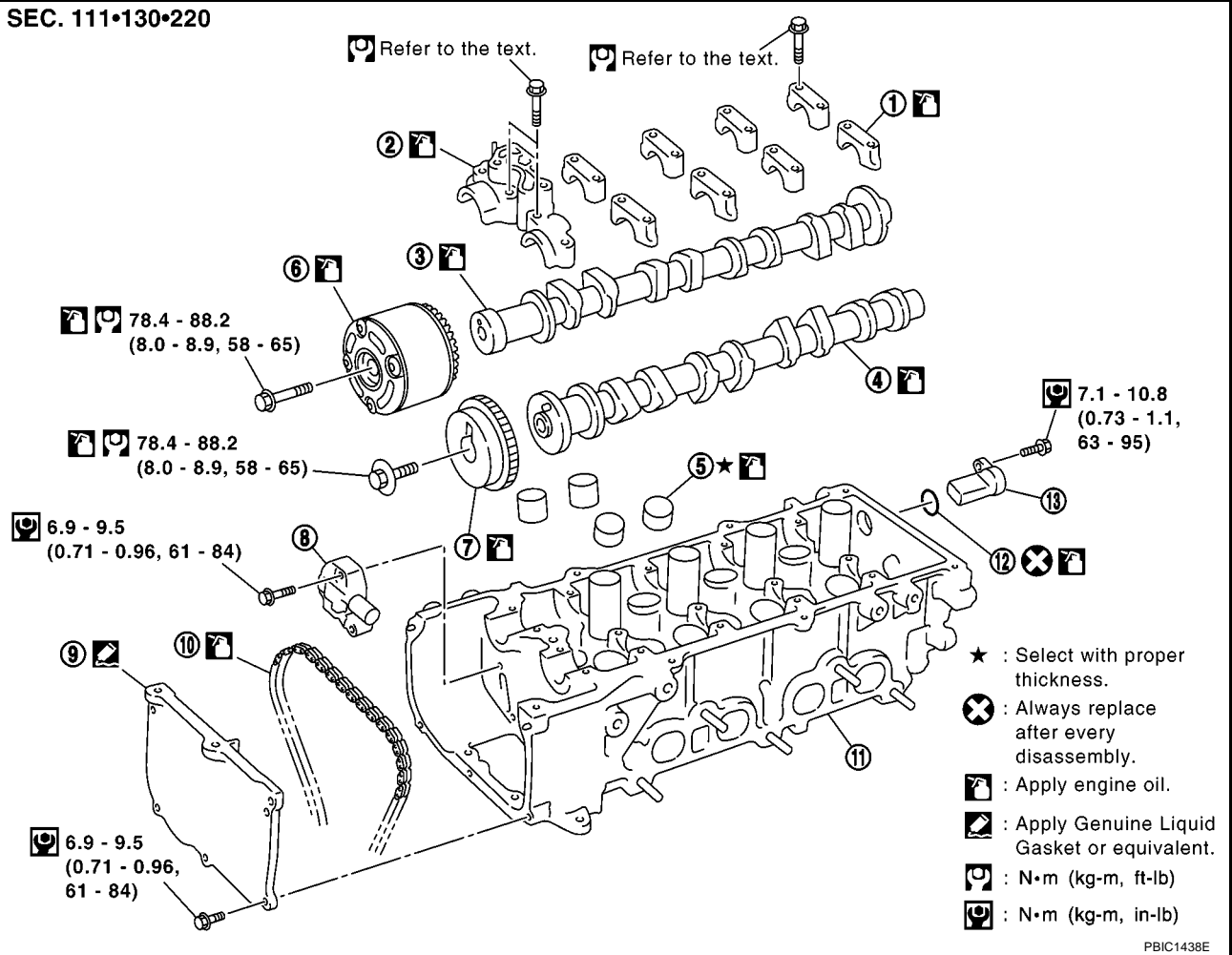


# CAMSHAFT

## CAMSHAFT

### Removal and Installation To ESM

SEC. 111•130•220



PBIC1438E

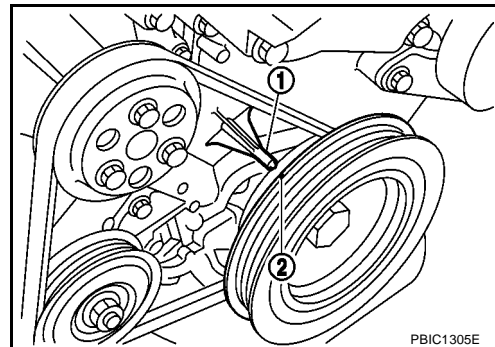
- |                                      |                             |                               |
|--------------------------------------|-----------------------------|-------------------------------|
| 1. Camshaft bracket (No. 2 - 5)      | 2. Camshaft bracket (No. 1) | 3. Camshaft (intake)          |
| 4. Camshaft (exhaust)                | 5. Valve lifter             | 6. Camshaft sprocket (intake) |
| 7. Camshaft sprocket (exhaust)       | 8. Chain tensioner          | 9. Cylinder head front cover  |
| 10. Timing chain                     | 11. Cylinder head           | 12. O-ring                    |
| 13. Camshaft position sensor (PHASE) |                             |                               |

## REMOVAL

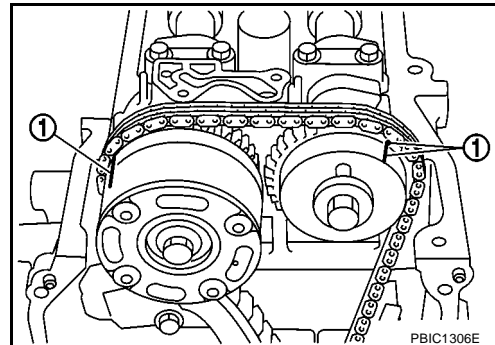
- Remove RH front fender protector.
  - Secure the engine position using one of the following methods. Remove RH engine mount stay and engine mount bracket (upper). Refer to EM-69, "Removal and Installation" on ESM.
    - Mount engine slingers and hook with hoist. Refer to EM-69, "Removal and Installation" on ESM.
    - Support the oil pan bottom with a jack stand, etc.
  - Remove rocker cover. Refer to EM-33, "ROCKER COVER" on ESM.
  - Remove the camshaft position sensor (PHASE) from the back of the cylinder head if necessary.
- CAUTION:**
- Handle camshaft position sensor (PHASE) with care. Avoid impacts.
  - The tip of the sensor is magnetic, so do not let metal dust get on it or place it next to objects which can be affected by magnets.
- Remove RH headlamp. Refer to LT-6, "HEADLAMP-CONVENTIONAL TYPE" on ESM.
  - Remove the cylinder head front cover.
  - Following the procedure below, place cylinder No. 1 at TDC of its compression stroke

## CAMSHAFT

- a. Turn the crankshaft pulley clockwise as seen from the engine front, and match up the crankshaft pulley TDC mating mark (no color) (2) with the timing indicator (1) on the front cover.



- b. Confirm mating marks (1) stamped on intake and exhaust sprockets are located as shown.
  - If there is no position mark at the position in the figure, turn the crankshaft pulley once more to position them as in the figure.
- c. Make sure mating marks on intake and exhaust camshaft sprockets are located as shown in the figure, then paint mating marks on the timing chain links.

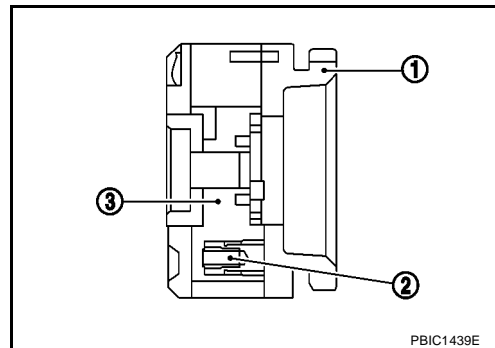


8. Make sure the intake camshaft sprocket is in the most advanced position.

### CAUTION:

Installation and removal of the intake camshaft sprocket must be done in the most advanced position for the following reasons, so make sure you follow the procedure exactly.

- The sprocket (1) and vane (camshaft coupling) (3) are designed to spin and move within the range of a certain angle.
- With the engine stopped the vane (3) is in the most retarded position. It will not spin because it is locked to the sprocket side by the internal lock pin (2).
- If the camshaft sprocket mounting bolts are turned in the situation described above (the most retarded position), the lock pin (2) will become damaged and cause malfunctions because of the increased horizontal load (cutting force) on the lock pin (2).
- Put the intake camshaft sprocket in the most advance position in the following steps.



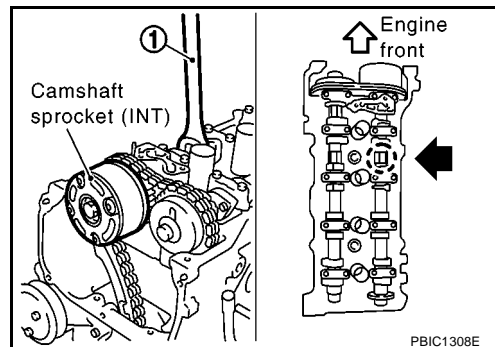
### CAUTION:

The chain tensioner must not be removed before doing this step.

### NOTE:

The spinning direction in the following description is as seen from the engine front.

- a. Immobilize the hexagonal part of the camshaft with a wrench (1) to prevent the intake camshaft from moving.



## CAMSHAFT

- b. Apply air pressure with an air gun (2) to the advanced angle side oil passage of the intake valve timing control on the top surface of the No. 1 camshaft bracket (1).

### Compression pressure

: 300 kPa (3.00 bar, 3 kg/cm<sup>2</sup>, 43.5 psi) or more

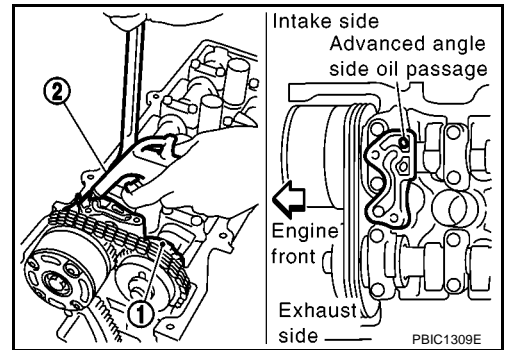
#### NOTE:

The air pressure is used to move the lock pin into the disengage position.

- Keep applying air pressure until step "e" is completed.

#### CAUTION:

- Be sure not to damage the oil passage with the tip of the air gun.
- Wipe all the oil off on the top surface of the No. 1 camshaft bracket to prevent oil from being blown with the air, and the area around the air gun should be covered with a rag when applying air pressure. Eye protection should be worn as needed.



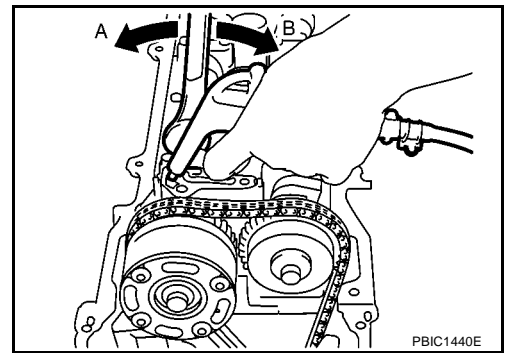
- c. Turn the intake camshaft slowly counter-clockwise in direction A (towards the intake manifold).

- Keep the air pressure on.

#### CAUTION:

Also be sure the wrench immobilizing the camshaft does not come loose.

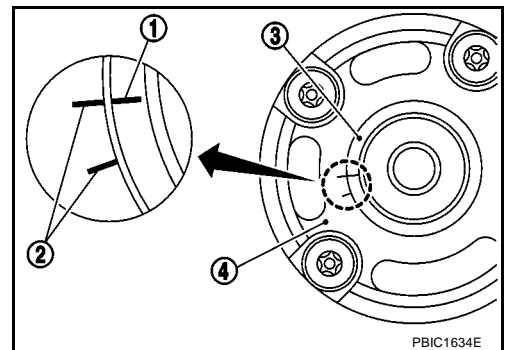
- d. While doing the above, once you hear a click (the sound of the internal lock pin disengaging) from inside the intake camshaft sprocket, start turning the intake camshaft in the opposite direction, direction B (clockwise: towards the exhaust manifold) and to the most advanced angle position.



- Keep the air pressure on.
- If there is no click, as soon as the vane (camshaft coupling) starts moving independently of the camshaft sprocket, the lock pin has become disengaged.
- If the lock pin does not become disengaged, shake the wrench immobilizing the camshaft slightly.
- If this still does not help in disengaging the lock pin, tap the intake camshaft front very lightly with a plastic hammer.

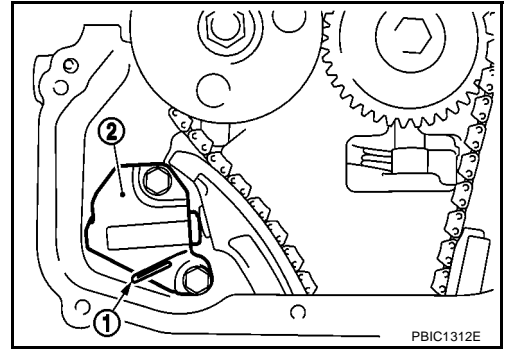
- e. Once the vane starts to spin and then the camshaft sprocket starts to spin with the camshaft, it has reached the most advanced position, so stop.

- Make sure the most advanced position locating intake valve timing control advance mark (1) of vane (3) and alignment mark (2) of sprocket (4) as shown in the figure.



## CAMSHAFT

9. Attach the stopper pin (1) such as a paper clip to secure the plunger in the full compressed position and remove the chain tensioner (2).



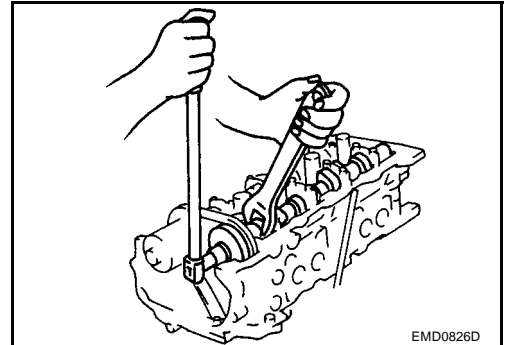
10. Keeping the wrench on the camshaft hexagonal part, loosen the mounting bolts and remove the intake and exhaust camshaft sprockets.

### CAUTION:

- Make sure the tools do not come in contact with the A/C piping.
- Do not loosen mounting bolts with securing anything other than the camshaft hexagonal part or with tensioning the timing chain.

### NOTE:

With the front cover attached, the timing chain and crankshaft sprocket will not come off, so there is no need to take steps to maintain the timing chain tension.



- The intake camshaft sprocket should be handled with the following precautions in mind.

### CAUTION:

- When removing intake camshaft sprocket, using adhesive tape or equivalent, prevent vane from rotating so that lock pin will not rejoin in the most retarded position.
- Handle it carefully, and avoid any chance of impact caused by dropping.
- Do not disassemble. (Do not loosen the four front bolts.)

### NOTE:

While removing the intake camshaft sprocket, if the lock pin has been rejoined in the most retarded position, do the following to restore it.

- a. Reinstall the intake camshaft sprocket to the intake camshaft and tighten the mounting bolts enough to prevent air leaking out when the air pressure is applied later.

### CAUTION:

**To prevent internal lock pin from damaging, keep the torque on the mounting bolts to the minimum required to prevent air from escaping.**

- b. Apply the air pressure, disengage the lock pin following step 8, and turn the vane to the most advanced position. (The timing chain need not be attached for this step.)
- c. Remove the intake camshaft sprocket from camshaft.

11. Remove camshaft brackets.

- Loosen bolts in several steps in reverse order shown in the figure.

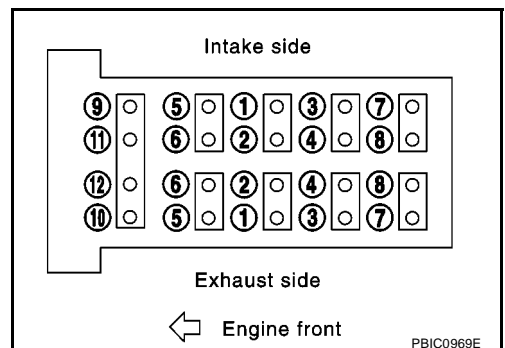
12. Remove camshaft.

### CAUTION:

**Do not deform or damage intake camshaft rear end signal plate.**

13. Remove valve lifter.

- Identify installation position of each valve. Arrange removed valve lifters so they cannot be mixed up.

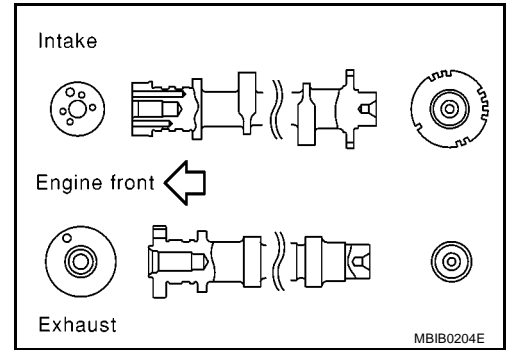


## INSTALLATION

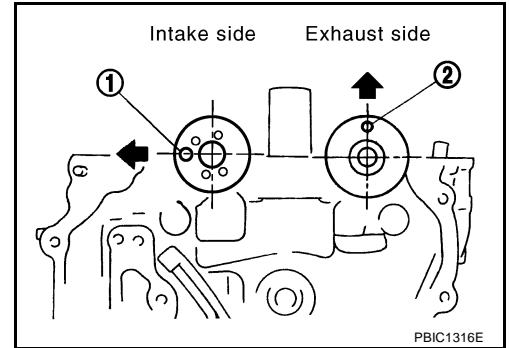
1. Install valve lifter.

## CAMSHAFT

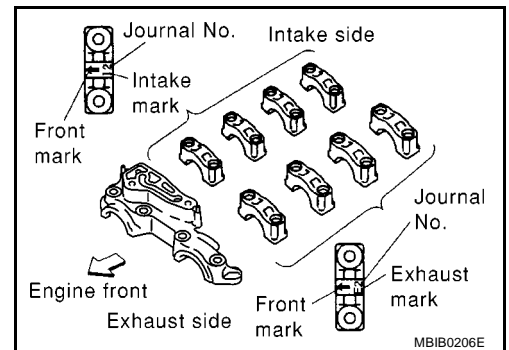
- Install it in its original positions.
2. Install camshaft.
- You can distinguish between the intake and the exhaust by looking at the different shapes of the front and rear ends of the camshaft.



- Install the camshaft front ends dowel pin hole (1) and dowel pin (2) so that they are positioned as shown in the figure.



3. Install camshaft brackets.
- Completely remove any foreign material on bottom surfaces of camshaft brackets and top surface of cylinder head.
  - Referring to the marks on top of the camshaft bracket, install so that it is in the same position and facing the same direction as when removed.



4. Tighten camshaft bracket bolts in the following order.
- a. Bolt sizes vary with installation position. Refer to the following when installing bolts.

### Bolt color

1 - 10 : Black

11, 12 : Gold

- b. First tighten bolts 9 through 12, then tighten bolts 1 through 8 in numerical order.

: 2.0 N·m (0.2 kg-m, 18 in-lb)

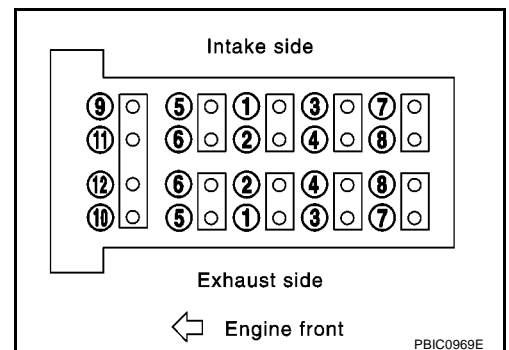
- c. Tighten all bolts in numerical order shown in the figure.

: 5.9 N·m (0.6 kg-m, 52 in-lb)

- d. Retighten all bolts in numerical order shown in the figure.

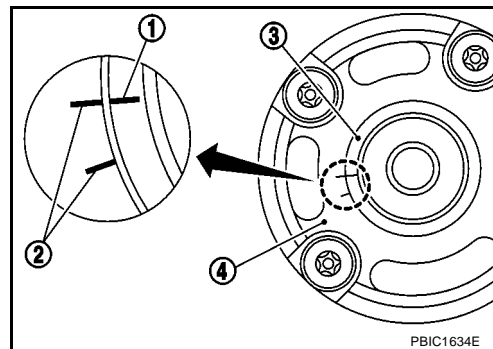
: 9.0 - 11.8 N·m (0.92 - 1.2 kg-m, 80 - 104 in-lb)

5. Install the intake camshaft sprocket in the following procedure:

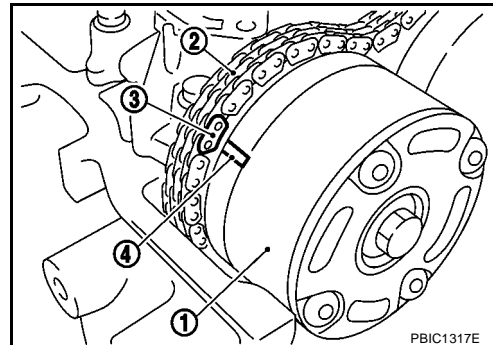


## CAMSHAFT

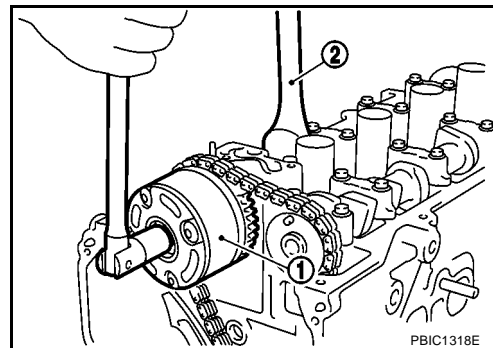
- Make sure the most advanced position checking intake valve timing control advance mark (1) of vane (3) and alignment mark (2) of sprocket (4) are located as shown in the figure.



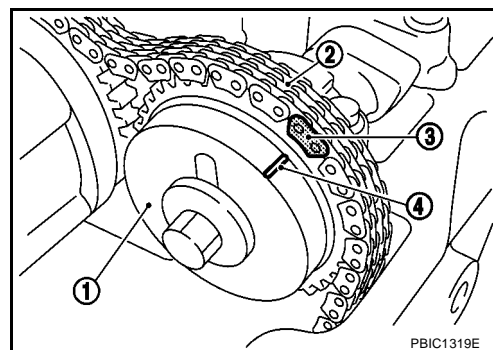
- Install timing chain (2) by aligning its mating mark (3) (marked when timing chain is removed) with mark (4) on camshaft sprocket (1).
- Install by aligning the dowel pin on the back of the camshaft sprocket with dowel pin hole on the camshaft.



- Keeping the camshaft hexagonal part still with the wrench (2), tighten the mounting bolt for the intake camshaft sprocket (1).



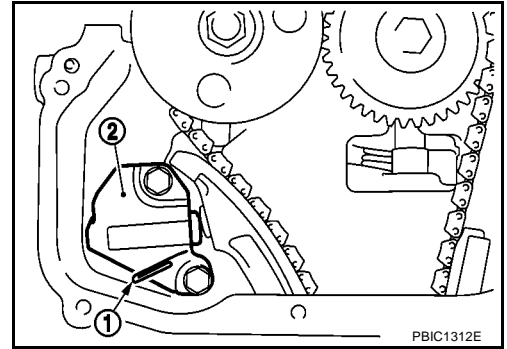
- Remove adhesive tape or equivalent from camshaft sprocket.
- Install the exhaust camshaft sprocket (1) in the following procedure:
    - Install timing chain (2) by aligning its mating mark (3) (marked when timing chain is removed) with mark (4) on camshaft sprocket (1).
    - Install by aligning the dowel pin groove of the sprocket with dowel pin on the camshaft.
    - Keeping the camshaft hexagonal part still with the wrench, tighten the mounting bolt for the exhaust camshaft sprocket.
    - Make sure the markings for the intake and the exhaust camshaft sprockets and the timing chain are all lined up.



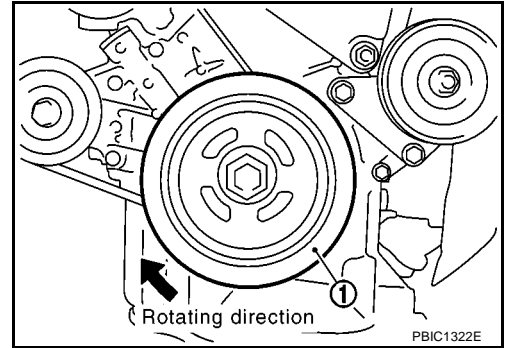
## CAMSHAFT

### 7. Install chain tensioner (2).

- Install the stopper pin (1) with plunger secured.
- After installation, remove the stopper pin (1) and release the plunger.
- Make sure again that mating marks on the intake and exhaust camshaft sprockets and mating marks on timing chain are aligned.



### 8. Turn the crankshaft pulley (1) slowly clockwise to return the intake camshaft sprocket to the most retarded position.



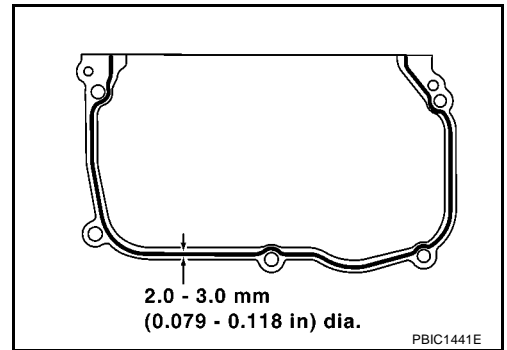
- When first turning the crankshaft the intake camshaft sprocket will turn. Once it is turned more, and the vane (camshaft) also turns, then it has reached the most retarded position.
- After spinning the crankshaft slightly in a counterclockwise direction, you can make sure the lock pin has joined by seeing if the vane and the sprocket move together.

### 9. Install the cylinder head front cover.

- Evenly apply the liquid gasket to the position shown in figure. Use Genuine Liquid Gasket or equivalent.
- Install so that the cylinder head front cover matches up with the dowel pin on the cylinder head side.

### 10. Install camshaft position sensor (PHASE).

- Make sure no foreign particles attach to the flange, O-ring, or attachment hole.
- Tighten the mounting bolt after making sure it is fully inserted into the mounting hole.



### 11. Inspect and adjust valve clearance. Refer to EM-45, "Valve Clearance" on ESM.

### 12. Reinstall removed parts in reverse order of removal.

## INSPECTION AFTER REMOVAL

### Camshaft Runout

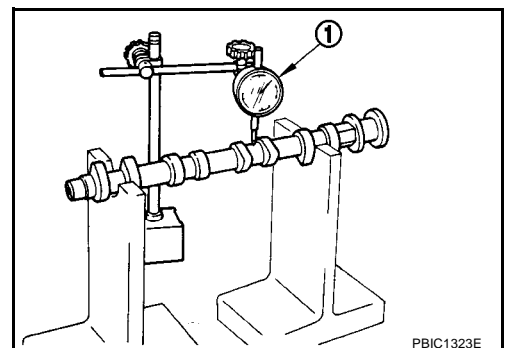
- Put V block on precise flat bed, and support No. 2 and No. 5 journal of camshaft.

#### CAUTION:

**Do not support journal No. 1 (on the side of the camshaft sprocket) because it has a different diameter from the other four locations.**

- Set a dial gauge (1) vertically onto journal No. 3.
- Rotate the camshaft in one direction by hand and read indication on the gauge. (Total indication reading)

**Limit : 0.04 mm (0.0016 in) or less**





## CAMSHAFT

- If exceeds the limit, replace the camshaft.

### Camshaft Cam Height

- Measure with a micrometer (1).

#### Standard

##### CR10DE

Intake : 39.155 - 39.345 mm (1.5415 - 1.5490 in)

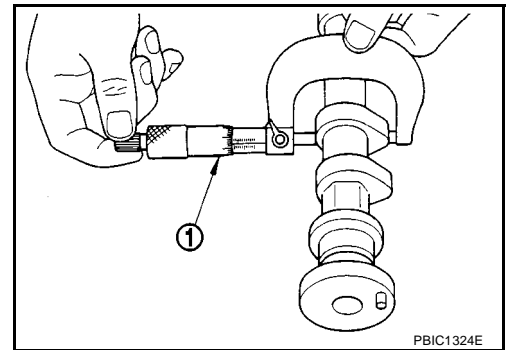
Exhaust : 39.155 - 39.345 mm (1.5415 - 1.5490 in)

##### CR12DE, CR14DE

Intake : 40.359 - 40.549 mm (1.5889 - 1.5964 in)

Exhaust : 39.743 - 39.933 mm (1.5647 - 1.5722 in)

- If it exceeds the standard, replace the camshaft.



### Camshaft Journal Clearance

#### Outer Diameter of Camshaft Journal

- Measure with a micrometer (1).

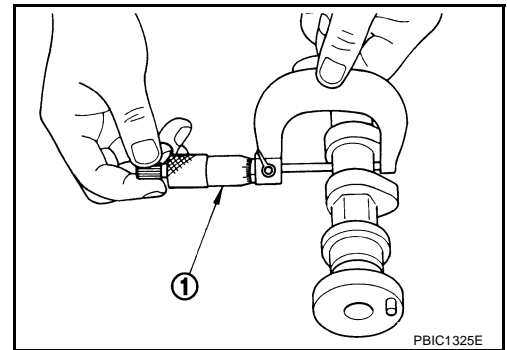
#### Standard

##### No. 1

: 27.935 - 27.955 mm (1.0998 - 1.1006 in)

##### No. 2 to No. 5

: 23.450 - 23.470 mm (0.9232 - 0.9240 in)



#### Inner Diameter of Camshaft Journal

- Tighten camshaft bracket bolts to the specified torque.
- Using an inside micrometer (1), measure inner diameter of the camshaft bracket.

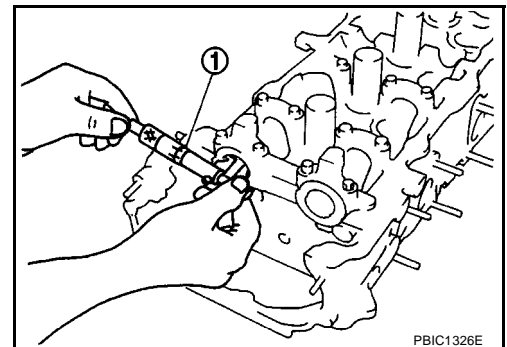
#### Standard

##### No. 1

: 28.000 - 28.021 mm (1.1024 - 1.1032 in)

##### No. 2 to No. 5

: 23.500 - 23.525 mm (0.9252 - 0.9262 in)



### Calculation of Camshaft Journal Clearance

(Journal clearance) = (inner diameter of camshaft bracket) - (outer diameter of camshaft journal).

#### Standard

##### No. 1

: 0.045 - 0.086 mm (0.0018 - 0.0034 in)

##### No. 2 to No. 5

: 0.030 - 0.071 mm (0.0012 - 0.0028 in)

- If clearance exceeded the standard, replace the camshaft and/or the cylinder head. Refer to the standard values for each individual part.

### NOTE:

Since the camshaft brackets and the cylinder head are machined together, replacement must be done using the cylinder head assembly.



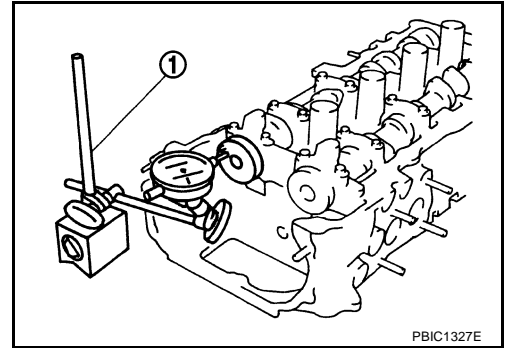
# CAMSHAFT

## Camshaft End Play

- Set a dial gauge (1) to the camshaft front end in thrust direction. Move the camshaft back and forth (axially) and read indication on the gauge.

**Standard : 0.070 - 0.143 mm (0.0028 - 0.0056 in)**

- When out of the standard, replace with new camshaft and measure again.
- When out of the standard again, replace with new cylinder head.



## Camshaft Sprocket Runout

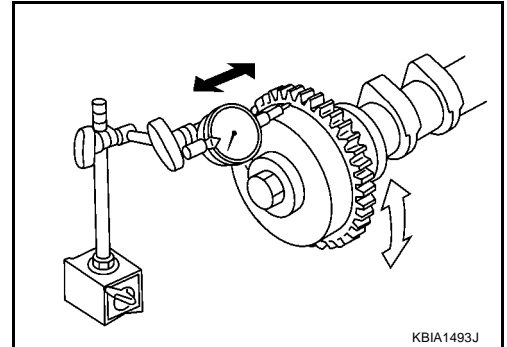
- Put V block on precise flat bed, and support No. 2 and No. 5 journal of camshaft.
- Using a dial gauge, measure camshaft sprocket runout.

### Limit

**Intake : 0.20 mm (0.0079 in)**

**Exhaust : 0.15 mm (0.0059 in)**

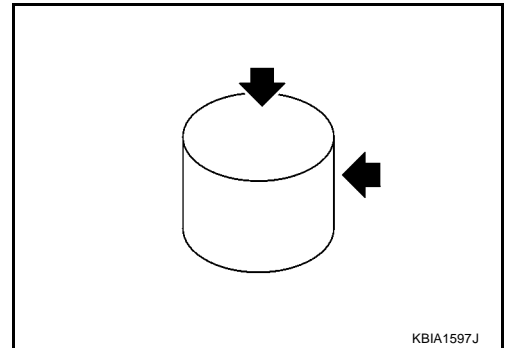
- If it exceeds the limit, replace camshaft sprocket.



## Valve Lifter

Check for cracks and wear on valve lifter surface.

- If anything above is found, replace valve lifter.

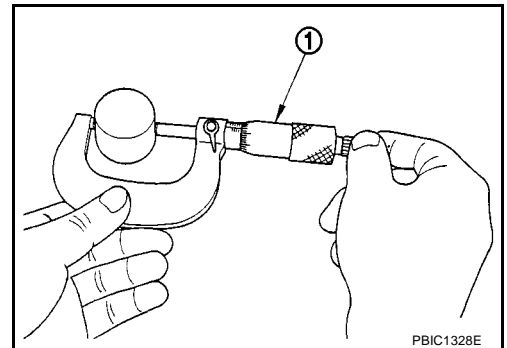


## Valve Lifter Clearance

### Outer Diameter of Valve Lifter

- Measure with a micrometer (1).

**Standard : 29.960 - 29.975 mm (1.1795 - 1.1801 in) dia.**

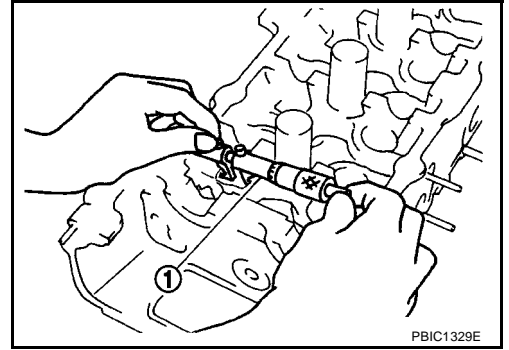


## CAMSHAFT

### Valve Lifter Hole Diameter

- Using an inside micrometer (1), measure the valve lifter hole diameter in cylinder head.

**Standard : 30.000 - 30.021 mm (1.1811 - 1.1819 in) dia.**



Calculation of valve lifter clearance

(Valve lifter clearance) = (valve lifter hole diameter) - (outer diameter of valve lifter)

**Standard : 0.025 - 0.061 mm (0.0010 - 0.0024 in)**

- If clearance exceeded the standard, replace either one or both of valve lifter and cylinder head. Refer to the standard values for valve lifter outer diameter and hole diameter.