

## GROUP 11C

# ENGINE MECHANICAL **<3.0L>**

## CONTENTS

GENERAL DESCRIPTION.....	<b>11C-2</b>	OIL PAN .....	<b>11C-21</b>
ENGINE DIAGNOSIS.....	<b>11C-2</b>	REMOVAL AND INSTALLATION .....	11C-21
SPECIAL TOOLS.....	<b>11C-3</b>	INSPECTION.....	11C-23
ON VEHICLE SERVICE.....	<b>11C-5</b>	CRANKSHAFT FRONT OIL SEAL... ..	<b>11C-24</b>
DRIVE BELT TENSION CHECK AND ADJUSTMENT .....	<b>11C-5</b>	REMOVAL AND INSTALLATION .....	11C-24
IGNITION TIMING CHECK.....	<b>11C-5</b>	CRANKSHAFT REAR OIL SEAL.... ..	<b>11C-25</b>
IDLE MIXTURE CHECK.....	<b>11C-6</b>	REMOVAL AND INSTALLATION .....	11C-25
CURB IDLE SPEED CHECK .....	<b>11C-7</b>	CYLINDER HEAD GASKET..... ..	<b>11C-27</b>
COMPRESSION PRESSURE CHECK.....	<b>11C-7</b>	REMOVAL AND INSTALLATION .....	11C-27
MANIFOLD VACUUM CHECK.....	<b>11C-8</b>	TIMING BELT .....	<b>11C-29</b>
LASH ADJUSTER CHECK.....	<b>11C-9</b>	REMOVAL AND INSTALLATION .....	11C-29
INSPECTION.....	<b>11C-35</b>	INSPECTION..... ..	11C-35
ENGINE ASSEMBLY.....	<b>11C-11</b>	SPECIFICATIONS .....	<b>11C-35</b>
REMOVAL AND INSTALLATION .....	<b>11C-11</b>	FASTENER TIGHTENING SPECIFICATIONS .....	11C-35
CAMSHAFT AND CAMSHAFT OIL SEAL .....	<b>11C-16</b>	SERVICE SPECIFICATIONS .....	11C-36
REMOVAL AND INSTALLATION .....	<b>11C-16</b>	SEALANT .....	11C-36

## GENERAL DESCRIPTION

The 6G72 (3.0L) engine is a six-cylinder engine. The cylinder numbers are assigned as 1-3-5 for the right bank and 2-4-6 for the left bank from the front of the engine (timing belt side). This engine is fired in the order of the 1, 2, 3, 4, 5 and 6 cylinders.

M1111000100107

ITEMS		SPECIFICATIONS	
Type		V-type, overhead camshaft	
Number of cylinders		6	
Bore mm (in)		91.1 (3.59)	
Stroke mm (in)		76.0 (2.99)	
Piston displacement cm <sup>3</sup> (cu in)		2,972 (181.4)	
Compression ratio		9.0	
Firing order		1-2-3-4-5-6	
Valve timing	Intake valve	Opens (BTDC)	15°
		Closes (ABDC)	53°
	Exhaust valve	Opens (BBDC)	53°
		Closes (ATDC)	15°

## ENGINE DIAGNOSIS

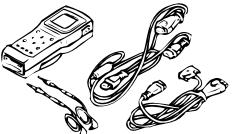
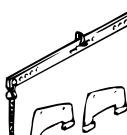
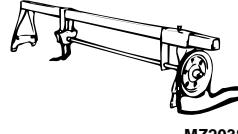
M1111000700080

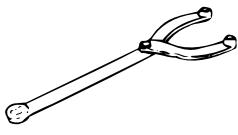
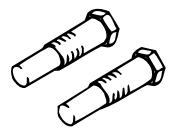
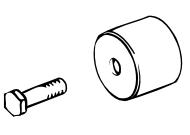
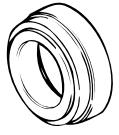
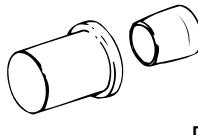
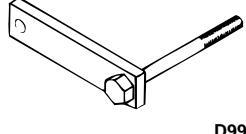
SYMPTOMS	PROBABLE CAUSE	REMEDY
Compression is too low	Blown cylinder head gasket	Replace the gasket.
	Worn or damaged piston rings	Replace the rings.
	Worn piston or cylinder	Repair or replace the piston and/or the cylinder block.
	Worn or damaged valve seat	Repair or replace the valve and/or the seat ring
Drop in oil pressure	Engine oil level is too low	Check the engine oil level.
	Malfunction of oil pressure switch	Replace the oil pressure switch.
	Clogged oil filter	Install a new filter.
	Worn oil pump gears or cover	Replace the gears and/or the cover.
	Thin or diluted engine oil	Change the engine oil to the correct viscosity.
	Stuck (opened) oil relief valve	Repair the relief valve.
	Excessive bearing clearance	Replace the bearings.
Oil pressure too high	Stuck (closed) oil relief valve	Repair the relief valve.

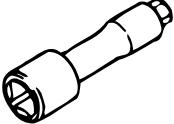
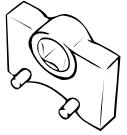
SYMPTOMS	PROBABLE CAUSE	REMEDY
Noisy valves	Malfunction of lash adjuster (including entry of air into high pressure chamber)	Check the lash adjuster.
	Thin or diluted engine oil (low oil pressure)	Change the engine oil.
	Worn or damaged valve stem or valve guide	Replace the valve and/or the guide.
Connecting rod noise/ main bearing noise	Insufficient oil supply	Check the engine oil level.
	Thin or diluted engine oil	Change the engine oil.
	Excessive bearing clearance	Replace the bearings.

## SPECIAL TOOLS

M1111000600124

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 B991502	MB991502 Scan tool (MUT-II)	MB991496-OD	<ul style="list-style-type: none"> <li>• Ignition timing check</li> <li>• Idle speed check</li> </ul>
 MB991453	MB991453 Engine hanger assembly	MZ203827-01	Supporting the engine assembly during remove and installation of the transaxle
 MZ203827	GENERAL SERVICE TOOL MZ203827 Engine lifter	MZ203827-01	
 D998443	MD998443 Lash adjuster holder (8)	MD998443-01	Supporting of the lash adjuster to prevent it from falling when rocker shaft assembly is removed or installed

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 MB990767	MB990767 End yoke holder	MB990767-01	Holding the camshaft sprocket and crankshaft pulley when loosening and tightening bolt
 D998715	MD998715 Crankshaft pulley holder pin	MIT308239	
 D998713	MD998713 Camshaft oil seal installer	MD998713-01	Camshaft oil seal installation
 B991559	MB991559 Camshaft oil seal installer adapter	-	Camshaft oil seal installation (left bank side) (Use with MD998713)
 D998717	MD998717 Crankshaft front oil seal installer	MD998717-01	Crankshaft front oil seal installation
 D998781	MD998781 Flywheel stopper	General service tool	Flywheel <M/T> or drive plate <A/T> supporting
 D998718	MD998718 Crankshaft rear oil seal installer	MD998718-01	Crankshaft rear oil seal installation

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 D998051	MD998051 Cylinder head bolt wrench	MD998051-01 or General service tool	Cylinder head bolt loosening and tightening
 D998767	MD998767 Tensioner pulley socket wrench	MD998752-01	Timing belt tension adjustment
 D998769	MD998769 Crankshaft sprocket spacer	General service tool	Used if the crankshaft needs to be rotated to attach the timing belt, etc.

## ON VEHICLE SERVICE

### DRIVE BELT TENSION CHECK AND ADJUSTMENT

M1111003100128  
Refer to GROUP 00, Maintenance Service – Drive Belts  
(Check Condition) [P.00-39](#)

### IGNITION TIMING CHECK

M1111001700102

#### Required Special Tool:

MB991502: Scan Tool (MUT-II)

1. Before inspection, set vehicles in the following condition:
  - Engine coolant temperature: 80 – 95°C (176 - 203°F)
  - Lights and all accessories: OFF
  - Transaxle: "P" range

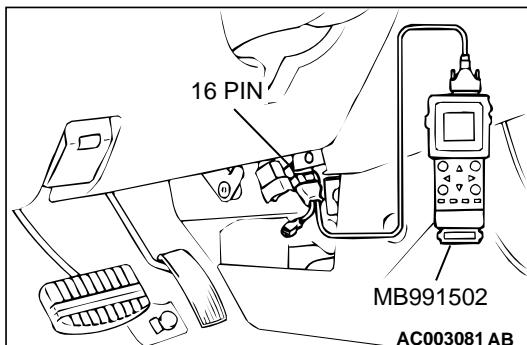
#### CAUTION

To prevent damage to scan tool MB991502, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991502.

2. Connect scan tool MB991502 to the data link connector.
3. Set up a timing light.
4. Start the engine and run it at idle.
5. Check that the idle speed is approximately 700 r/min.
6. Select scan tool MB991502 actuator test "item number 17."
7. Check that basic ignition timing is within the standard value.

**Standard value: 5° BTDC ± 3°**

8. If the basic ignition timing is not within the standard value, check the following items:



- Diagnosis output
- Timing belt cover and crankshaft position sensor installation conditions
- Crankshaft sensing blade condition

**⚠ CAUTION**

If the actuator test is not canceled, the forced drive will continue for 27 minutes. Driving in this state could lead to engine failure.

9. Press the clear key on scan tool MB991502 (select forced drive stop mode), and cancel the actuator test.
10. Check that the actual ignition timing is at the standard value.

**Standard value: Approximately 15° BTDC**

*NOTE: Ignition timing fluctuates about  $\pm 7^\circ$  Before Top Dead Center, even under normal operating condition.*

*NOTE: It is automatically further advanced by about 5° to 10° Before Top Dead Center at higher altitudes.*

## IDLE MIXTURE CHECK

M1111002100103

**Required Special Tool:**

MB991502: Scan Tool (MUT-II)

1. Before inspection, set vehicles in the following condition:
  - Engine coolant temperature: 80 – 95°C (176 - 203°F)
  - Lights and all accessories: OFF
  - Transaxle: "P" range

**⚠ CAUTION**

To prevent damage to scan tool MB991502, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991502.

2. Connect scan tool MB991502 to the data link connector.
3. Check that the basic ignition timing is within the standard value.

**Standard value: 5° BTDC  $\pm 3^\circ$**

4. Start the engine and increase the engine speed to 2,500 r/min for 2 minutes.
5. Set the CO, HC tester.
6. Check the CO contents and the HC contents at idle.

**Standard value:**

**CO contents: 0.5% or less**

**HC contents: 100 ppm or less**

7. If the CO and HC contents do not remain inside the standard value, check the following items:

*NOTE: Replace the catalytic converter when the CO and HC contents do not remain inside the standard value, even though the result of the inspection is normal for all items.*

- Diagnosis output
- Closed-loop control (When the closed-loop control is carried out normally, the output signal of the heated oxygen sensor changes between 0 – 400 mV and 600 – 1,000 mV at idle.)
- Fuel pressures

- Injector
- Ignition coil, spark plug cable, spark plug
- EGR system and EGR valve leak
- Evaporative emission control system
- Compression pressure

## CURB IDLE SPEED CHECK

M1111003500115

### Required Special Tool:

MB991502: Scan Tool (MUT-II)

1. Before inspection and adjustment set vehicles in the following condition.
  - Engine coolant temperature: 80 – 95°C (176 - 203°F)
  - Lights and all accessories: OFF
  - Transaxle: "P" range

### CAUTION

To prevent damage to scan tool MB991502, always turn the ignition switch to the "LOCK" (OFF) position before connecting or disconnecting scan tool MB991502.

2. Connect scan tool MB991502 to the data link connector.
3. Check the basic ignition timing.

**Standard value: 5° BTDC ± 3°**

4. Start the engine.
5. Run the engine at idle for 2 minutes.
6. Check the idle speed. Select item number 22 and take a reading of the idle speed.

**Curb idle speed: 700 ± 100 r/min**

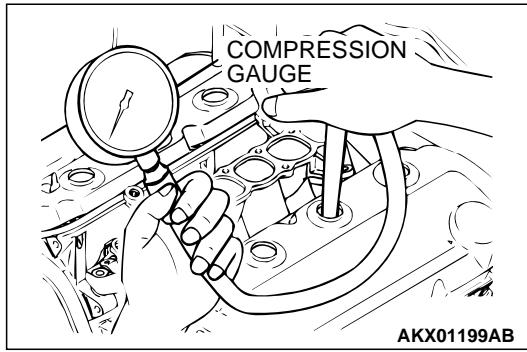
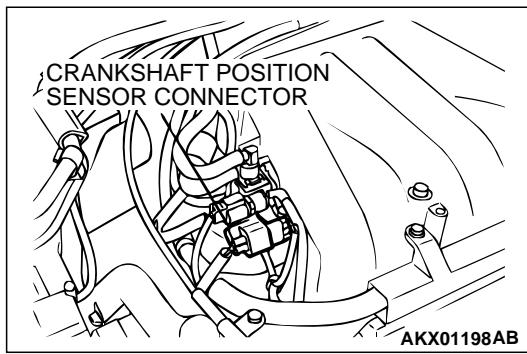
*NOTE: The idle speed is controlled automatically by the idle air control system.*

7. If the idle speed is outside the standard value, refer to GROUP 13B, Diagnosis – Symptom Chart [P.13B-22](#).

## COMPRESSION PRESSURE CHECK

M1111002600090

1. Before inspection, check that the engine oil, starter and battery are normal. Also, set the vehicle in the following condition:
  - Engine coolant temperature: 80 – 95°C (176 - 203°F)
  - Lights, and all accessories: OFF
  - Transaxle: "P" range
2. Disconnect the spark plug cables.
3. Remove all of the spark plugs.



4. Disconnect the crankshaft position sensor connector.

*NOTE: Doing this will prevent the engine control module from carrying out ignition and fuel injection.*

**⚠ WARNING**

**Keep your distance from the spark plug hole when cranking. Oil, fuel, etc., may spray out from the spark plug hole and may cause serious injury.**

5. Cover the spark plug hole with a shop towel etc., during cranking. After the engine has been cranked, check for foreign material adhering to the shop towel.

6. Set compression gauge to one of the spark plug holes.

7. Crank the engine with the throttle valve fully open and measure the compression pressure.

**Standard value (at engine speed of 250 – 400 r/min):824 kPa (119 psi)**

**Minimum limit (at engine speed of 250 – 400 r/min):575 kPa (83 psi)**

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

**Limit: 98 kPa (14 psi)**

9. 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 to 8.

(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.

10. Connect the crankshaft position sensor connector.

11. Install the spark plugs and spark plug cables.

12. Use the scan tool to erase the diagnostic trouble codes.

*NOTE: This will erase the diagnostic trouble code resulting from the distributor connector being disconnected.*

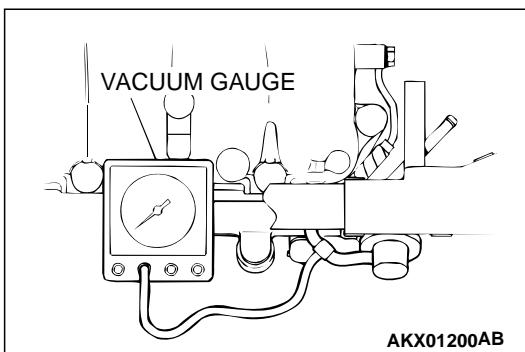
## MANIFOLD VACUUM CHECK

M1111002700105

1. Before inspection, set vehicles in the following condition:

- Engine coolant temperature: 80 – 95°C (176 - 203°F)
- Lights and all accessories: OFF
- Transmission: "P" range

2. Connect a tachometer.



3. Attach a Tee-fitting union to the vacuum hose between the fuel pressure regulator and the intake manifold plenum, and connect a vacuum gauge.
4. Start the engine and check that idle speed is within specification. Then check the vacuum gauge reading.

**Idle speed:  $700 \pm 100$  r/min**

**Minimum limit: 60 kPa (18 in Hg)**

## LASH ADJUSTER CHECK

M1111002900110

If an abnormal noise (chattering noise) suspected to be caused by malfunction of the lash adjuster is produced immediately after starting the engine and does not disappear, perform the following check.

*NOTE: An abnormal noise due to malfunction of the lash adjuster is produced immediately after starting the engine and changes with the engine speed, irrespective of the engine load. If, the abnormal noise is not produced immediately after starting the engine or does not change with the engine speed, or it changes with the engine load, the lash adjuster is not the cause for the abnormal noise.*

*NOTE: When the lash adjuster is malfunctioning, the abnormal noise is rarely eliminated by continuing the warming-up of the engine at idle speed.*

*However, the abnormal noise may disappear only when seizure is caused by oil sludge in the engine whose oil is not maintained properly.*

1. Start the engine.
2. Check if the abnormal noise produced immediately after starting the engine, changes with the change in the engine speed.  
If the abnormal noise is not produced immediately after starting the engine or it does not change with the engine speed, the lash adjuster is not the cause for the noise.  
Therefore, investigate other causes. The abnormal noise is probably caused by some other parts than the engine proper if it does not change with the engine speed. (In this case, the lash adjuster is in good condition.)
3. With the engine idling, change the engine load (shift from N to D range, for example) to make sure that there is no change in the level of abnormal noise.  
If there is a change in the level of abnormal noise, suspect a tapping noise due to worn crankshaft bearing or connecting rod bearing. (In this case, the lash adjuster is in good condition.)
4. After completion of warm-up, run the engine at idle to check for abnormal noise.

If the noise is reduced or disappears, clean the lash adjuster (Refer to GROUP 11D-Engine overhaul – Rocker Arms and Camshaft – Inspection P.11D-25.) As it is suspected that the noise is due to seizure of the lash adjuster. If there is no change in the level of the abnormal noise, proceed to step 5.

5. Run the engine to bleed the lash adjuster system. (Refer to P.11C-10.)
6. If the abnormal noise does not disappear after air bleeding operation, clean the lash adjuster (Refer to GROUP 11D-Engine overhaul – Rocker Arms and Camshaft – Inspection P.11D-25.)

#### Bleeding lash adjuster system

*NOTE: Parking the vehicle on a grade for a long time may decrease oil in the lash adjuster, causing air to enter the high pressure chamber when starting the engine.*

*NOTE: After parking for many hours, oil may run out from the oil passage and take time before oil is supplied to the lash adjuster, causing air to enter the high pressure chamber.*

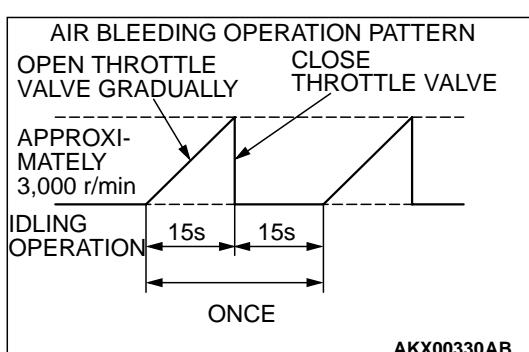
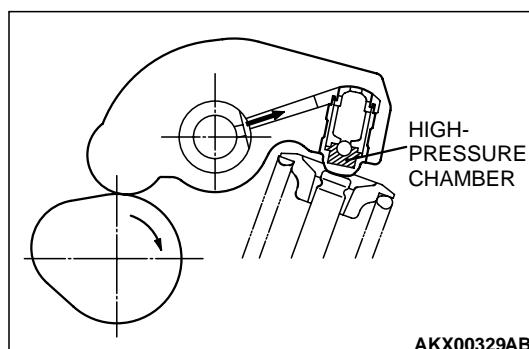
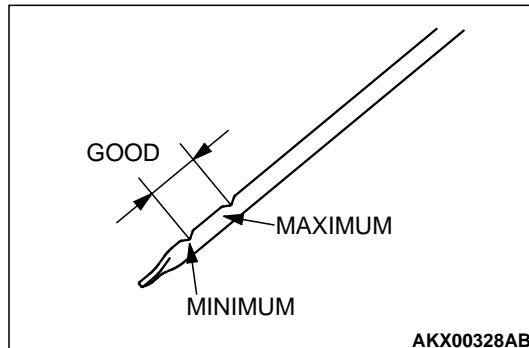
*NOTE: In the above cases, abnormal noise can be eliminated by bleeding the lash adjuster system.*

1. Check engine oil and add or change oil if required.

*NOTE: If the engine oil level is low, air is sucked from the oil screen, causing air to enter the oil passage.*

*NOTE: If the engine oil level is higher than specification, oil may be stirred by the crankshaft, causing oil to be mixed with a large quantity of air.*

*NOTE: If oil is deteriorated, air is not easily separated from oil, increasing the quantity of air contained in oil.*



*NOTE: If air mixed with oil enters the high pressure chamber inside the lash adjuster from the above causes, air in the high pressure chamber is compressed excessively while the valve is opened, resulting in an abnormal noise when the valve closes.*

*This is the same phenomenon as that observed when the valve clearance has become excessive. The lash adjuster can resume normal function when air entered the lash adjuster is removed.*

2. Idle the engine for one to three minutes to warm it up.
3. Repeat the operation pattern, shown in left figure, at no load to check for abnormal noise. (Usually the abnormal noise is eliminated after repetition of the operation 10 to 30 times. If, however, no change is observed in the level of abnormal noise after repeating the operation more than 30 times, suspect that the abnormal noise is due to some other factors.)
4. After elimination of abnormal noise, repeat the operation shown in left figure five more times.

5. Run the engine at idle for one to three minutes to make sure that the abnormal noise has been eliminated.

## ENGINE ASSEMBLY

### REMOVAL AND INSTALLATION

M1112001000151

#### ⚠ CAUTION

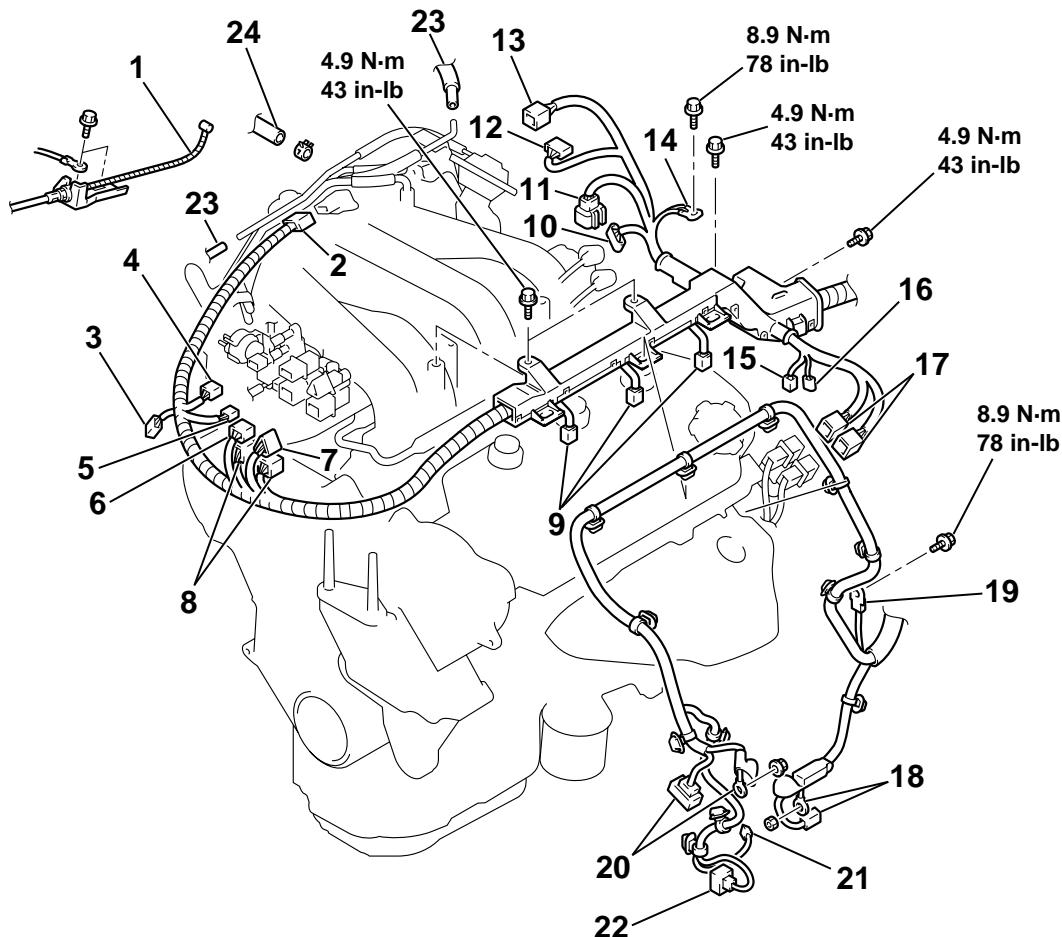
\*: Indicates parts which should be temporarily tightened, and then fully tightened after placing the vehicle horizontally and loading the full weight of the engine on the vehicle body.

#### Pre-removal Operation

- Hood Removal (Refer to GROUP 42, Hood [P.42-5](#).)
- Fuel Line Pressure Reduction [Refer to GROUP 13B, On-vehicle Service – Fuel Pump Relay Disconnection (How to Reduce Pressurized Fuel Lines) [P.13B-523](#).]
- Engine Coolant Draining [Refer to GROUP 00, Maintenance Service – Engine Coolant (Change) [P.00-50](#).]
- Air Cleaner Removal (Refer to GROUP 15, Air Cleaner [P.15-4](#).)
- Reserve Tank and Radiator Removal (Refer to GROUP 14, Radiator [P.14-15](#).)
- Front Exhaust Pipe Removal (Refer to GROUP 15, Exhaust Pipe and Main Muffler [P.15-19](#).)

#### Post-installation Operation

- Front Exhaust Pipe Installation (Refer to GROUP 15, Exhaust Pipe and Main Muffler [P.15-19](#).)
- Reserve Tank and Radiator Installation (Refer to GROUP 14, Radiator [P.14-15](#).)
- Air Cleaner Installation (Refer to GROUP 15, Air Cleaner [P.15-4](#).)
- Drive Belt Tension Adjustment [Refer to GROUP 00 Maintenance Service – Drive Belts (Check Condition) [P.00-39](#).]
- Engine Coolant Refilling [Refer to GROUP 00, Maintenance Service – Engine Coolant (Change) [P.00-50](#).]
- Accelerator Cable Adjustment (Refer to GROUP 17, On-vehicle Service – Accelerator Cable Check and Adjustment [P.17-4](#).)
- Hood Installation (Refer to GROUP 42, Hood [P.42-5](#).)



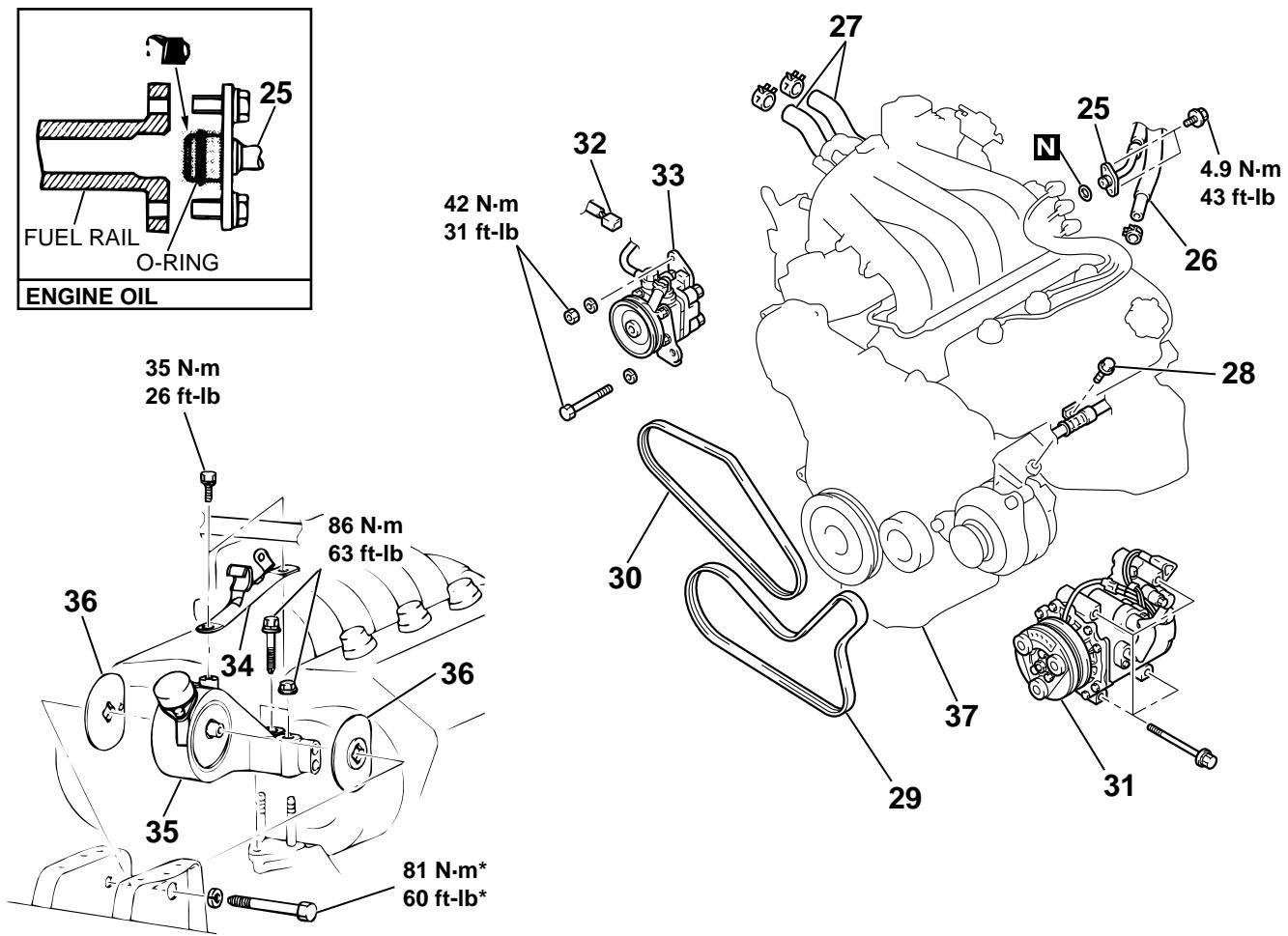
AC004714AB

**REMOVAL STEPS**

1. ACCELERATOR CABLE CONNECTION
2. MANIFOLD DIFFERENTIAL PRESSURE SENSOR CONNECTOR
3. CONTROL WIRING HARNESS AND POWER STEERING WIRING HARNESS COMBINATION CONNECTOR
4. EGR SOLENOID VALVE CONNECTOR
5. EVAPORATIVE EMISSION PURGE SOLENOID VALVE CONNECTOR
6. KNOCK SENSOR CONNECTOR
7. CRANKSHAFT POSITION SENSOR CONNECTOR
8. RIGHT BANK HEATED OXYGEN SENSOR CONNECTOR
9. INJECTOR CONNECTOR
10. DISTRIBUTOR CONNECTOR
11. CONTROL WIRING HARNESS AND INJECTOR WIRING HARNESS COMBINATION CONNECTOR

**REMOVAL STEPS (Continued)**

12. THROTTLE POSITION SENSOR CONNECTOR
13. IDLE AIR CONTROL MOTOR CONNECTOR
14. GROUND WIRE CONNECTION
15. ENGINE COOLANT TEMPERATURE GAUGE UNIT CONNECTOR
16. ENGINE COOLANT TEMPERATURE SENSOR CONNECTOR
17. LEFT BANK HEATED OXYGEN SENSOR CONNECTOR
18. STARTER CONNECTOR
19. GROUND WIRE CONNECTION
20. GENERATOR CONNECTOR
21. OIL PRESSURE SWITCH CONNECTOR
22. A/C COMPRESSOR CONNECTOR
23. VACUUM HOSE CONNECTION
24. BRAKE BOOSTER VACUUM HOSE CONNECTION



AC005055AB

- |   |   |
|---|---|
| >>D<< 25. HIGH-PRESSURE FUEL HOSE CONNECTION  | 32. POWER STEERING PRESSURE SWITCH CONNECTOR  |
| 26. FUEL RETURN HOSE CONNECTION               | 33. POWER STEERING OIL PUMP   |
| 27. HEATER HOSE CONNECTION                    | 34. ENGINE MOUNT STAY   |
| 28. SUCTION HOSE CONNECTION                   | • TRANSAXLE ASSEMBLY (REFER TO GROUP 23A, TRANSAXLE ASSEMBLY <a href="#">P.23A-290</a> .) |
| 29. DRIVE BELT (GENERATOR AND A/C COMPRESSOR) | <<C>> >>C<< 35. ENGINE MOUNT BRACKET  |
| 30. DRIVE BELT (POWER STEERING OIL PUMP)      | >>B<< 36. ENGINE MOUNT STOPPER  |
| <<A>> 31. A/C COMPRESSOR                      | <<D>> >>A<< 37. ENGINE ASSEMBLY   |

**Required Special Tools:**

- MB991453: Engine Hanger Assembly

- MZ203827: Engine Lifter

**REMOVAL SERVICE POINTS****<<A>> A/C COMPRESSOR REMOVAL**

Remove the A/C compressor from the compressor bracket with the hose attached.

*NOTE: Place the removed A/C compressor where it will not be a hindrance when removing and installing the engine assembly, and secure it with a cord or wire.*

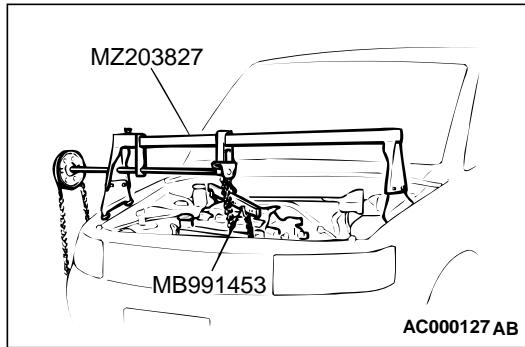
## &lt;&lt;B&gt;&gt; POWER STEERING OIL PUMP REMOVAL

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

*NOTE: Place the removed power steering oil pump in a place where it will not be a hindrance when removing and installing the engine assembly, and secure it with a cord or wire.*

## &lt;&lt;C&gt;&gt; ENGINE MOUNT BRACKET REMOVAL

1. Support the engine with a garage jack.
2. Remove special tools MB991453 and MZ203827 which were attached when the transaxle assembly was removed.
3. Hold the engine assembly with a chain block or similar tool.
4. Place a garage jack against the engine oil pan with a piece of wood in between, jack up the engine so that the weight of the engine is no longer being applied to the engine mount bracket, and then remove the engine mount bracket.



## &lt;&lt;D&gt;&gt; ENGINE ASSEMBLY REMOVAL

After checking that all cables, hoses and harness connectors, etc., are disconnected from the engine, lift the chain block slowly to remove the engine assembly upward from the engine compartment.

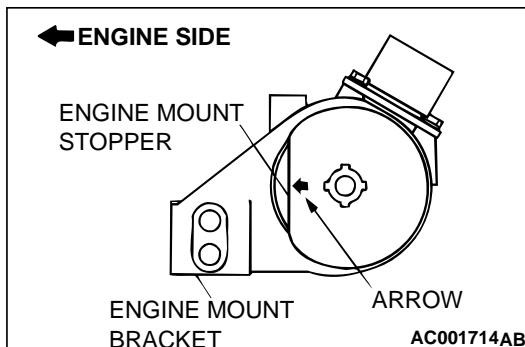
## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; ENGINE ASSEMBLY INSTALLATION

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

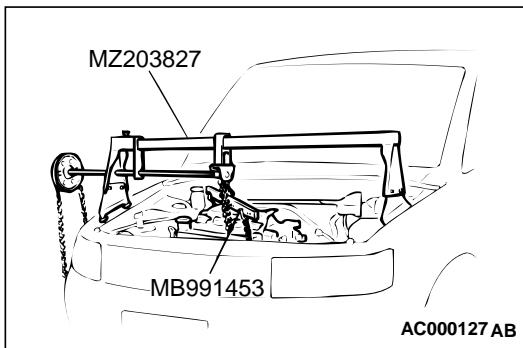
## &gt;&gt;B&lt;&lt; ENGINE MOUNT STOPPER INSTALLATION

Clamp the engine mount stopper so that the arrow points in the direction as shown in the diagram.

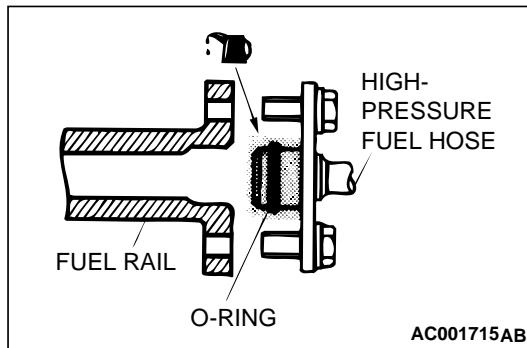


## &gt;&gt;C&lt;&lt; ENGINE MOUNT BRACKET INSTALLATION

1. Place a garage jack against the engine oil pan with a piece of wood in between, and install the engine mount bracket while adjusting the position of the engine.
2. Support the engine with the garage jack.



3. Remove the chain block and support the engine assembly with special tools MB991453 and MZ203827.



#### >>D<< HIGH-PRESSURE FUEL HOSE INSTALLATION

##### **⚠ CAUTION**

**Do not allow engine oil to enter the fuel rail.**

1. Apply a small amount of new engine oil to the O-ring.
2. Turning the high-pressure fuel hose to the right and left, install it to the fuel rail, while being careful not to damage the O-ring. After installing, check that the hose turns smoothly.
3. If the hose does not turn smoothly, the O-ring may be clamped. Disconnect the high-pressure fuel hose and check the O-ring for damage.
4. Re-insert the fuel rail and check that the hose turns smoothly.

## CAMSHAFT AND CAMSHAFT OIL SEAL

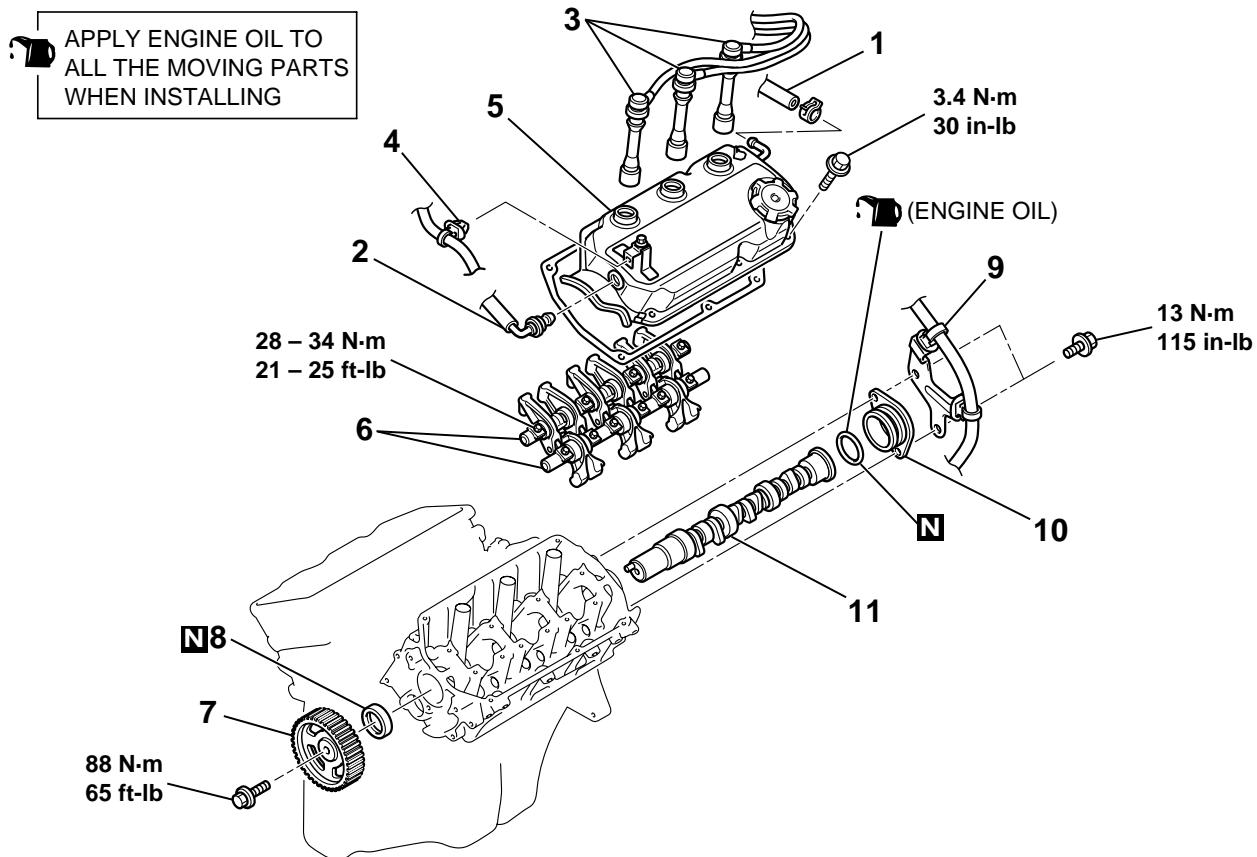
## REMOVAL AND INSTALLATION

M1112001900121

## &lt;LEFT BANK&gt;

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

- Timing Belt Removal and Installation (Refer to P.11C-29.)
- Thermostat Housing Assembly Removal and Installation (Refer to GROUP 14, Water Hose and Water Pipe P.14-23.)



AC004834AB

## CAMSHAFT REMOVAL STEPS

1. BLOW-BY HOSE CONNECTION
  2. PCV HOSE CONNECTION
  3. SPARK PLUG CABLE
  4. BATTERY CABLE CONNECTION
  5. ROCKER COVER
  6. ROCKER ARM AND SHAFT ASSEMBLY
  7. CAMSHAFT SPROCKET
- <<A>> >>D<<      <<B>> >>B<<      >>A<<

## CAMSHAFT REMOVAL STEPS

9. BATTERY CABLE AND HARNESS BRACKET
  10. THRUST CASE
  11. CAMSHAFT
- CAMSHAFT OIL SEAL REMOVAL STEPS**
7. CAMSHAFT SPROCKET
  8. CAMSHAFT OIL SEAL

## Required Special Tools:

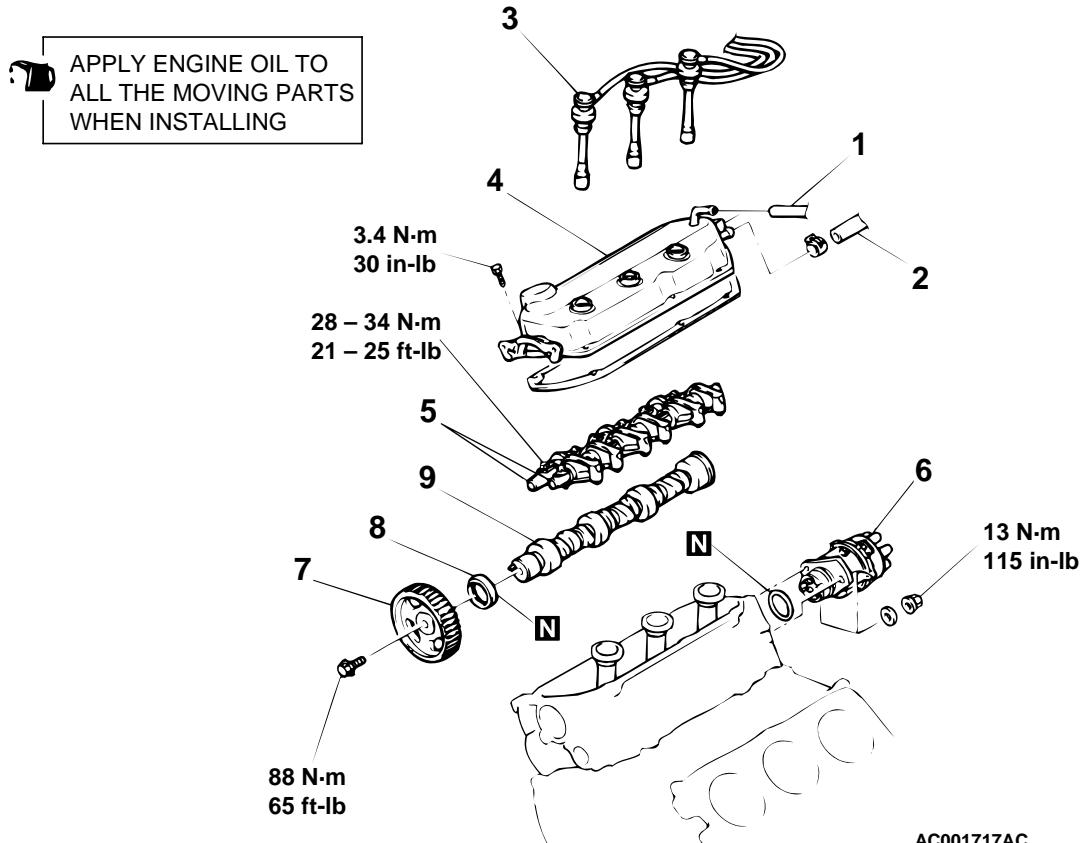
- MB990767: End Yoke Holder
- MB991559: Camshaft Oil Seal Adapter

- MD998443: Auto-lash Adjuster Holder
- MD998713: Camshaft Oil Seal Installer
- MD998715: Crankshaft Pulley Holder Pin

## &lt;RIGHT BANK&gt;

## Pre-removal and Post-installation Operation

- Timing Belt Removal and Installation (Refer to P.11C-29.)
- Intake Manifold Plenum Removal and Installation (Refer to GROUP 15, Intake Manifold Plenum P.15-5)



## CAMSHAFT REMOVAL STEPS

1. BREather HOSE CONNECTION  
2. BLOW-BY HOSE CONNECTION  
3. SPARK PLUG CABLE  
4. ROCKER COVER  
<<A>> >>D<< 5. ROCKER ARM AND SHAFT ASSEMBLY  
>>C<< 6. DISTRIBUTOR

&lt;&lt;B&gt;&gt; &gt;&gt;B&lt;&lt;

&lt;&lt;B&gt;&gt; &gt;&gt;B&lt;&lt;

## CAMSHAFT REMOVAL STEPS

- CAMSHAFT SPROCKET  
CAMSHAFT  
CAMSHAFT OIL SEAL  
REMOVAL STEPS  
7. CAMSHAFT SPROCKET  
8. CAMSHAFT OIL SEAL

## Required Special Tools:

- MB990767: End Yoke Holder
- MD998443: Auto-lash Adjuster Holder

- MD998713: Camshaft Oil Seal Installer
- MD998715: Crankshaft Pulley Holder Pin

## REMOVAL SERVICE POINTS

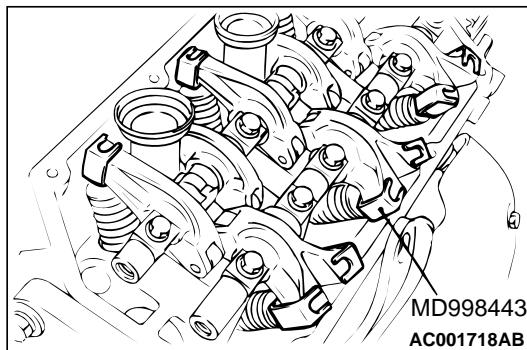
## &lt;&lt;A&gt;&gt; ROCKER ARM AND SHAFT ASSEMBLY REMOVAL

1. Install special tool MD998443 as shown in the illustration so that the lash adjusters will not fall out.

**CAUTION**

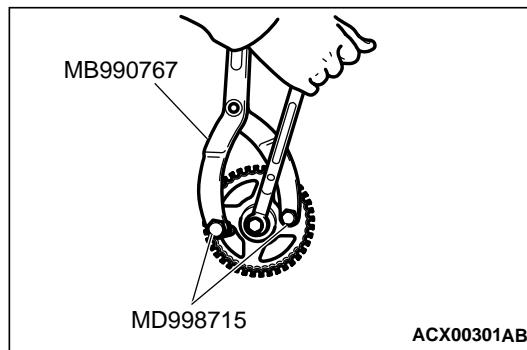
**Never disassemble the rocker arm and shaft assembly.**

2. Loosen the rocker arm and shaft assembly mounting bolts, then remove the rocker arm and shaft assembly with the bolts still attached.



## &lt;&lt;B&gt;&gt; CAMSHAFT SPROCKET REMOVAL

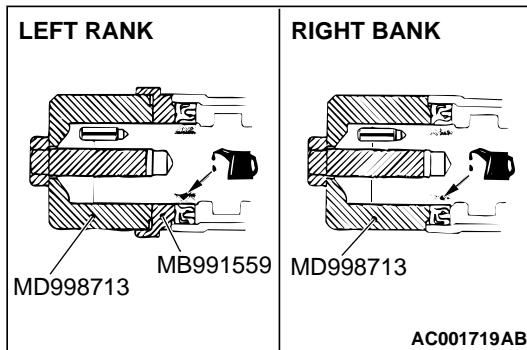
1. Use special tools MB990767 and MD998715 to loosen the camshaft sprocket mounting bolt.
2. Remove the camshaft sprocket.



## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; CAMSHAFT OIL SEAL INSTALLATION

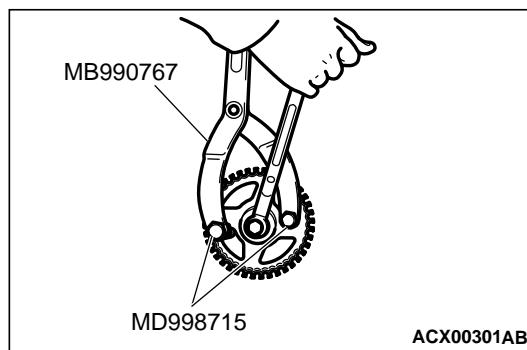
1. Apply engine oil to the camshaft oil seal lip.
2. Use special tools MB991559 and MD998713 to press-fit the camshaft oil seal.



## &gt;&gt;B&lt;&lt; CAMSHAFT SPROCKET INSTALLATION

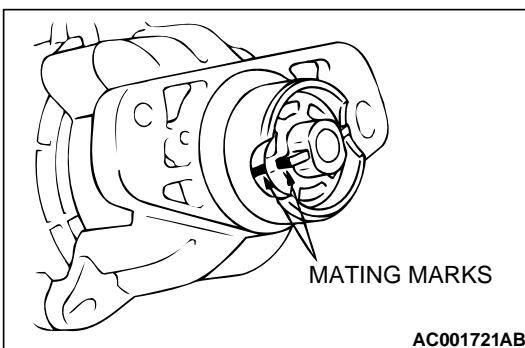
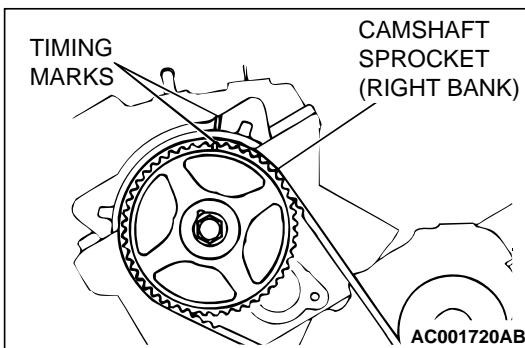
1. Install the camshaft sprocket.
2. Use special tools MB990767 and MD998715 to tighten the camshaft sprocket mounting bolt to the specified torque.

**Tightening torque: 88 N·m (65 ft-lb)**



## &gt;&gt;C&lt;&lt; DISTRIBUTOR INSTALLATION

1. Align the timing mark of the camshaft sprocket (right bank) with that of the cylinder head.



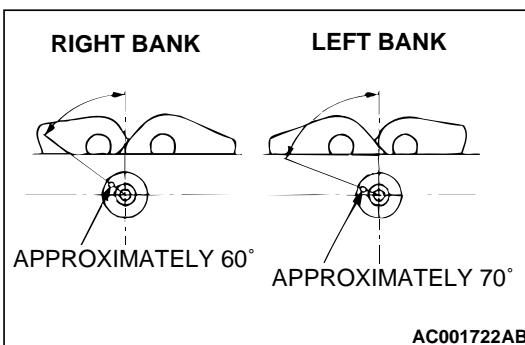
2. Align the mating marks on the distributor housing and coupling, then install the distributor to the engine.

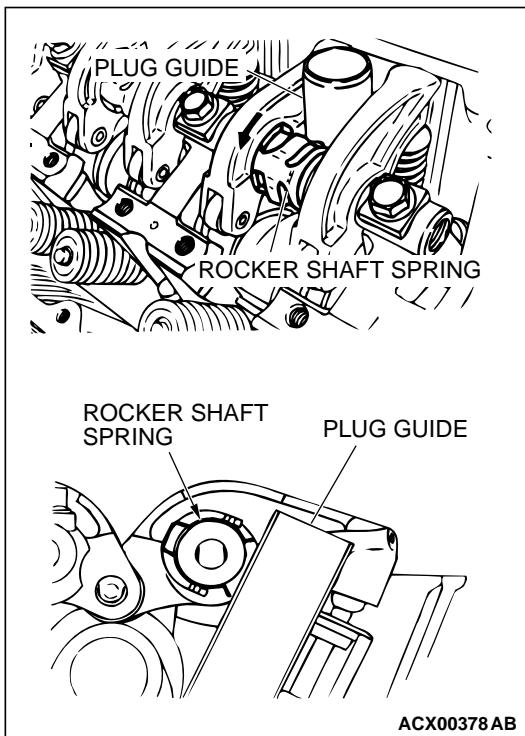
>>D<< ROCKER ARM AND SHAFT ASSEMBLY  
INSTALLATION

1. Rotate the camshaft until the dowel pin on its front end is located as shown in the illustration.

*NOTE: Placing the camshaft in the illustrated position minimizes the amount of cam lift, making it easier to install the rocker arm and shaft assembly.*

2. Temporarily tighten the rocker shaft with the bolts so that all rocker arms on the inlet valve side do not push the valves.





3. Position the rocker shaft spring so that it takes a right angle against the plug guide.  
*NOTE: Set the rocker shaft spring before installing the rocker arm and shaft assembly on the exhaust side.*
4. Tighten the rocker arm and shaft assembly mounting bolts to the specified torque.

**Tightening torque: 28 – 34 N·m (21 – 25 ft-lb)**

5. Remove special tool MD998443.

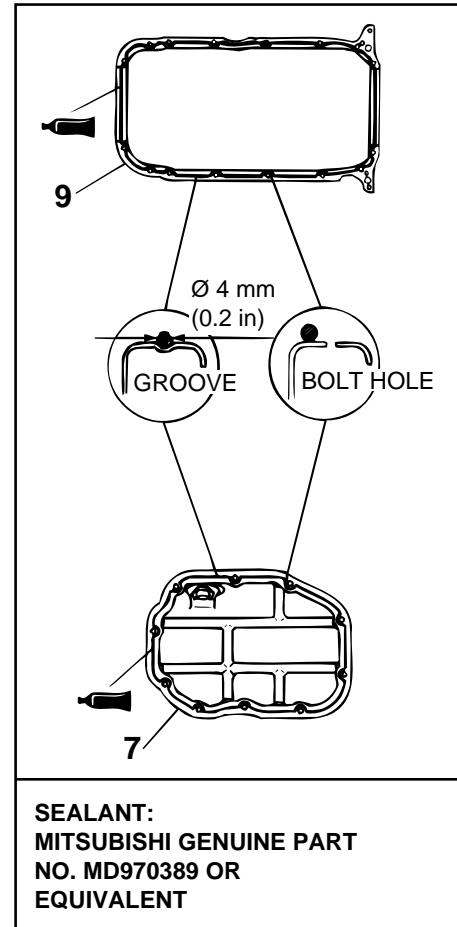
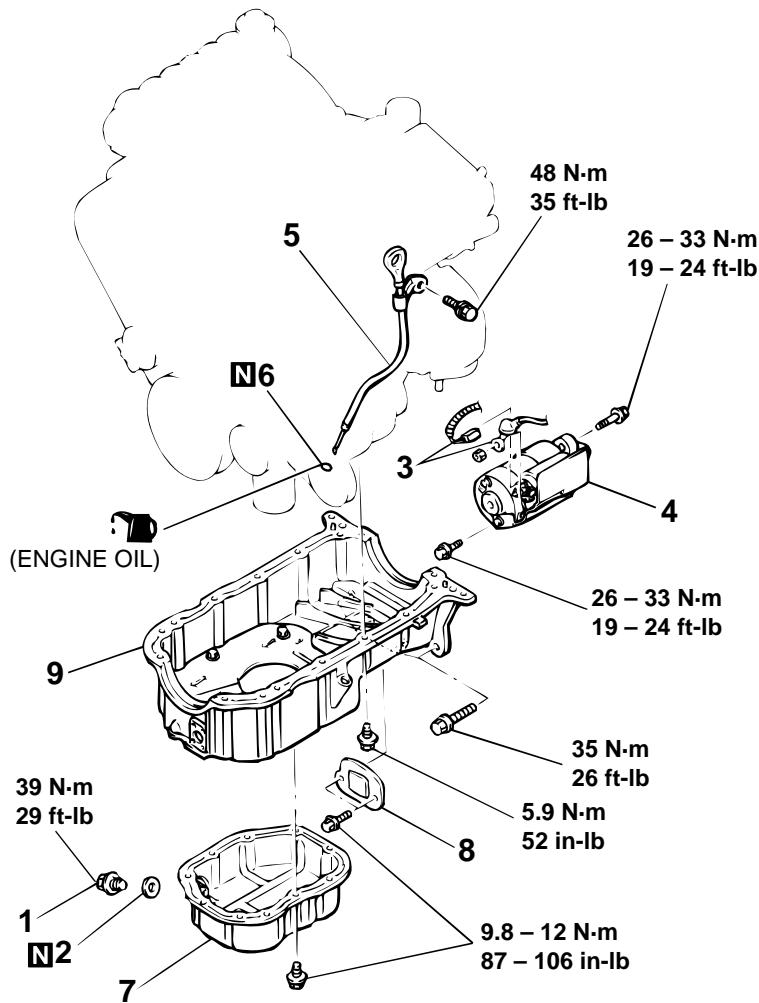
## OIL PAN

## REMOVAL AND INSTALLATION

M1112002800086

## Pre-removal and Post-installation operation

- Engine Oil Draining and Refilling (Refer to GROUP 12, On-vehicle Service – Engine Oil Replacement [P.12-3](#).)
- Front Exhaust Pipe Removal and Installation (Refer to GROUP 15, Exhaust Pipe and Main Muffler [P.15-19](#).)



AC001723AC

## LOWER OIL PAN REMOVAL STEPS

- <<A>> >>C<< 1. DRAIN PLUG  
<<A>> >>B<< 2. DRAIN PLUG GASKET  
<<A>> >>B<< 7. LOWER OIL PAN

## UPPER OIL PAN REMOVAL STEPS

- >>C<< 1. DRAIN PLUG  
>>C<< 2. DRAIN PLUG GASKET  
>>C<< 3. STARTER CONNECTOR

## UPPER OIL PAN REMOVAL STEPS (Continued)

4. STARTER  
5. OIL DIPSTICK AND DIPSTICK GUIDE  
6. O-RING  
7. LOWER OIL PAN  
8. COVER  
9. UPPER OIL PAN

## REMOVAL SERVICE POINTS

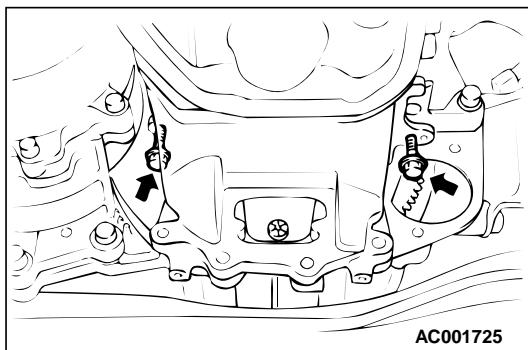
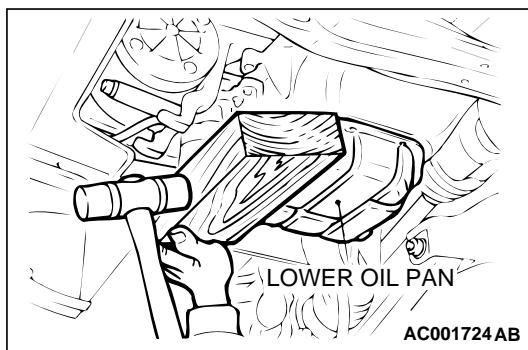
## &lt;&lt;A&gt;&gt; LOWER OIL PAN REMOVAL

1. Remove the oil pan, lower mounting bolts.

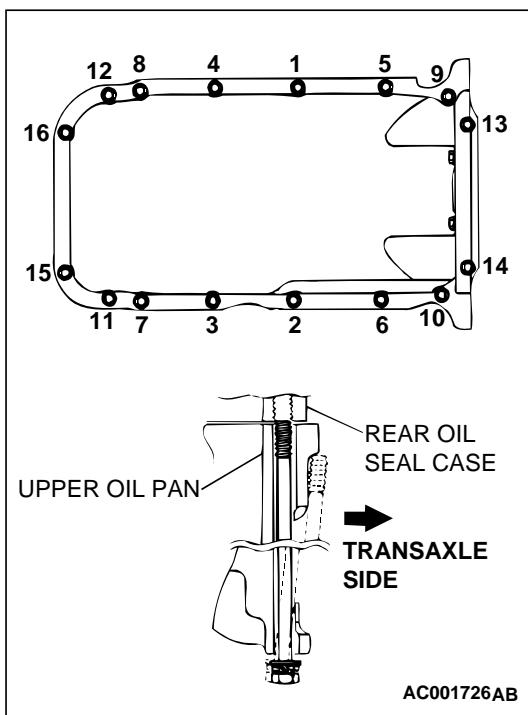
**⚠ CAUTION**

Do not use the oil pan remover (MD998727). It will damage the upper oil pan.

2. Place a wooden block against the lower oil pan as shown in the illustration and remove by tapping with a hammer.

**<<B>> UPPER OIL PAN REMOVAL**

1. Remove the upper oil pan mounting bolts.
2. Screw the bolts (M10) securing the upper oil pan to the transaxle assembly in the illustrated bolt holes, then remove the upper oil pan.

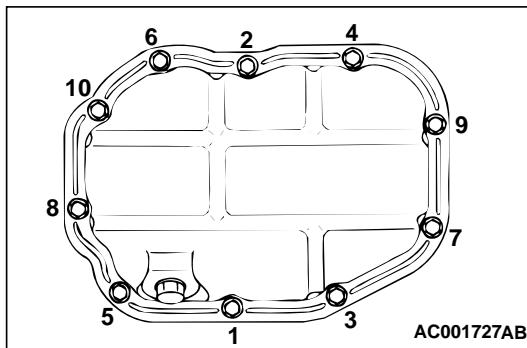
**INSTALLATION SERVICE POINTS****>>A<< UPPER OIL PAN INSTALLATION****⚠ CAUTION**

The bolt holes for bolts 13 and 14 in the illustration are cut away on the transaxle side. Be careful not to insert these bolts at an angle.

Tighten the oil pan, upper mounting bolts in the order shown.

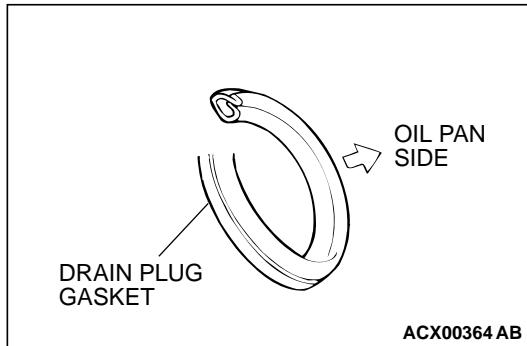
## &gt;&gt;B&lt;&lt; LOWER OIL PAN INSTALLATION

Tighten the lower oil pan mounting bolts in the order shown.



## &gt;&gt;C&lt;&lt; DRAIN PLUG GASKET INSTALLATION

Replace the gasket with a new gasket. Install the new gasket in the direction shown in the illustration.



## INSPECTION

M1112002900083

- Check the oil pan for cracks.
- Check the oil pan sealant-coated surface for damage and deformation.

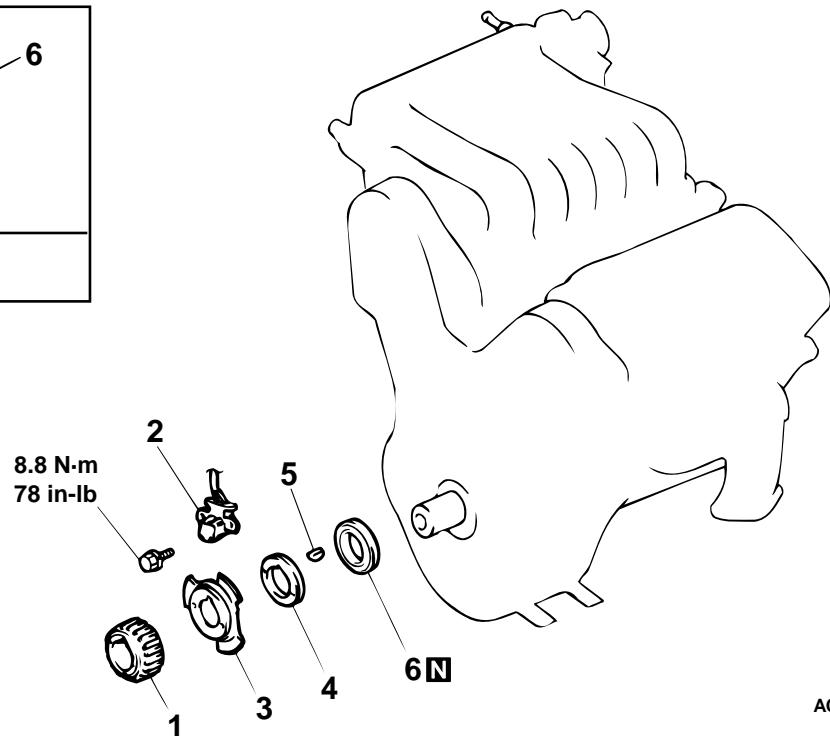
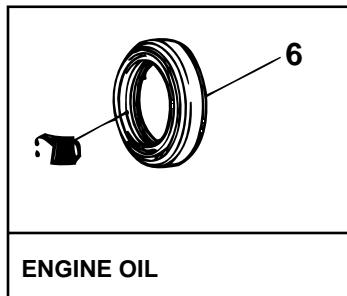
## CRANKSHAFT FRONT OIL SEAL

## REMOVAL AND INSTALLATION

M1112003400111

## Pre-removal and Post-installation Operation

- Timing Belt Removal and Installation (Refer to P.11C-29.)



AC001728 AC

- REMOVAL STEPS**
- >>B<< 1. CRANKSHAFT SPROCKET  
2. CRANKSHAFT POSITION  
SENSOR  
>>B<< 3. CRANKSHAFT SENSING BLADE

- REMOVAL STEPS (Continued)**
- >>B<< 4. CRANKSHAFT SPACER  
5. KEY  
>>A<< 6. CRANKSHAFT FRONT OIL SEAL

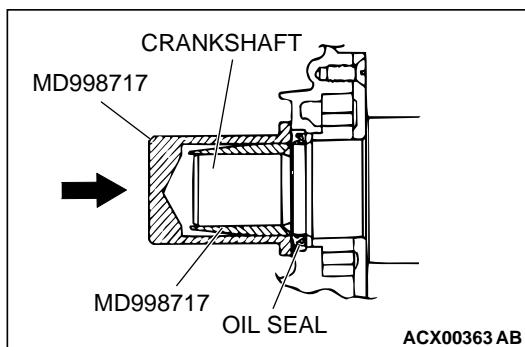
## Required Special Tool:

- MD998717: Crankshaft Front Oil Seal Installer

## INSTALLATION SERVICE POINTS

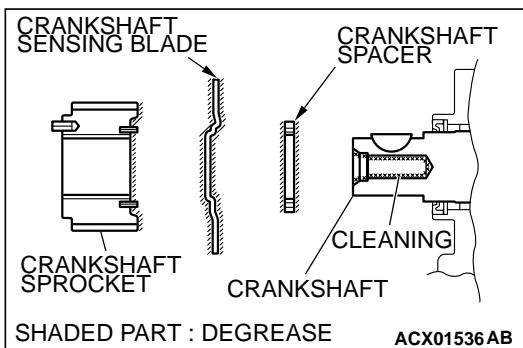
## &gt;&gt;A&lt;&lt; CRANKSHAFT FRONT OIL SEAL INSTALLATION

- Apply a small amount of engine oil to the oil seal lip and then insert.
- Using special tool MD998717, tap the oil seal into the front case.



>>B<< CRANKSHAFT SPACER/CRANKSHAFT SENSING  
BLADE/CRANKSHAFT SPROCKET INSTALLATION

To prevent the crankshaft pulley mounting bolt from loosening, degrees or clean the crankshaft, the crankshaft spacer, the crankshaft sensing blade and the crankshaft at the shown positions.



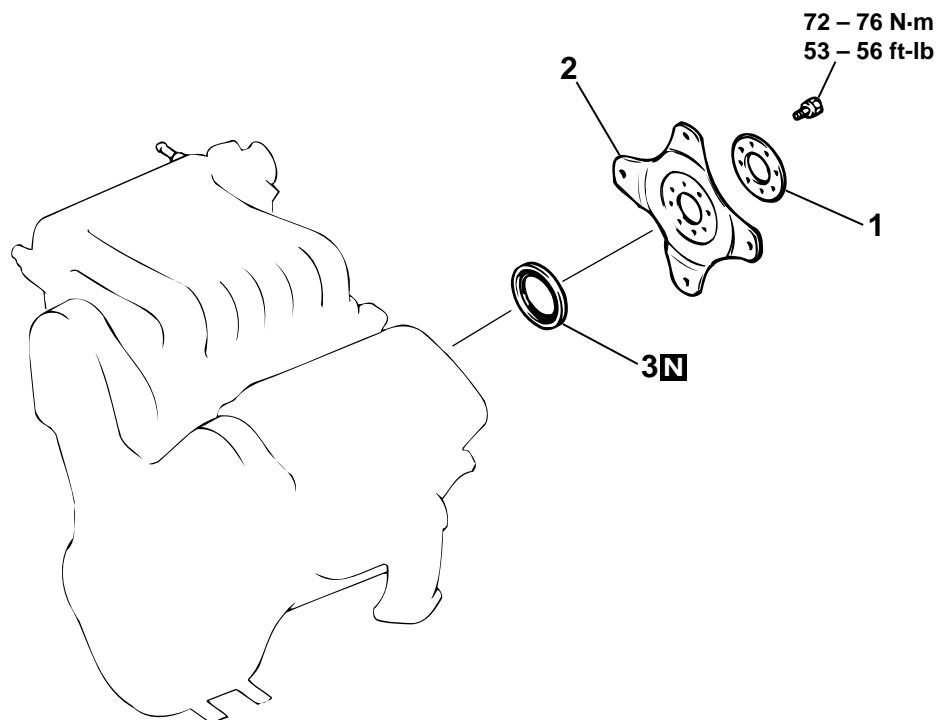
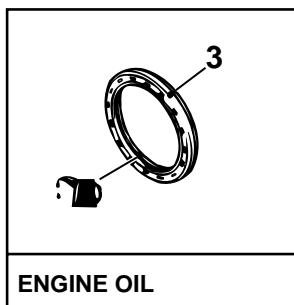
## CRANKSHAFT REAR OIL SEAL

## REMOVAL AND INSTALLATION

M1112003700112

## Pre-removal and Post-installation Operation

- Transaxle Assembly Removal and Installation (Refer to GROUP 23A, Transaxle Assembly P.23A-290.)

<<A>> >>B<< REMOVAL STEPS  
1. ADAPTER PLATE<<A>> >>B<< REMOVAL STEPS (Continued)  
>>A<< 2. DRIVE PLATE  
3. CRANKSHAFT REAR OIL SEAL

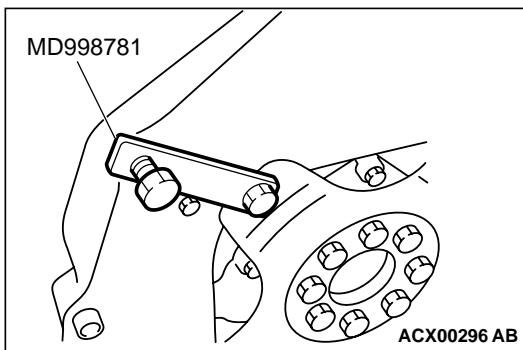
## Required Special Tools:

- MD998718: Crankshaft Rear Oil Seal Installer

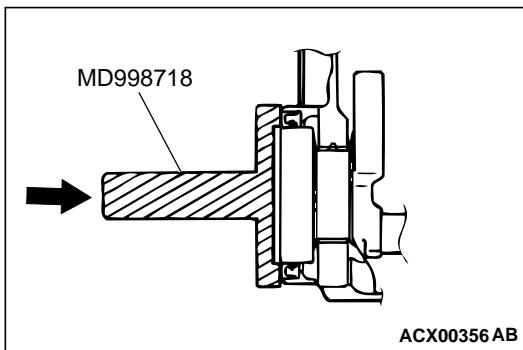
- MD998781: Flywheel Stopper

**REMOVAL SERVICE POINT****<<A>> ADAPTER PLATE/DRIVE PLATE REMOVAL**

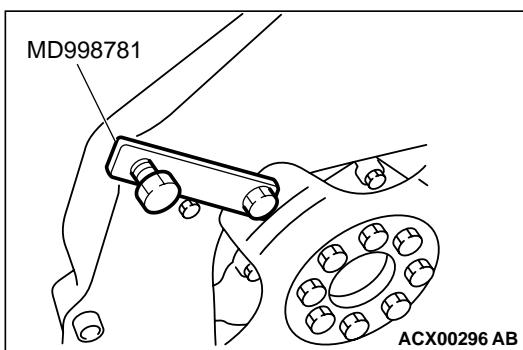
Use special tool MB998781 to secure the drive plate, and remove the bolts.

**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. Use special tool MD998718 to tap in the oil seal as shown in the illustration.

**>>B<< DRIVE PLATE/ADAPTER PLATE INSTALLATION**

Use special tool MD998781 to hold the drive plate in the same manner as removal. Then install the bolts.



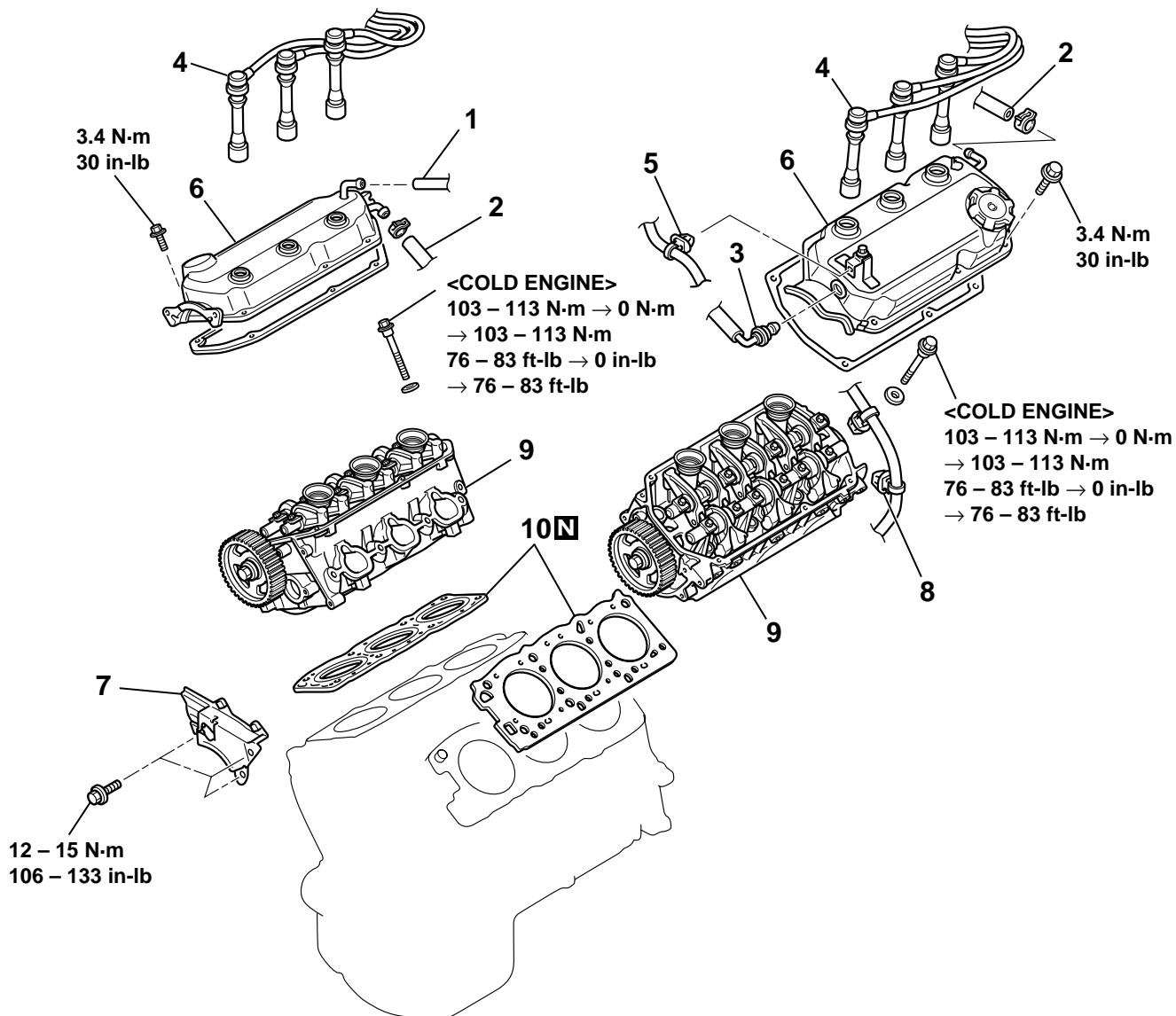
## CYLINDER HEAD GASKET

## REMOVAL AND INSTALLATION

M1112004000116

## Pre-removal and Post-installation Operation

- Engine Coolant Draining and Refilling [Refer to GROUP 00, Maintenance Service – Engine Coolant (Change) P.00-50.]
- Timing Belt Removal and installation (Refer to P.11C-29.)
- Generator Removal and Installation (Refer to GROUP16, Generator P.16-14.)
- Intake Manifold Removal and installation (Refer to GROUP 15, Intake Manifold P.15-10.)
- Exhaust Manifold Removal and Installation (Refer to GROUP 15, Exhaust Manifold P.15-16.)
- Water Inlet Pipe Removal and Installation (Refer to GROUP 14, Water Hose and Water Pipe P.14-23.)



AC004838AB

- REMOVAL STEPS**
1. BREather HOSE
  2. BLOW-BY HOSE
  3. PCV HOSE

- REMOVAL STEPS (Continued)**
4. SPARK PLUG CABLE
  5. BATTERY CABLE CONNECTION

TSB Revision

**REMOVAL STEPS (Continued)**

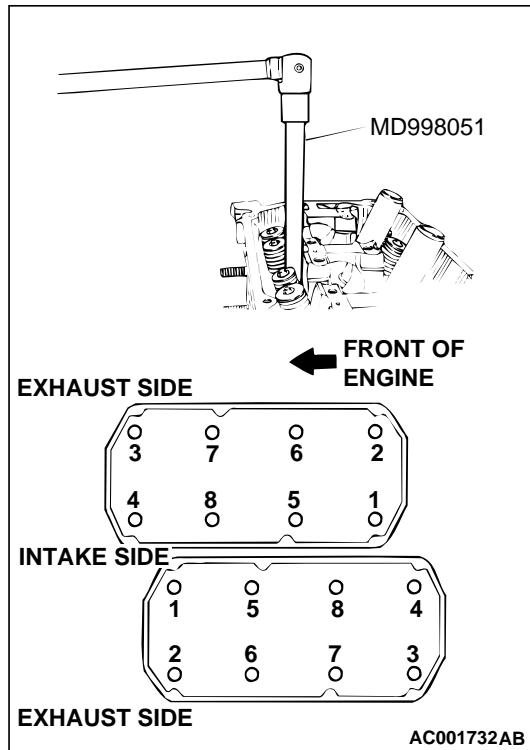
6. ROCKER COVER
7. TIMING BELT REAR COVER
8. BATTERY CABLE CONNECTION
- <<A>> >>B<< 9. CYLINDER HEAD ASSEMBLY
- >>A<< 10. CYLINDER HEAD GASKET

**Required Special Tool:**

- MD998051: Cylinder Head Bolt Wrench

**REMOVAL SERVICE POINT****<<A>> CYLINDER HEAD ASSEMBLY REMOVAL**

Using special tool MD998051, loosen the cylinder head bolts in two or three steps in the order of the numbers shown in the illustration, then remove the cylinder head assembly.

**INSTALLATION SERVICE POINTS****>>A<< CYLINDER HEAD GASKET INSTALLATION**

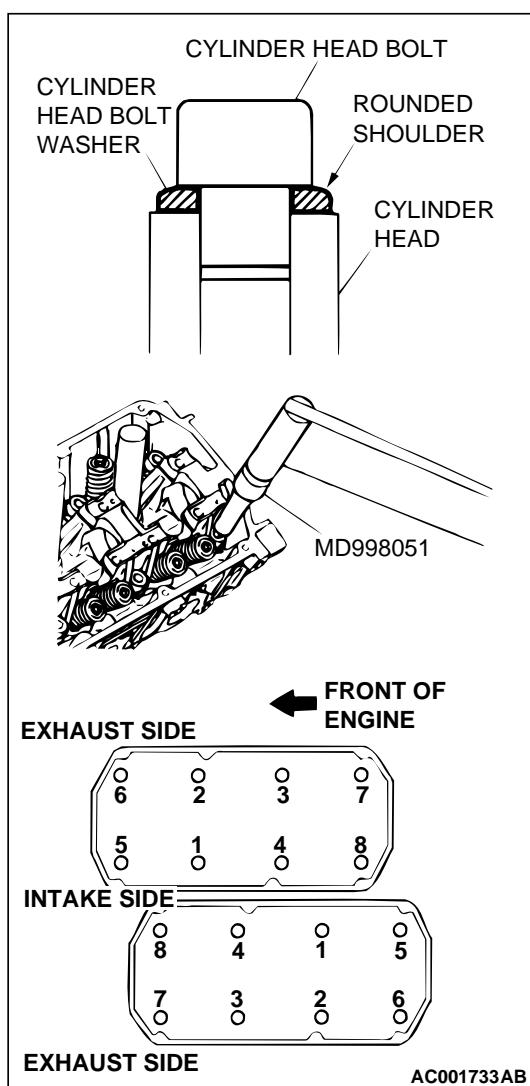
1. Wipe off all oil and grease from the gasket mounting surface.
2. Match the shapes of the cylinder head holes with their respective cylinder head gasket holes.

**>>B<< CYLINDER HEAD ASSEMBLY INSTALLATION**

 **CAUTION**

Be careful that no foreign material gets into the cylinder, coolant passages or oil passages. Engine damage may result.

1. Use a scraper to clean the gasket surface of the cylinder head assembly.

**CAUTION**

Attach the cylinder head bolt washer in the direction shown in the illustration.

- Using special tool MD998051 and a torque wrench, tighten the bolts to the specified torque in the order shown in the illustration. (in two or three steps)

**Tightening torque: 103 – 113 N·m (76 – 83 ft-lb)**

- Loosen the mounting bolts in the reverse sequence to that shown.

- Tighten the mounting bolts progressively in the shown sequence to the specified torque again.

**Tightening torque: 103 – 113 N·m (76 – 83 ft-lb)**

## TIMING BELT

### REMOVAL AND INSTALLATION

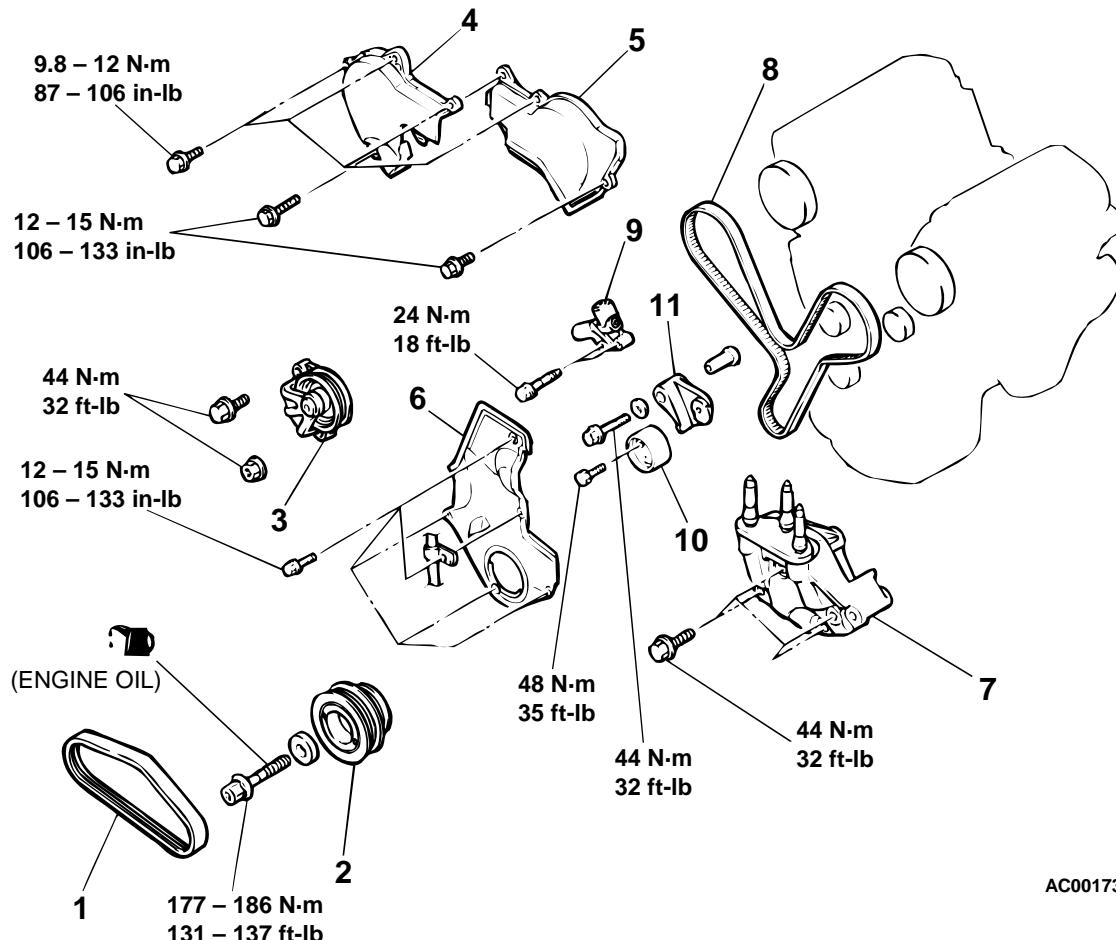
M1112004300117

#### Pre-removal Operation

- Generator Removal (Refer to GROUP 16, Generator P.16-14.)
- Engine Mount Bracket Removal (Refer to GROUP 32, Engine Mounting P.32-5.)

#### Post-installation Operation

- Engine Mount Bracket Installation (Refer to GROUP 32, Engine Mounting P.32-5.)
- Generator Installation (Refer to GROUP 16, Generator P.16-14.)
- Drive Belt Tension Adjustment [Refer to GROUP 00, Maintenance Service – Drive Belts (Check Condition).P.00-39]



AC001734 AC

**REMOVAL STEPS**

1. DRIVE BELT (POWER STEERING OIL PUMP)  
 <<A>> >>D<< 2. CRANKSHAFT PULLEY  
 3. TENSIONER PULLEY ASSEMBLY (POWER STEERING OIL PUMP)  
 4. TIMING BELT FRONT UPPER COVER, RIGHT  
 5. TIMING BELT FRONT UPPER COVER, LEFT

6. TIMING BELT FRONT LOWER COVER  
 >>C<< 7. ENGINE SUPPORT BRACKET, RIGHT  
 <<B>> >>B<< 8. TIMING BELT  
 >>A<< 9. AUTO-TENSIONER  
 10. TENSIONER PULLEY  
 11. TENSIONER ARM

**Required Special Tools:**

MB990767: End Yoke Holder

MD998715: Crankshaft Pulley Holder Pin

MD998767: Tensioner Wrench

MD998769: Crankshaft Pulley Spacer

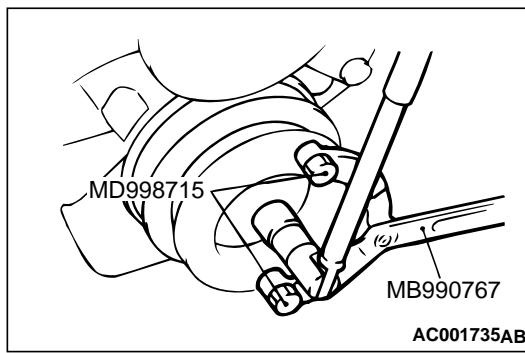
## REMOVAL SERVICE POINTS

## &lt;&lt;A&gt;&gt; CRANKSHAFT PULLEY REMOVAL

**CAUTION**

Use only the specified special tools, or a damaged pulley damper could result.

Use special tools MB990767 and MD998715 to remove the crankshaft pulley from the crankshaft.

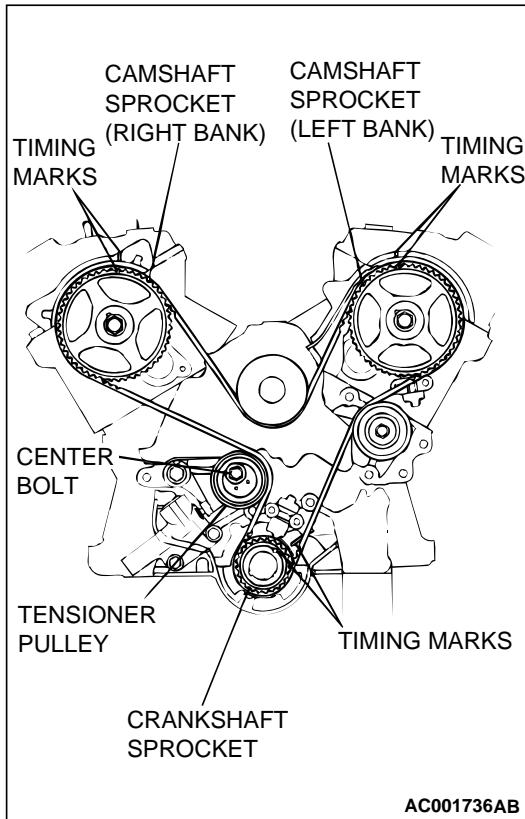


## &lt;&lt;B&gt;&gt; TIMING BELT REMOVAL

**CAUTION**

Never turn the crankshaft counterclockwise.

1. Turn the crankshaft clockwise to align each timing mark and to set the number 1 cylinder to compression top dead center.
2. If the timing belt is to be reused, chalk an arrow on the flat side of the belt, indicating the clockwise direction.
3. Loosen the center bolt of the tensioner pulley, then remove the timing belt.



## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; AUTO-TENSIONER INSTALLATION

1. While holding the auto-tensioner with your hand, press the end of the pushrod against a metal surface (such as the cylinder block) with a force of 98 – 196 N (22 – 44 pound) and measure how far the pushrod is pushed in.

**Standard value: Within 1 mm (0.04 inch)**

**A: Length when no force is applied**

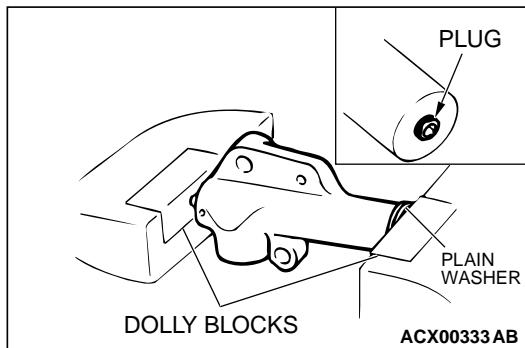
**B: Length when force is applied**

**A – B: Amount pushed in**

2. If it is not within the standard value range, replace the auto-tensioner.

**⚠ CAUTION**

- Place the auto-tensioner perpendicular to the jaws of the vice.
- If there is a plug at the base of the auto-tensioner, insert a plain washer onto the end of the auto-tensioner to protect the plug.
- 3. Place two blocks in a vice as shown in the illustration, and then place the auto-tensioner in the vice.



**⚠ CAUTION**

**Never compress the pushrod too fast, or it may be damaged.**

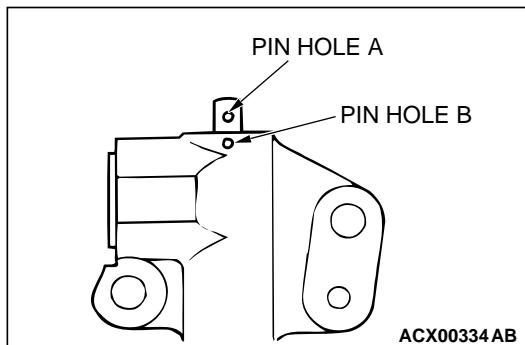
4. Slowly compress the pushrod of the auto-tensioner until pin hole A in the pushrod is aligned with pin hole B in the cylinder.
5. Insert the setting pin into the pin holes once they are aligned.

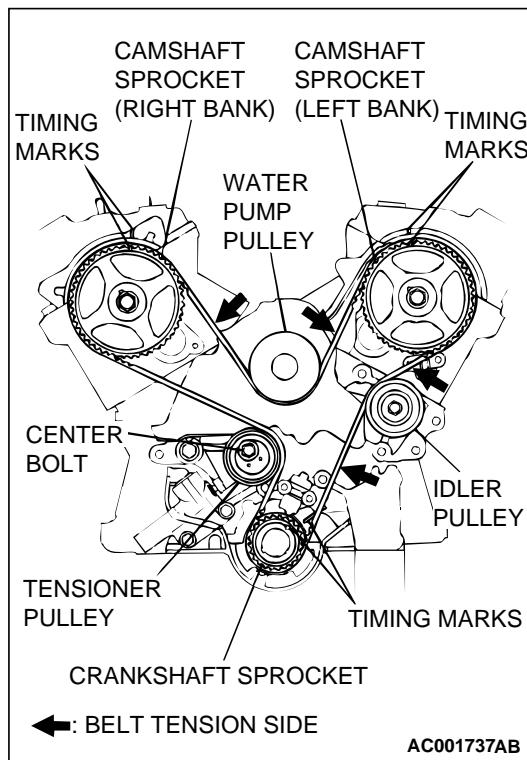
*NOTE: If replacing the auto-tensioner, the pin will already be inserted into the pin holes of the new part.*

**⚠ CAUTION**

**Do not remove the setting pin from the auto-tensioner.**

6. Install the auto-tensioner to the engine.





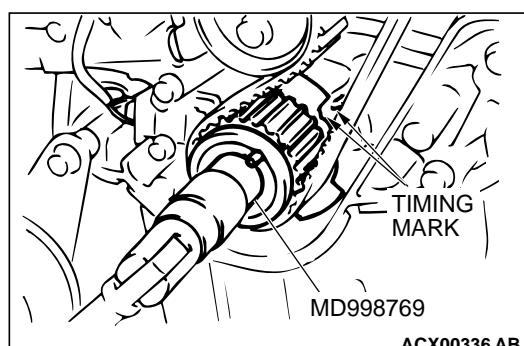
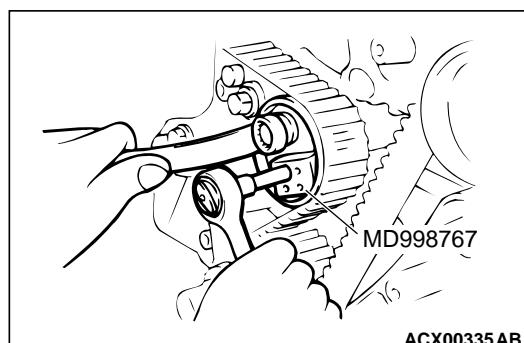
## &gt;&gt;B&lt;&lt; TIMING BELT INSTALLATION

1. Align the timing marks on the camshaft sprockets with those on the rocker cover and the timing mark on the crankshaft sprocket with that on the engine block as shown in the illustration.

**CAUTION**

The camshaft sprocket (right bank) can turn easily due to the spring force applied, so be careful not to get your fingers caught.

2. Install the timing belt by the following procedure so that there is no deflection in the timing belt between each sprocket and pulley.
  - (1) Crankshaft sprocket
  - (2) Idler pulley
  - (3) Camshaft sprocket (Left bank)
  - (4) Water pump pulley
  - (5) Camshaft sprocket (Right bank)
  - (6) Tensioner pulley
3. Turn the camshaft sprocket (Right bank) counterclockwise until the tension side of the timing belt is firmly stretched. Check all the timing marks again.
4. Use special tool MD998767 to push the tensioner pulley into the timing belt, then temporarily tighten the center bolt.



5. Use special tool MD998769 to turn the crankshaft 1/4 turn counterclockwise, then turn it again clockwise until the timing marks are aligned.

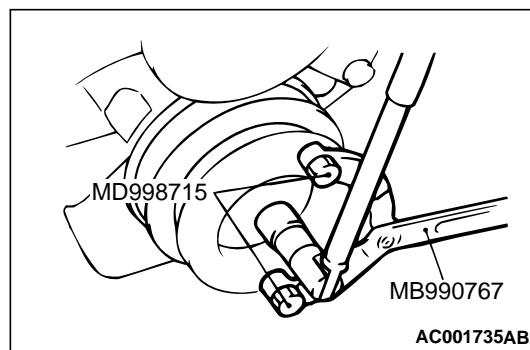
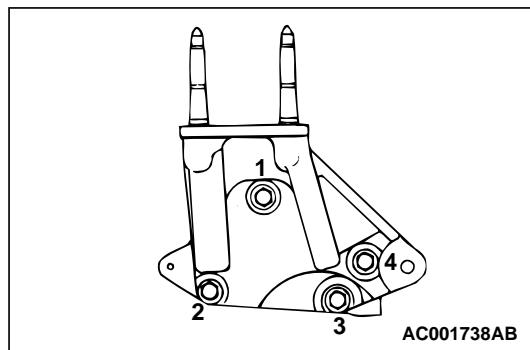
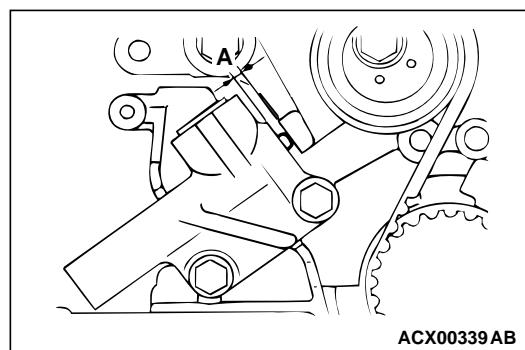
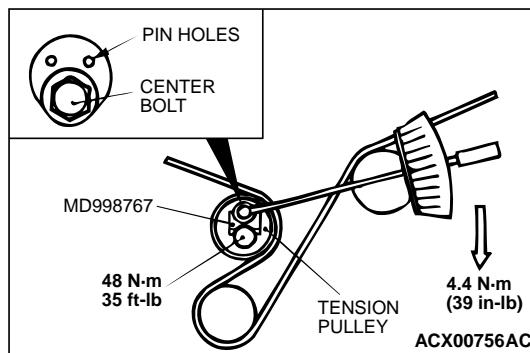
**CAUTION**

When tightening the center bolt, be careful that the tensioner pulley does not turn with the bolt.

6. Loosen the center bolt of the tensioner pulley. Use special tool MD998767 and a torque wrench to apply the tension torque to the timing belt as shown in the illustration. Then tighten the center bolt to the specified torque.

**Standard value: 4.4 N·m (39 in-lb) <Timing belt tension torque>**

**Tightening torque: 48 N·m (35 ft-lb)**



7. Remove the setting pin that has been inserted into the auto-tensioner.

8. Turn the crankshaft clockwise twice to align the timing marks.

9. Wait for at least five minutes, then check that the auto-tensioner pushrod extends within the standard value range.

**Standard value (A): 3.8 – 5.0 mm (0.15 – 0.20 inch)**

10. If not, repeat the operation in steps (5) to (9) above.

11. Check again that the timing marks of the sprockets are aligned.

**>>C<< CARIGHT ENGINE SUPPORT BRACKET INSTALLATION**

Tighten the right engine support bracket mounting bolts in the order shown in the illustration.

**>>D<< CRANKSHAFT PULLEY INSTALLATION**

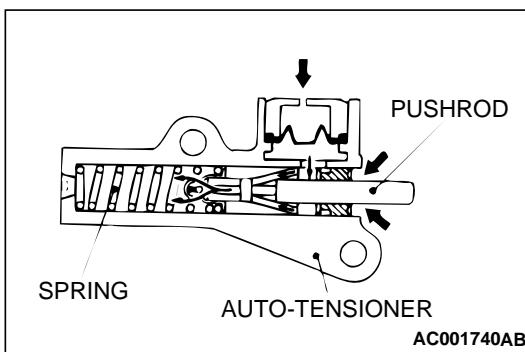
Use special tools MB990767 and MD998715 to install the crankshaft pulley.

## INSPECTION

M1112004400084

## AUTO-TENSIONER

- Check the auto-tensioner for possible leaks.
- Check the pushrod for cracks.



## SPECIFICATIONS

## FASTENER TIGHTENING SPECIFICATIONS

M1111003800138

ITEMS	SPECIFICATIONS	
Auto-tensioner attaching bolt	24 N·m (18 ft-lb)	
Camshaft sprocket attaching bolt	88 N·m (65 ft-lb)	
Camshaft thrust case attaching bolt	13 N·m (115 in-lb)	
Control wiring harness protector attaching bolt	4.9 N·m (43 in-lb)	
Crankshaft bolt	177 – 186 N·m (131 – 137 ft-lb)	
Crankshaft position sensor attaching bolt	8.8 N·m (78 in-lb)	
Cylinder head bolt <cold engine>	103 – 113 N·m → 0 N·m → 103 – 113 N·m (76 – 83 ft-lb → 0 ft-lb → 76 – 83 ft-lb)	
Distributor attaching bolt	13 N·m (115 in-lb)	
Drive plate bolt	72 – 76 N·m (53 – 56 ft-lb)	
Engine mount bracket attaching bolt	M10	86 N·m (63 ft-lb)
	M12	81 N·m (60 ft-lb)
Engine mount bracket attaching nut	86 N·m (63 ft-lb)	
Engine mount stay attaching nut	35 N·m (26 ft-lb)	
Engine support bracket right attaching nut	44 N·m (32 ft-lb)	
Ground wire attaching bolt	8.9 N·m (78 in-lb)	
High-pressure fuel hose attaching bolt	4.9 N·m (43 in-lb)	
Lower oil pan attaching bolt	9.8 – 12 N·m (87 – 106 in-lb)	
Oil dipstick guide attaching bolt	48 N·m (35 ft-lb)	
Oil pan cover attaching bolt	9.8 – 12 N·m (87 – 106 in-lb)	
Oil pan drain plug	39 N·m (29 ft-lb)	
Power steering oil pump attaching bolt	42 N·m (31 ft-lb)	
Rocker arm and shaft assembly attaching bolt	28 – 34 N·m (21 – 25 ft-lb)	
Rocker cover attaching bolt	3.4 N·m (30 in-lb)	
Starter attaching bolt	26 – 33 N·m (19 – 24 ft-lb)	

TSB Revision

ITEMS	SPECIFICATIONS	
Tensioner pulley attaching bolt	44 N·m (32 ft-lb)	
Timing belt front lower cover attaching bolt	9.8 – 12 N·m (87 – 106 in-lb)	
Timing belt front upper cover attaching bolt	M6	9.8 – 12 N·m (87 – 106 in-lb)
	M8	12 – 15 N·m (106 – 133 in-lb)
Timing belt rear cover attaching bolt	12 – 15 N·m (106 – 133 in-lb)	
Timing belt tensioner arm attaching bolt	44 N·m (32 ft-lb)	
Timing belt tensioner pulley attaching bolt	48 N·m (35 ft-lb)	
Upper oil pan attaching bolt	M6	5.9 N·m (52 in-lb)
	M10	35 N·m (26 ft-lb)

**SERVICE SPECIFICATIONS**

M1111000300145

ITEMS	STANDARD VALUE	LIMIT
Basic ignition timing at idle	5°BTDC ± 3°	–
Actual ignition timing at idle	Approximately 15° BTDC	–
CO content %	0.5 or less	–
HC contents ppm	100 or less	–
Curb idle speed r/min	700 ± 100	–
Compression pressure (250 – 400 r/min) kPa (psi)	824 (119)	Minimum 575 (83)
Compression pressure difference of all cylinder kPa (psi)	–	98 (14)
Intake manifold vacuum at curb idle kPa (in Hg)	–	Minimum 60 (18)
Auto-tensioner pushrod movement mm (in)	Within 1.0 (0.04)	–
Auto-tensioner rod protrusion mm (in)	3.8 – 5.0 (0.15 – 0.20)	–

**SEALANT**

M1111000500172

ITEM	SPECIFIED SEALANT
Oil pan	MITSUBISHI GENUINE Sealant Part No. MD970389 or equivalent