ENGINE MECHANICAL

EM

EM8275

AIR FILTER
INSPECTION

EMIM0-01

1.   **REMOVE AIR FILTER**
2.   **INSPECT AIR FILTER**
Visually check that the filter is not excessively dirty or oily.
3.   **CLEAN AIR FILTER**
Clean the filter element with compressed air. First blow from the inside thoroughly. Then blow off the out side of the filter element.
4.   **REINSTALL AIR FILTER**

EM

COMPRESSION
INSPECTION

EM1MI–01

HINT:

If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.
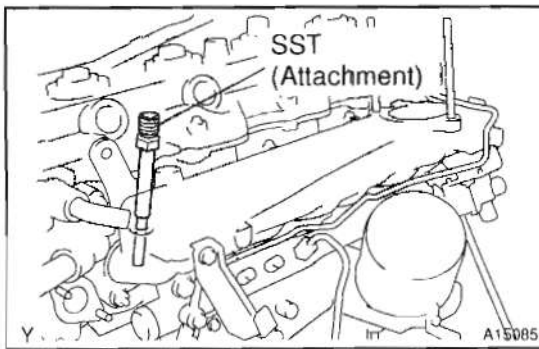
1.   WARM UP AND STOP ENGINE

Allow the engine to warm up to normal operating temperature.

2.   REMOVE GLOW PLUGS (See page EM–11)

3.   DISCONNECT INJECTOR CONNECTORS
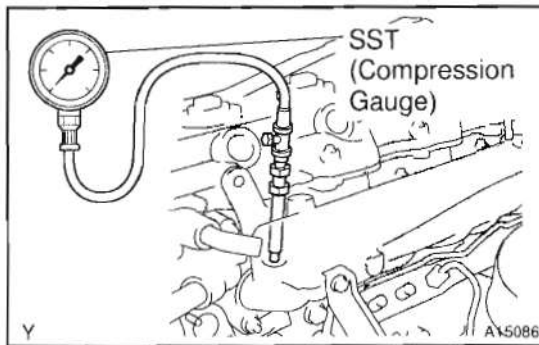

4.   CHECK CYLINDER COMPRESSION PRESSURE

HINT:

Turn the starter before measuring the compression and discharge the foreign objects.

(a)   Install SST (attachment) to the glow plug hole.

SST   09992–00025 (09992–00121)

Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

(b)   Connect SST (compression gauge) to the SST (attachment).

SST   09992–00025 (09992–00211)

(c)   Fully open the throttle valve, and start the engine.

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

HINT:

Always use a fully charged battery to obtain engine revolution of 250 rpm or more.

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

NOTICE:

This measurement must be done in as short a time as possible.

Compression pressure:

2,700 kPa (27.5 kgf/cm^2, 391 psi) or more

Minimum pressure:

2,200 kPa (22.5 kgf/cm^2, 320 psi) or more

Difference between each cylinder:
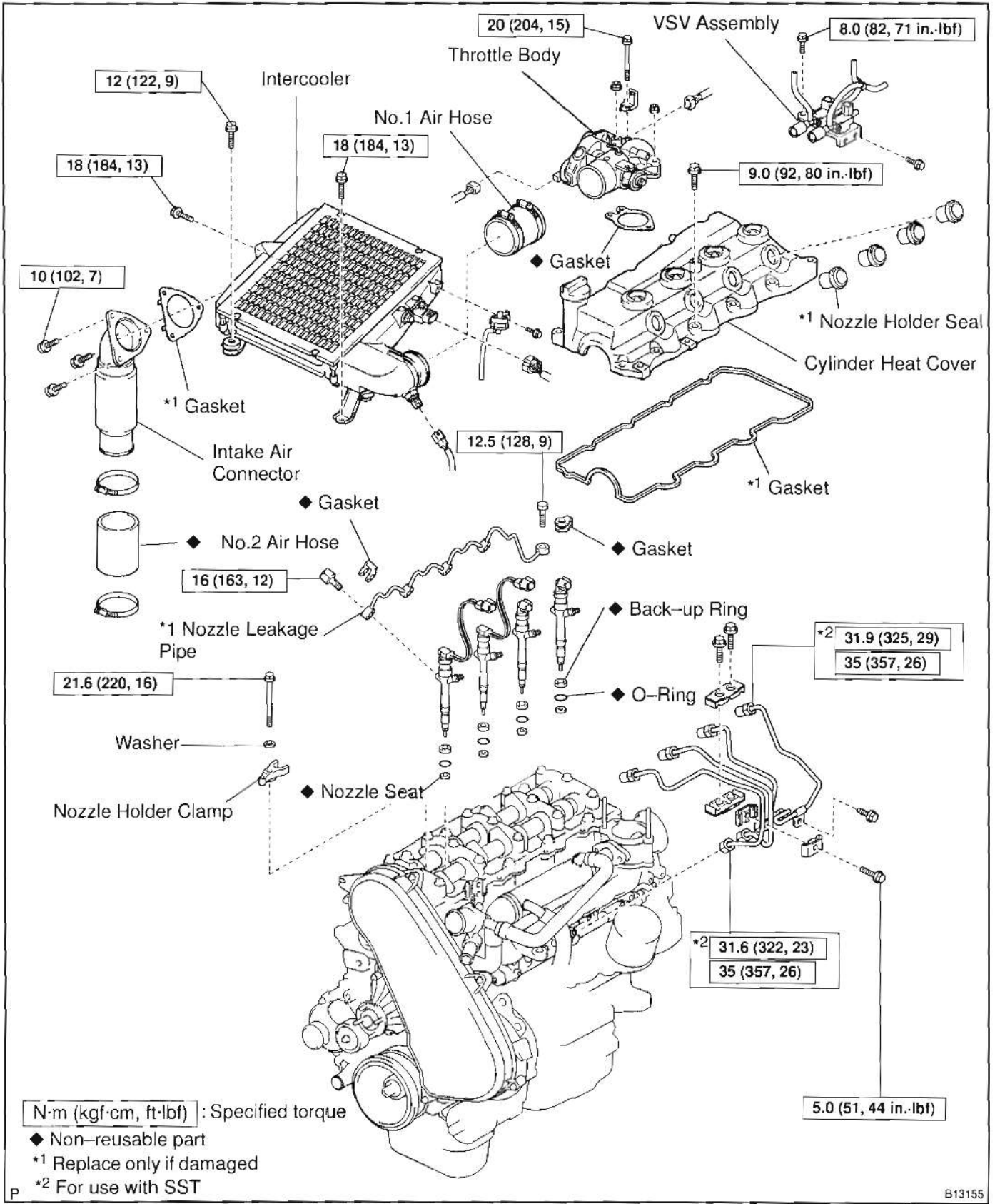
500 kPa (5.0 kgf/cm^2, 71 psi) or less

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

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

(g)   Remove SST.
       SST   09992–00025 (09992–00121, 09992–00211)

5.   **RECONNECT INJECTOR CONNECTORS**

6.   **REINSTALL GLOW PLUGS (See page EM–16)**

7.   **START ENGINE AND CHECK FOR LEAK**

EM

VALVE CLEARANCE
COMPONENTS

EM1M2-01

20 (204, 15)   VSV Assembly   8.0 (82, 71 in.·lbf)

Throttle Body

12 (122, 9)   Intercooler

No.1 Air Hose

18 (184, 13)   18 (184, 13)

9.0 (92, 80 in.·lbf)

◆ Gasket

*1 Nozzle Holder Seal

Cylinder Heat Cover

10 (102, 7)

*1 Gasket

Intake Air
Connector

12.5 (128, 9)

*1 Gasket

◆ Gasket

◆ No.2 Air Hose

◆ Gasket

16 (163, 12)

◆ Back–up Ring

*1 Nozzle Leakage
Pipe

*2 31.9 (325, 29)

35 (357, 26)

21.6 (220, 16)

◆ O–Ring

Washer

Nozzle Holder Clamp

◆ Nozzle Seat

*2 31.6 (322, 23)

35 (357, 26)

5.0 (51, 44 in.·lbf)

N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

P   *2 For use with SST

B13155

INSPECTION

EM1M3–01

HINT:

Inspect and adjust the valve clearance when the engine is cold.

NOTICE:

*   Before removing the injection pipes, clean them up with a soft brush and compressed air.
*   After removing the injection pipe, affix the gum tape on the supply pump, common rail and the whole injector installation area of the cylinder head cover for preventing dust from coming into them.
*   After removing the cylinder head cover, put a vinyl bag and rubber band for preventing from mixing foreign objects over the injector inlet.

2.   **REMOVE CYLINDER HEAD COVER**

EM
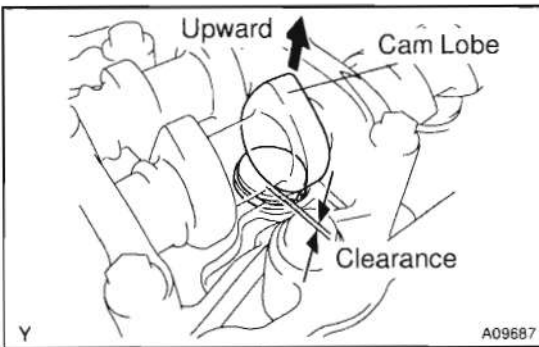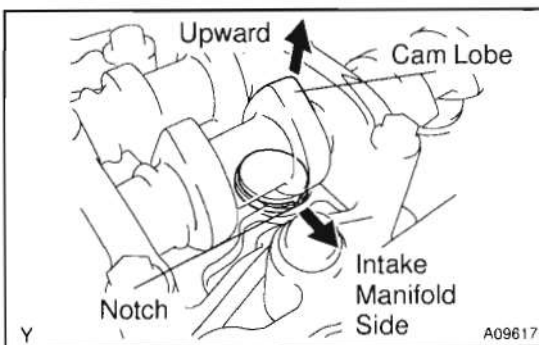

4.   **INSPECT VALVE CLEARANCE**
(a)   Turn the crankshaft so that the cam lobe of the camshaft on the inspecting valve points upward.
(b)   Using a feeler gauge, measure the clearance between the valve lifter and camshaft.
(c)   Measure the clearance at 16 places.
(d)   Record the out–of–specification valve clearance measurements. They will be used later to determine the required replacement adjusting shim.
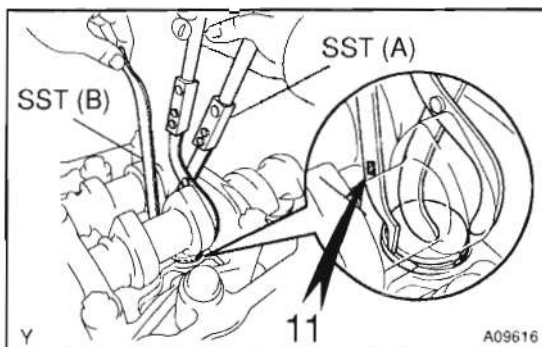
Valve clearance (Cold):

Intake	0.20 – 0.30 mm (0.008 – 0.012 in.)
Exhaust	0.35 – 0.45 mm (0.014 – 0.018 in.)

5.   **ADJUST VALVE CLEARANCE**
(a)   Remove the adjusting shim.
   (1)   Turn the crankshaft so that the cam lobe of the camshaft on the adjusting valve points upward.
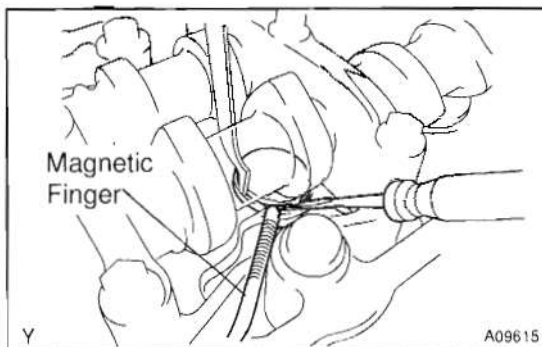   (2)   Position the notch of the valve lifter facing the intake manifold side.

EM

(3)   Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).
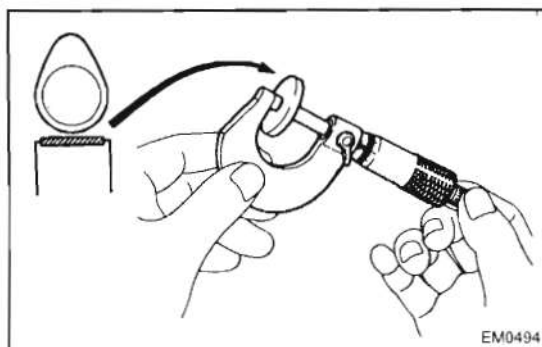
SST   09248–55050 (09248–05510, 09248–05520)

HINT:

Apply SST (B) on the side marked with "11".

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

(b)   Determine the replacement adjusting shim size by following the Formula or Charts:

(1)   Using a micrometer, measure the thickness of the removed shim.

(2)   Calculate the thickness of a new shim so that the valve clearance comes within specified value.

T .... Thickness of removed adjusting shim

A .... Measured valve clearance

N .... Thickness of new adjusting shim
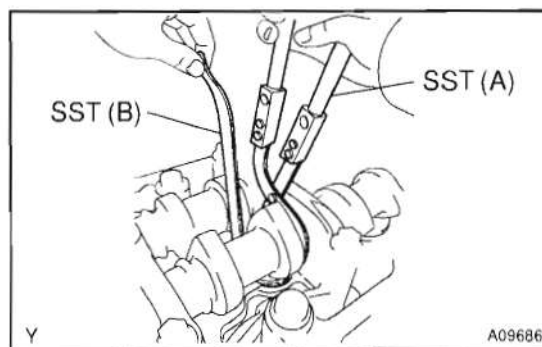
Intake: N = T + (A – 0.25 mm (0.010 in.))

Exhaust: N = T + (A – 0.40 mm (0.016 in.))

(3)   Select a new shim with a thickness as close as possible to the calculated value.

HINT:

Shims are available in 32 sizes in increments of 0.025 mm (0.0020 in.), from 2.525 mm (0.0994 in.) to 3.300 mm (0.1299 in.).

(c)   Place a new adjusting shim on the valve lifter.

(d)   Using SST (A), press down the valve lifter and remove SST (B).

SST   09248–55050 (09248–05510, 09248–05520)

(e)   Recheck the valve clearance.

6.   **REINSTALL INJECTORS (See page FU–8)**

7.   **REINSTALL CYLINDER HEAD COVER (See page EM–56)**

8.   **REINSTALL INTERCOOLER (See page EM–16)**

Adjusting Shim Selection Chart (Intake)

Measured clearance mm (in.)	2.525 (0.0994)	2.550 (0.1004)	2.575 (0.1014)	2.600 (0.1024)	2.625 (0.1033)	2.650 (0.1043)	2.675 (0.1053)	2.700 (0.1063)	2.725 (0.1073)	2.750 (0.1083)	2.775 (0.1093)	2.800 (0.1102)	2.825 (0.1112)	2.850 (0.1122)	2.875 (0.1132)	2.900 (0.1142)	2.925 (0.1152)	2.950 (0.1161)	2.975 (0.1171)	3.000 (0.1181)	3.025 (0.1191)	3.050 (0.1201)	3.075 (0.1211)	3.100 (0.1220)	3.125 (0.1230)	3.150 (0.1240)	3.175 (0.1250)	3.200 (0.1260)	3.225 (0.1270)	3.250 (0.1280)	3.275 (0.1289)	3.300 (0.1299)
0.000 – 0.020 (0.0000 – 0.0008)											01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
0.021 – 0.040 (0.0008 – 0.0016)										01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.041 – 0.060 (0.0016 – 0.0024)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.061 – 0.080 (0.0024 – 0.0031)								01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.081 – 0.100 (0.0032 – 0.0039)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.101 – 0.120 (0.0040 – 0.0047)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.121 – 0.140 (0.0048 – 0.0055)						01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
0.141 – 0.160 (0.0056 – 0.0063)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.161 – 0.180 (0.0063 – 0.0071)				01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0.181 – 0.199 (0.0071 – 0.0078)			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.200 – 0.300 (0.0079 – 0.0118)																																
0.301 – 0.320 (0.0119 – 0.0126)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
0.321 – 0.340 (0.0126 – 0.0134)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
0.341 – 0.360 (0.0134 – 0.0142)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
0.261 – 0.380 (0.0142 – 0.0150)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
0.381 – 0.400 (0.0150 – 0.0157)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.401 – 0.420 (0.0158 – 0.0165)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.421 – 0.440 (0.0166 – 0.0173)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
0.441 – 0.460 (0.0174 – 0.0181)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32								
0.461 – 0.480 (0.0181 – 0.0189)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32									
0.481 – 0.500 (0.0189 – 0.0197)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.501 – 0.520 (0.0197 – 0.0205)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.521 – 0.540 (0.0205 – 0.0213)	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32											
0.541 – 0.560 (0.0213 – 0.0220)	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32												
0.561 – 0.580 (0.0221 – 0.0228)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32													
0.581 – 0.600 (0.0229 – 0.0236)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.601 – 0.620 (0.0237 – 0.0244)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.621 – 0.640 (0.0244 – 0.0252)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32															
0.641 – 0.660 (0.0252 – 0.0260)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																
0.661 – 0.680 (0.0260 – 0.0268)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																	
0.681 – 0.700 (0.0268 – 0.0276)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.701 – 0.720 (0.0276 – 0.0283)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.721 – 0.740 (0.0284 – 0.0291)	20	21	22	23	24	25	26	27	28	29	30	31	32																			
0.741 – 0.760 (0.0292 – 0.0299)	21	22	23	24	25	26	27	28	29	30	31	32																				
0.761 – 0.780 (0.0300 – 0.0307)	22	23	24	25	26	27	28	29	30	31	32																					
0.781 – 0.800 (0.0307 – 0.0315)	23	24	25	26	27	28	29	30	31	32																						
0.801 – 0.820 (0.0315 – 0.0323)	23	24	25	26	27	28	29	30	31	32																						
0.821 – 0.840 (0.0323 – 0.0331)	24	25	26	27	28	29	30	31	32																							
0.841 – 0.860 (0.0331 – 0.0339)	25	26	27	28	29	30	31	32																								
0.861 – 0.880 (0.0339 – 0.0346)	26	27	28	29	30	31	32																									
0.881 – 0.900 (0.0347 – 0.0354)	27	28	29	30	31	32																										
0.901 – 0.920 (0.0355 – 0.0362)	27	28	29	30	31	32																										
0.921 – 0.940 (0.0363 – 0.0370)	28	29	30	31	32																											
0.941 – 0.960 (0.0370 – 0.0378)	29	30	31	32																												
0.961 – 0.980 (0.0378 – 0.0386)	30	31	32																													
0.981 – 1.000 (0.0386 – 0.0394)	31	32																														
1.001 – 1.020 (0.0394 – 0.0402)	31	32																														
1.021 – 1.040 (0.0402 – 0.0409)	32																															

New shim thickness mm (in.)

No.	Shim mark	Thickness	Shim mark	No.	Thickness
01	2525	2.525 (0.0994)	2925	17	2.925 (0.1152)
02	2550	2.550 (0.1004)	2950	18	2.950 (0.1161)
03	2575	2.575 (0.1014)	2975	19	2.975 (0.1171)
04	2600	2.600 (0.1024)	3000	20	3.000 (0.1181)
05	2625	2.625 (0.1033)	3025	21	3.025 (0.1191)
06	2650	2.650 (0.1043)	3050	22	3.050 (0.1201)
07	2675	2.675 (0.1053)	3075	23	3.075 (0.1211)
08	2700	2.700 (0.1063)	3100	24	3.100 (0.1220)
09	2725	2.725 (0.1073)	3125	25	3.125 (0.1230)
10	2750	2.750 (0.1083)	3150	26	3.150 (0.1240)
11	2775	2.775 (0.1093)	3175	27	3.175 (0.1250)
12	2800	2.800 (0.1102)	3200	28	3.200 (0.1260)
13	2825	2.825 (0.1112)	3225	29	3.225 (0.1270)
14	2850	2.850 (0.1122)	3250	30	3.250 (0.1280)
15	2875	2.875 (0.1132)	3275	31	3.275 (0.1289)
16	2900	2.900 (0.1142)	3300	32	3.300 (0.1299)

Intake valve clearance (Cold):
   0.20 – 0.30 mm (0.0079 – 0.0118 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.350 mm (0.0138 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.16 2.900 mm (0.1142 in.) shim.

Adjusting Shim Selection Chart (Exhaust)

Measured clearance mm (in.) \ Installed shim thickness mm (in.)	2.525 (0.0994)	2.550 (0.1004)	2.575 (0.1014)	2.600 (0.1024)	2.625 (0.1033)	2.650 (0.1043)	2.675 (0.1053)	2.700 (0.1063)	2.725 (0.1073)	2.750 (0.1083)	2.775 (0.1093)	2.800 (0.1102)	2.825 (0.1112)	2.850 (0.1122)	2.875 (0.1132)	2.900 (0.1142)	2.925 (0.1152)	2.950 (0.1161)	2.975 (0.1171)	3.000 (0.1181)	3.025 (0.1191)	3.050 (0.1201)	3.075 (0.1211)	3.100 (0.1220)	3.125 (0.1230)	3.150 (0.1240)	3.175 (0.1250)	3.200 (0.1260)	3.225 (0.1270)	3.250 (0.1280)	3.275 (0.1289)	3.300 (0.1299)
0.000 - 0.020 (0.0000 - 0.0008)																	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0.021 - 0.040 (0.0008 - 0.0016)																01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
0.041 - 0.060 (0.0016 - 0.0024)															01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
0.061 - 0.080 (0.0024 - 0.0031)														01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
0.081 - 0.100 (0.0032 - 0.0039)													01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
0.101 - 0.120 (0.0040 - 0.0047)													01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
0.121 - 0.140 (0.0048 - 0.0055)												01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
0.141 - 0.160 (0.0056 - 0.0063)											01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
0.161 - 0.180 (0.0063 - 0.0071)										01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.181 - 0.200 (0.0071 - 0.0079)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.201 - 0.220 (0.0079 - 0.0087)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.221 - 0.240 (0.0087 - 0.0094)								01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.241 - 0.260 (0.0095 - 0.0102)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.261 - 0.280 (0.0103 - 0.0110)						01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
0.281 - 0.300 (0.0111 - 0.0118)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.301 - 0.320 (0.0119 - 0.0126)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.321 - 0.340 (0.0126 - 0.0134)				01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0.341 - 0.344 (0.0134 - 0.0135)			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.350 - 0.450 (0.0138 - 0.0177)																																
0.451 - 0.470 (0.0178 - 0.0185)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
0.471 - 0.490 (0.0185 - 0.0193)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
0.491 - 0.510 (0.0193 - 0.0201)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
0.511 - 0.530 (0.0201 - 0.0209)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
0.531 - 0.550 (0.0209 - 0.0217)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.551 - 0.570 (0.0217 - 0.0224)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.571 - 0.590 (0.0225 - 0.0232)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
0.591 - 0.610 (0.0233 - 0.0240)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32								
0.611 - 0.630 (0.0241 - 0.0248)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32									
0.631 - 0.650 (0.0248 - 0.0256)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.651 - 0.670 (0.0256 - 0.0264)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.671 - 0.690 (0.0264 - 0.0272)	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32											
0.691 - 0.710 (0.0272 - 0.0280)	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32												
0.711 - 0.730 (0.0280 - 0.0287)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32													
0.731 - 0.750 (0.0288 - 0.0295)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.751 - 0.770 (0.0296 - 0.0303)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.771 - 0.790 (0.0304 - 0.0311)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32															
0.791 - 0.810 (0.0311 - 0.0319)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																
0.811 - 0.830 (0.0319 - 0.0327)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																	
0.831 - 0.850 (0.0327 - 0.0335)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.851 - 0.870 (0.0335 - 0.0343)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.871 - 0.890 (0.0343 - 0.0350)	20	21	22	23	24	25	26	27	28	29	30	31	32																			
0.891 - 0.910 (0.0351 - 0.0358)	21	22	23	24	25	26	27	28	29	30	31	32																				
0.911 - 0.930 (0.0359 - 0.0366)	22	23	24	25	26	27	28	29	30	31	32																					
0.931 - 0.950 (0.0367 - 0.0374)	23	24	25	26	27	28	29	30	31	32																						
0.951 - 0.970 (0.0374 - 0.0382)	23	24	25	26	27	28	29	30	31	32																						
0.971 - 0.990 (0.0382 - 0.0390)	24	25	26	27	28	29	30	31	32																							
0.991 - 1.010 (0.0390 - 0.0398)	25	26	27	28	29	30	31	32																								
1.011 - 1.030 (0.0398 - 0.0406)	26	27	28	29	30	31	32																									
1.031 - 1.050 (0.0406 - 0.0413)	27	28	29	30	31	32																										
1.051 - 1.070 (0.0414 - 0.0421)	27	28	29	30	31	32																										
1.071 - 1.090 (0.0422 - 0.0429)	28	29	30	31	32																											
1.091 - 1.110 (0.0430 - 0.0437)	29	30	31	32																												
1.111 - 1.130 (0.0437 - 0.0445)	30	31	32																													
1.131 - 1.150 (0.0445 - 0.0453)	31	32																														
1.151 - 1.170 (0.0453 - 0.0461)	31	32																														
1.171 - 1.190 (0.0461 - 0.0469)	32																															

New shim thickness mm (in.)

No.	Shim mark	Thickness	Shim mark	No.	Thickness
01	2525	2.525 (0.0994)	2925	17	2.925 (0.1152)
02	2550	2.550 (0.1004)	2950	18	2.950 (0.1161)
03	2575	2.575 (0.1014)	2975	19	2.975 (0.1171)
04	2600	2.600 (0.1024)	3000	20	3.000 (0.1181)
05	2625	2.625 (0.1033)	3025	21	3.025 (0.1191)
06	2650	2.650 (0.1043)	3050	22	3.050 (0.1201)
07	2675	2.675 (0.1053)	3075	23	3.075 (0.1211)
08	2700	2.700 (0.1063)	3100	24	3.100 (0.1220)
09	2725	2.725 (0.1073)	3125	25	3.125 (0.1230)
10	2750	2.750 (0.1083)	3150	26	3.150 (0.1240)
11	2775	2.775 (0.1093)	3175	27	3.175 (0.1250)
12	2800	2.800 (0.1102)	3200	28	3.200 (0.1260)
13	2825	2.825 (0.1112)	3225	29	3.225 (0.1270)
14	2850	2.850 (0.1122)	3250	30	3.250 (0.1280)
15	2875	2.875 (0.1132)	3275	31	3.275 (0.1289)
16	2900	2.900 (0.1142)	3300	32	3.300 (0.1299)

Exhaust valve clearance (Cold):
0.35 – 0.45 mm (0.0138 – 0.0177 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.500 mm (0.0197 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.16 2.900 mm (0.1142 in.) shim.

A15092

IDLE SPEED AND MAXIMUM SPEED
INSPECTION
EM1M4-01

1. INITIAL CONDITIONS
(a) Engine at normal operating temperature.
(b) Air cleaner installed.
(c) All pipes and hoses of air induction system connected.
(d) All accessories switched OFF.
(e) All vacuum lines properly connected.
(f) ECD system wiring connectors fully plugged.
(g) Valve clearance set correctly.

EM

TAC

A04550
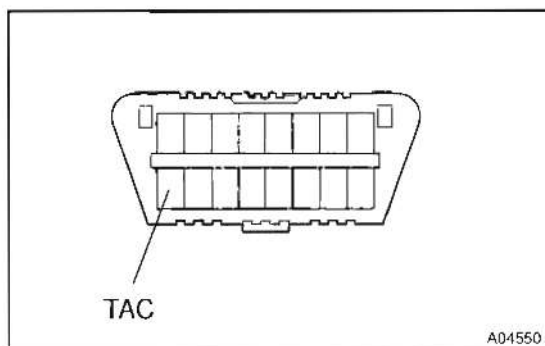
2. CONNECT TACHOMETER
Connect the tester probe of a tachometer to terminal 9 (TAC) of the DLC3.

3. INSPECT IDLE SPEED
(a) Start the engine.
(b) Check the idle speed.
   Idle speed: 650 – 750 rpm
If the idle speed is not as specified, check the troubleshooting in DI section.

4. INSPECT MAXIMUM SPEED
(a) Start the engine.
(b) Depress the accelerator pedal all the way.
(c) Check the maximum speed.
   Maximum speed: 4,500 – 4,700 rpm
If the maximum speed is not as specified, check the troubleshooting in DI section.

5. DISCONNECT TACHOMETER

TIMING BELT

COMPONENTS

EMORR–04

EM

12 (122, 9)

18 (184, 13)

18 (184, 13)

Intake Air Connector

10 (102, 7)

Intercooler

8.0 (82, 71 in.·lbf)

VSV Assembly

20 (204, 15)

*1 Gasket

Throttle Body

No.1 Air Hose

◆ No.2 Air Hose

9.0 (92, 78 in.·lbf)

◆ Gasket

*1 Nozzle Holder Seal

Cylinder Heat Cover

*1 Gasket

Timing Belt Idler Pulley

No.1 Camshaft Timing Pulley

Key

Timing Belt Cover

98 (1,000, 72)

5.0 (51, 44 in.·lbf)

◆ Washer

Timing Belt

35 (350, 25)

No.2 Camshaft Timing Pulley

Flange

Timing Belt Tensioner

13 (133, 9)

*2 31.9 (325, 29)

35 (357, 26)

31 (316, 23)

6.0 (61, 53 in.·lbf)

*2 31.6 (322, 23)

35 (357, 26)

N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

A15093

EM1M5–01

REMOVAL

HINT:

If replacing the timing belt before the timing belt warning light comes on, (light comes on after 100,000 km of driving), be sure to reset the timing belt counter of the speedometer to zero.
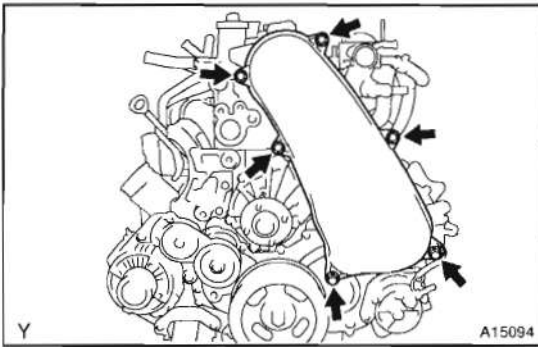
1. REMOVE TIMING BELT COVER

Remove the 6 bolts seal washers and timing belt cover.
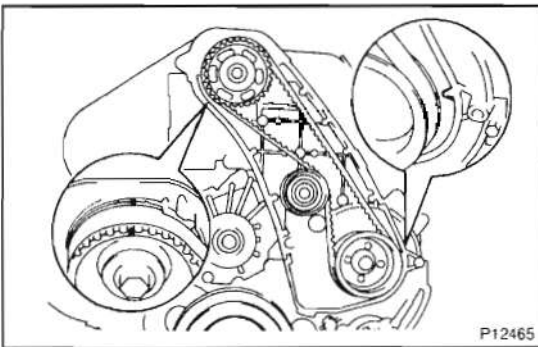
2. SET NO.1 CYLINDER TO TDC / COMPRESSION

Turn the crankshaft pulley clockwise, set both No.1 and No.2 camshaft pulley grooves at TDC marks.
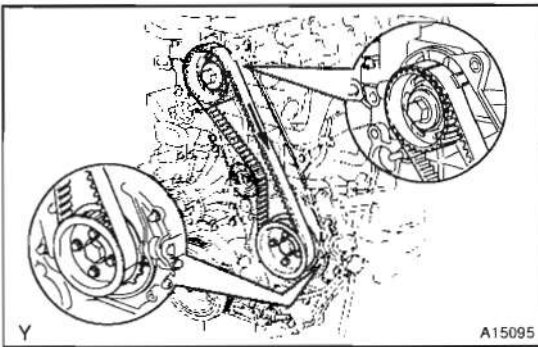
3. IF RE-USING TIMING BELT, MARK TIMING BELT

HINT:

If reusing the timing belt, draw a direction arrow on the bolt (in the direction of engine revolution), and place matchmarks on the pulleys and belt as shown in the illustration.
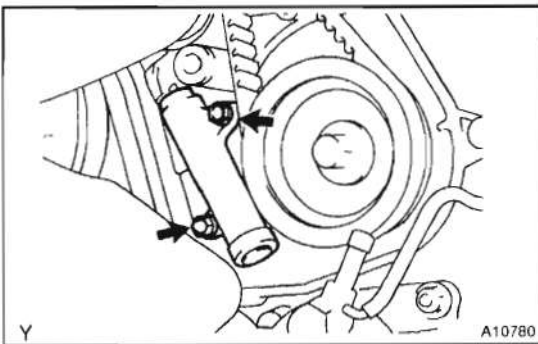
4. REMOVE TIMING BELT TENSIONER

Alternately loosen the 2 bolts, remove them and timing belt tensioner.

A15096
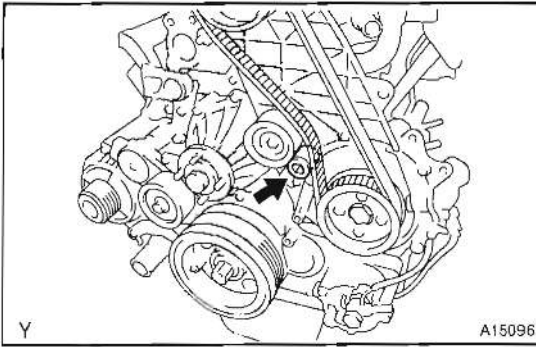
5. REMOVE TIMING BELT IDLER PULLEY

Using a 10 mm hexagon wrench, remove the bolt, timing belt idler pulley and washer.

A15097
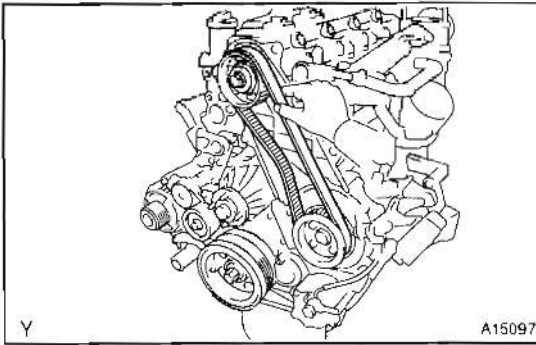
6. REMOVE TIMING BELT

A15098
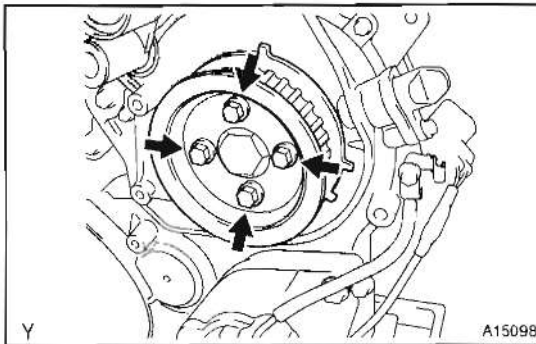
7. REMOVE PUMP DRIVE SHAFT PULLEY

Remove the 4 bolts, pump drive shaft pulley flange and pump drive shaft pulley.

8. REMOVE INTERCOOLER (See page TC–11)

A15099
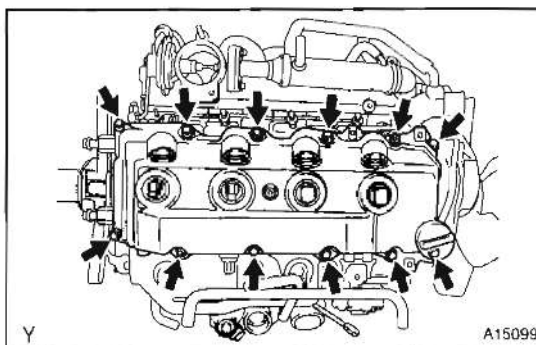
9. REMOVE CYLINDER HEAD COVER

(a) Disconnect the 4 injector connectors

(b) Remove the 2 bolts and disconnect the engine wire protector.

(c) Using SST, remove the 4 injection pipes
(See page FU–6).

(d) Remove the 4 nozzle holder seals.

(e) Remove the 10 bolts, 2 nuts, cylinder head cover and gasket.

A15101
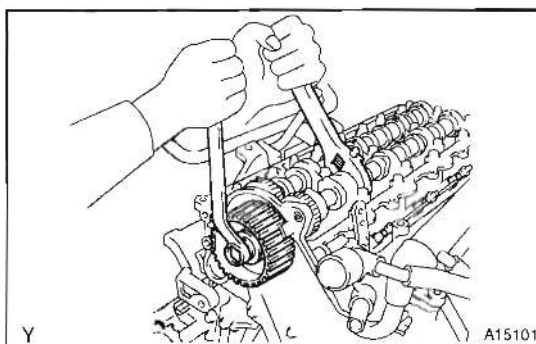
10. REMOVE NO.1 CAMSHAFT TIMING PULLEY

(a) Hold the hexagonal wrench head portion of the camshaft with a wrench, and remove the No.1 camshaft timing pulley bolt.

SST

Y   A15102
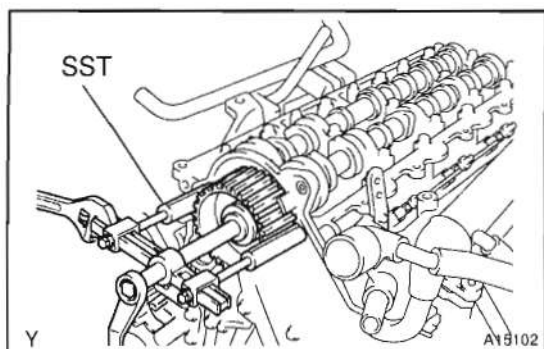
(b) Using SST, remove the No.1 camshaft timing pulley.
     SST   09950–40011 (09951–04010, 09952–04010,
           09953–04020, 09954–04010, 09955–04061)
(c) Remove the set key.

EMISB-02

INSPECTION

1. INSPECT TIMING BELT

NOTICE:

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

If there are any defects, check these points:

(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 is locked.

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

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

(e) If there is noticeable wear on the belt teeth, check timing cover for damage and check gasket has been installed correctly and for foreign material on the pulley teeth.

If necessary, replace the timing belt.
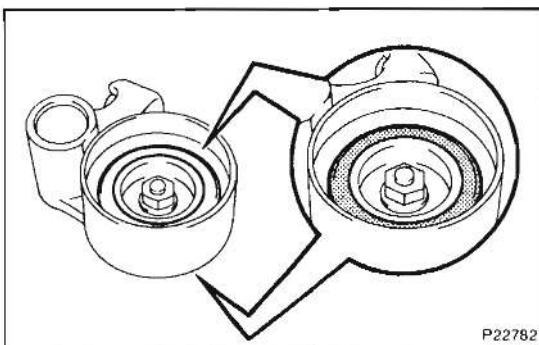
2. INSPECT IDLER PULLEY

(a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.
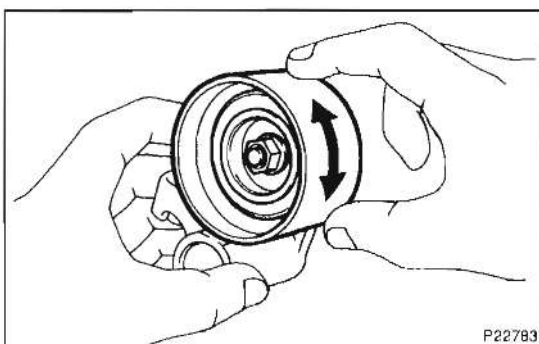
(b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.
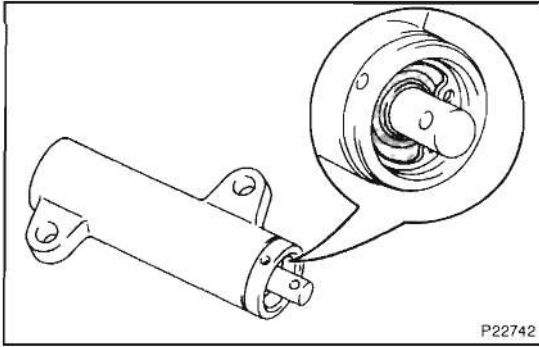
3. INSPECT TIMING BELT TENSIONER

(a) Visually check the seal portion of the tensioner for oil leakage.

HINT:

If there is only the faintest trace of oil on the seal on the push rod side, the tensioner is all right.

If leakage is found, replace the tensioner.
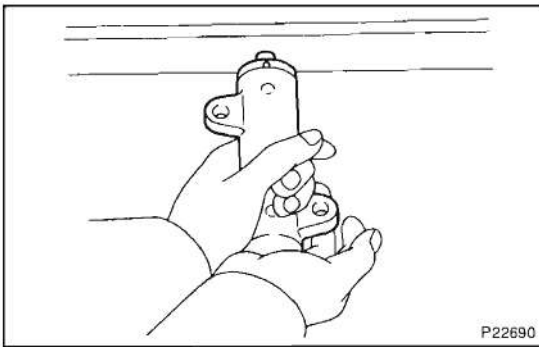
(b) Hold the tensioner with both hands and push the push rod strongly as shown to check that it doesn't move.

If the push rod moves, replace the tensioner.

NOTICE:

Never hold the tensioner push rod facing downward.
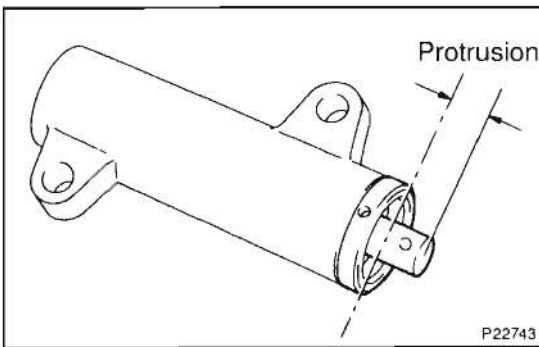
(c) Measure the protrusion of the push rod from the housing end.

Protrusion: 8.1 – 8.9 mm (0.319 – 0.350 in.)

If the protrusion is not as specified, replace the tensioner.

EM1M6-02

INSTALLATION

NOTICE:

- When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.
- In case of having the common rail and/or injectors replaced, must replace injection pipes, too.
- In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.
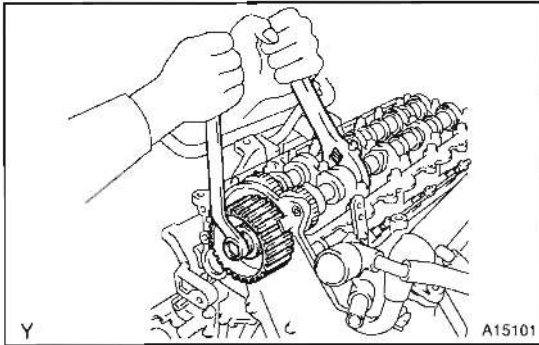
1. **INSTALL NO.1 CAMSHAFT TIMING PULLEY**
(a) Install the set key to the key groove of the camshaft.
(b) Align the pulley set key with the key groove of the No.1 camshaft timing pulley, slide the No.1 camshaft timing pulley.
(c) Temporarily install the No.1 timing pulley bolt.
(d) Hold the hexagon wrench head portion of the camshaft with a wrench, and tighten the No.1 camshaft timing pulley bolt.
Torque: 98 N·m (1,000 kgf·cm, 72 ft·lbf)

2. **INSTALL CYLINDER HEAD COVER**
(a) Remove any old packing (FIPG) material.
(b) Apply seal packing to the cylinder head s shown the illustration.
Seal packing: Part No. 08826–0080 or equivalent
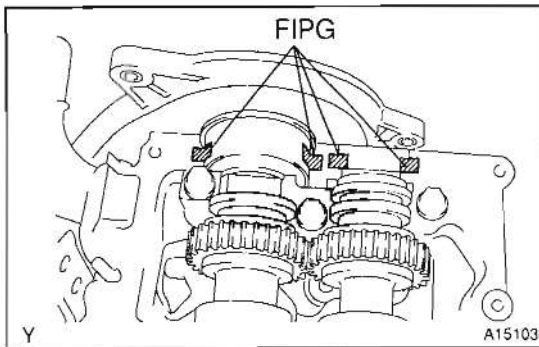
(c) Install the gasket to the cylinder head cover.
HINT:
Replace the gasket if any damage is identified.
(d) Install the cylinder head cover with the 10 bolts and 2 nuts.
Torque: 9.0 N·m (92 kgf·cm, 78 in.·lbf)

3. **INSTALL INTERCOOLER (See page TC–12)**
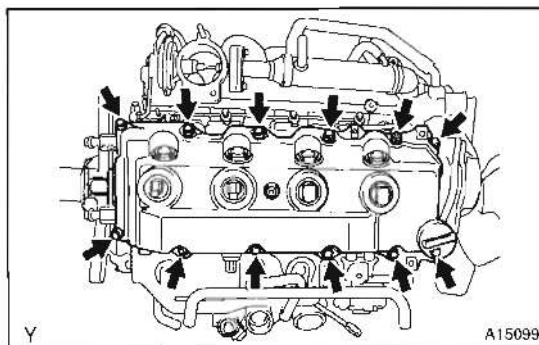
4. **INSTALL PUMP DRIVE SHAFT PULLEY**
Align the knock pin of the injection pump drive gear with the knock pin hole of the pump drive shaft pulley, install the pulley and No.2 camshaft timing pulley flanges with the 4 bolts.
Torque: 31 N·m (316 kgf·cm, 23 ft·lbf)
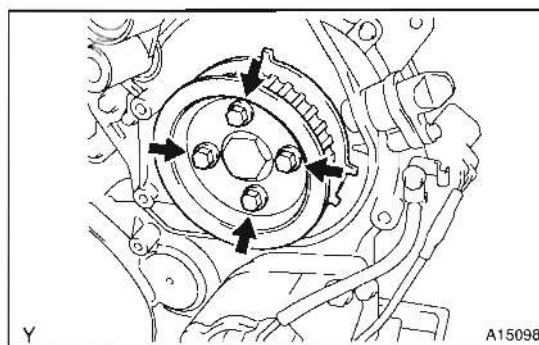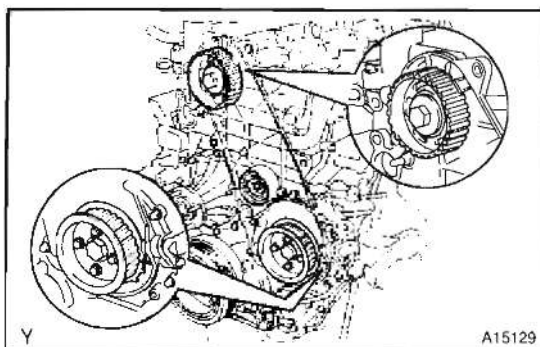
5.   SET NO.1 CYLINDER TO TDC / COMPRESSION
Set the timing pulley at each position.
NOTICE:
When turning the crankshaft, the valve heads will hit against the position top. So do not turn it more than necessary.
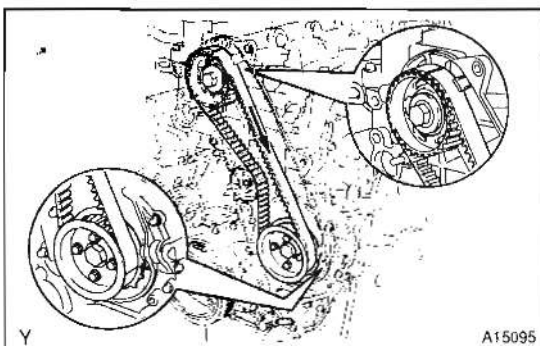
6.   INSTALL TIMING BELT
NOTICE:
The engine should be cold.
HINT:
If re–using the timing belt, align the points marked during removal, and install the belt with the arrow pointing in the direction of engine revolution.
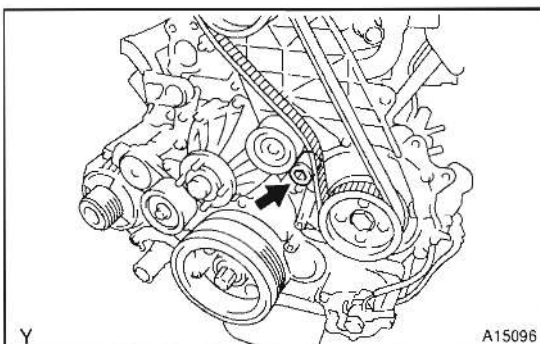
7.   INSTALL TIMING BELT IDLER PULLEY
(a)   Using a 10 mm hexagon wrench, install the washer and timing belt idler pulley with the bolt.
       Torque: 35 N·m (350 kgf·cm, 25 ft·lbf)
(b)   Check that the idler pulley moves smoothly.
If it doesn't move smoothly, check the idler pulley and washer.
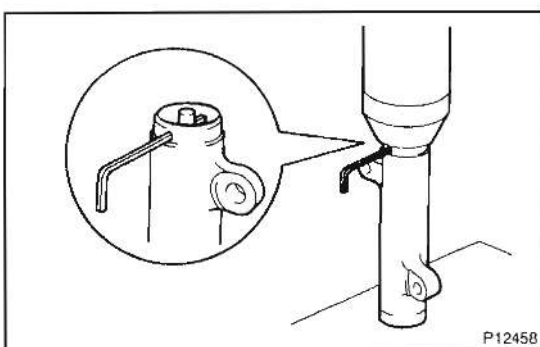
8.   SET TIMING BELT TENSIONER
(a)   Using a press, slowly press in the push rod using 981 – 9,807 N (100 – 1,000 kgf, 220 –2,205 lbf) of force.
(b)   Align the holes of the push rod and housing, pass a 1.5 mm hexagon wrench through the holes to keep the setting position of the push rod.
(c)   Release the press.
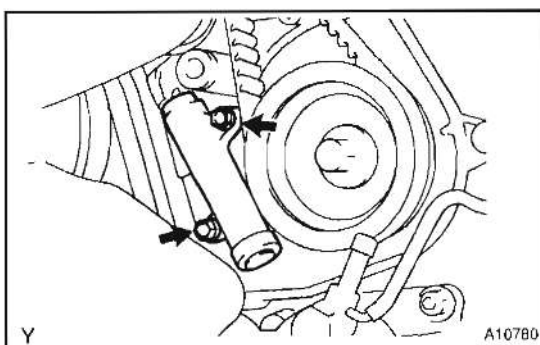
9.   INSTALL TIMING BELT TENSIONER
(a)   Temporarily install the timing belt tensioner with the 2 bolts while pushing the idler pulley toward the timing belt.
(b)   Tighten the 2 bolts.
       Torque: 13 N·m (133 kgf·cm, 9 ft·lbf)
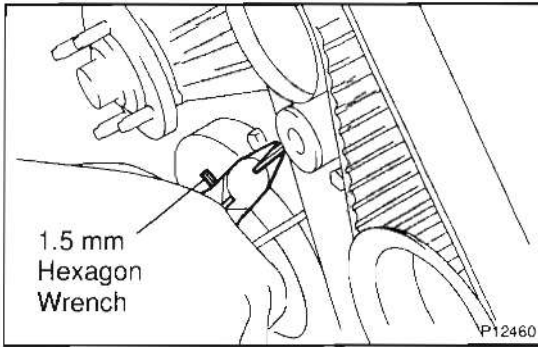
(c)   Remove the 1.5 mm hexagon wrench from the tensioner.

1.5 mm
Hexagon
Wrench

P12460
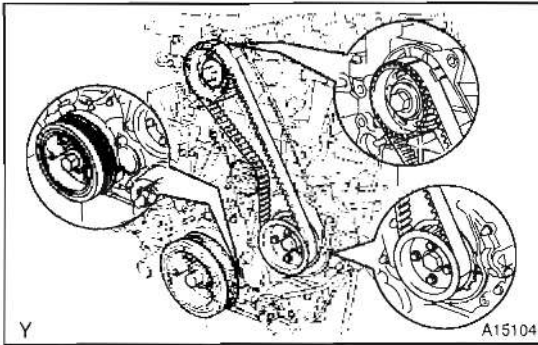
10.   CHECK VALVE TIMING

Turn the crankshaft pulley clockwise and check that each pulley aligns with the timing marks (TDC mark) as shown in the illustration.

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

Y   A15104
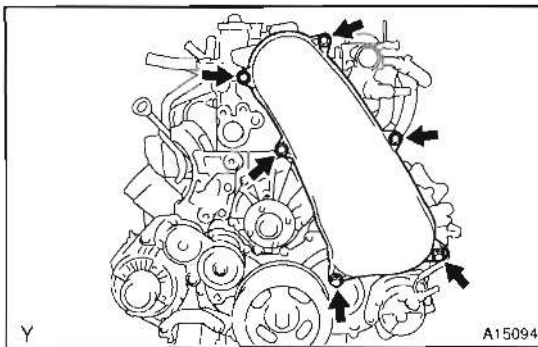
11.   INSTALL TIMING BELT COVER

Install the timing belt cover with the 6 seal washers and bolts.
   Torque: 6.0 N·m (61 kgf·cm, 53 in.·lbf)

Y   A15094

TIMING GEAR
COMPONENTS

EM156–02

12 (122, 9)

18 (184, 13)

18 (184, 13)

Intake Air Connector

10 (102, 7)

Intercooler

VSV Assembly

8.0 (82, 71 in.·lbf)

20 (204, 15)

Throttle Body

*1 Gasket

No.1 Air Hose

◆ No.2 Air Hose

9.0 (92, 78 in.·lbf)

◆ Gasket

*1 Nozzle Holder Seal

Cylinder Heat Cover

*1 Gasket

Timing Belt Idler Pulley

No.1 Camshaft Timing Pulley

Key

Timing Belt Cover

98 (1,000, 72)

5.0 (51, 44 in.·lbf)

Timing Belt

◆ Washer

35 (350, 25)

No.2 Camshaft Timing Pulley

Flange

Timing Belt Tensioner

13 (133, 9)

31 (316, 23)

*2 31.9 (325, 29)

35 (357, 26)

6.0 (61, 53 in.·lbf)

*2 31.6 (322, 23)

35 (357, 26)

N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

A15093

Fan
Fluid Coupring
Wate Pump Pulley
Drive Belt
Timing Belt No.2 Cover

18 (184, 13)
10 (102, 7)

Crankshaft Pulley
◆ Crankshaft Front Oil Seal
365 (3,700, 269)
13 (133, 10)
Timing Gear Cover

Crank Angle Sensor Plate
103 (1,050, 76)
◆ O–Ring
Bearing
Crankshaft Timing Gear
Supply Pump Drive Gear
◆ O–Ring

◆ O–Ring
◆ Supply Pump Drive Gear Seal
◆ O–Ring
Vacuum Pump
21 (214, 15)

No.1 Idler Sub Gear
Idler Gear
No.2 Idler Sub Gear
Snap Ring
Idler Gear Shaft
Wave Washer

Snap Ring
50 (510, 37)
Thrust Plate
Wave Washer
Idler Gear Spring

N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

Y   A15106

EM0RW-03

REMOVAL

NOTICE:
When removing the crankshaft pulley and timing gear as the timing belt is off and the valve interferes with the piston, never, turn the crankshaft to the right beyond the dead point above the No. 1 cylinder.

1. **REMOVE TIMING BELT AND PULLEYS**
   (See page EM–11)
2. **REMOVE DRIVE BELT, FAN AND WATER PUMP PULLEY** (See page CO–5)

3. **REMOVE TIMING BELT NO. 2 COVER**
   Remove the 4 bolts, nut and timing belt No. 2 cover.
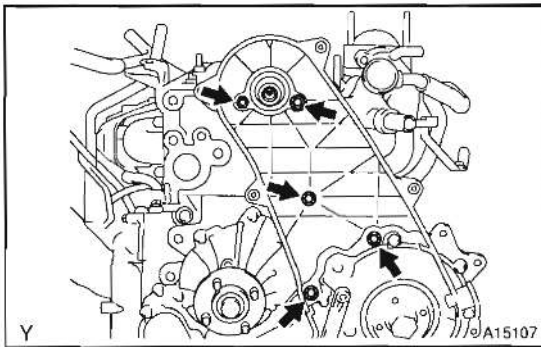
4. **REMOVE VACUUM PUMP**
   (a) Remove the vacuum hose.
   (b) Remove the 2 nuts and vacuum pump.
   (c) Remove 2 the O–rings.
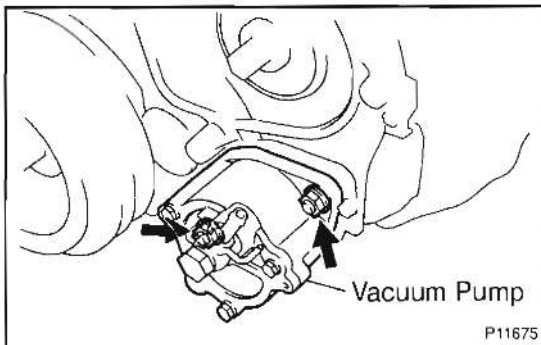
5. **REMOVE CRANKSHAFT PULLEY**
   (a) Using SST, remove the pulley bolt and plate.
       SST   09213–58012, 09330–00021
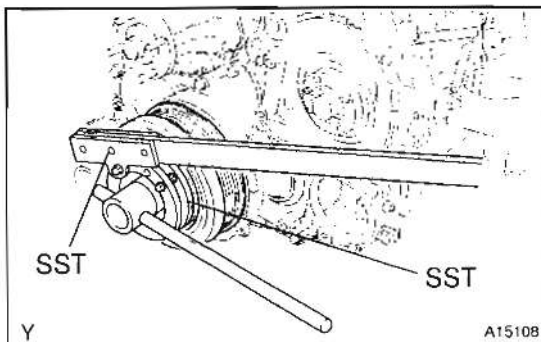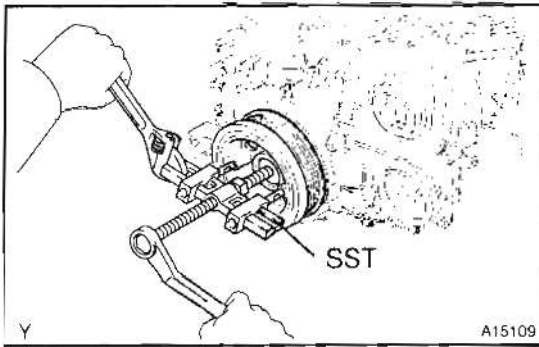
(b) Using SST, remove the crankshaft pulley.
SST   09950–50012, (09951–05010, 09952–05010, 09953–05010, 09954–05020)
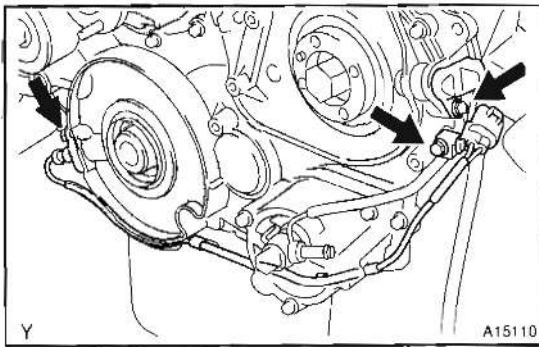
6.   REMOVE TIMING GEAR COVER

(a) Remove the bolt, crankshaft position sensor and O–ring.
(b) Remove the bolt, crankshaft position sensor and O–ring and disconnect the 3 clamps.
(c) Remove the bolt, nut and washer and disconnect the vacuum pipe.
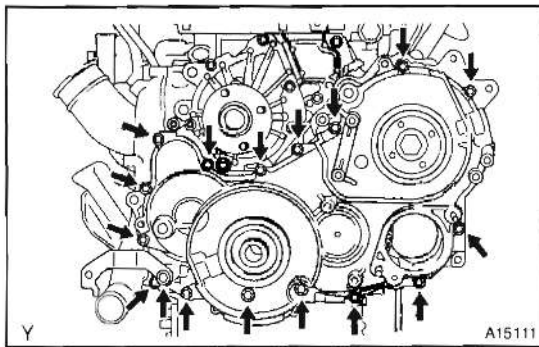
(d) Remove the 14 bolts and 2 nuts.
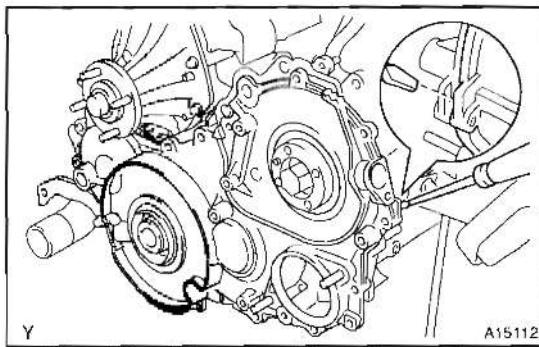
(e) Using a screwdriver, pry out the timing gear cover.
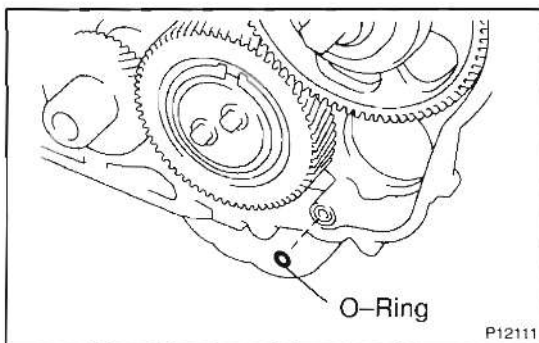
(f) Remove the O–ring.
(g) Remove the crank angle sensor plate.
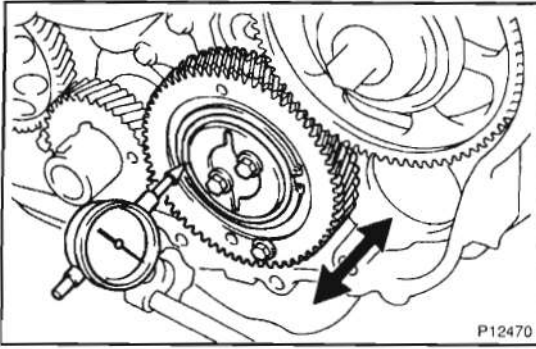
7. CHECK THRUST CLEARANCE OF IDLER GEAR

Using a dial indicator, measure the thrust clearance.

Standard thrust clearance:

0.06 – 0.11 mm (0.0024 – 0.0043 in.)

Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust plate. If necessary, replace the idler gear and/or idler gear shaft.

8. REMOVE TIMING GEARS

NOTICE:

- **The matchmarks on each gear faces the front of the engine.**
- **Take care not to damage the gear teeth when removing and installing the gears. Do not use parts that are scratched or damaged, they cause noise.**
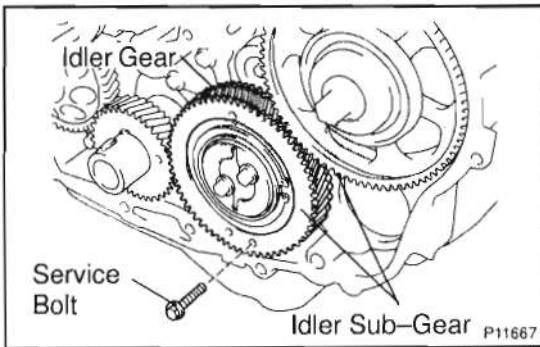
(a) Remove the crankshaft timing gear.

(1) Secure the idler sub–gears to the idler gear with a service bolt.

Recommended service bolt:

Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	28.0 mm (1.10 in.)

HINT:

When removing the idler gear, make sure that the torsional spring force of the sub–gears has been eliminated by the above operation.
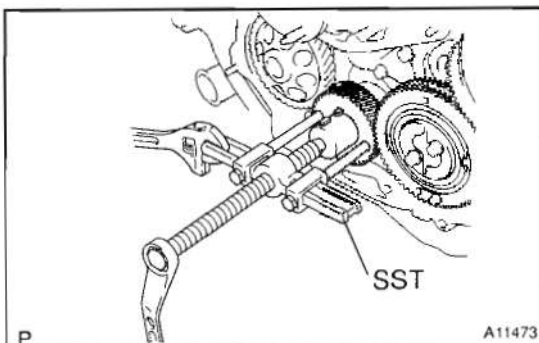
(2) Using SST, remove the crankshaft timing gear.

SST   09950–50012 (09951–05010, 09952–05010, 09953–05010, 09954–05020)
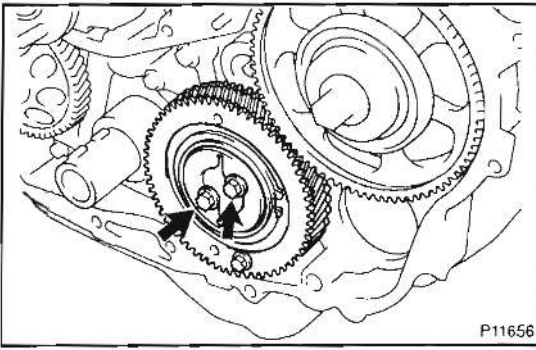
(b)   Remove the 2 bolts, thrust plate, idler gear assembly and idler gear shaft.
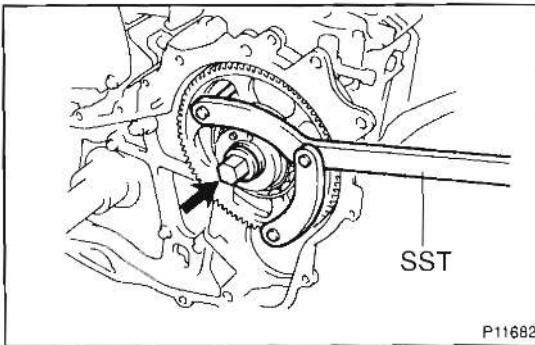
(c)   Remove the supply pump drive gear.
   (1)   Using SST, remove the supply pump drive gear set nut.
   SST   09960–10010 (09962–01000, 09963–00600)
   (2)   Remove the O–ring.
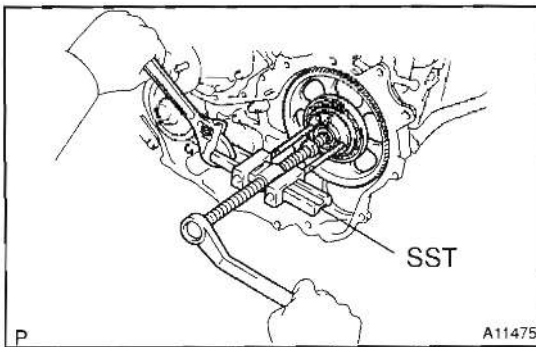
   (3)   Using SST, remove the supply pump drive gear.
   SST   09950–50012 (09951–05010, 09952–05010, 09953–05010, 09954–05020)

NOTICE:
• **Tighten the 2 bolts of SST more than 8 mm (0.31 in.).**
• **Set the SST so that it is balanced.**
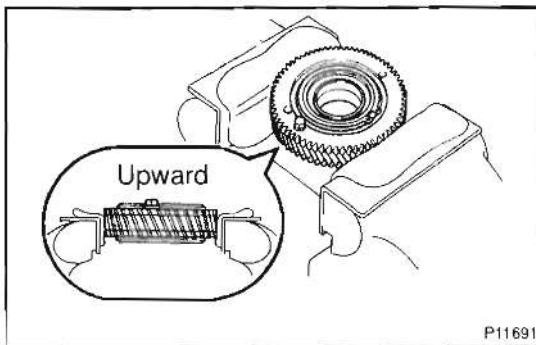
9.   DISASSEMBLY IDLER GEAR
(a)   Mount the idler gear and No.2 idler sub–gear in a vise.
NOTICE:
Be careful not to damage the gears.
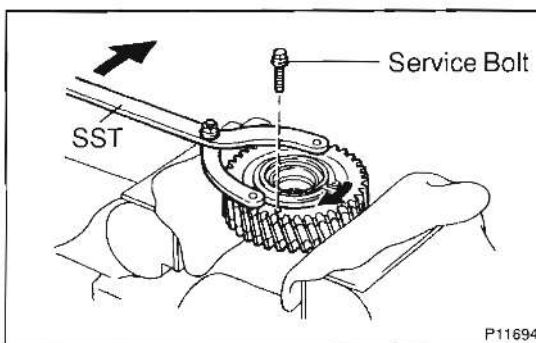
(b)   Using SST, turn the No.1 idler sub–gear clockwise and re-move the service bolt.
   SST   09960–10010 (09962–01000, 09963–00600)
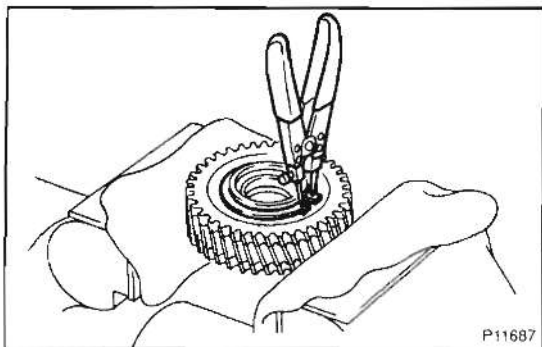
(c) Using snap ring pliers, remove the snap ring.
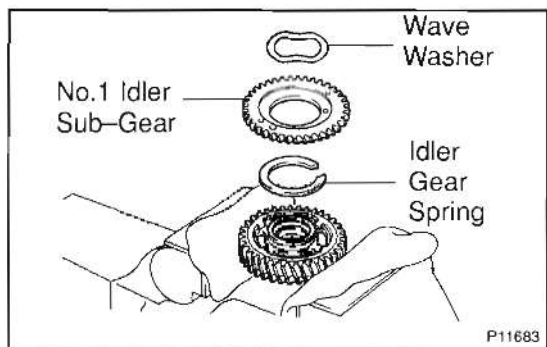
(d) Remove the wave washer.
(e) Remove the No.1 idler sub–gear.
(f) Remove the idler gear spring.
(g) Remove the idler gear assembly from the vice and turn it upside down.
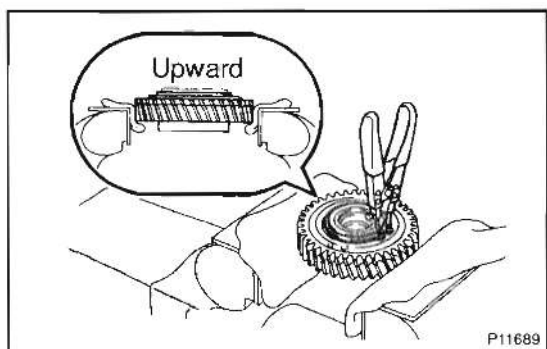
(h) Mount the idler gear in a vise.
NOTICE:
Be careful not to damage the gear.
(i) Using snap ring pliers, remove the snap ring.
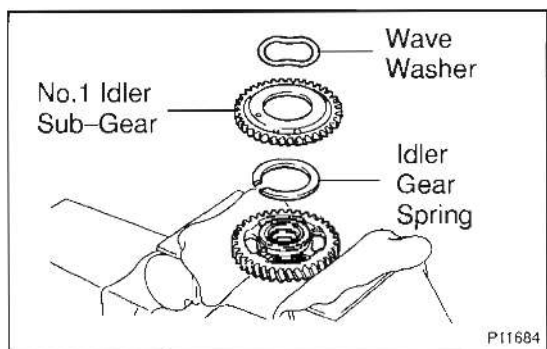
(j) Remove the wave washer.
(k) Remove the No.2 idler sub–gear.
(l) Remove the idler gear spring.

INSPECTION

EM157–02
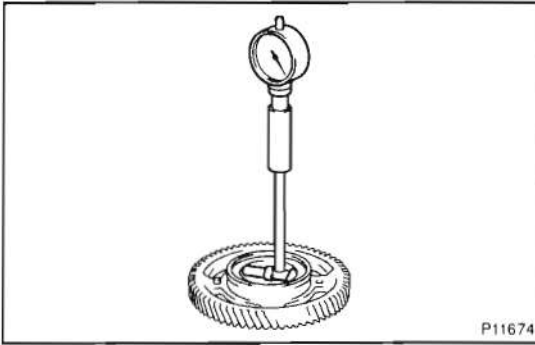
1. **INSPECT IDLER GEAR**
(a) Using a cylinder gauge, measure the inside diameter of the idler gear.
   Idler gear inside diameter:
   44.000 – 44.025 mm (1.7323 – 1.7333 in.)
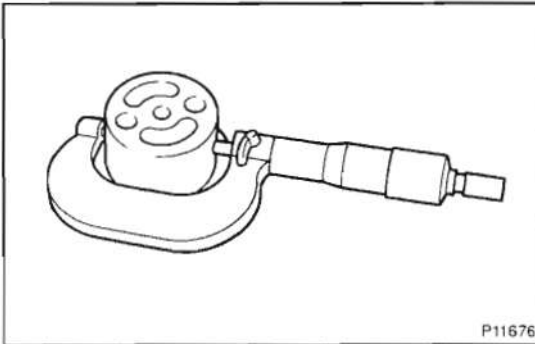
(b) Using a micrometer, measure the diameter of the idler gear shaft.
   Idler gear shaft diameter:
   43.955 – 43.990 mm (1.7305 – 1.7319 in.)
(c) Subtract the idler gear shaft diameter measurement from the idler gear inside diameter measurement.
   Standard oil clearance:
   0.010 – 0.070 mm (0.0004 – 0.0028 in.)
   Maximum oil clearance: 0.20 mm (0.0079 in.)
If the clearance is greater than maximum, replace the gear and shaft.
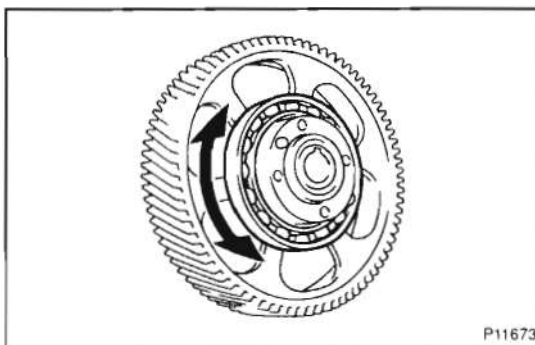
2. **INSPECT RADIAL BALL BEARING BEARING**
Check that bearing is not rough or worn.
If necessary, replace the bearing. (See page EM–28)

3. CHECK BACKLASH OF TIMING GEARS

Using a dial indicator, measure the backlash.

Standard gear backlash:

0.02 – 0.15 mm (0.0008 – 0.0060 in.)

Maximum gear backlash: 0.20 mm (0.0079 in.)

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

Balance Shaft No.1 x Oil Pump
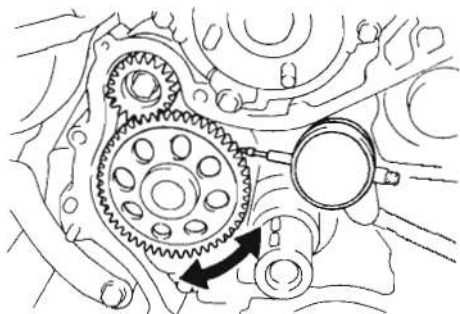
Balance Shaft No.2 x Injection Pump
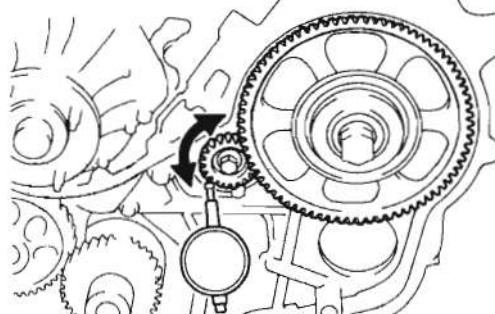
Crankshaft x Idler
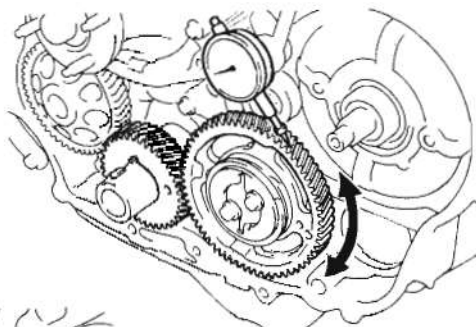
Oil Pump x Crankshaft
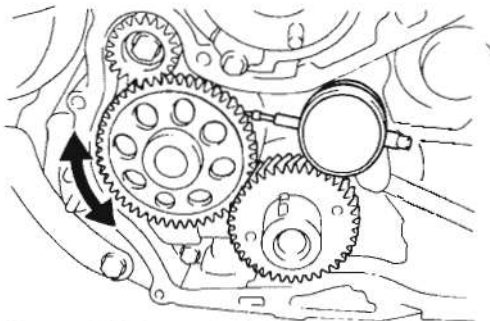
Injection Pump x Idler
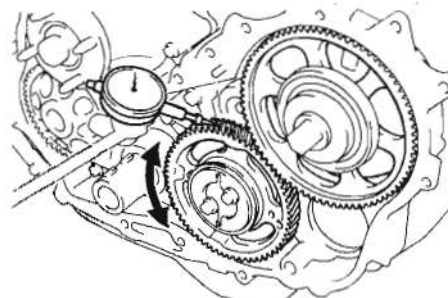
P11653   P11695
P11652 P11671 P11670

Z09204

REPLACEMENT

EM158-02

HINT:
There are 2 methods (a and b) to replace the oil seal as follows:
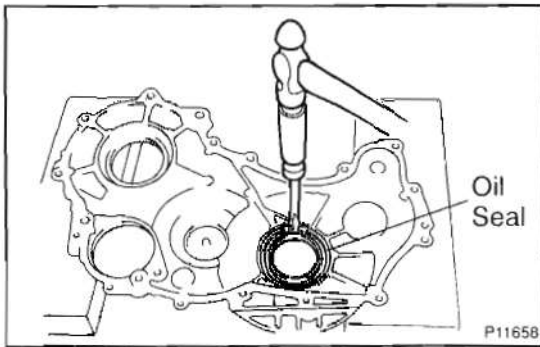
1. REPLACE CRANKSHAFT FRONT OIL SEAL

(a) If the timing gear cover is removed from the cylinder block:

(1) Using a screwdriver and hammer, tap out the oil seal.
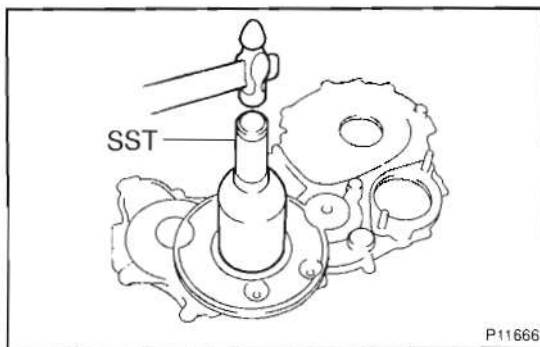
(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
SST   09214–76011

(3) Apply MP grease to the oil seal lip.
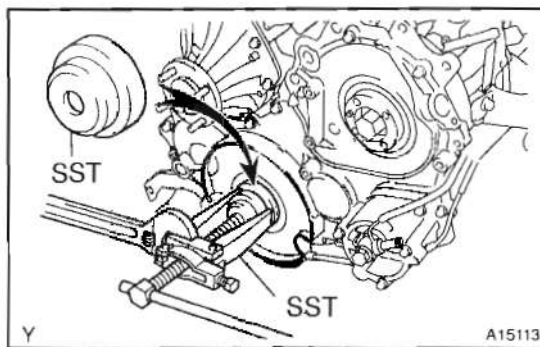
(b) If the timing gear cover is installed to the cylinder block:

(1) Using SST, remove the oil seal.
SST   09308–10010, 09950–20017
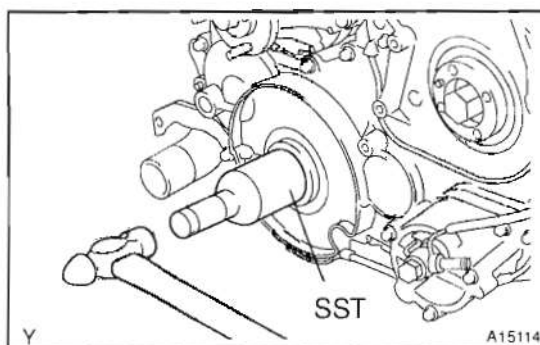
(2) Apply MP grease to a new oil seal lip.

(3) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.
SST   09214–76011
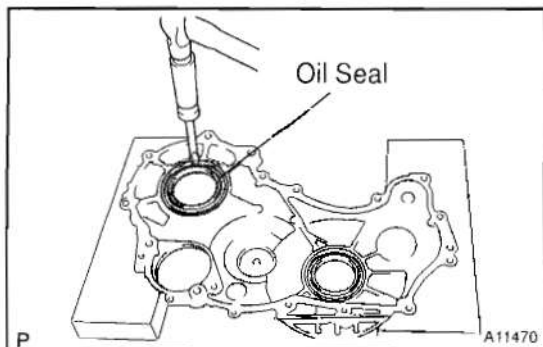
2. REPLACE SUPPLY PUMP DRIVE GEAR OIL SEAL

(a) If the timing gear cover is removed from cylinder block:

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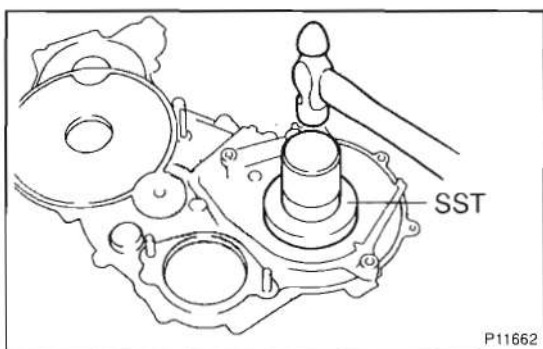
(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.

SST   09223–78010

(3) Apply MP grease to the oil seal lip.
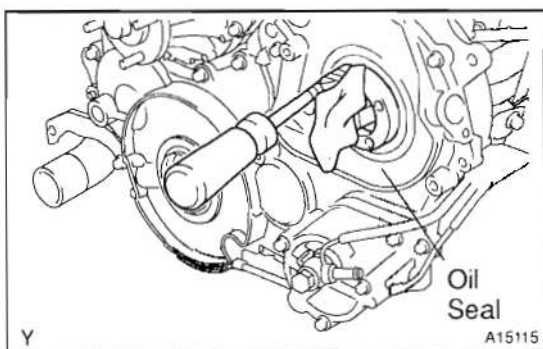
(b) If the timing gear cover is installed to the cylinder block:

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

NOTICE:

Be careful not to damage the supply pump drive gear. Tape the screwdriver tip.
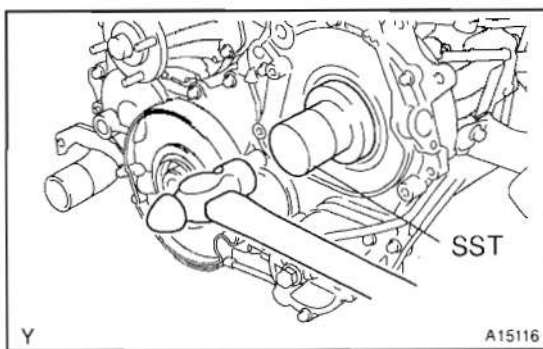
(2) Apply MP grease to the oil seal lip.

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

SST   09223–78010
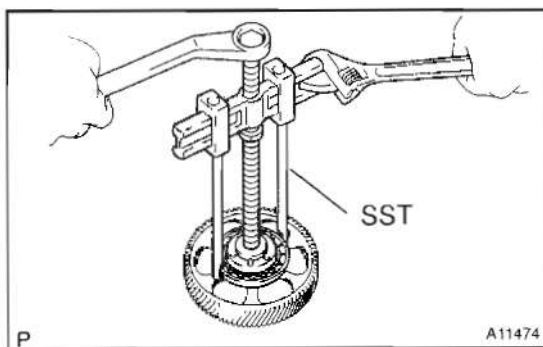
3. REPLACE RADIAL BALL BEARING

(a) Using SST, remove the bearing.

SST   09950–40011 (09951–04010, 09952–04010, 09953–04020, 09954–04010, 09955–04041)
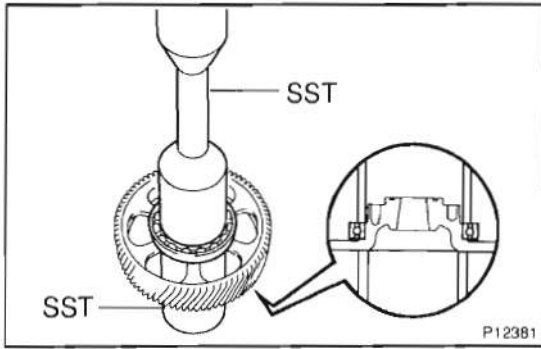
(b) Using SST and a press, press in a new bearing.
SST   09214–76011, 09223–00010

INSTALLATION

EM1M7-01

NOTICE:

- When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.
- In case of having the common rail and/or injectors replaced, must replace injection pipes, too.
- In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.

1. ASSEMBLE IDLER GEAR

(a) Mount the idler gear in a vise.

HINT:

Install the idler gear with the cut–off mark facing downward.

NOTICE:

Be careful not to damage the gear.
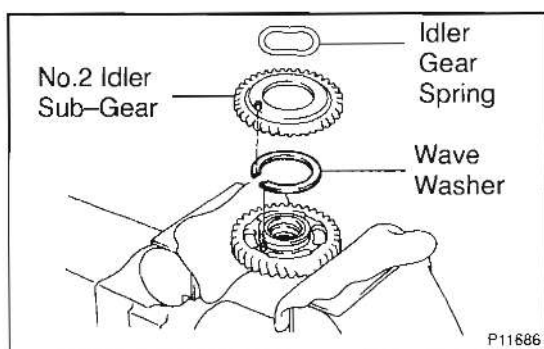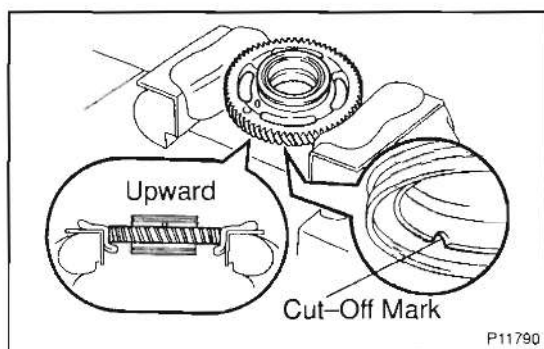
(b) Install the idler gear spring.

(c) Install the No.2 idler sub–gear.

(d) Install the wave washer.

HINT:

Align the pins on the gears with the spring ends.
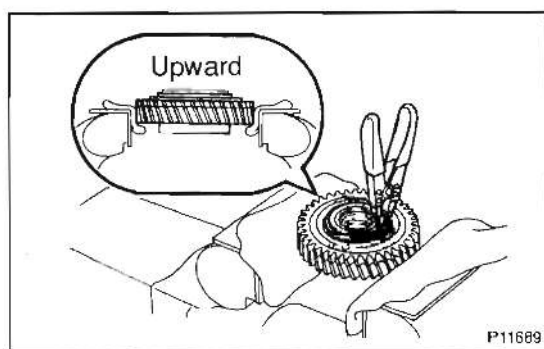
(e) Using snap ring pliers, install the snap ring.
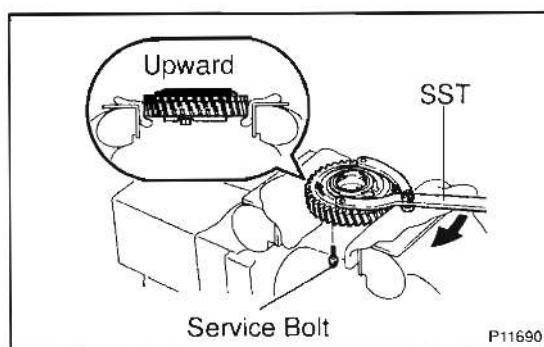
(f) Using SST, align the holes of the idler gear and No.2 idler sub–gear by turning the No.2 idler sub–gear clockwise, and install a service bolt.

SST   09960–10010 (09962–01000, 09963–00600)

(g) Remove the idler gear assembly from the vice and turn it upside down.
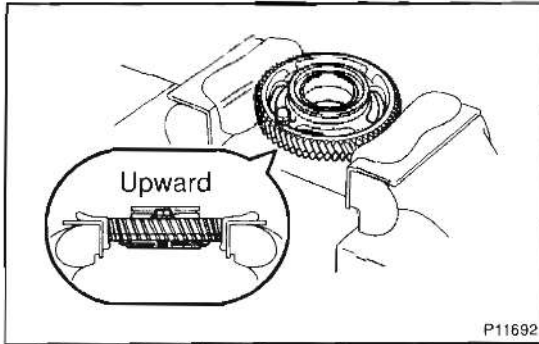
(h) Mount the idler gear and No.2 idler sub–gear in a vise.
NOTICE:
Be careful not to damage the gears.
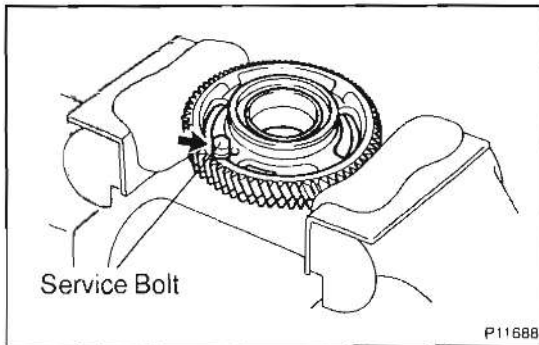
(i) Remove the service bolt.
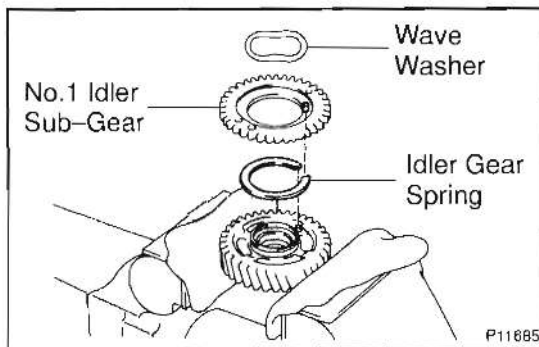
(j) Install the idler gear spring.
(k) Install the No.1 idler sub–gear.
(l) Install the wave washer.
HINT:
Align the pins on the gears with the spring ends.
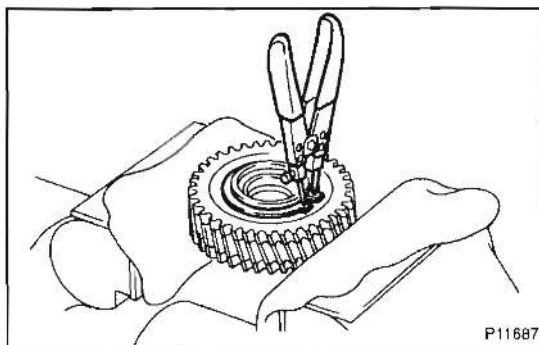
(m) Using snap ring pliers, install the snap ring.
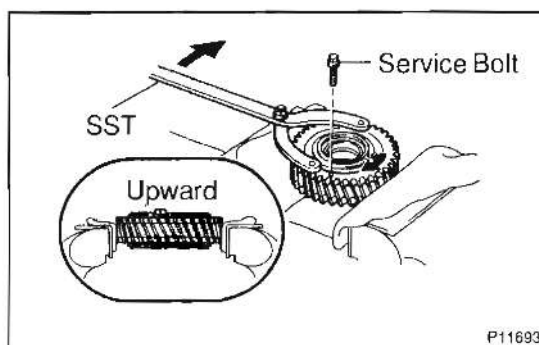
(n) Using SST, align the holes of the idler gear and No.1 idler sub–gear by turning the No.1 idler sub–gear clockwise, and install a service bolt.
SST   09960–10010 (09962–01000, 09963–00600)

2. INSTALL TIMING GEAR

NOTICE:

- **The matchmarks on each gear faces the front of the engine.**
- **Take care not to damage the gear teeth when removing and installing the gears. Do not use parts that are scratched or damaged, they cause noise.**

SST

P12096
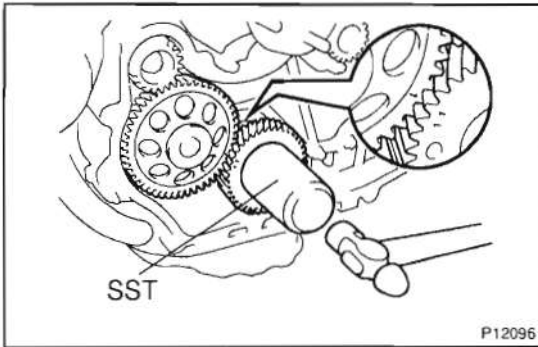
(a) Install the crankshaft timing gear.
(1) With the crankshaft key groove facing upward, install the crankshaft timing gear into the crankshaft.
(2) When doing this, the matchmarks of the oil pump drive shaft gear and crankshaft timing gear should be matched at "1".
(3) Using SST and a hammer, tap in the timing gear.
SST   09223–00010

P12095
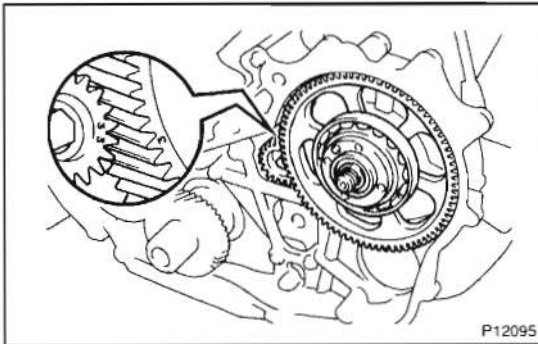
(b) Install the supply pump drive gear.
(1) Install the set key to the groove of the supply pump drive shaft.
(2) The matchmarks on the No.2 balance shaft driven gear should be aligned with "3" marks.

New O–Ring

P12107
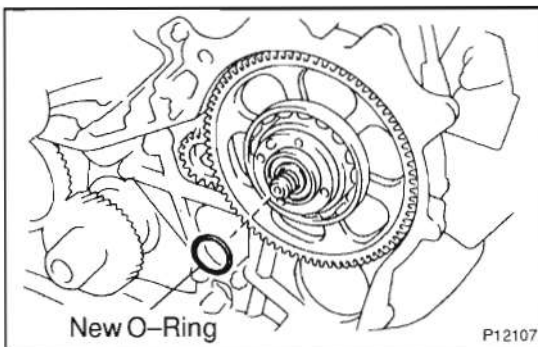
(3) Install a new O–ring to the supply pump drive gear.

SST

P12378
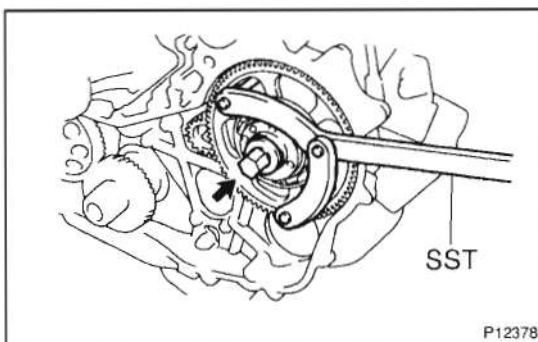
(4) Install the supply pump drive gear set nut.
(5) Using SST, torque the nut.
SST   09960–10010 (09962–01000, 09963–00600)
Torque: 103 N·m (1,050 kgf·cm, 76 ft·lbf)
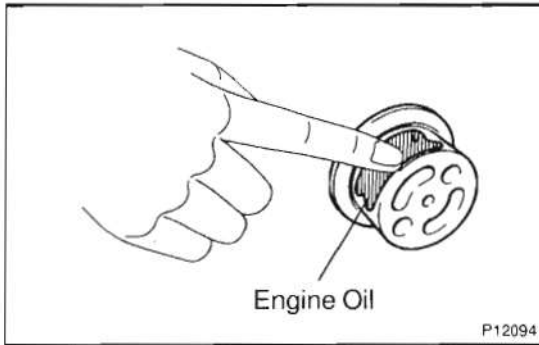
Engine Oil
P12094

(c) Install the idler gear.
(1) Coat the idler gear shaft with engine oil as shown in the illustration.

Idler
Gear
Shaft
P12632
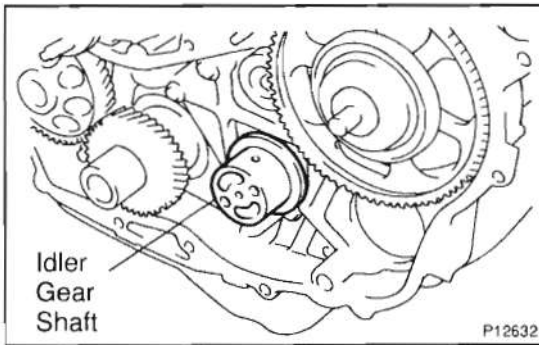
(2) Install the idler gear shaft to the cylinder block.

P12379

(3) Align the idler gear assembly timing marks "5" and "4" with the crankshaft timing gear mark "5" and supply pump drive gear timing mark "4" respectively, and mesh the gears.

P12110
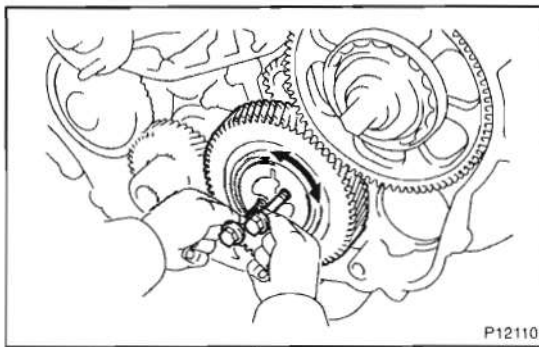
(4) Align the thrust plate set bolt holes.

P12109
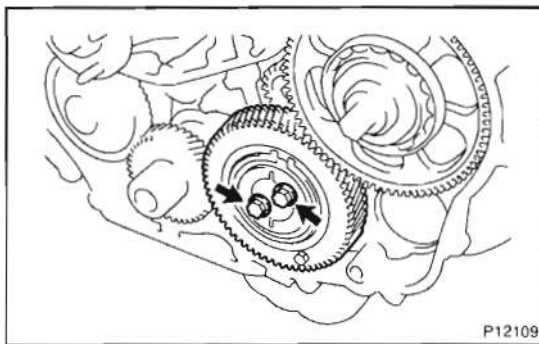
(5) Install the thrust plate with the 2 bolts. Torque the bolts.
Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)

Idler Gear

Service Bolt

Idler Sub–Gear   P11667
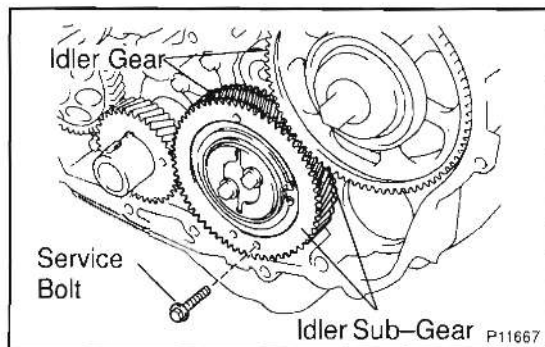
(6)   Remove the service bolt.
(d)   Install the crank angle sensor plate.

New O–Ring

Z09482
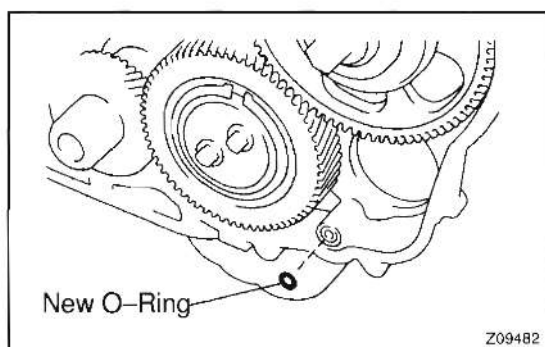
3.   INSTALL TIMING GEAR COVER

(a)   Install a new O–ring to the timing gear case.

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

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

CORRECT WRONG

P12098
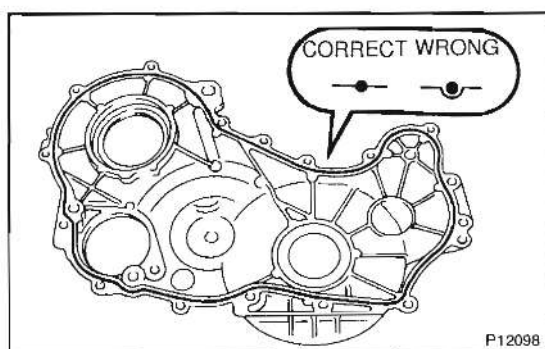
(c)   Apply seal packing to the timing gear cover as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent

- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(d)   Install the timing gear cover with the 14 bolts and 2 nuts.

Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

Y   A15111
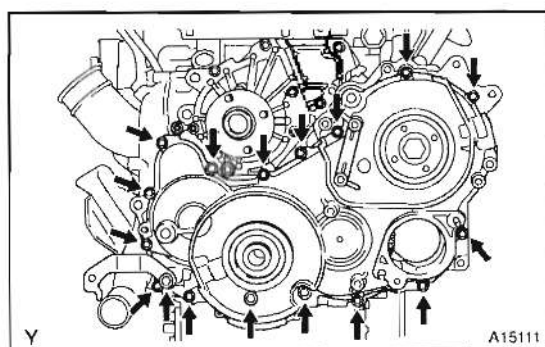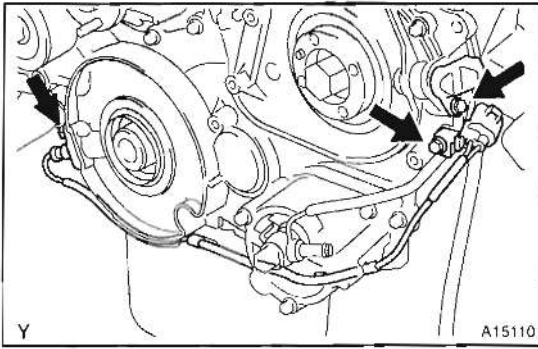
(e) Connect the vacuum pipe with the bolt, nut and washer.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

(f) Install a new O-rings to crankshaft position sensor and camshaft position sensor.

(g) Install the crankshaft position sensor with the bolt, and connect the 3 clamps.
Torque: 8.5 N·m (87 kgf·cm, 75 in.·lbf)

(h) Install the camshaft position sensor with the bolt.
Torque: 8.5 N·m (87 kgf·cm, 75 in.·lbf)
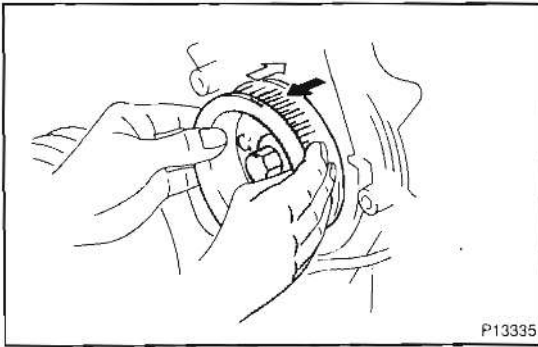
4. CHECK SUPPLY PUMP DRIVE SHAFT THRUST CLEARANCE

(a) Temporarily install the No.2 camshaft timing pulley and flange with the 4 bolts.

(b) Move the No.2 camshaft timing pulley back and forth to check that the supply pump drive shaft has sufficient thrust clearance.
Reference: 0.15 – 0.55 mm (0.0059 – 0.0217 in.)

If the thrust clearance is not sufficient, loosen the 2 supply pump nuts and 3 pump stay bolts, then retighten them.

If the thrust clearance is still not sufficient, remove the timing gear cover and then reinstall it.
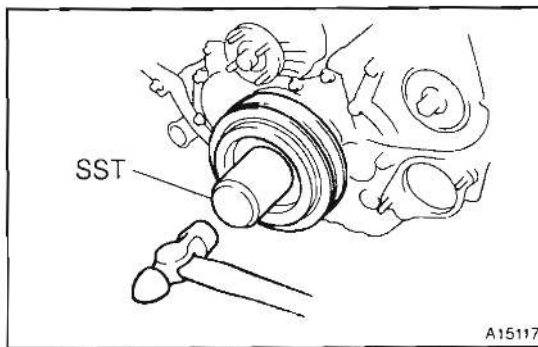
5. INSTALL CRANKSHAFT PULLEY

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

(b) Using SST and a hammer, tap in the pulley.
SST   09214-60010
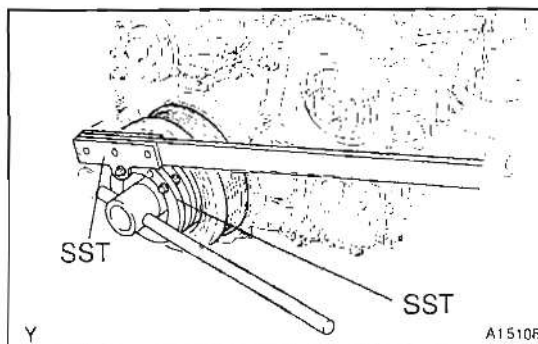
(c) Using SST, install and torque the plate bolt.
SST   09213-58012, 09330-00021
Torque: 365 N·m (3,700 kgf·cm, 269 ft·lbf)
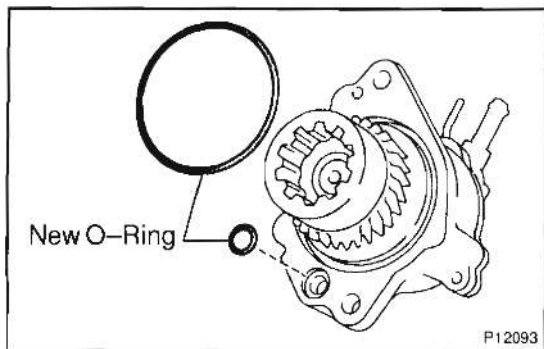
6. INSTALL VACUUM PUMP

(a) Install 2 new O–rings to the vacuum pump.

New O–Ring

P12093
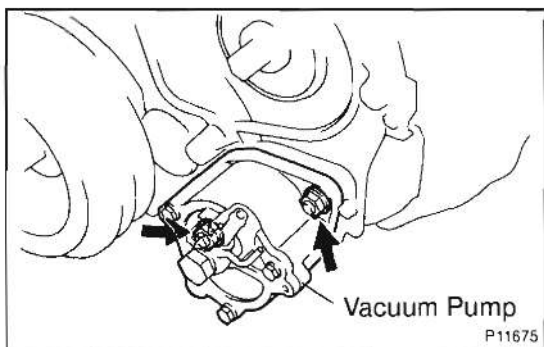
(b) Install the vacuum pump with the 2 nuts.
Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)

7. INSTALL TIMING BELT NO. 2 COVER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of timing gear cover and timing belt No. 2 cover.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

Vacuum Pump

P11675

(b) Apply seal packing to the timing gear cover as shown in the illustration.
Seal packing: Part No. 08826–00080 or equivalent

- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

FIPG

Y

A15173
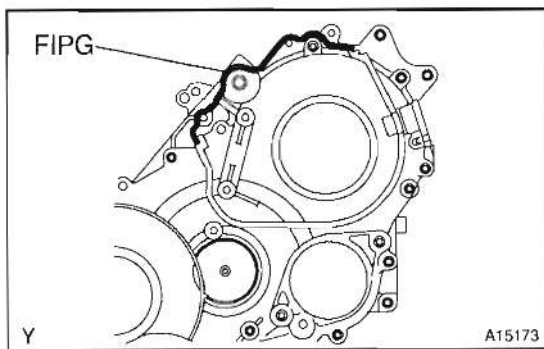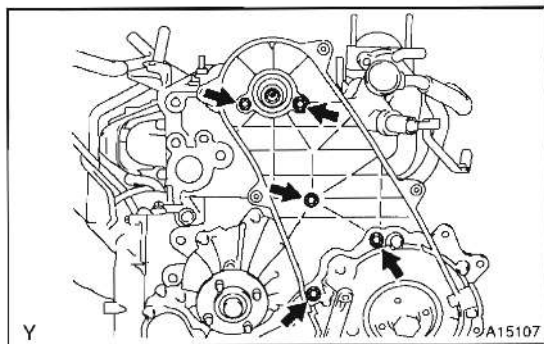
(c) Install the timing belt No. 2 cover with the 4 bolts and nut.
Torque: 10 N·m (102 kgf·cm, 7 ft·lbf)

8. INSTALL TIMING BELT AND PULLEYS
(See page EM–16)

9. INSTALL WATER PUMP PULLEY, FAN AND DRIVE BELT (See page CO–8)

Y

A15107

CYLINDER HEAD
COMPONENTS

EM1SC–02

Exhaust Manifold
Hear Insulator

◆ No.2 Air Hose

Intake Air
Connector

*1 Gasket | 12 (122, 9) |

| 18 (184, 13) |

Intercooler

Turbo Pressure
Sensor

| 10 (102, 7) |

| 12 (122, 9) |

Exhaust Manifold
w/ Turbocharger
Assembly

Turbo Insulator

| 12 (122, 9) |

No.1 Air Hose

| 52 (530, 38) |

| 39 (398, 29) |

| 26 (265, 19) |

Turbine
Oultel Elbow

◆ Gasket

◆ Gasket

| 19 (194, 14) |

◆ Gasket

| 12 (122, 9) |

Turbocharger
Stay

| N·m (kgf·cm, ft·lbf) | : Specified torque

◆ Non–reusable part
*1 Replace only if damaged

Y

A15125

Engine Wire

Spring

Injector

21.6 (220, 16)

Nozzle Holder

◆ Back–up Ring

◆ O–Ring

9.0 (92, 80 in.·lbf)

Nozzle Leakage Pipe

Cylinder Head Cover

12.5 (127, 9)

Gasket

◆ Gasket

16 (163, 12)

Grommet

◆ Gasket

19 (194, 63)

Glow Plug Connector

VSV Assembly

Camshaft Bearing Cap

Camshaft

1st 85 (867, 63)
2nd Turn 90°
3rd Turn 90°

Cylinder Head

Glow Plug

Throttle Body

◆ Gasket

Timing Belt No.2 Cover

Key

13 (133, 10)

EGR Valve

No.1 Camshaft Pulley

◆ Gasket

◆ Gasket

98 (1,000, 72)

Intake Manifold

13 (133, 10)

10 (102, 7)

◆ Gasket

Timing Belt Cover

Check Valve

◆ Gasket

◆ Gasket

29 (296, 21)

21 (214, 15)

No.2 Nozzle Leakage Pipe

12.7 (130, 10)

38 (387, 28)

◆ Washer

Common Rail

Timing Belt

6.0 (61, 53 in.·lbf)

Timing Belt Idler

35 (357, 26)

13 (133, 10)

Timing Belt Tensioner

N·m (kgf·cm, ft·lbf) : Specified torque

Y   ◆ Non–reusable part ★ Precoated part

A15126

Adjusting Shim

Valve Lifter

Keeper

Spring Retainer

Valve Spring

Spring Seat

◆ Oil Seal

Valve Guide
Bushing

Semi Circular Plug

Cylinder Head

★ Water Temperature Sender Gauge

No. 1 Engine Hanger

47 (479, 35)

◆ Gasket

19 (194, 14)

Valve

Water Outlet Housing

N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

★ Precoated part

Y

A15127

REMOVAL

EM1MB–01

NOTICE:
When removing the injection pipes, clean them up with a brush and compressed air.
1. DRAIN ENGINE COOLANT
2. REMOVE INTERCOOLER (See page TC–11)
3. REMOVE TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY (See page TC–5)
4. DISCONNECT ENGINE WIRE
5. REMOVE DIESEL THROTTLE BODY
   (See page ED–5)
6. REMOVE INJECTION PIPE (See page FU–6)
7. REMOVE FUEL INLET PIPE (See page FU–16)
8. REMOVE CYLINDER HEAD COVER
   (See page EM–11)
9. REMOVE INJECTORS (See page FU–6)
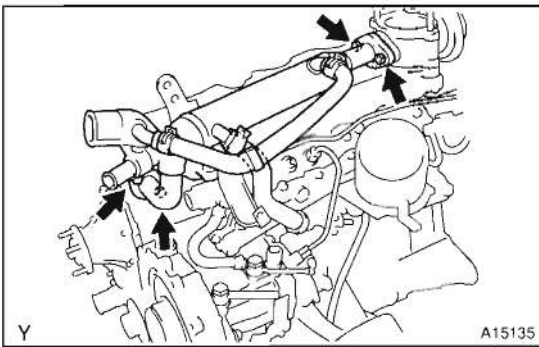
10. **REMOVE EGR COOLER PIPE**
(a) Remove the 2 water hoses.
(b) Remove the 2 bolts, nuts, EGR cooler pipe and 2 gaskets.
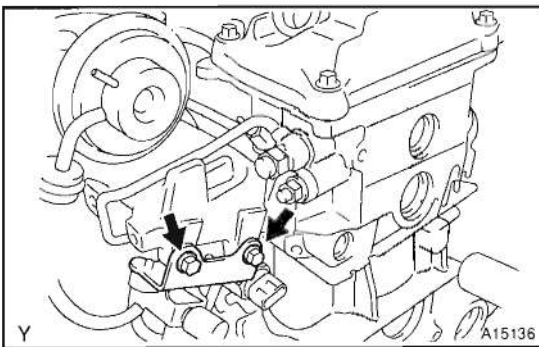
11. **REMOVE EVRV**
(a) Disconnect the vacuum hose, and remove the 2 bolts and E–VRV.
(b) Remove the EGR valve and gasket.
12. **REMOVE OIL FILTER** (See page LU–2)
13. **REMOVE LEAKAGE PIPE NO. 2** (See page FU–6)
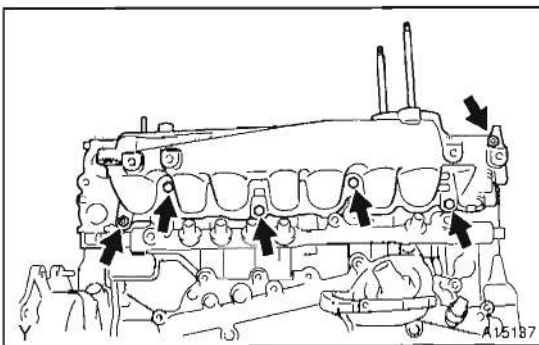
14. **REMOVE INTAKE MANIFOLD**
Remove the 4 bolts, 2 nuts, intake manifold and gasket.
15. **REMOVE GLOW PLUG** (See page ST–1)
16. **REMOVE COMMON RAIL** (See page FU–21)

A15138
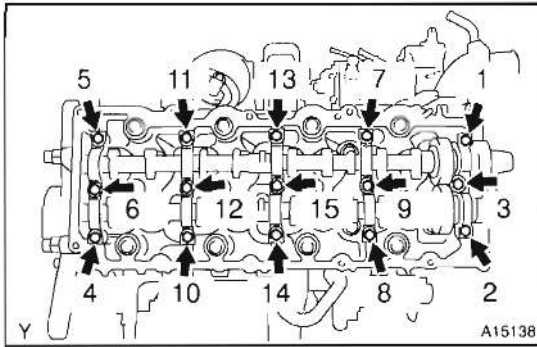
17. REMOVE CAMSHAFT

(a) Uniformly loosen and remove the 15 bolts in several passes, in the sequence shown.

(b) Remove the 5 camshaft bearing caps.

(c) Remove the intake and exhaust camshafts.

A15139
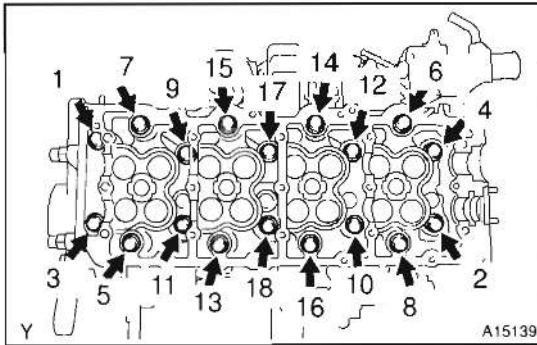
18. REMOVE CYLINDER HEAD

(a) Uniformly loosen and remove the 18 cylinder head bolts, in several passes, in the sequence shown.

NOTICE:

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

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

HINT:

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

NOTICE:

Be careful not to damage the contact surfaces of cylinder head and block.

DISASSEMBLY

EM1MC–01

1.   REMOVE WATER OUTLET HOUSING

Remove the 2 bolts, water outlet housing and gasket.

2.   REMOVE ENGINE HANGER NO. 1

3.   REMOVE SEMI CIRCULAR PLUG

4.   REMOVE VALVE LIFTERS AND SHIMS

HINT:

Arrange the valve lifters and shims in correct order.

5.   REMOVE VALVES

(a)   Using SST, compress the valve spring and remove the 2 keepers.

SST   09202–70020 (09202–00010)

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

HINT:

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

(c)   Using needle–nose pliers, remove the oil seal.

Y   A15141

Gasket Scraper

A15142

EM1MD-01
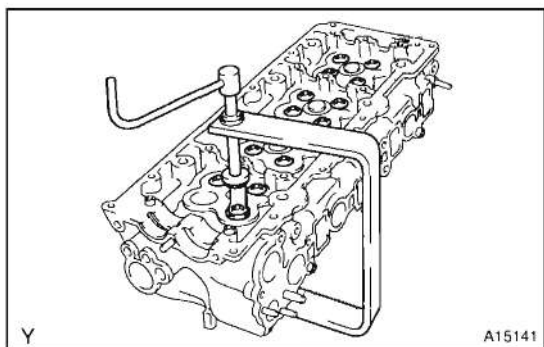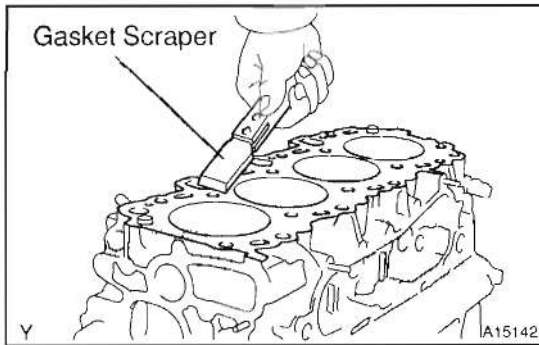
INSPECTION

1. **CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK**
(a) Turn the crankshaft, and bring each piston to the top dead center (TDC). Using a gasket scraper, remove all the carbon from the piston top surface.
(b) Remove all the gasket material from the top of the cylinder block.

NOTICE:
Be careful not to scratch the surfaces.

(c) Using compressed air, blow carbon and oil from the bolt holes.

CAUTION:
Protect your eyes when using high–compressed air.

A15143
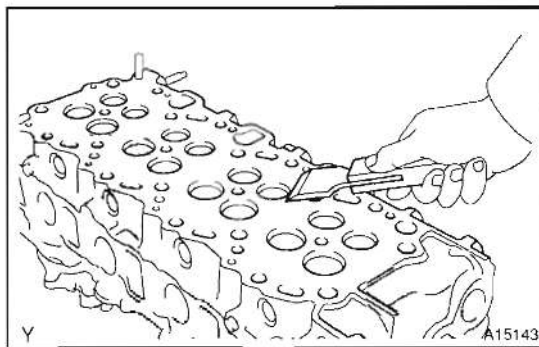
2. **REMOVE GASKET MATERIAL**
Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.

NOTICE:
Be careful not to scratch the cylinder block contact surface.

Guide
Bushing

A15145
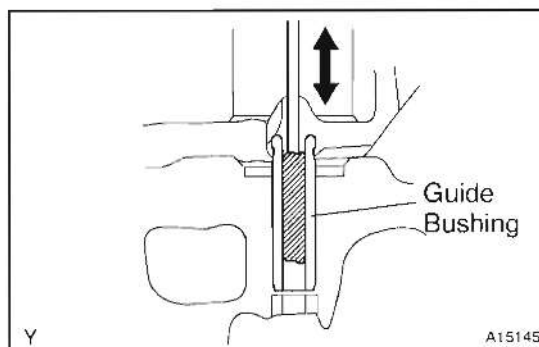
3. **CLEAN VALVE GUIDE BUSHINGS**
Using a valve guide bushing brush and solvent, clean all the guide bushings.

A15146
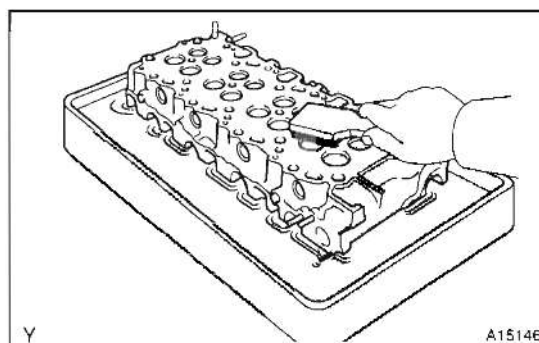
4. **CLEAN CYLINDER HEAD**
Using soft brush and solvent, thoroughly clean the cylinder head.
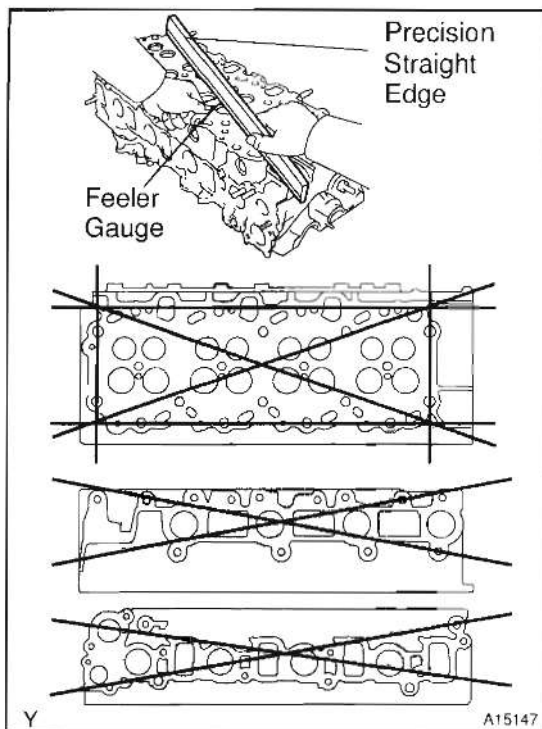
5. INSPECT FOR FLATNESS

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

Maximum warpage: 0.15 mm (0.0059 in.)

If warpage is greater than maximum, replace the cylinder head.
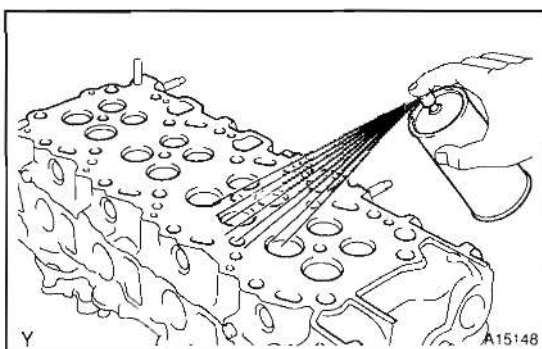
6. INSPECT FOR CRACKS

Using a dye penetrate, check the combustion chambers, intake ports, exhaust ports and surface contacting the cylinder block. If cracked, replace the cylinder head.
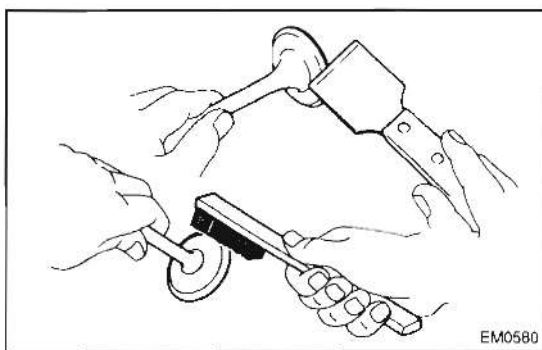
7. CLEAN VALVES

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

(b) Using a wire brush, thoroughly clean the valve.
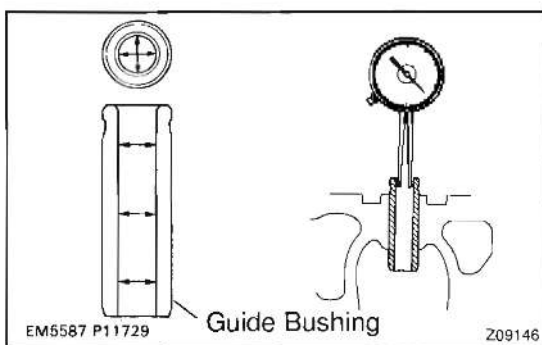
8. INSPECT VALVE STEMS AND GUIDE BUSHINGS

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

Bushing inside diameter:
6.010 – 6.030 mm (0.23661 – 0.23740 in.)
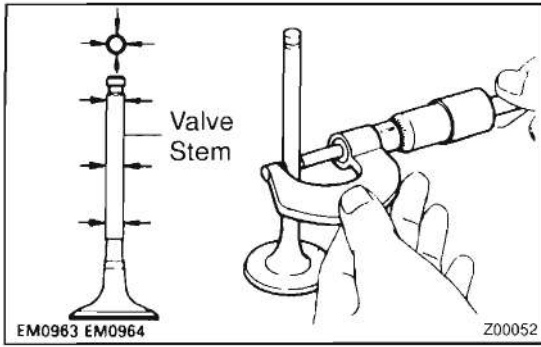
(b) Using a micrometer, measure the diameter of the valve stem.

Valve stem diameter:

Intake	5.970 – 5.985 mm (0.23504 – 0.23563 in.)
Exhaust	5.960 – 5.975 mm (0.23465 – 0.23524 in.)

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

Standard oil clearance:

Intake	0.025 – 0.060 mm (0.0010 – 0.0024 in.)
Exhaust	0.035 – 0.070 mm (0.0014 – 0.0028 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 guide bushing. (See page EM–52)
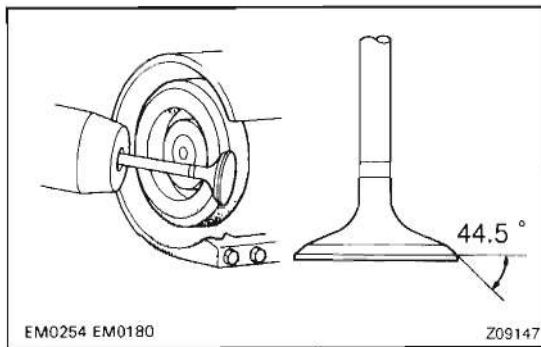
9. INSPECT AND GRIND VALVES

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

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

Valve face angle: 44.5°
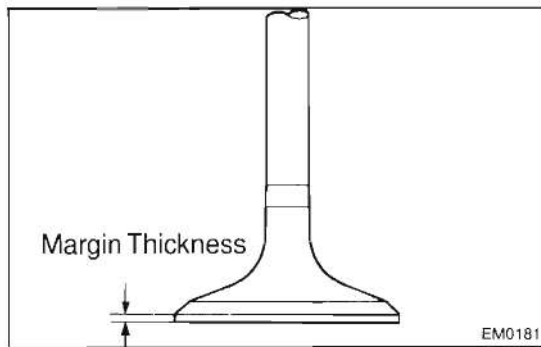
(c) Check the valve head margin thickness.

Standard margin thickness:

Intake	1.1 mm (0.043 in.)
Exhaust	1.2 mm (0.047 in.)

Minimum margin thickness:

Intake	0.6 mm (0.023 in.)
Exhaust	0.7 mm (0.027 in.)

If the margin thickness is less than minimum, replace the valve.
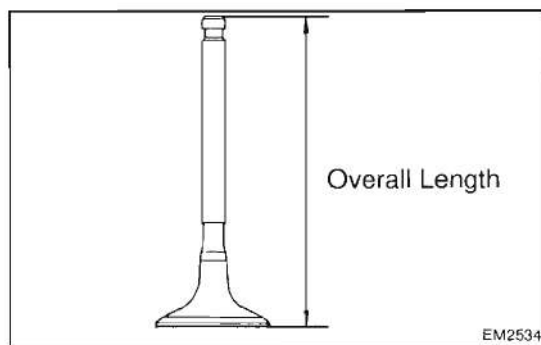
(d) Check the valve overall length.

Standard overall length:

Intake	105.15 – 105.75 mm (4.1398 – 4.1634 in.)
Exhaust	105.02 – 105.62 mm (4.1346 – 4.1583 in.)

Minimum overall length:
Intake: 104.65 mm (4.1201 in.)
Exhaust: 104.52 mm (4.1150in.)

If the overall length is less than minimum, replace the valve.
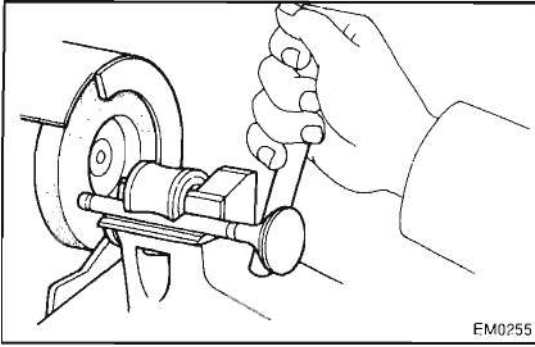
(e) Check the surface of the valve stem tip for wear.
If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.
NOTICE:
Do not grind off more than minimum overall length.
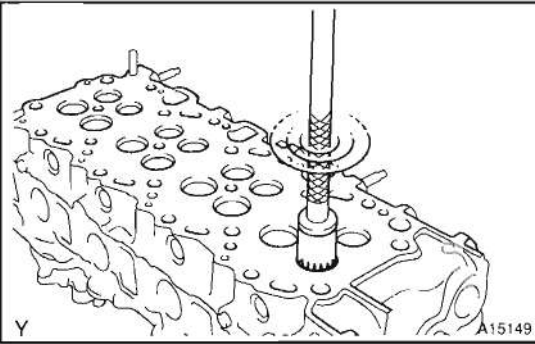
10. INSPECT AND CLEAN VALVE SEATS
(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.

Width
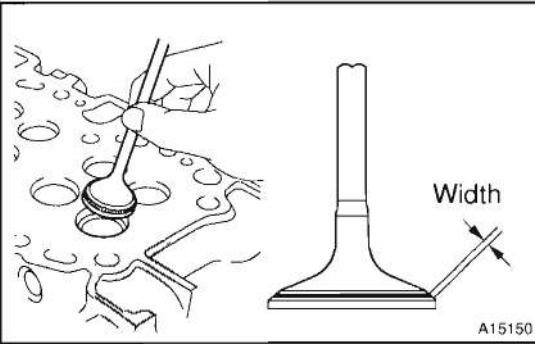
(b) Check the valve seating position.
Apply a light coat of prussian blue (or white lead) to the valve face. Lightly press the valve against the seat. Do not rotate valve.
(c) Check the valve face and seat for the following:
• If blue appears 360° around the valve face, the valve is concentric. If not, replace the valve.
• If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
• Check that the seat contact is in 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 seats as follows:

45° 25°

IN 1.2 – 1.6 mm (0.047 – 0.063 in.)
EX 1.6 – 2.0 mm (0.063 – 0.079 in.)

(1) If the seating is too high on the valve face, use 25° and 45° cutters to correct the seat.

IN: 70°
EX: 75°   45°

IN 1.2 – 1.6 mm (0.047 – 0.063 in.)
EX 1.6 – 2.0 mm (0.063 – 0.079 in.)

(2) Intake:
If the seating is too low on the valve face, use 70° and 45° cutters to correct the seat.
(3) Exhaust:
If the seating is too low on the valve face, use 75° and 45° cutters to correct the seat.
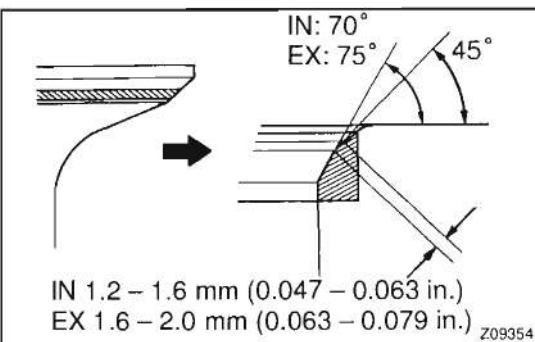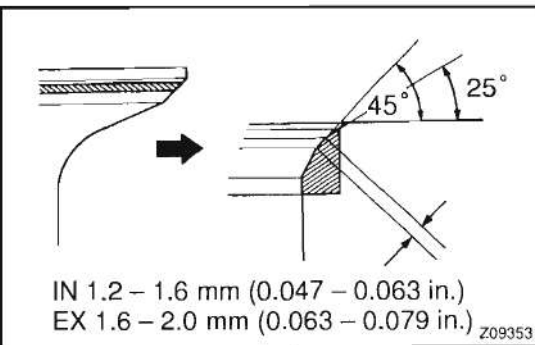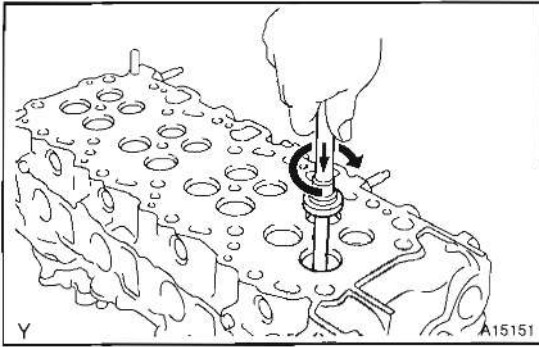
(d) Hand–lap the valve and valve seat with an abrasive compound.

(e) After hand–lapping, clean the valve and valve seat.
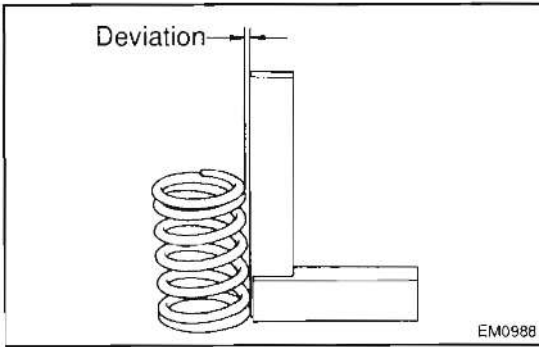
11. INSPECT VALVE SPRINGS

(a) Using a steel square, measure the deviation of the valve spring.
Maximum deviation: 2.0 mm (0.079 in.)
If the deviation is greater than maximum, replace the valve spring.
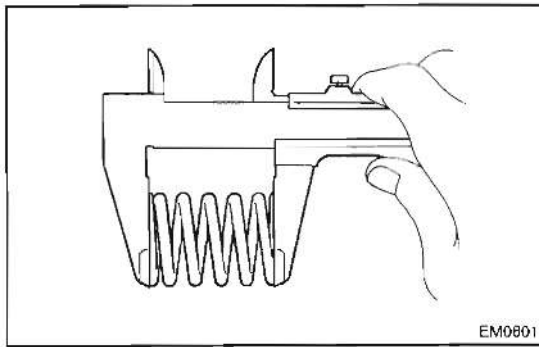
(b) Using a vernier caliper, measure the free length of the valve spring.
Free length:

Paint Color	
Blue	46.8 mm (1.843 in.)
None	46.5 mm (1.831 in.)

If the free length is not as specified, replace the valve spring.
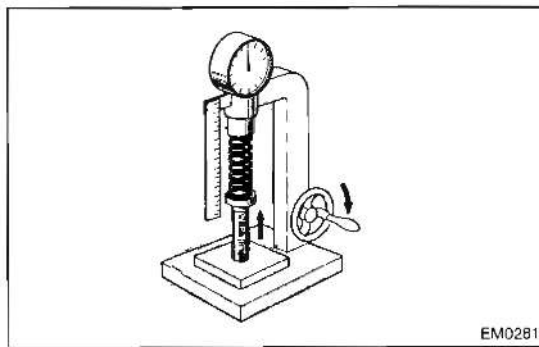
(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension: at 33.1 mm (1.303 in.)
If the installed tension is not as specified, replace the valve spring.

Paint Color	
Blue	149.9 – 166.1 N (15.3 – 16.9 kgf, 33.7 – 37.4 lbf)
None	150.2 – 165.8 N (15.3 – 16.9 kgf, 33.8 – 37.3 lbf)
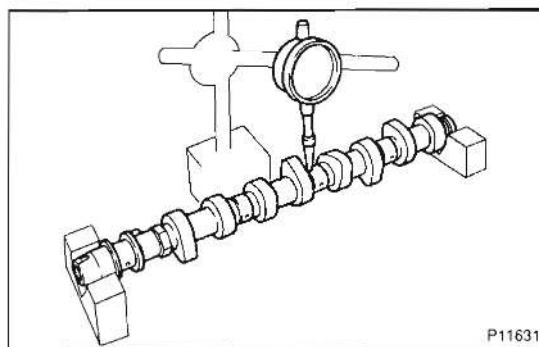
12. INSPECT CAMSHAFT FOR RUNOUT

(a) Place the camshaft on V–blocks.

(b) Using a dial indicator, measure the circle runout at the center journal.
Maximum circle runout: 0.03 mm (0.0012 in.)
If the circle runout is greater than maximum, replace the camshaft.
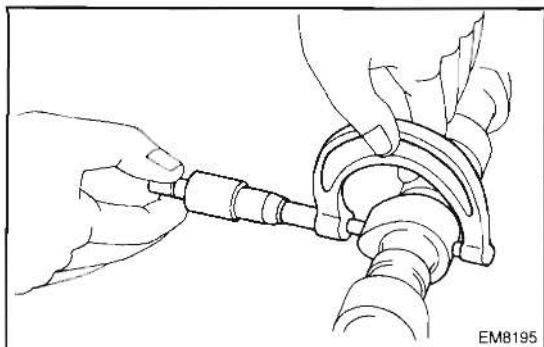
13. INSPECT CAM LOBES
Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

Intake	47.180 – 47.280 mm (1.85748 – 1.86141 in.)
Exhaust	48.070 – 48.170 mm (1.89252 – 1.89645 in.)

Minimum cam lobe height:

Intake	46.76 mm (1.8409 in.)
Exhaust	47.65 mm (1.8760 in.)

If the cam lobe height is less than minimum, replace the camshaft.
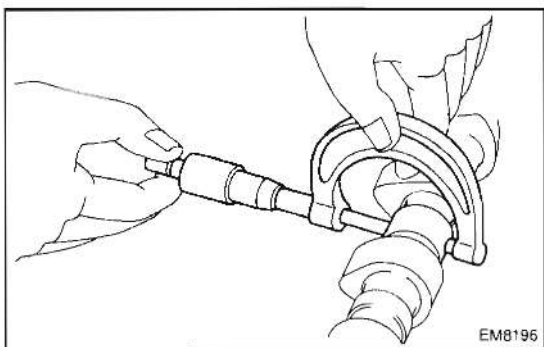
14. INSPECT CAMSHAFT JOURNALS
Using a micrometer, measure the journal diameter.

Journal diameter:
27.969 – 27.985 mm (1.1011 – 1.1018 in.)

If the journal diameter is not as specified, check the oil clearance.

15. INSPECT CAMSHAFT BEARINGS
Check the bearings for flaking and scoring.

If the bearings are damaged, replace the bearing caps and cylinder head as a set.

16. INSPECT CAMSHAFT JOURNAL OIL CLEARANCE
(a) Clean the bearing caps and camshaft journals.

(b) Place the camshaft on the cylinder head.

(c) Lay a strip of Plastigage across each of the camshaft journals.

(d) Install the bearing caps. (See page EM–56)

Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)

NOTICE:

Do not turn the camshaft.

(e) Remove the bearing caps.

(f) Measure the Plastigage at its widest point.

Standard oil clearance:
0.025 – 0.062 mm (0.0010 – 0.0024 in.)
Maximum oil clearance: 0.10 mm (0.039 in.)

If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(g) Completely remove the Plastigage.
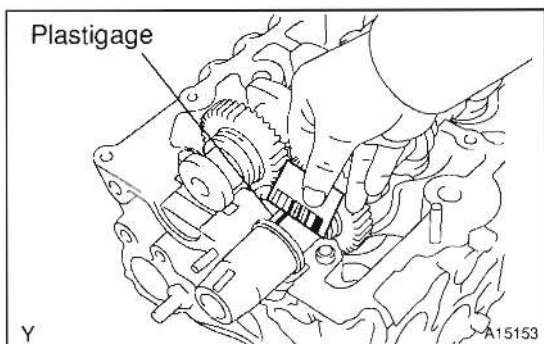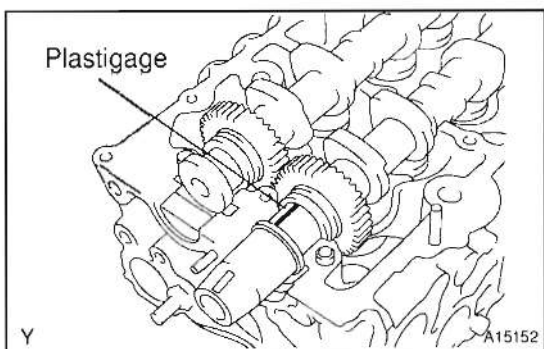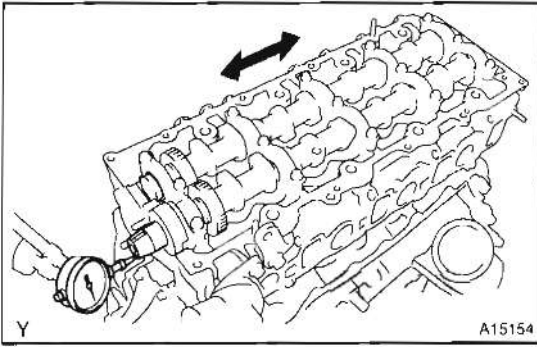
17. INSPECT CAMSHAFT THRUST CLEARANCE

(a) Install the camshaft. (See page EM–56)

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

Standard thrust clearance:

0.035 – 0.185 mm (0.00138 – 0.00728 in.)

Maximum thrust clearance: 0.25 mm (0.0098 in.)

If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.
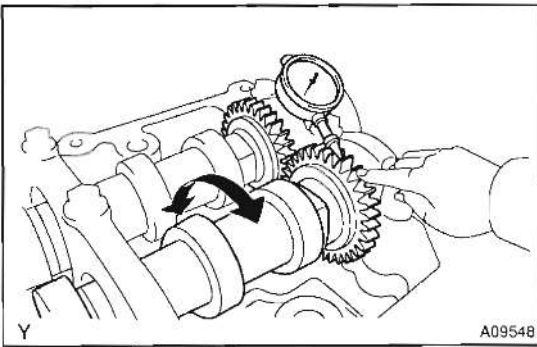
18. INSPECT CAMSHAFT GEAR BACKLASH

(a) Install the camshafts. (See page EM–56)

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

Standard backlash:

0.035 – 0.089 mm (0.00138 – 0.00350 in.)

Maximum backlash: 0.189 mm (0.00744 in.)

If the backlash is greater than maximum, replace the camshafts.
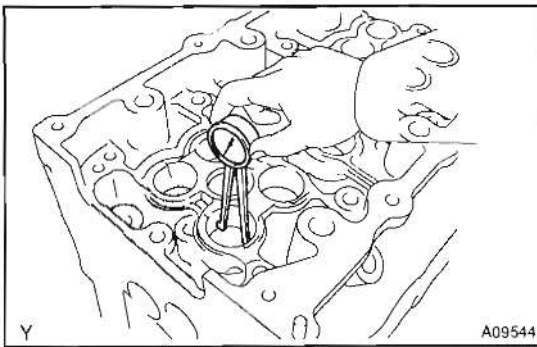
19. INSPECT VALVE LIFTERS AND LIFTER BORES

(a) Using a caliper qugem measure the lifter bore diameter of the cylinder head.

Lifter diameter:

31.000 – 31.021 mm (1.22047 – 1.22130in.)
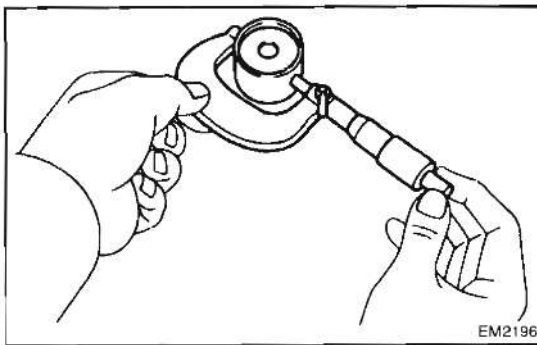
(b) Using a micrometer, measure the lifter diameter.

Lifter diameter:

30.966 – 30.976 mm (1.21913 – 1.21953 in.)

(c) Substract the lifter diameter measurement from the lifter bore diameter measurement.

Standard oil clearance:

0.024 – 0.055 mm (0.00094 – 0.00217 in.)

Maximum oil clearance: 0.08 mm (0.0031 in.)

If the oil clearance is greater than maximum, replace the lifter. If necessary, replace the cylinder head.
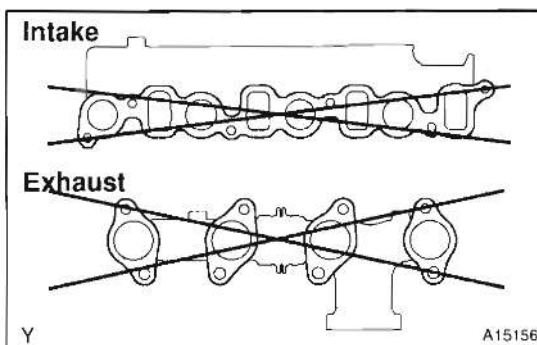
20. INSPECT INTAKE AND EXHAUST MANIFOLDS

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

Maximum warpage: 0.40 mm (0.0157 in.)

If warpage is greater than maximum, replace the manifold.
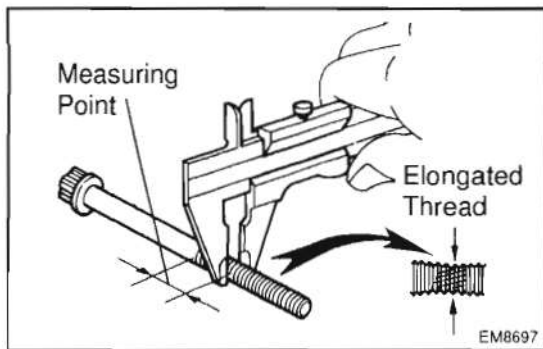
21. INSPECT CYLINDER HEAD BOLTS
Using vernier calipers, measure the minimum outer diameter of the compressed thread at the measuring point.

Standard outer diameter:
11.8 – 12.0 mm (0.465 – 0.472 in.)
Minimum outer diameter: 11.6 mm (0.457 in.)

If the outer diameter is less than minimum, replace the bolt.
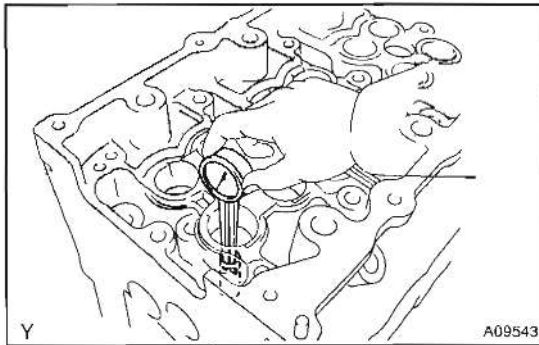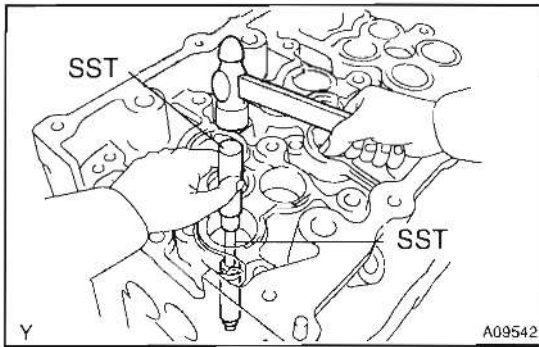
REPLACEMENT

1. REPLACE VALVE GUIDE BUSHINGS

(a) Using SST and a hammer, tap out the guide bushing.
SST 09201–10000 (09201–01060) 09950–70010 (09951–07100)

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

Both intake and exhaust

Bushing bore diameter mm (in.)	Bushing size
10.985 – 11.006 (0.4325 – 0.4333)	Use STD
11.035 – 11.056 (0.4344 – 0.4353)	Use O/S 0.05

V03700

(c) Select a new guide bushing (STD or O/S 0.05).
If the bushing bore diameter of the cylinder head is greater than 11.006 mm (0.4333 in.), machine the bushing bore to the following dimension:

Rebored cylinder head bushing bore dimension: 11.035 – 11.056 mm (0.4344 – 0.4353 in.)

If the bushing bore diameter of the cylinder head is greater than 13.077 mm (0.5148 in.), replace the cylinder head.
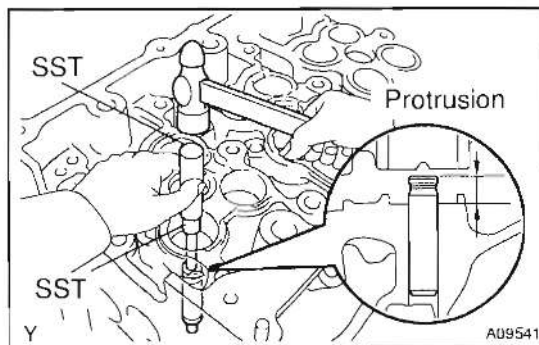
(d) Using SST and a hammer, tap in a new guide bushing until there is 10.3 – 10.7 mm (0.406 – 0.421 in.) protruding from the cylinder head.
SST 09201–10000 (09201–01060) 09950–70010 (09951–07100)
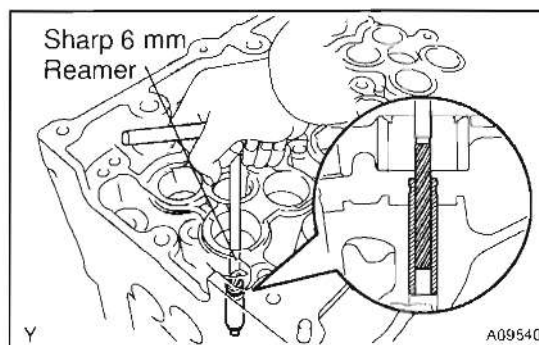
(e) Using a sharp 6 mm reamer, ream the guide bushing to obtain the standard specified clearance (See page EM–44) between the guide bushing and valve stem.
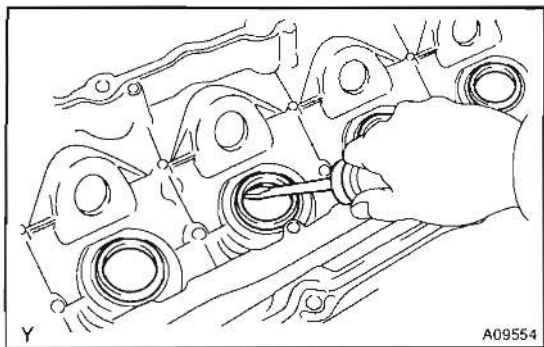
2. REPLACE NOZZLE HOLDER GASKETS

(a) Using a screwdriver, pry off the nozzle holder gasket.
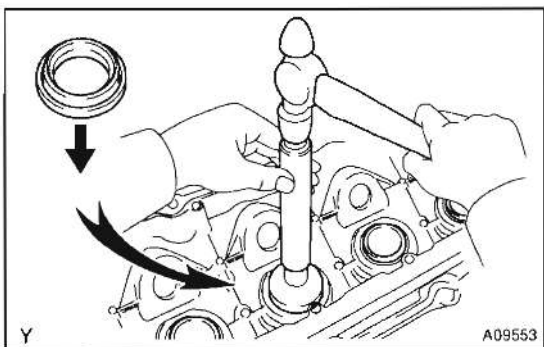
(b) Using SST and a hammer, tap in a new nozzle holder gasket until its surface is flush with the upper edge of the cylinder head cover.

SST   09950–60010 (09951–00280, 09951–00500, 09952–06010), 09950–70010 (09951–07100)

(c) Apply a light coat of MP grease to the nozzle holder gasket lip.

REASSEMBLY

EMIMF-0'

HINT:
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.
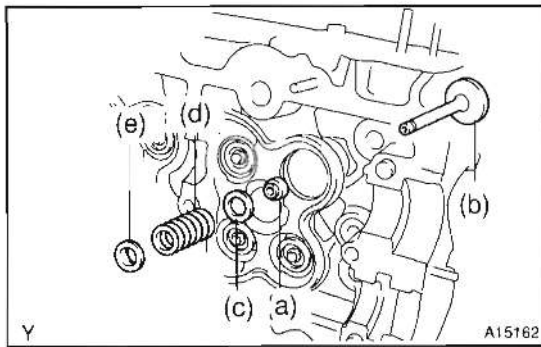
1. INSTALL VALVES
(a) Install the oil seal.
(b) Install the valve.
(c) Install the spring seat.
(d) Install the valve spring.
(e) Install the spring retainer.
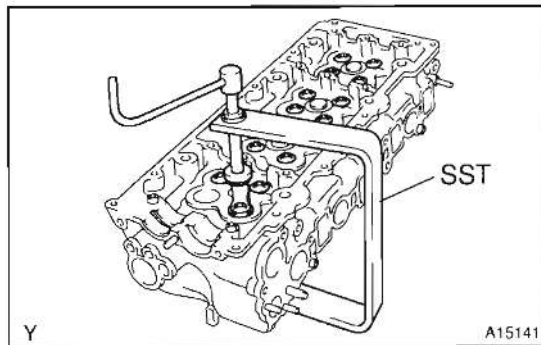
(f) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST   09202–70020 (09202–00010)
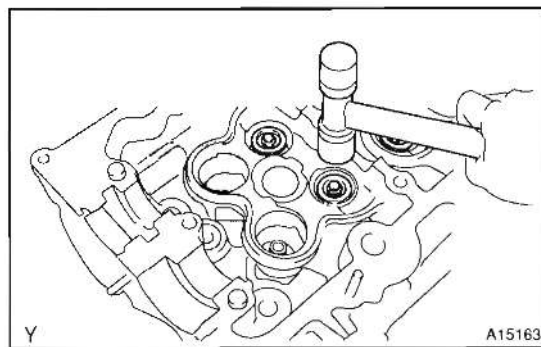
(g) Using a plastic–faced hammer, lightly tap the valve stem tip to assure a proper fit.

2. INSTALL VALVE LIFTERS AND SHIMS
(a) Install the valve lifter and shim.
(b) Check that the valve lifter rotates smoothly by hand.

3. INSTALL WATER TEMPERATURE SENDER GAUGE
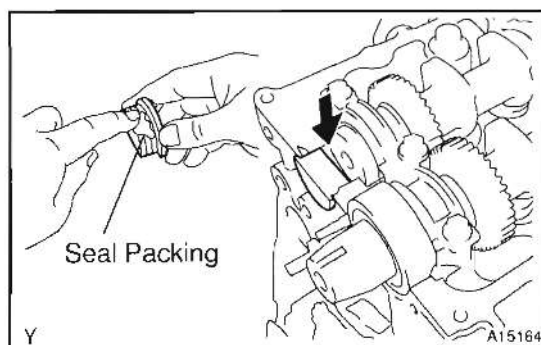
4. INSTALL SEMI CIRCULAR PLUG
(a) Remove any old packing (FIPG) material.
(b) Apply seal packing to the semi circular plug as shown.
Seal packing: Part No. 08826–00080 or equivalent
Thickness: 0.5 mm (0.020 in.)
(c) Install the semi circular plug to the cylinder head.
NOTICE:
Prevent FIPG from being stuck to the camshaft thrust groove.

5.   INSTALL WATER OUTLET HOUSING

Install a new gasket, the water outlet pipe with the 2 bolts.

Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)

6.   INSTALL ENGINE HANGER NO. 1

Install the engine hanger to the cylinder head.

Torque: 47 N·m (479 kgf·cm, 35 ft·lbf)

INSTALLATION

EM1MG–01

NOTICE:
- When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.
- In case of having the common rail and/or injectors replaced, must replace injection pipes, too.
- In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.

1. **CHECK PISTON PROTRUSION AND SELECT CYLINDER HEAD GASKET**

(a) Check the piston protrusions for each cylinder.
   (1) Clean the cylinder block with solvent.
   (2) Sent the piston of the cylinder to be measured to slightly before TDC.
   (3) Place a dial indicator on the cylinder block, and set the dial indicator at 0 mm (0 in.).
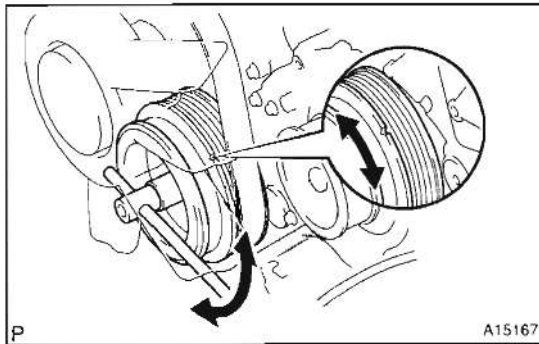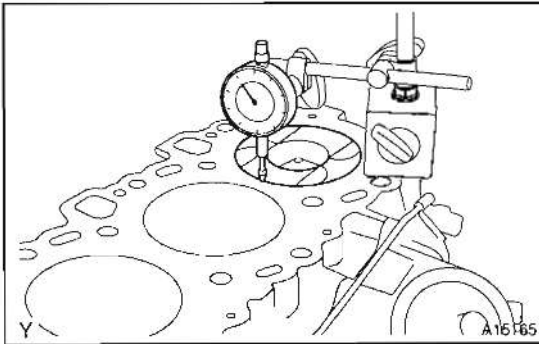
HINT:
- Use a dial indicator measuring tip a shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.
   (4) Find where the piston head protrudes most by slowly turning the crankshaft clockwise and counterclockwise.

   (5) Measure each cylinder at 2 places as shown in the illustration, making a total of 8 measurements.
   (6) For the piston protrusion value of each cylinder, use the average of the 2 measurements of each cylinder.

Protrusion: 0.005 – 0.254 mm (0.00020 – 0.01000 in.)
(When removing piston and connecting rod assembly)
If the protrusion is not as specified, remove the piston and connecting rod assembly and reinstall it.
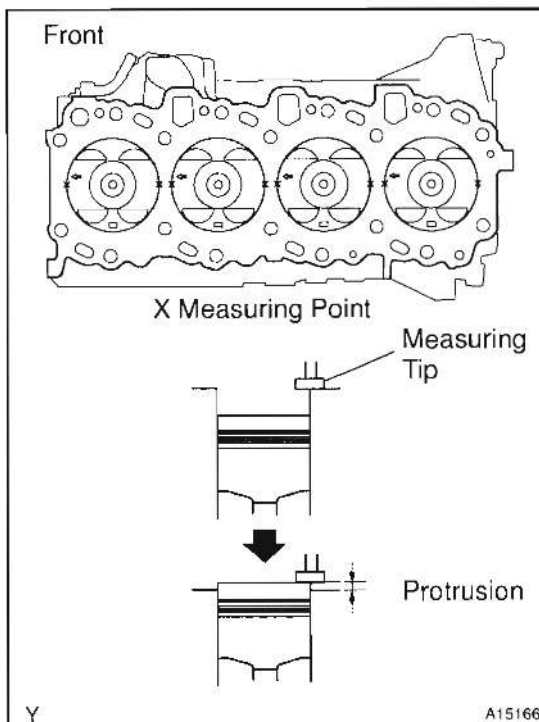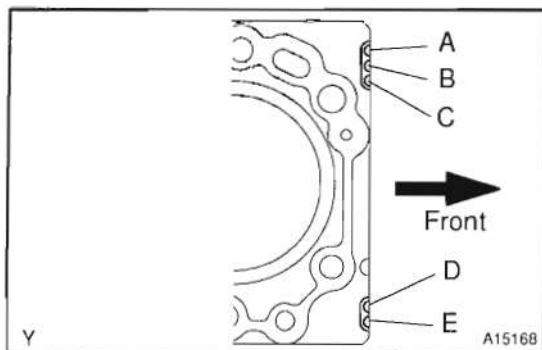
(b)   Select a new cylinder head gasket.

HINT:

There are 5 sizes of new cylinder head gaskets, marked "A", "B", "C", "D" or "E" according.

Installed cylinder head gasket thickness:

A	0.80 – 0.90 mm (0.0315 – 0.0354 in.)
B	0.85 – 0.95 mm (0.0335 – 0.0374 in.)
C	0.90 – 1.00 mm (0.0354 – 0.0394 in.)
D	0.95 – 1.05 mm (0.0374 – 0.0413 in.)
E	1.00 – 1.10 mm (0.0394 – 0.0433 in.)

Select the largest piston protrusion value from the measurements made, then select the appropriate cylinder head gasket according to the table below.

Piston protrusion mm (in.)	Gasket size
0.005 – 0.054 (0.00019 – 0.00213)	Use A
0.055 – 0.104 (0.00217 – 0.00409)	Use B
0.105 – 0.154 (0.00413 – 0.00606)	Use C
0.155 – 0.204 (0.00610 – 0.00803)	Use D
0.205 – 0.255 (0.00807 – 0.01004)	Use E

2.   SET NO. 1 CYLINDER TO APPROX. 90° BTDC/COMPRESSION

Using the crankshaft pulley bolt, turn the crankshaft, and set the dot mark of the crankshaft timing pulley at the position of 90° BTDC.

NOTICE:

If the timing belt is disengaged, having the crankshaft timing pulley at wrong angle can cause the piston head and valve head to come into contact with each other.

3.   PLACE CYLINDER HEAD ON CYLINDER BLOCK

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

NOTICE:

Be careful of the installation direction.

(b)   Place the cylinder head in position on the cylinder head gasket.
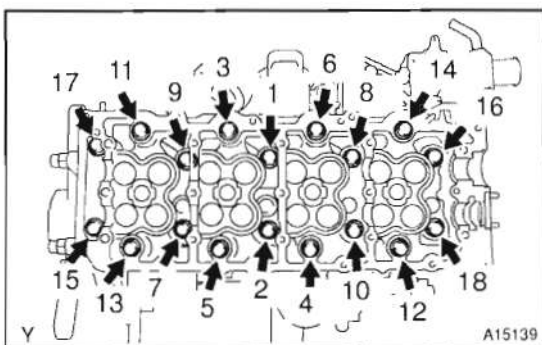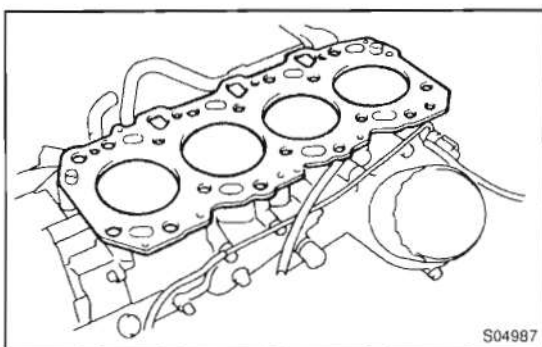
4.   INSTALL CYLINDER HEAD BOLTS

HINT:

- The cylinder head bolts are tightened in 3 progressive steps (steps (b), (d) and (e)).
- If any bolts is broken or deformed, replace it.

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

(b)   Install and uniformly tighten the 18 cylinder head bolts, in several passes, in the sequence shown.

Torque: 85 N·m (867 kgf·cm, 63 ft·lbf)
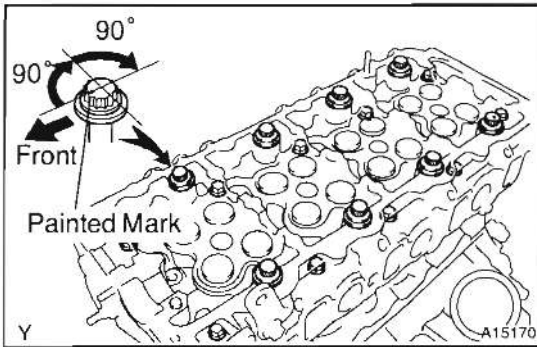
(c) Mark the front of the cylinder head bolt with paint.

(d) Retighten the cylinder head bolts 90° in the numerical order shown.

(e) Retighten cylinder head bolts by an additional 90°.

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

5. INSTALL GLOW PLUG AND GLOW PLUG CONNECTOR (See page ST–4)
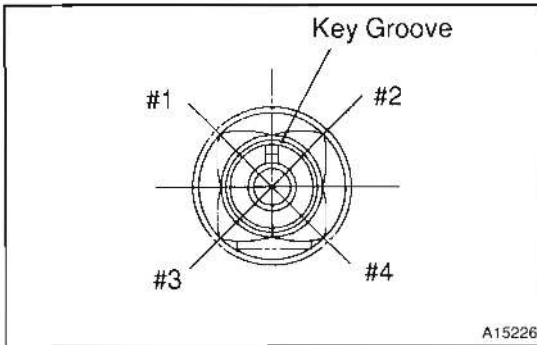
6. INSTALL CAMSHAFT

(a) Rotate the crankshaft about 90° counterclockwise from the TDC position to lower the piston.

(b) Place the camshaft No. 1 with its camlobs #3 and #4 facing downward on the cylinder head as shown in the illustration.
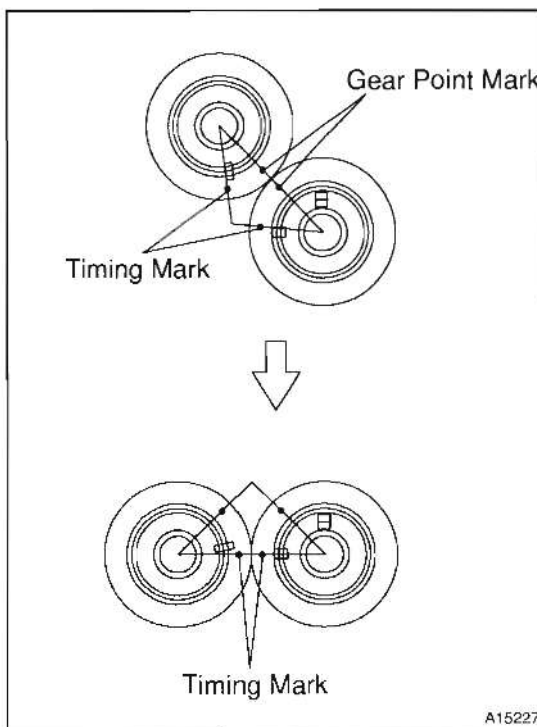
(c) Mesh the gear point marks of the camshaft No. 1 and No. 2.

(d) Rotate the camshaft No. 2 with its gear in mesh to place it on the journal of exhaust side cylinder head as shown in the illustration.

(e) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the bearing cap No. 1 and cylinder head.

- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.

- Thoroughly clean all components to remove all the loose material.

- Using a non–residue solvent, clean both sealing surfaces.
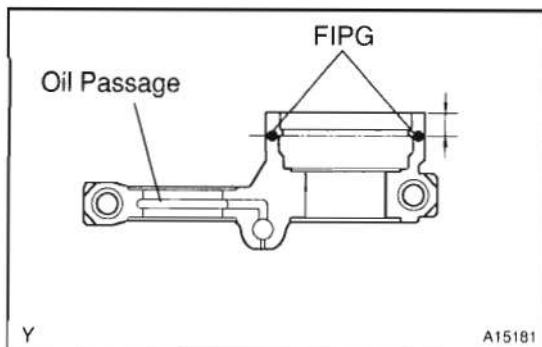
(f) Apply seal packing to the camshaft bearing cap No. 1 as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent
Thickness: 0.5 mm (0.020 in.)

- Install a nozzle that has been cut to a 4 mm (0.16 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

NOTICE:
Prevent FIPG from being stuck to the oil passage of the bearing cap No. 1.
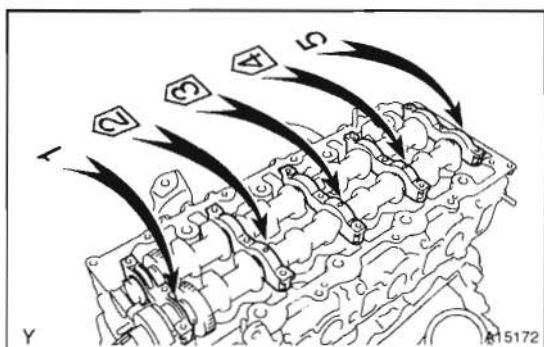
(g) Install the 5 bearing caps in their proper locations.
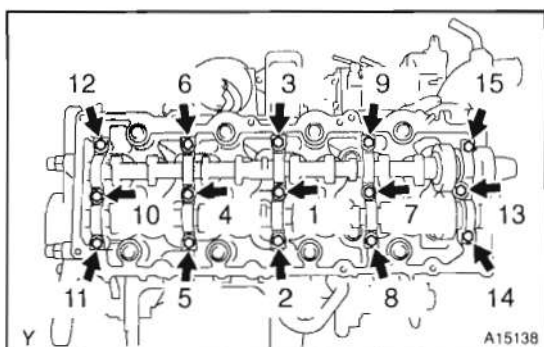
(h) Install and uniformly tighten the 10 bearing cap bolts in several passes in the sequence shown.
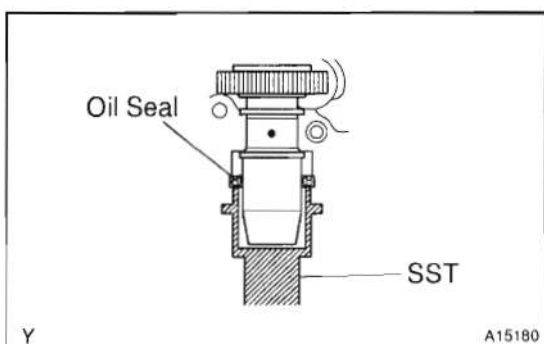
7. INSTALL CAMSHAFT OIL SEAL
Using SST and hammer, install the camshaft oil seal.
SST 09223–50010
8. INSTALL COMMON RAIL (See page FU–22)
9. INSTALL GLOW PLUG (See page ST–1)
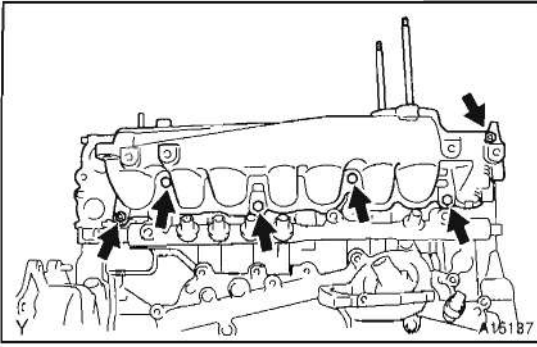
10. INSTALL INTAKE MANIFOLD
Install a new gasket and intake manifold with the 4 bolts and 2 nuts.

Torque: 29 N·m (296 kgf·cm, 21 ft·lbf)

11. INSTALL EGR VALVE
(a) Install the gasket and EGR valve.
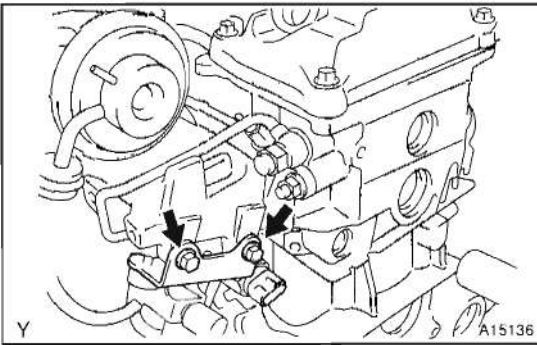
(b) Install the E–VRV with the 2 bolts, and connect the vacuum hose.

Torque: 20 N·m (204 kgf·cm, 15 ft·lbf)
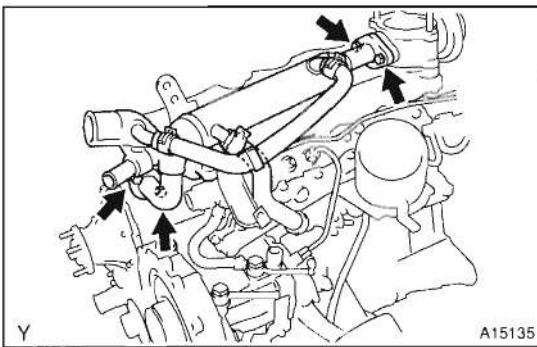
12. INSTALL EGR COOLER PIPE
(a) Install new 2 gaskets and EGR cooler pipe with the 2 bolts and nuts.
(b) Install the 2 water hoses.

13. INSTALL INJECTOR (See page FU–8)
14. INSTALL LEAKAGE PIPE NO. 2 (See page FU–8)
15. INSTALL CYLINDER HEAD COVER
    (See page EM–16)
16. INSTALL FUEL INLET PIPE (See page FU–18)
17. INSTALL INJECTION PIPE (See page FU–8)
18. CONNECT ENGINE WIRE
19. INSTALL DIESEL THROTTLE BODY (See page ED–7)
20. INSTALL TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY (See page TC–8)
21. INSTALL INTERCOOLER (See page TC–12)
22. INSTALL OIL FILTER (See page LU–2)
23. FILL WITH ENGINE OIL AND ENGINE COOLANT

CYLINDER BLOCK
COMPONENTS

EM15J–02

Alternator

Drive Belt Tensioner

◆ Gasket

62 (632, 46)

Water Pump

21 (214, 15)

13 (133, 10)

Water Pump Cover

Drive Belt

◆ Gasket

18 (184, 13)

Water Pump Pulley

Fluid Coupling

Fan

Vacuum Pipe

8.0 (82, 71 in.·lbf)

◆ Gasket

◆ Oil Filter

◆ Gasket

Oil Cooler

Oil Cooler Cover

◆ Gasket

16 (163, 12)

13 (133, 10)

Engine Wire

N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

Y

A15118

RH Engine Mounting Bracket

68 (693, 50)

13 (133, 10)

Water Inlet

Thermostat

◆ O-Ring

68 (693, 50)

LH Engine Mounting Bracket

16 (163, 12)

13 (133, 10)

Alternator Bracket

21 (214, 15)

13 (133, 10)

◆ Gasket

Driven Rotor

◆ O-Ring

Timing Gear Case

50 (510, 37)

Idler Gear Shaft

Idler Gear

Thrust Plate

13 (133, 10)

Supply Pump Drive Gear

Crank Angle Sensor Plate

Crankshaft Timing Gear

Supply Pump

Crankshaft Pulley

365 (3,700, 269)

◆ Crankshaft Front Oil Seal

21 (214, 15)

Vacuum Pump

◆ O-Ring

Timing Gear Cover

◆ O-Ring

◆ Supply Pump Drive Gear Oil Seal

21 (214, 15)

21 (214, 15)

21 (214, 15)

N·m (kgf·cm, ft·lbf) : Specified torque
Y ◆ Non-reusable part

A15119

Piston Ring (No.1 Compression)

Piston Ring (No.2 Compression)

Piston Ring (Oil Ring)

Piston Pin

Piston

◆ Snap Ring

◆ Snap Ring

Connecting Rod Bushing

Oil Orifice

Connecting Rod

◆ Oil Seal

Connecting Rod Bearing

M/T: 145 (1,479, 107)

A/T: 178 (1,820, 131)

8.0 (82, 71 in.·lbf)

Flywheel

Balance shaft Drive Gear

RH Balance Shaft

Thrust Washer

LH Balance Shaft

Rear End Plate

13 (133, 9)

Rear Oil Seal Retainer

Upper Main Bearing

Oil Nozzle

Upper Crankshaft Thrust Washer

13 (133, 10)

36 (367, 27)

26 (265, 19)

Crankshaft

Lower Main Bearing

Lower Crankshaft Thrust Washer

Connecting Rod Bearing

Connecting Rod Cap

Main Bearing Cap

1st 35 (357, 26)
2nd Turn 90°

1st 50 (510, 37)
2nd Turn 90°

◆ Gasket

8.0 (82, 71 in.·lbf)

Oil Strainer

8.0 (82, 71 in.·lbf)

16 (163, 13)

Low Engine Oil Level Warning Sensor

Oil Pan

16 (163, 13)

◆ Gasket

N·m (kgf·cm, ft·lbf) : Specified torque

34 (347, 25)

Y   ◆ Non–reusable part

A15120

DISASSEMBLY

EM1M8–01

1.   **REMOVE CLUTCH COVER AND DISC**
2.   **REMOVE FLYWHEEL**
Remove the 8 bolts and flywheel.

P11677
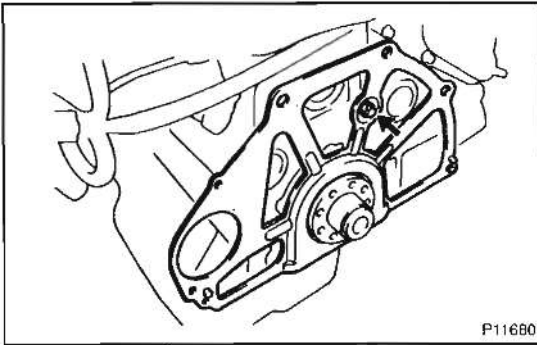
3.   **REMOVE REAR END PLATE**
Remove the bolt and end plate.
4.   **INSTALL ENGINE TO ENGINE STAND FOR DIS-ASSEMBLY**
5.   **REMOVE TIMING BELT AND PULLEYS**
     (See page EM–11)
6.   **REMOVE CYLINDER HEAD**
     (See page EM–41)
7.   **REMOVE ALTERNATOR AND ALTERNATOR BRACK-ET (See page CO–5)**
8.   **REMOVE WATER PUMP (See page CO–5)**
9.   **REMOVE SUPPLY PUMP (See page FU–16)**
10. **REMOVE OIL COOLER (See page LU–19)**
11. **REMOVE TIMING GEARS (See page EM–21)**
12. **TIMING GEAR CASE (See page LU–7)**
13. **REMOVE WATER INLET AND THERMOSTAT (See page CO–11)**
14. **REMOVE WATER TEMPERATURE SENSOR**
15. **REMOVE ENGINE MOUNTING**
16. **REMOVE OIL PAN**
17. **REMOVE PLUG HOLE**

P11680
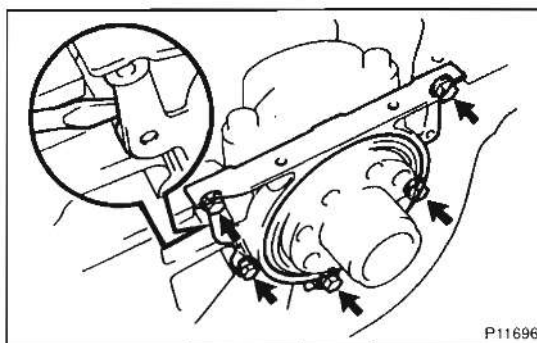
18. **REMOVE REAR OIL SEAL RETAINER**
Remove the 5 bolts and retainer.

P11696

Balance
Shaft

P11721

RH Balance
Shaft

LH Balance
Shaft

P11794
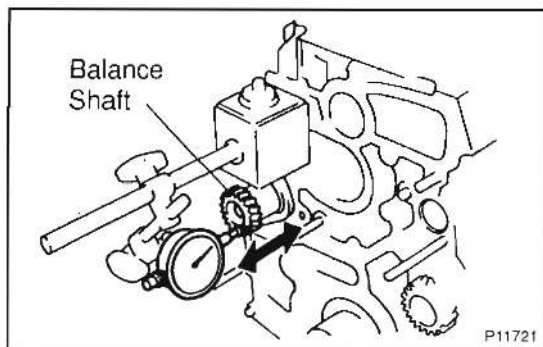
19. CHECK THRUST CLEARANCES OF RH AND LH BALANCE SHAFTS OF ENGINE BALANCER

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

Standard thrust clearance:
0.065 – 0.140 mm (0.0026 – 0.0055 in.)
Maximum thrust clearance: 0.25 mm (0.0098 in.)

If the thrust clearance is greater than maximum, replace the balance shaft thrust washer.

If necessary, replace the balance shaft.
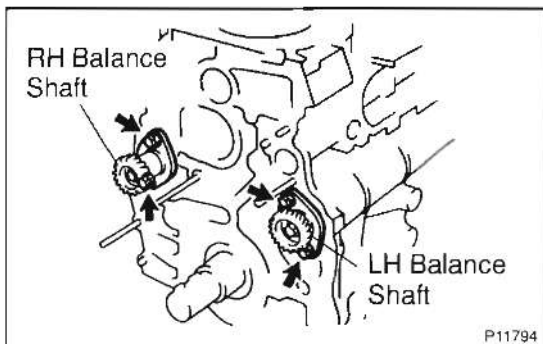
20. REMOVE RH AND LH BALANCE SHAFTS
(a) Remove the 2 bolts and RH balance shaft.
(b) Remove the 2 bolts and LH balance shaft.

Balance
Shaft

P12246
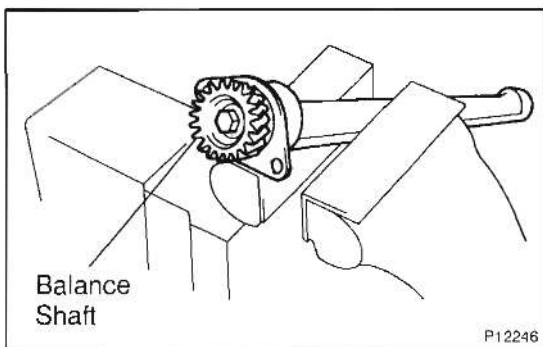
21. DISASSEMBLE RH AND LH BALANCE SHAFTS
(a) Mount the weight of the balance shaft in a vise.
NOTICE:
Be careful not to damage the balance shaft.

Balance Shaft
Driven Gear

Thrust
Washer

P12247
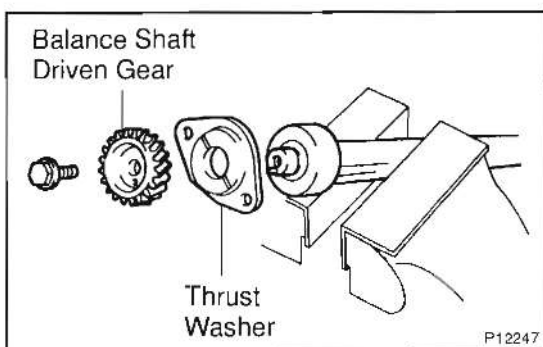
(b) Remove the bolt, balance shaft driven gear and thrust washer.

P11663
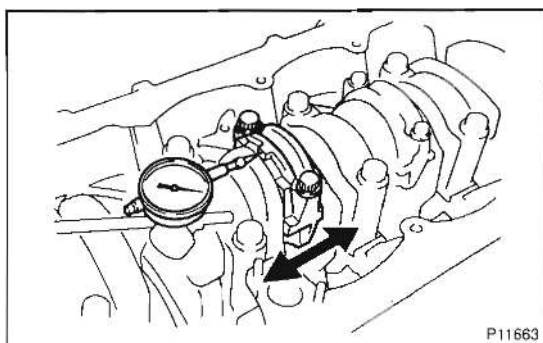
22. CHECK CONNECTING ROD THRUST CLEARANCE

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

Standard thrust clearance:
0.10 – 0.30 mm (0.0039 – 0.0118 in.)
Maximum thrust clearance: 0.40 mm (0.0157 in.)

If the thrust clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.
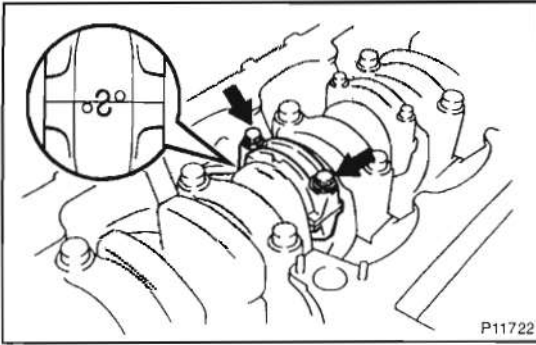
23. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

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

(b) Remove the connecting rod cap bolts.
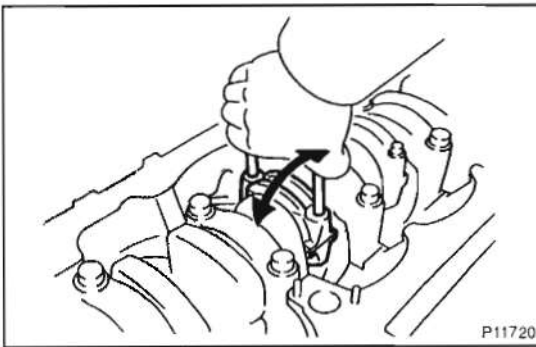
(c) Using the 2 removed connecting rod bolts, pry the connecting rod cap back and forth, and remove the connecting cap.

HINT:

Keep the lower bearing inserted with the connecting rod cap.

(d) Clean the crank pin and bearing.

(e) Check the crank pin and bearing for pitting and scratches. If the crank pin or bearing is damaged, replace the bearings. If necessary, grind or replace the crankshaft.
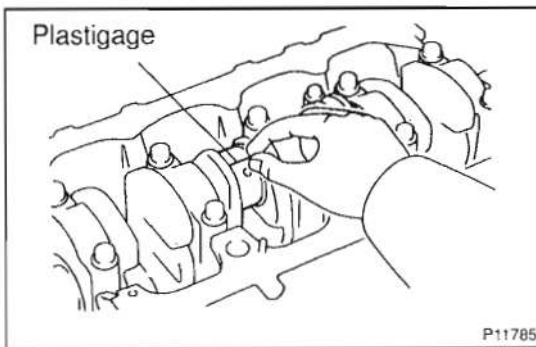
(f) Lay a strip of Plastigage across the crank pin.

(g) Install the connecting rod cap with the 2 bolts.
(See page EM–83)
1st
Torque: 35 N·m (357 kgf·cm, 26 ft·lbf)
2nd Turn 90 °
NOTICE:
Do not turn the crankshaft.
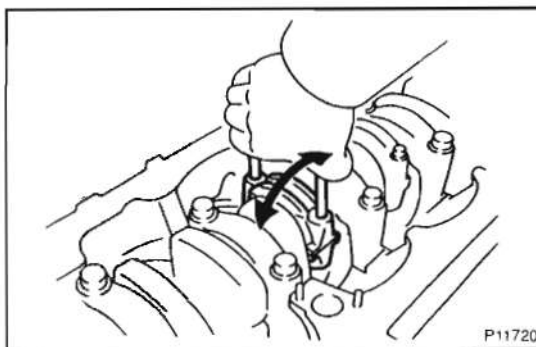
(h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c) above)
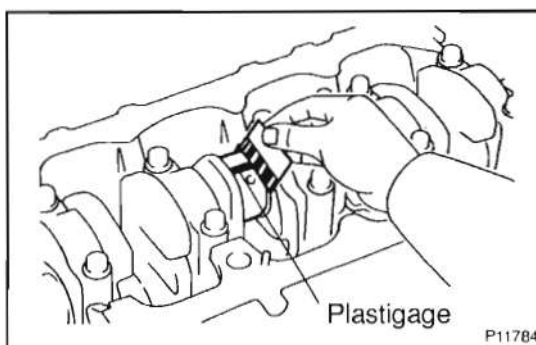
(i) Measure the Plastigage at its widest point.
Standard oil clearance:
STD: 0.036 – 0.054 mm (0.0014 – 0.0021 in.)
If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or replace the crankshaft.

HINT:

If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers inprinted on the crankshaft and connecting rod, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "2", "3", "4", "5" and "6" accordingly.

Mark 2, 3, 4, 5 or 6

Front

Mark 1, 2 or 3

No.3   No.4

No.2

No.1
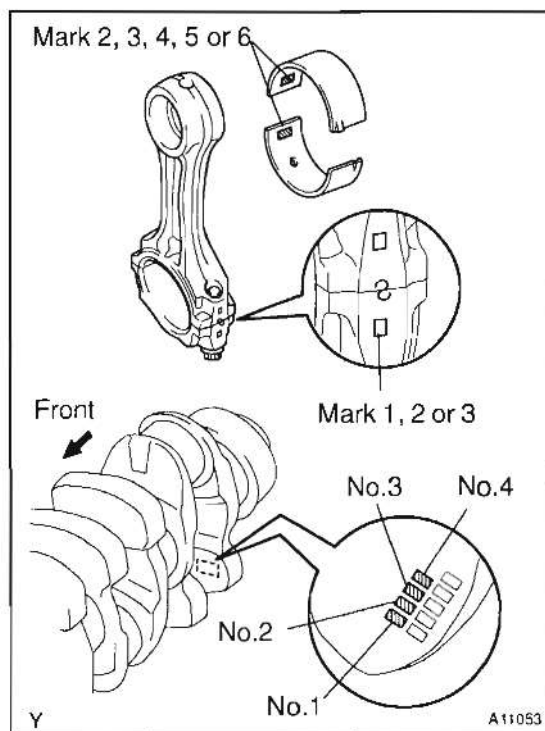
Y   A11053

	Number Marked								
Cylinder block	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Use bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Cylinder block "2" + crankshaft "1"
= Total number 3 (Use bearing "3")

Y   A11054

Reference
Connecting rod big end inner diameter:

Mark "1"	62.014 – 62.020 mm (2.4415 – 2.4417 in.)
Mark "2"	62.020 – 62.026 mm (2.4417 – 2.4420 in.)
Mark "3"	62.026 – 62.032 mm (2.4420 – 2.4422 in.)

Crankshaft pin diameter:

Mark "1"	58.994 – 59.000 mm (2.3226 – 2.3228 in.)
Mark "2"	58.988 – 58.994 mm (2.3224 – 2.3226 in.)
Mark "3"	58.982 – 58.988 mm (2.3221 – 2.3224 in.)

Standard sized bearing center wall thickness:

Mark "2"	1.486 – 1.489 mm (0.0585 – 0.0586 in.)
Mark "3"	1.489 – 1.492 mm (0.0586 – 0.0587 in.)
Mark "4"	1.492 – 1.495 mm (0.0587 – 0.0589 in.)
Mark "5"	1.495 – 1.498 mm (0.0589 – 0.0590 in.)
Mark "6"	1.498 – 1.501 mm (0.0590 – 0.0591 in.)

(j)   Completely remove the Plastigage.

Ridge Reamer   P11937

24. REMOVE PISTON AND CONNECTING ROD AS-SEMBLIES

(a)   Using a ridge reamer, remove all the carbon from the top of the cylinder.

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

HINT:

• Keep the bearings, connecting rod and cap together.

• Arrange the piston and connecting rod assemblies in correct order.
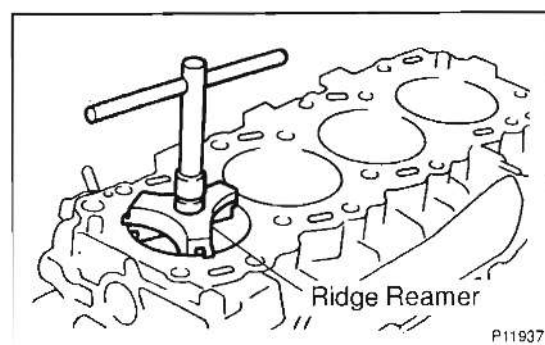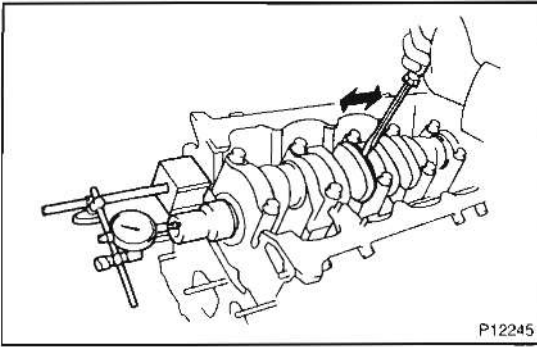
25. CHECK CRANKSHAFT THRUST CLEARANCE

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

Standard thrust clearance:
0.040 – 0.240 mm (0.0016 – 0.0094 in.)
Maximum thrust clearance: 0.30 mm (0.0118 in.)

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

Thrust washer thickness:

STD	2.430 – 2.480 mm (0.0957 – 0.0976 in.)
U/S 0.250	2.555 – 2.605 mm (0.1006 – 0.1026 in.)
U/S 0.125	2.493 – 2.543 mm (0.0981 – 0.1001 in.)
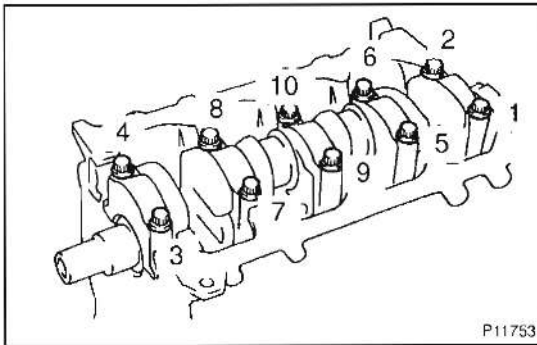
26. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Uniformly loosen and remove the main bearing cap bolts in several passes, in the sequence shown.
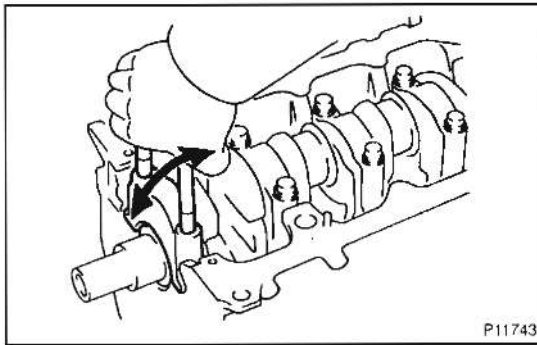
(b) Using the removed main bearing cap bolts, pry the main bearing cap back and forth, and remove the main bearing caps, lower bearings and lower thrust washers (No.5 main bearing cap only).

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

(c) Lift out the crankshaft.

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

(d) Clean each main journal and bearing.

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

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

plastigage

P11791

Plastigage

P11792

No.2

No.1

No.5

No.4

No.3

front

No.5

No.4

No.3

Mark 2, 3, 4, 5
or 6

No.1   No.2

Y

A11055
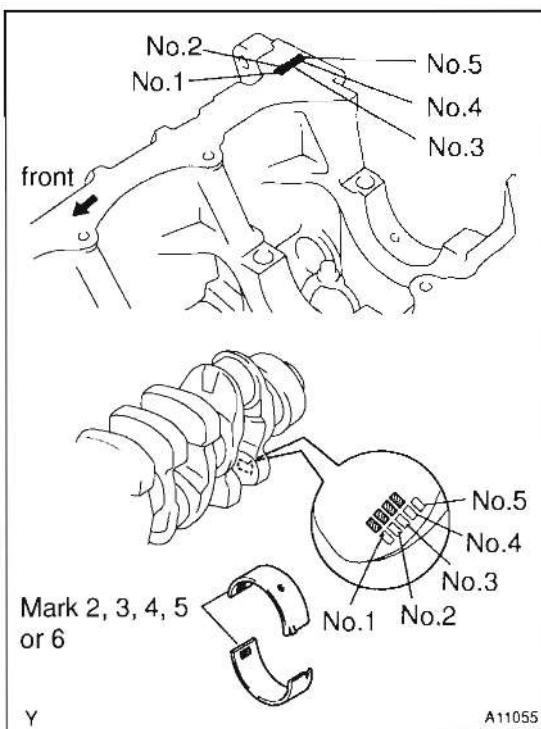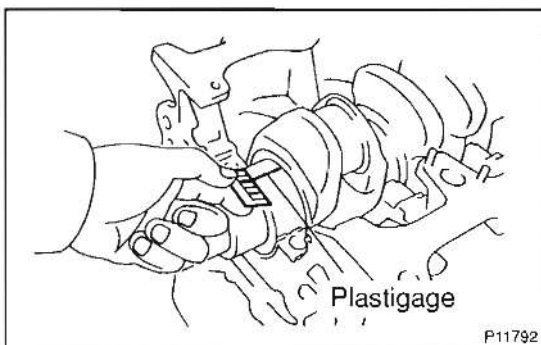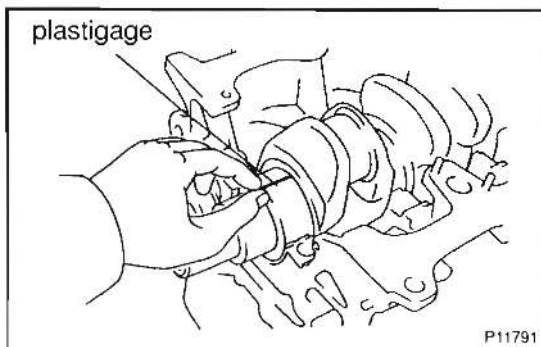
(f)   Place the crankshaft on the cylinder block.

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

(h)   Install the main bearing caps. (See page EM–83)
   1st
   Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)
   2nd Turn 90 °
   NOTICE:
   Do not turn the crankshaft.

(i)   Remove the main bearing caps. (See procedure (a) and (b) above)

(j)   Measure the Plastigage at its widest point.
   Standard clearance:
   STD: 0.030 – 0.048 mm (0.00118 – 0.00189 in.)
   Maximum clearance: 0.10 mm (0.0039 in.)

HINT:

If replacing the cylinder block subassembly, the bearing standard clearance will be:

   0.030 – 0.048 mm (0.00118 – 0.00189 in.)

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

HINT:

If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the cylinder block and crankshaft, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "2", "3", "4", "5" and "6" accordingly.

	Number Marked								
Cylinder block	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Use bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Cylinder block "2" + crankshaft "1"
   = Total number 3 (Use bearing "3")

Y

A11056

Reference
Cylinder block main journal bore diameter:

Mark "1"	75.000 – 75.006 mm (2.9528 – 2.9530 in.)
Mark "2"	75.006 – 75.012 mm (2.9530 – 2.9532 in.)
Mark "3"	75.012 – 75.018 mm (2.9532 – 2.9535 in.)

Crankshaft journal diameter:

Mark "1"	69.994 – 70.000 mm (2.7557 – 2.7559 in.)
Mark "2"	69.988 – 69.994 mm (2.7554 – 2.7557 in.)
Mark "3"	69.982 – 69.988 mm (2.7552 – 2.7554 in.)

Standard sized bearing center wall thickness:

Mark "2"	2.482 – 2.485 mm (0.09772 – 0.09783 in.)
Mark "3"	2.485 – 2.488 mm (0.09783 – 0.09795 in.)
Mark "4"	2.488 – 2.491 mm (0.09795 – 0.09807 in.)
Mark "5"	2.491 – 2.494 mm (0.09807 – 0.09819 in.)
Mark "6"	2.494 – 2.497 mm (0.09819 – 0.09831 in.)

(k) Completely remove the Plastigage.

27. REMOVE CRANKSHAFT

(a) Lift out the crankshaft.

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

HINT:

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

P11939

28. REMOVE CHECK VALVES AND OIL NOZZLES

Remove the 4 check valves and oil nozzles.

Cylinder Block Orifice

P12244
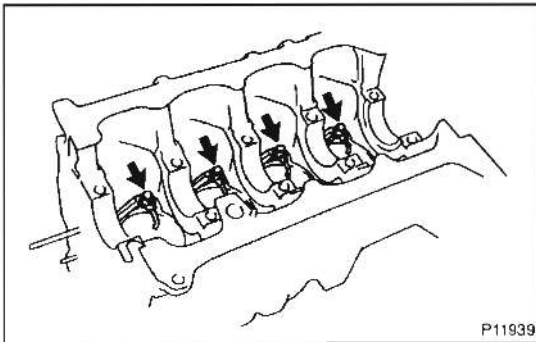
29. REMOVE CYLINDER BLOCK ORIFICE

Remove the cylinder block orifice from the cylinder block.

P11746
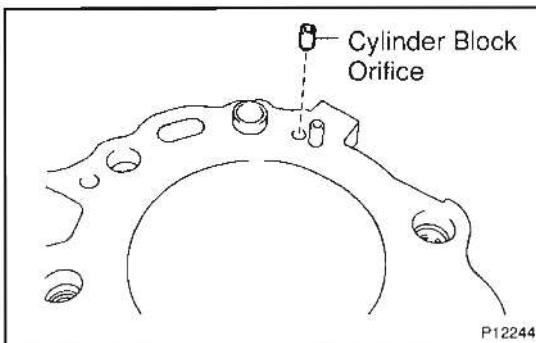
30. CHECK FIT BETWEEN PISTON AND PISTON PIN

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

If any movement is felt, replace the piston and pin as a set.
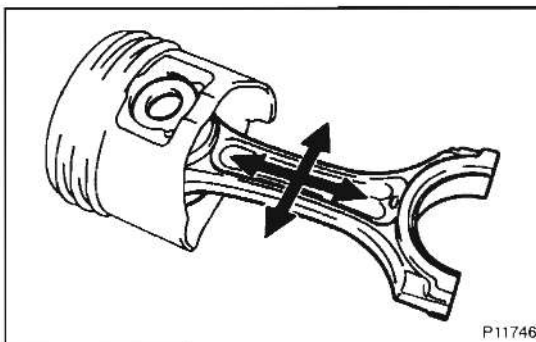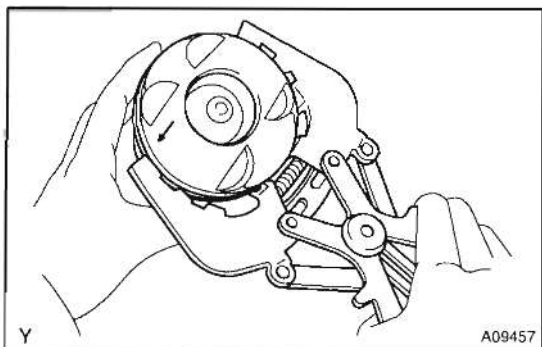
31. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the 2 compression rings and oil ring.

(b) Remove the coil by hand.

HINT:

Arrange the rings in correct order only.
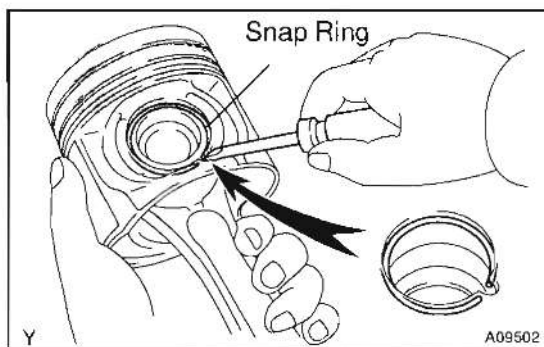
32. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using a small screwdriver, pry off the snap ring form the piston.

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

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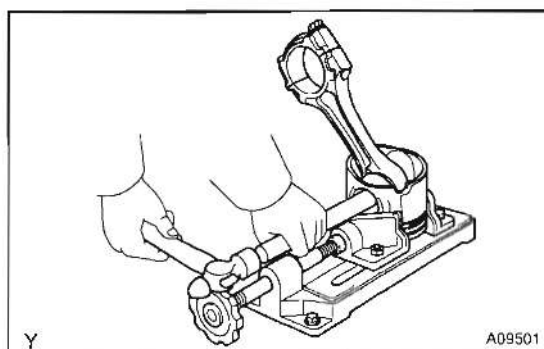
(c) Using a plastic–faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.

HINT:

• The piston pin are matched set.

• Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

Gasket
Scraper

P11935

INSPECTION

EM15L–02
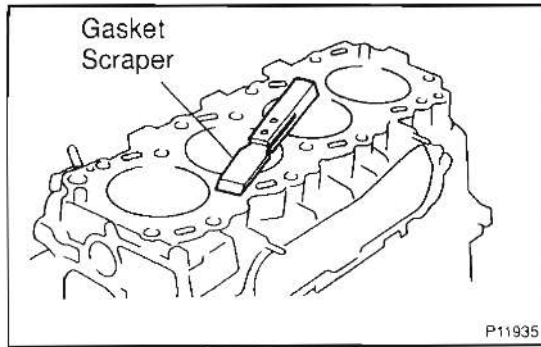
1. CLEAN CYLINDER BLOCK

(a) Remove the gasket material.
Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

(b) Clean the cylinder block.
Using a soft brush and solvent, thoroughly clean the cylinder block.

Precision
Straight Edge

Feeler
Gauge

Y

A11057
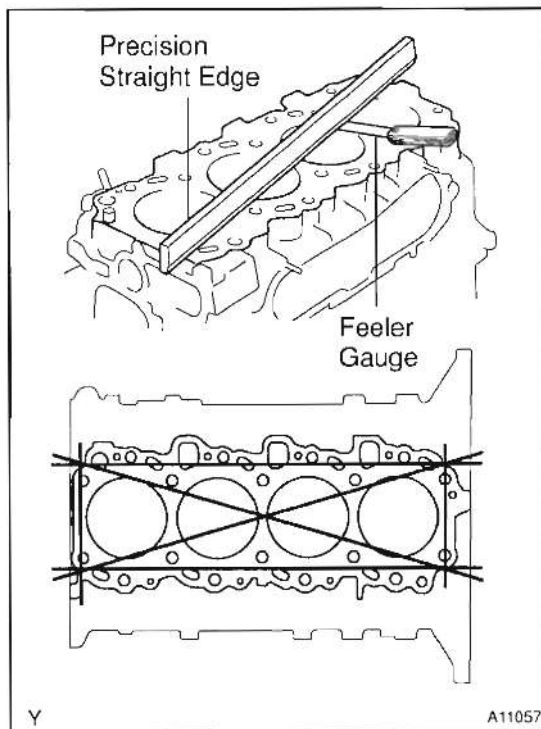
2. INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS

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

Maximum warpage: 0.10 mm (0.0039 in.)

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

P11744
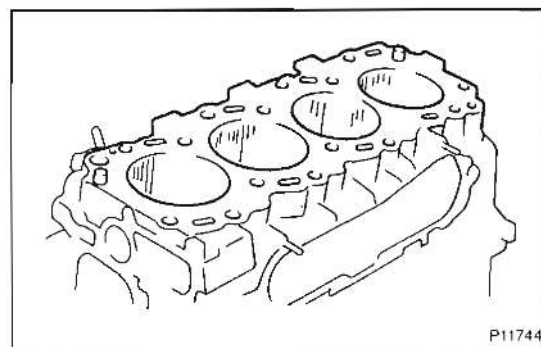
3. INSPECT CYLINDER FOR VERTICAL SCRATCHES

Visually check the cylinder for vertical scratches.

If deep scratches are present, rebore all the 4 cylinders. If necessary, replace the cylinder block.

Front

No.4
No.3
No.2
No.1   Mark 1, 2 or 3
P11742
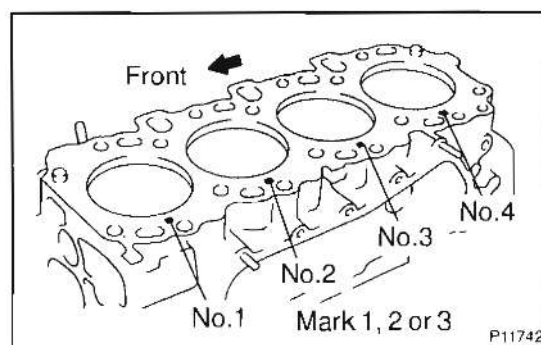
4. INSPECT CYLINDER BORE DIAMETER

HINT:

There are 3 sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the cylinder block.
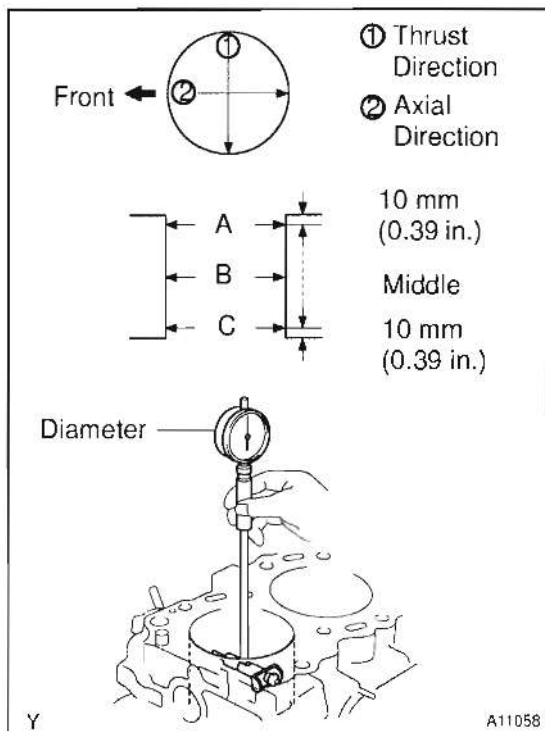
Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

Standard diameter:

STD Mark	96.000 – 96.010 mm (3.7795 – 3.7799 in.)
STD Mark	96.010 – 96.020 mm (3.7799 – 3.7803 in.)
STD Mark	96.020 – 96.030 mm (3.7803 – 3.7807 in.)

Maximum diameter:

STD	96.23 mm (3.7886 in.)

If the diameter is greater than maximum, rebore all the 4 cylinders. If necessary, replace the cylinder block.
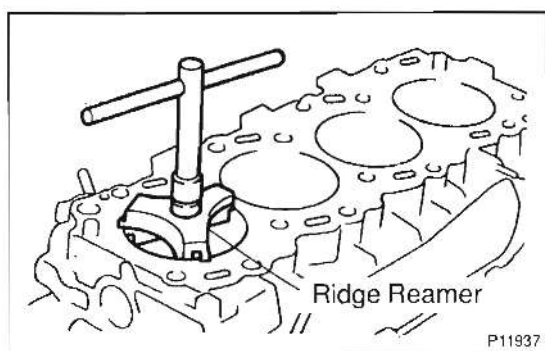
5. REMOVE CYLINDER RIDGE
If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.
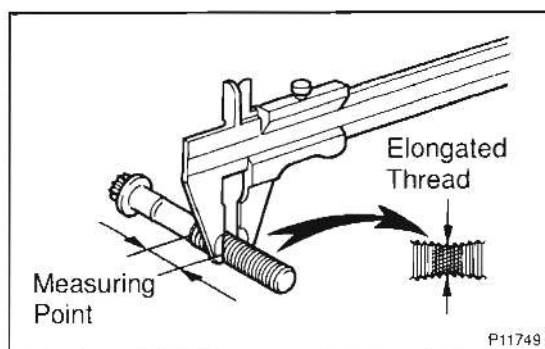
6. INSPECT MAIN BEARING CAP BOLTS
Using vernier calipers, measure the minimum diameter of the compressed thread at the measuring point.

Standard diameter:
13.500 – 14.000 mm (0.5315 – 0.5512 in.)
Minimum diameter: 12.60 mm (0.4961 in.)
If the diameter is less than minimum, replace the bolt.
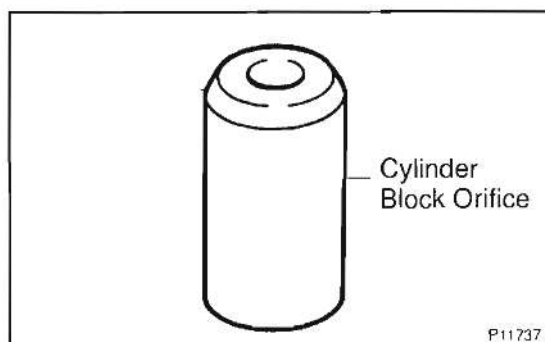
7. INSPECT CYLINDER BLOCK ORIFICE
Visually check that the orifice is not clogged.
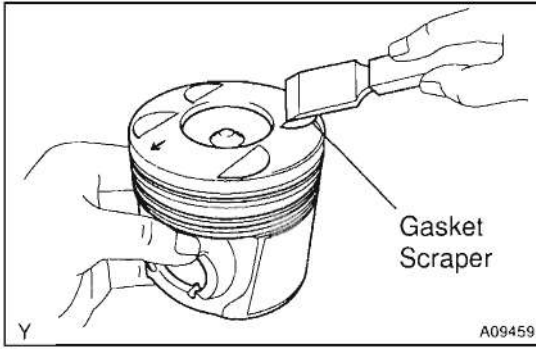
8. CLEAN PISTON

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

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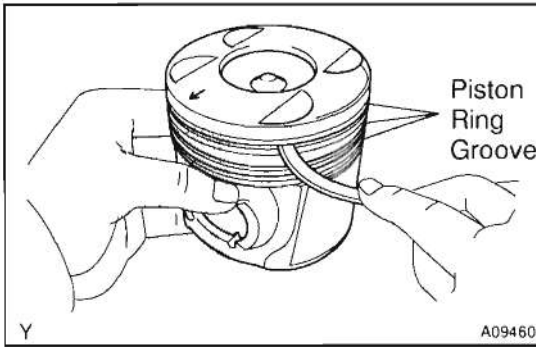
(b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.

Piston Ring Groove
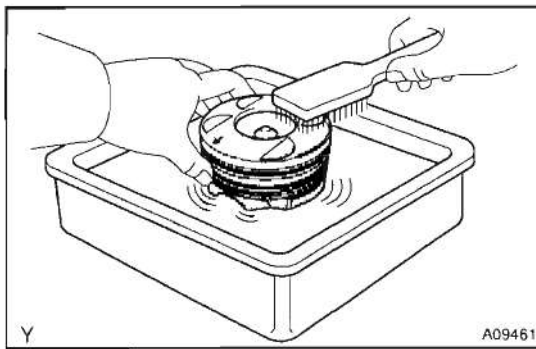
(c) Using solvent and a brush, thoroughly clean the piston.
NOTICE:
Do not use a wire brush.
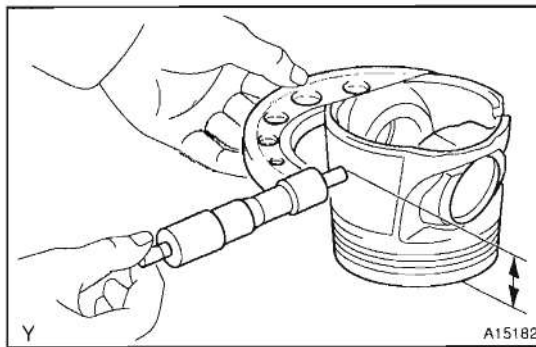
9. INSPECT PISTON AND PISTON RING

(a) Inspect the piston oil clearance.
HINT:
There are 3 sizes of the standard piston diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the piston top.

(1) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 63.63 mm (2.5051 in.) from the piston head.

Piston diameter:

STD Mark 1	95.920 – 95.930 mm (3.77637 – 3.77676 in.)
STD Mark 2	95.930 – 95.940 mm (3.77676 – 3.77715 in.)
STD Mark 3	95.940 – 95.950 mm (3.77716 – 3.77755 in.)

(2) Measure the cylinder bore diameter in the thrust directions. (See page EM–83)
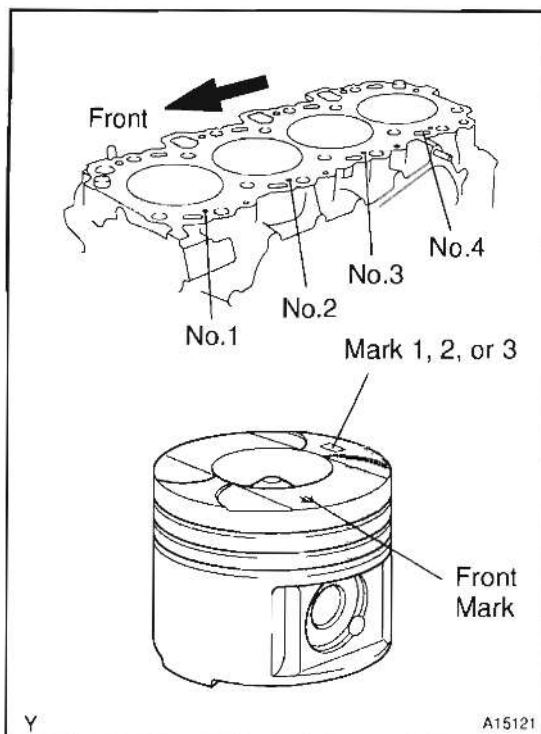
(3) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:
0.070 – 0.090 mm (0.00276 – 0.00354 in.)
Maximum oil clearance: 0.14 mm (0.0055 in.)

If the oil clearance is greater than maximum, replace all the 4 pistons and rebore all the 4 cylinders. If necessary, replace the cylinder block.

HINT:

(Use new cylinder block): Use a piston with the same number mark as the cylinder bore diameter marked on the cylinder block.
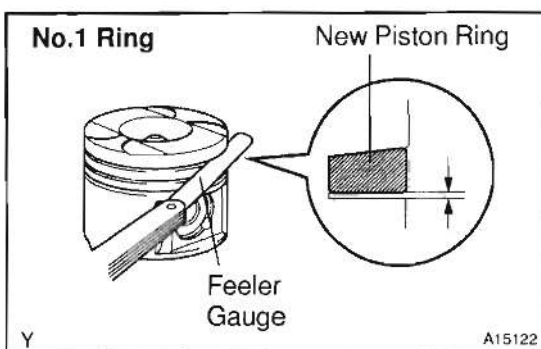
(b) Inspect the piston ring groove clearance.
(1) No.1 ring:
Install a new No.1 piston ring to the piston. Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

Ring groove clearance (No.1):
0.091 – 0.135 mm (0.00358 – 0.00531 in.)
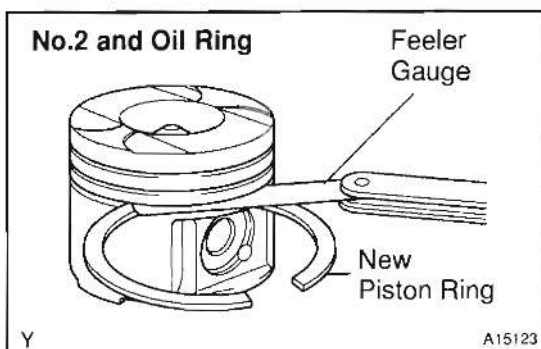
(2) No.2 and oil ring:
Using a feeler gauge, measure the clearance between the new piston ring and the wall of the ring groove.

Ring groove clearance (No.2 and oil ring):

| No.2 | 0.090 – 0.130 mm (0.00358 – 0.00512 in.) |
| Oil | 0.030 – 0.070 mm (0.00118 – 0.00276 in.) |

If the clearance is greater than maximum, replace the piston.
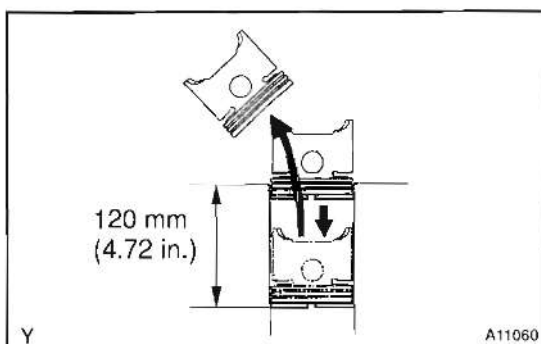
(c) Inspect the piston ring end gap.
(1) Insert the piston ring into the cylinder bore.
(2) Using a piston, push the piston ring a little beyond the bottom of the ring travel, 120 mm (4.72 in.) from the top of the cylinder block.
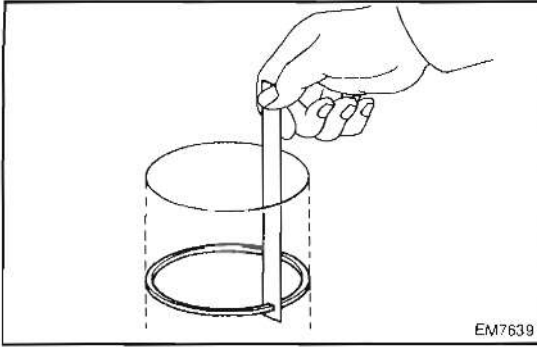
(3) Using a feeler gauge, measure the end gap.

Standard end gap:

No.1	0.27 – 0.39 mm (0.0106 – 0.0154 in.)
No.2	0.47 – 0.57 mm (0.0185 – 0.0224 in.)
Oil	0.20 – 0.40 mm (0.0079 – 0.0157 in.)

Maximum end gap:

No.1	0.85 mm (0.0335 in.)
No.2	1.07 mm (0.0421 in.)
Oil	0.77 mm (0.0303 in.)

If the end gap is greater than maximum, replace the piston ring. If the end gap is greater than maximum, even with a new piston ring, rebore all the 4 cylinders or replace the cylinder block.
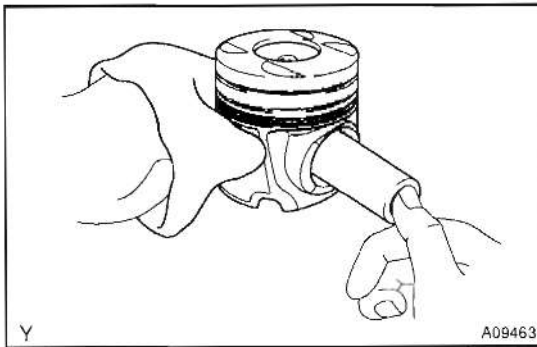
(d) Inspect the pistion pin fit.
At 80°C (176°F), you should be able to push the piston pin into the piston pin hole with your thumb.
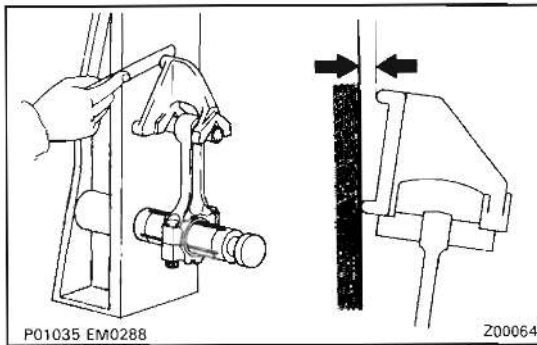
(e) Using a rod aligner and feeler gauge, check the connecting rod alignment.
(1) Check for bend.
Maximum bend:
0.03 mm (0.0012 in.) per 100 mm (3.94 in.)
If bend is greater than maximum, replace the connecting rod assembly.
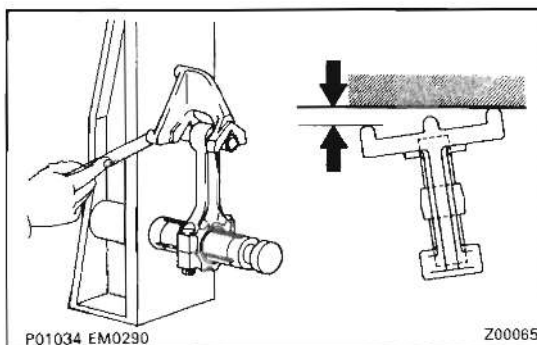
(2) Check for twist.
Maximum twist:
0.15 mm (0.0059 in.) per 100 mm (3.94 in.)
If twist is greater than maximum, replace the connecting rod assembly.
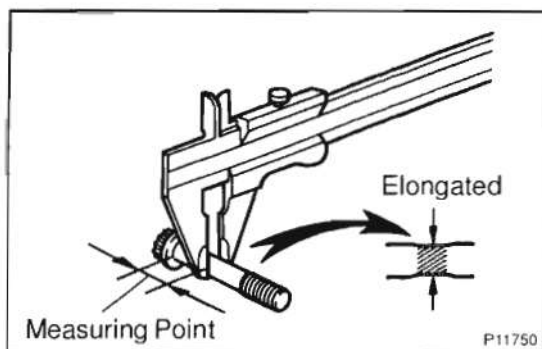
(f)   Using vernier calipers, measure the minimum diameter of the compressed bolt at the measuring point.
Standard diameter:
8.500 – 8.600 mm (0.3346 – 0.3385 in.)
Minimum diameter: 8.30 mm (0.3268 in.)
If the diameter is less than minimum, replace the connecting rod bolt.
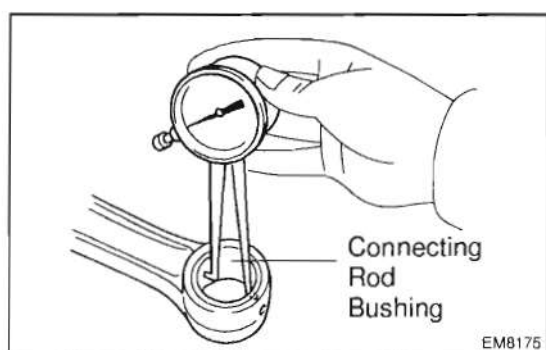
(g)   Inspect the piston pin oil clearance.
(1)   Using caliper gauge, measure the inside diameter of the connecting rod bushing.
Bushing inside diameter:

Mark A	34.012 – 34.016 mm (1.33905 – 1.33921 in.)
Mark B	34.016 – 34.020 mm (1.33921 – 1.33937 in.)
Mark C	34.020 – 34.024 mm (1.33937 – 1.33952 in.)
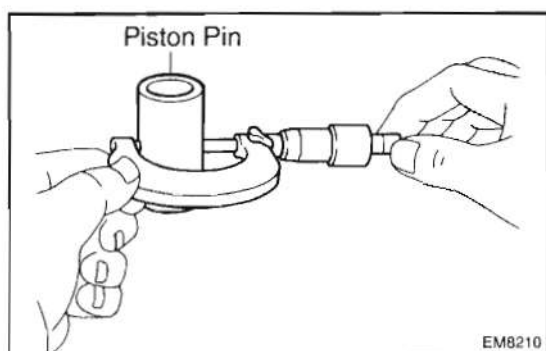
(2)   Using a micrometer, measure the piston pin diameter.
Piston pin diameter:

Mark A	33.996 – 34.000 mm (1.33842 – 1.33858 in.)
Mark B	34.000 – 34.004 mm (1.33858 – 1.33874 in.)
Mark C	34.004 – 34.008 mm (1.33874 – 1.33889 in.)

(3)   Subtract the piston pin diameter measurement from the bushing inside diameter measurement.
Standard oil clearance:
0.012 – 0.020 mm (0.00047 – 0.00079 in.)
Maximum oil clearance: 0.03 mm (0.0012 in.)
If the oil clearance is greater than maximum, replace the bushing. If necessary, replace the piston and piston pin as a set.
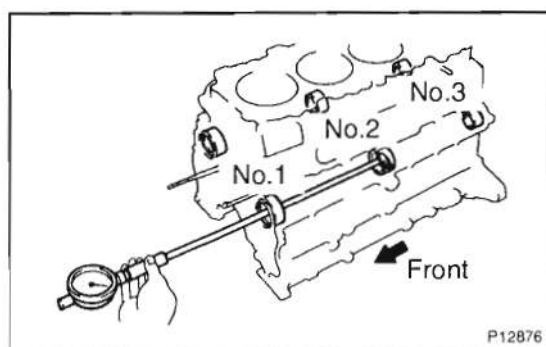
10.   INSPECT RH AND LH BALANCE SHAFT
(a)   Using cylinder gauge, measure the inside diameter of the balance shaft bearing.
Bearing inside diameter (from front side):

No.1	42.000 – 42.020 mm (1.6535 – 1.6543 in.)
No.2	41.000 – 41.020 mm (1.6142 – 1.6150 in.)
No.3	32.000 – 32.020 mm (1.2598 – 1.2606 in.)
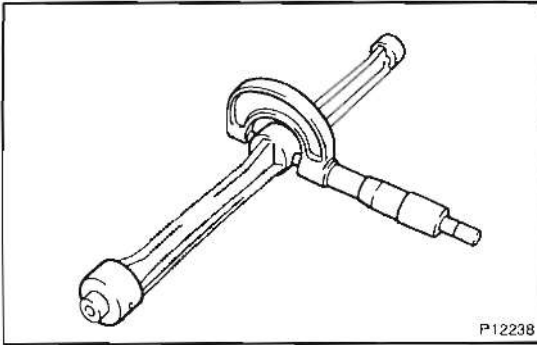
(b) Using a micrometer, measure the diameter of the balance shaft main journals.

Main journal diameter (from front side):

No.1	41.941 – 41.960 mm (1.6512 – 1.6520 in.)
No.2	40.931 – 40.950 mm (1.6115 – 1.6122 in.)
No.3	31.941 – 31.960 mm (1.2575 – 1.2583 in.)

(c) Subtract the balance shaft main journal diameter measurement from the balance shaft bearing inside diameter measurement.

Standard oil clearance:

No.1	0.040 – 0.079 mm (0.0016 – 0.0031 in.)
No.2	0.040 – 0.079 mm (0.0016 – 0.0031 in.)
No.3	0.050 – 0.089 mm (0.0020 – 0.0035 in.)

Maximum oil clearance:

No.1	0.18 mm (0.0071 in.)
No.2	0.19 mm (0.0075 in.)
No.3	0.18 mm (0.0071 in.)

If the clearance is greater than maximum, replace the cylinder block and balance shaft.
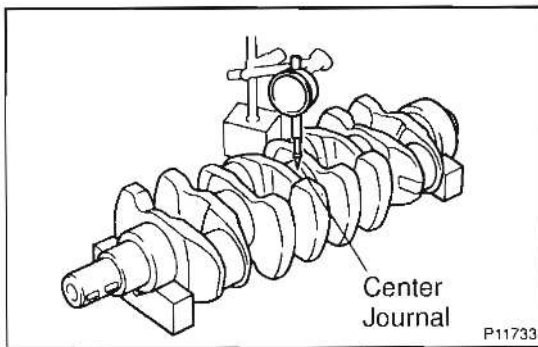
Center Journal

11. INSPECT CRANKSHAFT FOR RUNOUT
(a) Place the crankshaft on V–blocks.
(b) Using a dial indicator, measure the circle runout at the center journal.
Maximum circle runout: 0.06 mm (0.0024 in.)
If the circle runout is greater than maximum, replace the crankshaft.
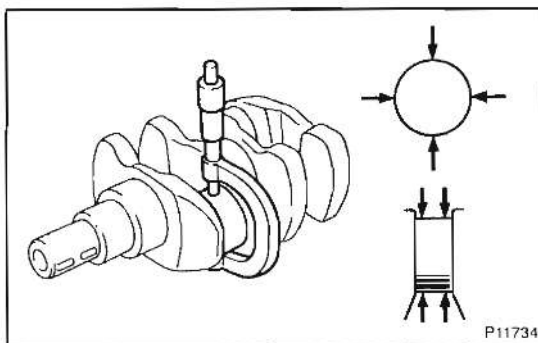
12. INSPECT MAIN JOURNALS AND CRANK PINS
(a) Using a micrometer, measure the diameter of each main journal and crank pin.
Main journal diameter:

Mark 1	69.994 – 70.000 mm (2.75566 – 2.75590 in.)
Mark 2	69.988 – 69.994 mm (2.75543 – 2.75566 in.)
Mark 3	69.982 – 69.988 mm (2.75519 – 2.75543 in.)

Crank pin diameter:

Mark 1	58.994 – 59.000 mm (2.32259 – 2.32283 in.)
Mark 2	58.988 – 58.994 mm (2.32236 – 2.32259 in.)
Mark 3	58.982 – 58.988 mm (2.32212 – 2.32236 in.)

If the diameter is not as specified, check the oil clearance (See page EM–64). If necessary, grind or replace the crankshaft.

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

Maximum taper and out–of–round:
0.020 mm (0.0008 in.)

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

REPLACEMENT

EMIM9-01

1. REPLACE CONNECTING ROD BUSHING

(a) Using SST and a press, press out the bushing.
    SST   09222–67010 (09222–06010, 09222–06030)
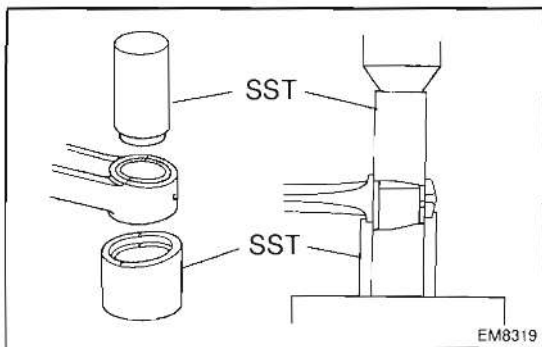
(b) Using a round file, lightly file off any roughness from the small end of the connecting rod.
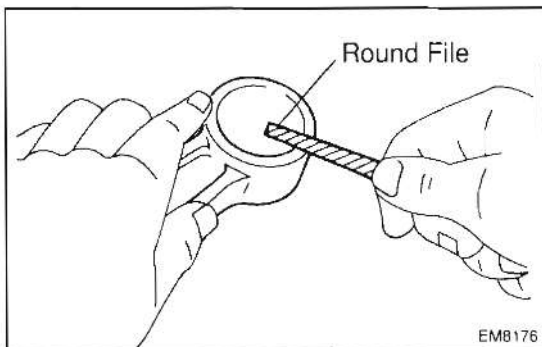
(c) Attach the bushing to SST with the ball of SST inside the oil hole of the bushing.
    SST   09222–67010 (09222–06020)
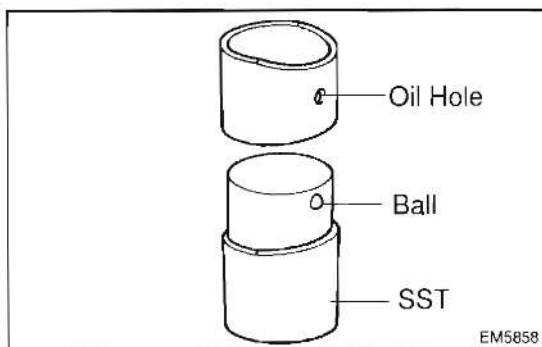
(d) Align the oil holes of a new bushing and the connecting rod.
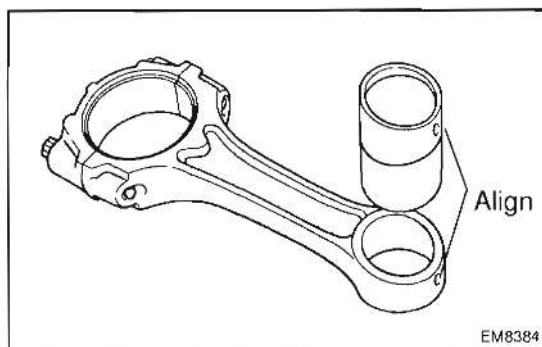
(e) Using SST and a press, press in the bushing.
    SST   09222–67010 (09222–06010, 09222–06020, 09222–06030)

EM–81
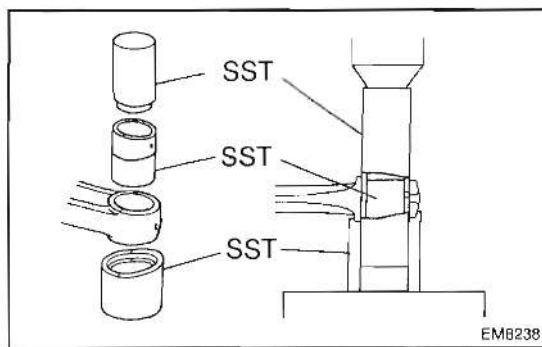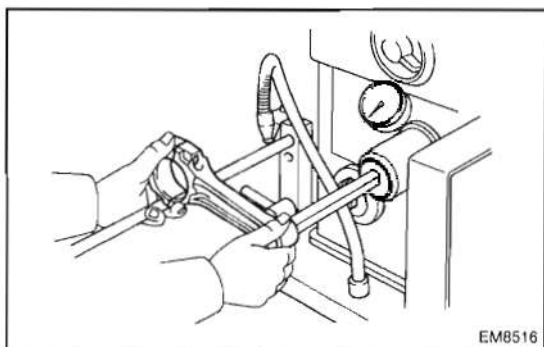
(f) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page EM–72) between the bushing and piston pin.
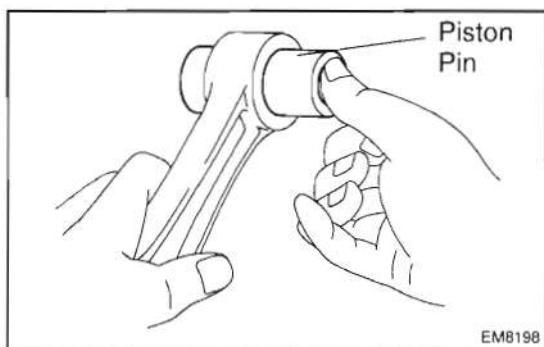
(g) Check the piston pin fit at normal room temperature. Coat the piston pin with engine oil, and push it into the connecting rod with your thumb.

2. GRIND AND HONE MAIN JOURNALS AND/OR CRANK PINS

Grind and hone the main journals and/or crank pins to the finished undersized diameter (See page EM–72).

Install new main journal and/or crankshaft pin undersized bearings.
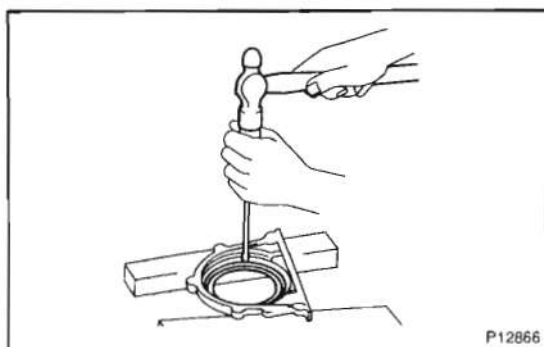
3. REPLACE CRANKSHAFT REAR OIL SEAL

HINT:

There are 2 methods (A and B) to replace the oil seal which are as follows.

(a) If the rear oil seal retainer is removed from the cylinder block:
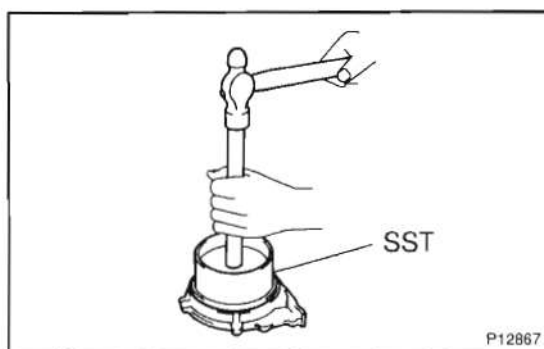
    (1) Using a screwdriver and hammer, tap out the oil seal.

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

    SST   09223–15030, 09252–10010

    (3) Apply MP grease to the oil seal lip.
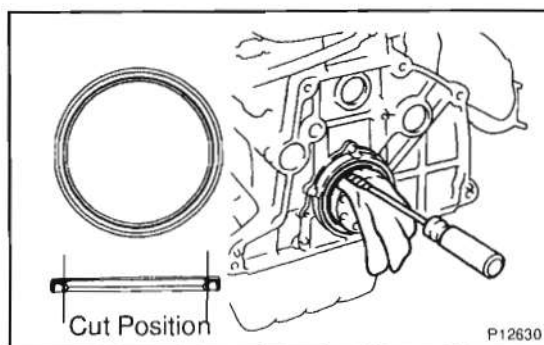
(b) If the rear oil seal retainer is installed to the cylinder block:

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

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

NOTICE:

Be careful not to damage the crankshaft. Tape the screwdriver tip.
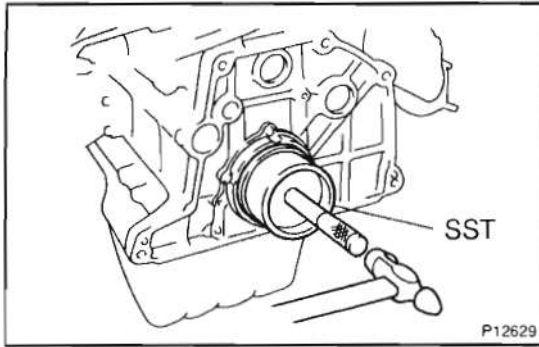
(3) Apply MP grease to a new oil seal lip.
(4) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
SST   09223–15030, 09252–10010

EM1MA–01

REASSEMBLY

NOTICE:
- When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.
- In case of having the common rail and/or injectors replaced, must replace injection pipes, too.
- In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.

HINT:
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O–rings and oil seals with new parts.
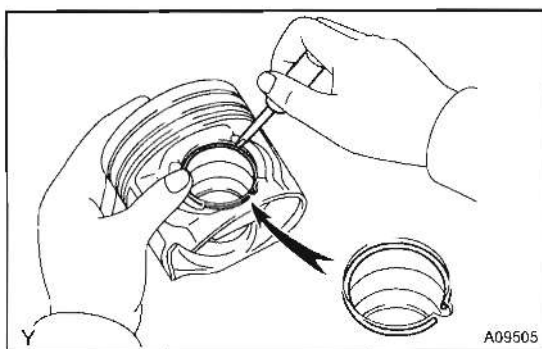
1. **ASSEMBLE PISTON AND CONNECTING ROD**
   (a) Install a new snap ring on one side of the piston pin hole.
   (b) Gradually heat the piston to 80°C (176°F).
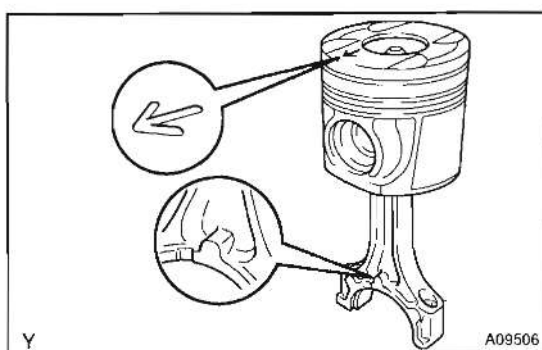
   (c) Coat the piston pin with engine oil.
   (d) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.
   (e) Install a new snap ring on the other side of the piston pin hole.
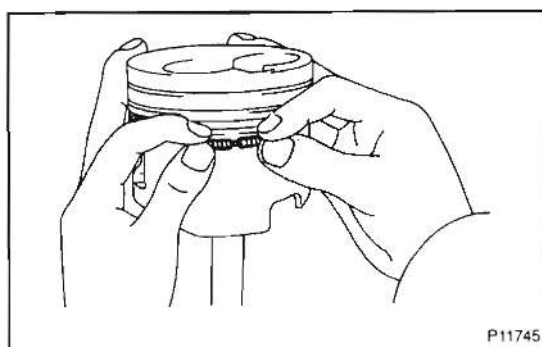
2. **INSTALL PISTON RINGS**
   (a) Install the coil by hand.
   (b) Install a piston ring expander, install the oil ring.

Coil Joint

Oil Ring Ends

EM0242
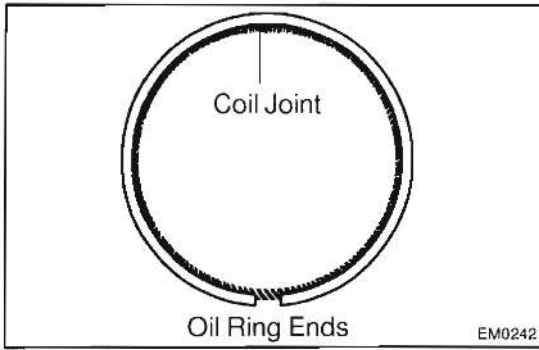
HINT:
Face the end gap of the oil ring in the opposite direction of coil joint.
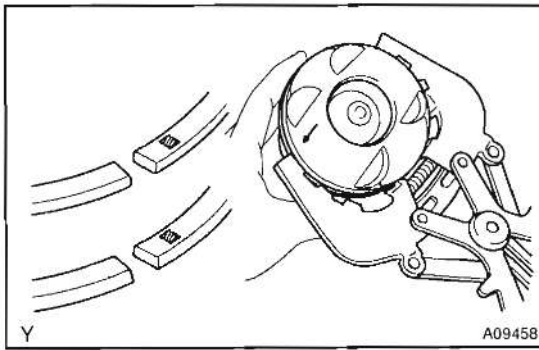
(c) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
Code mark:

No.1	NP
No.2	N

Y

A09458

No.1

Oil

Front Mark

No.2

Y

A15124
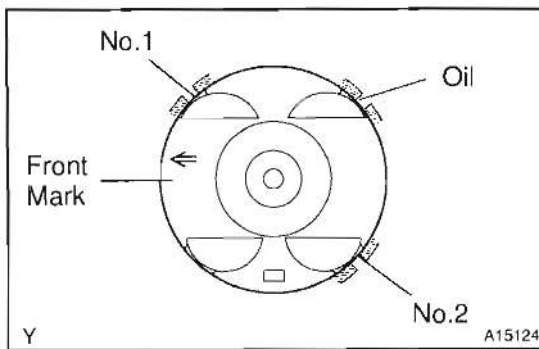
(d) Position the piston rings so that the ring ends are as shown.
NOTICE:
Do not align the ring ends.

Bearing Claw

Bearing Claw

Y

A11063
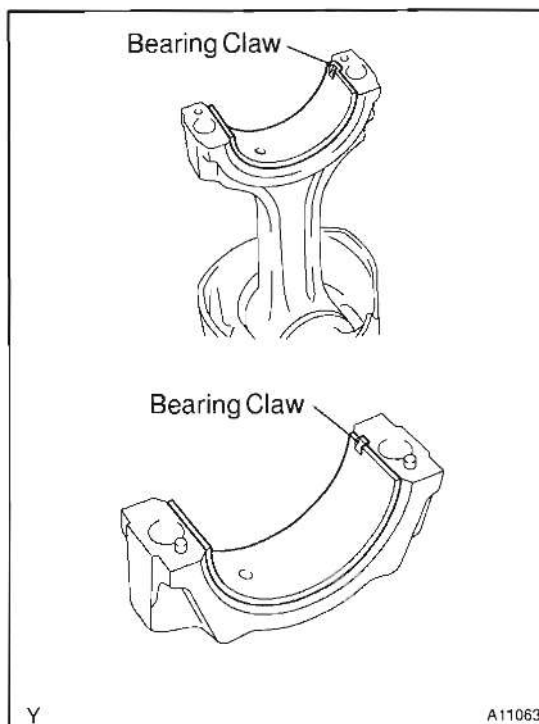
3. INSTALL BEARINGS
(a) Align the bearing claw with the groove of the connecting rod or connecting cap.
(b) Install the bearings in the connecting rod and connecting rod cap.
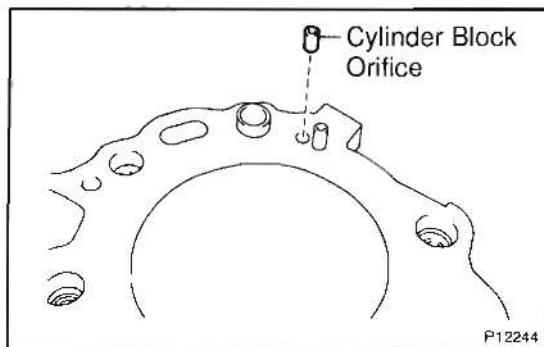
4. INSTALL CYLINDER BLOCK ORIFICE

Install the cylinder block orifice to the cylinder brock.
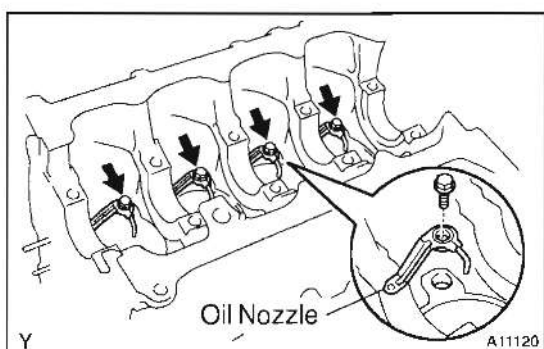
5. INSTALL OIL NOZZLES AND CHECK VALVES

(a) Align the pin of the oil nozzle with the pin hole of the cylinder block.

(b) Install the oil nozzle with the check valve. Install the 4 oil nozzles and check valves.

Torque: 25 N·m (260 kgf·cm, 19 ft·lbf)
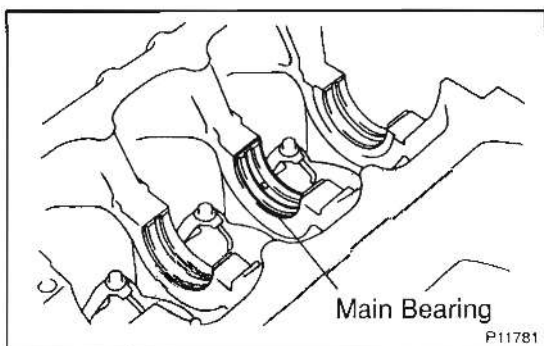
6. INSTALL MAIN BEARINGS

(a) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings.
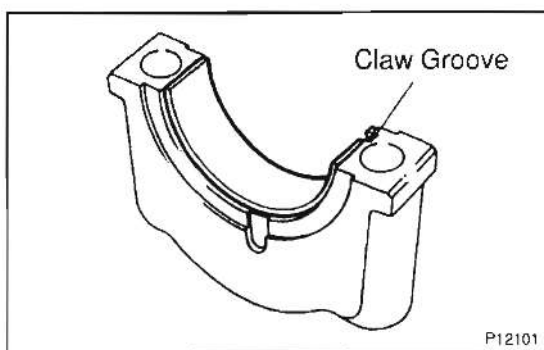
(b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

7. PLACE CRANKSHAFT ON CYLINDER BLOCK

Place the crankshaft on the cylinder brock.
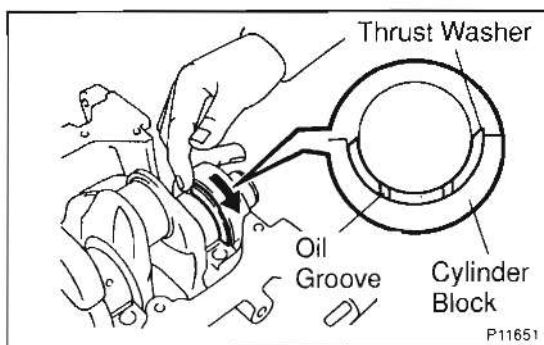
8. INSTALL UPPER THRUST WASHERS

(a) Push the crankshaft toward the front (rear) side.

(b) Install the 2 thrust washers to the No.5 journal position of the cylinder block with the oil grooves facing outward.
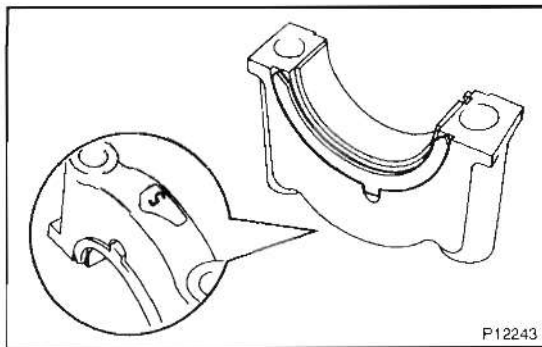
9. PLACE MAIN BEARING CAP AND LOWER THRUST WASHERS ON CYLINDER BLOCK

(a) Install the 2 thrust washers on the No.5 bearing cap with the grooves facing outward.
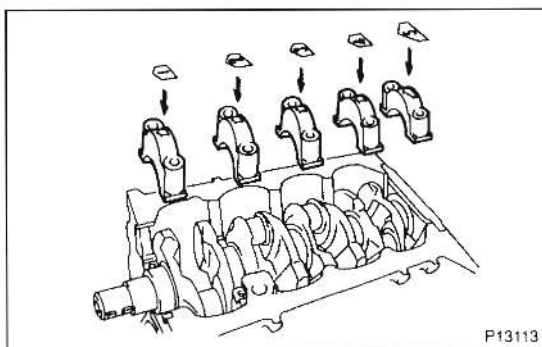
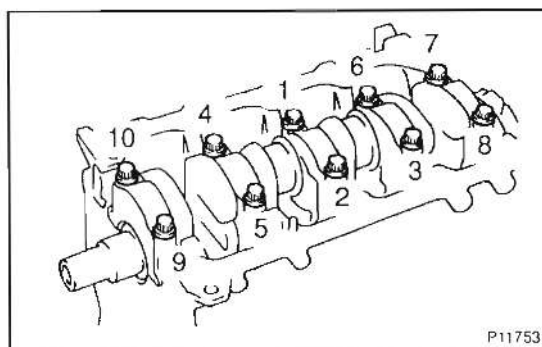(b) Install the 5 main bearing caps in their proper locations.

HINT:

Each bearing cap has a number and front mark.

10. INSTALL MAIN BEARING CAP BOLTS

HINT:

- The main bearing cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any one of the main bearing cap bolt is broken or deformed, replace it.

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

(b) Install and uniformly tighten the 10 bolts of the main bearing caps in several passes, in the sequence shown.

Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)

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

(c) Mark the front of the main bearing cap bolt with paint.
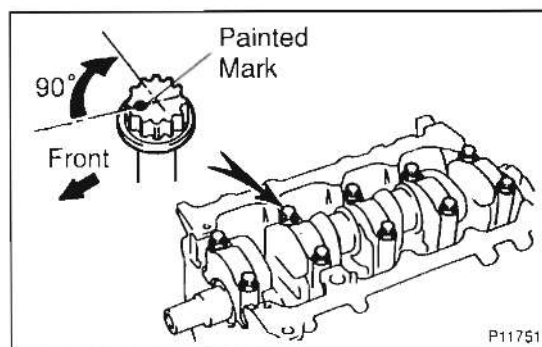
(1) Retighten the main bearing cap bolts 90 ° in the numerical order shown above.

(2) Check that the painted mark is now at a 90 ° angle to the front.

(3) Check that the crankshaft turns smoothly.

(4) Check the crankshaft thrust clearance(See page EM–80).
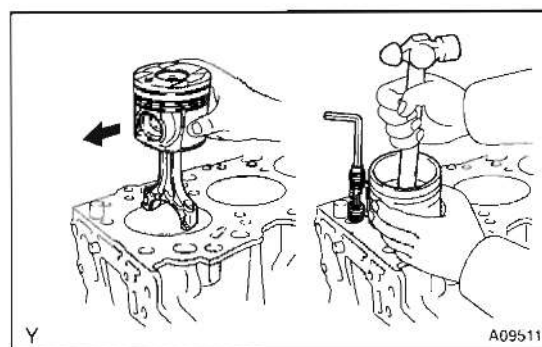
11. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES

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

Front Mark
(Protrusion)

P11782
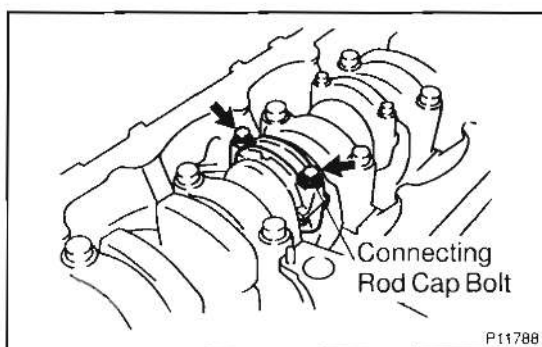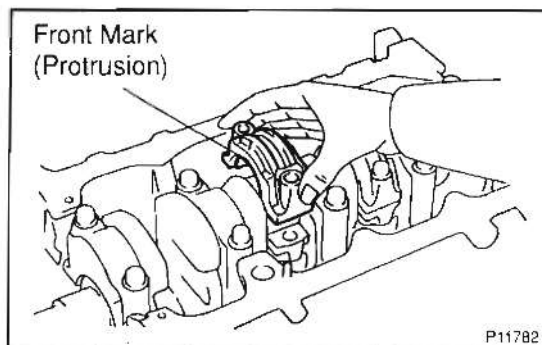
12. PLACE CONNECTING ROD CAP ON CONNECTING ROD
(a) Match the numbered connecting rod cap with the connecting rod.
(b) Install the connecting rod cap with the front mark facing forward.

Connecting
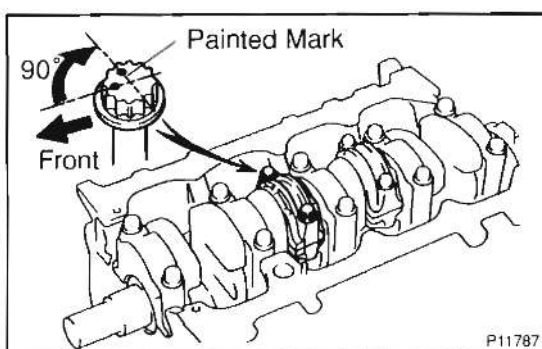Rod Cap Bolt

P11788

(c) Install the connecting rod cap bolts.
HINT:
• The connecting rod bolts are tightened in 2 progressive steps (steps (b) and (d)).
• If any connecting rod bolt is broken or deformed, replace it.
(d) Apply a light of engine oil on the threads and under the heads of the connecting rod cap bolts.
(e) Install and alternately tighten the bolts of the connecting rod cap in several passes.
   Torque: 35 N·m (357 kgf·cm, 26 ft·lbf)
If any one of the connecting rod bolts does not meet the torque specification, replace the rod bolt.
(f) Mark the front of the connecting rod bolt with paint.

Painted Mark
90°
Front

P11787

(g) Retighen the connecting rod cap bolts 90° as shown .
(h) Check that the painted mark is now at a 90° angle to the front.
(i) Check that the crankshaft turns smoothly.
13. CHECK CONNECTING ROD THRUST CLEARANCE (See step EM–64)
14. INSTALL REAR OIL SEAL RETAINER
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the retainer and cylinder block.
   • Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
   • Thoroughly clean all components to remove all the loose material.
   • Using a non–residue solvent, clean both sealing surfaces.

Seal
Packing

P13116
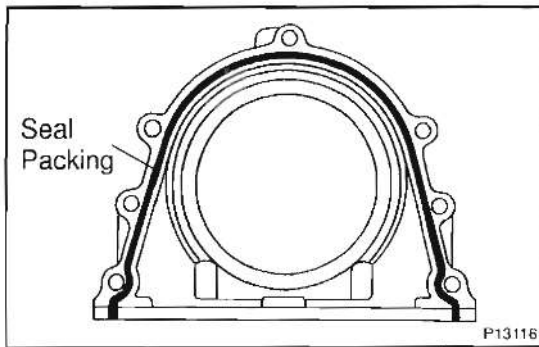
(b) Apply seal packing to the retainer as shown in the illustration.
Seal packing: Part No. 08826-00080 or equivalent
- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.

HINT:
Avoid applying an excessive amount to the surface.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

P12092
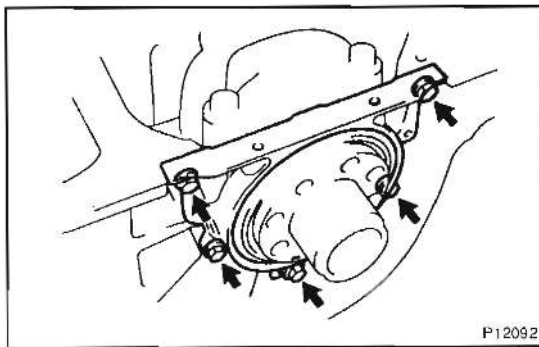
(c) Install the retainer with the 5 bolts.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

Balance Shaft
Driven Gear

Thrust
Washer

P12247
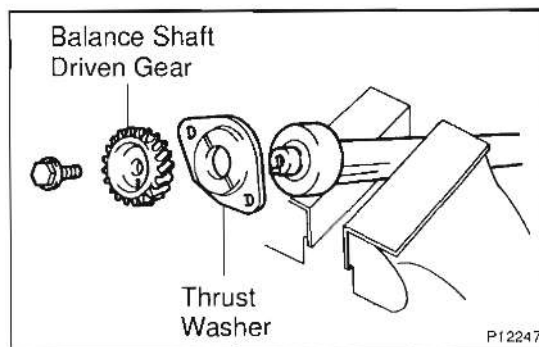
15. ASSEMBLY RH AND LH BALANCE SHAFTS
(a) Mount the weight of the balance shaft in a vise.
NOTICE:
Be careful not to damage the balance shafts.
(b) Align the balance shaft knock pin with the knock pin hole of the balance shaft driven gear, install the thrust washer and balance shaft driven gear.
(c) Install and torque the bolt.
Torque: 36 N·m (367 kgf·cm, 27 ft·lbf)

RH
Balance
Shaft

LH Balance
Shaft

P11794
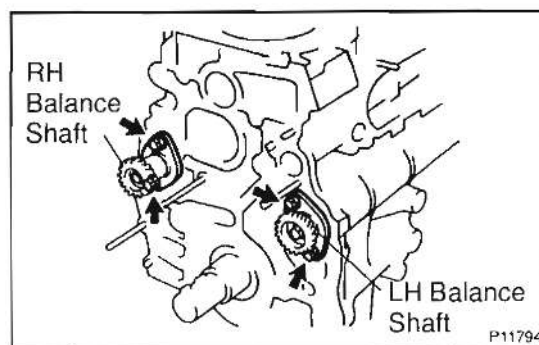
16. INSTALL RH AND LH BALANCE SHAFTS
(a) Install the RH balance shaft with the 2 bolts.
(b) Install the LH balance shaft with the 2 bolts.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)
17. INSTALL PLUG HOLE
18. INSTALL ENGINE MOUNTING
Torque: 68 N·m (693 kgf·cm, 50 ft·lbf)
**19. INSTALL WATER TEMPERATURE SENSOR**
**20. INSTALL WATER INLET AND THRMOSTAT (See page CO-13)**

21. INSTALL OIL COOLER (See page LU–19)
22. INSTALL OIL PAN AND TIMING GEAR CASE
    (See page LU–12)
23. INSTALL SUPPLY PUMP (See page FU–18)
24. INSTALL TIMING GEARS (See page EM–31)
25. INSTALL WATER PUMP (See page CO–8)
26. INSTALL ALTERNATOR AND ALTERNATOR BRACK-
    ET (See page CO–8)
27. INSTALL CYLINDER HEAD (See page EM–56)
28. INSTALL TIMING BELT AND PULLEYS
    (See page EM–16)
29. DISCONNECT ENGINE FROM ENGINE STAND
30. INSTALL REAR END PLATE
Install the rear end plate with the bolt.
    Torque: 8.0 N·m (82 kgf·cm, 71 in.·lbf)
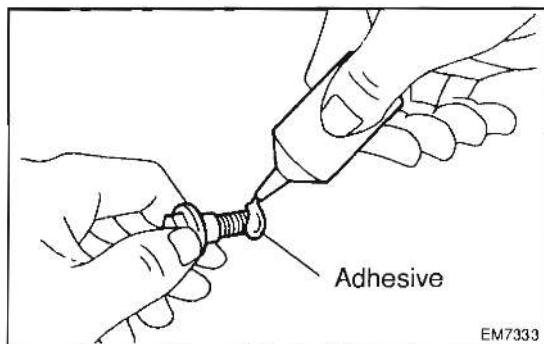
Adhesive
EM7333

31. **INSTALL FLYWHEEL (M/T) OR DRIVE PLATE (A/T)**
(a) Apply adhesive to 2 or 3 threads of the mounting bolt end.
    Adhesive:
    Part No. 08833–00070, THREE BOND 1324, or equivalent

P11677
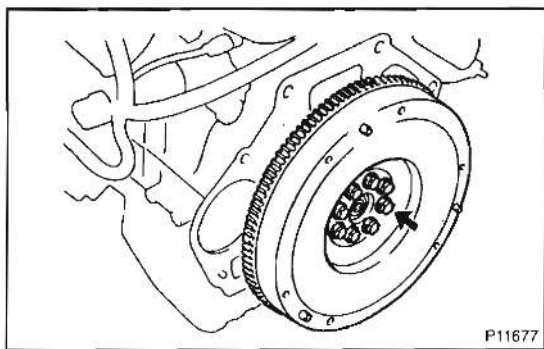
(b) Install the flywheel or drive plate on the crankshaft.
(c) Install and uniformly tighten the mounting bolts in several passes, in the sequence shown.
    Torque:
    M/T: 145 N·m (1,479 kgf·cm, 107 ft·lbf)
    A/T: 178 N·m (1,820 kgf·cm, 131 ft·lbf)
32. **M/T:**
    INSTALL CLUTCH COVER AND DISC