

## GROUP 11F

# ENGINE OVERHAUL

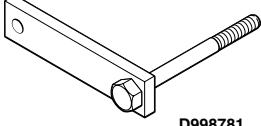
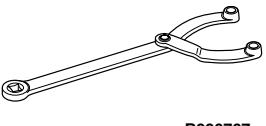
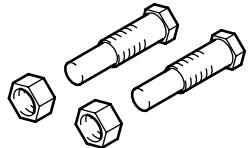
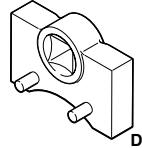
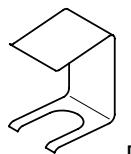
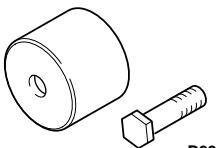
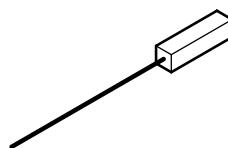
## <3.8L MIVEC ENGINE>

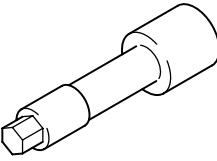
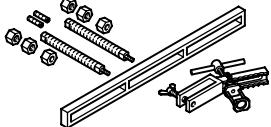
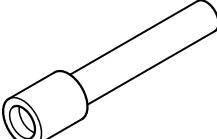
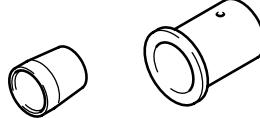
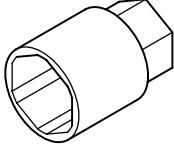
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## SPECIAL TOOLS

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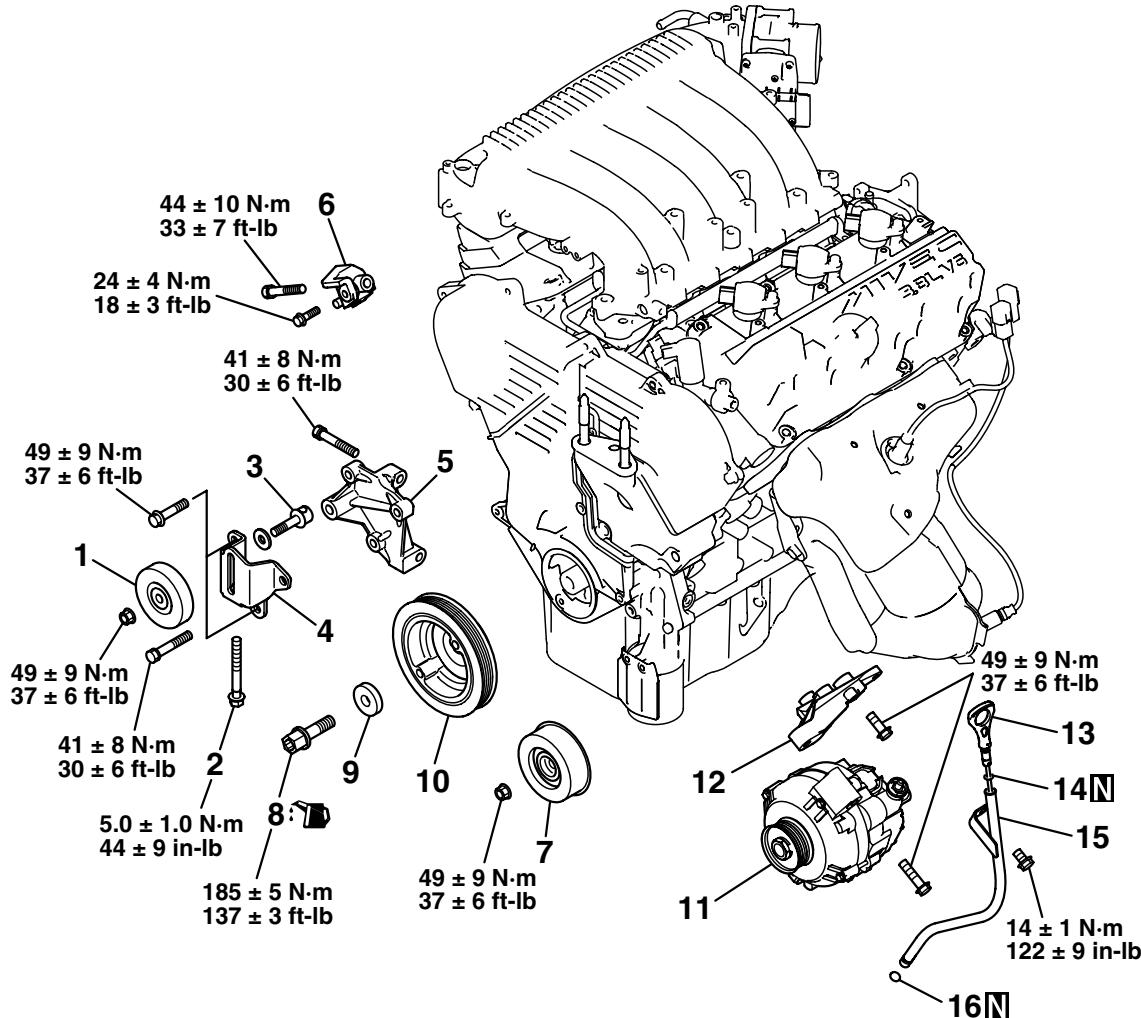
TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 D998781	MD998781 Flywheel stopper	General service tool	Loosening and tightening crankshaft bolts
 B990767	MB990767 End yoke holder	MB990767-01	Holding camshaft sprocket when loosening or torquing bolt.
	MD998715 Pin	MIT308239	
	MD998769 Crankshaft spacer	General service tool	Rotation of crankshaft when installing piston and timing belt
 D998767	MD998767 Tensioner wrench	MD998752-01	Adjustment of timing belt tension
 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
 D998713	MD998713 Camshaft oil seal installer	MD998713-01	Installation of camshaft oil seal
	MD998442 Air bleed wire	General service tool	Air bleeding of auto lash adjuster

<b>TOOL</b>	<b>TOOL NUMBER AND NAME</b>	<b>SUPERSESSION</b>	<b>APPLICATION</b>
	MD998051 Cylinder head bolt wrench	General service tool	Loosening and tightening cylinder head bolts
	MD998735 Valve spring compressor	MD998735-01	Compression of valve spring
	MD998772 Valve spring compressor	MLR-MD998772 or General service tool	Compression of valve spring
	MB991999 Valve stem seal installer	General service tool	Installation of valve stem seal
	MD998717 Crankshaft front oil seal installer	MD998717-01	Installation of crankshaft front oil seal
	MD998012 Oil pressure switch wrench	—	Removal and installation of engine oil pressure switch
	MD998718 Crankshaft rear oil seal installer	MD998718-01	Installation of crankshaft rear oil seal

## GENERATOR AND DRIVE BELT

## REMOVAL AND INSTALLATION

M1113001300456



AK403323AB

## REMOVAL STEPS

1. IDLER PULLEY
2. ADJUSTING BOLT
3. ADJUSTING STUD
4. TENSIONER BRACKET
5. POWER STEERING PUMP  
BRACKET
6. POWER STEERING PUMP  
BRACKET STAY
7. DRIVE BELT TENSIONER

## REMOVAL STEPS (Continued)

<<A>> >>A<<

8. CRANKSHAFT BOLT
9. CRANKSHAFT PULLEY WASHER
10. DAMPER PULLEY
11. GENERATOR
12. GENERATOR BRACKET
13. OIL DIPSTICK
14. O-RING
15. OIL DIPSTICK GUIDE
16. O-RING

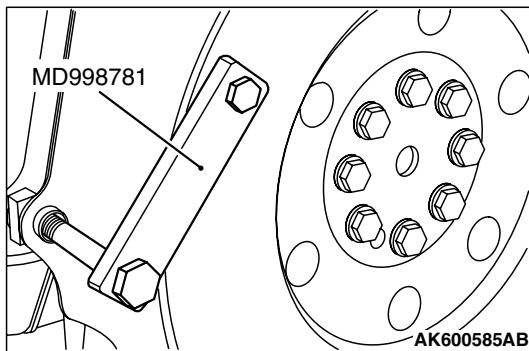
## Required Special Tool:

- MD998781: Flywheel Stopper

## REMOVAL SERVICE POINT

### <<A>> CRANKSHAFT BOLT LOOSENING

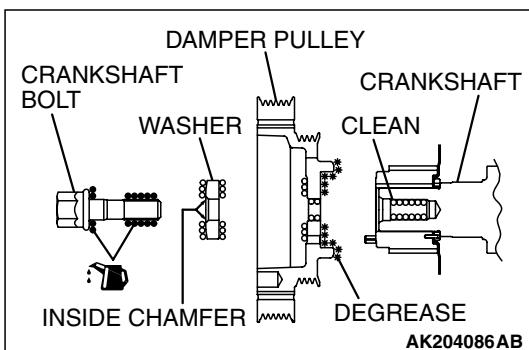
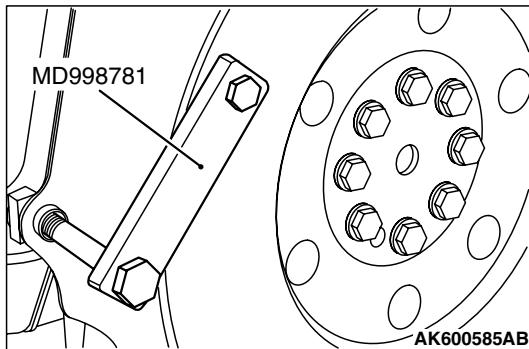
1. Using special tool MD998781, hold the drive plate.
2. Remove the crankshaft bolt.



## INSTALLATION SERVICE POINT

### >>A<< CRANKSHAFT BOLT TIGHTENING

1. Using special tool MD998781, hold the drive plate.



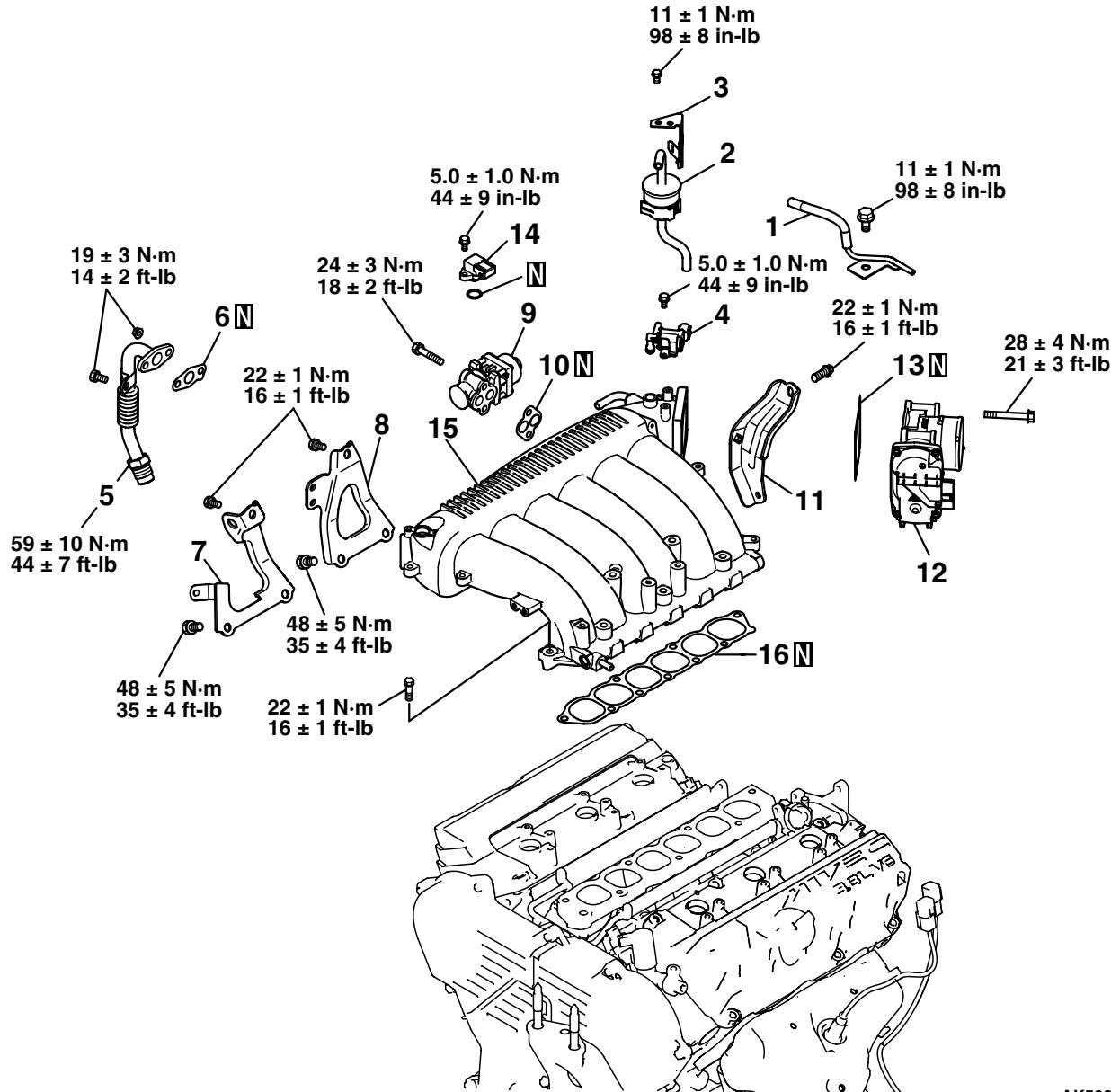
2. Clean the bolt hole in crankshaft bolt, damper pulley seating surface and the washer.
3. Degrease the cleaned seating surface of the damper pulley.
4. Install the damper pulley.
5. Apply a minimum amount of engine oil to the thread and lower flange of the crankshaft bolt.
6. Install the washer to the crankshaft bolt with its inside chamfered side toward the bolt head.
7. Tighten the crankshaft bolt to the specified torque.

**Tightening torque:  $185 \pm 5 \text{ N}\cdot\text{m}$  ( $137 \pm 3 \text{ ft-lb}$ )**

INTAKE MANIFOLD PLENUM AND THROTTLE BODY  
ASSEMBLY

## REMOVAL AND INSTALLATION

M1113003300225



AK500697AB

## REMOVAL STEPS

1. VACUUM PIPE AND HOSE ASSEMBLY
2. PURGE CHAMBER ASSEMBLY
3. HANESS BRACKET
4. SOLENOID VALVE
- >>E<< 5. EXHAUST GAS RECIRCULATION PIPE
- >>D<< 6. EXHAUST GAS RECIRCULATION PIPE GASKET
7. INTAKE MANIFOLD PLENUM STAY, FRONT

## REMOVAL STEPS (Continued)

8. INTAKE MANIFOLD PLENUM STAY, REAR
9. EXHAUST GAS RECIRCULATION VALVE
- >>C<< 10. EXHAUST GAS RECIRCULATION VALVE GASKET
11. THROTTLE BODY STAY
12. THROTTLE BODY
- >>B<< 13. THROTTLE BODY GASKET
- >>A<< 14. BOOST SENSOR

**REMOVAL STEPS (Continued)**

15. INTAKE MANIFOLD PLENUM
16. INTAKE MANIFOLD PLENUM VALVE  
GASKET

**INSTALLATION SERVICE POINT**

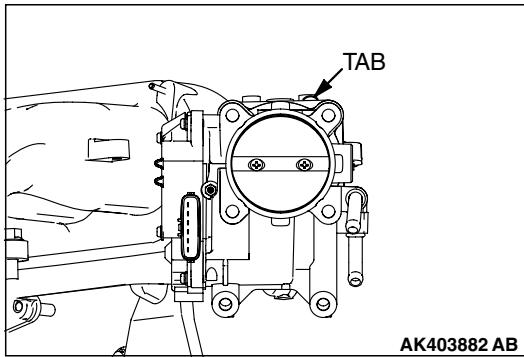
**>>A<< BOOST SENSOR INSTALLATION**

**CAUTION**

- Do not strike or drop the sensor.
- Never use a sensor that has been dropped.

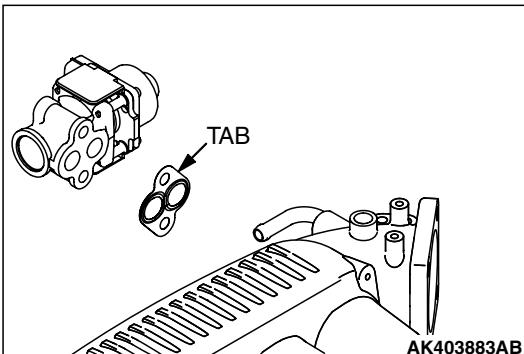
**>>B<< THROTTLE BODY GASKET INSTALLATION**

Install the throttle body gasket so that the tab is positioned as shown in the illustration.



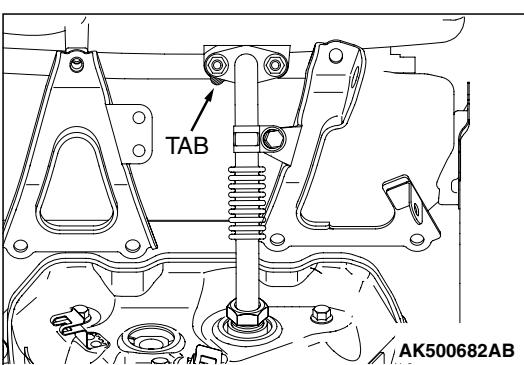
**>>C<< EXHAUST GAS RECIRCULATION VALVE GASKET  
INSTALLATION**

Install the exhaust gas recirculation valve gasket so that the tab is positioned as shown in the illustration.



**>>D<< EXHAUST GAS RECIRCULATION PIPE GASKET  
INSTALLATION**

Install the exhaust gas recirculation pipe gasket so that the tab is positioned as shown in the illustration.



>>E<< EXHAUST GAS RECIRCULATION PIPE  
INSTALLATION**CAUTION**

Use care to prevent deforming the bellows of the exhaust gas recirculation pipe.

1. Tighten temporarily the flare nut of exhaust gas recirculation pipe and the nut as shown in the illustration.
2. Tighten each the flare nuts of exhaust gas recirculation pipe and the nut to the specified torque.

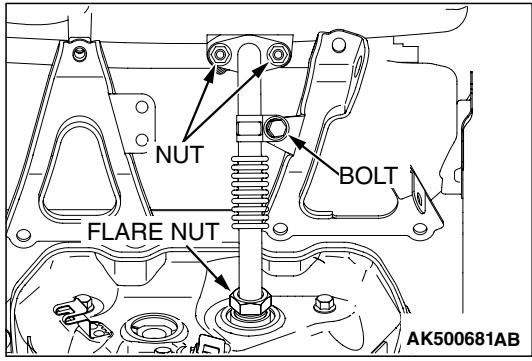
**Tightening torque:**

$59 \pm 10 \text{ N}\cdot\text{m} (44 \pm 7 \text{ ft-lb})$  <FLARE NUT>

$19 \pm 3 \text{ N}\cdot\text{m} (14 \pm 2 \text{ ft-lb})$  <NUt>

3. Tighten the bolt shown in the illustration to the specified torque.

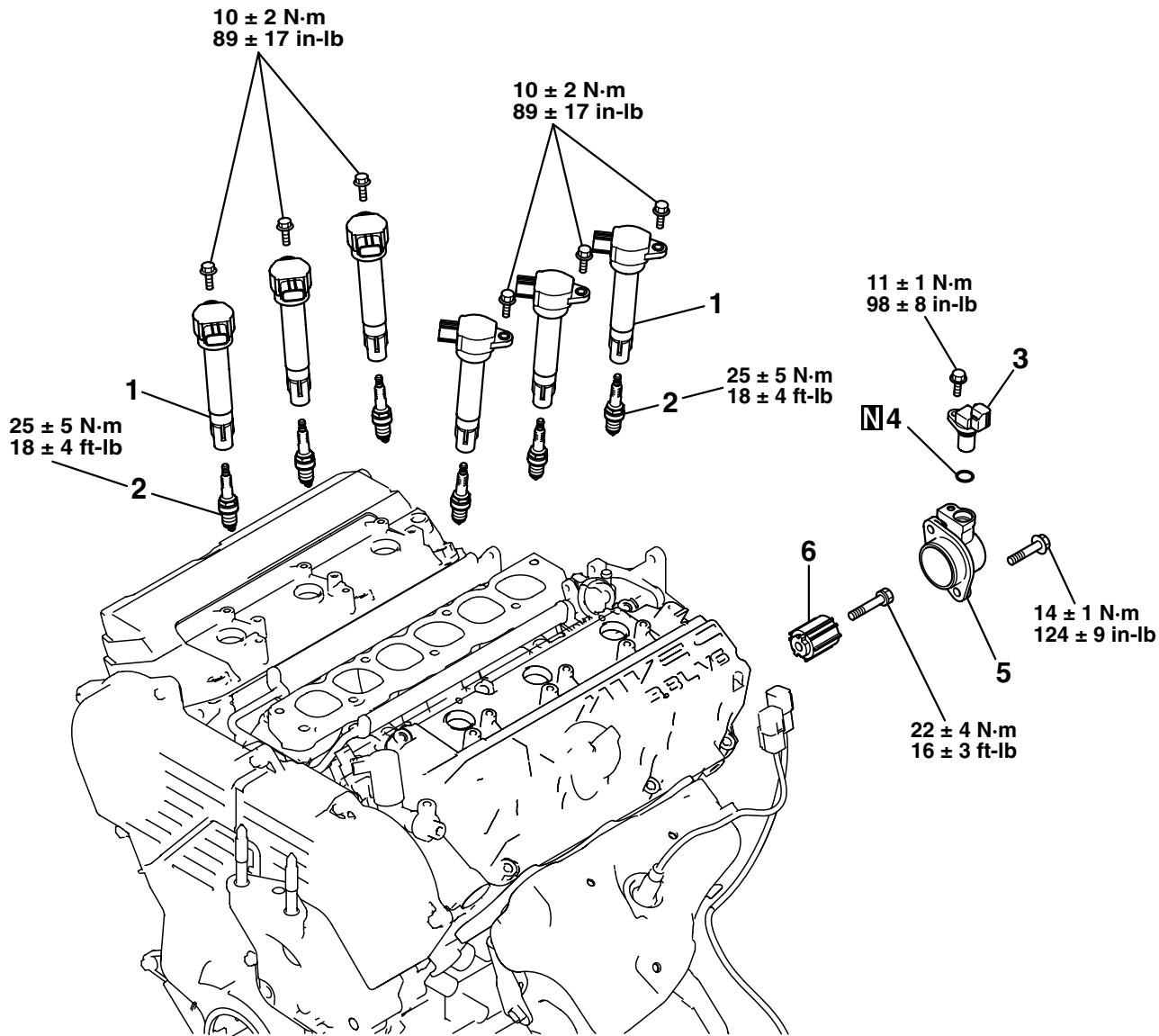
**Tightening torque:  $19 \pm 3 \text{ N}\cdot\text{m} (14 \pm 2 \text{ ft-lb})$**



## IGNITION SYSTEM

### REMOVAL AND INSTALLATION

M1113001600220



AK403325AB

#### REMOVAL STEPS

1. IGNITION COIL
2. SPARK PLUGS
3. CAMSHAFT POSITION SENSOR
4. O-RING

#### REMOVAL STEPS (Continued)

>>B<<	5. CAMSHAFT POSITION SENSOR SUPPORT
<<A>> >>A<<	6. CAMSHAFT POSITION SENSING CYLINDER

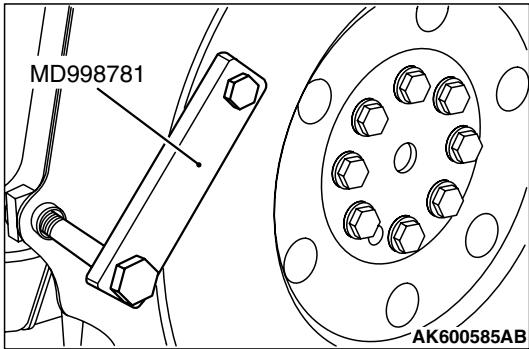
#### Required Special Tool:

- MD998781: Flywheel Stopper

## REMOVAL SERVICE POINT

<<A>> CAMSHAFT POSITION SENSING CYLINDER  
REMOVAL

1. Using special tool MD998781, hold the drive plate.
2. Loosen the camshaft position sensing cylinder bolt.

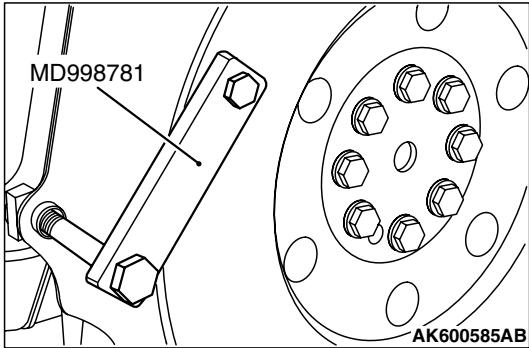


## INSTALLATION SERVICE POINT

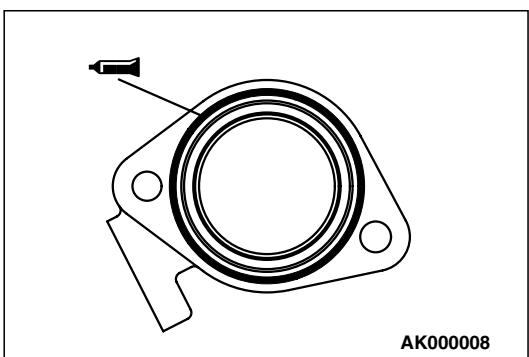
>>A<< CAMSHAFT POSITION SENSING CYLINDER  
INSTALLATION

1. Using special tool MD998781, hold the drive plate.
2. Tighten the camshaft position sensing cylinder bolt to the specified torque.

**Tightening torque:  $22 \pm 4 \text{ N}\cdot\text{m} (16 \pm 3 \text{ ft-lb})$**

>>B<< CAMSHAFT POSITION SENSOR SUPPORT  
INSTALLATION

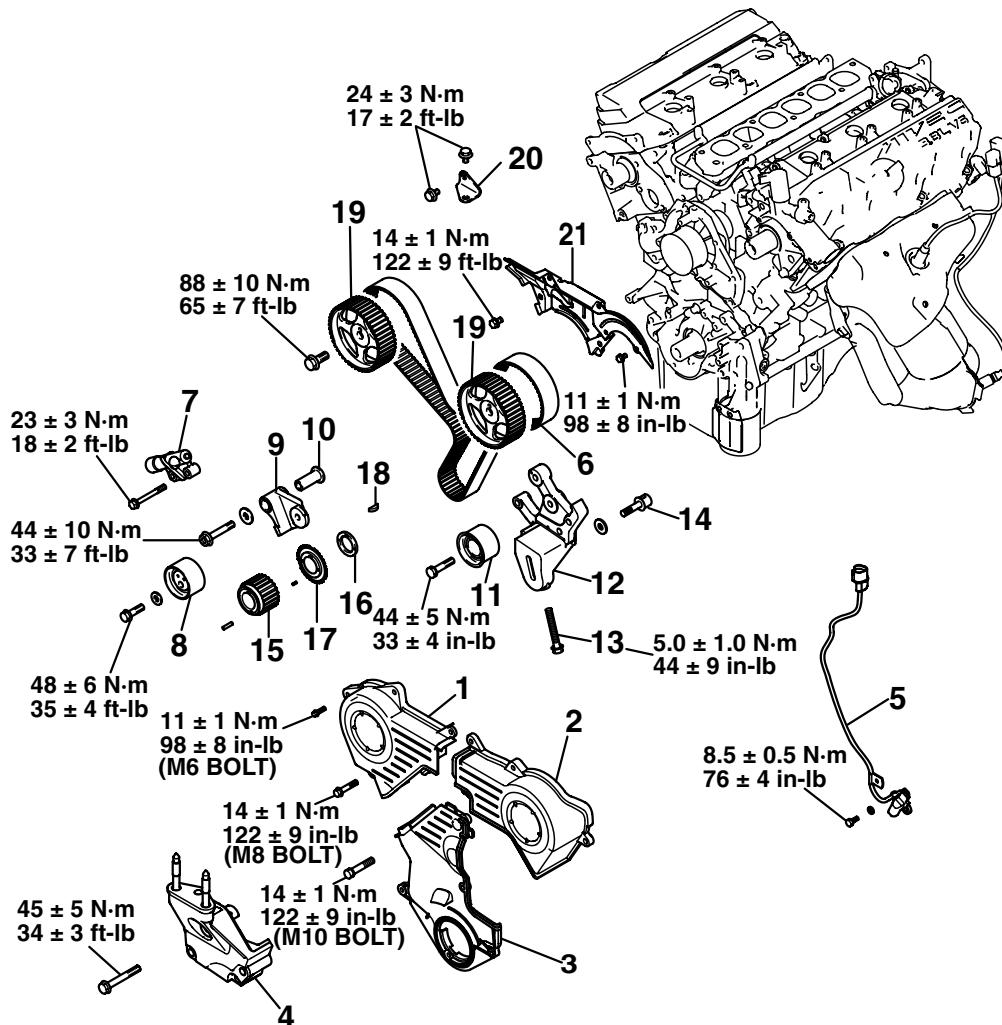
Apply a 3 mm (0.12 inch) diameter bead of sealant (Mitsubishi Genuine Part number MD970389 or equivalent) to the cam-shaft position sensor support.



## TIMING BELT

### REMOVAL AND INSTALLATION

M1113001901086



AK403326 AB

#### REMOVAL STEPS

1. TIMING BELT FRONT UPPER COVER, RIGHT
2. TIMING BELT FRONT UPPER COVER, LEFT
3. TIMING BELT FRONT LOWER COVER
- >>E<< 4. ENGINE SUPPORT BRACKET, RIGHT
- >>E<< 5. CRANKSHAFT POSITION SENSOR
- <<A>> >>D<< 6. TIMING BELT
- >>C<< 7. AUTO-TENSIONER
8. TENSIONER PULLEY
9. TENSIONER ARM

#### REMOVAL STEPS (Continued)

10. SHAFT
11. IDLER PULLEY
12. TENSIONER BRACKET
13. ADJUSTING BOLT
14. ADJUSTING STUD
- >>B<< 15. CRANKSHAFT SPROCKET
- >>B<< 16. CRANKSHAFT SPACER
- >>B<< 17. CRANKSHAFT SENSING BLADE
18. KEY
- <<B>> >>A<< 19. CAMSHAFT SPROCKET
20. BRACKET
21. TIMING BELT REAR COVER

#### Required Special Tools:

- MB990767: End Yoke Holder
- MD998715: Pins
- MD998767: Tensioner Pulley Wrench
- MD998769: Crankshaft Spacer

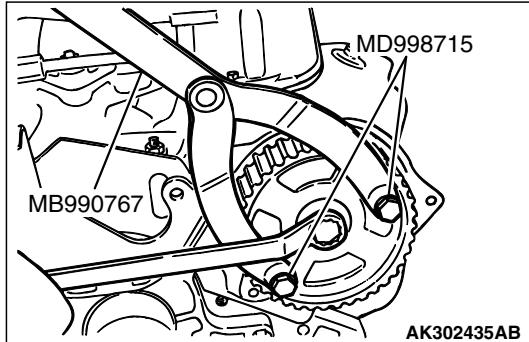
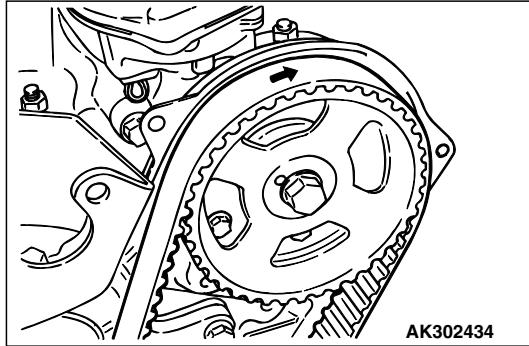
## REMOVAL SERVICE POINTS

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

**CAUTION**

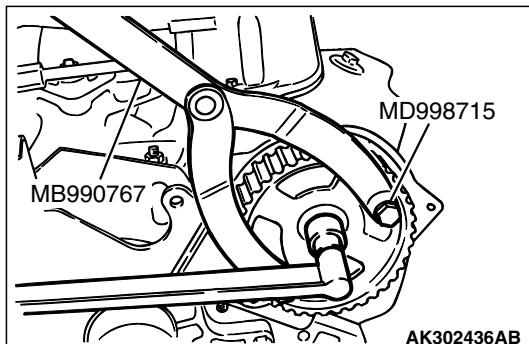
Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be kept free from oil and water. These parts should not be washed or immersed in solvent. Replace parts if contaminated. If there is oil or water on any part, check the front case oil seal, camshaft oil seal, and water pump for leaks.

1. Mark the belt running direction for reinstallation.
2. Loosen the tensioner pulley bolt, and then remove the timing belt.



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

1. While holding the camshaft sprocket with special tools MB990767 and MD998715, loosen the camshaft sprocket bolt.
2. Remove the camshaft sprocket.

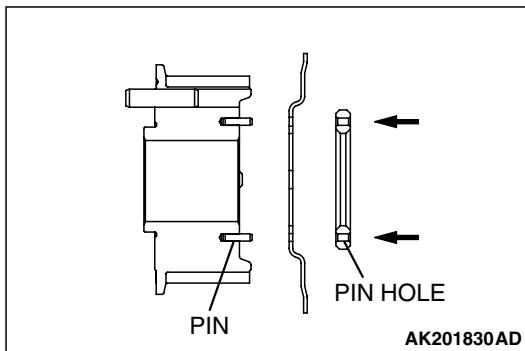
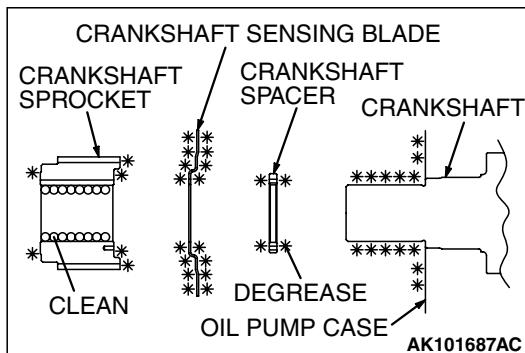


## INSTALLATION SERVICE POINT

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

1. Fit the camshaft sprocket to the front end of the camshaft.
2. While holding the camshaft sprocket with special tools MB990767 and MD998715, tighten the camshaft sprocket bolt.

**Tightening torque:  $88 \pm 10 \text{ N}\cdot\text{m} (65 \pm 7 \text{ ft-lb})$**



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

1. Clean the hole in the crankshaft sprocket.
2. Clean and degrease the mating surfaces of the crankshaft sprocket, sensing blade, and spacer.

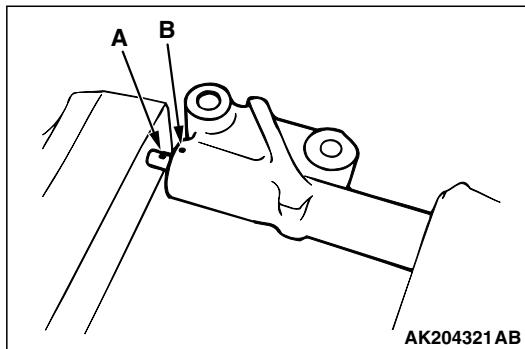
*NOTE: Degreasing is necessary to prevent decrease in friction on the mating surfaces.*

3. Align the location of pin and pin hole, and then apply equal force in the direction of the arrow.

**CAUTION**

**Do not bend the sensing blade when installing sprocket.**

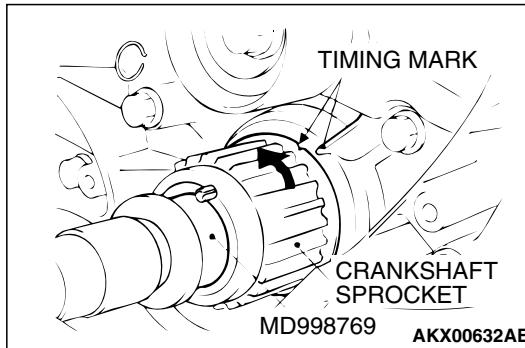
4. Install the crankshaft sprocket to the crankshaft.



### >>C<< AUTO-TENSIONER INSTALLATION

If the auto-tensioner rod is fully extended, reset it as follows:

1. Clamp the auto-tensioner in the vise with soft jaws.
2. Push in the rod little by little with the vise until set hole A in the rod is aligned with hole B in the cylinder.
3. Insert a wire [1.4 mm (0.055 inch) in diameter] into the set holes. This auto-tensioner setting wire will be used during timing belt alignment.
4. Unclamp the auto-tensioner from the vise.

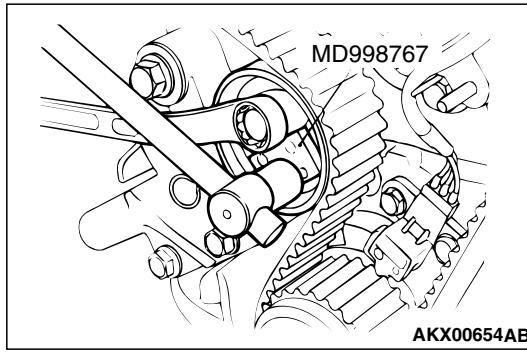
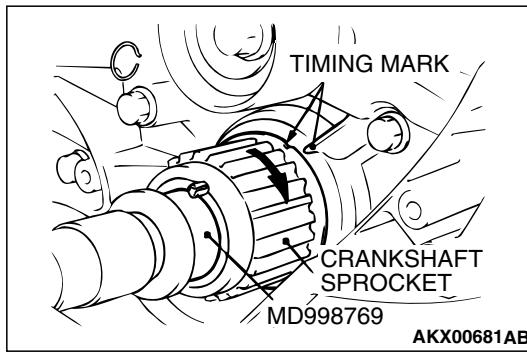
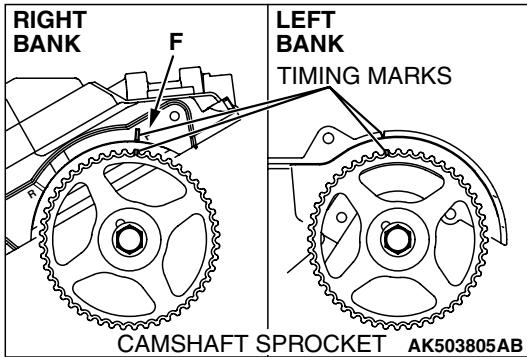


### >>D<< TIMING BELT INSTALLATION

**CAUTION**

**Do not turn the camshaft when the piston in No.1 cylinder is at top dead center on the compression stroke. Doing so can cause the lifted valve to hit against the piston, damaging parts.**

1. Install special tool MD998769 and the crankshaft pulley washer, and then tighten the crankshaft bolt.
2. Align the timing mark on the crankshaft sprocket with the timing mark on the oil pump case, and then rotate the sprocket three teeth counterclockwise.

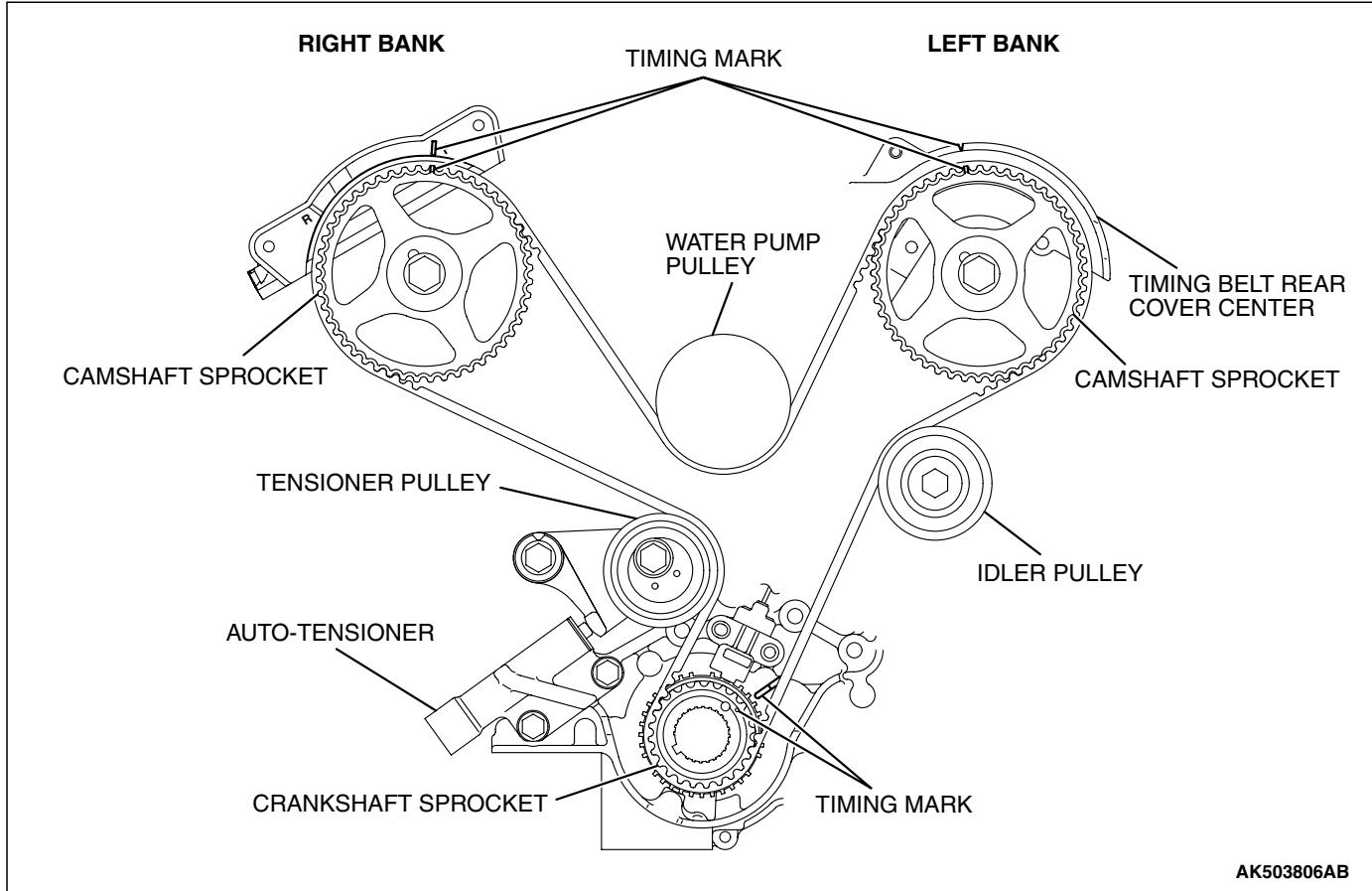


3. Align the timing mark on the left bank camshaft sprocket with the timing mark on the rocker cover.
4. Align the timing mark on the right bank camshaft sprocket with the timing mark on the rocker cover.

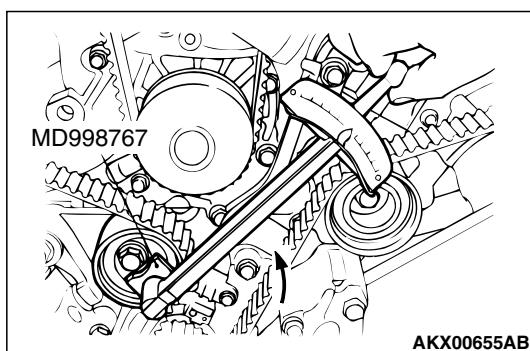
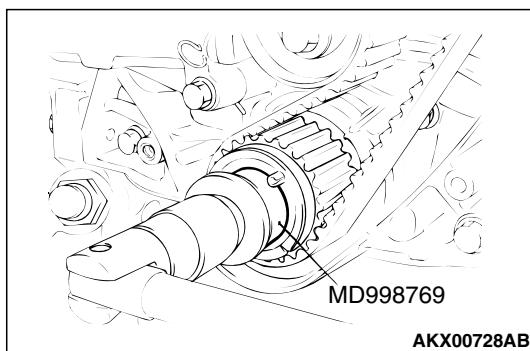
*NOTE: Align the timing mark, on the right bank, with F.*

5. Align the timing mark on the crankshaft sprocket with the timing mark on the oil pump case.
6. Install the timing belt on each sprocket and pulley in the following sequence. Do not leave the belt slack between each sprocket and pulley.
  - (1) Crankshaft sprocket
  - (2) Idler pulley
  - (3) Left bank camshaft sprocket
  - (4) Water pump pulley
  - (5) Right bank camshaft sprocket
  - (6) Tensioner pulley
7. Install special tool MD998767 to the tensioner pulley. While pushing the pulley lightly against the belt using the special tool, tighten the flange bolt.

**Tightening torque:  $48 \pm 6 \text{ N}\cdot\text{m}$  ( $35 \pm 4 \text{ ft-lb}$ )**



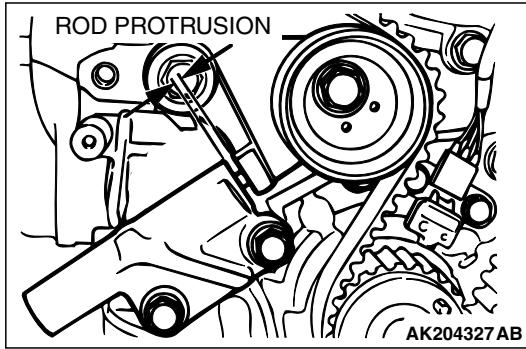
8. Check to see that the timing marks of all the sprockets are in alignment.
9. Rotate the crankshaft a quarter turn counterclockwise. Then rotate it back clockwise to verify that all the timing marks are aligned.



10. Loosen the flange bolt securing the tensioner pulley, and then mount special tool MD998767 and a torque wrench on the tensioner pulley.
11. Torque it to 4.4 N·m (39 in-lb) with the torque wrench.
12. While holding the tensioner pulley in position, tighten the flange bolt to the specified torque.

**Tightening torque:  $48 \pm 6 \text{ N}\cdot\text{m} (35 \pm 4 \text{ ft-lb})$**

13. Rotate the crankshaft two turns clockwise and leave it alone for approximately five minutes.



14. Check to see whether the metal wire inserted when the auto-tensioner was installed can be removed without any resistance.

If the metal wire can be removed without any resistance, it means that the belt has a proper tension. Therefore, remove the metal wire. In this condition, check that the rod protrusion of the auto-tensioner is within the standard value.

**Standard value: 4.8 – 6.0 mm (0.19 – 0.24 inch)**

15. If the metal wire offers resistance when removed, repeat the previous steps 10 through 13 until proper belt tension is obtained.

### >>E<< ENGINE SUPPORT BRACKET, RIGHT INSTALLATION

The mounting bolts of the right engine support bracket must be tightened in the order shown in the illustration.

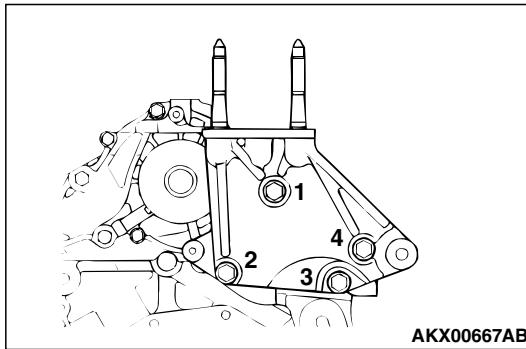
**Tightening torque:  $45 \pm 5 \text{ N}\cdot\text{m}$  ( $34 \pm 3 \text{ ft-lb}$ )**

Bolt length

85 mm (33.5 inch) – Bolt 3

95 mm (37.4 inch) – Bolts 2 and 4

100 mm (39.4 inch) – Bolt 1



### INSPECTION

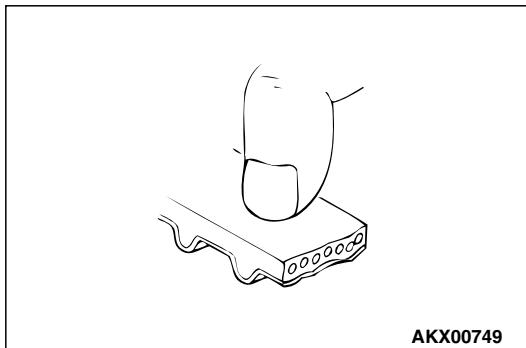
M1113002000845

#### TIMING BELT

Replace the belt if any of the following conditions exist.

1. Hardening of rubber backing.

Back side is glossy without resilience and leaves no indent when pressed with fingernail.

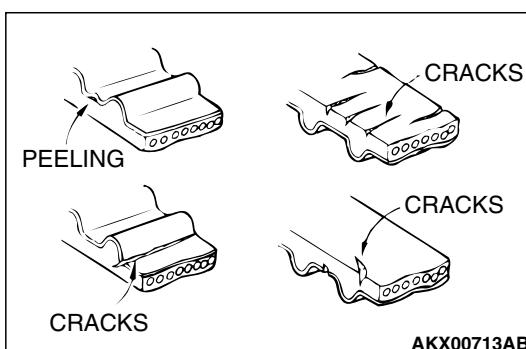


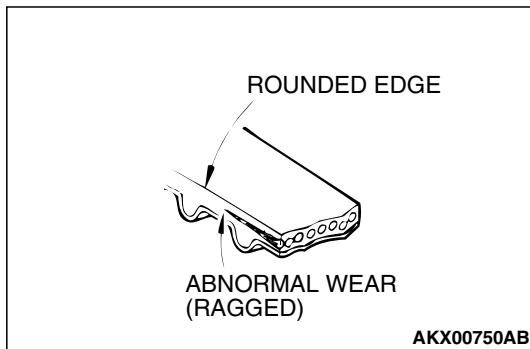
2. Cracks on rubber back.

3. Cracks or peeling of canvas.

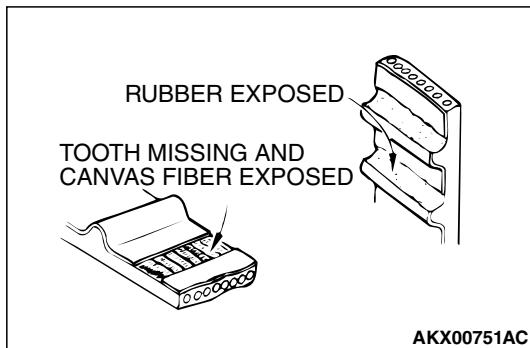
4. Cracks on tooth bottom.

5. Cracks on belt.





6. Abnormal wear of belt sides. Normal wear is indicated if the sides are sharp as if cut by a knife. Abnormal wear is indicated if the sides are ragged.



7. Abnormal wear on teeth.

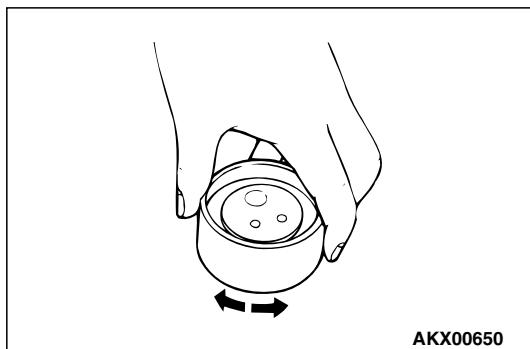
**Initial stage:**

**Canvas worn (fluffy canvas fibers, rubbery texture gone, white discoloration, canvas texture indistinct)**

**Final stage:**

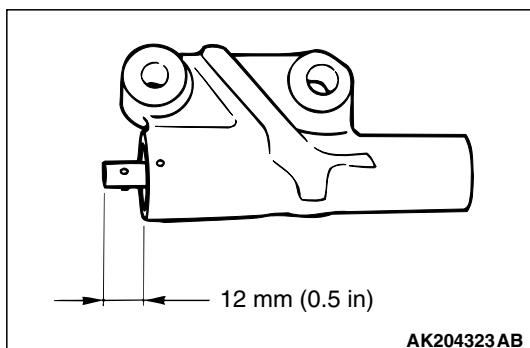
**Canvas worn, exposing rubber (tooth width reduced)**

8. Missing tooth.



**TENSIONER PULLEY AND IDLER PULLEY**

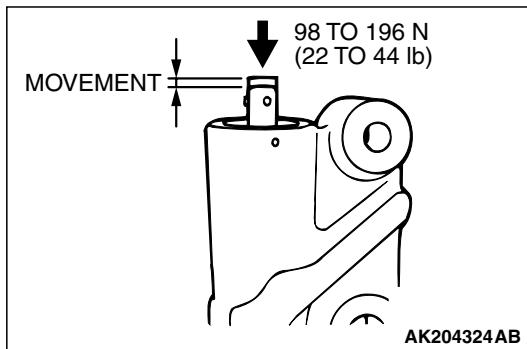
Turn the pulley. If it does not rotate smoothly, or develops noise or excessive play, replace the pulley.



**AUTO-TENSIONER**

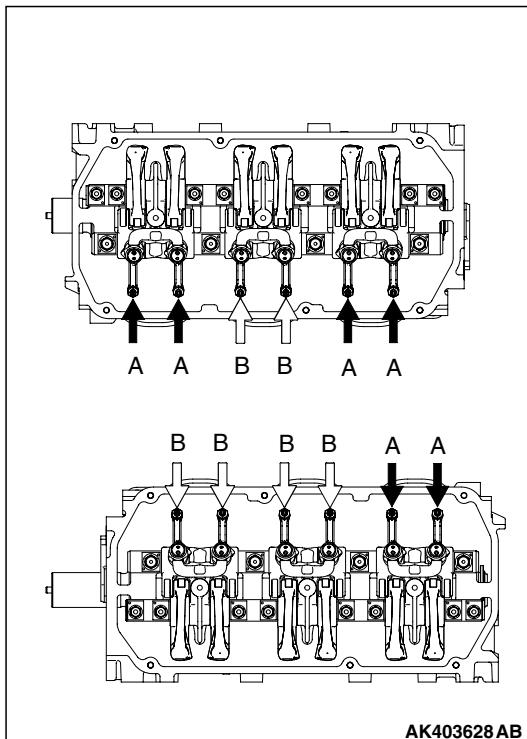
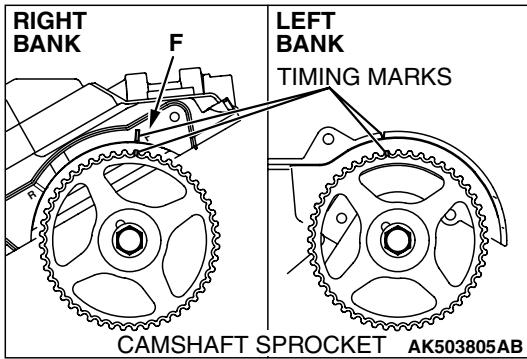
1. Check for oil leaks. If oil leaks are evident, replace the auto-tensioner.
2. Check the rod end for wear or damage and replace the auto-tensioner if necessary.
3. Measure the rod protrusion. If it is out of specification, replace the auto-tensioner.

**Standard value: 12 mm (0.5 inch)**



4. Press the rod with a force of 98 to 196 N (22 to 44 pounds) and measure the movement of the rod.  
If the measured value is out of the standard value, replace the auto-tensioner.

**Standard value: 1.0 mm (0.03 inch) or less**



### VALVE CLEARANCE ADJUSTMENT

Adjust the valve clearance as follows:

**CAUTION**

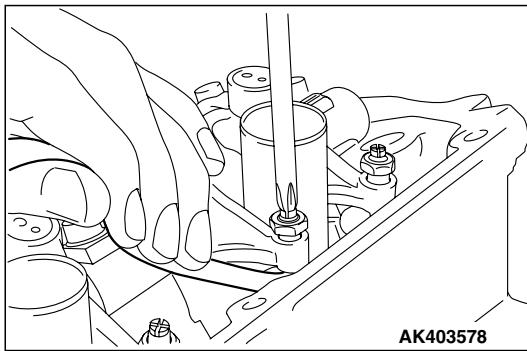
**Rotate the crankshaft clockwise at any time.**

1. Rotate crankshaft clockwise and then align the timing mark on the camshaft sprocket with the timing mark on the rocker cover. (Place No.1 cylinder on the top dead center of compression stroke.)  
*NOTE: Align the timing mark, on the right bank, with F.*
2. Remove the rocker cover.

3. Measure the valve clearances marked with arrows shown in the illustration.

A: When No.1 cylinder is on the top dead center of compression stroke.

B: When No.4 cylinder is on the top dead center of compression stroke.



4. Using a thickness gauge, adjust the clearance between the valve shaft end and the adjusting screw.

**Standard value (in cold state): 0.10 mm (0.004 inch)**

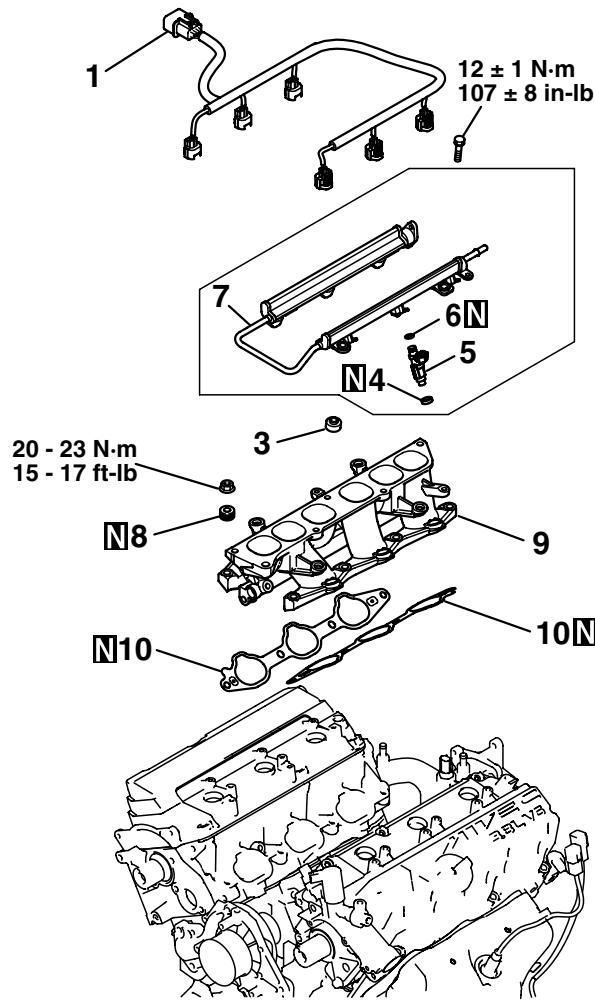
*NOTE: After the engine assembly is installed on the vehicle, check the valve clearance again with the engine warmed up. Adjust if necessary.*

5. Hold the adjusting screw with a screwdriver so it does not rotate then tighten the lock nut.
6. Rotate the crankshaft one time clockwise and then align the timing mark with the timing mark on the crankshaft sprocket. (Place No.4 cylinder on the top dead center of compression stroke.)
7. Adjust the valve clearance for the rest of the valves.
8. Install the rocker cover.

## INTAKE MANIFOLD AND FUEL PARTS

### REMOVAL AND INSTALLATION

M1113004300347



## REMOVAL STEPS

1. INJECTOR HARNESS
2. INJECTOR AND FUEL RAIL
3. INSULATOR
4. INSULATOR
- >>B<< 5. INJECTOR

## REMOVAL STEPS (Continued)

6. O-RING
7. FUEL RAIL
8. CONED DISC SPRING
- >>A<< 9. INTAKE MANIFOLD
10. INTAKE MANIFOLD GASKET

## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; INTAKE MANIFOLD INSTALLATION

1. Tighten the nuts "R" to  $6.4 \pm 1.5 \text{ N}\cdot\text{m}$  ( $57 \pm 13 \text{ in-lb}$ ).
2. Tighten the nuts "L" to the specified torque.

**Tightening torque: 20 – 23 N·m (15 – 17 ft-lb)**

3. Tighten the nuts "R" to the specified torque.

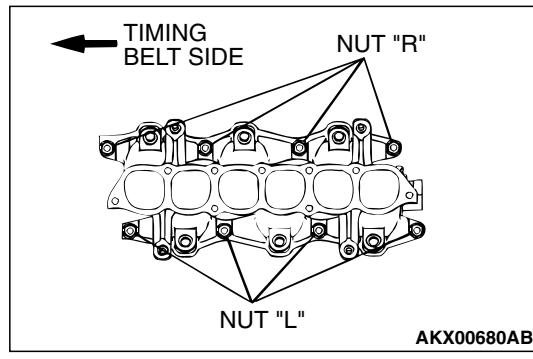
**Tightening torque: 20 – 23 N·m (15 – 17 ft-lb)**

4. Tighten the nuts "L" to the specified torque.

**Tightening torque: 20 – 23 N·m (15 – 17 ft-lb)**

5. Tighten the nuts "R" to the specified torque.

**Tightening torque: 20 – 23 N·m (15 – 17 ft-lb)**

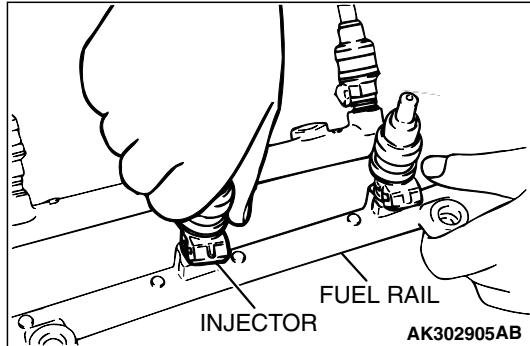


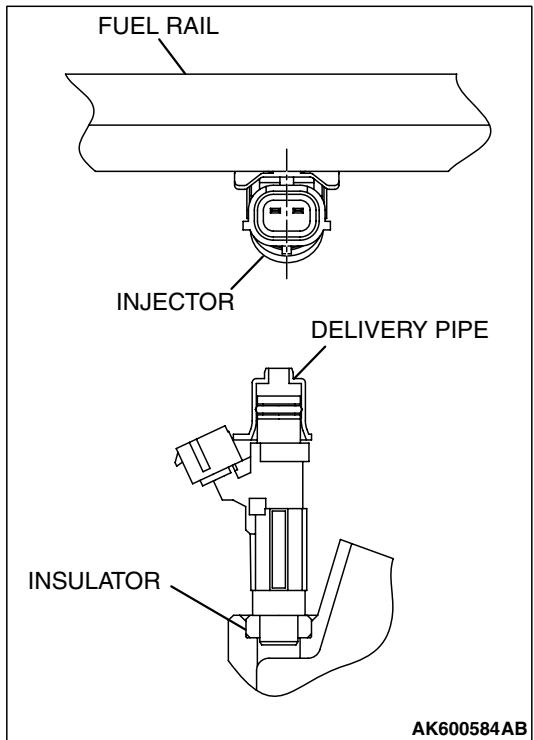
## &gt;&gt;B&lt;&lt; INJECTOR INSTALLATION

**CAUTION**

**Use care not to let engine oil enter the fuel rail.**

1. Apply clean engine oil to the O-ring.
2. Insert the injector into the fuel rail.
3. Make sure the injector rotates smoothly. If not, remove the injector to check the O-ring for damage, and replace the O-ring if necessary. Then reinsert the injector and check that it rotates smoothly.





4. Confirm the protrusion of injector is at center. If not, rotate the injector for protrusion to be center.

**⚠ CAUTION**

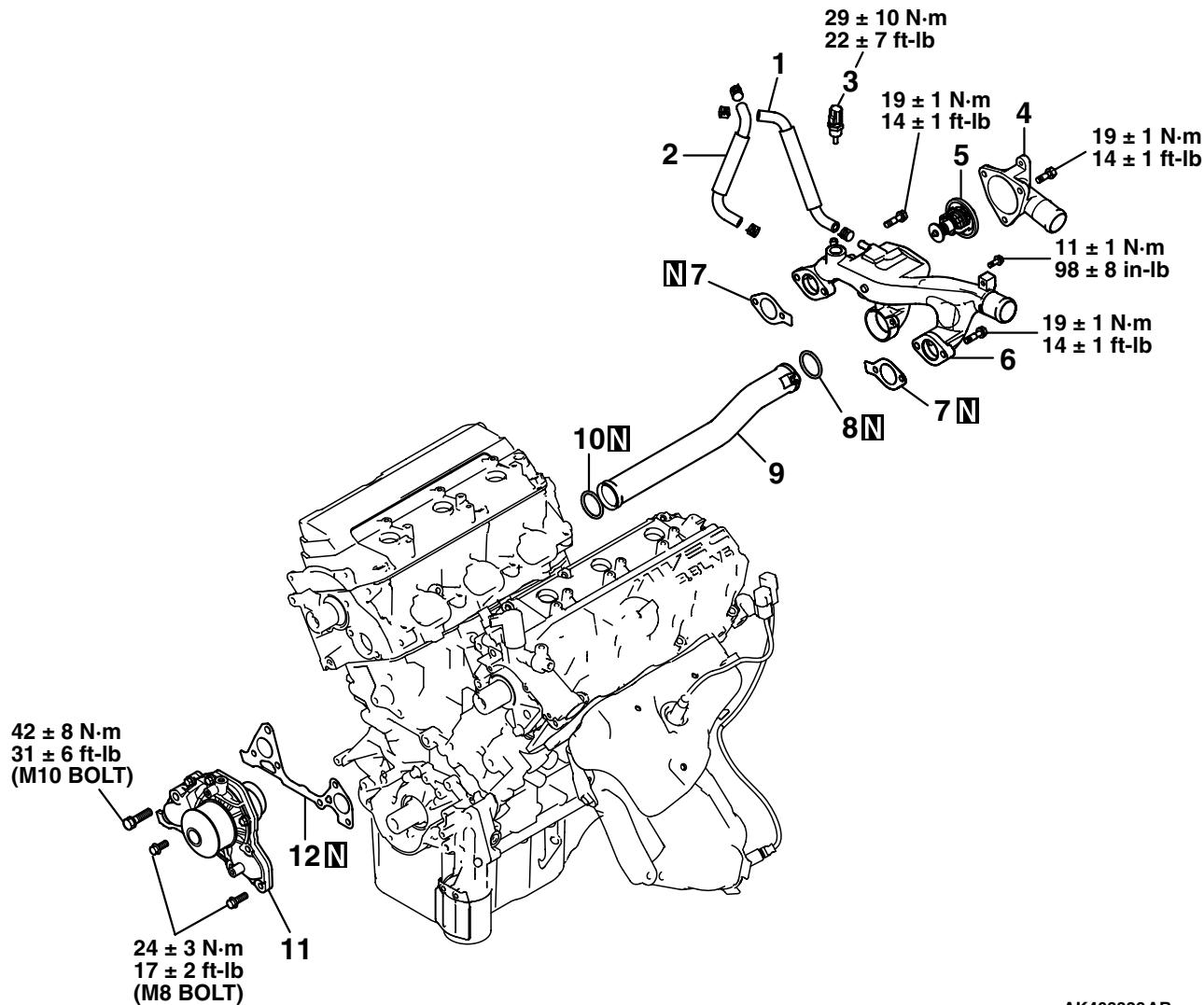
Connect the injector securely, having no air leakage from the insulator.

5. Install the insulator, connecting securely to injector without the clearance.

## WATER PUMP &amp; WATER HOSE

## REMOVAL AND INSTALLATION

M1113017900480



AK403328AB

## REMOVAL STEPS

1. WATER HOSE
2. WATER HOSE
- >>D<< 3. ENGINE COOLANT TEMPERATURE SENSOR
4. WATER INLET FITTING
- >>C<< 5. THERMOSTAT
6. THERMOSTAT HOUSING

## REMOVAL STEPS (Continued)

>>B<<	7. THERMOSTAT HOUSING GASKET
>>A<<	8. O-RING
>>A<<	9. WATER INLET PIPE
>>A<<	10. O-RING
	11. WATER PUMP
	12. WATER PUMP GASKET

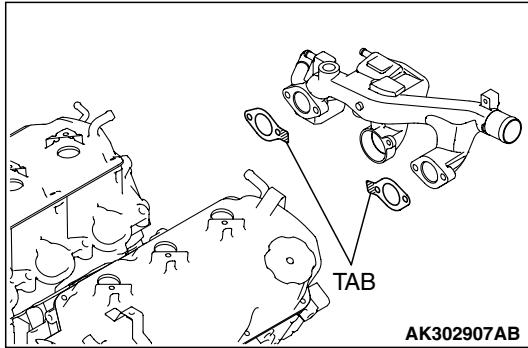
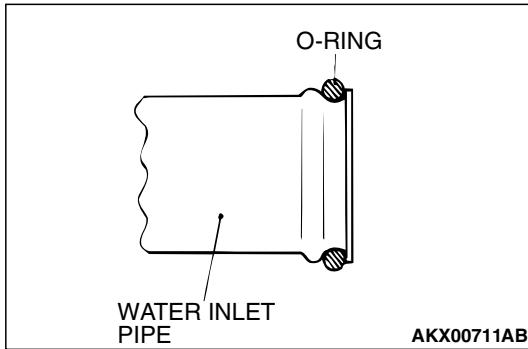
## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; O-RING AND WATER INLET PIPE INSTALLATION

**CAUTION**

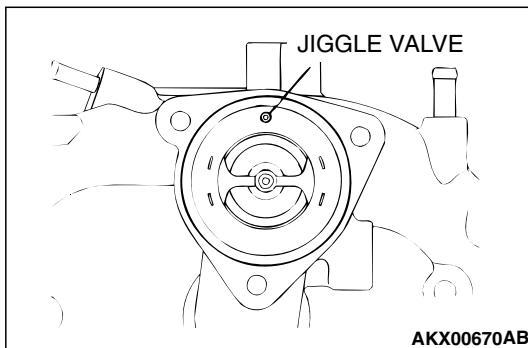
Keep the O-ring free of oil or grease.

1. Attach a new O-ring to each end of the water inlet pipe.
2. Wet the O-ring with water.
3. Insert the front end of the pipe into the water pump.



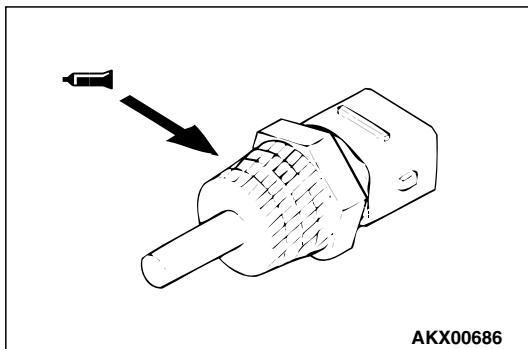
## &gt;&gt;B&lt;&lt; THERMOSTAT HOUSING GASKET INSTALLATION

Install the thermostat housing gasket so that the tab is positioned as shown in the illustration.



## &gt;&gt;C&lt;&lt; THERMOSTAT INSTALLATION

1. Check that the rubber ring is free from damage and seated correctly in the thermostat flange.
2. Install the thermostat as shown in the illustration. The jiggle valve must be at the top position.



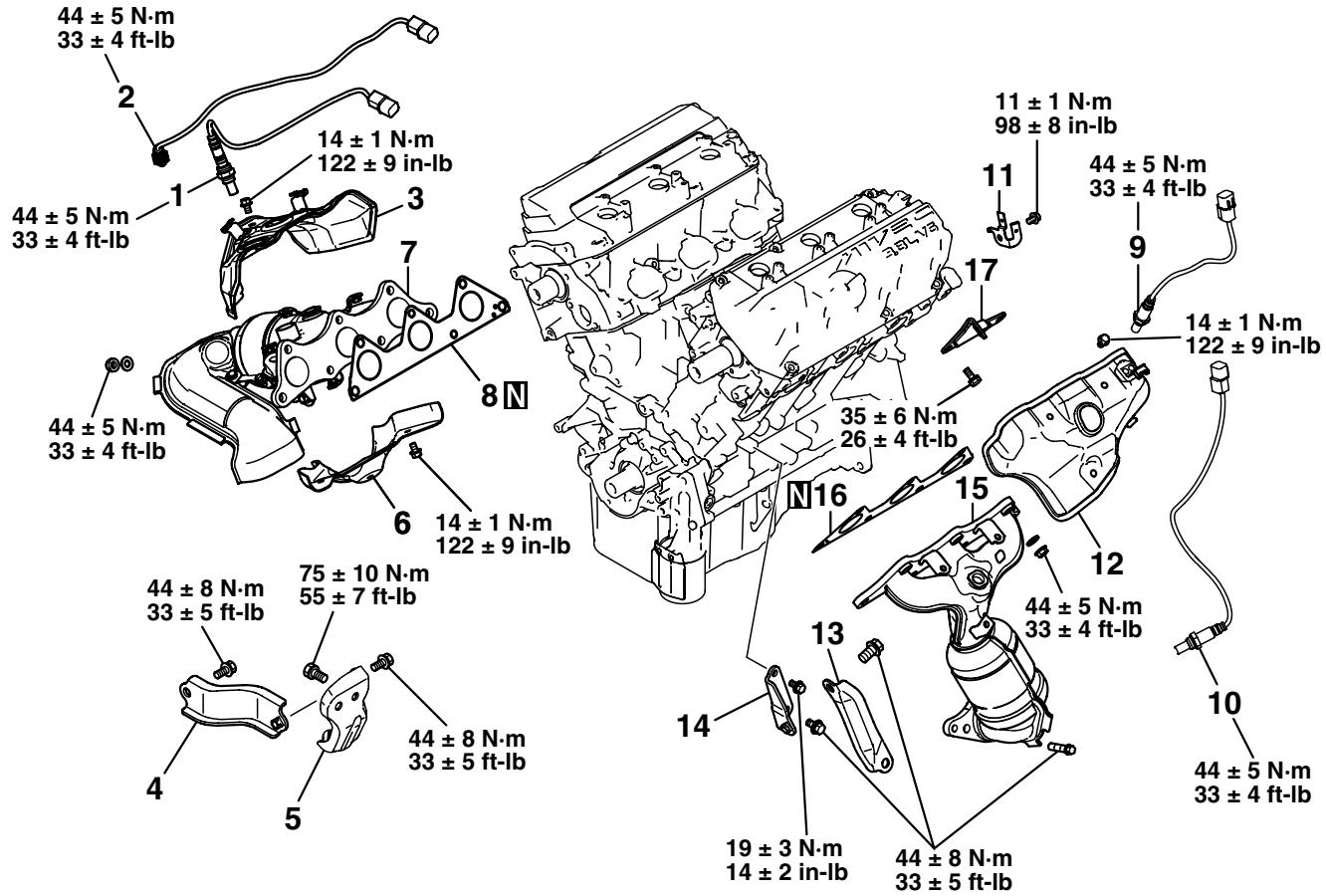
## &gt;&gt;D&lt;&lt; SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE SENSOR

Apply sealant (3M™ AAD Part number 8731 or equivalent) to the engine coolant temperature sensor.

## EXHAUST MANIFOLD

## REMOVAL AND INSTALLATION

M1113004900952



AK503810AB

## REMOVAL STEPS

1. RIGHT BANK HEATED OXYGEN SENSOR (FRONT)
2. RIGHT BANK HEATED OXYGEN SENSOR (REAR)
3. HEAT PROTECTOR, RIGHT
- >>B<< 4. EXHAUST MANIFOLD STAY, RIGHT "B"
5. EXHAUST MANIFOLD STAY, RIGHT "A"
6. HEAT PROTECTOR, LOWER RIGHT
7. EXHAUST MANIFOLD, RIGHT
8. EXHAUST MANIFOLD GASKET

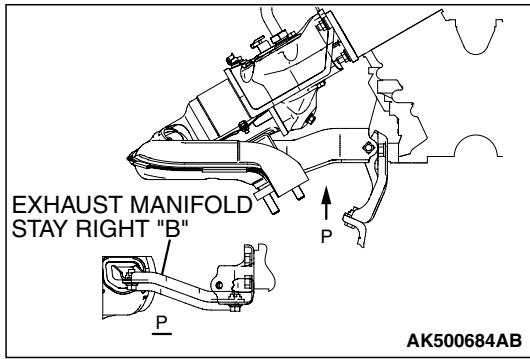
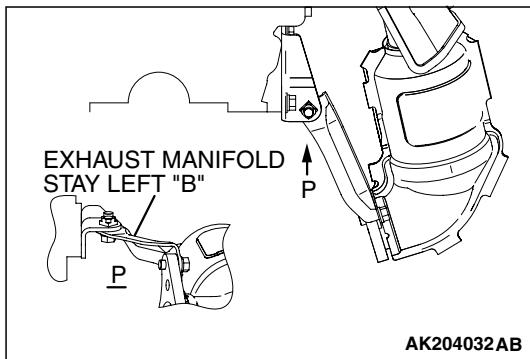
## REMOVAL STEPS (Continued)

9. LEFT BANK HEATED OXYGEN SENSOR (FRONT)
10. LEFT BANK HEATED OXYGEN SENSOR (REAR)
11. CONNECTOR BRACKET
12. HEAT PROTECTOR, LEFT
- >>A<< 13. EXHAUST MANIFOLD STAY, LEFT "B"
14. EXHAUST MANIFOLD STAY, LEFT "A"
15. EXHAUST MANIFOLD, LEFT
16. EXHAUST MANIFOLD GASKET
17. ENGINE HANGER

## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; EXHAUST MANIFOLD STAY, LEFT "B" INSTALLATION

1. Tighten temporarily the left "B" of exhaust manifold stay together with the exhaust manifold and the left "A" of exhaust manifold stay.
2. Tighten the bolt on the exhaust manifold side to the specified torque.  
**Tightening torque:  $44 \pm 8 \text{ N}\cdot\text{m} (33 \pm 5 \text{ ft-lb})$**
3. Tighten the bolt on the left "A" side of exhaust manifold stay to the specified torque.  
**Tightening torque:  $44 \pm 8 \text{ N}\cdot\text{m} (33 \pm 5 \text{ ft-lb})$**



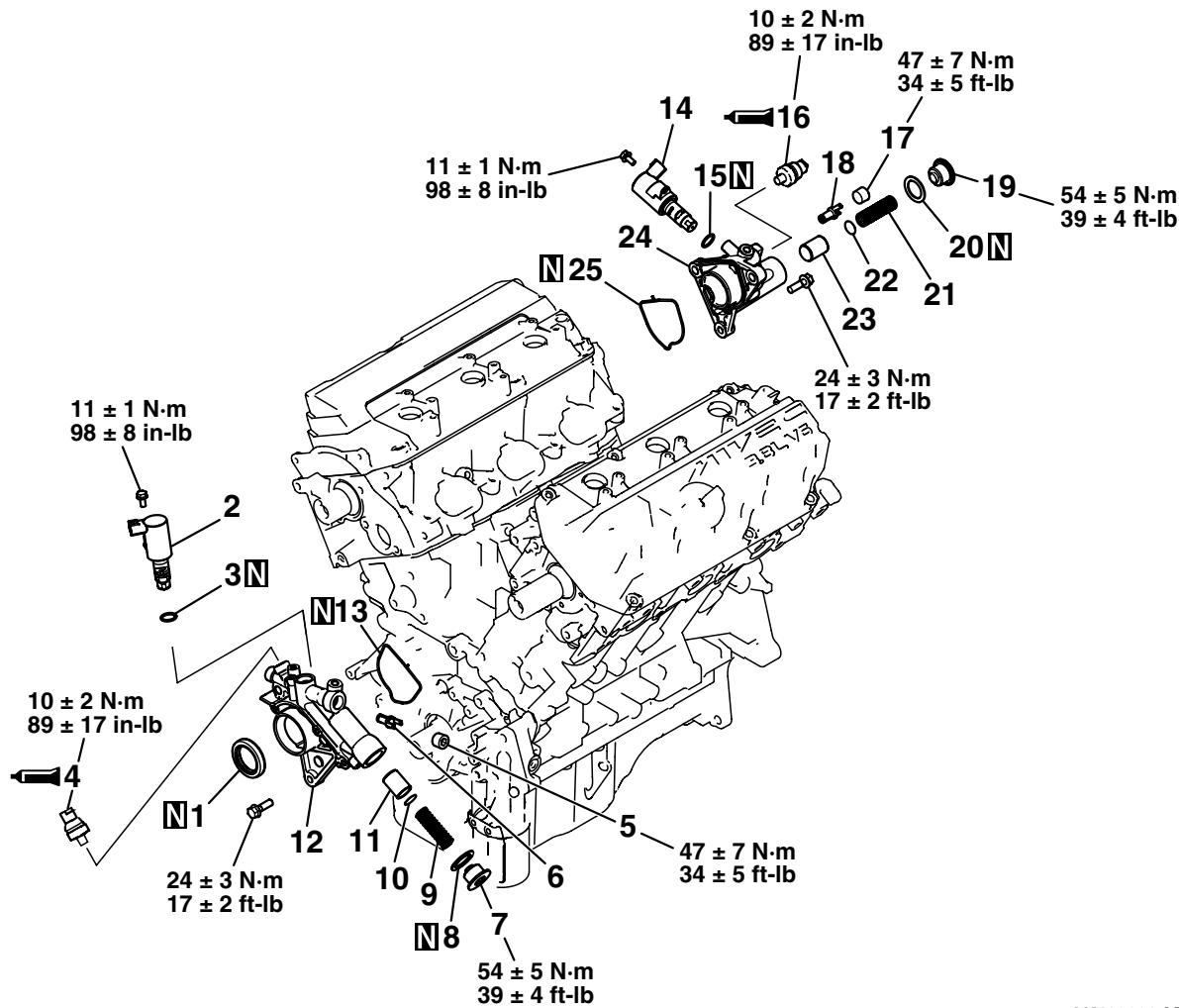
## &gt;&gt;B&lt;&lt; EXHAUST MANIFOLD STAY, RIGHT "B" INSTALLATION

1. Tighten temporarily the right "B" of exhaust manifold stay together with the exhaust manifold and the right "A" of exhaust manifold stay.
2. Tighten the bolt on the exhaust manifold side to the specified torque.  
**Tightening torque:  $44 \pm 8 \text{ N}\cdot\text{m} (33 \pm 5 \text{ ft-lb})$**
3. Tighten the bolt on the right "A" side of exhaust manifold stay to the specified torque.  
**Tightening torque:  $44 \pm 8 \text{ N}\cdot\text{m} (33 \pm 5 \text{ ft-lb})$**

## ENGINE OIL CONTROL VALVE

## REMOVAL AND INSTALLATION

M1113028000016



AK403606 AB

## REMOVAL STEPS

- >>C<< 1. OIL SEAL
- >>B<< 2. ENGINE OIL CONTROL VALVE
- 3. O-RING
- >>A<< 4. ENGINE OIL PRESSURE SWITCH
- 5. TAPER PLUG
- 6. ENGINE OIL CONTROL VALVE FILTER
- 7. ACCUMULATOR BOLT
- 8. GASKET
- 9. ACCUMULATOR SPRING
- 10. ACCUMULATOR SPRING SEAT
- 11. ACCUMULATOR PLUNGER
- 12. ENGINE OIL CONTROL VALVE HOUSING LEFT
- 13. ENGINE OIL CONTROL VALVE HOUSING GASKET

## REMOVAL STEPS (Continued)

- >>B<< 14. ENGINE OIL CONTROL VALVE
- 15. O-RING
- >>A<< 16. ENGINE OIL PRESSURE SWITCH
- 17. TAPER PLUG
- 18. ENGINE OIL CONTROL VALVE FILTER
- 19. ACCUMULATOR BOLT
- 20. GASKET
- 21. ACCUMULATOR SPRING
- 22. ACCUMULATOR SPRING SEAT
- 23. ACCUMULATOR PLUNGER
- 24. ENGINE OIL CONTROL VALVE HOUSING RIGHT
- 25. ENGINE OIL CONTROL VALVE HOUSING GASKET

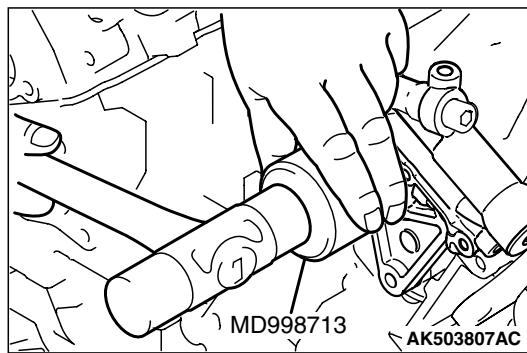
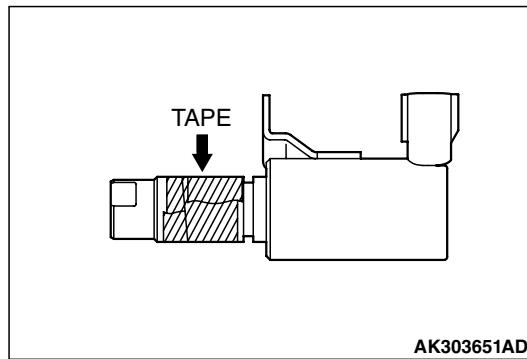
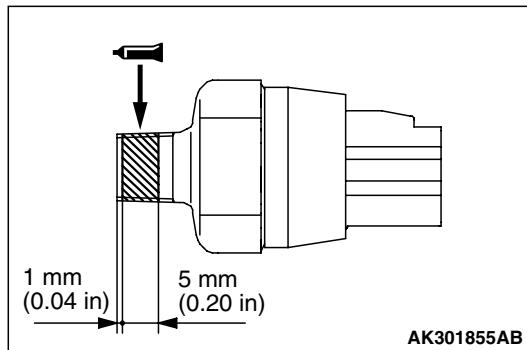
**Required Special Tool:**

- MD998713: Camshaft Oil Seal Installer

**INSTALLATION SERVICE POINTS**

**>>A<< ENGINE OIL PRESSURE SWITCH INSTALLATION**

Apply sealant (3M™ AAD Part number 8672 or equivalent) to the threads of the engine oil pressure switch.



**>>B<< ENGINE OIL CONTROL VALVE INSTALLATION**

**⚠ CAUTION**

- Never re-use the O-ring.
- Before installing O-ring, wind sealing tape around the oil passages cut-out area of engine oil control valve, to prevent damage. If the O-ring is damaged, it can cause an oil leak.

1. Apply a small amount of engine oil to the O-ring and then install it to the engine oil control valve.
2. Install the engine oil control valve to the cylinder head.
3. Tighten the engine oil control valve.

**Tightening torque:  $11 \pm 1 \text{ N}\cdot\text{m} (98 \pm 8 \text{ in-lb})$**

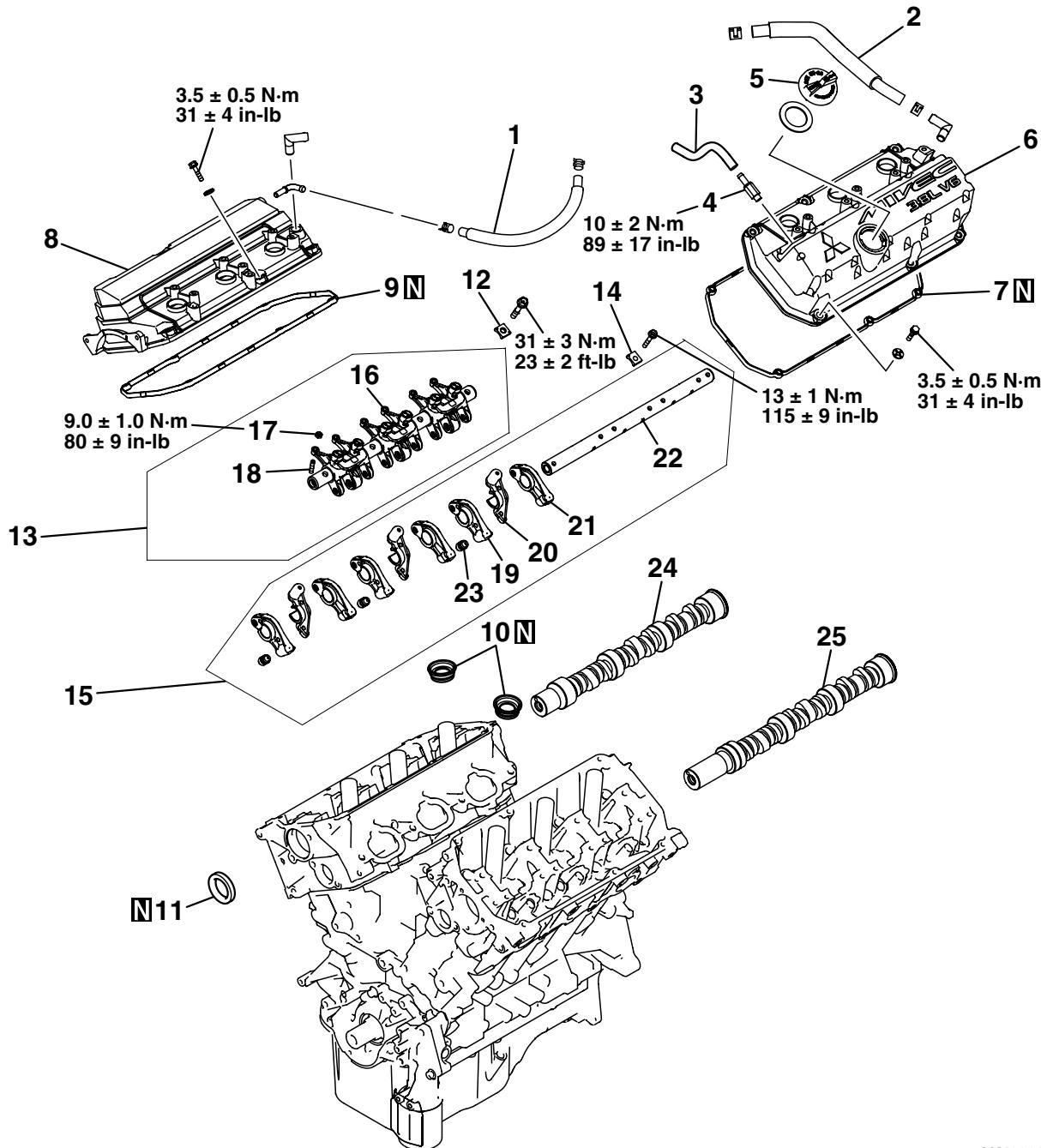
**>>C<< OIL SEAL INSTALLATION**

1. Apply engine oil to the lip area of the oil seal and the front end outside diameter of camshaft.
2. Using special tool MD998713, install the camshaft oil seal.

# ROCKER ARMS AND CAMSHAFT

## REMOVAL AND INSTALLATION

M1113005401072



AK403330AB

**REMOVAL STEPS**

1. BREather HOSE
2. BLOW-BY HOSE
3. POSITIVE CRANKCASE VENTILATION HOSE
4. POSITIVE CRANKCASE VENTILATION VALVE
5. OIL FILLER CAP

**REMOVAL STEPS (Continued)**

6. ROCKER COVER, LEFT
7. ROCKER COVER GASKET
8. ROCKER COVER, RIGHT
9. ROCKER COVER GASKET
10. OIL SEAL
- >>E<< 11. CAMSHAFT OIL SEAL
12. ROCKER SHAFT CAP

**REMOVAL STEPS (Continued)**

<<A>> >>D<< 13. ROCKER ARMS AND SHAFT  
ASSEMBLY  
14. ROCKER SHAFT CAP  
<<B>> >>D<< 15. ROCKER ARMS AND SHAFT  
ASSEMBLY  
16. ROCKER ARMS AND SHAFT  
INTEAKE  
>>C<< 17. NUT  
>>C<< 18. ADJUSTING SCREW  
19. ROCKER ARM C  
20. PISTON ARM ASSEMBLY  
21. ROCKER ARM D  
22. ROCKER ARM SHAFT  
>>B<< 23. LASH ADJUSTER  
>>A<< 24. CAMSHAFT, RIGHT  
>>A<< 25. CAMSHAFT, LEFT

**Required Special Tools:**

- MD998442: Air Bleed Wire
- MD998443: Lash Adjuster Holder
- MD998713: Camshaft Oil Seal Installer

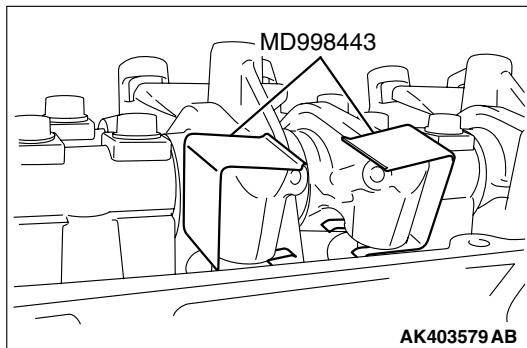
**REMOVAL SERVICE POINT****<<A>> ROCKER ARMS AND ROCKER ARM SHAFT  
REMOVAL**

When the rocker arm is removed from the rocker shaft, tag them to show the installation location for the reinstallation of the rocker arm, the piston arm assembly and so on.

**<<B>> ROCKER ARMS AND SHAFT REMOVAL****CAUTION**

If the lash adjuster is re-used, clean the lash adjuster.  
(Refer to lash adjuster inspection [P.11F-32](#).)

Set special tool MD998443 to prevent the lash adjuster from coming free and falling to the floor.



## INSTALLATION SERVICE POINTS

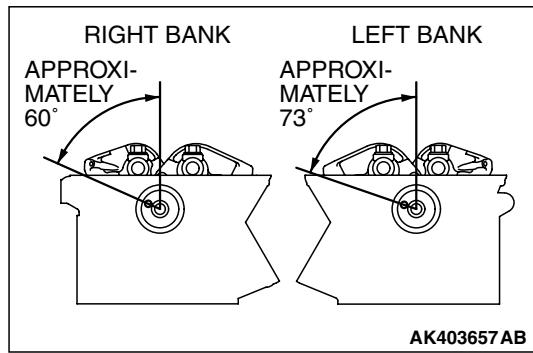
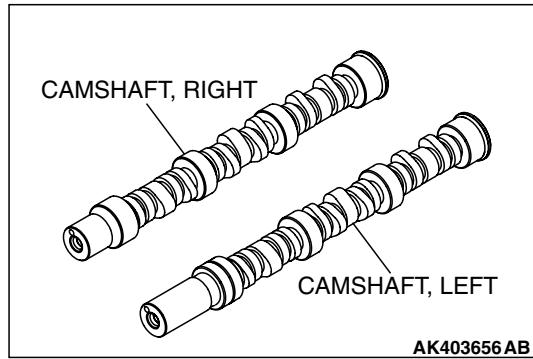
## &gt;&gt;A&lt;&lt; CAMSHAFT INSTALLATION

**CAUTION**

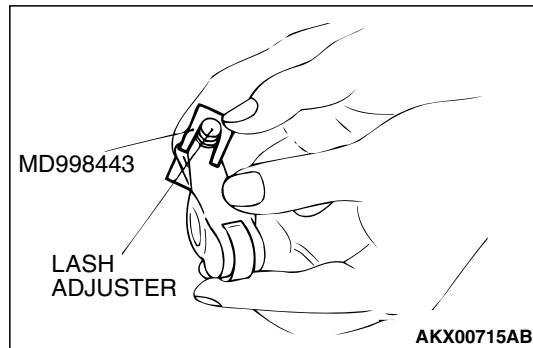
Use care to prevent confusion of the right and left bank camshafts.

1. Apply engine oil to the camshaft journals and cams and then install the camshafts.

*NOTE: The camshaft with a longer overall length is for the left bank.*



2. Check to see that the dowel pin of the camshaft is located at the position shown.

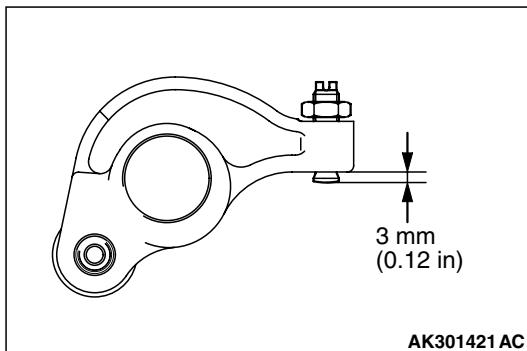


## &gt;&gt;B&lt;&lt; LASH ADJUSTER INSTALLATION

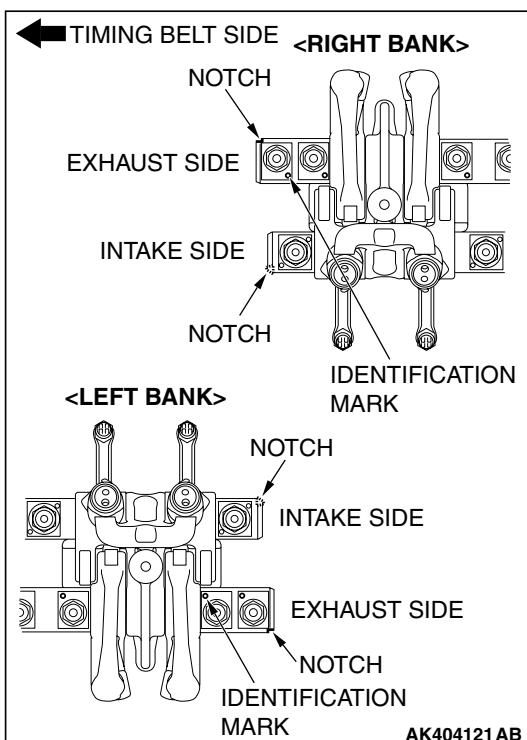
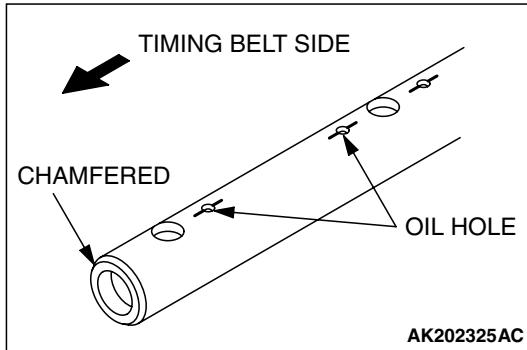
**CAUTION**

If the lash adjuster is re-used, clean the lash adjuster.  
(Refer to lash adjuster inspection [P.11F-32](#).)

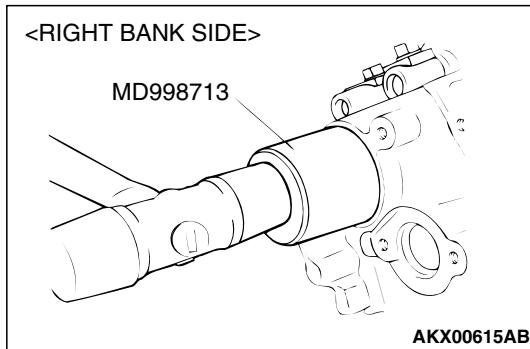
Fit the lash adjuster onto the rocker arm without allowing diesel fuel to spill out. Fit special tool MD998443 to prevent the lash adjuster from coming free and falling to the floor.

**>>C<< ADJUSTING SCREW INSTALLATION**

When installing the screw to the rocker arm temporarily, project it slightly 3 mm (0.12 in) from the same face level of the rocker arm end as shown.

**>>D<< ROCKER ARMS AND SHAFT INSTALLATION**

1. Position the end with the larger chamfer at the right on the front bank, and at the left on the rear bank.  
*NOTE: The side with the four bolt holes is on the intake side.*
2. Position the side with the oil holes on the lower side (cylinder head side).
3. Check that notches in the each rocker shaft are facing the direction shown in the illustration.
4. Install the rocker shaft cap as its identification mark is in the direction shown.
5. Tighten the mounting bolts to the specified torque.  
**Tightening torque:**  
**Intake side:  $31 \pm 3 \text{ N}\cdot\text{m} (23 \pm 2 \text{ ft-lb})$**   
**Exhaust side:  $13 \pm 1 \text{ N}\cdot\text{m} (115 \pm 9 \text{ in-lb})$**
6. Remove special tool MD998443.



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

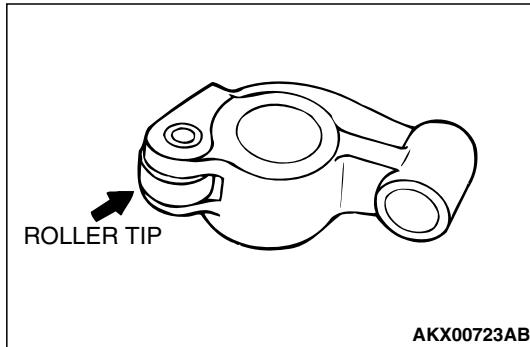
1. Apply engine oil to the lip area of the oil seal and the front end outside diameter of camshaft.
2. Using special tool MD998713, install the camshaft oil seal.

## INSPECTION

M1113005500894

## ROCKER ARM SHAFT

Check the rocker arm mounting areas of the rocker arm shafts for wear or damage. Replace as necessary.



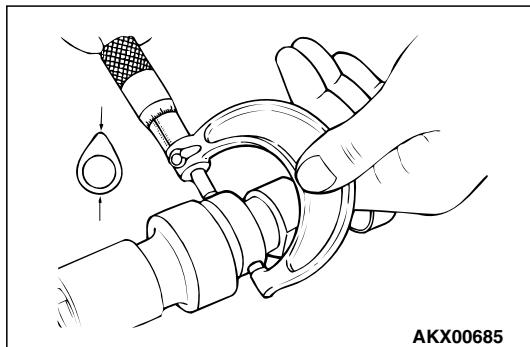
## ROCKER ARM

1. Check the roller surface and replace the rocker arm if recesses, damage or heat seizure is observed.
2. Check roller rotation and replace the rocker arm if uneven rotation or roller backlash of the roller is observed.
3. Check the inside diameter and replace the rocker arm if damage or seizure is observed.

## CAMSHAFT

1. Check the camshaft bearing journals for damage and binding. If the journals are binding, check the cylinder head for damage. Also check the cylinder head for clogged oil holes.
2. Check the tooth surface of the distributor drive gear teeth of the camshaft and replace if abnormal wear is evident.
3. Check the cam surface for abnormal wear and damage and replace if necessary. Also measure the cam height and replace if out of minimum limit.

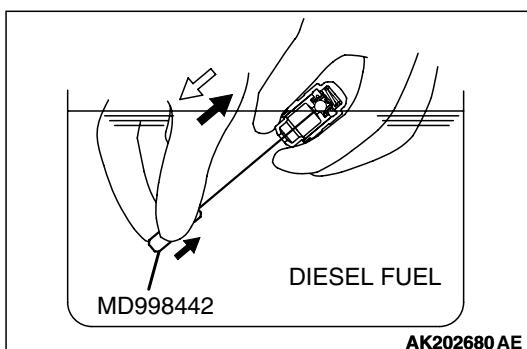
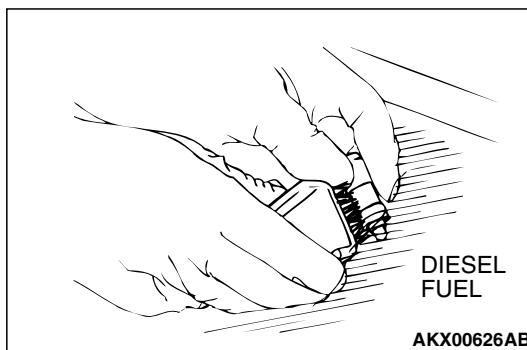
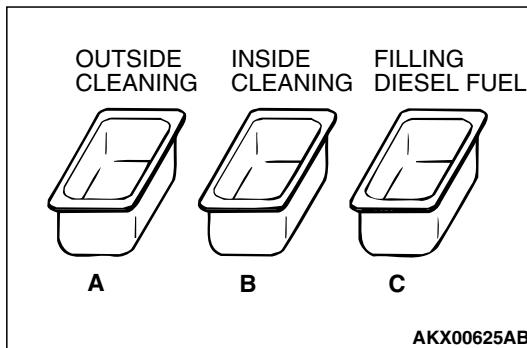
## Standard value:



	STANDARD VALUE	MINIMUM LIMIT
A: Intake low speed cam A	33.55 mm (1.321 in)	33.05 mm (1.301 in)

	STANDARD VALUE	MINIMUM LIMIT
B: Intake low speed cam B	37.35 mm (1.470 in)	36.85 mm (1.451 in)
C: Intake high speed cam	37.21 mm (1.465 in)	36.71 mm (1.445 in)
D: Exhaust cam	37.87 mm (1.491 in)	37.37 mm (1.471 in)

## LASH ADJUSTERS



### ⚠ CAUTION

- The lash adjusters are precision-engineered mechanisms. Do not allow them to become contaminated by dirt or other foreign substances.
- Do not attempt to disassemble the lash adjusters.
- Use only fresh diesel fuel to clean the lash adjusters.

1. Prepare three containers and approximately 5 dm<sup>3</sup> (30.5 quart) of diesel fuel. Into each container, pour enough diesel fuel to completely cover a lash adjuster when it is standing upright. Then, perform the following steps with each lash adjuster.
2. Place the lash adjuster in container A and clean its outside surface.

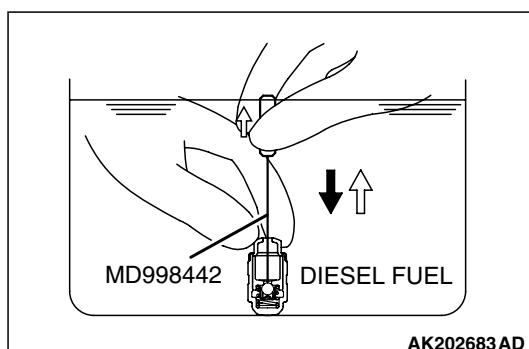
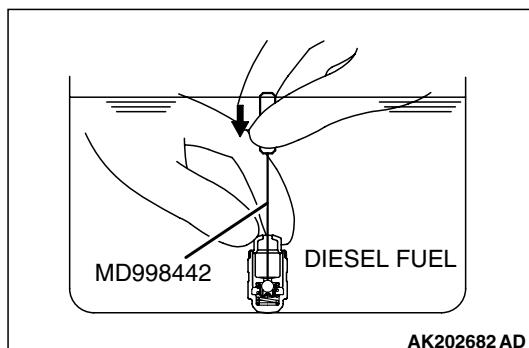
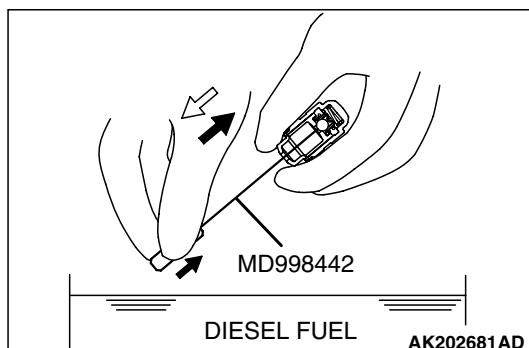
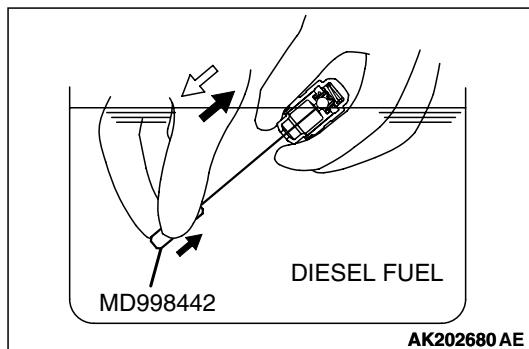
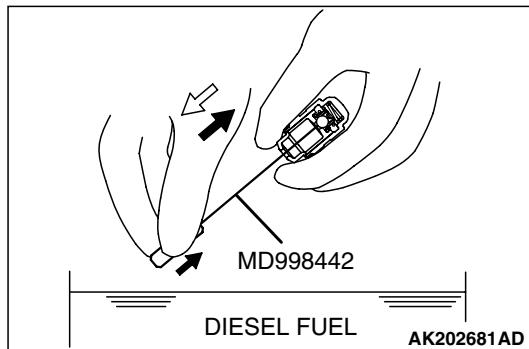
*NOTE: Use a nylon brush if deposits are hard to remove.*

### ⚠ CAUTION

The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.

3. While gently pushing down the internal steel ball using wire [0.5 mm (0.020 inch) in diameter] or special tool MD998442, move the plunger through five to ten strokes until it slides smoothly. In addition to eliminating stiffness in the plunger, this operation will remove dirty oil.

*NOTE: If the plunger remains stiff or the mechanism appears otherwise abnormal, replace the lash adjuster.*



4. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

**CAUTION**

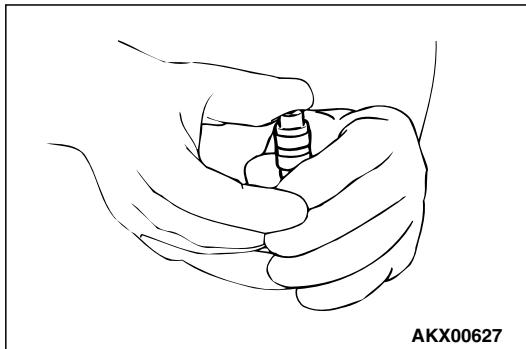
**The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.**

5. Place the lash adjuster in container B. Then, gently push down the internal steel ball using a wire [0.5 mm (0.020 inch) in diameter] or special tool MD998442 and move the plunger through five to ten strokes until it slides smoothly. This operation will clean the lash adjuster's pressure chamber.
6. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

**CAUTION**

**Do not use container C for cleaning. If cleaning is performed in container C, foreign matter could enter the pressure chamber when the chamber is filled with diesel fuel.**

7. Place the lash adjuster in container C. Then, gently push down the internal steel ball using a wire [0.5 mm (0.020 inch) in diameter] or special tool MD998442.
8. Stand the lash adjuster with its plunger at the top, then push the plunger downward firmly until it moves through its greatest possible stroke. Return the plunger slowly, then release the steel ball and allow the pressure chamber to fill with diesel fuel.



9. Remove the lash adjuster from the container, then stand the lash adjuster with its plunger at the top. Push the plunger firmly and check that it does not move.

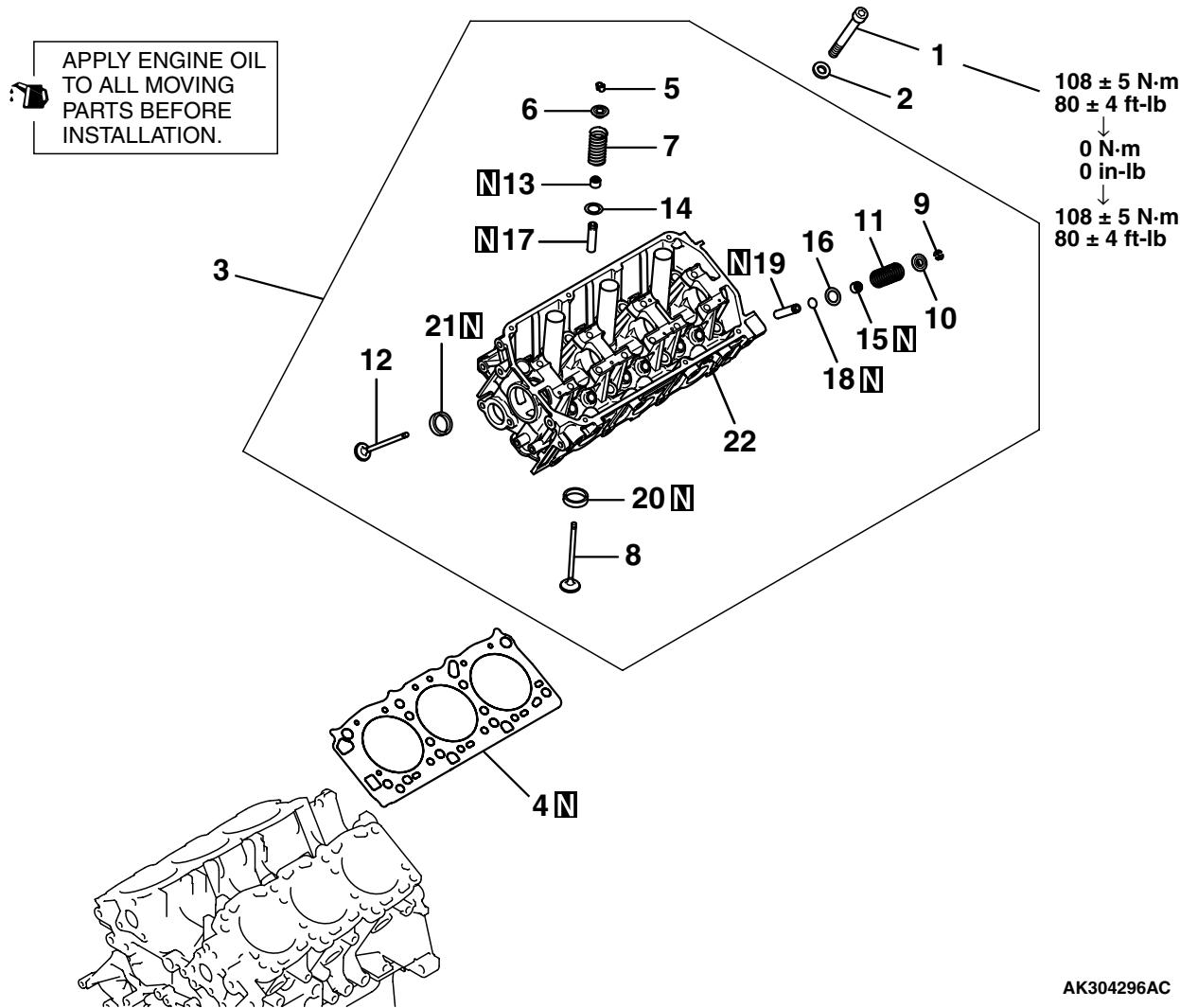
*NOTE: If the lash adjuster contracts or moves, repeat steps 7 through 9 again to fill it with diesel fuel completely. Replace the lash adjuster if it still contracts or moves after performing these steps.*

10. Stand the lash adjuster upright to prevent diesel fuel from spilling out. Do not allow the lash adjuster to become contaminated by dirt or other foreign matter. Install the lash adjuster onto the engine as soon as possible.

## CYLINDER HEAD AND VALVES

### REMOVAL AND INSTALLATION

M1113006901070



#### REMOVAL STEPS

<<A>> >>D<< 1. CYLINDER HEAD BOLT  
2. WASHER  
3. CYLINDER HEAD ASSEMBLY  
4. CYLINDER HEAD GASKET

#### REMOVAL STEPS (Continued)

<<B>> >>C<< 5. RETAINER LOCK  
6. VALVE SPRING RETAINER  
>>B<< 7. VALVE SPRING  
8. INLET VALVE

**REMOVAL STEPS (Continued)**

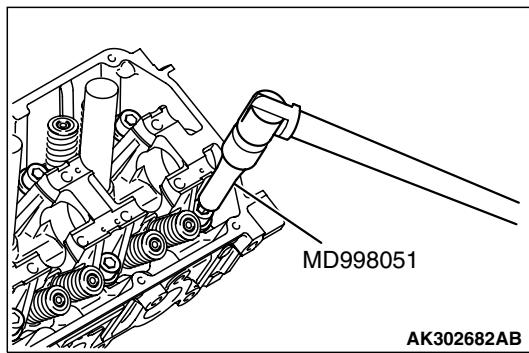
<<B>> >>C<< 9. RETAINER LOCK  
10. VALVE SPRING RETAINER  
>>B<< 11. VALVE SPRING  
12. EXHAUST VALVE  
>>A<< 13. VALVE STEM SEAL  
14. VALVE SPRING SEAT  
>>A<< 15. VALVE STEM SEAL  
16. VALVE SPRING SEAT  
17. INLET VALVE GUIDE  
18. SNAP RING  
19. EXHAUST VALVE GUIDE  
20. INLET VALVE SEAT  
21. EXHAUST VALVE SEAT  
22. CYLINDER HEAD

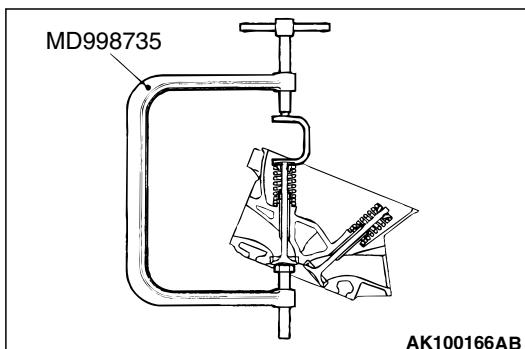
**Required Special Tools:**

- MB991999: Valve Stem Seal Installer
- MD998051: Cylinder Head Bolt Wrench
- MD998735: Valve Spring Compressor
- MD998772: Valve Spring Compressor

**REMOVAL SERVICE POINTS****<<A>> CYLINDER HEAD BOLT REMOVAL**

Use special tool MD998051 to loosen the cylinder head bolt.

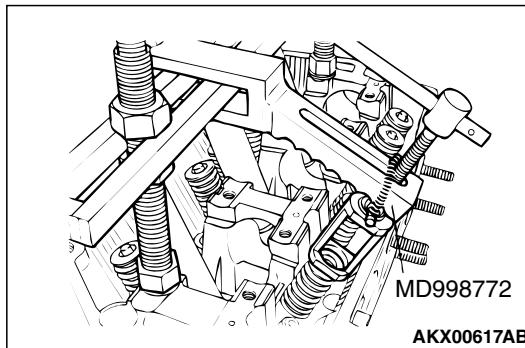




**<<B>> RETAINER LOCK REMOVAL**

1. Using special tool MD998735 or MD998772, compress the spring.
2. Remove the retainer locks.

*NOTE: Tag removed valves, springs and other components, noting their cylinder numbers and locations to facilitate reassembly. Store these components safely.*



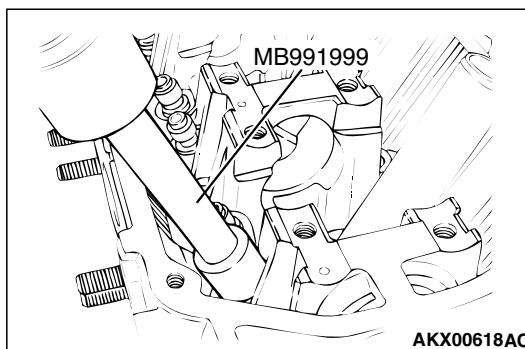
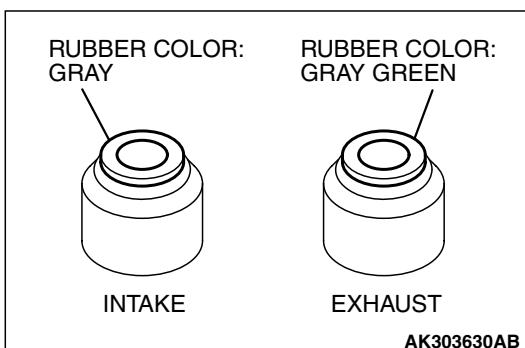
**INSTALLATION SERVICE POINTS**

**>>A<< VALVE STEM SEAL INSTALLATION**

1. Install the valve spring seat.

**CAUTION**

- Valve stem seals for intake valves and for exhaust valves are different. Be sure to install the correct ones.
- Valve stem seal identification color  
Intake: GRAY  
Exhaust: GRAY GREEN



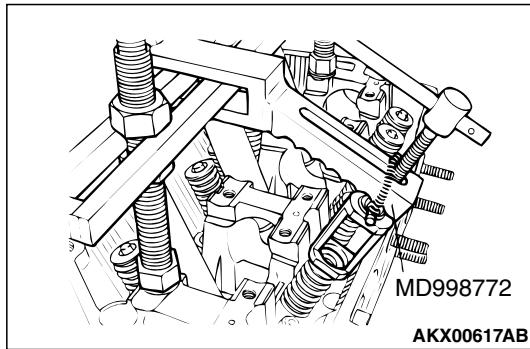
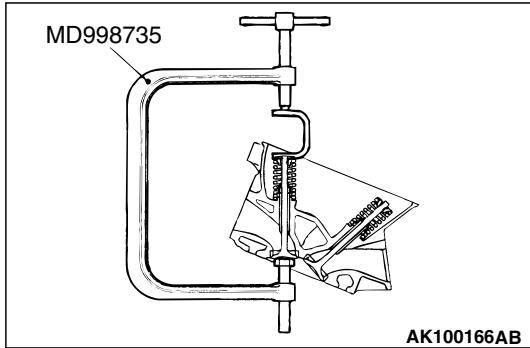
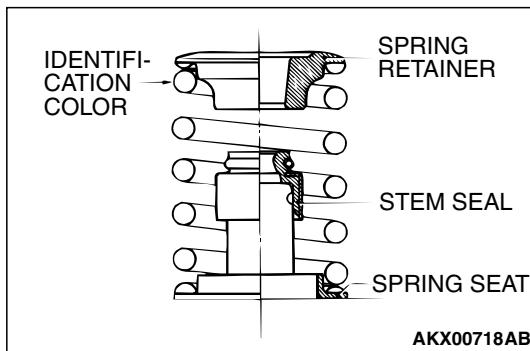
**CAUTION**

**Always use the special tool to install the valve stem seal. Improperly installed valve stem seals may leak oil.**

2. Using special tool MB991999, install a new stem seal to the valve guide.

## &gt;&gt;B&lt;&lt; VALVE SPRING INSTALLATION

Install the valve spring end with its identification color toward the spring retainer.



## &gt;&gt;C&lt;&lt; RETAINER LOCK INSTALLATION

Using special tool MD998735 or MD998772, compress the valve spring and insert the retainer lock into position.

*NOTE: The valve spring, if excessively compressed, causes the bottom end of retainer to damage the stem seal.*

## &gt;&gt;D&lt;&lt; CYLINDER HEAD BOLT INSTALLATION

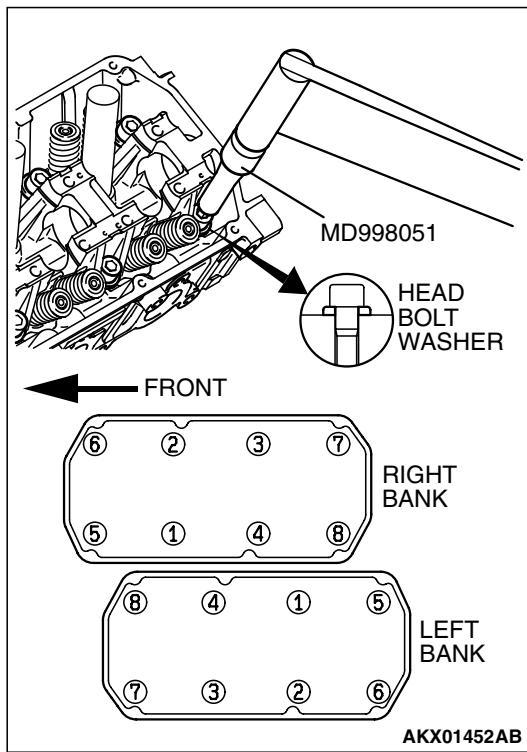
**CAUTION**

Attach the head bolt washer in the direction shown in the figure.

1. Tighten the bolts in the illustrated sequence in two or three steps.

**Tightening torque:  $108 \pm 5 \text{ N}\cdot\text{m}$  ( $80 \pm 4 \text{ ft-lb}$ )**

2. Back off the bolts once and tighten them again to the specified torque in step1.



## INSPECTION

M1113007000925

## CYLINDER HEAD

1. Check the cylinder head gasket surface for flatness by using a straightedge in the directions of A through G shown in the illustration.

**Standard value: 0.03 mm (0.0012 inch)**

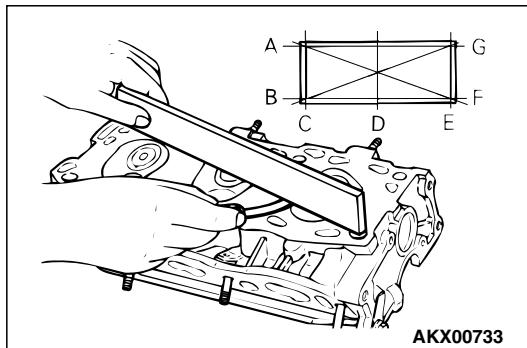
**Limit: 0.2 mm (0.007 inch)**

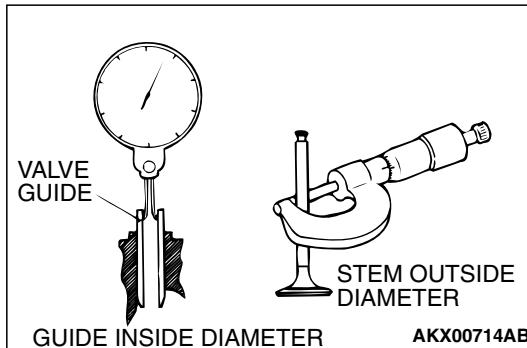
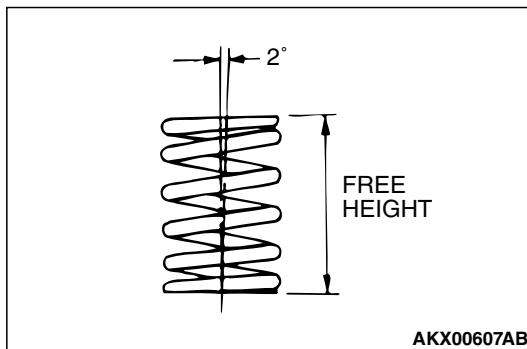
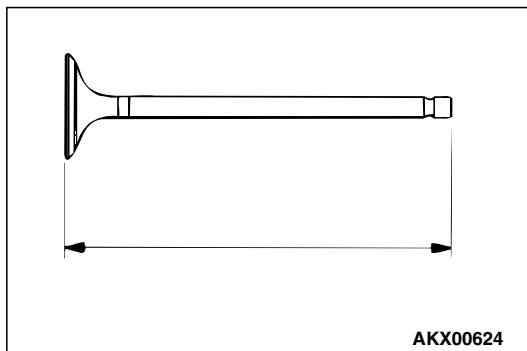
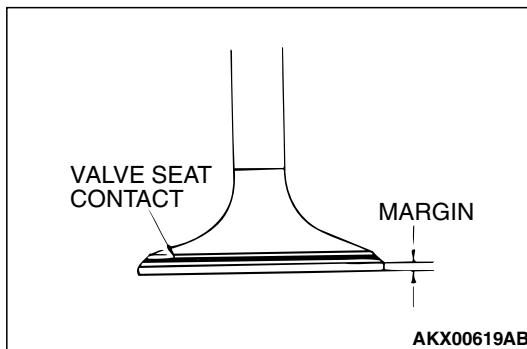
2. If the service limit is exceeded, correct to meet the specification.

**Grinding limit: \*0.2 mm (0.007 inch)**

3. \*If the service limit is exceeded, correct to meet the specification.

**Cylinder head height (specification when new):  
120 mm (4.7 inches)**





## VALVE

1. Check the valve face for correct contact. If incorrect, reface using a valve refacer. The valve should make a uniform contact with the seat at the center of the valve face.
2. If the margin exceeds the service minimum limit, replace the valve.

### Standard value:

<Intake> 1.0 mm (0.04 inch)  
<Exhaust> 1.2 mm (0.05 inch)

### Minimum limit:

<Intake> 0.5 mm (0.02 inch)  
<Exhaust> 0.7 mm (0.03 inch)

3. Measure the valve's total length. If the measurement is less than specified, replace the valve.

### Standard value:

<Intake> 109.33 mm (4.304 inches)  
<Exhaust> 113.50 mm (4.468 inches)

### Minimum limit:

<Intake> 108.83 mm (4.285 inches)  
<Exhaust> 113.00 mm (4.449 inches)

## VALVE SPRINGS

1. Measure the free height of the spring and, if it is smaller than the minimum limit, replace the spring.

### Standard value:

<Intake> 56.19 mm (2.212 inches)  
<Exhaust> 53.30 mm (2.098 inches)

### Limit:

<Intake> 55.19 mm (2.173 inches)  
<Exhaust> 52.30 mm (2.059 inches)

2. Measure the squareness of the spring and, if the limit is exceeded, replace the spring.

### Standard value: 2° or less

### Limit: 4°

## VALVE GUIDES

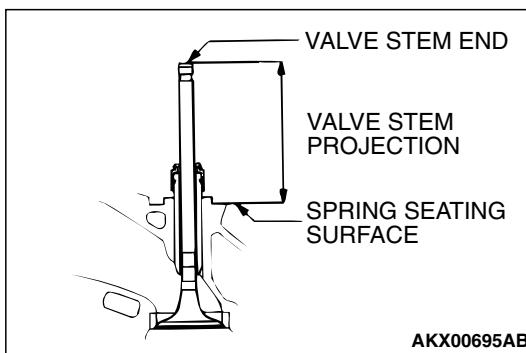
Measure the clearance between the valve guide and valve stem. If the limit is exceeded, replace the valve guide, valve, or both.

### Standard value:

<Intake> 0.02 – 0.05 mm (0.0008 – 0.0019 inch)  
<Exhaust> 0.04 – 0.06 mm (0.0016 – 0.0023 inch)

### Limit:

<Intake> 0.10 mm (0.003 inch)  
<Exhaust> 0.15 mm (0.005 inch)



### VALVE SEAT

Assemble the valve, then measure the valve stem projection between the end of the valve stem and the spring seating surface. If the measurement exceeds the specified limit, replace the valve seat.

#### Standard value:

<Intake> 48.33 mm (1.903 inches)  
<Exhaust> 50.70 mm (1.996 inches)

#### Limit:

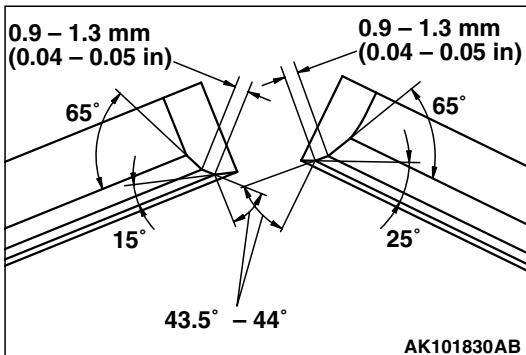
<Intake> 48.83 mm (1.922 inches)  
<Exhaust> 51.20 mm (2.02 inches)

### VALVE SEAT RECONDITIONING PROCEDURE

#### ⚠ CAUTION

Before correcting the valve seat, check the clearance between the valve guide and valve and, if necessary, replace the valve guide.

1. Using the special tool or a seat grinder, correct to obtain the specified seat width and angle.
2. After correcting the valve seat, lap the valve and valve seat using lapping compound. Then, check the valve stem projection.

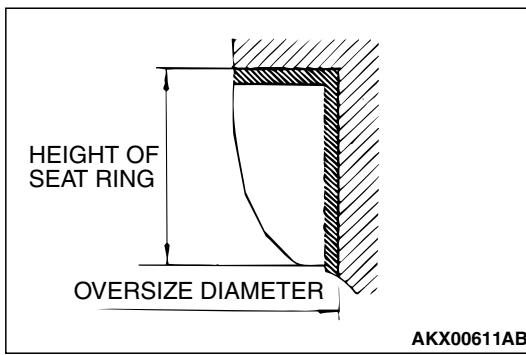
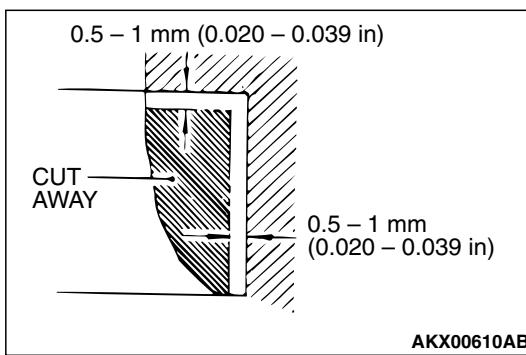


### VALVE SEAT REPLACEMENT PROCEDURE

#### ⚠ CAUTION

Before replacing the valve seat, check the valve guide and, if necessary, replace the valve guide.

1. Cut the valve seat from the inside to thin the wall thickness. Then, remove the valve seat.



2. Re bore the valve seat hole in the cylinder head to a selected oversize valve seat diameter.

#### Seat ring hole diameter:

##### Intake valve

0.3 oversize 37.80 – 37.83 mm (1.4882 – 1.4894 inches)

0.6 oversize 38.10 – 38.13 mm (1.5000 – 1.5012 inches)

##### Exhaust valve

0.3 oversize 34.80 – 34.83 mm (1.3701 – 1.3713 inches)

0.6 oversize 35.10 – 35.13 mm (1.3819 – 1.3831 inches)

3. Before fitting the valve seat, either heat the cylinder head up to approximately 250°C (482°F) or cool the valve seat in liquid nitrogen, to prevent the cylinder head bore from galling.
4. Using a valve seat cutter, correct the valve seat to the specified width and angle. Using a valve seat cutter, correct the valve seat to the specified width and angle. See "VALVE SEAT RECONDITIONING PROCEDURE" on the previous page.

### VALVE GUIDE REPLACEMENT PROCEDURE

1. Remove the snap ring from the exhaust valve guide.
2. Using a press, remove the valve guide toward the cylinder head gasket surface.

#### **CAUTION**

**Do not install a valve guide of the same size again.**

3. Re-bore the valve guide hole of the cylinder head so that it fits the press-fitted oversize valve guide.

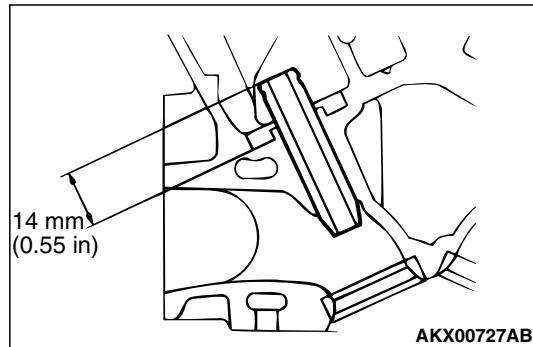
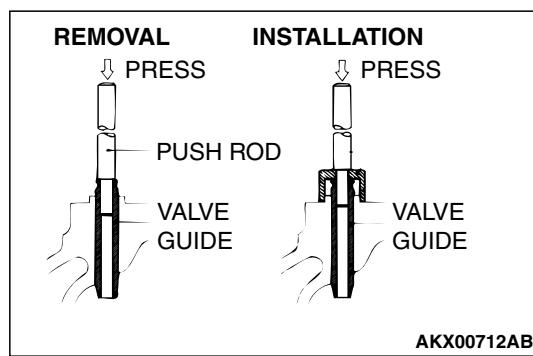
**Valve guide hole diameter:**

**0.05 oversize 11.05 – 11.07 mm (0.4350 – 0.4358 inch)**  
**0.25 oversize 11.25 – 11.27 mm (0.4429 – 0.4437 inch)**  
**0.50 oversize 11.50 – 11.52 mm (0.4528 – 0.4535 inch)**

4. Install the new snap ring into the groove of exhaust valve guide.
5. Press-fit the valve guide until it protrudes 14 mm (0.55 inch) from the cylinder head top surface as shown in the illustration.

*NOTE: When press-fitting the valve guide, work from the cylinder head top surface.*

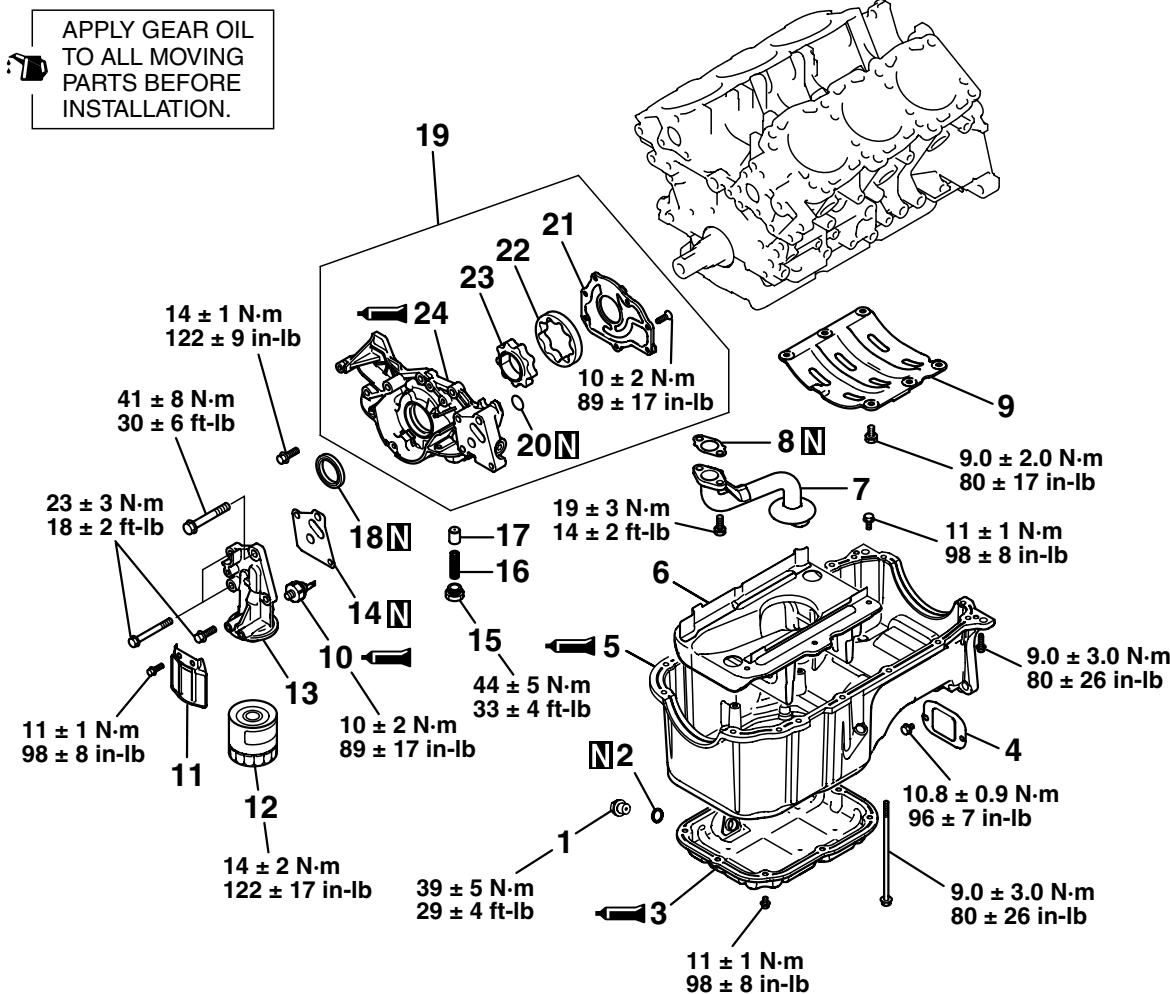
*NOTE: After installing the valve guides, insert new valves in them to check for sliding condition.*



## **OIL PAN AND OIL PUMP**

## REMOVAL AND INSTALLATION

M1113008100840



AK403331 AB

## REMOVAL STEPS

- 1. DRAIN PLUG
- >>H<< 2. DRAIN PLUG GASKET
- <<A>> >>G<< 3. OIL PAN, LOWER
- 4. COVER
- <<B>> >>F<< 5. OIL PAN, UPPER
- 6. BAFFLE PLATE
- 7. OIL SCREEN
- 8. OIL SCREEN GASKET
- 9. BAFFLE PLATE
- <<C>> >>E<< 10. ENGINE OIL PRESSURE SWITCH
- 11. OIL FILTER COVER
- >>D<< 12. OIL FILTER

## **REMOVAL STEPS (Continued)**

- 13. OIL FILTER BRACKET
- 14. OIL FILTER BRACKET GASKET
- 15. RELIEF PLUG
- 16. RELIEF SPRING
- 17. RELIEF PLUNGER
- >>**C**<< 18. CRANKSHAFT FRONT OIL SEAL
- >>**B**<< 19. OIL PUMP CASE ASSEMBLY
- 20. O-RING
- 21. OIL PUMP COVER
- <<**D**>> >>**A**<< 22. OIL PUMP OUTER ROTOR
- <<**D**>> >>**A**<< 23. OIL PUMP INNER ROTOR
- 24. OIL PUMP CASE

### Required Special Tools:

- MD998012: Oil Pressure Switch Socket Wrench
- MD998717: Crankshaft Front Oil Seal Installer

## REMOVAL SERVICE POINT

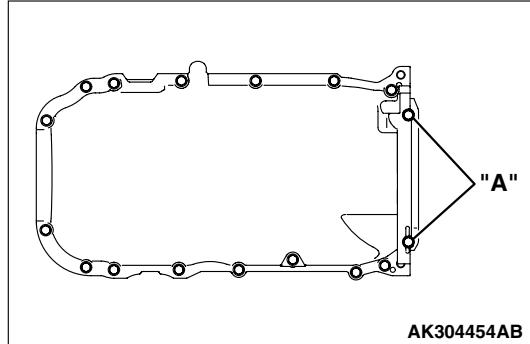
## &lt;&lt;A&gt;&gt; OIL PAN, LOWER REMOVAL

1. Remove the lower oil pan mounting bolts.

**CAUTION**

**Do not use a scraper or special tool to remove the oil pan.**

2. Remove the lower oil pan by tapping on its side with a plastic hammer (mallet) through a wooden plank held against it.



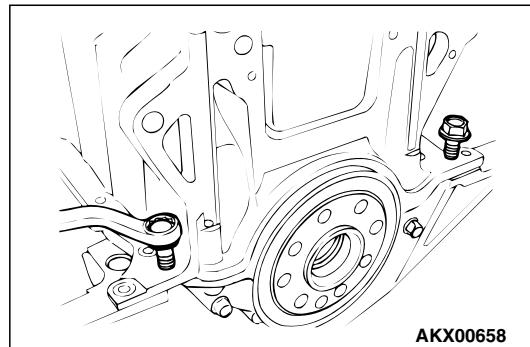
## &lt;&lt;B&gt;&gt; OIL PAN, UPPER REMOVAL

1. Remove the long bolts "A" shown in the illustration first.
2. Remove all other bolts.

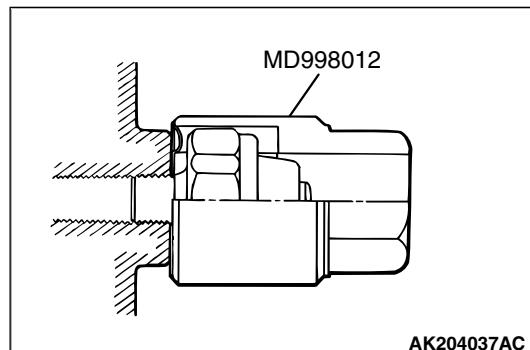
**CAUTION**

**Do not use a scraper or special tool to remove the oil pan.**

3. Remove the oil pan.

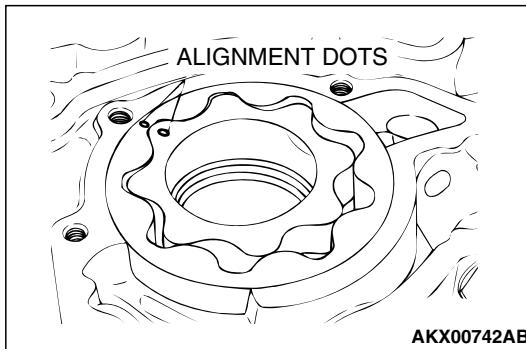


4. Screw M10 bolts into the two bolt holes in the oil pan to break the joint and remove the oil pan.



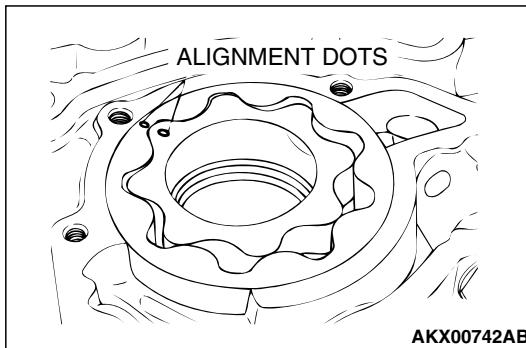
## &lt;&lt;C&gt;&gt; ENGINE OIL PRESSURE SWITCH REMOVAL

Using special tool MD998012, remove the engine oil pressure switch.



## &lt;&lt;D&gt;&gt; OUTER ROTOR / INNER ROTOR REMOVAL

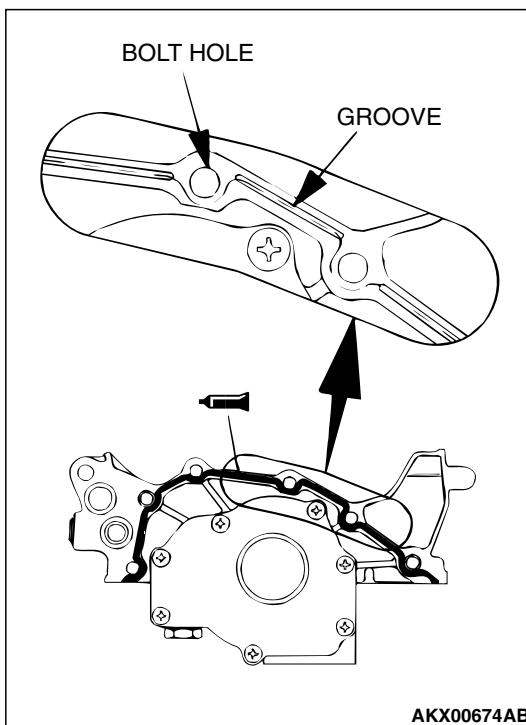
Make alignment dots on the outer and inner rotors for ease of reassembly.



## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; INNER ROTOR / OUTER ROTOR INSTALLATION

Apply engine oil to the rotors. Then install the rotors, ensuring that the alignment dots made at disassembly are properly aligned.

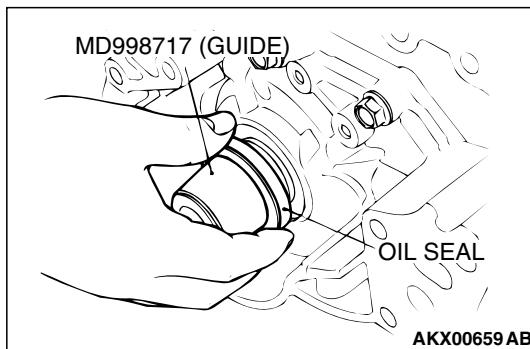


## &gt;&gt;B&lt;&lt; OIL PUMP CASE ASSEMBLY INSTALLATION

1. Clean the gasket mating surfaces of oil pump case and cylinder block.
2. Apply a 3 mm (0.1 inch) diameter bead of sealant (Mitsubishi Genuine Part number MD970389 or equivalent) to the oil pump case. Apply sealant as indicated by the broken line in the illustration; the grooves must be traced and the bolt holes must be surrounded with a bead of sealant.
3. Install the oil pump case assembly to the front of the cylinder block.  
*NOTE: Be sure to install the oil pump case quickly while the sealant is wet (within 15 minutes).*
4. Tighten the oil pump case mounting bolts to the specified torque.

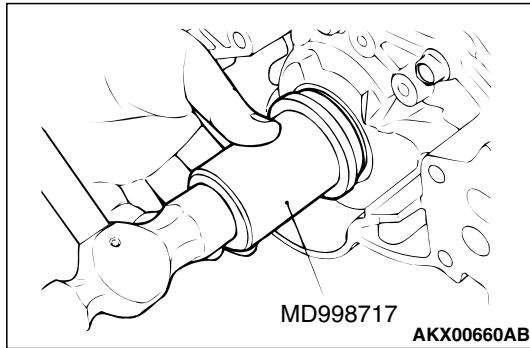
**Tightening torque:  $14 \pm 1 \text{ N}\cdot\text{m} (122 \pm 9 \text{ in-lb})$**

*NOTE: After installation, keep the sealed area away from oil and coolant for approximately one hour.*



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

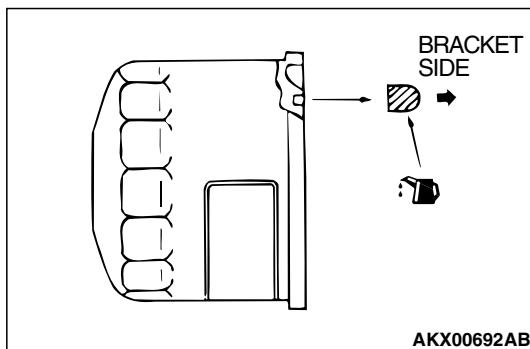
1. Install the guide of special tool MD998717 to the front end of the crankshaft.
2. Apply engine oil to the lip area of a new oil seal and push it in until it contacts the oil pump case.
3. Using special tool MD998717, press-fit the oil seal into the oil pump case.



## &gt;&gt;D&lt;&lt; OIL FILTER INSTALLATION

1. Clean the installation surface of the filter bracket.
2. Apply engine oil to the O-ring of the oil filter.
3. Install the oil filter to the bracket and tighten it to the specified torque.
 

**Tightening torque:  $14 \pm 2 \text{ N}\cdot\text{m} (122 \pm 17 \text{ in-lb})$**
4. If no torque wrench can be used for tightening, use the following procedure.
  - (1) Screw in the oil filter until its O-ring contacts the oil filter bracket.
  - (2) Tighten the oil filter 1 turn.

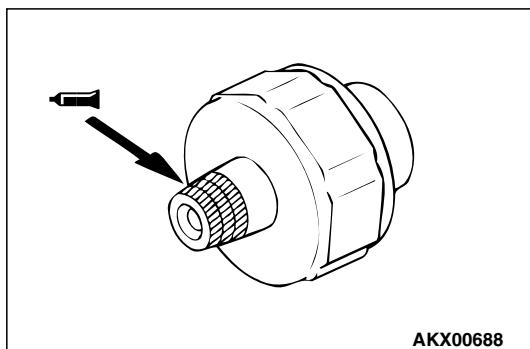


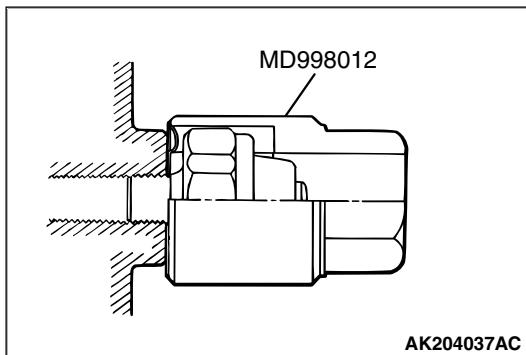
## &gt;&gt;E&lt;&lt; ENGINE OIL PRESSURE SWITCH INSTALLATION

**CAUTION**

**Be careful not to block the oil passage with sealant.**

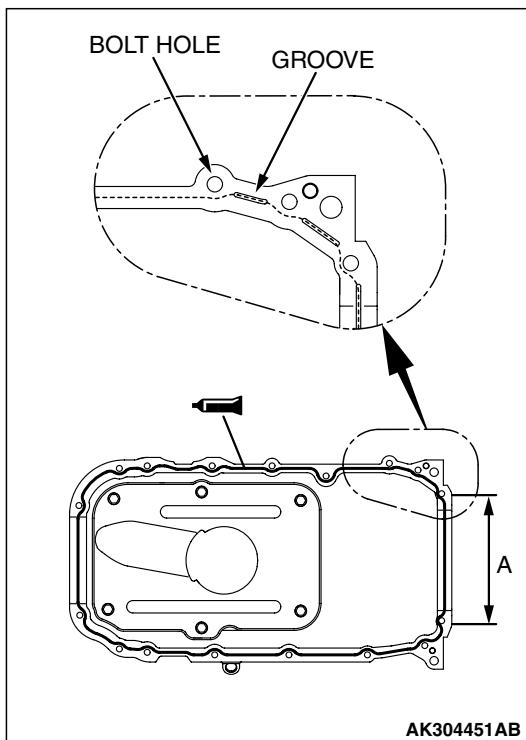
1. Apply sealant (3M™ AAD Part number 8672 or equivalent) to the thread of engine oil pressure switch.





2. Tighten the engine oil pressure switch together with the oil filter bracket to the specified torque, using special tool MD998012.

**Tightening torque:  $10 \pm 2 \text{ N}\cdot\text{m} (87 \pm 17 \text{ in-lb})$**



#### >>F<< OIL PAN, UPPER INSTALLATION

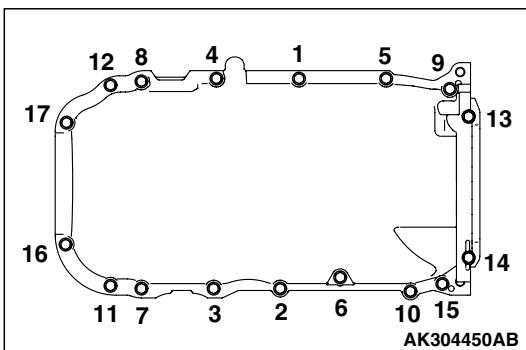
1. Clean both gasket surfaces of the upper oil pan and cylinder block.
2. Apply a 4 mm (0.2 inch) diameter bead of sealant (Mitsubishi Genuine Parts number MD970389 or equivalent) to the upper oil pan. Apply sealant as indicated by the broken line in the illustration; the grooves must be traced and the bolt holes must be surrounded with a bead of sealant.

#### **CAUTION**

**When installing the upper oil pan, be sure not to expel the sealant from the oil pan flange at portion A in the illustration.**

3. Install the oil pan to the bottom of the cylinder block.

*NOTE: Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).*



4. Tighten the upper oil pan bolts in the sequence shown.

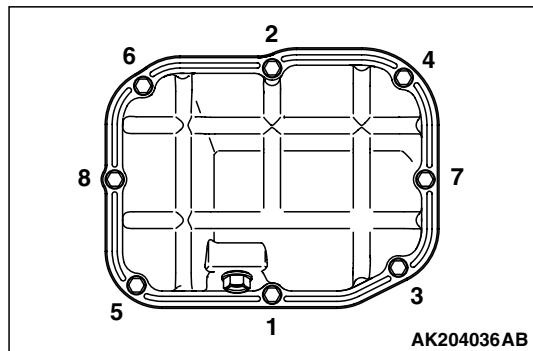
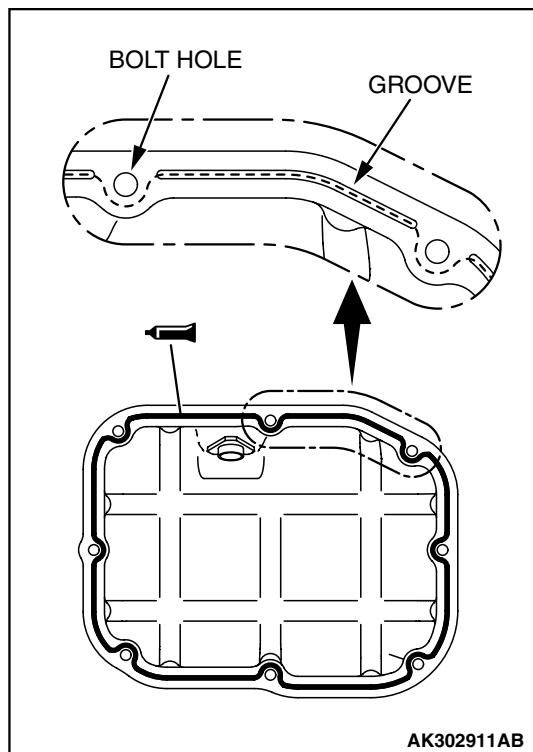
**Tightening torque:  $9.0 \pm 3.0 \text{ N}\cdot\text{m} (80 \pm 26 \text{ in-lb})$**

*NOTE: After installation, keep the sealed area away from the oil and coolant for approximately one hour.*

## &gt;&gt;G&lt;&lt; OIL PAN, LOWER INSTALLATION

1. Clean both gasket surfaces of the upper and lower oil pans.
2. Apply a 4 mm (0.2 inch) diameter bead of sealant (Mitsubishi Genuine Parts number MD970389 or equivalent) to the lower oil pan. Apply sealant as indicated by the broken line in the illustration; the grooves must be traced and the bolt holes must be surrounded with a bead of sealant.
3. Install the lower oil pan to the upper oil pan.

*NOTE: Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).*



4. Tighten the lower oil pan bolts in the sequence shown.

**Tightening torque:  $11 \pm 1 \text{ N}\cdot\text{m} (98 \pm 8 \text{ in-lb})$**

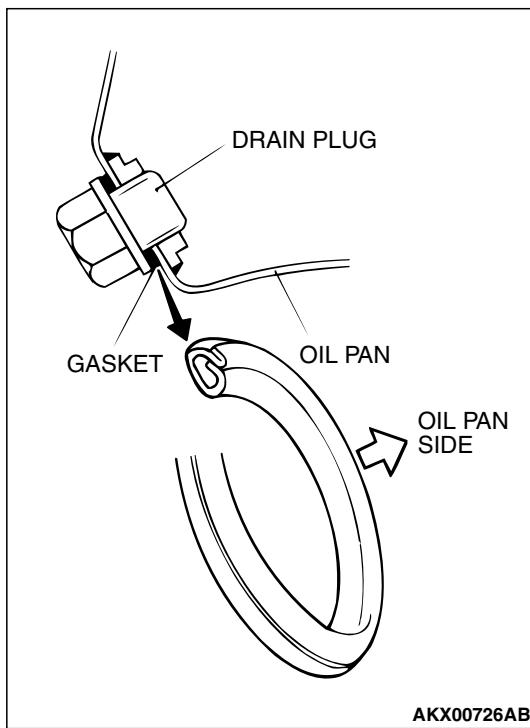
*NOTE: After installation, keep the sealed area away from oil for approximately one hour.*

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

**CAUTION**

If the gasket is installed in the wrong direction, oil leaks will occur.

Install the drain plug gasket in the direction shown.

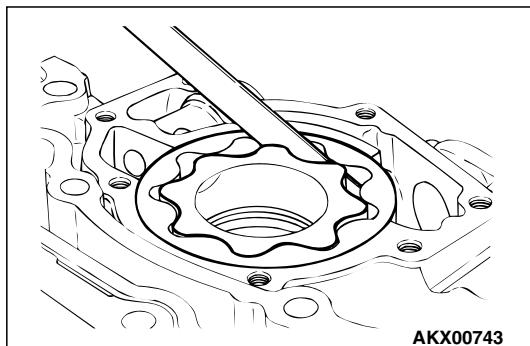
**INSPECTION**

M1113008200171

**OIL PUMP**

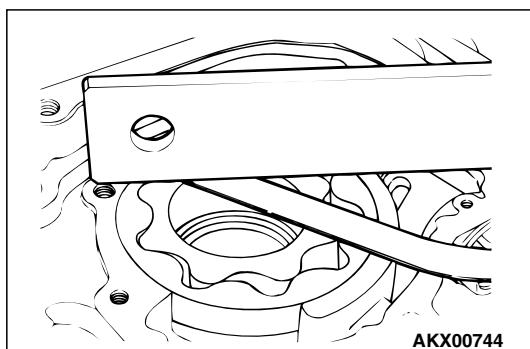
1. Check the tip clearance.

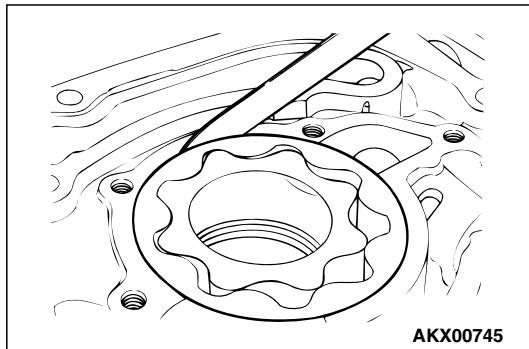
**Standard value: 0.06 – 0.18 mm (0.003 – 0.007 inch)**



2. Check the side clearance.

**Standard value: 0.04 – 0.10 mm (0.002 – 0.003 inch)**





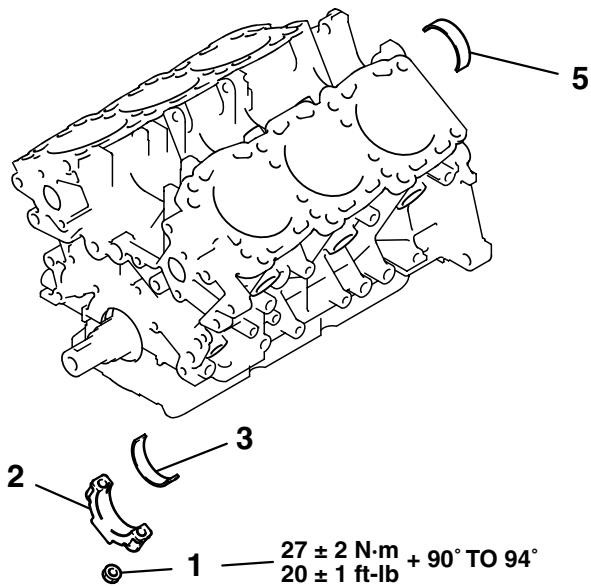
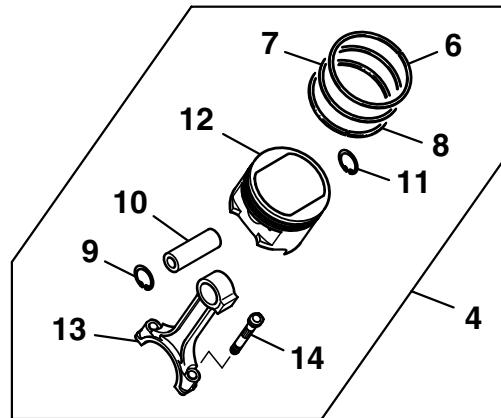
3. Check the body clearance.

**Standard value: 0.10 – 0.18 mm (0.004 – 0.007 inch)**  
**Limit: 0.35 mm (0.013 inch)**

## PISTON AND CONNECTING ROD REMOVAL AND INSTALLATION

M1113008401178

APPLY ENGINE OIL  
 TO ALL MOVING  
 PARTS BEFORE  
 INSTALLATION.



AK201085AC

### REMOVAL STEPS

>>G<< 1. CONNECTING ROD CAP NUT  
 <<A>> >>F<< 2. CONNECTING ROD CAP  
 >>D<< 3. CONNECTING ROD BEARING,  
 LOWER

### REMOVAL STEPS (Continued)

>>E<< 4. PISTON AND CONNECTING ROD  
 ASSEMBLY  
 >>D<< 5. CONNECTING ROD BEARING,  
 UPPER

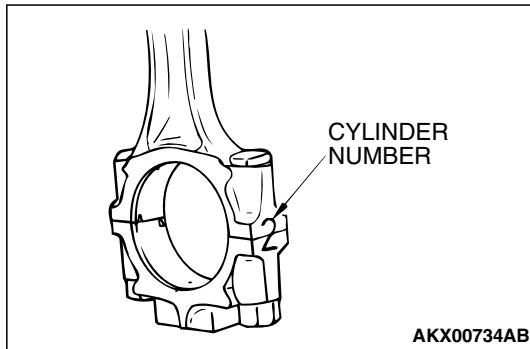
**REMOVAL STEPS (Continued)**

- >>C<< 6. PISTON RING NO.1
- >>C<< 7. PISTON RING NO.2
- >>B<< 8. OIL RING
- 9. SNAP RING
- <<B>> >>A<< 10. PISTON PIN
- 11. SNAP RING
- 12. PISTON
- 13. CONNECTING ROD
- 14. BOLT

**REMOVAL SERVICE POINTS**

**<<A>> CONNECTING ROD CAP REMOVAL**

1. Mark the cylinder number on the side of the connecting rod big end for correct reassembly.
2. Keep the removed connecting rods, caps, and bearings in order according to the cylinder number.



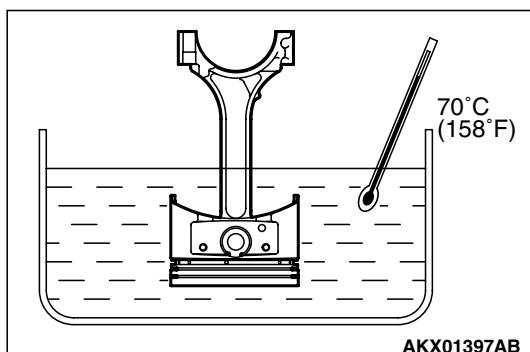
**<<B>> PISTON PIN REMOVAL**

1. Remove the snap rings.

**CAUTION**

The clearance between the piston and the piston pin is a tight fit at room temperature. Therefore, be sure to heat the piston before pulling out the piston pin. Use care since the piston is hot after heating.

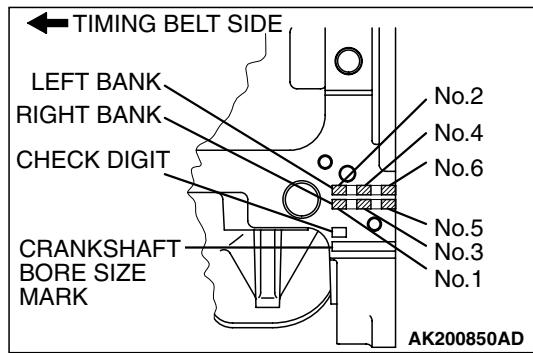
2. Heat the piston to approximately 70°C (158°F) and pull out the piston pin.



## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; PISTON PIN INSTALLATION

- When replacing the piston, note the cylinder bore size mark on the cylinder block as illustrated, and select a piston according to the following table.



CYLINDER BORE SIZE MARK	PISTON SIZE MARK
I	A
II	None
III	C

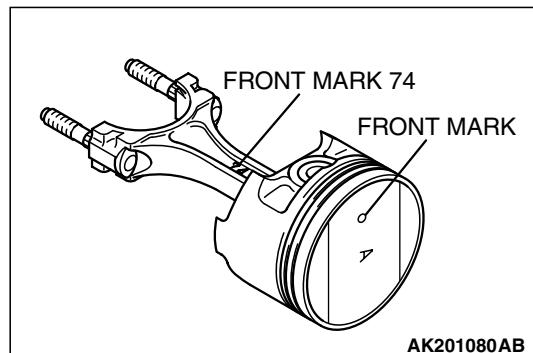
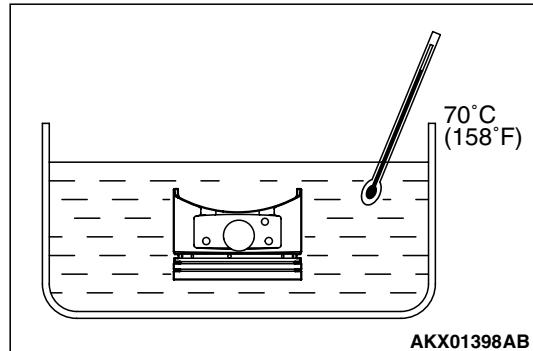
NOTE: The piston size mark shows on the top of the piston.

- Set the snap ring into one side of the piston pin hole.

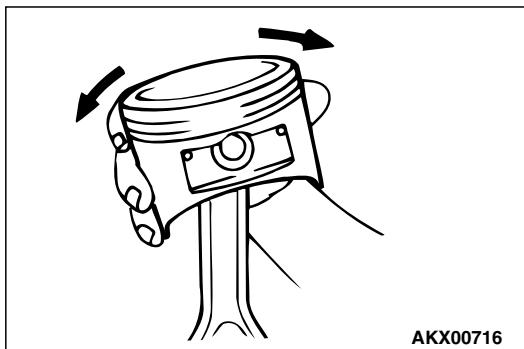
**CAUTION**

Apply an ample coat of engine oil to the periphery of the piston pin and the hole of the connecting rod small end. The clearance between the piston and the piston pin is a tight fit at room temperature. Therefore, be sure to heat the piston before inserting the piston pin. Use care since the piston is hot after heating.

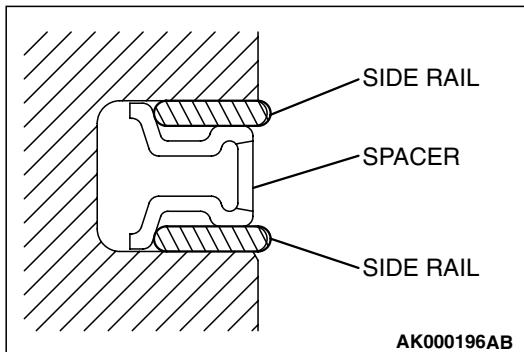
- Heat the piston to approximately 70°C (158°F).



- With the front mark of the connecting rod and that of the piston located on the same side, insert the piston pin.
- Set the snap ring into the other side of the piston pin hole.



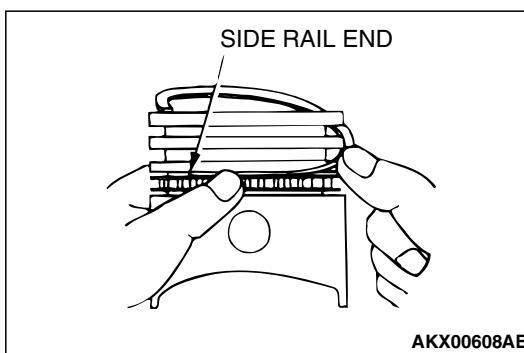
6. Check that the piston moves smoothly.



#### >>B<< OIL RING INSTALLATION

1. Fit the oil ring spacer into the piston ring groove.

*NOTE: The side rails and spacer may be installed in either direction.*



#### CAUTION

**Do not use any piston ring expander when installing the side rail. It will break the side rail.**

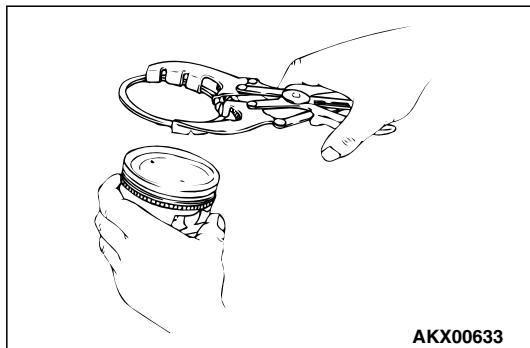
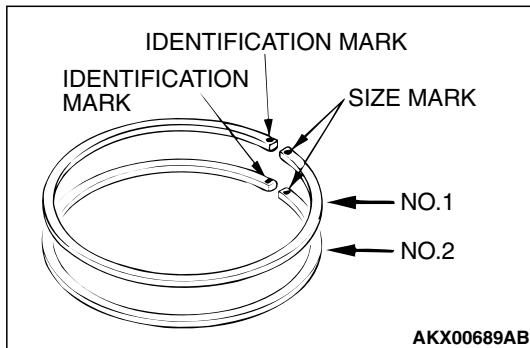
2. Install the upper side rail by hand.

To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into the position. See illustration.

3. Install the lower side rail in the same procedure as described in step 2.
4. Make sure that the side rails move smoothly in both directions.

>>C<< PISTON RING NO.2 / PISTON RING NO.1  
INSTALLATION

1. To prevent wrong installation, check the identification mark of each piston ring. The identification mark is stamped near the ring gap.

**Identification mark****Number 1 ring: 1T****Number 2 ring: 2T***NOTE: Size marks on piston rings are as follows.***SIZE****SIZE MARK**

Standard	None
0.25 mm (0.010 in) oversize diameter	25
0.50 mm (0.020 in) oversize diameter	50

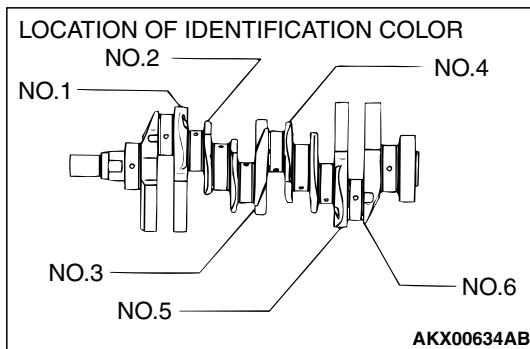
2. Using a piston ring expander, fit the number 2 piston ring into the number 2 groove of piston.

*NOTE: Install the piston rings with their identification mark facing up, to the piston crown side.*

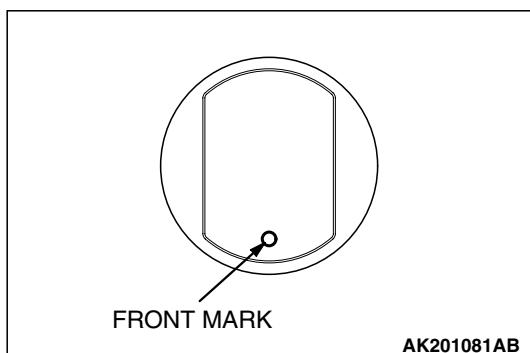
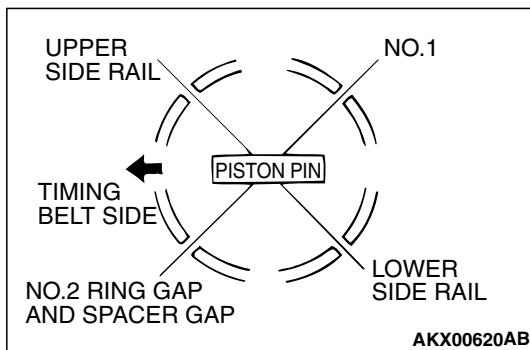
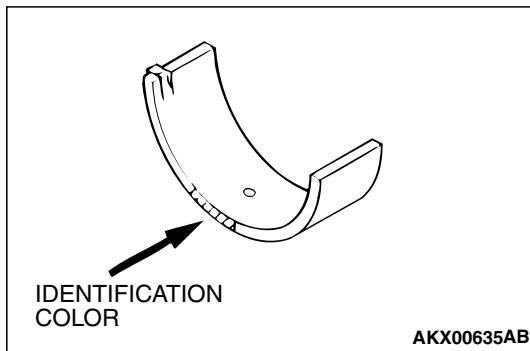
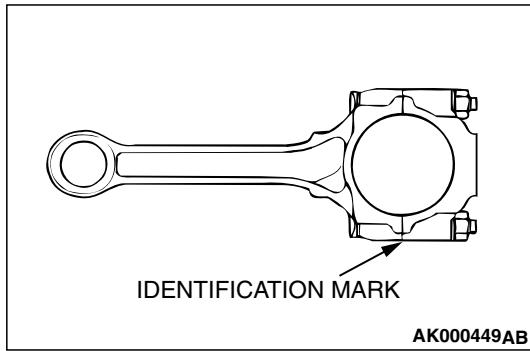
3. Install the number 1 piston ring in the same manner as step 2.

## &gt;&gt;D&lt;&lt; CONNECTING ROD BEARING INSTALLATION

1. Measure the crankshaft pin diameter and confirm its classification from the following table. In the case of a crankshaft supplied as a service part, identification color of its pins are painted at the positions shown in the illustration.



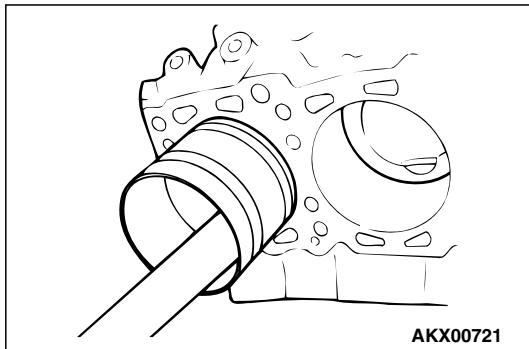
CRANKSHAFT PIN OUTSIDE DIAMETER		CONNECTING ROD	BEARING
IDENTIFICATION COLOR	SIZE mm (in)	IDENTIFICATION MARK	IDENTIFICATION COLOR
Yellow	54.994 – 55.000 (2.1651 – 2.1654)	0	Pink
		1	Red
		2	Green
None	54.988 – 54.994 (2.1649 – 2.1651)	0	Red
		1	Green
		2	Black
White	54.982 – 54.988 (2.1646 – 2.1649)	0	Green
		1	Black
		2	Brown



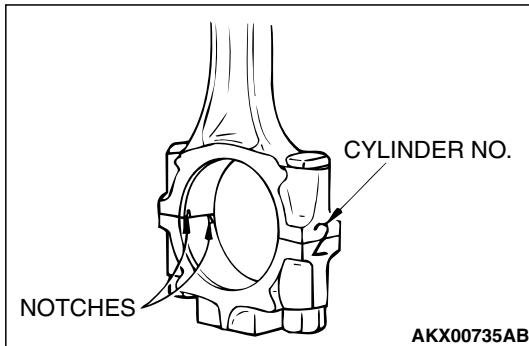
- From the above table, select a bearing whose size is appropriate for the crankshaft pin outside the diameter. For example, if the crankshaft pin outside diameter Identification color is "yellow" and the connecting rod Identification mark is "2," select a bearing whose Identification color is "green." If there is no identification color paint on the crankshaft, measure the pin outside diameter and select bearing appropriate for the measured value.
- Install the selected bearing in the big end and in the cap of the connecting rod.

#### >>E<< PISTON AND CONNECTING ROD INSTALLATION

- Liberally coat the circumference of the piston, piston ring, and oil ring with engine oil.
- Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the illustration.
- Rotate the crankshaft so that the crank pin is on the center of the cylinder bore.
- Insert the piston and connecting rod assembly into the cylinder with the front mark on the piston crown pointing to the timing belt side.

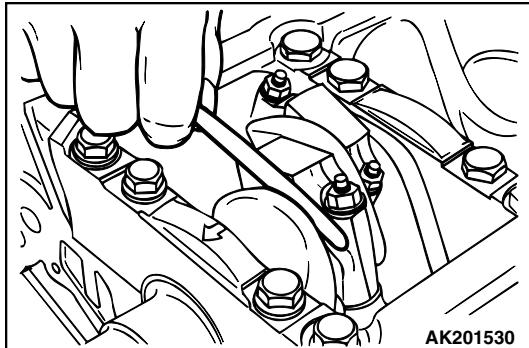


- Using a suitable piston ring compressor tool, install the piston and connecting rod assembly into the cylinder block.



#### >>F<< CONNECTING ROD CAP INSTALLATION

- Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches are on the same side as shown.



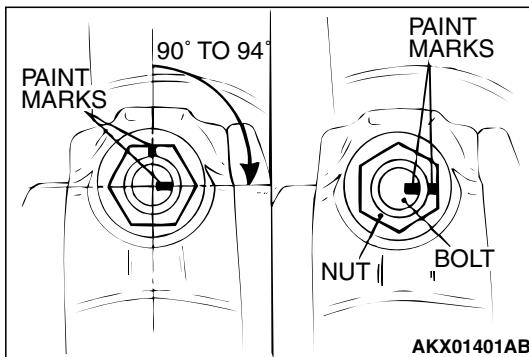
- Make sure that the connecting rod big end side clearance meets the specification.

**Standard value: 0.10 – 0.25 mm (0.004 – 0.009 inch)**

**Limit: 0.4 mm (0.02 inch)**

#### >>G<< CONNECTING ROD CAP NUT INSTALLATION

- The connecting rod bolts should be examined before reuse. If the bolt threads are damaged, the bolt should be replaced. Hand-thread the nut to the full length of the bolt threads. If the nut does not run down smoothly, the bolt should be replaced.
- Before installation of each nut, apply engine oil to the threaded portion and bearing surface of the nut.
- Loosely tighten each nut to the bolt.
- Then tighten the nuts alternately to a torque of  $27 \pm 2$  N·m ( $20 \pm 1$  ft-lb) to install the cap properly.



5. Make a paint mark on the head of each nut.

**CAUTION**

- If the nut is turned less than 90 degrees, proper fastening performance may not be achieved. Be careful to tighten the nut exactly 90 degrees.
- If the nut is overtightened (exceeding 94 degrees), loosen the nut completely and then retighten it by repeating the tightening procedure from step 3.

6. Make a paint mark on the bolt end at a position 90 to 94 degrees from the paint mark made on the nut in the direction of tightening the nut.
7. Turn the nut another 90 to 94 degrees and make sure that the paint marks on the nut and bolt are aligned.

## INSPECTION

M1113008500901

### PISTON

Replace the piston if scratches or seizure is evident on its surfaces (especially the thrust surface). Replace the piston if it is cracked.

### PISTON PIN

1. Insert the piston pin into the piston pin hole with a thumb. You should feel a slight resistance. Replace the piston pin if it can be easily inserted or there is excessive play.
2. The piston and piston pin must be replaced as an assembly.

### PISTON RING

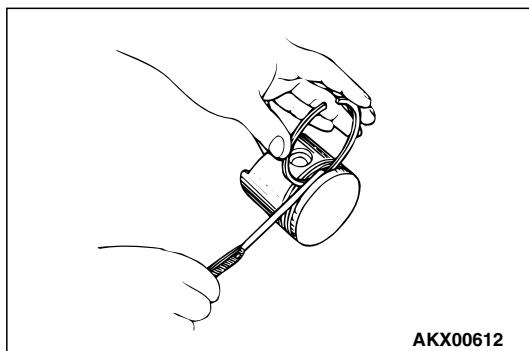
1. Check the piston ring for damage, excessive wear, and breakage. Replace if defects are evident. If the piston has been replaced with a new one, the piston rings must also be replaced with new ones.
2. Check for clearance between the piston ring and ring groove. If the limit is exceeded, replace the ring or piston, or both.

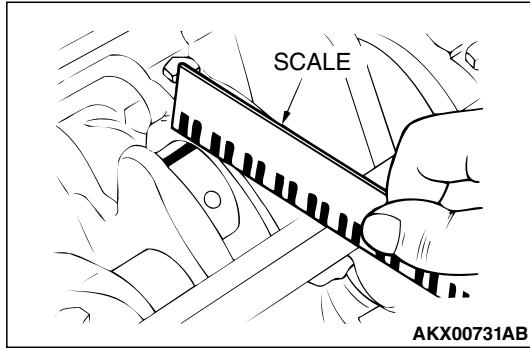
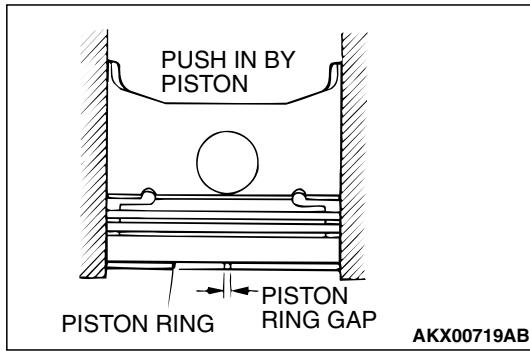
#### Standard value:

Number 1: 0.03 – 0.07 mm (0.0012 – 0.0027 inch)

Number 2: 0.02 – 0.06 mm (0.0008 – 0.0023 inch)

Limit: 0.1 mm (0.003 inch)





3. Insert the piston ring into the cylinder bore. Force the ring down with a piston, the piston crown being in contact with the ring, to correctly position it at right angles to the cylinder wall. Then, measure the end gap with a feeler gauge. If the ring gap is excessive, replace the piston ring.

**Standard value:**

Number 1: 0.25 – 0.40 mm (0.010 – 0.016 inch)

Number 2: 0.35 – 0.50 mm (0.014 – 0.020 inch)

Oil: 0.10 – 0.35 mm (0.004 – 0.014 inch)

**Limit:**

Number 1, Number 2: 0.8 mm (0.03 inch)

Oil: 1.0 mm (0.03 inch)

**CRANKSHAFT PIN OIL CLEARANCE <PLASTIGAGE METHOD>**

The crankshaft oil clearance can be measured easily by using plastigage, as follows:

1. Remove oil from the crankshaft pin and the bearing inner surface.
2. Cut plastigage to the same length as the width of the bearing and place it on the pin in parallel with its axis.
3. Install the connecting rod cap carefully and tighten the nuts to the specified torque.
4. Carefully remove the connecting rod cap.
5. Measure the width of the smashed plastigage at its widest section by using a scale printed on the plastigage bag.

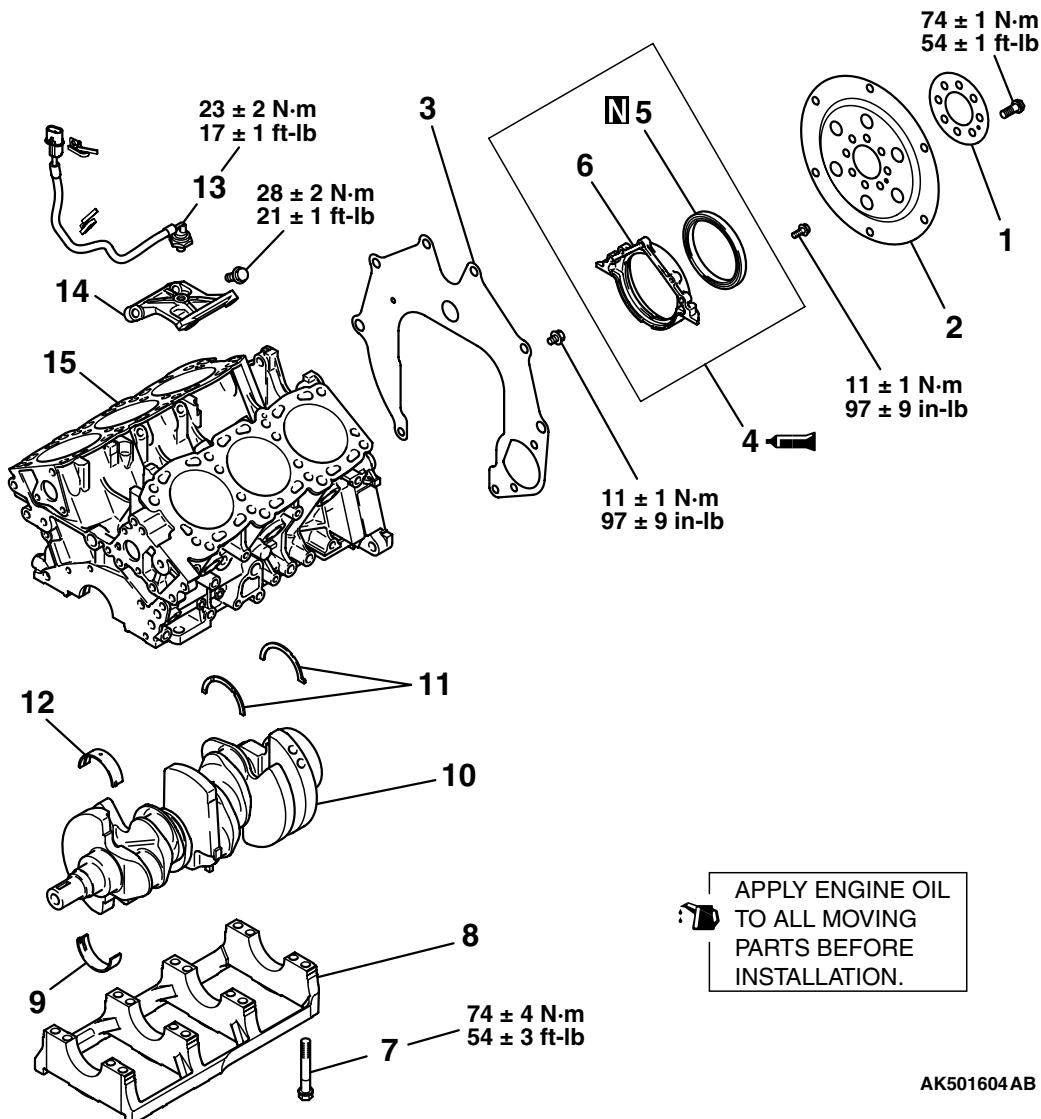
**Standard value:** 0.020 – 0.038 mm (0.0008 – 0.0015 inch)

**Limit:** 0.1 mm (0.003 inch)

# CRANKSHAFT AND CYLINDER BLOCK

## REMOVAL AND INSTALLATION

M1113008701812



AK501604AB

### REMOVAL STEPS

1. ADAPTER PLATE
2. DRIVE PLATE
3. REAR PLATE
- >>F<< 4. OIL SEAL CASE ASSEMBLY
- >>E<< 5. CRANKSHAFT REAR OIL SEAL
6. OIL SEAL CASE
- >>D<< 7. BEARING CAP BOLT
- >>D<< 8. BEARING CAP

### REMOVAL STEPS (Continued)

- >>B<< 9. CRANKSHAFT BEARING, LOWER
10. CRANKSHAFT
- >>C<< 11. THRUST BEARING
- >>B<< 12. CRANKSHAFT BEARING, UPPER
13. KNOCK SENSOR
- >>A<< 14. KNOCK SENSOR BRACKET
15. CYLINDER BLOCK

### Required Special Tool:

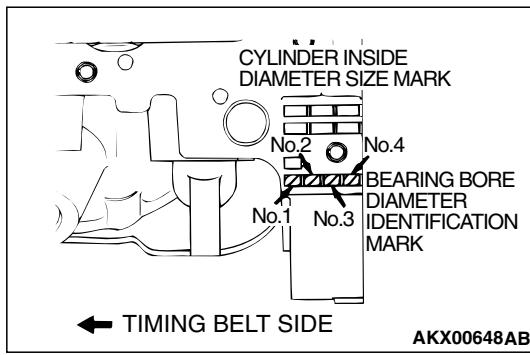
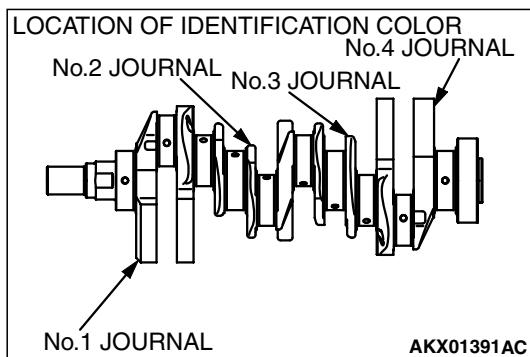
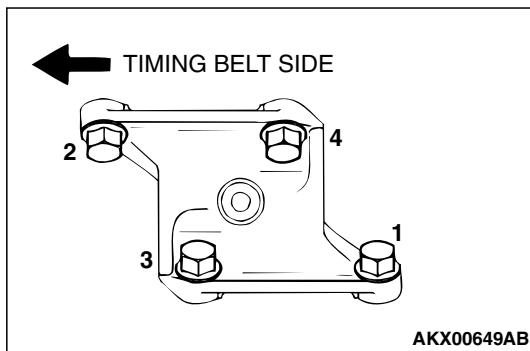
- MD998718: Crankshaft Rear Oil Seal Installer

## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; KNOCK SENSOR BRACKET INSTALLATION

Check that the bracket is in proper contact with the cylinder block boss and tighten to the specified torque in the order shown.

**Tightening torque:  $28 \pm 2 \text{ N}\cdot\text{m} (21 \pm 1 \text{ ft-lb})$**

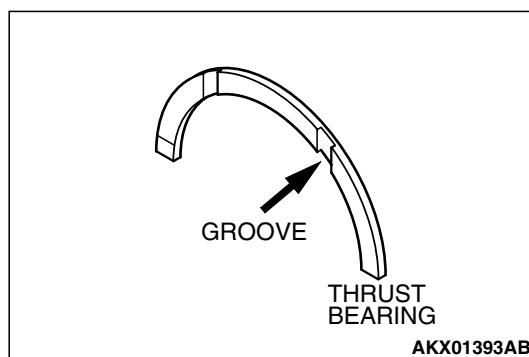
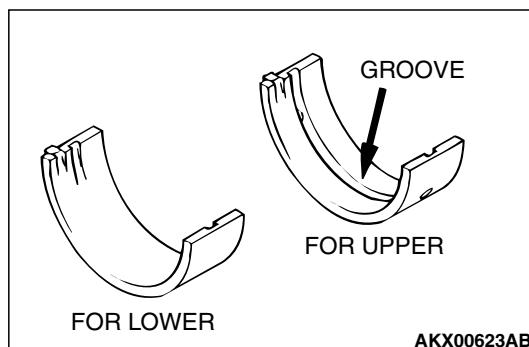
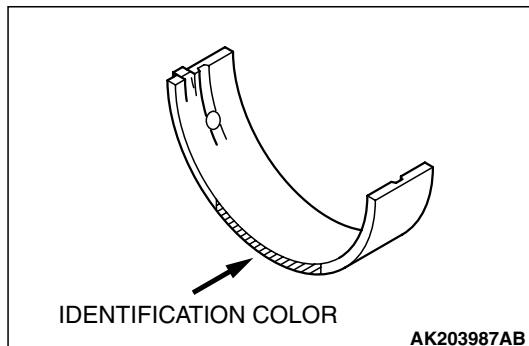


## &gt;&gt;B&lt;&lt; CRANKSHAFT BEARING INSTALLATION

1. Measure the crankshaft journal diameter and confirm its classification from the following table. In the case of a crankshaft supplied as a service part, identification color of its journals are painted at the positions shown in the illustration.
2. The cylinder block bearing bore diameter identification marks are stamped at the position shown in the illustration from left to right, beginning at No.1.

CRANKSHAFT JOURNAL OUTSIDE DIAMETER		CYLINDER BLOCK BEARING BORE	CRANKSHAFT BEARING No.1, 4	CRANKSHAFT BEARING No.2, 3
IDENTIFICATION COLOR	SIZE mm (in)	IDENTIFICATION MARK	IDENTIFICATION COLOR	IDENTIFICATION COLOR
Yellow	63.994 – 64.000 (2.5194 – 2.5197)	I	Pink	Blue
		II	Red	Pink
		III	Green	Red
None	63.988 – 63.994 (2.5192 – 2.5194)	I	Red	Pink
		II	Green	Red
		III	Black	Green

CRANKSHAFT JOURNAL OUTSIDE DIAMETER		CYLINDER BLOCK BEARING BORE	CRANKSHAFT BEARING No.1, 4	CRANKSHAFT BEARING No.2, 3
IDENTIFICATION COLOR	SIZE mm (in)	IDENTIFICATION MARK	IDENTIFICATION COLOR	IDENTIFICATION COLOR
White	63.982 – 63.988 (2.5190 – 2.5192)	I	Green	Red
		II	Black	Green
		III	Brown	Black



3. From the above table, select a bearing whose size is appropriate for the crankshaft journal outside diameter. If the crankshaft journal outside diameter ID color is "yellow" and the cylinder block bearing bore ID mark is "III," for example, select a bearing whose ID color is "green" <No.1, 4> or "red" <No.2, 3>.

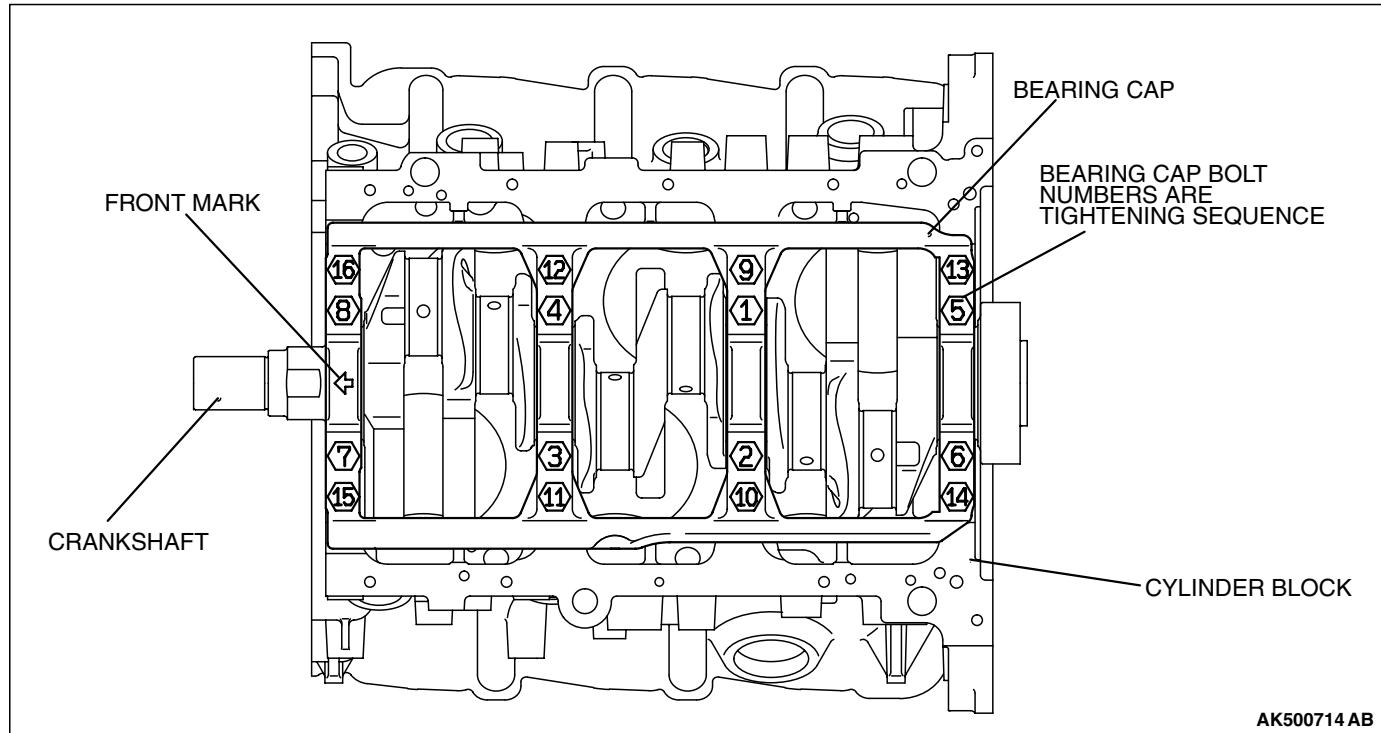
If there is no ID color paint on the crankshaft, measure the journal outside diameter and select a bearing appropriate for the measured value.

4. Install bearings with the groove toward the cylinder block.
5. Install the bearings having no groove to the bearing cap.

#### >>C<< THRUST BEARING INSTALLATION

1. Install the thrust bearing in the No.3 bearing bore in the cylinder block and in the bearing cap. For easier installation, apply engine oil to the bearings; this will help hold them in position.
2. The thrust bearings must be installed with their groove toward the crankshaft weight side.

## &gt;&gt;D&lt;&lt; BEARING CAP / BEARING BOLT INSTALLATION



AK500714AB

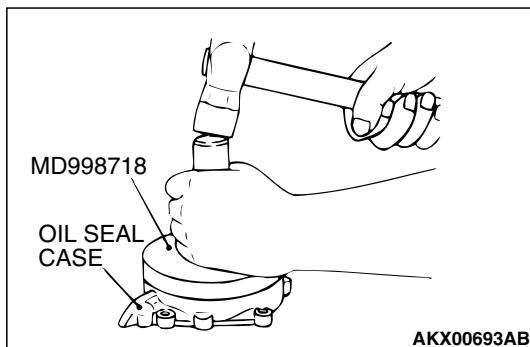
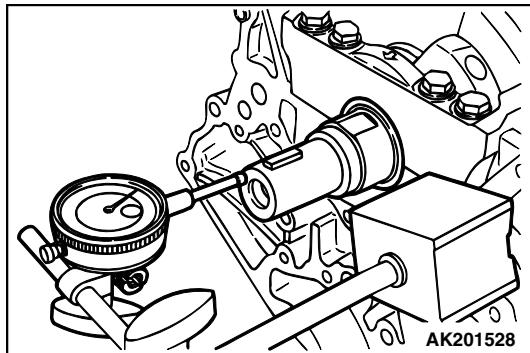
1. Attach the bearing cap on the cylinder block as shown in the illustration.
2. Tighten the bearing cap bolts to specified torque in the sequence shown in the illustration.

**Tightening torque:  $74 \pm 4 \text{ N}\cdot\text{m} (54 \pm 3 \text{ ft-lb})$**

3. Check that the crankshaft rotates smoothly.
4. Check the end play. If it exceeds the limit value, replace the thrust bearing.

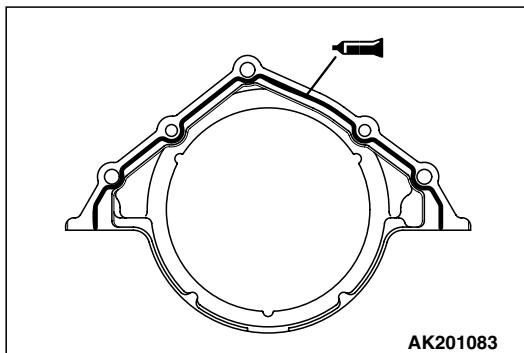
**Standard value: 0.05 – 0.25 mm (0.002 – 0.009 inch)**

**Limit: 0.3 mm (0.01 inch)**



## &gt;&gt;E&lt;&lt; CRANKSHAFT REAR OIL SEAL INSTALLATION

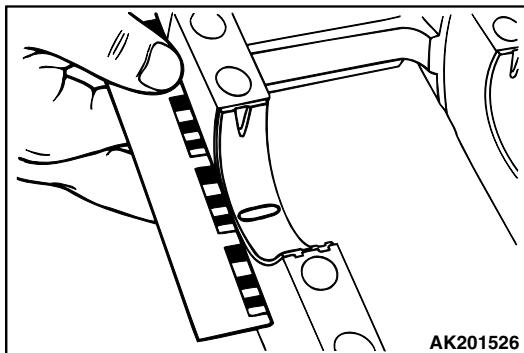
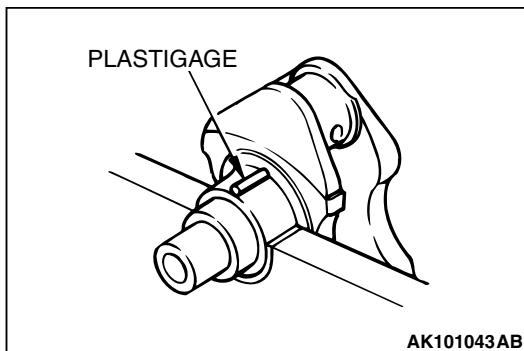
Using special tool MD998718, press-fit a new crankshaft rear oil seal into the oil seal case.



#### >>F<< OIL SEAL CASE INSTALLATION

1. Apply the sealant (Mitsubishi Genuine Part number MD970389 or equivalent) to the oil seal case.
2. Apply a small amount of engine oil to the entire circumference of the oil seal lip section, and place the oil seal case on the cylinder block.

*NOTE: Install the oil seal case within 15 minutes after applying liquid gasket. Then wait at least one hour. Do not start the engine or let engine oil or coolant touch the sealant during that time.*



4. Install the crankshaft bearing cap carefully and tighten the bolts to the specified torque.

**Tightening torque:  $74 \pm 4 \text{ N}\cdot\text{m} (54 \pm 3 \text{ ft-lb})$**

5. Carefully remove the crankshaft bearing cap.
6. Measure the width of the smashed plastigage at its widest section by using a scale printed on the plastigage bag.

**Standard value:**

**0.02 – 0.03 mm (0.0008 – 0.0012 inch) <No.1, 4>  
0.03 – 0.04 mm (0.0012 – 0.0016 inch) <No.2, 3>**

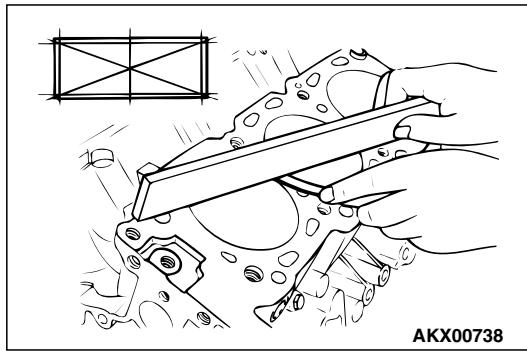
**Limit: 0.1 mm (0.003 inch)**

#### CRANKSHAFT REAR OIL SEAL

1. Check the oil seal lip for wear and damage.
2. Check the rubber for deterioration or hardening.
3. Check the oil seal case for cracks and damage.

#### CYLINDER BLOCK

1. Visually check for scratches, rust, and corrosion. Use a flaw detecting agent for the check. If defects are evident, correct or replace.



- Using a straightedge and feeler gauge, check the block top surface for warpage. Make sure that the surface is free from gasket chips and other foreign matter.

**Standard value: 0.05 mm (0.002 inch)**

**Limit: 0.1 mm (0.003 inch)**

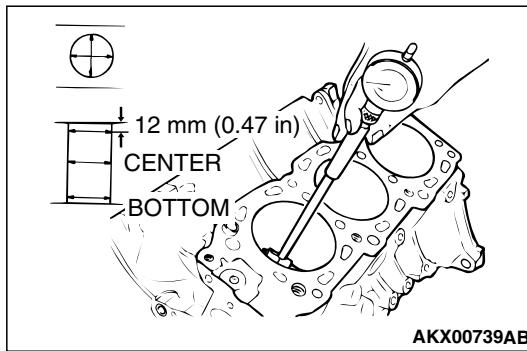
- If the distortion is excessive, correct within the allowable limit or replace.

**Grinding limit: \*0.2 mm (0.008 inch)**

**\*Includes/combined with cylinder head grinding.**

**Cylinder block height (when new):**

**227.9 – 228.1 mm (8.972 – 8.980 inches)**

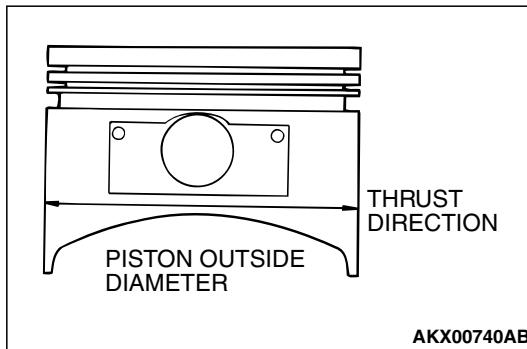


- Check the cylinder walls for scratches and seizure. If defects are evident, correct (bored to an oversize) or replace.
- Using a cylinder gauge, measure the cylinder bore and cylindricality. If worn badly, correct by boring the cylinders to an oversize and replace pistons and piston rings. Measure at the points shown in the illustration.

**Standard value:**

**Cylinder Inside Diameter: 95.0 mm (3.740 inches)**

**Cylindricality: 0.01 mm (0.0003 inch)**



### BORING CYLINDER

- Oversize pistons to be used should be determined on the basis of the largest bore cylinder.

#### Piston size identification

SIZE	IDENTIFICATION MARK
0.25 mm (0.010 in) Oversize diameter	0.25
0.50 mm (0.020 in) Oversize diameter	0.50

*NOTE: Size mark is stamped on the piston top.*

- Measure the outside diameter of the piston to be used. Measure it in the thrust direction as shown.
- Based on the measured piston Outside Diameter (OD), calculate the boring finish dimension.

**Boring finish dimension = Piston OD + (clearance between piston OD and cylinder) – 0.02 mm (0.0008 inch) (honing margin)**

#### CAUTION

**To prevent distortion that may result from temperature rise during honing, bore cylinders in the order of number 2, number 4, number 6, number 1, number 3 and number 5.**

- Bore all cylinders to the calculated boring finish dimension.
- Hone to the final finish dimension (piston OD + clearance between piston OD and cylinder).

**Standard value:**

**Cylinder Inside Diameter: 95.0 mm (3.740 inches)**

**Cylindricality: 0.01 mm (0.0003 inch)**

6. Check the clearance between the piston and cylinder.

**Clearance between piston and cylinder:****0.03 – 0.05 mm (0.0012 – 0.0020 inch)***NOTE: When boring cylinders, finish all six cylinders to the same oversize. Do not bore only one cylinder to an oversize.*

## SPECIFICATION(S)

### FASTENER TIGHTENING SPECIFICATIONS

M1113023401799

ITEMS	SPECIFICATIONS
<b>Generator and drive belt</b>	
Adjusting bolt	5.0 ± 1.0 N·m (44 ± 9 in-lb)
Crankshaft bolt	185 ± 5 N·m (137 ± 3 ft-lb)
Drive belt tensioner nut	49 ± 9 N·m (37 ± 6 ft-lb)
Generator bolt	49 ± 9 N·m (37 ± 6 ft-lb)
Generator bracket bolt	49 ± 9 N·m (37 ± 6 ft-lb)
Idler pulley nut	49 ± 9 N·m (37 ± 6 ft-lb)
Oil dipstick guide bolt	14 ± 1 N·m (122 ± 9 in-lb)
Power steering pump bracket bolt	41 ± 8 N·m (30 ± 6 ft-lb)
Power steering pump bracket stay bolt M8	24 ± 4 N·m (18 ± 3 ft-lb)
Power steering pump bracket stay bolt M10	44 ± 10 N·m (33 ± 7 ft-lb)
Tensioner bracket bolt (Flange bolt)	49 ± 9 N·m (37 ± 6 ft-lb)
Tensioner bracket bolt (Bolt, washer assembly)	41 ± 8 N·m (30 ± 6 ft-lb)
<b>Intake manifold plenum and throttle body assembly</b>	
Boost sensor bolt	5.0 ± 1.0 N·m (44 ± 9 in-lb)
Exhaust gas recirculation pipe bolt	19 ± 3 N·m (14 ± 2 ft-lb)
Exhaust gas recirculation pipe nut	19 ± 3 N·m (14 ± 2 ft-lb)
Exhaust gas recirculation pipe flare nut	59 ± 10 N·m (43 ± 7 ft-lb)
Exhaust gas recirculation valve bolt	24 ± 3 N·m (18 ± 2 ft-lb)
Intake manifold plenum bolt	22 ± 1 N·m (16 ± 1 ft-lb)
Intake manifold plenum stay bolt M8	22 ± 1 N·m (16 ± 1 ft-lb)
Intake manifold plenum stay bolt M10	48 ± 5 N·m (35 ± 4 ft-lb)
Solenoid valve bolt	5.0 ± 1.0 N·m (44 ± 9 in-lb)
Throttle body bolt	28 ± 4 N·m (21 ± 3 ft-lb)
Throttle body stay bolt	22 ± 1 N·m (16 ± 1 ft-lb)
Vacuum pipe and hose bolt	11 ± 1 N·m (98 ± 8 in-lb)
<b>Ignition system</b>	
Ignition coil bolt	10 ± 2 N·m (89 ± 17 in-lb)
Spark plugs	25 ± 5 N·m (18 ± 4 ft-lb)
Camshaft position sensor bolt	11 ± 1 N·m (98 ± 8 in-lb)

ITEMS	SPECIFICATIONS
Camshaft position sensor support bolt	$14 \pm 1 \text{ N}\cdot\text{m}$ ( $122 \pm 9 \text{ in-lb}$ )
Camshaft position sensing cylinder bolt	$22 \pm 4 \text{ N}\cdot\text{m}$ ( $16 \pm 3 \text{ ft-lb}$ )
<b>Timing belt</b>	
Adjusting bolt	$5.0 \pm 1.0 \text{ N}\cdot\text{m}$ ( $44 \pm 9 \text{ in-lb}$ )
Auto-tensioner bolt	$23 \pm 3 \text{ N}\cdot\text{m}$ ( $18 \pm 2 \text{ ft-lb}$ )
Bracket bolt	$24 \pm 3 \text{ N}\cdot\text{m}$ ( $18 \pm 2 \text{ ft-lb}$ )
Camshaft sprocket bolt	$88 \pm 10 \text{ N}\cdot\text{m}$ ( $65 \pm 7 \text{ ft-lb}$ )
Crankshaft position sensor bolt	$8.5 \pm 0.5 \text{ N}\cdot\text{m}$ ( $76 \pm 4 \text{ in-lb}$ )
Engine support bracket bolt	$45 \pm 5 \text{ N}\cdot\text{m}$ ( $34 \pm 4 \text{ ft-lb}$ )
Idler pulley bolt	$44 \pm 5 \text{ N}\cdot\text{m}$ ( $33 \pm 4 \text{ ft-lb}$ )
Tensioner pulley bolt	$48 \pm 6 \text{ N}\cdot\text{m}$ ( $35 \pm 4 \text{ ft-lb}$ )
Tensioner arm bolt	$44 \pm 10 \text{ N}\cdot\text{m}$ ( $33 \pm 7 \text{ ft-lb}$ )
Timing belt front cover bolt M6	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Timing belt front cover bolt M8, M10	$14 \pm 1 \text{ N}\cdot\text{m}$ ( $122 \pm 9 \text{ in-lb}$ )
Timing belt rear cover bolt M6	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Timing belt rear cover bolt M8	$14 \pm 1 \text{ N}\cdot\text{m}$ ( $122 \pm 9 \text{ in-lb}$ )
<b>Intake manifold and fuel parts</b>	
Injector and fuel rail bolt	$12 \pm 1 \text{ N}\cdot\text{m}$ ( $107 \pm 8 \text{ in-lb}$ )
Intake manifold nut	$20 - 23 \text{ N}\cdot\text{m}$ ( $15 - 17 \text{ ft-lb}$ )
<b>Water pump &amp; water hose</b>	
Engine coolant temperature sensor	$29 \pm 10 \text{ N}\cdot\text{m}$ ( $22 \pm 7 \text{ ft-lb}$ )
Thermostat housing bolt M6	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Thermostat housing bolt M8	$19 \pm 1 \text{ N}\cdot\text{m}$ ( $14 \pm 1 \text{ ft-lb}$ )
Water inlet fitting bolt	$19 \pm 1 \text{ N}\cdot\text{m}$ ( $14 \pm 1 \text{ ft-lb}$ )
Water pump bolt M8	$24 \pm 3 \text{ N}\cdot\text{m}$ ( $17 \pm 2 \text{ ft-lb}$ )
Water pump bolt M10	$42 \pm 8 \text{ N}\cdot\text{m}$ ( $31 \pm 6 \text{ ft-lb}$ )
<b>Exhaust manifold</b>	
Connector bracket bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Engine hanger bolt	$35 \pm 6 \text{ N}\cdot\text{m}$ ( $26 \pm 4 \text{ ft-lb}$ )
Exhaust manifold nut	$44 \pm 5 \text{ N}\cdot\text{m}$ ( $33 \pm 4 \text{ ft-lb}$ )
Exhaust manifold stay bolt M8	$19 \pm 3 \text{ N}\cdot\text{m}$ ( $14 \pm 2 \text{ ft-lb}$ )
Exhaust manifold stay bolt M10	$44 \pm 8 \text{ N}\cdot\text{m}$ ( $33 \pm 5 \text{ ft-lb}$ )
Exhaust manifold stay bolt M12	$75 \pm 10 \text{ N}\cdot\text{m}$ ( $55 \pm 7 \text{ ft-lb}$ )
Heat protector bolt	$14 \pm 1 \text{ N}\cdot\text{m}$ ( $122 \pm 9 \text{ in-lb}$ )
Heated oxygen sensor	$44 \pm 5 \text{ N}\cdot\text{m}$ ( $33 \pm 4 \text{ ft-lb}$ )
<b>Engine oil control valve</b>	
Accumulator bolt	$54 \pm 5 \text{ N}\cdot\text{m}$ ( $39 \pm 4 \text{ ft-lb}$ )
Engine oil control valve housing bolt	$24 \pm 3 \text{ N}\cdot\text{m}$ ( $17 \pm 2 \text{ ft-lb}$ )
Engine oil control valve bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Engine oil pressure switch	$10 \pm 2 \text{ N}\cdot\text{m}$ ( $89 \pm 17 \text{ in-lb}$ )

<b>ITEMS</b>	<b>SPECIFICATIONS</b>
Taper plug	$47 \pm 7 \text{ N}\cdot\text{m}$ ( $34 \pm 5 \text{ ft-lb}$ )
<b>Rocker arms and camshaft</b>	
Adjusting nut	$9.0 \pm 1.0 \text{ N}\cdot\text{m}$ ( $80 \pm 9 \text{ in-lb}$ )
Positive crankcase ventilation valve	$10 \pm 2 \text{ N}\cdot\text{m}$ ( $89 \pm 17 \text{ in-lb}$ )
Rocker arms and shaft bolt <Exhaust side>	$13 \pm 1 \text{ N}\cdot\text{m}$ ( $115 \pm 9 \text{ in-lb}$ )
Rocker arms and shaft bolt <Intake side>	$31 \pm 3 \text{ N}\cdot\text{m}$ ( $23 \pm 2 \text{ ft-lb}$ )
Rocker cover bolt	$3.5 \pm 0.5 \text{ N}\cdot\text{m}$ ( $31 \pm 4 \text{ in-lb}$ )
<b>Cylinder head and valve</b>	
Cylinder head bolt	$108 \pm 5 \text{ N}\cdot\text{m}$ ( $80 \pm 4 \text{ ft-lb}$ ) $\rightarrow 0 \text{ N}\cdot\text{m}$ ( $0 \text{ in-lb}$ ) $\rightarrow 108 \pm 5 \text{ N}\cdot\text{m}$ ( $80 \pm 4 \text{ ft-lb}$ )
<b>Oil pan and oil pump</b>	
Baffle plate bolt <Cylinder block side>	$9.0 \pm 2.0 \text{ N}\cdot\text{m}$ ( $80 \pm 17 \text{ in-lb}$ )
Baffle plate bolt <Oil pan side>	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Cover bolt	$10.8 \pm 0.9 \text{ N}\cdot\text{m}$ ( $96 \pm 7 \text{ in-lb}$ )
Drain plug	$39 \pm 5 \text{ N}\cdot\text{m}$ ( $29 \pm 4 \text{ ft-lb}$ )
Engine oil pressure switch	$10 \pm 2 \text{ N}\cdot\text{m}$ ( $89 \pm 17 \text{ in-lb}$ )
Oil filter bracket bolt M8	$23 \pm 3 \text{ N}\cdot\text{m}$ ( $18 \pm 2 \text{ ft-lb}$ )
Oil filter bracket bolt M10	$41 \pm 8 \text{ N}\cdot\text{m}$ ( $30 \pm 6 \text{ ft-lb}$ )
Oil filter bracket cover bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Oil pan, lower bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Oil pan, upper bolt	$9.0 \pm 3.0 \text{ N}\cdot\text{m}$ ( $80 \pm 26 \text{ in-lb}$ )
Oil pump case bolt	$14 \pm 1 \text{ N}\cdot\text{m}$ ( $122 \pm 9 \text{ in-lb}$ )
Oil pump cover bolt	$10 \pm 2 \text{ N}\cdot\text{m}$ ( $89 \pm 17 \text{ in-lb}$ )
Oil screen bolt	$19 \pm 3 \text{ N}\cdot\text{m}$ ( $14 \pm 2 \text{ ft-lb}$ )
Relief plug	$44 \pm 5 \text{ N}\cdot\text{m}$ ( $33 \pm 4 \text{ ft-lb}$ )
<b>Piston and connecting rod</b>	
Connecting rod cap nut	$27 \pm 2 \text{ N}\cdot\text{m}$ ( $20 \pm 1 \text{ ft-lb}$ ) $+ 90^\circ$ to $94^\circ$
<b>Crankshaft and cylinder block</b>	
Bearing cap bolt	$74 \pm 4 \text{ N}\cdot\text{m}$ ( $54 \pm 3 \text{ ft-lb}$ )
Drive plate bolt	$74 \pm 1 \text{ N}\cdot\text{m}$ ( $54 \pm 1 \text{ ft-lb}$ )
Knock sensor	$23 \pm 2 \text{ N}\cdot\text{m}$ ( $17 \pm 1 \text{ ft-lb}$ )
Knock sensor bracket bolt	$28 \pm 2 \text{ N}\cdot\text{m}$ ( $22 \pm 1 \text{ ft-lb}$ )
Oil seal case bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )
Rear plate bolt	$11 \pm 1 \text{ N}\cdot\text{m}$ ( $98 \pm 8 \text{ in-lb}$ )

## **GENERAL SPECIFICATIONS**

M1113000201062

<b>DESCRIPTIONS</b>	<b>SPECIFICATIONS</b>
Type	$60^\circ \text{ V}$ , OHV, SOHC
Number of cylinders	6
Combustion chamber	Pentroof type

DESCRIPTIONS		SPECIFICATIONS		
Total displacement cm <sup>3</sup> (cu in)		3,828 (233.6)		
Cylinder bore mm (in)		95.0 (3.74)		
Piston stroke mm (in)		90.0 (3.54)		
Compression ratio		10.5		
Valve timing	Intake valve	Opens (BTDC)	-2° <Low speed cam A>	
			0° <Low speed cam B>	
			15° <High speed cam>	
	Exhaust valve	Closes (ABDC)	50° <Low speed cam A>	
			52° <Low speed cam B>	
			69° <High speed cam>	
		Opens (BBDC)	57°	
		Closes (ATDC)	19	
Lubrication system		Pressure feed, full-flow filtration		
Oil pump type		Trochoid type		

**SERVICE SPECIFICATIONS**

M1113000301092

ITEMS	STANDARD VALUE	LIMIT
<b>Timing belt</b>		
Auto tensioner rod length mm (in)	4.8 – 6.0 (0.19 – 0.21)	–
Auto tensioner rod production length mm (in)	12 (0.5)	–
Auto tensioner rod pushed-in amount [when pushed with a force of 98 to 196 N (22 to 44 lb)] mm (in)	1.0 (0.03) or less	–
Valve clearance mm (in)	0.10 ± 0.03 (0.004 ± 0.001)	
<b>Rocker arms and camshaft</b>		
Camshaft cam height mm (in)	Intake	Low speed cam A 33.55 (1.321)
		Low speed cam B 37.35 (1.4705)
		High speed cam 37.21 (1.465)
	Exhaust	37.87 (1.491)
Camshaft journal outside diameter mm (in)	45 (1.8)	
<b>Cylinder head and valves</b>		
Cylinder head flatness of gasket surface mm (in)	Less than 0.03 (0.001)	
Cylinder head grinding limit of gasket surface mm (in) Total resurfacing depth of cylinder head and cylinder block	–	
Cylinder head overall height mm (in)	120 (4.7)	
Valve thickness of valve head (margin) mm (in)	Intake	1.0 (0.04)
	Exhaust	1.2 (0.05)
<b>TSB Revision</b>		

<b>ITEMS</b>		<b>STANDARD VALUE</b>	<b>LIMIT</b>
Valve overall height mm (in)	Intake	109.33 (4.304)	Minimum 109.83 (4.285)
	Exhaust	113.50 (4.468)	Minimum 113.00 (4.449)
Valve stem outside diameter mm (in)	Intake	6.0 (0.24)	–
	Exhaust	6.0 (0.24)	–
Valve thickness to valve guide clearance mm (in)	Intake	0.02 – 0.05 (0.0008 – 0.0019)	0.10 (0.003)
	Exhaust	0.04 – 0.06 (0.0016 – 0.0023)	0.15 (0.005)
Valve face angle mm (in)		43.5° – 44°	–
Valve spring free length mm (in)	Intake	56.19 (2.212)	55.19 (2.173)
	Exhaust	53.30 (2.098)	52.30 (2.059)
Valve spring load/installed height N (lb) /mm (in)	Intake	262/44.2 (59/1.74)	–
	Exhaust	235/44.2 (53/1.74)	–
Valve spring out-of-squareness		2° or less	4°
Valve seat valve contact width mm (in)		0.9 – 1.3 (0.04 – 0.05)	–
Valve guide inside diameter mm (in)		6.0 (0.24)	–
Valve guide projection from cylinder head upper surface mm (in)		14 (0.6)	–
Valve stem projection mm (in)	Intake	48.30 (1.902)	48.80 (1.921)
	Exhaust	51.71 (2.036)	52.21 (2.056)
Oversize rework dimensions of valve guide hole mm (in)	0.05 oversize diameter	11.05 – 11.07 (0.4351 – 0.4358)	–
	0.25 oversize diameter	11.25 – 11.27 (0.4429 – 0.4437)	–
	0.50 oversize diameter	11.50 – 11.52 (0.4528 – 0.4535)	–
Intake oversize rework dimensions of valve seat hole mm (in)	0.3 oversize diameter	37.80 – 37.83 (1.4881 – 1.4894)	–
	0.6 oversize diameter	38.10 – 38.13 (1.5000 – 1.5012)	–
Exhaust oversize rework dimensions of valve seat hole mm (in)	0.3 oversize diameter	34.80 – 34.83 (1.3701 – 1.3713)	–
	0.6 oversize diameter	35.10 – 35.13 (1.3819 – 1.3831)	–
<b>Oil pan and oil pump</b>			
Oil pump tip clearance mm (in)		0.06 – 0.18 (0.003 – 0.007)	–
Oil pump side clearance mm (in)		0.04 – 0.10 (0.002 – 0.003)	–
Oil pump body clearance mm (in)		0.10 – 0.18 (0.004 – 0.007)	0.35 (0.013)

ITEMS	STANDARD VALUE	LIMIT
Oil pressure at curb idle speed kPa (psi) [oil temperature is 75 to 90°C (167 to 194°F)]	80 (11.6) or more	—
<b>Piston and connecting rod</b>		
Piston outside diameter mm (in)	95.0 (3.74)	—
Piston ring to ring groove clearance mm (in)	No.1	0.03 – 0.07 (0.0012 – 0.0027)
	No.2	0.02 – 0.06 (0.0008 – 0.0023)
Piston ring end gap mm (in)	No.1	0.25 – 0.40 (0.010 – 0.016)
	No.2	0.35 – 0.50 (0.014 – 0.019)
	Oil ring side rail	0.10 – 0.35 (0.003 – 0.014)
Piston pin outside diameter mm (in)	22.0 (0.87)	—
Crankshaft pin oil clearance mm (in)	0.02 – 0.038 (0.0008 – 0.0015)	0.1 (0.003)
Connecting rod big end side clearance mm (in)	0.10 – 0.25 (0.003 – 0.009)	—
<b>Crankshaft and cylinder block</b>		
Crankshaft end play mm (in)	0.05 – 0.25 (0.002 – 0.009)	0.3 (0.01)
Crankshaft journal outside diameter mm (in)	64 (2.520)	—
Crankshaft pin outside diameter mm (in)	55 (2.165)	—
Crankshaft journal oil clearance mm (in)	No.1, 4	0.02 – 0.03 (0.0008 – 0.0012)
	No.2, 3	0.03 – 0.04 (0.0012 – 0.0016)
Piston to cylinder clearance mm (in)	0.03 – 0.05 (0.0012 – 0.0019)	—
Cylinder block flatness of gasket surface mm (in)	0.05 (0.02)	0.1 (0.003)
Cylinder block grinding limit of gasket surface mm (in) total resurfacing depth of both cylinder head and cylinder block	—	0.2 (0.008)
Cylinder block overall height mm (in) [upper plane of cylinder block from crankshaft center]	227.9 – 228.1 (8.972 – 8.980)	—
Cylinder bore inside diameter mm (in)	95.0 (3.74)	—
Cylindricity mm (in)	0.01 (0.0003)	—

## SEALANTS

M1113000500350

ITEMS	SPECIFIED SEALANT	QUANTITY
Camshaft position sensor support	MITSUBISHI genuine part No. MD970389 or equivalent	As required
Engine coolant temperature sensor	3M™ AAD Part No. 8731 or equivalent	As required
Engine oil pressure switch	3M™ AAD Part No. 8672 or equivalent	As required
Oil pump case	MITSUBISHI genuine part No. MD970389 or equivalent	As required
Oil pan	MITSUBISHI genuine part No. MD970389 or equivalent	As required
Oil seal case	MITSUBISHI genuine part No. MD970389 or equivalent	As required