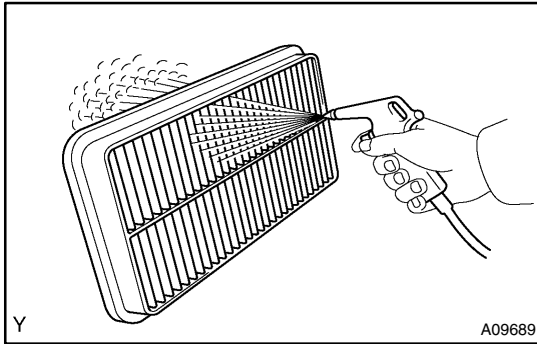


---

# ENGINE MECHANICAL

|                                    |       |
|------------------------------------|-------|
| AIR FILTER .....                   | EM-1  |
| COMPRESSION .....                  | EM-2  |
| VALVE CLEARANCE .....              | EM-4  |
| IDLE SPEED AND MAXIMUM SPEED ..... | EM-10 |
| TIMING BELT .....                  | EM-11 |
| CYLINDER HEAD .....                | EM-24 |
| CYLINDER BLOCK .....               | EM-53 |





## AIR FILTER INSPECTION

EM0HP-02

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**

## COMPRESSION INSPECTION

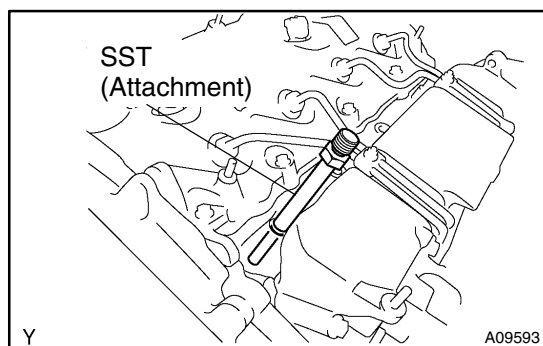
EM0HQ-02

**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.

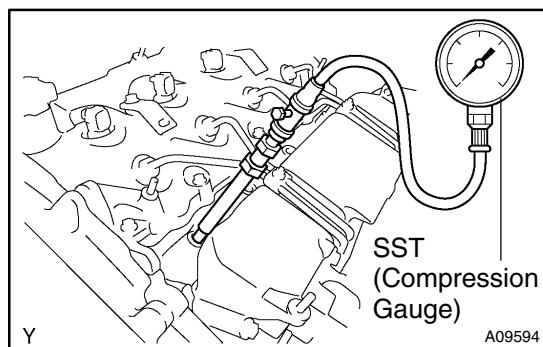
**2. REMOVE GLOW PLUGS (See page EM-12)****3. DISCONNECT INJECTOR CONNECTORS****4. CHECK CYLINDER COMPRESSION PRESSURE****HINT:**

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: 12.3 N·m (125 kgf·cm, 9 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:**

**2,746 kPa (28.0 kgf/cm<sup>2</sup>, 398 psi) or more**

**Minimum pressure:**

**2,256 kPa (23.0 kgf/cm<sup>2</sup>, 327 psi) or more**

**Difference between each cylinder:**

**490 kPa (5.0 kgf/cm<sup>2</sup>, 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)

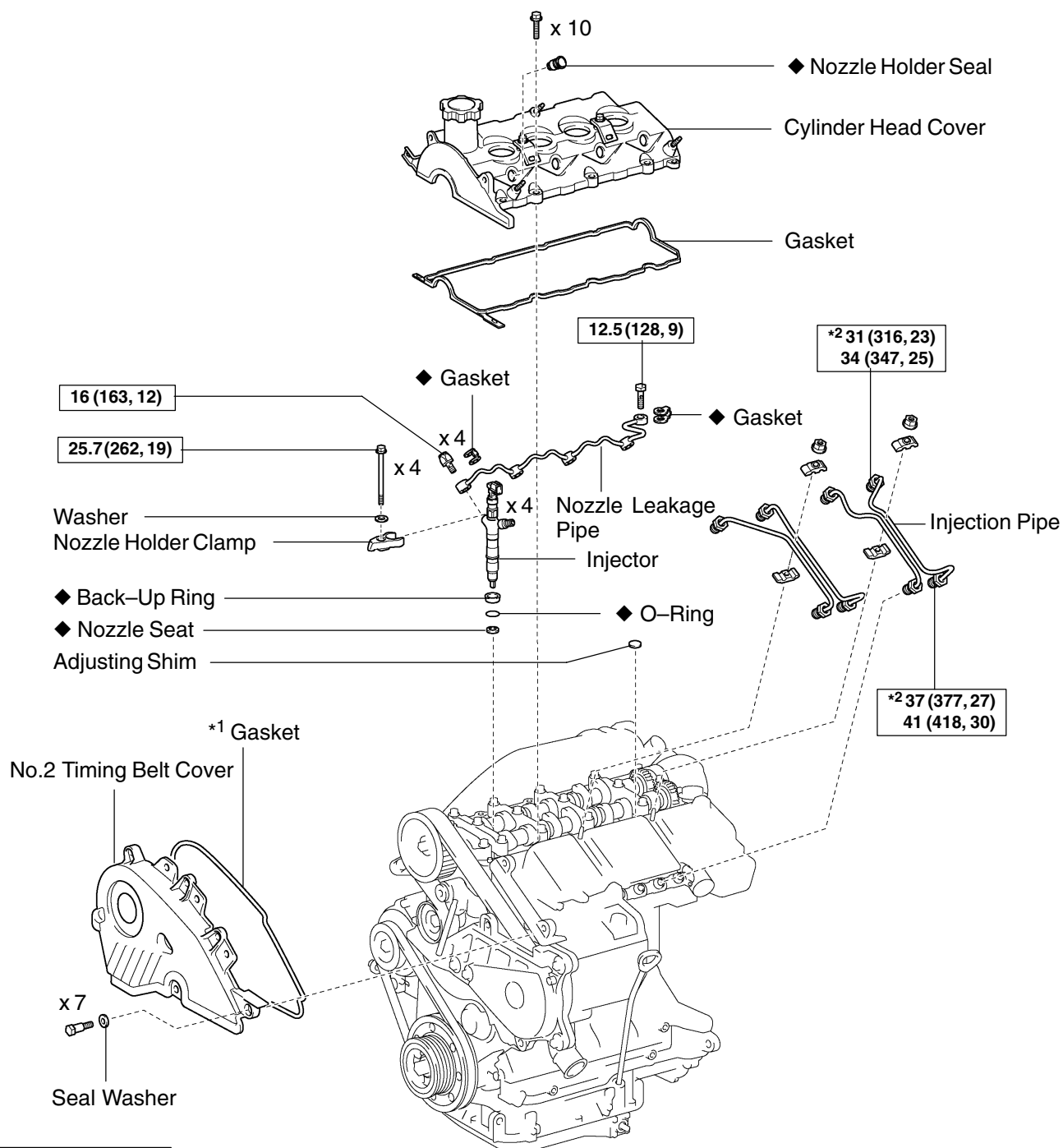
**5. RECONNECT INJECTOR CONNECTORS**

**6. REINSTALL GLOW PLUGS (See page EM-18)**

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

# VALVE CLEARANCE COMPONENTS

EM138-02



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

◆ Non-reusable part

\*1 Replace only if damaged

\*2 For use with SST

Y

A09685

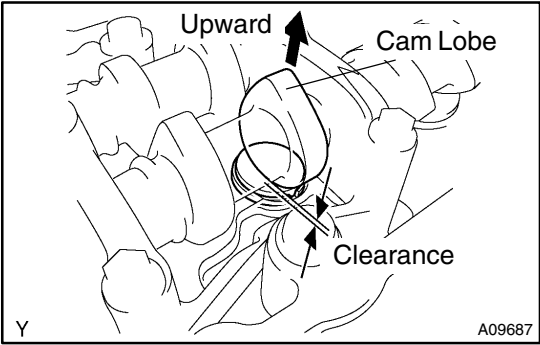
# INSPECTION

## HINT:

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

## NOTICE:

- **Befor 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 installatoin 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.**
1. **REMOVE NO.2 TIMING BELT COVER**  
(See page EM-12)
  2. **REMOVE INJECTION PIPES** (See page FU-6)
  3. **REMOVE CYLINDER HEAD COVER**  
(See page EM-28)
  4. **REMOVE NOZZLE LEAKAGE PIPE**  
(See page FU-6)
  5. **REMOVE INJECTORS** (See page FU-6)

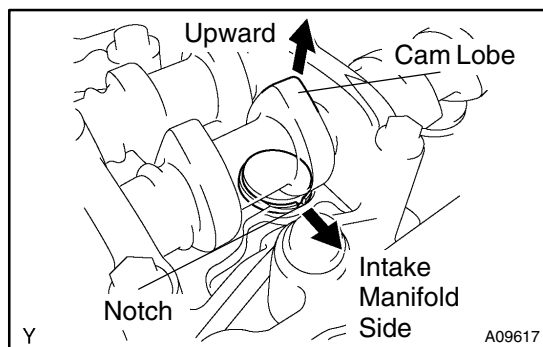


## 6. INSPECT VALVE CLEARANCE

- (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):

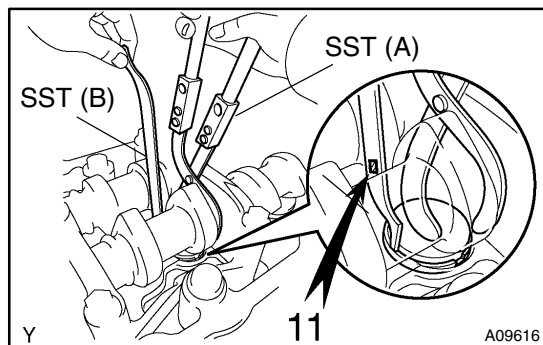
|         |                                    |
|---------|------------------------------------|
| Intake  | 0.20 – 0.30 mm (0.008 – 0.012 in.) |
| Exhaust | 0.35 – 0.45 mm (0.014 – 0.018 in.) |



## 7. 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.

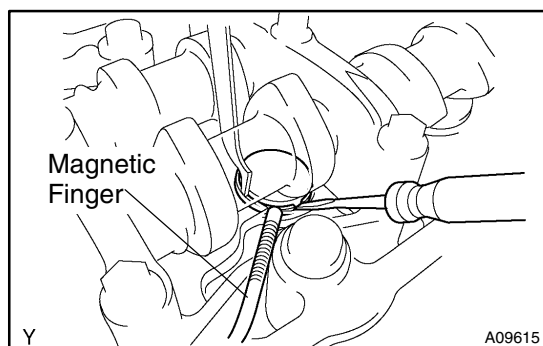


- (3) Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).

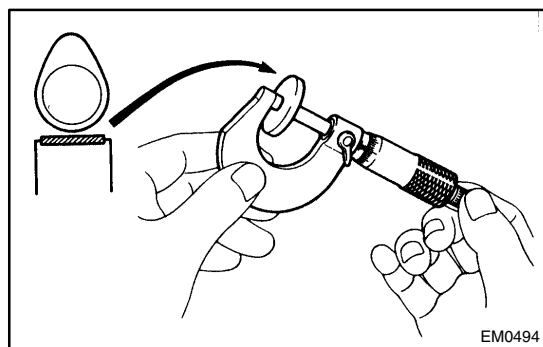
SST 09248-55050 (09248-05510, 09248-05520)

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

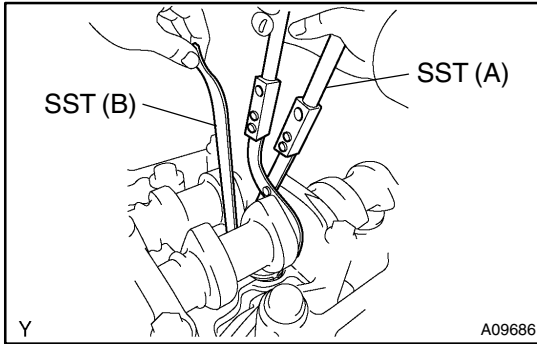
**Intake:  $N = T + (A - 0.25 \text{ mm (0.010 in.)})$**

**Exhaust:  $N = T + (A - 0.40 \text{ mm (0.016 in.)})$**

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

HINT:

Shims are available in 17 sizes in increments of 0.05 mm (0.0020 in.), from 2.50 mm (0.0984 in.) to 3.30 mm (0.1299 in.).



- (c) Install a new adjusting shim.
  - (1) Place a new adjusting shim on the valve lifter.
  - (2) Using SST (A), press down the valve lifter and remove SST (B).
- SST 09248-55050 (09248-05510, 09248-05520)
- (d) Recheck the valve clearance.
- 8. REINSTALL INJECTORS (See page FU-8)**
- 9. REINSTALL NOZZLE LEAKAGE PIPE (See page FU-8)**
- 10. REINSTALL CYLINDER HEAD COVER (See page EM-46)**
- 11. REINSTALL INJECTION PIPES (See page FU-8)**
- 12. REINSTALL NO.2 TIMING BELT COVER (See page EM-18)**

### Adjusting Shim Selection Chart (Intake)

| New shim thickness mm (in.) |               |          |               |
|-----------------------------|---------------|----------|---------------|
| Shim No.                    | Thickness     | Shim No. | Thickness     |
| 01                          | 2.500(0.0984) | 19       | 2.950(0.1161) |
| 03                          | 2.550(0.1004) | 21       | 3.000(0.1181) |
| 05                          | 2.600(0.1024) | 23       | 3.050(0.1201) |
| 07                          | 2.650(0.1043) | 25       | 3.100(0.1220) |
| 09                          | 2.700(0.1063) | 27       | 3.150(0.1240) |
| 11                          | 2.750(0.1083) | 29       | 3.200(0.1260) |
| 13                          | 2.800(0.1102) | 31       | 3.250(0.1280) |
| 15                          | 2.850(0.1122) | 33       | 3.300(0.1299) |
| 17                          | 2.900(0.1142) |          |               |

**Intake valve clearance (Cold):**

**0.20 – 0.30 mm (0.008 – 0.012 in.)**

**EXAMPLE:** The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.450 mm (0.0177 in.).

Replace the 2.800 mm (0.1102 in.) shim with a new No.21 shim.

Adjusting Shim Selection Chart (Exhaust)

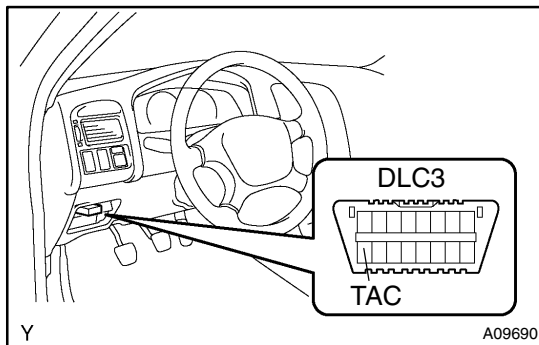
| Installed shim thickness<br>mm (in.) | 2.500 (0.0984) | 2.525 (0.0994) | 2.550 (0.1004) | 2.575 (0.1014) | 2.600 (0.1024) | 2.625 (0.1033) | 2.650 (0.1043) | 2.675 (0.1053) | 2.700 (0.1063) | 2.725 (0.1073) | 2.750 (0.1073) | 2.775 (0.1093) | 2.800 (0.1102) | 2.825 (0.1112) | 2.850 (0.1122) | 2.875 (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             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             |    |
| 0.021 ~ 0.040 (0.0008 ~ 0.0016)      |                |                |                |                |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             |    |
| 0.041 ~ 0.060 (0.0016 ~ 0.0024)      |                |                |                |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             |    |
| 0.061 ~ 0.080 (0.0024 ~ 0.0031)      |                |                |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 19             |    |
| 0.081 ~ 0.100 (0.0032 ~ 0.0039)      |                |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             |    |
| 0.101 ~ 0.120 (0.0040 ~ 0.0047)      |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             |    |
| 0.121 ~ 0.140 (0.0048 ~ 0.0055)      |                |                |                |                |                |                |                |                |                |                | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             |    |
| 0.141 ~ 0.160 (0.0056 ~ 0.0063)      |                |                |                |                |                |                |                |                |                | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             |    |
| 0.161 ~ 0.180 (0.0063 ~ 0.0071)      |                |                |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23 |
| 0.181 ~ 0.200 (0.0071 ~ 0.0079)      |                |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25 |
| 0.201 ~ 0.220 (0.0079 ~ 0.0087)      |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25 |
| 0.221 ~ 0.240 (0.0087 ~ 0.0094)      |                |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25 |
| 0.241 ~ 0.260 (0.0095 ~ 0.0102)      |                |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27 |
| 0.261 ~ 0.280 (0.0103 ~ 0.0110)      |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27 |
| 0.281 ~ 0.300 (0.0111 ~ 0.0118)      |                |                |                |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 29 |
| 0.301 ~ 0.320 (0.0119 ~ 0.0126)      |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 29 |
| 0.321 ~ 0.340 (0.0126 ~ 0.0134)      |                |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 29 |
| 0.341 ~ 0.349 (0.0134 ~ 0.0137)      |                | 01             | 01             | 01             | 03             | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             |    |
| 0.350 ~ 0.450 (0.0138 ~ 0.0177)      |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.451 ~ 0.460 (0.0178 ~ 0.0181)      | 03             | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |    |
| 0.461 ~ 0.480 (0.0181 ~ 0.0189)      | 05             | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |    |
| 0.481 ~ 0.500 (0.0189 ~ 0.0197)      | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |    |
| 0.501 ~ 0.520 (0.0197 ~ 0.0205)      | 05             | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |    |
| 0.521 ~ 0.540 (0.0205 ~ 0.0213)      | 07             | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |    |
| 0.541 ~ 0.560 (0.0213 ~ 0.0220)      | 07             | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |    |
| 0.561 ~ 0.580 (0.0221 ~ 0.0228)      | 09             | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |    |
| 0.581 ~ 0.600 (0.0229 ~ 0.0236)      | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |    |
| 0.601 ~ 0.620 (0.0237 ~ 0.0244)      | 09             | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |    |
| 0.621 ~ 0.640 (0.0244 ~ 0.0252)      | 11             | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |    |
| 0.641 ~ 0.660 (0.0252 ~ 0.0260)      | 11             | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |    |
| 0.661 ~ 0.680 (0.0260 ~ 0.0268)      | 13             | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |    |
| 0.681 ~ 0.700 (0.0268 ~ 0.0276)      | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |    |
| 0.701 ~ 0.720 (0.0276 ~ 0.0283)      | 13             | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.721 ~ 0.740 (0.0284 ~ 0.0291)      | 15             | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.741 ~ 0.760 (0.0292 ~ 0.0299)      | 15             | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.761 ~ 0.780 (0.0300 ~ 0.0307)      | 17             | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.781 ~ 0.800 (0.0307 ~ 0.0315)      | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.801 ~ 0.820 (0.0315 ~ 0.0323)      | 17             | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.821 ~ 0.840 (0.0323 ~ 0.0331)      | 19             | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.841 ~ 0.860 (0.0331 ~ 0.0339)      | 19             | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.861 ~ 0.880 (0.0339 ~ 0.0346)      | 21             | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.881 ~ 0.900 (0.0347 ~ 0.0354)      | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.901 ~ 0.920 (0.0355 ~ 0.0362)      | 21             | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.921 ~ 0.940 (0.0363 ~ 0.0370)      | 23             | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.941 ~ 0.960 (0.0370 ~ 0.0378)      | 23             | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.961 ~ 0.980 (0.0378 ~ 0.0386)      | 25             | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 0.981 ~ 1.000 (0.0386 ~ 0.0394)      | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 1.001 ~ 1.020 (0.0394 ~ 0.0402)      | 25             | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 1.021 ~ 1.040 (0.0402 ~ 0.0409)      | 27             | 27             | 29             | 29             | 31             | 31             | 33             | 33             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |
| 1.041 ~ 1.060 (0.0410 ~ 0.0417)      | 27             | 29             | 29             | 31             | 31             | 33             |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |    |

# IDLE SPEED AND MAXIMUM SPEED INSPECTION

EMOW5-02

## 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.



## 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: 700 – 800 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.

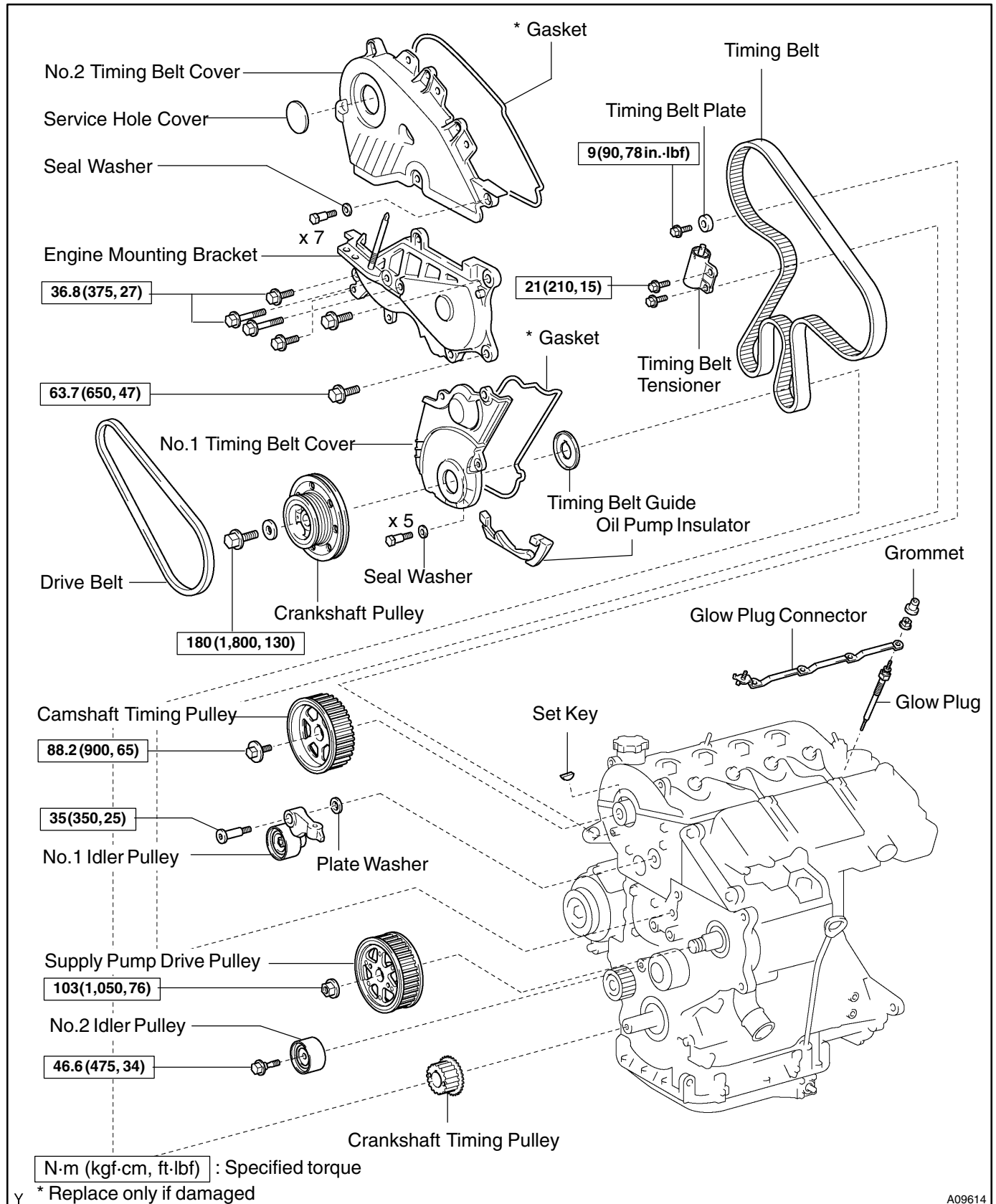
**Maximum speed: 5,100 – 5,250 rpm**

If the maximum speed is not as specified, check the troubleshooting in DI section.

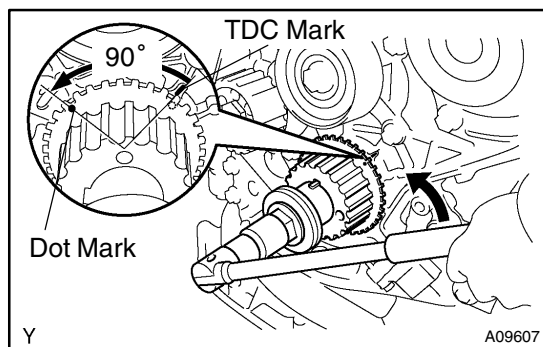
## 5. DISCONNECT TACHOMETER

# TIMING BELT COMPONENTS

EMOHV-02



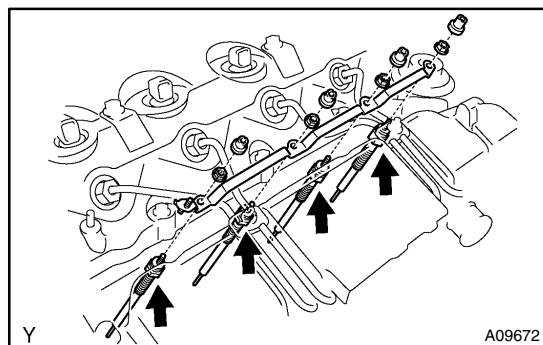
A09614



## REMOVAL

### NOTICE:

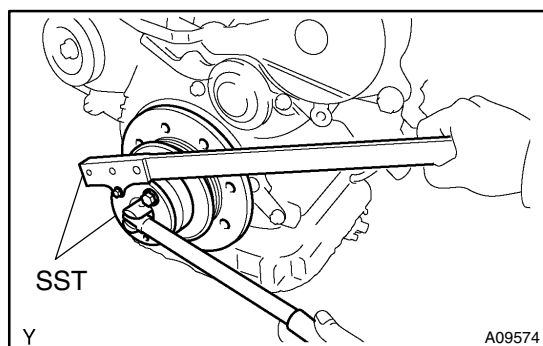
Under the condition with the timing belt removed, in case of rotating the camshaft, make the position of the crankshaft rotated counterclockwise by 90° from TDC/compression of No.1 cylinder.



### 1. REMOVE GLOW PLUGS FOR ENGINE

- (a) Remove the 4 grommets.
- (b) Remove the 4 nuts and glow plug connector.
- (c) Remove the 4 glow plugs.

### 2. REMOVE DRIVE BELT

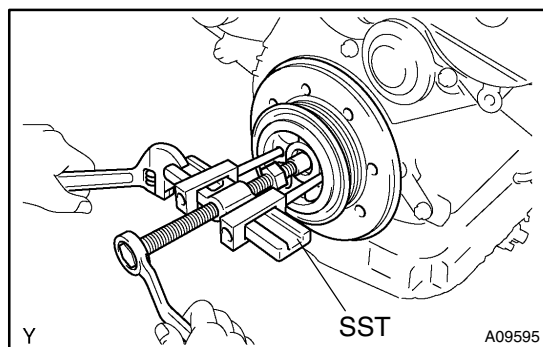


### 3. REMOVE CRANKSHAFT PULLEY

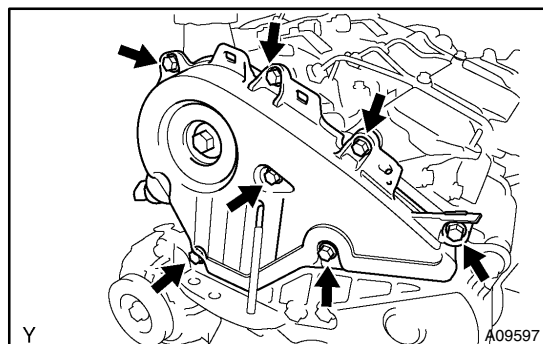
- (a) Using SST, remove the pulley bolt.  
SST 09213-54015 (91651-60855), 09330-00021

#### HINT:

When using bolt (91651-60855), a plate washer (5 mm or 0.20 in.) must be inserted between the bolt and SST.

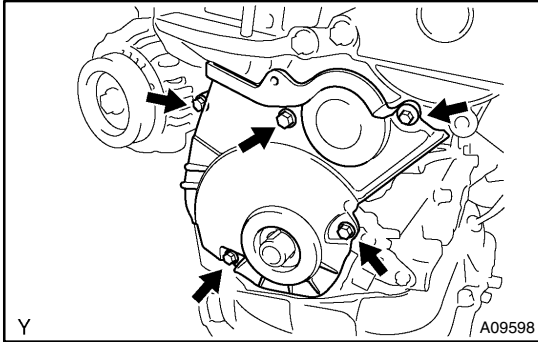


- (b) Using SST, remove the pulley.  
SST 09950-50012 (09951-05010, 09952-05010, 09953-05010, 09953-05020, 09954-05030)



### 4. REMOVE NO.2 TIMING BELT COVER

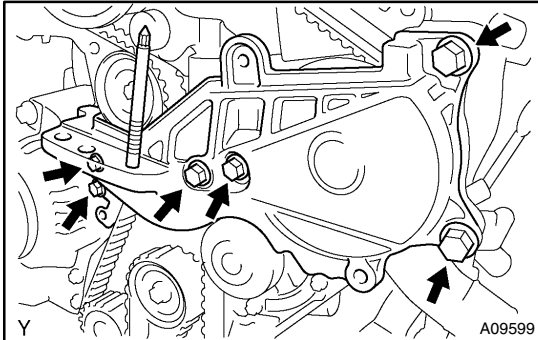
Remove the 7 bolts, 7 seal washers and timing belt cover.



### 5. REMOVE NO.1 TIMING BELT COVER

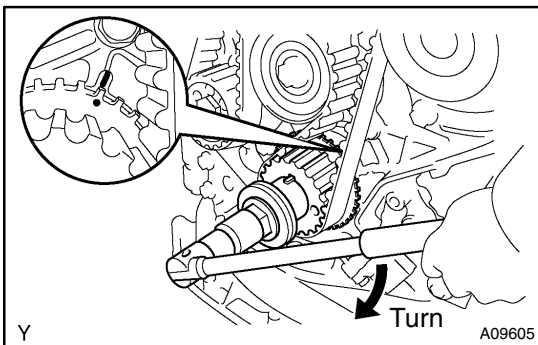
- (a) Remove the 5 bolts, 5 seal washers and timing belt cover.
- (b) Remove the oil pump insulator.

### 6. REMOVE TIMING BELT GUIDE



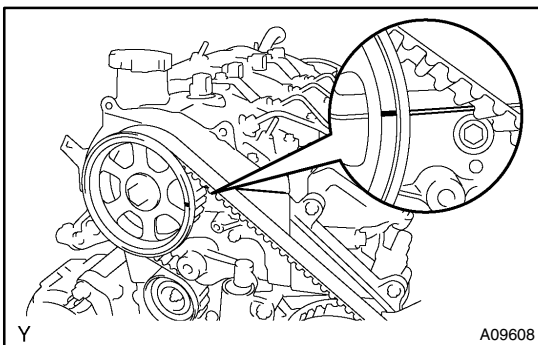
### 7. REMOVE ENGINE MOUNTING BRACKET

Remove the 6 bolts and engine mounting bracket.



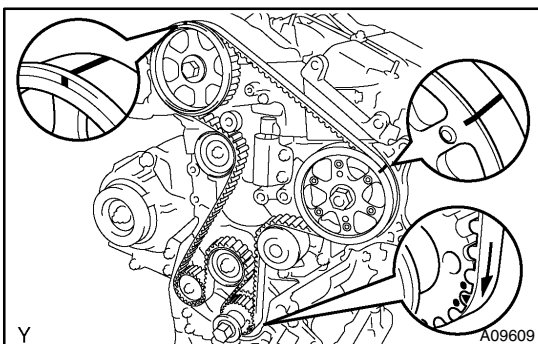
### 8. SET NO.1 CYLINDER TO TDC/COMPRESSION

- (a) Using the crankshaft pulley bolt, align the dot mark of the crankshaft timing pulley with the TDC mark of the oil pump by turning the crankshaft.



- (b) Check that the timing mark of the camshaft timing pulley is aligned with the top end of the cylinder head.

If not, revolve the crankshaft 1 (360°) and align the mark as above.

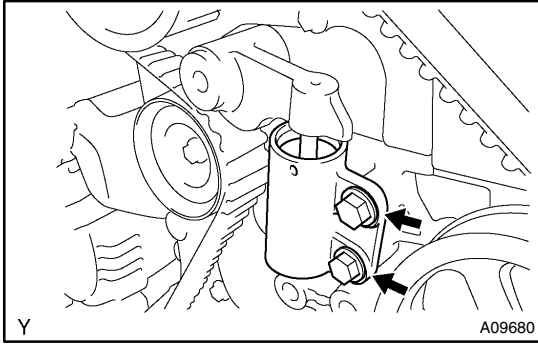


### 9. REMOVE TIMING BELT

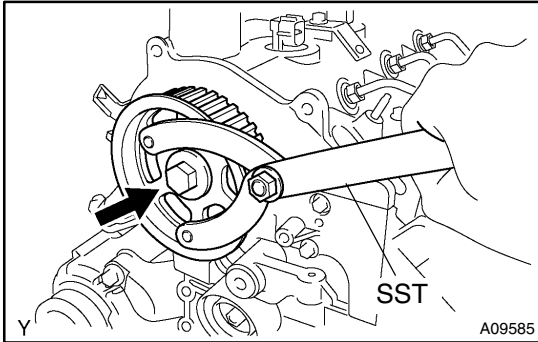
#### HINT:

If re-using the timing belt, draw a direction arrow on the timing belt (in direction of engine revolution), and place matchmarks on the pulleys and timing belt.

- (a) Remove the bolt and timing belt plate.

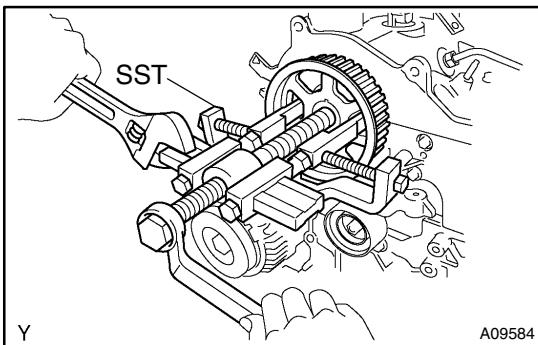


- (b) Alternately loosen the 2 bolts, and remove them and the timing belt tensioner.
- (c) Remove the timing belt.

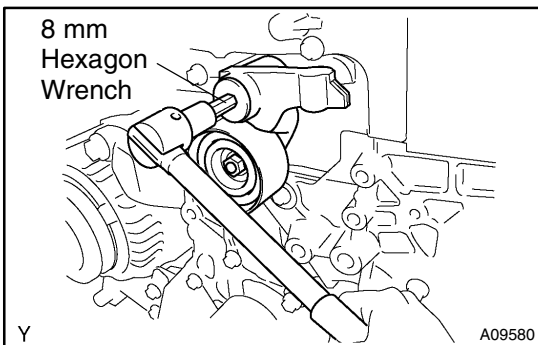


#### 10. REMOVE CAMSHAFT TIMING PULLEY

- (a) Using SST, remove the pulley bolt.  
SST 09960-10010 (09962-01400, 09963-01000)

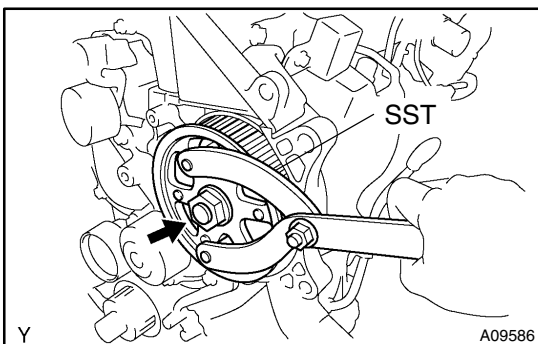


- (b) Using SST, remove the timing pulley.  
SST 09950-40011 (09951-04010, 09952-04010, 09953-04020, 09954-04010, 09955-04071, 09957-04010, 09958-04011)
- (c) Remove the set key.



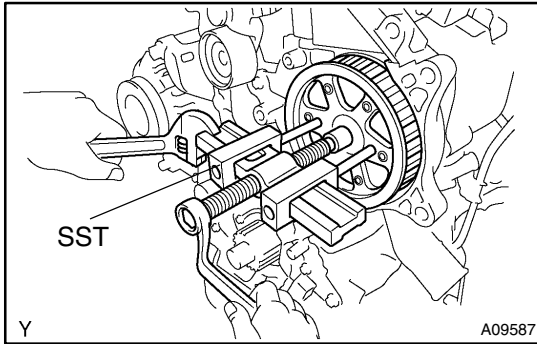
#### 11. REMOVE NO.1 IDLER PULLEY

Using an 8 mm hexagon wrench, remove the idler pulley shaft, idler pulley and plate washer.



#### 12. REMOVE SUPPLY PUMP DRIVE PULLEY

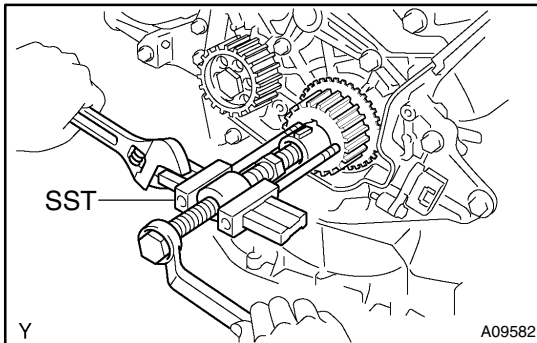
- (a) Using SST, remove the pulley nut.  
SST 09960-10010 (09962-01000, 09963-01000)



- (b) Using SST, remove the drive pulley.  
SST 09950-50012 (09951-05010, 09952-05010,  
09953-05020, 09954-05020)

### 13. REMOVE NO.2 IDLER PULLEY

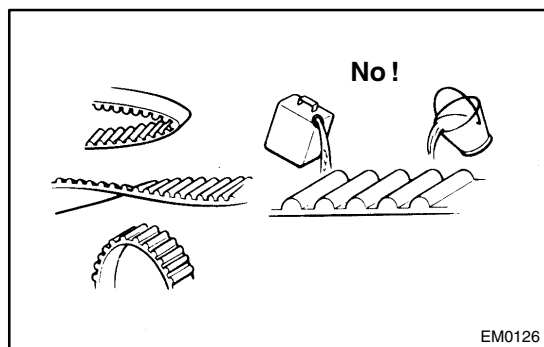
Remove the bolt and idler pulley.



### 14. REMOVE CRANKSHAFT TIMING PULLEY

If the pulley cannot be removed by hand, use SST to remove the timing pulley.

- SST 09950-05012 (09951-05010, 09952-05010,  
09953-05010, 09953-05020, 09954-05020)



## INSPECTION

### 1. INSPECT TIMING BELT

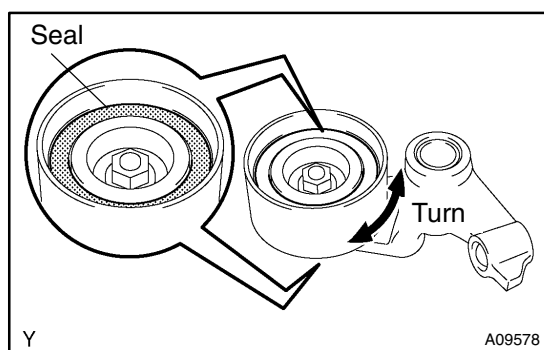
#### NOTICE:

- 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 mounting bolt of the camshaft timing pulley.

If there are any defects, as shown in the illustration, check these points:

- Premature parting
  - Check the proper installation.
  - Check the timing belt cover gasket for damage and proper installation is locked.
- If the belt teeth are cracked or damaged, check to see if either camshaft or water pump is locked.
- 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 lock.
- If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.
- If there is noticeable wear on the belt teeth, check the 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.



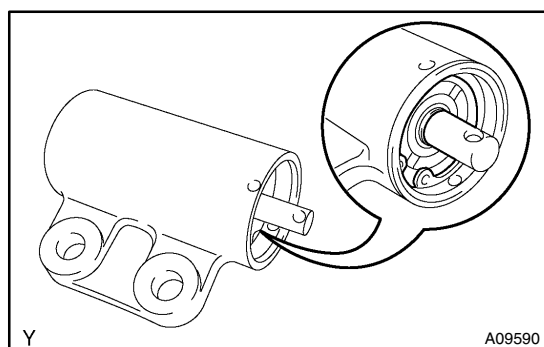
### 2. INSPECT IDLER PULLEYS

- Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.

- Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.



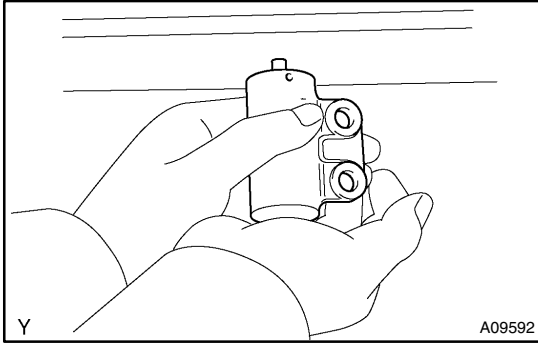
### 3. INSPECT TIMING BELT TENSIONER

- 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.

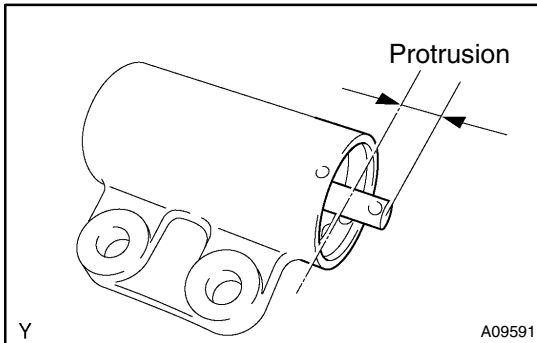
If leakage is found, replace the tensioner.



- (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:**

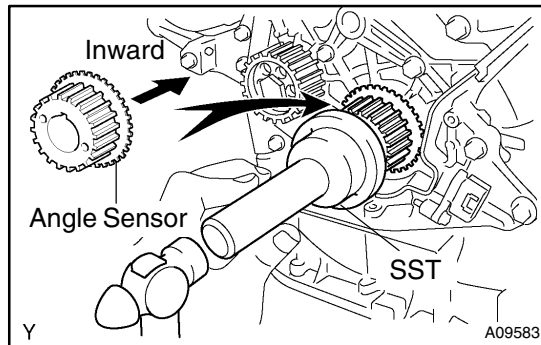
**Never hold the tensioner push rod facing downward.**



- (c) Measure the protrusion of the push rod from the housing end.

**Protrusion: 9.0 – 10.6 mm (0.354 – 0.417 in.)**

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

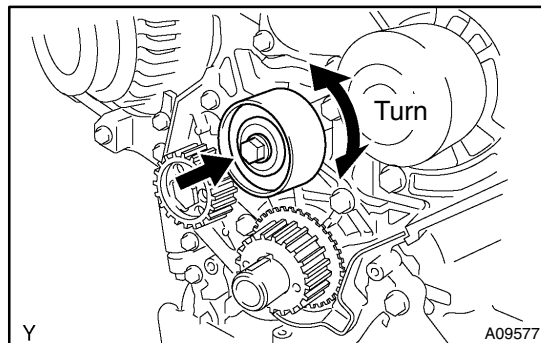


## INSTALLATION

### 1. INSTALL CRANKSHAFT TIMING PULLEY

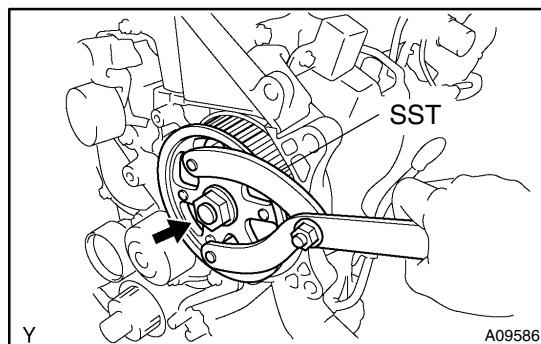
- Align the pulley set key with the key groove of the timing pulley.
- Using SST and a hammer, tap in the timing pulley, facing the angle sensor inward.

SST 09223-46011



### 2. INSTALL NO.2 IDLER PULLEY

- Install the idler pulley with the bolt.  
**Torque: 46.6 N·m (475 kgf·cm, 34 ft·lbf)**
- Check that the idler pulley moves smoothly.

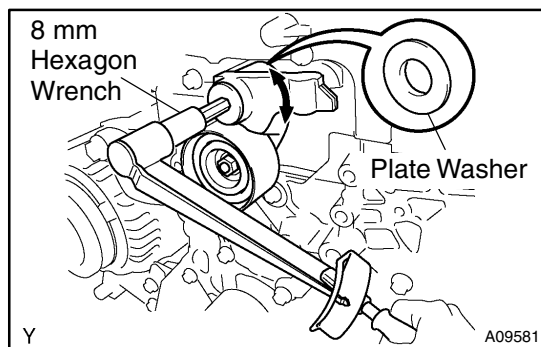


### 3. INSTALL SUPPLY PUMP DRIVE PULLEY

- Align the pulley set key with the key groove of the drive pulley, and slide on the timing pulley.
- Using SST, install the pulley nut.

SST 09960-10010 (09962-01000, 09963-01000)

**Torque: 103 N·m (1,050 kgf·cm, 76 ft·lbf)**

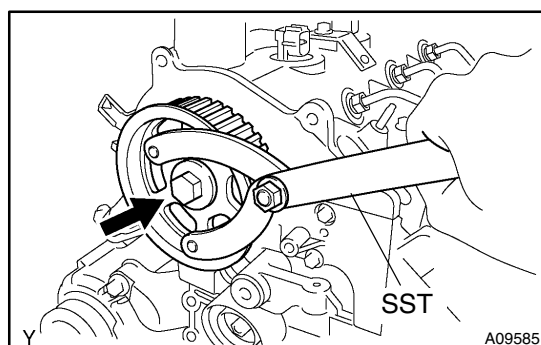


### 4. INSTALL NO.1 IDLER PULLEY

- Using an 8 mm hexagon wrench, install the plate washer and idler pulley with the idler pulley shaft.

**Torque: 35 N·m (350 kgf·cm, 25 ft·lbf)**

- Check that the pulley bracket moves smoothly.

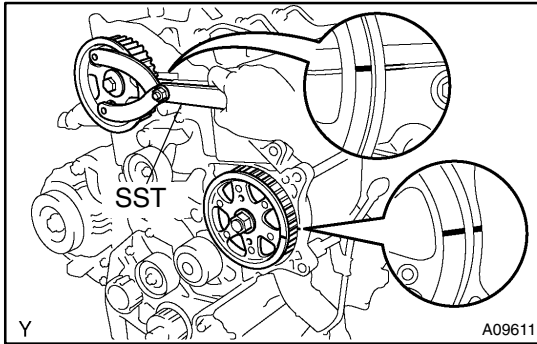


### 5. INSTALL CAMSHAFT TIMING PULLEY

- Install the pulley set key to the key groove of the camshaft.
- Align the pulley set key with the key groove of the timing pulley, and slide on the timing pulley.
- Using SST, install the pulley bolt.

SST 09960-10010 (09962-01000, 09963-01000)

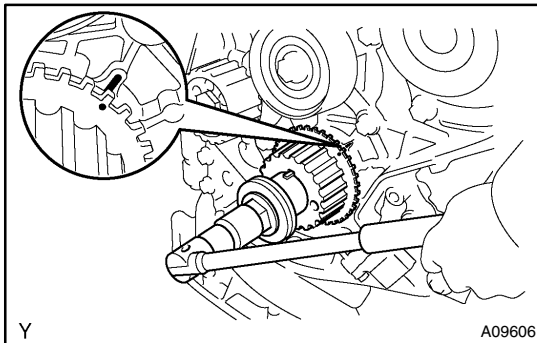
**Torque: 88.2 N·m (900 kgf·cm, 65 ft·lbf)**



## 6. SET NO.1 CYLINDER TO TDC/COMPRESSION

- (a) Using SST, set the timing and drive pulleys at each position.

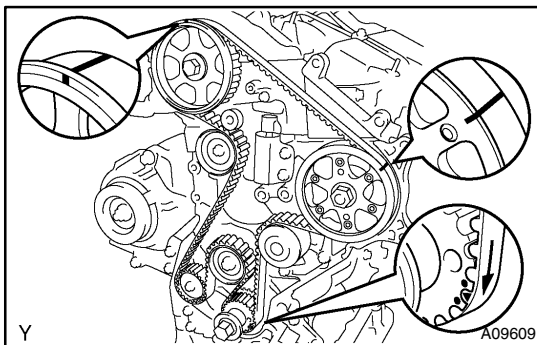
SST 09960-10010 (09962-01400, 09963-01000)



- (b) Using the crankshaft pulley bolt, align the dot mark of the crankshaft timing pulley with the TDC mark of the oil pump by turning the crankshaft.

### NOTICE:

**When turning the camshaft or crankshaft, the valve heads will hit against the piston top so do not turn them more than necessary.**



## 7. INSTALL TIMING BELT

### NOTICE:

**The engine should be cold.**

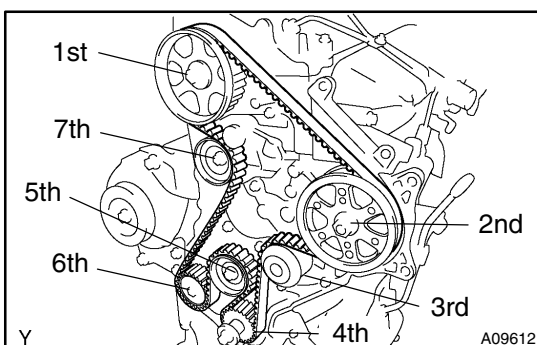
### HINT:

If re-using the timing belt, align the points marked during removal, and install the timing belt with the arrow pointing in the direction of engine revolution.

- (a) Remove any oil or water on each pulleys, and keep them clean.

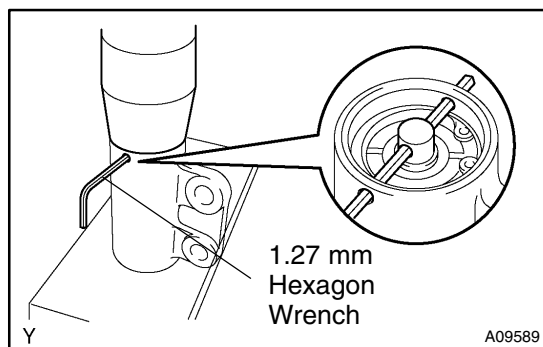
### NOTICE:

**Only wipe the pulleys; do not use any cleansing agent.**



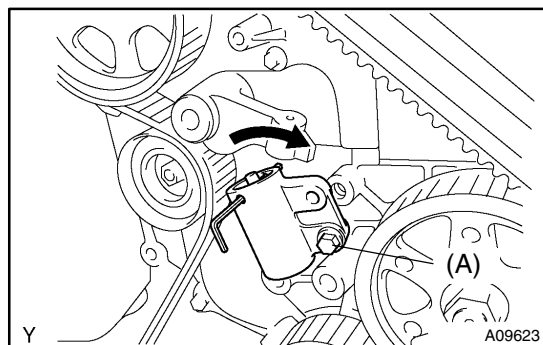
- (b) Install the timing belt in this order:

- 1st: Camshaft timing pulley
- 2nd: Supply pump drive pulley
- 3rd: Water pump pulley
- 4th: Crankshaft timing pulley
- 5th: No.2 idler pulley
- 6th: Oil pump pulley
- 7th: No.1 idler pulley



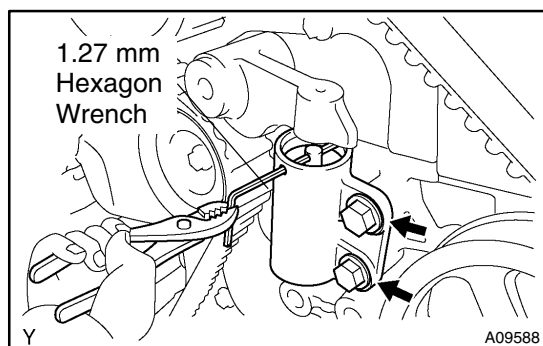
### 8. SET TIMING BELT TENSIONER

- Using a press, slowly press in the push rod using 981 – 9,807 N (100 – 1,000 kgf, 200 – 2,205 lbf) of pressure.
- Align the holes of the push rod and housing, pass a 1.27 mm hexagon wrench through the holes to keep the setting position of the push rod.
- Release the press.

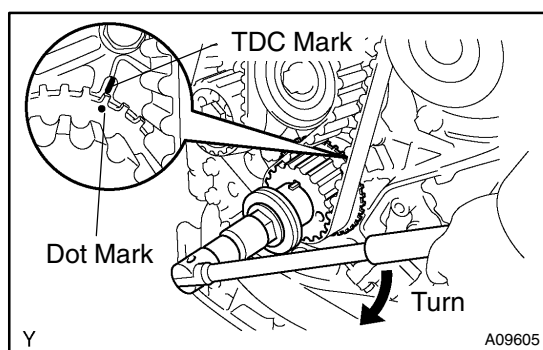


### 9. INSTALL TIMING BELT TENSIONER

- Temporarily install the tensioner with the bolt (A).
- Turn the tensioner clockwise and temporarily install the other bolt.

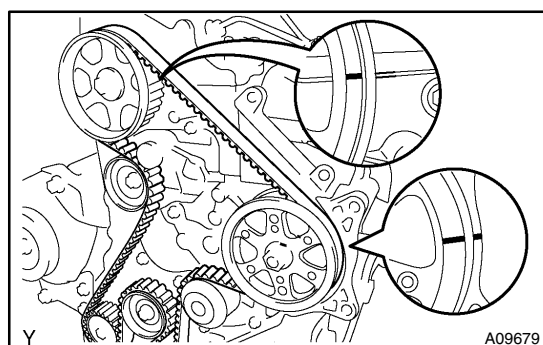


- Alternately tighten the 2 bolts.  
**Torque: 21 N·m (210 kgf·cm, 15 ft·lbf)**
- Remove the 1.27 mm hexagon wrench from the tensioner.



### 10. CHECK VALVE TIMING

- Slowly turn the crankshaft 2 revolutions from TDC to TDC.
- NOTICE:**  
**Always turn the crankshaft clockwise.**



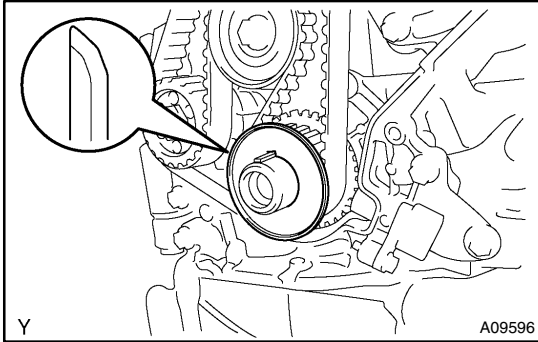
- Check that each pulley aligns with the timing marks as shown in the illustration.

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

- Remove the crankshaft pulley bolt.

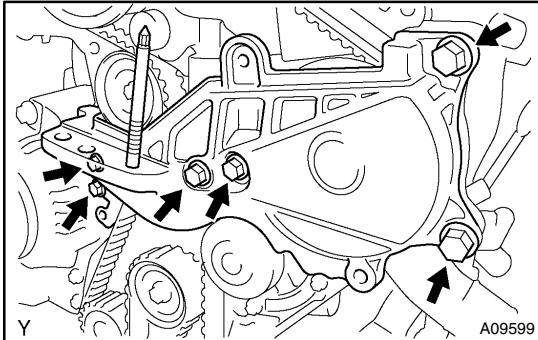
### 11. INSTALL TIMING BELT PLATE

**Torque: 9 N·m (90 kgf·cm, 78 in·lbf)**



## 12. INSTALL TIMING BELT GUIDE

Install the belt guide, facing the cap side outward.



## 13. INSTALL ENGINE MOUNTING BRACKET

Install the engine mounting bracket with the 6 bolts.

**Torque:**

**36.8 N·m (375 kgf·cm, 27 ft·lbf) for 14 mm head bolt**

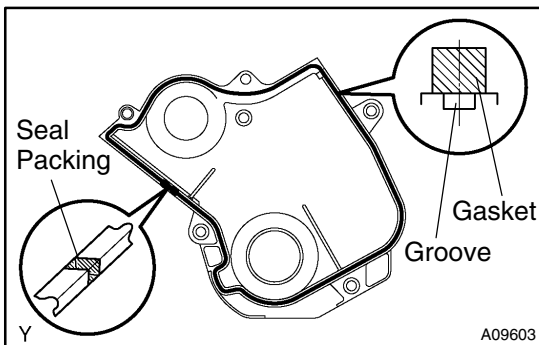
**63.7 N·m (650 kgf·cm, 47 ft·lbf) for 17 mm head bolt**

## 14. INSTALL NO.1 TIMING BELT COVER

- (a) Check that the timing belt cover gasket have cracks or peeling, etc.

If the gasket has cracks or peeling, etc., replace it using these steps:

- Using a screwdriver and gasket scraper, remove all the old gasket material.
- Thoroughly clean all components to remove all the loose material.

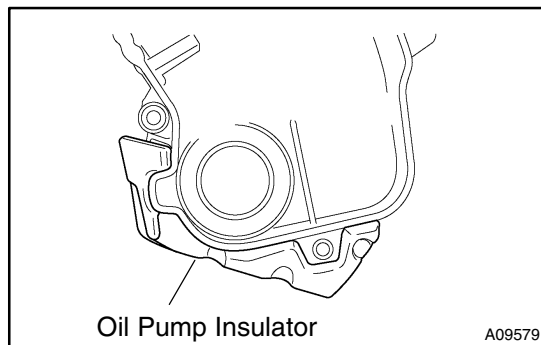


- Remove the backing paper from a new gasket and install the gasket evenly to the part of the timing belt cover shaded black in the illustration.

### NOTICE:

- **Affix the gasket at the center of the groove.**
- **At the corner portion, affix the gasket without making its thickness lessen.**
  - After installing the gasket, press down on it so that the adhesive firmly sticks to the timing belt cover.
  - In case that there is a clearance between the joint portion of the gasket, apply the same amount of seal packing as the width and height of the gasket.

**Seal packing: Part No. 08826-00080 or equivalent**



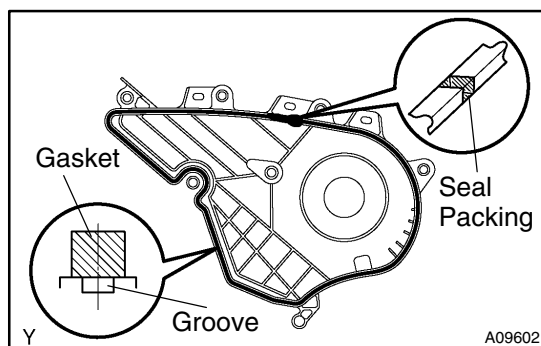
- (b) Install the oil pump insulator to the belt cover.
- (c) Install the No.1 timing belt cover and gasket with the 5 bolts and 5 seal washers.
- (d) After installing the belt cover, check that there is no peeling off of the gasket.

#### 15. INSTALL NO.2 TIMING BELT COVER

- (a) Check that the timing belt cover gasket have cracks or peeling, etc.

If the gasket has cracks or peeling, etc., replace it using these steps:

- Using a screwdriver and gasket scraper, remove all the old gasket material.
- Thoroughly clean all components to remove all the loose material.



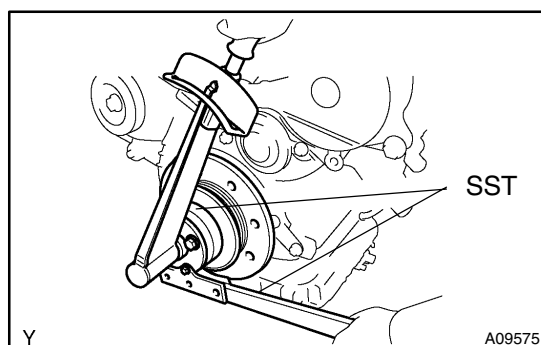
- Remove the backing paper from a new gasket and install the gasket evenly to the part of the timing belt cover shaded black in the illustration.

#### NOTICE:

- **Affix the gasket at the center of the groove.**
- **At the corner portion, affix the gasket without making its thickness lessen.**
  - After installing the gasket, press down on it so that the adhesive firmly sticks to the timing belt cover.
  - In case that there is a clearance between the joint portion of the gasket, apply the same amount of seal packing as the width and height of the gasket.

**Seal packing: Part No. 08826-00080 or equivalent**

- (b) Install the No.2 timing belt cover and gasket with the 7 bolts and 7 seal washers.



#### 16. INSTALL CRANKSHAFT PULLEY

- (a) Align the pulley set key with the key groove of the pulley, and slide the pulley to the crankshaft.
- (b) Using SST, install the pulley bolt.

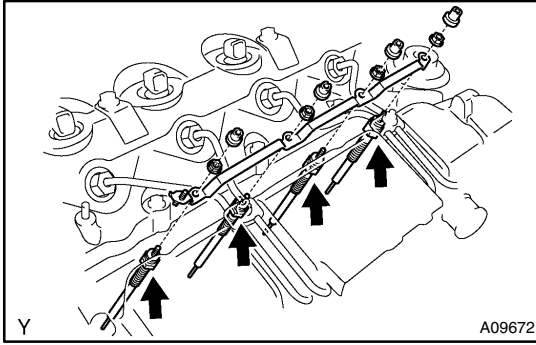
SST 09213-54015 (91651-60855) 09330-00021

**Torque: 180 N·m (1,800 kgf·cm, 130 ft·lbf)**

#### HINT:

When using bolt (91651-60855), a plate washer (5 mm or 0.20 in.) must be inserted between the bolt and SST.

#### 17. INSTALL DRIVE BELT

**18. INSTALL GLOW PLUGS FOR ENGINE**

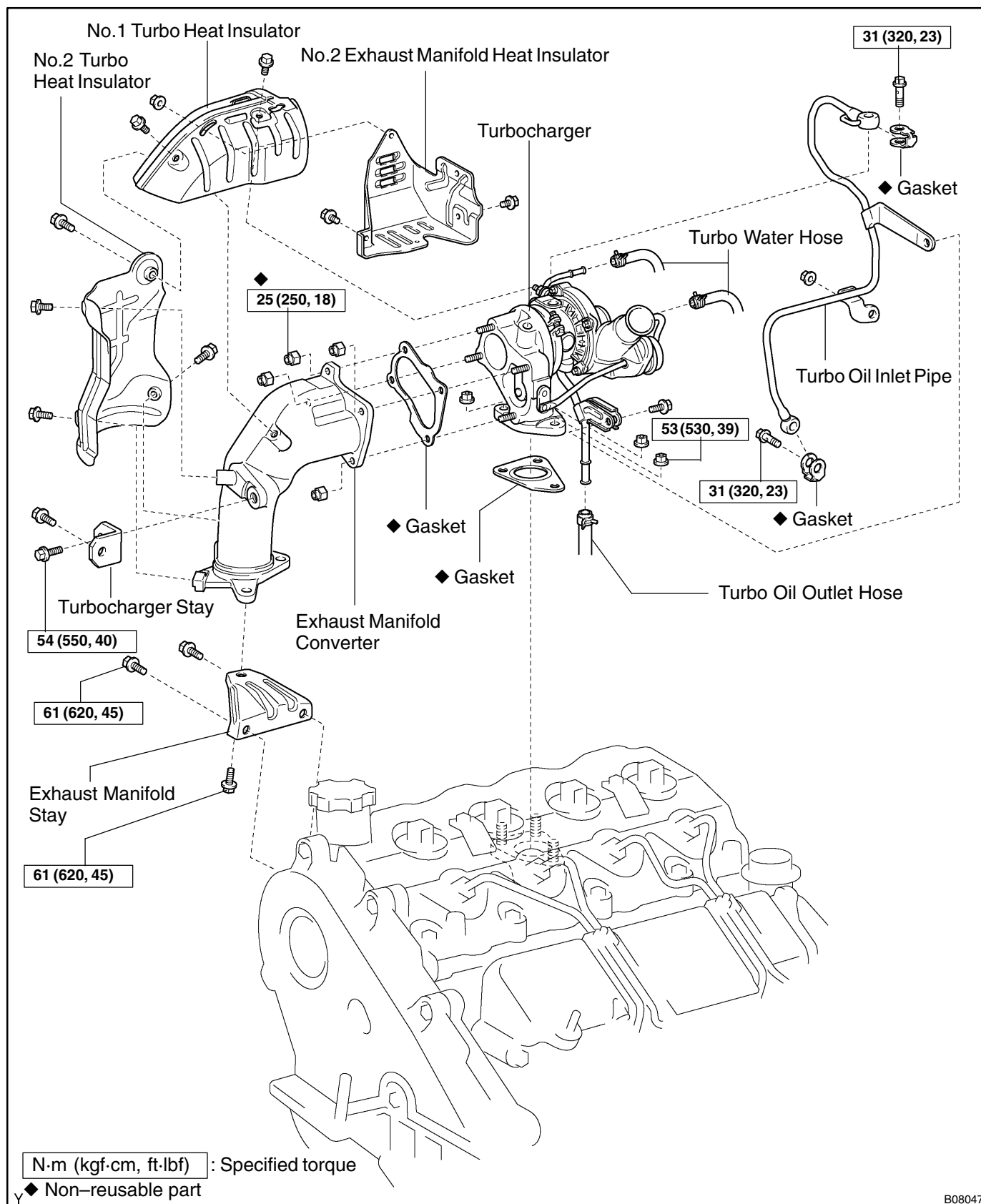
- (a) Install the 4 glow plugs.

**Torque: 12.3 N·m (125 kgf·cm, 9 ft·lbf)**

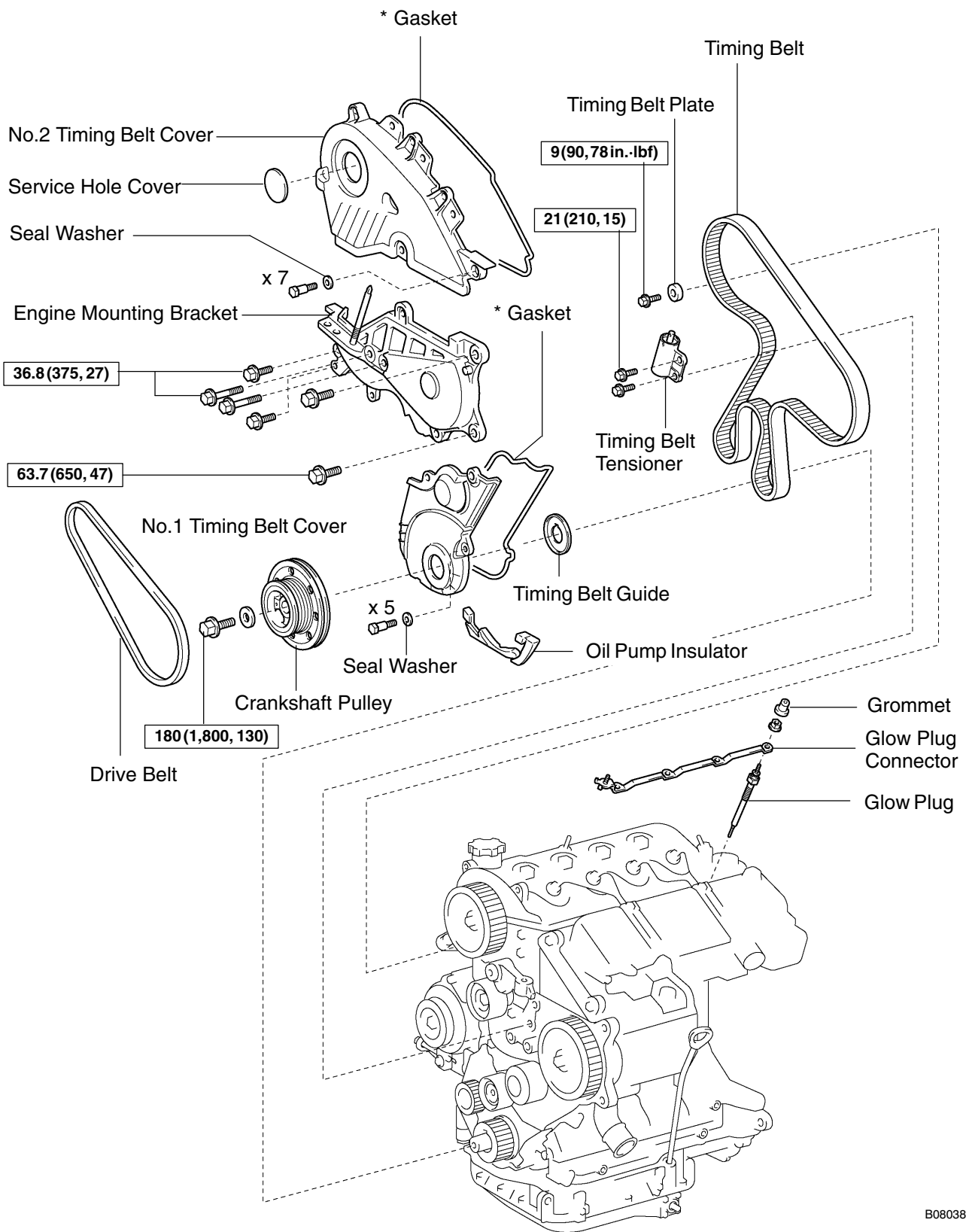
- (b) Install the glow plug connector with the 4 nuts.  
(c) Install the 4 grommets.

# CYLINDER HEAD COMPONENTS

EM13L-01



B08047



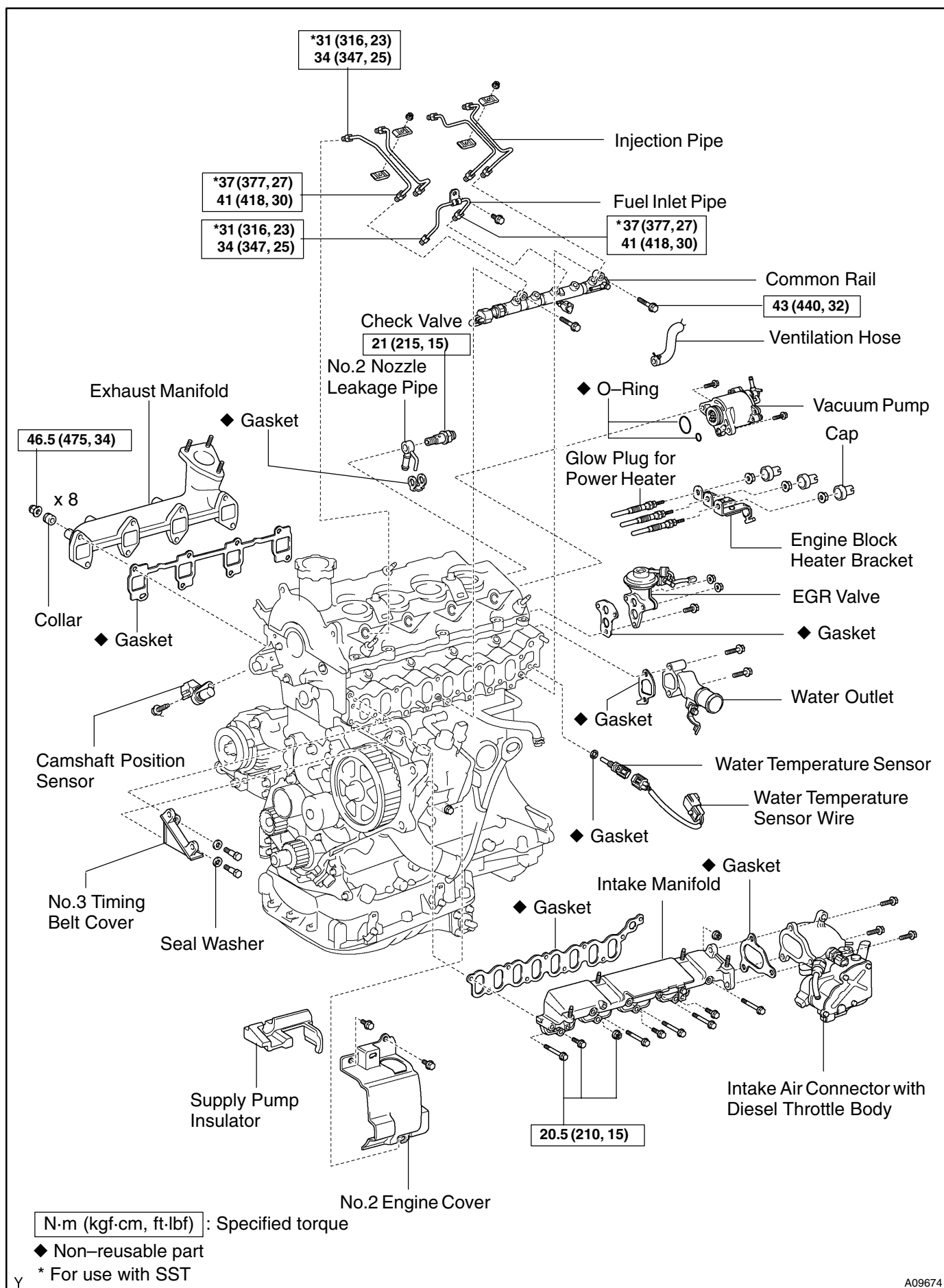
B08038

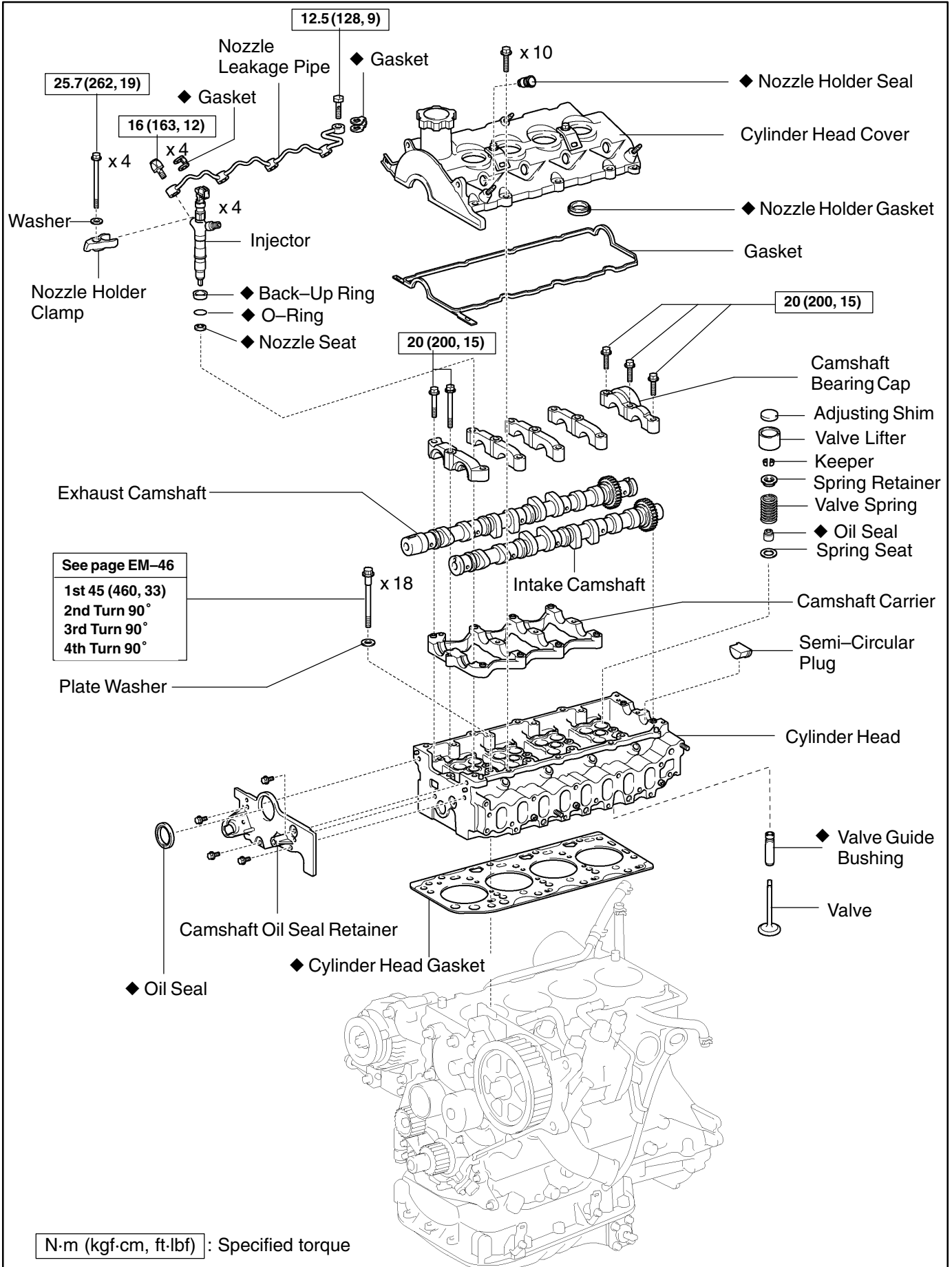
Y

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

\* Replace only if damaged

A09681



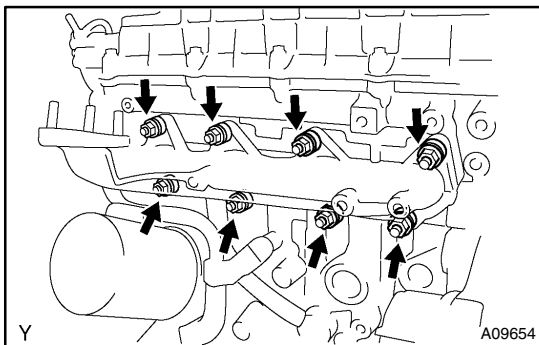


## REMOVAL

### NOTICE:

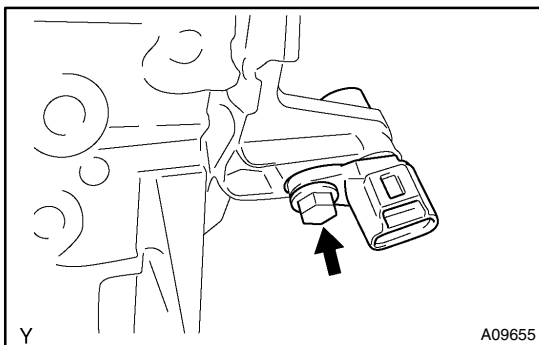
- Before removing the inlet pipe and fuel injection pipes, clean them up with a soft brush and compressed air.
- After removing the injection pipe, affix the gum tape on the supply pump, common rail and the whole injector installatoin area of the cylinder head cover for preventing dust from coming into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

1. REMOVE TURBOCHARGER (See page TC-7)
2. REMOVE TIMING BELT (See page EM-12)
3. REMOVE CAMSHAFT TIMING PULLEY (See page EM-12)

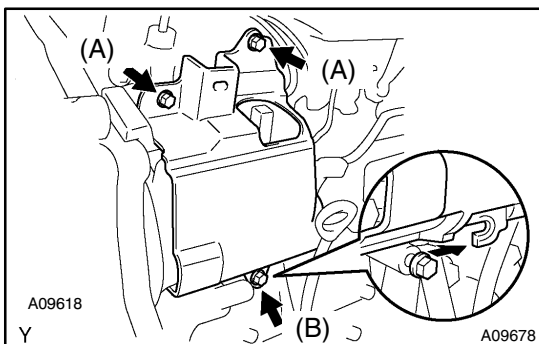


#### 4. REMOVE EXHAUST MANIFOLD

Remove the 8 nuts, 8 collars, exhaust manifold and gasket.



#### 5. REMOVE CAMSHAFT POSITION SENSOR



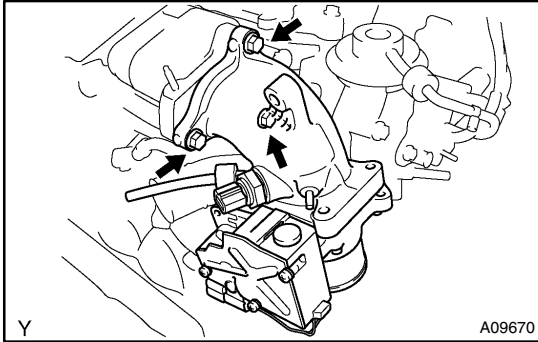
#### 6. REMOVE NO.2 ENGINE COVER

- (a) Remove the 2 bolts (A).
- (b) Loosen the bolt (B) and remove the cover.

#### 7. REMOVE SUPPLY PUMP INSULATOR

#### 8. REMOVE FUEL INLET PIPE (See page FU-16)

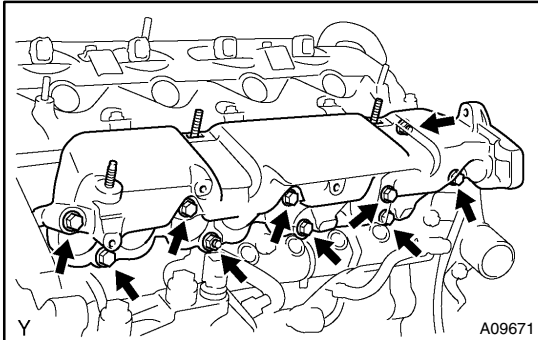
#### 9. REMOVE INJECTION PIPES (See page FU-6)



# 10. REMOVE INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY

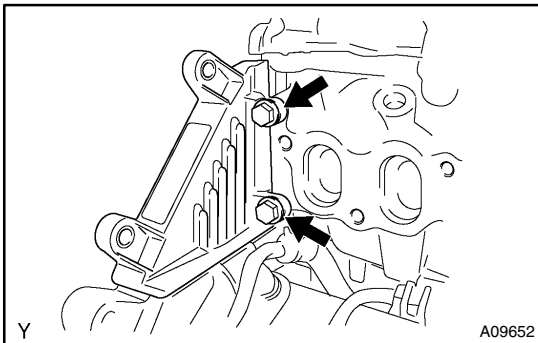
Remove the 3 bolts, the intake air connector with diesel throttle body and gasket.

# 11. LOOSEN COMMON RAIL SET BOLTS



# 12. REMOVE INTAKE MANIFOLD

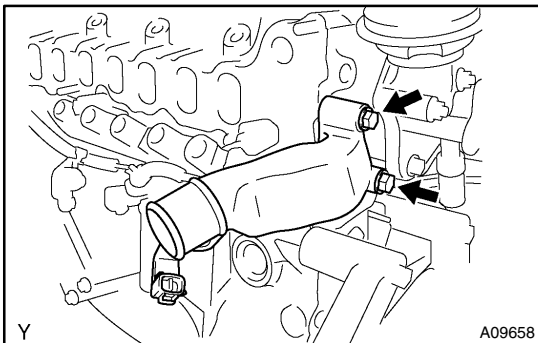
Remove the 8 bolts, 2 nuts, intake manifold and gasket.



# 13. REMOVE NO.3 TIMING BELT COVER

Remove the 2 bolts, 2 seal washers and timing belt cover.

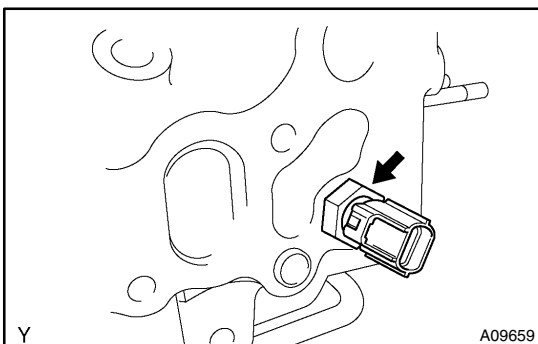
# 14. REMOVE VENTILATION HOSE



# 15. REMOVE WATER OUTLET

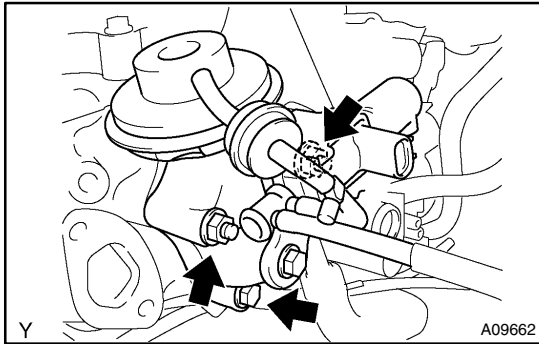
Remove the 2 bolts, water outlet and gasket.

# 16. REMOVE COMMON RAIL (See page FU-22)

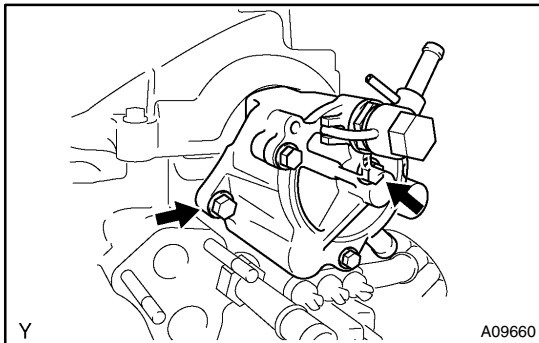


# 17. REMOVE WATER TEMPERATURE SENSOR

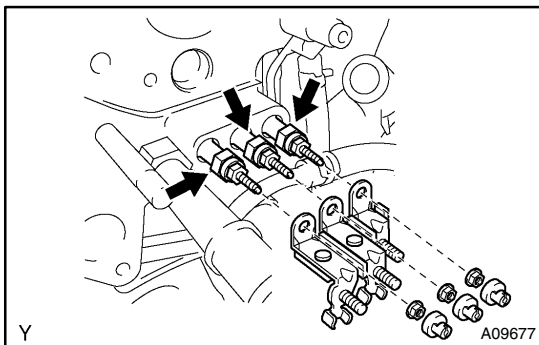
- (a) Remove the water temperature sensor wire.
- (b) Remove the water temperature sensor and gasket.

**18. REMOVE EGR VALVE**

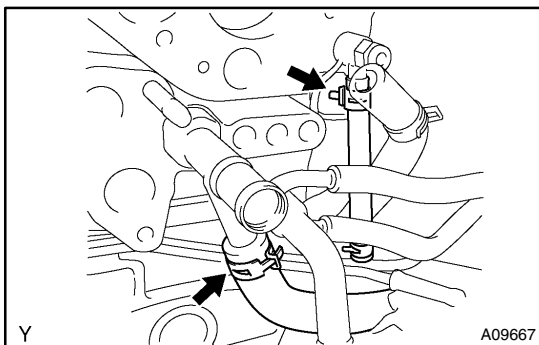
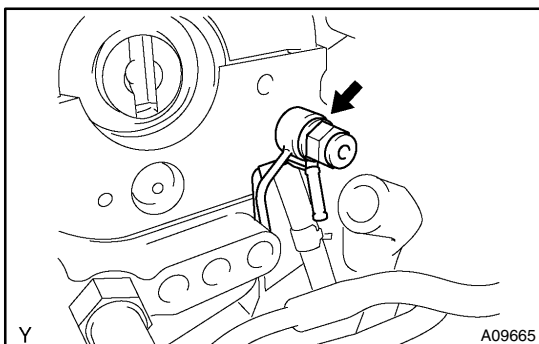
Remove the bolt, 2 nuts, the EGR valve and gasket.

**19. REMOVE VACUUM PUMP**

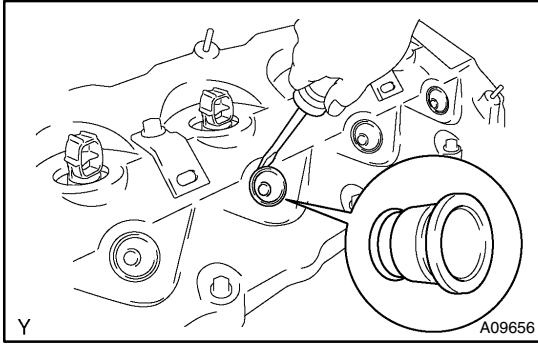
Remove the 2 bolts, vacuum pump and 2 O-rings.

**20. REMOVE GLOW PLUGS FOR POWER HEATER**

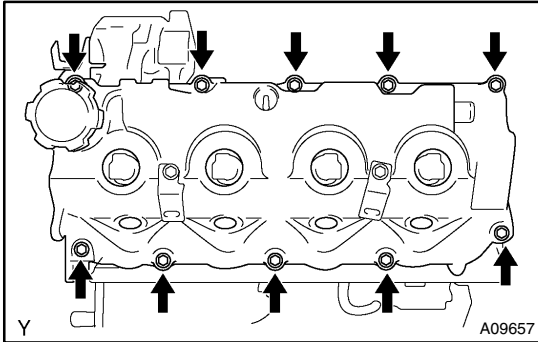
- (a) Remove the 3 caps.
- (b) Remove the 3 nuts and engine block heater bracket.
- (c) Remove the 3 glow plugs.

**21. DISCONNECT FUEL HOSE AND NO.2 OIL COOLER HOSE****22. REMOVE NO.2 NOZZLE LEAKAGE PIPE**

Remove the check valve, leakage pipe and gasket.

**23. REMOVE CYLINDER HEAD COVER**

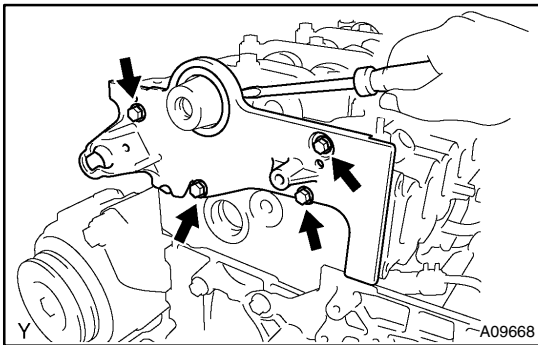
- (a) Using a screwdriver, pry out the 4 nozzle holder seals.



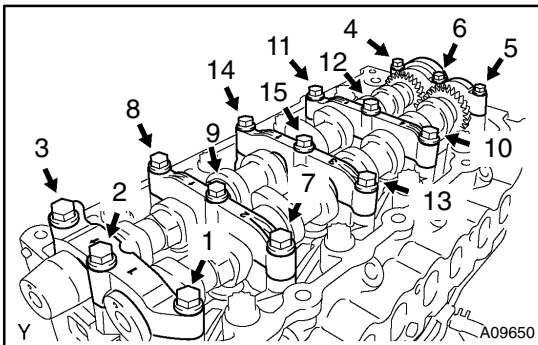
- (b) Remove the 10 bolts, cylinder head cover and gasket.

**24. REMOVE NOZZLE LEAKAGE PIPE**

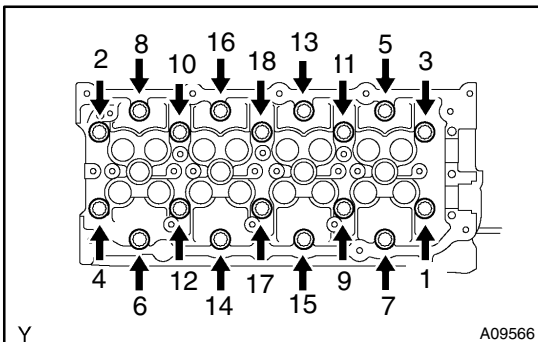
(See page FU-6)

**25. REMOVE INJECTORS (See page FU-6)****26. REMOVE CAMSHAFT OIL SEAL RETAINER**

- (a) Remove the 4 bolts.  
(b) Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and camshaft bearing cap.

**27. REMOVE CAMSHAFTS**

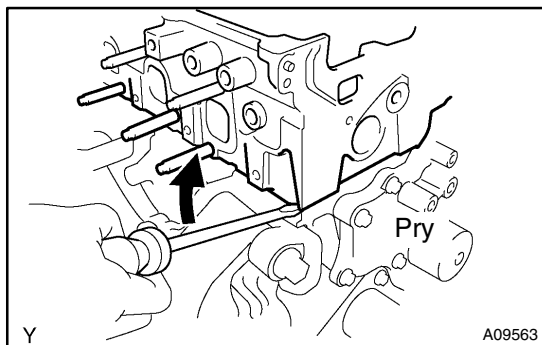
- (a) Uniformly loosen and remove the 15 bearing cap bolts in several passes and in the sequence shown.  
(b) Remove the 5 bearing caps, 2 camshafts and camshaft carrier.

**28. REMOVE CYLINDER HEAD**

- (a) Uniformly loosen the 18 cylinder head bolts in several passes and in the sequence shown. Remove the 18 cylinder head bolts and plate washers.

**NOTICE:**

**Cylinder 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 cylinder head on wooden blocks on a bench.

**HINT:**

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

**NOTICE:**

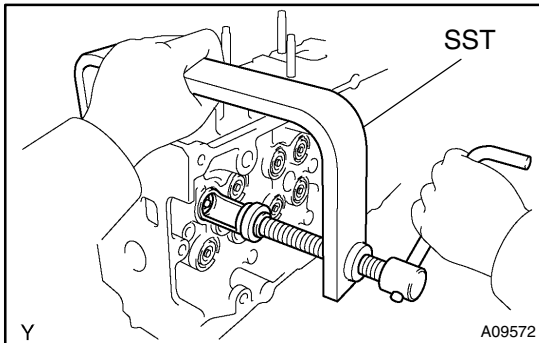
**Be careful not to damage the contact surfaces of the cylinder head and cylinder block.**

## DISASSEMBLY

### 1. REMOVE VALVE LIFTERS

HINT:

Arrange the valve lifters in the correct order.

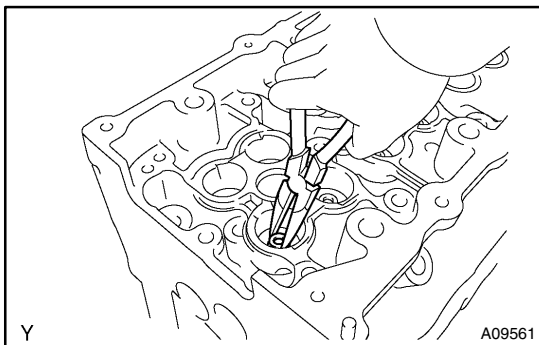


### 2. REMOVE VALVES

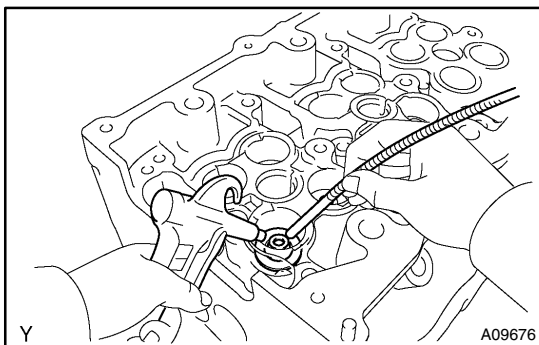
- (a) Using SST, compress the valve spring and remove the 2 keepers.

SST 09202-70020 (09202-00010)

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



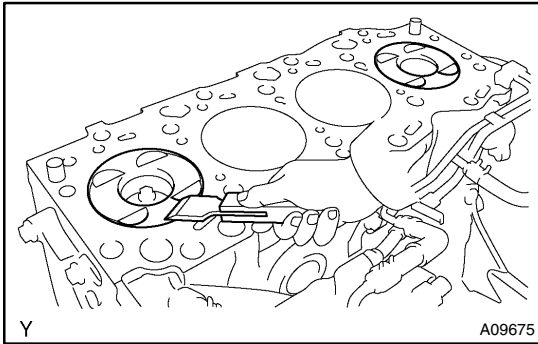
- (c) Using needle-nose pliers, remove the oil seal.



- (d) Using compressed air and a magnetic finger, remove the spring seat by blowing air.

HINT:

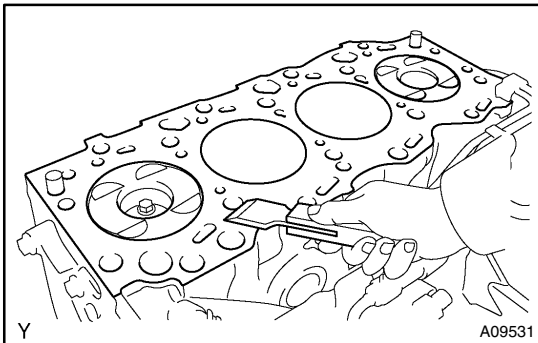
Arrange the valves, valve springs, spring seats and spring retainers in the correct order.



## INSPECTION

### 1. CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK

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



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

#### NOTICE:

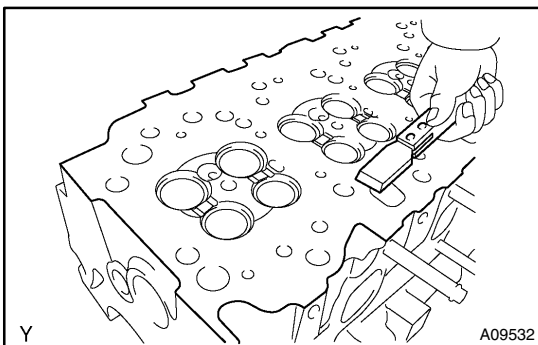
**Be careful not to scratch the cylinder head contact surface.**

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

#### CAUTION:

**Protect your eyes when using high-pressure compressed air.**

### 2. INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS (See page EM-64)

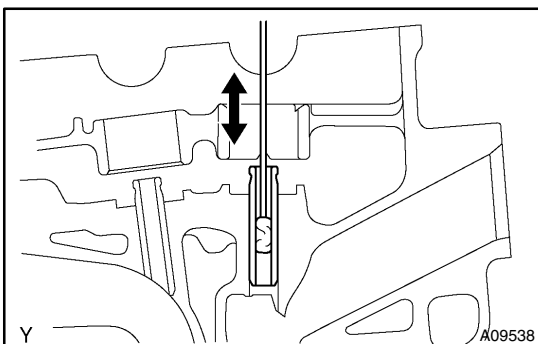


### 3. CLEAN CYLINDER HEAD

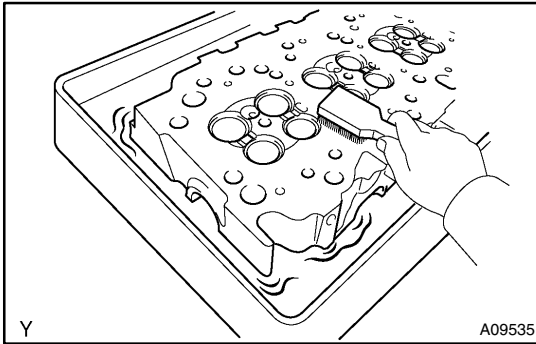
- (a) Using a gasket scraper, remove all the gasket material from the contact surface of the cylinder block.

#### NOTICE:

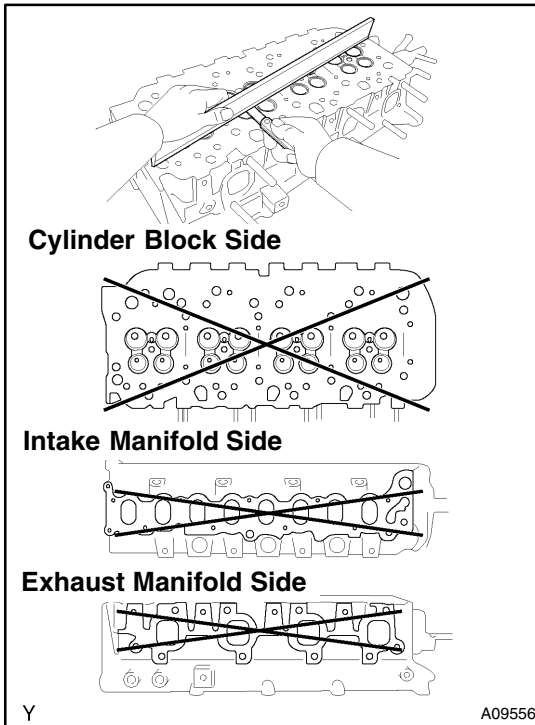
**Be careful not to scratch the cylinder block contact surface.**



- (b) Using a valve guide bushing brush and solvent, clean all the guide bushings.



- (c) Using a soft brush and solvent, thoroughly clean the cylinder head.



#### 4. INSPECT CYLINDER HEAD

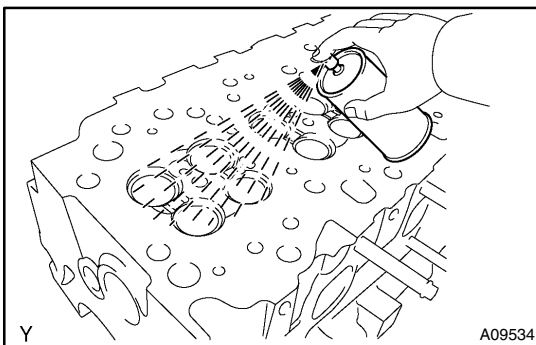
- (a) Inspect for flatness.  
Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

**Maximum warpage:**

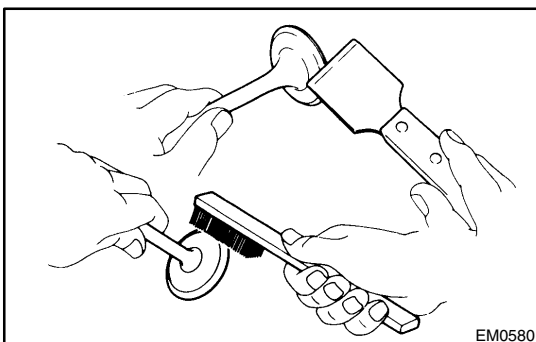
**0.08 mm (0.0031 in.) for cylinder block side**

**0.20 mm (0.0079 in.) for manifold side**

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

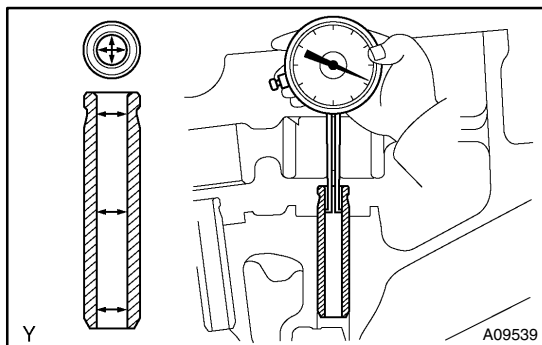


- (b) Inspect for cracks.  
Using a dye penetrant, check the intake ports, exhaust ports and cylinder block contact surface for cracks.  
If cracked, replace the cylinder head.



#### 5. CLEAN VALVES

- (a) Using a gasket scraper, chip off any carbon from the valve head.  
(b) Using a wire brush, thoroughly clean the valve.

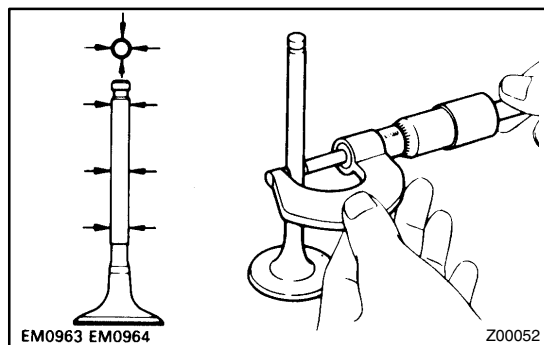


## 6. INSPECT VALVE STEMS AND GUIDE BUSHINGS

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

**Bushing inside diameter:**

**6.010 – 6.030 mm (0.2366 – 0.2374 in.)**



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

**Valve stem diameter:**

|         |                                        |
|---------|----------------------------------------|
| Intake  | 5.970 – 5.985 mm (0.1957 – 0.1963 in.) |
| Exhaust | 5.960 – 5.975 mm (0.2346 – 0.2352 in.) |

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

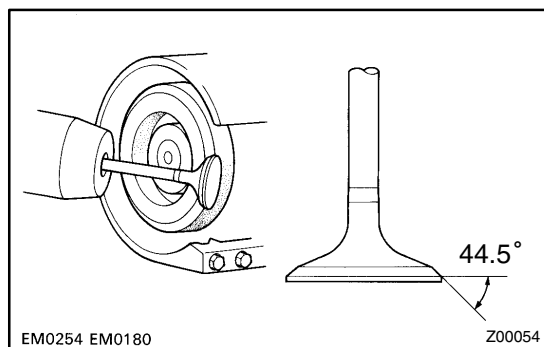
**Standard oil clearance:**

|         |                                        |
|---------|----------------------------------------|
| 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.) |

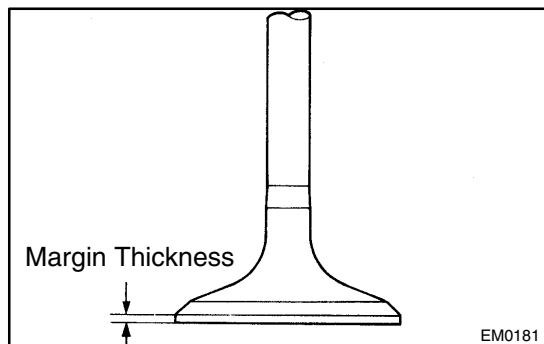
If the clearance is greater than maximum, replace the valve and guide bushing. (See page EM-42)



## 7. 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°**

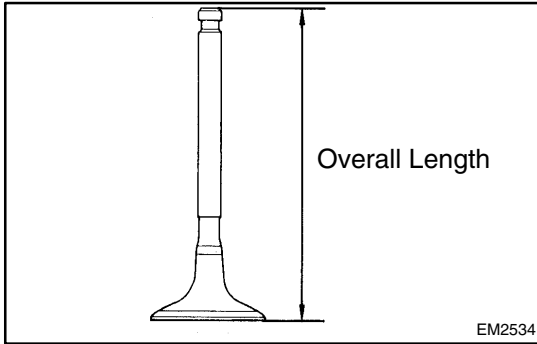


- (c) Check the valve head margin thickness.

**Standard margin thickness: 0.9 mm (0.035 in.)**

**Minimum margin thickness: 0.6 mm (0.024 in.)**

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



- (d) Check the valve overall length.

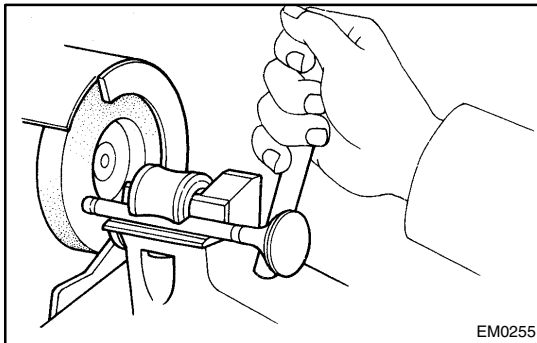
**Standard overall length:**

|         |                        |
|---------|------------------------|
| Intake  | 102.53 mm (4.0366 in.) |
| Exhaust | 101.97 mm (4.0146 in.) |

**Minimum overall length:**

|         |                         |
|---------|-------------------------|
| Intake  | 102.10 mm (4.0197 in.)  |
| Exhaust | 101.55 mm (3.99801 in.) |

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

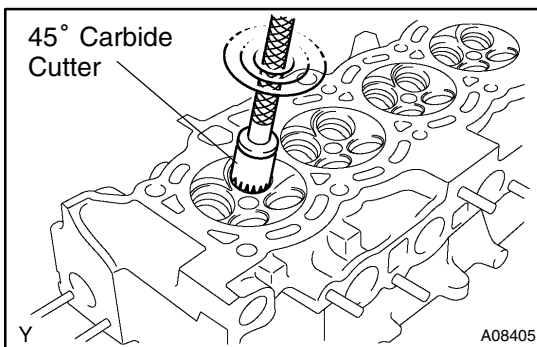


- (e) Check the surface of the valve stem tip for wear.

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

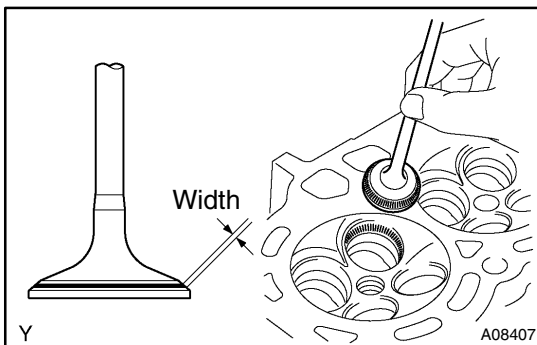
**NOTICE:**

**Do not grind off more than the minimum length.**



**8. INSPECT AND CLEAN VALVE SEATS**

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



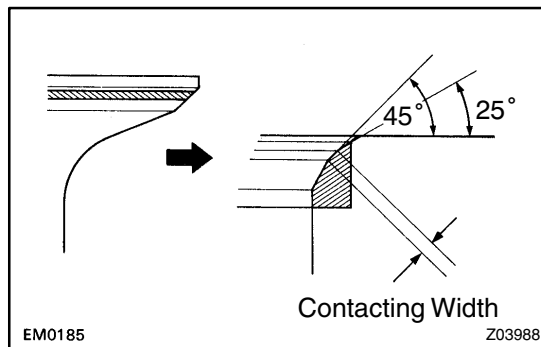
- (b) Check the valve seating position.

Apply a 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:

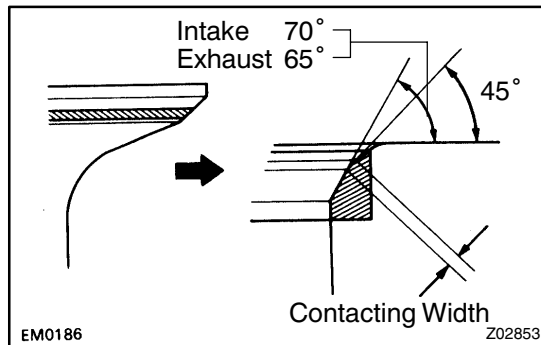
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is in the middle of the valve face with the following width:

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

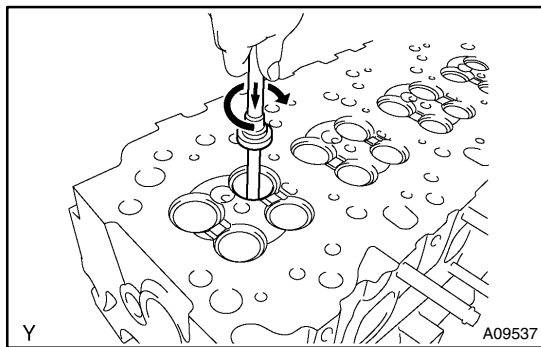


If not, correct the valve seats as follows:

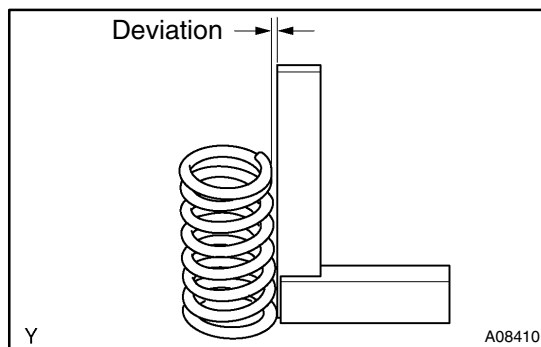
- (1) If the seating is too high on the valve face, use 25° and 45° cutters to correct the seat.



- (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 65° and 45° cutters to correct the seat.



- (d) Hand-lap the valve and valve seat with an abrasive compound.
- (e) After hand-lapping, clean the valve and valve seat.

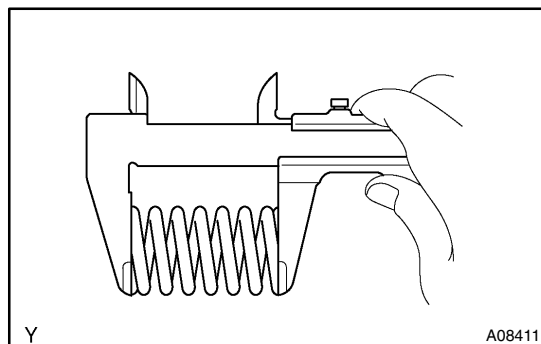


## 9. INSPECT VALVE SPRINGS

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

**Maximum deviation: 2.0 mm (0.079 in.)**

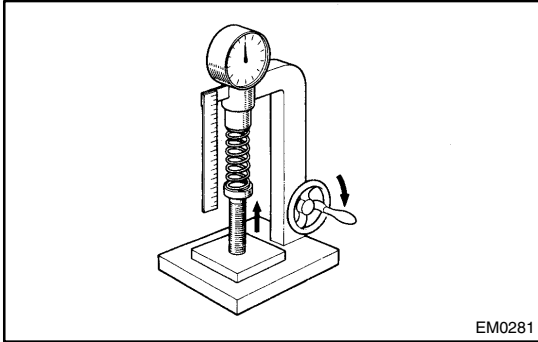
If the deviation is greater than maximum, replace the valve spring.



- (b) Using a vernier caliper, measure the free length of the valve spring.

**Free length: 40.45 mm (1.5925 in.)**

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



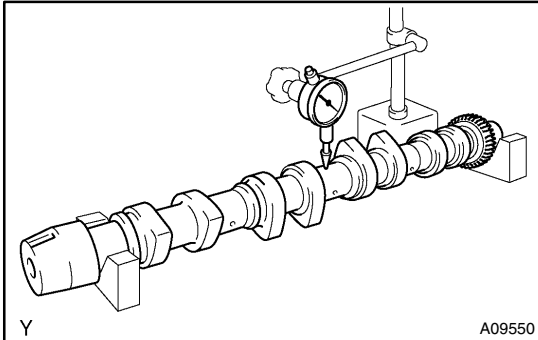
- (c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

**Installed tension:**

**177 – 195 N (18.0 – 19.9 kgf, 39.7 – 44.1 lbf)**

**at 31.1 mm (1.224 in.)**

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



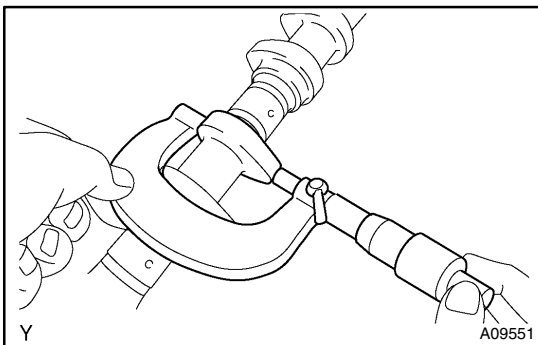
## 10. INSPECT CAMSHAFTS

- (a) Inspect the circle runout.

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

**Maximum circle runout: 0.06 mm (0.0024 in.)**

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



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

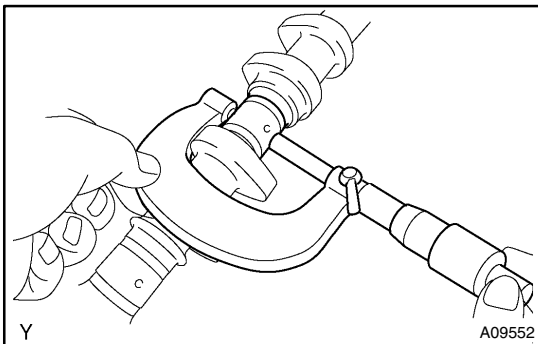
**Standard cam lobe height:**

|         |                                        |
|---------|----------------------------------------|
| Intake  | 46.57 – 46.67 mm (1.8335 – 1.8374 in.) |
| Exhaust | 47.52 – 47.62 mm (1.8709 – 1.8748 in.) |

**Minimum cam lobe height:**

|         |                       |
|---------|-----------------------|
| Intake  | 46.10 mm (1.8150 in.) |
| Exhaust | 47.05 mm (1.8524 in.) |

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

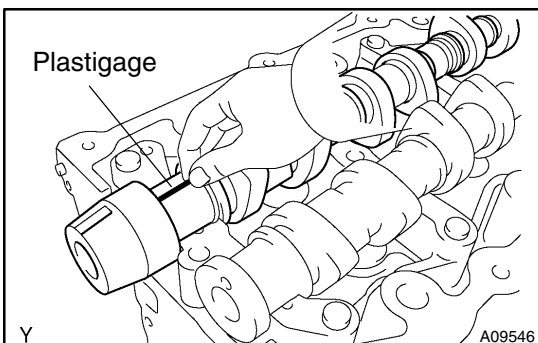


- (c) Using a micrometer, measure the journal diameter.

**Journal diameter:**

**26.969 – 26.985 mm (1.0618 – 1.0624 in.)**

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

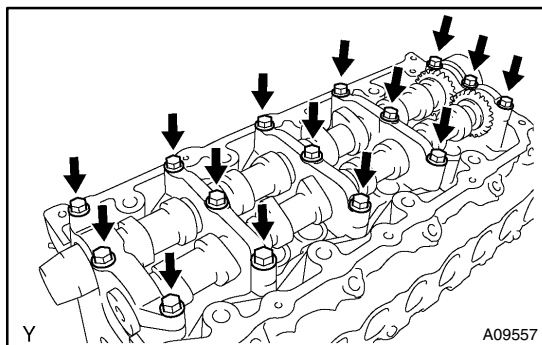


- (d) Inspect the journal oil clearance.

- (1) Clean the bearing caps and camshaft carrier.
- (2) Check that bearings for flaking and scoring.

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

- (3) Place the camshaft carrier and camshafts on the cylinder head.
- (4) Lay a strip of Plastigage across each of the camshaft journals.

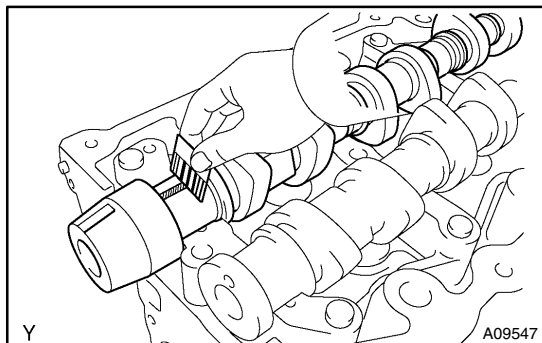


- (5) Install the bearing caps. (See page EM-46)

**NOTICE:**

**Do not turn the camshaft.**

- (6) Remove the bearing caps.



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

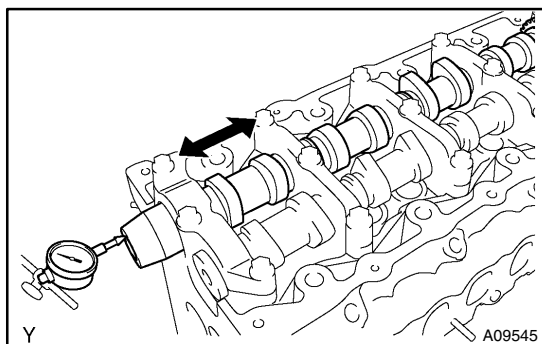
**Standard oil clearance:**

**0.025 – 0.062 mm (0.0010 – 0.0024 in.)**

**Maximum oil clearance: 0.08 mm (0.0031 in.)**

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

- (8) Completely remove the Plastigage.



- (e) Inspect the camshaft thrust clearance.

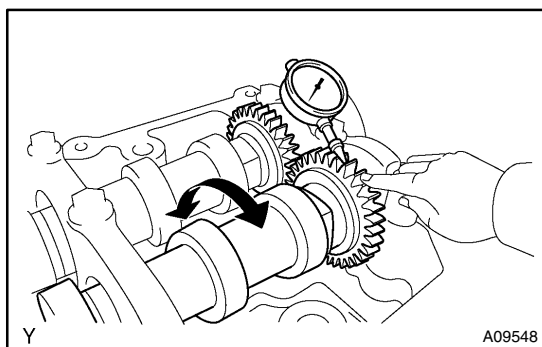
- (1) Install the camshaft. (See page EM-46)

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

**Standard thrust clearance:**

**0.035 – 0.110 mm (0.0014 – 0.0043 in.)**

If the thrust clearance is not as specified, replace the camshaft. If necessary, replace the bearing caps, camshaft carrier and cylinder head as a set.



- (f) Inspect the camshaft gear backlash.

- (1) Install the camshafts. (See page EM-46)

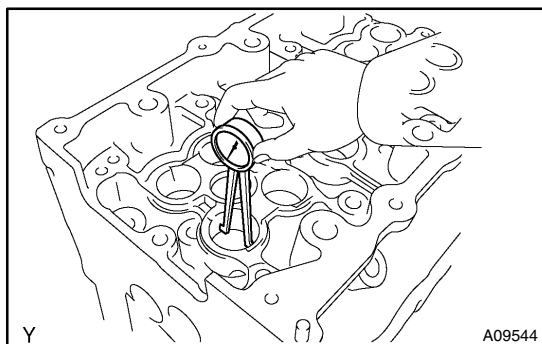
- (2) Using a dial indicator, measure the backlash.

**Standard backlash:**

**0.014 – 0.070 mm (0.0006 – 0.0028 in.)**

**Maximum backlash: 0.17 mm (0.0067 in.)**

If the backlash is greater than maximum, replace the camshafts.

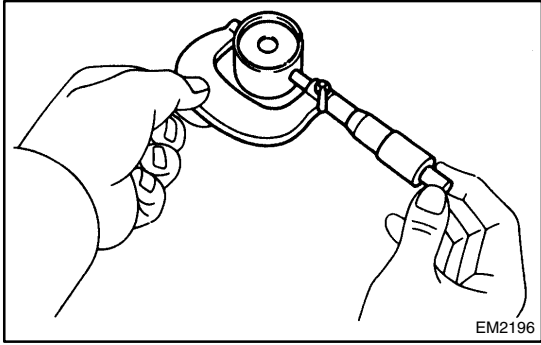


## 11. INSPECT VALVE LIFTERS AND LIFTER BORES

- (a) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

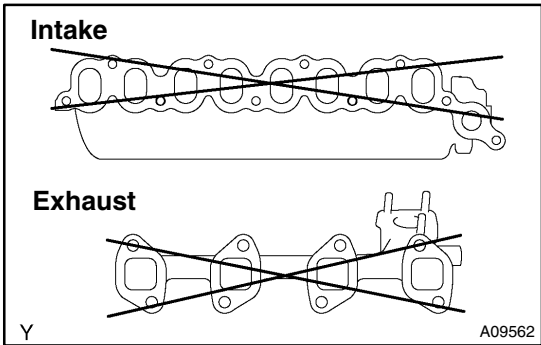
**Lifter bore diameter:**

**28.010 – 28.031 mm (1.1028 – 1.1036 in.)**



- (b) Using a micrometer, measure the lifter diameter.  
**Lifter diameter:**  
**27.975 – 27.985 mm (1.1014 – 1.1018 in.)**
- (c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.  
**Standard oil clearance:**  
**0.025 – 0.056 mm (0.0010 – 0.0022 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.



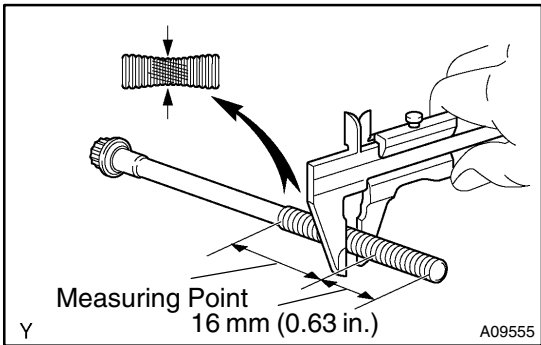
## 12. INSPECT MANIFOLDS

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

**Maximum warpage:**

|         |                     |
|---------|---------------------|
| Intake  | 0.1 mm (0.0039 in.) |
| Exhaust | 0.4 mm (0.0157 in.) |

If warpage is greater than maximum, replace the manifold.



## 13. INSPECT CYLINDER HEAD BOLTS

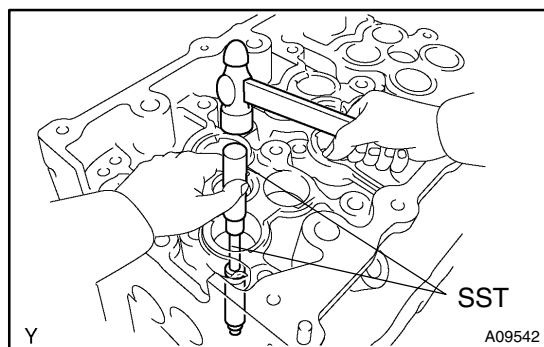
Using vernier calipers, measure the tension portion diameter of the bolt.

**Standard outside diameter:**

**10.75 – 11.00 mm (0.4232 – 0.4331 in.)**

**Minimum outside diameter: 10.40 mm (0.4094 in.)**

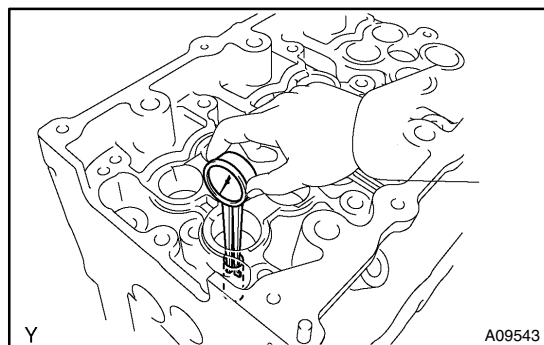
If the diameter is less than minimum, replace the bolt.



## 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 the cylinder head.

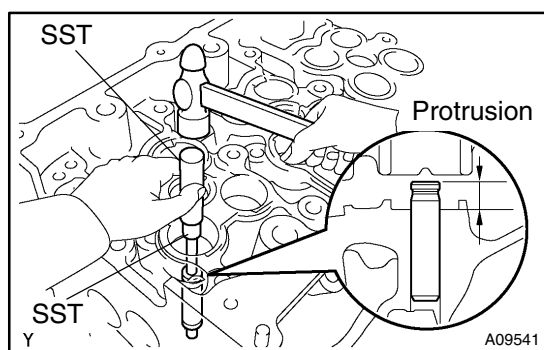
Both intake and exhaust

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

- (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 dimensions:

**11.035 – 11.056 mm (0.4344 – 0.4353 in.)**

- If the bushing bore diameter of the cylinder head is greater than 11.056 mm (0.4353 in.), replace the cylinder head.

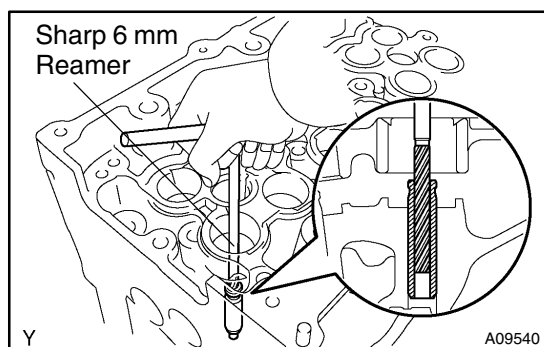


- (d) Using SST and a hammer, tap in a new guide bushing to the specified protrusion height.

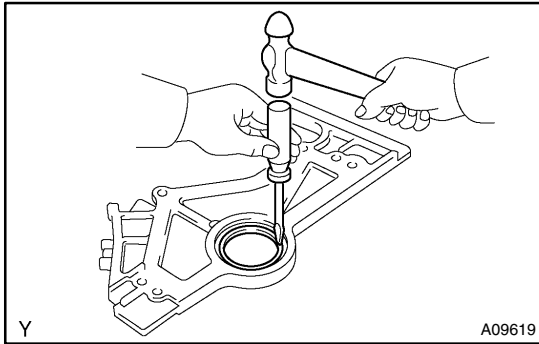
**Protrusion height:**

|         |                                        |
|---------|----------------------------------------|
| Intake  | 10.05 – 10.45 mm (0.3957 – 0.4114 in.) |
| Exhaust | 9.65 – 10.05 mm (0.3799 – 0.3957 in.)  |

SST 09201-10000 (09201-01060),  
 09950-70010 (09951-07100)



- (e) Using a sharp 6 mm reamer, ream the guide bushing to obtain the specified standard clearance (See page EM-34) between the guide bushing and valve stem.



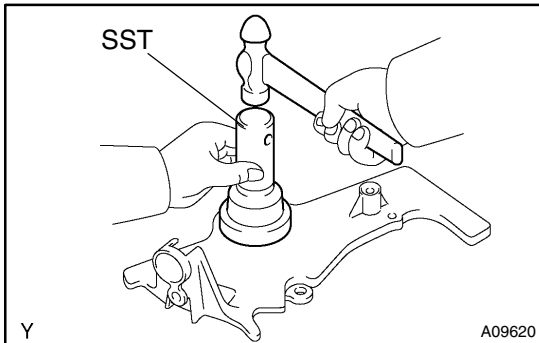
## 2. REPLACE CAMSHAFT OIL SEAL

### HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

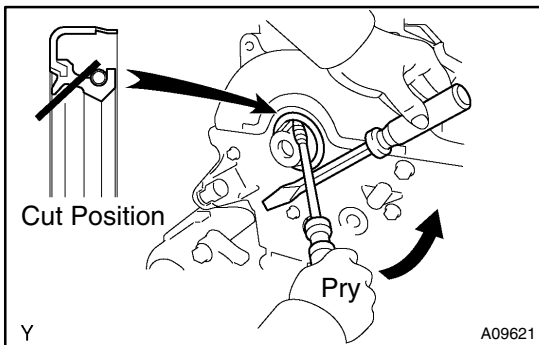
- (a) If the camshaft oil seal retainer is removed from the cylinder head:

- (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 camshaft oil seal retainer edge.

SST 09223-46011

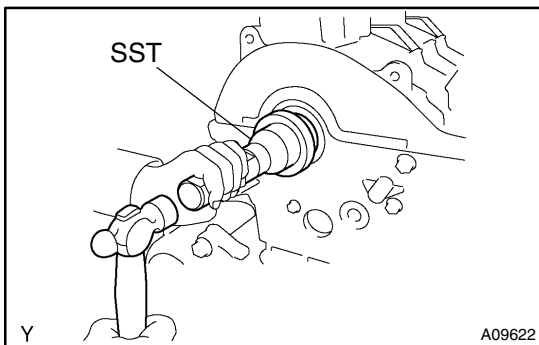


- (b) If the camshaft oil seal retainer is installed to the cylinder head:

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

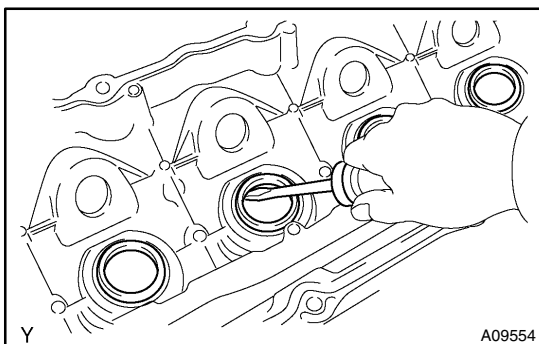
### NOTICE:

**Be careful not to damage the camshaft. Tape the screwdriver tip.**



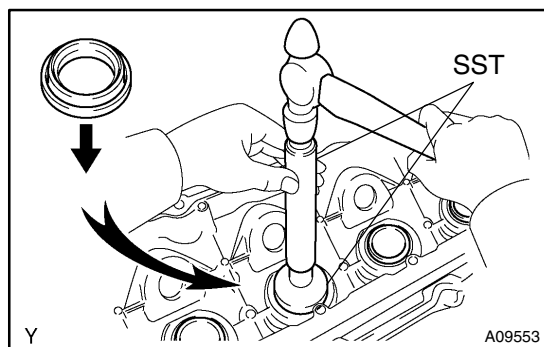
- (3) Using SST and a hammer, tap in a new oil seal until its surface is flush with the camshaft oil seal retainer edge.

SST 09223-46011



## 3. 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.

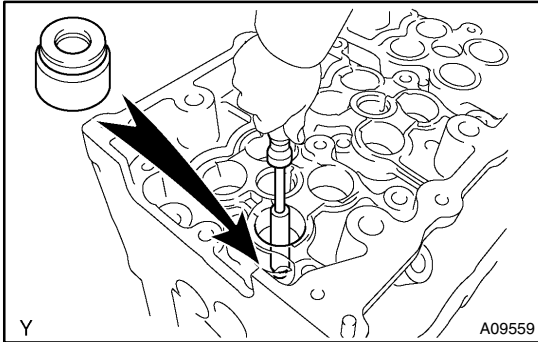
## REASSEMBLY

### HINT:

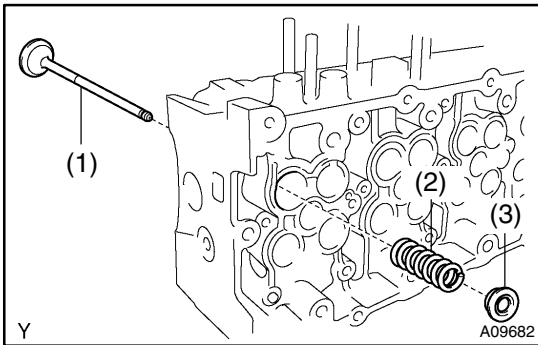
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

### 1. INSTALL VALVES

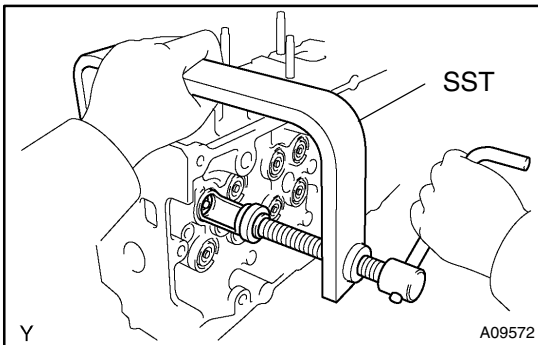
- (a) Install the spring seat.



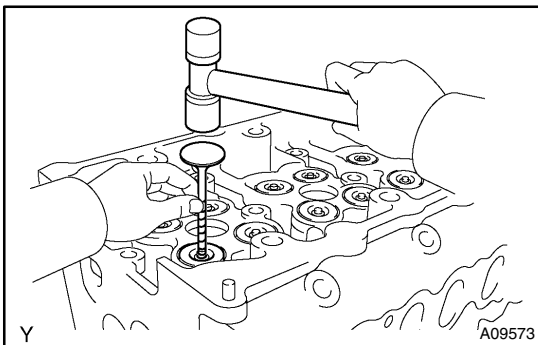
- (b) Install a new oil seal on the valve guide bushing.



- (c) Install the valve (1), valve spring (2) and spring retainer (3).



- (d) Using SST, compress the valve spring and place the 2 keepers around the valve stem.  
SST 09202-70020 (09202-00010)



- (e) Using a plastic-faced hammer and the valve stem (not in use) tip wound with vinyl tape, lightly tap the valve stem tip to assure proper fit.

### NOTICE:

**Be careful not to damage the valve stem tip.**

### 2. INSTALL VALVE LIFTERS

- (a) Install the valve lifter.  
(b) Check that the valve lifter rotates smoothly by hand.

## INSTALLATION

### NOTICE:

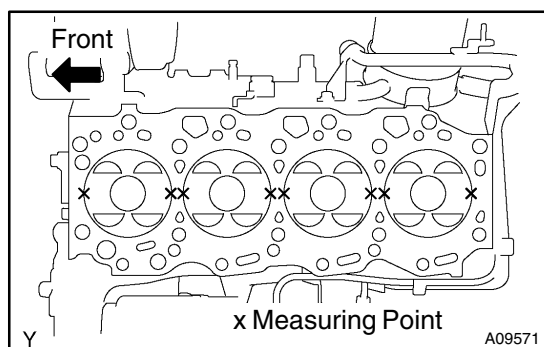
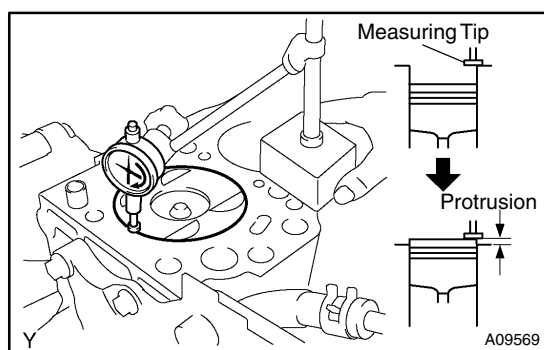
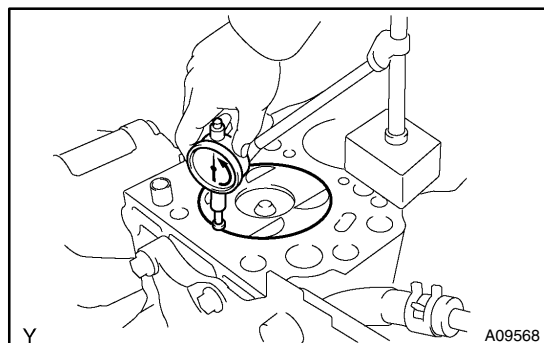
- In case of having the cylinder head and/or common rail and/or injectors replaced, must replace injection pipes, too.
- In case of having the cylinder head and/or cylinder block and/or common rail replaced, must replace fuel inlet pipe, too.
- In case of having the size of the cylinder head gasket changed also, must change the fuel inlet pipe.

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

- (a) Check piston protrusions for each cylinder.
- (1) Clean the cylinder block with solvent.
  - (2) Set 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 as shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.

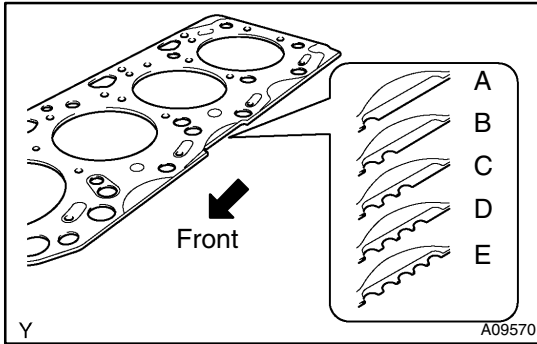


- (4) Find where the piston head protrudes most by slowly turning the crankshaft clockwise and counter-clockwise.
- (5) Measure each cylinder at 2 places as shown in the illustration, marking a total of 8 measurements.
- (6) For the piston protrusion value of each cylinder, use the average of the 2 measurements of each cylinder.

**Protrusion: 0.165 – 0.425 mm (0.0065 – 0.0168 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. (See page EM-56)



(b) Select new cylinder head gasket.

HINT:

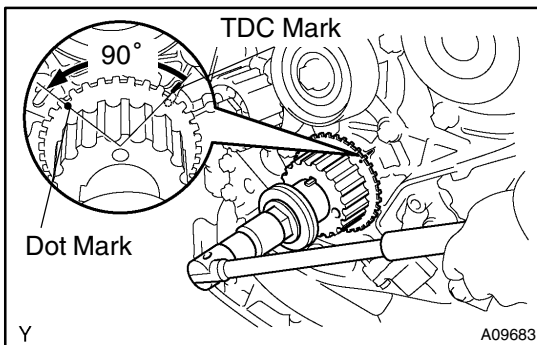
There are 5 sizes of new cylinder head gaskets, marked "A", "B", "C", "D" or "E" according.

**New installed cylinder head gasket thickness:**

|   |                                      |
|---|--------------------------------------|
| A | 0.85 – 0.95 mm (0.0335 – 0.0374 in.) |
| B | 0.90 – 1.00 mm (0.0354 – 0.0394 in.) |
| C | 0.95 – 1.05 mm (0.0374 – 0.0413 in.) |
| D | 1.00 – 1.10 mm (0.0394 – 0.0433 in.) |
| E | 1.05 – 1.15 mm (0.0413 – 0.0453 in.) |

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

| Piston protrusion mm (in.)      | Gasket size |
|---------------------------------|-------------|
| 0.165 – 0.220 (0.0065 – 0.0087) | Use A       |
| 0.220 – 0.270 (0.0087 – 0.0106) | Use B       |
| 0.270 – 0.320 (0.0106 – 0.0126) | Use C       |
| 0.320 – 0.370 (0.0126 – 0.0146) | Use D       |
| 0.370 – 0.425 (0.0146 – 0.0167) | Use E       |

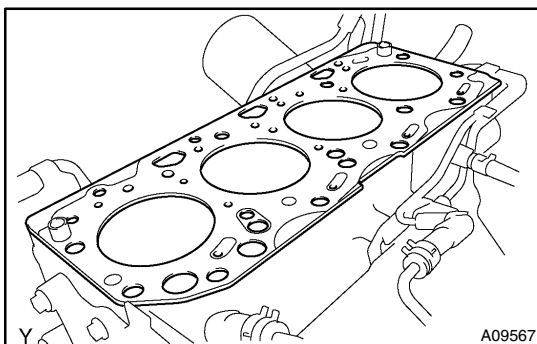


## 2. SET NO.1 CYLINDER TO APPROX. 90° BTDC/COMPRESSION

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.**



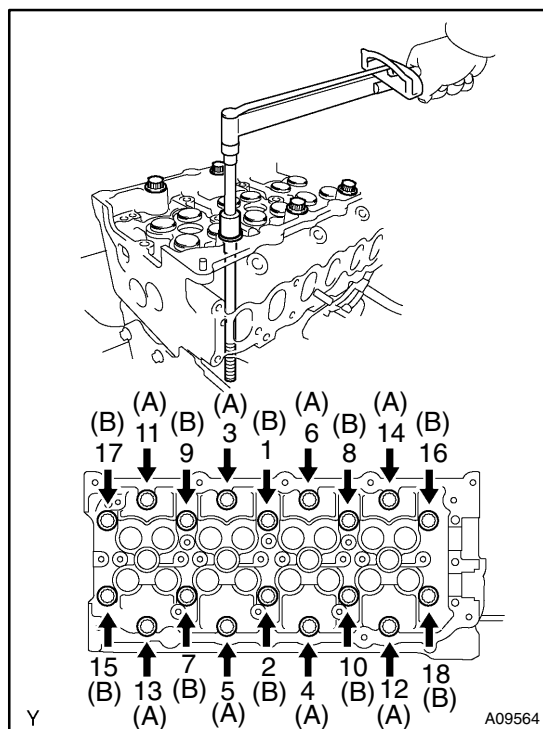
## 3. PLACE CYLINDER HEAD ON CYLINDER BLOCK

(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 4 progressive steps (steps (c) , (e), (f) and (g)).
  - If any cylinder head bolt 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 and plate washers.
  - (b) Install the plate washer to the cylinder head bolt.
  - (c) Install and uniformly tighten the 18 cylinder head bolts and plate washers in several passes and in the sequence shown.

**Torque: 45 N·m (460 kgf·cm, 33 ft·lbf)**

##### HINT:

Each bolt length is indicated in the illustration.

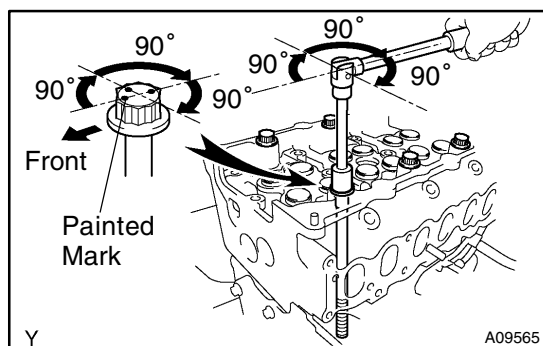
##### Bolt length:

**(A) 160 mm (6.30 in.)**

**(B) 104 mm (4.09 in.)**

If any of the cylinder head bolt does not meet the torque specification, replace the cylinder head bolt.

- (d) Mark the front of the cylinder head bolt with paint.
- (e) Retighten the cylinder head bolts by 90° in the numerical order shown first.
- (f) Retighten the cylinder head bolts by 90° in the numerical order shown secondary.
- (g) Retighten the cylinder head bolts by additional 90° in the numerical order shown third.
- (h) Check that the painted mark is at the intake manifold side now.

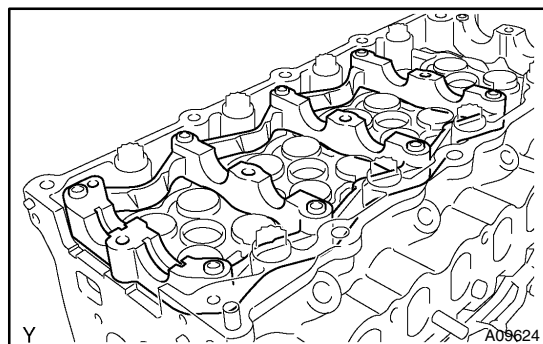


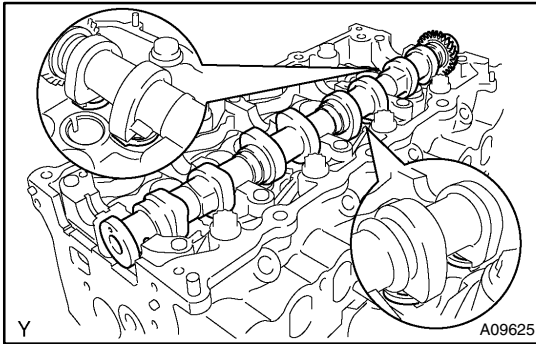
#### 5. INSTALL CAMSHAFTS

##### NOTICE:

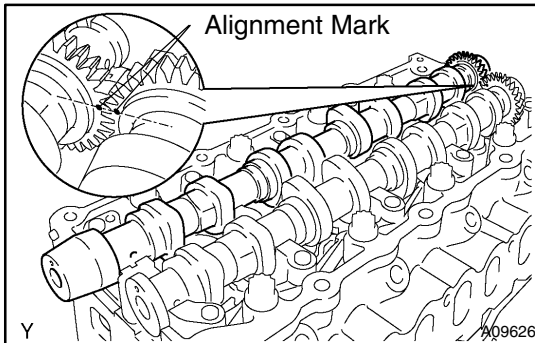
Since the thrust clearance of the camshaft is small, the camshaft must be kept leveled while it is being installed. If the camshaft is not kept leveled, the portion of the cylinder head receiving the shaft thrust may crack or be damaged, causing the camshaft to seize or break. To avoid this, the following steps should be carried out.

- (a) Place the camshaft carrier in position on the cylinder head.

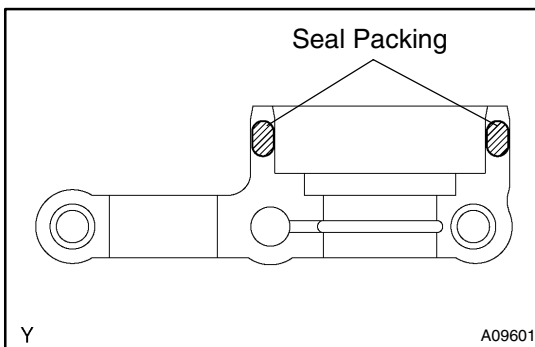




- (b) Install the intake camshaft.
- (1) Apply engine oil to the cam and gear of the camshaft, and the journal of the camshaft carrier.
  - (2) Place the intake camshaft on top of the camshaft carrier as shown in the illustration so that the No.3 and No.4 of cylinder cam lobes face downward.

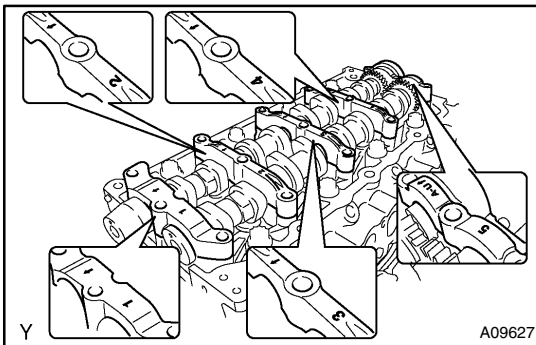


- (c) Install the exhaust camshaft.
- (1) Apply engine oil to the cam and gear of the camshaft, and the journal of the camshaft carrier.
  - (2) Engage the exhaust camshaft gear to the intake camshaft gear by matching the alignment marks on each gear.
  - (3) Roll down the exhaust camshaft onto the bearing journals while engaging gears with each other.

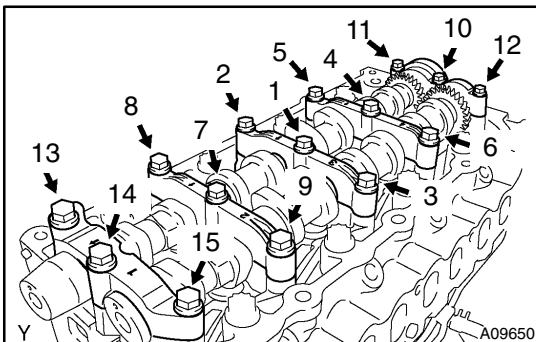


- (d) Install the camshaft bearing caps.
- (1) Remove any old packing (FIPG) material from the No.5 camshaft bearing cap.
  - (2) Apply a seal packing to the No.5 camshaft bearing cap as shown in the illustration.

**Seal packing: Part No. 08826-00080 or equivalent**



- (3) Place the 5 bearing caps in their proper locations.



- (4) Install and uniformly tighten the 15 bearing cap bolts in several passes and in the sequence shown.

**Torque: 20 N·m (200 kgf·cm, 15 ft·lbf)**

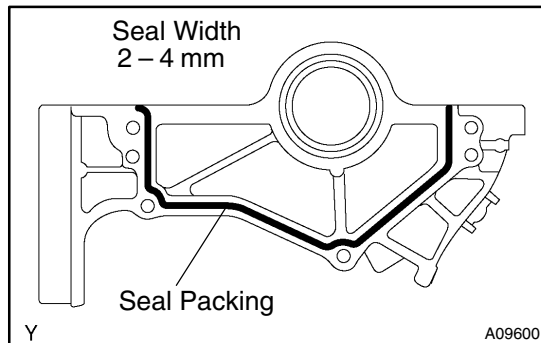
## 6. CHECK AND ADJUST VALVE CLEARANCE

(See page EM-5)

## 7. INSTALL CAMSHAFT OIL SEAL RETAINER

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

- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.



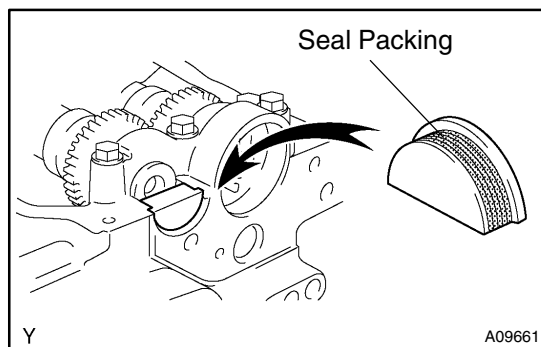
- (b) Apply seal packing to the oil seal retainer as shown in the illustration.

**Seal packing: Part No. 08826-00080 or equivalent**

- Install a nozzle that has been cut to a 2 – 4 mm (0.08 – 0.16 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

- (c) Install the oil seal retainer with the 4 bolts. Uniformly tighten the 4 bolts in several passes.

**Torque: 8.8 N·m (90 kgf·cm, 78 in.-lbf)**



**8. INSTALL SEMI-CIRCULAR PLUG**

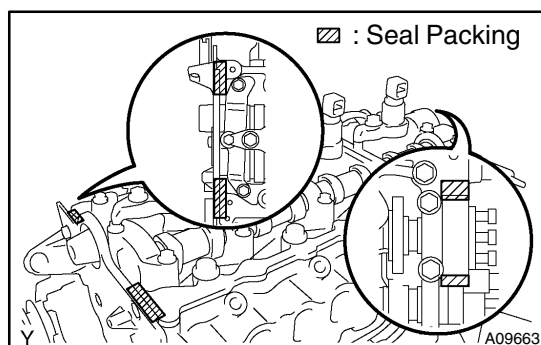
- (a) Remove any old packing (FIPG) material.  
 (b) Apply a seal packing to the semi-circular plug grooves.

**Seal packing: Part No. 08826-00080 or equivalent**

- (c) Install the semi-circular plug to the cylinder head.

**9. INSTALL INJECTORS (See page FU-8)**

**10. INSTALL NOZZLE LEAKAGE PIPE (See page FU-8)**



**11. INSTALL CYLINDER HEAD COVER**

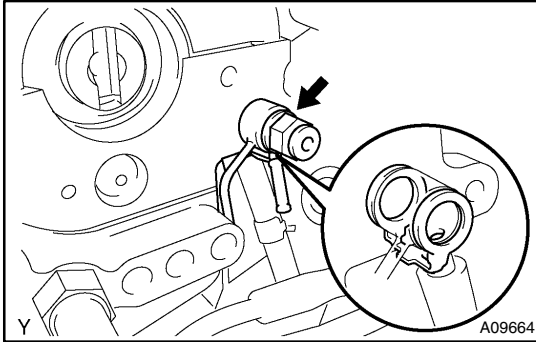
- (a) Remove any old packing (FIPG) material.  
 (b) Apply a seal packing to the cylinder head.

**Seal packing: Part No. 08826-00080 or equivalent**

- (c) Install the gasket to the head cover.  
 (d) Install the cylinder head cover with the 10 bolts.

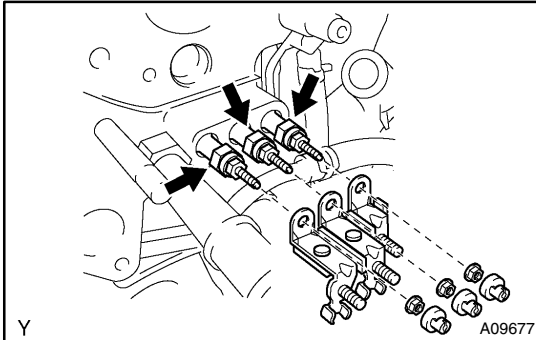
**Torque: 13.2 N·m (135 kgf·cm, 10 ft·lbf)**

- (e) Install new 4 nozzle holder seals.

**12. INSTALL NO.2 NOZZLE LEAKAGE PIPE**

Install a new gasket and the leakage pipe with the check valve.

**Torque: 21 N·m (215 kgf·cm, 15 ft·lbf)**

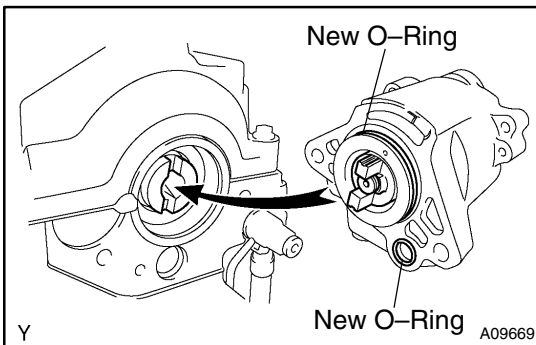
**13. CONNECT FUEL HOSE AND NO.2 OIL COOLER HOSE****14. INSTALL GLOW PLUGS FOR POWER HEATER**

(a) Install the 3 glow plugs.

**Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)**

(b) Install the engine block heater bracket with the 3 nuts.

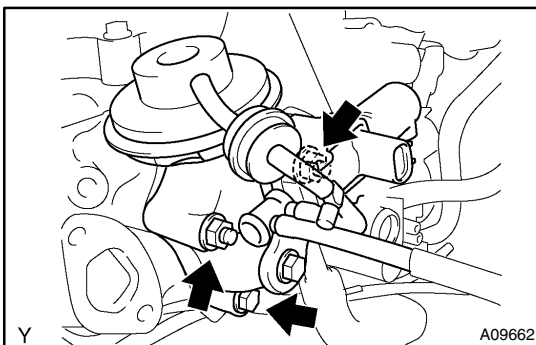
(c) Install the 3 caps.

**15. INSTALL VACUUM PUMP**

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

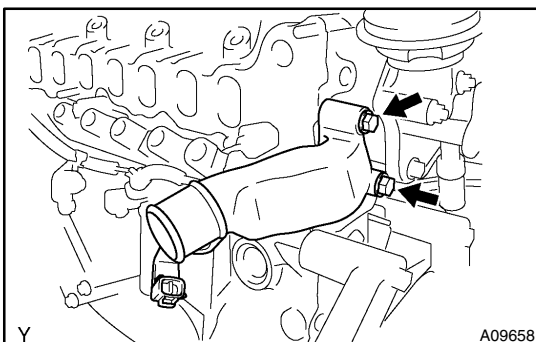
(b) Insert the vacuum pump, aligning the slit of the exhaust camshaft with the coupling of the vacuum pump. Install the 2 bolts.

**Torque: 28 N·m (280 kgf·cm, 20 ft·lbf)**

**16. INSTALL EGR VALVE**

Install a new gasket and the EGR valve with the bolt and 2 nuts.

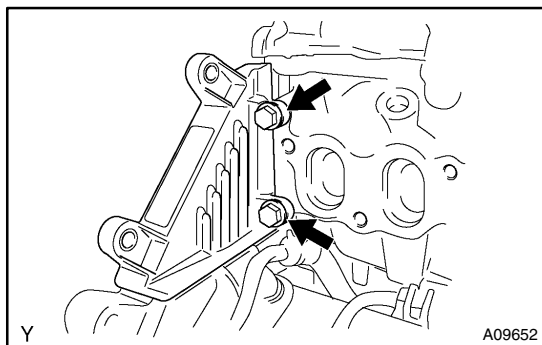
**Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)**

**17. INSTALL WATER TEMPERATURE SENSOR****18. TEMPORARILY INSTALL COMMON RAIL****19. INSTALL WATER OUTLET**

Install a new gasket and the water outlet with the 2 bolts.

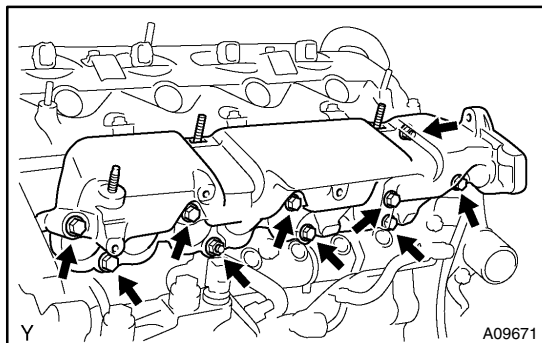
**Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)**

**20. INSTALL VENTILATION HOSE**

**21. INSTALL NO.3 TIMING BELT COVER**

Install the timing belt cover with the 2 bolts and 2 seal washers.

**Torque: 7.4 N·m (75 kgf·cm, 65 in.-lbf)**

**22. INSTALL INTAKE MANIFOLD**

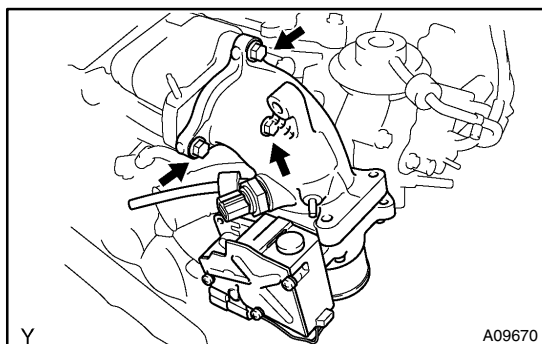
Install a new gasket and the intake manifold with the 8 bolts and 2 nuts.

**Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)**

**23. TIGHTEN COMMON RAIL SET BOLTS**

(See page FU-23)

**Torque: 43 N·m (440 kgf·cm, 32 ft·lbf)**

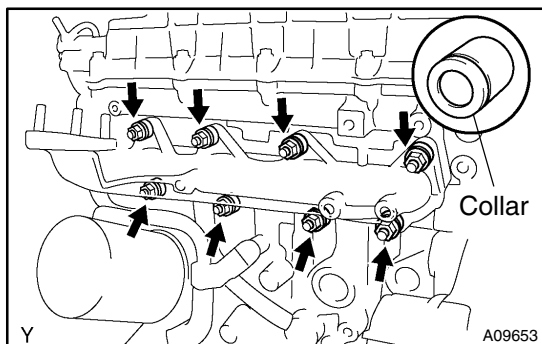
**24. INSTALL INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY**

Install a new gasket and the intake air connector with diesel throttle body with the 3 bolts.

**Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)**

**25. INSTALL INJECTION PIPES (See page FU-8)****26. INSTALL FUEL INLET PIPE (See page FU-8)****27. INSTALL SUPPLY PUMP INSULATOR**

(See page FU-18)

**28. INSTALL NO.2 ENGINE COVER****29. INSTALL CAMSHAFT POSITION SENSOR****30. INSTALL EXHAUST MANIFOLD**

Install the exhaust manifold with the 8 collars and 8 nuts.

**Torque: 46.5 N·m (475 kgf·cm, 34 ft·lbf)**

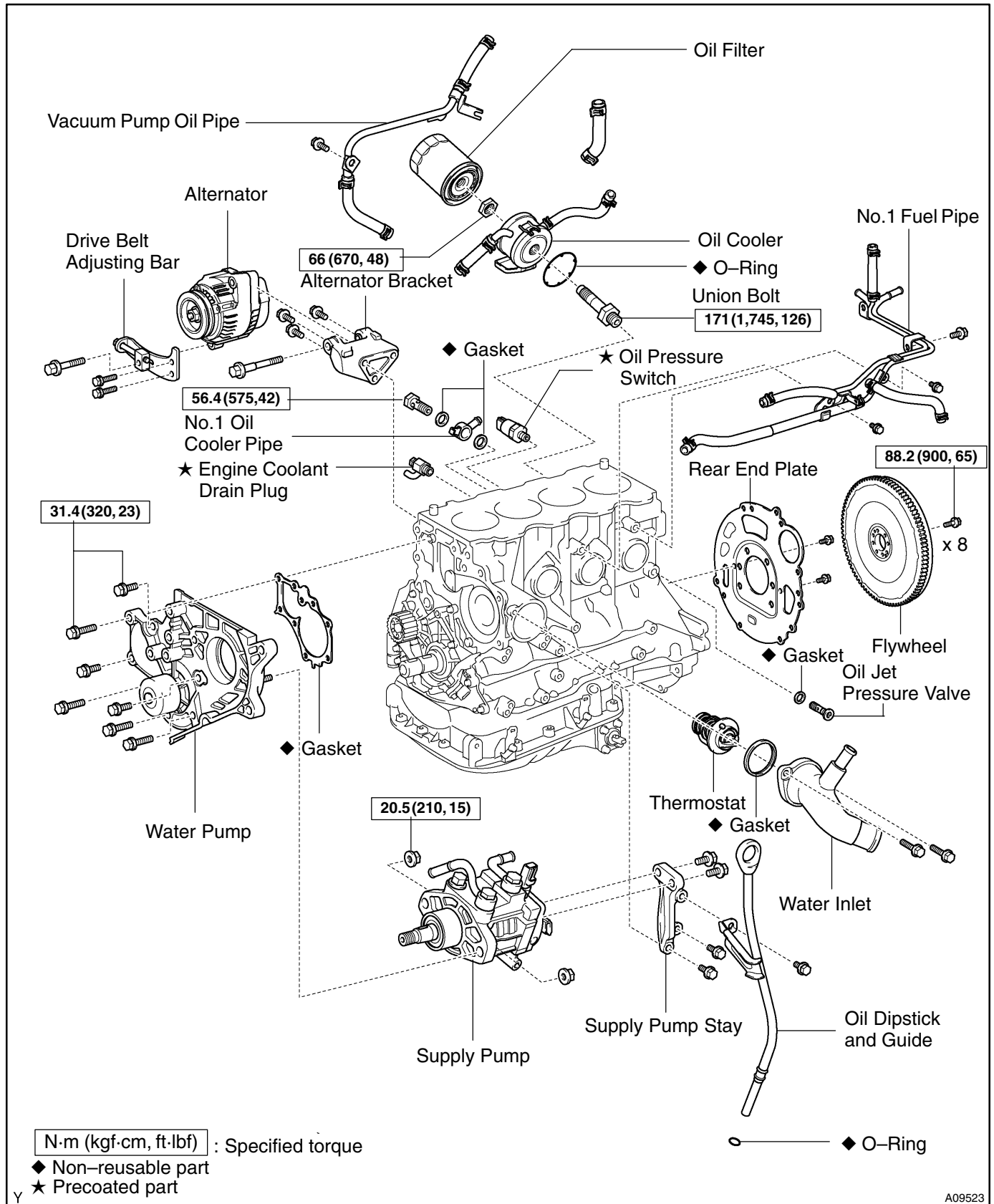
**31. INSTALL CAMSHAFT TIMING PULLEY**

(See page EM-18)

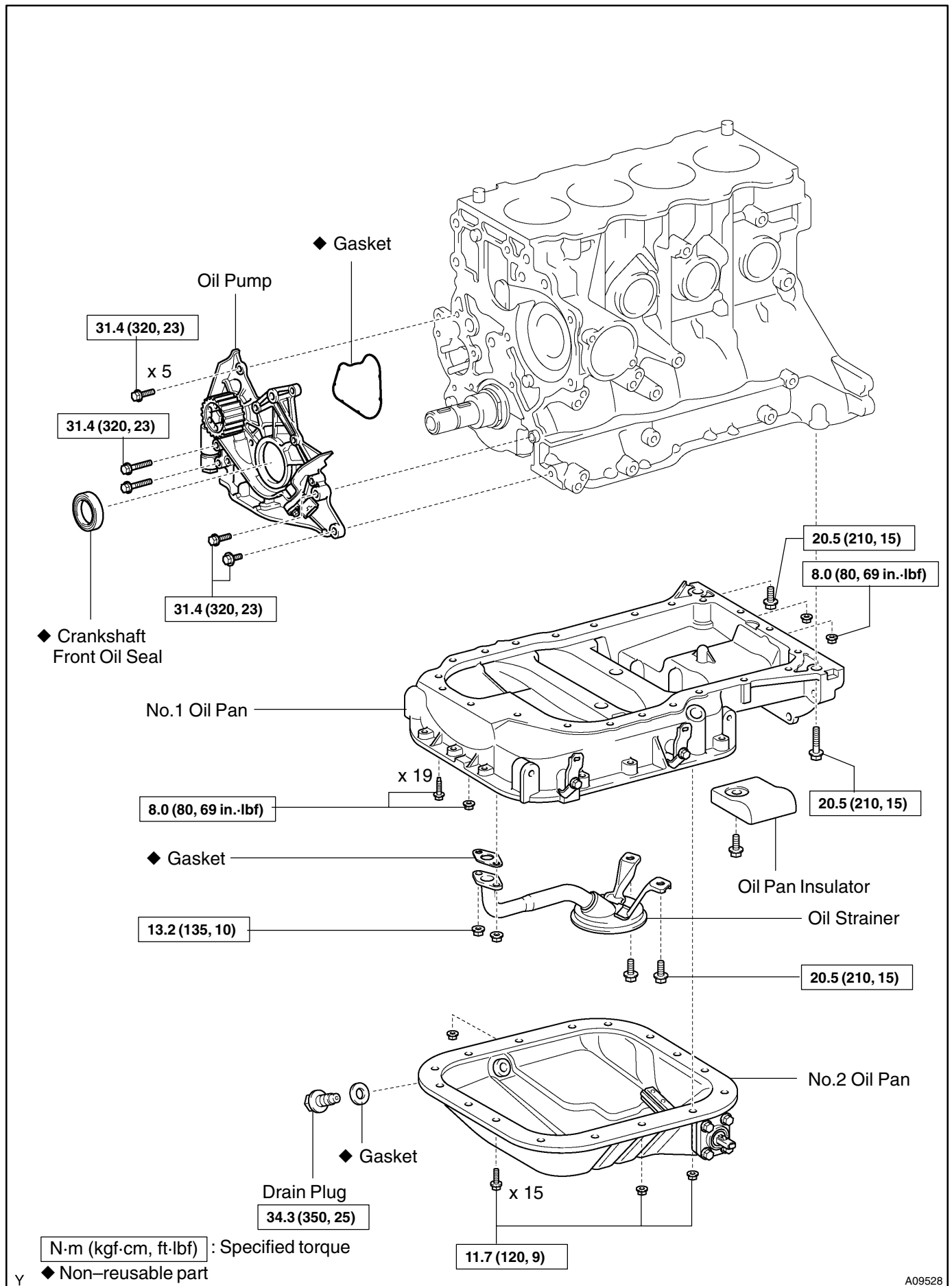
**32. INSTALL TIMING BELT (See page EM-18)****33. INSTALL TURBOCHARGER (See page TC-18)**

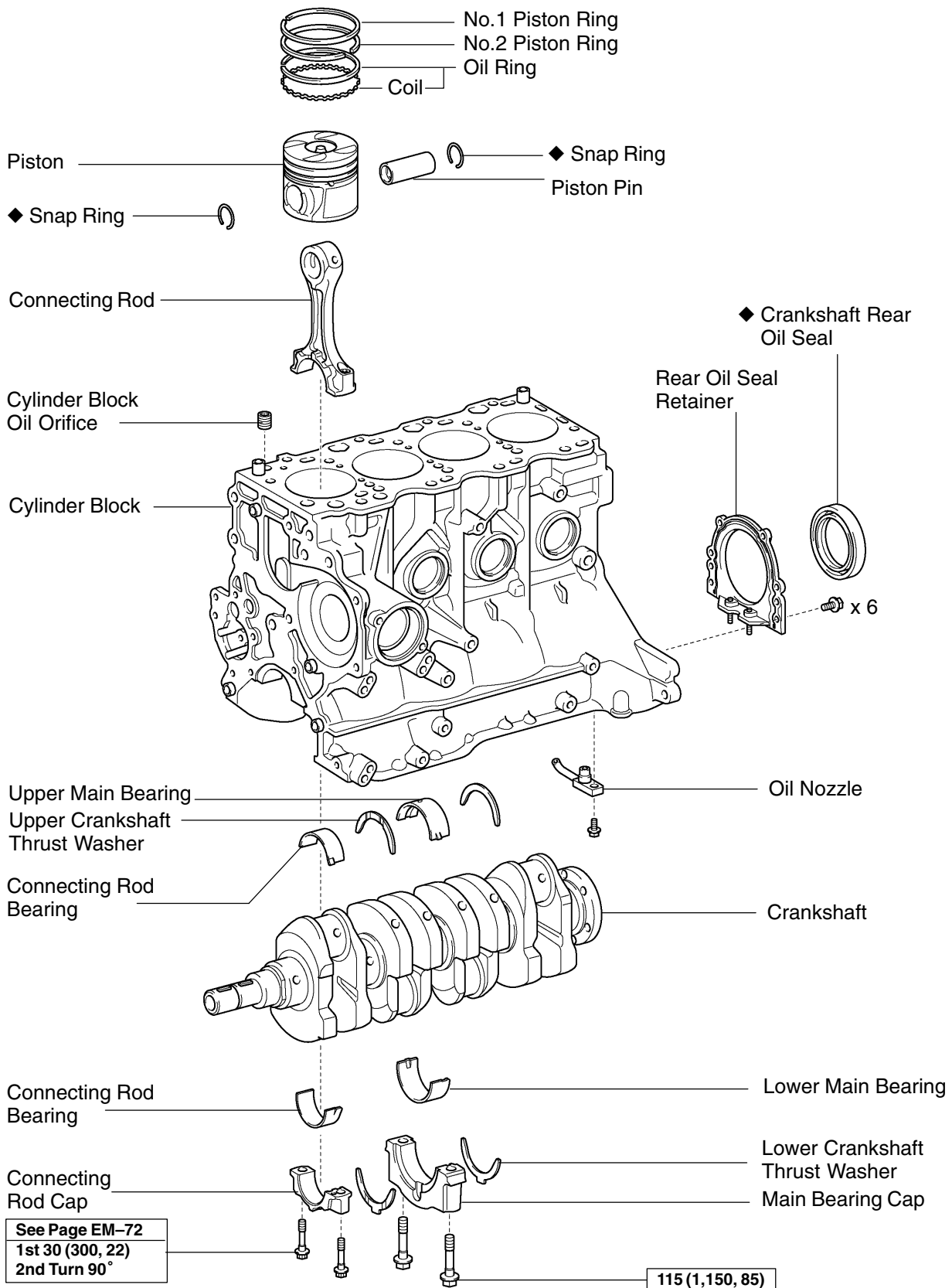
# CYLINDER BLOCK COMPONENTS

EM13H-01



A09523



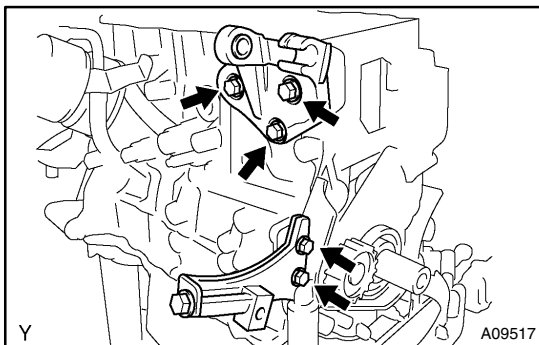


N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

## DISASSEMBLY

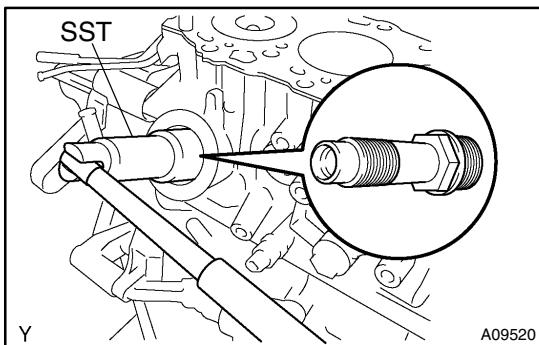
1. REMOVE FLYWHEEL
2. REMOVE REAR END PLATE
3. INSTALL ENGINE TO ENGINE STAND FOR DIS-  
ASSEMBLY
4. REMOVE TIMING BELT AND PULLEYS  
(See page EM-12)
5. REMOVE CYLINDER HEAD (See page EM-28)
6. REMOVE SUPPLY PUMP (See page FU-16)
7. REMOVE WATER PUMP (See page CO-6)
8. REMOVE WATER INLET AND THERMOSTAT  
(See page CO-10)
9. REMOVE ALTERNATOR



### 10. REMOVE ALTERNATOR BRACKET AND DRIVE BELT ADJUSTING BAR

- (a) Remove the 3 bolts and alternator bracket.
- (b) Remove the 2 bolts and adjusting bar.

### 11. REMOVE OIL COOLER (See page LU-19)



### 12. REMOVE OIL COOLER UNION BOLT

Using SST, remove the union bolt.

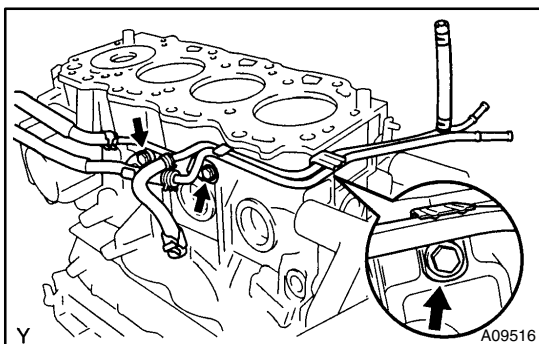
SST 09229-55010

### 13. REMOVE ENGINE COOLANT DRAIN UNION

### 14. REMOVE NO.1 OIL COOLER PIPE

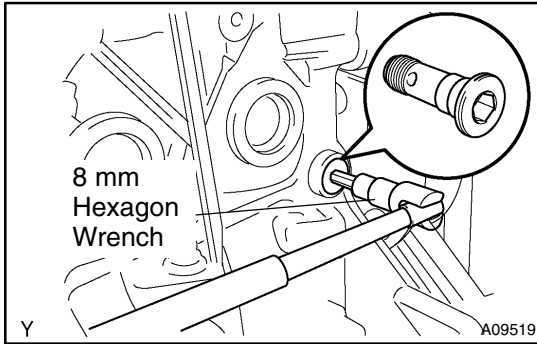
### 15. REMOVE OIL PRESSURE SWITCH

(See page LU-1)

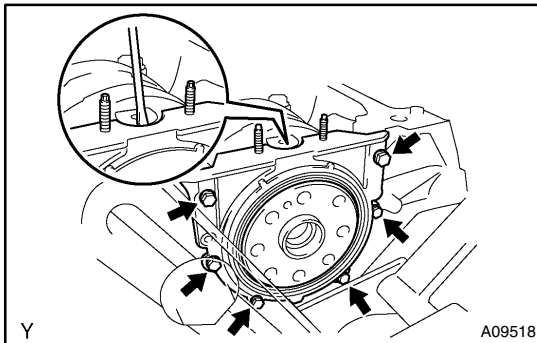


### 16. REMOVE NO.1 FUEL PIPE

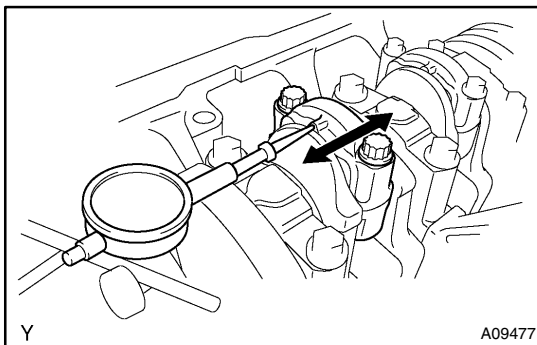
Remove the 3 bolts and fuel pipe.

**17. REMOVE OIL JET PRESSURE VALVE**

Using an 8 mm hexagon wrench, remove the pressure valve and gasket.

**18. REMOVE NO.2 OIL PAN, OIL STRAINER AND NO.1 OIL PAN (See page LU-7)****19. REMOVE OIL PUMP (See page LU-7)****20. REMOVE REAR OIL SEAL RETAINER**

- Remove the 6 bolts.
- Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and main bearing cap.

**21. CHECK CONNECTING ROD THRUST CLEARANCE**

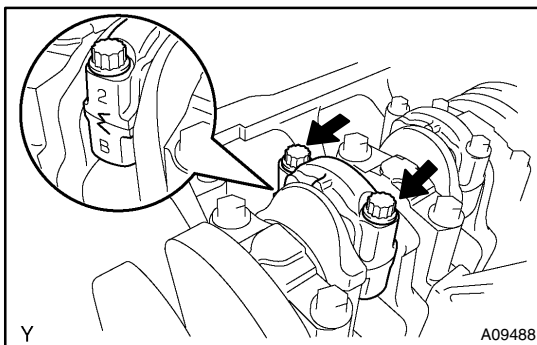
Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

**Standard thrust clearance:**

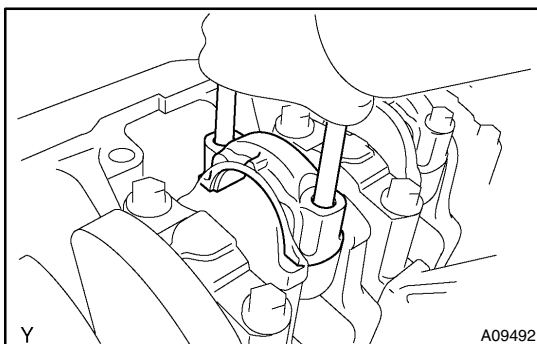
**0.08 – 0.30 mm (0.0031 – 0.0118 in.)**

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

If the thrust clearance is greater than maximum, replace the connecting rod assembly(s). If necessary, replace the crankshaft.

**22. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE**

- Check the matchmarks on the connecting rod and cap to ensure correct reassembly.
- Remove the 2 connecting rod cap bolts.

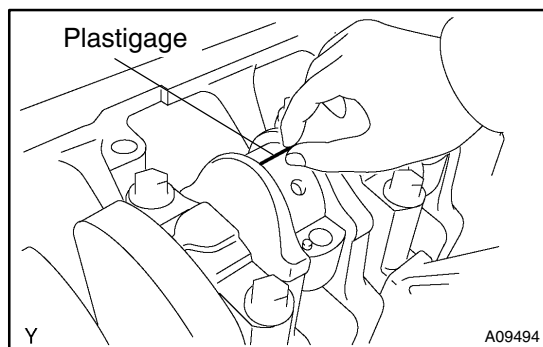


- Using 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

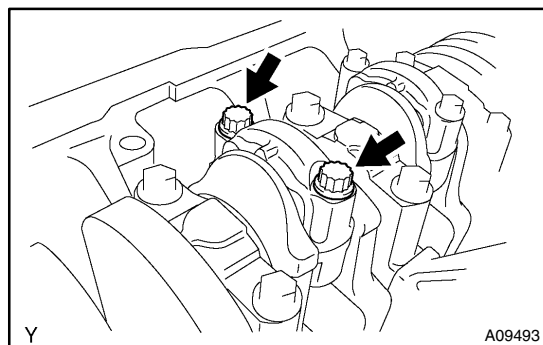
**HINT:**

Keep the lower bearing inserted with the connecting rod cap.

- Clean the crank pin and bearing.
- Check the crank pin and bearing for pitting and scratches. If the crank pin or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



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

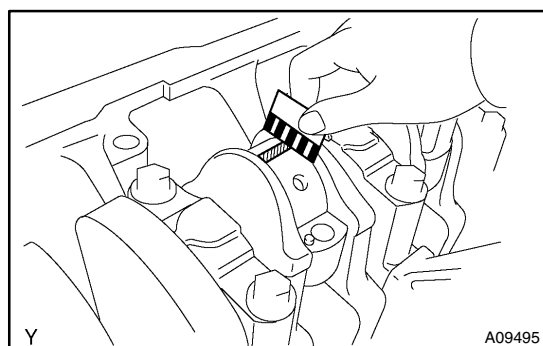


- (g) Install the connecting rod cap with the 2 bolts.  
(See page EM-72)

**NOTICE:**

**Do not turn the crankshaft.**

- (h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c))



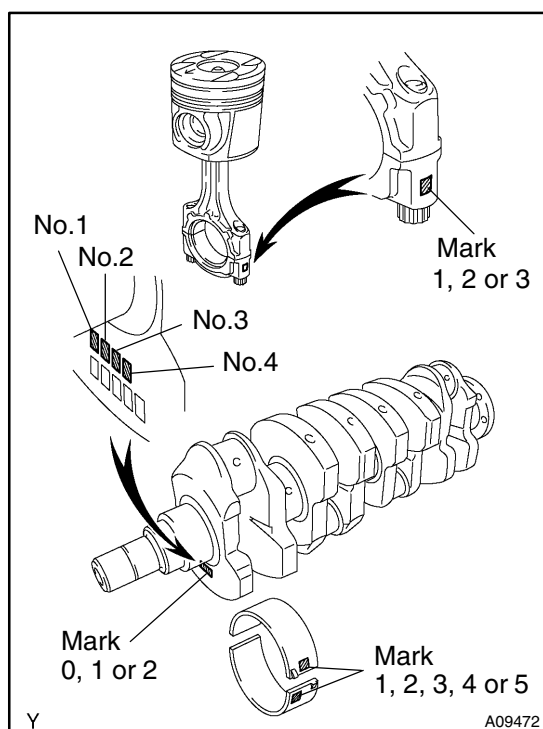
- (i) Measure the Plastigage at its widest point.

**Standard oil clearance:**

**0.038 – 0.056 mm (0.0015 – 0.0022 in.)**

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

If the oil clearance is greater than maximum, replace the bearings. If necessary, 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 crankshaft and connecting rod cap, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "1", "2", "3", "4" and "5" accordingly.

|                    | Number marked |   |   |   |   |   |   |   |   |
|--------------------|---------------|---|---|---|---|---|---|---|---|
|                    | 1             |   |   | 2 |   |   | 3 |   |   |
| Connecting rod cap |               |   |   |   |   |   |   |   |   |
| Crankshaft         | 0             | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 2 |
| Use bearing        | 1             | 2 | 3 | 2 | 3 | 4 | 3 | 4 | 5 |

EXAMPLE: Connecting rod cap "2" + Crankshaft "1"  
= Total number 3 (Use bearing "3")

**Reference****Connecting rod big end inside diameter:**

|          |                                          |
|----------|------------------------------------------|
| Mark "1" | 53.500 – 53.506 mm (2.1063 – 2.1065 in.) |
| Mark "2" | 53.506 – 53.512 mm (2.1065 – 2.1068 in.) |
| Mark "3" | 53.512 – 53.518 mm (2.1068 – 2.1070 in.) |

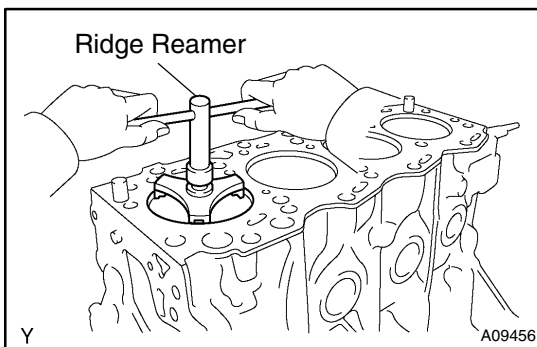
**Crankshaft crank pin diameter:**

|          |                                          |
|----------|------------------------------------------|
| Mark "0" | 50.494 – 50.500 mm (1.9880 – 1.9882 in.) |
| Mark "1" | 50.488 – 50.494 mm (1.9877 – 1.9880 in.) |
| Mark "2" | 50.482 – 50.488 mm (1.9875 – 1.9877 in.) |

**Standard sized bearing center wall thickness:**

|          |                                        |
|----------|----------------------------------------|
| Mark "1" | 1.478 – 1.481 mm (0.0582 – 0.0583 in.) |
| Mark "2" | 1.481 – 1.484 mm (0.0583 – 0.0584 in.) |
| Mark "3" | 1.484 – 1.487 mm (0.0584 – 0.0585 in.) |
| Mark "4" | 1.487 – 1.490 mm (0.0585 – 0.0587 in.) |
| Mark "5" | 1.490 – 1.493 mm (0.0587 – 0.0588 in.) |

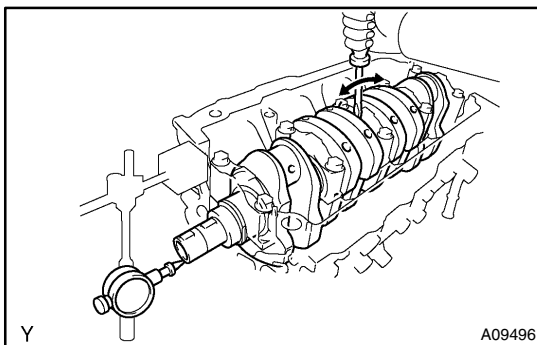
- (j) Completely remove the Plastigage.

**23. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES**

- Using a ridge reamer, remove all the carbon from the top of the cylinder.
- 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 the correct order.

**24. 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:**

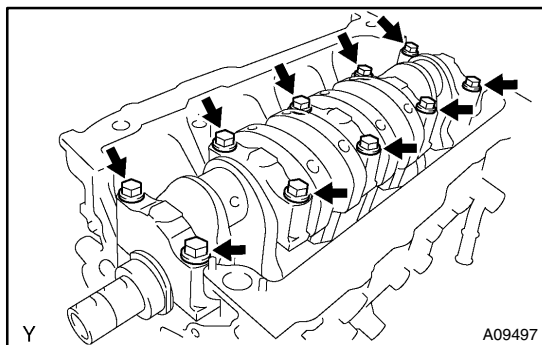
**0.040 – 0.240 mm (0.0016 – 0.0094 in.)**

**Maximum thrust clearance: 0.30 mm (0.0118 in.)**

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

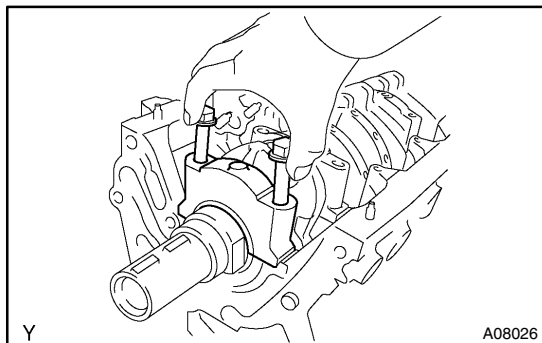
**Thrust washer thickness:**

|           |                                        |
|-----------|----------------------------------------|
| STD       | 2.680 – 2.730 mm (0.1055 – 0.1075 in.) |
| O/S 0.125 | 2.743 – 2.793 mm (0.1080 – 0.1100 in.) |
| O/S 0.250 | 2.805 – 2.855 mm (0.1104 – 0.1124 in.) |



## 25. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

- (a) Uniformly loosen and remove the 10 main bearing cap bolts.



- (b) Using the removed main bearing cap bolts, wiggle the cap back and forth, and remove the 5 main bearing caps, 5 lower bearings and 2 lower thrust washers (No.3 main bearing cap only).

### HINT:

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

- (c) Lift out the crankshaft.

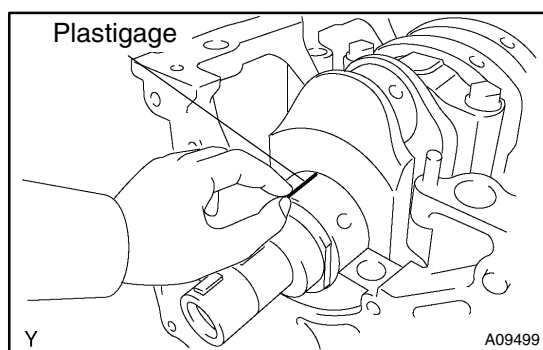
### HINT:

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

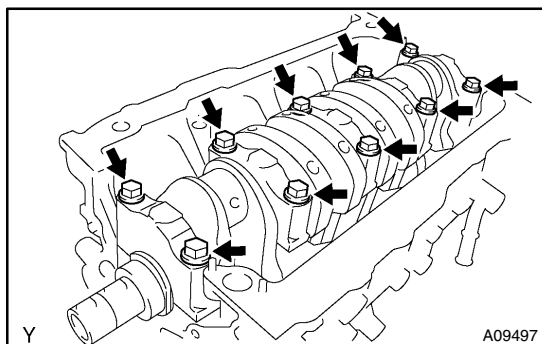
- (d) Clean each main journal and bearing.  
 (e) Check each main journal and bearing for pitting and scratches.

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

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



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

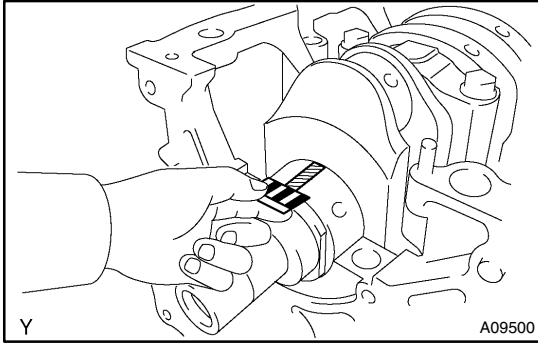


- (h) Install the main bearing caps. (See page EM-72)

### NOTICE:

**Do not turn the crankshaft.**

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



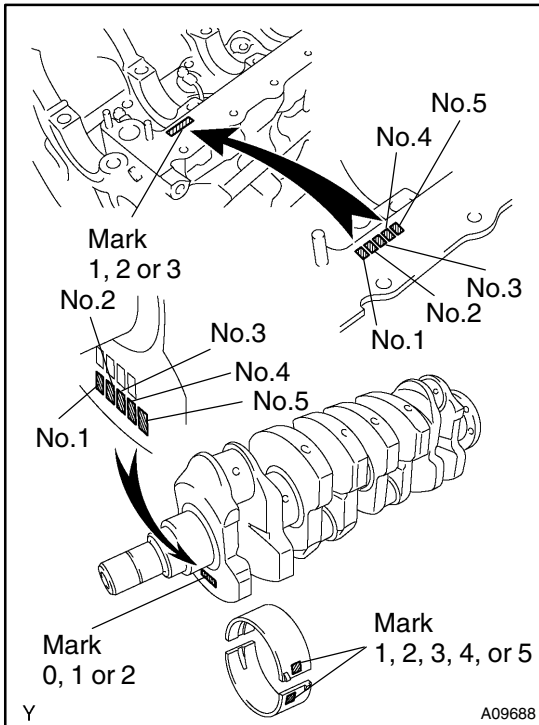
- (j) Measure the Plastigage at its widest point.

**Standard oil clearance:**

**0.032 – 0.050 mm (0.0013 – 0.0020 in.)**

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

If the oil clearance is greater than maximum, replace the bearings. If necessary, 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 "1", "2", "3", "4" and "5" accordingly.

|                | Number marked |   |   |   |   |   |   |   |   |
|----------------|---------------|---|---|---|---|---|---|---|---|
| Cylinder block | 1             |   |   | 2 |   |   | 3 |   |   |
| Crankshaft     | 0             | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 2 |
| Use bearing    | 1             | 2 | 3 | 2 | 3 | 4 | 3 | 4 | 5 |

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

**Reference**

**Cylinder block main journal bore diameter:**

|          |                                          |
|----------|------------------------------------------|
| Mark "1" | 61.000 – 61.006 mm (2.4016 – 2.4018 in.) |
| Mark "2" | 61.006 – 61.012 mm (2.4018 – 2.4020 in.) |
| Mark "3" | 61.012 – 61.018 mm (2.4020 – 2.4023 in.) |

**Crankshaft main journal diameter:**

|          |                                          |
|----------|------------------------------------------|
| Mark "0" | 57.004 – 57.010 mm (2.2442 – 2.2445 in.) |
| Mark "1" | 56.998 – 57.004 mm (2.2440 – 2.2442 in.) |
| Mark "2" | 56.992 – 56.998 mm (2.2438 – 2.2440 in.) |

**Standard sized bearing center wall thickness:**

|          |                                        |
|----------|----------------------------------------|
| Mark "1" | 1.976 – 1.979 mm (0.0778 – 0.0779 in.) |
| Mark "2" | 1.979 – 1.982 mm (0.0779 – 0.0780 in.) |
| Mark "3" | 1.982 – 1.985 mm (0.0780 – 0.0781 in.) |
| Mark "4" | 1.985 – 1.988 mm (0.0781 – 0.0783 in.) |
| Mark "5" | 1.988 – 1.991 mm (0.0783 – 0.0784 in.) |

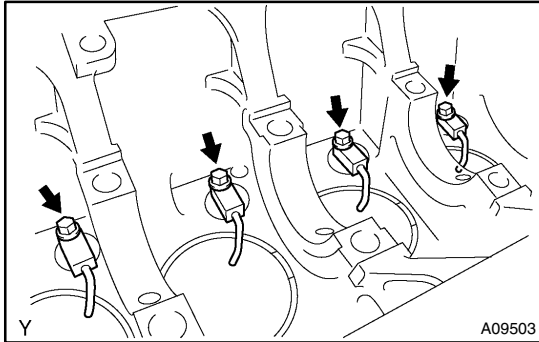
- (k) Completely remove the Plastigage.

**26. REMOVE CRANKSHAFT**

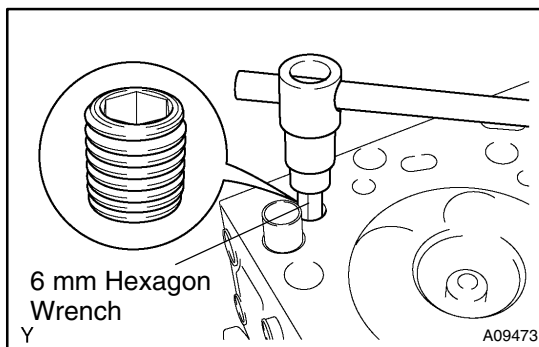
- (a) Lift out the crankshaft.
- (b) Remove the 5 upper bearings and 2 upper thrust washers from the cylinder block.

**HINT:**

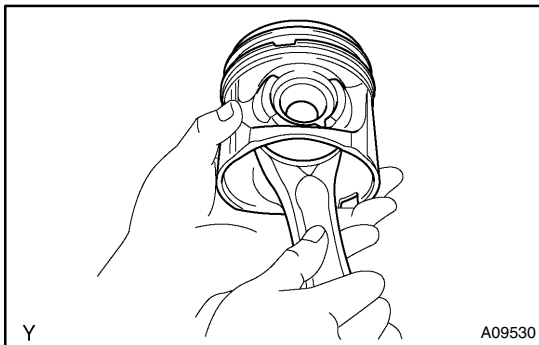
Arrange the main bearing caps, bearings and thrust washers in the correct order.

**27. REMOVE OIL NOZZLES**

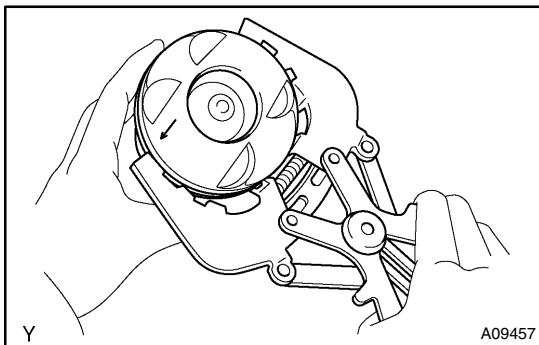
Remove the bolt and oil nozzle. Remove the 4 oil nozzles.

**28. REMOVE CYLINDER BLOCK OIL ORIFICE**

Using a 6 mm hexagon wrench, remove the oil orifice.

**29. 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.

**30. REMOVE PISTON RINGS**

- (a) Using a piston ring expander, remove the No.1 piston ring, No.2 piston ring and oil ring.

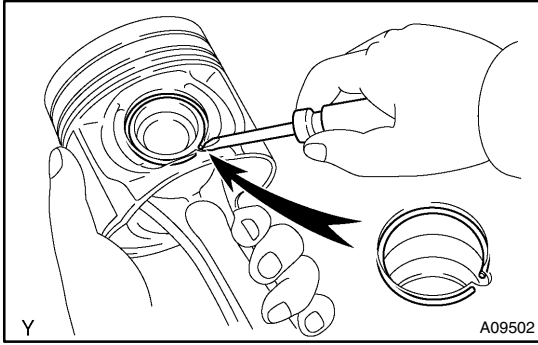
**NOTICE:**

**Make the expansion of the piston ring as small as necessary.**

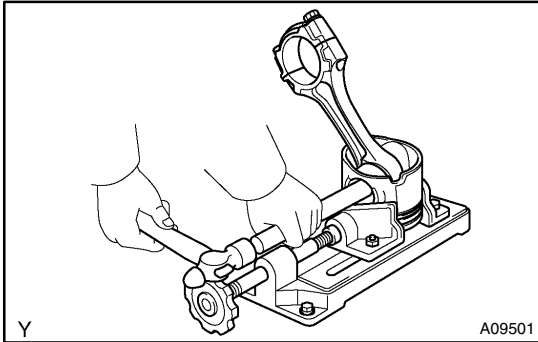
- (b) Remove the coil by hand.

**HINT:**

Arrange the piston rings in correct order only.

**31. DISCONNECT CONNECTING ROD FROM PISTON**

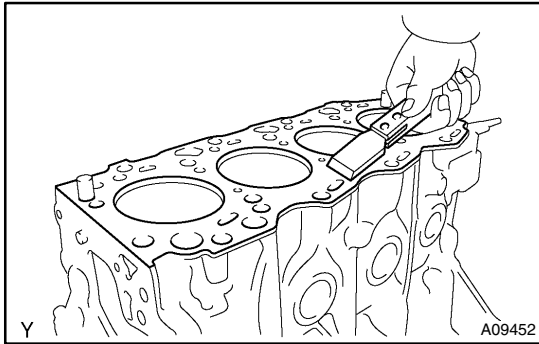
- (a) Using a small screwdriver, pry off the snap rings from the piston.
- (b) Gradually heat the piston to approx. 60°C (140°F).



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

**HINT:**

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

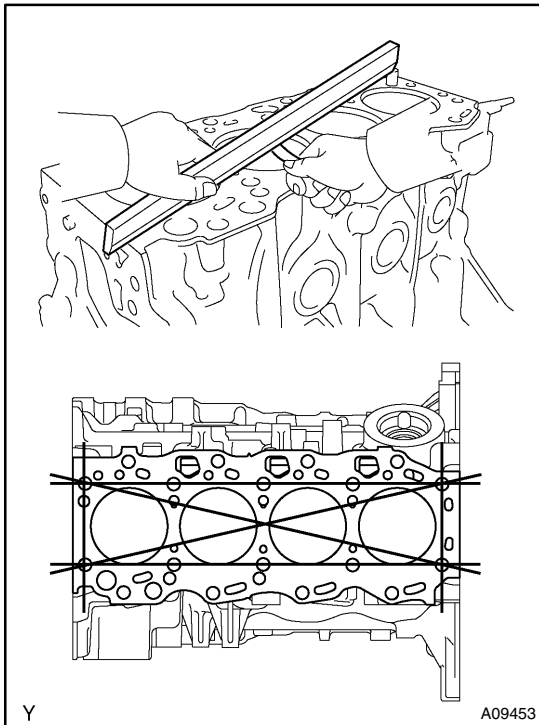


## INSPECTION

### 1. CLEAN CYLINDER BLOCK

Remove the gasket material.

- (1) Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
- (2) Using a soft brush and solvent, thoroughly clean the cylinder block.



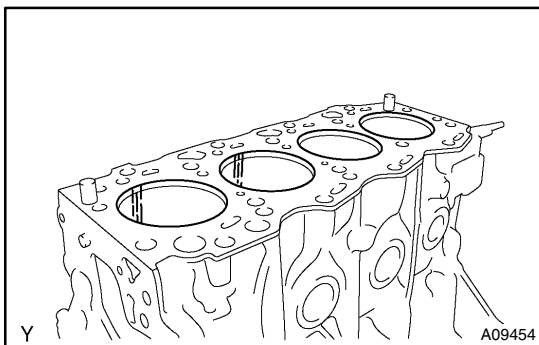
### 2. INSPECT CYLINDER BLOCK

- (a) Inspect for flatness.

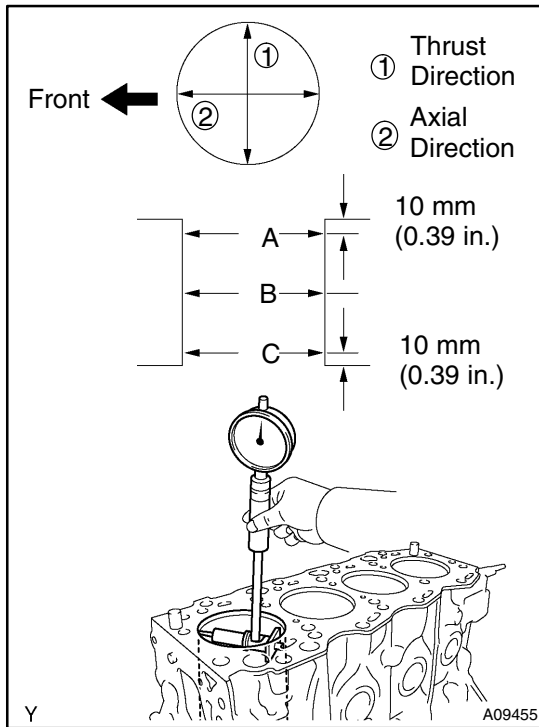
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

**Maximum warpage: 0.05 mm (0.0020 in.)**

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



- (b) Visually check the cylinder for vertical scratches. If deep scratches are found, replace the cylinder block.



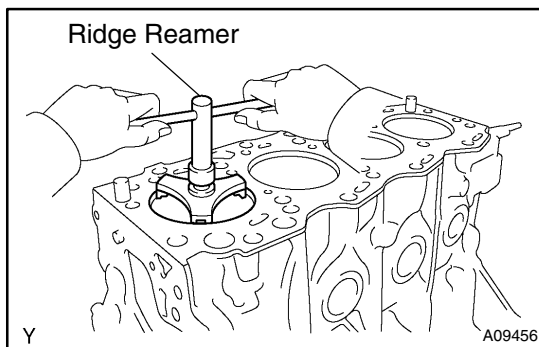
- (c) Inspect the cylinder bore diameter.  
Using a cylinder gauge, measure the cylinder bore diameter at the positions A, B and C in the thrust and axial directions.

**Standard diameter:**

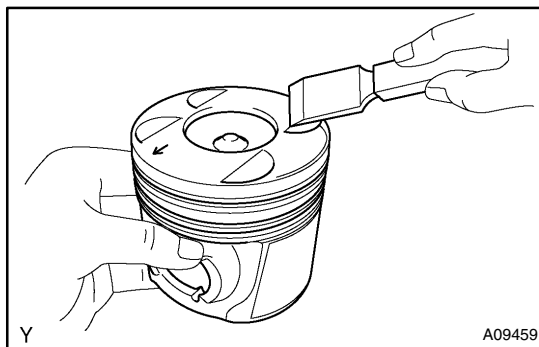
**82.200 – 82.213 mm (3.2362 – 3.2367 in.)**

**Maximum diameter: 82.400 mm (3.2441 in.)**

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

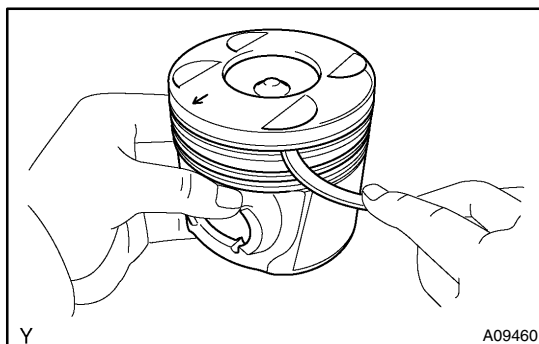


- (d) Remove the cylinder ridge.  
If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.

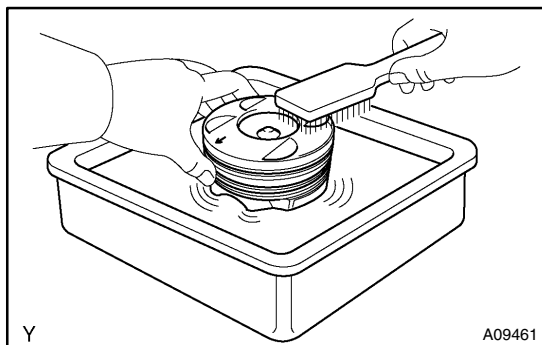


### 3. CLEAN PISTON

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



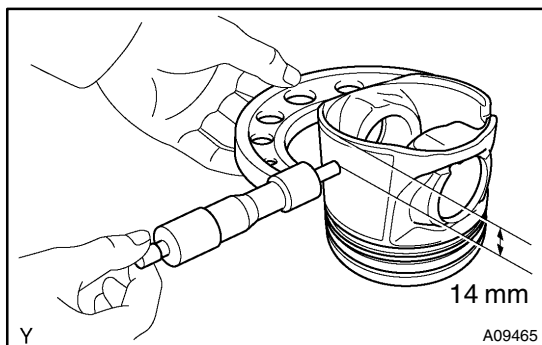
- (b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



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

**NOTICE:**

**Do not use a wire brush.**



#### 4. INSPECT PISTON AND PISTON RING

(a) Inspect the piston oil clearance.

- (1) Using a micrometer, measure the piston diameter at a right angles to the piston pin center line, 14 mm (0.55 in.) below the skirt bottom edge.

**Piston diameter:**

**82.148 – 82.182 mm (3.2341 – 3.2355 in.)**

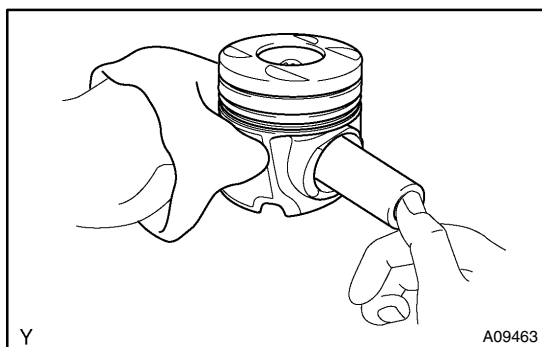
- (2) Measure the cylinder bore diameter in the thrust directions. (See step 2)
- (3) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

**Standard oil clearance:**

**0.018 – 0.065 mm (0.0007 – 0.0026 in.)**

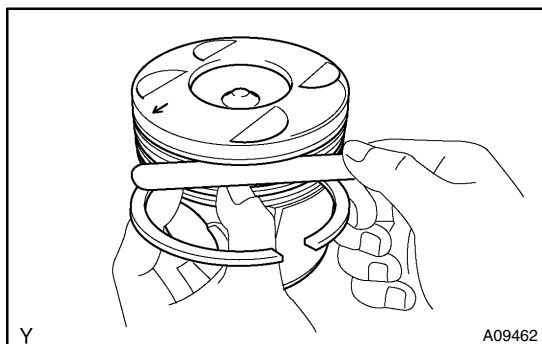
**Maximum oil clearance: 0.14 mm (0.0055 in.)**

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



(b) Inspect the piston pin fit.

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



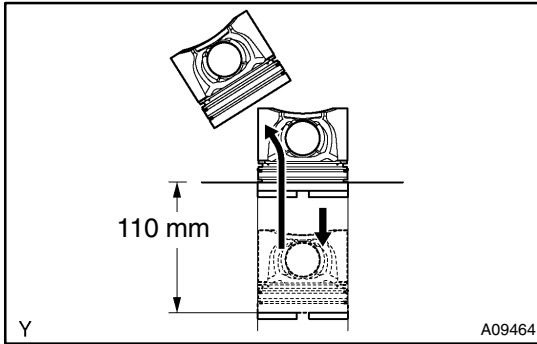
(c) Inspect the piston ring groove clearance.

Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

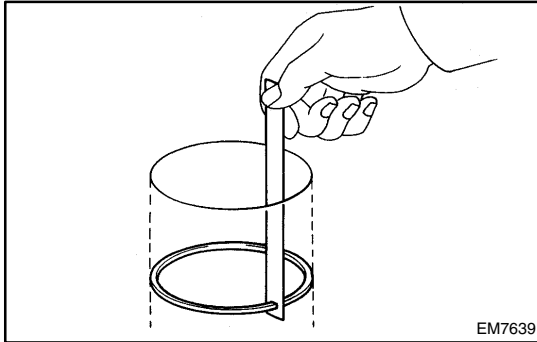
**Ring groove clearance:**

|      |                                      |
|------|--------------------------------------|
| No.1 | 0.08 – 0.12 mm (0.0031 – 0.0047 in.) |
| No.2 | 0.06 – 0.10 mm (0.0024 – 0.0039 in.) |
| Oil  | 0.03 – 0.07 mm (0.0012 – 0.0028 in.) |

If the clearance is not as specified, replace the piston.



- (d) 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, 110 mm (4.33 in.) from the top of the cylinder block.



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

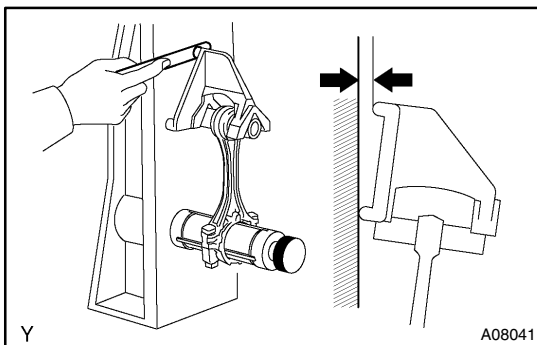
**Standard end gap:**

|      |                                    |
|------|------------------------------------|
| No.1 | 0.27–0.43 mm (0.0106 – 0.0169 in.) |
| No.2 | 0.39–0.58 mm (0.0154 – 0.0228 in.) |
| Oil  | 0.20–0.44 mm (0.0079 – 0.0173 in.) |

**Maximum end gap:**

|      |                      |
|------|----------------------|
| No.1 | 0.82 mm (0.0323 in.) |
| No.2 | 1.00 mm (0.0394 in.) |
| Oil  | 0.90 mm (0.0354 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, replace the cylinder block.



**5. INSPECT CONNECTING ROD AND PISTON PIN**

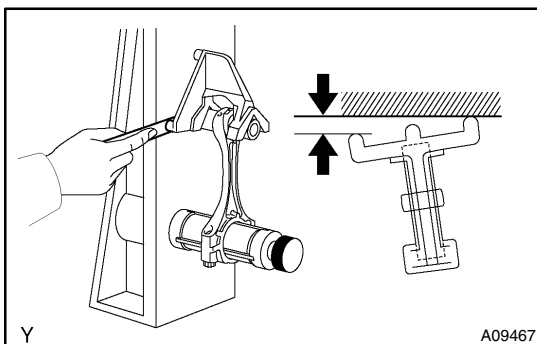
- (a) Using a rod aligner and feeler gauge, check the connecting rod alignment.

- (1) Check for out-of-alignment.

**Maximum out-of-alignment:**

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

If out-of-alignment is greater than maximum, replace the connecting rod assembly.

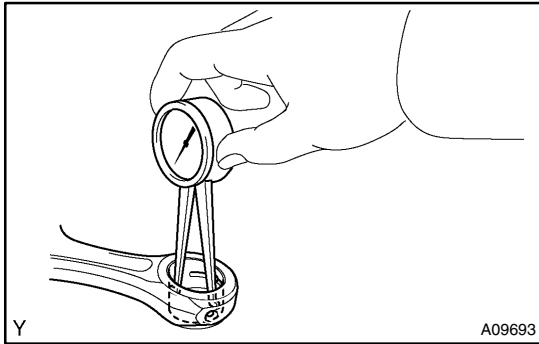


- (2) Check for twist

**Maximum twist:**

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

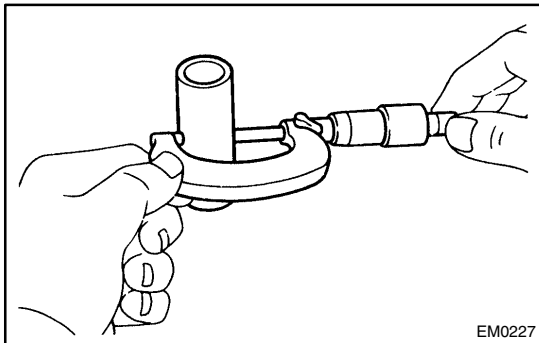
If twist is greater than maximum, replace the connecting rod assembly.



- (b) Inspect the piston pin oil clearance.
- (1) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

**Bushing inside diameter:**

**31.015 – 31.027 mm (1.2211 – 1.2215 in.)**



- (2) Using a micrometer, measure the piston pin diameter.

**Piston pin diameter:**

**31.000 – 31.012 mm (1.2205 – 1.2209 in.)**

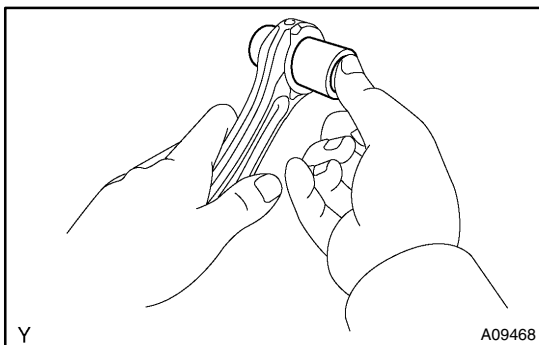
- (3) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

**Standard oil clearance:**

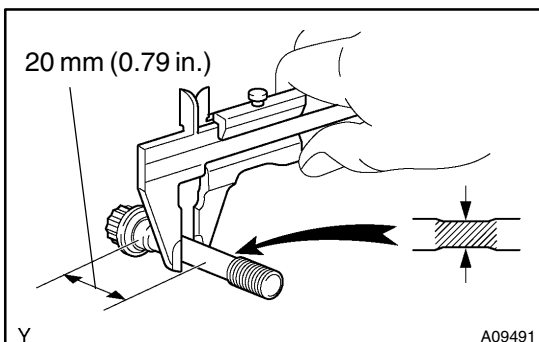
**0.011 – 0.019 mm (0.0004 – 0.0007 in.)**

**Maximum oil clearance: 0.025 mm (0.0010 in.)**

If the oil clearance is greater than maximum, replace the connecting rod. If necessary, replace the piston and piston pin as a set.



- (c) Inspect 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.



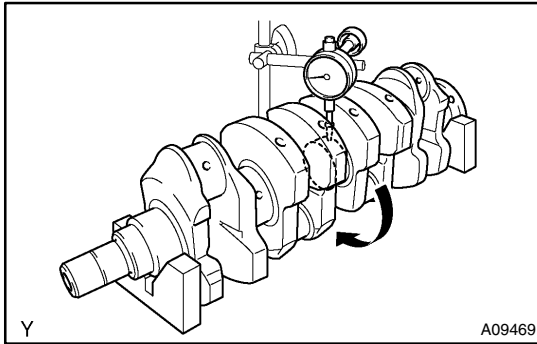
- (d) Inspect the connecting rod bolt. Using vernier calipers, measure the tension portion diameter.

**Standard diameter:**

**8.2 – 8.3 mm (0.323 – 0.327 in.)**

**Minimum diameter: 8.0 mm (0.315 in.)**

If the diameter is less than minimum, replace the connecting rod bolt.



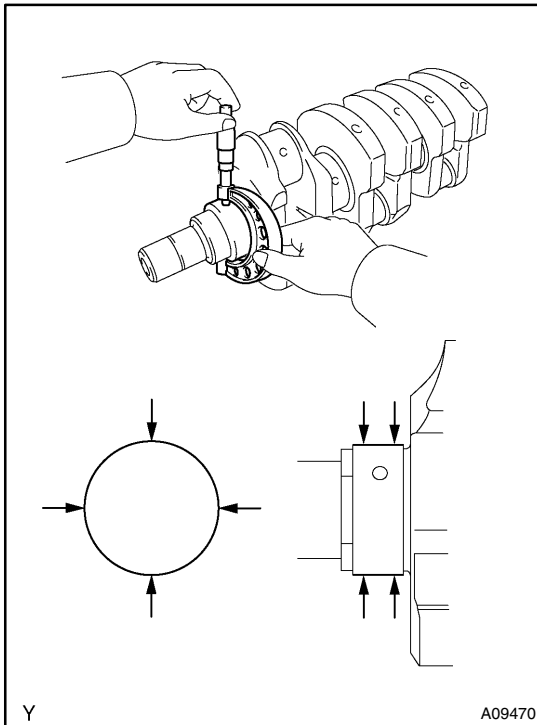
## 6. INSPECT CRANKSHAFT

(a) Inspect for circle runout.

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

**Maximum circle runout: 0.025 mm (0.0010 in.)**

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



(b) Inspect the main journals and crank pins.

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

**Main journal diameter:**

**56.992 – 57.010 mm (2.2438 – 2.2445 in.)**

**Crank pin diameter:**

**50.482 – 50.500 mm (1.9875 – 1.9882 in.)**

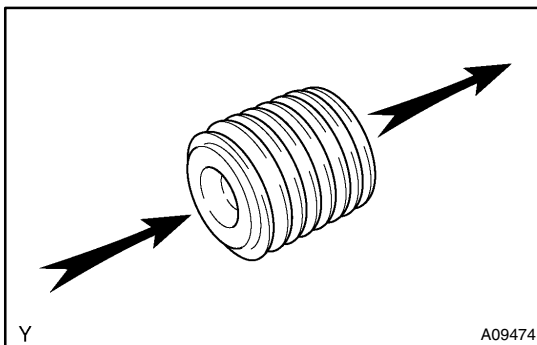
If the diameter is not as specified, replace the crankshaft.

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

**Maximum taper and out-of-round:**

**0.01 mm (0.0004 in.)**

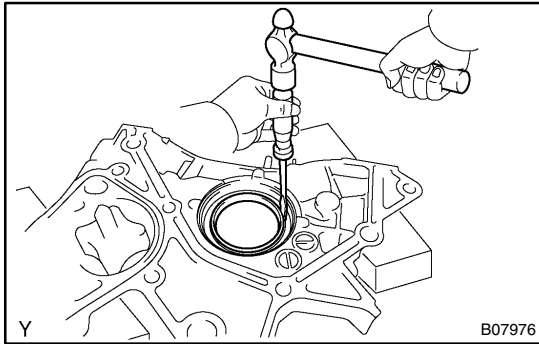
If the taper and out-of-round is greater than maximum, replace the crankshaft.



## 7. INSPECT CYLINDER BLOCK OIL ORIFICE

Check the oil orifice for clogging.

If necessary, replace the oil orifice.



## REPLACEMENT

### 1. REPLACE CRANKSHAFT FRONT OIL SEAL

#### HINT:

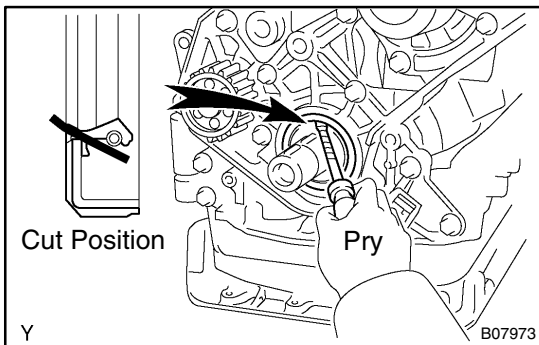
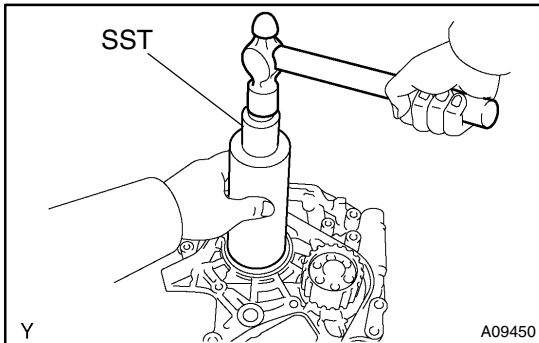
There are 2 methods ((a) and (b)) to replace the oil seal.

(a) If the oil pump 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 oil pump edge.

SST 09316-60011 (09316-00011, 09316-00021)

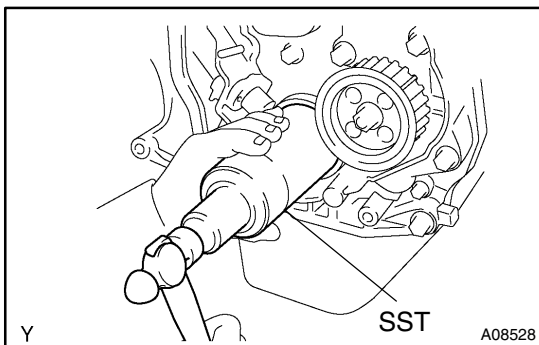


(b) If the oil pump is installed to the cylinder block:

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

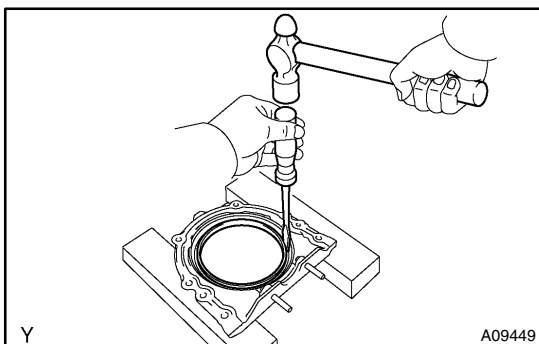
#### NOTICE:

**Be careful not to damage the crankshaft. Tape the screwdriver tip.**



- (3) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil pump edge.

SST 09316-60011 (09316-00011)



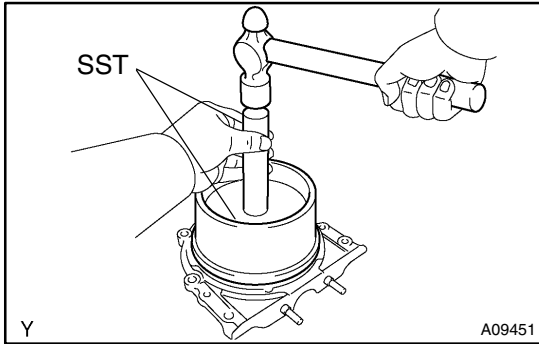
### 2. REPLACE CRANKSHAFT REAR OIL SEAL

#### HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

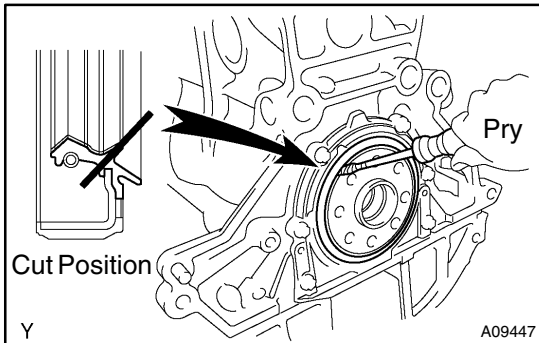
(a) If the rear oil seal retainer is removed from the cylinder block:

- (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, 09950-70010 (09951-07100)

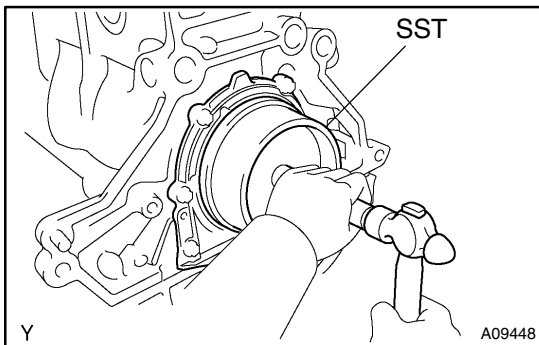


- (b) If rear oil seal retainer is installed to cylinder block:

- (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.**



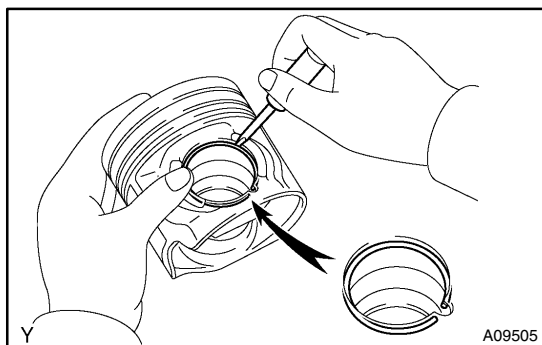
- (3) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

SST 09223-15030, 09950-70010 (09951-07100)

## REASSEMBLY

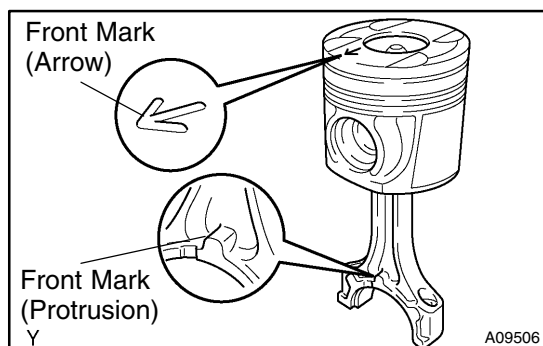
### HINT:

- 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

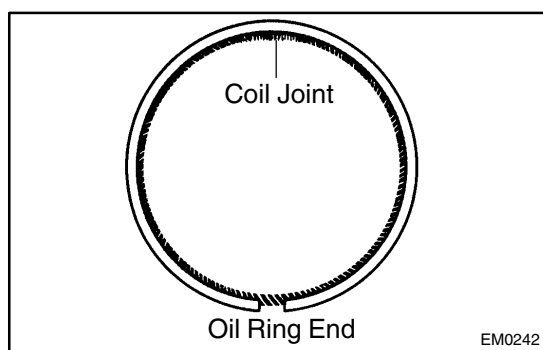
- Install a new snap ring on one side of the piston pin hole.
- Gradually heat the piston to 60°C (140°F).
- Coat the piston pin and piston hole of the piston with engine oil.



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

### 2. INSTALL PISTON RINGS

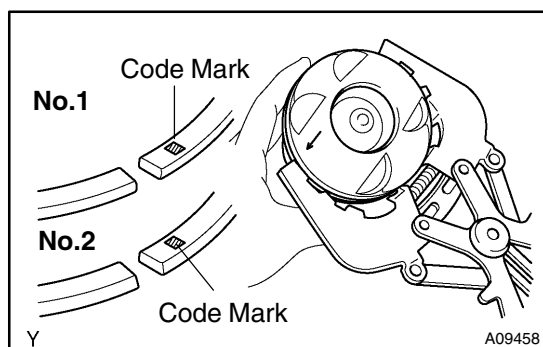
- Install the coil by hand.



- Using a piston ring expander, install the oil ring.

### HINT:

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



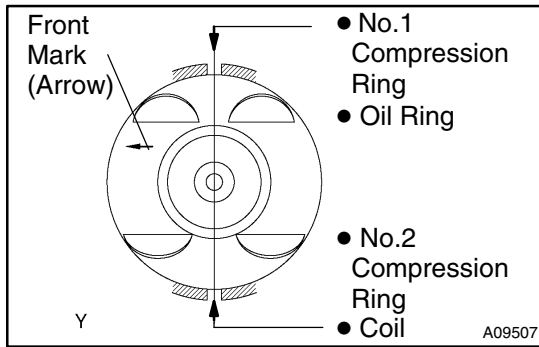
- Using a piston ring expander, install the No.2 and No.1 piston rings with the code mark facing upward.

### Code mark:

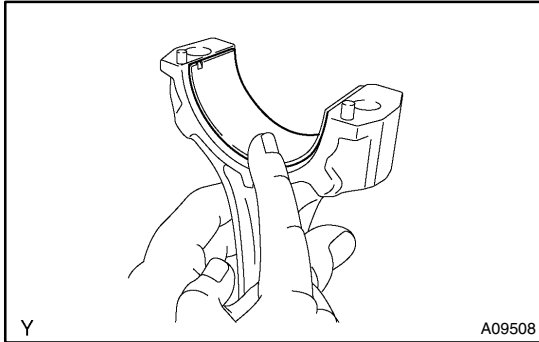
|      |    |
|------|----|
| No.1 | 1T |
| No.2 | 2T |

### NOTICE:

Make the expansion of the piston ring as small as necessary.

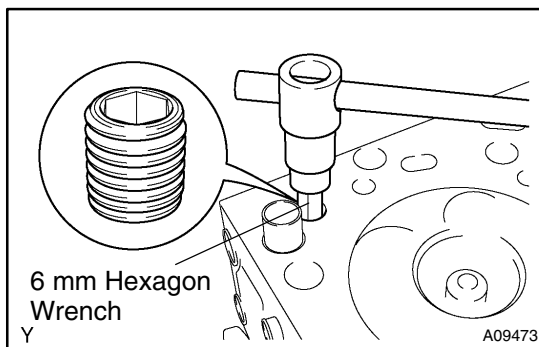


- (d) Position the piston rings so that the ring ends are as shown.



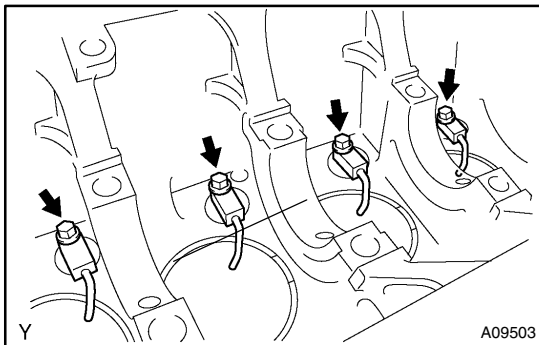
### 3. INSTALL CONNECTING ROD BEARINGS

- (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.



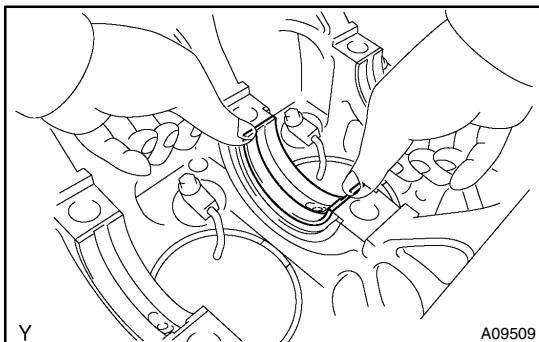
### 4. INSTALL CYLINDER BLOCK OIL ORIFICE

Using a 6 mm hexagon wrench, install the oil orifice.  
**Torque: 9 N·m (90 kgf·cm, 78 in.·lbf)**



### 5. INSTALL OIL NOZZLES

Install the oil nozzle with the bolt. Install the 4 oil nozzles.  
**Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)**

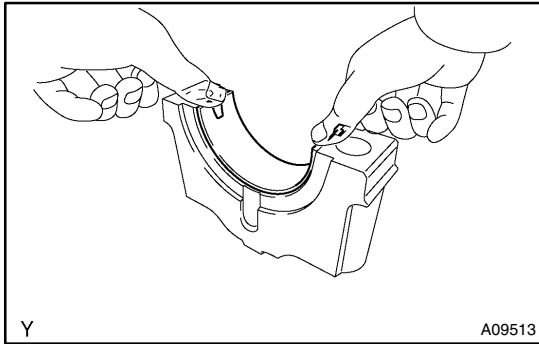


### 6. INSTALL MAIN BEARINGS

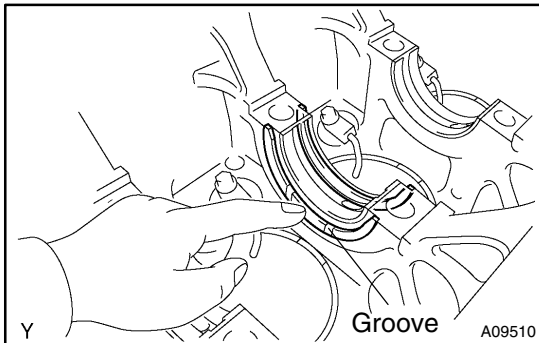
**HINT:**

Upper bearings have an oil groove and oil holes; lower bearings do not.

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



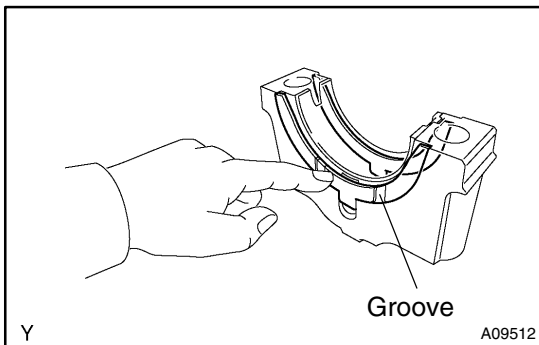
- (b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.



### 7. INSTALL UPPER THRUST WASHERS

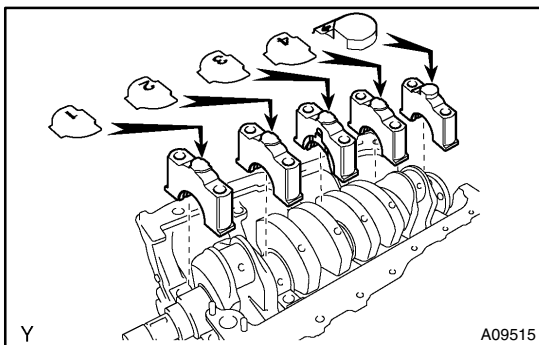
Install the 2 thrust washers under the No.3 journal position of the cylinder block with the oil grooves facing outward.

### 8. PLACE CRANKSHAFT ON CYLINDER BLOCK

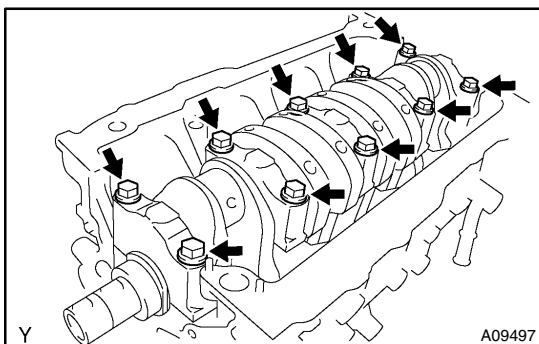


### 9. INSTALL MAIN BEARING CAPS AND LOWER THRUST WASHERS

- (a) Install the 2 thrust washers on the No.3 bearing cap with the oil grooves facing outward.

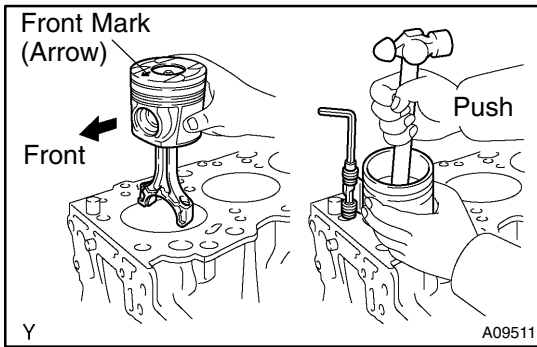


- (b) Install the 5 main bearing caps in their proper locations.  
HINT:  
Each bearing cap has a number and a front mark.



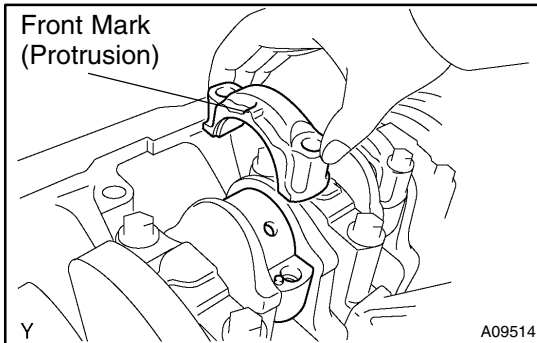
- (c) Apply a light coat of engine oil on the threads and under the heads of the main bearing cap bolts.  
(d) Install and uniformly tighten the 10 bolts of the main bearing cap in several passes.  
**Torque: 115 N·m (1,150 kgf·cm, 85 ft·lbf)**  
(e) Check that the crankshaft turns smoothly.

### 10. CHECK CRANKSHAFT THRUST CLEARANCE (See page EM-56)



### 11. INSTALL PISTON AND CONNECTING ROD ASSEMBLES

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



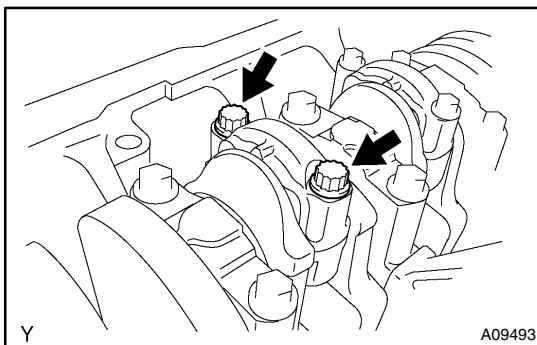
### 12. PLACE CONNECTING ROD CAP ON CONNECTING ROD

- Match the numbered connecting rod cap with the connecting rod.
- Install the connecting rod cap with the front mark facing forward.

### 13. INSTALL CONNECTING ROD CAP BOLTS

HINT:

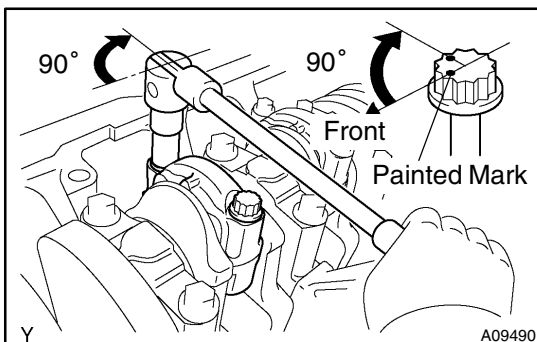
- The cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any of the connecting rod cap bolts is broken or deformed, replace it.



- Apply a light coat of engine oil on the threads and under the heads of the connecting rod cap bolts.
- Install and alternately tighten the 2 cap bolts in several passes.

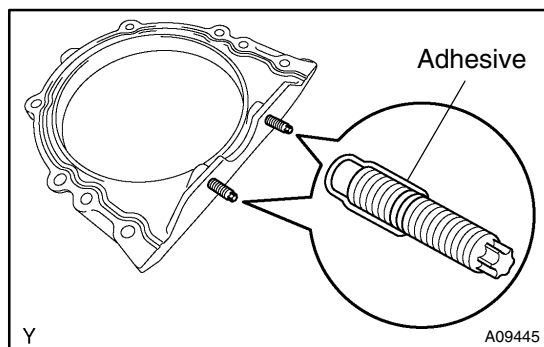
**Torque: 30 N·m (300 kgf·cm, 22 ft·lbf)**

If any of the cap bolts does not meet the torque specification, replace the connecting rod cap bolts.



- Mark the front of the cap bolt with the paint.
- Relight the cap bolts 90° as shown.
- Check that the painted mark is now at a 90° angle to the front.
- Check that the crankshaft turns smoothly.

### 14. CHECK CONNECTING ROD THRUST CLEARANCE (See page EM-56)



### 15. INSTALL STUD BOLT OF REAR OIL SEAL RETAINER

#### HINT:

When using a new rear oil seal retainer, stud bolt must be installed.

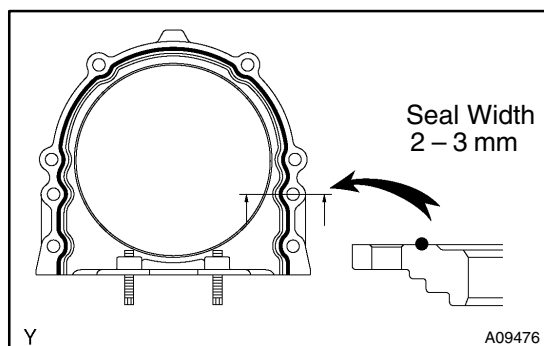
Apply adhesive to the threads of the stud bolt and install it.

**Adhesive: Part No. 08833-00070, THREE BOND 1324 or equivalent**

### 16. 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 oil seal retainer and cylinder block.

- Thoroughly clean all components to remove all the loose material.
- Using a non-residue solvent, clean both sealing surfaces.



(b) Apply seal packing to the oil seal retainer as shown in the illustration.

**Seal packing: Part No. 08826-00080 or equivalent**

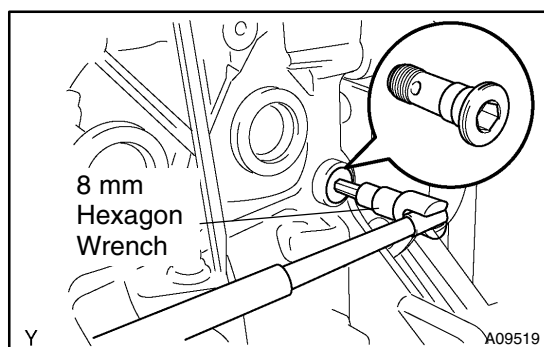
- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the oil seal retainer with the 6 bolts. Uniformly tighten the bolt in several passes.

**Torque: 7.4 N·m (75 kgf·cm, 65 in.-lbf)**

### 17. INSTALL OIL PUMP (See page LU-14)

### 18. INSTALL NO.1 OIL PAN, OIL STRAINER AND NO.2 OIL PAN (See page LU-14)



### 19. INSTALL OIL JET PRESSURE VALVE

Using an 8 mm hexagon wrench, install a new gasket and the pressure valve.

**Torque: 30 N·m (310 kgf·cm, 22 ft.-lbf)**

### 20. INSTALL NO.1 FUEL PIPE

Install the fuel pipe with the 3 bolts.

**Torque:**

**8.8 N·m (90 kgf·cm, 78 in.-lbf) for 12 mm head**

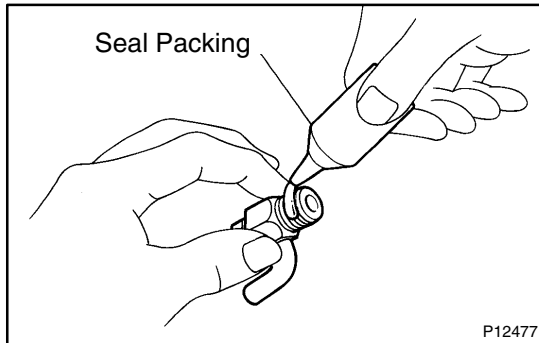
**20.5 N·m (210 kgf·cm, 15 ft.-lbf) for 14 mm head**

**21. INSTALL OIL PRESSURE SWITCH**

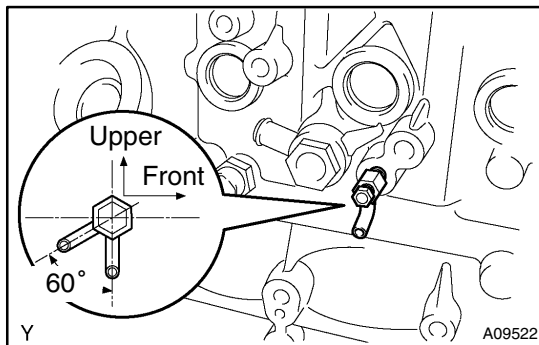
(See page LU-1)

**22. INSTALL NO.1 OIL COOLER PIPE**

Install 2 new gaskets and the oil cooler pipe with the union bolt.

**Torque: 56.4 N·m (575 kgf·cm, 42 ft·lbf)****23. INSTALL ENGINE COOLANT DRAIN UNION**

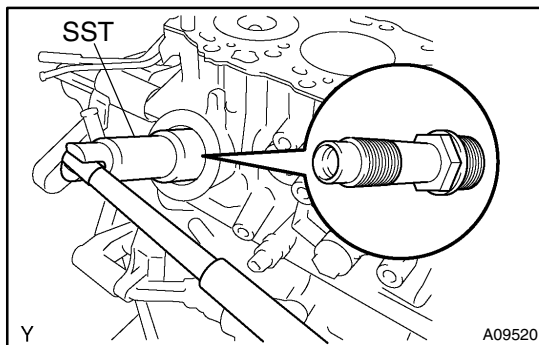
(a) Apply seal packing to 2 or 3 threads.

**Seal packing: Part No. 08826-00100 or equivalent**

(b) Install the drain union.

**Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)****HINT:**

After applying the specified torque, if the drain pipe of the drain union is not at the position shown in the illustration, rotate the drain union further to clockwise and make the drain pipe face downward.

**24. INSTALL OIL COOLER UNION BOLT**

Using SST, install the union bolt.

SST 09229-55010

**Torque: 171 N·m (1,745 kgf·cm, 126 ft·lbf)****25. INSTALL OIL COOLER (See page LU-21)****26. REMOVE ALTERNATOR BRACKET AND DRIVE BELT ADJUSTING BAR**

(a) Install the alternator bracket with the 3 bolts.

**Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)**

(b) Install the adjusting bar with the 2 bolts.

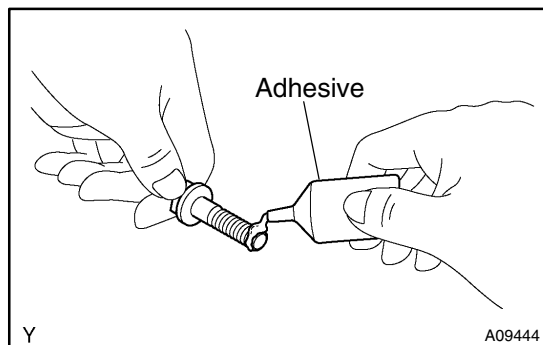
**Torque: 31.4 N·m (320 kgf·cm, 23 ft·lbf)****27. INSTALL ALTERNATOR****28. INSTALL THERMOSTAT AND WATER INLET**

(See page CO-12)

**29. INSTALL WATER PUMP (See page CO-8)****30. INSTALL SUPPLY PUMP (See page FU-18)****31. INSTALL CYLINDER HEAD (See page EM-46)****32. INSTALL TIMING BELT AND PULLEYS**

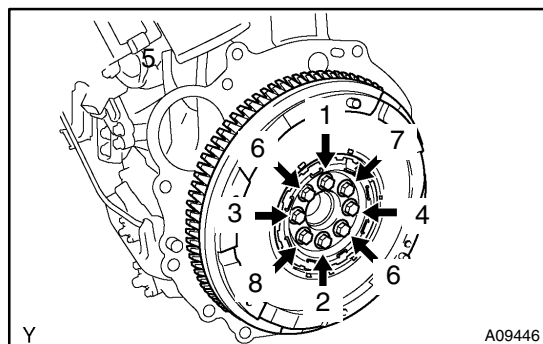
(See page EM-18)

**33. DISCONNECT ENGINE FROM ENGINE STAND**

**34. INSTALL REAR END PLATE****35. INSTALL FLYWHEEL**

- (a) Apply adhesive to 2 or 3 threads of the bolt end.

**Adhesive: Part No. 08833-00070, THREE BOND 1324 or equivalent**



- (b) Install and uniformly tighten the 8 bolts in several passes and in the sequence shown.

**Torque: 88.2 N·m (900 kgf·cm, 65 ft·lbf)**