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# **ENGINE**

## **<4G9-GDI>**

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# ENGINE

## <4G9-GDI>

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# 11A-2 ENGINE <4G9-GDI> – General Information/Service Specifications

## GENERAL INFORMATION

Items		4G93-GDI	
Total displacement ml		1,834	
Bore × Stroke mm		81 × 89	
Compression ratio		12.0	
Combustion chamber		Pentroof + ball-in-piston	
Camshaft arrangement		DOHC	
Number of valve	Intake	8	
	Exhaust	8	
Valve timing	Intake	Opening	BTDC 15°
		Closing	ABDC 56°
	Exhaust	Opening	BBDC 55°
		Closing	ATDC 15°
Fuel system		Electronically controlled multipoint fuel injection	
Rocker arm		Roller type	
Auto-lash adjuster		Equipped	

## SERVICE SPECIFICATIONS

Items		Standard value	Limit
Alternator drive belt tension (When checked)	Vibration frequency Hz	143 – 185	–
	Tension N	294 – 490	–
	Deflection (Reference value) mm	9.7 – 12.9	–
Alternator drive belt tension (When adjusted)	Vibration frequency Hz	155 – 175	–
	Tension N	343 – 441	–
	Deflection (Reference value) mm	10.5 – 12.0	–
Alternator drive belt tension (When replaced)	Vibration frequency Hz	203 – 234	–
	Tension N	588 – 784	–
	Deflection (Reference value) mm	6.7 – 8.5	–

Items		Standard value	Limit
Power steering oil pump and A/C compressor drive belt tension (When checked)	Vibration frequency Hz	114 – 139	–
	Tension N	392 – 588	–
	Deflection (Reference value) mm	10.0 – 12.0	–
Power steering oil pump and A/C compressor drive belt tension (When adjusted)	Vibration frequency Hz	121 – 133	–
	Tension N	441 – 539	–
	Deflection (Reference value) mm	10.0 – 11.0	–
Power steering oil pump and A/C compressor drive belt tension (When replaced)	Vibration frequency Hz	145 – 166	–
	Tension N	637 – 834	–
	Deflection (Reference value) mm	7.0 – 9.0	–
Basic ignition timing		5° BTDC ± 3°	–
Ignition timing		Approx. 16° BTDC*1	–
Idle speed r/min		600 ± 50*1	–
CO contents %		0.6 or less	–
HC contents ppm		200 or less	–
Compression pressure kPa – r/min		1,720 – 300	1,337 – 300
Compression pressure difference of all cylinder kPa		–	Max. 100
Intake manifold vacuum kPa		–	Min. 60*2
Cylinder head bolt shank length mm		–	96.4
Auto-tensioner push rod movement mm		Within 1	–
Timing belt tension torque Nm (Reference value)		2.5 – 4.0	–
Auto-tensioner rod protrusion amount mm		3.8 – 4.5	–

**NOTE**

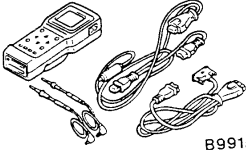
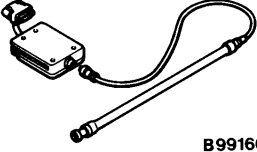
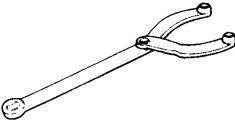
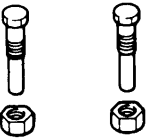
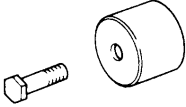
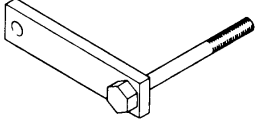
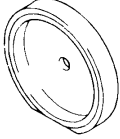
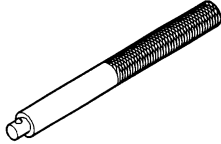
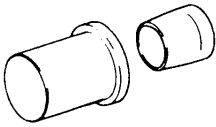
\*1: Indicates the value measured within 4 minutes since the engine was started.

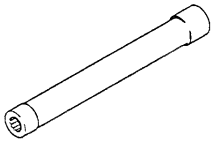
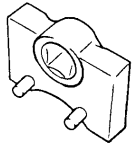
\*2: Indicates the value when more than 4 minutes have passed since the engine was started.

**SEALANTS**

Items	Specified sealants	Remarks
Beam camshaft cap Cylinder head	3M ATD Part No.8660 or equivalent	–
Cam position sensor support Oil pan	MITSUBISHI GENUINE PART MD970389 or equivalent	Semi-drying sealant
Thrust case Flywheel or drive plate bolt	3M Stud Locking 4170 or equivalent	–

## SPECIAL TOOLS

Tool	Number	Name	Use
 B991502	MB991502	MUT-II sub assembly	<ul style="list-style-type: none"> <li>● Measuring the drive belt tension</li> <li>● Checking the ignition timing</li> <li>● Checking the idle speed</li> <li>● Erasing diagnosis code</li> </ul>
 B991668	MB991668	Belt tension meter set	Measuring the drive belt tension (used together with the MUT-II)
	MB990767	End yoke holder	<ul style="list-style-type: none"> <li>● Holding the camshaft sprocket</li> <li>● Holding the crankshaft sprocket</li> </ul>
	MD998719 or MD998754	Crankshaft pulley holder pin	<ul style="list-style-type: none"> <li>● Holding the camshaft sprocket</li> <li>● Holding the crankshaft sprocket</li> </ul>
	MD998713	Camshaft oil seal installer	Press-in of the camshaft oil seal
	MD998781	Flywheel stopper	Securing the flywheel or drive plate
	MD998776	Crankshaft rear oil seal installer	Press-in of the crankshaft rear oil seal
	MB990938	Handle	Press-in of the crankshaft rear oil seal
	MD998717	Crankshaft front oil seal installer	Press-in of crankshaft front oil seal

Tool	Number	Name	Use
 A long, cylindrical metal tool with a hexagonal end and a small circular mark on the side.	MB991653	Cylinder head bolt wrench	Cylinder head bolt removal and installation
 A specialized socket wrench with a rectangular body and a circular opening in the center.	MD998767	Tension pulley socket wrench	Timing belt tension adjustment

## ON-VEHICLE SERVICE

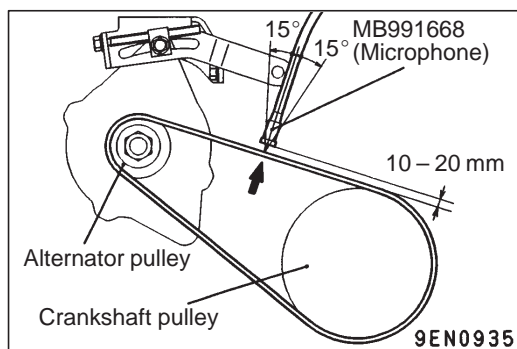
### DRIVE BELT TENSION CHECK AND ADJUSTMENT

#### ALTERNATOR DRIVE BELT TENSION CHECK

Check the drive belt tension in the following procedure.

#### Standard value:

Vibration frequency Hz	143 – 185
Tension N	294 – 490
Deflection (Reference value) mm	9.7 – 12.9

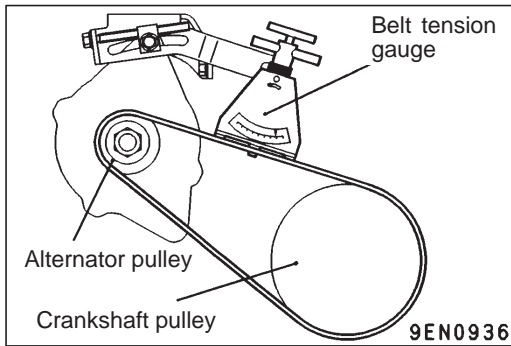


#### <When using the MUT-II>

1. Connect the special tool (belt tension meter set) to the MUT-II.
2. Connect the MUT-II to the diagnosis connector.
3. Turn the ignition switch to ON and select "Belt Tension Measurement" from the menu screen.
4. Hold the microphone to the middle of the drive belt between the pulleys (at the place indicated by the arrow), about 10 – 20 mm away from the rear surface of the belt and so that it is perpendicular to the belt (within an angle of  $\pm 15^\circ$ ).
5. Gently tap the middle of the belt between the pulleys (the place indicated by the arrow) with your finger as shown in the illustration, and check that the vibration frequency of the belt is within the standard value.

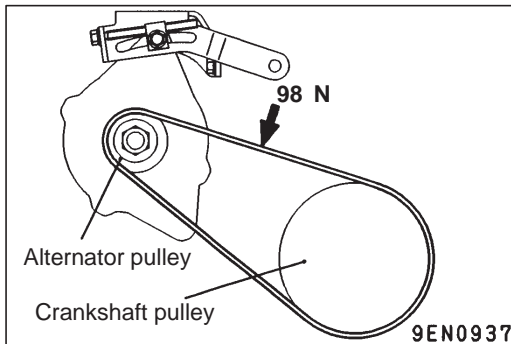
#### Caution

- (1) The temperature of the surface of the belt should be as close as possible to normal temperature.
- (2) Do not let any contaminants such as water or oil get onto the microphone.
- (3) If strong gusts of wind blow against the microphone or if there are any loud sources of noise nearby, the values measured by the microphone may not correspond to actual values.
- (4) If the microphone is touching the belt while the measurement is being made, the values measured by the microphone may not correspond to actual values.
- (5) Do not take the measurement while the vehicle's engine is running.



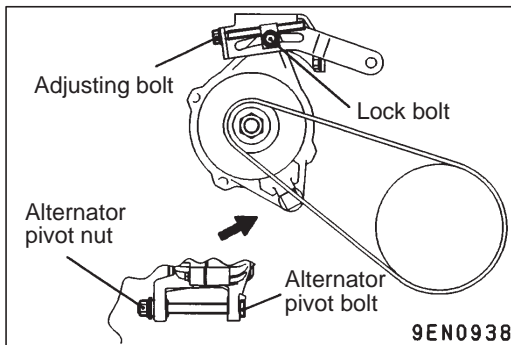
#### <When using a tension gauge>

Use a belt tension gauge to check that the belt tension is within the standard value.



#### <Belt deflection check>

Apply 98 N of force to the middle of the drive belt between the pulleys (at the place indicated by the arrow) and check that the amount of deflection is within the standard value.



#### ALTERNATOR DRIVE BELT TENSION ADJUSTMENT

1. Loosen the nut of the alternator pivot bolt.
2. Loosen the lock bolt.
3. Use the adjusting bolt to adjust the belt tension and belt deflection to the standard values.

#### Standard value:

Items	When adjusted	When replaced
Vibration frequency Hz	155 – 175	203 – 234
Tension N	343 – 441	588 – 784
Deflection (Reference value) mm	10.5 – 12.0	6.7 – 8.5

4. Tighten the nut of the alternator pivot bolt.

**Tightening torque: 44 Nm**

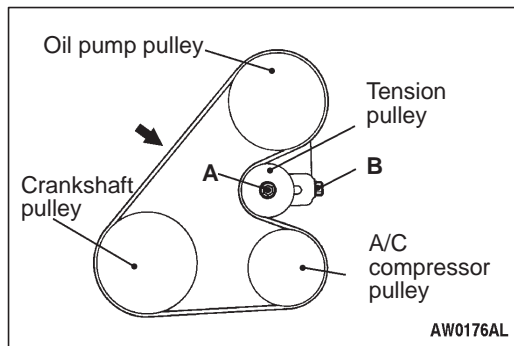
5. Tighten the lock bolt.

**Tightening torque: 22 Nm**

6. Tighten the adjusting bolt.

**Tightening torque: 5 Nm**





### POWER STEERING OIL PUMP AND AIR CONDITIONER COMPRESSOR DRIVE BELT TENSION CHECK AND ADJUSTMENT

1. Check if the belt tension is within the standard value using one of the methods below.

#### Standard value:

Items	When checked	When adjusted	When replaced
Vibration frequency Hz	114 – 139	121 – 133	145 – 166
Tension N	392 – 588	441 – 539	637 – 834
Deflection (Reference value) mm	10.0 – 12.0	10.0 – 11.0	7.0 – 9.0

#### <When measuring the vibration frequency>

With your finger tip lightly tap the centre of the belt between the pulleys in the location shown by the arrow in the illustration and then measure the belt vibration frequency.

#### NOTE

Refer to P.11A-7 for information regarding the vibration frequency measurement method using MUT-II.

#### <When measuring the tension>

Use a belt tension gauge to measure the belt tension.

#### <When measuring the deflection>

Apply 98 N of pressure against the location between the pulleys shown by the arrow in the illustration and then measure the deflection.

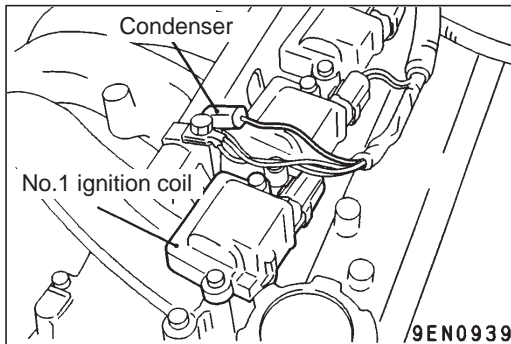
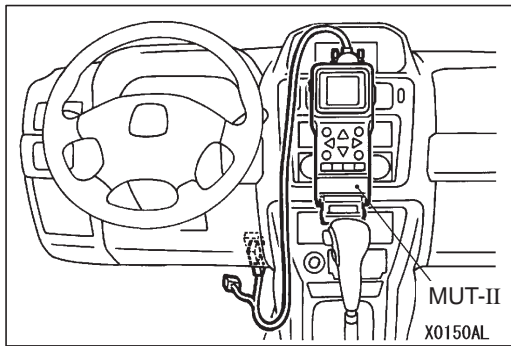
2. If the tension or deflection is outside the standard value, adjust by the following procedure.
  - (1) Loosen tensioner pulley fixing nut A.
  - (2) Adjust the amount of belt deflection using adjusting bolt B.
  - (3) Tighten fixing nut A.

#### Tightening torque: 25 Nm

- (4) Check the belt deflection amount and tension, and readjust if necessary.

#### Caution

Check after turning the crankshaft once or more clockwise (right turn).



## IGNITION TIMING CHECK

1. Before inspection, set the vehicle to the pre-inspection condition.
2. Connect the MUT-II to the diagnosis connector.

3. Set the timing light to the condenser of the No.1 ignition coil power supply line (terminal No.3).
4. Start the engine and run at idle.
5. Check that engine idle speed is within the standard value.

**Standard value: 600 ± 50 r/min**

### NOTE

After 4 minutes or more have passed in the idle running condition, the idle speed will become 750 r/min.

6. Select No.17 of the MUT-II Actuator test.

### NOTE

At this time, the engine speed will become approximately 750 r/min.

7. Check that basic ignition timing is within the standard value.

**Standard value: 5° BTDC ± 3°**

8. If the basic ignition timing is outside the standard value, inspect the GDI system while referring to GROUP 13A – Troubleshooting.
9. Press the MUT-II clear key (Select a forced driving cancel mode) to release the Actuator test.

### Caution

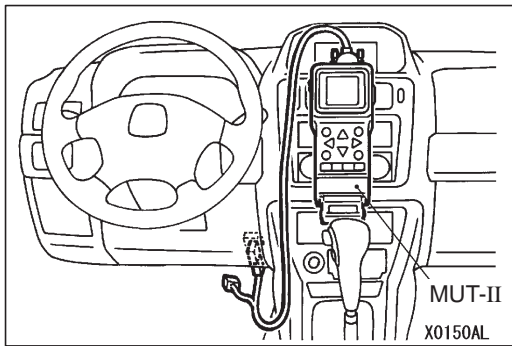
**If the test is not cancelled, a forced driving will continue for 27 minutes. Driving under this condition may damage the engine.**

10. Check that ignition timing is at the standard value.

**Standard value: approx. 16° BTDC**

### NOTE

- (1) The ignition timing will become approximately 5° BTDC after more than 4 minutes have passed since the basic ignition timing set mode was released.
- (2) The ignition timing may fluctuate within ±7° BTDC. This is normal.
- (3) In higher altitude, the ignition timing is more advanced than the standard value by approximately 5 degree.



### IDLE SPEED CHECK

1. Before inspection, set the vehicle to the pre-inspection condition.
2. Turn off the ignition switch and then connect the MUT-II to the diagnosis connector.
3. Check the basic ignition timing.

#### NOTE

Refer to P.11A-9 concerning the check procedure of the basic ignition timing.

**Standard value: 5° BTDC ± 3°**

4. Run the engine at idle for 2 minutes.
5. Check the idle speed. Select item No. 22 and take a reading of the idle speed.

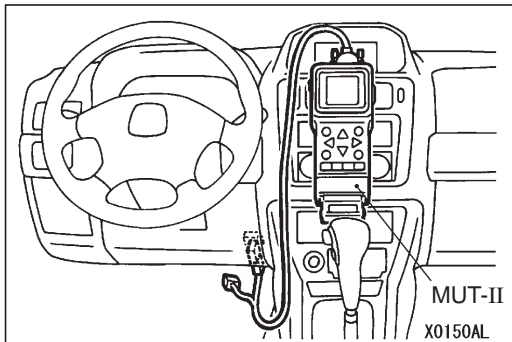
**Standard value: 600 ± 50 r/min**

#### NOTE

(1) After 4 minutes or more have passed in the idle running condition, the idle speed will become 750 r/min.

(2) The idle speed is controlled automatically by the idle speed control system.

6. If the idle speed is outside the standard value, inspect the GDI components by referring to GROUP 13A – Troubleshooting.



### IDLE MIXTURE CHECK

1. Before inspection, set the vehicle to the pre-inspection condition.
2. Connect the MUT-II to the diagnosis connector.
3. Check that the basic ignition timing is within the standard value.

#### NOTE

Refer to P.11A-10 concerning the check procedure of the basic ignition timing.

**Standard value: 5° BTDC ± 3°**

4. Run the engine at 2,500 r/min for 2 minutes.
5. Set the CO, HC tester.

6. Check the CO contents and the HC contents at idle.

**NOTE**

This measurement should be performed in less than approximately 4 minutes since the engine speed become the idle speed.

**Standard value**

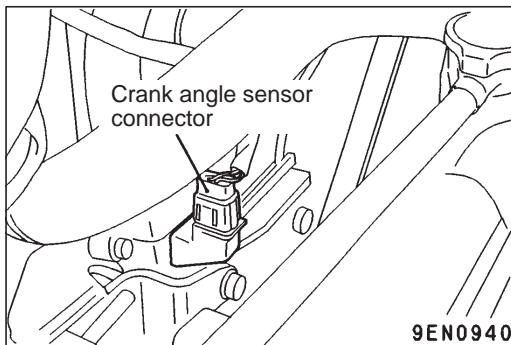
**CO contents: 0.6% or less**

**HC contents: 200 ppm or less**

7. If there is a deviation from the standard value, check the following items:
  - Diagnosis output
  - Fuel pressure
  - Injector
  - Ignition coil, spark plug
  - EGR control system
  - Evaporative emission control system
  - Compression pressure

**NOTE**

Replace the three way catalyst when the CO and HC contents are not within the standard value, even though the result of the inspection is normal on all items.

**COMPRESSION PRESSURE CHECK**

1. Before inspection, check that the engine oil, starter and battery are normal. In addition, set the vehicle to the pre-inspection condition.
2. Remove all of the ignition coils and spark plugs.
3. Disconnect the crank angle sensor connector.

**NOTE**

Doing this will prevent the engine-ECU from carrying out ignition and fuel injection.

4. Cover the spark plug hole with a shop towel etc., and after the engine has been cranked, check that no foreign material is adhering to the shop towel.

**Caution**

- (1) **Keep away from the spark plug hole when cranking.**
- (2) **If compression is measured with water, oil, fuel, etc., that has come from cracks inside the cylinder, these materials will become heated and will gush out from the spark plug hole, which is dangerous.**

5. Set compression gauge to one of the spark plug holes.
6. Crank the engine with the throttle valve fully open and measure the compression pressure.

**Standard value (at engine speed of 300 r/min):**

**1,720 kPa**

**Limit (at engine speed of 300 r/min):**

**Min. 1,337 kPa**

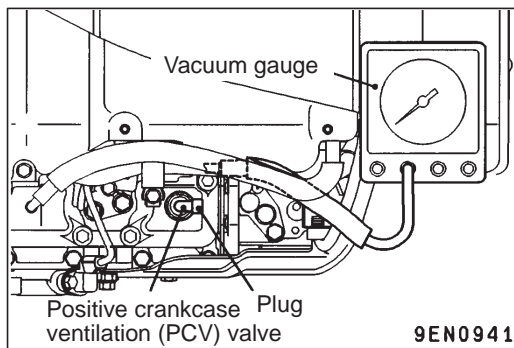
7. Measure the compression pressure for all the cylinders, and check that the pressure differences of the cylinders are below the limit.

**Limit: Max. 100 kPa**

8. If there is a cylinder with compression or a compression difference that is outside the limit, pour a small amount of engine oil through the spark plug hole, and repeat the operations in steps 6 and 7.
  - (1) If the compression increases after oil is added, the cause of the malfunction is a worn or damaged piston ring and/or cylinder inner surface.
  - (2) If the compression does not rise after oil is added, the cause is a burnt or defective valve seat, or pressure is leaking from the gasket.
9. Connect the crank angle sensor connector.
10. Install the spark plugs and ignition coils.
11. Use the MUT-II to erase the diagnosis codes.

**NOTE**

This will erase the diagnosis code resulting from the crank angle sensor connector being disconnected.



**MANIFOLD VACUUM CHECK**

1. Before inspection, set the vehicle to the pre-inspection condition.
2. Turn off the ignition switch.
3. Connect the engine tachometer or connect the MUT-II to the diagnosis connector.
4. Disconnect the ventilation hose from the positive crankcase ventilation (PCV) valve, and then connect a vacuum gauge to the ventilation hose. Plug the positive crankcase ventilation (PCV) valve.
5. Start the engine and run it at idle for 4 minutes or more, and then check the intake manifold vacuum while the engine is idling.

**Limit: Min. 60 kPa**

6. Turn off the ignition switch.
7. Remove the vacuum gauge, and then connect the ventilation hose to the positive crankcase ventilation (PCV) valve.
8. Remove the engine tachometer or the MUT-II.

## 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.

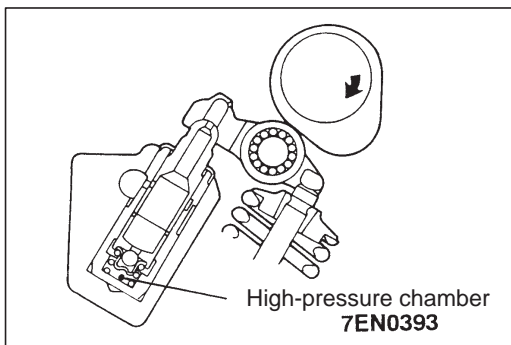
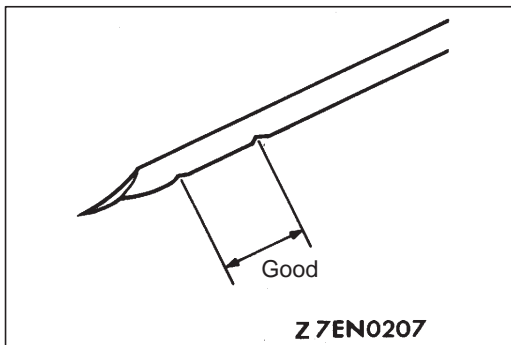
The only case where the noise might disappear is if the oil in the engine has not been looked after properly and oil sludge has caused the lash adjusters to stick.

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. (Refer to P.11A-14, LASH ADJUSTER AIR BLEEDING.)
6. If the noise has not disappeared even after the air bleeding, clean the lash adjusters. (Refer to the Engine Workshop Manual.)

## &lt;LASH ADJUSTER AIR BLEEDING&gt;

## NOTE

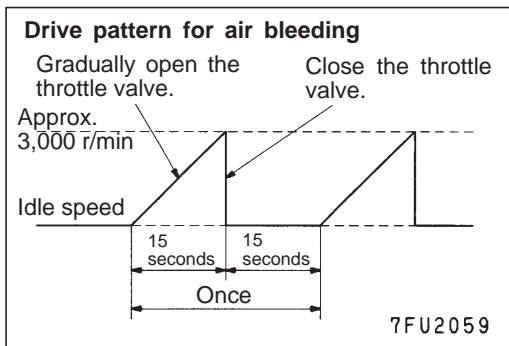
- (1) If the vehicle is parked on a slope for a long period of time, the amount of oil inside the lash adjuster will decrease, and air may get into the high pressure chamber when starting the engine.
- (2) After parking the vehicle for long periods, the oil drains out of the oil passage, and it takes 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.



# CRANKSHAFT PULLEY

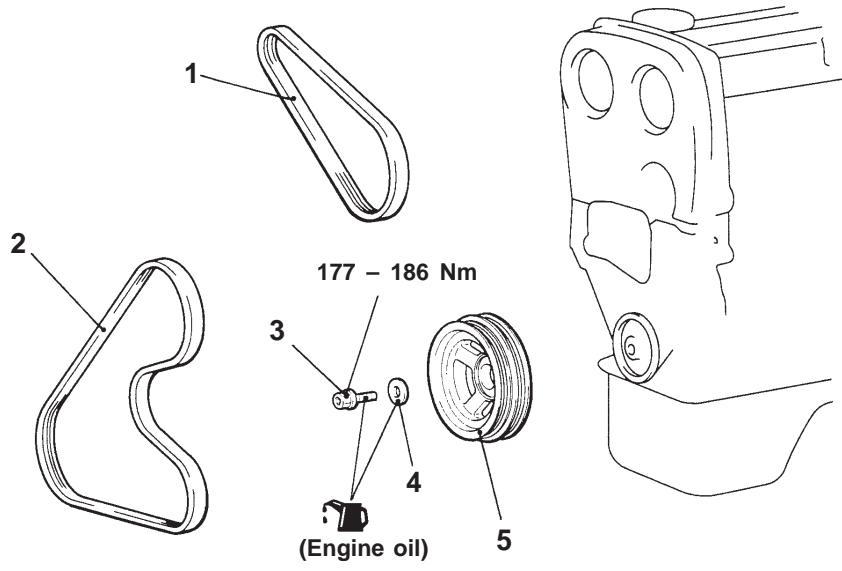
## REMOVAL AND INSTALLATION

**Pre-removal Operation**

Engine Cover and Under Cover Removal

**Post-installation Operation**

- Drive Belt Tension Adjustment (Refer to P.11A-7.)
- Engine Cover and Under Cover Installation

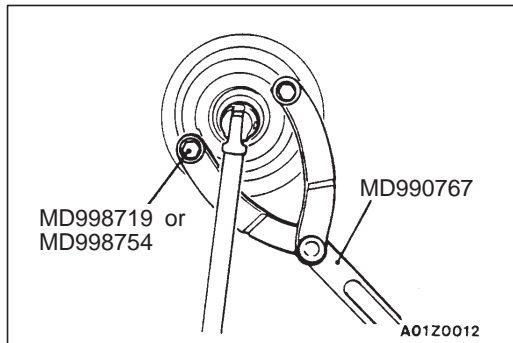


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**Removal steps**

1. Drive belt (Power steering and A/C)
2. Drive belt (Alternator)
3. Crankshaft pulley bolt

4. Crankshaft pulley washer
5. Crankshaft pulley



**REMOVAL SERVICE POINT**

◀A▶ **CRANKSHAFT PULLEY BOLT REMOVAL**

**INSTALLATION SERVICE POINT**

▶A◀ **CRANKSHAFT PULLEY BOLT INSTALLATION**

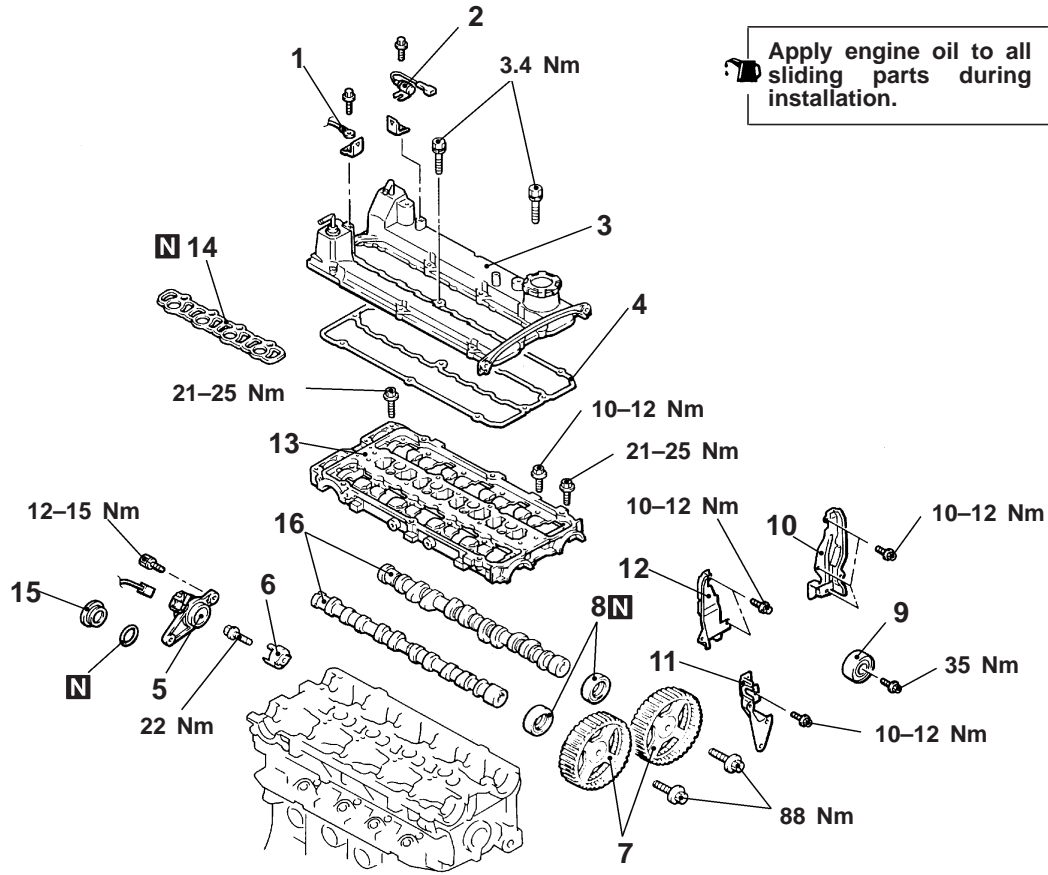
When installing the crankshaft bolt, apply the minimum amount of engine oil to the bearing surface and thread of the bolt.

# CAMSHAFT AND CAMSHAFT OIL SEAL

## REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operation**

- Air Intake Hose and Resonance Tank Removal and Installation (Refer to GROUP 15 – Air Cleaner and Resonance Tank.)
- Timing Belt Removal and Installation (Refer to P.11A-29.)
- Engine Coolant Draining and Supplying (Refer to GROUP 14 – On-vehicle Service.)
- Intake Manifold Removal and Installation (Refer to GROUP 15.)
- Fuel Pump (High Pressure) and Fuel Pressure Regulator (High Pressure) Removal and Installation (Refer to GROUP 13A.)



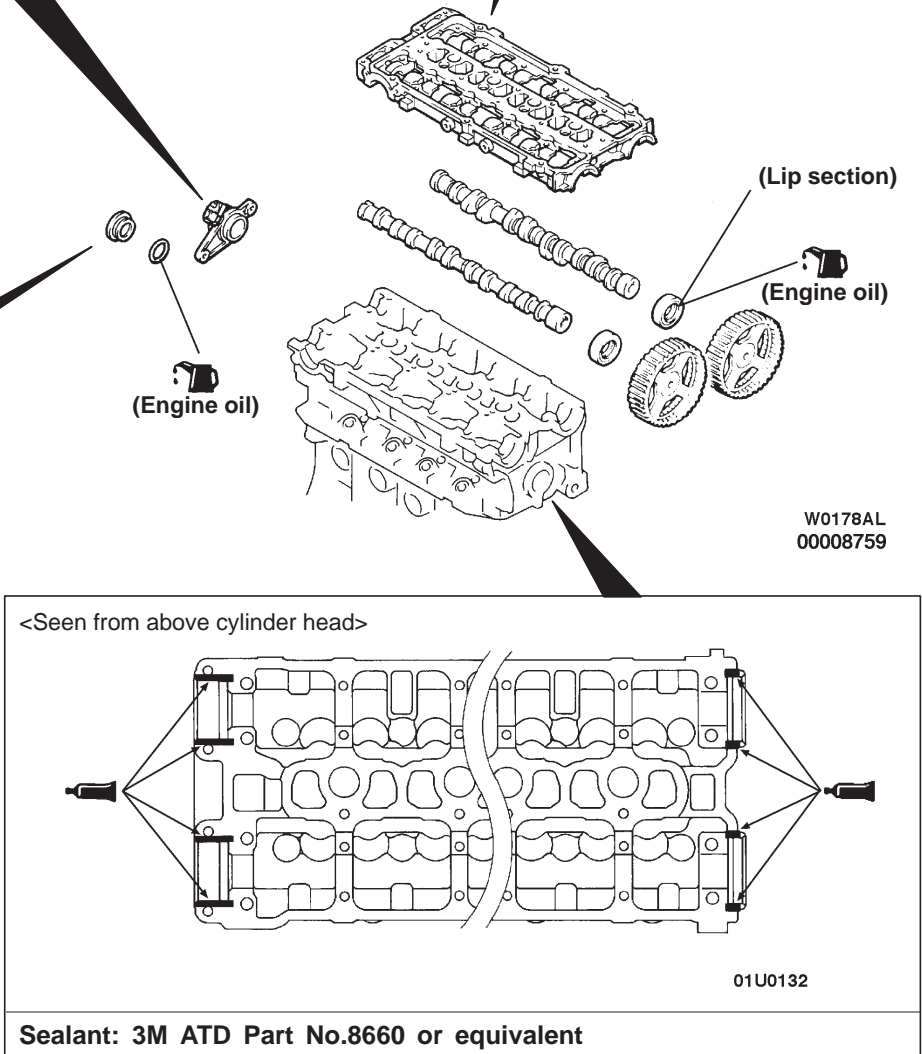
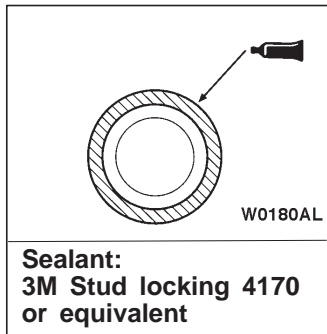
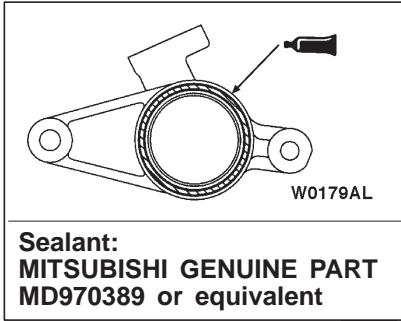
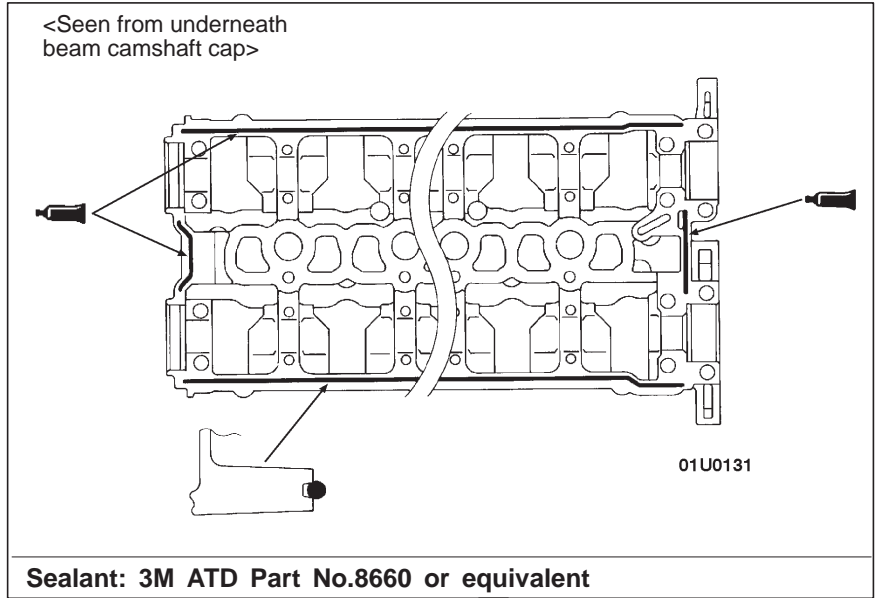
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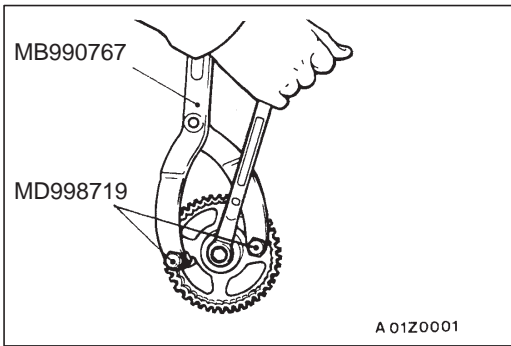
**Removal steps**

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>1. Earth cable connection</li> <li>2. Condenser</li> <li>3. Rocker cover</li> <li>4. Rocker cover gasket</li> <li>5. Camshaft position sensor support</li> <li>6. Camshaft position sensing cylinder</li> <li>7. Camshaft sprocket</li> <li>8. Camshaft oil seal</li> </ul> | <ul style="list-style-type: none"> <li>9. Idler pulley</li> <li>10. Timing belt rear cover, upper (LH)</li> <li>11. Timing belt rear cover, lower (RH)</li> <li>12. Timing belt rear cover, upper (RH)</li> <li>13. Beam camshaft cap</li> <li>14. Beam camshaft cap gasket</li> <li>15. Thrust case</li> <li>16. Camshaft</li> </ul> |
|--|---|



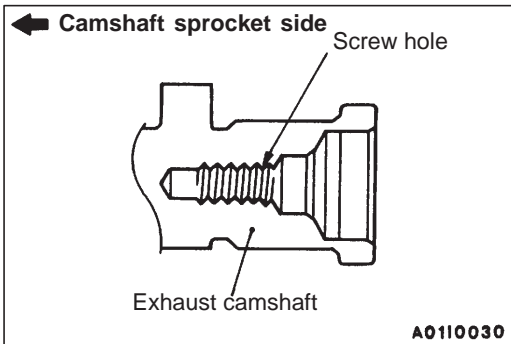
Lubrication points





**REMOVAL SERVICE POINT**

**◀A▶ CAMSHAFT SPROCKET REMOVAL**



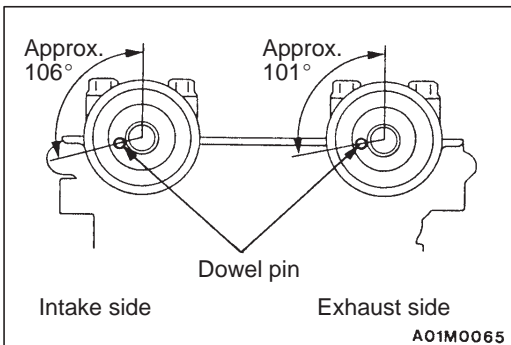
**INSTALLATION SERVICE POINTS**

**▶A◀ CAMSHAFT INSTALLATION**

1. Apply engine oil to journals and cams of the camshafts.
2. Install the camshafts on the cylinder head.

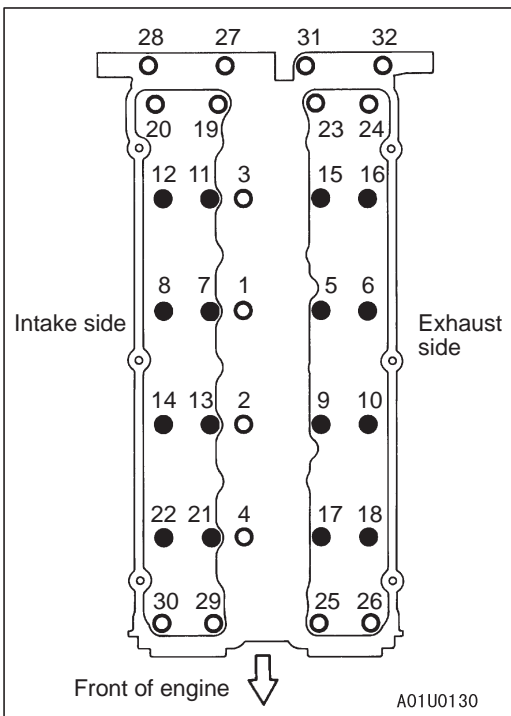
**Caution**

Be careful not to confuse the intake camshaft with the exhaust one. There is a screw hole for the cam position sensing cylinder mounting bolt on the exhaust-side camshaft.



**▶B◀ BEAM CAMSHAFT CAP INSTALLATION**

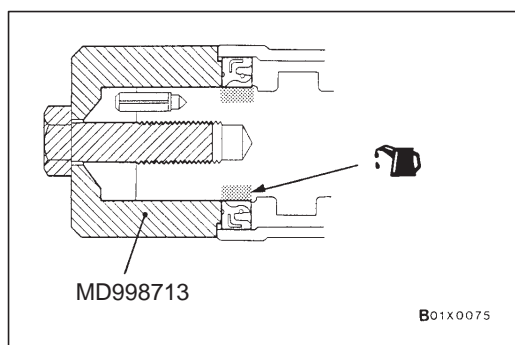
1. Place the camshaft dowel pin as shown in the illustration.



2. Tighten the beam camshaft cap mounting bolts to the specified torque in the order shown in the illustration.

**Tightening torque:**

- : 10 – 12 Nm
- : 21 – 25 Nm

**►C◄ CAMSHAFT OIL SEAL INSTALLATION**

1. Apply engine oil to the entire circumference of the oil seal lip.
2. Press-fit the oil seal as shown in the illustration.

**►D◄ CAMSHAFT SPROCKET INSTALLATION**

Use the special tool to secure the camshaft sprocket in the same way as during removal, and then tighten the bolt to the specified torque.

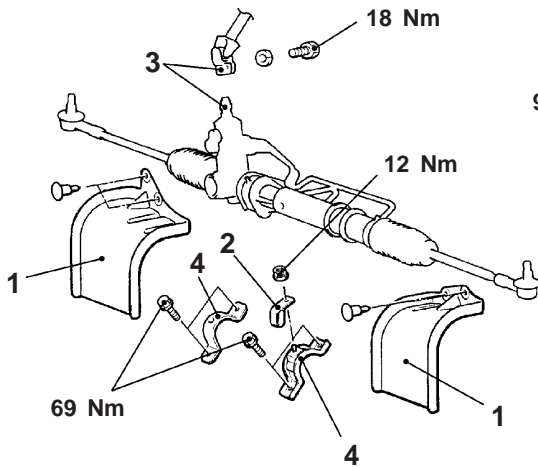
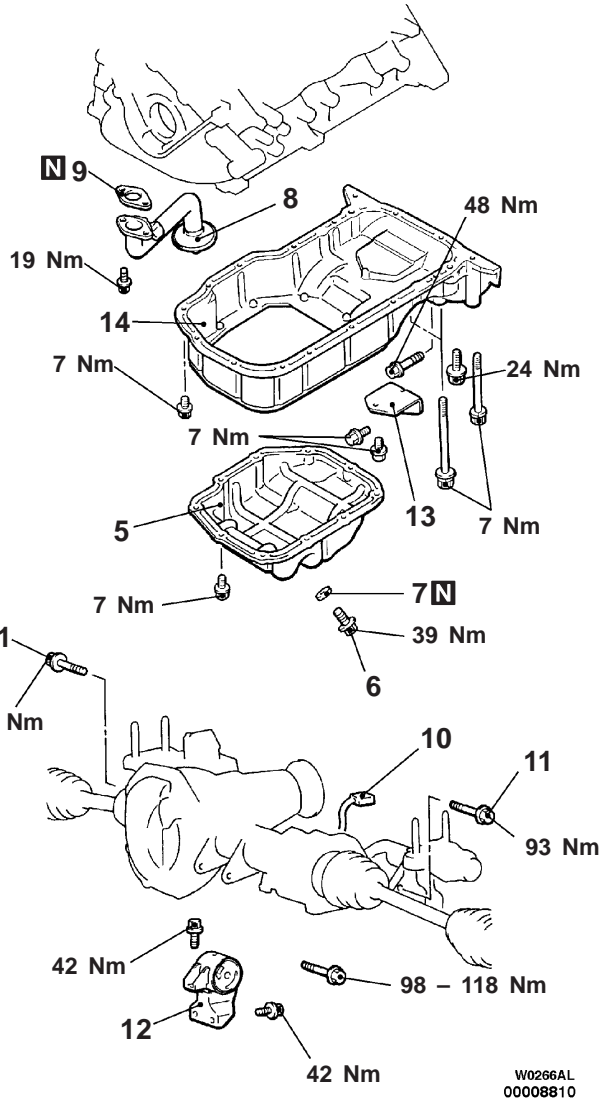
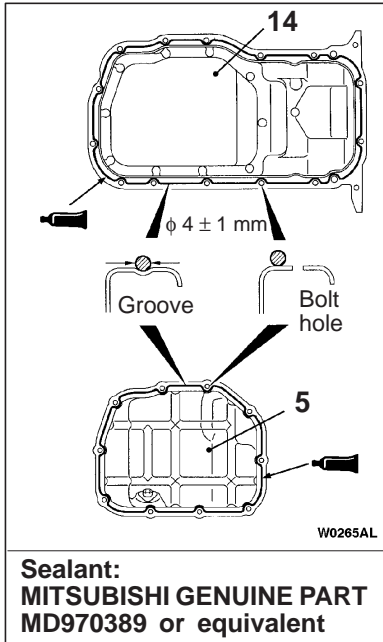
**Tightening torque: 88 Nm**

# OIL PAN

## REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operation**

- Under Cover Removal and Installation
- Oil Level Gauge Removal and Installation
- Engine Oil Draining and Supplying (Refer to GROUP 12 – On-vehicle Service.)



**Removal steps**

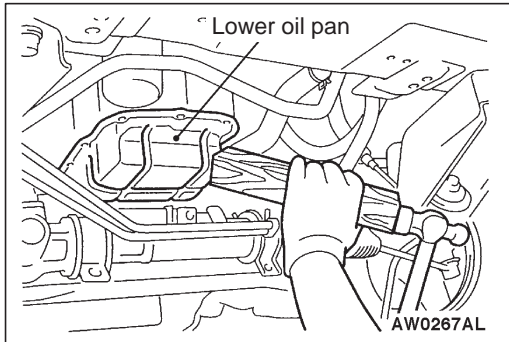
1. Splash shield
2. Power steering pressure hose clamp
3. Steering gear box and shaft connection
4. Steering gear box installation bolt
5. Lower oil pan
6. Drain plug
7. Gasket

8. Oil screen
9. Gasket
10. Free-wheeling clutch engage switch connector connection
11. Front differential mount center bolt
12. Front differential mount
13. Bell housing cover
14. Upper oil pan



**REMOVAL SERVICE POINTS****◀A▶ STEERING GEAR BOX INSTALLATION BOLT REMOVAL**

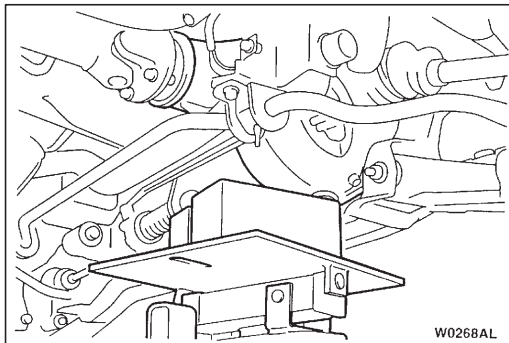
Remove the steering gear box installation bolts and lower the steering gear box.

**◀B▶ LOWER OIL PAN REMOVAL**

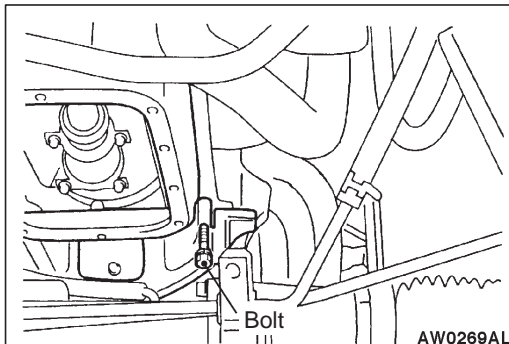
Place a piece of wood against the lower oil pan, and tap the piece of wood with a hammer to remove the lower oil pan.

**Caution**

Because the upper oil pan used is made from aluminium, the oil pan remover (MB998727) should not be used.

**◀C▶ FRONT DIFFERENTIAL MOUNT CENTER BOLT/ FRONT DIFFERENTIAL MOUNT REMOVAL**

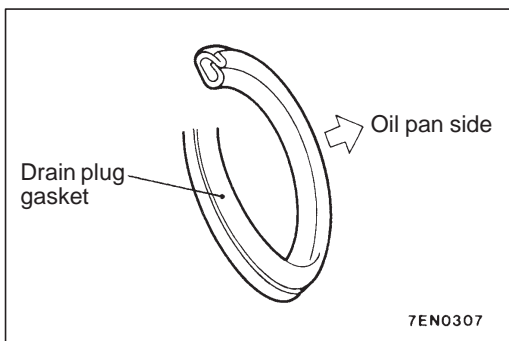
1. Support the front differential by a jack, and remove the front differential mount center bolts and the front differential mount.
2. Remove the jack and lower the front differential.

**◀D▶ UPPER OIL PAN REMOVAL**

After removing all installation bolts, install 2 bolts (M6 × 85) in the upper oil pan as shown, noting that one located on the left side and one on the right side. Turn the bolts to remove the upper oil pan.

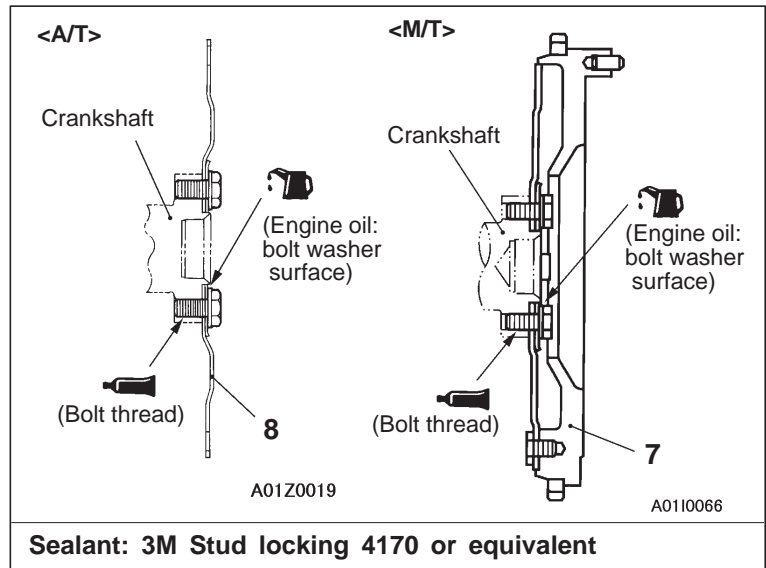
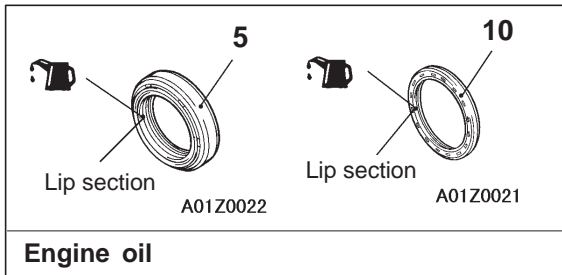
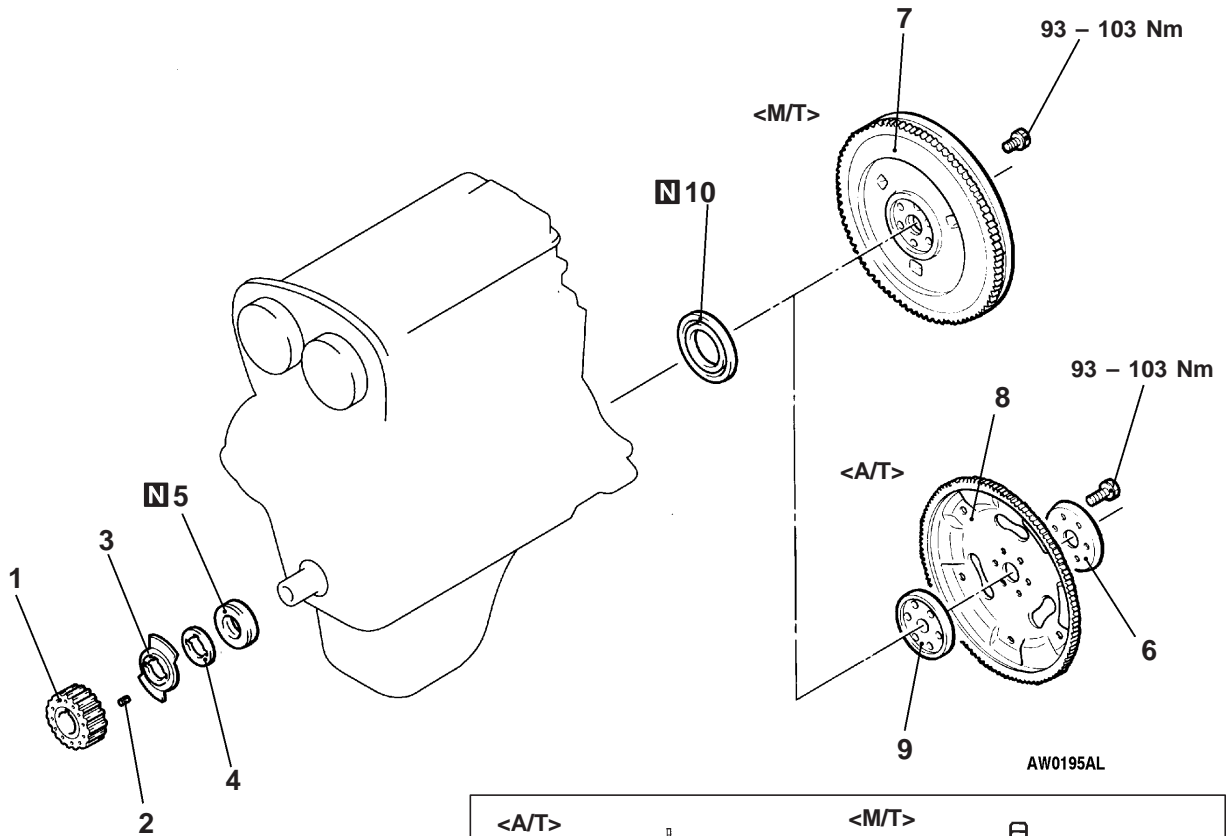
**Caution**

Because the upper oil pan used is made from aluminium, the oil pan remover (MB998727) should not be used.

**INSTALLATION SERVICE POINT****▶A◀ DRAIN PLUG GASKET INSTALLATION**

Install the drain plug gasket in the direction so that it faces as shown in the illustration.

# CRANKSHAFT OIL SEAL REMOVAL AND INSTALLATION



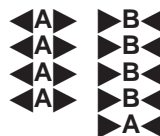
### Crankshaft front oil seal removal steps

- Timing belt (Refer to P.11A-29.)
- Crank angle sensor (Refer to GROUP 16.)
- 1. Crankshaft sprocket
- 2. Key
- 3. Crankshaft sensing blade
- 4. Crankshaft spacer
- 5. Crankshaft front oil seal

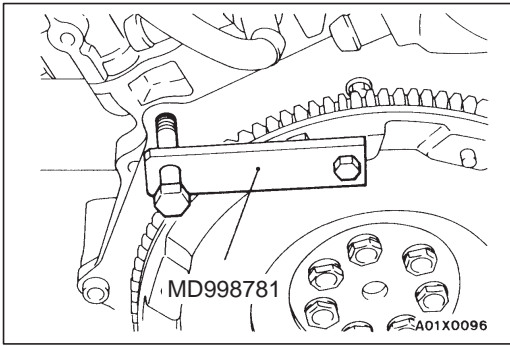


### Crankshaft rear oil seal removal steps

- Transmission assembly (M/T: Refer to GROUP 22.) (A/T: Refer to GROUP 23.)
- Clutch cover and disc <M/T>
- 6. Adapter plate <A/T>
- 7. Flywheel <M/T>
- 8. Drive plate <A/T>
- 9. Crankshaft adapter <A/T>
- 10. Crankshaft rear oil seal



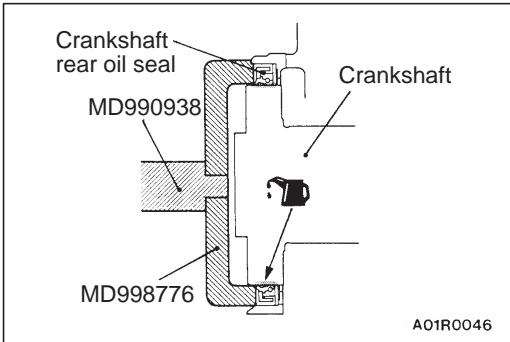




**REMOVAL SERVICE POINT**

**◀A▶ ADAPTER PLATE<A/T>/FLYWHEEL <M/T>/DRIVE PLATE <A/T>/CRANKSHAFT ADAPTER <A/T> REMOVAL**

Use the special tool to secure the flywheel or drive plate, and remove the bolts.



**INSTALLATION SERVICE POINTS**

**▶A▶ CRANKSHAFT REAR OIL SEAL INSTALLATION**

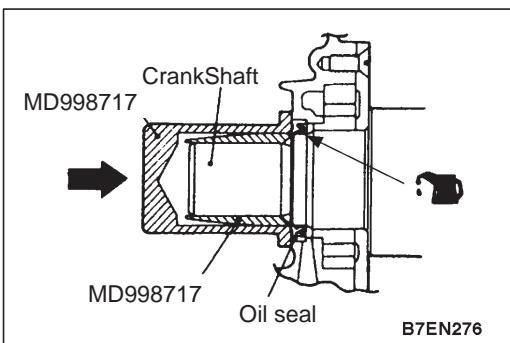
1. Apply a small amount of engine oil to the entire circumference of the oil seal lip.
2. Install the oil seal by tapping it as far as the chamfered position of the oil seal case as shown in the illustration.

**▶A▶ CRANKSHAFT ADAPTER <A/T>/DRIVE PLATE <A/T>/FLYWHEEL <M/T>/ADAPTER PLATE<A/T> INSTALLATION**

1. Clean off all sealant, oil and other substances which are adhering to the threaded bolts, crankshaft thread holes and the drive plate.
2. Apply oil to the bearing surface of the drive plate bolts.
3. Apply oil to the crankshaft thread holes.
4. Apply sealant to the threaded mounting holes.

**Specified sealant: 3M Stud locking 4170 or equivalent**

5. Use the special tool to hold the drive plate in the same manner as removal, and install the bolt.



**▶C▶ CRANKSHAFT FRONT OIL SEAL INSTALLATION**

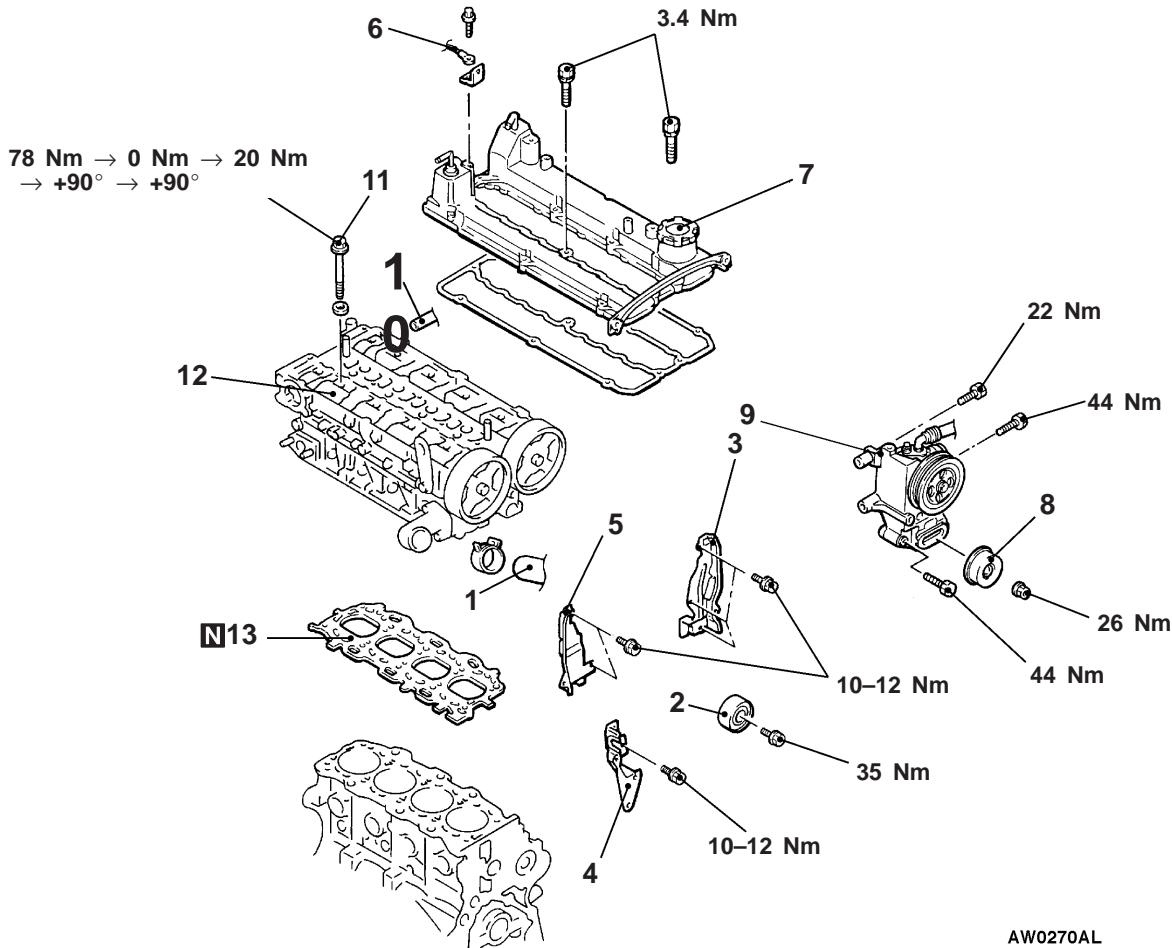
1. Apply a small amount of engine oil to the entire circumference of the oil seal lip.
2. Tap the oil seal unit it is flush with the oil seal case.

# CYLINDER HEAD GASKET

## REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operation**

- Fuel Discharge Prevention (Refer to GROUP 13A – On-vehicle Service.) <Pre-removal only>
- Engine Coolant Draining and Supplying (Refer to GROUP 14 – On-vehicle Service.)
- Engine Oil Draining and Supplying (Refer to GROUP 12 – On-vehicle Service.)
- Intake Manifold Removal and Installation (Refer to GROUP 15.)
- Fuel Pressure Regulator (High Pressure) and Fuel Pump (High Pressure) Removal and Installation (Refer to GROUP 13A.)
- Water Bypass Pipe Assembly Removal and Installation (Refer to GROUP 14 – Water Hose and Pipe.)
- Timing Belt Removal and Installation (Refer to P.11A-29.)



**Removal steps**

1. Radiator upper hose connection
2. Idler pulley
3. Timing belt rear cover, upper (LH)
4. Timing belt rear cover, lower (RH)
5. Timing belt rear cover, upper (RH)
6. Earth cable connection
7. Rocker cover assembly

8. Tension Pulley
9. Power steering oil pump and bracket assembly
10. Heater hose connection
11. Cylinder head bolt
12. Cylinder head assembly
13. Cylinder head gasket

**REMOVAL SERVICE POINTS**

**◀A▶ POWER STEERING OIL PUMP AND BRACKET ASSEMBLY REMOVAL**

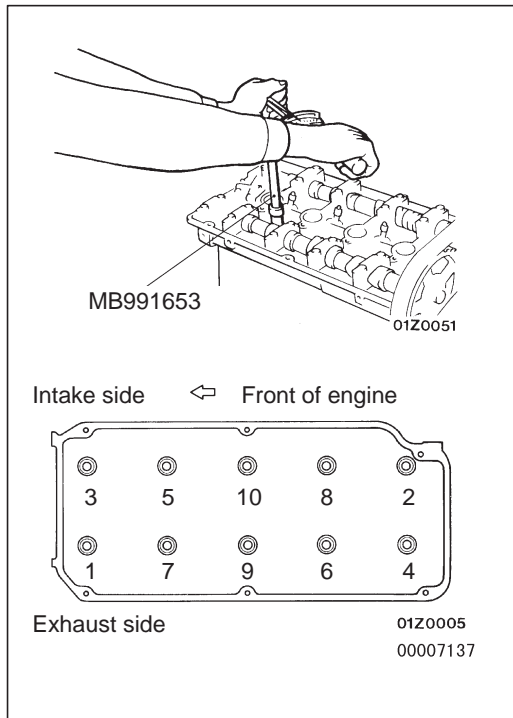
Remove the power steering oil pump and bracket assembly from the engine with the hose attached.

**NOTE**

Place the removed power steering oil pump and bracket assembly in a place where it will not be a hindrance when removing and installing the cylinder head assembly, and tie it with a cord.

**◀B▶ CYLINDER HEAD BOLT REMOVAL**

Use the special tool to loosen the bolts in two or three steps in the order of the numbers shown in the illustration, and then remove the bolts.



**INSTALLATION SERVICE POINTS**

**▶A▶ CYLINDER HEAD GASKET INSTALLATION**

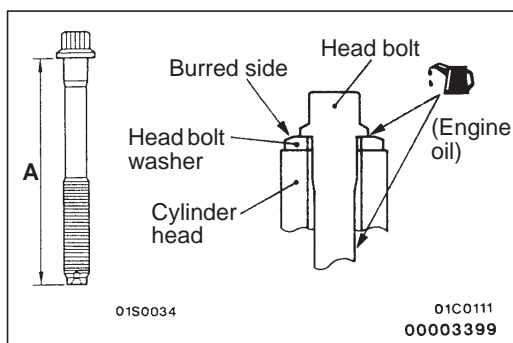
1. Wipe off all oil and grease from the gasket mounting surface.
2. Install so that the shapes of the cylinder head holes match the shapes of the respective cylinder head gasket holes.

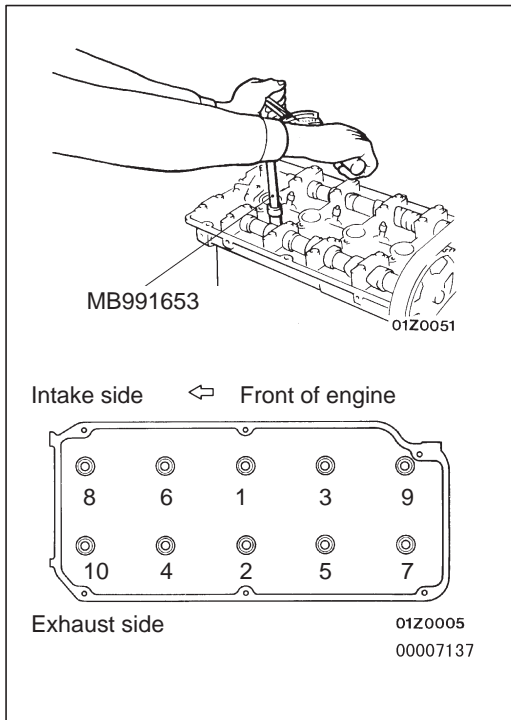
**▶B▶ CYLINDER HEAD BOLT INSTALLATION**

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): 96.4 mm**

2. The head bolt washer should be installed with the burred side caused by tapping out facing upwards.
3. Apply a small amount of engine oil to the thread section and the washer of the cylinder head bolt.



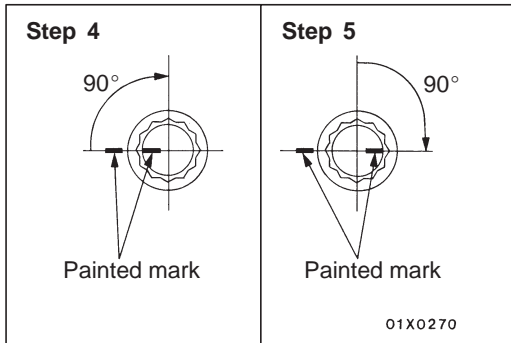


4. Tighten the bolts by the following procedure.

Step	Operation	Remarks
1	Tighten to 74 Nm.	Carry out in the order shown in the illustration.
2	Fully loosen.	Carry out in the reverse order of that shown in the illustration.
3	Tighten to 20 Nm.	Carry out in the order shown in the illustration.
4	Tighten 90° of a turn.	In the order shown in the illustration. Mark the head of the cylinder head bolt and cylinder head by paint.
5	Tighten 90° of a turn.	In the order shown in the illustration. Check that the painted mark of the head bolt is lined up with that of the cylinder head.

**Caution**

1. Always make a tightening angle just 90°. If it is less than 90°, the head bolt will be loosened.
2. If it is more than 90°, remove the head bolt and repeat the procedure from step 1.

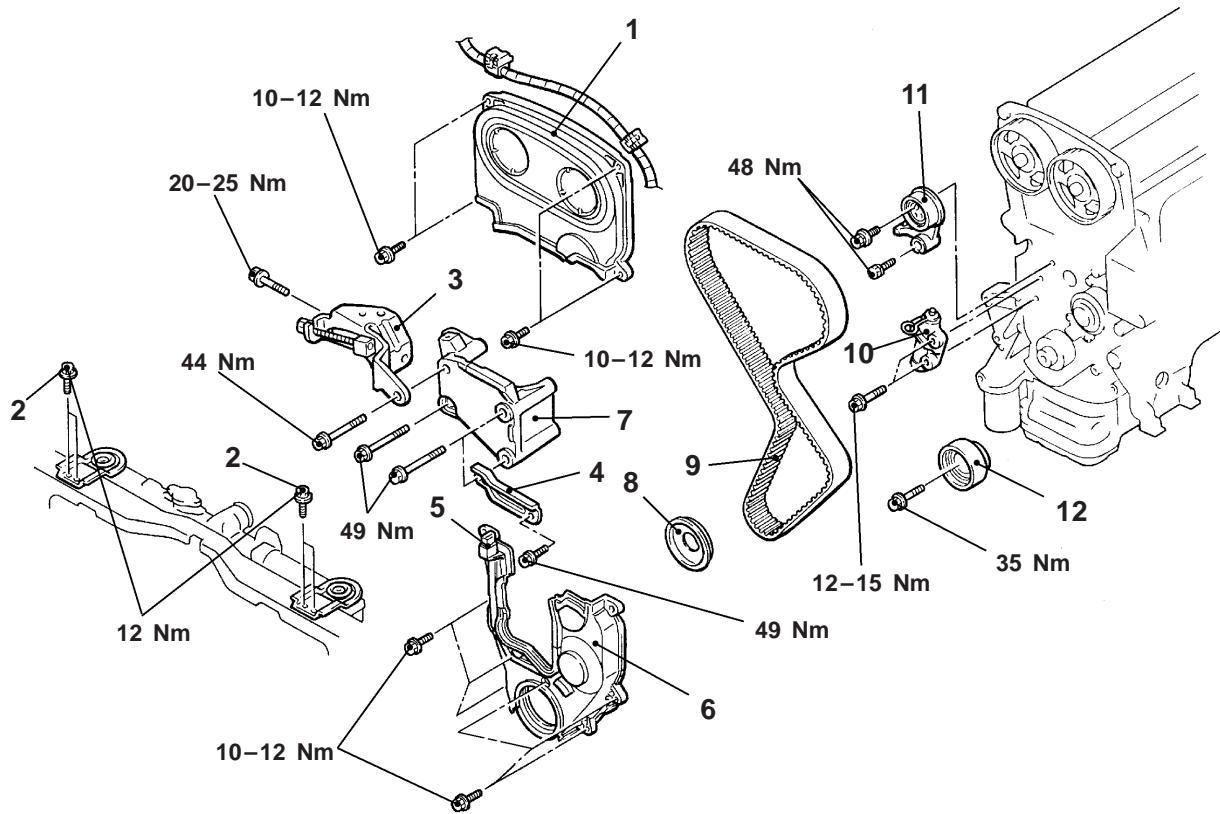


# TIMING BELT

## REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operation**

- Engine Cover Removal and Installation
- Air Intake Duct Removal and Installation (Refer to GROUP 15 – Air Cleaner and Resonance Tank.)
- Crankshaft Pulley Removal and Installation (Refer to P.11A-17.)



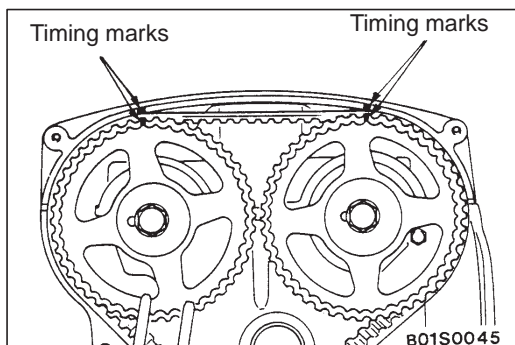
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**Removal steps**

1. Timing belt front upper cover
2. Radiator upper installation bolts
3. Alternator brace
4. Power steering oil pump bracket stay
5. Crank angle sensor connector
6. Timing belt front lower cover



7. Accessory mount
8. Front flange
- Timing belt tension adjustment
9. Timing belt
10. Auto tensioner
11. Tensioner pulley and arm assembly
12. Idler pulley



## REMOVAL SERVICE POINT

### ◀A▶ TIMING BELT REMOVAL

1. Turn the crankshaft clockwise to align each timing mark.

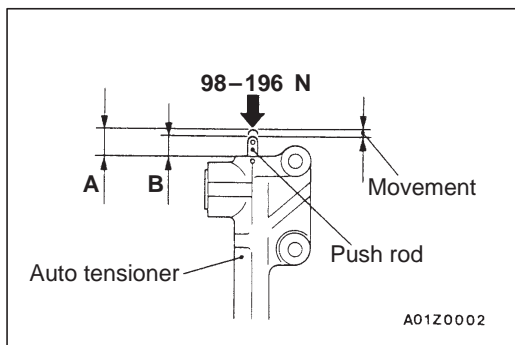
#### Caution

The crankshaft must always be turned clockwise.

2. Loosen the tensioner pulley center bolt and remove the timing belt.

#### Caution

If the timing belt is to be re-used, use chalk to mark (on its flat side) an arrow indicating the clockwise direction.



## INSTALLATION SERVICE POINTS

### ▶A◀ AUTO TENSIONER INSTALLATION

1. Apply 98–196 N force to the push rod of the auto tensioner by pressing it against a metal (cylinder block, etc.), and measure the movement of the push rod.

#### Standard value:

Within 1 mm

A: Length when it is free (not pressed)

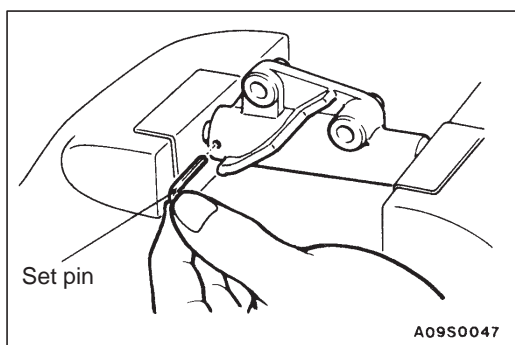
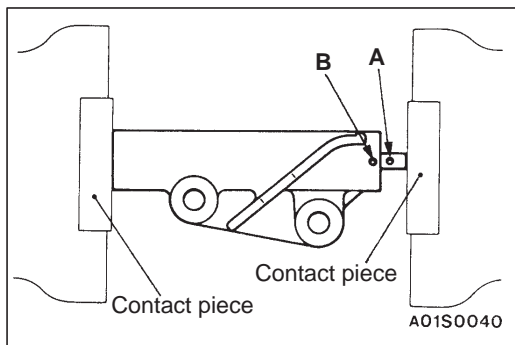
B: Length when it is pressed

A – B: Movement

2. If it is out of the standard value, change the auto tensioner.
3. Use a press or vice to gently compress the auto tensioner push rod until pin hole A of the push rod and pin hole B of the tensioner cylinder are aligned.

#### Caution

If the compression speed is too fast, the push rod may become damaged, so be sure to carry out this operation slowly.

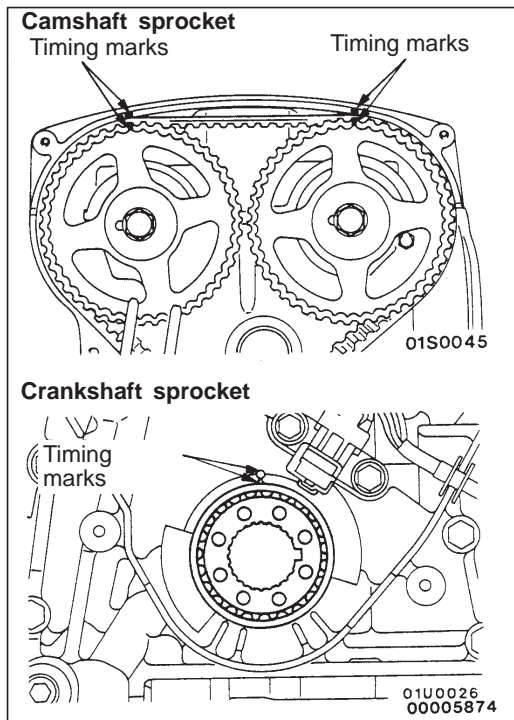


4. Once the holes are aligned, insert the set pin.

#### NOTE

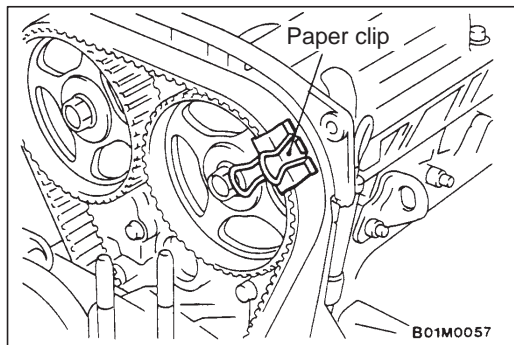
When replacing the auto tensioner with a new part, the pin will be in the auto tensioner.

5. Install the auto tensioner to the engine.

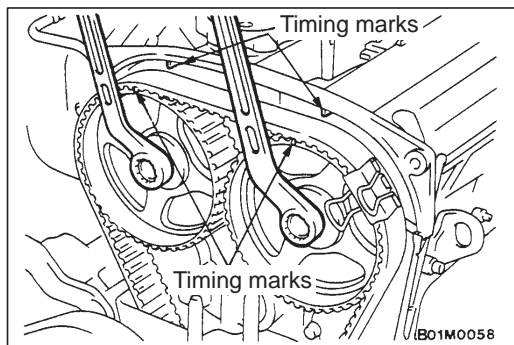


### ►B◄ TIMING BELT INSTALLATION

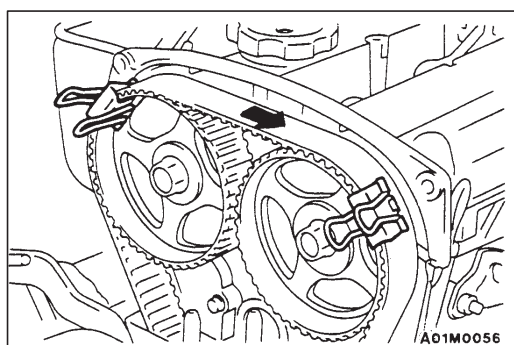
1. Align the timing marks of each camshaft sprocket and the crankshaft sprocket.
2. Loosen the tensioner pulley center bolt.
3. Move the crankshaft sprocket half a tooth width in the anti-clockwise direction.



4. Place the timing belt on the exhaust-side camshaft sprocket, and hold it in the position shown in the illustration with a paper clip.

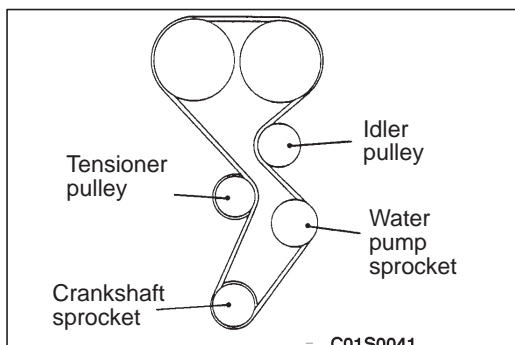


5. Place the timing belt on the intake-side sprocket while using two wrenches to align the timing marks.

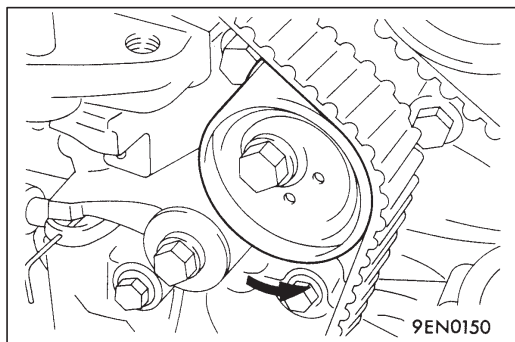


6. Hold the belt in the position shown in the illustration with another paper clip.

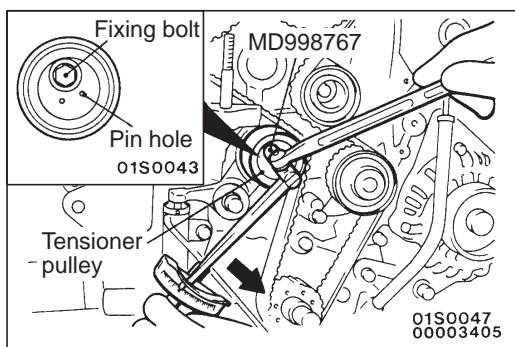




- Place the belt onto the idler pulley, water pump sprocket, crankshaft sprocket and tensioner pulley in that order.
- Remove the two paper clips.



- Lift the tensioner pulley in the direction of the arrow and tighten the tensioner pulley bolt.
- Check to be sure that all timing marks are aligned.
- Adjust the timing belt tension.



#### ▶◀ TIMING BELT TENSION ADJUSTMENT

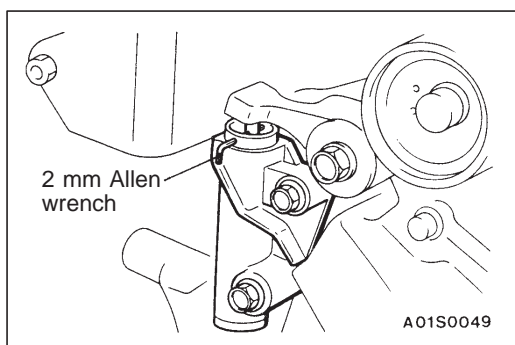
- After turning the crankshaft a 1/4 turn anti-clockwise, turn it clockwise to the position where the timing marks are aligned.
- Loosen the fixing bolt of the tensioner pulley and using the special tool and a torque wrench, apply tension to the timing belt; then tighten the fixing bolt at the specified torque.

#### Standard Value:

2.5 – 4.0 Nm [timing belt tension torque (reference value)]

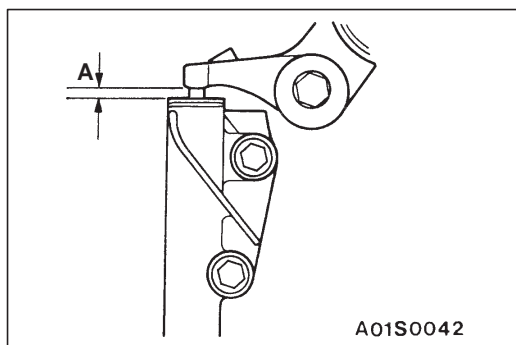
#### Caution

When tightening the fixing bolt, ensure that the tensioner pulley shaft doesn't rotate with the bolt.



- Take out the 2 mm Allen wrench from the auto tensioner. At this time, check to be sure that 2 mm Allen wrench can be pulled out easily. Turn the crankshaft clockwise 2 turns, and after leaving it in this position for 5 minutes or more, check again to be sure that the auto tensioner 2 mm Allen wrench can be pulled out or inserted easily.



**NOTE**

Even if the 2 mm Allen wrench cannot be easily inserted, then it is satisfactory if the amount of protrusion of the auto tensioner rod is within the standard value.

**Standard value (A): 3.8 – 4.5 mm**

If it is outside the standard value, repeat the operations in steps 1 to 4.

4. Check to be sure that the timing marks on all sprockets are aligned.

## ENGINE ASSEMBLY

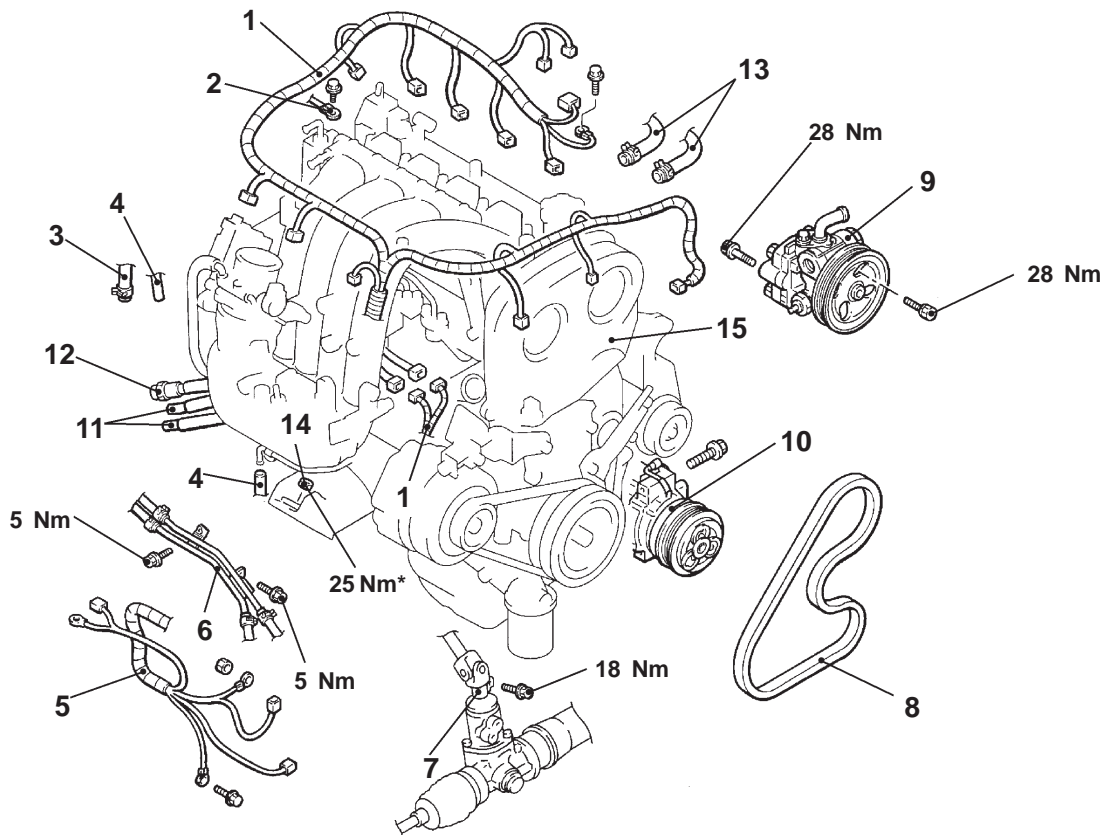
## REMOVAL AND INSTALLATION

## Caution

Mounting locations marked by \* should be provisionally tightened, and then fully tightened after placing the vehicle horizontally and loading the full weight of the engine on the vehicle body.

**Pre-removal and Post-installation Operation**

- Fuel Discharge Prevention (Refer to GROUP 13A – On-vehicle Service.) <Pre-removal only>
- Engine Coolant Draining and Supplying (Refer to GROUP 14 – On-vehicle Service.)
- Engine Oil Draining and Supplying (Refer to GROUP 12 – On-vehicle Service.)
- Hood Removal and Installation (Refer to GROUP 42.)
- Radiator Assembly Removal and Installation (Refer to GROUP 14.)
- Air Cleaner and Resonance Tank Removal and Installation (Refer to GROUP 15.)
- Transmission Assembly Removal and Installation (Refer to GROUP 23.)
- Drive Belt Tension Adjustment (Refer to P.11A-7.) <Post-installation only>



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**Removal steps**

- |   |         |                                   |
|---|---------|-----------------------------------|
| 1. Engine harness connector               |         | 8. Drive belt                     |
| 2. Earth cable connection                 |         | 9. Power steering oil pump        |
| 3. Brake booster vacuum hose connection   | ◀A▶     | 10. A/C compressor                |
| 4. Vacuum hose connection                 | ◀B▶     | 11. Fuel return hose connection   |
| 5. Battery cable connection               |         | 12. Fuel pressure hose connection |
| 6. A/T fluid pipe clamp                   |         | 13. Heater hose connection        |
| 7. Steering gear box and shaft connection | ◀C▶ ▶A▶ | 14. Engine mount installation nut |
|   |         | 15. Engine assembly               |

**REMOVAL SERVICE POINTS****◀A▶ POWER STEERING OIL PUMP REMOVAL**

Remove the power steering oil pump from the engine with the hose attached.

**NOTE**

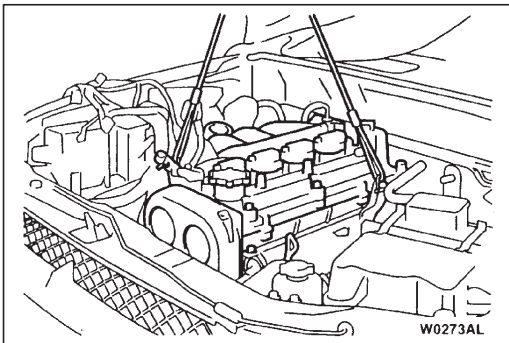
Place the removed power steering oil pump where it will not be a hindrance when removing and installing the engine assembly, and tie it with a cord.

**◀B▶ A/C COMPRESSOR REMOVAL**

Disconnect the A/C compressor connector and remove the compressor from the compressor bracket with the hose still attached.

**NOTE**

Place the removed A/C compressor where it will not be a hindrance when removing and installing the engine assembly, and tie it with a cord.

**◀C▶ ENGINE ASSEMBLY REMOVAL**

1. Check that all cables, hoses and harness connectors, etc. are disconnected from the engine.
2. Lift the chain block slowly to remove the engine assembly upward from the engine compartment.

**INSTALLATION SERVICE POINT****▶A◀ ENGINE ASSEMBLY INSTALLATION**

Install the engine assembly, checking that the cables, hoses, and harness connectors are not clamped.

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# ENGINE <4G9>

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## GENERAL

### OUTLINE OF CHANGES

Due to the new addition of the 4G94 engine vehicles, the following service procedures have been established regarding the sections which differ from that of the previous models with the 4G93 engine. The same procedures as before are applied except for the items shown below.

- Change in the CO and HC concentration
- Change in compression pressure
- Change of the limits in the intake manifold negative pressure
- Removal and installation of camshaft and camshaft oil seal
- Removal and installation of cylinder head gasket
- Change in the protrusion of the auto tensioner rod

### GENERAL INFORMATION

Items	4G94-GDI
Total displacement mL	1,999
Bore × Stroke mm	81.5 × 95.8
Compression ratio	11.0

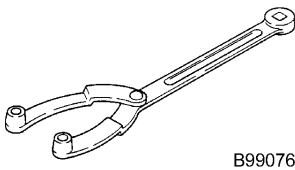
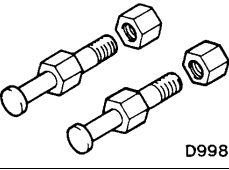
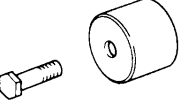
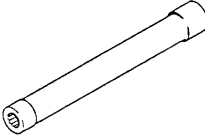
### SERVICE SPECIFICATIONS

Item	Standard value	Limit
CO concentration %	0.5 or less	–
HC concentration ppm	100 or less	–
Compression pressure kPa – r/min	1,800 – 200	1,320 – 200
Intake manifold negative pressure kPa	–	56
Shank length of cylinder head bolt mm	–	96.4
Protrusion of auto tensioner rod mm	4.8 – 5.5	–

### SEALANT AND ADHESIVE

Application location	Specified sealants	Remarks
Beam camshaft cap	MITSUBISHI GENUINE PART MD970389 or equivalent	Semi-drying sealant
Cylinder head		
Camshaft position sensor support		
Camshaft thrust cover	3M Stud Locking 4170 or equivalent	–

**SPECIAL TOOLS**

Tools	Number	Name	Use
 B990767	MB990767	Front hub and flange yolk holder	Camshaft sprocket held
 D998719	MD998719	Crankshaft pulley holder pin	
	MD998713	Camshaft oil seal installer	Press-fitting camshaft oil seal
	MB991653	Cylinder head bolt wrench	Removal and installation of cylinder head bolt

**ON-VEHICLE SERVICE****IDLE MIXTURE CHECK****Standard value**

CO contents: 0.5% or less

HC contents: 100 ppm or less

**COMPRESSION PRESSURE CHECK**Standard value (at engine speed of 200 r/min):  
1,800 kPaLimit (at engine speed of 200 r/min):  
Min. 1,320 kPa**MANIFOLD VACUUM CHECK**

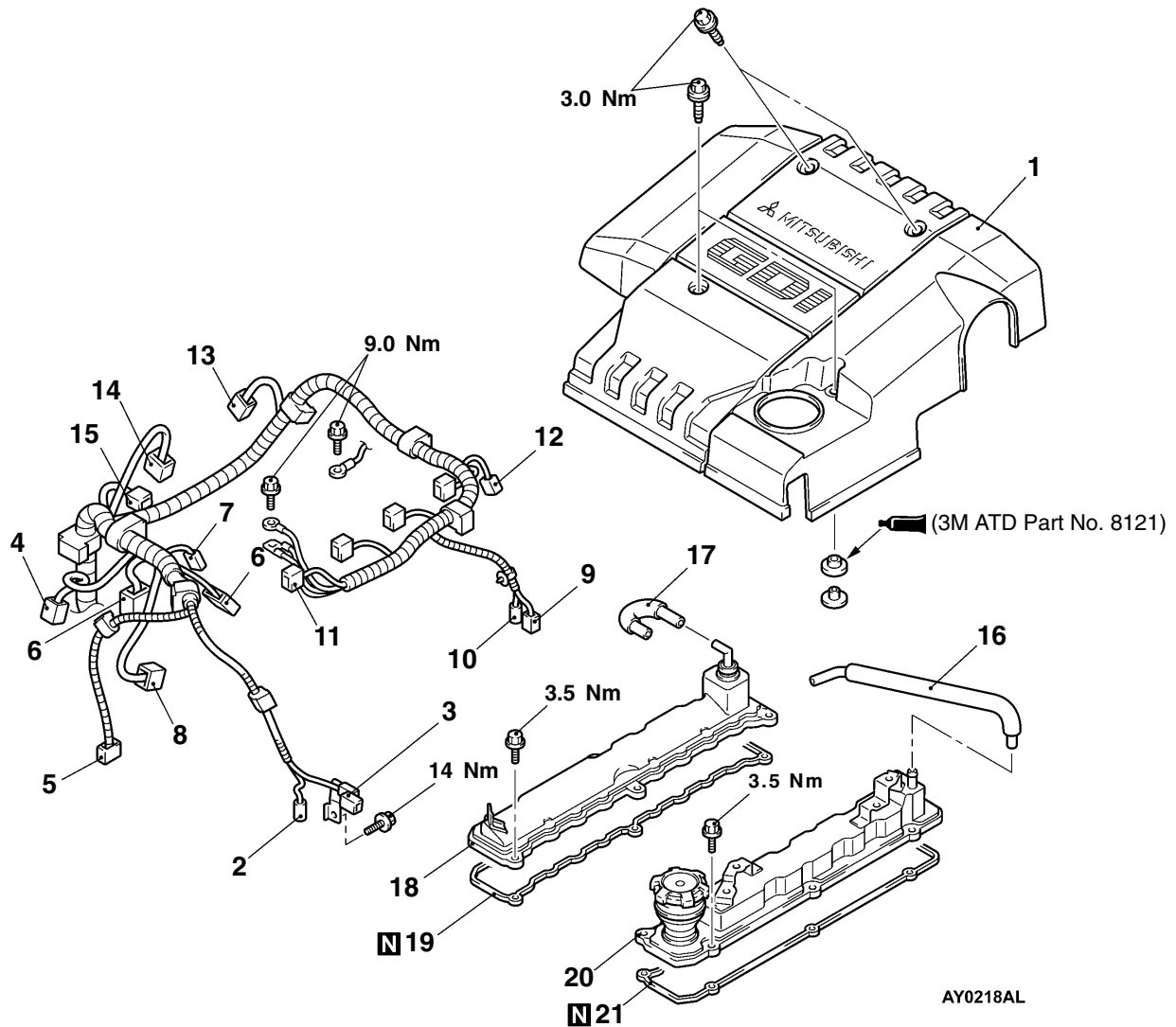
Limit: Min. 56 kPa

## CAMSHAFT AND CAMSHAFT OIL SEAL

### REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operations**

- Fuel Overflow Prevention Operation <only for pre-removal>
- Fuel Leak Check <only for post-installation>
- Air Bleeding The High-pressure Fuel Line <only for post-installation>  
[Refer to GROUP 13A – Fuel Pump (High-pressure).]
- Removal and Installation of Under Cover
- Check and Adjustment of Drive Belt Tension <only for post-installation>
- Draining and Filling of Engine Coolant
- Removal and Installation of Air Intake Hose and Resonance Tank



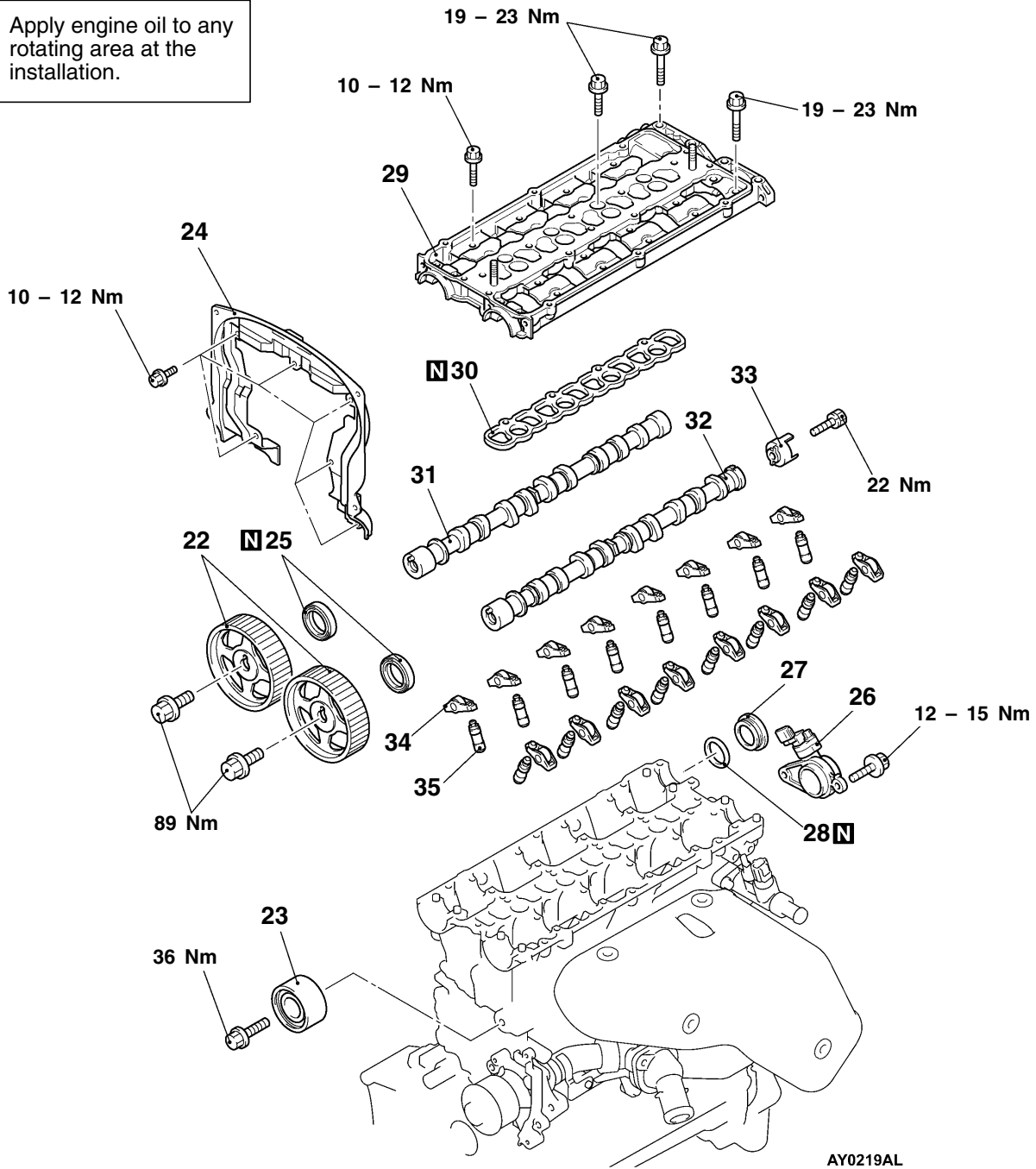
### Removal steps



1. Engine cover
2. Power steering oil pressure switch connector
3. A/C compressor magnetic clutch connector
4. Ignition failure sensor connector
5. Crank angle sensor connector
6. Front wiring harness and injector/EGR wiring harness combination connector
7. Fuel pressure sensor connector
8. Detonation sensor connector
9. Engine coolant temperature sensor connector
10. Engine coolant temperature gauge unit connector
11. Ignition coil connector
12. Camshaft position sensor connector
13. Throttle control servo connector
14. Throttle position sensor connector
15. Purge control solenoid valve connector
16. Breather hose
17. PCV hose
  - Ignition coil
  - Intake manifold
  - Timing belt
18. Intake rocker cover
19. intake rocker cover gasket
20. Exhaust rocker cover
21. Exhaust rocker cover gasket



Apply engine oil to any rotating area at the installation.



◀A▶

▶D▶

- 22. Camshaft sprocket
- 23. Idler pulley
- 24. Timing belt rear upper cover
- 25. Camshaft oil seal
  - Fuel pump (high-pressure)  
(Refer to GROUP 13A.)
- 26. Camshaft position sensor support
- 27. Camshaft thrust cover

▶C▶

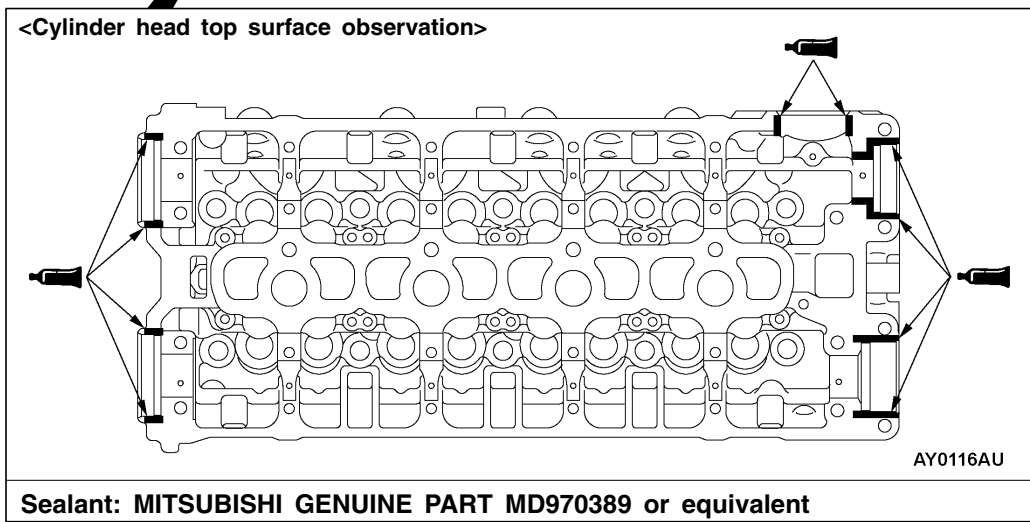
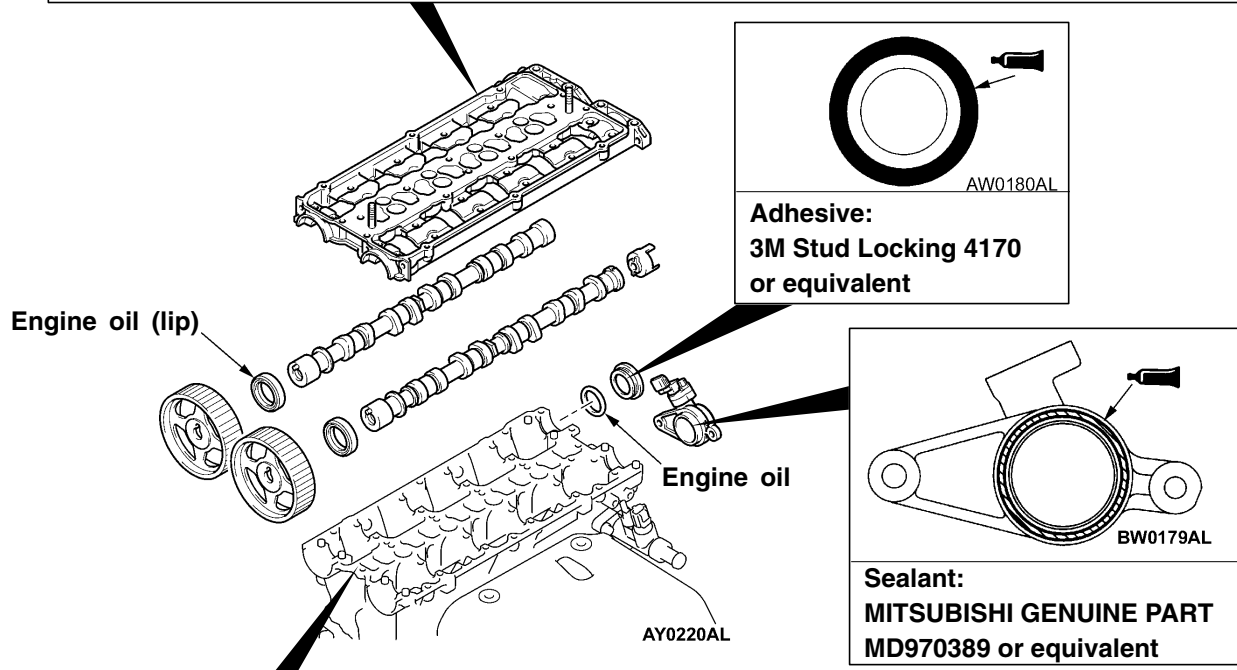
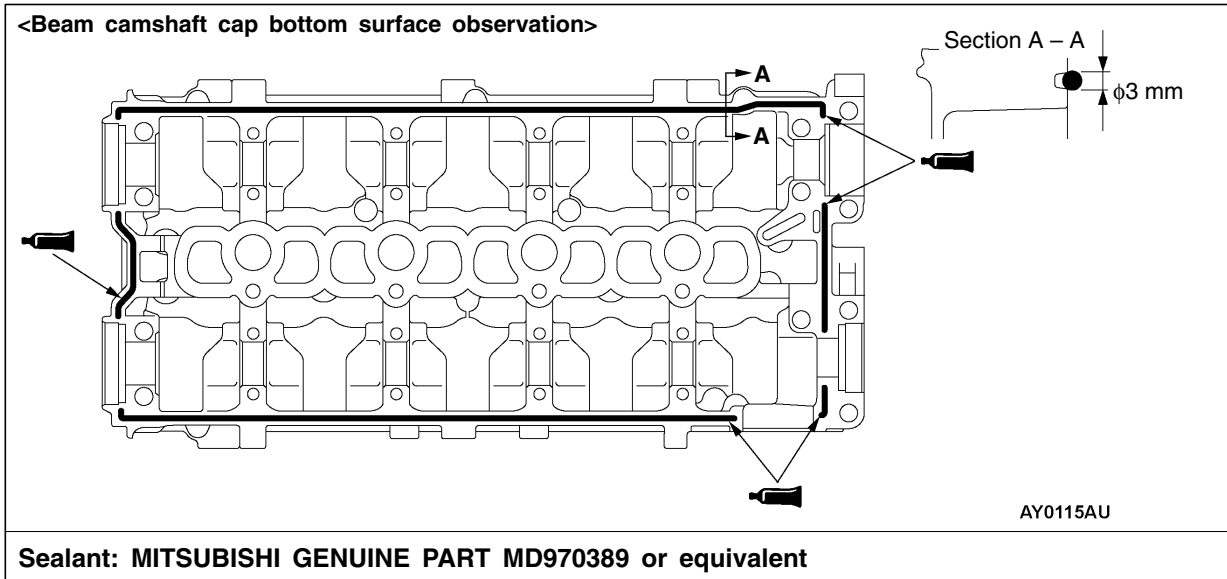
▶B▶

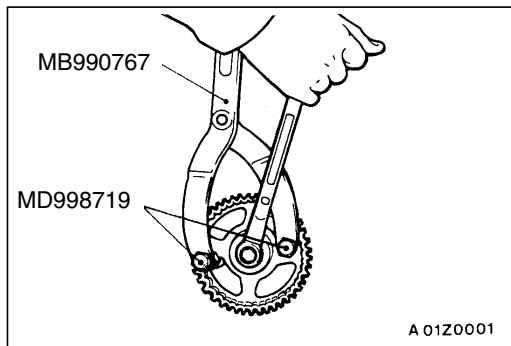
▶B▶

▶A▶

- 28. O-ring
- 29. Beam camshaft cap
- 30. Beam camshaft cap gasket
- 31. Intake camshaft
- 32. Exhaust camshaft
- 33. Camshaft position sensing cylinder
- 34. Rocker arm
- 35. Lash adjuster

LUBRICANT AND SEALANT APPLICATION LOCATIONS

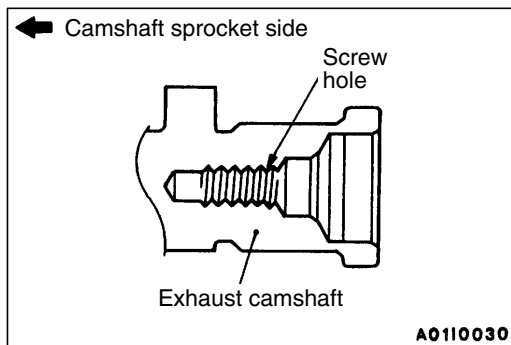


**REMOVAL SERVICE POINT****◀A▶ CAMSHAFT SPROCKET REMOVAL****Caution**

To avoid the danger of damage caused by interference of the valve and the piston, rotate the crankshaft from No.1 cylinder compression top dead centre to 90° in the forward direction (clockwise).

**INSTALLATION SERVICE POINTS****▶A▶ LASH ADJUSTER INSTALLATION****Caution**

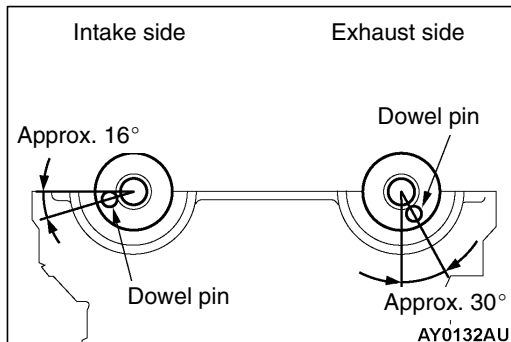
To use the lash adjuster again, be sure to clean and check it before installation.  
(Refer to Engine Workshop Manual.)

**▶B▶ EXHAUST CAMSHAFT/INTAKE CAMSHAFT INSTALLATION**

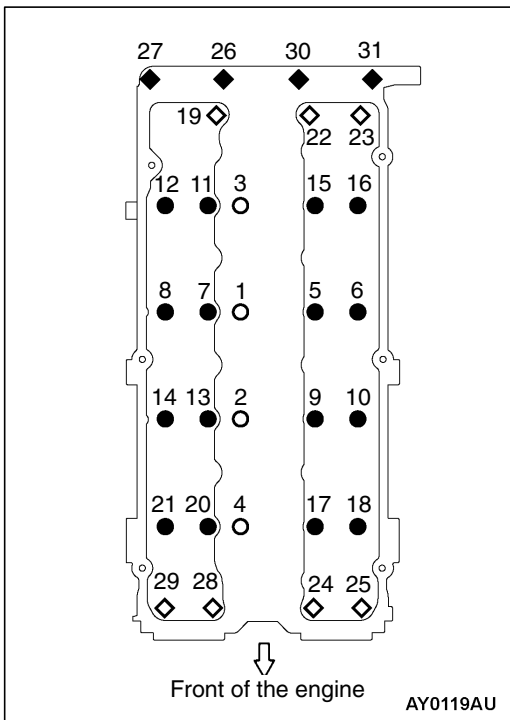
1. Apply engine oil to the cam and the journal of the camshaft.
2. Install the camshaft to the cylinder head.

**Caution**

Do not mistake the intake side for the exhaust side. There is a screw hole for the camshaft position sensing cylinder mounting bolt at the exhaust side of the camshaft.

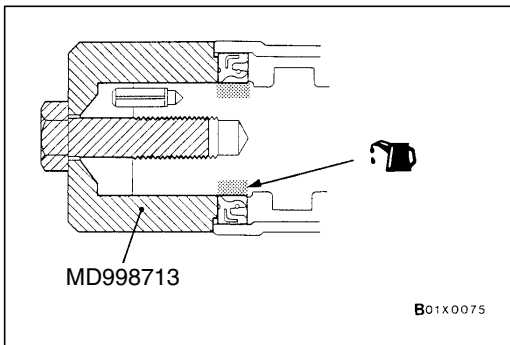
**▶C▶ BEAM CAMSHAFT CAP INSTALLATION**

1. Set the dowel pin of the camshaft at the position shown in the illustration.



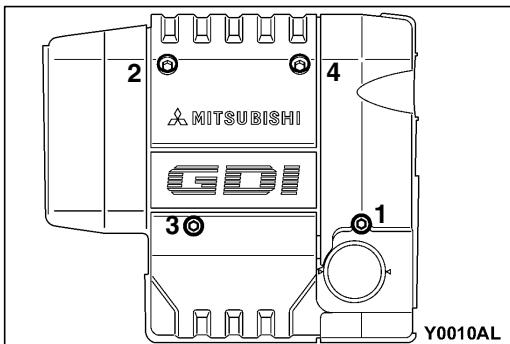
- Tighten the beam camshaft cap mounting bolt to the specified torque in the order of the numbers shown in the illustration.

Symbol	Number of unit	Dimensions mm (Nominal diameter × nominal length)	Tightening torque Nm
○	4	8 × 32	19 – 23
●	16	6 × 35	10 – 12
◇	7	8 × 40	19 – 23
◆	4	8 × 40	



#### ►D◄ CAMSHAFT OIL SEAL INSTALLATION

- Apply engine oil to the circumference of the oil seal lip.
- Press-fit the oil seal as shown in the illustration.



#### ►E◄ ENGINE COVER INSTALLATION

- Tighten the mounting bolt temporarily in the order of the numbers shown in the illustration so that the engine cover can be moved by hand.
- Tighten the mounting bolt to the specified torque in the order of the numbers shown in the illustration.

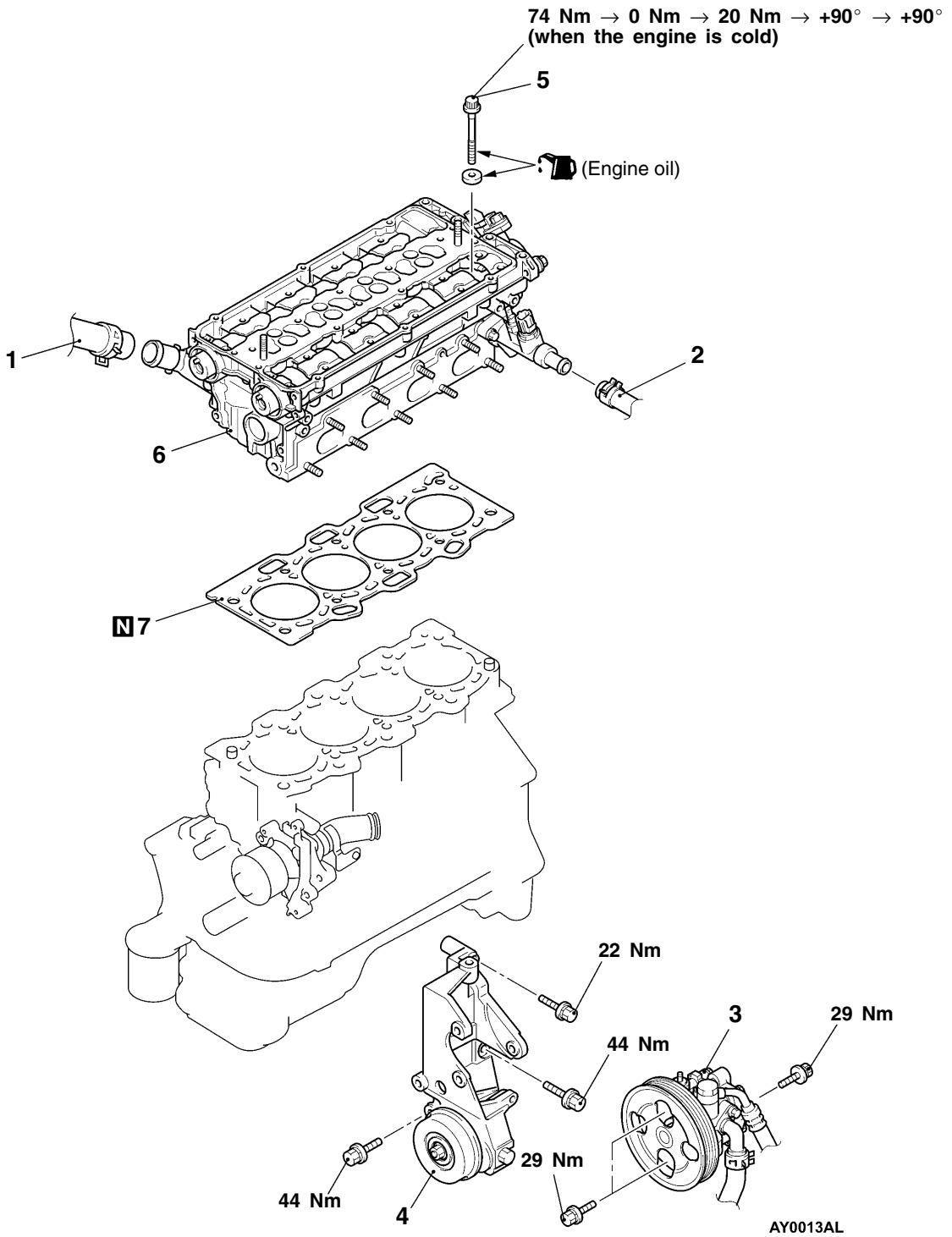
**Tightening torque: 3.0 Nm**

## CYLINDER HEAD GASKET

### REMOVAL AND INSTALLATION

**Pre-removal and Post-installation Operations**

- Removal and Installation of Engine Cover (Refer to P.11A-5.)
- Fuel Overflow Prevention Operation <only for pre-removal>
- Fuel Leak Check <only for post-installation>
- Air Bleeding the High-pressure Fuel Line <only for post-installation>  
[Refer to GROUP 13A – Fuel Pump (High-pressure).]
- Removal and Installation of Under Cover
- Check and Adjustment of Drive Belt Tension <only for post-installation>
- Draining and Filling of Engine Coolant
- Removal and Installation of Timing Belt Rear Upper Cover (Refer to P.11A-6.)
- Removal and Installation of Fuel Pump (High-pressure) (Refer to GROUP 13A.)
- Removal and Installation of Exhaust Manifold
- Removal and Installation of Water Pipe
- Removal and Installation of EGR Valve and Support Assembly



**Removal steps**

- ◀A▶ ▶C▶ 1. Connection of radiator upper hose
- ▶B▶ 2. Connection of heater hose
- ▶A▶ 3. Power steering oil pump
- ▶A▶ 4. Power steering oil pump bracket

- ◀C▶ ▶B▶ 5. Cylinder head bolt
- ▶A▶ 6. Cylinder head assembly
- ▶A▶ 7. Cylinder head gasket

**REMOVAL SERVICE POINTS****◀A▶ RADIATOR UPPER HOSE REMOVAL**

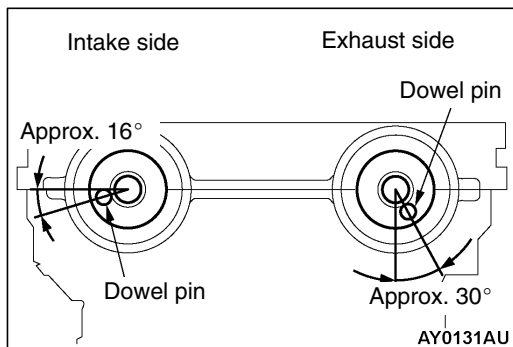
Put mating marks on the radiator upper hose and the hose clamp for removal.

**◀B▶ POWER STEERING OIL PUMP REMOVAL**

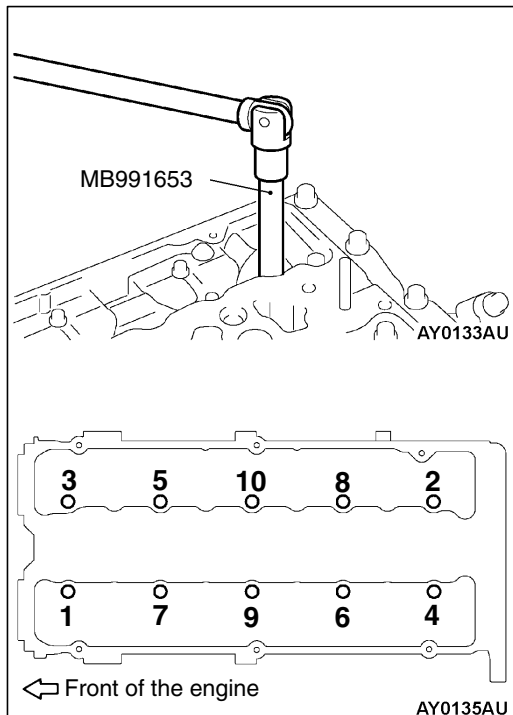
Remove the power steering oil pump with the hose attached from the bracket.

**NOTE**

Tie the removed power steering oil pump and the A/C compressor with strings to set aside so that they will not hinder the removal and installation of the engine assembly.

**◀C▶ CYLINDER HEAD BOLT REMOVAL**

1. Set the dowel pin of the camshaft at the position shown in the illustration.



2. Use the special tool to loosen the bolt in the order of the numbers shown in the illustration in two to three stages for removal.

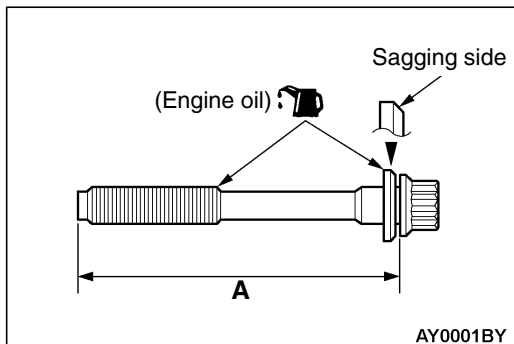
**INSTALLATION SERVICE POINTS****▶A◀ CYLINDER HEAD GASKET INSTALLATION**

1. Remove gasket attached on the mounting surface of the gasket.

**Caution**

**Be careful not to let foreign objects get inside the engine coolant and the oil line.**

2. Install so that the each hole of the cylinder head is aligned with each hole of the cylinder head gasket.

**▶B◀ CYLINDER HEAD BOLT INSTALLATION**

1. Check that the neck down length of the cylinder head bolt is within the limit. If it is outside the limit value, replace the bolt with a new one.

**Limit (A): 96.4 mm**

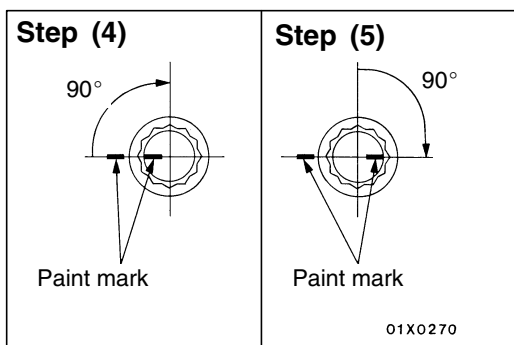
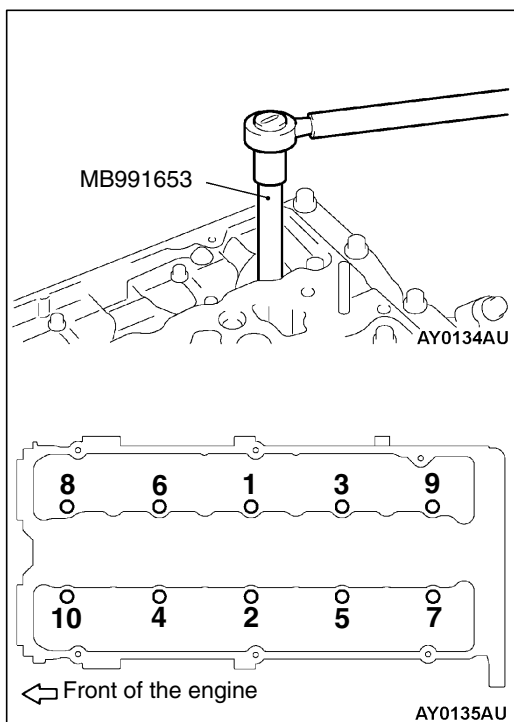
2. Face the sagging side of the bored cylinder head bolt washer towards the direction shown in the illustration to install to the cylinder head bolt.
3. Apply a little amount of engine oil to the cylinder head bolt thread and the washer.

4. Use the special tool to tighten the bolt according to the following procedure (plasticity tightening).
  - (1) Tighten the bolt to 74 Nm in the order of the numbers shown in the illustration.
  - (2) Loosen the bolt completely in the reverse order of the numbers shown in the illustration.
  - (3) Tighten the bolt to 20 Nm in the order of the numbers shown in the illustration.

- (4) Put the paint mark on the head of the cylinder head bolt and the cylinder to tighten to the 90° in the order of the numbers shown in the illustration.
- (5) Tighten to the 90° in the order of the numbers shown in the illustration so that the paint marks on the head of the cylinder head bolt and cylinder head are aligned.

**Caution**

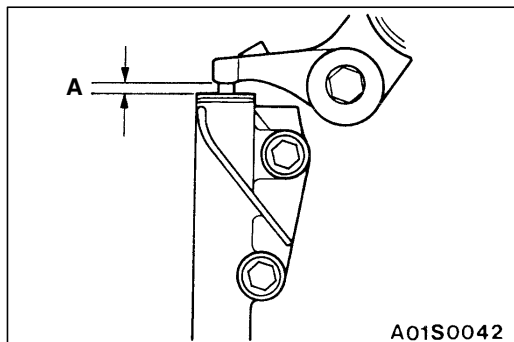
1. If the tightening angle is less than 90°, the bolt is not sufficiently tightened.
2. If the tightening angle is beyond the limit, remove the bolt and start from step 1 again.





**►C◄ RADIATOR UPPER HOSE INSTALLATION**

1. Insert the radiator upper hose to the convex section of the water outlet fitting.
2. Align the mating mark on the radiator upper hose with that of the hose clamp to install.

**TIMING BELT****INSTALLATION SERVICE POINT**

Timing belt tension adjustment

Standard value (A): 4.8 – 5.5 mm