

GROUP 11B

ENGINE OVERHAUL

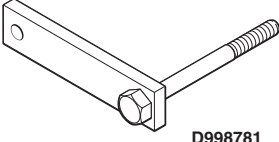
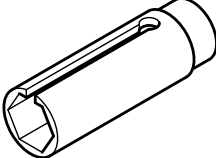
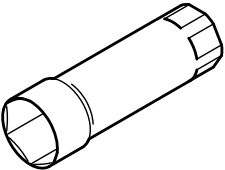
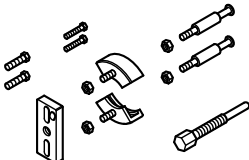
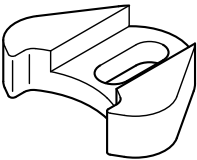
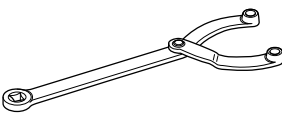
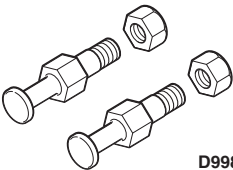
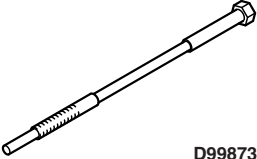
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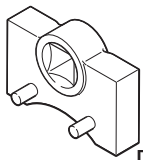
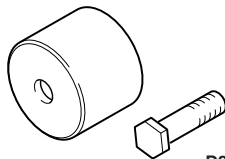
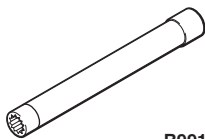
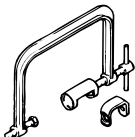
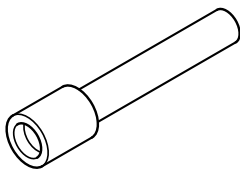
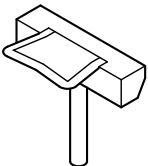
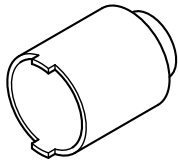
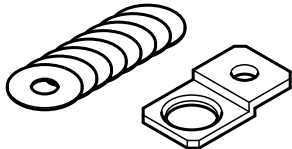
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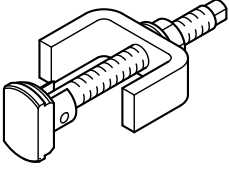
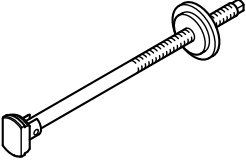
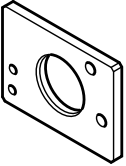
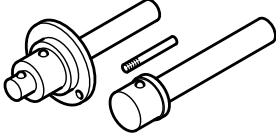
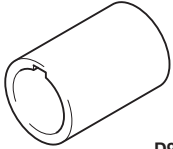
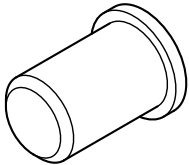
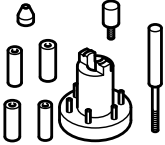
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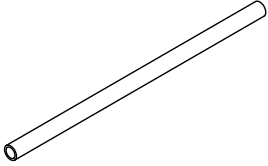
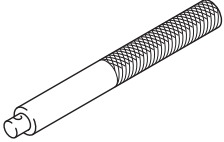
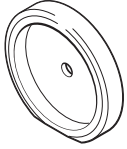
SPECIAL TOOLS

M1113000602698

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
 D998781	MD998781 Flywheel stopper	General service tool	Supporting drive plate
	MD998770 Oxygen sensor wrench	MD998770-01 or General service tool	Removal and installation of oxygen sensor
	MB991398 Spark plug wrench	–	Removal and installation of spark plug
	MD998778 Crankshaft sprocket puller	General service tool	Removal of crankshaft sprocket
	MD998785 Sprocket stopper	MD998785	Supporting counterbalance shaft sprocket
 B990767	MB990767 End yoke holder	MB990767-01	Holding camshaft sprocket when loosening or torquing bolt
 D998719	MD998719 Pins	MIT308239	
 D998738	MD998738 Adjusting screw	MD998738-01	<ul style="list-style-type: none"> • Holding the auto-tensioner • Timing belt tension adjustment

TOOL	TOOL NUMBER AND NAME	SUPERSESION	APPLICATION
 D998767	MD998767 Tension pulley wrench	MD998752-01	Adjustment of timing belt tension
 D998713	MD998713 Camshaft oil seal installer	MD998713-01	Installation of camshaft oil seal
 B991654	MB991654 Cylinder head bolt wrench (12)	General service tool	Removal and installation of cylinder head bolt
	MD998735 Valve spring compressor	MD998735-01	Compression of valve spring
	MB991999 Valve steam seal installer	General service tool	Installation of valve steam seal
 D998727	MD998727 Oil pan FIPG cutter	MD998727-01	Removal of oil pan
	MD998162 Plug wrench	MD998162-01	Removal and installation of front case cap plug
	MD998783 Plug wrench retainer	General service tool	

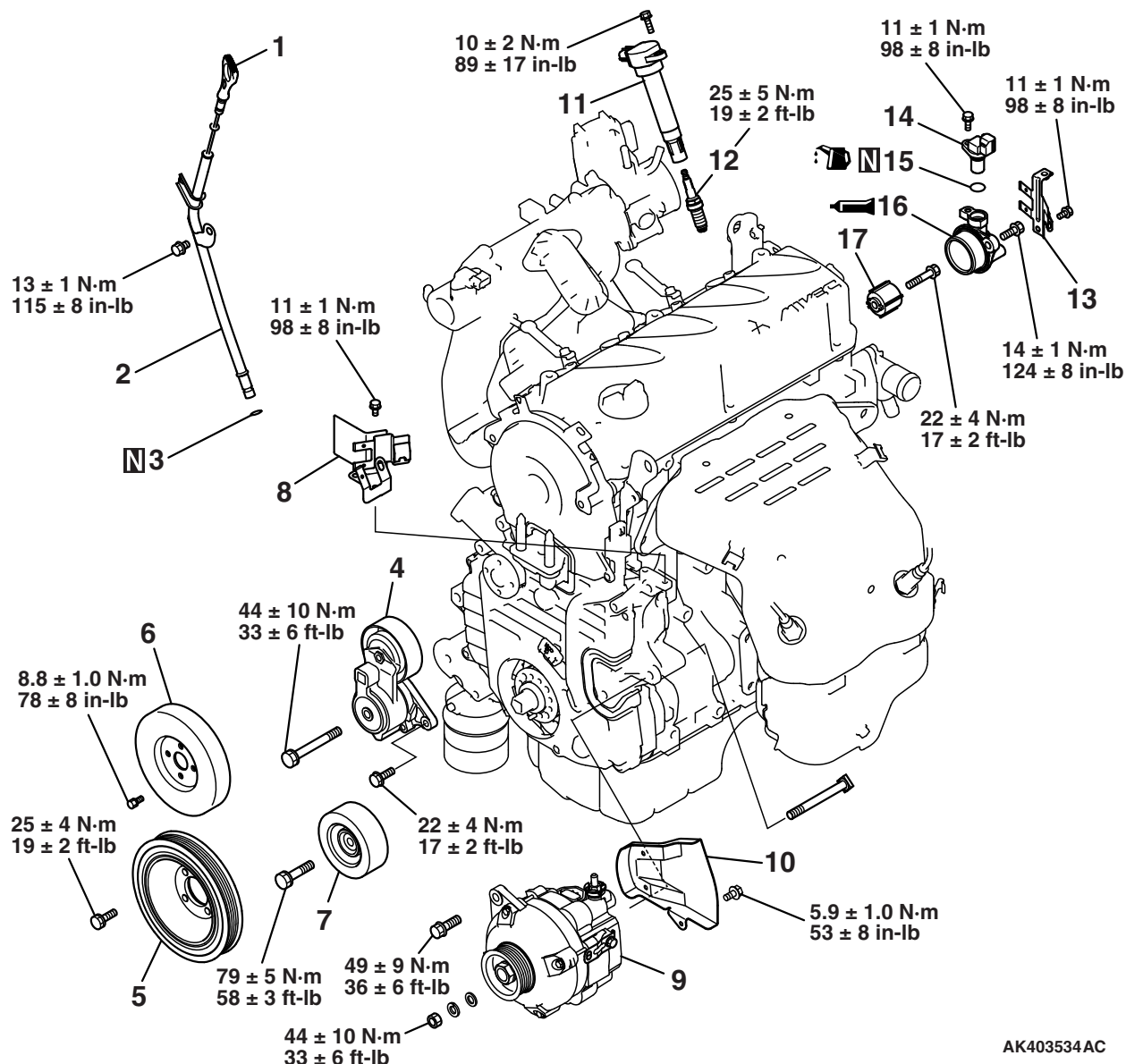
TOOL	TOOL NUMBER AND NAME	SUPERSESION	APPLICATION
	MD998371 Silent shaft bearing puller	MD998371-01	Removal of counterbalance shaft front bearing
	MD998372 Silent shaft bearing puller	MD998372-01	Removal of counterbalance shaft rear bearing
	MB991603 Bearing installer stopper	General service tool	Removal and installation of rear bearing
	MD998705 Silent shaft bearing installer	MD998373-01 Use with MB990938-01	Installation of counterbalance shaft bearing
 D998285	MD998285 Crankshaft front oil seal guide	MD998285-01	Installation of crankshaft front oil seal
	MD998375 Crankshaft front oil seal installer	MD998375-01	
	MD998780 Piston pin setting tool	MIT216941	Removal and installation of piston pin

TOOL	TOOL NUMBER AND NAME	SUPERSESSION	APPLICATION
	MB992010 Bolt guide	–	Removal and installation of piston and connecting rod assembly
	MB990938 Handle	MB990938-01	Installation of crankshaft rear oil seal
 D998776	MD998776 Crankshaft rear oil seal installer	MD998376-01	

GENERATOR AND IGNITION SYSTEM

REMOVAL AND INSTALLATION

M1113001001908



AK403534 AC

REMOVAL STEPS

1. OIL DIPSTICK
2. OIL DIPSTICK GUIDE
3. O-RING
4. AUTO TENSIONER
- >>D<< 5. CRANKSHAFT PULLEY
6. WATER PUMP PULLEY
7. IDLER PULLEY
8. CONNECTOR BRACKET
9. GENERATOR
10. GENERATOR COVER

REMOVAL STEPS (Continued)

11. IGNITION COIL
- <<A>> >>C<< 12. SPARK PLUG
13. CONNECTOR BRACKET
14. CAMSHAFT POSITION SENSOR
15. O-RING
- >>B<< 16. CAMSHAFT POSITION SENSOR SUPPORT
- <> >>A<< 17. CAMSHAFT POSITION SENSING CYLINDER

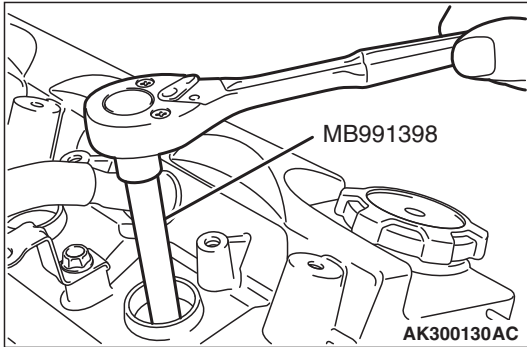
Required Special Tools:

- MB991398: Spark Plug Wrench
- MD998781: Flywheel Stopper

REMOVAL SERVICE POINT

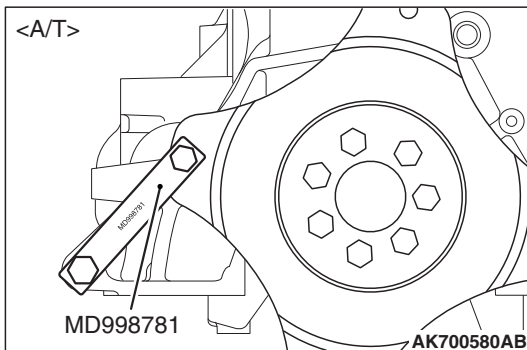
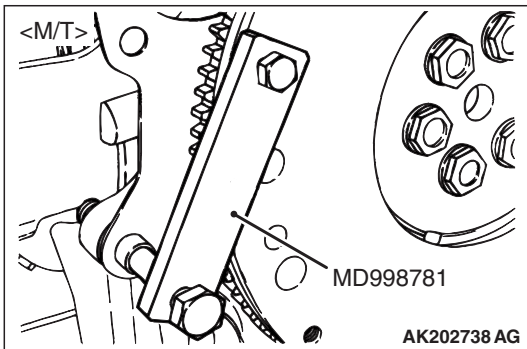
<<A>> SPARK PLUG REMOVAL

Using special tool MB991398, remove the spark plug.



<> CAMSHAFT POSITION SENSING CYLINDER REMOVAL

1. Using special tool MD998781, hold the drive plate or flywheel.
2. Remove the camshaft position sensing cylinder.

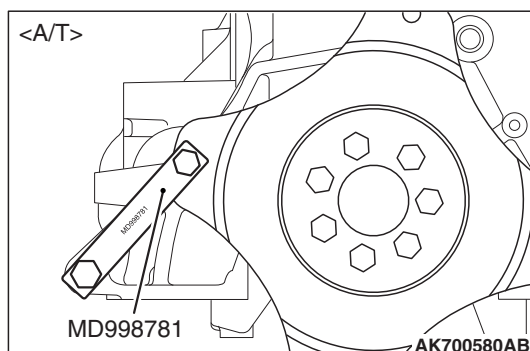
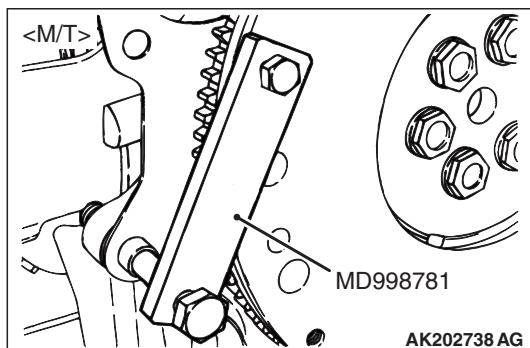


INSTALLATION SERVICE POINT

>>A<< CAMSHAFT POSITION SENSING CYLINDER INSTALLATION

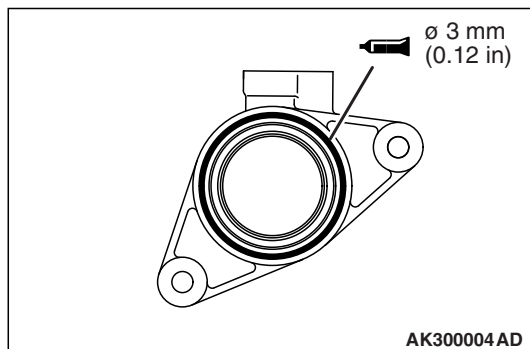
1. Using special tool MD998781, hold the drive plate or flywheel.
2. Tighten the camshaft position sensing cylinder to the specified torque.

Tightening torque: 22 ± 4 N·m (17 ± 2 ft-lb)



>>B<< CAMSHAFT POSITION SENSOR SUPPORT INSTALLATION

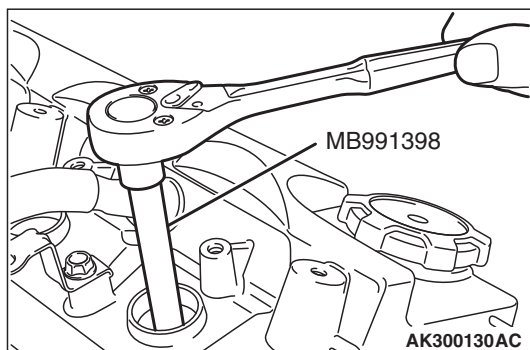
Apply a 3 mm (0.12 inch) bead of sealant (Three bond 1207F or equivalent) in the groove as shown.



>>C<< SPARK PLUG INSTALLATION

Using special tool MB991398, tighten the spark plug to the specified torque.

Tightening torque: 25 ± 5 N·m (19 ± 2 ft-lb)



>>D<< CRANKSHAFT PULLEY TIGHTENING

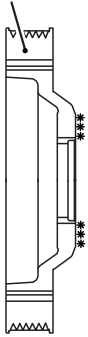
1. Using a rag, wipe dirt on the crankshaft surface and the crankshaft pulley washer.
2. Using a rag, wipe dirt on the crankshaft pulley and then degrease the place specified in the illustration.

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

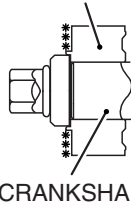
3. Install the crankshaft pulley.

*: AFTER WIPING UP DIRT BY A RAG,
REMOVE GREASE.

CRANKSHAFT PULLEY



CRANKSHAFT
SPROCKET



CRANKSHAFT

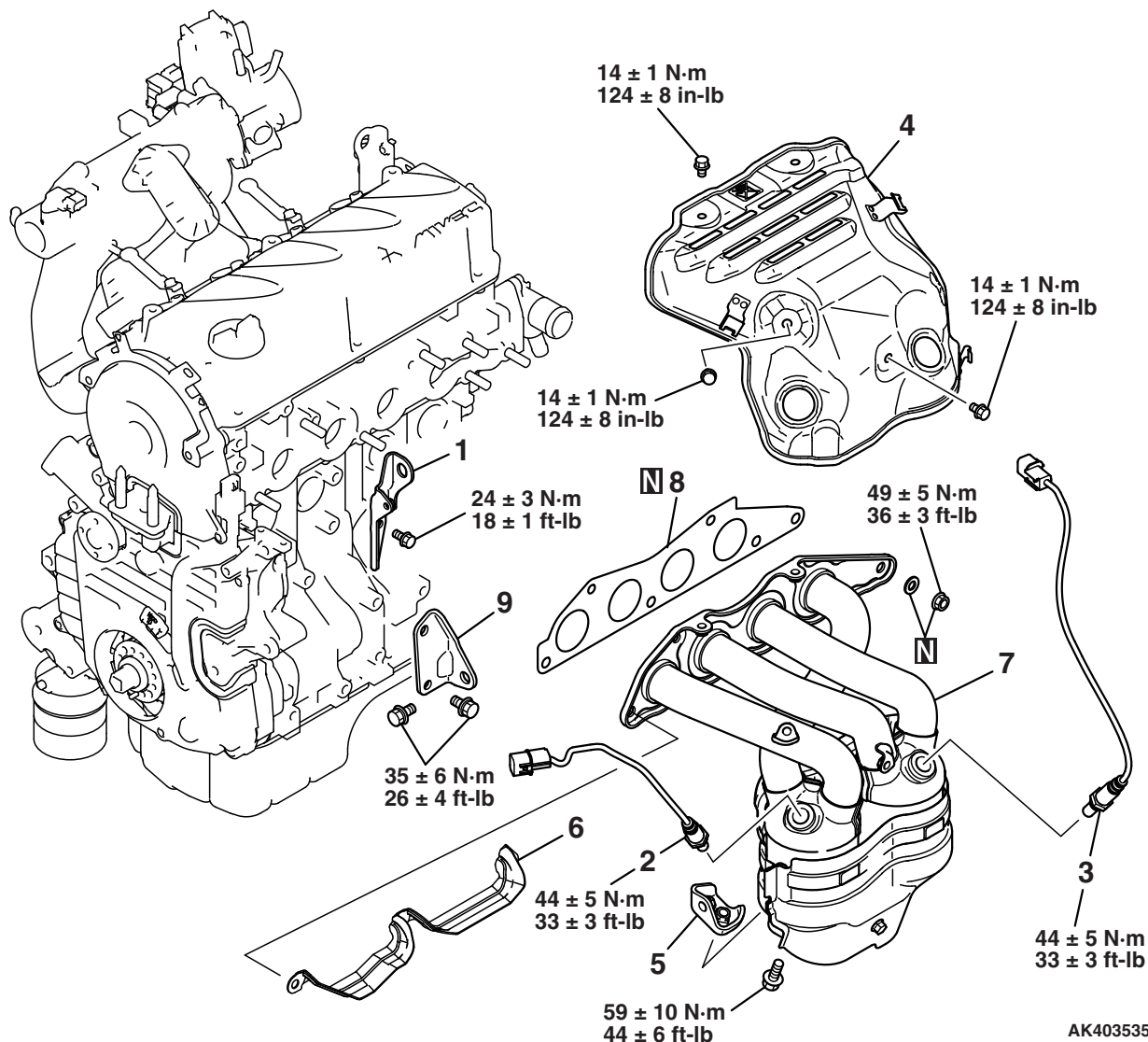
← ENGINE FRONT

AK603867AC

EXHAUST MANIFOLD

REMOVAL AND INSTALLATION

M1113004901847



REMOVAL STEPS

- <<A>> >>B<< 1. ENGINE HANGER
 <<A>> >>B<< 2. OXYGEN SENSOR
 <<A>> >>B<< 3. OXYGEN SENSOR
 >>B<< 4. EXHAUST MANIFOLD COVER
 >>A<< 5. EXHAUST MANIFOLD BRACKET
 "B"

REMOVAL STEPS (Continued)

6. HEAT PROTECTOR LOWER <A/T>
 7. EXHAUST MANIFOLD
 8. EXHAUST MANIFOLD GASKET
 9. EXHAUST MANIFOLD BRACKET
 "A"

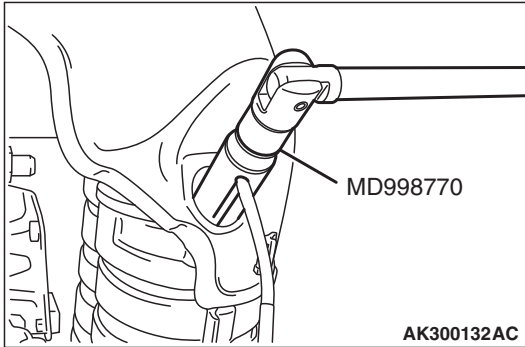
Required Special Tool:

- MD998770: Oxygen Sensor Wrench

REMOVAL SERVICE POINT

<<A>> OXYGEN SENSOR REMOVAL

Using special tool MD998770, remove the oxygen sensor.



INSTALLATION SERVICE POINT

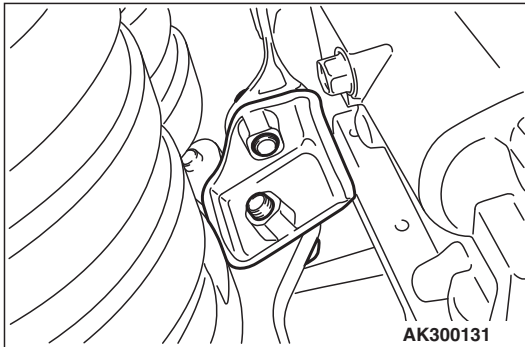
>>A<< EXHAUST MANIFOLD BRACKET "B" INSTALLATION

Check to ensure that the exhaust manifold bracket "B" is in close contact with the exhaust manifold and the cylinder block before tightening the respective mounting bolts to the specified torque.

Tightening torque:

$59 \pm 10 \text{ N}\cdot\text{m}$ ($44 \pm 6 \text{ ft}\cdot\text{lb}$) <bolt, washer assembly>

$35 \pm 6 \text{ N}\cdot\text{m}$ ($26 \pm 4 \text{ ft}\cdot\text{lb}$) <flange bolt>

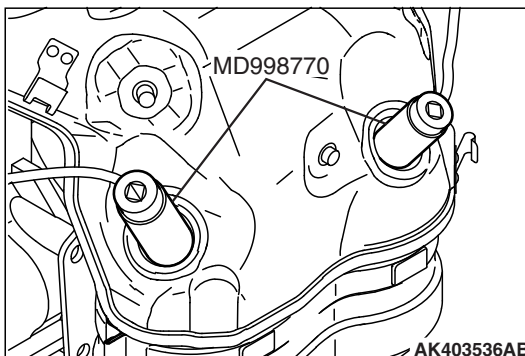


>>B<< OXYGEN SENSOR / EXHAUST MANIFOLD COVER INSTALLATION

1. Install the exhaust manifold cover to the exhaust manifold.
2. Temporarily tighten the exhaust manifold cover bolt.
3. Using special tool MD998770, install both of the oxygen sensors to the exhaust manifold.

NOTE: Do not remove the special tool after the oxygen sensor is installed.

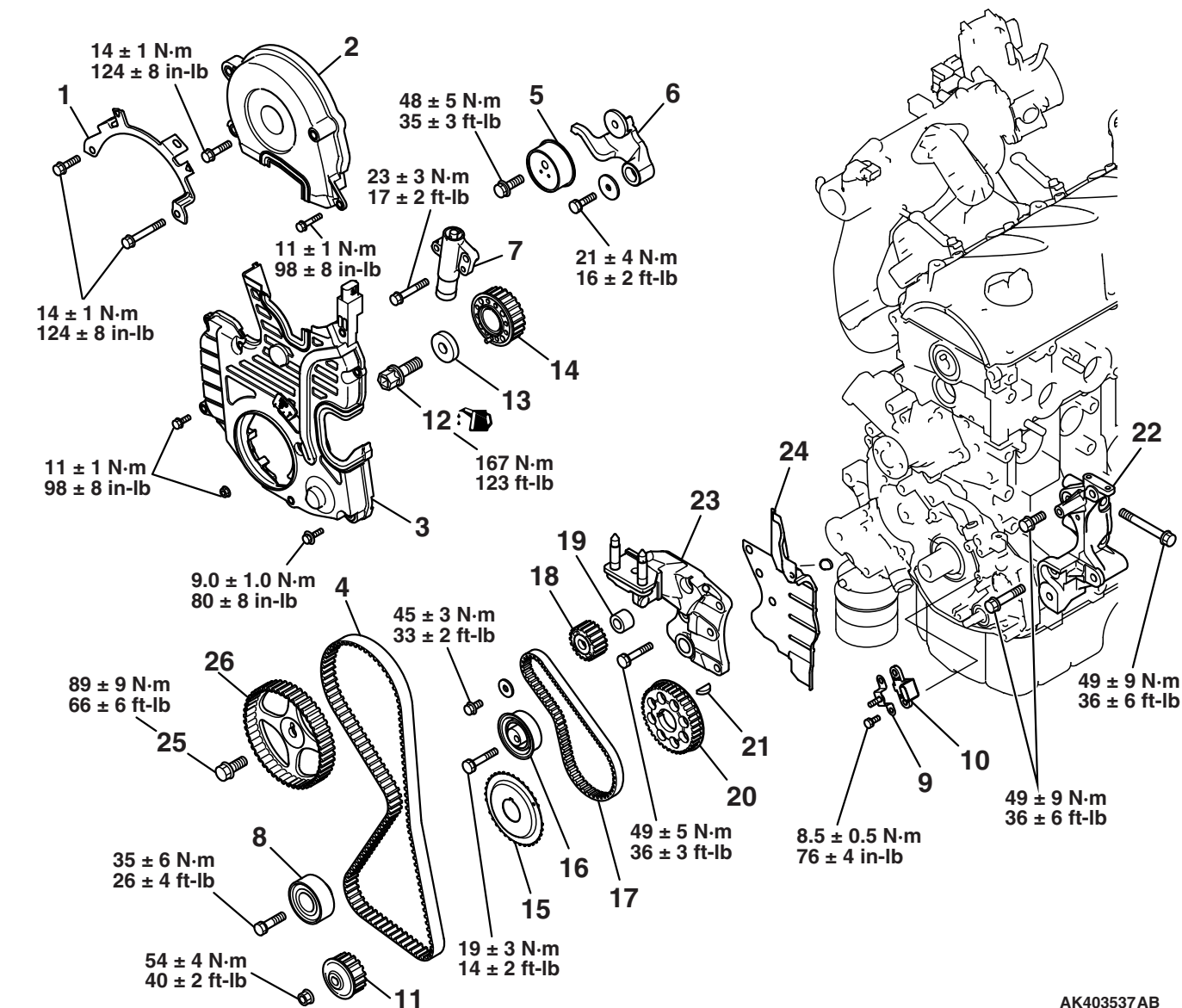
4. Tighten the exhaust manifold cover bolt to the specified torque of $14 \pm 1 \text{ N}\cdot\text{m}$ ($124 \pm 8 \text{ in}\cdot\text{lb}$).
5. Remove the special tool.



TIMING BELT

REMOVAL AND INSTALLATION

M1113001901882



AK403537AB

REMOVAL STEPS

1. CONNECTOR BRACKET
2. TIMING BELT FRONT UPPER COVER
3. TIMING BELT FRONT LOWER COVER
4. TIMING BELT
5. TENSIONER PULLEY
6. TENSIONER ARM
7. AUTO-TENSIONER
8. IDLER PULLEY
9. BRACKET
10. CRANKSHAFT POSITION SENSOR
11. OIL PUMP SPROCKET
12. CRANKSHAFT BOLT
13. CRANKSHAFT PULLEY WASHER

REMOVAL STEPS (Continued)

14. CRANKSHAFT SPROCKET
15. CRANKSHAFT SENSING BLADE
16. TENSIONER "B"
17. TIMING BELT "B"
18. COUNTERBALANCE SHAFT SPROCKET
19. SPACER
20. CRANKSHAFT SPROCKET "B"
21. CRANKSHAFT KEY
22. GENERATOR BRACKET
23. ENGINE SUPPORT BRACKET
24. TIMING BELT REAR COVER
25. CAMSHAFT SPROCKET BOLT
26. CAMSHAFT SPROCKET

Required Special Tools:

- MB990767: End Yoke Holder
- MD998719: Pins
- MD998767: Tensioner Pulley Wrench
- MD998778: Crankshaft Sprocket Puller
- MD998781: Flywheel Stopper
- MD998785: Sprocket Stopper
- MD998738: Adjusting Screw

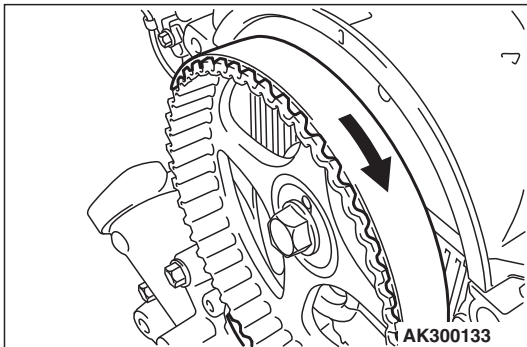
REMOVAL SERVICE POINTS

<<A>> TIMING BELT REMOVAL

⚠ CAUTION

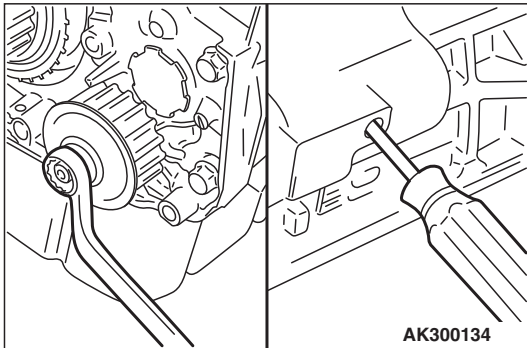
Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be washed or immersed in solvent. Replace parts if contaminated. If there is oil or water on any part, check the front case oil seals, camshaft oil seal, and water pump for leaks.

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



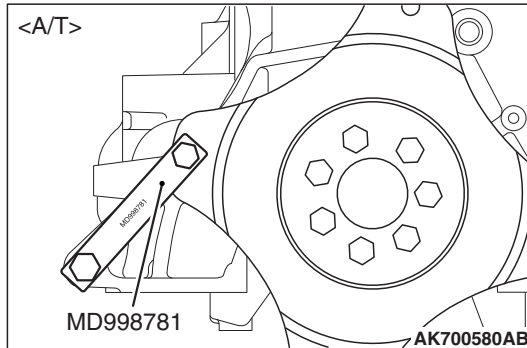
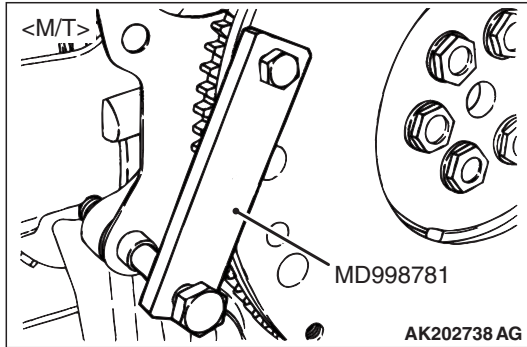
<> OIL PUMP SPROCKET REMOVAL

1. Remove the plug on the left side of the cylinder block.
2. Insert a Phillips screwdriver [shank diameter 8 mm (0.3 inch)] through the plug hole to block the left counterbalance shaft.
3. Loosen the nut, and then remove the oil pump sprocket.



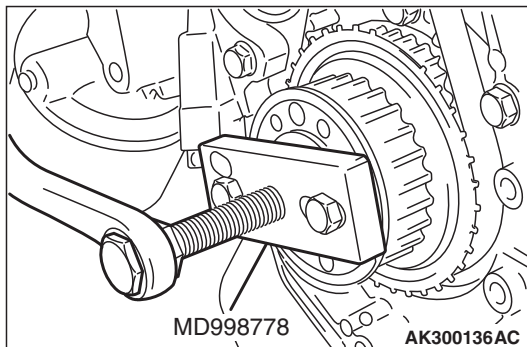
<<C>> CRANKSHAFT BOLT LOOSENING

1. Install special tool MD998781 to hold the drive plate or flywheel.
2. Loosen and remove the crankshaft bolt and washer.



<<D>> CRANKSHAFT SPROCKET REMOVAL

1. Set special tool MD998778 as shown in the illustration.
2. Screw in the center bolt of the special tool to remove the crankshaft sprocket.

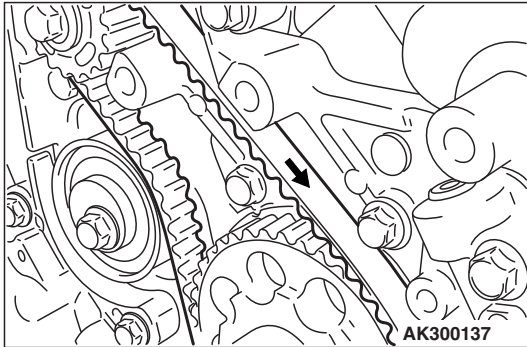


<<E>> TIMING BELT "B" REMOVAL

CAUTION

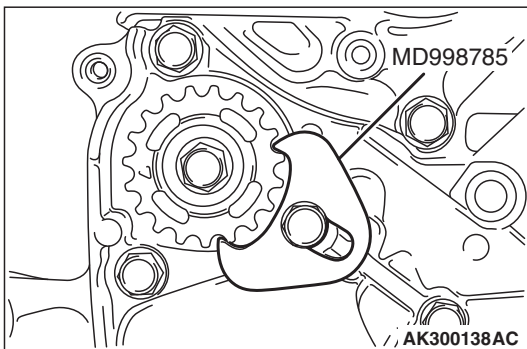
Water or oil on the belt shortens its life drastically, so the removed timing belt, sprocket, and tensioner must be free from oil and water. These parts should not be washed or immersed in solvent. Replace parts if contaminated. If there is oil or water on each part, check the front case oil seals, camshaft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

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



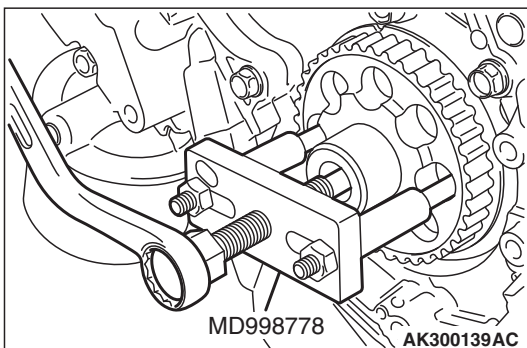
<<F>> COUNTERBALANCE SHAFT SPROCKET REMOVAL

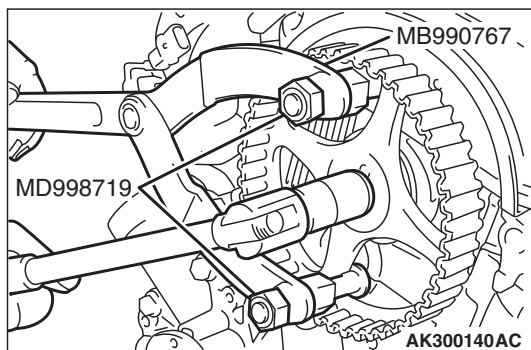
1. Set special tool MD998785 as shown to prevent the counterbalance shaft sprocket from turning together.
2. Loosen the bolt and remove the sprocket.



<<G>> CRANKSHAFT SPROCKET "B" REMOVAL

1. Set special tool MD998778 as shown in the illustration.
2. Screw in the center bolt of the special tool to remove crankshaft sprocket "B."



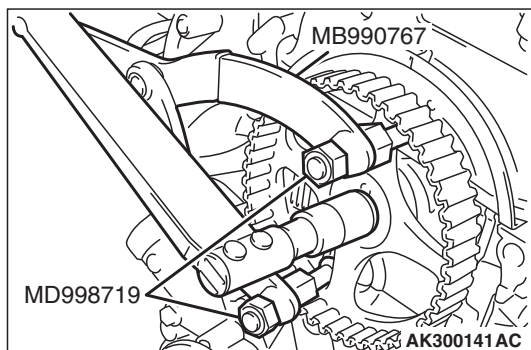
**<<H>> CAMSHAFT SPROCKET BOLT REMOVAL**

1. While holding the camshaft sprocket with special tools MB990767 and MD998719, loosen the camshaft sprocket bolt.
2. Remove the camshaft sprocket.

INSTALLATION SERVICE POINTS**>>A<< CAMSHAFT SPROCKET BOLT INSTALLATION**

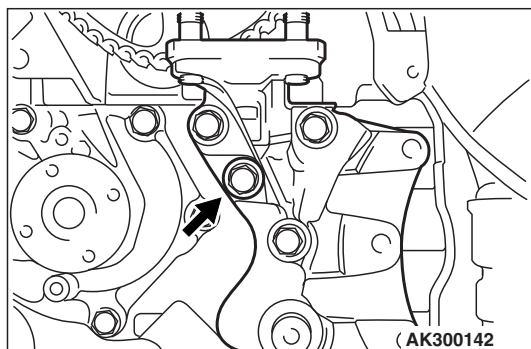
1. Fit the camshaft sprocket to the front of the camshaft.
2. While holding the camshaft sprocket with special tools MB990767 and MD998719, tighten the camshaft sprocket bolt.

Tightening torque: 89 ± 9 N·m (66 ± 6 ft-lb)

**>>B<< ENGINE SUPPORT BRACKET INSTALLATION**

Coat the threads of the seal bolt in the illustration with 3M™ AAD 8672 or equivalent before tightening.

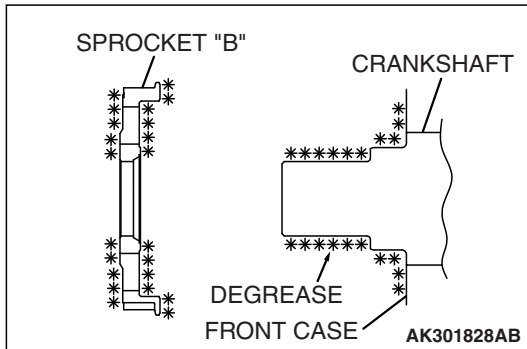
Tightening torque: 49 ± 5 N·m (36 ± 3 ft-lb)



>>C<< CRANKSHAFT SPROCKET "B" INSTALLATION

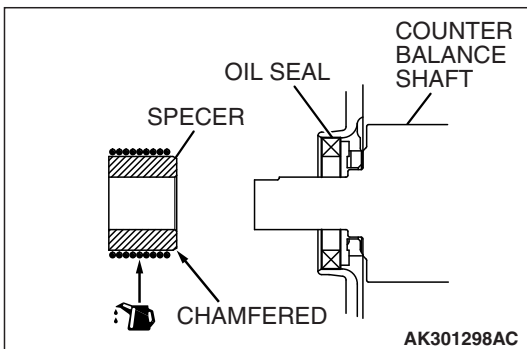
Clean and then degrease the front of the front case, crankshaft sprocket "B" and crankshaft surface on which sprocket "B" is attached.

NOTE: Degreasing is necessary to prevent decrease in the friction between contacting surfaces.



>>D<< SPACER INSTALLATION

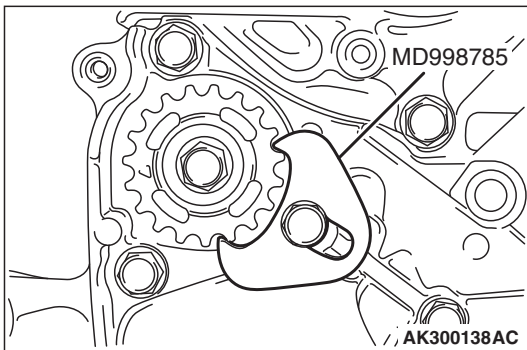
1. Apply a thin coat of clean engine oil to the lip area of the oil seal.
2. Install the spacer with the chamfered end facing toward the oil seal.



>>E<< COUNTERBALANCE SHAFT SPROCKET INSTALLATION

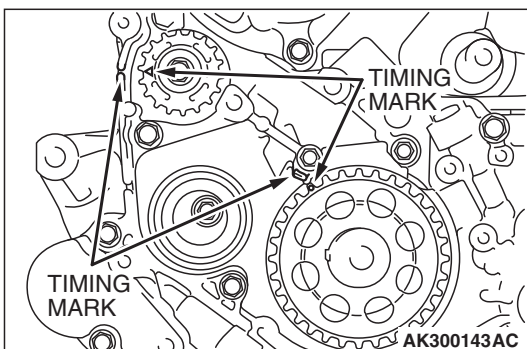
1. Install the counterbalance shaft sprocket and screw on the bolt.
2. Install special tool MD998785 as shown in the illustration to lock the counterbalance shaft.
3. Tighten the bolt, and then remove the special tool.

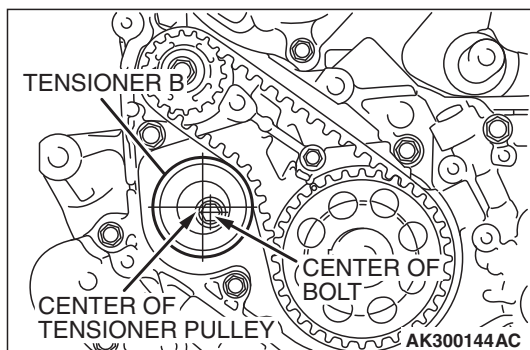
Tightening torque: 45 ± 3 N·m (33 ± 2 ft-lb)



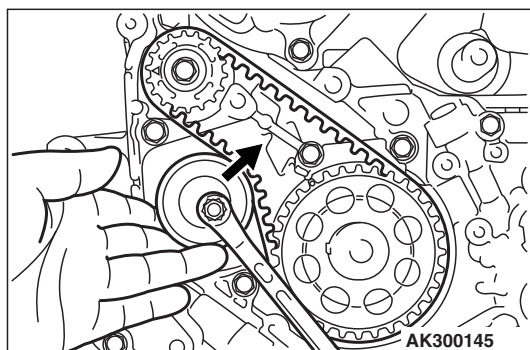
>>F<< TIMING BELT "B" INSTALLATION

1. Align timing marks on the crankshaft sprocket "B" and counterbalance shaft sprocket with the marks on the front case.
2. Install the timing belt "B" on the crankshaft sprocket "B" and counterbalance shaft sprocket. There should be no slack on the tension side.



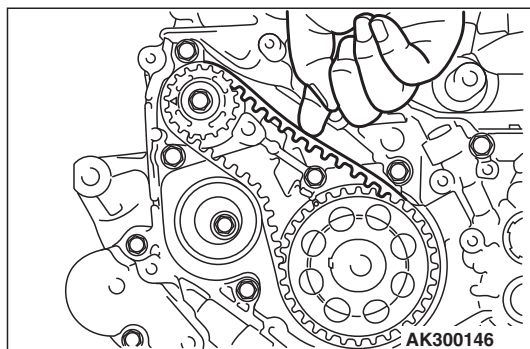


3. Make sure that the tensioner pulley center and the bolt center are positioned as shown in the illustration.



4. Move tensioner "B" in the direction of the arrow while lifting with your finger to give sufficient tension to the tension side of timing belt. In this condition, tighten the bolt to secure tensioner "B." When the bolt is tightened, use care to prevent the tensioner pulley shaft from turning with the bolt. If the shaft is turned with the bolt, the belt will be over tensioned.

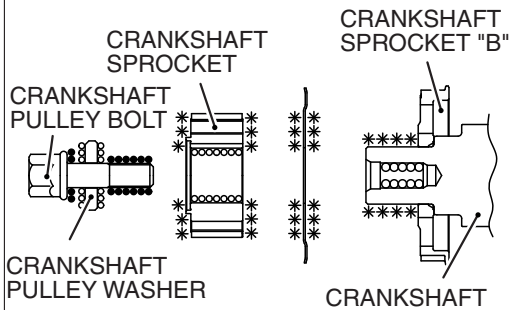
Tightening torque: 19 ± 3 N·m (14 ± 2 ft-lb)



5. Check that timing marks on the sprockets are aligned with the timing marks on the front case.
6. With your index finger, press the center of timing belt "B" at the tension side as shown. The bolt must deflect 8 to 12 mm (0.31 to 0.47 inch).

>>G<< CRANKSHAFT SENSING BLADE / CRANKSHAFT SPROCKET / CRANKSHAFT PULLEY WASHER / CRANKSHAFT BOLT INSTALLATION

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

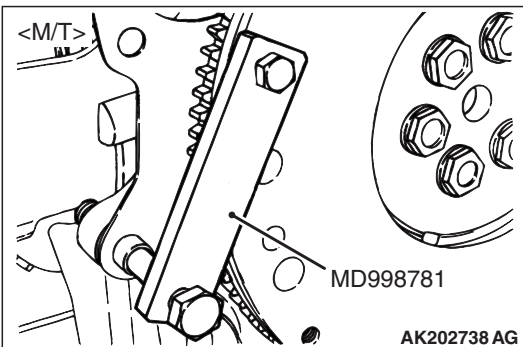


← ENGINE FRONT

AK603868AB

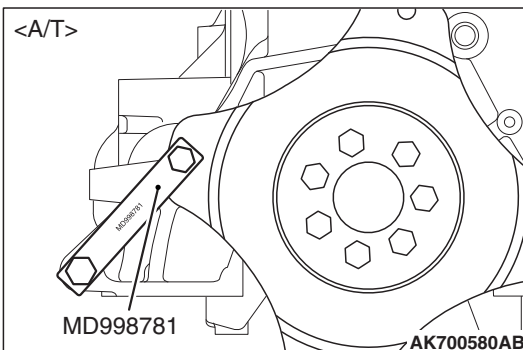
1. Wipe dirt on the crankshaft sprocket hole using a rag.
2. Using a rag, wipe dirt on the crankshaft spacer, crankshaft sensing blade, crankshaft sprocket, oil pump case and crankshaft sprocket installation surface. And then perform degreasing.

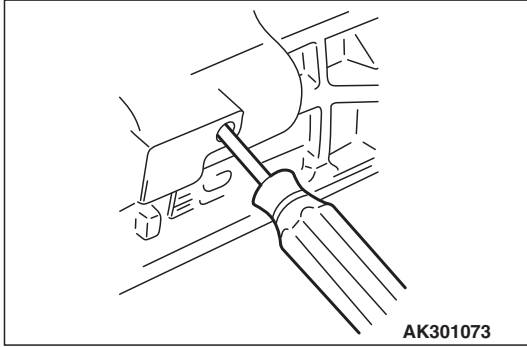
NOTE: Degreasing is necessary to prevent decrease in friction between the mating surface due to presence of oil.



3. Lock the drive plate or flywheel using the special tool MD998781.
4. Tighten the crankshaft bolt to the specified torque.

Tightening torque: 167 N·m (123 ft-lb)



**>>H<< OIL PUMP SPROCKET INSTALLATION**

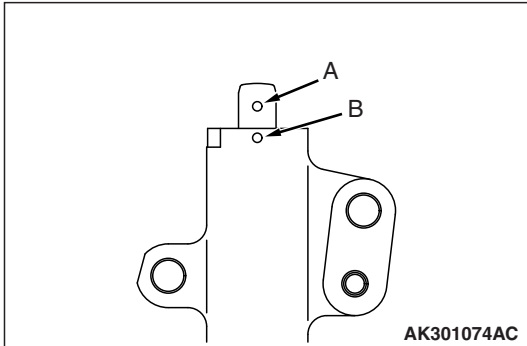
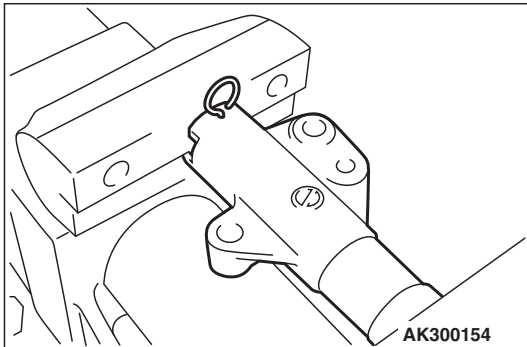
1. Insert a Phillips head screwdriver [shank diameter 8 mm (0.3 inch)] through the plug hole on the left side of the cylinder block to block the left counterbalance shaft.
2. Install the oil pump sprocket.
3. Apply a thin coat of engine oil to the seating surface of the nut.
4. Tighten the nut to the specified torque.

Tightening torque: 54 ± 4 N·m (40 ± 2 ft-lb)

>>I<< AUTO-TENSIONER INSTALLATION

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

1. Clamp the auto-tensioner in a vise with soft jaws.



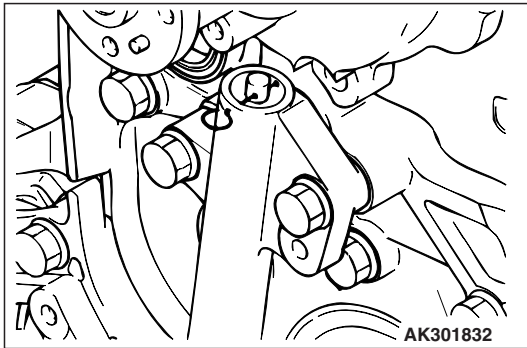
2. Push in the rod little by little with the vise until the set hole A in the rod is aligned with hole B in the cylinder.
3. Insert a wire [1.4 mm (0.055 inch) in diameter] into the set holes. This auto-tensioner setting wire will be used during timing belt alignment.
4. Unclamp the auto-tensioner from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

⚠ CAUTION

Leave the wire installed in the auto-tensioner.

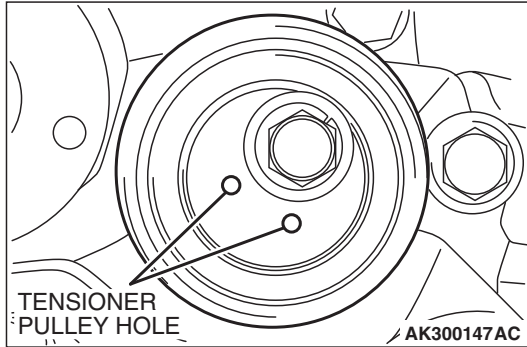
5. Install the auto-tensioner onto the front case and tighten to the specified torque.

Tightening torque: 23 ± 3 N·m (17 ± 2 ft-lb)



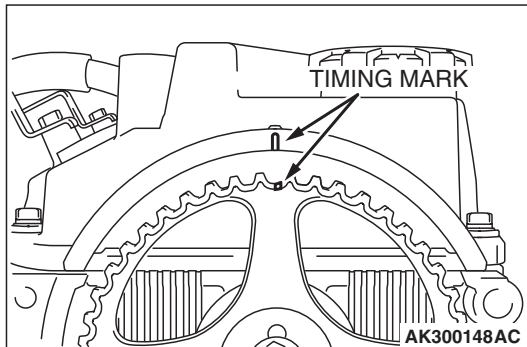
>>J<< TENSIONER PULLEY INSTALLATION

Set the tensioner pulley so that the holes for attaching a wrench are positioned as shown in the illustration.

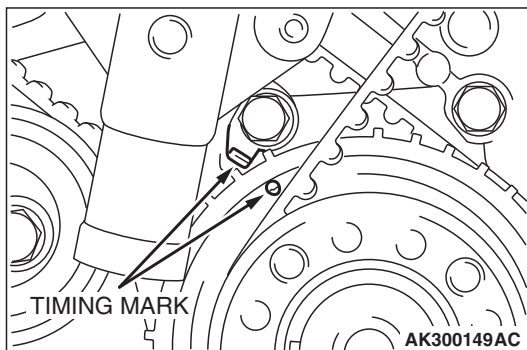


>>K<< TIMING BELT INSTALLATION

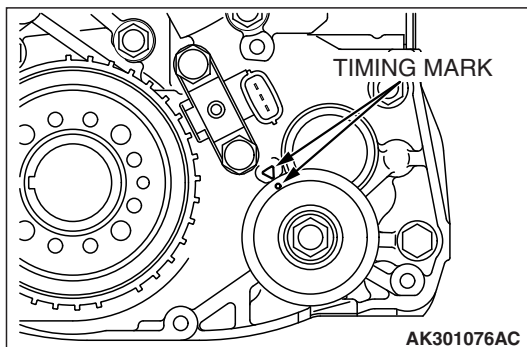
1. Align the timing mark on the camshaft sprocket with the timing mark on the rocker cover.

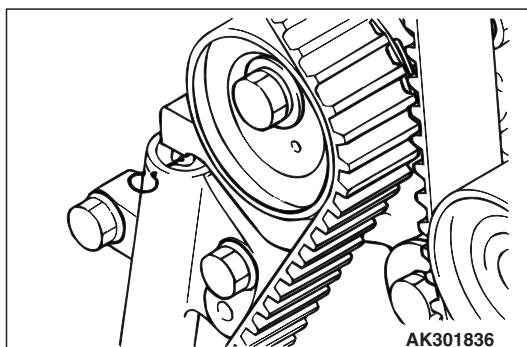
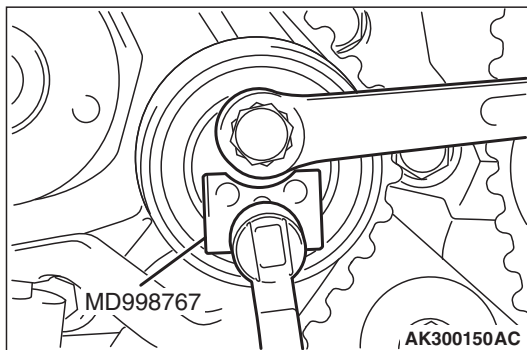
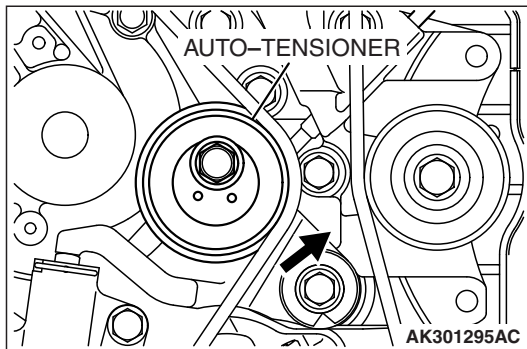
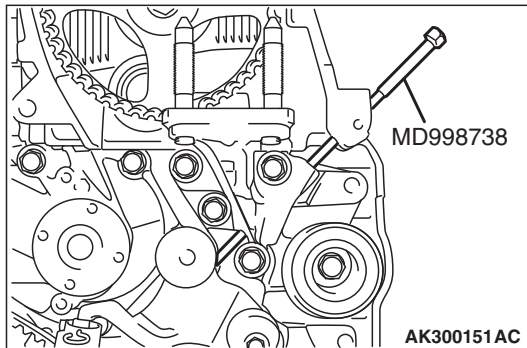
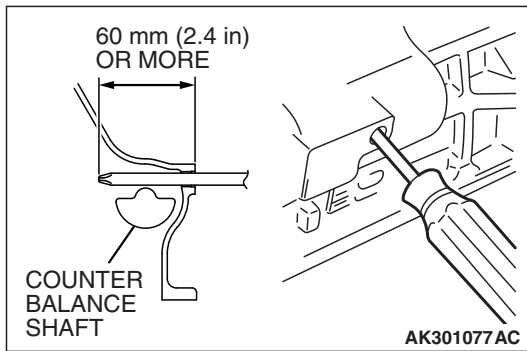


2. Align the timing mark on the crankshaft sprocket with the timing mark on the front case.

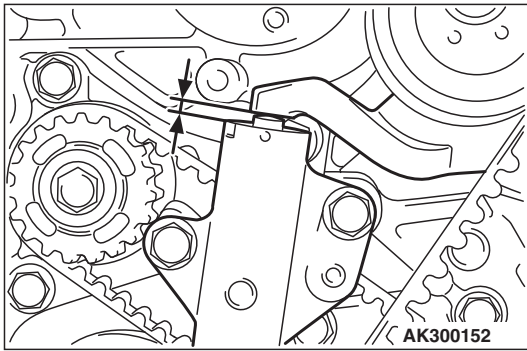


3. Align the timing mark on oil pump sprocket with its mating mark.





4. Remove the plug on the cylinder block and insert a Phillips head screwdriver [shank diameter 8 mm (0.3 inch)] through the hole.
If it can be inserted as deep as 60 mm (2.4 inches) or more, the timing marks are correctly aligned.
if the inserted depth is only 20 to 25 mm (0.8 to 0.9 inch), turn the oil pump sprocket one turn and realign the timing marks, then check to ensure that the screwdriver can be inserted 60 mm (2.4 inches) or more. Keep the screwdriver inserted until the timing belt is completely installed.
5. Set special tool MD998738 as shown and screw it in up to the position where the wire inserted in the auto-tensioner can be moved lightly.
6. Install the timing belt on the crankshaft sprocket, oil pump sprocket, idler pulley, camshaft sprocket, and tensioner pulley in that order.
7. Lift up the tensioner pulley in the direction of the arrow and tighten the center bolt.
8. Check that all timing marks are aligned.
9. Remove the screwdriver inserted in step 5 and install the plug.
10. Turn the crankshaft a quarter turn counterclockwise. Then, turn it clockwise until the timing marks are aligned again.
11. Install special tool MD998767, socket wrench and torque wrench, onto the tensioner pulley, and loosen the tensioner pulley center bolt.
NOTE: Use a torque wrench that can measure 0 to 5.0 N·m (0 – 44 in-lb).
12. Torque to 3.5 N·m (31 in-lb) with the torque wrench.
13. Holding the tensioner pulley with special tool MD998767 and torque wrench, tighten the center bolt to specification.
Tightening torque: 48 ± 5 N·m (35 ± 3 ft-lb)
14. The wire inserted at the auto-tensioner installation is pulled out and then the special tool MD998738 is removed by hand.
15. Give two clockwise turns to the crankshaft. Wait for 15 minutes, then proceed with the following inspection steps.



16. 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: 3.8 – 4.5 mm (0.15 – 0.18 inch)

17. If the metal wire offers resistance when removed, repeat the previous steps 10 through 15 until the standard value is obtained as measured by the rod projection of the auto-tensioner rod.

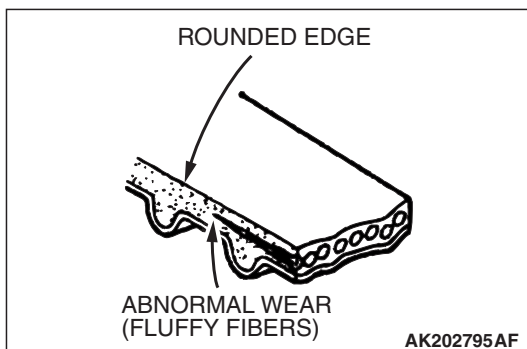
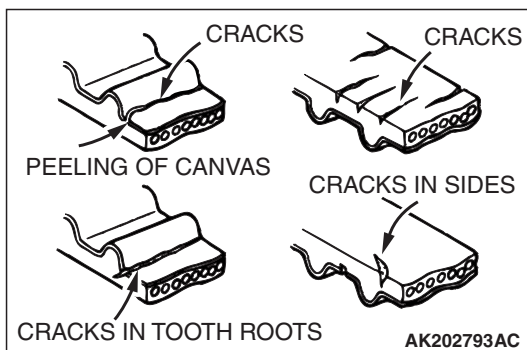
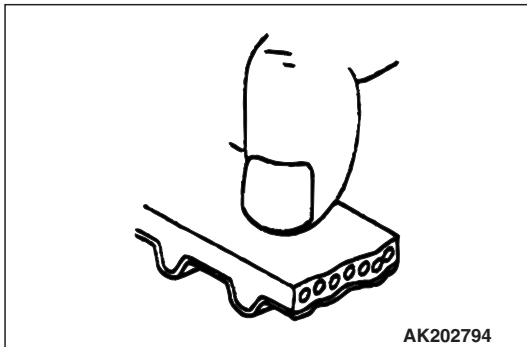
INSPECTION

M1113002001257

TIMING BELT

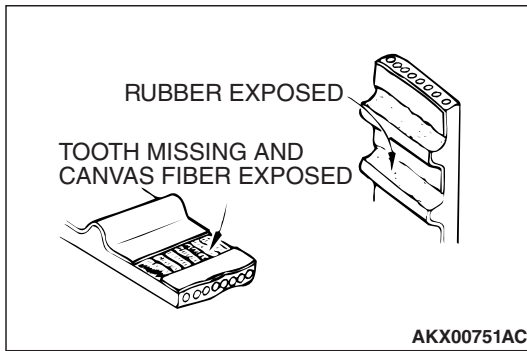
Replace the belt if any of the following conditions exist:

1. Hardening of rubber backing.
Back side should be glossy without resilience and leave no indent when pressed with fingernail.



2. Cracks on rubber back.
3. Cracks or peeling of canvas.
4. Cracks at bottom of ribs.
5. Cracks on belt sides.

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:

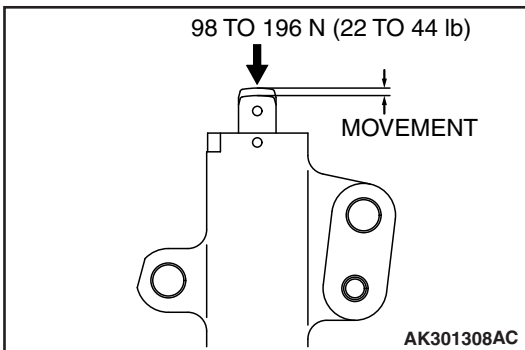
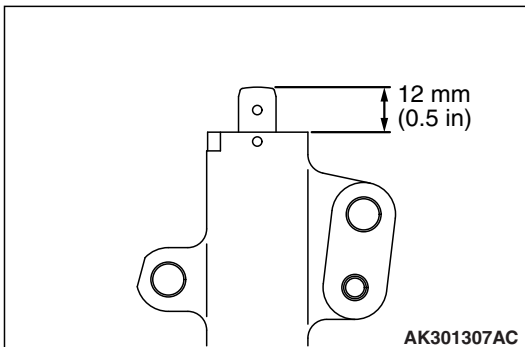
Canvas worn, exposing rubber (tooth width reduced)

8. Missing tooth.

AUTO-TENSIONER

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

Standard value: 12 mm (0.5 inch)



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

Standard value: 1.0 mm (0.03 inch) or less

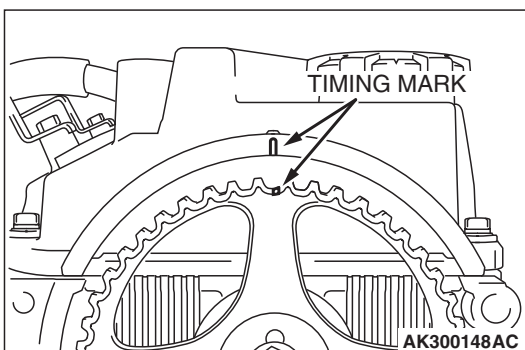
VALVE CLEARANCE ADJUSTMENT

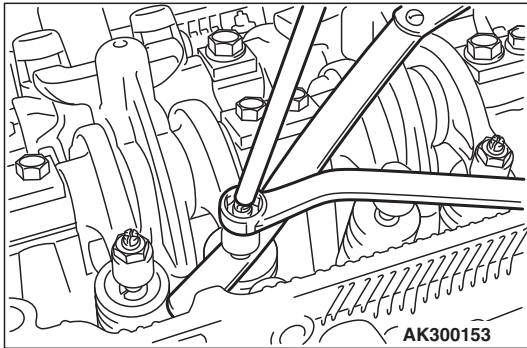
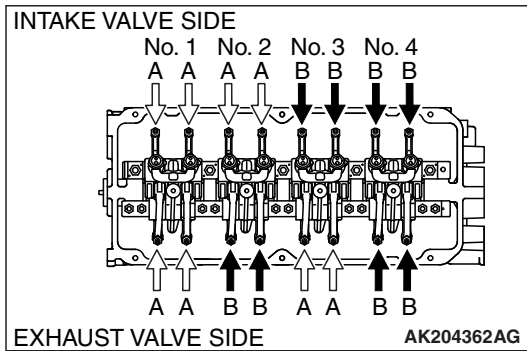
Adjust the valve clearance as follows:

⚠ CAUTION

Rotate the crankshaft clockwise at any time.

1. Rotate crankshaft clockwise and then align the timing mark on the camshaft sprocket with the timing mark on the rocker cover. (Place Number 1 cylinder on the top dead center of compression stroke.)
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):

Intake side: 0.11 mm (0.004 inch)

Exhaust side: 0.20 mm (0.008 inch)

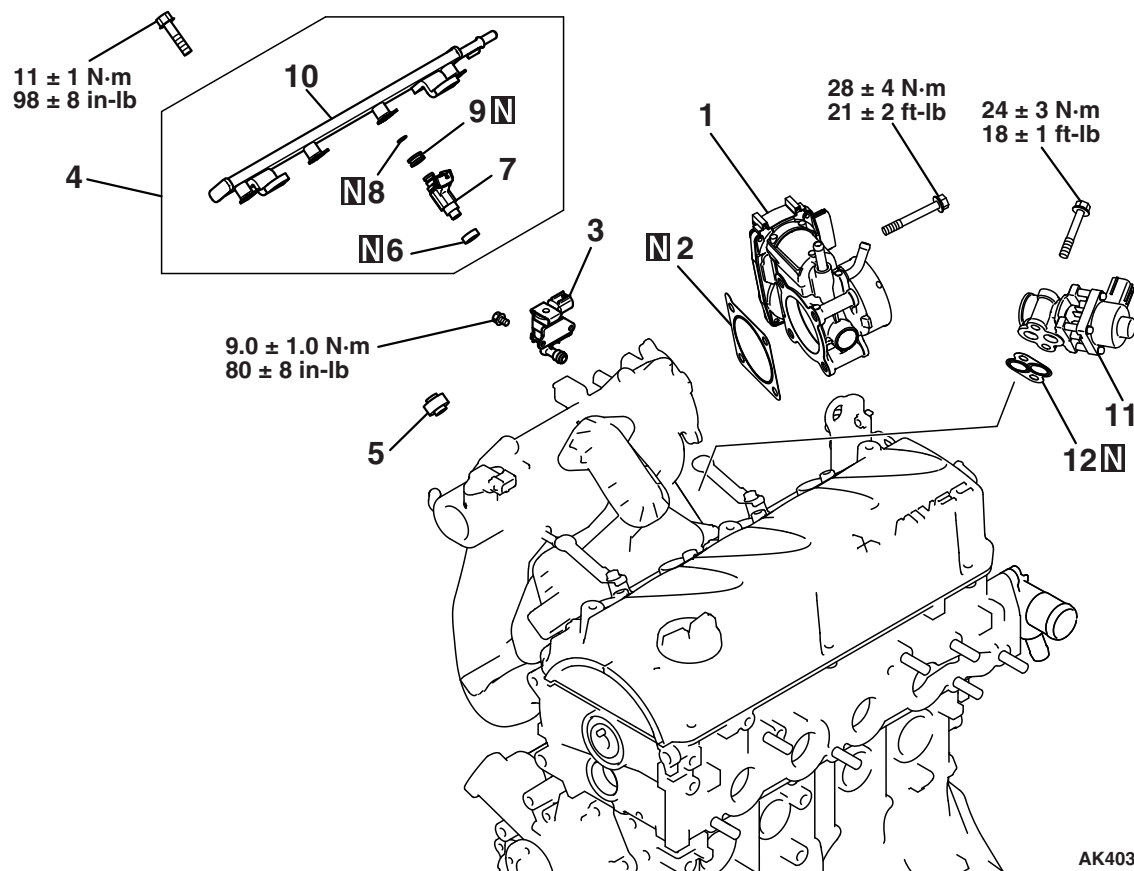
NOTE: After the engine assembly is installed on the vehicle, check the valve clearance again with the engine warmed up. Adjust if necessary.

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.

FUEL AND EMISSION PARTS

REMOVAL AND INSTALLATION

M1113002201499



REMOVAL STEPS

- >>C<< 1. THROTTLE BODY
2. THROTTLE BODY GASKET
3. SOLENOID VALVE
4. INJECTOR AND FUEL RAIL
5. INSULATOR
6. INSULATOR
>>B<< 7. INJECTOR
8. O-RING

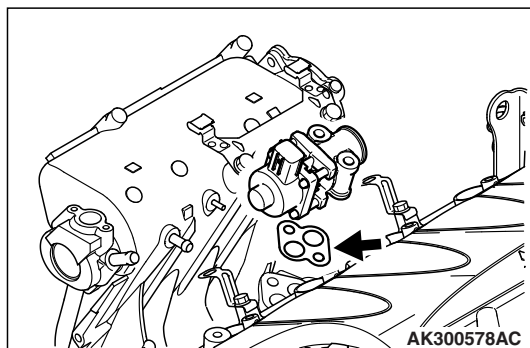
REMOVAL STEPS (Continued)

9. GROMMET
10. FUEL RAIL
11. EXHAUST GAS
RECIRCULATION VALVE
>>A<< 12. EXHAUST GAS
RECIRCULATION VALVE
GASKET

INSTALLATION SERVICE POINTS

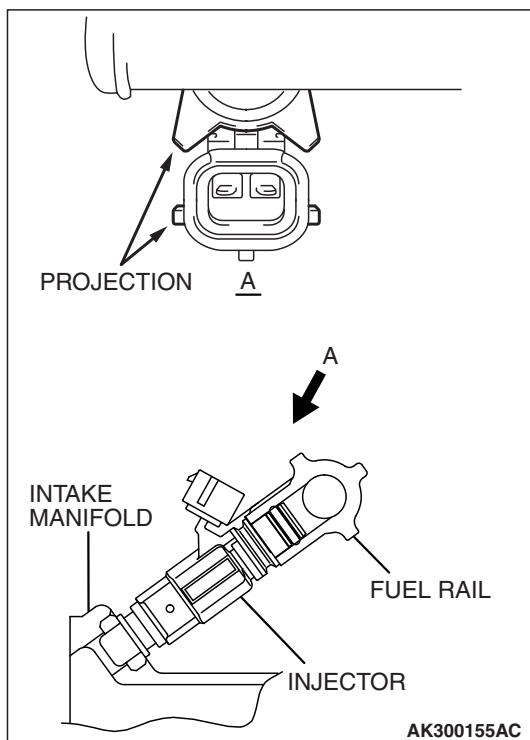
>>A<< EXHAUST GAS RECIRCULATION VALVE GASKET INSTALLATION

Install a new gasket in the position shown in the illustration.



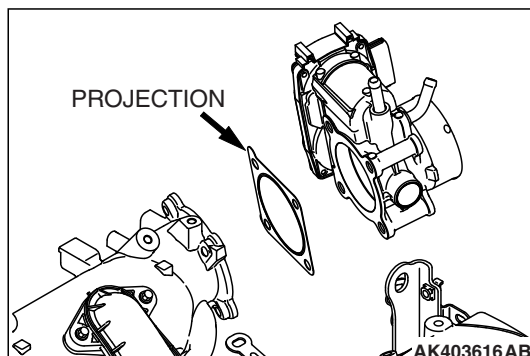
>>B<< INJECTORS INSTALLATION

1. Apply clean gasoline 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, reinstall the injector and check that it rotates smoothly.



>>C<< THROTTLE BODY GASKET INSTALLATION

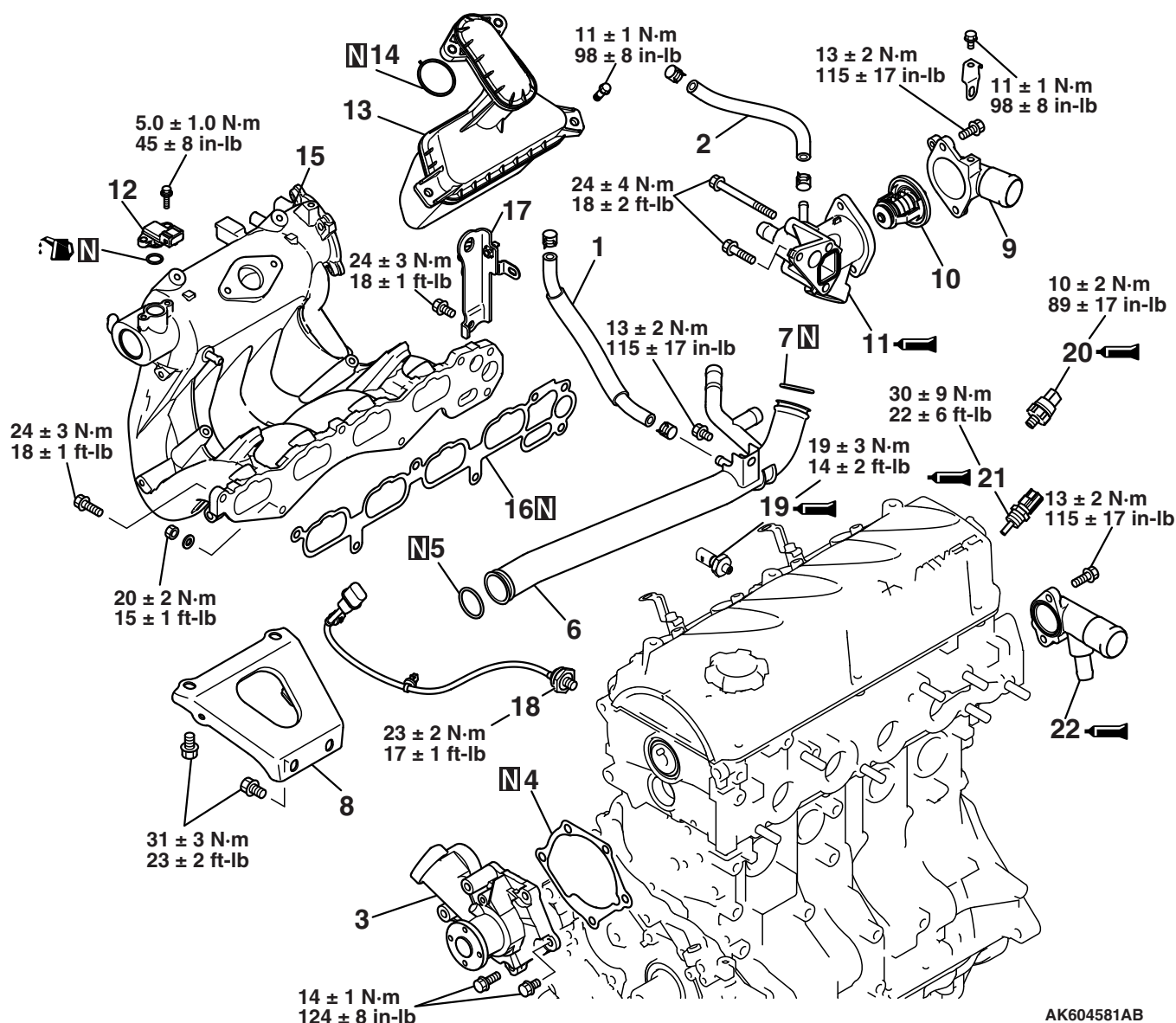
Install a new gasket so that the projection is positioned as shown in the illustration.



INTAKE MANIFOLD AND WATER PUMP

REMOVAL AND INSTALLATION

M1113025500324



AK604581AB

REMOVAL STEPS

1. WATER HOSE
2. WATER HOSE
3. WATER PUMP
4. WATER PUMP GASKET
- >>H<< 5. O-RING
- >>H<< 6. WATER INLET PIPE
- >>H<< 7. O-RING
- >>G<< 8. INTAKE MANIFOLD STAY
9. WATER INLET FITTING
- >>F<< 10. THERMOSTAT
- >>E<< 11. THERMOSTAT HOUSING
12. MANIFOLD ABSOLUTE PRESSURE SENSOR

REMOVAL STEPS (Continued)

13. INTAKE MANIFOLD PLENUM RESONATOR
14. GASKET
15. INTAKE MANIFOLD
16. INTAKE MANIFOLD GASKET
17. ENGINE HANGER
18. KNOCK SENSOR
- >>D<< 19. ENGINE ENGINE ENGINE OIL PRESSURE SWITCH
- >>C<< 20. ENGINE ENGINE ENGINE OIL PRESSURE SWITCH
- >>B<< 21. ENGINE ENGINE COOLANT TEMPERATURE SENSOR
- >>A<< 22. WATER OUTLET FITTING

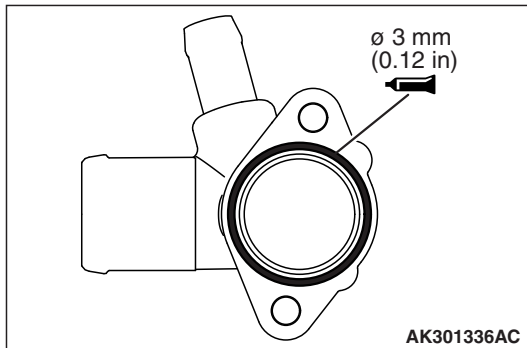
INSTALLATION SERVICE POINTS

>>A<< WATER OUTLET FITTING INSTALLATION

1. Apply a 3 mm (0.12 inch) diameter bead of sealant (Three bond 1207F or equivalent) to the groove as shown in the illustration.
2. Install the housing quickly (within 15 minutes) while the sealant is wet and tighten the bolts to the specified torque.

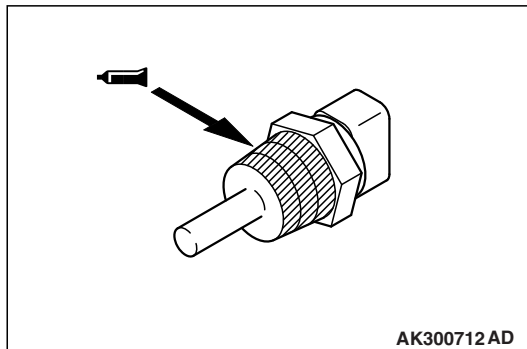
Tightening torque: 13 ± 2 N·m (115 ± 17 in-lb)

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



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

Apply sealant (Three bond 1324N, LOCTITE 262 or equivalent) to the engine coolant temperature sensor.

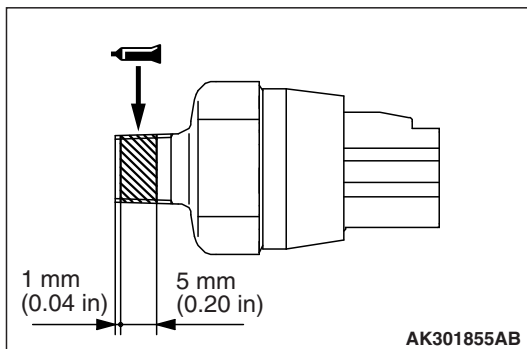


>>C<< SEALANT APPLICATION TO ENGINE OIL PRESSURE SWITCH

⚠ CAUTION

Do not block the oil passage with sealant.

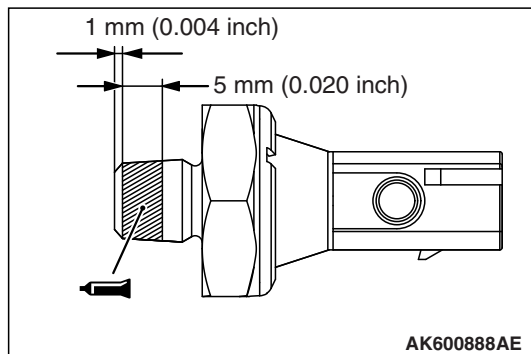
Apply sealant (Three bond 1212D, Three bond 1215 or equivalent) to the threads of the engine oil pressure switch.



>>D<< SEALANT APPLICATION TO ENGINE OIL PRESSURE SWITCH

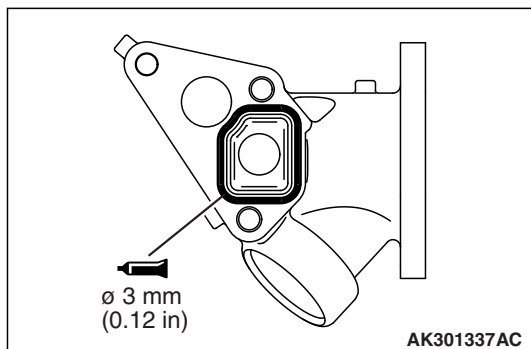
⚠ CAUTION**Do not block the oil passage with sealant.**

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

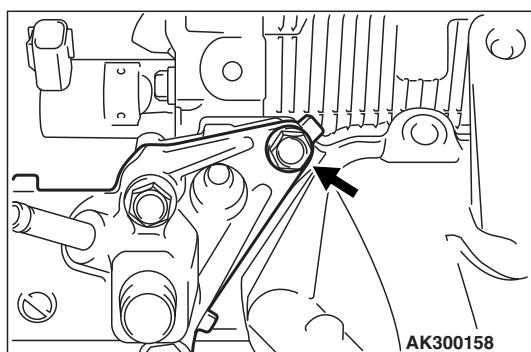


>>E<< THERMOSTAT HOUSING INSTALLATION

1. Apply a 3 mm (0.12 inch) diameter bead of sealant (Three bond 1207F or equivalent) to the groove as shown in the illustration.

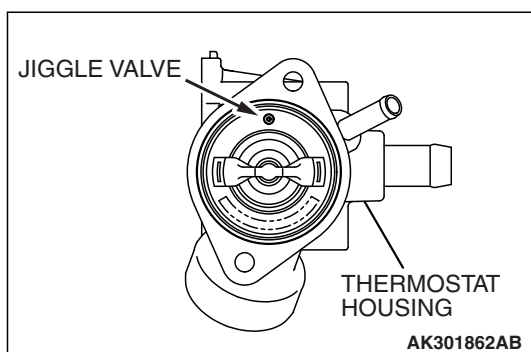


2. Coat the threads of the bolt indicated in the illustration with (Three bond 1212D, Three bond 1215 or equivalent) before tightening.
3. Install the housing quickly (within 15 minutes) while the sealant is wet and tighten the bolts to the specified torque.

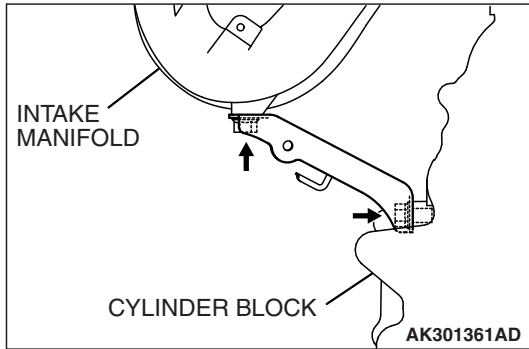
Tightening torque: 24 ± 4 N·m (18 ± 2 ft-lb)*NOTE: After installation, keep the sealed area away from the coolant for approximately one hour.*

>>F<< THERMOSTAT INSTALLATION

1. Check that the rubber ring is undamaged 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.



>>G<< INTAKE MANIFOLD STAY INSTALLATION



1. Install the intake manifold stay and tighten the bolts just finger tight.
2. Check to ensure that the stay is in close contact with the bosses of the intake manifold and cylinder block.
3. First tighten the intake manifold side bolts to the specified torque, then the cylinder block side bolts to the specified torque.

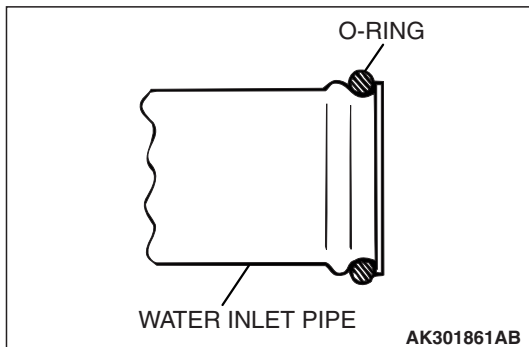
Tightening torque: 31 ± 3 N·m (23 ± 2 ft-lb)

>>H<< WATER INLET PIPE / O-RING INSTALLATION

CAUTION

Keep the O-ring free of oil or grease.

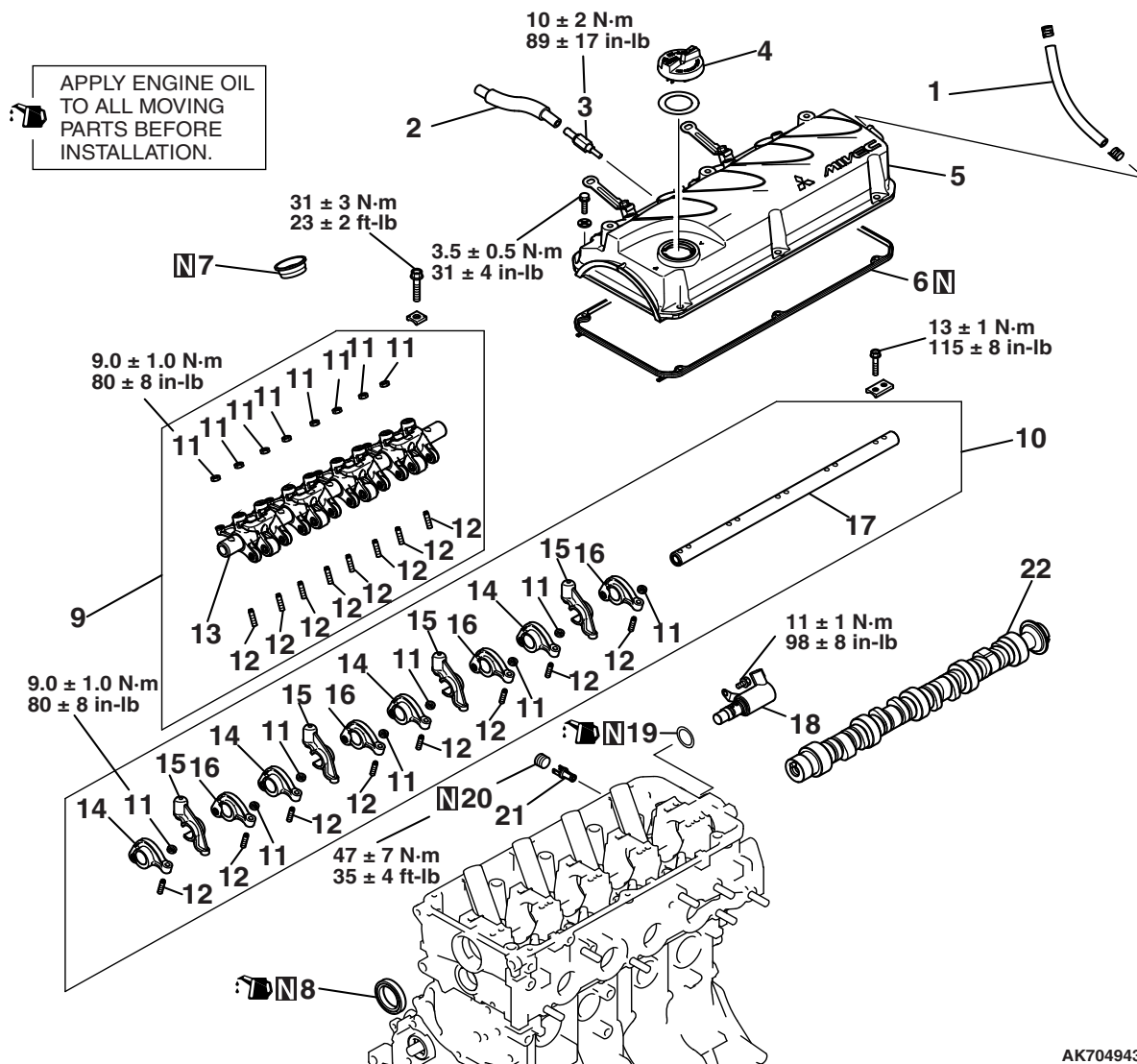
1. Attach a new O-ring to each end of the water inlet pipe.
2. Wet the O-ring with water.
3. Insert the rear end of the pipe into the thermostat housing.



ROCKER ARMS AND CAMSHAFT

REMOVAL AND INSTALLATION

M1113005401845



AK704943AB

REMOVAL STEPS

1. BREATHER HOSE
2. POSITIVE CRANKCASE VENTILATION HOSE
3. POSITIVE CRANKCASE VENTILATION VALVE
4. OIL FILLER CAP
5. ROCKER COVER
6. ROCKER COVER GASKET
7. OIL SEAL
8. OIL SEAL
- >>D<< 9. ROCKER ARMS AND ROCKER ARM SHAFT (INTAKE SIDE)
- <<A>> >>C<< 10. ROCKER ARMS AND ROCKER ARM SHAFT (EXHAUST SIDE)
- <<A>> >>C<< 11. NUT

REMOVAL STEPS (Continued)

- >>B<< 12. ADJUSTING SCREW
13. ROCKER ARM SHAFT ASSEMBLY (INTAKE SIDE)
14. ROCKER ARM "C"
15. PISTON ARM ASSEMBLY
16. ROCKER ARM "D"
17. ROCKER ARM SHAFT (EXHAUST SIDE)
- >>A<< 18. ENGINE OIL CONTROL VALVE
- >>A<< 19. O-RING
20. TAPER PLUG
21. ENGINE OIL CONTROL VALVE FILTER
22. CAMSHAFT

Required Special Tool:

- 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.

INSTALLATION SERVICE POINTS

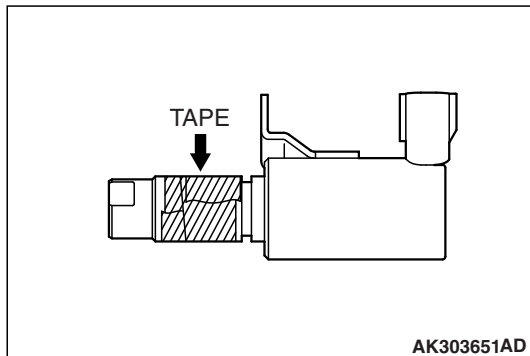
>>A<< ENGINE OIL CONTROL VALVE / O-RING INSTALLATION

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.

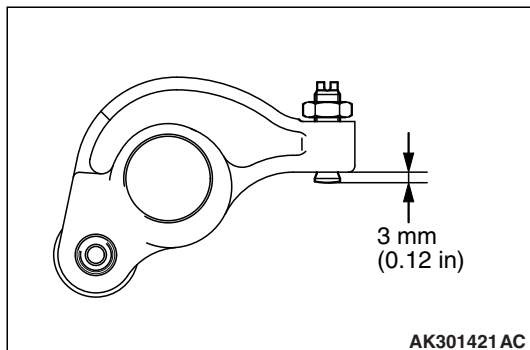
1. Apply a small amount of engine oil to the O-ring and then install it to the engine oil control valve.
2. Install the engine oil control valve to the cylinder head.
3. Tighten the engine oil control valve.

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



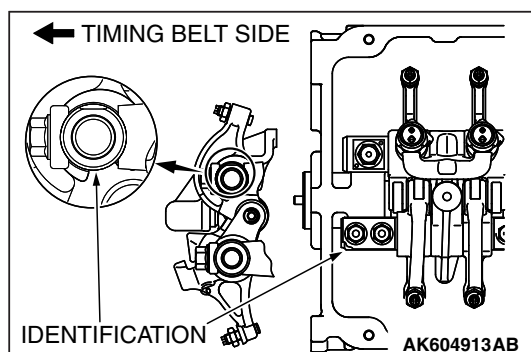
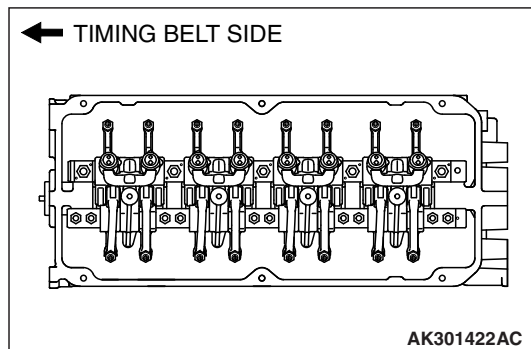
>>B<< ADJUSTING SCREW INSTALLATION

When installing provisionally the screw to the rocker arm, project it slightly 3 mm (0.12 inch) from the face of the rocker arm end.



>>C<< ROCKER SHAFT SPRING / ROCKER ARMS AND ROCKER ARM SHAFT INSTALLATION

1. In accordance with the tags made during removal, install the rocker arm, and other parts to the rocker arm shaft.
2. Install the rocker arm shaft with oil hole to the lower (cylinder head) side.
3. Temporarily install the rocker arm and a rocker arm shaft assembly (intake side).
4. Temporarily install the rocker arm, rocker arm and a rocker arm shaft assembly (exhaust side).



5. Confirm that the rocker arm and rocker arm shaft assembly are in position and then tighten to the specified torque.

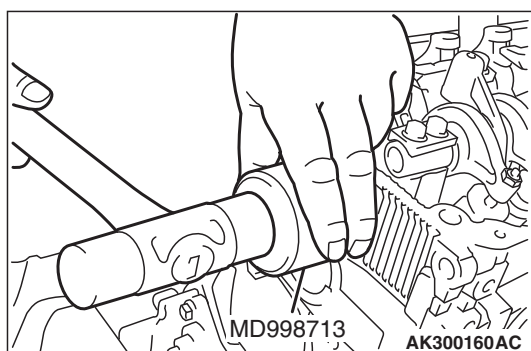
Tightening torque

M6: 13 ± 1 N·m (115 ± 8 in-lb)

M8: 31 ± 3 N·m (23 ± 2 ft-lb)

>>D<< 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.

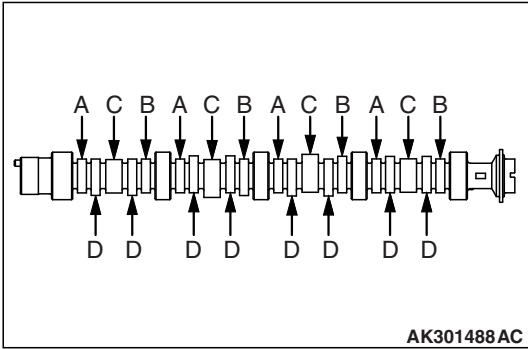
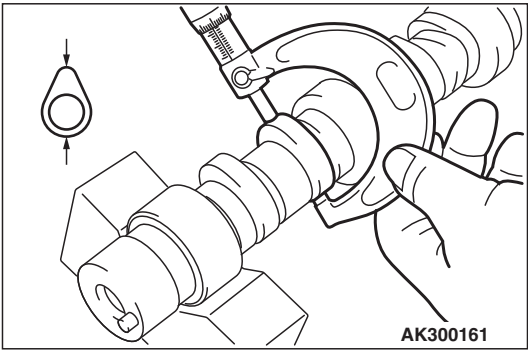


INSPECTION

M1113005500883

CAMSHAFT

Measure the cam height. If it is below the limit, replace the camshaft.

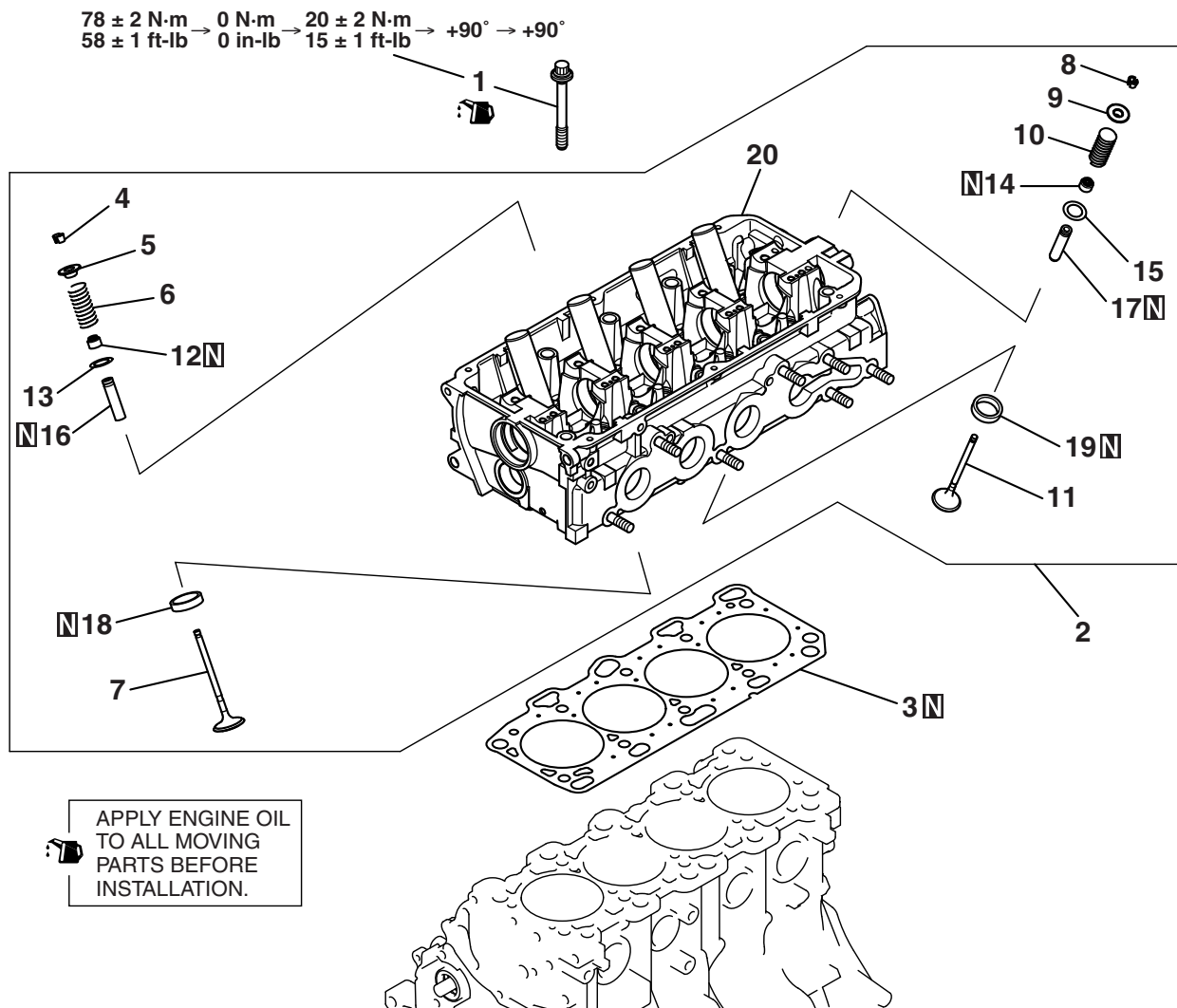


	STANDARD VALUE	MINIMUM LIMIT
A: Intake low speed cam A	37.47 mm (1.475 in)	36.97 mm (1.455 in)
B: Intake low speed cam B	37.47 mm (1.475 in)	36.97 mm (1.455 in)
C: Intake high speed cam	37.21 mm (1.465 in)	36.71 mm (1.445 in)
D: Exhaust cam	37.86 mm (1.491 in)	37.36 mm (1.471 in)

CYLINDER HEAD AND VALVES

REMOVAL AND INSTALLATION

M1113006902192



AK301262AC

REMOVAL STEPS

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

REMOVAL STEPS (Continued)

- >>A<< 11. EXHAUST VALVE
12. VALVE STEM SEAL
13. VALVE SPRING SEAT
- >>A<< 14. VALVE STEM SEAL
15. VALVE SPRING SEAT
16. INTAKE VALVE GUIDE
17. EXHAUST VALVE GUIDE
18. INTAKE VALVE SEAT
19. EXHAUST VALVE SEAT
20. CYLINDER HEAD

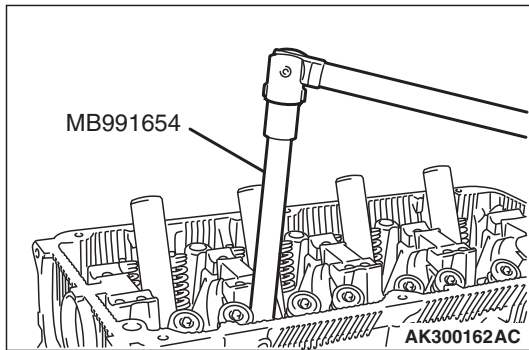
Required Special Tools:

- MB991654: Cylinder Head Bolt Wrench (12)
- MB991999: Valve Stem Seal Installer
- MD998735: Valve Spring Compressor

REMOVAL SERVICE POINTS

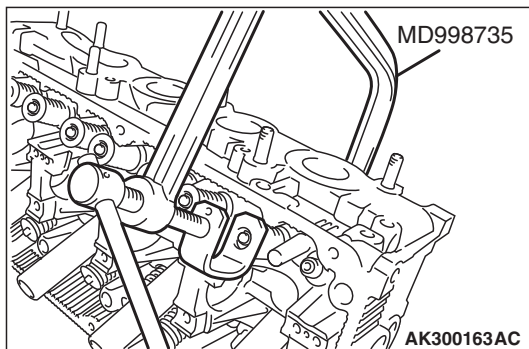
<<A>> CYLINDER HEAD BOLTS REMOVAL

Using special tool MB991654, loosen the cylinder head bolts. Loosen each bolt evenly, little by little, in two or three steps.



<> RETAINER LOCK REMOVAL

1. Set special tool MD998735 as illustrated to compress the valve spring. Remove the retainer lock.
2. Relieve the spring tension and remove the valve, retainer, spring, etc. Tag the removed valves, springs, and other parts, to indicate their cylinder number and location for reassembly.



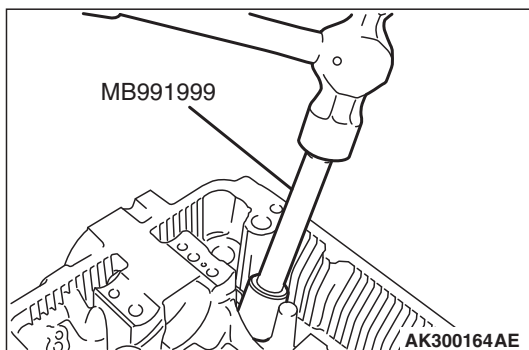
INSTALLATION SERVICE POINTS

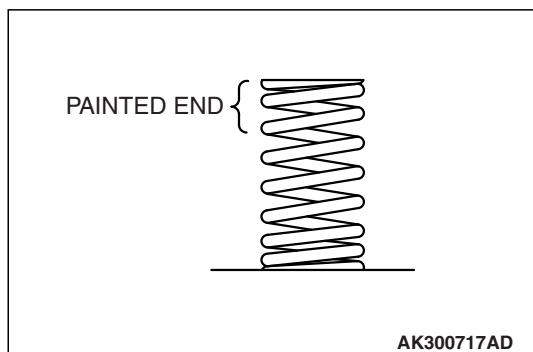
>>A<< VALVE STEM SEAL INSTALLATION

CAUTION

The special tool must be used to install the valve stem seal. Improper installation could result in oil leaking past the valve guide.

1. Install the valve spring seat.
2. Using special tool MB991999, install a new valve stem seal.



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

Install the valve spring with its identification color painted end (larger pitch side) upward (toward the valve spring retainer).

Identification:

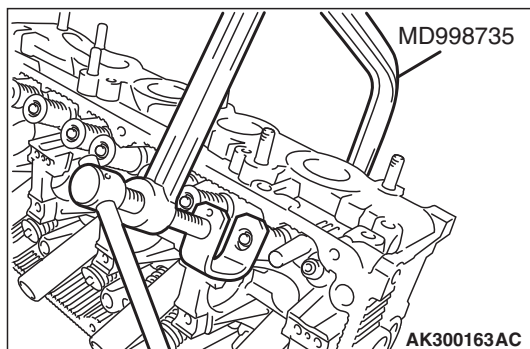
<Intake> Light blue

<Exhaust> Orange

>>C<< RETAINER LOCK INSTALLATION**⚠ CAUTION**

Do not compress the valve spring excessively. It can damage the stem seal.

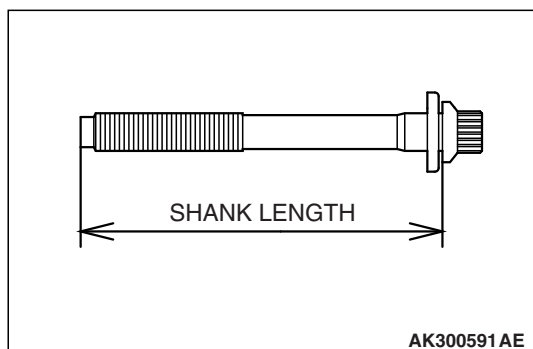
1. Set special tool MD998735 as illustrated to compress the valve spring. Install the retainer locks.
2. Relieve the spring tension. Check that the retainer locks are seated correctly.

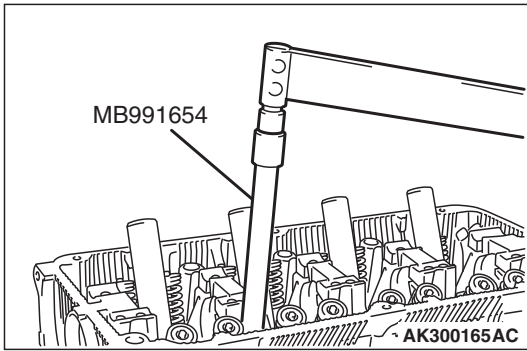
**>>D<< CYLINDER HEAD BOLT INSTALLATION**

1. When the removed cylinder head bolts are to be reused, check that the shank length of each bolt meets the limit. If it exceeds the limit, replace the bolts.

Limit: 99.4 mm (3.91 inches)

2. Apply engine oil to the thread of the bolts and to the washers.



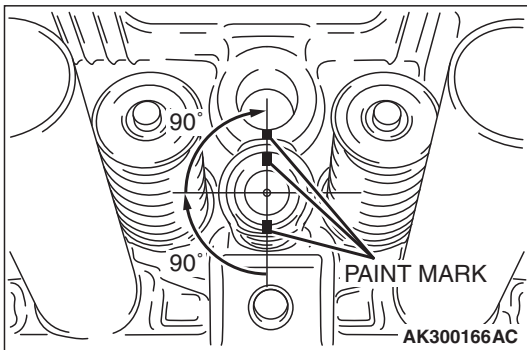
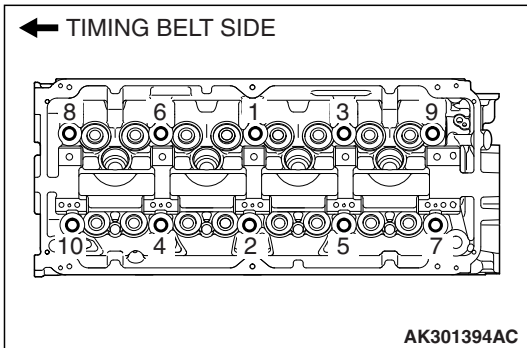


3. Using special tool MB991654 tighten the bolts to the specified torque, using the tightening sequence shown.

Tightening torque: $78 \pm 2 \text{ N}\cdot\text{m}$ ($58 \pm 1 \text{ ft}\cdot\text{lb}$)

4. Loosen all bolts fully in the reverse order of tightening.
5. Retighten the loosened bolts to the specified torque in the tightening sequence shown.

Tightening torque: $20 \pm 2 \text{ N}\cdot\text{m}$ ($15 \pm 1 \text{ ft}\cdot\text{lb}$)



6. Make a paint mark across each bolt head and cylinder head.
7. Tighten the cylinder head bolts 90 degrees in the specified order.
8. Tighten the bolts another 90 degrees in the same order as in step 7, and check that the paint marks on the cylinder head bolt are aligned with the paint marks on the cylinder head.

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.

INSPECTION

M1113007002051

CYLINDER HEAD

1. Check the cylinder head gasket surface for flatness by using a straight edge and feeler gauge.

Standard value: Less than 0.03 mm (0.001 inch)

Limit: 0.2 mm (0.007 inch)

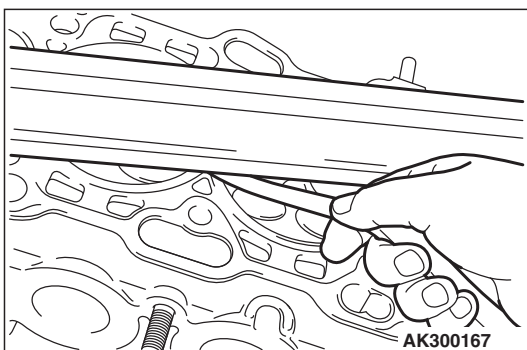
2. If it exceeds the limit, correct to meet specification.

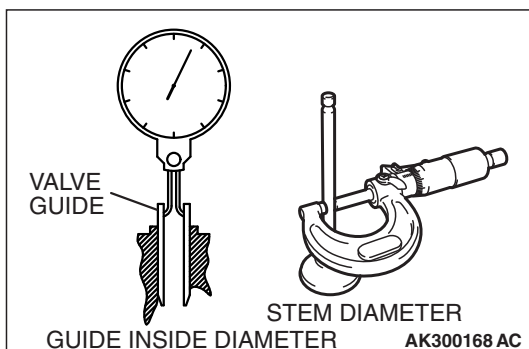
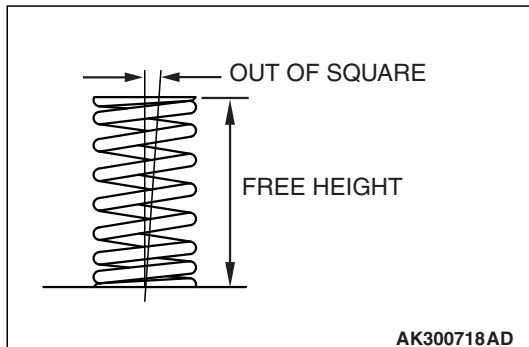
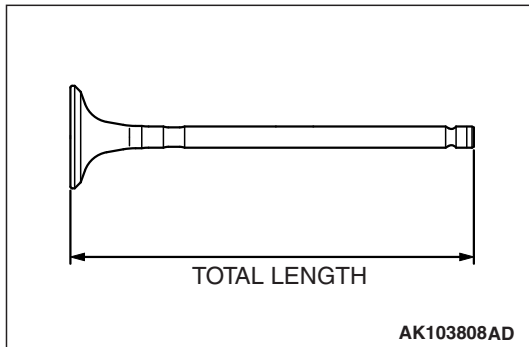
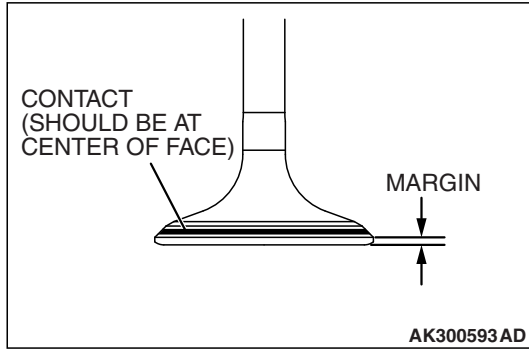
Grinding limit: *0.2 mm (0.007 inch)

*** Includes combined with cylinder block grinding.**

Cylinder head height (Specification when new):

120 mm (4.7 inches)





VALVE

1. Check the valve seat contact. Valve seat contact should be uniform at the center of the valve face. If incorrect, reface using a valve refacer.
2. If the margin is below the limit, replace the valve.

Standard value:

<Intake> 1.0 mm (0.03 inch)

<Exhaust> 1.2 mm (0.04 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 the limit, replace the valve.

Standard value:

<Intake> 111.33 mm (4.383 inches)

<Exhaust> 113.54 mm (4.470 inches)

Minimum limit:

<Intake> 110.83 mm (4.363 inches)

<Exhaust> 113.04 mm (4.450 inches)

VALVE SPRING

1. Measure the free height of the spring. If it is less than the limit, replace.

Standard value:

<Intake> 54.8 mm (2.16 inches)

<Exhaust> 56.1 mm (2.21 inches)

Minimum limit:

<Intake> 53.8 mm (2.12 inches)

<Exhaust> 55.1 mm (2.17 inches)

2. Measure the squareness of the spring. If it exceeds the limit, replace.

Standard value: 2 degrees or less

Limit: 4 degrees

VALVE GUIDE

Measure the clearance between the valve guide and valve stem. If it exceeds the limit, replace the valve guide or valve, or both.

Standard value:

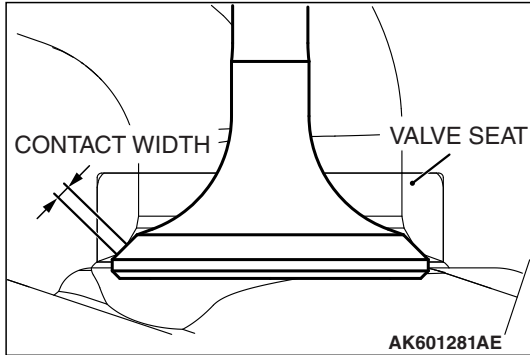
<Intake> 0.020 – 0.047 mm (0.0008 – 0.0019 inch)

<Exhaust> 0.035 – 0.062 mm (0.0014 – 0.0024 inch)

Limit:

<Intake> 0.10 mm (0.003 inch)

<Exhaust> 0.15 mm (0.005 inch)



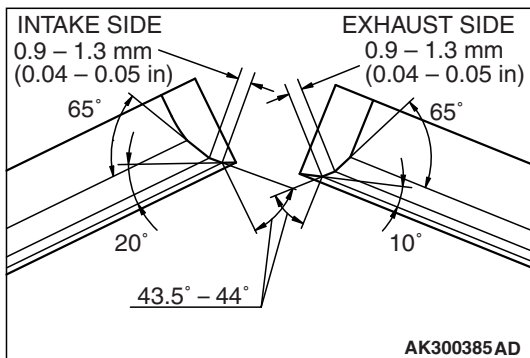
VALVE SEAT

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.

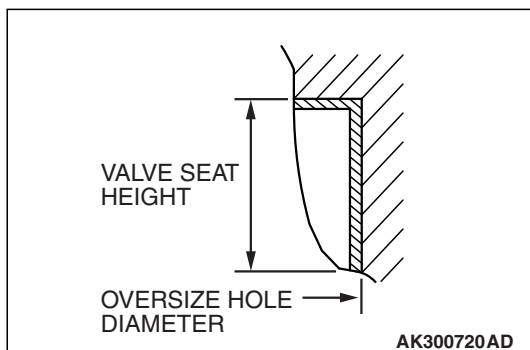
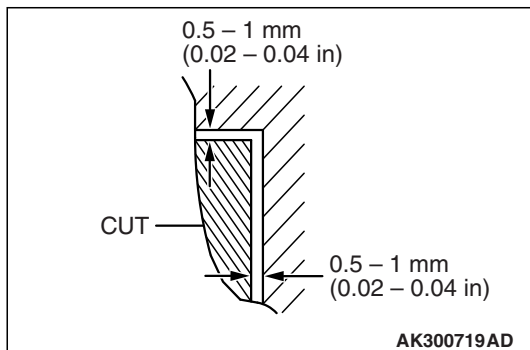


VALVE SEAT RECONDITIONING PROCEDURE

1. Before correcting the valve seat, check for clearance between the valve guide and valve and, if necessary, replace the valve guide.
2. Using the seat grinder, correct to obtain the specified seat width and angle.
3. After correcting the valve seat, lap the valve and valve seat using lapping compound. Then, check the valve stem projection.

VALVE SEAT REPLACEMENT PROCEDURE

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.

Intake seat ring hole diameters

0.3 oversize:

35.30 – 35.33 mm (1.3898 – 1.3909 inches)

0.6 oversize:

35.60 – 35.63 mm (1.4016 – 1.4028 inches)

Exhaust seat ring hole diameters

0.3 oversize:

33.30 – 33.33 mm (1.3110 – 1.3122 inches)

0.6 oversize:

33.60 – 33.63 mm (1.3228 – 1.3240 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.
See "VALVE SEAT RECONDITIONING PROCEDURE" on the previous page.

VALVE GUIDE REPLACEMENT PROCEDURE

1. Using a press, remove the valve guide toward the cylinder block.

CAUTION

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

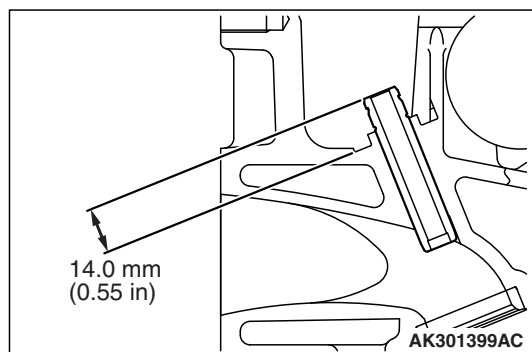
2. Rebore the valve guide hole of the cylinder head so that it fits the press-fitted oversize valve guide.

Valve guide hole diameters

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)



3. Press-fit the valve guide until it protrudes 14.0 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.

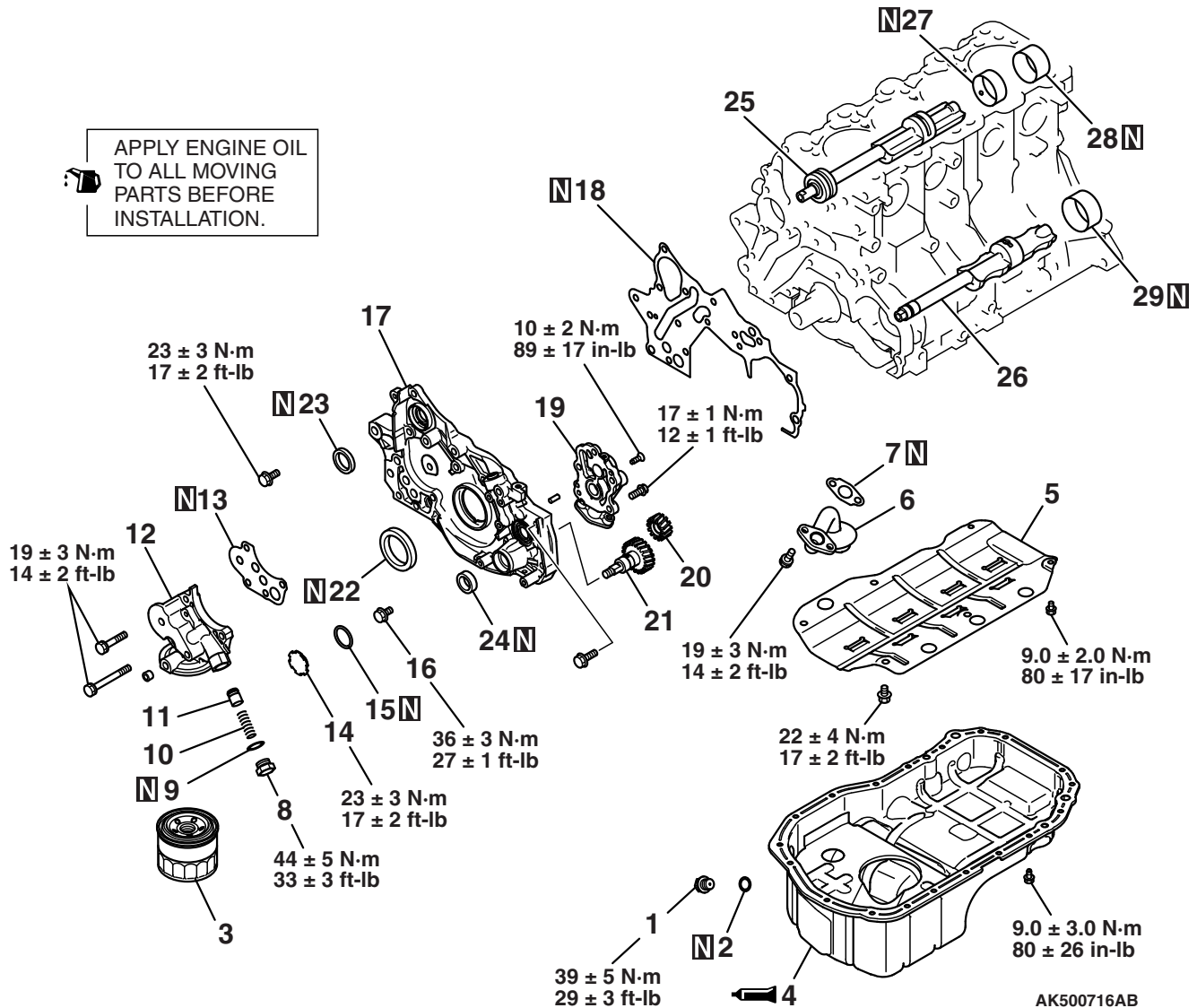
NOTE: Pay attention to the difference in length of the valve guides. [Intake side: 45.5 mm (1.79 inches); exhaust side: 50.5 mm (1.99 inches)]

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

OIL PAN AND OIL PUMP

REMOVAL AND INSTALLATION

M1113008101724



REMOVAL STEPS

1. DRAIN PLUG
- >>M<< 2. DRAIN PLUG GASKET
- >>L<< 3. OIL FILTER
- <<A>> >>K<< 4. OIL PAN
5. BAFFLE PLATE
6. OIL SCREEN
7. OIL SCREEN GASKET
8. RELIEF PLUG
9. GASKET
10. RELIEF SPRING
11. RELIEF PLUNGER
- >>J<< 12. OIL FILTER BRACKET
- <> >>I<< 13. OIL FILTER BRACKET GASKET
- <<C>> >>H<< 14. PLUG
15. O-RING
- >>H<< 16. FLANGE BOLT
17. FRONT CASE

REMOVAL STEPS (Continued)

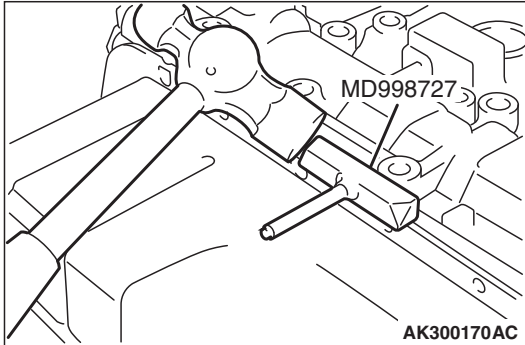
18. FRONT CASE GASKET
19. OIL PUMP COVER
- >>G<< 20. OIL PUMP DRIVEN GEAR
- >>G<< 21. OIL PUMP DRIVE GEAR
- >>F<< 22. CRANKSHAFT FRONT OIL SEAL
- >>E<< 23. OIL PUMP OIL SEAL
- >>D<< 24. COUNTERBALANCE SHAFT OIL SEAL
25. COUNTERBALANCE SHAFT, LEFT
26. COUNTERBALANCE SHAFT, RIGHT
- <<D>> >>C<< 27. COUNTERBALANCE SHAFT, FRONT BEARING
- <<E>> >>B<< 28. COUNTERBALANCE SHAFT, REAR BEARING, RIGHT
- <<E>> >>A<< 29. COUNTERBALANCE SHAFT, REAR BEARING, LEFT

Required Special Tools:

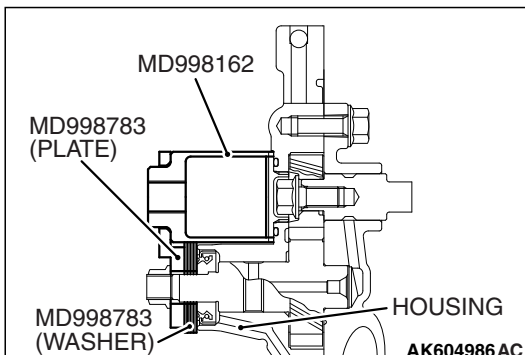
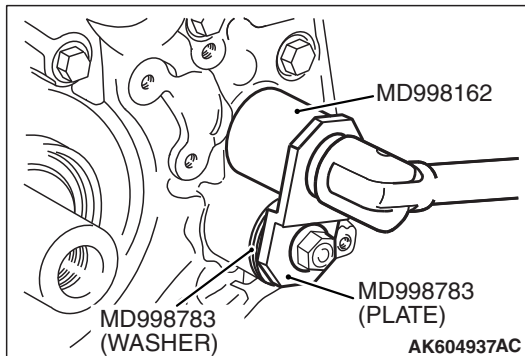
- MB991603: Bearing Installer Stopper
- MD998162: Plug Wrench
- MD998285: Crankshaft Front Oil Seal Guide
- MD998371: Silent Shaft Bearing Puller
- MD998372: Silent Shaft Bearing Puller
- MD998375: Crankshaft Front Oil Seal Installer
- MD998705: Silent Shaft Bearing Installer
- MD998727: Oil Pan FIPG Cutter
- MD998783: Plug Wrench Retainer

REMOVAL SERVICE POINTS**<<A>> OIL PAN REMOVAL**

1. Remove all oil pan bolts.
2. Drive in special tool MD998727 between the cylinder block and oil pan.
NOTE: Never use a screwdriver or chisel to remove the oil pan. It will deform the oil pan flange and result in oil leakage.
3. Gently hit the special tool on its corner (shoulder), then slide it along the oil pan to remove it.

**<> PLUG REMOVAL**

1. Align the special tool, Plug Wrench (MD998162), with the notch.
2. Set the special tool, Plug Retainer (MD998783), pushing it slight. Place the washer to fit the clearance between Plug Retainer and the housing.

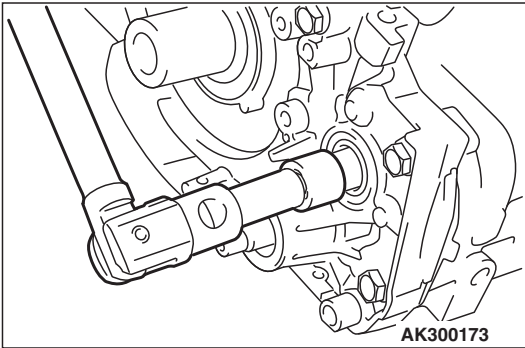
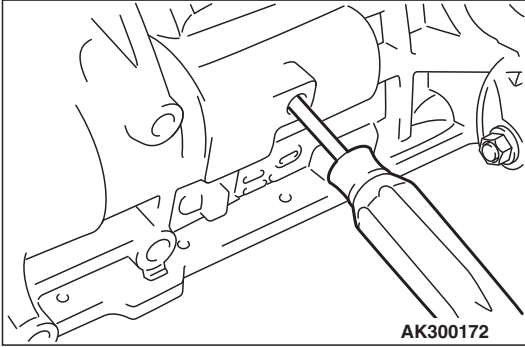
**⚠ CAUTION**

If loosening the plug cap too much, the oil pump shaft would be affected by excessive force and bent.

3. Loosen the plug cap slightly and remove the special tool, Plug Wrench Retainer (MD998162).
4. Remove the plug cap.

<<C>> FLANGE BOLT REMOVAL

1. Remove the plug on the side of the cylinder block.
2. Insert a Phillips screwdriver [shank diameter 8 mm (0.3 inch)] into the plug hole to lock the counterbalance shaft.



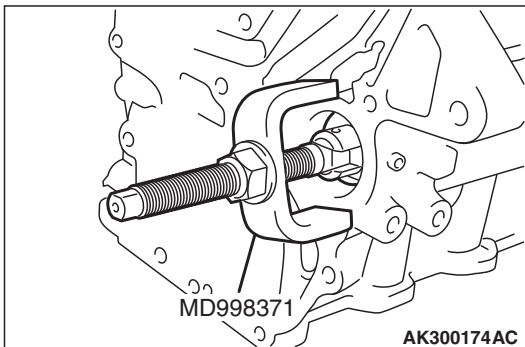
3. Loosen the flange bolt.

<<D>> COUNTERBALANCE SHAFT FRONT BEARING REMOVAL

CAUTION

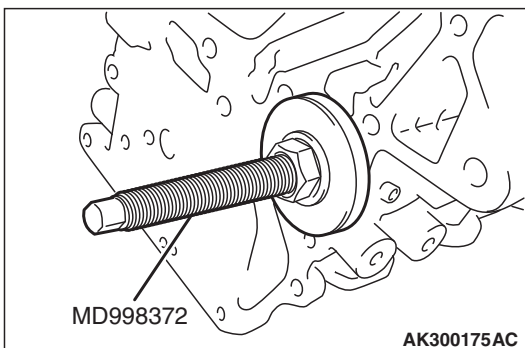
Be sure to remove the front bearing first. If it has not been removed, special tool MD998372 cannot be used for rear balance shaft bearing removal.

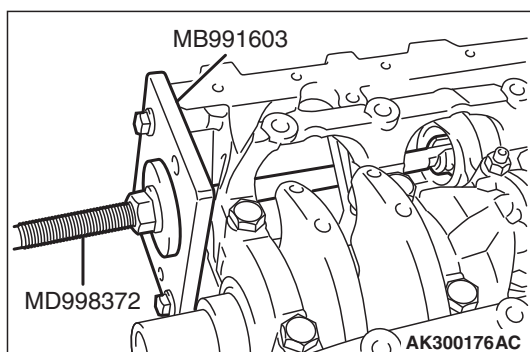
Using special tool MD998371, remove the counterbalance shaft front bearing from the cylinder block.



<<E>> COUNTERBALANCE SHAFT REAR BEARING REMOVAL

1. Install special tools MB991603 and MD998372 in front of the cylinder block when removing the left counterbalance shaft rear bearing.

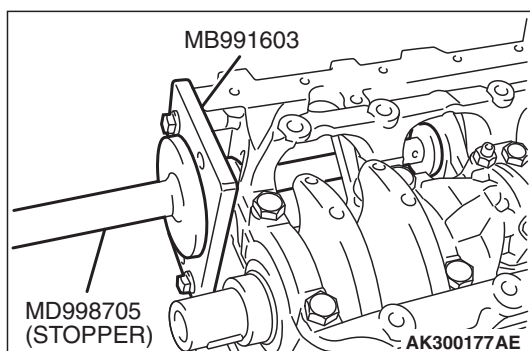




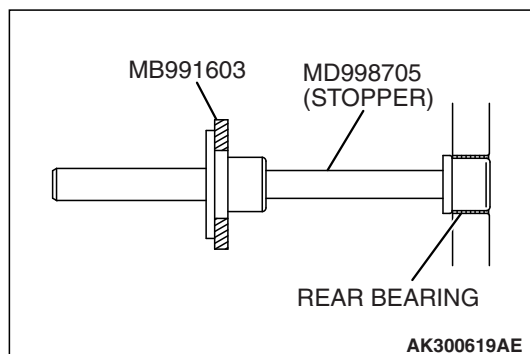
- Using special tool MD998372, remove the right counterbalance shaft rear bearing from the cylinder block.

INSTALLATION SERVICE POINTS

>>A<< LEFT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION

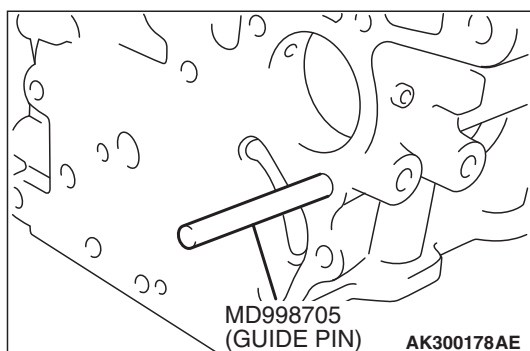


- Install special tool MB991603 to the cylinder block.
- Apply engine oil to the rear bearing outer surface and bearing hole in the cylinder block.

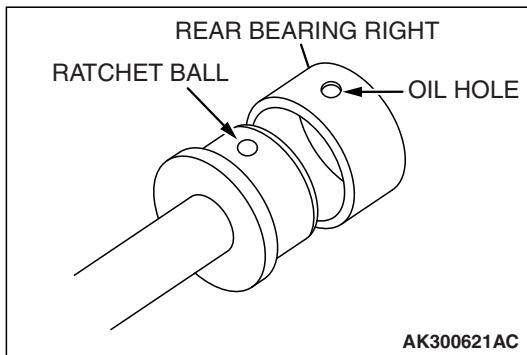


- Using special tool MD998705, install the rear bearing.
- NOTE:** The left rear bearing has no oil holes.

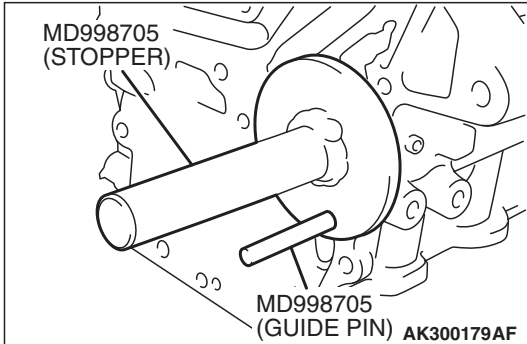
>>B<< RIGHT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION



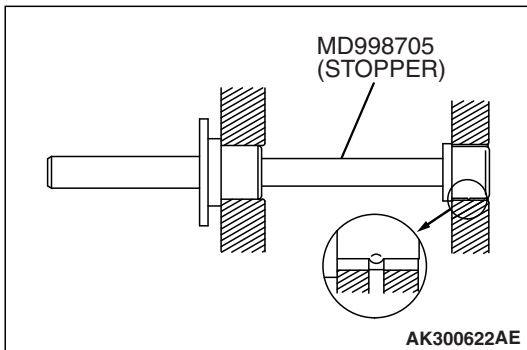
- Install the guide pin of special tool MD998705 in the threaded hole of the cylinder block as shown.



2. Align the ratchet ball of special tool MD998705 with the oil hole in the rear bearing to install the bearing of special tool MD998705.
3. Apply engine oil to the bearing outer surface and bearing hole in the cylinder block.

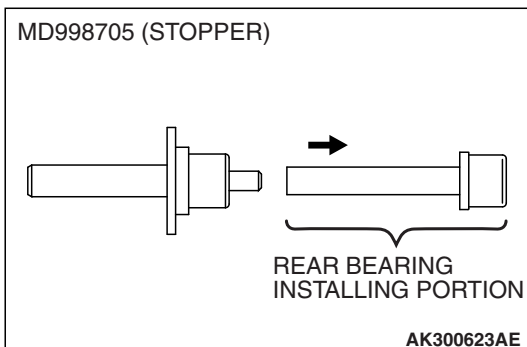


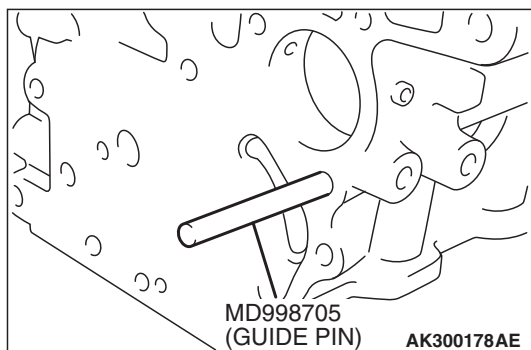
4. Using special tool MD998705, install the rear bearing. Make sure that the oil hole of the bearing is aligned with the oil hole of the cylinder block.



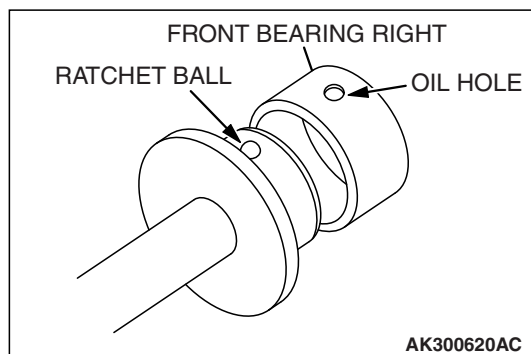
>>C<< COUNTERBALANCE SHAFT FRONT BEARING INSTALLATION

1. Remove the rear bearing installing portion from special tool MD998705.

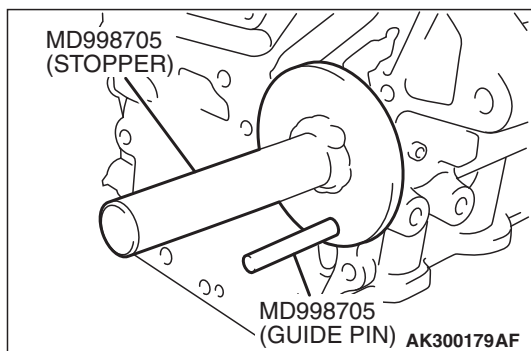




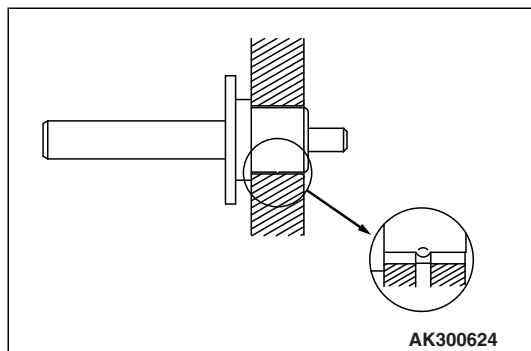
2. Install the guide pin of special tool MD998705 in the threaded hole of the cylinder block as shown.



3. Align the ratchet ball of the special tool MD998705 with the oil hole in the rear bearing to install the bearing of the special tool MD998705.
4. Apply engine oil to the front bearing outer surface and bearing hole in the cylinder.

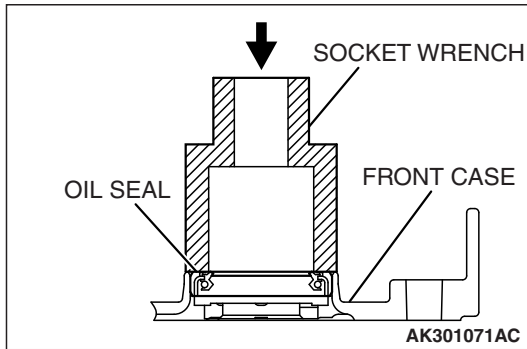


5. Using special tool MD998705, install the rear bearing. Make sure that the oil hole of the bearing is aligned with the oil hole of the cylinder block.



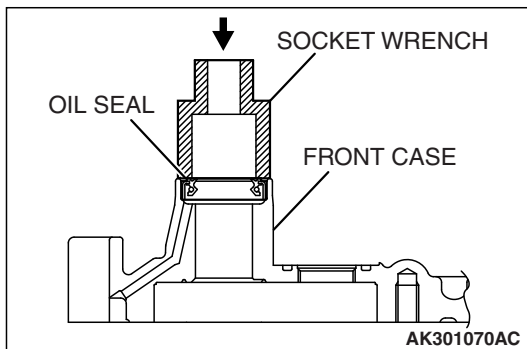
>>D<< COUNTERBALANCE SHAFT OIL SEAL INSTALLATION

Using a suitable socket wrench, install the counterbalance shaft oil seal into the front case.



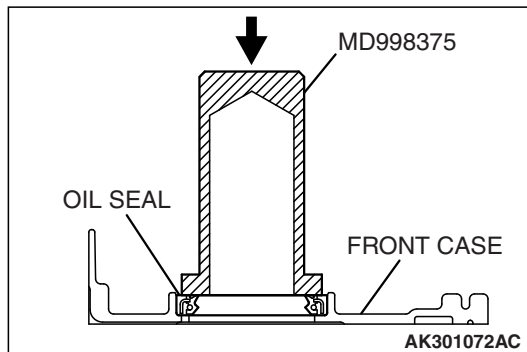
>>E<< OIL PUMP OIL SEAL INSTALLATION

Using a suitable socket wrench, install the oil pump oil seal into the front case.



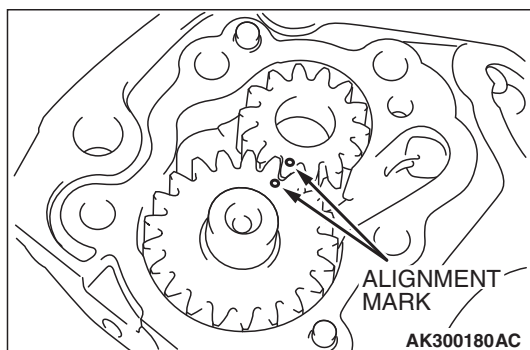
>>F<< CRANKSHAFT FRONT OIL SEAL INSTALLATION

Using special tool MD998375, install the crankshaft front oil seal into the front case.

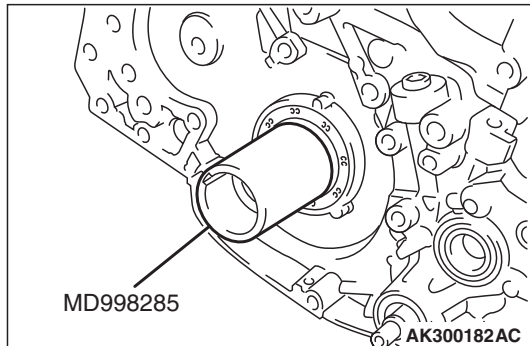
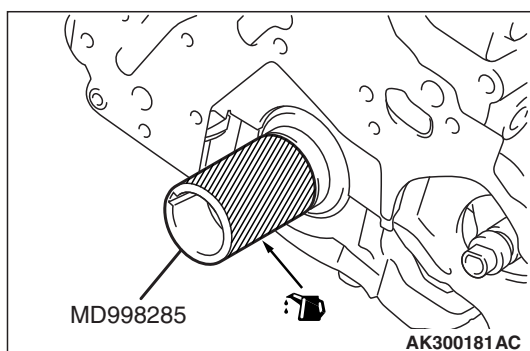


**>>G<< OIL PUMP DRIVEN GEAR/OIL PUMP
DRIVE GEAR INSTALLATION**

Install the oil pump gears into the front case and align the alignment marks.

**>>H<< OIL PUMP CASE INSTALLATION**

1. Set special tool MD998285 on the front end of crankshaft and apply a thin coat of engine oil to the outer surface of special tool MD998285.
2. Apply engine oil to the lip of the crankshaft front oil seal.



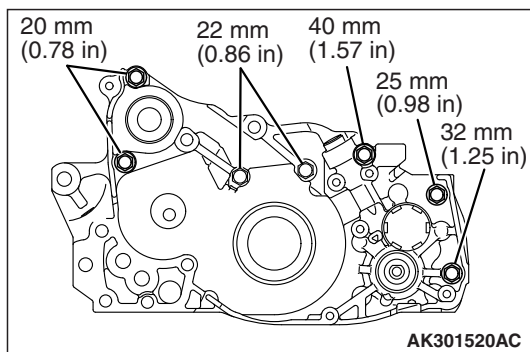
3. Install the front case carefully to prevent damaging the oil seal.

⚠ CAUTION

Carefully install the tightening bolts, paying attention to their different lengths, respectively.

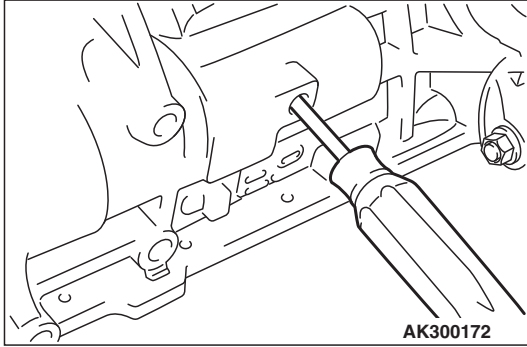
4. Tighten all flange bolts to the specified torque.

Tightening torque: 23 ± 3 N·m (17 ± 2 ft-lb)



>>I<< FLANGE BOLT INSTALLATION

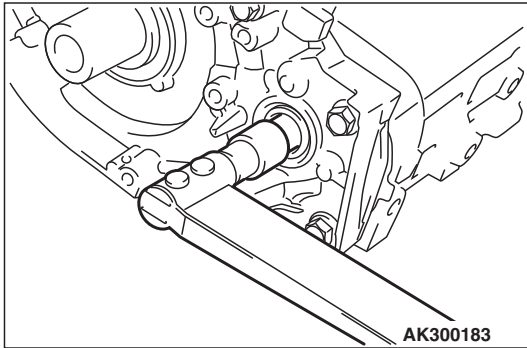
1. Insert a Phillips head screwdriver [shank diameter 8 mm (0.3 inch)] into the hole in the left side of the cylinder block to lock the counterbalance shaft.



2. Secure the oil pump driven gear onto the left counterbalance shaft by tightening the flange bolt to the specified torque.

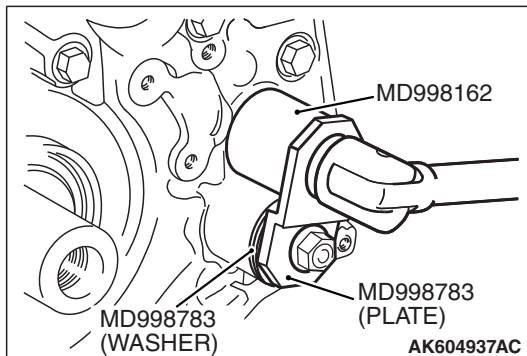
Tightening torque: 36 ± 3 N·m (27 ± 1 ft-lb)

3. Pull out the screwdriver and screw in the plug.



>>J<< PLUG INSTALLATION

1. Install the new o-ring to the oil pump case.
2. Slightly tighten the plug cap by hand.
3. Fit special tool, Plug Retainer (MD998783), into the plug cap notch.

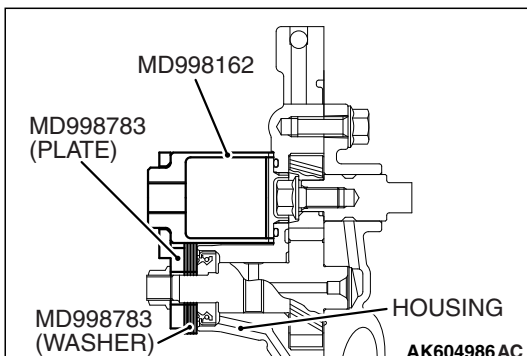


4. Set the special tool, Plug Retainer (MD998783), pushing it slightly. Place the washer to fit the clearance between Plug Retainer and the housing.

⚠ CAUTION

Unless fitting the clearance between Plug Retainer and the housing, the oil pump shaft would be affected by excessive force and bent.

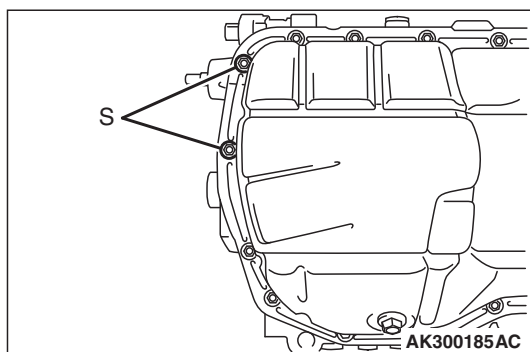
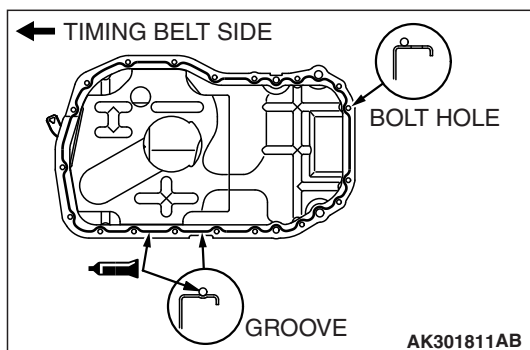
5. Tighten the plug cap to the specified torque of 23 ± 3 N·m.



>>K<< OIL PAN INSTALLATION

1. Clean both gasket surfaces of oil pan and cylinder block.
2. Apply a 4 mm (0.15 inch) diameter bead of sealant (Three bond 1207F or equivalent) to the flange of the oil pan.
3. Install the oil pump case assembly to the front side of the cylinder block.

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



4. Fit an 8 mm (0.30 inch) bolt in each of the two holes identified by the letter "S" in the illustration, and fit a 10 mm (0.39 inch) bolt in each of the remaining 17 holes. Tighten all bolts to the specified torque.

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

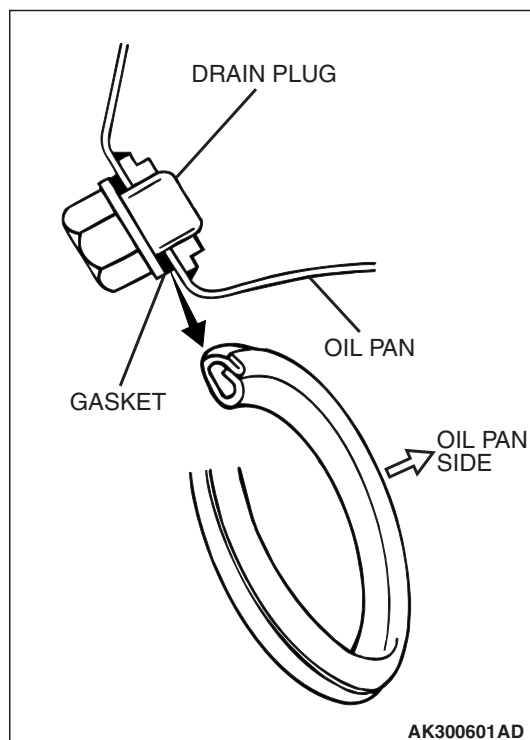
NOTE: After installation, keep the sealed area away from oil for approximately one hour.

>>L<< DRAIN PLUG GASKET INSTALLATION

⚠ CAUTION

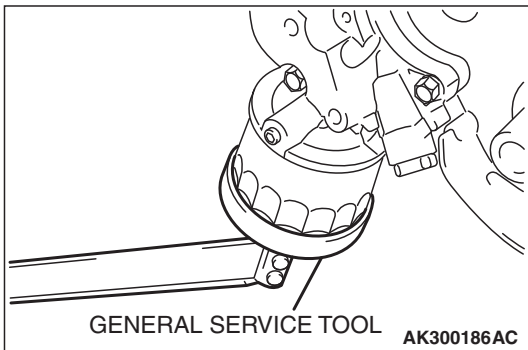
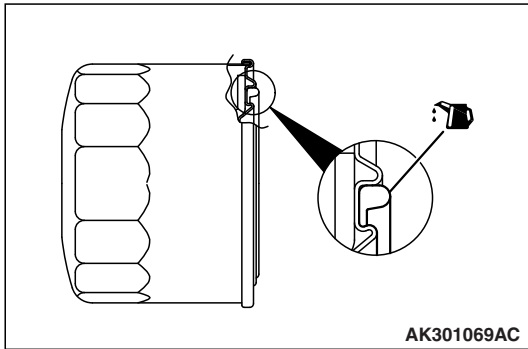
If the gasket is installed in the wrong direction, oil leaks will occur.

Install the drain plug gasket in the direction shown.



>>M<< OIL FILTER INSTALLATION

1. Clean the installation surface of the filter bracket.
2. Apply engine oil to the o-ring of the oil filter.



3. Using general service tool, install the oil filter to the bracket and tighten it to the specified torque.

Tightening torque:

Part number MD356000 filter:

14 ± 2 N·m (124 ± 17 in-lb)

Other Mitsubishi filter:

17 ± 3 N·m (13 ± 1 ft-lb)

4. If a torque wrench cannot be used, use the following procedure:
 - (1) Screw in the oil filter until its o-ring contacts the oil filter bracket.
 - (2) Tighten the oil filter as follows:

Part number MD356000 filter: one turn
Other Mitsubishi filter: 3/4 turn

INSPECTION

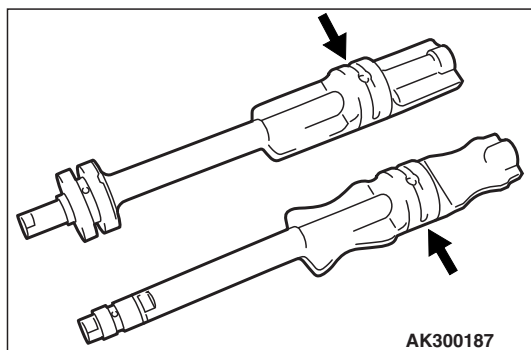
M1113008200278

FRONT CASE

1. Check the oil passage for clogging. Clean if necessary.
2. Check the left counterbalance shaft front bearing for wear, damage and seizure. If the bearing is damaged, replace the front case.
3. Check the front case for cracks and other damage.
Replace cracked or damaged front case.

OIL SEAL

1. Check the oil seal lip for wear and damage. Replace the oil seal if necessary.
2. Check the oil seal lip for deterioration. Replace the oil seal if necessary.



COUNTERBALANCE SHAFT

1. Check the oil holes for clogging and clean if necessary.
2. Check the journal for seizure, damage and contact with bearing. If there is anything wrong with the journal, replace the counterbalance shaft, bearing or front case assembly if required.

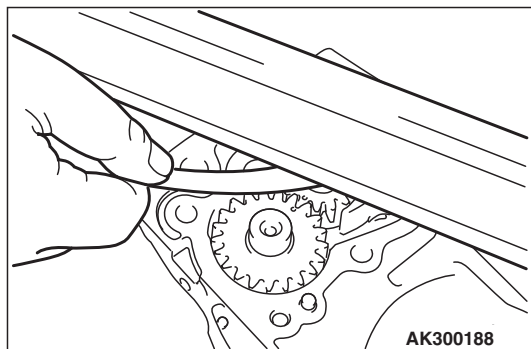
OIL PUMP

1. Assemble the oil pump gears to the front case and rotate it to ensure smooth rotation with no looseness.
2. Ensure that there is no ridge wear on the contact surface between the front case and the gear surface of the oil pump cover.
3. Check the side clearance.

Standard value:

Drive gear 0.08 – 0.14 mm (0.0031 – 0.0055 inch)

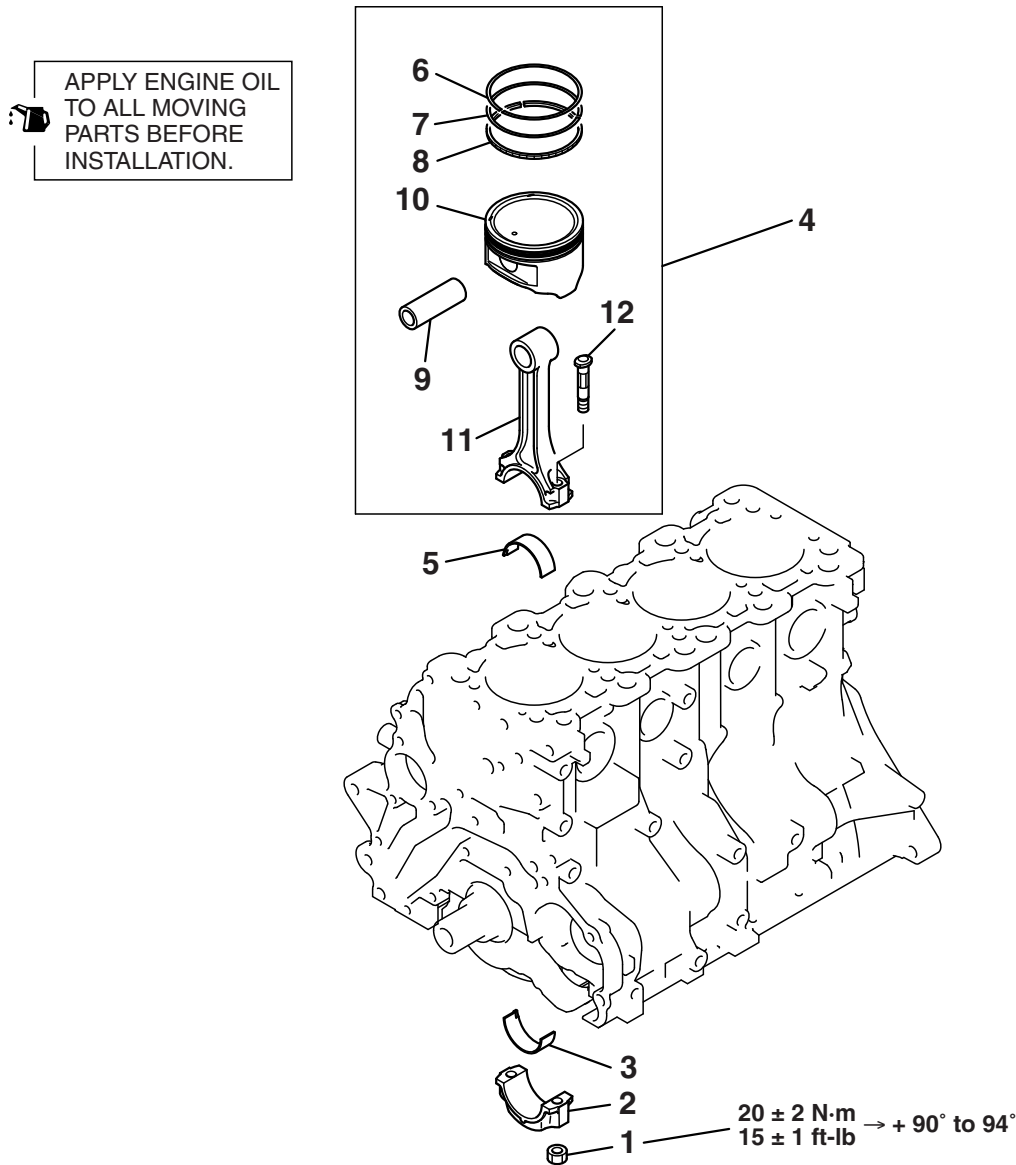
Driven gear 0.06 – 0.12 mm (0.0024 – 0.0047 inch)



PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION

M1113008402494



AK301260AC

REMOVAL STEPS

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

REMOVAL STEPS (Continued)

- >>C<< 7. PISTON RING Number 2
- >>B<< 8. OIL RING
- <<C>> >>A<< 9. PISTON PIN
- 10. PISTON
- 11. CONNECTING ROD
- 12. BOLT

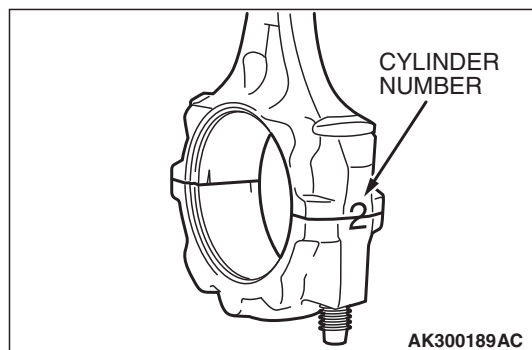
Required Special Tools:

- MIT216941: Piston Pin Setting Tool
- MB992010: Bolt Guide

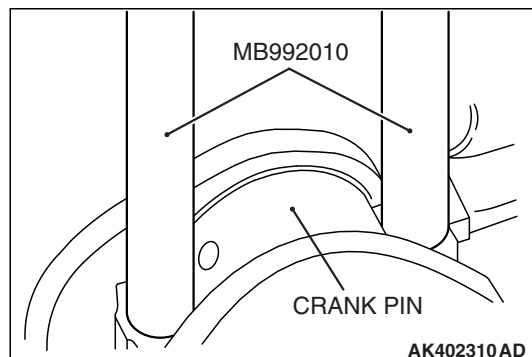
REMOVAL SERVICE POINTS

<<A>> CONNECTING ROD CAP REMOVAL

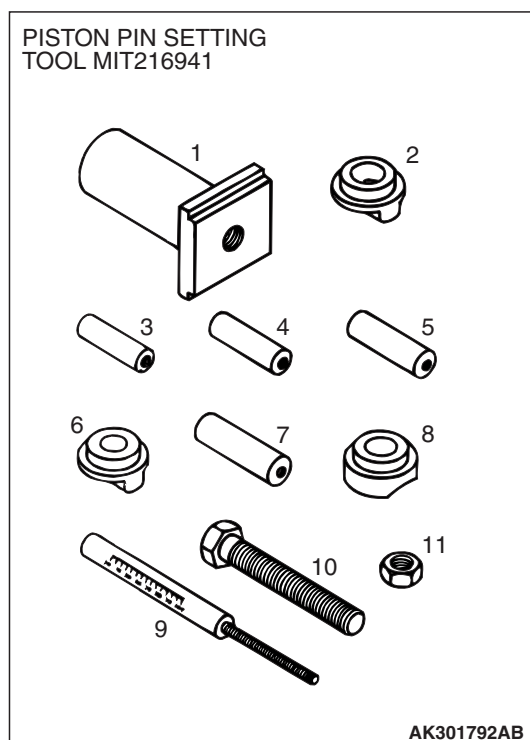
1. Mark the cylinder number on the side of the connecting rod big end for correct reassembly.
2. Keep the removed connecting rods, caps, and bearings in that order according to the cylinder number.

<> PISTON AND CONNECTING ROD
ASSEMBLY REMOVAL

1. Not to damage the crank pin, attach a special tool MB992010, to the connecting rod bolt.
2. Remove the piston and connecting rod assembly from the cylinder block.

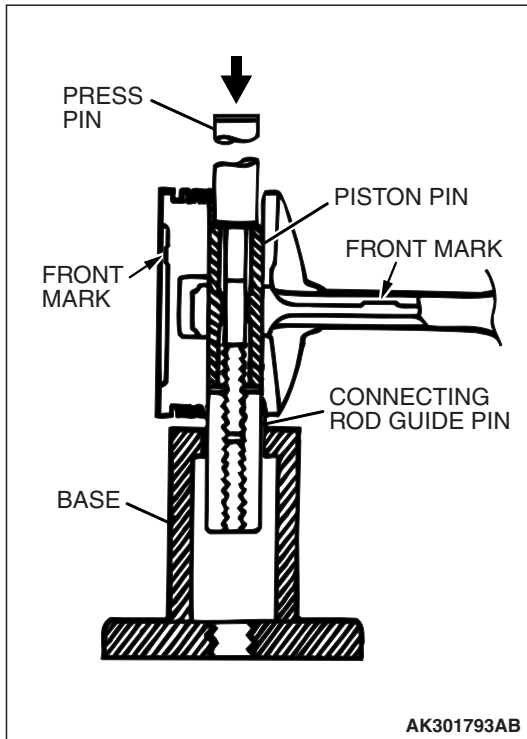


<<C>> PISTON PIN REMOVAL



ITEM NUMBER	PART NUMBER	DESCRIPTION
1	MIT310134	Base
2	MIT310136	Piston support
3	MIT310137	Connecting rod guide pin
4	MIT310138	Connecting rod guide pin
5	MIT310139	Connecting rod guide pin
6	MIT310140	Piston support
7	MIT310141	Connecting rod guide pin
8	MIT310142	Piston support
9	MIT48143	Press pin
10	216943	Stop screw
11	10396	Nut

1. Remove the stop screw from the base.
2. Select the correct piston support for your application (See above). Fit the piston support onto the base. Place the base on press support blocks.



3. Insert the press pin through the piston pin hole. Select the correct connecting rod guide pin (See above). Thread the guide pin onto the threaded portion of the press pin.
4. Position the piston assembly on the piston support in the press. With the press pin up as shown, insert the guide pin through the hole in the piston and through the hole in the piston support.

CAUTION

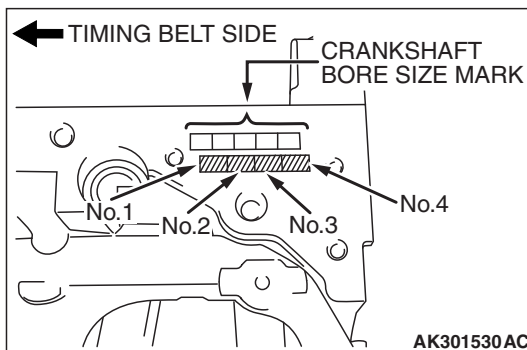
To avoid piston damage, the piston support must seat squarely against the piston. Verify that the piston pin will slide through the hole in the piston support.

5. Press the piston pin out of the assembly.
6. Remove the piston pin from the press pin.

INSTALLATION SERVICE POINTS

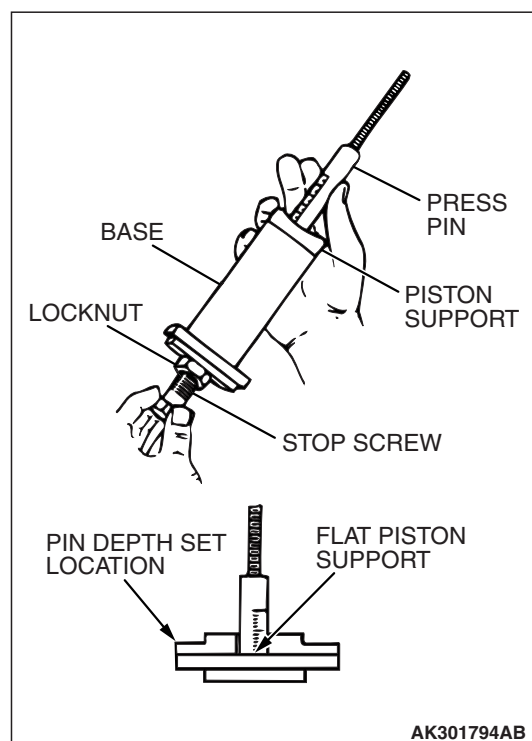
>>A<< PISTON PIN INSTALLATION

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

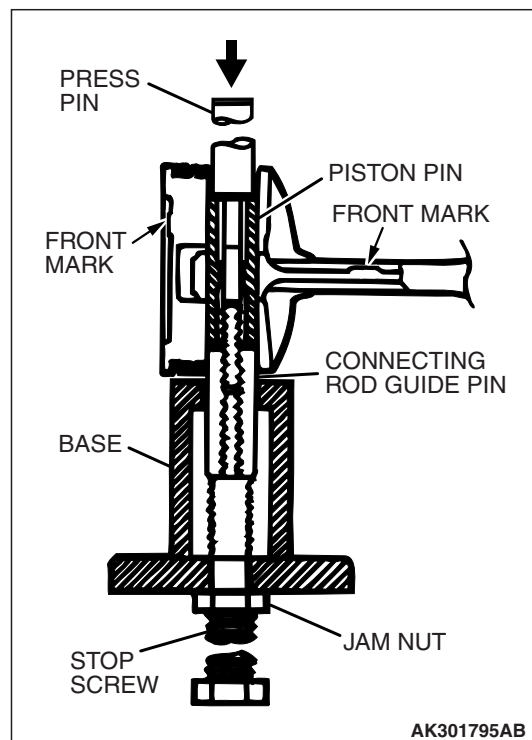


CYLINDER BORE SIZE MARK	PISTON SIZE MARK
I	A
II	None
III	C

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



2. Thread the stop screw and lock nut assembly into the base. Fit the correct piston support on top of the base. Insert the press pin, threaded end up, into the hole in the piston support until the press pin touches the stop screw.
3. Using the markings on the press pin, adjust the stop screw to the depth shown on the instruction for special tool MIT216941.

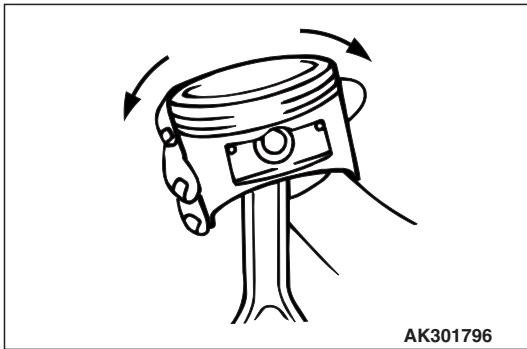


4. Place the base on press support blocks.
5. Slide the piston pin over the threaded end of the press pin, and thread the correct guide pin up against it.
6. Coat the piston pin with engine oil. With the connecting rod held in position, slide the guide pin through the piston and connecting rod.
7. Press the piston pin through the connecting rod until the guide pin contacts the stop screw.

⚠ CAUTION

Due to production tolerance variations, it is necessary to visually inspect the piston pin depth after installation to verify that the piston pin is centered. Adjust if necessary.

8. Remove the piston assembly from the base. Remove the guide pin and press pin from the assembly.



9. Check that the piston moves smoothly.

>>B<< OIL RING INSTALLATION

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

⚠ CAUTION

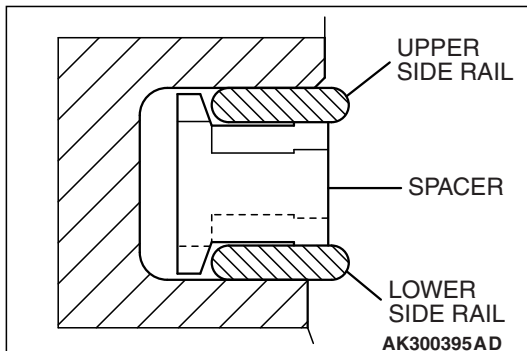
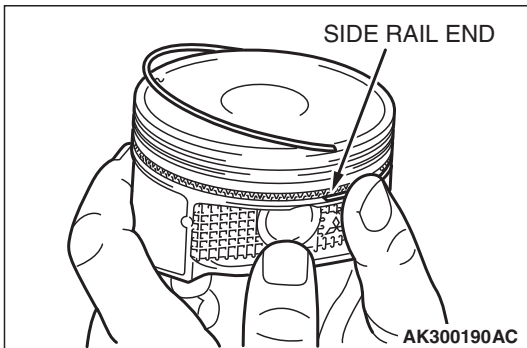
Do not use a piston ring expander when installing the side rail.

2. Install the upper side rail.

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

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

NOTE: New spacers and side rails are colored for identification of their sizes.



SIZE	IDENTIFICATION COLOR
Standard	None
0.50 mm (0.020 in) oversize diameter	Red

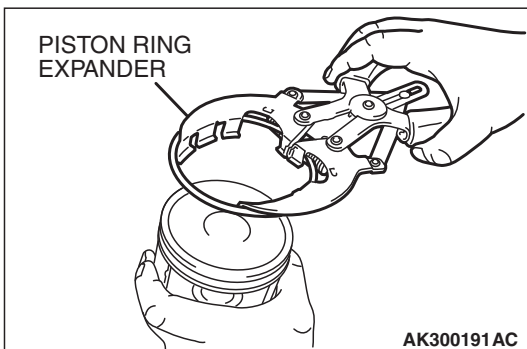
3. Install the lower side rail in the same manner as described in step 2.
4. Make sure that the side rails move smoothly in both directions.

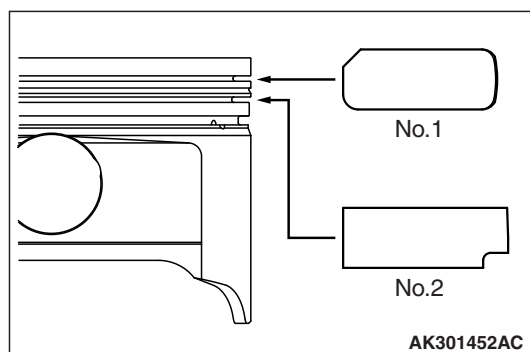
>>C<< PISTON RING NUMBER 2 / PISTON RING NUMBER 1 INSTALLATION

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

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

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



**Identification mark:****Number 1 ring: 1R****Number 2 ring: 2R**

NOTE: Confirm the profile for Number 1 and Number 2 piston rings carefully. Install them correctly by paying careful attention to the direction of the top and bottom.

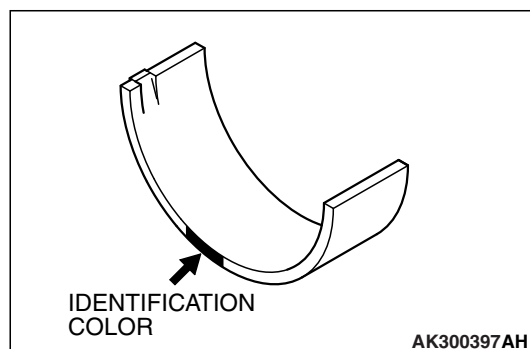
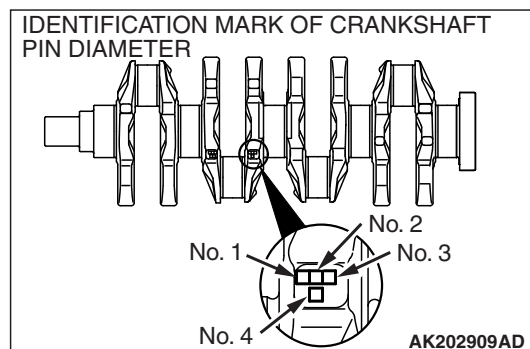
NOTE: The identification mark and the size mark are stamped on the upper plane of the piston ring (piston top side).

SIZE	SIZE MARK
Standard	None
0.50 mm (0.020 in) oversize diameter	50

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

>>D<< CONNECTING ROD BEARING INSTALLATION

- Measure the crankshaft pin diameter and confirm its classification from the following table. On a crankshaft supplied as a service part, identification marks of its pins are stamped at the positions shown in the illustration.



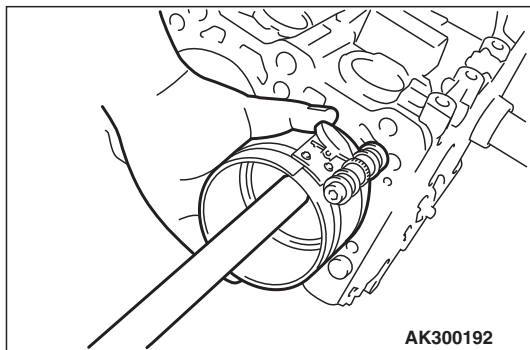
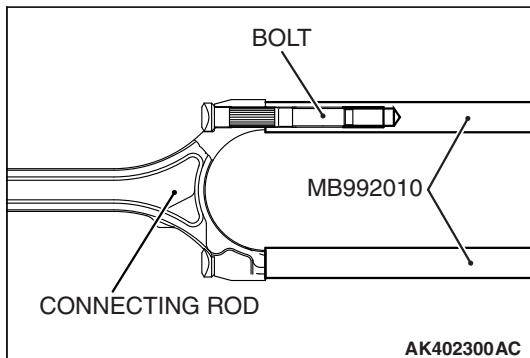
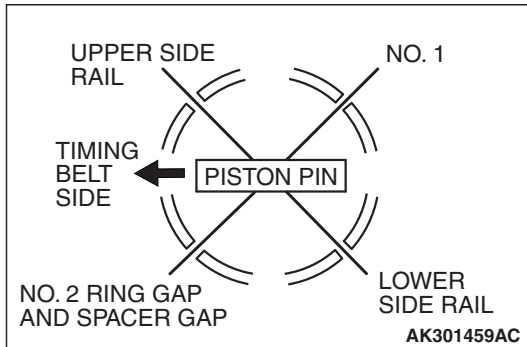
CRANKSHAFT PIN OUTSIDE DIAMETER		CONNECTING ROD BEARING
IDENTIFICATION MARK	SIZE mm (in)	IDENTIFICATION COLOR
I	44.995 – 45.000 (1.7715 – 1.7717)	Black
II	44.985 – 44.995 (1.7711 – 1.7715)	Purple
III	44.980 – 44.985 (1.7709 – 1.7711)	Green

- If the crankshaft pin outside diameter identification mark is "I," for example, select a bearing whose identification color is "Black"

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

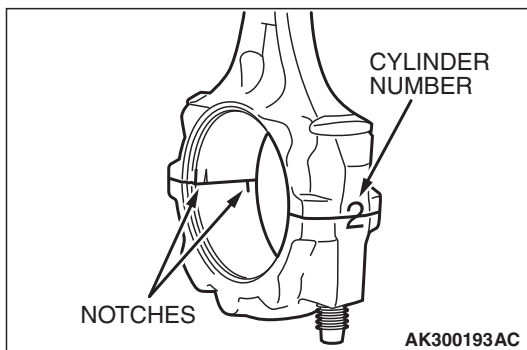
- Install the selected bearing in the big end and in the cap of the connecting rod.

>>E<< PISTON AND CONNECTING ROD INSTALLATION

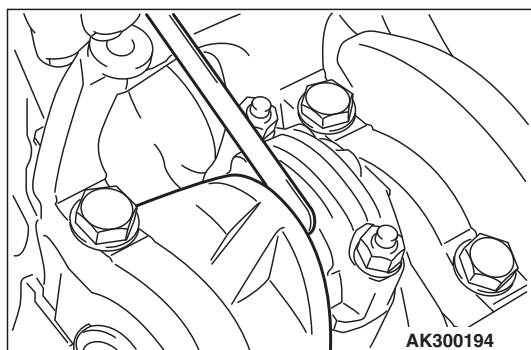


1. Apply engine oil to the circumference of the piston, piston rings, and oil ring.
2. Arrange the piston ring and oil ring gaps (side rail and spacer) as shown in the illustration.
3. Rotate the crankshaft so that the crank pin is on the center of the cylinder bore.
4. Not to damage the crank pin, attach a special tool MB992010, to the connecting rod bolt.
5. Use suitable thread protectors on the connecting rod bolts before inserting the piston and connecting rod assembly into the cylinder block.
Care must be taken not to nick the crank pin.
6. Insert the piston and connecting rod assembly into the cylinder with the front mark on the piston crown pointing to the timing belt side.
7. 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: 0.10 – 0.25 mm (0.004 – 0.009 inch)

Limit: 0.4 mm (0.015 inch)

>>G<< CONNECTING ROD CAP NUT TIGHTENING

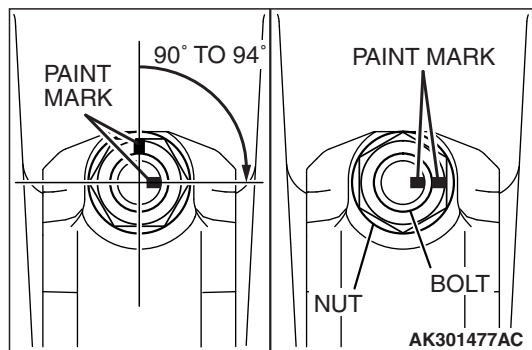
1. The connecting rod bolts should be examined before reuse. If the bolt threads are damaged, the bolt should be replaced. Hand-thread the nut to the full length of the bolt threads. If the nut does not run down smoothly, the bolt should be replaced.
2. Before installing each nut, apply engine oil to the threaded portion and bearing surface of the nut.
3. Loosely tighten each nut to the bolt.
4. Then tighten the nuts alternately to the specified torque to install the cap properly.

Tightening torque: 20 ± 2 N·m (14 ± 1 ft-lb)

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



INSPECTION

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PISTON RING

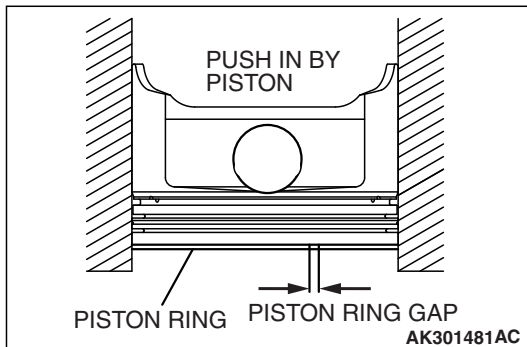
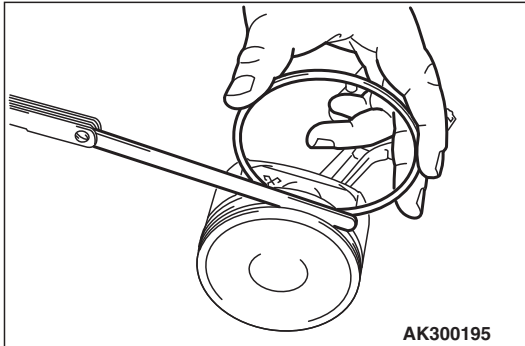
1. Check the piston ring for damage, excessive wear, and breakage. Replace if defects are evident. If the piston has been replaced, the piston rings must also be replaced.
2. Check for clearance between the piston ring and ring groove. If it exceeds the limit, replace the ring or piston, or both.

Standard value:

Number 1: 0.03 – 0.07 mm (0.0012 – 0.0028 inch)

Number 2: 0.02 – 0.06 mm (0.0008 – 0.0024 inch)

Limit: 0.1 mm (0.003 inch)



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

Standard value:

Number 1: 0.15 – 0.30 mm (0.006 – 0.012 inch)

Number 2: 0.28 – 0.43 mm (0.011 – 0.017 inch)

Oil: 0.10 – 0.40 mm (0.003 – 0.015 inch)

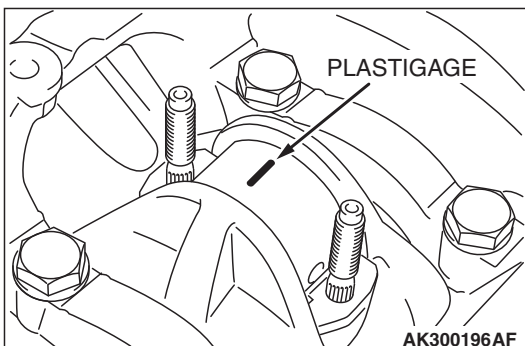
Limit:

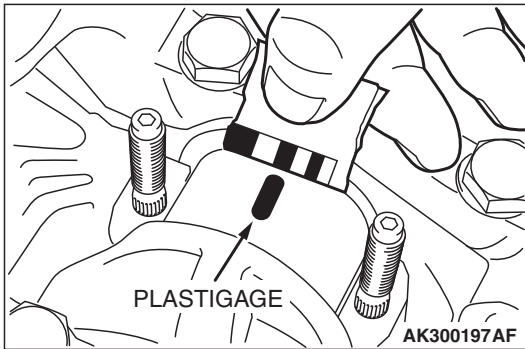
Number 1, Number 2: 0.8 mm (0.03 inch)

Oil: 1.0 mm (0.03 inch)

CRANKSHAFT PIN OIL CLEARANCE <PLASTIGAGE METHOD>

1. Remove oil from the crankshaft pin and the connecting rod bearing.
2. Cut plastigage to the same length as the width of the bearing and place it on the pin, 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 plastigage at its widest part by using a scale printed on the plastigage package.
- Standard value: 0.03 – 0.06 mm (0.0012 – 0.0023 inch)**
Limit: 0.1 mm (0.003 inch)

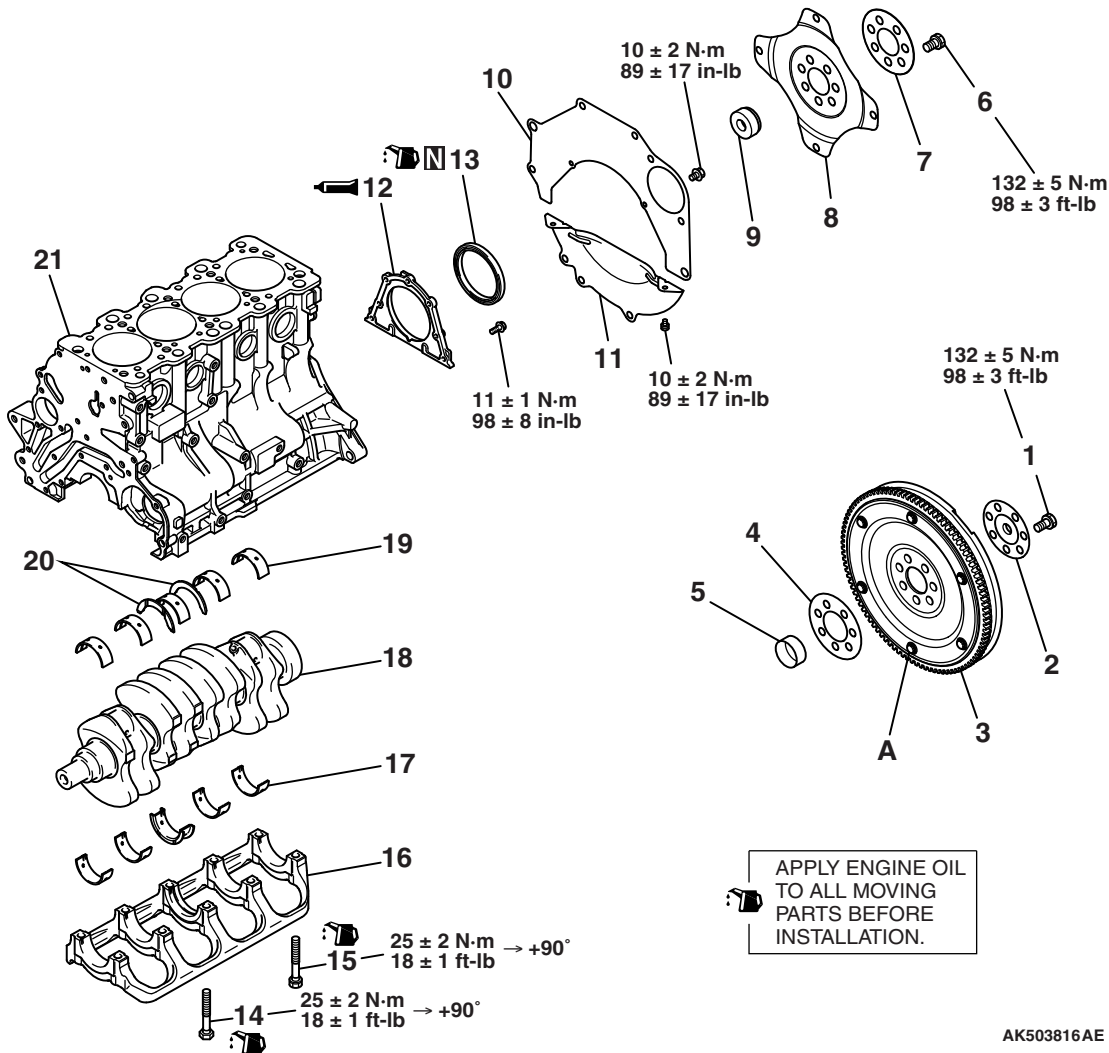
CRANKSHAFT AND CYLINDER BLOCK

REMOVAL AND INSTALLATION

M1113008703540

CAUTION

Do not remove any of the bolts "A" of the flywheel shown in the illustration. The balance of the flexible type flywheel is adjusted in an assembled condition. Removing the bolt, therefore, can cause the flexible flywheel to be out of balance, causing damage.



AK503816AE

REMOVAL STEPS

- <<A>> >>F<<
1. FLYWHEEL BOLT <M/T>
 2. ADAPTER PLATE <M/T>
 3. FLYWHEEL <M/T>
 4. ADAPTER PLATE <M/T>
 5. CRANKSHAFT BUSHING <M/T>
- <<A>> >>F<<
6. DRIVE PLATE BOLT <A/T>
 7. ADAPTER PLATE <A/T>
 8. DRIVE PLATE <A/T>
 9. CRANKSHAFT BUSHING <A/T>
 10. REAR PLATE
 11. BELL HOUSING COVER

REMOVAL STEPS (Continued)

- >>E<<
12. OIL SEAL CASE
- >>D<<
13. OIL SEAL
- >>C<<
14. BEARING CAP BOLT (HEAD 17)
 15. BEARING CAP BOLT (HEAD 14)
- >>C<<
16. BEARING CAP
- >>B<<
17. CRANKSHAFT BEARING (LOWER)
 18. CRANKSHAFT
- >>B<<
19. CRANKSHAFT BEARING (UPPER)
- >>A<<
20. CRANKSHAFT THRUST BEARING
 21. CYLINDER BLOCK

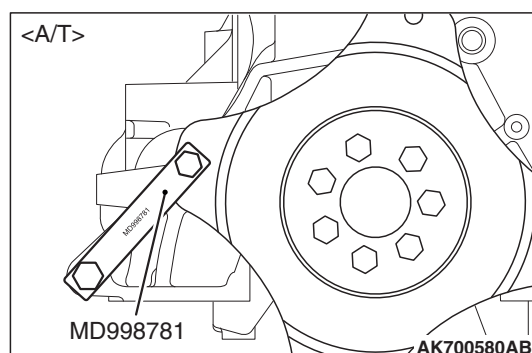
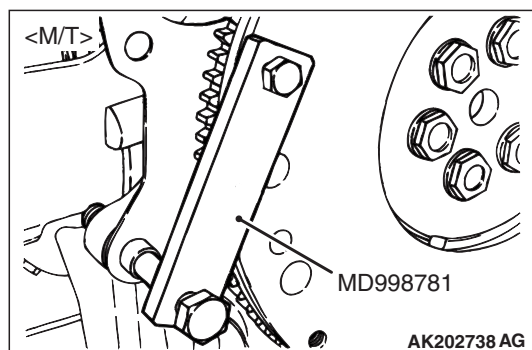
Required Special Tools:

- MB990938: Handle
- MD998776: Crankshaft Rear Oil Seal Installer
- MD998781: Flywheel Stopper

REMOVAL SERVICE POINT

<<A>> FLYWHEEL BOLT / DRIVE PLATE BOLT
LOOSENING

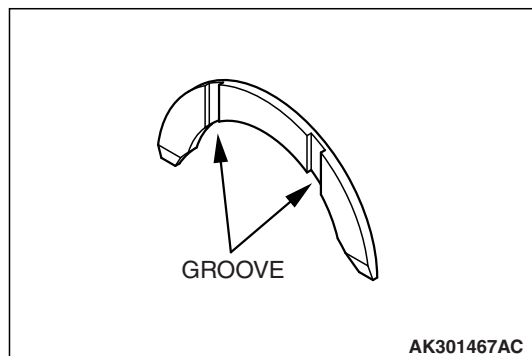
1. Install special tool MD998781 to hold the flywheel or drive plate.
2. remove the flywheel bolt or drive plate bolt.



INSTALLATION SERVICE POINTS

>>A<< CRANKSHAFT THRUST BEARING INSTALLATION

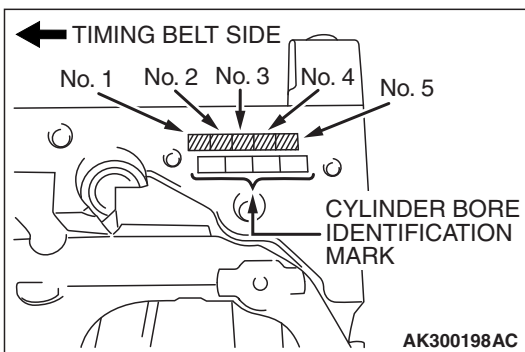
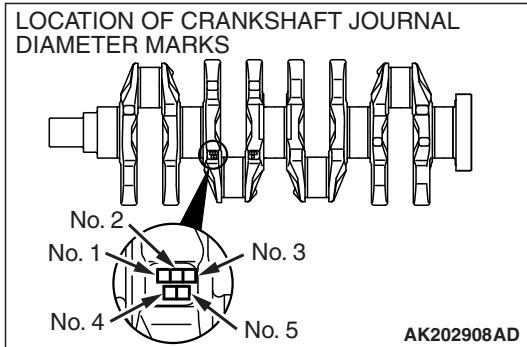
1. Install the two thrust bearings in the number 3 bearing bore in the cylinder block. For easier installation, apply engine oil to the bearings; this will help hold them in position.
2. The thrust bearings must be installed with their grooved side facing toward the crankshaft web.



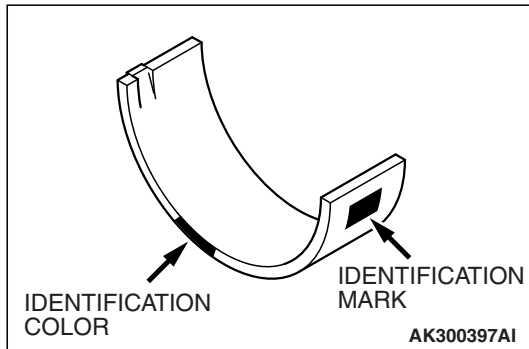
>>B<< CRANKSHAFT BEARING INSTALLATION

When bearing replacement is required, select and install the correct bearing by the following procedure.

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 marks of its journals are stamped 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.

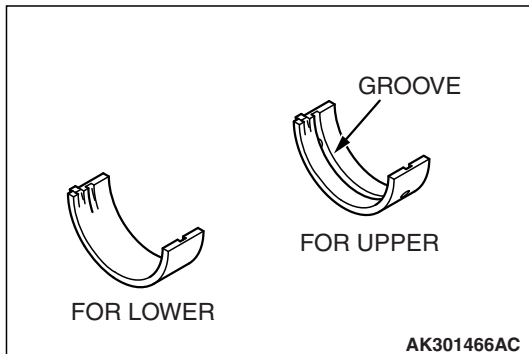


CRANKSHAFT JOURNAL OUTSIDE DIAMETER		CYLINDER BLOCK BEARING BORE	CRANKSHAFT BEARING	CRANKSHAFT BEARING FOR NUMBER 3
IDENTIFICATION MARK	SIZE mm (in)	IDENTIFICATION MARK	IDENTIFICATION MARK OR COLOR	IDENTIFICATION MARK OR COLOR
0 or Yellow	56.994 – 57.000 (2.2439 – 2.2441)	0	1 or Black	0 or Red
		1	2 or Purple	1 or Black
		2	3 or Green	2 or Purple
1 or None	56.988 – 56.994 (2.2436 – 2.2439)	0	2 or Purple	1 or Black
		1	3 or Green	2 or Purple
		2	4 or Blue	3 or Green
2 or White	56.982 – 56.988 (2.2434 – 2.2436)	0	3 or Green	2 or Purple
		1	4 or Blue	3 or Green
		2	5 or Yellow	4 or Blue



For example, if the crankshaft journal outside diameter identification mark is "0" and cylinder block bearing bore identification mark is "1," select a bearing whose identification mark is "2" for number 1, 2, 4 and 5, and a bearing whose identification mark is "1" for number 3.

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



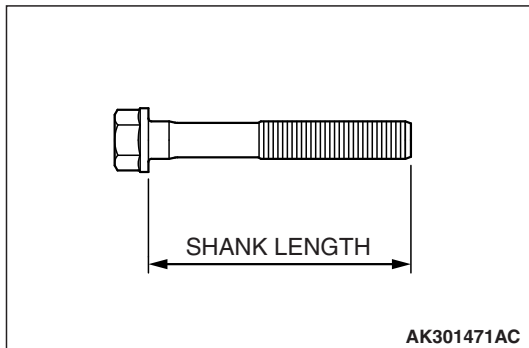
3. Install the bearings having an oil groove to the cylinder block.
4. Install the bearings having no oil groove to the bearing cap.

>>C<< BEARING CAP / BEARING CAP BOLT INSTALLATION

1. Install the bearing caps so that the arrow points to the timing belt side.
2. Before installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If it exceeds the limit, replace the bolt.

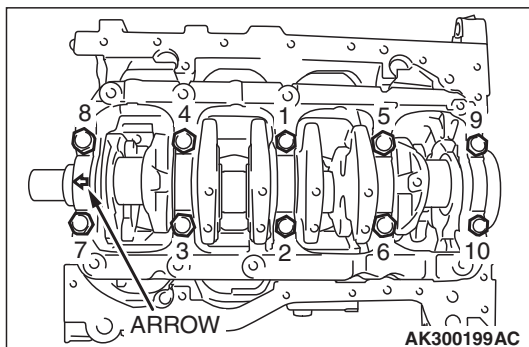
Limit: 71.1 mm (2.79 inches)

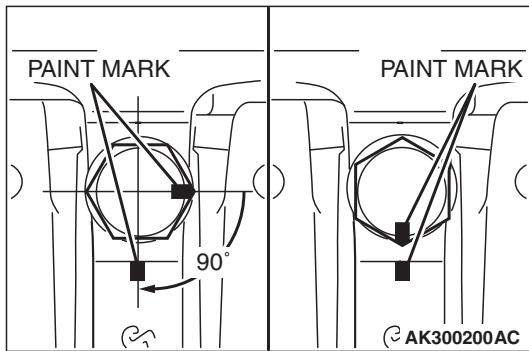
3. Apply engine oil to the threaded portion and bearing surface of the bolt.



4. Tighten the bolts to the specified torque in the tightening sequence shown.

Tightening torque: 25 ± 2 N·m (18 ± 1 ft-lb)





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

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.

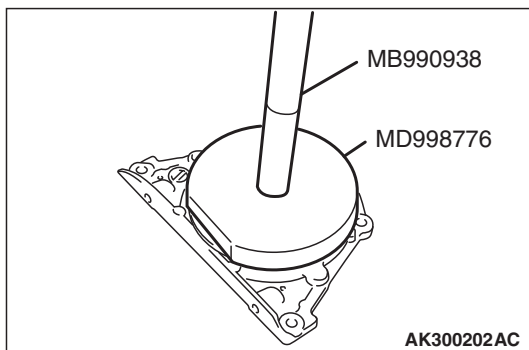
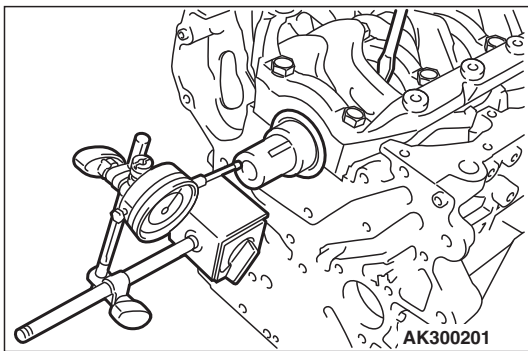
6. Make a paint mark on the bearing cap 90 degrees from the paint mark made on the bolt, in the direction of tightening the bolt.

7. Turn each bolt 90 degrees in the tightening sequence specified in step 4, and make sure that the paint marks on the bolt and cap are aligned.

8. Make sure that the crankshaft turns smoothly and the end play is correct. If the end play exceeds the limit, replace the number 3 crankshaft bearings.

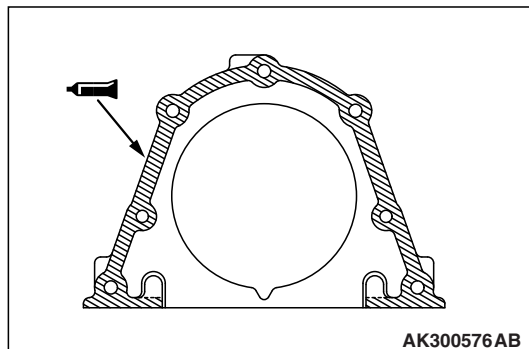
Standard value: 0.05 – 0.25 mm (0.002 – 0.009 inch)

Limit: 0.40 mm (0.015 inch)



>>D<< OIL SEAL INSTALLATION

Using special tools MD998776 and MB990938, press-fit the oil seal in the case.



>>E<< SEALANT APPLICATION TO OIL SEAL CASE

1. Apply sealant Three bond 1207F or equivalent to the gasket surface of oil seal case.

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

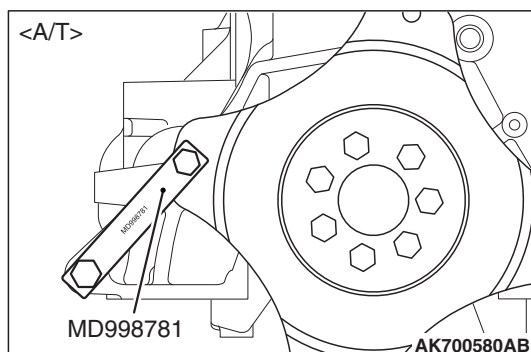
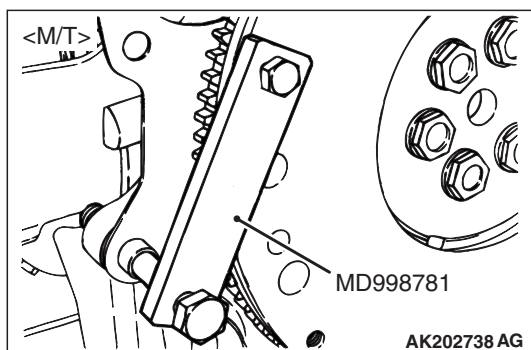
2. Apply engine oil to the oil seal lip, and then install the oil seal case onto the cylinder block.

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

>>F<< FLYWHEEL BOLT / DRIVE PLATE BOLT
INSTALLATION

1. Install special tool MD998781 to hold the flywheel or drive plate.
2. Tighten the flywheel bolt or drive plate bolt to the specified in the tightening sequence shown.

Tightening torque: 132 ± 5 N·m (98 ± 3 ft-lb)

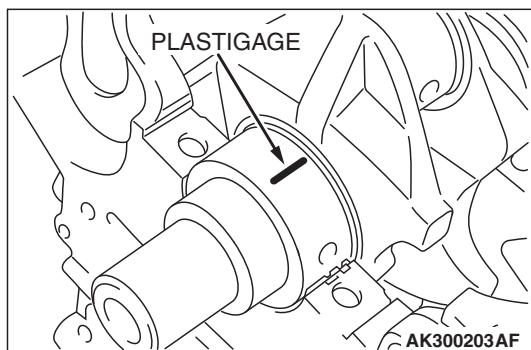


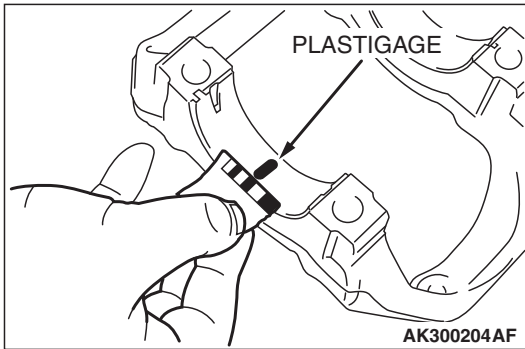
INSPECTION

M1113008801875

CRANKSHAFT JOURNAL OIL CLEARANCE
<PLASTIGAGE METHOD>

1. Remove oil from the crankshaft journal and crankshaft bearing.
2. Install the crankshaft.
3. Cut the plastigage to the same length as the width of bearing and place it on journal in parallel with its axis.
4. Install the crankshaft bearing cap carefully and tighten the bolts to the specified torque.
5. Carefully remove the crankshaft bearing cap.





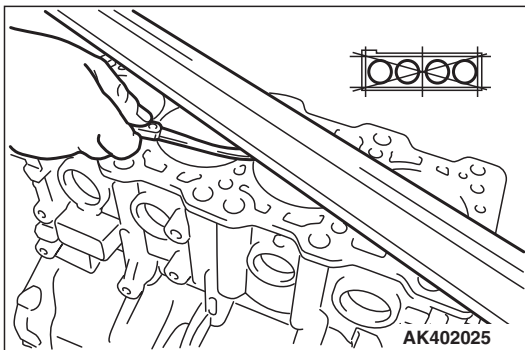
6. Measure the width of the plastigage at its widest part by using a scale printed on the plastigage package.

Standard value

Number 1, 2, 4: 0.018 – 0.036 mm (0.0007 – 0.0014 inch)

Number 3: 0.024 – 0.042 mm (0.0009 – 0.0017 inch)

Limit: 0.1 mm (0.003 inch)



CYLINDER BLOCK

1. Visually check for scratches, rust, and corrosion.
Use also 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 (0.0020 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 (0.007 inch)

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

Cylinder block height (when new):

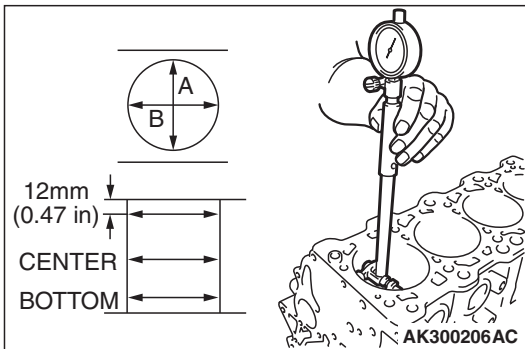
284 mm (11.2 inches)

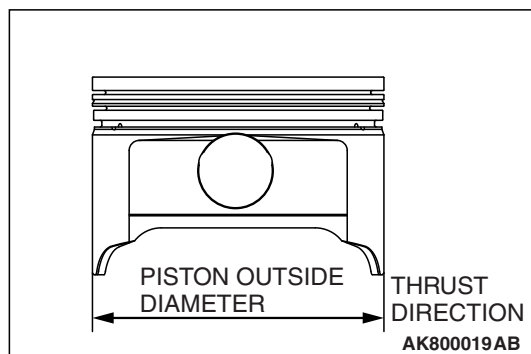
4. Check cylinder walls for scratches and seizure. If defects are evident, replace or bore to oversize and replace pistons and piston rings.
5. Using a cylinder gauge, measure the cylinder bore and cylindrically. If worn badly, correct the cylinder to an oversize and replace the piston and piston rings. Measure at the points shown in the illustration.

Standard value:

Cylinder inner diameter 87.0 mm (3.43 inches)

Cylindrically 0.01 mm (0.0003 inch) or less





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
0.50 mm (0.020 in) oversize diameter	50

NOTE: Size mark is stamped on the piston top.

2. Measure the outside diameter (Over diameter) of the piston to be used. Measure it in thrust direction as shown.
3. Based on the measured piston Over diameter, calculate the boring finish dimension.

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

CAUTION

To prevent distortion that may result from temperature rise during honing, bore cylinders, working from number 2 to number 4 to number 1 to number 3.

4. Bore all cylinders to the calculated boring finish dimension.
5. Hone to the final finish dimension (piston Over diameter + clearance between piston Over diameter and cylinder).
6. Check the clearance between the piston and cylinder.

**Clearance between piston and cylinder:
0.02 – 0.04 mm (0.0008 – 0.0015 inch)**

NOTE: When boring cylinders, finish all of four cylinders to the same oversize. Do not bore only one cylinder to an oversize.

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

M1113023404000

ITEM	SPECIFICATION
Generator and ignition system	
Auto-tensioner bracket bolt M10	44 ± 10 N·m (33 ± 6 ft-lb)
Auto-tensioner bracket bolt M8	22 ± 4 N·m (17 ± 2 ft-lb)
Camshaft position sensing cylinder bolt	22 ± 4 N·m (17 ± 2 ft-lb)
Camshaft position sensor bolt	11 ± 1 N·m (98 ± 8 in-lb)
Camshaft position sensor support bolt	14 ± 1 N·m (124 ± 8 in-lb)
Connector bracket bolt	11 ± 1 N·m (98 ± 8 in-lb)
Crankshaft pulley bolt	25 ± 4 N·m (19 ± 2 ft-lb)
Generator bolt	49 ± 9 N·m (36 ± 6 ft-lb)
Generator pivot nut	44 ± 10 N·m (33 ± 6 ft-lb)
Generator cover bolt	5.9 ± 1.0 N·m (53 ± 8 in-lb)
Idler pulley bolt	79 ± 5 N·m (58 ± 3 ft-lb)
Ignition coil bolt	10 ± 2 N·m (89 ± 17 in-lb)
Oil dipstick guide bolt	13 ± 1 N·m (115 ± 8 in-lb)
Spark plugs	25 ± 5 N·m (19 ± 3 ft-lb)
Water pump pulley bolt	8.8 ± 1.0 N·m (78 ± 8 in-lb)
Exhaust manifold	
Engine hanger bolt	24 ± 3 N·m (18 ± 1 ft-lb)
Exhaust manifold bracket bolt (Bolt, washer assembly)	59 ± 10 N·m (44 ± 6 ft-lb)
Exhaust manifold bracket bolt (Flange bolt)	35 ± 6 N·m (26 ± 4 ft-lb)
Exhaust manifold cover bolt	14 ± 1 N·m (124 ± 8 in-lb)
Exhaust manifold nut	49 ± 5 N·m (36 ± 3 ft-lb)
Oxygen sensor	44 ± 5 N·m (33 ± 3 ft-lb)
Timing belt	
Auto-tensioner bolt	23 ± 3 N·m (17 ± 2 ft-lb)
Camshaft sprocket bolt	89 ± 9 N·m (66 ± 6 ft-lb)
Counterbalance shaft sprocket bolt	45 ± 3 N·m (33 ± 2 ft-lb)
Crankshaft bolt	167 N·m (123 ft-lb)
Crankshaft position sensor bolt	8.5 ± 0.5 N·m (76 ± 4 in-lb)
Engine support bracket bolt and nut	49 ± 5 N·m (36 ± 3 ft-lb)
Generator bracket bolt	49 ± 9 N·m (36 ± 6 ft-lb)
Idler pulley bolt	35 ± 6 N·m (26 ± 4 ft-lb)
Oil pump sprocket nut	54 ± 4 N·m (40 ± 2 ft-lb)
Tensioner "B" bolt	19 ± 3 N·m (14 ± 2 ft-lb)
Tensioner arm bolt	21 ± 4 N·m (16 ± 2 ft-lb)
Tensioner pulley bolt	48 ± 5 N·m (35 ± 3 ft-lb)
Timing belt cover bolt M6 (Bolt, washer assembly)	9.0 ± 1.0 N·m (80 ± 8 in-lb)
Timing belt cover bolt M6 (Flange bolt and nut)	11 ± 1 N·m (98 ± 8 in-lb)

ITEM	SPECIFICATION
Timing belt cover bolt M8	14 ± 1 N·m (124 ± 8 in-lb)
Fuel and emission parts	
Exhaust gas recirculation valve bolt	24 ± 3 N·m (18 ± 1 ft-lb)
Injectors and fuel rail bolt	11 ± 1 N·m (98 ± 8 in-lb)
Solenoid valve bolt	9.0 ± 1.0 N·m (80 ± 8 in-lb)
Throttle body bolt	28 ± 4 N·m (21 ± 2 ft-lb)
Intake manifold and water pump	
Engine coolant temperature sensor	30 ± 9 N·m (22 ± 6 ft-lb)
Engine hanger bolt	24 ± 3 N·m (18 ± 1 ft-lb)
Engine oil pressure switch <Cylinder head side>	10 ± 2 N·m (89 ± 17 in-lb)
Engine oil pressure switch <Cylinder block side>	19 ± 3 N·m (14 ± 2 ft-lb)
Harness bracket bolt	11 ± 1 N·m (98 ± 8 in-lb)
Intake manifold bolt	24 ± 3 N·m (18 ± 1 ft-lb)
Intake manifold nut	20 ± 2 N·m (15 ± 1 ft-lb)
Intake manifold plenum resonator bolt	11 ± 1 N·m (98 ± 8 in-lb)
Intake manifold stay bolt	31 ± 3 N·m (23 ± 2 ft-lb)
Knock sensor	23 ± 2 N·m (17 ± 1 ft-lb)
Manifold absolute pressure sensor bolt	5.0 ± 1.0 N·m (45 ± 8 in-lb)
Thermostat housing bolt	24 ± 4 N·m (18 ± 2 ft-lb)
Water inlet fitting bolt	13 ± 2 N·m (115 ± 17 in-lb)
Water inlet pipe bolt	13 ± 2 N·m (115 ± 17 in-lb)
Water outlet fitting bolt	13 ± 2 N·m (115 ± 17 in-lb)
Water pump bolt	14 ± 1 N·m (124 ± 8 in-lb)
Rocker arms and camshaft	
Engine oil control valve bolt	11 ± 1 N·m (98 ± 8 ft-lb)
Positive crankcase ventilation valve	10 ± 2 N·m (89 ± 17 in-lb)
Rocker arms and rocker arm shaft bolt <exhaust side>	13 ± 1 N·m (115 ± 8 in-lb)
Rocker arms and rocker arm shaft bolt <intake side>	31 ± 3 N·m (23 ± 2 ft-lb)
Rocker cover bolt	3.5 ± 0.5 N·m (31 ± 4 in-lb)
Taper plug	47 ± 7 N·m (35 ± 4 ft-lb)
Ajusting nut	9.0 ± 1.0 N·m (80 ± 8 in-lb)
Cylinder head and valves	
Cylinder head bolt	78 ± 2 N·m (58 ± 1 ft-lb) → 0 N·m (0 in-lb) → 20 ± 2 N·m (15 ± 1 ft-lb) → +90° → +90°
Oil pan and oil pump	
Baffle plate bolt M6	9.0 ± 2.0 N·m (80 ± 17 in-lb)
Baffle plate bolt M8	22 ± 4 N·m (17 ± 2 ft-lb)
Drain plug	39 ± 5 N·m (29 ± 3 ft-lb)
Flange bolt	36 ± 3 N·m (27 ± 1 ft-lb)
Front case bolt	23 ± 3 N·m (17 ± 2 ft-lb)

ITEM		SPECIFICATION
Oil filter bracket bolt		19 ± 3 N·m (14 ± 2 ft-lb)
Oil filter other than MITSUBISHI genuine filter p/n MD356000		17 ± 3 N·m (13 ± 1 ft-lb)
Oil filter part number MD356000		14 ± 2 N·m (124 ± 17 in-lb)
Oil pan bolt		9.0 ± 3.0 N·m (80 ± 26 in-lb)
Oil pump cover bolt		17 ± 1 N·m (12 ± 1 ft-lb)
Oil pump cover screw		10 ± 2 N·m (89 ± 17 in-lb)
Oil screen bolt		19 ± 3 N·m (14 ± 2 ft-lb)
Plug		23 ± 3 N·m (17 ± 2 ft-lb)
Relief plug		44 ± 5 N·m (33 ± 3 ft-lb)
Piston and connecting rod		
Connecting rod cap nut		20 ± 2 N·m (15 ± 1 ft-lb) → +90° to 94°
Crankshaft and cylinder block		
Bearing cap bolt		25 ± 2 N·m (18 ± 1 ft-lb) → +90°
Bell housing cover bolt		10 ± 2 N·m (89 ± 17 in-lb)
Flywheel and drive plate bolt		132 ± 5 N·m (98 ± 3 ft-lb)
Oil seal case bolt		11 ± 1 N·m (98 ± 8 in-lb)
Rear plate bolt		10 ± 2 N·m (89 ± 17 in-lb)

GENERAL SPECIFICATIONS

M1113000200531

DESCRIPTION			SPECIFICATION
Type			In-line OHV, SOHC
Number of cylinders			4
Combustion chamber			Pent roof type
Total displacement cm ³ (cu. in)			2,378 (145.1)
Cylinder bore mm (in)			87 (3.43)
Piston stroke mm (in)			100 (3.94)
Compression ratio			9.5
Valve timing	Intake valve	Opens (BTDC)	10° <Low speed cam A>
			12° <Low speed cam B>
			24° <High speed cam>
		Closes (ABDC)	42° <Low speed cam A>
			44° <Low speed cam B>
			68° <High speed cam>
Exhaust valve	Opens (BBDC)	58°	
	Closes (ATDC)	18°	
Lubrication system			Pressure feed, full-flow filtration
Oil pump type			Involute gear type

SERVICE SPECIFICATIONS

M1113000302288

ITEM			STANDARD VALUE	LIMIT
Timing belt				
Auto tensioner rod length mm (in)			3.8 – 4.5 (0.15 – 0.18)	–
Auto-tensioner rod projection length mm (in)			12 (0.5)	–
Auto-tensioner rod pushed-in amount [When pushed with a force of 98 – 196 N (22 – 44 lb)] mm (in)			1.0 (0.03) or less	–
Valve clearance mm (in)	Intake		0.11 (0.004)	–
	Exhaust		0.20 (0.008)	–
Rocker arms and camshaft				
Camshaft cam height mm (in)	Intake	Low speed cam A	37.47 (1.475)	Minimum 36.97 (1.455)
		Low speed cam B	37.47 (1.475)	Minimum 36.97 (1.455)
		High speed cam	37.21 (1.465)	Minimum 36.71 (1.445)
	Exhaust		37.86 (1.491)	Minimum 37.36 (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)	–
Cylinder head bolt shank length mm (in)			–	99.4 (3.91)
Valve thickness of valve head (margin) mm (in)	Intake		1.0 (0.03)	Minimum 0.5 (0.02)
	Exhaust		1.2 (0.04)	Minimum 0.7 (0.03)
Valve overall height mm (in)	Intake		111.33 (4.383)	Minimum 110.83 (4.363)
	Exhaust		113.54 (4.470)	Minimum 113.04 (4.450)
Valve stem outside diameter mm (in)			6.0 (0.24)	–
Valve thickness to valve guide clearance mm (in)	Intake		0.020 – 0.047 (0.0008 – 0.0019)	0.10 (0.003)
	Exhaust		0.035 – 0.062 (0.0014 – 0.0024)	0.15 (0.005)
Valve face angle mm (in)			43.5° – 44°	–
Valve spring free length mm (in)	Intake		54.8 (2.16)	Minimum 53.8 (2.12)
	Exhaust		56.1 (2.21)	Minimum 55.1 (2.17)
Valve spring load/installed height N (lb)/mm (in)			267 (60)/44.2 (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)	–

ITEM		STANDARD VALUE	LIMIT
Valve guide inside diameter mm (in)		6.0 (0.24)	–
Valve guide projection from cylinder head upper surface mm (in)		14.0 (0.55)	–
Valve stem projection mm (in)	Intake	48.33 (1.903)	48.83 (1.922)
	Exhaust	48.34 (1.903)	48.84 (1.922)
Oversize rework dimensions of valve guide hole mm (in)	0.05 oversize diameter	11.05 – 11.07 (0.4350 – 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	35.30 – 35.33 (1.3898 – 1.3909)	–
	0.6 oversize diameter	35.60 – 35.63 (1.4016 – 1.4028)	–
Exhaust oversize rework dimensions of valve seat hole mm (in)	0.3 oversize diameter	33.30 – 33.33 (1.3110 – 1.3122)	–
	0.6 oversize diameter	33.60 – 33.63 (1.3228 – 1.3240)	–
Oil pan and oil pump			
Oil pump side clearance mm (in)	Drive gear	0.08 – 0.14 (0.0031 – 0.0055)	–
	Driven gear	0.06 – 0.12 (0.0024 – 0.0047)	–
Piston and connecting rod			
Piston outside diameter mm (in)		87 (3.43)	–
Piston ring side clearance mm (in)	Number 1	0.03 – 0.07 (0.0012 – 0.0028)	0.1 (0.003)
	Number 2	0.02 – 0.06 (0.0008 – 0.0024)	0.1 (0.003)
Piston ring end gap mm (in)	Number 1	0.15 – 0.30 (0.006 – 0.012)	0.8 (0.03)
	Number 2	0.28 – 0.43 (0.011 – 0.017)	0.8 (0.03)
	Oil ring side rail	0.10 – 0.40 (0.004 – 0.016)	1.0 (0.03)
Piston pin outside diameter mm (in)		22.0 (0.87)	–
Piston pin press-in load N (lb) (Room temperature)		7,350 – 17,200 (1,653 – 3,866)	–
Crankshaft pin oil clearance mm (in)		0.03 – 0.06 (0.0012 – 0.0023)	0.1 (0.003)
Connecting rod big end side clearance mm (in)		0.10 – 0.25 (0.004 – 0.009)	0.4 (0.015)
Crankshaft and cylinder block			

ITEM		STANDARD VALUE	LIMIT
Crankshaft end play mm (in)		0.05 – 0.25 (0.002 – 0.009)	0.40 (0.015)
Crankshaft journal outside diameter mm (in)		57.0 (2.24)	–
Crankshaft pin outside diameter mm (in)		45.0 (1.77)	–
Crankshaft journal oil clearance mm (in)	Number 1,2,4 journal	0.018 – 0.036 (0.0007 – 0.0014)	0.1 (0.003)
	Number 3 journal	0.024 – 0.042 (0.0009 – 0.0017)	0.1 (0.003)
Bearing cap bolt shank length mm (in)		–	71.1 (2.79)
Piston to cylinder clearance mm (in)		0.02 – 0.04 (0.0008 – 0.0015)	–
Cylinder block flatness of gasket surface mm (in)		0.05 (0.002)	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 (0.007)
Cylinder block overall height mm (in)		284 (11.2)	–
Cylinder block inside diameter mm (in)		87.0 (3.43)	–
Cylindricity mm (in)		0.01 (0.0003)	–

SEALANTS

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ITEM	SPECIFIED SEALANT	QUANTITY
Camshaft position sensor support	Three bond 1207F (Mitsubishi Part Number 1000A992) or equivalent.	As required
Engine support bracket seal bolt	Three bond 1212D, Three bond 1215 or equivalent.	As required
Thermostat housing	Three bond 1207F (Mitsubishi Part Number 1000A992) or equivalent.	As required
Thermostat housing seal bolt	Three bond 1212D, Three bond 1215 or equivalent.	As required
Water outlet fitting	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 pan	Three bond 1207F (Mitsubishi Part Number 1000A992) or equivalent.	As required
Oil seal case	Three bond 1207F (Mitsubishi Part Number 1000A992) or equivalent.	As required