

GROUP 11D

ENGINE OVERHAUL

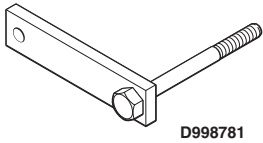
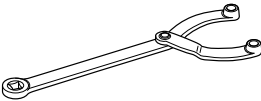
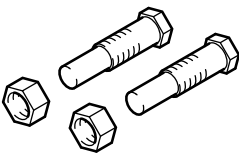

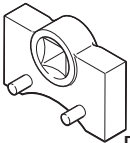
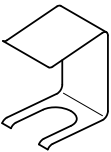
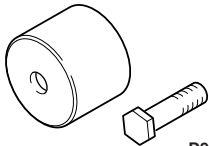
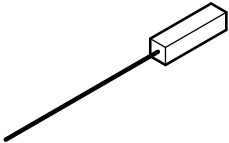
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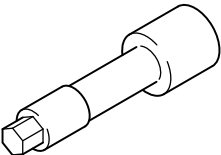
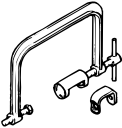
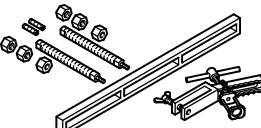
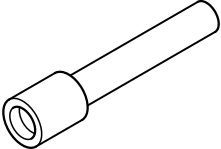
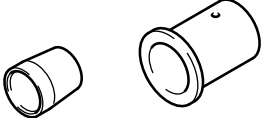
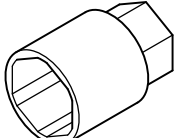
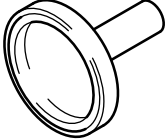
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SPECIAL TOOLS

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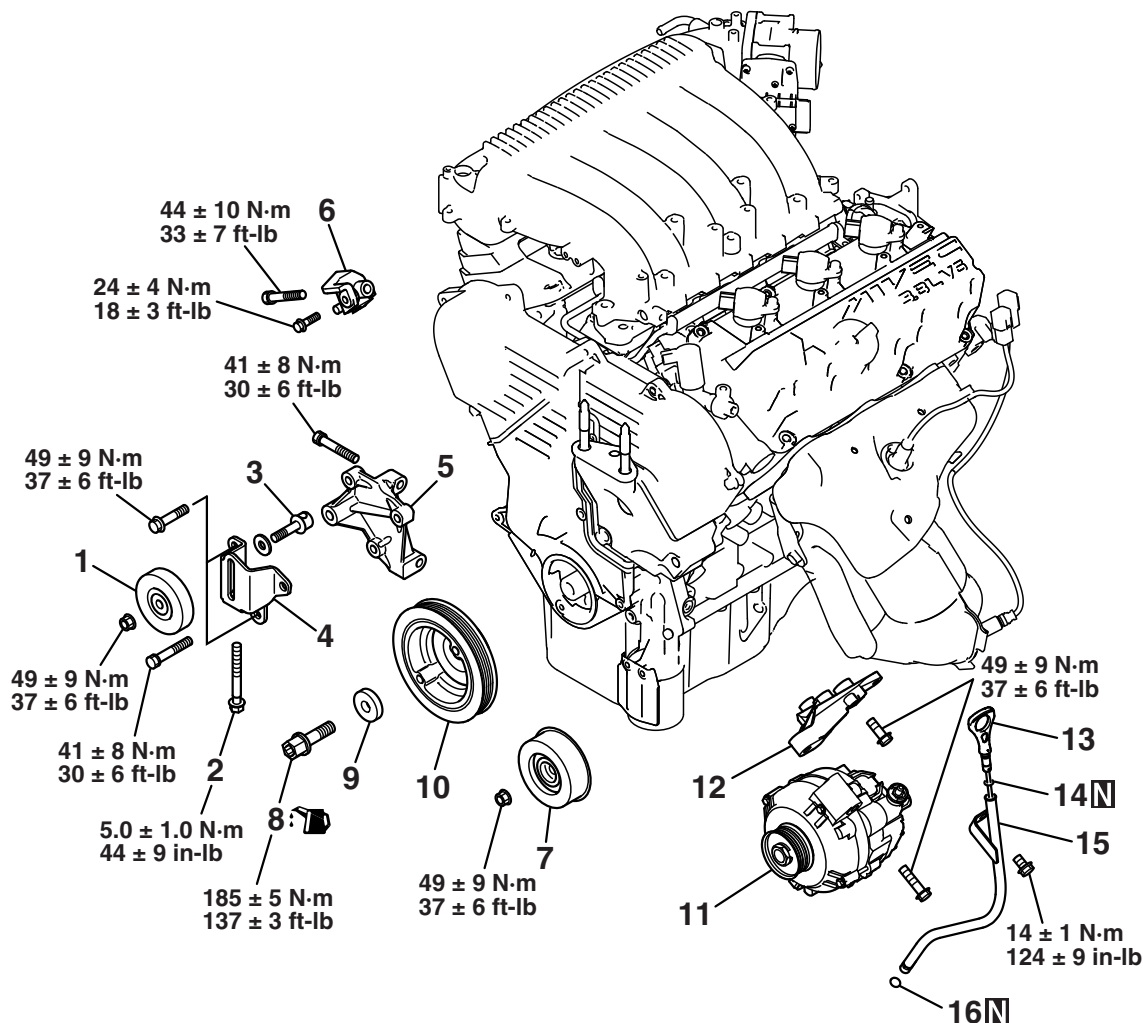
| TOOL | TOOL NUMBER AND NAME | SUPERSESSION | APPLICATION |
|--|---|----------------------|---|
|  D998781 | MD998781 Flywheel stopper | General service tool | Loosening and tightening crankshaft bolts |
|  B990767 | MB990767 End yoke holder | MB990767-01 | Holding camshaft sprocket when loosening or torquing bolt. |
|  MD998715 Pin | MD998715 Pin | MIT308239 | |
|  MD998769 | 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 | MD998442 Air bleed wire | General service tool | Air bleeding of auto lash adjuster |

| TOOL | TOOL NUMBER AND NAME | SUPERSESSION | APPLICATION |
|---|---|---|--|
|  | 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

M1113001300683



AK403323AD

REMOVAL STEPS

1. TENSIONER 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

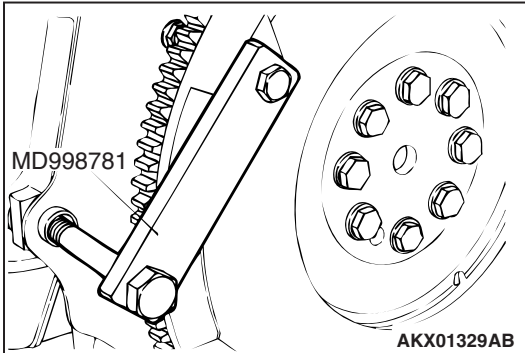
Required Special Tool:

- MD998781: Flywheel Stopper

REMOVAL SERVICE POINT

<<A>> CRANKSHAFT BOLT LOOSENING

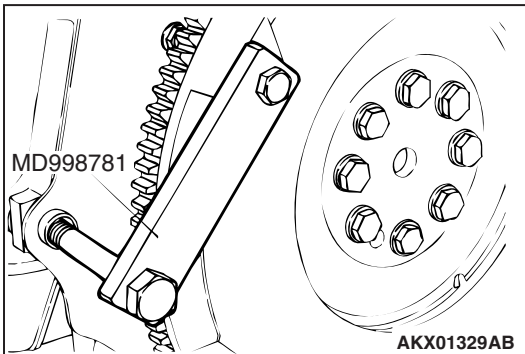
1. Using special tool MD998781, hold the drive plate or flywheel.
2. Remove the crankshaft bolt.



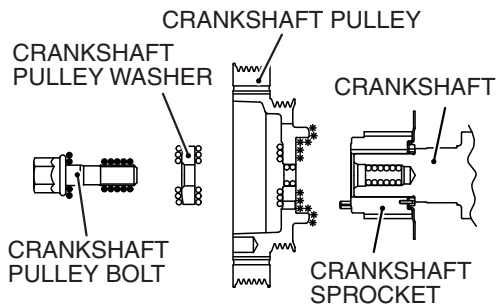
INSTALLATION SERVICE POINT

>>A<< CRANKSHAFT BOLT TIGHTENING

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



- : DIRT IS WIPED UP BY A RAG.
- *: AFTER WIPING UP DIRT BY A RAG, REMOVE GREAS.
- : AFTER WIPING UP DIRT BY A RAG, MINIMUM ENGINE OIL APPLIED.



← ENGINE FRONT

AK604567AB

2. Using a rag, wipe dirt on the crankshaft thread hole and the crankshaft pulley washer.
3. Using a rag, wipe dirt on the crankshaft pulley and then degrease the place specified in the illustration.

NOTE: Perform degreasing to prevent the friction resistance from decreasing in the compressed area due to the residual oil.

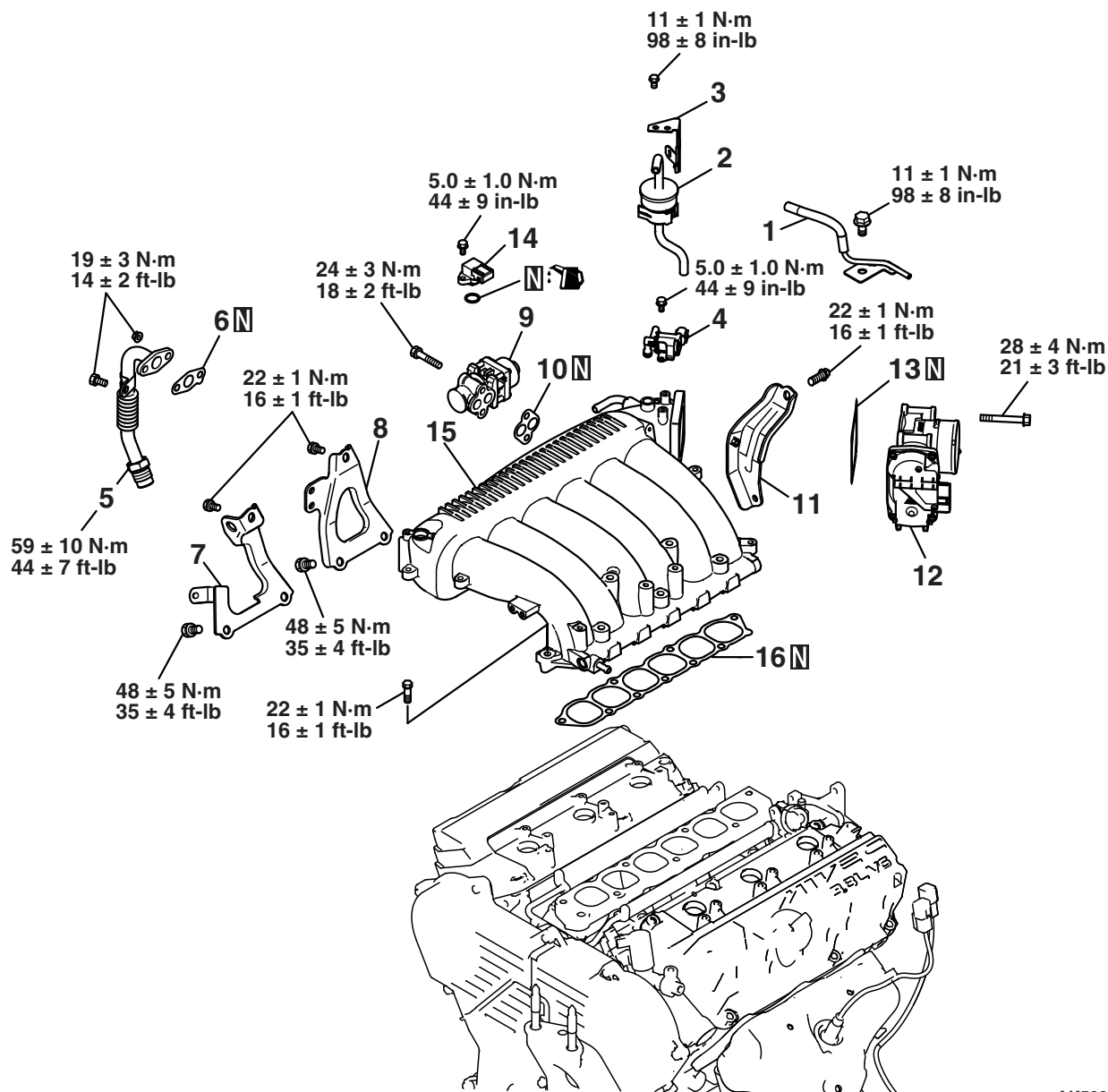
4. Install the crankshaft pulley.
5. Apply the minimum amount of engine oil to the crankshaft bolt threads and the seating surface.
6. Turning the inside chamfer side of the crankshaft pulley washer toward the bolt head, install the crankshaft pulley washer to the crankshaft bolt.
7. Tighten the crankshaft bolt to the specified torque.

Tightening torque: 185 ± 5 N·m (137 ± 3 ft·lb)

INTAKE MANIFOLD PLENUM AND THROTTLE BODY ASSEMBLY

REMOVAL AND INSTALLATION

M1113003300430



AK500697AD

REMOVAL STEPS

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

REMOVAL STEPS (Continued)

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

INSTALLATION SERVICE POINT

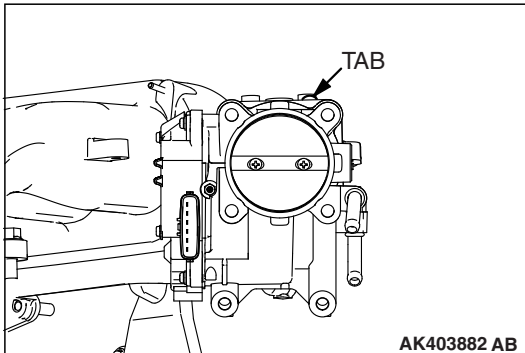
>>A<< BOOST SENSOR INSTALLATION

CAUTION

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

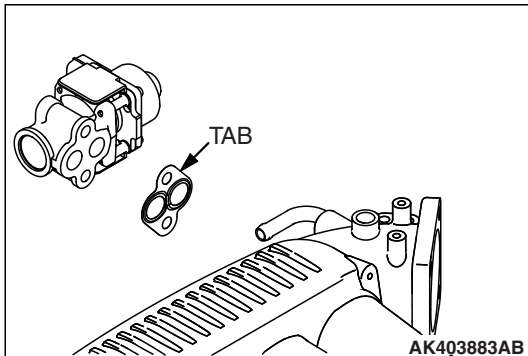
>>B<< THROTTLE BODY GASKET INSTALLATION

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



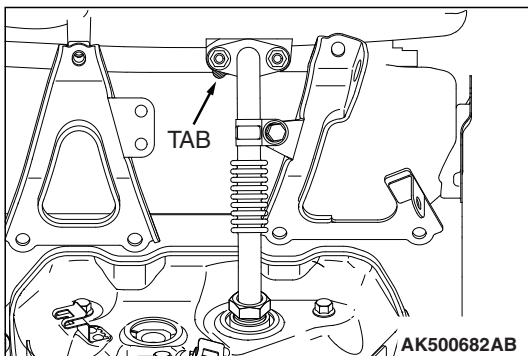
>>C<< EXHAUST GAS RECIRCULATION VALVE GASKET INSTALLATION

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.



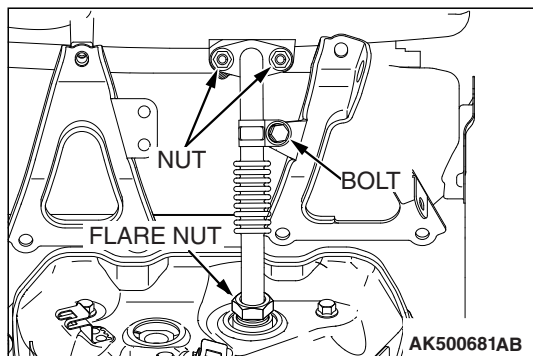
>>E<< EXHAUST GAS RECIRCULATION PIPE
INSTALLATION CAUTION

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: **$59 \pm 10 \text{ N}\cdot\text{m}$ ($44 \pm 7 \text{ ft}\cdot\text{lb}$) <FLARE NUT>** **$19 \pm 3 \text{ N}\cdot\text{m}$ ($14 \pm 2 \text{ ft}\cdot\text{lb}$) <NUT>**

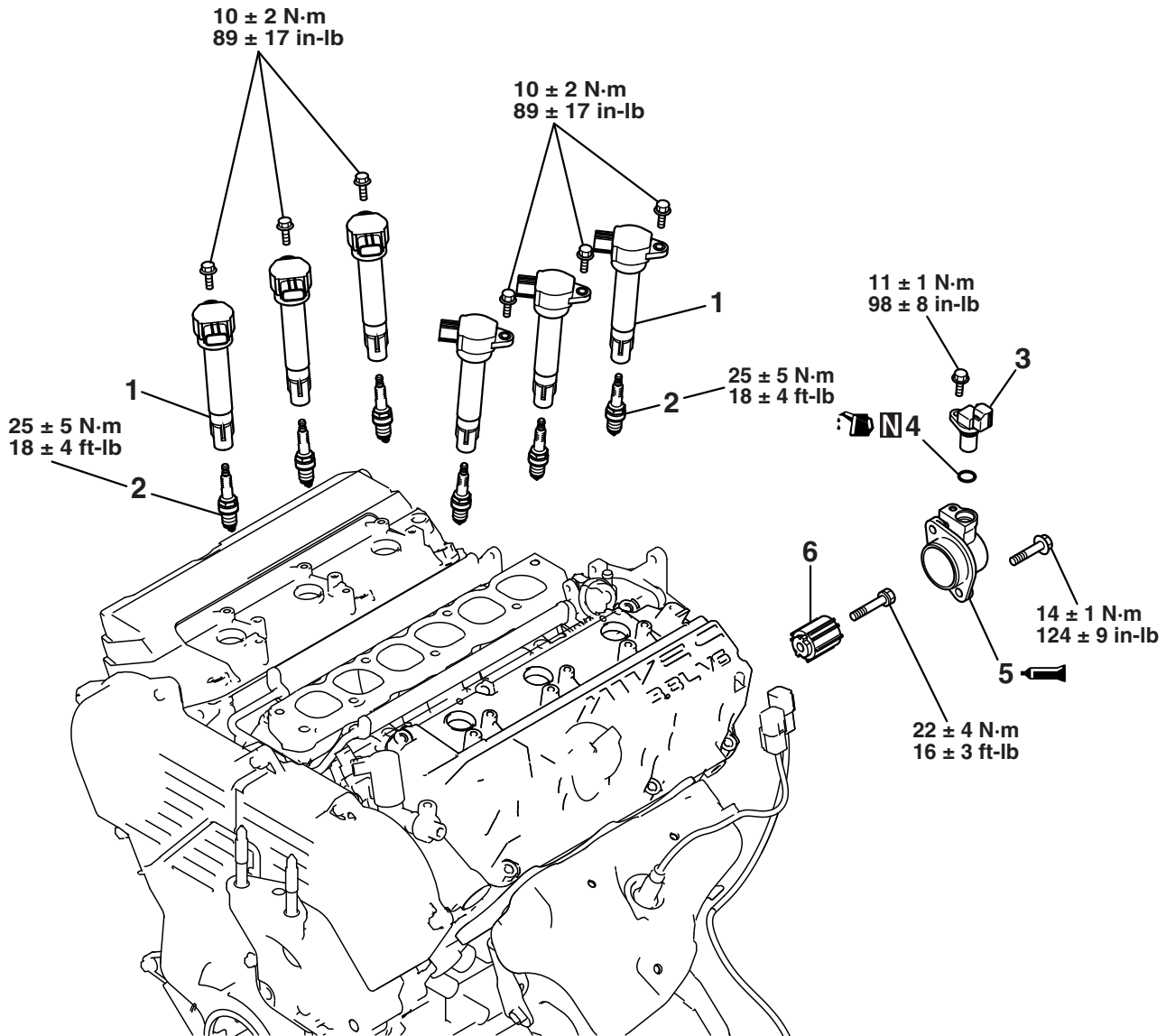
3. Tighten the bolt shown in the illustration to the specified torque.

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

IGNITION SYSTEM

REMOVAL AND INSTALLATION

M1113001600446



AK403325AD

REMOVAL STEPS

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

>>B<<

<<A>>

REMOVAL STEPS (Continued)

5. CAMSHAFT POSITION SENSOR SUPPORT
6. CAMSHAFT POSITION SENSING CYLINDER

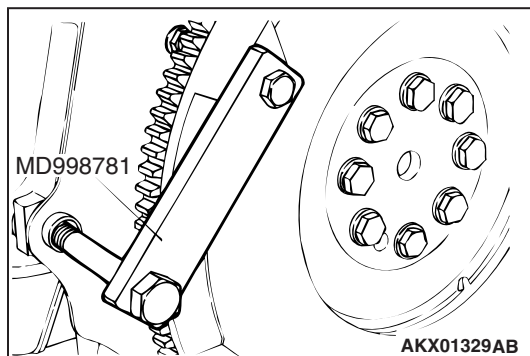
Required Special Tool:

- 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.

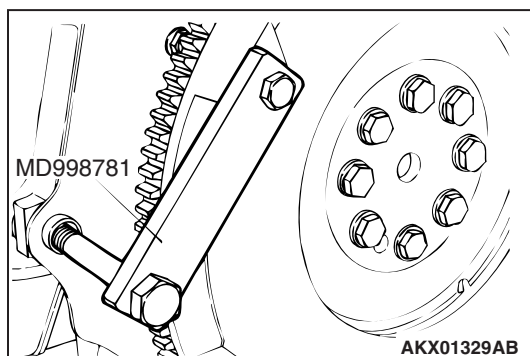


INSTALLATION SERVICE POINT

>>A<< CAMSHAFT POSITION SENSING CYLINDER INSTALLATION

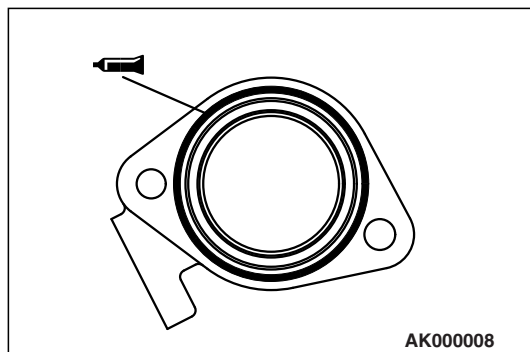
1. Using special tool MD998781, hold the drive plate.
2. Tighten the camshaft position sensing cylinder bolt to the specified torque.

Tightening torque: 22 ± 4 N·m (16 ± 3 ft-lb)



>>B<< CAMSHAFT POSITION SENSOR SUPPORT INSTALLATION

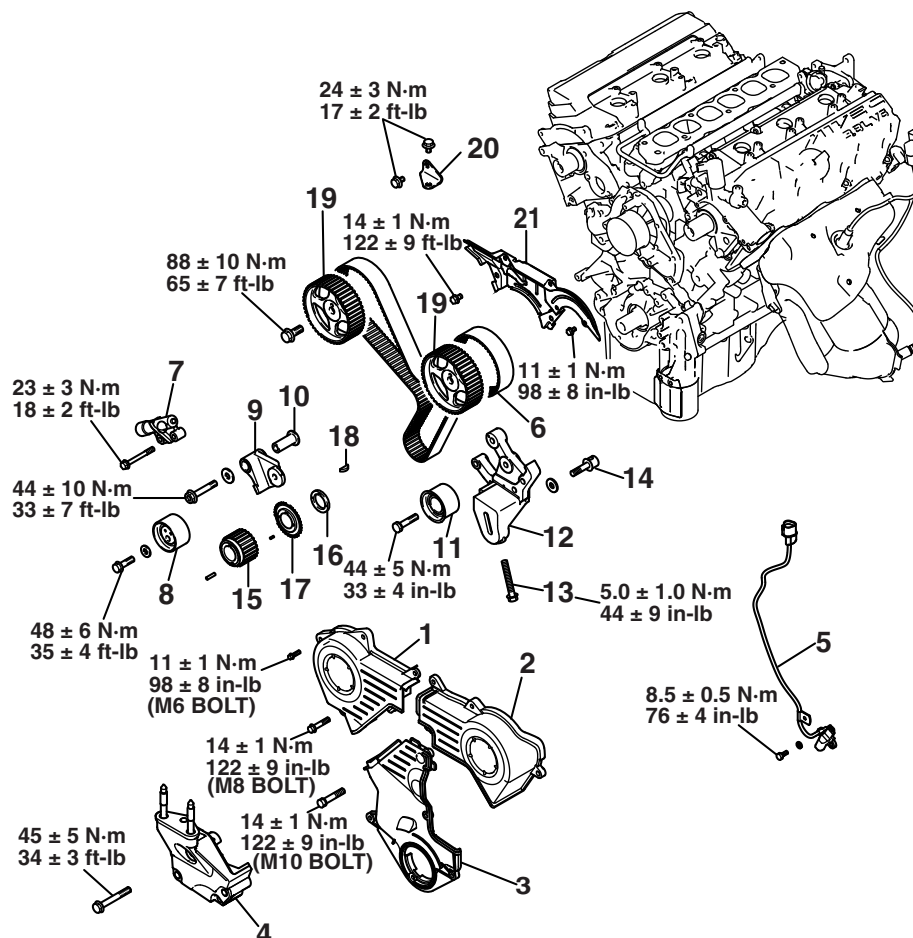
Apply a 3 mm (0.12 inch) diameter bead of sealant (Three bond 1207F or equivalent) to the camshaft position sensor support.



TIMING BELT

REMOVAL AND INSTALLATION

M1113001901893



REMOVAL STEPS

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

REMOVAL STEPS (Continued)

9. TENSIONER ARM
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
- <> >>A<< 19. CAMSHAFT SPROCKET
20. BRACKET
21. TIMING BELT REAR COVER

NOTE:

*1: In case that the amount of rod protrusion is 5 mm with the set pin inserted.

*2: In case that the amount of rod protrusion is 1 mm with the set pin inserted.

Required Special Tools:

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

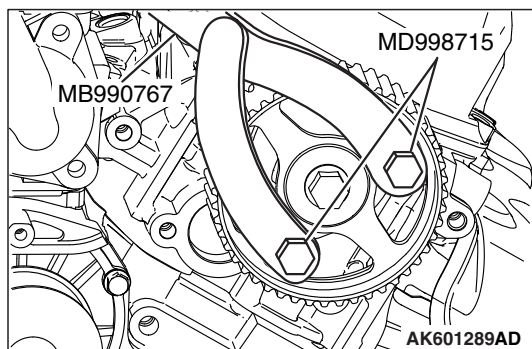
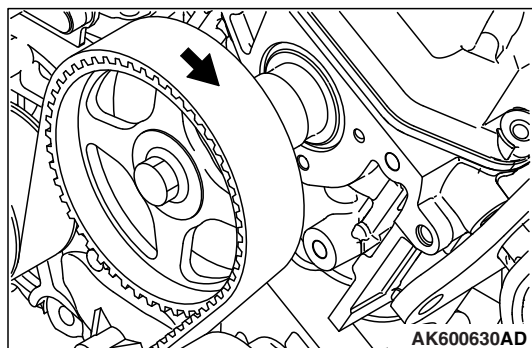
REMOVAL SERVICE POINTS

<<A>> 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.



<> CAMSHAFT SPROCKET REMOVAL

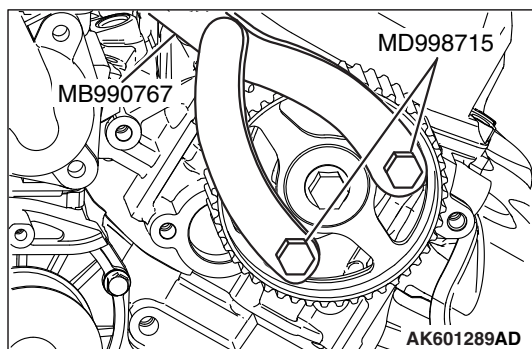
1. While holding the camshaft sprocket with special tools MB990767 and MD998715, loosen the camshaft sprocket bolt.
2. Remove the camshaft sprocket.

INSTALLATION SERVICE POINT

>>A<< 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.

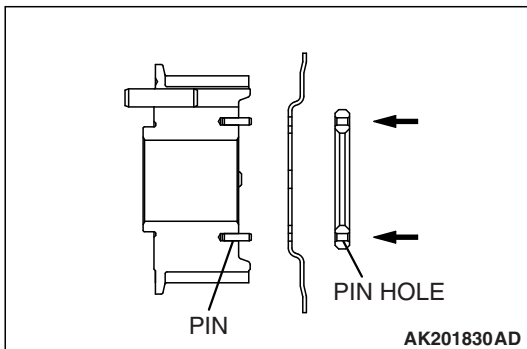
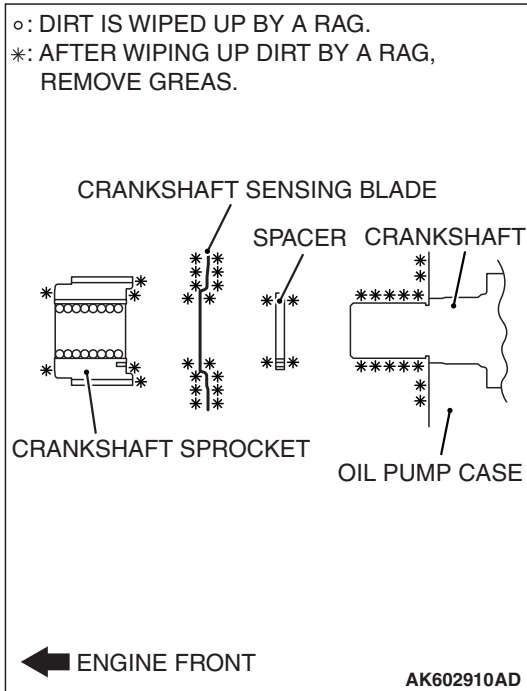
Tightening torque: 88 ± 10 N·m (65 ± 7 ft-lb)



>>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.

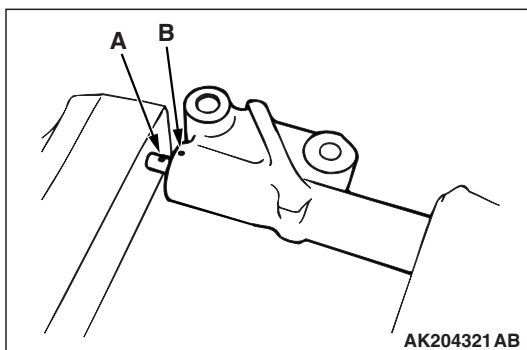
4. Install the crankshaft sprocket to the crankshaft.

>>C<< AUTO-TENSIONER INSTALLATION

<In case that the amount of rod protrusion is 5 mm with the set pin inserted.>

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<< AUTO-TENSIONER INSTALLATION

<In case that the amount of rod protrusion is 1 mm with the set pin inserted.>

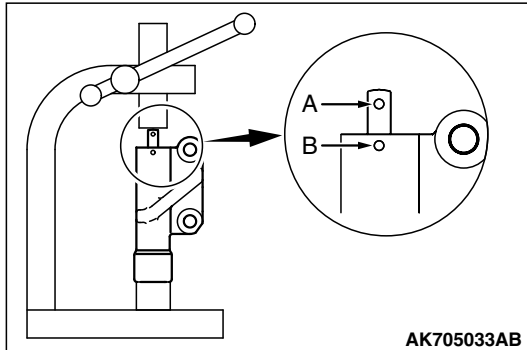
⚠ CAUTION

- If the lateral type press is used, the appropriate air bleeding is not carried out. Always use longitudinal type press.
- To prevent damage to the auto tensioner, do not apply the load of 5,000N (1,124 lb) or more.
- To prevent damage to the auto tensioner, do not press the rod below the cylinder end plane.

1. Set the auto tensioner to the longitudinal type press as shown in the illustration.
2. Push in the rod little by little with the longitudinal type press until set hole A in the rod is aligned with hole B in the cylinder.
3. Insert a wire [2 mm (0.08 inch) in diameter] into the set holes. This auto-tensioner setting wire will be used during timing belt alignment.

⚠ CAUTION

To prevent the air from being incorporated, keep the auto tensioner with its rod upward after the air bleeding.



>>E<< TIMING BELT INSTALLATION

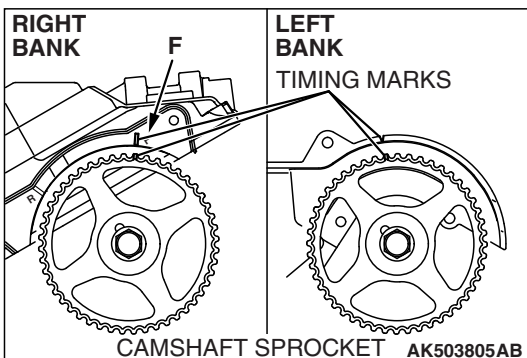
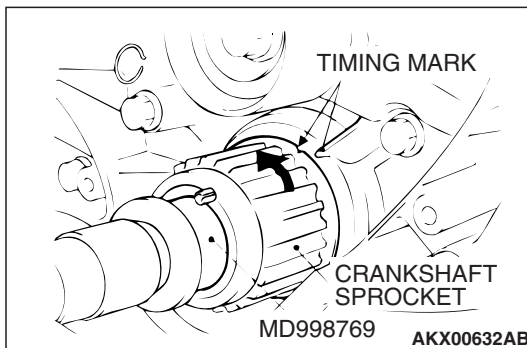
<In case that the amount of rod protrusion is 5 mm with the set pin inserted.>

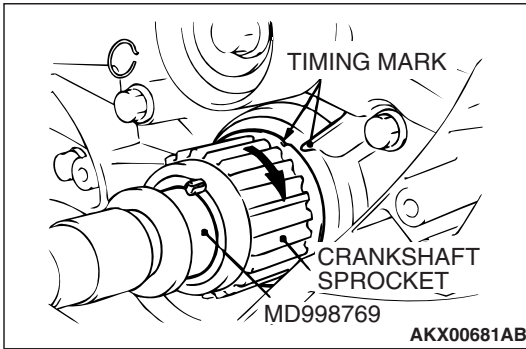
⚠ CAUTION

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.



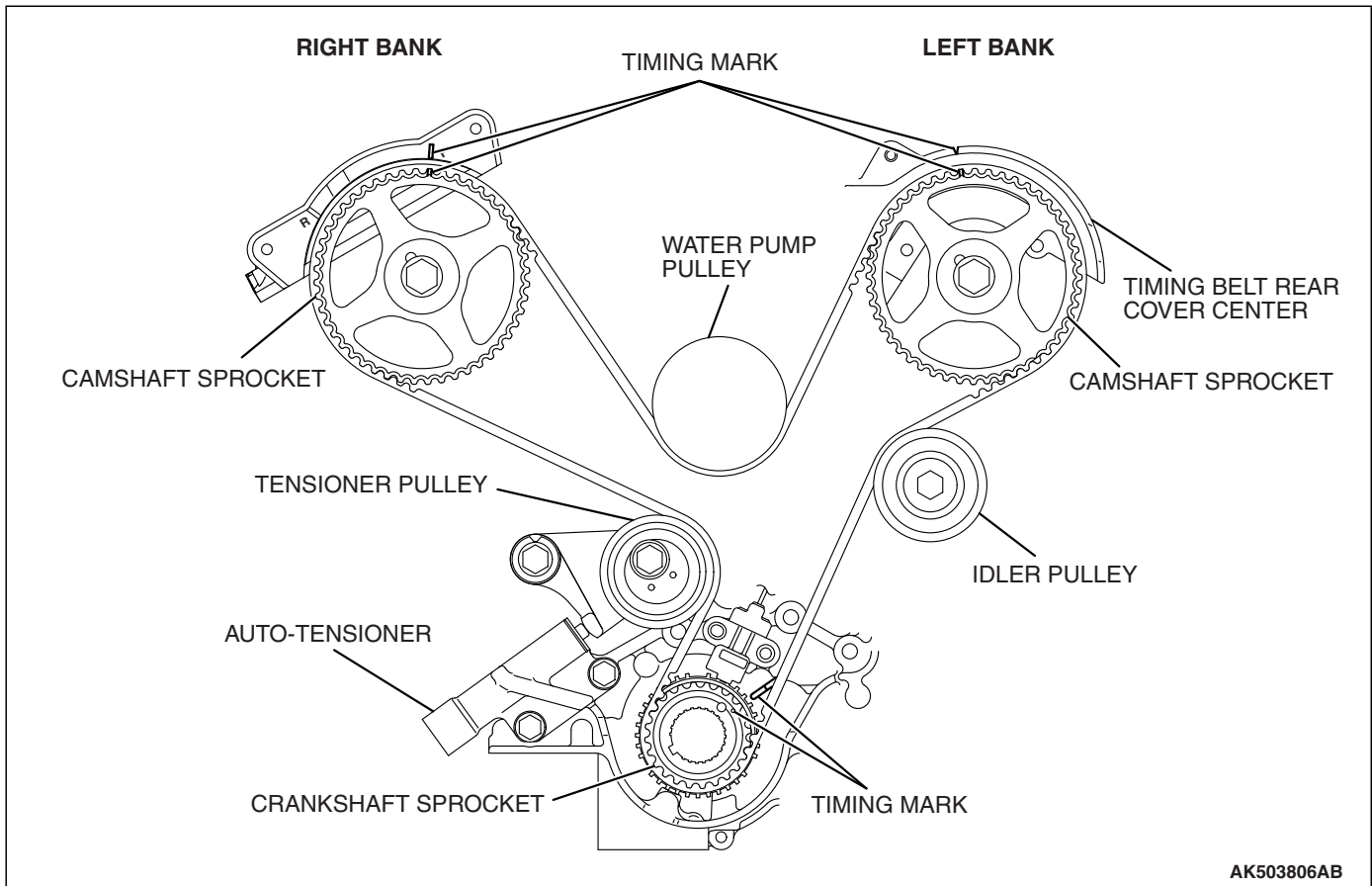
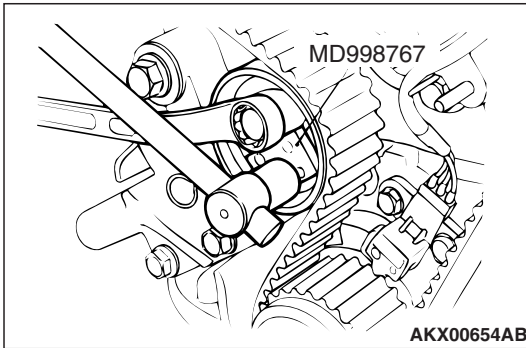


5. Align the timing mark on the crankshaft sprocket with the timing mark on the oil pump case.
6. Install the timing belt on each sprocket and pulley in the following sequence. Do not leave the belt slack between each sprocket and pulley.

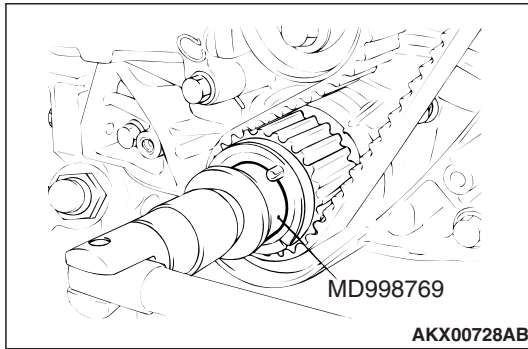
- (1) Crankshaft sprocket
- (2) Idler pulley
- (3) Left bank camshaft sprocket
- (4) Water pump pulley
- (5) Right bank camshaft sprocket
- (6) Tensioner pulley

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.

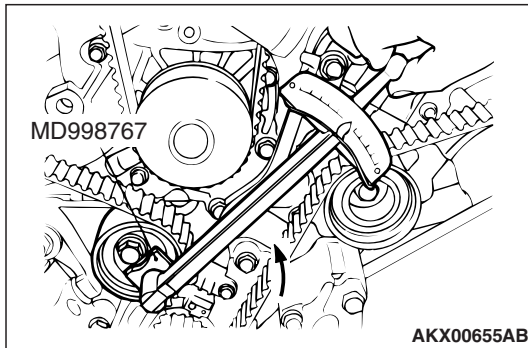
Tightening torque: 48 ± 6 N·m (35 ± 4 ft-lb)



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.



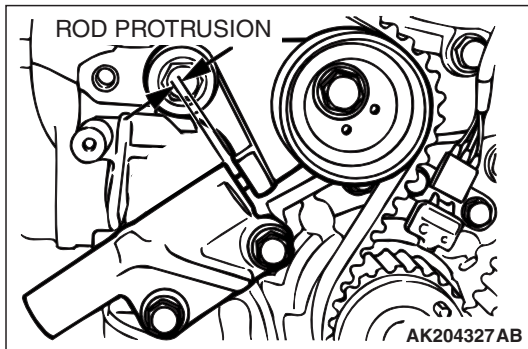
10. Loosen the flange bolt securing the tensioner pulley, and then mount special tool MD998767 and a torque wrench on the tensioner pulley.

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 ± 6 N·m (35 ± 4 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.

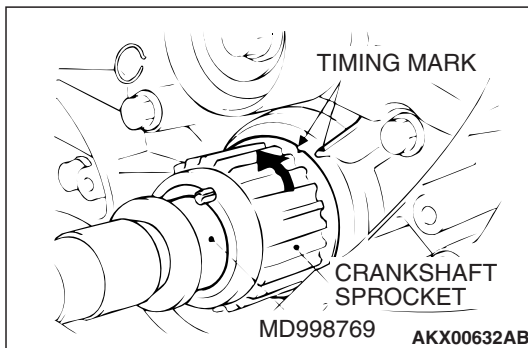
>>F<< TIMING BELT INSTALLATION

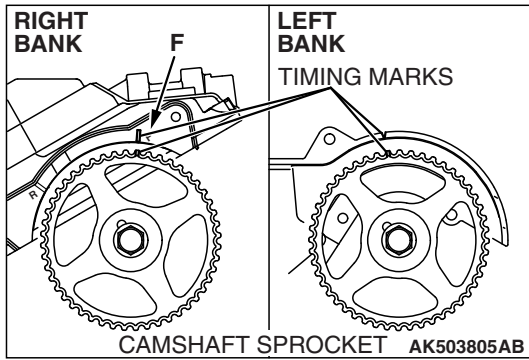
<In case that the amount of rod protrusion is 1 mm with the set pin inserted.>

⚠ CAUTION

Do not turn the camshaft when the piston in Number 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.

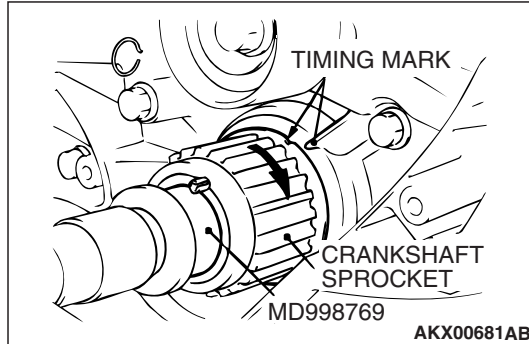
1. Install special tool MD998769 and the crankshaft pulley washer, and then tighten the crankshaft bolt.
2. Align the timing mark on the crankshaft sprocket with the timing mark on the oil pump case, and then rotate the sprocket three teeth counterclockwise.



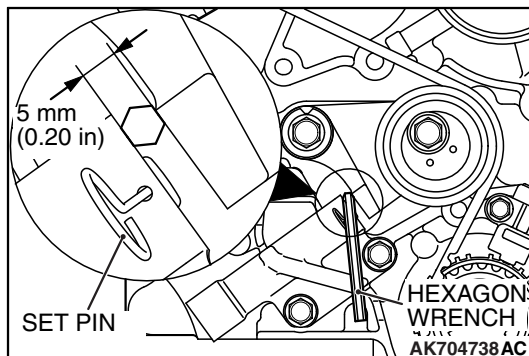


3. Align the timing mark on the left bank camshaft sprocket with the timing mark on the rocker cover.
4. Align the timing mark on the right bank camshaft sprocket with the timing mark on the rocker cover.

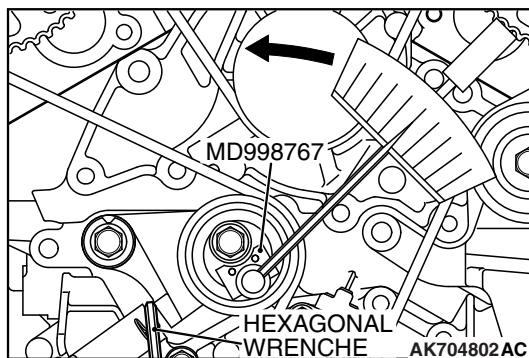
NOTE: Align the timing mark, on the right bank, with F.



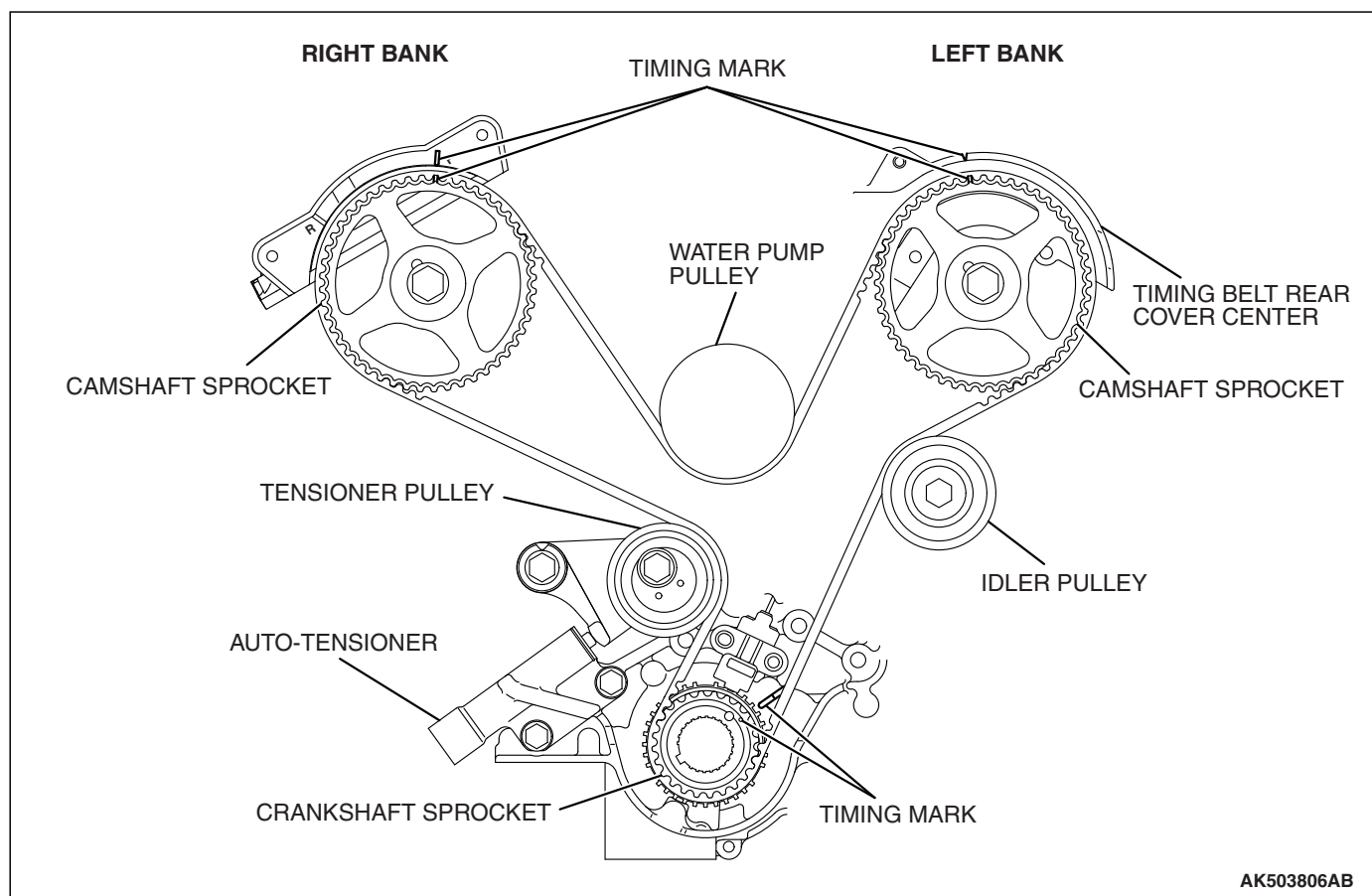
5. Align the timing mark on the crankshaft sprocket with the timing mark on the oil pump case.
6. Install the timing belt on each sprocket and pulley in the following sequence. Do not leave the belt slack between each sprocket and pulley.
 - (1) Crankshaft sprocket
 - (2) Idler pulley
 - (3) Left bank camshaft sprocket
 - (4) Water pump pulley
 - (5) Right bank camshaft sprocket
 - (6) Tensioner pulley



7. Lightly pressing the tensioner pulley against the belt, insert the hexagonal wrench having the width of 5mm (0.2 inch) between the tensioner body and tensioner arm to temporarily tighten the center bolt.

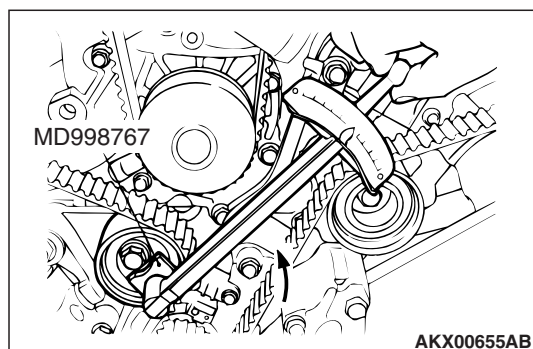
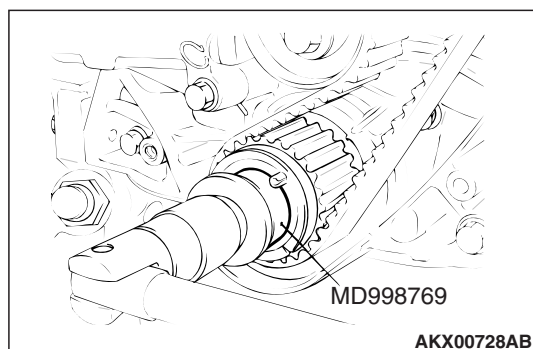


8. Inserting the hexagonal wrench, loosen the center bolt of the tensioner pulley to install the special tool the torque wrench. Applying the torque of 4.4 N·m (39 in-lb) to prevent the tensioner pulley from rotating, tighten the center bolt to 48 ± 6 N·m (35 ± 4 ft-lb).



9. Check to see that the timing marks of all the sprockets are in alignment.

10. Rotate the crankshaft a quarter turn counterclockwise. Then rotate it back clockwise to verify that all the timing marks are aligned.

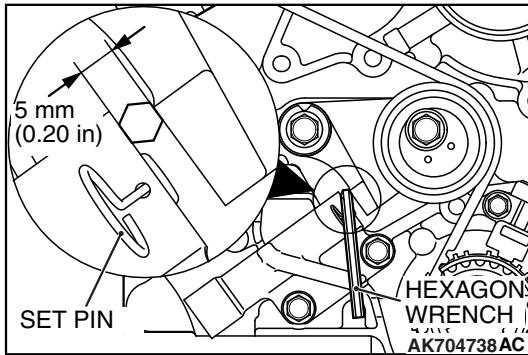


11. Loosen the flange bolt securing the tensioner pulley, and then mount special tool MD998767 and a torque wrench on the tensioner pulley.

12. Torque it to 4.4 N·m (39 in-lb) with the torque wrench.

13. While holding the tensioner pulley in position, tighten the flange bolt to the specified torque.

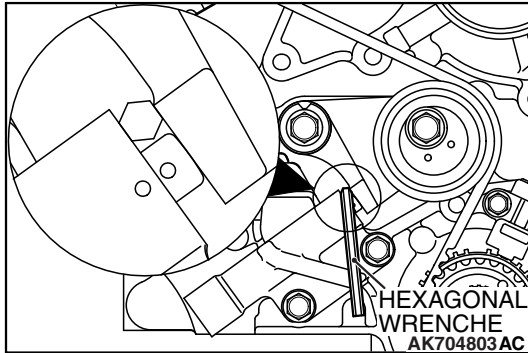
Tightening torque: 48 ± 6 N·m (35 ± 4 ft-lb)



14. Pull out set pin having $\phi 2$ mm (0.08 inch) inserted into the auto tensioner.

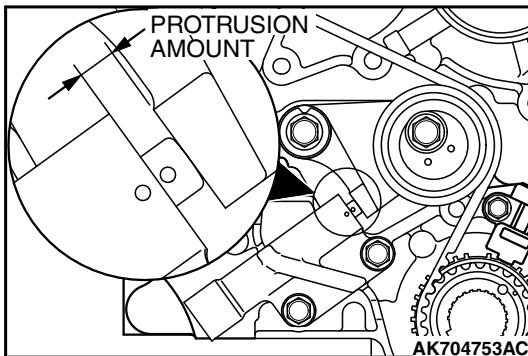
CAUTION

If the hexagonal wrench is removed first, the timing belt would possibly become loose and come off the tooth.



15. Pull out the hexagonal wrench.

16. Rotate the crankshaft two turns clockwise and let it stand for approximately five minutes.



17. Check whether the amount of the rod protrusion of the auto tensioner is within the standard value.

Standard value: 4.8 – 6.0 mm (0.189 – 0.236 inch)

18. When it deviates from the standard value, carry out the tension adjustment of the tensioner pulley again to obtain the appropriate belt tension.

>>G<< ENGINE SUPPORT BRACKET, RIGHT INSTALLATION

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

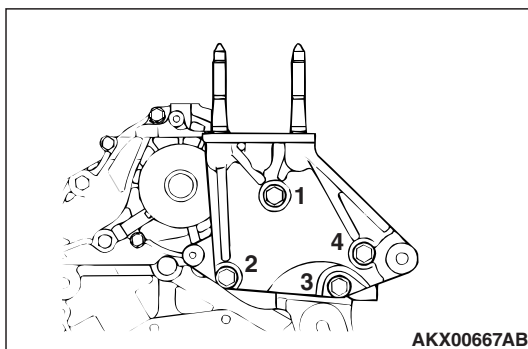
Tightening torque: 45 \pm 5 N·m (34 \pm 3 ft-lb)

Bolt length

85 mm (3.35 inch) – Bolt 3

95 mm (3.74 inch) – Bolts 2 and 4

100 mm (3.94 inch) – Bolt 1

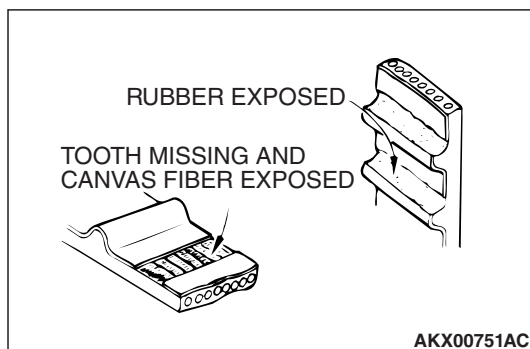
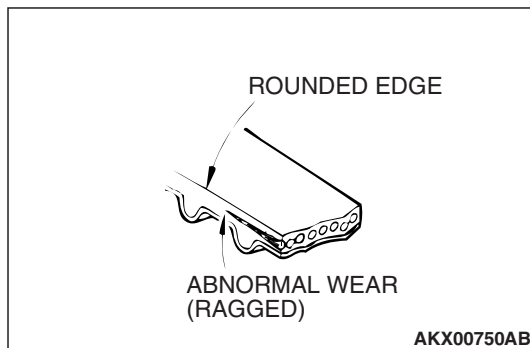
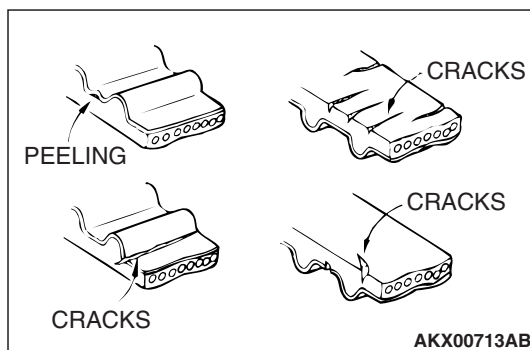
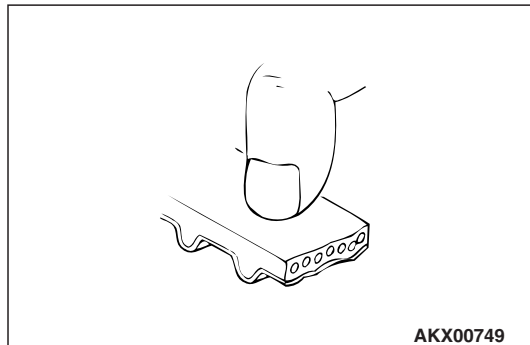


INSPECTION

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)

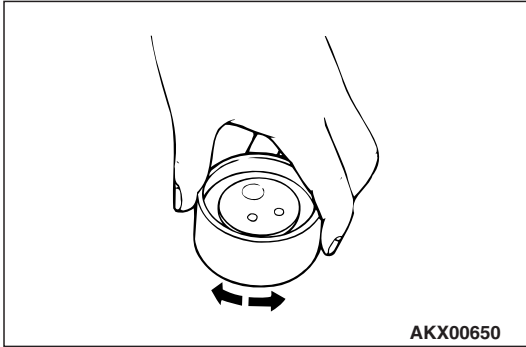
Final stage:

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.

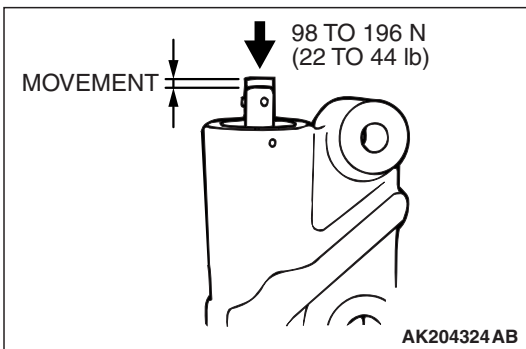
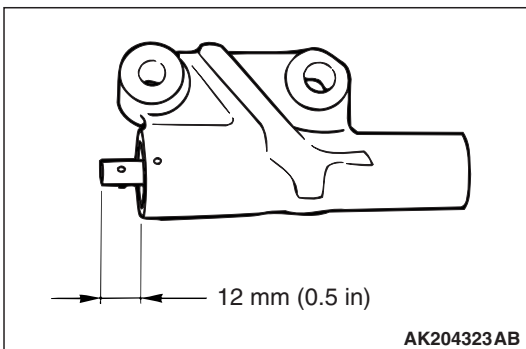


AUTO-TENSIONER

<In case that the amount of rod protrusion is 5 mm with the set pin inserted.>

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.

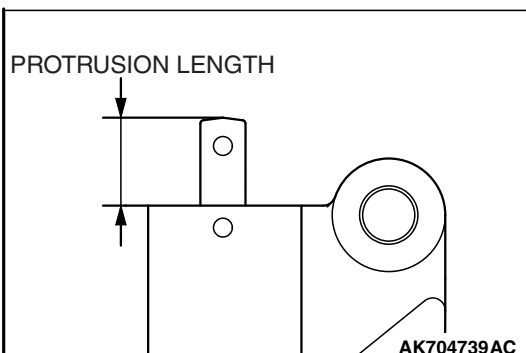
Standard value: 1.0 mm (0.03 inch) or less

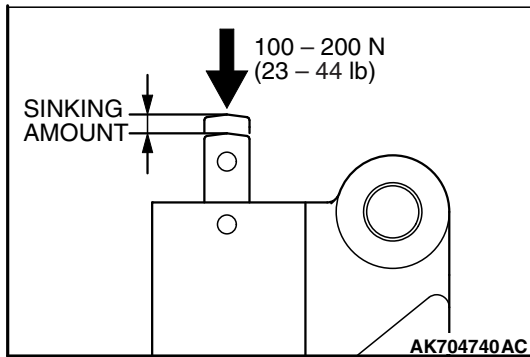
AUTO-TENSIONER

<In case that the amount of rod protrusion is 1 mm with the set pin inserted.>

1. Check the auto tensioner for oil leaks from the sealed sections. Replace it if there is a leak.
2. Check the rod end for wear and other wear and other damage. Replace the auto tensioner if necessary.
3. Measure the length of rod protrusion. If it deviates from the standard value, replace the auto tensioner.

Standard value: 13.5 – 14.5 mm (0.532 – 0.570 inch)





4. Measure the amount of the retraction when the rod is pressed with the force of 100 – 200 N (23 – 44 lb). If it deviates from the standard value, replace the auto tensioner.

Standard value: within 1.0 mm (0.04 inch)

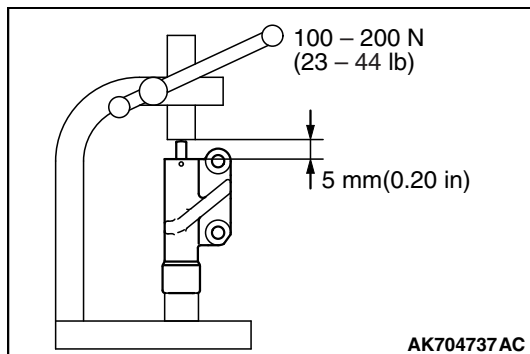
AIR BLEEDING PROCEDURE OF AUTO-TENSIONER

<In case that the amount of rod protrusion is 1 mm with the set pin inserted.>

When the auto tensioner is not kept with its rod upward, or when the set pin having $\phi 2$ mm (0.08 inch) is pulled out before the installation to the engine, carry out the air bleeding as follows.

CAUTION

- If the lateral type press is used, the appropriate air bleeding is not carried out. Always use longitudinal type press.
- To prevent damage to the auto tensioner, do not apply the load of 5,000N (1,124 lb) or more.
- To prevent damage to the auto tensioner, do not press the rod below the cylinder end plane.



1. Set the auto tensioner to the longitudinal type press as shown in the illustration.
2. Slowly press down the rod, two or three times, to the cylinder end plane.
3. When the rod protrusion has approximately 5 mm (0.20 inch), apply the load of 100 – 200N (23 – 44 lb). Check whether the auto tensioner has sufficient stiffness.
4. If the auto tensioner does not have sufficient stiffness, replace the auto tensioner.
5. Slowly pressing down the rod, insert the set pin having $\phi 2$ mm (0.08 inch) through the hole to fix the auto tensioner.

CAUTION

To prevent the air from being incorporated, keep the auto tensioner with its rod upward after the air bleeding.

VALVE CLEARANCE ADJUSTMENT

Adjust the valve clearance as follows:

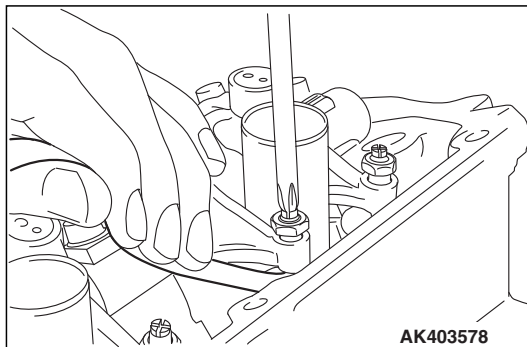
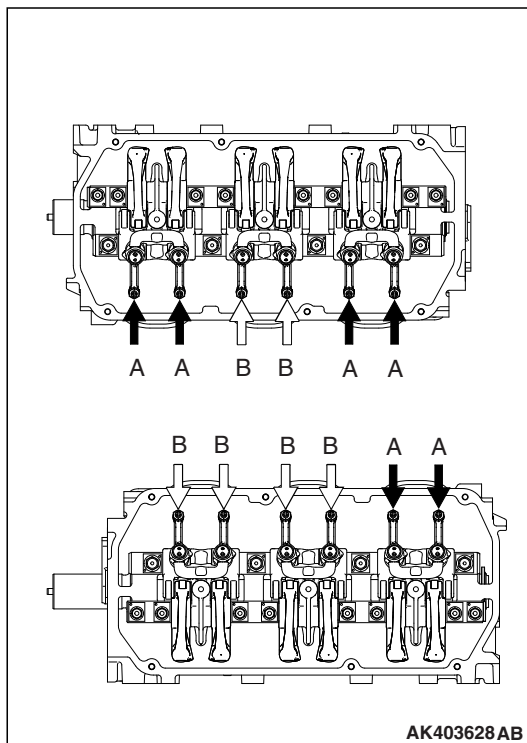
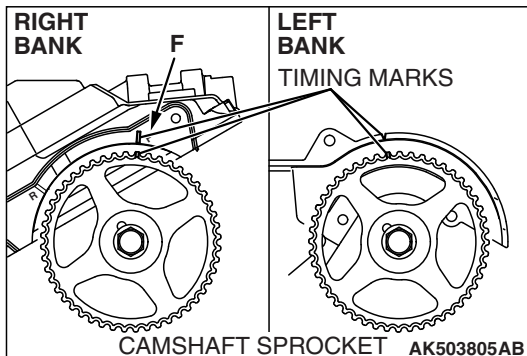
CAUTION

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 Number 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 Number 1 cylinder is on the top dead center of compression stroke.

B: When Number 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)

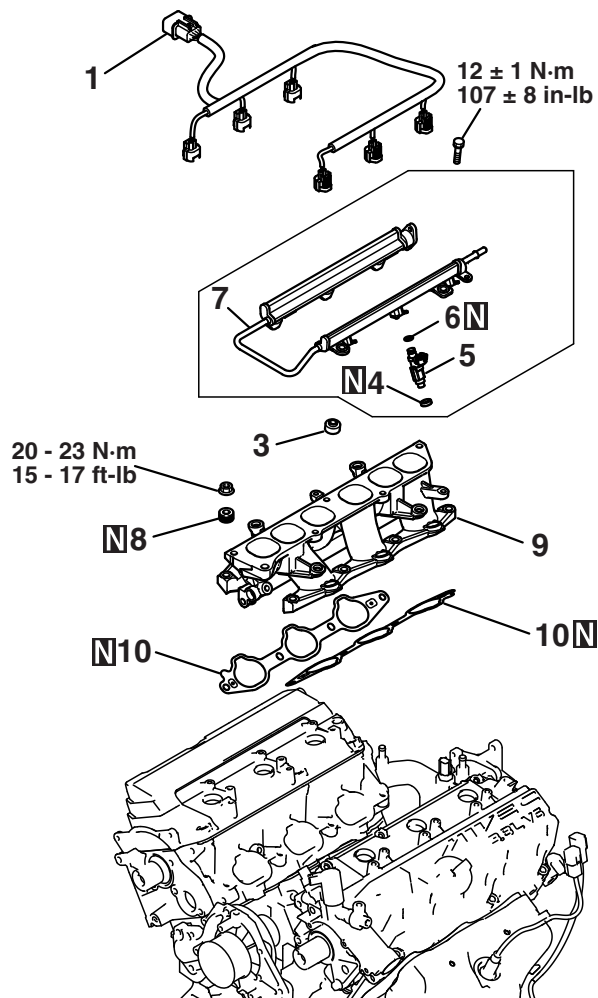
NOTE: After the engine assembly is installed on the vehicle, check the valve clearance again with the engine warmed up. Adjust if necessary.

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 Number 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

M1113004300262



AK403327AB

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

>>A<< INTAKE MANIFOLD INSTALLATION

1. Tighten the nuts "R" to 6.4 ± 1.5 N·m (57 ± 13 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.

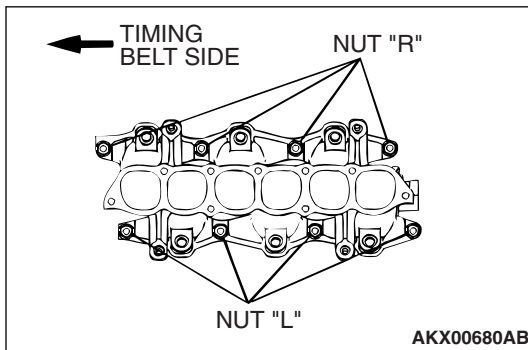
Tightening torque: 20 – 23 N·m (15 – 17 ft-lb)

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)

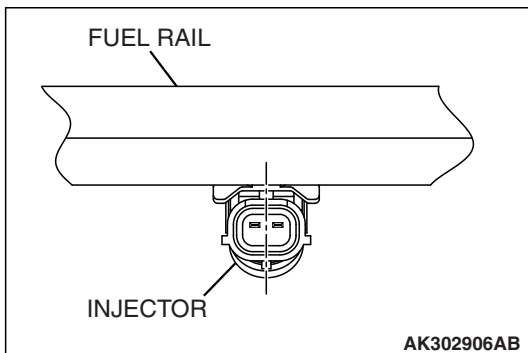
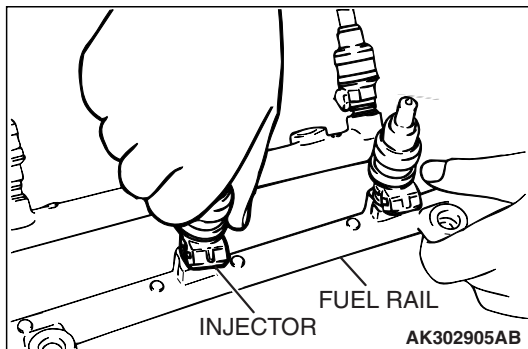


>>B<< INJECTOR INSTALLATION

⚠ CAUTION

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

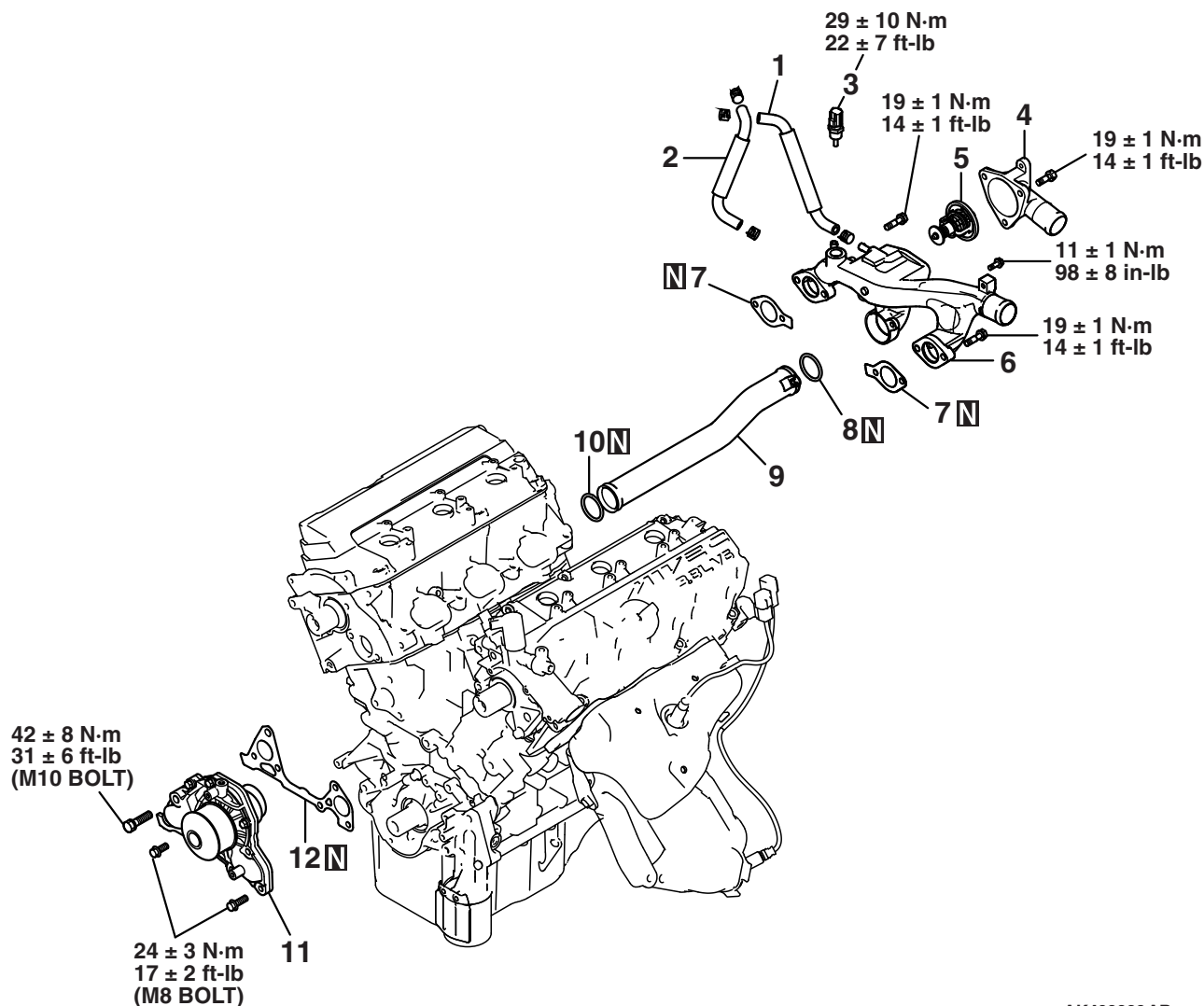
1. Apply clean engine oil to the O-ring.
2. Insert the injector into the fuel rail.
3. Make sure the injector rotates smoothly. If not, remove the injector to check the O-ring for damage, and replace the O-ring if necessary. Then reinsert the injector and check that it rotates smoothly.
4. Confirm the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



WATER PUMP & WATER HOSE

REMOVAL AND INSTALLATION

M1113017900695



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

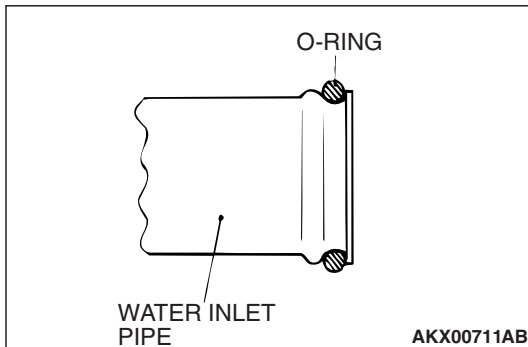
INSTALLATION SERVICE POINTS

>>A<< O-RING AND WATER INLET PIPE INSTALLATION

CAUTION

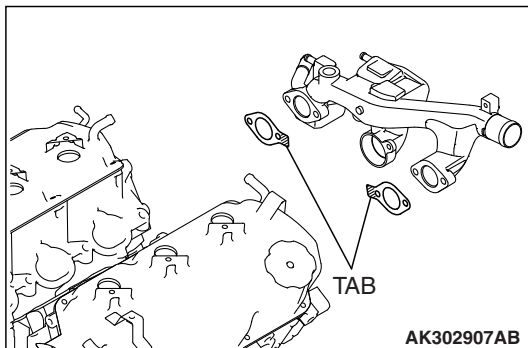
Keep the O-ring free of oil or grease.

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.



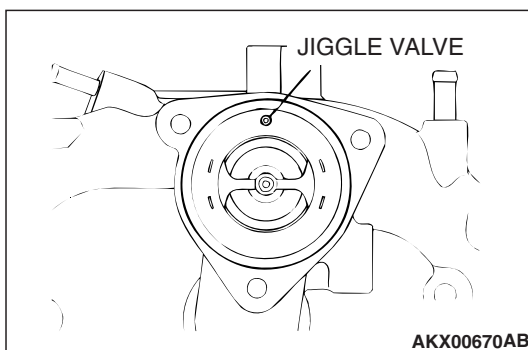
>>B<< THERMOSTAT HOUSING GASKET INSTALLATION

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



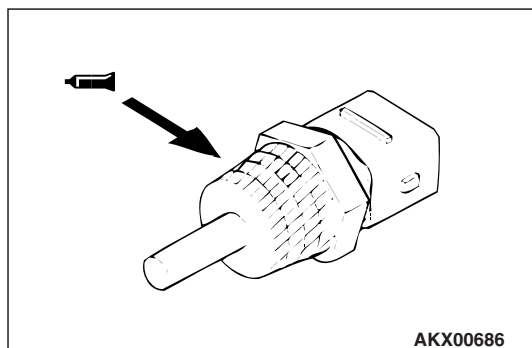
>>C<< THERMOSTAT INSTALLATION

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.



>>D<< SEALANT APPLICATION TO ENGINE
COOLANT TEMPERATURE SENSOR

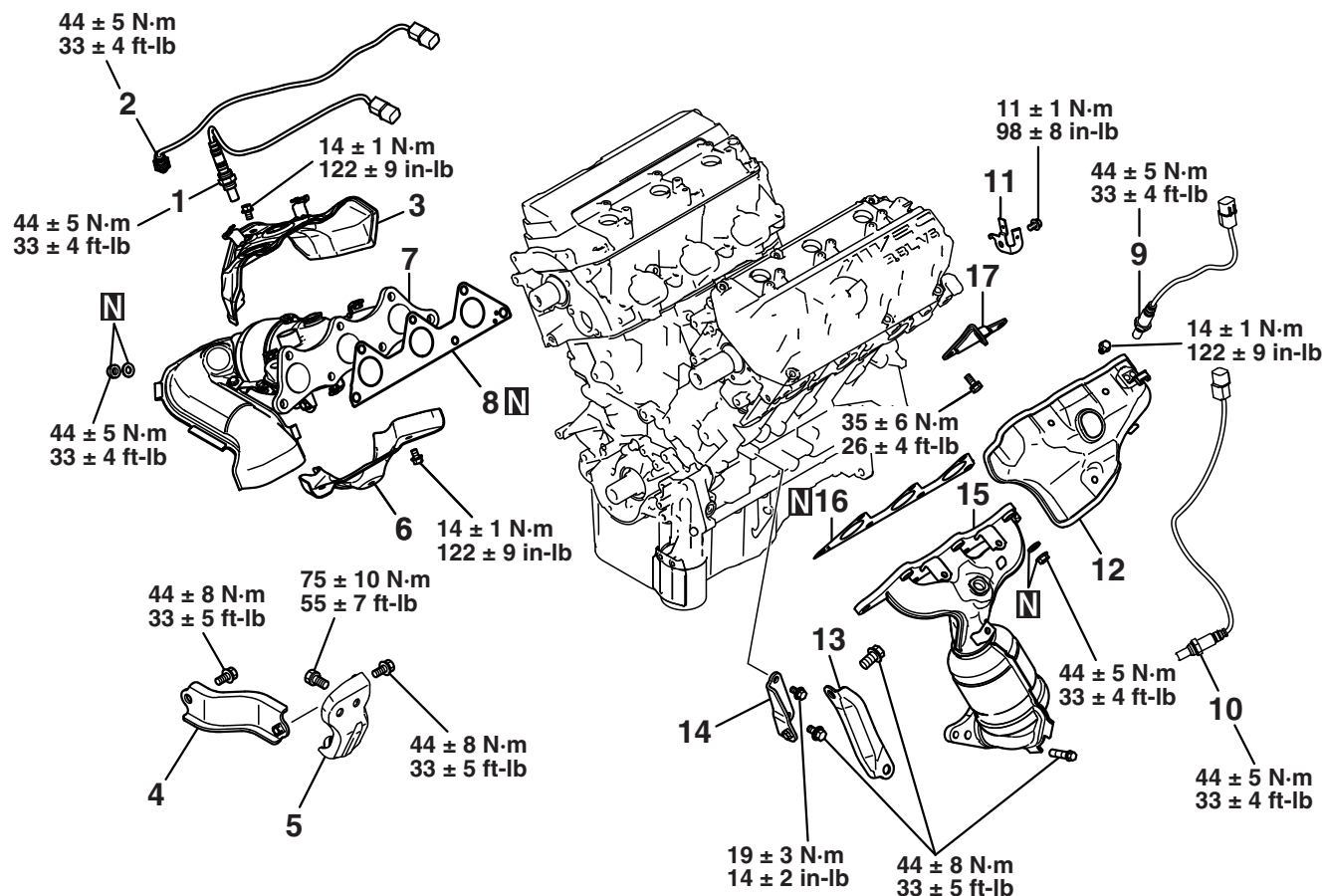
Apply sealant (3M™ AAD Part number 8731 or equivalent) to the engine coolant temperature sensor.



EXHAUST MANIFOLD

REMOVAL AND INSTALLATION

M1113004901836



AK503810AD

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

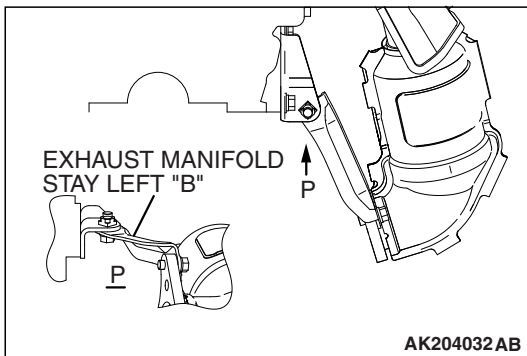
INSTALLATION SERVICE POINTS

>>A<< 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.
3. Tighten the bolt on the left "A" side of exhaust manifold stay to the specified torque.

Tightening torque: 44 ± 8 N·m (33 ± 5 ft-lb)

Tightening torque: 44 ± 8 N·m (33 ± 5 ft-lb)

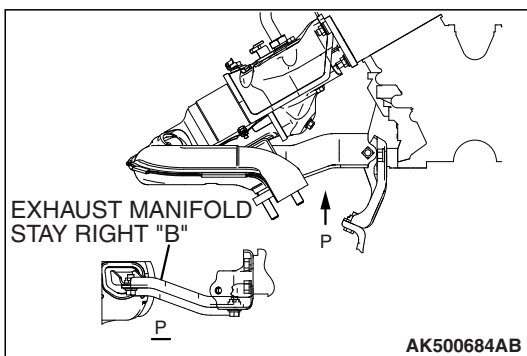


>>B<< EXHAUST MANIFOLD STAY, RIGHT "B" INSTALLATION

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.
3. Tighten the bolt on the right "A" side of exhaust manifold stay to the specified torque.

Tightening torque: 44 ± 8 N·m (33 ± 5 ft-lb)

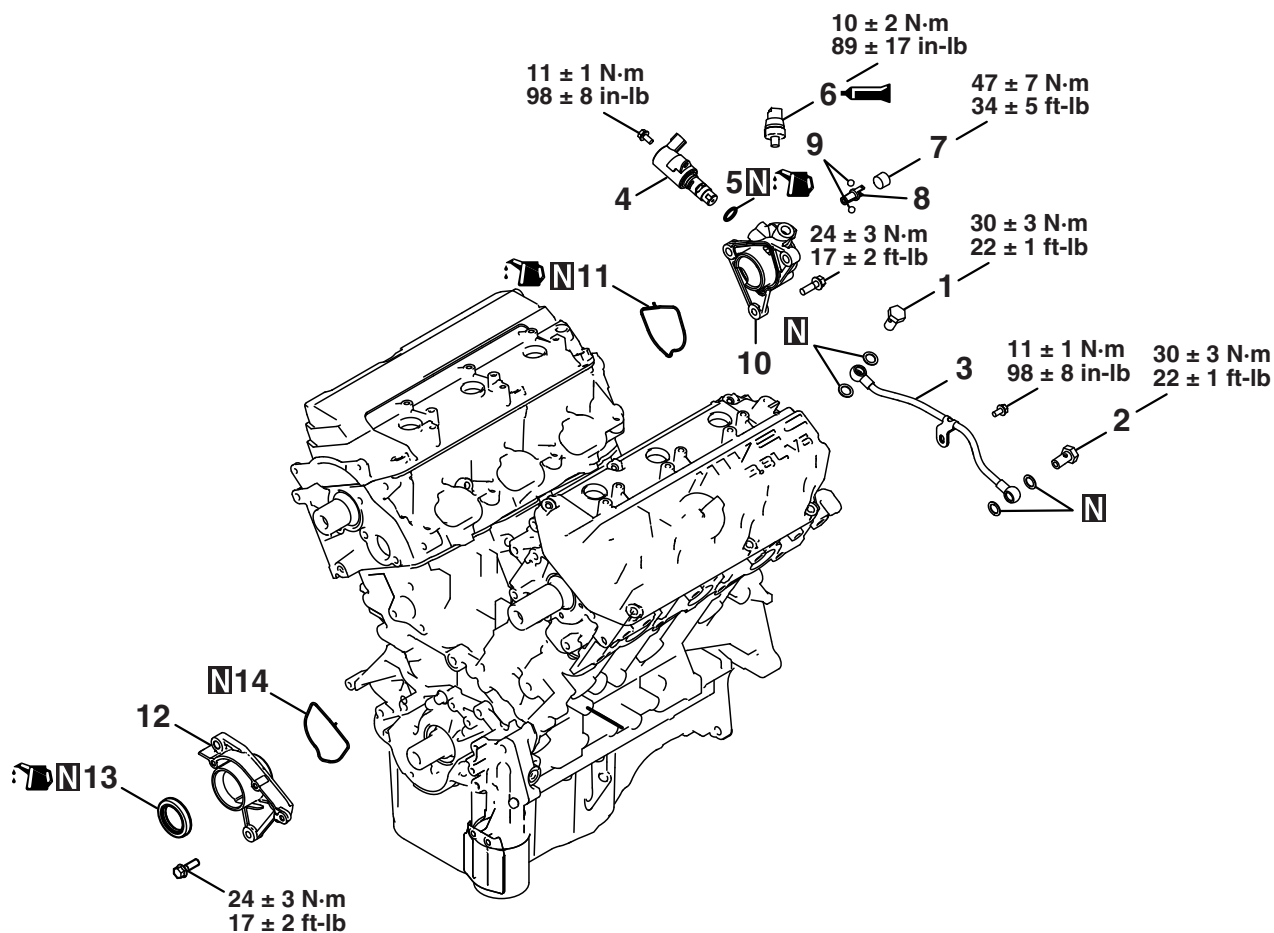
Tightening torque: 44 ± 8 N·m (33 ± 5 ft-lb)



ENGINE OIL CONTROL VALVE

REMOVAL AND INSTALLATION

M1113028000243



AK705031AB

REMOVAL STEPS

- >>E<< 1. EYE BOLT
2. EYE BOLT
3. OIL PIPE
>>D<< 4. OIL FEEDER CONTROL VALVE
5. O-RING
>>C<< 6. OIL PRESSURE SWITCH
7. TAPER PLUG
8. OIL FEEDER CONTROL VALVE
FILTER

REMOVAL STEPS (Continued)

9. STEEL BALL
>>A<< 10. OIL FEEDER CONTROL VALVE
HOUSING
>>A<< 11. OIL FEEDER CONTROL VALVE
HOUSING GASKET
>>A<< 12. OIL SEAL CASE
>>B<< 13. OIL SEAL
>>A<< 14. OIL SEAL CASE GASKET

Required Special Tool:

- MD998713: Camshaft Oil Seal Installer

INSTALLATION SERVICE POINTS

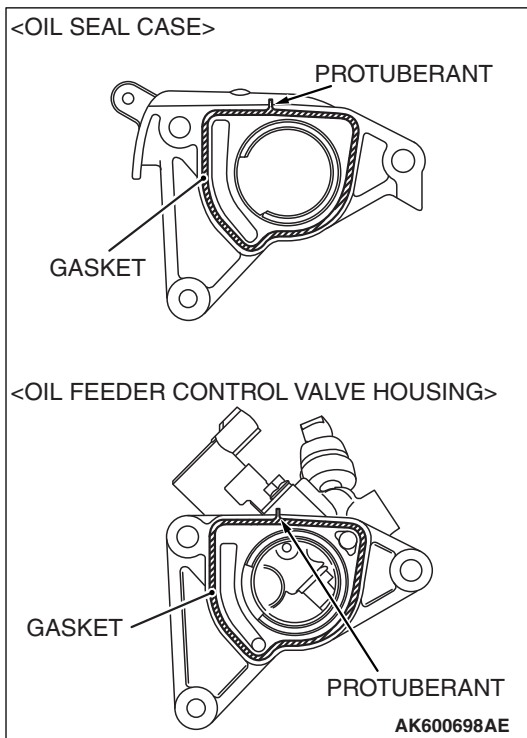
>>A<< OIL FEEDER CONTROL VALVE HOUSING / OIL FEEDER CONTROL VALVE HOUSING GAS- KET / OIL SEAL CASE / OIL SEAL CASE GASKET

CAUTION

- Oil passage shall be free from foreign matters.
- Shall confirm fully that matching plane and such are free from foreign matters.

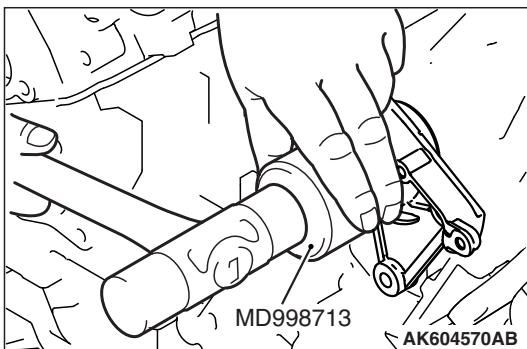
1. Install the oil feeder control valve housing gasket and oil seal case gasket so that the protuberant is positioned as shown in the illustration.
2. Tighten the oil feeder control valve housing and oil seal case.

Tightening torque: 24 ± 3 N·m (17 ± 2 ft-lb)



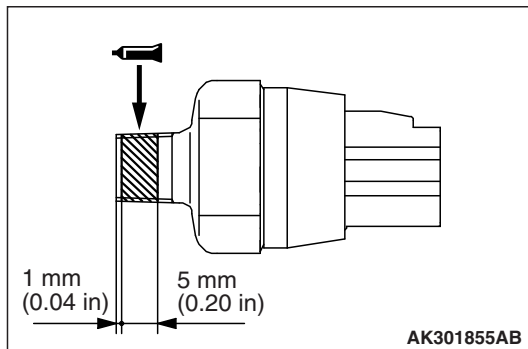
>>B<< OIL SEAL INSTALLATION

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.



>>C<< ENGINE OIL PRESSURE SWITCH
INSTALLATION

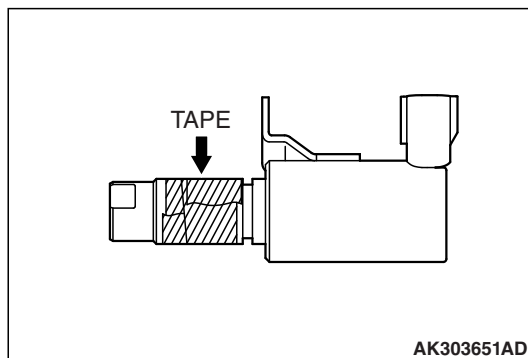
Apply sealant (Three bond 1212D, Three bond 1215 or equivalent) to the threads of engine oil pressure switch.

>>D<< 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.

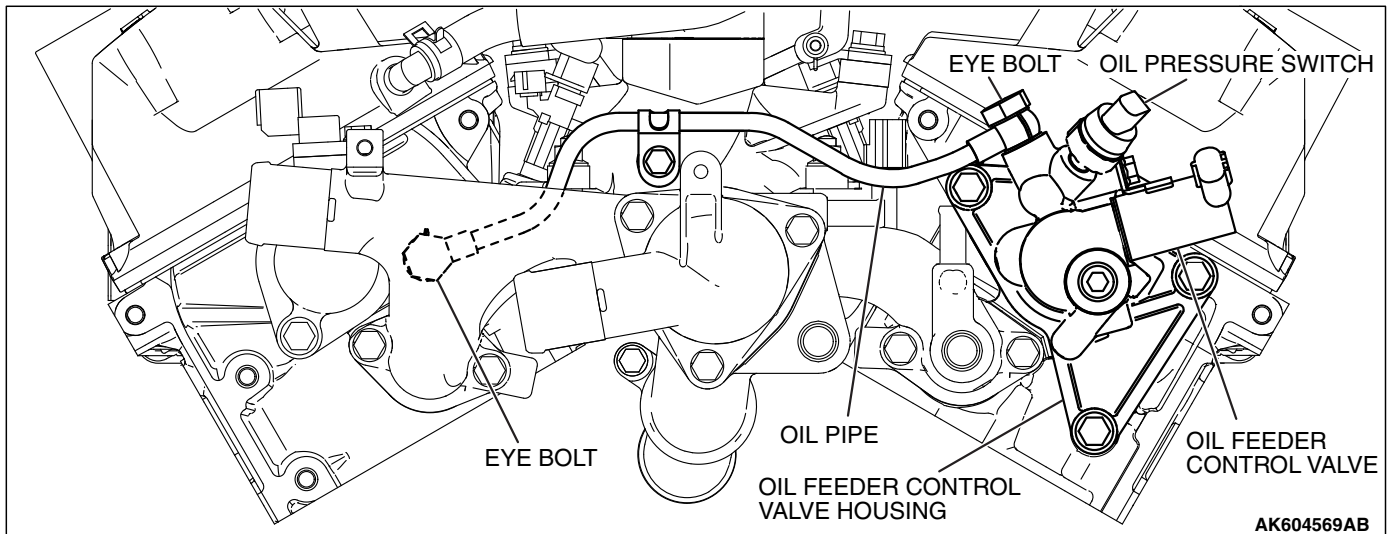
Tightening torque: 11 ± 1 N·m (98 ± 8 in-lb)



>>E<< OIL PIPE / EYE BOLT INSTALLATION

⚠ CAUTION

Oil pipe shall be installed by following instruction so that pipe does not become deformed.



1. Install the oil pipe and eye bolt gasket lightly with eye bolt by hand.

2. Tighten eye bolt.

Tightening torque: 30 ± 3 N·m (22 ± 1 ft-lb)

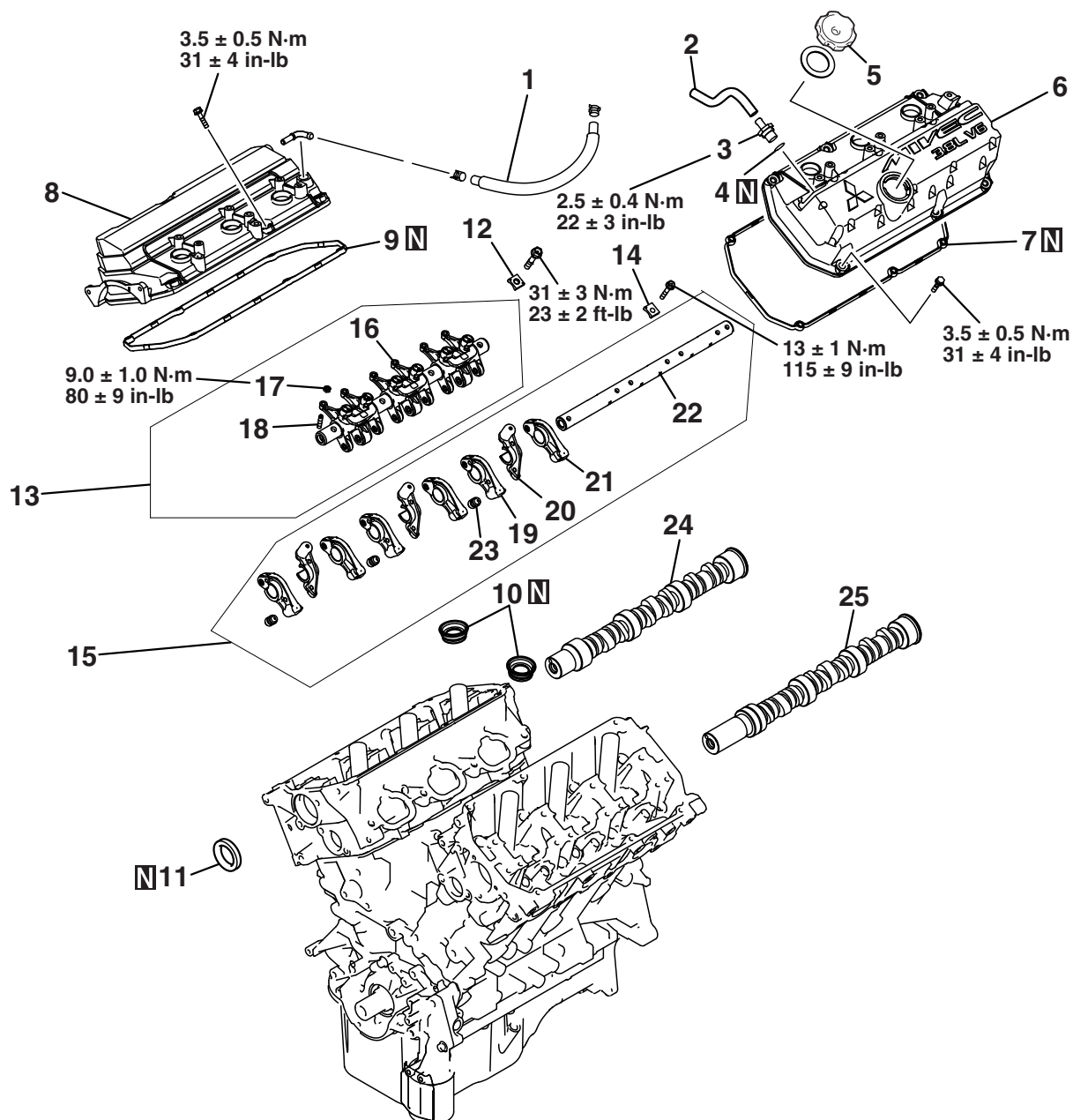
3. Tighten the flange bolt.

Tightening torque 11 ± 1 N·m (98 ± 8 in-lb)

ROCKER ARMS AND CAMSHAFT

REMOVAL AND INSTALLATION

M1113005402150



AK802505AB

REMOVAL STEPS

1. BREATHER HOSE
2. POSITIVE CRANKCASE VENTILATION HOSE
3. POSITIVE CRANKCASE VENTILATION VALVE
4. O-RING
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
<> >>D<< 15. ROCKER ARMS AND SHAFT ASSEMBLY
16. ROCKER ARMS AND SHAFT INTAKE
>>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

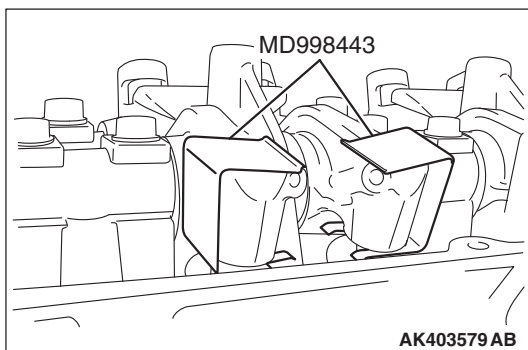
When the rocker arm is removed from the rocker shaft, tag them to show the installation location for the reinstallation of the rocker arm, the piston arm assembly and so on.

<> ROCKER ARMS AND SHAFT REMOVAL

⚠ CAUTION

If the lash adjuster is re-used, clean the lash adjuster.
(Refer to lash adjuster inspection [P.11D-38.](#))

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



INSTALLATION SERVICE POINTS

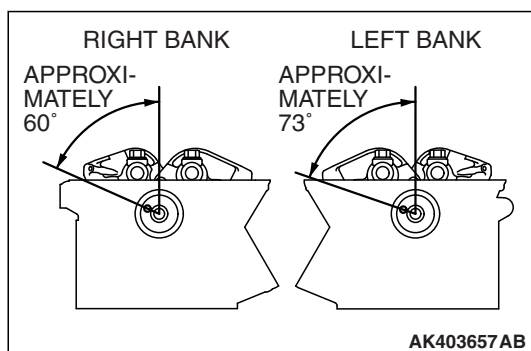
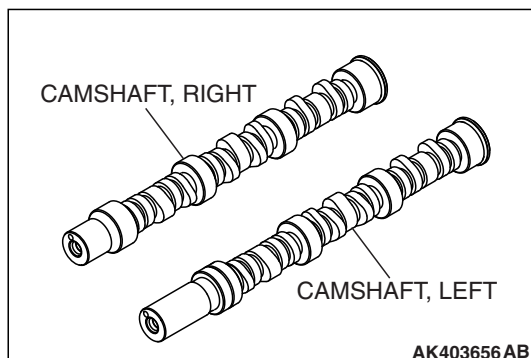
>>A<< CAMSHAFT INSTALLATION

⚠ 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.



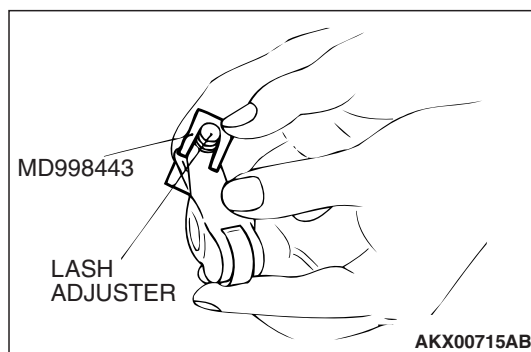
2. Check to see that the dowel pin of the camshaft is located at the position shown.

>>B<< LASH ADJUSTER INSTALLATION

⚠ CAUTION

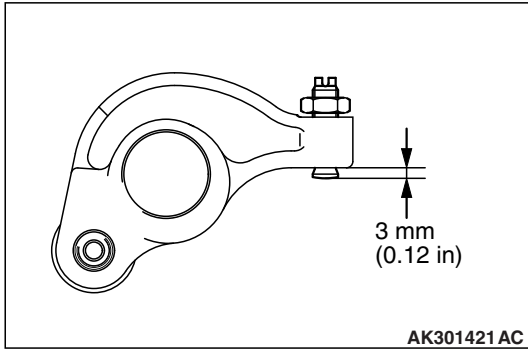
If the lash adjuster is re-used, clean the lash adjuster. (Refer to lash adjuster inspection [P.11D-38](#).)

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.



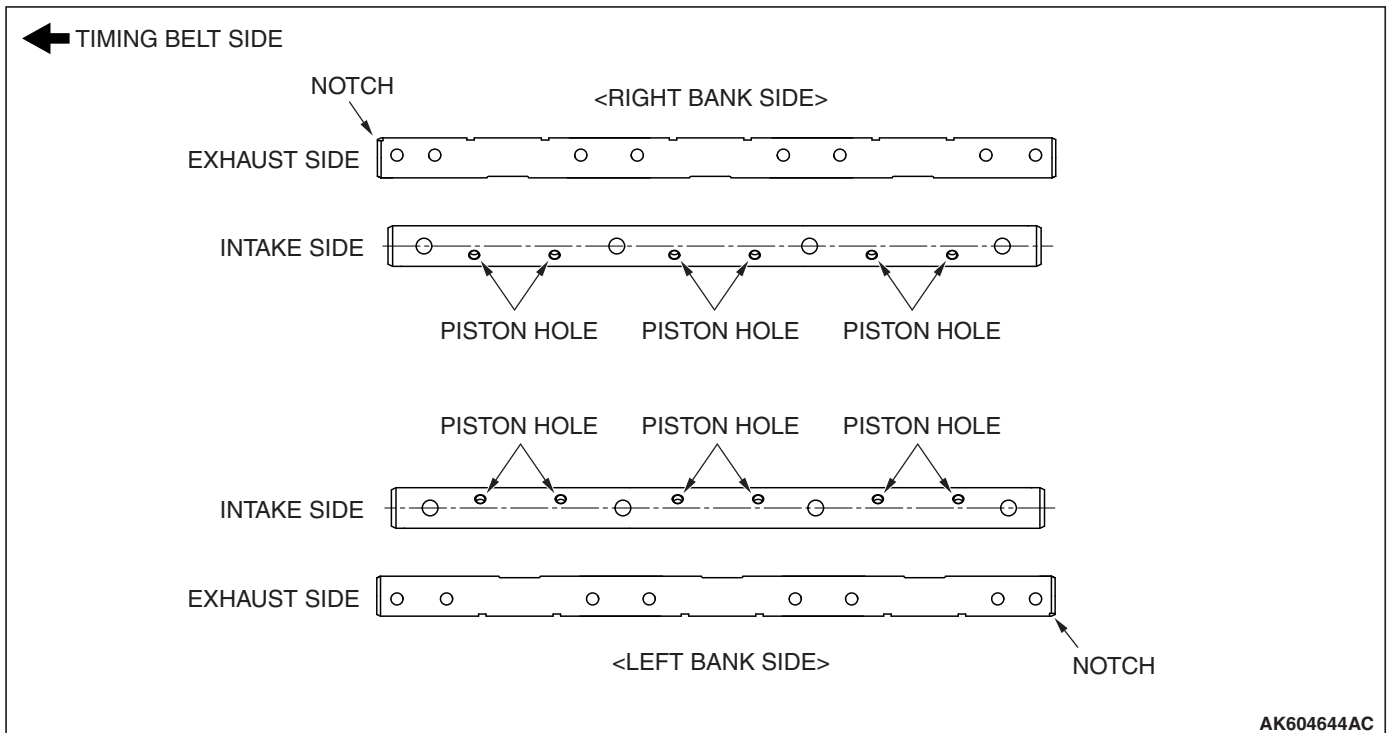
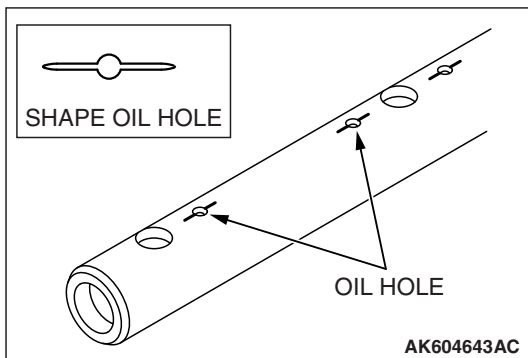
>>C<< ADJUSTING SCREW INSTALLATION

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.



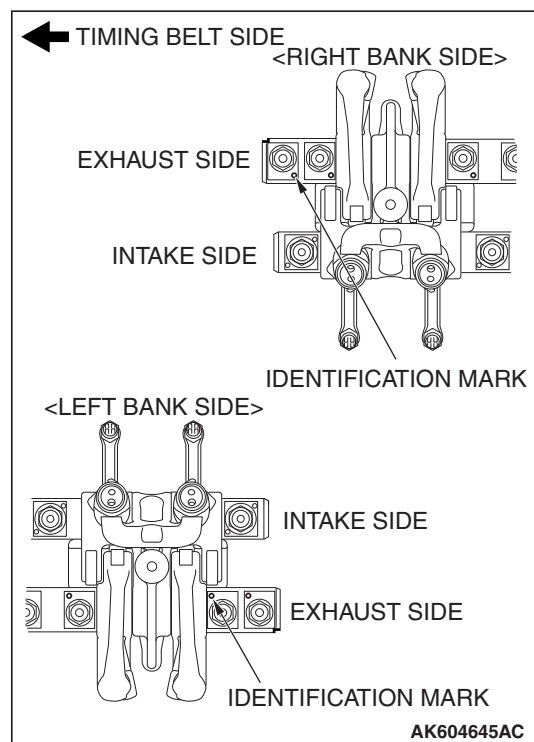
>>D<< ROCKER ARMS AND SHAFT INSTALLATION

1. Place each rocker arm shaft with the side having the oil holes of the illustrated shape facing down (toward the cylinder head).



2. Check that the oil holes on each rocker arm shaft are in the positions shown in the illustration.

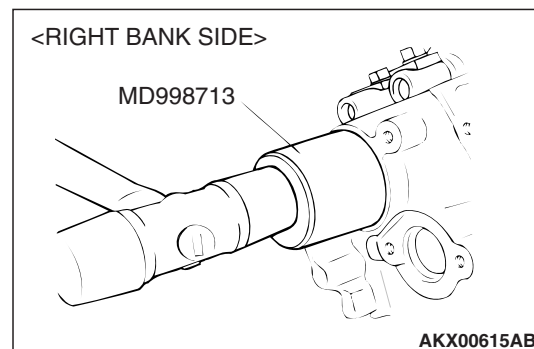
NOTE: The intake rocker arm shafts have four bolt holes each.



3. Check that the notch on each exhaust side rocker arm shaft is at the position shown in the illustration.

NOTE: The exhaust rocker arm shafts have six bolt holes each.

4. According the tags showing the reinstallation locations, install the rocker arms and all other parts on each rocker arm shaft.
5. When installing the rocker arm shaft, check that the identification marks are at the positions shown in the illustration.
6. Tighten the intake rocker arm shaft bolts to the specified torque of 13 ± 1 N·m (115 ± 9 in-lb).
7. Tighten the exhaust rocker arm shaft bolts to the specified torque of 13 ± 1 N·m (115 ± 9 in-lb).
8. Remove the lash adjuster holder (MD998443).



>>E<< 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

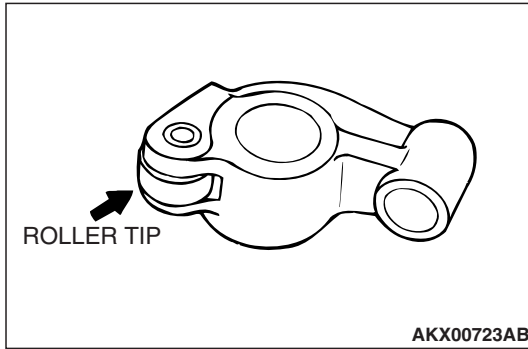
M1113005501295

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.

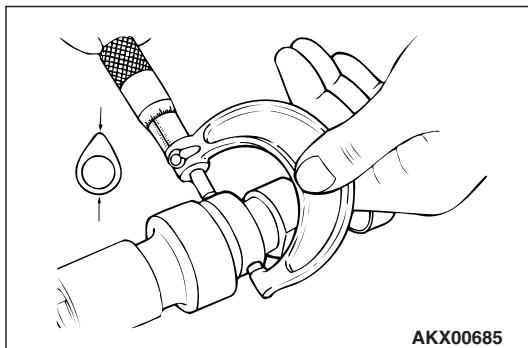


CAMSHAFT

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) |
| 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) |

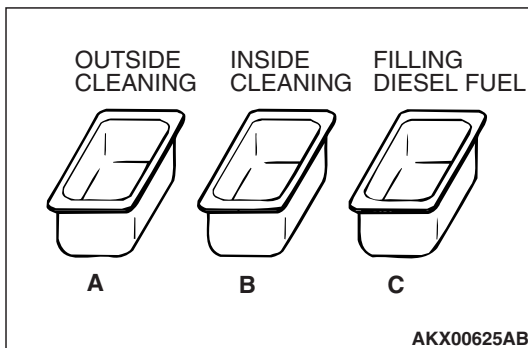


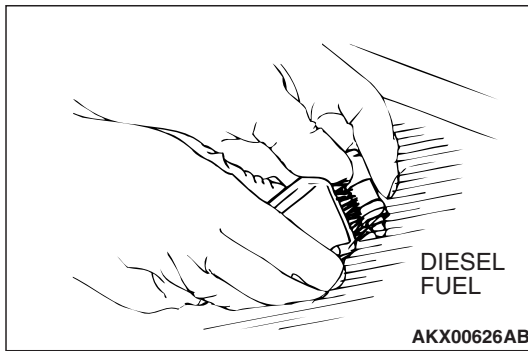
LASH ADJUSTERS

⚠ 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 dm³ (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.



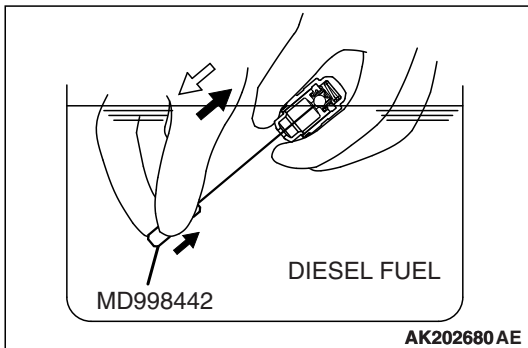


2. Place the lash adjuster in container A and clean its outside surface.

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

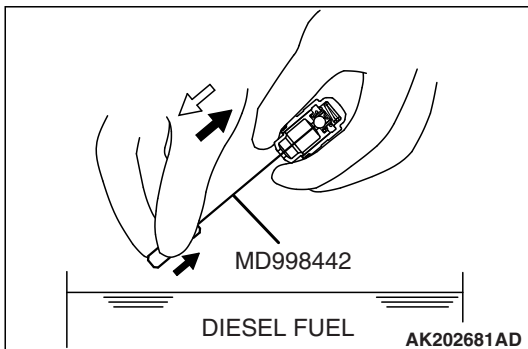
⚠ CAUTION

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.

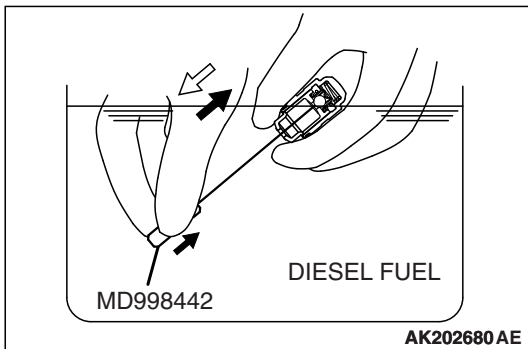
NOTE: If the plunger remains stiff or the mechanism appears otherwise abnormal, replace the lash adjuster.



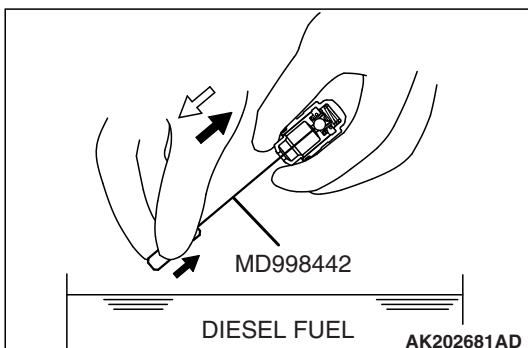
4. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

⚠ 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.

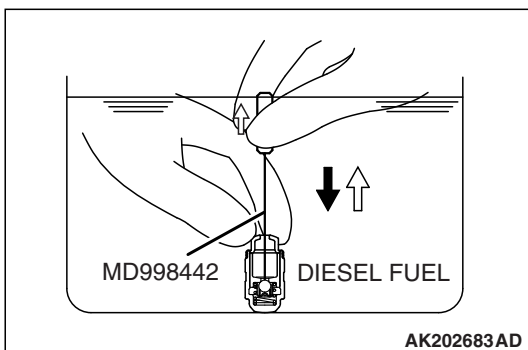
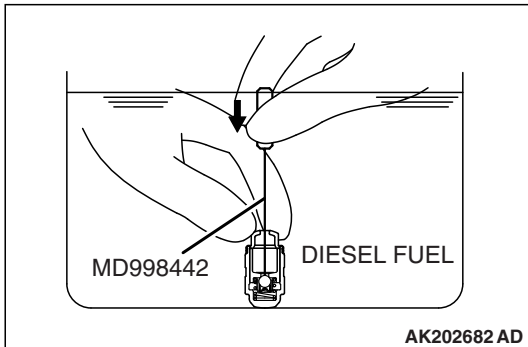


6. Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

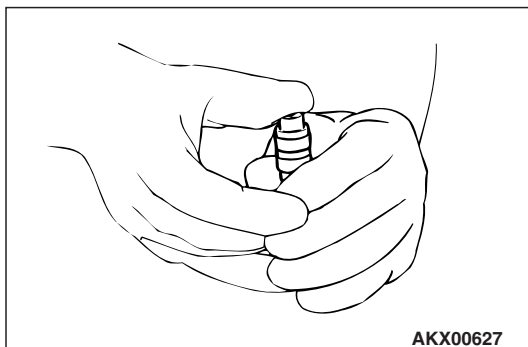
⚠ CAUTION

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.

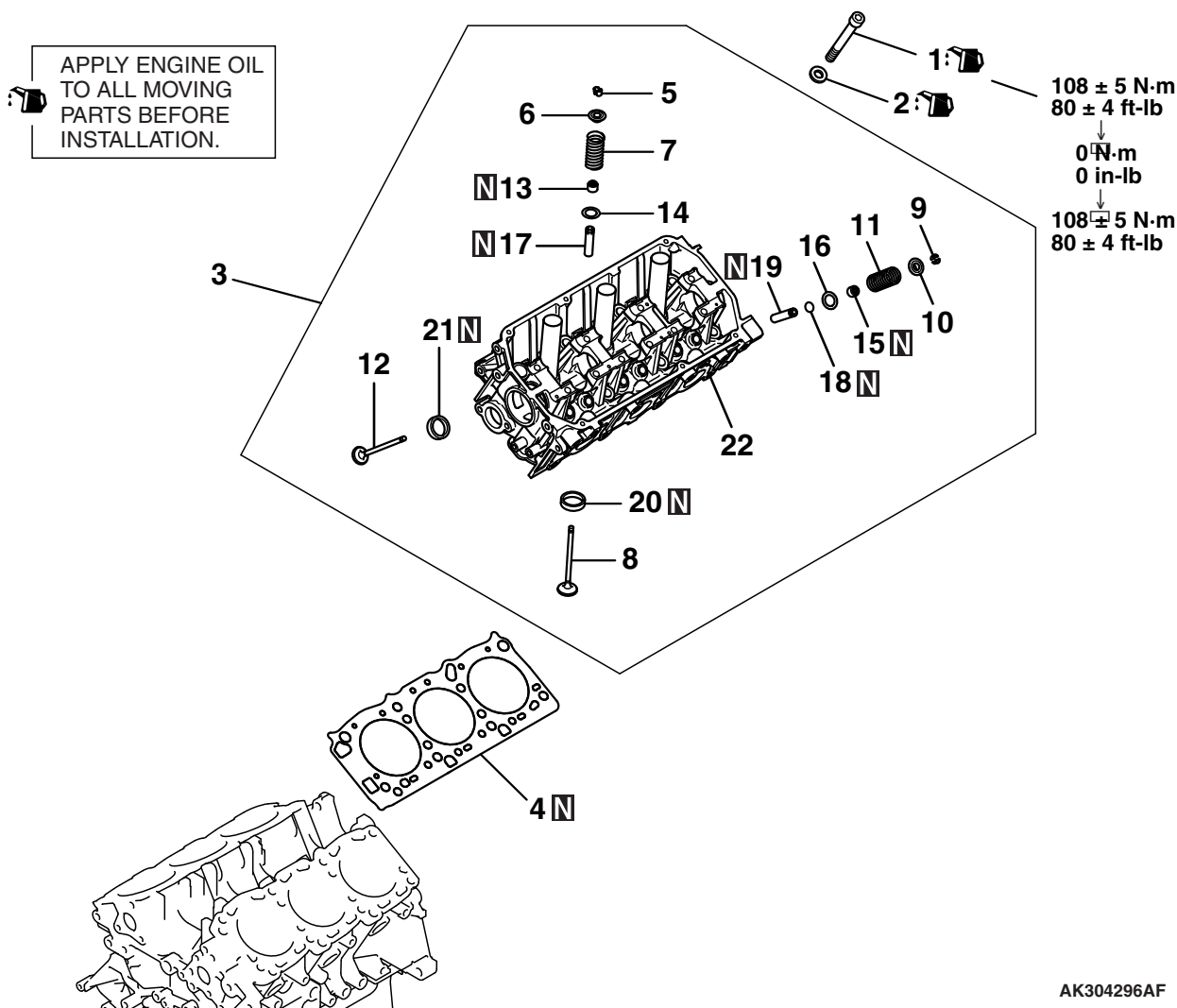
Replace the lash adjuster if it still contracts or moves after performing these steps.

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

M1113006902200



REMOVAL STEPS

- <<A>> >>D<< 1. CYLINDER HEAD BOLT
2. WASHER
3. CYLINDER HEAD ASSEMBLY
<> >>C<< 4. CYLINDER HEAD GASKET
5. RETAINER LOCK
6. VALVE SPRING RETAINER
 >>B<< 7. VALVE SPRING
8. INLET VALVE
<> >>C<< 9. RETAINER LOCK
10. VALVE SPRING RETAINER
 >>B<< 11. VALVE SPRING

REMOVAL STEPS (Continued)

- >>A<< 12. EXHAUST VALVE
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

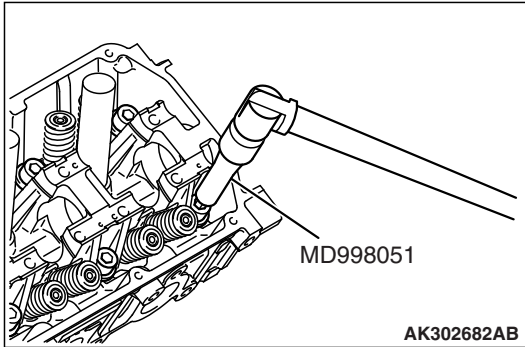
Required Special Tools:

- 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

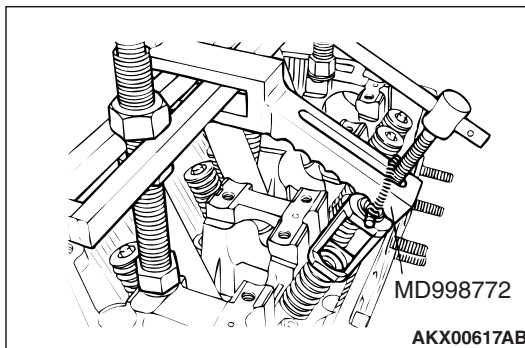
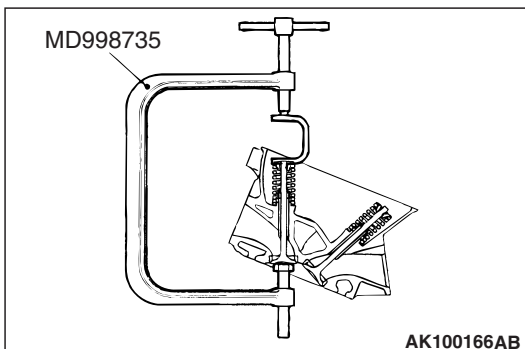
Use special tool MD998051 to loosen the cylinder head bolt.



<> 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.



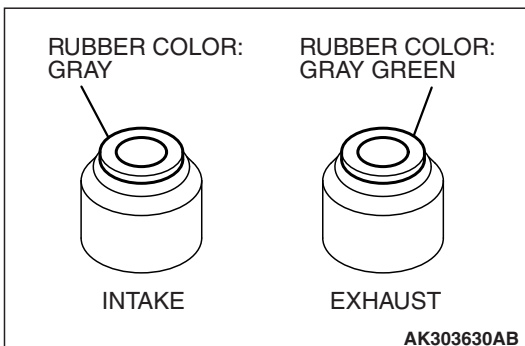
INSTALLATION SERVICE POINTS

>>A<< VALVE STEM SEAL INSTALLATION

1. Install the valve spring seat.

CAUTION

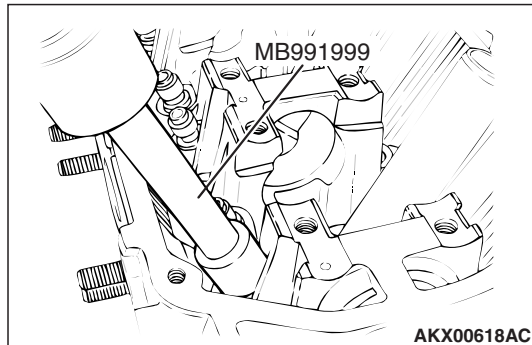
- Valve stem seals for intake valves and for exhaust valves are different. Be sure to install the correct ones.
- Valve stem seal identification color
Intake: GRAY
Exhaust: GRAY GREEN



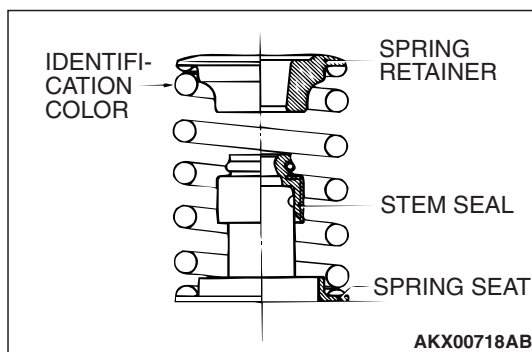
⚠ CAUTION

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.

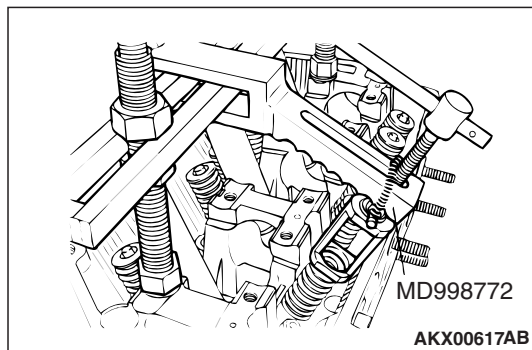
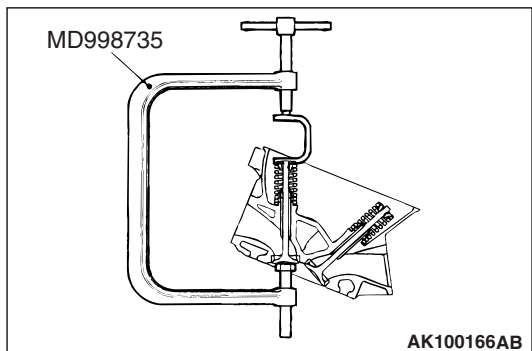
**>>B<< VALVE SPRING INSTALLATION**

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

**>>C<< 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.



>>D<< CYLINDER HEAD BOLT INSTALLATION

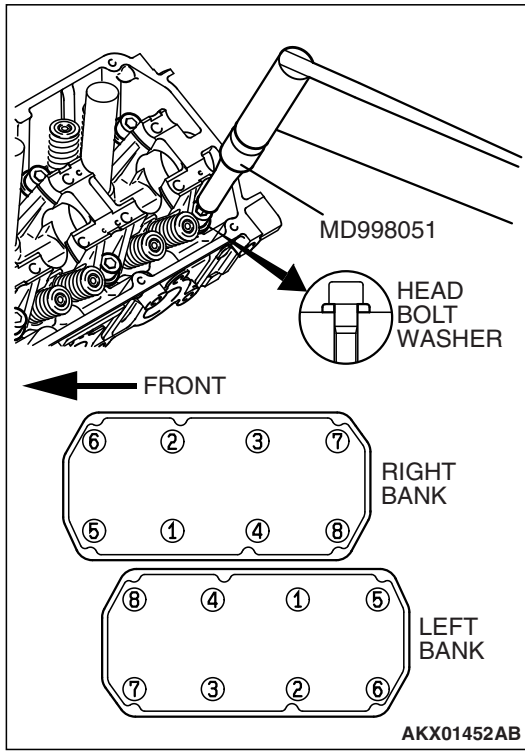
CAUTION

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 ± 5 N·m (80 ± 4 ft-lb)

2. Back off the bolts once and tighten them again to the specified torque in step 1.



INSPECTION

M1113007001962

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)

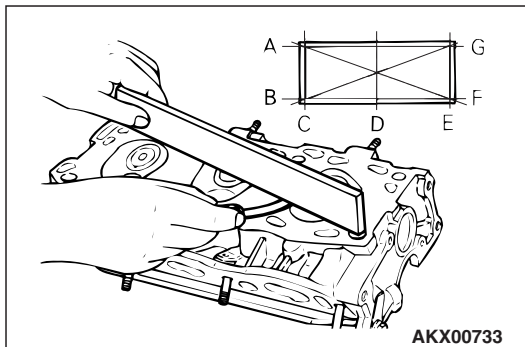
Limit: 0.2 mm (0.007 inch)

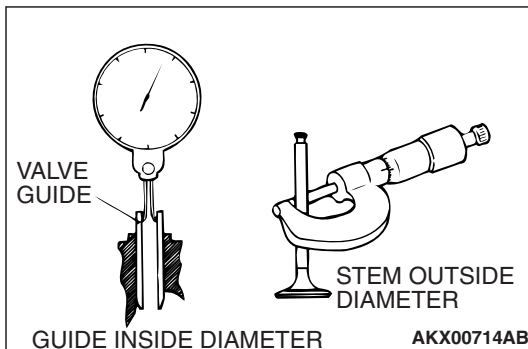
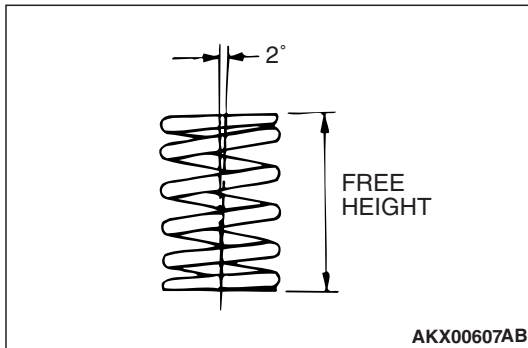
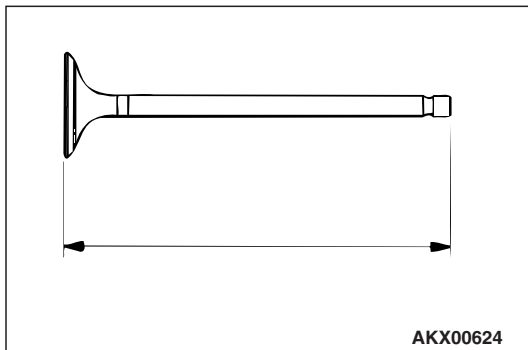
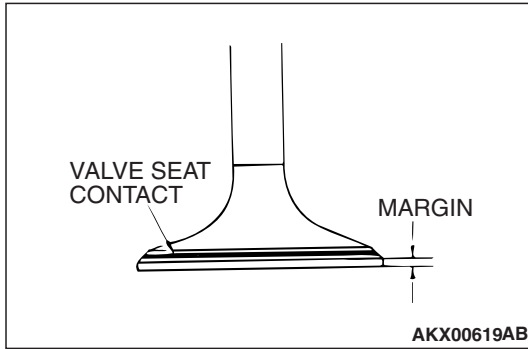
2. If the service limit is exceeded, correct to meet the specification.

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:

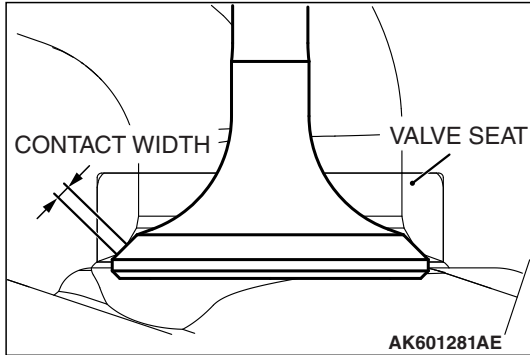
<Intake> 0.02 – 0.05 mm (0.0008 – 0.0019 inch)

<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 contact width. If the measurement exceeds the specified limit, replace the valve seat.

Standard value: 0.9 – 1.3 mm (0.04 – 0.05 inch)

⚠ CAUTION

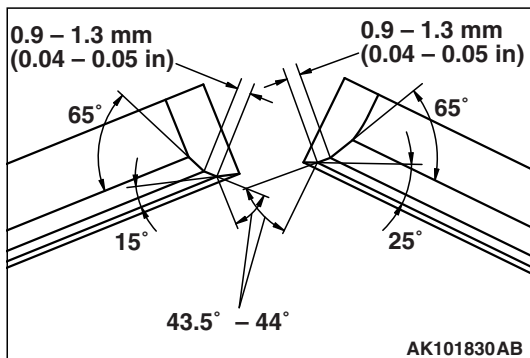
If the variation in the width exceeds 0.2 mm (0.008 inch) even if the contact width is within the standard value, replace or correct the valve seat.

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.

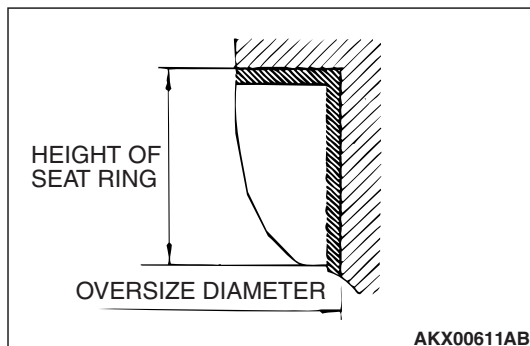
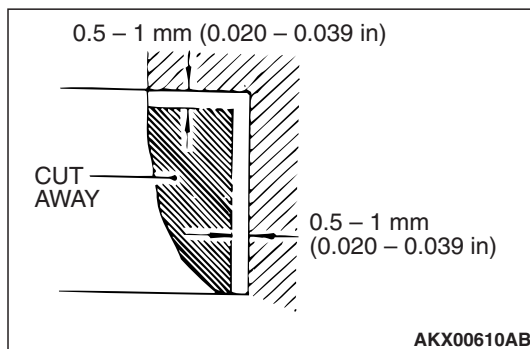


VALVE SEAT REPLACEMENT PROCEDURE

⚠ 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. Rebore 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)

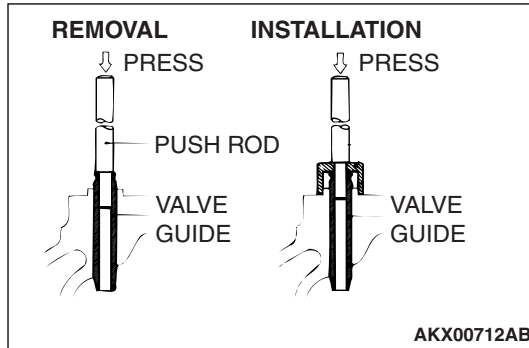
0.6 oversize 38.10 – 38.13 mm (1.5000 – 1.5012 inches)

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)

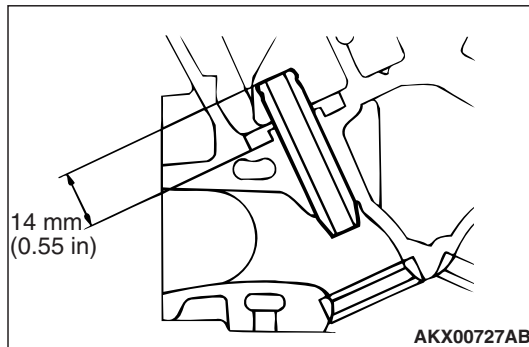
0.25 oversize 11.25 – 11.27 mm (0.4429 – 0.4437 inch)

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.

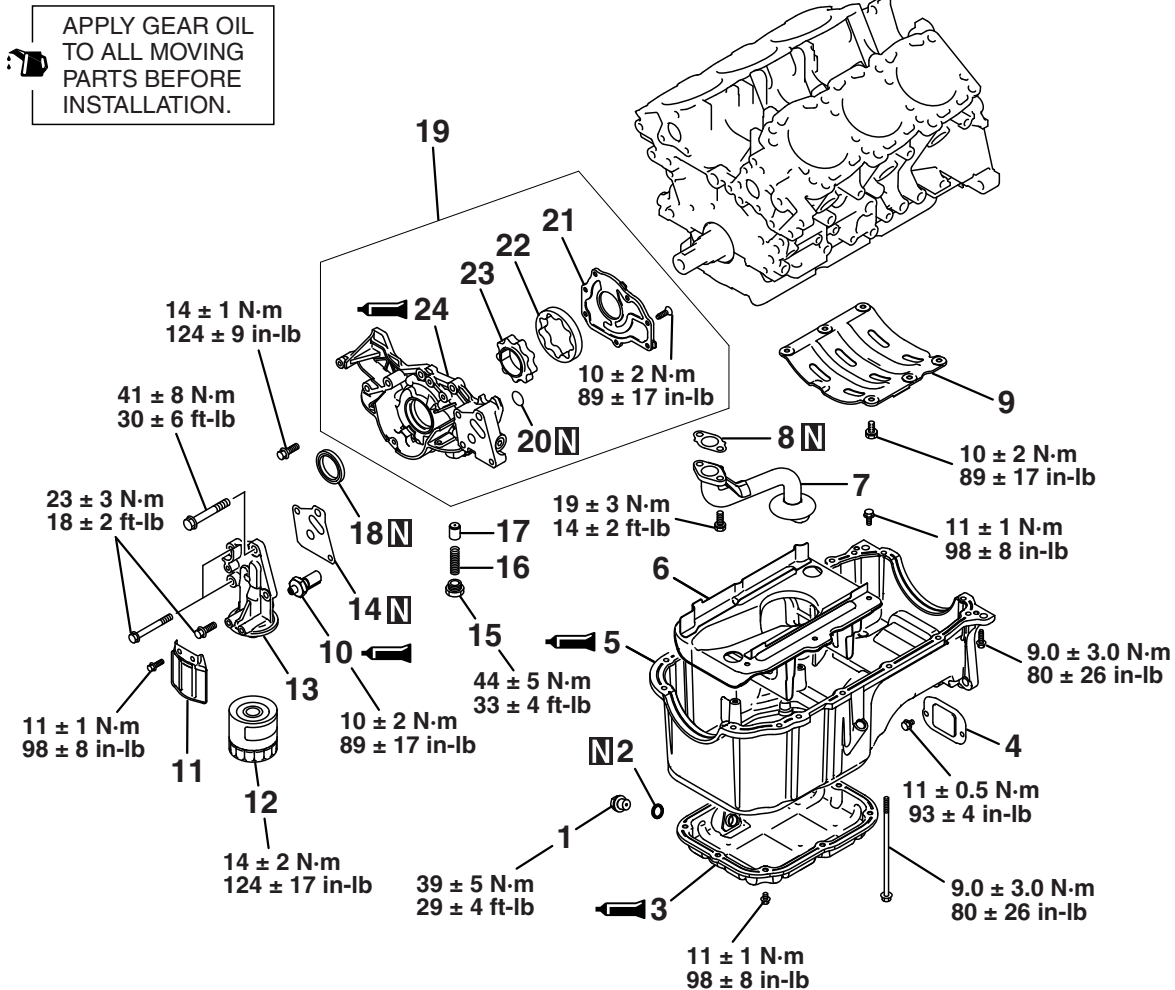
NOTE: After installing the valve guides, insert new valves in them to check for sliding condition.



OIL PAN AND OIL PUMP

REMOVAL AND INSTALLATION

M1113008102006



AK604571AD

REMOVAL STEPS

1. DRAIN PLUG
- >>H<< 2. DRAIN PLUG GASKET
- <<A>> >>G<< 3. OIL PAN, LOWER
- <> >>F<< 4. COVER
5. OIL PAN, UPPER
6. BAFFLE PLATE
7. OIL SCREEN
8. OIL SCREEN GASKET
9. BAFFLE PLATE
- >>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
- <<C>> >>A<< 22. OIL PUMP OUTER ROTOR
- <<C>> >>A<< 23. OIL PUMP INNER ROTOR
24. OIL PUMP CASE

Required Special Tools:

- MD998717: Crankshaft Front Oil Seal Installer

REMOVAL SERVICE POINT

<<A>> 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.

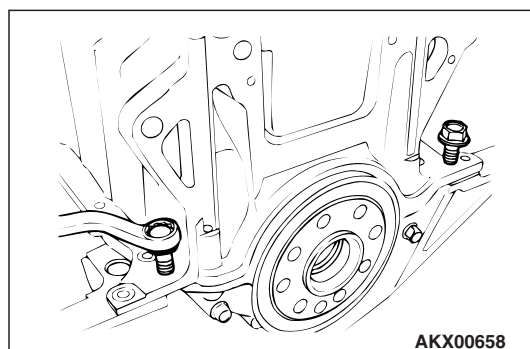
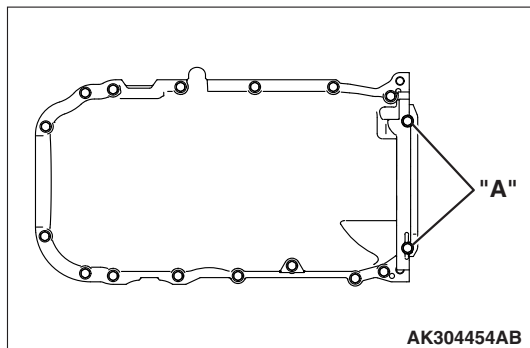
<> OIL PAN, UPPER REMOVAL

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

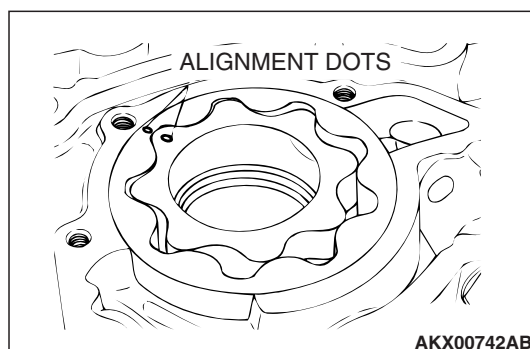
⚠ CAUTION

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.

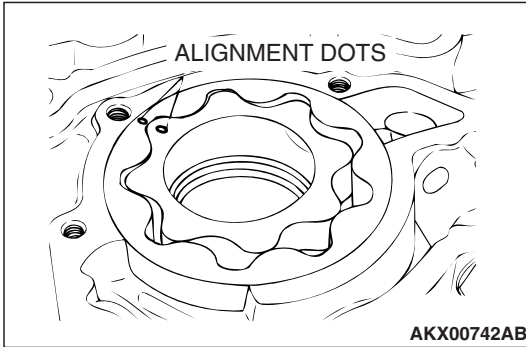


<<C>> OUTER ROTOR / INNER ROTOR REMOVAL

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

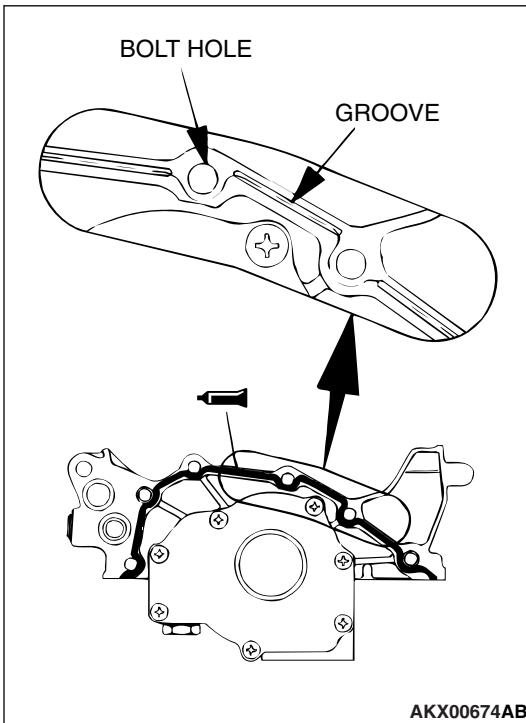
INSTALLATION SERVICE POINTS

>>A<< 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.

>>B<< 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 (Three bond 1217G 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.

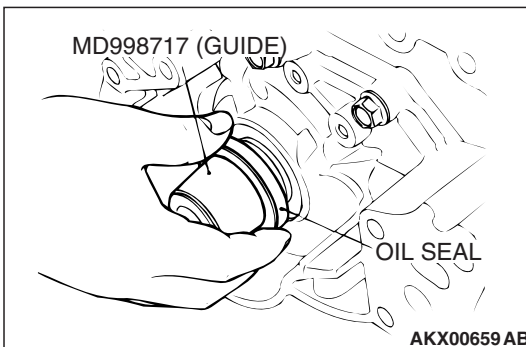
NOTE: Be sure to install the oil pump case quickly while the sealant is wet (within 15 minutes).

4. Tighten the oil pump case mounting bolts to the specified torque.

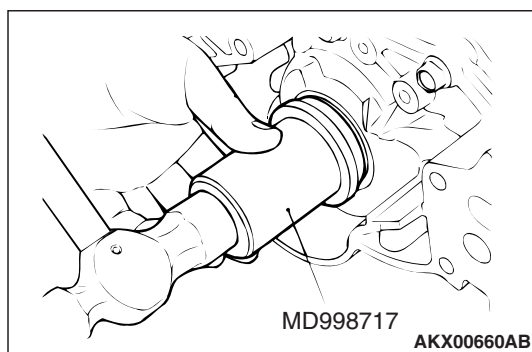
Tightening torque: 14 ± 1 N·m (124 ± 9 in-lb)

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

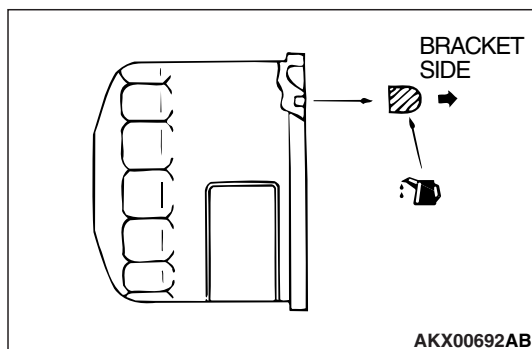
>>C<< CRANKSHAFT FRONT OIL SEAL INSTALLATION



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.



- Using special tool MD998717, press-fit the oil seal into the oil pump case.



>>D<< OIL FILTER INSTALLATION

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

Tightening torque: 14 ± 2 N·m (124 ± 17 in-lb)

- If no torque wrench can be used for tightening, use the following procedure.
 - Screw in the oil filter until its O-ring contacts the oil filter bracket.
 - Tighten the oil filter 1 turn.

>>E<< ENGINE OIL PRESSURE SWITCH INSTALLATION

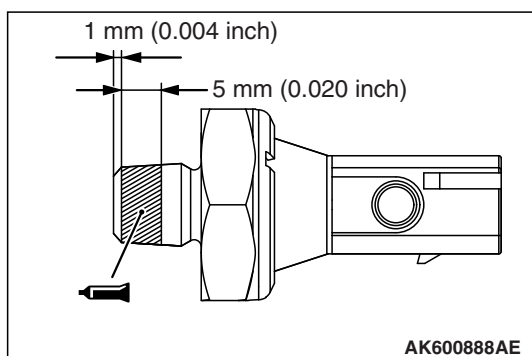
CAUTION

Keep the end of threaded portion clear of sealant. Avoid an overtightening.

- Apply sealant to the oil pressure switch threads.

Specified sealant:

Three bond 1212D, Three bond 1215 or equivalent



>>F<< OIL PAN, UPPER INSTALLATION

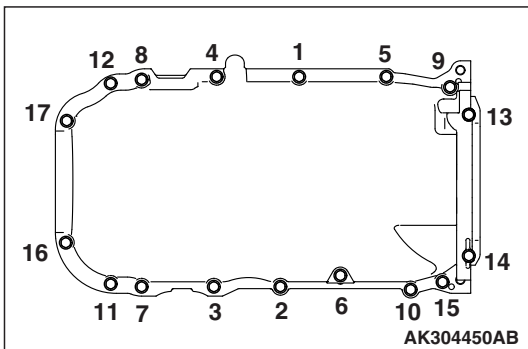
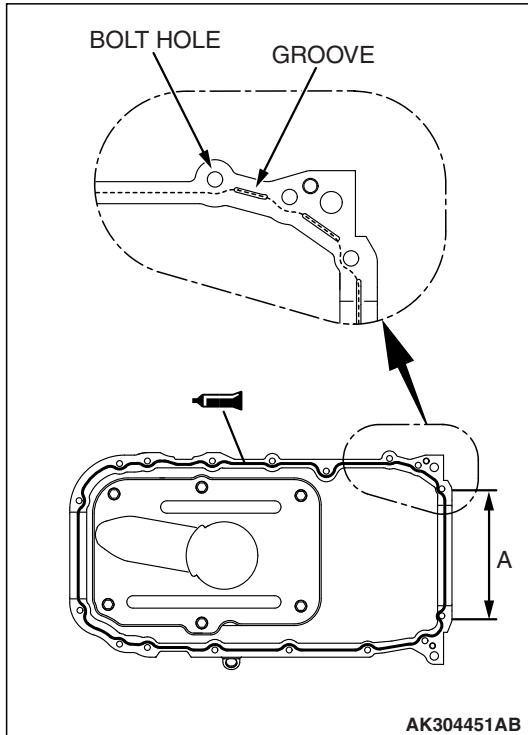
1. Clean both gasket surfaces of the upper oil pan and cylinder block.
2. Apply a 4 mm (0.2 inch) diameter bead of sealant (Three bond 1217G or equivalent) to the upper oil pan.
Apply sealant as indicated by the broken line in the illustration; the grooves must be traced and the bolt holes must be surrounded 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.

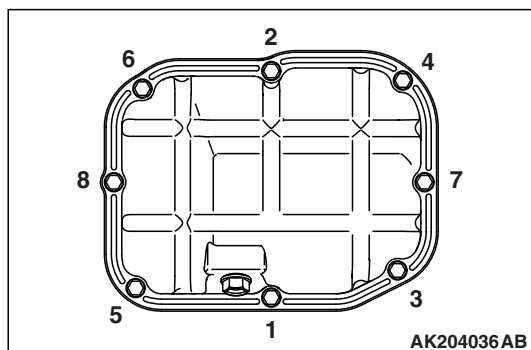
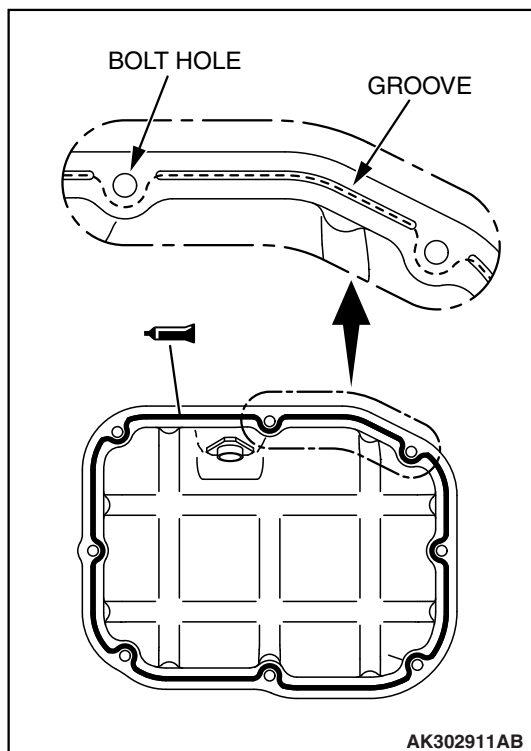
NOTE: Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).



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

Tightening torque: 9.0 ± 3.0 N·m (80 ± 26 in-lb)

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

**>>G<< 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 (Three bond 1217G 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 ± 1 N·m (98 ± 8 in-lb)

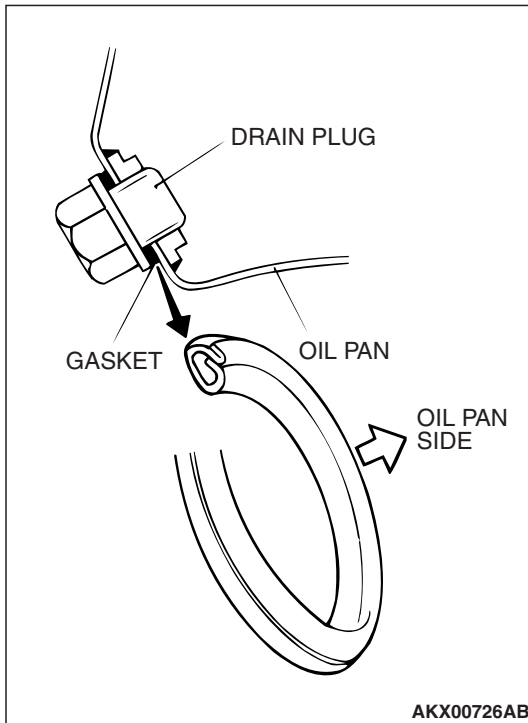
NOTE: After installation, keep the sealed area away from oil for approximately one hour.

>>H<< 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.



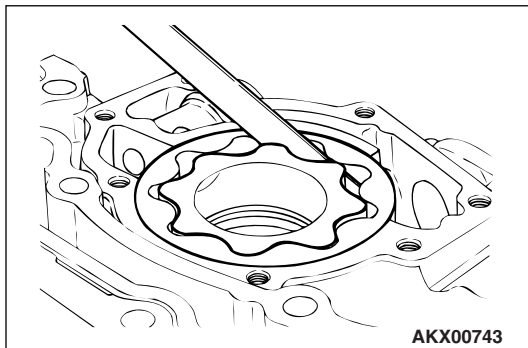
INSPECTION

M1113008200171

OIL PUMP

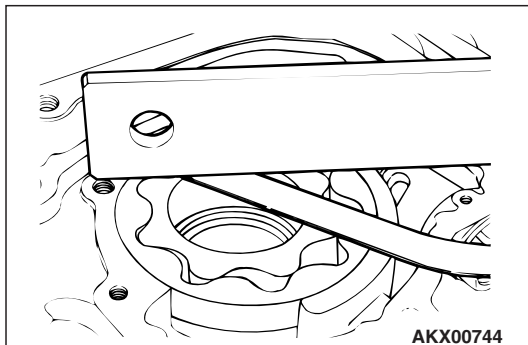
1. Check the tip clearance.

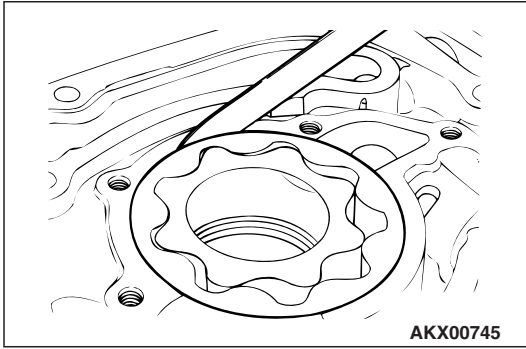
Standard value: 0.06 – 0.18 mm (0.003 – 0.007 inch)



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)

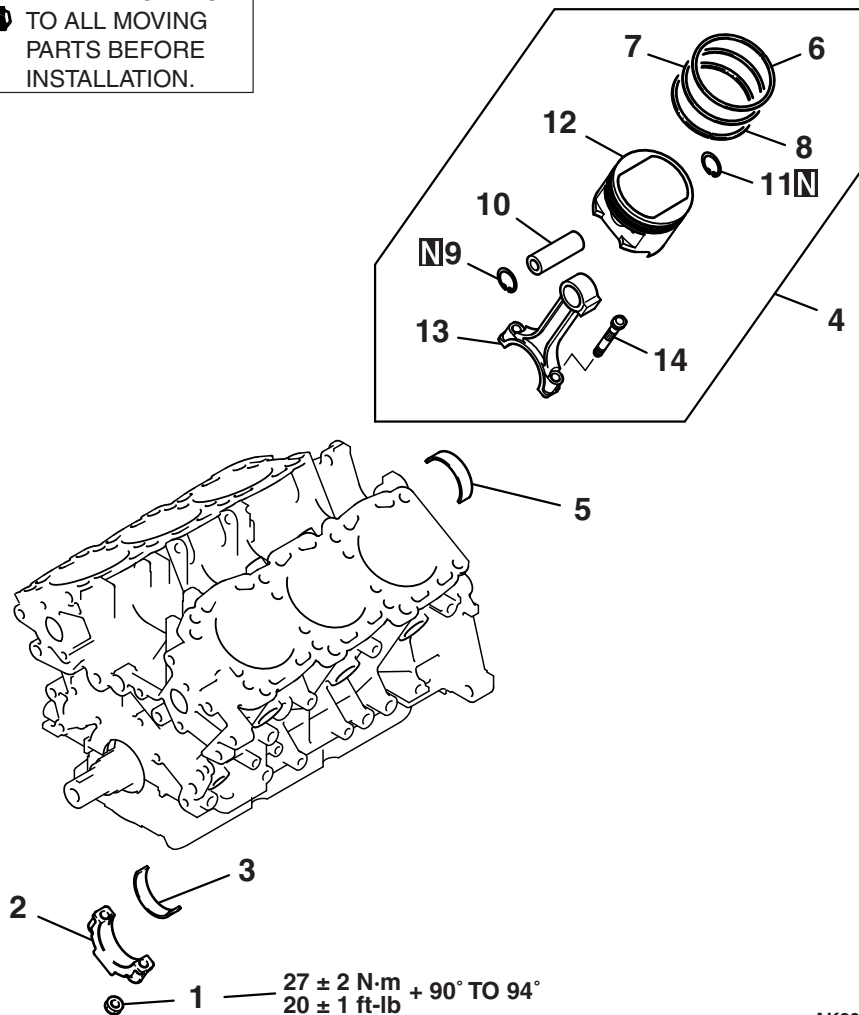
Limit: 0.35 mm (0.013 inch)

PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION

M1113008403066

APPLY ENGINE OIL
TO ALL MOVING
PARTS BEFORE
INSTALLATION.



AK201085AE

REMOVAL STEPS

- <<A>> >>G<< 1. CONNECTING ROD CAP NUT
>>F<< 2. CONNECTING ROD CAP
>>D<< 3. CONNECTING ROD BEARING,
LOWER
>>E<< 4. PISTON AND CONNECTING ROD
ASSEMBLY
>>D<< 5. CONNECTING ROD BEARING,
UPPER
>>C<< 6. PISTON RING NUMBER 1

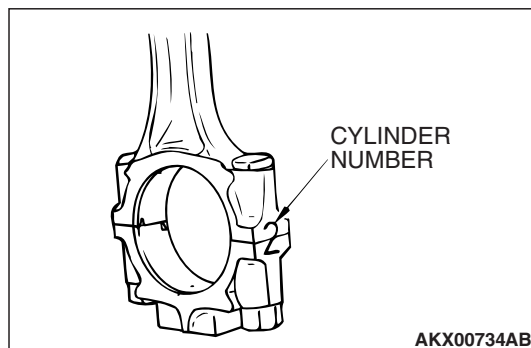
REMOVAL STEPS (Continued)

- >>C<< 7. PISTON RING NUMBER 2
>>B<< 8. OIL RING
9. SNAP RING
<> >>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.



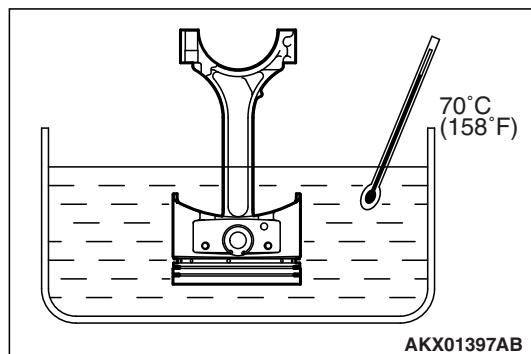
<> PISTON PIN REMOVAL

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.

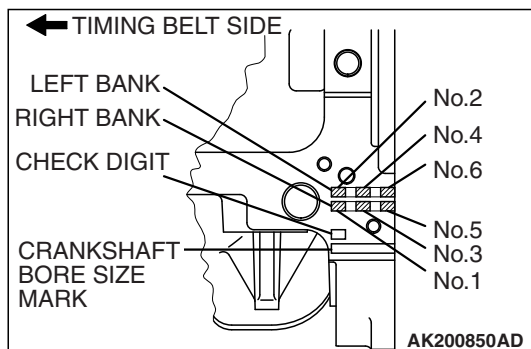
2. Heat the piston to approximately 70°C (158°F) and pull out the piston pin.



INSTALLATION SERVICE POINTS

>>A<< PISTON PIN INSTALLATION

1. 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 |

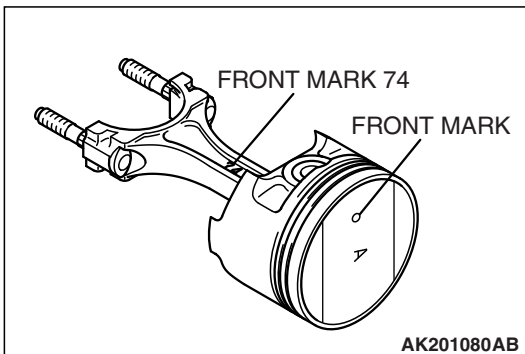
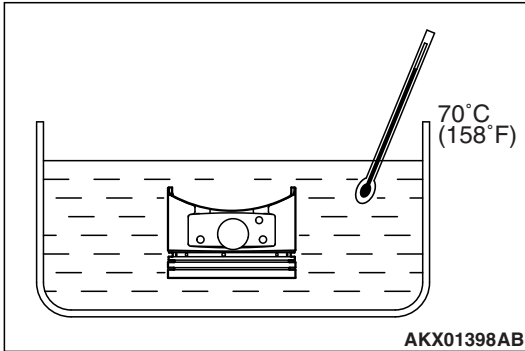
NOTE: The piston size mark shows on the top of the piston.

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

⚠ CAUTION

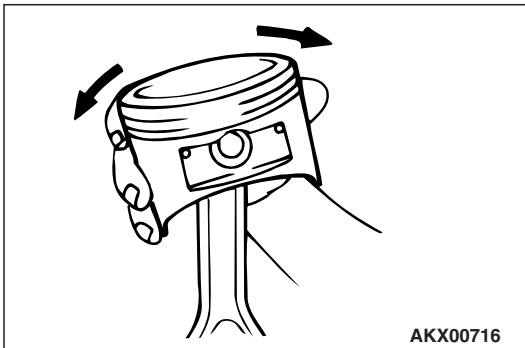
Apply an ample coat of engine oil to the periphery of the piston pin and the hole of the connecting rod small end. The clearance between the piston and the piston pin is a tight fit at room temperature. Therefore, be sure to heat the piston before inserting the piston pin. Use care since the piston is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

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



4. With the front mark of the connecting rod and that of the piston located on the same side, insert the piston pin.

5. Set the snap ring into the other side of the piston pin hole.

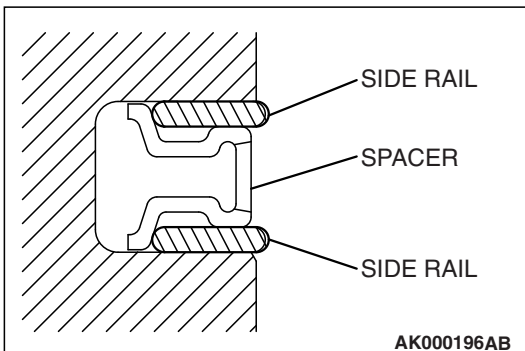


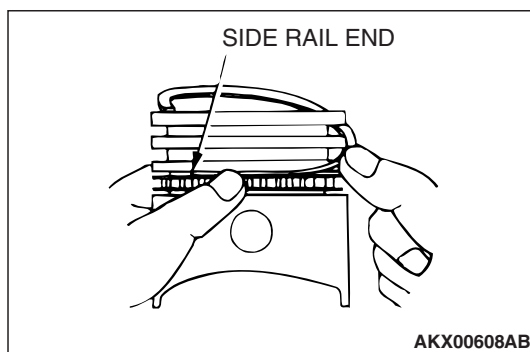
6. Check that the piston moves smoothly.

>>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 NUMBER 2 / PISTON RING NUMBER 1 INSTALLATION

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

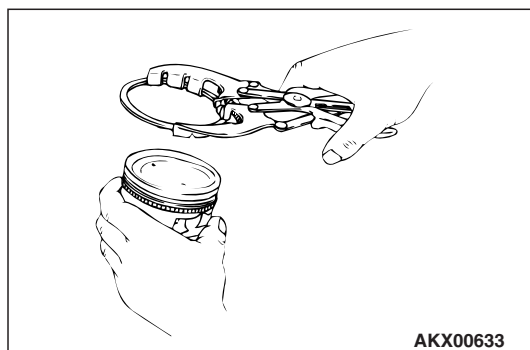
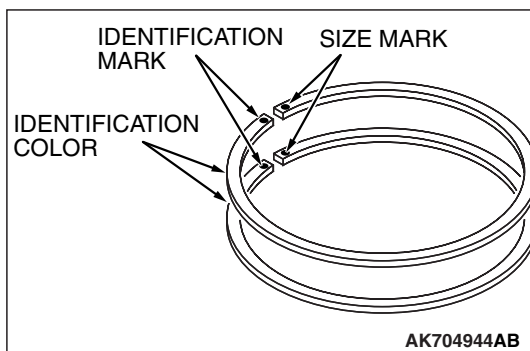
Identification mark

Number 1 ring: 1T

Number 2 ring: 2T

NOTE: Size marks on piston rings are as follows.

| RING SIZE | | SIZE MARK | SIZE COLOR |
|--------------------------------------|----------|-----------|------------|
| Standard | Number 1 | None | Pink |
| | Number 2 | None | White |
| 0.25 mm (0.010 in) oversize diameter | | 25 | None |
| 0.50 mm (0.020 in) oversize diameter | | 50 | None |



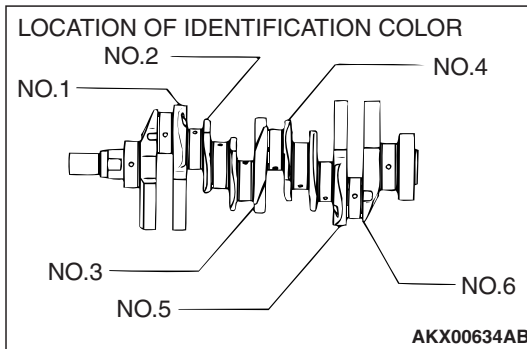
2. Using a piston ring expander, fit the number 2 piston ring into the number 2 groove of piston.

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

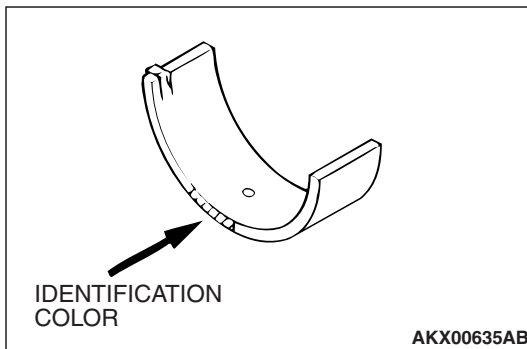
3. Install the number 1 piston ring in the same manner as step 2.

>>D<< 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.



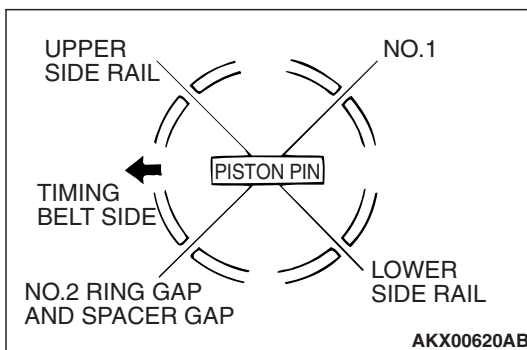
| CONNECTING ROD | CRANKSHAFT PIN OUTSIDE DIAMETER | | BEARING |
|---------------------|---------------------------------|--------------------------------------|----------------------|
| IDENTIFICATION MARK | IDENTIFICATION COLOR | SIZE mm (in) | IDENTIFICATION COLOR |
| None | Yellow | 54.994 – 55.000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

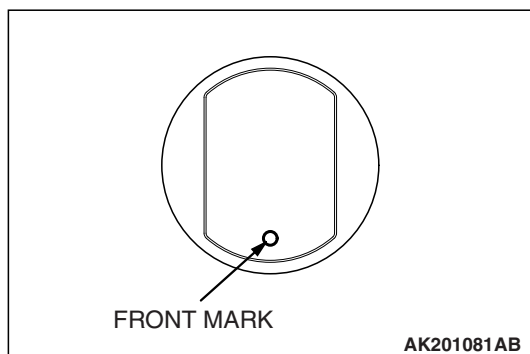


2. From the above table, select a bearing whose size is appropriate for the crankshaft pin outside the diameter.
3. Install the selected bearing in the big end and in the cap of the connecting rod.

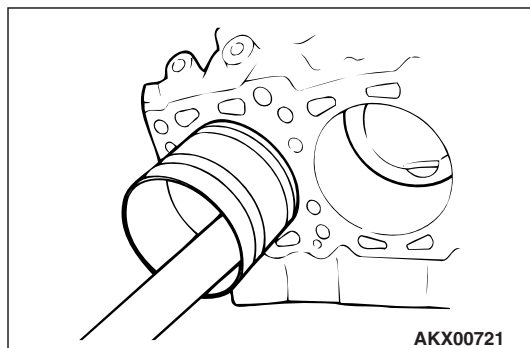
>>E<< PISTON AND CONNECTING ROD INSTALLATION

1. Liberally coat the circumference of the piston, piston ring, and oil ring with engine oil.
2. Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the illustration.
3. Rotate the crankshaft so that the crank pin is on the center of the cylinder bore.





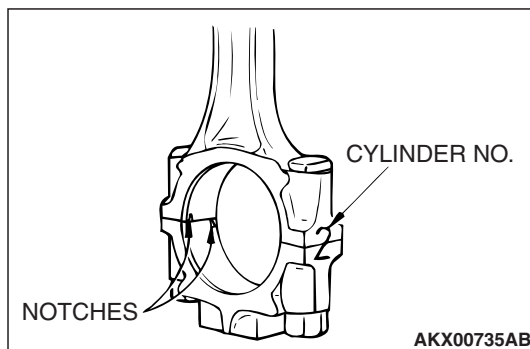
4. Insert the piston and connecting rod assembly into the cylinder with the front mark on the piston crown pointing to the timing belt side.



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

>>F<< CONNECTING ROD CAP INSTALLATION

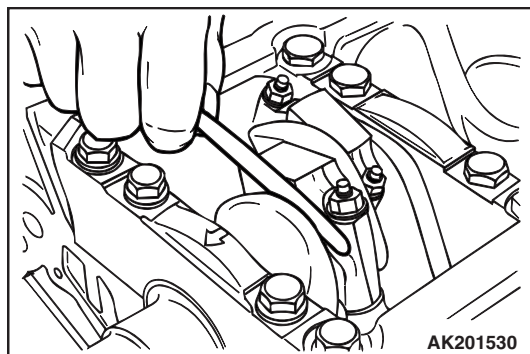
1. Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches are on the same side as shown.



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

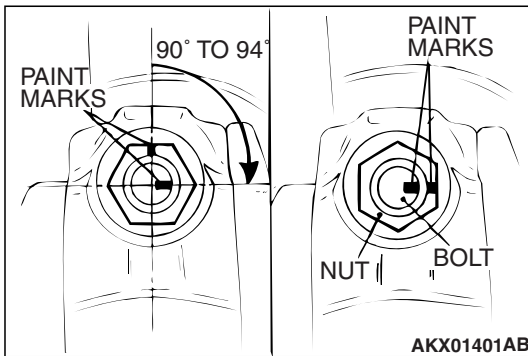
Standard value: 0.05 – 0.25 mm (0.002 – 0.009 inch)

Limit: 0.4 mm (0.02 inch)



>>G<< CONNECTING ROD CAP NUT INSTALLATION

1. 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.
2. Before installation of each nut, apply engine oil to the threaded portion and bearing surface of the nut.
3. Loosely tighten each nut to the bolt.
4. Then tighten the nuts alternately to a torque of 27 ± 2 N·m (20 ± 1 ft-lb) to install the cap properly.
5. Make a paint mark on the head of each nut.



⚠ CAUTION

- When the tightening angle is smaller than the specified tightening angle, the appropriate tightening capacity cannot be secured.
 - When the tightening angle is larger than the specified tightening angle, remove the bolt to start from the beginning again according to the procedure.
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

M1113008501915

PISTON

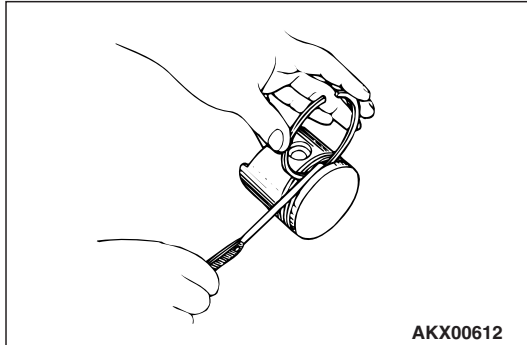
Replace the piston if scratches or seizure is evident on its surfaces (especially the thrust surface). Replace the piston if it is cracked.

PISTON PIN

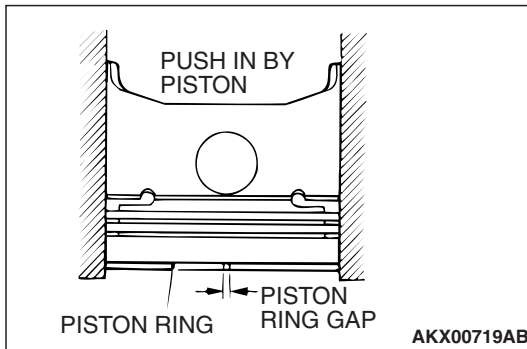
1. Insert the piston pin into the piston pin hole with a thumb. You should feel a slight resistance. Replace the piston pin if it can be easily inserted or there is excessive play.
2. The piston and piston pin must be replaced as an assembly.

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)**

AKX00612



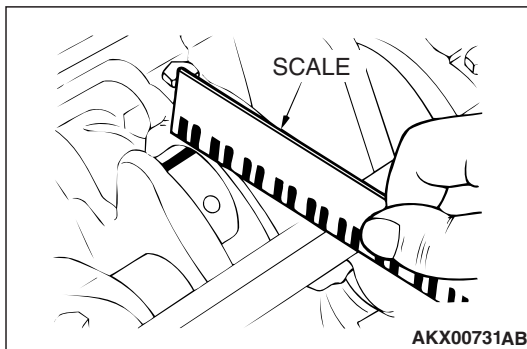
AKX00719AB

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.

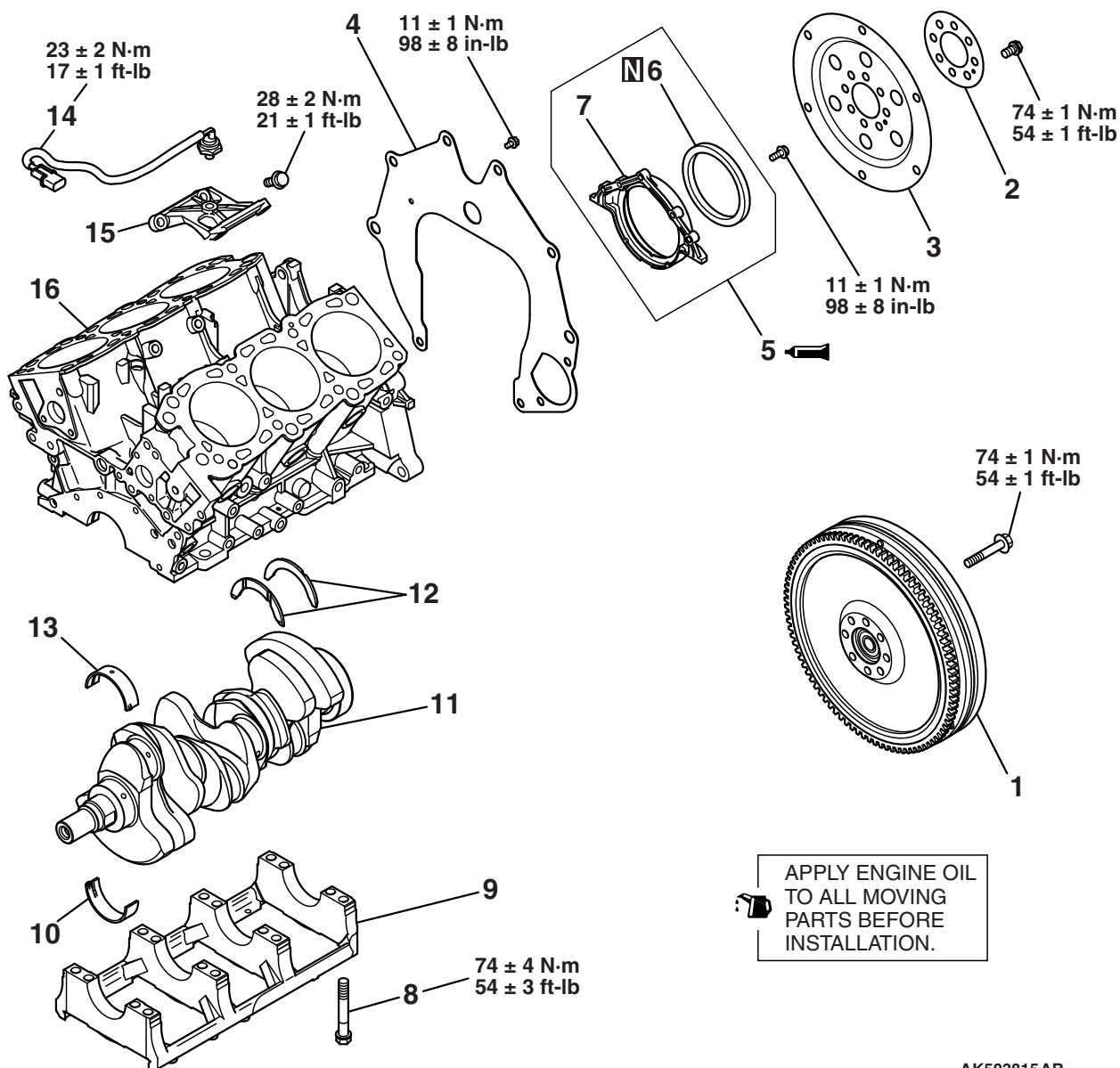
Standard value: 0.020 – 0.044 mm (0.0008 – 0.0017 inch)**Limit: 0.1 mm (0.003 inch)**

AKX00731AB

CRANKSHAFT AND CYLINDER BLOCK

REMOVAL AND INSTALLATION

M1113008702978



AK503815AB

REMOVAL STEPS

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

REMOVAL STEPS (Continued)

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

Required Special Tool:

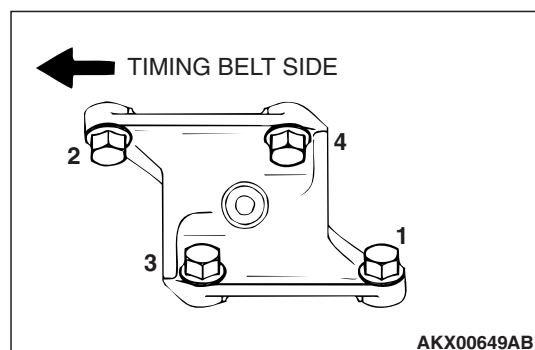
- MD998718: Crankshaft Rear Oil Seal Installer

INSTALLATION SERVICE POINTS

>>A<< KNOCK SENSOR BRACKET INSTALLATION

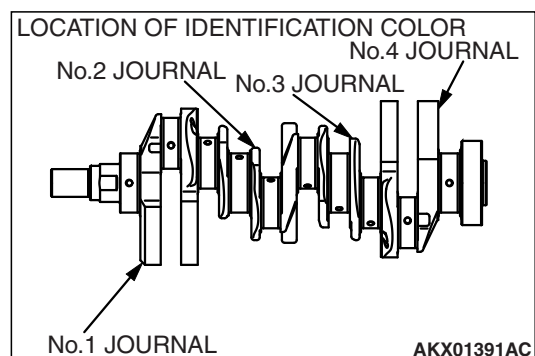
Check that the bracket is in proper contact with the cylinder block boss and tighten to the specified torque in the order shown.

Tightening torque: 28 ± 2 N·m (21 ± 1 ft-lb)

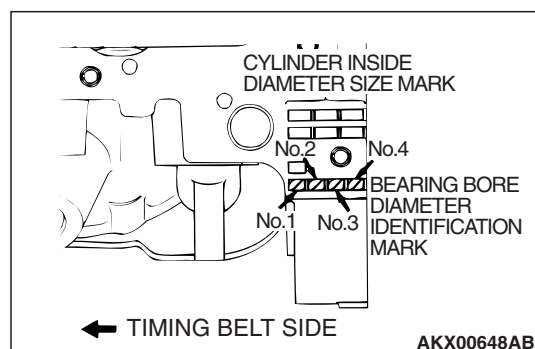


>>B<< CRANKSHAFT BEARING INSTALLATION

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.

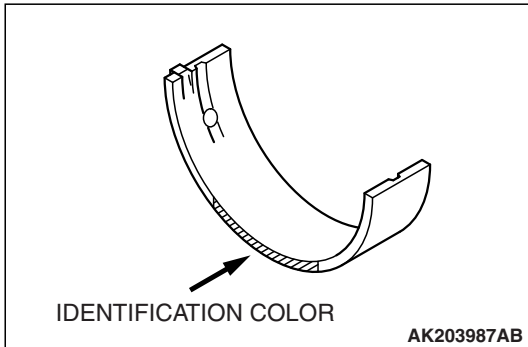


2. The cylinder block bearing bore diameter identification marks are stamped at the position shown in the illustration from left to right, beginning at Number 1.



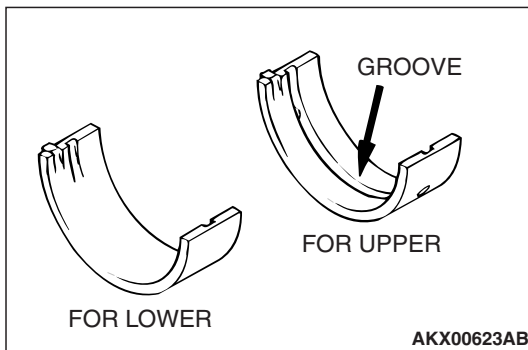
| CRANKSHAFT JOURNAL OUTSIDE DIAMETER | | CYLINDER BLOCK BEARING BORE | CRANKSHAFT BEARING Number 1, 4 | CRANKSHAFT BEARING Number 2, 3 |
|-------------------------------------|--------------------------------------|-----------------------------|--------------------------------|--------------------------------|
| 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 Number 1, 4 | CRANKSHAFT BEARING Number 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 |

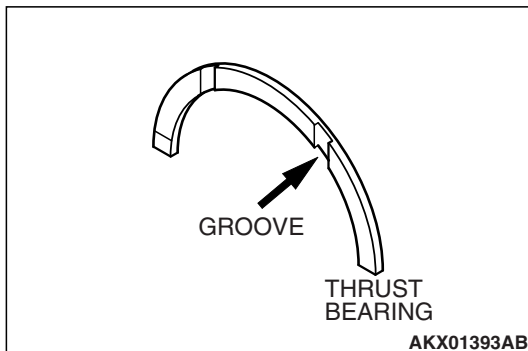


3. From the above table, select a bearing whose size is appropriate for the crankshaft journal outside diameter. If the crankshaft journal outside diameter ID color is "yellow" and the cylinder block bearing bore ID mark is "III," for example, select a bearing whose ID color is "green" <Number 1, 4> or "red" <Number 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 valve.

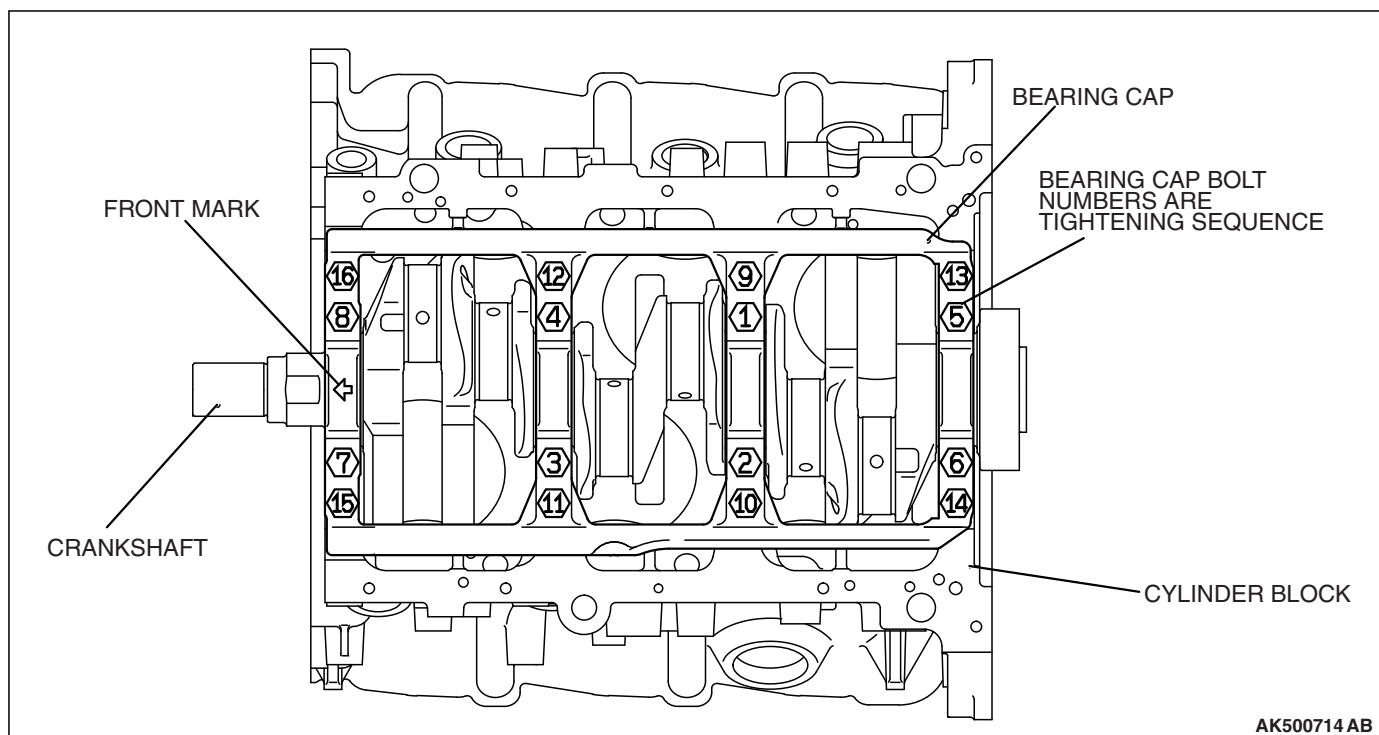


4. Install bearings with the groove toward the cylinder block.
5. Install the bearings having no groove to the bearing cap.



>>C<< THRUST BEARING INSTALLATION

1. Install the thrust bearing in the Number 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.

>>D<< BEARING CAP / BEARING BOLT
INSTALLATION

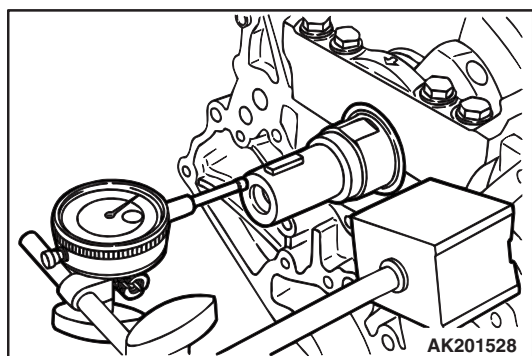
1. Attach the bearing cap on the cylinder block as shown in the illustration.
2. Tighten the bearing cap bolts to specified torque in the sequence shown in the illustration.

Tightening torque: 74 ± 4 N·m (54 ± 3 ft-lb)

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

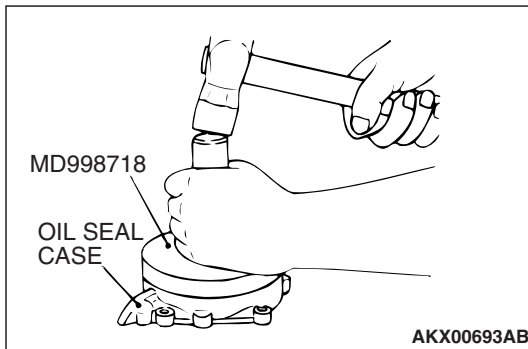
Standard value: 0.05 – 0.25 mm (0.002 – 0.009 inch)

Limit: 0.3 mm (0.01 inch)



>>E<< CRANKSHAFT REAR OIL SEAL INSTALLATION

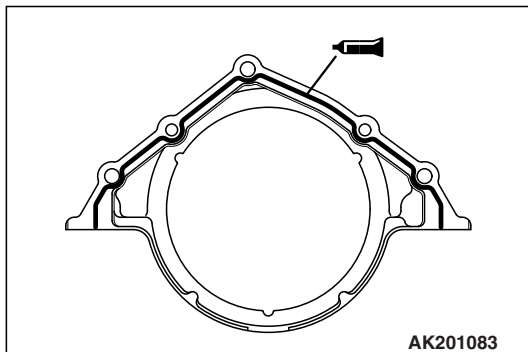
Using special tool MD998718, press-fit a new crankshaft rear oil seal into the oil seal case.



>>F<< OIL SEAL CASE INSTALLATION

1. Apply the sealant (Three bond 1217G 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.

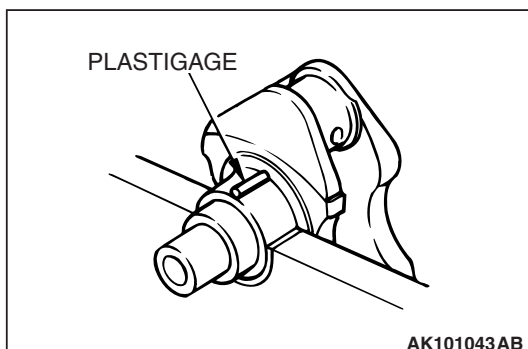


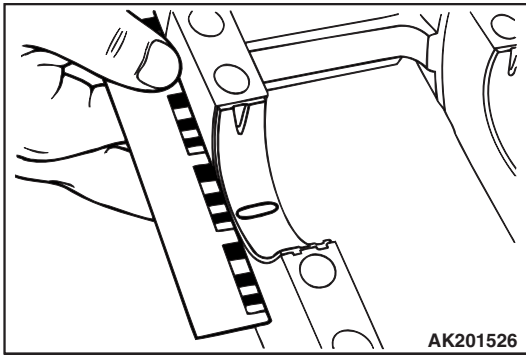
INSPECTION

M1113008801886

CRANKSHAFT JOURNAL OIL CLEARANCE <PLASTIGAGE METHOD>

1. Remove oil from the crankshaft journal and crankshaft bearing inner surface.
2. Install the crankshaft.
3. Cut plastigage to the same length as the width of the bearing and place it on the journal in parallel with its axis.





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

Tightening torque: 74 ± 4 N·m (54 ± 3 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:

0.012 – 0.030 mm (0.0005 – 0.0012 inch) <Number 1, 4>

0.018 – 0.036 mm (0.0007 – 0.0014 inch) <Number 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.
2. 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)

3. 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):

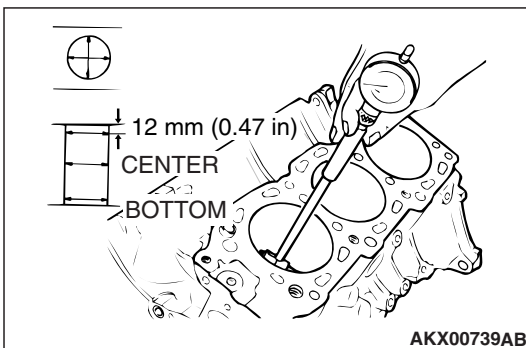
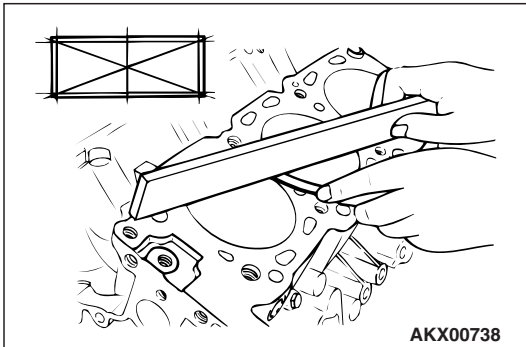
227.9 – 228.1 mm (8.972 – 8.980 inches)

4. Check the cylinder walls for scratches and seizure. If defects are evident, correct (bored to an oversize) or replace.
5. Using a cylinder gauge, measure the cylinder bore and cylindricity. 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)

Cylindricity: 0.01 mm (0.0003 inch)



BORING CYLINDER

1. 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.

2. Measure the outside diameter of the piston to be used. Measure it in the thrust direction as shown.
3. 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.

4. Bore all cylinders to the calculated boring finish dimension.
5. 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)

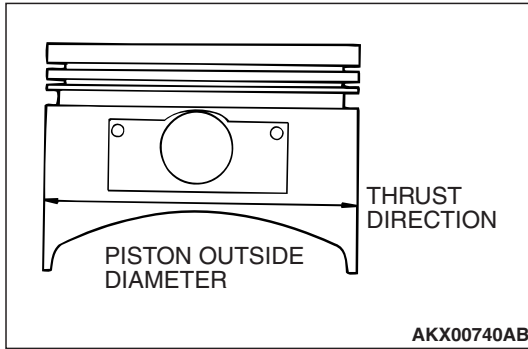
Cylindricity: 0.01 mm (0.0003 inch)

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.



SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

M1113023403999

| ITEMS | SPECIFICATIONS |
|--|------------------------------|
| Generator and drive belt | |
| 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) |
| Intake manifold plenum and throttle body assembly | |
| 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) |
| Ignition system | |
| 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) |
| Camshaft position sensor support bolt | 14 ± 1 N·m (122 ± 9 in-lb) |
| Camshaft position sensing cylinder bolt | 22 ± 4 N·m (16 ± 3 ft-lb) |
| Timing belt | |
| Adjusting bolt | 5.0 ± 1.0 N·m (44 ± 9 in-lb) |
| Auto-tensioner bolt | 23 ± 3 N·m (18 ± 2 ft-lb) |
| Bracket bolt | 24 ± 3 N·m (18 ± 2 ft-lb) |
| Camshaft sprocket bolt | 88 ± 10 N·m (65 ± 7 ft-lb) |
| Crankshaft position sensor bolt | 8.5 ± 0.5 N·m (76 ± 4 in-lb) |

| ITEMS | SPECIFICATIONS |
|---|------------------------------|
| Engine support bracket bolt | 45 ± 5 N·m (34 ± 4 ft-lb) |
| Idler pulley bolt | 44 ± 5 N·m (33 ± 4 ft-lb) |
| Tensioner pulley bolt | 48 ± 6 N·m (35 ± 4 ft-lb) |
| Tensioner arm bolt | 44 ± 10 N·m (33 ± 7 ft-lb) |
| Timing belt front cover bolt M6 | 11 ± 1 N·m (98 ± 8 in-lb) |
| Timing belt front cover bolt M8, M10 | 14 ± 1 N·m (122 ± 9 in-lb) |
| Timing belt rear cover bolt M6 | 11 ± 1 N·m (98 ± 8 in-lb) |
| Timing belt rear cover bolt M8 | 14 ± 1 N·m (122 ± 9 in-lb) |
| Intake manifold and fuel parts | |
| Injector and fuel rail bolt | 12 ± 1 N·m (107 ± 8 in-lb) |
| Intake manifold nut | 20 – 23 N·m (15 – 17 ft-lb) |
| Water pump & water hose | |
| Engine coolant temperature sensor | 29 ± 10 N·m (22 ± 7 ft-lb) |
| Thermostat housing bolt M6 | 11 ± 1 N·m (98 ± 8 in-lb) |
| Thermostat housing bolt M8 | 19 ± 1 N·m (14 ± 1 ft-lb) |
| Water inlet fitting bolt | 19 ± 1 N·m (14 ± 1 ft-lb) |
| Water pump bolt M8 | 24 ± 3 N·m (17 ± 2 ft-lb) |
| Water pump bolt M10 | 42 ± 8 N·m (31 ± 6 ft-lb) |
| Exhaust manifold | |
| Connector bracket bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Engine hanger bolt | 35 ± 6 N·m (26 ± 4 ft-lb) |
| Exhaust manifold nut | 44 ± 5 N·m (33 ± 4 ft-lb) |
| Exhaust manifold stay bolt M8 | 19 ± 3 N·m (14 ± 2 ft-lb) |
| Exhaust manifold stay bolt M10 | 44 ± 8 N·m (33 ± 5 ft-lb) |
| Exhaust manifold stay bolt M12 | 75 ± 10 N·m (55 ± 7 ft-lb) |
| Heat protector bolt | 14 ± 1 N·m (122 ± 9 in-lb) |
| Heated oxygen sensor | 44 ± 5 N·m (33 ± 4 ft-lb) |
| Engine oil control valve | |
| Eye bolt | 30 ± 3 N·m (22 ± 1 ft-lb) |
| Oil pipe bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Engine oil control valve housing bolt | 24 ± 3 N·m (17 ± 2 ft-lb) |
| Engine oil control valve bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Engine oil pressure switch | 10 ± 2 N·m (89 ± 17 in-lb) |
| Taper plug | 47 ± 7 N·m (34 ± 5 ft-lb) |
| Oil seal case bolt | 24 ± 3 N·m (17 ± 2 ft-lb) |
| Rocker arms and camshaft | |
| Adjusting nut | 9.0 ± 1.0 N·m (80 ± 9 in-lb) |
| Positive crankcase ventilation valve | 2.5 ± 0.4 N·m (22 ± 3 in-lb) |
| Rocker arms and shaft bolt <Exhaust side> | 13 ± 1 N·m (115 ± 9 in-lb) |
| Rocker arms and shaft bolt <Intake side> | 31 ± 3 N·m (23 ± 2 ft-lb) |

| ITEMS | SPECIFICATIONS |
|---|--|
| Rocker cover bolt | 3.5 ± 0.5 N·m (31 ± 4 in-lb) |
| Cylinder head and valve | |
| Cylinder head bolt | 108 ± 5 N·m (80 ± 4 ft-lb) → 0 N·m (0 in-lb) → 108 ± 5 N·m (80 ± 4 ft-lb) |
| Oil pan and oil pump | |
| Baffle plate bolt <Cylinder block side> | 10 ± 2 N·m (89 ± 17 in-lb) |
| Baffle plate bolt <Oil pan side> | 11 ± 1 N·m (98 ± 8 in-lb) |
| Cover bolt | 11 ± 0.5 N·m (93 ± 4 in-lb) |
| Drain plug | 39 ± 5 N·m (29 ± 4 ft-lb) |
| Engine oil pressure switch | 10 ± 2 N·m (89 ± 17 in-lb) |
| Oil filter bracket bolt M8 | 23 ± 3 N·m (18 ± 2 ft-lb) |
| Oil filter bracket bolt M10 | 41 ± 8 N·m (30 ± 6 ft-lb) |
| Oil filter bracket cover bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Oil pan, lower bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Oil pan, upper bolt | 9.0 ± 3.0 N·m (80 ± 26 in-lb) |
| Oil pump case bolt | 14 ± 1 N·m (122 ± 9 in-lb) |
| Oil pump cover bolt | 10 ± 2 N·m (89 ± 17 in-lb) |
| Oil screen bolt | 19 ± 3 N·m (14 ± 2 ft-lb) |
| Relief plug | 44 ± 5 N·m (33 ± 4 ft-lb) |
| Piston and connecting rod | |
| Connecting rod cap nut | 27 ± 2 N·m (20 ± 1 ft-lb) + 90° to 94° |
| Crankshaft and cylinder block | |
| Bearing cap bolt | 74 ± 4 N·m (54 ± 3 ft-lb) |
| Flywheel or drive plate bolt | 74 ± 1 N·m (54 ± 1 ft-lb) |
| Knock sensor | 23 ± 2 N·m (17 ± 1 ft-lb) |
| Knock sensor bracket bolt | 28 ± 2 N·m (22 ± 1 ft-lb) |
| Oil seal case bolt | 11 ± 1 N·m (98 ± 8 in-lb) |
| Rear plate bolt | 11 ± 1 N·m (98 ± 8 in-lb) |

GENERAL SPECIFICATIONS

M1113000201062

| DESCRIPTIONS | SPECIFICATIONS |
|--|------------------|
| Type | 60° V, OHV, SOHC |
| Number of cylinders | 6 |
| Combustion chamber | Pentroof type |
| Total displacement cm ³ (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 |

| DESCRIPTIONS | | | SPECIFICATIONS |
|--------------------|---------------|---------------|-------------------------------------|
| Valve timing | Intake valve | Opens (BTDC) | -2° <Low speed cam A> |
| | | | 0° <Low speed cam B> |
| | | | 15° <High speed cam> |
| | | Closes (ABDC) | 50° <Low speed cam A> |
| | | | 52° <Low speed cam B> |
| | | | 69° <High speed cam> |
| Exhaust valve | Opens (BBDC) | 57° | |
| | Closes (ATDC) | 19 | |
| Lubrication system | | | Pressure feed, full-flow filtration |
| Oil pump type | | | Trochoid type |

SERVICE SPECIFICATIONS

M1113000302299

| ITEMS | | | STANDARD VALUE | LIMIT |
|--|---------|-----------------|--------------------------------|-----------------------|
| Timing belt | | | | |
| 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) | |
| Rocker arms and camshaft | | | | |
| Camshaft cam height mm (in) | Intake | Low speed cam A | 33.55 (1.321) | Minimum 33.05 (1.301) |
| | | Low speed cam B | 37.35 (1.4705) | Minimum 36.85 (1.451) |
| | | High speed cam | 37.21 (1.465) | Minimum 36.71 (1.445) |
| | Exhaust | | 37.87 (1.491) | Minimum 37.37(1.471) |
| Camshaft journal outside diameter mm (in) | | | 45 (1.8) | – |
| Cylinder head and valves | | | | |
| Cylinder head flatness of gasket surface mm (in) | | | Less than 0.03 (0.001) | 0.2 (0.007) |
| Cylinder head grinding limit of gasket surface mm (in) Total resurfacing depth of cylinder head and cylinder block | | | – | 0.2 (0.007) |
| Cylinder head overall height mm (in) | | | 120 (4.7) | – |
| Valve thickness of valve head (margin) mm (in) | Intake | 1.0 (0.04) | Minimum 0.5 (0.02) | |
| | Exhaust | 1.2 (0.05) | Minimum 0.7 (0.03) | |
| 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) | |

| ITEMS | | STANDARD VALUE | LIMIT |
|---|------------------------|------------------------------------|---------------|
| 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) | – |
| Oil pan and oil pump | | | |
| 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) |
| Piston and connecting rod | | | |
| Piston outside diameter mm (in) | | 95.0 (3.74) | – |

| ITEMS | | STANDARD VALUE | LIMIT |
|--|--------------------|------------------------------------|-------------|
| Piston ring to ring groove clearance mm (in) | Number 1 | 0.03 – 0.07 (0.0012 – 0.0027) | 0.1 (0.003) |
| | Number 2 | 0.02 – 0.06 (0.0008 – 0.0023) | 0.1 (0.003) |
| Piston ring end gap mm (in) | Number 1 | 0.25– 0.40 (0.010 – 0.016) | 0.8 (0.03) |
| | Number 2 | 0.35 – 0.50 (0.014 – 0.019) | 0.8 (0.03) |
| | Oil ring side rail | 0.10 – 0.35 (0.003 – 0.014) | 1.0 (0.03) |
| Piston pin outside diameter mm (in) | | 22.0 (0.87) | – |
| Crankshaft pin oil clearance mm (in) | | 0.020 – 0.044 (0.0008 – 0.0017) | 0.1 (0.003) |
| Connecting rod big end side clearance mm (in) | | 0.05 – 0.25 (0.002 – 0.009) | – |
| Crankshaft and cylinder block | | | |
| 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) | Number 1, 4 | 0.012 – 0.030 (0.0005 – 0.0012) | 0.1(0.003) |
| | Number 2, 3 | 0.018 – 0.036 (0.0007 – 0.0014) | 0.1(0.003) |
| 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

M1113000502259

| ITEMS | SPECIFIED SEALANT | QUANTITY |
|-----------------------------------|--|-------------|
| Camshaft position sensor support | Three bond 1207F (Mitsubishi Part Number 1000A992) or equivalent | As required |
| Engine coolant temperature sensor | Three bond 1324N, LOCTITE 262 or equivalent | As required |
| Engine oil pressure switch | Three bond 1212D, Three bond 1215 or equivalent | As required |
| Oil pump case | Three bond 1217G (Mitsubishi Part Number 1000A923) or equivalent | As required |
| Oil pan | | |
| Oil seal case | | |