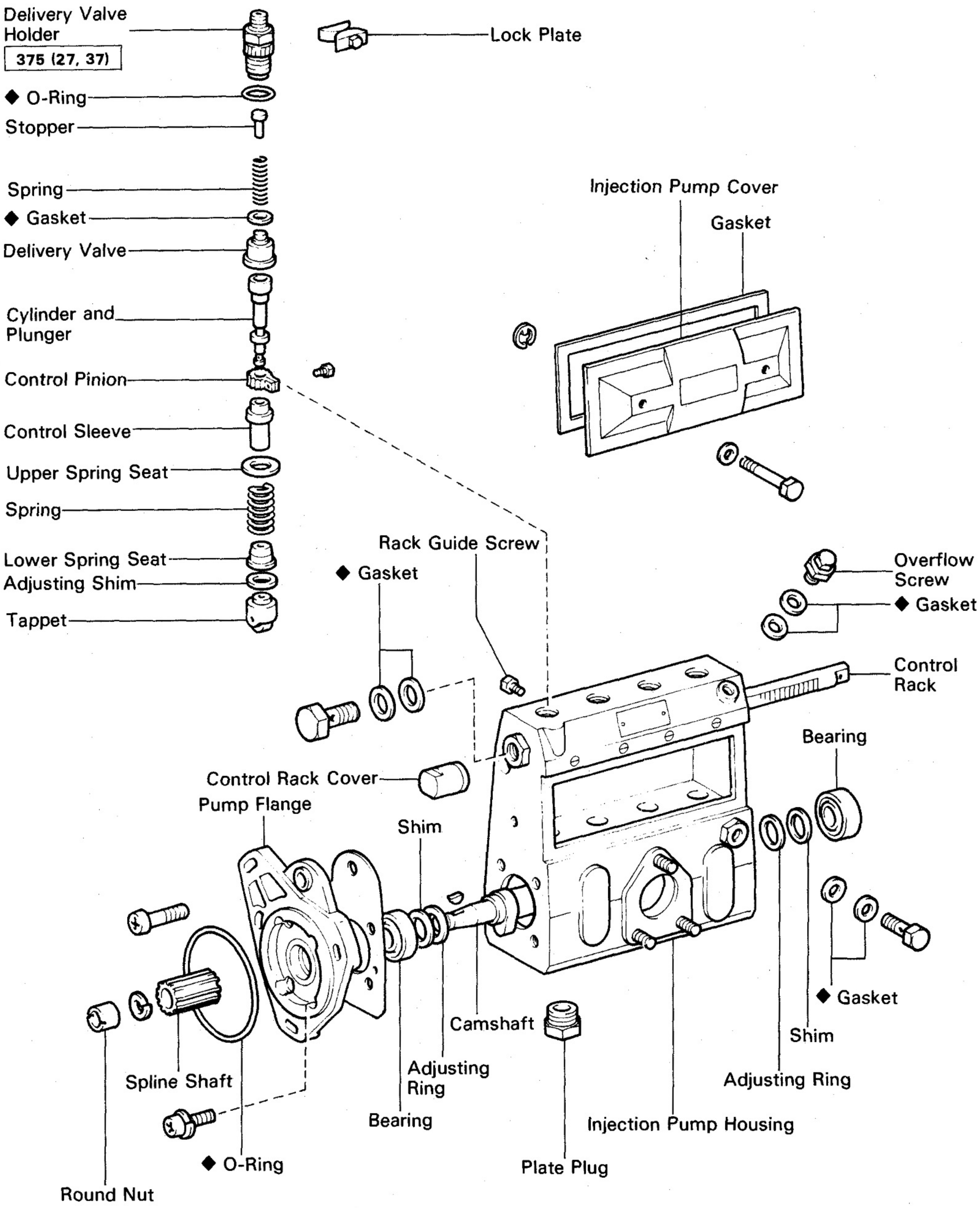
(b) Before removing the injection pump, check if the matchmarks are aligned. If not, place new matchmarks for reinstallation.

(c) Remove the three nuts and injection pump.

(d) [13B-T]
Remove the cylinder block insulator.

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

COMPONENTS

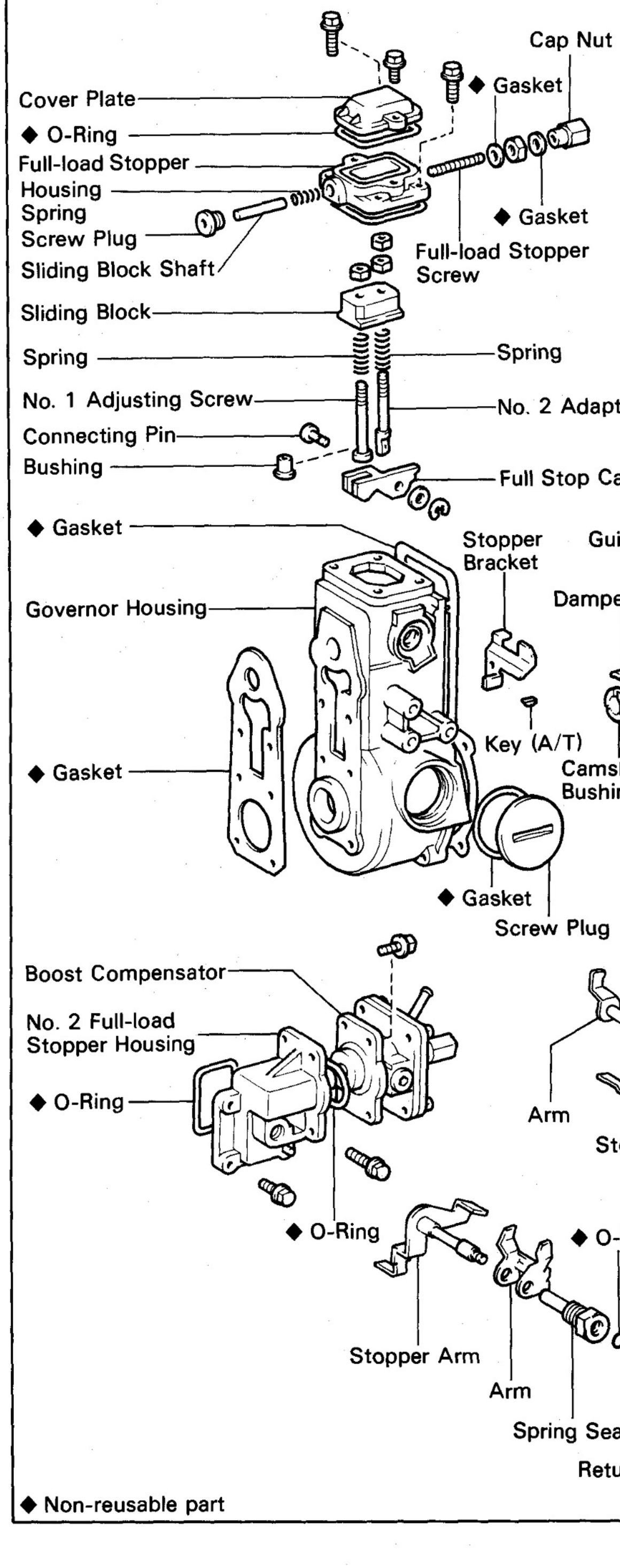


kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

FU1373

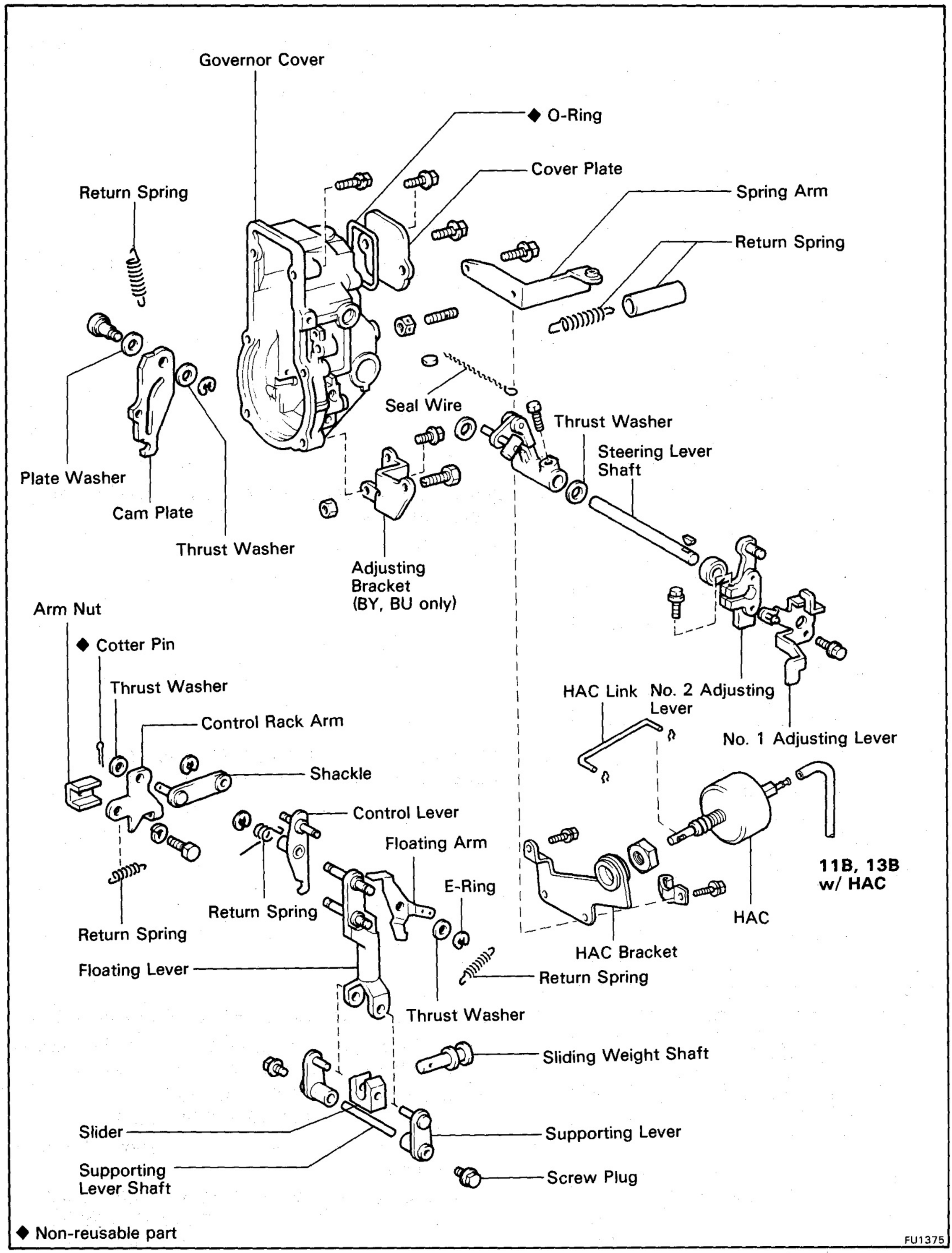
COMPONENTS (Cont'd)



◆ Non-reusable part

FU1374

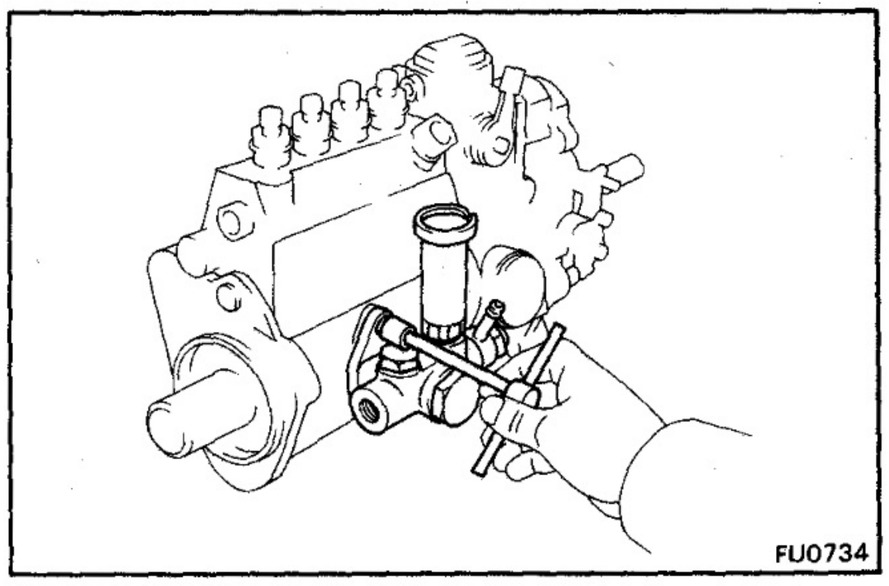
COMPONENTS (Cont'd)



DISASSEMBLY OF INJECTION PUMP

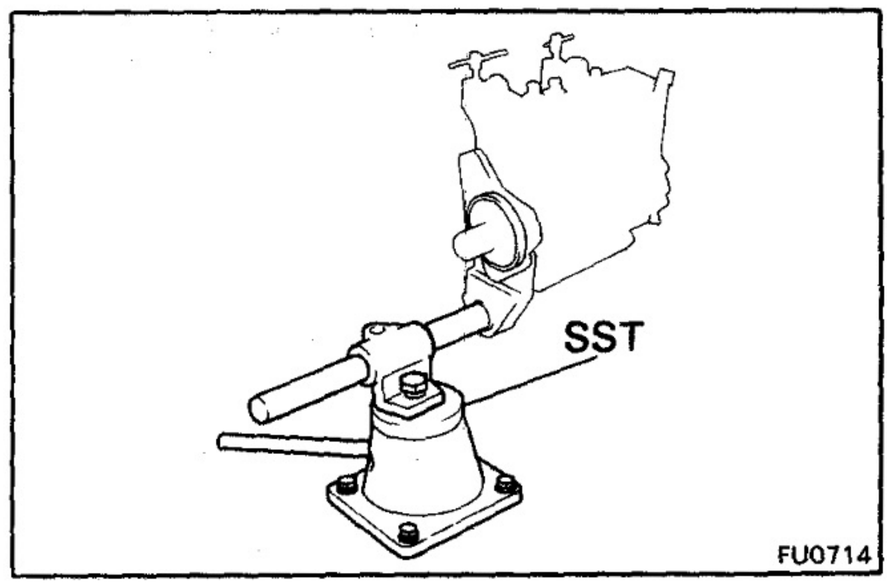
(See pages FU-23 to 25)

NOTE: After disassembly of the pump plunger and delivery valve parts, place them in clean diesel fuel and arrange them in order to avoid mixing them up.



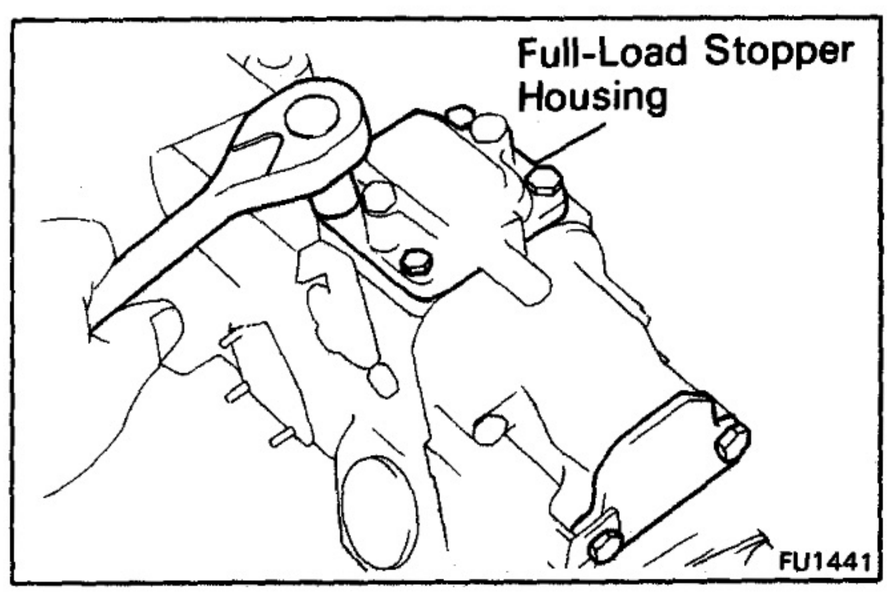
1. REMOVE FUEL FEED PUMP

Remove the three nuts, spring washers and feed pump.

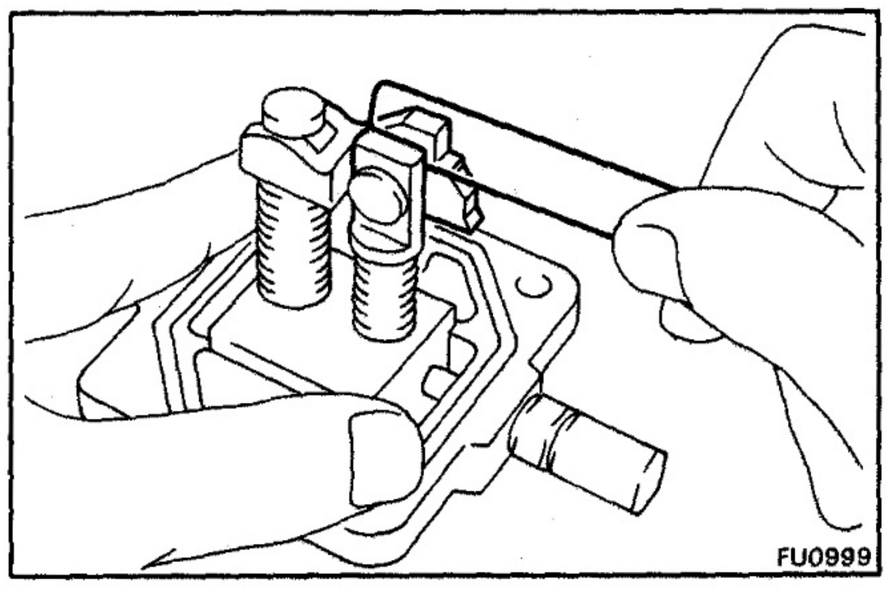


2. INSTALL INJECTION PUMP TO SST (STAND) FOR DISASSEMBLY

SST 09241-76022



3. REMOVE FULL-LOAD STOPPER HOUSING ASSEMBLY FROM GOVERNOR HOUSING



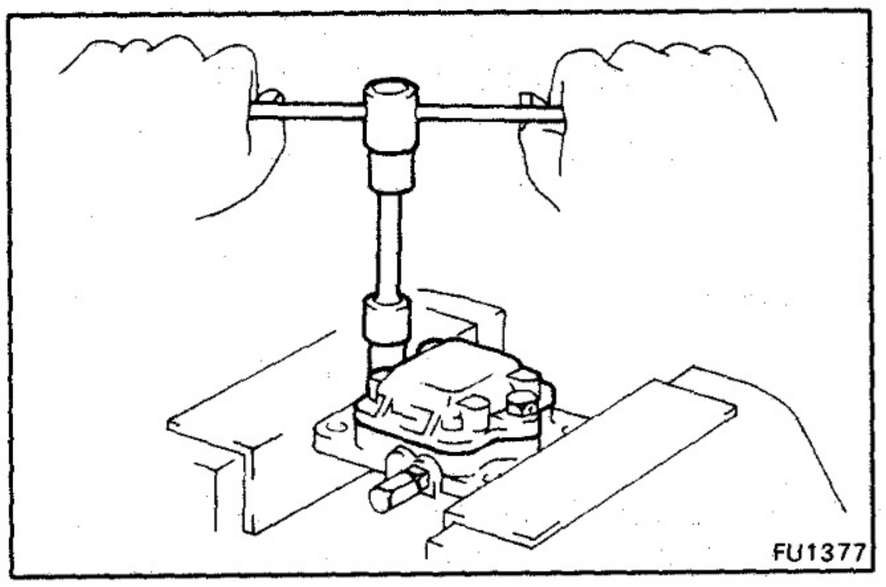
4. CHECK FULL STOP CAM THRUST CLEARANCE

Using a feeler gauge, measure the thrust clearance between the full stop can and No. 2 adapter screw.

Thrust clearance: 0.03 – 0.08 mm (0.0012 – 0.0032 in.)

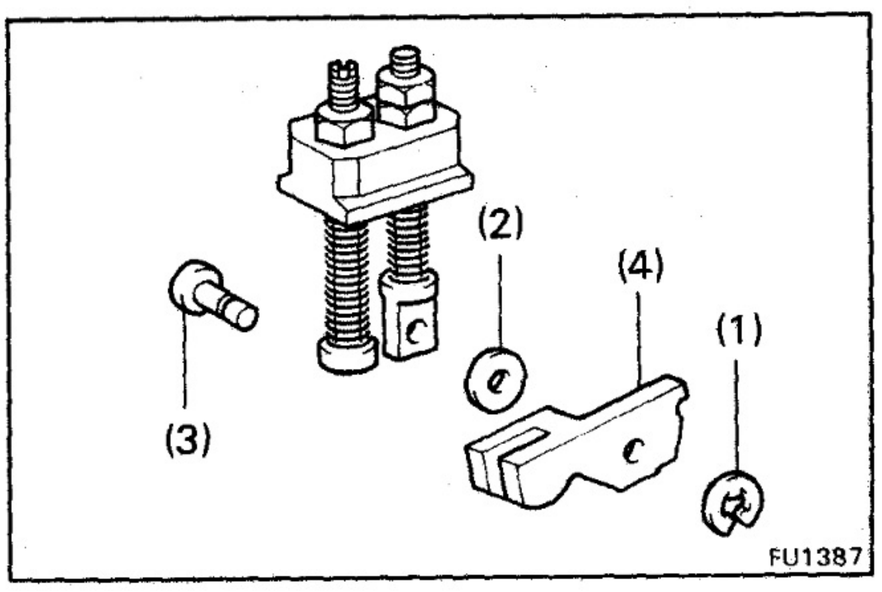
If the clearance is not within specification, replace the thrust washer.

Thrust washer thickness: 0.05 mm (0.0020 in.)
0.10 mm (0.0039 in.)
0.20 mm (0.0079 in.)

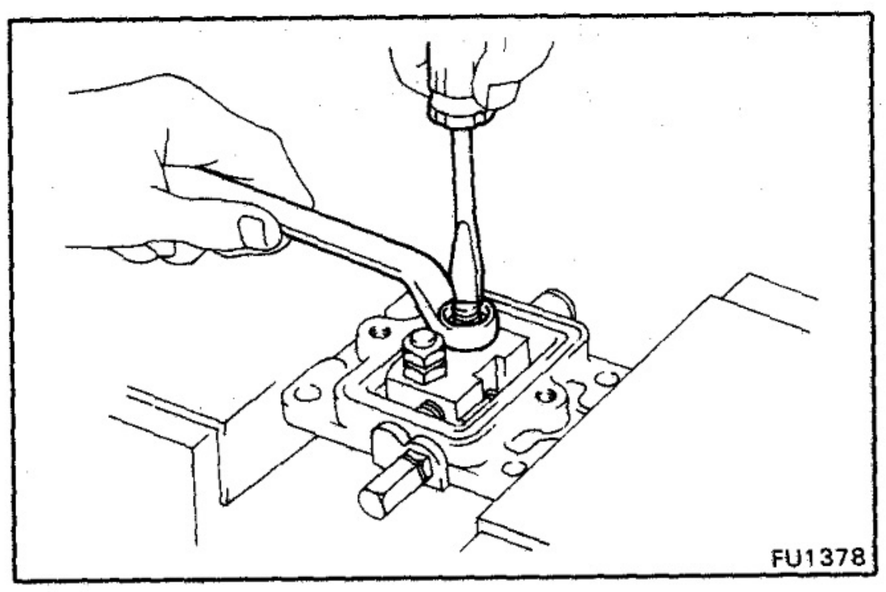


5. DISASSEMBLE FULL-LOAD STOPPER HOUSING ASSEMBLY

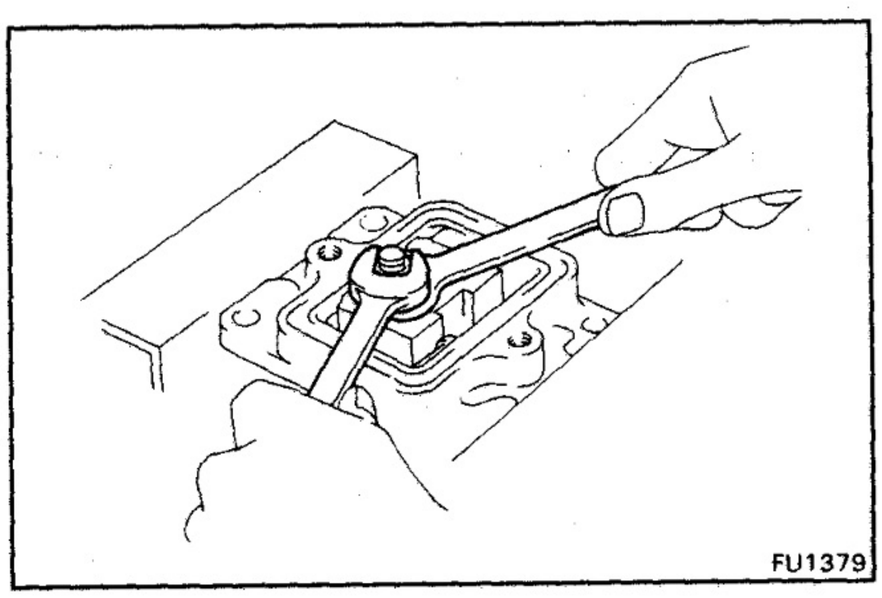
(a) Remove the two bolts, cover plate and O-ring.



(b) Remove the E-ring (1), thrust washer (2), connecting pin (3) and full stop cam (4).



(c) Remove the nut, No. 1 adaptor screw, spring and bushing.



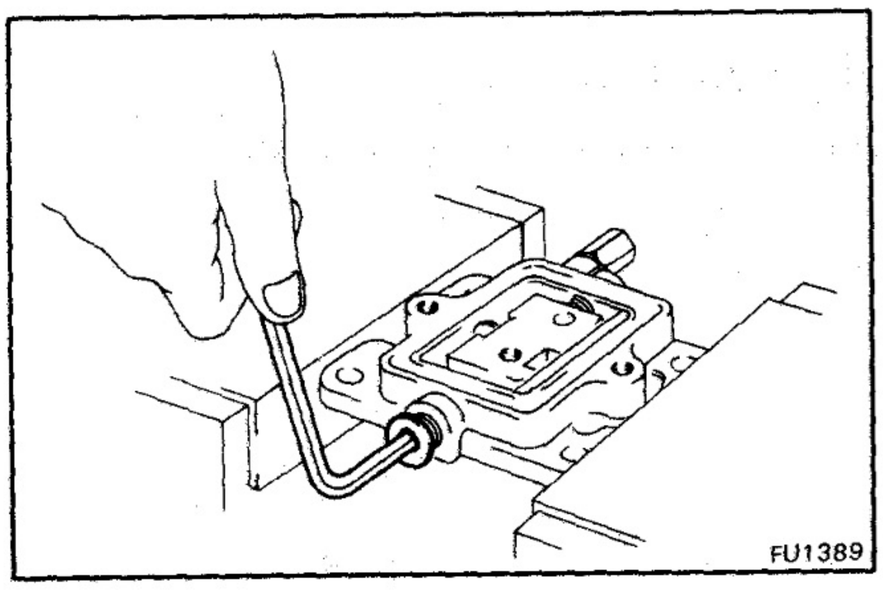
(d) Remove the two nuts, No. 2 adapter screw and spring.

[ex. 13B-T (w/o HAC)]

(e) Remove the cap nut, gasket, nut, gasket and stopper screw.

(f) Using a hexagon wrench, remove the screw plug.

(g) Remove the sliding block shaft, spring and sliding block.

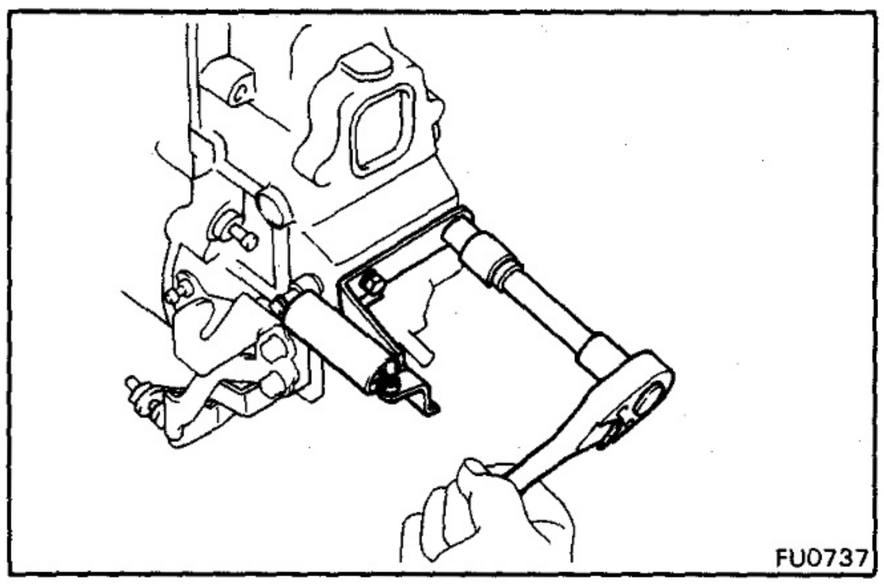


[ex. 13B-T (w/ HAC), 13B-T]

(e) Using a hexagon wrench, remove the screw plug.

(f) Remove the sliding block shaft, spring and sliding block.

(g) Remove the cap nut, gasket, nut, gasket and stopper screw.


FU0737

6. [w/o HAC]
REMOVE COVER PLATE OR DASH POT (DP)

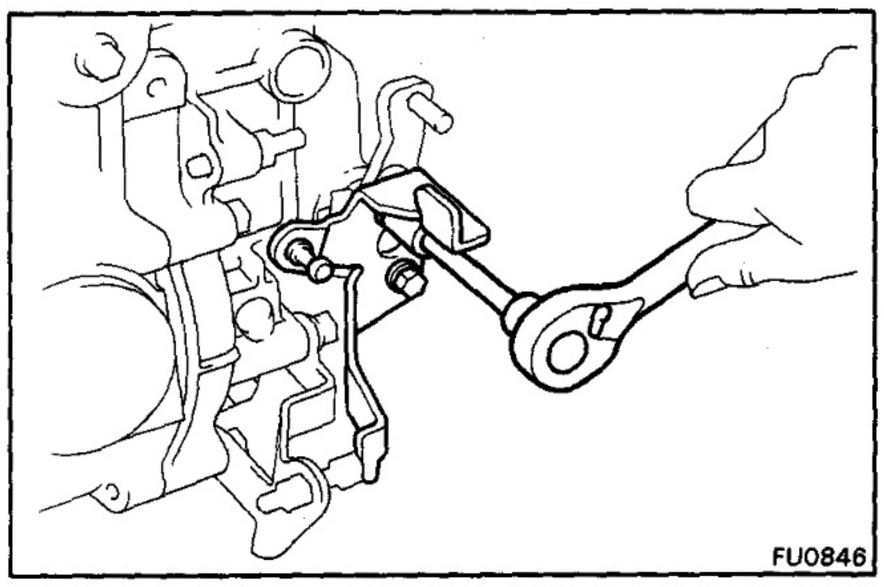
Remove bolts, cover plate or DP and O-Ring.

7. [w/o HAC]
REMOVE SPRING ARM

Remove the two bolts, spring arm and return spring.

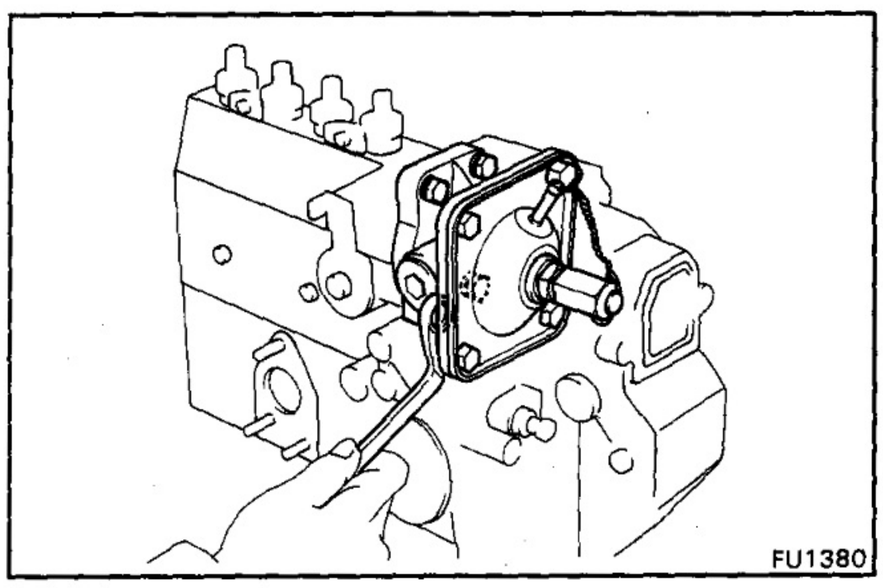
8. [w/ HAC]
REMOVE HIGH ALTITUDE COMPENSATOR (HAC), SPRING ARM AND COVER PLATE

(a) Disconnect the HAC link.
(b) Remove the three bolts, HAC, spring arm and return spring.
(c) Remove the bolt, cover plate and O-ring.


FU0846

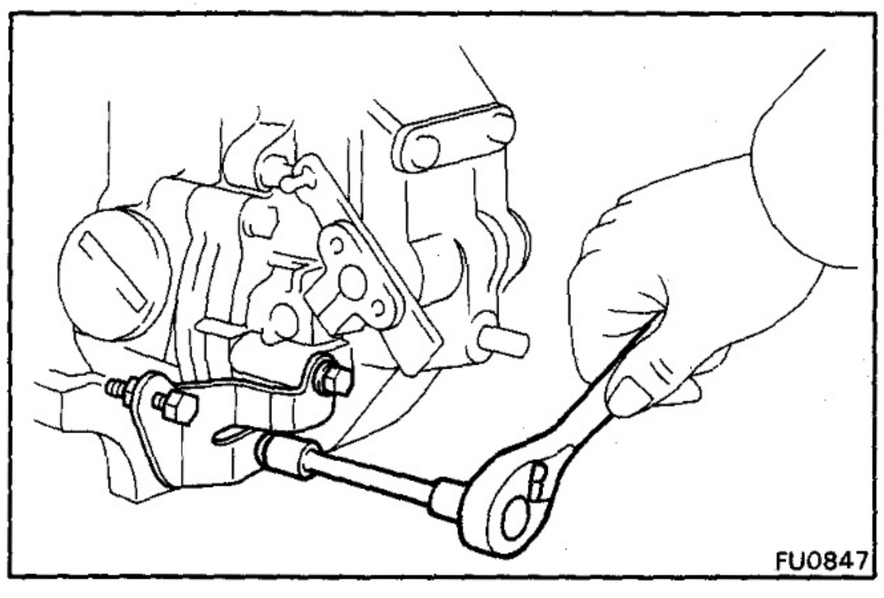
9. REMOVE NO. 1 ADJUSTING LEVER

Remove the two bolts and No. 1 adjusting lever.


FU1380

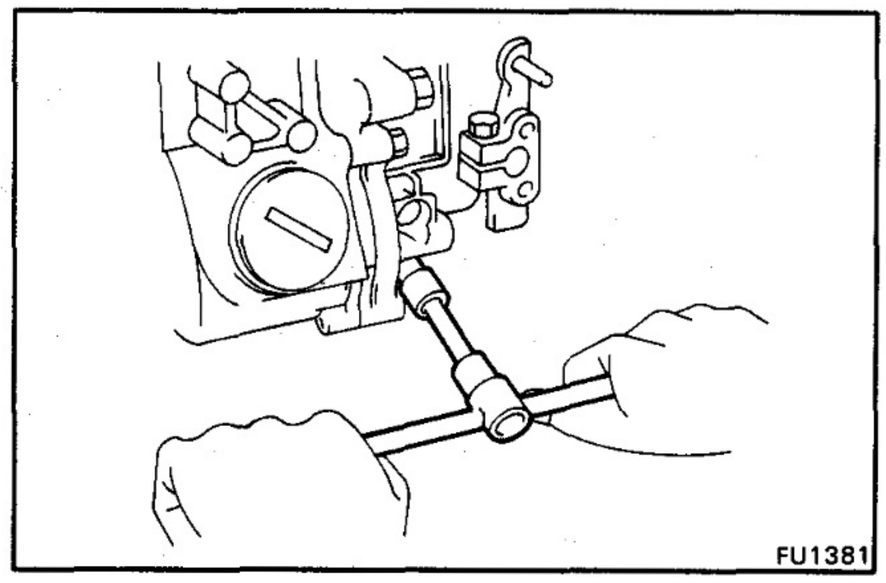
10. [13B-T]
REMOVE BOOST COMPENSATOR

Remove the four bolts, boost compensator and O-ring.


FU0847

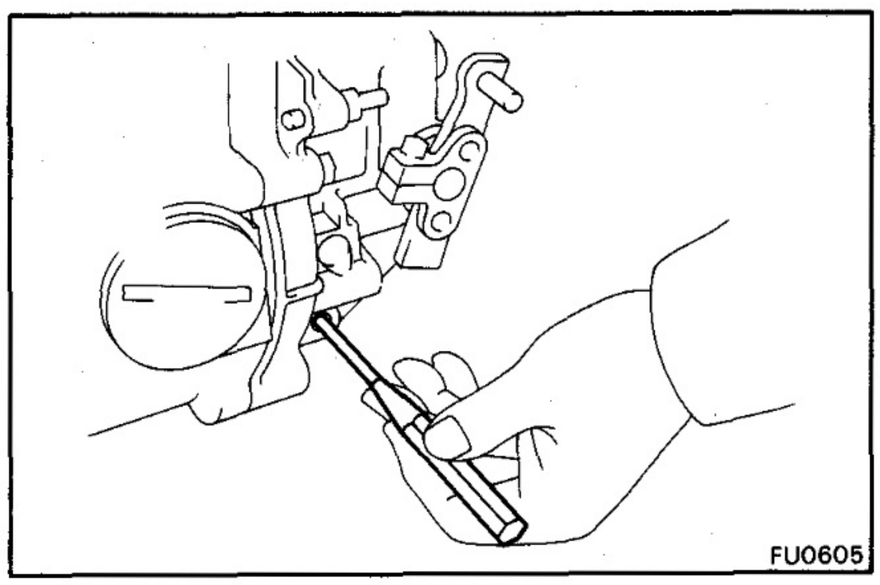
11. [BY, BU]
REMOVE ADJUSTING BRACKET

Remove the two bolts and adjusting bracket.

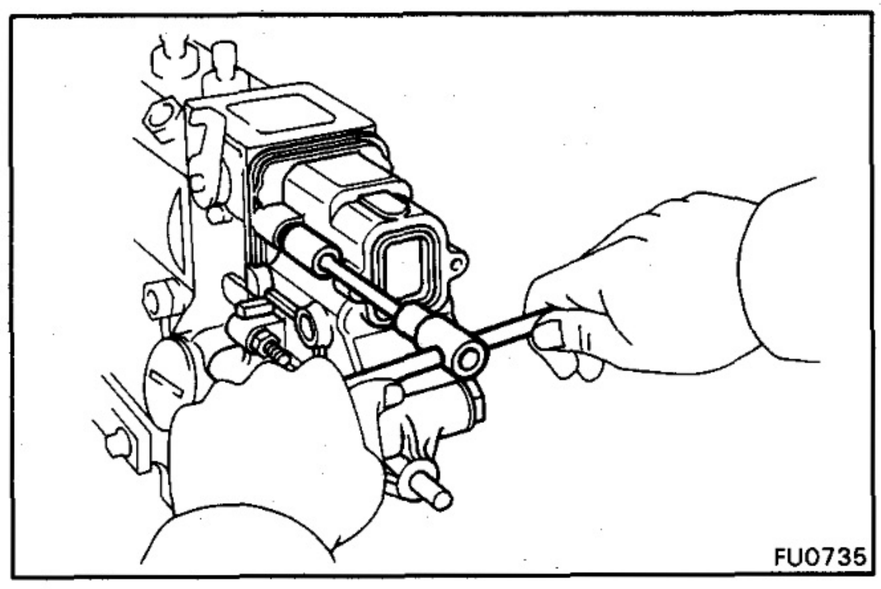

FU1381

12. REMOVE GOVERNOR COVER ASSEMBLY

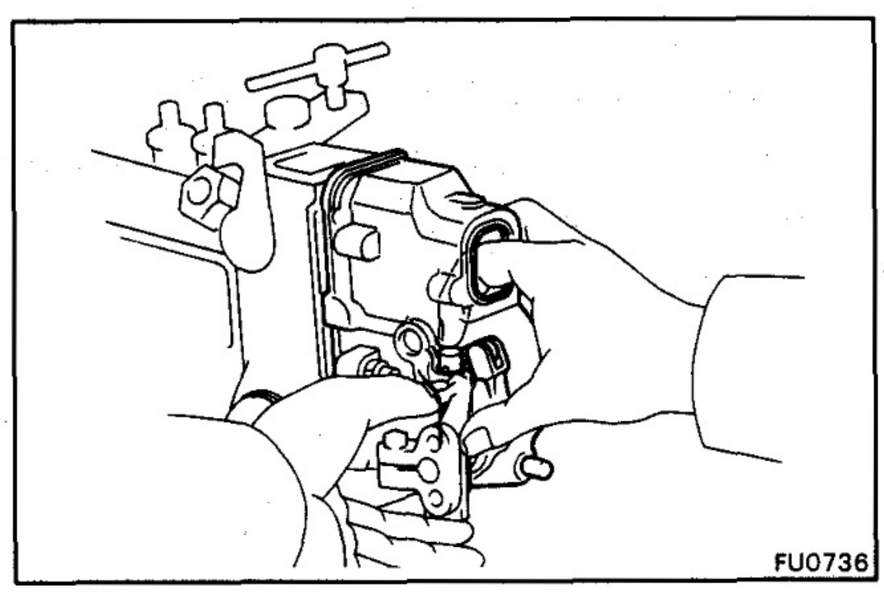
(a) Remove the two screw plugs.


FU0605

(b) Using a pin punch, push out the supporting lever shaft from the governor cover.


FU0735

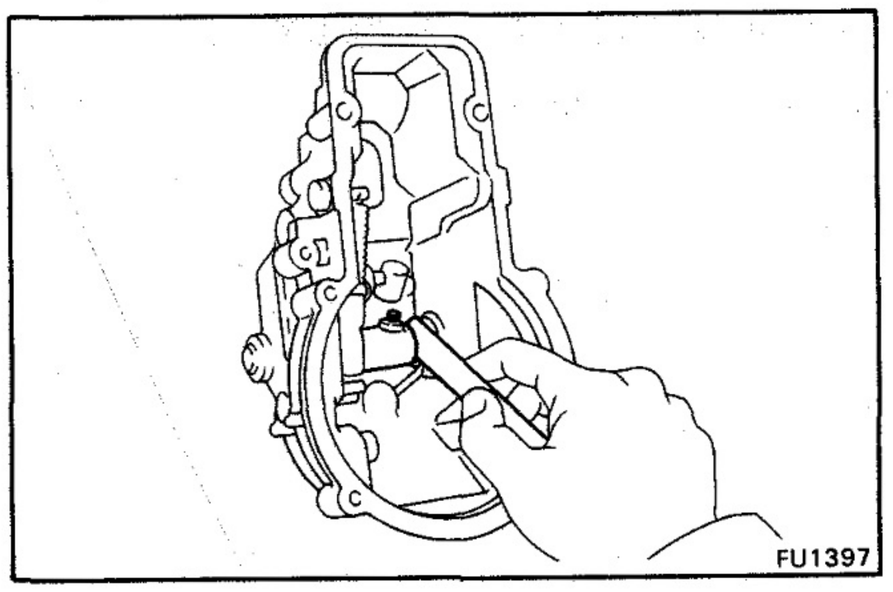
(c) Remove the five (BY, BU) or six (BJ, BB) governor bolts.


FU0736

(d) Turn the engine stop lever fully counterclockwise.

(e) With the adjusting lever turned toward the idle speed side, lift the governor cover up, and pulling from the groove on the floating lever, extract the sliding block. Then remove the governor cover assembly and gasket.

CAUTION: Be careful not to drop the slider and supporting levers.



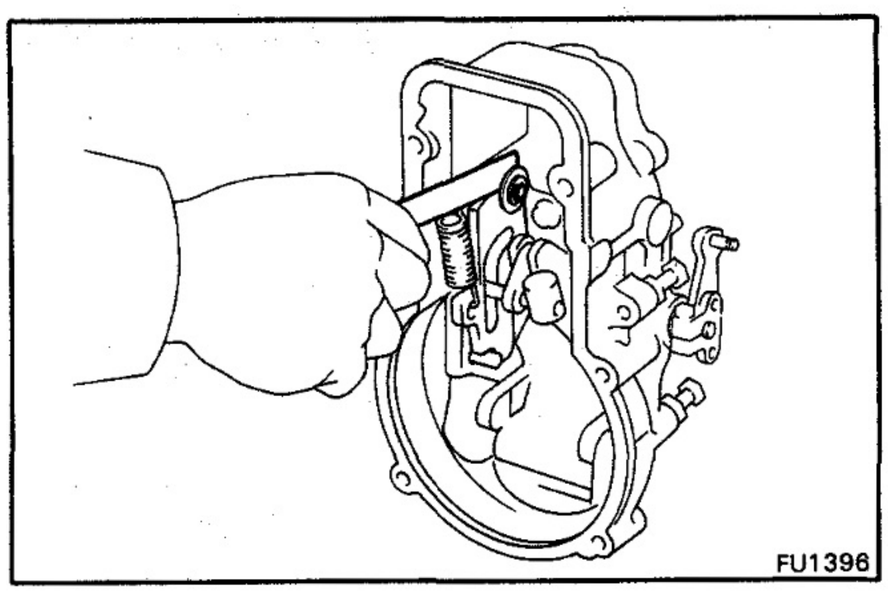
13. CHECK STEERING LEVER THRUST CLEARANCE

Using a feeler gauge, measure the thrust clearance between the steering lever and governor cover.

Thrust clearance: 0.05 – 0.20 mm (0.0020 – 0.0079 in.)

If the clearance is not within specification, replace the a thrust washer.

Thrust washer thickness:
0.50 mm (0.0197 in.)
0.55 mm (0.0217 in.)
0.60 mm (0.0236 in.)
0.65 mm (0.0256 in.)
0.70 mm (0.0276 in.)
0.75 mm (0.0295 in.)
0.80 mm (0.0315 in.)



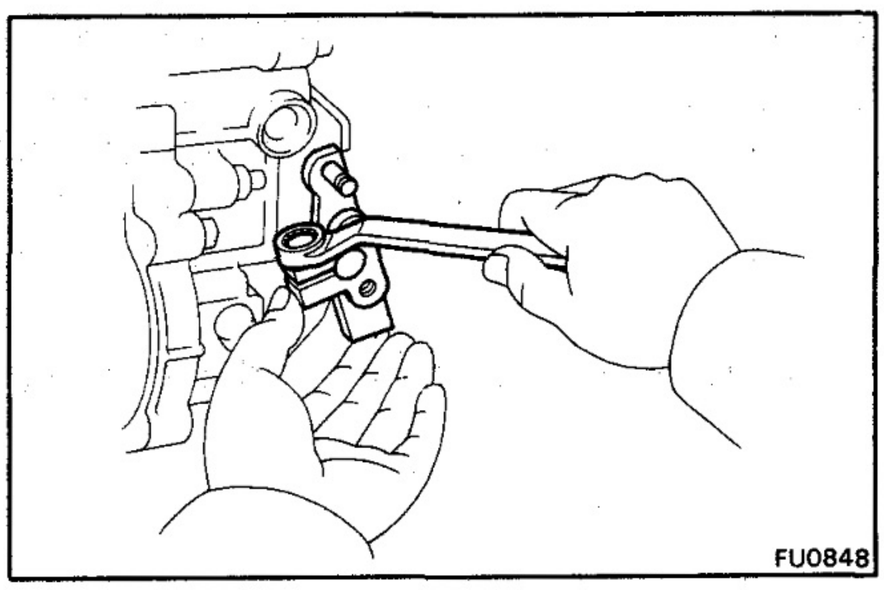
14. CHECK CAM PLATE THRUST CLEARANCE

Using a feeler gauge, measure the thrust clearance between the cam plate and governor cover.

Thrust clearance: 0.08 – 0.12 mm (0.0031 – 0.0047 in.)

If the clearance is not within specification, replace the thrust washer.

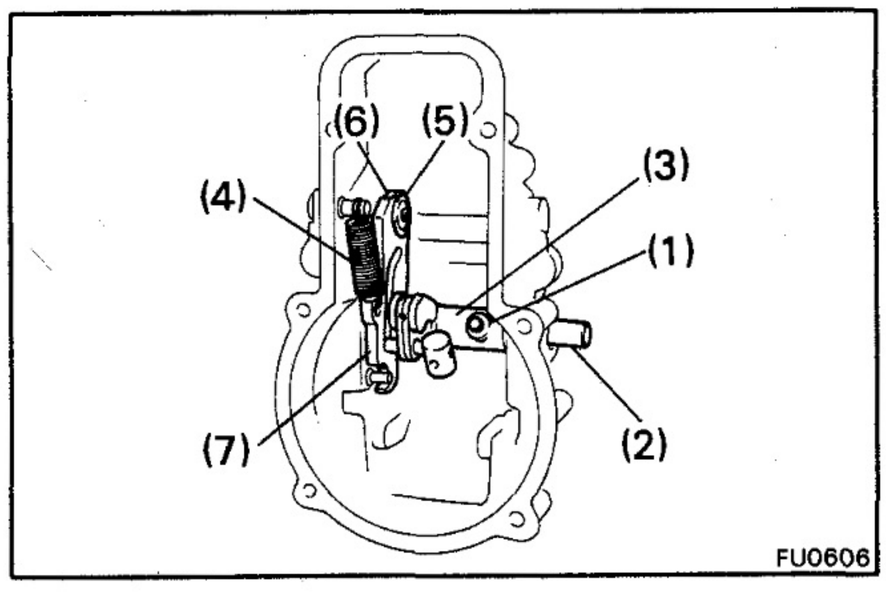
Thrust washer thickness:
0.2 mm (0.008 in.)
0.3 mm (0.012 in.)
0.4 mm (0.016 in.)
0.5 mm (0.020 in.)



15. DISASSEMBLE GOVERNOR COVER ASSEMBLY

(a) Loosen the holding bolt of the No. 2 adjusting lever and pull out the No. 2 adjusting lever.

(b) Remove the set key.

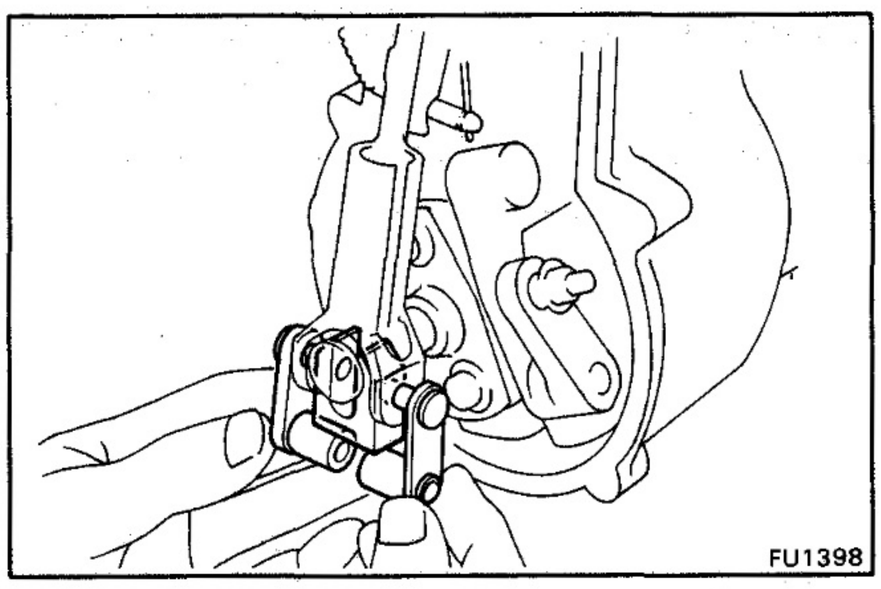


(c) Remove the taper bolt (1).

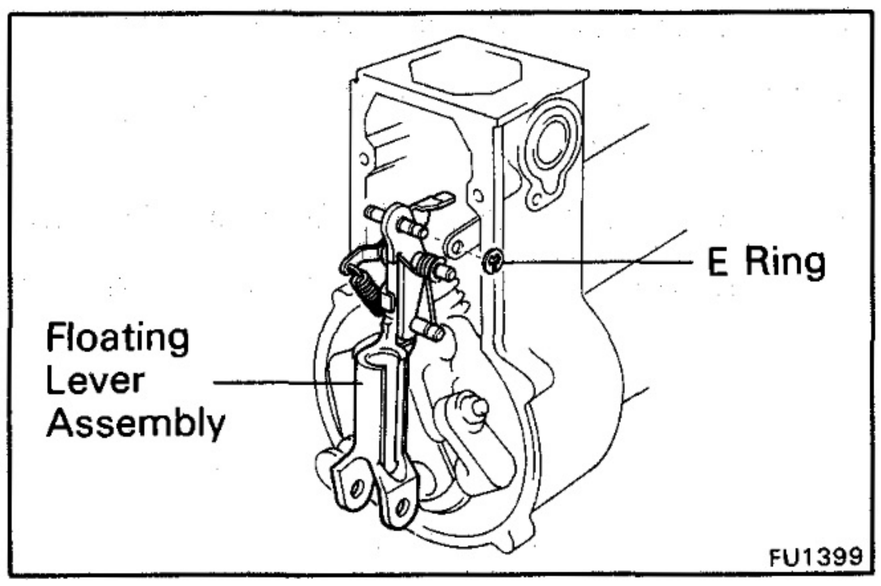
(d) Pull out the steering lever shaft (2) and remove the steering lever (3).

(e) Remove the return spring (4).

(f) Remove the E-ring (5), washer (6) and cam plate (7).

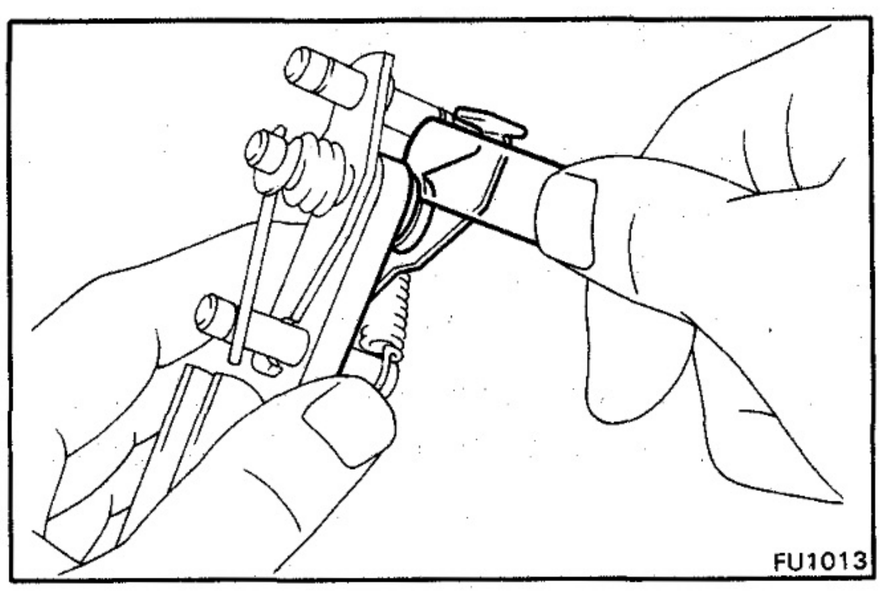


16. REMOVE SUPPORTING LEVERS AND SLIDER



17. REMOVE FLOATING LEVER ASSEMBLY

Remove the E-ring and floating lever assembly.



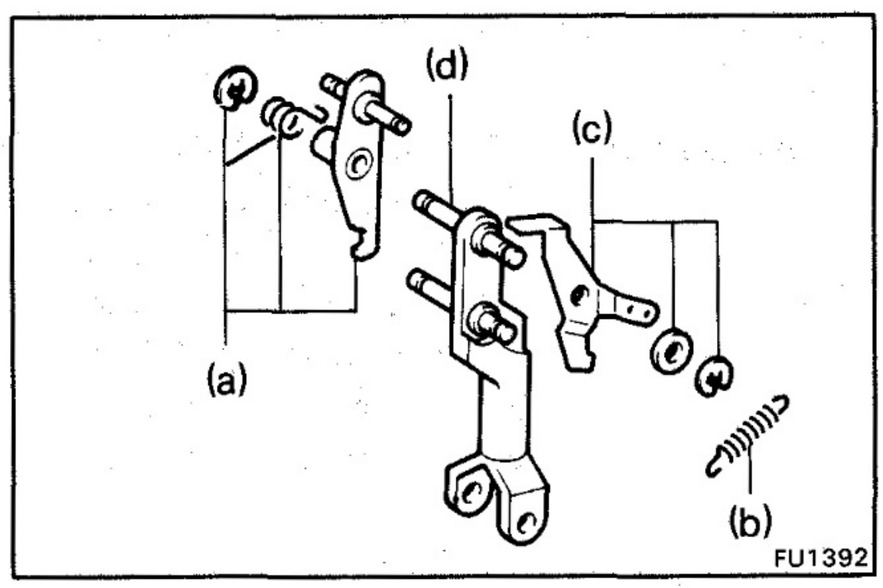
18. CHECK FLOATING LEVER ARM THRUST CLEARANCE

Using a feeler gauge, measure the thrust clearance between the floating arm and floating lever.

Thrust clearance: 0.05 — 0.12mm (0.0020 — 0.0047 in.)

If the clearance is not within specification, replace the thrust washer.

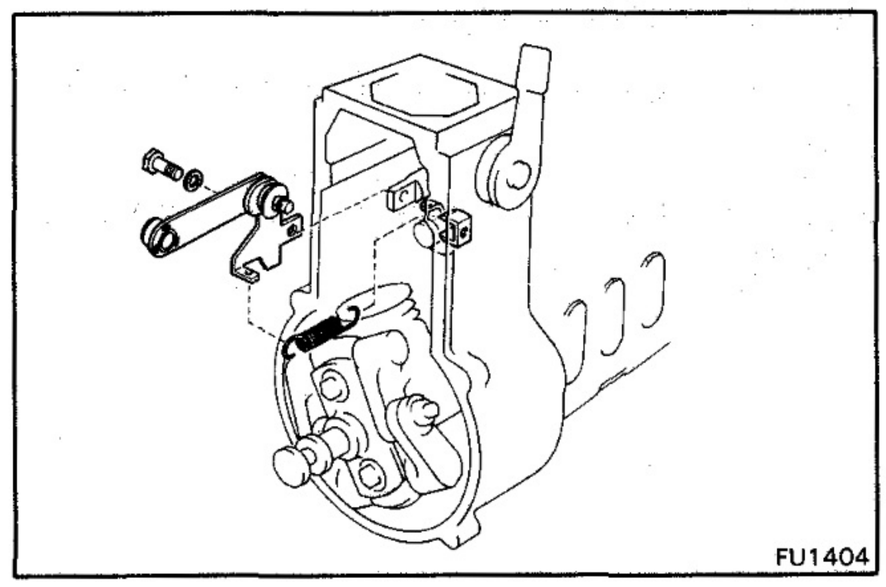
Thrust washer thickness: 0.05 mm (0.0020 in.)
0.10 mm (0.0029 in.)
0.20 mm (0.0079 in.)
0.40 mm (0.0156 in.)



19. DISASSEMBLE FLOATING LEVER ASSEMBLY

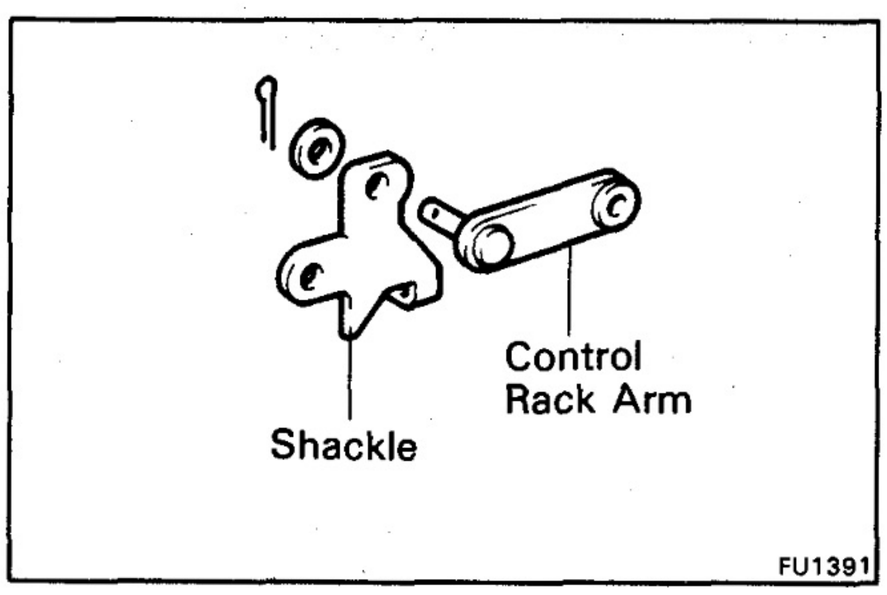
Disassemble the following parts:

(a) E-ring, return spring and control lever
(b) Return spring
(c) E-ring, thrust washer and floating arm
(d) Floating lever



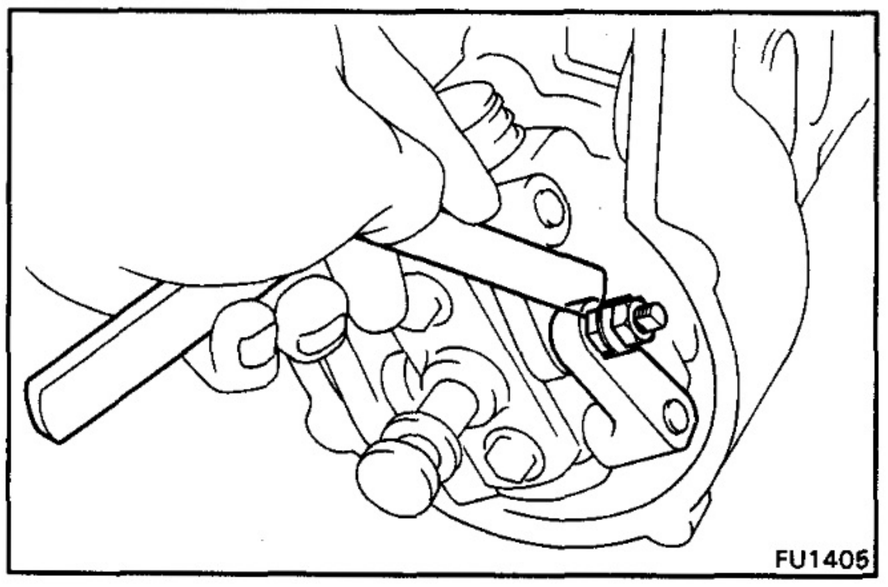
20. REMOVE SHACKLE AND CONTROL RACK ARM ASSEMBLY

(a) Remove the return spring.
(b) Remove the bolt, spring washer, arm nut and the shackle and arm assembly.



21. DISASSEMBLE SHACKLE AND CONTROL RACK ARM ASSEMBLY

Remove the cotter pin and washer, and disassemble the shackle and arm.

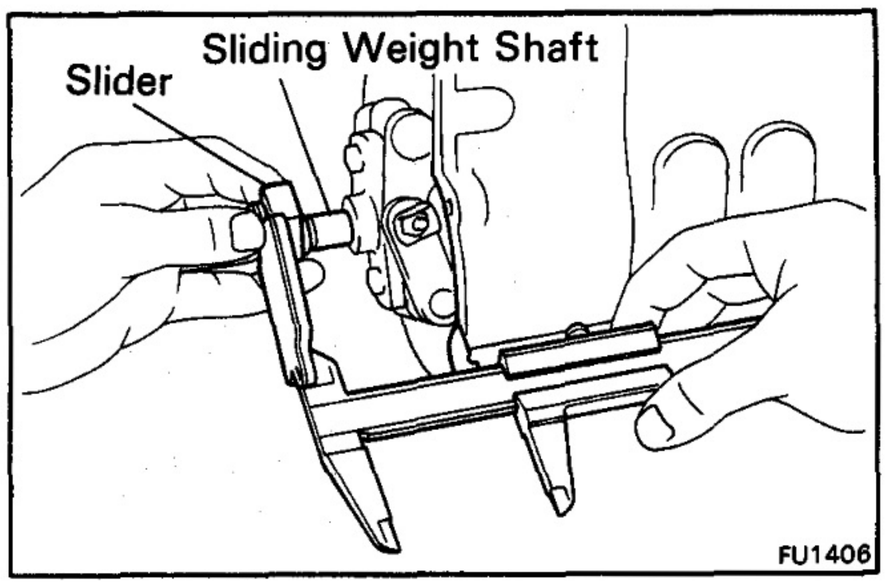


22. CHECK JOINT BOLT THRUST CLEARANCE

Using a feeler gauge, measure the thrust clearance between the joint bolt and flyweight.

Thrust clearance: 1.5 — 2.0 mm (0.059 — 0.079 in.)

If the clearance is not within specification, adjust with the two lock nuts.

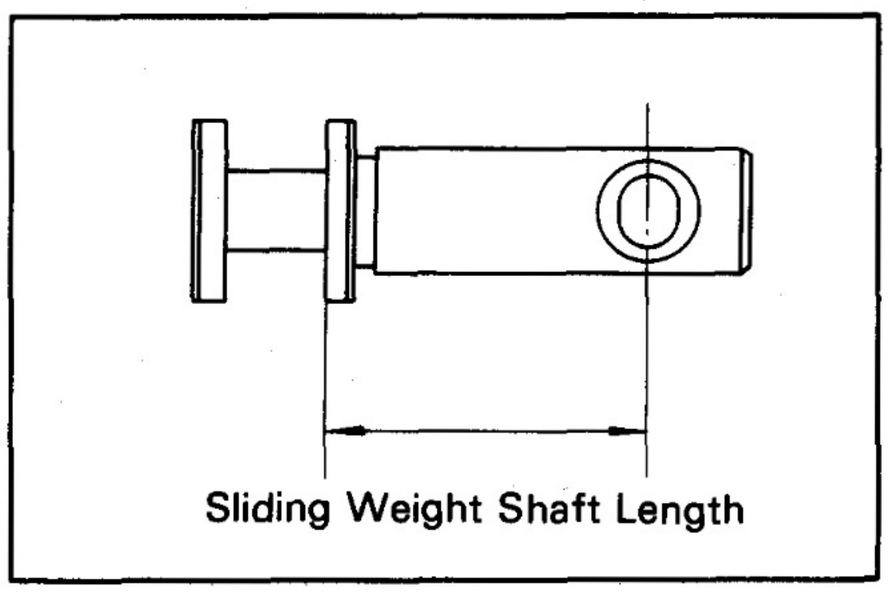


23. CHECK SLIDING WEIGHT SHAFT FITTING DIMENSION

While pulling on the sliding weight shaft, measure the fitting dimensions with calipers as shown.

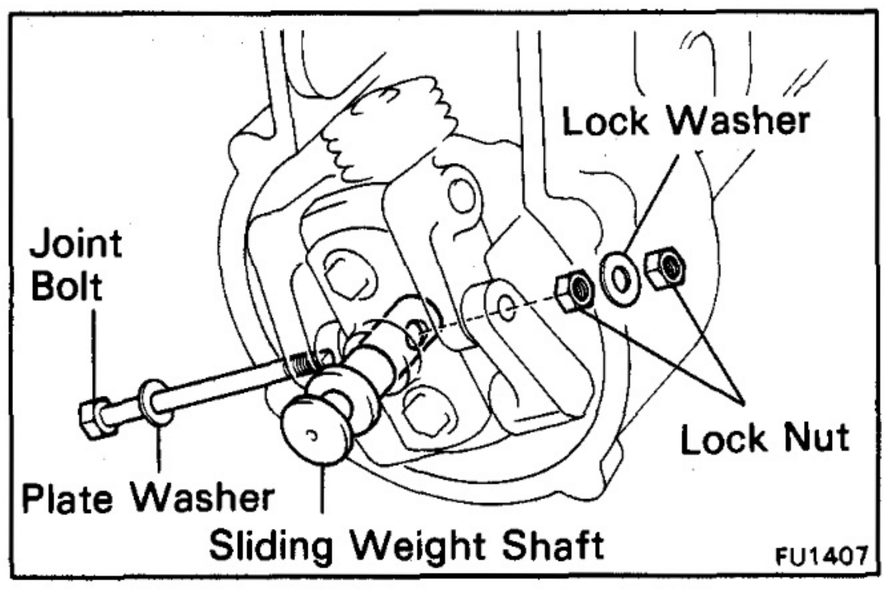
Fitting dimensions: 49.7 — 50.1 mm (1.957 — 1.972 in.)

CAUTION: If the fitting dimensions are not within specification, it may be impossible to adjust the governor.



If the dimension is not within specification, replace the sliding weight shaft.

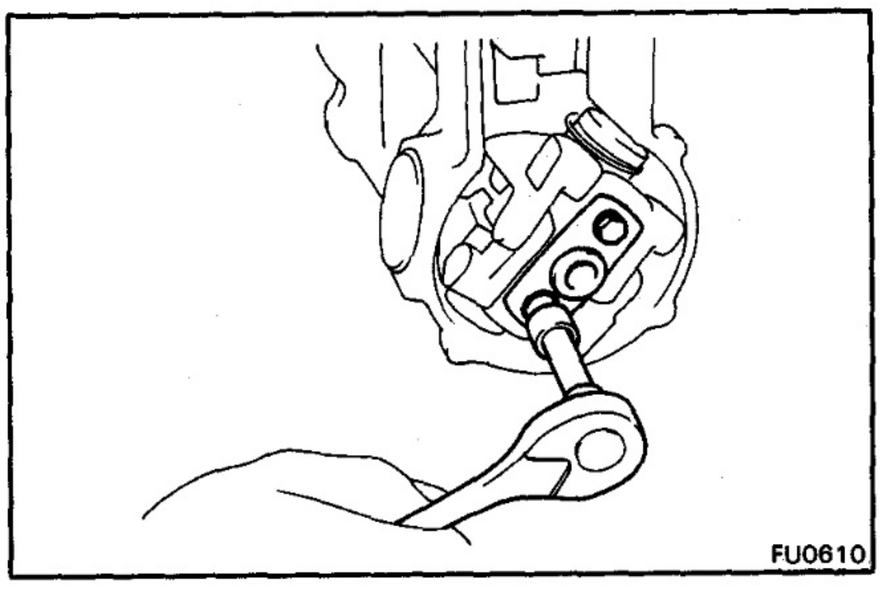
Sliding weight shaft length:
30.7 mm (1.209 in.)
30.9 mm (1.217 in.)
31.1 mm (1.224 in.)
31.3 mm (1.232 in.)
31.5 mm (1.240 in.)
31.7 mm (1.248 in.)
31.9 mm (1.256 in.)



24. REMOVE SLIDING WEIGHT SHAFT

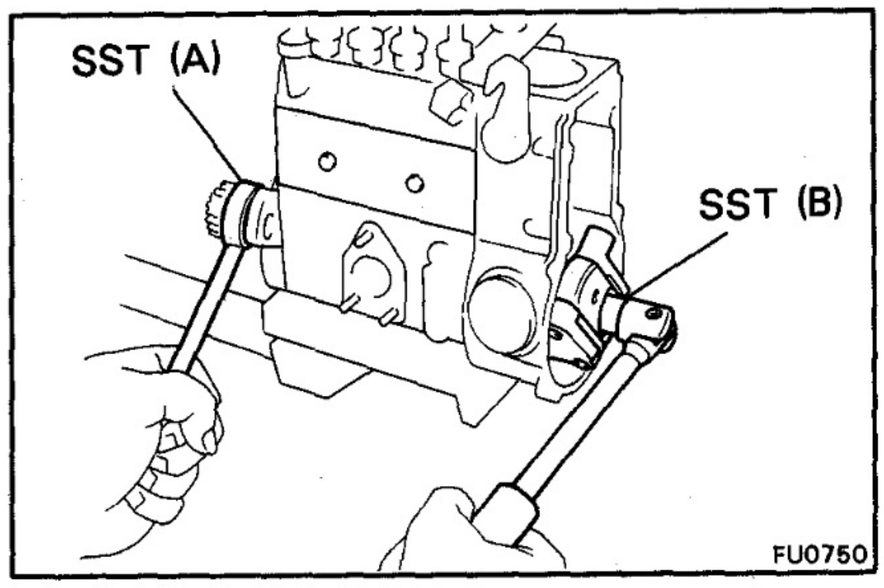
(a) Unstake the lock washer, and remove the lock nuts and lock washer.

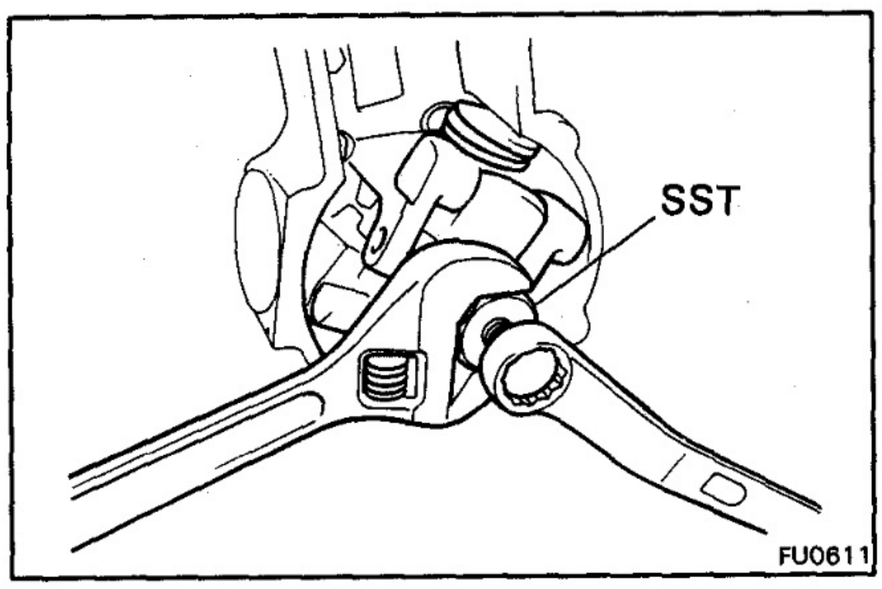
(b) Pull out the joint bolt with the plate washer and sliding weight shaft.



25. REMOVE GUIDE BUSHING

Remove the two bolts and guide bushing.





26. REMOVE FLYWEIGHT ASSEMBLY

(a) Using SST (A) to hold the spline shaft, remove the round nut with SST (B).

SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09260-78010)

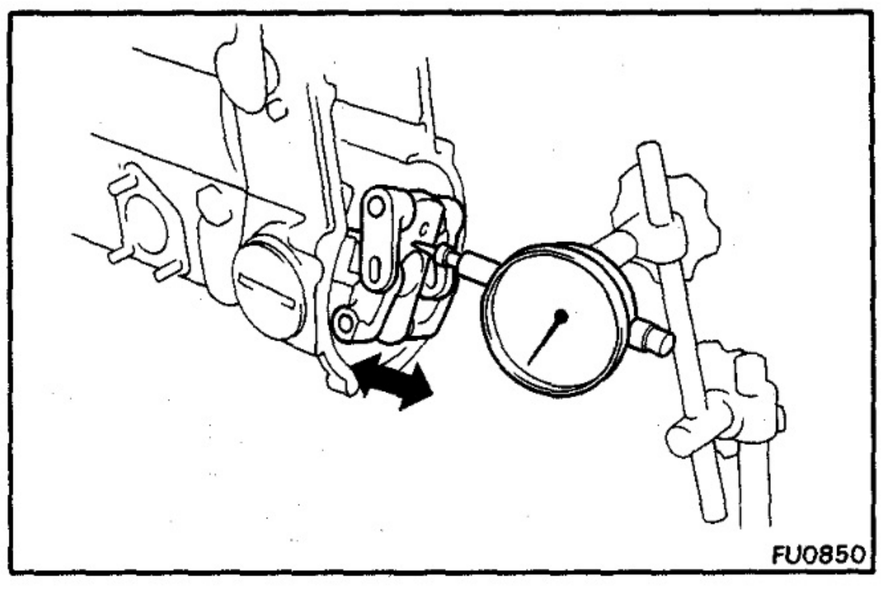
(b) [A/T]
Remove the spring washer.

(c) [M/T]
Remove the adjusting shim, the flyweight assembly and six dampers.

(d) [A/T]
Using SST, remove the flyweight assembly.

SST 09260-58010 (09267-76011)

(e) [A/T]
Remove the set key.



27. [M/T]
CHECK FLYWEIGHT THRUST CLEARANCE

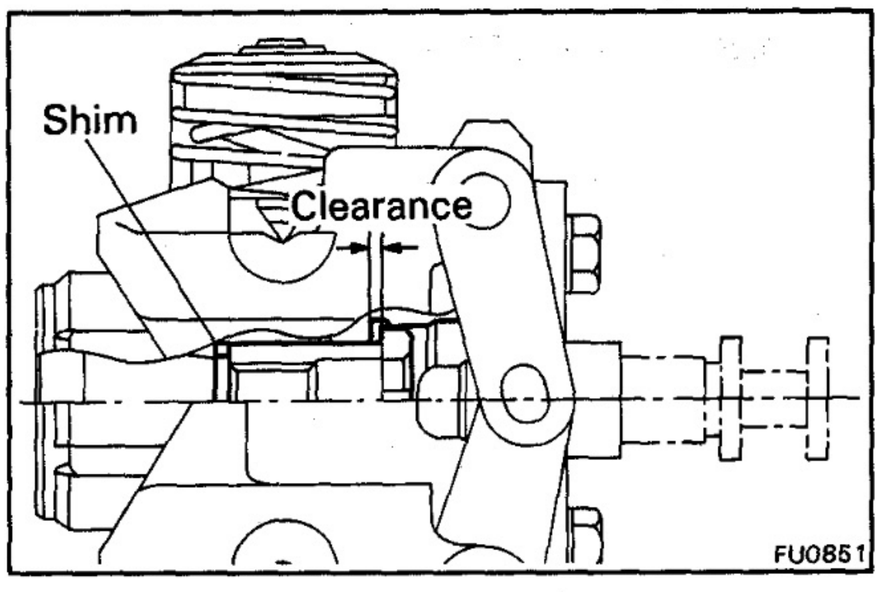
(a) Install the flyweight assembly without the dampers with the adjusting shim and round nut.

Torque: 550 kg-cm (40 ft-lb, 54 N·m)

(b) Using a dial indicator, measure the thrust clearance between the flyweight holder and camshaft bushing.

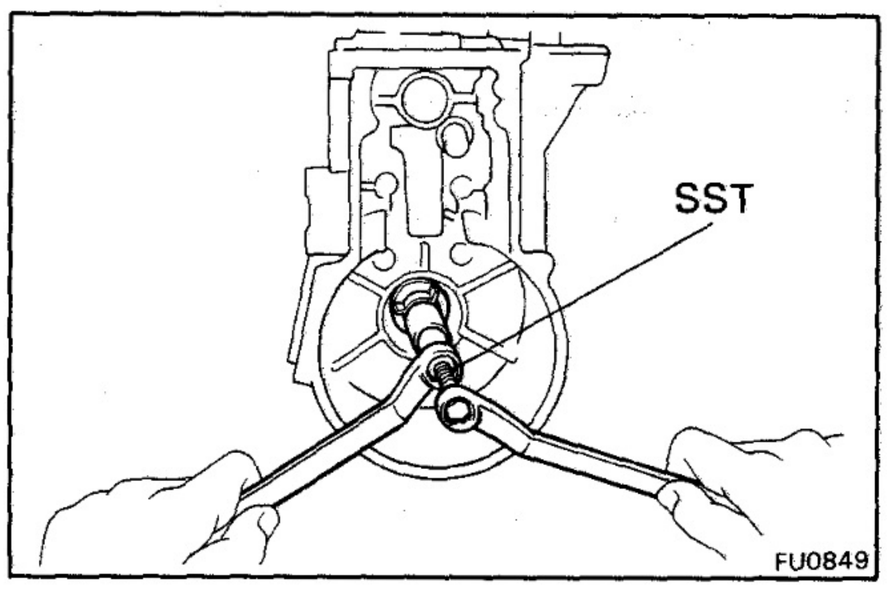
Thrust clearance: 0.02 — 0.10 mm (0.0008 — 0.0039 in.)

If the clearance is not within specification, replace the adjusting shim.



Adjusting shim thickness	mm (in.)
1.60 (0.0630)	1.90 (0.0748)
1.65 (0.0650)	1.95 (0.0768)
1.70 (0.0670)	2.00 (0.0787)
1.75 (0.0689)	2.10 (0.0827)
1.80 (0.0709)	2.20 (0.0866)
1.85 (0.0728)	2.30 (0.0906)

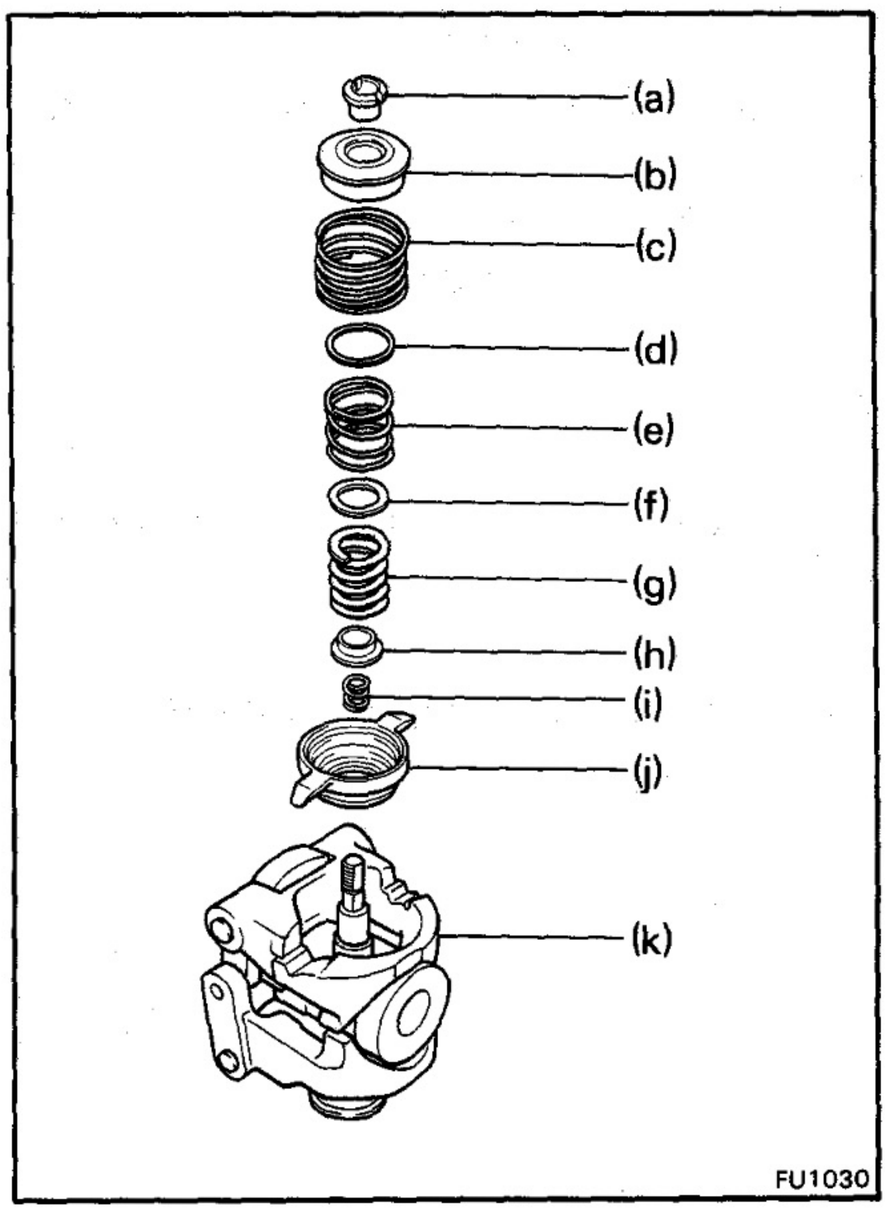
(c) Remove the flyweight assembly.



28. [M/T]
REMOVE CAMSHAFT BUSHING

Using SST, remove the camshaft bushing.

SST 09260-58010 (09267-76030)

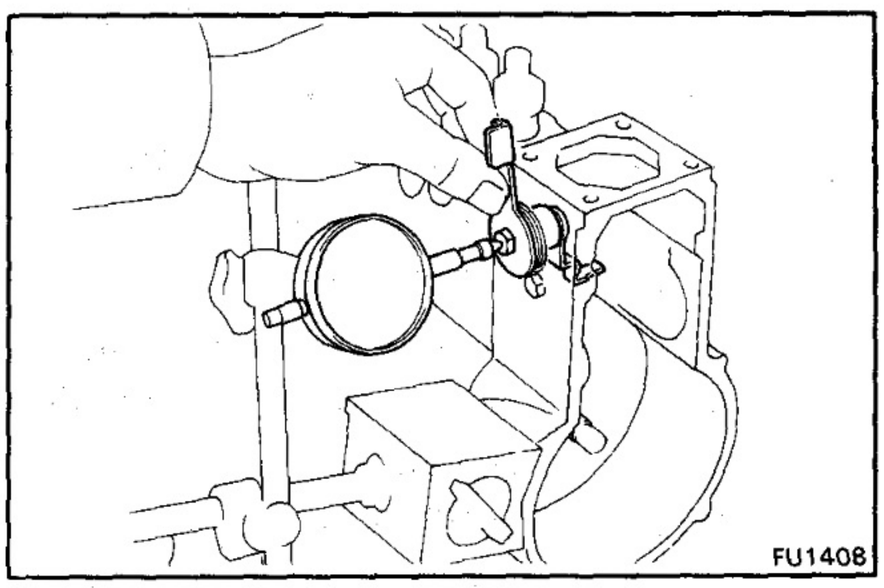


29. DISASSEMBLE FLYWEIGHT ASSEMBLY

Disassemble the following parts:

(a) Adjusting nut
(b) Spring guide
(c) Outer idle spring
(d) Outer adjusting washer
(e) Inner idle spring
(f) Inner adjusting washer
(g) Speed control spring
(h) Inner spring seat
(i) Mechanical spring
(j) Spring seat
(k) Flyweights with holder

CAUTION: Be careful not to mix these parts up.



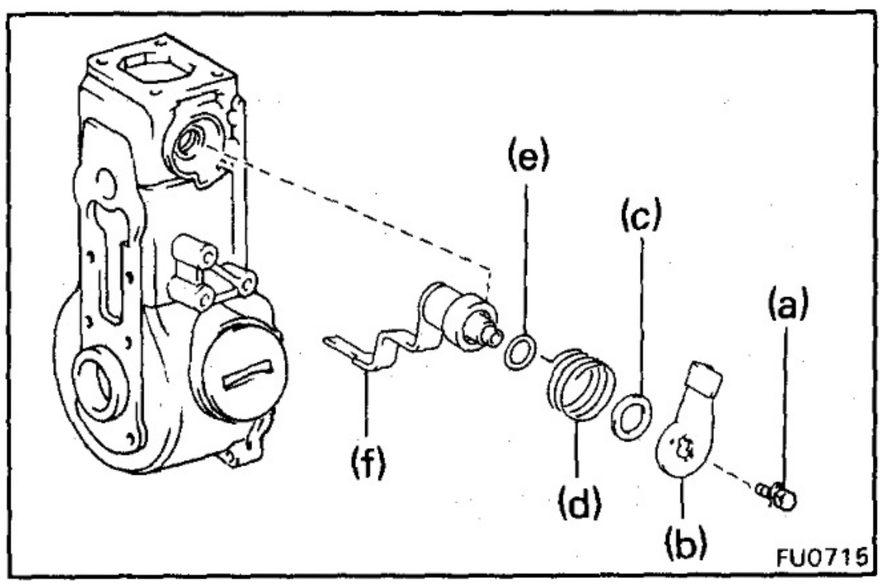
30. [11B, 13B]
CHECK STOPPER ARM THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance between the stopper arm and governor housing.

Thrust clearance: 0.05 – 0.20 mm (0.0020 – 0.0079 in.)

If the clearance is not within specification, replace the thrust washer.

Thrust washer thickness: 0.1 mm (0.004 in.)
0.2 mm (0.008 in.)
0.5 mm (0.020 in.)

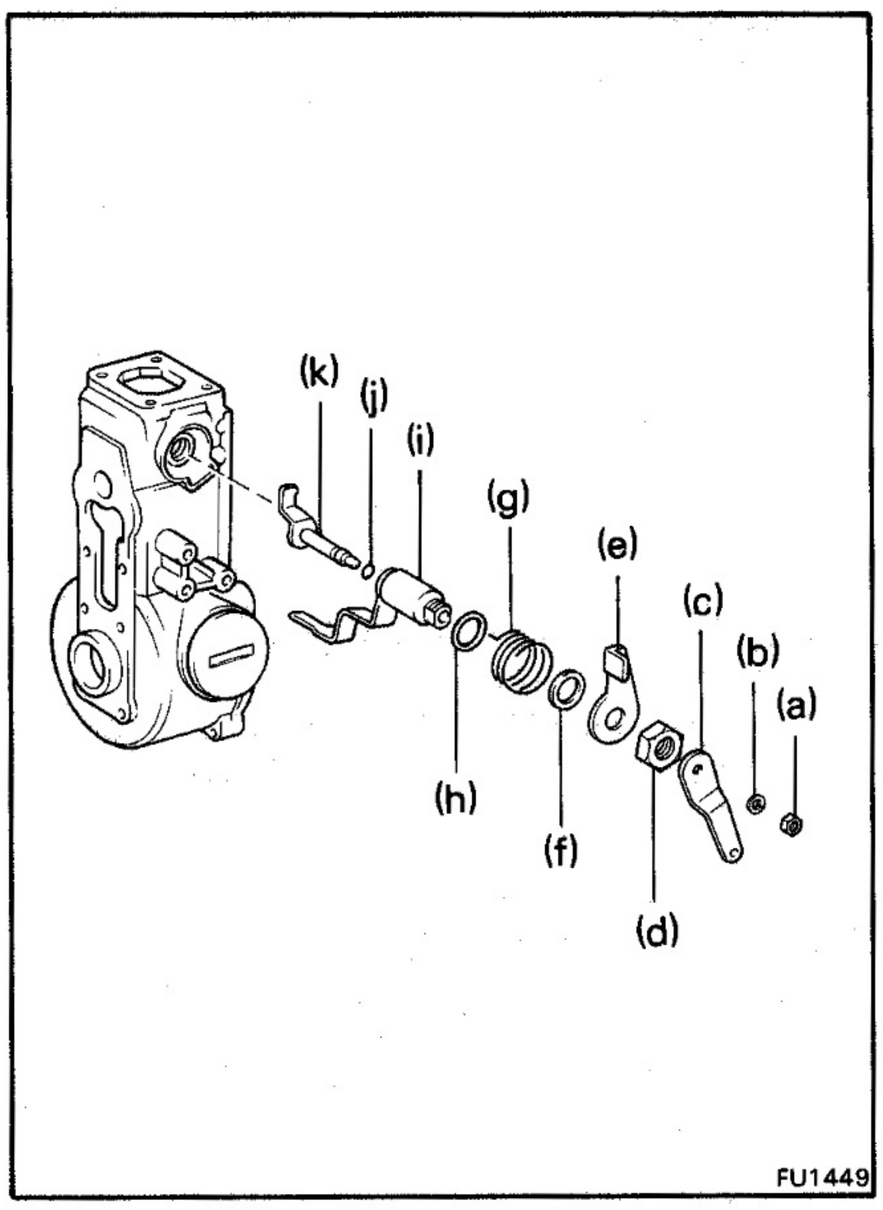


31. [11B, 13B]
REMOVE STOP LEVER AND STOPPER ARM

Remove the following parts:

[w/o HAC]

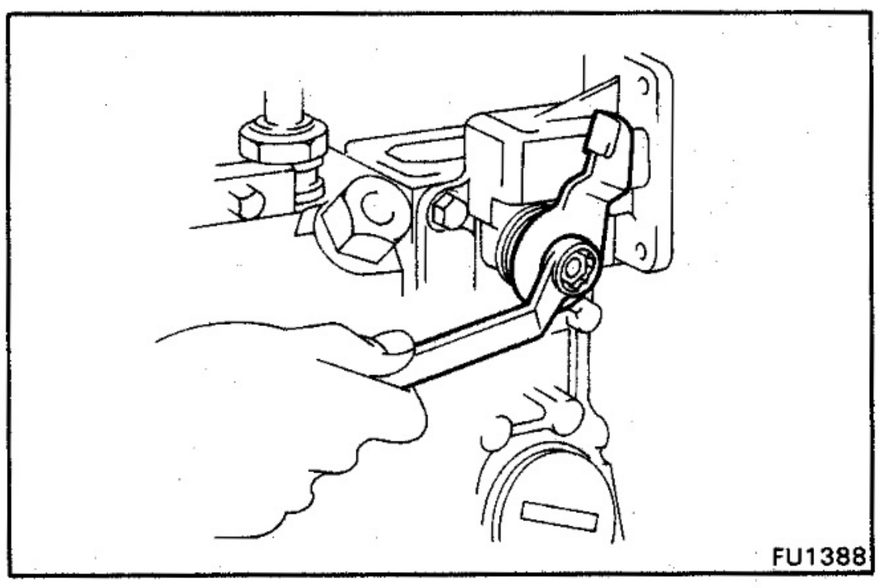
(a) Bolt
(b) Stop lever
(c) Thrust washer
(d) Return spring
(e) O-ring
(f) Stopper arm



FU1449

[w/ HAC]

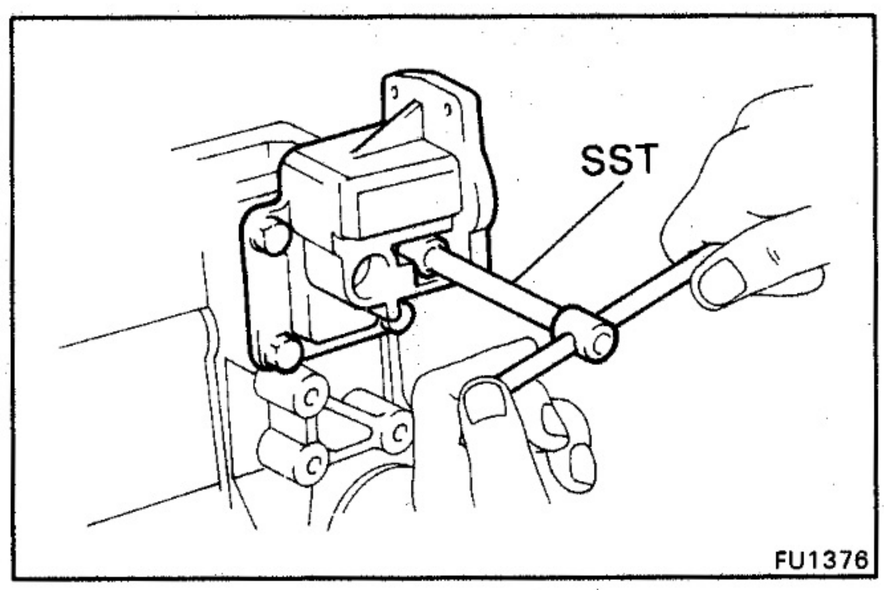
(a) Nut
(b) Spring washer
(c) HAC lever
(d) Nut
(e) Stop lever
(f) Thrust washer
(g) Return spring
(h) O-ring
(i) Stopper arm
(j) O-ring
(k) Arm


FU1388

32. [13B-T]
REMOVE NO. 2 FULL-LOAD STOPPER HOUSING

(a) Remove the nut, stop lever, return spring and O-ring.

(b) Remove the spring seat.

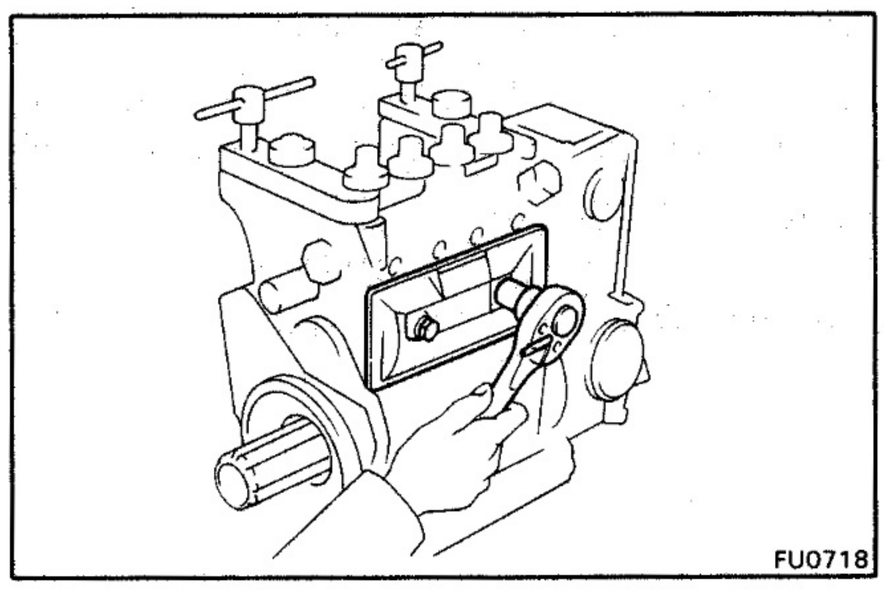


FU1376

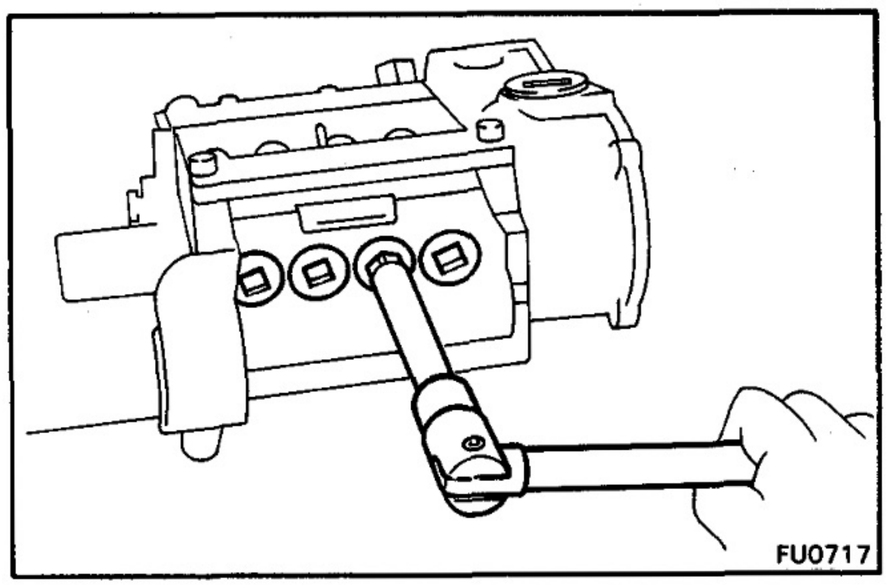
(c) Using SST, remove the four bolts, No. 2 full-load stopper housing and O-ring.

SST 09260-58010 (09276-76010)

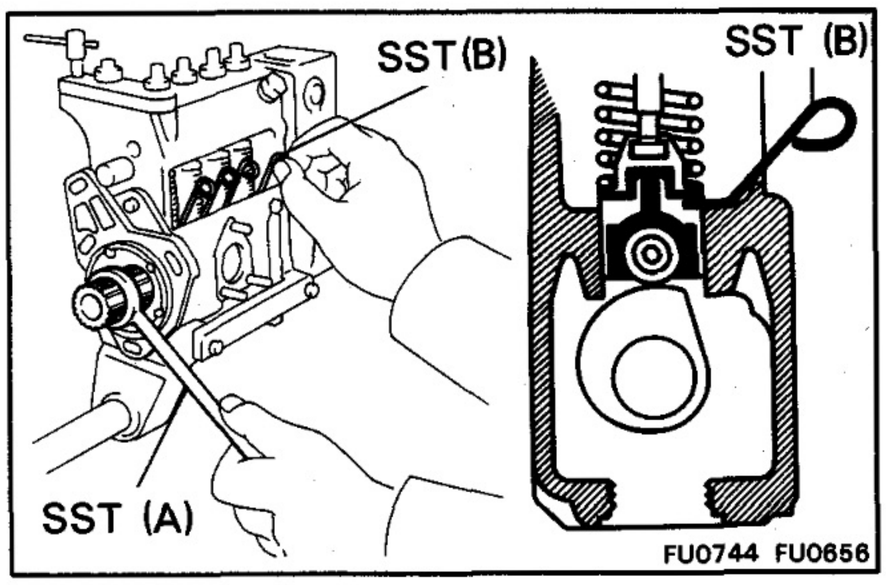
(d) Remove the arm and stopper arm.


FU0718

33. REMOVE INJECTION PUMP COVER



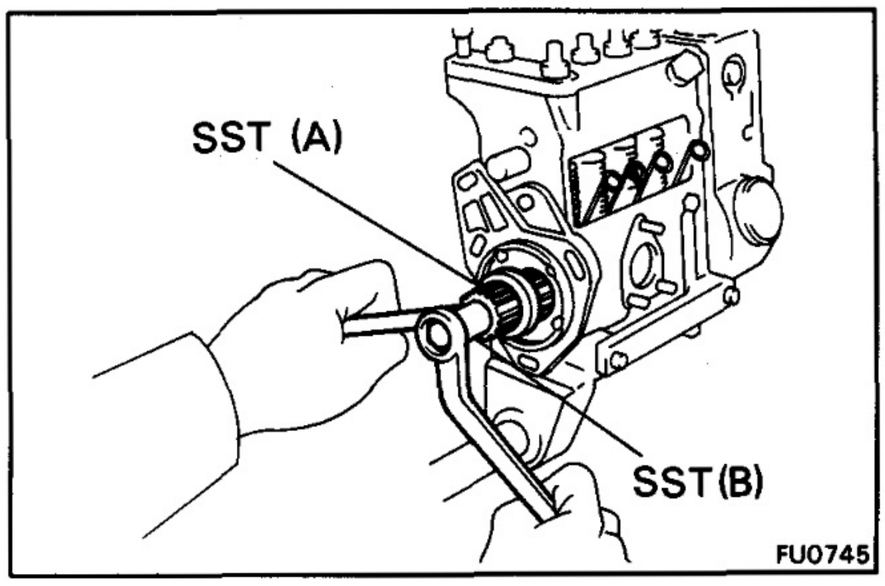
34. REMOVE PLATE PLUGS



35. INSTALL SST TO TAPPET SERVICE HOLES

Using SST (A), turn the camshaft and insert SST (B) into each tappet service hole when the tappets are at their highest positions.

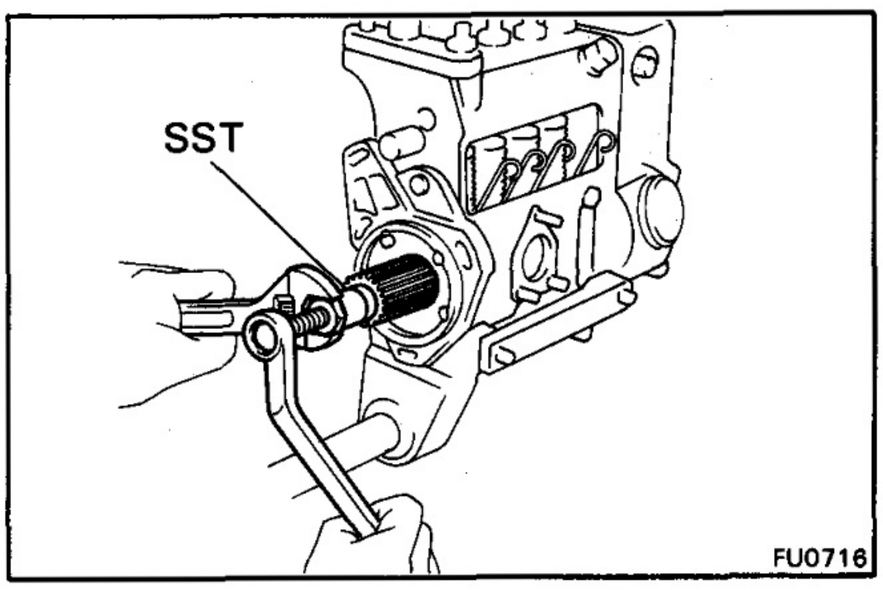
SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09274-46011)



36. REMOVE SPLINE SHAFT

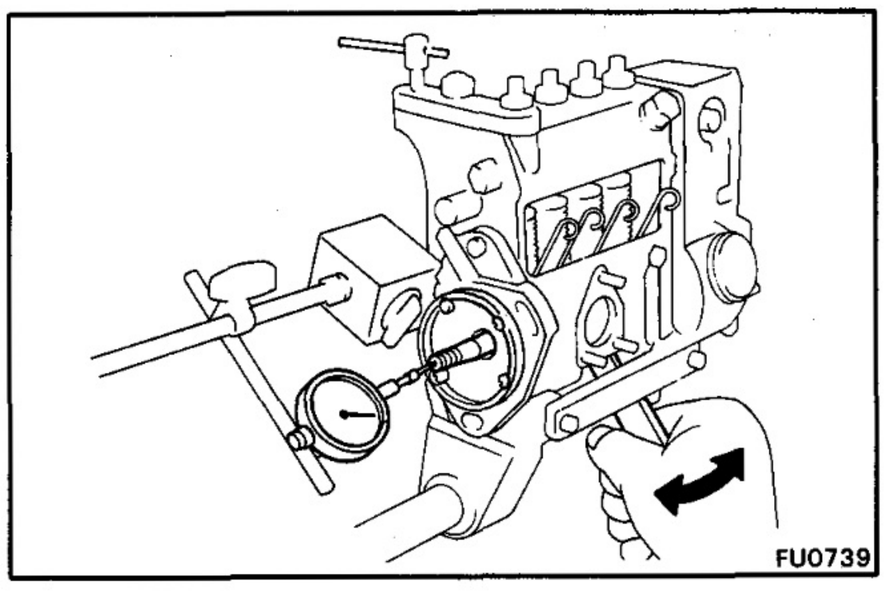
(a) Using SST (A) to hold the spline shaft, remove the round nut with SST (B).

SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09266-76011)



(b) Using SST, remove the spline shaft.

SST 09260-58010 (09267-76011)



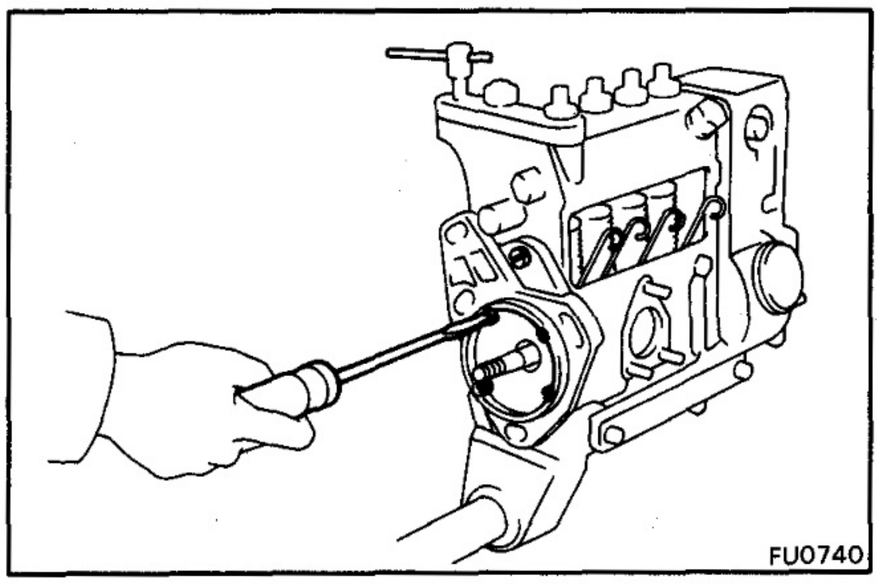
37. CHECK CAMSHAFT THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth with a wooden stick.

Standard clearance: 0.03 — 0.05 mm (0.0012 — 0.0020 in.)
Maximum clearance: 0.1 mm (0.004 in.)

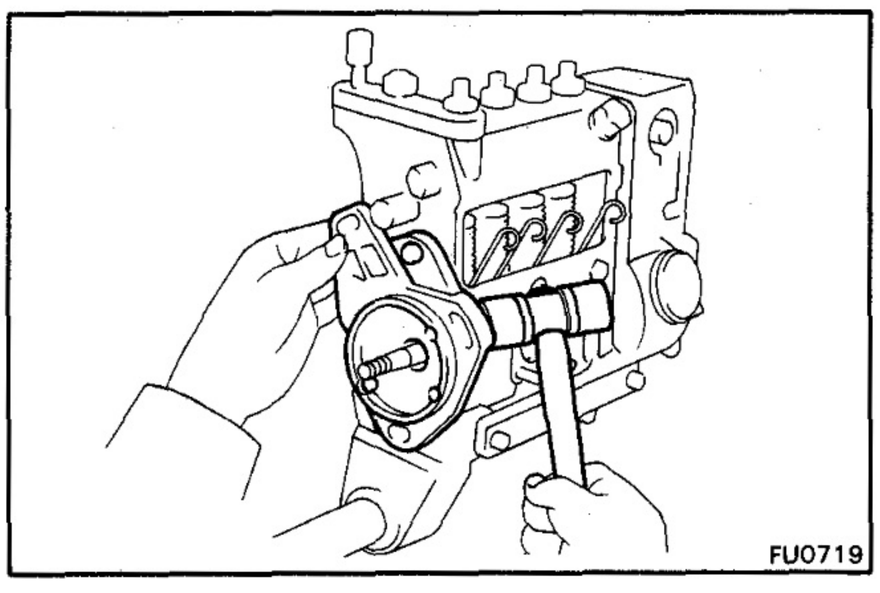
If the clearance is greater than maximum, replace the adjusting shim.

Adjusting shim thickness mm (in.)	
Front Shim	Rear Shim
0.10 (0.0039)	0.10 (0.0039)
0.12 (0.0047)	0.15 (0.0059)
0.14 (0.0055)	0.30 (0.0118)
0.16 (0.0063)	0.50 (0.0197)
0.18 (0.0071)	
0.50 (0.0197)	



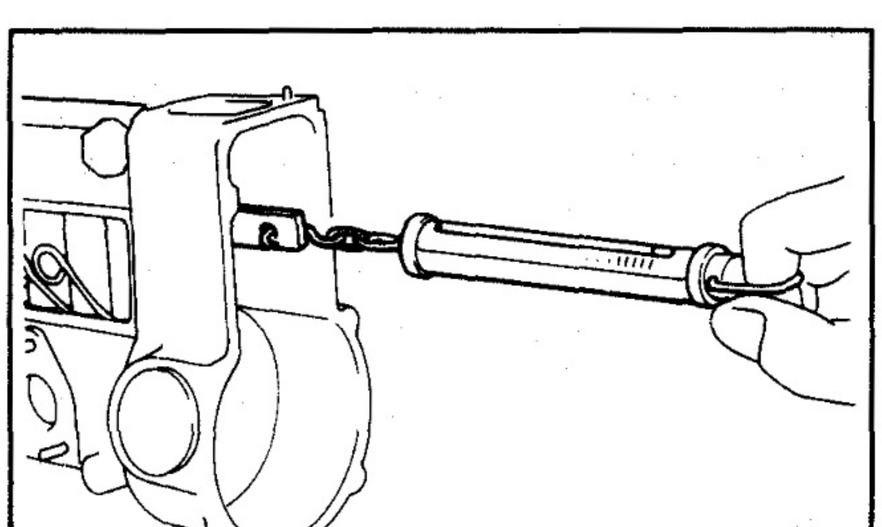
38. REMOVE PUMP FLANGE

(a) Remove the five screws.



(b) Using a plastic-faced hammer, lightly tap off the pump flange.

39. REMOVE CAMSHAFT



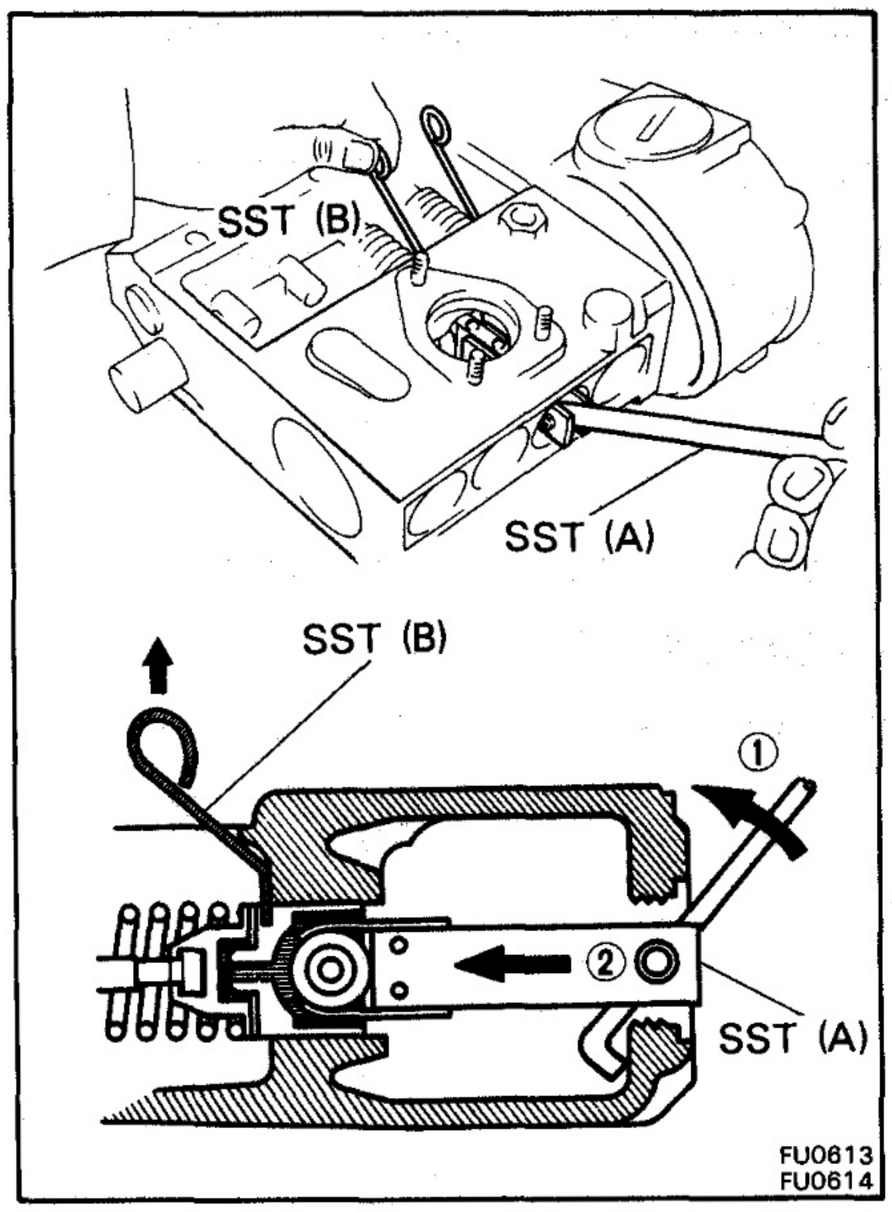
40. CHECK CONTROL RACK SLIDING RESISTANCE

Using a spring scale, measure the control rack sliding resistance. The rack should move smoothly.

Sliding resistance: 120 g (4.2 oz) or less

NOTE:

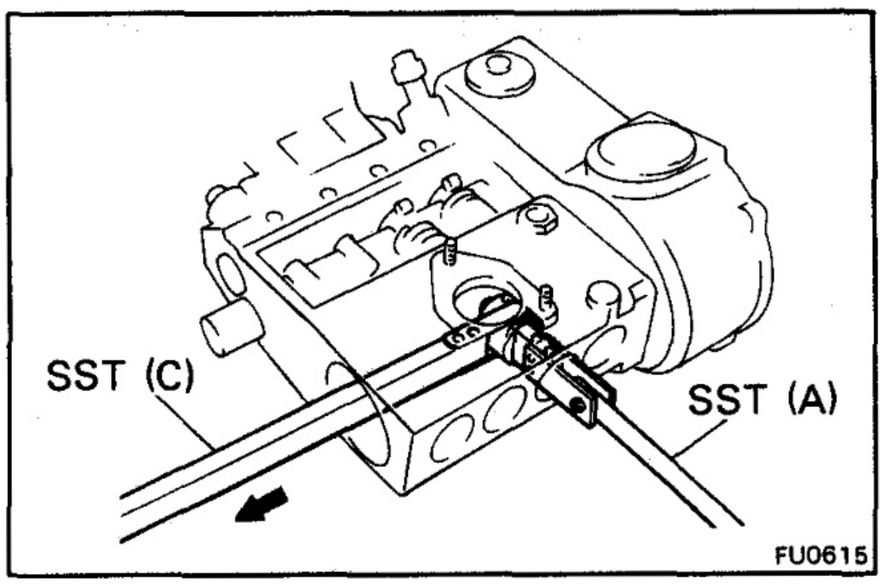
- If rack movement is not smooth, inspect the tappet and control spring, etc. when you remove them.
- Move the control rack right and left as far as it will go to confirm the pinion stop installation position.



41. REMOVE TAPPETS, PLUNGERS AND PINIONS

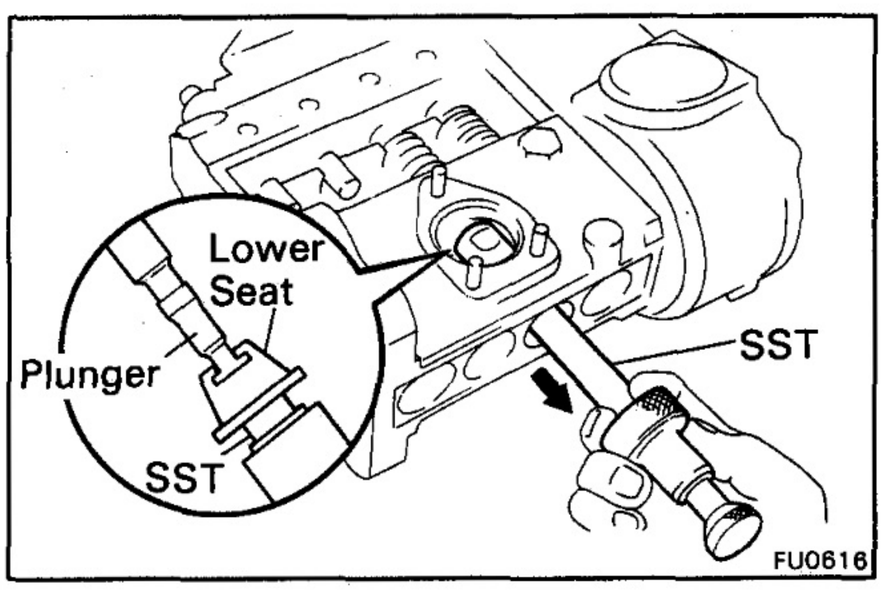
(a) Using SST (A), push the tappet to remove SST (B).

SST (A) 09260-58010 (09272-76011)
(B) 09260-58010 (09274-46011)



(b) Using SST (A), hold the tappet in the camshaft chamber and take out the tappet through the camshaft bearing hole with SST (C).

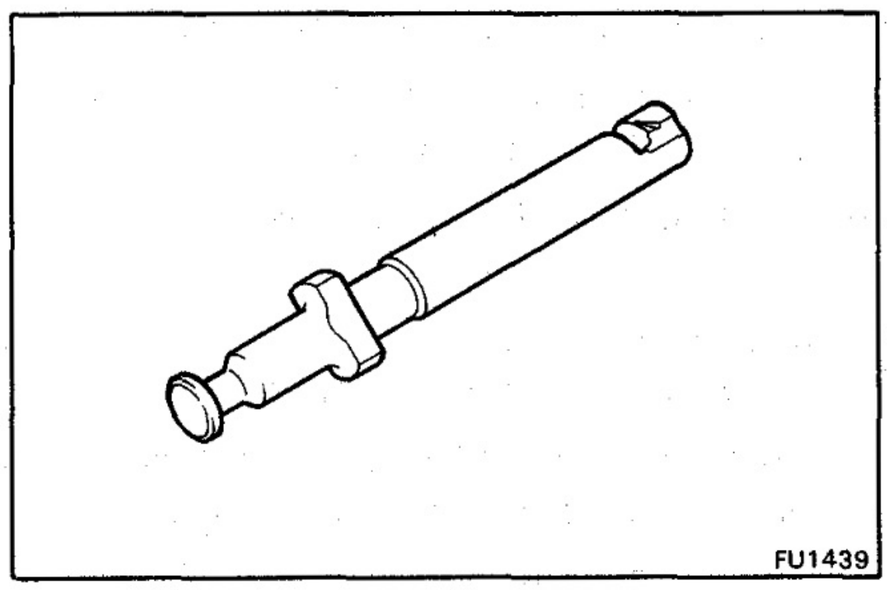
SST (A) 09260-58010 (09272-76011)
SST (C) 09260-58010 (09273-76011)



(c) Using SST, hold the lower spring seat and take it out together with the plunger.

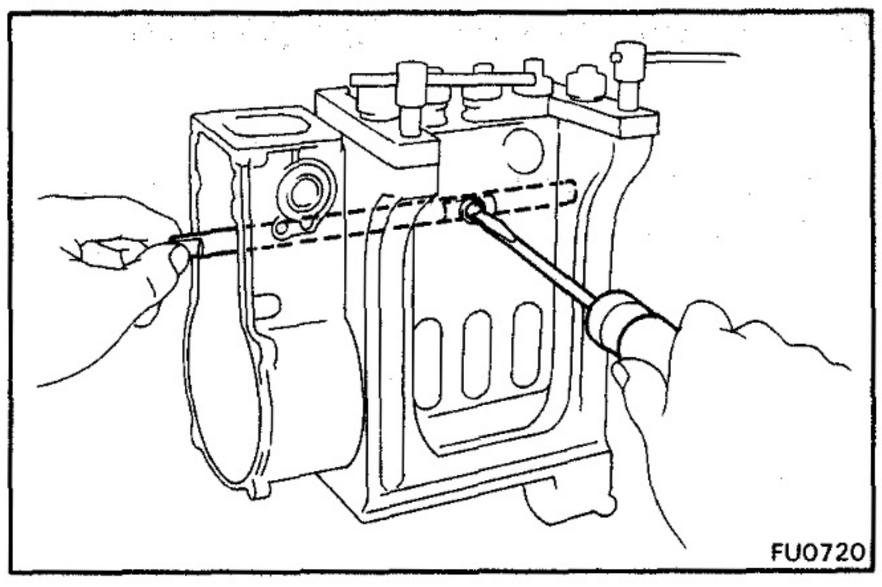
SST 09260-58010 (09275-46010)

(d) Remove the spring, upper spring seat and pinion with the sleeve.



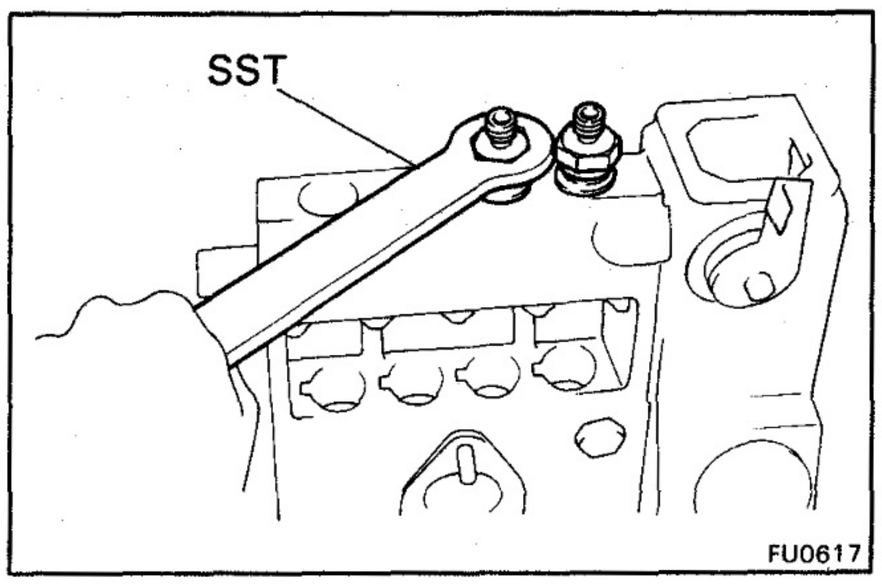
NOTE:

- Do not touch the sliding surfaces of the plunger.
- Arrange all parts for each cylinder, in order, in a parts pan.



42. REMOVE CONTROL RACK

Remove the rack guide screw and pull out the control rack.

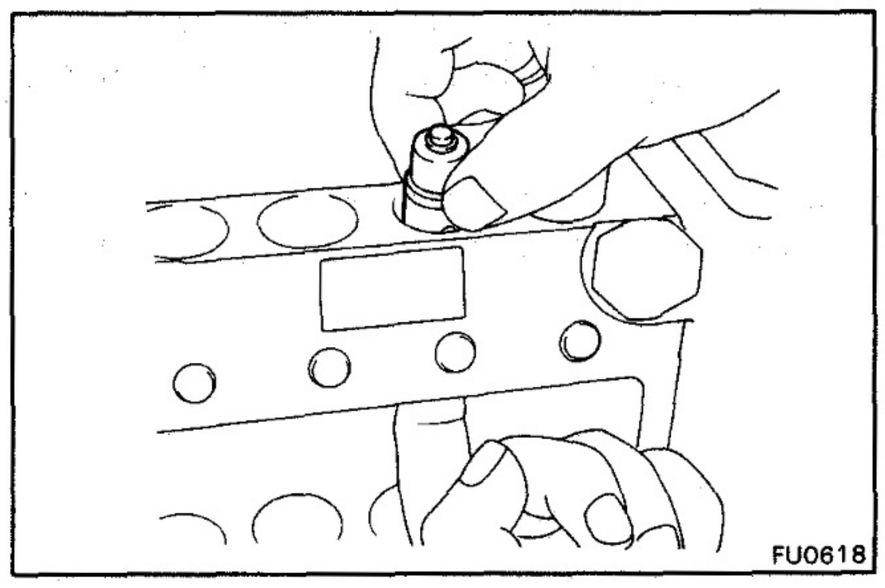


43. REMOVE DELIVERY VALVES AND PUMP CYLINDERS

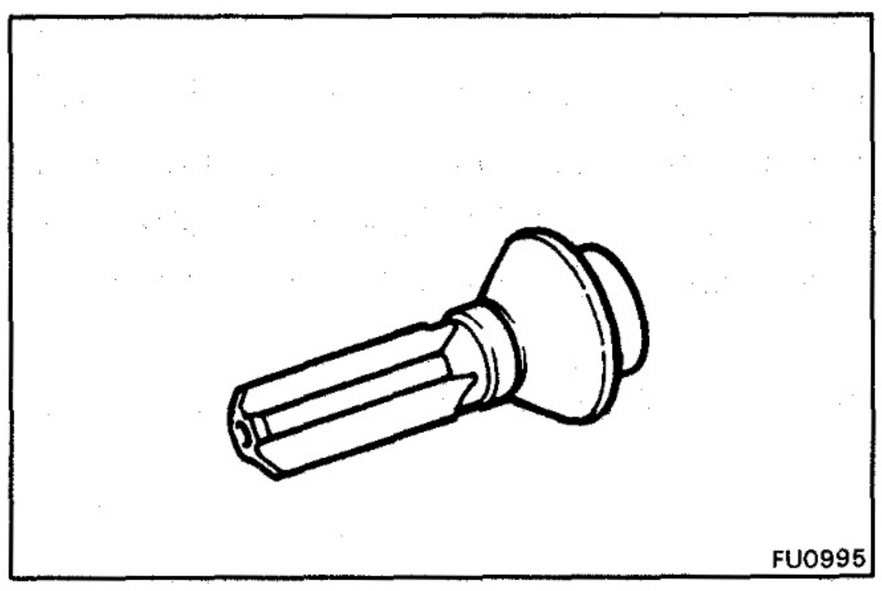
(a) Remove the two lock plates.

(b) Using SST, remove the delivery valve holder, O-ring, stopper and spring.

SST 09260-58010 (09270-76010)

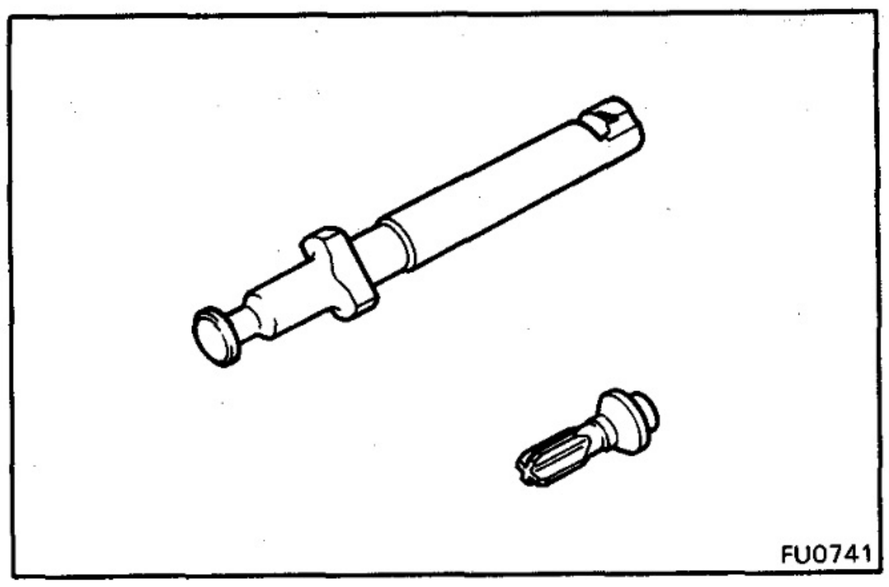


(c) Raise the pump cylinder with your forefinger and remove it together with the delivery valve and gasket.



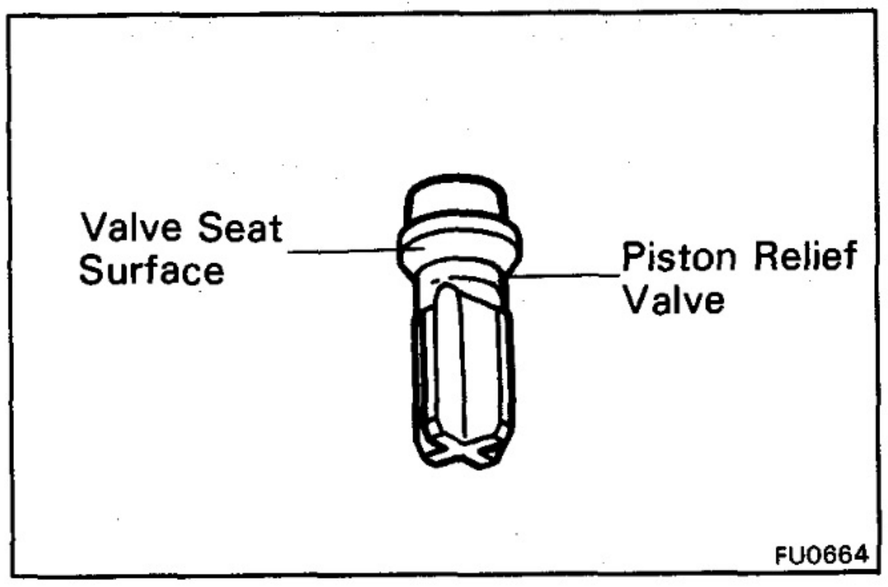
NOTE:

- Do not touch the sliding surfaces of the delivery valve.
- Arrange all parts for each cylinder, in order, in a parts pan.


FU0741

INSPECTION AND REPAIR OF INJECTION PUMP

NOTE: Do not touch the sliding surfaces of the pump plunger and delivery valves.

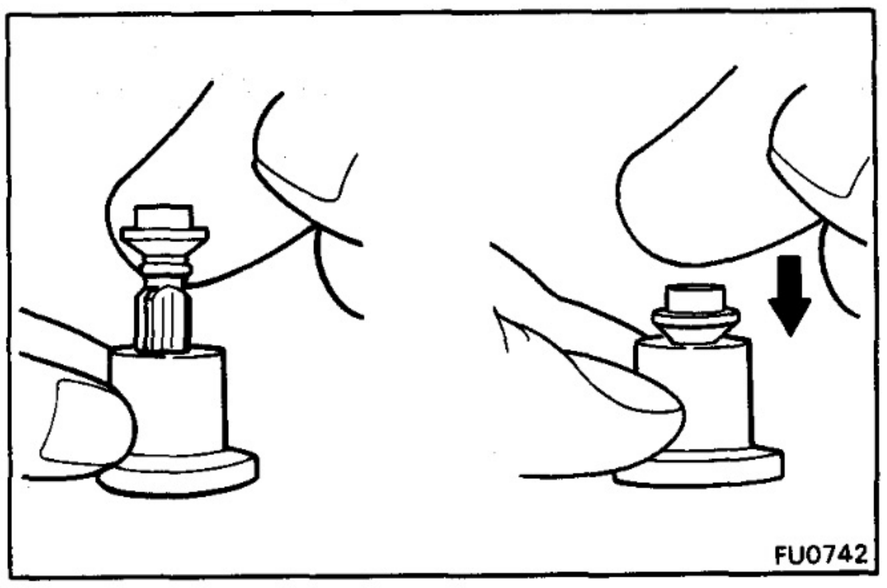


FU0664

1. INSPECT DELIVERY VALVES

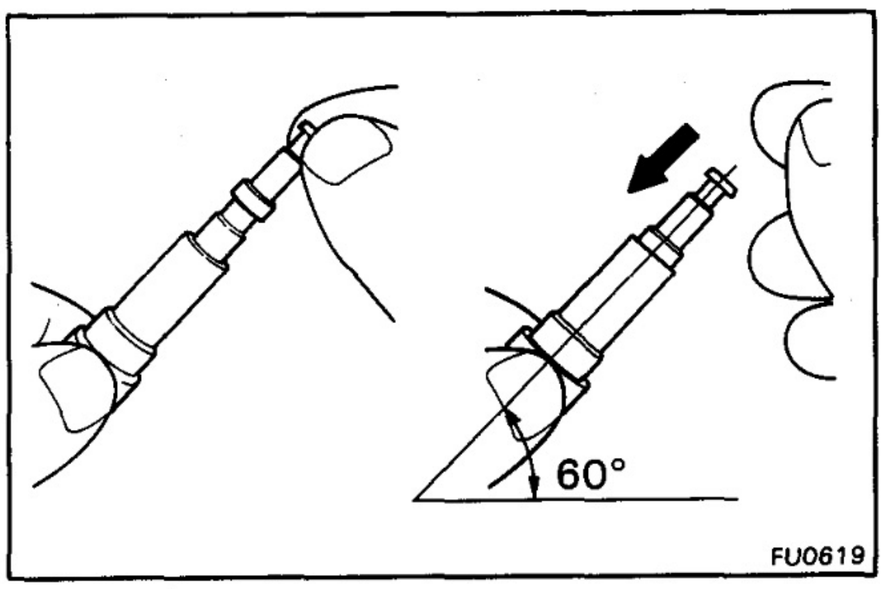
(a) Check the valve seat surface and piston relief valve for scratches.

If necessary, replace the valve as a set.


FU0742

(b) Pull up the valve and release it. Check that it sinks smoothly to the valve seat. If not, replace the valve as a set.

NOTE: Before using a new valve set, wash off the rust prevention compound with diesel fuel and perform the above test.



FU0619

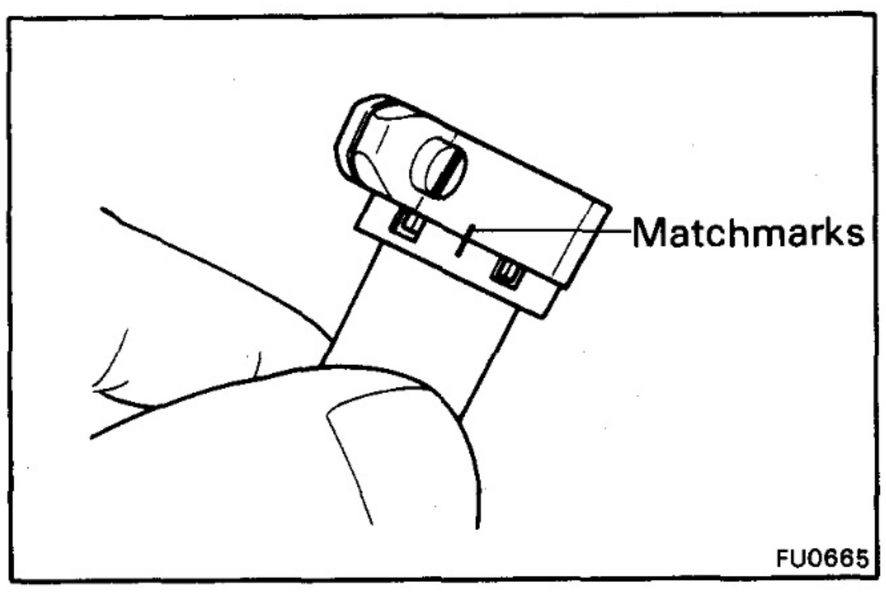
2. INSPECT PUMP PLUNGERS

(a) Tilt the cylinder slightly and pull out the plunger.

(b) When released, the plunger should sink down smoothly into the cylinder by its own weight.

(c) Rotate the plunger and repeat the test at various positions.

If the plunger sticks at any position, replace it as a set.

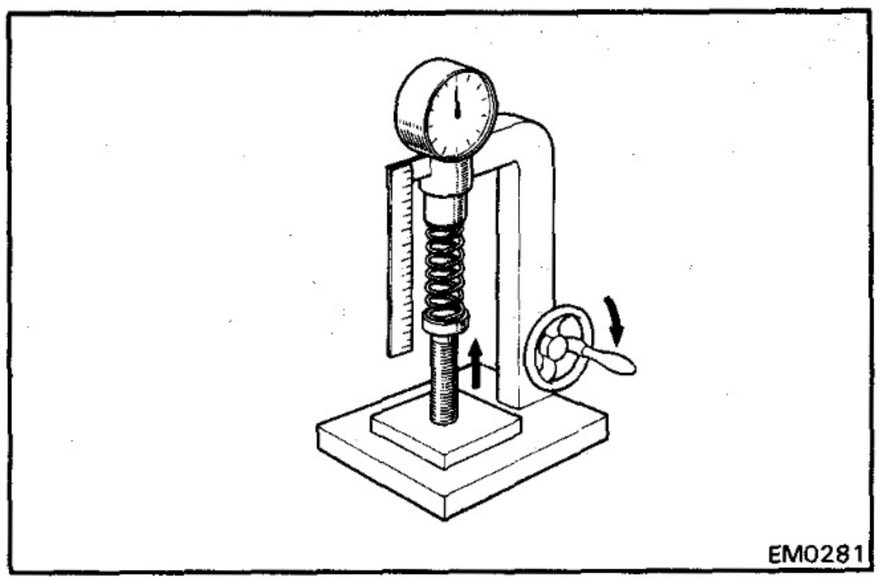


FU0665

3. INSPECT CONTROL RACK AND PINION

Check the tooth surfaces of the control rack and pinion for wear or damage.

NOTE: Before disassembling the pinion, check that the matchmarks of the pinion and sleeve are aligned.


EM0281

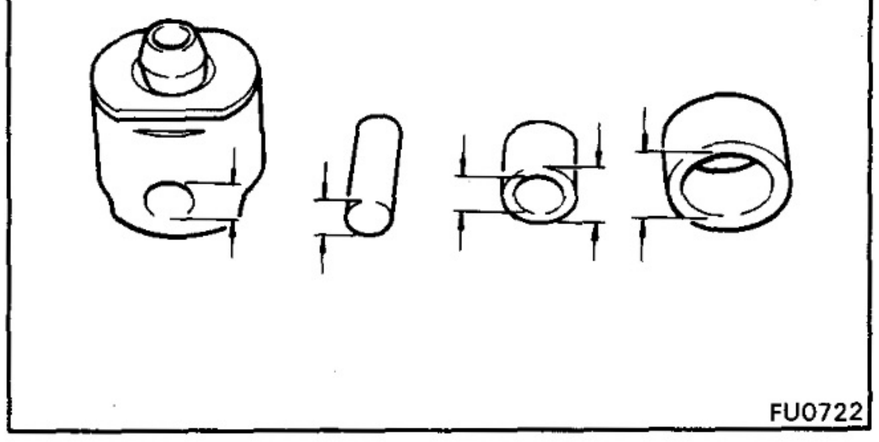
4. INSPECT SPRINGS

Using a spring tester, check the tension of each spring at the specified length.

mm (in.)

Spring / Item	Plunger spring	Delivery valve spring	Outer idle spring	Inner idle spring	Speed control spring
Free length	49.3–49.5 (1.941–1.949)	19.4–20.0 (0.768–0.787)	23.6–24.0 (0.929–0.945)	25.8–26.2 (1.016–1.031)	23.8–24.2 (0.937–0.053)
Installed length	44.0 (1.732)	17.75 (0.6988)	22.8 (0.898)	26.0 (1.024)	24.0 (0.945)
Installed load	15.1 kg (33.3 lb) (148 N)	3.1 kg (6.8 lb) (30 N)	60 g (0.13 lb) (0.6 N)	–	–

If not as specified, replace the spring.

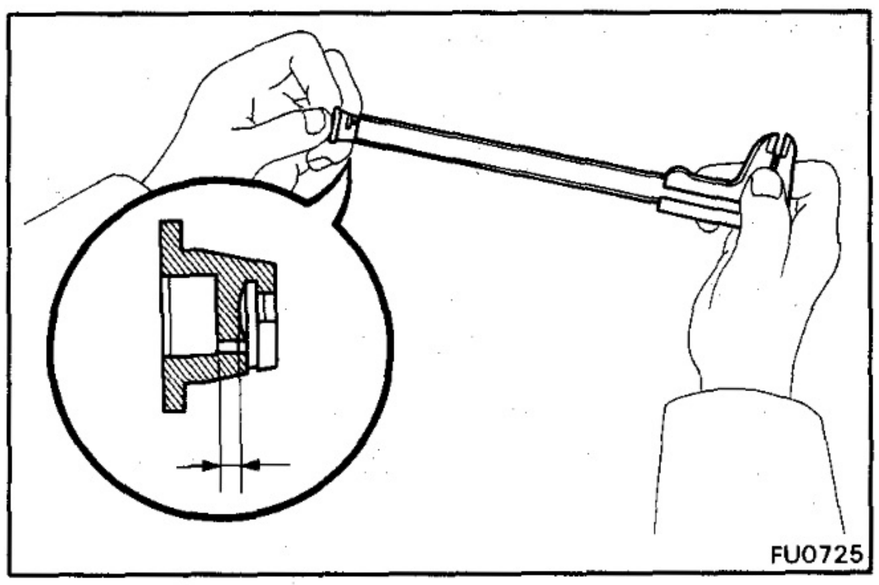

FU0722

5. INSPECT TAPPETS

Measure the combined looseness with the tappet roller in the assembled state.

Maximum combined looseness: 0.3 mm (0.012 in.)

If the combined looseness is greater than maximum, replace the tappet.

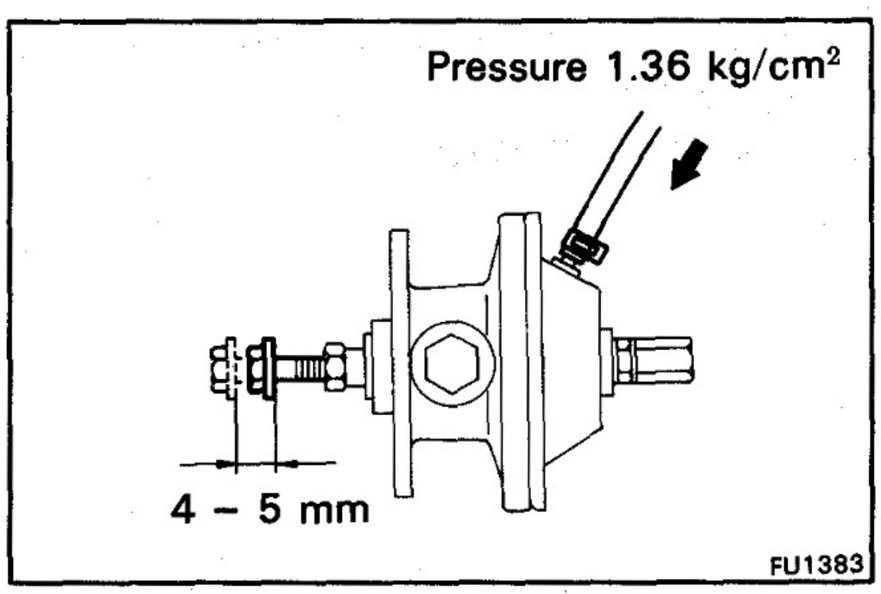

FU0725

6. INSPECT LOWER SPRING SEATS

Using calipers, measure the plunger contacting surface wear of the lower spring seat.

Maximum wear: 0.2 mm (0.008 in.)

If the wear is greater than maximum, replace the spring seat.



FU1383

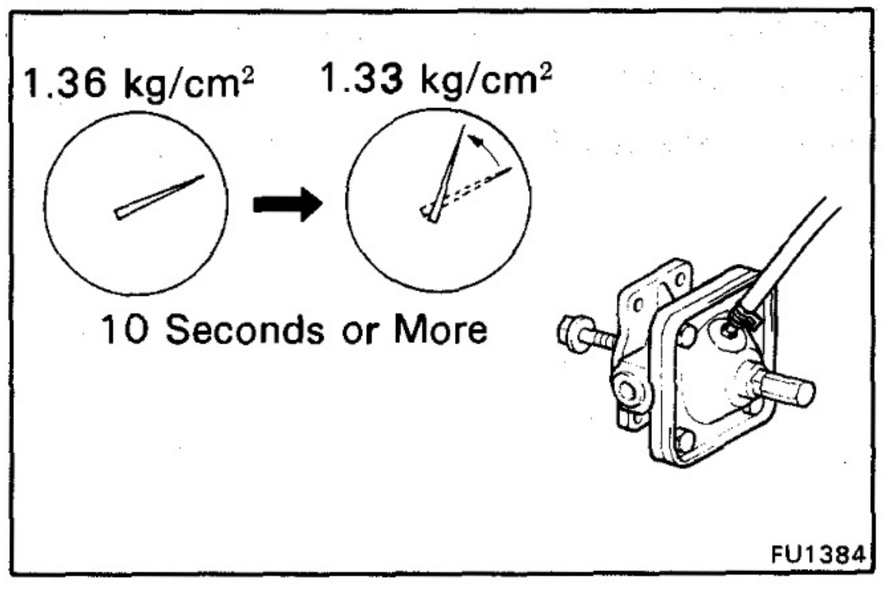
7. [13B-T] INSPECT BOOST COMPENSATOR

(a) Apply 1.36 kg/cm² (19.3 psi, 133 kPa) of pressure to the boost compensator.

(b) Measure the push rod stroke.

Push rod stroke: 4.0 – 5.0 mm (0.157 – 0.197 in.)

If the stroke is not within specification, replace the boost compensator.



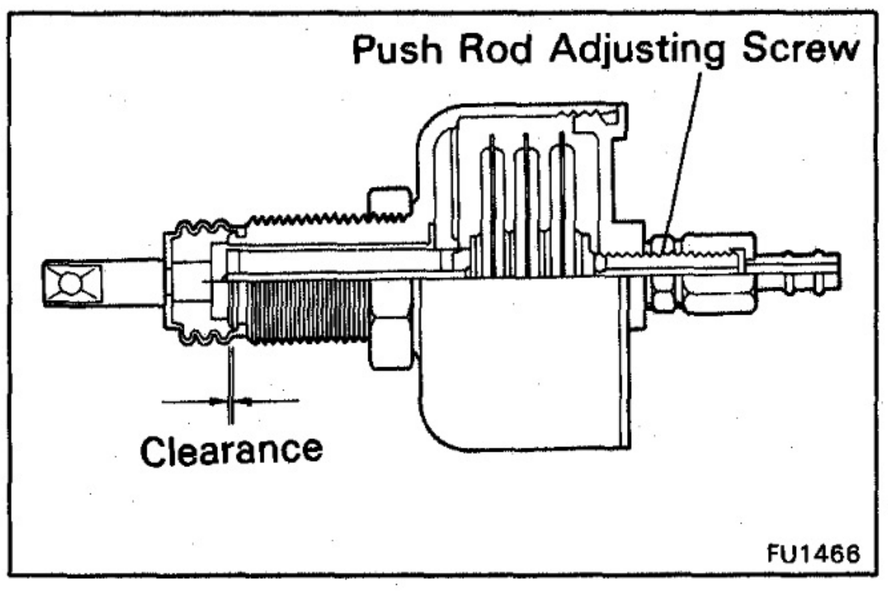
FU1384

(c) Apply 1.36 kg/cm² (19.3 psi, 133 kPa) of pressure to the boost compensator.

(d) Measure the time it takes for the pressure to drop to 1.33 kg/cm² (18.9 psi, 130 kPa).

Pressure drop: 10 seconds or more

If the pressure drops in less time than specified, replace the boost compensator.

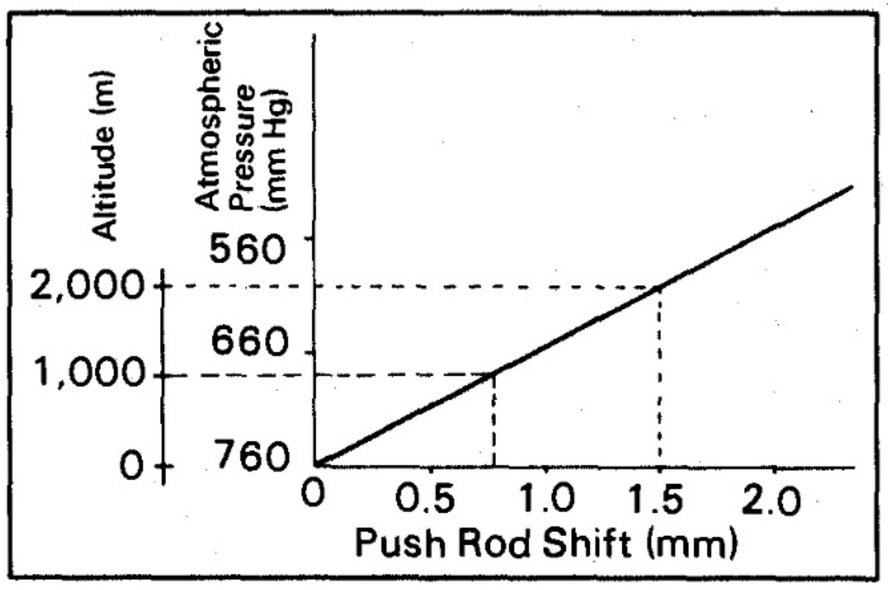


8. INSPECT AND ADJUST HIGH ALTITUDE COMPENSATOR (HAC)

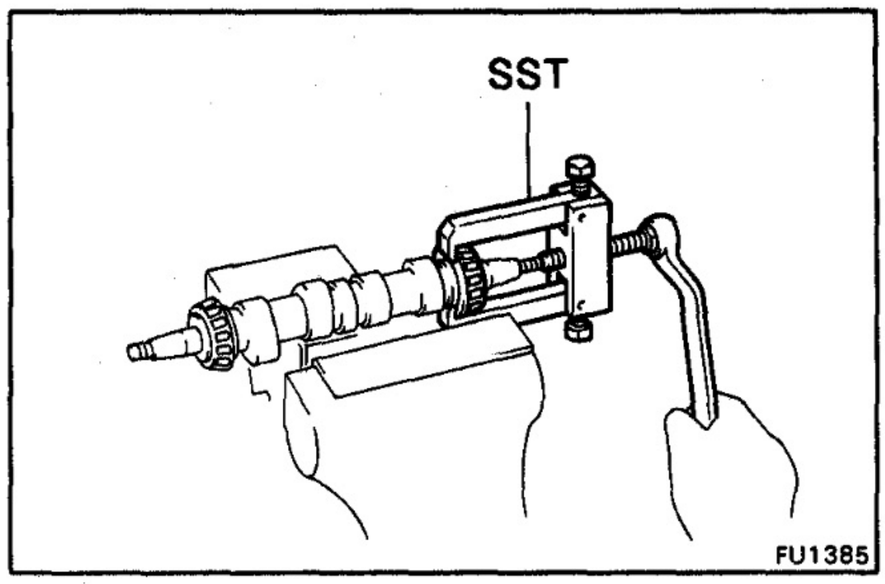
Measure the clearance between the push rod flange and body.

Clearance (at sea level): 0.2 – 0.5 mm (0.008 – 0.020 in.)

If the clearance is not within specification, adjust by turning the push rod adjusting screw.



NOTE: Since the position of the push rod depends on altitude, the clearance mentioned above must be 0.2 – 0.5 mm (0.008 – 0.020 in.) plus the amount of push rod shift as shown in the figure.



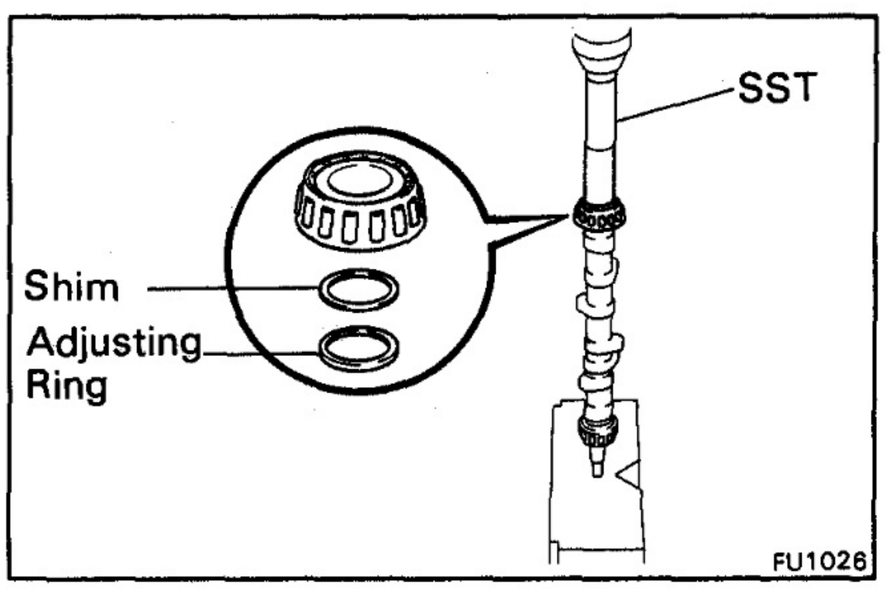
9. REPLACE CAMSHAFT BEARINGS

(a) Using SST, remove the bearing.

SST 09260-58010 (09287-58010)

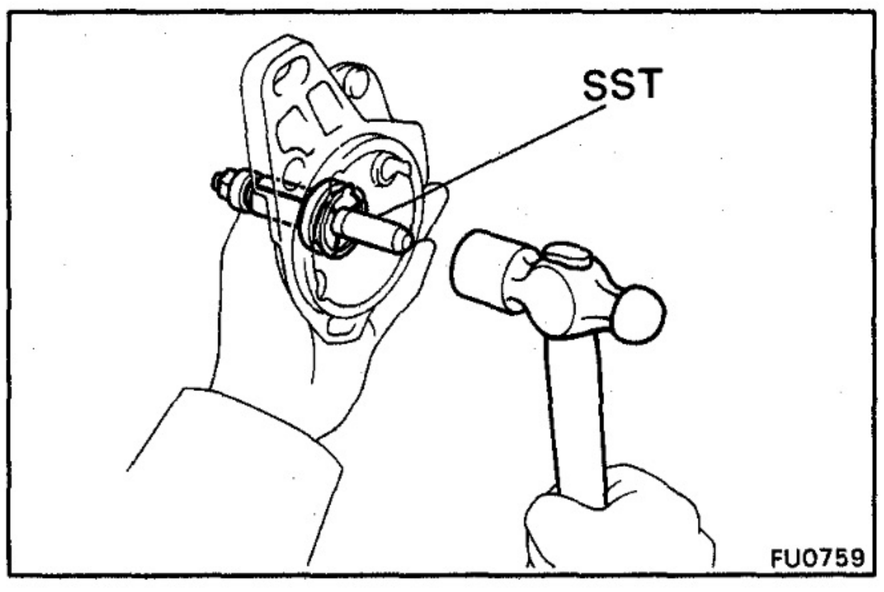
NOTE:

- Arrange the removed shims separately to prevent loss or getting them mixed up with others shims.
- If the thrust clearance is greater then maximum during disassembly, select a proper shim. (See page FU-36)



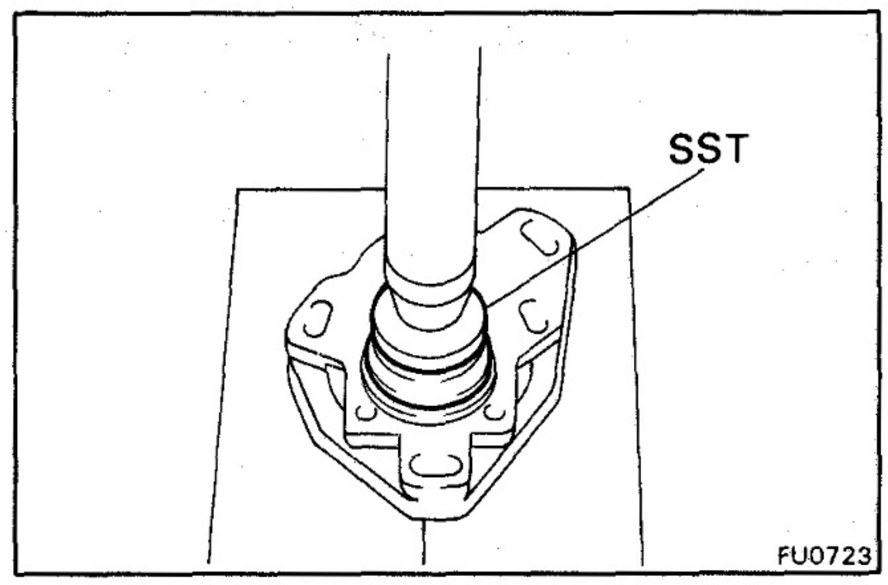
(b) Using SST and a press, press in the adjusting ring, shim and a new bearing.

SST 09260-58010 (09285-76020)



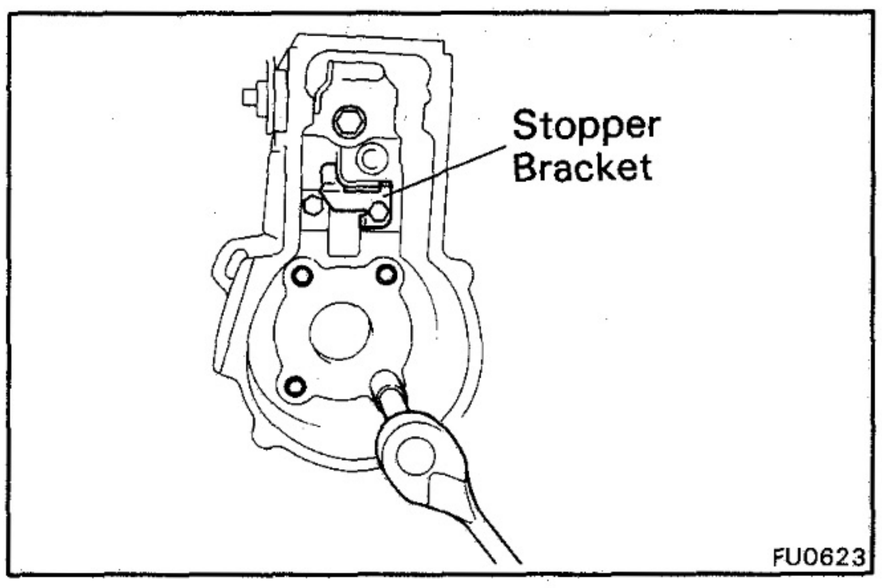
(c) Using SST and a hammer, drive out the outer race from the pump flange.

SST 09260-58010 (09286-78010)

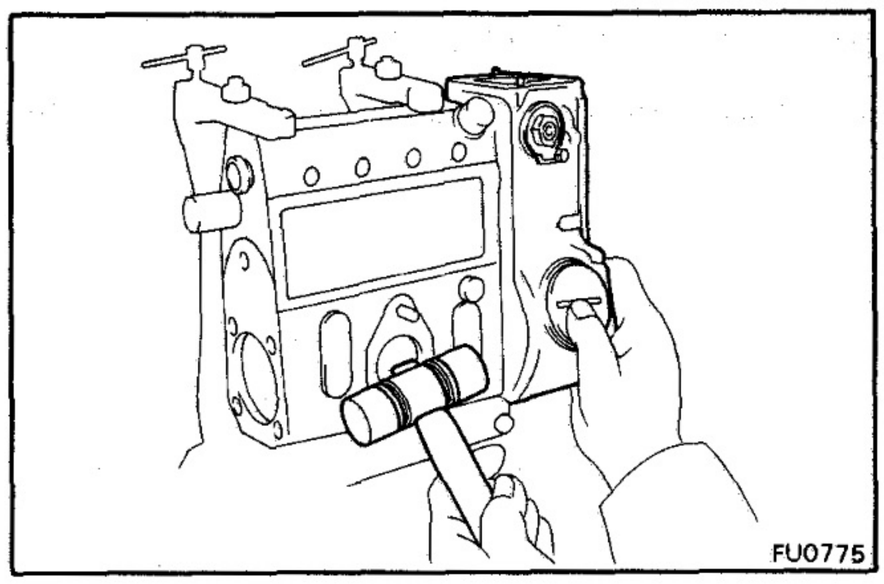


(d) Using SST and a press, press a new outer race into the pump flange.

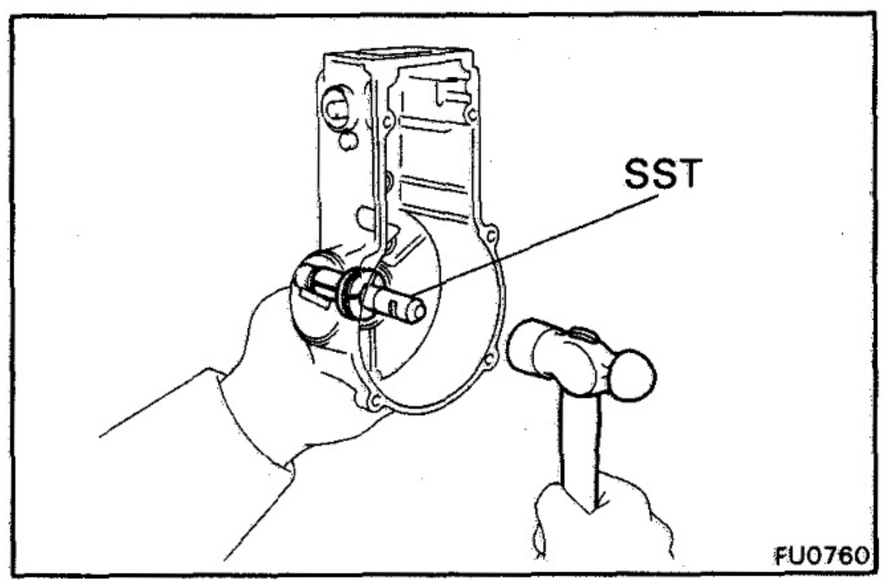
SST 09260-58010 (09289-00010)



(e) Remove the seven bolts and stopper bracket.

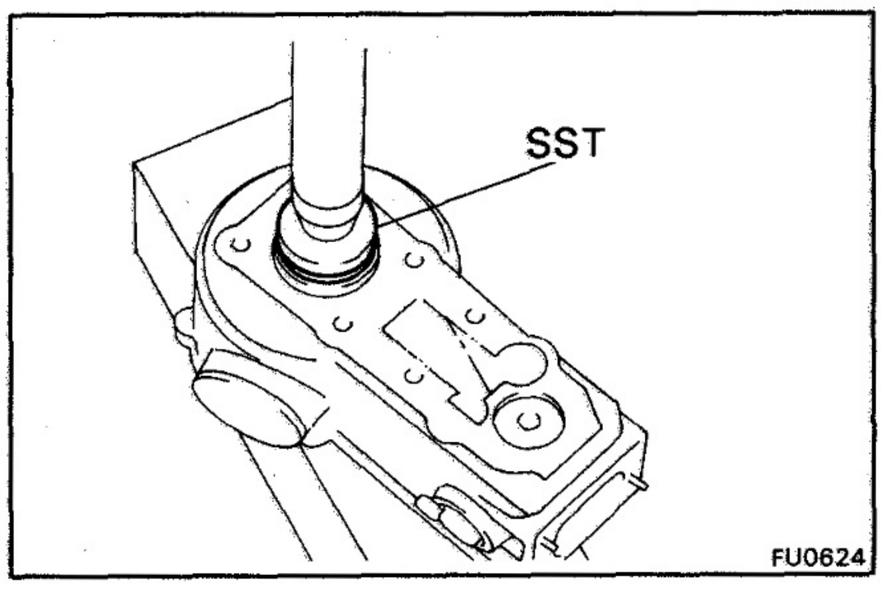


(f) Using a plastic-faced hammer, lightly tap off the governor housing.



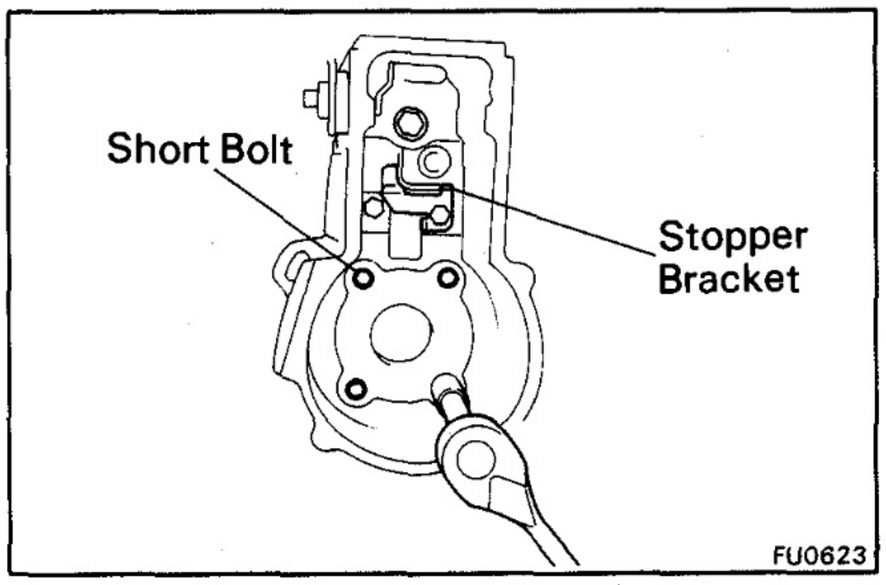
(g) Using SST and a hammer, drive out the outer race from the governor housing.

SST 09260-58010 (09286-76011)



(h) Using SST and a press, press a new outer race into the governor housing.

SST 09260-58010 (09289-00010)



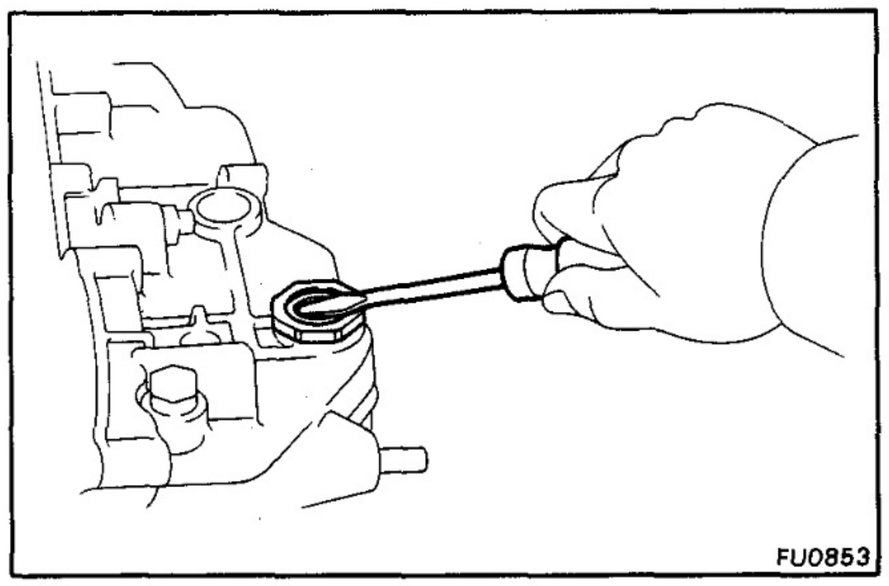
(i) Install a new gasket, the governor housing and stopper bracket with the seven bolts. Torque the bolts.

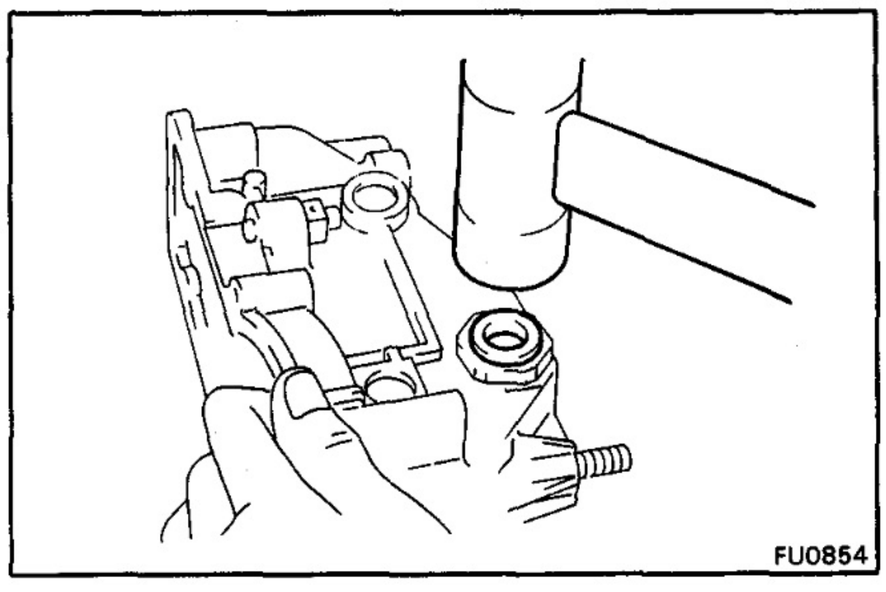
Torque:

10 mm bolt head	**85 kg-cm (74 in.-lb, 8.3 N·m)**
20 mm bolt head	**190 kg-cm (14 ft-lb, 19 N·m)**

10. REPLACE GOVERNOR COVER OIL SEAL

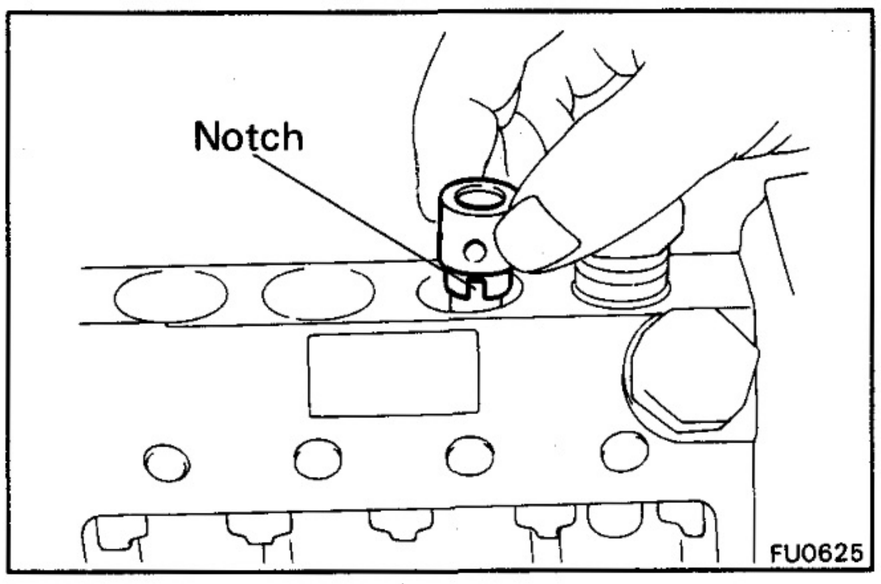
(a) Using a screwdriver, pry out the oil seal.





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

(c) Using a plastic-faced hammer, tap in the new oil seal.

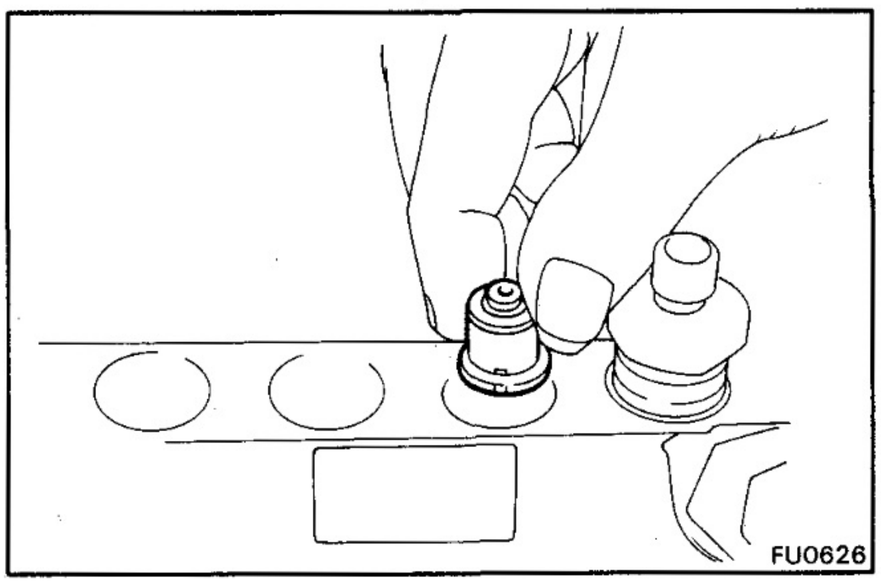


ASSEMBLY OF INJECTION PUMP (Pump Body)

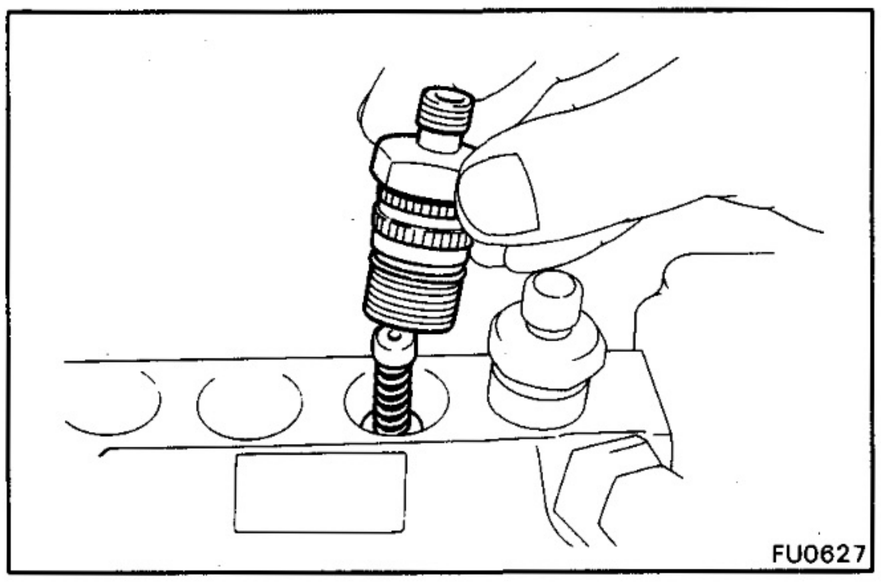
(See page FU-23)

1. INSTALL PUMP CYLINDERS AND DELIVERY VALVES

(a) Align the pump cylinder notch with the pump housing knock pin and install it.



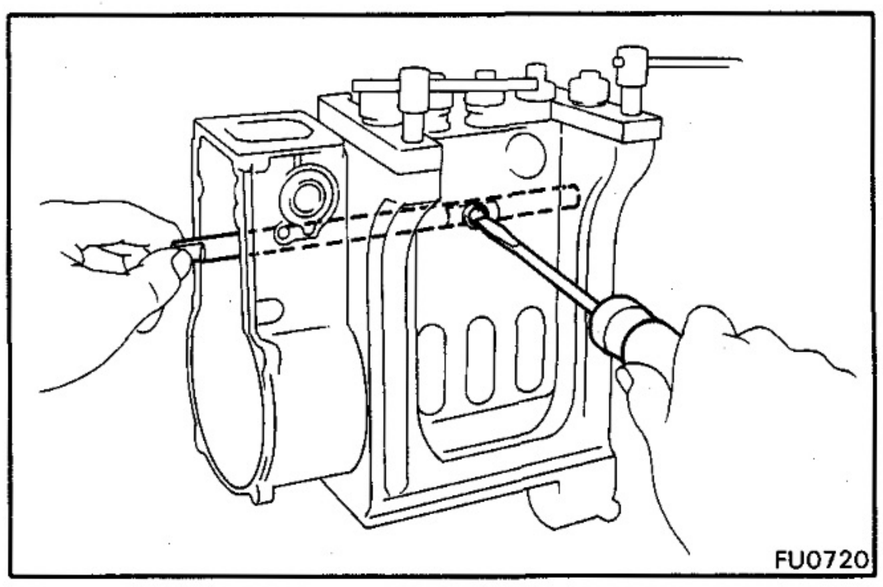
(b) Place the delivery valve on the pump cylinder.



(c) Install a new gasket, the spring and stopper on the delivery valve.

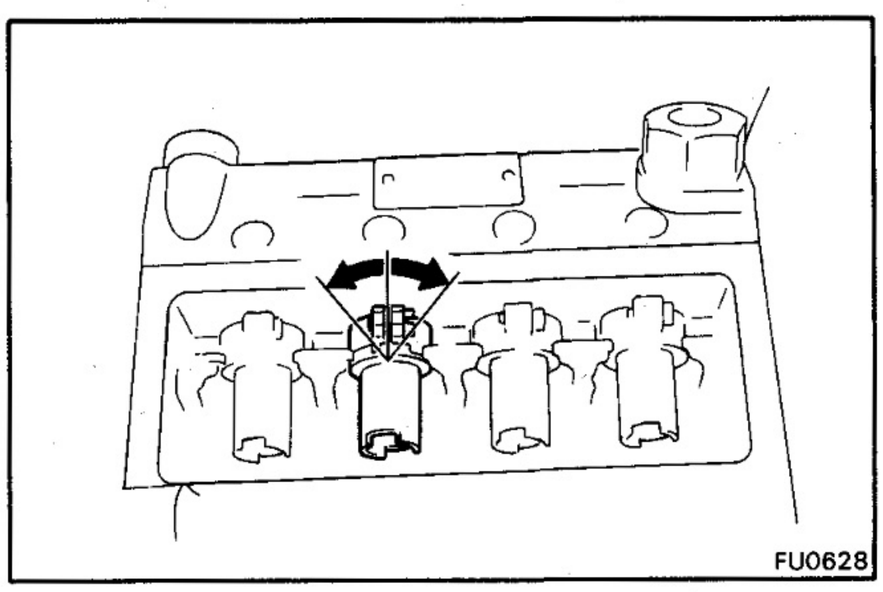
(d) Temporarily tighten the delivery valve holder with a new O-ring by hand.

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



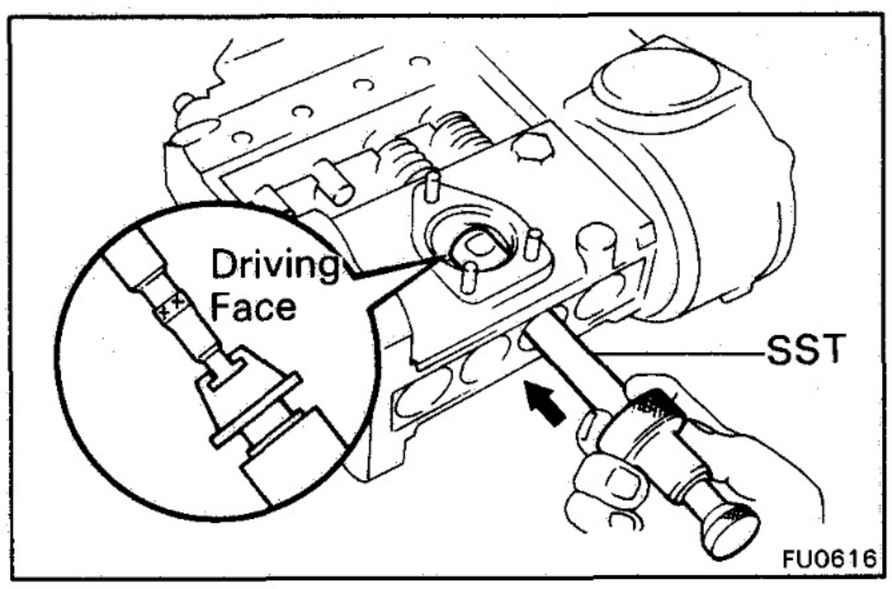
2. INSTALL CONTROL RACK AND PINION

(a) Insert the control rack to the pump housing and install it with the rack guide screw.



(b) Assemble so that the pinion with the sleeve swings evenly left and right when the rack is moved to the right and left.

(c) When installing the pinion to each pump cylinder, check the control rack for smooth and easy movement.



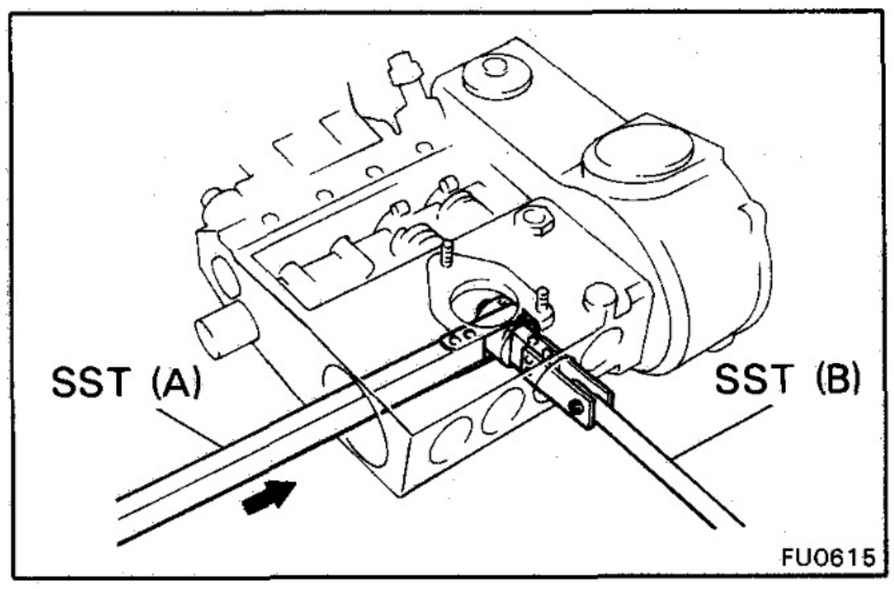
3. INSTALL PLUNGERS AND TAPPETS

(a) Install the upper spring seat and spring.

(b) Using SST, assemble the plunger and lower spring seat, inserting the driving face marked with a number and the lower seat notch part upward (cover plate side).

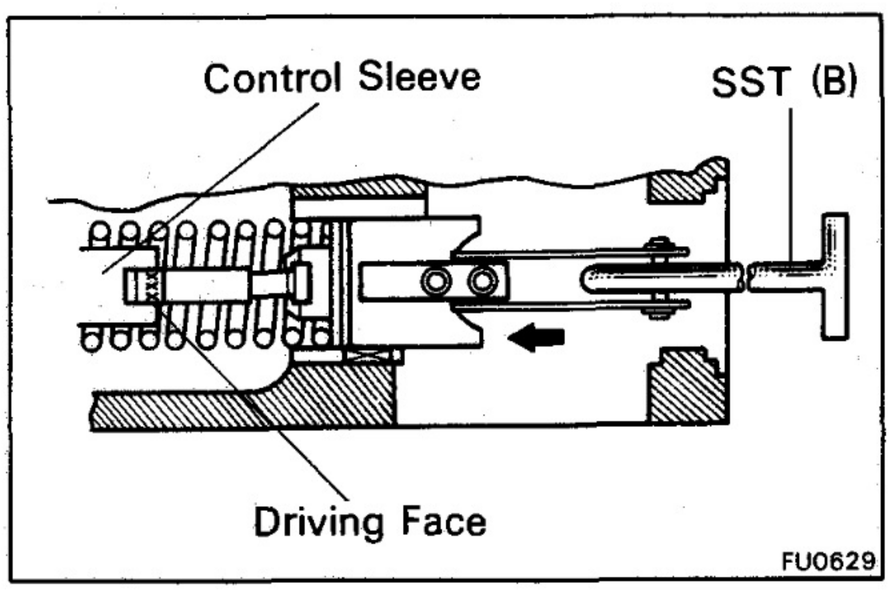
SST 09260-58010 (09275-46010)

(c) After assembling the plunger, turn the lower spring seat a half turn to position the notch facing downward so the plunger will not slip out.



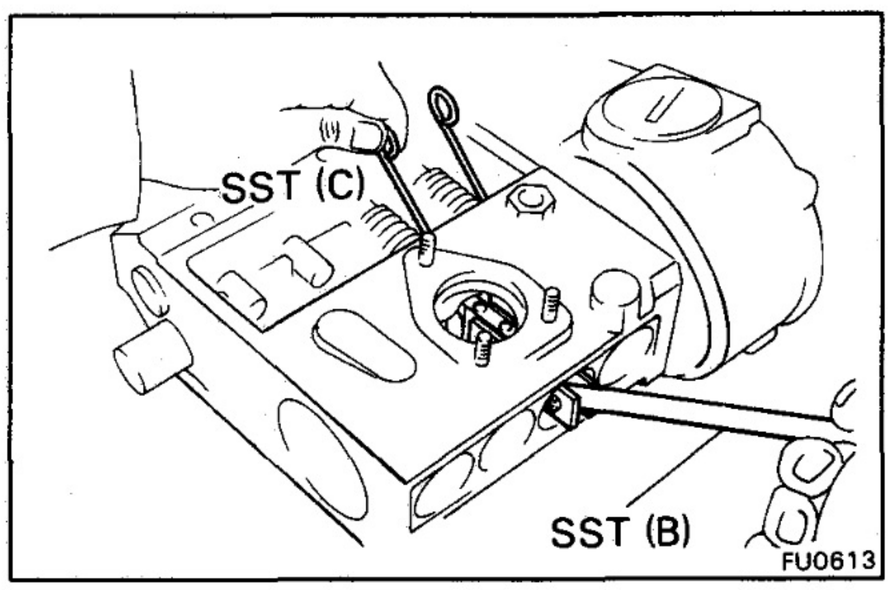
(d) Using SST (A), insert the tappet and adjusting shim through the camshaft bearing hole and move the tappet to SST (B).

SST (A) 09260-58010 (09273-76011)
(B) 09260-58010 (09272-76011)



(e) Align the protrusion of the tappet with the pump housing groove.

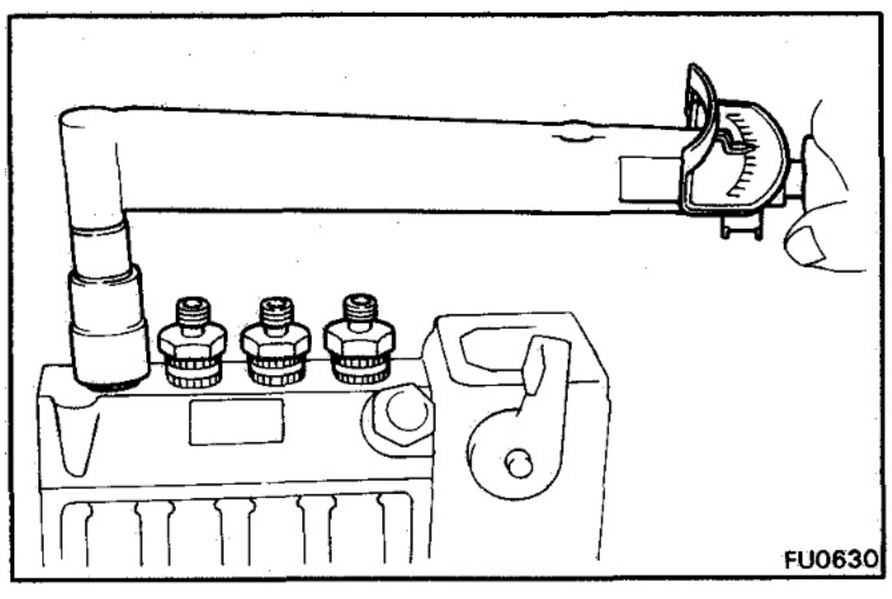
(f) Align the driving face of the plunger with the control sleeve groove.



(g) Using SST (B), press in the tappet and hold it with SST (C).

SST (B) 09260-58010 (09272-76011)
(C) 09260-58010 (09274-46011)

(h) When installing each plunger and tappet, check the control rack for smooth and easy movement.



4. TORQUE DELIVERY VALVE HOLDERS

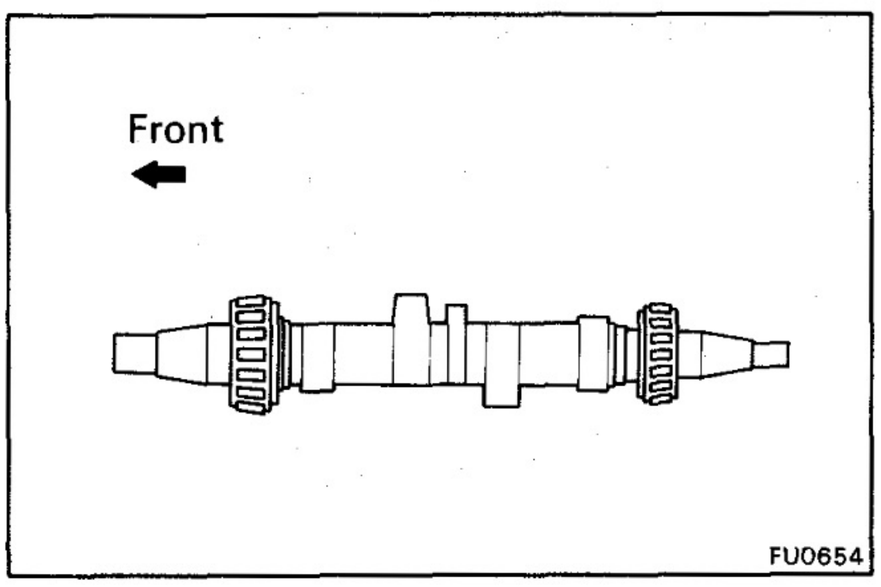
(a) When one delivery valve holder is tightened, move the control rack to the right and left and inspect the tightness of the rack.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

(b) Install the lock plates with the two bolts.

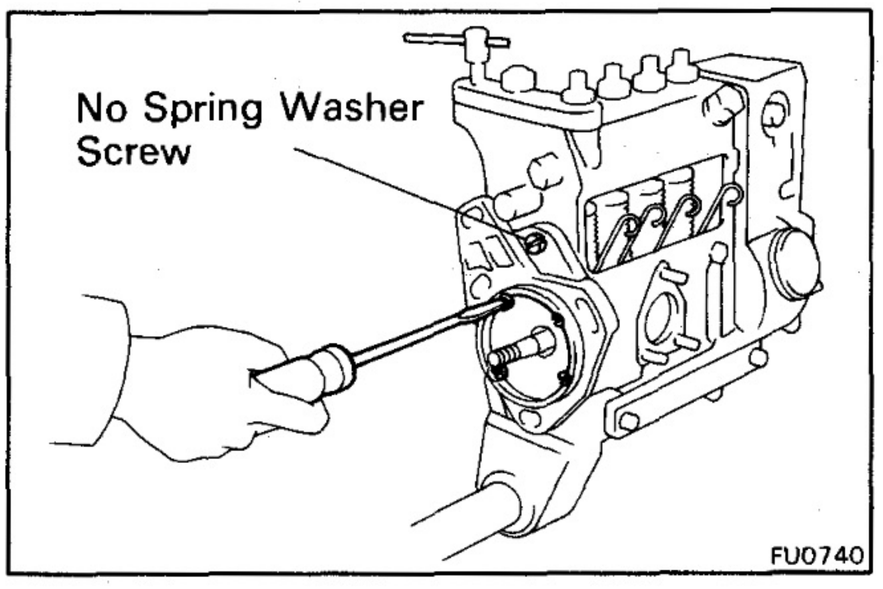
5. CHECK CONTROL RACK SLIDING RESISTANCE (See step 40 on page FU-37)

Sliding resistance: 120 g (4.2 oz) or less



6. INSTALL CAMSHAFT

(a) Insert the camshaft into the injection pump housing with the large bearing side facing forward.



(b) Apply liquid sealer to the screw without the spring washer.

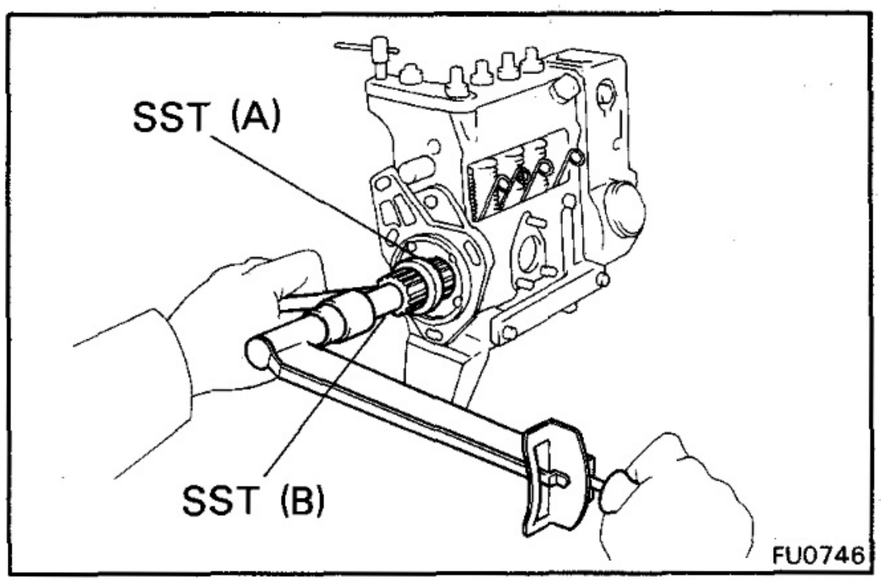
(c) Install a new gasket and the pump flange with the five screws.

7. CHECK CAMSHAFT THRUST CLEARANCE

(See step 37 on page FU-36)

Standard clearance: **0.03 — 0.05 mm (0.0012 — 0.0020 in.)**

Maximum clearance: **0.1 mm (0.004 in.)**



8. INSTALL SPLINE SHAFT

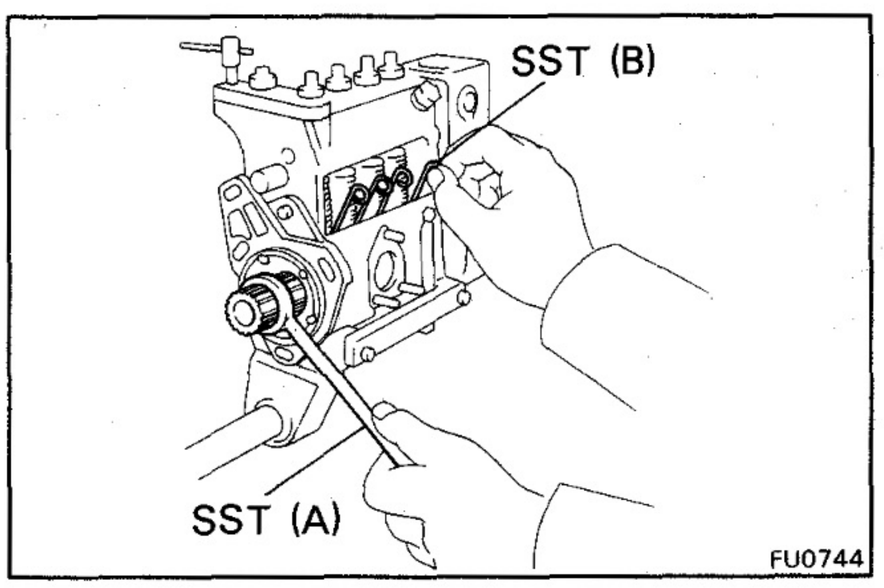
(a) Install the set key on the camshaft.

(b) Align the set key groove of the spline shaft with the set key.

(c) Using SST (A) to hold the spline shaft, install the spring washer and round nut with SST (B).

SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09266-76011)

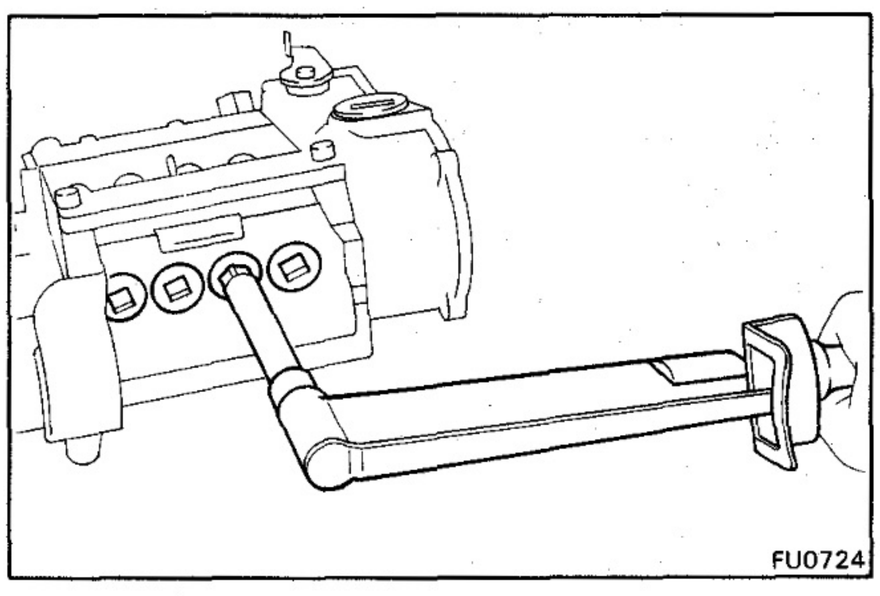
Torque: 925 kg-cm (69 ft-lb, 93 N·m)



9. REMOVE SST FROM TAPPET HOLES

Using SST (A), turn the camshaft and remove SST (B).

SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09274-46011)

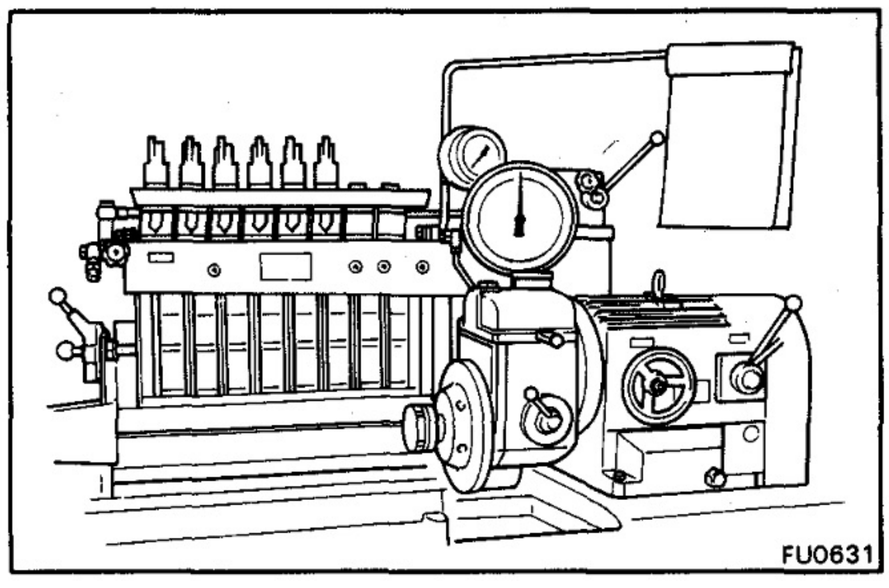


10. INSTALL PLATE PLUGS

(a) Apply liquid sealer on the plug threads.

(b) Install the four plate plugs.

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

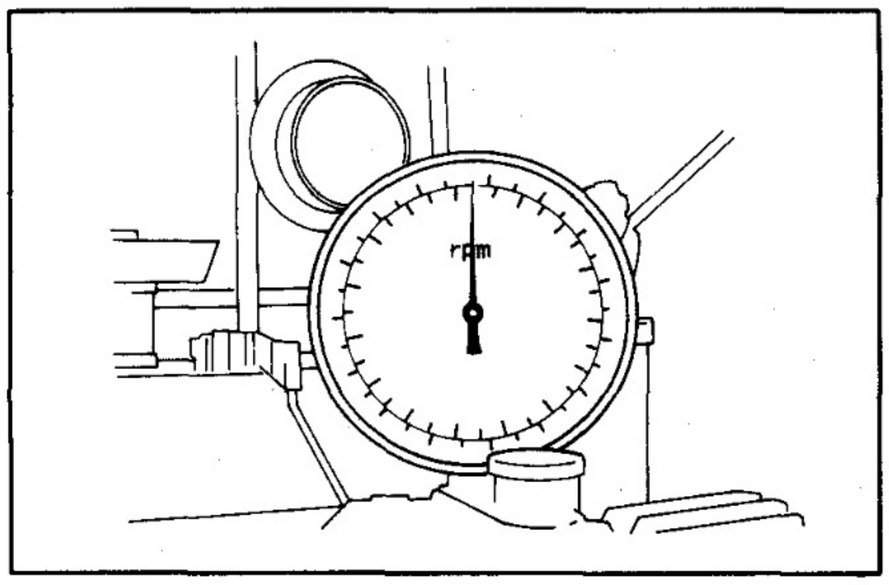

FU0631

ADJUSTMENT OF INJECTION PUMP (Pump Body)

1. PRE-TEST CHECK AND PREPARATIONS

(a) The specifications for test nozzle and nozzle holder are as follows.

Test nozzle: DN 12 SD 12A
Test nozzle holder valve opening pressure:
175 kg/cm² (2,489 psi, 17,162 kPa)

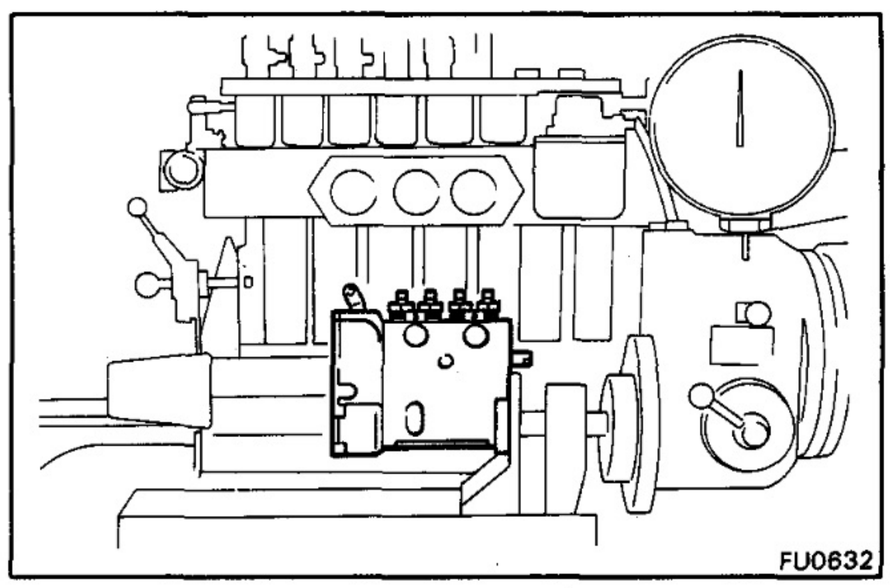


(b) Check the accuracy of the tachometer.

Allowable error: ± 40 rpm at 2,000 rpm

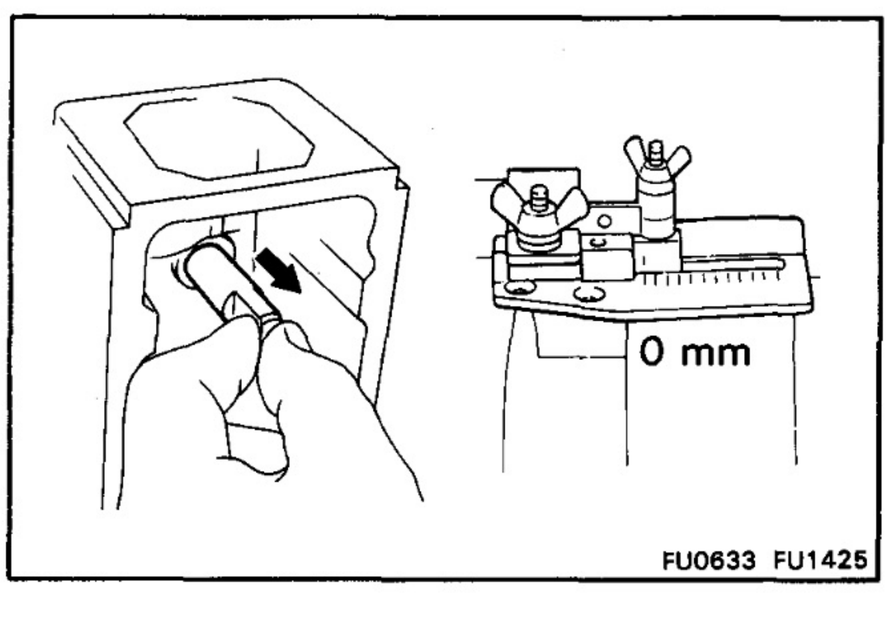
(c) Remove the spline shaft.
(See step 36 on page FU-36)

(d) Remove the control rack cover.


FU0632

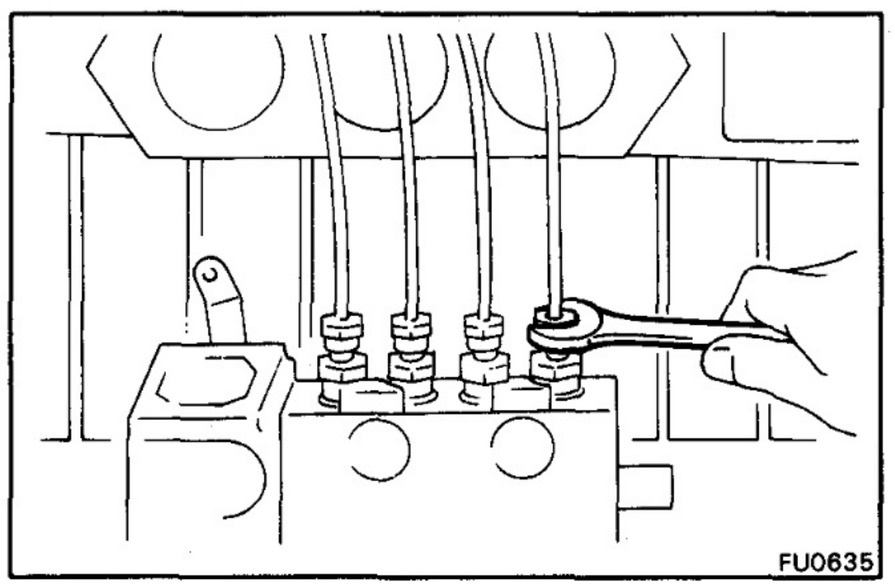
(e) Mount the injection pump body on the pump tester.

(f) Rotate the pump by hand and check that it turns smoothly.



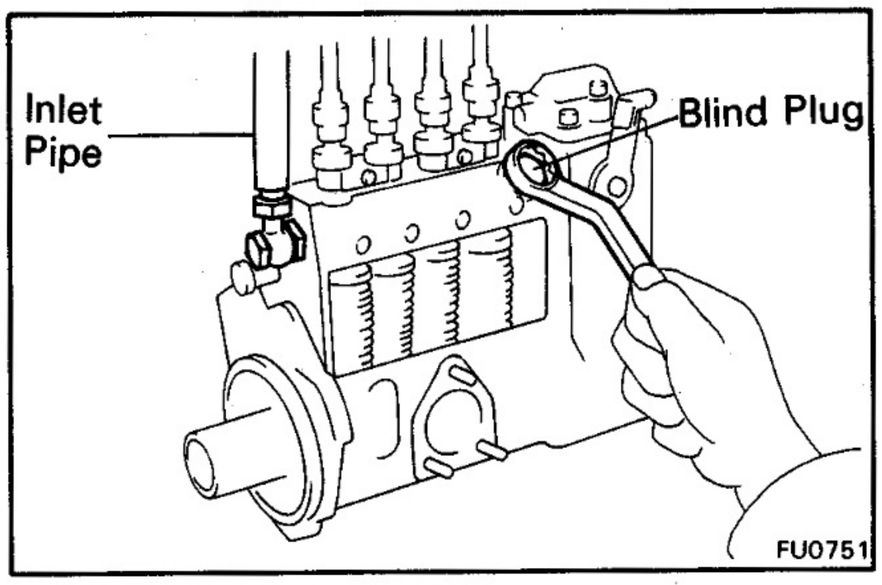
FU0633 FU1425

(g) Install the rack scale so that its zero point is at the position where the control rack is pulled fully toward the governor side, and set it to allow easy reading of the scale graduations.


FU0635

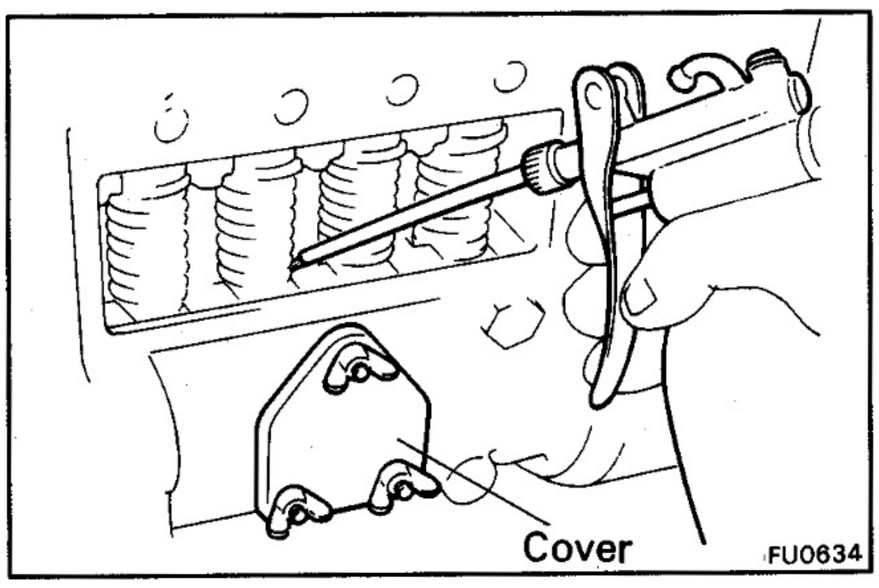
(h) Install an injection pipe with the following specifications.

Outer diameter: 6.0 mm (0.236 in.)
Inner diameter: 2.0 mm (0.079 in.)
Length: 600 mm (23.62 in.)
Minimum bending radius: 25 mm (0.98 in.) or more

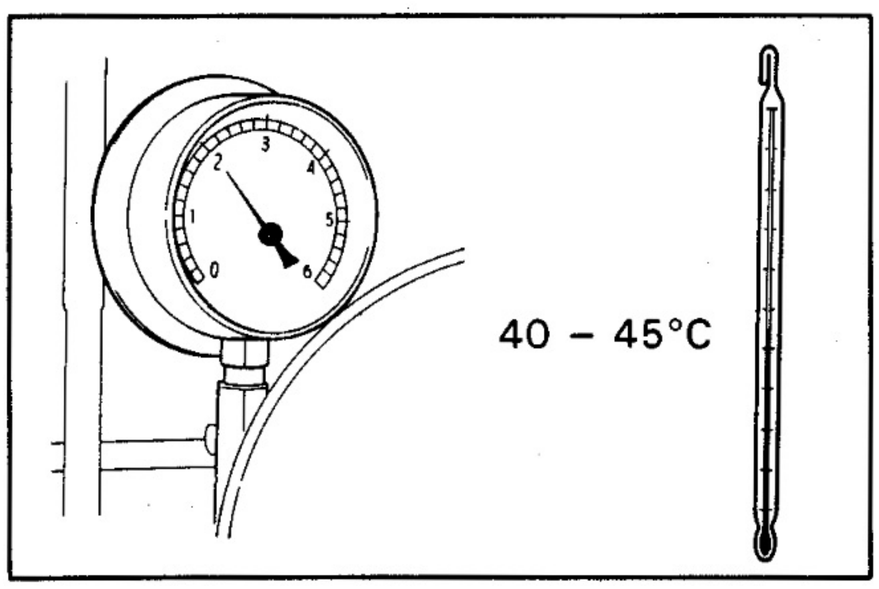


(i) Connect the fuel inlet pipe.

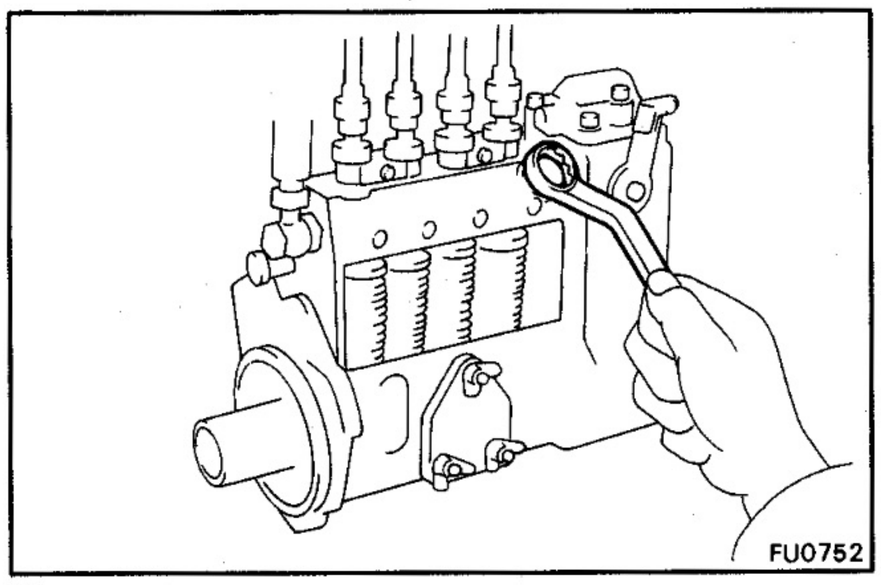
(j) Install the blind plug to the bleeder hole.



(k) Install the cover to the feed pump installation surface, and fill the pump camshaft chamber with engine oil.



(l) Fuel feeding pressure to injection pump should be 2.0 kg/cm² (28 psi, 196 kPa).
Fuel temperature for pump testing should be 40 – 45°C (104 – 113°F).

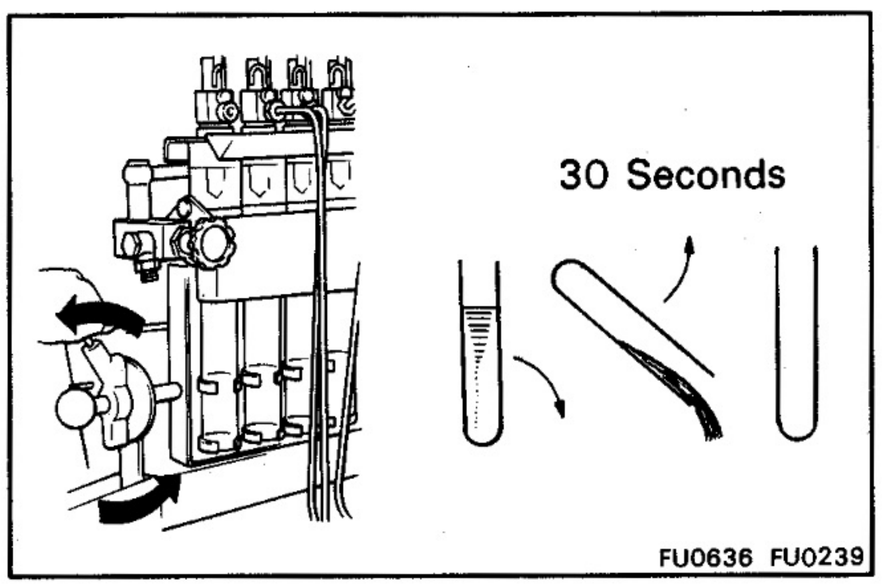


(m) Bleed the air from the pump housing.

NOTE: Be careful that fuel does not enter the pump housing during bleeding.

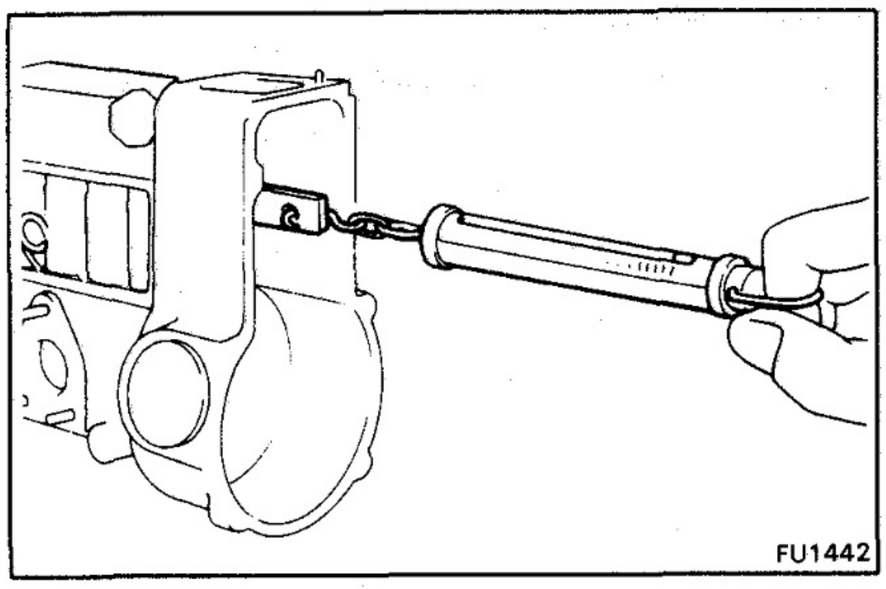
(n) Race the injection pump to 1,000 rpm for 5 minutes.

CAUTION: Check that there is no fuel leakage or abnormal noise.



NOTE:

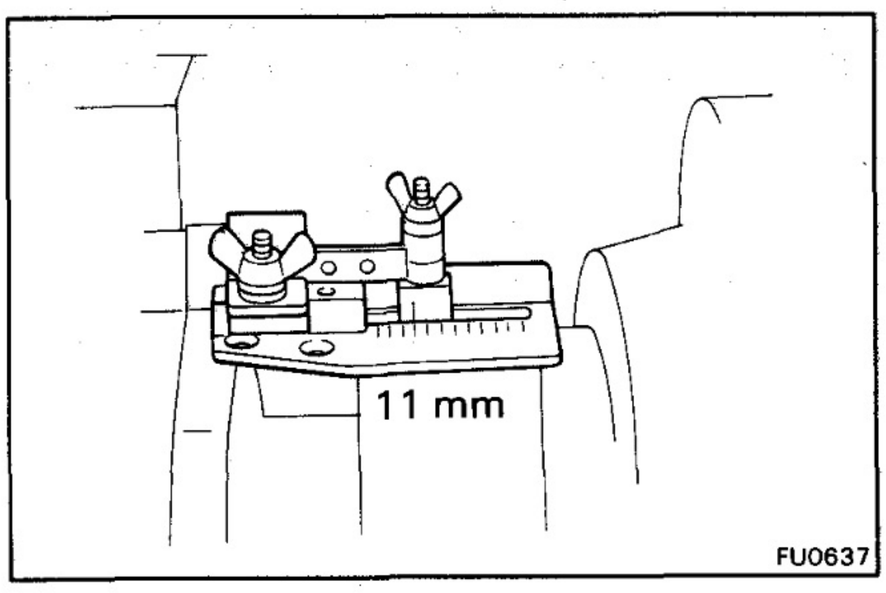
- Measure the volume of each injection cylinder with a measuring cylinder.
- Tilt the measuring cylinder for 30 seconds and pour out the fuel. Then, raise the cylinder upright and measure the next one.
- To obtain an accurate reading, wait until the bubbles in the graduated cylinder disappear before measuring.



2. CHECK CONTROL RACK SLIDING RESISTANCE

Using a spring scale, measure the control rack sliding resistance at the below-listed rpm.

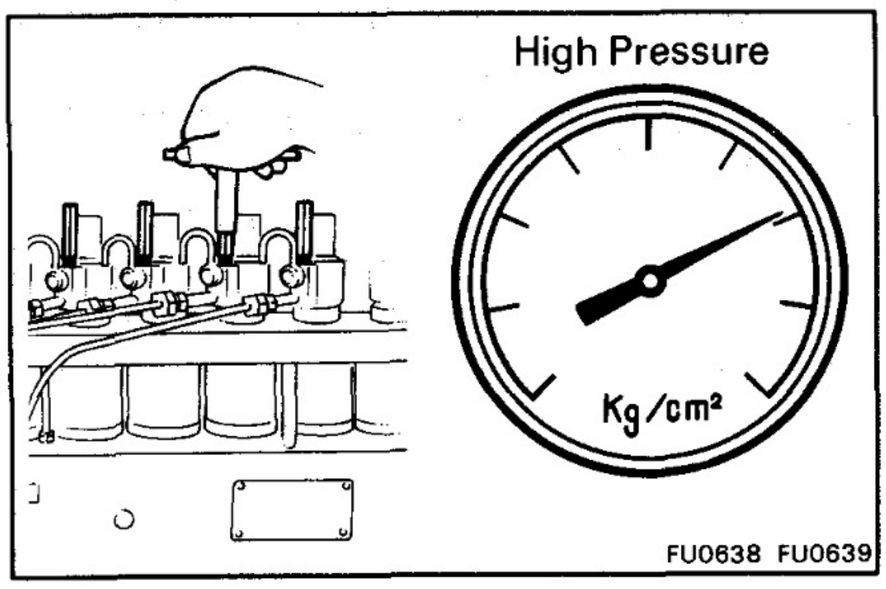
Pum rpm	Sliding resistance g (oz)
0 rpm	120 (4.2) or less
1,000 rpm	50 (1.8) or less



3. INSPECT AND ADJUST INJECTION TIMING

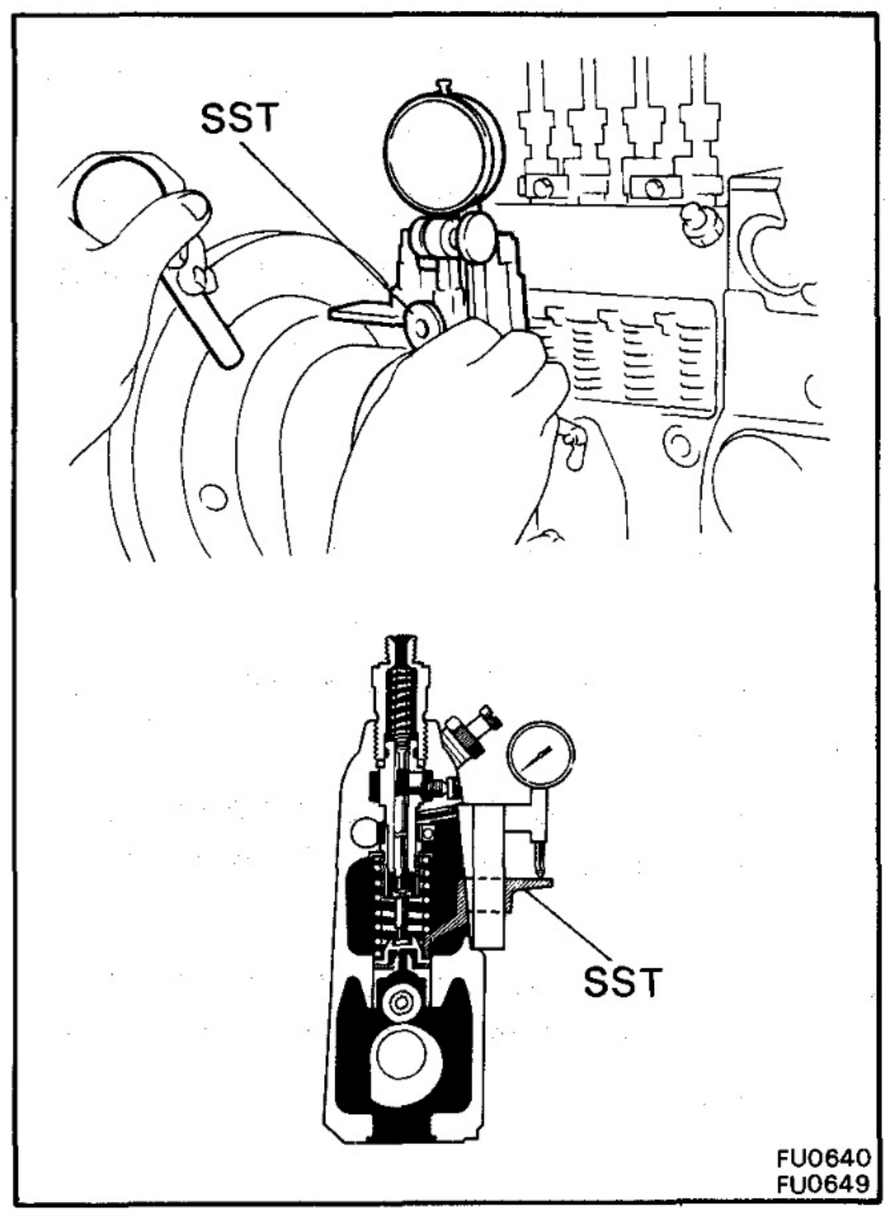
[Pre-stroke for No. 1 plunger]

(a) Set the control rack position at 11.0 mm (0.433 in.).



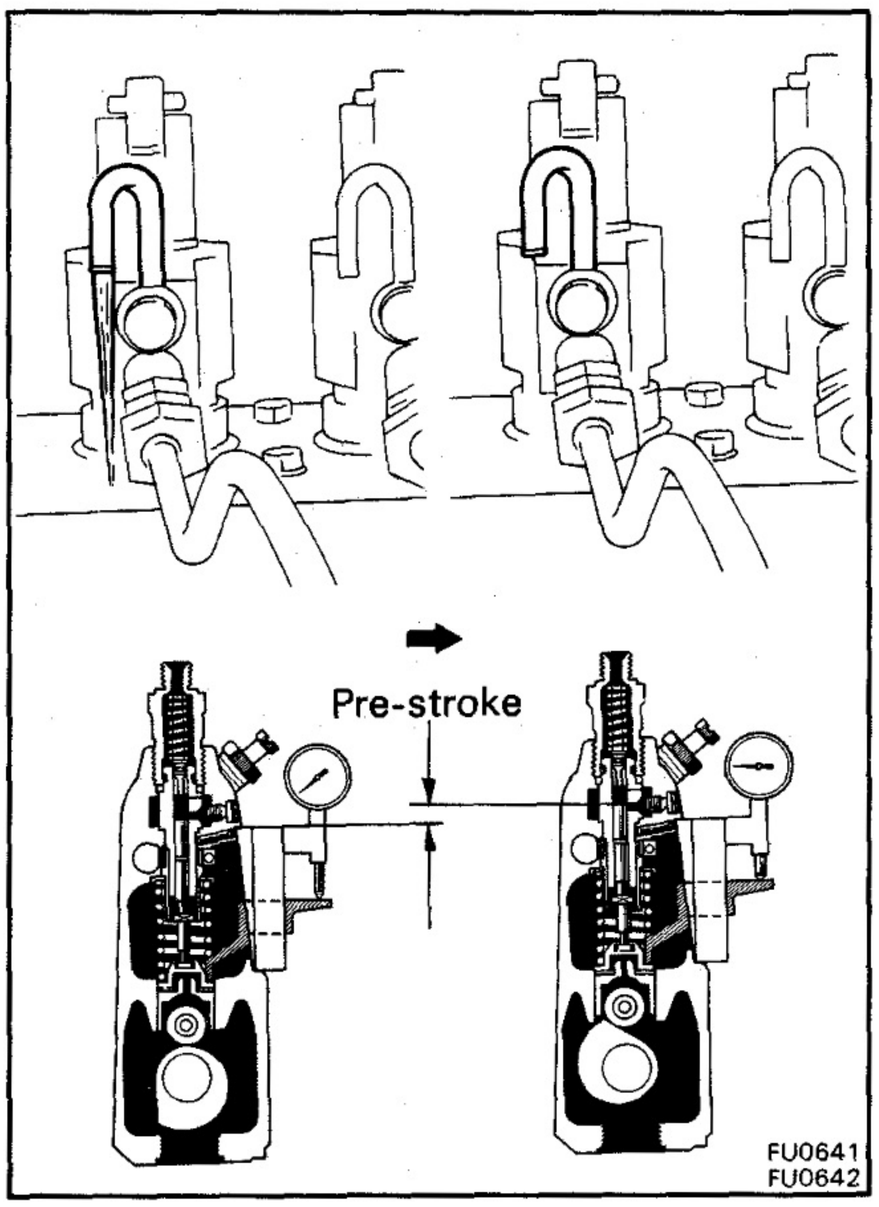
(b) Loosen the overflow cock of the pump tester bench nozzle holder.

(c) Fuel feeding pressure to the injection pump should be on the high side.



(d) Using SST, set the No. 1 tappet to BDC position, and then set the dial gauge on the No. 1 tappet.

SST 09260-58010 (09283-46010)



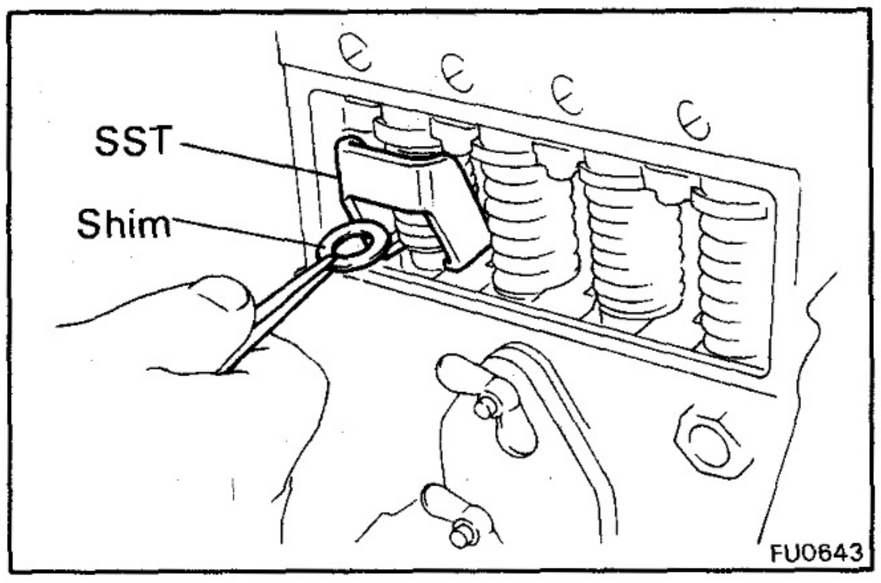
(e) Rotate the camshaft clockwise, and measure the lift of the No. 1 plunger when it moves from BDC to the injection starting position (the point where fuel flowing from the overflow pipe stops).

Pre-stroke: 3.05 – 3.15 mm (0.1201 – 0.1240 in.)

If the pre-stroke is not within specification, replace the adjusting shim.

Adjusting shim thickness	mm (in.)		
0.10	(0.0039)	0.80	(0.0315)
0.15	(0.0059)	0.90	(0.0354)
0.20	(0.0079)	1.00	(0.0394)
0.30	(0.0118)	1.10	(0.0433)
0.40	(0.0158)	1.20	(0.0472)
0.50	(0.0197)	1.30	(0.0512)
0.60	(0.0236)	1.40	(0.0551)
0.70	(0.0276)		

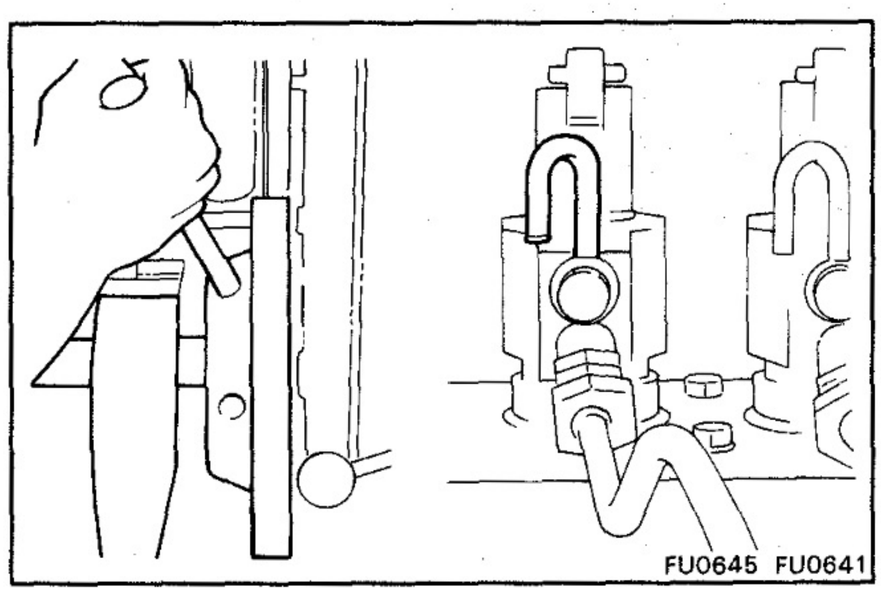
NOTE: The pre-stroke will increase with a decrease shim thickness and decrease with an increase.



(f) Using SST, adjust by changing the tappet adjusting shim.

SST 09260-58010 (09280-46010)

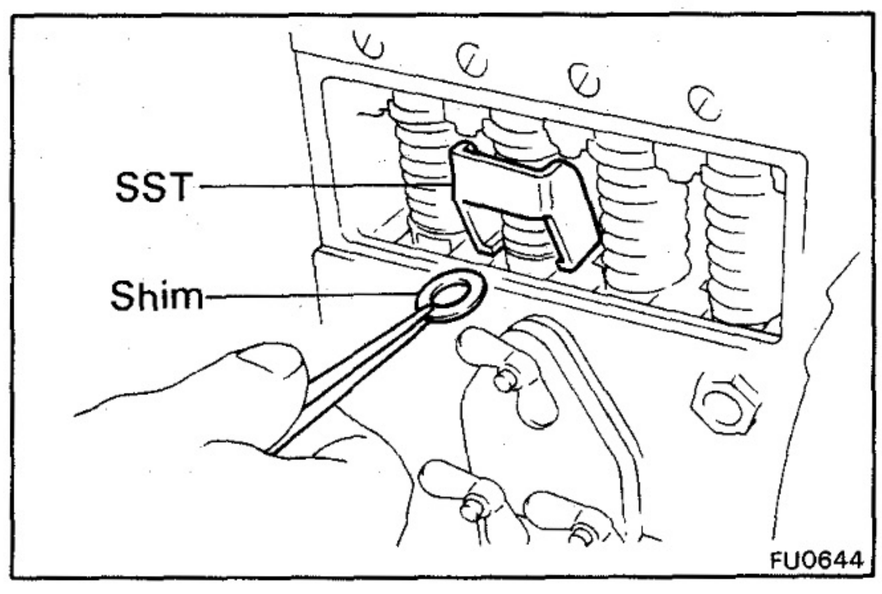
(g) When adjusting the pre-stroke, the matchmarks placed on the pump and pump retainer during disassembly may not align. Therefore, make a note of the pre-stroke value for installation of the pump retainer.



[Injection Interval]

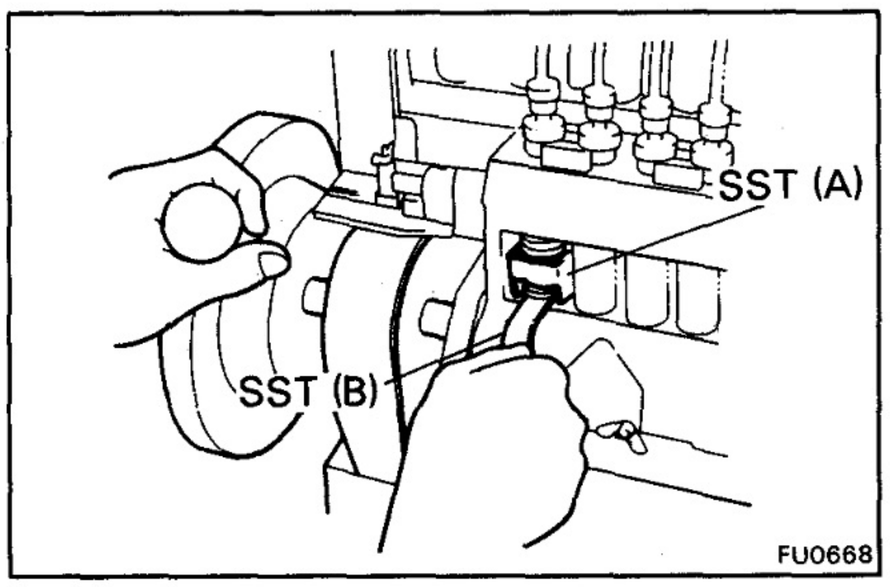
Using the No. 1 cylinder injection starting time position as a base, inspect and adjust the injection starting angles in the order of injection.

Cylinder No.	Injection starting angle
1	0
3	89°30′ – 90°30′
4	179°30′ – 180°30′
2	269°30′ – 270°30′



If the injection starting angles are not within specification, adjust by using the same procedure as for pre-stroke adjustment.

NOTE: The injection stating angle will change about 30′ with 0.1 mm (0.004 in.) change is shim thickness.



[Tappet Clearance]

(a) Using SST (A), insert the 0.2 mm (0.008 in.) gauge of SST (B) between the spring lower seat and adjusting shim, and rotate the camshaft slowly.

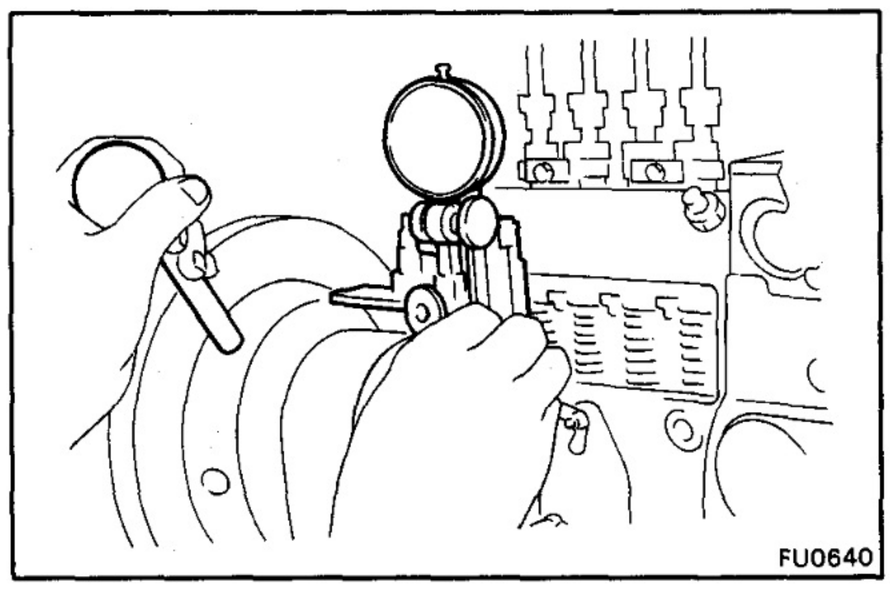
SST (A) 09260-58010 (09280-46010)
(B) 09288-46011

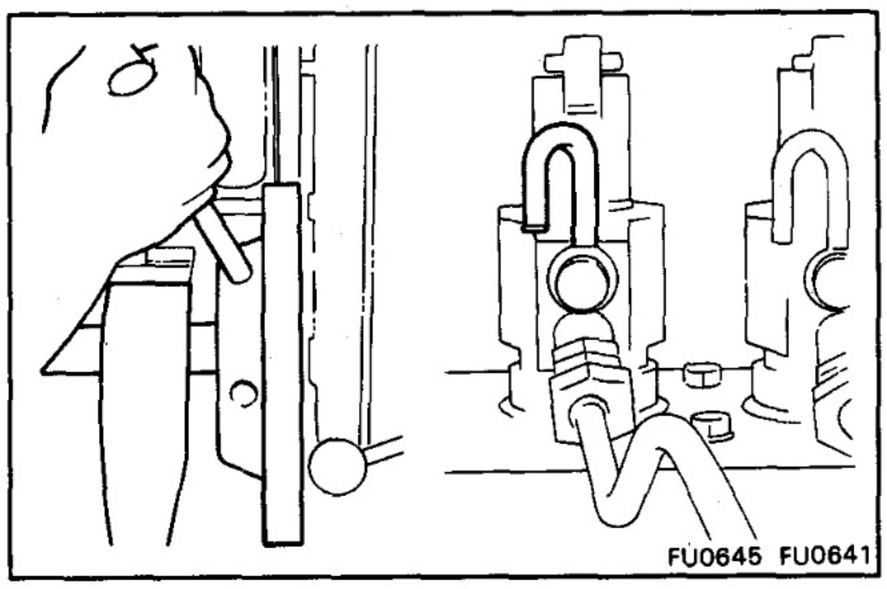
Tappet clearance: 0.2 mm (0.008 in.) or more

CAUTION: If there is interference between the plunger driving face and lower portion of the cylinder, or if resistance if felt while rotating the camshaft, it indicates that there is less than 0.2 mm (0.008 in.) clearance, so do not rotate it any further.

(b) If the tappet clearance is less than 0.2 mm (0.008 in.), recheck and adjust the pre-stroke.

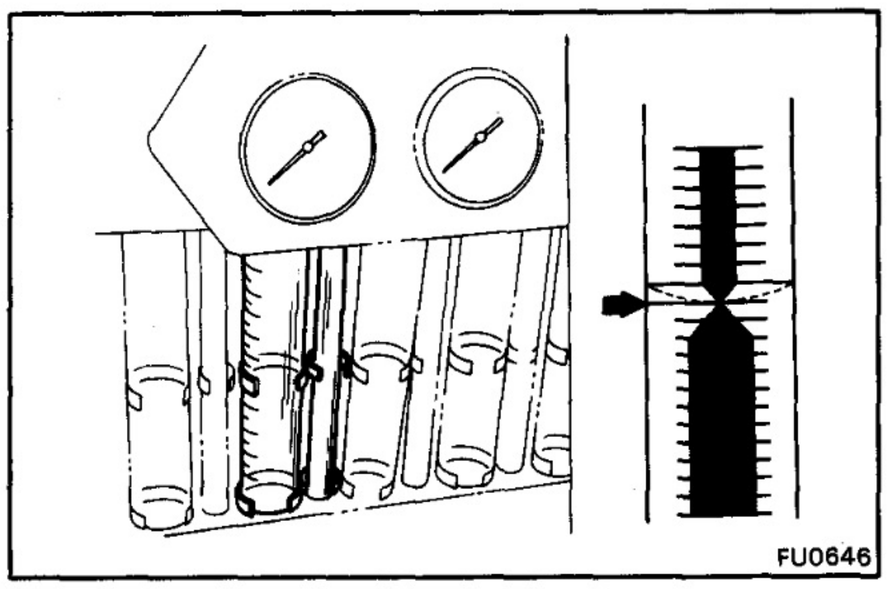
Pre-stroke: 3.05 — 3.15 mm (0.1201 — 0.1240 in.)





(c) Recheck and adjust the injection starting angle.

Cylinder No.	Injection starting angle
1	0
3	89°30′ – 90°30′
4	179°30′ – 180°30′
2	269°30′ – 270°30′



4. CHECK AND ADJUST INJECTION VOLUME

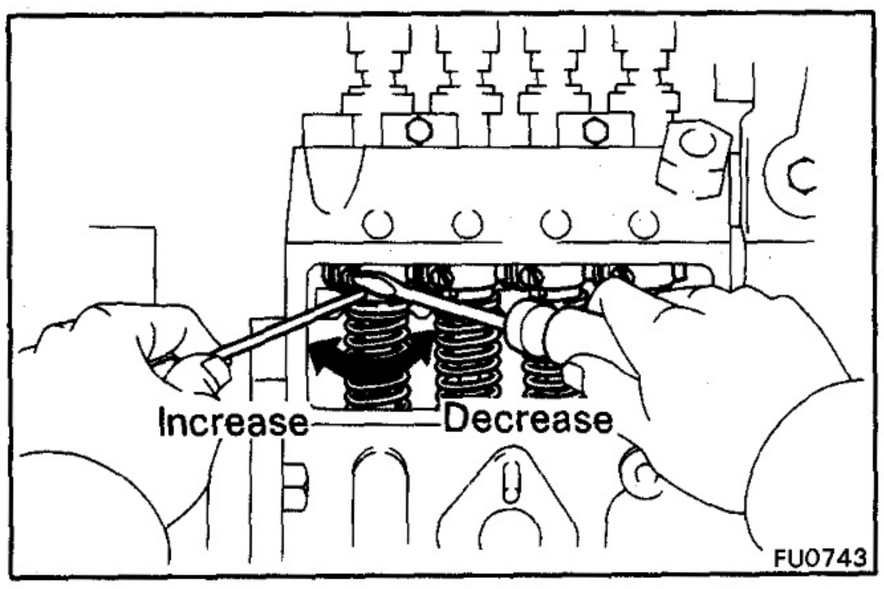
(a) Remove the blind plug from the bleeder hole and install an overflow valve.

(b) Measure the injection volume for each control rack position and pump rpm.

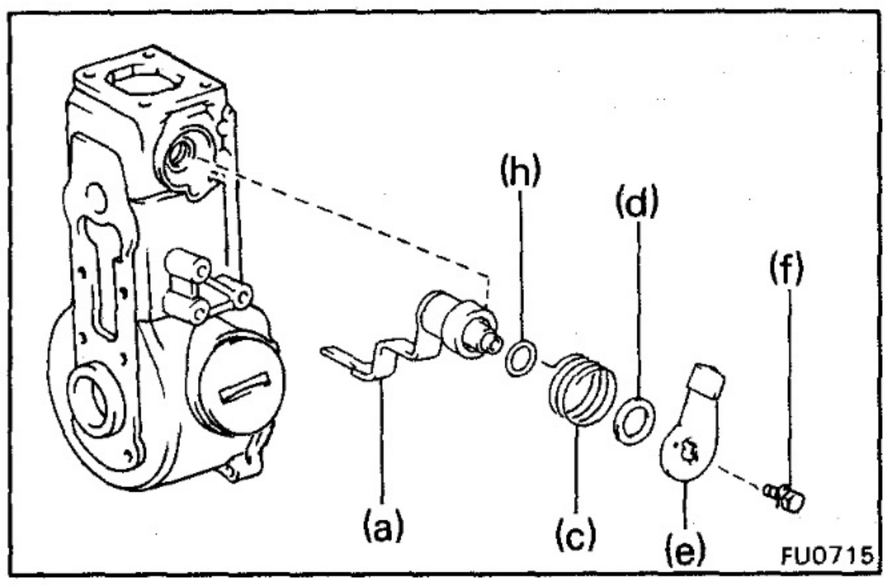
Item	Control rack position mm (in.)	Pump rpm	Measuring stroke	Injection volume of each cylinder cc (cu in.)	Variation limit cc (cu in.)
11B w/o HAC	16.0 (0.630)	100	200	10.0 – 14.0 (0.61 – 0.85)	1.6 (0.10)
	10.4 (0.409)	1,100	200	9.5 – 10.1 (0.58 – 0.62)	0.9 (0.05)
	10.2 (0.402)	1,800	200	8.9 – 10.1 (0.54 – 0.62)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)

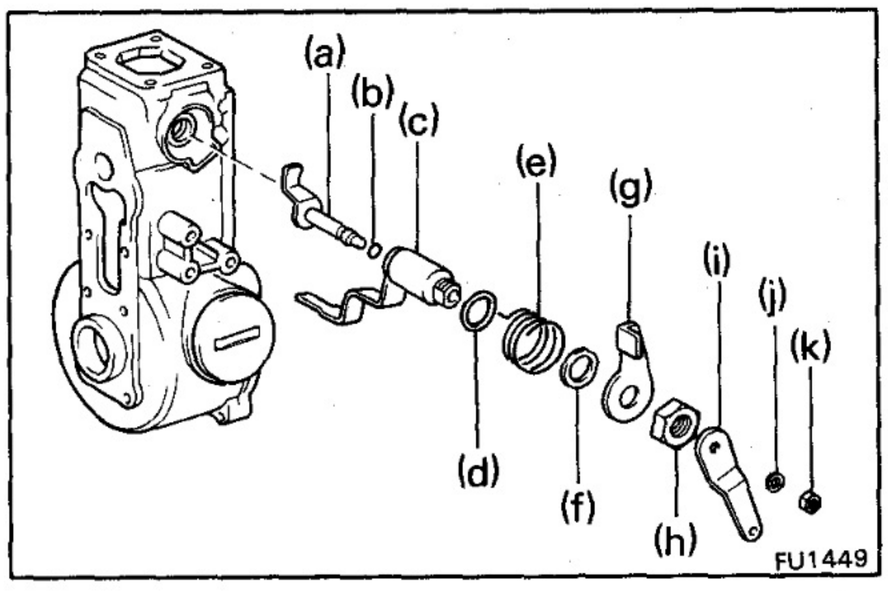
Cont'd

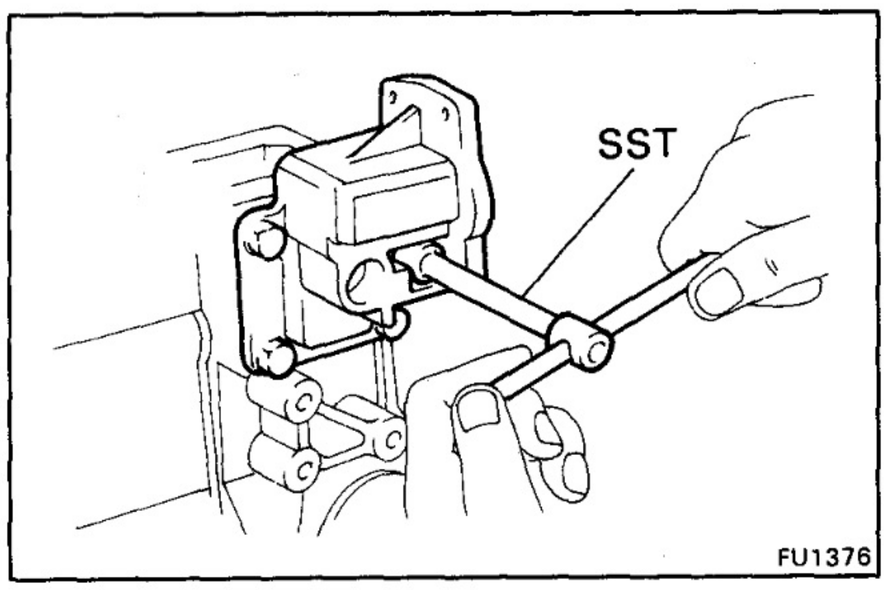
Item	Control rack position mm (in.)	Pump rpm	Measuring stroke	Injection volume of each cylinder cc (cu in.)	Variation limit cc (cu in.)
11B w/ HAC	16.0 (0.630)	100	200	10.0 – 14.0 (0.61 – 0.85)	1.6 (0.10)
	10.4 (0.409)	1,100	200	9.5 – 10.1 (0.58 – 0.62)	0.9 (0.05)
	10.3 (0.406)	1,800	200	9.3 – 10.5 (0.57 – 0.64)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
13B w/o HAC	16.0 (0.630)	100	200	12.4 – 16.4 (0.76 – 1.00)	1.6 (0.10)
	10.5 (0.413)	1,100	200	11.2 – 11.8 (0.68 – 0.72)	0.9 (0.05)
	10.3 (0.406)	1,700	200	11.0 – 11.8 (0.67 – 0.72)	1.2 (0.07)
	Approx. 9.1 (0.356)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
13B w/ HAC	16.0 (0.630)	100	200	12.4 – 16.4 (0.76 – 1.00)	1.6 (0.10)
	10.5 (0.413)	1,100	200	11.2 – 11.8 (0.68 – 0.72)	0.9 (0.05)
	10.4 (0.409)	1,700	200	11.4 – 12.2 (0.70 – 0.74)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
13B-T M/T	16.0 (0.630)	100	200	8.4 – 12.4 (0.51 – 0.76)	1.6 (0.10)
	11.1 (0.437)	1,100	200	13.5 – 14.3 (0.82 – 0.87)	0.9 (0.05)
	10.9 (0.429)	1,700	200	12.9 – 13.9 (0.79 – 0.85)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
13B-T A/T	16.0 (0.630)	100	200	12.4 – 17.6 (0.76 – 1.07)	1.6 (0.10)
	10.8 (0.425)	1,100	200	12.8 – 13.6 (0.78 – 0.83)	0.9 (0.05)
	10.9 (0.429)	1,700	200	13.6 – 14.6 (0.83 – 0.89)	1.2 (0.07)
	Approx. 8.4 (0.331)	400	500	4.3 – 7.3 (0.26 – 0.45)	1.5 (0.09)

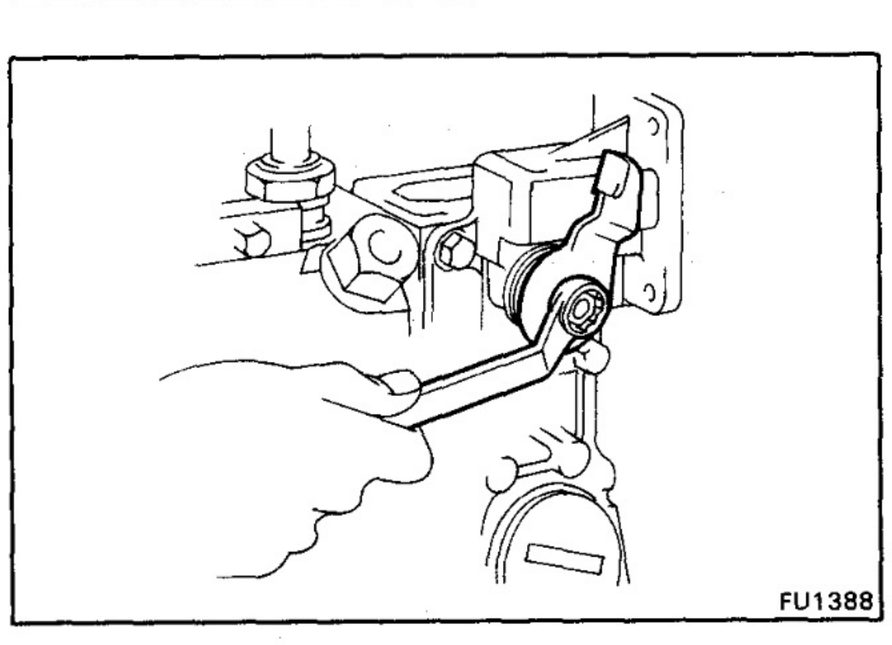


If the injection volume is not within specification, adjust by loosen the pinion clamp screw and rotate the control sleeve.









ASSEMBLY OF INJECTION PUMP (Governor)

(See pages FU-24, 25)

1. [11B, 13B]
INSTALL STOP LEVER AND STOPPER ARM

Install the following parts:

[w/o HAC]

(a) Stopper arm
(b) O-ring
(c) Return spring
(d) Thrust washer
(e) Stop lever
(f) Bolt

[w/ HAC]

(a) Arm
(b) O-ring
(c) Stopper arm
(d) O-ring
(e) Return spring
(f) Thrust washer
(g) Stop lever
(h) Nut
(i) HAC lever
(j) Spring washer
(k) Nut

2. [11B, 13B]
CHECK STOPPER ARM THRUST CLEARANCE
(See step 30 on page FU-34)

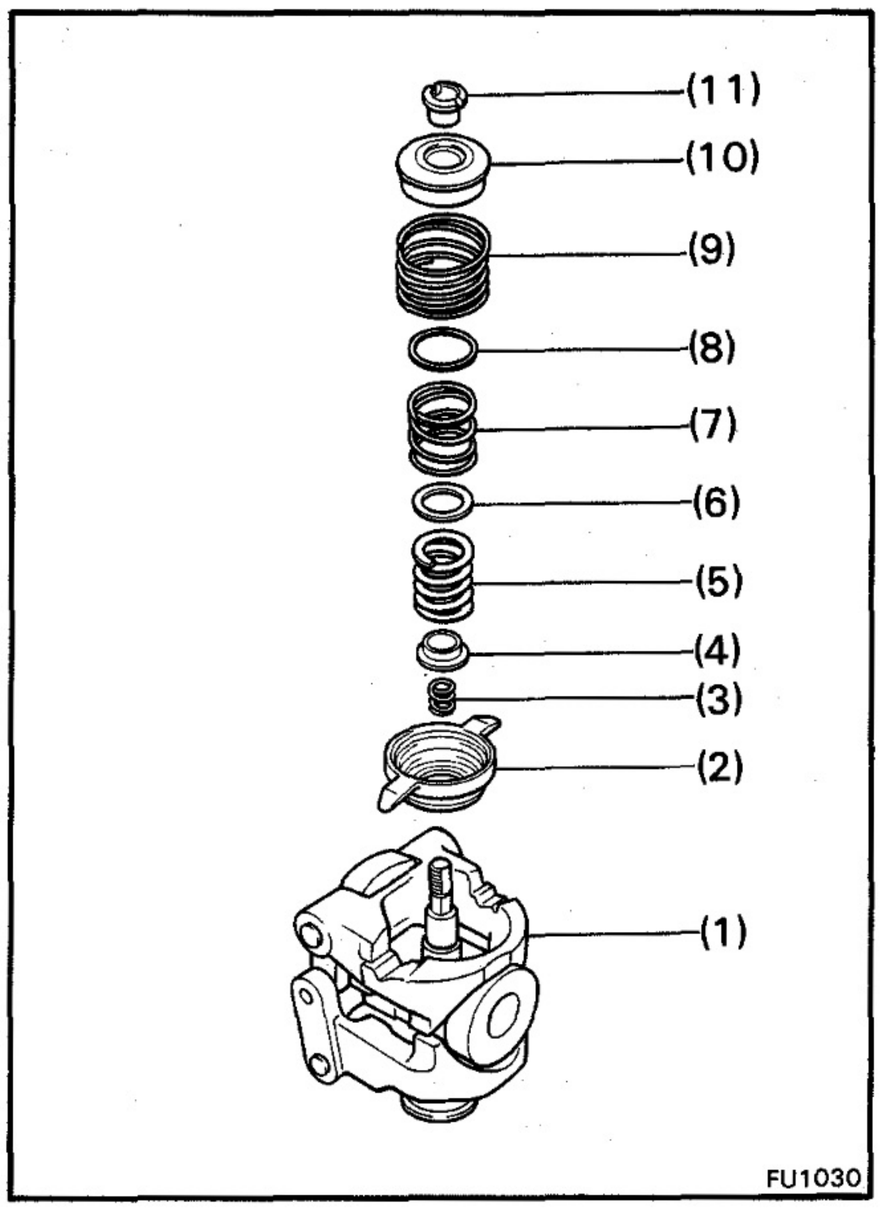
Thrust clearance: 0.05 — 0.20 mm (0.0020 — 0.0079 in.)

3. [13B-T]
INSTALL NO. 2 FULL-LOAD STOPPER HOUSING

(a) Install the arm and stopper arm to the governor housing.
(b) Using SST, install a new O-ring, the No. 2 full-load stopper housing with the four bolts.

SST 09260-58010 (09276-76010)

(c) Install the spring seat.
(d) Install a new O-ring to the full-load stopper housing.
(e) Install the return spring and stop lever with the nut.

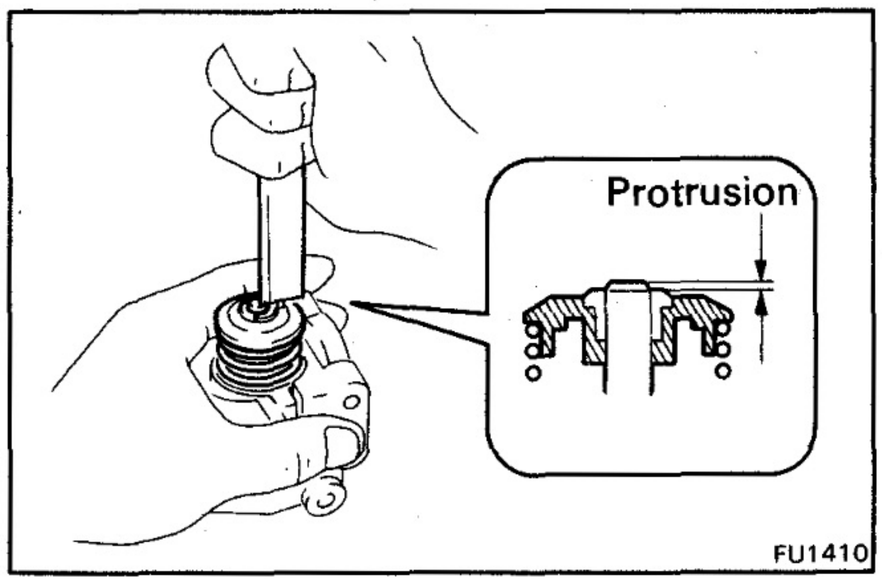


4. ASSEMBLE FLYWEIGHT

(a) Assemble the following parts:

(1) Flyweights with holder
(2) Spring seat
(3) Mechanical spring
(4) Inner spring seat
(5) Speed control spring
(6) Inner adjusting washer
(7) Inner idle spring
(8) Outer adjusting washer
(9) Outer idle spring
(10) Spring guide
(11) Adjusting nut

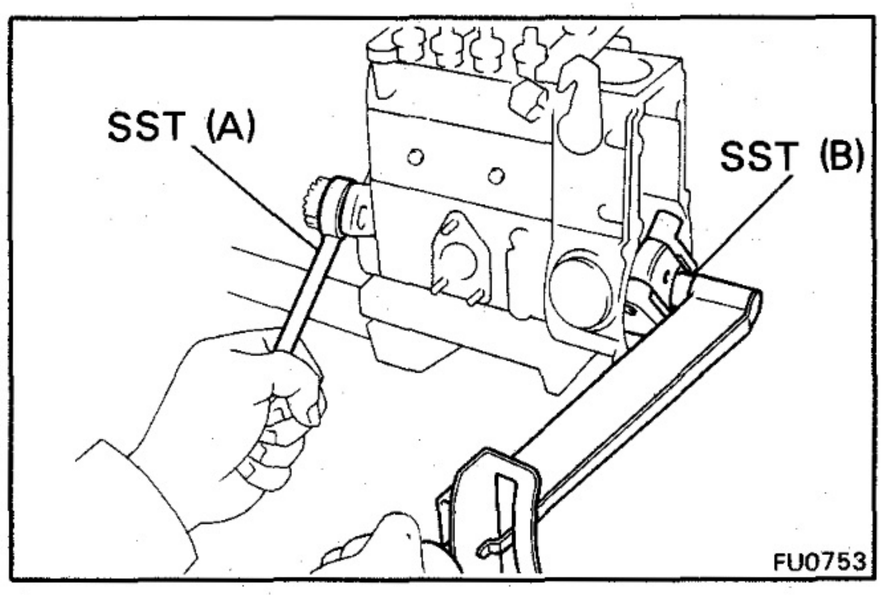
CAUTION: Assemble the adjusting washers on the guide sleeve side.



(b) Install and adjust the adjusting nut.

Adjusting nut protrusion: Minus 0.4 — Plus 0.2 mm (Minus 0.016 — Plus 0.008 in.)

CAUTION: If the protrusion is too large, the adjusting nut will contact the governor housing.



5. [M/T] CHECK FLYWEIGHT THRUST CLEARANCE

(a) Install the camshaft bushing and the flyweight assembly without the dampers.

(b) Using SST (A) to hold the spline shaft, install and torque the adjusting shim and round nut with SST (B).

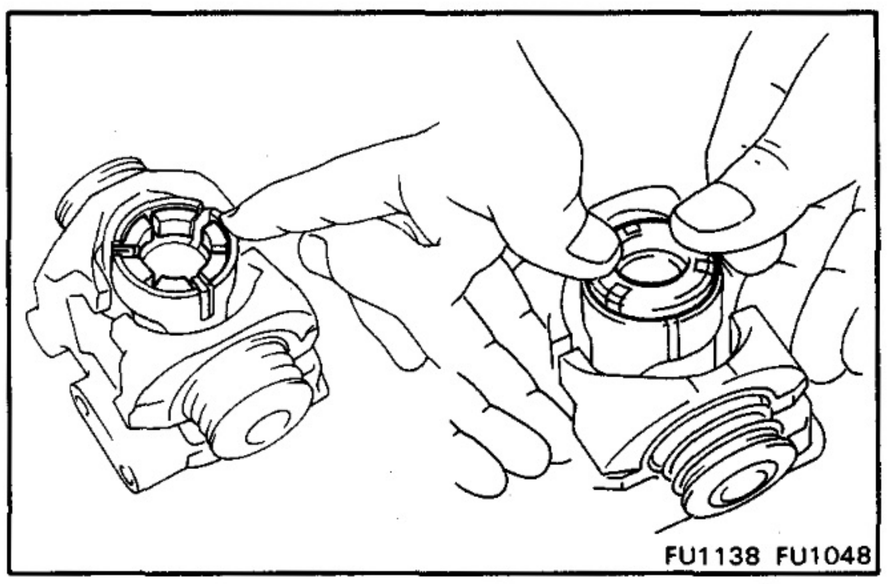
SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09260-78010)

Torque: 550 kg-cm (40 ft-lb, 54 N·m)

(c) Measure the thrust clearance.
(See step 27 on page FU-33)

Thrust clearance: 0.02 — 0.10 mm (0.0008 — 0.0039 in.)

(d) Remove the flyweight assembly and camshaft bushing. (See steps 26, 27 on pages FU-33, 34)

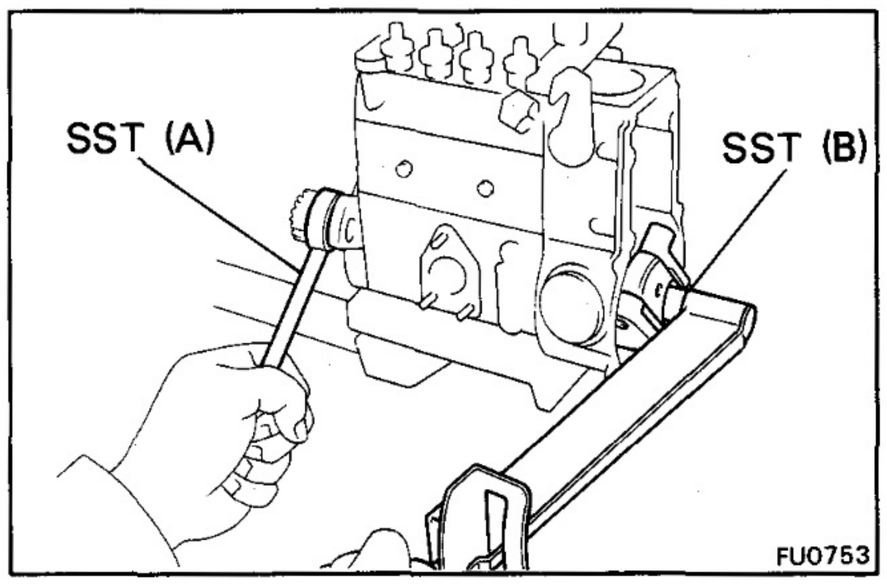


6. [M/T]
INSTALL DAMPERS AND CAMSHAFT BUSHING

(a) Place the six dampers in position into the flyweight holder.

(b) Push in the camshaft bushing.

CAUTION: Do not damage the dampers.



7. INSTALL FLYWEIGHT ASSEMBLY

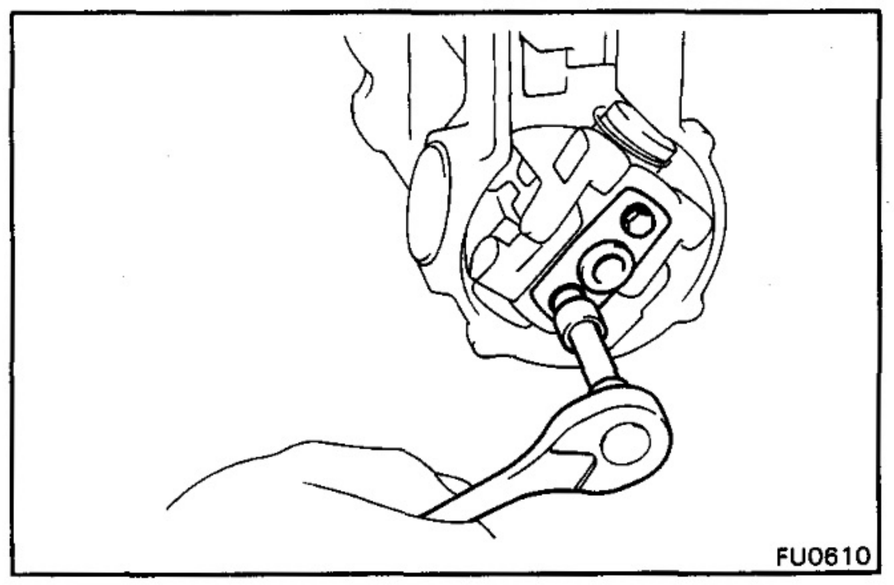
(a) [A/T]
Install the flyweight set key.

(b) [A/T]
Align the set key with the flyweight key groove.

(c) Slide the flyweight assembly onto the camshaft.

(d) Using SST (A) to hold the spline shaft, install the round nut together with the spring washer (A/T) or adjusting shim (M/T) with SST (B).

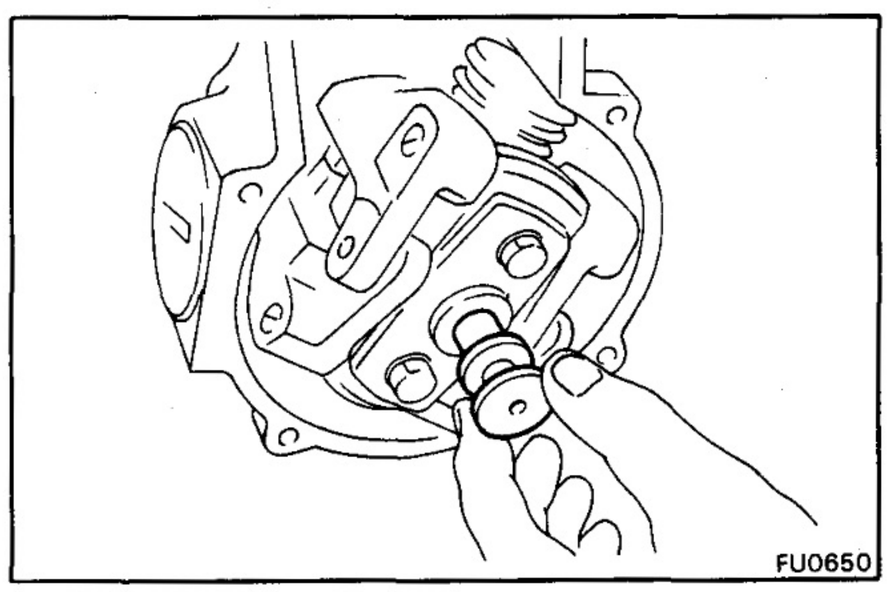
SST (A) 09260-58010 (09278-46020)
(B) 09260-58010 (09260-78010)



8. INSTALL GUIDE BUSHING

Install the guide bushing with the two bolts.

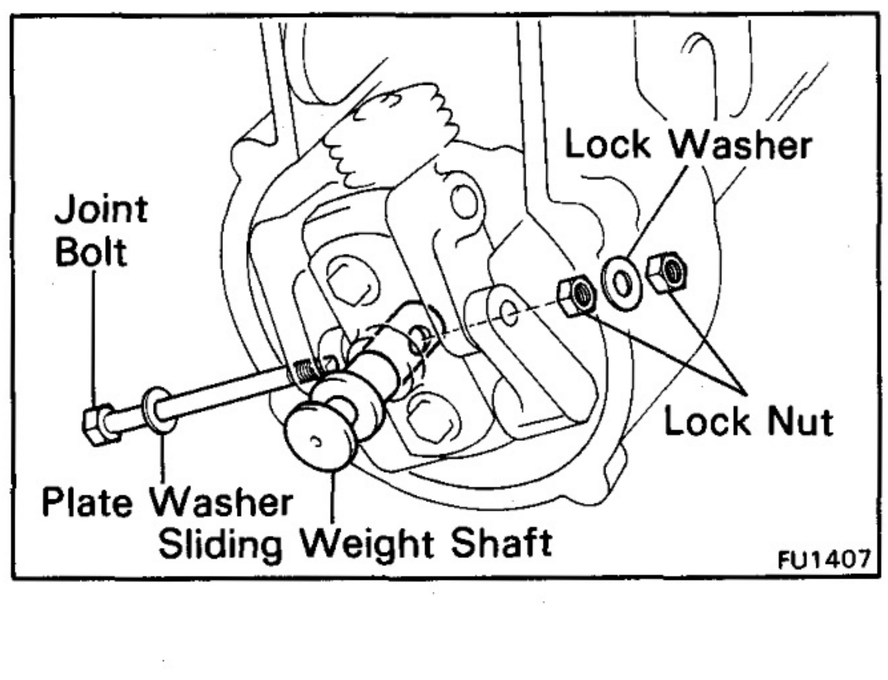
Torque: 80 kg-cm (69 in.-lb, 7.8 N·m)



9. INSTALL SLIDING WEIGHT SHAFT

(a) Insert the sliding weight shaft into the guide bushing.

(b) Check that the sliding weight shaft slides lightly.



(c) Install the plate washer to the joint bolt and pass the joint bolt through the flyweight and sliding weight shaft holes, and install the lock nuts and lock washer.

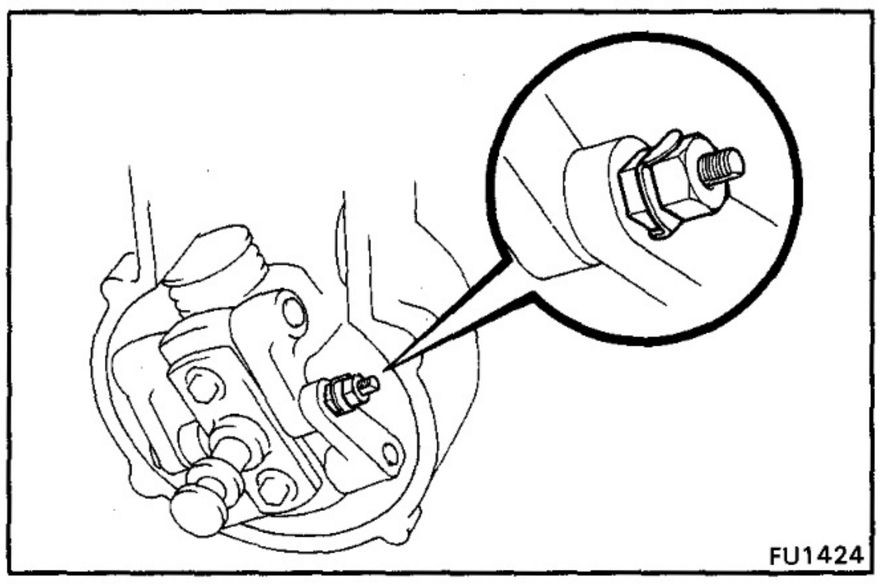
NOTE: The plate washer should be installed on the joint bolt head side and on the elongated hole side of the flyweight.

(d) Adjust the joint bolt thrust clearance.
(See step 22 on page FU-32)

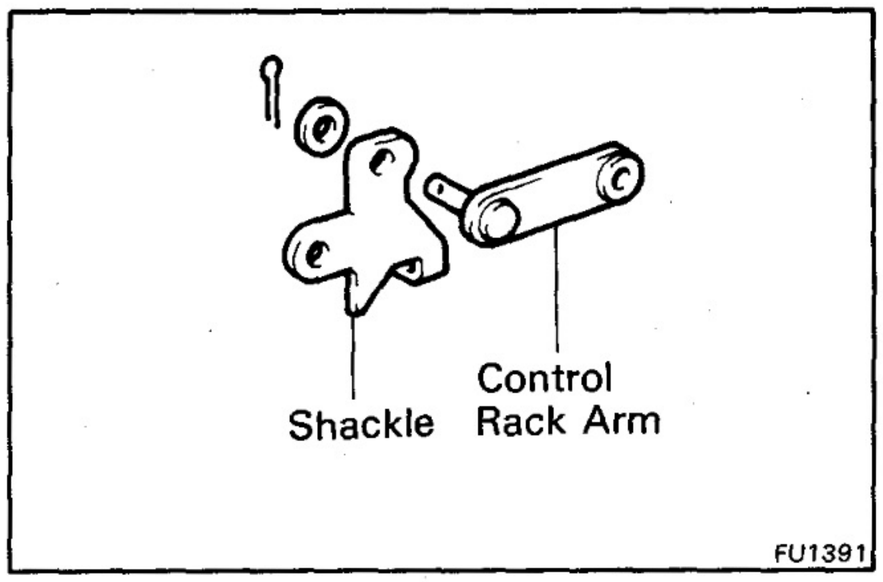
Thrust clearance: 1.5 — 2.0 mm (0.059 — 0.079 in.)

(e) Check the sliding weight shaft fitting dimension.
(See step 23 on page FU-32)

Fitting dimension: 49.7 — 50.1 mm (1.957 — 1.972 in.)

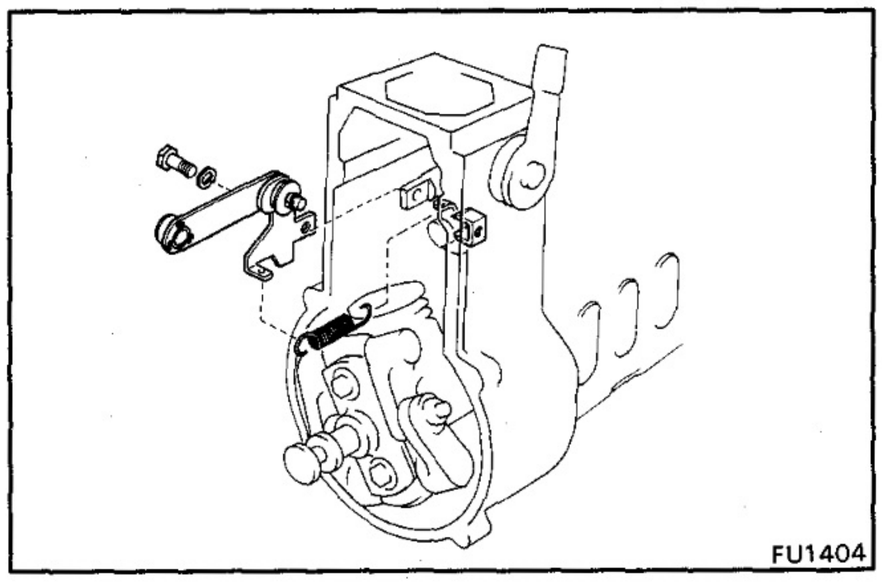


(f) Stake the lock washer.



10. ASSEMBLE SHACKLE AND CONTROL RACK ARM

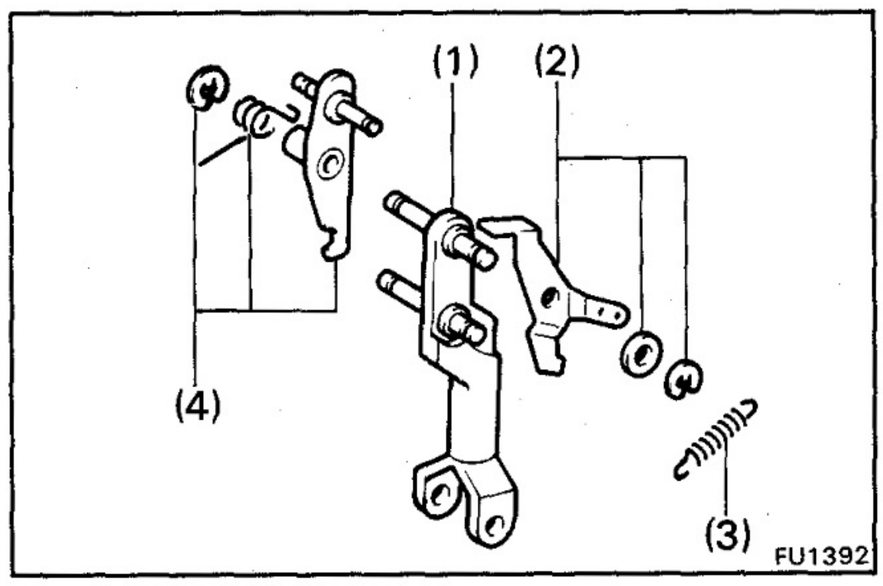
Assemble the shackle, control rack arm and washer with the cotter pin.



11. INSTALL SHAFT AND CONTROL RACK ARM ASSEMBLY

(a) Install the shackle and control rack arm assembly with the arm nut, spring washer and bolt.

(b) Install the return spring.



12. ASSEMBLE FLOATING LEVER

(a) Assemble the following parts:

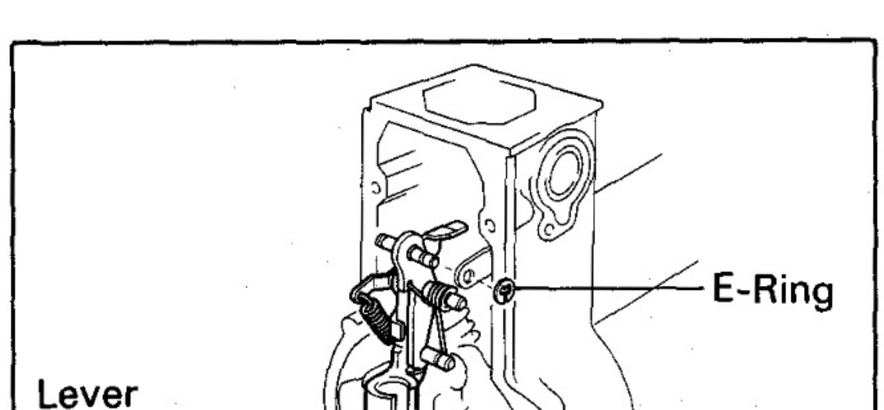
(1) Floating lever

(2) Floating arm, thrust washer and E-ring.
Check the floating lever arm thrust clearance.
(See step 18 on page FU-31)

Thrust clearance: 0.05 — 0.20 mm (0.0020 — 0.0079 in.)

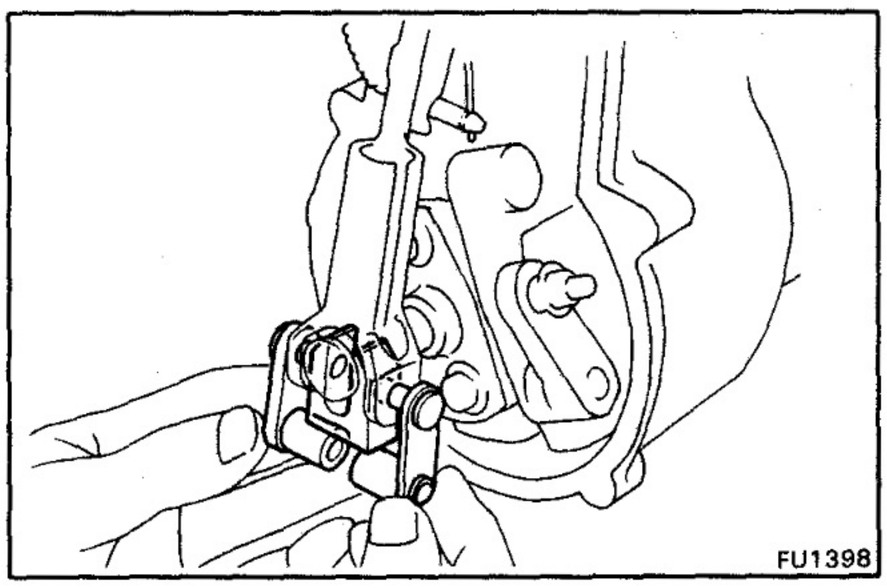
(3) Return spring

(4) Control lever, return spring and E-ring

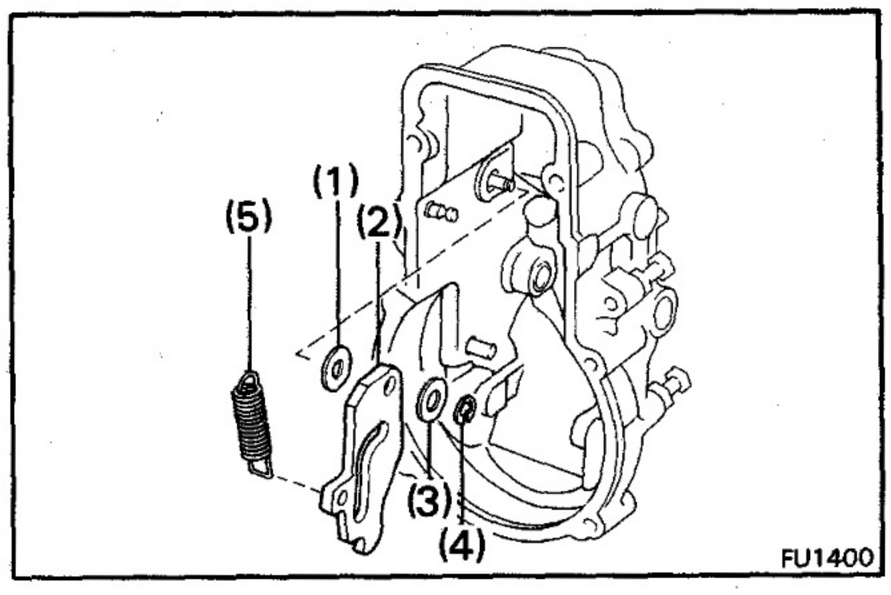


13. INSTALL FLOATING LEVER ASSEMBLY

Install the floating lever assembly with the E-ring.



14. INSTALL SLIDER AND SUPPORTING LEVERS



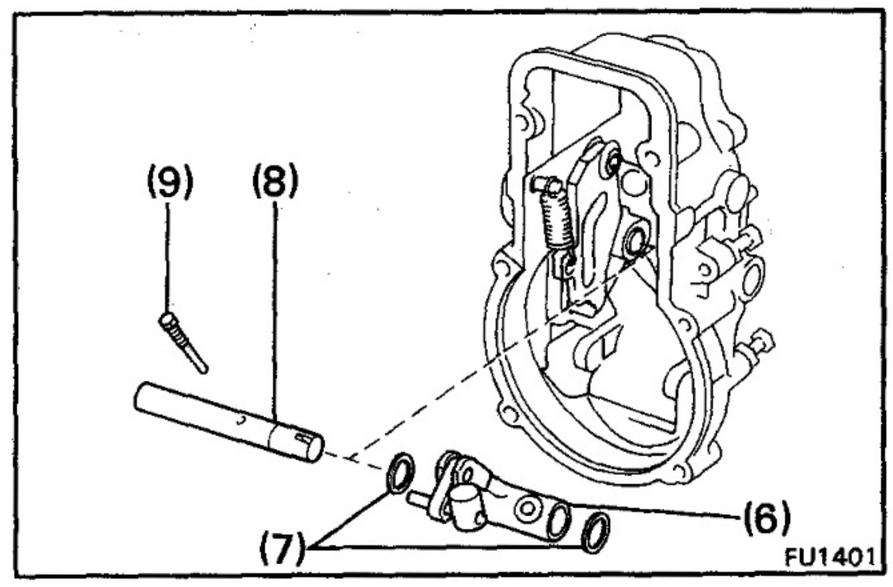
15. ASSEMBLE GOVERNOR COVER

(a) Install the plate washer (1), cam plate (2), thrust washer (3) with the E-ring (4).

(b) Check the cam plate thrust clearance.
(See step 14 on page FU-30)

Thrust clearance: 0.08 — 0.12 mm (0.0031 — 0.0047 in.)

(c) Install the return spring (5).



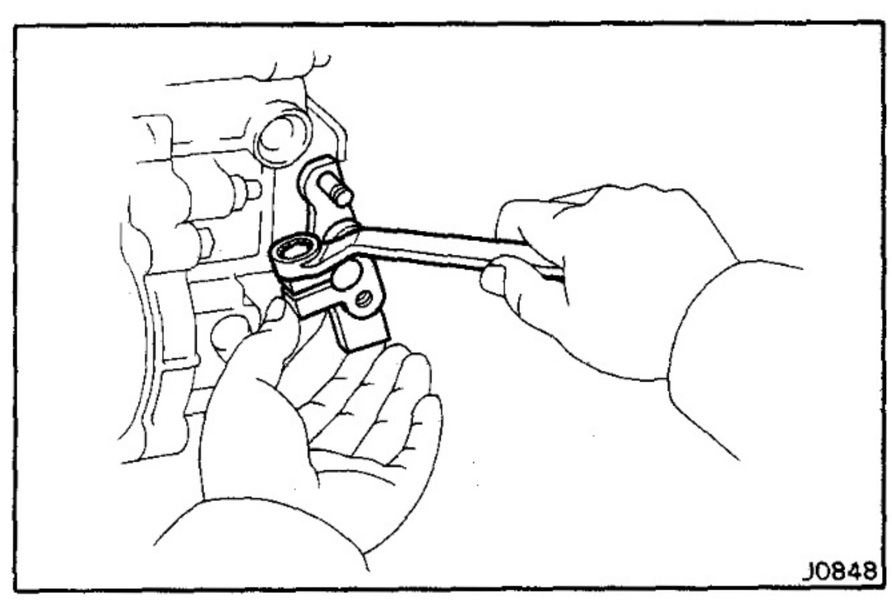
(d) Install the steering lever (6), thrust washers (7) and steering lever shaft (8).

(e) Check the steering lever thrust clearance.
(See step 13 on page FU-30)

Thrust clearance: 0.05 — 0.20 mm (0.0020 — 0.0079 in.)

(f) Position the key groove of the steering lever upward, and install the taper bolt (9).

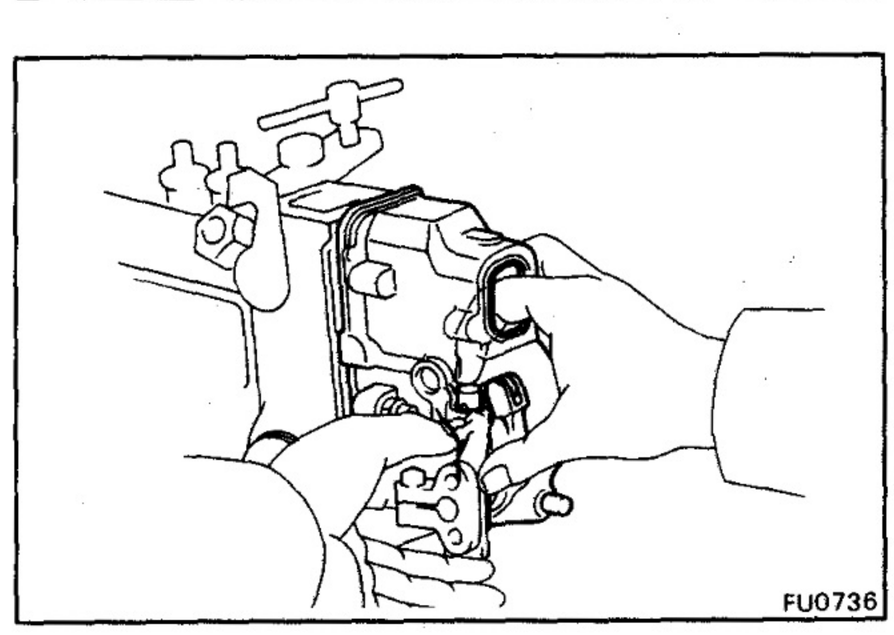
Torque: 55 kg-cm (48 in.-lb, 5.4 N·m)



(g) Install the set key on the adjusting lever shaft.

(h) Align the set key groove of the No. 2 adjusting lever with the set key and slide it over the key.

(i) Tighten the No. 2 adjusting lever holding bolt.



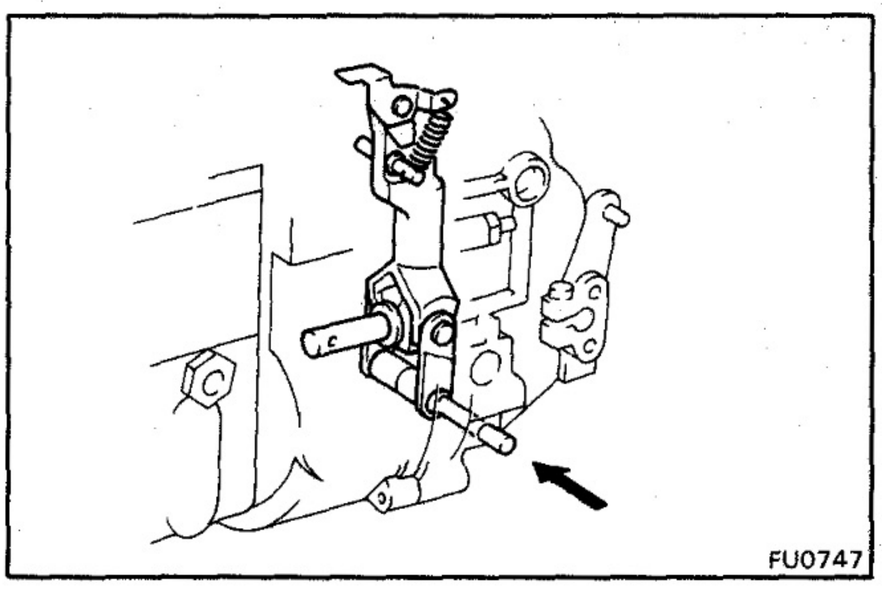
16. INSTALL GOVERNOR COVER ASSEMBLY

(a) Place a new gasket in position on the governor housing.

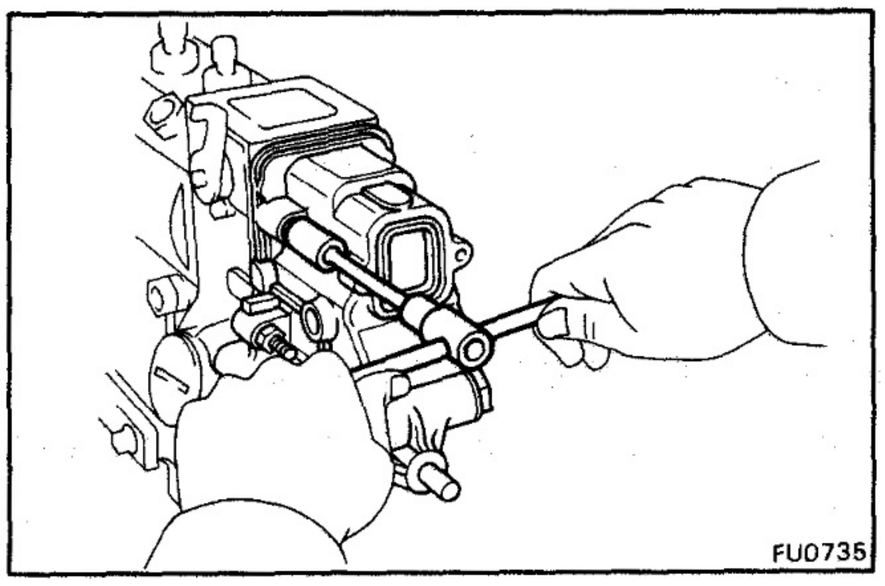
(b) Turn the engine stop lever counterclockwise.

(c) With the adjusting lever turned toward the idle speed side support the sliding block with your finger and insert it into the floating lever hole.

CAUTION: Position the long end of the sliding block upward.

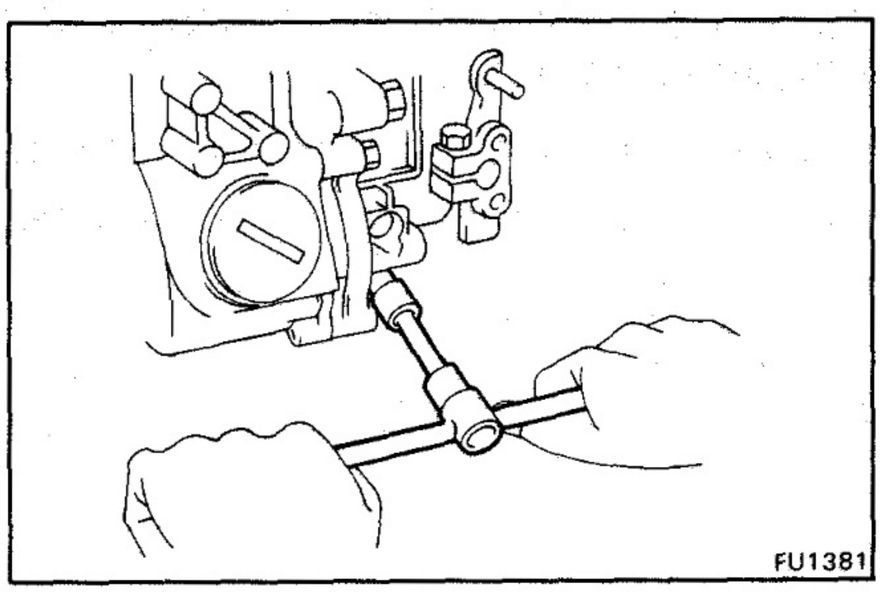


(d) Pass the supporting lever shaft through the supporting lever holes and insert it.



(e) Install the govenor cover with the five (BY, BU) or six (BJ, BB) bolts.

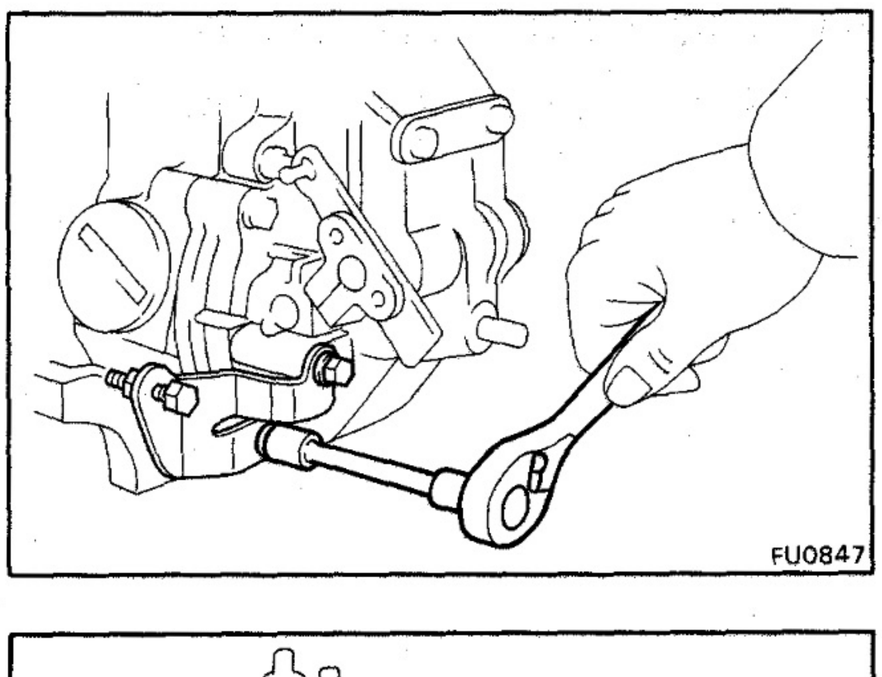
Torque: 85 kg-cm (74 in.-lb, 8.3 N·m)



(f) Apply liquid sealer on the threads and under the screw plug heads.

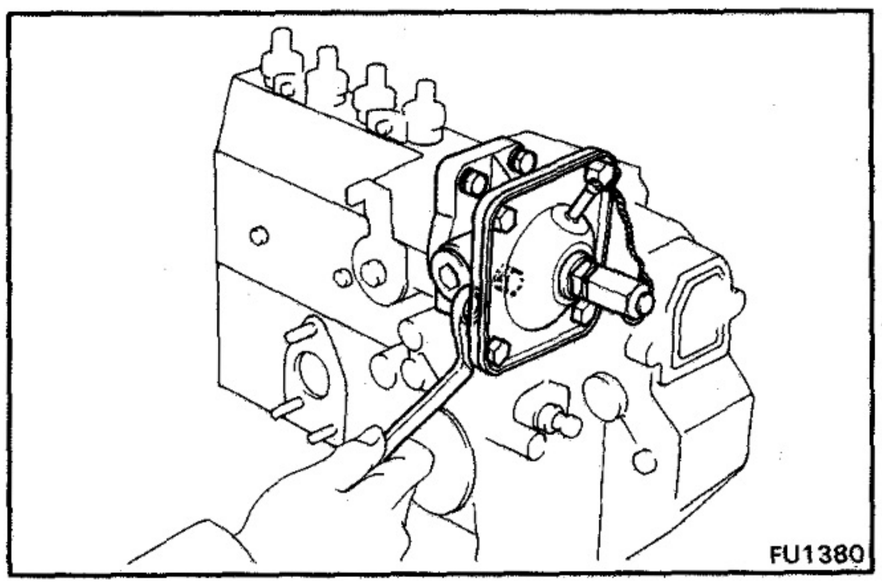
(g) Install the screw plugs.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)



17. [BY, BU]
INSTALL ADJUSTING BRACKET

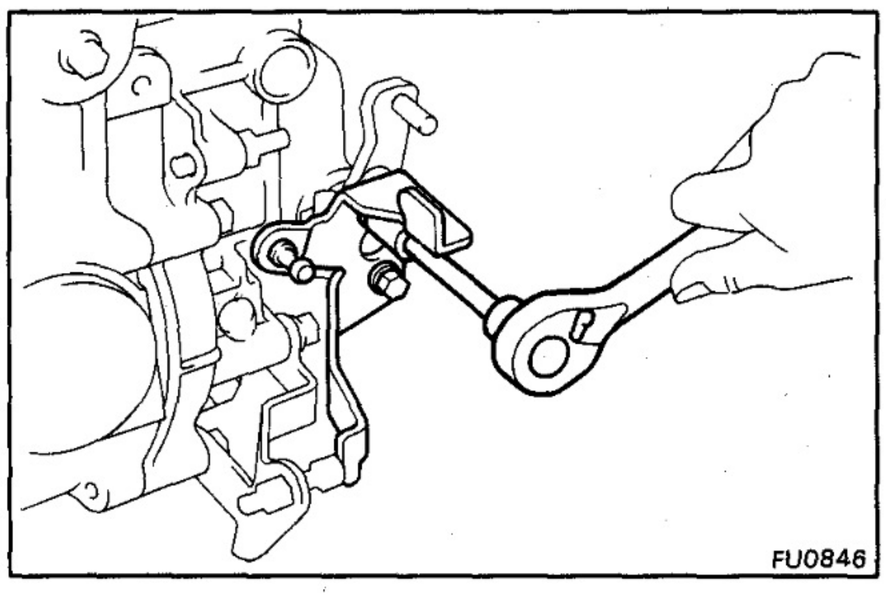
Install the adjusting bracket with the two bolts.



18. [13B-T]
INSTALL BOOST COMPENSATOR

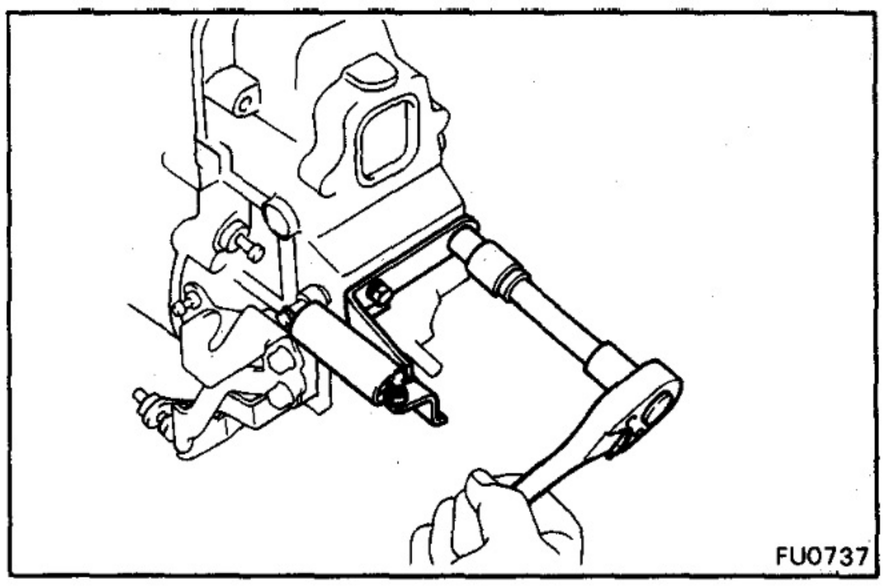
Install a new O-ring and the boost compensator with the four bolts.

Torque: 85 kg-cm (74 in.-lb, 8.3 N·m)



19. INSTALL NO. 1 ADJUSTING LEVER

Install the No. 1 adjusting lever with the two bolts.



20. [w/o HAC]
INSTALL SPRING ARM

(a) Install the spring arm with the two bolts.

(b) Install the return spring.

21. [w/o HAC]
INSTALL COVER PLATE OR DASH POT (DP)

Install a new O-ring and cover plate or DP with the two bolts.

22. [w/ HAC]
INSTALL COVER PLATE, SPRING ARM AND HIGH ALTITUDE COMPENSATOR (HAC)

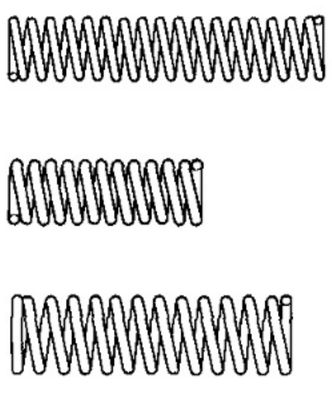
(a) Install a new O-ring and the cover plate with the bolt.

(b) Install the spring arm and HAC with the three bolts.

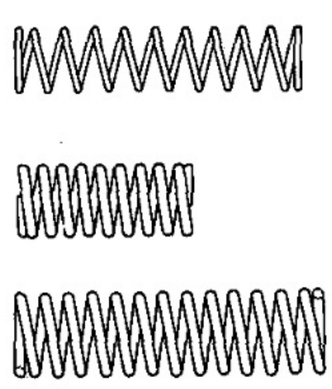
(c) Install the return spring.

(d) Connect the HAC link.

ex. 13B-T (w/o HAC)



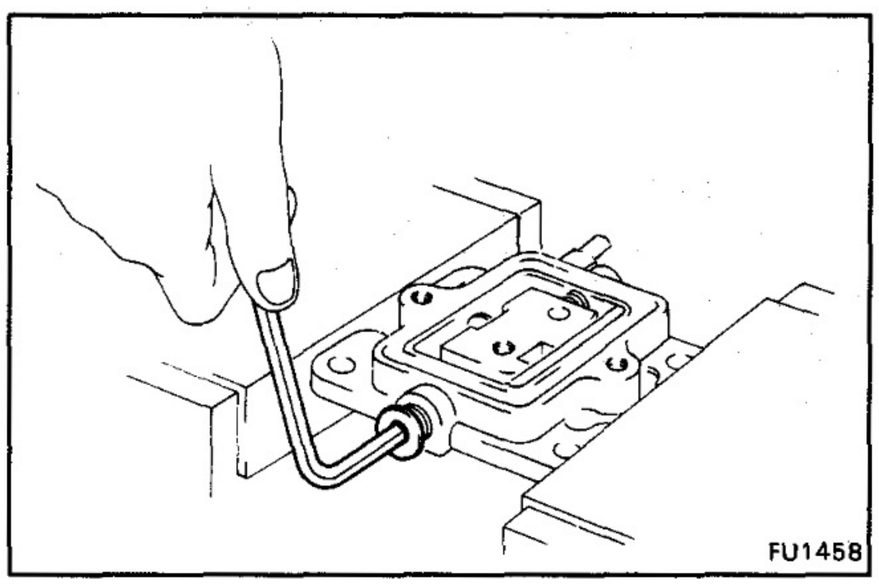
ex. 13B-T (w/ HAC), 13B-T



FU1402
FU1403

23. ASSEMBLE FULL-LOAD STOPPER HOUSING

NOTE: Use the springs indicated "A", "B" and "C".


FU1458

[ex. 13B-T (w/o HAC)]

(a) Install the sliding block, spring "A" and sliding block shaft.

(b) Apply liquid sealer on the threads and under the screw plug head.

(c) Using a hexagon wrench, install the screw plug.

(d) Install the stopper screw, a new gasket and the nut.

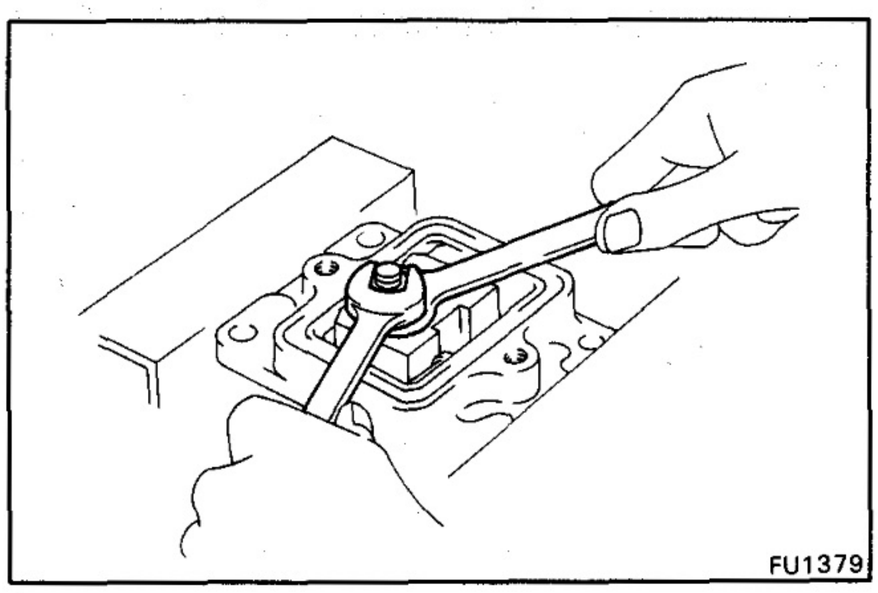
[ex. 13B-T (w/ HAC), 13B-T]

(a) Install the stopper screw, a new gasket and the nut.

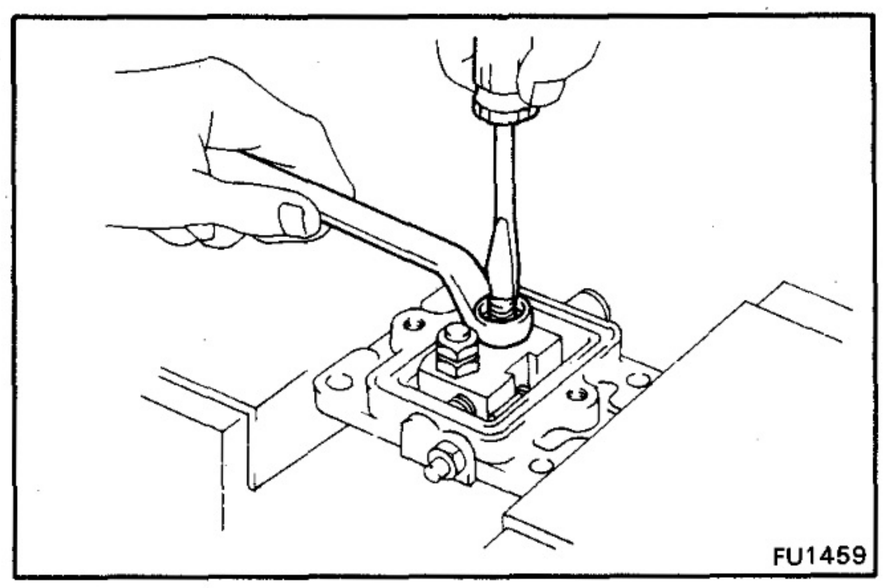
(b) Install the sliding block, spring "A" and sliding block shaft.

(c) Apply liquid sealer on the threads and under the screw plug head.

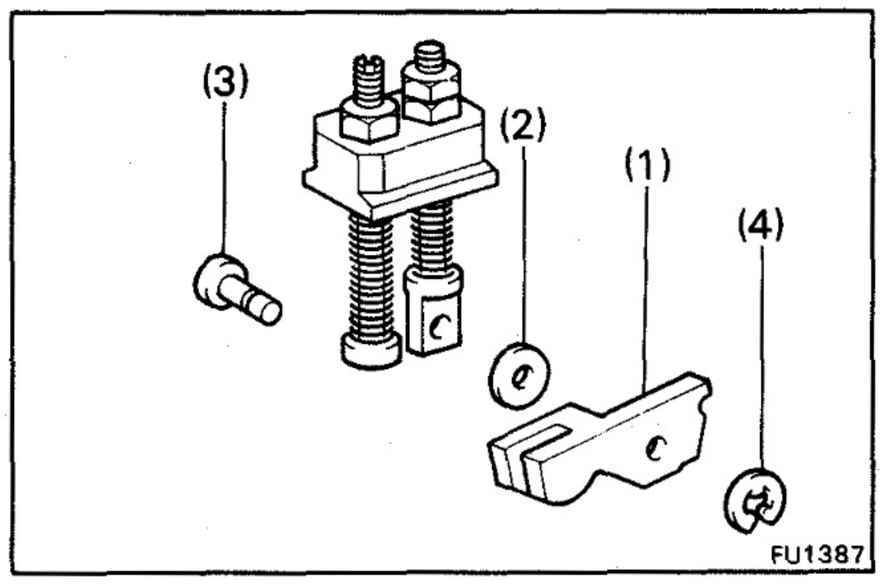
(d) Using a hexagon wrench, install the screw plug.


FU1379

(e) Install the No. 2 adapter screw, spring "B" and two nuts.


FU1459

(f) Install the No. 1 adapter screw, spring "C", bushing and nut.

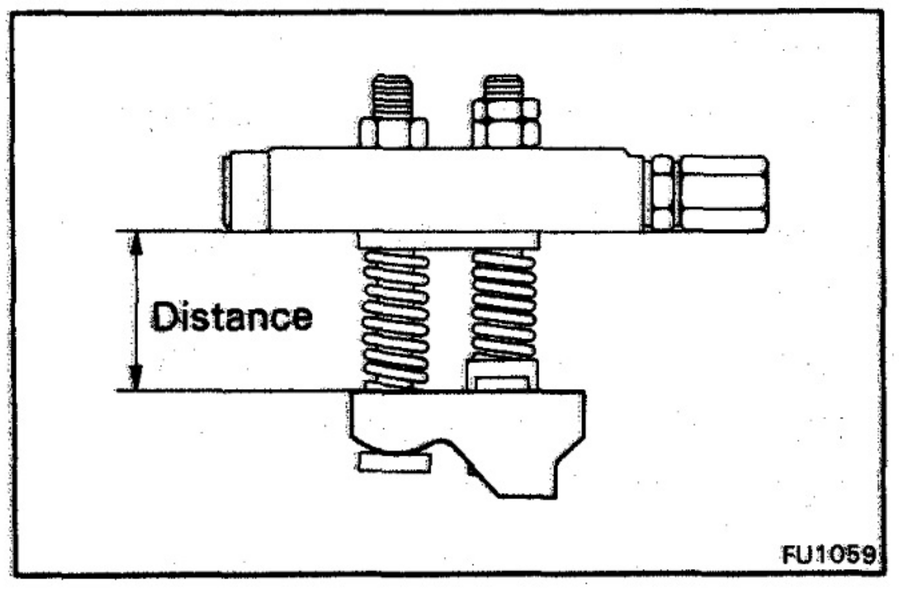


FU1387

(g) Install the full stop cam (1), thrust washer (2), connecting pin (3) and E-ring (4).

(h) Check the full stop cam thrust clearance.
(See step 4 on page FU-26)

Thrust clearance: 0.03 – 0.08 mm (0.0012 – 0.0032 in.)

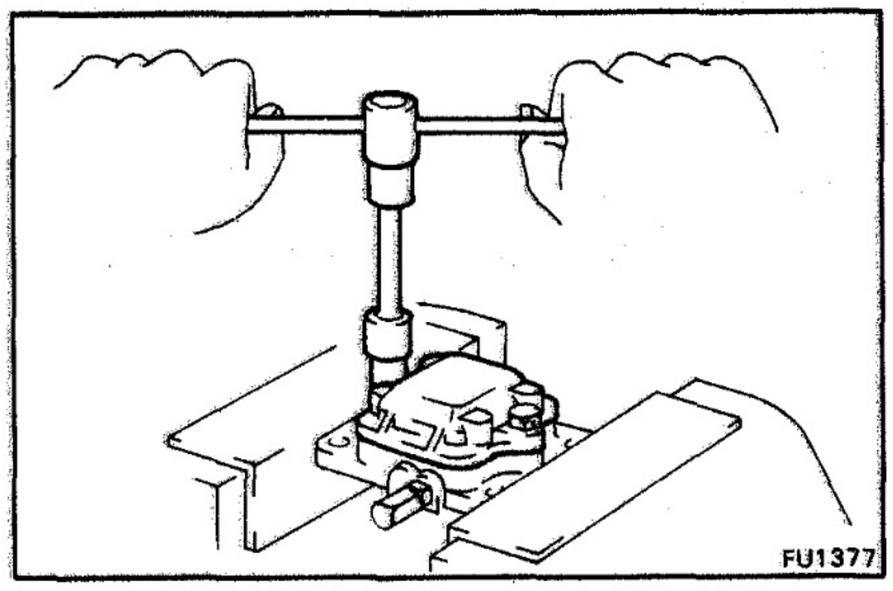


(i) Preset the full stop cam position with the No. 1 and No. 2 adapter screws.

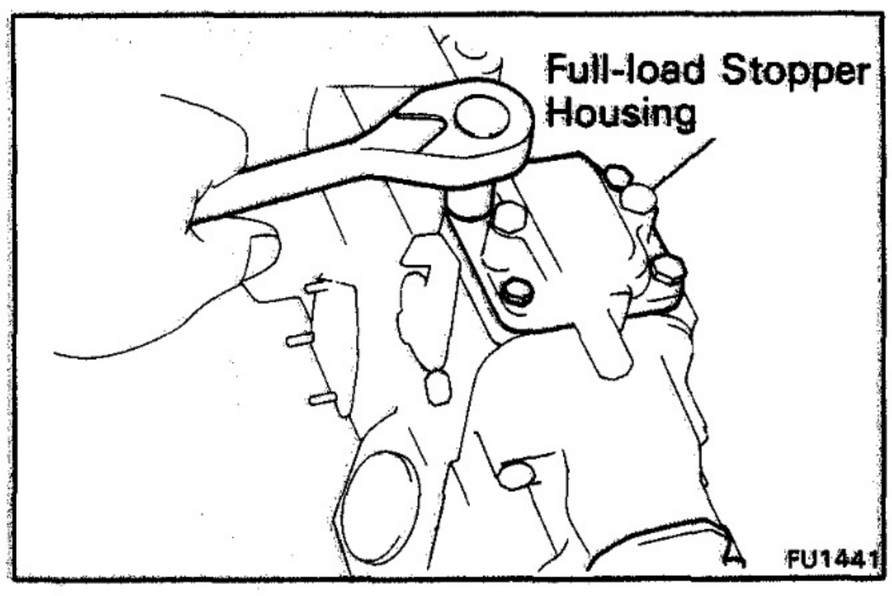
Distance:

ex. 13B-T (w/o HAC)
Approx. 27.0 mm (1.06 in.)
ex. 13B-T (w/ HAC), 13B-T
Approx. 22.5 mm (0.89 in.)

(j) Install a new gasket and the cap nut.



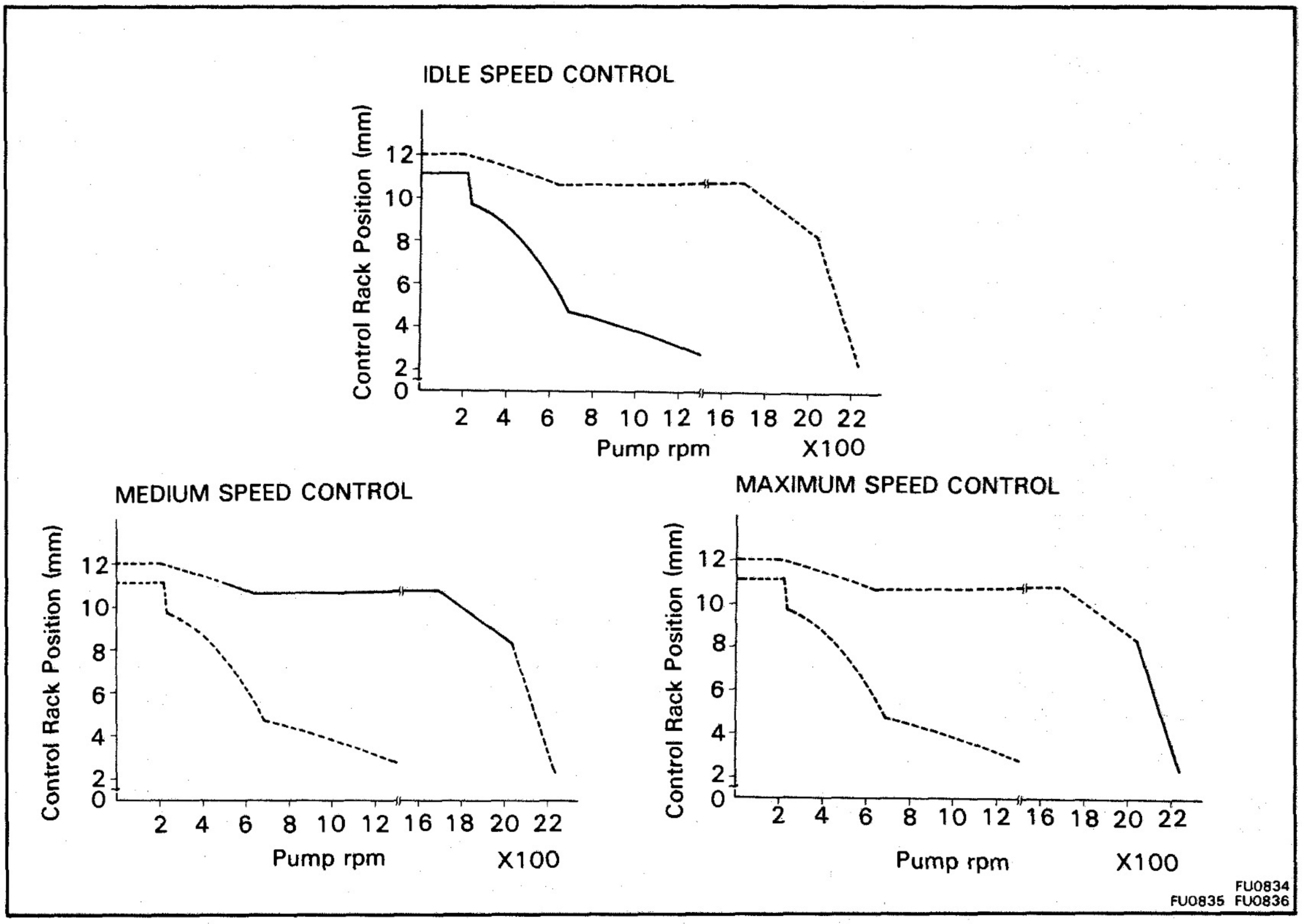
(k) Install a new O-ring, the cover plate with the two bolts.



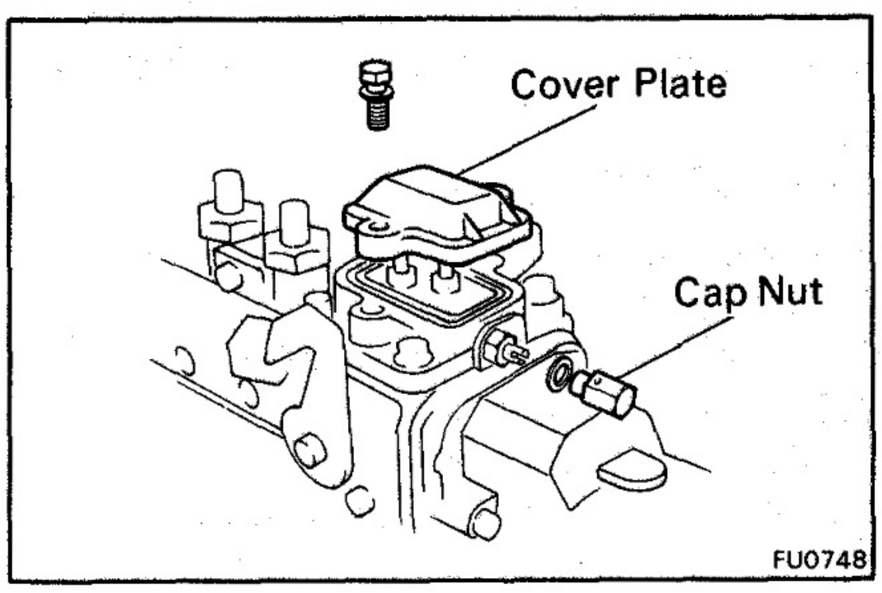
24. INSTALL FULL-LOAD STOPPER HOUSING ASSEMBLY WITH NEW O-RING

ADJUSTMENT OF INJECTION PUMP (Governor)

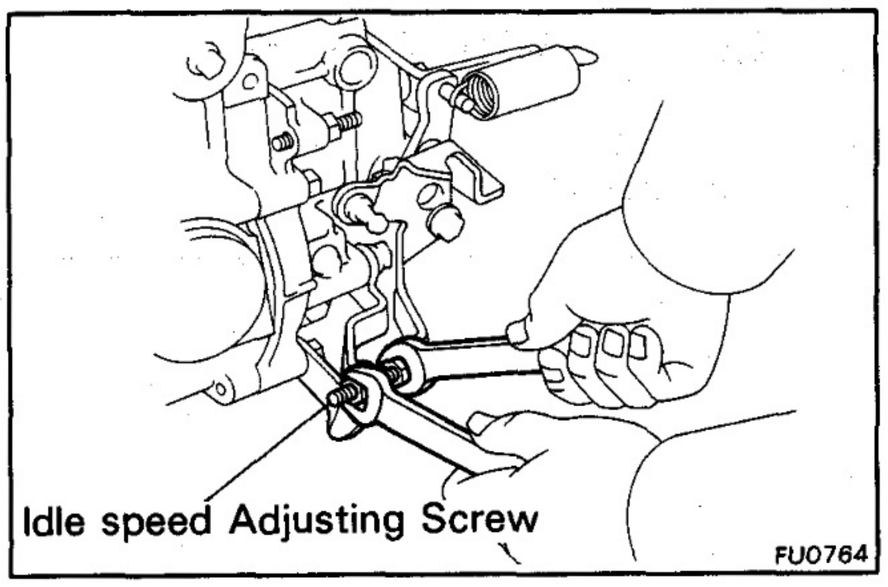
Governor Characteristics Diagram



1. PRE-TEST CHECK AND PREPARATION
(See step 1 on page FU-48)



2. REMOVE COVER PLATE OF FULL-LOAD STOPPER HOUSING AND CAP NUT



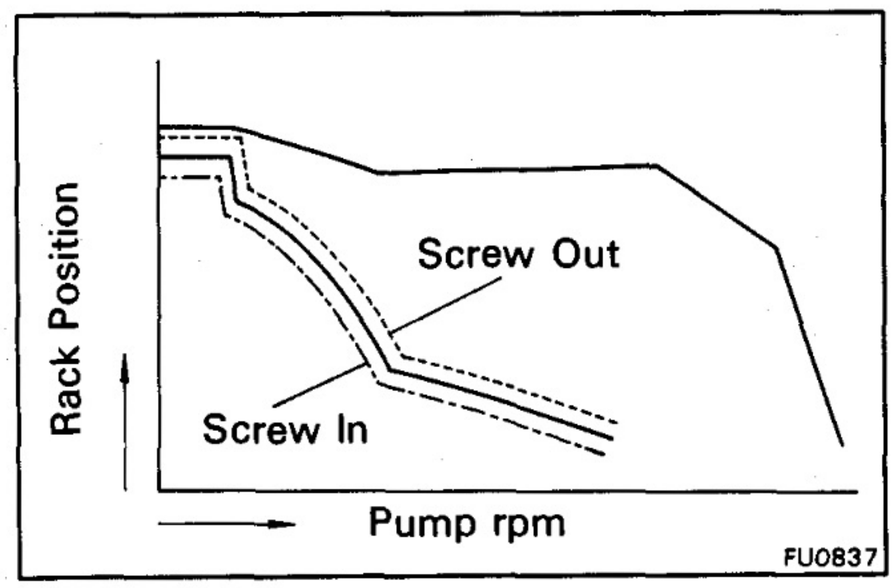
3. INSPECT AND ADJUST IDLE SPEED CONTROL

(a) Measure the control rack position.

Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)
ex. 13B-T A/T	Idle	325	9.0 – 9.2 (0.354 – 0.362)
13B-T A/T	Idle	400	8.1 – 8.7 (0.319 – 0.343)

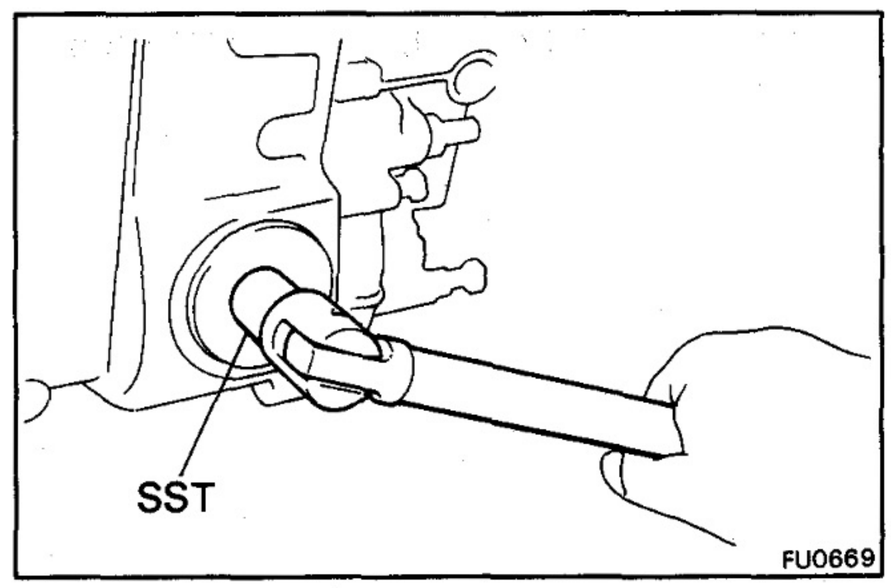
If not within specification, adjust by turning the idle speed adjusting screw.

NOTE: The adjusting screw will change the governor characteristics as shown in the illustration.



(b) Reset the adjusting lever to idle position and measure the control rack position.

Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
ex. 13B-T A/T	Idle	100	10.6 (0.417) or more	–
		325	8.8 – 9.4 (0.346 – 0.370)	Idle speed adjusting screw
		600	5.6 – 7.0 (0.220 – 0.276)	Washer (A)
		800	3.9 – 4.7 (0.154 – 0.185)	Washer (B)
		1,200	2.4 – 3.8 (0.094 – 0.150)	–
13B-T A/T	Idle	100	10.6 (0.417) or more	–
		400	8.1 – 8.7 (0.319 – 0.343)	Idle speed adjusting screw
		600	6.2 – 6.6 (0.244 – 0.260)	Washer (A)
		800	4.0 – 4.8 (0.157 – 0.189)	Washer (B)
		1,200	2.4 – 3.8 (0.094 – 0.150)	–

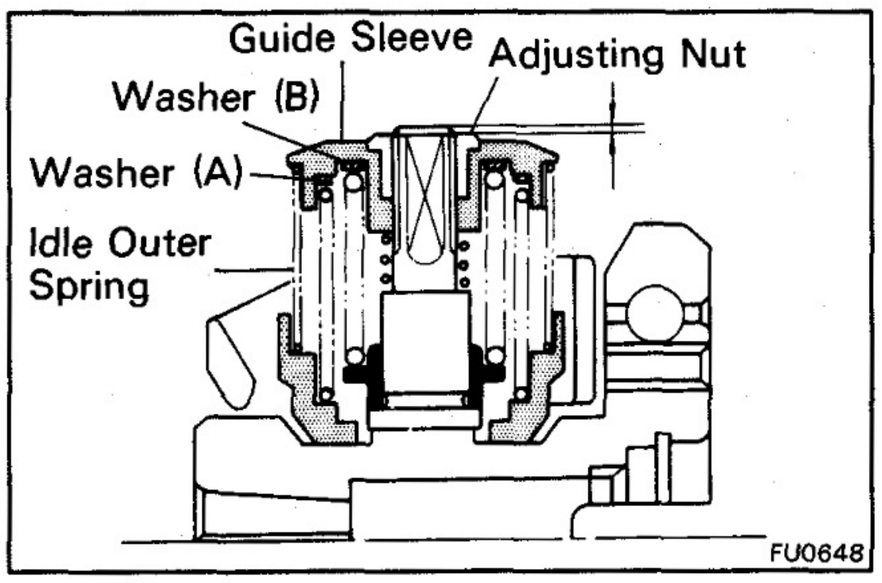


(c) Using SST, remove the screw plug and adjust by turning the adjusting nut or changing the adjusting washers.

SST 09260-58010 (09260-78020)

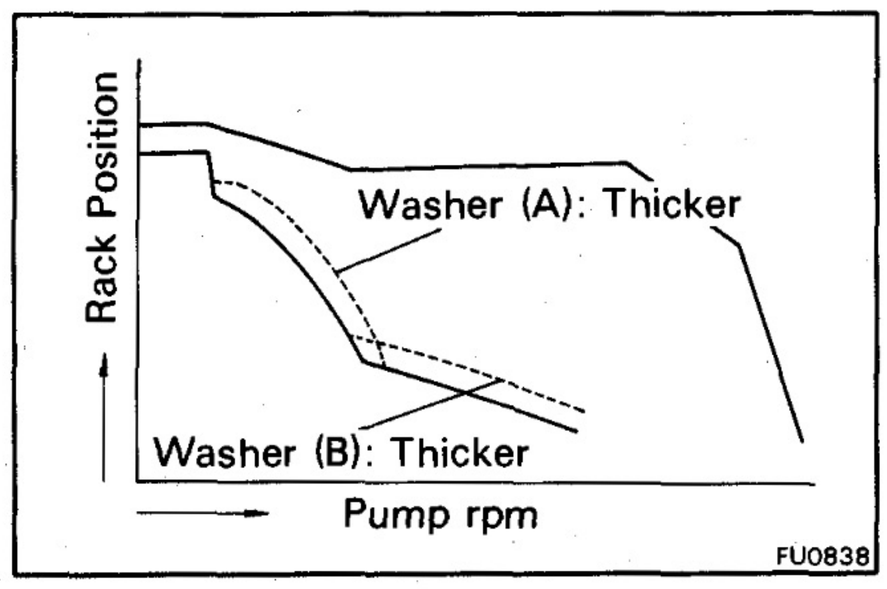
Adjusting washer thickness:

0.2 mm (0.008 in.)	**Outer**
0.4 mm (0.016 in.)	**Inner and outer**
0.5 mm (0.20 in.)	**Outer**
0.55 mm (0.0216 in.)	**Inner**
0.6 mm (0.024 in.)	**Inner and outer**



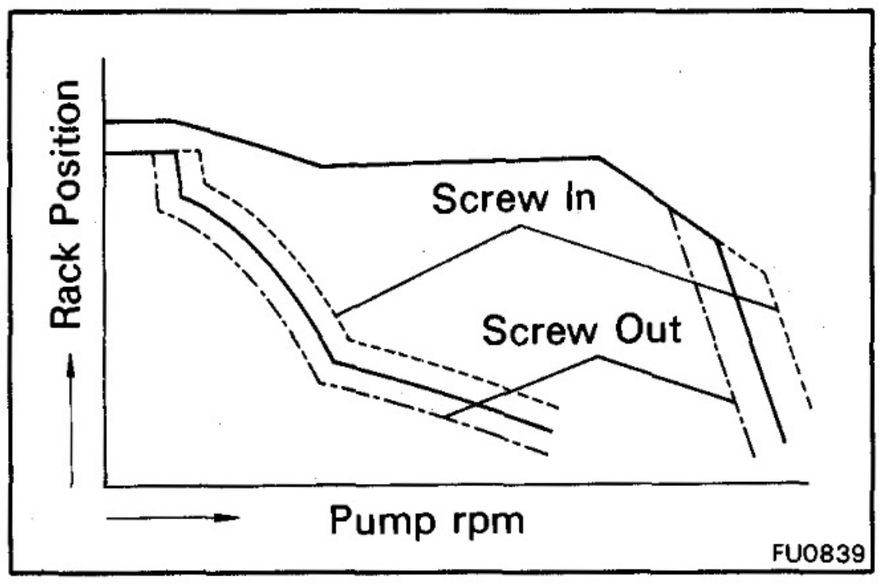
CAUTION:

- **To unsure that there is no interference between the adjusting nut and housing, set the amount of protrusion within minus 0.4 mm (0.016 in.) to plus 0.2 mm (0.008 in.).**
- **Be sure the assemble the adjusting washers on the guide sleeve side.**



NOTE:

- By adding a thicker washer, the governor characteristics will change as shown in the illustration.



- The adjusting nut will change the governor characteristics as shown in the illustration.

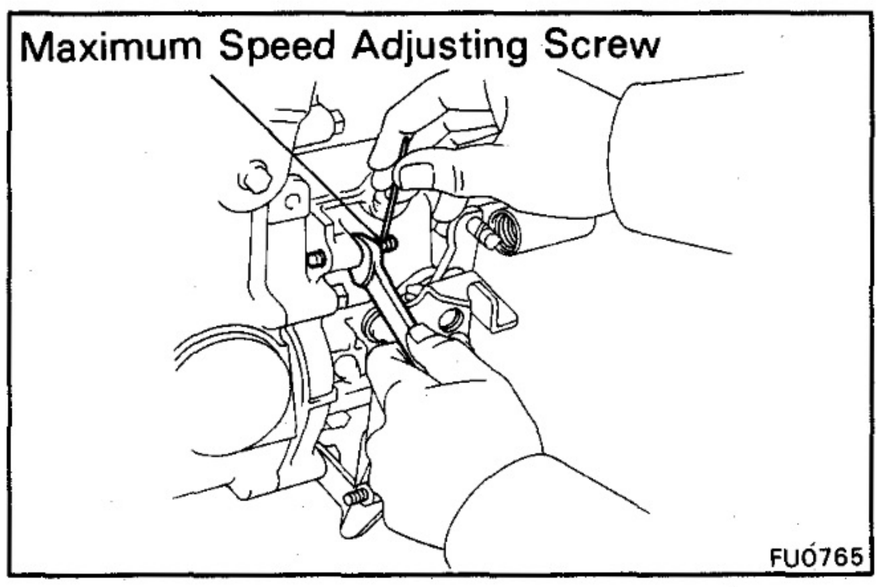
4. PRESET MAXIMUM SPEED CONTROL

(a) [13B-T]
Apply 0.27 kg/cm² (3.9 psi, 26 kPa) of pressure to the boost compensator.

(b) Measure the control rack position.

Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)
ex. 13B-T A/T	Maximum	2,100	7.0 – 8.4 (0.276 – 0.331)
13B-T A/T	Maximum	2,100	6.3 – 7.7 (0.248 – 0.303)

If not within specification, adjust by turning the maximum adjusting screw.



5. INSPECT AND ADJUST MEDIUM SPEED CONTROL

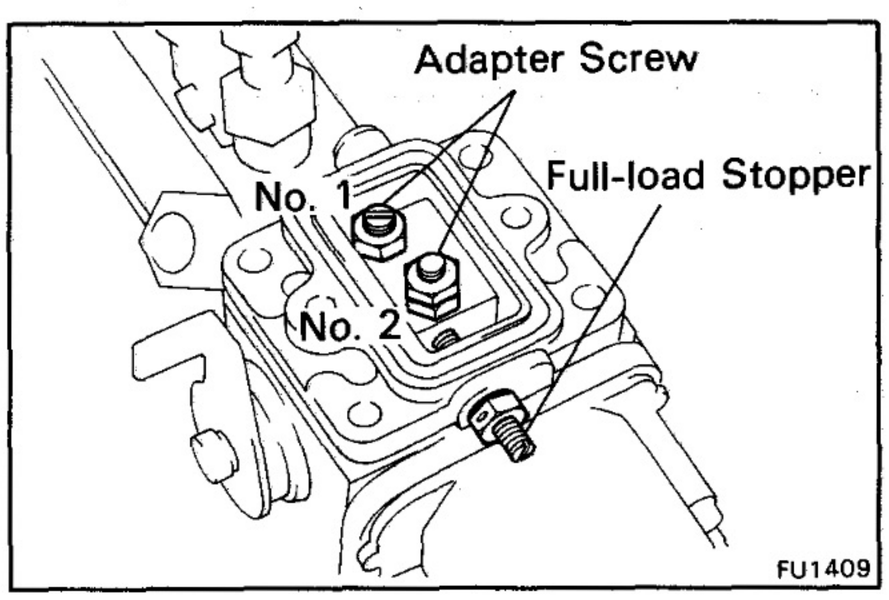
(a) [13B-T]
Apply 0.27 kg/cm² (3.9 psi, 26 kPa) of pressure to the boost compensator.

(b) Raise the pump speed above 600 rpm.

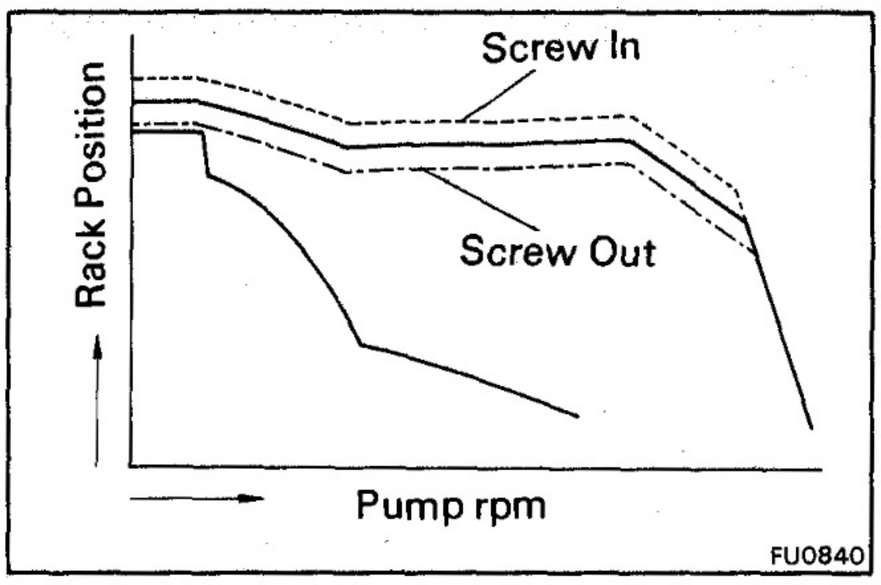
(c) Move the adjusting lever to the idle speed side, and then set the adjusting lever to the maximum speed side.

(d) Measure the control rack position.

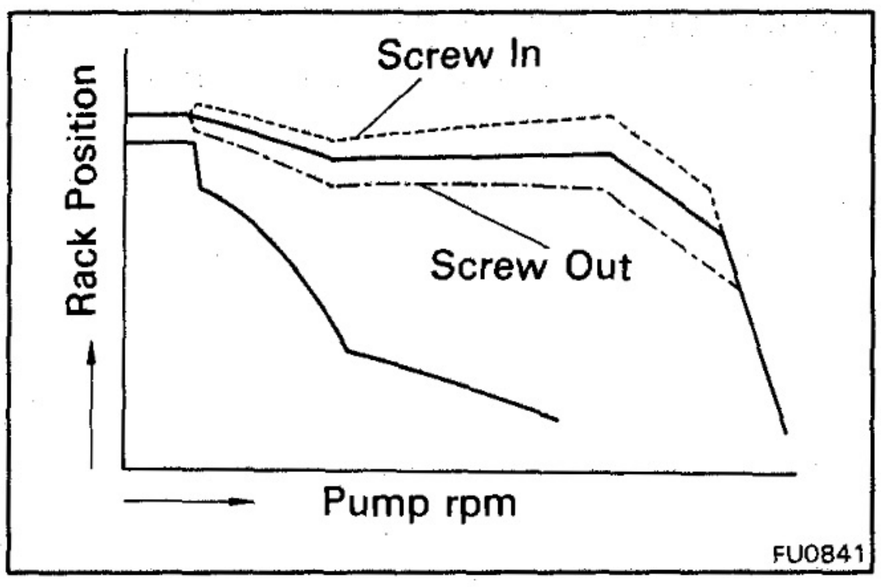
Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
11B w/o HAC	Maximum	500	10.0 – 11.0 (0.394 – 0.435)	No. 1 adapter screw
		700	10.0 – 10.8 (0.394 – 0.425)	–
		1,100	10.1 – 10.7 (0.398 – 0.421)	Full-load stopper screw
		1,800	9.6 – 10.6 (0.378 – 0.417)	No. 1 and No. 2 adapter screws
		1,900	9.3 – 10.1 (0.366 – 0.398)	–
11B w/ HAC	Maximum	500	10.1 – 11.1 (0.398 – 0.437)	No. 1 adapter screw
		700	10.1 – 10.9 (0.398 – 0.429)	–
		1,100	10.1 – 10.7 (0.398 – 0.421)	Full-load stopper screw
		1,800	9.7 – 10.7 (0.382 – 0.421)	No. 1 and No. 2 adapter screws
		1,900	9.4 – 10.2 (0.370 – 0.402)	–
13B w/o HAC	Maximum	500	10.2 – 11.2 (0.402 – 0.441)	No. 1 adapter screw
		700	10.0 – 10.8 (0.394 – 0.425)	–
		1,100	10.2 – 10.8 (0.402 – 0.425)	Full-load stopper screw
		1,700	10.0 – 10.7 (0.394 – 0.421)	No. 1 and No. 2 adapter screws
		1,800	9.4 – 10.4 (0.370 – 0.409)	–
13B w/ HAC	Maximum	500	10.3 – 11.3 (0.406 – 0.445)	No. 1 adapter screw
		700	10.0 – 10.8 (0.394 – 0.425)	–
		1,100	10.2 – 10.8 (0.402 – 0.425)	Full-load stopper screw
		1,700	10.1 – 10.8 (0.398 – 0.425)	No. 1 and No. 2 adapter screws
		1,800	9.5 – 10.5 (0.374 – 0.413)	–
13B-T M/T	Maximum	500	10.7 – 11.5 (0.421 – 0.453)	No. 1 adapter screw
		700	10.8 – 11.6 (0.425 – 0.457)	–
		1,100	10.8 – 11.4 (0.425 – 0.449)	Full-stopper screw
		1,700	10.5 – 11.3 (0.413 – 0.445)	No. 1 and No. 2 adapter screws
		1,900	9.4 – 10.2 (0.370 – 0.402)	–
13B-T A/T	Maximum	500	10.6 – 11.4 (0.417 – 0.449)	No. 1 adapter screw
		700	10.3 – 11.1 (0.406 – 0.437)	–
		1,100	10.5 – 11.1 (0.413 – 0.437)	Full-load stopper screw
		1,700	10.5 – 11.3 (0.413 – 0.445)	No. 1 and No. 2 adapter screws
		1,900	9.5 – 10.3 (0.374 – 0.406)	–



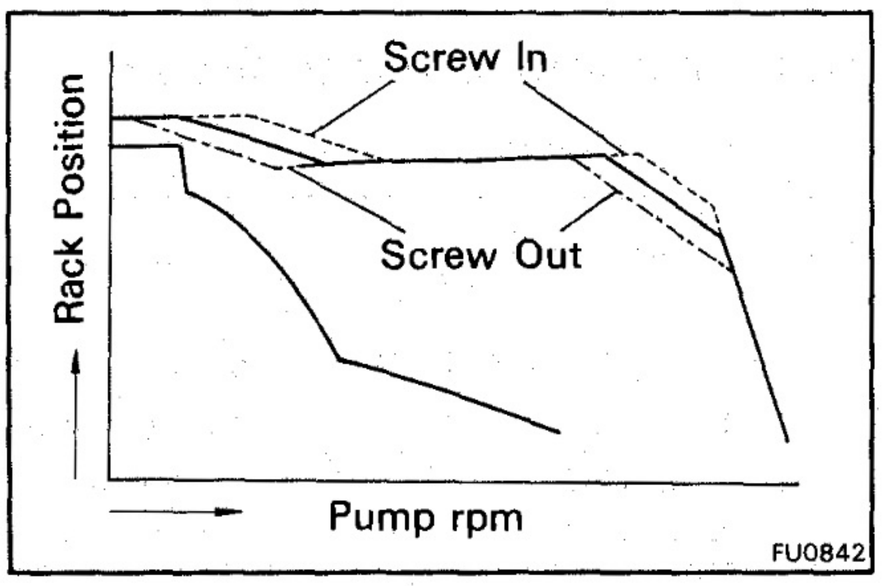
If not within specification, adjust by turning No. 1, No. 2 adapter and full-load stopper screws.



NOTE:
- The full-load stopper will change the governor characteristics as shown in the illustration.



- The No. 1 adapter screw will change the governor characteristics as shown in the illustration.



- By turning adapter screws No. 1 and No. 2 together, the governor characteristics will change as shown in the illustration.

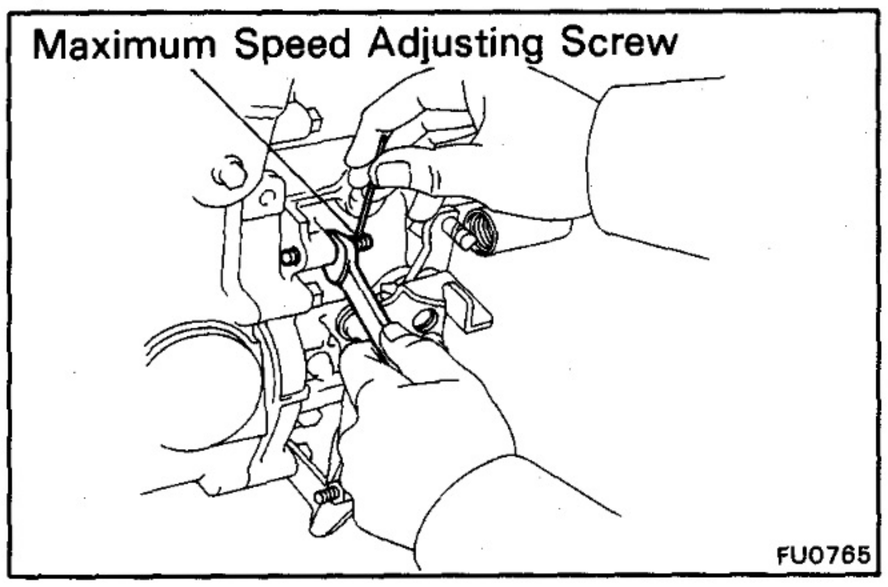
6. INSPECT AND ADJUST MAXIMUM SPEED CONTROL

(a) [13B-T]
Apply 0.27 kg/cm² (3.9 psi, 26 kPa) of pressure to the boost compensator.

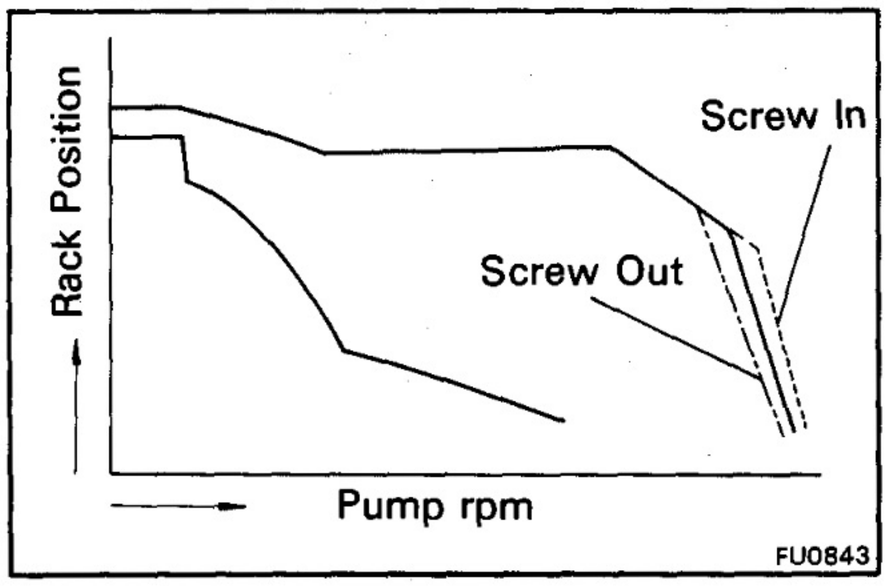
(b) Measure the control rack position.

Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
11B, 13B	Maximum	2,100	7.0 – 8.4 (0.276 – 0.331)	Maximum adjusting screw
		2,200	6.0 (0.236) or less	–
	Idle → Maximum	0	Approx. 16.0 (0.630)	*
13B-T M/T	Maximum	2,100	7.0 – 8.4 (0.276 – 0.331)	Maximum adjusting screw
		2,200	6.2 (0.244) or less	–
	Idle → Maximum	0	Approx. 16.0 (0.630)	*
13B-T A/T	Maximum	2,100	6.3 – 7.7 (0.248 – 0,303)	Maximum adjusting screw
		2,200	6.2 (0.244) or less	–
	Idle → Maximum	0	Approx. 16.0 (0.630)	*

* With the pump not moving (0 rpm), move the stop lever and return it, change the adjusting lever position from idle to maximum position.



If not within specification, adjust by turning the maximum speed adjusting screw.

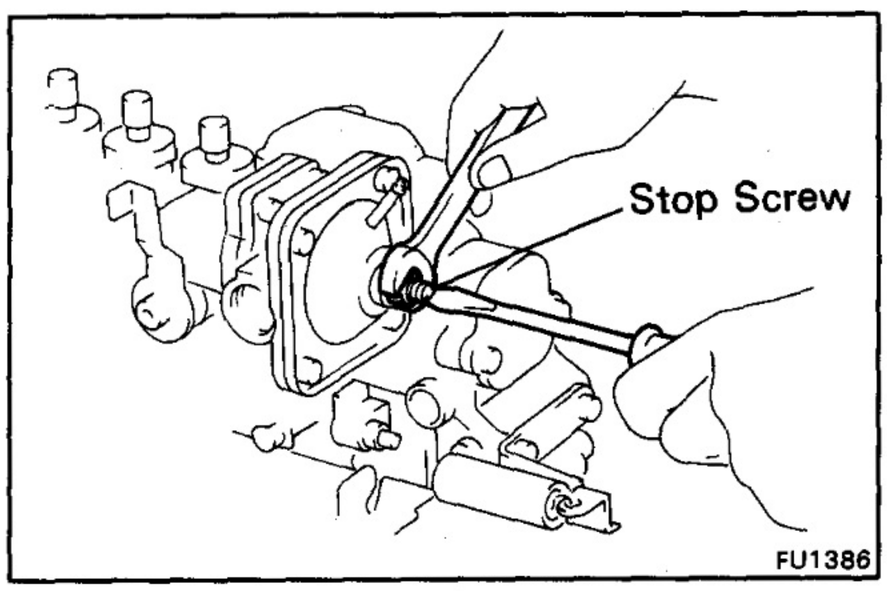


NOTE: The maximum adjusting screw will change the governor characteristics as shown in the illustration.

8. [13B-T]
INSPECT AND ADJUST BOOST COMPENSATOR

Measure the control rack position.

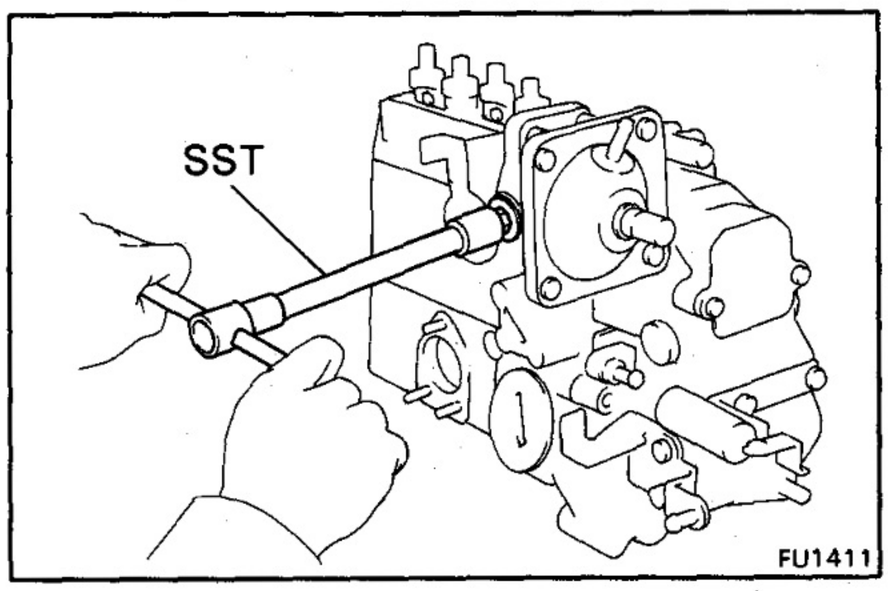
Item	Adjusting lever position	Pump rpm	Boost compensator pressure kg/cm² (psi, kPa)	Control rack position mm (in.)	Adjusting point
13B-T M/T	Maximum	500	0	10.4 – 11.0 (0.409 – 0.433)	Stop screw
			0.12 (1.7, 12)	10.7 – 11.5 (0.421 – 0.453)	Guide bushing
13B-T A/T	Maximum	500	0	10.5 – 11.1 (0.413 – 0.437)	Stop screw
			0.12 (1.7, 12)	10.6 – 11.4 (0.417 – 0.449)	Guide bushing



If not within specification, adjust with the stop screw or guide bushing.

[Stop screw]

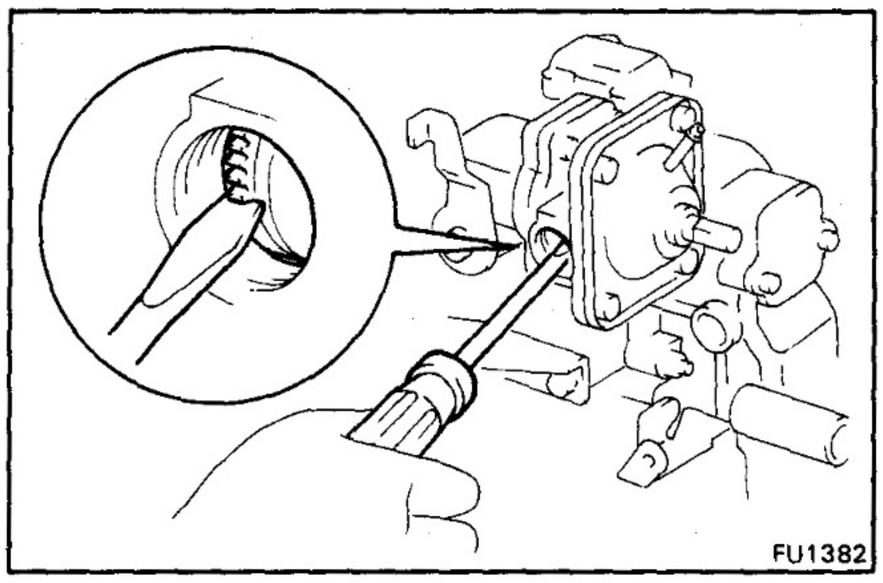
- Adjust by turning the stop screw.



[Guide Bushing]

- Using SST, remove the screw plug.

SST 09043-38100

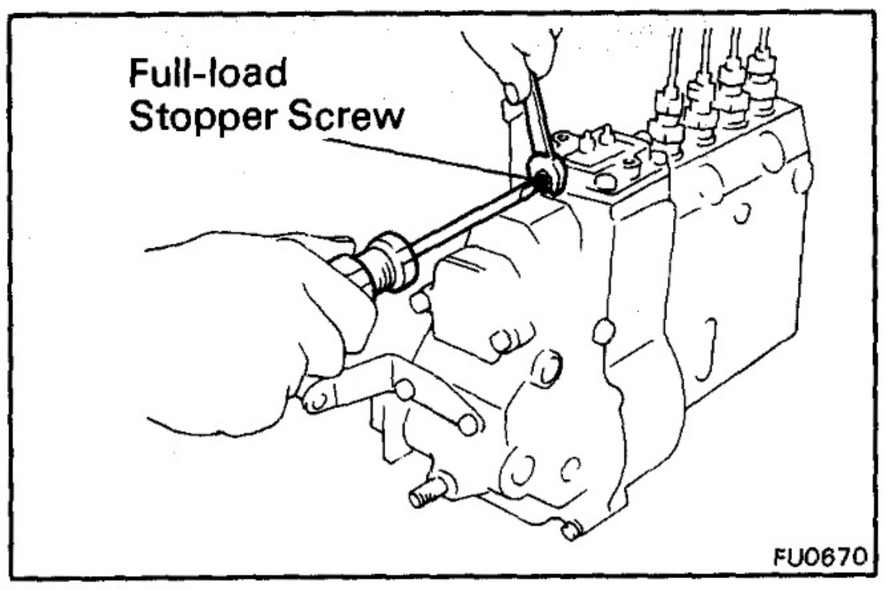


- Adjust by turning the guide bushing.

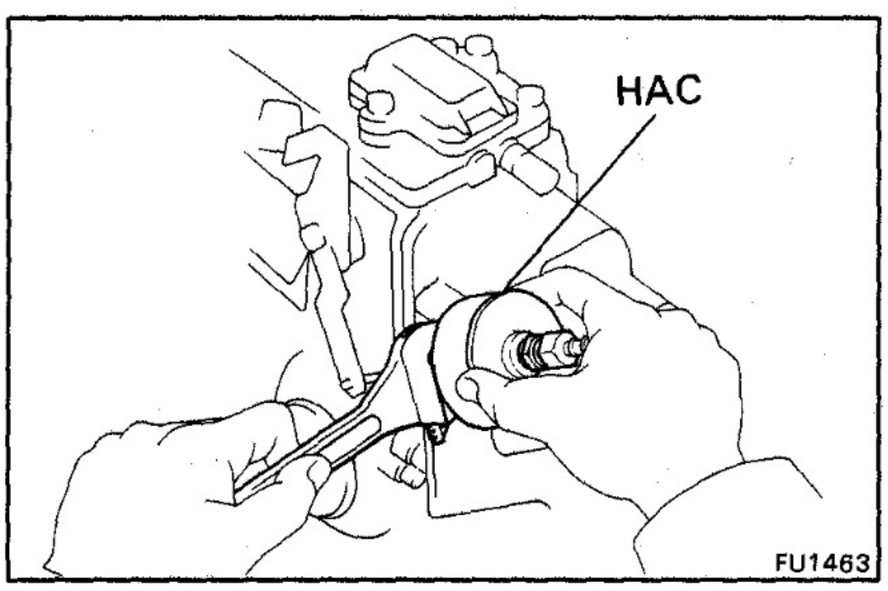
8. INSPECT AND ADJUST TOTAL INJECTION VOLUME

Measure the injection volume at 1,000 strokes.

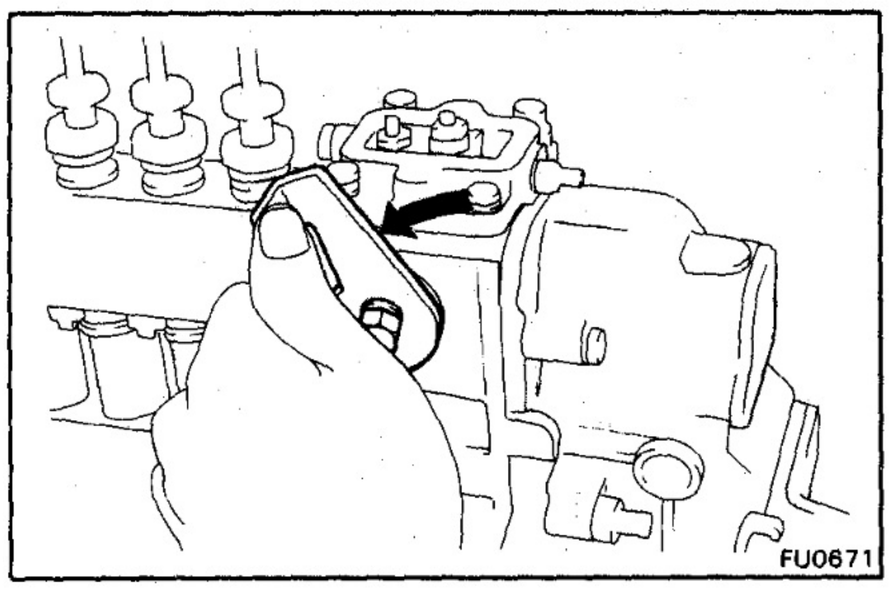
Item	Asdjusting lever position	Boost compensator pressure kg/cm² (psi, kPa)	Pump rpm	Total injection volume of each cylinder cc (cu in.)	Adjusting point
11B w/o HAC	Maximum	–	500	31.0 – 40.0 (1.89 – 2.44)	Full-load screw
			1,100	47.5 – 50.5 (2.90 – 3.08)	
			1,800	44.5 – 50.5 (2.72 – 3.08)	
11B w/ HAC	Maximum	–	500	31.0 – 40.0 (1.89 – 2.44)	HAC
			1,100	47.5 – 50.5 (2.90 – 3.08)	
			1,800	46.5 – 52.5 (2.84 – 3.20)	
13B w/o HAC	Maximum	–	500	38.5 – 47.5 (2.35 – 2.90)	Full-load stopper screw
			1,100	56.0 – 59.0 (3.42 – 3.60)	
			1,700	54.0 – 60.0 (3.30 – 3.66)	
13B w/ HAC	Maximum	–	500	40.5 – 49.5 (2.47 – 3.02)	HAC
			1,100	56.0 – 59.0 (3.42 – 3.60)	
			1,700	56.0 – 62.0 (3.42 – 3.78)	
13B-T M/T	Maximum	0.27 (3.9, 26)	500	45.5 – 54.5 (2.78 – 3.33)	Full-load stopper screw
		0.27 (3.9, 26)	1,100	68.0 – 71.0 (41.5 – 4.33)	
		0.27 (3.9, 26)	1,700	64.0 – 70.0 (3.91 – 4.27)	
		0	500	31.0 – 37.0 (1.89 – 2.26)	
13B-T A/T	Maximum	0.27 (3.9, 26)	500	47.5 – 56.5 (2.90 – 3.45)	Full-load stopper screw
		0.27 (3.9, 26)	1,100	64.5 – 67.5 (3.94 – 4.12)	
		0.27 (3.9, 26)	1,700	67.5 – 73.5 (4.12 – 4.48)	
		0	500	46.5 – 52.5 (2.84 – 3.20)	



[w/o HAC]
If not within specification, adjust by turning full-load stopper screw.



[w/ HAC]
If not within specification, adjust by turning the HAC body.



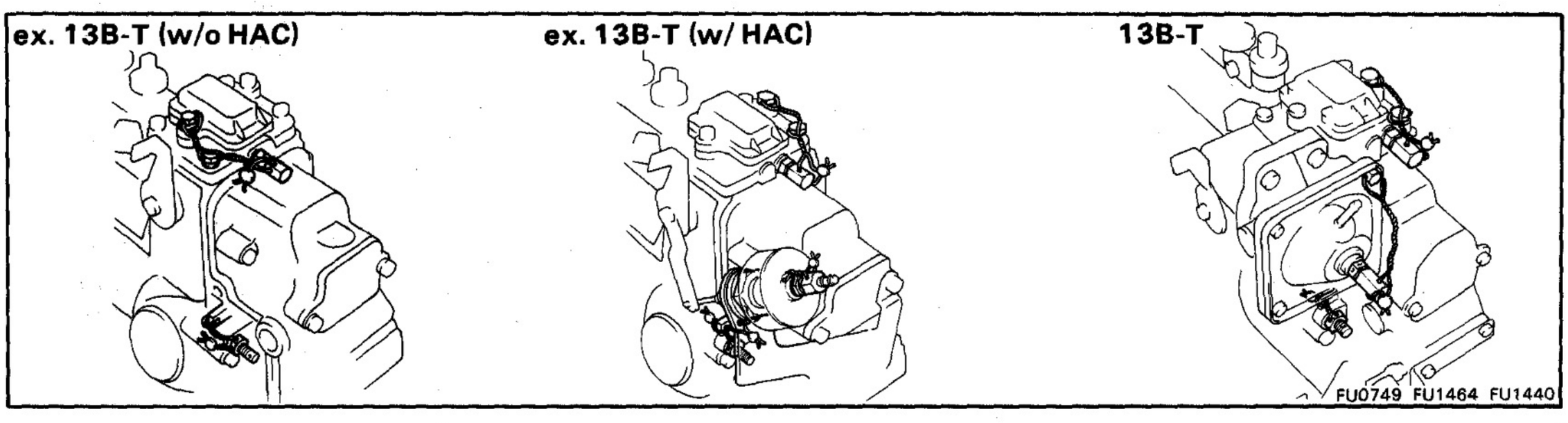
9. CHECK STOP LEVER OPERATION

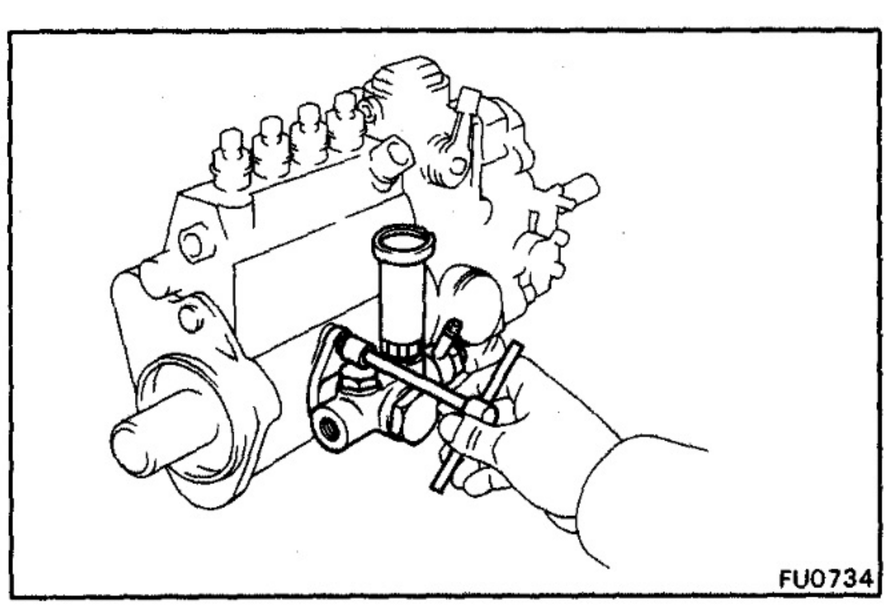
Measure the rack position when the stop lever operates.

Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
Idle	0	5.5 (0.217) or less	–

10. SEAL PARTS

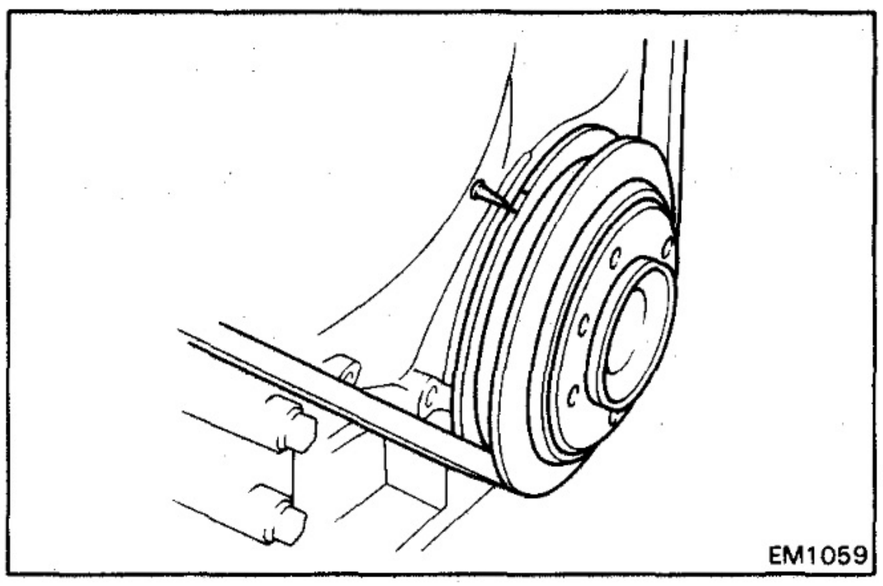
Seal with new wire as shown in the illustration.





11. REMOVE COVER AND INSTALL FUEL FEED PUMP

Install the feed pump with a new O-ring.



INSTALLATION OF INJECTION PUMP

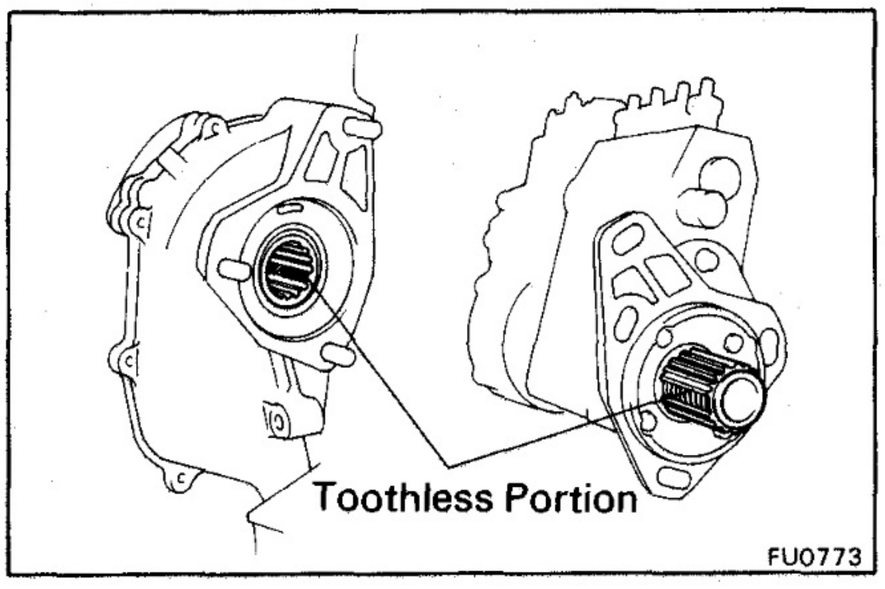
(See page FU-20)

1. SET NO. 1 CYLINDER TO TDC/COMPRESSION

(a) Set the No. 1 cylinder to TDC/compression.
Align the groove on the pulley with the timing pointer 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.

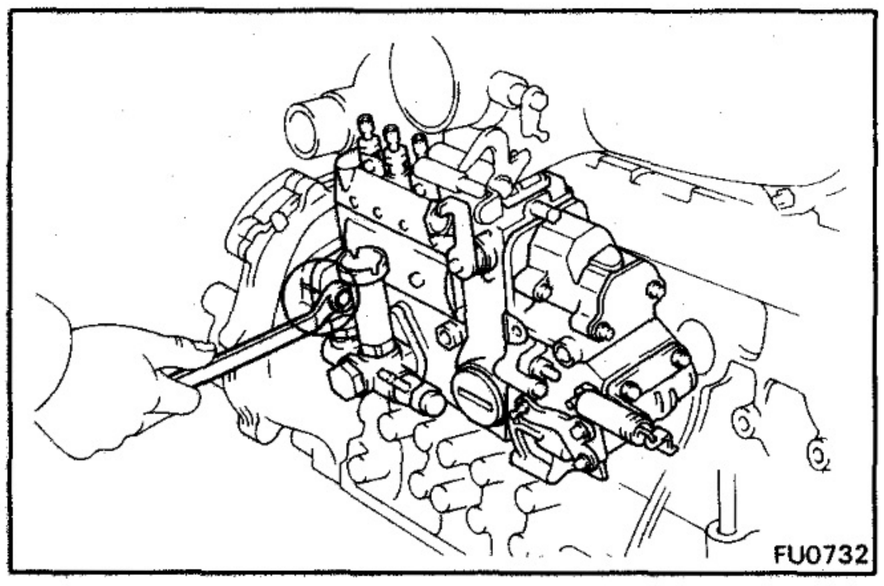


2. INSTALL INJECTION PUMP

(a) Install a new O-ring to the injection pump flange.

(b) Apply MP grease to the timer hub toothless portion and pump toothless portion.

(c) Align the timer hub spline notch with the injection pump spline notch.

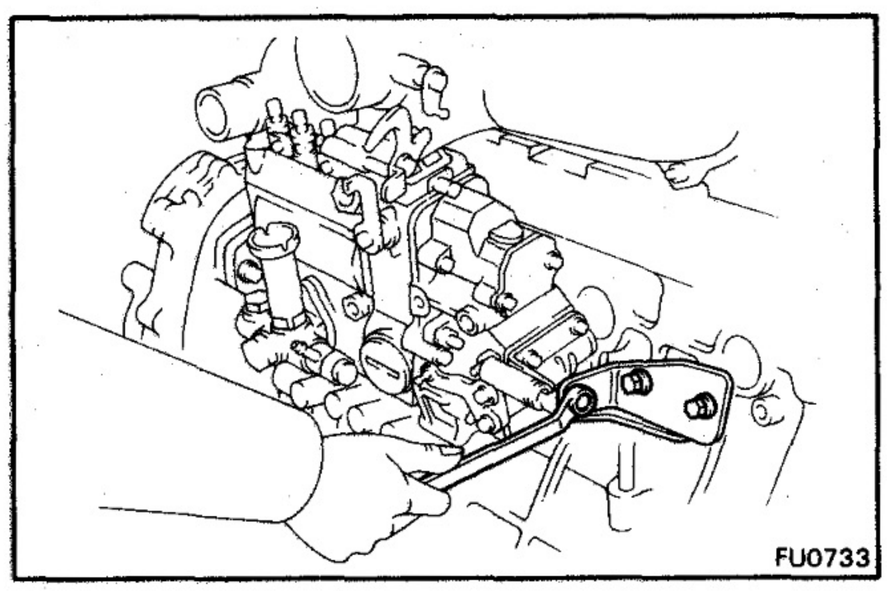


(d) Align the matchmarks on the injection pump and timing gear case.

(e) Install and torque the three nuts holding the injection pump to the timing case.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

(f) [13B-T]
Install the cylinder block insulator.

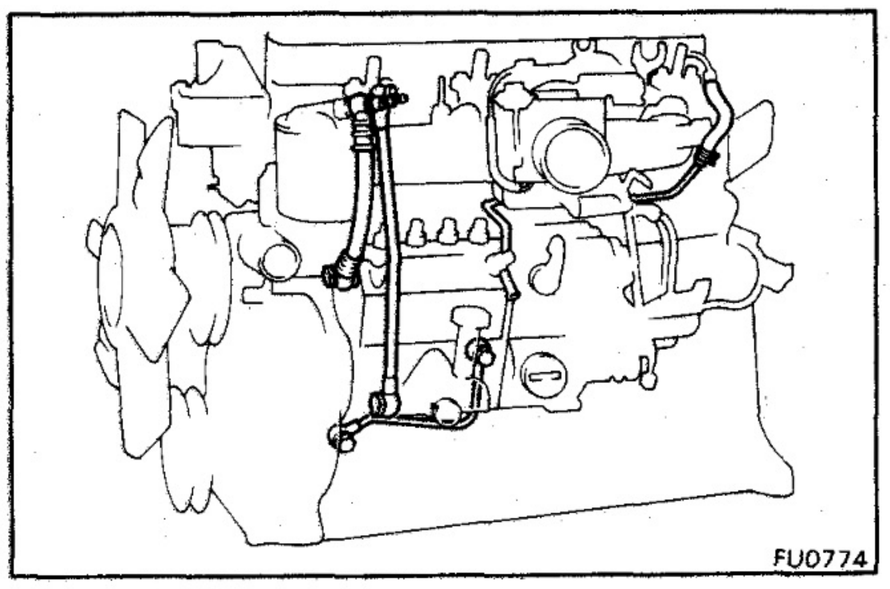


(g) Install the pump stay with the two bolts and nut.
Torque the bolts and nut.

Torque: Bolt 185 kg-cm (13 ft-lb, 18 N·m)
Nut 375 kg-cm (27 ft-lb, 37 N·m)

3. INSTALL CYLINDER HEAD COVER

4. INSTALL FUEL FILTER ASSEMBLY



5. INSTALL FOLLOWING HOSES AND PIPES:

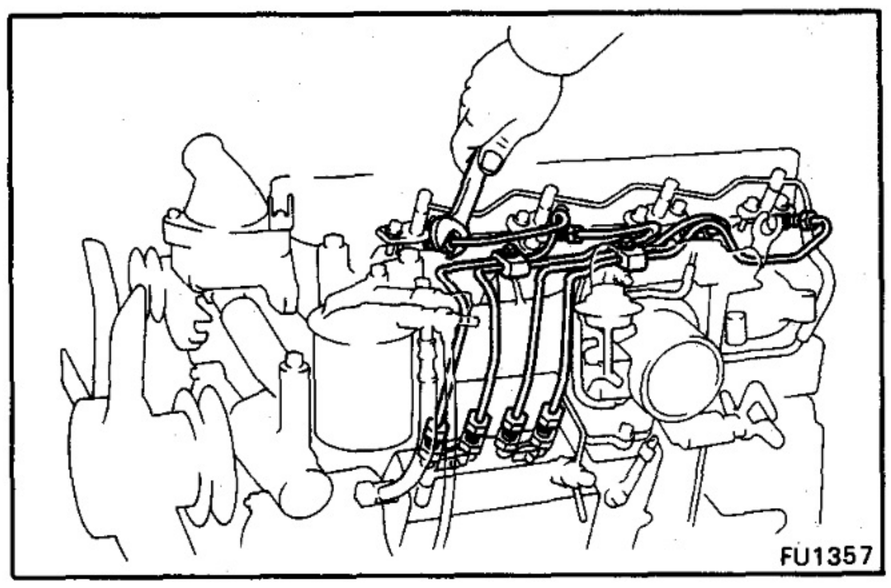
(a) Oil pipe

(b) Fuel inlet hose

(c) Fuel return hose

(d) No. 2 leakage pipe with hose

(e) Fuel pipe and hose (For fuel filter)

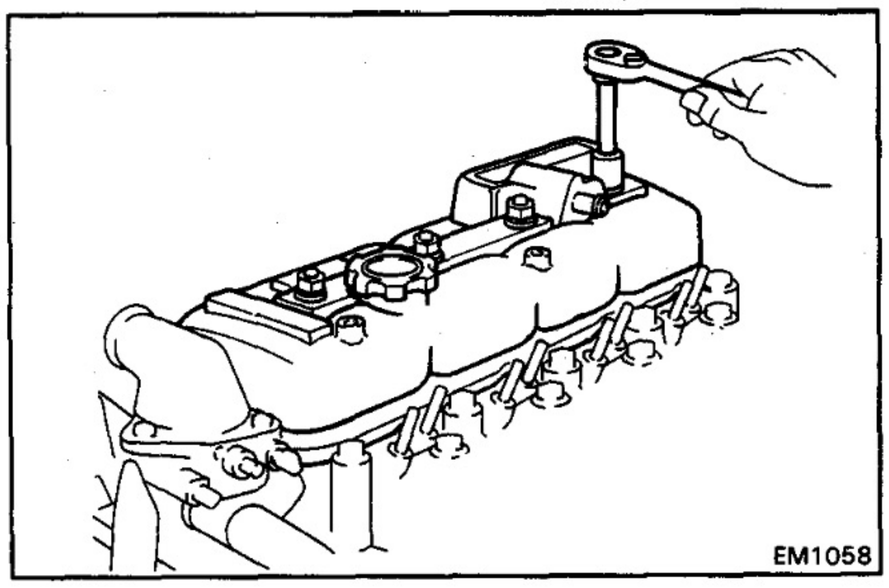


6. INSTALL ACCELERATOR CONNECTING ROD

7. [13B-T]
CONNECT BOOST COMPENSATOR VACCUM HOSE

8. [13B-T A/T]
CONNECT DASH POT (DP) VACCUM HOSE

9. INSTALL INJECTION PIPES

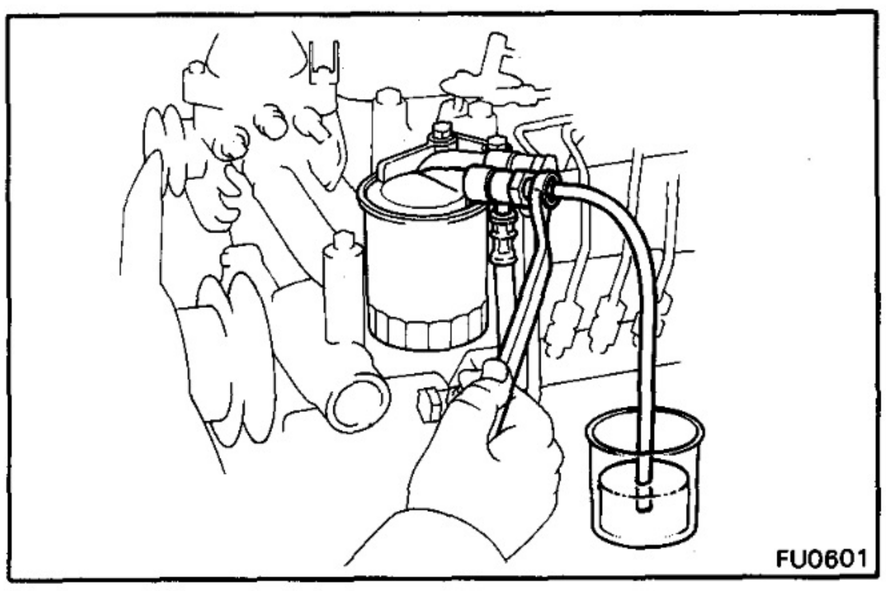


10. INSTALL CYLINDER HEAD COVER

(a) Install the gasket to the head cover.

(b) Install the head cover with the four seal washers and cap nuts.

Torque: 125 kg-cm (9 ft-lb, 12 N·m)



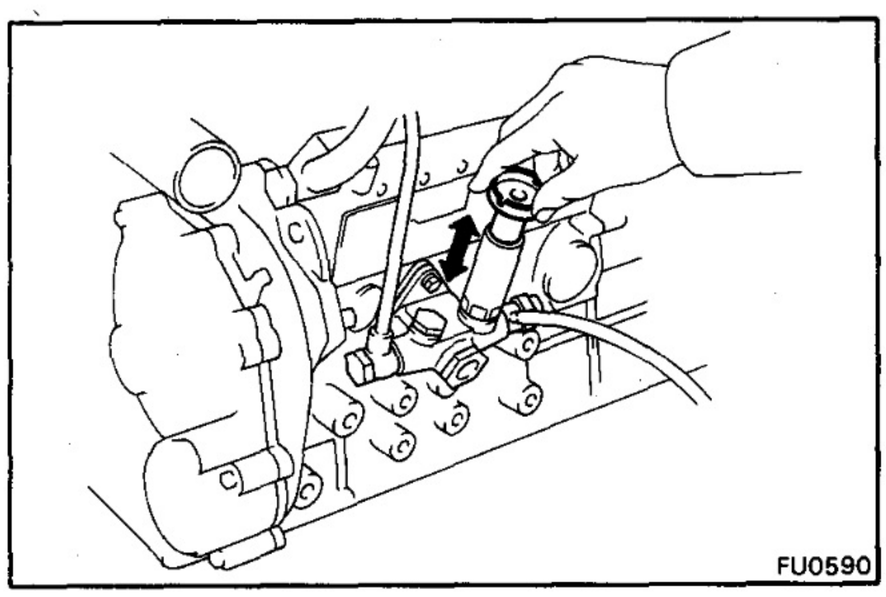
11. BLEED FUEL FILTER AND INJECTION PUMP

CAUTION: Be careful that fuel does not splash on the rubber hoses.

(a) Connect a vinyl tube to the fuel filter bleeder plug.

(b) Insert other end of the tube in a container of fuel.

(c) Loosen the fuel filter bleeder plug.

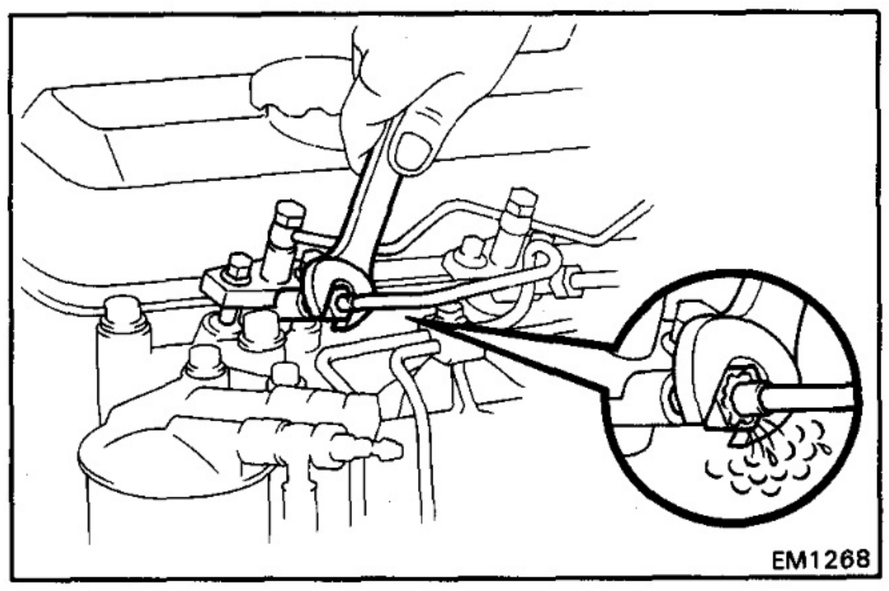


(d) Turn the priming pump handle counterclockwise to free it.

(e) Operate the priming pump handle until there are no air bubbles emitted from the fuel filter bleeder plug.

(f) Tighten the fuel filter bleeder plug.

(g) Turn the priming pump handle clockwise and tighten it.



12. BLEED AIR FROM FUEL LINE

(a) Loosen all union nuts of the injection pipe on the nozzle side.

(b) Crank the engine to bleed the air and force out fuel from the injection pipe.

(c) Tighten the union nuts.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

13. START ENGINE AND CHECK FOR FUEL LEAKS

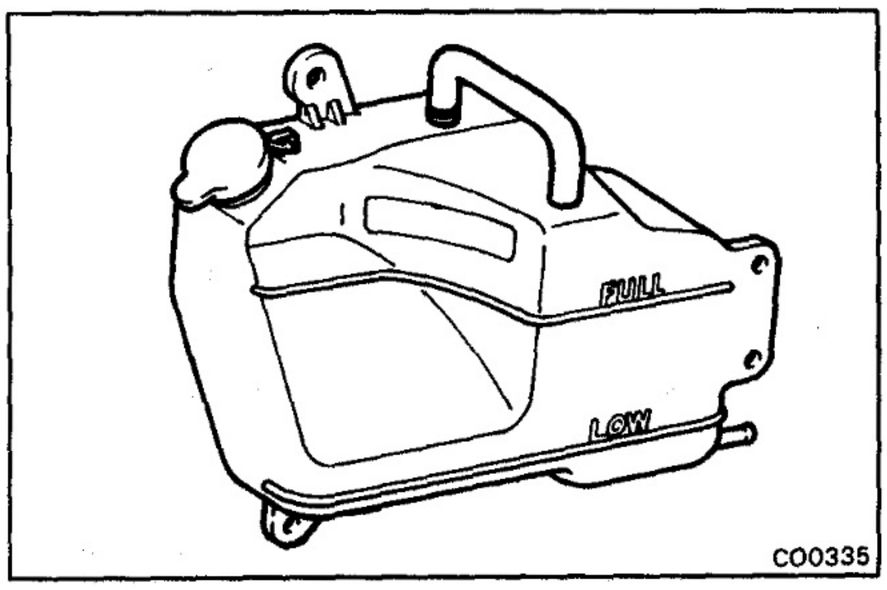
COOLING SYSTEM

	Page
TROUBLESHOOTING	CO-2
CHECK AND REPLACEMENT OF ENGINE COOLANT	CO-2
WATER PUMP	CO-4
THERMOSTAT	CO-10
RADIATOR	CO-12

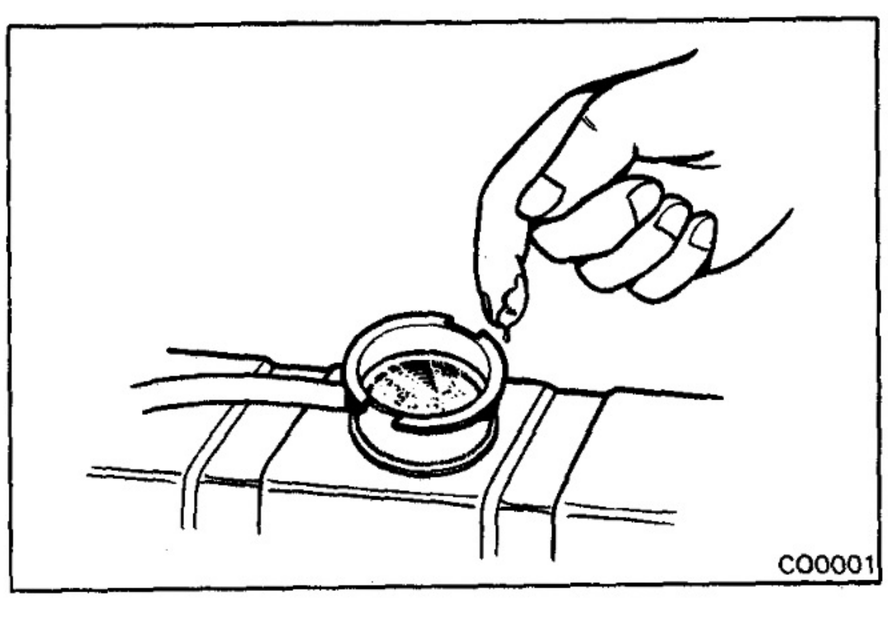
TROUBLESHOOTING

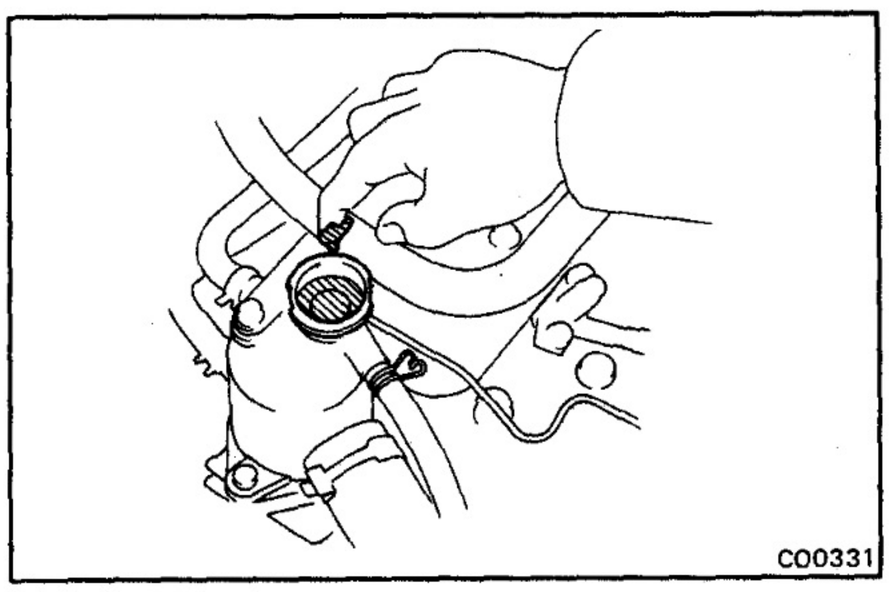
Problem	Possible cause	Remedy	Page
Engine overheats	Fan belt loose or missing	Adjust or replace belt	CH-5
	Dirt, leaves or insects on radiator or condenser	Clean radiator or condenser	CO-12
	Hoses, water pump, thermostat housing, radiator, heater, core plugs or head gasket leakage	Repair as necessary	
	Thermostat faulty	Check thermostat	CO-10
	Injection timing retarded	Set timing	EM-19
	Fluid coupling faulty	Replace fluid coupling	
	Radiator hose plugged or rotted	Replace hose	
	Water pump faulty	Replace water pump	CO-4
	Radiator plugged or cap faulty	Check radiator	CO-12
	Cylinder head or block cracked or water passage clogged	Repair as necessary	

NOTE: The thermostat on the 11B, 13B and 13B-T engines is equipped with a by-pass valve essential to the cooling system. Therefore, if the engine tends to overheat, removal of the thermostat will adversely effect cooling efficiency.



CO0335


CO0001


CO0331

CHECK AND REPLACEMENT OF ENGINE COOLANT

1. CHECK ENGINE COOLANT LEVEL AT RESERVE TANK

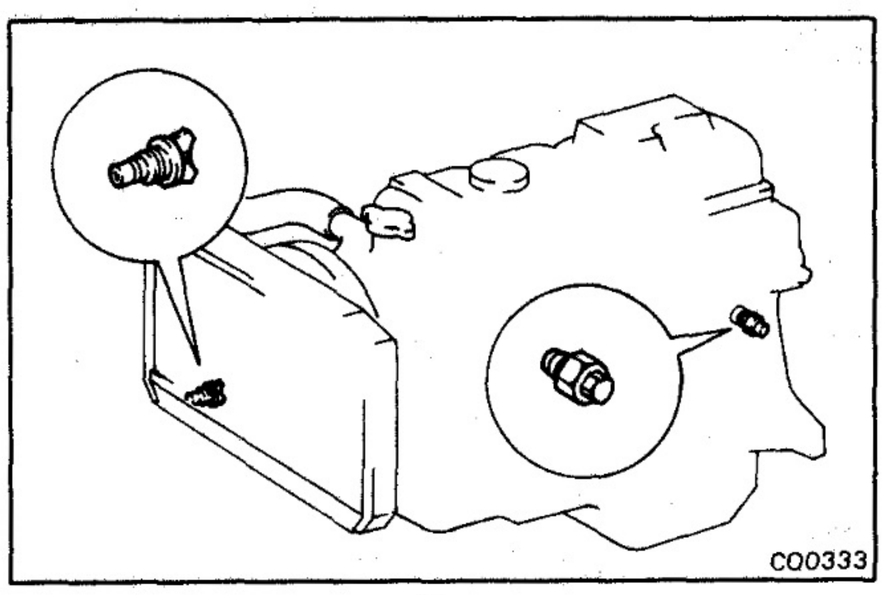
The coolant level should be between the "LOW" and "FULL" lines.

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 (water outlet cap).

(b) Drain the coolant from radiator and engine drain cocks. (Engine drain cock is at left rear 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.

Coolant capacity:

BY
w/o Heater
12.2 liters (12.9 US qts, 10.7 Imp. qts)

BJ
M/T
w/o Heater
12.1 liters (12.8 US qts, 10.6 Imp. qts)
w/ Heater
14.2 liters (15.0 US qts, 12.5 Imp. qts)
A/T
w/o Heater
11.5 liters (12.2 US qts, 10.1 Imp. qts)
w/ Heater
13.6 liters (14.4 US qts, 12.0 Imp. qts)

BU
Regular cab type
w/o Heater
11.6 liters (12.3 US qts, 10.2 Imp. qts)
w/ Heater
12.5 liters (13.2 US qts, 11.0 Imp. qts)
Wide cab type
w/o Heater
12.1 liters (12.8 US qts, 10.6 Imp. qts)
w/ Heater
13.0 liters (13.7 US qts, 11.4 Imp. qts)

BB
w/o Heater
12.4 liters (13.1 US qts, 10.9 Imp. qts)

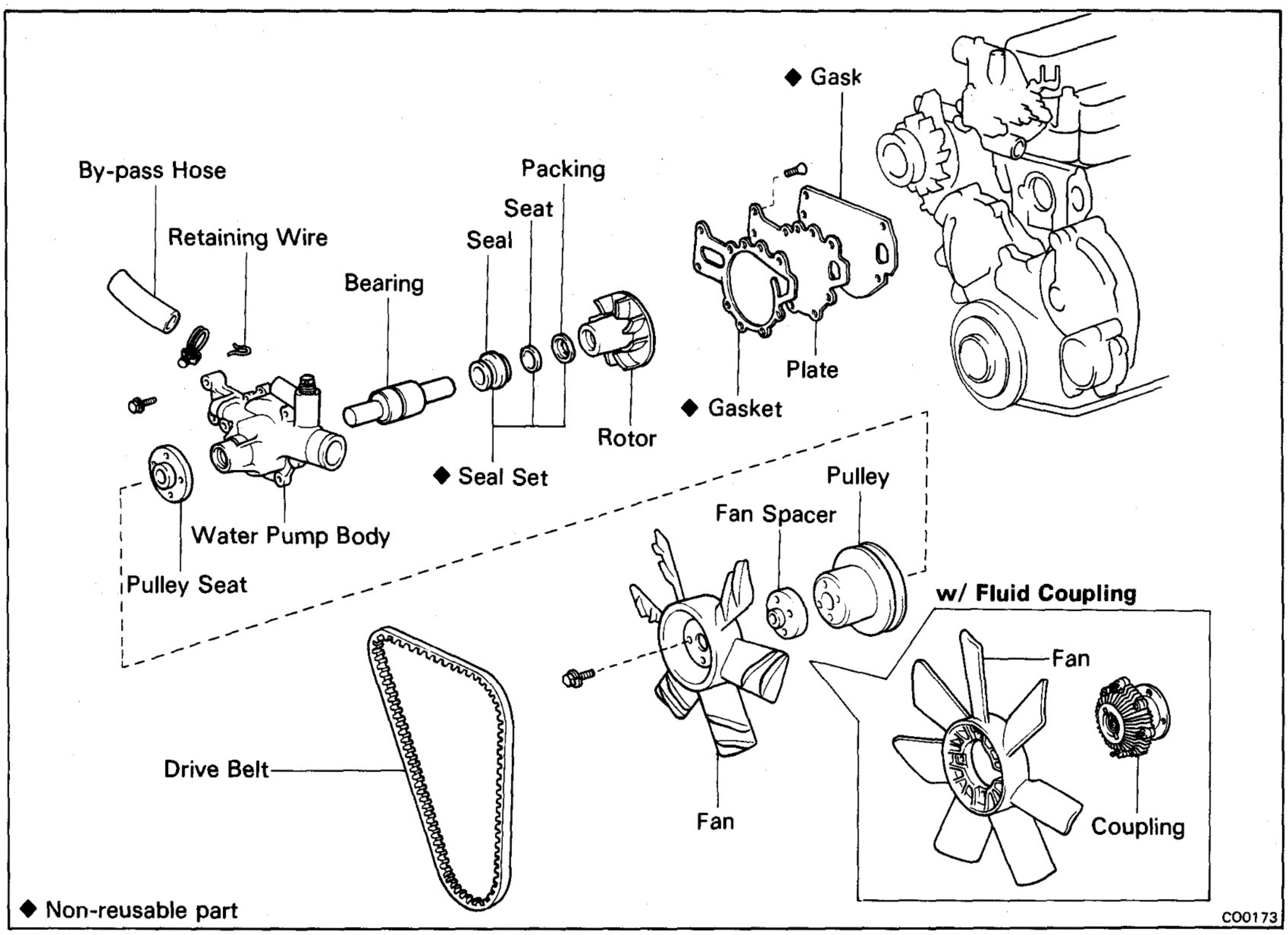
(e) Install the radiator cap (water outlet cap).

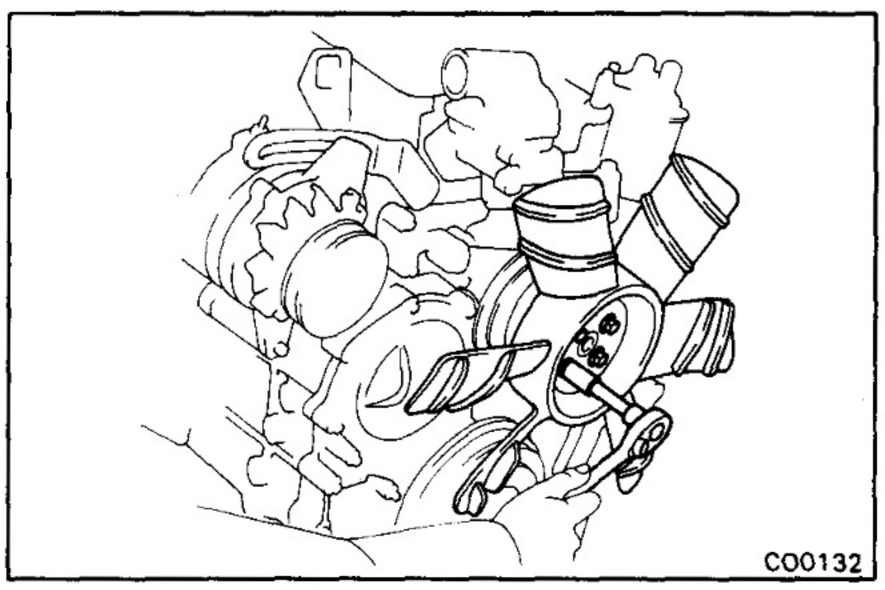
(f) Start the engine and check for leaks.

(g) Recheck the coolant level and refill as necessary.

WATER PUMP

COMPONENTS





REMOVAL OF WATER PUMP

1. **DRAIN ENGINE COOLANT (See page CO-3)**

2. **REMOVE DRIVE BELT**

3. **[w/o FLUID COUPLING]**
   REMOVE FAN, FAN SPACER AND WATER PUMP PULLEY

   (a) Remove the four bolts mounting the fan to the pulley seat.

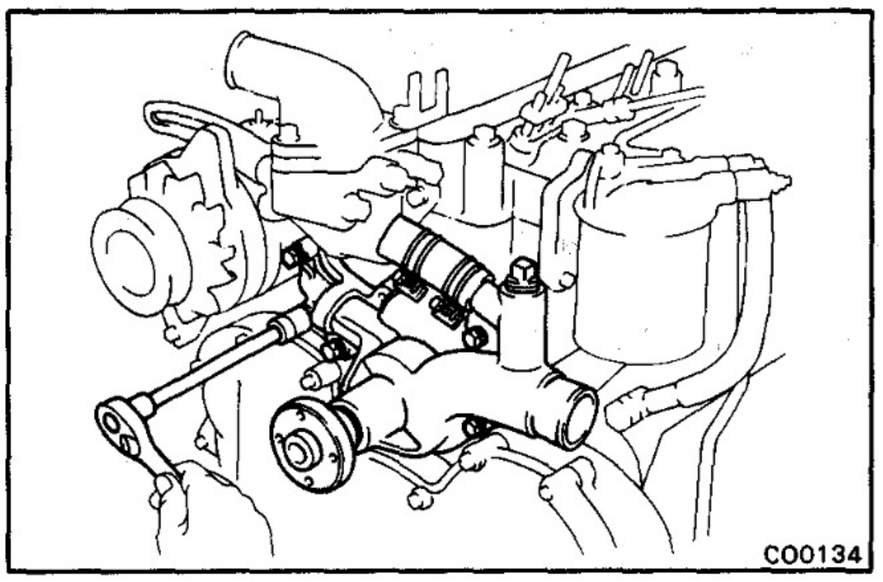
   (b) Remove the fan, fan spacer and pulley.

   [w/ FLUID COUPLING]
   REMOVE FAN, FLUID COUPLING AND WATER PUMP PULLEY

   (a) Remove the four nuts mounting the fluid coupling to the pulley seat.

   (b) Remove the fluid coupling with the fan assembly and pulley.

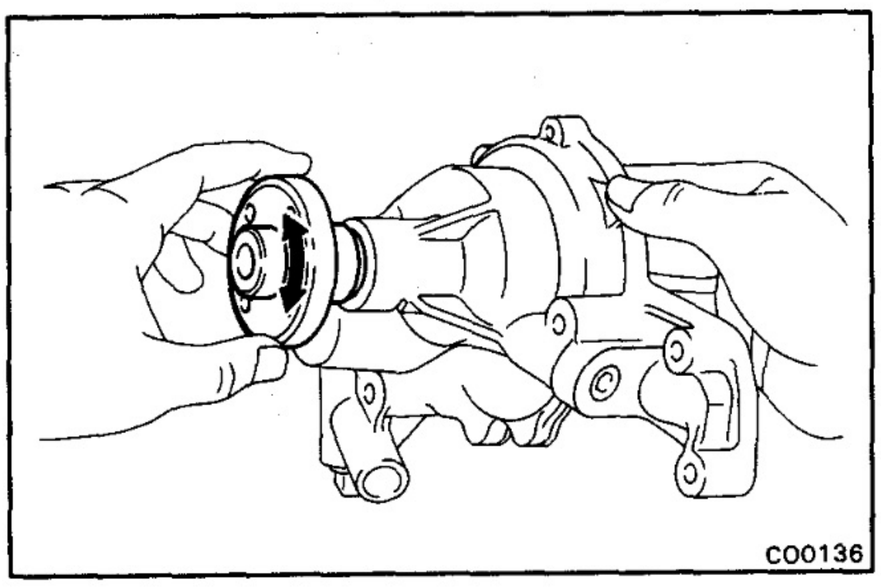
4. **DISCONNECT WATER BY-PASS HOSE**



5. REMOVE WATER PUMP

Remove the five bolts, water pump and gasket.

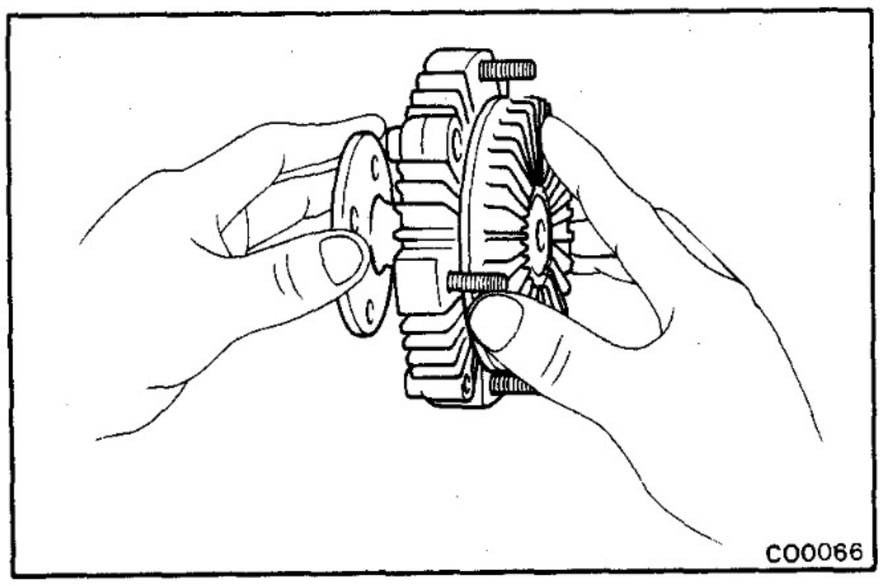
INSPECTION AND REPAIR OF WATER PUMP



1. INSPECT WATER PUMP BEARING

Turn the pulley seat and check that the water pump bearing moves smoothly and quietly.

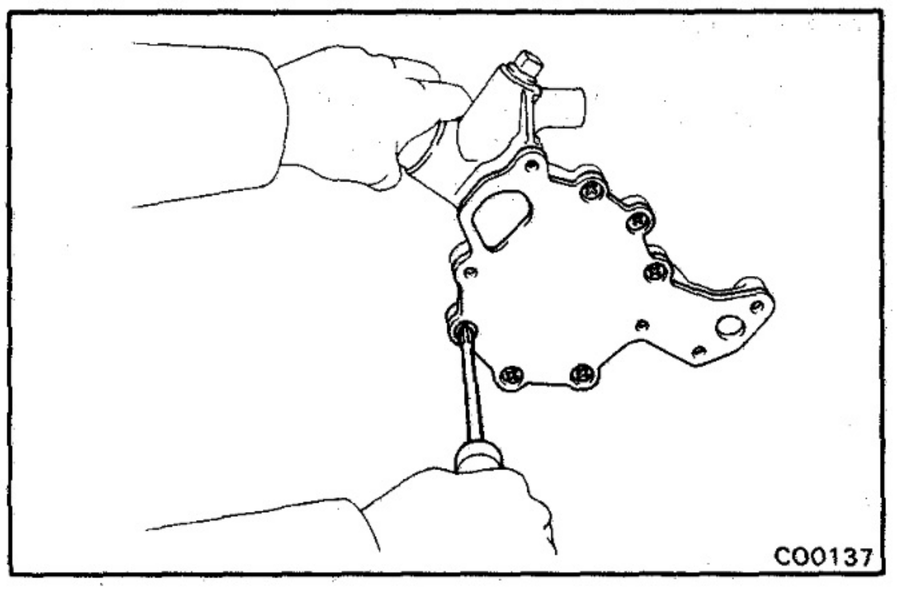
If necessary, replace the water pump bearing.



2. INSPECT FLUID COUPLING

Check that the fluid coupling is not damaged and that no silicon oil leaks.

If necessary, replace the fluid coupling.



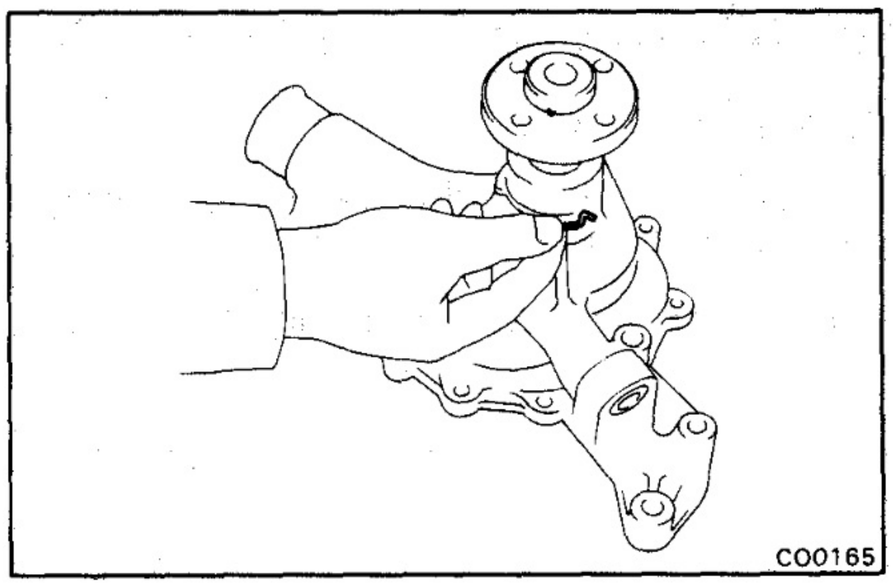
DISASSEMBLY OF WATER PUMP

(See page CO-4)

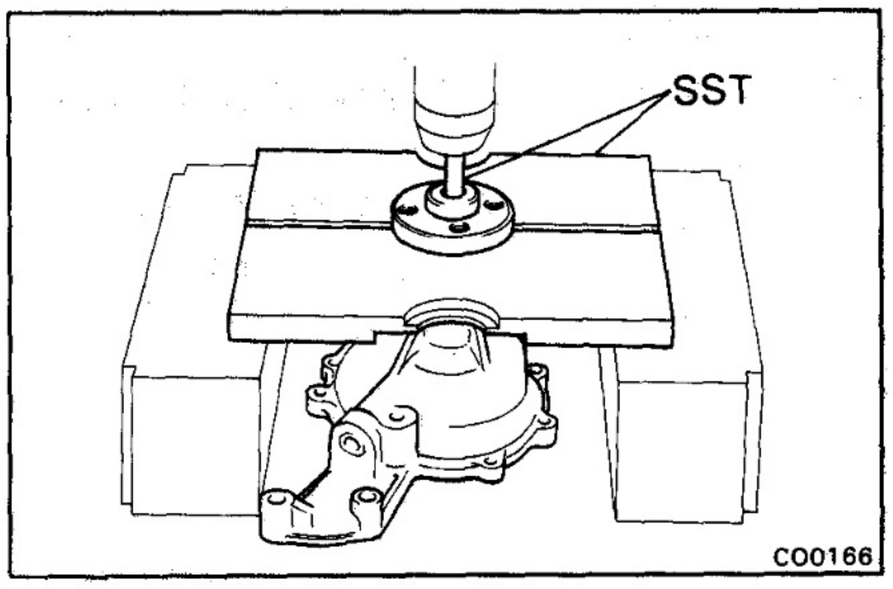
1. [w/ FLUID COUPLING]
   REMOVE STUD BOLTS FROM PULLEY SEAT

2. **REMOVE WATER PUMP PLATE**

   Remove the six screws, plate and gasket.



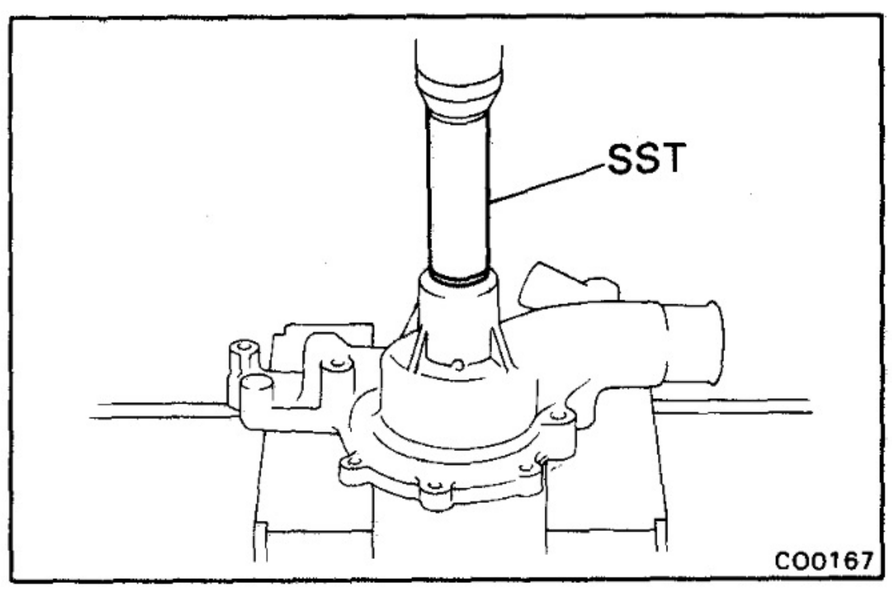
3. **REMOVE RETAINING WIRE**



4. **REMOVE PULLEY SEAT**

   Using SST and a press, press the shaft of the bearing and remove the pulley seat.

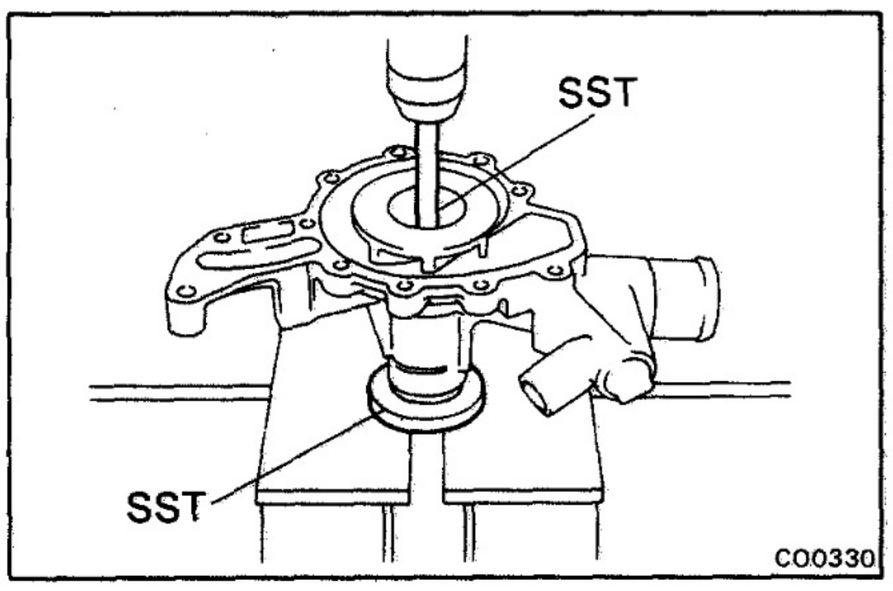
   SST 09236-00101 (09237-00010 and 09237-00050)



5. [BY, BU]
   REMOVE WATER PUMP BEARING

   Using SST and a press, press the outer race of the bearing and remove the bearing together with the rotor.

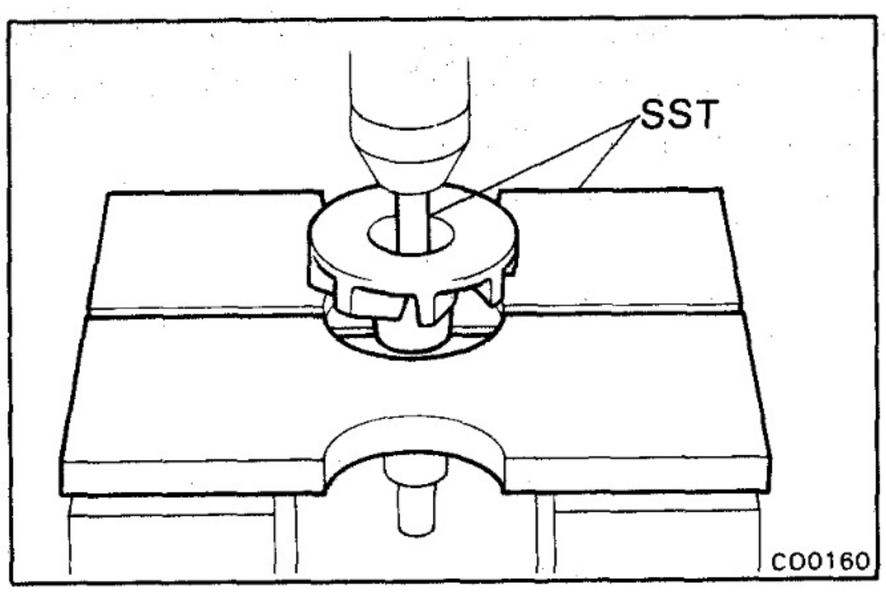
   SST 09236-00101 (09237-00030)



6. [BJ, BB]
   REMOVE WATER PUMP ROTOR AND BEARING

   Using SST and a press, press the shaft of the bearing and remove the rotor and bearing.

   SST 09236-00101 (09237-00010) and 09506-35010



7. [BY, BU]
REMOVE ROTOR

Using SST and a press, press the shaft of the bearing and remove the rotor.

SST 09236-00101 (09237-00010 and 09237-00050)

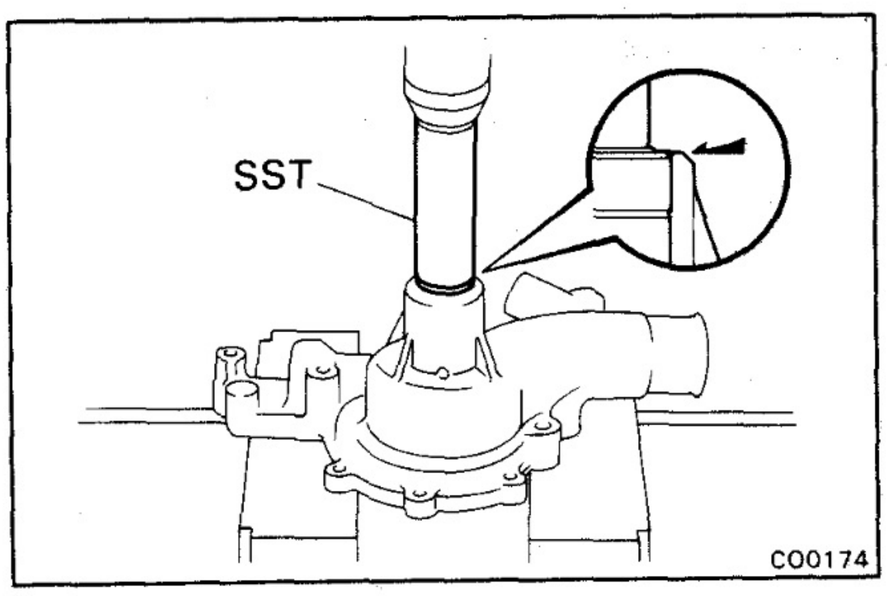
8. REMOVE SEAL, SEAT AND PACKING

ASSEMBLY OF WATER PUMP

(See page CO-4)

CAUTION: When installing the water pump, clear away any rust or foreign material which may enter the seal.

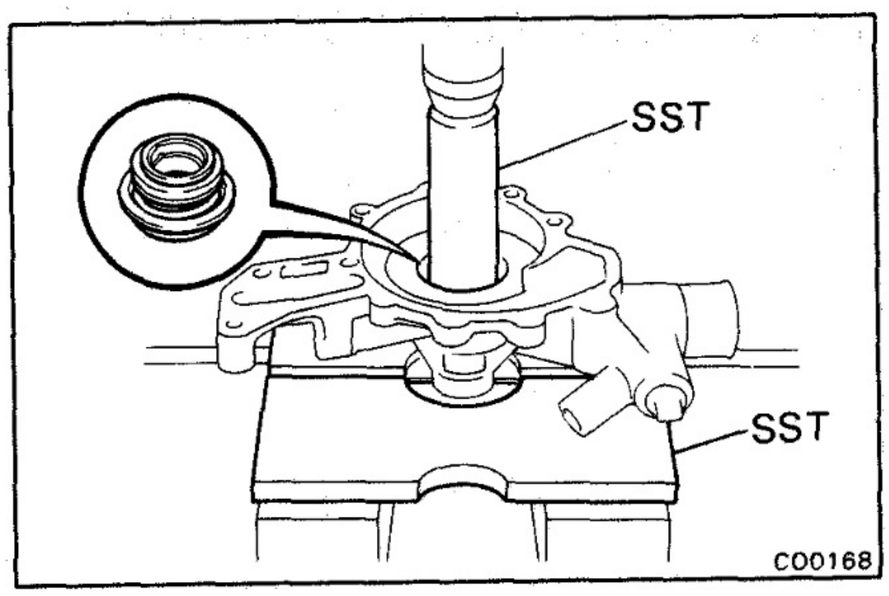
NOTE:
[BY, BU]
Always assemble the water pump with a new seal set.
[BJ, BB]
Always assemble the water pump with a new seal set and a new bearing.



1. INSTALL WATER PUMP BEARING

Using SST and a press, press the outer race of the bearing until its surface is flush with the water pump body edge.

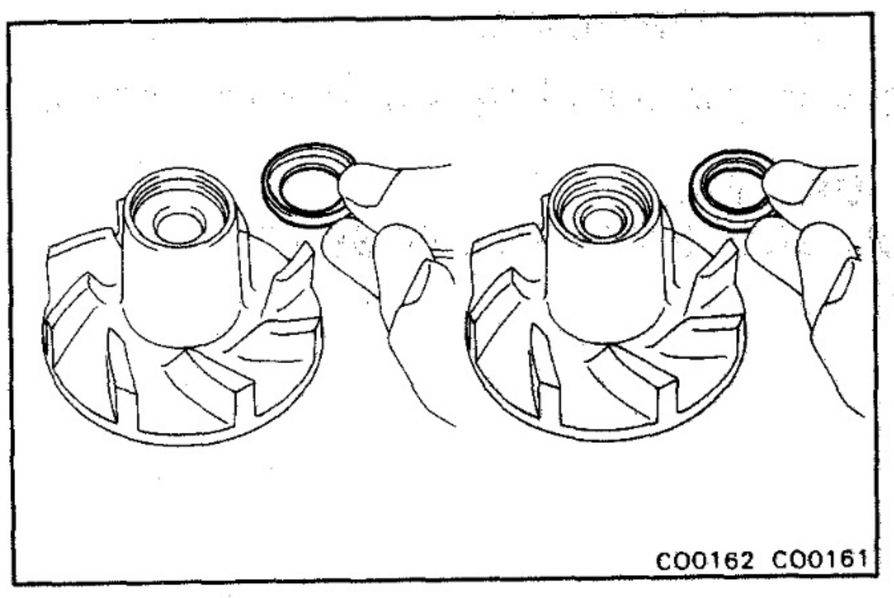
SST BY, BU 09236-00101 (09237-00030)
BJ, BB 09236-00101 (09237-00020)



2. INSTALL SEAL

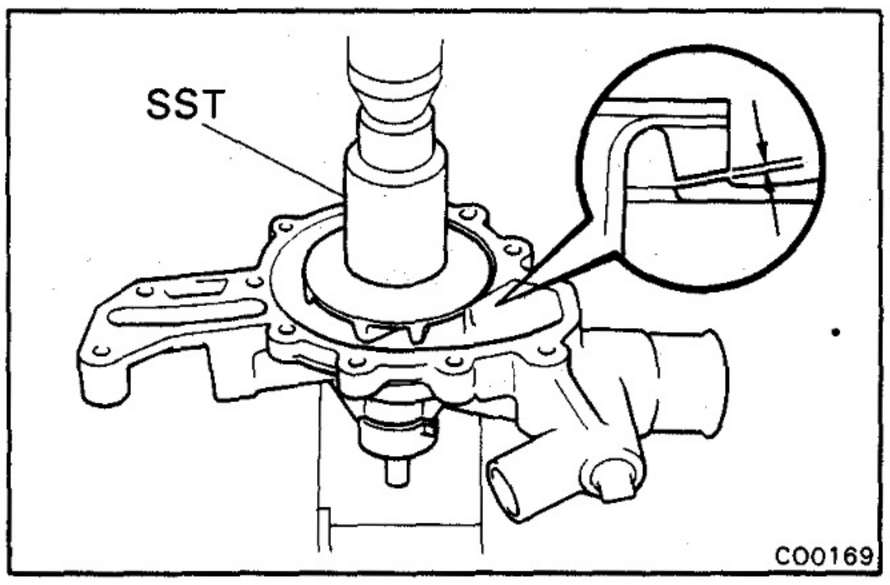
Using SST and a press, press in a new seal.

SST BY, BU 09236-00101
(09237-00010 and 09237-00020)
BJ, BB 09238-47012 and 09506-35010



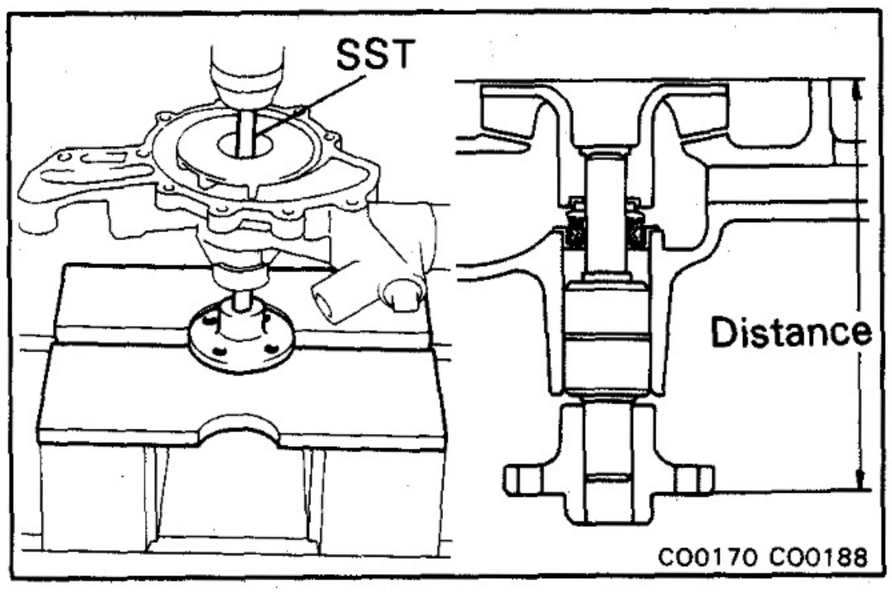
3. INSTALL ROTOR

(a) Install a new packing and seat into the rotor.



(b) Using SST and a press, press in the rotor to a clearance of 0.4 – 1.1 mm (0.016 – 0.043 in.) between the rotor and pump body.

SST 09236-00101 (09238-40010)

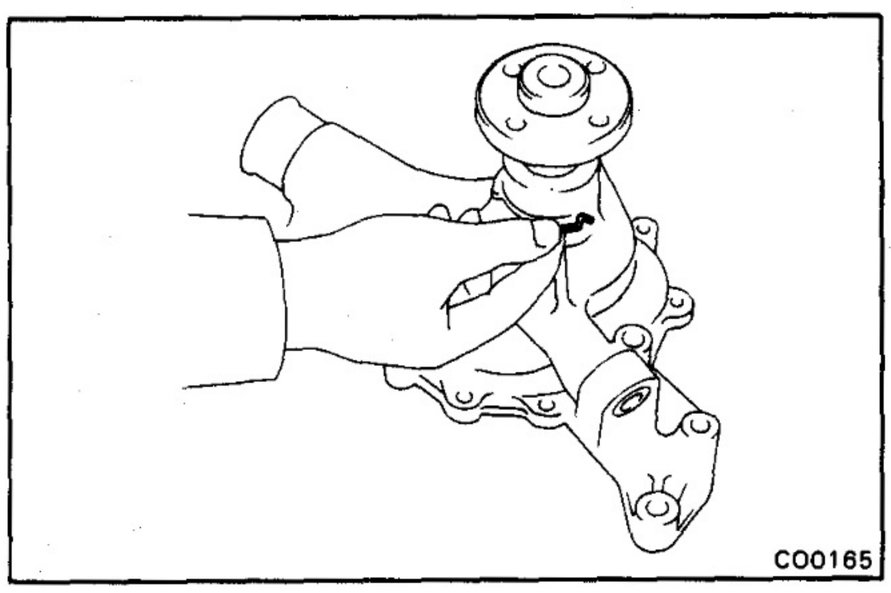


4. INSTALL PULLEY SEAT

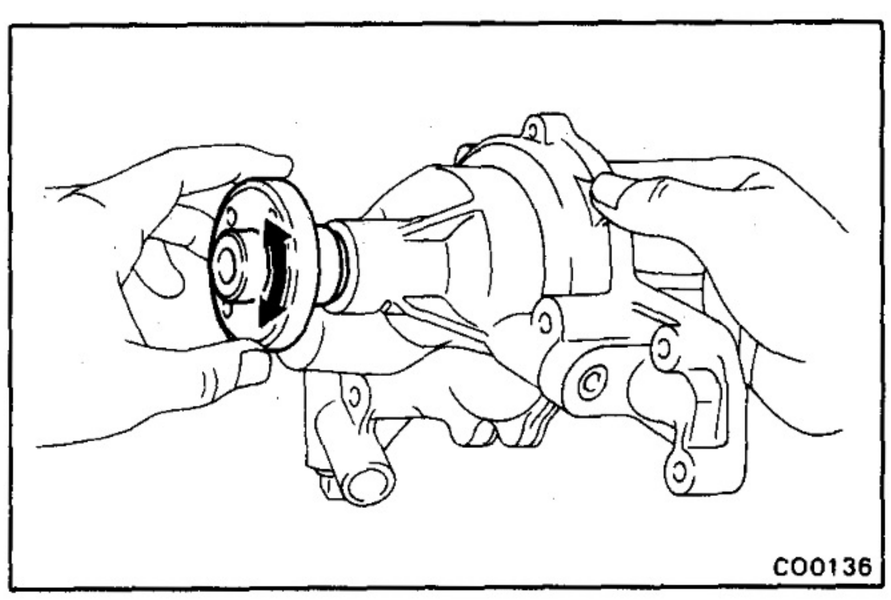
Using SST and a press, press the shaft of the bearing and install the pulley seat to the indicated distance between the pump body and pulley seat in the figure.

Distance between the pump body and pulley seat:

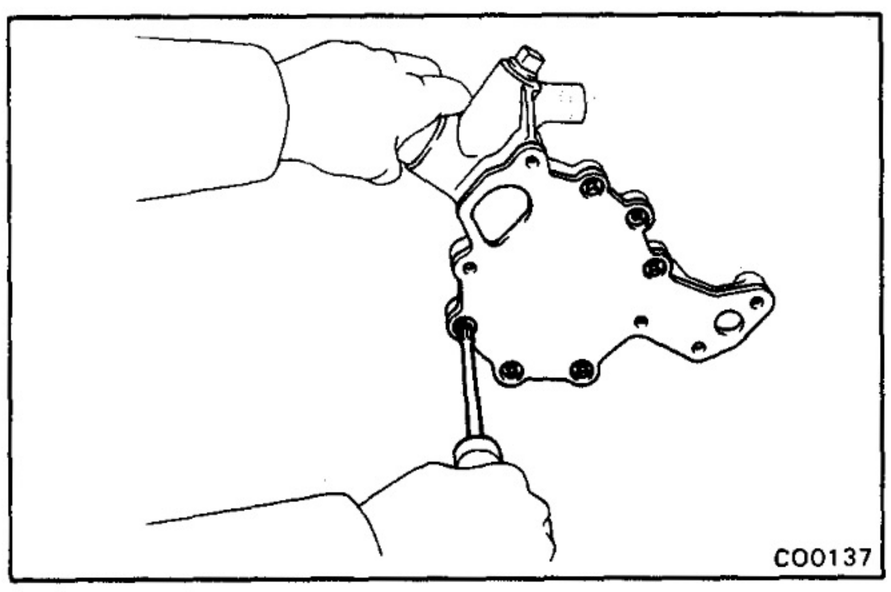
BY, BU (w/o Coupling), BB
141.2 – 142.6 mm (5.559 – 5.614 in.)
BU (w/ Coupling)
117.1 – 118.5 mm (4.610 – 4.665 in.)
BJ
133.6 – 135.0 mm (5.260 – 5.315 in.)



5. INSTALL RETAINING WIRE



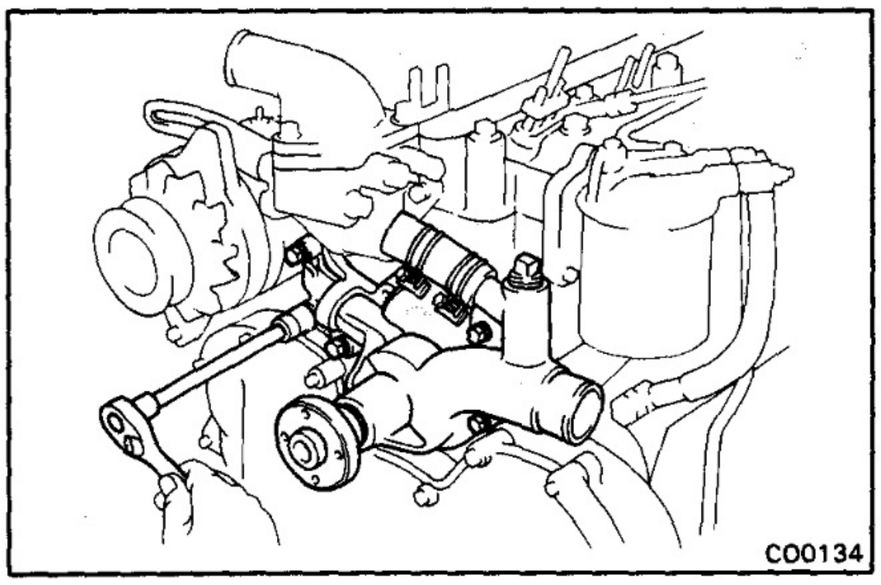
6. CHECK THAT WATER PUMP BEARING ROTATES SMOOTHLY



7. INSTALL WATER PUMP PLATE

Install a new gasket and the plate with the six screws.

8. [w/ FLUID COUPLING]
INSTALL STUD BOLTS TO PULLEY SEAT



INSTALLATION OF WATER PUMP

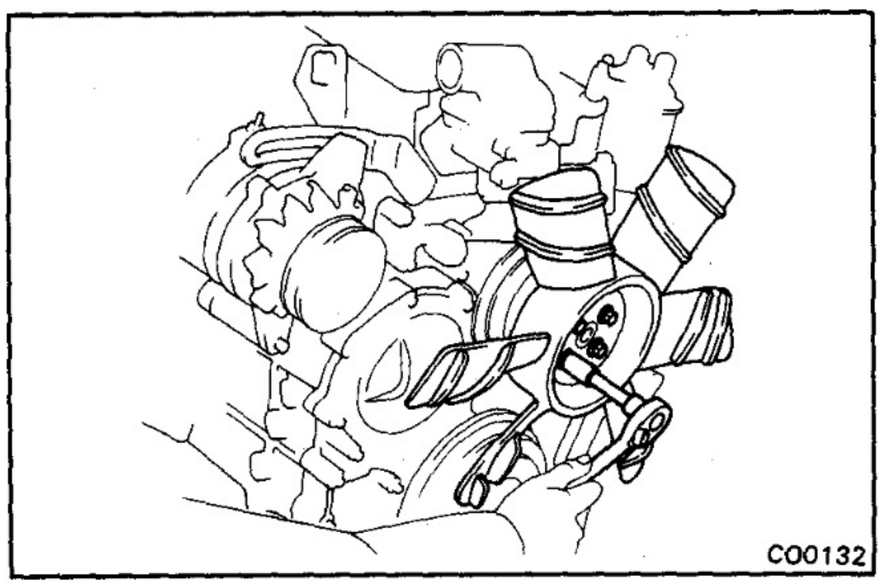
(See page CO-4)

1. **INSTALL WATER PUMP**

   Install a new gasket and water pump with the five bolts. Torque the bolts.

   Torque: 250 kg-cm (18 ft-lb, 25 N·m)

2. **CONNECT WATER BY-PASS HOSE**



3. **[w/o FLUID COUPLING]**
   INSTALL WATER PUMP PULLEY, FAN SPACER AND FAN

   Install the water pump pulley, fan spacer and fan with the four bolts.

   [w/ FLUID COUPLING]
   INSTALL WATER PUMP PULLEY, FLUID COUPLING AND FAN

   Install the water pump pulley, fluid coupling and fan with the four nuts.

4. **INSTALL AND ADJUST DRIVE BELT**
   (See step 8 on pages EM-41, 42)

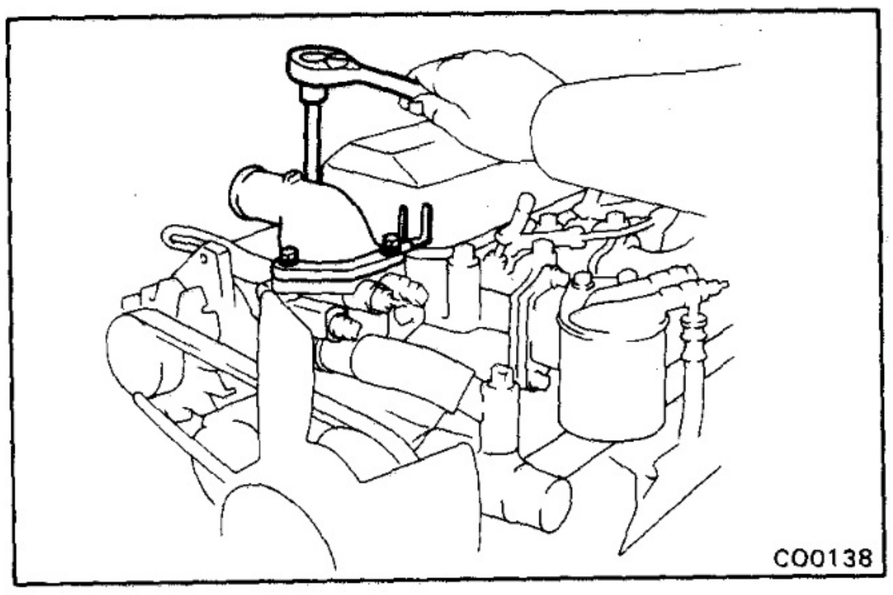
5. **FILL ENGINE WITH COOLANT (See page CO-3)**

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

THERMOSTAT

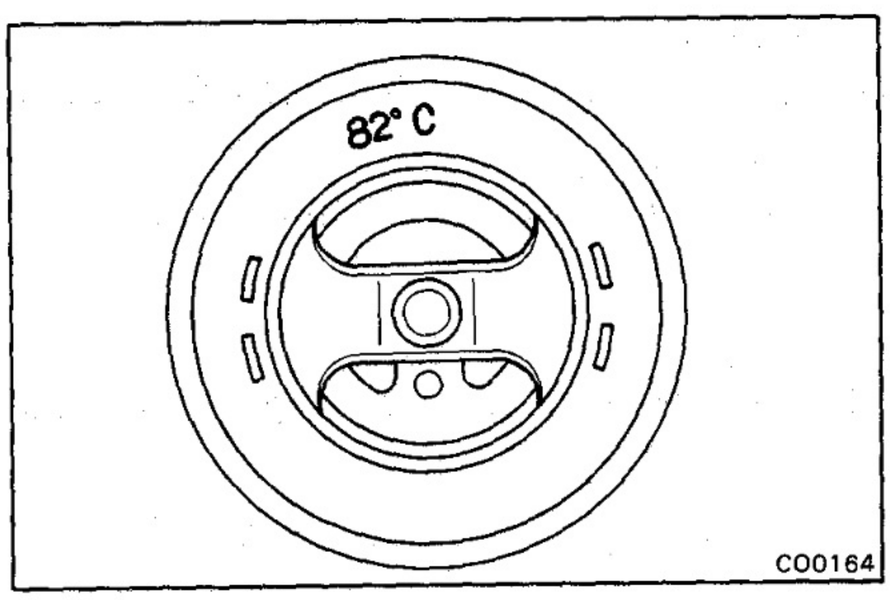
REMOVAL OF THERMOSTAT

1. **DRAIN ENGINE COOLANT (See page CO-3)**
2. **DISCONNECT RADIATOR INLET HOSE FROM WATER OUTLET**
3. **[13B-T]**
   REMOVE VACUUM PIPE CLAMP BOLT
4. **[WATER OUTLET CAP TYPE]**
   DISCONNECT COOLANT RESERVOIR HOSE AND WATER BY-PASS HOSE(S)
5. **REMOVE WATER OUTLET**
   Remove the three bolts, water outlet and gasket.
6. **REMOVE THERMOSTAT**

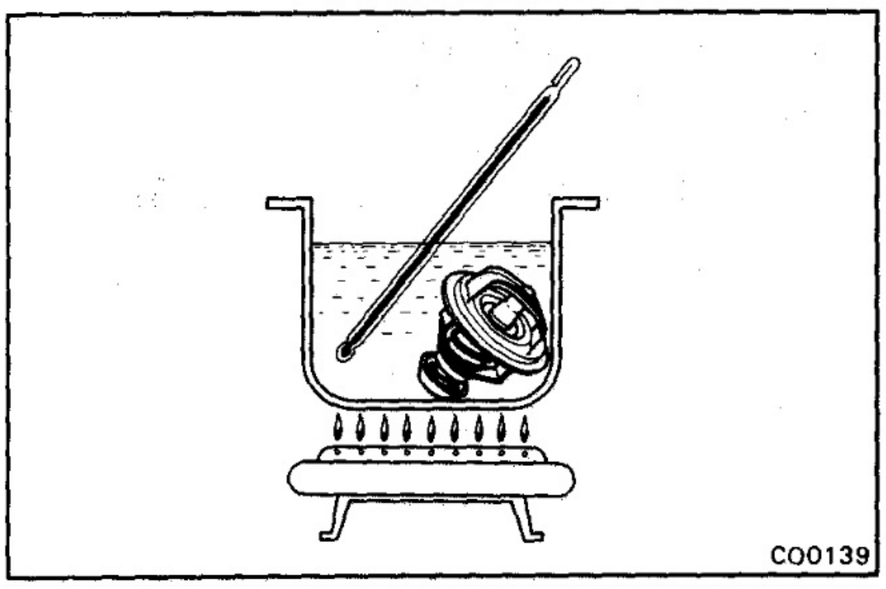

CO0138

INSPECTION OF THERMOSTAT

NOTE: The thermostat is numbered with the valve opening temperature.



CO0164

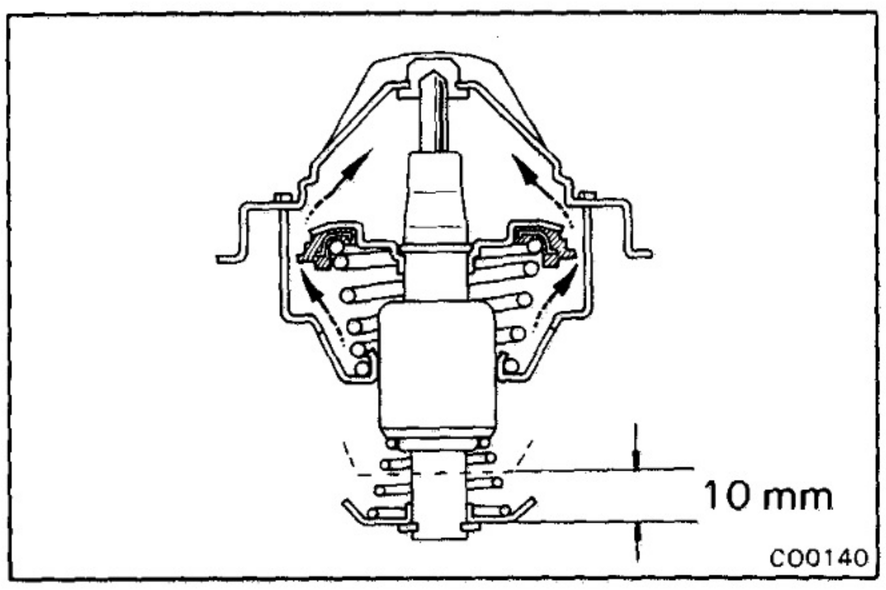

CO0139

(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.

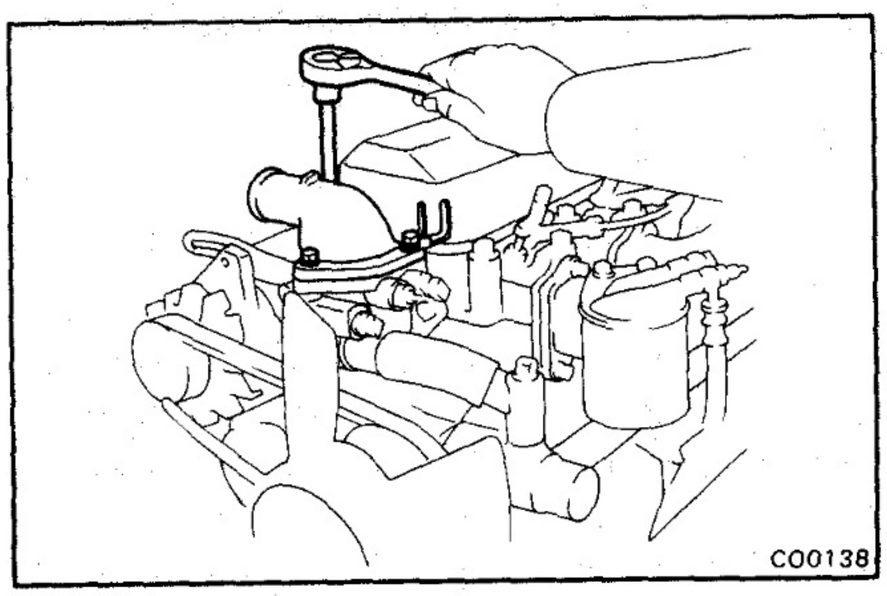


CO0140

(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 minimum, replace the thermostat.



INSTALLATION OF THERMOSTAT

1. **PLACE THERMOSTAT IN WATER INLET**

2. **INSTALL WATER OUTLET**

   Install a new gasket and 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. **[13B-T]**
   INSTALL VACUUM PIPE CLAMP BOLT

5. **CONNECT RADIATOR INLET HOSE**

6. **FILL ENGINE WITH COOLANT (See page CO-3)**

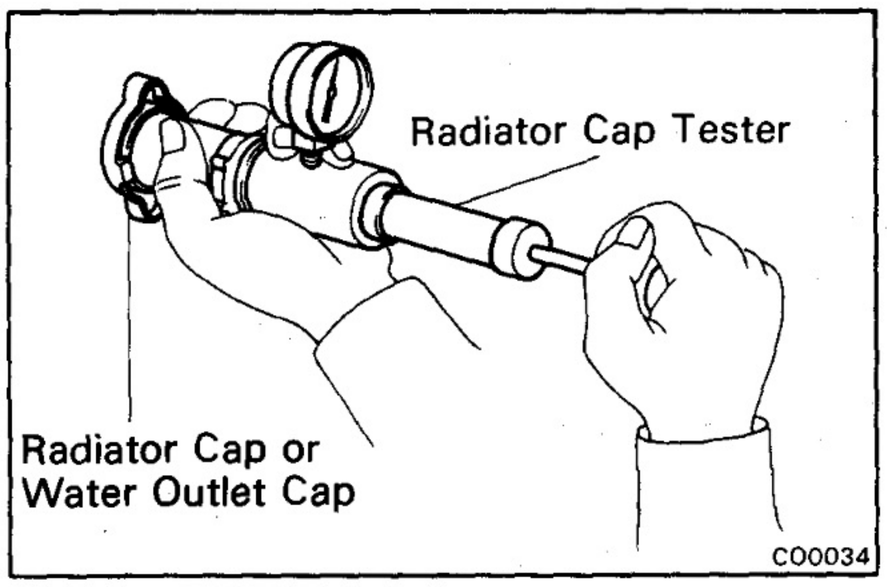
7. **START ENGINE AND CHECK FOR LEAKS**

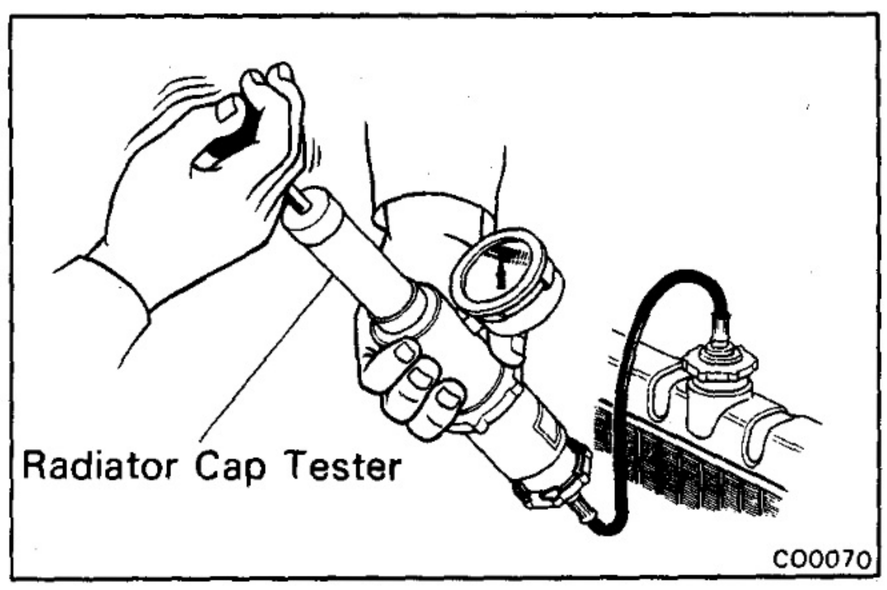
RADIATOR

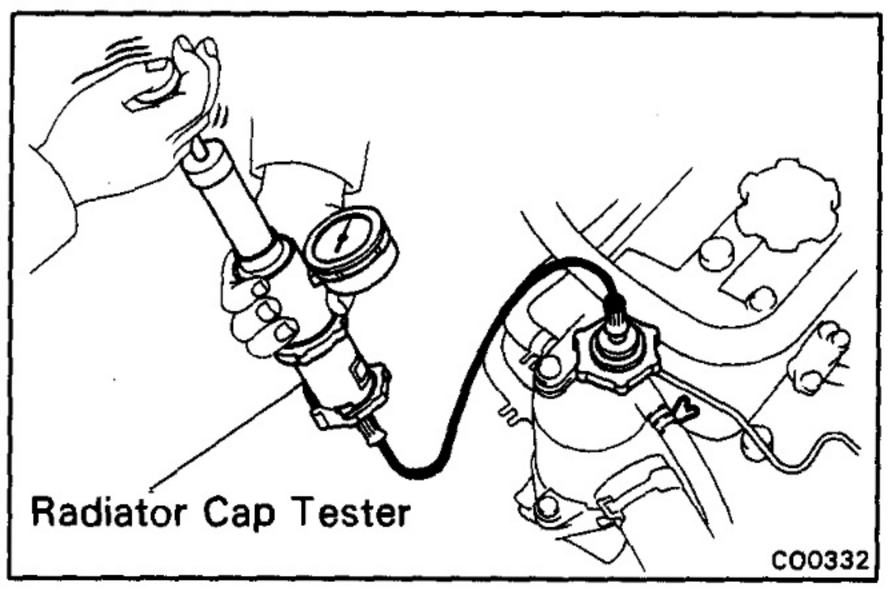
CLEANING OF RADIATOR

Using water or steam cleaner, remove any mud and dirt from the radiator core.

CAUTION: 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.

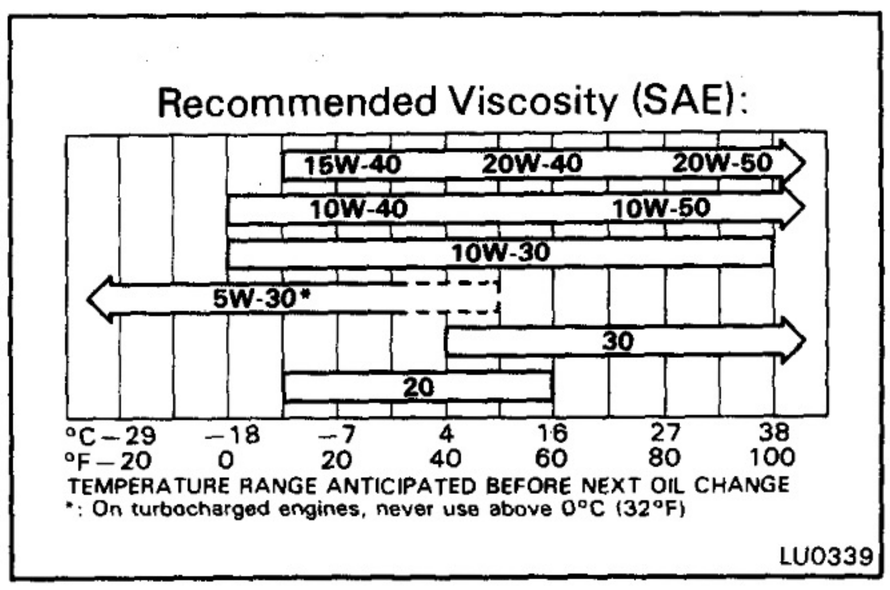
If the pressure drops, check for leaks from the hoses, radiator or water pump. If no external leaks are found, check the heater core, cylinder block and head.

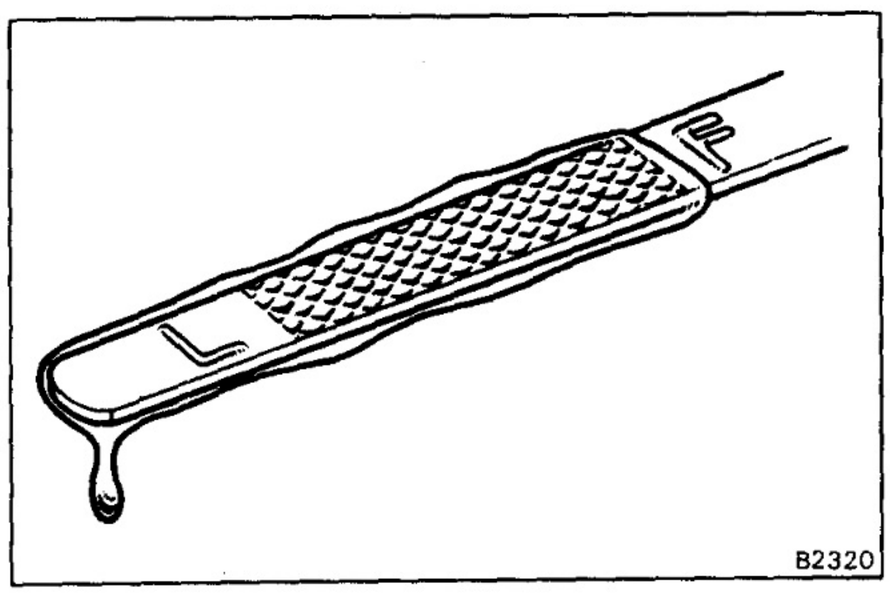
LUBRICATION SYSTEM

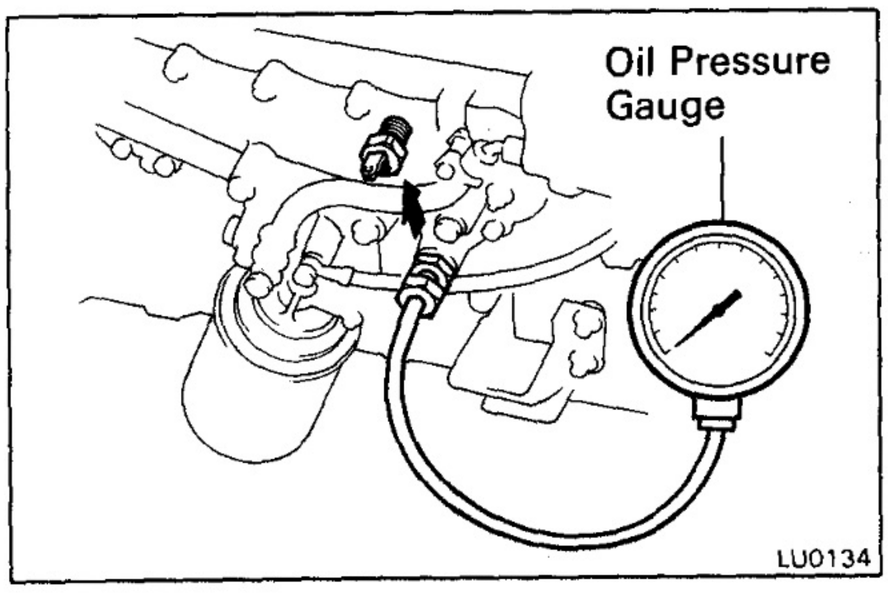
	Page
TROUBLESHOOTING	LU-2
OIL PRESSURE CHECK	LU-2
REPLACEMENT OF ENGINE OIL AND OIL FILTER	LU-3
OIL PUMP	LU-5
OIL COOLER AND RELIEF VALVE	LU-14

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-86
	Gasket faulty	Replace gasket	
Low oil pressure	Oil leakage	Repair as necessary	
	Relief valve faulty	Repair relief valve	LU-9
	Oil pump faulty	Repair oil pump	LU-4
	Engine oil poor quality	Replace engine oil	LU-3
	Crankshaft bearing faulty	Replace bearing	EM-66
	Connecting rod bearing faulty	Replace bearing	EM-66
	Oil filter clogged	Replace oil filter	LU-3
High oil pressure	Relief valve faulty	Repair relief valve	LU-9







OIL PRESSURE CHECK

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

If the oil quality is poor, replace it.

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

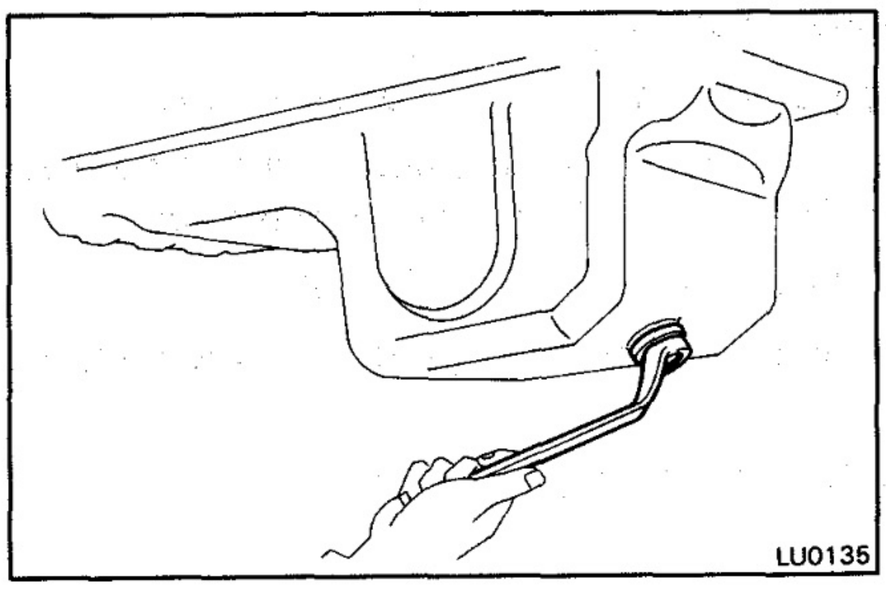
Start the engine and warm it up to normal operating temperature.

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)**

NOTE: Check for oil leakage after reinstalling the pressure switch.

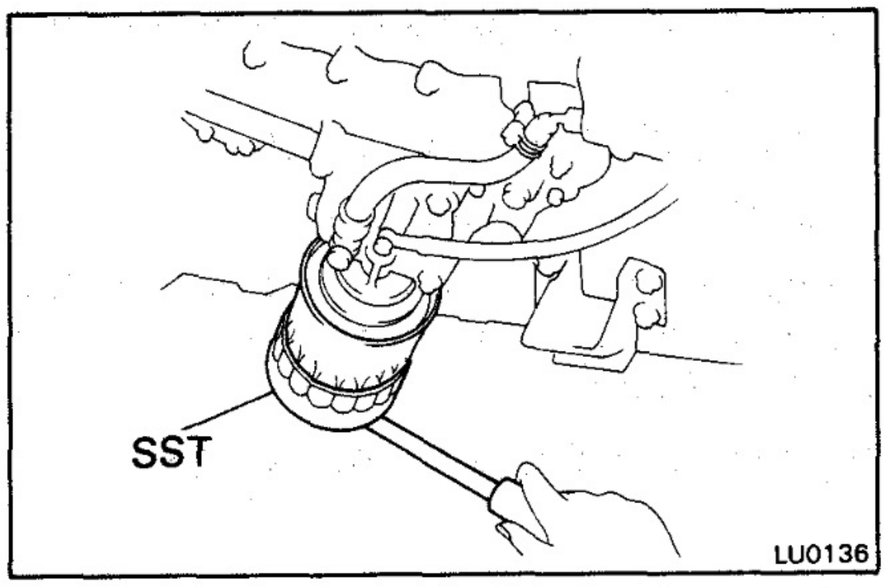


REPLACEMENT OF ENGINE OIL AND OIL FILTER

1. DRAIN ENGINE OIL

(a) Remove the oil filler cap.

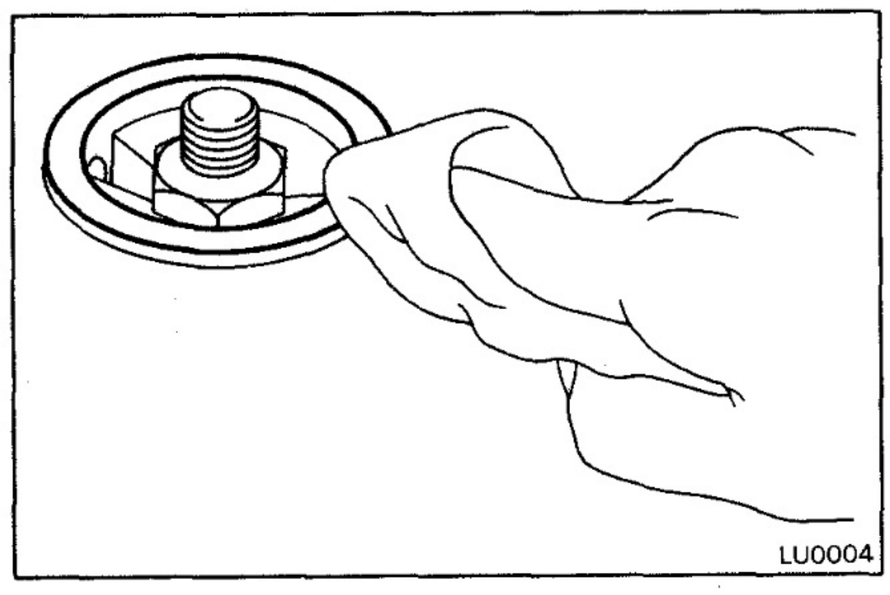
(b) Remove the oil drain plug and drain the oil into a container.



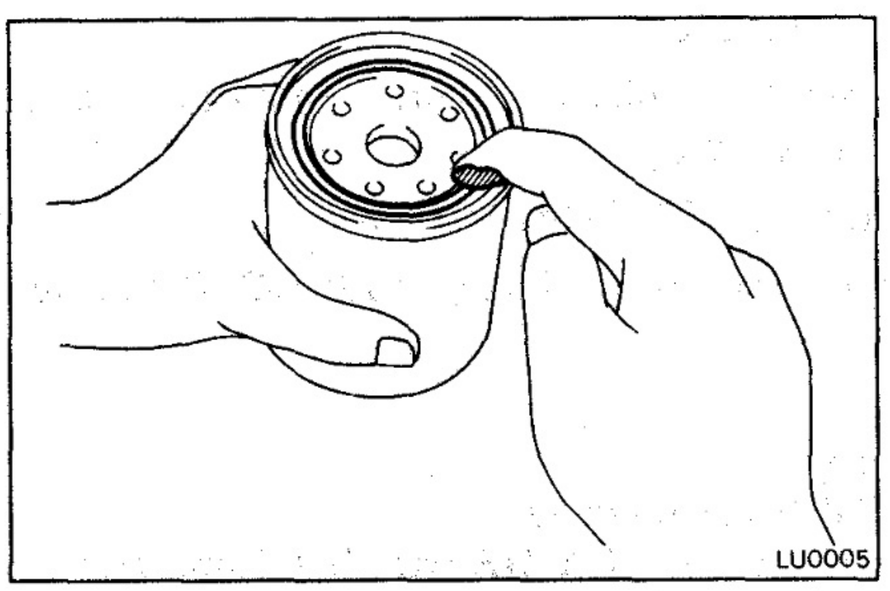
2. REPLACE OIL FILTER [CARTRIDGE TYPE]

(a) Using SST, remove the oil filter.

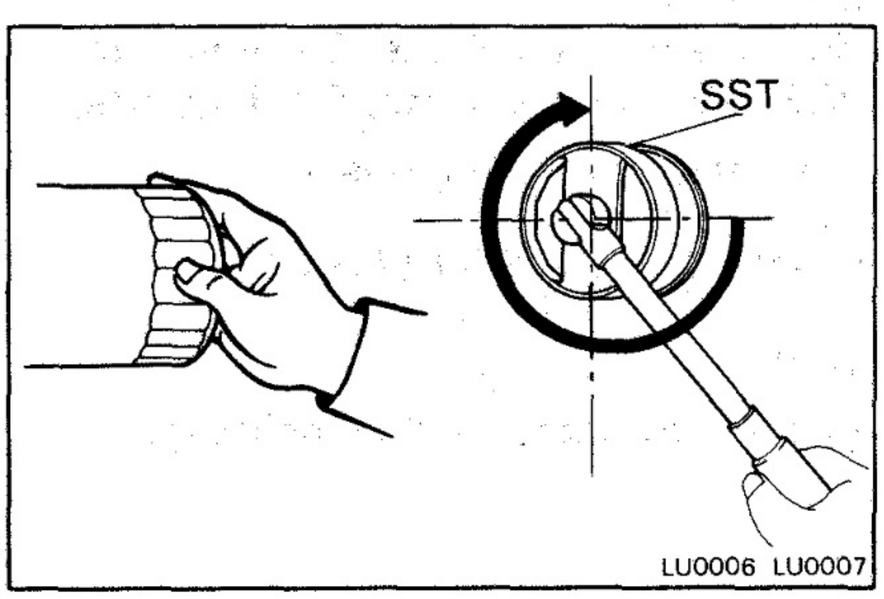
SST 09228-44011



(b) Inspect and clean the oil filter installation surface.



(c) Apply clean engine oil to the gasket of the new oil filter.

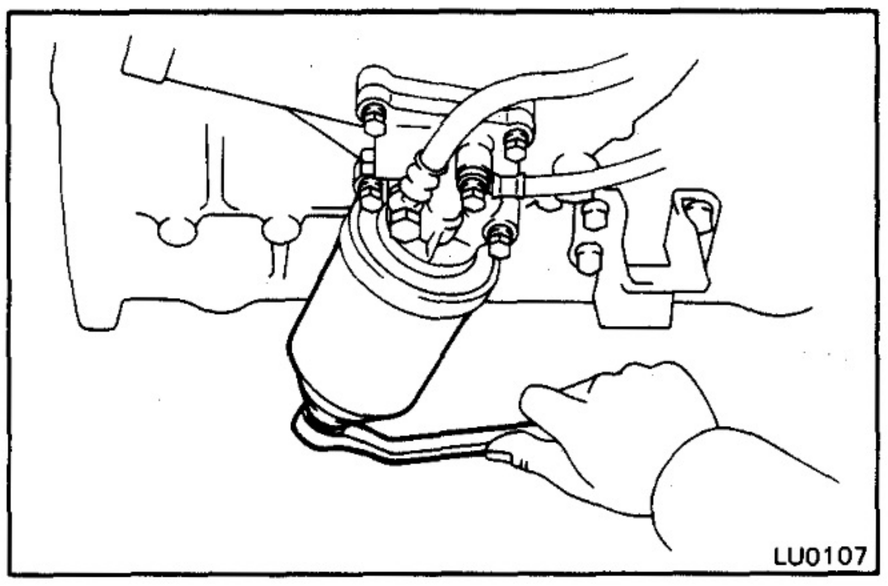


(d) Lightly screw in the oil filter until you feel resistance.

(e) Using SST, tighten the oil filter an extra 3/4 turn.

SST 09228-44011

(f) After engine warm up, check for oil leakage.



[PAPER ELEMENT TYPE]

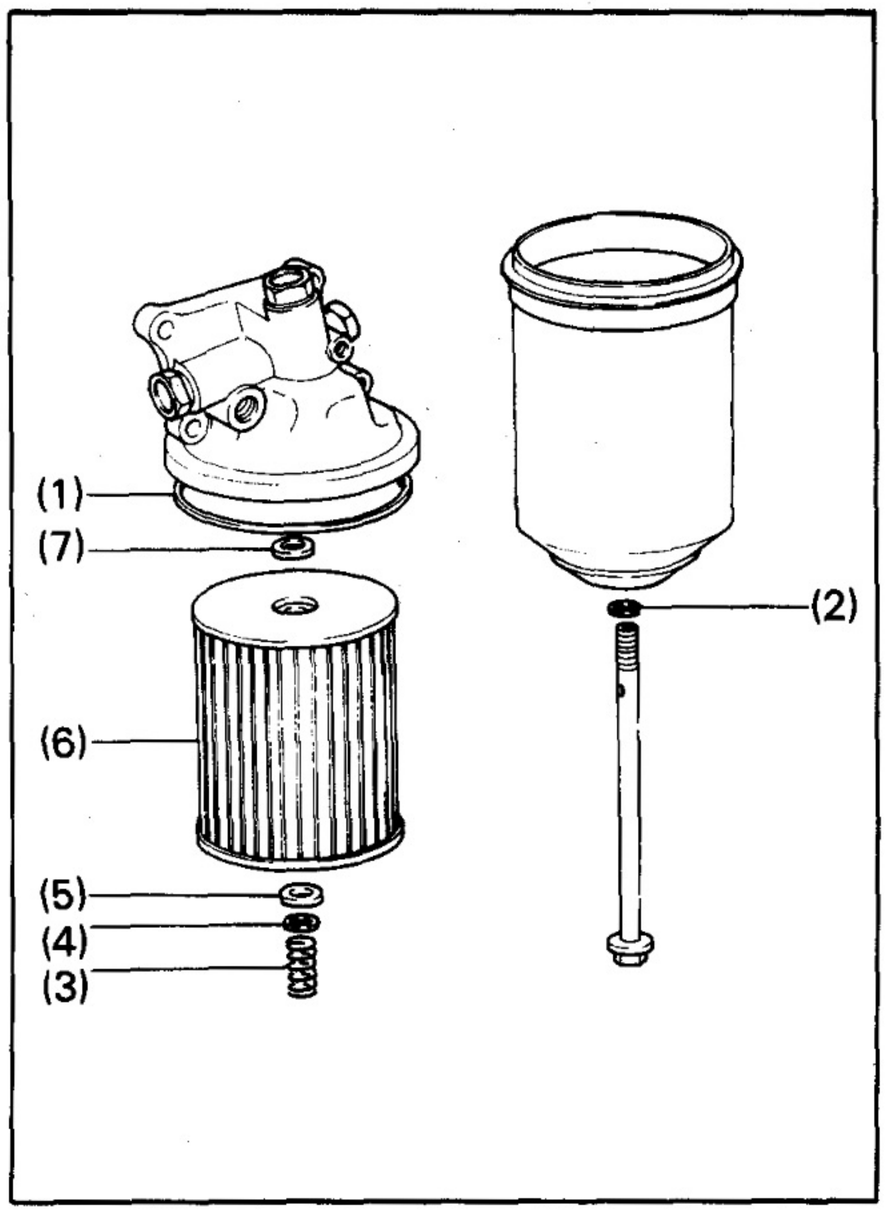
(a) Remove the guide bolt and oil filter assembly.

(b) Remove the rubber gasket, element, rubber gasket, plate washer and spring from the oil filter case.

(c) Remove the O-ring from the guide bolt.

(d) Remove the oil filter bracket gasket from the oil filter bracket.

(e) Clean the filter case and guide bolt.



(f) Install a new oil filter bracket gasket (1) to the oil filter bracket.

(g) Install a new O-ring (2) to the guide bolt.

- Put a light coat of engine oil on the O-ring.

(h) Install the spring (3), plate washer (4), a new rubber gasket (5), a new element (6) and a new rubber gasket (7) to the oil filter case.

(i) Install the oil filter assembly with the guide bolt.

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:

Drain and refill

w/o Oil filter change

5.8 liters (6.1 US qts, 5.1 Imp. qts)

w/ Oil filter change

6.7 liters (7.1 US qts, 5.9 Imp. qts)

Dry fill 7.3 liters (7.7 US qts, 6.4 Imp. qts)

(c) Install the oil filler cap with the gasket.

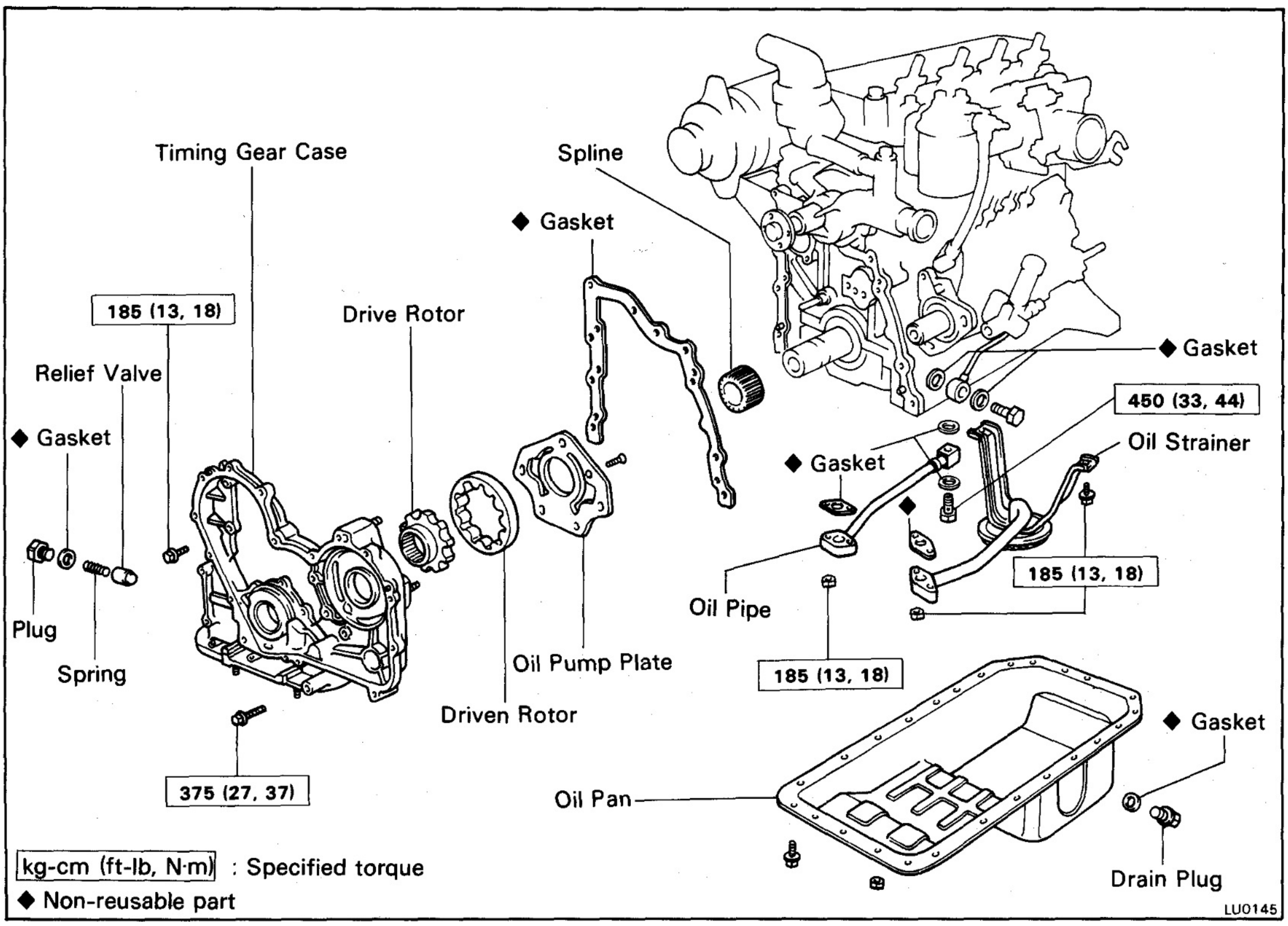
4. START ENGINE AND CHECK FOR LEAKS

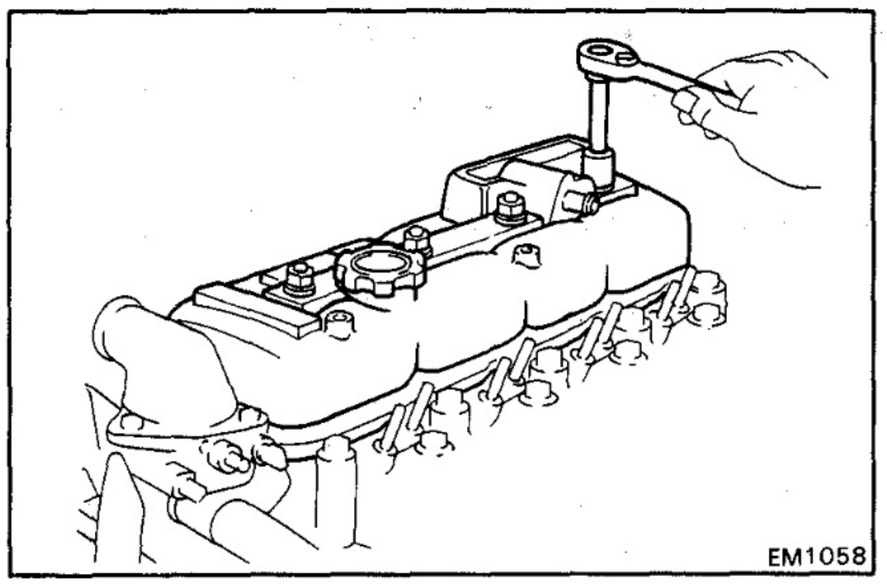
5. RECHECK OIL LEVEL

Recheck the engine oil level and refill as necessary.

OIL PUMP

COMPONENTS





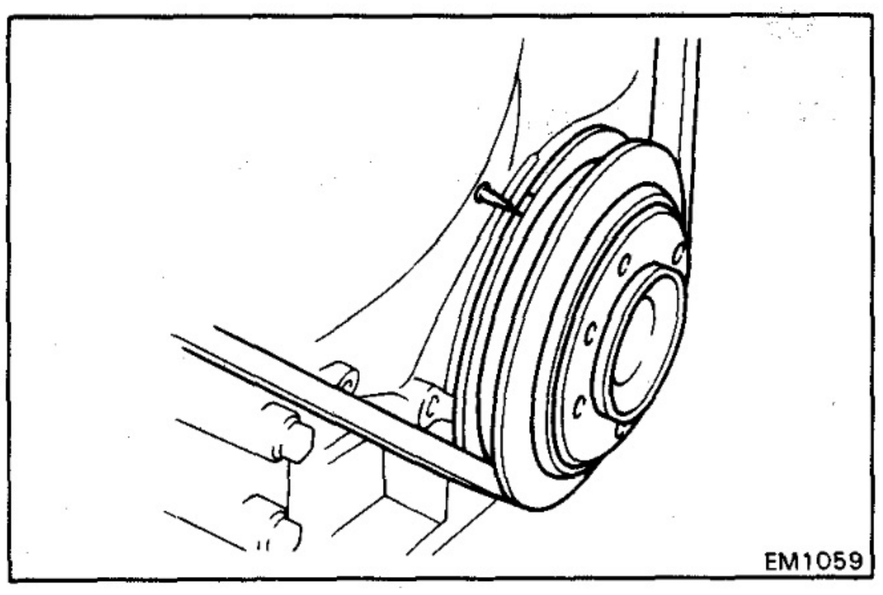
REMOVAL AND DISASSEMBLY OF OIL PUMP

NOTE: When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

1. [13B-T]
REMOVE INTAKE AIR CONNECTOR PIPE

2. REMOVE CYLINDER HEAD COVER

Remove the four cap nuts, seal washers, head cover and gasket.

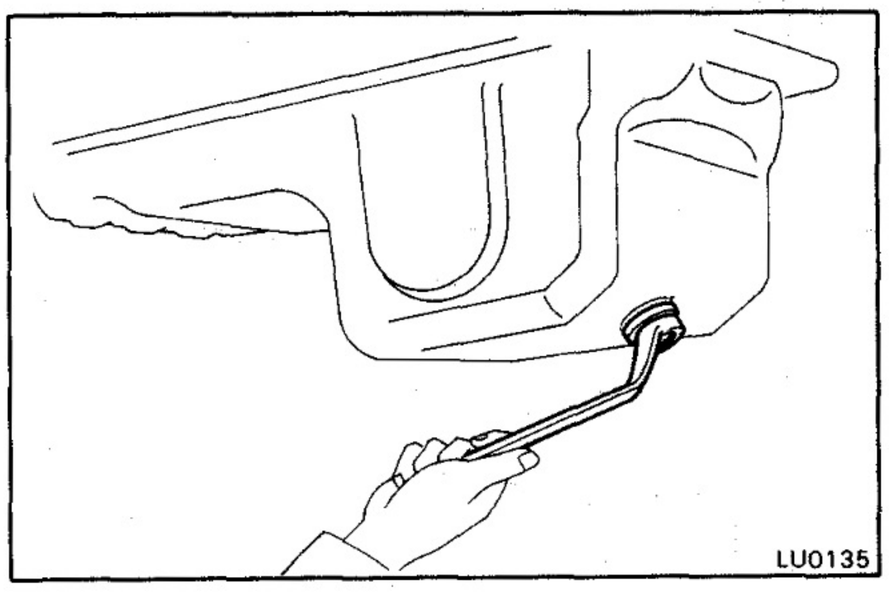


3. SET NO. 1 CYLINDER TO TDC/COMPRESSION

(a) Set the No. 1 cylinder to TDC/compression.
Align the groove on the pulley with the timing pointer 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.

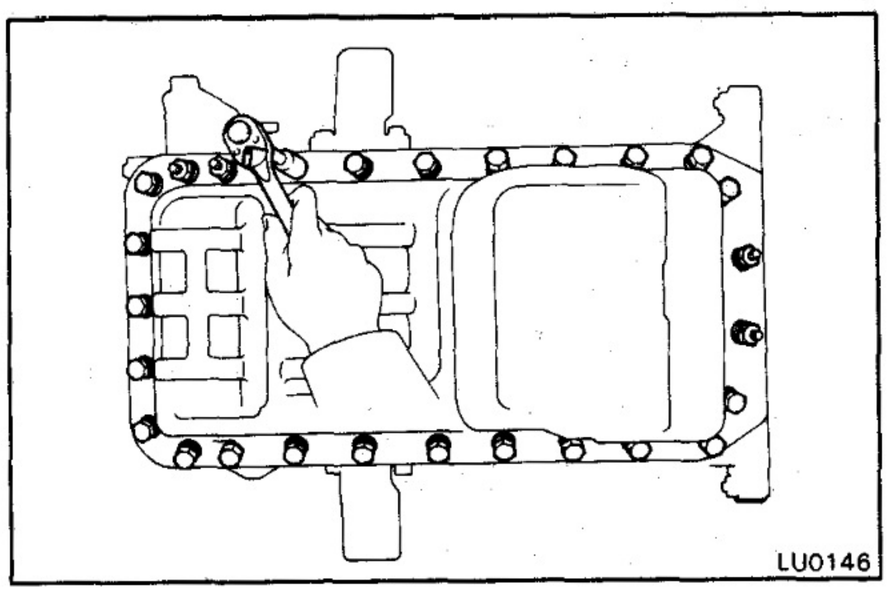
If not, turn the crankshaft one revolution (360°) and align the mark as above.



4. DRAIN ENGINE OIL

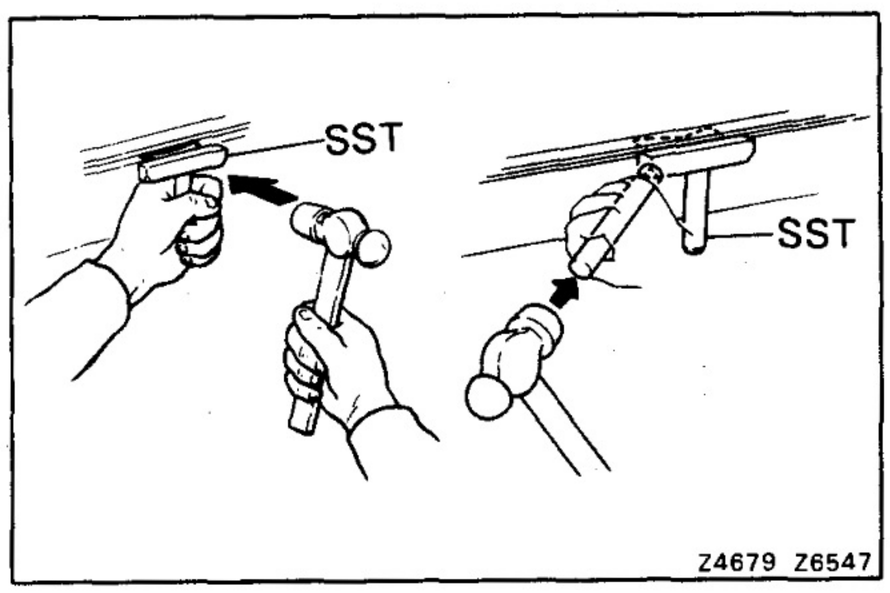
(a) Remove the oil filler cap.

(b) Remove the oil drain plug and drain the oil into a container.



5. REMOVE OIL PAN

(a) Remove the twenty three bolts and four nuts.

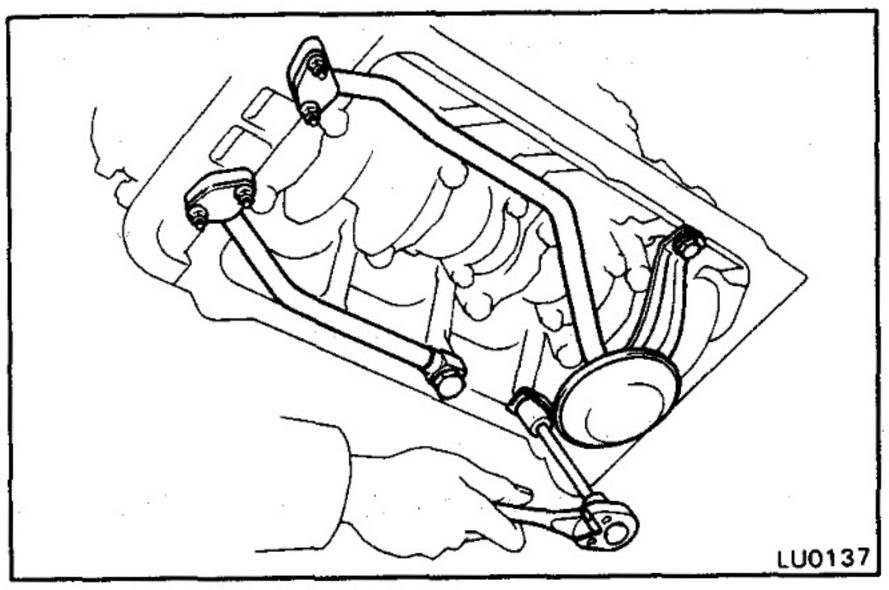


(b) Insert the SST blade between the cylinder block and oil pan, cut off applied sealer and remove the oil pan.

SST 09032-00100

NOTE:

- Do not use SST for the timing gear case side.
- Be careful not to damage the oil pan flange.



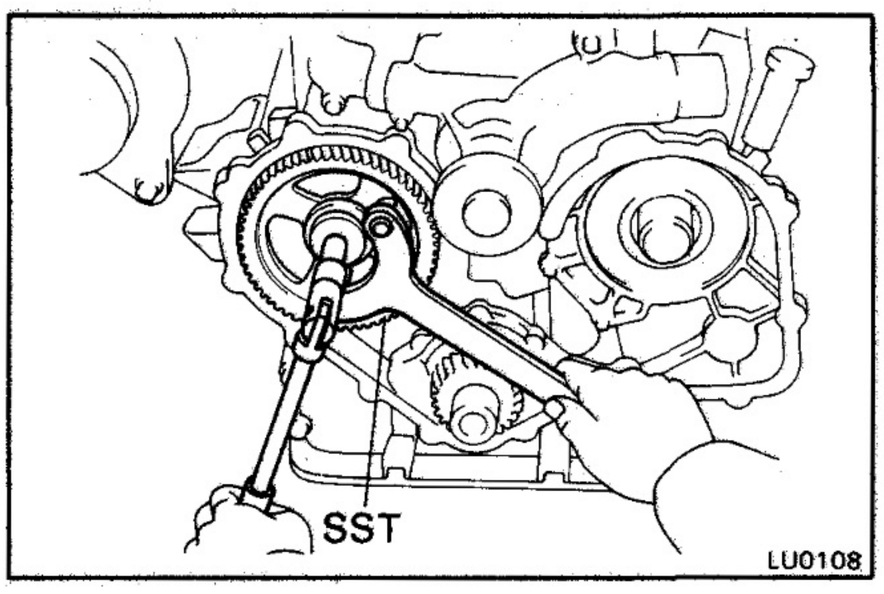
6. REMOVE OIL STRAINER AND OIL PIPE

(a) Remove the two bolts, two nuts, oil strainer and gasket.

(b) Remove the union bolt, two nuts, oil pipe and gaskets.

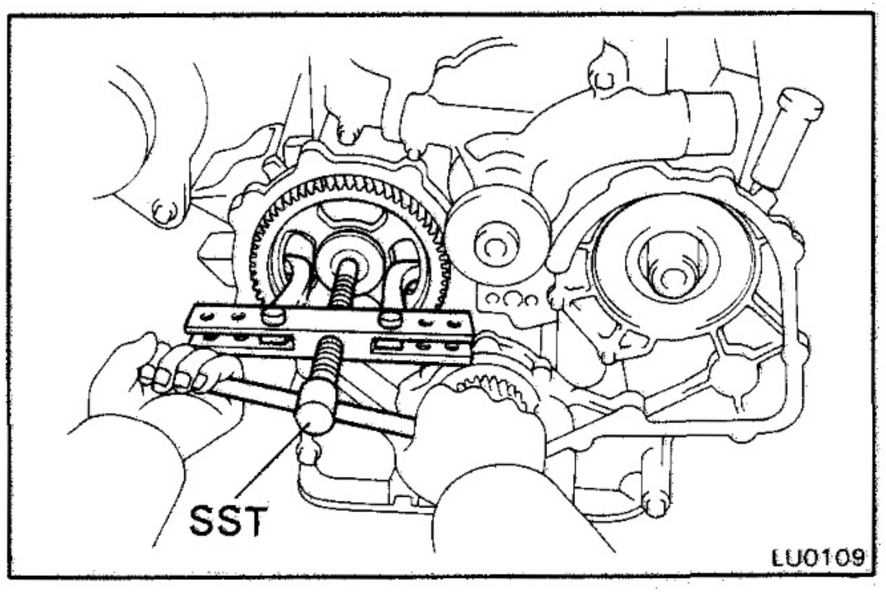
7. REMOVE DRIVE BELT

8. REMOVE IDLE GEAR AND SHAFT
(See steps 12 to 19 on pages EM-54 to 56)

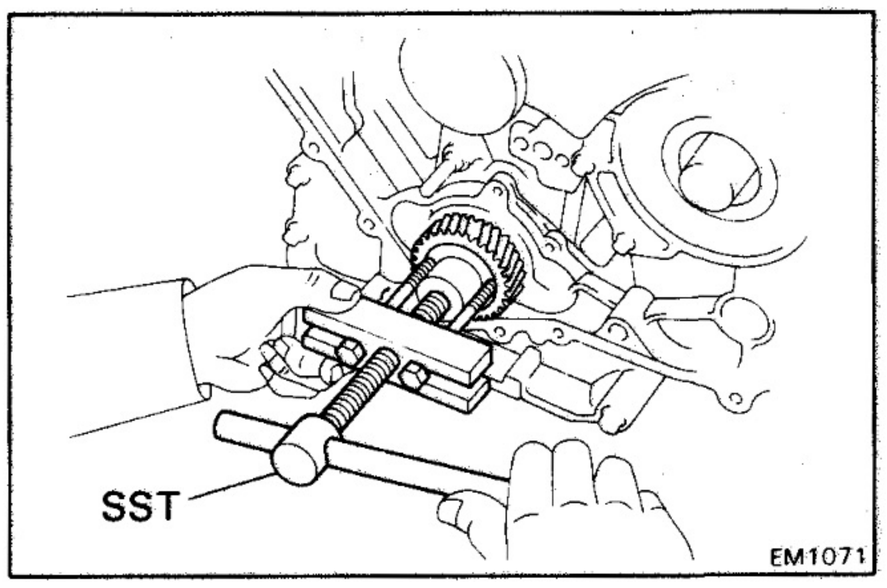


9. REMOVE CAMSHAFT TIMING GEAR

(a) Using SST, remove the mount bolt and plate washer.
SST 09278-54012

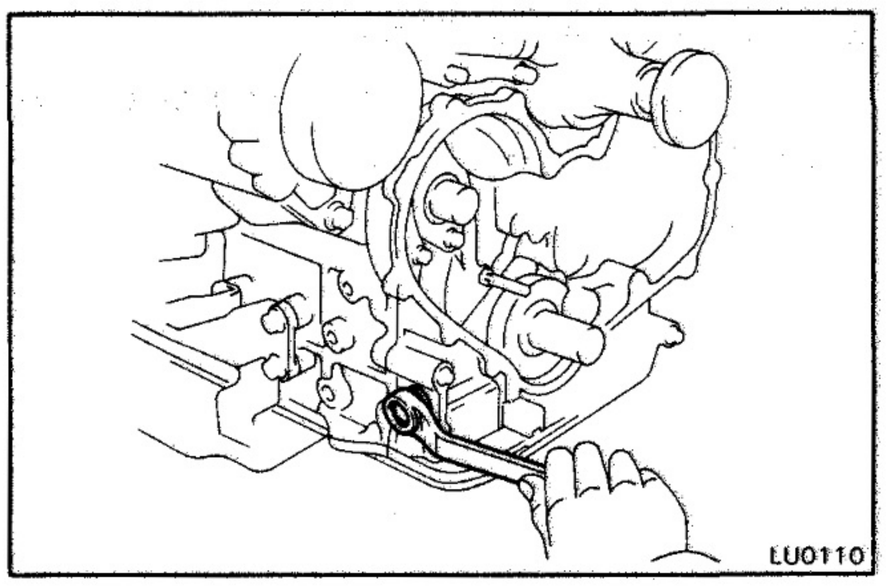


(b) Using SST, remove the timing gear.
SST 09950-20017



10. REMOVE CRANKSHAFT TIMING GEAR

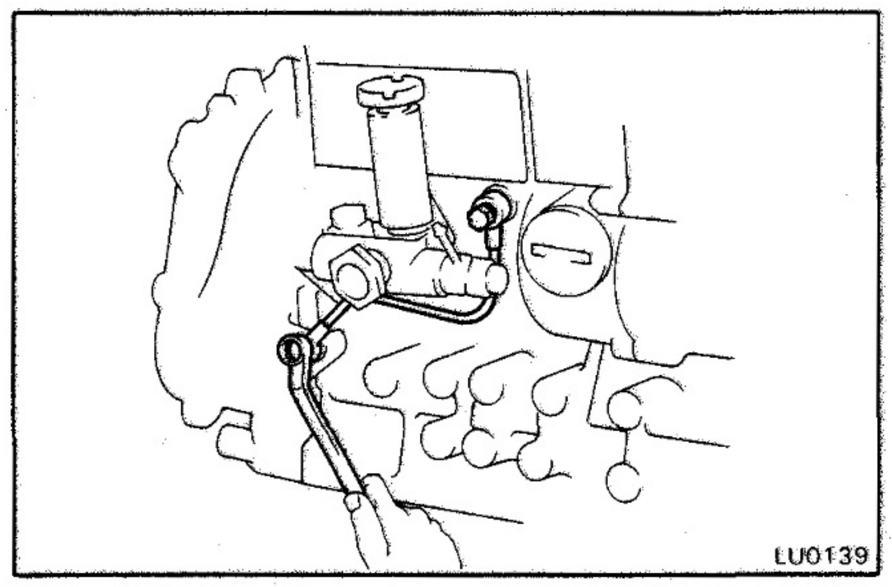
Using SST, remove the timing gear.
SST 09213-60017



11. REMOVE RELIEF VALVE

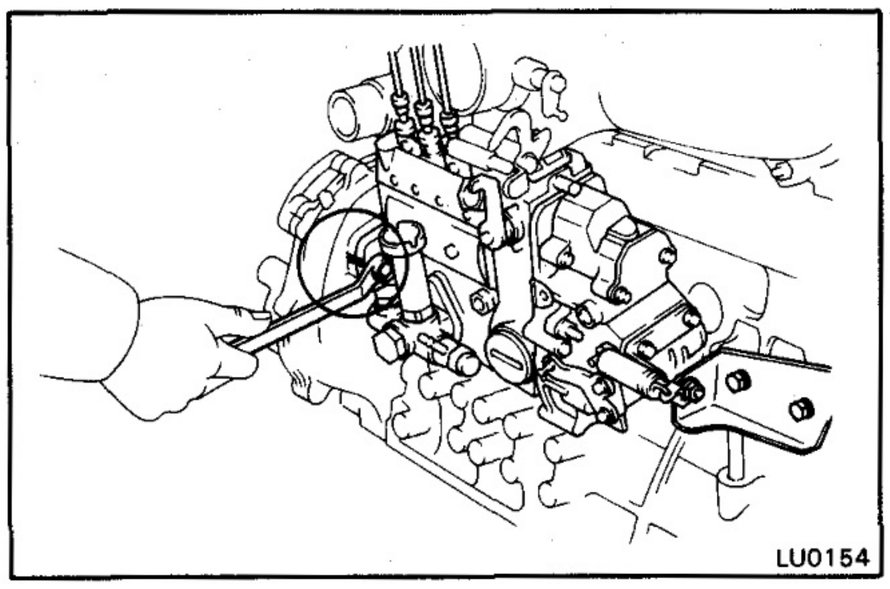
Remove the plug, gasket, spring and relief valve.

12. REMOVE FUEL FILTER ASSEMBLY



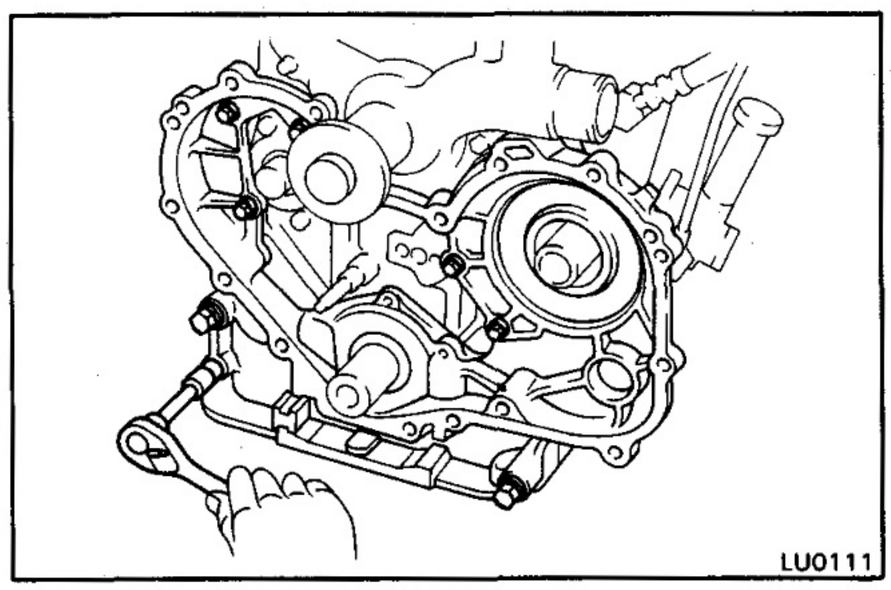
13. REMOVE TIMING GEAR CASE

(a) Remove the union bolt and two gaskets, and disconnect the injection oil pipe.

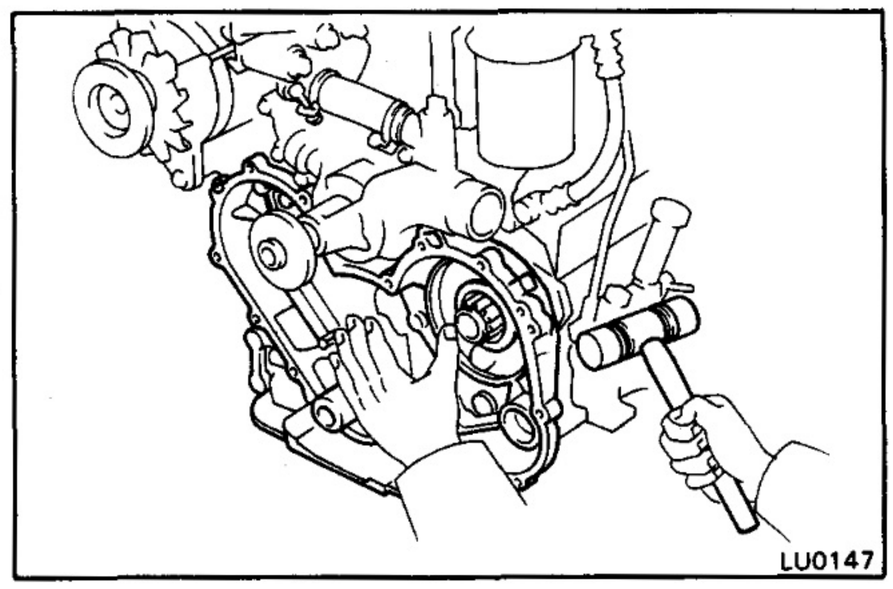

LU0154

(b) Before removing the three nuts holding the injection pump to the timing gear case, check if the matchmarks are aligned. If not, place new matchmarks for reinstallation.

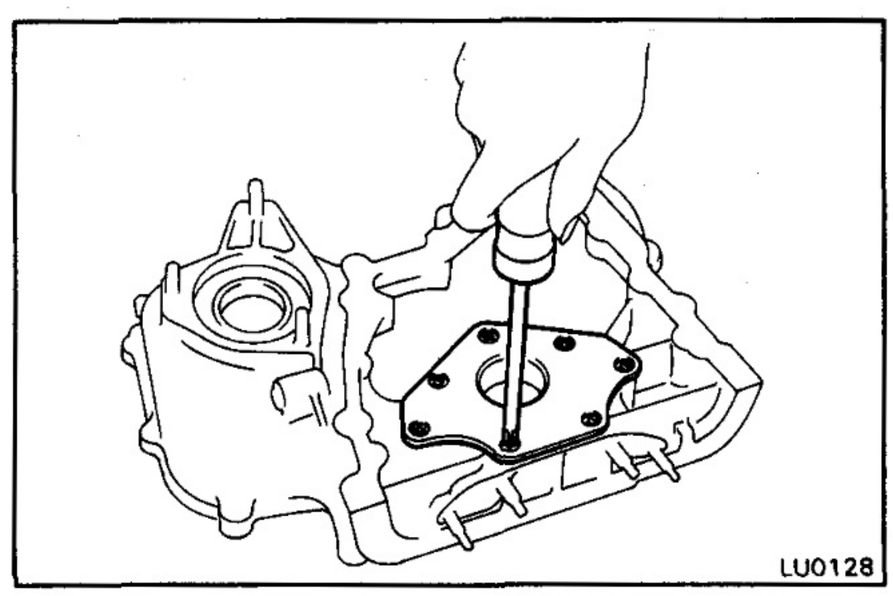
(c) Remove the three nuts.


LU0111

(d) Remove the eight bolts.

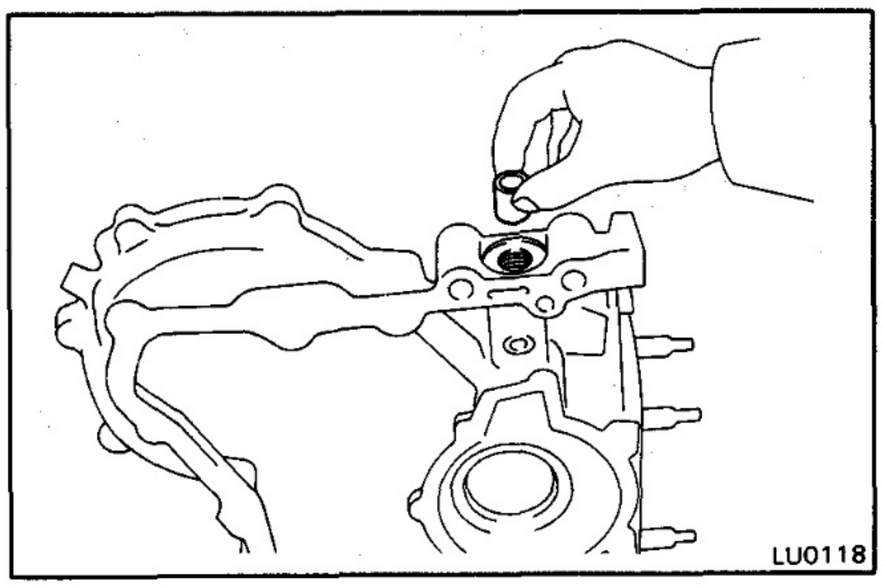

LU0147

(e) Using a plastic-faced hammer, lightly tap out the timing gear case and gasket.


LU0128

14. DISASSEMBLE OIL PUMP ASSEMBLY

Remove the seven screws, oil pump plate, drive and driven rotors from the timing gear case.

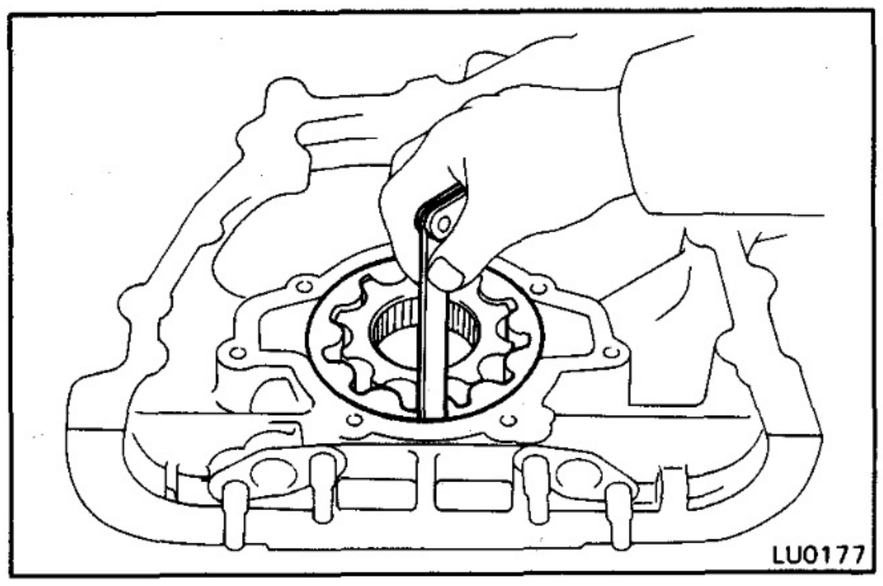


INSPECTION OF OIL PUMP

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 necessary, replace the valve and/or timing gear case.

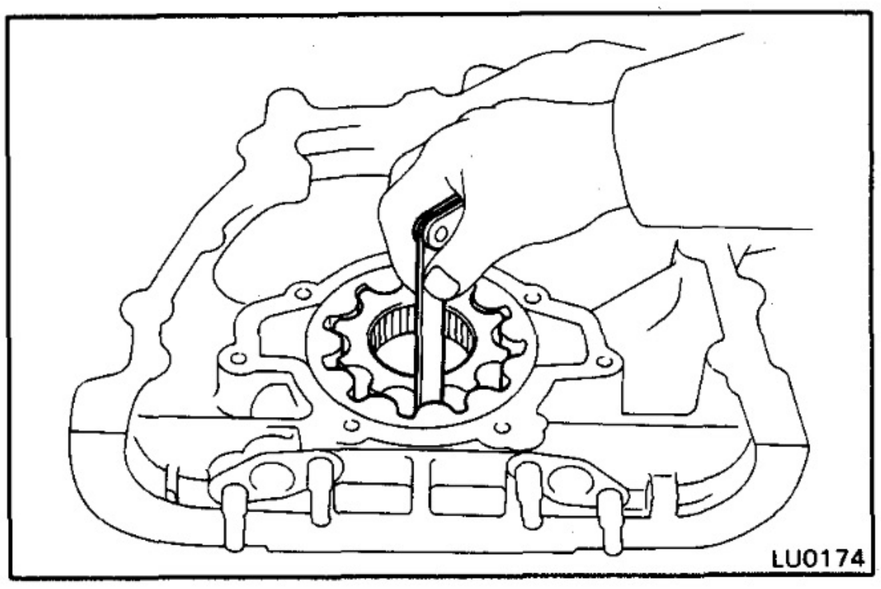


2. INSPECT BODY CLEARANCE

Using a feeler gauge, measure the clearance between the driven rotor and body.

Standard clearance: **0.14 — 0.22 mm (0.0055 — 0.0087 in.)**
Maximum clearance: **0.4 mm (0.016 in.)**

If the clearance is greater than maximum, replace the rotor and/or timing gear case.

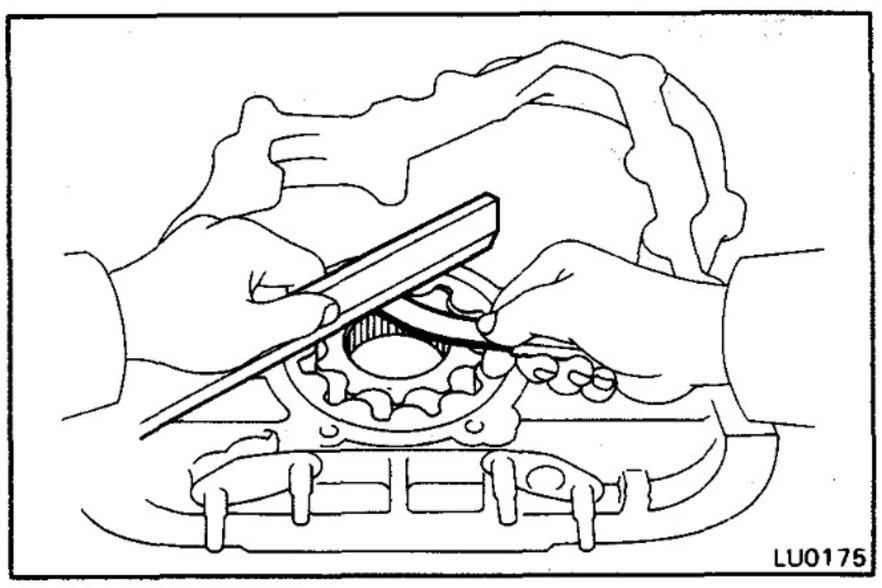


3. INSPECT TIP CLEARANCE

Using a feeler gauge, measure the clearance between both rotor tips.

Standard clearance: **0.11 — 0.24 mm (0.0043 — 0.0094 in.)**
Maximum clearance: **0.3 mm (0.012 in.)**

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

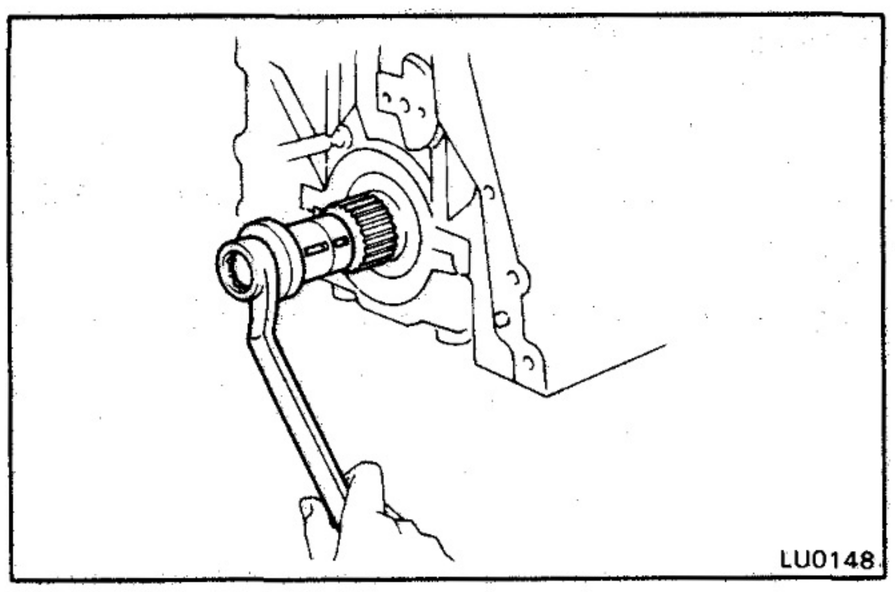


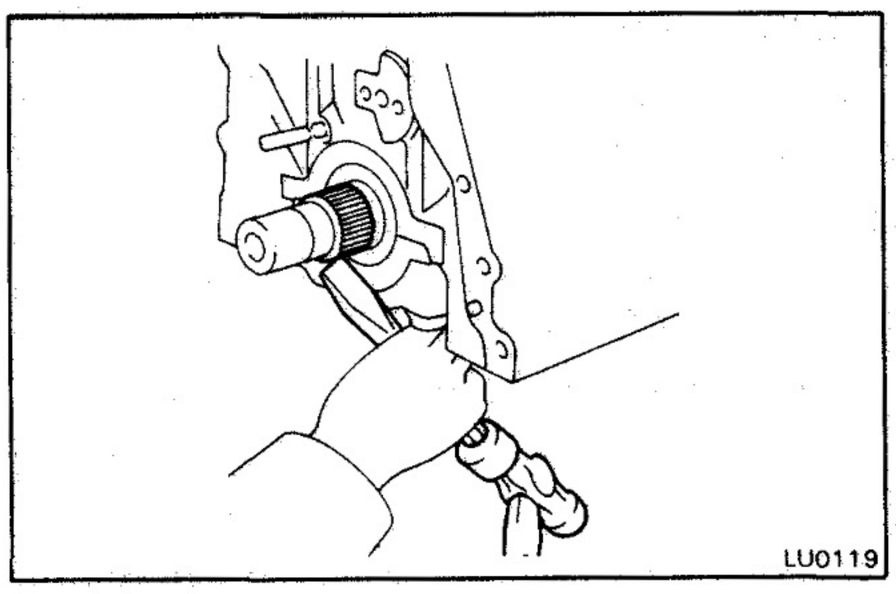
4. INSPECT SIDE CLEARANCE

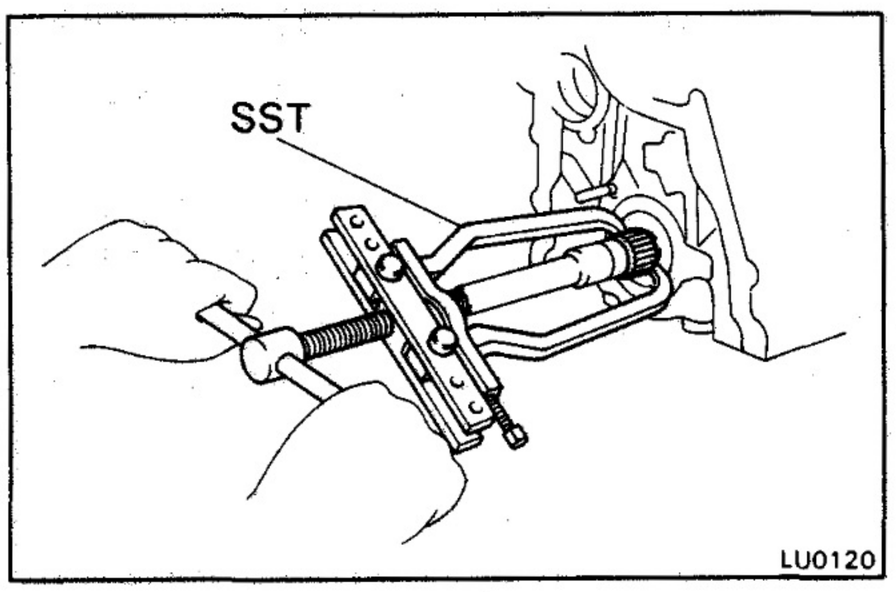
Using a feeler gauge and flat block, measure the side clearance as shown.

Standard clearance: **0.035 — 0.090 mm (0.0014 — 0.0035 in.)**
Maximum clearance: **0.15 mm (0.0059 in.)**

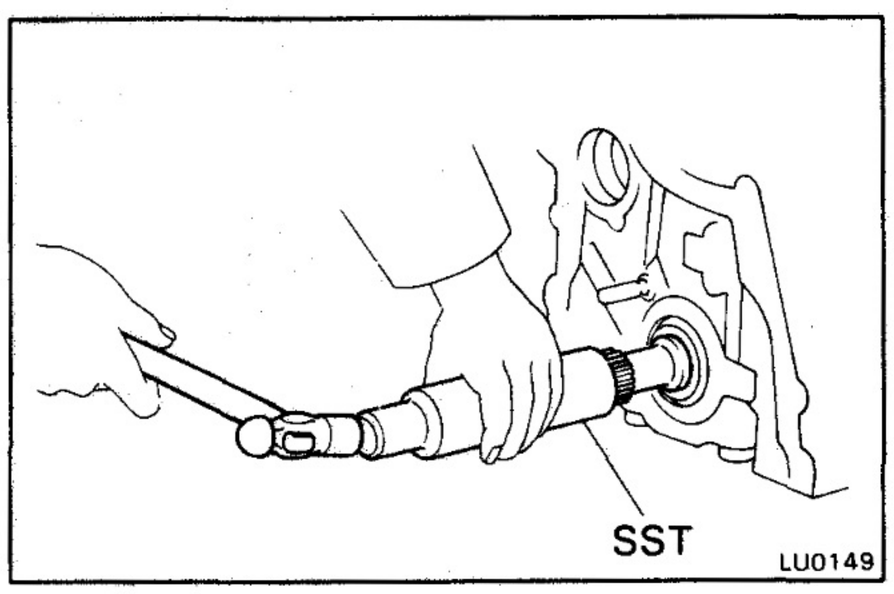
If the clearance is greater than maximum, replace the rotors and/or timing gear case.


LU0148


LU0119



LU0120



LU0149

REPLACEMENT OF OIL PUMP DRIVE SPLINE

(See page LU-5)

1. REMOVE OIL PUMP DRIVE SPLINE

(a) Remove the timing gear set keys.

(b) Using the crankshaft pulley mount bolt, turn the crankshaft so that the lower hole of the spline goes to the 6 o'clock position and the upper hole the 12 o'clock position.

CAUTION: Do not turn the crankshaft more than 1/4 of a turn.

(c) Using a chisel and hammer, drive the spline out of the spline hole until SST can be hooked to spline's end.

(d) Using SST, remove the spline.

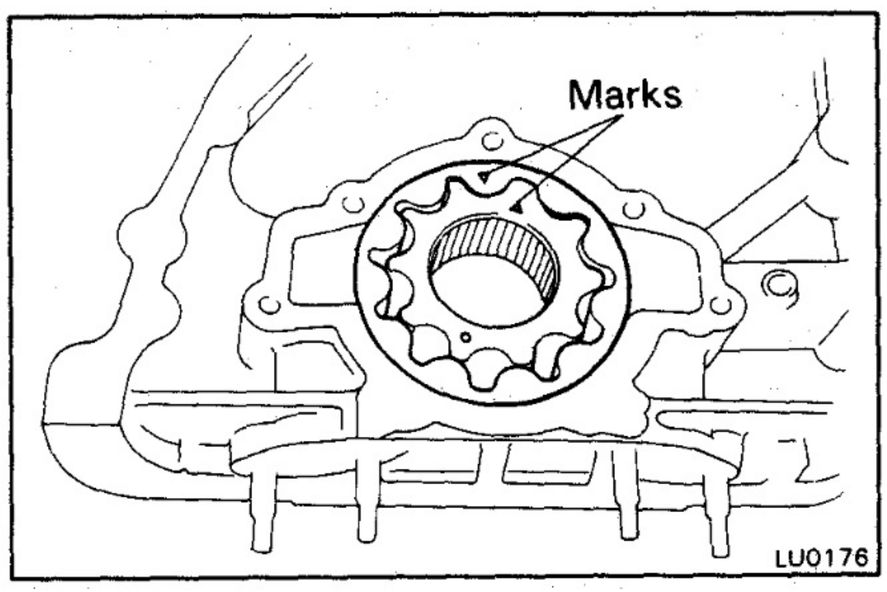
SST 09950-20017

2. INSTALL OIL PUMP DRIVE SPLINE

(a) Using SST and a hammer, tap in a new spline.

SST 09608-35014 (09608-06040)

(b) Install the timing gear set keys.



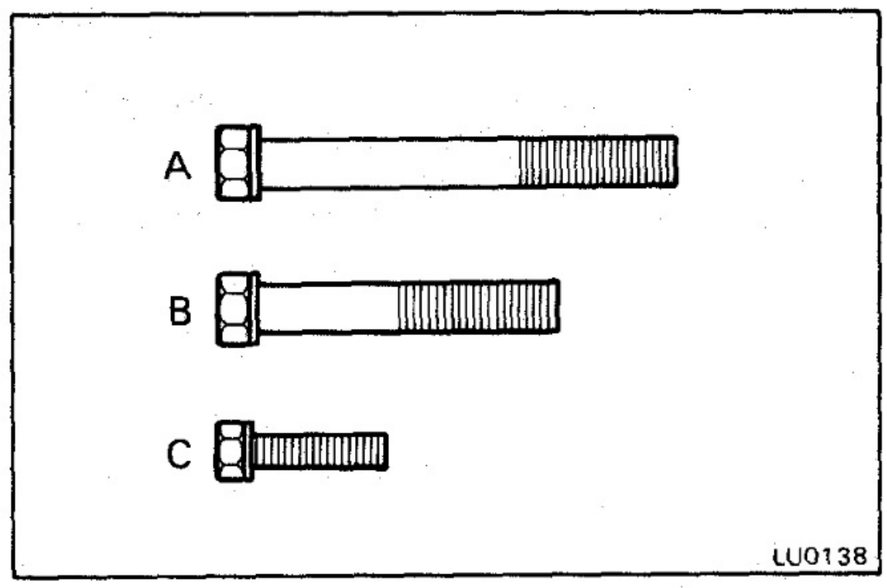
ASSEMBLY AND INSTALLATION OF OIL PUMP

(See page LU-5)

1. ASSEMBLE OIL PUMP ASSEMBLY

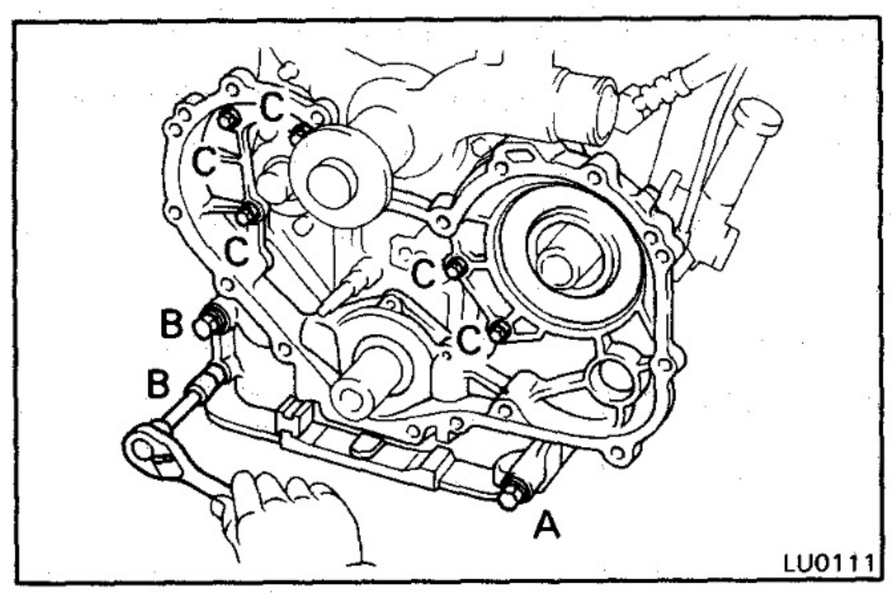
(a) Put the drive and driven rotors into the timing gear case with the marks facing the oil pump plate side.

(b) Install the oil pump plate with the seven screws.



2. INSTALL TIMING GEAR CASE

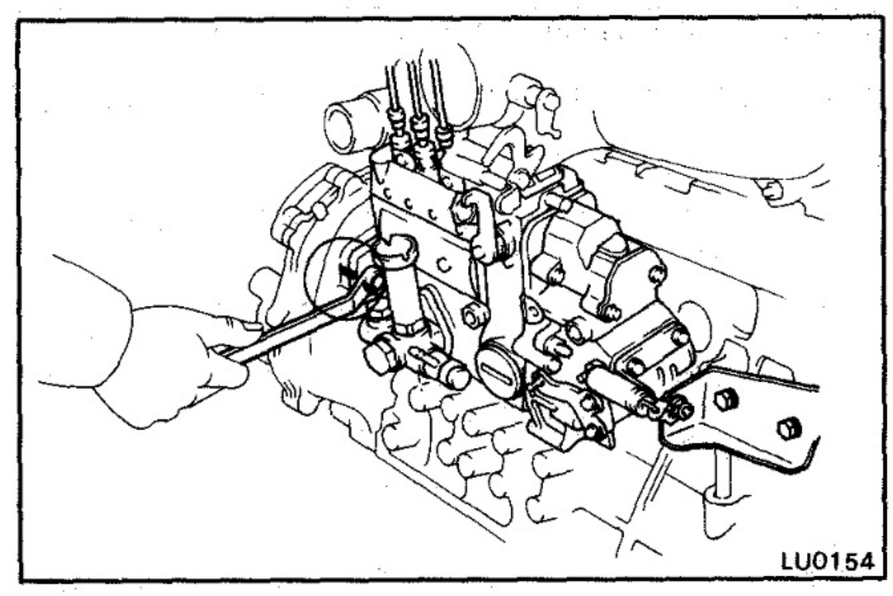
NOTE: Use the bolts indicated by A, B and C.



(a) Place a new gasket and timing gear case in position.

(b) Install and uniformly tighten the eight bolts in several passes.

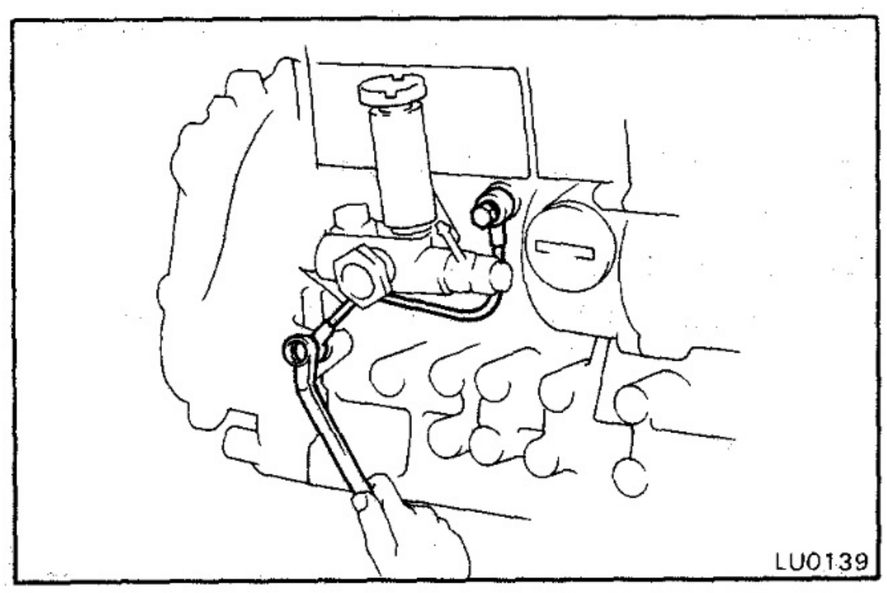
Torque: Bolt A and B 375 kg-cm (27 ft-lb, 37 N·m)
Bolt C 185 kg-cm (13 ft-lb, 18 N·m)



(c) Align the matchmarks on the injection pump and timing gear case.

(d) Install the three nuts holding the injection pump to the timing gear case. Torque the nuts.

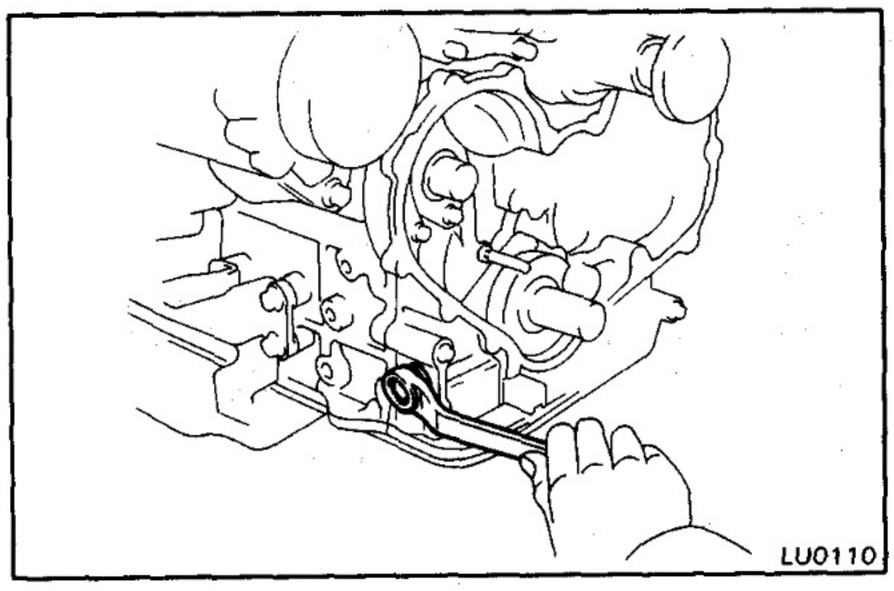
Torque: 375 kg-cm (27 ft-lb, 37 N·m)



(e) Connect the injection oil pipe with the union bolt and two new gaskets.

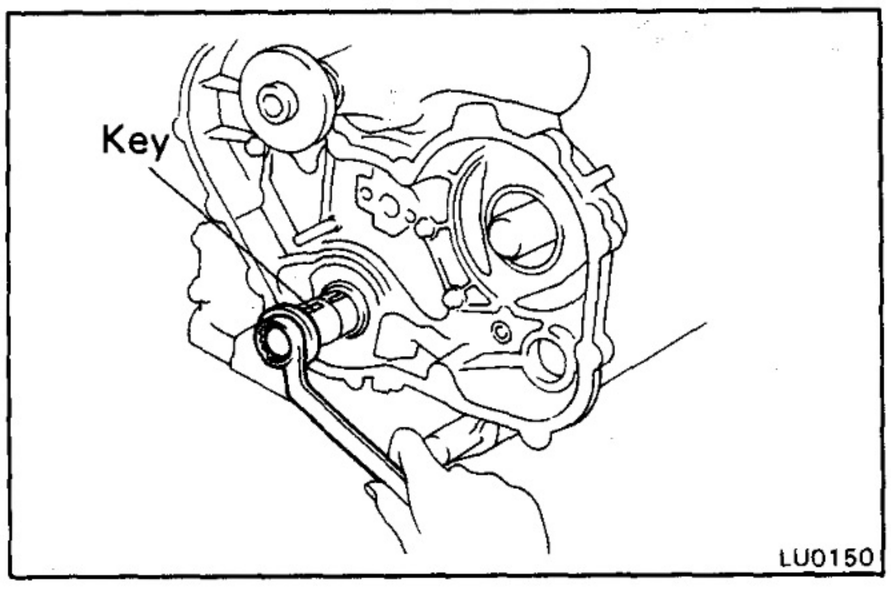
Torque: 110 kg-cm (8 ft-lb, 11 N·m)

3. INSTALL FUEL FILTER ASSEMBLY



4. INSTALL RELIEF VALVE

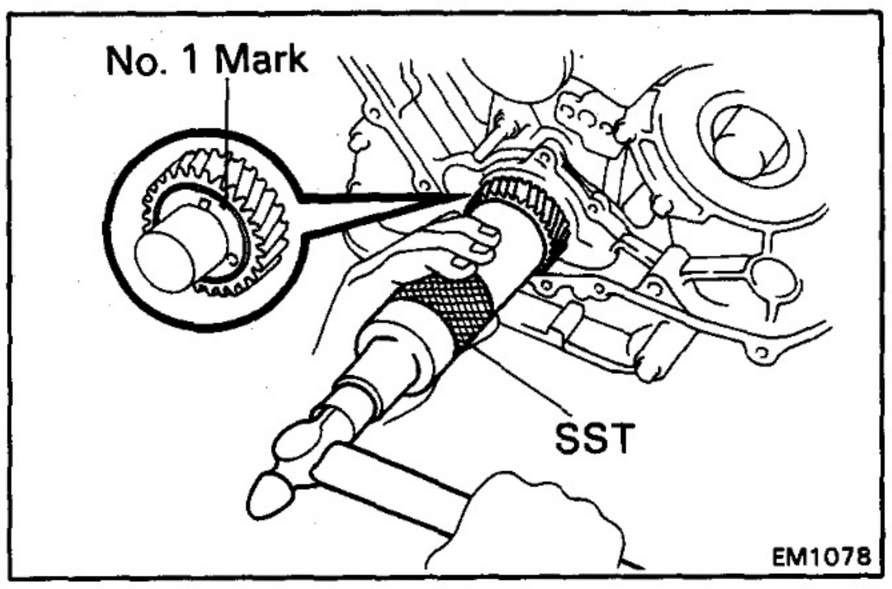
Install the relief valve, spring, new gasket and plug.



5. SET CRANKSHAFT

Using crankshaft pulley mount bolt, turn the crankshaft to the key on the crankshaft facing upward.

CAUTION: Do not turn the crankshaft more than 1/4 of a turn.



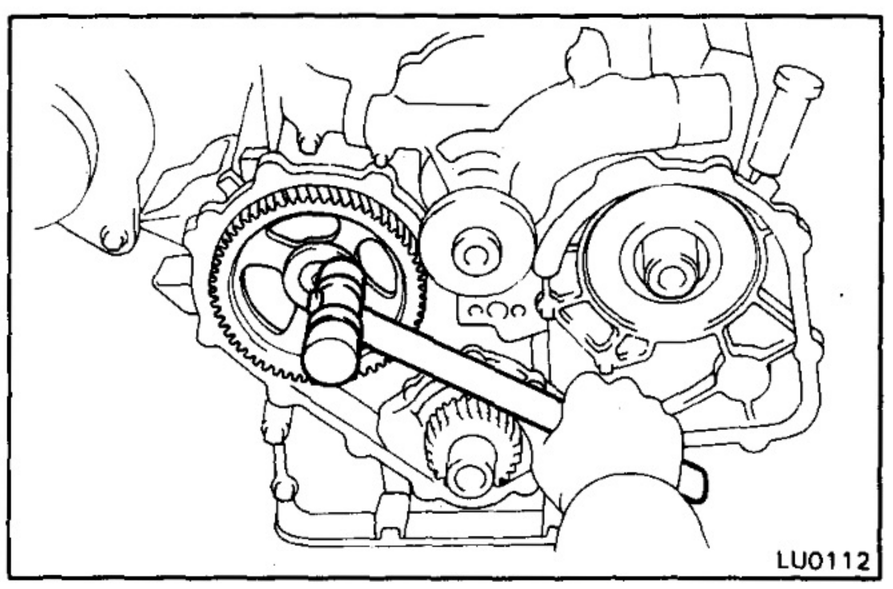
6. INSTALL CRANKSHAFT TIMING GEAR

(a) Put the timing gear on the crankshaft with the No. 1 mark of the timing gear facing forward.

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

(c) Using SST and a hammer, drive in the timing gear.

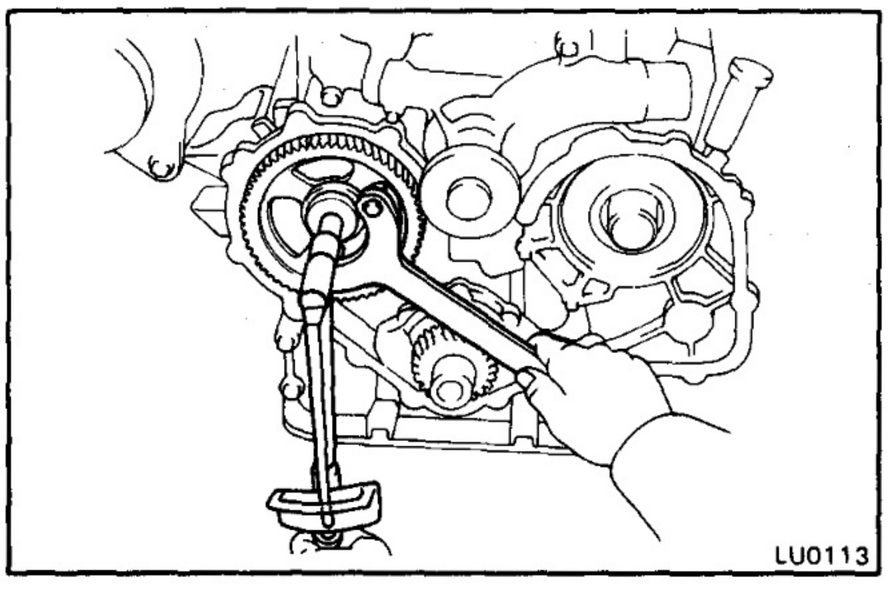
SST 09608-35014 (09608-06040)



7. 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.

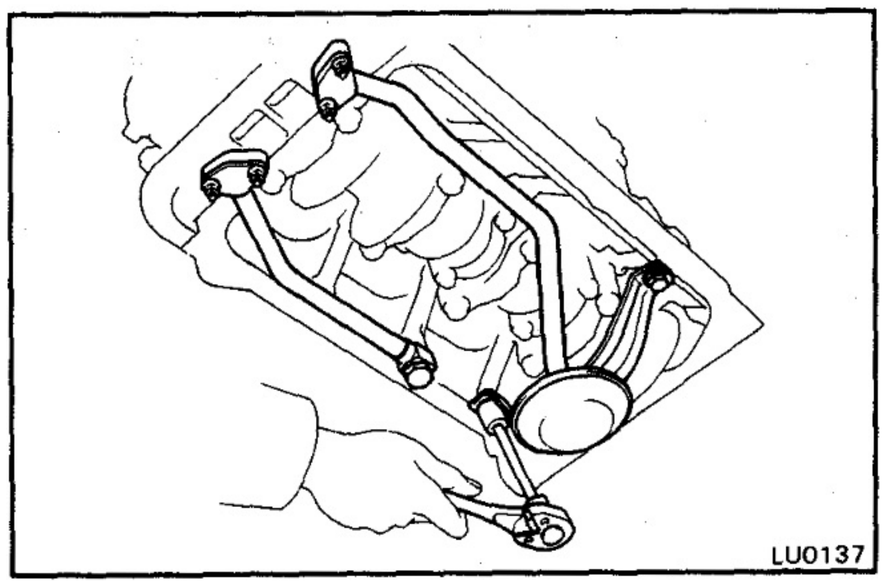


(c) Using SST, install and torque the pulley mount bolt.

SST 09278-54012

Torque: 375 kg-cm (27 ft-lb, 37 N·m)

8. INSTALL IDLE GEAR AND SHAFT
(See steps 3 to 9 on pages EM-61 to 64)



9. INSTALL OIL STRAINER AND OIL PIPE

(a) Install three new gaskets and oil pipe with the union bolt and two nuts.

Torque: Bolt 450 kg-cm (33 ft-lb, 44 N·m)
Nut 185 kg-cm (13 ft-lb, 18 N·m)

(b) Install a new gasket and oil strainer with the two bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

10. INSTALL OIL PAN

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pan and cylinder block.

- Using a razor blade and gasket scraper, remove all the residual packing 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.

CAUTION: Do not use a solvent which will affect the painted surfaces.

(b) Apply seal packing to the oil pan as shown in the figure.

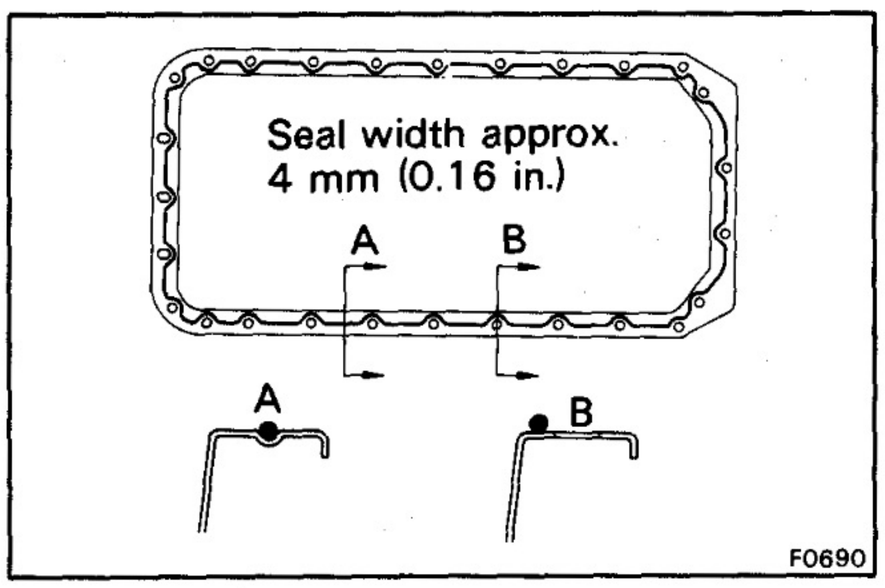
Seal packing: Part No. 08826-00080 or equivalent

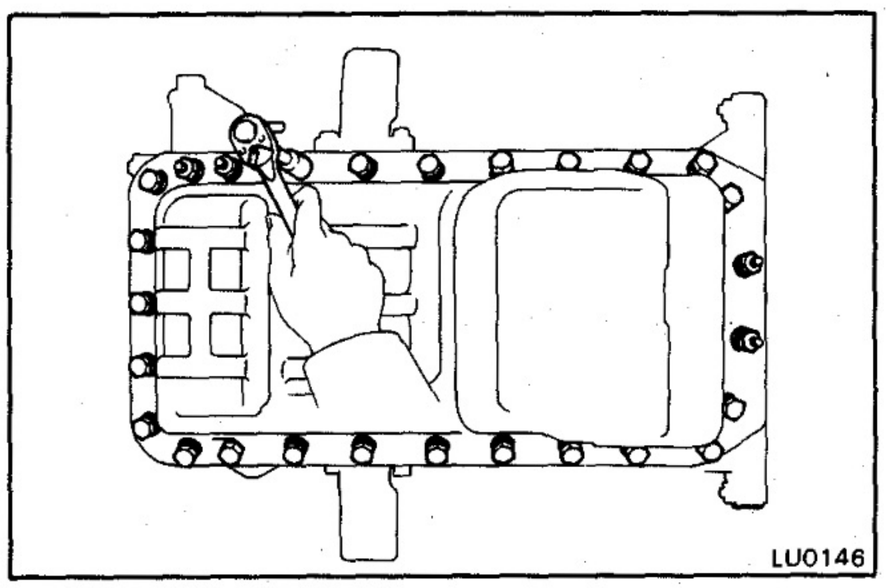
- Install a nozzle that has been cut to a 4 mm (0.16 in.) opening.

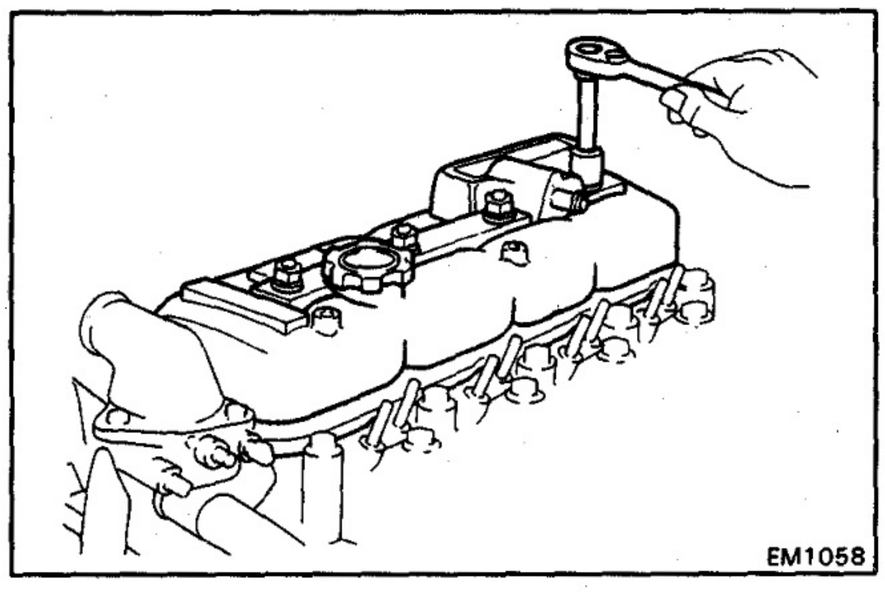
NOTE: Avoid applying an excess amount to the surface. Be particularly careful near oil passages.

- Parts must be assembled within 3 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 three bolts and four nuts.







11. INSTALL CYLINDER HEAD COVER

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

(b) Install the head cover with the four seal washers and cap nuts.

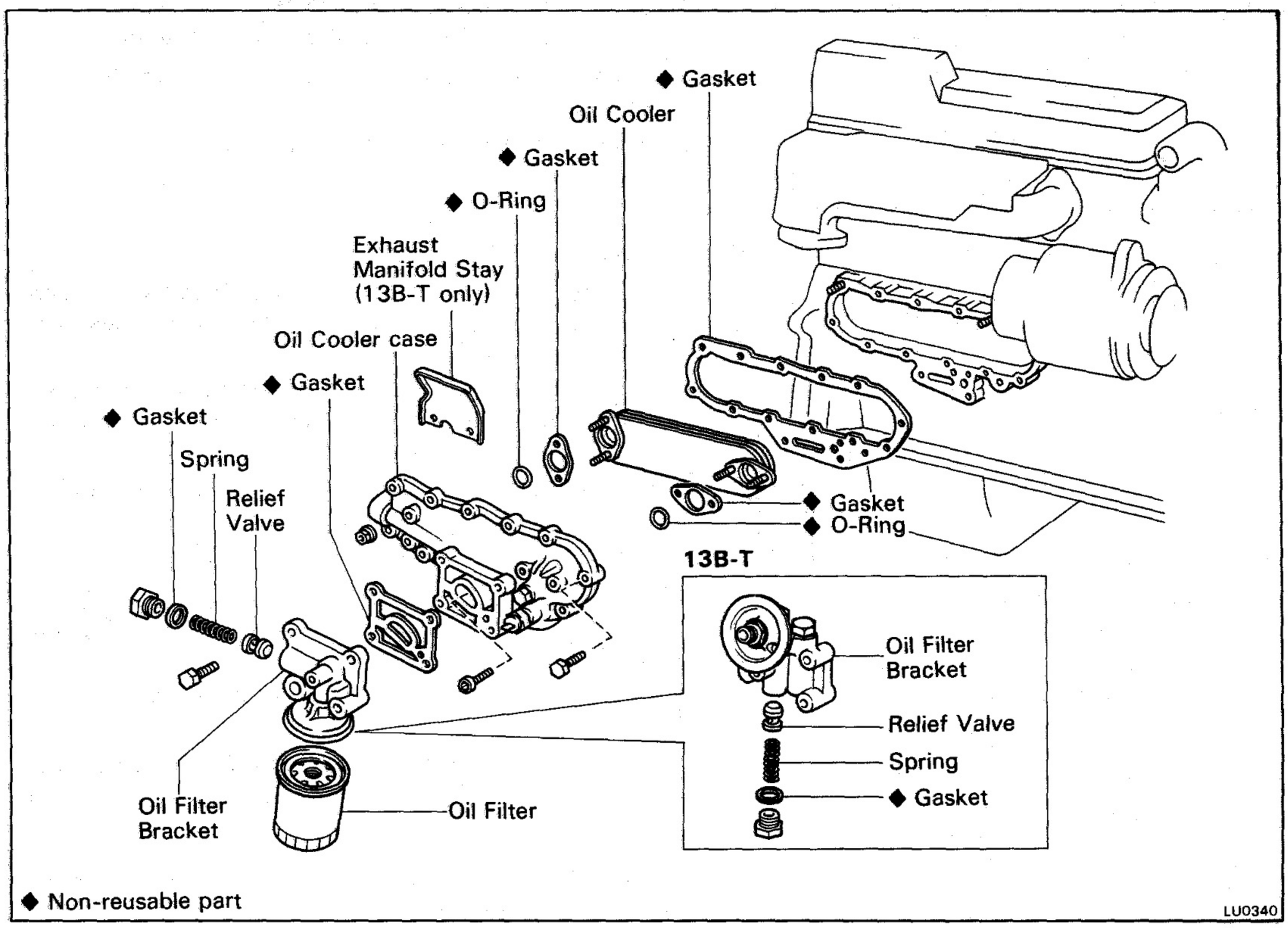
Torque: 125 kg-cm (9 ft-lb, 12 N·m)

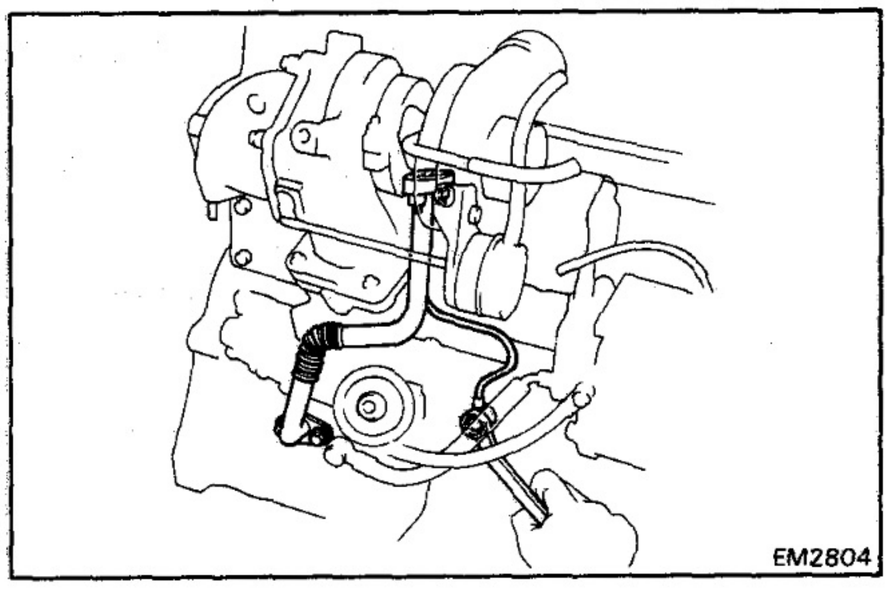
12. [13B-T]
INSTALL INTAKE AIR CONNECTOR PIPE

13. FILL WITH ENGINE OIL (See page LU-4)

OIL COOLER AND RELIEF VALVE

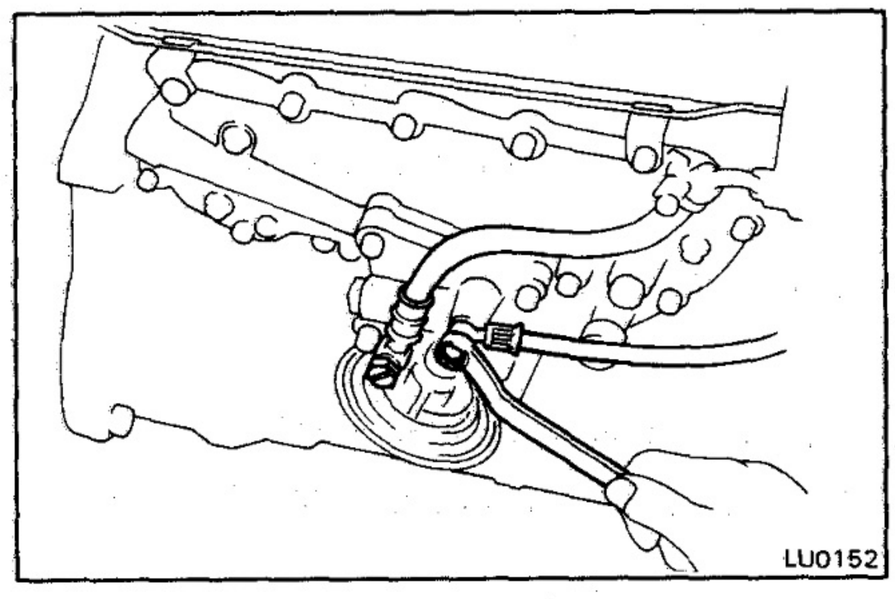
COMPONENTS



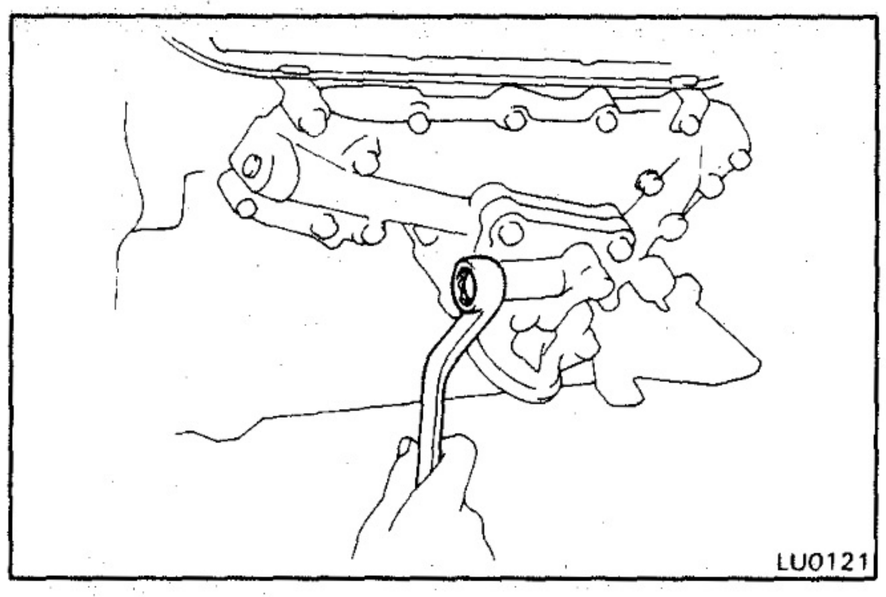


REMOVAL OF OIL COOLER AND RELIEF VALVE

1. **REMOVE OIL FILTER (See page LU-3)**
2. **[13B-T]**
   REMOVE TURBOCHARGER OIL PIPE
   (a) Remove the union bolt and two gaskets from the oil clooler case.
   (b) Remove the two bolts, two nuts, turbocharger oil pipe and gasket.

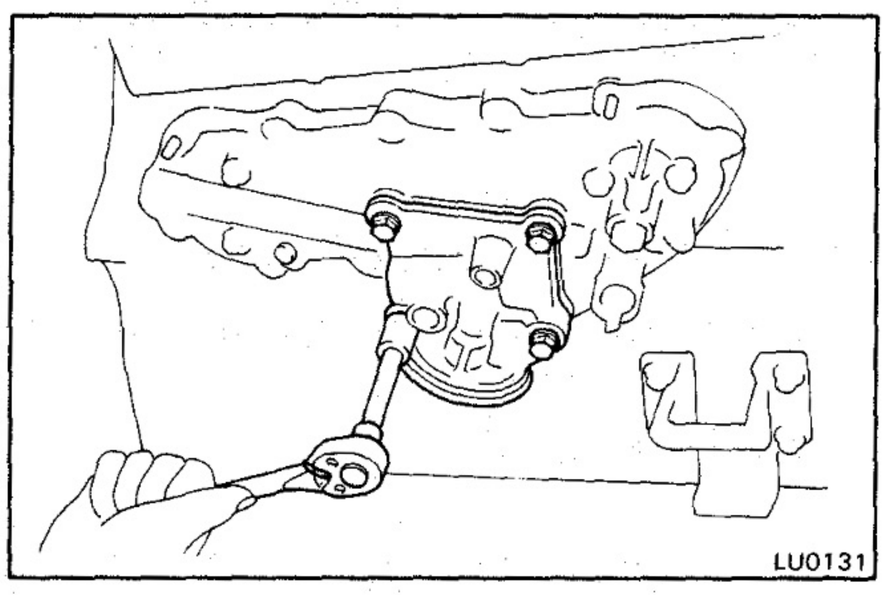


3. **DISCONNECT ALTERNATER OIL PIPES**
   Remove the two union bolts and four gaskets from the oil filter bracket.



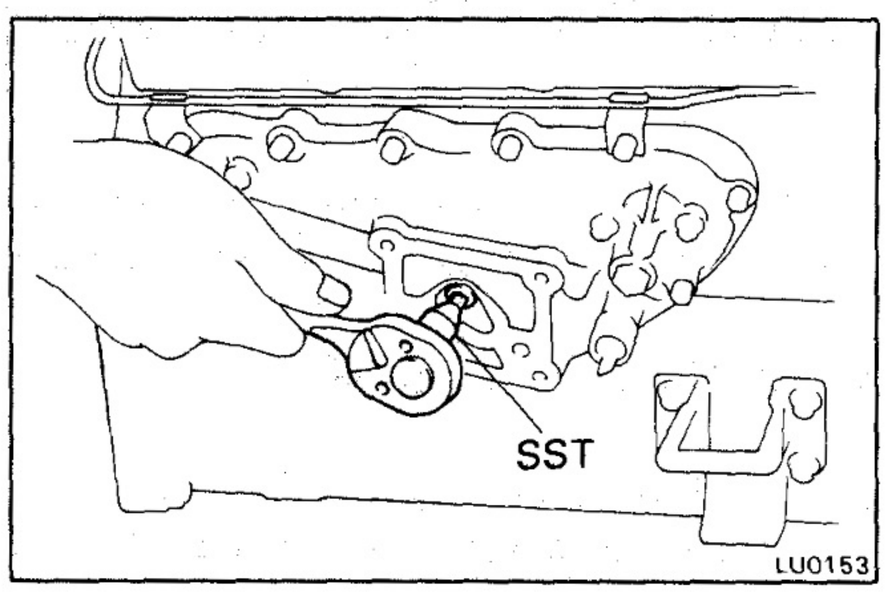
4. REMOVE RELIEF VALVE

Remove the plug, gasket, spring and relief valve.



5. REMOVE OIL FILTER BRACKET

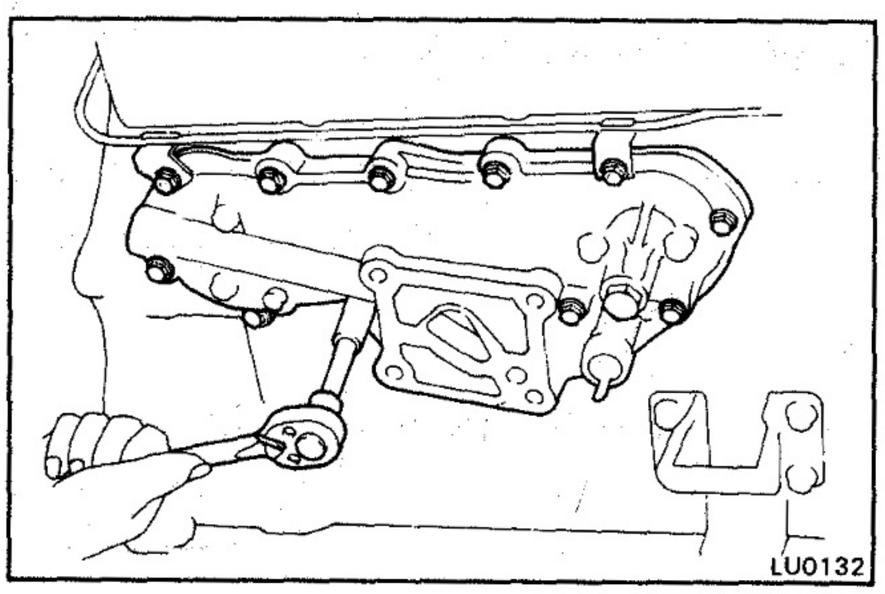
Remove the four bolts, bracket and gasket.



6. REMOVE OIL COOLER CASE WITH OIL COOLER

(a) Using SST, remove the bolt holding the oil cooler case and cylinder block as shown.

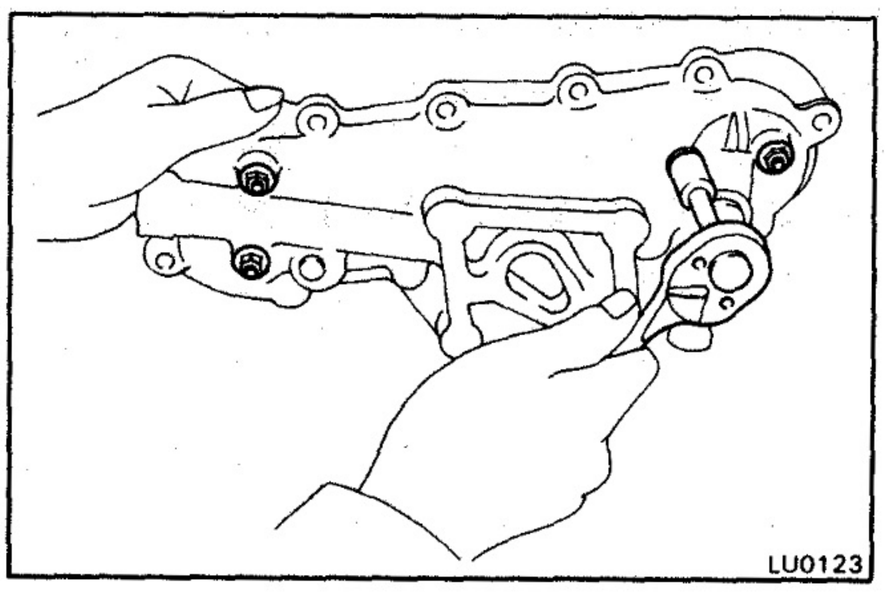
SST 09313-30021



(b) [11B, 13B]
Remove the nine bolts, two nuts, oil cooler case with the oil cooler and gasket.

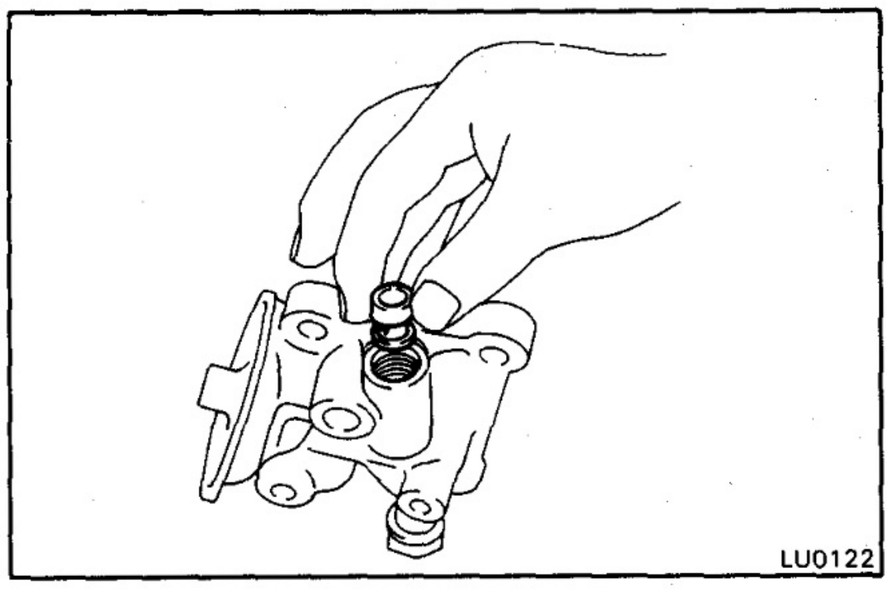
(c) [13B-T]
Remove the two bolts, nuts and manifold stay.

(d) [13B-T]
Remove the seven bolts, two nuts, oil cooler case with the oil cooler and gasket.



7. REMOVE OIL COOLER FROM OIL COOLER CASE

Remove the four nuts, oil cooler, two O-rings and two gaskets.

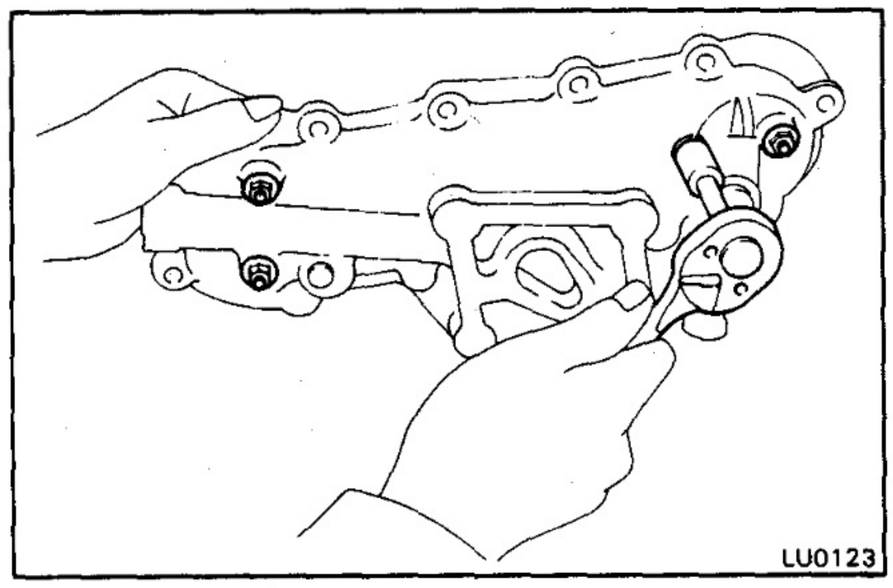


INSPECTION OF COMPONENTS

INSPECT RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If necessary, replace the valve and/or oil filter bracket.



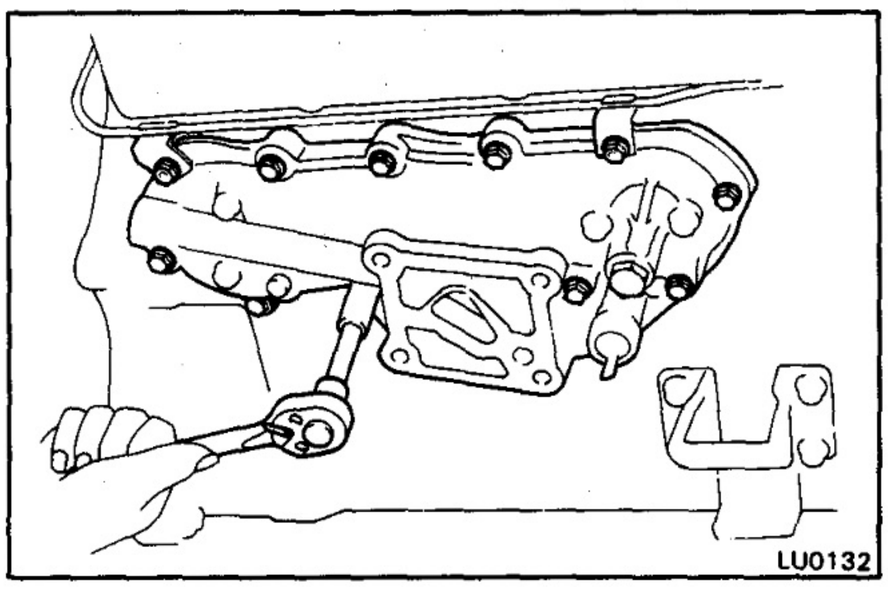
INSTALLATION OF OIL COOLER AND RELIEF VALVE

(See page LU-14)

1. INSTALL OIL COOLER TO OIL COOLER CASE

Install two new gaskets, two new O-rings and the oil cooler with the four nuts. Torque the nuts.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)



2. INSTALL OIL COOLER CASE AND OIL COOLER ASSEMBLY

(a) [11B, 13B]
Install a new gasket, the oil cooler case and oil cooler assembly with the nine bolts and two nuts. Torque the bolts and nuts.

Torque: 185 kg-cm (13 ft-lb, 18 N·m)

(b) [13B-T]
Install a new gasket, the oil cooler case and oil cooler assembly with the seven bolts and two nuts. Torque the bolts and nuts.

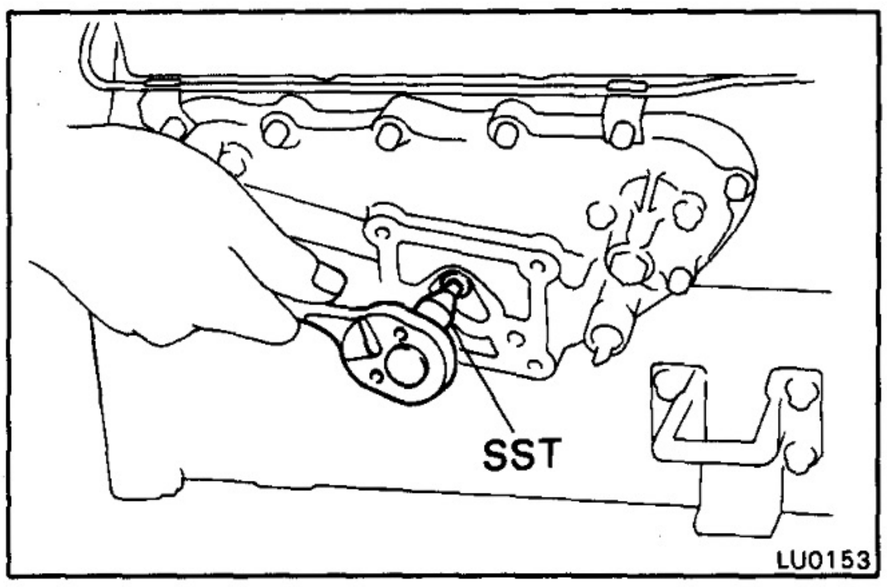
Torque: 185 kg-cm (13ft-lb, 18 N·m)

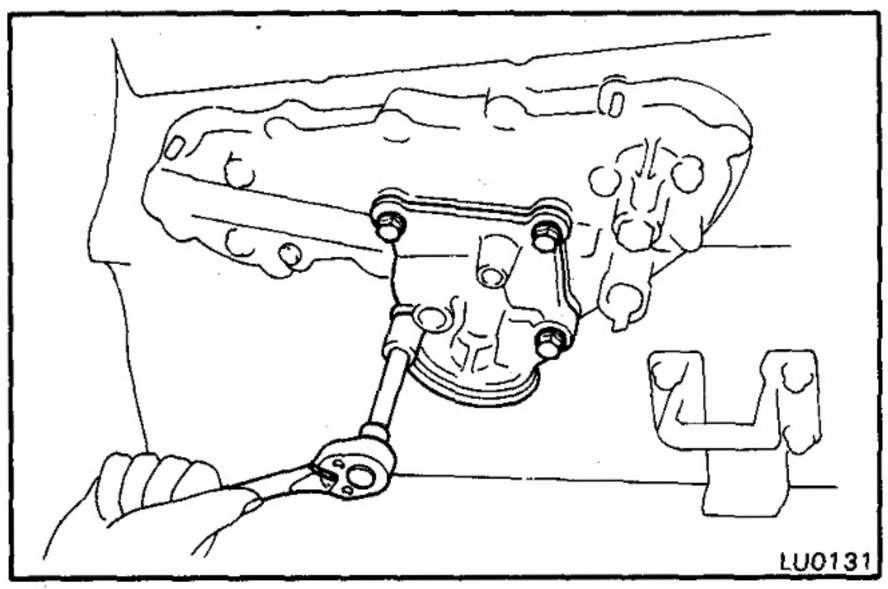
(c) [13B-T]
Install the manifold stay with the two bolts and nuts.

(d) 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)

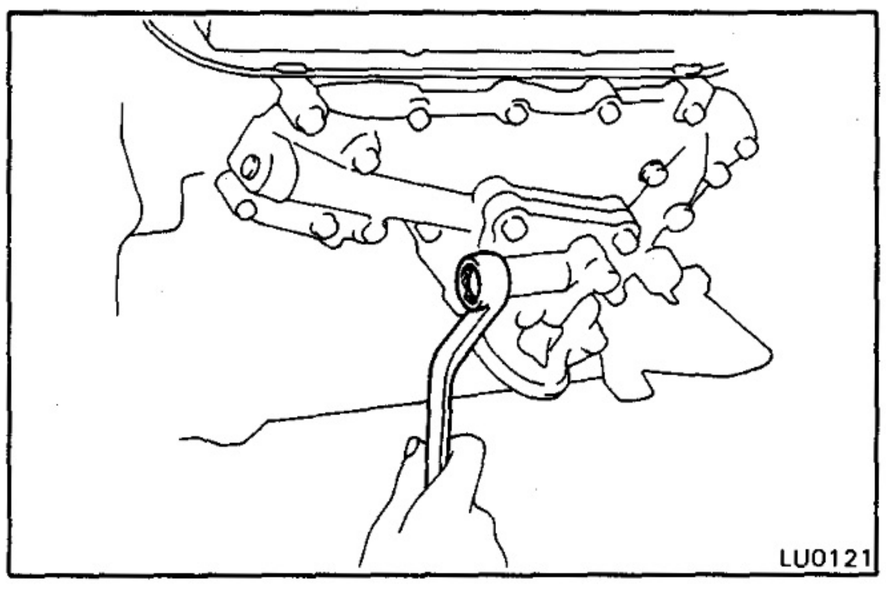




3. INSTALL OIL FILTER BRACKET

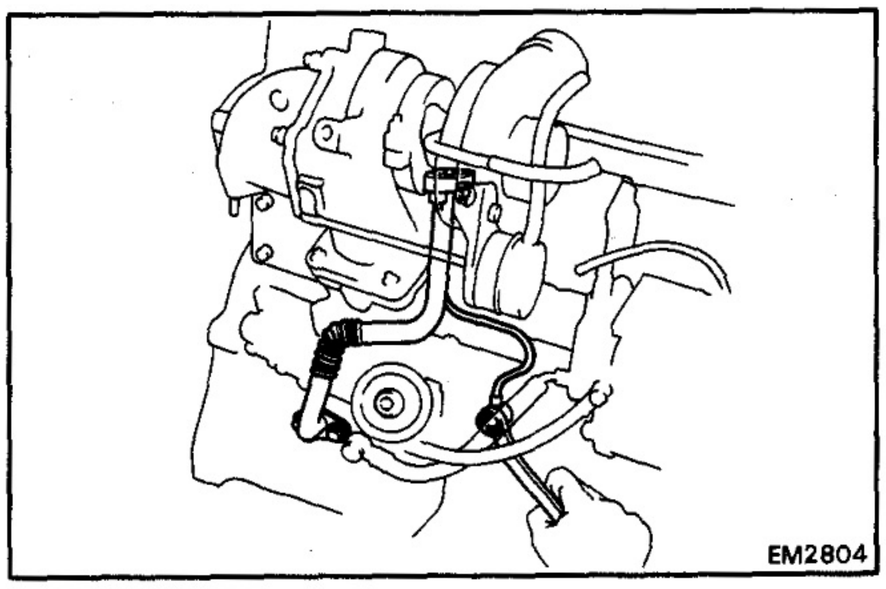
Install a new gasket, oil filter bracket with the four bolts. Torque the bolts.

Torque: 375 kg-cm (27 ft-lb, 37 N·m)



4. INSTALL RELIEF VALVE

Install the relief valve, spring, new gasket and plug.

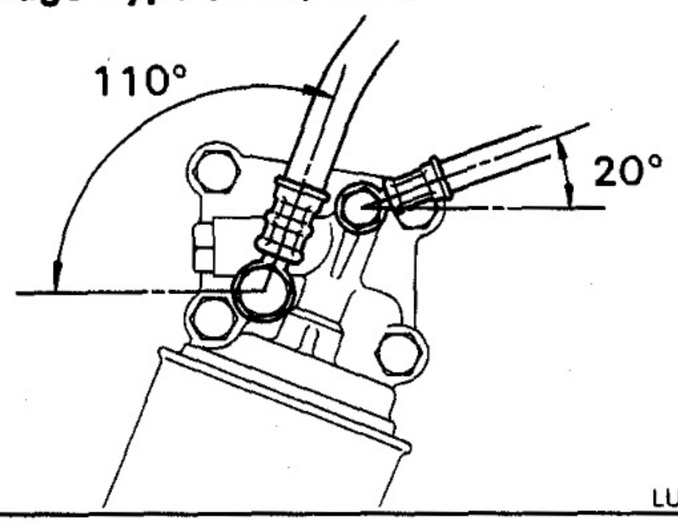


5. [13B-T]
INSTALL TURBOCHARGER OIL PIPE

Install the turbocharger oil pipe with the two bolts, two nuts, union bolt and gaskets.

6. INSTALL OIL FILTER (See page LU–3)

Cartridge Type (11B, 13B)

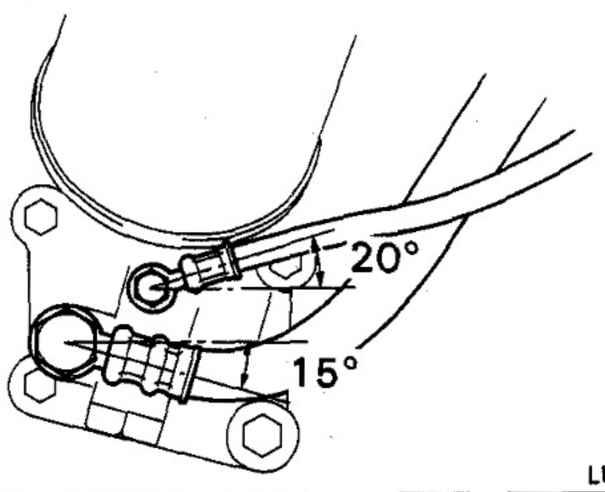


7. CONNECT ALTERNATOR OIL PIPES

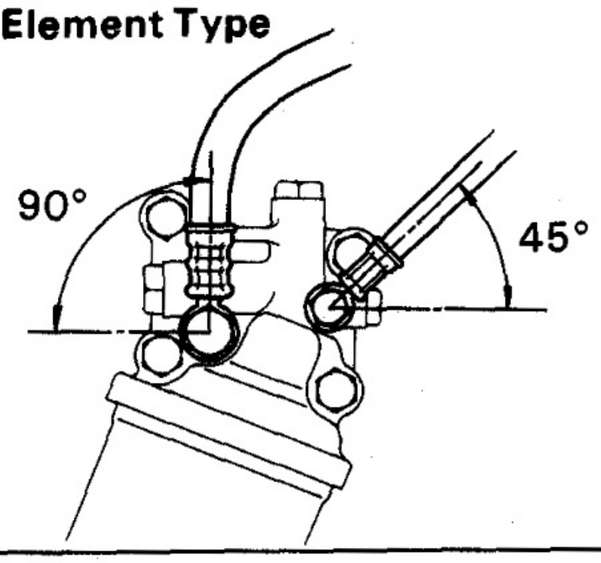
Connect the alternator oil pipes with four new gaskets and two union bolts as shown.

8. FILL WITH ENGINE OIL (See page LU-4)

Cartride Type (13B-T)



Paper Element Type

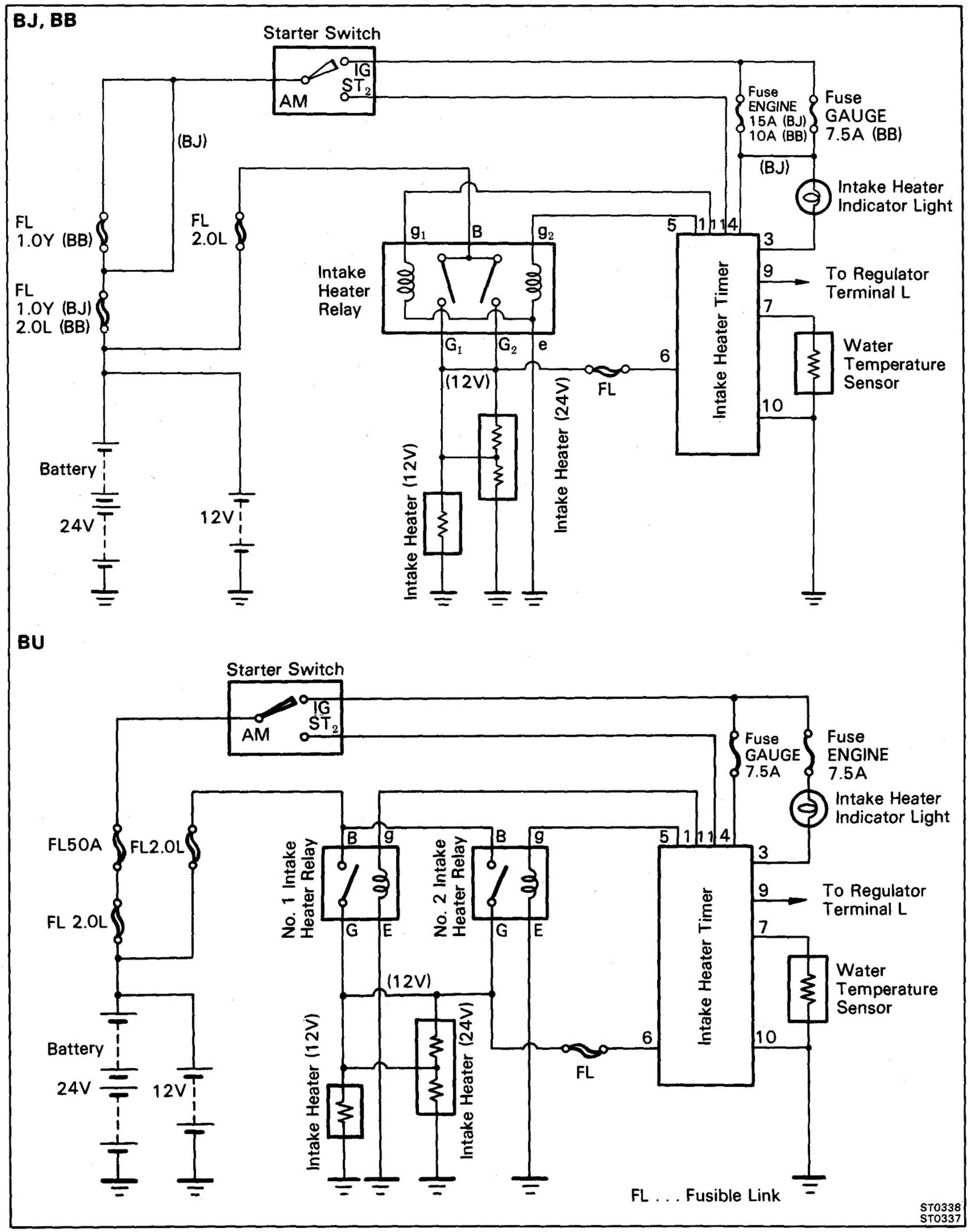


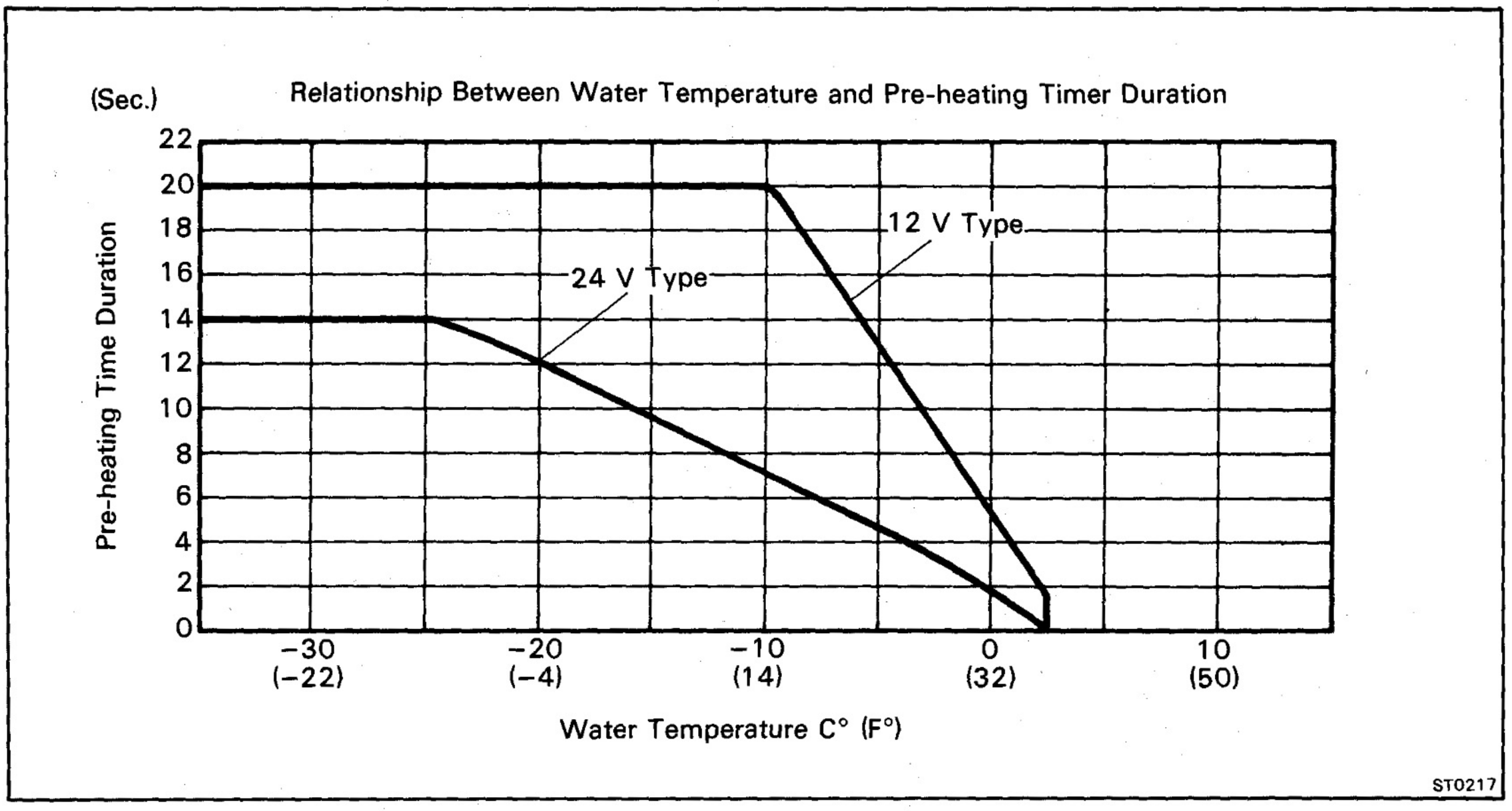
STARTING SYSTEM

	Page
PRE-HEATING SYSTEM	ST-2
TROUBLESHOOTING	ST-8
STARTING SYSTEM CIRCUIT	ST-8
STARTER	ST-9
STARTER RELAY	ST-17

PRE-HEATING SYSTEM

SYSTEM CIRCUIT



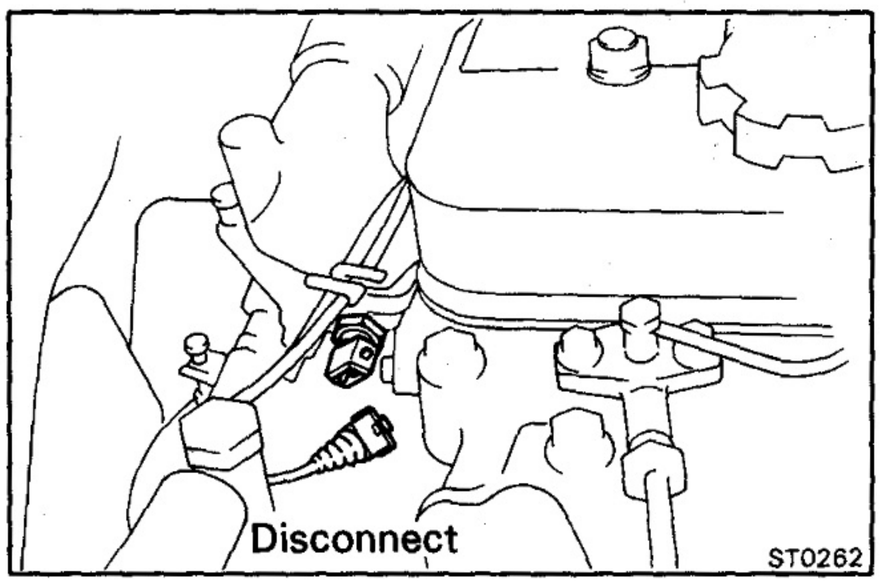


INSPECTION OF COMPONENTS

Intake Heater Timer

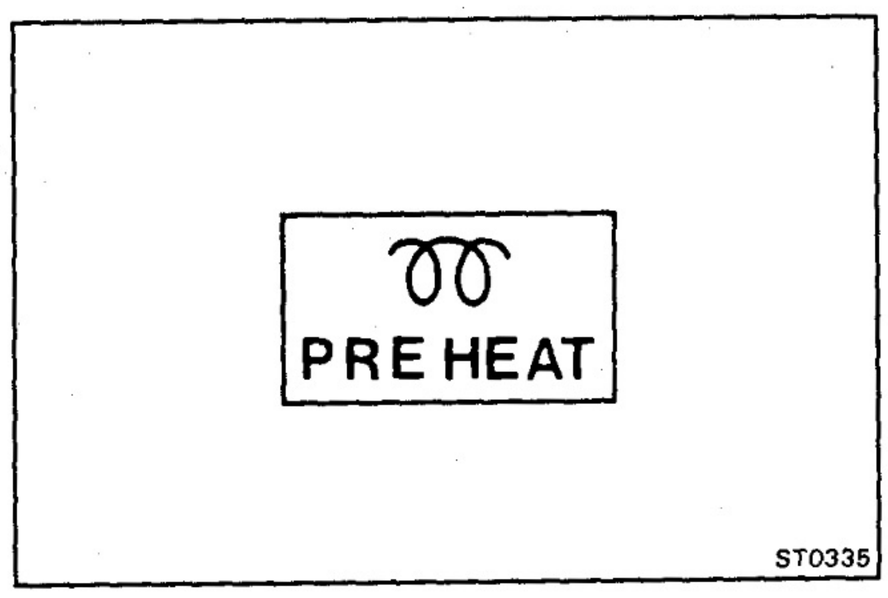
LOCATION

BJ: Top of the glove box.
BU: Under the instrument panel on the driver's side.
BB: Under the instrument panel center.



INSPECT INTAKE HEATER TIMER

(a) Disconnect the water temperature sensor connector.

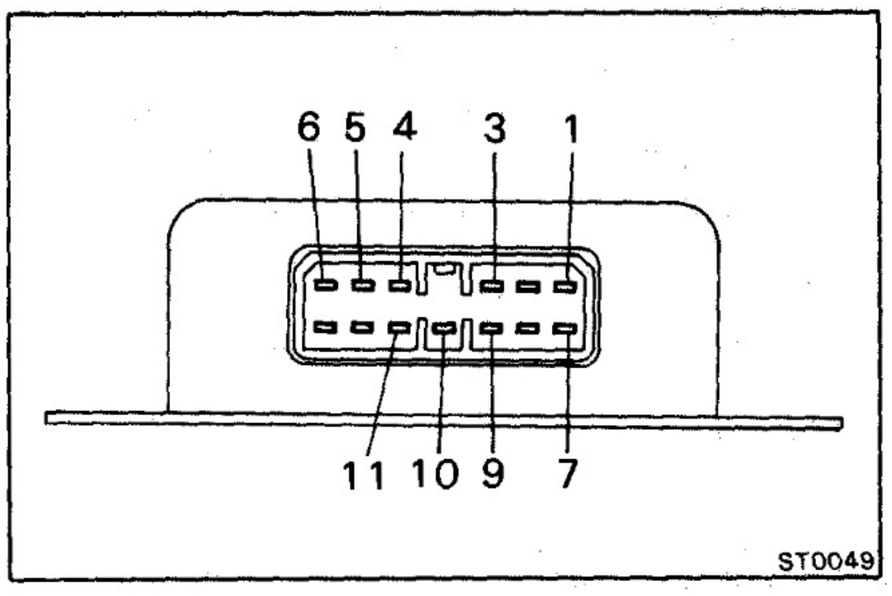


(b) Turn the starter switch to "ON," and measure the time the pre-heating indicator is lit.

Light lighting time:

12 V type Approx. 20 seconds
24 V type Approx. 14 seconds

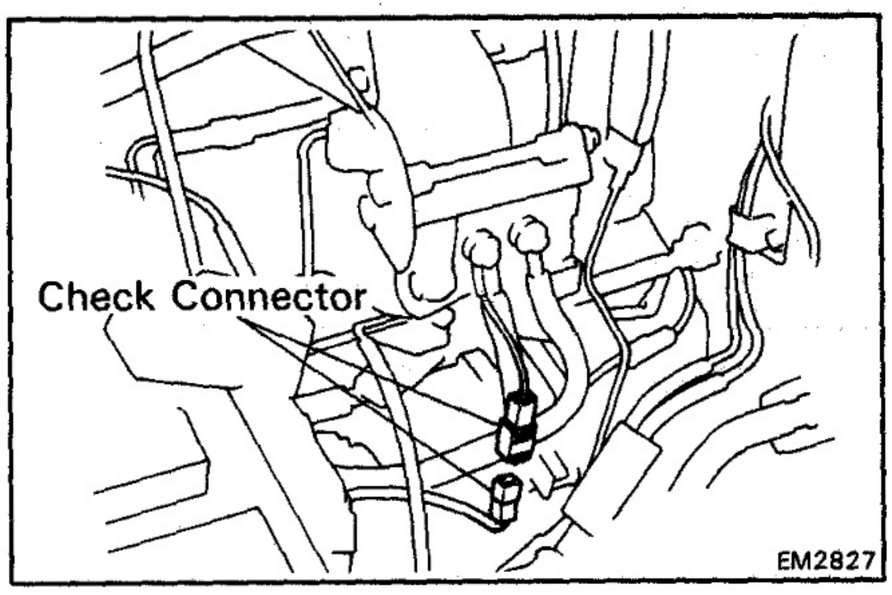
CAUTION: Since power consumption is high, perform this check as few times as possible.



(c) Turn the starter switch to "START," and then check that there is voltage at terminal 5 of the intake heater timer.

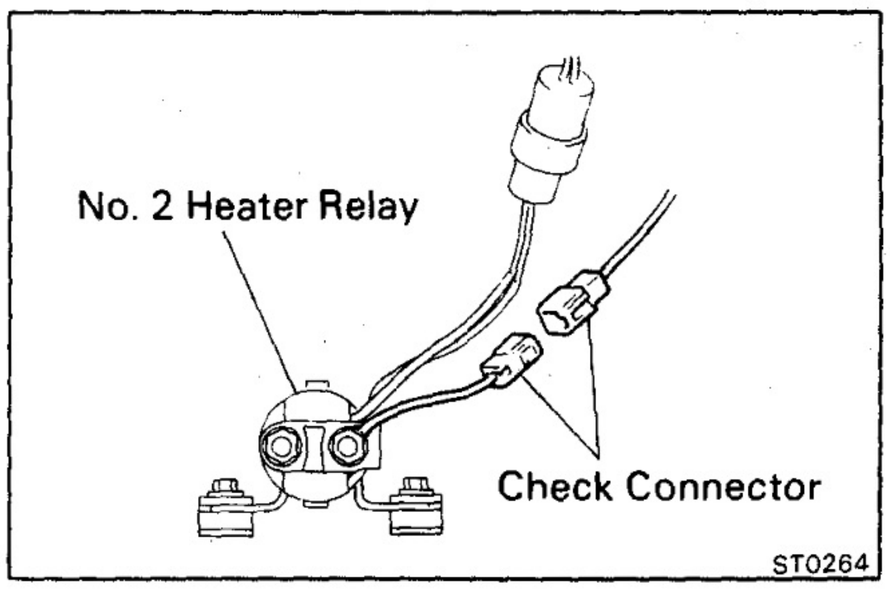
After-heating time: Approx. 70 seconds

CAUTION: Since power consumption is high, perform this check as few times as possible.

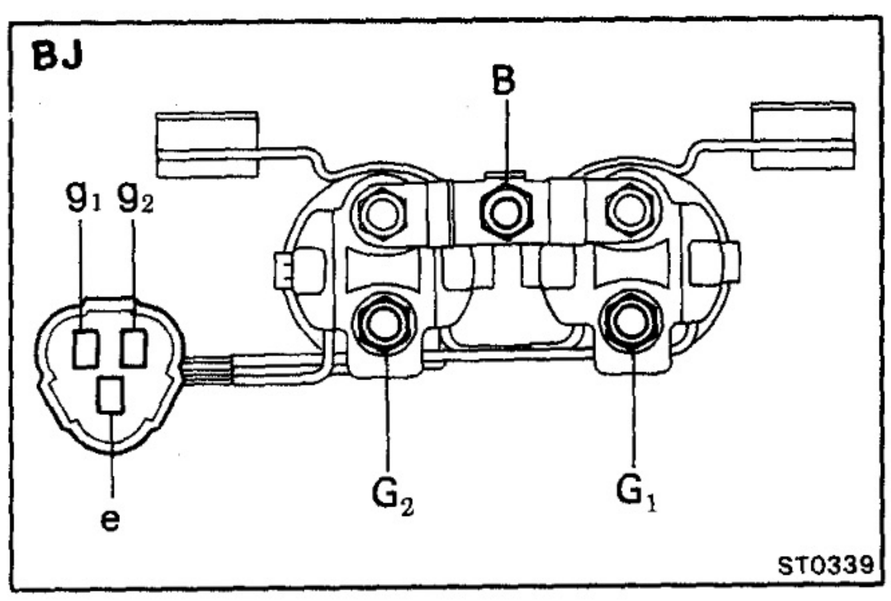


(d) Turn the starter switch to "START."

(e) [BJ, BB]
Disconnect the MALFUNCTION CHECK connector of the intake heater, and check that the "PREHEAT" light comes on when the after-heating is finished.



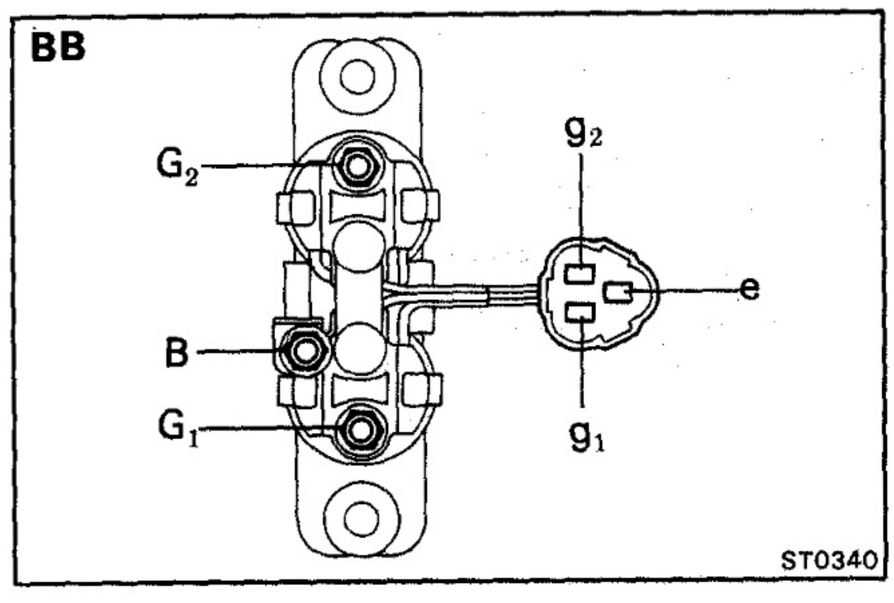
[BU]
Disconnect the MALFUNCTION CHECK connector of the No. 2 heater relay, and check that the "PREHEAT" light comes on when the after-heating is finished.



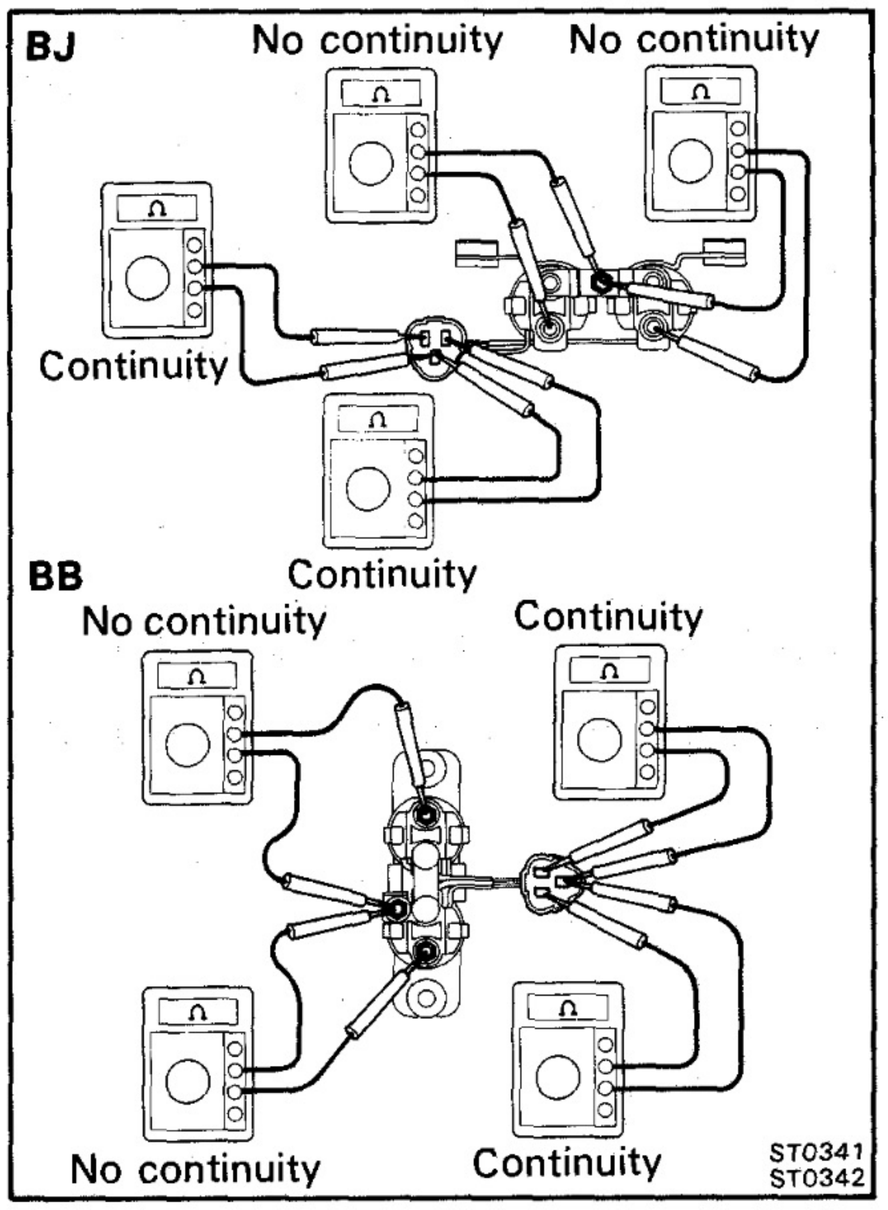
Intake Heater Relay (BJ, BB)

LOCATION

BJ: In front of the battery.



BB: Below the left fender apron.



1. INSPECT RELAY CONTINUITY

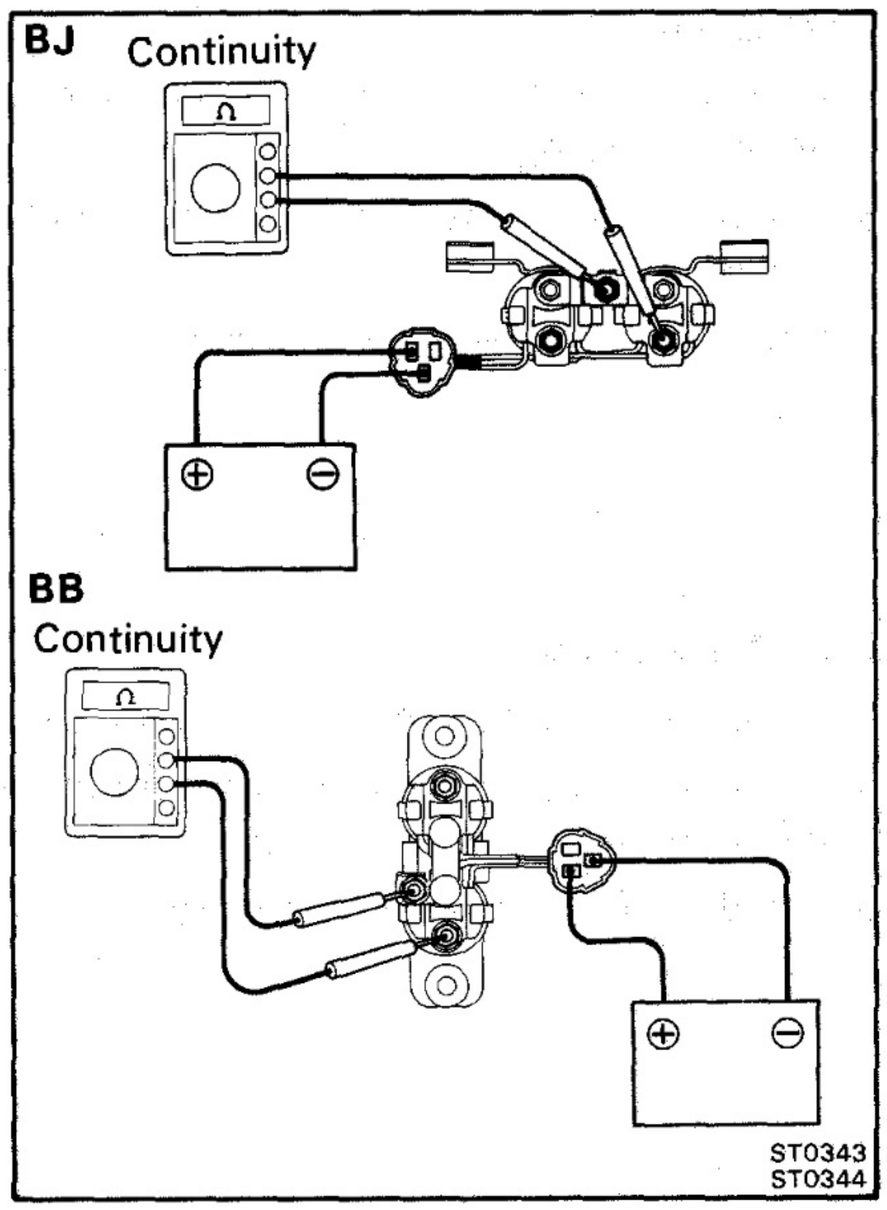
(a) Using an ohmmeter, check that there is continuity between terminals e and g_1.

(b) Check that there is continuity between terminals e and g_2.

(c) Check that there is no continuity between terminals B and G_1.

(d) Check that there is no continuity between terminals B and G_2.

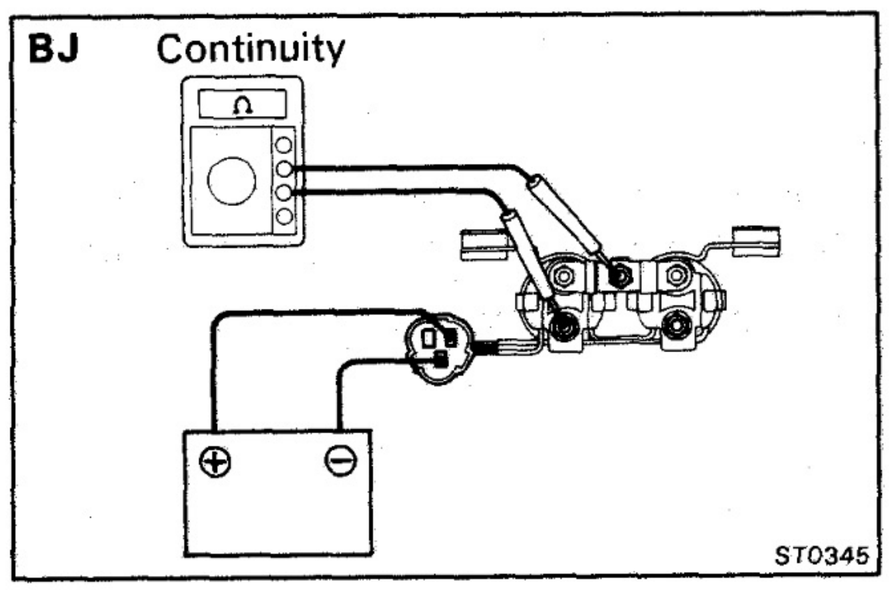
If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage across terminals e and g_1.

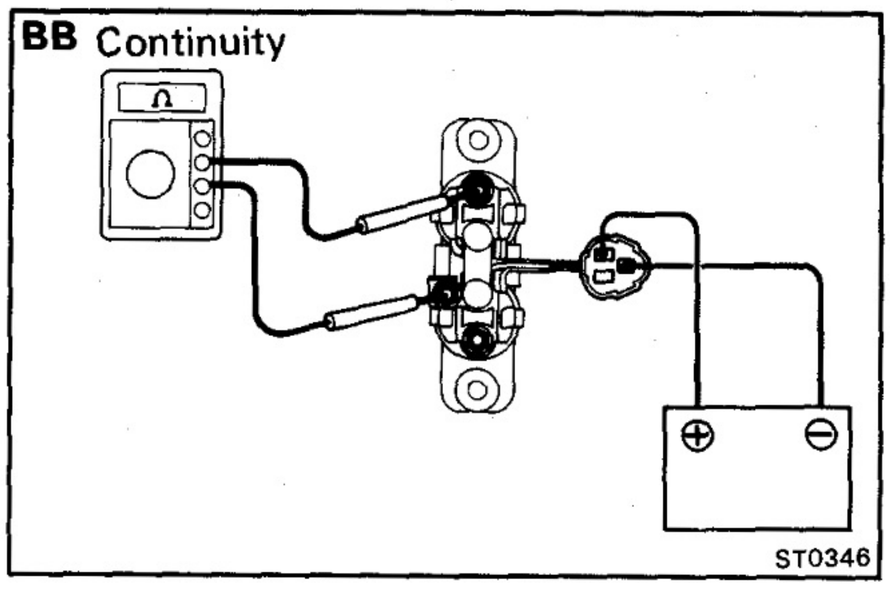
(b) Using an ohmmeter, check that there is continuity between terminals B and G_1.

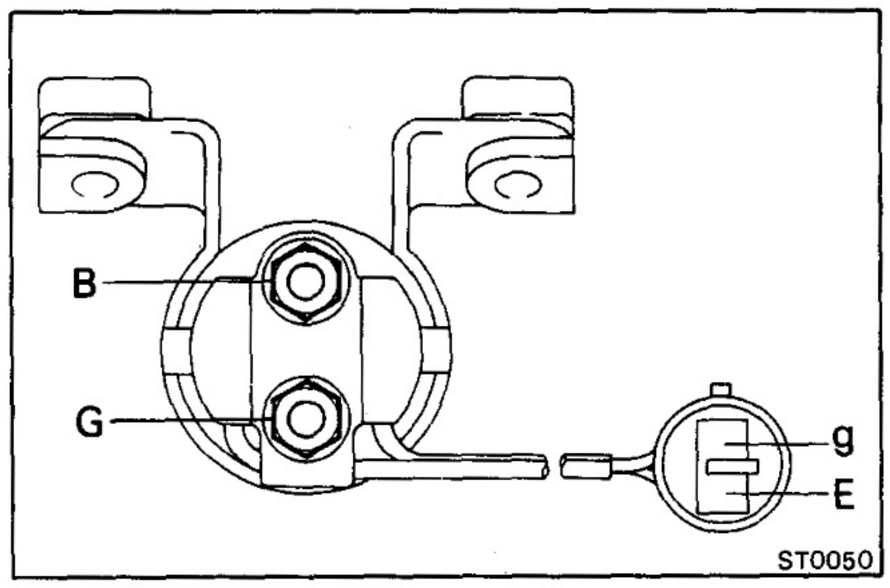


(c) Apply battery voltage across terminals e and g_2.

(d) Using an ohmmeter, check that there is continuity between terminals B and G_2.

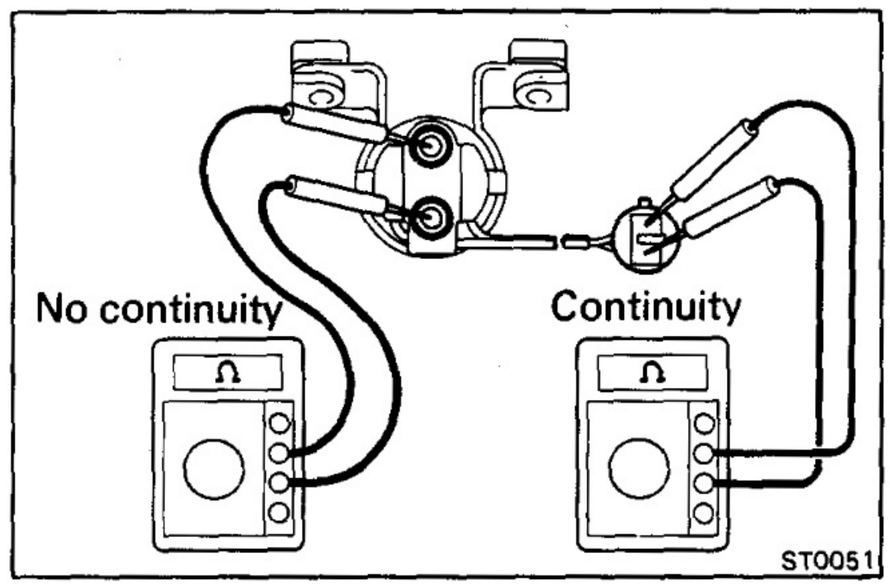
If operation is not as described, replace the relay.





No. 1 and No. 2 Intake Heater Relays (BU)

LOCATION: Mounted on the frame at the rear of the engine.

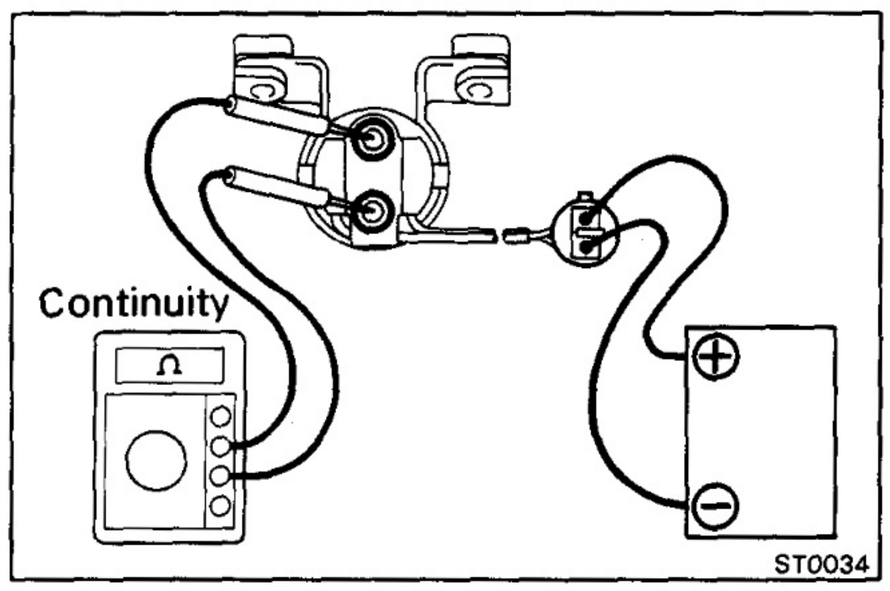


1. INSPECT RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals E and g.

(b) Using an ohmmeter, check that there is no continuity between terminals B and G.

If continuity is not as specified, replace the relay.

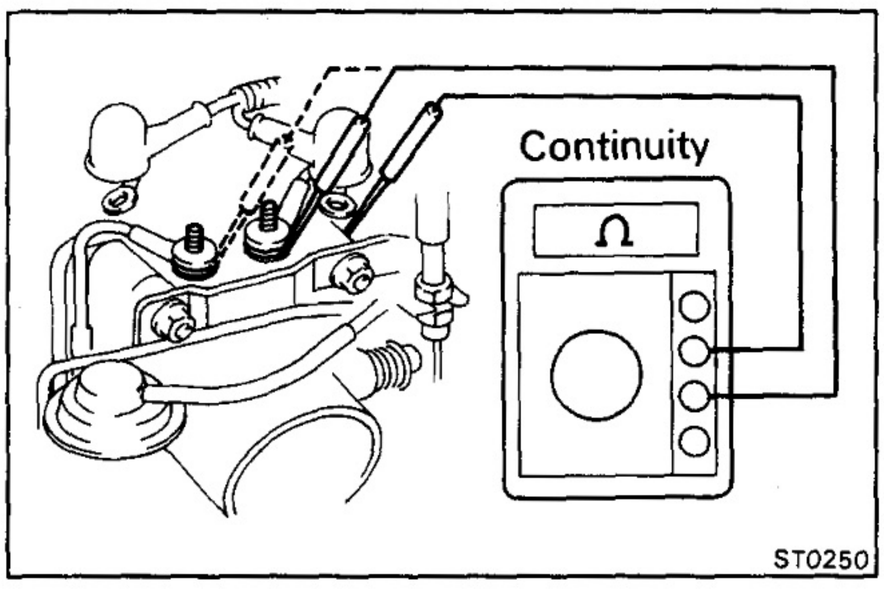


2. INSPECT RELAY OPERATION

(a) Apply battery voltage between terminals E and g.

(b) Using an ohmmeter, check that there is continuity between terminals B and G.

If operation is not as described, replace the relay.

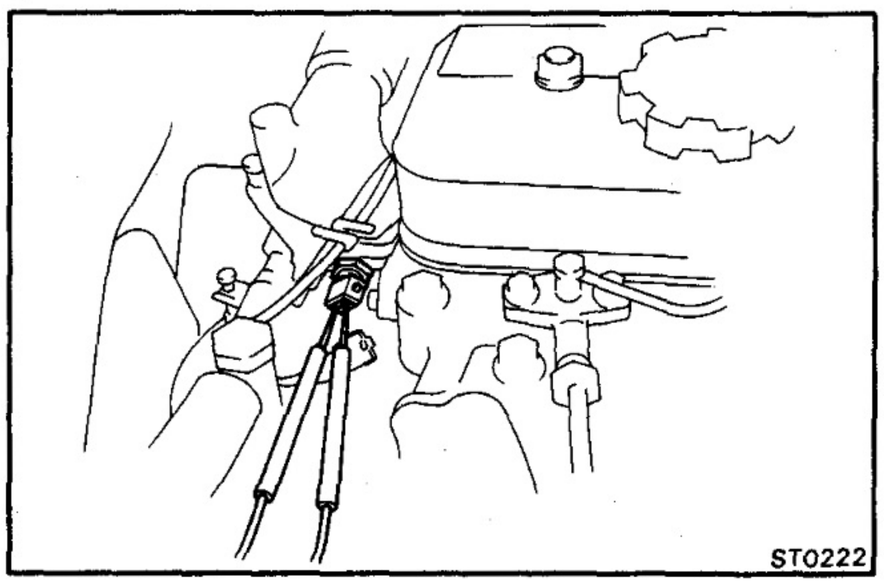


Intake Heater

INSPECT INTAKE HEATER

Using an ohmmeter, check that there is continuity between each terminal of the intake heater and ground.

If there is no continuity, replace the intake heater.

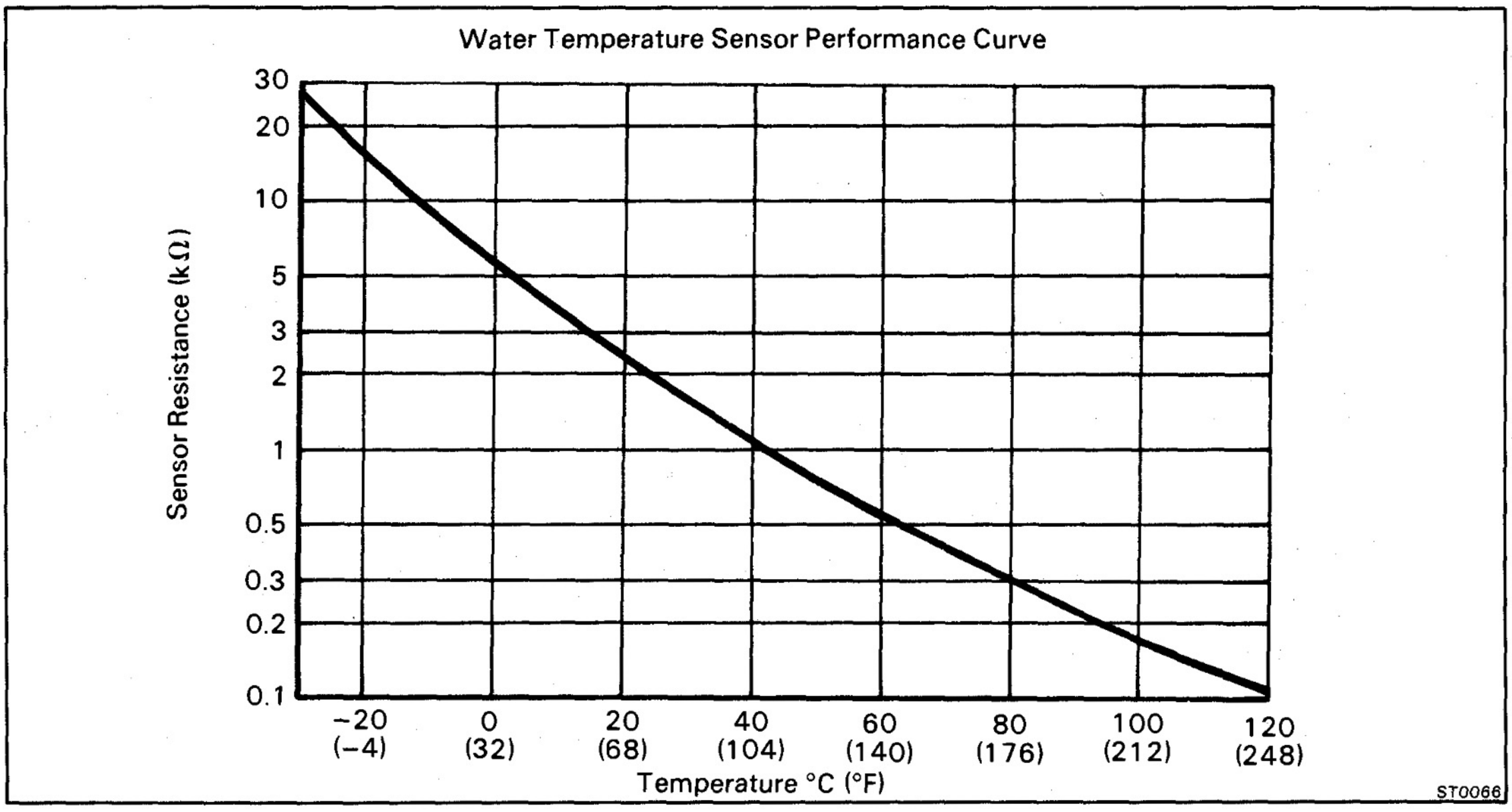


Water Temperature Sensor

INSPECT WATER TEMPERATURE SENSOR

Using an ohmmeter, check the resistance between the water temperature sensor terminals.

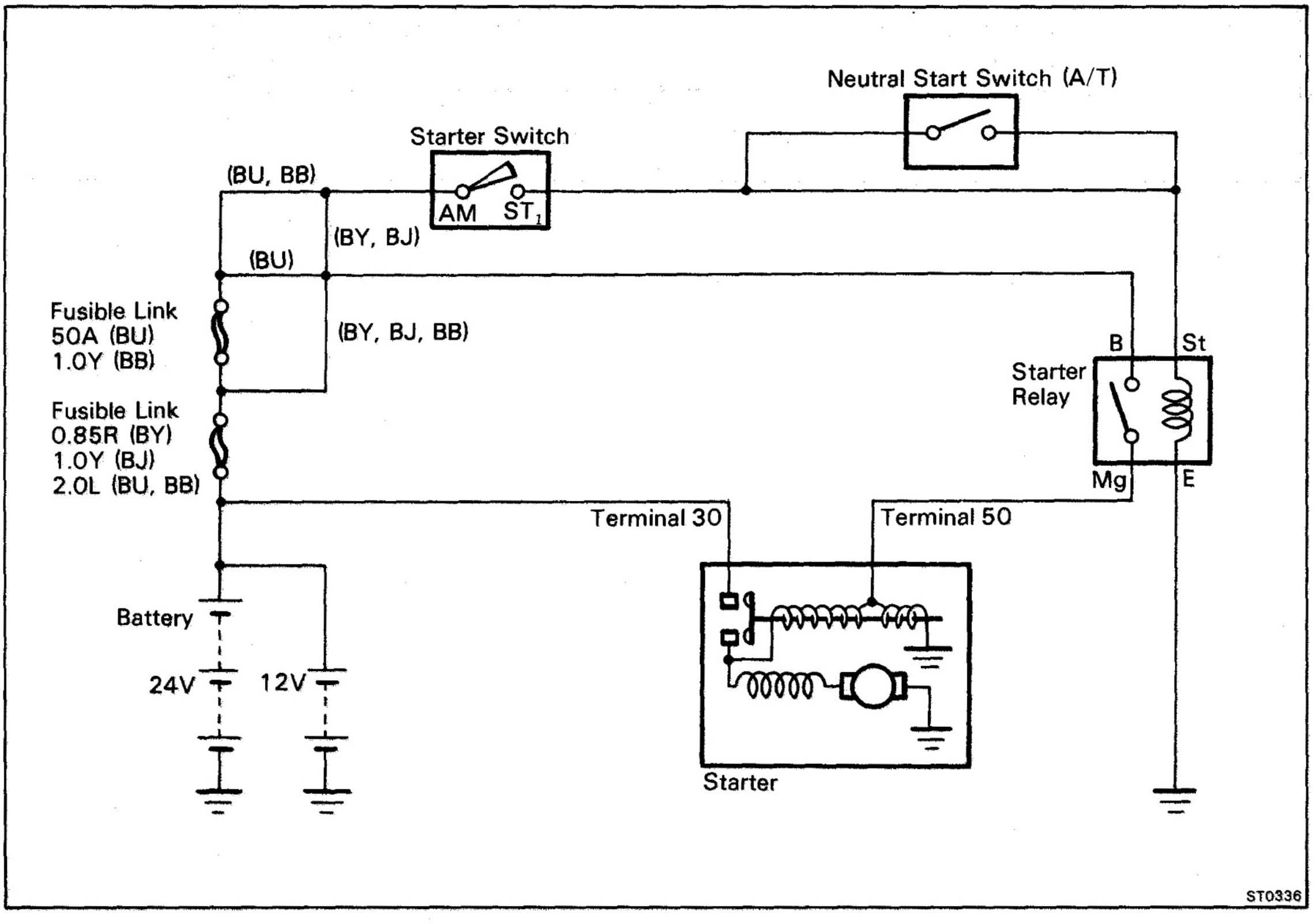
If the resistance is not as specified, replace the water temperature sensor.



TROUBLESHOOTING

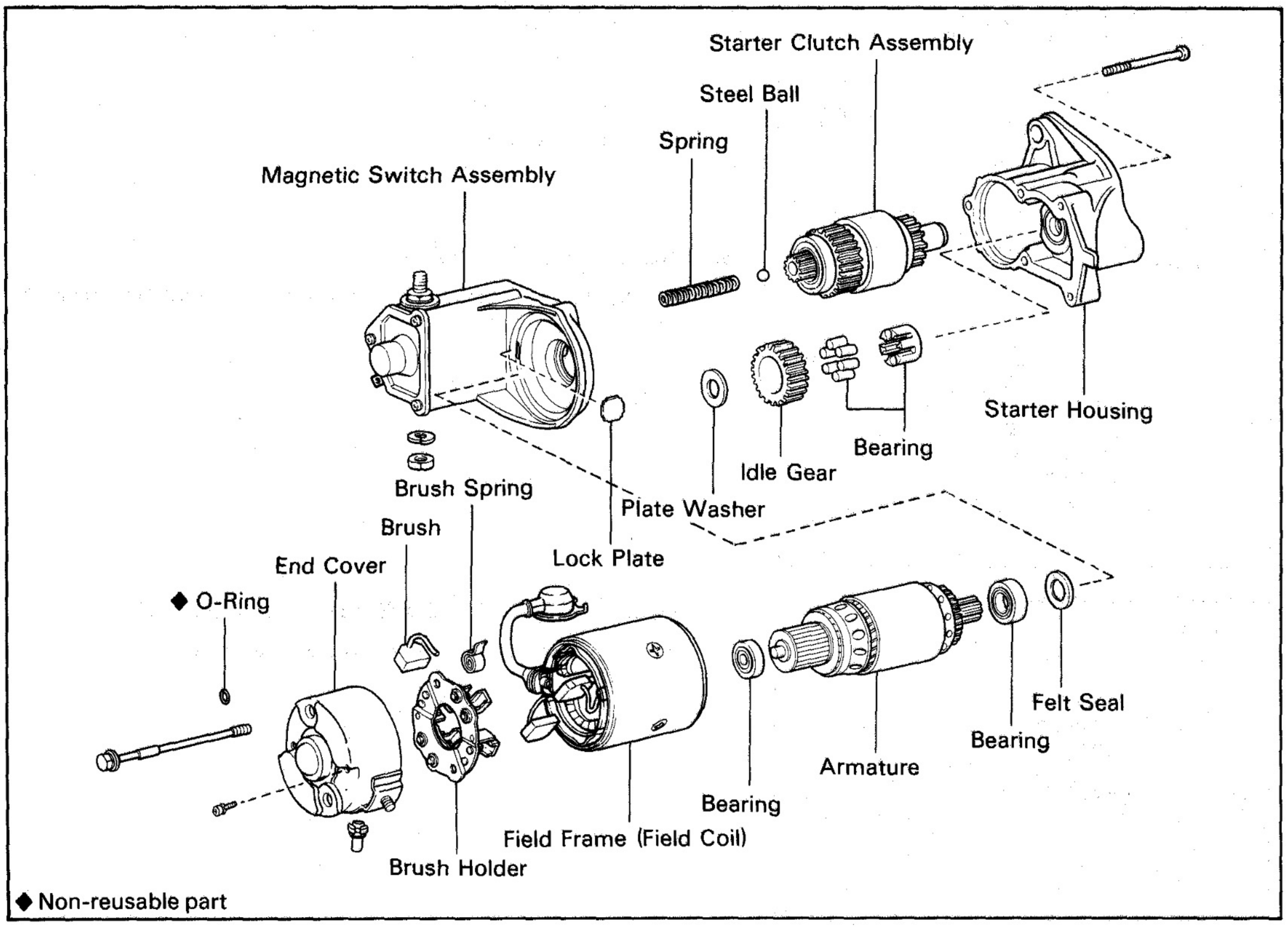
Problem	Possible cause	Remedy	Page
Engine will not crank	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4
	Battery cables loose, corroded or worn	Repair or replace cables	
	Fusible link blown	Replace fusible link	
	Starter relay faulty	Check starter relay	ST-17
	Starter faulty	Repair starter	ST-9
	Starter switch faulty	Replace starter switch	
Engine cranks slowly	Battery charge low	Check battery specific gravity Charge or replace battery	CH-4
	Battery cables loose, corroded or worn	Repair or replace cables	
	Starter faulty	Repair starter	ST-9
Starter keeps running	Starter faulty	Repair starter	ST-9
	Starter switch faulty	Replace starter switch	
	Short in wiring	Repair wiring	
Starter spins - engine will not crank	Pinion gear teeth broken or faulty starter	Repair starter	ST-9
	Flywheel teeth broken	Replace flywheel	

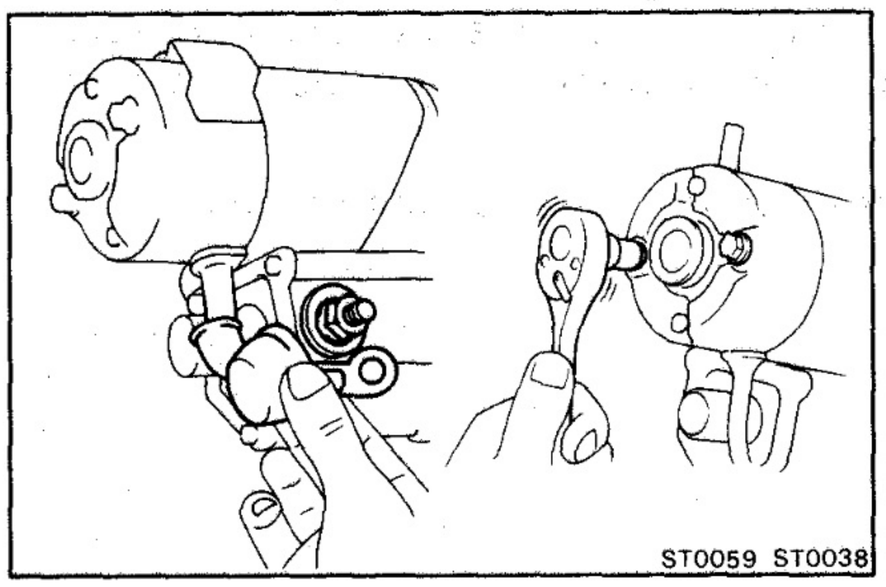
STARTING SYSTEM CIRCUIT



STARTER

COMPONENTS





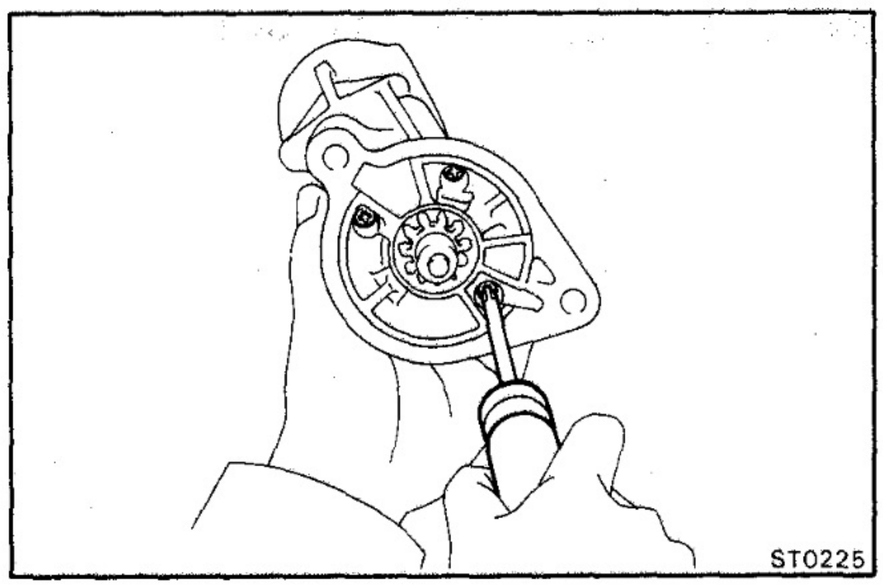
DISASSEMBLY OF STARTER

1. REMOVE FIELD FRAME WITH ARMATURE FROM MAGNETIC SWITCH

(a) Remove the nut and spring washer. Disconnect the lead wire from the magnetic switch terminal.

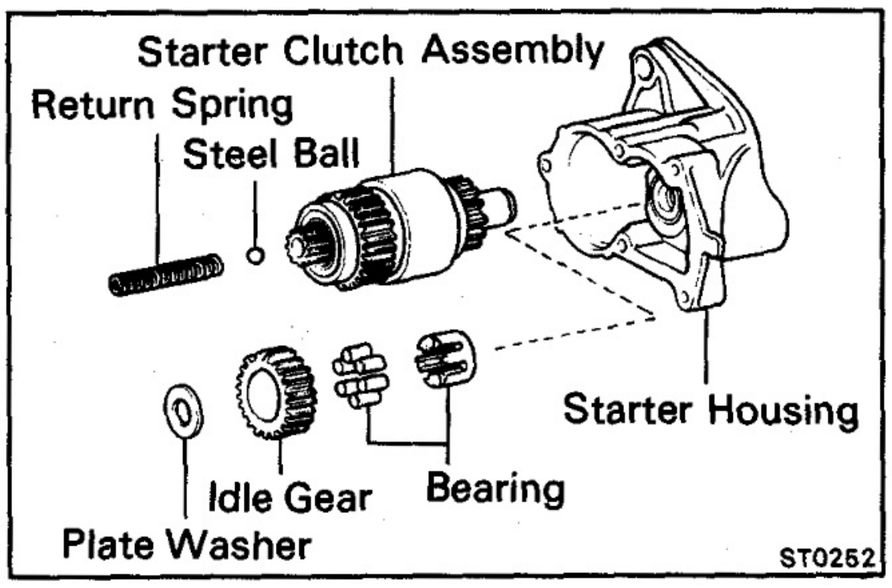
(b) Remove the two through bolts, plate washers and O-rings. Pull out the field frame with the armature.

(c) Remove the felt seal and lock plate.

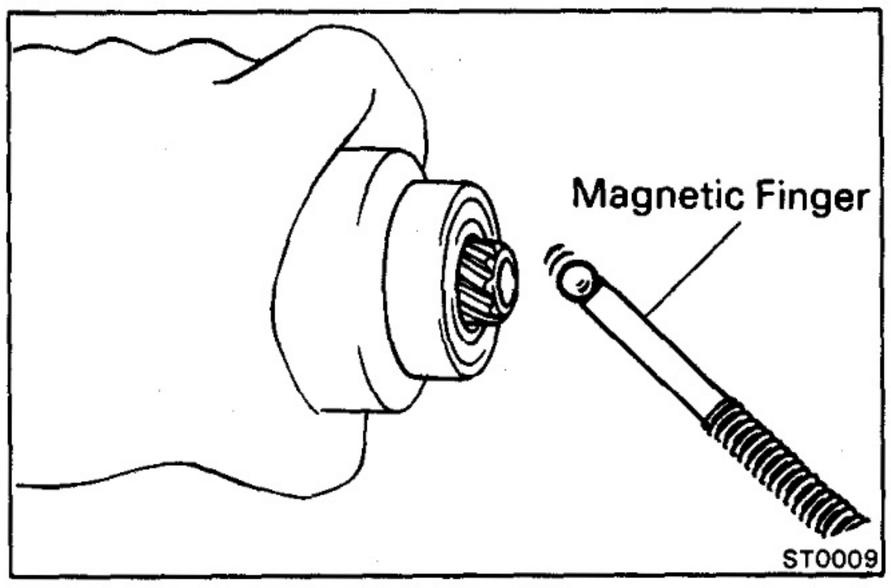


2. REMOVE STARTER HOUSING, STARTER CLUTCH ASSEMBLY AND IDLE GEAR FROM MAGNETIC SWITCH ASSEMBLY

(a) Remove the three screws.

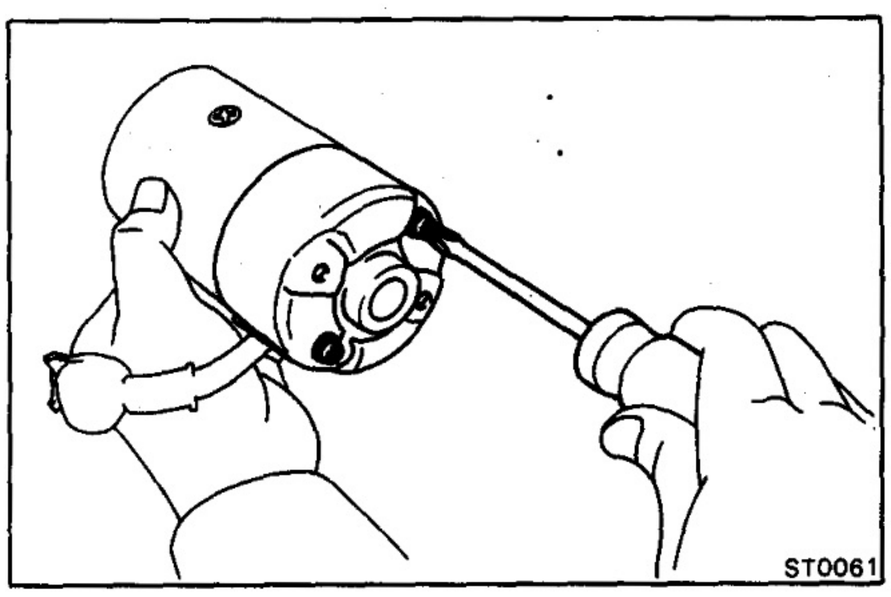


(b) Remove the following parts:
- (1) Starter housing
- (2) Starter clutch assembly
- (3) Return spring
- (4) Plate washer
- (5) Idle gear
- (6) Bearing



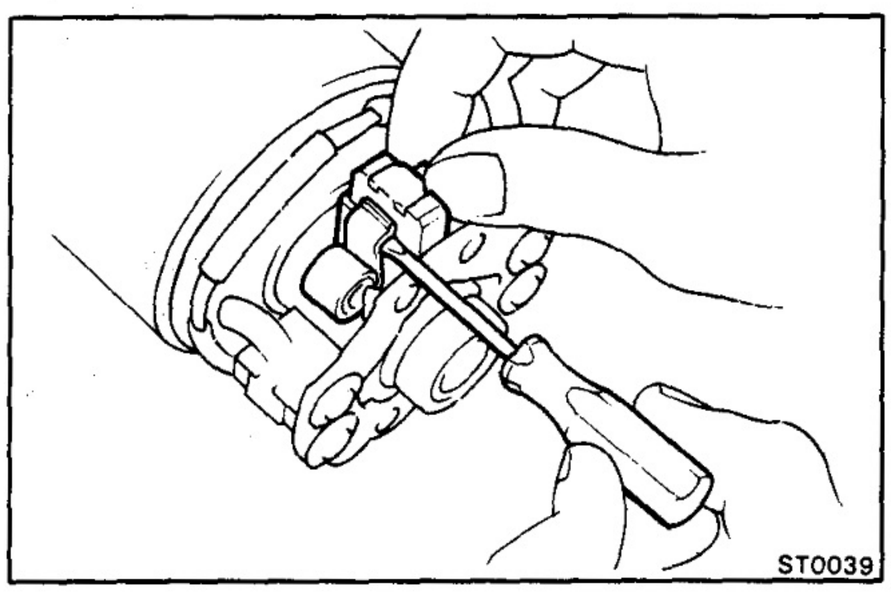
3. REMOVE STEEL BALL

Using a magnetic finger, remove the steel ball from the clutch shaft hole.



4. REMOVE BRUSHES AND BRUSH HOLDER

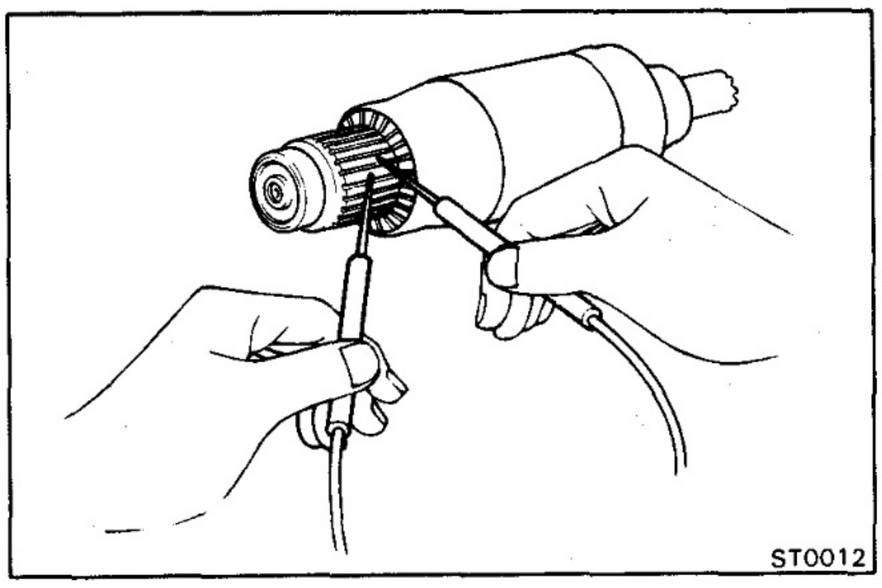
(a) Remove the two screws and end cover.



(b) Using a screwdriver, hold the brush spring back, and remove the brush from the brush holder. Remove the four brushes.

(c) Pull the brush holder off the field frame.

5. REMOVE ARMATURE FROM FIELD FRAME



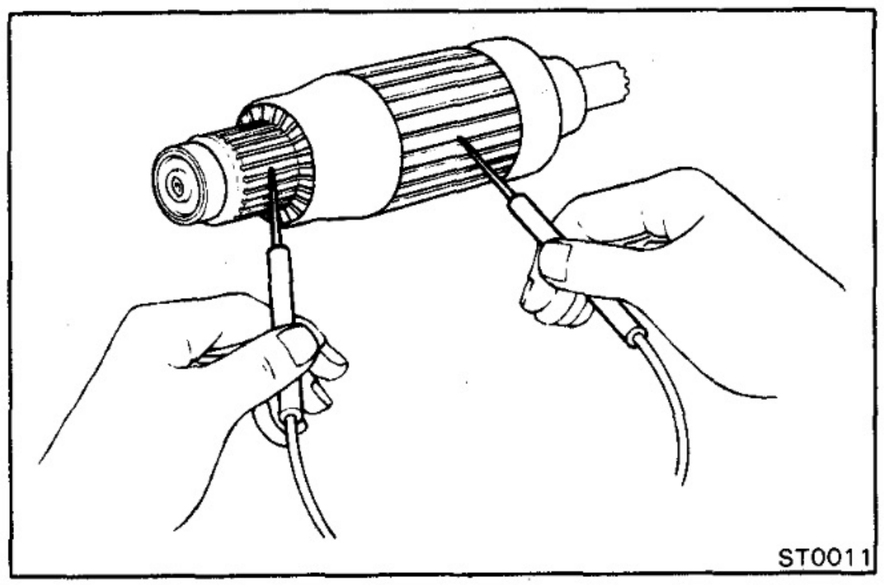
INSPECTION AND REPAIR OF STARTER

Armature Coil

1. INSPECT ARMATURE FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the segments of the commutator.

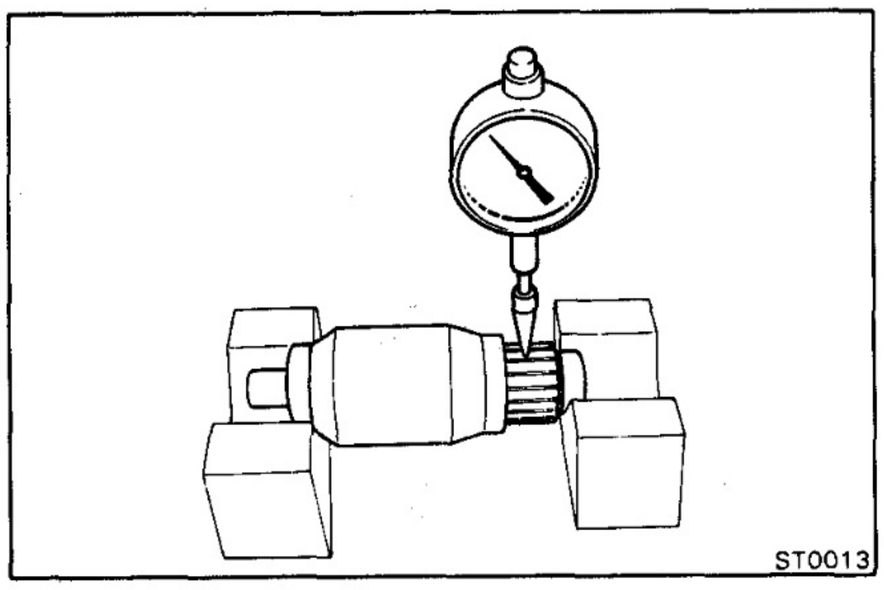
If there is no continuity between any segment, replace the armature.



2. INSPECT ARMATURE 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

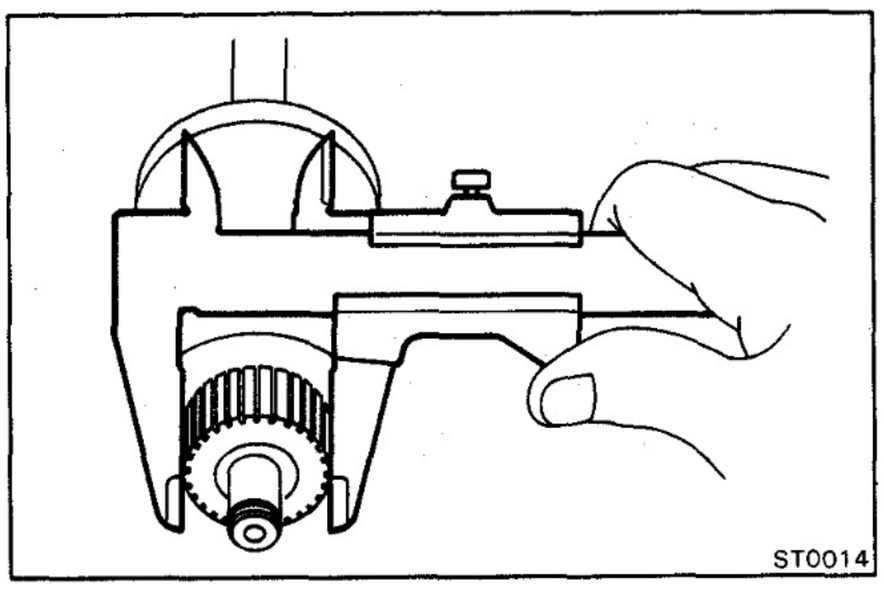
1. INSPECT COMMUTATOR FOR DIRTY AND BURNT SURFACES

If the surface is dirty or burnt, clean with sandpaper (No. 400) or on a lathe.

2. INSPECT COMMUTATOR CIRCLE RUNOUT

Maximum circle runout: 0.05 mm (0.0020 in.)

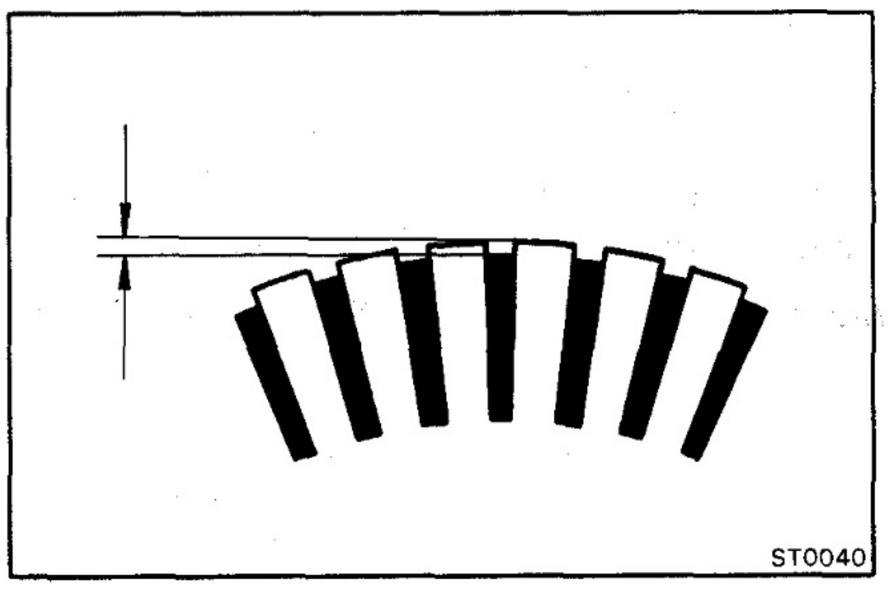
If the circle runout is greater than maximum, correct on a lathe.



3. INSPECT DIAMETER OF COMMUTATOR

Standard diameter: 36 mm (1.42 in.)
Minimum diameter: 35 mm (1.38 in.)

If the diameter of the commutator is less than minimum, replace the armature.

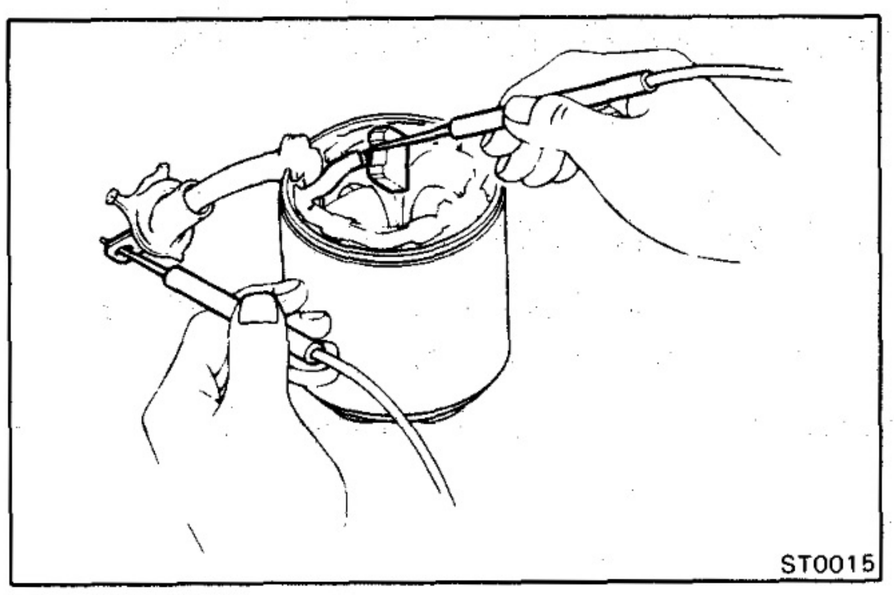


4. INSPECT UNDERCUT DEPTH

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.

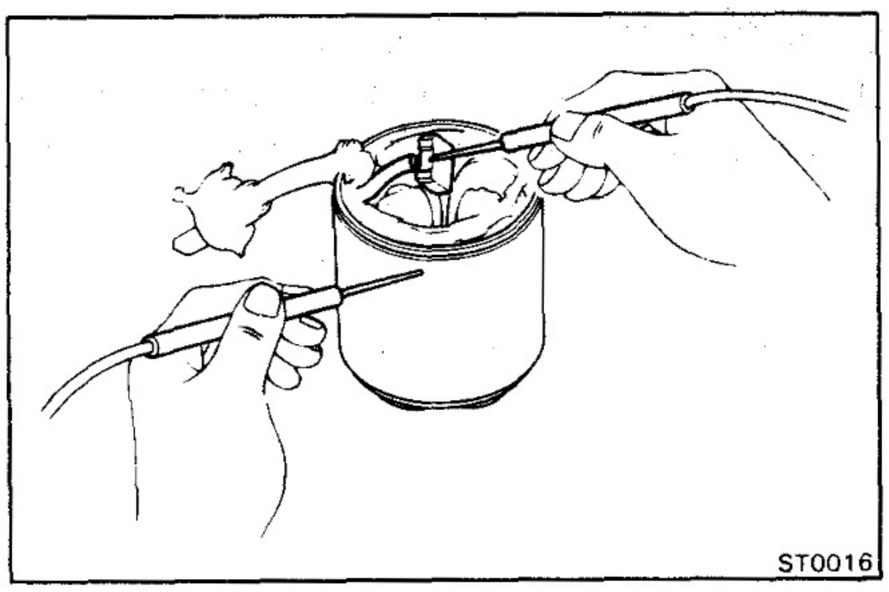


Field Frame (Field Coil)

1. INSPECT FIELD COIL FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

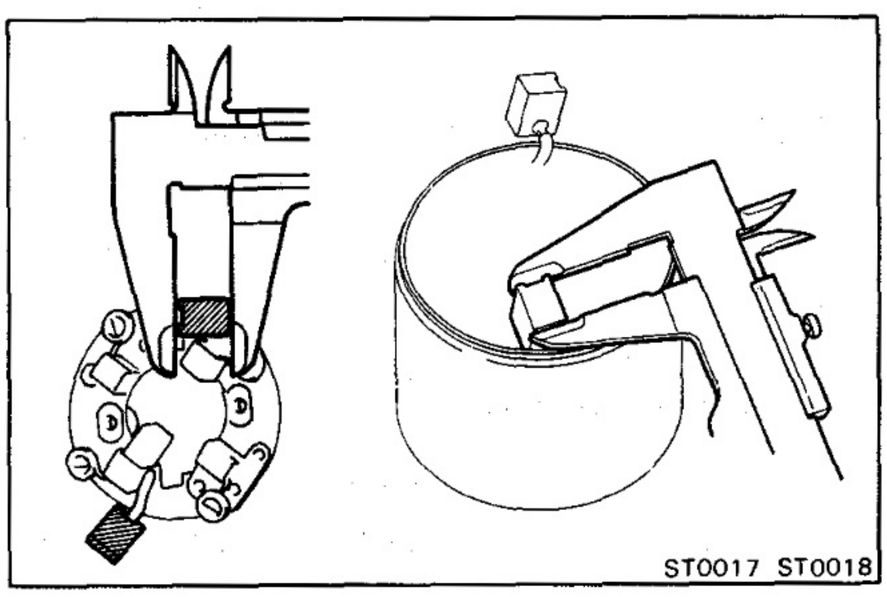
If there is no continuity, replace the field frame.



2. INSPECT FIELD COIL FOR GROUND

Using an ohmmeter, check that there is no continuity between the lead wire and field frame.

If there is continuity, repair or replace the field frame.



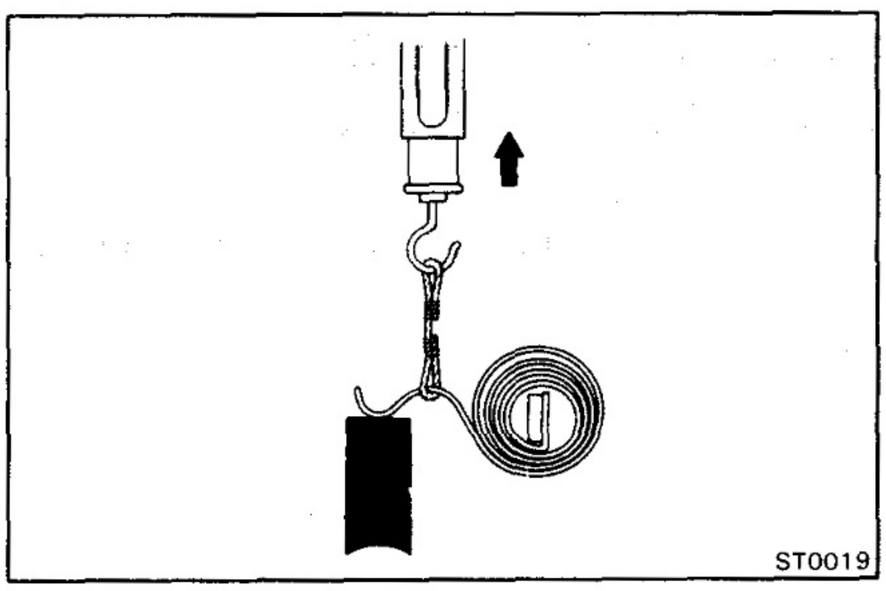
Brushes

INSPECT BRUSH LENGTH

Using calipers, measure the brush lengh.

Standard length: 20.5 mm (0.807 in.)
Minimum length: 13.0 mm (0.512 in.)

If length is less than minimum, replace the brush holder and/or field frame.



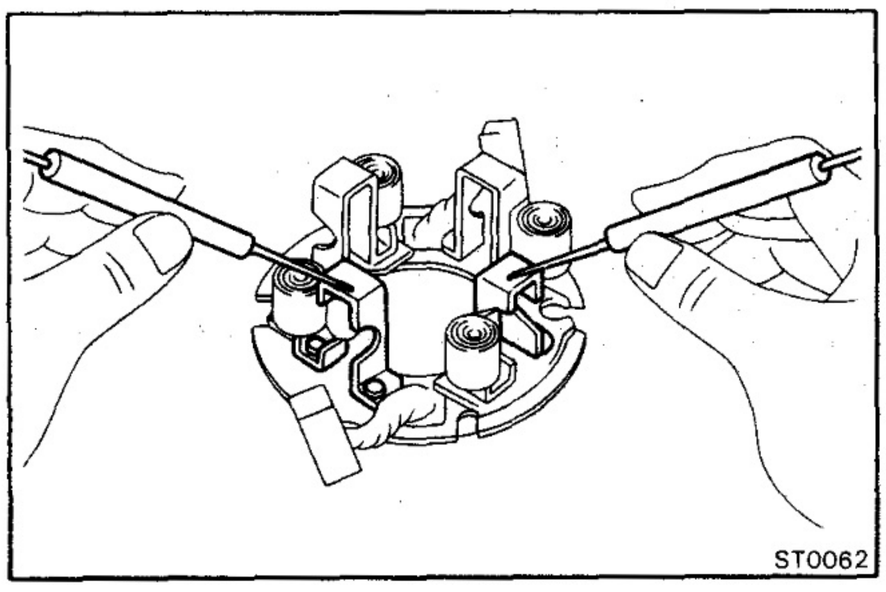
Brush Springs

INSPECT BRUSH SPRING LOAD

Take the pull scale reading the instant the brush spring separates from the brush.

Standard install load:
3.2 — 4.0 kg (7.1 — 8.8 lb, 31 — 39 N)

If the installed load is not withim specification, replace the brush springs.

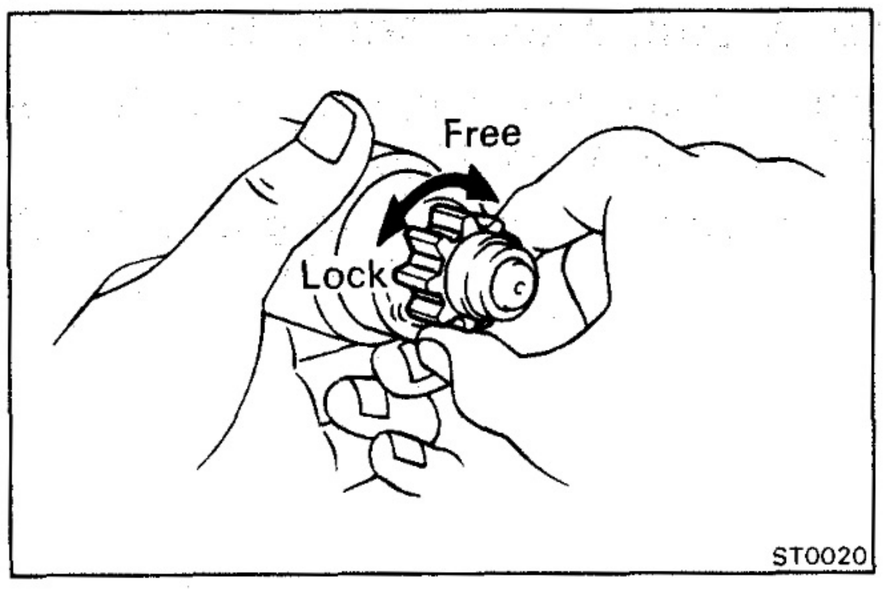


Brush Holder

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

Rotate the clutch pinion gear clockwise and check that it turns freely. Try to rotate the pinion gear counterclockwise and check that it locks.

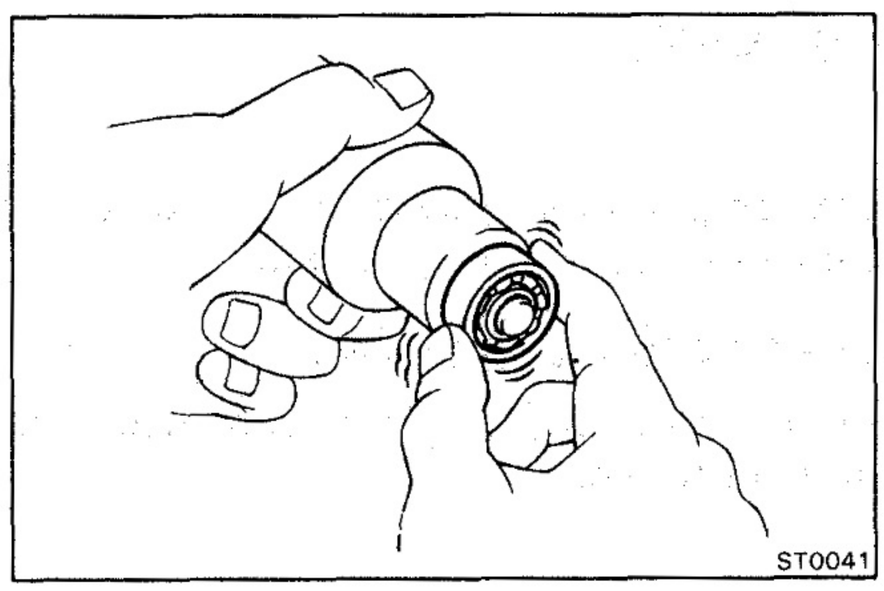
If necessary, replace the clutch assembly.

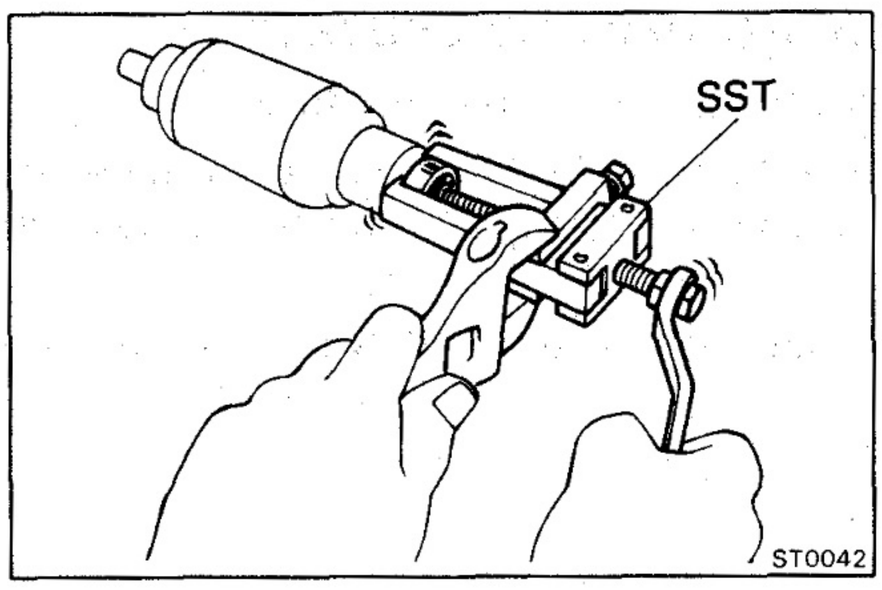
Bearings

1. INSPECT BEARINGS

Turn each bearing by hand while applying inward force.

If resistance is felt or if the bearing sticks, replace the bearing.

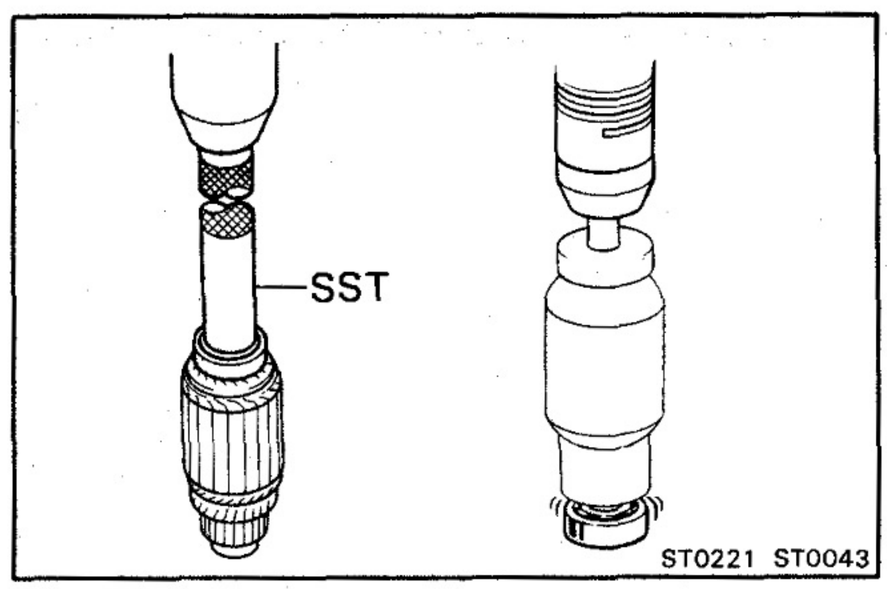




2. IF NECESSARY, REPLACE BEARINGS

(a) Using SST, remove the bearing.

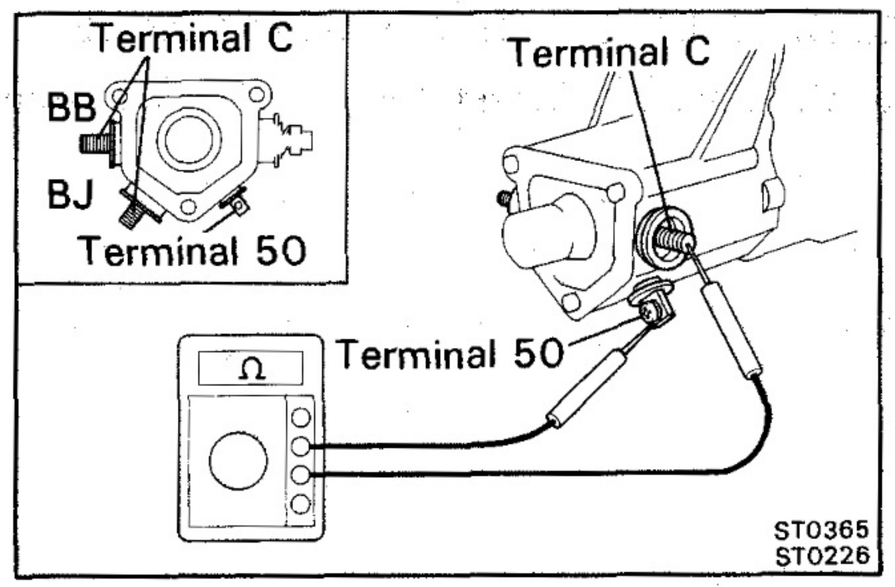
SST 09286-46011



(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.

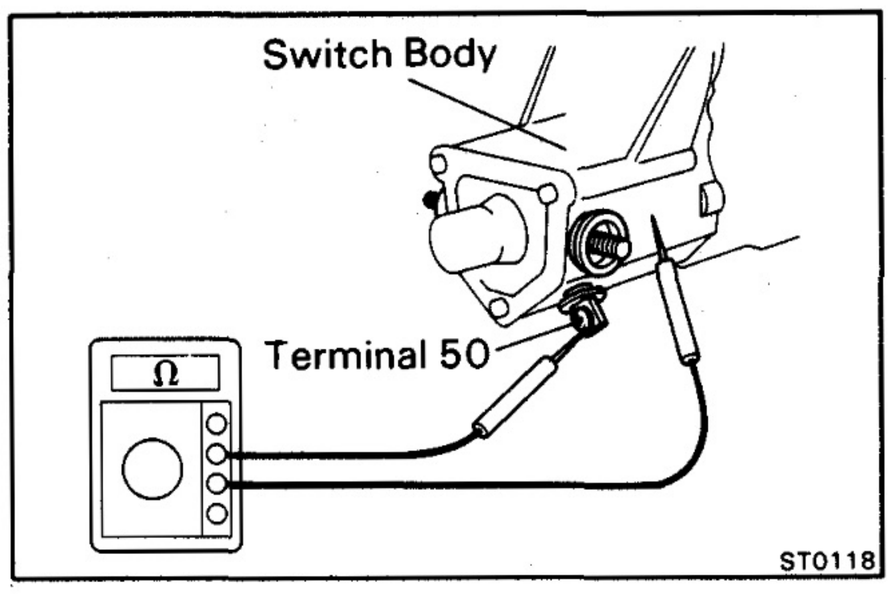


Magnetic Switch

1. PERFORM PULL-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 assembly.



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.

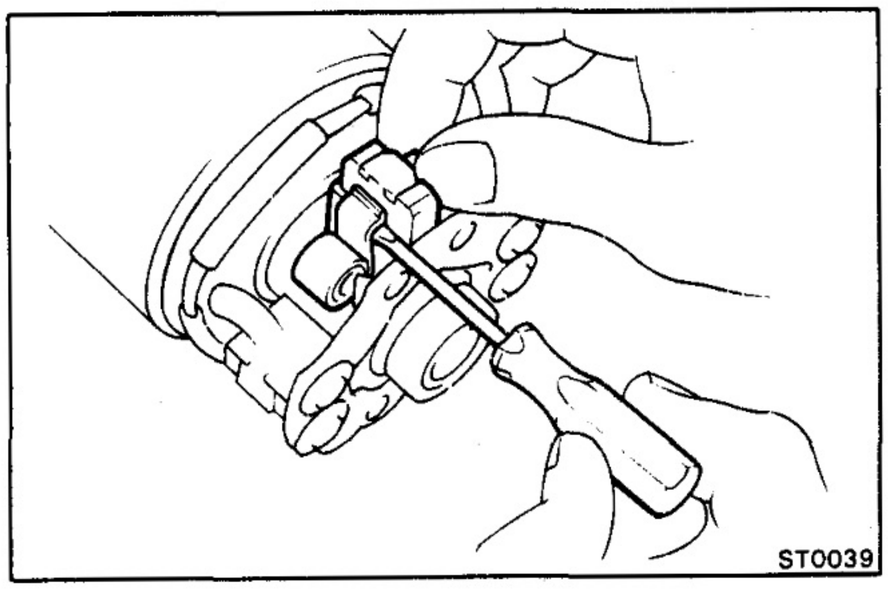
ASSEMBLY OF STARTER

(See page ST-9)

NOTE: 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.

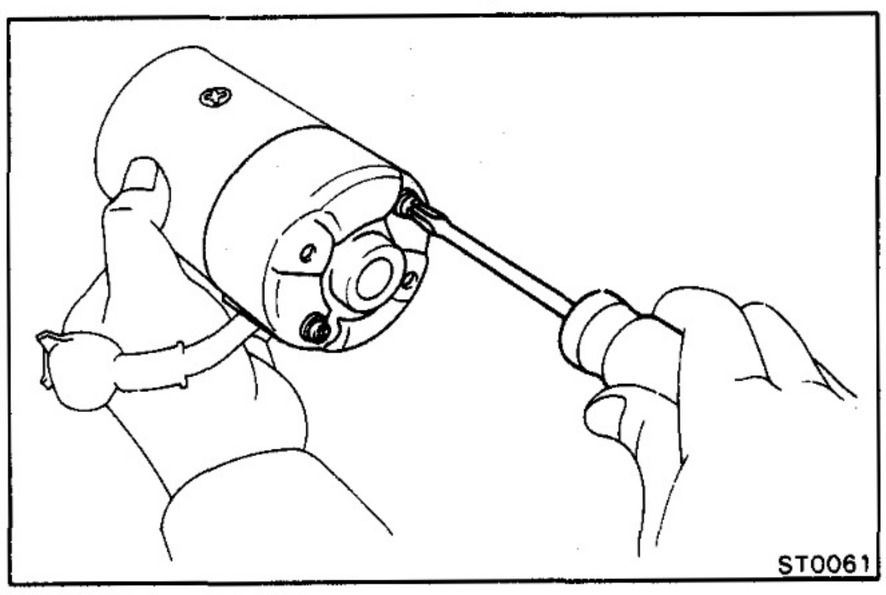


2. INSTALL BRUSH HOLDER AND BRUSHES

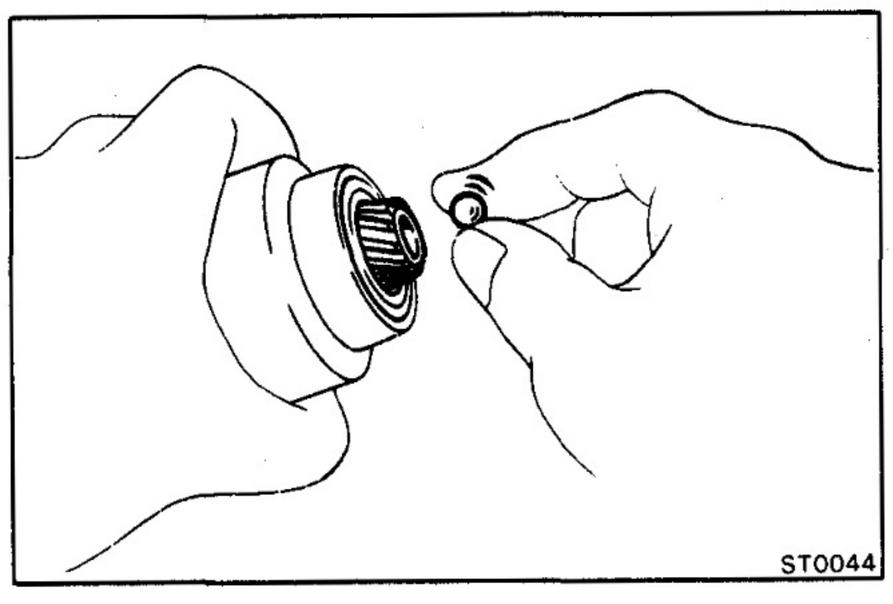
(a) Place the brush holder on the armature shaft.

(b) Using a screwdriver, hold the brush spring back and install the brush into the brush holder. Install four brushes.

NOTE: Check that the positive (+) lead wires are not grounded.

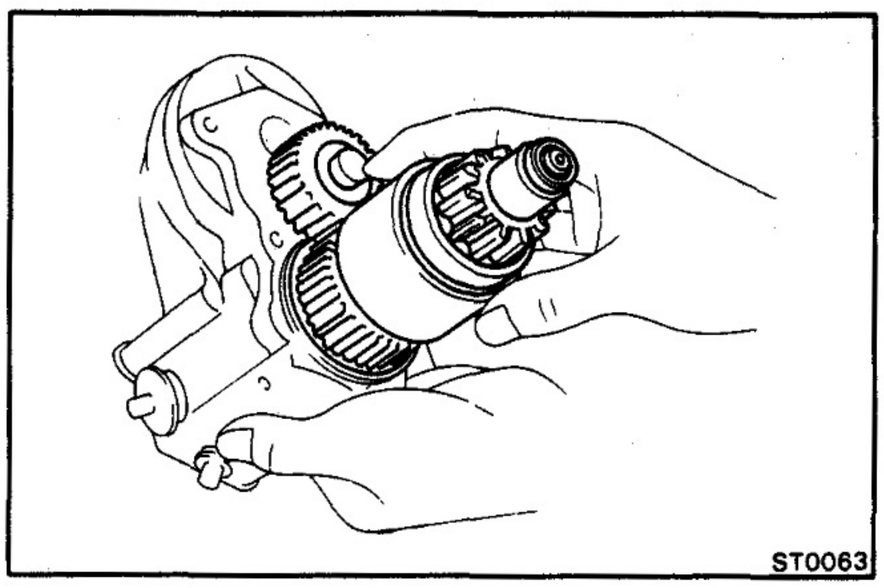


(c) Install the end cover with the two screws.

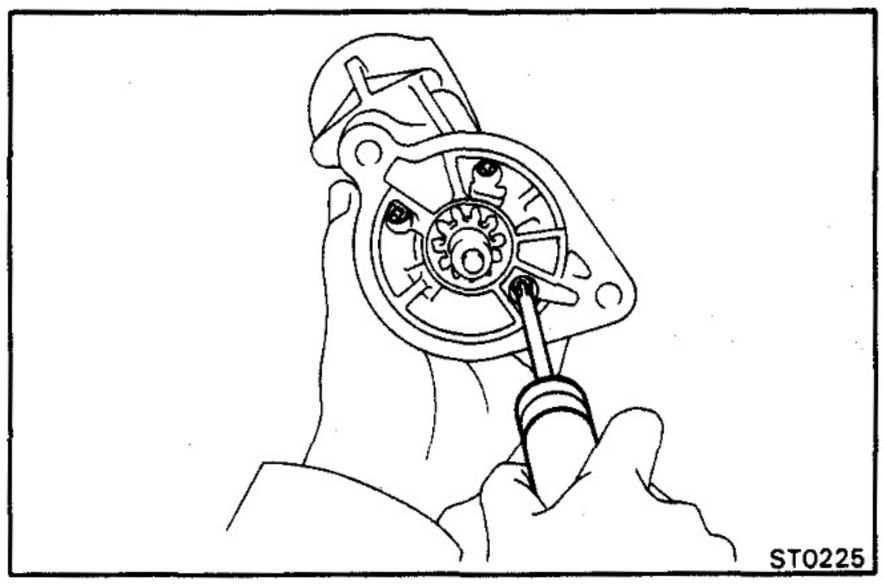


3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

Apply grease to the ball, and insert it into the clutch shaft hole.

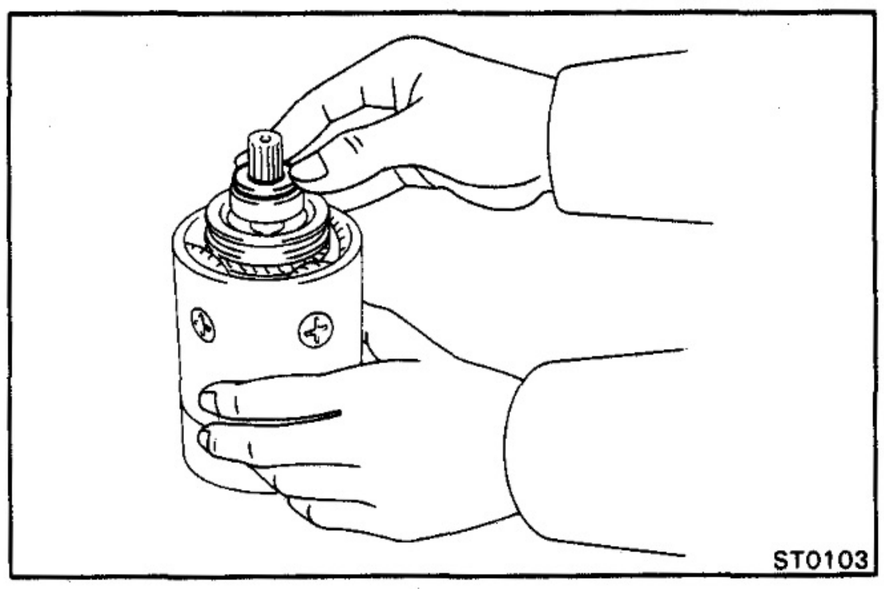


4. INSTALL RETURN SPRING, STARTER CLUTCH ASSEMBLY, PLATE WASHER, IDLE GEAR AND BEARING TO MAGNETIC SWITCH ASSEMBLY



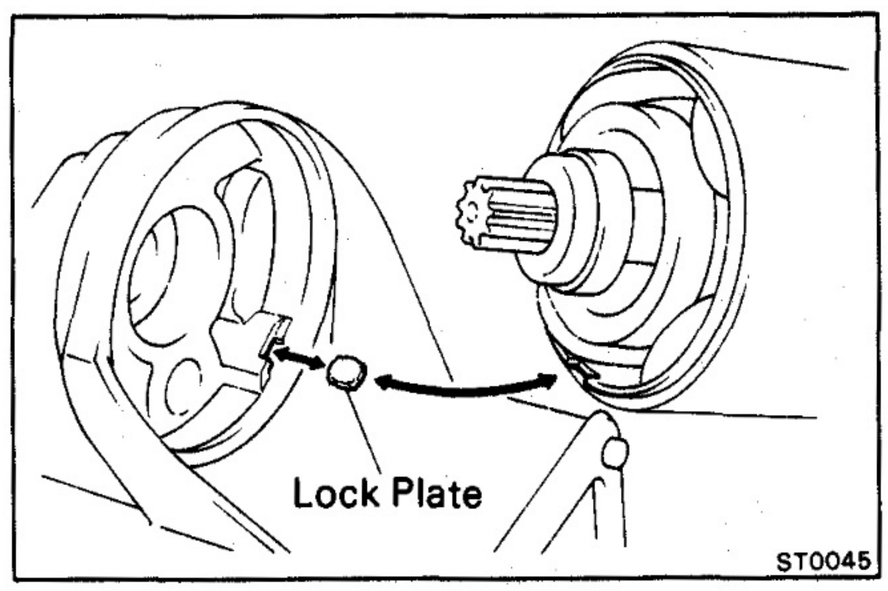
5. INSTALL STARTER HOUSING

Install the starter housing to the magnetic switch assembly with the three screws.



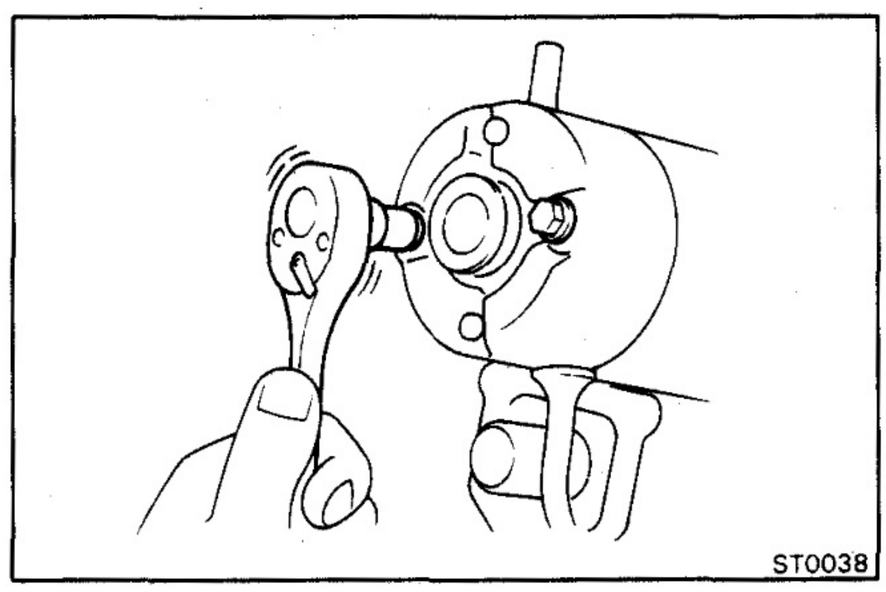
6. INSTALL FIELD FRAME WITH ARMATURE IN MAGNETIC SWITCH

(a) Place the felt seal on the armature shaft.



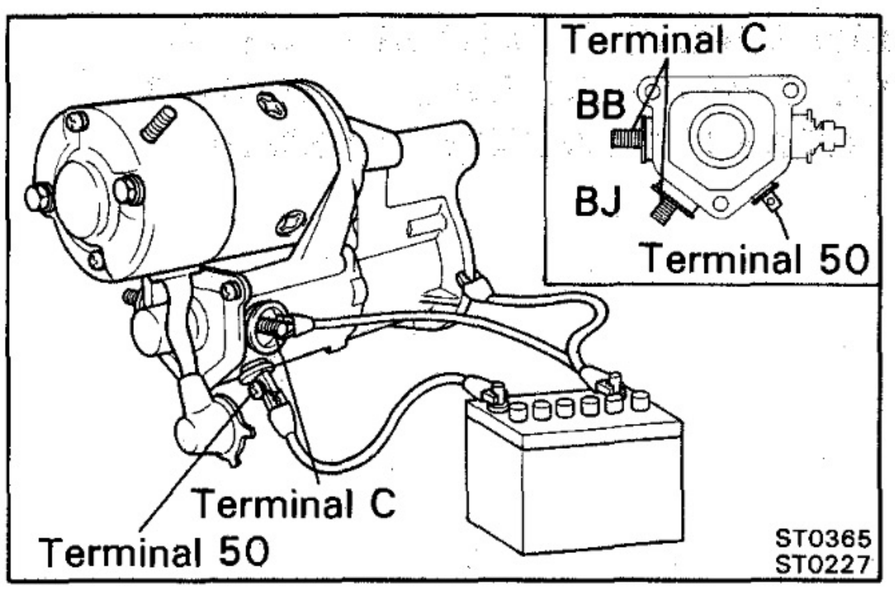
(b) Place the lock plate on the magnetic switch.

(c) Align the lock plate with the notch on the field frame and insert the field frame with the armature.



(d) Install the two through bolts with the plate washers and O-rings.

(e) Connect the lead wire to the magnetic switch terminal.



PERFORMANCE TEST OF STARTER

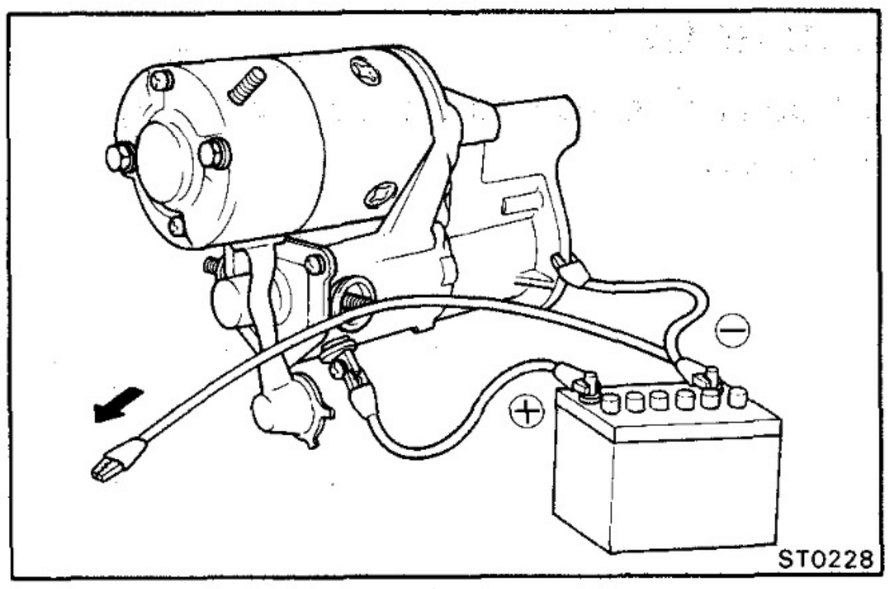
CAUTION: These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

1. PERFORM PULL-IN TEST

(a) Disconnect the lead wire from terminal C.

(b) Connect the battery to the magnetic switch as shown. Check that the clutch pinion gear moves outward.

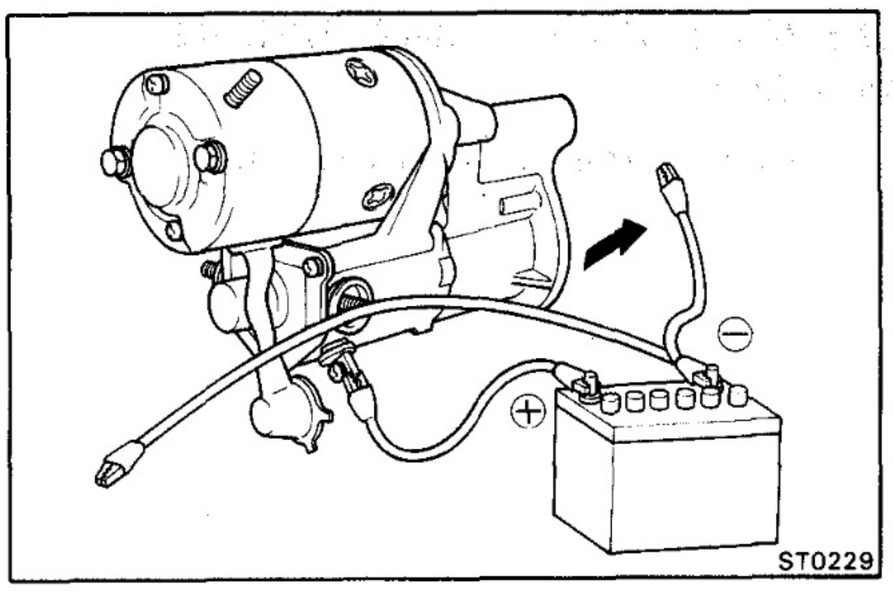
If the clutch pinion gear does not move, replace the magnetic switch assembly.



2. PERFORM HOLD-IN TEST

While connected as above with the clutch pinion gear out, disconnect the negative (–) lead from terminal C. Check that the clutch pinion gear remains out.

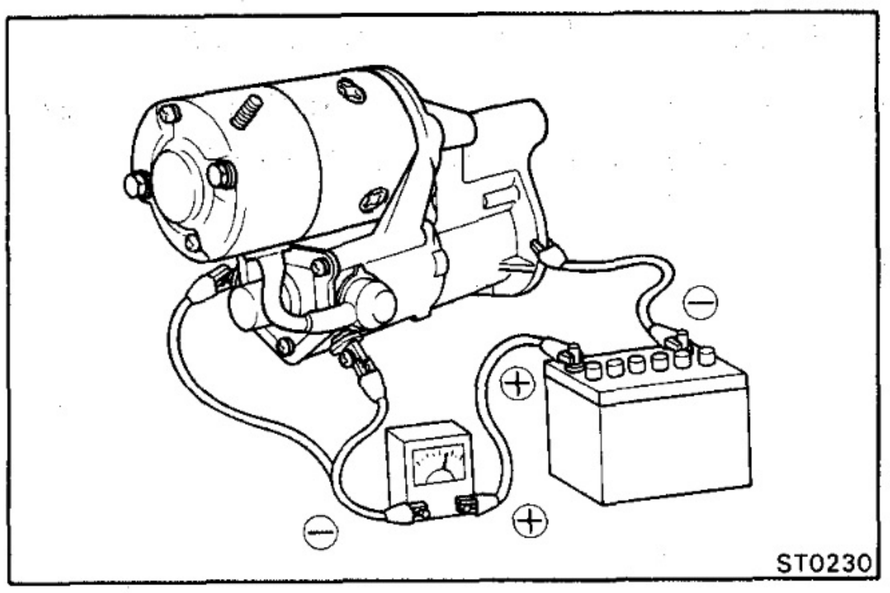
If the clutch pinion gear returns inward, replace the magnetic switch assembly.



3. INSPECT PINION GEAR RETURN

Disconnect the negative (–) lead from the switch body. Check that the clutch pinion gear returns inward.

If the clutch pinion gear does not return, replace the magnetic switch assembly.



4. PERFORM NO-LOAD PERFORMANCE TEST

(a) Connect the lead wire to terminal C.

(b) Connect the battery and ammeter to the starter as shown.

(c) Check that the starter rotates smoothly and steadily with the clutch pinion gear moving outward. check that the ammeter shows the specified current.

Specified current:

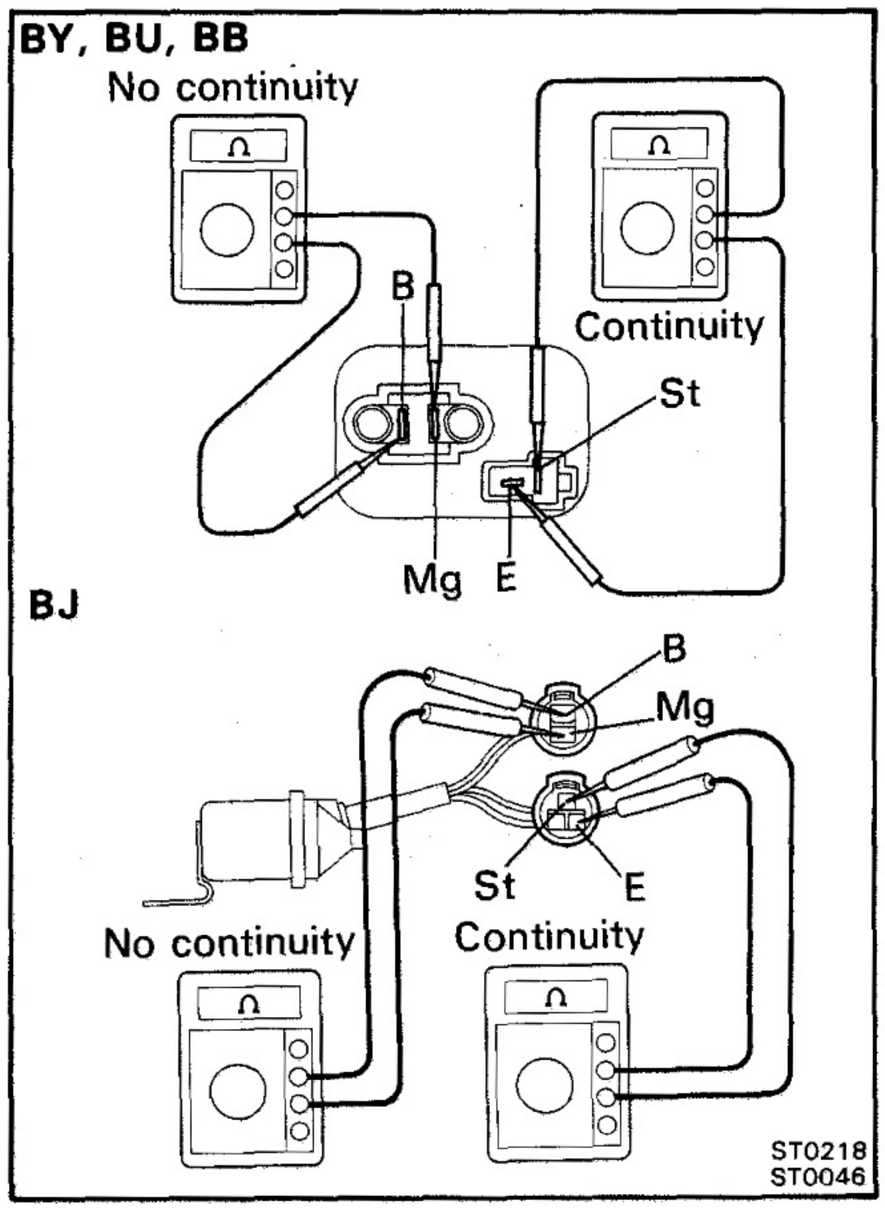
2.5 kw type 180 A or less at 11 V
4.5 kw type 90 A or less at 23 V

STARTER RELAY

INSPECTION OF STARTER RELAY

LOCATION

BY: Under the instrument panel on the driver's side.
BJ: Between the left fender and left fender apron.
BU: Under the instrument panel center.
BB: Inside wall adjacent to passenger door.

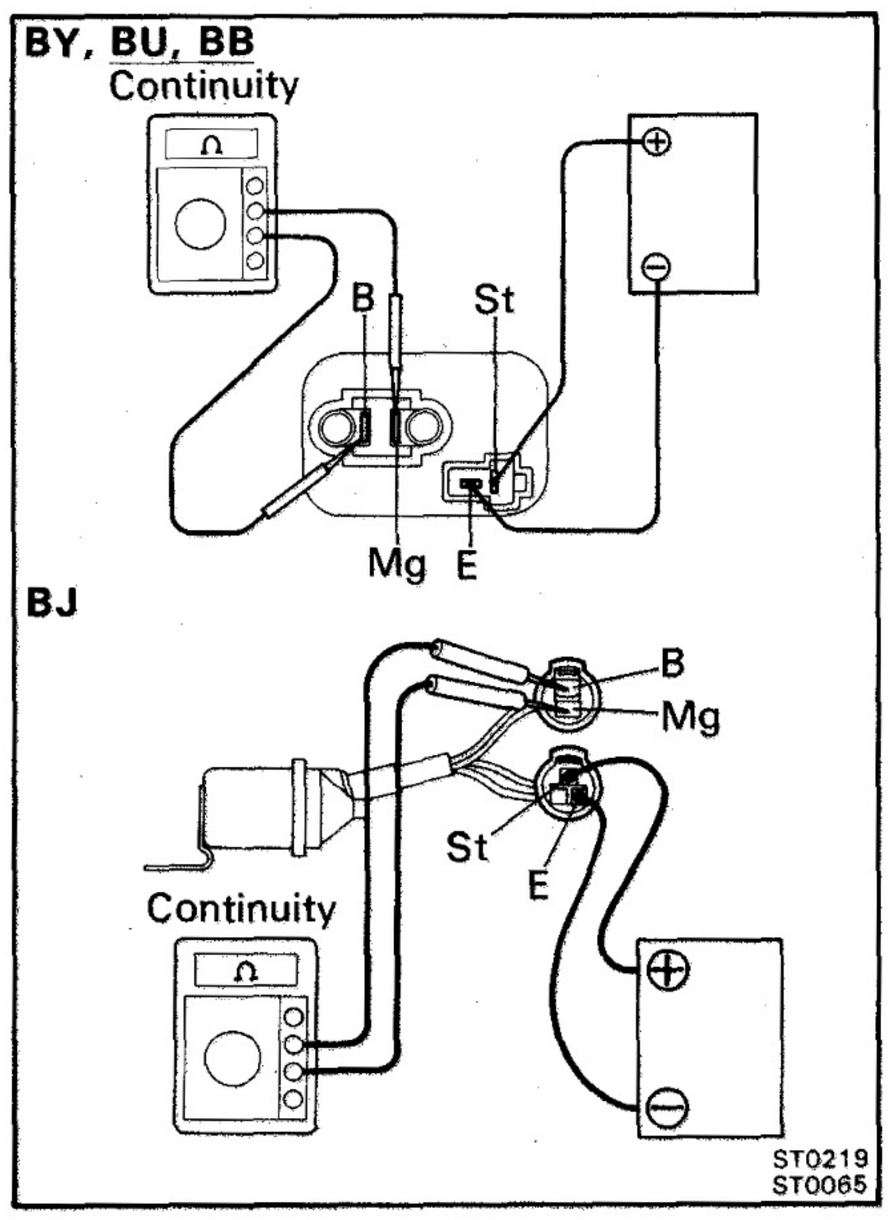


1. INSPECT RELAY CONTINUITY

(a) Using an ohmmeter, check that there is continuity between terminals E and St.

(b) Using an ohmmeter, check that there is no continuity between terminals B and Mg.

If continuity is not as specified, replace the relay.



2. INSPECT RELAY OPERATION

(a) Apply battery voltage between terminals E and St.

(b) Using an ohmmeter, check that there is continuity between terminals B and Mg.

If operation is not as described, replace the relay.

CHARGING SYSTEM

	Page
PRECAUTIONS	CH-2
TROUBLESHOOTING	CH-2
CHARGING SYSTEM CIRCUIT	CH-3
ON-VEHICLE INSPECTION	CH-4
ALTERNATOR	CH-9
ALTERNATOR REGULATOR (w/o IC Regulator)	CH-19
CHARGE LIGHT RELAY (w/ IC Regulator)	CH-21

PRECAUTIONS

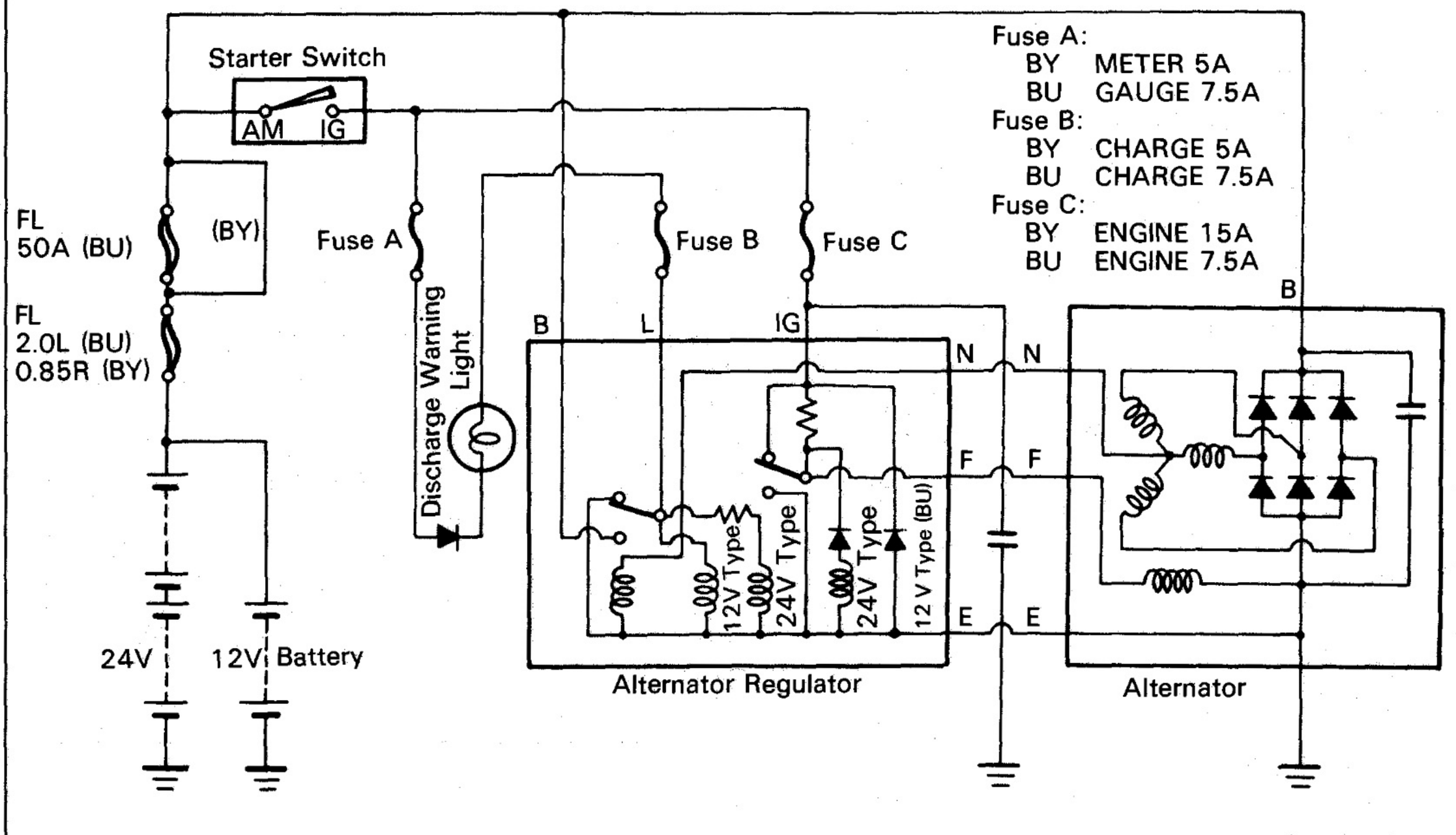
1. **Check that the battery cables are connected to the correct terminals.**
2. **Disconnect the battery cables when the battery is given a quick charge.**
3. **Do not perform tests with a high voltage insulation resistance tester.**
4. **Never disconnect the battery while the engine is running.**

TROUBLESHOOTING

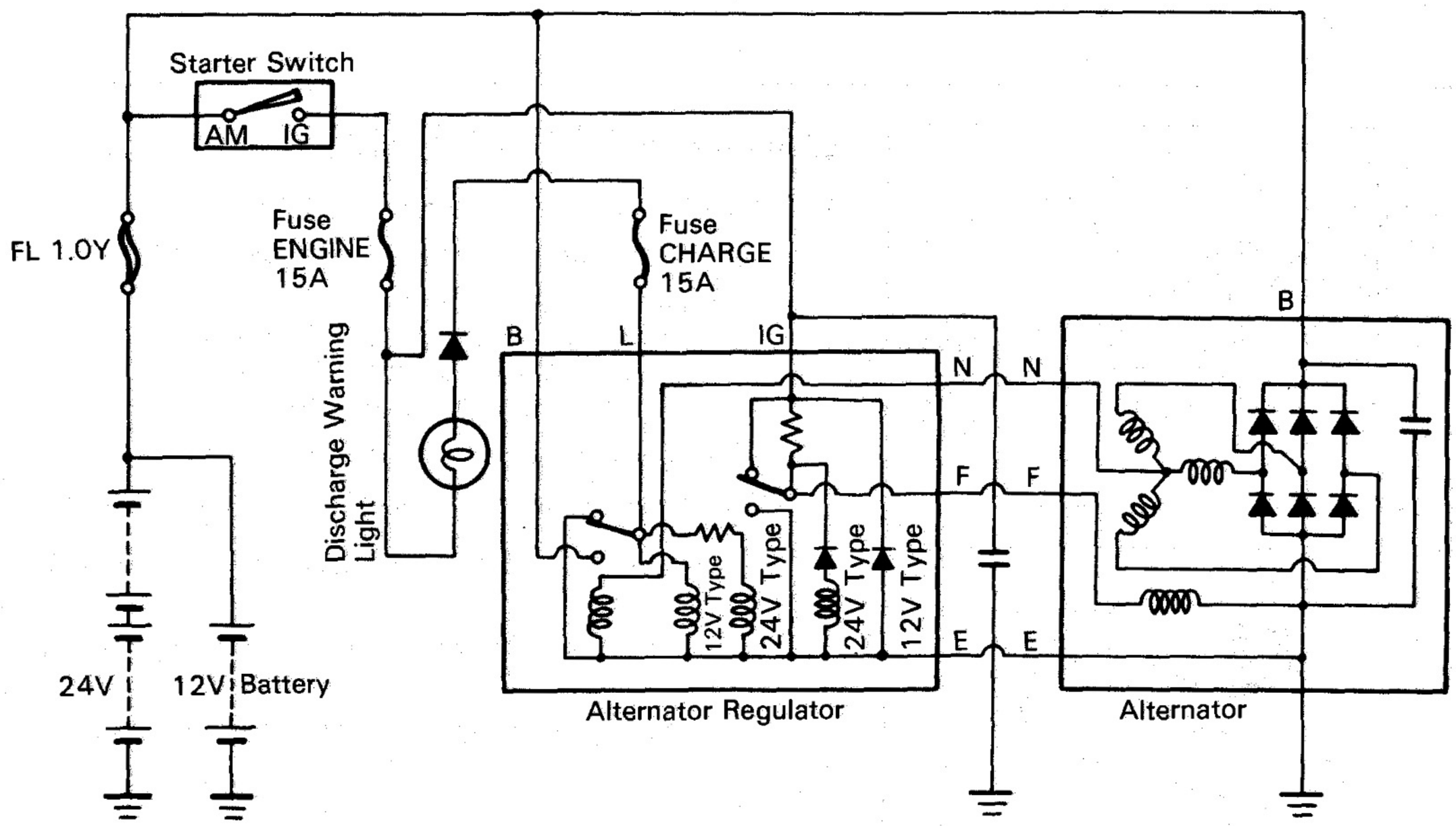
Problem	Possible cause	Remedy	Page
Discharge warning light does not light with starter switch at "ON" and engine not running	Fuse blown	Check fuses	
	Light burned out	Replace light	
	Wiring connection loose	Tighten loose connection	
	Alternator regulator faulty	Check regulator	CH-19
	Charge light relay faulty	Check relay	CH-21
	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 replace cables	
	Fuse blown	Check fuse	
	Fusible link blown	Replace fusible link	
	Alternator regulator, IC regulator, charge light relay or alternator faulty	Check charging system	CH-6
	Wiring faulty	Repair wiring	

CHARGING SYSTEM CIRCUIT

w/o IC Regulator [BY, BU]



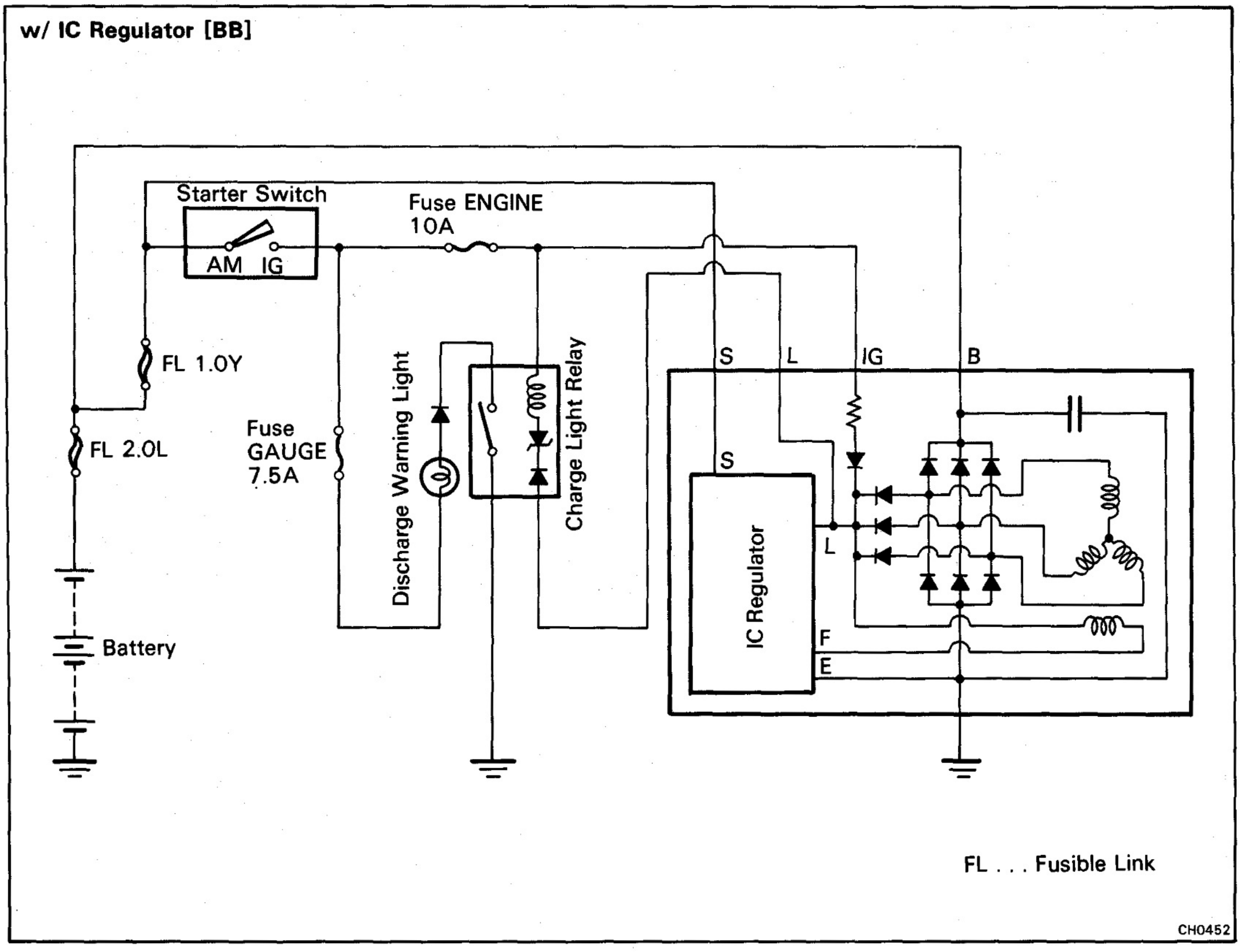
w/o IC Regulator [BJ]

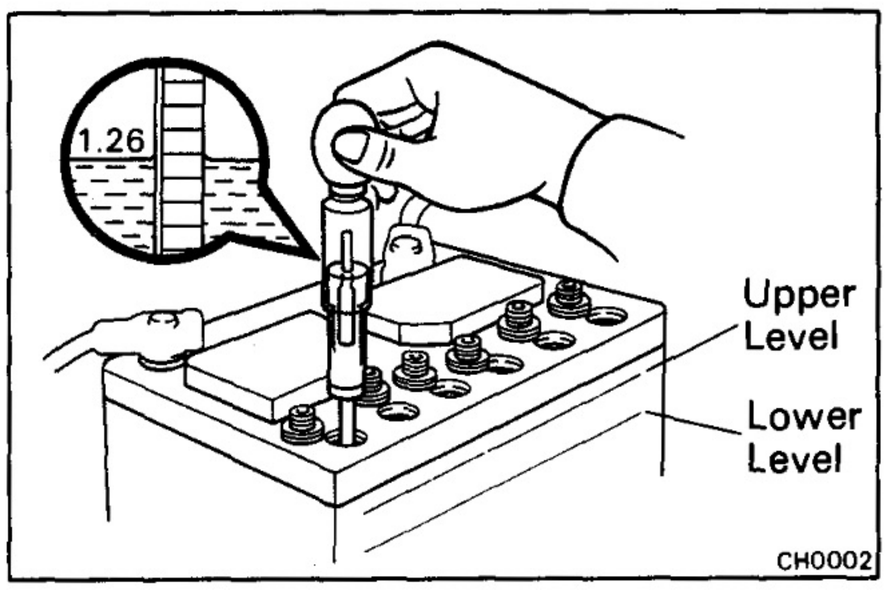


FL . . . Fusible Link

CH0450
CH0451

CHARGING SYSTEM CIRCUIT (Cont'd)





ON-VEHICLE INSPECTION

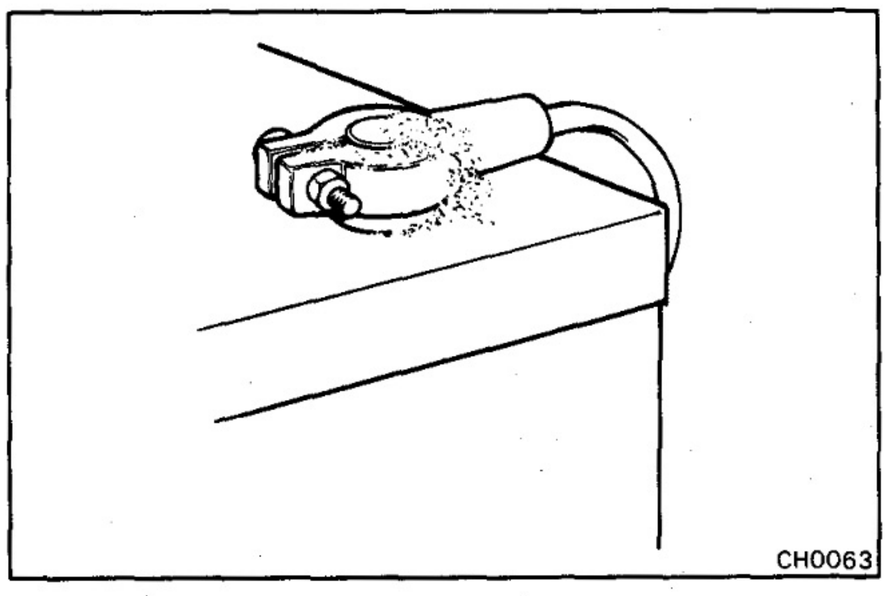
1. INSPECT BATTERY SPECIFIC GRAVITY

(a) Check the specific gravity of each cell.

Standard specific gravity:
When fully charged at 20°C (68°F)
1.25 – 1.27 (ex. NX110 – 5)
1.27 – 1.29 (NX110 – 5)

(b) Check the electrolyte quantity of each cell.

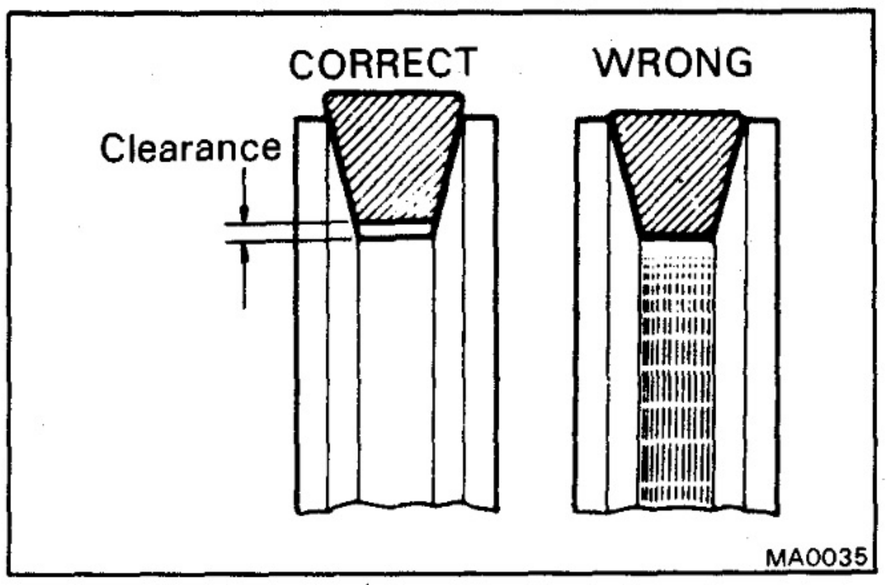
If insufficient, refill with distilled (or purified) water.



2. CHECK BATTERY TERMINALS, FUSIBLE LINKS AND FUSES

(a) Check that the battery terminals are not loose or corroded.

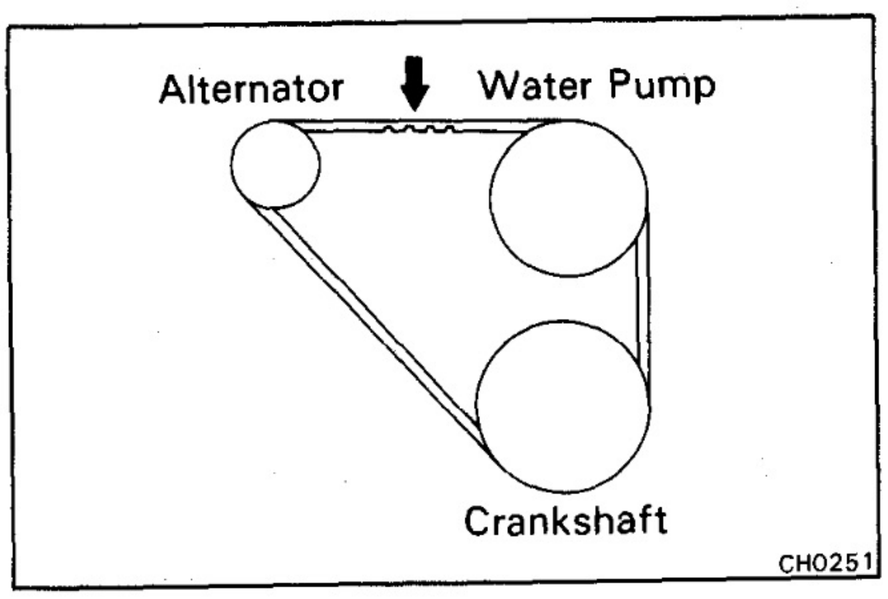
(b) Check the fusible links and fuses for continuity.



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	**8 – 12 mm (0.31 – 0.47 in.)**
Used belt	**11 – 16 mm (0.43 – 0.63 in.)**

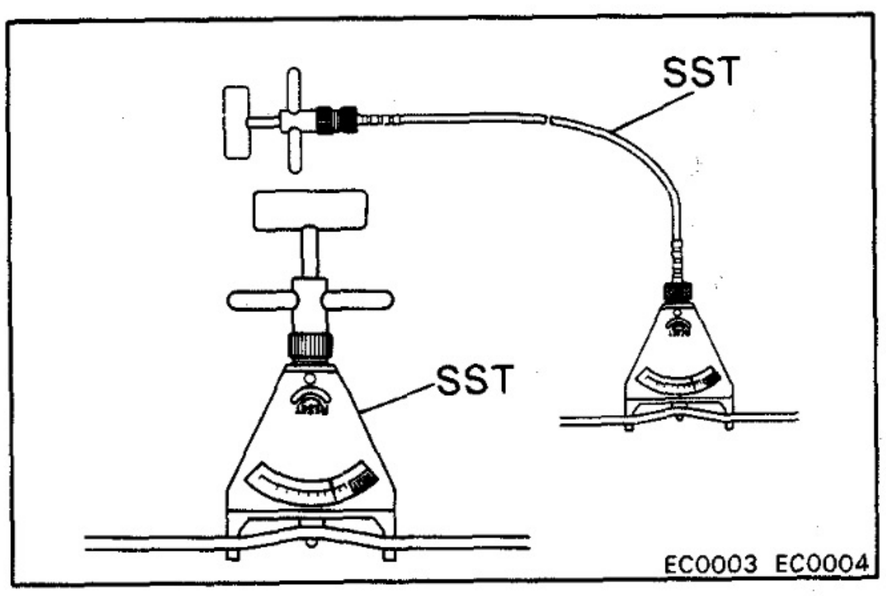
Double belt type

New belt	**12 – 15 mm (0.47 – 0.59 in.)**
Used belt	**14 – 20 mm (0.55 – 0.79 in.)**

If necessary, adjust the drive belt deflection.

NOTE:

- "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 about 5 minutes and recheck the deflection.



[Reference]

Using SST, check the drive belt tension.

SST 09216-00020 and 09216-00030

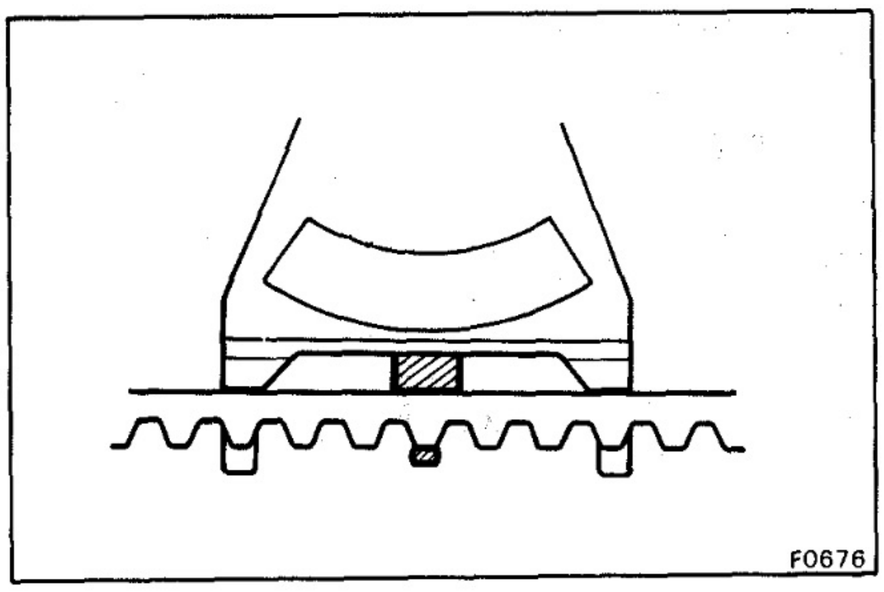
Drive belt tension:

Single belt type

New belt	**55 – 65 kg**
Used belt	**30 – 45 kg**

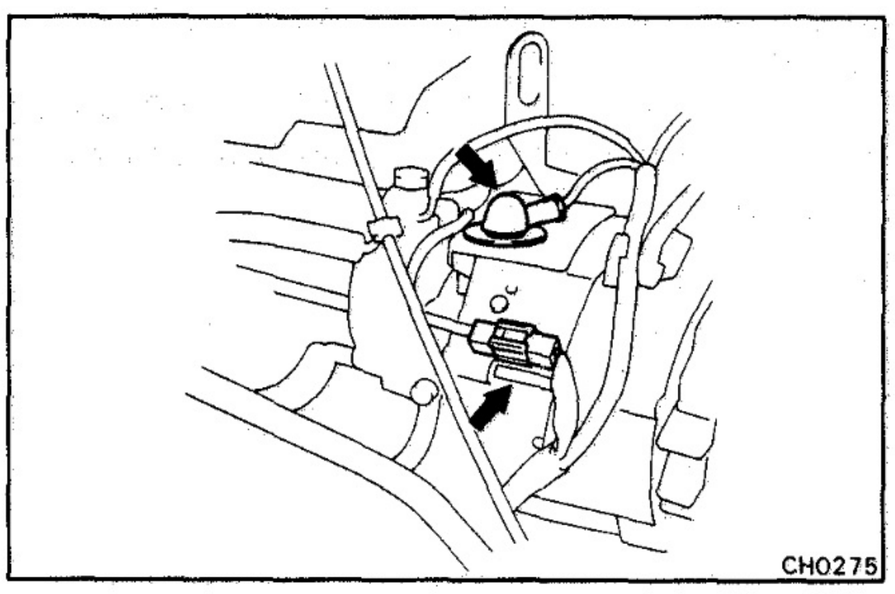
Double belt type

New belt	**45 – 55 kg**
Used belt	**20 – 35 kg**



If necessary, adjust the drive belt tension.

NOTE: When checking the tension, be sure the gauge is on the belt protrusion.



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 LIGHT CIRCUIT

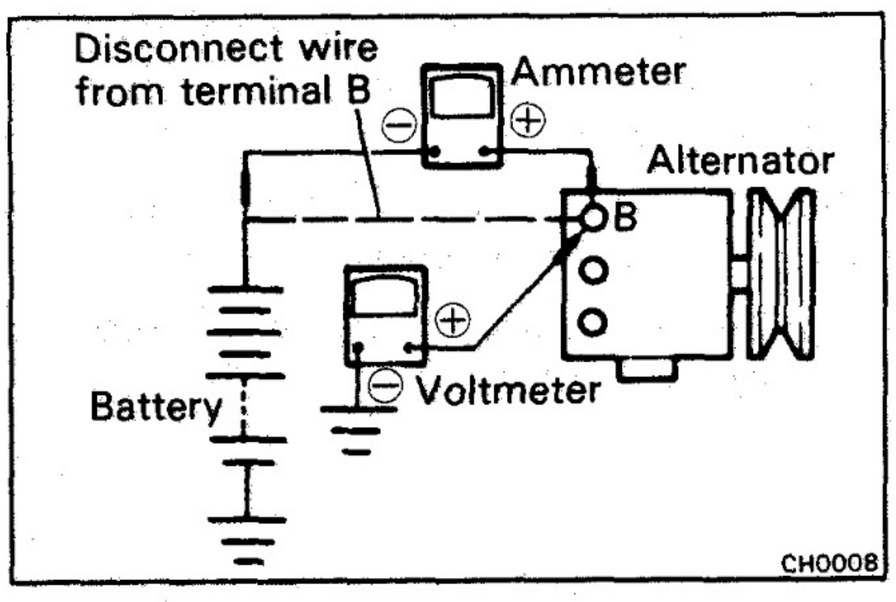
(a) Warm up the engine and turn it off.

(b) Turn off all accessories.

(c) Turn the starter switch to "ON." Check that the charge light is lit.

(d) Start the engine. Check that the light goes out.

If the light does not operate as described, troubleshoot the charge light circuit.

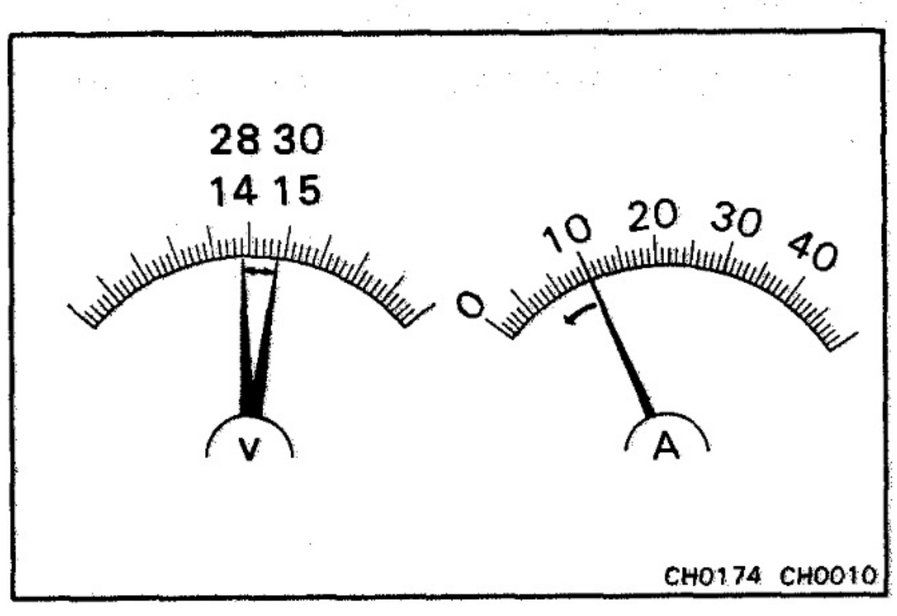


6. INSPECT CHARGING CIRCUIT WITHOUT LOAD

NOTE: If a battery/alternator tester is available, connect the tester to the charging circuit according to the manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter to the charging circuit as follows:

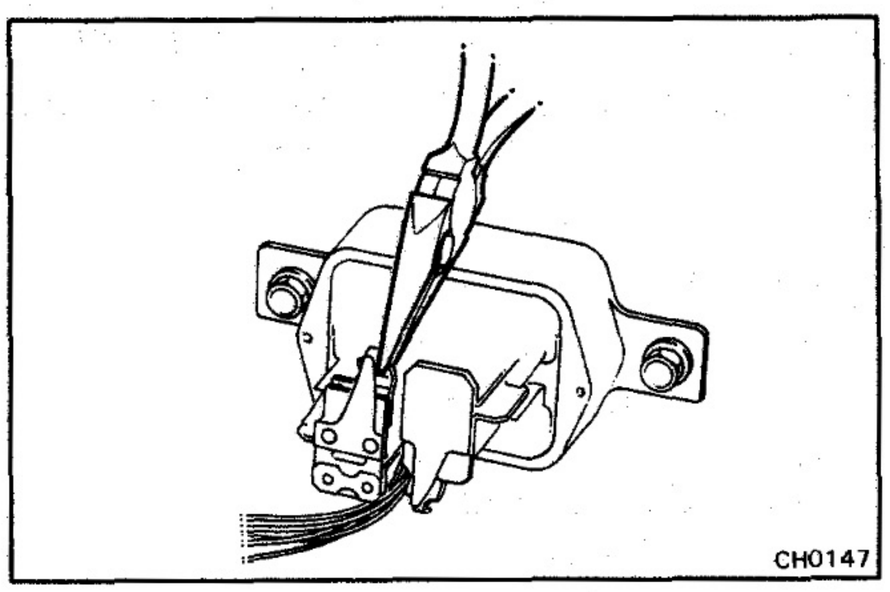
- Disconnect the wire from terminal B of the alternator and connect the wire to the negative (–) terminal of the ammeter.
- Connect the test lead from the positive (+) terminal of the ammeter to terminal B of the alternator.
- Connect the positive (+) lead of the voltmeter to terminal B of the alternator.
- Connect the negative (–) lead of the voltmeter to the body ground.



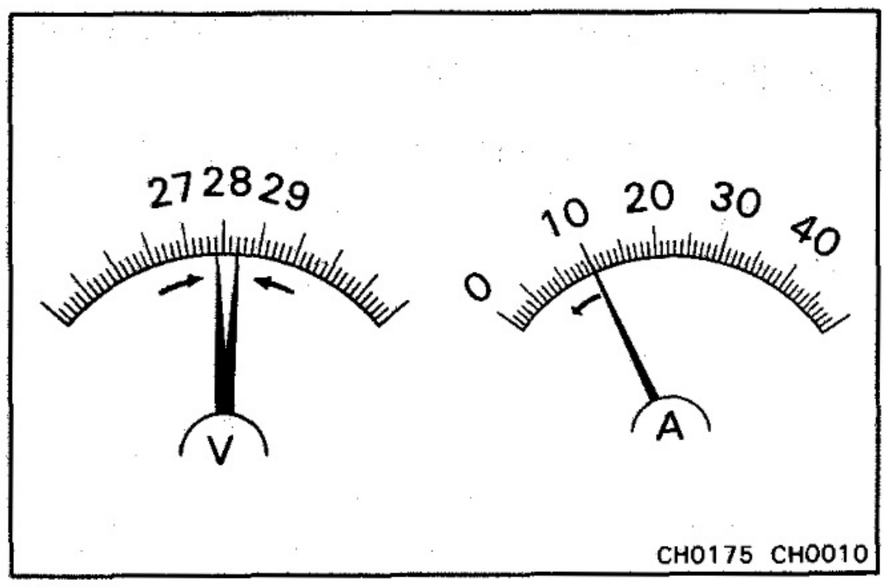
(b) Check the charging circuit as follows:

With the engine running from idle to 2,000 rpm, check the reading on the ammeter and voltmeter.

[w/o IC Regulator]
Standard amperage: 10 A or less
Standard voltage:
12 V type 13.8 – 14.8 V at 25°C (77°F)
24 V type 27.0 – 29.0 V at 25°C (77°F)

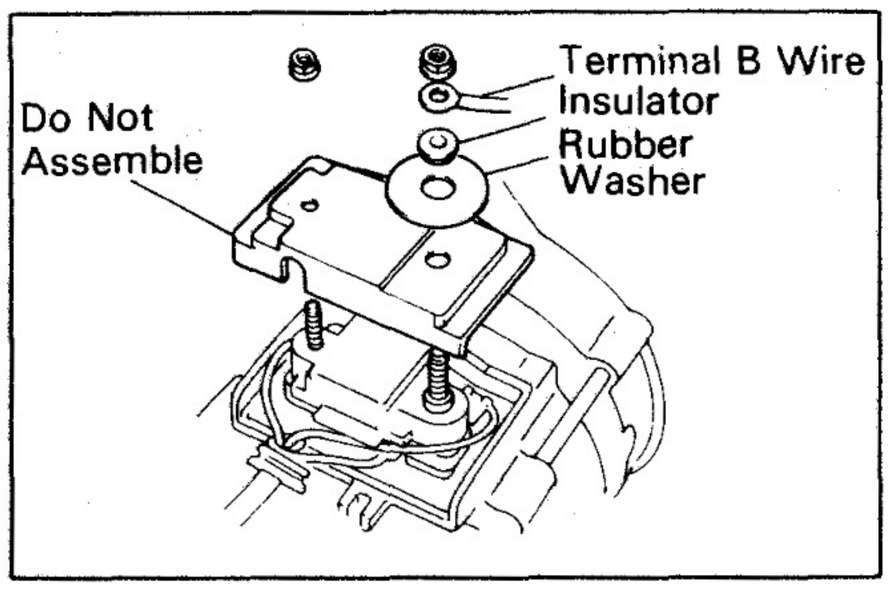


If the reading is not within standard voltage, adjust the regulator or replace it.



[w/ IC Regulator]
Standard amperage: 10 A or less
Standard voltage: 27.9 – 28.5 V at 25°C (77°F)

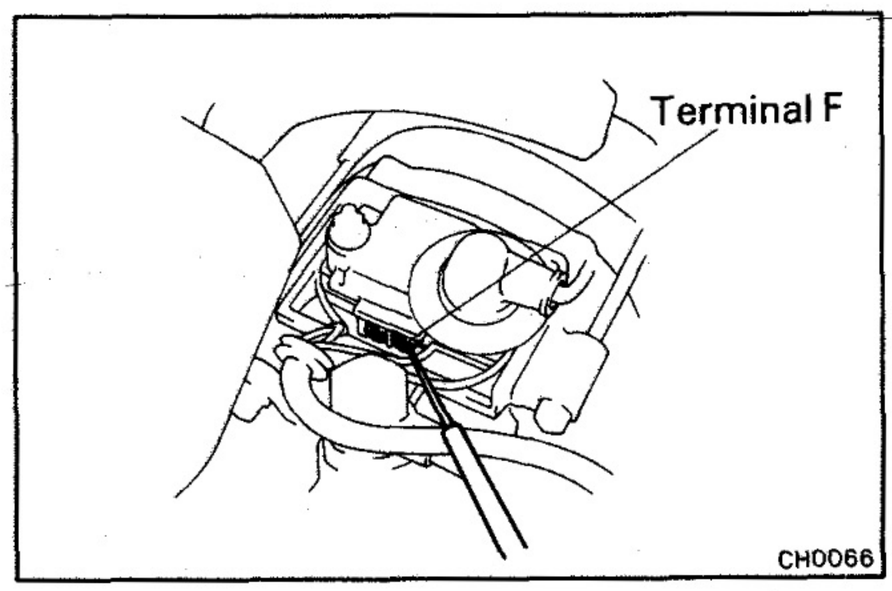
If the voltage reading is greater than standard voltage, replace the IC regulator.



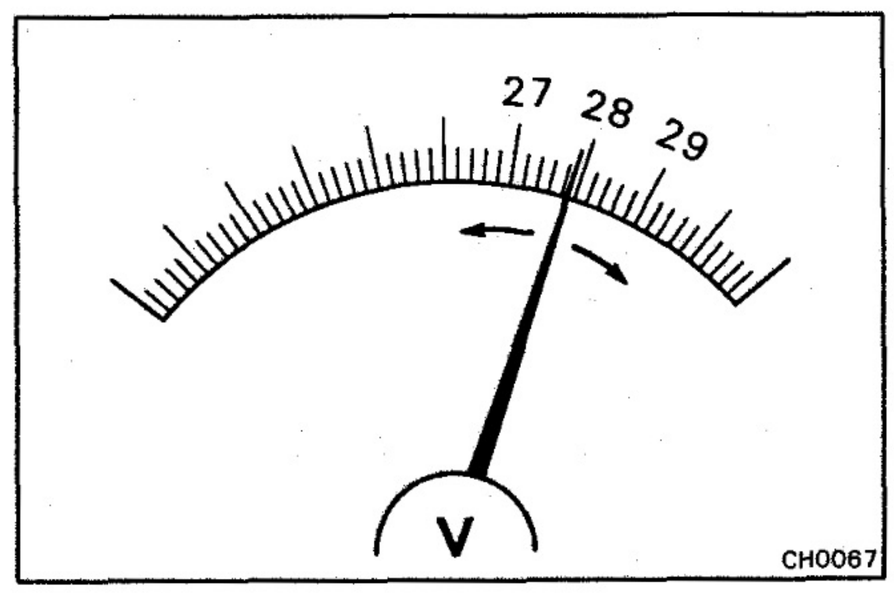
If the voltage reading is less than standard voltage, check the IC regulator and alternator as follows:

- Remove the brush holder cover and connect the terminal B wire to the original position.

CAUTION: Battery voltage is applied to terminal B, so disconnect the battery before beginning work.

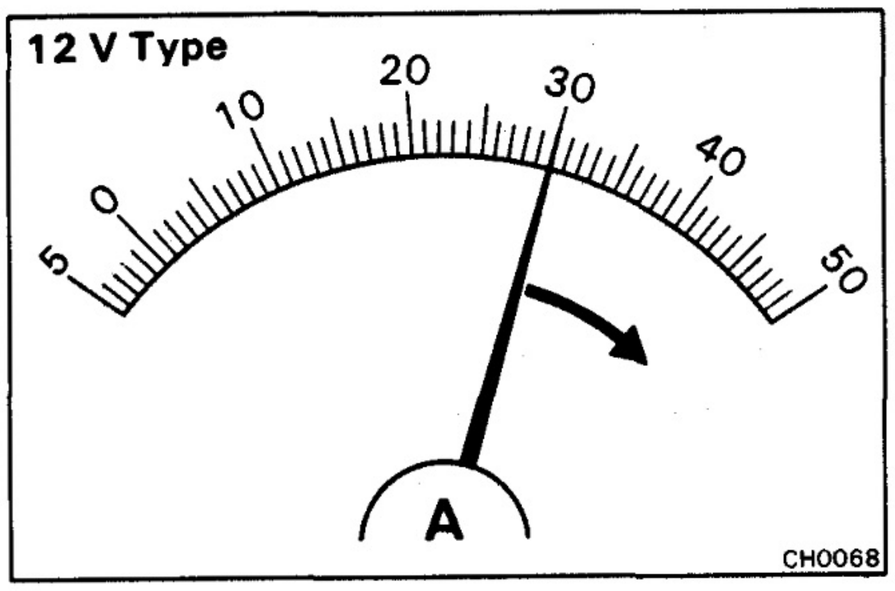


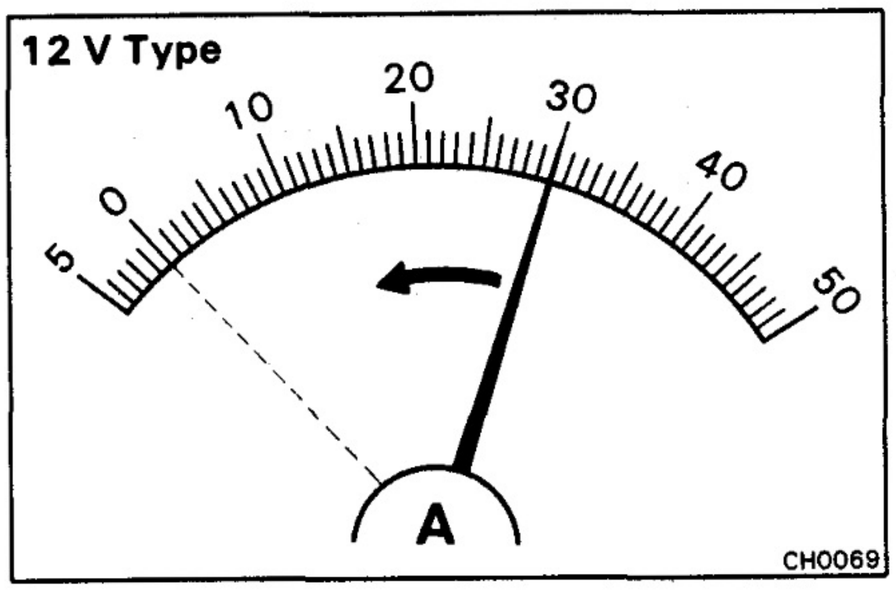
- With terminal F grounded, start the engine and check the reading on the voltmeter.



If the voltage reading is more than standard voltage, replace the IC regulator.

If the voltage reading is less than standard voltage, 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 "HI."

(b) Check the reading on the ammeter.

Standard amperage:

12 V type	**30A or more**
24 V, 25 A type	**15A or more**
24 V, 30 A type	**20A or more**
24 V, 55 A type	**30A or more**

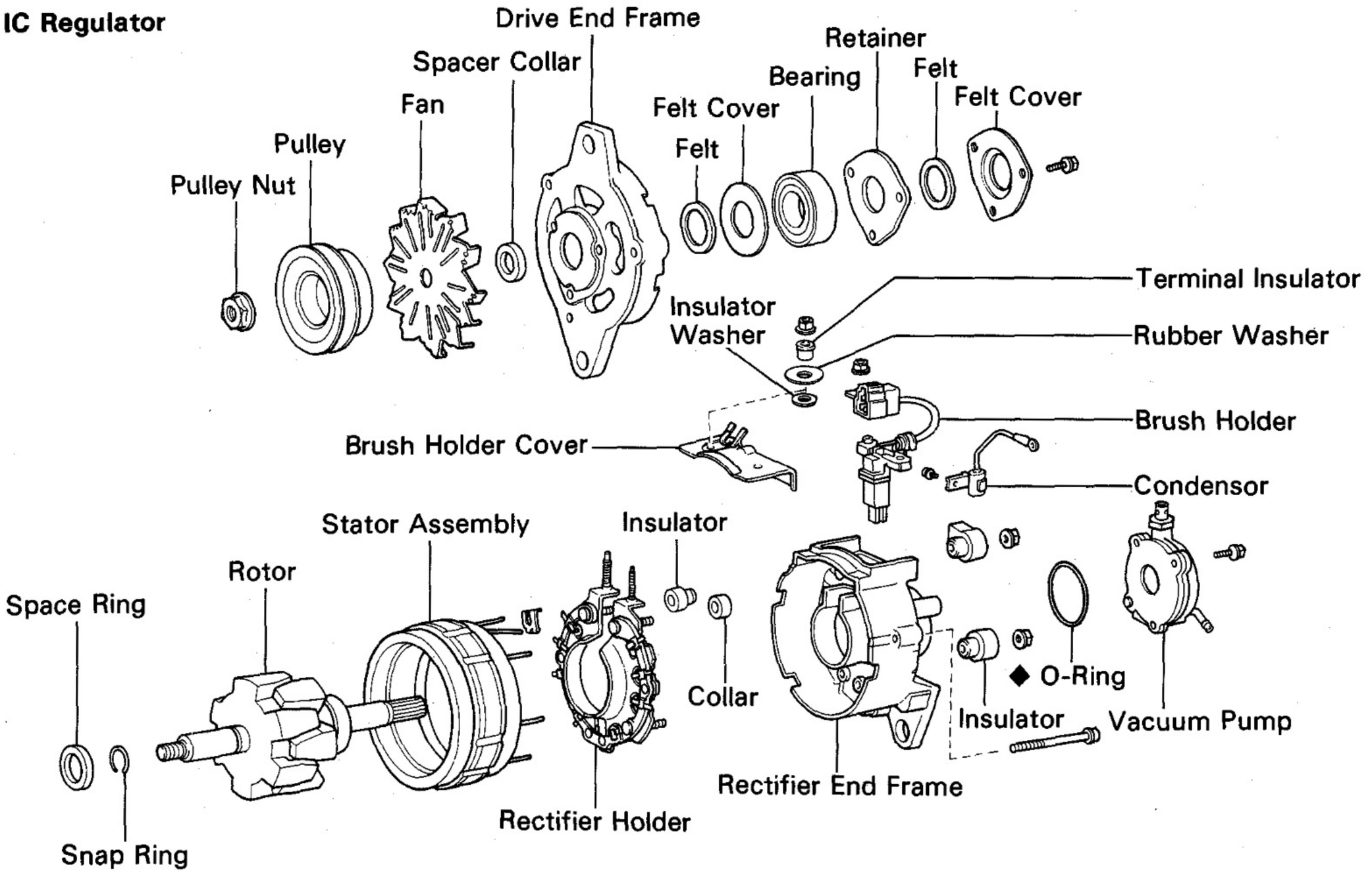
If the ammeter reading is less than standard amperage, repair the alternator. (See page CH-9)

NOTE: If the battery is fully charged, the indication will sometimes be less than standard amperage.

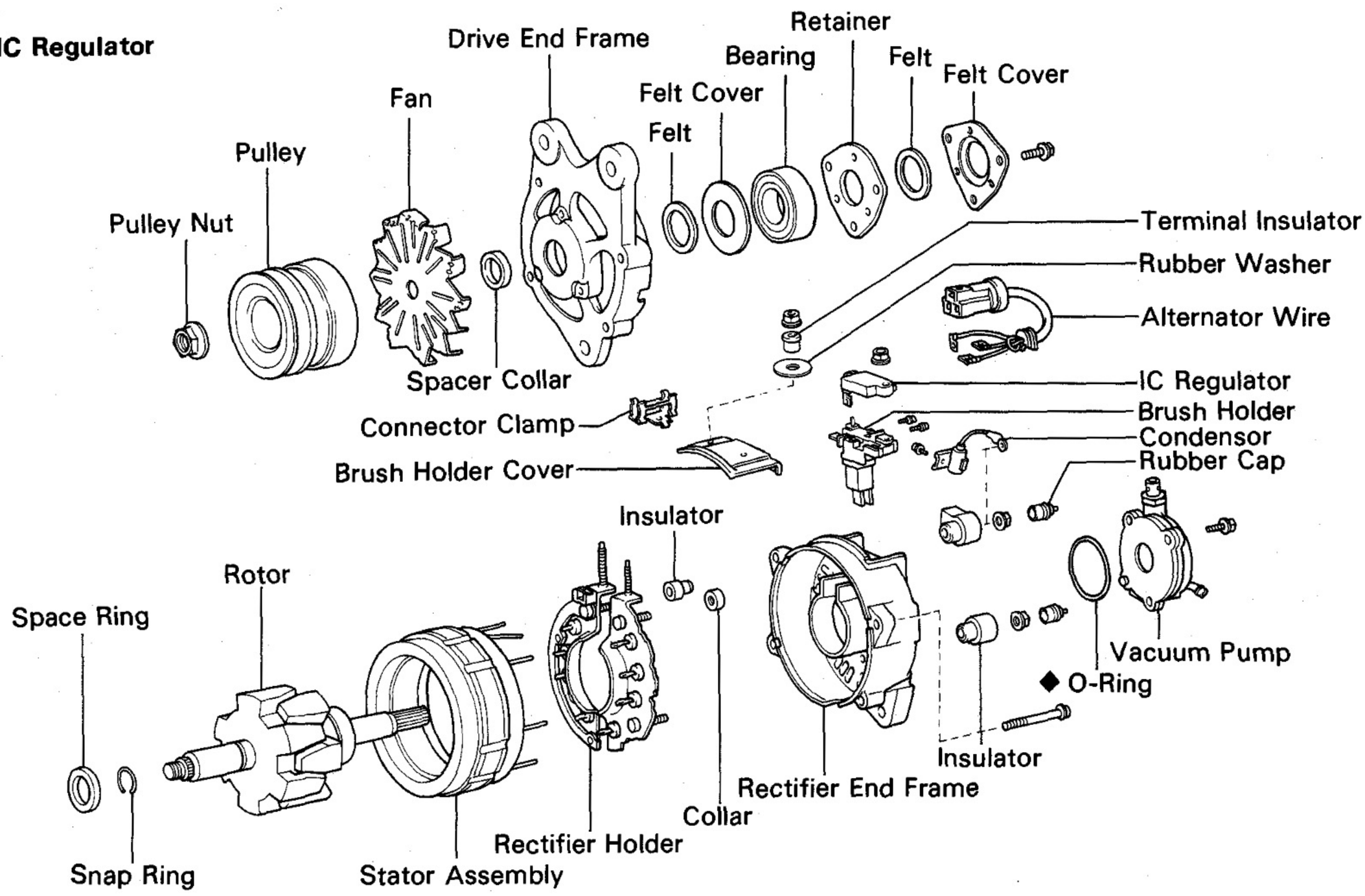
ALTERNATOR

COMPONENTS

w/o IC Regulator

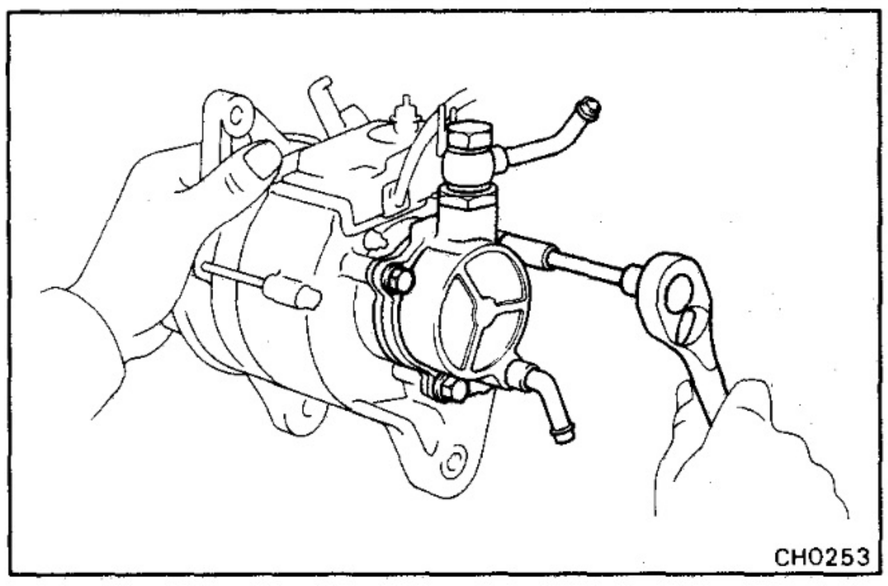


w/ IC Regulator



◆ Non-reusable part

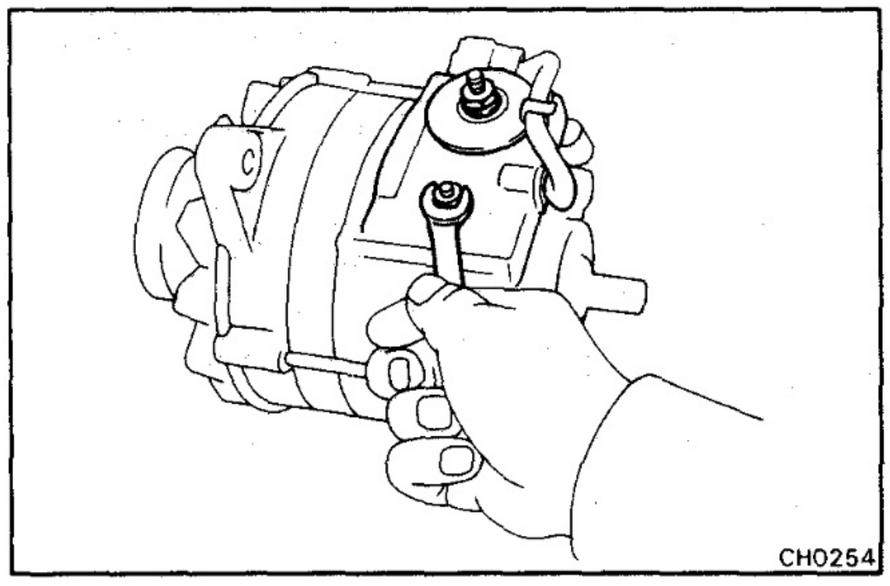
CH0454
CH0455



DISASSEMBLY OF ALTERNATOR

1. REMOVE VACUUM PUMP

Remove the three bolts, vacuum pump and O-ring.



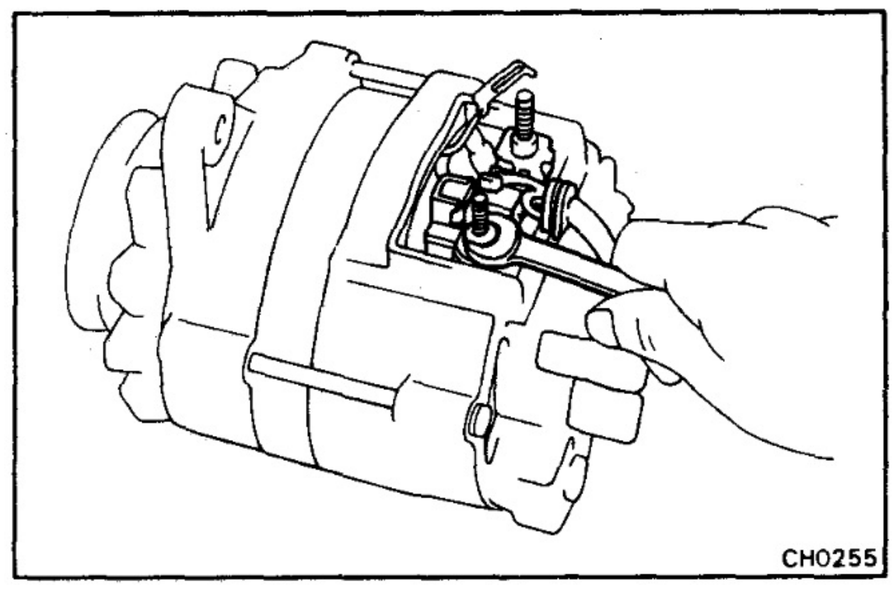
2. REMOVE BRUSH HOLDER COVER

[w/o IC Regulator]

Remove the two nuts, terminal insulator, rubber washer and brush holder cover.

[w/ IC Regulator]

Remove the screw, two nuts, connector clamp, terminal insulator, rubber washer and brush holder cover.

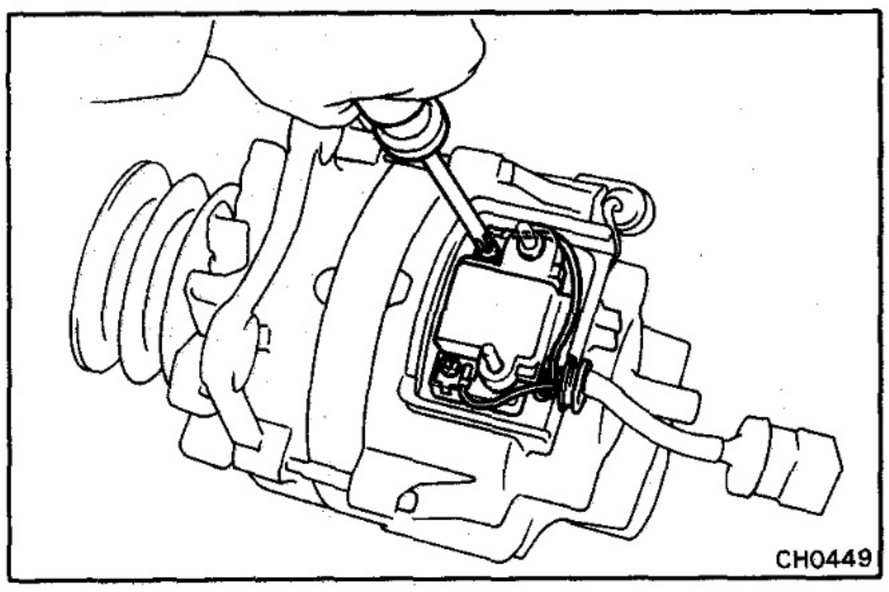


3. [w/o IC REGULATOR] REMOVE BRUSH HOLDER

(a) Remove the insulator washer and disconnect the lead wire.

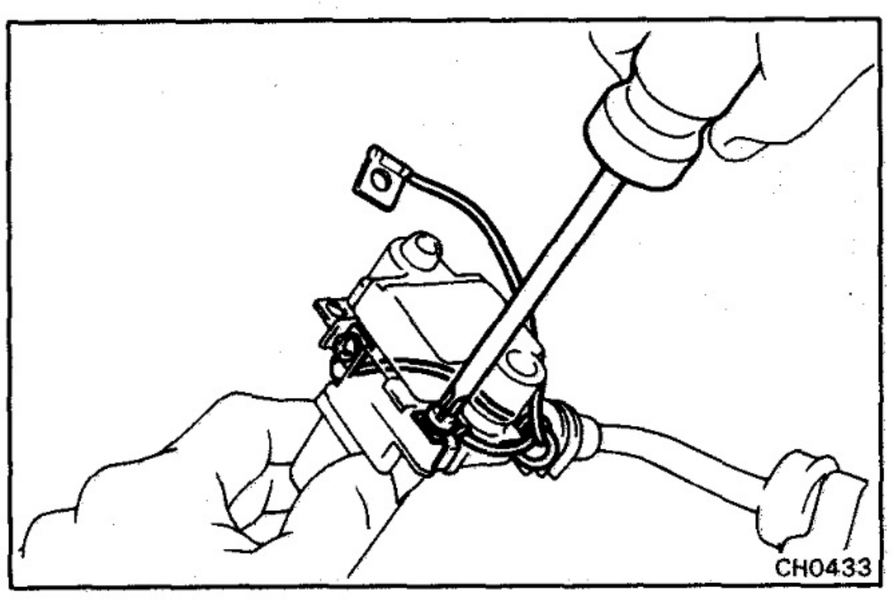
(b) Remove the screw and disconnect the wire clamp of the brush holder.

(c) Remove the nut and brush holder.



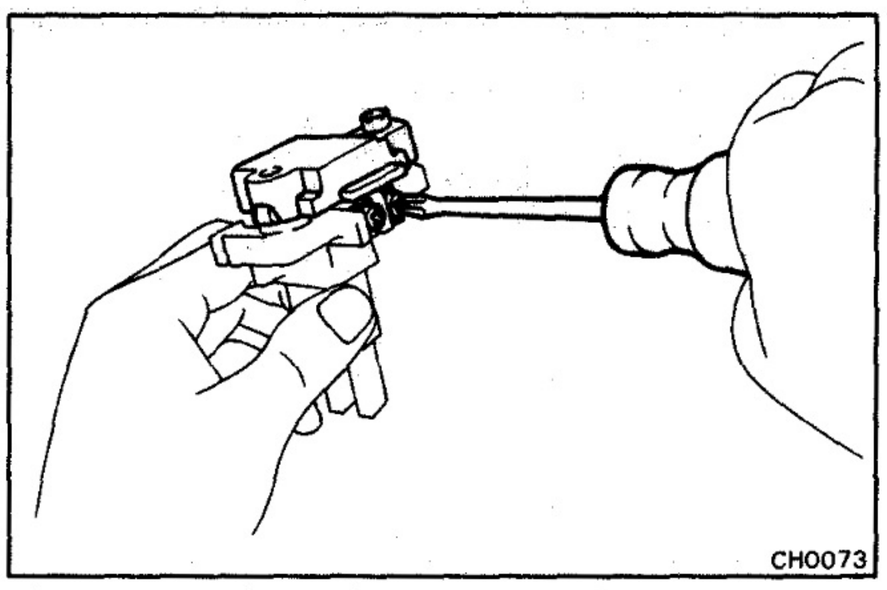
4. [w/ IC REGULATOR] REMOVE BRUSH HOLDER AND IC REGULATOR ASSEMBLY

Remove the screw, brush holder and IC regulator assembly.

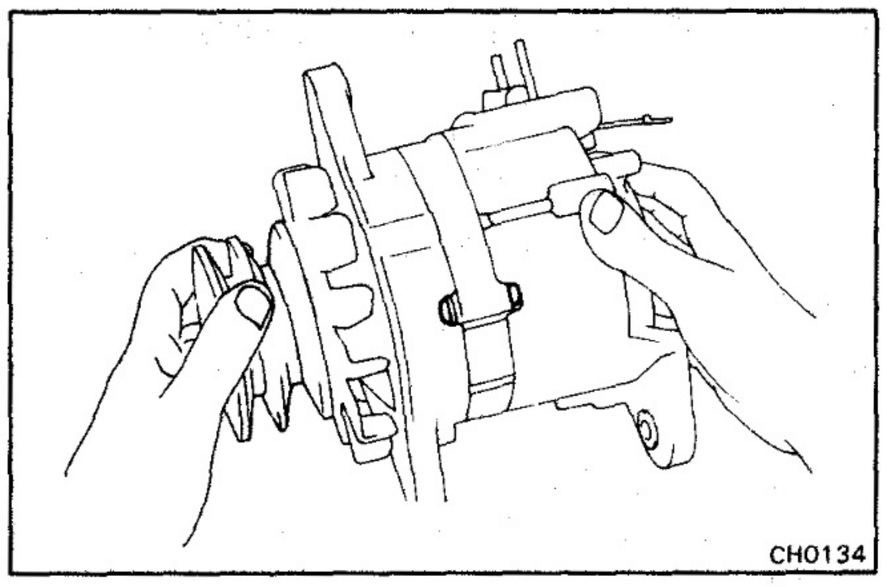


5. [w/ IC REGULATOR] SEPARATE BRUSH HOLDER AND IC REGULATOR

(a) Remove the two screws and alternator wire connector.



(b) Remove the two screws, and separate the brush holder and IC regulator.

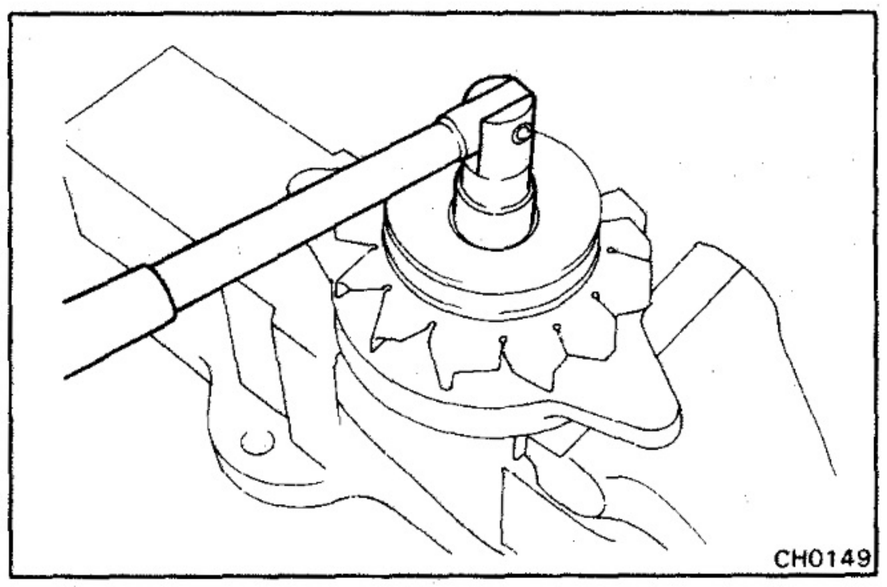


6. REMOVE DRIVE END FRAME WITH ROTOR FROM STATOR

(a) [w/o IC Regulator]
Remove the three through screws.
[w/ IC Regulator]
Remove the four through screws.

(b) Remove the end frame with the rotor.

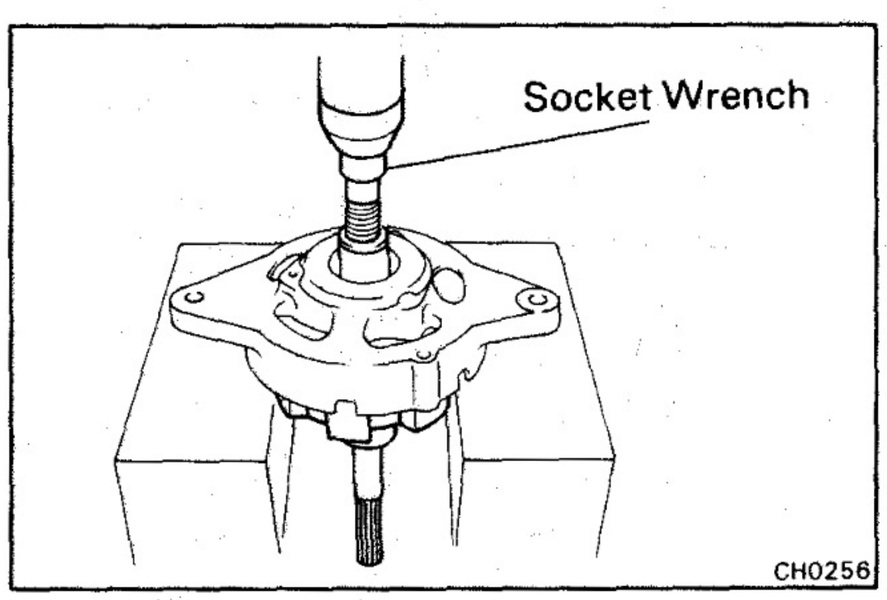
NOTE: If necessary, lightly tap the rotor shaft with a plastic-faced hammer.



7. REMOVE PULLEY AND FAN

(a) Mount the rotor in a soft jaw vise.

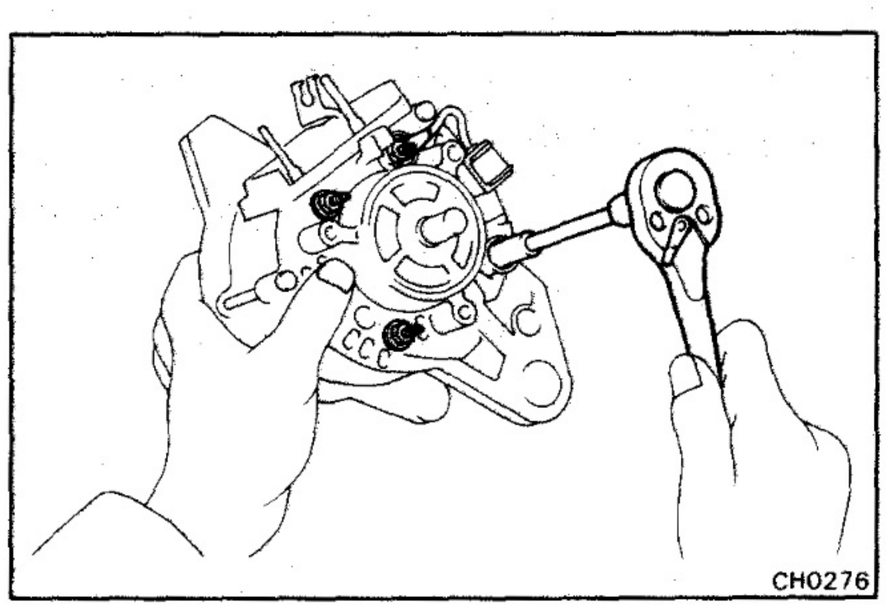
(b) Remove the pulley nut, pulley and fan.



8. REMOVE ROTOR

(a) Using a socket wrench and press, press out the rotor, space ring and spacer collar.

(b) Remove the snap ring from the rotor shaft.

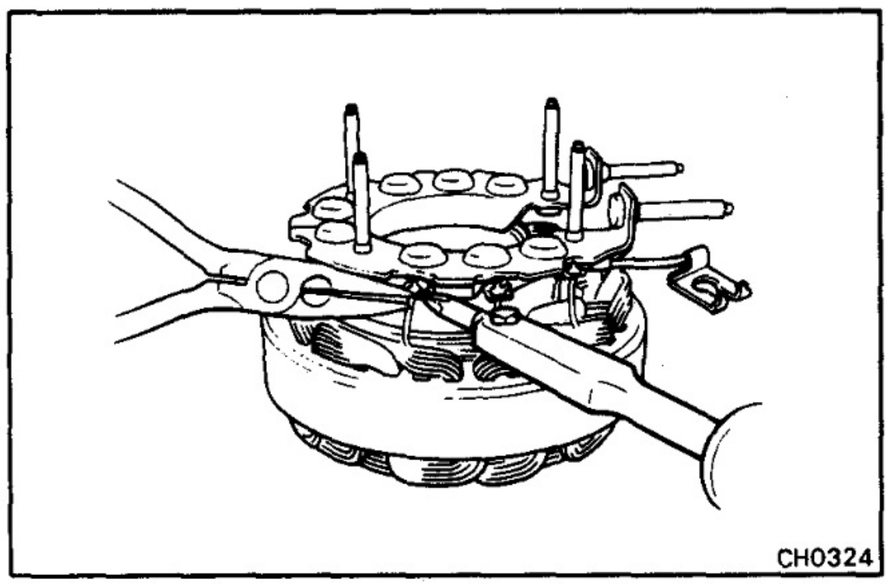


9. REMOVE STATOR WITH RECTIFIER HOLDER

(a) [w/ IC Regulator]
Remove the two rubber caps.

(b) Remove the four nuts, two terminal insulators and stator with the rectifier holder.

(c) Remove the two insulators and collars from the rectifier holder studs.


CH0324

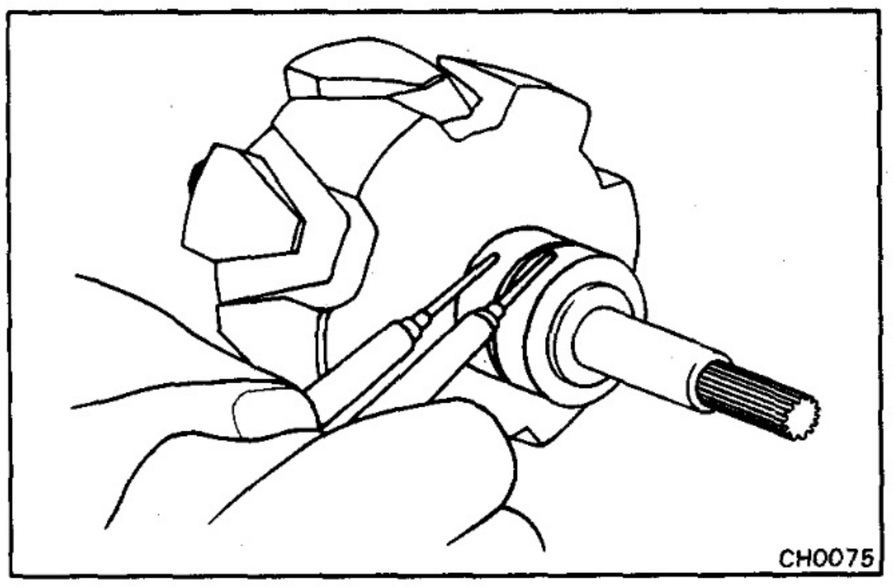
10. REMOVE RECTIFIER HOLDER

Hold the rectifier terminal with needle-nose pliers and unsolder the leads.

CAUTION: Protect rectifiers from heat.

INSPECTION AND REPAIR OF ALTERNATOR

Rotor


CH0075

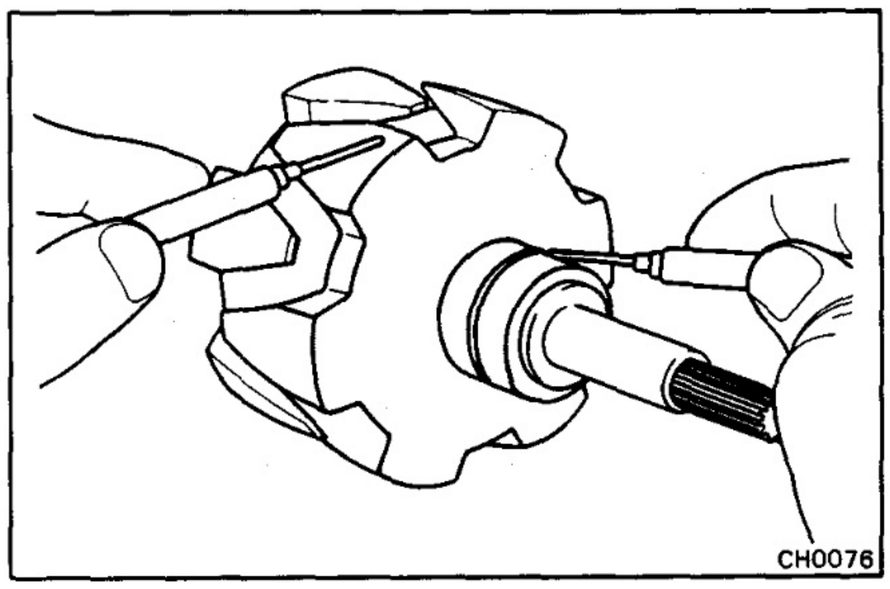
1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance:

w/o IC Regulator
12 V type Approx. 4.0 Ω
24 V type Approx. 19.0 Ω
w/ IC Regulator
Approx. 9.0 Ω

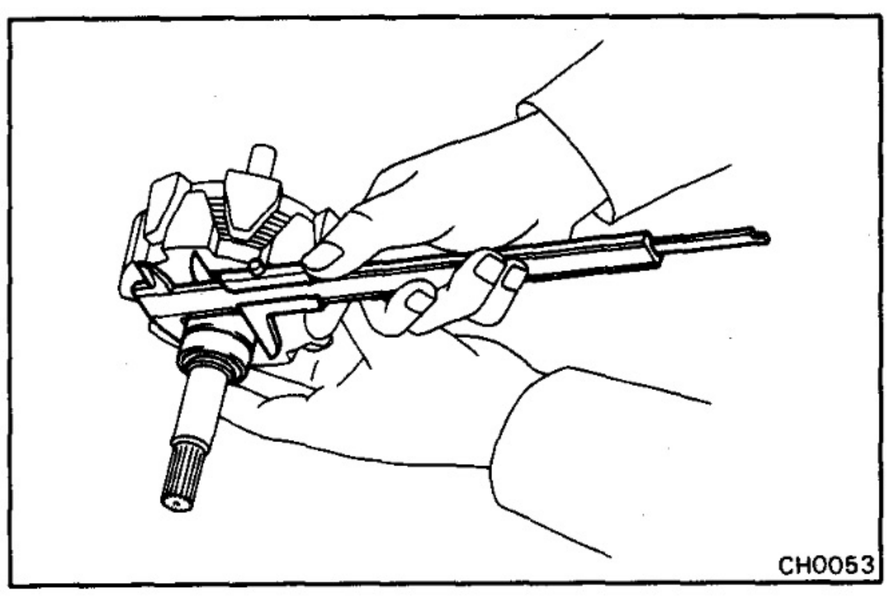
If there is no continuity, replace the rotor.


CH0076

2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

If there is continuity, replace the rotor.


CH0053

3. INSPECT SLIP RINGS

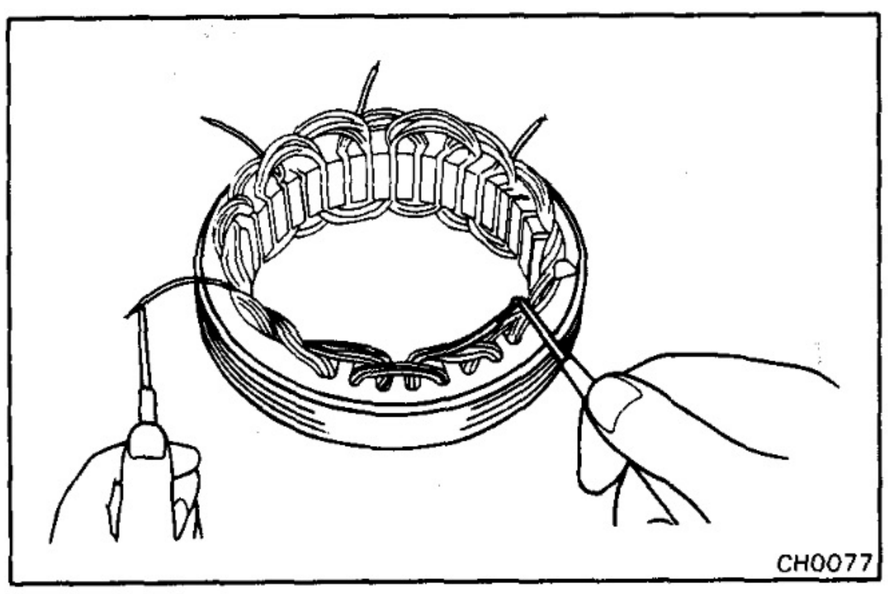
(a) Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.

(b) Using calipers, measure the slip ring diameter.

Standard diameter: 32.3 – 32.5 mm (1.272 – 1.280 in.)
Minimum diameter: 32.1 mm (1.264 in.)

If the diameter is less than minimum, replace the rotor.

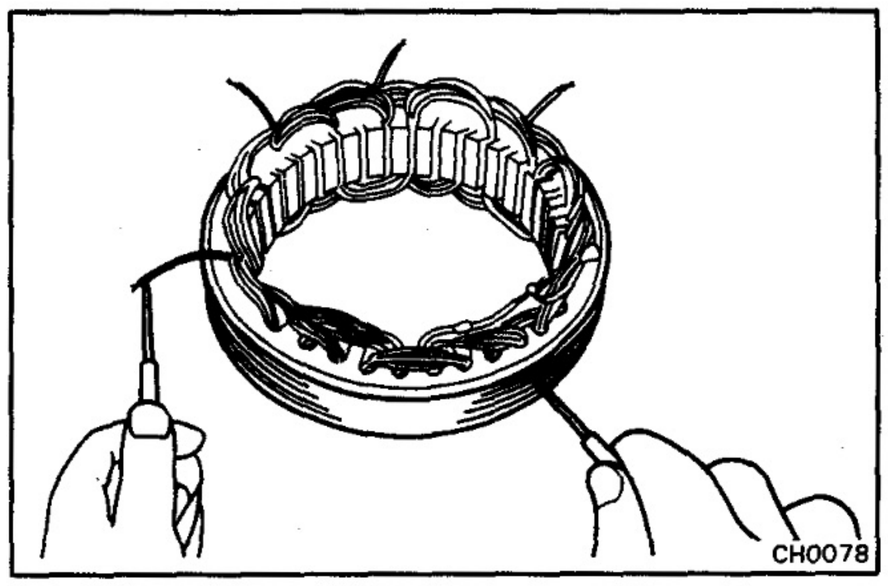

CH0077

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 stator.



2. INSPECT STATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the coil leads and stator core.

If there is continuity, replace the stator.

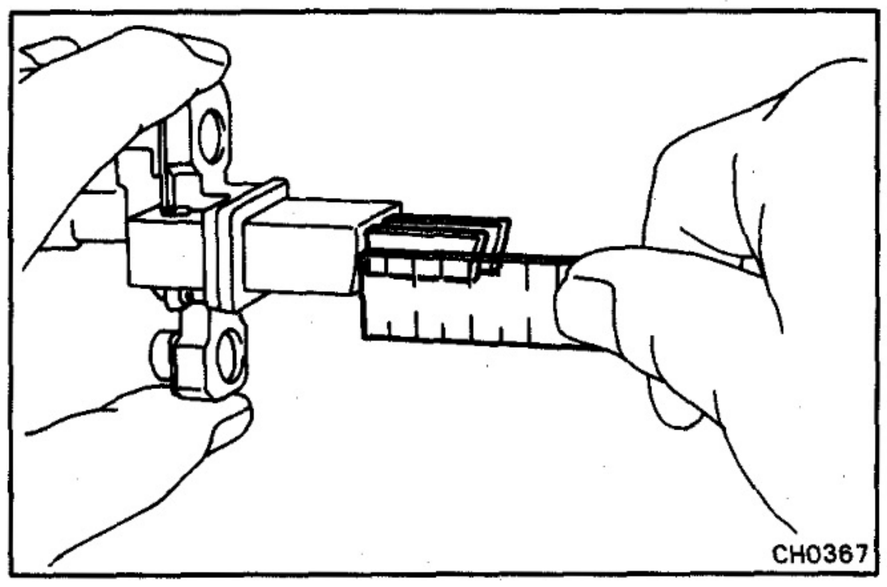
Brush and Brush Holder

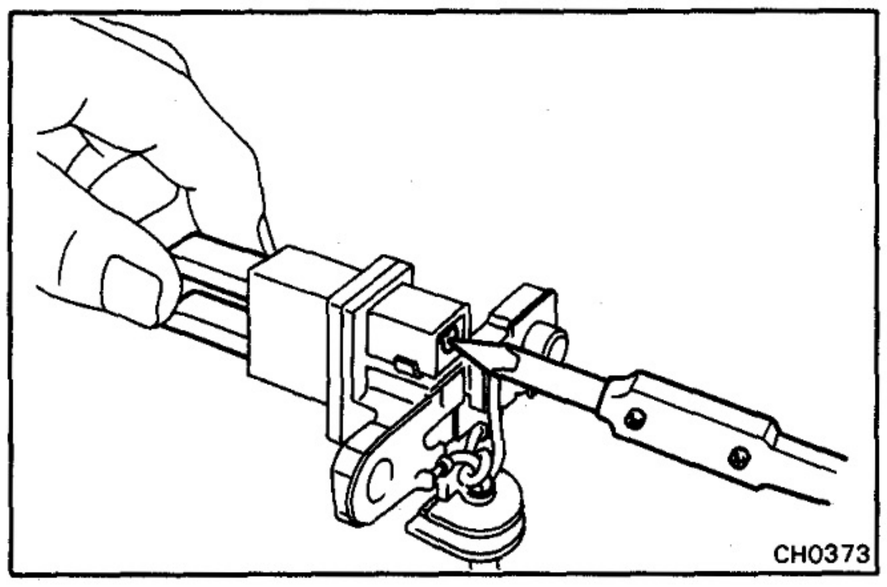
1. INSPECT EXPOSED BRUSH LENGTH

Using a scale, measure the brush length.

Standard exposed length: 20.0 mm (0.787 in.)
Minimum exposed length: 5.5 mm (0.217 in.)

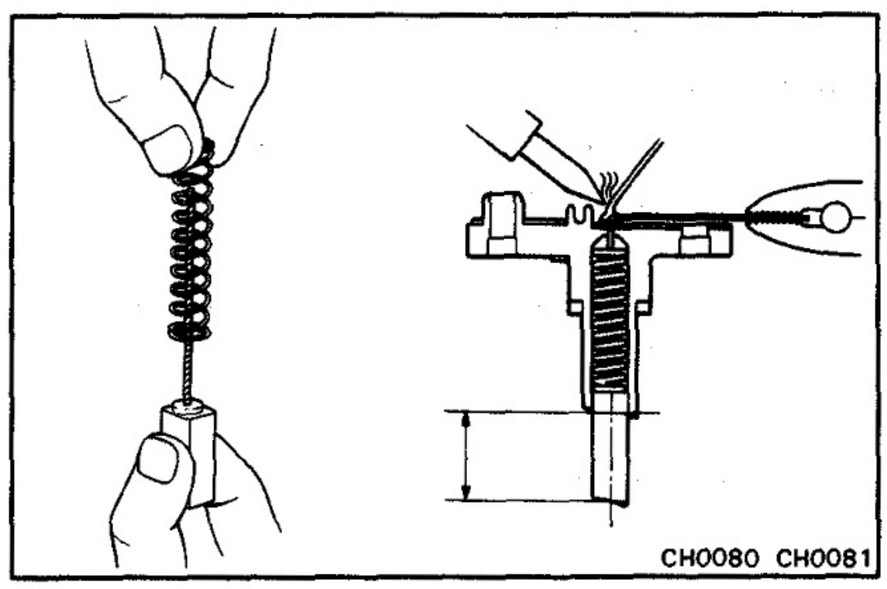
If the brush length is less than minimum, replace the brushes.





2. IF NECESSARY, REPLACE BRUSH

(a) Unsolder and remove the brush and spring.



(b) Insert the brush wire through the spring.

(c) Install the brush in the brush holder.

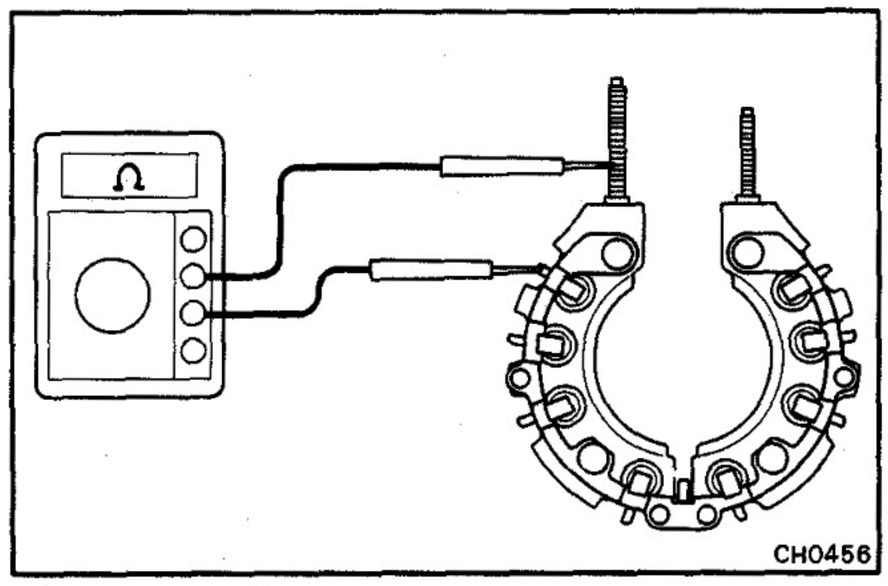
(d) Solder the wire to the brush holder at the standard length.

Exposed length: 20.0 mm (0.787 in.)

(e) Check that the brush moves smoothly in the brush holder.

(f) Cut off any excess wire.

(g) Apply insulation paint to the soldered point.



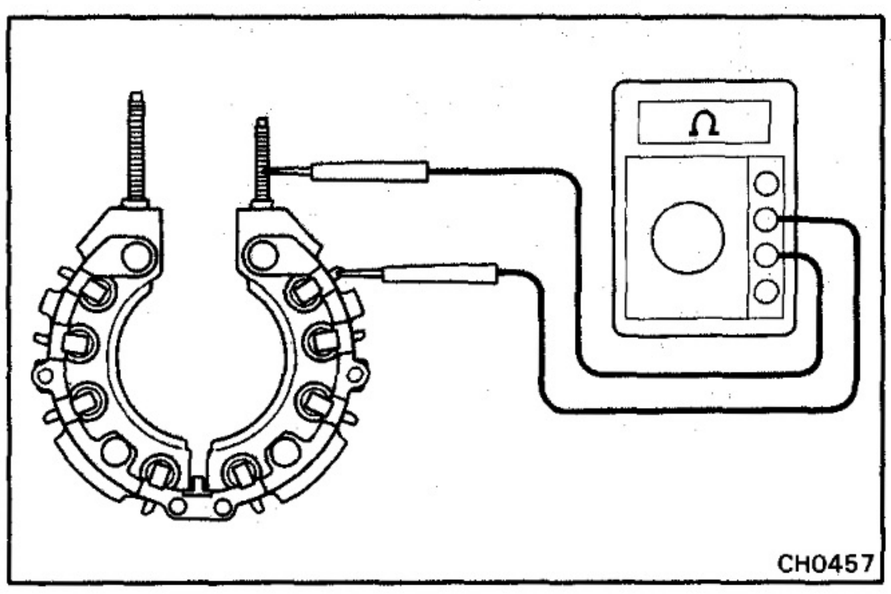
Rectifier

1. INSPECT POSITIVE SIDE RECTIFIER

(a) Using an ohmmeter, measure the continuity between the rectifier terminal and rectifier positive (+) stud.

(b) Check that there is continuity in one direction and that there is no continuity when the ohmmeter probes are reversed.

If continuity is not as specified, replace the rectifier holder.

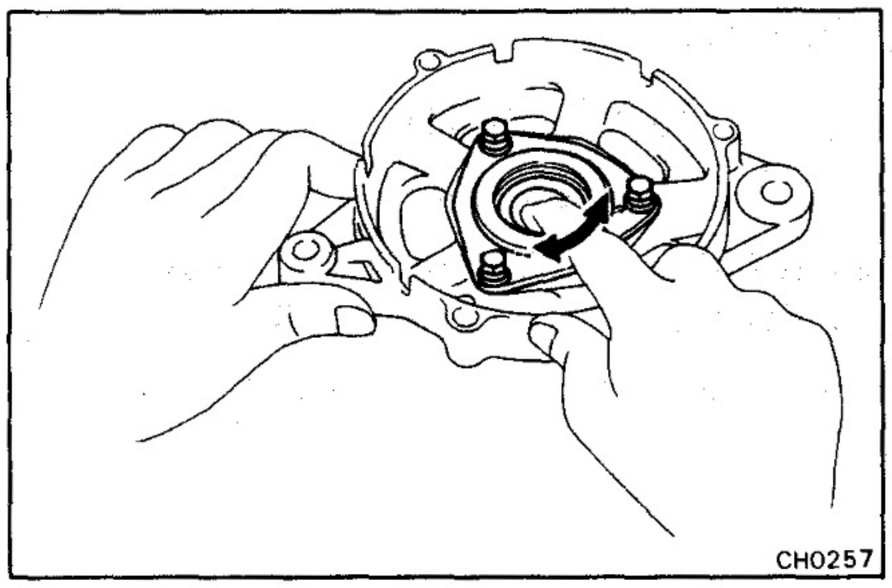


2. INSPECT NEGATIVE SIDE RECTIFIER

(a) Measure the continuity between the rectifier terminal and rectifier negative (–) stud.

(b) Check that there is continuity in one direction and that there is no continuity when the ohmmeter probes are reversed.

If continuity is not as specified, replace the rectifier holder.

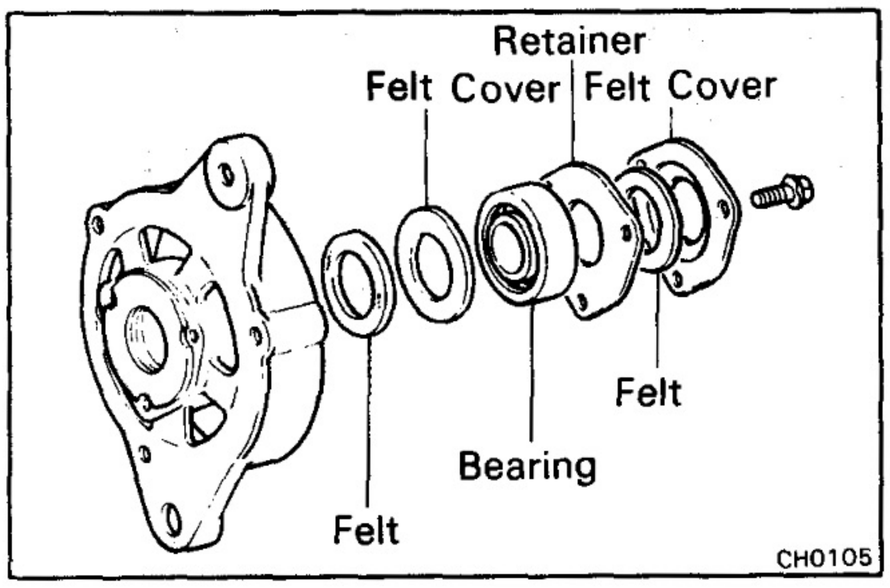


Bearing

1. INSPECT BEARING

Check the bearing for roughness.

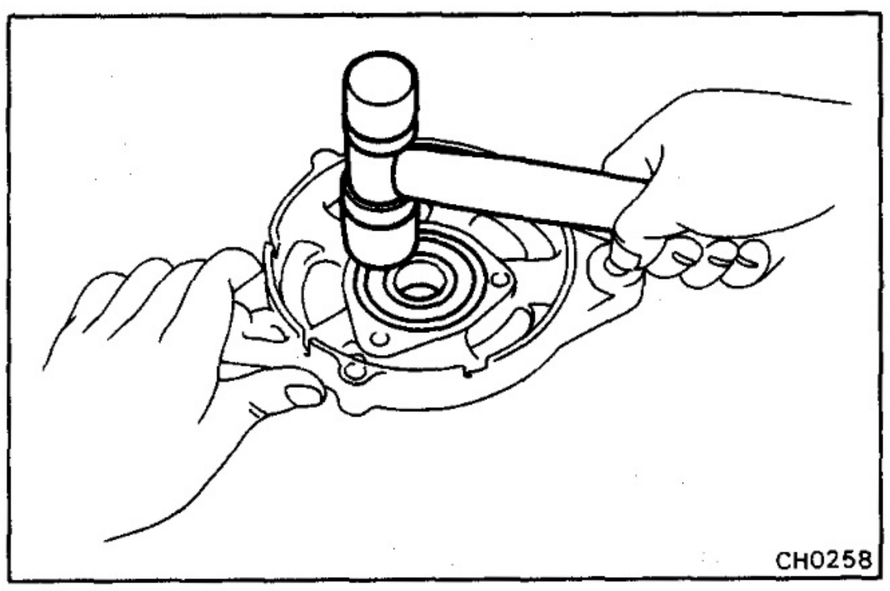
If rough, replace the bearing.



2. IF NECESSARY, REPLACE BEARING

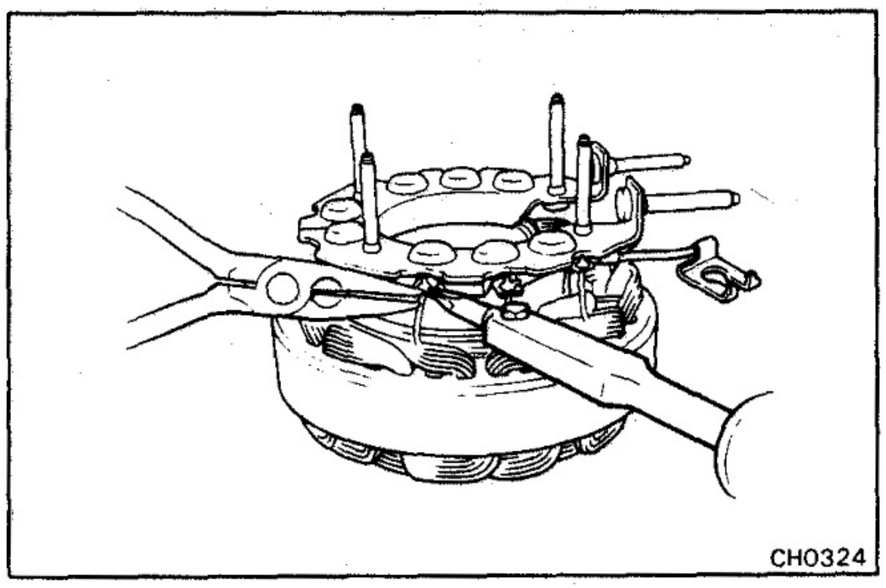
(a) Remove the following parts:

(1) Three bolts
(2) Felt cover
(3) Felt
(4) Retainer
(5) Bearing
(6) Felt cover
(7) Felt



(b) Install the following parts:

(1) Felt
(2) Felt cover
(3) Bearing
If necessary, lightly tap the bearing with a plastic-faced hammer.
(4) Retainer
(5) Felt
(6) Felt cover
(7) Three bolts


CH0324

ASSEMBLY OF ALTERNATOR

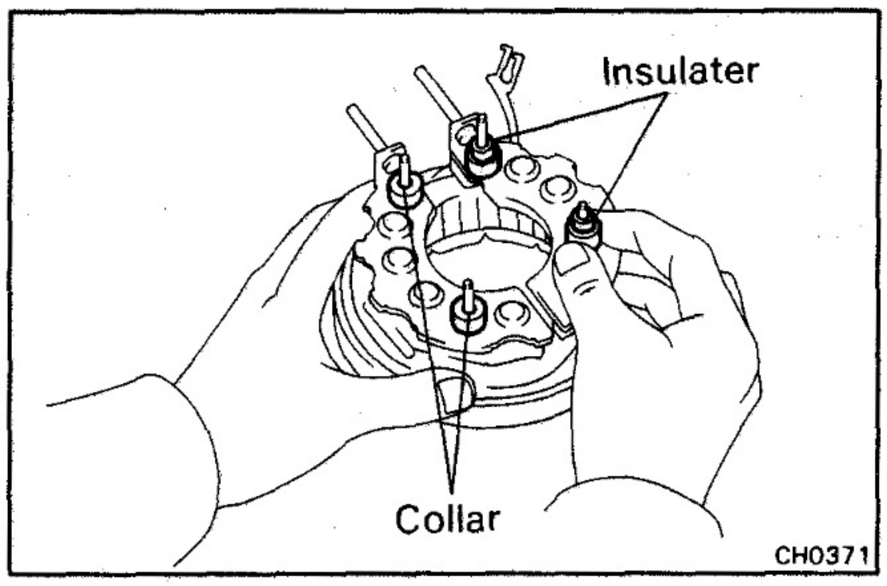
(See page CH-9)

1. INSTALL RECTIFIER HOLDER TO STATOR

Hold the rectifier terminal with needle-nose pliers while soldering the leads.

CAUTION: Protect the rectifiers from heat.

2. ASSEMBLE RECTIFIER END FRAME AND RECTIFIER HOLDER



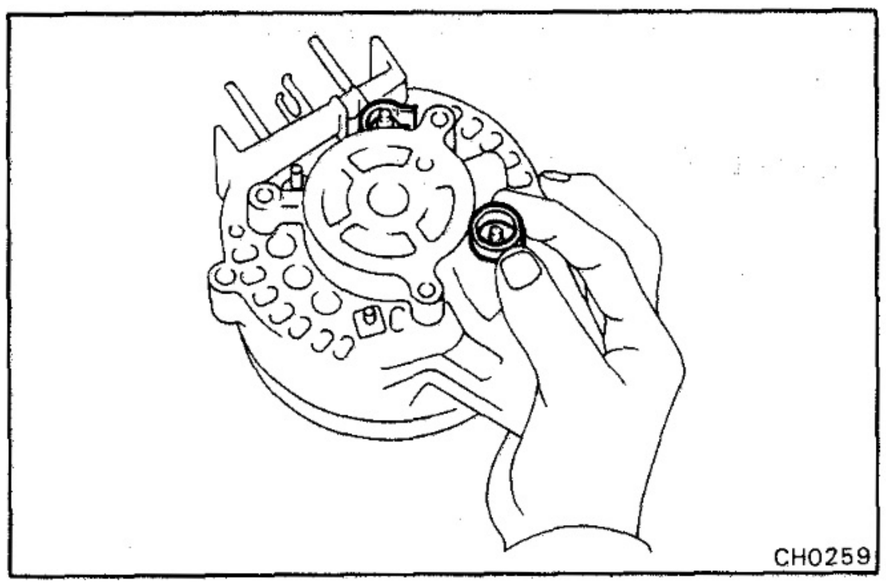
CH0371

(a) Place the two inner terminal insulators on the positive (+) side studs.

(b) Place the two collars on the negative (–) side studs.

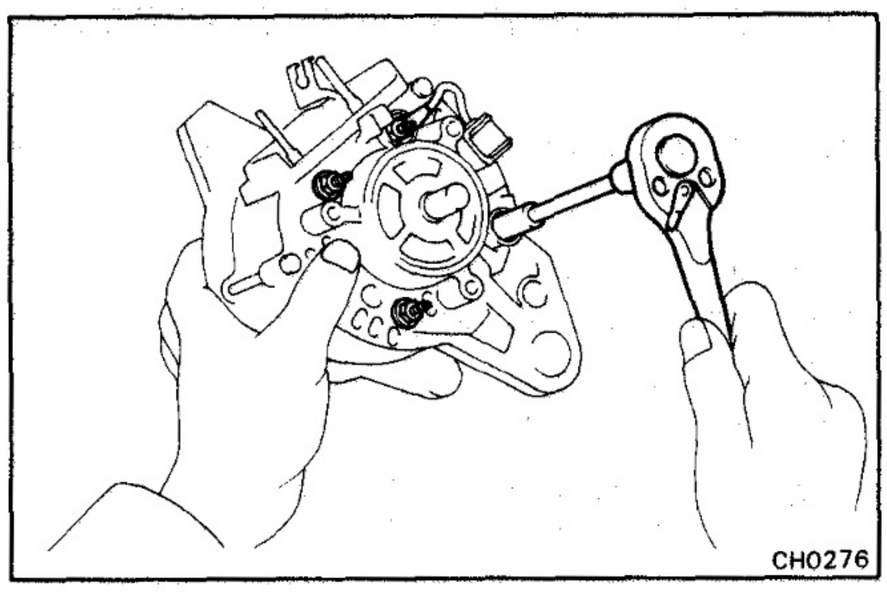
(c) Install the rectifier end frame on the rectifier holder.

(d) Check that the wires are not touching the frame.


CH0259

(e) Place the two outer terminal insulators on the positive (+) side studs.

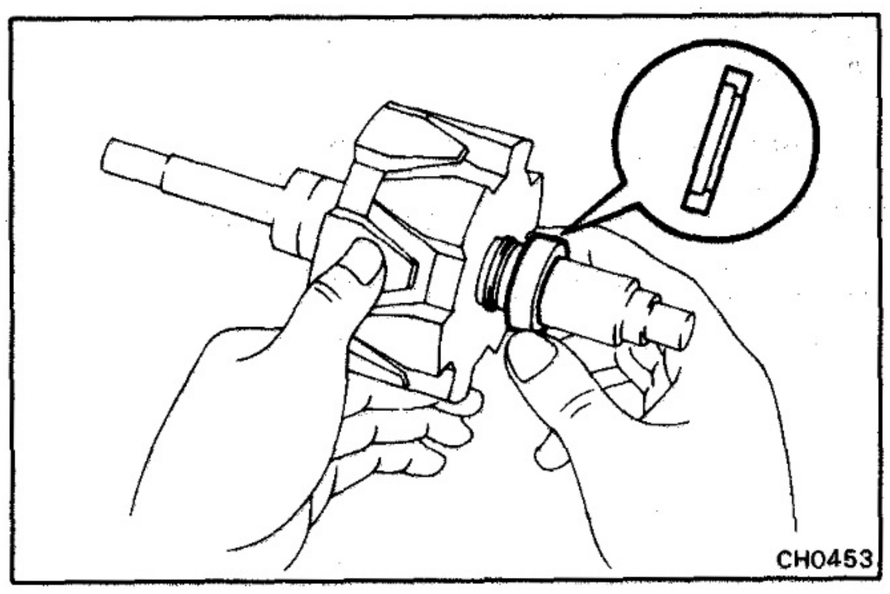
(f) Install the lead wire of the condenser on the positive (+) side stud.


CH0276

(g) Install the four nuts on the studs.

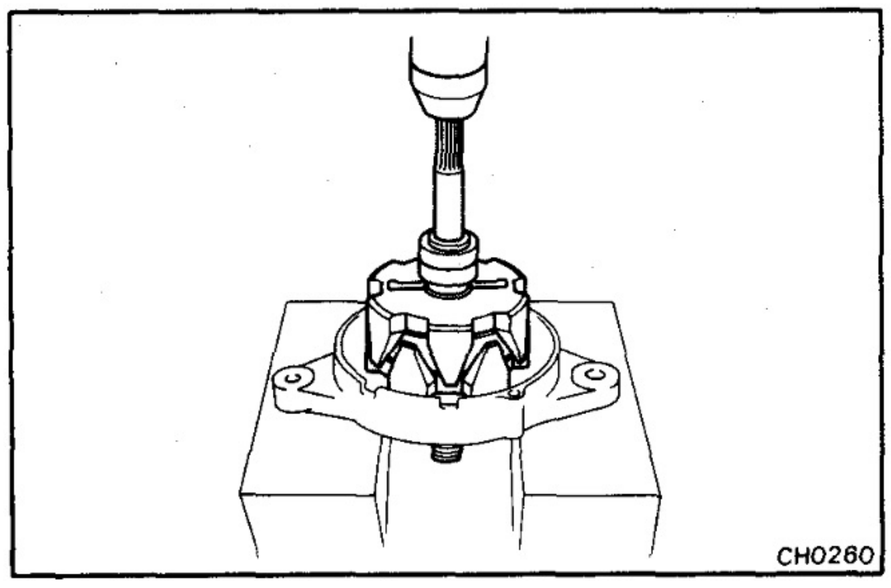
(h) [w/ IC Regulator]
Install the two rubber caps on the positive (+) studs of the rectifier holder.

3. INSTALL ROTOR

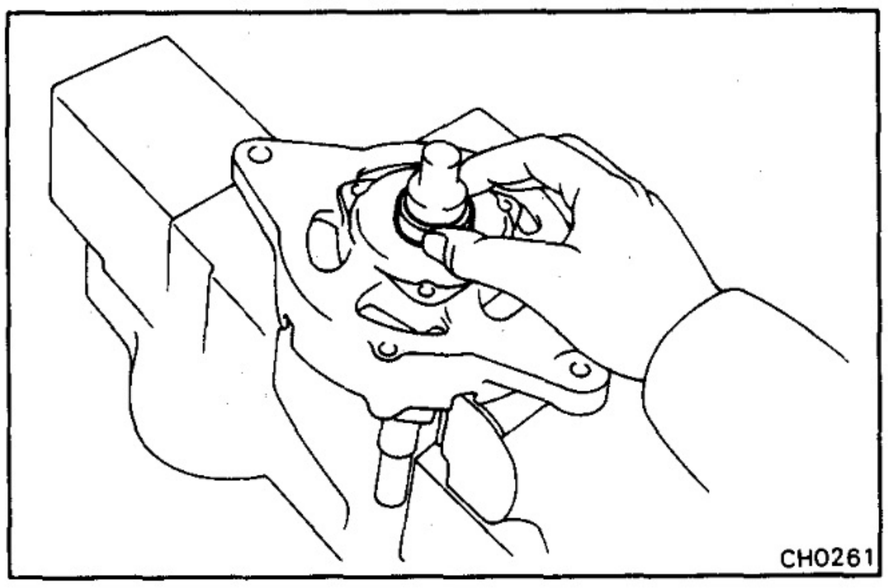

CH0453

(a) Install the snap ring on the rotor shaft groove.

(b) Install the space ring on the rotor shaft.



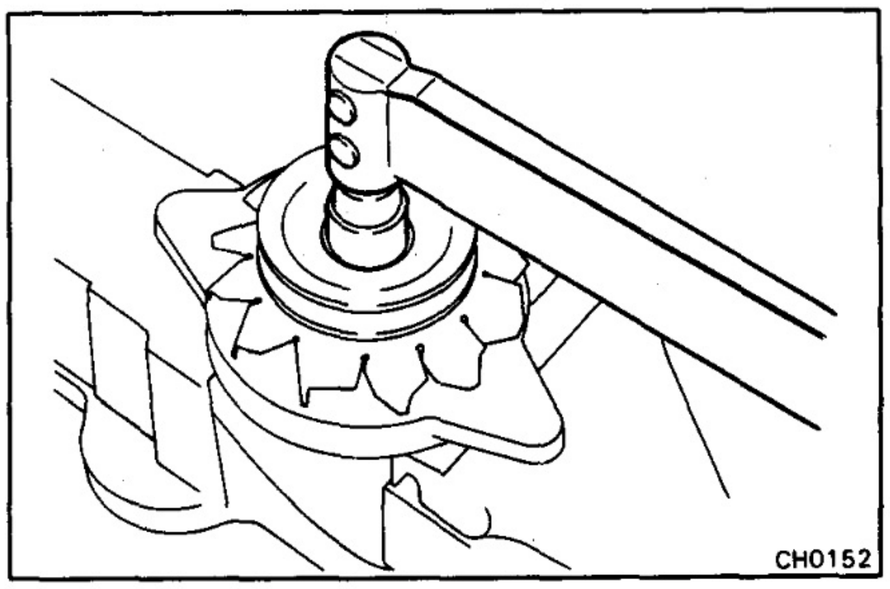
(c) Using a press, press in the rotor.



4. INSTALL FAN AND PULLEY

(a) Mount the rotor in a soft jaw vise.

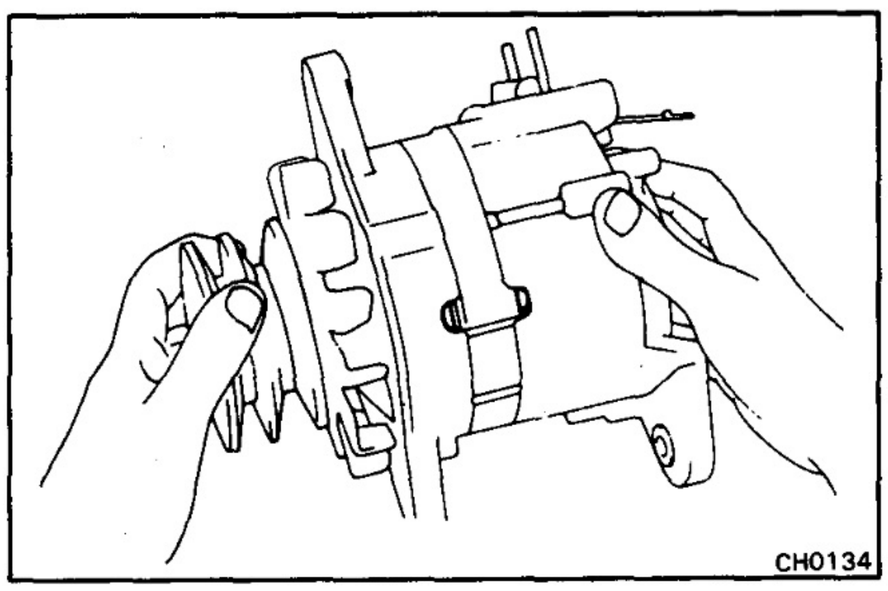
(b) Install the spacer collar.



(c) Slide the fan and pulley onto the shaft.

(d) Install and torque the pulley nut.

Torque: 900 kg-cm (65 ft-lb, 88 N·m)

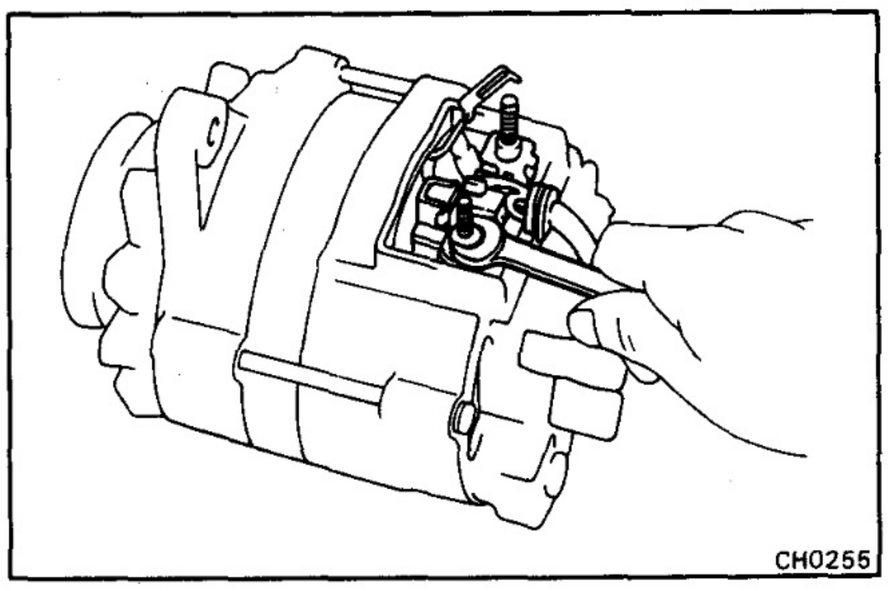


5. ASSEMBLE DRIVE END FRAME AND RECTIFIER END FRAME

(a) Assemble the drive end frame and rectifier end frame.

(b) [w/o IC Regulator]
Install the three through screws.
[w/ IC Regulator]
Install the four through screws.

(c) Make sure the rotor rotates smoothly.

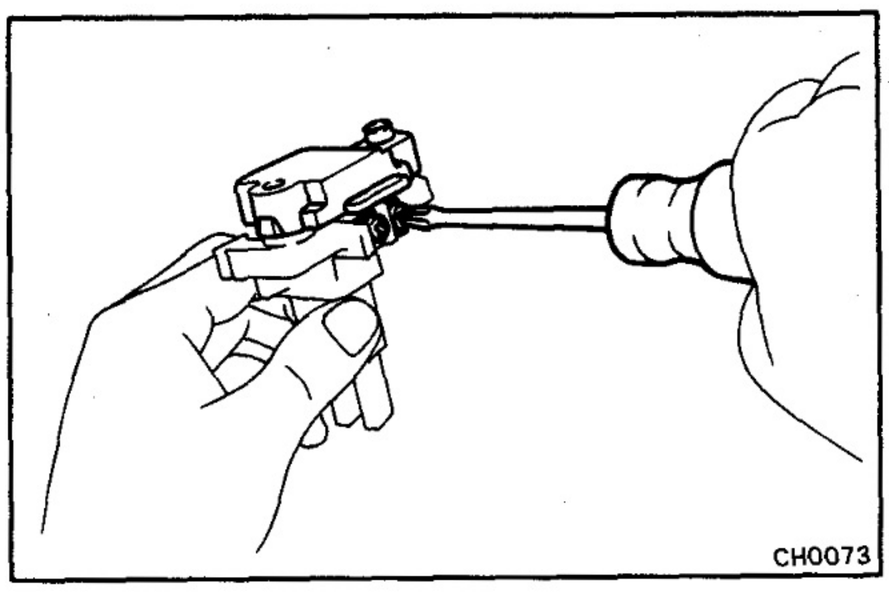


**6. [w/o IC REGULATOR]
INSTALL BRUSH HOLDER**

(a) Install the brush holder with the nut.

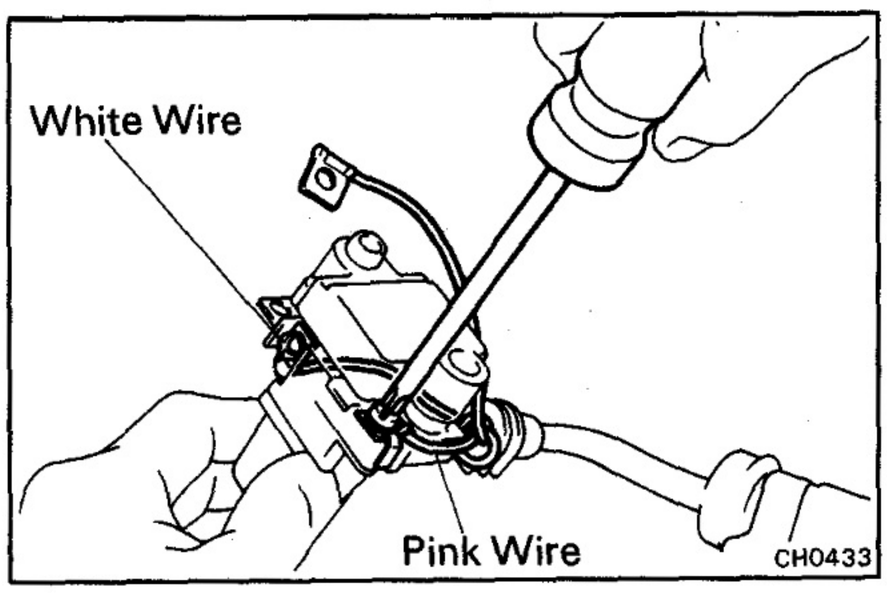
(b) Connect the brush holder wire clamp with the screw.

(c) Connect the lead wire to terminal B.

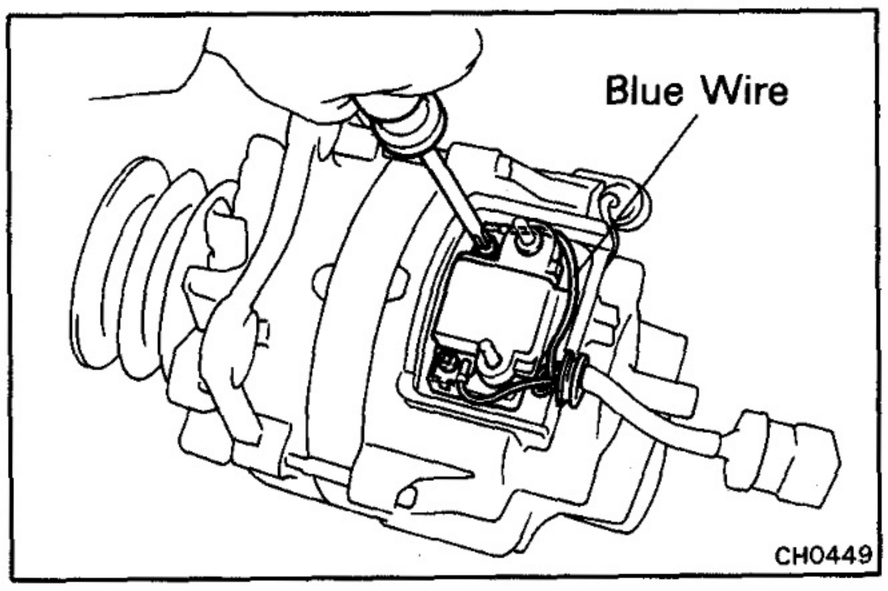


7. [w/ IC REGULATOR]
ASSEMBLE BRUSH HOLDER AND IC REGULATOR

(a) Assemble the brush holder and IC regulator with the two screws.

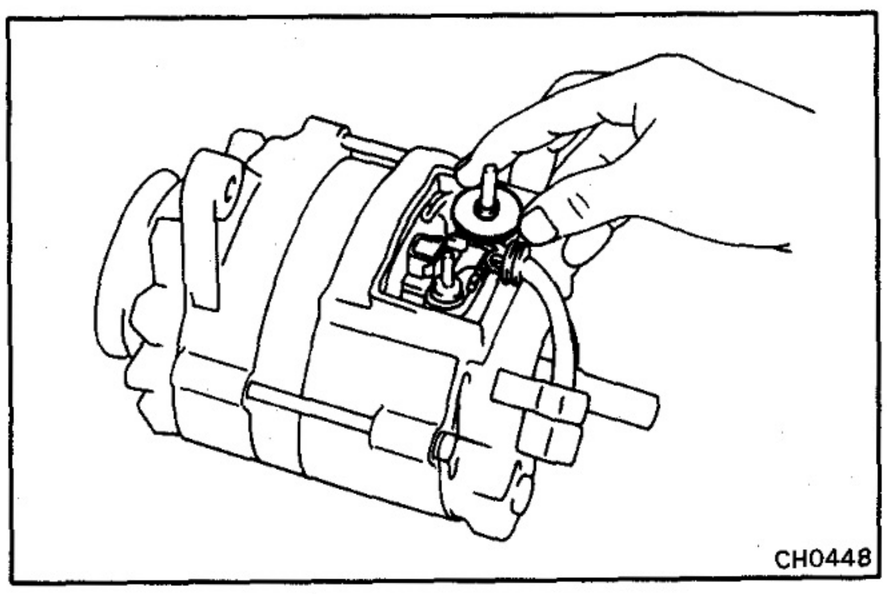


(b) Connect the two wires of the alternator wire connector to the terminals of the IC regulator with the two screws as shown.



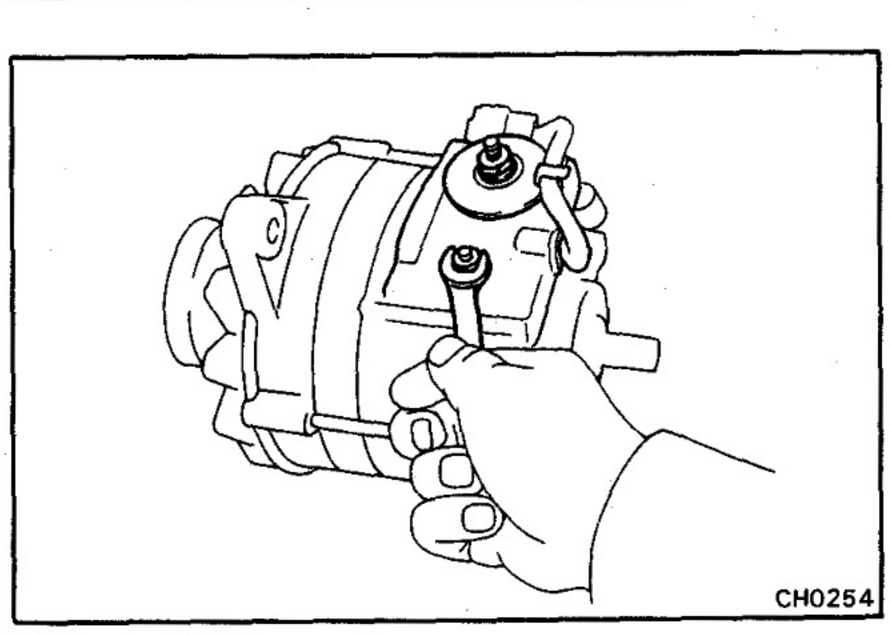
8. [w/ IC REGULATOR]
INSTALL BRUSH HOLDER AND IC REGULATOR ASSEMBLY

Install the brush holder and IC regulator assembly with the screw. Connect the alternator wire to the terminal of the IC regulator as shown.



9. INSTALL BRUSH HOLDER COVER

(a) [w/o IC Regulator]
Place the insulator washer on terminal B.

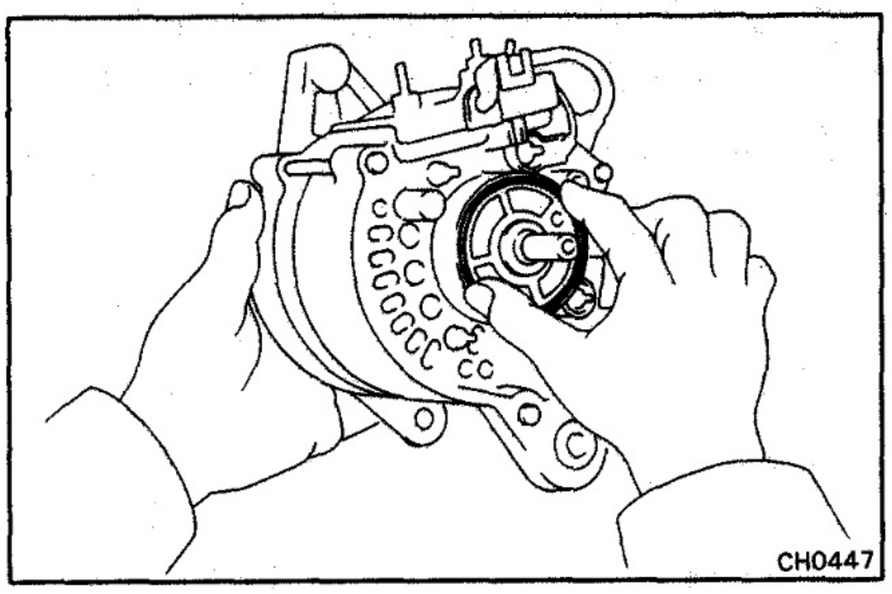


(b) Place the cover on the rectifier end frame.

(c) Place the terminal insulator and rubber washer on terminal B.

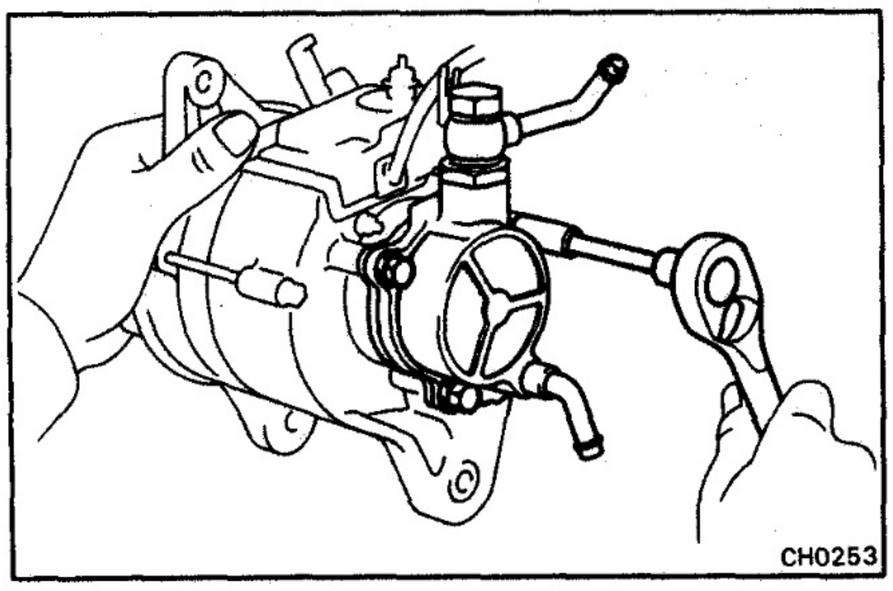
(d) [w/o IC Regulator]
Install the two nuts.

(e) [w/ IC Regulator]
Install the screw and two nuts together with the connector clamp.



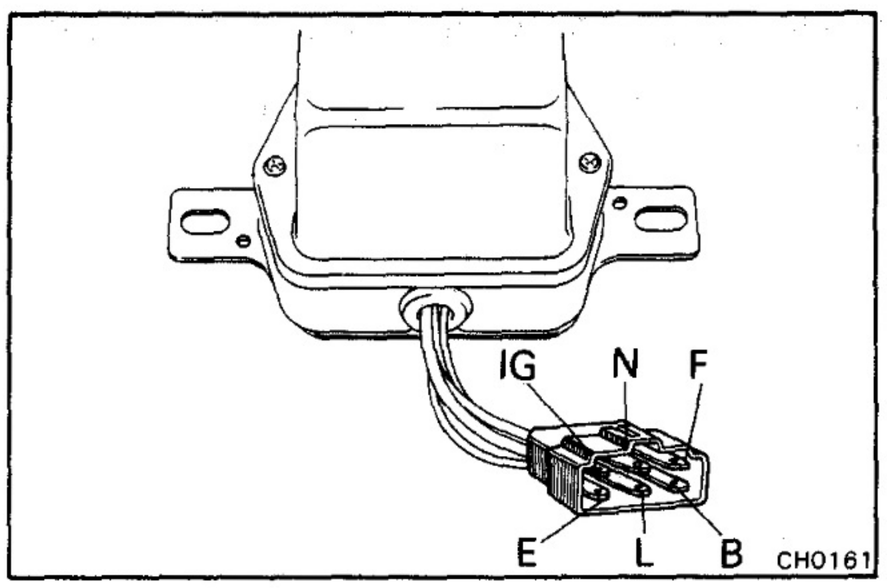
10. INSTALL VACUUM PUMP

(a) Place a new O-ring on the rectifier end frame.



(b) Install the vacuum pump with the three bolts. Torque the bolts.

Torque: 80 kg-cm (69 in.-lb, 7.8 N·m)

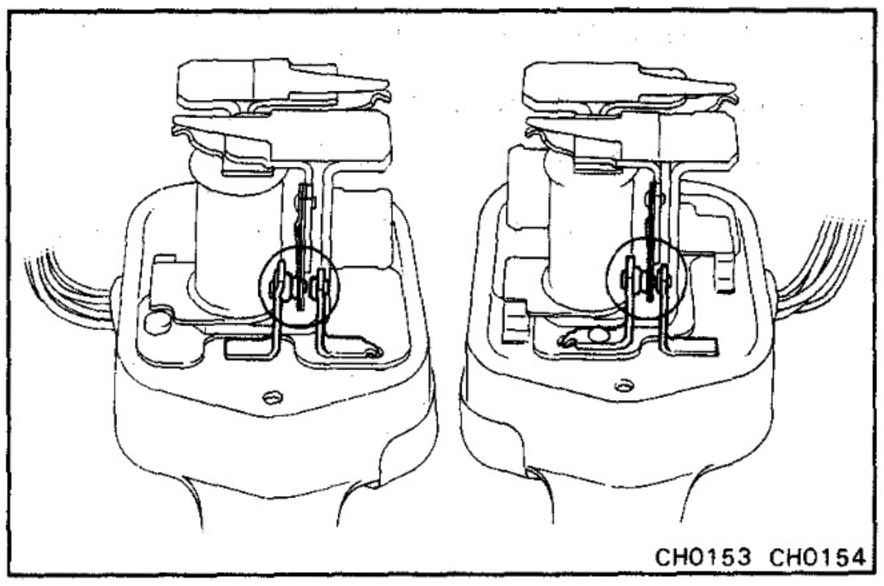


ALTERNATOR REGULATOR (w/o IC Regulator)

INSPECTION OF ALTERNATOR REGULATOR

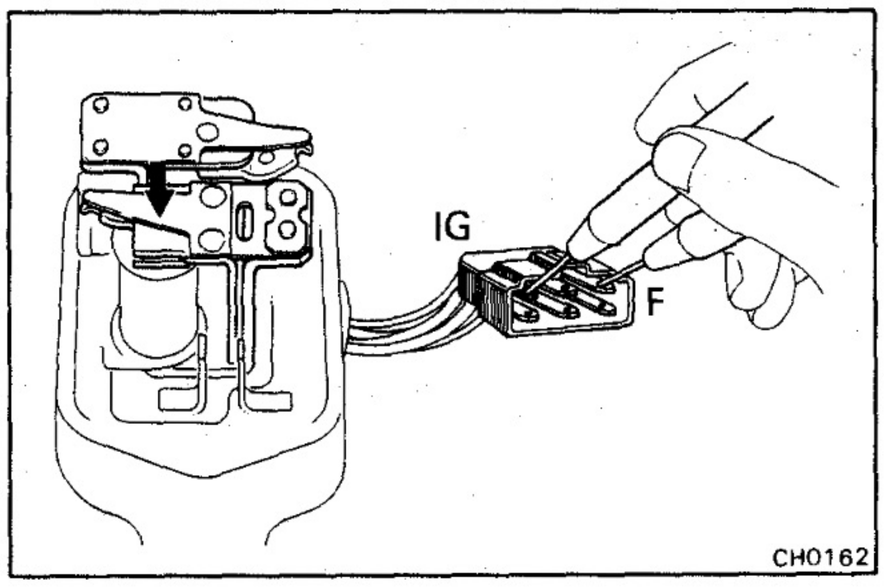
1. DISCONNECT REGULATOR CONNECTOR

2. REMOVE TWO MOUNTING BOLTS AND REGULATOR



3. INSPECT POINT SURFACES FOR BURN OR DAMAGE

If defective, replace the regulator.

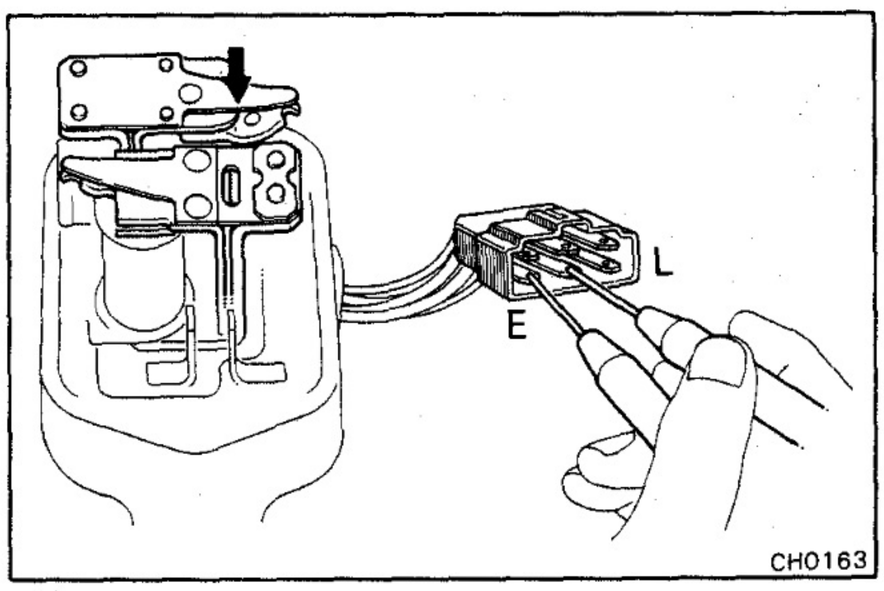


4. INSPECT RESISTANCE BETWEEN TERMINALS

(a) Using an ohmmeter, measure the resistance between terminals IG and F.

Resistance (voltage regulator):

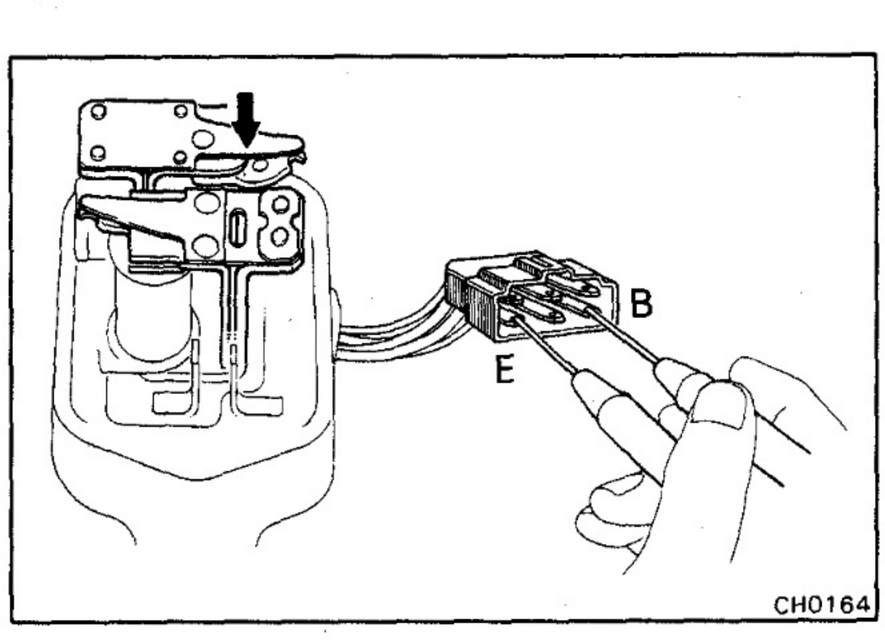
At rest		**0 Ω**
Pulled in	**12 V type**	**Approx. 10.5 Ω**
	24 V type	**Approx. 200 Ω**



(b) Measure the resistance between terminals L and E.

Resistance (voltage relay):

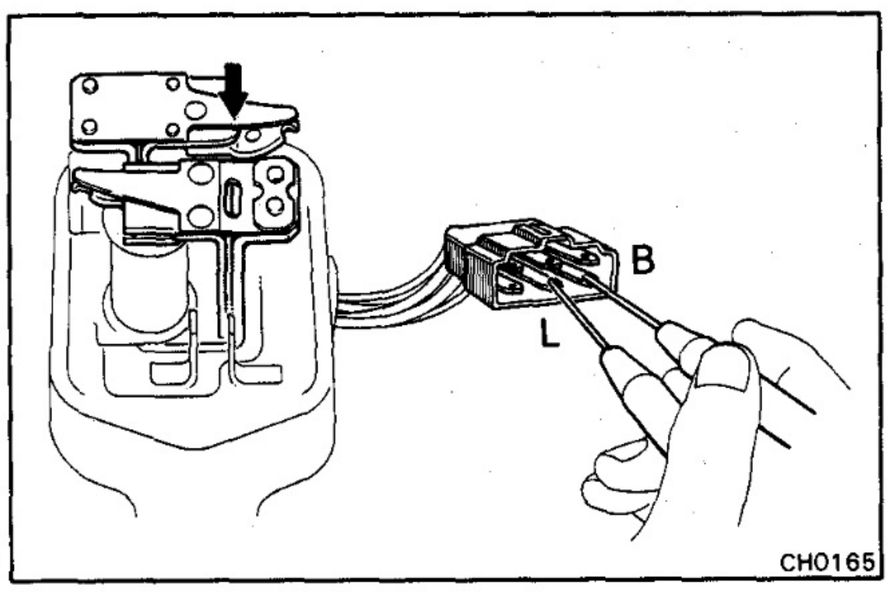
At rest		**0 Ω**
Pulled in	**12 V type**	**Approx. 102 Ω**
	24 V type	**Approx. 199 Ω**



(c) Measure the resistance between terminals B and E.

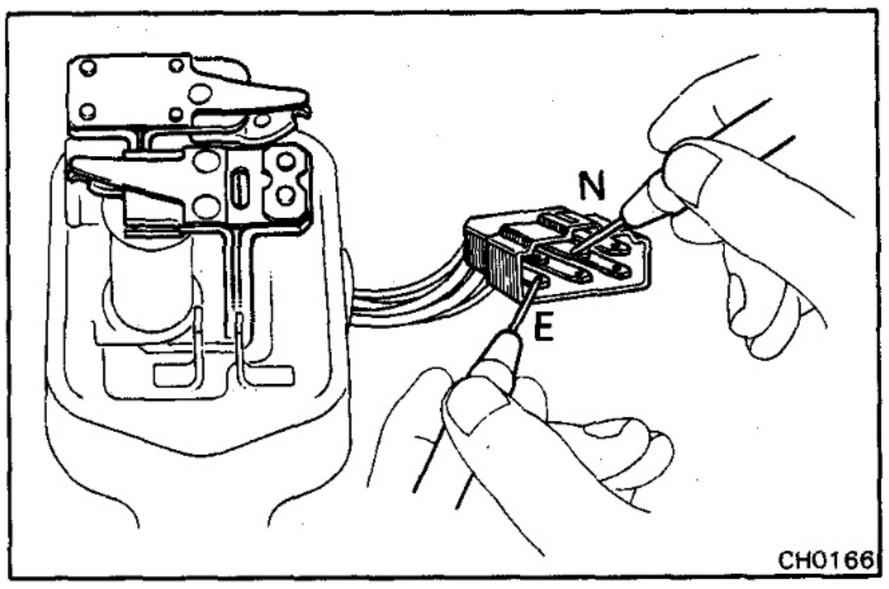
Resistance (voltage relay):

At rest		**Infinity**
Pulled in	**12 V type**	**Approx. 102 Ω**
	24 V type	**Approx. 199 Ω**



(d) Measure the resistance between terminals B and L.

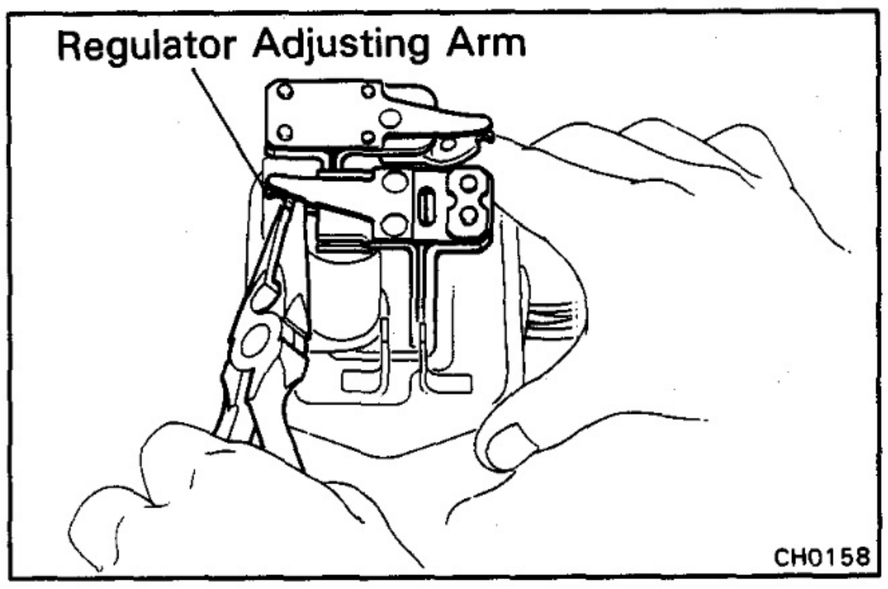
Resistance (voltage relay): At rest Infinity
Pulled in 0 Ω



(e) Measure the resistance between terminals N and E.

Resistance: 12 V type Approx. 24 Ω
24 V type Approx. 102 Ω

If any of the above checks are not as specified, replace the alternator regulator.

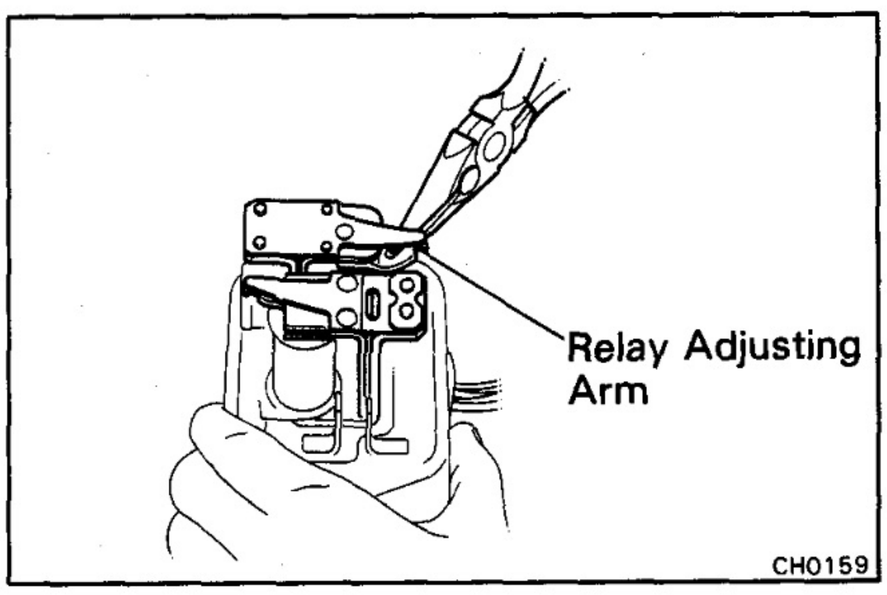


VOLTAGE ADJUSTMENT OF ALTERNATOR REGULATOR

1. ADJUST VOLTAGE REGULATOR

Bend the regulator adjusting arm to adjust.

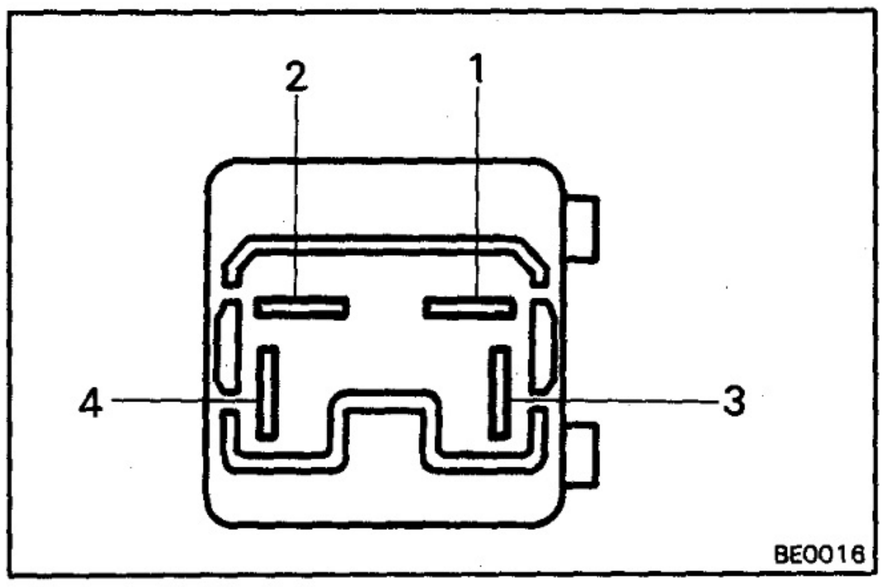
Regulating voltage:
12 V type 13.8 – 14.8 V at 25°C (77°F)
24 V type 27.0 – 29.0 V at 25°C (77°F)



2. ADJUST VOLTAGE RELAY

Bend the relay adjusting arm to adjust.

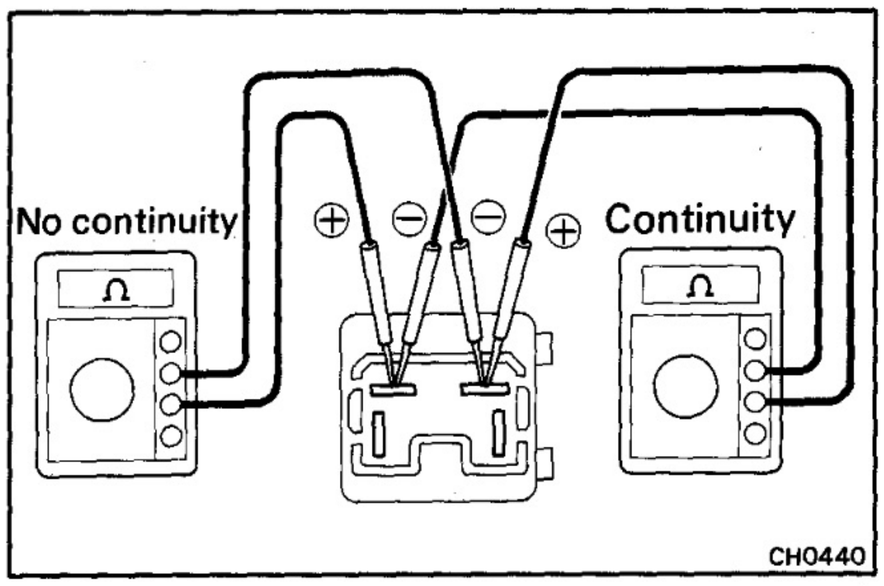
Relay actuating voltage:
12 V type 4.0 – 5.8 V
24 V type 8.0 – 11.6 V



CHARGE LIGHT RELAY (w/ IC Regulator)

INSPECTION OF CHARGE LIGHT RELAY

LOCATION: Inside wall adjacent to passenger door.



1. INSPECT RELAY CONTINUITY

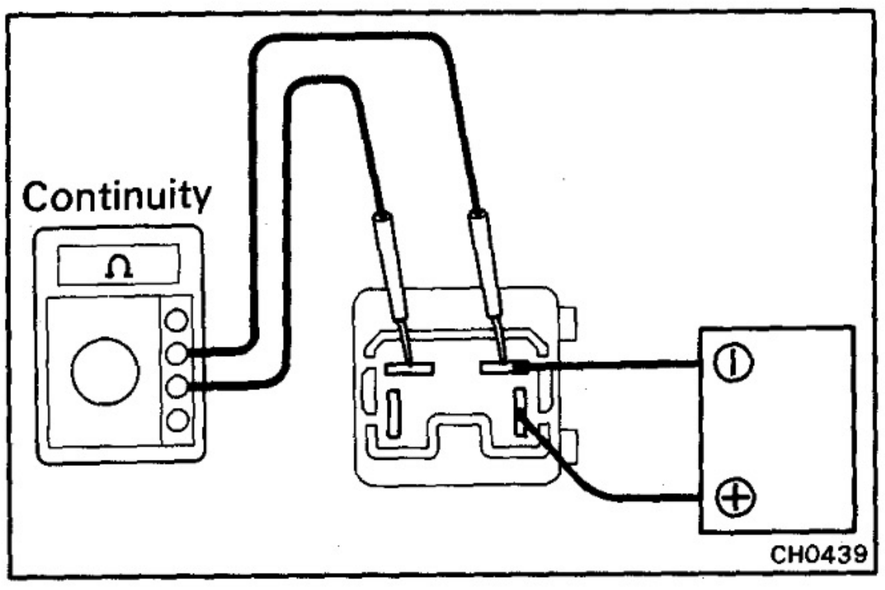
Using an ohmmeter, check that there is continuity between the following terminals:

- **1 ↔ 2**

  Positive (+) test probe to terminal 1
  Negative (–) test probe to terminal 2
  Continuity
  Positive (+) test probe to terminal 2
  Negative (–) test probe to terminal 1
  No continuity

If continuity is not as specified, replace the relay.

CAUTION: Depending on the ohmmeter, there may be instances in which probe polarity is reversed.



2. INSPECT RELAY OPERATION

Apply battery positive (+) terminal to terminal 3 and negative (–) terminal to terminal 1.

- **1 ↔ 2 Continuity**

If operation is not as described, replace the relay.

SERVICE SPECIFICATIONS

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LUBRICATION SYSTEM	A-14
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CHARGING SYSTEM	A-15

ENGINE MECHANICAL

Specifications

Drive belt deflection with 10 kg (22.0 lb, 98 N)					
Fan pulley – Alternator					
Single belt		New belt	8 – 12 mm		0.31 – 0.47 in.
		Used belt	11 – 16 mm		0.43 – 0.63 in.
Double belt		New belt	12 – 15 mm		0.47 – 0.59 in.
		Used belt	14 – 20 mm		0.55 – 0.79 in.
Drive belt tension with SST (Reference)					
Fan pulley – Alternator					
Single belt		New belt	55 – 65 kg		
		Used belt	30 – 45 kg		
Double belt		New belt	45 – 55 kg		
		Used belt	20 – 35 kg		
Engine oil capacity	Dry fill		7.3 liters	7.7 US qts	6.4 Imp. qts
	Drain and refill				
	w/ Oil filter change		6.7 liters	7.1 US qts	5.9 Imp. qts
	w/o Oil filter change		5.8 liters	6.1 US qts	5.1 Imp. qts
Valve clearance	at Hot	Intake	0.20 mm	0.008 in.	
		Exhaust	0.36 mm	0.014 in.	
Injection timing			10 ± 1° BTDC		
Injection order			1–3–4–2		
Idle speed					
	11B, 13B	M/T	625 – 675 rpm		
	13B	A/T	770 – 820 rpm		
	13B-T	M/T	625 – 675 rpm		
	13B-T	A/T	800 – 850 rpm		
Maximum speed			4,050 – 4,200 rpm		
Compression pressure	at 250 rpm	STD	30.0 kg/cm^2	427 psi	2,942 kPa
		Limit	20.0 kg/cm^2	284 psi	1,961 kPa
Difference of pressure between each cylinder			2.0 kg/cm^2 (28 psi, 196 kPa) or less		

Cylinder head	Cylinder block surface warpage				
		Limit		0.2 mm	0.008 in.
	Intake manifold surface warpage				
		Limit		0.2 mm	0.008 in.
	Exhaust manifold surface warpage				
		Limit		0.2 mm	0.008 in.
	Valve seat	Refacing angle		30°, 45°, 60°	
		Contacting angle		45°	
		Contacting width		1.9 – 2.3 mm	0.075 – 0.091 in.
Valve guide bushing	Inside diameter			9.01 – 9.03 mm	0.3547 – 0.3555 in.
Valve	Valve overall length	STD	IN & EX	127.95 mm	5.0374 in.
		Limit	IN & EX	127.45 mm	5.0177 in.
	Valve face angle		IN & EX	45.5°	
	Stem diameter	Intake		8.968 – 8.984 mm	0.3531 – 0.3537 in.
		Exhaust	11B, 13B	8.954 – 8.970 mm	0.3525 – 0.3531 in.
			13B-T	8.940 – 8.956 mm	0.3520 – 0.3526 in.

Specifications (Cont'd)

Valve (cont'd)	Stem oil clearance	STD	IN		0.026 – 0.062 mm	0.0010 – 0.0024 in.
			EX	11B, 13B	0.040 – 0.076 mm	0.0016 – 0.0030 in.
				13B-T	0.054 – 0.090 mm	0.0021 – 0.0035 in.
		Limit	IN		0.10 mm	0.0039 in.
			EX	11B, 13B	0.12 mm	0.0047 in.
				13B-T	0.13 mm	0.0051 in.
	Valve head margin thickness					
		STD	IN		1.4 mm	0.055 in.
			EX	11B	1.3 mm	0.051 in.
				13B, 13B-T	1.7 mm	0.067 in.
		Limit	IN		0.9 mm	0.035 in.
			EX	11B	0.8 mm	0.031 in.
				13B, 13B-T	1.2 mm	0.047 in.
Valve spring	Free length	STD		Inner	54.84 mm	2.1591 in.
				Outer	58.30 mm	2.2953 in.
		Limit		Inner	52.80 mm	2.0787 in.
				Outer	56.30 mm	2.2165 in.
	Installed tension					
	at 42.25 mm (1.6634 in.)			Inner	14.2 kg 31.3 lb	139 N
	at 44.75 mm (1.7618 in.)			Outer	27.8 kg 61.3 lb	273 N
	Squareness			Limit	2.0 mm	0.079 in.
Valve rocker arm and shaft	Rocker arm inside diameter				18.512 – 18.533 mm	0.7288 – 0.7296 in.
	Shaft diameter				18.472 – 18.493 mm	0.7272 – 0.7280 in.
				STD	0.019 – 0.061 mm	0.0007 – 0.0024 in.
				Limit	0.1 mm	0.004 in.
Push rod	Circle runout			Limit	0.5 mm	0.020 in.
Manifold	Cylinder head surface warpage					
		Limit		IN & EX	0.4 mm	0.016 in.
Turbocharger	Turbocharging pressure			STD	0.42 – 0.56 kg/cm² (6.0 – 8.0 psi, 41 – 55 kPa)	
	Bearing shaft axial play			STD	0.13 mm (0.0051 in.) or less	
Timing gear	Gear backlash					
	Crankshaft to Idle gear			STD	0.058 – 0.162 mm	0.0023 – 0.0064 in.
				Limit	0.3 mm	0.012 in.
	Camshaft to Idle gear			STD	0.058 – 0.162 mm	0.0023 – 0.0064 in.
				Limit	0.3 mm	0.012 in.
	Injection pump gear to Idle gear			STD	0.058 – 0.162 mm	0.0023 – 0.0064 in.
				Limit	0.3 mm	0.012 in.
	Idle gear thrust clearance			STD	0.06 – 0.17 mm	0.0024 – 0.0067 in.
				Limit	0.3 mm	0.012 in.
	Idle gear shaft diameter				44.935 – 44.955 mm	1.7691 – 1.7699 in.
	Idle gear inside diameter				44.969 – 44.995 mm	1.7704 – 1.7715 in.
	Idle gear oil clearance			STD	0.014 – 0.060 mm	0.0006 – 0.0024 in.
				Limit	0.2 mm	0.008 in.

Specifications (Cont'd)

Camshaft and bearing	Thrust clearance		STD	0.06 – 0.13 mm	0.0024 – 0.0051 in.
			Limit	0.3 mm	0.012 in.
	Journal oil clearance		STD	0.025 – 0.066 mm	0.0010 – 0.0026 in.
			Limit	0.1 mm	0.004 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.
	Camshaft 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.
	Circle runout		Limit	0.06 mm	0.0024 in.
	Cam lobe height	STD IN	11B, 13B	44.705 – 44.795 mm	1.7600 – 1.7636 in.
			13B-T	44.909 – 44.999 mm	1.7681 – 1.7716 in.
		EX		44.774 – 44.864 mm	1.7628 – 1.7663 in.
		Limit IN	11B, 13B	44.27 mm	1.7429 in.
			13B-T	44.47 mm	1.7508 in.
		EX		44.34 mm	1.7457 in.
Push rod	Circle runout		Limit	0.5 mm	0.020 in.
Valve lifter	Valve lifter diameter			26.972 – 26.985 m	1.0619 – 1.0624 in.
	Valve lifter bore diameter			27.01 –27.03 mm	1.0634 – 1.0642 in.
	Oil clearance		STD	0.025 – 0.058 mm	0.0010 – 0.0023 in.
			Limit	0.1 mm	0.004 in.
Cylinder block	Warpage		Limit	0.2 mm	0.008 in.
Cylinder liner	Cylinder liner bore				
		STD	11B	95.00 – 95.03 mm	3.7402 – 3.7413 in.
			13B, 13B-T	102.00 – 102.03 mm	4.0157 – 4.0169 in.
		Limit	11B	95.33 mm	3.7531 in.
			13B, 13B-T	102.33 mm	4.0287 in.
	Ridge protrusion			0.01 – 0.10 mm	0.0004 – 0.0039 in.
	Cylinder liner shim thickness			0.05 mm	0.0020 in.
				0.10 mm	0.0039 in.
Piston and piston ring	Piston diameter		11B	94.94 – 94.97 mm	3.7378 – 3.7390 in.
			13B	101.93 – 101.96 mm	4.0130 – 4.0142 in.
			13B-T	101.92 – 101.95 mm	4.0126 – 4.0138 in.
	Piston oil clearance				
		STD	11B	0.05 – 0.07 mm	0.0020 – 0.0028 in.
			13B	0.06 – 0.08 mm	0.0024 – 0.0031 in.
			13B-T	0.07 – 0.09 mm	0.0028 – 0.0035 in.
		Limit		0.15 mm	0.0059 in.

Specifications (Cont'd)

Piston and piston ring (cont'd)	Piston ring end gap				
	No. 1 ring	STD		0.30 – 0.57 mm	0.0118 – 0.0224 in.
		Limit		1.37 mm	0.0539 in.
	No. 2 ring	STD	11B	0.35 – 0.67 mm	0.0138 – 0.0264 in.
			13B, 13B-T	0.45 – 0.72 mm	0.0177 – 0.0283 in.
		Limit	11B	1.47 mm	0.0579 in.
			13B, 13B-T	1.52 mm	0.0598 in.
	Oil ring	STD	11B	0.35 – 0.67 mm	0.0138 – 0.0264 in.
			13B, 13B-T	0.40 – 0.72 mm	0.0157 – 0.0283 in.
		Limit	11B	1.47 mm	0.0579 in.
			13B, 13B-T	1.52 mm	0.0598 in.
	Ring groove clearance				
	No. 1 ring		11B, 13B	0.08 – 0.12 mm	0.0031 – 0.0047 in.
	No. 2 ring		11B, 13B	0.04 – 0.08 mm	0.0016 – 0.0031 in.
			13B-T	0.06 – 0.10 mm	0.0024 – 0.0394 in.
	Oil ring			0.03 – 0.07 mm	0.0012 – 0.0028 in.
	Piston pin installing temperature			60°C	140°F
Connecting rod and bearing	Thrust clearance		STD	0.20 – 0.32 mm	0.0079 – 0.0126 in.
			Limit	0.4 mm	0.016 in.
	Piston pin diameter			34.000 – 34.010 mm	1.3386 – 1.3390 in.
	Bushing inside diameter			34.009 – 34.019 mm	1.3389 – 1.3393 in.
	Pin to bushing oil clearance		STD	0.004 – 0.014 mm	0.0002 – 0.0006 in.
			Limit	0.05 mm	0.0020 in.
	Rod bend per 100 mm (3.94 in.)		Limit	0.05 mm	0.0020 in.
	Rod twist per 100 mm (3.94 in.)		Limit	0.05 mm	0.0020 in.
Crankshaft	Thrust clearance		STD	0.04 – 0.25 mm	0.0016 – 0.0098 in.
			Limit	0.3 mm	0.012 in.
	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.
	Main journal oil clearance		STD	0.030 – 0.074 mm	0.0012 – 0.0029 in.
			Limit	0.1 mm	0.004 in.
	Main journal diameter		STD	69.98 – 70.00 mm	2.7551 – 2.7559 in.
	Main journal finished diameter				
		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.
	Crank pin oil clearance		STD	0.030 – 0.070 mm	0.0012 – 0.0028 in.
			Limit	0.1 mm	0.004 in.
	Crank pin diameter		STD	60.98 – 61.00 mm	2.4008 – 2.4016 in.
	Crank pin finished diameter				
		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.
	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 x Cylinder block		1,200	87	118
Valve rocker support x Cylinder head		185	13	18
Cylinder head cover x Cylinder head		125	9	12
Exhaust manifold x Cylinder head		475	34	47
Water outlet housing x Cylinder head		185	13	18
Intake manifold x Cylinder head		185	13	18
Camshaft gear x Camshaft		375	27	37
Camshaft thrust washer x Cylinder block		185	13	18
Idle gear x Cylinder block		475	34	47
Idle gear shaft union bolt		110	8	11
Timing gear cover	14 mm bolt head	375	27	37
	12 mm bolt head	185	13	18
Crankshaft pulley x Crankshaft		2,450	177	240
Connecting rod cap x Connecting rod		1,200	87	118
Main bearing cap x Cylinder block		2,000	145	196
Rear oil seal retainer x Cylinder block		185	13	18
Water pump x Cylinder block		250	18	25
Water outlet x Water outlet housing		185	13	18
Oil pan drain plug		350	25	34
Timing gear case x Cylinder block				
	14 mm bolt head	375	27	37
	12 mm bolt head	185	13	18
Injection pump oil pipe union bolt		110	8	11
Oil Strainer x Cylinder block		185	13	18
Oil pipe x Cylinder block	Bolt	450	33	44
	Nut	185	13	18
Oil cooler x Oil cooler cover		130	9	13
Oil cooler cover x Cylinder block		185	13	18
Oil filter bracket mount bolt		375	27	37
Injection nozzle retaining nut		350	25	34
Injection nozzle mount nut		185	13	18
Nozzle leakage pipe x Injection nozzle		250	18	25
Injection pipe x Injection nozzle and pump		250	18	25
Fuel inlet and outlet pipe x Fuel feed pump		375	27	37

FUEL SYSTEM

Injection nozzle	Nozzle type	11B	ND – DLLA 155P16
		13B	ND – DLLA 150P9
		13B-T	ND – DLLA 150P10
	Nozzle opening pressure		200 – 210 kg/cm² (2,845 – 2,987 psi, 19,613 – 20,594 kPa)
Feed pump	Suction test		
	Suction pipe	Inner diameter	8 mm 0.31 in.
		Length	2 m 78.74 in.
	Suction height		1 m 39.37 in.
	Feed pump	at 150 rpm	Fuel must dishcarge within 40 seconds
	Priming pump	at 60 strokes/min.	Fuel must discharge within 25 strokes
	Discharge test		
	Discharge nozzle diameter		1.54 mm 0.0606 in.
	Pressure	at 600 rpm	1.8 – 2.2 kg/cm² (26 – 31 psi, 177 – 216 kPa)
	Volume	at 1,000 rpm	900 cc/min. (54.9 cu in./min.) or more
Automatic timer	Timer advance angle		
	11B w/o HAC	at 1,450 rpm	Advance begins (≦ 0.5°)
		at 1,750 rpm	3.5 – 4.5°
	13B w/o HAC	at 1,400 rpm	Advance begins (≦ 0.5°)
		at 1,700 rpm	4.5 – 5.5°
	11B, 13B w/ HAC	at 1,000 rpm	Advance begins (≦ 0.5°)
		at 1,700 rpm	3.0 – 4.0°
	13B-T	at 1,400 rpm	Advance begins (≦ 0.5°)
		at 1,700 rpm	3.5 – 4.5°
	Adjusting shim thickness		0.5, 0.6, 0.7, 0.8, 0.9, 1.0 mm (0.020, 0.024, 0.028, 0.031 0.035, 0.039 in.)
Injection pump	Direction of rotation		Clockwise as seen from drive side
	Cam lift		8.0 mm 0.315 in.
	Injection order		1–3–4–2
	Tappet combined looseness	Limit	0.3 mm 0.012 in.
	Camshaft thrust clearance	STD	0.03 – 0.05 mm 0.0012 – 0.0020 in.
		Limit	0.1 mm 0.004 in.
	Camshaft adjusting shim thickness	Front	0.10, 0.12, 0.14, 0.16, 0.18, 0.50 mm (0.0039, 0.0047, 0.0055, 0.0063, 0.0071, 0.0197 in.)
		Rear	0.10, 0.15, 0.30, 0.50 mm (0.0039, 0.0059, 0.0118, 0.0197 in.)
	Plunger spring		
	Free length		49.3 – 49.5 mm 1.941 – 1.949 in.
	Installed length		44.0 mm 1.732 in.
	Installed load		15.1 kg 33.3 lb 148 N
	Delivery valve spring		
	Free length		19.5 – 20.0 mm 0.768 – 0.787 in.
	Installed length		17.75 mm 0.6988 in.
	Installed load		3.1 kg 6.8 lb 30 N

FUEL SYSTEM (Cont'd)

Governor	Steering lever thrust clearnce	0.05 – 0.20 mm	0.0020 – 0.0079 in.
	Steering lever thrust washer thickness	0.50 .... 0.80 mm	0.0197 .... 0.0315 in.
		[7 sizes in 0.05 mm (0.0020 in.) increments]	
	Cam plate thrust clearance	0.08 – 0.12 mm	0.0031 – 0.0047 in.
	Cam plate thrust washer thickness	0.2, 0.3, 0.4, 0.5 mm (0.008, 0.012, 0.016, 0.020 in.)	
	Floating lever arm thrust clearance	0.05 – 0.12 mm	0.0020– 0.0047 in.
	Floating lever arm thrust washer thickness	0.05, 0.10, 0.20, 0.40 mm (0.0020, 0.039, 0.0079, 0.0156 in.)	
	Sliding weight shaft fitting dimension	49.7 – 50.1 mm	1.957 – 1.972 in.
	Sliding weight shaft length	30.7 .... 31.9 mm	1.209 .... 1.256 in.
		[7 sizes in 0.2 mm (0.008 in) increments]	
	Flyweight thrust clearance	0.02 – 0.10 mm	0.0008 – 0.0039 in.
	Flyweight adjusting shim thickness	1.60 .... 2.00, 2.10, 2.20, 2.30 mm	
		[9 sizes in 0.05 mm (0.0020in.) increments and 2.10, 2.20, 2.30 mm (0.0827, 0.0866, 0.0906 in.)]	
	Joint bolt thrust clearance	1.5 – 2.0 mm	0.059 – 0.079 in.
	Stopper arm thrust clearance (11B, 13B)	0.05 – 0.20 mm	0.0020 – 0.0079 in.
	Stopper arm thrust washer thickness (11B, 13B)	0.1, 0.2, 0.5 mm (0.004, 0.008, 0.020 in.)	
	Governor adjusting nut protrusion	Minus 0.4 (0.016) to Plus 0.2 mm (0.008 in.)	
	Idle outer spring		
	Free length	23.6 – 24.0 mm	0.929 – 0.945 in.
	Installed length	22.8 mm	0.898 in.
	Installed load	60 g 0.13 lb	0.6 N
	Idle inner spring		
	Free length	25.8 – 26.2 mm	1.016 – 1.031 in.
	Installed length	26.0 mm	1.024 in.
	Speed control spring		
	Free length	23.8 – 24.2 mm	0.937 – 0.953 in.
	Installed length	24.0 mm	0.945 in.
Boost compensator	Push rod stroke		
	Apply 1.36 kg/cm² (19.3 psi, 133 kPa) of pressure	4.0 – 5.0 mm	0.157 – 0.197 mm
	Pressure drop	10 seconds or more	
High altitude compensator (HAC)	Clearance at sea level	0.2 – 0.5 mm	0.008 – 0.020 in.

Injection Pump Adjustment and Test

Preparations of pump tester	Test nozzle type	DN12 SD12A
	Test nozzle opening pressure	175 kg/cm² 2,491 psi 17,162 kPa
	Injection pipe Outer diameter	6.0 mm 0.236 in.
	Inner diameter	2.0 mm 0.079 in.
	Length	600 mm 23.6 in.
	Minimum bending radius	25 mm (0.98 in.) or more
	Fuel temperature	40 – 45°C 104 – 113°F
	Fuel feeding pressure	2.0 kg.cm² 28.4 psi 196 kPa
Control rack	Sliding resistance Pump at 0 rpm	120 g (4.2 oz) or less
	Pump at 1,000 rpm	50 g (1.8 oz) or less
Injection timing	Pre-stroke Control rack position at 11.0 mm (0.433 in.)	3.05 – 3.15 mm 0.1201 – 0.1240 in.
	Injection interval	89°30′ – 90°30′
	Pre-stroke and Injection interval adjusting shim thickness	0.10 .... 1.40, 0.15 mm (0.0039 .... 0.055, 0.0059 in.) [15sizes in 0.1 mm (0.004 in.) increments and 0.15 mm (0.0059 in.)]
	Tappet clearance	0.2 mm (0.008 in.) or more

Injection volume

Item	Control rack Position mm (in.)	Pump rpm	Measuring strokes	Injection volume cc (cu in.)	Variation limit cc (cu in.)
11B w/o HAC	16.0 (0.630)	100	200	10.0 – 14.0 (0.61 – 0.85)	1.6 (0.10)
	10.4 (0.409)	1,100	200	9.5 – 10.1 (0.58 – 0.62)	0.9 (0.05)
	10.2 (0.402)	1,800	200	8.9 – 10.1 (0.54 – 0.62)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
11B w/ HAC	16.0 (0.630)	100	200	10.0 – 14.0 (0.61 – 0.85)	1.6 (0.10)
	10.4 (0.409)	1,100	200	9.5 – 10.1 (0.58 – 0.62)	0.9 (0.05)
	10.3 (0.406)	1,800	200	9.3 – 10.5 (0.57 – 0.64)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
13B w/o HAC	16.0 (0.630)	100	200	12.4 – 16.4 (0.76 – 1.00)	1.6 (0.10)
	10.5 (0.409)	1,100	200	11.2 – 11.8 (0.68 – 0.62)	0.9 (0.05)
	10.3 (0.406)	1,700	200	11.0 – 11.8 (0.67 – 0.72)	1.2 (0.07)
	Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)

Injection Pump Adjustment and Test (Cont'd)

Injection volume (cont'd)	Item	Control rack Position mm (in.)	Pump rpm	Measuring strokes	Injection Volume cc (cu in.)	Variation Limit cc (cu in.)
	13B w/o HAC	16.0 (0.630)	100	200	12.4 – 16.4 (0.76 – 1.00)	1.6 (0.10)
		10.5 (0.413)	1,100	200	11.2 – 11.8 (0.68 – 0.72)	0.9 (0.05)
		10.4 (0.409)	1,700	200	11.4 – 12.2 (0.70 – 0.74)	1.2 (0.07)
		Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
	13B-T M/T	16.0 (0.630)	100	200	8.4 – 12.4 (0.51 – 0.76)	1.6 (0.10)
		11.1 (0.437)	1,100	200	13.5 – 14.3 (0.82 – 0.87)	0.9 (0.05)
		10.9 (0.429)	1,700	200	12.9 – 13.9 (0.79 – 0.85)	1.2 (0.07)
		Approx. 9.1 (0.358)	325	500	3.5 – 6.5 (0.21 – 0.40)	1.5 (0.09)
	13B-T A/T	16.0 (0.630)	100	200	12.4 – 17.6 (0.76 – 1.07)	1.6 (0.10)
		10.8 (0.425)	1,100	200	12.8 – 13.6 (0.78 – 0.83)	0.9 (0.05)
		10.9 (0.429)	1,700	200	13.6 – 14.6 (0.83 – 0.89)	1.2 (0.07)
		Approx. 8.4 (0.331)	400	500	4.3 – 7.3 (0.26 – 0.45)	1.5 (0.09)

Governor Adjustment and Test

Idle speed control	Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
	ex. 13B-T A/T	Idle	100	10.6 (0.417) or more	—
			325	8.8 – 9.4 (0.346 – 0.370)	Idle speed adjusting screw
			600	5.6 – 7.0 (0.220 – 0.276)	Washer (A)
			800	3.9 – 4.7 (0.154 – 0.185)	Washer (B)
			1,200	2.4 – 3.8 (0.094 – 0.150)	—
	13B-T A/T	Idle	100	10.6 (0.417) or more	—
			400	8.1 – 8.7 (0.319 – 0.343)	Idle speed adjusting screw
			600	6.2 – 6.6 (0.244 – 0.260)	Washer (A)
			800	4.0 – 4.8 (0.157 – 0.189)	Washer (B)
			1,200	2.4 – 3.8 (0.094 – 0.150)	—

Governor Adjustment and Test (Cont'd)

Idle speed control	Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
	11B w/o HAC	Maximum	500	10.0 – 11.0 (0.394 – 0.425)	No.1 adapter screw
			700	10.0 – 10.8 (0.394 – 0.425)	–
			1,100	10.1 – 10.7 (0.398 – 0.421)	Full-load stopper screw
			1,800	9.6 – 10.6 (0.378 – 0.417)	No.1 and No.2 adapter screws
			1,900	9.3 – 10.1 (0.366 – 0.398)	–
	11B w/ HAC	Maximum	500	10.1 – 11.1 (0.398 – 0.437)	No.1 adapter screw
			700	10.1 – 10.9 (0.398 – 0.429)	–
			1,100	10.1 – 10.7 (0.398 – 0.421)	Full-load stopper screw
			1,800	9.7 – 10.7 (0.382 – 0.421)	No.1 and No.2 adapter screws
			1,900	9.4 – 10.2 (0.370 – 0.402)	–
	13B w/o HAC	Maximum	500	10.2 – 11.2 (0.402 – 0.441)	No.1 adapter screw
			700	10.0 – 10.8 (0.394 – 0.425)	–
			1,100	10.2 – 10.8 (0.402 – 0.425)	Full-load stopper screw
			1,700	10.0 – 10.7 (0.394 – 0.421)	No. 1 and No. 2 adapter screws
			1,800	9.4 – 10.4 (0.370 – 0.409)	–
	13B w/ HAC	Maximum	500	10.3 – 11.3 (0.406 – 0.445)	No.1 adapter screw
			700	10.0 – 10.8 (0.394 – 0.425)	–
			1,100	10.2 – 10.8 (0.402 – 0.425)	Full-load stopper screw
			1,700	10.1 – 10.8 (0.398 – 0.425)	No.1 and No.2 adapter screws
			1,800	9.5 – 10.5 (0.374 – 0.413)	–

Governor Adjustment and Test (Cont'd)

Medium speed control (cont'd)	Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
	13B-T M/T Apply 0.27 kg/cm² (3.9 spi, 26 kPa) of pressure to the boost compensator	Maximum	500	10.7 – 11.5 (0.421 – 0.453)	No.1 adapter screw
			700	10.8 – 11.6 (0.425 – 0.457)	—
			1,100	10.8 – 11.4 (0.425 – 0.449)	Full-load stopper screw,
			1,700	10.5 – 11.3 (0.413 – 0.445)	No. 1 and No. 2 adapter screws
			1,900	9.4 – 10.2 (0.370 – 0.402)	—
	13B-T A/T Apply 0.27 kg/cm² (3.9 psi, 26 kPa) of pressure to the boost compensator	Maximum	500	10.6 – 11.4 (0.417 – 0.449)	No.1 adapter screw
			700	10.3 – 11.1 (0.406 – 0.437)	—
			1,100	10.5 – 11.1 (0.413 – 0.437)	Full-load stopper screw
			1,700	10.5 – 11.3 (0.413 – 0.445)	No.1 and No.2 adapter screws
			1,900	9.5 – 10.3 (0.374 – 0.406)	—

Maximum speed control (cont'd)	Item	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
	11B, 13B	Maximum	2,100	7.0 – 8.4 (0.276 – 0.331)	Maximum speed adjusting screw
			2,200	6.0 (0.236) or less	—
	*13B-T M/T	Maximum	2,100	7.0 – 8.4 (0.276 – 0.331)	Maximum speed adjusting screw
			2,200	6.2 (0.244) or less	—
	*13B-T A/T	Maximum	2,100	6.3 – 7.7 (0.248 – 0.303)	Maximum speed adjusting screw
			2,200	6.2 (0.244) or less	—

Boost compensator	Item	Adjusting lever position	Pump rpm	Boost compensator pressure kg/cm² (psi, kPa)	Control rack position mm (in.)	Adjusting point
	13B-T M/T	Maximum	500	0	10.4 – 11.0 (0.409 – 0.433)	Stop screw
				0.12 (1.7, 12)	10.7 – 11.5 (0.421 – 0.453)	Guide bushing
	13B-T A/T	Maximum	500	0	10.5 – 11.1 (0.413 – 0.437)	Stop screw
				0.12 (1.7, 12)	10.6 – 11.4 (0.417 – 0.449)	Guide bushing

* Apply 0.27 kg/cm² (3.9 psi, 26 kPa) of pressure to the boost compensator.

Governor Adjustment and Test (Cont'd)

Total injection volume	Item	Adjusting lever position	Boost compensator pressure kg/cm² (psi, kPa)	Pump rpm	Total injection volume cc (cu in.)	Adjusting point
	11B w/o HAC	Maximum	—	500	31.0 – 40.0 (1.89 – 2.44)	Full-load stopper screw
				1,100	47.5 – 50.5 (2.90 – 3.08)	
				1,800	44.5 – 50.5 (2.72 – 3.08)	
	11B w/ HAC	Maximum	—	500	31.0 – 40.0 (1.89 – 2.44)	HAC
				1,100	47.5 – 50.5 (2.90 – 3.08)	
				1,800	46.5 – 52.5 (2.84 – 3.20)	
	13B w/o HAC	Maximum	—	500	38.5 – 47.5 (2.35 – 2.90)	Full-load stopper screw
				1,100	56.0 – 59.0 (3.42 – 3.60)	
				1,700	54.0 – 60.0 (3.30 – 3.66)	
	13B w/ HAC	Maximum	—	500	40.5 – 49.5 (2.47 – 3.02)	HAC
				1,100	56.0 – 59.0 (3.42 – 3.60)	
				1,700	56.0 – 62.0 (3.42 – 3.78)	
	13B-T M/T	Maximum	0.27 (3.9, 26)	500	45.5 – 54.5 (2.78 – 3.33)	Full-load stopper screw
			0.27 (3.9, 26)	1,100	68.0 – 71.0 (3.91 – 4.27)	
			0.27 (3.9, 26)	1,700	64.0 – 70.0 (3.91 – 4.27)	
			0	500	31.0 – 37.0 (1.89 – 2.26)	
	13B-T A/T	Maximum	0.27 (3.9, 26)	500	47.5 – 56.5 (2.90 – 3.45)	Full-load stopper screw
			0.27 (3.9, 26)	1,100	64.5 – 67.5 (3.94 – 4.12)	
			0.27 (3.9, 26)	1,700	67.5 – 73.5 (4.12 – 4.48)	
			0	500	46.5 – 52.5 (2.84 – 3.20)	

Stop lever	Adjusting lever position	Pump rpm	Control rack position mm (in.)	Adjusting point
	Idle	0	5.5 (0.217) or less	—

COOLING SYSTEM

Coolant capacity				
BY				
	w/o Heater	12.2 liters	12.9 US qts	10.7 Imp. qts
BJ				
M/T				
	w/o Heater	12.1 liters	12.8 US qts	10.6 Imp. qts
	w/ Heater	14.2 liters	15.0 US qts	12.5 Imp. qts
A/T				
	w/o Heater	11.5 liters	12.2 US qts	10.1 Imp. qts
	w/ Heater	13.6 liters	14.4 US qts	12.0 Imp. qts
BU				
Regular cab type				
	w/o Heater	11.6 liters	12.3 US qts	10.2 Imp. qts
	w/ Heater	12.5 liters	13.2 US qts	11.0 Imp. qts
Wide cab type				
	w/o Heater	12.1 liters	12.8 US qts	10.6 Imp. qts
	w/ Heater	13.0 liters	13.7 US qts	11.4 Imp. qts
BB				
	w/o Heater	12.4 liters	13.1 US qts	10.9 Imp. qts
Radiator cap	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
Thermostat	Valve opening temperature			
	82°C type	80 – 84°C	176 – 183°F	
	88°C type	86 – 90°C	187 – 194°F	
	Valve life			
	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		

LUBRICATION SYSTEM

Engine oil capacity				
	Dry fill	7.3 liter	7.7 US qts	6.4 Imp. qts
	Drain and refill			
	w/ Oil filter change	6.7 liter	7.1 US qts	5.9 Imp. qts
	w/o Oil filter change	5.8 liter	6.1 US qts	5.1 Imp. qts
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	Body clearance STD	0.14 – 0.22 mm	0.0055 – 0.0087 in.	
	Limit	0.4 mm	0.016 in.	
	Tip clearance STD	0.11 – 0.24 mm	0.0043 – 0.0094 in.	
	Limit	0.3 mm	0.012 in.	
	Side clearance STD	0.035 – 0.090 mm	0.0014 – 0.0035 in.	
	Limit	0.15 mm	0.0059 in.	

STARTING SYSTEM

Pre-heating system	Pre-heating type		Intake heater		
Starter	Rated output		12V 2.5 kw, 24V 4.5 kw		
	No-load characteristic				
	2.5 kw type	Ampere	180A or less at 11V		
	4.5 kw type	Ampere	90A or less at 23V		
		rpm	3,500 rpm or more		
	Brush length	STD	20.5 mm	0.807 in.	
		Limit	13.0 mm	0.512 in.	
	Spring installed load		3.2 – 4.0 kg	7.1 – 8.8 lb	31 – 39 N
	Commutator				
	Diameter	STD	36 mm	1.42 in.	
		Limit	35 mm	1.38 in.	
	Undercut depth	STD	0.7 mm	0.028 in.	
		Limit	0.2 mm	0.008 in.	
	Circle runout	Limit	0.05 mm	0.0020 in.	

CHARGING SYSTEM

Battery specific gravity when fully charged at 20°C (68°F)				
		NX110-5	1.25 – 1.27	
		ex. NX110-5	1.27 – 1.29	
Alternator	Rated output		12V 40A, 12V 45A, 12V 55A, 24V25A, 24V 30A, 24V 55A	
	Rotor coil resistance			
	w/o IC regulator	12V type	Approx. 4.0 Ω	
		24V type	Approx. 19.0 Ω	
	w/ IC regulator		Approx. 9.0 Ω	
	Slip ring diameter	STD	32.3 – 32.5 mm	1.272 – 1.280 in.
		Limit	32.1 mm	1.264 in.
	Brush exposed length	STD	20.0 mm	0.787 in.
		Limit	5.5 mm	0.217 in.
Alternator regulator	Regulator voltage	12V type	13.8 – 14.8 V	
		24V type	27.0 – 29.0 V	
	Voltage relay actuating voltage			
		12V type	4.0 – 5.8 V	
		24V type	8.0 – 11.6 V	

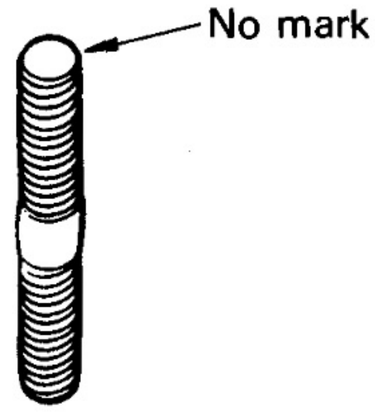
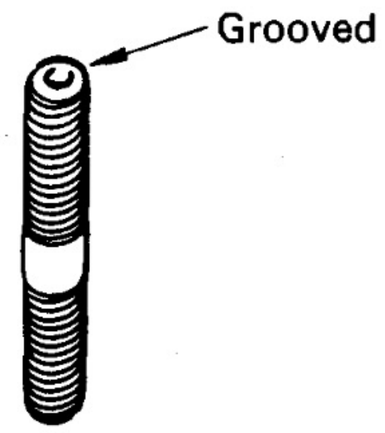
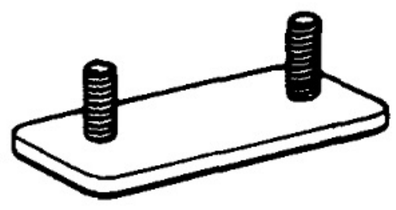
STANDARD BOLT TORQUE SPECIFICATIONS

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	 No mark	4T
	 No mark	4T			
Hexagon flange bolt w/washer hexagon bolt	 No mark	4T		 Grooved	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	Torque specifications					
			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

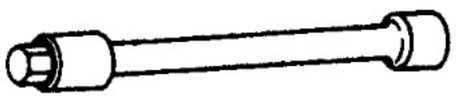
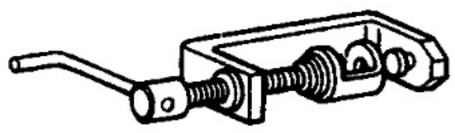
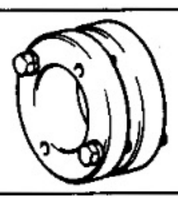
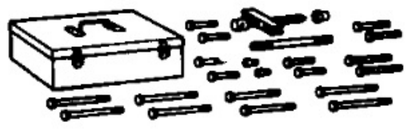
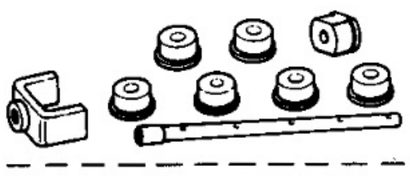
SST (SPECIAL SERVICE TOOLS)

NOTE: Classification

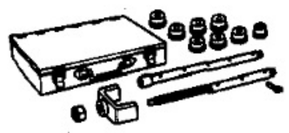
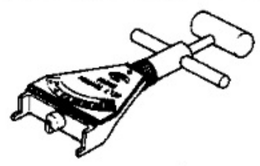
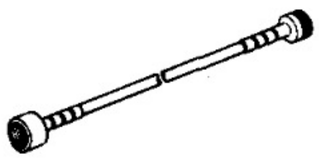
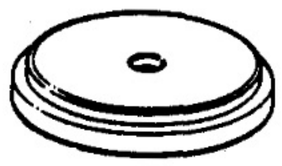
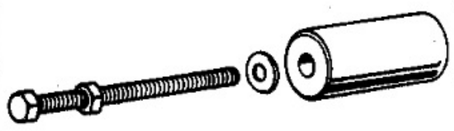
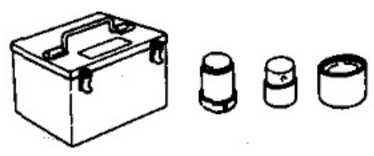
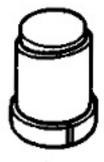
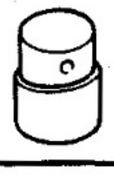
A = SST required for vehicle inspections and minor repairs and multipurpose SST.

B = SST required for major repairs involving disassembly of components.

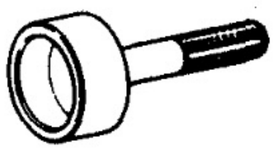
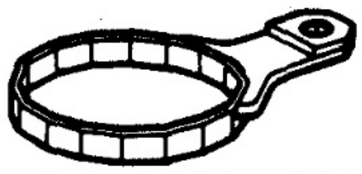
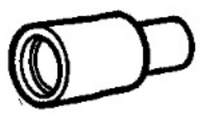
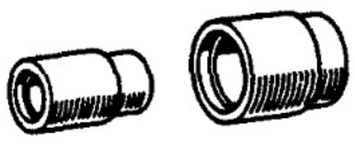
C = SST required for rather special, less frequent work not of classifiable as either A or B.

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09032-00100	(Oil Pan Seal Cutter)	A	●			●		
	09043-38100	(Hexagon 10 mm Wrench)	A		●				
	09201-58010	(Valve Stem Oil Seal Replacer)	B	●					
	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 Puller)	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)		●					

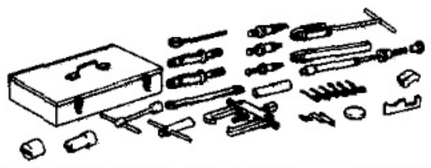
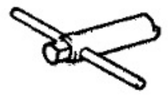
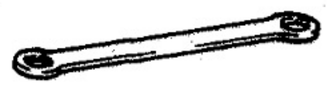
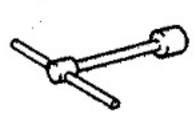
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09215-00100	(Camshaft Bearing Remover & Replacer)	C	●					
	(09215-00130)	(Bolt)		●					
	(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	●					●
	09218-56020	(Cylinder Liner Remover & Replacer)	B	●					
	09218-56030	(Cylinder Liner Remover & Replacer)	B	●					
	09219-56010	(Piston Cooler Remover)	B	●					
	09222-58010	(Connecting Rod Bushing Remover & Replacer)	B	●					
	(09222-01020)	(Remover & Replacer)		●					
	(09222-01030)	(Guide)		●					

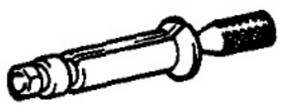
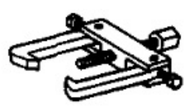
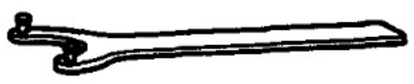
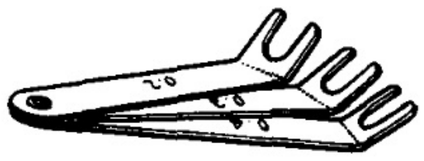
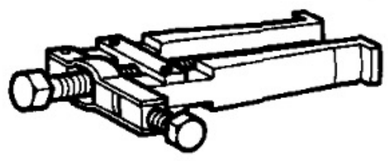
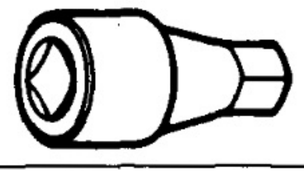
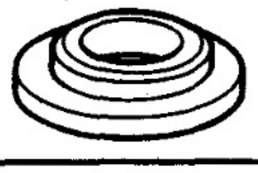
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration			EM	FU	CO	LU	ST	CH
	(09222-01040)	(Base)	●					
	09222-76012	(Connecting Rod Bushing Remover & Replacer)	B	●				
	09223-46011	(Crankshaft Front Oil Seal Replacer)	B	●				
	09223-56010	(Crankshaft Rear Oil Seal Replacer)	B	●				
	09228-34010	(Oil Filter Wrench)	A		●			
	09228-44011	(Oil Filter Wrench)	A				●	
	09236-00101	(Water Pump Overhaul Tool Set)	B			●		
	(09237-00010)	(Water Pump Bearing Remover & Replacer)				●		
	(09237-00020)	(Bearing Stay)				●		
	(09237-00030)	(Bearing Stay)				●		
	(09237-00050)	(Shaft "B")				●		
	(09238-40010)	(Water Pump Bearing Remover & Replacer)				●		
	09238-47012	(Water Pump Bearing Remover & Replacer)	B			●		
	09241-76022	(Injection Pump Stand Set)	C		●			

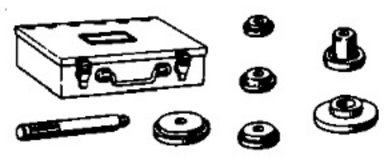
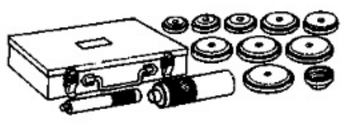
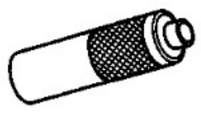
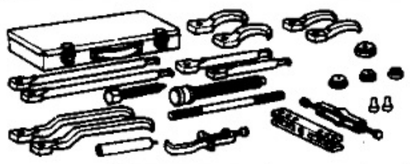
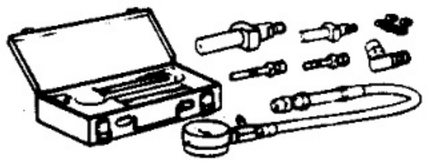
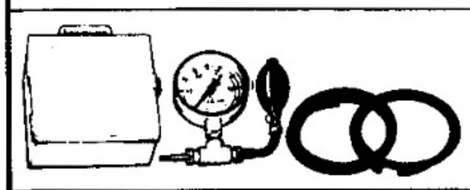
SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration				EM	FU	CO	LU	ST	CH
	09260-58010	(Injection Pump Tool Set)	B		●				
	(09260-78010)	(Round Nut Wrench)			●				
	(09260-78020)	(Screw Plug Wrench)			●				
	(09266-76011)	(Automatic Timer Set Nut Wrench)			●				
	(09267-76011)	(Automatic Timer Extractor)			●				
	(09267-76020)	(Automatic Timer Remover)			●				
	(09267-76030)	(Camshaft Bushing Remover)			●				
	(09270-76010)	(Delivery Valve Holder Wrench)			●				
	(09272-76011)	(Tappet Roller Clamp)			●				
	(09273-76011)	(Tappet Clamp)			●				
	(09274-46011)	(Tappet Insert)			●				
	(09275-46010)	(Plunger Clamp)			●				
	(09276-76010)	(T Type Box 10 mm Wrench)			●				
	(09278-46020)	(Spline Shaft Holding Tool)			●				

SST (SPECIAL SERVICE TOOLS) (Cont'd)

Section / Classification / Part Name / Part No. / Illustration			EM	FU	CO	LU	ST	CH
	(09280-46010)	(Plunger Spring Holder)		●				
	(09283-46010)	(Tappet Gauge Holder Attachment)		●				
	(09285-76020)	(Injection Pump Camshaft Bearing Cone Replacer)		●				
	(09286-76011)	(Injection Pump Camshaft Bearing Cup Puller)		●				
	(09286-78010)	(Bearing Cup Remover)		●				
	(09287-58010)	(Injection Pump Camshaft Bearing Puller)			●			
	09278-54012	(Drive Shaft Holding Tool)	A	●			●	
	09285-76010	(Injection Camshaft Bearing Cone Replacer)	C					●
	09286-46011	(Injection Pump Spline Shaft Puller)	C		●			●
	09288-46011	(Tappet Adjusting Gauge)	C		●			
	09308-10010	(Oil Seal Puller)	A	●				
	09330-00021	(Companion Flange Holding Tool)	A	●				
	09313-30021	(Detent Ball Plug Socket)	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
	09608-12010	(Front Hub & Drive Pinion Bearing Replacer Set)	B	●					
	(09608-00020)	(Remover & Replacer Handle)		●					
	09608-35014	(Axle Hub & Drive Pinion Bearing Tool Set)	B	●			●		
	(09608-06040)	(Front Hub Inner Bearing Cone Replacer)		●			●		
	09950-20017	(Universal Puller)	A				●		
	09992-00023	(Cylinder Compression Check Gauge Set)	A	●					
	09992-00240	(Turbocharger Pressure Gauge)	C	●					

SSM (SPECIAL SERVICE MATERIALS)

Part Name	Part No.	Sec.	Use etc.
Seal packing black	08826-00080	EM LU	Push rod cover Oil pan