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# ENGINE

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# ENGINE <4G1>

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## GENERAL

### OUTLINE OF CHANGES

The following service procedures have been established due to the addition of the 4G13-SOHC 16 valve MPI engine. Furthermore, other items are the same as for the 4G13-SOHC 12 valve MPI engine.

- The basic ignition timing has been changed as a direct-mounted crank angle sensor has been used.
- The compression pressure has been changed.
- An auto-lash adjuster has been adopted.
- Camshaft and camshaft oil seal removal and installation
- Crankshaft front oil seal removal and installation
- Cylinder head gasket removal and installation

## GENERAL INFORMATION

|                    |         |         |               |
|--------------------|---------|---------|---------------|
| Items              |         |         | 4G13          |
| Compression ratio  |         |         | 10.0          |
| Combustion chamber |         |         | Pentroof type |
| Number of valve    | Intake  |         | 8             |
|                    | Exhaust |         | 8             |
| Valve timing       | Intake  | Opening | BTDC 17°      |
|                    |         | Closing | ABDC 39°      |
|                    | Exhaust | Opening | BBDC 49°      |
|                    |         | Closing | ATDC 7°       |
| Auto-lash adjuster |         |         | Equipped      |

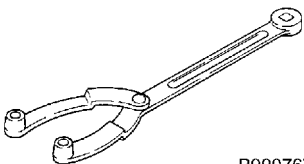
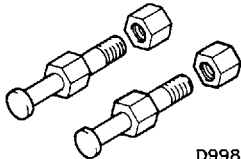

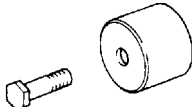
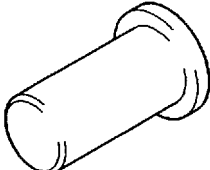
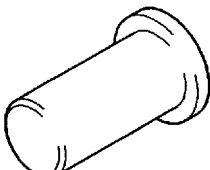
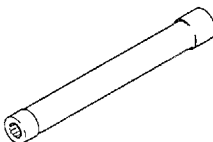
## SERVICE SPECIFICATIONS

| Items                                      | Standard value | Limit      |
|--|----------------|------------|
| Basic ignition timing                      | 5° BTDC ± 3°   | -          |
| Compression pressure (250 – 400 r/min) kPa | 1,598          | Min. 1,161 |
| Cylinder head bolt shank length mm         | -              | 103.2      |

## SEALANT

| Items                            | Specified sealant                              | Remarks             |
|----------------------------------|--|---------------------|
| Camshaft position sensor support | MITSUBISHI GENUINE PART MD970389 or equivalent | Semi-drying sealant |

## SPECIAL TOOLS

| Tool   | Number   | Name                                | Use   |
|--|----------|-------------------------------------|---|
| <br>B990767 | MB990767 | Front hub and flange yoke holder    | Holding the camshaft sprocket               |
| <br>D998719 | MD998719 | Crankshaft pulley holder pin        |   |
|             | MD998443 | Auto-lash adjuster holder           | Supporting of lash adjuster                 |
|             | MD998713 | Camshaft oil seal installer         | Press-in of the camshaft oil seal           |
|           | MD998304 | Crankshaft front oil seal installer | Press-fitting the crankshaft front oil seal |
|           | MD998305 | Crankshaft front oil seal guide     |   |
|           | MB991653 | Cylinder head bolt wrench           | Cylinder head bolt removal and installation |

## ON-VEHICLE SERVICE

### COMPRESSION PRESSURE CHECK

The disconnection of the distributor connector has been changed to the disconnection of the crank angle sensor connector due to the change of the crank angle sensor. Other service procedures are the same as before.

**Standard value (at engine speed of 250-400 r/min):**  
**1,598 kPa**

**Limit (at engine speed of 250 - 400 r/min):**  
**Min. 1,161 kPa**

### LASH ADJUSTER CHECK

If an abnormal noise (knocking) that seems to be coming from the lash adjuster is heard after starting the engine and does not stop, carry out the following check.

#### NOTE

- (1) The abnormal noise which is caused by a problem with the lash adjusters is generated after the engine is started, and will vary according to the engine speed. However, this noise is not related to the actual engine load.

Because of this, if the noise does not occur immediately after the engine is started, if it does not change in accordance with the engine speed, or if it changes in accordance with the engine load, the source of the noise is not the lash adjusters.

- (2) If there is a problem with the lash adjusters, the noise will almost never disappear, even if the engine has been run at idle to let it warm up.

The only case where the noise might disappear is if the oil in the engine has not been looked after properly and oil sludge has caused the lash adjusters to stick.

1. Start the engine.
2. Check that the noise occurs immediately after the engine is started, and that the noise changes in accordance with changes in the engine speed.  
If the noise does not occur immediately after the engine is started, or if it does not change in accordance with the engine speed, the problem is not being caused by the lash adjusters, so check for some other cause of the problem. Moreover, if the noise does not change in accordance with the engine speed, the cause of the problem is probably not with the engine. (In these cases, the lash adjusters are normal.)
3. While the engine is idling, check that the noise level does not change when the engine load is varied.  
If the noise level changes, the cause of the noise is probably parts striking because of worn crankshaft bearings or connecting rod bearings. (In such cases, the lash adjusters are normal.)

4. After the engine has warmed up, run it at idle and check if any noise can be heard.  
If the noise has become smaller or disappeared, oil sludge could make the lash adjusters stick. Clean the lash adjusters. (Refer to the Engine Workshop Manual.) If not improved, go to step 5.
5. Bleed air from the lash adjusters.
6. If the noise has not disappeared even after the air bleeding, clean the lash adjusters. (Refer to the Engine Workshop Manual.)

#### <LASH ADJUSTER AIR BLEEDING>

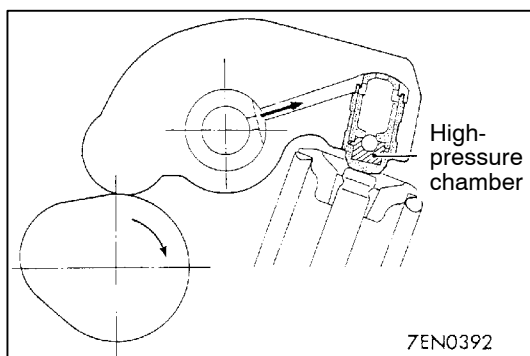
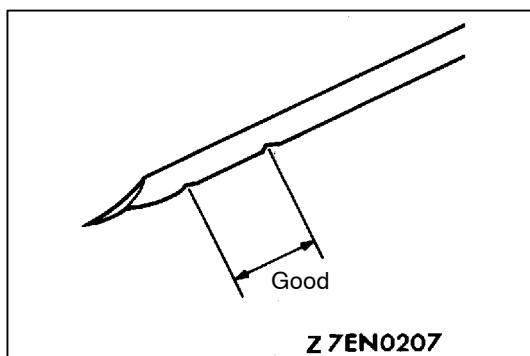
##### NOTE

- (1) If the vehicle is parked on a slope for a long period of time, the amount of oil inside the lash adjuster will decrease, and air may get into the high pressure chamber when starting the engine.
- (2) After parking the vehicle for long periods, the oil drains out of the oil passage, and it takes time for the oil to be supplied to the lash adjuster, so air can get into the high pressure chamber.
- (3) If either of the above situations occur, the abnormal noise can be eliminated by bleeding the air from inside the lash adjusters.

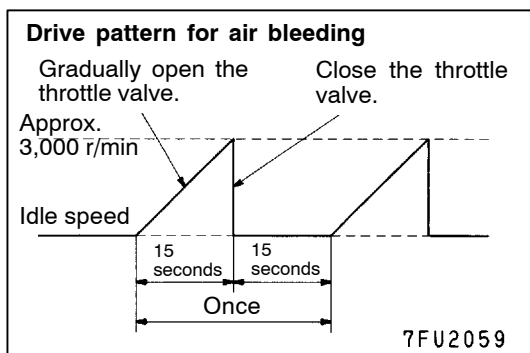
1. Check the engine oil and replenish or replace the oil if necessary.

##### NOTE

- (1) If there is a only small amount of oil, air will be drawn in through the oil screen and will get into the oil passage.
- (2) If the amount of oil is greater than normal, then the oil will being mixed by the crankshaft and a large amount of air may get mixed into the oil.
- (3) If the oil is degenerated, air and oil will not separate easily in oil, and the amount of air mixed into the oil will increase.



- (4) If the air which has been mixed in with the oil due to any of the above reasons gets into the high pressure chamber of the lash adjuster, the air inside the high pressure chamber will be compressed when the valve is open and the lash adjuster will over-compress, resulting in abnormal noise when the valve closes. This is the same effect as if the valve clearance is adjusted to be too large by mistake. If the air inside the lash adjusters is then released, the operation of the lash adjusters will return to normal.



2. Run the engine at idle for 1 - 3 minutes to let it warm up.
3. With no load on the engine, repeat the drive pattern shown in the illustration at left and check if the abnormal noise disappears. (The noise should normally disappear after 10 - 30 repetitions, but if there is no change in the noise level after 30 repetitions or more, the problem is probably not due to air inside the lash adjusters.)
4. After the noise has disappeared, repeat the drive pattern shown in the illustration at left a further 5 times.
5. Run the engine at idle for 1 - 3 minutes and check that the noise has disappeared.

# CAMSHAFT AND CAMSHAFT OIL SEAL

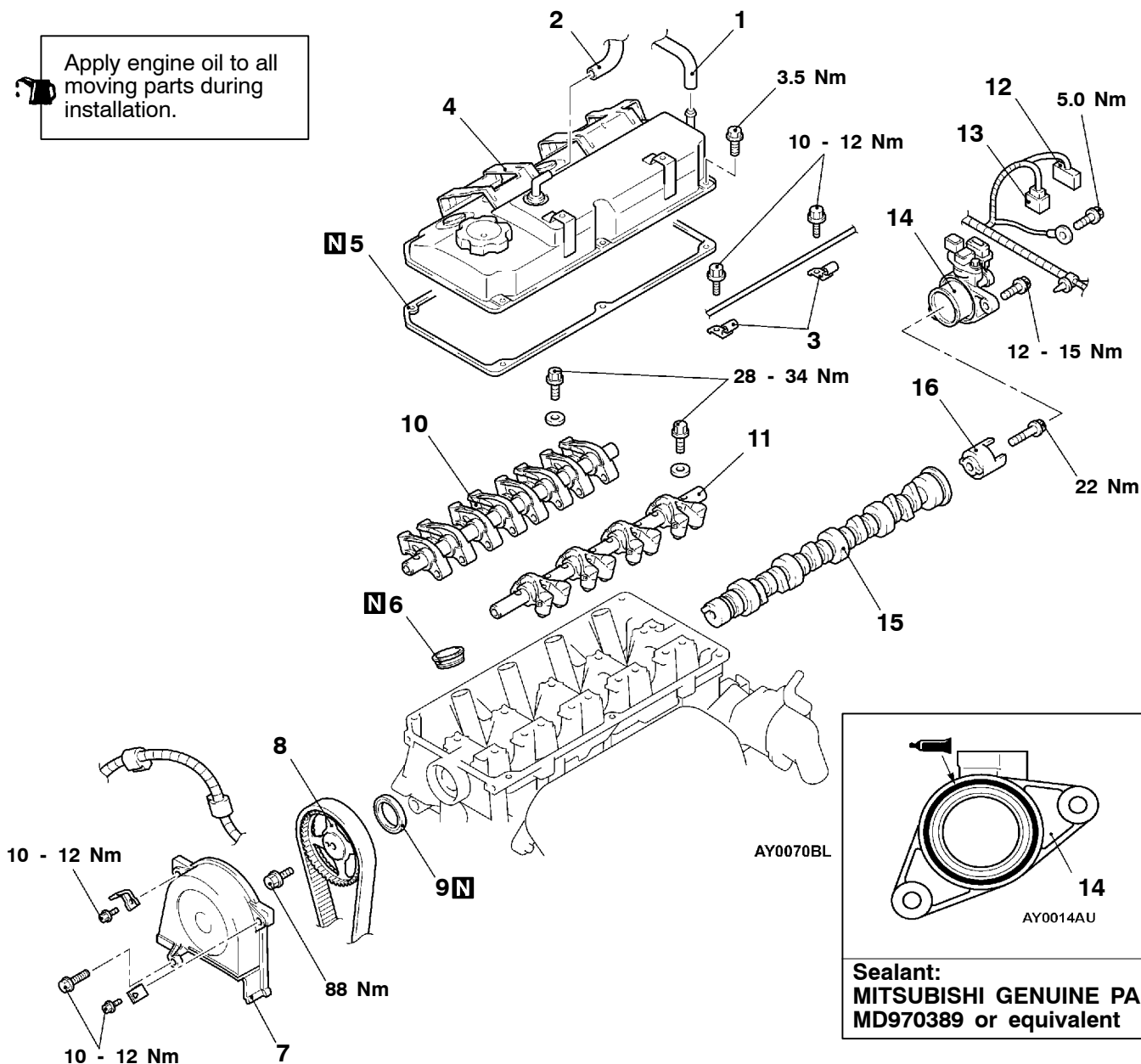
## REMOVAL AND INSTALLATION

### Pre-removal and Post-installation Operation

- Air Cleaner Removal and Installation
- Ignition Coil Removal and Installation  
(Refer to GROUP16.)



Apply engine oil to all moving parts during installation.



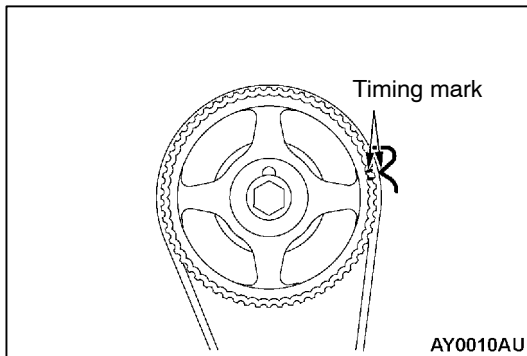
Sealant:  
MITSUBISHI GENUINE PART  
MD970389 or equivalent

### Removal steps

1. Breather hose connection
2. PCV hose connection
3. Accelerator cable clamp  
<LH drive vehicles>
4. Rocker cover
5. Rocker cover gasket
6. Spark plug guide
7. Timing belt front upper cover
8. Camshaft sprocket
9. Camshaft oil seal

10. Lash adjuster, intake rocker arm and shaft assembly
11. Lash adjuster, exhaust rocker arm and shaft assembly
12. Ignition failure sensor connector
13. Camshaft position sensor connector
14. Camshaft position sensor support
15. Camshaft
16. Camshaft position sensing cylinder





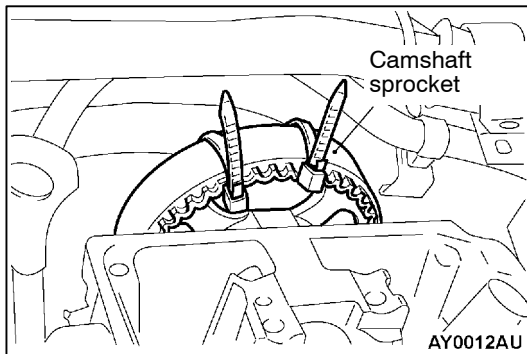
## REMOVAL SERVICE POINTS

### ◀A▶ CAMSHAFT SPROCKET REMOVAL

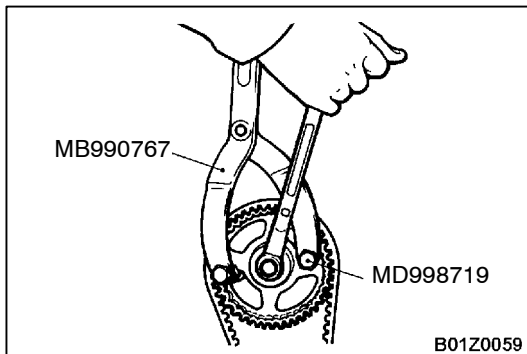
1. Turn the crankshaft in the forward direction (clockwise) to align the timing mark so that No.1 cylinder is at the compression TDC.

#### Caution

**Always turn the crankshaft in the forward direction (clockwise).**



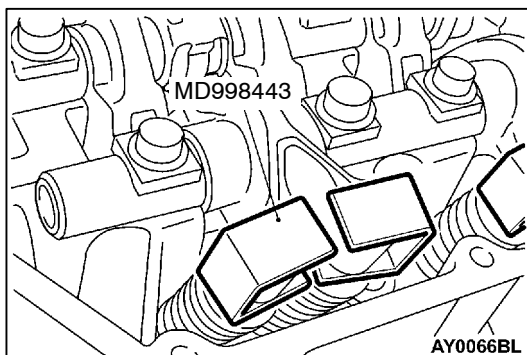
2. Secure the camshaft sprocket and the timing belt with band cables to prevent deviation from the relative positions between the camshaft sprocket and the timing belt.



3. Use the special tool to stop the camshaft sprocket from turning.
4. Remove the camshaft sprocket with the timing belt attached.

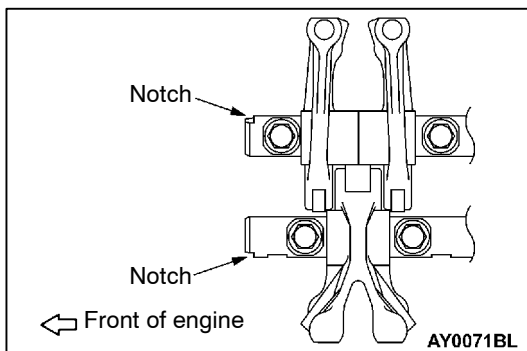
#### Caution

**Do not turn the crankshaft after the camshaft sprocket is removed.**



### ◀B▶ LASH ADJUSTER, INTAKE ROCKER ARM AND SHAFT ASSEMBLY/LASH ADJUSTER, EXHAUST ROCKER ARM AND SHAFT ASSEMBLY REMOVAL

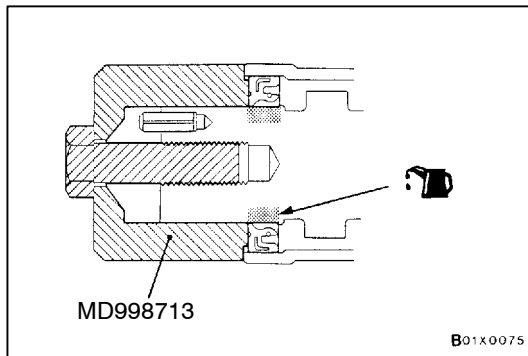
Before removing the lash adjuster, rocker arm and shaft assembly, install the special tools as shown in the illustration so that the lash adjusters will not fall out.



## INSTALLATION SERVICE POINTS

### ▶A▶ LASH ADJUSTER, EXHAUST ROCKER ARM AND SHAFT ASSEMBLY/LASH ADJUSTER, INTAKE ROCKER ARM AND SHAFT ASSEMBLY INSTALLATION

Position the rocker arm shaft so that their notches point the direction shown, and install the lash adjuster, rocker arm and shaft assembly.

**►B◄ CAMSHAFT OIL SEAL INSTALLATION**

1. Apply engine oil to the camshaft oil seal lip.
2. Use the special tool to press-fit the camshaft oil seal.

**►C◄ CAMSHAFT SPROCKET INSTALLATION**

Use the special tool to stop the camshaft sprocket from turning in the same way as was done during removal, and then tighten the bolts to the specified torque.

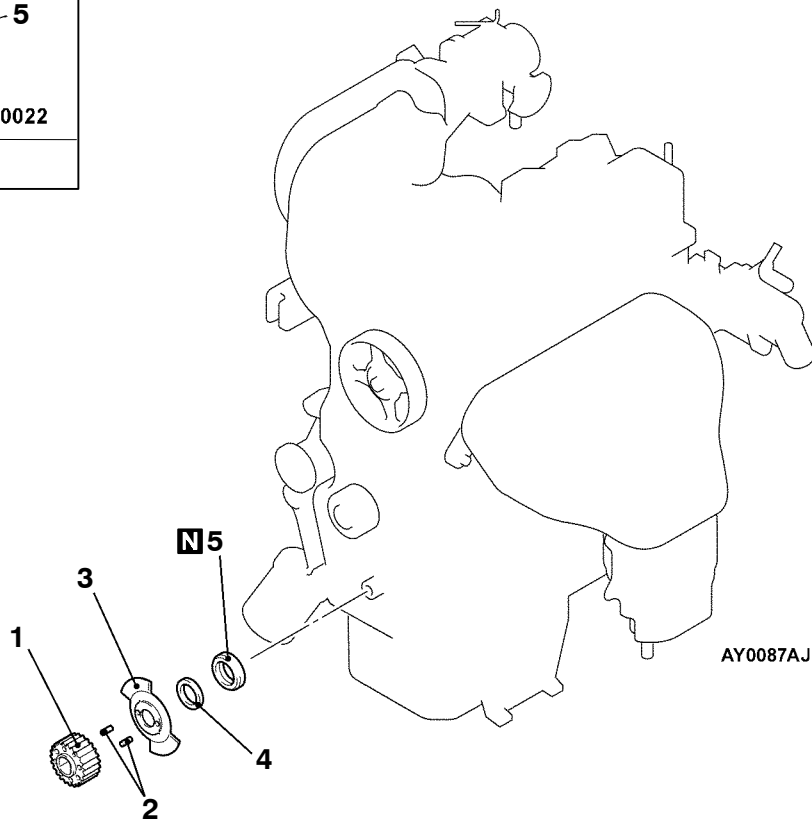
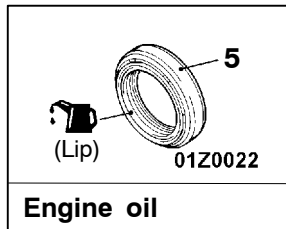
**Tightening torque: 88 Nm**

# CRANKSHAFT FRONT OIL SEAL

## REMOVAL AND INSTALLATION

### Pre-removal and Post-installation Operation

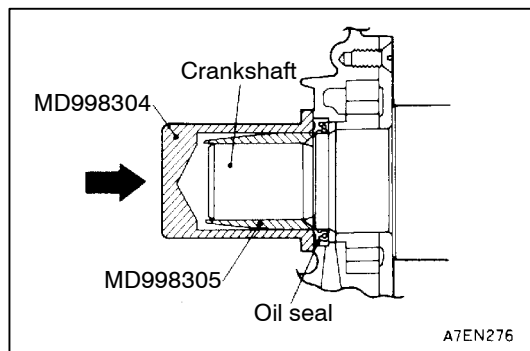
- Timing Belt Removal and Installation
- Crank angle sensor Removal and Installation  
(Refer to GROUP16.)



### Removal steps

- B◄ 1. Crankshaft sprocket  
►B◄ 2. Spring pin  
►B◄ 3. Crankshaft sensing blade

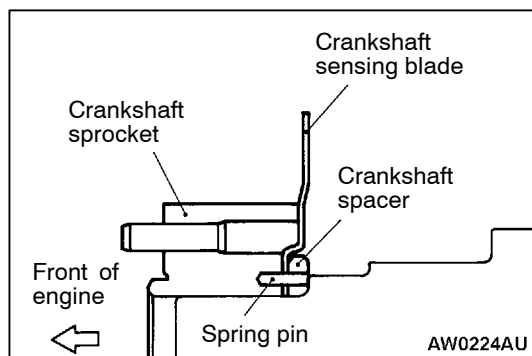
- B◄ 4. Crankshaft spacer  
►A◄ 5. Crankshaft front oil seal



## INSTALLATION SERVICE POINTS

### ►A◄ CRANKSHAFT FRONT OIL SEAL INSTALLATION

1. Apply a small amount of engine oil to the entire circumference of the oil seal lip.
2. Tap the oil seal unit it flushes with the oil seal case.



### ►B◄ CRANKSHAFT SPACER/CRANKSHAFT SENSING BLADE/SPRING PIN/CRANKSHAFT SPROCKET INSTALLATION

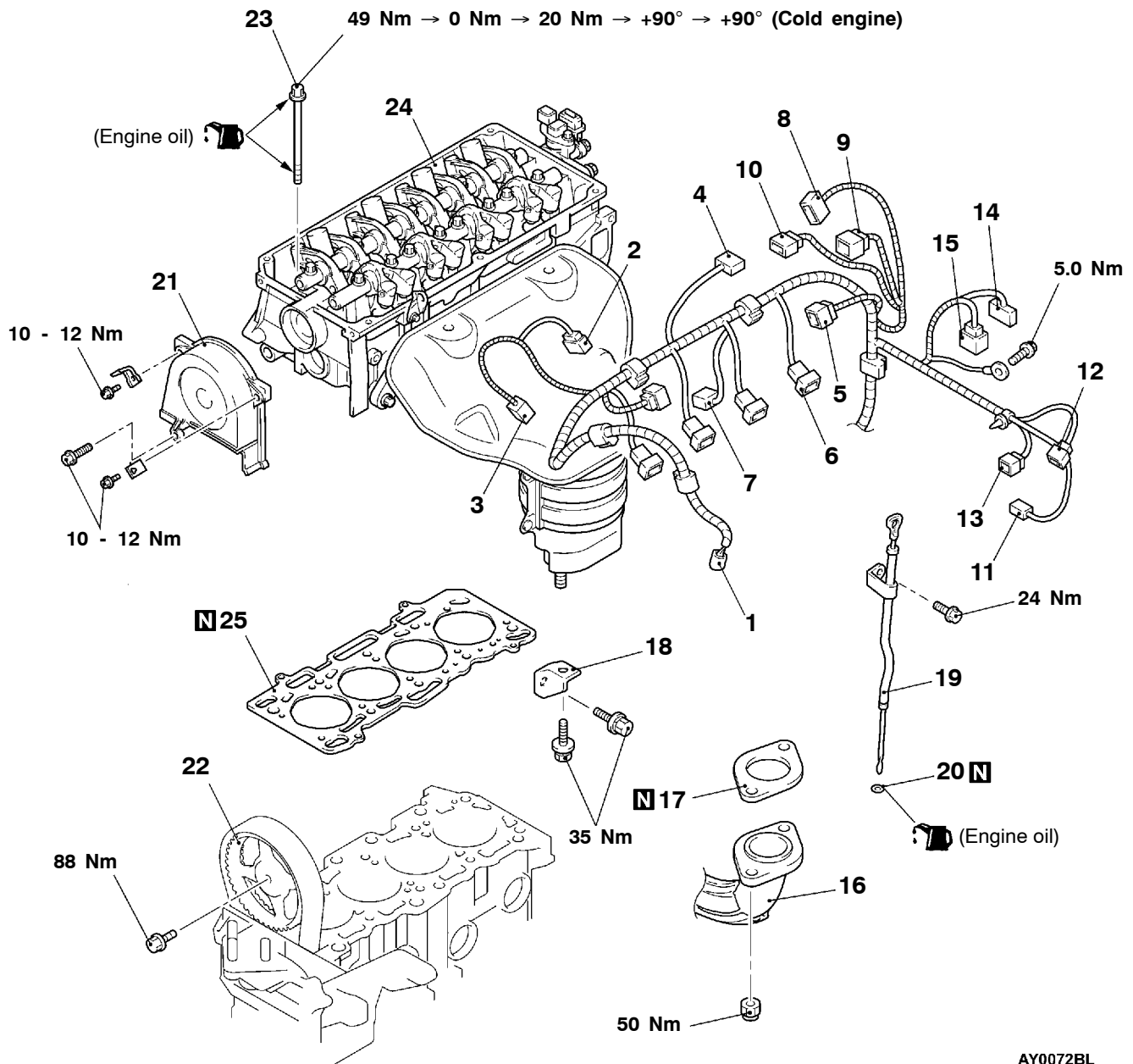
Install the crankshaft sprocket assembled with the spring pin, the crankshaft sensing blade, and the crankshaft spacer to the crankshaft.

## CYLINDER HEAD GASKET

### REMOVAL AND INSTALLATION

#### Pre-removal and Post-installation Operation

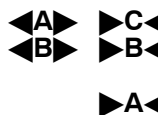
- Prevention of Fuel Discharge <before removal only>
- Fuel Leak Check <after installation only>
- Under Cover Removal and Installation
- Engine Coolant Draining and Supplying
- Engine Oil Draining and Supplying
- Air Cleaner Removal and Installation

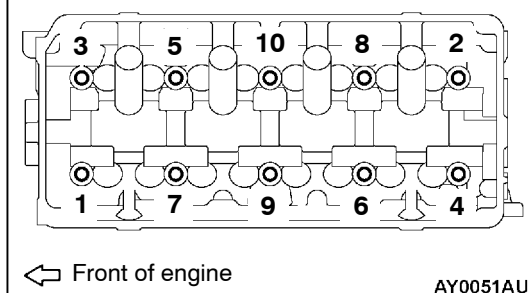
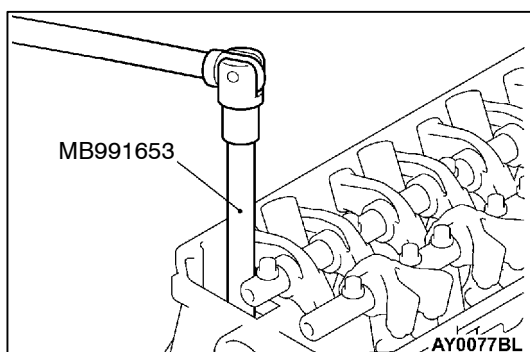
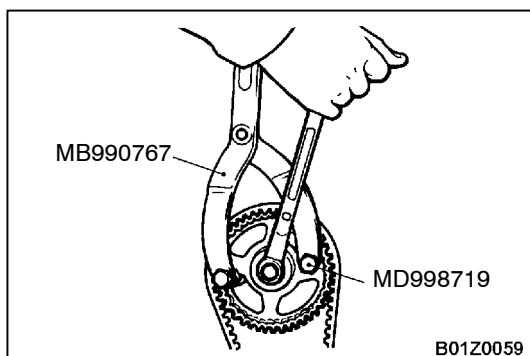
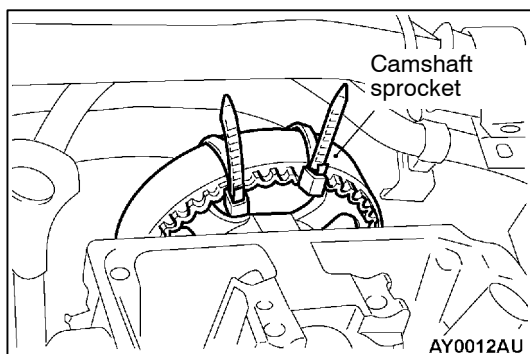
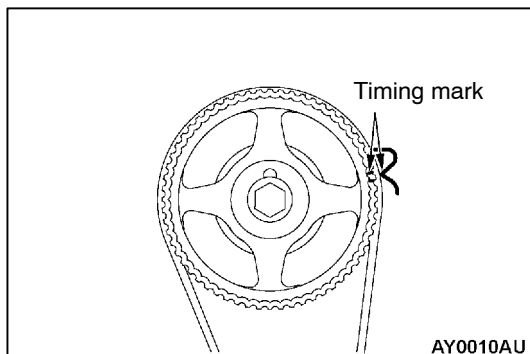


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**Removal steps**

- |   |   |
|---|---|
| 1. Crank angle sensor connector                     | 14. Ignition failure sensor connector   |
| 2. Detonation sensor connector                      | 15. Camshaft position sensor connector  |
| 3. Oxygen sensor (rear) connector                   | • Rocker cover (Refer to P.11A-8.)      |
| 4. Vacuum sensor connector                          | • Intake manifold (Refer to GROUP 15.)  |
| 5. Ignition coil connector                          | • Water inlet pipe (Refer to GROUP 14.) |
| 6. Injector connector                               | 16. Front exhaust pipe connection       |
| 7. EGR solenoid valve connector                     | 17. Front exhaust pipe gasket           |
| 8. Throttle position sensor connector               | 18. Exhaust manifold bracket            |
| 9. Idle speed control servo connector               | 19. Oil level gauge assembly            |
| 10. Purge control solenoid valve connector          | 20. O-ring                              |
| 11. Engine coolant temperature gauge unit connector | 21. Timing belt front upper cover       |
| 12. Oxygen sensor (front) connector                 | 22. Camshaft sprocket                   |
| 13. Engine coolant temperature sensor connector     | 23. Cylinder head bolts                 |
|   | 24. Cylinder head assembly              |
|   | 25. Cylinder head gasket                |





## REMOVAL SERVICE POINTS

### ◀A▶ CAMSHAFT SPROCKET REMOVAL

1. Turn the crankshaft in the forward direction (clockwise) to align the timing mark so that No.1 cylinder is at the compression TDC.

#### Caution

**Always turn the crankshaft in the forward direction (clockwise).**

2. Secure the camshaft sprocket and the timing belt with band cables to prevent deviation from the relative positions between the camshaft sprocket and the timing belt.

3. Use the special tool to stop the camshaft sprocket from turning.
4. Remove the camshaft sprocket with the timing belt attached.

#### Caution

**Do not turn the crankshaft after the camshaft sprocket is removed.**

### ◀B▶ CYLINDER HEAD BOLT REMOVAL

Use the special tool to loosen the bolts in 2 or 3 steps in order of the numbers shown in the illustration, and remove the cylinder head assembly.

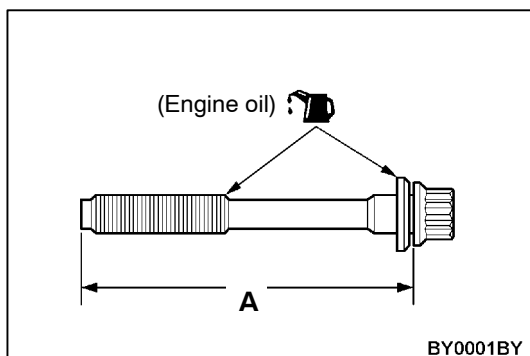
**INSTALLATION SERVICE POINTS****►A◄ CYLINDER HEAD GASKET INSTALLATION**

1. Wipe off all oil and grease from the gasket mounting surface.

**Caution**

**Do not allow foreign material to enter the engine coolant or oil passages and the cylinder.**

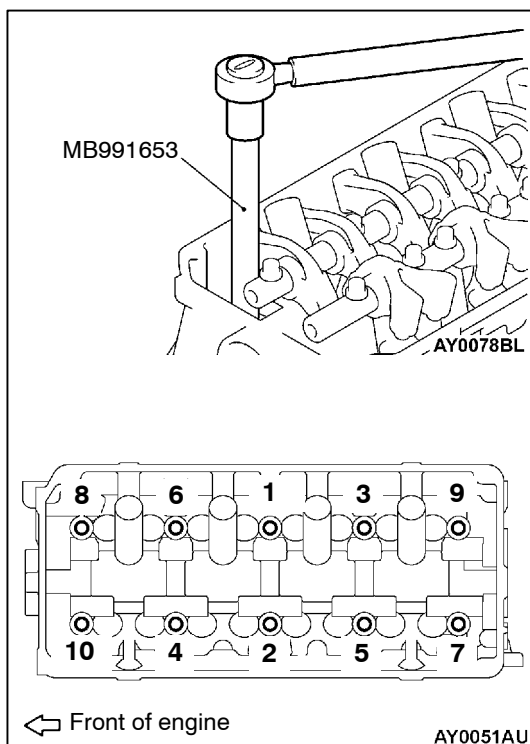
2. Install so that the shapes of the cylinder head holes match the shapes of the respective cylinder head gasket holes.

**►B◄ CYLINDER HEAD BOLT INSTALLATION**

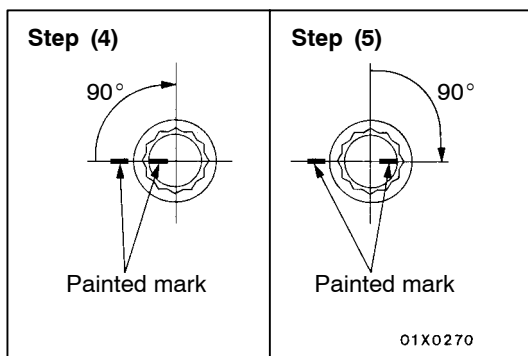
1. When installing the cylinder head bolts, the length below the head of the bolts should be within the limit. If it is outside the limit, replace the bolts.

**Limit (A): 103.2 mm**

2. Apply a small amount of engine oil to the thread section and the washer of the cylinder head bolt.



3. Use the special tool to tighten the bolts by the following procedure (angle-tightening procedure).
  - (1) Tighten the cylinder head bolts in the shown sequence to 49 Nm.
  - (2) Loosen the cylinder head bolts completely in the reverse of the shown sequence.
  - (3) Tighten the cylinder head bolts in the shown order to 20 Nm.



- (4) Mark the cylinder head bolts and the cylinder head with paint, and then tighten the bolts in the shown sequence to 90°.
- (5) Tighten the bolts in the shown sequence to additional 90°, and check that the paint marks on the cylinder head bolts are flush with the paint marks on the cylinder head.

**Caution**

- 1) If the tightening angle is less than 90°, the bolt is loose.
- 2) If the tightening angle is more than 90°, loosen the bolt and repeat the procedure from step 1.

**►C◄ CAMSHAFT SPROCKET INSTALLATION**

Use the special tool to stop the camshaft sprocket from turning in the same way as was done during removal, and then tighten the bolts to the specified torque.

**Tightening torque: 88 Nm**



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# ENGINE <4G9>

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## GENERAL

### OUTLINE OF CHANGES

The following service procedures have been changed. Furthermore, other items are the same as before.

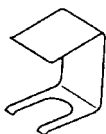
- The valve timing has been changed.

- The ignition timing has been changed.
- An auto-lash adjuster has been added.
- The timing belt lower cover has been changed.

## GENERAL INFORMATION

| Items        |         |         | 4G9      |
|--------------|---------|---------|----------|
| Valve timing | Intake  | Opening | BTDC 12° |
|              |         | Closing | ABDC 46° |
|              | Exhaust | Opening | BBDC 46° |
|              |         | Closing | ATDC 2°  |

## SPECIAL TOOL

| Tool   | Number   | Name                      | Use                         |
|--|----------|---------------------------|-----------------------------|
|  | MD998443 | Auto-lash adjuster holder | Supporting of lash adjuster |

## ON-VEHICLE SERVICE

### IGNITION TIMING CHECK

The ignition timing has been changed. Other service procedures are the same as before.

**Standard value: Approx. 8° BTDC**

### LASH ADJUSTER CHECK

If an abnormal noise (knocking) that seems to be coming from the lash adjuster is heard after starting the engine and does not stop, carry out the following check.

#### NOTE

- (1) The abnormal noise which is caused by a problem with the lash adjusters is generated after the engine is started, and will vary according to the engine speed. However, this noise is not related to the actual engine load.

Because of this, if the noise does not occur immediately after the engine is started, if it does not change in accordance with the engine speed, or if it changes in accordance with the engine load, the source of the noise is not the lash adjusters.

- (2) If there is a problem with the lash adjusters, the noise will almost never disappear, even if the engine has been run at idle to let it warm up.

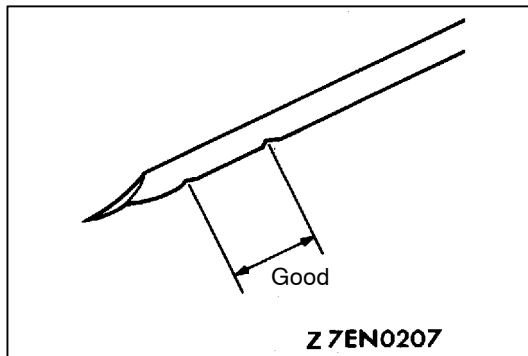
The only case where the noise might disappear is if the oil in the engine has not been looked after properly and oil sludge has caused the lash adjusters to stick.

1. Start the engine.
2. Check that the noise occurs immediately after the engine is started, and that the noise changes in accordance with changes in the engine speed.  
If the noise does not occur immediately after the engine is started, or if it does not change in accordance with the engine speed, the problem is not being caused by the lash adjusters, so check for some other cause of the problem. Moreover, if the noise does not change in accordance with the engine speed, the cause of the problem is probably not with the engine. (In these cases, the lash adjusters are normal.)
3. While the engine is idling, check that the noise level does not change when the engine load is varied (for example, by shifting from N → D).  
If the noise level changes, the cause of the noise is probably parts striking because of worn crankshaft bearings or connecting rod bearings. (In such cases, the lash adjusters are normal.)
4. After the engine has warmed up, run it at idle and check if any noise can be heard.  
If the noise has become smaller or disappeared, oil sludge could make the lash adjusters stick. Clean the lash adjusters. (Refer to the Engine Workshop Manual.) If not improved, go to step 5.
5. Bleed air from the lash adjusters.
6. If the noise has not disappeared even after the air bleeding, clean the lash adjusters. (Refer to the Engine Workshop Manual.)

#### <LASH ADJUSTER AIR BLEEDING>

##### NOTE

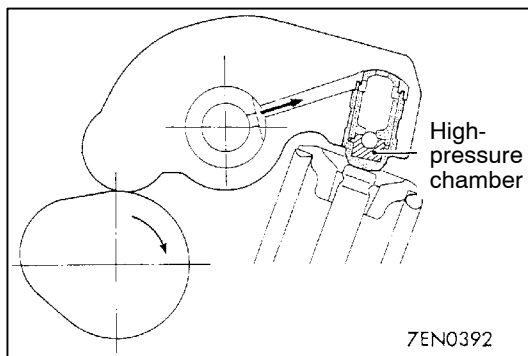
- (1) If the vehicle is parked on a slope for a long period of time, the amount of oil inside the lash adjuster will decrease, and air may get into the high pressure chamber when starting the engine.
- (2) After parking the vehicle for long periods, the oil drains out of the oil passage, and it takes time for the oil to be supplied to the lash adjuster, so air can get into the high pressure chamber.
- (3) If either of the above situations occur, the abnormal noise can be eliminated by bleeding the air from inside the lash adjusters.



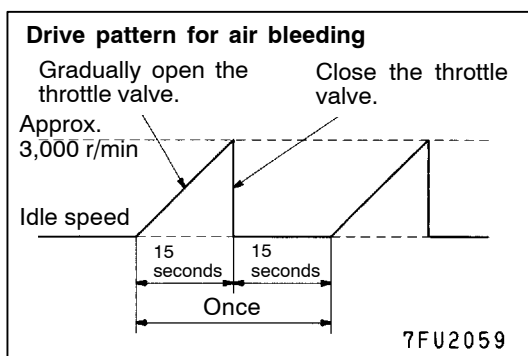
1. Check the engine oil and replenish or replace the oil if necessary.

## NOTE

- (1) If there is a only small amount of oil, air will be drawn in through the oil screen and will get into the oil passage.
- (2) If the amount of oil is greater than normal, then the oil will being mixed by the crankshaft and a large amount of air may get mixed into the oil.
- (3) If the oil is degenerated, air and oil will not separate easily in oil, and the amount of air mixed into the oil will increase.



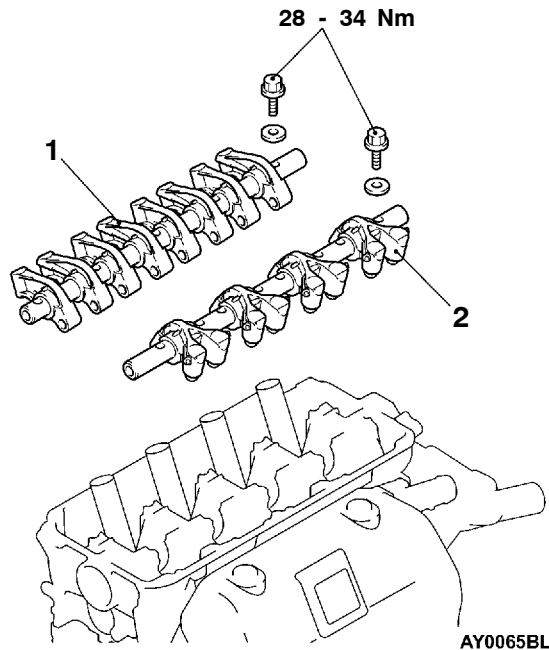
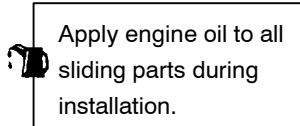
- (4) If the air which has been mixed in with the oil due to any of the above reasons gets into the high pressure chamber of the lash adjuster, the air inside the high pressure chamber will be compressed when the valve is open and the lash adjuster will over-compress, resulting in abnormal noise when the valve closes. This is the same effect as if the valve clearance is adjusted to be too large by mistake. If the air inside the lash adjusters is then released, the operation of the lash adjusters will return to normal.



2. Run the engine at idle for 1 - 3 minutes to let it warm up.
3. With no load on the engine, repeat the drive pattern shown in the illustration at left and check if the abnormal noise disappears. (The noise should normally disappear after 10 - 30 repetitions, but if there is no change in the noise level after 30 repetitions or more, the problem is probably not due to air inside the lash adjusters.)
4. After the noise has disappeared, repeat the drive pattern shown in the illustration at left a further 5 times.
5. Run the engine at idle for 1 - 3 minutes and check that the noise has disappeared.

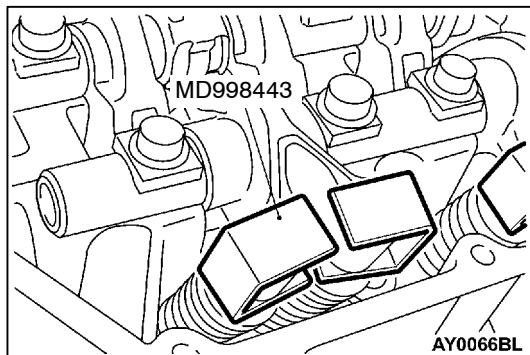
# CAMSHAFT AND CAMSHAFT OIL SEAL

## REMOVAL AND INSTALLATION



### Removal steps

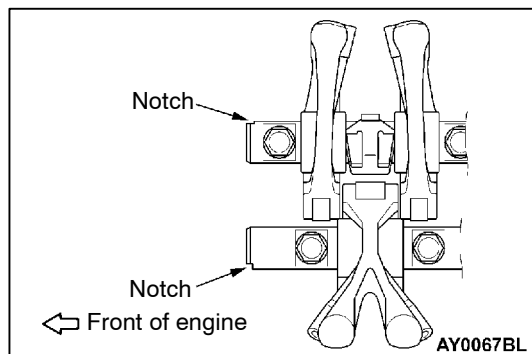
- ◀A▶ ▶A◀ 1. Lash adjuster, intake rocker arm and shaft assembly
- ◀A▶ ▶A◀ 2. Lash adjuster, exhaust rocker arm and shaft assembly



### REMOVAL SERVICE POINT

- ◀A▶ LASH ADJUSTER, INTAKE ROCKER ARM AND SHAFT ASSEMBLY/LASH ADJUSTER, EXHAUST ROCKER ARM AND SHAFT ASSEMBLY REMOVAL

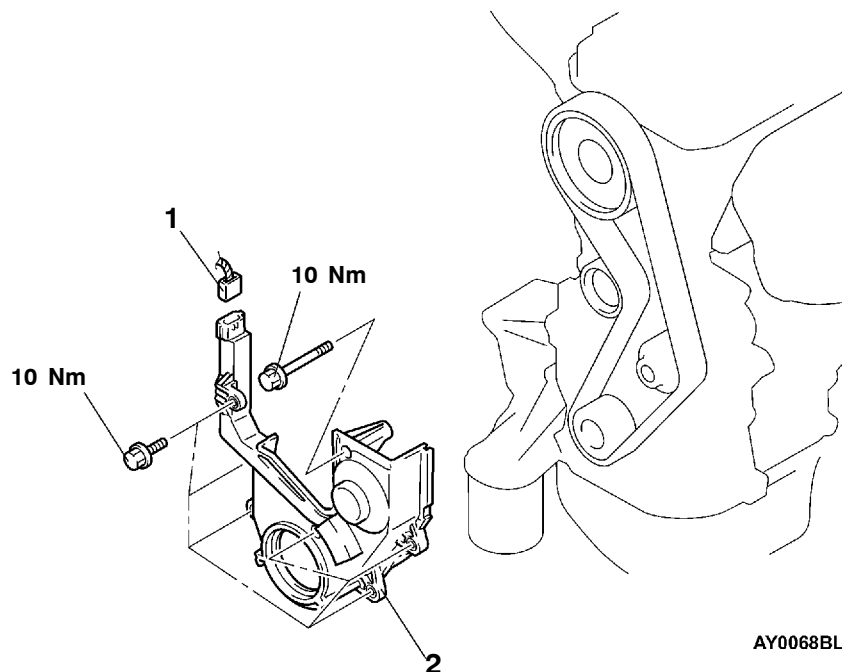
Before removing the lash adjuster, rocker arm and shaft assembly, install the special tools as shown in the illustration so that the lash adjusters will not fall out.



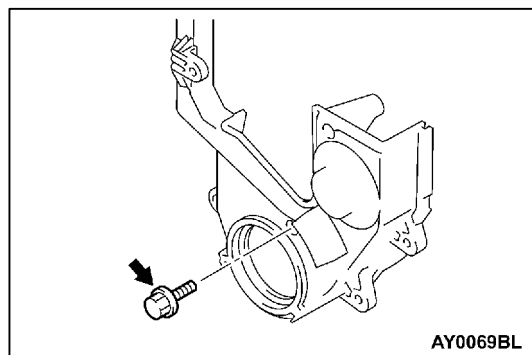
### INSTALLATION SERVICE POINT

- ▶A◀ LASH ADJUSTER, EXHAUST ROCKER ARM AND SHAFT ASSEMBLY/LASH ADJUSTER, INTAKE ROCKER ARM AND SHAFT ASSEMBLY INSTALLATION

Position the rocker arm shafts so that their notches point the direction shown, and install the lash adjuster, rocker arm and shaft assembly.

**TIMING BELT****REMOVAL AND INSTALLATION****Removal steps**

- A◄
1. Crank angle sensor connector
  2. Timing belt lower cover

**INSTALLATION SERVICE POINT****►A◄ TIMING BELT LOWER COVER INSTALLATION**

1. Mount the bolt shown in the illustration (M6 × 20 mm) first.
2. Mount the other bolts, and tighten them to the specified torque.

**Tightening torque: 10 Nm**