

GROUP 11F

ENGINE OVERHAUL

<2.4L ENGINE>

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GENERAL SPECIFICATIONS

M1113000202214

Item			Specifications
Engine model			4B12
Bore × stroke mm (in)			88.0 (3.46) × 97.0 (3.82)
Total displacement cm ³ (cu in)			2,359 (143.9)
Combustion chamber			Pent-roof type
Number of cylinders			4
Valve mechanism	Type	DOHC	
	Intake valve	8	
	Exhaust valve	8	
Compression ratio			10.5
Valve timing	Intake valve	Opens	40° BTDC –0° BTDC
		Closes	64° ABDC –24° ABDC
	Exhaust valve	Opens	24° BBDC –44° BBDC
		Closes	0° ATDC –20° ATDC
Fuel injection system type			Electronic control MPI
Ignition system type			Electronic spark-advance control type (4-coil type)
Generator type			Alternating current system (with built-in IC regulator)
Starter motor type			Reduction drive type

SERVICE SPECIFICATIONS

M1113000303151

Item		Standard value	Limit
Timing chain			
Valve clearance mm (in)	Intake	0.20 ± 0.03 (0.008 ± 0.001)	–
	Exhaust	0.30 ± 0.03 (0.012 ± 0.001)	–
Camshaft			
Cam height of camshaft mm (in)	Intake	44.1 (1.736)	43.6 (1.717)
	Exhaust	45.0 (1.772)	44.5 (1.752)
Camshaft oil clearance mm (in)		0 –0.032 (0.0013)	–
Cylinder head and valves			
Distortion of cylinder head bottom mm (in)		Within 0.05 (0.002)	0.2 (0.008)
Grinding limit of cylinder head bottom mm (in)		–	0.2 (0.008)
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)		47.2 (1.858)	46.2 (1.819)

Item		Standard value	Limit
Squareness of valve spring		2° or less	4°
Clearance between valve guide and valve stem mm (in)	Intake	0.020 –0.047 (0.0008 – 0.0019)	0.10 (0.0039)
	Exhaust	0.030 –0.054 (0.0012 – 0.0021)	0.11 (0.0043)
Valve seat contact width mm (in)	Intake	1.16 –1.46 (0.046 –0.058)	–
	Exhaust	1.35 –1.65 (0.053 –0.065)	–
Valve guide press-in height mm (in)		14.6 –15.2 (0.57 –0.60)	–
Piston and connecting rod			
Piston pin press-fit load N (lbf)		7,500 –17,500 (1.686 – 3.934)	–
Clearance between piston ring and ring groove mm (in)	Number 1	0.03 –0.07 (0.001 –0.003)	0.1 (0.004)
	Number 2	0.03 –0.07 (0.001 –0.003)	0.1 (0.004)
Piston ring end gap mm (in)	Number 1	0.15 –0.25 (0.006 –0.011)	0.8 (0.03)
	Number 2	0.25 –0.40 (0.010 –0.016)	0.8 (0.03)
	Oil	0.10 –0.35 (0.004 –0.014)	1.0 (0.04)
Clearance of connecting rod big end thrust mm (in)		0.10 –0.25 (0.004 –0.010)	0.4 (0.016)
Difference of outside diameter of connecting rod bolt mm (in)		–	0.1 (0.04)
Connecting rod bearing oil clearance mm (in)		0.018 –0.045 (0.0007 – 0.0018)	0.1 (0.04)
Crankshaft and cylinder block			
Under head length of crankshaft bearing cap bolt mm (in)		75.5 –76.5 (2.972 –3.012)	–
Crankshaft end play mm (in)		0.05 –0.25 (0.002 –0.010)	0.4 (0.016)
Crankshaft journal oil clearance mm (in)		0.012 –0.030 (0.0005 – 0.0012)	0.08 (0.0031)
Distortion of cylinder block top surface mm (in)		Within 0.05 (0.002)	0.2 (0.008)
Grinding limit of cylinder block top surface mm (in)		–	0.2 (0.008)
Cylinder block cylinder bore mm (in)		88 (3.46)	–
Cylindricity of cylinder block mm (in)		0.0076 (0.0003)	–

REWORK DIMENSIONS

M1113024301074

Item			Standard value
Cylinder head and valve			
Cylinder head oversize valve seat bore diameter mm (in)	Intake	0.30 Over size	36.22 –36.24 (1.426 –1.427)
	Exhaust	0.30 Over size	30.22 –30.24 (1.190 –1.191)
Cylinder head oversize valve guide bore diameter mm (in)		0.25 Over size	11.23 –11.25 (0.442 –0.443)

TORQUE SPECIFICATIONS

M1113023404323

Item	Specification
Generator and ignition system	
Idle pulley bolt	48 ± 7 N· m (36 ± 4 ft-lb)
Auto tensioner bolt	22 ± 4 N· m (17 ± 2 ft-lb)
Crankshaft pulley center bolt	210 N· m (155 ft-lb)
Generator nut	44 ± 10 N· m (32 ± 7 ft-lb)
Generator bolt	44 ± 10 N· m (32 ± 7 ft-lb)
Ignition coil bolt	10 ± 2 N· m (89 ± 17 in-lb)
Spark plug	25 ± 5 N· m (18 ± 3 ft-lb)
Power steering pump bracket bolt (M8)	26 ± 3 N· m (19 ± 2 ft-lb)
Power steering pump bracket bolt (M10)	44 ± 8 N· m (32 ± 5 ft-lb)
Throttle body and EGR system	
Vacuum pipe and hose bolt	11 ± 1 N· m (98 ± 8 in-lb)
Throttle body bolt	9.5 ± 2.5 N· m (84 ± 22 in-lb)
Throttle body stay bolt	20 ± 2 N· m (15 ± 1 ft-lb)
EGR valve support bolt	20 ± 2 N· m (15 ± 1 ft-lb)
EGR pipe bolt	20 ± 2 N· m (15 ± 1 ft-lb)
EGR support stay A bolt	20 ± 2 N· m (15 ± 1 ft-lb)
EGR support stay B bolt	20 ± 2 N· m (15 ± 1 ft-lb)
EGR valve bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Manifold absolute pressure (MAP) sensor screw	4.0 ± 1.0 N· m (36 ± 8 in-lb)
Solenoid valve screw	4.0 ± 1.0 N· m (36 ± 8 in-lb)
Intake manifold and fuel system	
Oil dipstick guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Injector protector rear bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Fuel rail bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Intake manifold bolt and nut	3.5 ± 1.5 N· m (31 ± 13 in-lb) → 20 ± 2 N· m (15 ± 1 ft-lb)

Item	Specification
Intake manifold stay bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Injector protector front bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Generator bracket bolt	44 ± 8 N· m (33 ± 5 ft-lb)
Detonation sensor bolt	20 ± 2 N· m (15 ± 1 ft-lb)
Engine oil pressure switch	10 ± 2 N· m (89 ± 17 in-lb)
Exhaust manifold	
Exhaust manifold upper cover bolt	14 ± 1 N· m (124 ± 8 in-lb)
Exhaust manifold lower cover bolt	14 ± 1 N· m (124 ± 8 in-lb)
Exhaust manifold nut	49 ± 5 N· m (36 ± 3 ft-lb)
Exhaust manifold bracket D bolt (M8)	20 ± 5 N· m (15 ± 3 ft-lb)
Exhaust manifold bracket A, B bolt (M10)	41 ± 10 N· m (30 ± 7 ft-lb)
Crankshaft position sensor bolt	11 ± 1 N· m (98 ± 8 in-lb)
Crankshaft position sensor cover bolt	11 ± 1 N· m (98 ± 8 in-lb)
Water hose and pipe	
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)
Engine hanger bolt	28 ± 8 N· m (21 ± 5 ft-lb)
Engine coolant temperature sensor	30 ± 9 N· m (22 ± 6 ft-lb)
Water pump bolt	24 ± 3 N· m (18 ± 1 ft-lb)
Water pipe nut	24 ± 3 N· m (18 ± 1 ft-lb)
Camshaft position sensor bolt	11 ± 1 N· m (98 ± 8 in-lb)
Oil pan and timing chain case	
Cylinder head cover bolt	3.0 ± 1.0 N· m (27 ± 8 in-lb) → 5.5 ± 0.5 N· m (49 ± 4 in-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 × 28)	24 ± 4 N· m (18 ± 2 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)
Air compressor bracket bolt	23 ± 6 N· m (17 ± 4 ft-lb)
Oil drain plug	39 ± 5 N· m (29 ± 3 ft-lb)
Oil filter	14 ± 2 N· m (124 ± 17 in-lb)
Positive Crankcase Ventilation Valve	2.5 ± 0.4 N· m (22 ± 3 in-lb)
Engine support bracket bolt (M8)	23 ± 2 N· m (17 ± 1 ft-lb)
Engine support bracket bolt (M10)	45 ± 5 N· m (33 ± 3 ft-lb)
Timing chain	
Chain upper 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	59 ± 5 N· m (44 ± 3 ft-lb)

Item	Specification
V.V.T. exhaust sprocket bolt	59 ± 5 N· m (44 ± 3 ft-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)
Camshaft	
Engine oil control valve (OCV) bolt	10 ± 2 N· m (89 ± 17 in-lb)
Camshaft bearing cap bolt (M6)	12 ± 1 N· m (107 ± 8 in-lb)
Front camshaft bearing cap bolt (M8)	17 ± 3 N· m (14 ± 2 ft-lb) → 30 ± 2 N· m (22 ± 1 ft-lb)
Cylinder head and valves	
Cylinder head bolt	35 ± 2 N· m (26 ± 1 ft-lb) → +90° +90°
Balancer chain	
Drive plate bolt	40 N· m (30 ft-lb) → 130 N· m (95 ft-lb)
Flywheel bolt	40 N· m (30 ft-lb) → 130 N· m (95 ft-lb)
Balancer shaft module bolt	20 N· m (15 ft-lb) → 44 N· m (32 ft-lb) → 0 → 20 N· m (15 ft-lb) → +135°
Balancer shaft chain tensioner bolt	10 ± 2 N· m (89 ± 17 in-lb)
Lever tensioner bolt	10 ± 2 N· m (89 ± 17 in-lb)
Balancer shaft chain guide bolt	10 ± 2 N· m (89 ± 17 in-lb)
Ladder frame bolt	26 ± 1 N· m (19 ± 1 ft-lb)
Piston and connecting rod	
Connecting rod cap bolt	5.0 N· m (44 in-lb) → 20 N· m (15 ft-lb) → +90°
Crankshaft and cylinder block	
Crankshaft sensing ring bolt	11 ± 1 N· m (98 ± 8 in-lb)
Bearing cap bolt	26.5 ± 2.0 N· m (20 ± 1 ft-lb) → +45°

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 body of the manual 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 tightening torque, further tighten 90° 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

M1113000503133

Points of application	Specified sealant / adhesive
Drive plate bolt	Three bond 1324 or equivalent
Oil pan	Three bond 1227D, Three bond 1217G (Mitsubishi Part No,1000A923), Three bond 1207F (Mitsubishi Part No,1000A992), LOCTITE 5971, LOCTITE 5900, LOCTITE 5970 or equivalent
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), or equivalent
Ladder frame	
Cylinder head gasket (matching area of the cylinder block and the cylinder head)	Three bond 1217G (Mitsubishi Part No,1000A923), or exact equivalent
Timing chain case	
Engine coolant temperature sensor	Three bond 1324N, LOCTITE 262 or equivalent
Engine oil pressure switch	Three bond 1212D, Three bond 1215 or equivalent

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

LIQUID GASKET (FIPG)

FIPG is used for some parts in the engine. It is necessary to pay attention to an application amount, application procedure and applied surface condition for this gasket to fully achieve its purpose. Too small amount causes leakage while too much amount squeezes out to block or narrow water and oil passages. Therefore, it is absolutely essential to apply a correct amount of liquid sealant continuously without break to eliminate leakage from joints. FIPG used for engine parts hardens reacting with moisture in the air, and is usually used for metal flanges.

⚠ 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.**

tion. Do not pour oil or water on applied locations or do not start the engine until sufficient time (approximately one hour) passes. The application procedure

DISASSEMBLY

Parts assembled with FIPG can be easily disassembled without using a special method. In some cases, however, it is necessary to lightly tap parts with a wooden hammer or similar tool to break sealant between mating surfaces. Or lightly driving a smooth and thin gasket scraper in mating surfaces is useful, but full care must be exercised not to damage mating surfaces. As special tool oil pan FIPG cutter (MD998727) is set, use this tool.

CLEANING OF GASKET SURFACE

Completely remove all deposits from the gasket surface with a gasket scraper or wire brush. Make sure that the surface to which FIPG is applied is smooth. The gasket surface must be free from grease and foreign substances. Be sure to remove old FIPG that has entered mounting holes and screw holes.

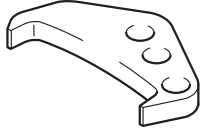
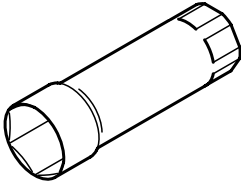
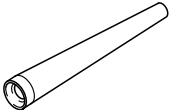
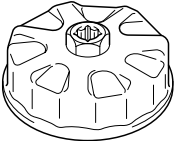
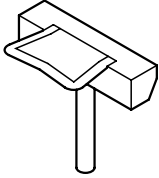
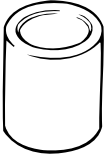
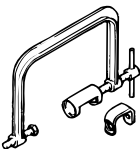
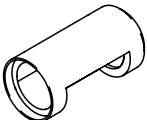
APPLICATION PROCEDURE

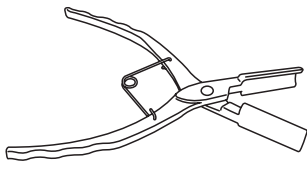
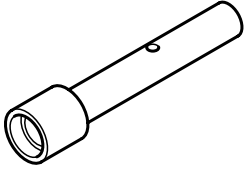
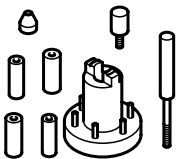
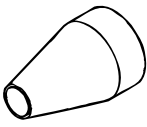
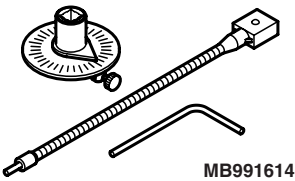
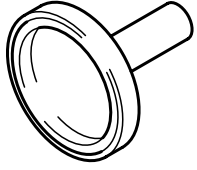
Apply FIPG in a determined diameter and continuously without break. Completely enclose the periphery of mounting holes. FIPG can be wiped off if it is not hardened. Install parts in place while FIPG is still wet. Take care not to allow FIPG to adhere to other locations than necessary locations during installa-

of FIPG may differ depending on areas. Follow the procedure in the body of the manual to apply FIPG.

SPECIAL TOOLS

M1113000602557

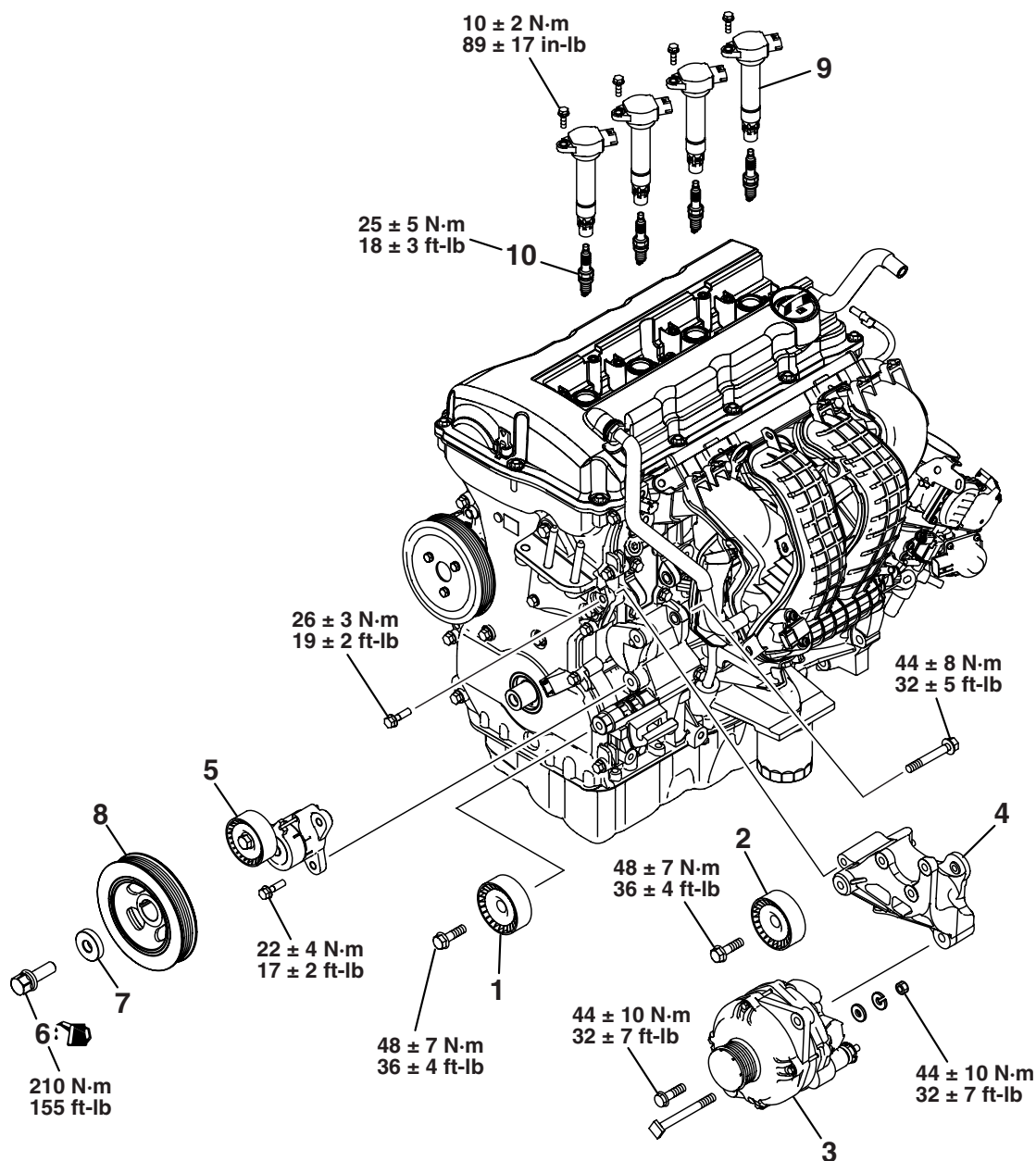
Tool	Tool number and name	Supersession	Application
 MB991883	MB991883 Flywheel stopper	—	Securing of drive plate
	MB991398 Spark plug wrench	—	Removal and installation of spark plug
 B992106	MB992106 O-ring installer	—	Installation of O-ring on injector injection nozzle side
 B991396	MB991396 Oil filter wrench	—	Removal and installation of oil filter
 D998727	MD998727 Oil pan FIPG cutter	MD998727-01	Removal of oil pan
	MB991448 Bushing 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	

Tool	Tool number and name	Supersession	Application
	MB992085 Valve stem seal pliers	—	Extraction of valve stem seal
	MD998737 Valve stem seal installer	MD998737-01	Installation of valve stem seal
	MD998780 Piston pin setting tool	MIT216941	Extraction and press fit of piston pin
	MB991659 Guide D	—	
 MB991614	MB991614 Angle gauge	General service tool	Installation of crankshaft bearing cap bolt and installation of balancer shaft module bolt
	MD998718 Rear oil seal installer	MD998718-01	Press fit of rear oil seal

GENERATOR AND IGNITION SYSTEM

REMOVAL AND INSTALLATION

M1113001002310



AK600613AJ

Removal steps

- >>C<< 1. Idler pulley
>>C<< 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
<> >>A<< 9. Ignition coil
10. Spark plug

Required Special Tool:

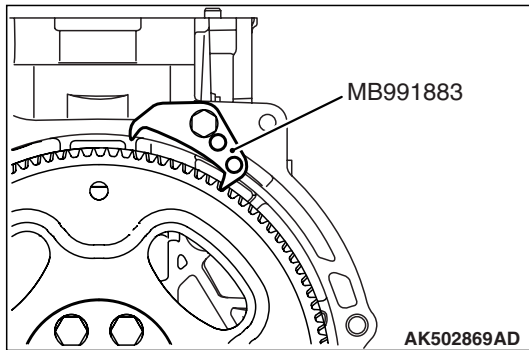
- MB991883: Flywheel Stopper

- MB991398: Spark plug wrench

REMOVAL SERVICE POINTS

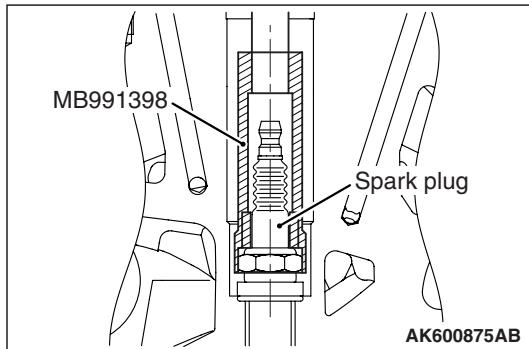
<<A>> CRANKSHAFT PULLEY CENTER BOLT REMOVAL

1. Use special tool MB991883, to secure the drive plate.
2. Remove the crankshaft pulley center bolt.



<> SPARK PLUG REMOVAL

Using special tool MB991398, removal the spark plug.

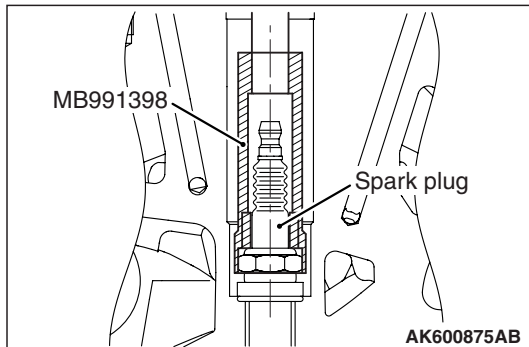


INSTALLATION SERVICE POINTS

>>A<< SPARK PLUG INSTALLATION

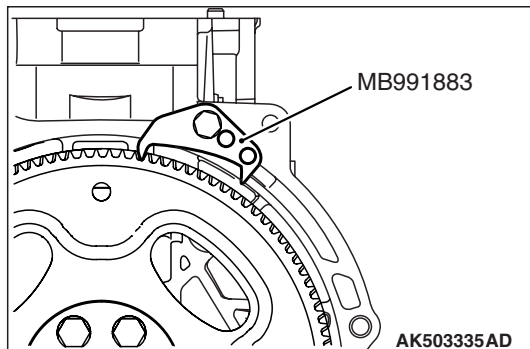
Use special tool MB991398, tighten the spark plug to specified tightening torque.

Tightening torque: 25 ± 5 N·m (18 ± 3 ft-lb)

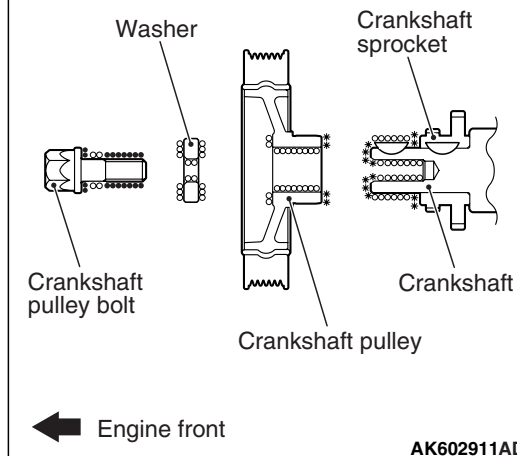


>>B<< CRANKSHAFT PULLEY / CRANKSHAFT
PULLEY WASHER / CRANKSHAFT PULLEY
CENTER BOLT INSTALLATION

1. Use special tool MB991883, to secure the drive plate.



- : 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.



2. Wipe the dirt on the crankshaft pulley washer and on the thread hole of the crankshaft using a rag.
 3. Wipe 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 the chamfered side on the inside of the crankshaft pulley washer facing the bolt top, install the crankshaft pulley washer to the crankshaft pulley center bolt.
 7. Tighten the crankshaft pulley center bolt to the specified tightening torque.

Tightening torque: 210 N·m (155 ft-lb)

>>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.

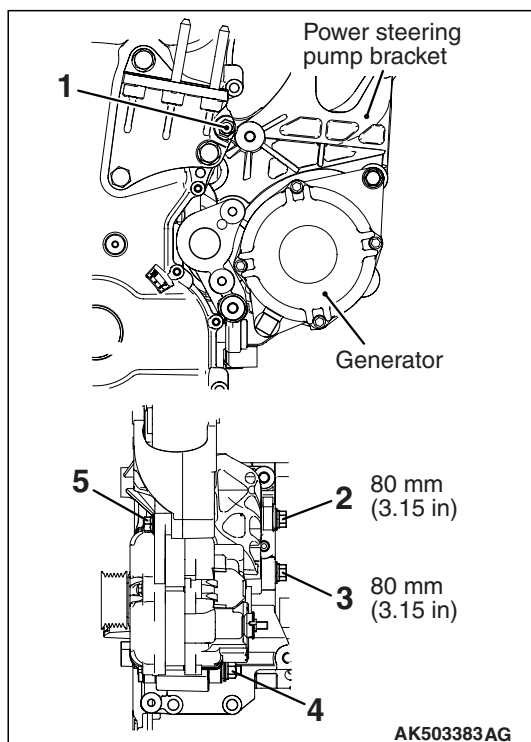
Specified torque

Power steering pump bracket:

M8 26 ± 3 N·m (19 \pm 32 ft-lb)

M10 44 ± 8 N·m (32 \pm 5 ft-lb)

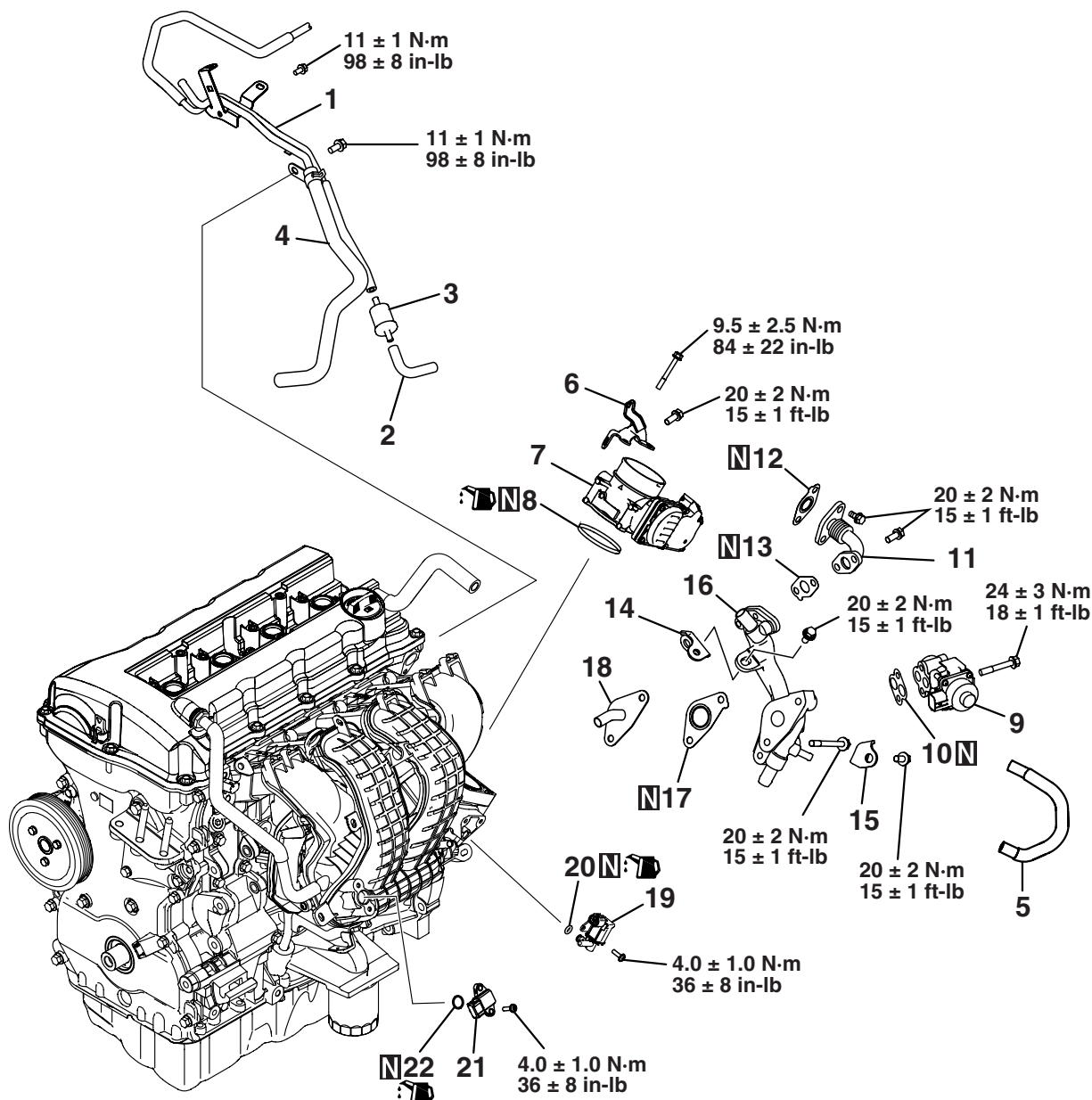
Generator: 44 ± 10 N·m (32 \pm 7 ft-lb)



THROTTLE BODY AND EGR SYSTEM

REMOVAL AND INSTALLATION

M1113032700416



AK900341AD

Removal steps

- 1. Vacuum pipe and hose
- 2. Purge hose
- 3. Chamber
- 4. Purge hose
- 5. Water hose
- 6. Throttle body stay
- >>D<< 7. Throttle body
- >>D<< 8. Throttle body gasket
- >>C<< 9. Exhaust gas recirculation valve
- >>C<< 10. Exhaust gas recirculation valve gasket
- 11. EGR pipe
- >>B<< 12. EGR pipe gasket

Removal steps (Continued)

- >>B<< 13. EGR valve support gasket
- 14. EGR support stay A
- 15. EGR support stay B
- 16. Exhaust gas recirculation valve support
- >>B<< 17. EGR inlet pipe gasket
- 18. EGR inlet pipe
- 19. Solenoid valve
- 20. O-ring
- >>A<< 21. Manifold absolute pressure (MAP) sensor
- 22. O-ring

INSTALLATION SERVICE POINTS

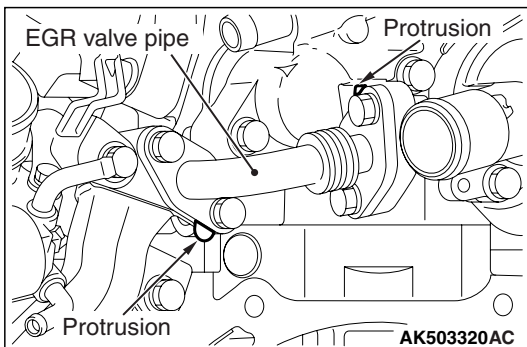
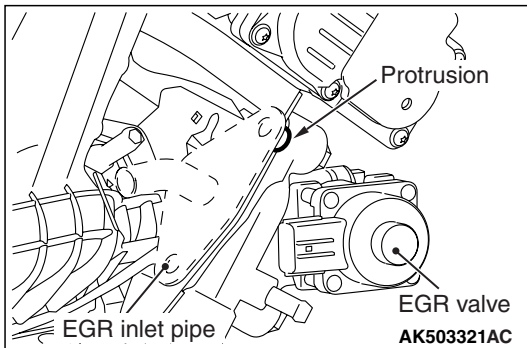
>>A<< MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR INSTALLATION

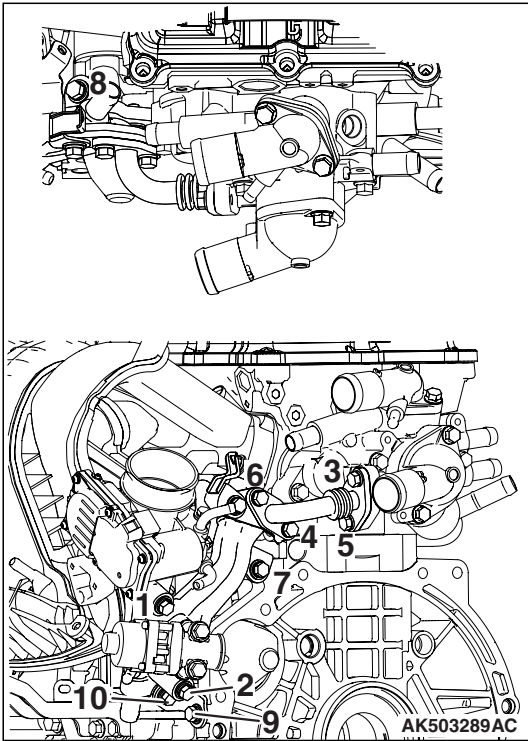
CAUTION

- 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 fallen down.

>>B<< EGR INLET PIPE GASKET / EGR VALVE SUPPORT GASKET / EGR PIPE GASKET INSTALLATION

1. Temporarily tighten each part so that the protrusion of each gasket is positioned as illustrated.



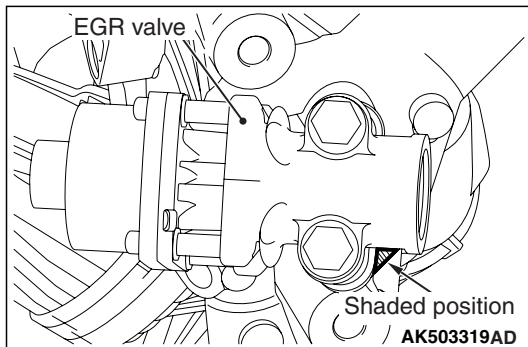


2. Tighten mounting bolts to the specified tightening torque in the order shown in the illustration.

Tightening torque: 20 ± 2 N·m (15 ± 1 ft-lb)

>>C<< EXHAUST GAS RECIRCULATION VALVE GASKET INSTALLATION

Install the Exhaust gas recirculation valve gasket with the diagonally shaded area used as the illustrated position so as not to confuse the front with the back.



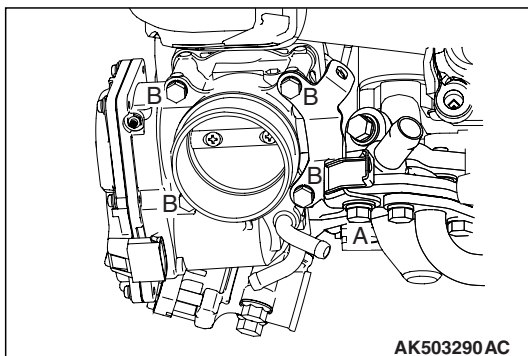
>>D<< THROTTLE BODY GASKET / THROTTLE BODY INSTALLATION

1. Make sure that the throttle body gasket is placed before installing the throttle body.
2. Temporarily tighten throttle body and throttle body stay mounting bolts at A and B in the illustration.
3. Tighten the throttle body mounting bolt at illustrated position A to the specified torque.

Tightening torque: 20 ± 2 N·m (15 ± 1 ft-lb)

4. Tighten the throttle body mounting bolts at illustrated position B to the specified tightening torque.

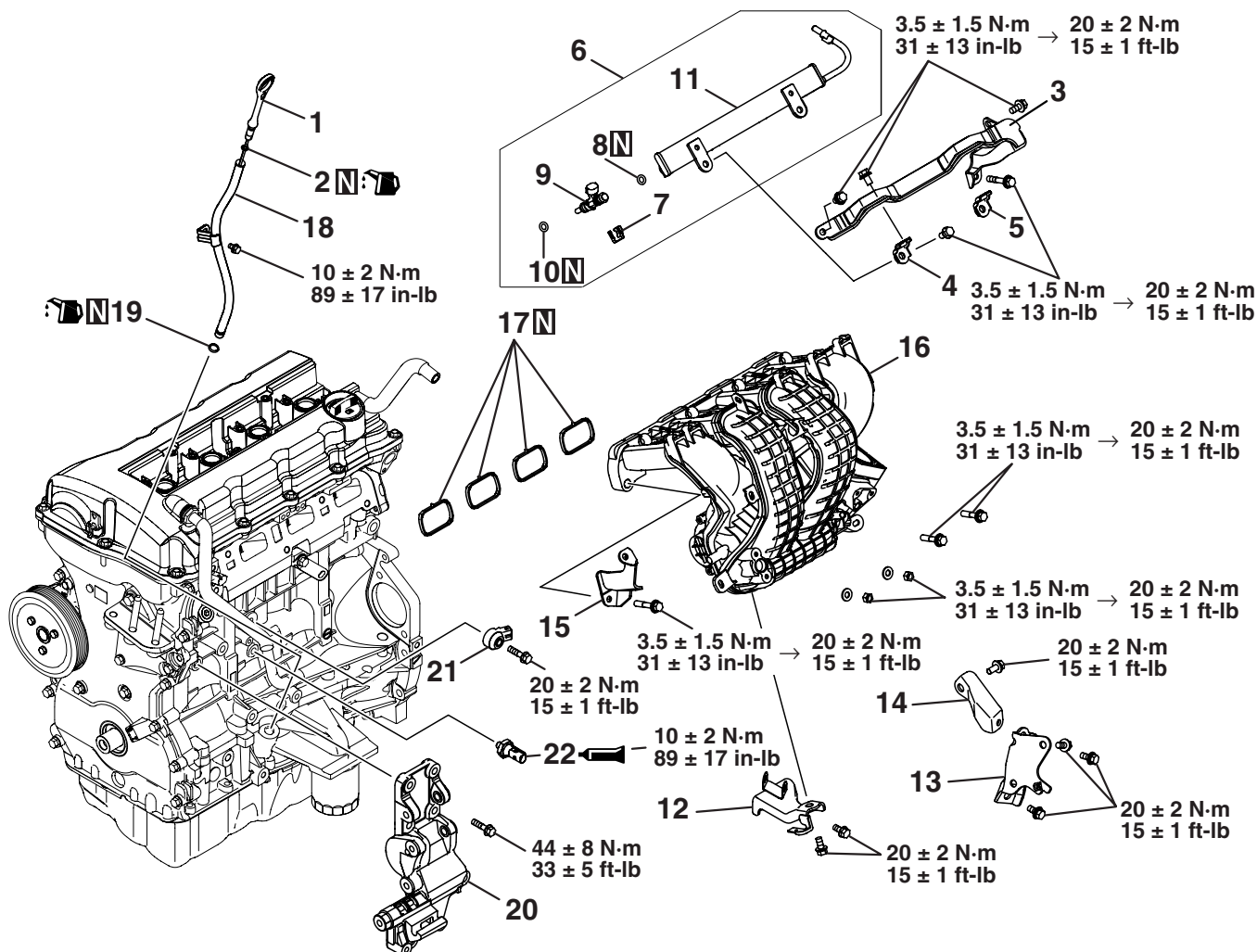
Tightening torque: 9.5 ± 2.5 N·m (84 ± 22 in-lb)



INTAKE MANIFOLD AND FUEL SYSTEM

REMOVAL AND INSTALLATION

M1113032500928



AK703791AC

Removal steps

1. Oil dipstick rod
2. O-ring
- >>G<< 3. Injector protector rear
- >>G<< 4. Bracket
- >>G<< 5. Bracket
- >>G<< 6. Fuel rail assembly
- >>F<< 7. Injection support
8. O-ring
- >>F<< 9. Injector
- >>E<< 10. O-ring
11. Fuel rail

Removal steps (Continued)

- >>D<< 12. Intake manifold stay
13. Intake manifold stay B
14. Intake manifold stay C
15. Injector protector front
- >>C<< 16. Intake manifold
17. Intake manifold gasket
18. Oil dipstick guide
19. O-ring
- >>B<< 20. Generator bracket
21. Detonation sensor
- >>A<< 22. Engine oil pressure switch

Required Special Tool:

- MB992106: O-ring installer

INSTALLATION SERVICE POINTS

>>A<< ENGINE OIL PRESSURE SWITCH INSTALLATION

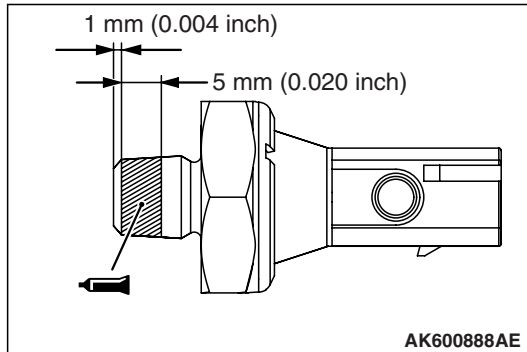
⚠ CAUTION

- Do not allow sealant to squeeze out to the screw tip.
- Do not tighten, exceeding the specified tightening torque.

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

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

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

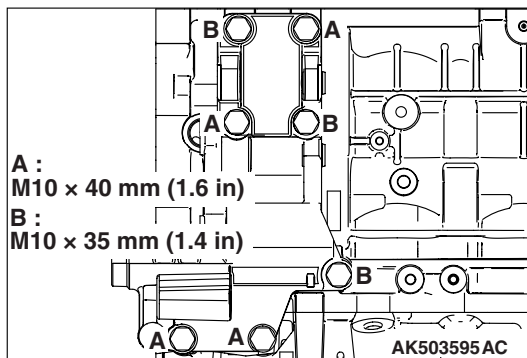
Tightening torque: 10 ± 2 N·m (89 ± 17 in-lb)

>>B<< GENERATOR BRACKET INSTALLATION

Tighten the Generator bracket to the specified tightening torque.

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

NOTE: Be careful to install mounting bolts because they are different in length.



>>C<< INTAKE MANIFOLD INSTALLATION

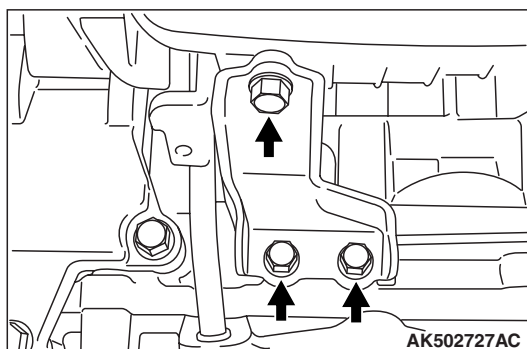
⚠ CAUTION

Temporarily tighten the inlet manifold because there is a bolt tightening procedure for the inlet manifold, delivery pipe and injector protector.

Tighten each inlet manifold bolt and nut to the temporarily torque of 3.5 ± 1.5 N·m (31 ± 13 in-lb).

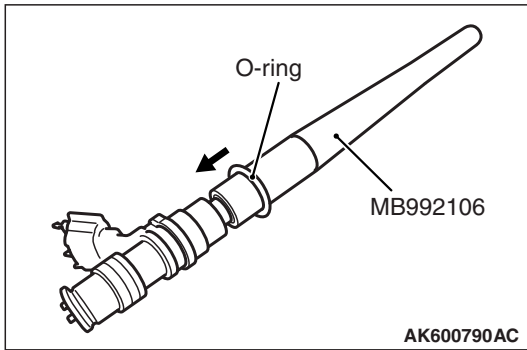
>>D<< INLET MANIFOLD STAY INSTALLATION

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

Tightening torque: 20 ± 2 N·m (15 ± 1 ft-lb)

>>E<< O-RING INSTALLATION

1. Apply gasoline to the O-ring.
2. 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.

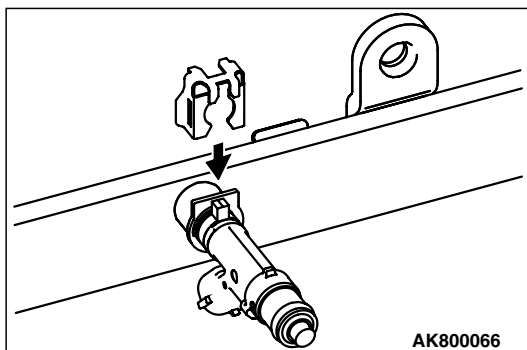
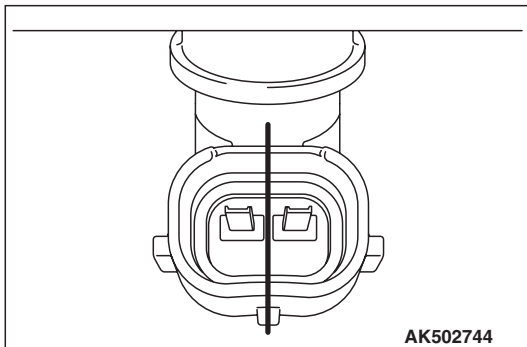


>>F<< INJECTOR AND INJECTOR SUPPORT INSTALLATION

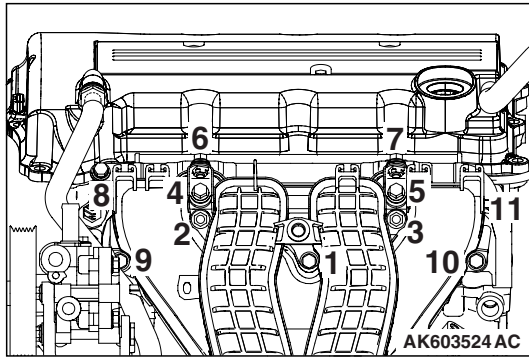
CAUTION

Do not allow gasoline to enter the delivery pipe.

1. Apply gasoline to the O-ring of the injector.
2. Insert the injector into the delivery pipe 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 delivery pipe 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 delivery pipe collar.

**>>G<< FUEL RAIL ASSEMBLY / BRACKET /
INJECTOR PROTECTOR REAR INSTALLATION**

1. Install the delivery pipe assembly, bracket and injector protector rear on the cylinder head.
2. Tighten mounting bolts together with temporarily tightened inlet manifold mounting bolts in the order shown in the illustration.
3. Tighten the delivery pipe assembly, bracket, injector protector rear and inlet manifold in the order shown in the illustration.

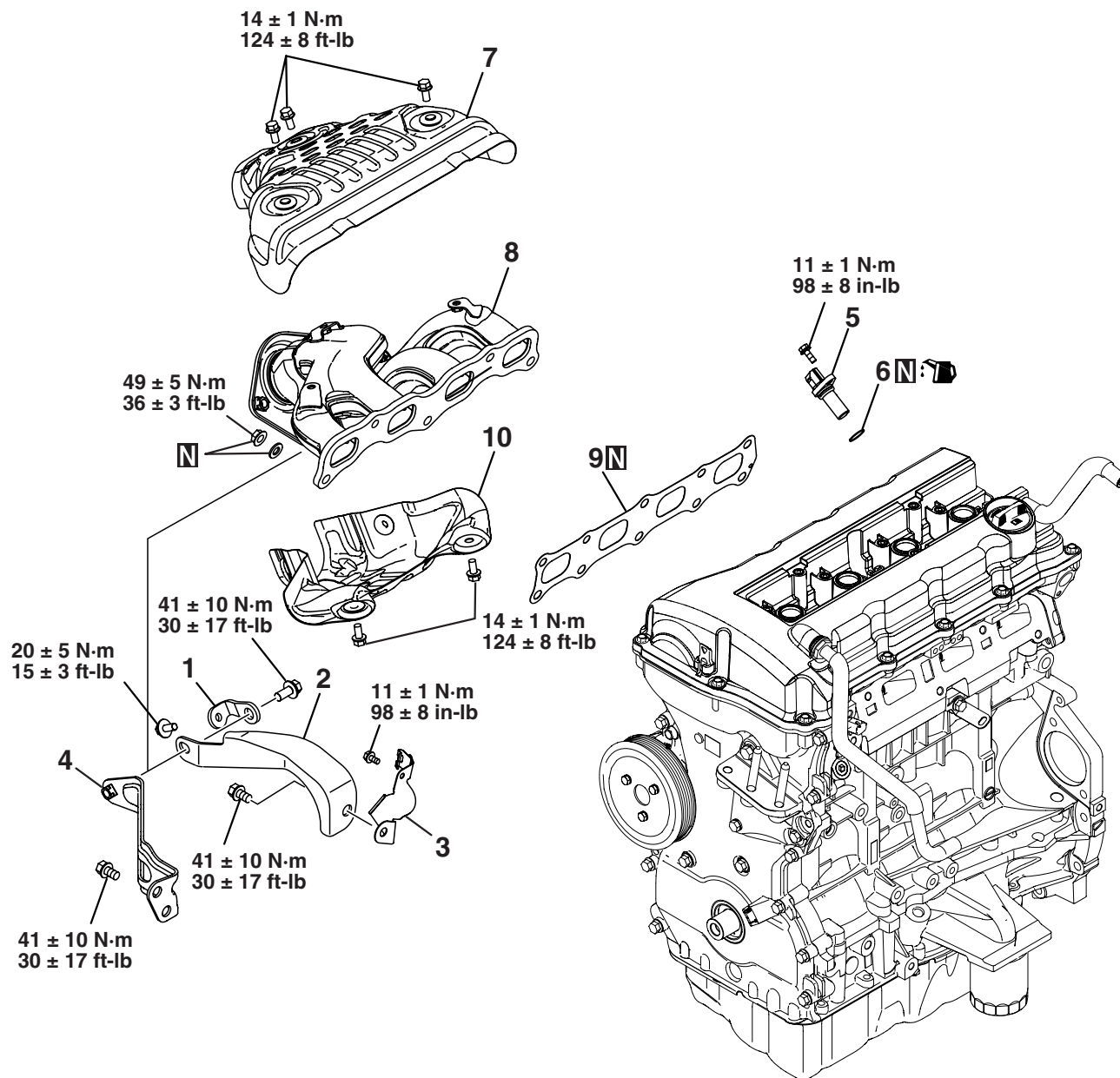
Temporarily torque: $3.5 \pm 1.5 \text{ N} \cdot \text{m}$ ($31 \pm 13 \text{ in-lb}$)

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

EXHAUST MANIFOLD

REMOVAL AND INSTALLATION

M1113011900868



AK603557AF

Removal steps

- >>B<< 1. Exhaust manifold bracket D
- >>B<< 2. Exhaust manifold bracket B
- >>B<< 3. Crankshaft position sensor cover
- >>B<< 4. Exhaust manifold bracket A
- >>A<< 5. Crankshaft position sensor

Removal steps (Continued)

- >>A<< 6. O-ring
- 7. Exhaust manifold upper cover
- 8. Exhaust manifold
- 9. Exhaust manifold gasket
- 10. Exhaust manifold lower cover

INSTALLATION SERVICE POINTS

>>A<< CRANKSHAFT POSITION SENSOR /
O-RING 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 fallen down.

Tighten the crankshaft position sensor to the specified tightening torque of $11 \pm 1 \text{ N} \cdot \text{m}$ ($98 \pm 8 \text{ in} \cdot \text{lb}$).

>>B<< EXHAUST MANIFOLD BRACKET
INSTALLATION**⚠ CAUTION**

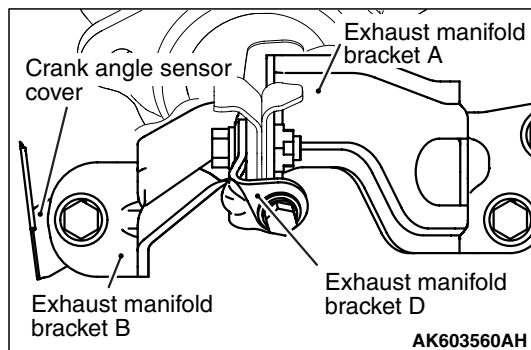
The exhaust manifold gasket, washers and nuts must not be reused.

Make sure that exhaust manifold bracket A is in intimate contact with the exhaust manifold and cylinder block, and then tighten it to the specified tightening torque.

Tightening torque:

M10 × 30: $41 \pm 10 \text{ N} \cdot \text{m}$ ($30 \pm 7 \text{ ft} \cdot \text{lb}$)

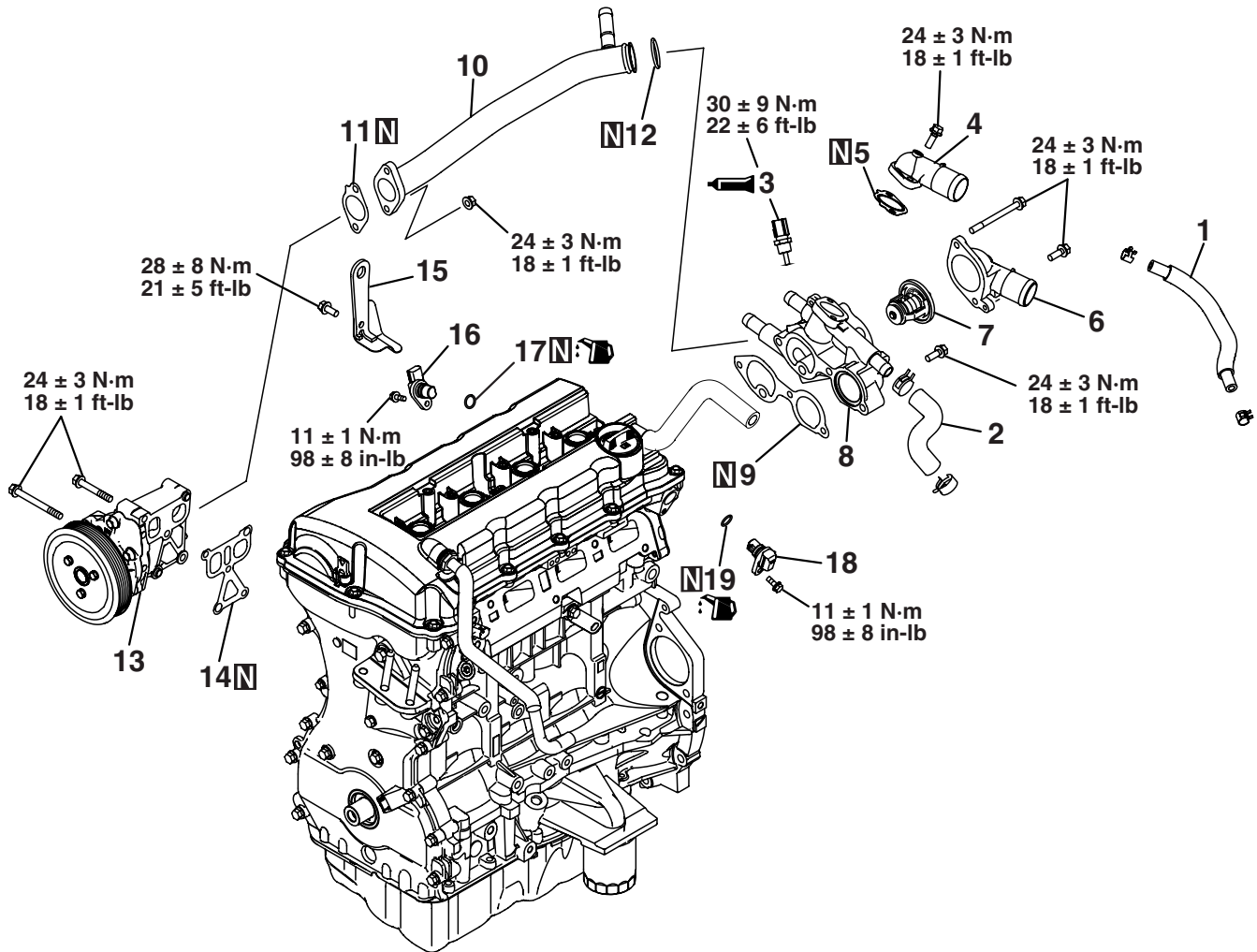
M8 × 20: $20 \pm 5 \text{ N} \cdot \text{m}$ ($15 \pm 3 \text{ ft} \cdot \text{lb}$)



WATER HOSE AND PIPE

REMOVAL AND INSTALLATION

M1113032900562



AK802148AB

Removal steps

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

Removal steps (Continued)

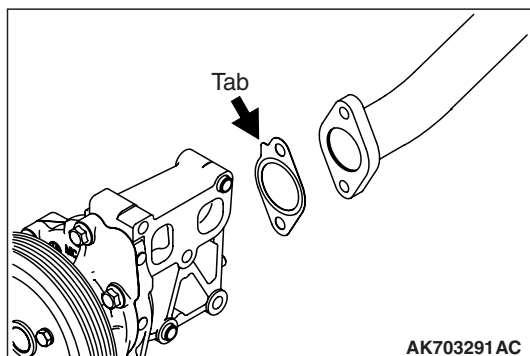
- >>A<< 11. Water pipe gasket
- 12. O-ring
- 13. Water pump assembly
- 14. Water pump gasket
- 15. Engine hanger
- 16. Camshaft position sensor
- 17. O-ring
- 18. Camshaft position sensor
- 19. O-ring

INSTALLATION SERVICE POINTS

>>A<< THERMOSTAT HOUSING / WATER PIPE
ASSEMBLY / WATER PIPE GASKET INSTALLA-
TION

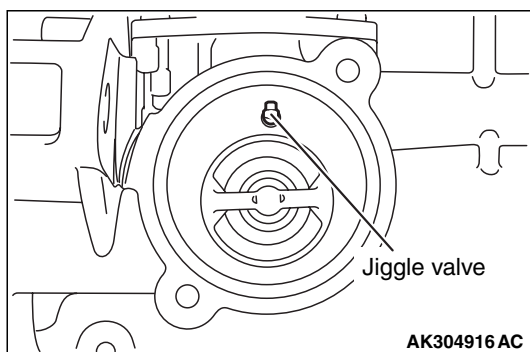
1. Assemble the thermostat housing and water pipe
2. Install the thermostat housing gasket.
3. Install a new water pipe gasket so that the tab is positioned as shown in the illustration.
4. Temporarily tighten them to the cylinder head and water pump. Then tighten them to the specified torque.

Specified torque: 24 ± 3 N·m (18 ± 1 ft-lb)

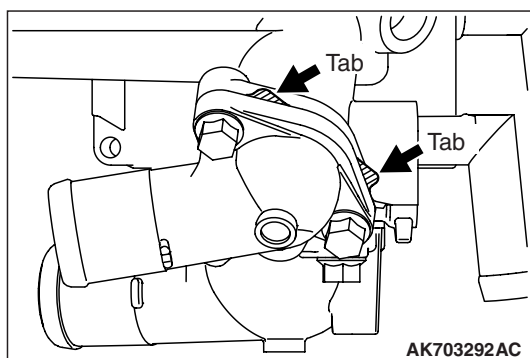


>>B<< THERMOSTAT INSTALLATION

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

>>C<< WATER OUTLET FITTING GASKET
INSTALLATION

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



>>D<< 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.

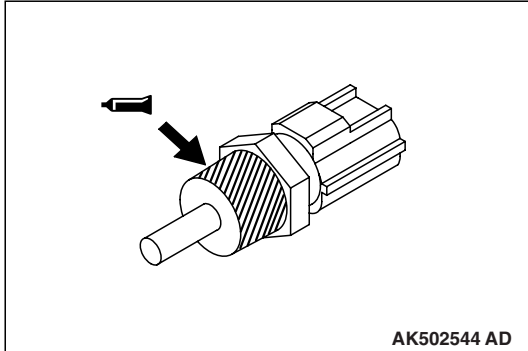
1. Apply an appropriate and minimum amount of sealant to the coolant temperature sensor, taking care not to allow sealant to squeeze out.

Specified sealant:

Three bond 1324N, LOCTITE 262 or equivalent

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

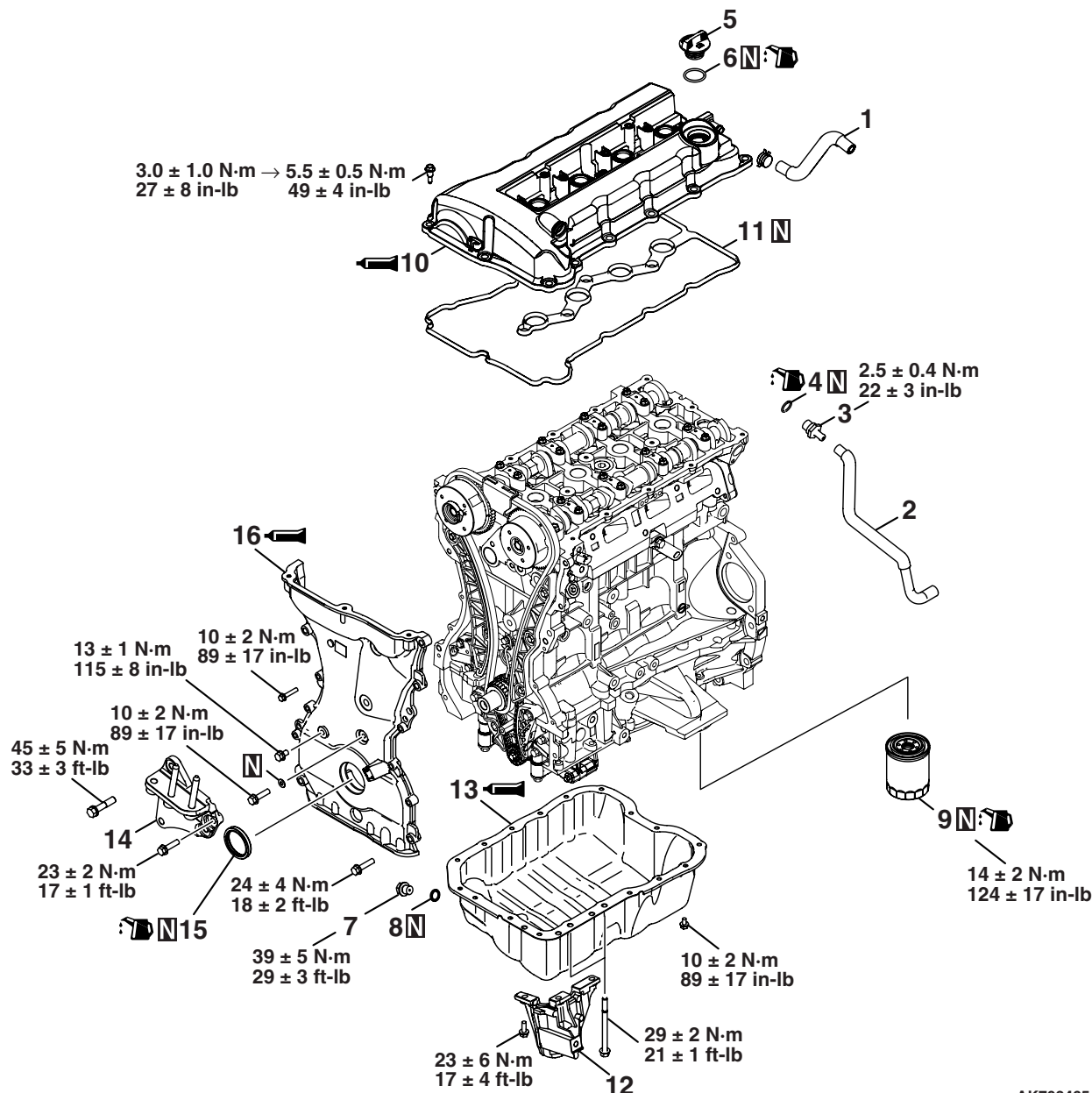
Tightening torque: 30 ± 9 N·m (22 ± 6 ft-lb)



OIL PAN AND TIMING CHAIN CASE

REMOVAL AND INSTALLATION

M1113026301207



Removal steps

1. Breather hose
2. PCV hose
3. Positive Crankcase Ventilation Valve
4. Positive Crankcase Ventilation Valve gasket
5. Oil filler cap
6. O-ring
7. Oil drain plug

Removal steps (Continued)

- | | | |
|-------|-------|--------------------------------|
| <<A>> | >>E<< | 8. Oil drain plug gasket |
| | >>D<< | 9. Oil filter |
| | | 10. Cylinder head cover |
| | | 11. Cylinder head cover gasket |
| | | 12. Air compressor bracket |
| <> | >>C<< | 13. Oil pan |
| | | 14. Engine support bracket |
| | >>B<< | 15. Front oil seal |
| <<C>> | >>A<< | 16. Timing chain case |

AK703465AB

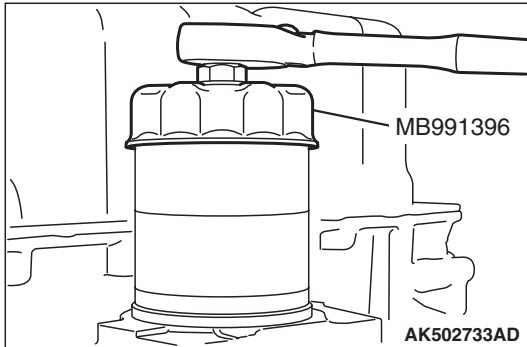
Required Special Tool:

- MB991396: Oil filter wrench
- MD998727: Oil pan FIPG cutter
- MB991448: Bushing remover and installer base

REMOVAL SERVICE POINTS

<<A>> OIL FILTER REMOVAL

Use special tool MB991396 to remove the oil filter.



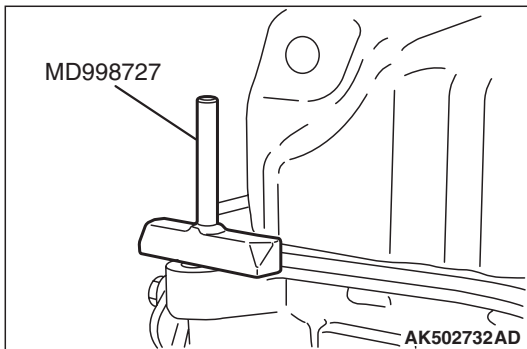
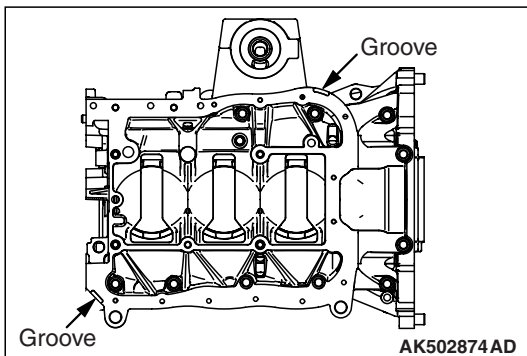
<> OIL PAN REMOVAL

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.

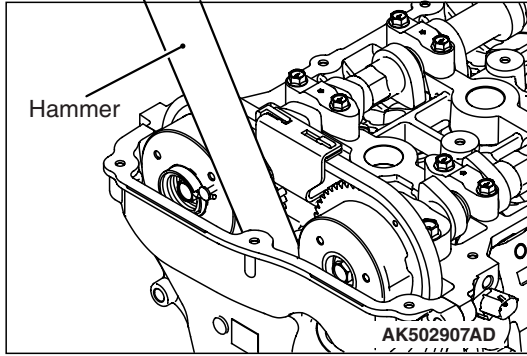
2. Lightly tap special tool oil pan FIPG cutter (MD998727) to drive in the illustrated groove of the oil pan and ladder frame.



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.



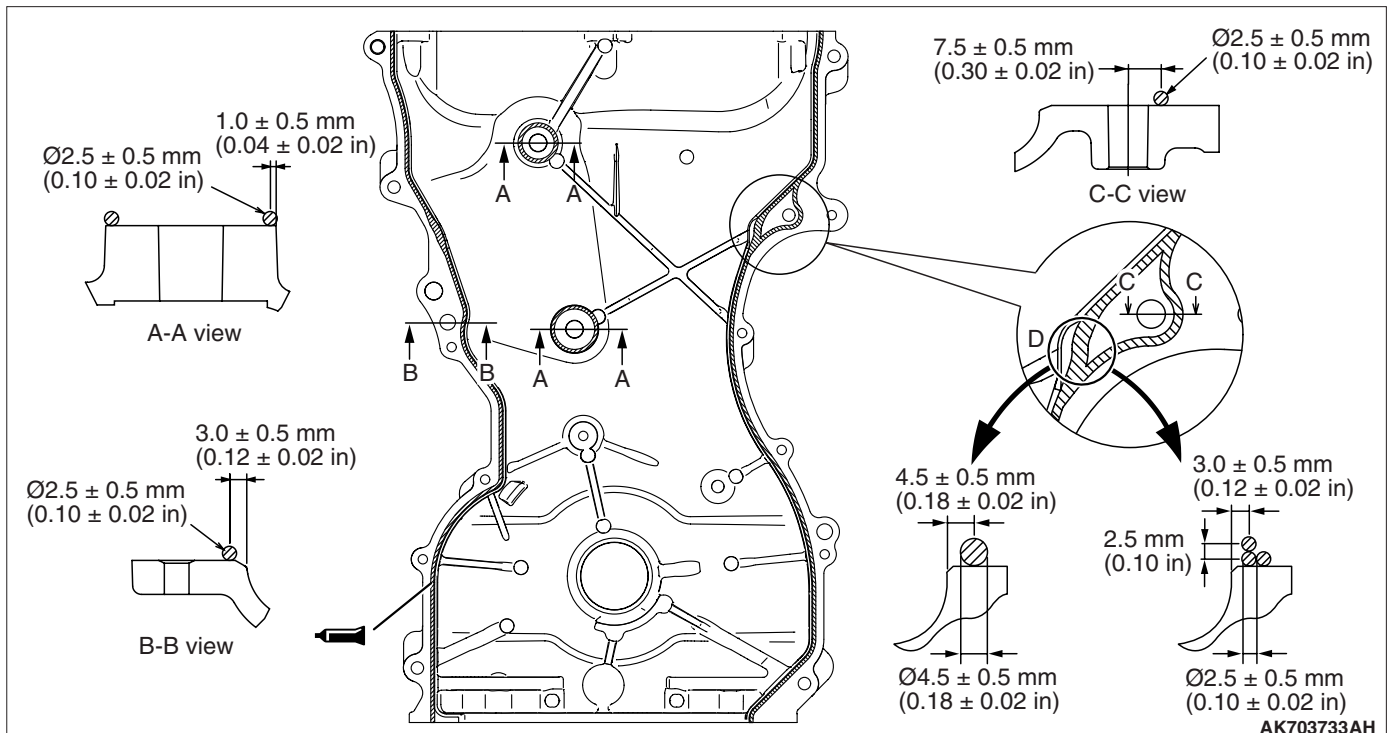
INSTALLATION SERVICE POINTS

>>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 the liquid gasket adhering to the timing chain case, the cylinder block and the cylinder head.
2. Completely remove the sealant remaining on the 3-plane contact surface among the cylinder head, the cylinder block and the gasket. Carry out the degreasing



⚠ CAUTION

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

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

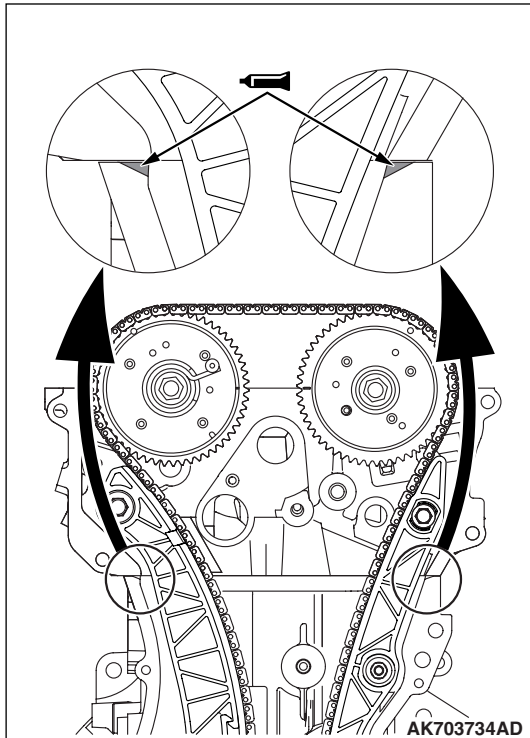
Specified sealant:

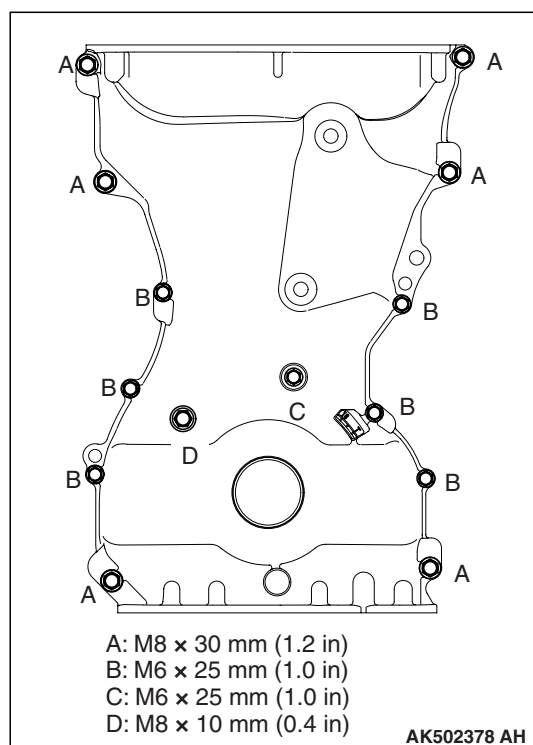
Three bond 1217G or exact equivalent

4. The engine oil staying at the cylinder gasket oozes to the 3-plane contact surface described in Step 2 and 3. Swiftly apply the liquid gasket to this area after degreasing.

Specified sealant:

Three bond 1217G or exact equivalent

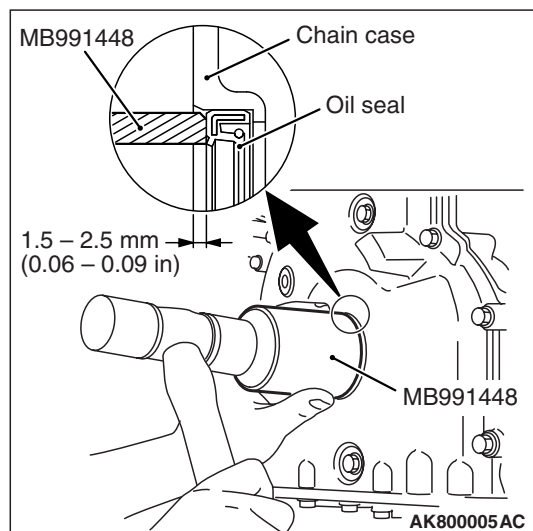




5. Tighten timing chain case mounting bolts to the specified tightening torque.

Tightening torque

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

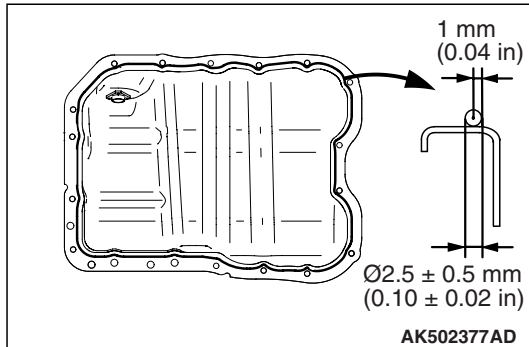


>>B<< FRONT OIL SEAL INSTALLATION

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

>>C<< OIL PAN INSTALLATION

1. Completely remove liquid gasket adhering to the cylinder block and oil pan.
2. 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 tightening torque.

Tightening torque:

M6: 10 ± 2 N·m (89 \pm 17 in-lb)

M8: 29 ± 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

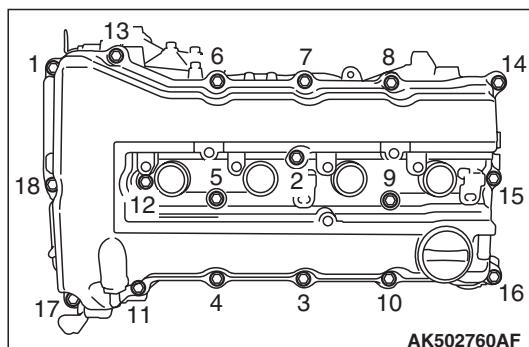
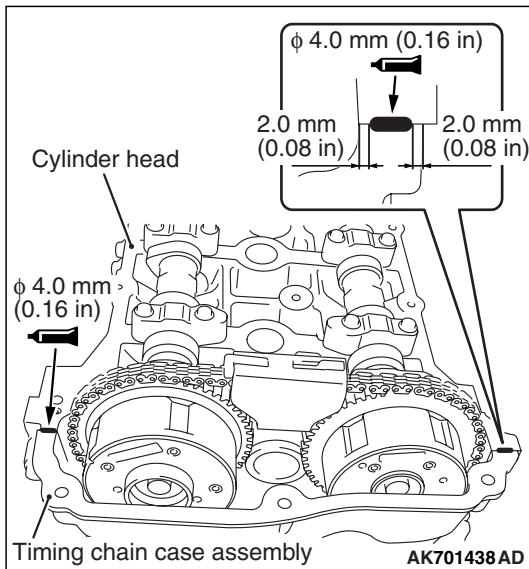
Install the cylinder head cover immediately after liquid gasket is applied.

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

Apply liquid gasket of 4 mm (0.15 inch) of thickness in diameter.

Specified sealant:

Three bond 1217G or exact equivalent



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

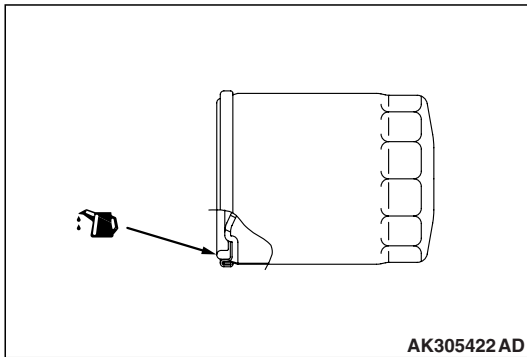
Tightening torque: 3.0 ± 1.0 N·m (27 \pm 8 in-lb)

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

Tightening torque: 5.5 ± 0.5 N·m (49 \pm 4 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.

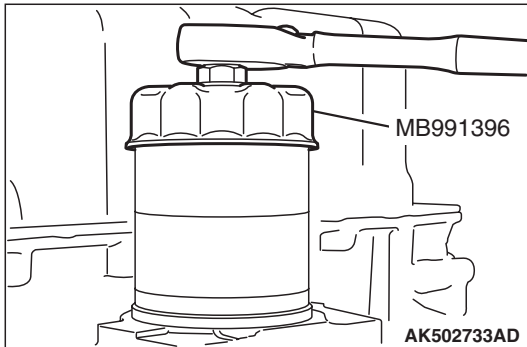
**⚠ CAUTION**

Use special tool MB991396 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.

Tightening torque

3/4 turns (14 ± 2 N·m [124 ± 17 in-lb])

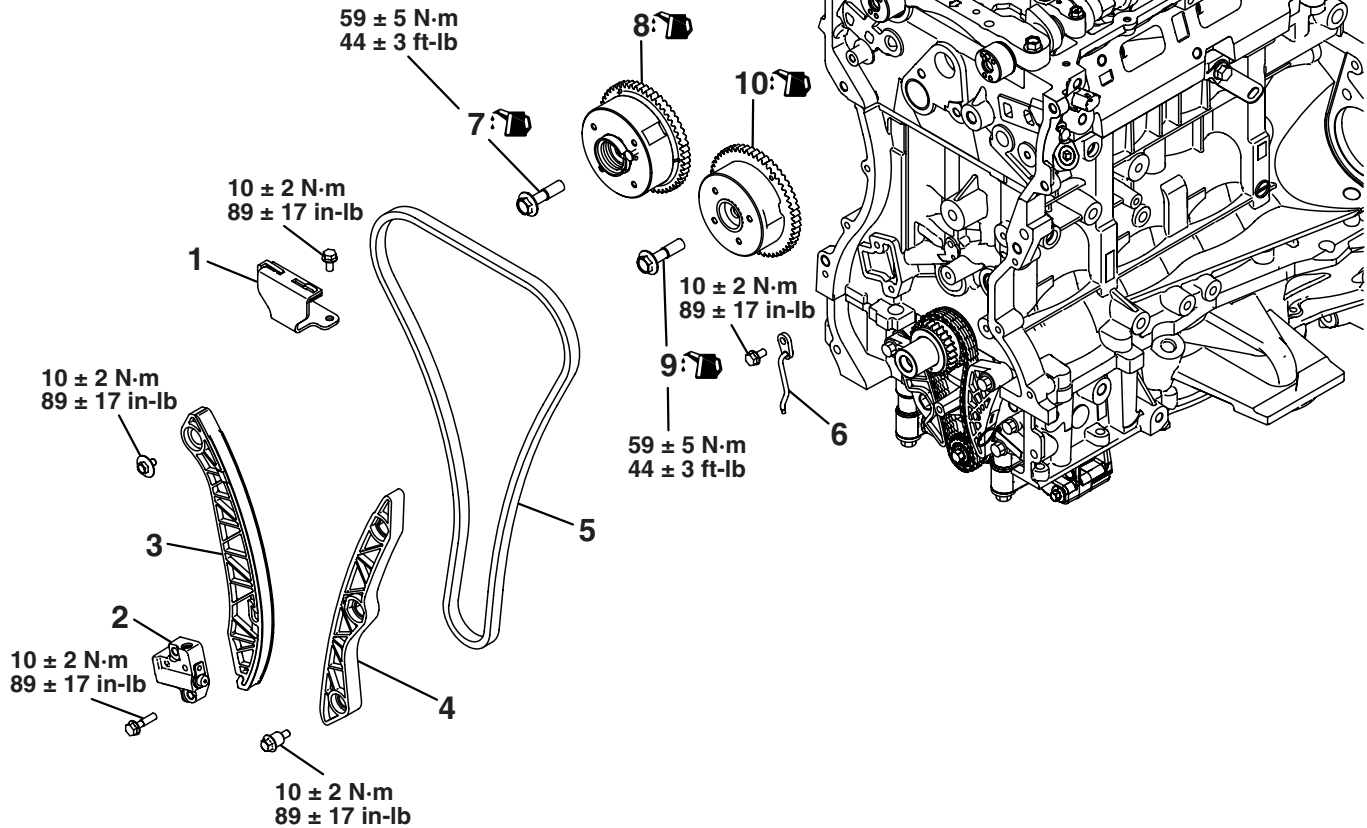


TIMING CHAIN

REMOVAL AND INSTALLATION

M1113026600603

Apply engine oil to
all moving parts
before installation.



AK502933AE

Removal steps

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

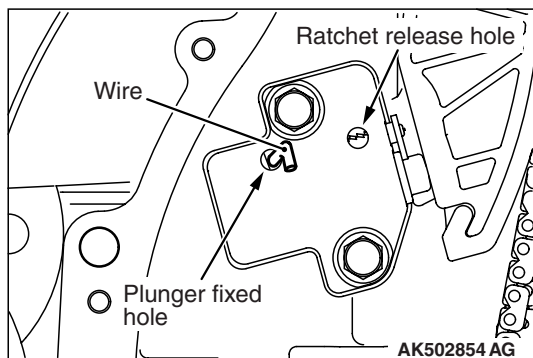
Removal steps (Continued)

- <> >>B<<
6. 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
- <<C>> >>A<<

REMOVAL SERVICE POINTS

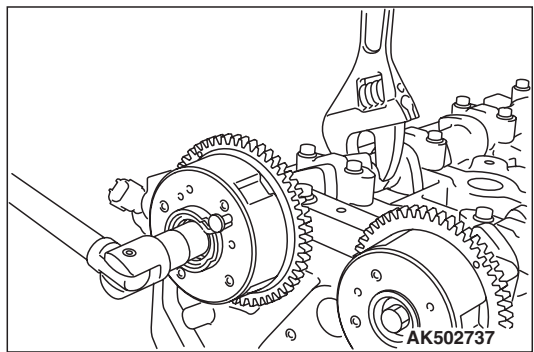
<<A>> TIMING CHAIN TENSIONER REMOVAL

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 [0.06 inch]) into the fixing hole of the plunger.
3. Remove the timing chain tensioner.



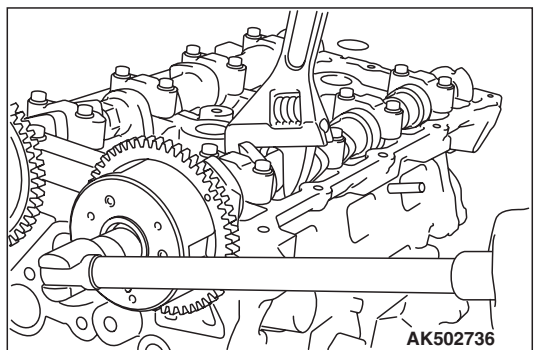
<> EXHAUST V.V.T. SPROCKET BOLT REMOVAL

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



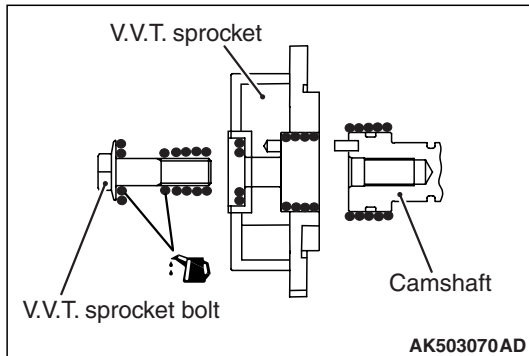
<<C>> INTAKE V.V.T. SPROCKET BOLT REMOVAL

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



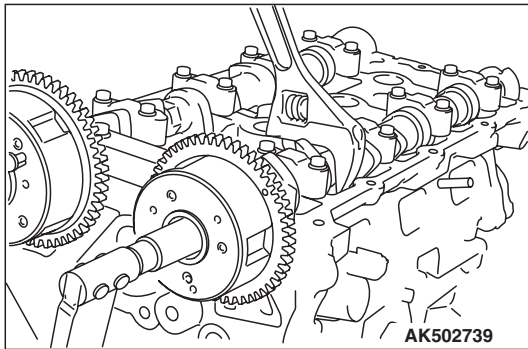
INSTALLATION SERVICE POINTS

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



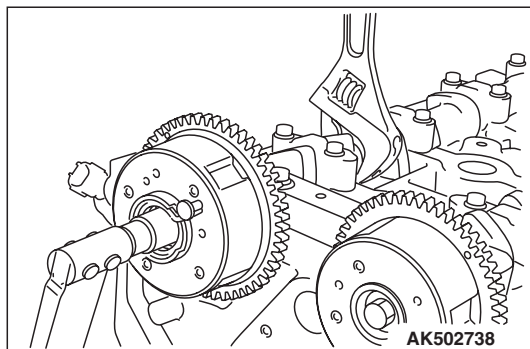
1. Assemble the intake V.V.T. sprocket assembly in the following procedure.
 - Make sure that the knock pin of the inlet camshaft assembly is positioned facing straight upward.
 - Apply an appropriate and minimum amount of engine oil to the circumference of the tip of the intake V.V.T. sprocket assembly 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 tightening torque.

Tightening torque: $59 \pm 5 \text{ N} \cdot \text{m}$ ($44 \pm 3 \text{ ft} \cdot \text{lb}$)



>>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.

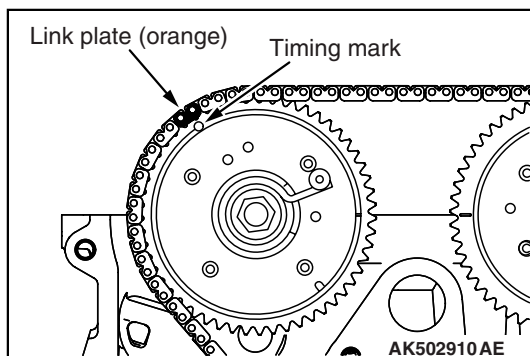
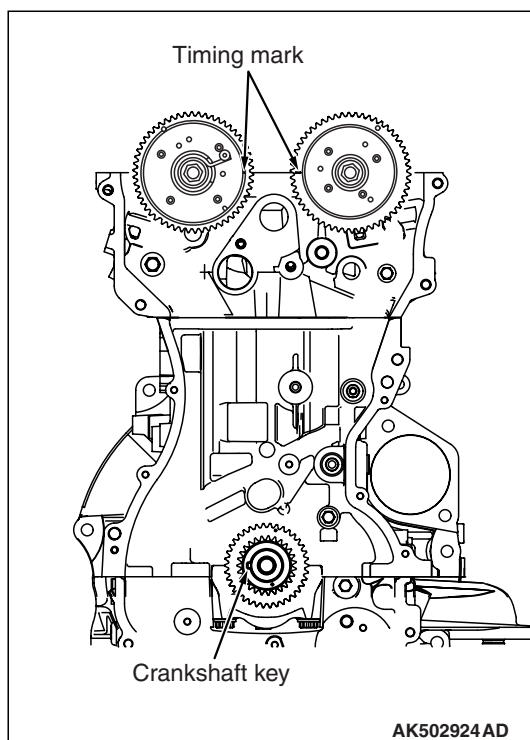


4. Hold the hexagonal portion of the camshaft with a wrench and tighten the camshaft sprocket bolt to the specified tightening torque.

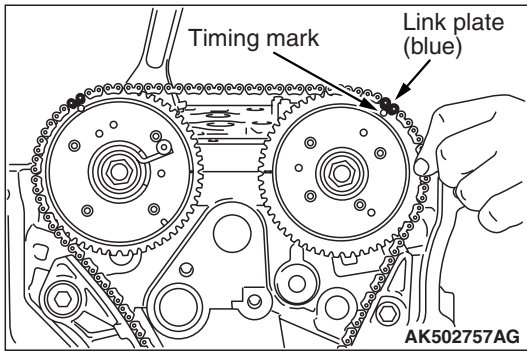
Tightening torque: 59 ± 5 N·m (44 ± 3 ft-lb)

>>C<< TIMING CHAIN INSTALLATION

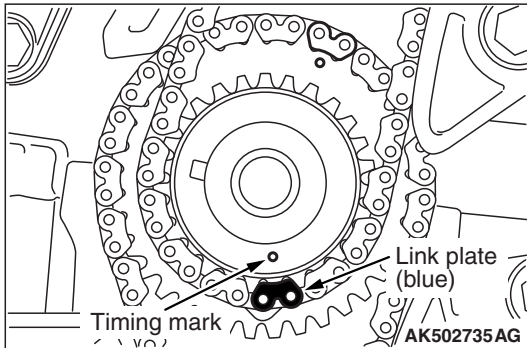
1. Align the timing mark of the V.V.T. sprocket.
2. Align the crankshaft sprocket keys with illustrated positions.



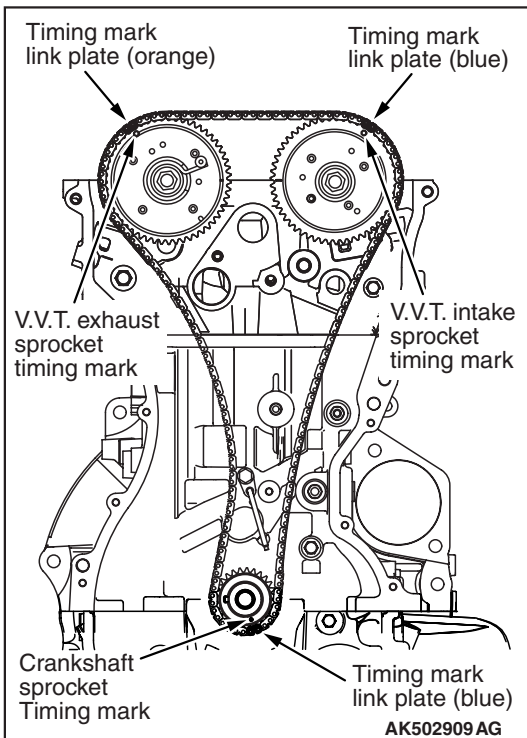
3. Align the link plate (orange) with the timing mark of the exhaust V.V.T. sprocket and loop the timing chain.



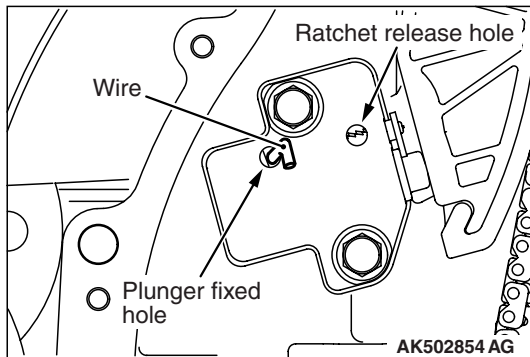
4. Align the link plate (blue) with the timing mark of the intake V.V.T. sprocket to loop the timing chain.
Rotate the intake V.V.T. sprocket by one or two teeth to align with the timing mark.



5. Align the timing mark of the crankshaft sprocket with the link plate (blue) to loop the timing chain. Because the 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 ± 2 N·m (89 ± 17 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

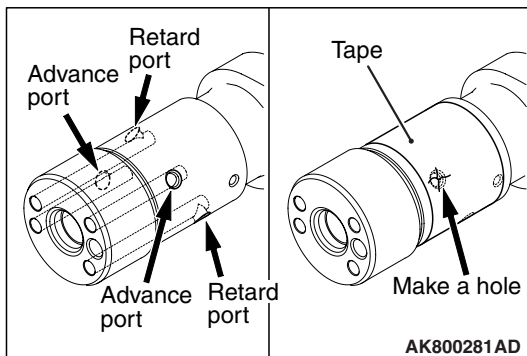
M1113026700804

INTAKE V.V.T. SPROCKET

CAUTION

Never overhaul the V.V.T. sprocket.

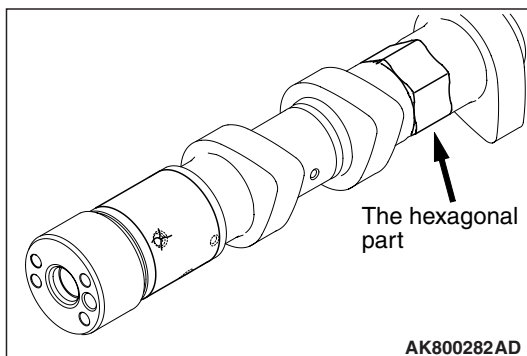
1. Seal with a tape all the intake camshaft ports for the advanced angle and the retarded angle.
2. Make a hole on the port for the advanced angle.



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.



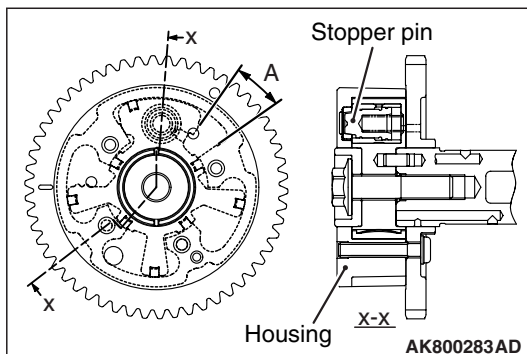
CAUTION

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 20°)

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



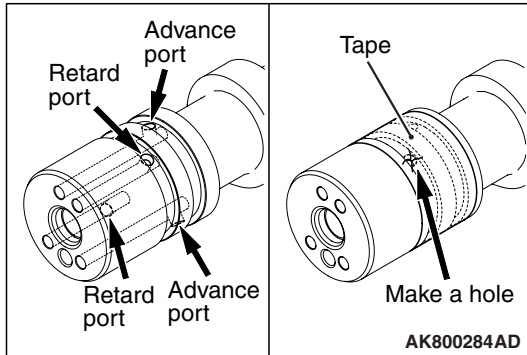
7. Completely remove the tape sealing the intake camshaft ports for the advanced angle and for the retarded angle.

EXHAUST V.V.T. SPROCKET

⚠ CAUTION

Never overhaul the V.V.T. sprocket.

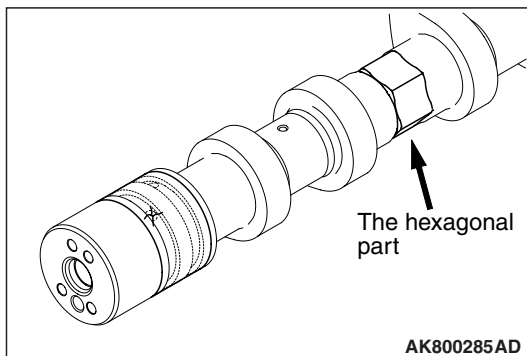
1. Seal with a tape all the exhaust camshaft ports for the advanced angle and the retarded angle.
2. Make a hole on the port for the retarded angle.



⚠ 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.



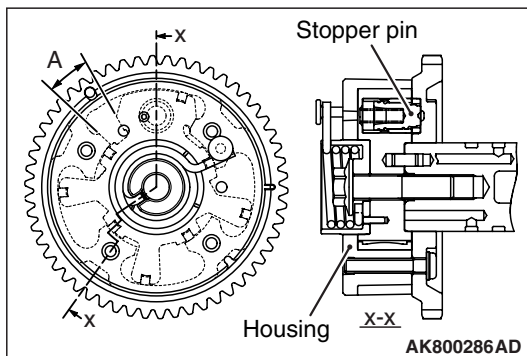
⚠ CAUTION

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 10°)

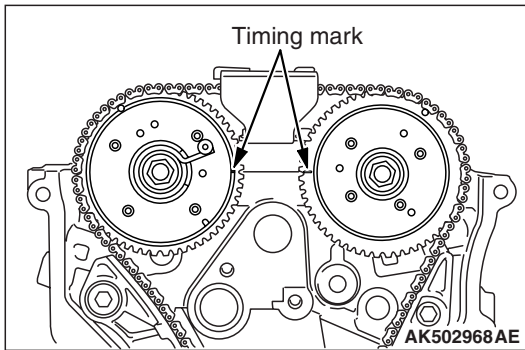
NOTE: The stopper pin is locked in the most advanced angle position.

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.

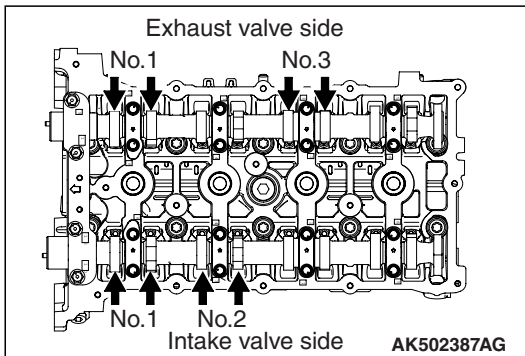


VALVE CLEARANCE ADJUSTMENT

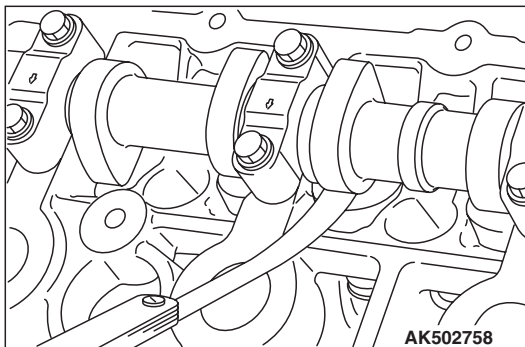
Measure valve clearance in the following procedure.

⚠ 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 Number 1 piston at top dead center on the compression stroke.)



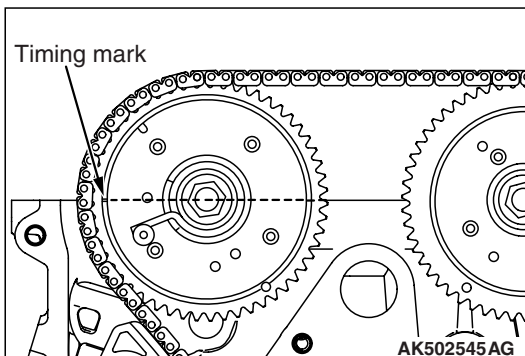
2. Valve clearance can be measured at the illustrated location in this condition.



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

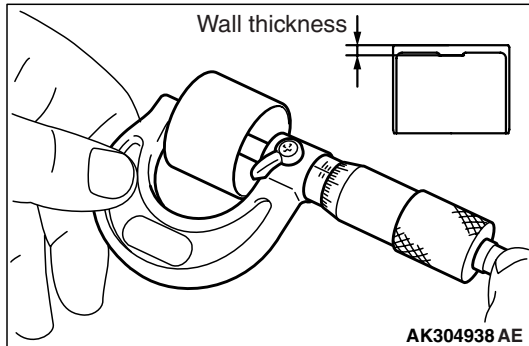
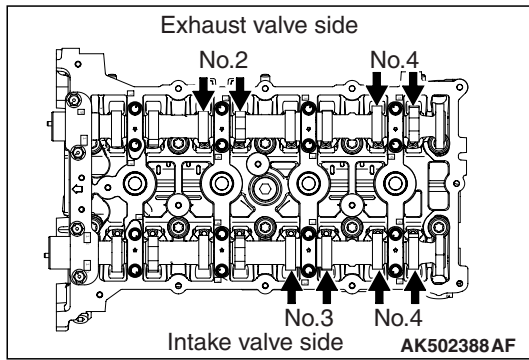
Standard value (when engine is cold):**Intake side: 0.20 ± 0.03 mm (0.008 ± 0.001 inch)****Exhaust side: 0.30 ± 0.03 mm (0.012 ± 0.001 inch)**

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



5. Rotate the crankshaft by one turn clockwise to set the Number 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 mm (0.1181 inch) and 3.690 mm (0.145 inch).

9. Select a valve tappet in the following procedure.
 - (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: $A = B + (C - 0.20 \text{ mm } [0.08 \text{ inch}])$

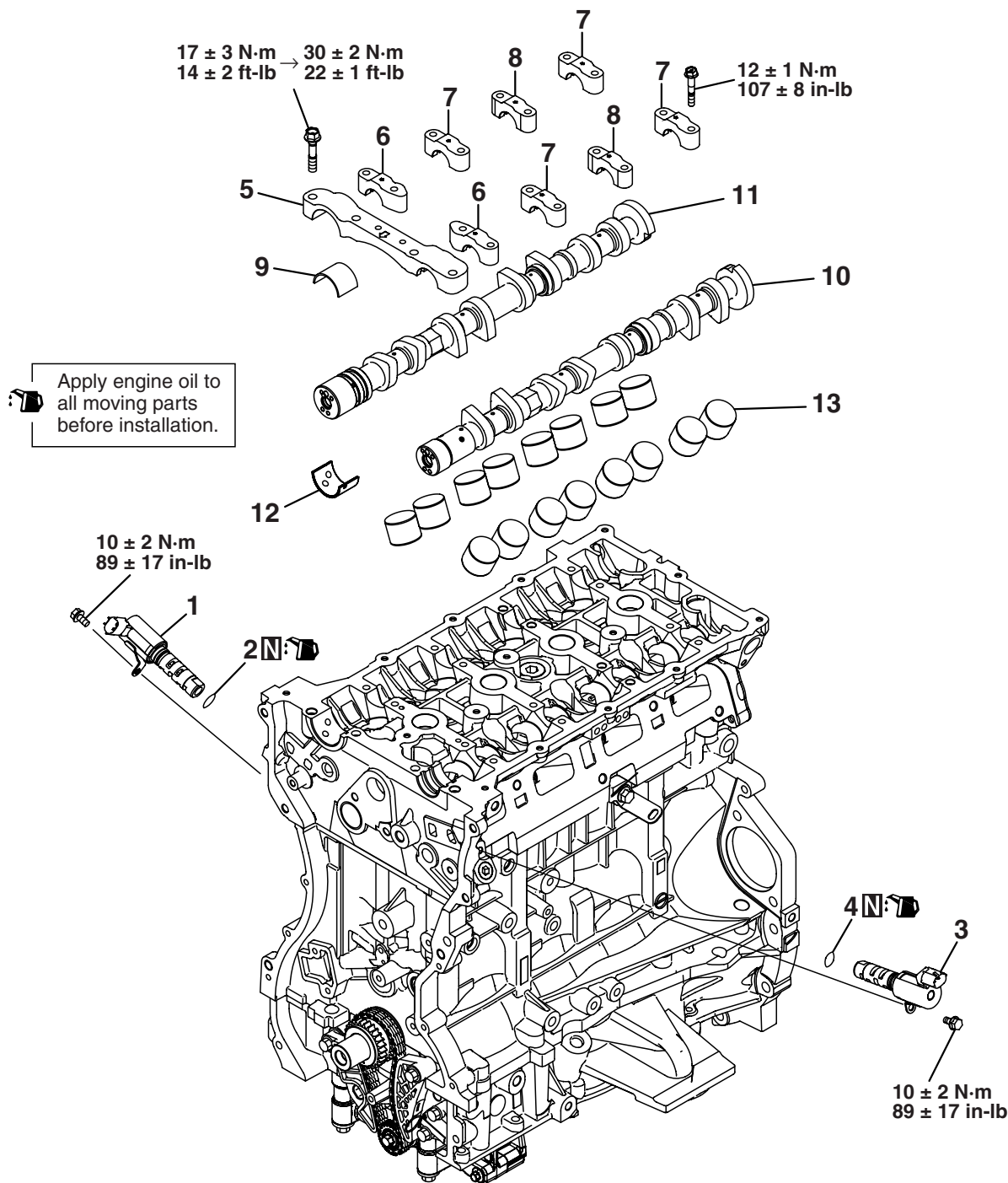
Exhaust side: $A = B + (C - 0.30 \text{ mm } [0.012 \text{ inch}])$

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

CAMSHAFT

REMOVAL AND INSTALLATION

M1113026900767



AK502934 AG

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
- <> >>A<< 13. Valve tappet

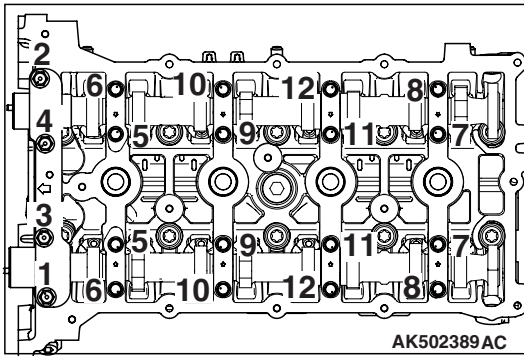
REMOVAL SERVICE POINTS

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

⚠ CAUTION

Loosing the installation bolts for the camshaft bearing cap at the same time causes the valve spring force, which makes the installation bolts jump out, resulting in the damaged threads. Always loose them four or five times.

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.



<> VALVE TAPPET REMOVAL

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

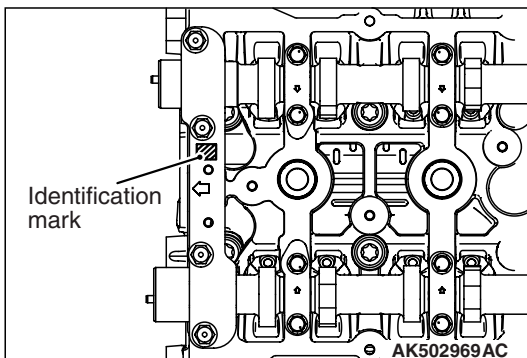
INSTALLATION SERVICE POINTS

>>A<< VALVE TAPPET INSTALLATION

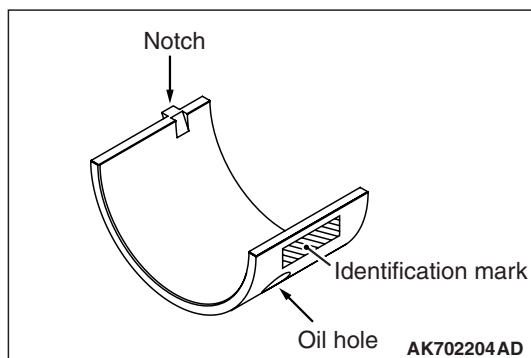
Install valve tappets at the same position based on tags describing the installed position for reassembly.

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

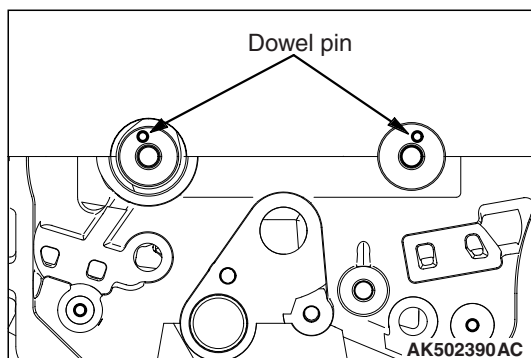
1. When replacing a camshaft bearing, select a bearing with the size corresponding to the identification mark in the table below.
2. Install camshaft bearings on the cylinder head.



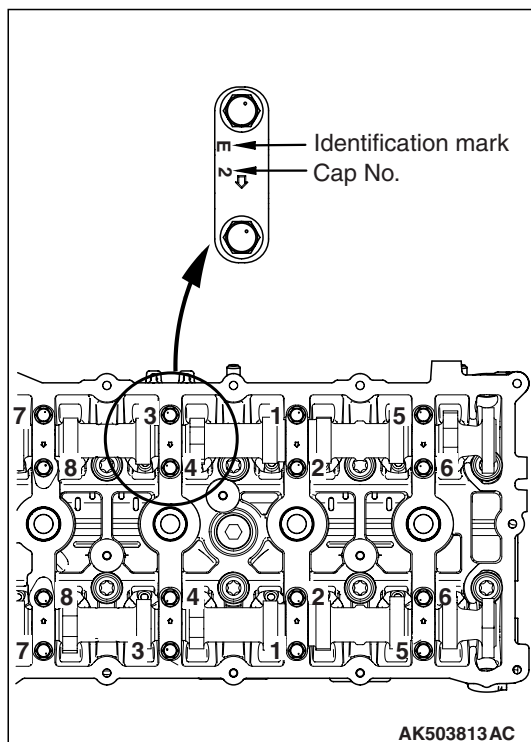
Camshaft		Camshaft bearing
Identificati on mark	Journal diameter mm (in)	Identification mark
1	40.000 –40.008 (1.5748 –1.5751)	1
2	40.008 –40.016 (1.5751 –1.5754)	2
3	40.016 –40.024 (1.5754 –1.5757)	3



- The identification mark of the camshaft bearing is painted at the illustrated position.



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



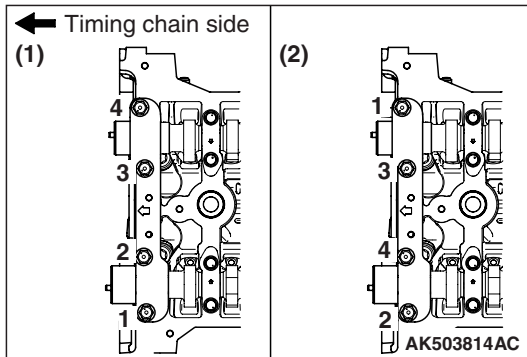
- Camshaft bearing caps Number 1 to Number 4 are of the same shape. Install them upon checking the identification mark so as not to misidentify cap Number and to confuse the intake side with the exhaust side.

Identification mark (stamped on front and Number 1 to Number 4 bearing caps)

I: Intake side

E: Exhaust side

- Tighten each camshaft bearing cap mounting bolt to the specified tightening torque of 12 ± 1 N·m (107 ± 1 in-lb) in the order of number shown in the figure in two or three steps.



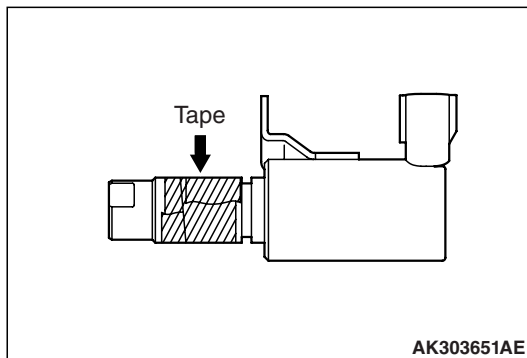
7. Tighten each front camshaft bearing cap mounting bolt to the temporarily torque of 17 ± 3 N·m (14 ± 2 ft-lb) in the order of number shown (1).
8. Tighten each front camshaft bearing cap mounting bolt to the specified tightening torque of 30 ± 2 N·m (22 ± 1 ft-lb) in the order of number shown (2).

>>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 oil feeder 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 oil feeder control valve.
2. Install the oil feeder control valve on the cylinder head.
3. Tighten the oil feeder control valve to the specified tightening torque of 10 ± 2 N·m (89 ± 17 in-lb).



INSPECTION

M1113027000518

CAMSHAFT

Measure camshaft height (camshaft major axis). If the height exceeds the limit, replace the camshaft.

Standard value:

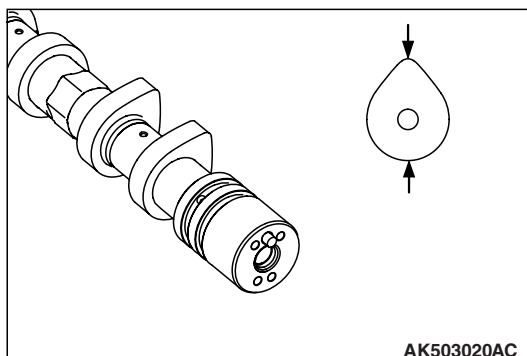
Intake: 44.1 mm (1.736 inch)

Exhaust: 45.0 mm (1.772 inch)

Limit:

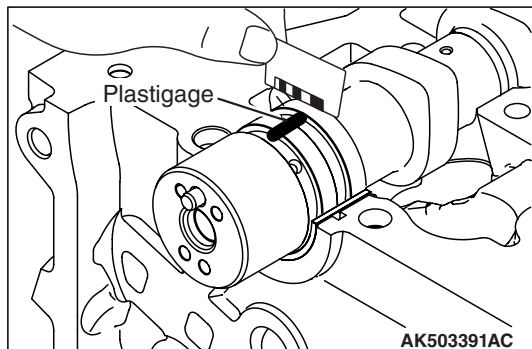
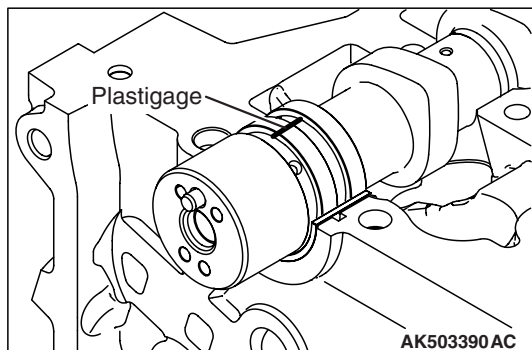
Intake: 43.6 mm (1.717 inch)

Exhaust: 44.5 mm (1.752 inch)



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.

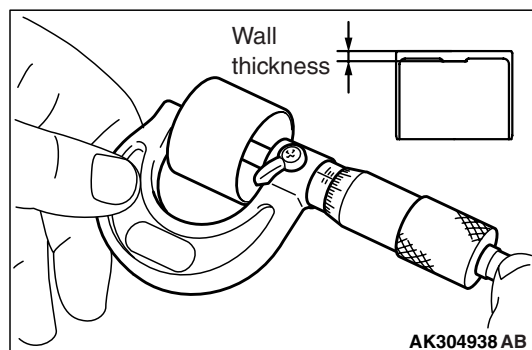
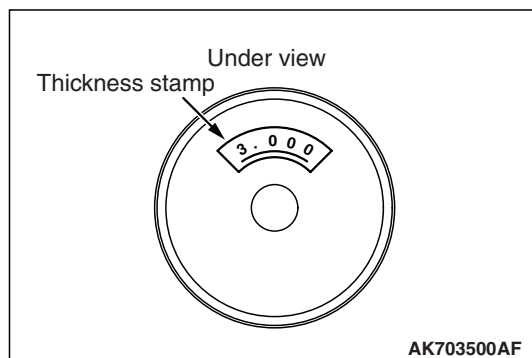
Standard value: 0 –0.032 mm (0.0013 inch)

⚠ CAUTION

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

VALVE TAPPET

1. Check the thickness stamp.



2. If the measured value in the table value is not in agreement with the value in the table to the thickness stamp, replace the valve tappet.

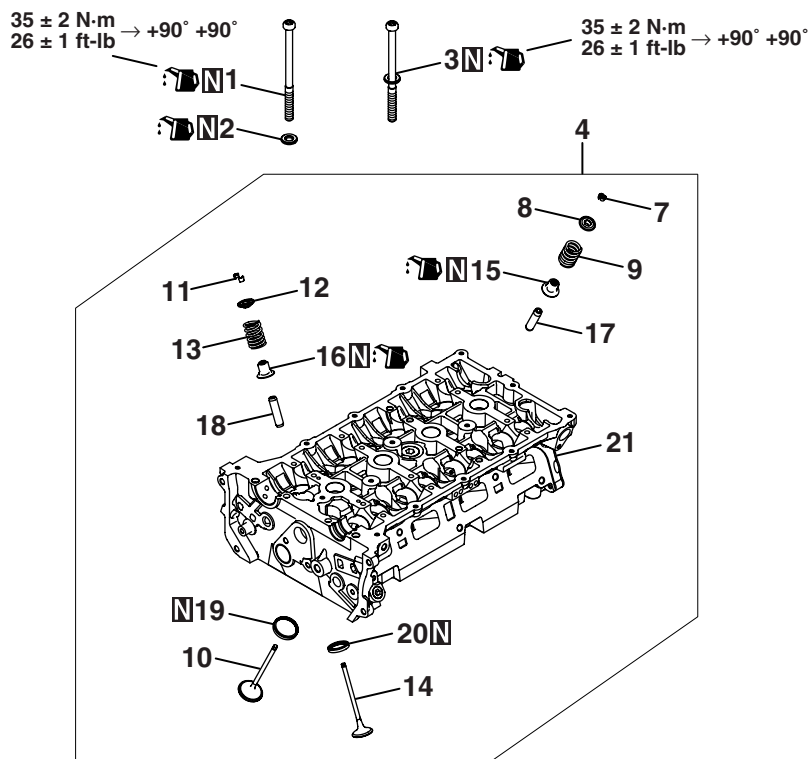
There are 47 kinds of valve tappets at intervals of 0.015 mm (0.0006 inch) in the range between 3.000 (0.1181 inch) and 3.690 mm (0.1453 inch).

Thickness mm (in)	Thickness stamp	Thickness mm (in)	Thickness stamp	Thickness mm (in)	Thickness stamp
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		

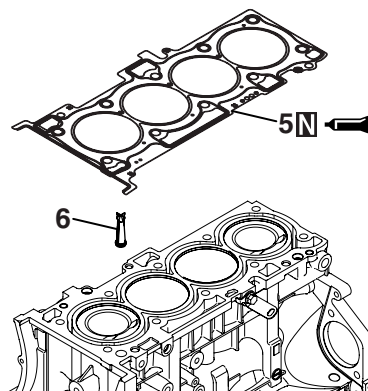
CYLINDER HEAD AND VALVES

REMOVAL AND INSTALLATION

M1113006903021



Apply engine oil to
all moving parts
before installation.



Removal steps

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

Removal steps (Continued)

- <<A>> >>B<< 11. Retainer lock
>>B<< 12. Valve spring retainer
>>B<< 13. Valve spring
>>B<< 14. Exhaust valve
<> >>A<< 15. Valve stem seal
<> >>A<< 16. Valve stem seal
>>B<< 17. Intake valve guide
>>B<< 18. Exhaust valve guide
>>B<< 19. Intake valve seat
>>B<< 20. Exhaust valve seat
>>B<< 21. Cylinder head

Required Special Tool:

- MD998735: Valve spring compressor
- MB992085: Valve stem seal pliers
- MB992089: Retainer holder C

REMOVAL SERVICE POINTS

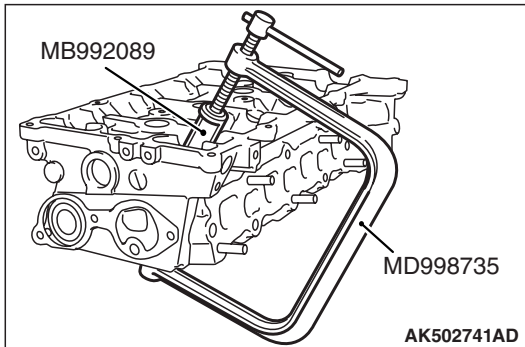
<<A>> RETAINER LOCK REMOVAL

CAUTION

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

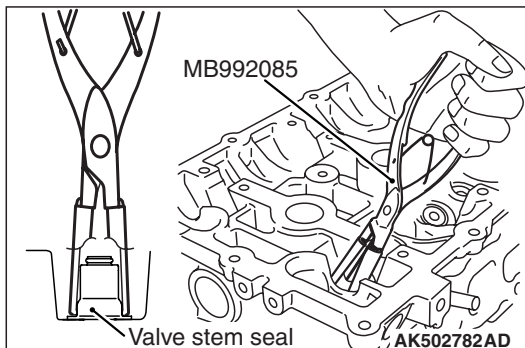
Use a special tool MD998735, and MB992089 to compress the valve spring and to remove the retainer lock.

NOTE: Store removed parts such as valves and springs with tags describing cylinder Number and installed position attached for reassembly.



<> 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.



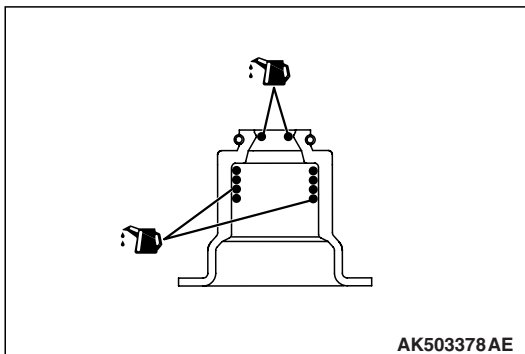
INSTALLATION SERVICE POINTS

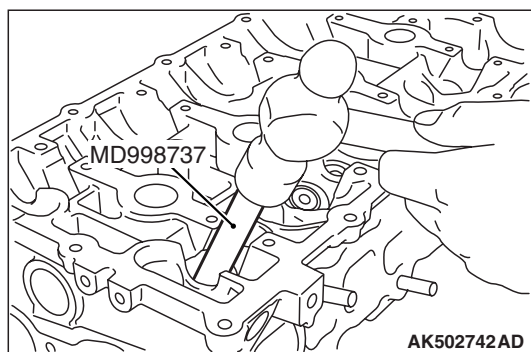
>>A<< VALVE STEM SEAL INSTALLATION

CAUTION

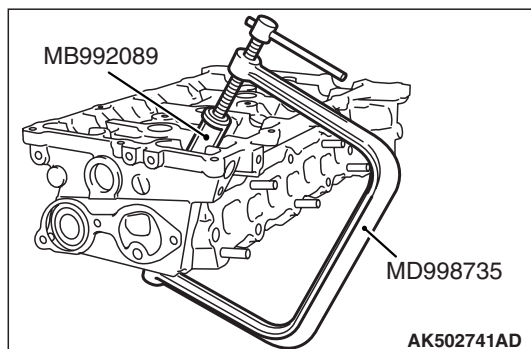
- The valve stem seal must not be reused.
- Do not damage the tappet wall during assembly.
- Be sure to use a special tool to install the valve stem seal. Poor installation causes oil loss via valve guides.
- If oil is not applied, the valve stem seal may rise to the surface after it is press fitted.

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



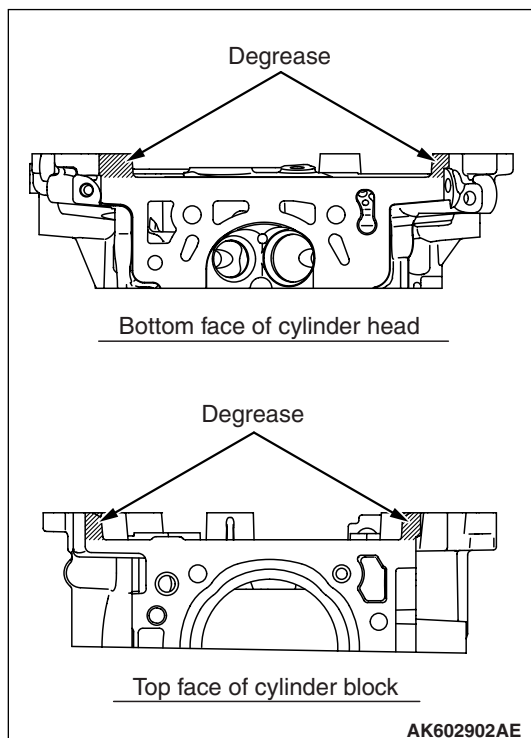


2. Use special tool MD998737 to press fit the valve stem seal into the valve guide with the valve stem used as a guide.



>>B<< RETAINER LOCK INSTALLATION

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



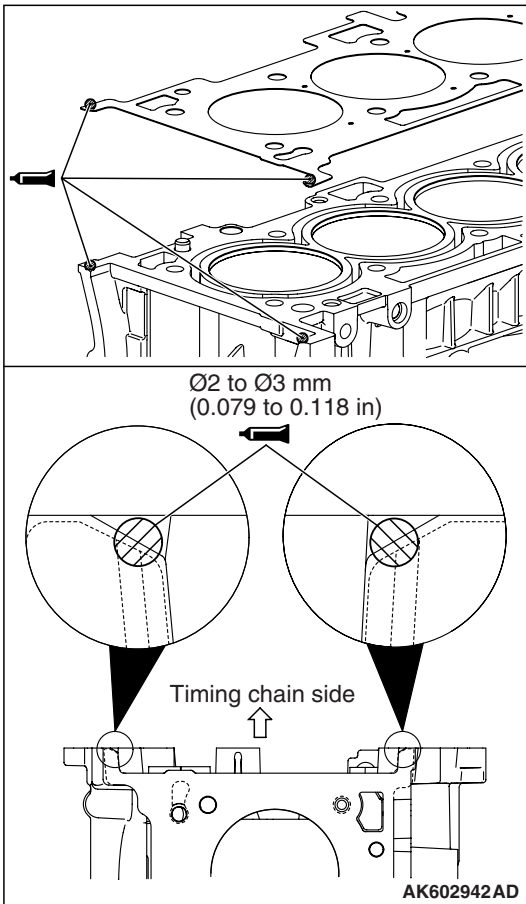
>>C<< CYLINDER HEAD GASKET / CYLINDER HEAD ASSEMBLY INSTALLATION

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.



3. As shown in the illustration, apply a 2.5 ± 0.5 mm (0.1 ± 0.02 inch) of sealant to the top face of cylinder block.

Specified sealant:

Three bond 1217G or exact equivalent

4. 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.

5. As shown in the illustration, apply a 2.5 ± 0.5 mm (0.1 ± 0.02 inch) of sealant to the top face of cylinder head gasket.

Specified sealant:

Three bond 1217G or exact equivalent

6. Install the cylinder head assembly.

>>D<< CYLINDER HEAD BOLT INSTALLATION

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

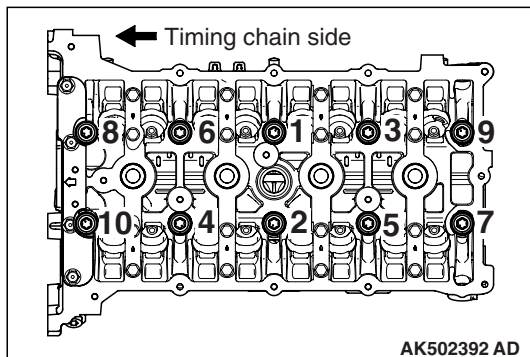
NOTE: Cylinder head bolts and washers must not be reused.

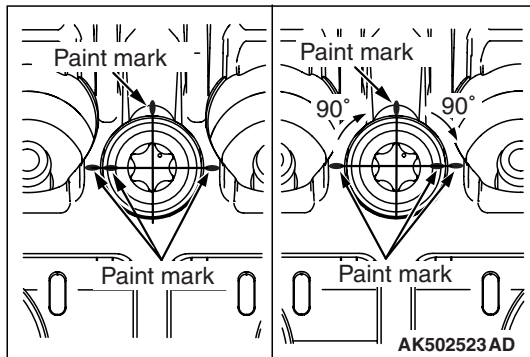
2. Apply an appropriate amount of engine oil to top and bottom surfaces of washers and threaded portion of bolts.

3. 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 tightening torque of 35 ± 2 N·m (26 ± 1 ft-lb) according to the assembly order.





- 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.

- Tighten the cylinder head 90° according to the tightening order.

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

INSPECTION

M1113007002589

CYLINDER HEAD

- Check the cylinder head for water leakage, gas leakage, damage or cracks before cleaning.
- 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 (0.008 inch) in combination with the cylinder block to be assembled.

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

Distortion on bottom

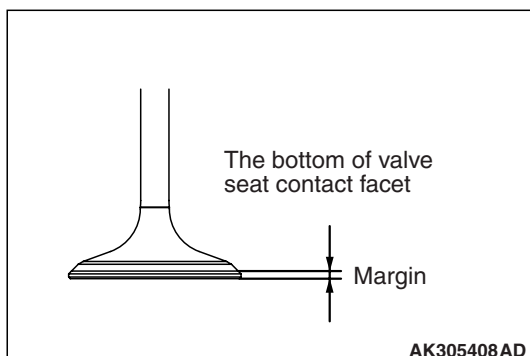
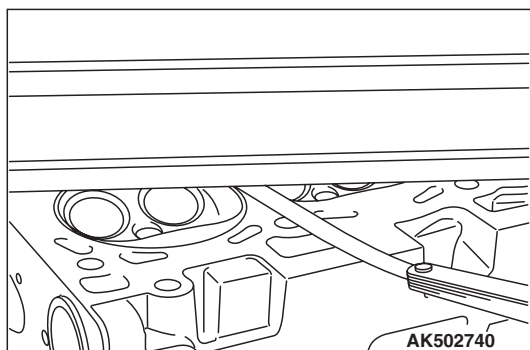
Standard value: Within 0.05 mm (0.002 inch)

Limit: 0.2 mm (0.008 inch)

Grinding limit: 0.2 mm (0.008 inch)

Cylinder head height

Standard value: 128.5 mm (5.06 inch)



VALVE

- Repair the valve seat if contact with the valve seat is poor, uneven or broken.
- Measure the margin.
If the limit is exceeded, replace the valve.

Standard value:

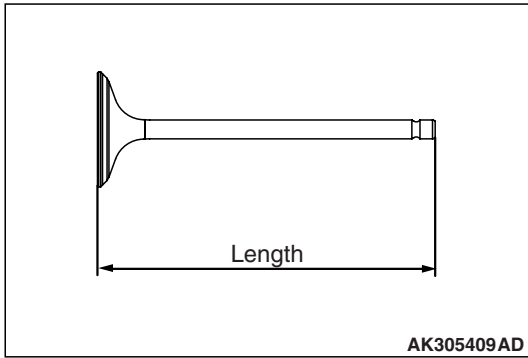
Intake 1.022 mm (0.0402 inch)

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 inch)

Exhaust 105.89 mm (4.169 inch)

Limit:

Intake 112.68 mm (4.436 inch)

Exhaust 105.39 mm (4.149 inch)

VALVE SPRING

1. Measure free height of the spring.
If the limit is exceeded, replace the spring.

Standard value: 47.2 mm (1.858 inch)

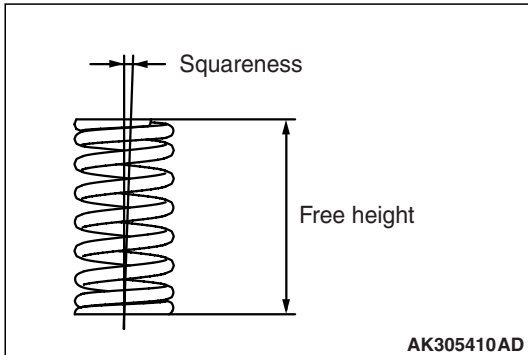
Limit: 46.2 mm (1.819 inch)

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:

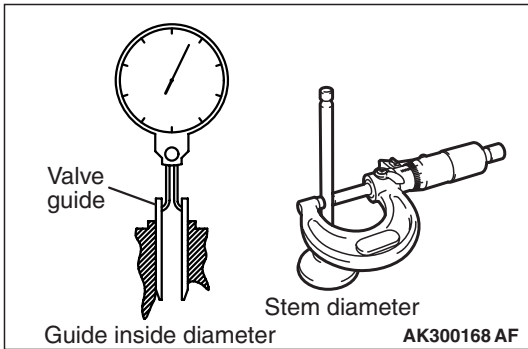
Intake 0.020 –0.047 mm (0.0008 –0.0019 inch)

Exhaust 0.030 –0.054 mm (0.0012 –0.0021 inch)

Limit:

Intake 0.10 mm (0.0039 inch)

Exhaust 0.11 mm (0.0043 inch)



VALVE SEAT

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

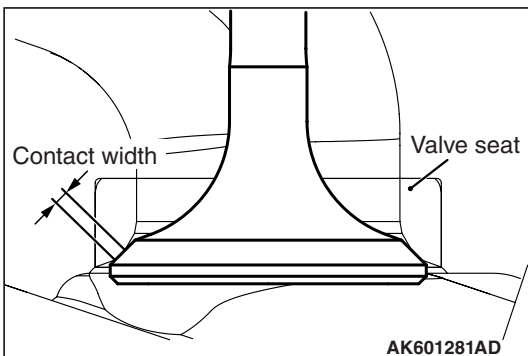
Standard value

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

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

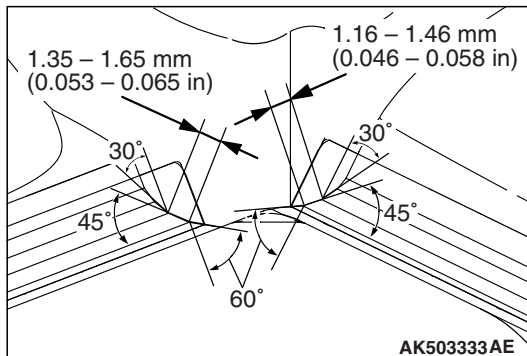
CAUTION

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

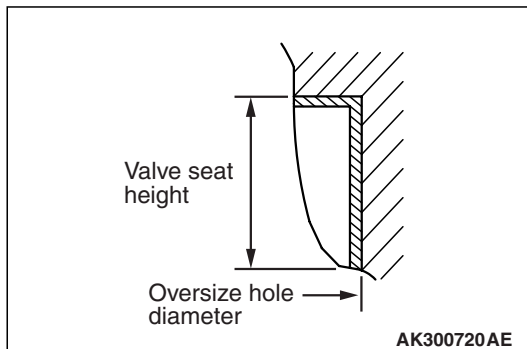
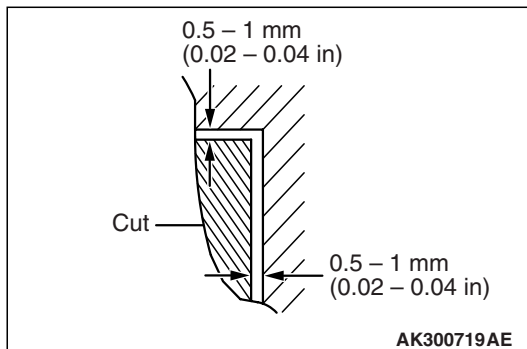


REPAIR PROCEDURE OF VALVE SEAT

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.

Intake valve seat bore diameter:

0.3 Over size: 36.22 - 36.24 mm (1.426 - 1.427 inch)

Exhaust valve seat bore diameter:

0.3 Over size: 30.22 - 30.24 mm (1.190 - 1.191 inch)

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

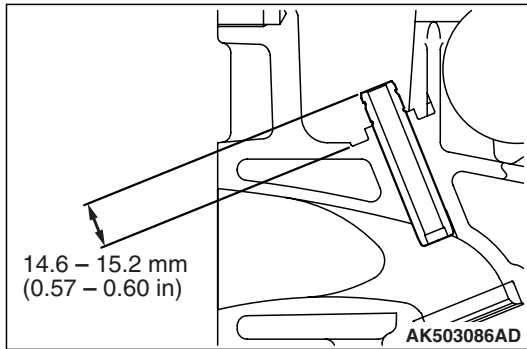
1. Pull out the valve guide with a press toward the cylinder block side.
2. Ream the valve guide hole of the cylinder head to match it with the diameter of the oversize valve guide to be press fitted.

⚠ 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.

Valve guide bore diameter

0.25 Over size: 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)

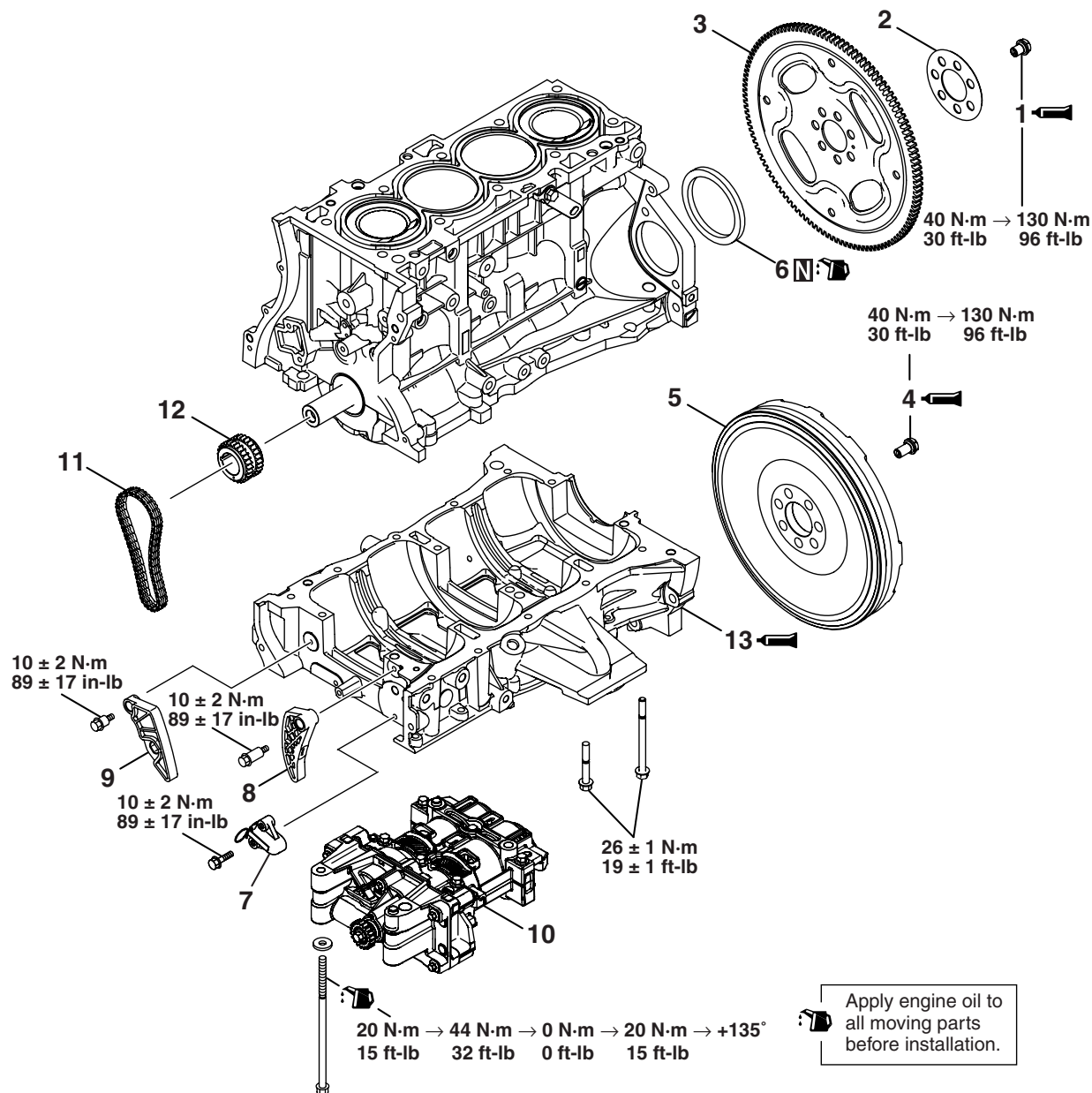
NOTE: Press fit the valve guide from the cylinder head top surface.

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

BALANCER CHAIN

REMOVAL AND INSTALLATION

M1113032200325



AK704645AB

Removal steps

- <<A>> >>E<< 1. Drive plate bolt <CVT>
2. Adapter plate <CVT>
3. Drive plate <CVT>
<<A>> >>E<< 4. Flywheel bolt <M/T>
5. Flywheel <M/T>
>>D<< 6. Rear oil seal
<> >>C<< 7. Balancer shaft chain tensioner

Removal steps (Continued)

- <> >>B<< 8. Balancer shaft tensioner lever
<> >>B<< 9. Balancer shaft chain guide
<> >>B<< 10. Balancer shaft module
<<C>> >>A<< 11. Balancer chain
12. Crankshaft sprocket
13. Ladder frame

Required Special Tool:

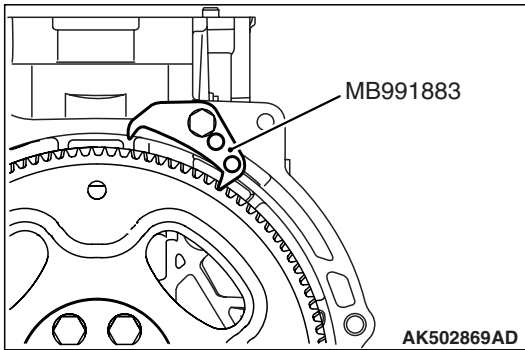
- MB991883: Flywheel stopper
- MB991614: Angle gauge

- MD998718: Rear oil seal installer

REMOVAL SERVICE POINTS

<<A>> DRIVE PLATE BOLT REMOVAL

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

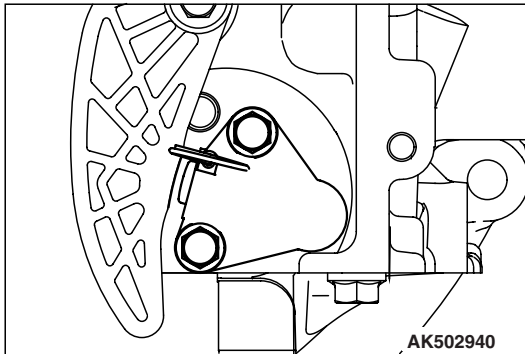


<> BALANCER SHAFT CHAIN TENSIONER / CRANKSHAFT SPROCKET / BALANCER CHAIN / BALANCER SHAFT MODULE REMOVAL

⚠ CAUTION

Reliably secure the plunger of the chain tensioner with hard wire to prevent it from jumping out of the main body.

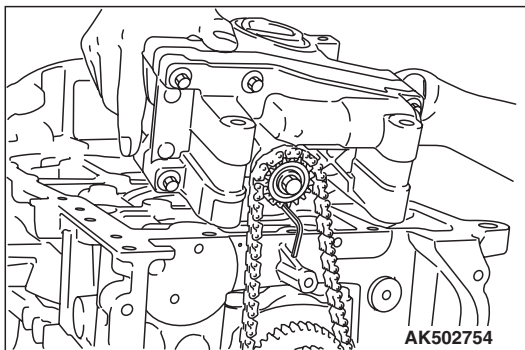
1. Push in the balancer shaft tensioner lever by hand and push in the plunger of the chain tensioner until it contacts the bottom. Then, insert hard wire (piano wire, etc.) of $\phi 1.5$ or hexagonal bar wrench (1.5 mm [0.06 inch]) into the plunger fixing hole to secure.
2. Remove the balancer shaft chain tensioner.

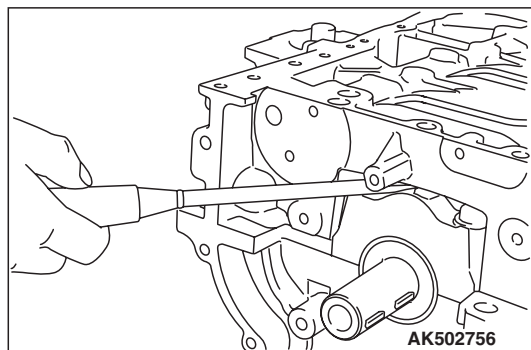
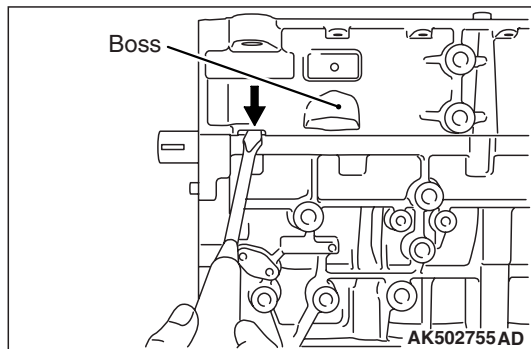


⚠ CAUTION

The balancer shaft module must not be disassembled because of assembly warranty.

3. Remove the crankshaft sprocket, balancer chain and balancer shaft module as a unit.



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

1. Pry the illustrated position with a screwdriver or tap the boss with a hammer.
2. If the ladder frame does not come off, insert a flatblade 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**

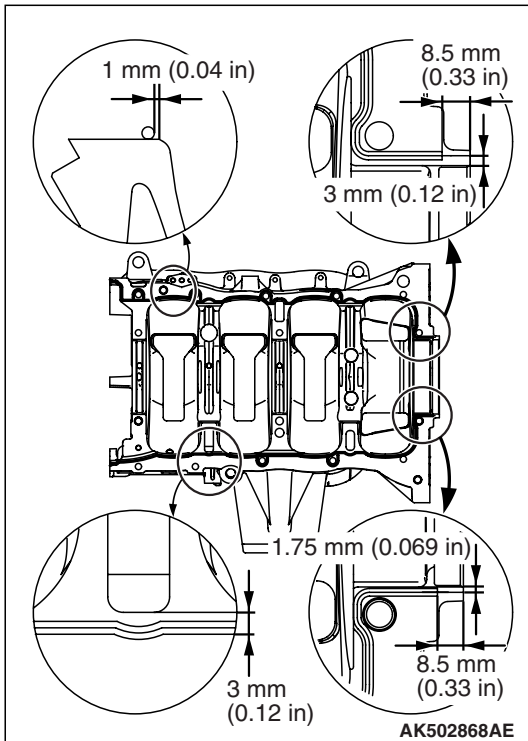
Be sure to remove liquid gasket that has entered mounting holes.

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.

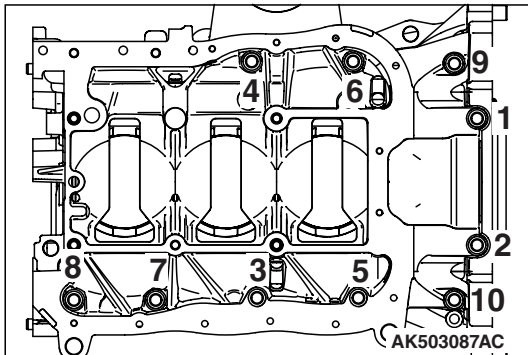
2. Degrease the surface where the liquid gasket is applied and the contact surface between the cylinder block and ladder frame.



3. Squeeze liquid gasket of $\phi 2.5 \pm 0.5$ mm (0.10 ± 0.02 inch) in thickness and apply it to the illustrated position of the ladder frame.

Specified sealant:

Three bond 1217G or exact equivalent



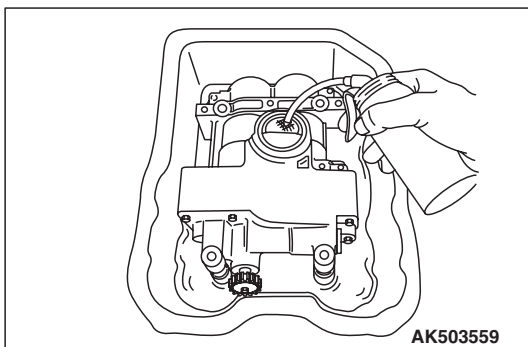
4. Tighten the ladder frame to the specified tightening torque in the order shown in the illustration.

Tightening torque: 26 ± 1 N·m (19 ± 1 ft-lb)

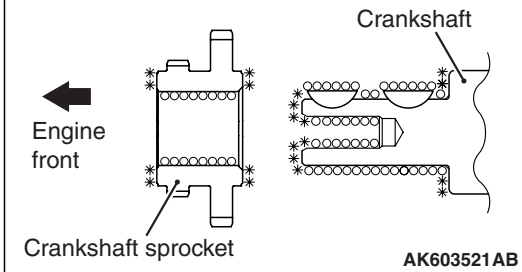
>>B<< CRANKSHAFT SPROCKET / BALANCER CHAIN / BALANCER SHAFT MODULE INSTALLATION

When the new balancer shaft module is installed, supply oil to the oil pump and the balancer shaft bearing in the balancer shaft module using the following procedures.

- i. Clean the inside of the removed oil pan. Put the balancer shaft module carefully into the oil pan so that the oil inlet can be upward.
- ii. Pour the engine oil so that the two-third of the balancer module can be immersed.
- iii. Also, pour approximate 50 cc of engine oil from the oil inlet.
- iv. By giving four clockwise rotations or more to the balancer shaft sprocket, the oil is supplied to the oil pump and the balancer shaft bearing.

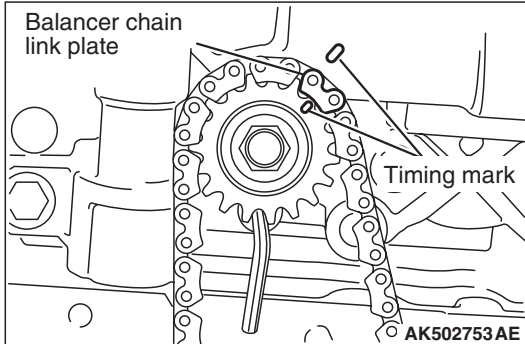


- : Wipe clean with a rag.
* : Wipe clean with a rag and degrease.



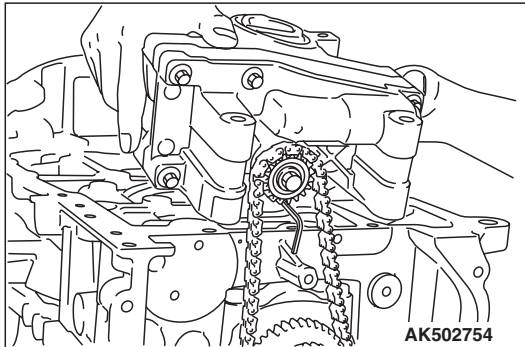
1. Wipe the dirt on the crankshaft sprocket and the crankshaft using a rag, and then remove the grease from the portion shown in the illustration.

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



2. Align the timing mark of the balancer shaft module sprocket with that of the balancer shaft module.
3. Insert a hexagonal bar wrench (3 mm [0.12 inch]) as illustrated to prevent the balancer shaft module sprocket from moving.
4. Loop the balancer chain, aligning its link plate with the timing mark.
5. Install the crankshaft sprocket on the crankshaft.

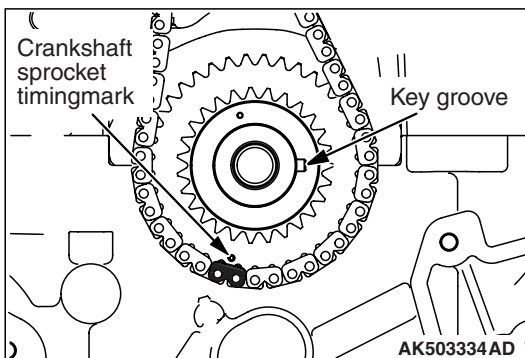
NOTE: Do not push in the crankshaft sprocket to the normal position. Push it in only up to the tip of the crankshaft.

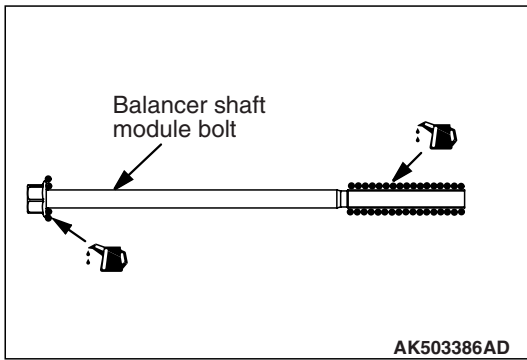


6. While slanting the balancer shaft module, align the link plate of another balancer chain with the timing mark of the crankshaft sprocket to loop. Gradually push in the crankshaft sprocket and fit it into the key groove of the crankshaft. Then, install the balancer shaft module on the ladder frame.

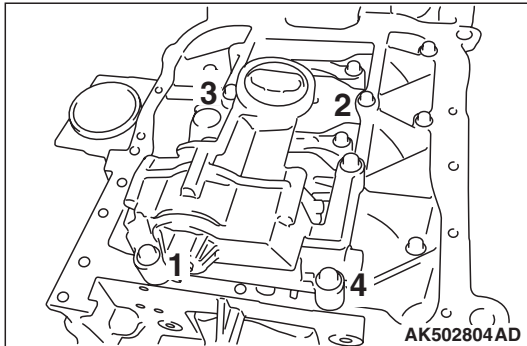
NOTE: Make sure that the balancer shaft module is completely intimate contact with the ladder frame.

NOTE: Make sure that the key groove of the crankshaft is aligned with the contact surface of the cylinder block and ladder frame as shown in the illustration.

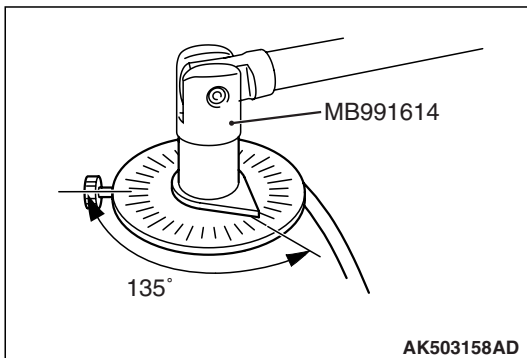




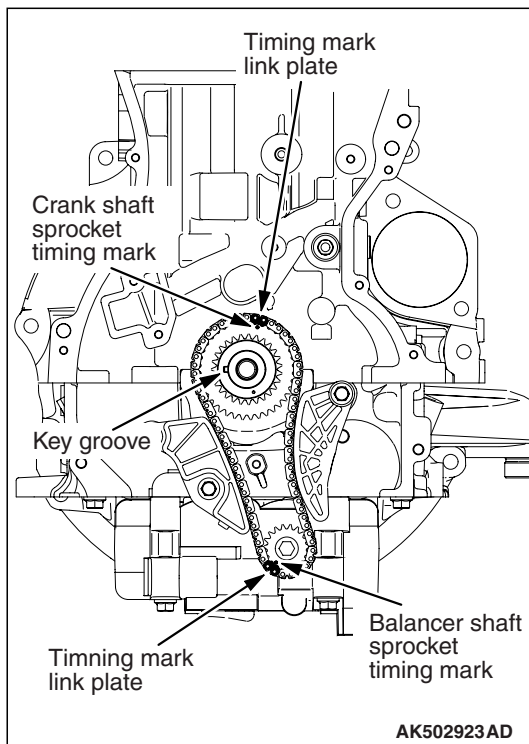
7. Apply an appropriate and minimum amount of engine oil to the screw thread of the balancer shaft module bolt.



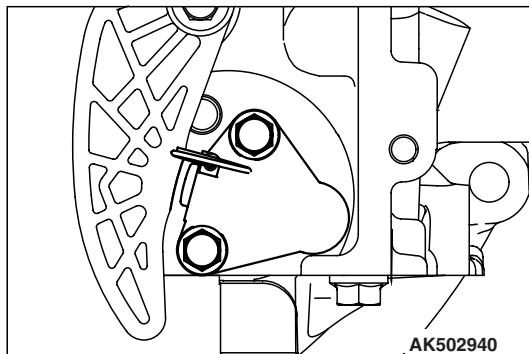
8. Tighten bolts to the specified tightening torque of 20 N·m (14 ft-lb) according to the assembly order in the illustration, retighten them to 44 N·m (32 ft-lb), and then completely loosen them.



9. After tightening them to the specified tightening torque of 20 N·m again, use special tool MB991614 to tighten them up to 135°.
10. Pull out the hexagonal bar wrench from the balancer module sprocket.



11. Make sure that the respective timing mark is aligned with each other as illustrated.
12. Install the balancer chain tensioner lever and balancer chain guide.



>>C<< BALANCER SHAFT CHAIN TENSIONER INSTALLATION

1. Attach the chain tensioner to the ladder frame.

⚠ CAUTION

Install the chain tensioner precisely in place after installing the tensioner lever and chain guide to prevent the plunger of the chain tensioner from jumping out.

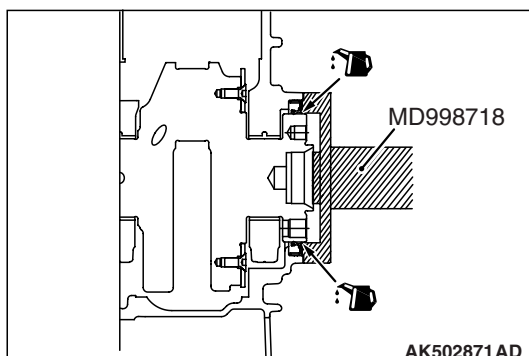
2. Remove the hard wire (piano wire, etc.) of $\phi 1.5$ or hexagonal bar wrench (1.5 mm [0.06 inch]) from the tensioner. This enables the plunger of the chain tensioner to push the balancer shaft tensioner lever to keep the balancer shaft chain tight.

>>D<< REAR OIL SEAL INSTALLATION

⚠ CAUTION

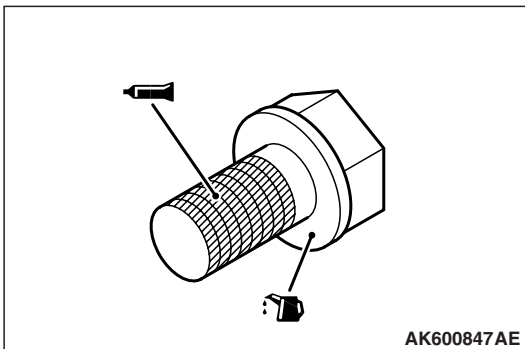
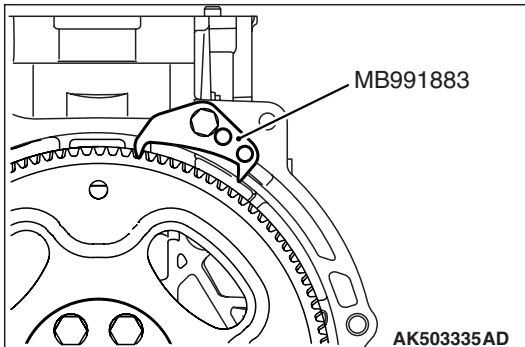
Do not apply oil to the circumference of the oil seal and oil seal pressing hole on the cylinder block side to prevent teeth from pulling out.

After applying a small amount of engine oil to the oil seal lip, use special tool MD998718 to press fit the oil seal.



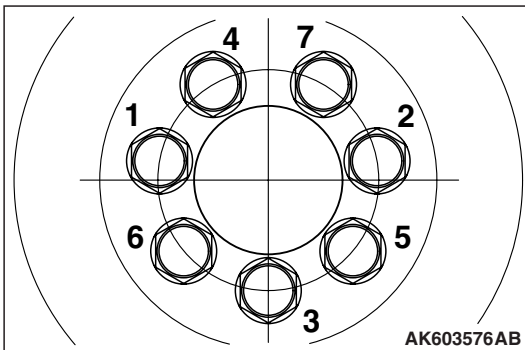
>>E<< DRIVE PLATE / FLYWHEEL BOLT INSTALLATION

1. Clean off sealant and oil of thread of crankshaft and drive plate bolt or flywheel bolt.
2. Use special tool MB991883 to secure the drive plate or flywheel.



3. Apply engine oil to thread of crankshaft and bolt seat area of drive plate or flywheel.
4. Apply the sealant to the thread of drive plate bolt or flywheel bolt.

Specified sealant:
Three bond 1324 or equivalent

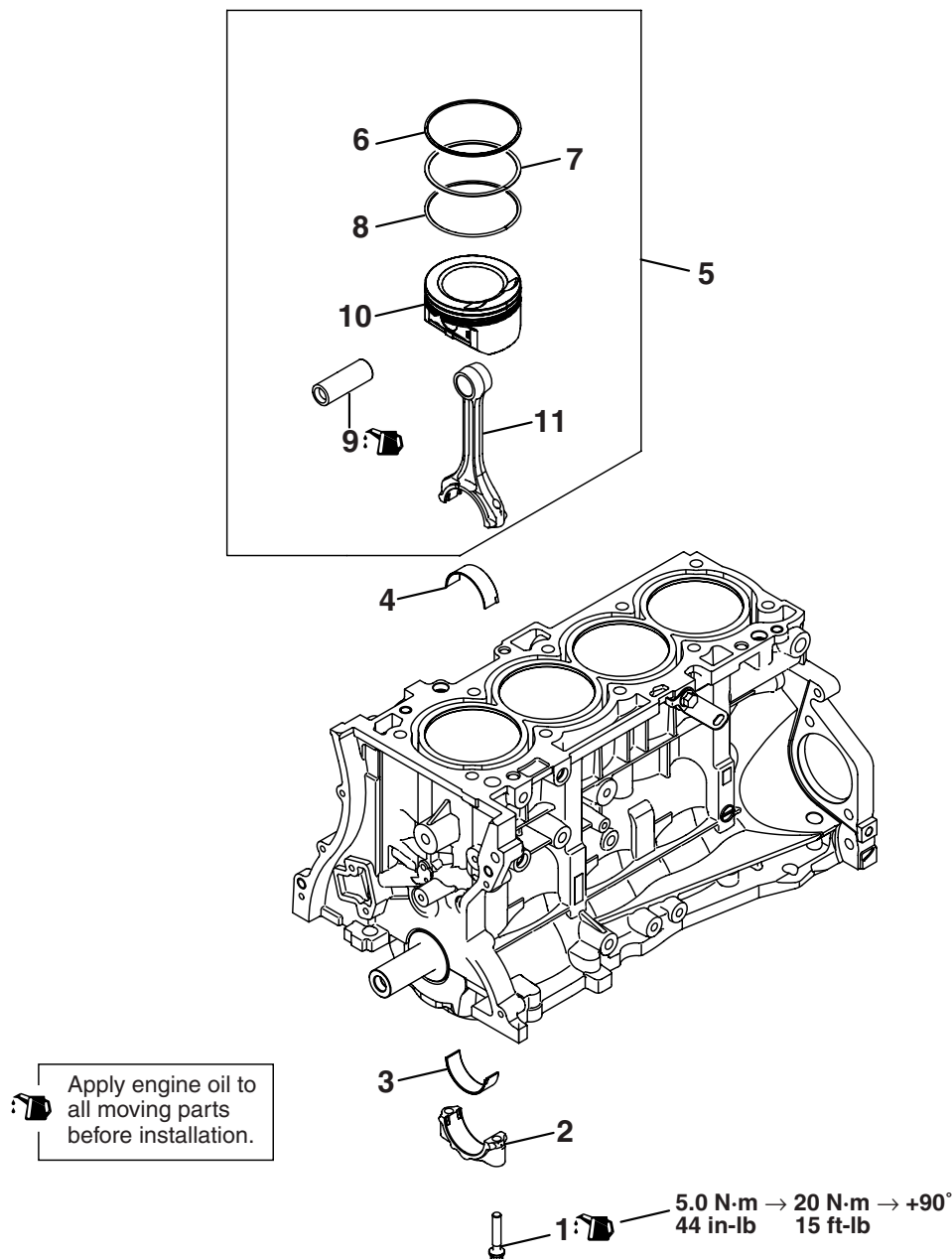


5. Tighten drive plate bolt or flywheel bolt to temporary torque of 40 N·m (32 ft-lb) in the order shown to illustration.
6. Tighten drive plate bolt or flywheel bolt to specified tightening torque of 130 N·m (95 ft-lb) in the order shown in the illustration.

PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION

M1113008403323



AK502937AF

- Removal steps**
- <<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 Number 1

- Removal steps (Continued)**
- >>C<< 7. Piston ring Number 2
 >>B<< 8. Oil ring
 <> >>A<< 9. Piston pin
 10. Piston
 <<A>> 11. Connecting rod

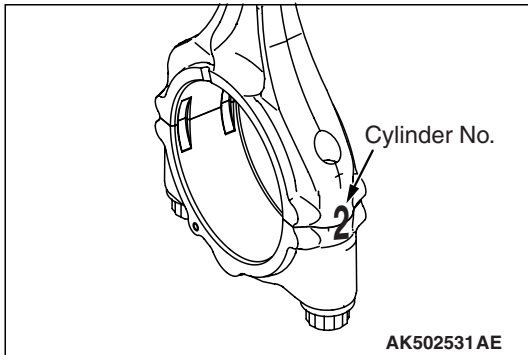
Required Special Tool:

- MD998780: Piston pin setting tool
- MD998718: Rear oil seal installer
- MB991659: Guide D

REMOVAL SERVICE POINTS

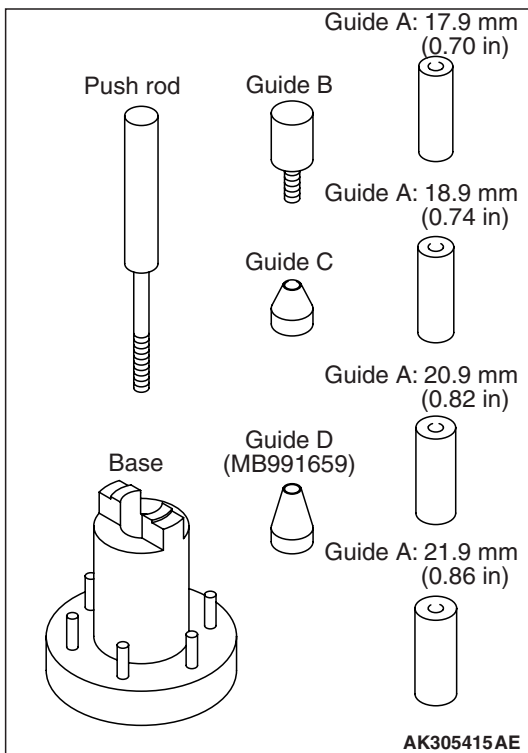
<<A>> CONNECTING ROD REMOVAL

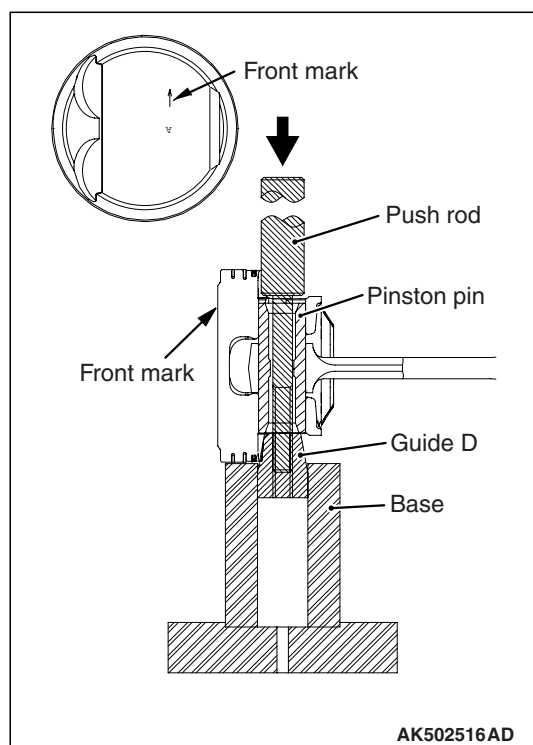
Enter cylinder Number for reassembly on the side of the connecting rod big end.



<> PISTON PIN REMOVAL

Special tool MD998780 consists of parts shown in the illustration. Use also special tool MB991659 to remove the piston pin.





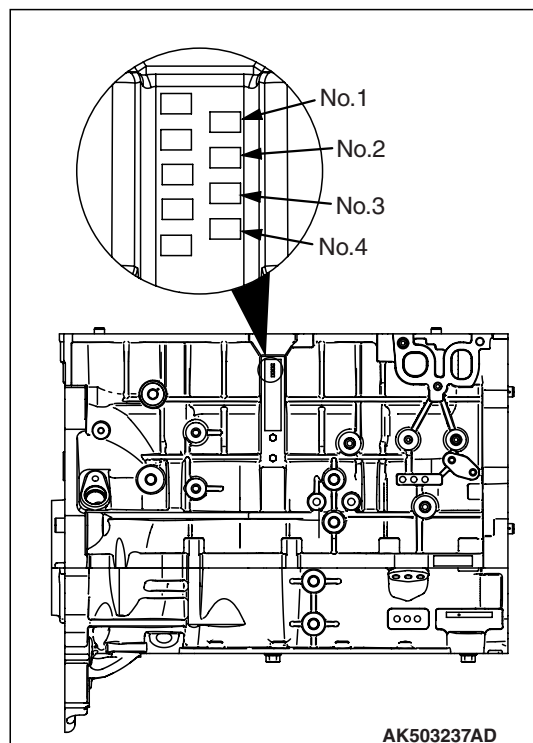
1. Insert the push rod into the piston pin from the front mark side of the piston top surface, and attach special tool MB991659.
2. Set the piston and connecting rod assembly on the base so that the front mark of the piston faces upward.
3. Use a press to push the push rod and pull out the piston pin.

NOTE: After pulling out the piston pin, organize pistons, piston pins and connecting rods by cylinder Number

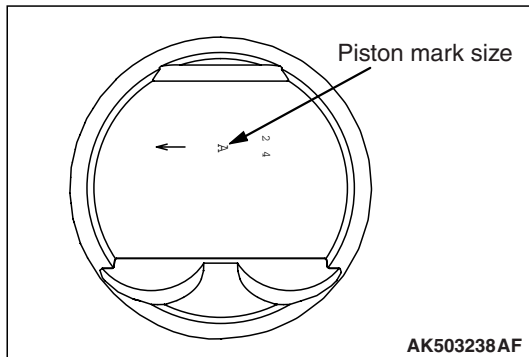
INSTALLATION SERVICE POINTS

>>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.



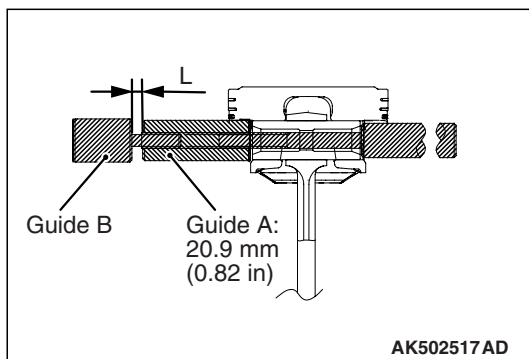
Cylinder bore size mark	Piston size mark
A	A
B	None
C	C



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

2. Insert the push rod into the piston pin and attach guide A.
3. Align the front mark of the piston with that of the connecting rod to assemble.
4. Apply engine oil to the circumference of the piston pin.
5. Insert the guide A side of the piston pin assembled in section 1 into the pin hole from the front mark side of the piston.
6. Screw guide B into guide A and open clearance between guide A and guide B by 3 mm (0.11 inch) (make the base in line with flushed surface) to assemble.
7. Set the piston on special tool piston setting base so that its front mark faces upward.
8. Use a press to press fit the piston pin. If the press fit load is below the standard value, replace the piston pin (piston assembly) or connecting rod, or both.

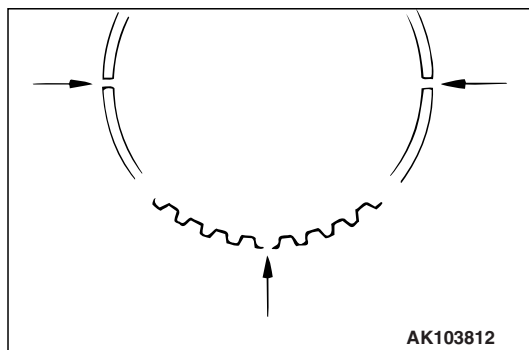
Standard value: 7,500 –17,500 N (1.686 –3.934 lbf)

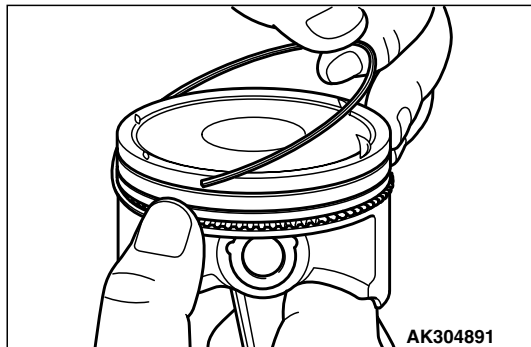


>>B<< OIL RING INSTALLATION

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.



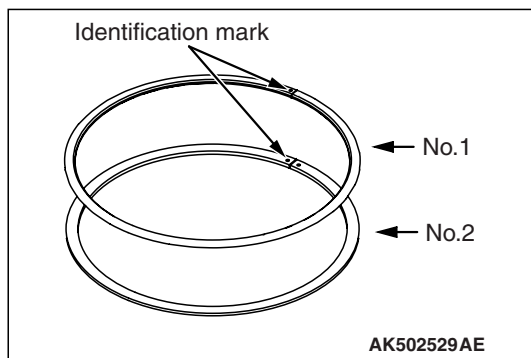
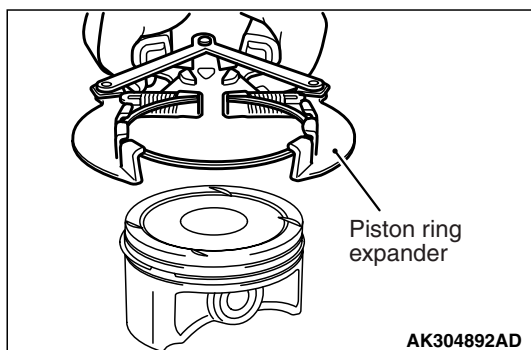
**⚠ CAUTION**

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 NUMBER. 2 / PISTON RING NUMBER. 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.

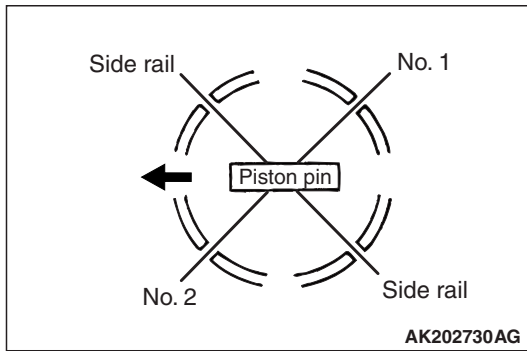
**Identification mark:**

Number 1 ring: 1T

Number 2 ring: 2T

>>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.

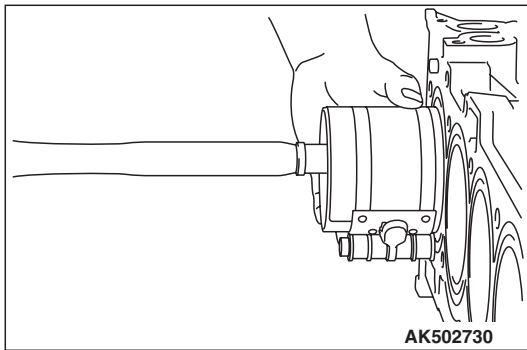


2. Arrange end gap positions of piston rings and oil ring (side rail and spacer) as shown in the illustration.
3. Insert the piston and connecting rod assembly from the top surface of the cylinder block with the front mark of the piston top face facing toward the timing belt side.

⚠ 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.

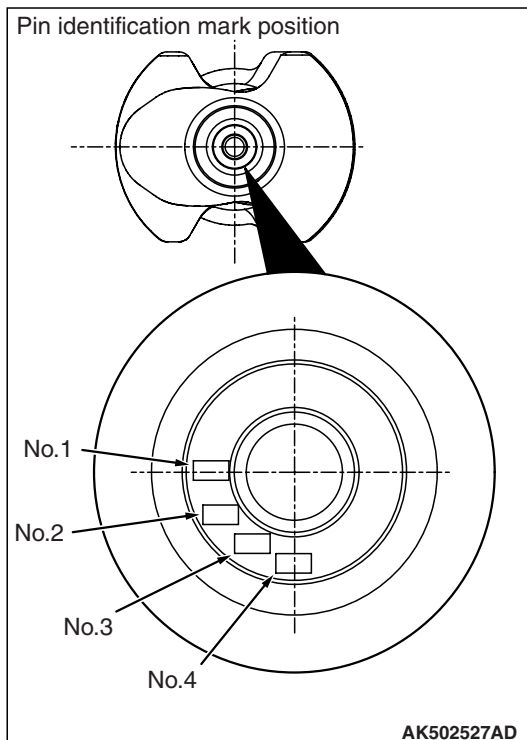


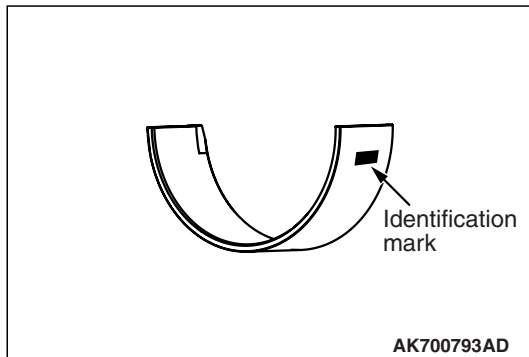
**>>E<< CONNECTING ROD BEARING
INSTALLATION**

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	47.966 –47.972 (1.8884 –1.8886)	1
2	47.960 –47.966 (1.8882 –1.8884)	2
3	47.954 –47.960 (1.8880 –1.8881)	3

2. An identification mark of a crankshaft is stamped at the illustrated position by Number





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

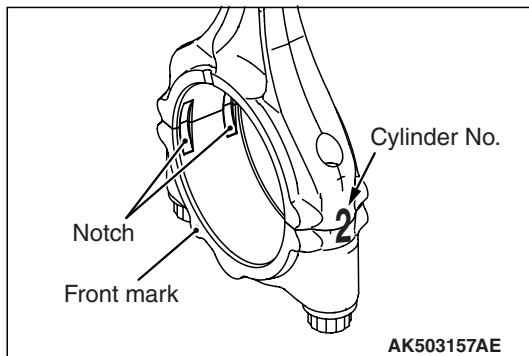
>>F<< CONNECTING ROD CAP INSTALLATION

NOTE: The connecting rod resulting from the breaking process has the high insertion force. The new connecting rod assembly may possibly be difficult to remove the connecting rod.

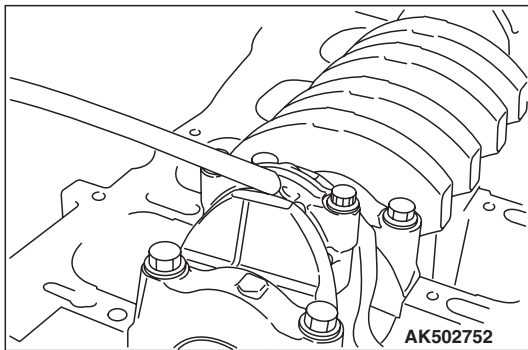
If difficult to remove it, alternately strike the two bolt heads with a plastic hammer while the connecting rod bolt is slightly loosened, or strike the center of the cap shaft's inside diameter slightly and outward.

If the outside of the cap is directly struck, the lateral force is added to the broken-out section. Thus, pay attention to the broken-out section that might be difficult to be separated or might fall.

Clean the broken-out section before the installation to the engine, using compression air.



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.

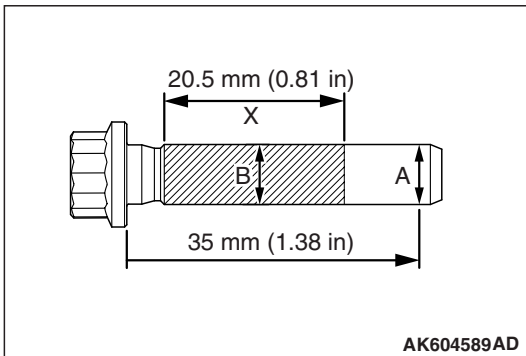


2. Make sure that clearance of the thrust of the connecting rod big end is appropriate.

Standard value: 0.10 –0.25 mm (0.004 –0.010 inch)

Limit: 0.4 mm (0.016 inch)

>>G<< CONNECTING ROD CAP BOLT INSTALLATION



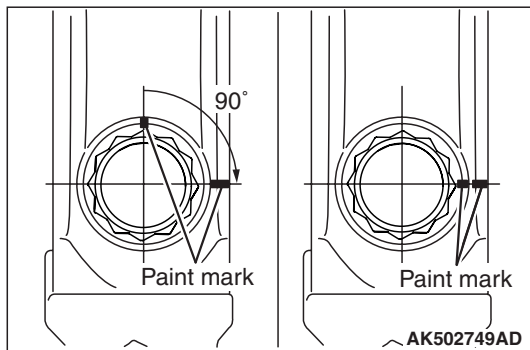
1. Check in the following procedure before reusing the connecting rod bolt.
 - (1) Measure the outside diameter "A."
 - (2) Measure the smallest outside diameter "B" within the range "X" shown in the illustration.
 - (3) If the difference of outside diameter of thread exceeds the limit, replace the connecting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

Limit: 0.1 mm (0.004 inch)

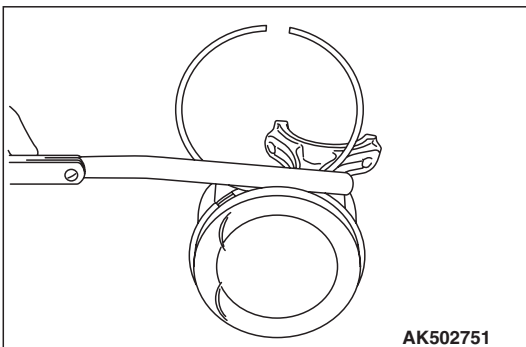
2. Apply engine oil to the threaded portion and seat surface of the bolt before installing it.
3. After installing each bolt and tightening it by fingers, tighten bolts alternately to properly assemble the cap.
4. Tighten the bolt in several steps until the torque reaches 5.0 N·m (44 in-lb).
5. Tighten the bolt in several steps until the torque reaches 20 N·m (14 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.

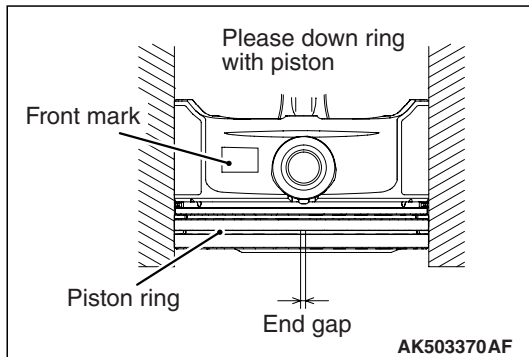
Standard value:

Number 1 ring: 0.03 –0.07 mm (0.001 –0.003 inch)

Number 2 ring: 0.03 –0.07 mm (0.001 –0.003 inch)

Limit: 0.1 mm (0.004 inch)

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- 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 free gauge. If the end gap is excessive, replace piston rings.

Standard value:

Number 1 ring: 0.15 – 0.25 mm (0.006 – 0.011 inch)

Number 2 ring: 0.25 – 0.40 mm (0.010 – 0.016 inch)

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

Limit:

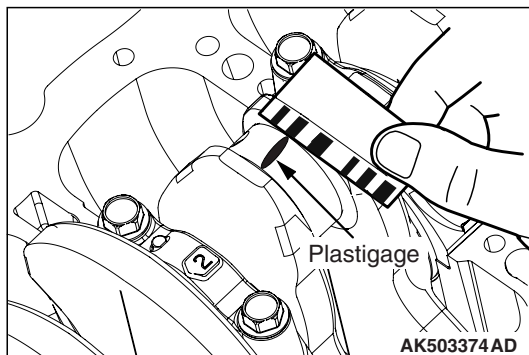
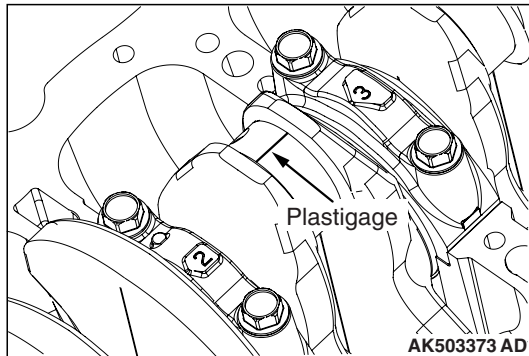
Number 1 ring: 0.8 mm (0.03 inch)

Number 2 ring: 0.8 mm (0.03 inch)

Oil ring: 1.0 mm (0.04 inch)

**CRANKSHAFT PIN OIL CLEARANCE
(PLASTIGAGE METHOD)**

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



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

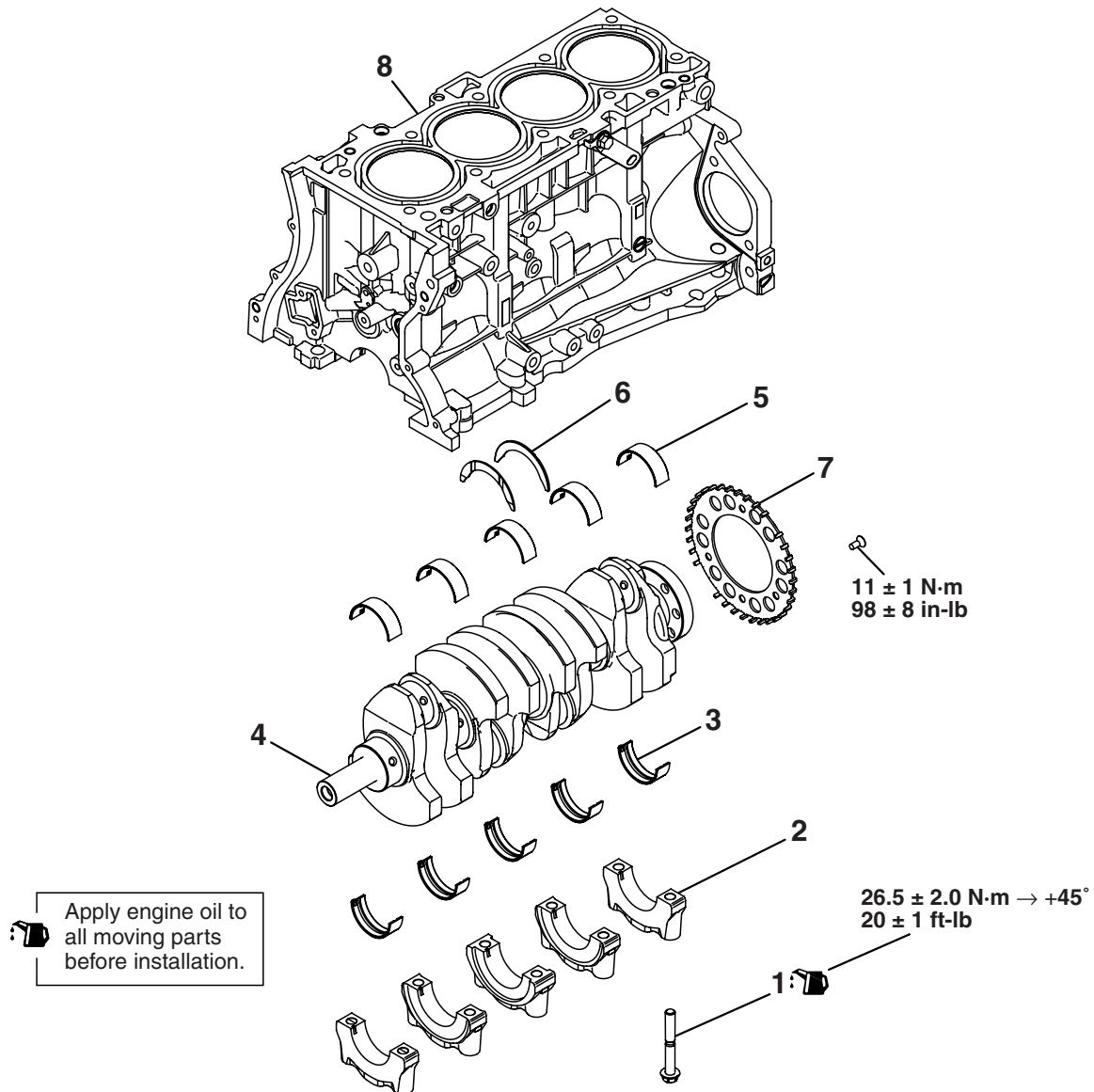
Standard value: 0.018 – 0.045 mm (0.0007 – 0.0018 inch)

Limit: 0.1 mm (0.04 inch)

CRANKSHAFT AND CYLINDER BLOCK

REMOVAL AND INSTALLATION

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Removal steps

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

Removal steps (Continued)

- >>C<< 5. Crankshaft bearing upper
- >>B<< 6. Thrust bearing
- >>A<< 7. Crankshaft sensing ring
- 8. Cylinder block

REMOVAL SERVICE POINT

<<A>> CRANKSHAFT REMOVAL

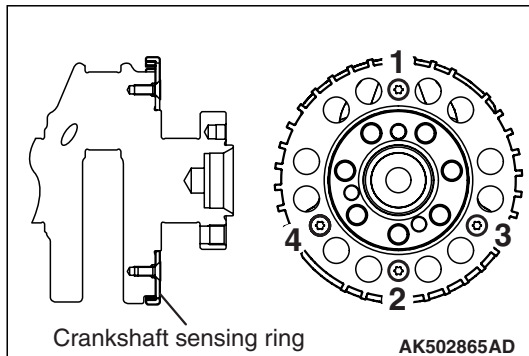
When temporarily placing the crankshaft with the crankshaft sensing ring attached, temporarily place it on a V-block to prevent teeth of the sensing ring from deforming.

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

INSTALLATION SERVICE POINTS

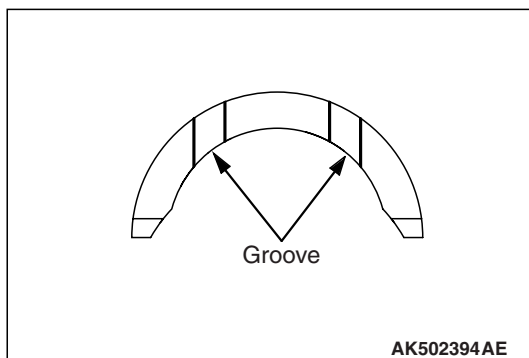
>>A<< CRANKSHAFT SENSING RING INSTALLATION

Tighten crankshaft sensing ring bolts to the torque of 11 ± 1 N·m (98 ± 8 in-lb) in the tightening order shown in the illustration.



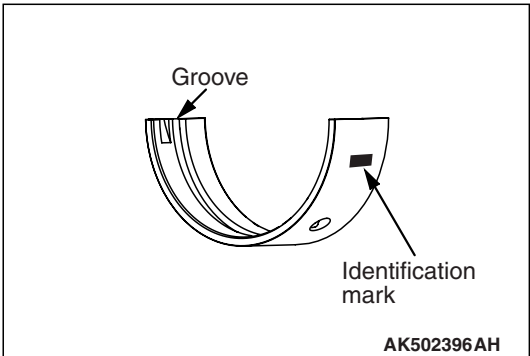
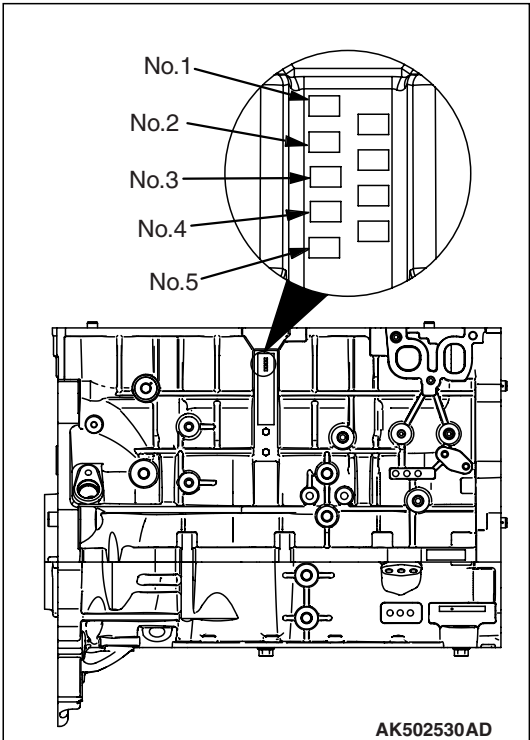
>>B<< THRUST BEARING INSTALLATION

1. Install the thrust bearing on the Number 3 bearing on the cylinder block side. Application of engine oil makes the installation easy.
2. Install the thrust bearing so that the grooved side is on the crankshaft weight side.



>>C<< CRANKSHAFT BEARING UPPER
INSTALLATION

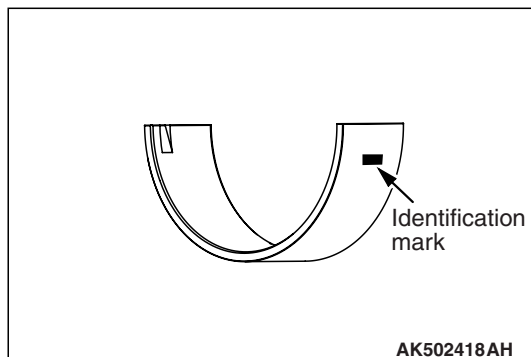
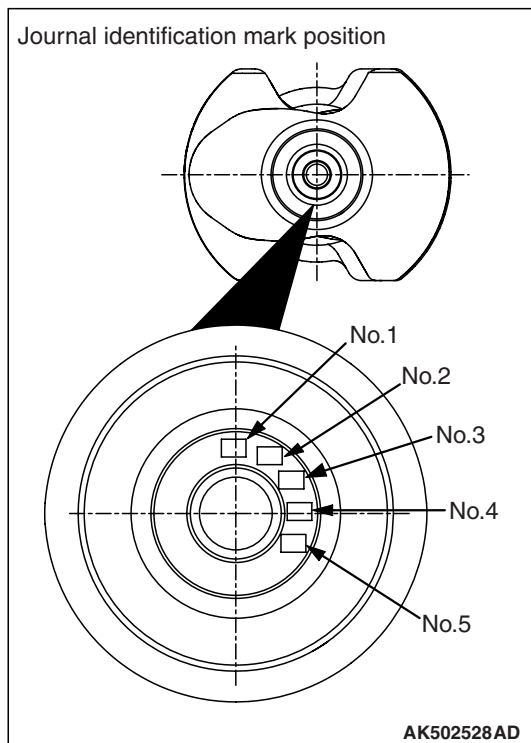
1. When replacing the crankshaft bearing upper, select a bearing with the size corresponding to the crankshaft journal diameter in the table below.



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

Cylinder block		Crankshaft bearing
Identification mark	Journal diameter mm (in)	Identification mark
1	56.000 –56.006 (2.2047 – 2.2049)	1
2	56.006 –56.012 (2.2050 –2.2051)	2
3	56.012 –56.018 (2.2050 –2.2054)	3

3. Install the selected crankshaft bearing upper.

**>>D<< CRANKSHAFT BEARING LOWER
INSTALLATION**

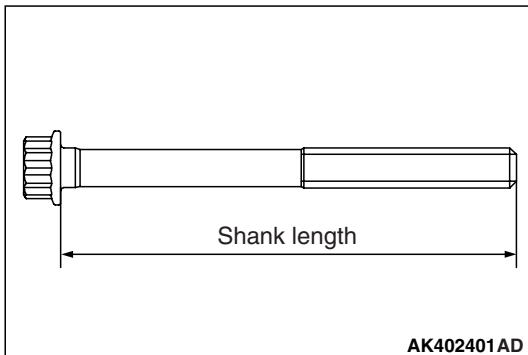
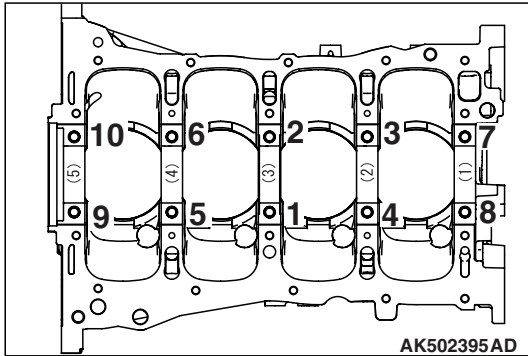
1. When replacing the crankshaft bearing lower, select a bearing with the size corresponding to the crankshaft journal diameter in the table below.

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

Crankshaft		Crankshaft bearing
Identification mark	Journal diameter mm (in)	Identification mark
0	51.985 –51.988 (2.04665 –2.04677)	0
1	51.982 –51.985 (2.04653 –2.04665)	1
2	51.979 –51.982 (2.04641 –2.04653)	2
3	51.976 –51.979 (2.04629 –2.04641)	3
4	51.973 –51.976 (2.04618 –2.04629)	4

3. Install the selected crankshaft bearing lower.

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



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

2. Make sure that the underhead length of the bolt is at or below the limit before installing the crankshaft bearing cap bolt. If the length exceeds the limit, replace the bolt with a new one.

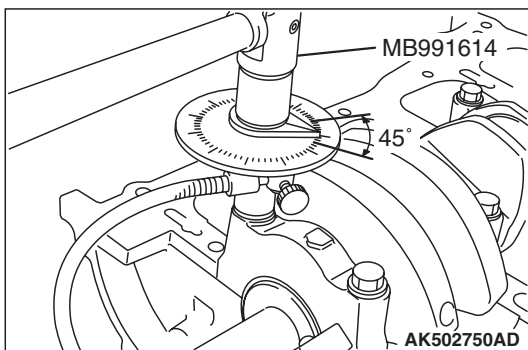
Limit: 75.5 –76.5 mm (2.972 –3.012 inch)

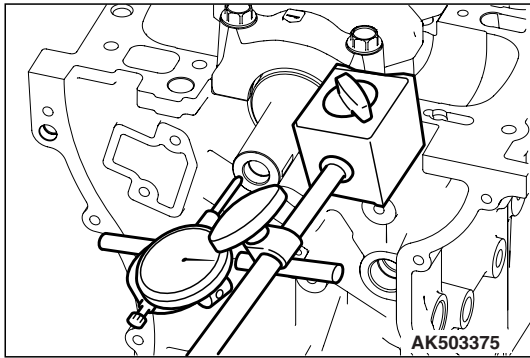
3. Apply engine oil to the threaded portion and seat surface of the bolt.

4. Tighten crankshaft bearing cap bolts to the torque of 26.5 ± 2.0 N·m (20 ± 1 ft-lb) according to the tightening order.

⚠ 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.
5. Use special tool Angle gauge (MB991614) to tighten bolts 45° according to the tightening order.





6. 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 (0.016 inch)

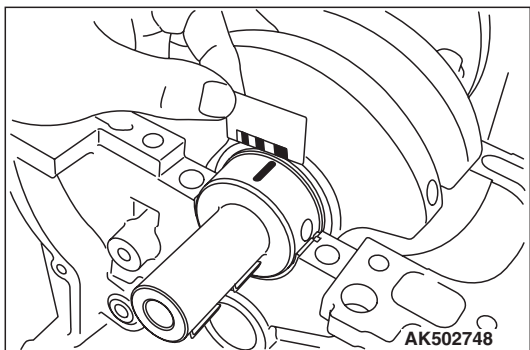
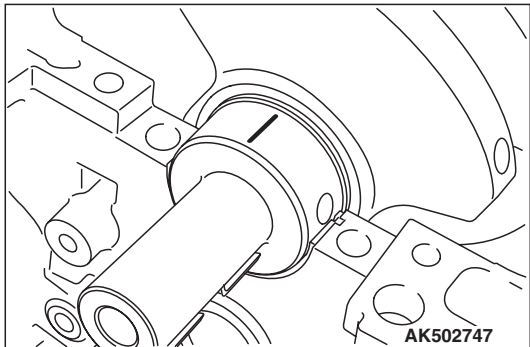
INSPECTION

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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.



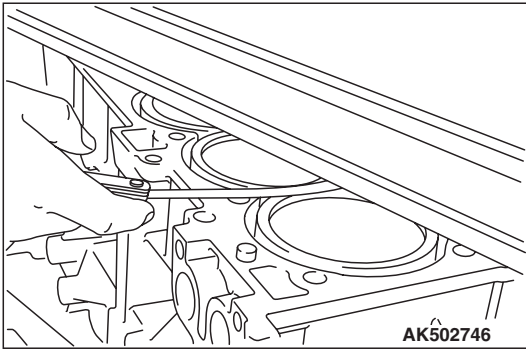
6. Measure the crushed plastigage width (area most widely crushed) using a scale printed on the plastigage bag.

Standard value: 0.012 –0.030 mm (0.0005 –0.0012 inch)

Limit: 0.08 mm (0.0031 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.



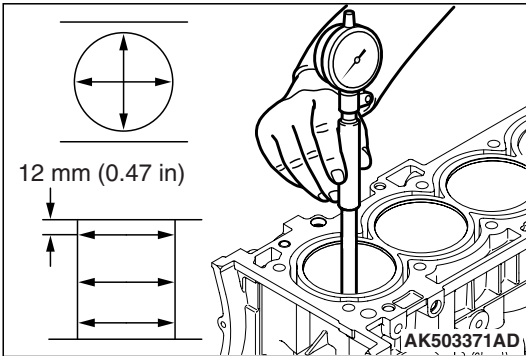
2. Measure distortion on the top surface of the cylinder block using a straight edge and feeler gauge.
If distortion exceeds the limit, grind and repair it.
A gasket or the like must not be adhered to the top surface of the cylinder block during measurement.

Distortion on bottom

Standard value: Within 0.05 mm (0.0020 inch)

Limit: 0.2 mm (0.008 inch)

Grinding limit: 0.2 mm (0.008 inch)



3. Check the cylinder wall for scratch or seizure. If there is any defect, replace the cylinder block.
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: 88 mm (3.4 inch)

Cylindricity: 0.0076 mm (0.0003 inch)

NOTES