

## GROUP 11B

# ENGINE OVERHAUL

## <2.0L ENGINE>

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## GENERAL SPECIFICATIONS

M1113000202377

Item		Specifications	
Engine model		4B11	
Type		In line OHV, DOHC	
Number of cylinders		4	
Combustion chamber		Pent-roof type	
Total displacement cm <sup>3</sup> (cu in)		1,998 (121.9)	
Cylinder bore mm (in)		86 (3.4)	
Piston stroke mm (in)		86 (3.4)	
Compression ratio		9.0	
Valve timing	Intake valve	Opens	10° BTDC -35° BTDC
		Closes	62° ABDC -37° ABDC
	Exhaust valve	Open	44° BBDC -9° BBDC
		Close	0° ATDC -35° ATDC
Auto lash adjuster		Non-equipped	

## SERVICE SPECIFICATIONS

M1113000303139

Item		Standard value	Limit
<b>Timing chain</b>			
Valve clearance mm (in)	Intake	0.20 ± 0.03 (0.008 ± 0.001)	-
	Exhaust	0.30 ± 0.03 (0.012 ± 0.001)	-
<b>Camshaft</b>			
Cam height of camshaft mm (in)	Intake	44.1 (1.74)	43.6 (1.72)
	Exhaust	45.0 (1.77)	44.5 (1.75)
Camshaft oil clearance mm (in)		0.035 -0.072 (0.0014 -0.0028)	-
<b>Cylinder head and valves</b>			
Distortion of cylinder head bottom mm (in)		Within 0.05 (0.002)	0.2 (0.01)
Grinding limit of cylinder head bottom mm (in)		-	0.2 (0.01)
Overall height of cylinder head mm (in)		128.5 (5.06)	-
Overall length of valve mm (in)	Intake	113.18 (4.456)	112.68 (4.436)
	Exhaust	105.89 (4.169)	105.39 (4.149)
Valve margin mm (in)	Intake	1.022 (0.0402)	0.522 (0.0206)
	Exhaust	1.094 (0.0431)	0.594 (0.0234)
Free height of valve spring mm (in)		51.5 (2.03)	51.0 (2.01)
Squareness of valve spring		2° or less	4°

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SERVICE SPECIFICATIONS**

**11B-3**

Item		Standard value	Limit
Clearance between valve guide and valve stem mm (in)	Intake	0.020 –0.047 (0.0008 –0.0019)	0.10 (0.004)
	Exhaust	0.030 –0.057 (0.0012 –0.0022)	0.15 (0.006)
Valve seat contact width mm (in)	Intake	1.16 –1.46 (0.046 –0.058)	–
	Exhaust	1.35 –1.65 (0.053 –0.065)	–
Oversize rework dimensions of valve guide hole mm (in)	0.25 oversize diameter	11.23 –11.25 (0.442 –0.443)	–
Intake oversize rework dimensions of valve seat hole mm (in)	0.3 oversize diameter	36.22 –36.24 (1.426 –1.427)	–
Exhaust oversize rework dimensions of valve seat hole mm (in)	0.3 oversize diameter	30.22 –30.24 (1.190 –1.191)	–
Valve guide press-in height mm (in)		14.6 –15.2 (0.57 –0.60)	–
<b>Oil pump chain</b>			
Oil cooler by-pass valve dimension mm (in)	Normal temperature	34.5 (1.358)	–
	97 –130° C (207 –217° F)	40.0 (15.75)	–
<b>Piston and connecting rod</b>			
Clearance between piston ring and ring groove mm (in)	No.1	0.02 –0.06 (0.001 –0.002)	0.10 (0.004)
	No.2	0.02 –0.06 (0.001 –0.002)	0.10 (0.004)
Piston ring end gap mm (in)	No.1	0.18 –0.28 (0.007 –0.011)	0.8 (0.03)
	No.2	0.28 –0.43 (0.011 –0.017)	0.8 (0.03)
	Oil	0.10 –0.34 (0.004 –0.013)	1.0 (0.04)
Clearance of connecting rod big end thrust mm (in)		0.10 –0.25 (0.004 –0.010)	0.4 (0.02)
Outside diameter of connecting rod bolt mm (in)		–	0.10 (0.004)
Connecting rod bearing oil clearance mm (in)		0.038 –0.069 (0.0015 –0.0027)	0.10 (0.004)
<b>Crankshaft and cylinder block</b>			
Out side diameter clearance of crankshaft bearing cap bolt mm (in)	M8	–	0.10 (0.004)
	M10	–	0.15 (0.006)
Crankshaft end play mm (in)		0.05 –0.25 (0.002 –0.010)	0.4 (0.02)
Crankshaft journal oil clearance mm (in)	No.1, 2, 4, 5	0.039 –0.065 (0.0015 –0.0026)	0.10 (0.004)
	No.3	0.051 –0.077 (0.0020 –0.0030)	0.10 (0.004)
Distortion of cylinder block top surface mm (in)		Within 0.05 (0.002)	0.2 (0.01)
Grinding limit of cylinder block top surface mm (in)		–	0.2 (0.01)

Item	Standard value	Limit
Cylinder block cylinder bore mm (in)	86 (3.4)	–
Cylindricity of cylinder block mm (in)	0.010 (0.0004)	–
Piston-to-cylinder clearanc mm (in)	0.03 –0.05 (0.001 –0.002)	–

## FASTENER TIGHTENING SPECIFICATIONS

M1113023404301

Item	Specification
<b>Generator and ignition system</b>	
Idler pulley bolt	48 ± 7 N· m (36 ± 4 ft-lb)
Generator nut	44 ± 10 N· m (32 ± 7 ft-lb)
Generator bolt	44 ± 10 N· m (32 ± 7 ft-lb)
Power steering pump bracket bolt (M8)	23 ± 2 N· m (17 ± 1 ft-lb)
Power steering pump bracket bolt (M10)	44 ± 8 N· m (33 ± 5 ft-lb)
Auto tensioner	22 ± 4 N· m (17 ± 2 ft-lb)
Crankshaft bolt	250 N· m (184 ft-lb) →0 →110 N· m (81 ft-lb) →+60°
Ignition coil bolt	9.5 ± 2.5 N· m (84 ± 22 in-lb)
Spark plug	18 ± 2 N· m (13 ± 1 ft-lb)
<b>Throttle body</b>	
Vacuum pump assembly bolt (M6)	11 ± 1 N· m (98 ± 8 in-lb)
Vacuum pump assembly bolt (M8)	24 ± 3 N· m (18 ± 1 ft-lb)
Solenoid valve screw	9.5 ± 2.5 N· m (84 ± 22 in-lb)
Throttle body bolt	23 ± 6 N· m (17 ± 4 ft-lb)
Air temperature sensor	14 ± 1 N· m (128 ± 8 in-lb)
Manifold absolute pressure (MAP) sensor screw	5.0 ± 1.0 N· m (48 ± 8 in-lb)
<b>Intake manifold and fuel system</b>	
Oil dipstick guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Fuel return pipe bolt	5.5 ± 1.5 N· m (49 ± 12 in-lb)
Fuel pressure regulator bolt	9.0 ± 3.0 N· m (80 ± 26 in-lb)
Fuel rail bolt	12 ± 3 N· m (106 ± 26 in-lb)
Intake manifold stay bolt	23 ± 6 N· m (17 ± 4 ft-lb)
Intake manifold nut	20 ± 2 N· m (15 ± 1 ft-lb)
Intake manifold assembly bolt washer	20 ± 2 N· m (15 ± 1 ft-lb)
Generator bracket bolt	44 ± 8 N· m (33 ± 5 ft-lb)
Knock sensor bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Engine oil pressure switch	10 ± 2 N· m (89 ± 17 in-lb)
<b>Exhaust manifold</b>	
Exhaust manifold cover bolt	10 ± 2 N· m (89 ± 17 in-lb)
Turbocharger bracket bolt (Cylinder block side)	51 ± 7 N· m (38 ± 4 ft-lb)
Turbocharger bracket bolt (Turbocharger side)	64 ± 5 N· m (47 ± 3 ft-lb)



<b>Item</b>	<b>Specification</b>
Exhaust fitting bracket bolt (Cylinder block side)	51 ± 7 N· m (38 ± 4 ft-lb)
Exhaust fitting bracket bolt (Exhaust fitting side)	64 ± 5 N· m (47 ± 3 ft-lb)
Oil return pipe bolt (M6)	9.0 ± 1.0 N· m (80 ± 8 in-lb)
Oil return pipe bolt (M8)	25 ± 4 N· m (19 ± 2 ft-lb)
Turbocharger and pipe assembly bolt	29 ± 2 N· m (21 ± 1 ft-lb) →+65° ± 5°
Exhaust manifold nut	49 ± 5 N· m (36 ± 3 ft-lb)
Water pipe A bolt (washer bolt)	9.5 ± 1.5 N· m (84 ± 13 in-lb)
Water pipe A bolt (Eye bolt)	28 ± 5 N· m (21 ± 3 ft-lb)
Water pipe B bolt (Eye bolt)	28 ± 5 N· m (21 ± 3 ft-lb)
Oil pipe bolt (Flange bolt)	9.5 ± 2.5 N· m (84 ± 22 in-lb)
Oil pipe bolt (Eye bolt)	17 ± 2 N· m (13 ± 1 ft-lb)
Exhaust fitting heat protector A bolt	25 ± 4 N· m (19 ± 2 ft-lb)
Exhaust fitting heat protector B bolt	25 ± 4 N· m (19 ± 2 ft-lb)
Exhaust fitting bolt, nut	64 ± 5 N· m (47 ± 3 ft-lb)
Air outlet fitting bolt	25 ± 4 N· m (19 ± 2 ft-lb)
<b>Water hose and pipe</b>	
Engine coolant temperature sensor	30 ± 9 N· m (22 ± 6 ft-lb)
Water inlet fitting bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Water outlet fitting bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Thermostat housing bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Water pipe nut	24 ± 3 N· m (18 ± 1 ft-lb)
Water pump bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Engine hanger bolt	28 ± 8 N· m (21 ± 5 ft-lb)
Camshaft position sensor	10 ± 2 N· m (89 ± 17 in-lb)
Crank position sensor	10 ± 2 N· m (89 ± 17 in-lb)
<b>Oil pan and timing chain case</b>	
PCV valve	2.5 ± 0.4 N· m (22 ± 3 in-lb)
Oil drain plug	39 ± 5 N· m (29 ± 3 ft-lb)
Oil filter	14 ± 2 N· m (124 ± 17 in-lb)
Cylinder head cover bolt	3.0 ± 1.0 N· m (27 ± 8 in-lb) →5.5 ± 0.5 N· m (49 ± 4 in-lb)
Air compressor bracket bolt	23 ± 6 N· m (17 ± 4 ft-lb)
Oil pan bolt (M6)	10 ± 2 N· m (89 ± 17 in-lb)
Oil pan bolt (M8)	29 ± 2 N· m (21 ± 1 ft-lb)
Engine support bracket assembly bolt (M10)	45 ± 5 N· m (33 ± 3 ft-lb)
Engine support bracket assembly bolt (M8)	23 ± 2 N· m (17 ± 1 ft-lb)
Timing chain case bolt (M6)	10 ± 2 N· m (89 ± 17 in-lb)
Timing chain case bolt (M8 × 10)	13 ± 1 N· m (115 ± 8 in-lb)
Timing chain case bolt (M8 × 30)	24 ± 4 N· m (18 ± 2 ft-lb)
Engine oil control valve heat protector bolt	10 ± 2 N· m (89 ± 17 in-lb)

Item	Specification
<b>Timing chain</b>	
Chain upper guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Timing chain tensioner bolt	10 ± 2 N· m (89 ± 17 in-lb)
Tensioner lever bolt	10 ± 2 N· m (89 ± 17 in-lb)
Timing chain guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Oil jet bolt	10 ± 2 N· m (89 ± 17 in-lb)
V.V.T. intake sprocket bolt	85 ± 5 N· m (63 ± 3 ft-lb)
V.V.T. exhaust sprocket bolt	85 ± 5 N· m (63 ± 3 ft-lb)
<b>Camshaft</b>	
Engine oil control valve (OCV) bolt	10 ± 2 N· m (89 ± 17 in-lb)
Front camshaft bearing cap bolt (M8)	17 ± 3 N· m (14 ± 2 ft-lb) →30 ± 2 N· m (22 ± 1 ft-lb)
Camshaft bearing cap bolt (M6)	12 ± 1 N· m (107 ± 8 in-lb)
<b>Cylinder head and valves</b>	
Cylinder head bolt	35 ± 2 N· m (26 ± 1 ft-lb) →+90° →+90°
<b>Oil pump chain</b>	
Flywheel bolt	40 N· m (30 ft-lb) →130 N· m (96 ft-lb)
Oil seal case bolt	10 ± 2 N· m (89 ± 17 in-lb)
Oil pump tensioner lever bolt	10 ± 2 N· m (89 ± 17 in-lb)
Oil pump chain guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Oil pump case bolt	26 ± 2 N· m (19 ± 1 ft-lb)
Oil pump sprocket bolt	23 ± 2 N· m (17 ± 1 ft-lb)
Oil cooler by-pass valve	54 ± 5 N· m (40 ± 3 ft-lb)
Ladder frame bolt	26 ± 1 N· m (19 ± 1 ft-lb)
Check valve	32 ± 2 N· m (24 ± 1 ft-lb)
<b>Piston and connecting rod</b>	
Connecting rod cap bolt	5.0 N· m (44 in-lb) →20 N· m (15 ft-lb) →+90°
<b>Crankshaft and cylinder block</b>	
Crankshaft sensing ring bolt	11 ± 1 N· m (98 ± 8 in-lb)
Bearing cap bolt (M8)	9.0 ± 2.0 N· m (80 ± 17 in-lb) →+90°
Bearing cap bolt (M10)	37.2 ± 2.0 N· m (28 ± 1 ft-lb) →+90°

**NEW TIGHTENING METHOD BY USING PLASTIC REGION TIGHTENING BOLT**

Plastic region tightening bolts are used in some parts of the engine. Install these bolts according to the method described in the relevant section because the tightening method of these bolts are different from the conventional method. The service limit is determined for these bolts. Be sure to strictly follow the service limit described in the body of the manual.

- Parts to be used
  1. Cylinder head bolt

2. Bearing cap bolt
  3. Connecting rod cap bolt
- Tightening method  
After tightening to the specified torque, further tighten 45° and 90°, or 180° (90° + 90°). Follow the tightening method described in the body of the manual because the tightening method differs from part to part.

## SEALANTS AND ADHESIVES

M1113000502839

Item	Specified sealant
Flywheel bolt	Three bond 1324 or equivalent
Rear oil seal case	Three bond 1227D, Three bond 1217G (Mitsubishi Part No.1000A923), Three bond 1207F (Mitsubishi Part No.1000A992), LOCTITE 5971, LOCTITE 5970, LOCTITE 5900
Oil pan	
Cylinder head cover (matching area of the cylinder head and the timing chain case assembly)	Three bond 1227D, Three bond 1217G (Mitsubishi Part No.1000A923)
Ladder frame	
Cylinder head gasket (matching area of the cylinder block and the cylinder head)	Three bond 1217G (Mitsubishi Part No.1000A923) or equivalent
Timing chain case	
Engine coolant temperature sensor	LOCTITE 262, Three bond 1324N or equivalent
Engine oil pressure switch	Three bond 1215, Three bond 1212D or equivalent

*NOTE: The number in square brackets shows the part number.*

### FORM-IN-PLACE GASKET (FIPG)

The engine has several parts to which the form-in-place gasket (FIPG) is used. To sufficiently achieve the aims of this gasket, it is necessary to pay attention to the application amount, procedure, and surface status.

If the application amount is too small, a leakage will occur. If the application amount is excessive, the FIPG will overflow and cause a clogging or narrowing of water and oil paths. Therefore, to eliminate the leak from the joint, it is indispensable that the FIPG be applied with a correct amount and without any gap.

Because the FIPG used for the engine parts becomes hardened by the reaction with the atmospheric moisture, it is normally used for the metal flange section.

#### CAUTION

Reapply the FIPG with care to the followings.

1. Completely remove the old FIPG including the residue in gaps of parts.
2. Using Mitsubishi genuine parts cleaner (MZ100387) or equivalent, degrease the FIPG application surface carefully.
3. According to the FIPG application procedures, apply it accurately.

### DISASSEMBLY

The parts installed with the FIPG can be disassembled easily without using any special method. However, in some cases, it is necessary to tear the sealant in between the mating surfaces by tapping the parts with a wooden hammer or similar tools. It is acceptable to lightly hit in a smooth, thin gasket scraper into the mating surface, but, in this case, a sufficient caution is required not to damage the mating surface. The oil pan FIPG cutter (Special tool: MD998727) is provided. Thus, use this special tool.

### GASKET SURFACE CLEANING

Use a gasket scraper or wire brush to completely remove all the foreign materials adhering to the gasket surface. Check that the FIPG application surface is smooth. There must be no grease or foreign material adhesion to the gasket surface. Do not forget to remove the old FIPG remaining in the mounting hole and tapped hole.

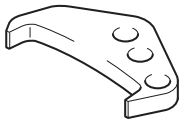
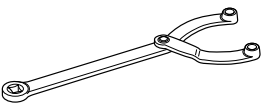
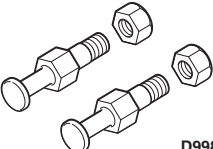
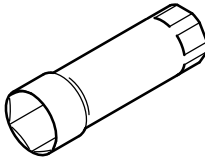
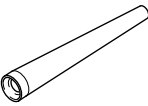
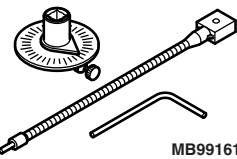
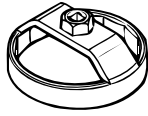
**APPLICATION PROCEDURE**

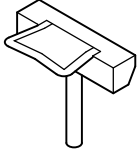
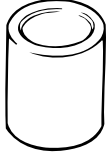
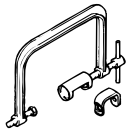
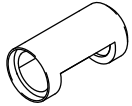
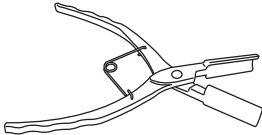
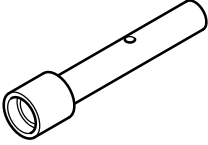
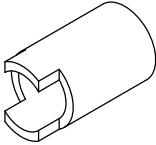
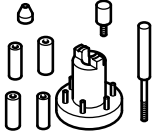
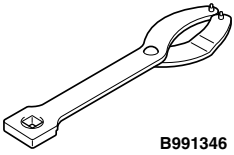
Apply the FIPG with a specified diameter and without any gap. Completely enclose around the mounting hole. When the FIPG is not hardened, it can be wiped off. When the FIPG is still moistened, perform the installation to the specified position. At the time of installation, prevent the FIPG from adhering to loca-

tions other than it is necessary. After the installation, until a sufficient period of time (approximately for t one hours) elapses, do not contact the oil or water to the application area. Also, do not start the engine. Because the FIPG application procedure may differ depending on the application area, apply the FIPG according to the procedure described in the text.

**SPECIAL TOOLS**

M1113000602494

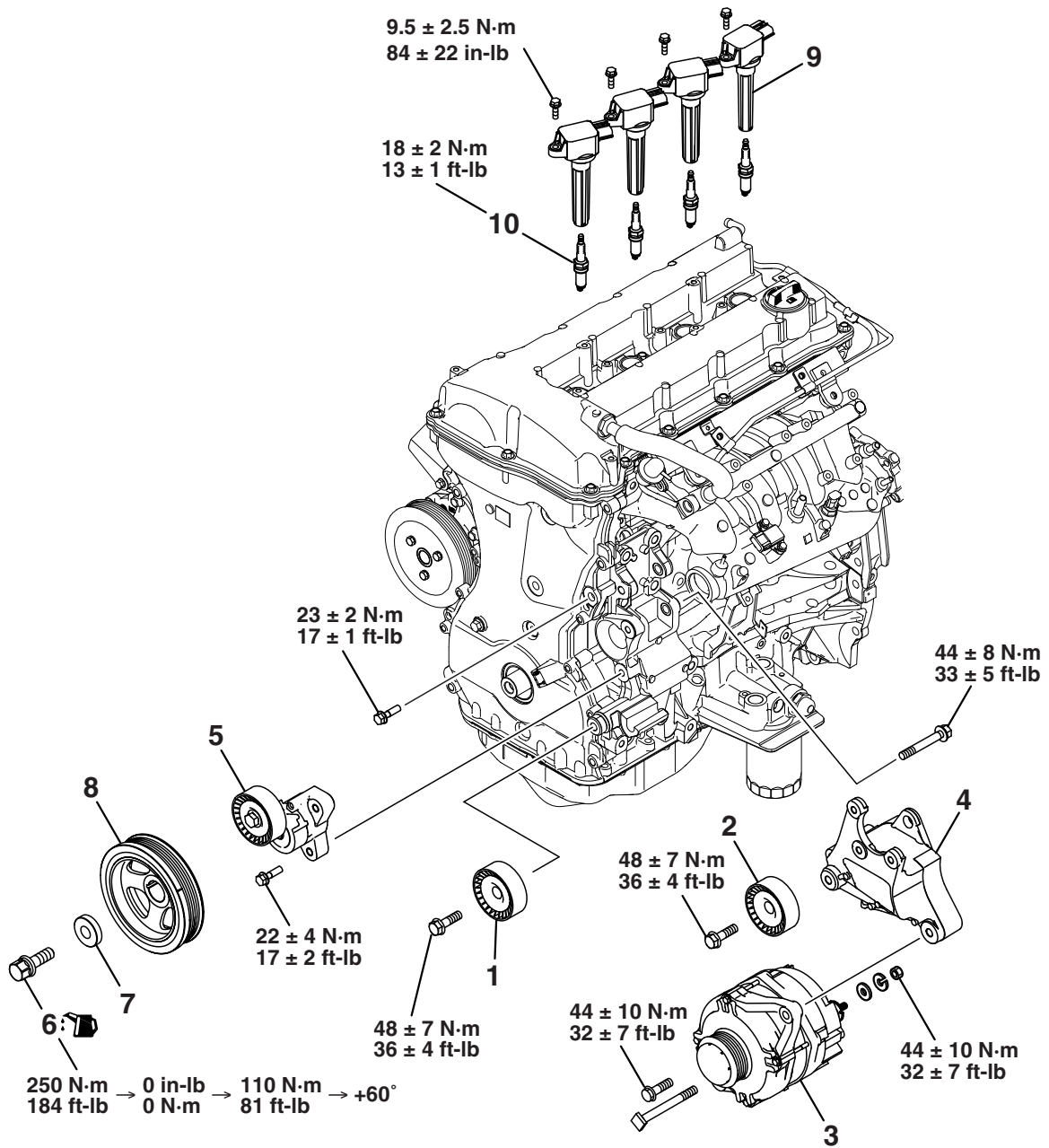
Tool	Tool number and name	Supersession	Application
 MB991883	MB991883 Flywheel stopper	–	Securing of flywheel
 B990767	MB990767 Front hub and flange yoke holder	MB990767-01	Holding the crankshaft pulley
 D998719	MD998719 Pin	MIT308239	
	MB991398 Spark plug wrench	–	Removal and installation of spark plug
 B992106	MB992106 O-ring installer	–	Installation of O-ring on injector injection nozzle side
 MB991614	MB991614 Angle gauge	General service tool	Installation of turbocharger and pipe assembly bolt and nut
 MB991610	MB991610 Oil filter wrench	General service tool	Removal and installation of oil filter

Tool	Tool number and name	Supersession	Application
 <p>D998727</p>	MD998727 Oil pan FIPG cutter	MD998727-01	Removal of oil pan
	MB991448 Bush remover and installer base	MB991448-01	Press fit of front oil seal
	MD998735 Valve spring compressor	MD998735-01	Compression of valve spring
	MB992089 Retainer holder C	MB992089-01	
	MB992085 Valve stem seal pliers	-	Extraction of valve stem seal
	MD998737 Valve stem seal installer	MD998737-01	Installation of valve stem seal
	MB992236 Circlip installer	-	Installation of circlip
	MD998780 Piston pin setting tool	MIT216941	
 <p>B991346</p>	MB991346 Top cover wrench	-	Holding the oil pump sprocket

# GENERATOR AND IGNITION SYSTEM

## REMOVAL AND INSTALLATION

M1113001002309



AK702234AE

### Removal steps

1. Idler pulley
2. Idler pulley
- >>C<< 3. Generator
- >>C<< 4. Power steering pump bracket
5. Auto tensioner

### Removal steps (Continued)

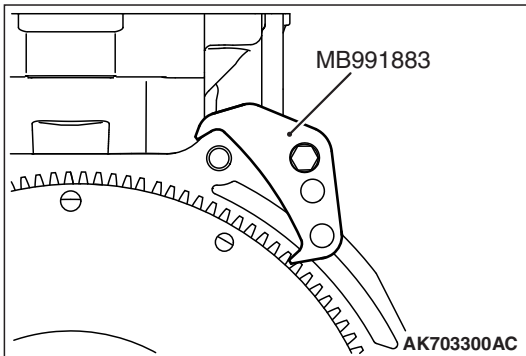
- <<A>> >>B<< 6. Crankshaft pulley center bolt
- >>B<< 7. Crankshaft pulley washer
- >>B<< 8. Crankshaft pulley
9. Ignition coil
- <<B>> >>A<< 10. Spark plug

### Required Special Tools:

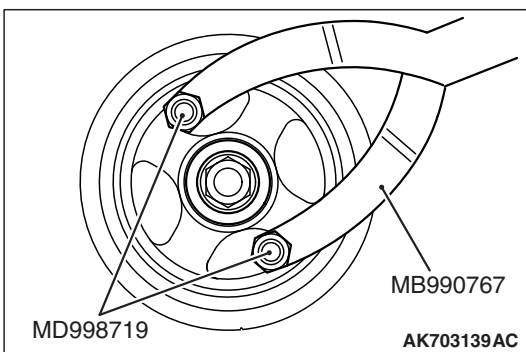
- MB990767: Front Hub And Flange Yoke Holder
- MB991398: Spark Plug Wrench
- MB991883: Flywheel Stopper
- MD998719: Pin

## REMOVAL SERVICE POINT

### <<A>> CRANKSHAFT PULLEY CENTER BOLT REMOVAL

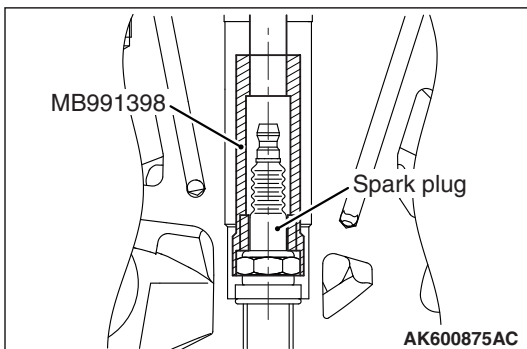


1. Use special tool MB991883 to secure the flywheel.  
Use the special tool MB990767 and MD998719 to insert the pin into the crankshaft pulley hole and prevent it from rotating.
2. Remove the crankshaft pulley center bolt.



### <<B>> SPARK PLUG REMOVAL

Using special tool MB991398, removal the spark plug.

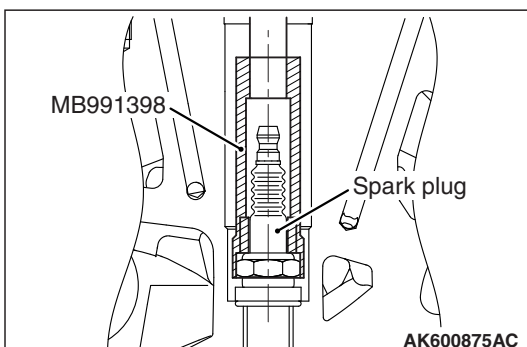


## INSTALLATION SERVICE POINTS

### >>A<< SPARK PLUGS INSTALLATION

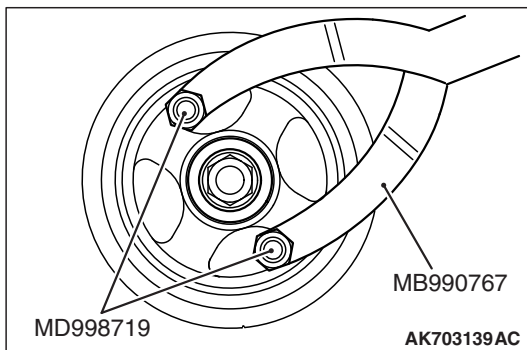
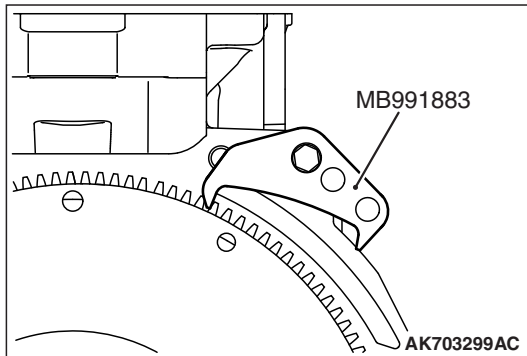
Using special tool MB991398, tighten the spark plug to the specified torque.

**Tightening torque:  $18 \pm 2$  N·m ( $13 \pm 1$  ft-lb)**

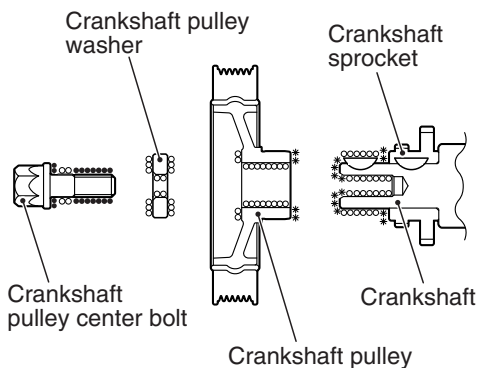


**>>B<< CRANKSHAFT PULLEY / CRANKSHAFT PULLEY WASHER / CRANKSHAFT PULLEY CENTER BOLT INSTALLATION**

1. Use special tool MB991883 to secure the flywheel.  
Use the special tool MB990767 and MD998719 to insert the pin into the crankshaft pulley hole and prevent it from rotating.



- : Wipe clean with a rag.
- \* : Wipe clean with a rag and degrease.
- : Wipe clean with a rag, degrease and apply a small amount of engine oil.



← Engine front

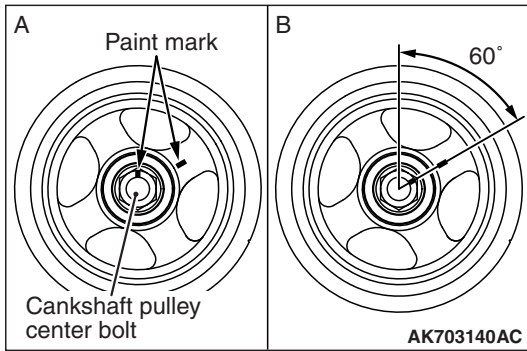
AK602911AG

2. Wipe off the dirt on the crankshaft pulley washer and on the thread hole of the crankshaft using a rag.
3. Wipe off the dirt on the crankshaft pulley and the crankshaft sprocket using a rag, and then remove the grease from the portion shown in the illustration.

*NOTE: Remove grease to prevent the coefficient of friction of the pressing portion from declining due to adhesion of oil.*

4. Install the crankshaft pulley.
5. Apply an appropriate and minimum amount of engine oil to the threaded portion of the crankshaft and lower part of the flange.
6. With off the chamfered side on the inside of the washer facing the bolt top, install the washer to the crankshaft pulley center bolt.
7. Tighten the crankshaft pulley center bolt to specified torque.  
**Tightening torque: 250 N·m (184 ft-lb)**
8. Loosen the crankshaft pulley center bolt fully.
9. Tighten the crankshaft pulley center bolt to specified torque.  
**Tightening torque: 110 N·m (81 ft-lb)**





10. As shown in the illustration "A," apply the paint mark to the crankshaft pulley on the extended line of the corner adjacent to the one of the crankshaft pulley center bolt corners.

**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.

11. Tighten the crankshaft pulley center bolt by 60° once more. Make sure the paint mark of crankshaft pulley center bolt is aligned with the paint mark of crankshaft pulley as shown in the illustration "B."

**>>C<< GENERATOR / POWER STEERING PUMP BRACKET INSTALLATION**

1. Temporarily tighten power steering pump bracket bolts.

**CAUTION**

Always loosen the power steering pump bracket bolt, and temporarily install the generator. Then tighten each bolt.

2. Loosen the power steering pump bracket bolts and make the power steering pump bracket unfixed.
3. Temporarily install the generator with the generator bolts.
4. Tighten them to the specified torque according to the order as illustrated.

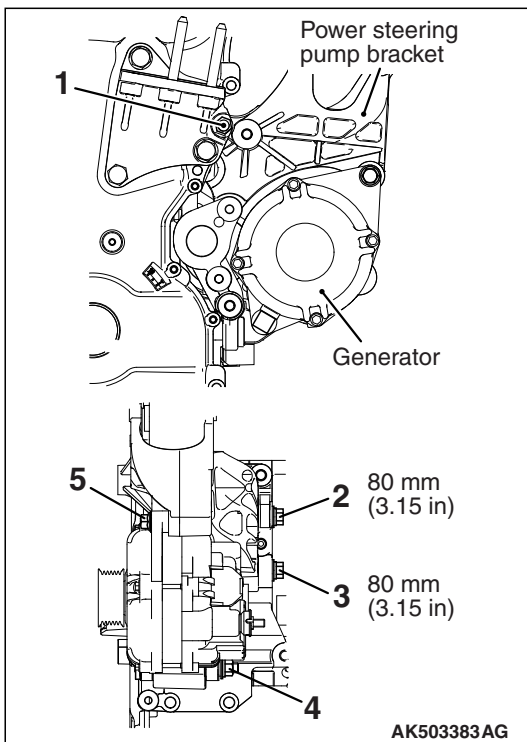
**Tightening torque**

**Power steering pump bracket:**

**M8 23 ± 2 N·m (17 ± 1 ft-lb)**

**M10 44 ± 8 N·m (33 ± 5 ft-lb)**

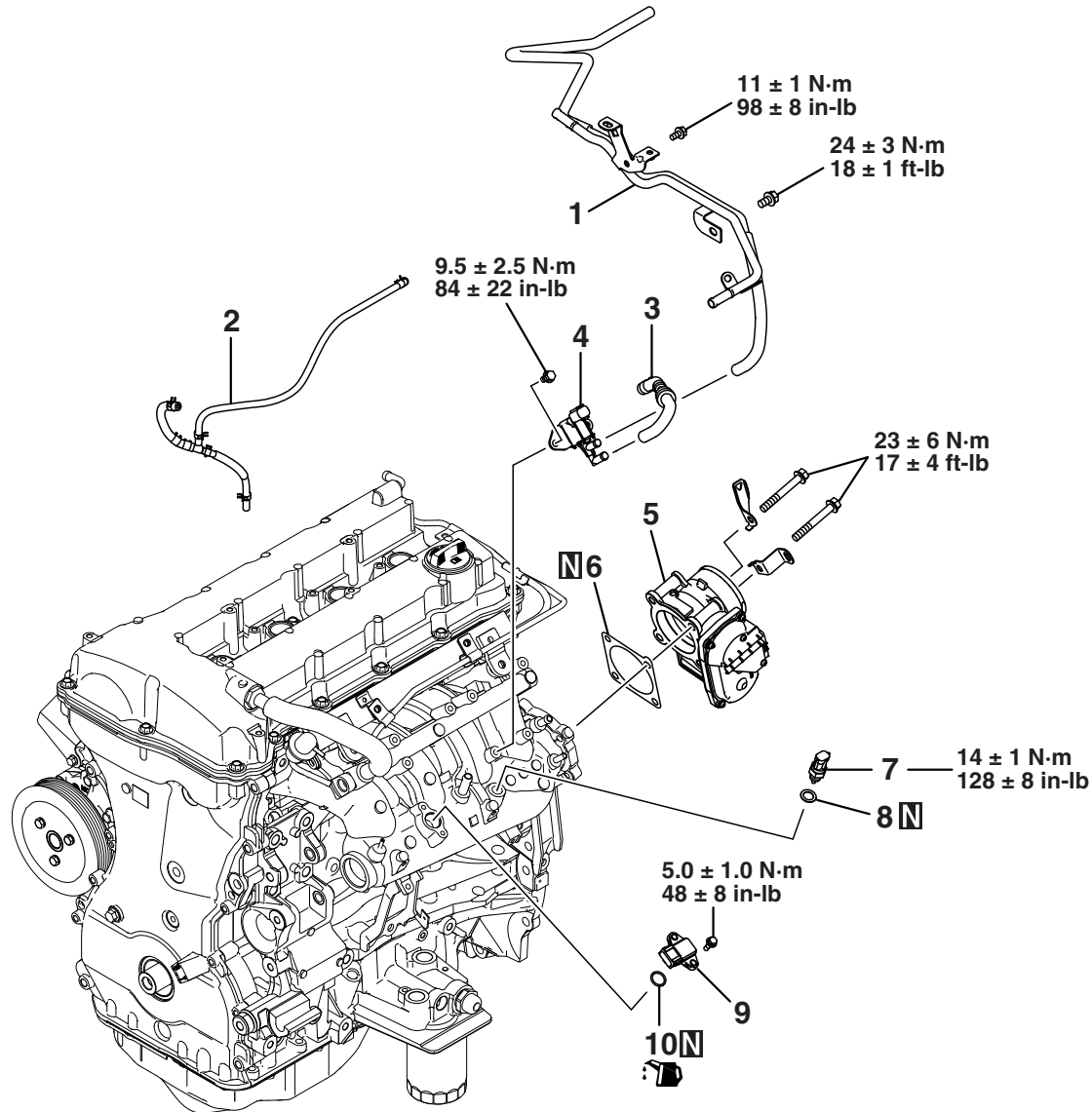
**Generator: 44 ± 10 N·m (32 ± 7 ft-lb)**



# THROTTLE BODY

## REMOVAL AND INSTALLATION

M1113009800154



AK802139AB

### Removal steps

1. Vacuum pipe and hose assembly
2. Vacuum hose
3. Vacuum hose
4. Solenoid valve
5. Throttle body
6. Throttle body gasket

>>B<<

### Removal steps (Continued)

7. Air temperature sensor
8. Gasket
9. Manifold absolute pressure (MAP) sensor
10. O-ring

>>A<<

## INSTALLATION SERVICE POINTS

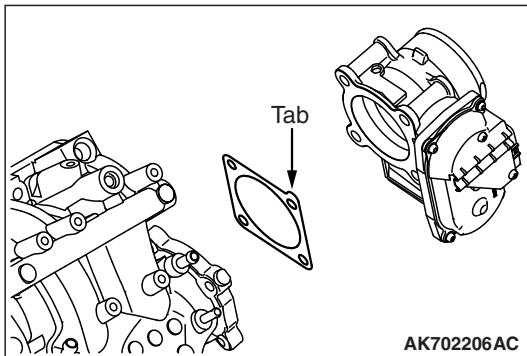
### >>A<< MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR INSTALLATION

**⚠ CAUTION**

- Install the manifold absolute pressure (MAP) sensor, taking care not to give a shock to it.
- Do not use a manifold absolute pressure (MAP) sensor that has been dropped.

### >>B<< THROTTLE BODY GASKET INSTALLATION

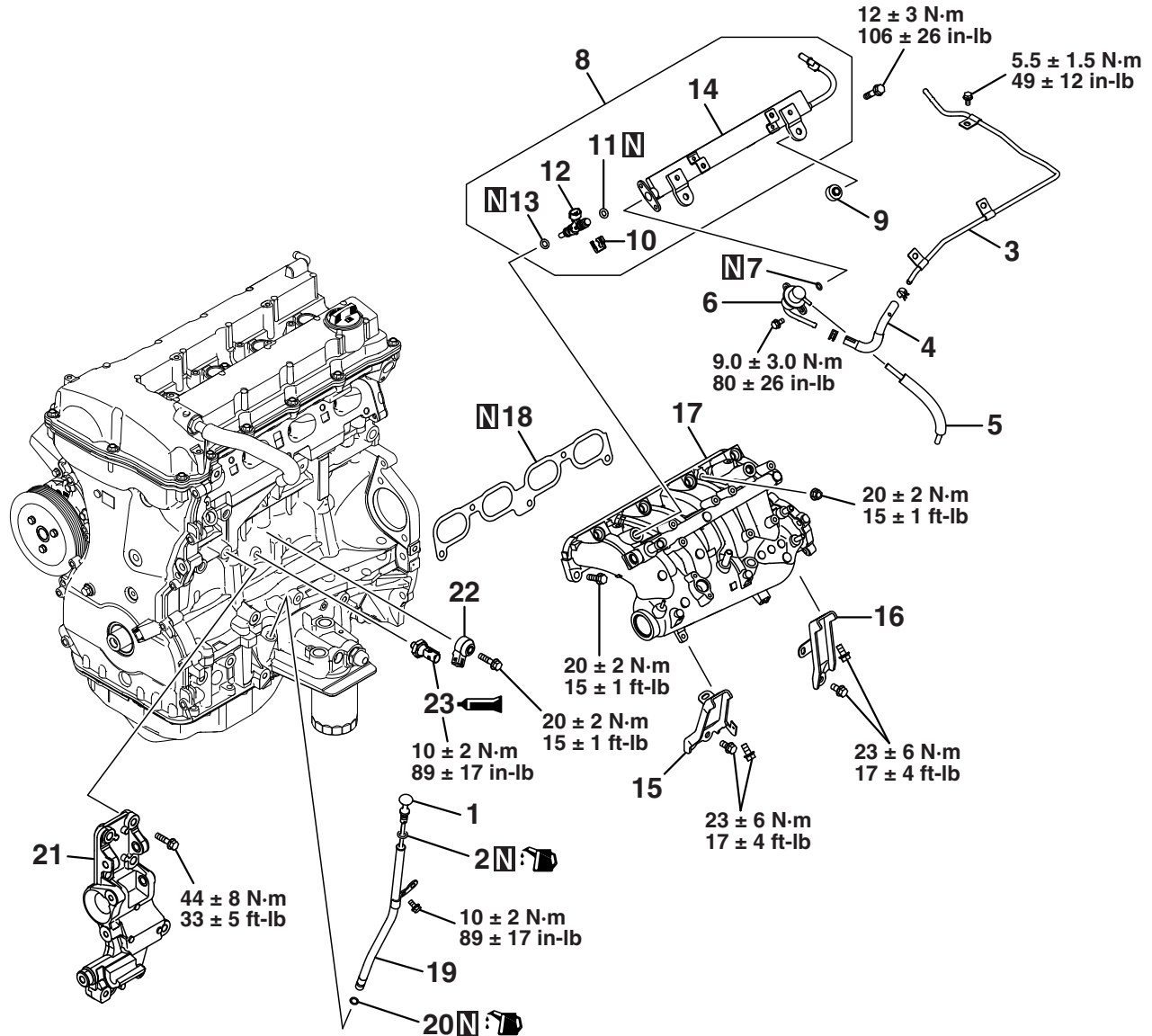
Install a new gasket so that the tab is positioned as shown in the illustration.



# INTAKE MANIFOLD AND FUEL SYSTEM

## REMOVAL AND INSTALLATION

M1113032500809



AK702232AF

### Removal steps

1. Oil dipstick rod
2. O-ring
3. Fuel return pipe
4. Fuel hose
5. Vacuum hose
- >>G<< 6. Fuel pressure regulator
- >>F<< 8. Fuel rail assembly
- >>E<< 9. Insulator
- >>E<< 10. Injection support
- >>E<< 11. O-ring
- >>E<< 12. Injector

### Removal steps (Continued)

- >>D<< 13. O-ring
- >>C<< 14. Fuel rail
- >>C<< 15. Intake manifold stay front
- >>C<< 16. Intake manifold stay rear
- >>C<< 17. Intake manifold
- >>C<< 18. Intake manifold gasket
- >>C<< 19. Oil dipstick guide
- >>C<< 20. O-ring
- >>C<< 21. Generator bracket
- >>B<< 22. Knock sensor
- >>A<< 23. Engine oil pressure switch

### Required Special Tool:

- MB992106: O-ring Installer

## INSTALLATION SERVICE POINTS

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

#### ⚠ CAUTION

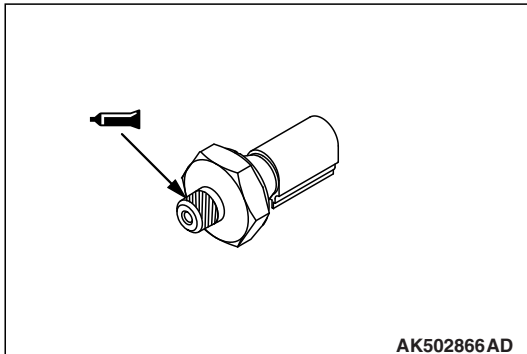
- Do not allow sealant to squeeze out to the screw tip.
- Do not exceed the specified torque.

1. Completely remove sealant adhering to the engine oil pressure switch and cylinder block threaded holes.
2. Apply sealant of 5 mm (0.2 inch) to the threaded portion of the engine oil pressure switch shown in the illustration.

**Specified sealant: Three bond 1212D, Three bond 1215 or equivalent**

3. Tighten the engine oil pressure switch to the cylinder block to the specified torque.

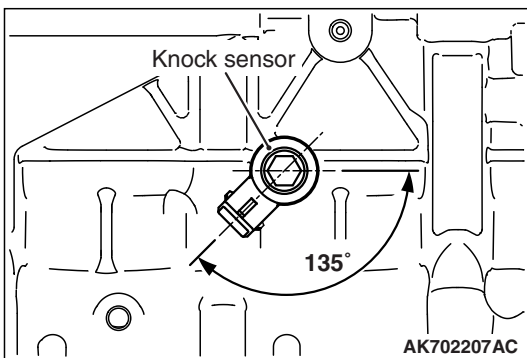
**Tightening torque:  $10 \pm 2$  N·m ( $89 \pm 17$  in-lb)**



### >>B<< KNOCK SENSOR INSTALLATION

Align the knock sensor connector with the position shown in the illustration, and then tighten it to the specified torque.

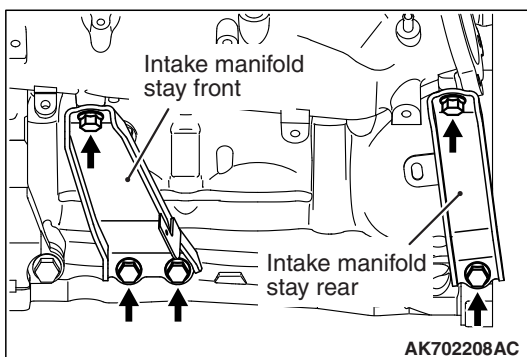
**Tightening torque:  $20 \pm 2$  N·m ( $15 \pm 1$  ft-lb)**

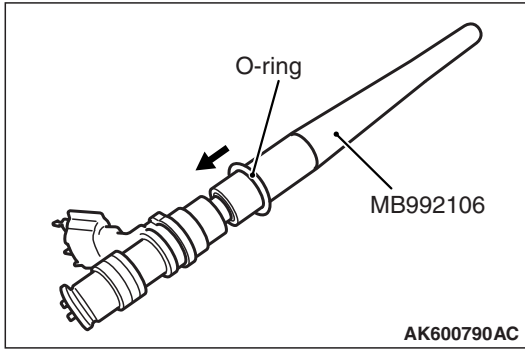


### >>C<< INTAKE MANIFOLD STAY INSTALLATION

Make sure that the intake manifold stay is in intimate contact with the intake manifold and cylinder block boss before tightening it to the specified torque.

**Tightening torque:  $23 \pm 6$  N·m ( $17 \pm 4$  ft-lb)**



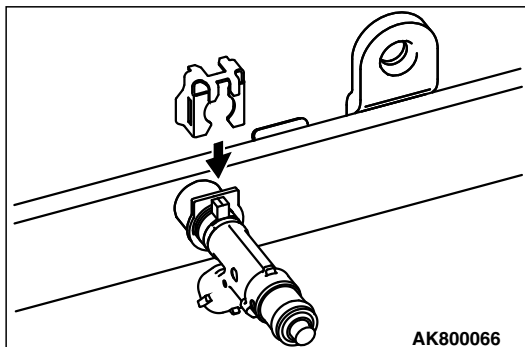
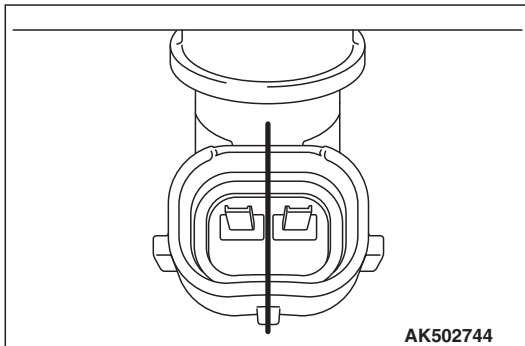
**>>D<< O-RING INSTALLATION**

When inserting an O-ring into the injector on the injection nozzle side, use special tool MB992106 to gradually expand the O-ring, and fit it in place.

**>>E<< INJECTOR / O-RING / INJECTOR SUPPORT INSTALLATION****⚠ CAUTION**

**Do not allow gasoline to enter the fuel rail.**

1. Apply gasoline to the O-ring of the injector.
2. Insert the injector into the fuel rail while rotating the injector from side to side, taking care not to damage the O-ring.
3. Check that the injector rotates smoothly. If it does not rotate smoothly, the O-ring may be caught. Remove the injector and check the O-ring for damage. Then, insert it again into the fuel rail and check.
4. Make sure that the protrusion of the injector is at the center as shown in the illustration.



5. Securely assemble the injector to the injector groove and fuel rail collar.

### >>F<< FUEL RAIL ASSEMBLY INSTALLATION

1. Apply gasoline to the pressure side O-ring of the injector.
2. Tighten the fuel rail assembly to the intake manifold to the specified torque.

**Tightening torque:  $12 \pm 3$  N·m ( $106 \pm 26$  in-lb)**

### >>G<< FUEL PRESSURE REGULATOR INSTALLATION

1. Apply gasoline to the new O-ring.

 **CAUTION**

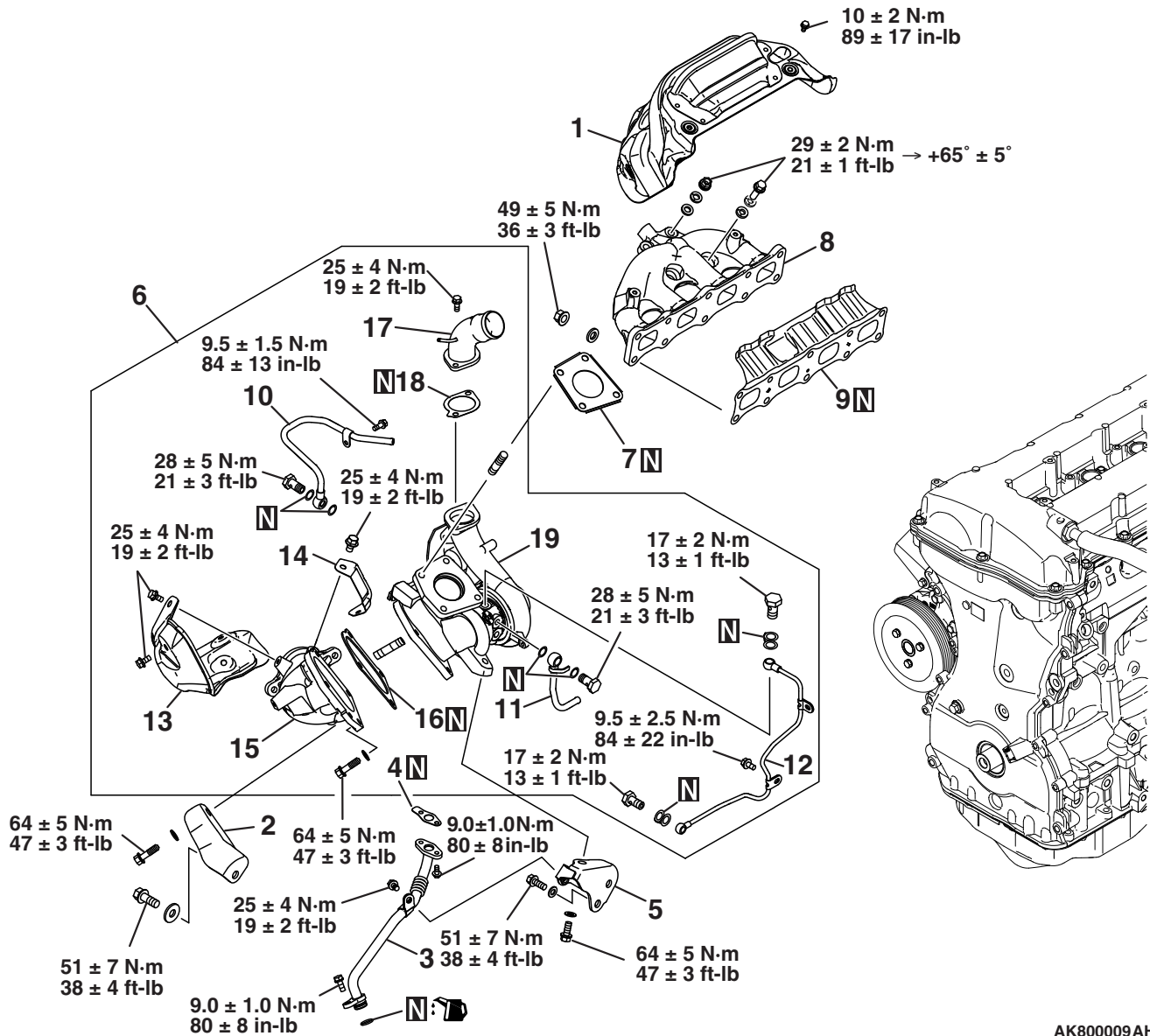
**Do not allow gasoline to enter the fuel rail.**

2. Insert the fuel pressure regulator into the fuel rail while rotating the injector from side to side, taking care not to damage the O-ring.
3. Check that the fuel pressure regulator rotates smoothly. If it does not rotate smoothly, the O-ring may be caught. Remove the fuel pressure regulator and check the O-ring for damage. Then, insert it again into the fuel rail and check.

# EXHAUST MANIFOLD

## REMOVAL AND INSTALLATION

M1113004901814



AK800009AH

### Removal steps

- >>F<< 1. Exhaust manifold cover
- >>E<< 2. Exhaust fitting bracket
- >>D<< 3. Oil return pipe
- >>C<< 4. Oil return pipe gasket
- >>B<< 5. Turbocharger bracket
- >>A<< 6. Turbocharger and pipe assembly
- >>A<< 7. Turbocharger gasket
- >>A<< 8. Exhaust manifold
- >>A<< 9. Exhaust manifold gasket
- >>A<< 10. Water pipe A

### Removal steps (Continued)

- >>B<< 11. Water pipe B
- >>B<< 12. Oil pipe
- >>B<< 13. Exhaust fitting heat protector A
- >>B<< 14. Exhaust fitting heat protector B
- >>B<< 15. Exhaust fitting
- >>B<< 16. Exhaust fitting gasket
- >>B<< 17. Air outlet fitting
- >>B<< 18. Air outlet fitting gasket
- >>B<< 19. Turbocharger

### Required Special Tool:

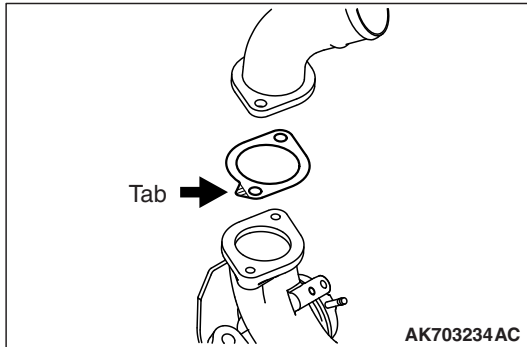
- MB991614: Angle Sensor



## INSTALLATION SERVICE POINTS

### >>A<< AIR OUTLET FITTING GASKET INSTALLATION

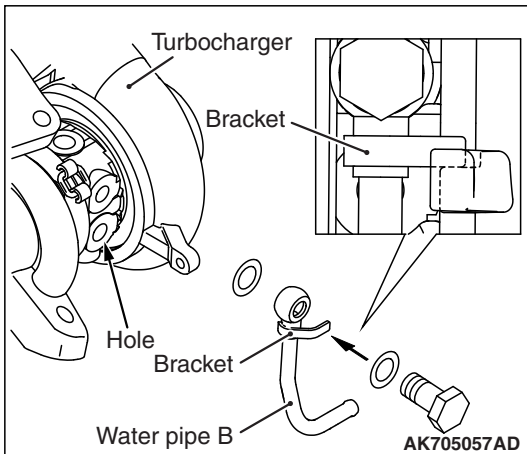
Install a new gasket so that the tab is positioned as shown in the illustration.



### >>B<< WATER PIPE B INSTALLATION

Make sure the bracket of water pipe "B" is inserted into the hole of turbocharger as shown in the illustration, and then install the eye bolt.

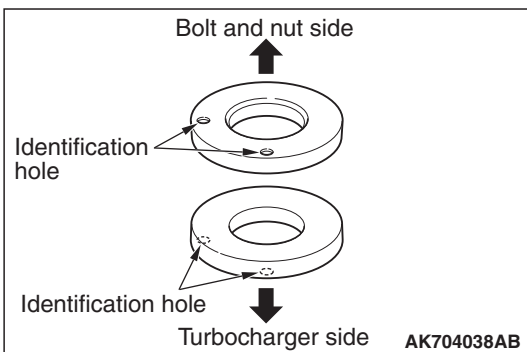
*NOTE: Be sure to install the gasket.*

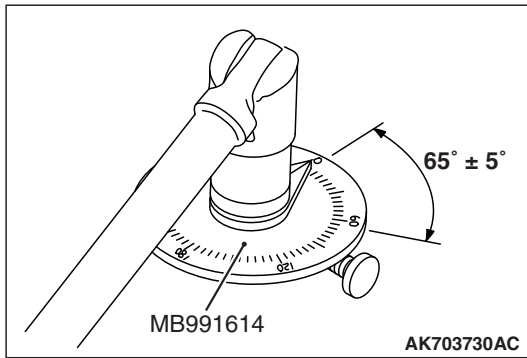


### >>C<< TURBOCHARGER AND PIPE ASSEMBLY INSTALLATION

1. Make sure the identification hole is properly in position as shown in the illustration, and then install the coned disc spring in the appropriate installation direction.
2. Tighten the bolts and nuts to the specified torque.

**Tightening torque:  $29 \pm 2$  N·m ( $21 \pm 1$  ft-lb)**



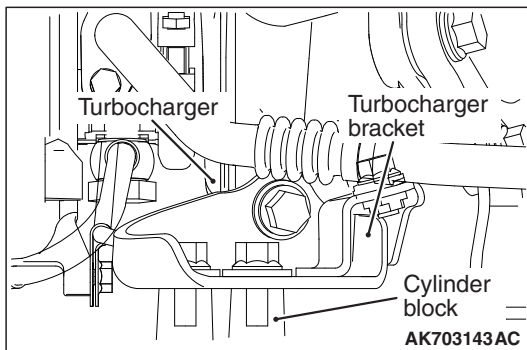


- Use special tool MB991614 to tighten bolts and nuts  $65^\circ \pm 5^\circ$ .

**⚠ 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 and nut to start from the beginning again according to the procedure.

### >>D<< TURBOCHARGER BRACKET INSTALLATION



- After temporarily tightening the turbocharger bracket with the installation bolts, check the exhaust manifold fastens securely to the cylinder block and the turbocharger.

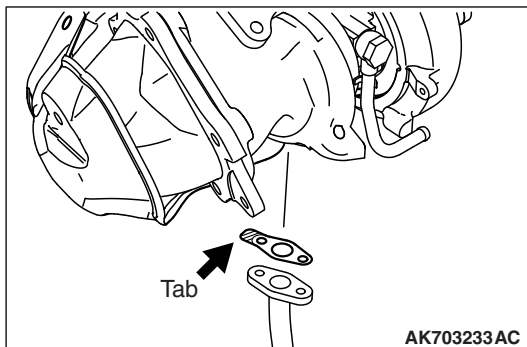
- Tighten the cylinder block side bolt to the specified tightening torque.

**Tightening torque:  $51 \pm 7$  N·m ( $38 \pm 4$  ft-lb)**

- Tighten the turbocharger side bolt to the specified tightening torque.

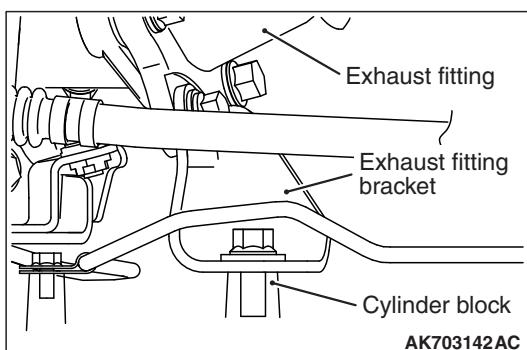
**Tightening torque:  $64 \pm 5$  N·m ( $47 \pm 3$  ft-lb)**

### >>E<< OIL RETURN PIPE GASKET INSTALLATION



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

### >>F<< EXHAUST FITTING BRACKET INSTALLATION



- After temporarily tightening the exhaust fitting bracket with the installation bolts, check the exhaust manifold fastens securely to the cylinder block and the exhaust fitting.

- Tighten the cylinder block side bolt to the specified tightening torque.

**Tightening torque:  $51 \pm 7$  N·m ( $38 \pm 4$  ft-lb)**

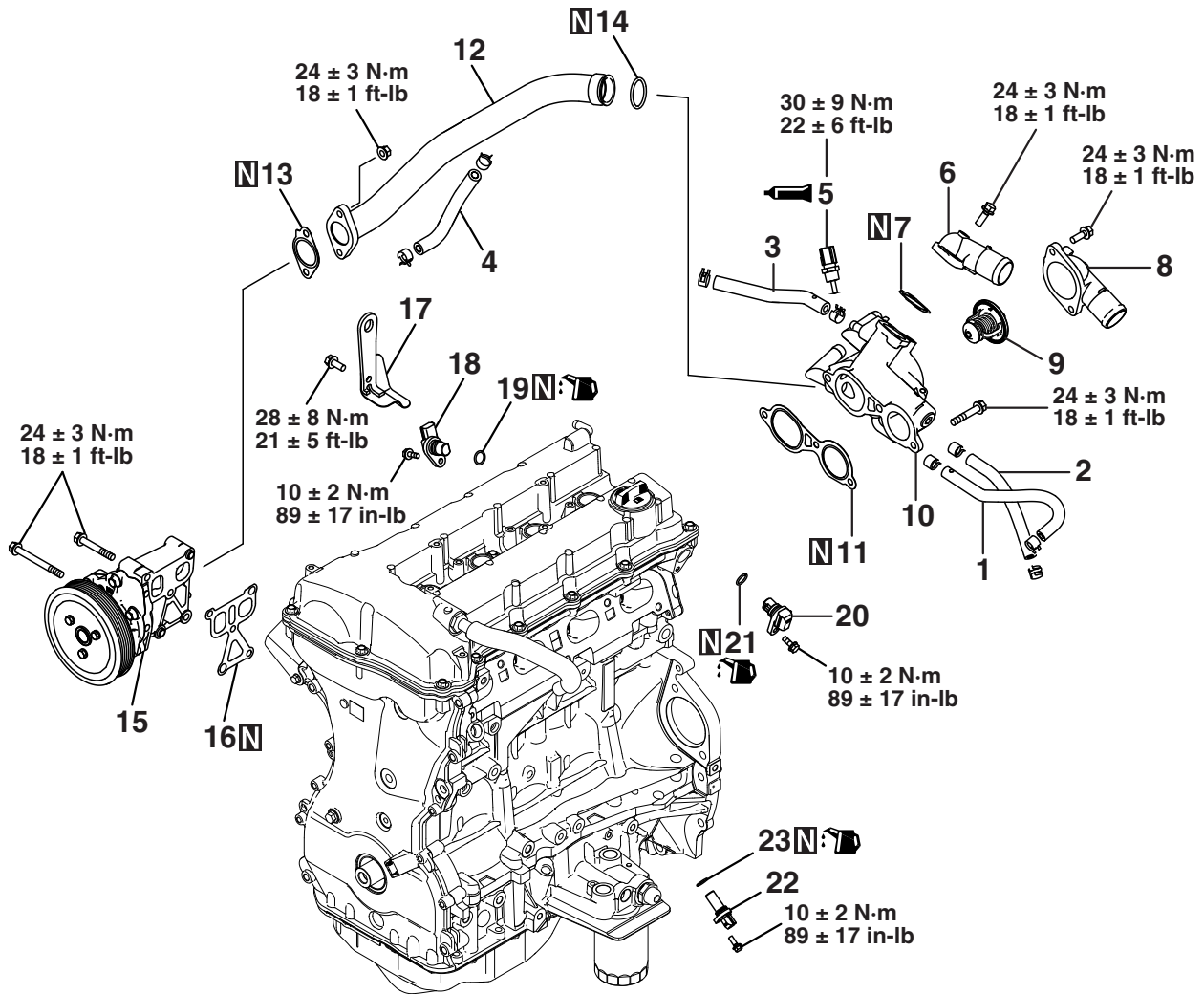
- Tighten the exhaust fitting bracket side bolt to the specified tightening torque.

**Tightening torque:  $64 \pm 5$  N·m ( $47 \pm 3$  ft-lb)**

# WATER HOSE AND PIPE

## REMOVAL AND INSTALLATION

M1113032900465



AK702230 AC

### Removal steps

1. Water hose
2. Water hose
3. Water hose
4. Water hose
- >>E<< 5. Engine coolant temperature sensor
- >>D<< 6. Water outlet fitting
- >>D<< 7. Water outlet fitting gasket
- >>C<< 8. Water inlet fitting
- >>C<< 9. Thermostat
- >>B<< 10. Thermostat housing
- >>B<< 11. Thermostat housing gasket
- >>B<< 12. Water pipe assembly

### Removal steps (Continued)

- >>B<< 13. Water pipe gasket
14. O-ring
15. Water pump assembly
16. Water pump gasket
17. Engine hanger
18. Intake camshaft position sensor
19. O-ring
20. Exhaust camshaft position sensor
21. O-ring
- >>A<< 22. Crankshaft position sensor
23. O-ring

## INSTALLATION SERVICE POINTS

>>A<< CRANKSHAFT POSITION SENSOR  
INSTALLATION**⚠ CAUTION**

- Do not apply a force such as torsion or twist to the O-ring during assembly of the sensor.
- Assemble the sensor, taking care not to give a shock to it.
- Do not use a sensor that has been dropped.

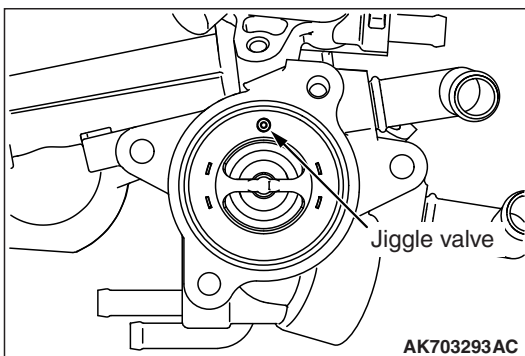
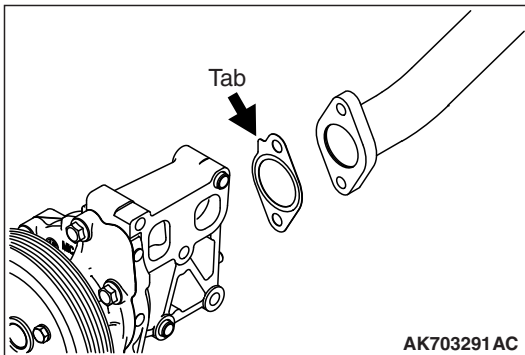
Tighten the crankshaft position sensor to the specified torque.

**Tightening torque:  $10 \pm 2$  N·m ( $89 \pm 17$  in-lb)**

>>B<< THERMOSTAT HOUSING / WATER PIPE  
ASSEMBLY / WATER PIPE GASKET  
INSTALLATION

1. Assemble the thermostat housing and water pipe
2. Install the thermostat housing gasket.
3. Install a new water pipe gasket so that the tab is positioned as shown in the illustration.
4. Temporarily tighten them to the cylinder head and water pump. Then tighten them to the specified torque.

**Tightening torque:  $24 \pm 3$  N·m ( $18 \pm 1$  ft-lb)**

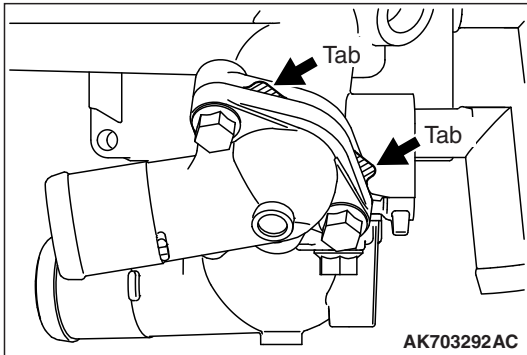


## &gt;&gt;C&lt;&lt; THERMOSTAT INSTALLATION

Install the thermostat with the jiggle valve facing almost straight upwards.

### >>D<< WATER OUTLET FITTING GASKET INSTALLATION

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



### >>E<< ENGINE COOLANT TEMPERATURE SENSOR INSTALLATION

#### **⚠ CAUTION**

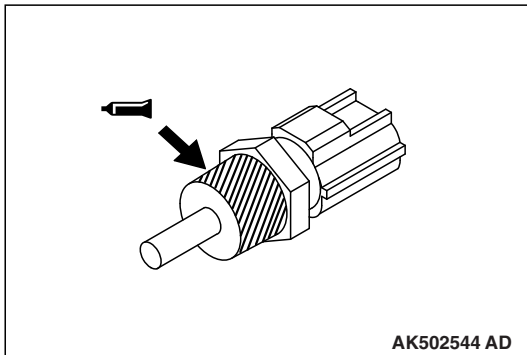
Be careful not to give a shock, twist and the like to the resin mold with a tool during installation.

1. Apply an appropriate and minimum amount of sealant to the engine coolant temperature sensor, taking care not to allow sealant to squeeze out.

**Three bond 1324N, LOCKTITE 262 or equivalent**

2. Tighten the engine coolant temperature sensor to the cylinder block to the specified torque.

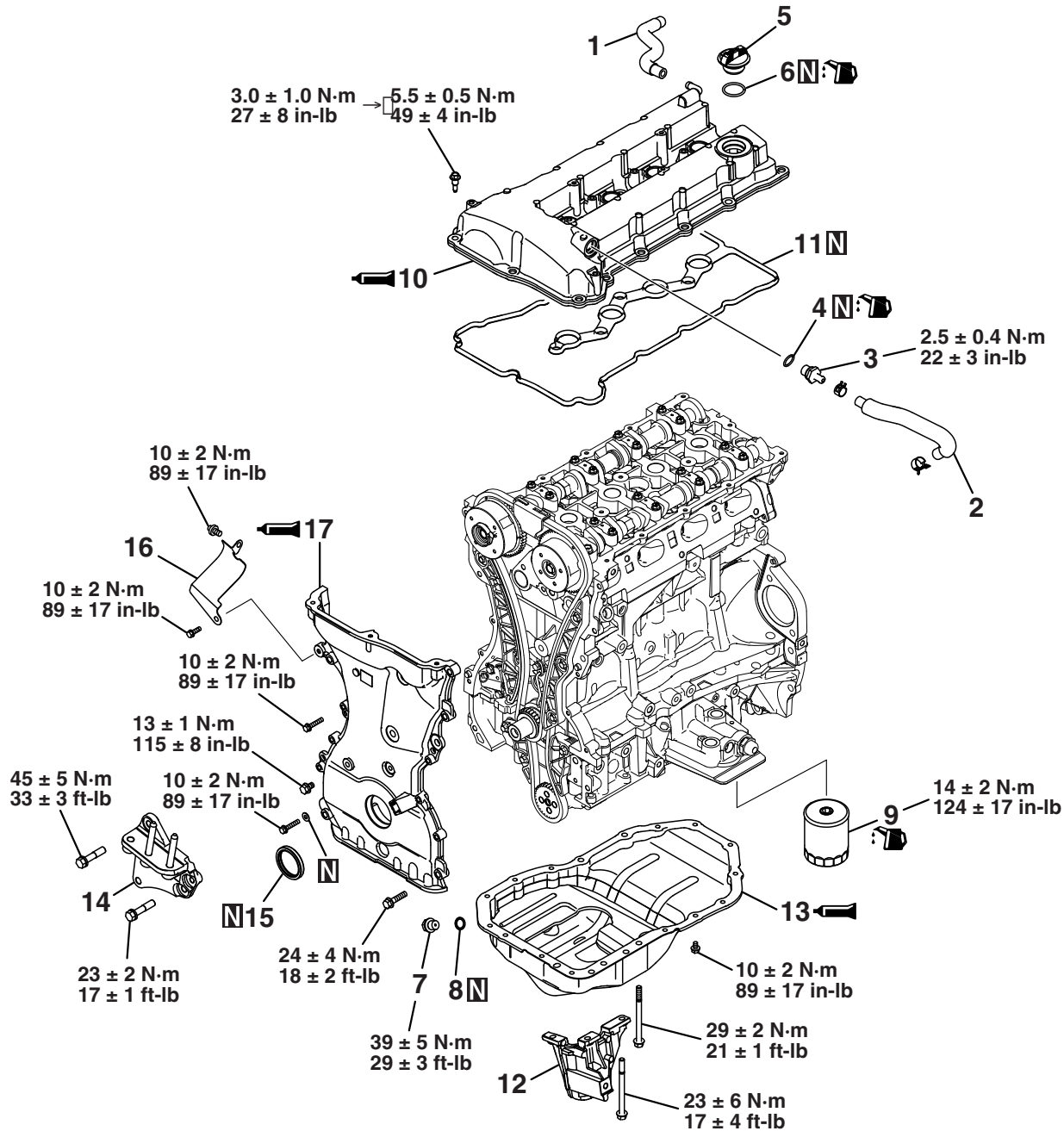
**Tightening torque:  $30 \pm 9 \text{ N} \cdot \text{m}$  ( $22 \pm 6 \text{ ft-lb}$ )**



# OIL PAN AND TIMING CHAIN CASE

## REMOVAL AND INSTALLATION

M1113026301199



AK800549AB

### Removal steps

1. Breather hose
2. PCV hose
3. PCV valve
4. O-ring
5. Oil filler cap
6. O-ring
7. Oil drain plug
8. Oil drain plug gasket
9. Oil filter

<<A>> >>E<<

### Removal steps (Continued)

- |             |   |
|-------------|---|
| >>D<<       | 10. Cylinder head cover                     |
| >>D<<       | 11. Cylinder head cover gasket              |
| >>D<<       | 12. Air compressor bracket                  |
| <<B>> >>C<< | 13. Oil pan                                 |
| <<B>> >>C<< | 14. Engine support bracket                  |
| >>B<<       | 15. Front oil seal                          |
| >>B<<       | 16. Engine oil control valve heat protector |
| <<C>> >>A<< | 17. Timing chain case                       |

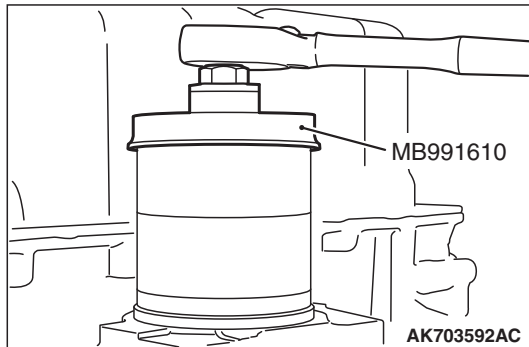
**Required Special Tools:**

- MB991610: Oil Filter Wrench
- MD998727: Oil Pan FIPG Cutter
- MB991448: Bush Remover And Installer Base

**REMOVAL SERVICE POINTS**

**<<A>> OIL FILTER REMOVAL**

Use special tool MB991610 to remove the oil filter.

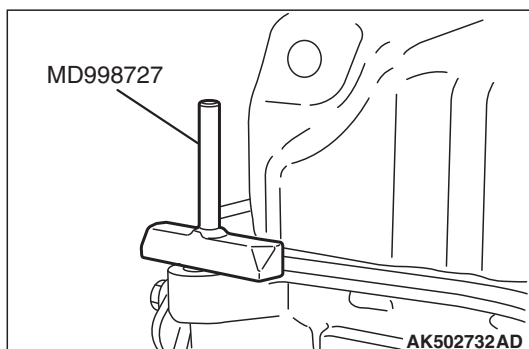
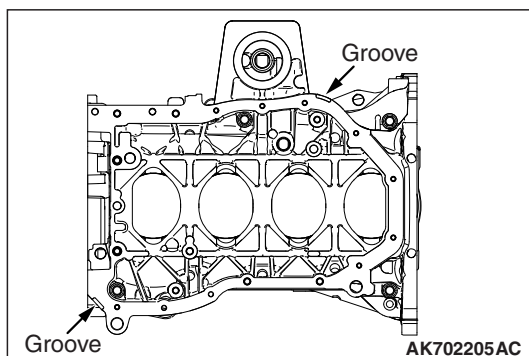


**<<B>> OIL PAN REMOVAL**

1. Remove oil pan tightening bolts.

**⚠ CAUTION**

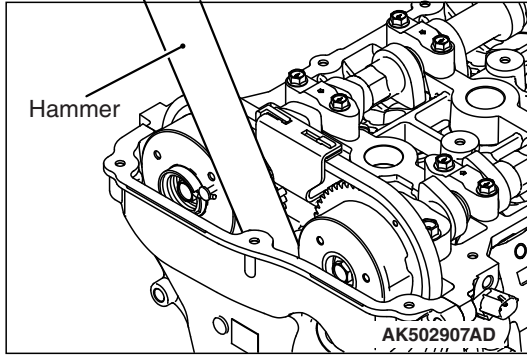
- Lightly tap the oil pan FIPG cutter to drive in, taking care not to damage the ladder frame and oil pan sealed area.
2. Lightly tap special tool MD998727 to drive in the illustrated groove of the oil pan and ladder frame.



3. Lightly tap and slide special tool MD998727 to remove the oil pan.

<<C>> TIMING CHAIN CASE REMOVAL

If the timing chain case is difficult to remove, insert a hammer handle as shown in the illustration and lightly pry it.

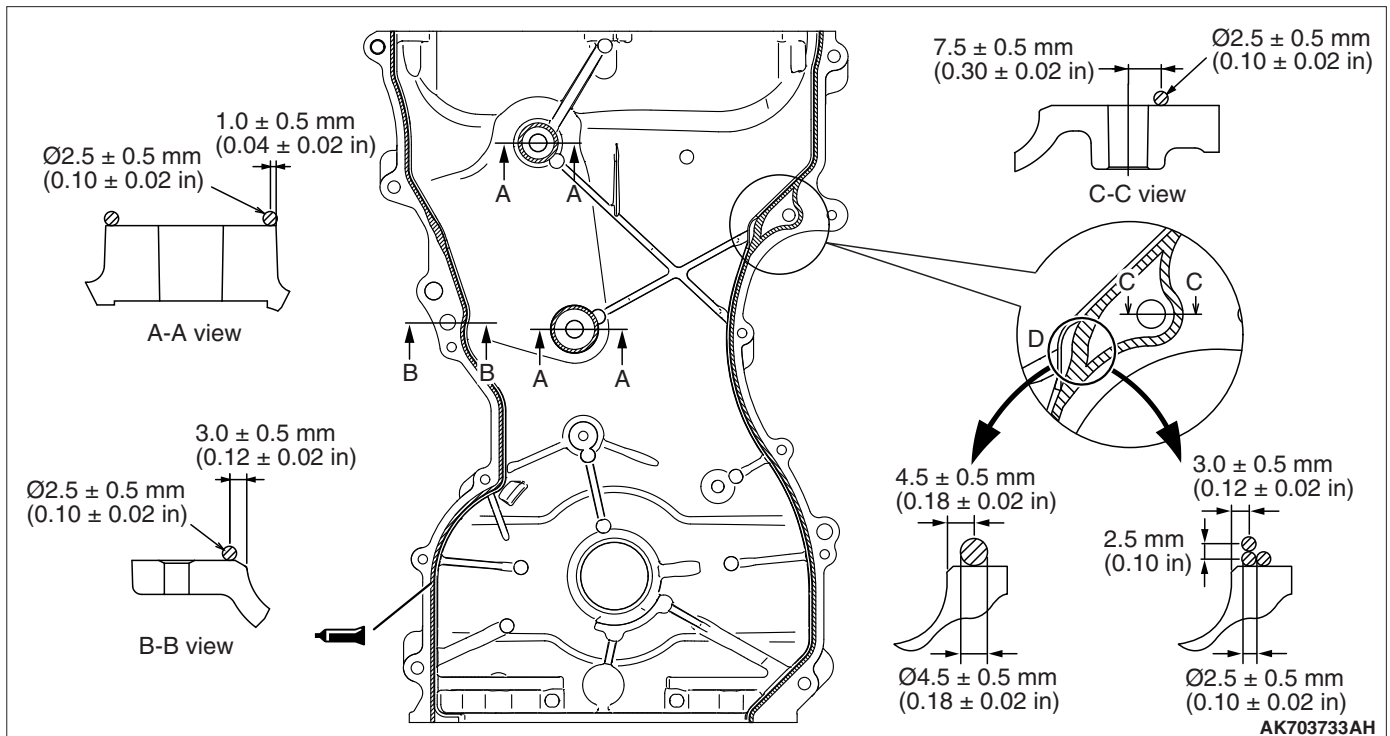


INSTALLATION SERVICE POINTS

>>A<< TIMING CHAIN CASE INSTALLATION

**CAUTION**

- Completely remove all the old liquid gasket, which might be remaining in the installation hole, the O-ring groove or among the components such as the cylinder head gasket.
  - Sufficiently check that there is no residual oil on the place where degreasing is performed. If fingerprints are left, do not touch it with bare hands after the degreasing, since the oils from your fingers will harm the seal ability.
1. Completely remove liquid gasket adhering to the timing chain case, cylinder block and cylinder head.
  2. Degrease the surface where the liquid gasket is applied and the contact surface between the cylinder block and the cylinder head.





**⚠ CAUTION**

**Install the timing chain case within three minutes after applying liquid gasket.**

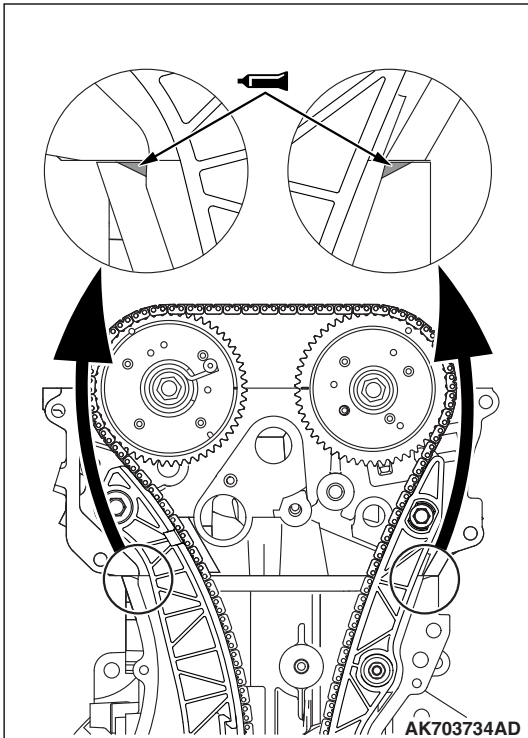
3. Apply liquid gasket of  $2.5 \pm 0.5$  mm ( $0.10 \pm 0.02$  inch) in thickness to the timing chain case. For illustrated A locations, however, apply liquid gasket of  $4.5 \pm 0.5$  mm ( $0.18 \pm 0.02$  inch) in diameter or liquid gasket of  $2.5 \pm 0.5$  mm ( $0.10 \pm 0.02$  inch) by putting one on top of another as shown in the illustration.

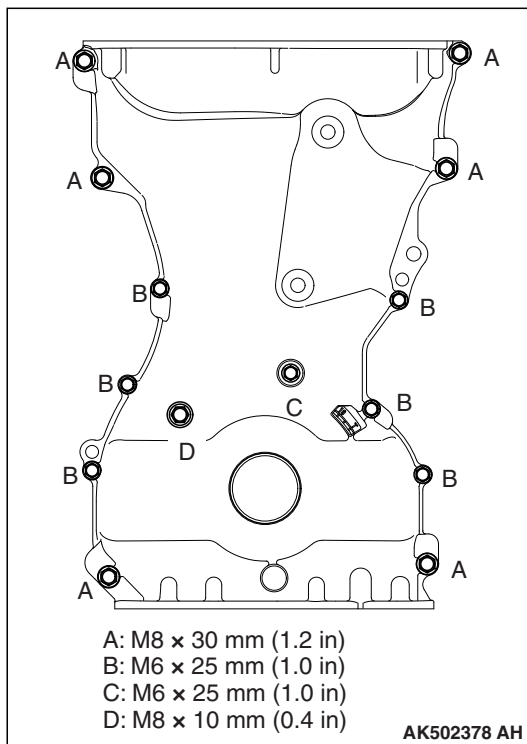
**Specified sealant: Three bond 1217G or exact equivalent**

4. Completely remove the sealant remaining on the gasket which is the three-plane mating surface between the cylinder head and the cylinder block. Degrease them.
5. The engine oil remaining at the cylinder gasket overflows from the three-plane mating surface described in Section 4. Apply the liquid gasket to this area as soon as grease is removed.

**Specified sealant: Three bond 1217G or exact equivalent**

6. Install the timing chain case.





- Tighten timing chain case mounting bolts to the specified torque.

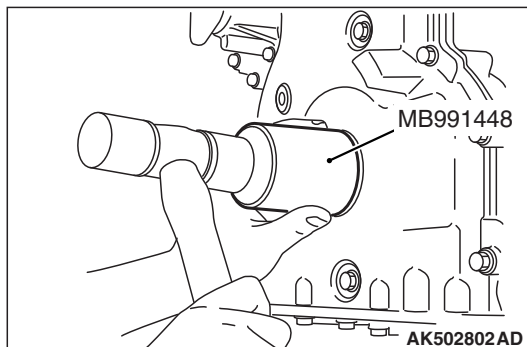
*NOTE: Be careful when install mounting bolts as they are different in length.*

**Tightening torque:**

- A:  $24 \pm 4$  N·m ( $18 \pm 2$  ft-lb)**  
**B:  $10 \pm 2$  N·m ( $89 \pm 17$  in-lb)**  
**C:  $10 \pm 2$  N·m ( $89 \pm 17$  in-lb)**  
**D:  $13 \pm 1$  N·m ( $115 \pm 8$  in-lb)**

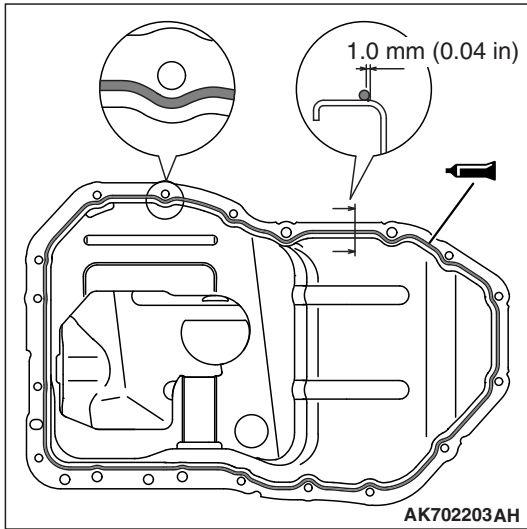
**>>B<< FRONT OIL SEAL INSTALLATION**

- Apply engine oil to the internal circumference of the oil seal.
- Use special tool MB991448 to install the front oil seal on the timing chain case.



**>>C<< OIL PAN INSTALLATION**

- Completely remove liquid gasket adhering to the cylinder block and oil pan.
- Degrease the cylinder block and oil pan.



**⚠ CAUTION**

Install the oil pan within three minutes after liquid gasket is applied.

3. Apply liquid gasket of  $\phi 2.5 \pm 0.5$  mm ( $0.10 \pm 0.02$  inch) of thickness in diameter to the illustrated area of the oil pan.

**Specified sealant: Three bond 1217G or exact equivalent**

4. Tighten the oil pan to the specified torque.

**Tightening torque:**

**M6:  $10 \pm 2$  N·m ( $89 \pm 17$  in-lb)**

**M8:  $29 \pm 2$  N·m ( $21 \pm 1$  ft-lb)**

**>>D<< CYLINDER HEAD COVER INSTALLATION**

1. Completely remove liquid gasket adhering to the cylinder head cover, timing chain case and cylinder head.
2. Degrease the cylinder head cover, timing chain case and cylinder head.

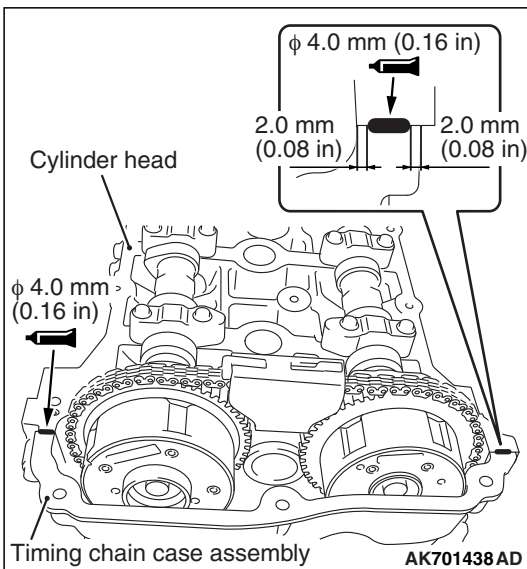
**⚠ CAUTION**

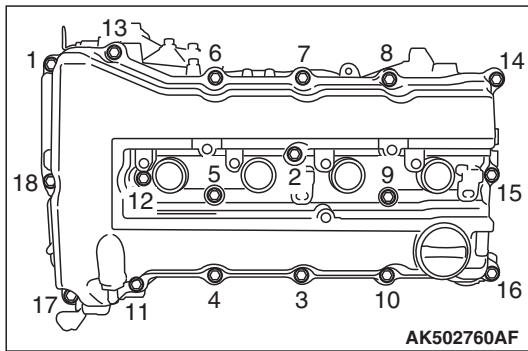
Install the cylinder head cover immediately after liquid gasket is applied.

3. Appropriately use a minimum amount of sealant. Be careful not to allow sealant to squeeze out from the application area.

Apply liquid gasket of 4.0 mm (0.16 inch) of thickness in diameter.

**Specified sealant: Three bond 1217G or exact equivalent**



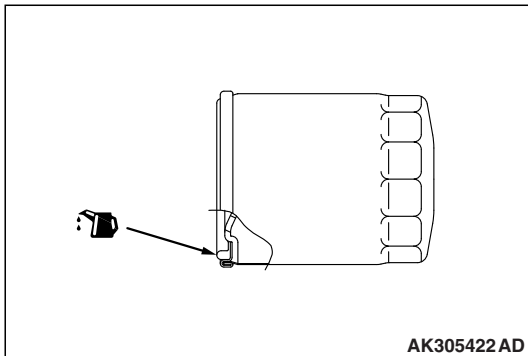


4. Tighten the cylinder head cover to the specified torque in the order shown in the illustration.

**Tightening torque:  $3.0 \pm 1.0 \text{ N} \cdot \text{m}$  ( $27 \pm 8 \text{ in-lb}$ )**

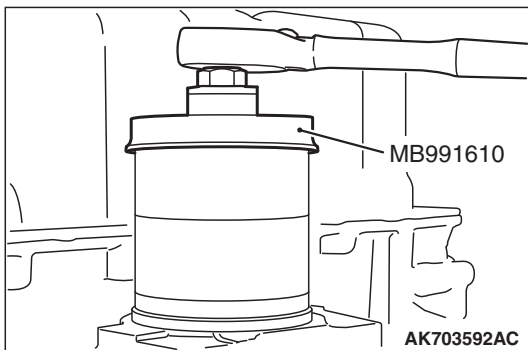
5. Then, tighten it to the specified torque in the same order.

**Tightening torque:  $5.5 \pm 0.5 \text{ N} \cdot \text{m}$  ( $49 \pm 4 \text{ in-lb}$ )**



### >>E<< OIL FILTER INSTALLATION

1. Clean the oil filter mounting surface of the ladder frame.
2. Apply engine oil to the O-ring of the oil filter.



#### **CAUTION**

**Use special tool MB991610 to install the oil filter. Tightening it by hand causes oil leakage due to lack of torque.**

3. Screw in the oil filter. When the O-ring contacts the mounting surface, use a filter wrench to tighten it specified torque.

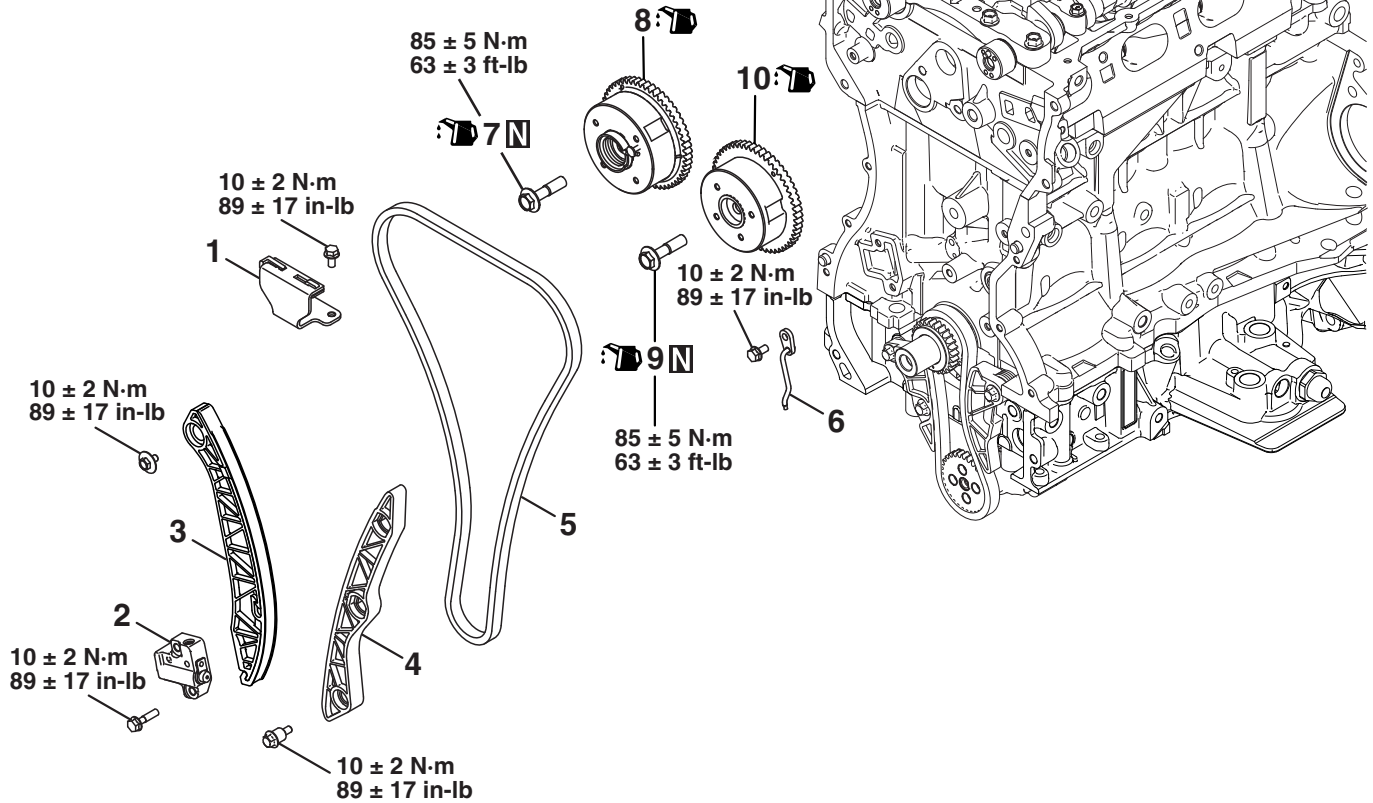
**Tightening torque:  $3/4 \text{ turn}$  ( $14 \pm 2 \text{ N} \cdot \text{m}$  [ $124 \pm 17 \text{ in-lb}$ ])**

# TIMING CHAIN

## REMOVAL AND INSTALLATION

M1113026600863

Apply engine oil to all moving parts before installation.



AK702228 AC

### Removal steps

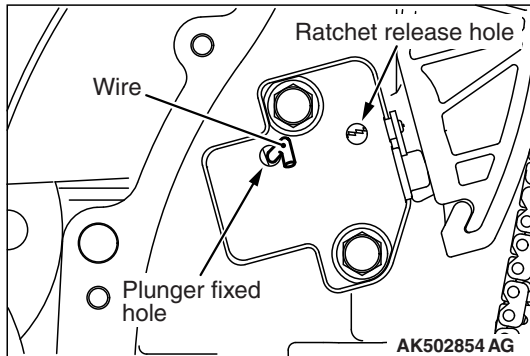
- <<A>> >>D<<  
>>C<<
1. Chain upper guide
  2. Timing chain tensioner
  3. Tensioner lever
  4. Timing chain guide
  5. Timing chain

### Removal steps (Continued)

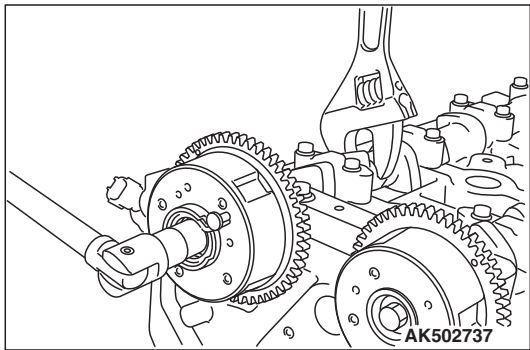
- <<B>> >>B<<  
<<C>> >>A<<
6. Chain oil jet
  7. Exhaust V.V.T. sprocket bolt
  8. Exhaust V.V.T. sprocket assembly
  9. Intake V.V.T. sprocket bolt
  10. Intake V.V.T. sprocket assembly

**REMOVAL SERVICE POINTS****<<A>> TIMING CHAIN TENSIONER REMOVAL**

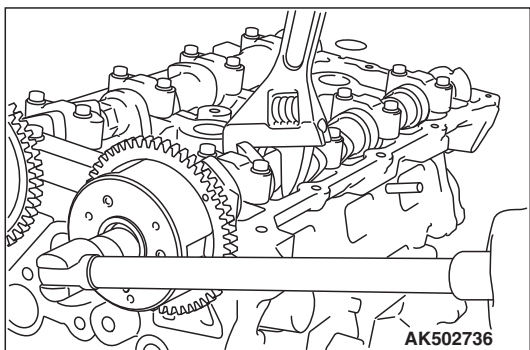
1. Insert a flatblade screwdriver into the release hole of the timing chain tensioner to release the latch.
2. Push the tensioner lever by hand and push in the plunger of the timing chain tensioner until it hits the bottom. Then, insert a hard wire (piano wire or the like) of  $\phi 1.5$  or hexagonal bar wrench (1.5 mm [0.05 inch]) into the fixing hole of the plunger.
3. Remove the timing chain tensioner.

**<<B>> EXHAUST V.V.T. SPROCKET BOLT REMOVAL**

Hold the hexagonal portion of the exhaust camshaft with a wrench and loosen the exhaust V.V.T. sprocket bolt.

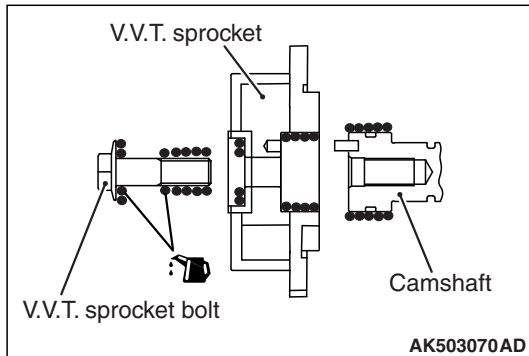
**<<C>> INTAKE V.V.T. SPROCKET BOLT REMOVAL**

Hold the hexagonal portion of the intake camshaft with a wrench and loosen the intake V.V.T. sprocket bolt.



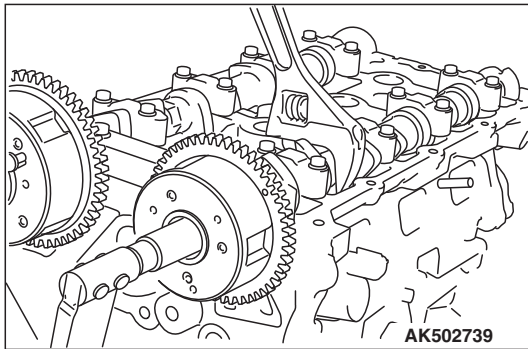
## INSTALLATION SERVICE POINTS

### >>A<< INTAKE V.V.T. SPROCKET BOLT INSTALLATION



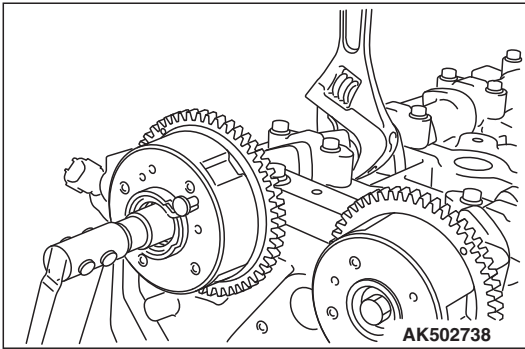
1. Assemble the intake V.V.T. sprocket assembly in the following procedure.
  - Make sure that the knock pin of the inlet camshaft assembly is positioned facing straight upward.
  - Apply an appropriate and minimum amount of engine oil to the circumference of the tip of the intake V.V.T. sprocket assembly and the entire circumference of the area into which the intake V.V.T. sprocket assembly is inserted.
  - Slowly insert the intake V.V.T. sprocket assembly into the normal position of the inlet camshaft assembly with its knock pin hole facing straight upward.
2. Install the V.V.T. sprocket.
3. Make sure that the V.V.T. sprocket is securely inserted into the bottom and that the V.V.T. sprocket does not rotate with the hexagonal portion of the camshaft secured with a wrench.
4. Hold the hexagonal portion of the camshaft with a wrench and tighten the intake V.V.T. sprocket bolt to the specified torque.

**Tightening torque: 85 ± 5 N·m (63 ± 3 ft-lb)**



### >>B<< EXHAUST V.V.T. SPROCKET BOLT INSTALLATION

1. Assemble the exhaust V.V.T. sprocket assembly in the following procedure.
  - Make sure that the knock pin of the exhaust camshaft assembly is positioned facing straight upward.
  - Apply an appropriate and minimum amount of engine oil to the circumference of the tip of the exhaust V.V.T. sprocket assembly and the entire circumference of the area into which the exhaust V.V.T. sprocket assembly is inserted.
  - Slowly insert the exhaust V.V.T. sprocket assembly into the normal position of the exhaust camshaft assembly with its knock pin hole facing straight upward.
2. Install the V.V.T. sprocket.
3. Make sure that the V.V.T. sprocket is securely inserted into the bottom and that the V.V.T. sprocket does not rotate with the hexagonal portion of the camshaft secured with a wrench.

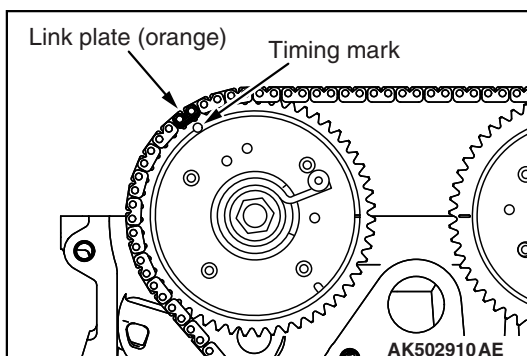
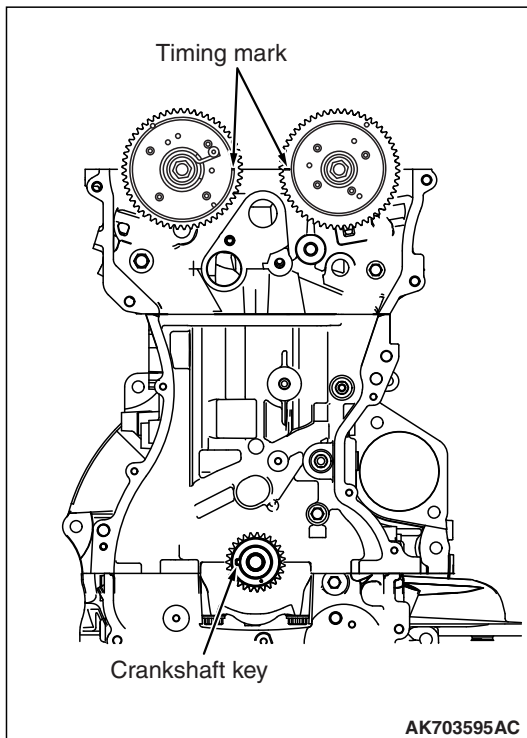


4. Hold the hexagonal portion of the camshaft with a wrench and tighten the camshaft sprocket bolt to the specified torque.

**Tightening torque:  $85 \pm 5$  N·m ( $63 \pm 3$  ft-lb)**

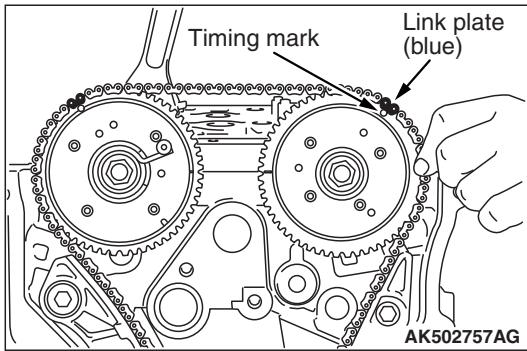
### >>C<< TIMING CHAIN INSTALLATION

1. Align the timing mark of the V.V.T. sprocket.
2. Align the crankshaft sprocket key with illustrated positions.

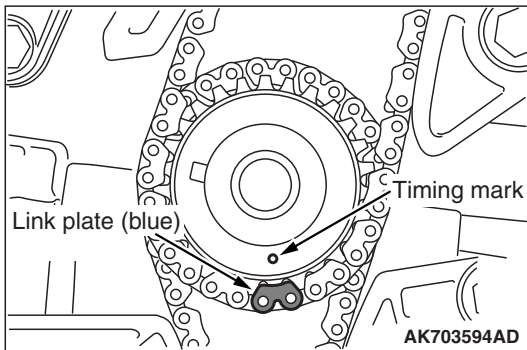


3. Align the link plate (orange) with the timing mark of the exhaust V.V.T. sprocket and loop the timing chain.

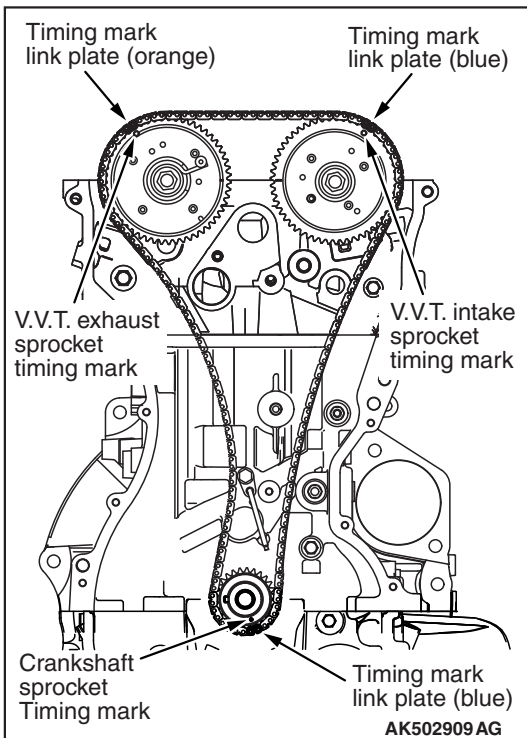




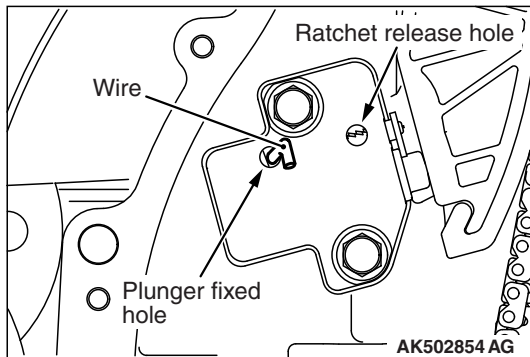
4. Align the link plate (blue) with the timing mark of the intake V.V.T. sprocket to loop the timing chain.  
Rotate the intake V.V.T. sprocket by one or two teeth to align with the timing mark.



5. Align the timing mark of the crankshaft sprocket with the link plate (blue) to loop the timing chain. Because of timing chain slacks, hold it to prevent the timing mark from coming off the link plate.



6. Make sure that the timing mark of each sprocket is aligned with the link plate of the timing chain at all of three locations.
7. Install the timing chain guide and tensioner lever.



## >>D<< TIMING CHAIN TENSIONER INSTALLATION

1. Install the timing chain tensioner on the cylinder block and tighten it to the specified torque.

**Tightening torque:  $10 \pm 2 \text{ N} \cdot \text{m}$  ( $89 \pm 17 \text{ in-lb}$ )**

2. Remove the hard wire (piano wire or the like) of  $\phi 1.5$  or hexagonal bar wrench (1.5 mm [0.05 inch]) from the timing chain tensioner. This enables the plunger of the timing chain tensioner to push the tensioner lever to keep the timing chain tight.

## INSPECTION

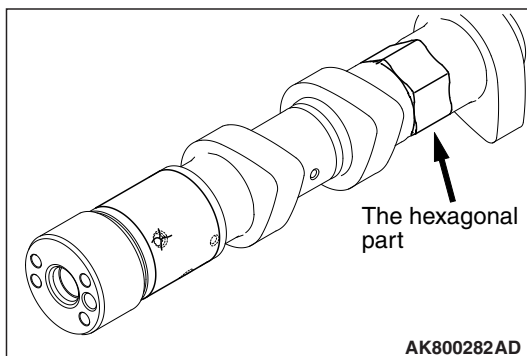
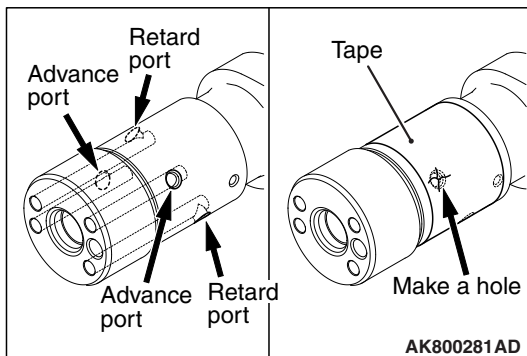
M1113026700967

### INTAKE V.V.T. SPROCKET

#### **CAUTION**

**Never overhaul the V.V.T. sprocket.**

1. Seal with a tape all the intake camshaft ports for the advanced angle and the retarded angle.
2. Make a hole on the port for the advanced angle.



#### **CAUTION**

**Fix the camshaft on a vise not to damage it.**

3. Fixing the hexagonal area of the intake camshaft on a vise, install the intake V.V.T. sprocket.

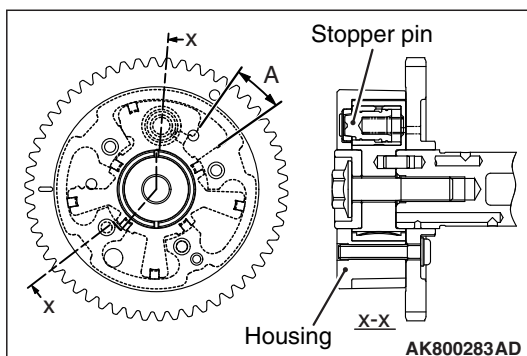
#### **CAUTION**

**When applying air pressure, keep in mind that oil could splash.**

4. By applying air pressure slowly to the holed port for the advanced angle, remove the stopper pin.
5. Turn the intake V.V.T. sprocket housing in the right and left directions. Check it smoothly moves in the range of A (approximately  $12.5^\circ$ )

*NOTE: The stopper pin is locked in the most retarded angle position.*

6. After the check, remove the intake V.V.T. sprocket from the intake camshaft



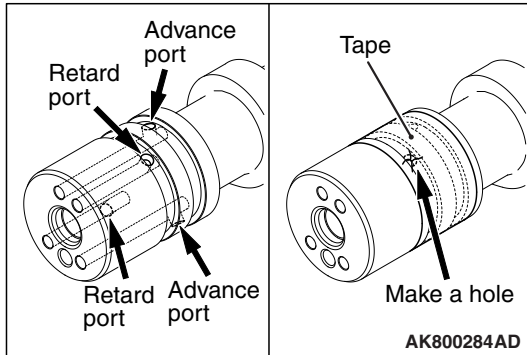
7. Completely remove the tape sealing the intake camshaft ports for the advanced angle and for the retarded angle.

## EXHAUST V.V.T. SPROCKET

### ⚠ CAUTION

Never overhaul the V.V.T. sprocket.

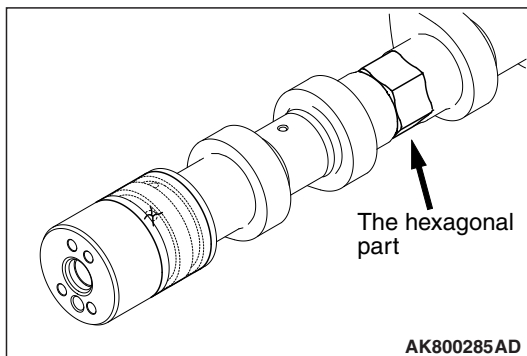
1. Seal with a tape all the exhaust camshaft ports for the advanced angle and the retarded angle.
2. Make a hole on the port for the retarded angle.



### ⚠ CAUTION

Fix the camshaft on a vise not to damage it.

3. Fixing the hexagonal area of the exhaust camshaft on a vise, install the exhaust V.V.T. sprocket.



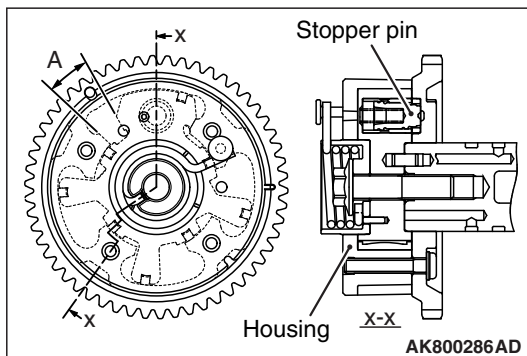
### ⚠ CAUTION

When applying air pressure, keep in mind that oil could splash.

4. By applying air pressure slowly to the holed port for the retarded angle, remove the stopper pin.
5. Turn the exhaust V.V.T. sprocket housing in the right and left directions. Check it smoothly moves in the range of A (approximately 17.5°)

*NOTE: The stopper pin is locked in the most advanced angle position.*

6. After the check, remove the exhaust V.V.T. sprocket from the exhaust camshaft
7. Completely remove the tape sealing the exhaust camshaft ports for the advanced angle and for the retarded angle.



**VALVE CLEARANCE ADJUSTMENT**

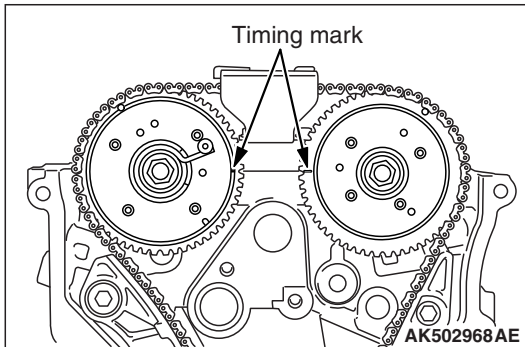
Measure valve clearance as described in the following procedure.

Check and adjust the valve clearance with the timing chain installed.

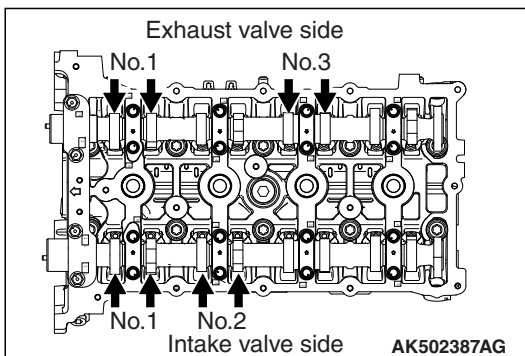
**⚠ CAUTION**

**Always rotate the crankshaft clockwise.**

1. Rotate the crankshaft clockwise to align the timing mark of the V.V.T. sprocket with the top surface of the cylinder head as illustrated. (Set the No. 1 piston at top dead center on the compression stroke.)



2. Valve clearance can be measured at the illustrated location in this condition.



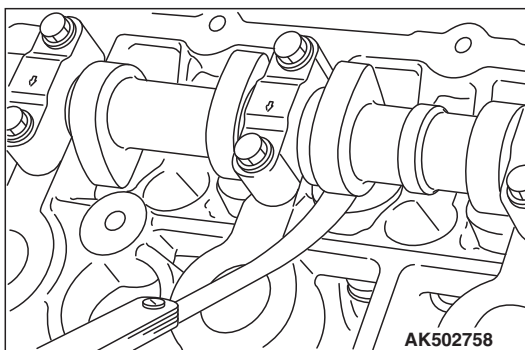
3. Use a thickness gauge to measure clearance between the camshaft and valve tappet.

**Standard value (when engine is cold)**

**Intake side:  $0.20 \pm 0.03$  mm ( $0.008 \pm 0.001$  inch)**

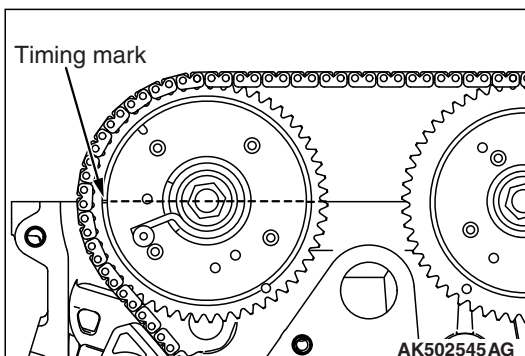
**Exhaust side:  $0.30 \pm 0.03$  mm ( $0.012 \pm 0.001$  inch)**

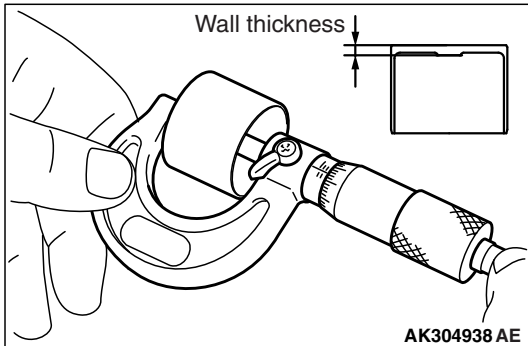
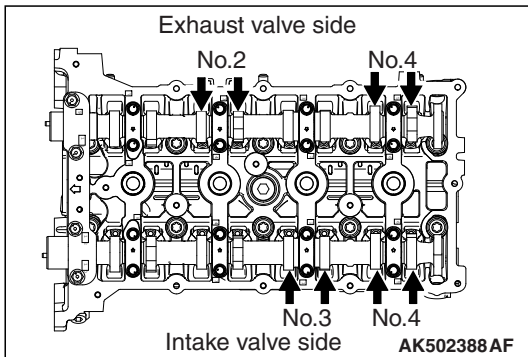
4. If measured values are out of the standard value, record measured values.



5. Rotate the crankshaft by one turn clockwise to set the No. 4 piston at top dead center on the compression stroke.

**NOTE:** The timing mark of the V.V.T. exhaust sprocket must be at the illustrated position.





6. Valve clearance can be measured at the illustrated location in this condition.
7. If measured values are out of the standard value, record measured values.
8. If the measured value is out of the standard value, replace the valve tappet.

*NOTE: There are 47 kinds of valve tappets at intervals of 0.015 mm (0.0006 inch) in the range between 3.000 (0.1181 inch) and 3.690 mm (0.1453 inch).*

9. Use the following procedure select a valve tappet.
  - (1) Measure thickness of a removed valve tappet.
  - (2) Calculate thickness of a valve tappet so that valve clearance meets the standard value.

**A: Thickness of valve tappet to be selected**

**B: Thickness of removed valve tappet**

**C: Measured valve clearance**

**Formula**

**Intake side:  $A = B + (C - 0.20 \text{ mm [0.008 inch]})$**

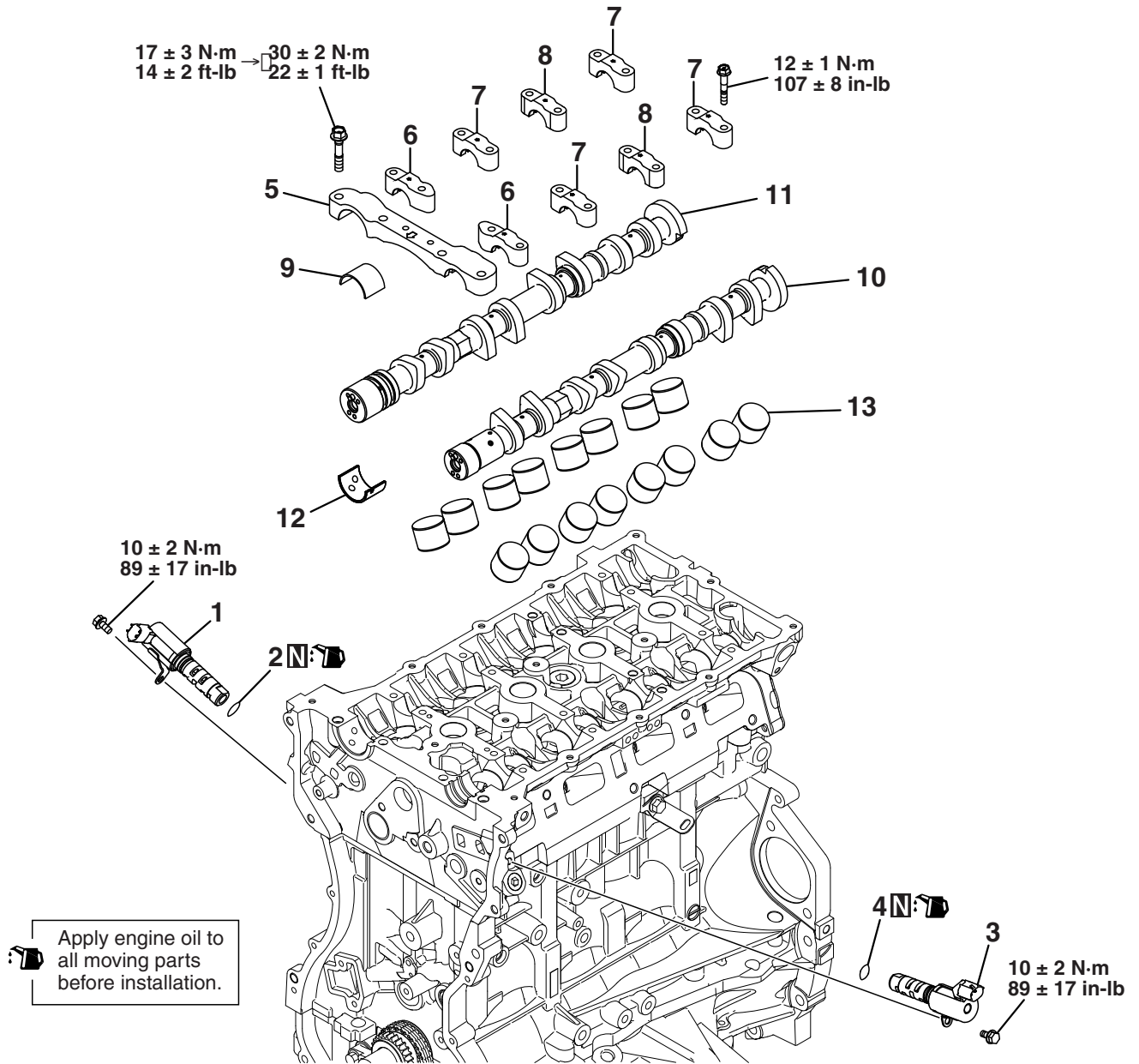
**Exhaust side:  $A = B + (C - 0.30 \text{ mm [0.012 inch]})$**

Refer to "Removal and installation of camshaft" for removal, installation and inspection procedure of valve tappets.

# CAMSHAFT

## REMOVAL AND INSTALLATION

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AK702227 AC

### Removal steps

- >>C<< 1. Engine oil control valve (OCV) exhaust
- >>C<< 2. O-ring
- >>C<< 3. Engine oil control valve (OCV) intake
- >>C<< 4. O-ring
- <<A>> >>B<< 5. Front camshaft bearing cap
- <<A>> >>B<< 6. Oil feeding camshaft bearing cap

### Removal steps (Continued)

- <<A>> >>B<< 7. Camshaft bearing cap
- <<A>> >>B<< 8. Thrust camshaft bearing cap
- >>B<< 9. Bearing
- >>B<< 10. Camshaft intake
- >>B<< 11. Camshaft exhaust
- >>B<< 12. Bearing
- <<B>> >>A<< 13. Valve tappet

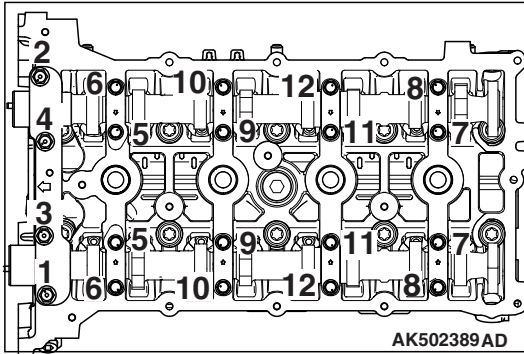


**REMOVAL SERVICE POINTS**

**<<A>> FRONT CAMSHAFT BEARING CAP / OIL FEEDING CAMSHAFT BEARING CAP / CAMSHAFT BEARING CAP / THRUST CAMSHAFT BEARING CAP REMOVAL**

**⚠ CAUTION**

Loosening the camshaft bearing cap installation bolts in four to five steps. Do not loosen bolts in one step as this causes the valve spring force to push on the bolts and make them jump out causing damage to the threads. First remove a mounting bolt of the front camshaft bearing cap and then a mounting bolt of each camshaft bearing cap in the order shown in the illustration.



**<<B>> VALVE TAPPET REMOVAL**

Pick out valve tappets with fingers and store removed valve tappets with tags describing the installed position attached for reassembly.

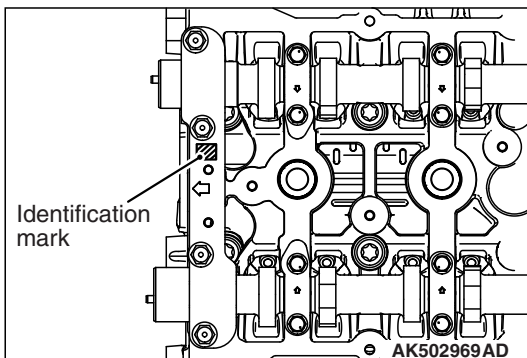
**INSTALLATION SERVICE POINTS**

**>>A<< VALVE TAPPET INSTALLATION**

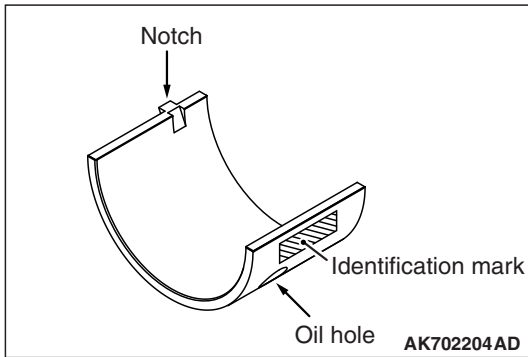
Install valve tappets at the same position based on tags describing the installed position for reassembly.

**>>B<< CAMSHAFT / BEARING / THRUST CAMSHAFT BEARING CAP / CAMSHAFT BEARING CAP / OIL FEEDING CAMSHAFT BEARING CAP / FRONT CAMSHAFT BEARING CAP INSTALLATION**

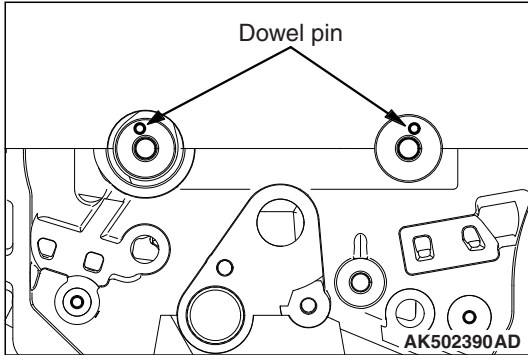
1. When replacing a camshaft bearing, select a bearing with the size corresponding to the identification mark in the table below.
2. Install camshaft bearings on the cylinder head.



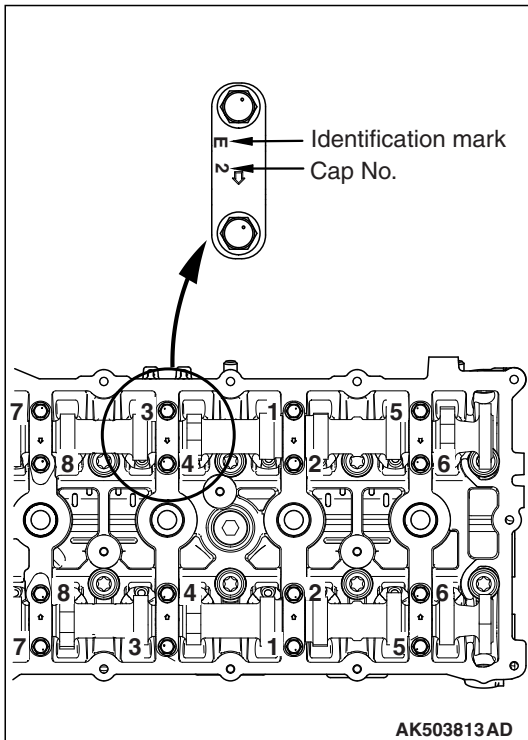
Front camshaft bearing cap		Camshaft bearing
Identification mark	Inner diameter mm (in)	Identification mark
1	40.000 –40.008 (1.5748 –1.5751)	1
2	40.008 –40.016 (1.5751 –1.5754)	2
3	40.016 –40.024 (1.5754 –1.5757)	3



3. The identification mark of the camshaft bearing is stamped at the illustrated position.



4. Set the dowel pins of the camshaft at the illustrated positions.



5. Install them upon checking the identification mark so as not to misidentify cap No. and to confuse the intake side with the exhaust side.

**Identification mark**

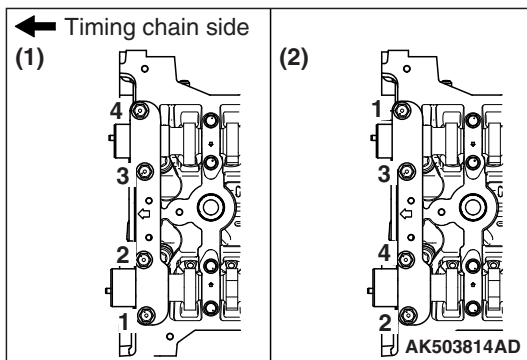
**I: Intake side**

**E: Exhaust side**

6. Tighten each camshaft bearing cap mounting bolt to the specified torque in the order of number shown in the figure in two or three steps.

**Tightening torque: 12 ± 1 N·m (106 ± 8 in-lb)**





7. Tighten each front camshaft bearing cap mounting bolt to the temporarily torque of  $17 \pm 3 \text{ N} \cdot \text{m}$  ( $14 \pm 2 \text{ ft-lb}$ ) in the order shown (1).
8. Tighten each front camshaft bearing cap mounting bolt to the specified torque in the order shown (2).

**Tightening torque:  $30 \pm 2 \text{ N} \cdot \text{m}$  ( $22 \pm 1 \text{ ft-lb}$ )**

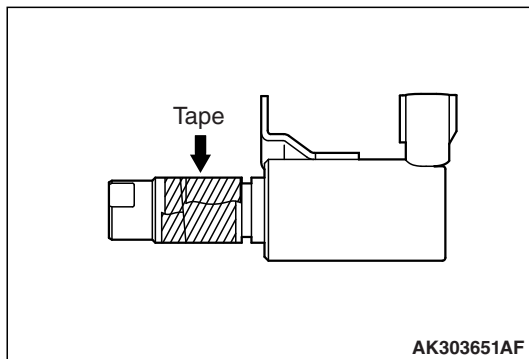
## >>C<< O-RING / ENGINE OIL CONTROL VALVE INSTALLATION

### ⚠ CAUTION

- The O-ring must not be reused.
- Wind non-adhesive tape (seal tape, etc.) around the notch of the oil passage of the engine oil control valve before installing the O-ring to prevent damage. Damage to the O-ring causes oil leakage.

1. Apply a small amount of engine oil to the O-ring of the engine oil control valve.
2. Install the engine oil control valve on the cylinder head.
3. Tighten the engine oil control valve to the specified torque.

**Tightening torque:  $10 \pm 2 \text{ N} \cdot \text{m}$  ( $89 \pm 17 \text{ in-lb}$ )**



## INSPECTION

M1113027000466

### CAMSHAFT

Measure camshaft height (camshaft major axis). If the height is less than the limit, replace the camshaft.

**Standard value:**

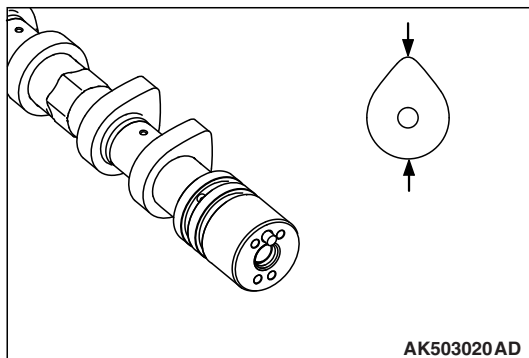
**Intake: 44.1 mm (1.74 inches)**

**Exhaust: 45.0 mm (1.77 inches)**

**Limit:**

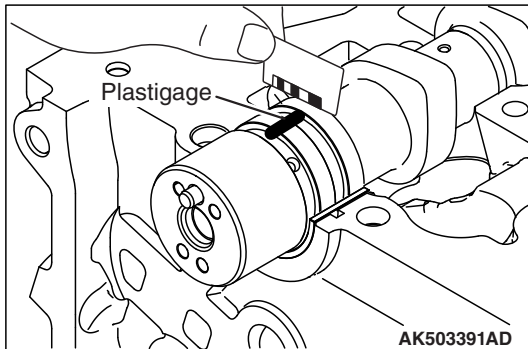
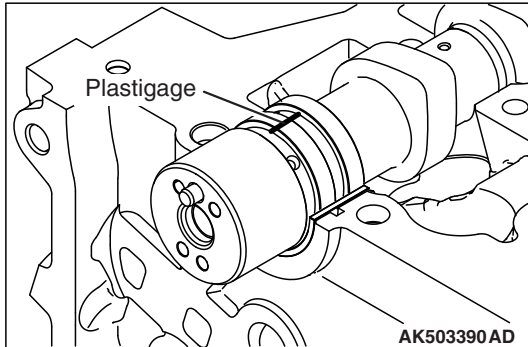
**Intake: 43.6 mm (1.72 inches)**

**Exhaust: 44.5 mm (1.75 inches)**



**CAMSHAFT OIL CLEARANCE (PLASTIGAGE METHOD)**

1. Thoroughly wipe oil on the outside diameter of the camshaft and the inside diameter of the bearing.
2. Install the bearing to the camshaft.
3. Put straightly the plastigage having the length of the bearing width on the journal axis, centering the axis.
4. Carefully install the bearing cap. Tighten the bolt as instructed in >>B<< Bolt Installation Point.
5. Remove the bolt and the bearing cap carefully.



6. Measure the plastigage whose width is most compressed using the scale printed on the plastigage bag. When the measured value deviates from the standard one, replace the bearing.

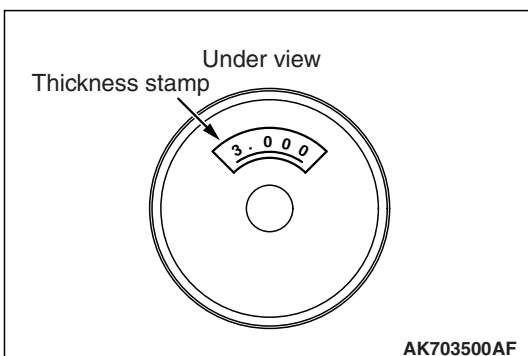
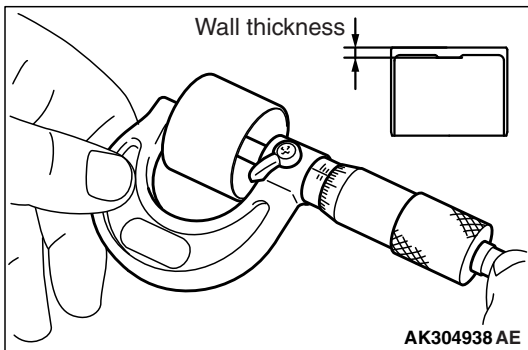
**Standard value: 0.035 –0.072 mm (0.0014 –0.0028 inch)**

**⚠ CAUTION**

**When the bearing is used again, be careful not to reverse the cylinder head side and the camshaft side during installation.**

**VALVE TAPPET**

1. Measure the valve tappet at the illustrated position. If the measured value is not in agreement with the value in the table corresponding to the identification mark, replace the valve tappet.



2. The valve tappet has an identification mark and stamping of thickness at illustrated positions.

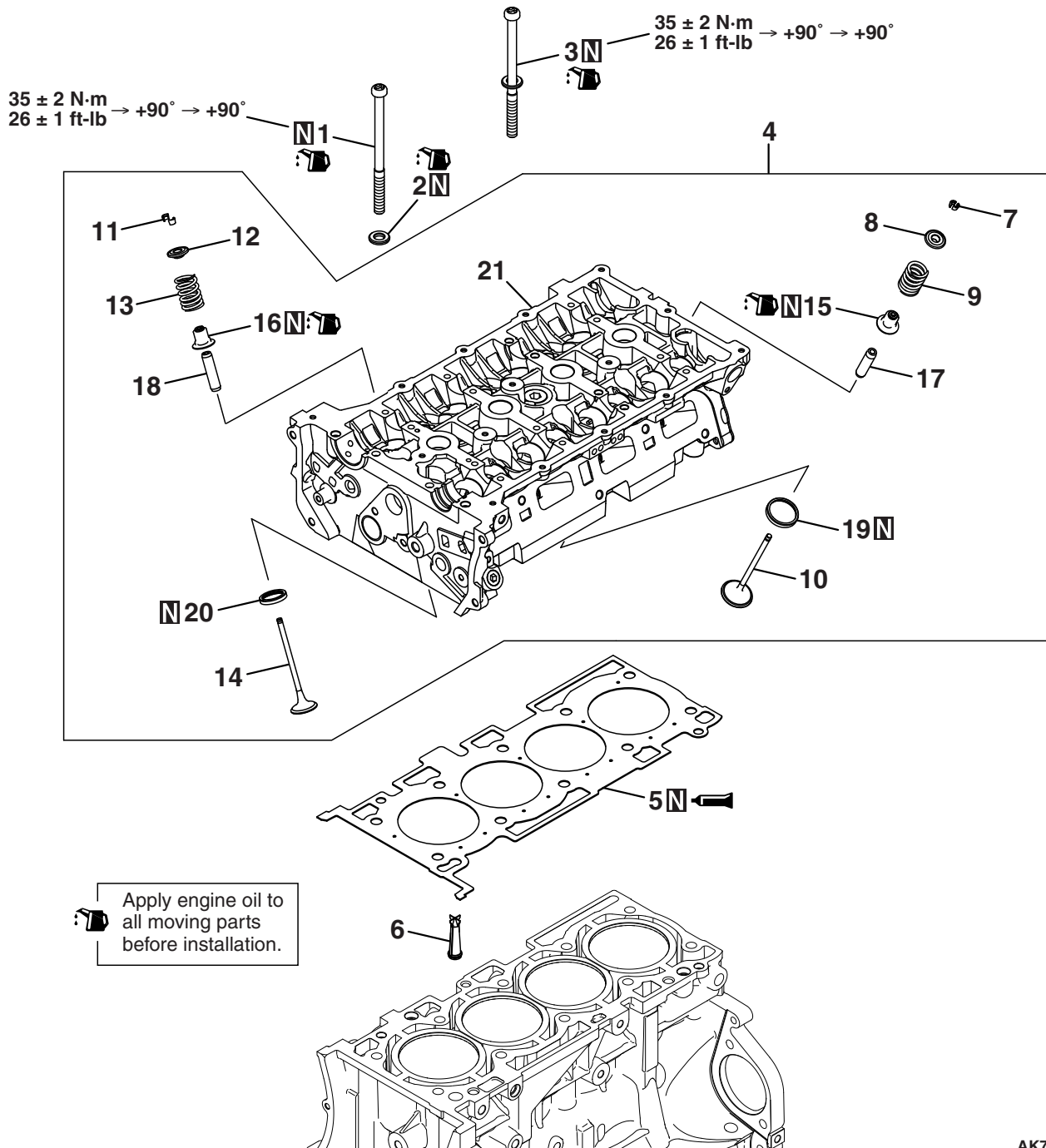
There are 47 kinds of valve tappets at intervals of 0.015 mm (0.0006 inch) in the range between 3.000 mm (0.1181 inch) and 3.690 mm (0.1453 inch).

<b>Thickness mm (in)</b>	<b>Thickness stamp</b>	<b>Thickness mm (in)</b>	<b>Identification mark</b>	<b>Thickness mm (in)</b>	<b>Identification mark</b>
3.000 (0.1181)	3.000	3.240 (0.1276)	3.240	3.480 (0.1370)	3.480
3.015 (0.1187)	3.015	3.255 (0.1281)	3.255	3.495 (0.1376)	3.495
3.030 (0.1193)	3.030	3.270 (0.1287)	3.270	3.510 (0.1382)	3.510
3.045 (0.1199)	3.045	3.285 (0.1293)	3.285	3.525 (0.1388)	3.525
3.060 (0.1205)	3.060	3.300 (0.1299)	3.300	3.540 (0.1394)	3.540
3.075 (0.1211)	3.075	3.315 (0.1305)	3.315	3.555 (0.1400)	3.555
3.090 (0.1217)	3.090	3.330 (0.1311)	3.330	3.570 (0.1406)	3.570
3.105 (0.1222)	3.105	3.345 (0.1317)	3.345	3.585 (0.1411)	3.585
3.120 (0.1228)	3.120	3.360 (0.1323)	3.360	3.600 (0.1417)	3.600
3.135 (0.1234)	3.135	3.375 (0.1329)	3.375	3.615 (0.1423)	3.615
3.150 (0.1240)	3.150	3.390 (0.1335)	3.390	3.630 (0.1429)	3.630
3.165 (0.1246)	3.165	3.405 (0.1341)	3.405	3.645 (0.1435)	3.645
3.180 (0.1252)	3.180	3.420 (0.1346)	3.420	3.660 (0.1441)	3.660
3.195 (0.1258)	3.195	3.435 (0.1352)	3.435	3.675 (0.1447)	3.675
3.210 (0.1264)	3.210	3.450 (0.1358)	3.450	3.690 (0.1453)	3.690
3.225 (0.1270)	3.225	3.465 (0.1364)	3.465		

# CYLINDER HEAD AND VALVES

## REMOVAL AND INSTALLATION

M1113006903010



Apply engine oil to all moving parts before installation.

AK702226 AC

### Removal steps

- >>E<< 1. Cylinder head bolt
- >>E<< 2. Cylinder head bolt washer
- >>E<< 3. Cylinder head bolt & washer assembly
- >>D<< 4. Cylinder head assembly
- >>D<< 5. Cylinder head gasket
- <<A>> >>C<< 6. Engine oil control valve (OCV) filter
- <<A>> >>C<< 7. Retainer lock
- <<A>> >>C<< 8. Valve spring retainer

### Removal steps (Continued)

- >>B<< 9. Valve spring
- <<A>> >>C<< 10. Intake valve
- <<A>> >>C<< 11. Retainer lock
- >>B<< 12. Valve spring retainer
- >>B<< 13. Valve spring
- <<B>> >>A<< 14. Exhaust valve
- <<B>> >>A<< 15. Valve stem seal
- <<B>> >>A<< 16. Valve stem seal
- <<B>> >>A<< 17. Intake valve guide

**Removal steps (Continued)**

18. Exhaust valve guide
19. Intake valve seat
20. Exhaust valve seat
21. Cylinder head

**Required Special Tools:**

- MD998735: Valve Spring Compressor
- MB992089: Retainer Holder C
- MB992085: Valve Stem Seal Pliers
- MD998737: Valve Stem Seal Installer

**REMOVAL SERVICE POINTS**

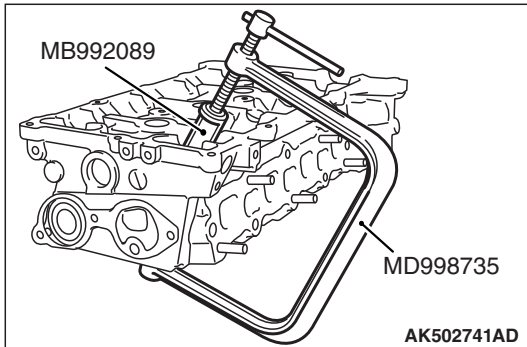
**<<A>> RETAINER LOCK REMOVAL**

**⚠ CAUTION**

Be careful not to allow retainer holder C to interfere with the wall of the tappet hole and to damage it.

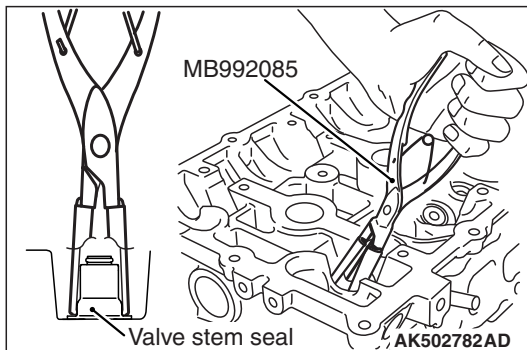
Use a special tool MD998735 and MB992089 to compress the valve spring and to remove the retainer lock.

*NOTE: Store removed parts such as valves and springs with tags describing cylinder No. and installed position attached for reassembly.*



**<<B>> VALVE STEM SEAL REMOVAL**

Use special tool MB992085 to firmly pinch the base (larger external shape) of the stem seal and twist it right and left for pulling out.



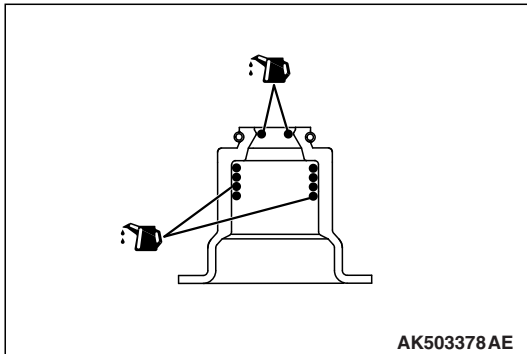
## INSTALLATION SERVICE POINTS

## &gt;&gt;A&lt;&lt; VALVE STEM SEAL INSTALLATION

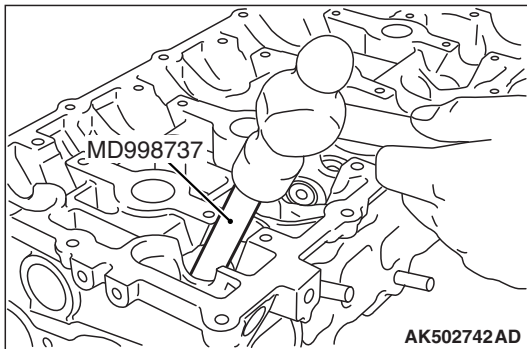
**⚠ CAUTION**

- The valve stem seal must not be reused.
- Do not damage the tappet wall during assembly.
- Be sure to use a special tool to install the valve stem seal. Poor installation causes oil loss via valve guides.
- If oil is not applied, the valve stem seal may rise to the surface after it is press fitted.

1. Apply a thin coat of engine oil to a new valve stem seal.

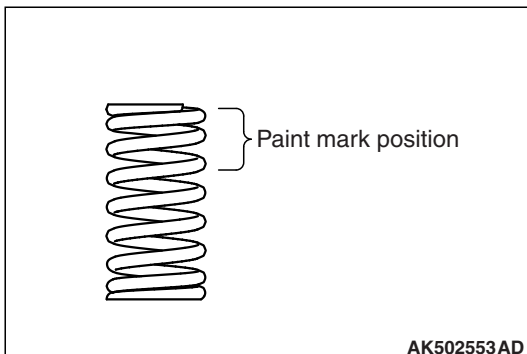


2. Use special tool MD998737 to press fit the valve stem seal into the valve guide with the valve stem used as a guide.



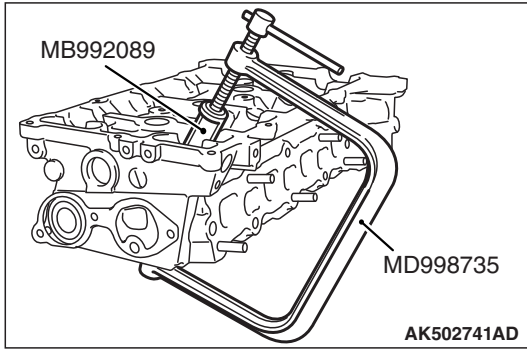
## &gt;&gt;B&lt;&lt; VALVE SPRING INSTALLATION

Install the valve spring so that the painted side faces toward the camshaft.



>>C<< RETAINER LOCK INSTALLATION

Use a special tool MD998735 and MB992089 to compress the valve spring and to install the retainer lock.



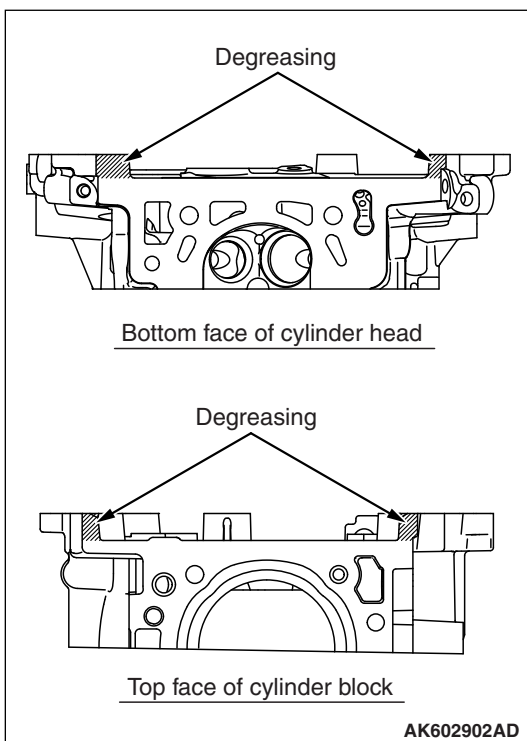
>>D<< CYLINDER HEAD GASKET / CYLINDER HEAD ASSEMBLY INSTALLATION

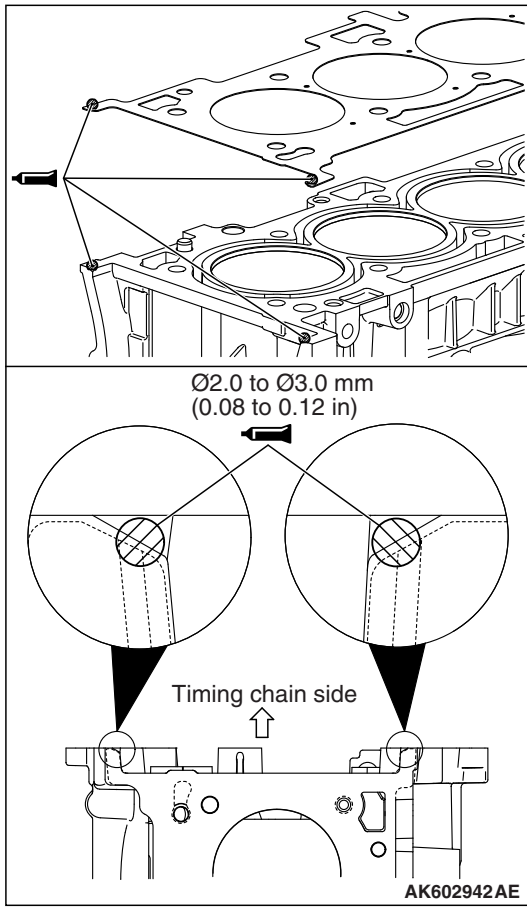
1. Completely remove the liquid gasket on the upper plane of the cylinder block and the lower plane of the cylinder head.

**CAUTION**

Sufficiently check that there is no residual oil on the place where degreasing is performed. If fingerprints are left, do not touch it with bare hands after the degreasing, since the oils from your fingers will harm the seal ability.

2. Degrease the place specified in the illustration.





- As shown in the illustration, apply a  $\phi 2.0$  to 3.0 mm (0.08 to 0.12 inch) of sealant to the top face of cylinder block.

**Specified sealant: Three bond 1217G or exact equivalent**

- Install the cylinder head gasket.

*NOTE: Check that the center of the liquid gasket is located toward the cylinder gasket in the position specified in the illustration.*

- As shown in the illustration, apply a  $\phi 2.0$  to 3.0 mm (0.08 to 0.12 inch) of sealant to the top face of cylinder head gasket.

**Specified sealant: Three bond 1217G or exact equivalent**

- Install the cylinder head assembly.

## >>E<< CYLINDER HEAD BOLT INSTALLATION

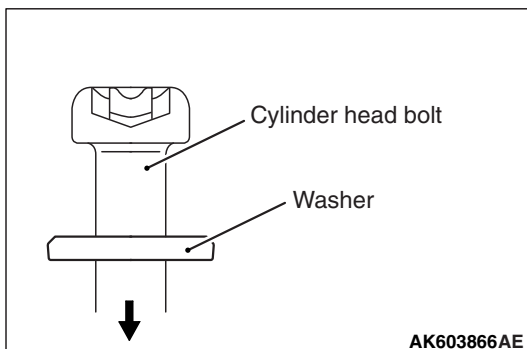
- Install new cylinder head bolts and washers in the following procedure.

*NOTE: Cylinder head bolts and washers must not be reused.*

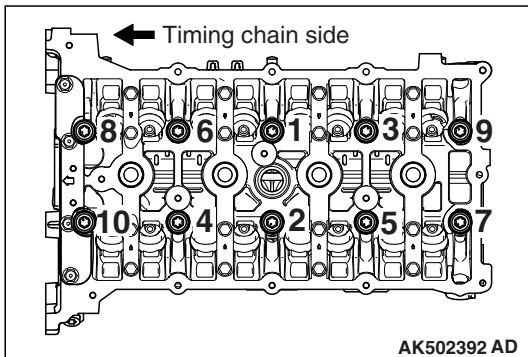
- Apply an appropriate amount of engine oil to top and bottom surfaces of washers and threaded portion of bolts.

- Install cylinder head bolts to the cylinder head.

*NOTE: Bolts and washers are different parts for bolts on the timing chain side.*

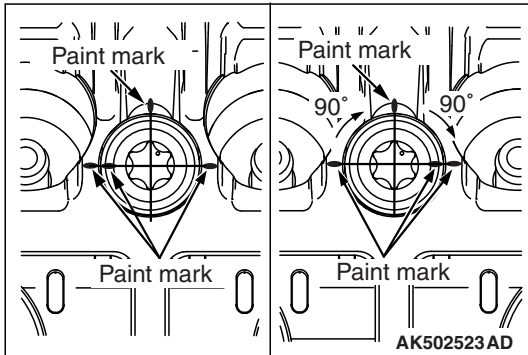






4. Tighten cylinder head bolts in several steps to the specified torque according to the assembly order shown.

**Tightening torque:  $35 \pm 2$  N·m ( $26 \pm 1$  ft-lb)**



5. Put a paint mark on all of cylinder head bolt heads and 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.

6. Tighten the cylinder head  $90^\circ$  according to the tightening order.

Tighten it further  $90^\circ$  and make sure that the paint mark on the cylinder head bolt is in a straight line with that on the cylinder head.

**INSPECTION**

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**CYLINDER HEAD**

1. Check the cylinder head for water leakage, gas leakage, damage or cracks before cleaning.
2. Completely remove oil, scale, sealant, carbon, etc. After cleaning oil passages, blow air to make sure that they are not clogged.

**CAUTION**

**The grinding limit shall be within 0.2 mm (0.01 inch) in combination with the cylinder block to be assembled.**

3. For the flatness on the cylinder head bottom, measure distortion using a straight edge and thickness gauge. If the distortion exceeds the limit, grind and repair it.

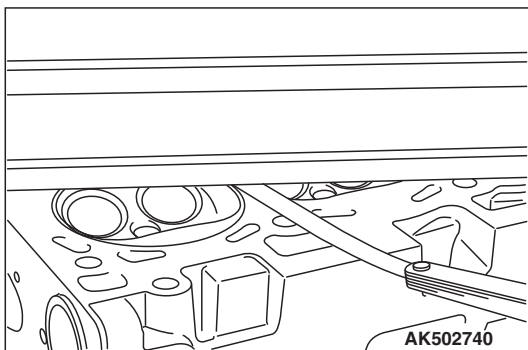
**Distortion on bottom**

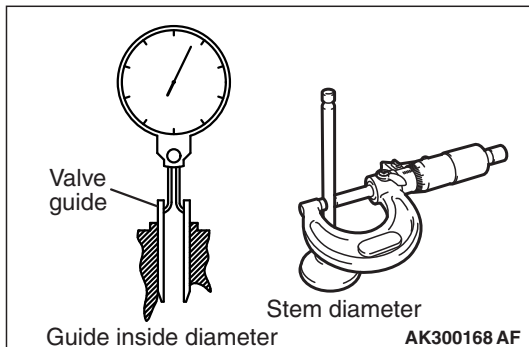
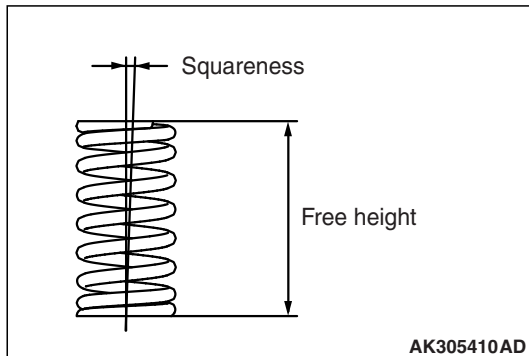
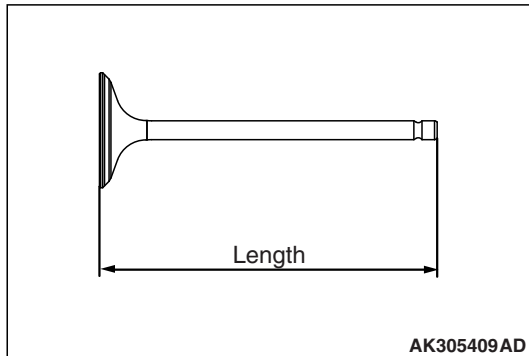
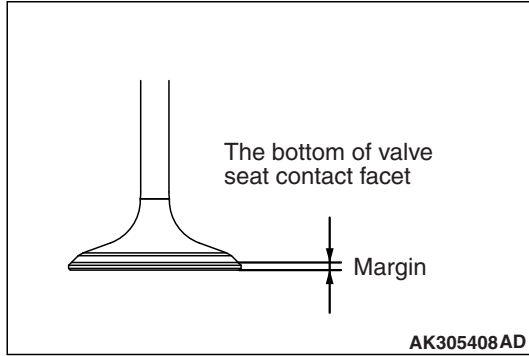
**Standard value: Within 0.05 mm (0.002 inch)**

**Limit: 0.2 mm (0.01 inch)**

**Grinding limit: 0.2 mm (0.01 inch)**

**Cylinder head height: 128.5 mm (5.06 inches)**



**VALVE**

1. Repair the valve seat if contact with the valve seat is poor, uneven or broken.
2. Measure the margin.

If the limit is exceeded, replace the valve.

**Standard value:**

**Intake 1.022 mm (0.0402 inch)**

**Exhaust 1.094 mm (0.0431 inch)**

**Limit:**

**Intake 0.522 mm (0.0206 inch)**

**Exhaust 0.594 mm (0.0234 inch)**

3. Measure overall length of the valve.

If the limit is exceeded, replace the valve.

**Standard value:**

**Intake 113.18 mm (4.456 inches)**

**Exhaust 105.89 mm (4.169 inches)**

**Limit:**

**Intake 112.68 mm (4.436 inches)**

**Exhaust 105.39 mm (4.149 inches)**

**VALVE SPRING**

1. Measure free height of the spring.

If the limit is exceeded, replace the spring.

**Standard value: 51.5 mm (2.03 inch)**

**Limit: 51.0 mm (2.01inch)**

2. Measure squareness of the spring.

If the inclination exceeds the limit, replace the spring.

**Standard value: 2° or less**

**Limit: 4°**

**VALVE GUIDE**

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

**Standard value:**

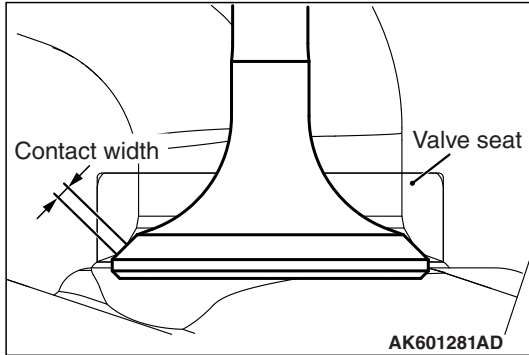
**Intake 0.020 –0.047 mm (0.0008 –0.0019 inch)**

**Exhaust 0.030 –0.057 mm (0.0012 –0.0022 inch)**

**Limit:**

**Intake 0.10 mm (0.004 inch)**

**Exhaust 0.15 mm (0.006 inch)**



## VALVE SEAT

Assemble the valve, then measure the contact width. If the measurement exceeds the specified limit, replace the valve seat.

### Standard value

Intake: 1.16 –1.46 mm (0.046 –0.058 inch)

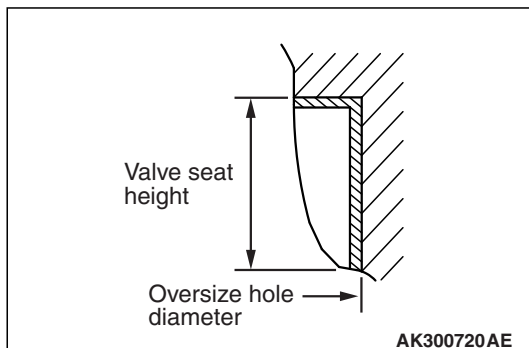
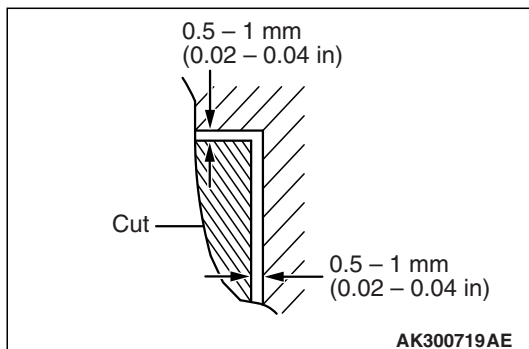
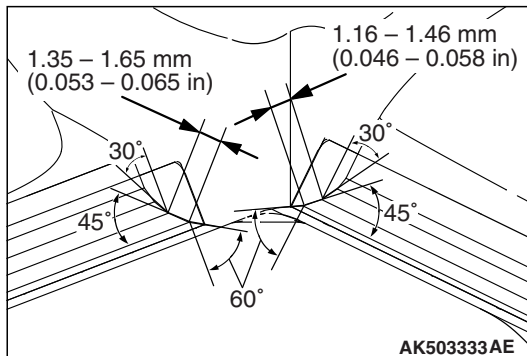
Exhaust: 1.35 –1.65 mm (0.053 –0.065 inch)

### ⚠ CAUTION

If the variation in the width exceeds 0.2 mm (0.01 inch) even if the contact width is within the standard value, replace or correct the valve seat.

## REPAIR PROCEDURE OF VALVE SEAT

1. Check clearance between valve guide and valve and replace the valve guide if necessary before repairing the valve seat.
2. Repair the valve seat so that seat width and seat angle are to the specified shape.
3. Lap valve and valve seat with lapping compound after repairing valve seat.



## REPLACEMENT PROCEDURE OF VALVE SEAT

1. Scrape the valve seat to be replaced from inside to make its wall thickness thin before pulling out.
2. Repair the valve seat hole of the cylinder head to match it with the diameter of the oversize valve seat to be press fitted.
  - Standard value: Intake valve seat bore diameter**  
0.3 O.S.: 36.22 –36.24 mm (1.426 –1.427 inches)
  - Standard value: Exhaust valve seat bore diameter**  
0.3 O.S.: 30.22 –30.24 mm (1.190 –1.191 inches)
3. Press fit the valve seat, taking care not to score the cylinder head bore at room temperature.
4. Ream the valve seat.  
Refer to "Repair procedure of valve seat."

**REPLACEMENT PROCEDURE OF VALVE GUIDE**

1. Pull out the valve guide with a press toward the cylinder block side.
2. Ream the valve guide hole of the cylinder head to match it with the diameter of the oversize valve guide to be press fitted.

**⚠ CAUTION**

**Do not use a valve guide with the same size as that of the pulled out valve guide because it cannot be press fitted.**

**Standard value: Valve guide bore diameter**

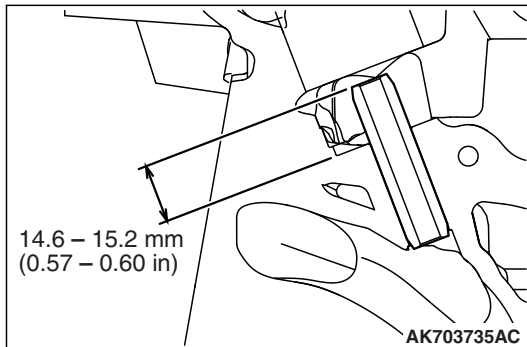
**0.25 O.S.: 11.23 –11.25 mm (0.442 –0.443 inch)**

3. Press fit the valve guide to the illustrated dimension.

**Standard value: 14.6 –15.2 mm (0.57 –0.60 inch)**

*NOTE: Press fit the valve guide from the cylinder head top surface.*

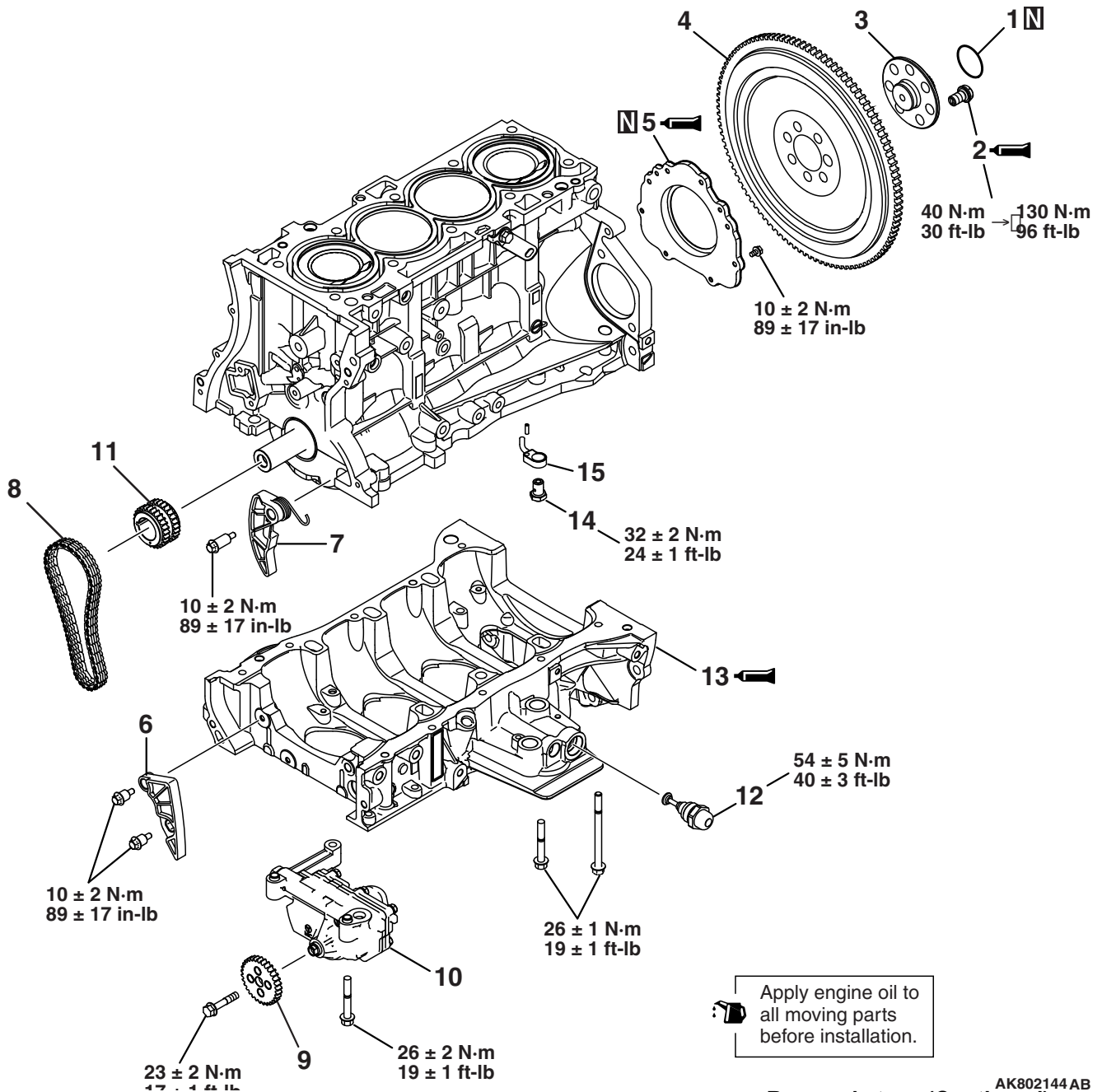
4. After pressing fit the valve guide, insert a new valve to check for sliding.



# OIL PUMP CHAIN

## REMOVAL AND INSTALLATION

M1113033700271



Apply engine oil to all moving parts before installation.

AK802144 AB

### Removal steps

- |       |       |                             |
|-------|-------|-----------------------------|
| <<A>> | >>E<< | 1. Silicon ring             |
|       |       | 2. Flywheel bolt            |
|       |       | 3. Flywheel hub             |
|       |       | 4. Flywheel                 |
|       | >>D<< | 5. Rear oil seal            |
|       |       | 6. Oil pump chain guide     |
|       |       | 7. Oil pump tensioner lever |
|       | >>C<< | 8. Oil pump chain           |

### Removal steps (Continued)

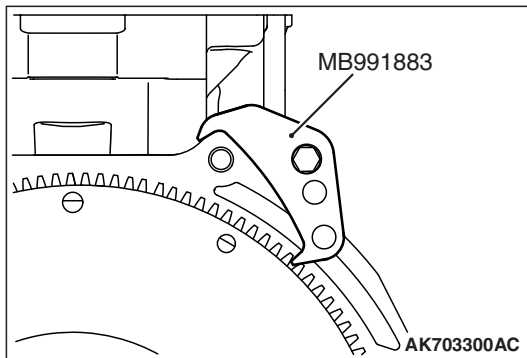
- |       |       |                              |
|-------|-------|------------------------------|
| <<B>> | >>C<< | 9. Oil pump sprocket         |
|       |       | 10. Oil pump case            |
|       | >>B<< | 11. Crankshaft sprocket      |
|       |       | 12. Oil cooler by-pass valve |
| <<C>> | >>A<< | 13. Ladder frame             |
|       |       | 14. Check valve              |
|       |       | 15. Oil jet                  |

### Required Special Tools:

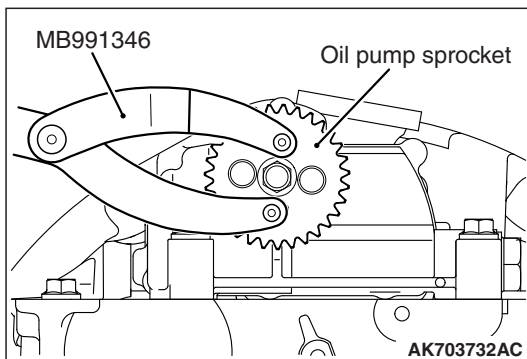
- MB991346: Top Cover Wrench
- MB991883: Flywheel Stopper

**REMOVAL SERVICE POINTS****<<A>> FLYWHEEL BOLT REMOVAL**

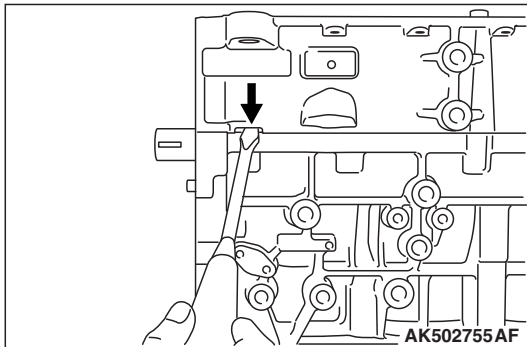
1. Use special tool MB991883 to secure the flywheel.
2. Remove the flywheel bolts.

**<<B>> OIL PUMP SPROCKET REMOVAL**

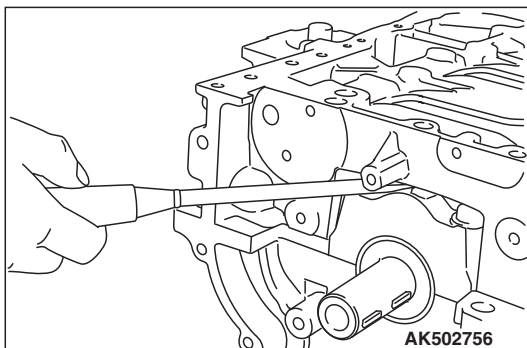
- Fix the oil pump sprocket with a special tool MB991346, loosen a center bolt, and remove the oil pump sprocket.

**<<C>> LADDER FRAME REMOVAL**

1. Pry the illustrated position with a screwdriver.



2. If the ladder frame does not come off, insert a flat blade screwdriver into the gap between the ladder frame and bearing cap as shown in the illustration and lightly pry it to remove the ladder frame.



## INSTALLATION SERVICE POINTS

### >>A<< LADDER FRAME INSTALLATION

**⚠ CAUTION**

Be sure to remove liquid gasket that has entered mounting holes.

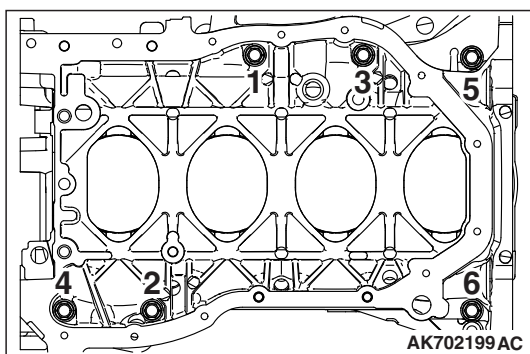
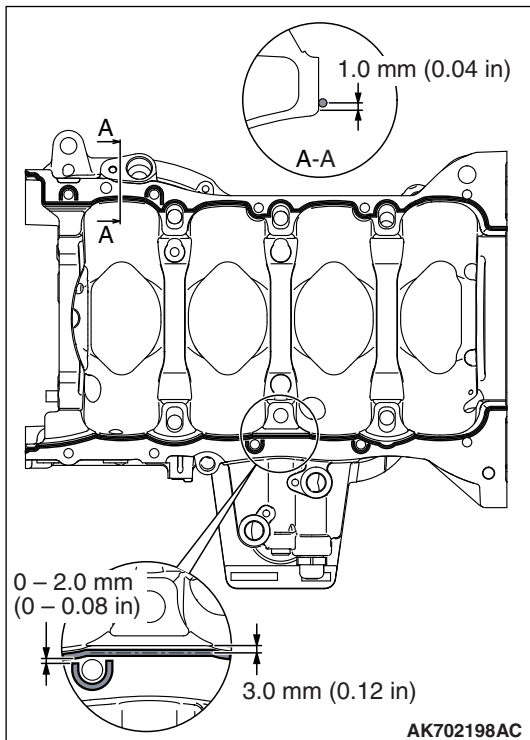
1. Completely remove liquid gasket adhering to the cylinder block and ladder frame.

**⚠ CAUTION**

Sufficiently check that there is no residual oil on the place where degreasing is performed. If fingerprints are left, do not touch it with bare hands after the degreasing, since the oils from your fingers will harm the seal ability.

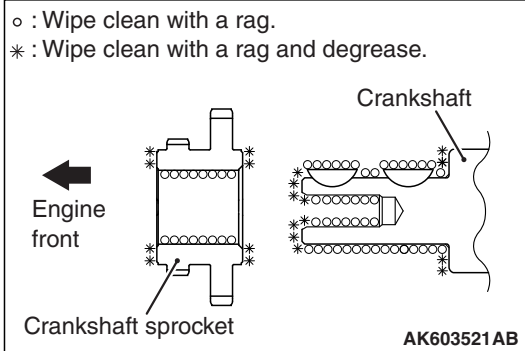
2. Degrease the surface where the liquid gasket is applied and the contact surface between the cylinder block and ladder frame.
3. Squeeze liquid gasket of  $\phi 2.0$  to 3.0 mm (0.08 to 0.12 inch) in thickness and apply it to the illustrated position of the ladder frame.

**Specified sealant: Three bond 1217G or equivalent**



4. Tighten the ladder frame to the specified torque in the order shown in the illustration.

**Tightening torque:  $26 \pm 1$  N·m ( $19 \pm 1$  ft·lb)**

**>>B<< CRANKSHAFT SPROCKET INSTALLATION**

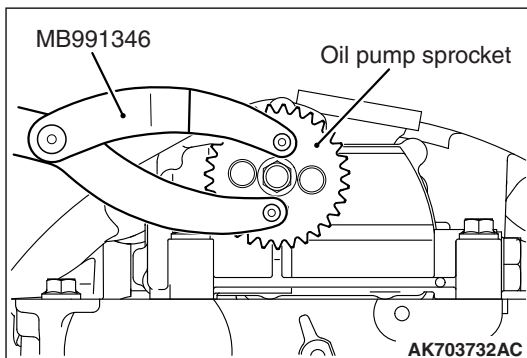
1. Wipe off the dirt on the crankshaft sprocket and the crankshaft using a rag, and then remove the grease from the portion shown in the illustration.

*NOTE: Remove grease to prevent a drop in the coefficient of friction of the pressing portion caused by adhesion of oil.*

2. Set the No. 1 piston at top dead center on the compression stroke.
3. Install the crankshaft sprocket to the crankshaft.

**>>C<< OIL PUMP SPROCKET / OIL PUMP CHAIN INSTALLATION**

1. Set the No. 1 piston at top dead center on the compression stroke.
2. Using the special tool MB991346, install the oil pump sprocket to the oil pump case.
3. Install the oil pump chain to the crankshaft sprocket.
4. Install the oil pump chain to the oil pump sprocket.

**>>D<< REAR OIL SEAL CASE INSTALLATION****⚠ CAUTION**

**Be sure to remove liquid gasket that has entered mounting holes.**

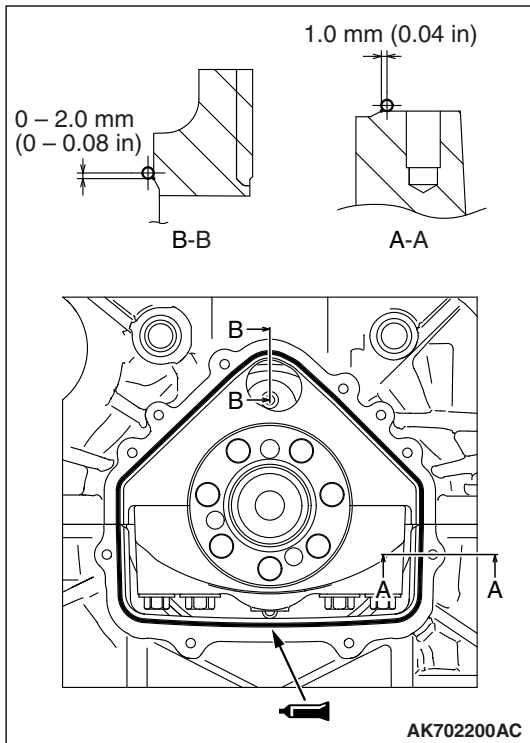
1. Completely remove liquid gasket adhering to the cylinder block, ladder frame and rear oil seal case.

**⚠ CAUTION**

**Sufficiently check that there is no residual oil on the place where degreasing is performed. If fingerprints are left, do not touch it with bare hands after the degreasing, since the oils from your fingers will harm the seal ability.**

2. Degrease the surface where the liquid gasket is applied and the contact surface between the cylinder block and ladder frame.





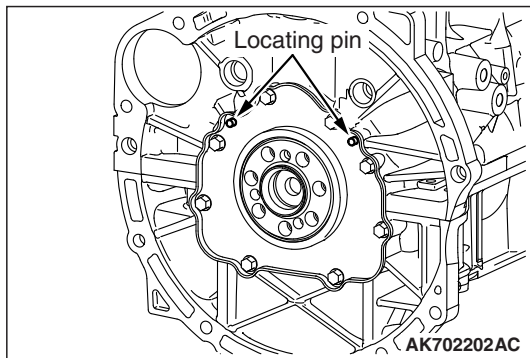
3. Apply a small amount of engine oil to the oil seal lip.

**CAUTION**

**Install the timing chain case within three minutes after applying liquid gasket.**

4. Squeeze liquid gasket of  $\phi 2.0$  to 3.0 mm (0.08 to 0.12 inch) in thickness and apply it to the illustrated position of the cylinder block and ladder frame.

**Specified sealant: Three bond 1217G or equivalent**



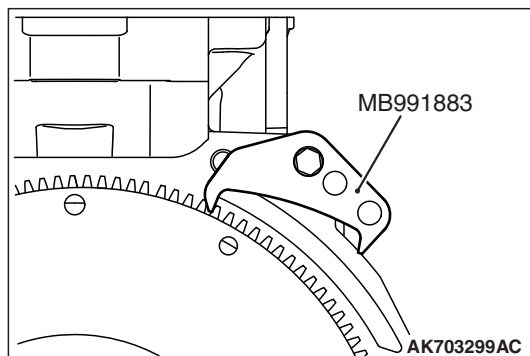
5. Install the rear oil seal case aligned with the locating pin and tighten it to the specified torque.

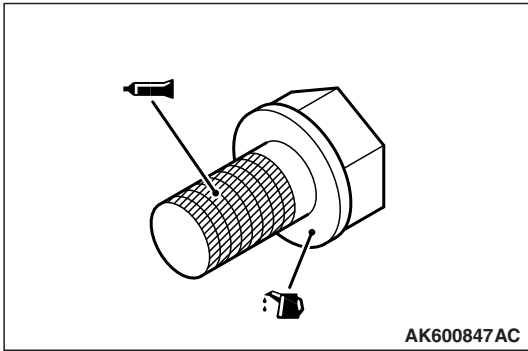
**Tightening torque:  $10 \pm 2$  N·m ( $89 \pm 17$  ft-lb)**

**>>E<< FLYWHEEL BOLT INSTALLATION**

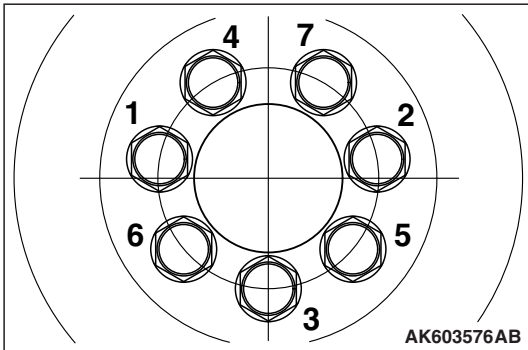
1. Clean off sealant and oil of thread of crankshaft and flywheel bolt.

2. Use special tool MB991883 to secure the flywheel.





3. Apply engine oil to thread of crankshaft and bolt seat area of flywheel.
4. Apply the sealant to the thread of flywheel bolt.  
**Specified sealant: Three bond 1324 or equivalent**



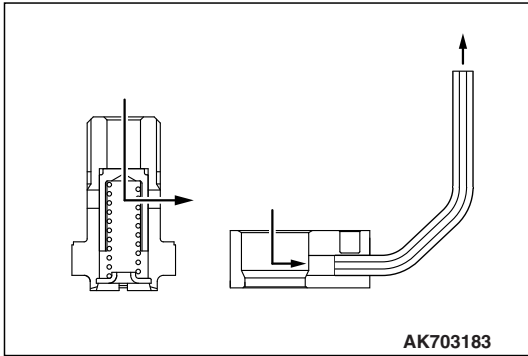
5. Tighten flywheel bolts to temporary torque 40 N·m (30 ft-lb) in the order shown to illustration.
6. Tighten flywheel bolts to specified torque in the order shown in the illustration.  
**Tightening torque: 130 N·m (96 ft-lb)**

**INSPECTION**

M1113033800096

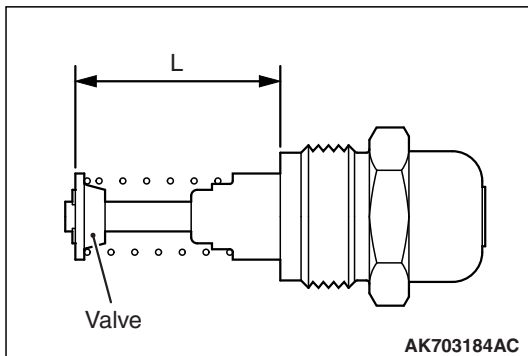
**OIL JET**

1. Check the oil jet and check valve for clogging
2. Check the oil jet for damage and deformation



**OIL COOLER BY-PASS VALVE**

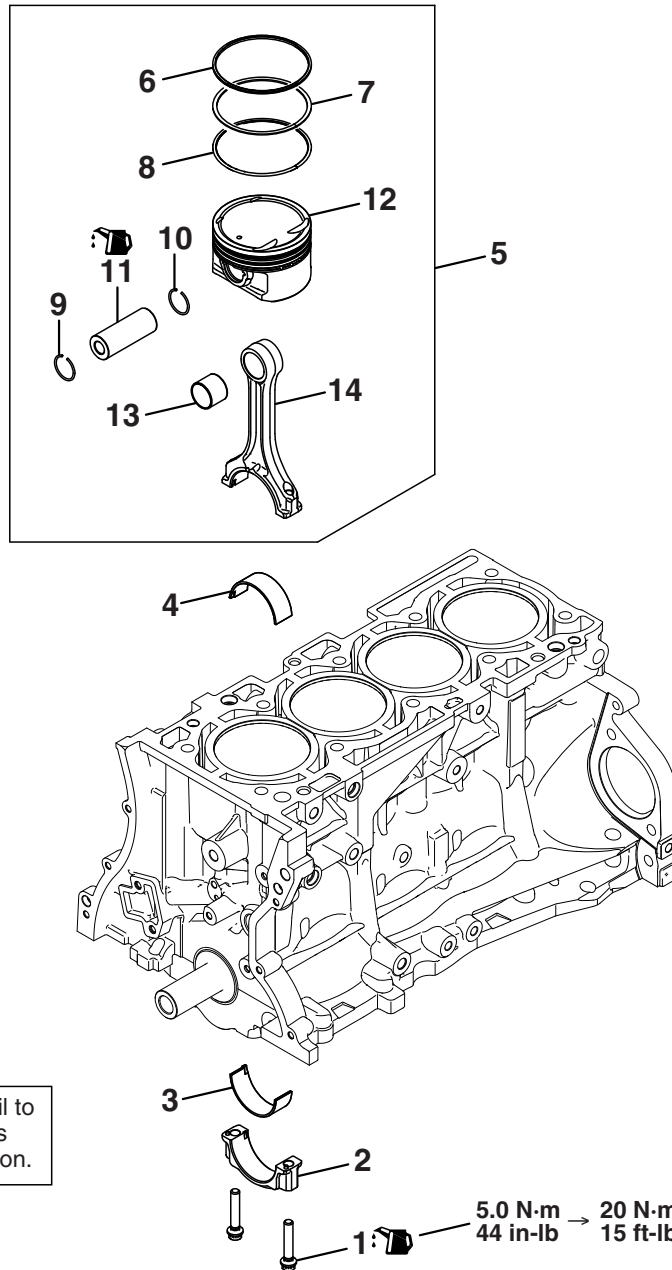
1. Make sure that valve moves smoothly.
2. Ensure that the dimension "L" measures the standard value under normal temperature and humidity.  
**Standard value: 34.5 mm (1.358 inches)**
3. The dimension must be the standard value when measured after the valve has been dipped in 97 to 103° C (207 to 217° F) oil.  
**Standard value: 40.0 mm (1.575 inches)**




# PISTON AND CONNECTING ROD

## REMOVAL AND INSTALLATION

M1113008403312



 Apply engine oil to all moving parts before installation.

AK702224AC

- |       |   |
|-------|---|
|       | <b>Removal steps</b>                    |
| <<A>> | >>G<< 1. Connecting rod cap bolt        |
|       | >>F<< 2. Connecting rod cap             |
|       | >>E<< 3. Connecting rod bearing         |
|       | >>E<< 4. Connecting rod bearing         |
|       | >>D<< 5. Piston connecting rod assembly |
|       | >>C<< 6. Piston ring No. 1              |
|       | >>C<< 7. Piston ring No. 2              |

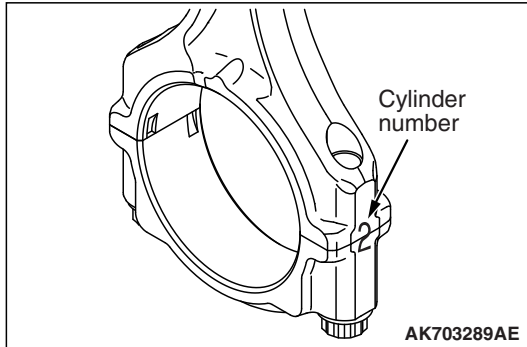
- |       |                                  |
|-------|----------------------------------|
|       | <b>Removal steps (Continued)</b> |
| <<B>> | >>B<< 8. Oil ring                |
| <<B>> | >>A<< 9. Circlip                 |
| <<B>> | >>A<< 10. Circlip                |
|       | >>A<< 11. Piston pin             |
|       | 12. Piston                       |
|       | 13. Bushing                      |
|       | 14. Connecting rod               |

### Required Special Tools:

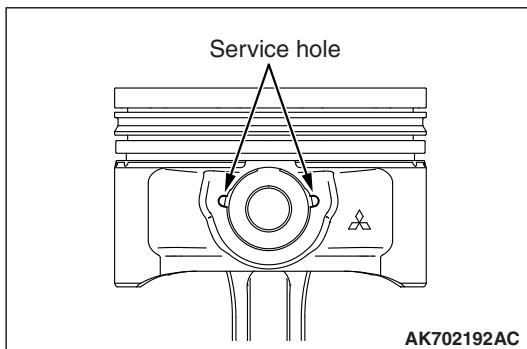
- MB992236: Circlip Installer
- MD998780: Piston Pin Setting Tool

**REMOVAL SERVICE POINTS****<<A>> CONNECTING ROD REMOVAL**

Mark the connecting rod on the big end with the cylinder number it is being removed from.

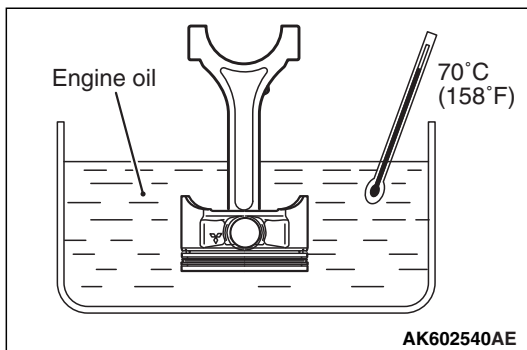
**<<B>> SNAP RING REMOVAL**

Insert the precise screwdriver into the service hole to remove the snap ring.

**<<C>> PISTON PIN REMOVAL****⚠ CAUTION**

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

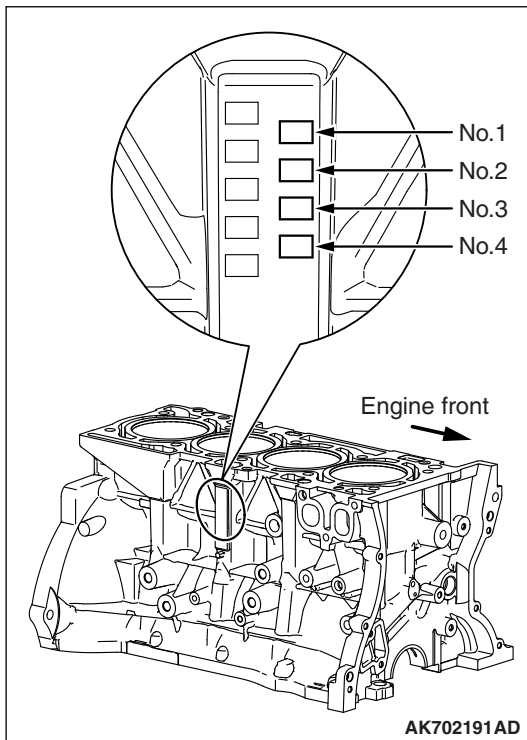
1. Into each container, pour enough engine oil to completely cover a piston.
2. Heat the engine oil to warm the piston to approximately 70° C (158° F), and then remove the piston pin.



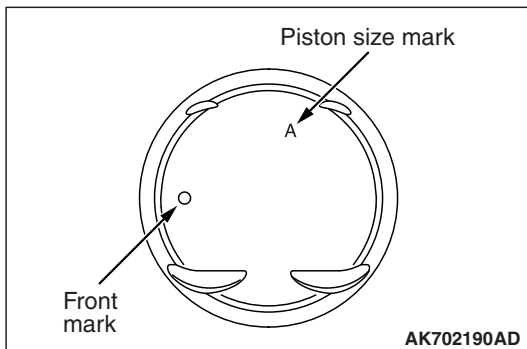
INSTALLATION SERVICE POINTS

>>A<< PISTON PIN INSTALLATION

1. When replacing a piston, check the cylinder bore size mark stamped on the illustrated position of the cylinder block and select a corresponding piston from the table below.



Cylinder bore size mark	Piston size mark
A	A
B	B or none
C	C

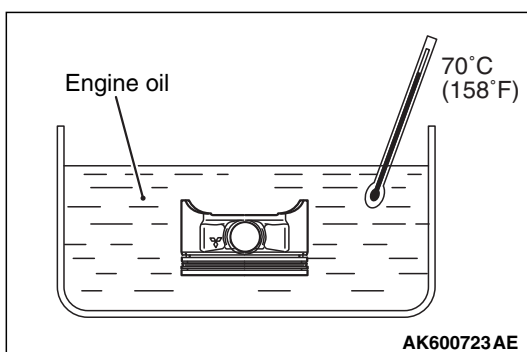


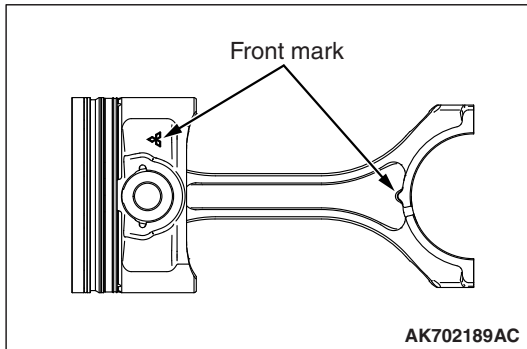
*NOTE: The piston size mark is indicated on the piston top face.*

**CAUTION**

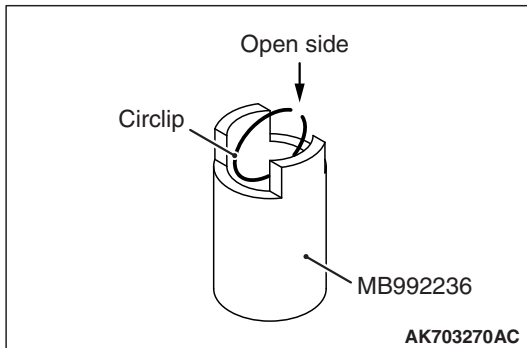
The clearance between the piston and the piston pin is a tight fit at room temperature. Therefore, be sure the heat the piston before pulling out the piston pin. Use care sine the piston is hot after heating.

2. Into each container, pour enough engine oil to completely cover a piston.
3. Heat the engine oil to warm the piston to approximately 70°C (158°F), and then remove the piston pin.
4. Sufficiently apply the engine oil to the outer circumference of piston pin and the small end hole of connecting rod.

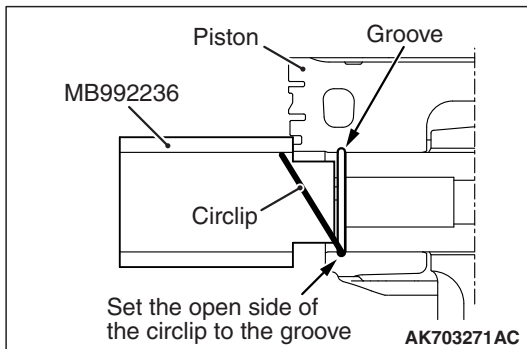




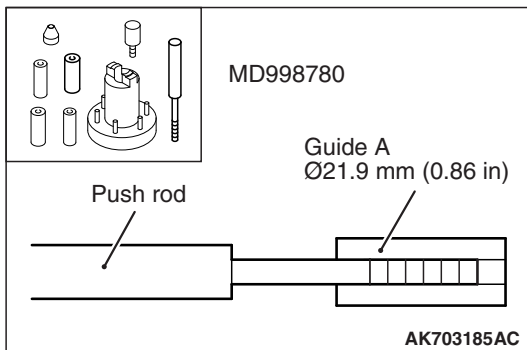
5. Put the front mark of connecting rod and the front mark of piston toward the same side, and then insert the piston pin.
6. Install the circlip to the piston according to the following procedure:



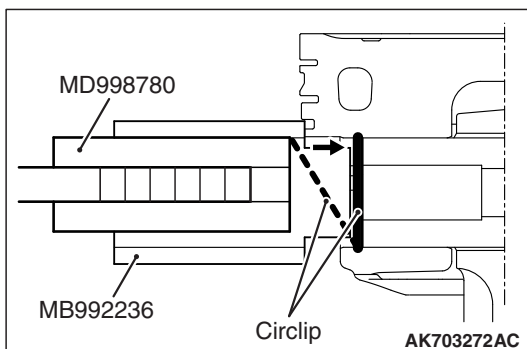
- (1) With the open side facing upward, install the new circlip to the special tool MB992236.



- (2) Align the open side of circlip with the piston groove, and then set the circlip together with the special tool MB992236.

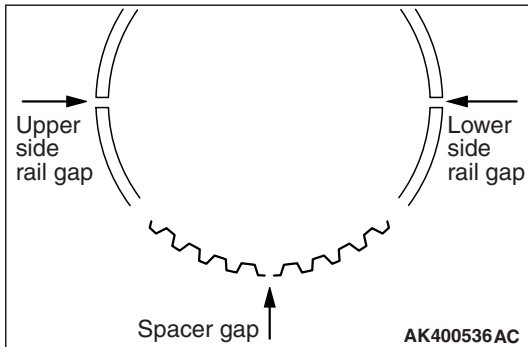
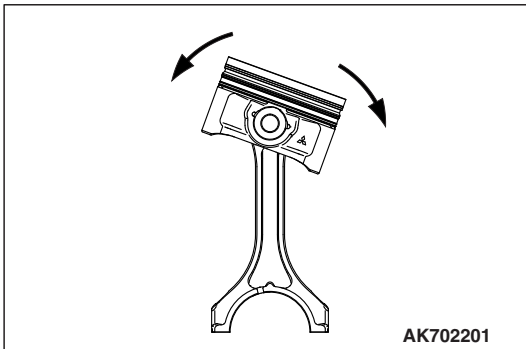


- (3) Install the guide A (Ø21.9 mm [0.88 inch]), to the push rod of special tool MD998780.



- (4) Push the opposite side of open side with the special tool MD998780, and install the circlip to the piston groove.
- (5) Make sure the circlip is seated into the groove.
- (6) Unless seated into the groove, the circlip must be pushed with the special tool MD998780 again to be seated into the groove.

7. Check that the piston moves smoothly.



### >>B<< OIL RING INSTALLATION

1. Assemble the spacer of the oil ring into the piston ring groove. Then, assemble the upper side rail, and after this assemble the lower side rail.

*NOTE: Install the side rail and end gap of the spacer so that they are at the position as shown in the illustration.*

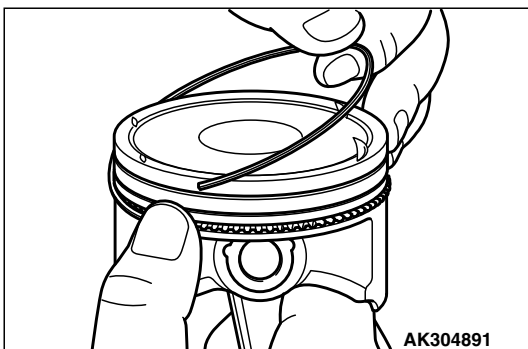
*NOTE: New spacers and side rails are identified by color marks as follows:*

Size	Color mark
Standard	Non mark
0.25 mm (0.010 inch) oversize	Two blue

#### **⚠ CAUTION**

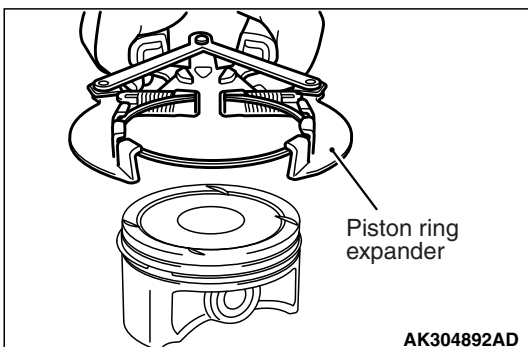
**The side rail may be broken if its end gap is widened by a ring expander as in other piston rings.**

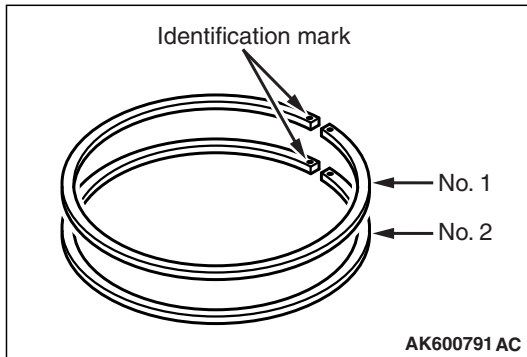
2. When assembling the side rail, push it by fingers, after fitting one end of the side rail into the piston groove, for easy assembly.
3. After assembling the oil ring into the piston, make sure that the side rail turns smoothly to either direction.



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

Use a piston ring expander to assemble piston rings with their identification marks facing upward. Piston rings can be assembled by hand without using the piston ring expander.





### Identification mark

No. 1 ring: 1R

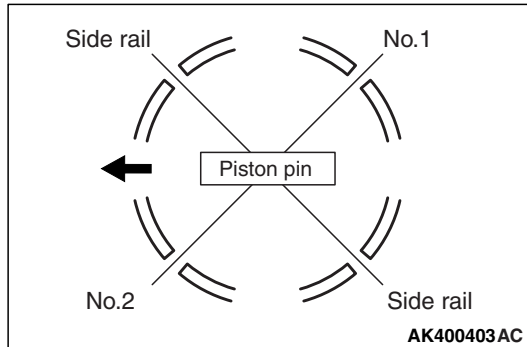
No. 2 ring: 2R

*NOTE: Each of the available piston rings has a size mark as follows:*

Size	Size mark
Standard	No mark
0.25 mm (0.010 inch) oversize	25

### >>D<< PISTON CONNECTING ROD ASSEMBLY INSTALLATION

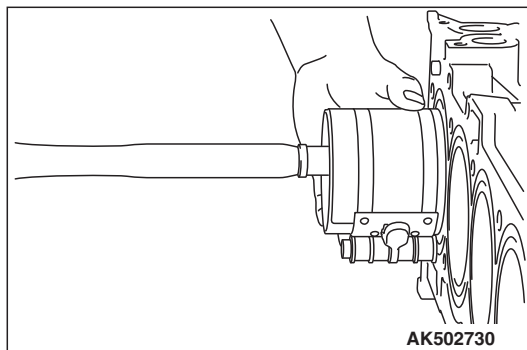
1. Apply a sufficient amount of engine oil to the circumference of the piston, piston rings and oil ring.
2. Arrange end gap positions of piston rings and oil ring (side rail and spacer) as shown in the illustration.
3. Insert the piston and connecting rod assembly from the top surface of the cylinder block with the front mark of the piston top face facing toward the timing chain side.



### **CAUTION**

**Driving it in hard causes breakage of piston rings and damage to the crank pin.**

4. Firmly tighten the piston ring with a ring band and insert the piston and connecting rod assembly.



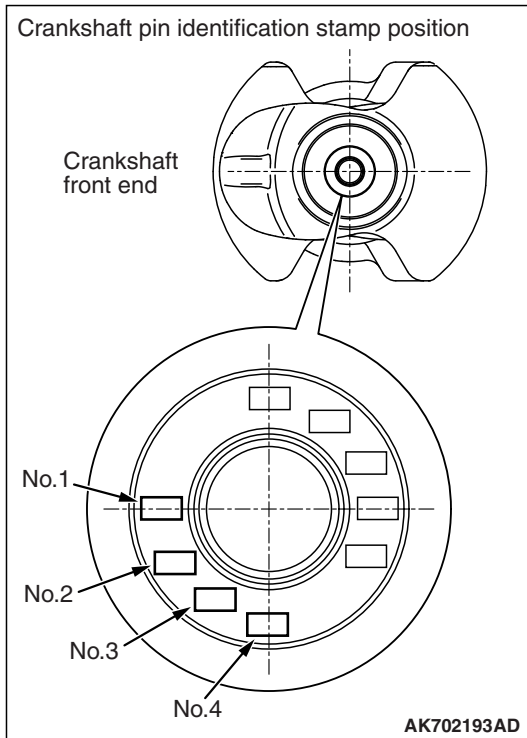


### >>E<< CONNECTING ROD BEARING INSTALLATION

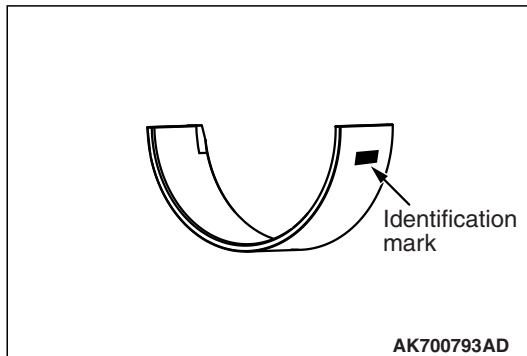
1. When replacing a connecting rod bearing, select the bearing corresponding to the crankshaft pin outside diameter according to the crankshaft pin identification in the table below.

Crankshaft pin		Connecting rod bearing
Identification mark	Journal diameter mm (in)	Identification mark
1	51.966 –51.972 (2.0459 –2.0461)	1
2	51.960 –51.966 (2.0457 –2.0459)	2
3	51.954 –51.960 (2.0454 –2.0457)	3

2. An identification mark of a crankshaft is stamped at the illustrated position by No.

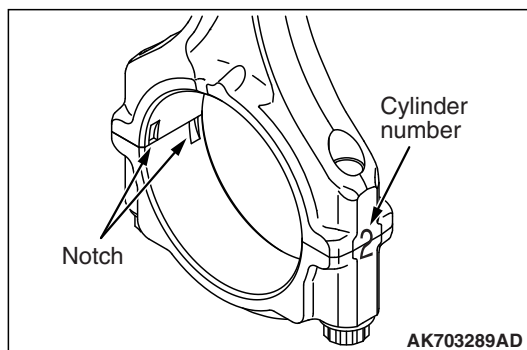


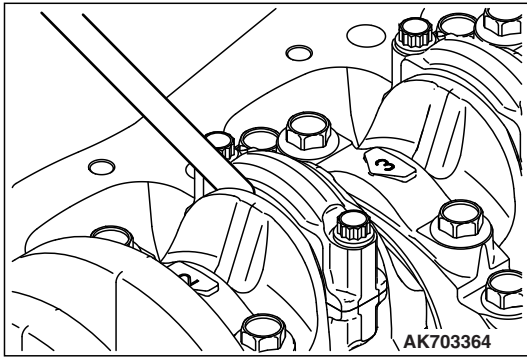
3. A connecting rod bearings an identification mark at the illustrated position.



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

1. Assemble the bearing cap on the connecting rod by aligning it with the mark put during removal. If a new connecting rod without a mating mark is used, assemble so that the detent notch of the bearing is on the same side as illustrated.





2. Make sure that clearance of the thrust of the connecting rod big end is appropriate.

**Standard value: 0.10 –0.25 mm (0.004 –0.010 inch)**  
**Limit: 0.4 mm (0.02 inch)**

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

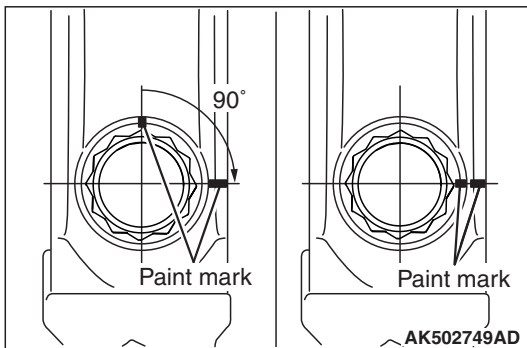
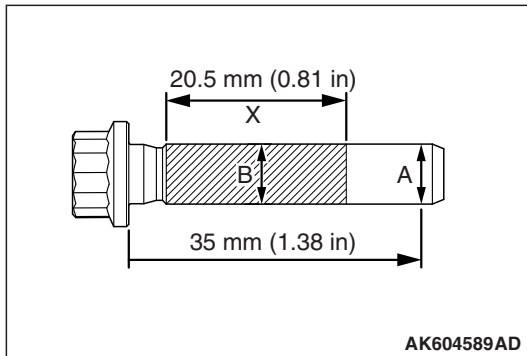
1. Check in the following procedure before reusing the connecting rod bolt.
  - (1) Measure the outside diameter "A."
  - (2) Measure the smallest outside diameter "B" within the range "X" shown in the illustration.
  - (3) If the difference of outside diameter of thread exceeds the limit, replace the connecting rod bolt.

**Limit: 0.10 mm (0.004 inch)**

2. Apply engine oil to the threaded portion and seat surface of the bolt before installing it.
3. After installing each bolt and tightening it by fingers, tighten bolts alternately to properly assemble the cap.
4. Tighten the bolt in several steps until the torque reaches 5.0 N·m (44 in-lb).
5. Tighten the bolt in several steps until the torque reaches 20 N·m (15 ft-lb).
6. Put a paint mark on the bolt head as illustrated.
7. Put a paint mark on the connecting rod at 90° position in the tightening direction of the bolt with reference to the paint mark position of the 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.
8. Tighten the bolt 90°, and make sure that the paint mark of the connecting rod is aligned with that of the bolt.



## INSPECTION

### PISTON RINGS

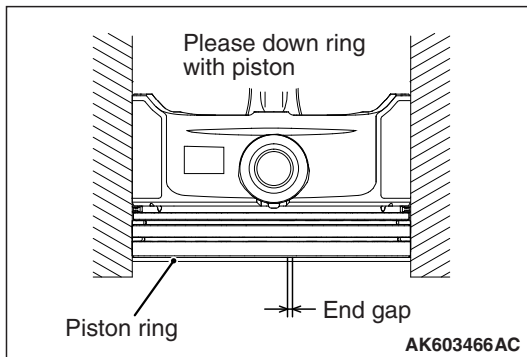
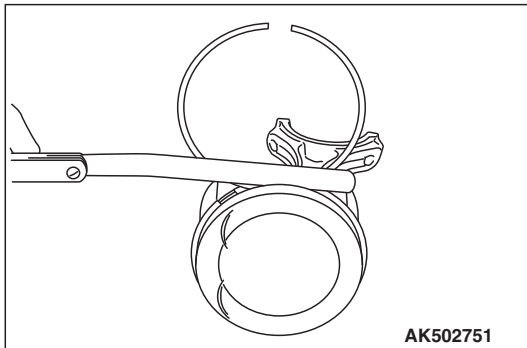
1. Check clearance between piston rings and ring grooves. If the limit is exceeded, replace piston rings or piston, or both.

**Standard value:**

**No. 1 ring: 0.02 –0.06 mm (0.001 –0.002 inch)**

**No. 2 ring: 0.02 –0.06 mm (0.001 –0.002 inch)**

**Limit: 0.10 mm (0.004 inch)**



2. Put piston rings into the cylinder bore, press them against the piston top face, and push them in. After achieving squareness, measure the end gap with a thickness gauge. If the end gap is excessive, replace piston rings.

**Standard value:**

**No. 1 ring: 0.18 –0.28 mm (0.007 –0.011 inch)**

**No. 2 ring: 0.28 –0.43 mm (0.011 –0.017 inch)**

**Oil ring: 0.10 –0.34 mm (0.004 –0.013 inch)**

**Limit:**

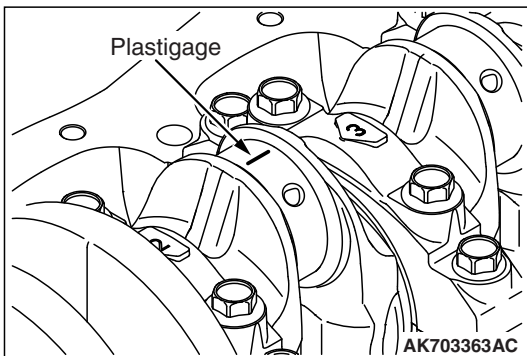
**No. 1 ring: 0.8 mm (0.03 inch)**

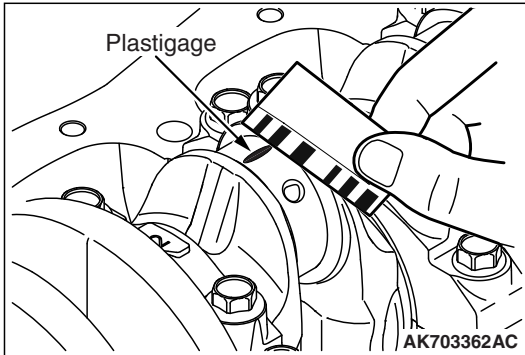
**No. 2 ring: 0.8 mm (0.03 inch)**

**Oil ring: 1.0 mm (0.04 inch)**

### CRANKSHAFT PIN OIL CLEARANCE (PLASTIGAGE METHOD)

1. Wipe oil off the crankshaft pin and connecting rod bearing.
2. Place a plastigage in length equal to the bearing width on the pin shaft straight in alignment with the shaft center.
3. Carefully install the connecting rod cap and tighten bolts to the specified torque of 5.0 N·m (44 in-lb) →20 N·m (15 ft-lb) →+90°.
4. Remove bolts and gently remove the connecting rod cap.



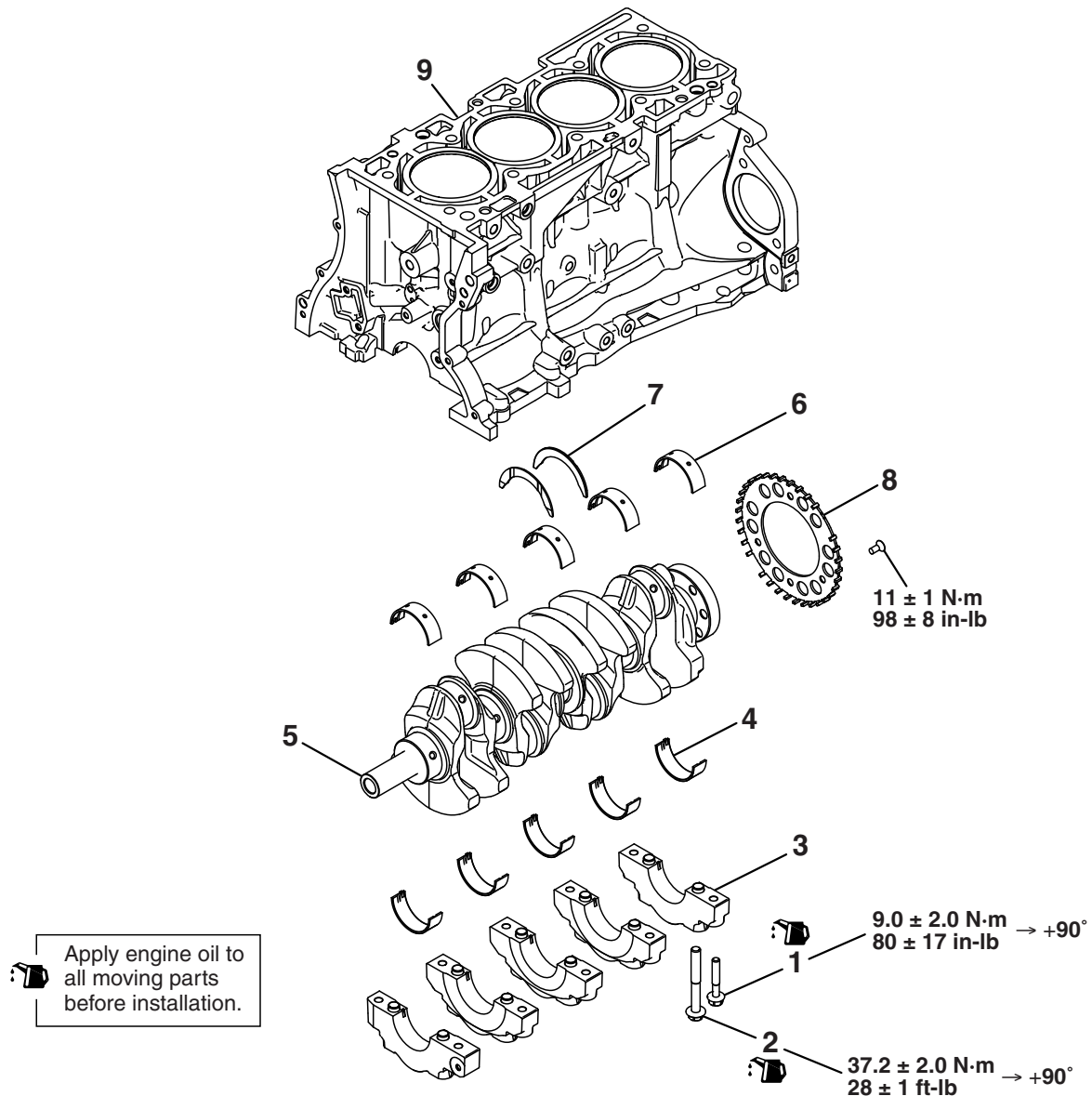


5. Measure the crushed plastigage width (area most widely crushed) using a scale printed on the plastigage bag.  
**Standard value: 0.038 –0.069 mm (0.0015 –0.0027 inch)**  
**Limit: 0.10 mm (0.004 inch)**

## CRANKSHAFT AND CYLINDER BLOCK

### REMOVAL AND INSTALLATION

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**Removal steps**

- <<A>>
- >>E<< 1. Crankshaft bearing cap bolt <M8>
  - >>E<< 2. Crankshaft bearing cap bolt <M10>
  - >>E<< 3. Crankshaft bearing cap
  - >>D<< 4. Crankshaft bearing lower
  - >>A<< 5. Crankshaft

**Removal steps (Continued)**

- >>C<< 6. Crankshaft bearing upper
- >>B<< 7. Thrust bearing
- >>A<< 8. Crankshaft sensing ring
- 9. Cylinder block

**REMOVAL SERVICE POINT**

**<<A>> CRANKSHAFT REMOVAL**

After removing the crankshaft with the crankshaft sensing ring attached, temporarily place it on a V-block to prevent teeth of the sensing ring from deforming.

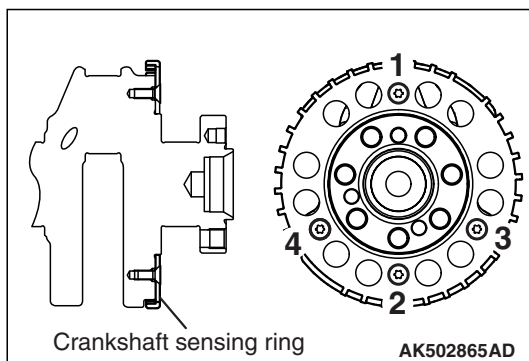
*NOTE: If a tooth bends, be sure to replace the crankshaft sensing ring with a new one.*

**INSTALLATION SERVICE POINTS**

**>>A<< CRANKSHAFT SENSING RING INSTALLATION**

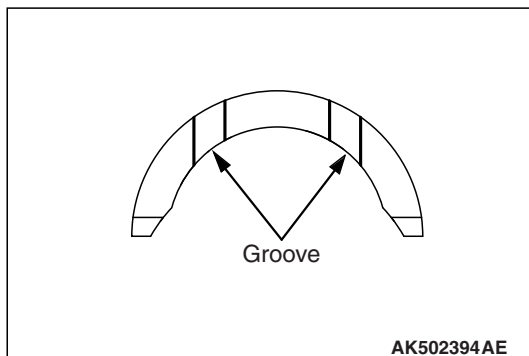
Tighten crankshaft sensing ring bolts to the specified torque in the tightening order shown in the illustration.

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



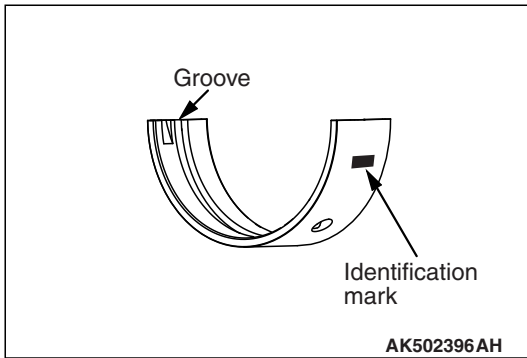
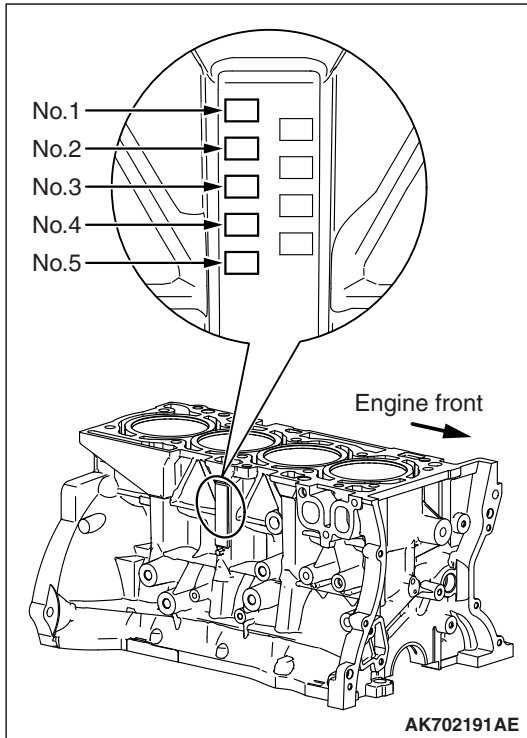
**>>B<< THRUST BEARING INSTALLATION**

1. Install the thrust bearing on the No. 3 bearing on the cylinder block side. Application of engine oil makes the installation easier.
2. Install the thrust bearing so that the grooved side is on the crankshaft weight side.



>>C<< CRANKSHAFT BEARING UPPER  
INSTALLATION

1. When replacing the crankshaft bearing upper, select a bearing with the size corresponding to the crankshaft journal diameter in the table below.



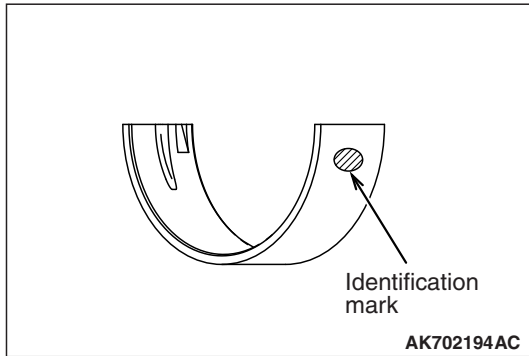
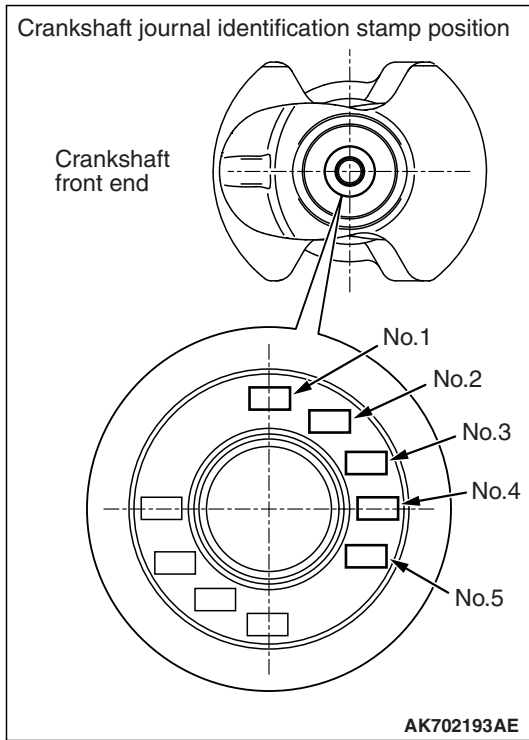
2. The crankshaft bearing upper has an identification mark at the illustrated position.

Cylinder block		Journal diameter mm (in)	Crankshaft bearing	
Identification mark			Identification mark	
No. 1, 2, 4, 5	No. 3		No. 1, 2, 4, 5	No. 3
1	0	56.000 -56.006 (2.2047 -2.2050)	1	0
2	1	56.006 -56.012 (2.2050 -2.2052)	2	1
3	2	56.012 -56.018 (2.2052 -2.2054)	3	2

3. Install the selected crankshaft bearing upper.

>>D<< CRANKSHAFT BEARING LOWER  
INSTALLATION

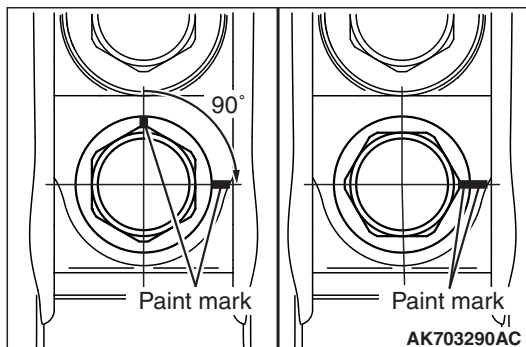
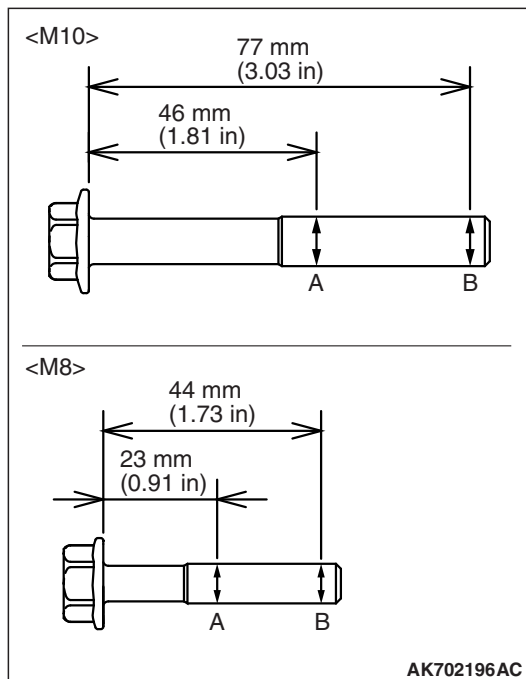
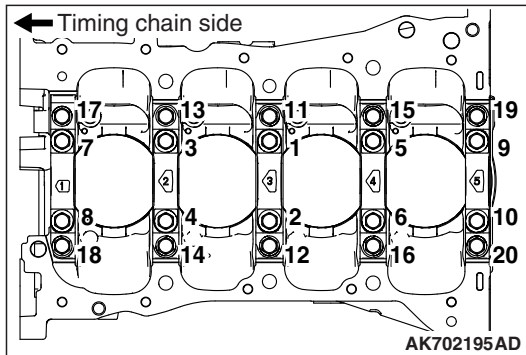
1. When replacing the crankshaft bearing lower, select a bearing with the size corresponding to the crankshaft journal diameter in the table below.



2. The crankshaft bearing lower has an identification color or identification mark at the illustrated position.
3. Install the selected crankshaft bearing lower.

Cylinder block		Journal diameter mm (in)	Crankshaft bearing	
Identification mark			Identification mark	
No. 1, 2, 4, 5	No. 3		No. 1, 2, 4, 5	No. 3
0	8	51.985 -51.988 (2.0467 -2.0468)	0	8
1	9	51.982 -51.985 (2.0465 -2.0467)	1	9
2	0	51.979 -51.982 (2.0464 -2.0465)	2	0
3	1	51.976 -51.979 (2.0463 -2.0464)	3	1
4	2	51.973 -51.976 (2.0462 -2.0463)	4	2

## >>E<< CRANKSHAFT BEARING CAP / CRANKSHAFT BEARING CAP BOLT INSTALLATION



1. Install the crankshaft bearing cap with reference to the identification mark as illustrated.

2. Before using the crankshaft bearing cap bolt again, carry out the check according to the following procedure:

- (1) Measure the 2 points on the outside diameter of thread as shown in the illustration.
- (2) When the difference between the measured outside diameters is beyond the limit value, replace the crankshaft bearing cap bolt.

### Limit value

**M10: 0.15 mm (0.006 inch)**

**M8: 0.10 mm (0.004 inch)**

3. Apply engine oil to the threaded portion and seat surface of the bolt.
4. Tighten crankshaft bearing cap bolts to the specified torque according to the tightening order.

### Tightening torque

**M10: 37.2 ± 2.0 N·m (27 ± 1 ft-lb)**

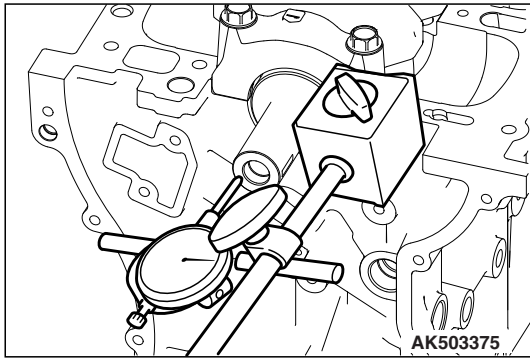
**M8: 9.0 ± 2.0 N·m (80 ± 17 in-lb)**

5. Make a paint mark on the head of each bolt.
6. Make a paint mark on the bearing cap 90° from the paint mark made on the bolt, in the direction of tightening the 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.
7. Turn each bolt 90° in the tightening sequence specified in step 1, and make sure that the paint marks on the bolt and cap are aligned.





8. Check end play of the crankshaft after installing the crankshaft bearing cap. If the end play exceeds the limit, replace the thrust bearing.

**Standard value: 0.05 –0.25 mm (0.002 –0.010 inch)**

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

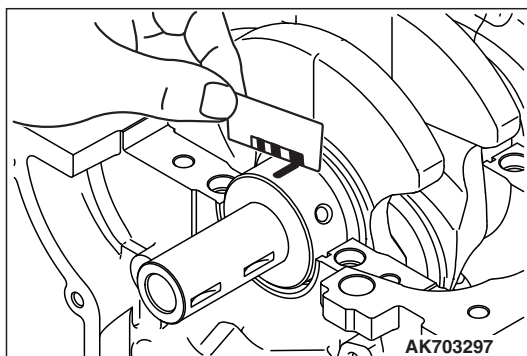
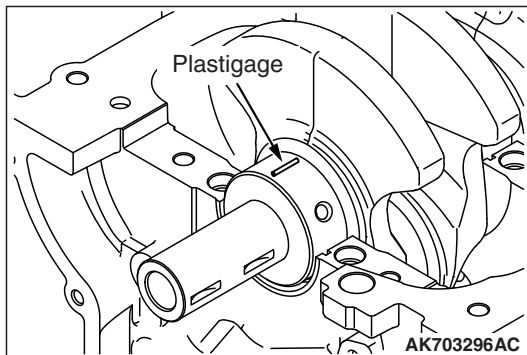
## INSPECTION

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### CRANKSHAFT OIL CLEARANCE (PLASTIGAGE METHOD)

Oil clearance can be easily measured by using a "plastigage." When using a "plastigage," perform measurement in the following procedure.

1. Fully wipe oil off the outside diameter of the crankshaft and inside diameter of the bearing.
2. Assemble the crankshaft.
3. Place a plastigage in length equal to the bearing width on the journal shaft straight in alignment with the shaft center.
4. Carefully install the bearing cap and tighten the bolt according to the main point of installation >>B<<.
5. Remove the bolt, and then carefully remove the crankshaft bearing cap.



6. Measure the crushed plastigage width (area most widely crushed) using a scale printed on the plastigage bag.

**Standard value:**

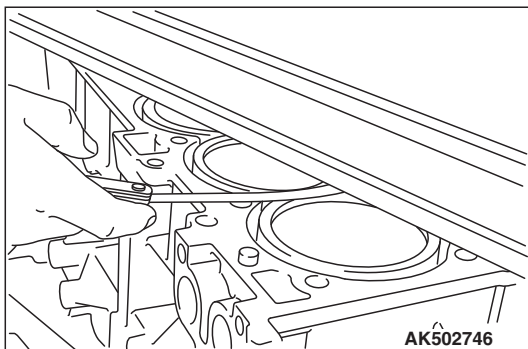
**No. 1, 2, 4, 5: 0.039 –0.065 mm (0.0015 –0.0026 inch)**

**No. 3: 0.051 –0.077 mm (0.0020 –0.0030 inch)**

**Limit: 0.10 mm (0.004 inch)**

### CYLINDER BLOCK

1. Visually check the cylinder block for scratch, rust and corrosion. Use a flaw detecting agent to check for cracks. If it is found faulty, repair or replace it.



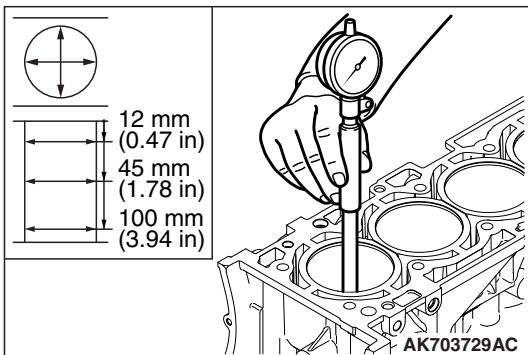
2. Measure distortion on the top surface of the cylinder block using a straight edge and thickness gauge.  
If distortion exceeds the limit, grind and repair it.  
A gasket or the like must not be adhered to the top surface of the cylinder block during measurement.

**Distortion on bottom**

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

**Limit: 0.2 mm (0.01 inch)**

**Grinding limit: 0.2 mm (0.01 inch)**



3. Check the cylinder bore for scoring or seizure. If faulty, correct (boring) or replace.
4. Measure the bore and cylindricity of the cylinder using a cylinder gauge.  
If the cylinder is excessively worn, repair the cylinder and replace the piston and piston rings.  
Measuring points are as shown in the illustration.

**Standard value**

**Cylinder bore: 86 mm (3.4 inches)**

**Cylindricity: 0.010 mm or less (0.0004 inch)**

**BORING CYLINDERS**

1. Oversize pistons should be based on the largest bore cylinder.

Size	Size mark
0.25 mm (0.010 inch) oversize	25

*NOTE: The size mark is stamped on the piston top.*

2. In case of 0.25 mm (0.010 inch) oversized piston, a hole shall be bored through the cylinder block so that the clearance can have the standard value. The standard measuring point for the outside piston diameter is at shown in the illustration.
3. Based on the measured piston outside diameter (O.D.), calculate the boring finish dimension.

**Boring finish dimension = Piston O.D. + 0.03 –0.05 mm (0.001 –0.002 inch) <Clearance between piston O.D. and cylinder> –0.02 mm (0.001 inch) <honing margin>**

4. Bore each cylinders to the calculated boring finish dimension.

**CAUTION**

**To prevent distortion caused by heat increased during boring, bore the cylinders in the following order: No.2, No.1, No.3.**

- 5.hone the cylinders to the final finish dimension (piston O.D. + piston-to-cylinder clearance).
6. Check the clearance between the pistons and cylinders.

**Standard value: 0.03 –0.05 mm (0.001 –0.002 inch)**

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

