ENGINE MECHANICAL

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DIESEL ENGINE DIAGNOSIS

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.

PRELIMINARY CHECKS

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

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

(c) Confirm 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.

DIAGNOSIS

PRECAUTION:

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

ENGINE WILL NOT CRANK

(Possible Cause)	(Check Procedure and Correction Method)
1. LOOSE OR CORRODED BATTERY CABLES	Check cables from battery to starter and make necessary repairs.
2. DISCHARGED BATTERY	Check alternator output and the drive belt. Repair as necessary. (See page CH-4)
3. INOPERATIVE STARTER	Check for battery voltage at starter terminals 30 and 50. If Okay, see STARTING SYSTEM, page (ST-7) for repair procedure.

ENGINE CRANKS SLOWLY-WILL NOT START

NOTE: Minimum cranking speed: 100 rpm Cold
150 rpm Hot

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

ENGINE CRANKS NORMALLY BUT WILL NOT START

(Possible Cause)	(Check Procedure and Correction Method)
1. NO FUEL TO NOZZLE HOLDER	Loosen any one injection pipe union nut from its nozzle holder. Crank the engine for approx. 5 seconds while confirming that fuel is being discharged from the pipe. If fuel is coming out, begin diagnosis from item 4. If not, begin from item 2.
2. NO FUEL CUT SOLENOID OPERATION	With 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 is battery voltage to the solenoid when the starter switch is ON. If battery voltage is confirmed, fuel cut solenoid is faulty and should be replaced. If no voltage, refer to ELECTRICAL DIAGNOSIS and make necessary repairs.
3. NO FUEL INTO INJECTION PUMP	Disconnect inlet hoses to fuel filter and feed clean fuel from separate container directly into 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 starter switch ON and the glow plug indicator light illuminated, check that there is voltage applied to the glow plugs. If not, refer to ELECTRICAL DIAGNOSIS and repair as necessary.
5. FAULTY GLOW PLUG OPERATION	Check glow plug continuity (See page ST-4). If no continuity, a broken wire is indicated and glow plug should be replaced.
6. FUEL LEAKAGE FROM INJECTION PIPE	Check for loose unions or cracks. If leaking, tighten to specified torque or, if necessary, replace pipe(s).

7. IMPROPER INJECTION TIMING	Turn crankshaft pulley clockwise to where either No. 1 or No. 4 piston is at TDC and, after releasing cold start advance system, check plunger stroke with SST. (See page EM-18) SST 09275-54010 **Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)** If not within specification, injection pump is improperly adjusted. **NOTE: If crankshaft pulley is off more than 10°, it could indicate a jumped timing belt.**
8. IMPROPER COLD START ADVANCE AND FAST IDLE	Measure timer piston stroke and fast idle lever opening angle with injection pump tester when cold start advance is operated.
9. FAULTY NOZZLE OR NOZZLE HOLDER	Check nozzle with nozzle tester. (See page FU-6) **Opening pressure: 135 – 155 kg/cm² (1,920 – 2,205 psi) (13,239 – 15,200 kPa)** If not within specification, nozzle adjustment is improper and pressure should be readjusted. If pressure cannot be adjusted to specification, replace nozzle holder assembly. (See page FU-8)

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 screw. Also check if accelerator cable is catching on something. If necessary, adjust so lever is in contact with screw, or make other required repairs.
2. IDLE SPEED TOO LOW	Check the idle speed as specified below. (See page EM-22) **Idle speed: 700 rpm** If not, adjust with idle adjusting screw. **NOTE: If less than specified, idling would normally be rough.**
3. FUEL LEAKAGE	Check for leaks at the pump connections, pump distributive 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 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 nozzle with nozzle tester. (See page FU-6) **Opening presure: 135 – 155 kg/cm² (1,920 – 2,205 psi) (13,239 – 15,200 kPa)** If pressure is not within specification, nozzle is faulty and injection pressure should be readjusted. (See page FU-8) • Faulty Delivery Valve If injection pressure is with specification, delivery valve is defective and should be replaced.

ENGINE SUDDENLY STOPS

(Possible Cause)	(Check Procedure and Correction Method)
1. ENGINE WILL NOT RE-START	Check to see if engine re-starts according to prescribed procedure. If not, refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and repair as necessary.
2. ROUGH IDLE	If idle is not stable, refer to ROUGH IDLE WITH WARM ENGINE and repair accordingly.
3. MALFUNCTION OF FUEL-CUT SOLENOID	Refer to ENGINE CRANKS NORMALLY BUT WILL NOT START, above, and check accordingly. **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 confirm that the air cleaner is not clogged or the engine overheating.**
2. **Not applicable if the customer desires an output power higher than specified for that vehicle. For accuracy, adjust with a chassis dynamo.**

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER ACCELERATOR CABLE ADJUSTMENT	With accelerator fully depressed, check that adjusting lever is in contact with maximum speed set screw. (See page EM-22) If not, adjust accordingly.
2. INSUFFICIENT MAXIMUM SPEED	Start engine, depress accelerator pedal to floor and check that maximum speed is as specified below. (See page EM-22) **Maximum speed: 5,800 ± 50 rpm** 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. Although both fittings are same size, they must not be interchanged.**
4. FUEL LEAKAGE	Refer to item 3 of ROUGH IDLE WITH WARM ENGINE.
5. CLOGGED FUEL FILTER	Disconnect inlet hose to fuel filter and feed clean fuel directly into the pump. If engine condition improves, fuel filter is clogged and should be replaced. (See page FU-2) **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. Confirm that the air cleaner is not clogged.
2. Confirm with the customer whether or not oil consumption has been excessive.

(Possible Cause)	(Check Procedure and Correction Method)
1. IMPROPER INJECTION TIMING	Refer to item 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 speed (2,000 – 3,000 rpm), 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: Confirm 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 SPEED TOO HIGH	After sufficiently warming up engine, check that idle speed is as specified below. (See page EM-22) **Idle speed: 700 rpm** If not, adjust with idle adjusting screw.
3. MAXIMUM SPEED TOO HIGH	Start engine, depress accelerator pedal to floor and check that maximum speed is as specified below. (See page EM-22) **Maximum speed: 5,800 ± 50 rpm** 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 temp. 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

(Possible Cause)	(Check Procedure and Correction Method)
BINDING ACCELERATOR CABLE	Operate adjusting lever on top of injection pump and check if engine returns to idle. (See page EM-22) If so, accelerator cable is binding or improperly adjusted 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

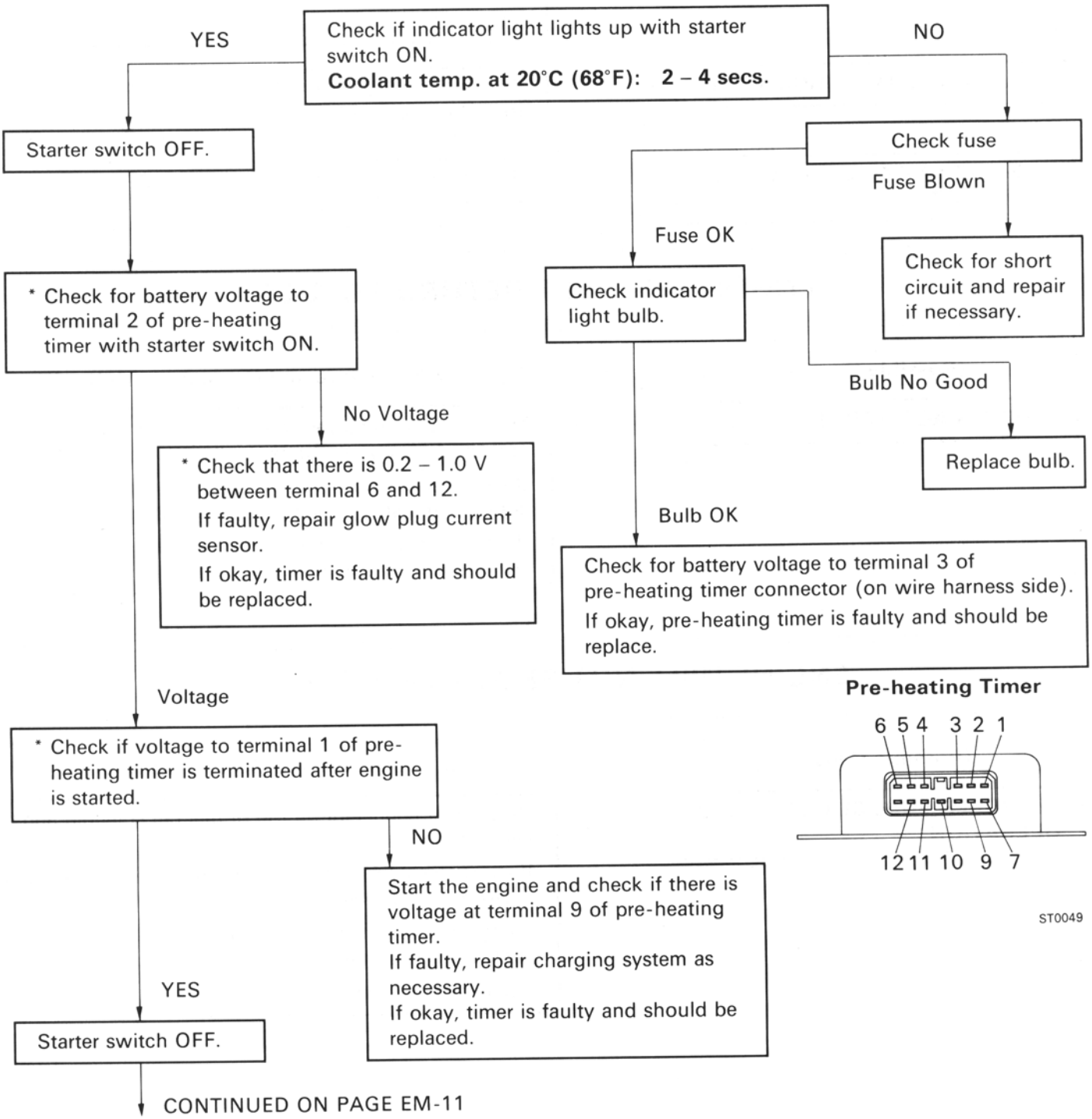
(Possible Cause)	(Check Procedure and Correction Method)
IMPROPER FUEL CUT-SOLENOID OPERATION	Disconnect connector on top of fuel cut solenoid and check if engine stops. If so, starter switch is faulty and should be repaired as necessary or replaced. If engine does not stop, either fuel cut solenoid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

DIESEL ELECTRICAL SYSTEM DIAGNOSIS

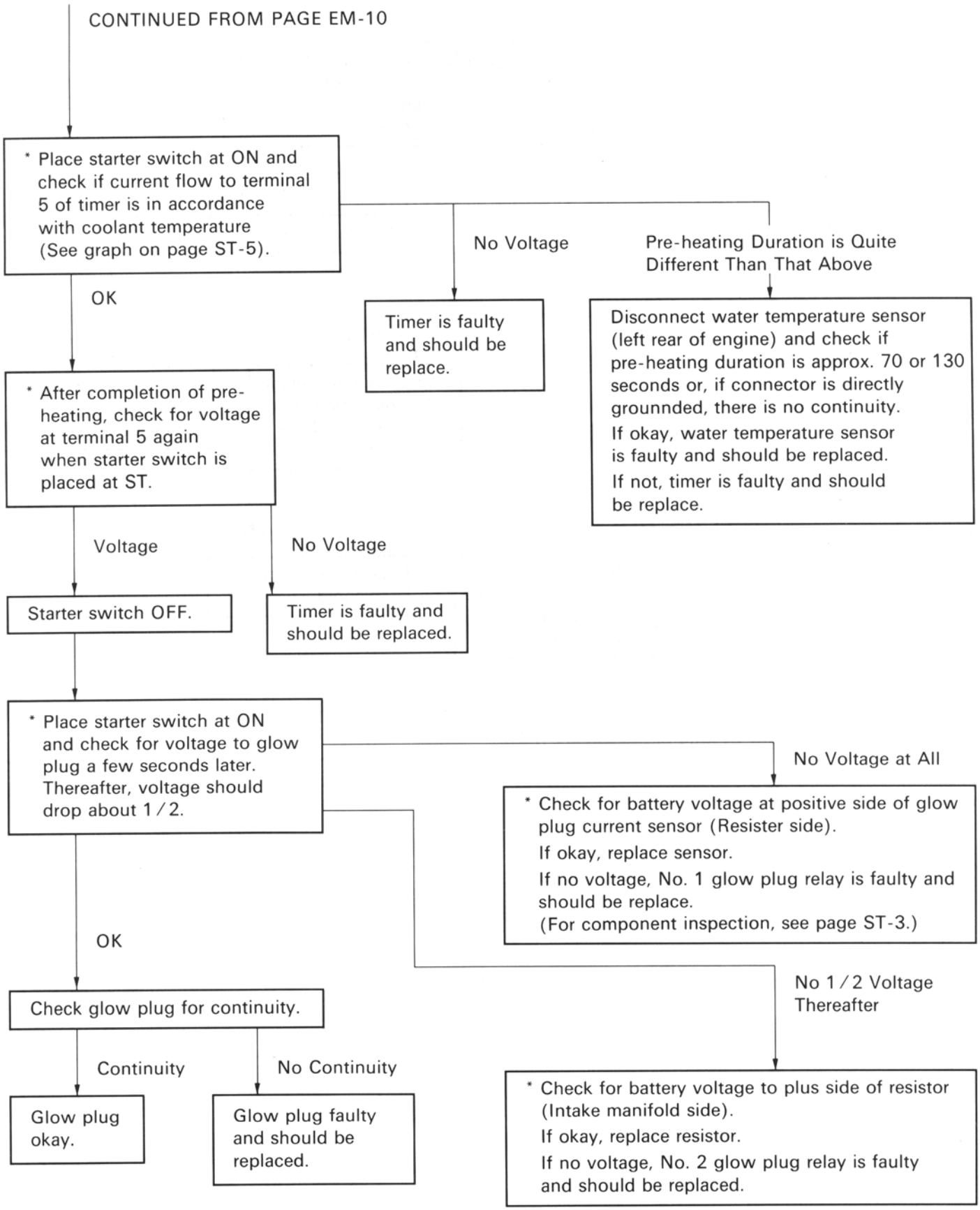
ENGINE DOES NOT START COLD

NOTE: 1. Battery voltage at least 12 volts – starter switch OFF.
2. Engine cranks normally.
3. Fusible link okay.
4. For voltage marked with an asterisk, check just as starter is turned ON because voltage changes with elapse of time.

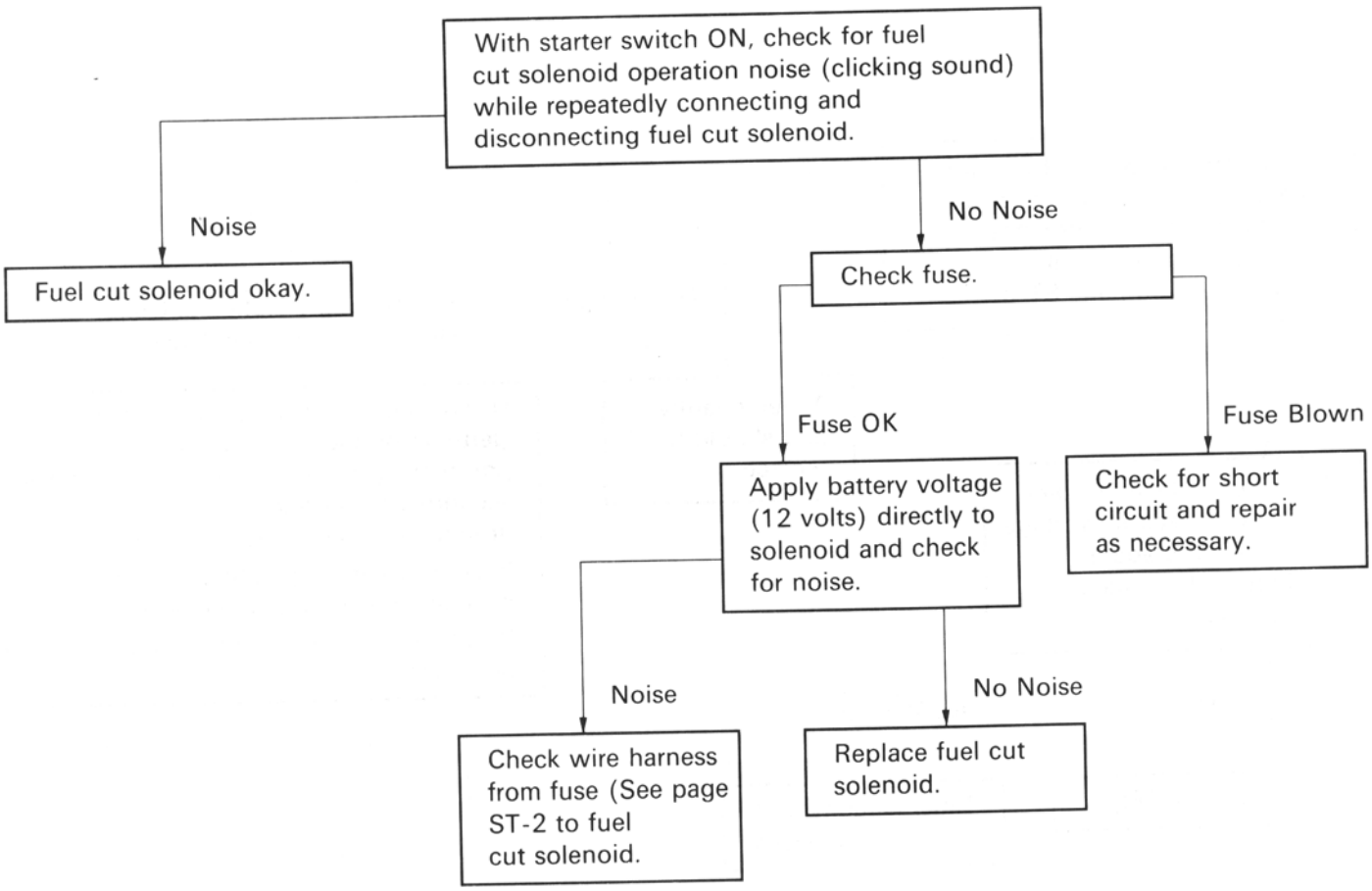
1. Super Glow System



CONTINUED FROM PAGE EM-10



2. Fuel Cut Solenoid



ENGINE TUNE-UP

INSPECTION OF ENGINE COOLANT

(See step 1 and 2 on page CO-3)

INSPECTION OF ENGINE OIL

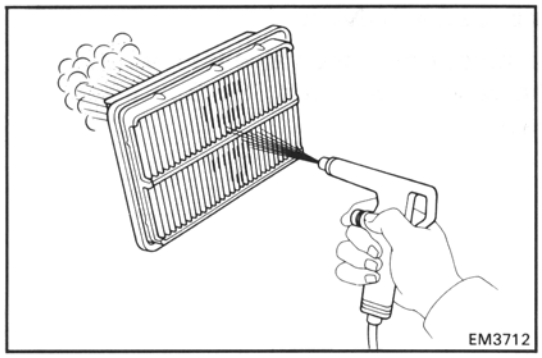
(See step 1 and 2 on page LU-3)

INSPECTION OF BATTERY

(See step 1 on page CH-3)

INSPECTION OF DRIVE BELT

(See step 14 on pages EM-35, 36)


EM3712

CLEANING OF AIR FILTER

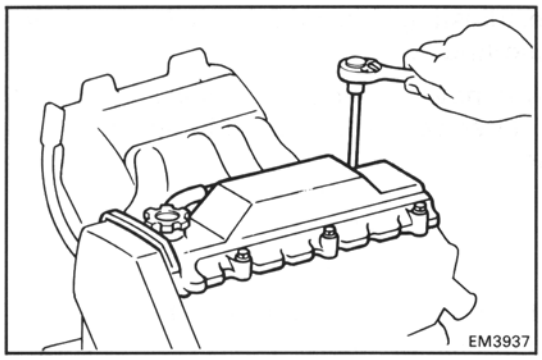
(a) Remove the air filter.
(See step 1 on page EM-41)

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

If necessary, replace the air filter element.

(c) Clean the element with compressed air.
First blow from the upper side thoroughly. Then blow off the lower side of the element.

(d) Install the air filter.
(See step 14 on page EM-59)


EM3937

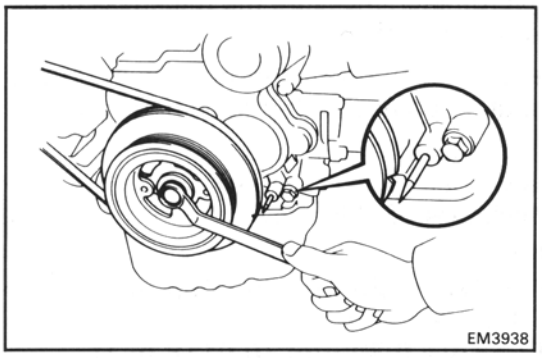
INSPECTION AND ADJUSTMENT OF VALVE CLEARANCE

NOTE: Check and adjust the valve clearance while the engine is cold.

1. REMOVE CYLINDER HEAD COVER

(a) Remove the PCV hose.

(b) Remove the eight bolts and pull out the head cover with the gasket.

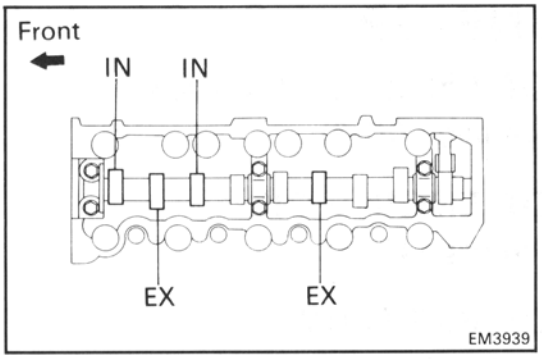

EM3938

2. MEASURE VALVE CLEARANCE

(a) Set the No.1 cylinder to TDC/compression.

- Turn the crankshaft pulley and align its groove with the timing pointer on the oil pump.
- Check that the valve lifters on the No.1 cylinder are loose and valve lifters on the No.4 are tight.

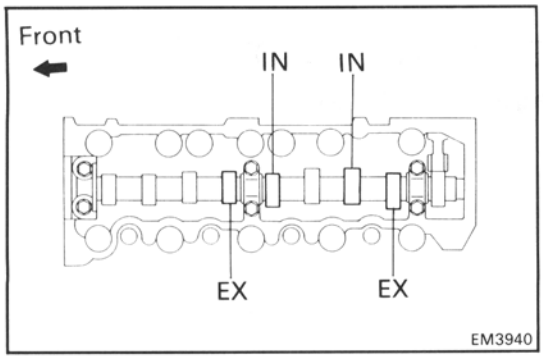
If not, turn crankshaft one complete revolution.



(b) Measure the clearance of half of the valves.

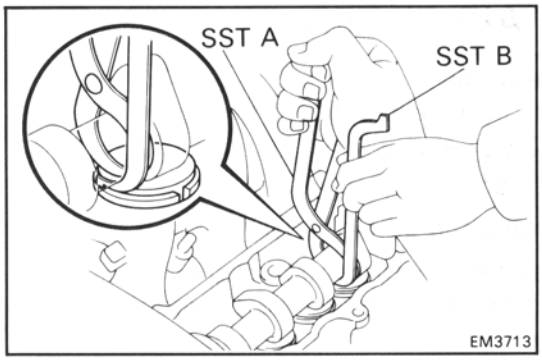
- Measure only those valves indicated in the figure.
- Record the measurements which are out of specification. They will be used later to determine the required replacement shims.

Valve clearance (Cold):
Intake 0.22 – 0.28 mm (0.009 – 0.011 in.)
Exhaust 0.27 – 0.33 mm (0.011 – 0.013 in.)



(c) Turn the crankshaft pulley one revolution (360°) and measure the other valves.

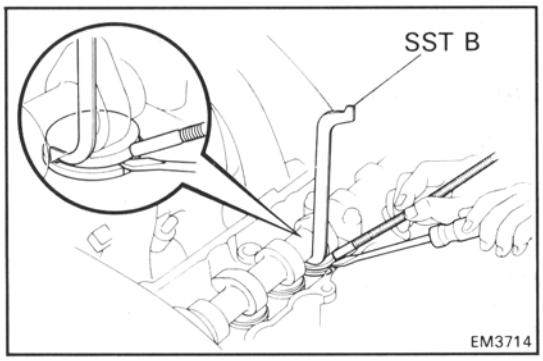
- Turn the crankshaft pulley one revolution and align its groove and timing pointer on the oil pump.
- Measure only the valves indicated in the figure.



3. ADJUST VALVE CLEARANCE

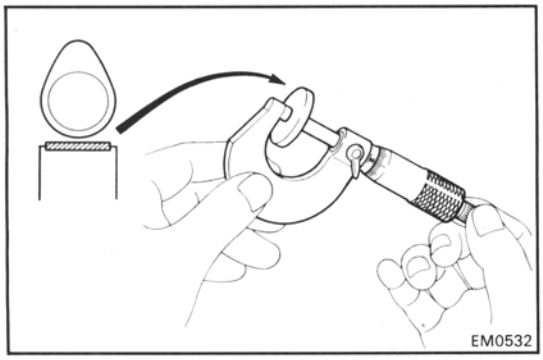
(a) Using SSTs, press down the valve lifter with SST A and hold the valve lifter down SST B.

SST 09248-55010



(b) Remove the adjusting shim with a small screwdriver and magnetic finger.

NOTE: For easy removal of the shim, when setting SST B, set it on the lifter so there is a wide space in the removal direction.



(c) Determine the replacement shim size by using the following (Formula or Chart).

- Using a micrometer, measure the thickness of the shim which was removed.
- Calculate the thickness of the new shim so the valve clearance comes within specified value.

T ..... Thickness of shim used
A ..... Valve clearance measured
N ..... Thickness of shim new

Intake side:
N = T + (A – 0.25 mm (0.0098 in.))
Exhaust side:
N = T + (A – 0.30 mm (0.0118 in.))

Intake

Measured Clearance (mm)	Installed Shim Thickness (mm)																																
	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300
0.000 – 0.025										02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24
0.026 – 0.050									02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26
0.051 – 0.075								02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26
0.076 – 0.100							02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28
0.101 – 0.125						02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28
0.126 – 0.150					02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30
0.151 – 0.175				02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30
0.176 – 0.200			02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32
0.201 – 0.219		02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32
0.220 – 0.280																																	
0.281 – 0.300	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	
0.301 – 0.325	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34		
0.326 – 0.350	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34			
0.351 – 0.375	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34				
0.376 – 0.400	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34					
0.401 – 0.425	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34						
0.426 – 0.450	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34							
0.451 – 0.475	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34								
0.476 – 0.500	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34									
0.501 – 0.525	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34										
0.526 – 0.550	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34											
0.551 – 0.575	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34												
0.576 – 0.600	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34													
0.601 – 0.625	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34														
0.626 – 0.650	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34															
0.651 – 0.675	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																
0.676 – 0.700	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																	
0.701 – 0.725	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																		
0.726 – 0.750	22	22	24	24	26	26	28	28	30	30	32	32	34	34																			
0.751 – 0.775	22	24	24	26	26	28	28	30	30	32	32	34	34																				
0.776 – 0.800	24	24	26	26	28	28	30	30	32	32	34	34																					
0.801 – 0.825	24	26	26	28	28	30	30	32	32	34	34																						
0.826 – 0.850	26	26	28	28	30	30	32	32	34	34																							
0.851 – 0.875	26	28	28	30	30	32	32	34	34																								
0.876 – 0.900	28	28	30	30	32	32	34	34																									
0.901 – 0.925	28	30	30	32	32	34	34																										
0.926 – 0.950	30	30	32	32	34	34																											
0.951 – 0.975	30	32	32	34	34																												
0.976 – 1.000	32	32	34	34																													
1.001 – 1.025	32	34	34																														
1.026 – 1.050	34	34																															
1.051 – 1.075	34																																

Intake valve clearance (cold):
0.22 – 0.28 mm (0.009 – 0.011 in.)

Example: **A 2.800 mm shim is installed and the measured clearance is 0.450 mm. Replace the 2.800 mm shim with shim No. 22 (3.000 mm).**

Shim thicknesses mm (in.)

Shim No.	Thickness	Shim No.	Thickness
02	2.500 (0.0984)	20	2.950 (0.1161)
04	2.550 (0.1004)	22	3.000 (0.1181)
06	2.600 (0.1024)	24	3.050 (0.1201)
08	2.650 (0.1043)	26	3.100 (0.1220)
10	2.700 (0.1063)	28	3.150 (0.1240)
12	2.750 (0.1083)	30	3.200 (0.1260)
14	2.800 (0.1102)	32	3.250 (0.1280)
16	2.850 (0.1122)	34	3.300 (0.1299)
18	2.900 (0.1142)		

Exhaust

Measured Clearance (mm)	Installed Shim Thickness (mm)																																
	2.500	2.525	2.550	2.575	2.600	2.625	2.650	2.675	2.700	2.725	2.750	2.775	2.800	2.825	2.850	2.875	2.900	2.925	2.950	2.975	3.000	3.025	3.050	3.075	3.100	3.125	3.150	3.175	3.200	3.225	3.250	3.275	3.300
0.000 – 0.025												02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22
0.026 – 0.050											02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24
0.051 – 0.075										02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24
0.076 – 0.100									02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26
0.101 – 0.125								02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26
0.126 – 0.150							02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28
0.151 – 0.175						02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28
0.176 – 0.200					02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30
0.201 – 0.225				02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30
0.226 – 0.250			02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32
0.251 – 0.269		02	02	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32
0.270 – 0.330																																	
0.331 – 0.325	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	
0.326 – 0.350	04	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34	
0.351 – 0.375	04	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34		
0.376 – 0.400	06	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34			
0.401 – 0.425	06	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34				
0.426 – 0.450	08	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34					
0.451 – 0.475	08	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34						
0.476 – 0.500	10	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34							
0.501 – 0.525	10	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34								
0.526 – 0.550	12	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34									
0.551 – 0.575	12	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34										
0.576 – 0.600	14	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34											
0.601 – 0.625	14	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34												
0.626 – 0.650	16	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34													
0.651 – 0.675	16	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34														
0.676 – 0.700	18	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34															
0.701 – 0.725	18	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																
0.726 – 0.750	20	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																	
0.751 – 0.775	20	22	22	24	24	26	26	28	28	30	30	32	32	34	34																		
0.776 – 0.800	22	22	24	24	26	26	28	28	30	30	32	32	34	34																			
0.801 – 0.825	22	24	24	26	26	28	28	30	30	32	32	34	34																				
0.826 – 0.850	24	24	26	26	28	28	30	30	32	32	34	34																					
0.851 – 0.875	24	26	26	28	28	30	30	32	32	34	34																						
0.876 – 0.900	26	26	28	28	30	30	32	32	34	34																							
0.901 – 0.925	26	28	28	30	30	32	32	34	34																								
0.926 – 0.950	28	28	30	30	32	32	34	34																									
0.951 – 0.975	28	30	30	32	32	34	34																										
0.976 – 1.000	30	30	32	32	34	34																											
1.001 – 1.025	30	32	32	34	34																												
1.026 – 1.050	32	32	34	34																													
1.051 – 1.075	32	34	34																														
1.076 – 1.100	34	34																															
1.101 – 1.125	34																																

Shim thicknesses mm (in.)

Shim No.	Thickness	Shim No.	Thickness
02	2.500 (0.0984)	20	2.950 (0.1161)
04	2.550 (0.1004)	22	3.000 (0.1181)
06	2.600 (0.1024)	24	3.050 (0.1201)
08	2.650 (0.1043)	26	3.100 (0.1220)
10	2.700 (0.1063)	28	3.150 (0.1240)
12	2.750 (0.1083)	30	3.200 (0.1260)
14	2.800 (0.1102)	32	3.250 (0.1280)
16	2.850 (0.1122)	34	3.300 (0.1299)
18	2.900 (0.1142)		

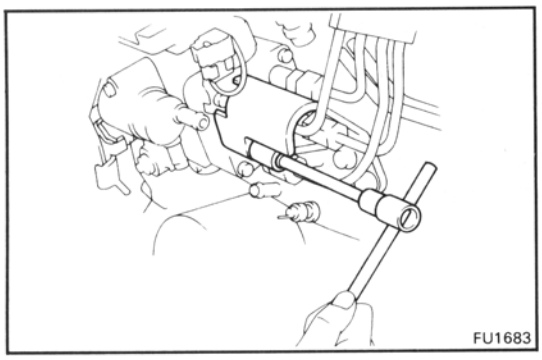
Exhaust valve clearance (cold):
0.27 – 0.33 mm (0.011 – 0.013 in.)

Example: **A 2.800 mm shim is installed and the measured clearance is 0.450 mm. Replace the 2.800 mm shim with shim No. 20 (2.950 mm).**

(d) Recheck the valve clearance.

(e) Adjust the valve clearance of the remaining cylinders as required.

4. **INSTALL CYLINDER HEAD COVER**
(See step 13 on page EM-63)

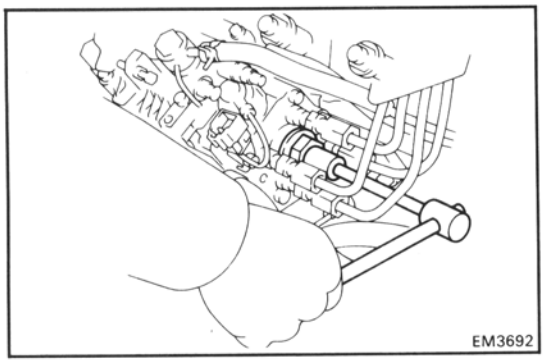

FU1683

INSPECTION AND ADJUSTMENT OF INJECTION TIMING

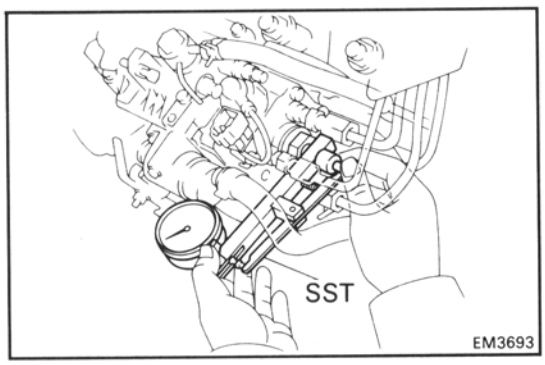
1. REMOVE ENGINE UNDER COVER

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

(a) Remove the bolt and injection pump protector.


EM3692

(b) Remove the distributive head plug bolt and gasket from the injection pump.



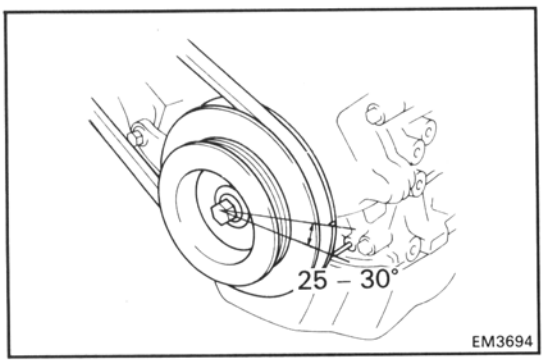
EM3693

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

SST 09275-54010

3. SET NO. 1 OR NO. 4 CYLINDER TO ABOUT 25 – 30° BTDC/COMPRESSION

Turn the crankshaft pulley clockwise so the pulley groove is 25 – 30° from the oil pump pointer.

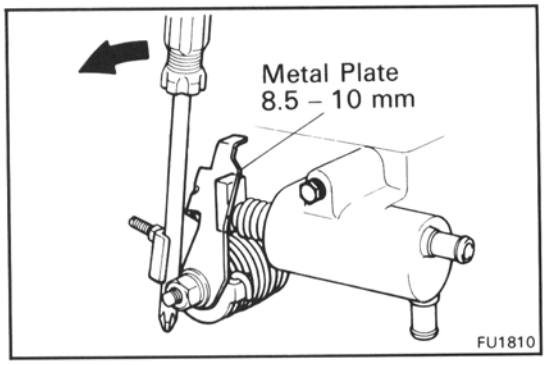


EM3694

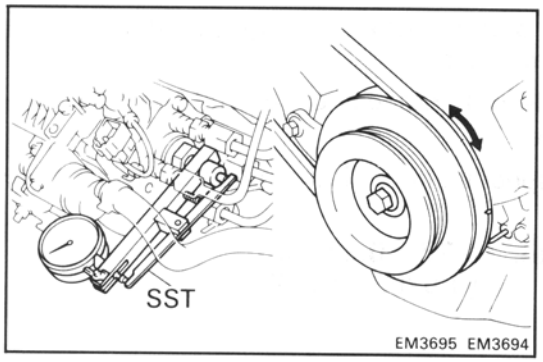
4. RELEASE COLD STARTING SYSTEM

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

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



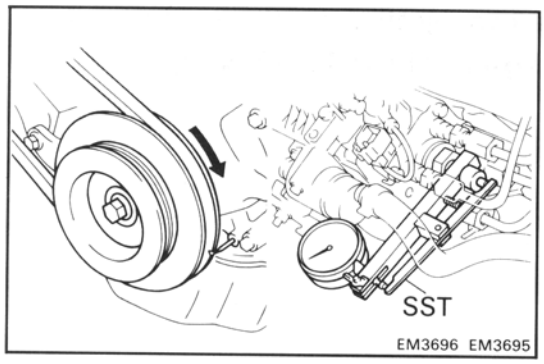
FU1810



5. CHECK INJECTION TIMING

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

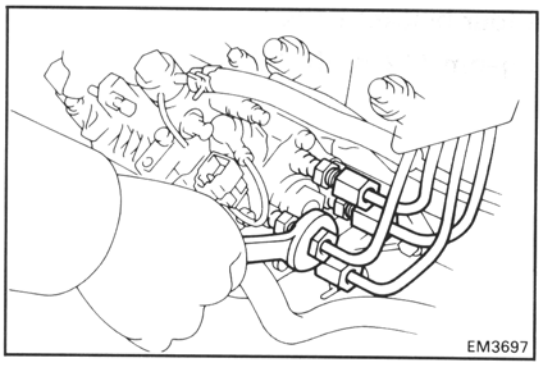
(b) Recheck to see that the dial indicator remains at 0 mm (0 in.) while rotating the crankshaft pulley slightly to the left and right.



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

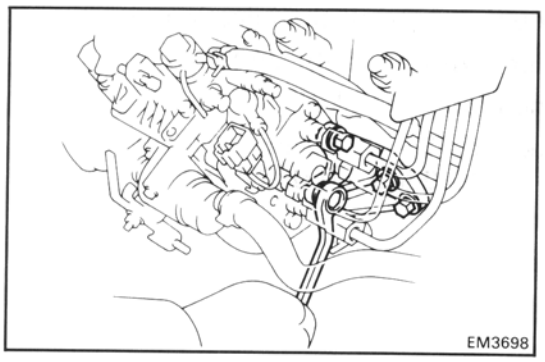
(d) Measure the plunger stroke.

Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)

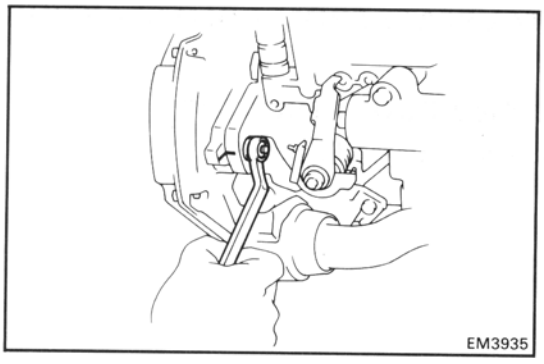


6. ADJUST INJECTION TIMING

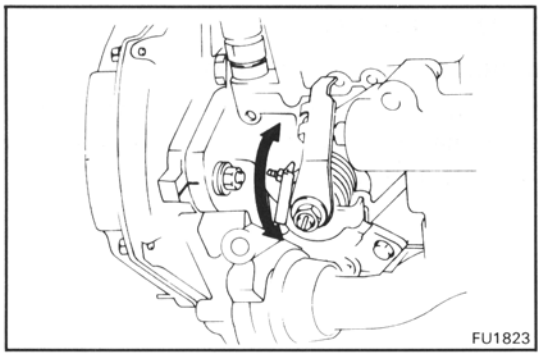
(a) Loosen the four injection pipe union nuts on the pump side.



(b) Loosen the four bracket bolts.



(c) Loosen the two injection pump mounting nuts.

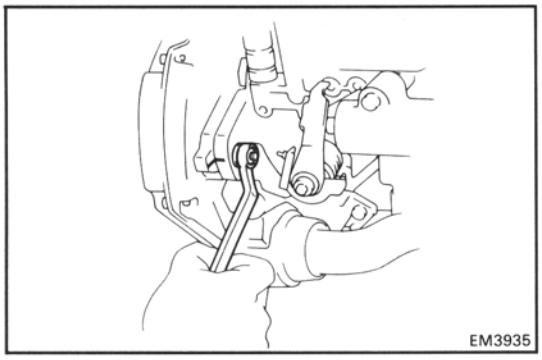

FU1823

(d) Adjust the plunger stroke be slightly tilting the injection pump body.

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

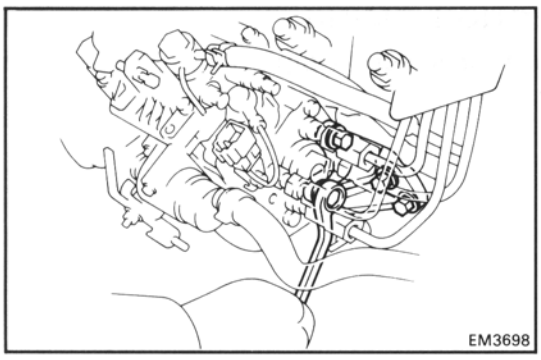
If greater than specification, tilt the pump away from the engine.

Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)


EM3935

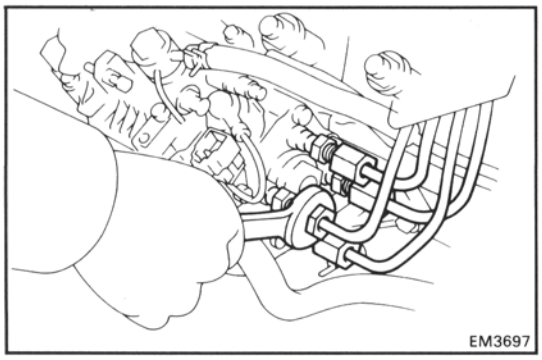
(e) Tighten the two injection pump mounting nuts.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)


EM3698

(f) Tighten the four bracket bolts.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)


EM3697

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

Torque: 300 kg-cm (22 ft-lb, 29 N·m)

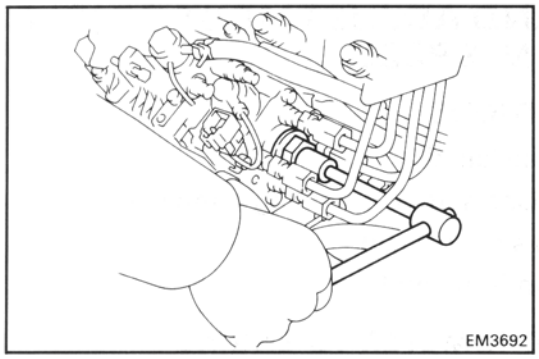
(h) Recheck the plunger stroke.

Plunger stroke: 0.77 – 0.83 mm (0.0303 – 0.0327 in.)

7. REMOVE METAL PLATE FROM COLD STARTING LEVER

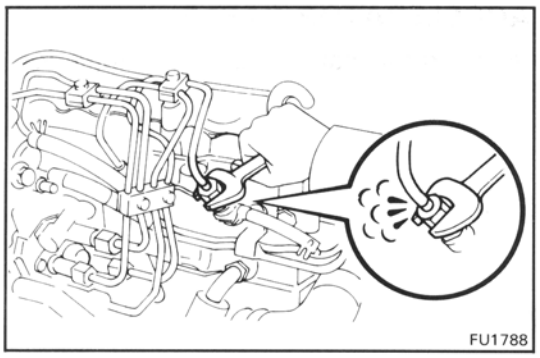
8. REMOVE SST AND DIAL INDICATOR

(a) Remove SST and dial indicator.



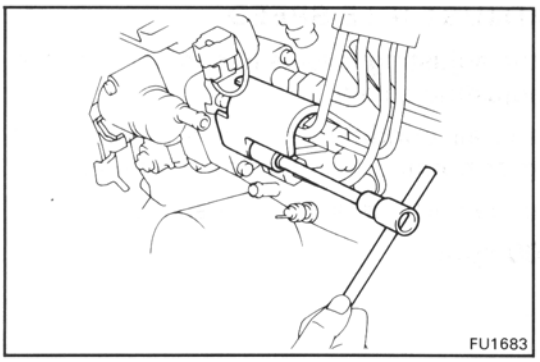
(b) Install the distributive head plug bolt with a new gasket. Torque the bolt.

Torque: 170 kg-cm (12 ft-lb, 17 N·m)



9. BLEED AIR FROM FUEL LINE

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



10. INSTALL INJECTION PUMP PROTECTOR

11. START ENGINE AND CHECK FOR LEAKS

12. INSTALL ENGINE UNDER COVER

INSPECTION AND ADJUSTMENT OF IDLE AND MAXIMUM SPEED

1. INITIAL CONDITIONS:

(a) Air cleaner installed

(b) Engine coolant normal operating temperature

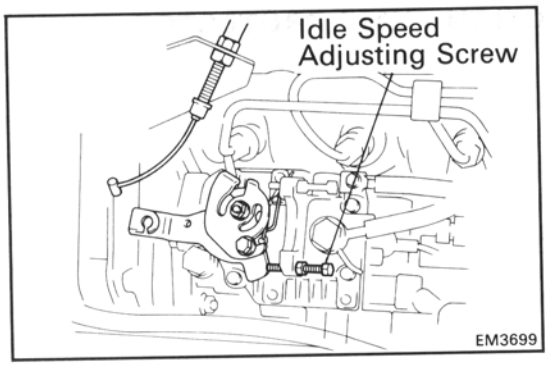
(c) Accessories switched off

(d) Transmission in neutral

2. CONNECT TACHOMETER TO ENGINE

3. DISCONNECT ACCELERATOR CABLE

Disconnect the accelerator cable from the injection pump.



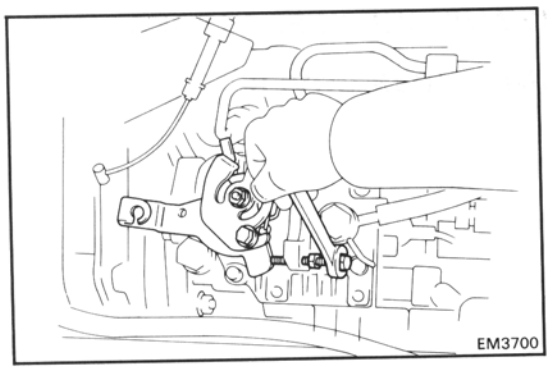
4. CHECK AND ADJUST IDLE SPEED

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

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

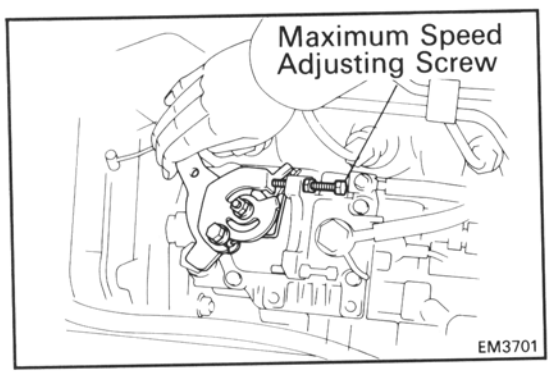
(b) Start the engine and check the idle speed.

Idle speed: 700 rpm



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

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

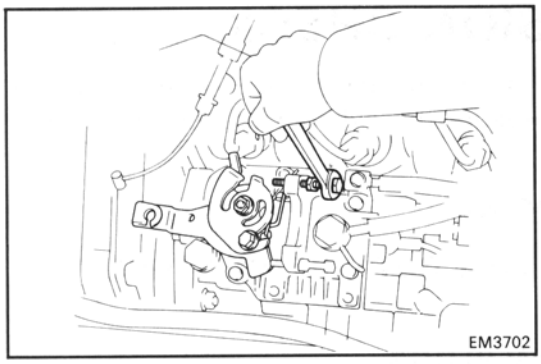


5. CHECK AND ADJUST MAXIMUM SPEED

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

Maximum speed: 5,800 rpm

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



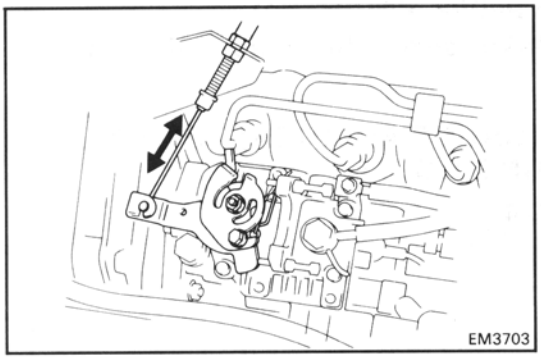
(b) Remove the maximum adjusting screw wire.

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

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

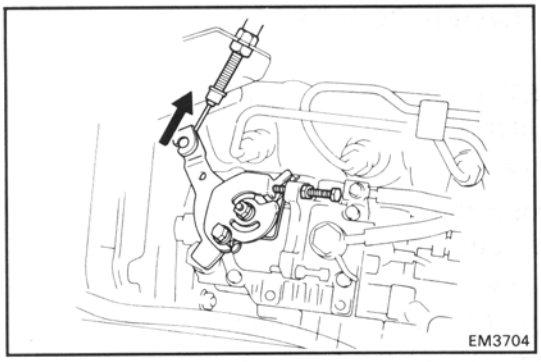
(d) Securely tighten the lock nut and recheck the maximum speed.

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



6. CONNECT ACCELERATOR CABLE

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

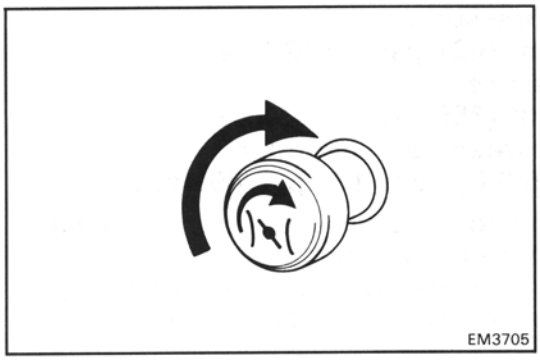


(b) Inspect to see that the adjusting lever is stopped by the maximum speed adjusting screw when the accelerator pedal is depressed all the way.

7. DISCONNECT TACHOMETER

INSPECTION AND ADJUSTMENT OF IDLE-UP SPEED

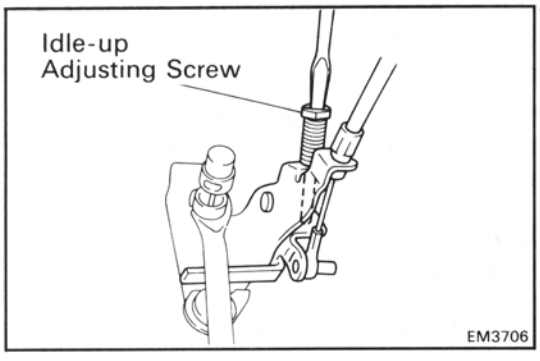
1. CHECK AND ADJUST IDLE-UP SPEED



(a) Turn the idle adjust knob to clockwise fully.

(b) Check the idle-up speed.

Idle-up speed: 1,300 rpm

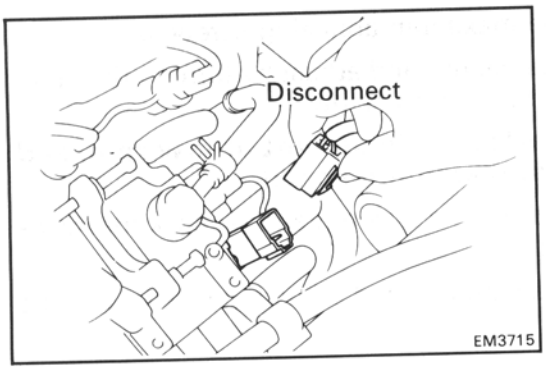


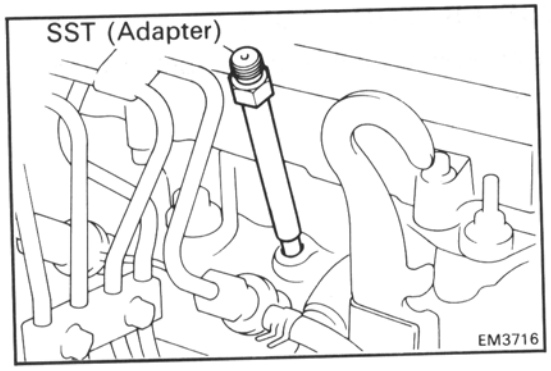
If not specification, turn the adjusting screw.

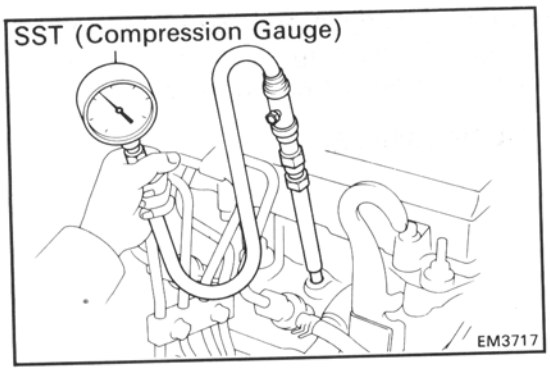
Idle-up speed: 1,300 rpm

NOTE: The adjusting screw is located above the acceleration pedal.

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 GLOW PLUGS**
   (See step 8 on pages EM-42, 43)
   CAUTION: Make sure the load wire is not grounded.

4. **INSTALL SST (GAUGE ADAPTER) TO GLOW PLUG MOUNTING HOLE**
   SST 09992-00024

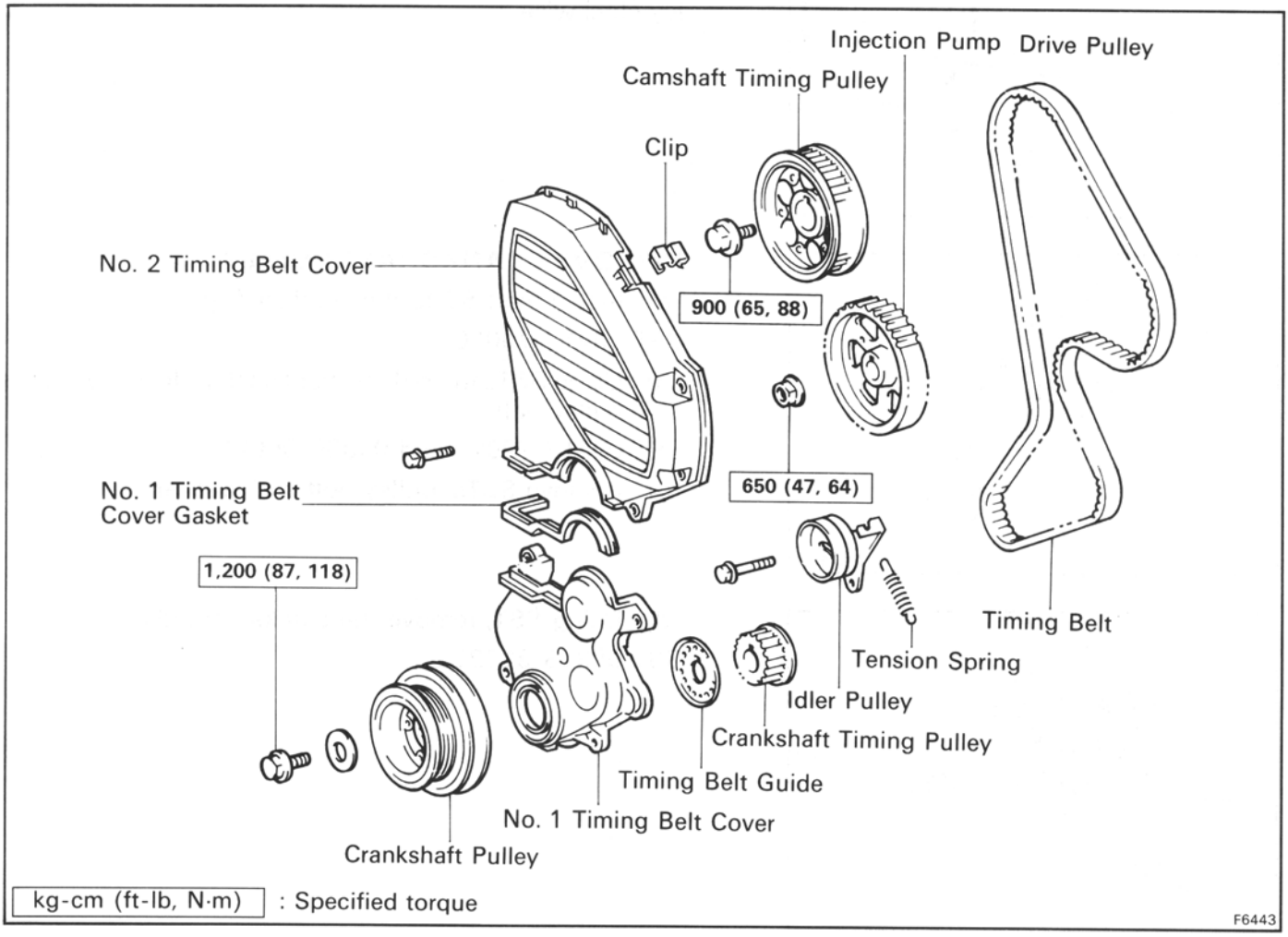
5. **MEASURE CYLINDER COMPRESSION PRESSURE**
   (a) Connect SST (compression gauge) to the SST (gauge adapter).
   SST 09992-00024
   (b) While cranking the engine with the starter motor, measure the compression.
   NOTE: A fully charged battery is necessary to obtain engine revolution of more than 250 rpm.
   (c) Repeat steps (a) and (b) for each cylinder.
   Compression pressure:
   30.0 kg/cm² (427 psi, 2,942 kPa)
   Minimum pressure:
   25.0 kg/cm² (356 psi, 2,452 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.

6. **INSTALL GLOW PLUGS**
   (See step 7 on page EM-57)

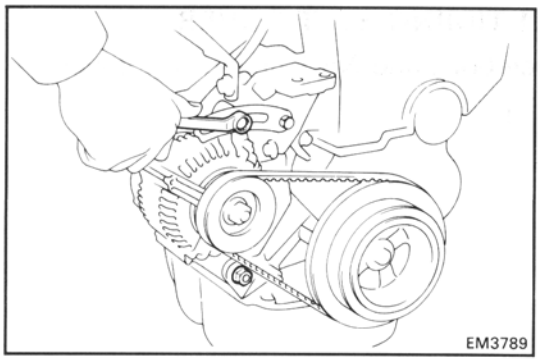
7. **CONNECT FUEL CUT SOLENOID WIRE CONNECTOR**

TIMING BELT

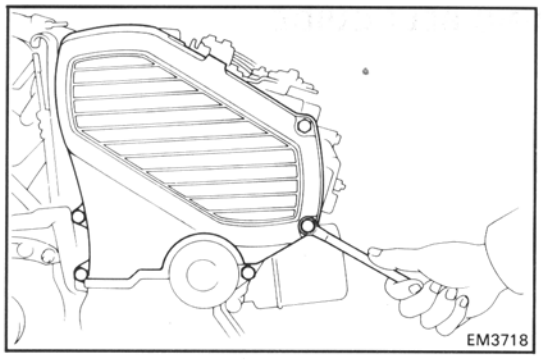
COMPONENTS



REMOVAL OF TIMING BELT



1. REMOVE DRIVE BELT



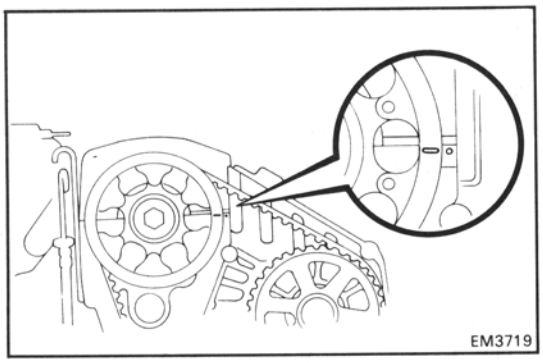
2. REMOVE NO.2 TIMING BELT COVER

Remove the clip, five bolts and the No.2 timing belt cover with the gasket.

3. REMOVE GLOW PLUGS

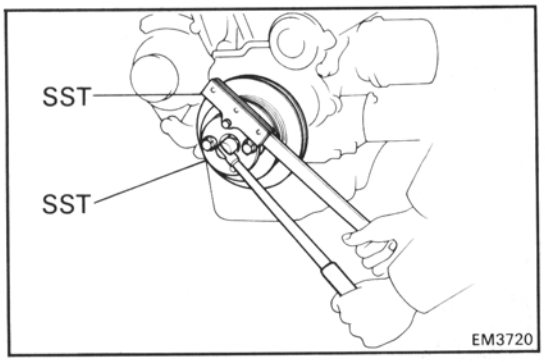
(See step 8 on pages EM-42, 43)

NOTE: It is necessary to remove the glow plugs so that the crankshaft will turn smoothly and enable the belt to be adjusted properly.



4. SET NO.1 CYLINDER AT TDC/COMPRESSION

Align the line mark of the camshaft timing pulley with the cavity of the cylinder head by turning the crankshaft pulley clockwise.



5. REMOVE CRANKSHAFT PULLEY

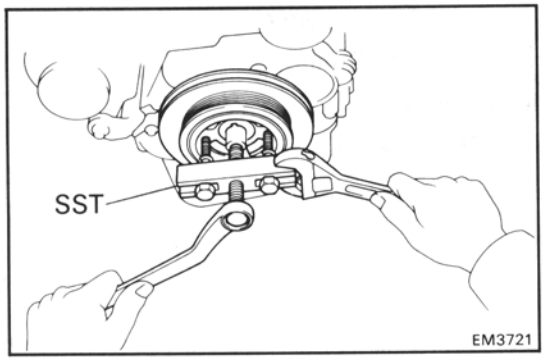
(a) Install the SST to the crankshaft pulley.

SST 09213-70010

(b) Using SSTs to hold the crankshaft pulley, loosen the pulley bolt.

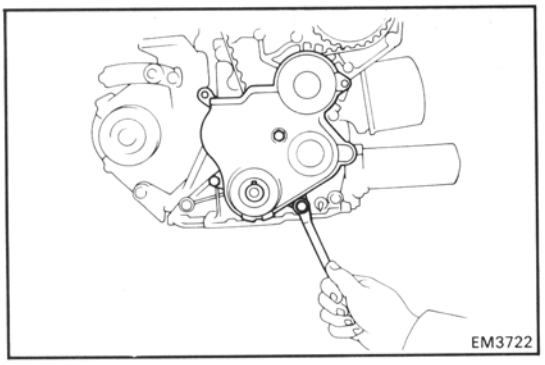
SST 09213-70010 and 09330-00021

(c) Remove SSTs, pulley bolt and washer.



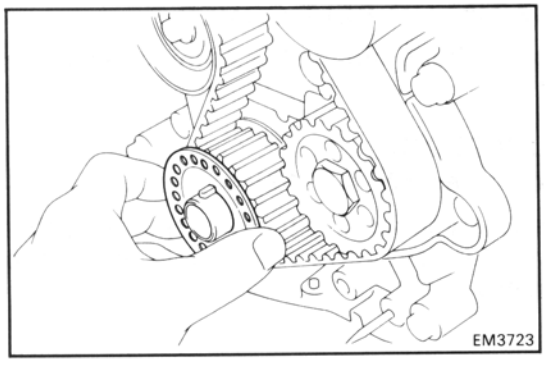
(d) Using SST, remove the crankshaft pulley.

SST 09213-31021

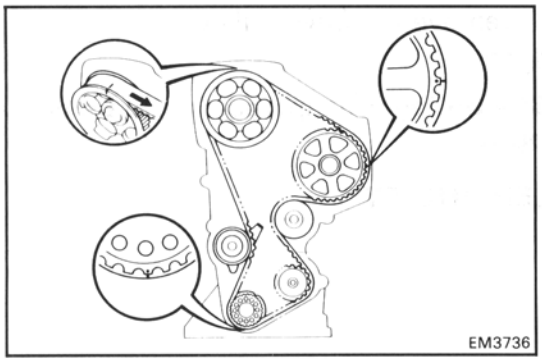


6. REMOVE NO.1 TIMING BELT COVER

Remove the three bolts and No.1 timing belt cover.

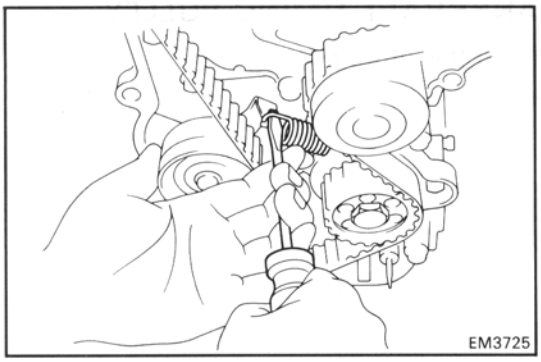


7. REMOVE TIMING BELT GUIDE



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.

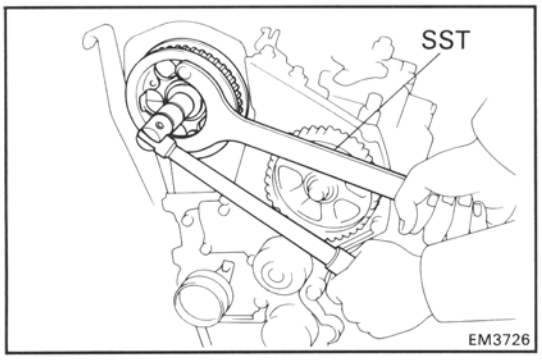


(a) Using a screwdriver, remove the tension spring.

CAUTION: Do not pinch the tension spring with pliers or such.

(b) Loosen the idler pulley bolt.

(c) Remove the timing belt from each pulley.

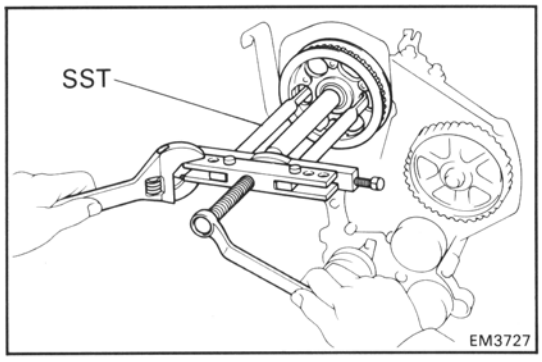


9. REMOVE CAMSHAFT TIMING PULLEY

(a) Using SST to hold the timing pulley, remove the pulley bolt.

SST 09278-54012

CAUTION: Avoid turning the camshaft or the valves will hit against the pistons.

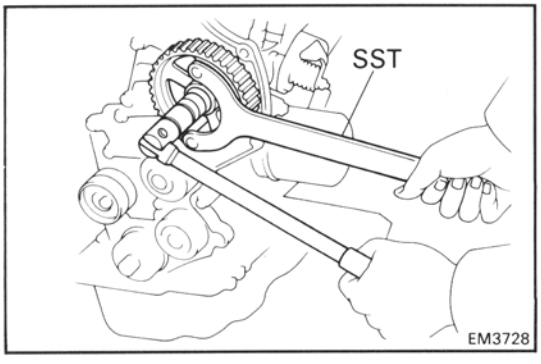


(b) Using SST, remove the timing pulley.

SST 09950-20016

CAUTION: The pulley will spring out so be careful not let if fall.

(c) Remove the woodruff key from the camshaft.

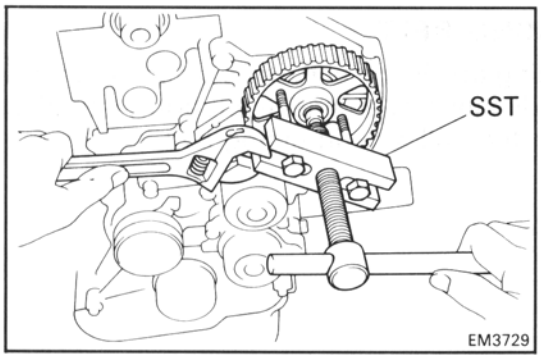


10. REMOVE INJECTION PUMP DRIVE PULLEY

(a) Using SST to hold the drive pulley, remove the pulley nut.

SST 09278-54012

CAUTION: Do not use an impact wrench.

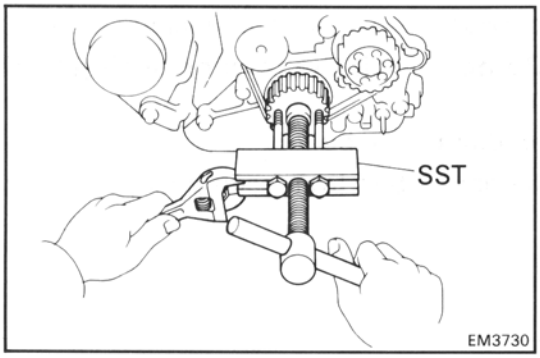


(b) Using SST, remove the drive pulley.

SST 09213-60017

CAUTION: The pulley will spring out so be careful not to drop it.

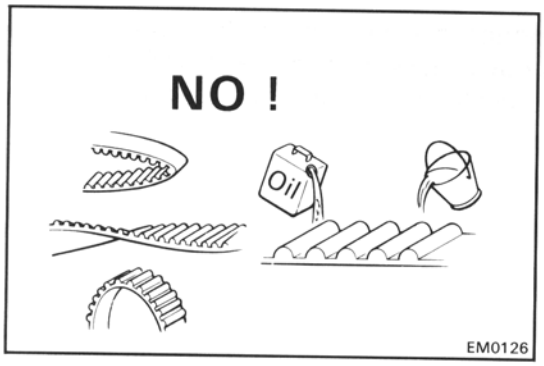
11. REMOVE IDLER PULLEY



12. REMOVE CRANKSHAFT TIMING PULLEY

Using SST, remove the timing pulley.

SST 09213-60017



INSPECTION OF COMPONENTS

1. INSPECT TIMING BELT

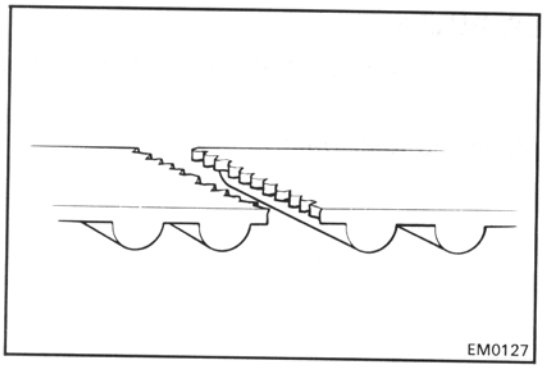
CAUTION:

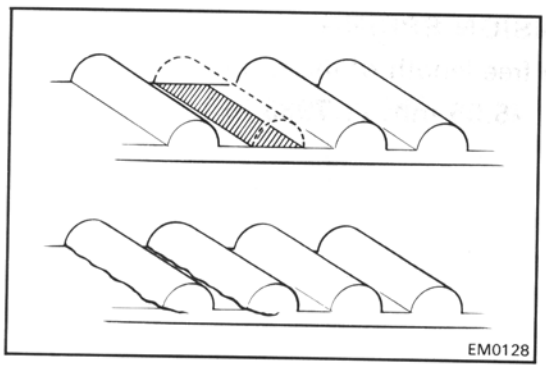
- **Do not bend, twist or turn the belt inside out.**
- **Do not allow the belt to come into contact with oil, water or steam.**
- **Do not utilize belt tension when installing or removing the set bolt of the camshaft timing pulley.**

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

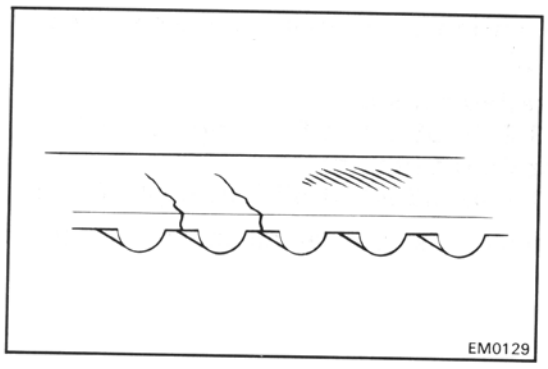
(a) Premature parting

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

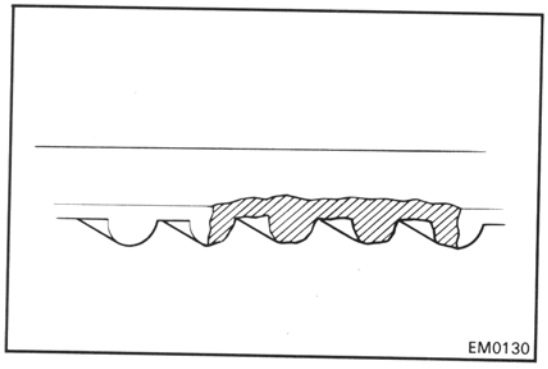




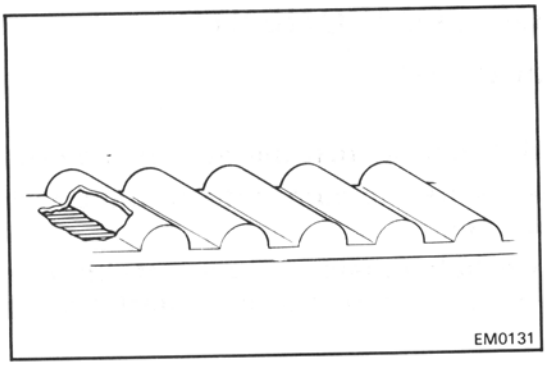
(b) If the belt teeth are cracked or damaged, check to see if the camshaft, water pump or oil pump is locked.



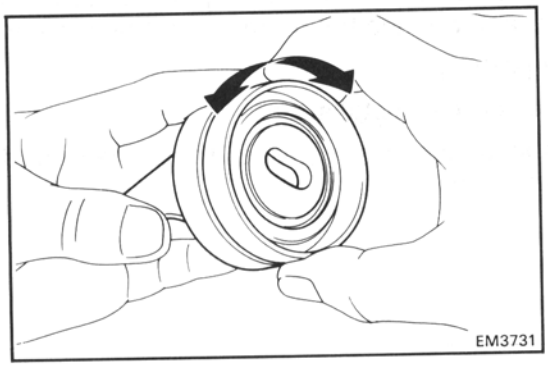
(c) If there is noticeable wear or cracks of the belt face, check to see if there are nicks on one side of the idler pulley lock.



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



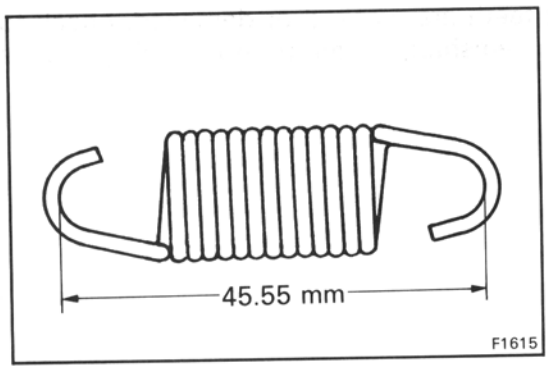
(e) If there is noticeable wear on the belt theeth, check the timing cover gasket for damage and proper installation. Check for foreign material on the pulley teeth.



2. INSPECT IDLER PULLEY

Check the turning smoothness of the timing belt idler pulley.

If necessary, replace the idler pulley.



3. INSPECT TENSION SPRING

(a) Check the free length of the spring.

Free length: 45.55 mm (1.7933 in.)

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

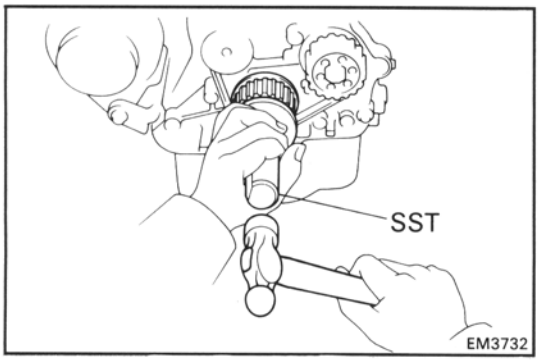
Standard installed tension:
6.0 kg (13.2 lb, 59 N) at 52.7 mm (2.07 in.)
Minimum installed tension:
5.4 kg (11.9 lb, 53 N) at 52.7 mm (2.07 in.)

If the installed tension is less than minimum, replace the tension spring.

INSTALLATION OF TIMING BELT

(See page EM-25)

NOTE: Remove any oil or water on the timing pulleys and keep it clean.

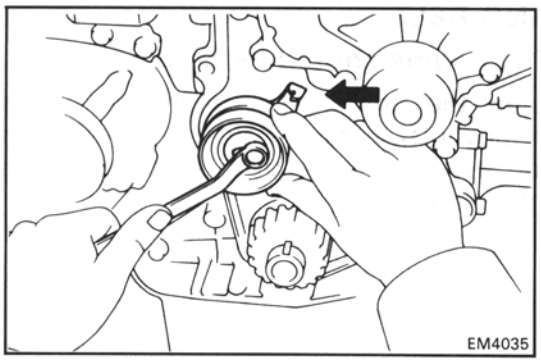


1. INSTALL CRANKSHAFT TIMING PULLEY

(a) Align the woodruff key groove of the timing pulley with the woodruff key on the crankshaft.

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

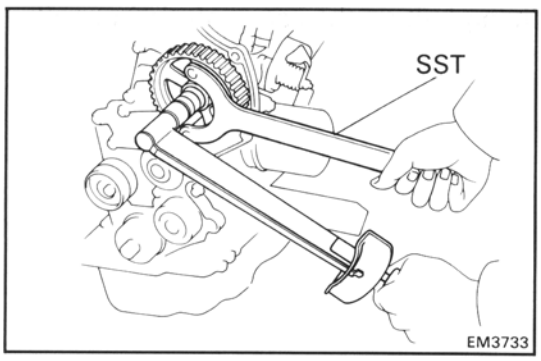
SST 09214-60010



2. INSTALL IDLER PULLEY

(a) Install the idler pulley.

(b) Pry the idler pulley toward the left as far as it will go and temporarily tighten it.



3. INSTALL INJECTION PUMP DRIVE PULLEY

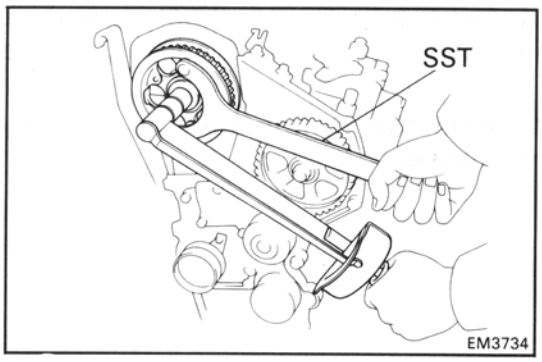
(a) Align the woodruff key groove of the drive pulley with the woodruff key on the drive shaft.

(b) Using SST to hold the drive pulley, install and torque the pulley nut.

SST 09278-54012

Torque: 650 kg-cm (47 ft-lb, 64 N·m)

CAUTION: Do not use an impact wrench.



4. INSTALL CAMSHAFT TIMING PULLEY

(a) Install the woodruff key to the groove of the camshaft.

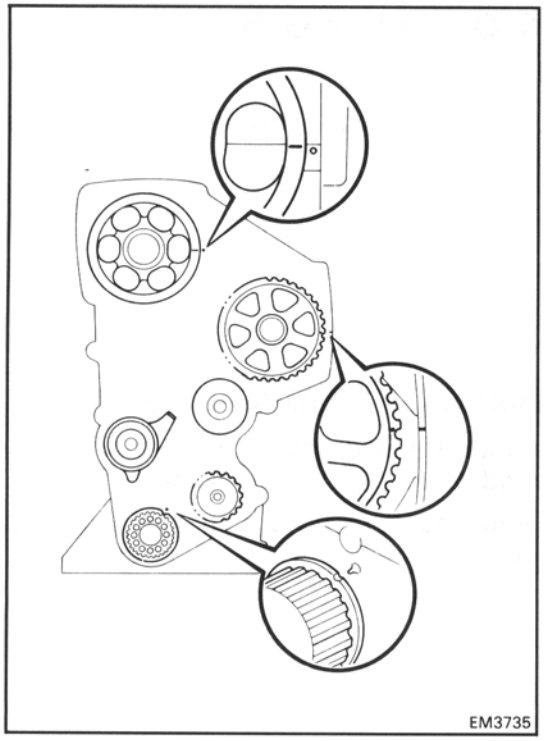
(b) Align the woodruff key groove of the timing pulley with the woodruff key on the camshaft.

(c) Using SST to hold the timing pulley, install and torque the pulley bolt.

SST 09278-54012

Torque: 900 kg-cm (65 ft-lb, 88 N·m)

CAUTION: Avoid turning the camshaft or the valves will hit against the pistons.


EM3735

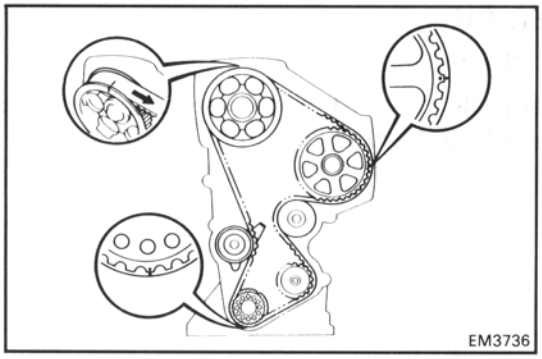
5. SET TIMING AND DRIVE PULLEYS

(a) Align the line mark of the camshaft timing pulley with the cavity of the cylinder head.

(b) Align the grooves of the crankshaft timing pulley with the protrusion mark on the oil pump.

CAUTION: When turning the crankshaft or camshaft, the valves will hit against the pistons so do not turn them more than necessary.

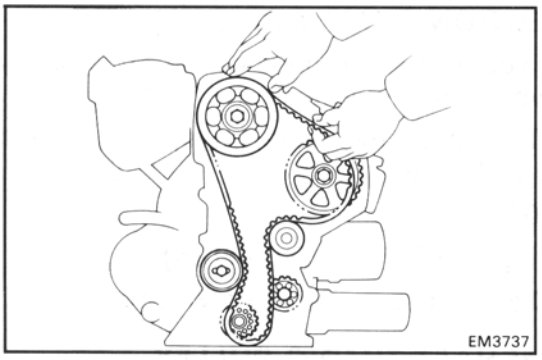
(c) Align the cavity of the injection pump drive pulley with the line mark on the water pump.


EM3736

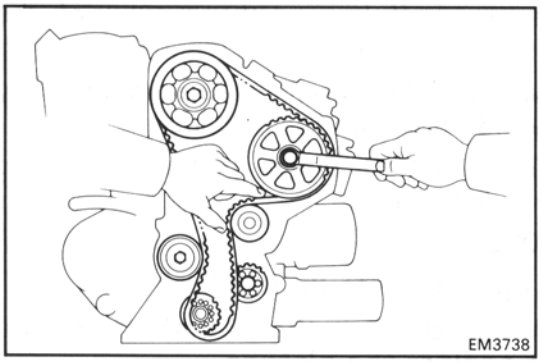
6. INSTALL TIMING BELT

CAUTION: The engine should be cold.

NOTE: If reusing the timing belt, align the points marked during removal (See step 8 on page EM-27) and install the timing belt with the arrow pointing in the direction of engine revolution.

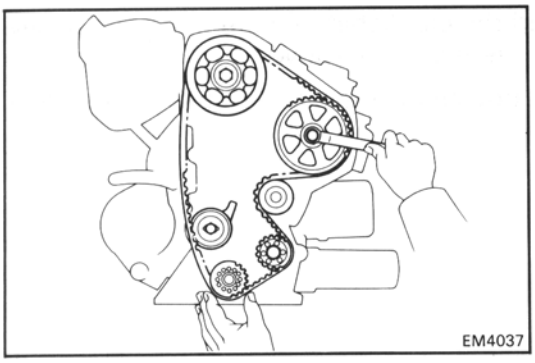

EM3737

(a) Place the timing belt on the camshaft timing pulley.


EM3738

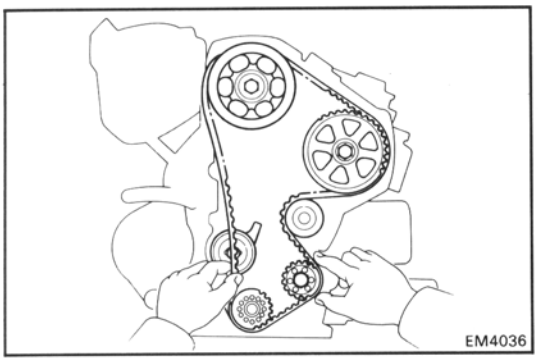
(b) Place the timing belt to the injection pump drive pulley while holding the pulley stationary with a wrench.

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


EM4037

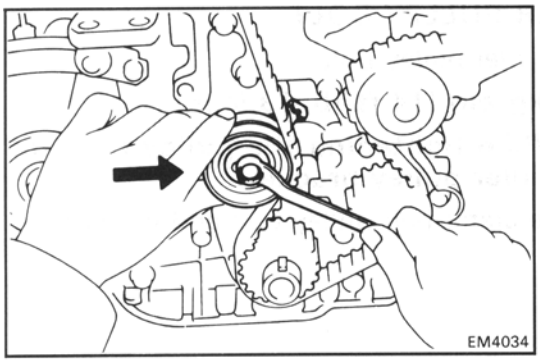
(c) Place the timing belt to the water pump pulley, oil pump drive pulley and crankshaft timing pulley.

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

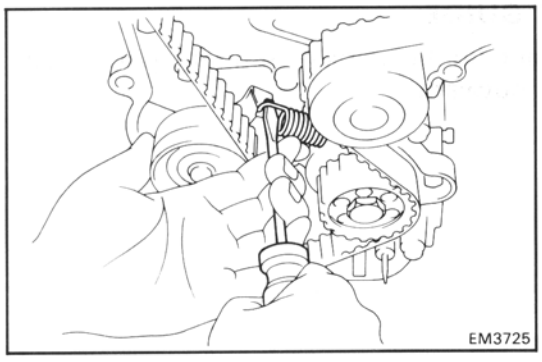

EM4036

(d) Place the timing belt to the idler pulley.

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


EM4034

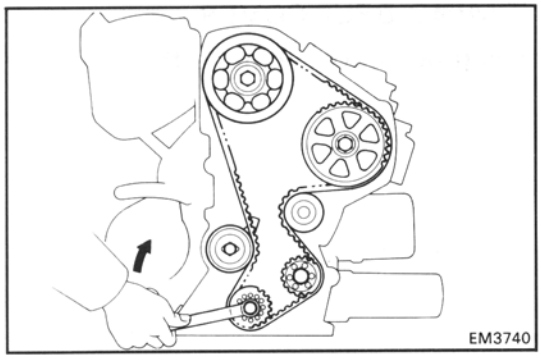
(e) Pry the idler pulley toward the right far as it will go and temporarily tighten it.


EM3725

(f) Using a screwdriver, install the tension spring.

CAUTION: Do not pinch the tension spring with pliers or such.

(g) Loosen the idler pulley bolt to where the idle pulley lightly moves with tension spring force.


EM3740

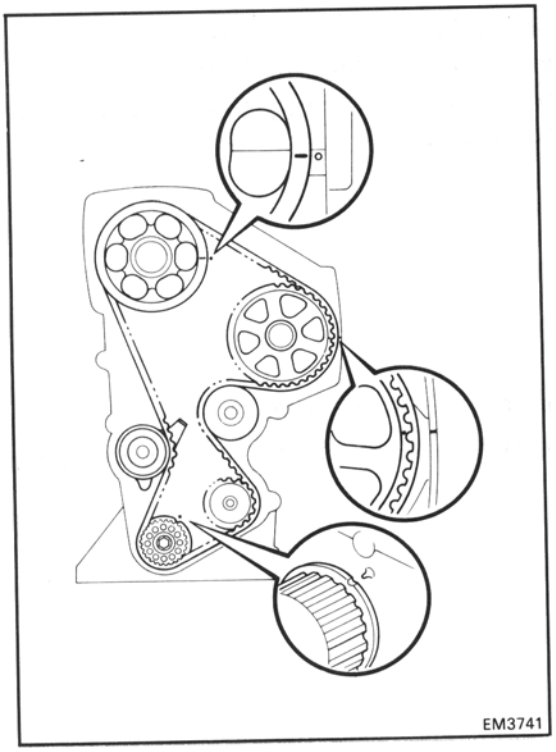
7. CHECK VALVE TIMING

(a) Temporarily install the crankshaft pulley bolt.

(b) Turn the crankshaft two revolutions to where the line mark of the camshaft pulley and the cavity of the cylinder head are again aligned.

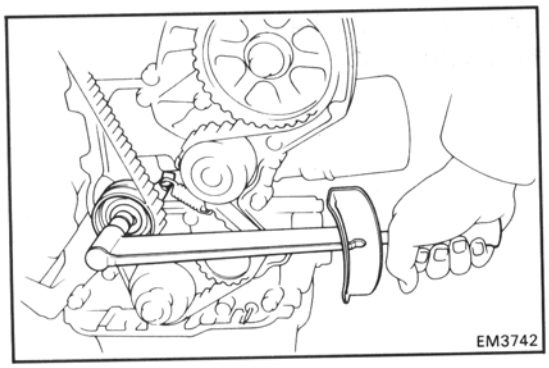
CAUTION: Always turn the crankshaft clockwise.

If turned counter clockwise, there is possibility of the belt teeth becoming unmeshed and the best tension changing.



(c) After turning the crankshaft, insure that each pulley aligns with the marks as shown.

If the marks do not align, repeat the above procedure from step 6.



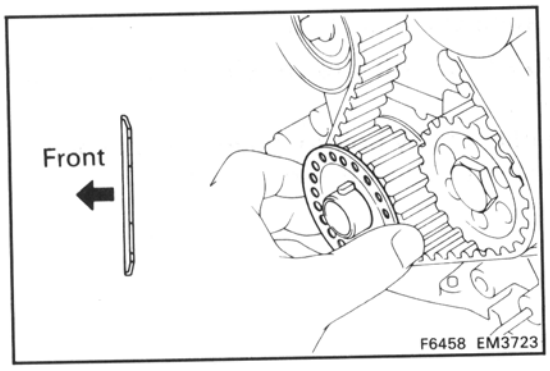
8. TORQUE IDLER PULLEY BOLT

(a) Torque the idler pulley bolt.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

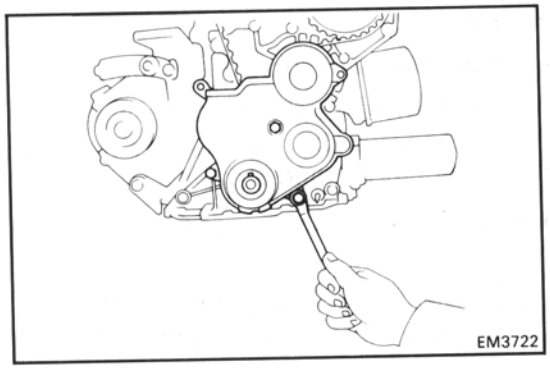
CAUTION: While tightening the pulley bolt, do not move the idler pulley bracket.

(b) Remove the crankshaft pulley bolt and washer.



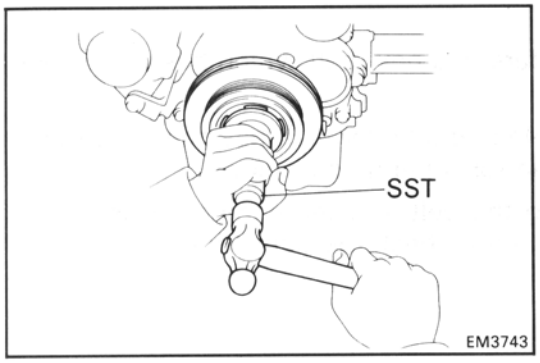
9. INSTALL BELT GUIDE

Place the belt guide on the crankshaft timing pulley, facing the cup side outward.



10. INSTALL NO.1 TIMING BELT COVER

Install the No.1 timing belt cover with the three bolts.

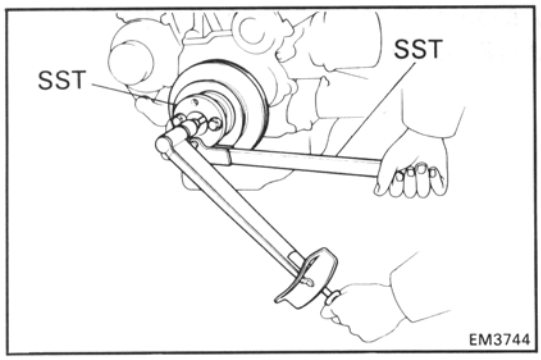


11. INSTALL CRANKSHAFT PULLEY

(a) Align the woodruff key groove of the crankshaft pulley with the woodruff key on the crankshaft.

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

SST 09223-46011



(c) Install the washer, pulley bolt and SST to the crankshaft pulley.

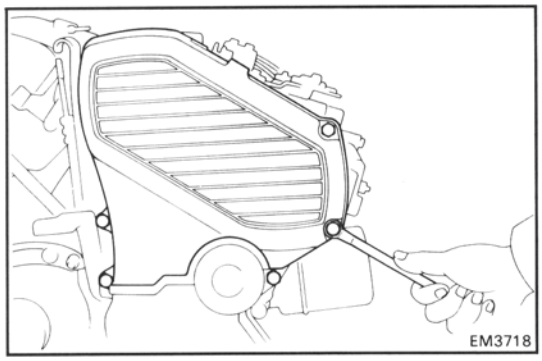
SST 09212-70010

(d) Using SST to hold the crankshaft pulley, torque the pulley bolt.

SST 09212-70010 and 09330-00021

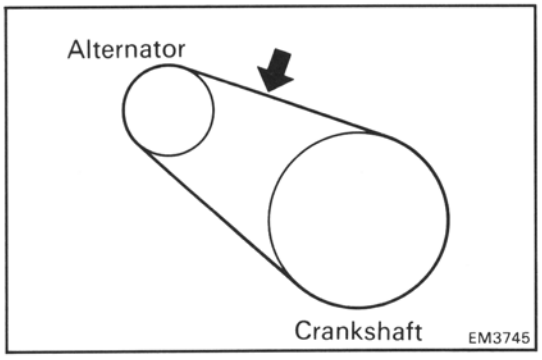
Torque: 1,200 kg-cm (87 ft-lb, 118 N·m)

12. INSTALL GLOW PLUGS
(See step 7 on page EM-57)



13. INSTALL NO.2 TIMING BELT COVER

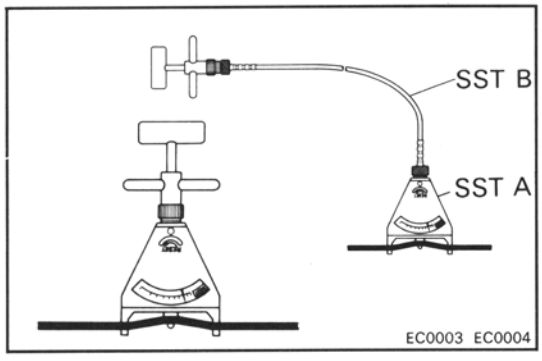
Install the No.2 timing belt cover and gasket with the clip and five bolts.



14. INSTALL AND ADJUST DRIVE BELT

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

New belt 6 – 7 mm (0.24 – 0.28 in.)
Used belt 8 – 11 mm (0.32 – 0.43 in.)

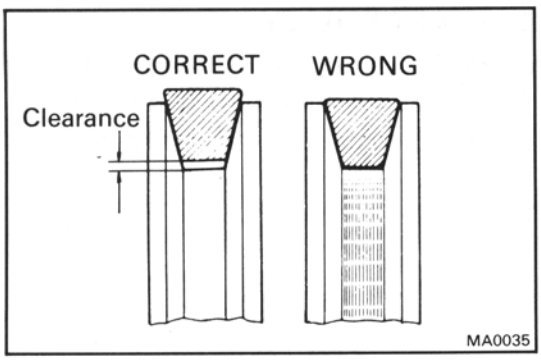


(Reference)

Using SST, check the drive belt tension.

SST A 09216-00020
SST B 09216-00030

Drive belt tension: New belt 45 – 55 kg
Used belt 20 – 35 kg

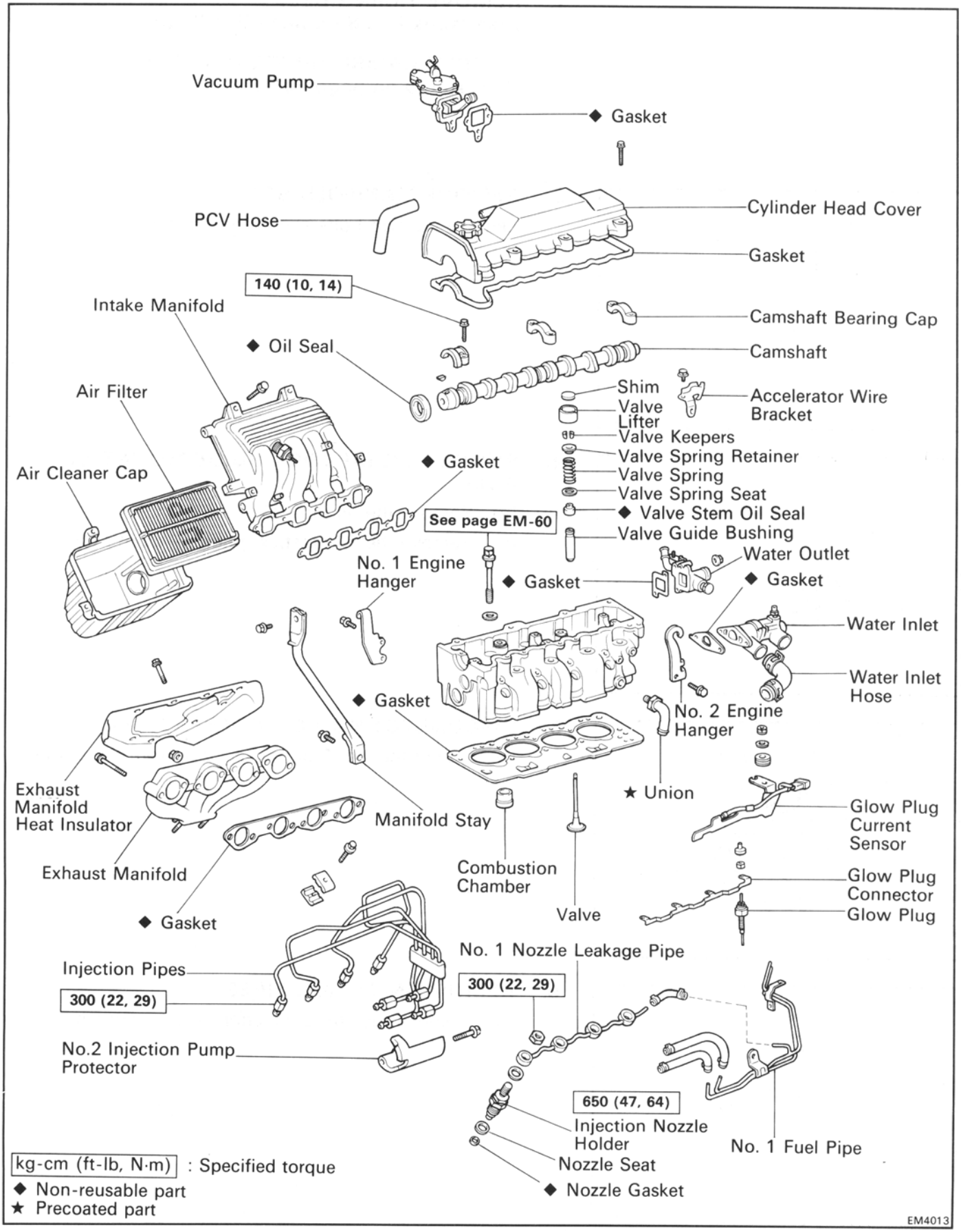


NOTE:
- "New belt" refers to a new belt which has never been used.
- "Used belt" refers to a belt which has been used on a running engine for 5 minutes or more.
- After installing the belt, run the engine for approx. 5 minutes and then recheck the deflection.

15. INSPECT AND ADJUST INJECTION TIMING
(See pages EM-18 to 20)

CYLINDER HEAD

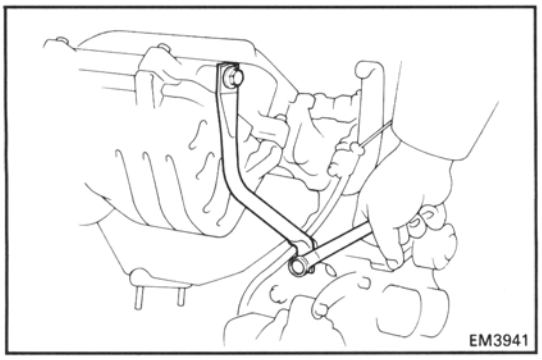
COMPONENTS



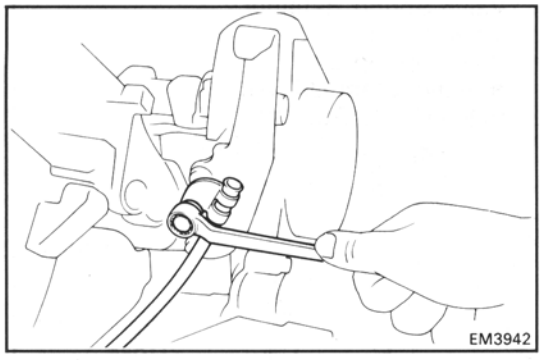
REMOVAL OF CYLINDER HEAD

(See page EM-37)

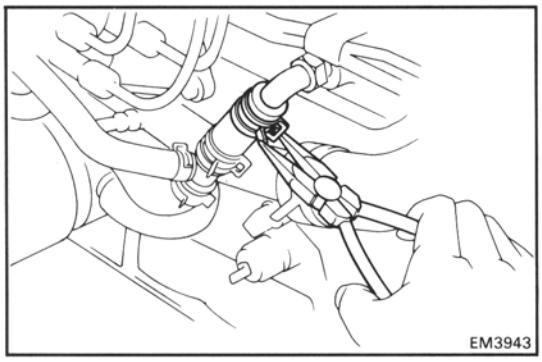
1. **REMOVE TIMING BELT**
   (See steps 1 to 8 on page EM-25 to 27)
2. **REMOVE CAMSHAFT TIMING PULLEY**
   (See step 9 on page EM-27)



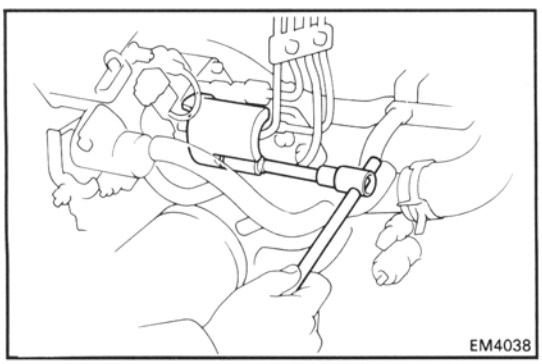
3. **REMOVE MANIFOLD STAY**
   Remove the two bolts and manifold stay.



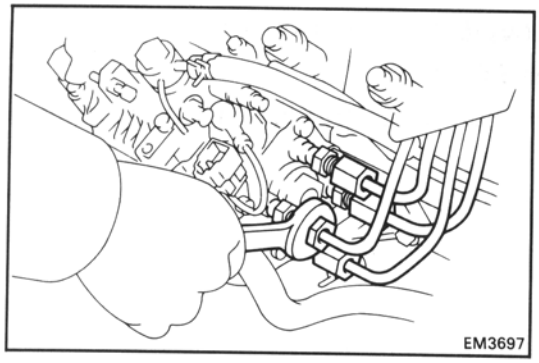
4. **REMOVE OIL DIPSTICK GUIDE MOUNTING BOLT**
   (a) Remove the oil dipstick.
   (b) Remove the oil dipstick guide mounting bolt.



5. **DISCONNECT NO.1 OIL COOLER HOSE**
   Disconnect the No. 1 oil cooler hose from the union.

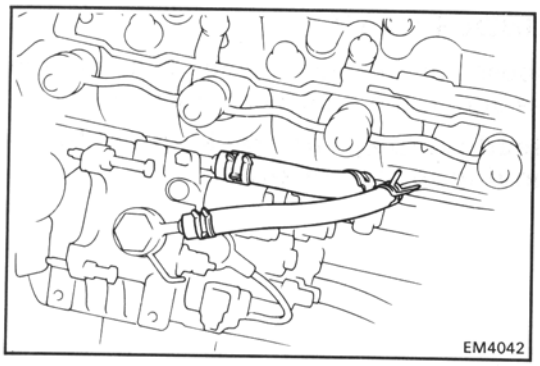


6. **REMOVE INJECTION PIPES**
   (a) Remove the No. 2 injection pump protector.



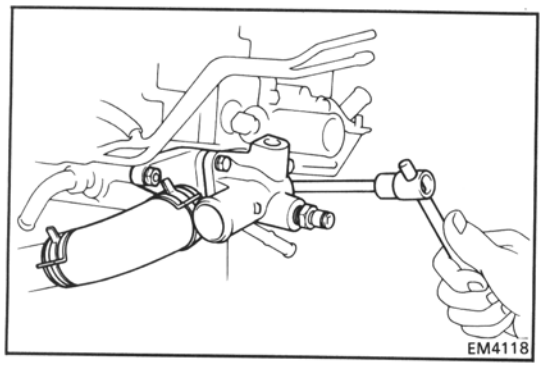
(b) Remove the injection pipe clamps.

(c) Disconnect both ends of the injection pipes from the injection pump and nozzle holders.



7. DISCONNECT FUEL HOSES

Disconnect the two fuel hoses from the injection pump.

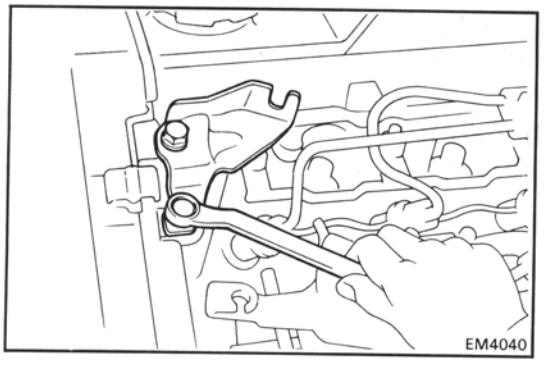


8. REMOVE WATER INLET

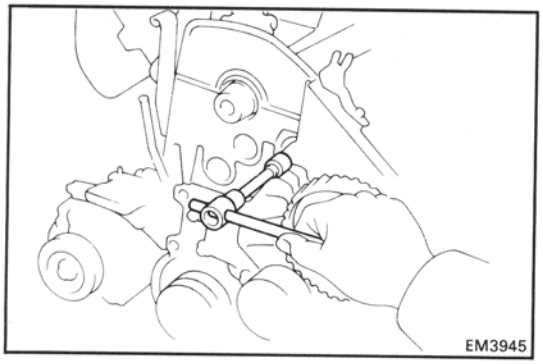
(a) Remove the two nuts.

(b) Disconnect the water inlet hose from the water inlet pipe.

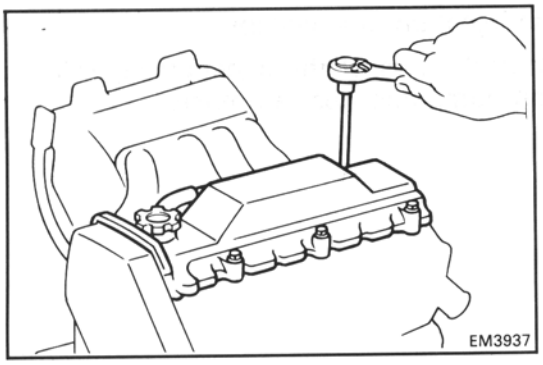
(c) Remove the water inlet and gasket.



9. REMOVE ACCELERATOR WIRE BRACKET



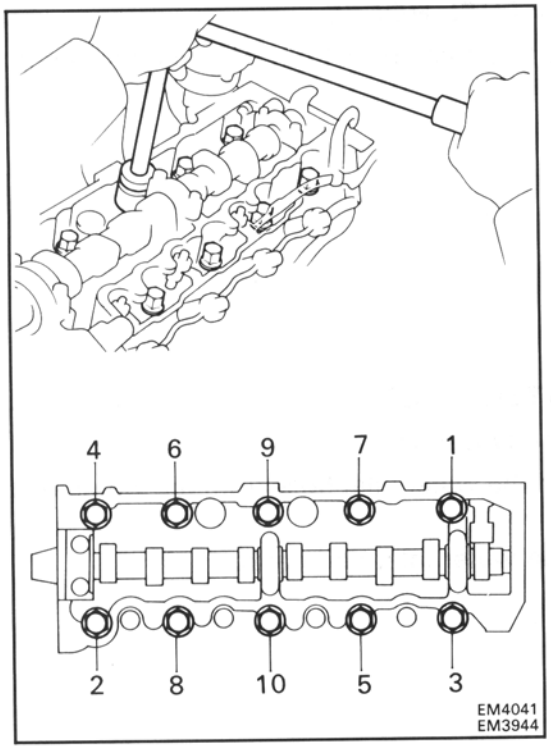
10. REMOVE WATER PUMP MOUNTING BOLT



11. REMOVE CYLINDER HEAD COVER

(a) Remove the PCV hose.

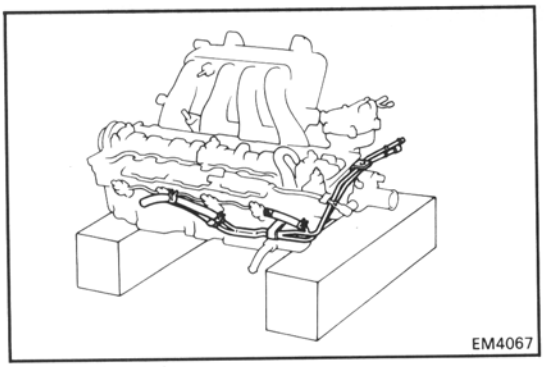
(b) Remove the eight bolts and cylinder head cover.



12. REMOVE CYLINDER HEAD

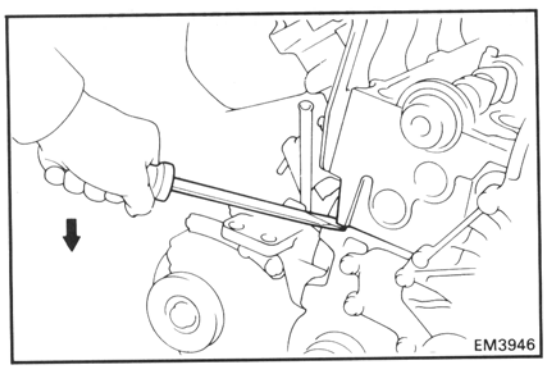
(a) Gradually loosen and remove the ten head bolts in three passes and in the numerical order shown.

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



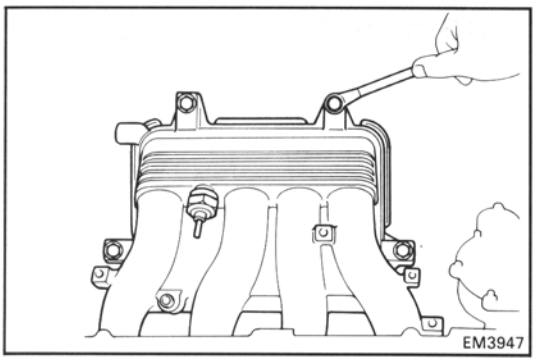
(b) Lift the cylinder head from the dowels on the cylinder block and place the head on wooden blocks on a bench.

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



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

(c) Remove the cylinder head gasket.

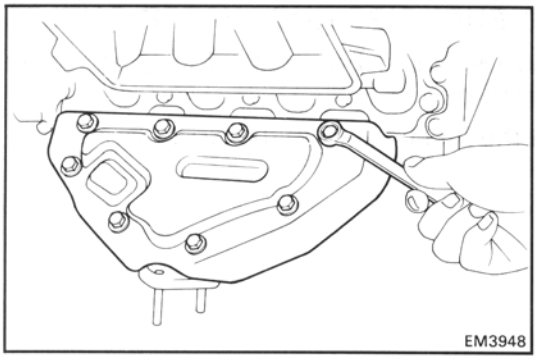


DISASSEMBLY OF CYLINDER HEAD

(See page EM-37)

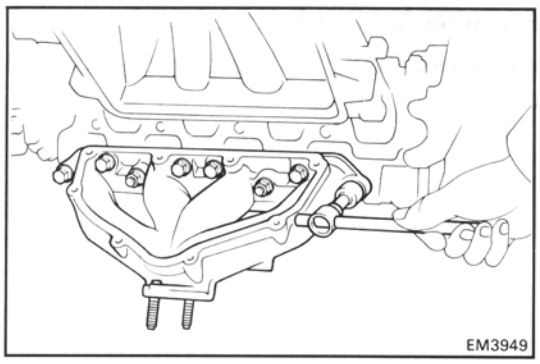
1. REMOVE AIR CLEANER CAP

Remove the four bolts, air cleaner cap and air filter.

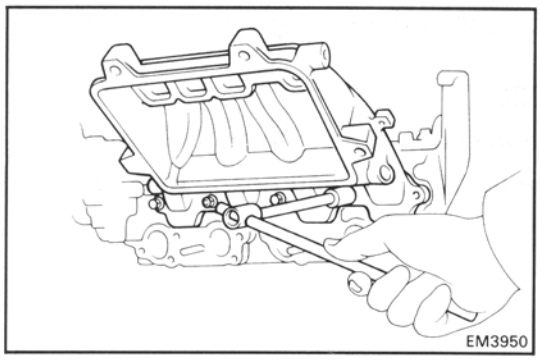


2. REMOVE EXHAUST MANIFOLD

(a) Remove the eight bolts and exhaust manifold heat insulator.

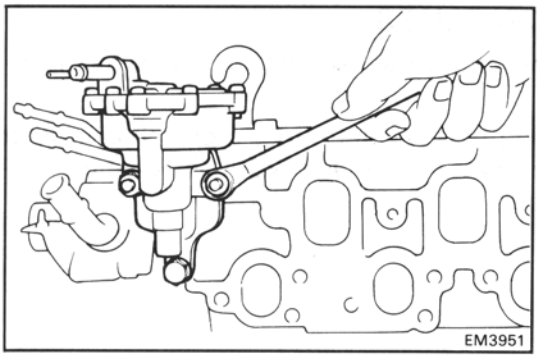


(b) Remove the six bolts, two nuts, exhaust manifold and gasket.



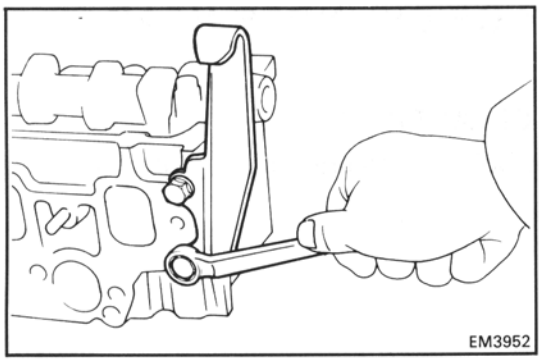
3. REMOVE INTAKE MANIFOLD

Remove the two bolts, two nuts, intake manifold and gasket.

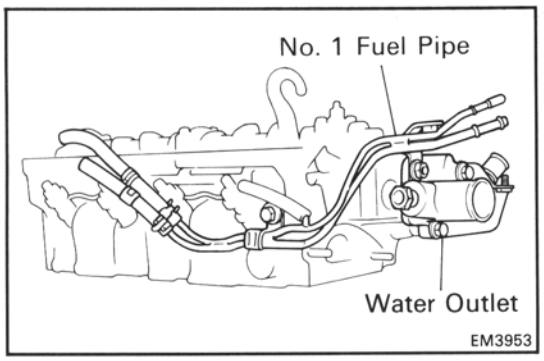


4. REMOVE VACUUM PUMP

Remove the two nuts, bolt, vacuum pump and gasket.



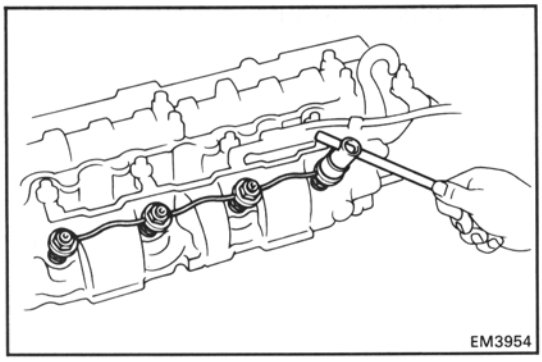
5. REMOVE NO.1 ENGINE HANGER



6. REMOVE NO.1 FUEL PIPE AND WATER OUTLET

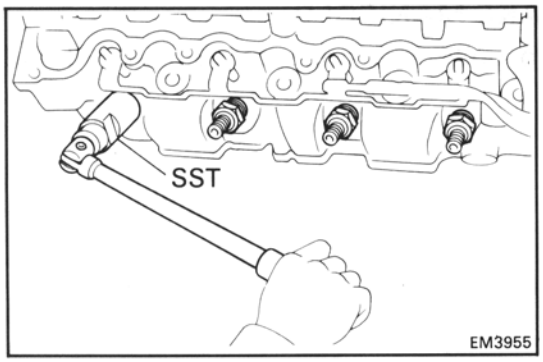
(a) Remove the two nuts, bolt, No.1 fuel pipe, water outlet and gasket.

(b) Disconnect the fuel hose from the No.1 nozzle leakage pipe.



7. REMOVE INJECTION NOZZLE HOLDERS

(a) Remove the four nuts, No.1 nozzle leakage pipe and four gaskets.

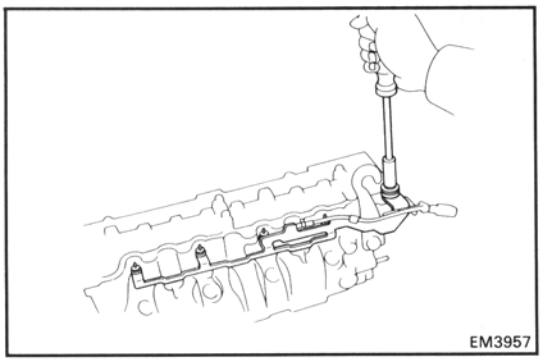


(b) Using SST, remove the four injection nozzle holders.

SST 09268-64020

(c) Arrange the injection nozzle holders in order.

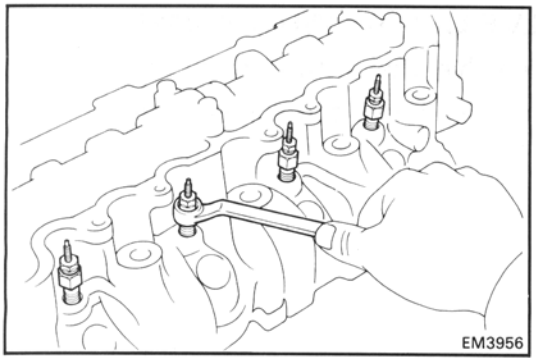
(d) Remove the nozzle seats and nozzle gaskets.



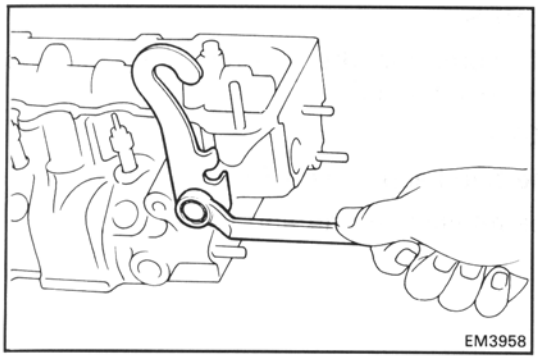
8. REMOVE GLOW PLUGS

(a) Remove the current sensor cover and four grommets.

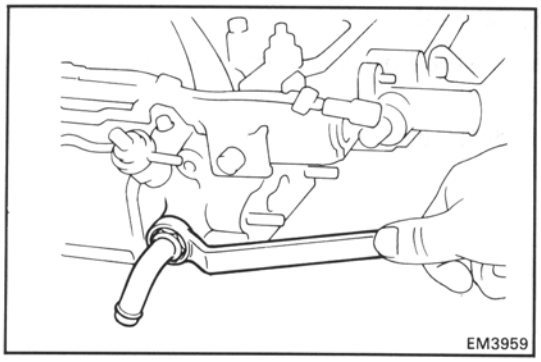
(b) Remove the nuts, washer, No.2 glow plug resistor insulator, current sensor and No.1 glow plug resistor insulator.



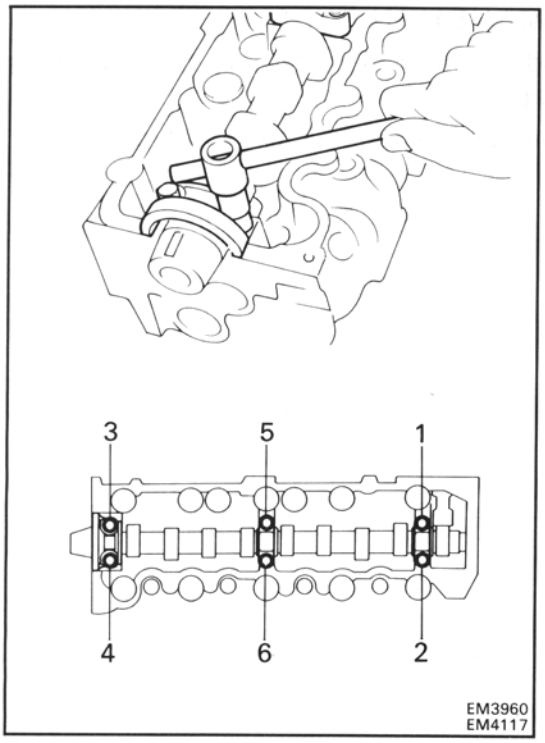
(c) Remove the nuts and glow plug connector.
(d) Remove the glow plugs.



9. REMOVE NO.2 ENGINE HANGER



10. REMOVE UNION

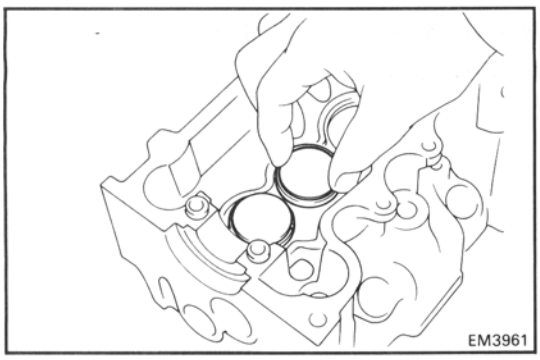


11. REMOVE CAMSHAFT

(a) Gradually loosen and remove the bearing cap bolts from in three passes and in the numerical order shown.

CAUTION: Loosen each cam bearing cap bolt a little time.

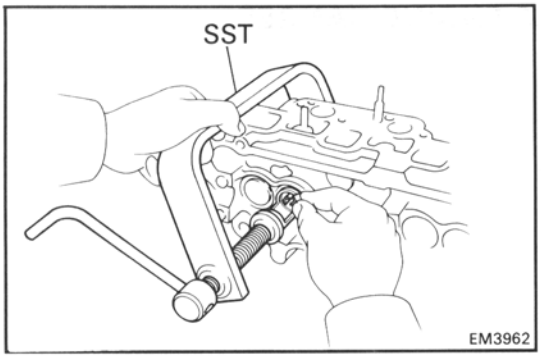
(b) Remove the bearing caps and camshaft.



12. REMOVE VALVE LIFTERS WITH SHIMS

(a) Pull out the valve lifter with shim by hand.

(b) Arrange the valve lifters and shims in order.



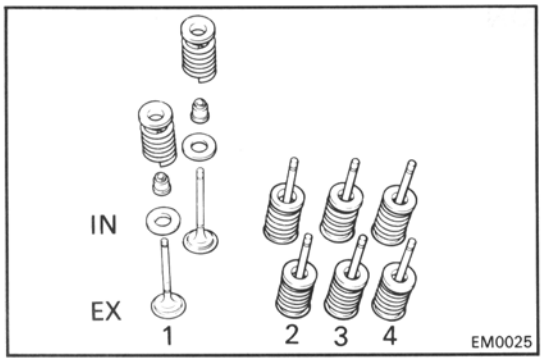
13. REMOVE VALVES

(a) Using SST, compress the retainer until the two keepers can be removed.

SST 09202-43013

(b) Remove the two keepers and SST.

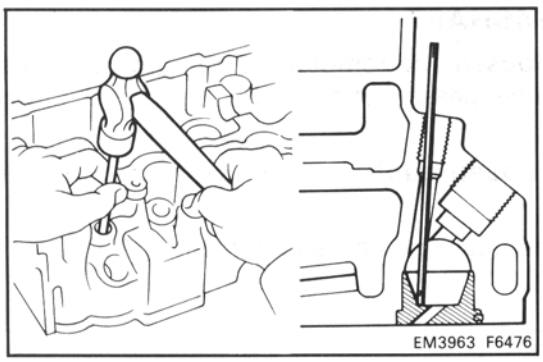
(c) Remove the retainer, spring and valve.



(d) Remove the oil seal.

(e) Using a small screwdriver or magnet, remove the spring seat.

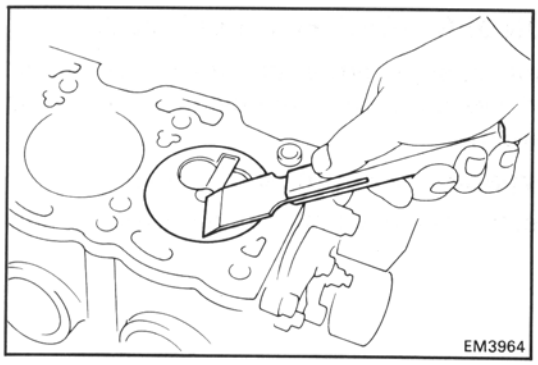
(f) Arrange the disassembled parts in order.



14. REMOVE COMBUSTION CHAMBERS

(a) Insert a rod 4 mm in diameter into the glow plug hole and tap out the combustion chambers.

(b) Arrange the combustion chambers in order.


EM3964

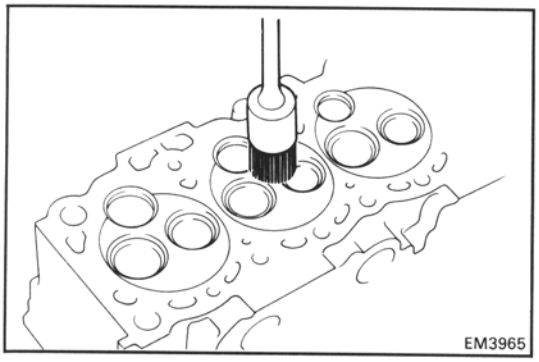
INSPECTION AND CLEANING OF COMPONENTS

1. CLEAN TOP OF PISTONS AND TOP OF CYLINDER 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.

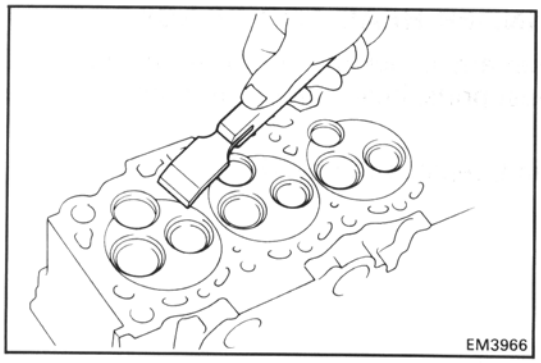
WARNING: Protect your eyes when using high pressure air.


EM3965

2. CLEAN COMBUSTION CHAMBER

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

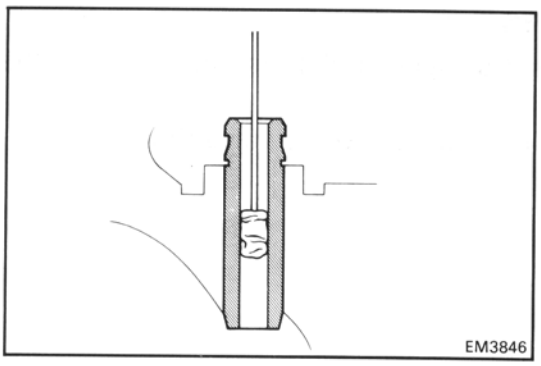
CAUTION: Be careful not to scratch the head gasket contact surface.


EM3966

3. REMOVE GASKET MATERIAL

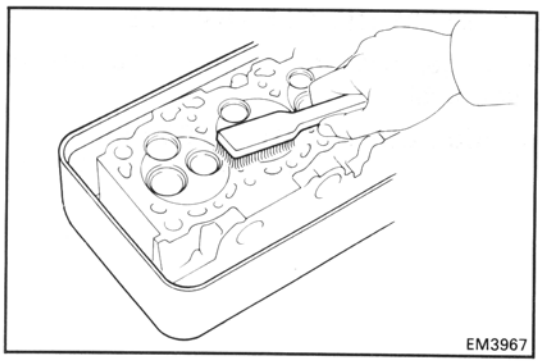
Using a gasket scraper, remove all gasket material from the head and manifold surfaces.

CAUTION: Be careful not to scratch the surfaces.


EM3846

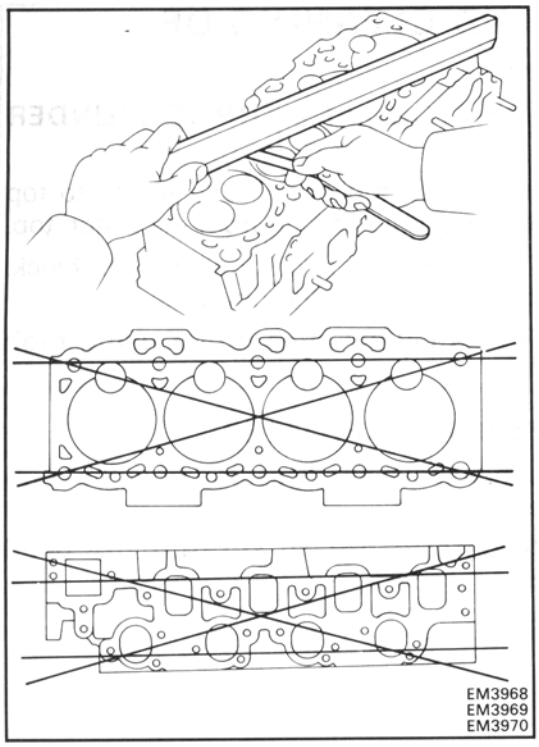
4. CLEAN VALVE GUIDE BUSHINGS

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


EM3967

5. CLEAN CYLINDER HEAD

Using a soft brush and solvent, clean the head.

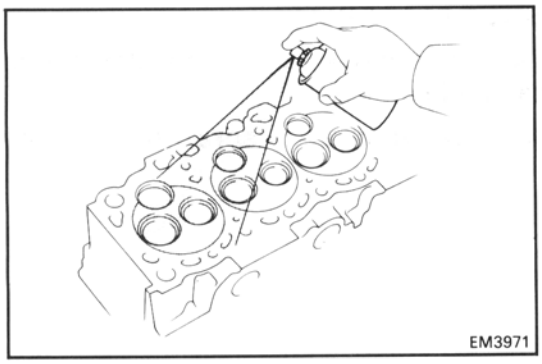


6. INSPECT CYLINDER HEAD FOR FLATNESS

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

Maximum warpage: 0.2 mm (0.008 in.)

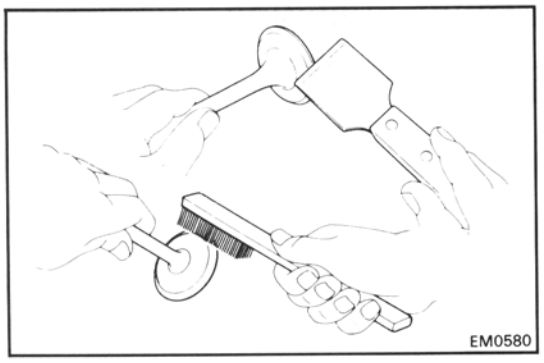
If warpage is greater than maximum, replace the cylinder head.



7. INSPECT CYLINDER HEAD FOR CRACKS

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

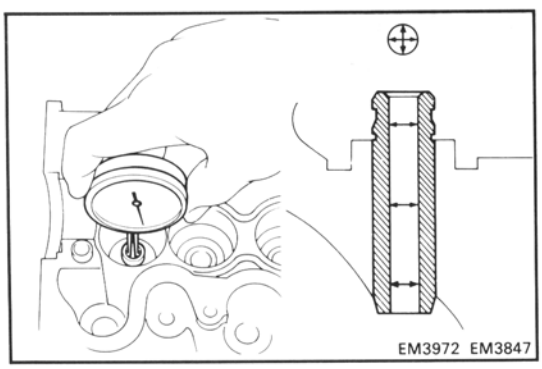
If a crack is found, replace the head.



8. CLEAN VALVES

(a) Use a gasket scraper to chip any carbon from the valve head.

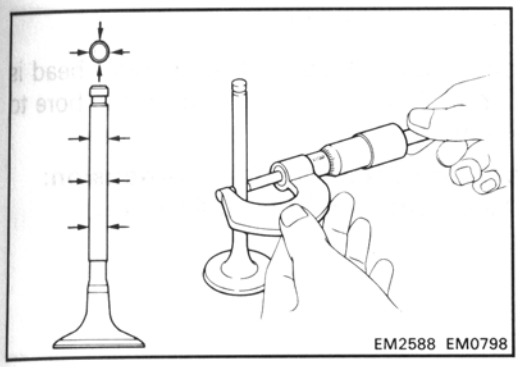
(b) Using a wire brush, clean the valve thoroughly.



9. INSPECT VALVE STEM OIL CLEARANCE

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

Standard inside diameter: 6.01 – 6.03 mm (0.2366 – 0.2374 in.)



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

Stem diameter:

Intake	**5.970 – 5.985 mm (0.2350 – 0.2356 in.)**
Exhaust	**5.965 – 5.980 mm (0.2348 – 0.2354 in.)**

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

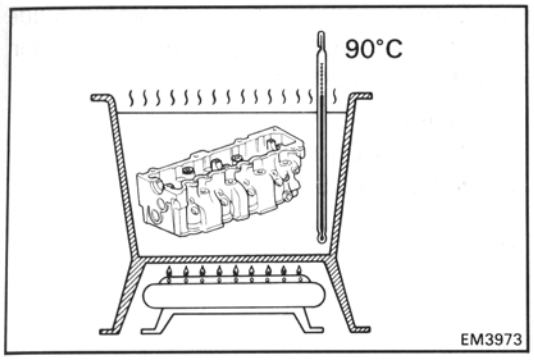
Standard oil clearance:

Intake	**0.025 – 0.060 mm (0.0010 – 0.0024 in.)**
Exhaust	**0.030 – 0.065 mm (0.0012 – 0.0026 in.)**

Maximum oil clearance:

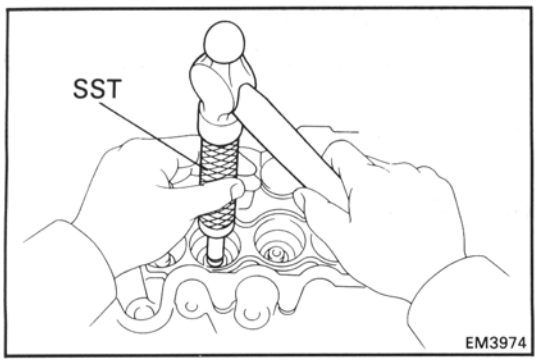
Intake	**0.08 mm (0.0031 in.)**
Exhaust	**0.10 mm (0.0039 in.)**

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



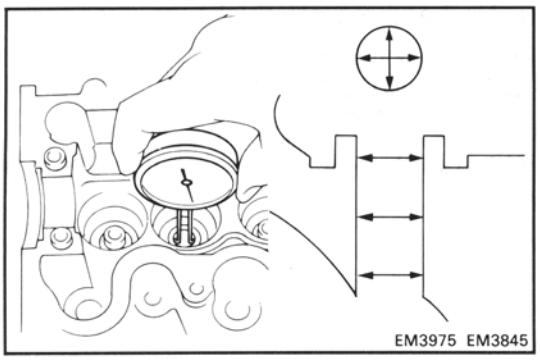
10. IF NECESSARY, REPLACE VALVE GUIDE BUSHING

(a) Gradually heat the cylinder head to approx. 90°C (194°F).



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

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(c) Using caliper gauge, measure the valve guide bushing bore of the cylinder head.

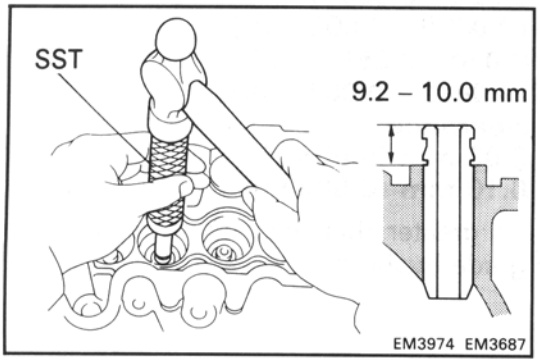
Both intake and exhaust

Bushing bore mm (in.)	Bushing size
10.993 – 11.02 (0.4328 – 0.4339)	Use STD
Over 11.02 (0.4339)	Use O/S 0.05

(d) Select a new valve guide bushing.

If the valve guide bushing bore of the cylinder head is more than 11.02 mm (0.4339 in.), machine the bore to the following dimension.

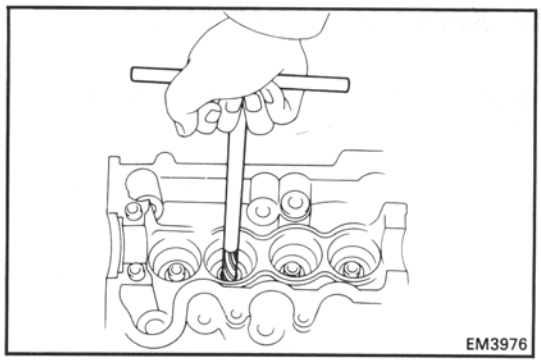
Rebored valve guide bushing bore dimension:
11.043 – 11.07 mm (0.4348 – 0.4358 in.)



(e) Gradually heat the cylinder head to approx. 90°C (194°F).

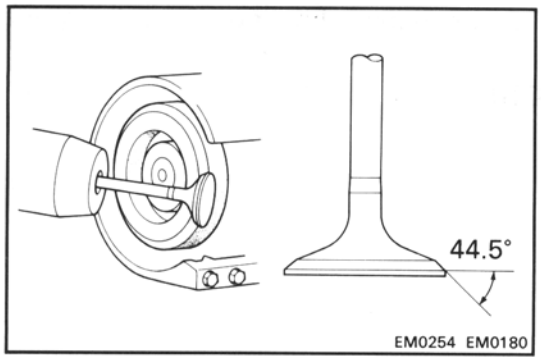
(f) Using SST and a hammer, drive in the new valve guide bushing to where there is 9.2 – 10.0 mm (0.362 – 0.394 in.) protruding from the cylinder head.

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(g) Using a sharp 6 mm reamer, ream the valve guide bushing to obtain the specified clearance between the bushing and new valve stem.

Standard oil clearance:
Intake 0.025 – 0.060 mm (0.0010 – 0.0024 in.)
Exhaust 0.030 – 0.065 mm (0.0012 – 0.0026 in.)

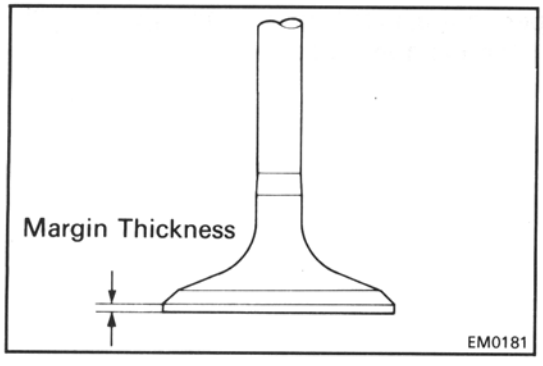


11. INSPECT AND GRIND VALVES

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

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

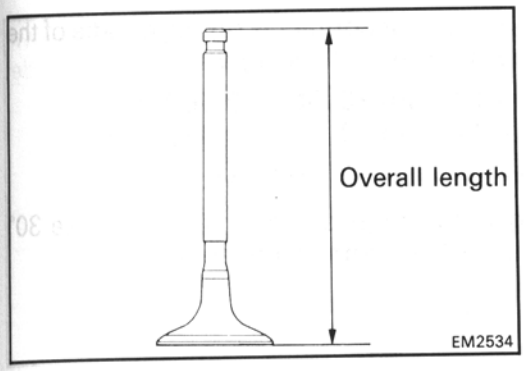
Valve face angle: 44.5°



(c) Check the valve head margin thickness.

Minimum margin thickness:
Intake 0.9 mm (0.035 in.)
Exhaust 1.0 mm (0.039 in.)

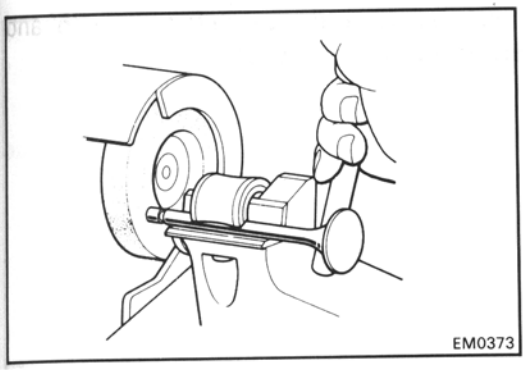
If the valve head margin thickness is less than minimum, replace the valve.



(d) Check the valve overall length.

Standard overall length: 91.28 mm (3.5937 in.)
Minimum overall length: 90.78 mm (3.5740 in.)

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

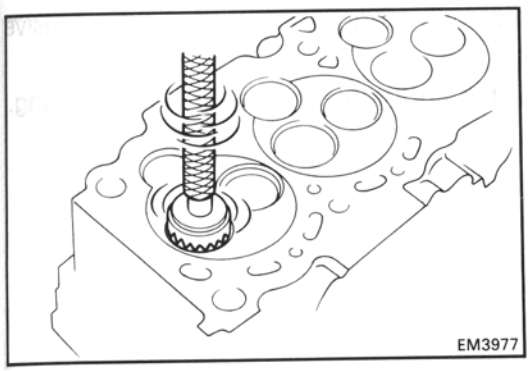


(e) Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, resurface it with a grinder or replace the valve.

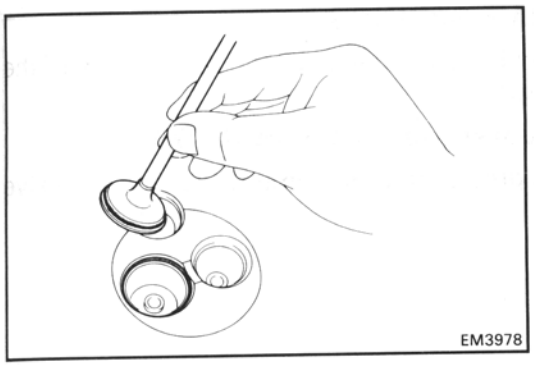
CAUTION: Do not grind off more than the minimum amount.

Minimum overall length: 90.78 mm (3.5740 in.)



12. INSPECT AND CLEAN VALVE SEATS

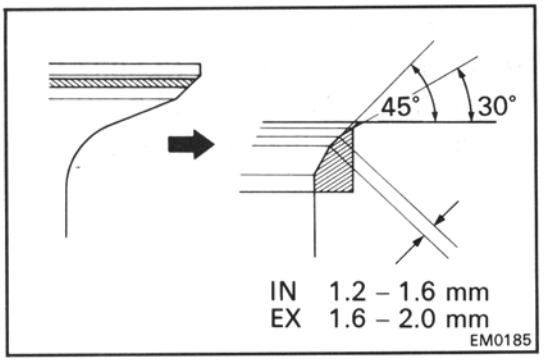
(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.



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

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

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

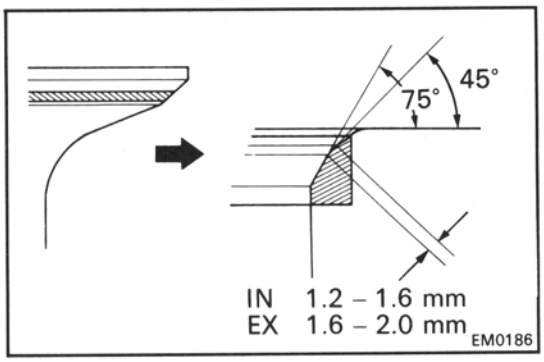


- Check that the seat contact is on the middle of the valve face with the following width:

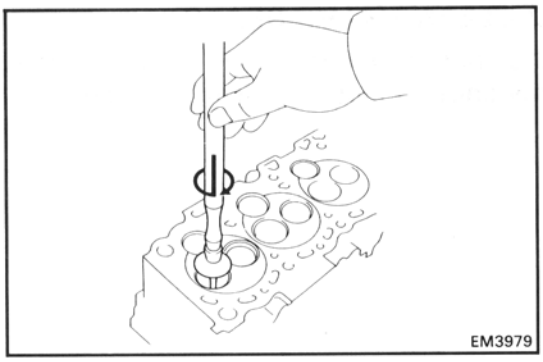
Intake: 1.2 – 1.6 mm (0.047 – 0.063 in.)
Exhaust: 1.6 – 2.0 mm (0.063 – 0.079 in.)

If not, correct the valve seat as follows:

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

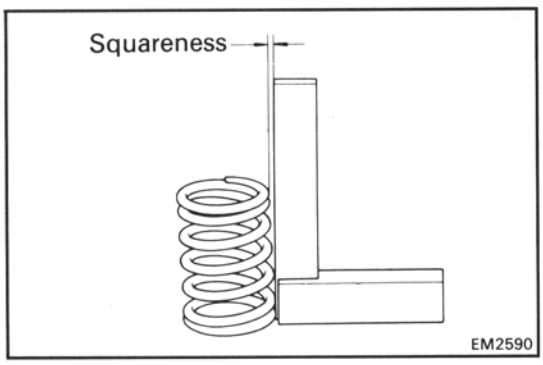


- If seating is too low on the valve face, use 75° and 45° cutters to correct the seat.



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

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

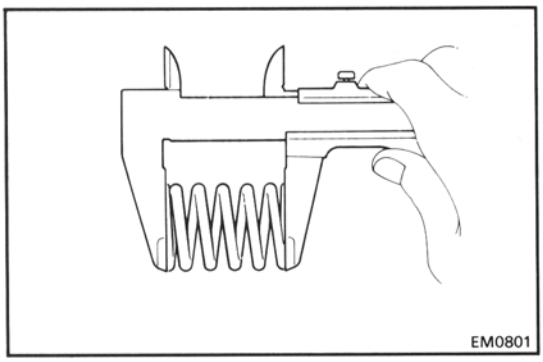


13. INSPECT VALVE SPRINGS

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

Maximum squareness: 2.0 mm (0.079 in.)

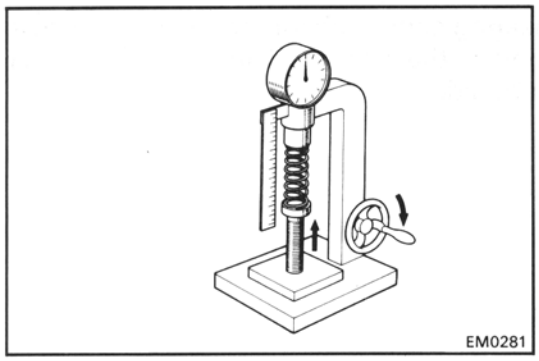
If squareness is greater than maximum, replace the valve spring.



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

Free length: 41.52 mm (1.6346 in.)

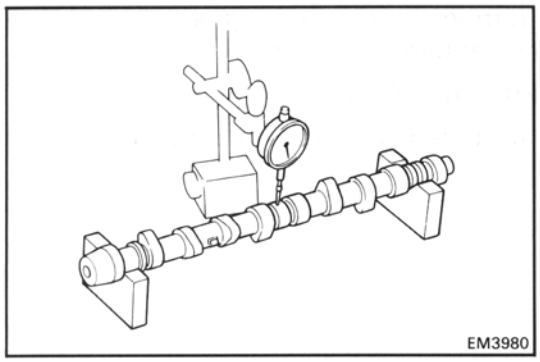
If not as specified, replace the valve spring.



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

Installed height: 34.16 mm (1.3449 in.)
Standard installed tension:
18.41 kg (40.6 lb, 181 N)
Minimum installed tension:
17.49 kg (38.6 lb, 172 N)

If the installed tension is less than minimum, replace the spring.

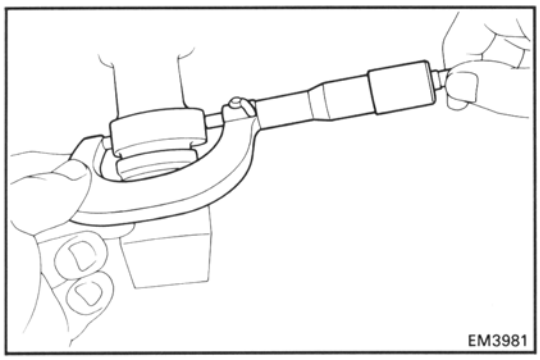


14. INSPECT CAMSHAFT

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

Maximum circle runout: 0.02 mm (0.0008 in.)

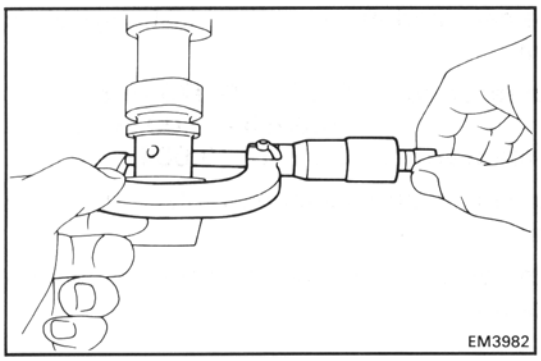
If the circle runout is greater than the maximum, replace the camshaft.



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

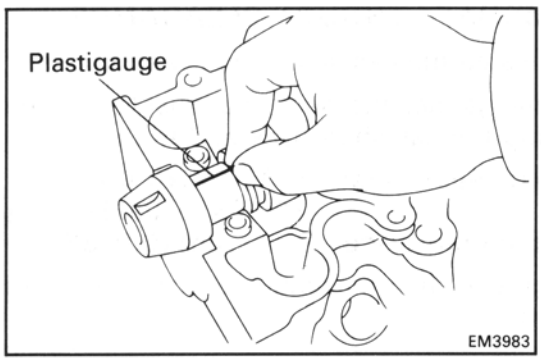
Standard cam lobe height:
Intake 43.84 – 43.94 mm (1.7260 – 1.7299 in.)
Exhaust 43.88 – 43.95 mm (1.7276 – 1.7303 in.)
Minimum cam lobe height:
Intake 43.54 mm (1.7142 in.)
Exhaust 43.58 mm (1.7157 in.)

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



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

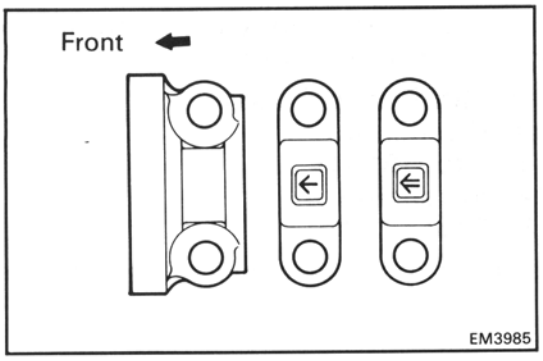
Standard diameter: 26.979 – 26.995 mm (1.0622 – 1.0628 in.)



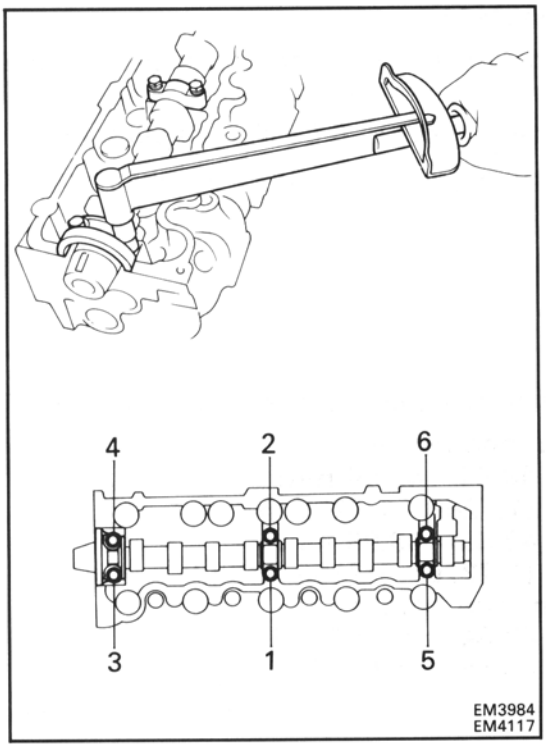
15. INSPECT CAMSHAFT OIL CLEARANCE

(a) Clean the bearing caps and camshaft journal.

(b) Lay a strip of Plastigauge across each journal.



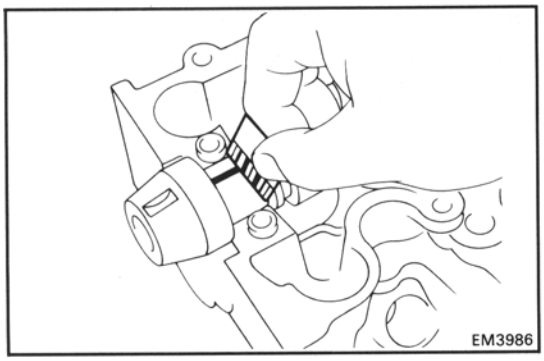
(c) Place the bearing caps each journal with the arrows pointing toward the front and in numerical order from the front side.



(d) Install and torque the cap bolts gradually in three passes in the sequence shown.

Torque: 140 kg-cm (10 ft-lb, 14 N·m)

NOTE: Do not turn the camshaft while the plastigauge is in place.



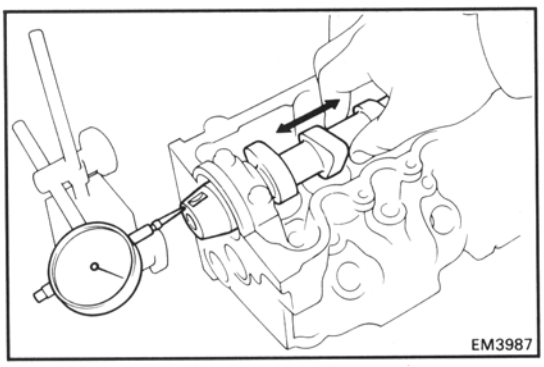
(e) Remove the caps and measure the Plastigage at its widest point.

Standard oil clearance: 0.037 – 0.073 mm (0.0015 – 0.0029 in.)

Maximum oil clearance: 0.1 mm (0.004 in.)

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

(f) Clean out the pieces of Plastigage from the bearing caps and journals.



16. INSPECT CAMSHAFT THRUST CLEARANCE

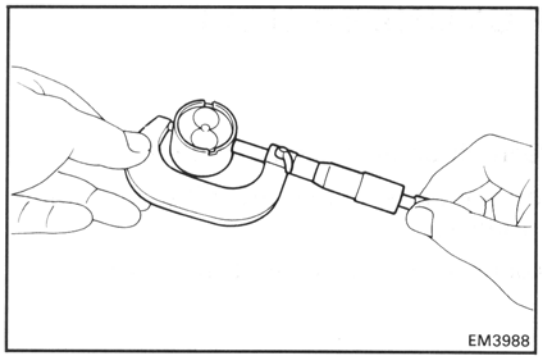
(a) Clean and install the camshaft and bearing caps.

(b) Using a dial gauge, measure the trust clearance while moving the camshaft back and forth.

Standard thrust clearance: 0.08 – 0.18 mm (0.0031 – 0.0071 in.)

Maximum thrust clearance: 0.25 mm (0.0098 in.)

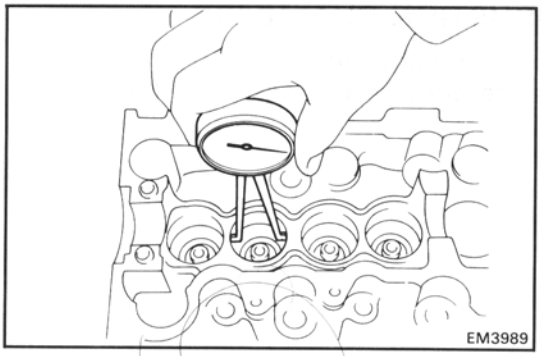
If clearance is greater than maximum, replace the head and / or camshaft.


EM3988

17. MEASURE VALVE LIFTER OIL CLEARANCE

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

Standard diameter: 33.966 – 33.976 mm (1.3372 – 1.3376 in.)


EM3989

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

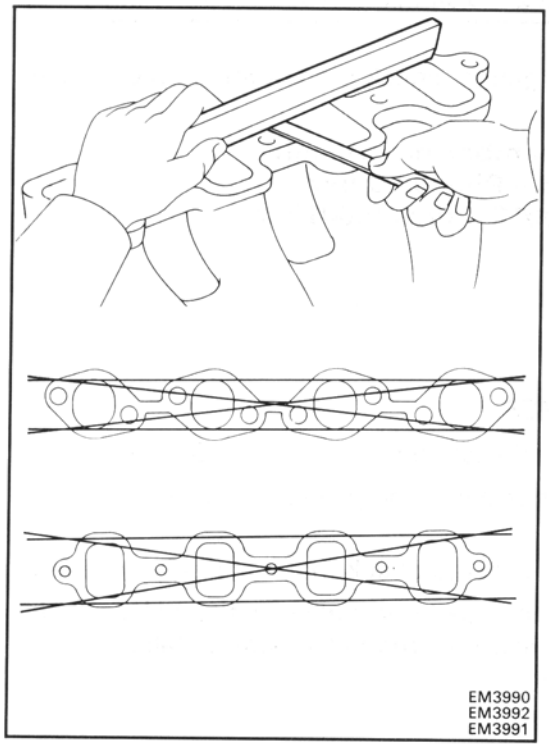
Standard inside diameter: 34.000 – 34.016 mm (1.3386 – 1.3392 in.)

(c) Subtract the valve lifter measurement from the cylinder head bore.

Standard oil clearance: 0.024 – 0.050 mm (0.0009 – 0.0020 in.)

Maximum oil clearance: 0.10 mm (0.0039 in.)

If clearance is greater than maximum, replace the head and / or valve lifter.


EM3990
EM3992
EM3991

18. INSPECT INTAKE AND EXHAUST MANIFOLDS

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

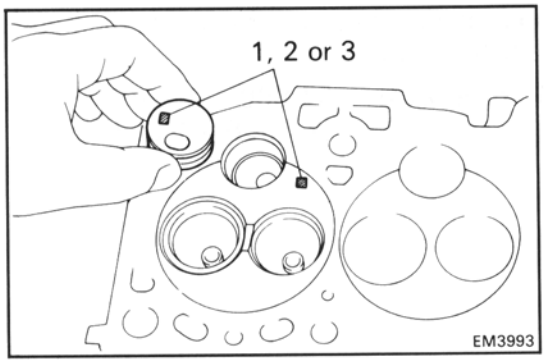
Maximum warpage: 0.2 mm (0.008 in.)

If warpage is greater than maximum, replace the manifold.

ASSEMBLY OF CYLINDER HEAD

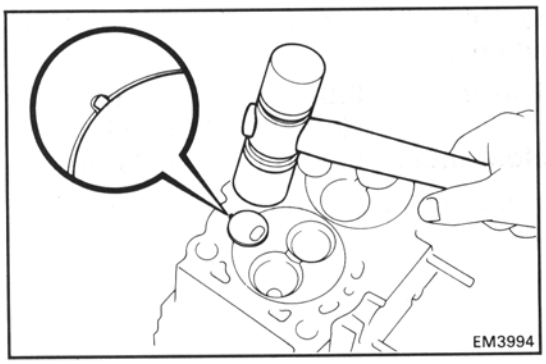
(See page EM-37)

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



1. INSTALL COMBUSTION CHAMBERS

NOTE: If replacing a combustion chamber, replace with one having the same number as marked on the cylinder head.

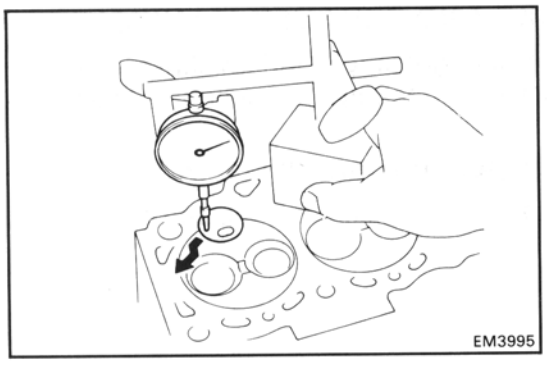


(a) Match the combustion chamber knock pin with the cylinder head notch.

(b) Using plastic-faced hammer, drive in the combustion chamber.

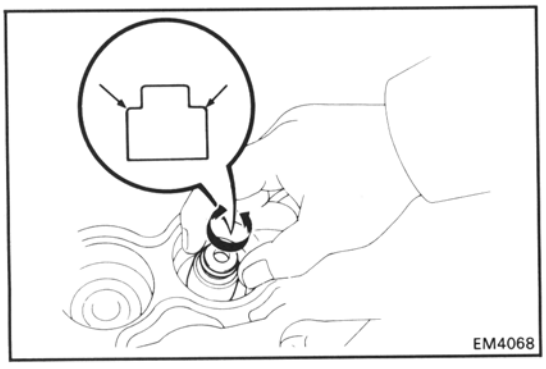
NOTE: Combustion chamber flange thickness

No.	Combustion chamber flange thickness
1	4.95 – 4.98 mm (0.1949 – 0.1961 in.)
2	4.99 – 5.01 mm (0.1965 – 0.1972 in.)
3	5.02 – 5.04 mm (0.1976 – 0.1984 in.)



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

Combustion chamber protrusion:
Minus 0.03 – Plus 0.03 mm
(Minus 0.0012 – Plus 0.0012 in.)



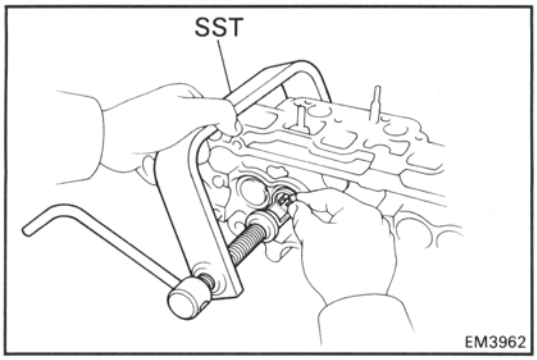
2. INSTALL VALVES

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

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

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

(c) Lubricate and insert the valve in the valve guide bushing. Check that the valves are installed in the correct order.

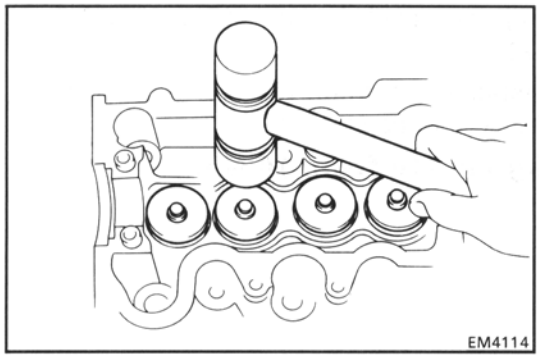


(d) Install the spring seat, spring and spring retainer on the cylinder head.

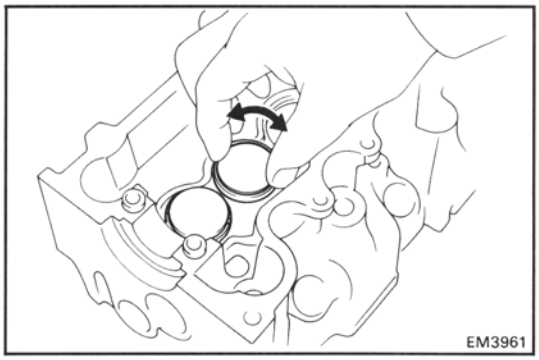
(e) Using SST, compress the valve retainers and place the two keepers around the valve stem.

SST 09202-70010

(f) Unscrew the SST confirm proper fit of the keepers.



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

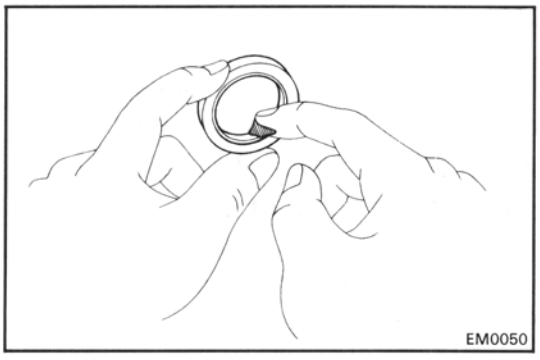


3. INSTALL VALVE LIFTERS WITH SHIMS

(a) Install the valve lifters with shims on the valve stem tips.

(b) Check the valve lifters and shims are installed in the correct order.

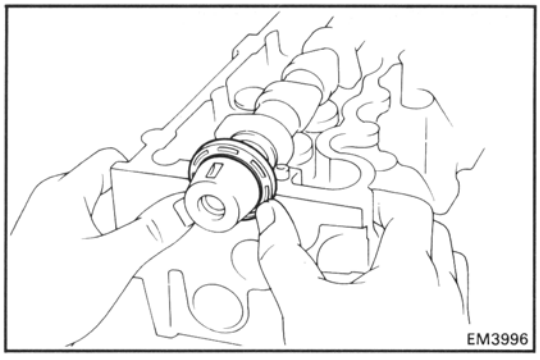
(c) Check the valve lifters rotate smoothly by hand.



4. INSTALL CAMSHAFT

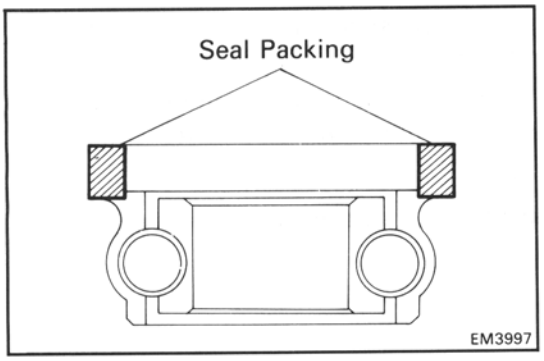
(a) Place the camshaft in the cylinder head.

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



(c) Install a new oil seal.

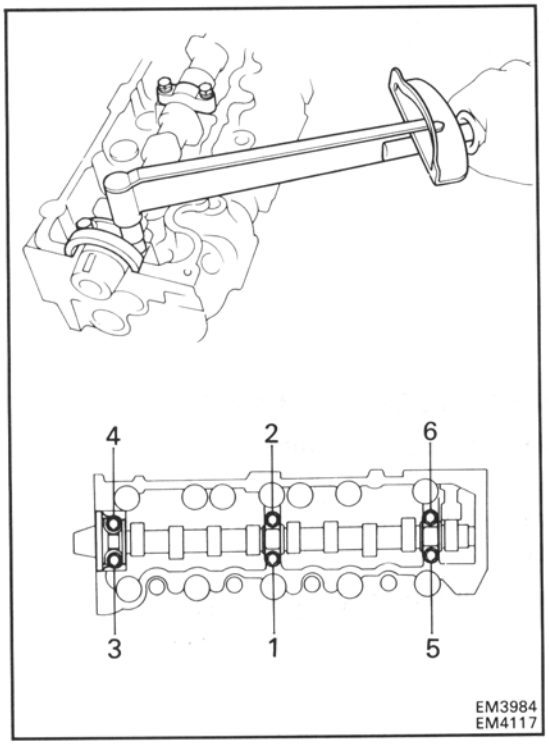
NOTE: Be careful not to install the oil seal slantwise.



(d) Apply seal packing to the No.1 bearing cap as shown in the figure.

Seal packing: Part No.08826 – 00080 or equivalent

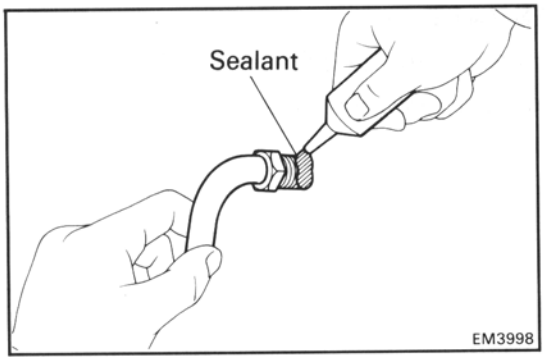
NOTE: Install the No.1 bearing cap immediately after applying the seal packing.



(e) Place bearing caps each journal. (See step (c) on page EM-52)

(f) Gradually install and tighten the cap bolts in three passes in the sequence shown.

Torque: 140 kg-cm (10 ft-lb, 14 N·m)



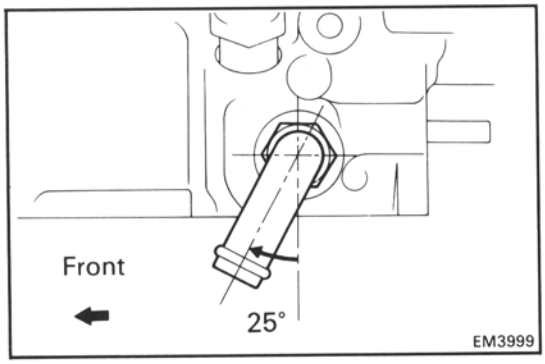
5. INSTALL UNION

(a) Clean the union threads and cylinder head union hole of any sealant, oil or foreign material. Remove any oil with kerosene or gasoline.

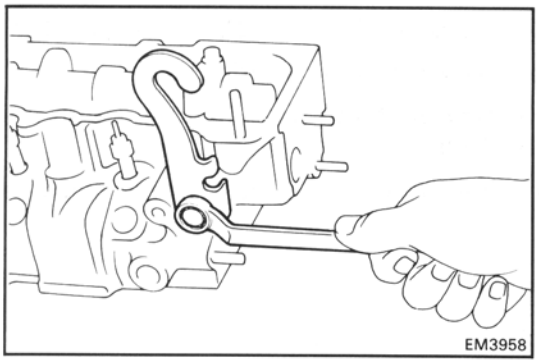
(b) Apply sealant to 2 or 3 threads of the union end.

Sealant: Part No. 08833 – 00070 or equivalent

NOTE: This adhesive will not harden while exposed to air. It will act as a sealant or binding agent only when applied to threads, etc. and air is cut off.

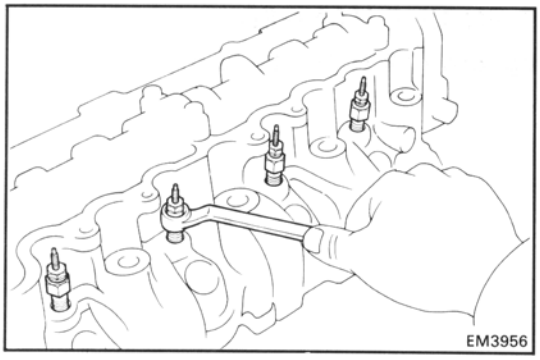


(c) Install the union in the sequence shown in the figure.



6. INSTALL NO.2 ENGINE HANGER

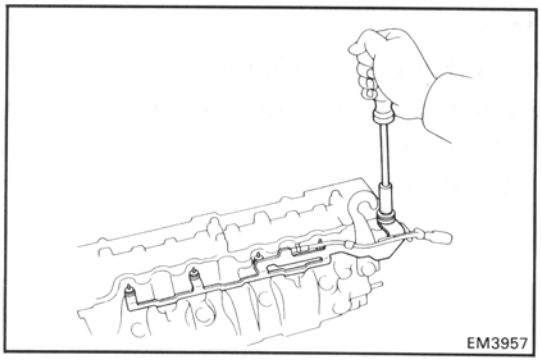
Torque: 380 kg-cm (27 ft-lb, 37 N·m)



7. INSTALL GLOW PLUGS

(a) Install and torque the glow plugs.

Torque: 130 kg-cm (9 ft-lb, 13 N·m)

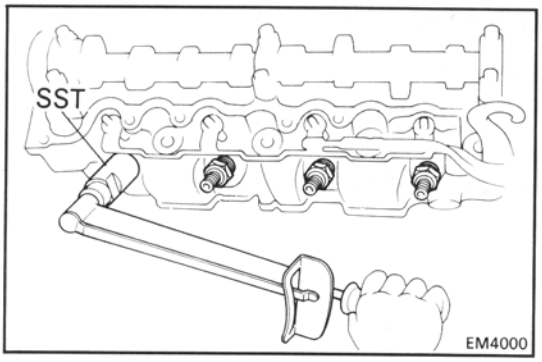


(b) Install the No.1 glow plug resistor insulator.

(c) Install the glow plug connector, current sensor, No.2 glow plug resistor insulator, washer and nuts.

(d) Tighten the five nuts.

(e) Install the four grommets and current sensor cover.



8. INSTALL INJECTION NOZZLE HOLDERS

(a) Clean off all carbon deposits on the nozzle seats.

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

(c) Using SST, install and torque the four injection nozzle holders.

SST 09268-64020

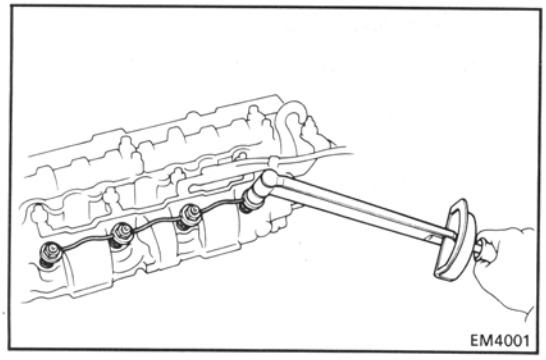
Torque: 650 kg-cm (47 ft-lb, 64 N·m)

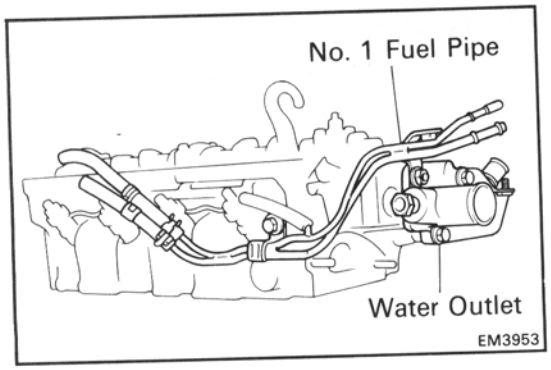
CAUTION: Over torquing could cause nozzle deformation and needle adhesion or other defects.

(d) Install the four new gaskets and nozzle leakage pipe with the four lock nuts.

Torque the lock nuts.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)



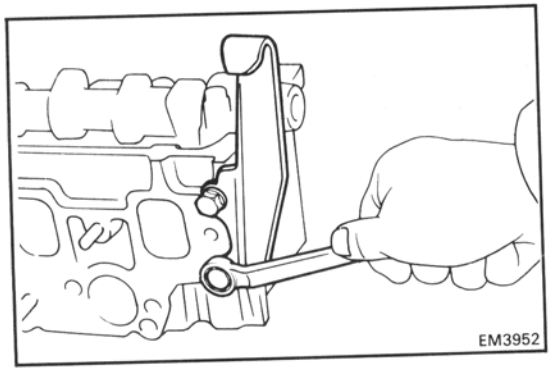


9. INSTALL WATER OUTLET AND NO. 1 FUEL PIPE

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

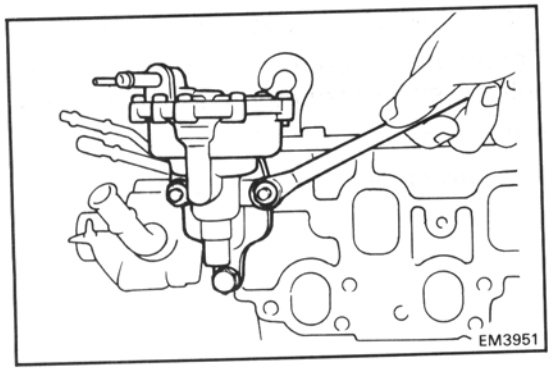
(b) Install the water outlet and No.1 fuel pipe with the two nuts and bolt.

(c) Connect the fuel hose to the No.1 nozzle leakage pipe.



10. INSTALL NO. 1 ENGINE HANGER

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

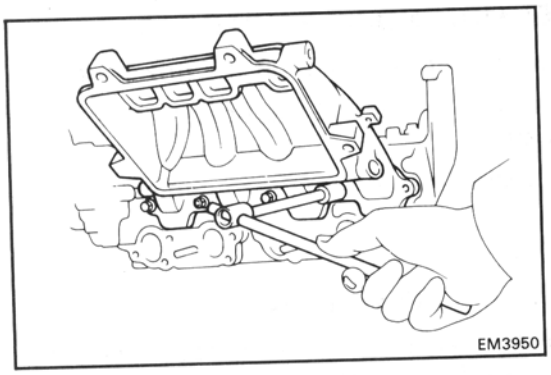


11. INSTALL VACUUM PUMP

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

(b) Install the vacuum pump with the two nuts and bolt in the sequence shown.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

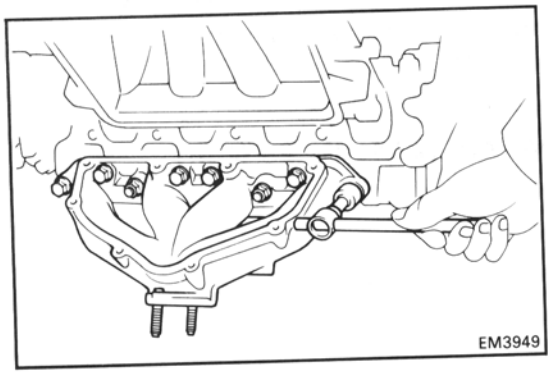


12. INSTALL INTAKE MANIFOLD

(a) Position a new gasket on the cylinder head.

(b) Install the intake manifold with the two bolts and two nuts.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

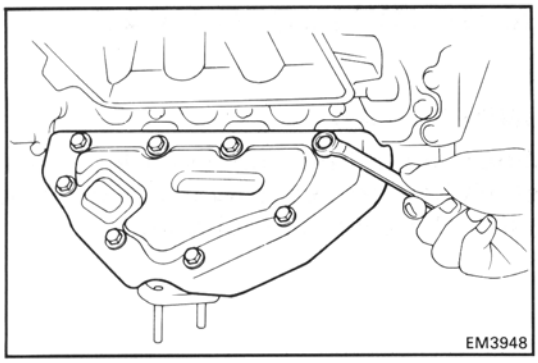


13. INSTALL EXHAUST MANIFOLD

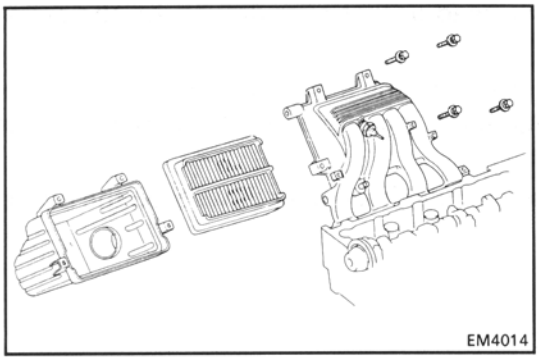
(a) Position a new gasket on the cylinder head.

(b) Install the exhaust manifold with the two nuts and six bolts.

Torque: 400 kg-cm (29 ft-lb, 39 N·m)

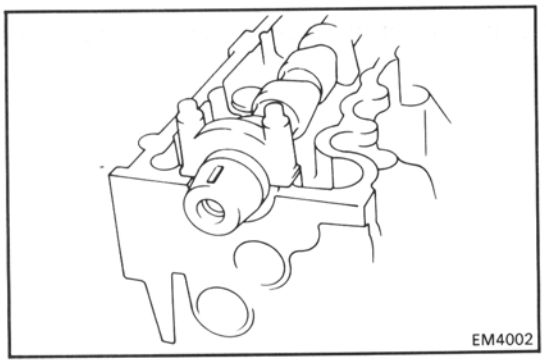


(c) Install the exhaust manifold heat insulator with the eight bolts.



14. INSTALL AIR CLEANER CAP

Install the air filter and cap with the four bolts in the sequence shown.

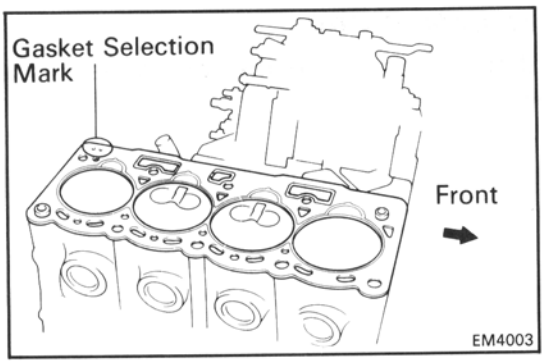

EM4002

INSTALLATION OF CYLINDER HEAD

(See page EM-37)

1. INSTALL CYLINDER HEAD

CAUTION: When installing the cylinder head, face the camshaft key groove upward to prevent interference with the valve and piston.



EM4003

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

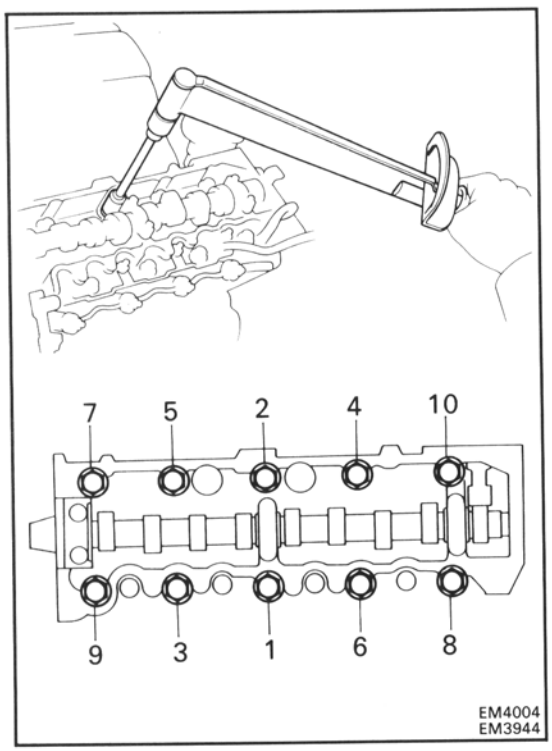
NOTE: Use a gasket of the same thickness (make your choice acoording to the thickness indentification number on the gasket).

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

2. TORQUE CYLINDER HEAD BOLTS

NOTE:

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



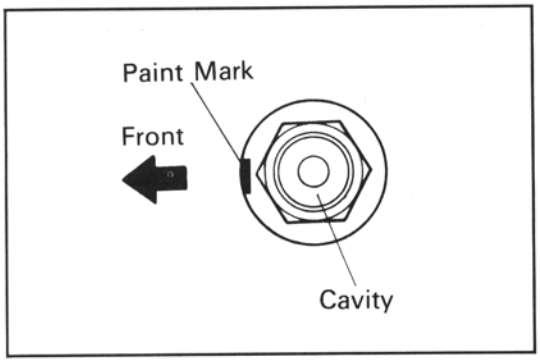
EM4004
EM3944

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

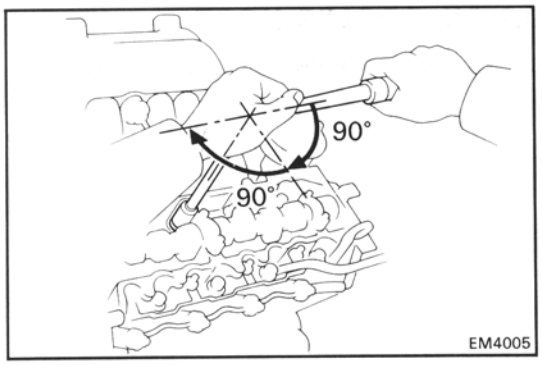
(b) First, uniformly torque the eighteen cylinder head bolts in several passes and in the sequence shown.

Torque: 690 kg-cm (50 ft-lb, 68 N·m)

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



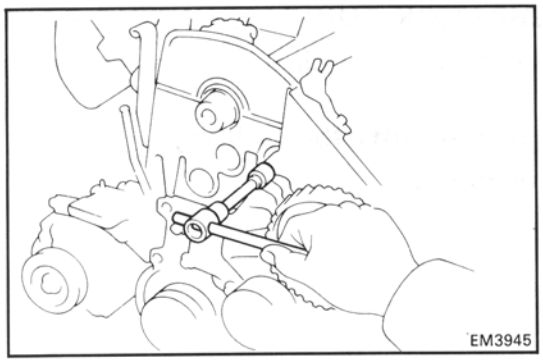
(c) Mark the front of the top of head bolt with paint.



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

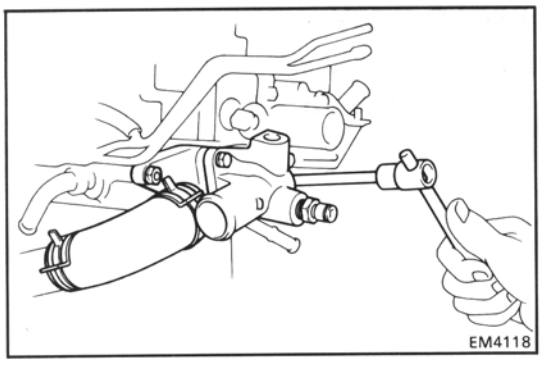
(e) Then tighten the bolts by an additional 90°.

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



3. INSTALL WATER PUMP MOUNTING BOLT

Torque: 195 kg-cm (14 ft-lb, 19 N·m)

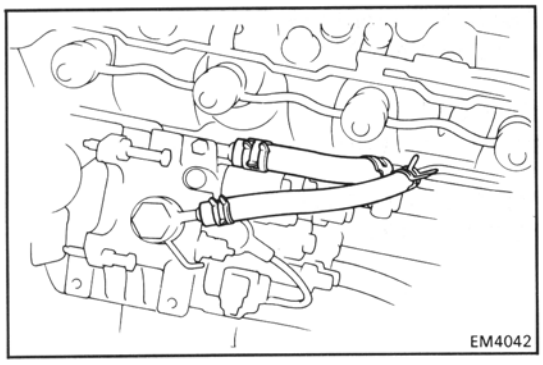


4. INSTALL WATER INLET

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

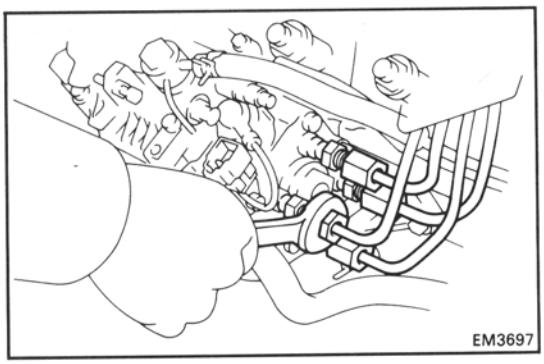
(b) Connect the water inlet hose to water inlet pipe and install the water inlet with the two nuts.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)



5. CONNECT FUEL HOSES

Connect the two fuel hoses to the injection pump.



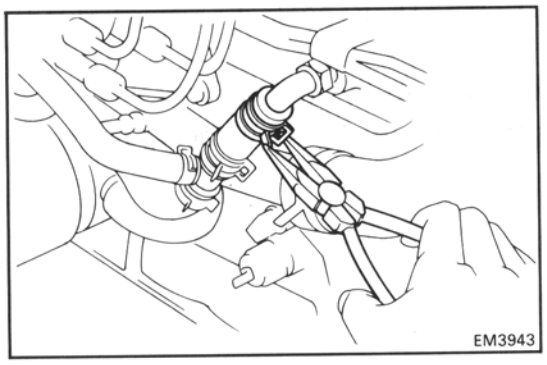
6. INSTALL INJECTION PIPES

(a) Connect both ends of the injection pipes to the injection pump and nozzle holder.

(b) Install the clamps holding the four injection pipes.

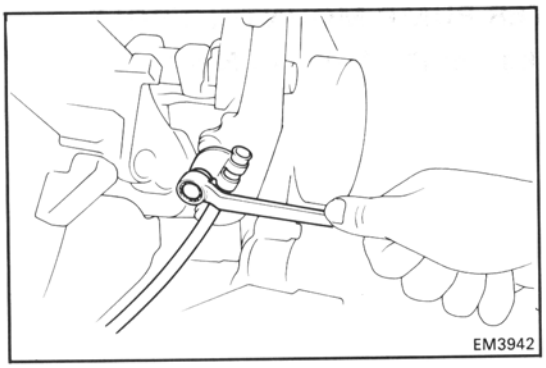
(c) Torque the union nuts of the injection pipes.

Torque: 300 kg-cm (22 ft-lb, 29 N·m)



7. CONNECT NO.1 OIL COOLER HOSE

Connect the No.1 oil cooler hose from the union.

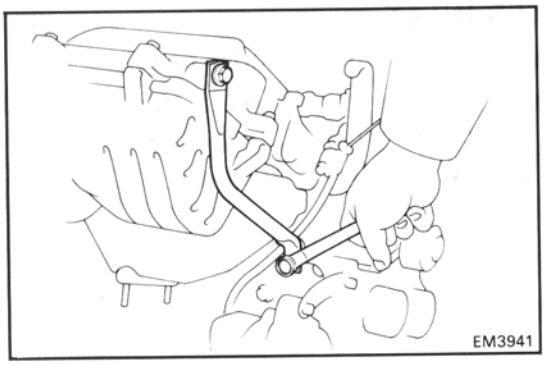


8. INSTALL OIL DIPSTICK GUIDE MOUNTING BOLT

(a) Install and torque the oil dipstick guide mounting bolt.

Torque: 195 kg-cm (14ft-lb, 19 N·m)

(b) Install the oil dipstick.



9. INSTALL MANIFOLD STAY

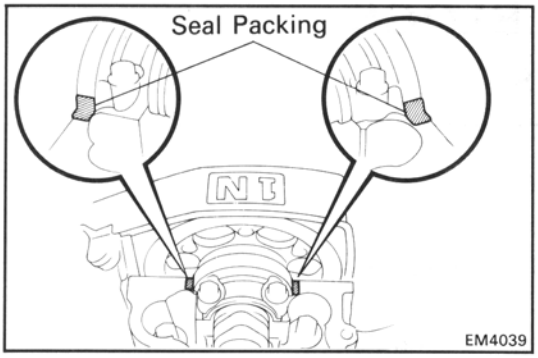
Install the manifold stay with the two bolts.

Torque: 400 kg-cm (29 ft-lb, 39 N·m)

10. INSTALL CAMSHAFT TIMING PULLEY
(See step 4 on page EM-31)

11. INSTALL TIMING BELT
(See steps 5 to 14 on pages EM-32 to 36)

12. ADJUST VALVE CLEARANCE
(See pages EM-13 to 17)



13. INSTALL CYLINDER HEAD COVER

(a) Place the head cover gasket on the head cover.

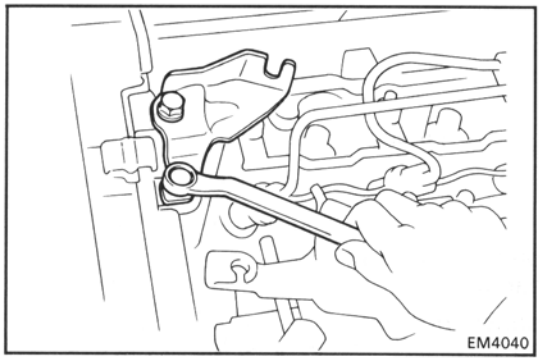
(b) Apply seal packing to two locations shown.

Seal packing: Part No. 08826-00080 or equivalent

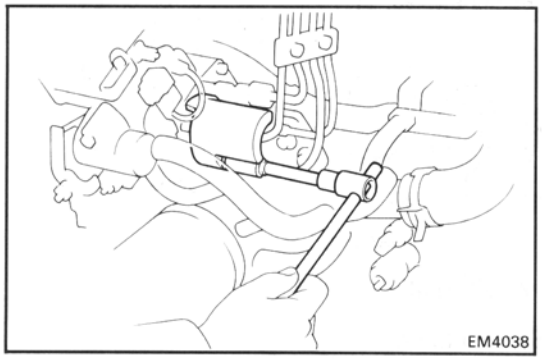
(c) Place the head cover on the cylinder head and install and torque the eight bolts.

Torque: 80 kg-cm (69 in.-lb, 7.8 N·m)

(d) Install the PCV hose.



14. INSTALL ACCELERATOR WIRE BRACKET

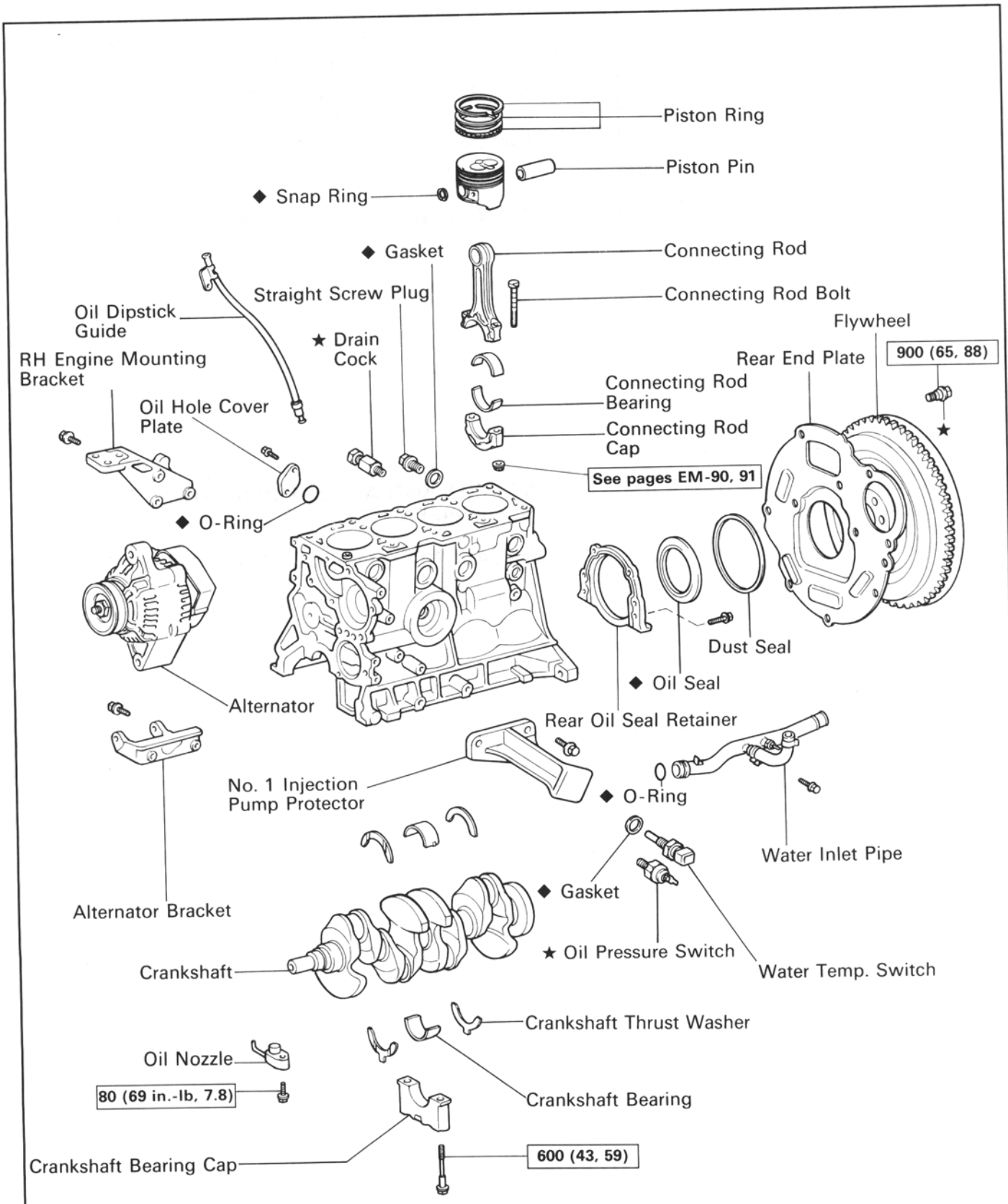


15. INSPECT AND ADJUST INJECTION TIMING (See page EM-18)

16. INSTALL NO. 2 INJECTION PUMP PROTECTOR

CYLINDER BLOCK

COMPONENTS

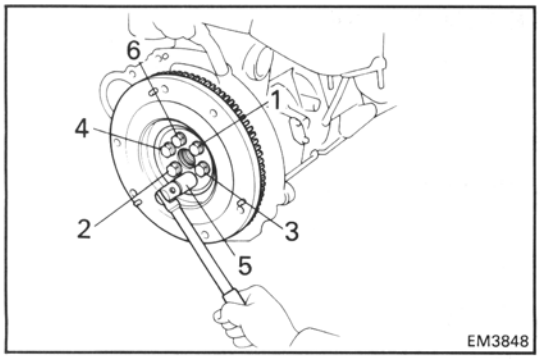


kg-cm (ft-lb, N·m) : Specified torque

◆ Non-reusable part

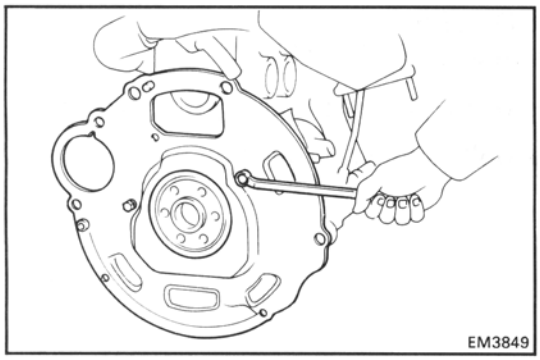
★ Precoated part

EM4015

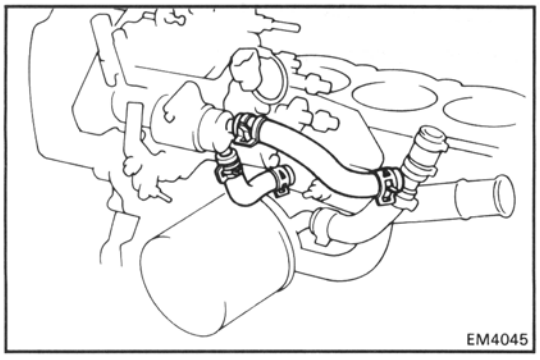


PREPARATION FOR DISASSEMBLY

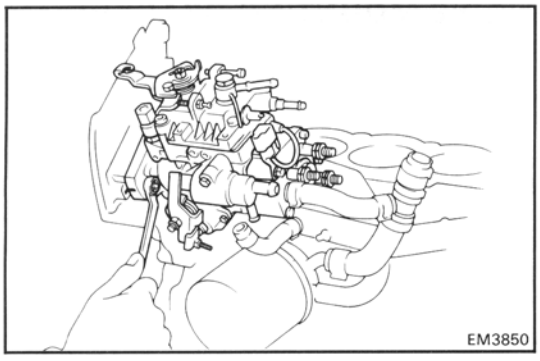
1. **REMOVE CLUTCH COVER AND DISC**
2. **REMOVE FLYWHEEL**



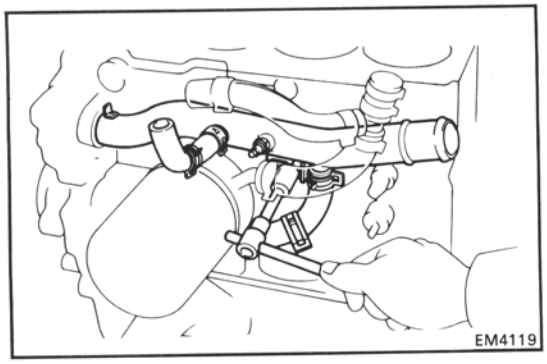
3. **REMOVE REAR END PLATE AND DUST SEAL**
4. **INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY**
5. **REMOVE TIMING BELT**
   (See steps 1 to 8 and 10 to 12 on pages EM-25 to 28)
6. **REMOVE CYLINDER HEAD**
   (See steps 3 to 12 on pages EM-38 to 40)



7. **REMOVE INJECTION PUMP**
   (a) Disconnect the No. 1 and No. 2 water by-pass hoses from the injection pump.



   (b) Remove the two bolts, nuts and injection pump.
8. **REMOVE WATER PUMP**
   (See step 4 on page CO-5)



9. REMOVE WATER INLET PIPE

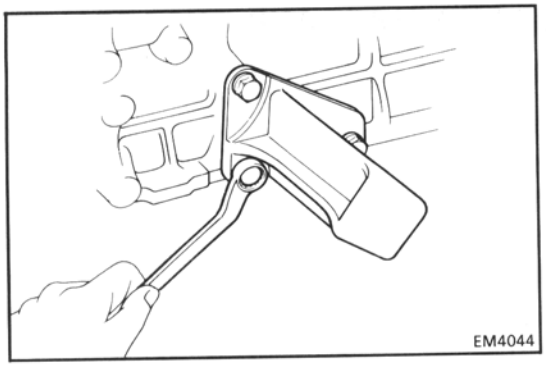
(a) Disconnect the No. 2 oil cooler hose from the oil cooler.

(b) Remove the bolt.

(c) Disconnect the water inlet pipe from the cylinder block.

(d) Remove the O-ring.

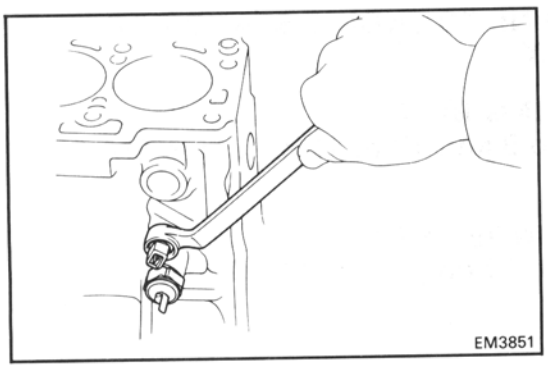
10. REMOVE OIL FILTER
(See step 2 on page LU-4)



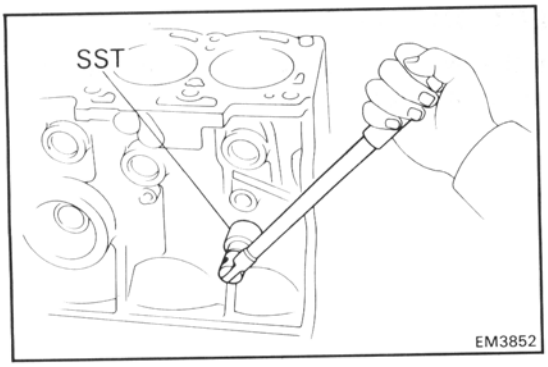
11. REMOVE OIL COOLER
(See step 2 on pages LU-11, 12)

12. REMOVE NO.1 INJECTION PUMP PROTECTOR

Remove the three bolts and No.1 injection pump protector.



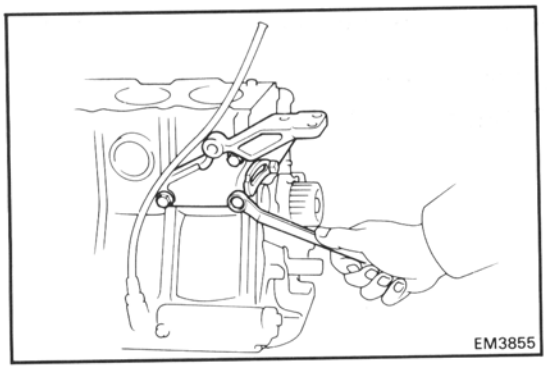
13. REMOVE WATER TEMP. SENSOR



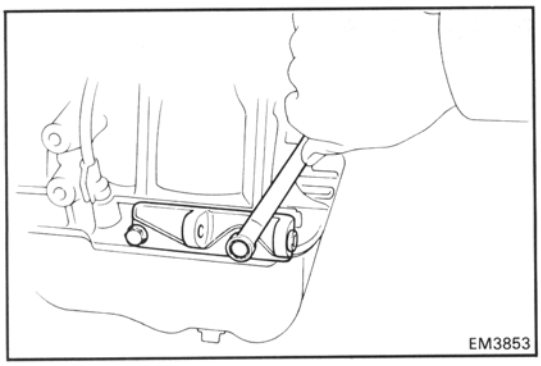
14. REMOVE OIL PRESSURE SWITCH

Using SST, remove the oil pressure switch.

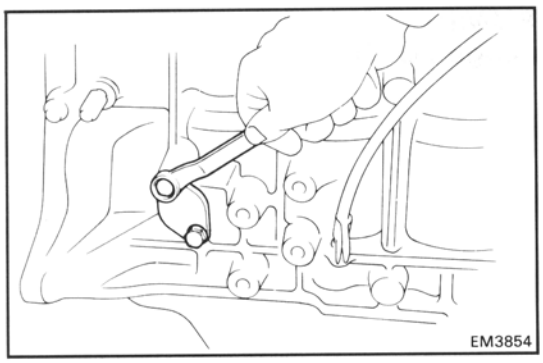
SST 09816-30010



15. REMOVE RH ENGINE MOUNTING BRACKET

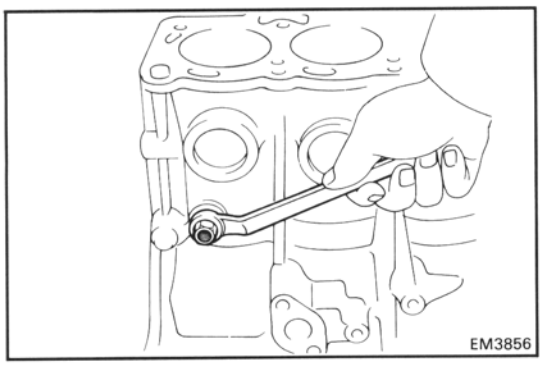


16. REMOVE ALTERNATOR BRACKET

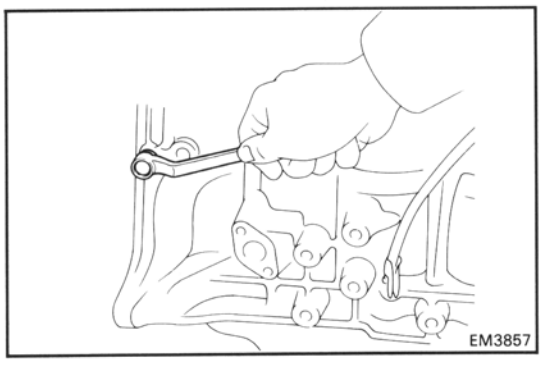


17. REMOVE OIL HOLE COVER PLATE

Remove the two bolts, oil hole cover plate and O-ring.



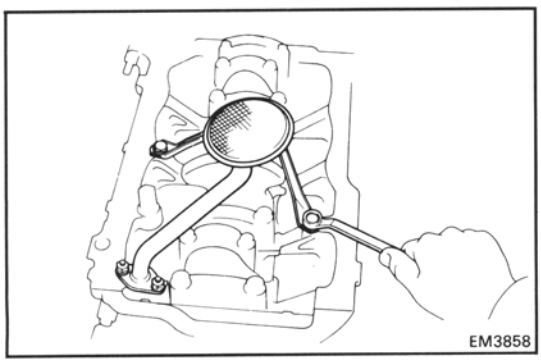
18. REMOVE DRAIN COCK



19. REMOVE STRAIGHT SCREW PLUG

Remove the plug and gasket.

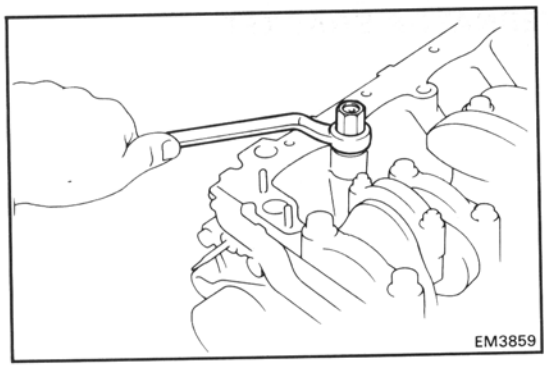
20. REMOVE OIL PAN
(See step 2 on page LU-6)



21. REMOVE OIL STRAINER

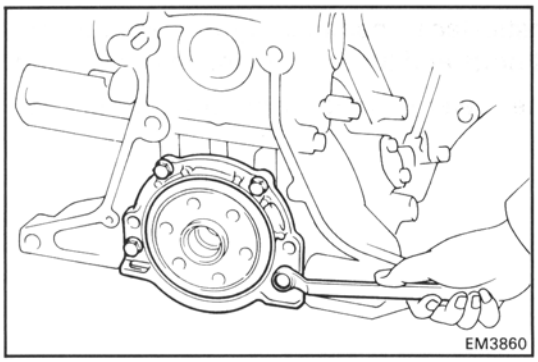
(a) Remove the two bolts and nuts.

(b) Remove the oil strainer and gasket.



22. REMOVE OIL REGULATOR

23. REMOVE OIL PUMP
(See step 4 on page LU-7)

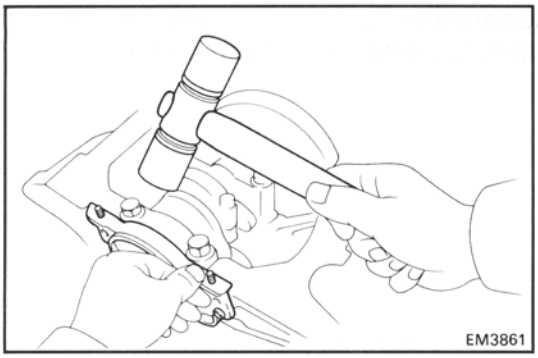

EM3860

DISASSEMBLY OF CYLINDER BLOCK

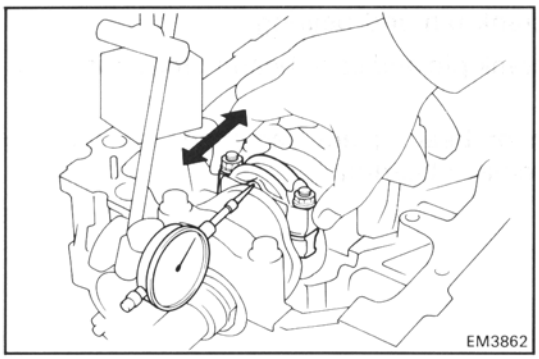
(See page EM-64)

1. REMOVE REAR OIL SEAL RETAINER

(a) Remove four bolts and rear oil seal retainer.


EM3861

(b) Using a plastic-faced hammer, lightly tap the rear oil seal retainer.


EM3862

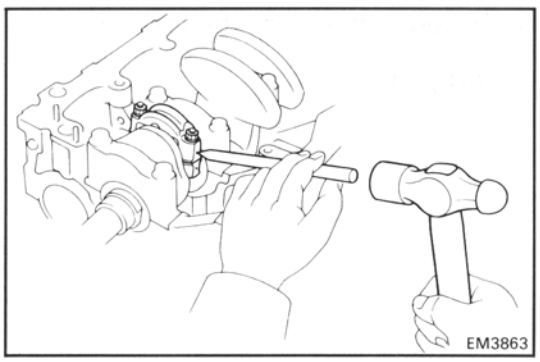
2. MEASURE CONNECTING ROD THRUST CLEARANCE

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

Standard thrust clearance: **0.08 – 0.30 mm (0.0031 – 0.0118 in.)**

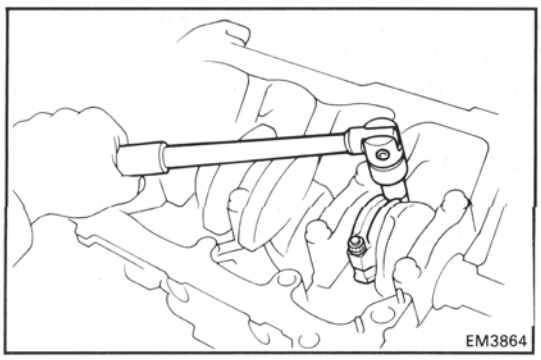
Maximum thrust clearance: **0.40 mm (0.0157 in.)**

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

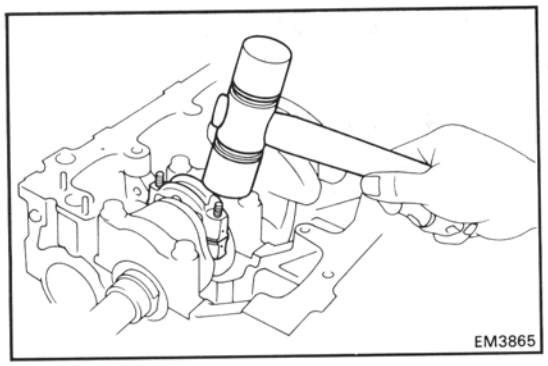

EM3863

3. MEASURE CONNECTING ROD OIL CLEARANCE

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

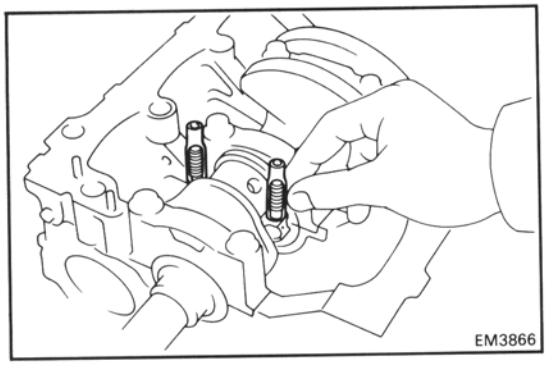

EM3864

(b) Remove the rod cap nuts.

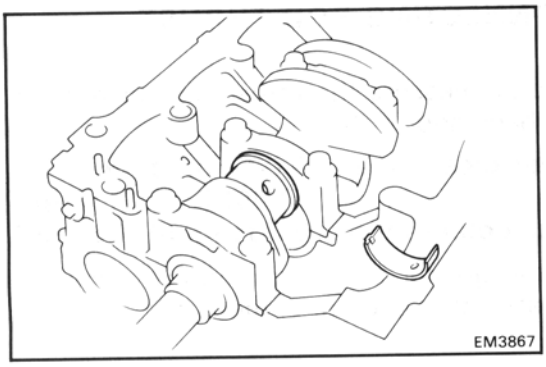


(c) Using a plastic-faced hammer, lightly tap the connecting rod bolts and lift the cap and lower bearing.

NOTE: Keep the lower bearing inserted with the cap.



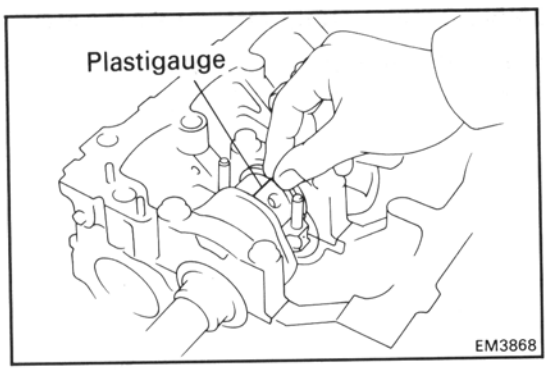
(d) Cover the connecting rod bolts with a short piece of hose to protect the crankshaft from damage.



(e) Clean the crank pin and bearing.

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

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



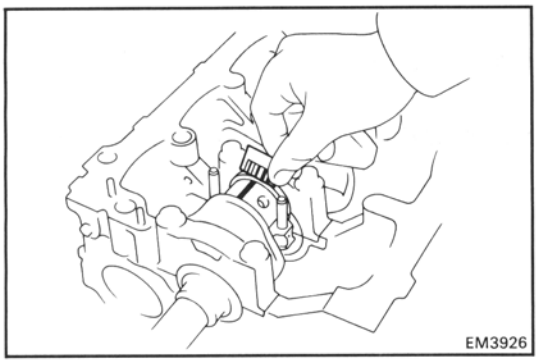
(g) Lay a strip of Plastigauge across the crank pin.

(h) Remove the short piece of hose.

(i) Align the punched marks on the rod and cap. Install and torque the cap nuts.
(See step 9 on pages EM-90, 91)

NOTE:

- Do not turn the crankshaft.
- Apply a light coating of engine oil on the nut threads and under the nut before installation.


EM3926

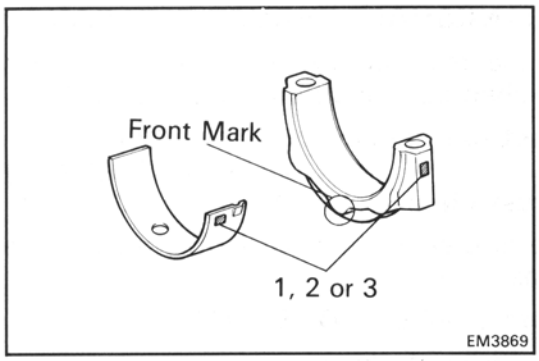
(j) Remove the rod cap. (See procedure (b) and (c).)

(k) Measure the Plastigauge at its widest point.

Standard clearance: 0.030 – 0.058 mm (0.0012 – 0.0023 in.)
Maximum clearance: 0.08 mm (0.0031 in.)

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

(l) Completely remove the Plastigauge.



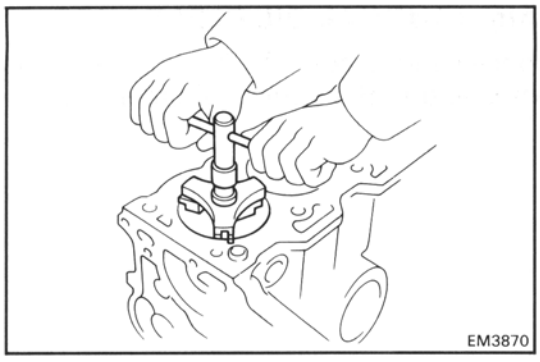
EM3869

NOTE: If replacing the bearing, replace with one having the same number as marked on the bearing cap.

There are three sizes of standard bearings supplied, marked 1, 2 or 3 respectively.

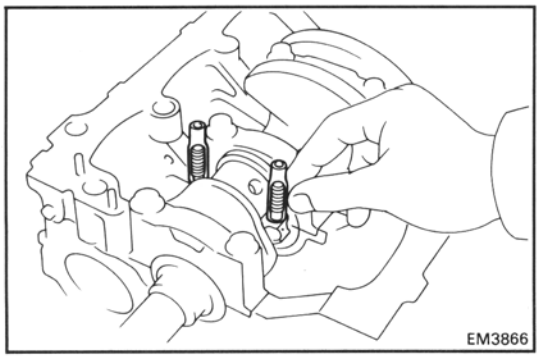
mm (in.)

Size	Big end inner diameter	Crank pin diameter	Bearing center wall thickness
1	47.015 – 47.022 (1.8510 – 1.8513)	43.988 – 44.000 (1.7318 – 1.7323)	1.488 – 1.492 (0.0586 – 0.0587)
2	47.023 – 47.030 (1.8513 – 1.8516)		1.491 – 1.496 (0.0587 – 0.0589)
3	47.031 – 47.038 (1.8516 – 1.8519)		1.496 – 1.500 (0.0589 – 0.0591)


EM3870

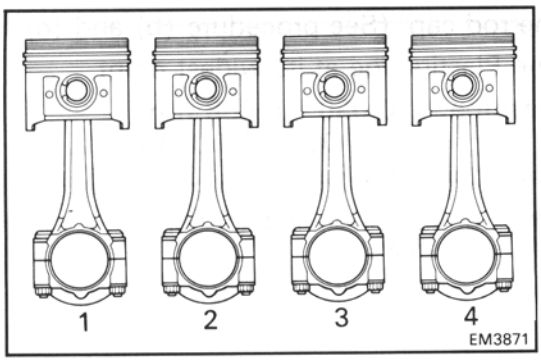
4. PUSH OUT PISTON AND CONNECTING ROD ASSEMBLIES

(a) Remove all the carbon from top of the cylinder.

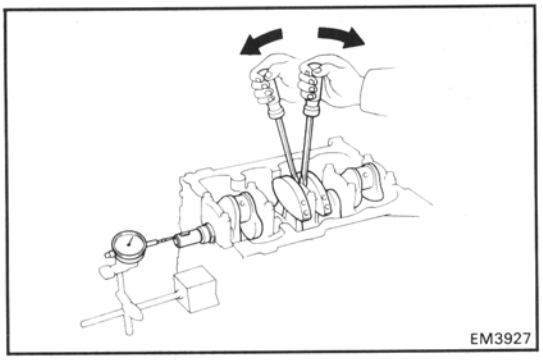

EM3866

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

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



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



5. MEASURE CRANKSHAFT THRUST CLEARANCE

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

Standard thrust clearance: **0.02 – 0.22 mm (0.0008 – 0.0087 in.)**

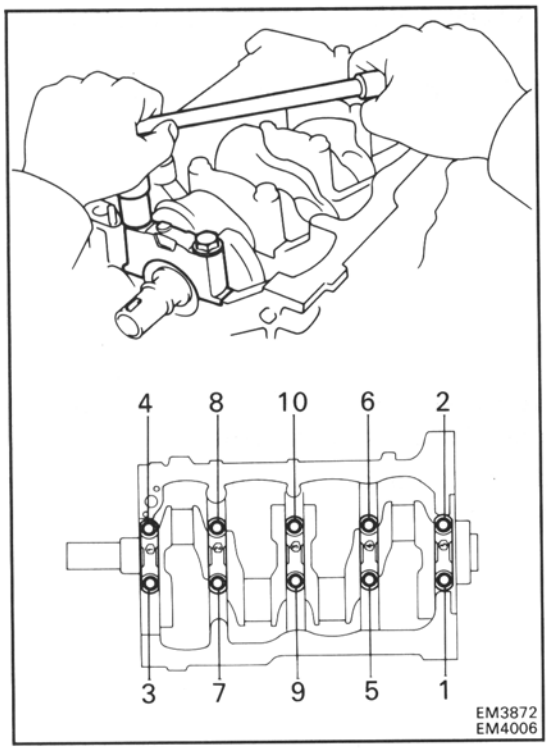
Maximum thrust clearance: **0.3 mm (0.012 in.)**

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

Over size thrust washer: **O/S 0.125, 0.250**

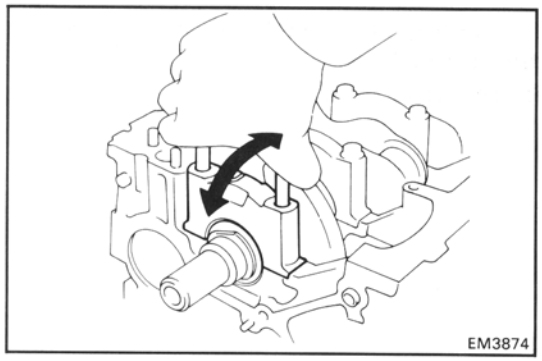
NOTE: Thrust washer thickness:

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



6. MEASURE MAIN JOURNAL OIL CLEARANCE

(a) Gradually loosen and remove the bearing cap bolts in three passes and in the numerical order shown.


EM3874

(b) Using the removed bearing cap bolts, pry the bearing cap back and forth, and remove it with the lower bearing and thrust washers (No.3 journal only).

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

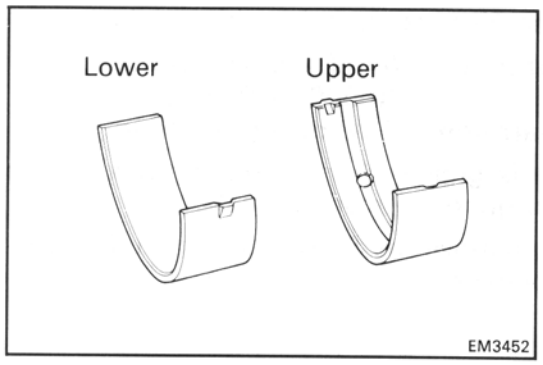
(c) Lift off the crankshaft.

NOTE: Keep the upper bearings and upper thrust washers (for the No.3 journal only) inserted in the cylinder block.

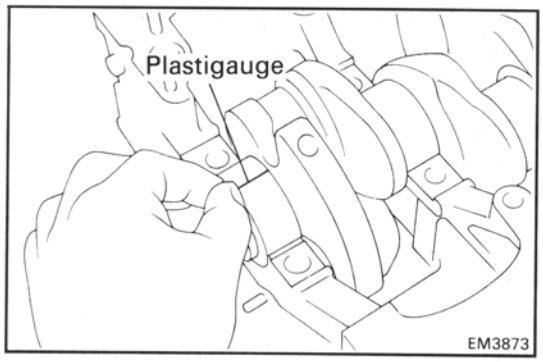
(d) Clean the journals and bearings.

(e) Check the journals and bearings for pitting and scratches.

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



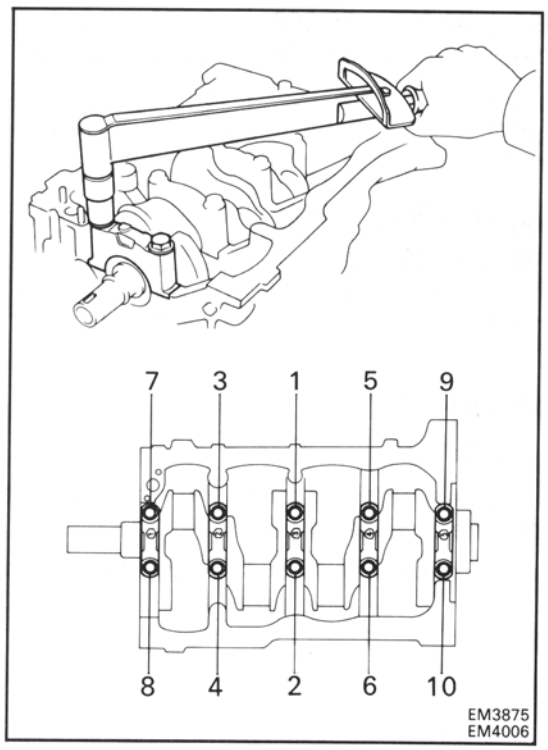
EM3452



EM3873

(f) Place the crankshaft on the cylinder block.

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



EM3875
EM4006

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

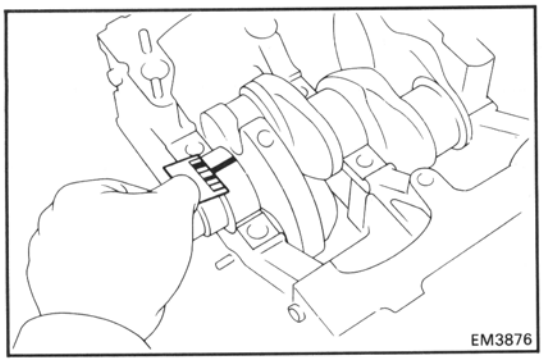
(i) Apply a light coat of engine oil on the threads and under the heads of the cap bolts.

(j) Torque the cap bolts in two or three passes and in the sequence shown.

Torque: 600 kg-cm (43 ft-lb, 59 N·m)

NOTE: Do not turn the crankshaft.

(k) Remove the bearing caps with the lower bearing and lower thrust washers.
(See procedure (a) and (b))

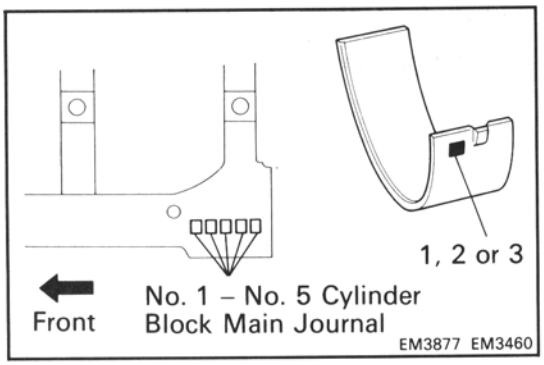


(l) Measure the Plastigauge at its widest point.

Standard clearance: **0.020 – 0.051 mm (0.0008 – 0.0020 in.)**
Maximum clearance: **0.08 mm (0.0031 in.)**

If the clearance is greater than maximum, replace the bearings and / or grind the main journals.

(m) Completely remove the Plastigauge from the bearings and journals.

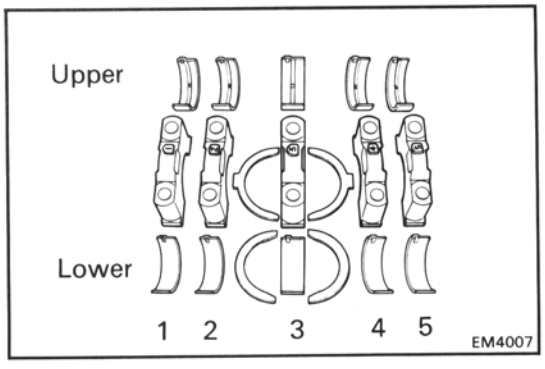


NOTE: If replacing the standard bearing, replace with one having the same number as marked on the bearing cap.

There are three sizes of standard bearings supplied, marked 1, 2 or 3 respectively.

mm (in.)

Size	Cylinder block main journal bore	Main journal diameter	Bearing center wall thickness
1	54.036 – 54.044 (2.1274 – 2.1277)	49.985 – 50.000 (1.9679 – 1.9685)	2.005 – 2.008 (0.0789 – 0.0791)
2	54.045 – 54.052 (2.1278 – 2.1280)		2.009 – 2.012 (0.0791 – 0.0792)
3	54.053 – 54.060 (2.1281 – 2.1283)		2.013 – 2.016 (0.0793 – 0.0794)
U / S 0.25	54.036 – 54.060 (2.1274 – 2.1283)	49.745 – 49.755 (1.9585 – 1.9589)	2.125 – 2.131 (0.0837 – 0.0839)
U / S 0.50		49.495 – 49.505 (1.9486 – 1.9490)	2.250 – 2.256 (0.0886 – 0.0888)

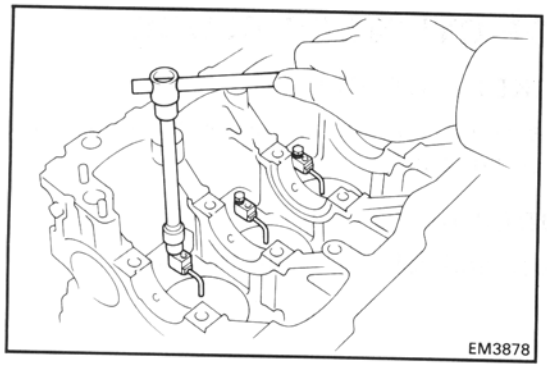


7. REMOVE CRANKSHAFT

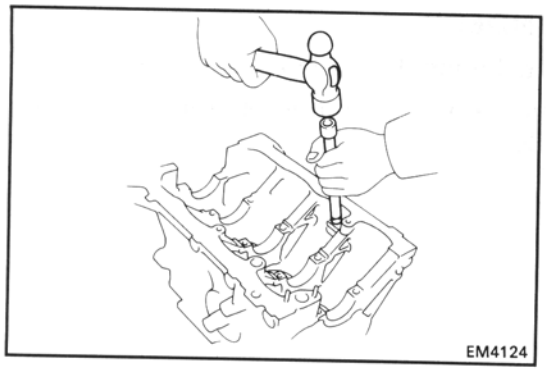
(a) Lift off the crankshaft.

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

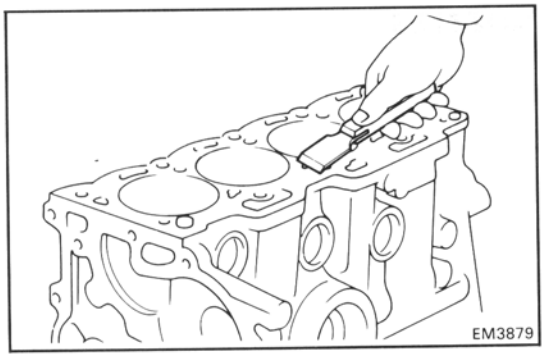
NOTE: Arrange the caps, bearings and thrust washers in correct order.



8. REMOVE OIL NOZZLES



9. REMOVE OIL DIPSTICK GUIDE


EM3879

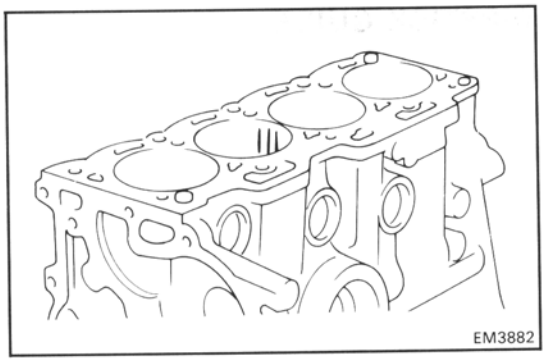
INSPECTION OF CYLINDER BLOCK

1. REMOVE GASKET MATERIAL

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

2. CLEAN CYLINDER BLOCK

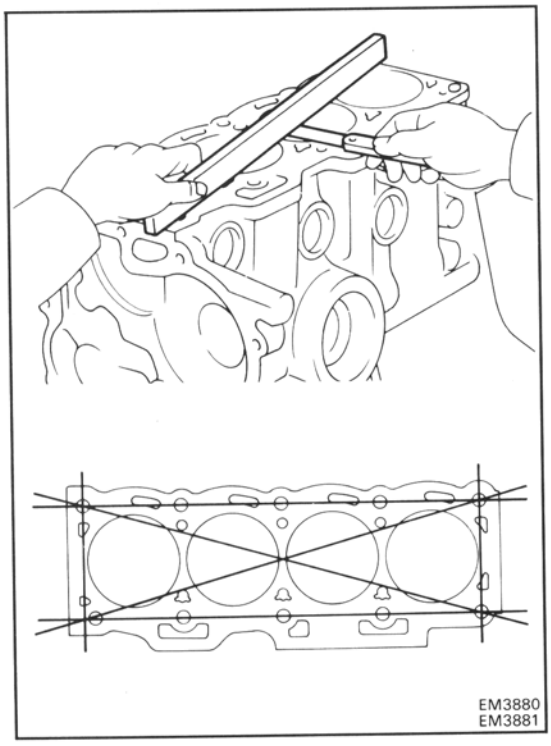
Using a soft brush and solvent, clean the block.


EM3882

3. INSPECT CYLINDERS

Visually inspect cylinders for vertical scratches.

If deep scratches are present, rebore all four cylinders. (See page EM-85)

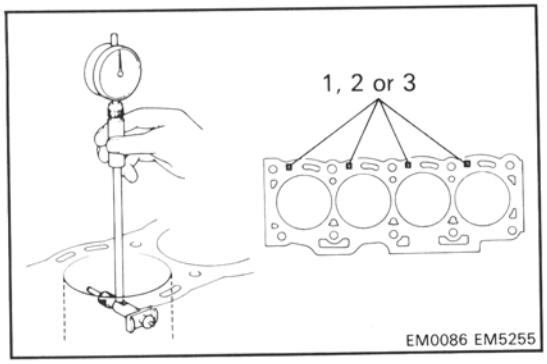

EM3880
EM3881

4. INSPECT CYLINDER BLOCK WARPAGE

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

Maximum warpage: 0.1 mm (0.004 in.)

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



EM0086 EM5255

5. MEASURE CYLINDER BORE

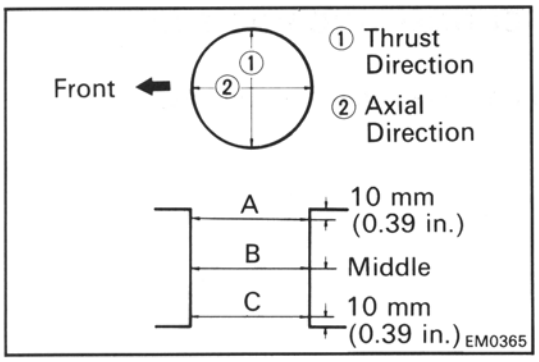
(a) Using a cylinder micrometer, measure the cylinder bore at positions A, B and C in the thrust and axial directions.

For standard sized piston
Standard diameter: 74.00 – 74.03 mm (2.9134 – 2.9146 in.)
Maximum diameter: 74.23 mm (2.9224 in.)
For Oversized piston (O/S 0.50)
Standard diameter: 74.50 – 74.53 mm (2.9331 – 2.9342 in.)
Maximum diameter: 74.73 mm (2.9421 in.)

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

NOTE: Standard Cylinder bore.

Cylinder No.	Cylinder bore
1	74.000 – 74.010 mm (2.9134 – 2.9138 in.)
2	74.010 – 74.020 mm (2.9138 – 2.9142 in.)
3	74.021 – 74.030 mm (2.9142 – 2.9146 in.)

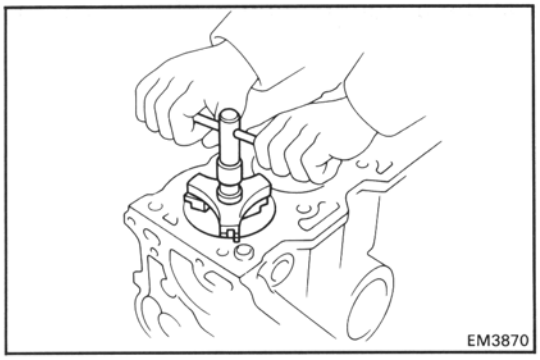


(b) Difference between measurements A, B and C is greater than taper limit.

Taper limit: 0.02 mm (0.0008 in.)

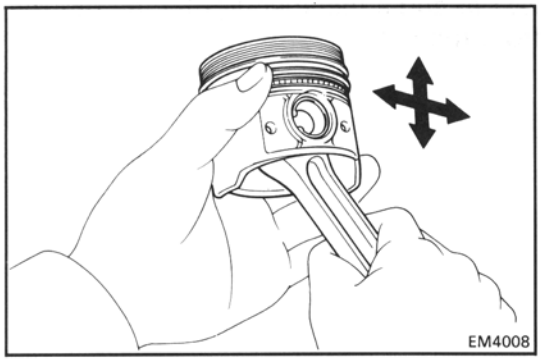
(c) Difference between the thrust and axial measurements is greater than out-of-round limit.

Out-of-round limit: 0.02 mm(0.0008 in.)



6. REMOVE CYLINDER RIDGE

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

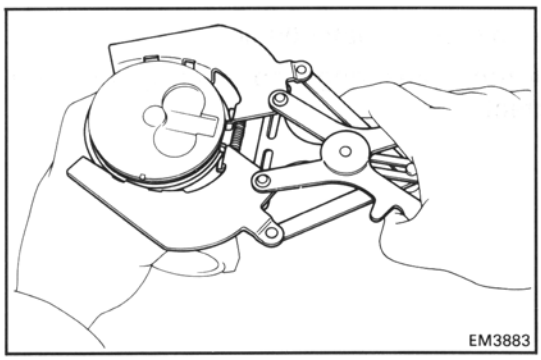


DISASSEMBLY OF PISTON AND CONNECTING ROD ASSEMBLIES

1. CHECK FIT BETWEEN PISTON AND PIN

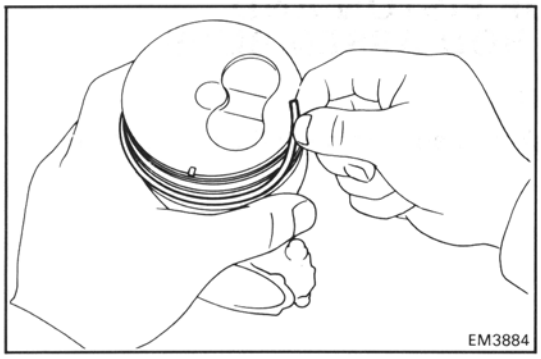
Try to move the piston back and forth on the piston pin.

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



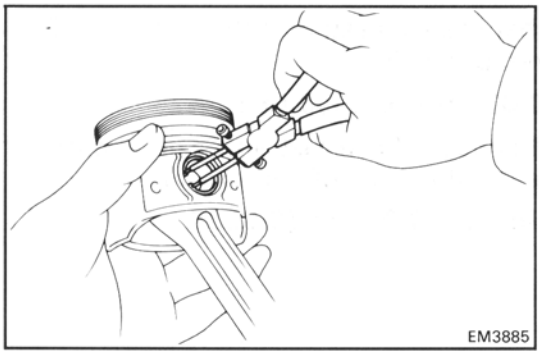
2. REMOVE PISTON RINGS

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



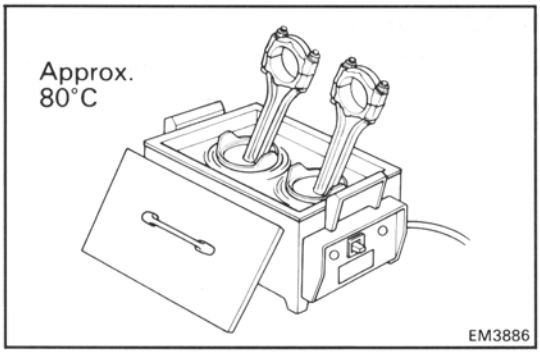
(b) Remove the two side rails and oil ring expander by hand.

NOTE: Arrange the rings in the correct order.

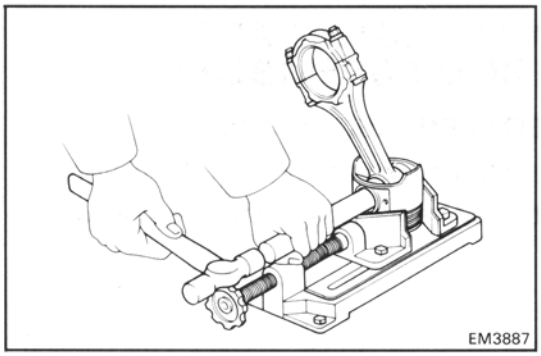


3. DISCONNECT CONNECTING ROD FROM PISTON

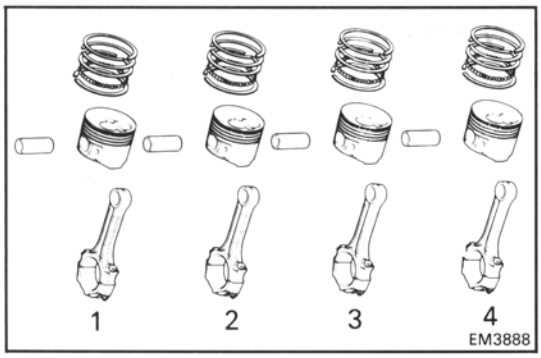
(a) Using snap ring pliers, remove the snap ring.



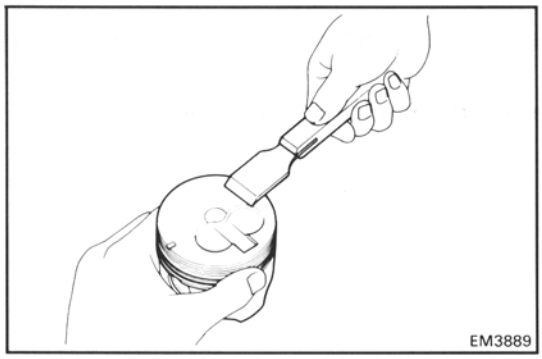
(b) Gradually heat the piston to approx. 80°C (176 °F).



(c) Using a brass bar and a hammer, lightly tap out the piston pin from the piston.



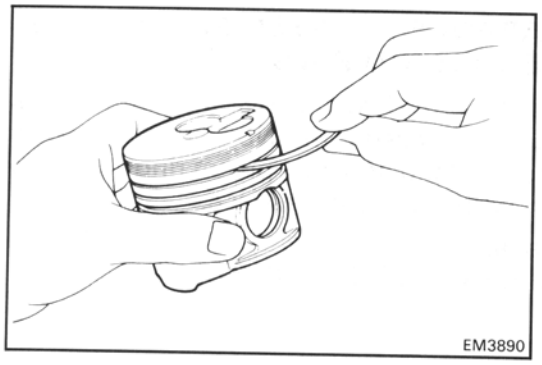
NOTE:
- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearing in correct order.



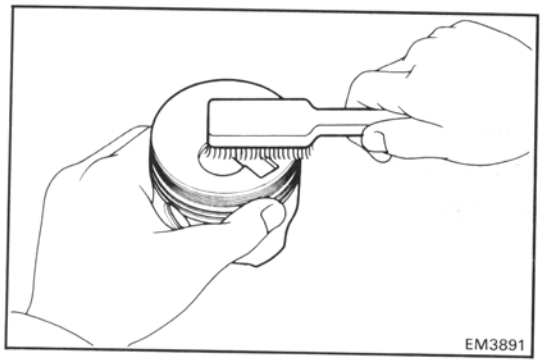
INSPECTION OF PISTON AND CONNECTING ROD ASSEMBLIES

1. CLEAN PISTON

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

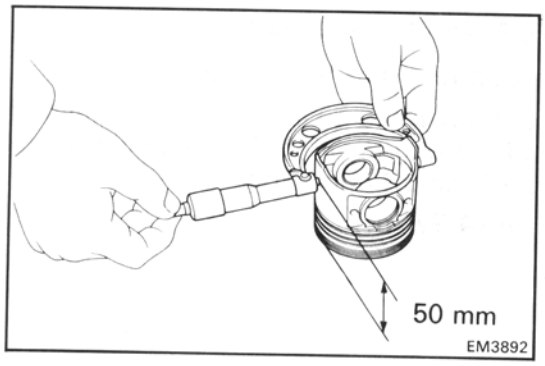


(b) Using a groove cleaning tool or broken ring, clean the ring grooves.



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

CAUTION: Do not use a wire brush.



2. MEASURE PISTON CLEARANCE

(a) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 50 mm (1.97 in.) from the piston head.

Piston diameter:

STD	**73.955 – 73.985 mm (2.9116 – 2.9128 in.)**
O/S 0.50	**74.455 – 74.458 mm (2.9313 – 2.9314 in.)**

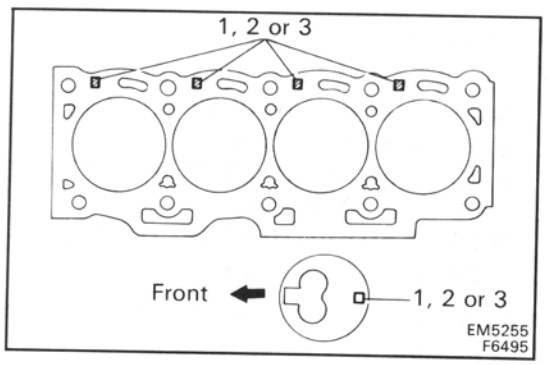
(b) Measure the cylinder bore diameter in thrust directions. (See page EM-77)

(c) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:
0.035 – 0.055 mm (0.0014 – 0.0022 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

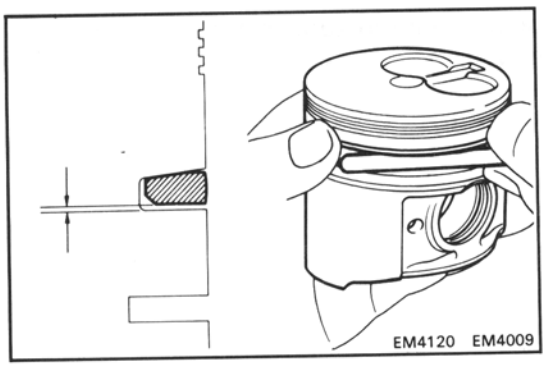
If the oil clearance is greater than maximum, replace all four pistons and/or rebore all four cylinders.

NOTE: Even when the oil clearance is greater than maximum, if may be possible to achieve standard oil clearance simply by choosing a standard piston with a narrower diameter.



mm (in.)

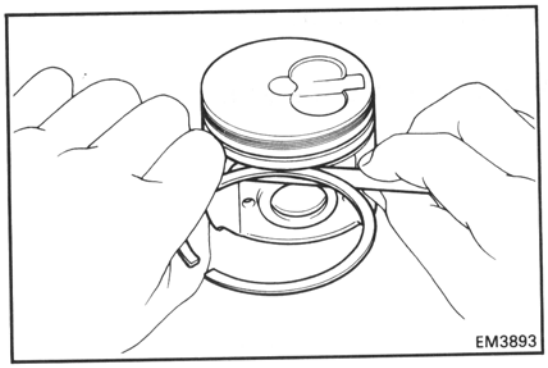
Piston No.	Piston Diameter	Cylinder Bore
1	73.955 – 73.965 (2.9116 – 2.9120)	74.000 – 74.010 (2.9134 – 2.9138)
2	73.966 – 73.975 (2.9120 – 2.9124)	74.010 – 74.020 (2.9138 – 2.9142)
3	73.976 – 73.985 (2.9124 – 2.9128)	74.021 – 74.030 (2.9142 – 2.9146)



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

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

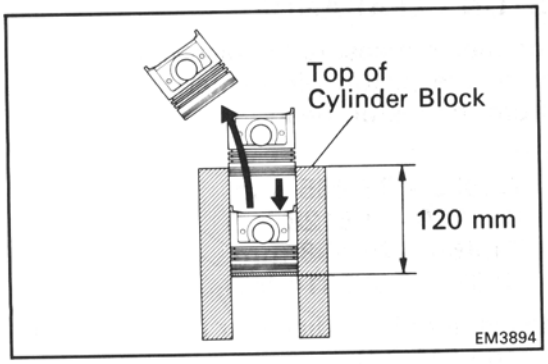
No. 1 ring clearance:
0.04 – 0.08 mm (0.0016 – 0.0031 in.)



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

No. 2 ring clearance:
0.04 – 0.08 mm (0.0016 – 0.0031 in.)

If not within specification, replace the piston.

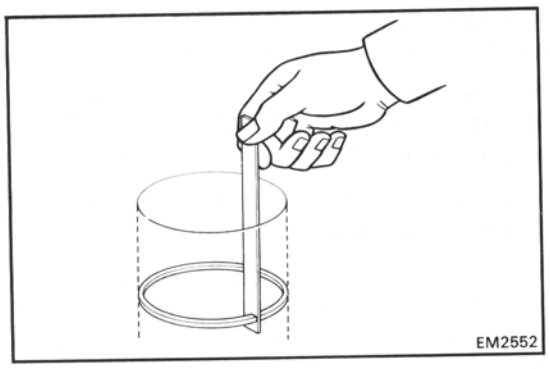


4. INSPECT PISTON RING END GAP

(a) Insert the piston ring into the cylinder.

(b) Using a piston, push the piston ring a little beyond the bottom of the ring travel to the following depth from the top of the cylinder block.

Depth: 120 mm (4.72 in.)



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

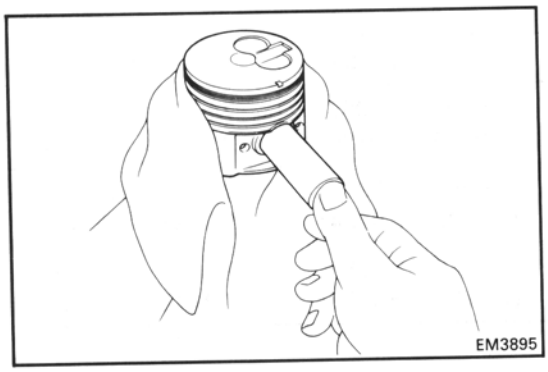
Ring end gap:

No.1	**STD**	**0.23 – 0.36 mm (0.0091 – 0.0142 in.)**
	Limit	**0.96 mm (0.0378 in.)**
No.2	**STD**	**0.40 – 0.55 mm (0.0157 – 0.0217 in.)**
	Limit	**1.05 mm (0.0413 in.)**
Oil	**STD**	**0.10 – 0.60 mm (0.0039 – 0.0236 in.)**
	Limit	**1.20 mm (0.0472 in.)**

If the clearance is greater than maximum, replace the piston ring and / or piston.

If the clearance is greater than maximum even with a new piston ring, rebore the cylinder and use an O / S piston ring.

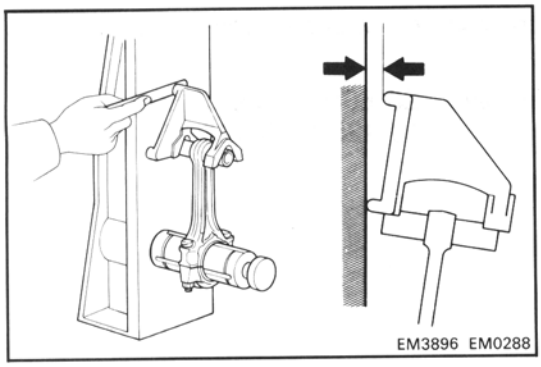
CAUTION: Do not file the ring end.



5. CHECK PISTON PIN FIT

At 80°C (176°F), the pin should be able to be pushed into the piston with your thumb.

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


EM3896 EM0288

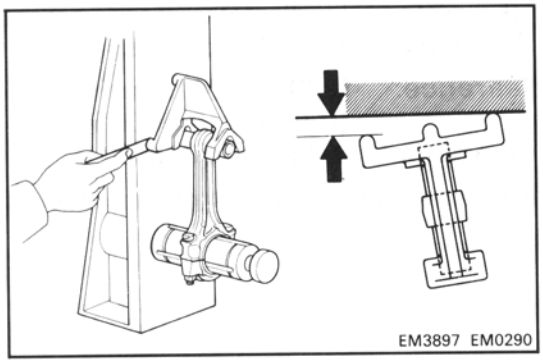
6. INSPECT CONNECTING RODS

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

- Check for bend.

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

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

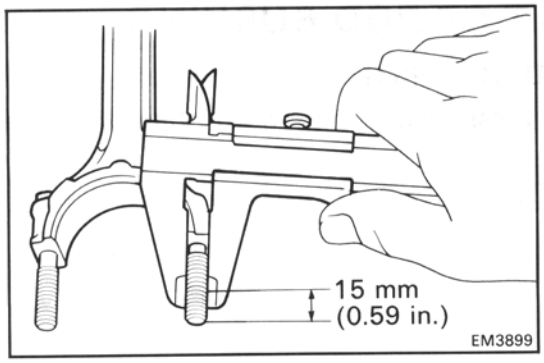

EM3897 EM0290

- Check for twist.

Maximum twist:
0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

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

NOTE: If replacing the connecting rods, replace the same number of connecting rod bearings as that of new connecting rod caps.



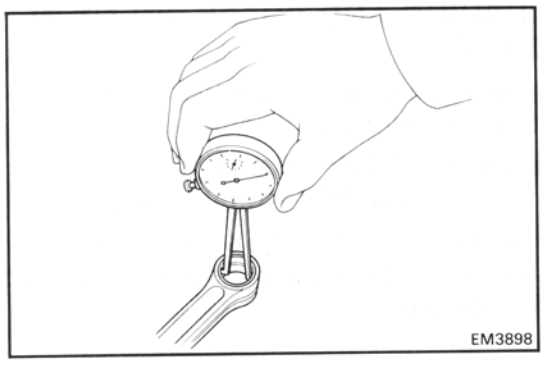
EM3899

(b) Inspect connecting rod bolts.

- Fix a nut to each of the connecting rod bolts threads and check that the nut can be turned by hand to the end of the threads.
- If a nut cannot be moved all the way down the threads, measure the compressed thread outer diameter with a measuring gauge.
- If the location of this area cannot be judged by visual inspection, use the dimension locations in the illustration and measure the outer diameter.

Standard diameter: **7.860 – 8.000 mm (0.3094 – 0.3150 in.)**
Minimum diameter: **7.60 mm (0.2992 in.)**

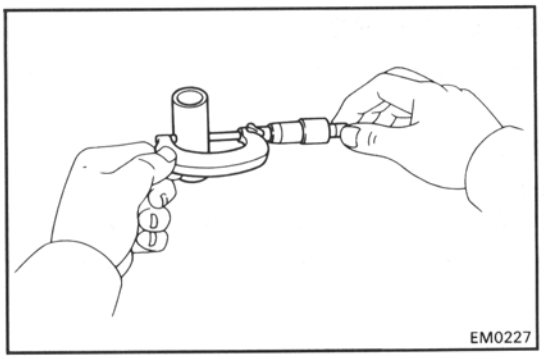
If the measurement is not within specifications, replace either the nut or connecting rod bolts.


EM3898

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

- Using a dial gauge, measure the inside diameter of the rod bushing.

Standard inside diameter: **23.511 – 23.523 mm (0.9256 – 0.9261 in.)**



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

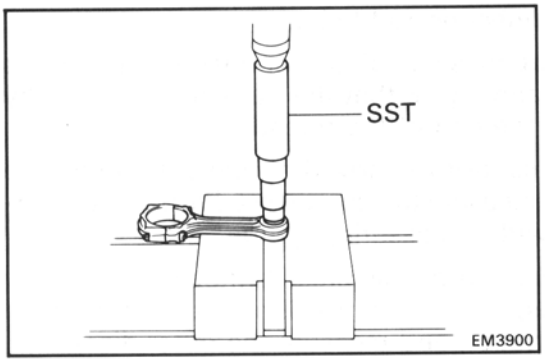
Standard diameter: 23.500 – 23.512 mm (0.9252 – 0.9257 in.)

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

Standard oil clearance: 0.007 – 0.015 mm (0.0003 – 0.0006 in.)

Maximum oil clearance: 0.05 mm (0.0020 in.)

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

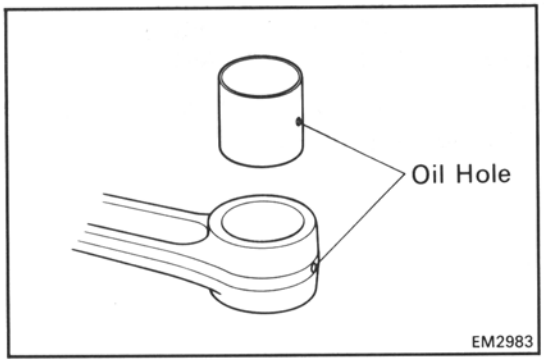


REPLACEMENT OF ROD BUSHING

1. REMOVE ROD BUSHING

Using SST and press, remove the rod bushing from the connecting rod.

SST 09222-66010

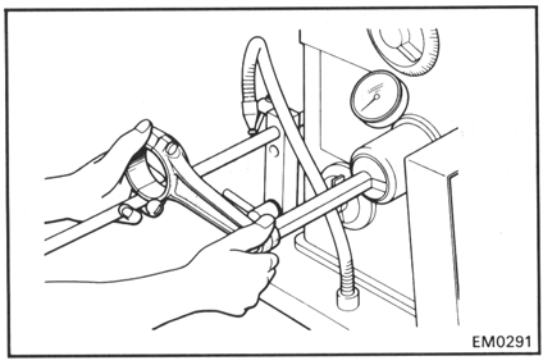


2. INSTALL NEW ROD BUSHING

Using SST and press, install the bushing to the connecting rod.

SST 09222-66010

NOTE: Align the bushing oil hole with the connecting rod oil hole.

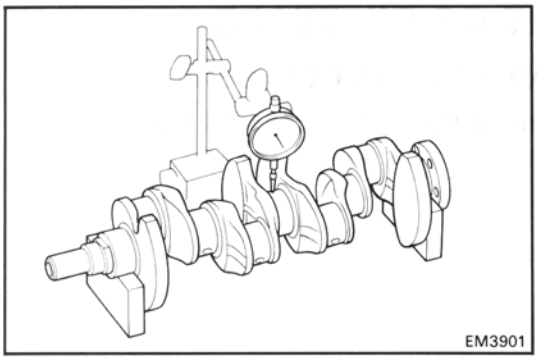


3. HONE NEW BUSHING AND CHECK PIN FIT IN CONNECTING ROD

(a) Hone the new bushing and check that the oil clearance is within standard specification.

Standard clearance: 0.007 – 0.015 mm (0.0003 – 0.0006 in.)

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


EM3901

INSPECTION OF CRANKSHAFT

1. MEASURE CRANKSHAFT FOR RUNOUT

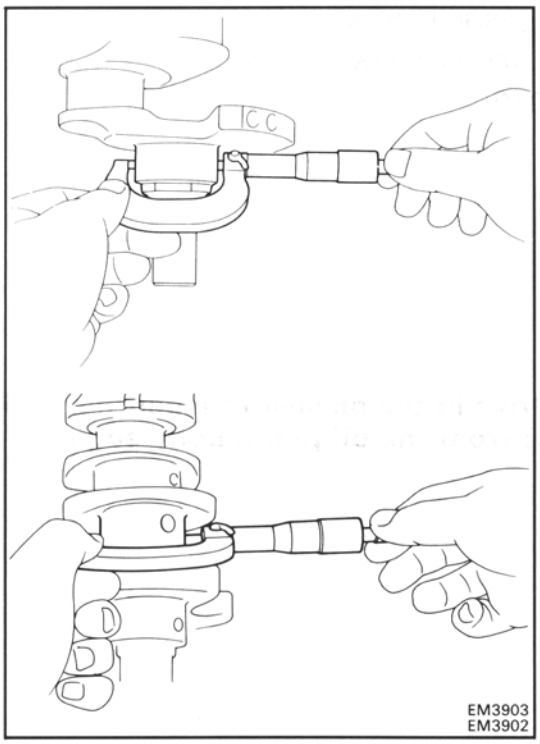
(a) Place the crankshaft on V-blocks.

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

Maximum circle runout: 0.06 mm (0.0024 in.)

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

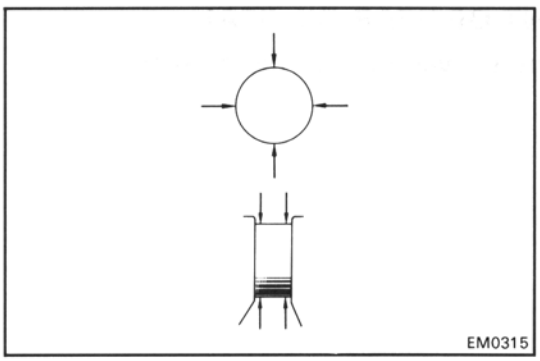
NOTE: Use a long spindle on the dial gauge.


EM3903
EM3902

2. INSPECT MAIN JOURNALS AND CRANK PINS

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

Standard main journal diameter:
49.985 – 50.000 mm (1.9679 – 1.9685 in.)
Standard crank pin diameter:
43.988 – 44.000 mm (1.7318 – 1.7323 in.)


EM0315

(b) Measure the journals for out-of-round and taper as shown.

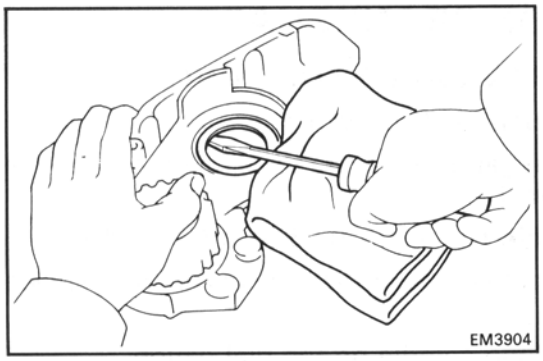
Maximum taper: 0.02 mm (0.0008 in.)
Maximum out-of- round: 0.02 mm (0.0008 in.)

If taper and out-of-round are greater than maximum, re-grind(main journal only) or replace the crankshaft.

3. GRIND AND HOME MAIN JOURNAL

Grind and hone the main journals to the undersized finished diameter.

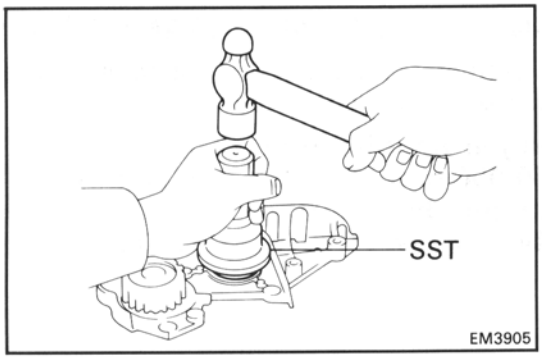
Main journal finished diameter:
U/S 0.25 49.745 – 49.755 mm
(1.9585 – 1.9589 in.)
0.50 49.495 – 49.505 mm
(1.9486 – 1.9490 in.)



REPLACEMENT OF OIL SEALS

1. REPLACEMENT OF FRONT OIL SEAL

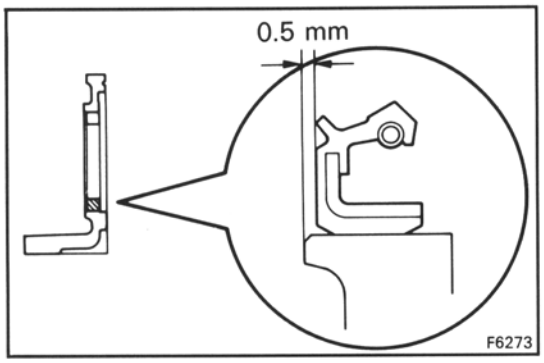
(a) Using a screwdriver, remove the oil seal.



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

(c) Using SST, install a new oil seal.

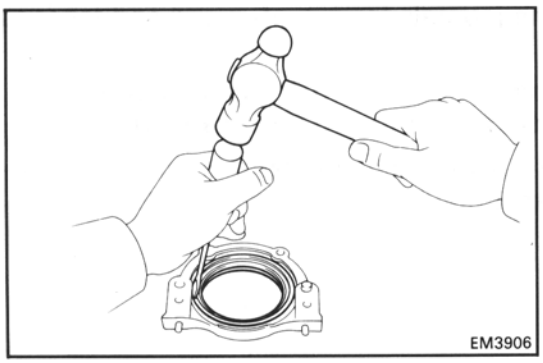
SST 09214-60010



CAUTION: Drive in the oil seal to a depth of 0.5 mm (0.020 in.) from the oil pump body edge.

2. REPLACEMENT OF REAR OIL SEAL

(a) Using a screwdriver, remove the oil seal.

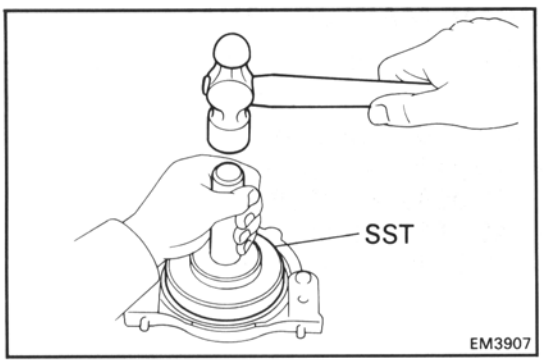


(b) Apply MP grease to a new oil seal.

(c) Using SST, install a new oil seal.

SST 09223-41020

NOTE: Be careful not to install the oil seal slantwise.

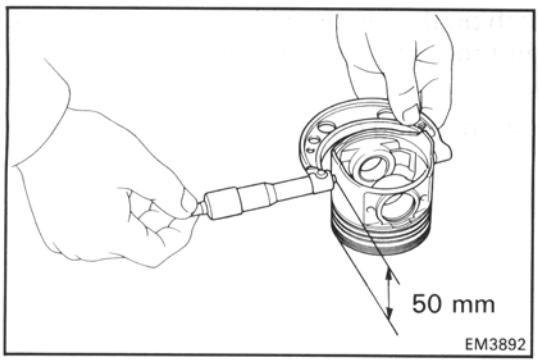


BORING OF CYLINDERS

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

1. SELECT OVERSIZED PISTON

Oversized piston diameter:
O/S 0.50 74.455 – 74.485 mm
(2.9313 – 2.9325 in.)



2. CALCULATE DIMENSION TO BORE CYLINDERS

(a) Using a micrometer, measure the piston diameter at a right angle to the piston pin center line, 50 mm(1.97 in.) the piston head.

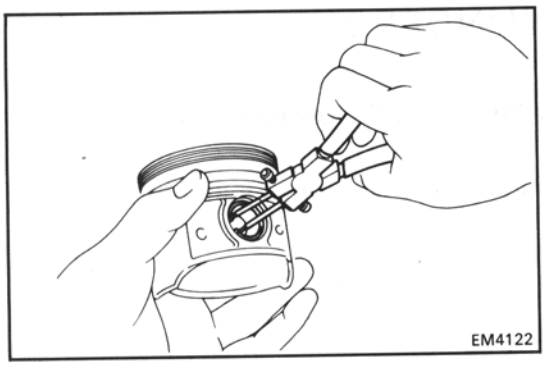
(b) Calculate the size each cylinder is to be rebored as follows.

Size to be rebored = P + C – H
P = piston diameter
C = piston clearance
0.035 – 0.055 mm (0.0014 – 0.0022 in.)
H = allowance for honing
Less than 0.02 mm (0.0008 in.)

3. BORE AND HONE CYLINDERS TO CALCULATED DIMENSIONS

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

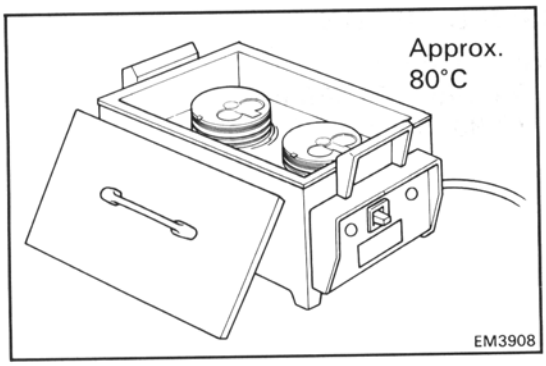
CAUTION: Excess honing will destroy the finished roundness.



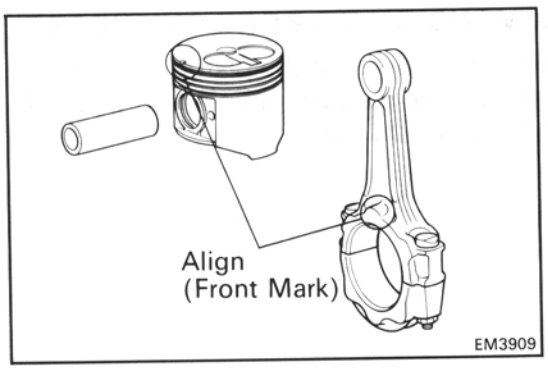
ASSEMBLY OF PISTON AND CONNECTING ROD

1. ASSEMBLE PISTON AND CONNECTING ROD

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



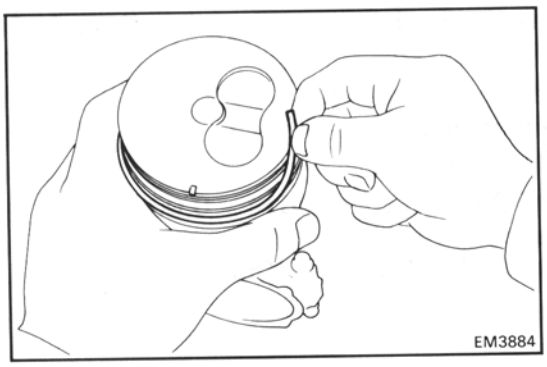
(b) Gradually heat the piston to approx. 80°C (176°F).



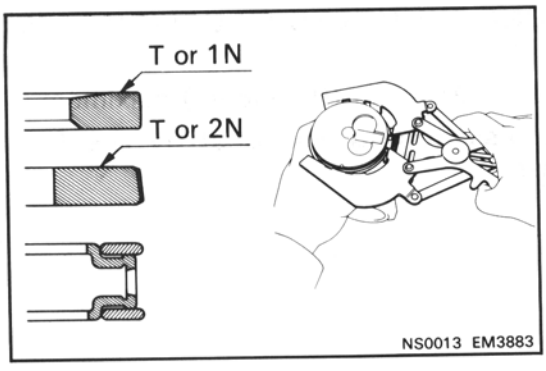
(c) Align the notch on the piston with the protrusion on the connecting rod and push the piston pin in with your thumb.

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

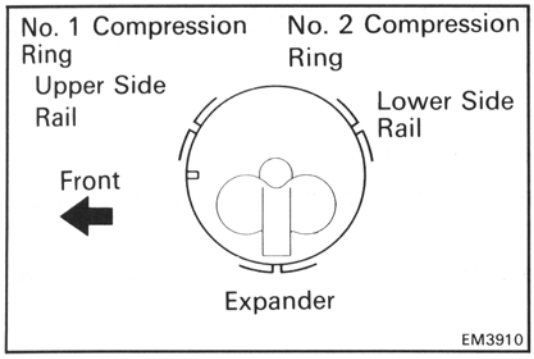
2. INSTALL PISTON RINGS



(a) Install the oil ring expander and two side rails by hand.



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



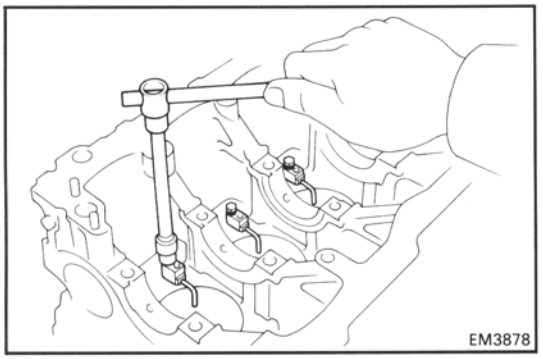
(c) Position the piston rings so that the ring ends are as shown.

CAUTION: Do not align the end gaps.

ASSEMBLY OF CYLINDER BLOCK

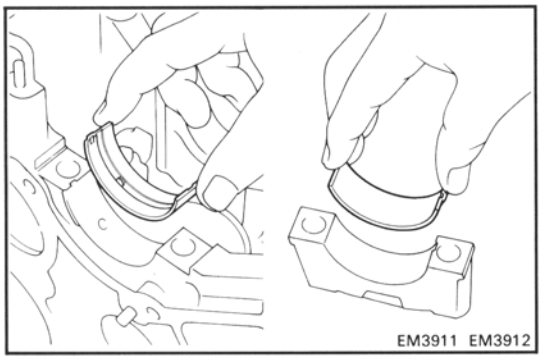
(See page EM-64)

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.



1. INSTALL OIL NOZZLES

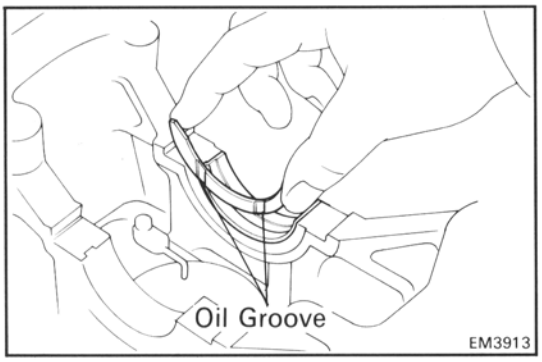
Torque: 80 kg-cm (69 in.-lb, 7.8 N·m)



2. INSTALL MAIN BEARINGS

Install the bearing in the cylinder block and bearing caps.

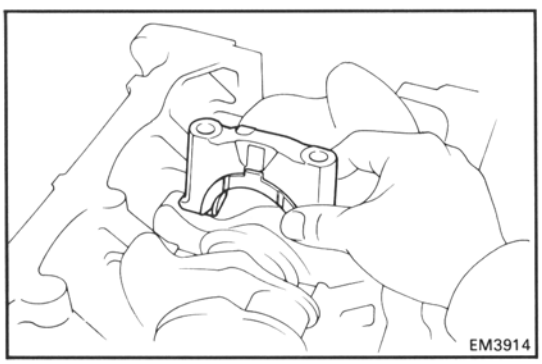
CAUTION: Install the bearing with the oil hole in the block.



3. INSTALL UPPER THRUST WASHERS

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

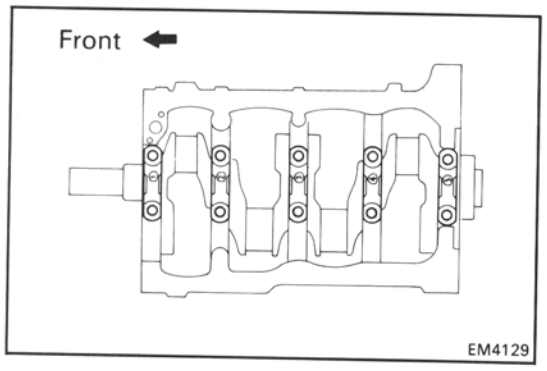
4. PLACE CRANKSHAFT IN CYLINDER BLOCK.



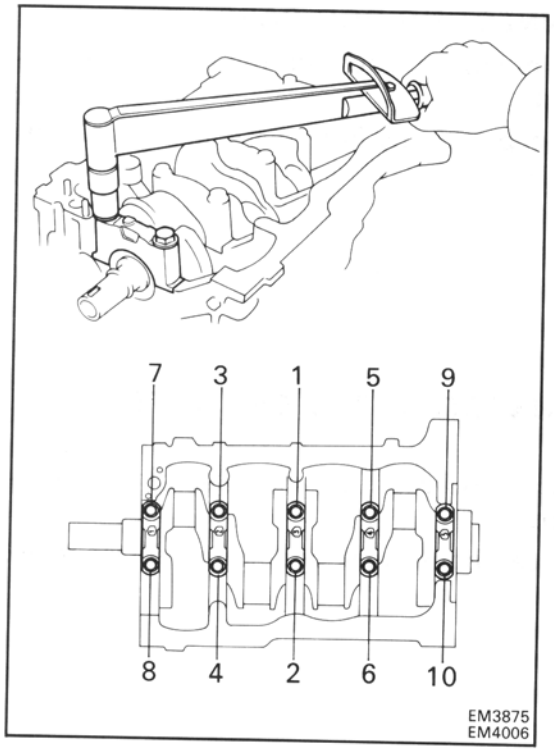
5. INSTALL MAIN BEARING CAPS

NOTE: Each bearing cap is numbered.

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



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



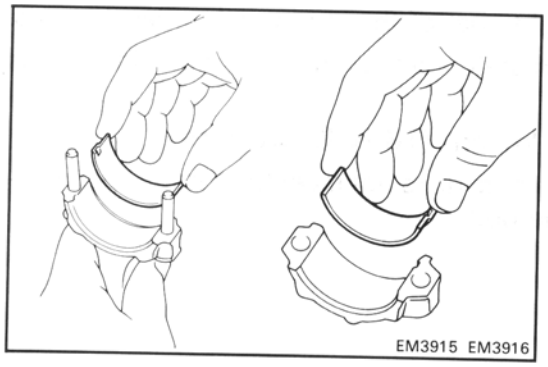
(c) Apply a light coat of engine oil on the threads and under the heads of the cap bolts.

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

Torque: 600 kg-cm (43 ft-lb, 59 N·m)

(e) Check that the crankshaft turns smoothly.

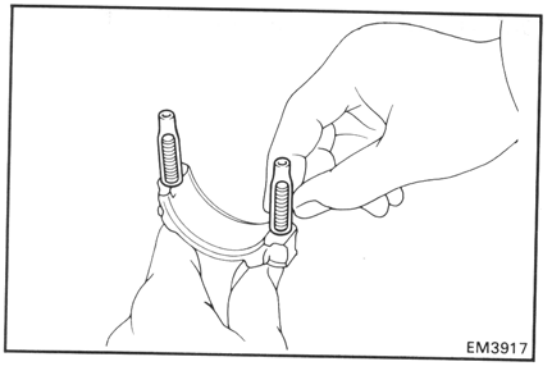
(f) Check the crankshaft thrust clearance.
(See step 5 on page EM-72)



6. INSTALL BEARINGS

(a) Install the bearings in the connecting rods and rod caps.

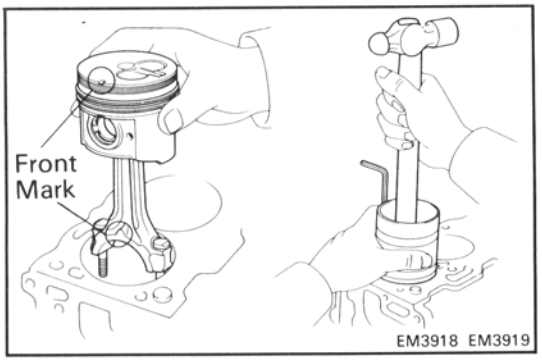
(b) Lubricate the face of the bearings with clean engine oil.



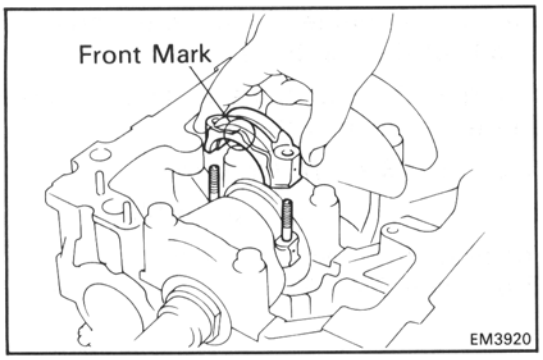
7. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES

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

(b) Lubricate the cylinder bore and rod journals with clean engine oil.



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



8. INSTALL CONNECTING ROD CAPS

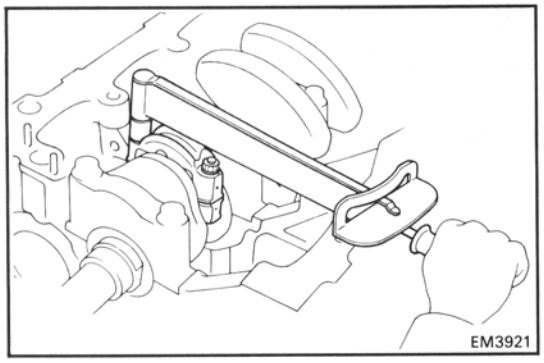
(a) Match the numbered cap with the numbered connecting rod.

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

9. TORQUE CONNECTING ROD CAP NUTS

NOTE:

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

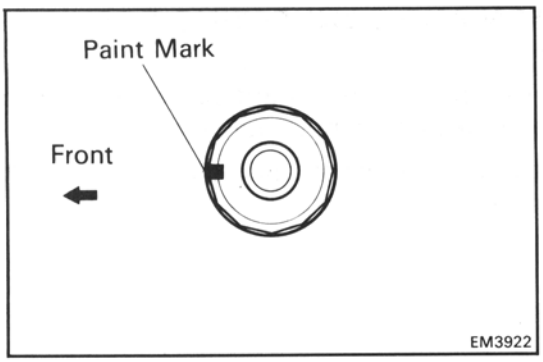


(a) Apply a light coat of the engine oil under the nuts.

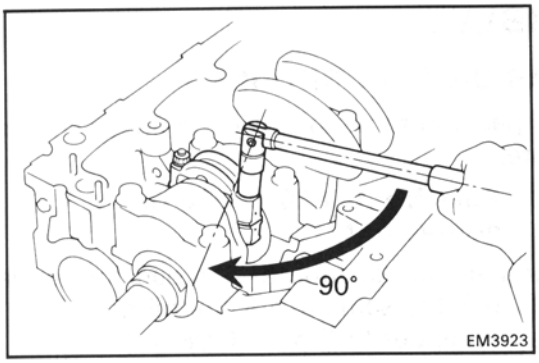
(b) First, alternately torque the cap nuts in several passes.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)

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



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

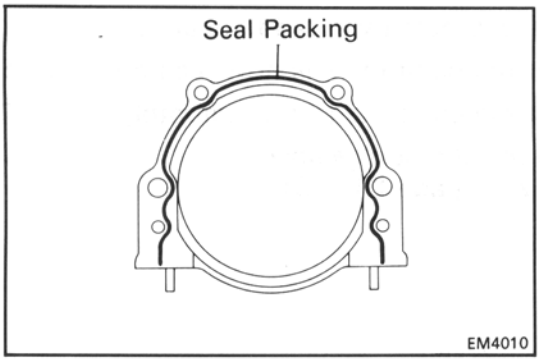


(d) Torque the cap nuts by an additional 90°.

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

(f) Check that the crankshaft turns smoothly.

(g) Check the rod thrust clearance.
(See step 2 on page EM-69)



POST ASSEMBLY

1. INSTALL REAR OIL SEAL RETAINER

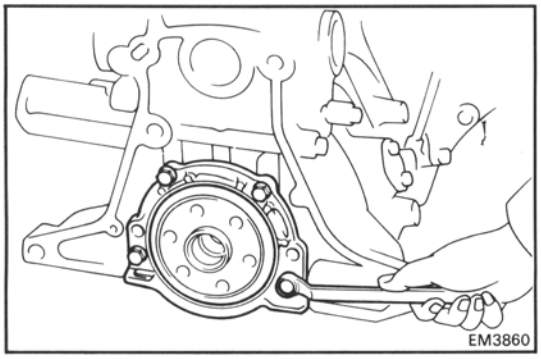
(a) Apply seal packing to the oil seal retainer as shown in the figure.

Seal packing: Part No. 08826-00080 or equivalent

NOTE: Cleaning and application of seal packing to the installation surface is the same as for the oil pan. However, use a nozzle cut to 2 mm (0.08 in.)

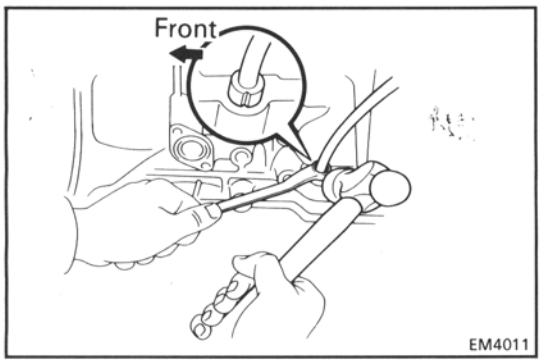
(b) Install the oil seal retainer with the four bolts. Torque the four bolts.

Torque: 80 kg-cm (69 in.-lb, 7.8 N·m)



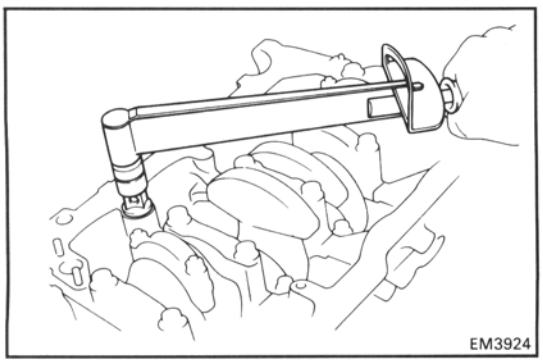
2. INSTALL OIL PUMP

(See step 2 on page LU-9)



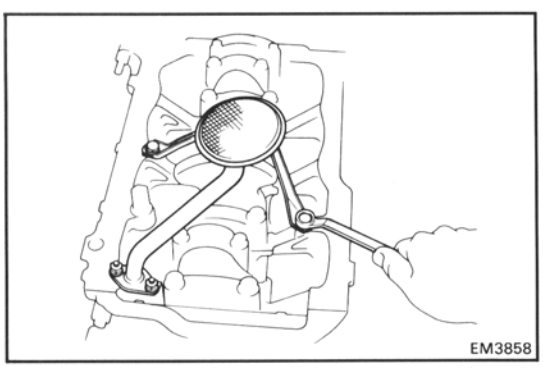
3. INSTALL OIL DIPSTICK GUIDE

Install the oil dipstick guide with the mark facing rightward.



4. INSTALL OIL REGULATOR

Torque: 250 kg-cm (18 ft-lb, 25 N·m)



5. INSTALL OIL STRAINER

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

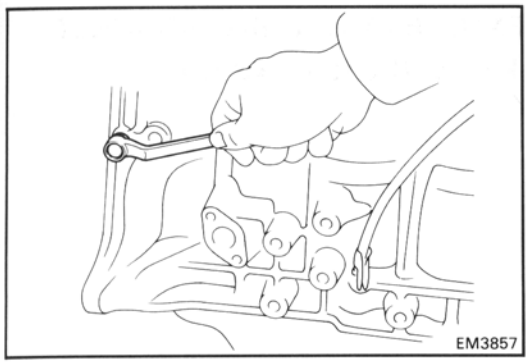
(b) Install the oil strainer with the two bolts and nuts.

(c) Torque the bolts.

Torque: Bolt 120 kg-cm (9 ft-lb, 12 N·m)
Nut 80 kg-cm (69 in.-lb, 7.8 N·m)

6. INSTALL OIL PAN

(See step 4 on page LU-10)

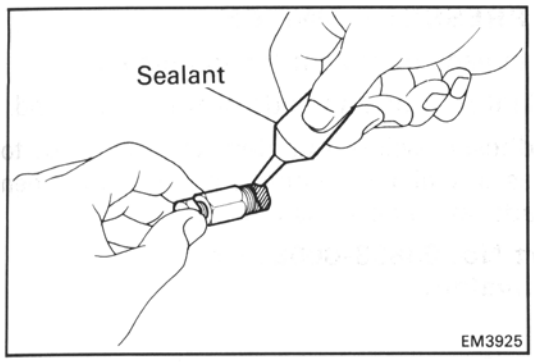


7. INSTALL STRAIGHT SCREW PLUG

(a) Install a new gasket to the plug.

(b) Install and torque the plug.

Torque: 250 kg-cm (18 ft-lb, 25 N·m)



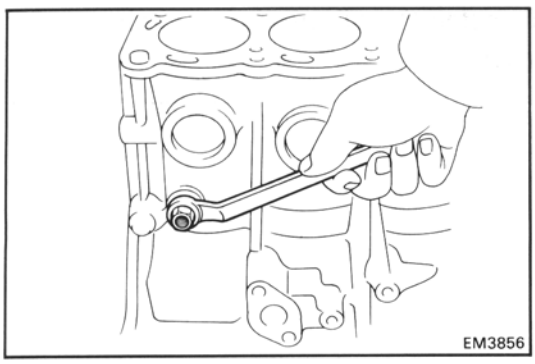
8. INSTALL DRAIN COCK

(a) Clean the drain cock threads and cylinder block drain cock hole of any sealant or foreign material.

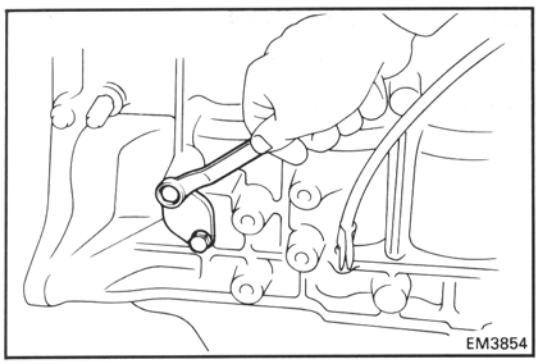
(b) Apply sealant to 2 or 3 threads of the drain cock end.

Sealant: Part No. 08833-00070 or equivalent

NOTE: This adhesive will not harden while exposed to air. It will act as a sealant or binding agent only when applied to threads, etc. and air is cut off.



(c) Install and tighten the drain cock.

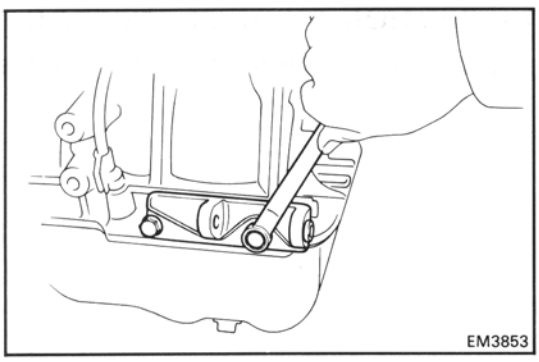


9. INSTALL OIL HOLE COVER PLATE

(a) Install a new O-ring to the cylinder block.

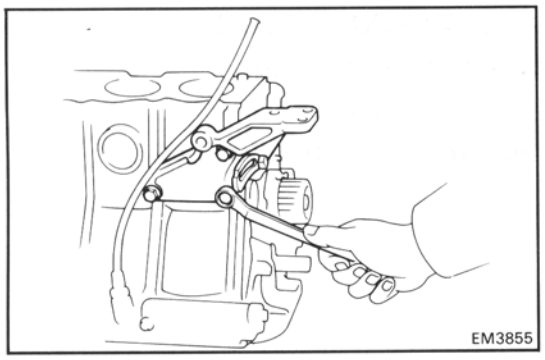
(b) Install and torque the oil hole cover plate with the two bolts.

Torque: 195 kg-cm (14 ft-lb, 19 N·m)



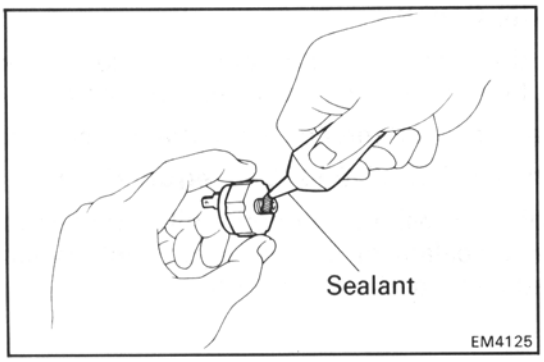
10. INSTALL ALTERNATOR BRACKET

Torque: 400 kg-cm (29 ft-lb, 39 N·m)



11. INSTALL RH ENGINE MOUNTING BRACKET

Torque: 440 kg-cm (32 ft-lb, 43 N·m)



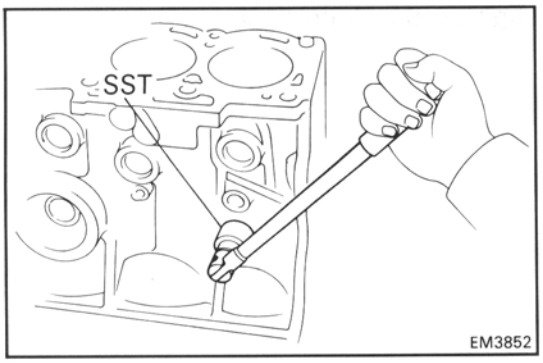
12. INSTALL OIL PRESSURE SWITCH

(a) Clean the threads of sealant foreign material.

(b) Apply sealant to 2 or 3 threads of the switch end.

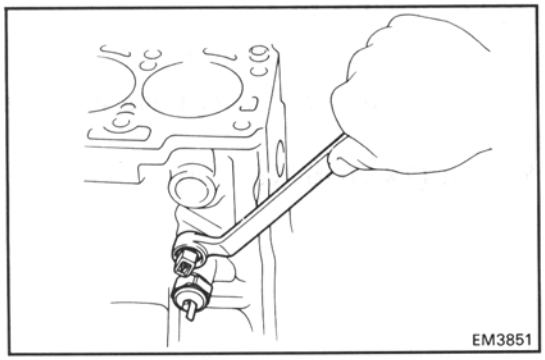
NOTE: This adhesive will not harden while exposed to air. It will act as a sealer or binding agent only when applied to threads, etc. and air is cut off.

Sealant: Part No. 08833-00080 or equivalent



(c) Using SST, install the oil pressure switch.

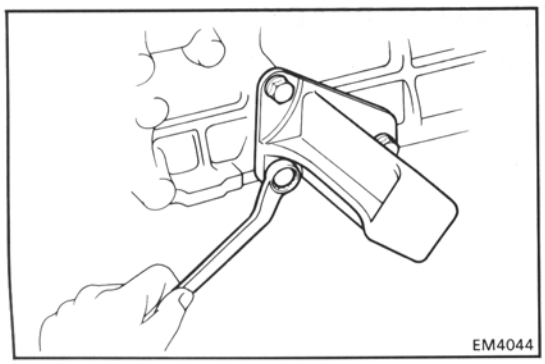
SST 09816-30010



13. INSTALL WATER TEMP. SENSOR

(a) Install a new gasket to the water temp. sensor.

(b) Install and torque the water temp. sensor.

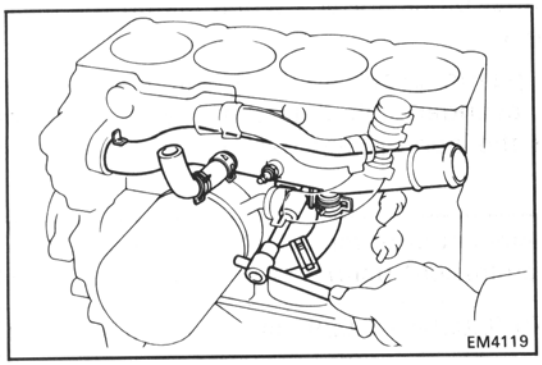


14. INSTALL NO.1 INJECTION PUMP PROTECTOR

Install the No.1 injection pump protector with the three bolts.

15. INSTALL OIL COOLER
(See steps 1, 2 on page LU-13)

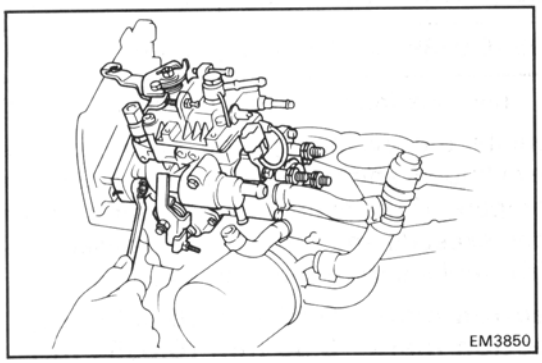
16. INSTALL OIL FILTER
(See step 2 on page LU-4)


EM4119

17. INSTALL WATER INLET PIPE

(a) Install a new O-ring to the water inlet pipe.
(b) Insert the water inlet pipe to the cylinder block.
(c) Install and tighten the bolt.
(d) Connect the No. 2 oil cooler hose to the oil cooler.

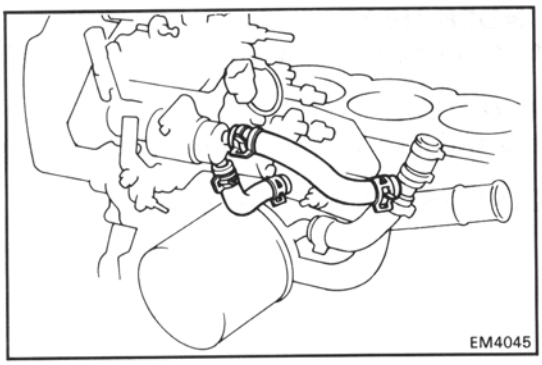
18. INSTALL WATER PUMP
(See step 1 on page CO-5)


EM3850

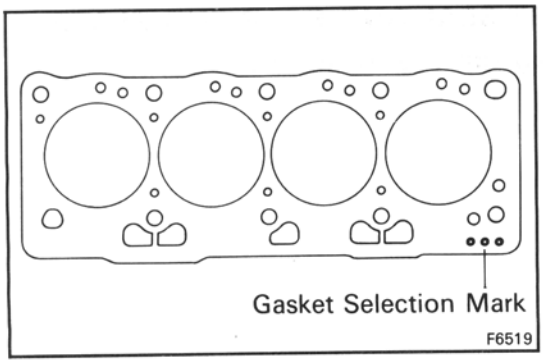
19. INSTALL INJECTION PUMP

(a) Align the matchmarks on the injection pump and water pump.
(b) Temporarily install the mounting bolts and nuts.

NOTE: Torque the mounting bolts and nuts to specification after adjusting the injection timing.


EM4045

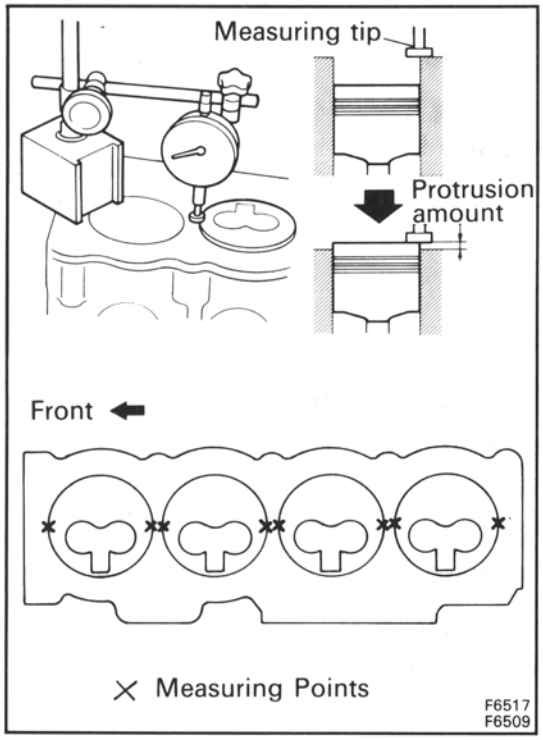
(c) Connect the No. 1 and No. 2 water by-pass hoses to the injection pump.

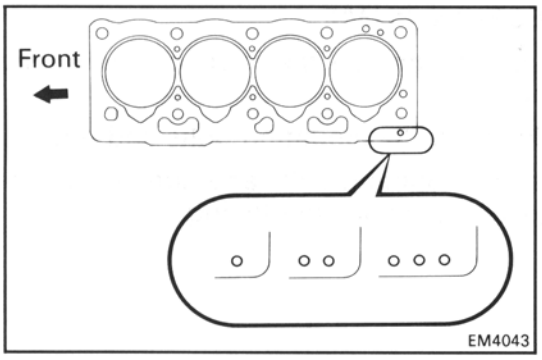


F6519

20. SELECT CYLINDER HEAD GASKET

NOTE:
- If only replacing the gasket, use a gasket of the same thickness (make your choice accoriding to the thickness indentification number on the gasket).
- If replacing the cylinder block, pistons, connecting rods, or crankshaft, use the following procedures to make the cylinder head gasket selection.





(a) Clean the cylinder block with solvent.

(b) Using a dial gauge, measure the amount of piston protrusion at all cylinders from at the upper surface of the cylinder block.

(c) Measuring is to be done at two points for each cylinder, as shown in the illustration.

NOTE:

- Change the dial gauge measuring tip to that shown in the illustration.
- Make certain that the measuring tip is vertical to the cylinder block surface when taking the measurements.

(d) From the piston protrusion measurements taken from each cylinder, calculate the average amount and select the appropriate gasket using the table below.

Selection mark	Amount of piston protrusion* (mm)	Head gasket thickness (mm)
1	0.65 – 0.75 (0.0256 – 0.0295 in.)	1.45 (0.0571 in.)
2	0.76 – 0.85 (0.0299 – 0.0335 in.)	1.55 (0.0610 in.)
3	0.86 – 0.95 (0.0339 – 0.0374 in.)	1.65 (0.0650 in.)

* (average from the eight measuring points)

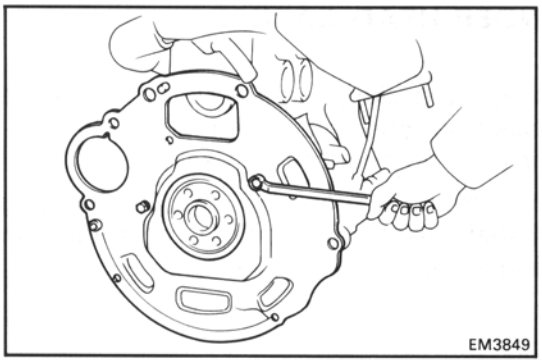
(e) Next, calculate the average piston protrusion for each of the cylinders and with the gasket selected in (d) and compare. If the average protrusion of even one cylinder exceeds the limit for the gasket selected in (d), replace with the next size gasket.

Limit: 1 Selection mark 0.80 mm (0.0315 in.)
Limit: 2 Selection mark 0.90 mm (0.0354 in.)

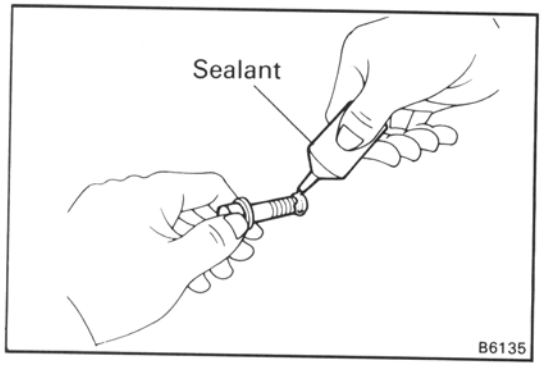
21. INSTALL CYLINDER HEAD
(See steps 1 to 9 on pages EM-60 to 62)

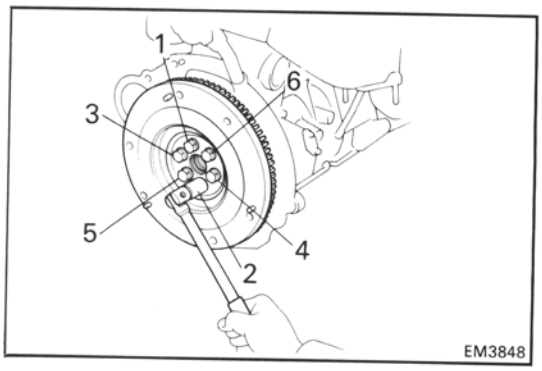
22. INSTALL TIMING BELT
(See steps 1 to 3 and 5 to 14 on pages EM-31 to 35)

23. REMOVE ENGINE FROM ENGINE STAND



24. INSTALL DUST SEAL AND REAR END PLATE
Torque: 50 kg-cm (43 in.-lb, 4.9 N.m)





25. INSTALL FLYWHEEL ON CRANKSHAFT

(a) Clean the set bolt threads and crankshaft bolt holes of any sealant, oil or foreign material.

Remove any oil with kerosene or gasoline.

(b) Apply sealant to 2 or 3 threads of the bolt end.

Sealant: Part No. 08833-00070 or equivalent

NOTE: This adhesive will not harden while exposed to air. It will act as a sealer or binding agent only when applied to threads, etc. and air is cut off.

(c) Install the flywheel on the crankshaft.
Torque the bolts to the specified torque in two or three passes in the sequence shown.

Torque: 900 kg-cm (65 ft-lb, 88 N·m)

26. INSTALL CLUTCH DISC AND COVER

NOTE: If necessary, inspect the clutch unit before installation.

27. INSPECT AND ADJUST INJECTION TIMING

(See page EM-18)