

ENGINE MECHANICAL

	Page
DIESEL ENGINE DIAGNOSIS	EM-2
DIESEL ELECTRICAL SYSTEM DIAGNOSIS	EM-11
ENGINE TUNE-UP	EM-14
COMPRESSION CHECK	EM-19
TIMING BELT	EM-20
Components	EM-20
Removal of Timing Belt	EM-20
Inspection of Components	EM-24
Installation of Timing Belt	EM-25
CYLINDER HEAD	EM-31
Components	EM-31
Removal of Cylinder Head	EM-32
Disassembly of Cylinder Head	EM-35
Inspection, Cleaning and Repair of Cylinder Head Components	EM-36
Replacement of Camshaft Oil Seal	EM-44
Assembly of Cylinder Head	EM-45
Installation of Cylinder Head	EM-46
CYLINDER BLOCK	EM-50
Components	EM-50
Disassembly of Cylinder Block	EM-51
Inspection of Cylinder Block	EM-55
Disassembly of Piston and Connecting Rod Assembly	EM-56
Inspection of Piston and Connecting Rod Assembly	EM-57
Replacement of Connecting Rod Bushing	EM-60
Inspection and Repair of Crankshaft	EM-61
Boring of Cylinders	EM-62
Replacement of Crankshaft Oil Seals	EM-63
Assembly of Piston and Connecting Rod Assembly	EM-64
Installation of Crankshaft, Piston and Connecting Rod Assembly	EM-66
Assembly of Cylinder Block	EM-67

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 specification.

The following fuel system diagnosis procedures are applicable to Toyota 1C, 1C-T, 2C, L, 2L and 2L-T engines equipped with the distributor type injection pump.

2. PRELIMINARY CHECKS

- (a) Before performing fuel system checks, check 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 needed.
- (c) Check that there is sufficient fuel in the tank.
- (d) Check if the fuel is contaminated with gasoline or other foreign elements. Only good-quality diesel fuel should be used.
- (e) Bleed air from the system by pumping the priming pump 30 – 40 times.
- (f) Check for water in the fuel filter and fuel tank and drain as necessary.
- (g) If the engine will not crank or if it cranks slowly, first troubleshoot the electrical system.

PRECAUTION

1. The basic troubleshooting procedures for the diesel engine (valve clearance, compression, bearings, valves, pistons, etc.) are the same checks you would make for a gasoline engine.
2. The repair of an 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 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-15 or 16) 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	Refer to items 1 and 2 of ENGINE WILL NOT CRANK .
2. DISCHARGED BATTERY	
3. IMPROPER ENGINE OIL	Check engine oil. If improper viscosity, drain and refill with oil of viscosity recommended by manufacturer.

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)

(Check Procedure and Correction Method)

1. NO FUEL TO NOZZLE

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 CUT SOLENOID OPERATION

With starter switch turned ON, check for fuel cut solenoid operation noise (clicking sound) while repeatedly connecting and disconnecting fuel cut solenoid.
If no noise, check if there are 12 volts to the solenoid when the starter switch is ON.
If 12 volts are confirmed, fuel cut solenoid is faulty and should be replaced. If not 12 volts, refer to ELECTRICAL DIAGNOSIS and make necessary repairs.

3. NO FUEL INTO INJECTION PUMP

Disconnect inlet hoses to fuel filter and feed clean fuel from separate container directly into fuel pump. If engine starts, either the fuel filter or line between fuel tank and filter is clogged and should be repaired accordingly.
If engine still does not start (no fuel intake), check fuel line between filter and pump.
If normal, pump is faulty and should be replaced.
NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.

4. INOPERATIVE PRE-HEATING OPERATION

With the starter switch turned ON and the glow plug indicator light illuminated, check that there are 6 volts applied to the glow plug.
If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary.

5. FAULTY GLOW PLUG OPERATION

Check glow plug for continuity.
If no continuity, a broken wire is indicated and the glow plug should be replaced.

6. FUEL LEAKAGE FROM
INJECTION PIPE

Check for loose unions or cracks.
If leaking, tighten to standard torque or, if necessary, replace pipe(s).

7. IMPROPER INJECTION
TIMING

Turn crankshaft clockwise to where either No. 1 or No. 4 piston is at TDC and, after releasing cold start advance system (LX), check plunger stroke with SST.

Standard:

L		0.94 – 1.06 mm (0.0370 – 0.0417 in.)
2L	w/o ACSD	1.06 – 1.22 mm (0.0417 – 0.0480 in.)
	w/ ACSD	0.82 – 0.98 mm (0.0323 – 0.0386 in.)
2L-T		0.75 – 0.87 mm (0.0295 – 0.0343 in.)

If not at the standard indicated above, injection pump is not adjusted properly.

NOTE: If injection timing is off more than 10°, it could indicate a slipped timing belt.

8. IMPROPER FAST IDLE

Measure timer piston stroke and fast idle lever opening angle with injection pump tester.

9. FAULTY NOZZLE OR
NOZZLE HOLDER

Check injection pressure with nozzle tester.

Standard pressure:

L, 2L (ex. LS Hong Kong & Singapore), 2L-T	105 – 125 kg/cm ² (1,493 – 1,778 psi, 10,297 – 12,258 kPa)
2L (LS Hong Kong & Singapore)	145 – 168 kg/cm ² (2,062 – 2,389 psi, 14,220 – 16,475 kPa)

If not within standard indicated above, nozzle adjustment is improper and pressure should be readjusted.

If pressure cannot be adjusted to standard, replace nozzle holder assembly.

ROUGH IDLE WITH WARM ENGINE

(Possible Cause)

(Check Procedure and Correction Method)

1. IMPROPER ADJUSTMENT OF ACCELERATOR CABLE

With accelerator pedal released, check that adjusting lever is in contact with idle speed adjusting screw. Also check if accelerator cable or linkage is catching on something. If necessary, adjust so lever is in contact with screw, or make other required repairs.

2. IDLE RPM TOO LOW

Check if idle rpm is at standard indicated below.
Standard idle rpm: 700 M/T (ex. LX)
800 M/T (LX) & A/T

NOTE: If less than standard, idling would normally be rough.

If not, adjust with idle speed adjusting screw.

3. FUEL LEAKAGE

Check for leaks at the pump connections, pump distributor head bolts, nozzle holder and delivery valve.

Tighten any loose connections to specified torque or replace parts as necessary.

4. IMPROPER INJECTION TIMING

Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

5. IMPROPER OPERATION OF NOZZLE OR DELIVERY VALVE

With engine idling, loosen the union nuts of 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 following procedure.

Faulty Nozzle or Nozzle Holder

Check injection pressure with nozzle tester.

Standard pressure:

L, 2L (ex. LS Hong Kong & Singapore), 2L-T

105 – 125 kg/cm²

(1,493 – 1,778 psi, 10,297 – 12,258 kPa)

2L (LS Hong Kong & Singapore)

145 – 168 kg/cm²

(2,062 – 2,389 psi, 14,220 – 16,475 kPa)

If pressure is not within standard indicated above, nozzle is faulty and injection pressure should be readjusted.

Faulty Delivery Valve

If injection pressure is within standard, delivery valve is defective and should be replaced.

6. NO FUEL INTO INJECTION PUMP

Refer to item 3 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

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 and repair accordingly.

3. MALFUNCTION OF FUEL CUT SOLENOID

Refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and check accordingly.

NOTE: No operation noise from the fuel cut solenoid may be due to loose electrical connections, so check connectors before proceeding with further repairs.

4. NO FUEL INTO INJECTION PUMP

Refer to item 3 of ENGINE CRANKS NORMALLY BUT WILL NOT START, above.

LACK OF POWER

NOTE:

1. First check that air cleaner is not clogged and engine not overheating.
2. Not applicable if customer desires 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 adjusting lever is in contact with maximum speed adjusting screw.
If not, adjust accordingly.

2. INSUFFICIENT NO-LOAD MAXIMUM RPM

Start engine, depress accelerator pedal to floor and check that no-load maximum rpm is within standard.
If not, adjust with maximum speed adjusting screw.

3. INTERCHANGED
OVERFLOW SCREW (OUT)
AND INLET (NO MARK)
FITTING

NOTE: Overflow screw is marked "OUT" and has an inner jet. They must not be interchanged.

4. FUEL LEAKAGE

Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.

5. CLOGGED FUEL FILTER

Disconnect inlet hose from fuel filter and feed clean fuel directly into the pump. If engine condition improves, fuel filter is clogged and should be replaced.

NOTE: When feeding fuel directly into pump, keep container at same level as vehicle fuel tank.

If no increase in engine condition after replacing fuel filter, check priming pump or perform other necessary repairs.

6. IMPROPER INJECTION
TIMING

Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

7. FAULTY NOZZLE OR
NOZZLE HOLDER

Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

EXCESSIVE EXHAUST SMOKE

NOTE:

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

(Possible Cause)

(Check Procedure and Correction Method)

1. IMPROPER INJECTION
TIMING

Refer to item 7 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 5 of LACK OF POWER.

NOTE: At high rpm (2,000 – 3,000), a clogged filter tends to make the exhaust smoke white.

3. FAULTY NOZZLE OR
NOZZLE HOLDER

Refer to item 9 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 clutch slipping, brakes grabbing, tires wrong size or air filter clogged.

(Possible Cause)

(Check Procedure and Correction Method)

1. FUEL LEAKAGE

Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.

2. IDLE RPM TOO HIGH

After sufficiently warming up engine, check that idle rpm is as specified below.

Idle rpm: 700 M/T (ex. LX)
800 M/T (LX) & A/T

If not, adjust with idle speed adjusting screw.

3. NO-LOAD MAXIMUM RPM
TOO HIGH

Start engine, depress accelerator pedal to floor and check that no-load maximum rpm is within standard.

No-load maximum rpm:

L, 2L (ex. LS Hong Kong & Singapore, Australia
LY & LN56) & 2L-T 4,900

2L (LS Hong Kong & Singapore, Australia
LY & LN56) 4,500

If not, adjust with maximum speed adjusting screw.

4. IMPROPER INJECTION
TIMING

Refer to item 7 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

5. FAULTY NOZZLE OR
NOZZLE HOLDER

Refer to item 9 of ENGINE CRANKS NORMALLY BUT WILL NOT START.

ENGINE NOISE WHEN WARM

(Clanking 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 7 of ENGINE CRANKS NORMALLY
BUT WILL NOT START.

3. FAULTY NOZZLE OR
NOZZLE HOLDER

Refer to item 9 of ENGINE CRANKS NORMALLY
BUT WILL NOT START.

ENGINE WILL NOT RETURN TO IDLE

NOTE (ex. w/ACSD): Check that idle adjusting knob is returned.

(Possible Cause)

BINDING ACCELERATOR
LINKAGE

(Check Procedure and Correction Method)

Operate adjusting lever on top of injection pump and check if engine returns to idle. If so, accelerator cable is binding or maladjusted and should be repaired accordingly. If engine does not return to idle, injection pump is faulty and should be replaced.

ENGINE WILL NOT SHUT OFF WITH KEY

(Possible Cause)

IMPROPER FUEL CUT
SOLENOID OPERATION

(Check Procedure and Correction Method)

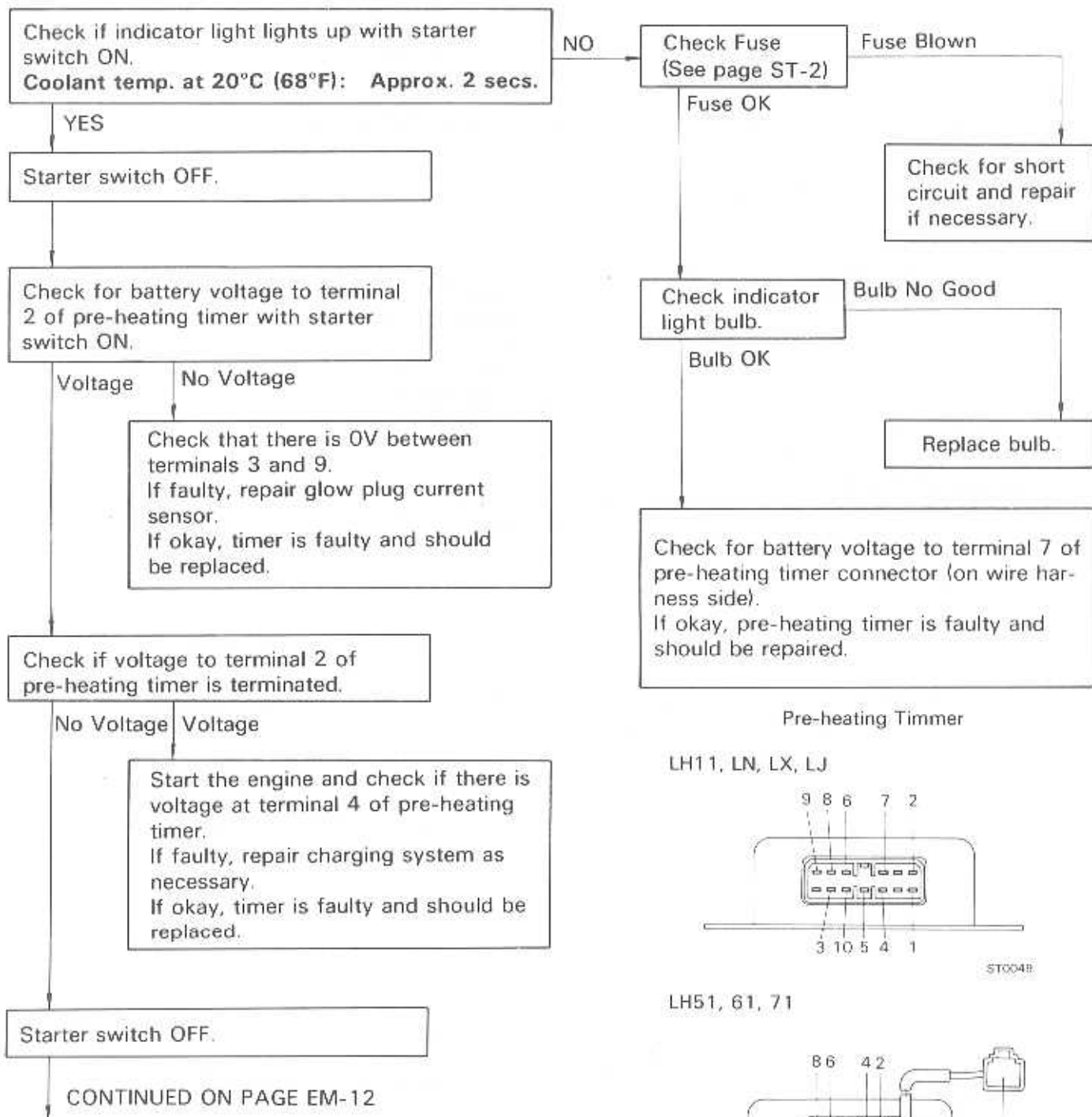
Disconnect connector on top of fuel cut solenoid and check if engine stops. If so, starter switch is faulty and should be repaired as necessary or replaced. If engine does not stop, either fuel cut solenoid is faulty or there is interference by foreign particles. Repair as necessary.

DIESEL ELECTRICAL SYSTEM DIAGNOSIS

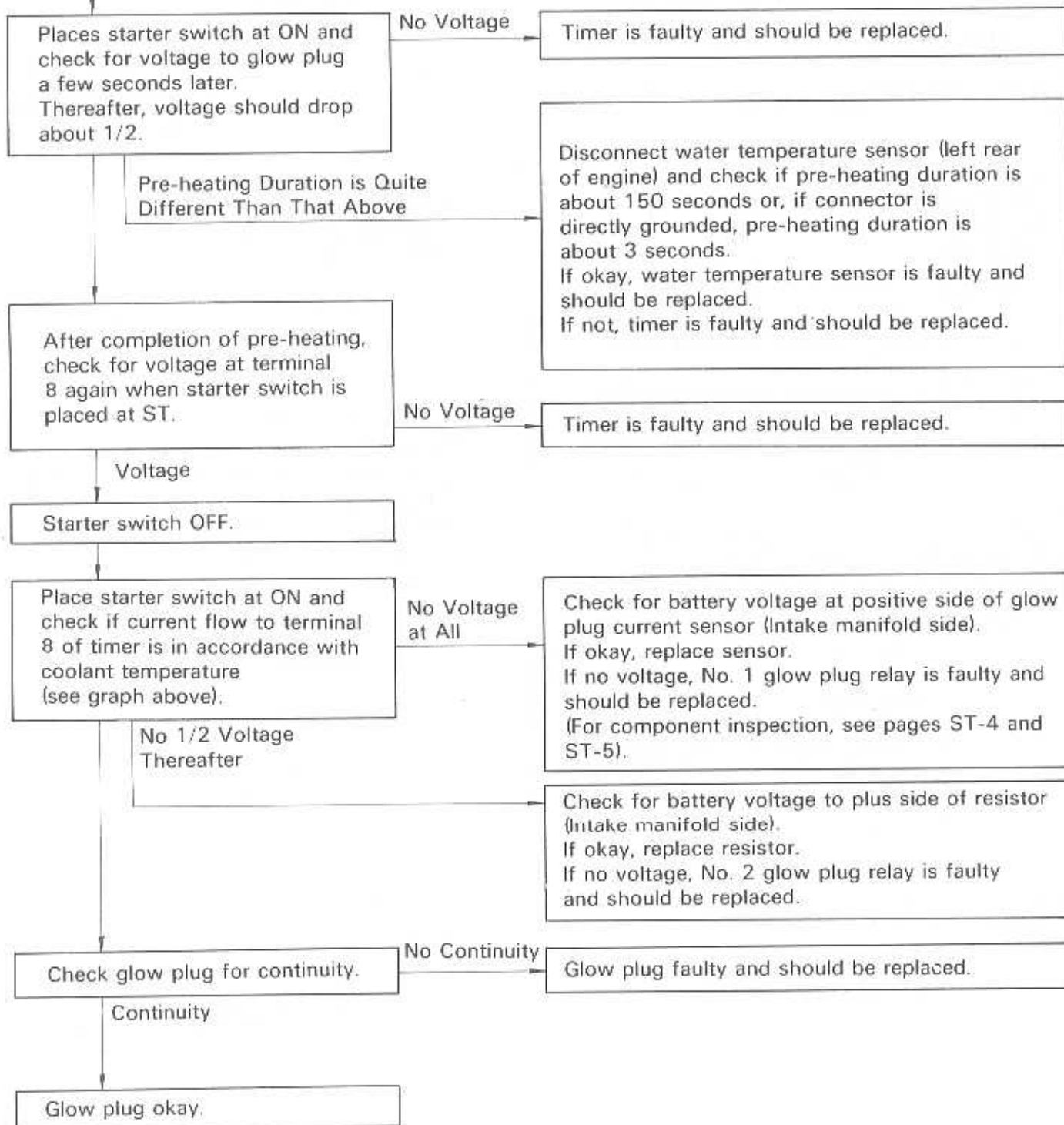
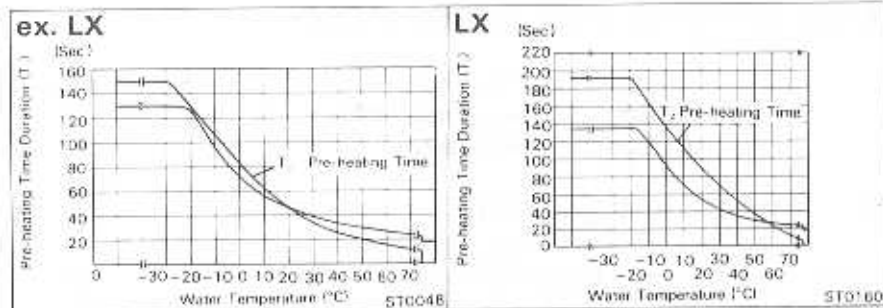
ENGINE DOES NOT START COLD

- NOTE:**
1. Battery voltage at least 12 volts — starter switch OFF.
 2. Engine cranks normally.
 3. Fusible link okay.

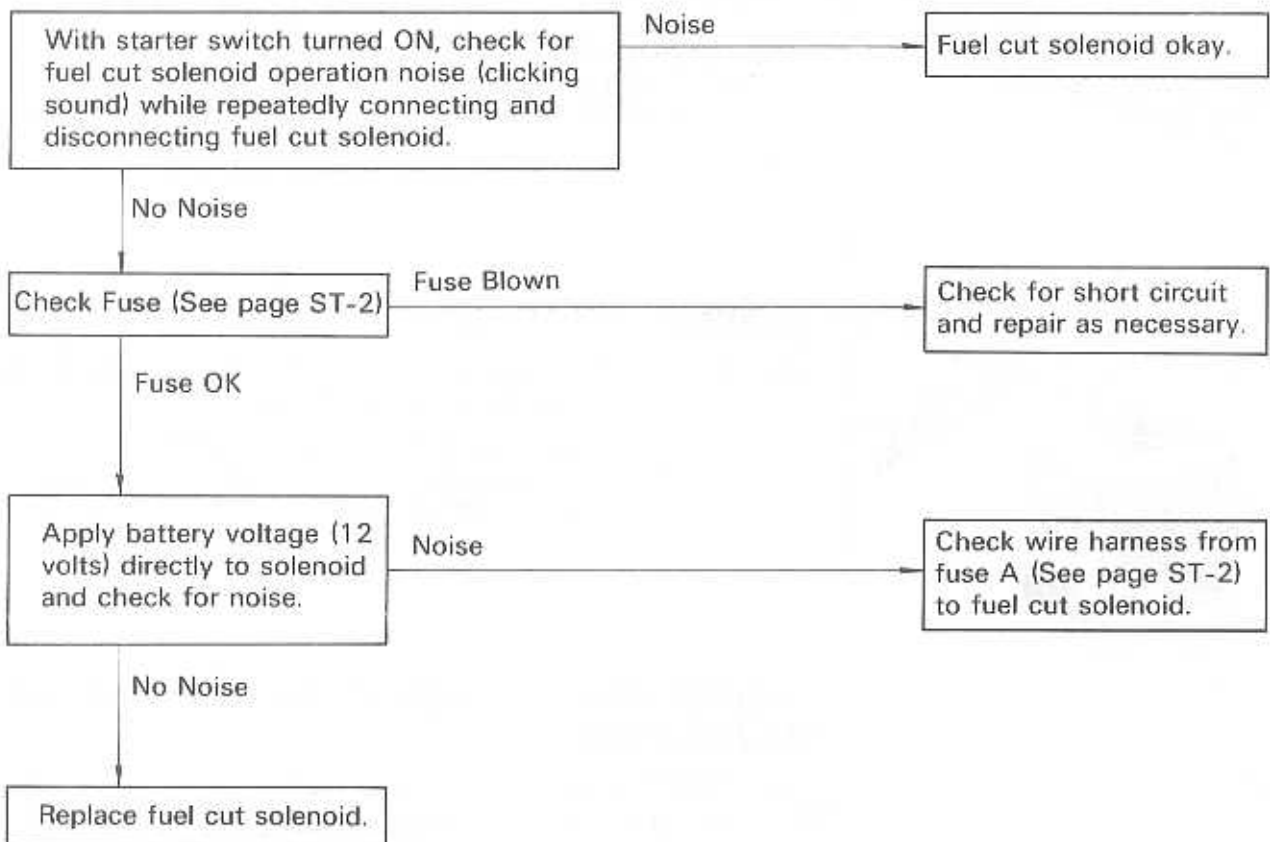
1. Super Glow System

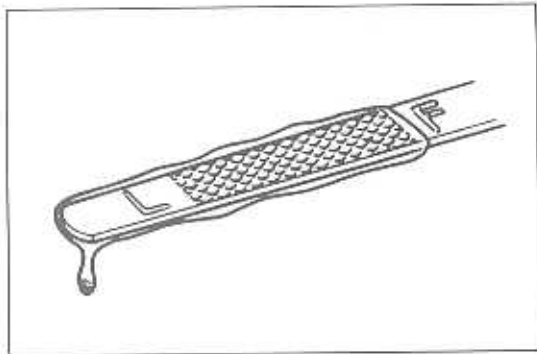


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2. Fuel Cut Solenoid



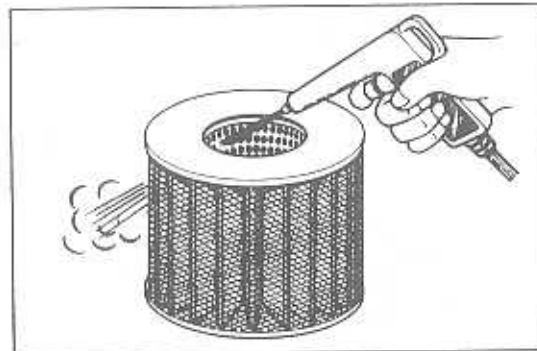


ENGINE TUNE-UP

INSPECT 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.



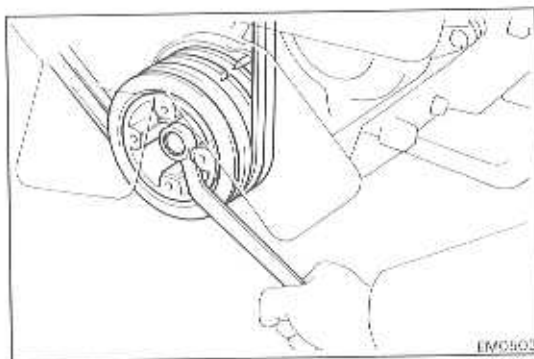
INSPECT AIR FILTER

- (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.

INSPECTION AND ADJUSTMENT OF VALVE CLEARANCES

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

1. REMOVE CYLINDER HEAD COVER (See page EM-32)



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.

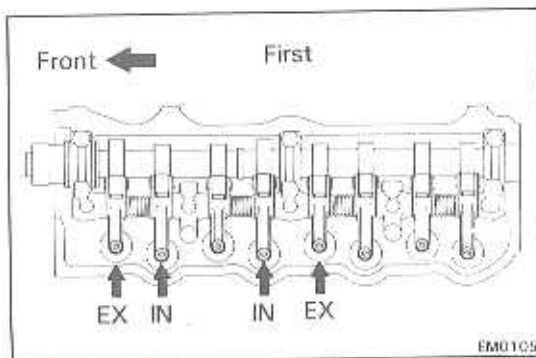
If not, turn the crankshaft one revolution (360°) and align the mark as above.

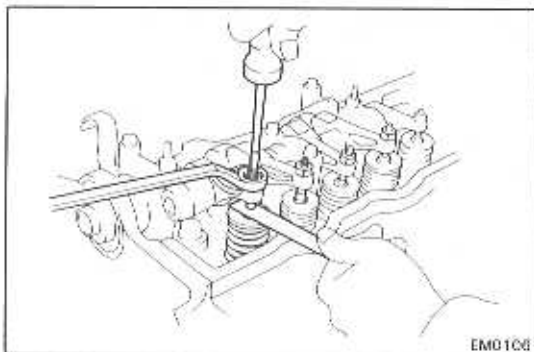
3. INSPECT AND ADJUST VALVE CLEARANCE

- (a) Measure only those valves indicated by arrows.

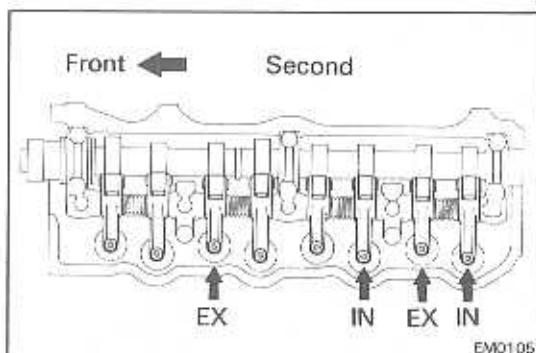
Valve clearance (Hot):

Intake	0.25 mm (0.0098 in.)
Exhaust	0.36 mm (0.0142 in.)

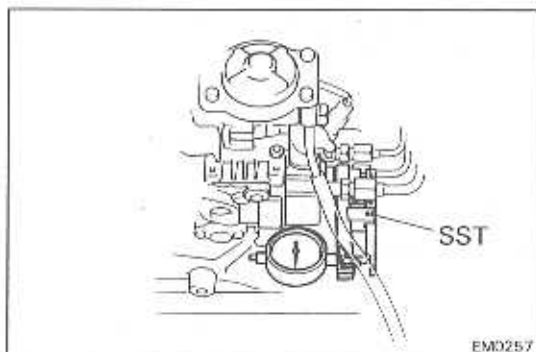




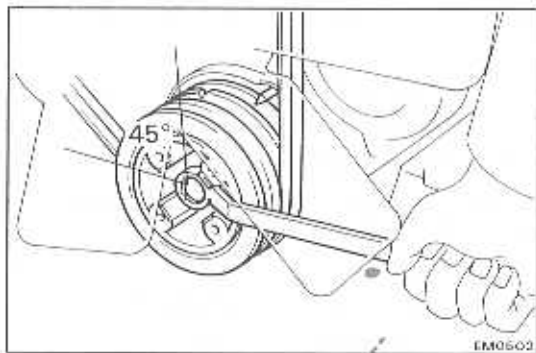
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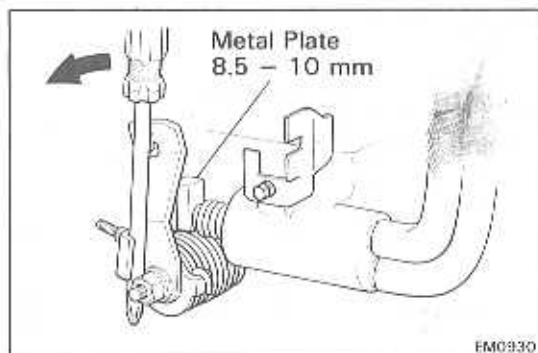
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EM0257



EM0502



EM0330

- 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.

4. INSTALL CYLINDER HEAD COVER (See page EM-49)

INSPECTION AND ADJUSTMENT OF INJECTION TIMING

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

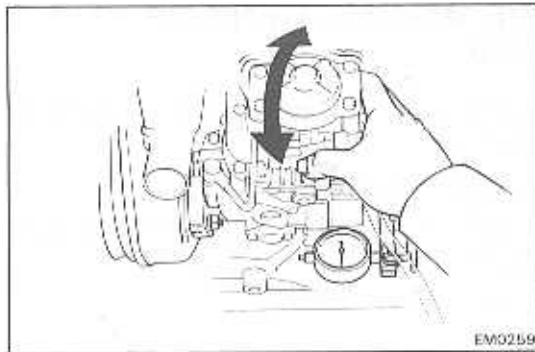
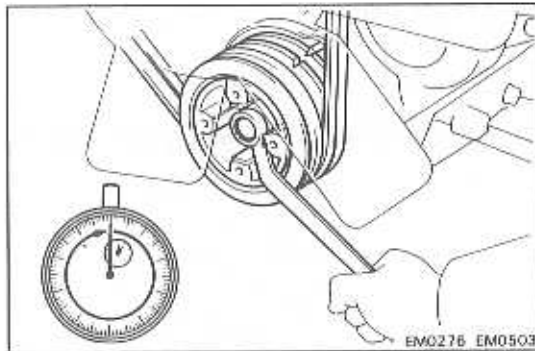
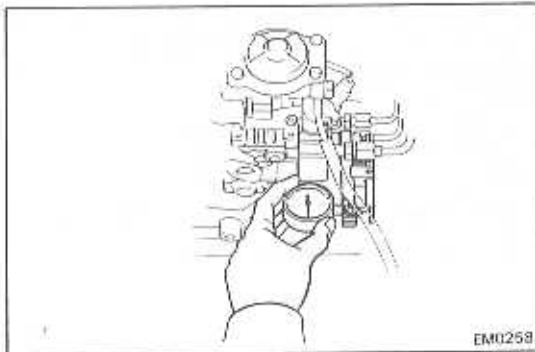
- (a) Remove the distributive head bolt.
- (b) Install SST and the dial indicator to the distributive head plug hole.

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2. SET NO. 1 OR NO. 4 CYLINDER TO 45° BTDC/COMPRESSION

3. RELEASE COLD STARTING SYSTEM

- (a) Using a screwdriver, turn the cold starting lever counterclockwise about 20° as shown.
- (b) Put a metal plate 8.5 – 10 mm (0.335 – 0.394 in.) thick between the cold starting lever and thermo wax plunger.



4. INSPECT AND ADJUST INJECTION TIMING

- (a) Set the dial gauge at zero mm (0 in.).
- (b) Recheck to see that the dial gauge remains at zero mm (0 in.), while rotating the crankshaft pulley slightly to the left and right.
- (c) Slowly rotate the crankshaft pulley until No. 1 or No. 4 cylinder is at TDC/compression.
- (d) Measure the plunger stroke.

Plunger stroke:

L	0.94 – 1.06 mm (0.0370 – 0.0417 in.)
2L	w/o ACSD 1.06 – 1.22 mm (0.0417 – 0.0480 in.)
	w/ ACSD 0.82 – 0.98 mm (0.0323 – 0.0386 in.)
2L-T	0.75 – 0.87 mm (0.0295 – 0.0343 in.)

- (e) Loosen the four injection pipe union nuts and fuel inlet pipe union nut at the injection pump side.
- (f) Loosen the four injection pump mounting bolts and two nuts.
- (g) Adjust the plunger stroke by slightly tilting the injection pump body.

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

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

- (h) Tighten the injection pump mounting bolts and nuts.

Torque:

Bolts	185 kg-cm (13 ft-lb, 18 N·m)
Nuts	210 kg-cm (15 ft-lb, 21 N·m)

- (i) Recheck the plunger stroke.
- (j) Tighten the injection pipe union nuts and fuel inlet pipe union nut.

Torque:

Injection pipe	250 kg-cm (18 ft-lb, 25 N·m)
Inlet pipe	230 kg-cm (17 ft-lb, 23 N·m)

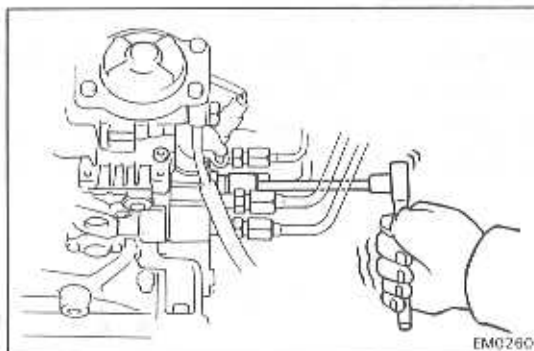
5. REMOVE METAL PLATE FROM COLD STARTING LEVER

6. REMOVE SST AND DIAL INDICATOR

- (a) Remove SST and the dial indicator.
- SST 09275-54010
- (b) Install the distribution head bolt with a new gasket. Torque the bolts.

Torque: 170 kg-cm (12 ft-lb, 17 N·m)

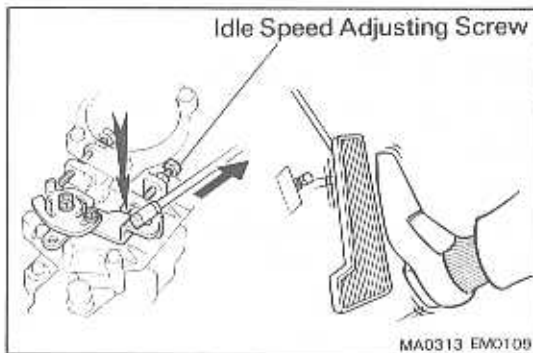
7. START ENGINE AND CHECK FOR LEAKS



INSPECTION AND ADJUSTMENT OF IDLE AND MAXIMUM SPEEDS

1. INITIAL CONDITIONS:

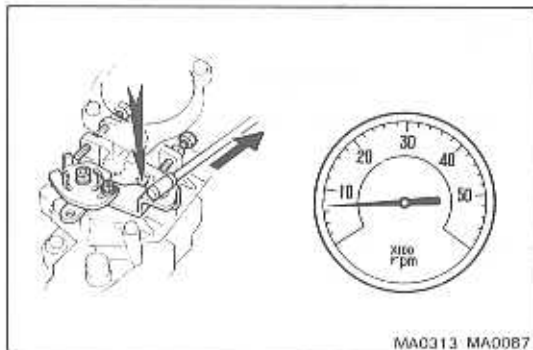
- (a) Air cleaner installed
- (b) Engine coolant normal operating temperature
- (c) Accessories switched off
- (d) Transmission in neutral



2. 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.



- (b) Install a tachometer to the engine.

- (c) Start the engine.

- (d) Check the idle speed.

Idle speed: 700 rpm M/T (ex. LX)
800 rpm M/T (LX) & A/T

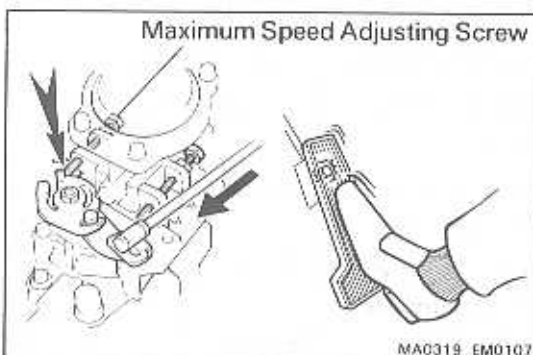
- (e) Adjust the idle speed.

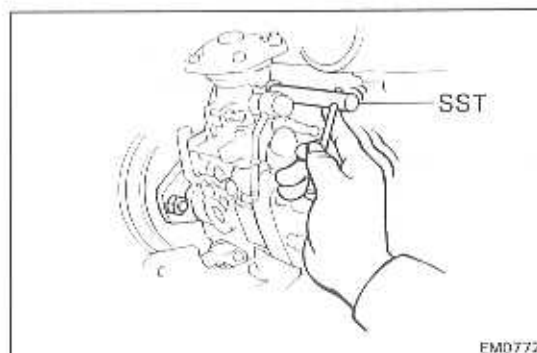
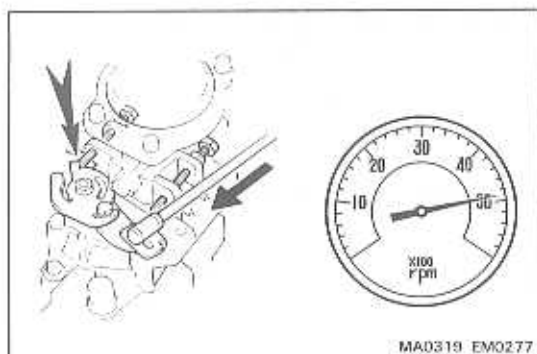
- Disconnect the accelerator linkage.
- Loosen the lock nut of the idle speed adjusting screw.
- Adjust the idle speed by turning the IDLE SPEED ADJUSTING SCREW.
- Securely tighten the lock nut.
- Connect the accelerator linkage.
- After adjustment, adjust the accelerator linkage.

3. 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 stop bolt of the accelerator pedal.





- (b) Install a tachometer to the engine.
- (c) Start the engine.
- (d) Depress the accelerator pedal all the way.
- (e) Check the maximum speed.

Maximum speed:

L, 2L (ex. LS Hong Kong & Singapore, Australia LY & LN56) & 2L-T	4,900 rpm
2L (LS Hong Kong & Singapore, Australia LY & LN56)	4,500 rpm

- (f) Adjust the maximum speed.
 - Disconnect the accelerator linkage.
 - Using SST, loosen the lock nut of the maximum speed adjusting screw.

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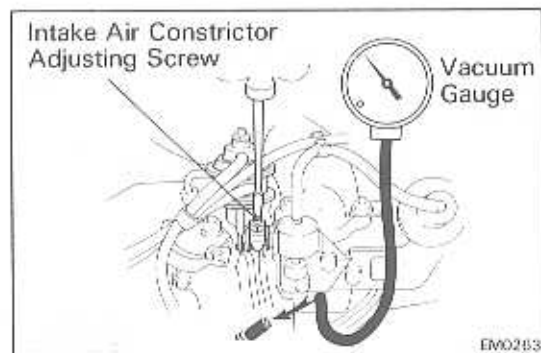
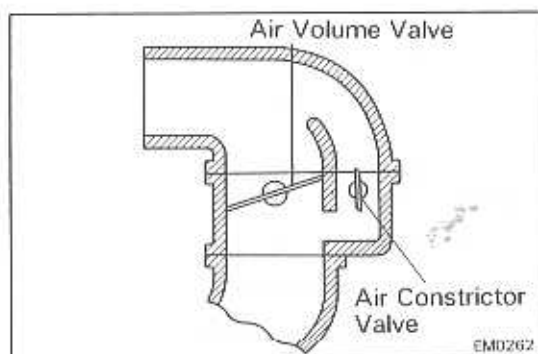
- Adjust the maximum speed by the **MAXIMUM SPEED ADJUSTING SCREW**.

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

- Using SST, securely tighten the lock nut.

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- Connect the accelerator linkage.
- After adjustment, adjust the stop bolt of the accelerator pedal.

**CHECK AND ADJUSTMENT OF INTAKE AIR VOLUME (LS, LX71 M/T)****1. INITIAL CONDITIONS:**

- (a) Air cleaner installed
- (b) Engine coolant normal operating temperature.
- (c) Accessories switched off
- (d) Transmission in neutral
- (e) 900 meters or less above sea level.
- (f) Intake air volume valve fully closed.

2. CHECK AND ADJUST INTAKE AIR VOLUME

- (a) Install a vacuum gauge to the intake manifold.
- (b) Start the engine.
- (c) Check the intake manifold vacuum.

Vacuum: 110 – 150 mmHg
(4.33 – 5.91 in.Hg, 14.7 – 20.0 kPa)

- (d) Adjust the vacuum by loosening the lock nut and turning the **INTAKE AIR CONSTRICTOR ADJUSTING SCREW**.

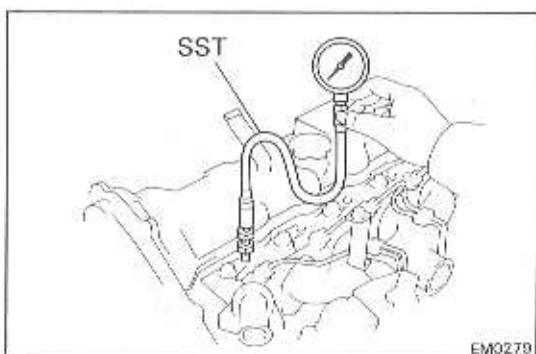
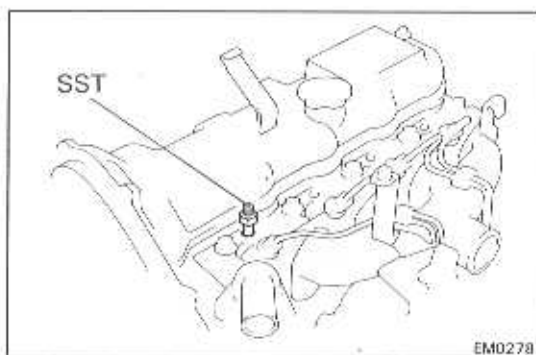
COMPRESSION CHECK

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

1. **WARM UP ENGINE**
2. **DISCONNECT FUEL CUT SOLENOID WIRE CONNECTOR**
3. **REMOVE FOUR GLOW PLUGS**
(See page EM-21)

CAUTION: Make sure the load wire is not grounded.

4. **INSTALL SST TO GLOW PLUG MOUNTING HOLE**
SST 09992-00023



5. **MEASURE CYLINDER COMPRESSION PRESSURE**

(a) Connect a compression gauge (SST) to SST.
SST 09992-00023

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

NOTE: Always use a fully charged battery so that at least 250 rpm can be reached.

(c) Repeat steps (a) and (b) for each cylinder.

Compression pressure:

→ L, 2L-T 30.0 kg/cm² (427 psi, 2,942 kPa) ← *
2L 32.0 kg/cm² (455 psi, 3,138 kPa)

Minimum pressure

20.0 kg/cm² (284 psi, 1,961 kPa)

Difference between each cylinder:

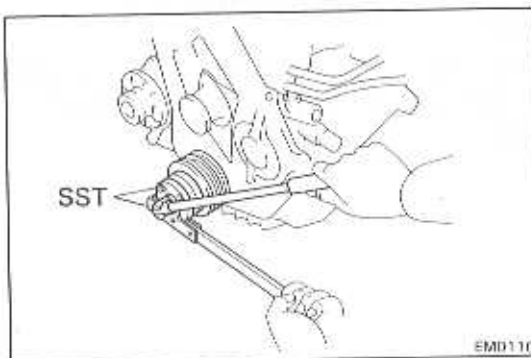
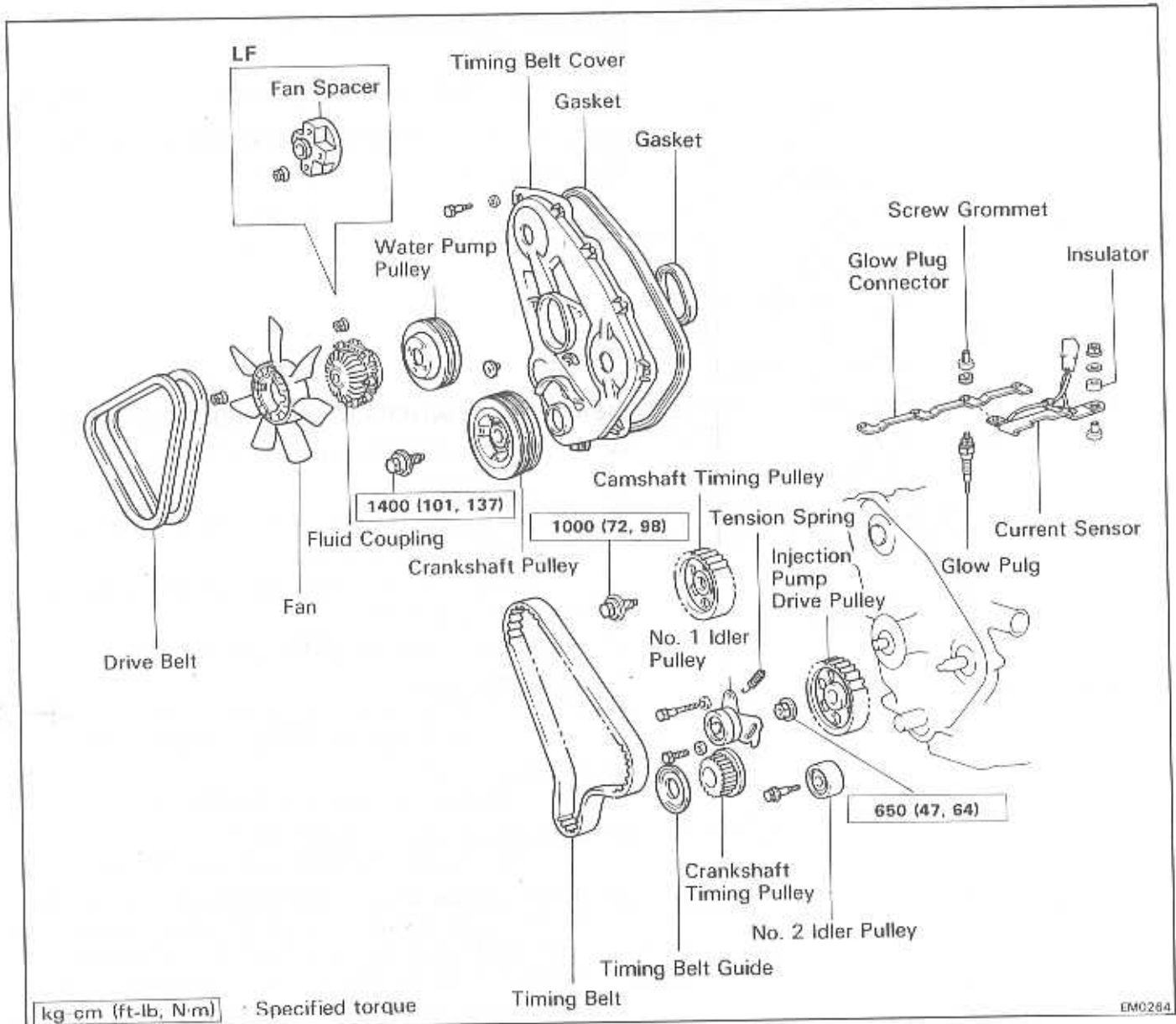
Less than 5.0 kg/cm² (71 psi, 490 kPa)

- (d) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the glow plug hole and repeat steps (a) and (b) for the cylinder with low compression.
 - If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
 - If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

TIMING BELT

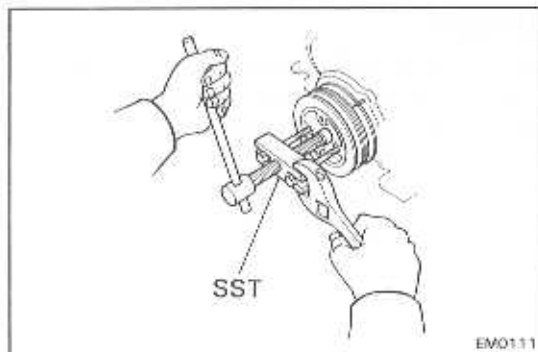
NOTE: If replacing the timing belt before the timing belt warning light comes on, (light comes on after 100, 000 km of driving), be sure to reset the timing belt counter of the speedometer to zero.

COMPONENTS

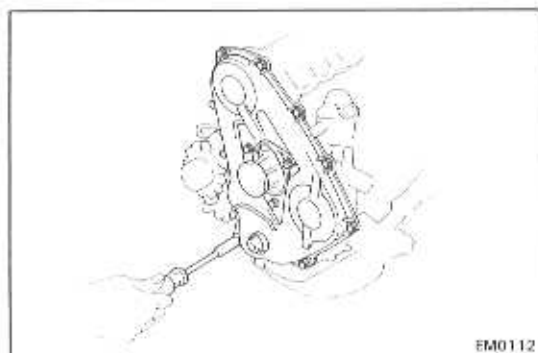


REMOVAL OF TIMING BELT

1. REMOVE DRIVE BELTS
2. REMOVE WATER PUMP PULLEY
(See step 3 on pages CO-4)
3. REMOVE CRANKSHAFT PULLEY
 - (a) Using SST, remove the mount bolt.
SST 09213-54012 and 09330-00020



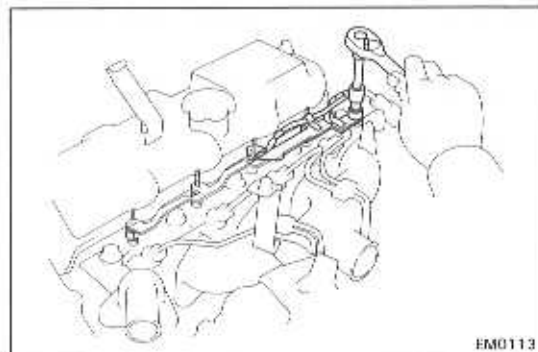
- (b) Using SST, remove the pulley.
SST 09213-60017



4. REMOVE TIMING BELT COVER

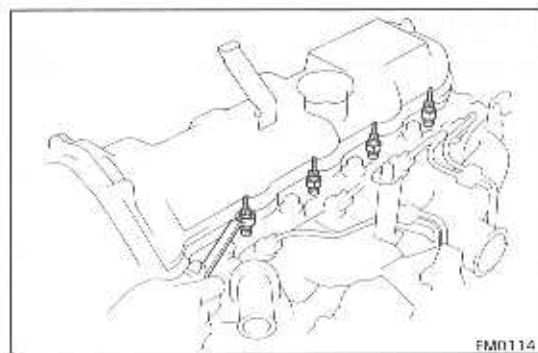
Remove the twelve bolts and belt cover with the two gaskets.

5. REMOVE TIMING BELT GUIDE

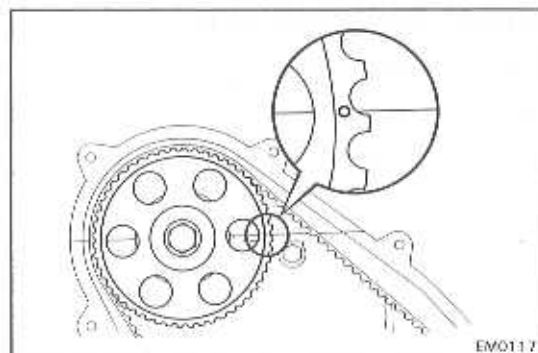


6. REMOVE CURRENT SENSOR AND FOUR GLOW PLUGS

- (a) Remove the four screw grommets.
(b) Remove the four glow plug connecting nuts.
(c) **[Europe (LH, LX, LN)]**
Remove the nut, plate washer, insulators and current sensor.
(d) Remove the glow plug connector.

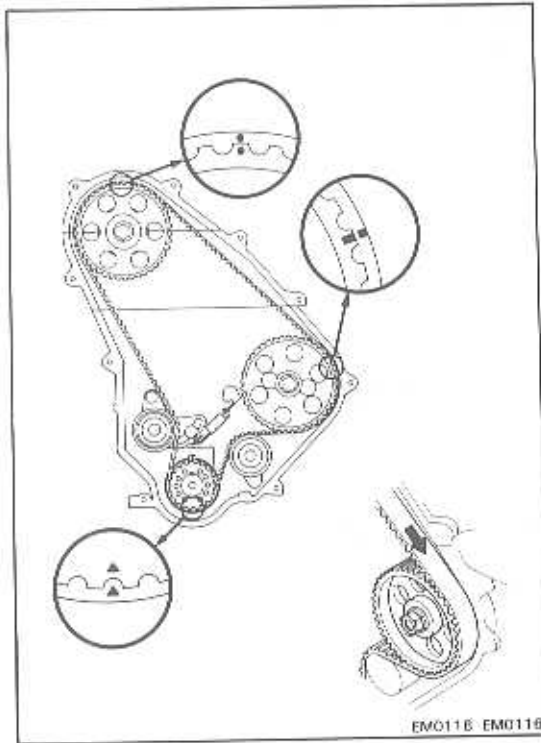


- (e) Remove the four glow plugs.



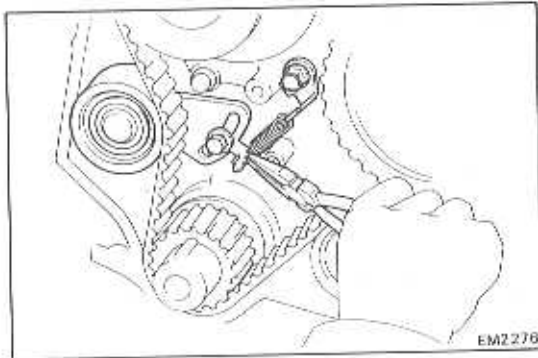
7. SET NO. 1 CYLINDER TO TDC/COMPRESSION

Using a crankshaft pulley mount bolt, align the TDC mark of the camshaft timing pulley with the top end of the cylinder head.

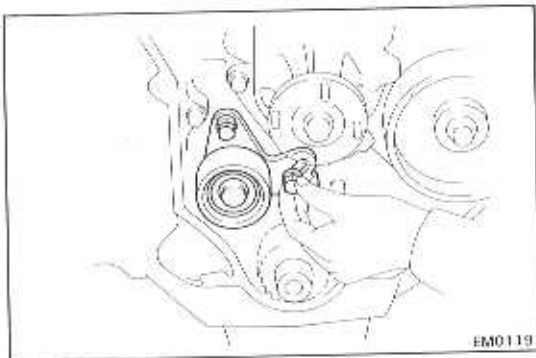


8. REMOVE TIMING BELT

NOTE: If reusing the timing belt, draw a direction arrow on the belt (in direction of engine revolution), and place matchmarks on the pulleys and timing belt.

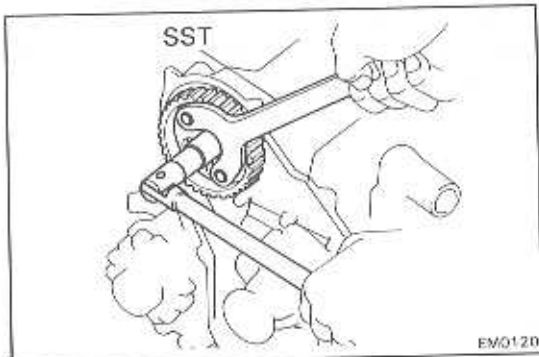


- (a) Using needle-nosed pliers, remove the tension spring.
- (b) Loosen the two No. 1 idler pulley mount bolts.
- (c) Remove the timing belt.



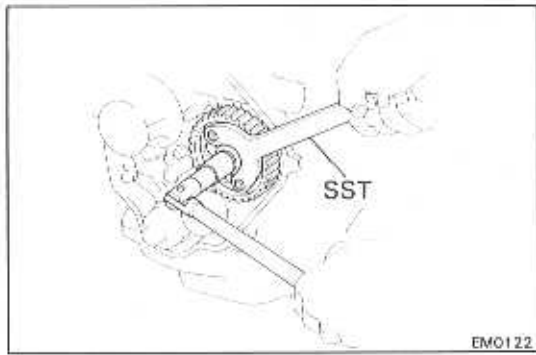
9. REMOVE NO. 1 IDLER PULLEY

Remove the two mount bolts, plate washers and idler pulley.

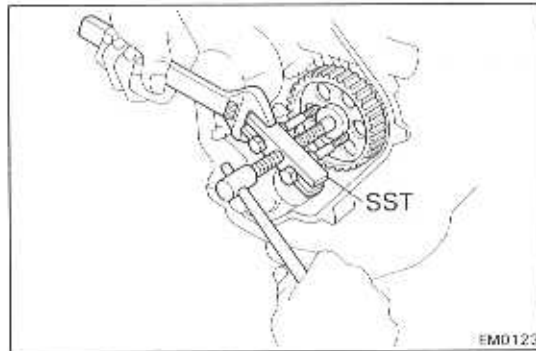


10. REMOVE CAMSHAFT TIMING PULLEY

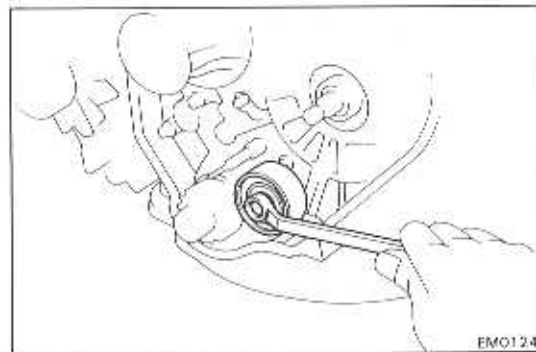
Using SST, remove the mount bolt.
SST 09278-54011

**11. REMOVE INJECTION PUMP DRIVE PULLEY**

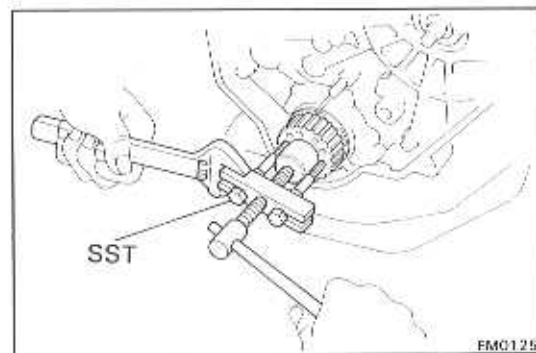
- (a) Using SST, remove the mount nut.
SST 09278-54011



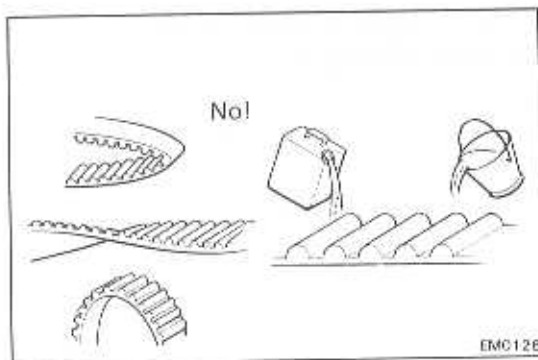
- (b) Using SST, remove the pump drive pulley.
SST 09213-60017

**12. REMOVE NO. 2 IDLER PULLEY**

- Remove the mount bolt and No. 2 idler pulley.

**13. REMOVE CRANKSHAFT TIMING PULLEY**

- Using SST, remove the crankshaft timing pulley.
SST 09213-60017



INSPECTION OF COMPONENTS

1. INSPECT TIMING BELT

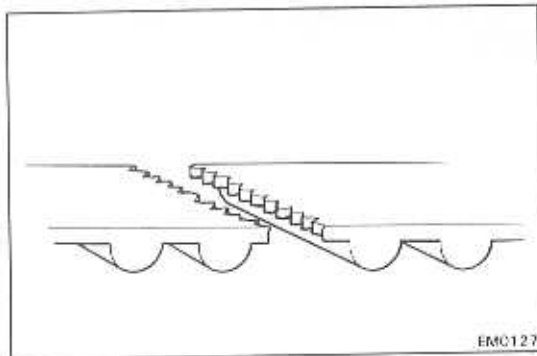
CAUTION:

1. Do not bend, twist or turn the belt inside out.
2. Do not allow the belt to come into contact with oil, water or steam.
3. Do not utilize belt tension when installing or removing the set bolt of the camshaft timing pulley.

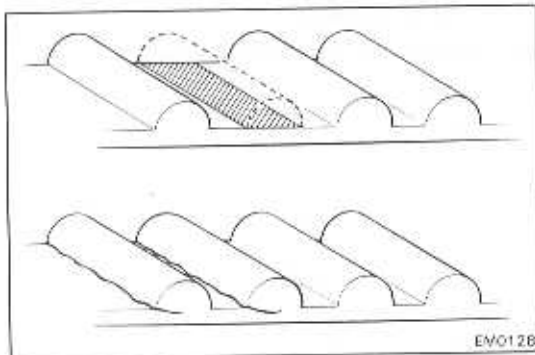
If there are defects as shown in the figures, check the following points and replace the timing belt if necessary.

(a) Premature parting

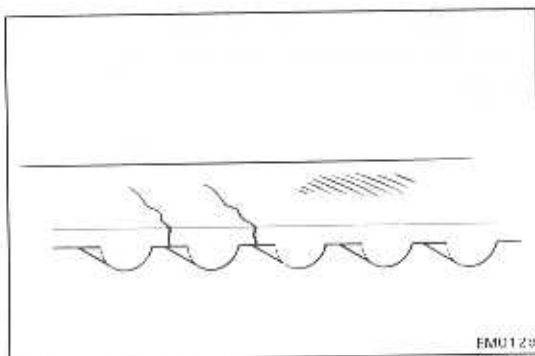
- Check for proper installation.
- Check the timing cover gasket for damage, and check for correct installation.



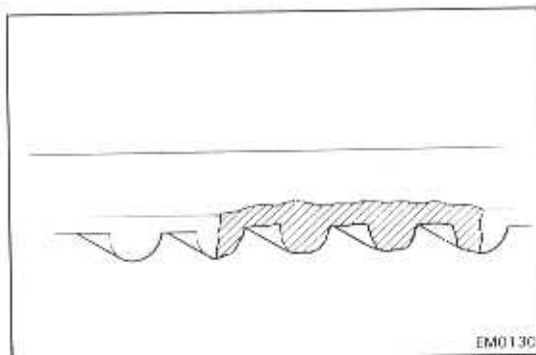
(b) If the belt teeth are cracked or damaged, check to see if the camshaft, water pump or oil pump is locked.

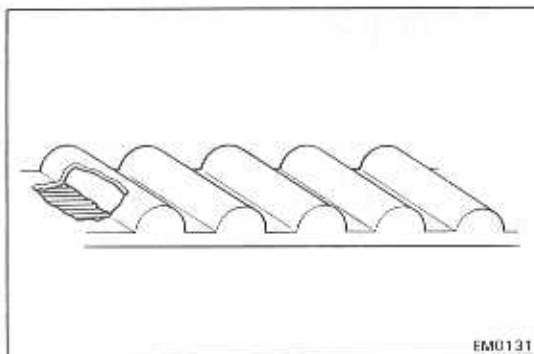


(c) If there is noticeable wear or cracks on the belt face, check to see if there are nicks on one side of the idler pulley lock.

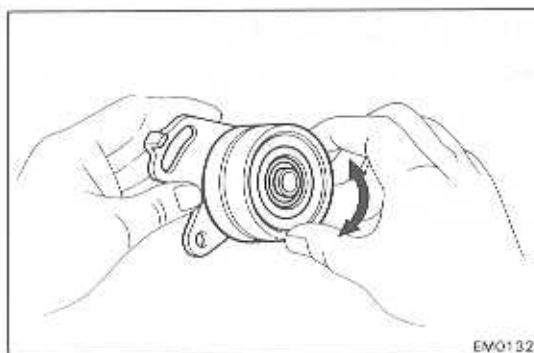


(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.





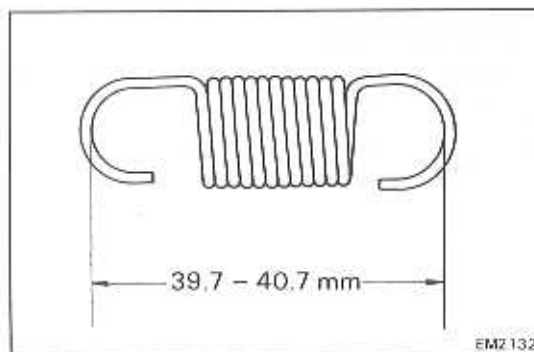
- (e) If there is noticeable wear on the belt teeth, check the timing cover gasket for damage and check for correct gasket installation. Check for foreign materials on the pulley teeth.



2. INSPECT IDLER PULLEYS

Check the turning smoothness of the timing belt idler pulleys.

If necessary, replace the idler pulley.



3. INSPECT TENSION SPRING

- (a) Check the free length of the spring.

Free length:

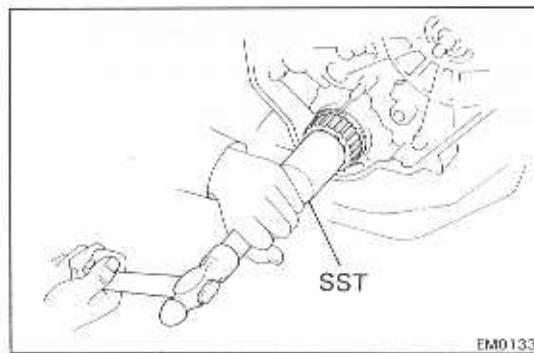
39.7 - 40.7 mm (1.563 - 1.602 in.)

- (b) Check the tension of the spring at the specified installed length.

Installed tension:

4.0 kg (8.8 lb, 39 N) at 52 mm (2.05 in.)

If not specified, replace the spring.



INSTALLATION OF TIMING BELT

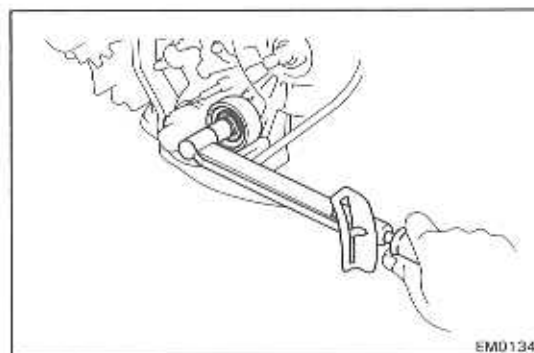
(See page EM-20)

1. INSTALL CRANKSHAFT TIMING PULLEY

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

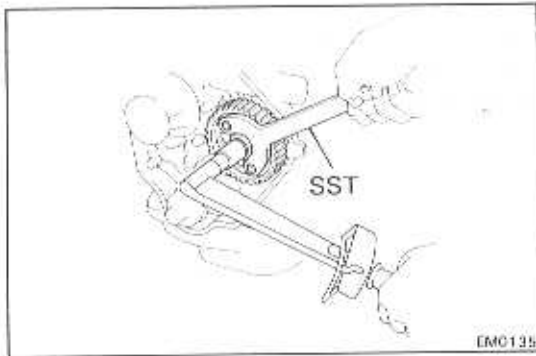
- (b) Using SST and a hammer, drive in timing pulley.

SST 09214-60010



2. INSTALL NO. 2 IDLER PULLEY

Torque: 400 kg-cm (29 ft-lb, 39 N·m)



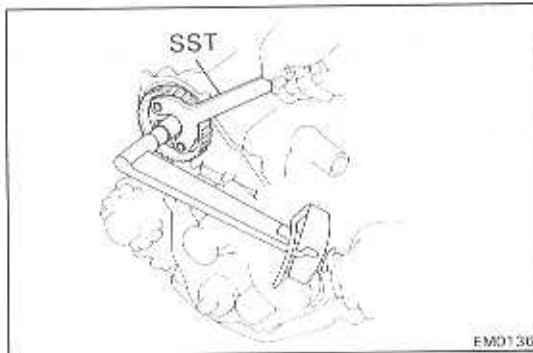
3. INSTALL INJECTION PUMP DRIVE PULLEY

- (a) Align the drive pulley set key with the key groove of the drive pulley.
- (b) Using SST, install the drive pulley with the mount nut. Torque the mount nut.

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

SST 09278-54011

CAUTION: Do not use an impact wrench.

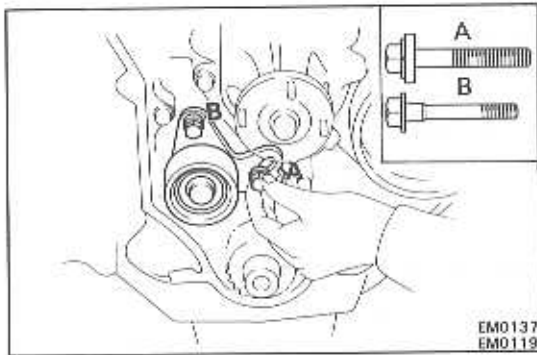


4. INSTALL CAMSHAFT TIMING PULLEY

- (a) Align the timing pulley knock pin with the pin hole of the timing pulley.
- (b) Using SST, install the timing pulley with the mount bolt and plate washer. Torque the mount bolt.

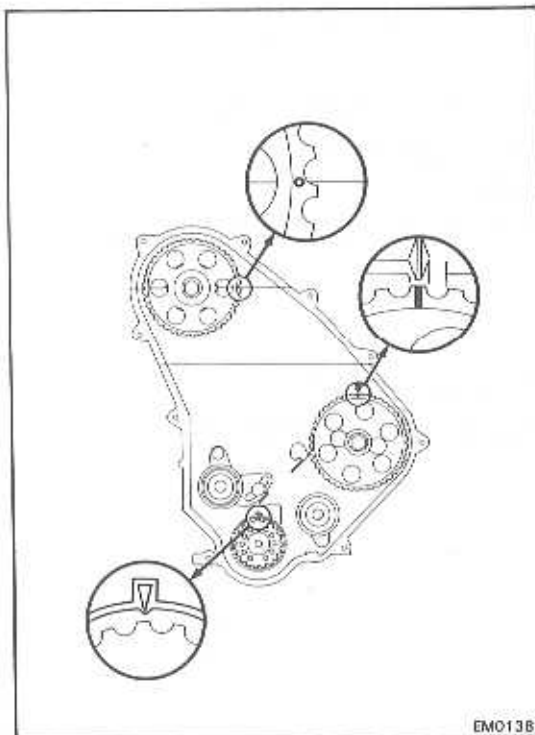
Torque: 1,000 kg-cm (72 ft-lb, 98 N·m)

SST 09278-54011



5. INSTALL NO. 1 IDLER PULLEY

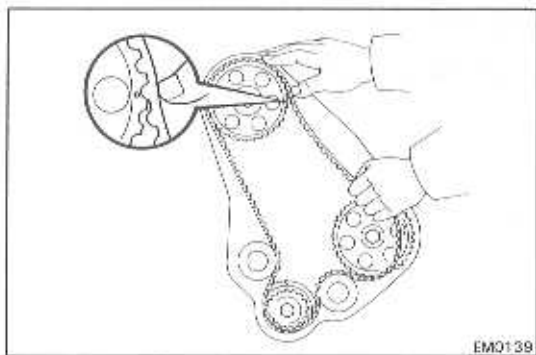
- (a) Temporarily install the idler pulley with the two mount bolts and plate washers.
- (b) Swing the idler pulley toward the left.



6. SET NO. 1 CYLINDER TO TDC/COMPRESSION

Align the timing and drive pulleys at each position.

CAUTION: The engine should be cold.

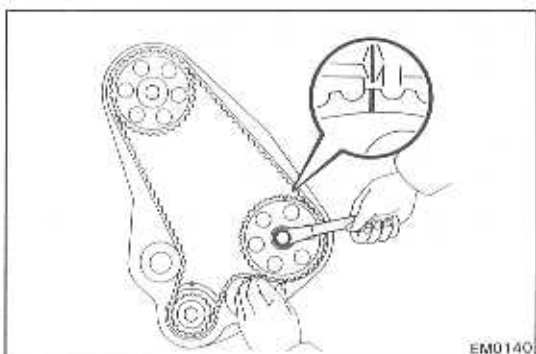


7. INSTALL TIMING BELT

If using new timing belt:

- (a) Install the timing belt to the camshaft timing pulley.

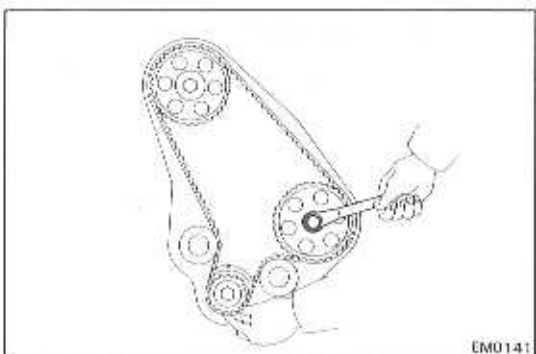
CAUTION: Be sure the timing belt is securely meshed and not loose.



- (b) Align the timing marks of the pump drive pulley and oil pump body.

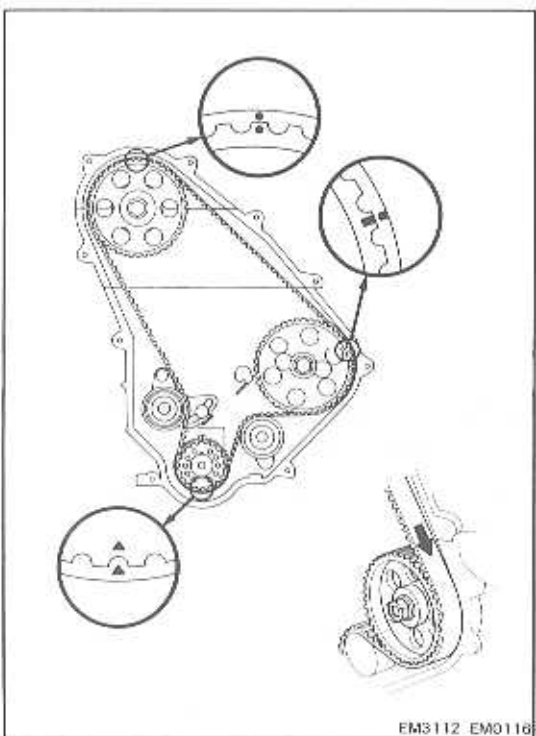
- (c) Install the timing belt to the pump drive pulley.

CAUTION: Be sure the timing belt is securely meshed and not loose.



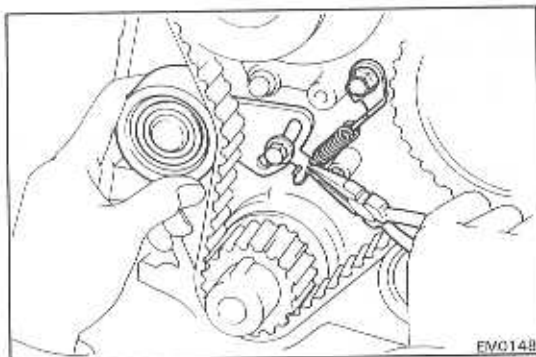
- (d) Install the timing belt to the No. 2 idler pulley and crankshaft timing pulley.

CAUTION: Be sure the belt is not twisted or too tight.



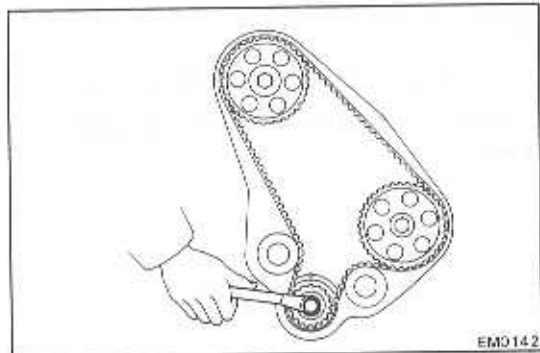
If reusing timing belt:

Align the points marked during removal and install the timing belt with the arrow pointing in the direction of engine revolution.



8. INSTALL TENSION SPRING

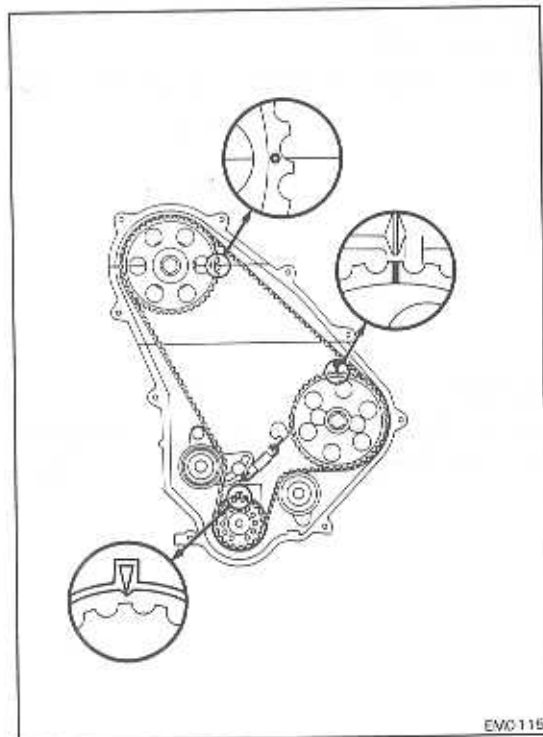
CAUTION: Loosen the mount bolts to where the timing belt idle pulley lightly moves with tension spring force.



9. CHECK POSITION OF TIMING AND DRIVE PULLEYS

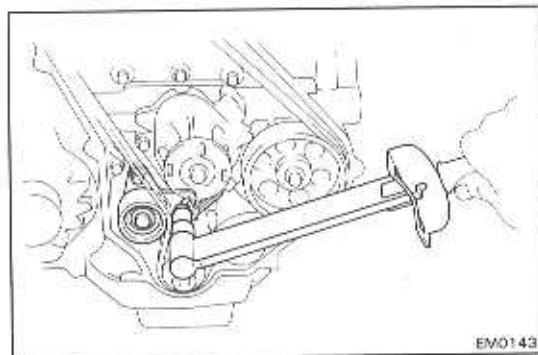
- Place a crankshaft pulley mount bolt on the crankshaft.
- Using a wrench, turn the crankshaft pulley mount bolt 2 revolutions from TDC to TDC.

CAUTION: Always turn the crankshaft clockwise.



- Check that each pulley aligns with the marks.

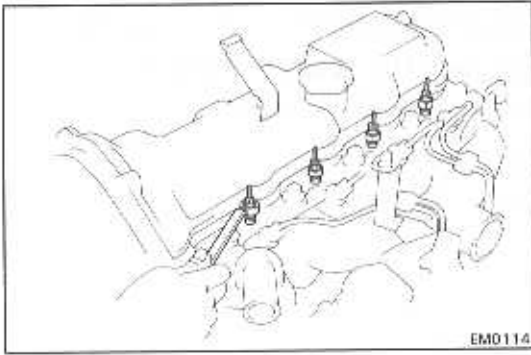
If the marks do not align, remove the timing belt and reinstall it.



10. TORQUE NO. 1 IDLER PULLEY MOUNT BOLTS

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

CAUTION: While tightening the mount bolts, do not move the idler pulley bracket.

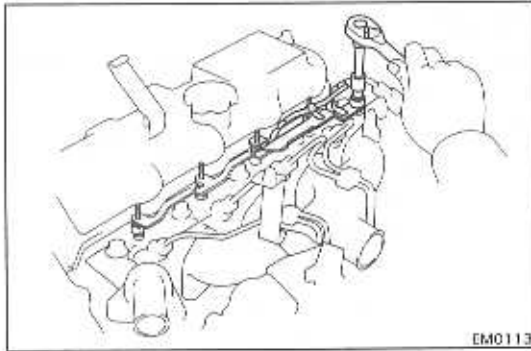


11. INSTALL FOUR GLOW PLUGS AND CURRENT SENSOR

(a) Install and torque the four glow plugs.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)

(b) Place the glow plug connector on the glow plugs.

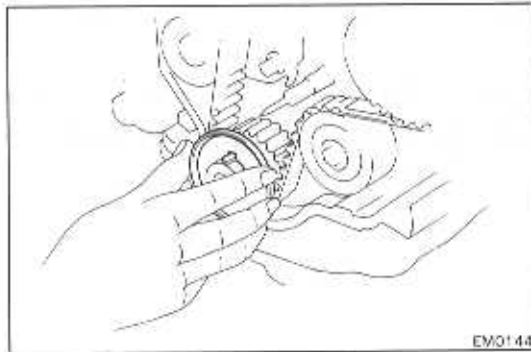


(c) **[Europe (LH, LX, LN)]**

Install the current sensor with the insulators, plate washer and nut.

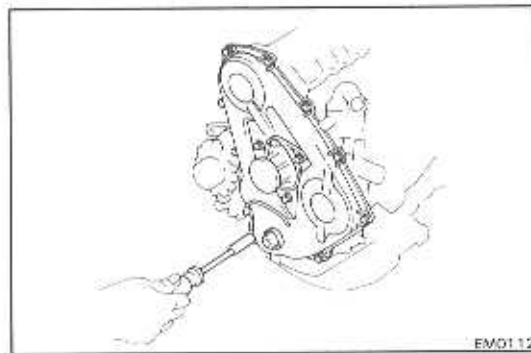
(d) Install the four glow plug connecting nuts.

(e) Install the four screw grommets.



12. INSTALL TIMING BELT GUIDE

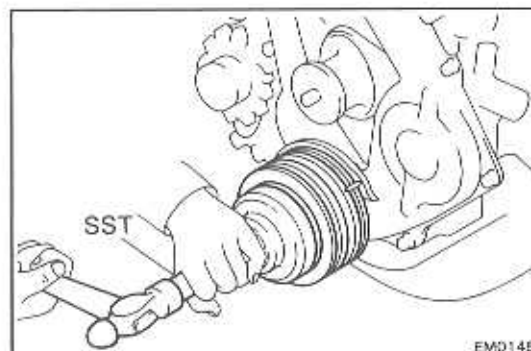
Align the set key on the crankshaft with the key groove of the belt guide and slide it in.



13. INSTALL TIMING BELT COVER

(a) Install the gaskets to the belt cover.

(b) Install the belt cover with the twelve bolts.

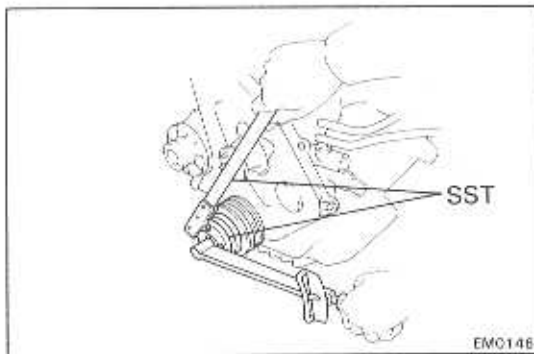


14. INSTALL CRANKSHAFT PULLEY

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

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

SST 09223-63010

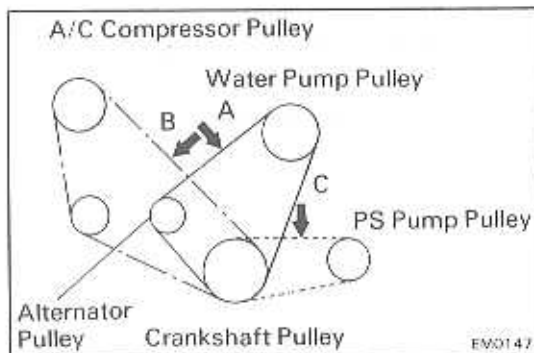


(c) Using SST, install the mount bolt and torque it.

Torque: 1,400 kg-cm (101 ft-lb, 137 N·m)

SST 09213-54012 and 09330-00020

15. INSTALL WATER PUMP PULLEY
(See step 4 on page CO-6)



16. INSTALL DRIVE BELTS

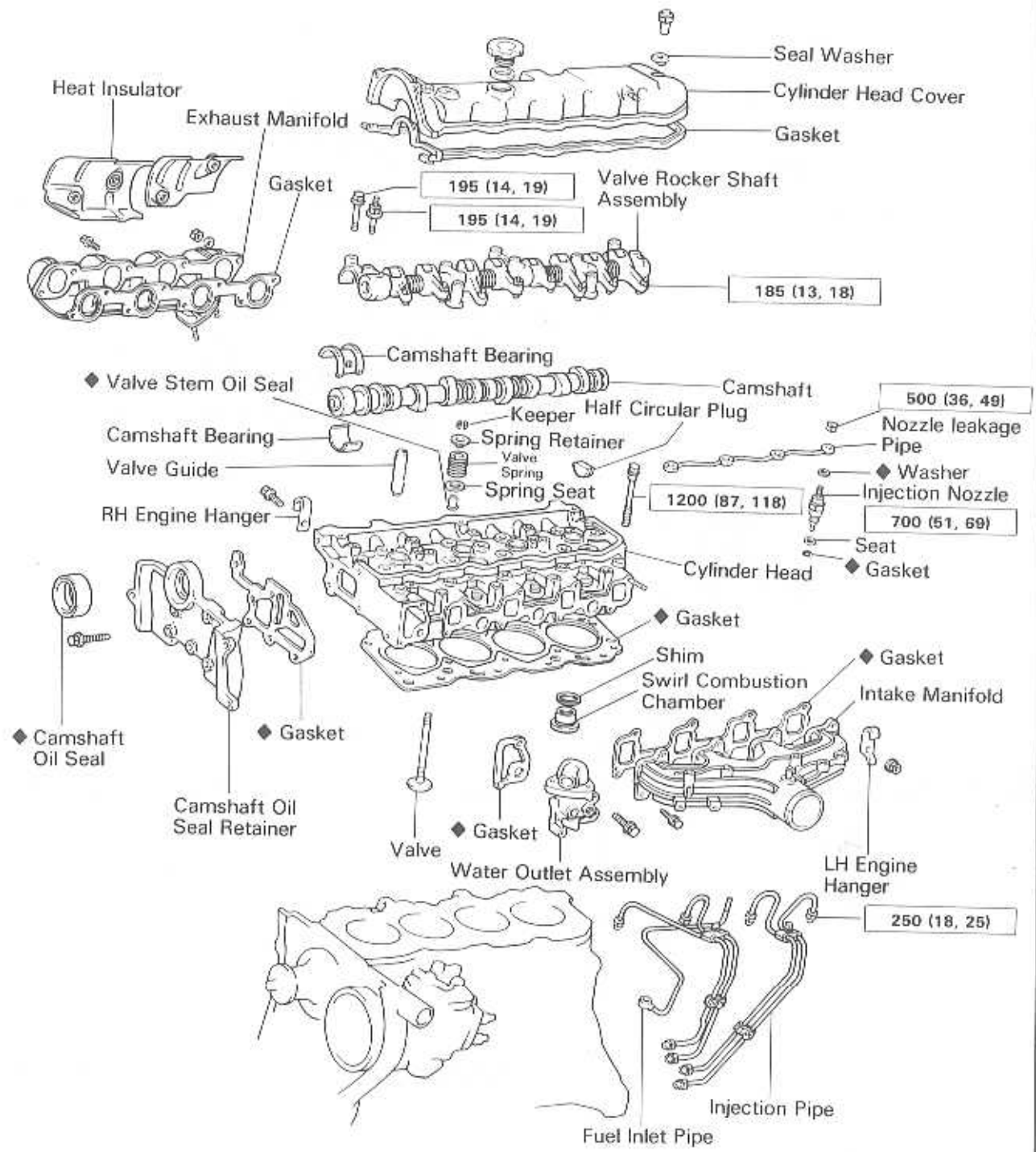
Drive belt deflection at 10 kg (22 lb, 98 N) mm (in.)

Position	Belt condition	
	New	Used
A (Water pump-Alternator)	7 - 10 (0.28 - 0.39)	10 - 14 (0.39 - 0.55)
B (Crankshaft-A/C compressor)	13 - 17 (0.51 - 0.67)	17 - 23 (0.67 - 0.91)
C (Crankshaft-PS pump)	8 - 10 (0.31 - 0.39)	10 - 14 (0.39 - 0.55)

NOTE:

- "New belt" refers to a belt which has never been used.
- "Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.

CYLINDER HEAD COMPONENTS

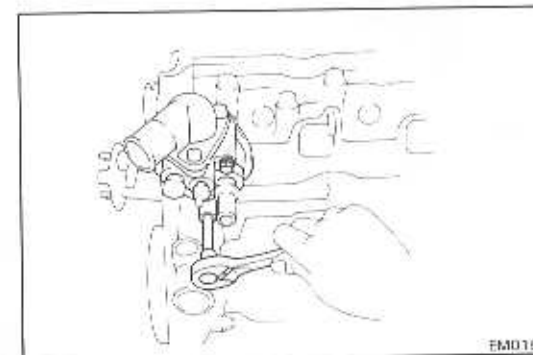
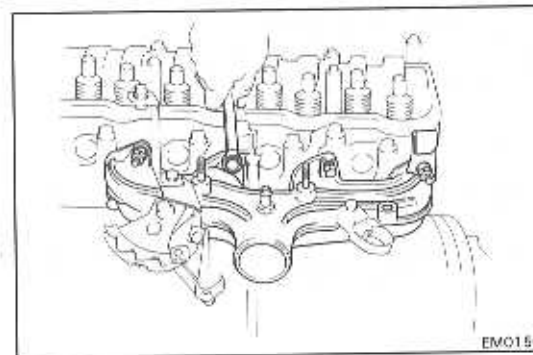
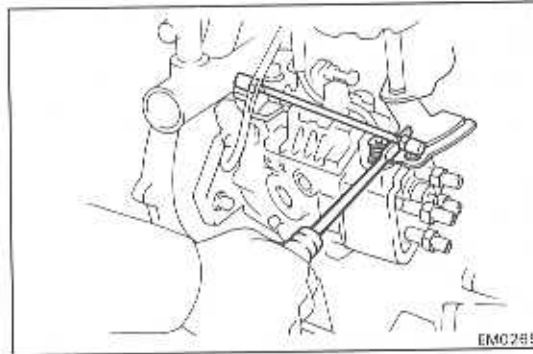
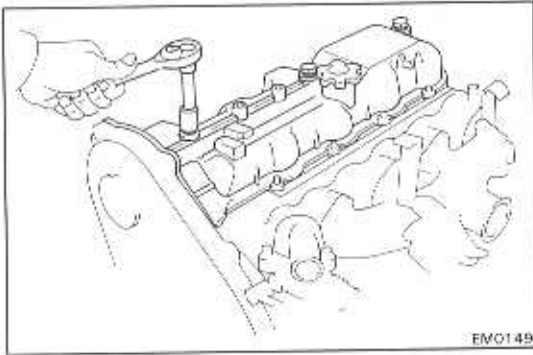


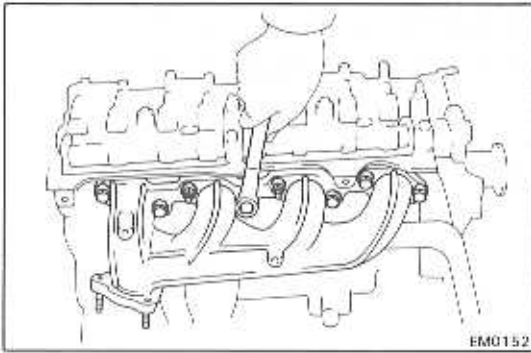
[kg-cm (ft-lb, N-m)] : Tightening torque

◆ Non-reusable part

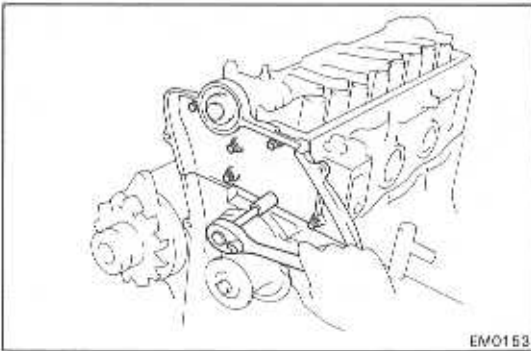
REMOVAL OF CYLINDER HEAD

1. **REMOVE FOUR INJECTION PIPES**
(See step 1 on page FU-7)
2. **REMOVE FOUR INJECTION NOZZLES**
(See steps 2, 3 on pages FU-7, 8)
3. **REMOVE FUEL INLET PIPE**
(See step 10 on page FU-14)
4. **REMOVE CYLINDER HEAD COVER**
 - (a) Remove the two bolts holding the head cover to the belt cover.
 - (b) Remove the three cap nuts, seal washers, head cover and gasket.
5. **REMOVE TIMING BELT**
(See steps 1 to 8 on pages EM-20 to 22)
6. **REMOVE CAMSHAFT TIMING PULLEY**
(See step 10 on page EM-22)
7. **DISCONNECT ACCELERATOR CONNECTING ROD FROM ACCELERATOR LINK**
8. **REMOVE INTAKE MANIFOLD AND LH ENGINE HANGER**
Remove the six bolts, two nuts, LH engine hanger and intake manifold and gasket.
9. **REMOVE WATER OUTLET ASSEMBLY**
Remove the two bolts, water outlet assembly and gasket.

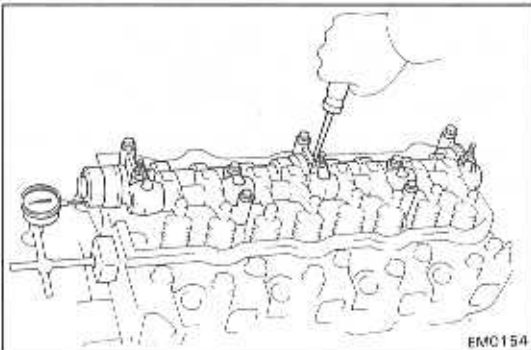


**10. REMOVE RH ENGINE HANGER****11. REMOVE EXHAUST MANIFOLD**

- (a) Remove the four bolts and two heat insulators.
- (b) Remove the six bolts, two nuts, two plate washers and exhaust manifold.

**12. REMOVE CAMSHAFT OIL SEAL RETAINER**

Remove the six bolts, retainer with oil seal and gasket.

**13. CHECK CAMSHAFT THRUST CLEARANCE**

- (a) Loosen the valve clearance adjusting screws.
- (b) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard clearance: 0.055 – 0.155 mm
(0.0022 – 0.0061 in.)

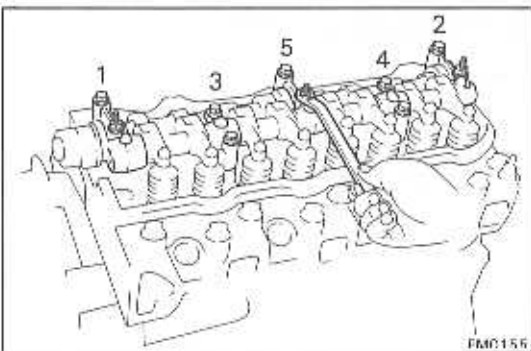
Maximum clearance: 0.3 mm (0.012 in.)

If the thrust clearance is greater than maximum, replace the camshaft and/or bearing.

14. REMOVE VALVE ROCKER SHAFT ASSEMBLY, CAMSHAFT AND BEARINGS, AND CHECK CAMSHAFT OIL CLEARANCE

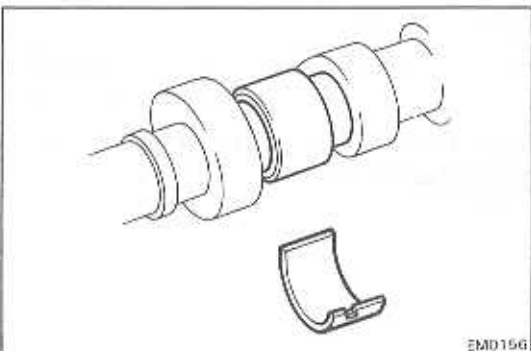
- (a) Gradually loosen and remove the ten bolts in three passes and in the numerical order shown.
- (b) Remove the rocker shaft assembly and camshaft with the three upper bearings.

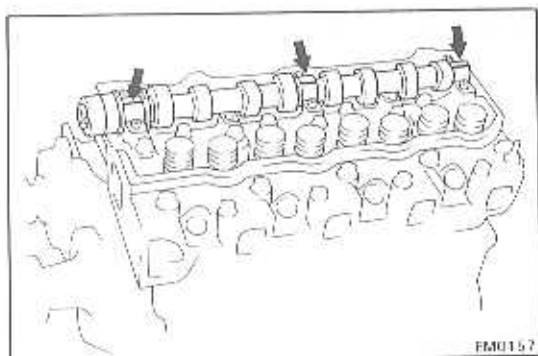
NOTE: Keep the upper bearing inserted with the caps.



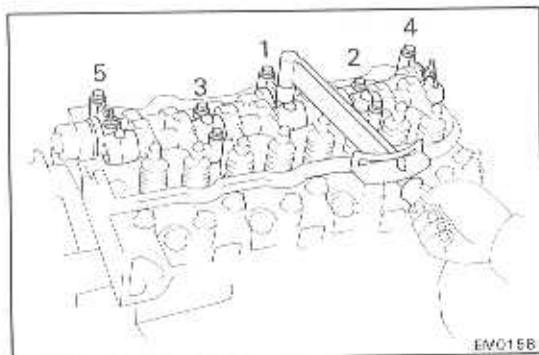
- (c) Clean each camshaft journal and bearing.
- (d) Check each camshaft journal and bearing for pitting and scratches.

If the camshaft journal and bearing are damaged, grind or replace the camshaft and replace the bearing.





- (e) Place the camshaft on the cylinder head.
- (f) Lay a strip of Plastigage across each journal.



- (g) Install the valve rocker shaft assembly on the cylinder head.
- (h) Install and gradually tighten the ten bolts in three passes in the sequence shown. Torque the bolts on the final pass.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

NOTE: Do not turn the camshaft.

- (i) Remove the rocker shaft assembly with the three upper bearing.

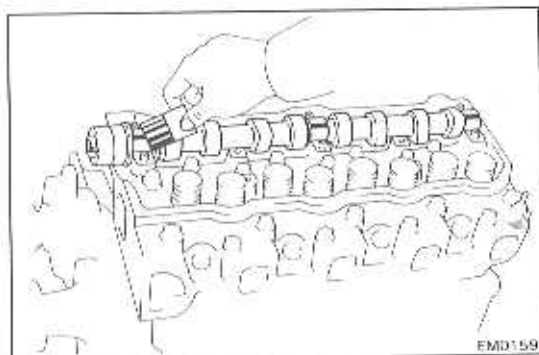
- (j) Measure the Plastigage at its widest point.

**Standard oil clearance: 0.022 – 0.074 mm
(0.0009 – 0.0029 in.)**

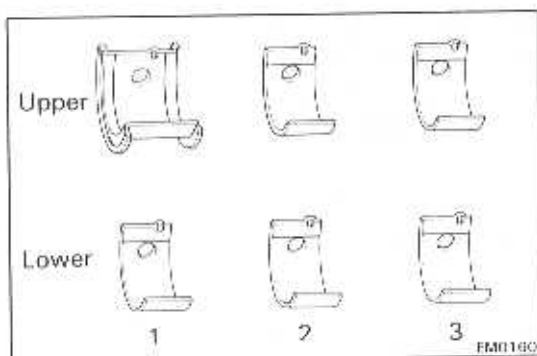
Maximum oil clearance: 0.1 mm (0.004 in.)

If clearance is greater than maximum, replace the bearing. Grind the camshaft or replace the camshaft as required.

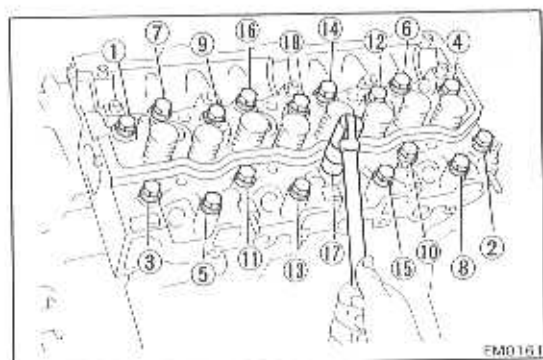
- (k) Completely remove the Plastigage.
- (l) Remove the camshaft and three lower bearings.



NOTE: Arrange the bearings in order.



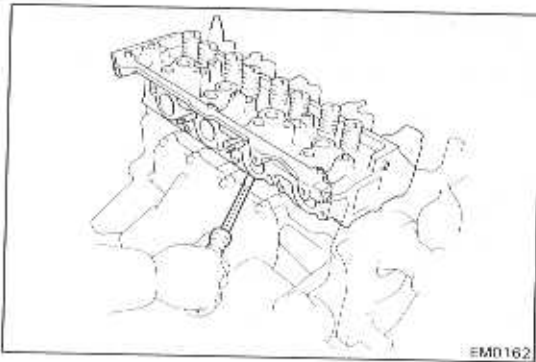
15. REMOVE HALF CIRCULAR PLUG



16. REMOVE CYLINDER HEAD

- (a) Gradually loosen and remove the eighteen head bolts in three passes and in the numerical order shown.

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

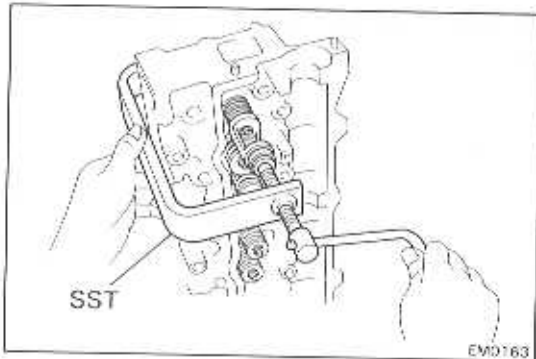


- (b) Lift the cylinder head from the dowels on the cylinder block and place the head on wooden blocks on a bench.

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

- (c) Remove the cylinder head gasket.

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-31)

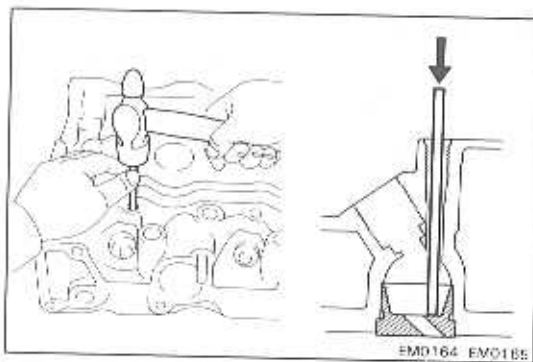
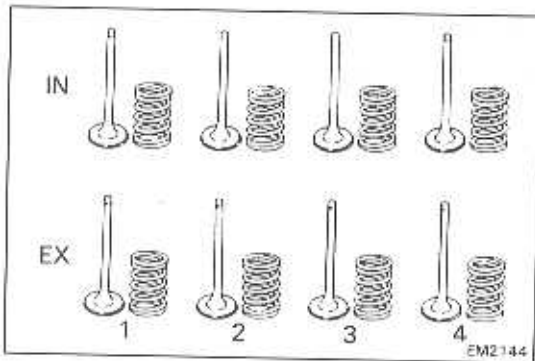
1. REMOVE VALVES

- (a) Using SST, remove the keepers, spring retainer and spring.

SST 09202-43013

- (b) Remove the valve, oil seal and spring seat.

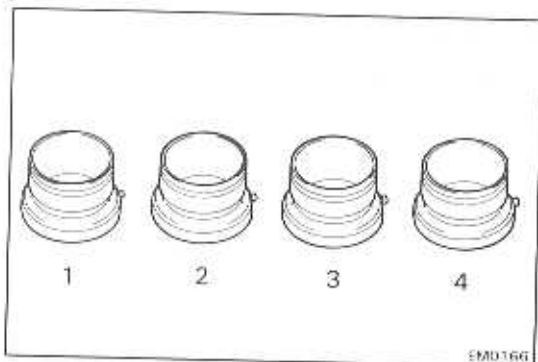
NOTE: Arrange the disassembled parts in order.

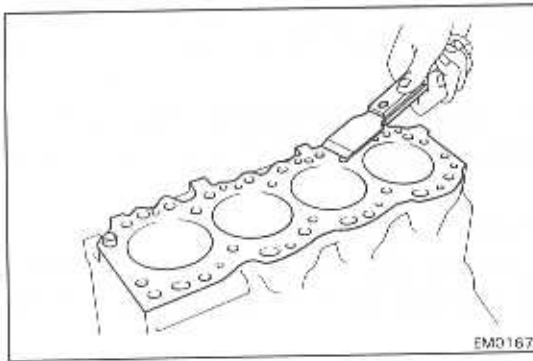


2. REMOVE COMBUSTION CHAMBERS

Drive out the combustion chambers and/or shim.

NOTE: Arrange the disassembled parts in order.



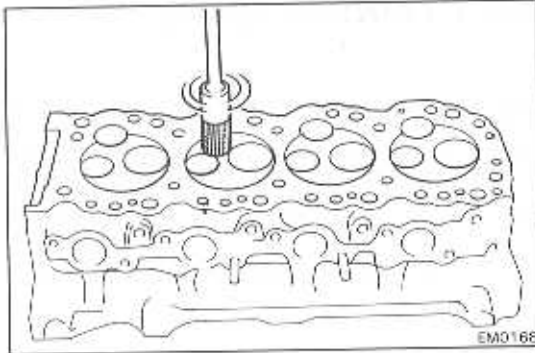


INSPECTION, CLEANING AND REPAIR OF CYLINDER HEAD COMPONENTS

1. CLEAN TOP OF PISTONS AND TOP OF BLOCK

- (a) Turn the crankshaft and bring each piston to top dead center. Scrape the carbon from the piston top.
- (b) Remove all gasket material from the top of the block. Blow carbon and oil from the bolt holes.

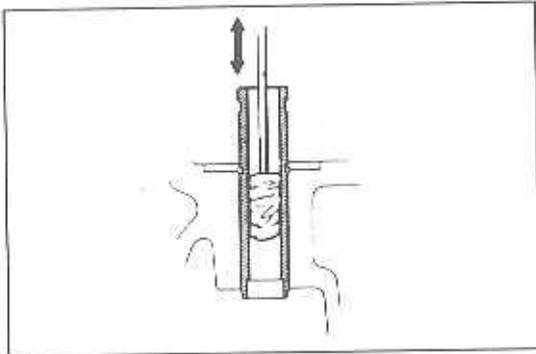
CAUTION: Protect your eyes when using compressed air.



2. CLEAN COMBUSTION CHAMBER

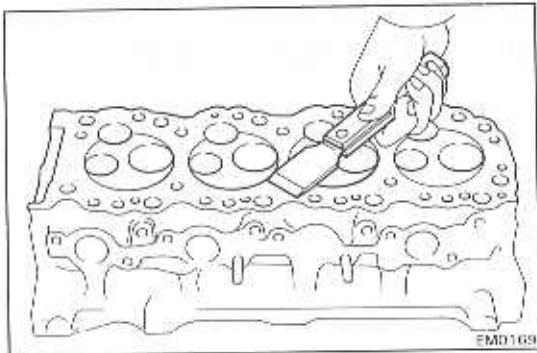
Using a wire brush, remove all the carbon from the combustion chambers.

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



3. CLEAN VALVE GUIDES

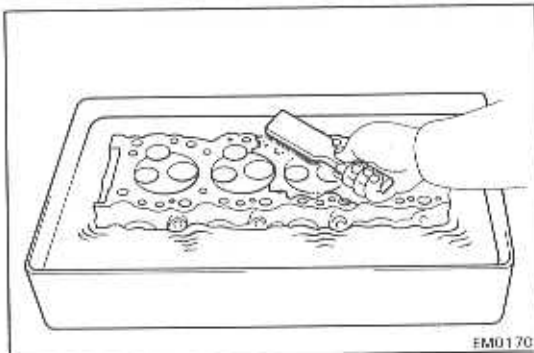
Using a valve guide brush and solvent, clean all the valve guides.



4. REMOVE GASKET MATERIAL

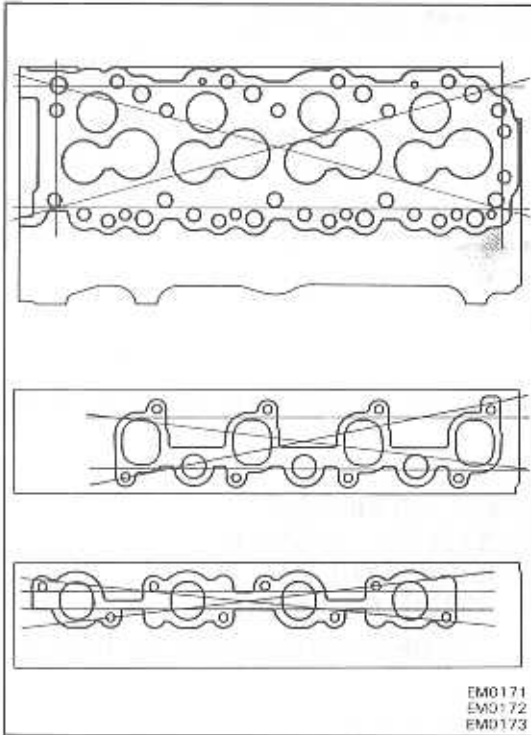
Using a gasket scraper, remove all gasket material from the manifold and head surface.

CAUTION: Be careful not to scratch the surfaces.



5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, clean the head.

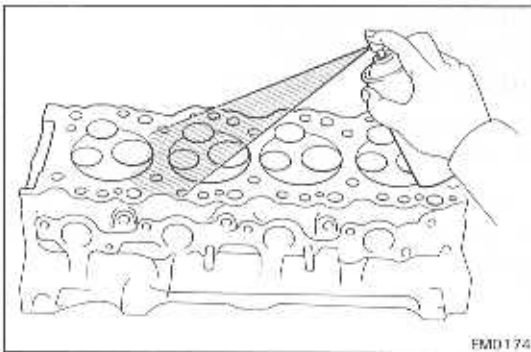


6. INSPECT CYLINDER HEAD FOR FLATNESS

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.)

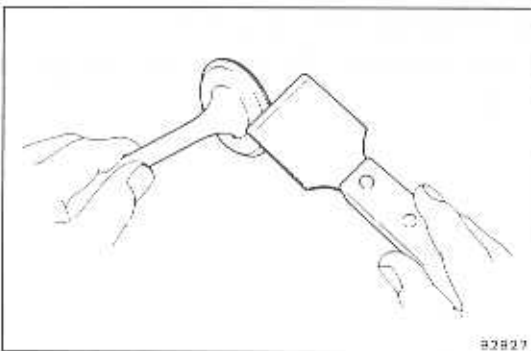
If warpage is greater than maximum, replace the cylinder head.



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 a crack is found, replace the cylinder head.

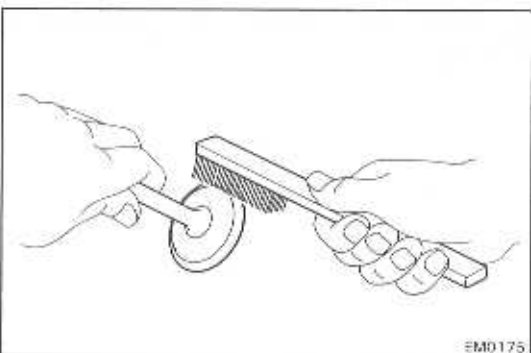


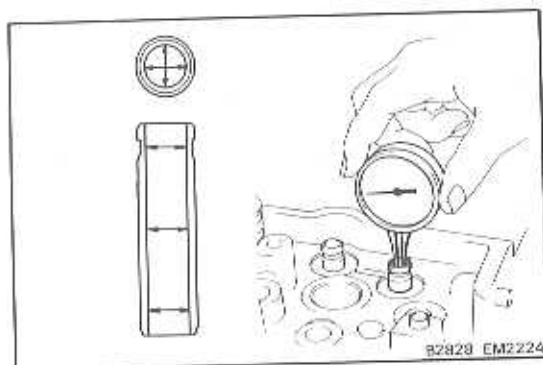
8. CLEAN VALVES

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



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

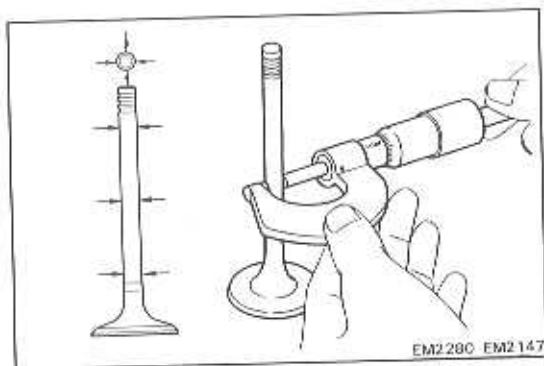




9. INSPECT VALVE STEM AND GUIDE

- (a) Using a dial indicator, measure the inside diameter of the valve guide.

Guide inside diameter: 8.51 – 8.53 mm
(0.3350 – 0.3358 in.)



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

Stem diameter:

Intake 8.473 – 8.489 mm
(0.3336 – 0.3342 in.)

Exhaust 8.454 – 8.470 mm
(0.3328 – 0.3335 in.)

- (c) Subtract the valve stem measurement from the valve guide measurement.

Standard stem oil clearance:

Intake 0.021 – 0.057 mm
(0.0008 – 0.0022 in.)

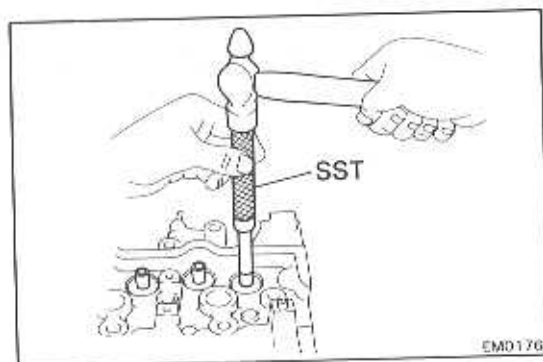
Exhaust 0.040 – 0.076 mm
(0.0016 – 0.0030 in.)

Maximum stem oil clearance:

Intake 0.10 mm (0.0039 in.)

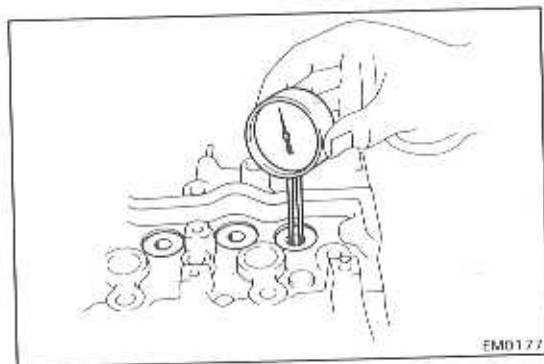
Exhaust 0.12 mm (0.0047 in.)

If the clearance is greater than the above values, re-place the valve and guide.



10. IF NECESSARY, REPLACE VALVE GUIDE

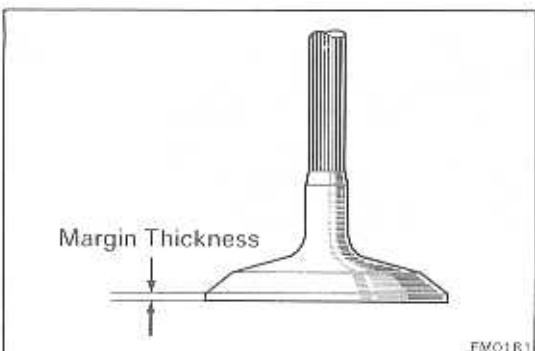
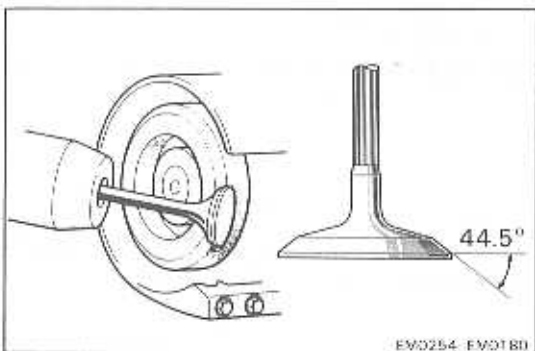
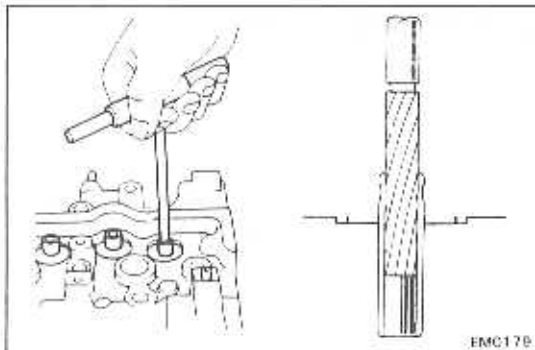
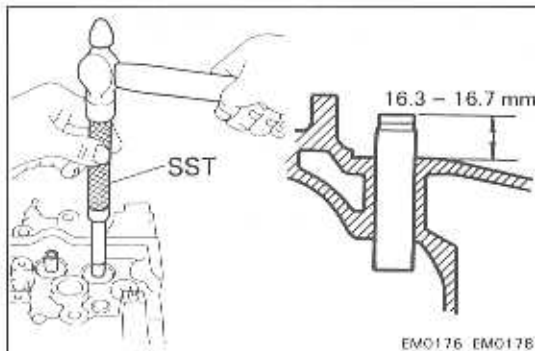
- (a) Using SST, and a hammer, drive out the valve guide.
SST 09201-60011



- (b) Using dial indicator, measure the valve guide bore of the cylinder head.

Both intake and exhaust

Guide bore mm (in.)	Guide size
13.994 – 14.018 (0.5509 – 0.5519)	Use STD
Over 14.018 (0.5519)	Use O/S 0.05



(c) Select a new valve guide.

If the valve guide bore of the cylinder head is more than 14.018 mm (0.5519 in.), machine the bore to the following dimensions.

Rebored cylinder head bushing bore dimensions:
14.044 – 14.068 mm (0.5529 – 0.5539 in.)

(d) Using SST and a hammer, drive in a new valve guide to where there is 16.3 – 16.7 mm (0.642 – 0.657 in.) protruding from the cylinder head.

SST 09201-60011

(e) Using a sharp 8.5 mm reamer, ream the valve guide to obtain the specified clearance between the valve guide and new valve.

Stem oil clearance:

Intake	0.021 – 0.057 mm (0.0008 – 0.0022 in.)
Exhaust	0.040 – 0.076 mm (0.0016 – 0.0030 in.)

11. INSPECT AND GRIND VALVES

(a) Grind valves only enough to remove pits and carbon. Make sure the valves are ground to the correct valve face angle.

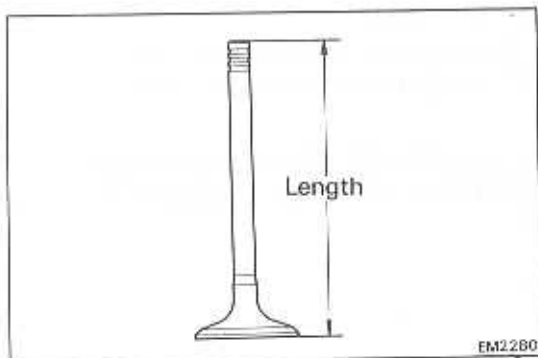
Valve face angle: 44.5°

(b) Check the valve head margin.

Minimum margin thickness:

Intake	0.9 mm (0.035 in.)
Exhaust	1.0 mm (0.039 in.)

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



(c) Check the valve overall length.

Standard overall length:

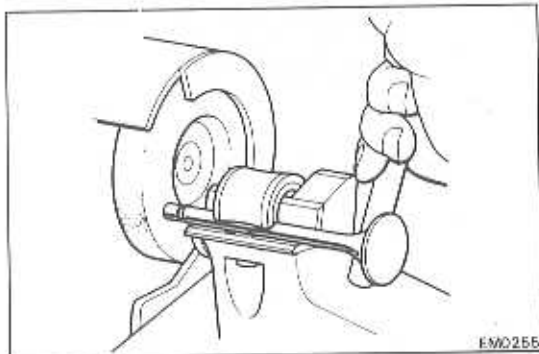
Intake 122.95 mm (4.8405 in.)

Exhaust 122.75 mm (4.8327 in.)

Minimum overall length:

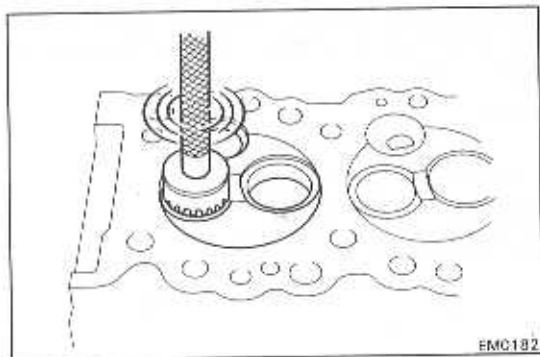
Intake 122.45 mm (4.8209 in.)

Exhaust 122.25 mm (4.8130 in.)



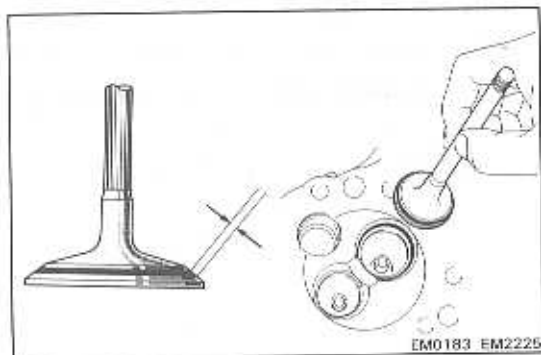
(d) If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

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



12. INSPECT AND CLEAN VALVE SEATS

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



(b) Check the valve seating position.

Apply a thin coat of prussian blue (or white lead) to the valve face. Install the valve. 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 valve face, the valve is concentric. If not, replace the valve.

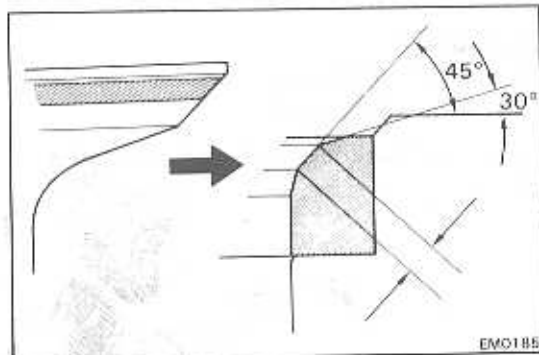
- If blue appears 360° around the valve seat, the guide and seat are concentric. If not, resurface the seat.

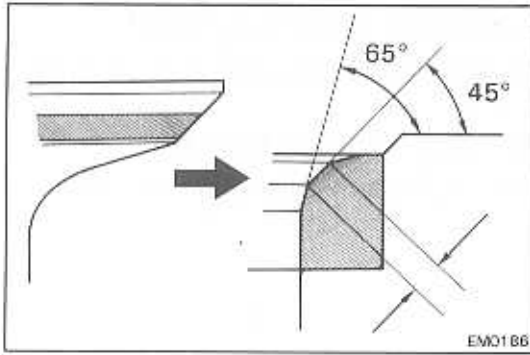
- Check that the seat contact is on the middle of the valve face with the following width:

1.2 – 1.6 mm (0.047 – 0.063 in.)

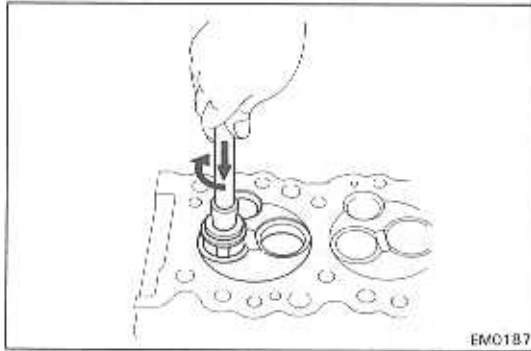
If not correct the valve seat as follows:

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

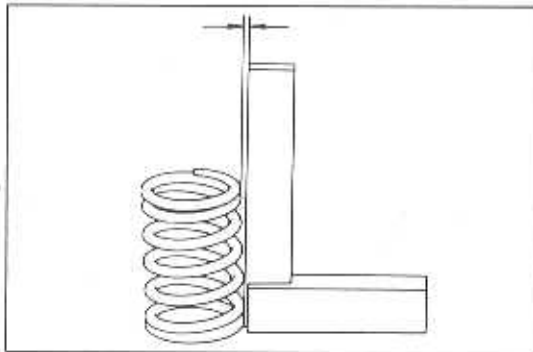




- (2) If seating is too low on the valve face, use 65° and 45° cutters to correct the seat.



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

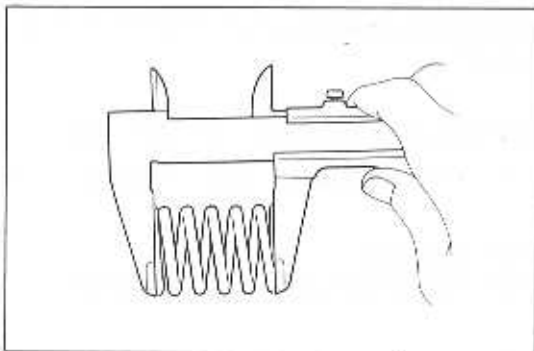


13. INSPECT VALVE SPRINGS

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

Maximum squareness: 2.0 mm (0.079 in.)

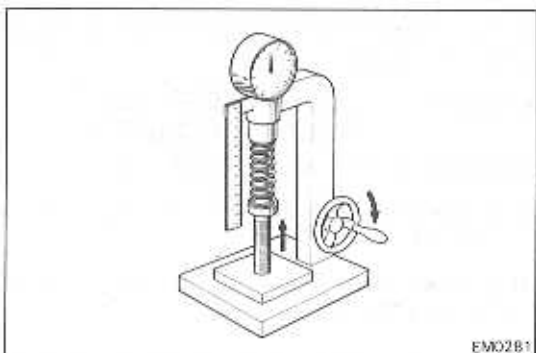
If squareness is greater than maximum, replace the valve spring.



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

Free length: 47.98 mm (1.8890 in.)

If not as specified, replace the valve spring.

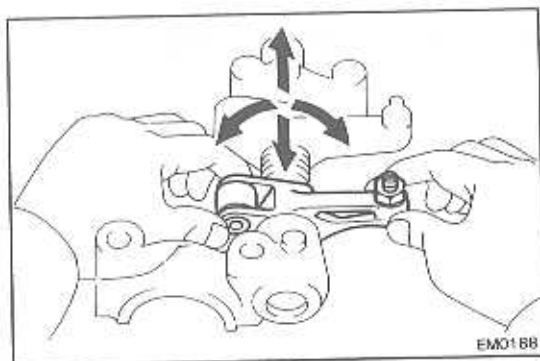


- (c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

Installed tension:

29.2 kg (64.4 lb, 286 N) at 39.3 mm (1.547 in.)

If not as specified, replace the valve spring.



14. INSPECT VALVE ROCKER ARM AND SHAFT

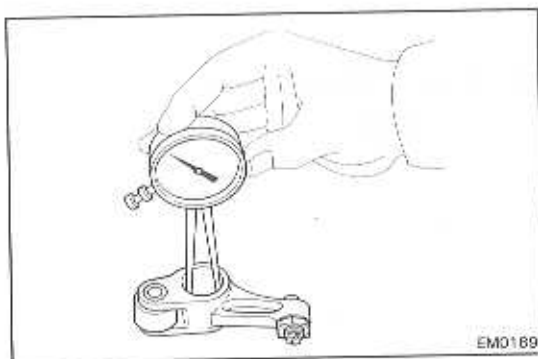
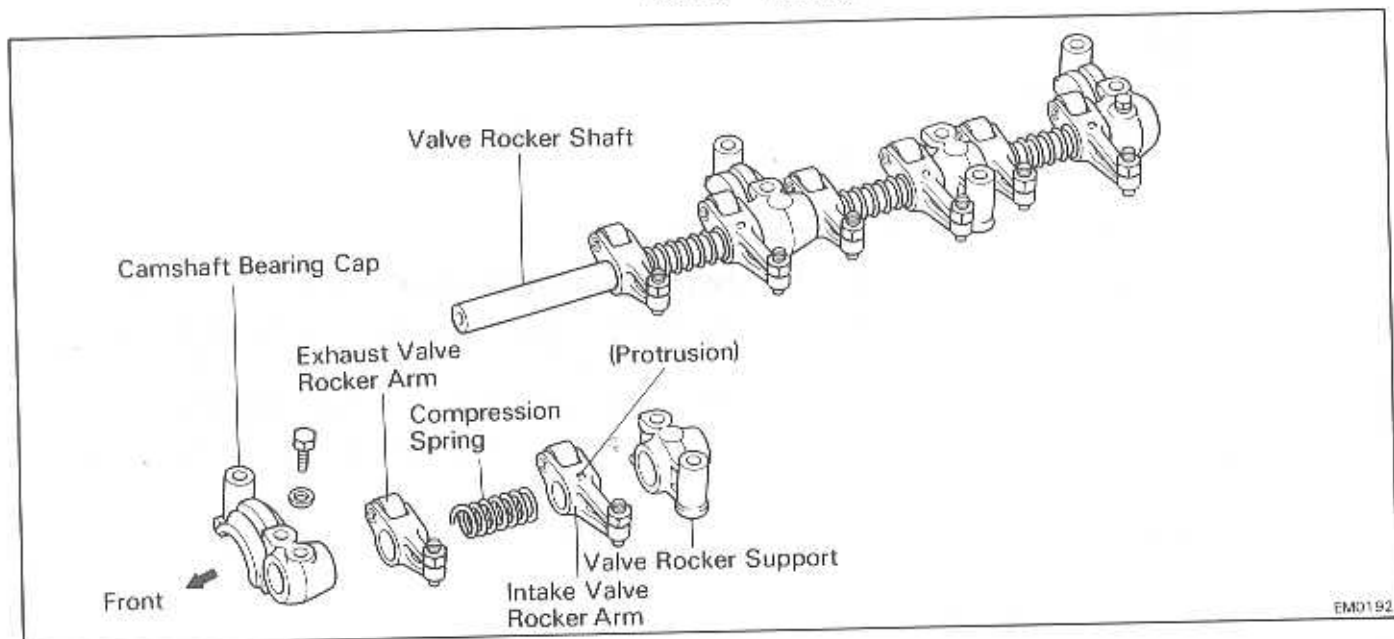
- (a) Check for rocker arm-to-shaft clearance by moving each rocker arm.

If movement is felt, disassemble and check.

- (b) Check that the rocker arm roller turns smoothly.

- (c) Disassemble the rocker arm assembly as shown in the figure.

NOTE: Arrange the disassembled parts in order.



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

Shaft diameter:

18.464 – 18.483 mm (0.7269 – 0.7277 in.)

- (e) Using dial indicator, measure the inside diameter of the rocker arm.

Rocker arm inside diameter:

18.500 – 18.521 mm (0.7283 – 0.7292 in.)

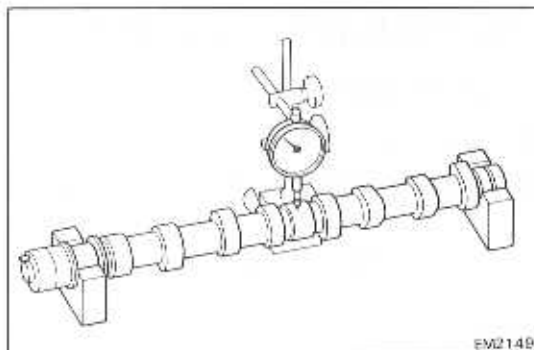
- (f) Subtract the rocker arm shaft measurement from the rocker arm measurement.

Standard oil clearance: 0.017 – 0.057 mm (0.0007 – 0.0022 in.)

Maximum oil clearance: 0.1 mm (0.004 in.)

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

- (g) Assemble the rocker arm assembly in reverse order as described in step 14-(b).



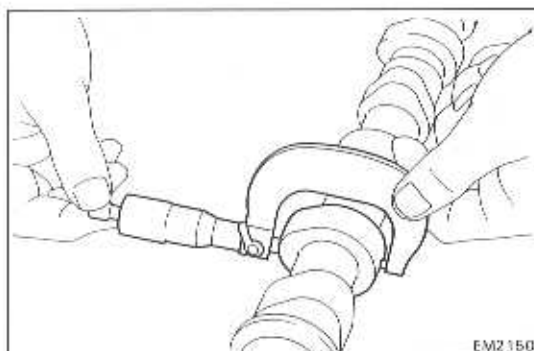
EM2149

15. 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: 0.1 mm (0.039 in.)

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



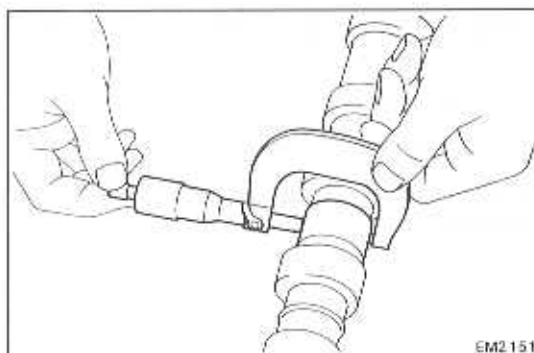
EM2150

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

Minimum cam lobe height:

Intake	L, 2L	46.76 mm (1.8409 in.)
	2L-T	46.29 mm (1.8224 in.)
Exhaust		47.25 mm (1.8602 in.)

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



EM2151

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

**Journal diameter: 34.969 – 34.985 mm
(1.3767 – 1.3774 in.)**

If the oil clearance even when new bearings are used, is greater than specified, regrind or replace the camshaft.

16. IF NECESSARY, GRIND AND HONE CAMSHAFT JOURNAL

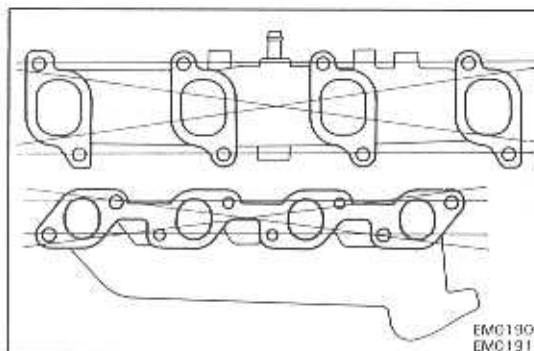
Grind and hone the journals to the undersized finished diameter.

Install new journal bearings.

Bearing size (U/S 0.125, 0.250)

Journal finished diameter:

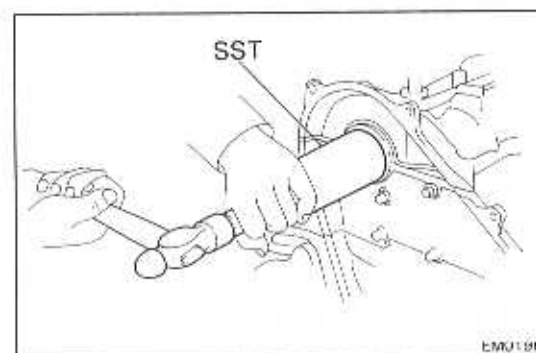
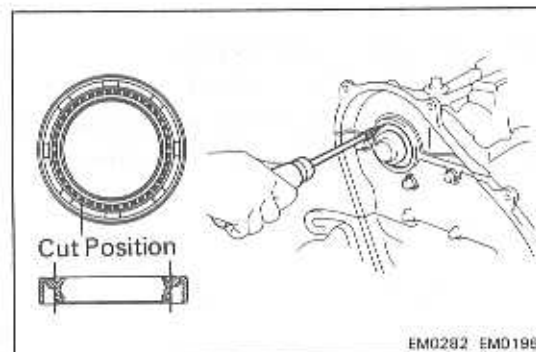
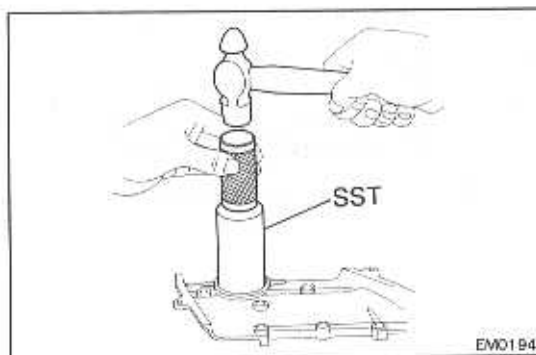
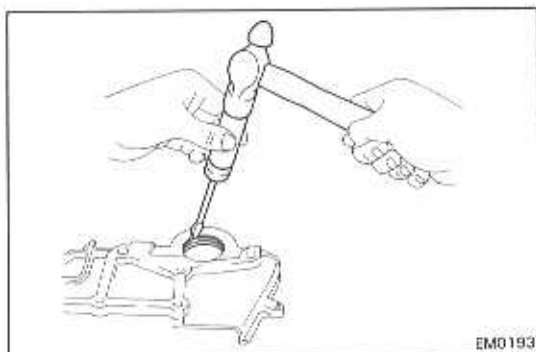
U/S 0.125	34.844 – 34.860 mm (1.3718 – 1.3724 in.)
	U/S 0.250 34.719 – 34.735 mm (1.3669 – 1.3675 in.)

EM0190
EM0191**17. 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.



REPLACEMENT OF CAMSHAFT OIL SEAL

NOTE: There are two methods of oil seal replacement.

REPLACE CAMSHAFT OIL SEAL

If camshaft oil seal retainer is removed from cylinder head:

- Using a screwdriver and hammer, drive out the oil seal.
- Using SST and a hammer, drive in a new oil seal until its surface is flush with the oil seal retainer edge.
SST 09214-60010
- Apply MP grease to the oil seal.

If camshaft oil seal retainer is installed to cylinder head:

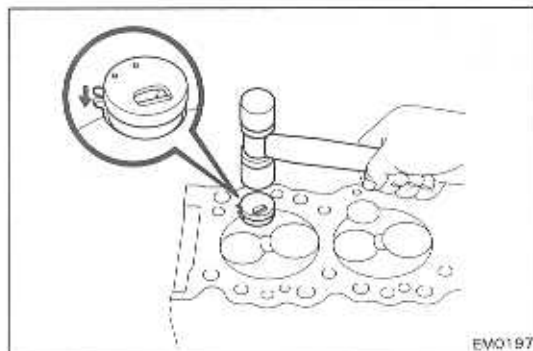
- Using a knife, cut off the oil seal lip.
 - Using a screwdriver, pry out the oil seal.
- CAUTION:** Be careful not to damage the camshaft. Tape the screwdriver.
- Apply MP grease to a new oil seal.
 - Using SST and a hammer, drive in the oil seal until its surface is flush with oil seal retainer edge.
SST 09214-60010

ASSEMBLY OF CYLINDER HEAD

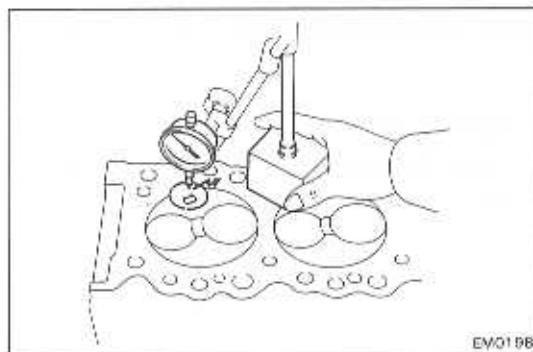
(See page EM-31)

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, O-rings and oil seals with new parts.



EM0197



EM0198

1. INSTALL SWIRL COMBUSTION CHAMBERS

- (a) Align the swirl combustion chamber knock pin with the cylinder head notch.
- (b) Using a plastic hammer, drive in the swirl combustion chamber (with the shim).

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

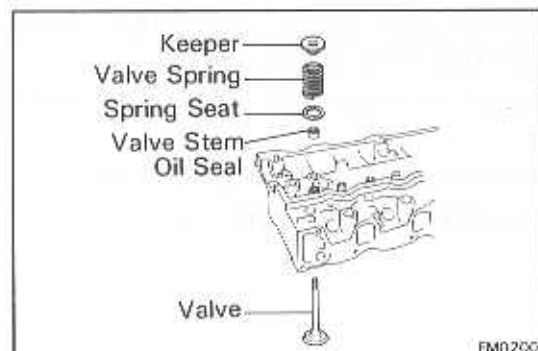
Combustion chamber protrusion:

0.01 – 0.07 mm (0.0004 – 0.0028 in.)

If the protrusion is not within specification, adjust it with a swirl combustion chamber shim.

Combustion chamber shim thickness:

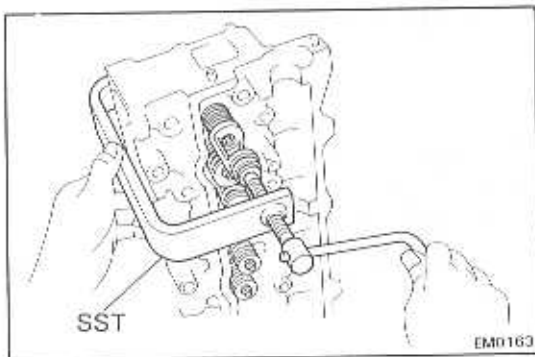
0.05 mm (0.0020 in.)
 0.10 mm (0.0039 in.)
 0.15 mm (0.0059 in.)
 0.20 mm (0.0079 in.)



EM0200

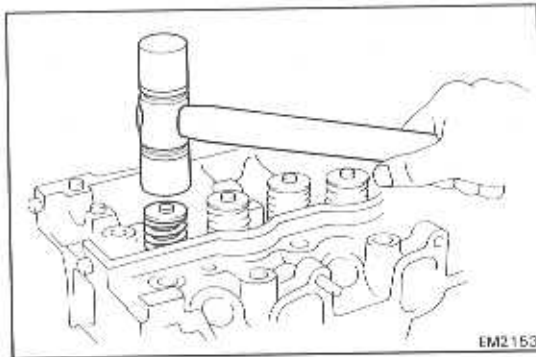
2. INSTALL VALVES

- (a) Insert the valve in the cylinder head valve guide. Check the valves are installed in the correct order.
- (b) Install the valve spring seat and new oil seal.
- (c) Install the springs and spring retainers on the valves.

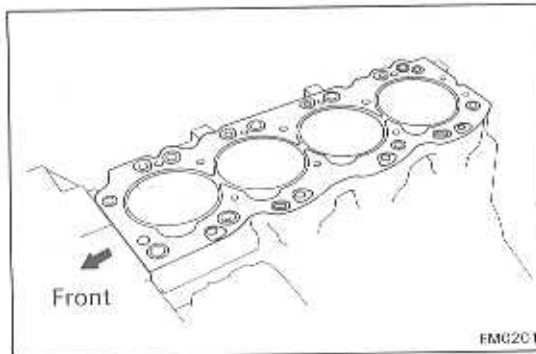


- (d) Using SST, compress the valve spring and place the two keepers around the valve stem.

SST 09202-43013



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



INSTALLATION OF CYLINDER HEAD

(See page EM-31)

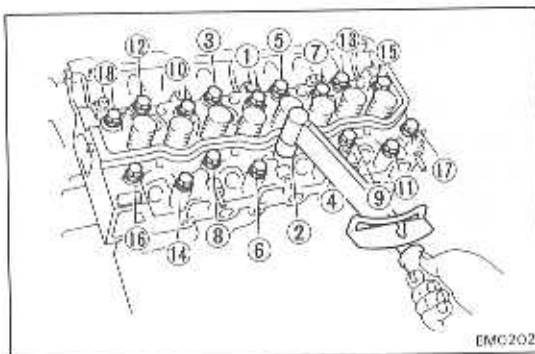
1. INSTALL CYLINDER HEAD

- (a) Install a new cylinder head gasket and the head on the cylinder block.

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

- (c) Install gradually and tighten the eighteen head bolts in three passes and in the sequence shown. Torque the bolts on the final pass.

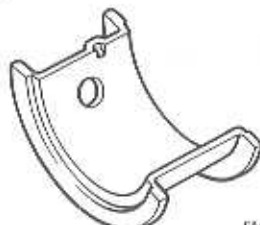
Torque: 1,200 kg-cm (87 ft-lb, 118 N·m)



2. INSTALL CAMSHAFT BEARINGS, CAMSHAFT AND VALVE ROCKER SHAFT ASSEMBLY

Upper (ex. No. 1
Camshaft Bearing)
and Lower Bearing

Upper Bearing
(No. 1 Camshaft
Bearing)

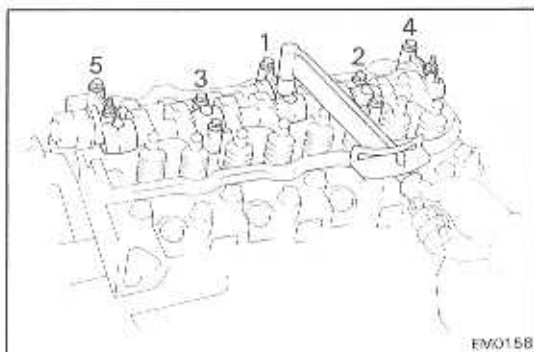


EMC203

- (a) Install the upper bearings to the camshaft bearing caps.

- (b) Install the lower bearings to the cylinder head.

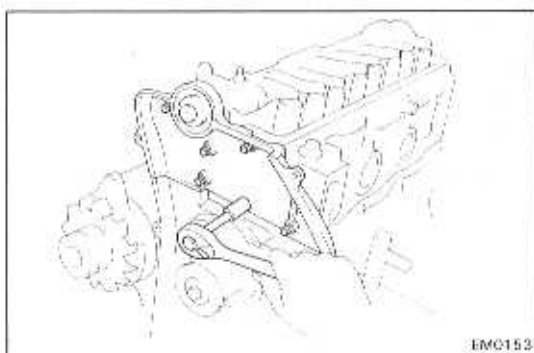
- (c) Place the camshaft in the cylinder head.



EM0158

- (d) Turn the crankshaft to lower the pistons.
- (e) Install the valve rocker shaft assembly on the cylinder head.
- (f) Gradually install and tighten the ten bolts in three passes in the sequence shown.
Torque the bolts on the final pass.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

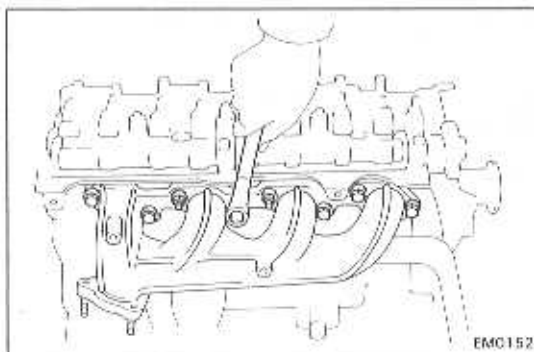


EM0153

3. INSTALL CAMSHAFT 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)



EM0152

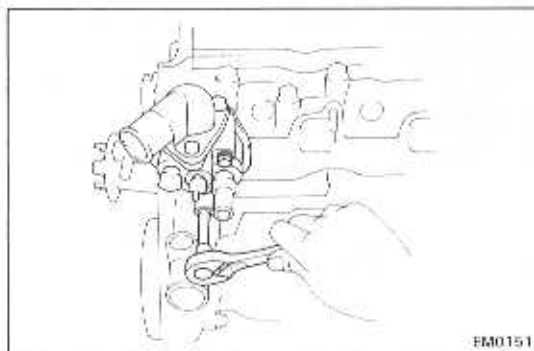
4. INSTALL EXHAUST MANIFOLD

- (a) Install a new gasket and the exhaust manifold with the six bolts, two plate washers and nuts. Torque the bolts and nuts.

Torque: L, 2L 400 kg-cm (29 ft-lb, 39 N·m)
2L-T 530 kg-cm (38 ft-lb, 52 N·m)

- (b) Install the two insulators with the four bolts. Torque the bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)



EM0151

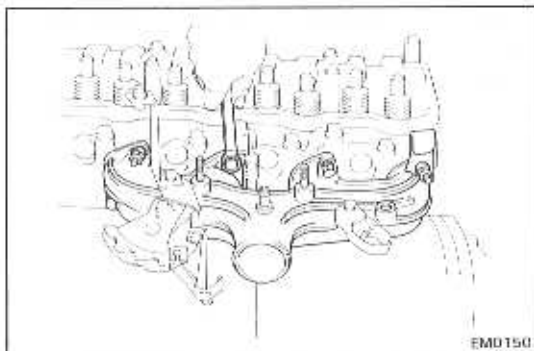
5. INSTALL RH ENGINE HANGER

Torque: 380 kg-cm (27 ft-lb, 37 N·m)

6. INSTALL WATER OUTLET ASSEMBLY

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

Torque: 195 kg-cm (14 ft-lb, 19 N·m)



EM0150

7. INSTALL INTAKE MANIFOLD AND LH ENGINE HANGER

Install a new gasket, intake manifold and LH engine hanger with the six bolts and two nuts.

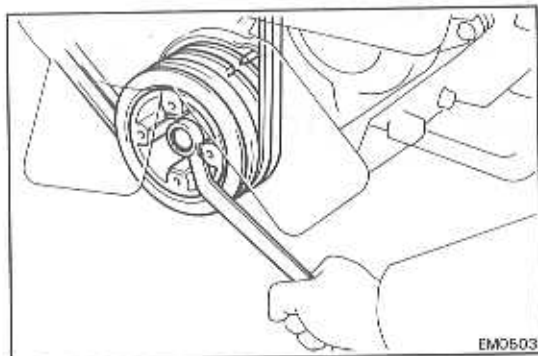
Torque: 240 kg-cm (17 ft-lb, 24 N·m)

8. CONNECT ACCELERATOR CONNECTING ROD

9. INSTALL FOUR INJECTION NOZZLES (See steps 3, 4 on page FU-12)

10. INSTALL FUEL INLET PIPE (See page FU-47)

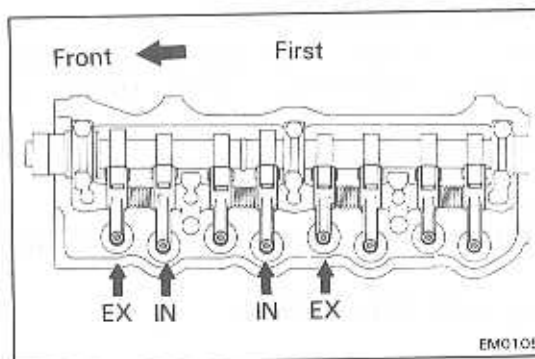
11. INSTALL FOUR INJECTION PIPES
(See page FU-12)
12. INSTALL CAMSHAFT TIMING PULLEY
(See page EM-26)
13. INSTALL TIMING BELT
(See steps 6 to 16 on pages EM-26 to 30)



EM0503

14. ADJUST VALVE CLEARANCES

- (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.



EM0105

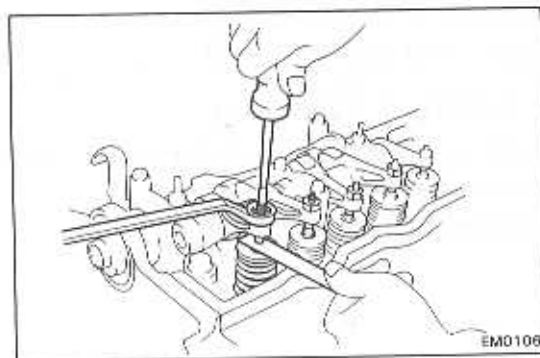
- (c) Adjust only those valves indicated by arrows.

Valve clearance (Cold):

Intake 0.27 mm (0.0106 in.)

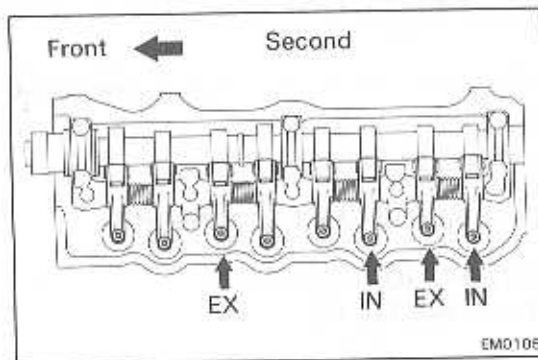
Exhaust 0.38 mm (0.0150 in.)

NOTE: After installing the cylinder head, warm up the engine and adjust the valve clearance.



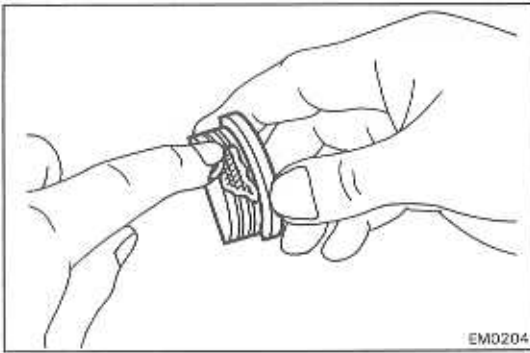
EM0106

- 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.

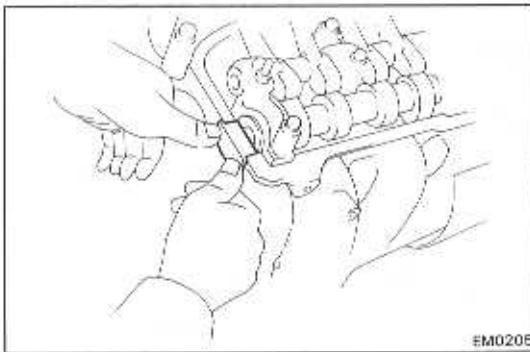


EM0105

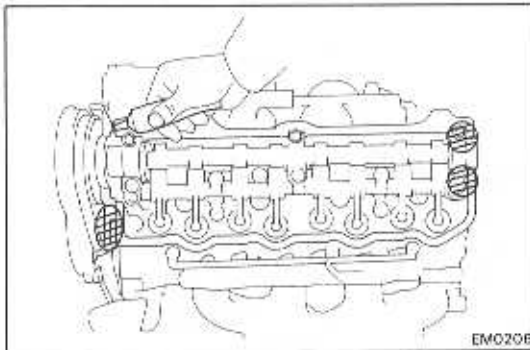
- (d) Turn the crankshaft one revolution (360°) and align the timing marks as above.
Adjust only the valves indicated by arrows.

**15. INSTALL HALF CIRCULAR PLUG**

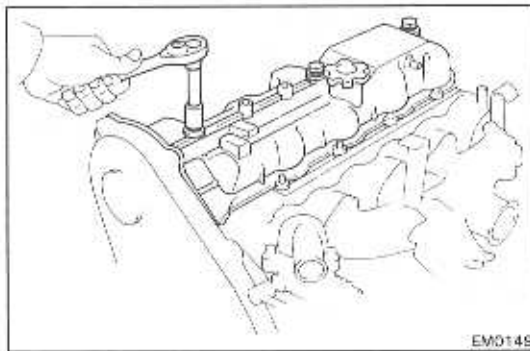
- (a) Apply seal packing black (Part No. 08826-00080) or equivalent to the half circular plug.



- (b) Install the half circular plug to the cylinder head.

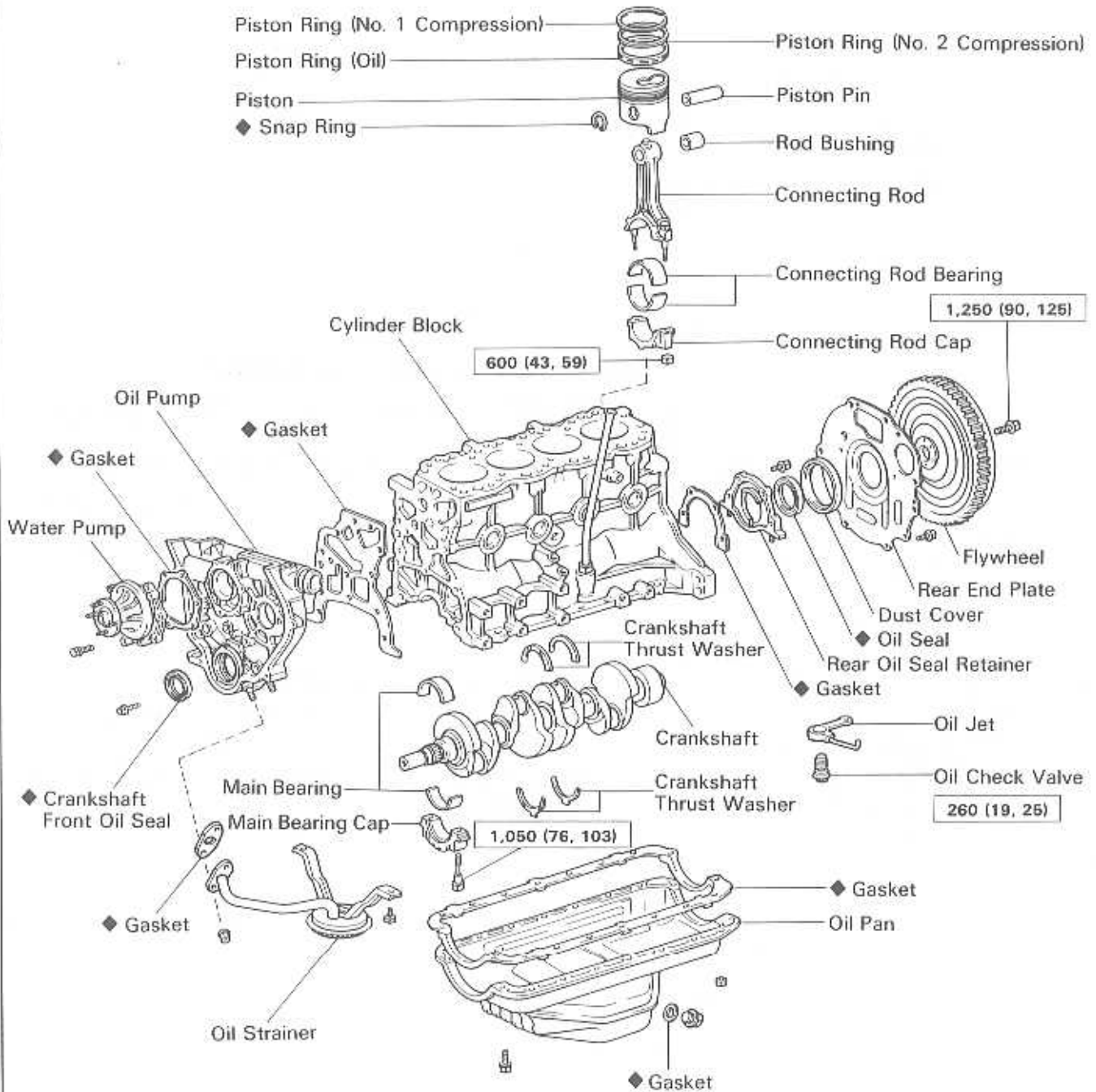
**16. INSTALL CYLINDER HEAD COVER**

- (a) Apply seal packing black (Part No. 08826-00080) or equivalent to the camshaft oil seal retainer, cylinder head and half circular plug as shown.



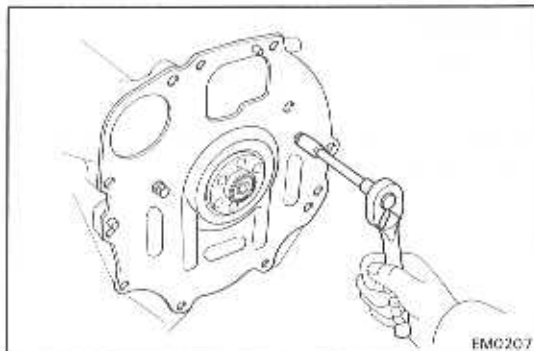
- (b) Install a gasket to the head cover.
- (c) Install the head cover with the three seal washers and cap nuts.
- (d) Install the remaining two timing gear cover mount bolts.

CYLINDER BLOCK COMPONENTS



kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part



DISASSEMBLY OF CYLINDER BLOCK

(See page EM-50)

1. REMOVE FLYWHEEL OR DRIVE PLATE

2. REMOVE REAR END PLATE

Remove the two bolts, end plate and dust cover.

3. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY

4. REMOVE CYLINDER HEAD

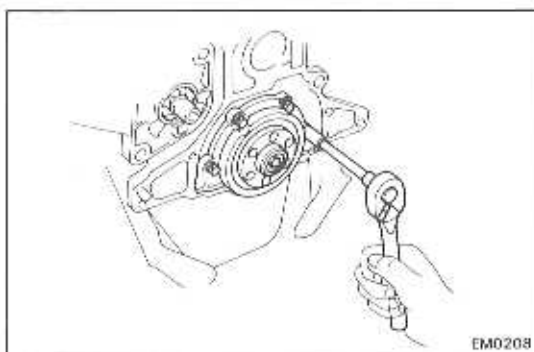
(See steps 1, 3 to 7, 12, 14 and 16 on pages EM-32 to 35)

5. REMOVE OIL PUMP

(See steps 1 to 7 on pages LU-4 and 5)

6. REMOVE REAR OIL SEAL RETAINER

Remove the four bolts, retainer and gasket.



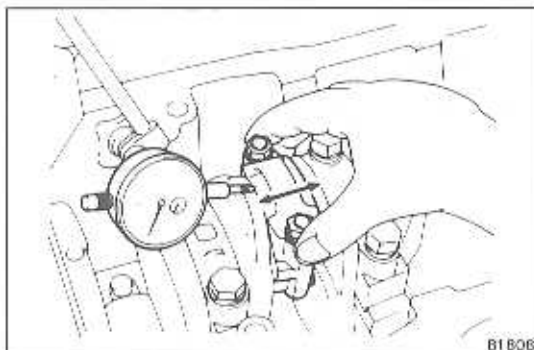
7. CHECK CONNECTING ROD THRUST CLEARANCE

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

Standard thrust clearance: 0.08 – 0.20 mm
(0.0031 – 0.0079 in.)

Maximum thrust clearance: 0.3 mm (0.012 in.)

If the clearance is greater than the maximum, replace the connecting rod and/or crankshaft.



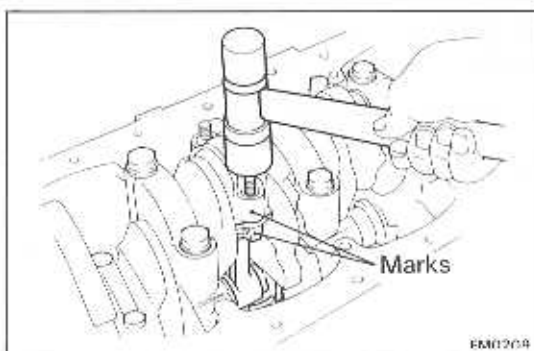
8. REMOVE CONNECTING ROD CAPS WITH LOWER BEARING AND CHECK OIL CLEARANCE

(a) Place matchmarks on the rod and cap.

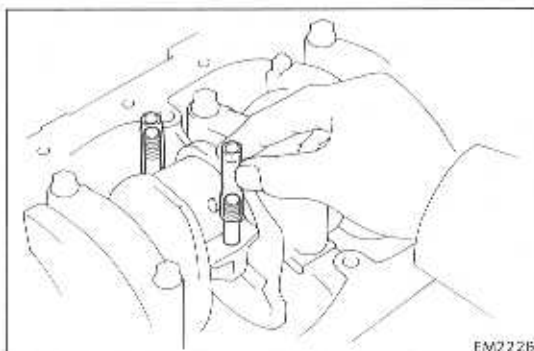
(b) Remove the rod nuts.

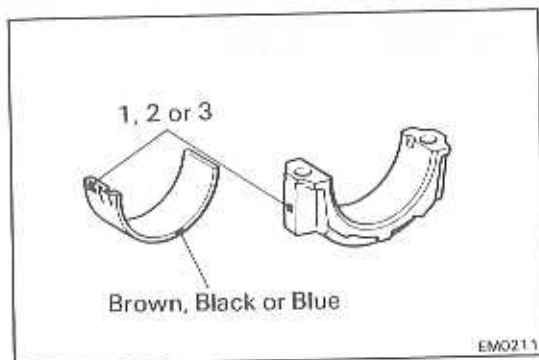
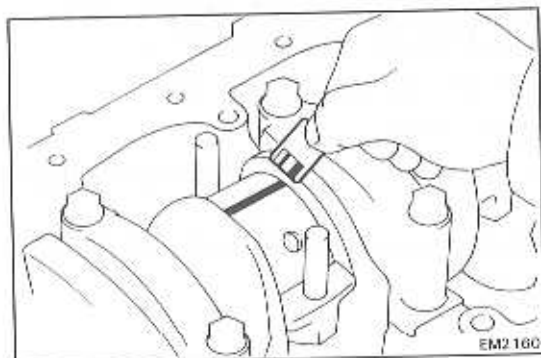
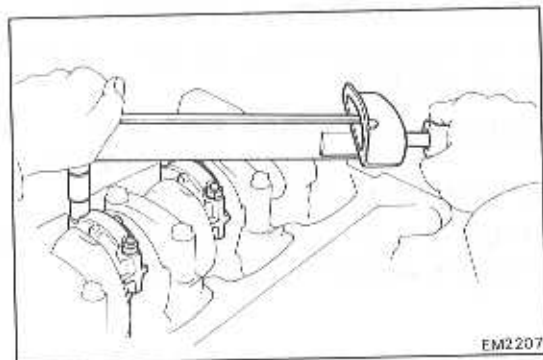
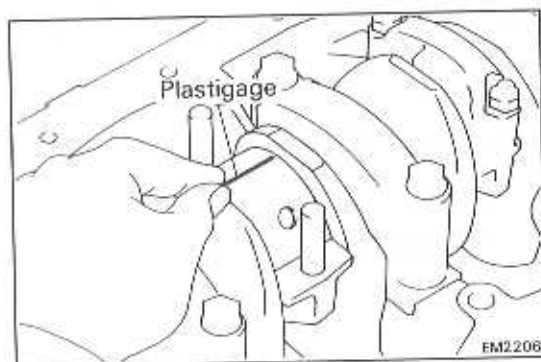
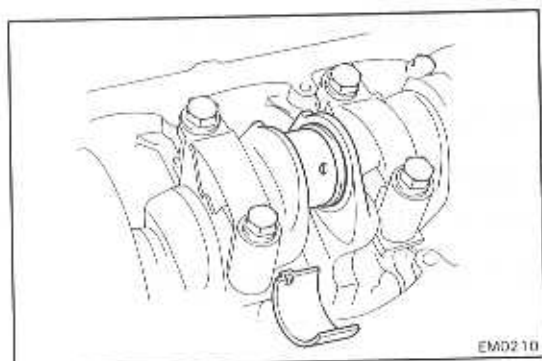
(c) Lightly tap the rod bolts and lift off the caps with the bearing.

NOTE: Keep the bearing inserted with the cap.



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





- (e) Clean each crank pin and bearing.
- (f) Check each crank pin and bearing for pitting and scratches.

If the crank pin and bearing are damaged, grind or replace the crankshaft and replace the bearing.

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

- (h) Install the rod caps (See page EM-67)

Torque: 600 kg-cm (43 ft-lb, 59 N·m)

NOTE: Do not turn the crankshaft.

- (i) Remove the rod cap.
- (j) Measure the Plastigage at its widest point.

Standard oil clearance: 0.036 – 0.064 mm
(0.0014 – 0.0025 in.)

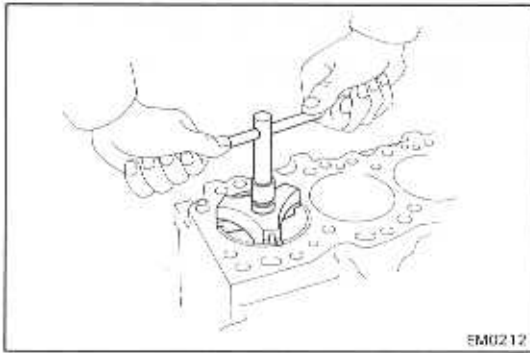
Maximum oil clearance: 0.1 mm (0.004 in.)

If the clearance is greater than maximum, replace the bearing. Grind the crank pins or replace the crankshaft as required.

NOTE: There six different standard bearings, distinguished numerically (1, 2 and 3) and by color (brown, black and blue).

For 2L-T engines, replace bearing with one having the same number as marked on the bearing cap. For L and 2L engines, replace with one having the color with corresponds to the number on the bearing cap, i. e., 1 with brown, 2 with black, 3 with blue.

- (k) Completely remove the Plastigage.

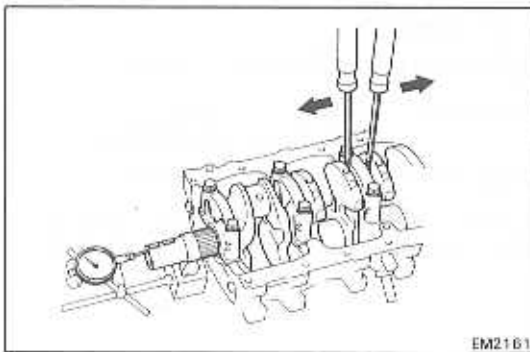
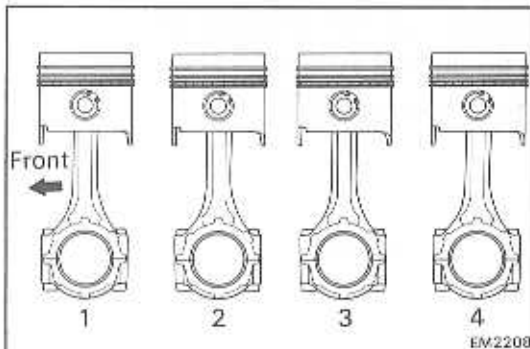


9. PUSH OUT PISTON AND CONNECTING ROD ASSEMBLY WITH UPPER BEARING

- Remove all the carbon from the piston ring ridge.
- Cover the rod bolts. (See page EM-51)
- Push out the piston and rod assembly with the bearing through the top of the cylinder block.

NOTE:

- Keep the bearing inserted with the rod.
- Arrange the piston and rod assembly in order.



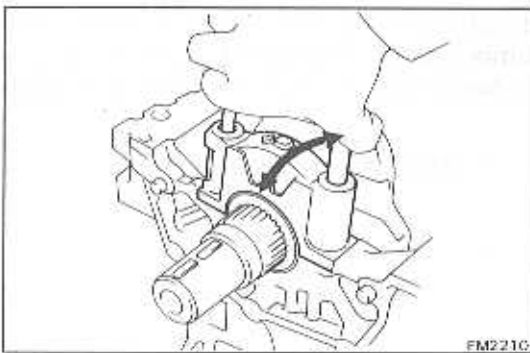
10. CHECK CRANKSHAFT THRUST CLEARANCE

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.

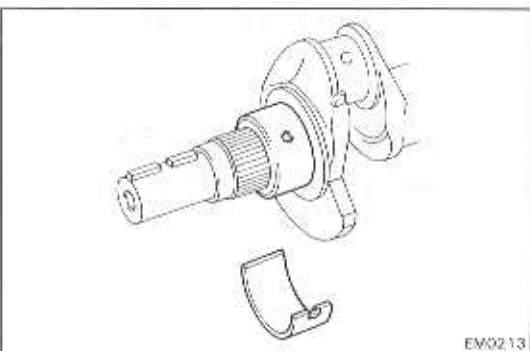


11. REMOVE MAIN BEARING CAPS WITH LOWER BEARING AND CHECK OIL CLEARANCE

- Loosen the bolts until the threads no longer mesh.
- Grasping the bolts together, pull off bearing cap.

NOTE: Keep the bearing inserted with the caps.

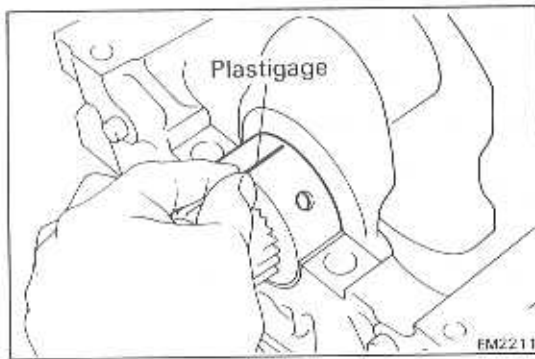
- Lift out the crankshaft.



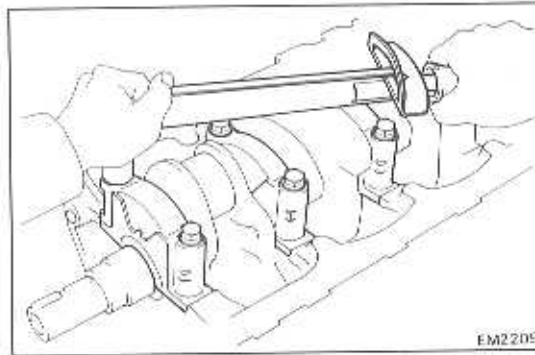
- Clean each journal and bearing.

- Check each journal and bearing for pitting and scratches.

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



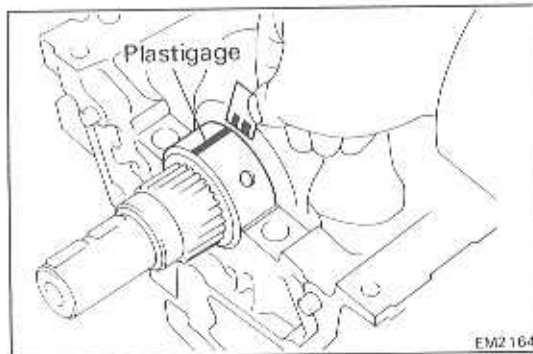
- (f) Place the crankshaft on the cylinder block.
 (g) Lay a strip of Plastigage across each journal.



- (h) Install the bearing cap (See page EM-66)

Torque: 1,050 kg-cm (76 ft-lb, 103 N-m)

NOTE: Do not turn the crankshaft.

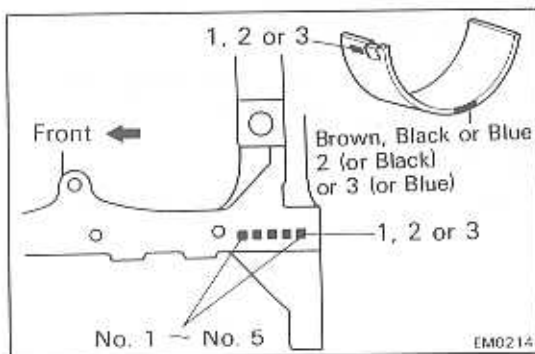


- (i) Remove the bearing cap.
 (j) Measure the Plastigage at its widest point.

**Standard oil clearance: 0.034 – 0.065 mm
 (0.0013 – 0.0026 in.)**

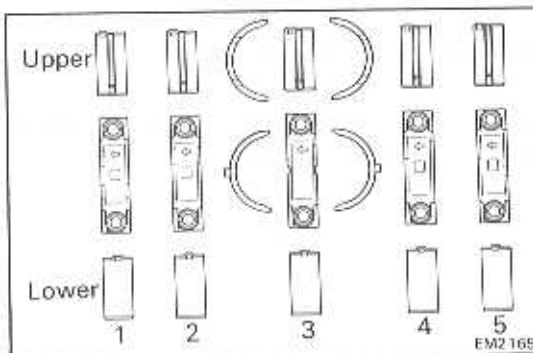
Maximum oil clearance: 0.1 mm (0.004 in.)

If the clearance is greater than maximum, replace the bearing. Grind the journals or replace the crankshaft as required.



NOTE: If using a standard bearing, replace with one having the same number as marked on the cylinder block or having its corresponding color, i. e., 1 or brown, 2 or black, 3 or blue.

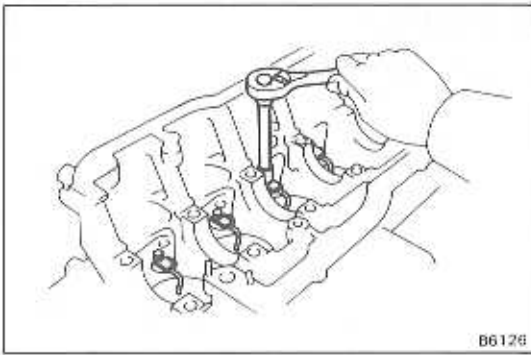
- (k) Completely remove the Plastigage.



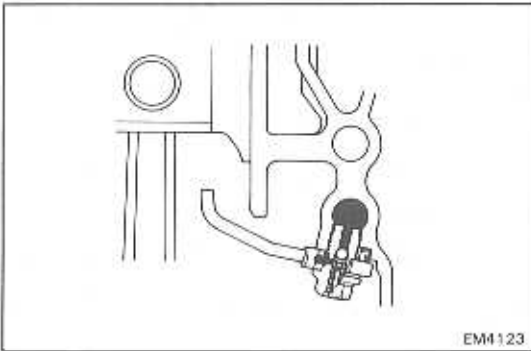
12. REMOVE CRANKSHAFT AND UPPER MAIN BEARINGS

- (a) Lift out the crankshaft.
 (b) Remove the bearing from the cylinder block.

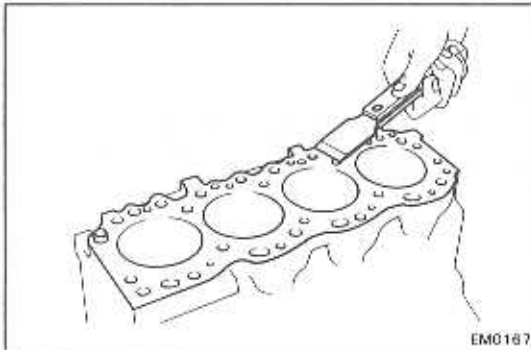
NOTE: Arrange the caps, bearings and thrust washers in order.



B6128

13. REMOVE OIL CHECK VALVES AND OIL JETS

EM123



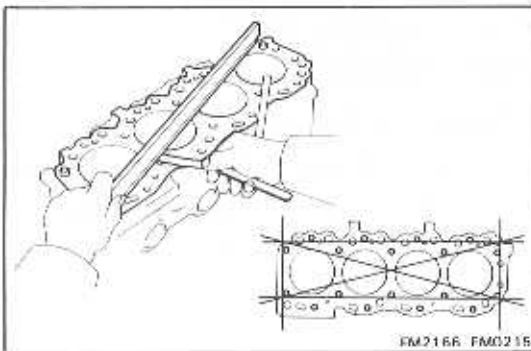
EM0167

INSPECTION OF CYLINDER BLOCK**1. REMOVE GASKET MATERIAL**

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

2. CLEAN CYLINDER BLOCK

Using a soft brush and solvent, clean the block.



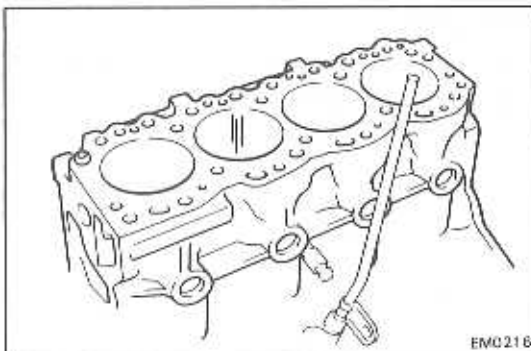
FM2166 FM0215

3. INSPECT TOP OF CYLINDER BLOCK

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.

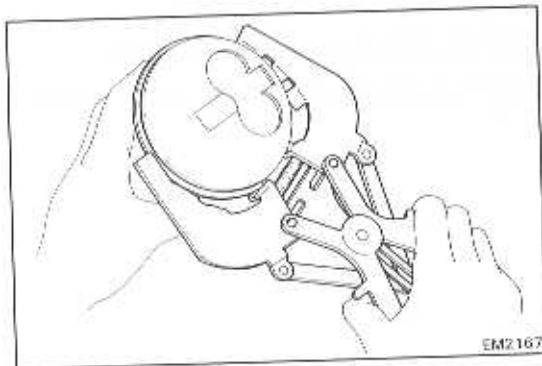
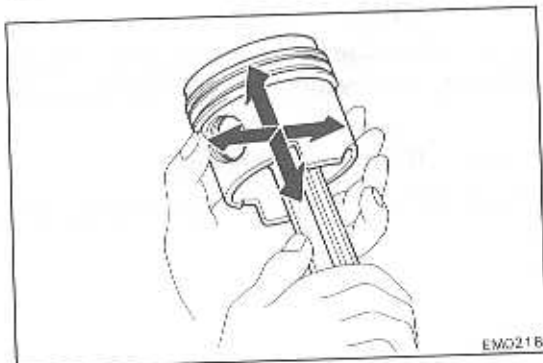
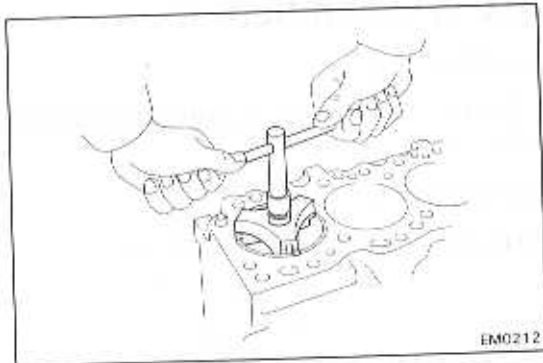
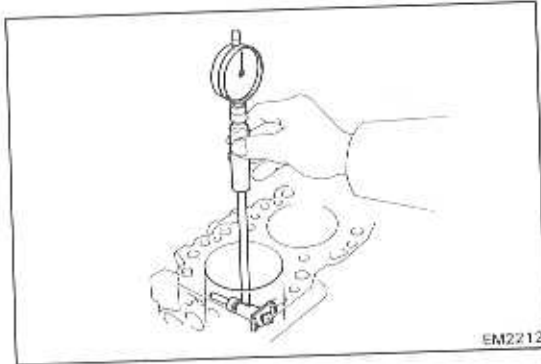
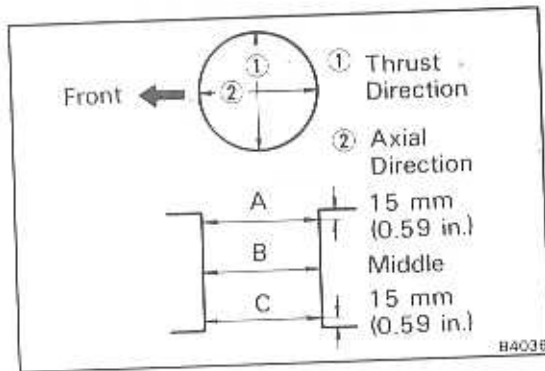


EM0216

4. INSPECT CYLINDERS

Visually check the cylinder for vertical scratches.

If deep scratches are present, rebore all four cylinders.



5. INSPECT CYLINDER BORES

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

Standard diameter

Piston size	Cylinder bore mm (in.)	
	L	2L, 2L-T
STD	90.000 – 90.030 (3.5433 – 3.5445)	92.000 – 92.030 (3.6220 – 3.6232)
O/S 0.50	90.500 – 90.530 (3.5630 – 3.5642)	92.500 – 92.530 (3.6417 – 3.6429)

Maximum diameter

Piston size	Cylinder bore mm (in.)	
	L	2L, 2L-T
STD	90.23 (3.5524)	92.23 (3.6311)
O/S 0.50	90.73 (3.5720)	92.73 (3.6508)

If the diameter is greater than maximum of the STD size, rebore all four cylinders.

If the diameter is greater than maximum of the O/S 0.50, replace the cylinder block.

6. REMOVE CYLINDER RIDGE

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

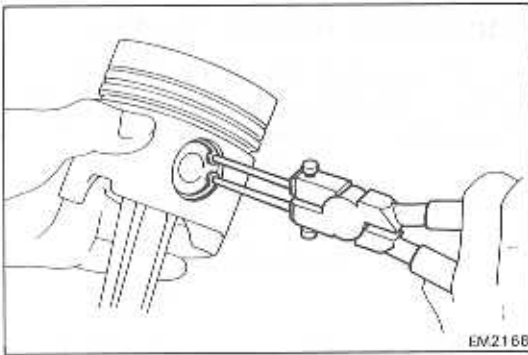
DISASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLY

1. CHECK FIT BETWEEN PISTON AND PIN

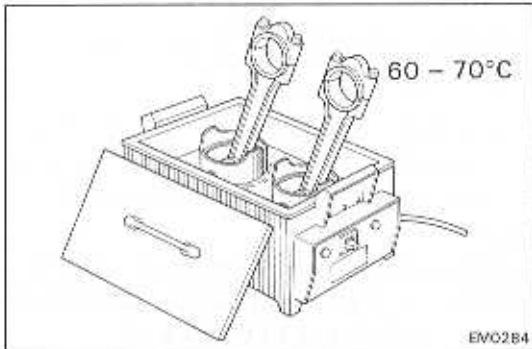
Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and pin.

2. REMOVE PISTON RINGS

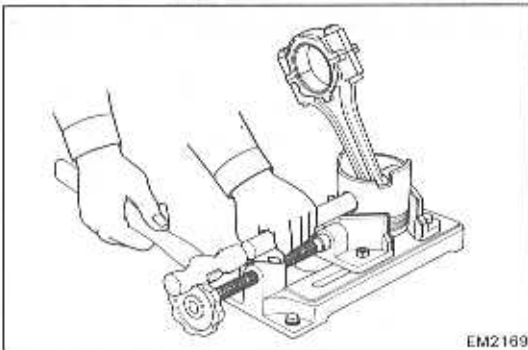
Using a piston ring expander, remove the piston rings. Keep the rings separate for each cylinder.



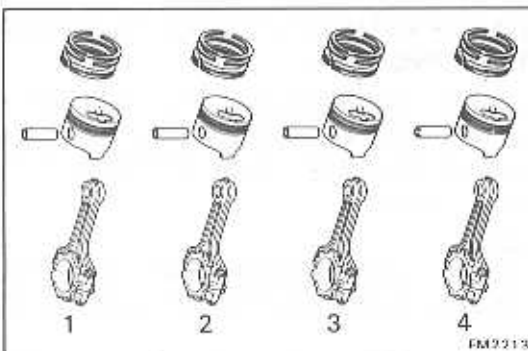
3. **DISCONNECT CONNECTING ROD FROM PISTON**
- (a) Using needle-nose pliers, remove the snap rings.



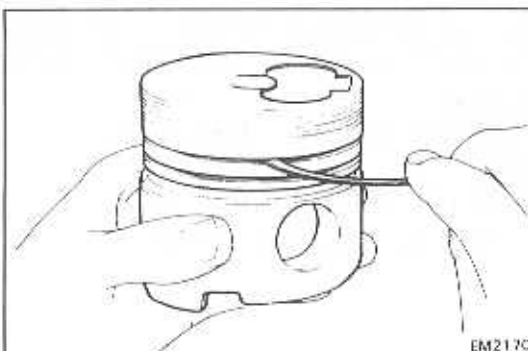
- (b) Gradually heat the piston to about 60 – 70°C (140 – 158°F).



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

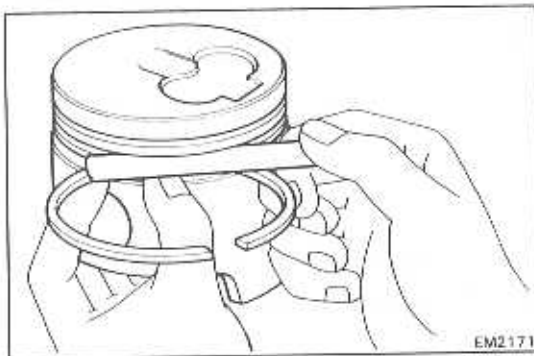
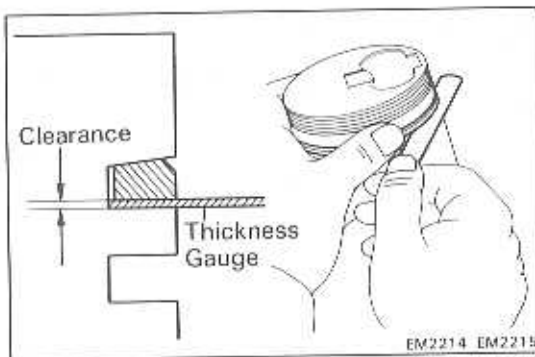
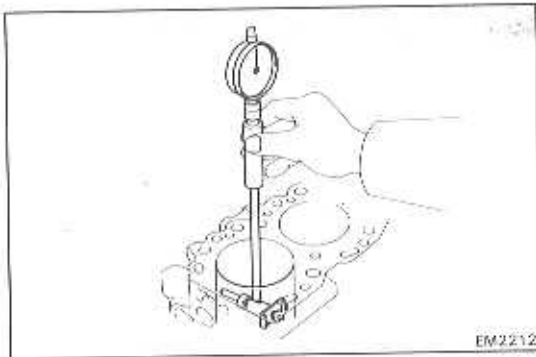
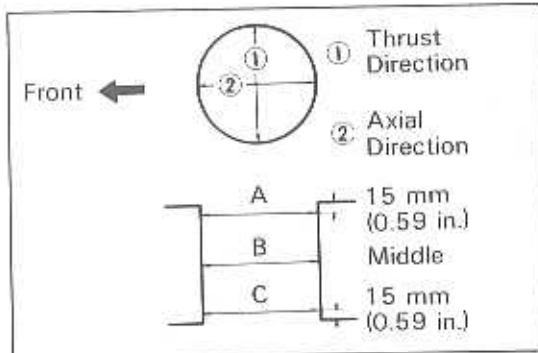
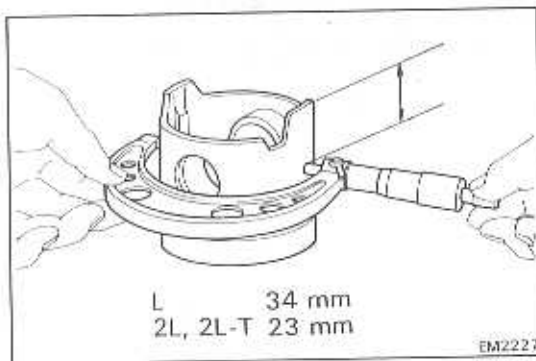
**NOTE:**

- The piston and pin are a matched set.
- Keep the piston, pin, rings and connecting rod together for each cylinder.

**INSPECTION OF PISTON AND CONNECTING ROD ASSEMBLY****1. CLEAN PISTON**

- (a) Scrape carbon from the piston top.
- (b) Using a groove cleaning tool or broken ring, clean the ring grooves.
- (c) Using solvent and brush, thoroughly clean the piston.

CAUTION: Do not use a wire brush.



2. INSPECT PISTON DIAMETER AND CLEARANCE

- (a) Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line 34 mm (1.34 in.) or 23 mm (0.91 in.) below the skirt bottom edge.

Standard diameter

Piston size	Piston bore mm (in.)	
	L	2L, 2L-T
STD	89.955 – 89.985 (3.5415 – 3.5427)	91.940 – 91.970 (3.6197 – 3.6209)
O/S 0.50	90.455 – 90.485 (3.5612 – 3.5624)	92.440 – 92.470 (3.6394 – 3.6405)

- (b) Measure the cylinder bore diameter in the thrust directions (See page EM-56) and subtract the piston diameter measurement from the cylinder diameter.

Standard clearance:

L 0.035 – 0.055 mm (0.0014 – 0.0022 in.)

2L, 2L-T 0.050 – 0.070 mm (0.0020 – 0.0028 in.)

Maximum clearance: 0.14 mm (0.0055 in.)

If the clearance is greater than maximum, replace the piston, or rebore all four cylinders and replace all four pistons.

3. INSPECT CLEARANCE BETWEEN PISTON RING LAND AND NEW PISTON RING

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

No. 1 ring clearance:

L 0.010 – 0.055 mm (0.0004 – 0.0022 in.)

2L, 2L-T 0.020 – 0.065 mm (0.0008 – 0.0026 in.)

- (b) Using a feeler gauge, measure the No. 2 and oil ring clearances between the ring land and new piston ring.

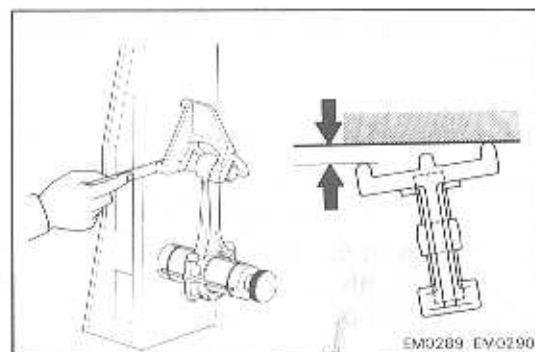
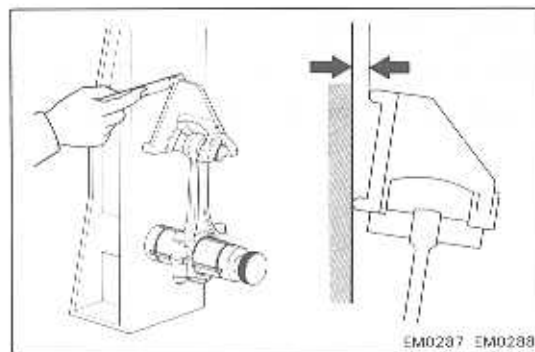
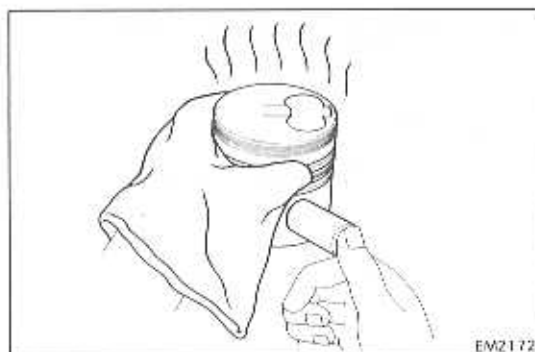
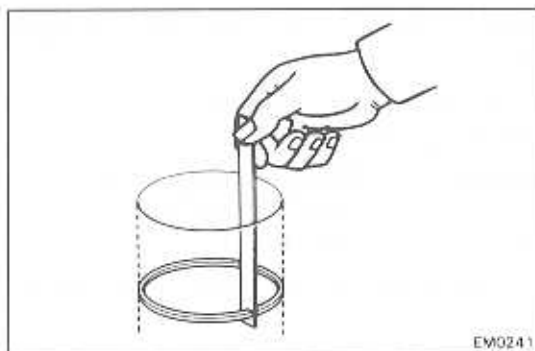
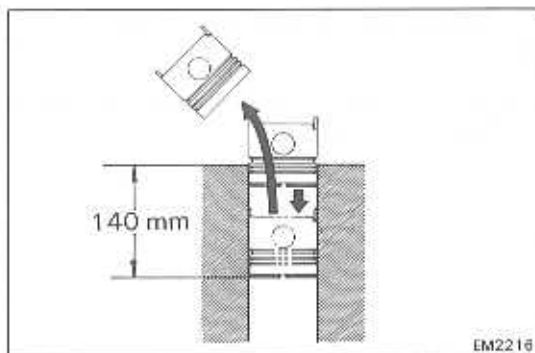
No. 2 ring clearance:

0.040 – 0.100 mm (0.0016 – 0.0039 in.)

Oil ring clearance:

0.030 – 0.070 mm (0.0012 – 0.0028 in.)

If not within specification, replace the piston.



4. INSPECT PISTON RING END GAP

- Insert a piston ring into the cylinder bore.
- Using a piston, push the piston ring a little beyond the bottom of the ring travel.
(140 mm (5.51 in.) from top surface of cylinder block)
- Using a feeler gauge, measure the end gap.

Piston ring end gap mm (in.)

Item	Piston ring	L	2L, 2L-T
Standard	No.1	0.30 - 0.57 (0.0118 - 0.0224)	0.35 - 0.62 (0.0138 - 0.0244)
	No.2	0.20 - 0.52 (0.0079 - 0.0205)	0.20 - 0.47 (0.0079 - 0.0185)
	Oil	0.20 - 0.52 (0.0079 - 0.0205)	
Maximum	No.1	1.30 (0.051)	
	No.2	1.12 (0.044)	1.07 (0.042)
	Oil	1.12 (0.044)	

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

If the gap exceeds the specified maximum even with a new piston ring, rebore the cylinder and use an o/s piston ring.

5. CHECK PISTON PIN FIT

At 60 - 70°C (140 - 158°F) you should be able to push the pin into the piston with your thumb.

If the pin can be installed at a normal temperature, replace the piston and pin.

6. INSPECT CONNECTING RODS

- Using a rod aligner, check the connecting rod alignment.

- Check for bend.

Maximum bend:

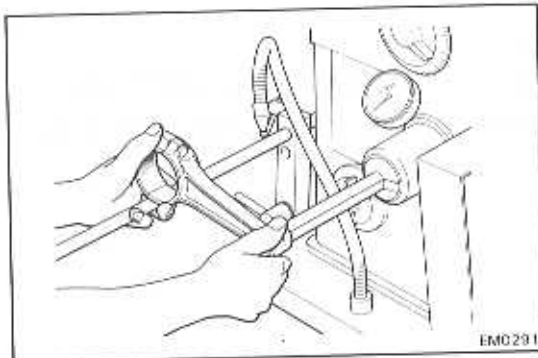
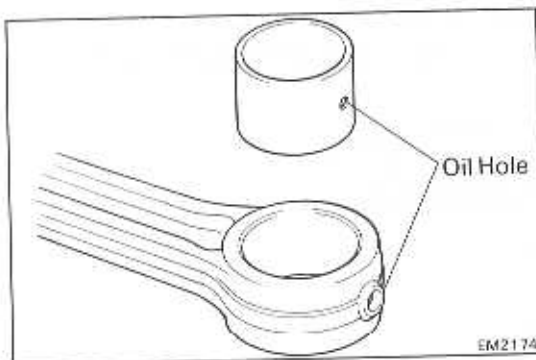
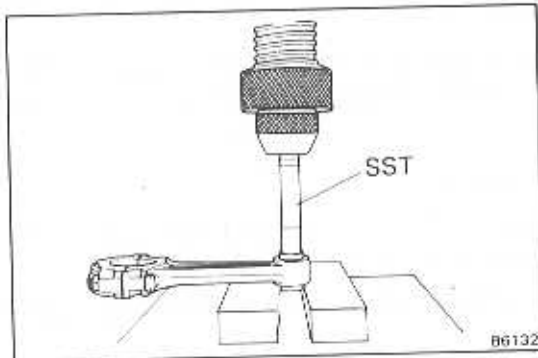
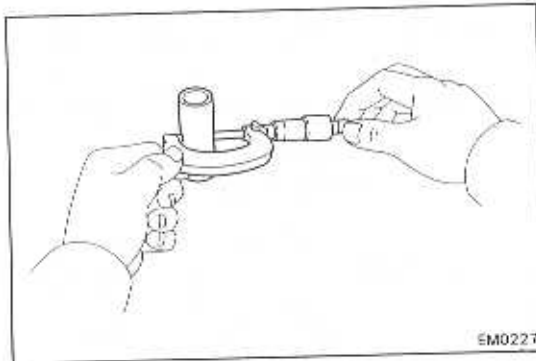
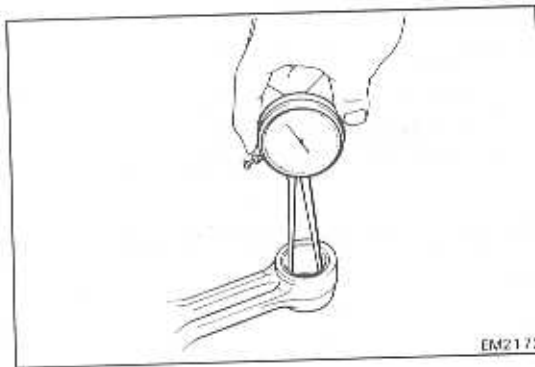
0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

- Check for twist.

Maximum twist:

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

If the rod is bent or twisted, replace the connecting rod.



(b) Measure the oil clearance between the rod bushing and piston pin.

- Using an inside dial indicator, measure the inside diameter of the rod bushing.

- Using a micrometer, measure the diameter of the piston pin.

- Subtract the piston pin diameter from the rod bushing inside diameter.

Standard oil clearance: 0.004 – 0.012 mm
(0.0002 – 0.0005 in.)

Maximum oil clearance: 0.05 mm (0.0020 in.)

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

REPLACEMENT OF CONNECTING ROD BUSHING

1. REMOVE ROD BUSHING

Using SST and a press, press out the bushing.

SST 09222-40011

2. INSTALL NEW ROD BUSHING

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

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

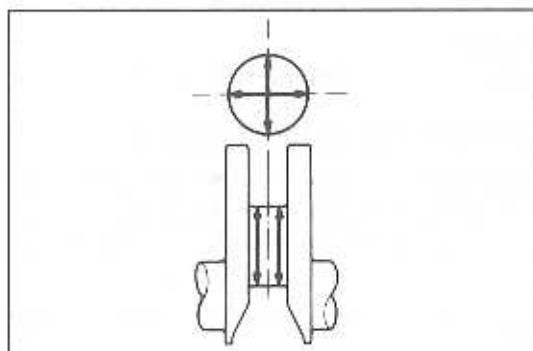
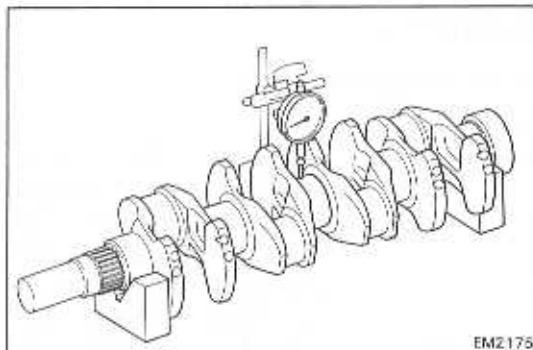
SST 09222-40011

3. HONE 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.

Standard oil clearance: 0.004 – 0.012 mm
(0.0002 – 0.0005 in.)

(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.



INSPECTION AND REPAIR OF CRANKSHAFT

1. INSPECT CRANKSHAFT

- (a) Place the crankshaft on V-blocks.
- (b) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.1 mm (0.039 in.)

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

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

Standard diameter (Standard sized bearing):

Main journal	61.985 – 62.000 mm (2.4403 – 2.4409 in.)
Crank pin	L, 2L 52.988 – 53.000 mm (2.0861 – 2.0866 in.)
	2L-T 54.988 – 55.000 mm (2.1649 – 2.1654 in.)

- (d) 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 the oil clearance even when new bearings are used, is greater than specified, regrind or replace the crankshaft.

2. GRIND AND HONE MAIN JOURNAL AND/OR CRANK PIN

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

Main journal finished diameter:

U/S 0.25	61.735 – 61.750 mm (2.4305 – 2.4311 in.)
U/S 0.50	61.385 – 61.500 mm (2.4167 – 2.4213 in.)

Crank pin finished diameter:

U/S 0.25	L, 2L 52.738 – 52.750 mm (2.0763 – 2.0768 in.)
	2L-T 54.738 – 54.750 mm (2.1550 – 2.1555 in.)
U/S 0.50	L, 2L 52.488 – 52.500 mm (2.0665 – 2.0669 in.)
	2L-T 54.488 – 54.500 mm (2.1452 – 2.1457 in.)

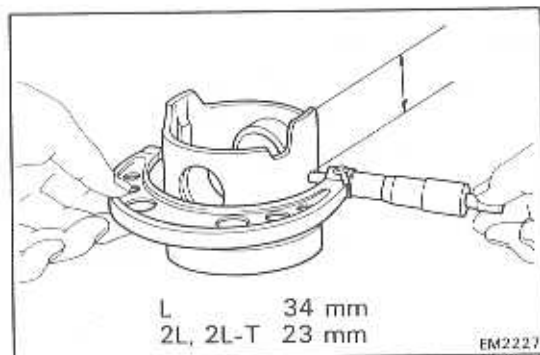
Install new main journal and/or crank pin undersize bearings.

BORING OF CYLINDERS

1. SELECT PISTON AND PISTON RING

Piston diameter:

Standard size	L	89.955 – 89.985 mm (3.5415 – 3.5427 in.)
	2L, 2L-T	91.940 – 91.970 mm (3.6197 – 3.6209 in.)
Oversize	L	90.455 – 90.485 mm (3.5612 – 3.5624 in.)
	2L, 2L-T	92.440 – 92.470 mm (3.6394 – 3.6405 in.)



Replace all the pistons.

Replace the piston rings with ones matching the pistons.

2. CALCULATE AMOUNT TO BORE CYLINDER

- Using a micrometer, measure the piston diameter at a right angle to the piston pin hole center line 34 mm (1.34 in.) or 23 mm (0.91 in.) below the skirt bottom edge.
- Calculate the amount each cylinder is to be rebored as follows:

$$\text{Size to be rebored} = P + C - H$$

P = Piston diameter

C = Piston clearance

L	0.035 – 0.055 mm (0.0014 – 0.0022 in.)
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2L, 2L-T	0.050 – 0.070 mm (0.0020 – 0.0028 in.)
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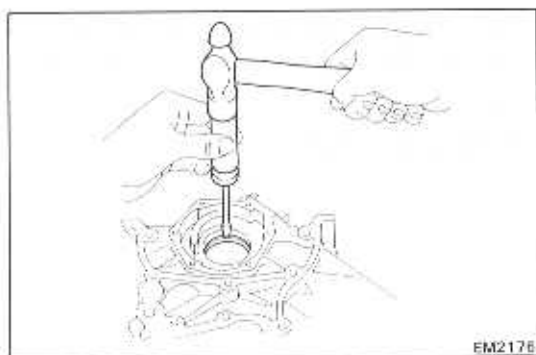
H = Allowance for honing

Less than 0.02 mm (0.0008 in.)

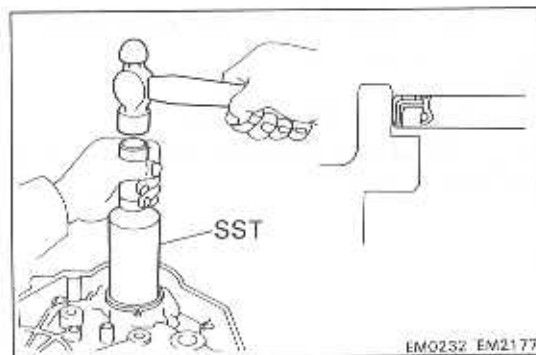
3. BORE AND HONE CYLINDERS TO CALCULATED DIMENSIONS

Maximum honing: 0.02 mm (0.0008 in.)

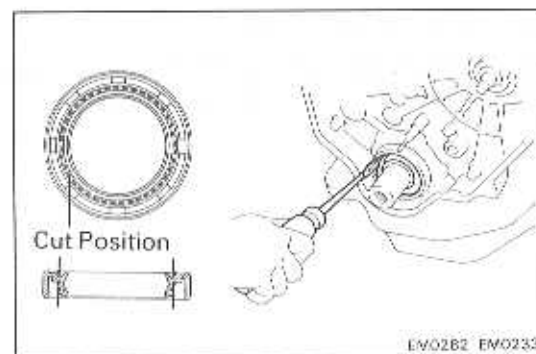
CAUTION: Excess honing will destroy the finished roundness.



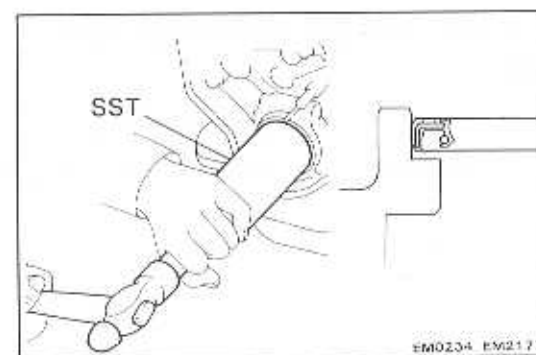
EM2176



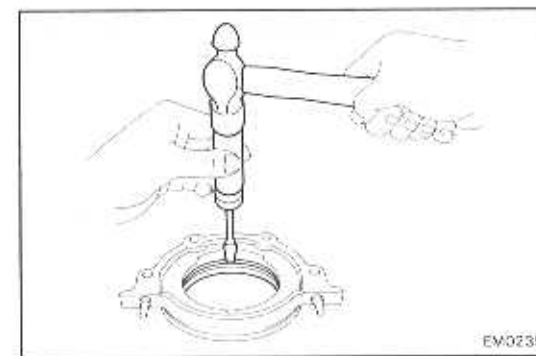
EM0232 EM2177



EM0282 EM0233



EM0234 EM2177



EM0235

REPLACEMENT OF CRANKSHAFT OIL SEALS

NOTE: There are two methods of oil seal replacement.

1. REPLACE CRANKSHAFT FRONT OIL SEAL

If oil pump body 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 to the depth of 0.5 mm (0.020 in.) from the oil pump body edge.
- SST 09214-60010
- (c) Apply MP grease to the oil seal.

If oil pump body is installed to cylinder block:

- (a) Using a knife, cut off the oil seal lip.
- (b) Using a screwdriver, pry out the oil seal.

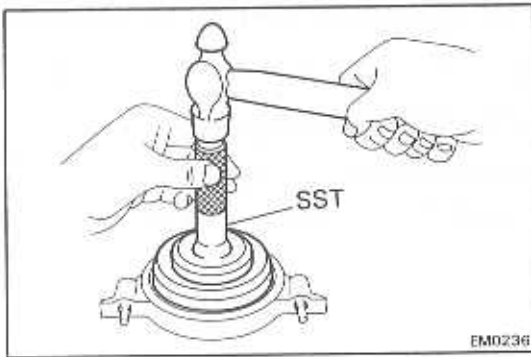
CAUTION: Be careful not to damage the crankshaft. Tape the screwdriver.

- (c) Apply MP grease to a new oil seal.
 - (d) Using SST and a hammer, drive in the oil seal to a depth of 0.5 mm (0.020 in.) from the oil pump body edge.
- SST 09214-60010

2. REPLACE CRANKSHAFT REAR OIL SEAL

If rear oil seal retainer is removed from cylinder block:

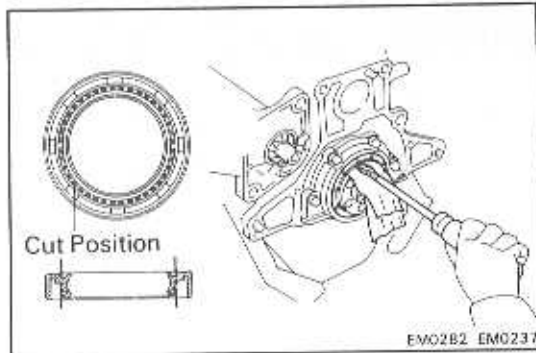
- (a) Using a screwdriver and hammer, drive out the oil seal.



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

SST 09223-63010

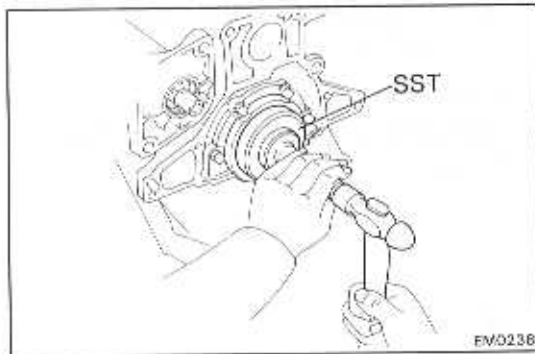
- (c) Apply MP grease to the oil seal.



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.

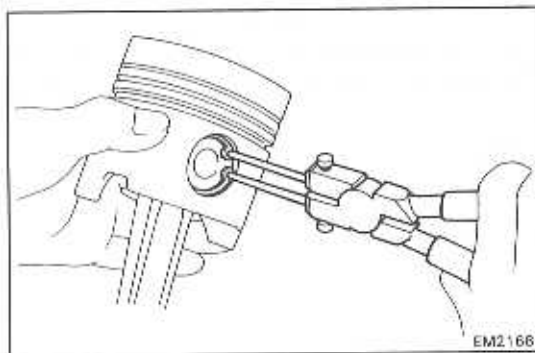
CAUTION: Be careful not to damage the crankshaft. Tape the screwdriver.



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

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

SST 09223-63010

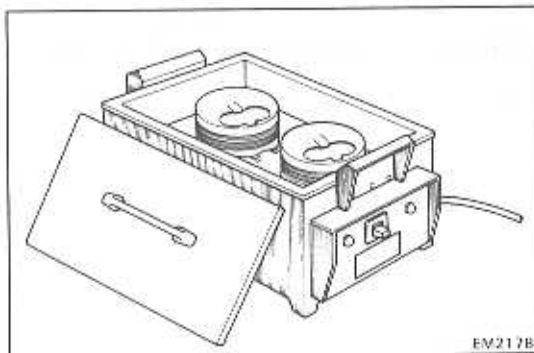


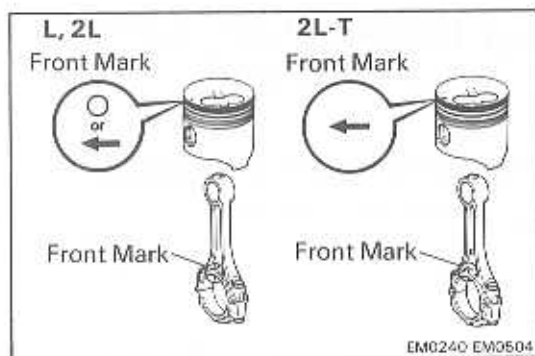
ASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLY

1. ASSEMBLE PISTON AND CONNECTING ROD

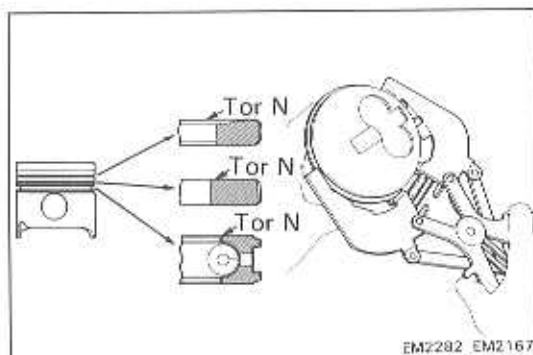
- (a) Install a new snap ring on one side of the piston pin hole.

- (b) Gradually heat the piston to about 60 – 70°C (140 – 158°F).



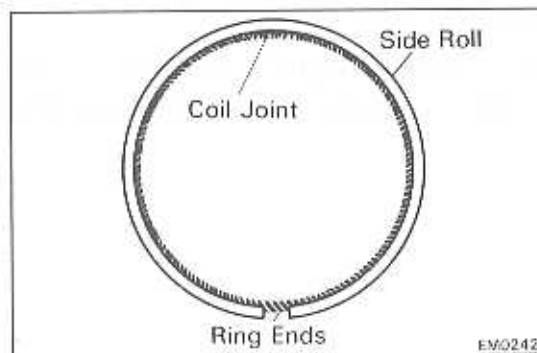


- (c) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.
- (d) Install a new snap ring on the other side of the piston pin hole.

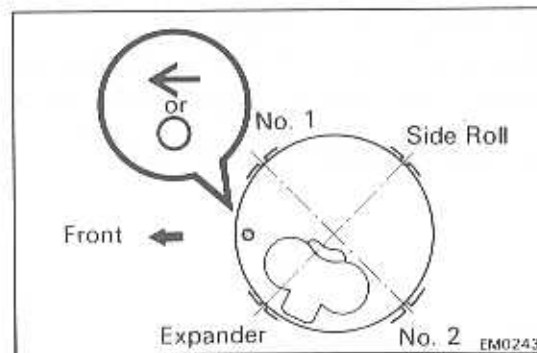


2. INSTALL PISTON RINGS

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

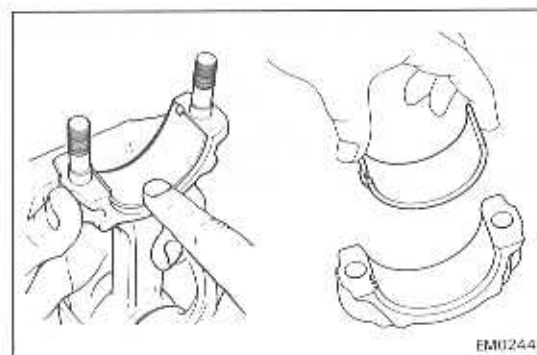


NOTE: When assembling the oil ring and expander coil, insure that the expander coil joint is at the opposite side of the ring ends.



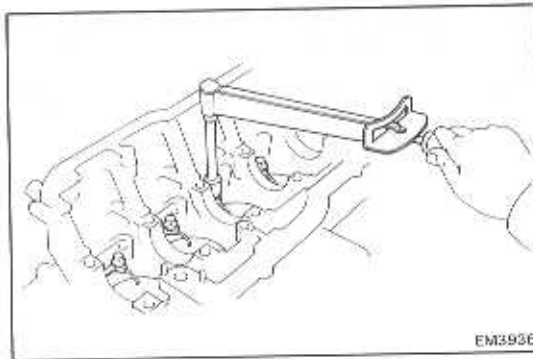
- (b) Position the piston rings so that the ring end gaps are as shown.

CAUTION: Do not align the end gaps.



3. INSTALL BEARINGS

Install the bearing inserts in the connecting rods and rod caps.



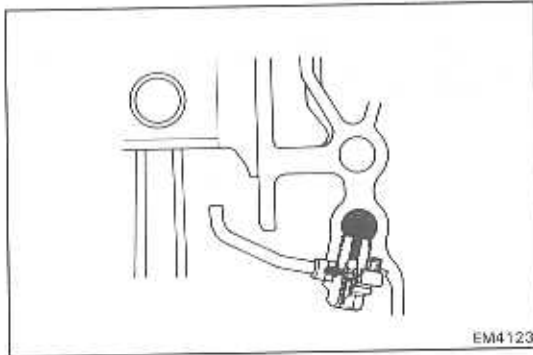
EM3936

INSTALLATION OF CRANKSHAFT, PISTON AND CONNECTING ROD ASSEMBLY

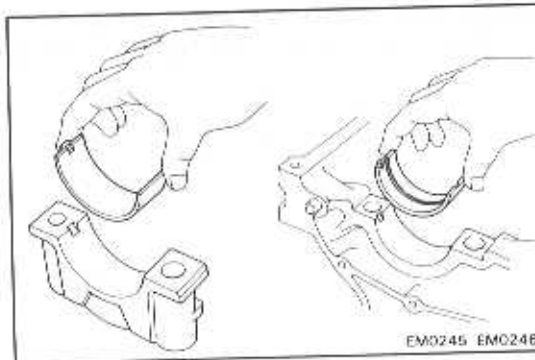
(See page EM-50)

1. INSTALL OIL JETS AND OIL CHECK VALVES

Torque: 260 kg-cm (19 ft-lb, 25 N·m)



EM4123

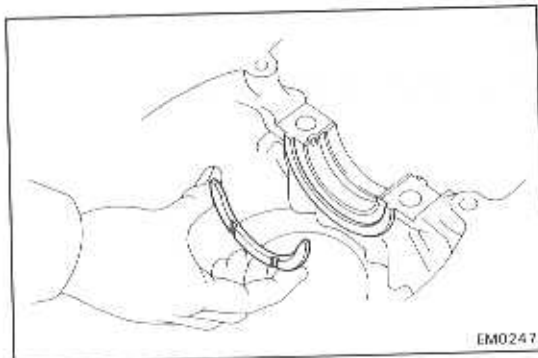


EM0245 EM0246

2. INSTALL MAIN BEARINGS

Install the bearing in the cylinder block and bearing caps.

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

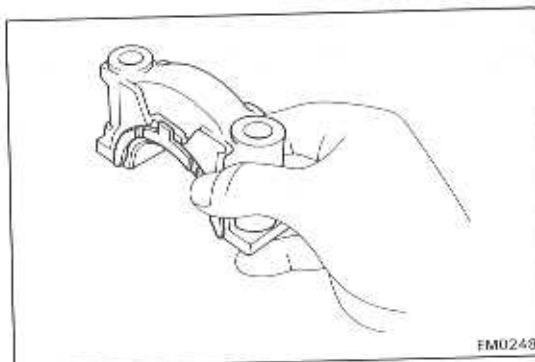


EM0247

3. INSTALL UPPER THRUST WASHERS

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

4. PLACE CRANKSHAFT ON CYLINDER BLOCK



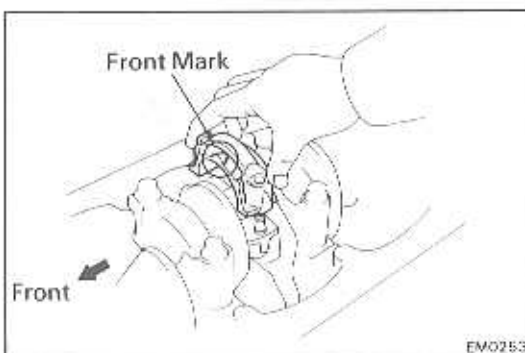
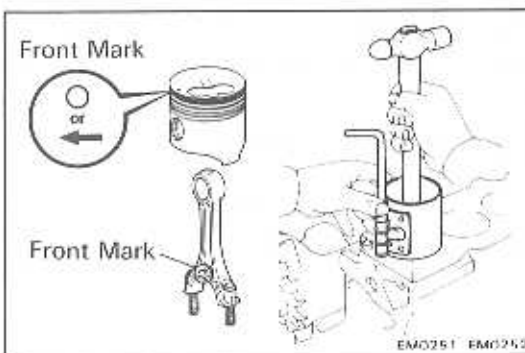
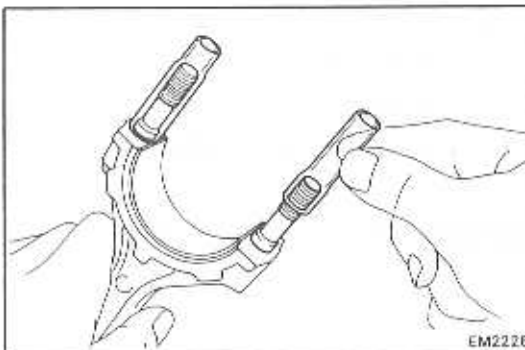
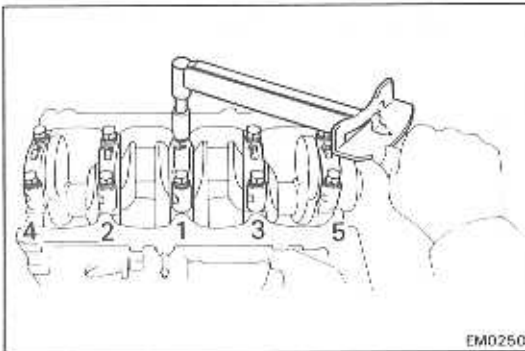
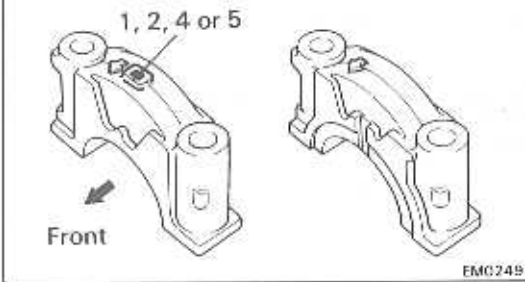
EM0248

5. INSTALL MAIN BEARING CAPS WITH LOWER THRUST WASHERS

NOTE: Each bearing cap is numbered.

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

Ex. No. 3 Bearing Cap No. 3 Bearing Cap



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

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

(d) Install and tighten the cap bolts in two or three passes and in the sequence shown.

Torque: 1,050 kg-cm (76 ft-lb, 103 N·m)

(e) Check that the crankshaft turns smoothly.

(f) Check the crankshaft thrust clearance.
(See page EM-53)

6. INSTALL PISTON AND CONNECTING ROD ASSEMBLY

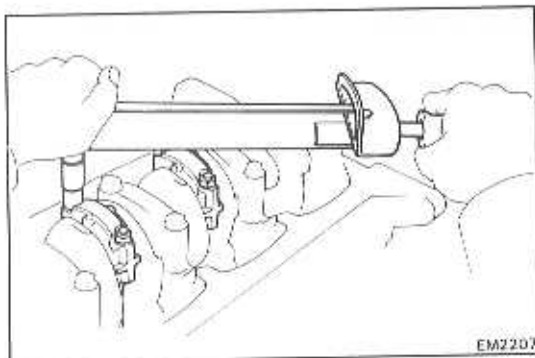
(a) Cover the rod bolts with a short piece of hose to protect the crankshaft from damage.

(b) Using a ring compressor, push the correctly numbered piston and rod assembly 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 rod.

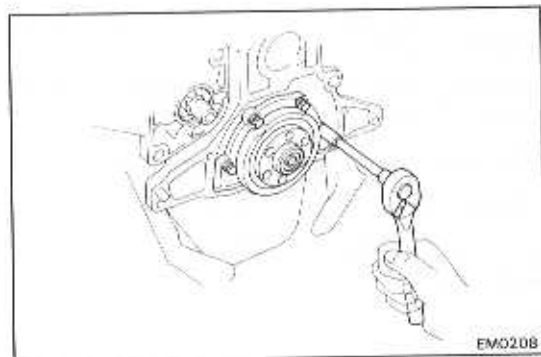
(b) Install the rod caps with the front mark facing forward.



- (c) Apply a light coat of the engine oil on the threads and under the rod nuts.
- (d) Install and tighten the rod nuts alternately in two or three passes.

Torque: 600 kg-cm (43 ft-lb, 59 N·m)

- (e) Check that the crankshaft turns smoothly.
- (f) Check the rod thrust clearance.
(See page EM-51)



ASSEMBLY OF CYLINDER BLOCK

(See page EM-50)

1. INSTALL REAR OIL SEAL RETAINER

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

Torque: 130 kg-cm (9 ft-lb, 13 N·m)

2. INSTALL OIL PUMP

(See steps 2 to 7 on pages LU-6, 7)

3. INSTALL CYLINDER HEAD

(See steps 1 to 3, 8, 10 to 14 and 16 on pages EM-46 to 49)

4. REMOVE ENGINE STAND

5. INSTALL REAR END PLATE

Install a dust seal and the end plate with the two bolts.
Torque the bolts.

Torque: 120 kg-cm (9 ft-lb, 12 N·m)

6. INSTALL FLYWHEEL OR DRIVE PLATE

Torque: 1,250 kg-cm (90 ft-lb, 123 N·m)

