

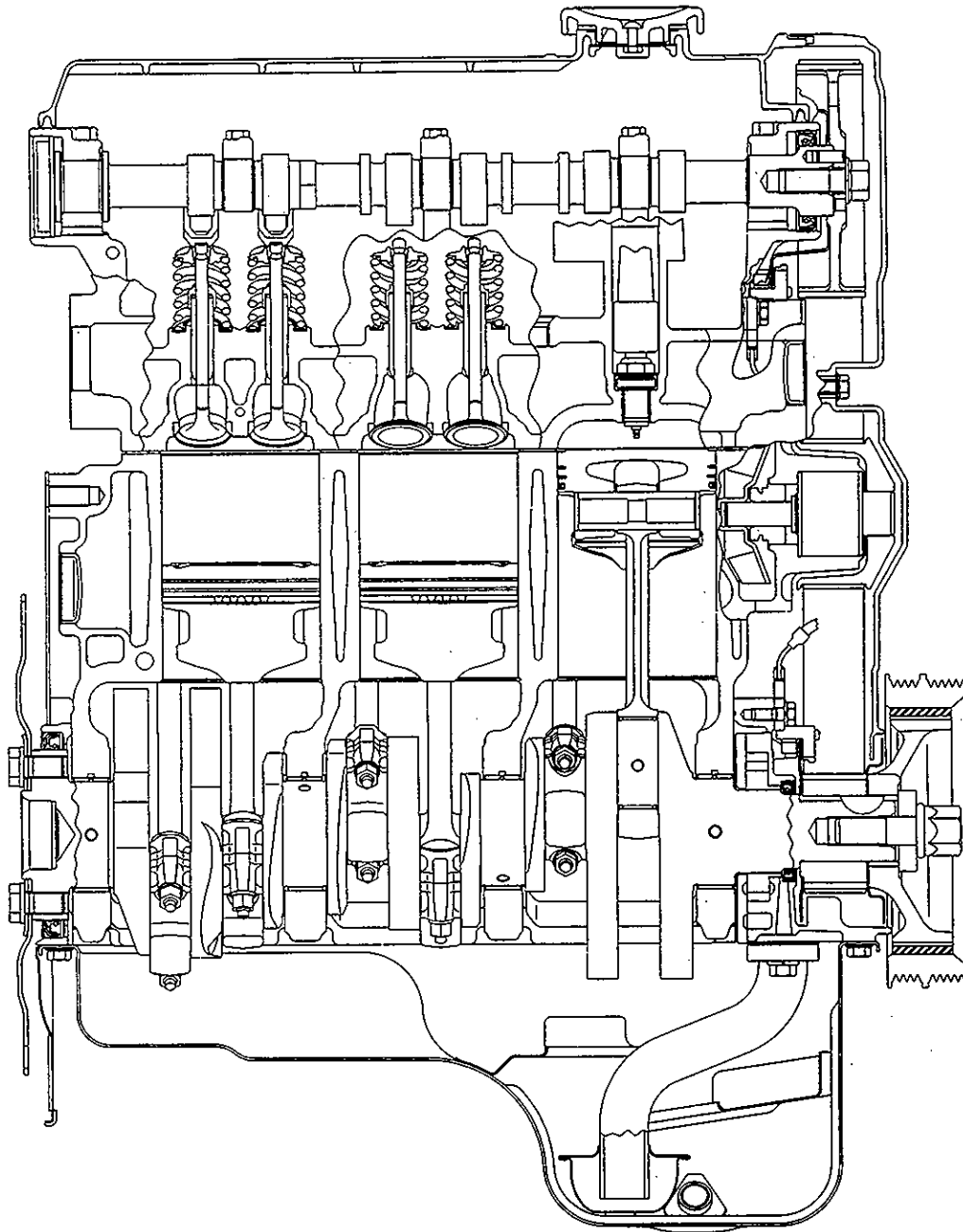
# ENGINE

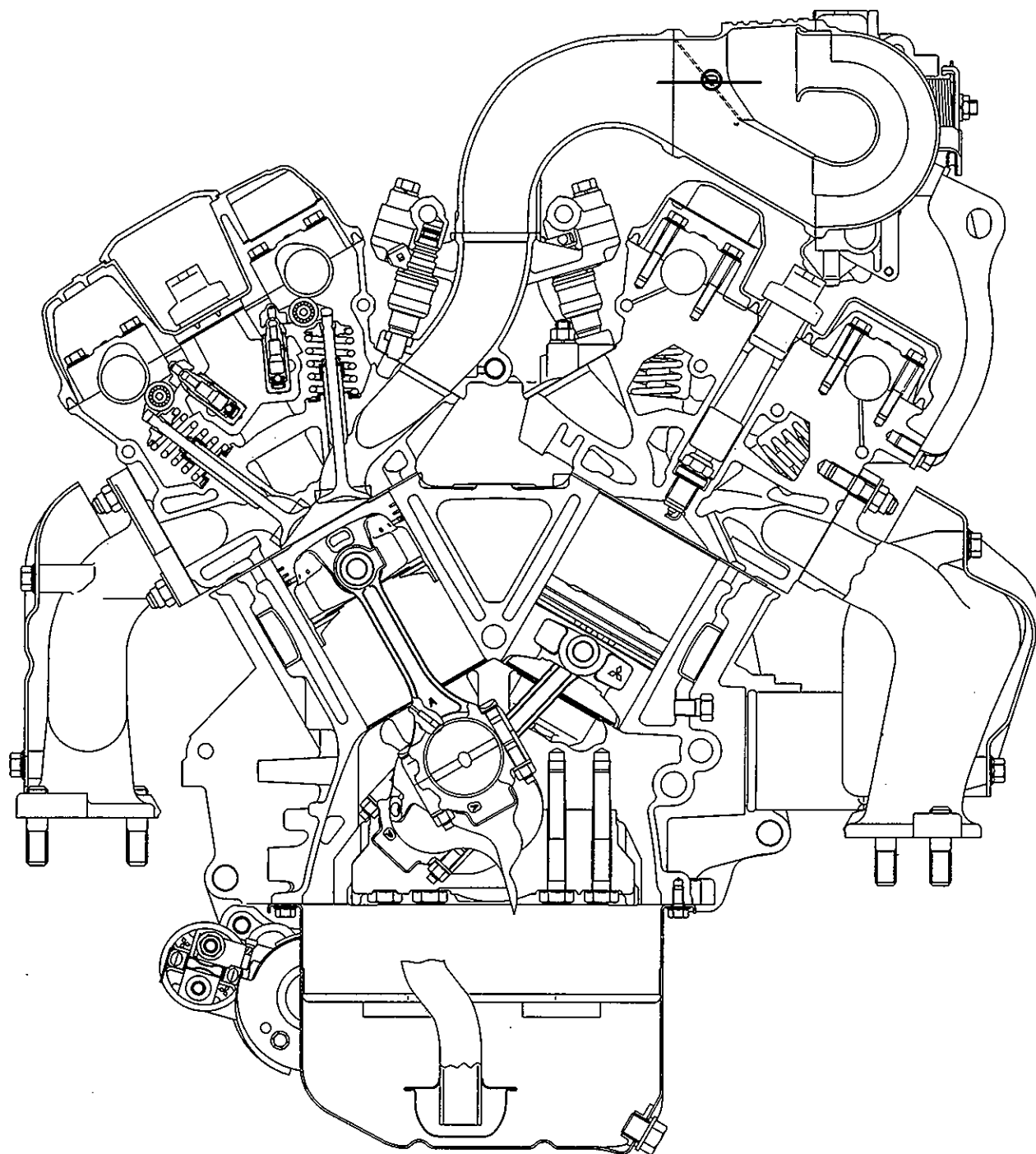
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## 6A12

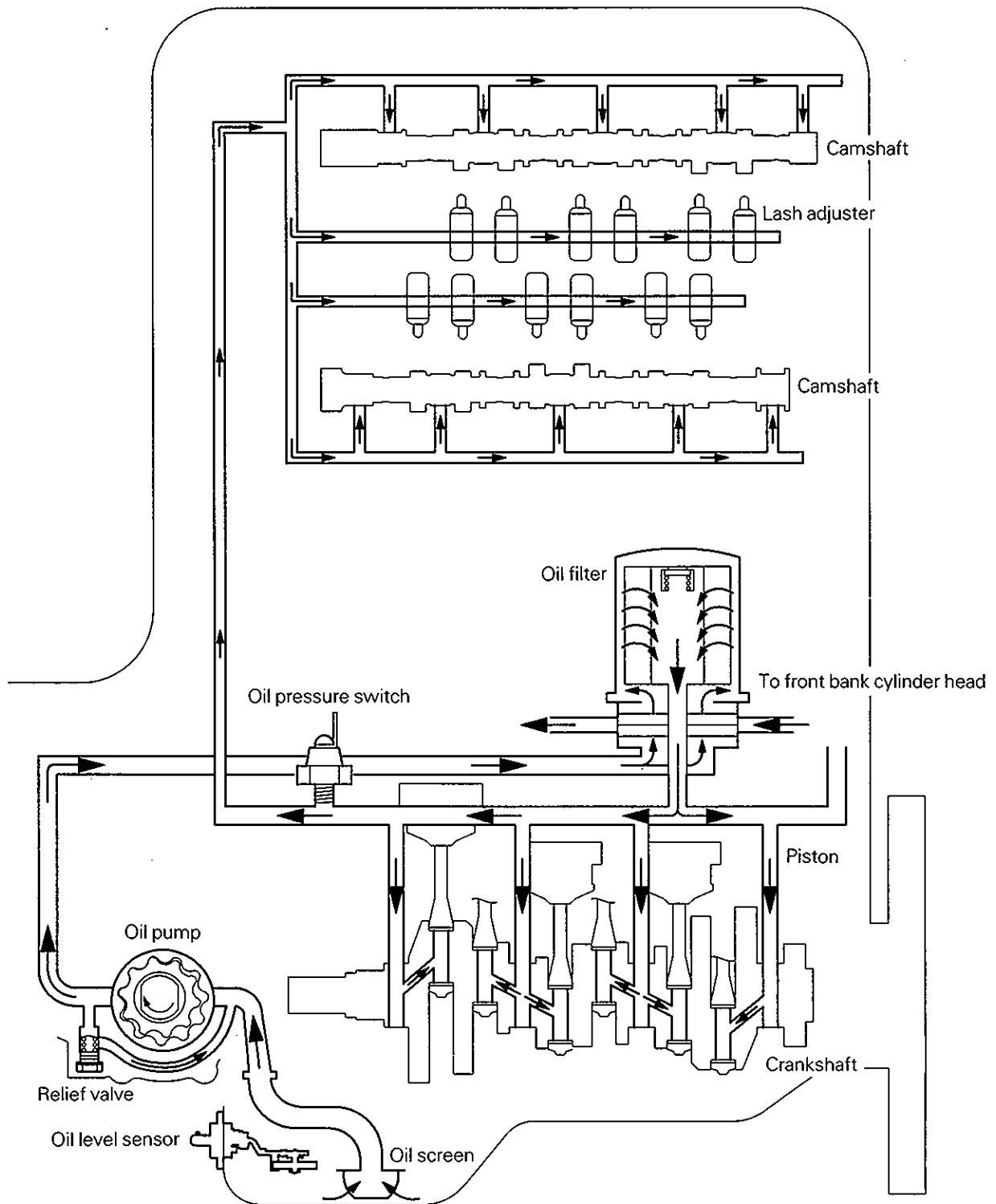
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**GENERAL INFORMATION****SECTIONAL VIEW**



## LUBRICATION SYSTEM



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## NOTES

# 1. SPECIFICATIONS

## GENERAL SPECIFICATIONS

Description		Specifications
Engine model .....		6A12
No. and arrangement of cylinders .....		6, V – type
Combustion chamber .....		Compact type
Total displacement .....		1,998 cm <sup>3</sup> (121.9 cu.in.)
Cylinder bore x stroke .....		78.4 x 69 mm (3.09 x 2.72 in.)
Compression ratio .....		10.0
Valve mechanism .....		Double overhead camshaft (both banks)
Lash adjuster .....		Hydraulic type
Rocker arm .....		Roller follower type
Valve timing		
Intake valve .....	Open .....	11° BTDC
	Close .....	53° ABDC
Exhaust valve .....	Open .....	53° BBDC
	Close .....	15° ATDC

## SERVICE SPECIFICATIONS

mm (in.)

	Standard	Limit
<b>Cylinder head</b>		
Flatness of gasket surface .....	Less than 0.05 (0.0019) .....	0.2 (0.008)
Grinding limit .....		*0.2 (0.008)
*Total resurfacing depth of both cylinder head and cylinder block.		
Overall height .....	131.9 – 132.1 (5.193 – 5.201)	
Oversize rework dimensions of valve guide hole (both intake and exhaust)		
0.05 .....	11.05 – 11.07 (0.4350 – 0.4358)	
0.25 .....	11.25 – 11.27 (0.4429 – 0.4437)	
0.50 .....	11.50 – 11.52 (0.4528 – 0.4535)	
Oversize rework dimensions of valve seat hole		
Intake   0.3 .....	32.30 – 32.33 (1.2717 – 1.2728)	
0.6 .....	32.60 – 32.63 (1.2835 – 1.2846)	
Exhaust  0.3 .....	29.80 – 29.82 (1.1732 – 1.1740)	
0.6 .....	30.10 – 30.12 (1.1850 – 1.1858)	
<b>Camshaft</b>		
Cam height		
Intake .....	35.20 (1.3858) .....	34.70 (1.366)
Exhaust .....	34.91 (1.3744) .....	34.41 (1.355)
Journal diameter .....	26 (1.02)	
Oil clearance .....	0.05 – 0.09 (0.020 – 0.0035)	
<b>Valve</b>		
Overall length		
Intake .....	107.02 (4.2134)	
Exhaust .....	105.68 (4.1606)	
Stem diameter		
Intake .....	5.97 – 5.98 (0.2350 – 0.2354)	
Exhaust .....	5.95 – 5.97 (0.2343 – 0.2350)	
Face angle .....	45° – 45.5°	
Stem-to guide clearance		
Intake .....	0.02 – 0.04 (0.0008 – 0.0016) .....	0.10 (0.004)
Exhaust .....	0.04 – 0.06 (0.0016 – 0.0024) .....	0.15 (0.006)
Thickness of valve head (Margin)		
Intake .....	1.0 (0.039) .....	0.7 (0.028)
Exhaust .....	1.3 (0.051) .....	0.8 (0.031)
Valve stem projection .....	48.40 (1.9055) .....	48.90 (1.9252)
<b>Valve spring</b>		
Free length .....	47.3 (1.862) .....	46.3 (1.823)
Load .....	250 N (25.0 kg, 55.1 lbs.) at installed height	
Installed height .....	39.2 (1.543) .....	38.2 (1.504)
Out-of-squareness .....	Less than 2° .....	4°

mm (in.)

	Standard	Limit
<b>Valve guide</b>		
Overall length		
Intake .....	45.5 (1.791)	
Exhaust .....	52.5 (2.067)	
I.D. ....	6.00 – 6.01 (0.236 – 0.237)	
O.D. ....	11.06 – 11.07 (0.4354 – 0.4358)	
Service size .....	0.05 (0.002), 0.25 (0.010)	
	0.50 (0.020) Oversize	
<b>Valve seat</b>		
Seat angle .....	44° – 44.5°	
Valve contact width .....	0.9 – 1.3 (0.035 – 0.051)	
Service size .....	0.30 (0.012), 0.60 (0.024) Oversize	
<b>Piston</b>		
O.D. ....	78.4 (3.087)	
Piston-to-cylinder clearance .....	0.02 – 0.04 (0.0008 – 0.0016)	
Service size .....	0.25 (0.010), 0.50 (0.020)	
	0.75 (0.030), 1.00 (0.039) Oversize	
<b>Piston ring</b>		
End gap		
No. 1 ring .....	0.25 – 0.40 (0.0098 – 0.0157)	0.8 (0.031)
No. 2 ring .....	0.40 – 0.55 (0.0157 – 0.0217)	0.8 (0.031)
Oil ring .....	0.10 – 0.35 (0.0039 – 0.0138)	1.0 (0.039)
Ring to ring groove clearance		
No. 1 ring .....	0.03 – 0.07 (0.0011 – 0.0028)	1.0 (0.039)
No. 2 ring .....	0.02 – 0.06 (0.0008 – 0.0024)	1.0 (0.039)
<b>Piston pin</b>		
O.D. ....	19.002 – 19.005 (0.7481 – 0.7482)	
Press-in load .....	5,000 – 15,000 N (500 – 1,500 kg, 1,102 – 3,307 lbs.)	
Press-in temperature .....	Room temperature	
<b>Connecting rod</b>		
Big end center-to-small end center length .....	125.4 – 125.5 (4.937 – 4.941)	
Bend .....	0.05 (0.0020) or less	
Twist .....	0.1 (0.004) or less	
Big end side clearance .....	0.10 – 0.25 (0.0039 – 0.0098)	0.4 (0.016)
<b>Crankshaft</b>		
End play .....	0.05 – 0.25 (0.0020 – 0.0098)	0.3 (0.012)
Journal O.D. ....	53 (2.09)	
Pin O.D. ....	43 (1.69)	
Out-of-roundness of journal and pin .....	Less than 0.003 (0.0001)	
Taper of journal and pin .....	Less than 0.005 (0.0002)	
Oil clearance of journal .....	0.02 – 0.05 (0.0008 – 0.0020)	0.1 (0.004)
Oil clearance of pin .....	0.02 – 0.05 (0.0008 – 0.0020)	0.1 (0.004)
<b>Cylinder block</b>		
Cylinder bore .....	78.4 (3.087)	
Flatness of gasket surface .....	Less than 0.05 (0.0020)	0.1 (0.004)
Grinding limit .....		*0.2 (0.008)

\*Total resurfacing depth of both cylinder head and cylinder block.



		mm (in.)
	Standard	Limit
<b>Flywheel</b>		
Runout .....		0.13 (0.005)
<b>Oil pump</b>		
Tip clearance .....	0.06 – 0.18 (0.0024 – 0.0070)	
Body clearance .....	0.10 – 0.18 (0.0040 – 0.0070)	
Side clearance .....	0.04 – 0.10 (0.0016 – 0.0039)	
<b>Drive belt</b>		
Deflection		
New belt .....	8.5 – 10.5 (0.335 – 0.402)	
Used belt .....	11.5 – 12.5 (0.453 – 0.492)	
Tension		
New belt .....	490 – 686 N (50 – 70 kg, 110 – 154 lbs.)	
Used belt .....	343 – 441 N (35 – 45 kg, 77 – 99 lbs.)	

**TORQUE SPECIFICATION**

	Nm	Torque kgm	ft.lbs.
<b>Drive belt</b>			
Alternator .....	45	4.5	33
Alternator bracket .....	23	2.3	17
Oil level gauge .....	14	1.4	10
Tensioner bracket .....	45	4.5	33
Crankshaft bolt .....	185	18.5	134
Alternator pivot bolt .....	12	1.2	9
<b>Timing belt</b>			
Timing belt front cover bolt .....	11	1.1	8
Engine support bracket bolt .....	50	5.0	36
Angle sensor nut .....	9	0.9	7
Tensioner pulley bolt .....	49	4.9	35
Tensioner arm bolt .....	45	4.5	33
Auto tensioner bolt .....	22	2.2	16
Camshaft sprocket bolt .....	90	9.0	65
Idler pulley bolt .....	36	3.6	26
Timing belt rear cover bolt .....	M6 .....	1.1	8
	M8 .....	1.3	9
Angle sensor bracket .....	9	0.9	7
<b>Fuel and emission control parts</b>			
Air intake plenum stay bolt .....	18	1.8	13
EGR valve bolt .....	22	2.2	16
Throttle body bolt .....	12	1.2	9
Air intake plenum bolt .....	18	1.8	13
Delivery pipe and injector .....	12	1.2	9
Fuel pipe bolt .....	9	0.9	7
Fuel pressure regulator bolt .....	9	0.9	7
<b>Ignition system</b>			
Center cover bolt .....	4	0.4	3
Spark plug .....	25	2.5	18
Power transistor bolt .....	13	1.3	9
Ignition coil bolt .....	13	1.3	9
Engine hanger bolt .....	13	1.3	9
<b>Water pump and water pipe</b>			
Engine coolant temperature gauge unit .....	11	1.1	8
Engine coolant temperature sensor .....	30	3.0	22
Water inlet fitting bolt .....	19	1.9	14
Water outlet fitting bolt .....	11	1.1	7
Thermostat housing bolt .....	24	2.4	17
Water pipe bolt .....	14	1.4	10
Water pump bolt .....	24	2.4	17

		Torque		
		Nm	kgm	ft.lbs.
<b>Intake and exhaust manifold</b>				
Intake manifold bolt and nut .....		18	1.8	13
Heat protector bolt .....		14	1.4	10
Exhaust manifold nut .....		30	3.0	22
<b>Rocker arm and camshaft</b>				
Rocker cover bolt .....		4	0.4	3
Bearing cap bolt .....	M6	11	1.1	8
	M6	20	2.0	14
<b>Cylinder head and valves</b>				
Cylinder head bolt .....		20 + 90° + 90°	2.0 + 90° + 90°	14.5 + 90° + 90°
[Tighten to 74 Nm (7.5 kgm, 54 ft.lbs.) and then completely loosen before finally tightening with above procedure.]				
<b>Oil pump case and oil pan</b>				
Oil pressure switch .....		10	1.0	7
Bolt .....		68	6.8	49
Drain plug .....		40	4.0	29
Oil level sensor bolt .....		9	0.9	7
Oil pan bolt .....		7	0.7	5
Oil screen bolt .....		19	1.9	14
Baffle plate bolt .....		9	0.9	7
Relief plug .....		45	4.5	33
Oil pump case bolt .....		14	1.4	10
Oil pump case cover screw .....		12	1.2	9
<b>Piston and connecting rod</b>				
Connecting rod cap nut .....		18 + 90° to 100°	1.8 + 90° to 100°	13 + 90° to 100°
<b>Crankshaft, cylinder block, flywheel and drive plate</b>				
Knock sensor .....		23	2.3	17
Idler pulley bracket bolt .....		36	3.6	26
Flywheel and drive plate bolt .....		100	10.0	72
Rear plate bolt .....		11	1.1	8
Bell housing cover bolt .....		9	0.9	7
Oil seal case bolt .....		11	1.1	8
Bearing cap bolt .....		2.5 + 90° to 100°	2.5 + 90° to 100°	18 + 90° to 100°

## NEW TIGHTENING METHOD – BY USE OF BOLTS TO BE TIGHTENED IN PLASTIC AREA

A new type of bolts, to be tightened in plastic area, is currently used in some parts of the engine. The tightening method for the bolts is different from the conventional one. Be sure to observe the method described in the text when tightening the bolts.

Service limits are provided for the bolts. Make sure that the service limits described in the text are strictly observed.

- Areas where the bolts are in use:

- (1) Cylinder head bolts
- (2) Main bearing cap bolts
- (3) Connecting rod cap bolts

- Tightening Method

After tightening the bolts to the specified torque, tighten them another 90° or 180° (twice 90°). The tightening method varies on different areas. Observe the tightening method described in the text.

## SEALANT

	Specified sealant	Quantity
Water pump .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Thermostat housing .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Engine coolant temperature sensor ....	3M Nut Locking part No. 4171 or equivalent .....	As required
Engine coolant temperature gauge unit .....	3M ATD Part No. 8660 or equivalent .....	As required
Camshaft bearing cap .....	3M ATD Part No. 8660 or equivalent .....	As required
Circular packing .....	3M ATD Part No. 8660 or equivalent .....	As required
Rocker cover .....	3M ATD Part No. 8660 or equivalent .....	As required
Oil pressure switch .....	3M ATD Part No. 8660 or equivalent .....	As required
Water outlet fitting .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Oil pump case .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Oil pan .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Oil seal case .....	Mitsubishi Genuine Part No. MD970389 ..... or equivalent	As required
Drive plate bolt .....	3M Nut Locking part No. 4171 or equivalent .....	As required
Flywheel bolt .....	3M Nut Locking part No. 4171 or equivalent .....	As required

## FORM-IN-PLACE GASKET

The engine has several areas where the form-in-place gasket (FIPG) is in use. To ensure that the gasket fully serves its purpose, it is necessary to observe some precautions when applying the gasket. Bead size, continuity and location are of paramount importance. Too thin a bead could cause leaks. Too thick a bead, on the other hand, could be squeezed out of location, causing blocking or narrowing of the fluid feed line. To eliminate the possibility of leaks from a joint, therefore, it is absolutely necessary to apply the gasket evenly without a break, while observing the correct bead size.

The FIPG used in the engine is a room temperature vulcanization (RTV) type and is supplied in a 100-gram tube (Part No. MD970389 or MD997110). Since the RTV hardens as it reacts with the moisture in the atmospheric air, it is normally used in the metallic flange areas. The FIPG, Part No. MD970389, can be used for sealing both engine oil and coolant, while Part No. 997110 can only be used for engine oil sealing.

### Disassembly

The parts assembled with the FIPG can be easily disassembled without use of a special method. In some cases, however, the sealant between the joined surfaces may have to be broken by lightly striking with a mallet or similar tool. A flat and thin gasket scraper may be lightly hammered in between the joined surfaces. In this case, however, care must be taken to prevent damage to the joined surfaces. For removal of the oil pan, the special tool "Oil Pan Remover" (MD998727) is available. Be sure to use the special tool to remove the oil pan.

### Surface Preparation

Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do not forget to remove the old sealant remaining in the bolt holes.


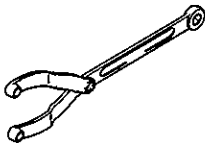
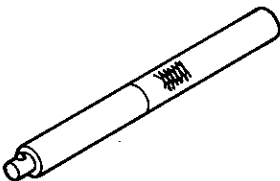
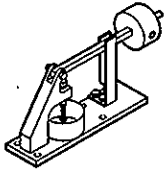
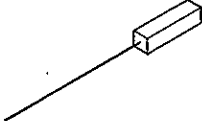

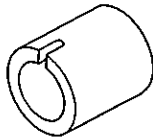
### Form-In-Place Gasket Application


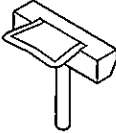
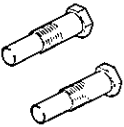
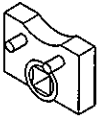
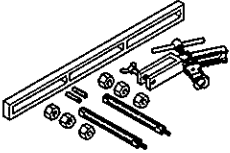
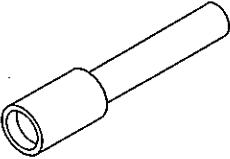

When assembling parts with the FIPG, you must observe some precautions, but the procedure is very simple as in the case of a conventional precut gasket.


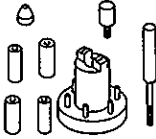
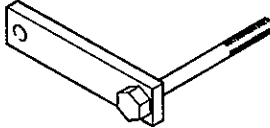
Applied FIPG bead should be of the specified size and without breaks. Also be sure to encircle the bolt hole circumference with a completely continuous bead. The FIPG can be wiped away unless it is hardened. While the FIPG is still moist (in less than 15 minutes), mount the parts in position. When the parts are mounted, make sure that the gasket is applied to the required area only. In addition, do not apply any oil or water to the sealing locations or start the engine until a sufficient amount of time (about one hour) has passed after installation is completed.

The FIPG application procedure may vary on different areas. Observe the procedure described in the text when applying the FIPG.

## 2. SPECIAL TOOLS

Tool	Number	Name	Use
	MB990685	Torque wrench	Adjustment of timing belt tension
	MB990767	End yoke holder	Holding camshaft sprocket when loosening or torquing bolt
	MB990938	Handle	Installation of crankshaft rear oil seal (Use with MD998776)
	MB998440	Leak-down tester	Leak-down test of lash adjuster
	MD998442	Air bleed wire	Air bleeding of lash adjuster
	MD998713	Camshaft front oil seal installer	Installation of camshaft front oil seal
	MD998716	Crankshaft wrench	Rotation of crankshaft when installing piston, connecting rod assembly or timing belt

Tool	Number	Name	Use
	MD998717	Crankshaft front oil seal installer	Installation of crankshaft front oil seal
	MD998727	Oil pan remover	Removal of the oil pan
	MD998754	Pulley holding pins (2)	Holding camshaft sprocket when loosening or torquing bolt
	MD998767	Socket wrench	Adjustment of timing belt tension
	MD998772	Valve spring compressor	Compression of valve spring
	MD998775	Valve stem seal installer	Installation of valve stem seal
	MD998776	Crankshaft rear oil seal installer	Installation of crankshaft rear oil seal (Use with MB990938)

Tool	Number	Name	Use
	MD998777	Camshaft oil seal installer adapter	Installation of camshaft oil seal
	MD998780	Piston pin setting tool	Removal and installation of piston pin
	MD998781	Flywheel stopper	Holding flywheel and drive plate



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## NOTES

# REMOVAL AND INSTALLATION

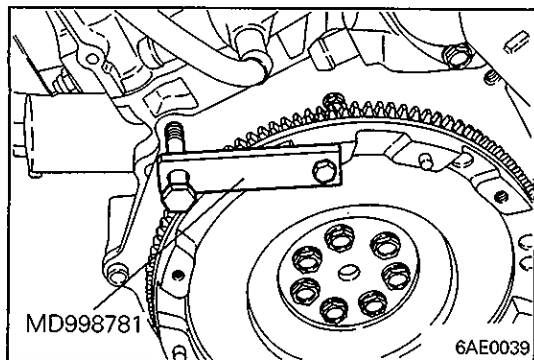
This exploded view diagram illustrates the removal and installation of various engine components. The main engine assembly is shown at the top right. Below it, several components are labeled with numbers and part codes:

- Component 1:** A timing belt.
- Component 2:** A set of three bolts (part code 45 | 4.5 | 33).
- Component 3:** A T-shaped bracket.
- Component 4:** A bolt (part code 23 | 2.3 | 17).
- Component 5:** An alternator.
- Component 6:** A bracket.
- Component 7:** A long rod or pin.
- Component 8:** A small pin or clip.
- Component 9:** A nut (part code N 9).
- Component 10:** A curved bracket.
- Component 11:** A large rectangular plate or cover.
- Component 12:** A pulley or roller.
- Component 13:** A bracket or support.
- Component 14:** A bolt (part code 185 | 18.5 | 134).
- Component 15:** A pulley or roller.
- Component 16:** A smaller pulley or roller.

The diagram shows the relative positions of these components as they would be assembled onto the engine. Part codes are provided in boxes next to the component numbers.

1. Drive belt
2. Nut
3. Bolt
4. Bolt
5. Alternator
6. Alternator bracket
7. Oil level gauge
8. Oil level gauge guide
9. O-ring
10. Timing indicator
11. Tensioner and bracket assembly
12. Tensioner pulley
13. Tensioner bracket
14. Crankshaft pulley bolt
15. Crankshaft pulley
16. Flange

16. Flange
15. Crankshaft pulley
- ◆A◆ 14. Crankshaft pulley bolt
13. Tensioner bracket
12. Tensioner pulley
11. Tensioner and bracket assembly
10. Timing indicator
9. O-ring
8. Oil level gauge guide
7. Oil level gauge
6. Alternator bracket
5. Alternator
3. Bolt
4. Bolt
2. Nut
- ◆B◆ 1. Drive belt



## REMOVAL SERVICE POINTS

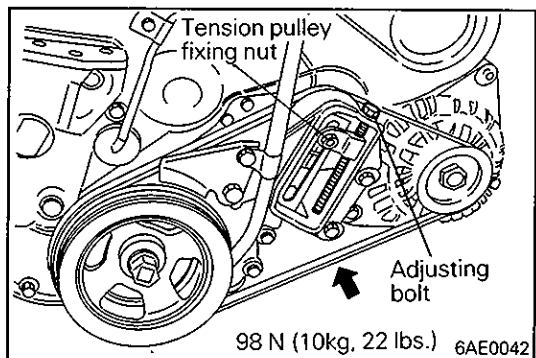
### ◀A▶ CRANKSHAFT PULLEY BOLT REMOVAL

- (1) Hold the flywheel or drive plate in position with the special tool before removing the crankshaft pulley bolts.

## INSTALLATION SERVICE POINTS

### ▶A▶ CRANKSHAFT PULLEY BOLT INSTALLATION

- (1) Hold the flywheel or drive plate in position with the special tool before installing the crankshaft pulley bolts.



### ▶B▶ DRIVE BELT TENSION ADJUSTMENT

- (1) Turn the adjusting bolt to make adjustment so that the standard deflection is obtained when the belt is pushed with a force of 98 N (10 kg, 22 lbs.) applied to the portion indicated by an arrow. After adjustment, tighten the tension pulley fixing nut.

#### Standard value:

**New belt** 8.5 – 10.5 mm (0.335 – 0.402 in.)

**Used belt** 11.5 – 12.5 mm (0.453 – 0.492 in.)

- (2) When a tension gauge is used, make adjustment until the following standard value is obtained.

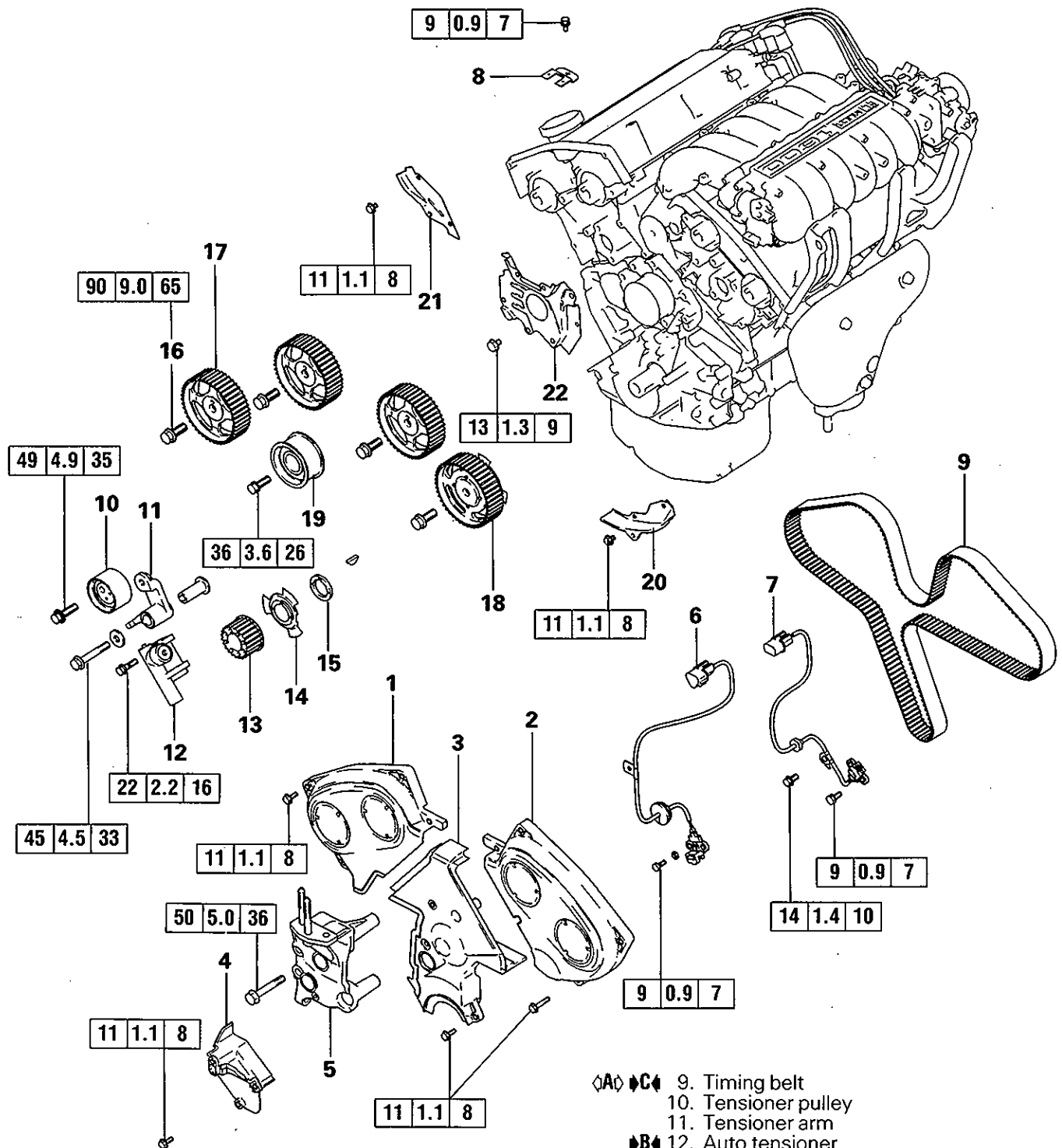
#### Standard value:

**New belt** 490 – 686 N (50 – 70 kg, 110 – 154 lbs.)

**Used belt** 343 – 441 N (35 – 45 kg, 77 – 99 lbs.)

## 4. TIMING BELT

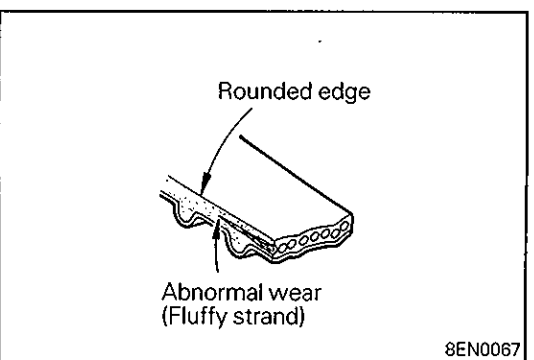
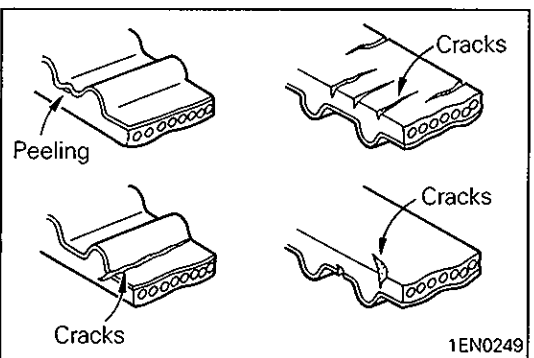
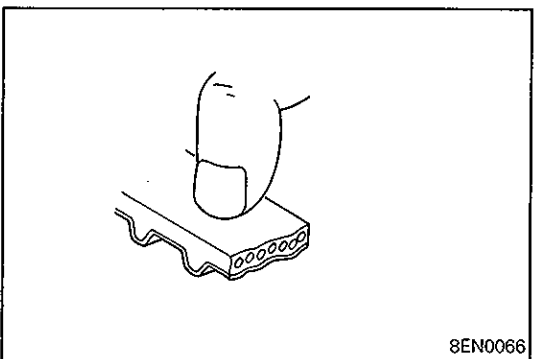
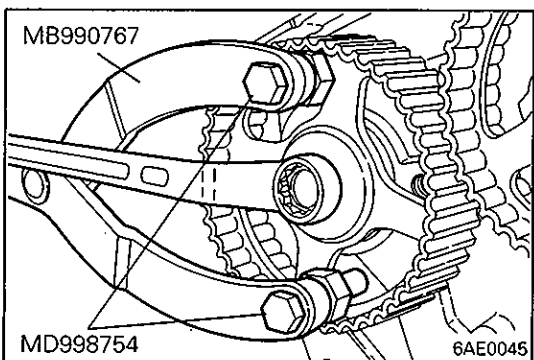
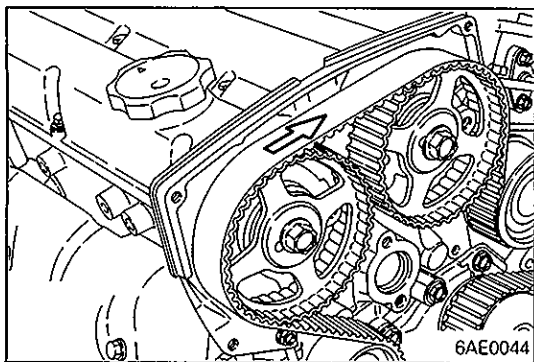
### REMOVAL AND INSTALLATION



#### Removal steps

1. Timing belt front cover, upper right
2. Timing belt front cover, upper left
3. Timing belt front cover, lower
4. Timing belt front cover, lower right
5. Engine support bracket
6. Angle sensor
7. Angle sensor
8. Angle sensor connector bracket

- ◇A◇ ◇C◇ 9. Timing belt
- 10. Tensioner pulley
- 11. Tensioner arm
- ◇B◇ 12. Auto tensioner
- 13. Crankshaft sprocket
- 14. Sensing plate
- 15. Washer
- ◇B◇ ◇A◇ 16. Camshaft sprocket bolt
- 17. Camshaft sprocket
- ◇B◇ 18. Camshaft sprocket with sensing plate
- 19. Idler pulley
- 20. Timing belt rear cover, left
- 21. Timing belt rear cover, right
- 22. Timing belt rear cover, center



## REMOVAL SERVICE POINTS

### ◊A◊ TIMING BELT REMOVAL

- (1) Mark the belt running direction for reference in reinstallation.
- (2) Loosen the bolt that secures the tensioner pulley to remove the timing belt.

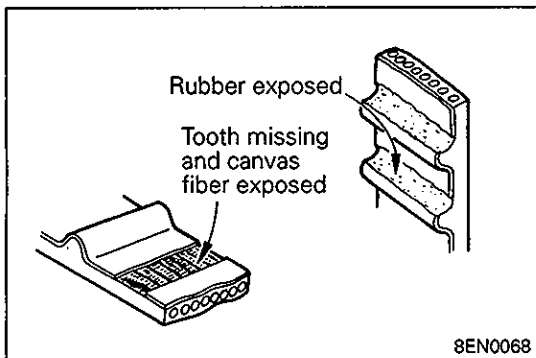
### ◊B◊ CAMSHAFT SPROCKET BOLT REMOVAL

## INSPECTION

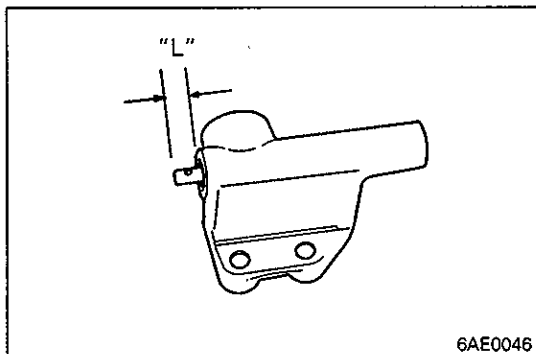
### TIMING BELT

Replace belt if any of the following conditions exist.

- (1) Hardening of back rubber.  
Back side is glossy without resilience and leaves no indent when pressed with fingernail.
- (2) Cracks on rubber back.
- (3) Cracks or peeling of canvas.
- (4) Cracks on tooth bottom.
- (5) Cracks or belt sides.
- (6) Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife.



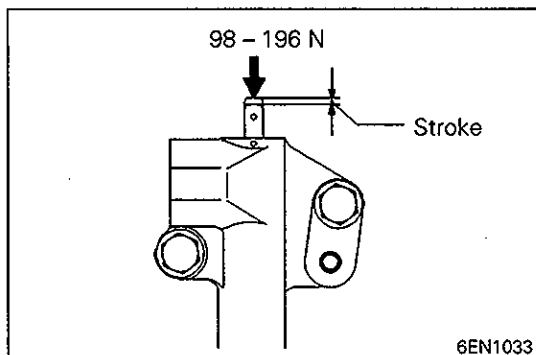
- (7) Abnormal wear on teeth.
- (8) Missing tooth.



### AUTO-TENSIONER

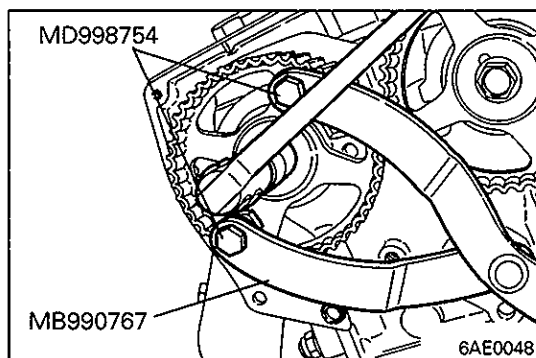
- (1) Check for oil leaks. If oil leaks are evident, replace the auto-tensioner.
- (2) Check the rod end for wear or damage and replace the auto-tensioner if necessary.
- (3) Measure the rod projection length "L". If the reading is outside the standard value, replace the auto tensioner.

**Standard value "L": 11 mm (0.433 in.)**



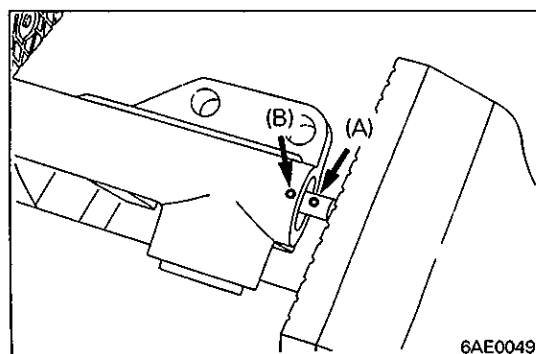
- (4) Press the rod by a force of 98 to 196 N and measure the rod stroke. If the measured value exceeds the standard value, replace the tensioner.

**Standard value: 1 mm (0.0393 in.) or less**



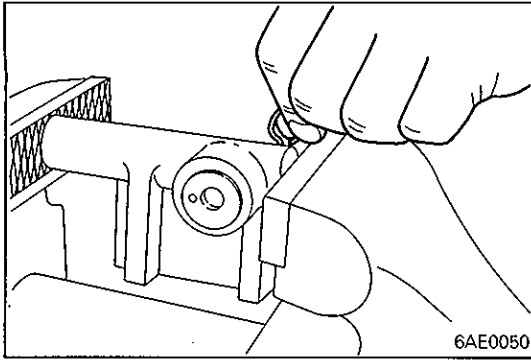
### INSTALLATION SERVICE POINTS

#### ◆A◆ CAMSHAFT SPROCKET BOLT INSTALLATION

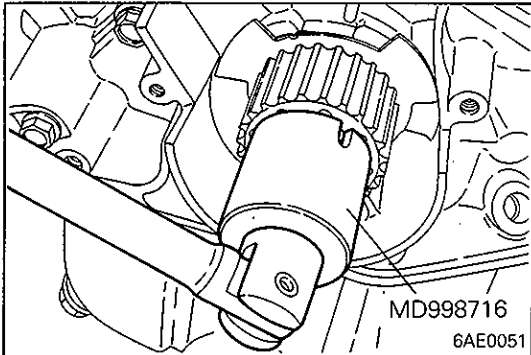


#### ◆B◆ AUTO TENSIONER SETTING

- (1) Set the auto tensioner in a vice, while making sure it is not tilted.
- (2) Slowly close the vice to force the rod in until the set hole (A) of the rod is lined up with the set hole (B) of the cylinder.



- (3) Insert a 1.4 mm (0.055 in.) wire in the set hole.
- (4) Remove the auto tensioner from the vice.

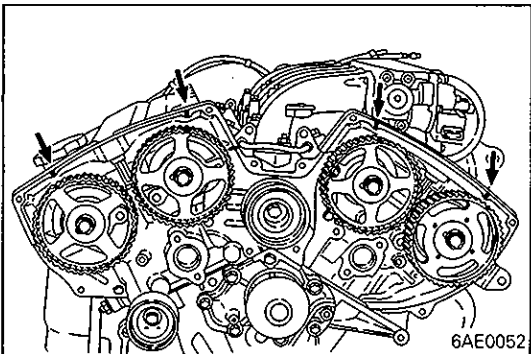


### ⚠ TIMING BELT INSTALLATION

- (1) Turn the crankshaft sprocket so that its timing mark will be away from the mating timing mark by approx. three teeth.

#### Caution

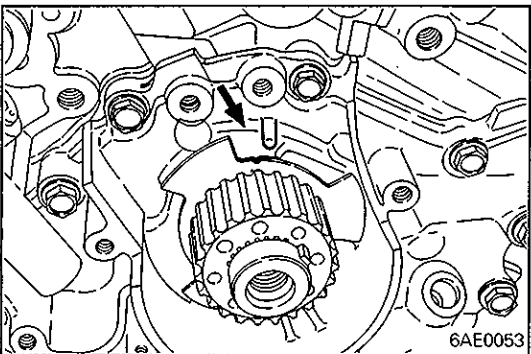
- If the timing marks are aligned, the piston is brought to the TDC. When the camshaft is turned under this condition, the valves may interfere with the piston.



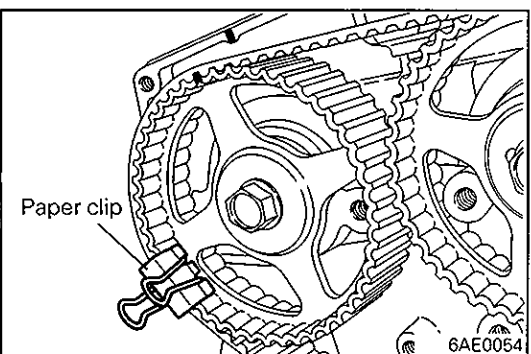
- (2) Bring the timing marks of the camshaft sprockets as shown in the illustration.

#### Caution

- If one of the camshaft sprockets on the right bank is turned with the timing mark on the other sprocket aligned, there may be danger for the intake and exhaust valves to interfere with each other.



- (3) Align the timing mark on the crankshaft sprocket with the mating timing mark, and then turn the crankshaft counter-clockwise by one tooth.

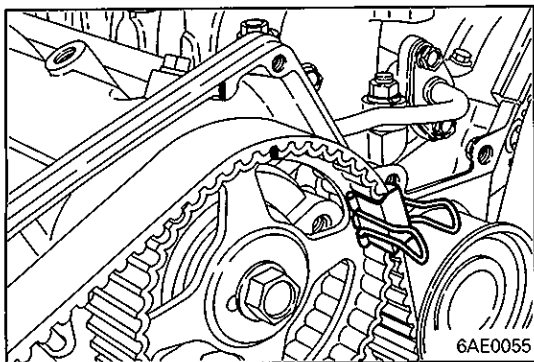


- (4) Place the timing belt over the sprockets in the following method.

#### Caution

- The camshaft sprockets on the right bank can turn very easily because of the valve spring tension. Use care not to allow your fingers to get caught between the sprockets.

- ① Align the timing mark of the right bank exhaust camshaft sprocket with the mating timing mark and hold the timing belt on the sprocket with a paper clip.

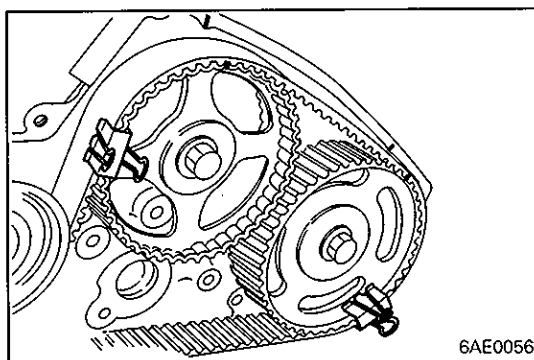


- ② Align the timing mark of the intake camshaft sprocket and place the timing belt around that sprocket. Then, clip the belt at the location shown.

#### Caution

- The camshaft sprockets can turn easily and do not give excessive tension to the timing belt.

- ③ Place the timing belt around the idler pulley.

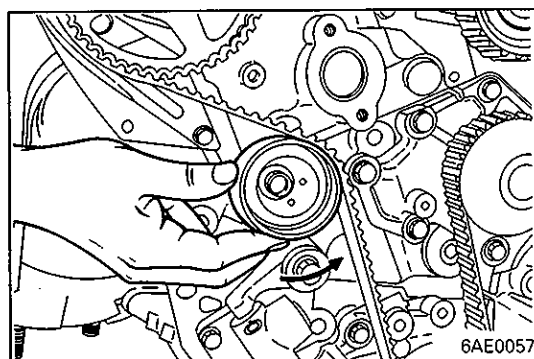


- ④ On the left bank, make sure that the timing marks of the camshaft sprockets are aligned and then hold the timing belt on these sprockets with paper clips.

- ⑤ Place the timing belt around the water pump pulley.

- ⑥ Place the timing belt around the crankshaft sprocket.

- ⑦ Place the timing belt around the tensioner pulley.

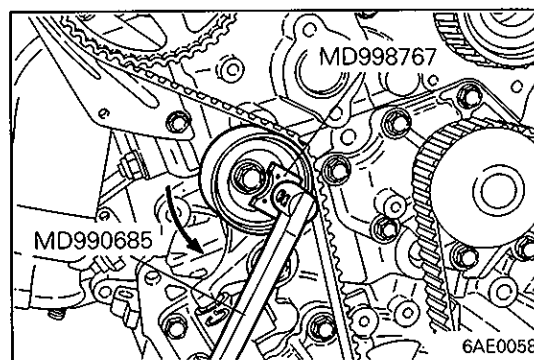


- (5) Move the tensioner pulley in the direction of the arrow and hold it in raised position by tightening the tensioner pulley bolt.

- (6) Check that all timing marks are aligned correctly.

- (7) Turn the crankshaft counterclockwise a quarter turn.

- (8) Turn back the crankshaft clockwise until the timing marks align again.

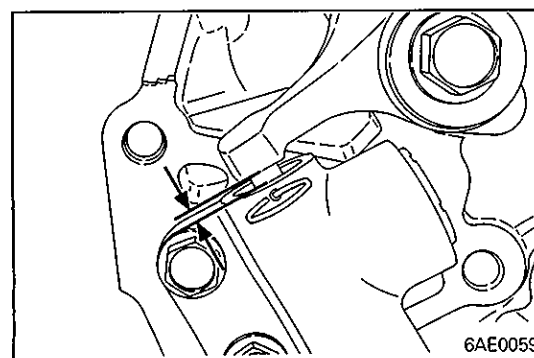


- (9) Install the special tool and a torque wrench of 0 – 5 Nm (0 – 0.5 kgm, 0 – 3.6 ft.lbs.) to the tensioner pulley.

- (10) Torque the tensioner pulley to 3 Nm (0.3 kgm, 2 ft.lbs.) with the torque wrench.

- (11) While holding the tensioner pulley, tighten the center bolt to specification.

- (12) Turn the crankshaft clockwise 2 turns and let it stand for about 5 minutes.



- (13) Make sure that the wire, which has been inserted when installing the auto tensioner, can be removed easily. Belt tension should be acceptable if the wire can be easily removed. Remove the wrench. The belt tension can also be verified by checking the protrusion amount of the auto tensioner rod which should conform to the following.

**Standard value: 3.8 – 4.5 mm (0.1496 – 0.1772 in.)**

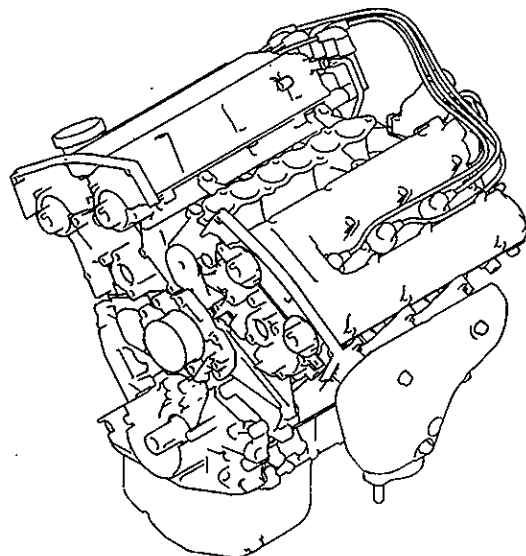
- (14) If the wire cannot be removed easily or the rod protrusion is not up to specification, repeat steps (9) through (12) to obtain the correct tension.



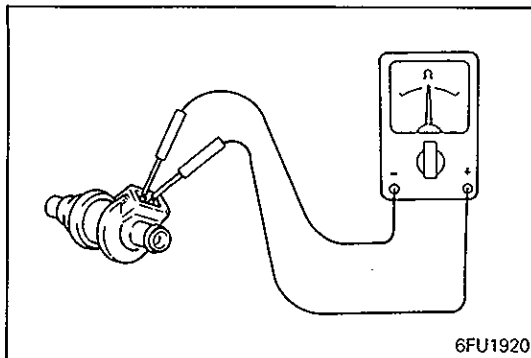
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## NOTES

## REMOVAL AND INSTALLATION



1. Air intake plenum stay, front
2. Air intake plenum stay, rear
3. EGR valve
4. Gasket } Europe, General export
5. Vacuum pipe
6. Throttle body
- ◆C◆ 7. Gasket
8. Air intake plenum
9. Gasket
10. Control harness
11. Delivery pipe and injector
12. Insulator
13. Insulator
- ◆B◆ 14. Injector support (left bank only)
- ◆B◆ 15. Injector
16. Grommet
17. O-ring
18. Fuel pipe
19. O-ring
- ◆B◆ 20. Fuel pressure regulator
21. O-ring
22. Delivery pipe

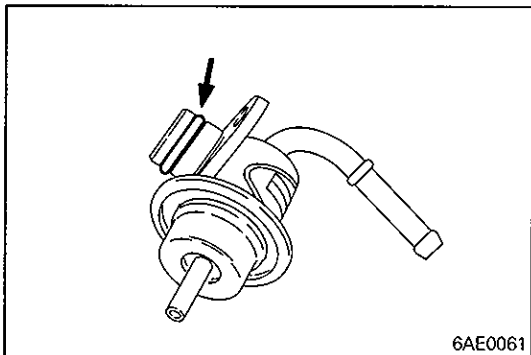


## INSPECTION

### INJECTOR

- (1) Using a circuit tester, measure the resistance of each injector.

**Standard value: 13 – 16  $\Omega$**



## INSTALLATION SERVICE POINTS

### ◆A◆ FUEL PRESSURE REGULATOR INSTALLATION

- (1) Apply spindle oil or gasoline to the new O-ring installed on the fuel pressure regulator.
- (2) Insert the fuel pressure regulator in the delivery pipe.
- (3) Make sure that the fuel pressure regulator turns smoothly; then align the threaded holes and tighten the regulator bolts to specification.

#### Caution

- If the regulator does not turn smoothly, the O-ring probably gets caught somewhere in the delivery pipe. In such a case, remove the fuel pressure regulator and reinsert it into the delivery pipe. Check it again for smooth rotation before securing.

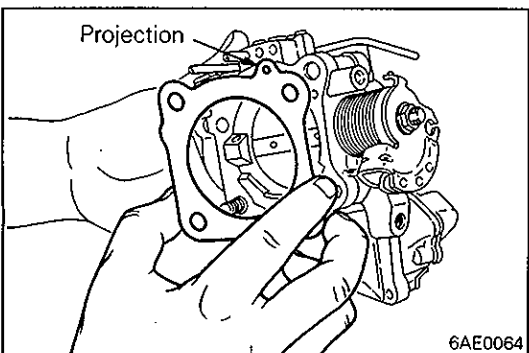
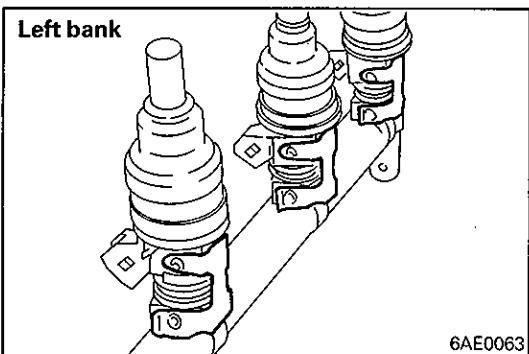
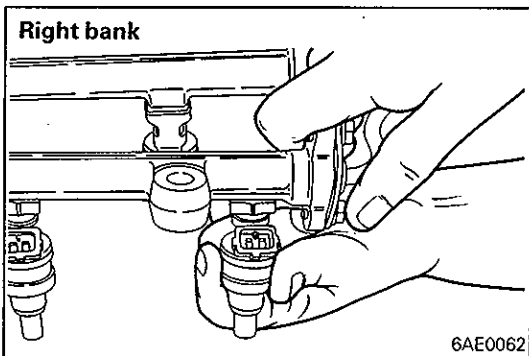
### ◆B◆ INJECTOR/INJECTOR SUPPORT INSTALLATION

- (1) Install new grommet and O-ring on the injector.
- (2) Apply spindle oil or gasoline to the O-ring of the injector.
- (3) While turning the injector in both directions, install it in the delivery pipe.
- (4) Make sure that the injector turns smoothly.

#### Caution

- If the injector does not turn smoothly, the O-ring probably gets caught somewhere in the delivery pipe. In such a case, remove the injector and reinsert it into the delivery pipe. Check it again for smooth rotation.

- (5) On the right bank, align the marks on the injector and delivery pipe.
- (6) On the left bank, also install the injector support.

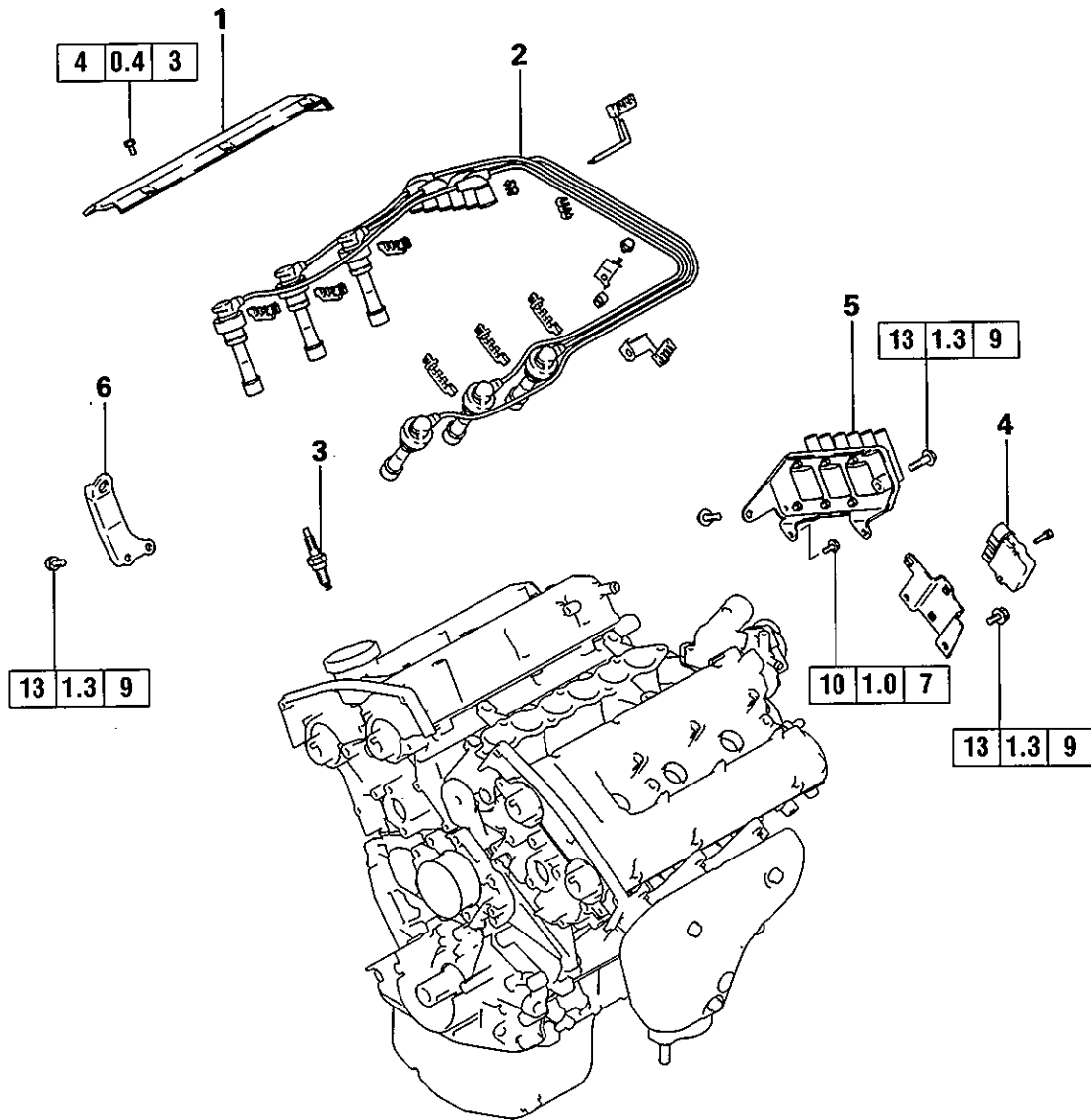


### ◆C◆ GASKET INSTALLATION

- (1) Locate the projection on the gasket as shown.

## 6. IGNITION SYSTEM

### REMOVAL AND INSTALLATION



#### Removal steps

1. Center cover
2. Plug cord
3. Plug
4. Power transistor
5. Ignition coil
6. Engine hanger

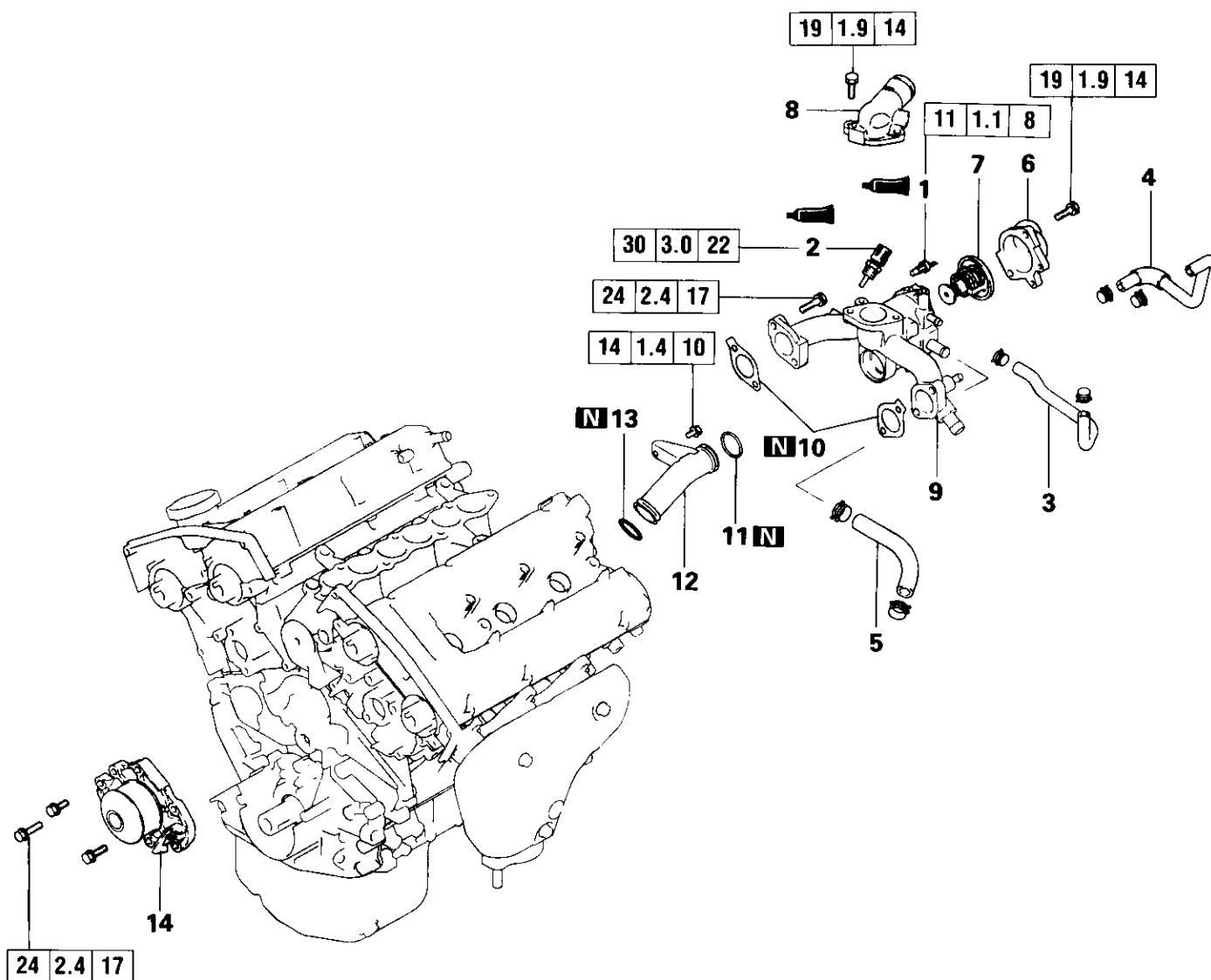
274

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**NOTES**

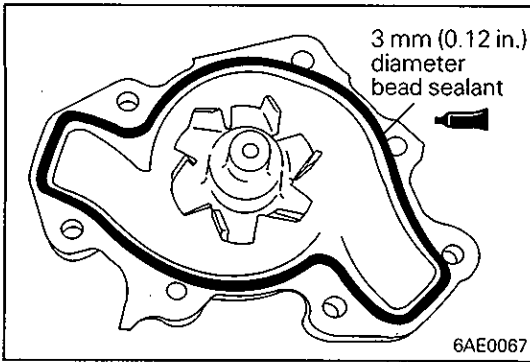
## 7. WATER PUMP AND WATER PIPE

### REMOVAL AND INSTALLATION



#### Removal steps

- ◆F◆ 1. Engine coolant temperature gauge unit
- ◆E◆ 2. Engine coolant temperature sensor
- 3. Water hose
- 4. Water hose
- 5. Water hose
- 6. Water inlet fitting
- ◆D◆ 7. Thermostat
- ◆C◆ 8. Water outlet fitting
- 9. Thermostat housing
- 10. Gasket
- ◆B◆ 11. O-ring
- ◆B◆ 12. Water pipe
- ◆B◆ 13. O-ring
- ◆A◆ 14. Water pump

**INSTALLATION SERVICE POINTS****◆A◆ SEALANT APPLICATION TO WATER PUMP**

Specified sealant:

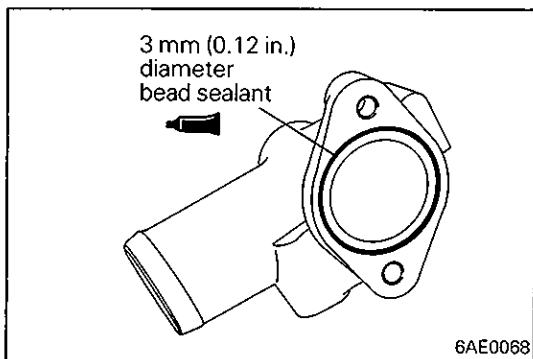
Mitsubishi Genuine Part No. MD970389 or equivalent

**◆B◆ WATER PIPE / O-RING INSTALLATION**

(1) Wet the O-ring (with water) to facilitate assembly.

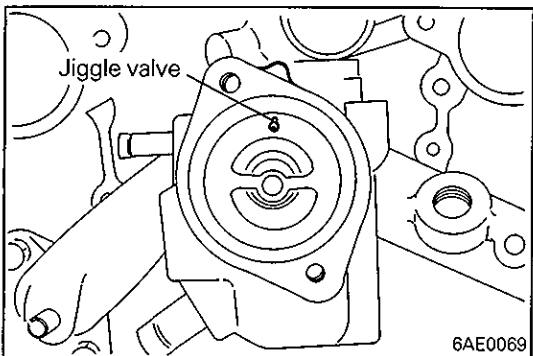
**Caution**

- Keep the O-ring free of oil or grease.
- Secure the water pipe after the thermostat housing has been installed.

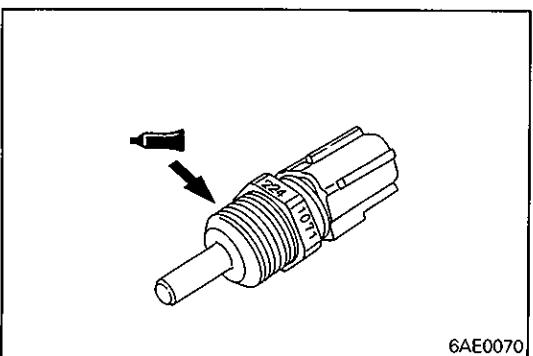
**◆C◆ SEALANT APPLICATION TO WATER OUTLET FITTING**

Specified sealant:

Mitsubishi Genuine Part No. MD970389 or equivalent

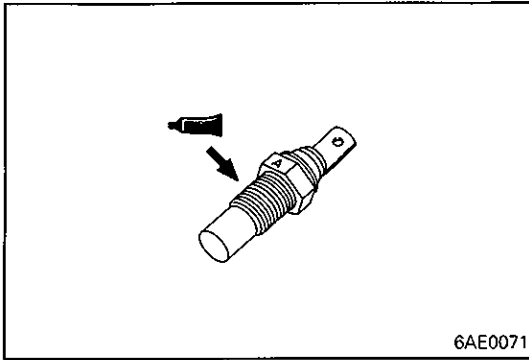
**◆D◆ THERMOSTAT INSTALLATION**

(1) Install the thermostat so that the jiggle valve will be located in the thermostat housing as shown.

**◆E◆ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE SENSOR**

Specified sealant:

3M Nut locking Part No. 4171 or equivalent



↗F↖ **SEALANT APPLICATION TO ENGINE COOLANT  
TEMPERATURE GAUGE UNIT**

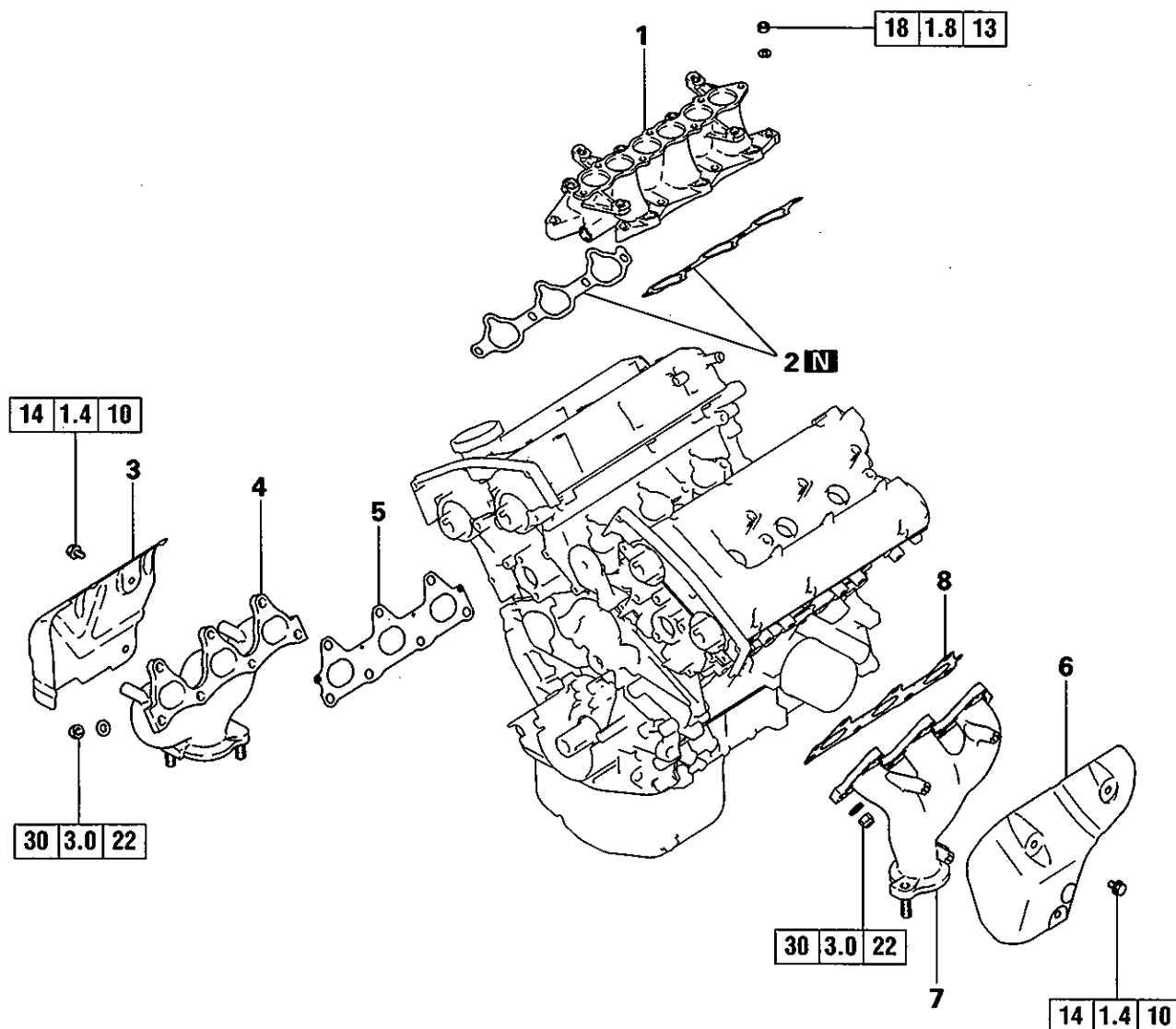
**Specified sealant:**  
**3M ATD Part No. 8660 or equivalent**



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## NOTES

## 8. INTAKE MANIFOLD AND EXHAUST MANIFOLD REMOVAL AND INSTALLATION



### Removal steps

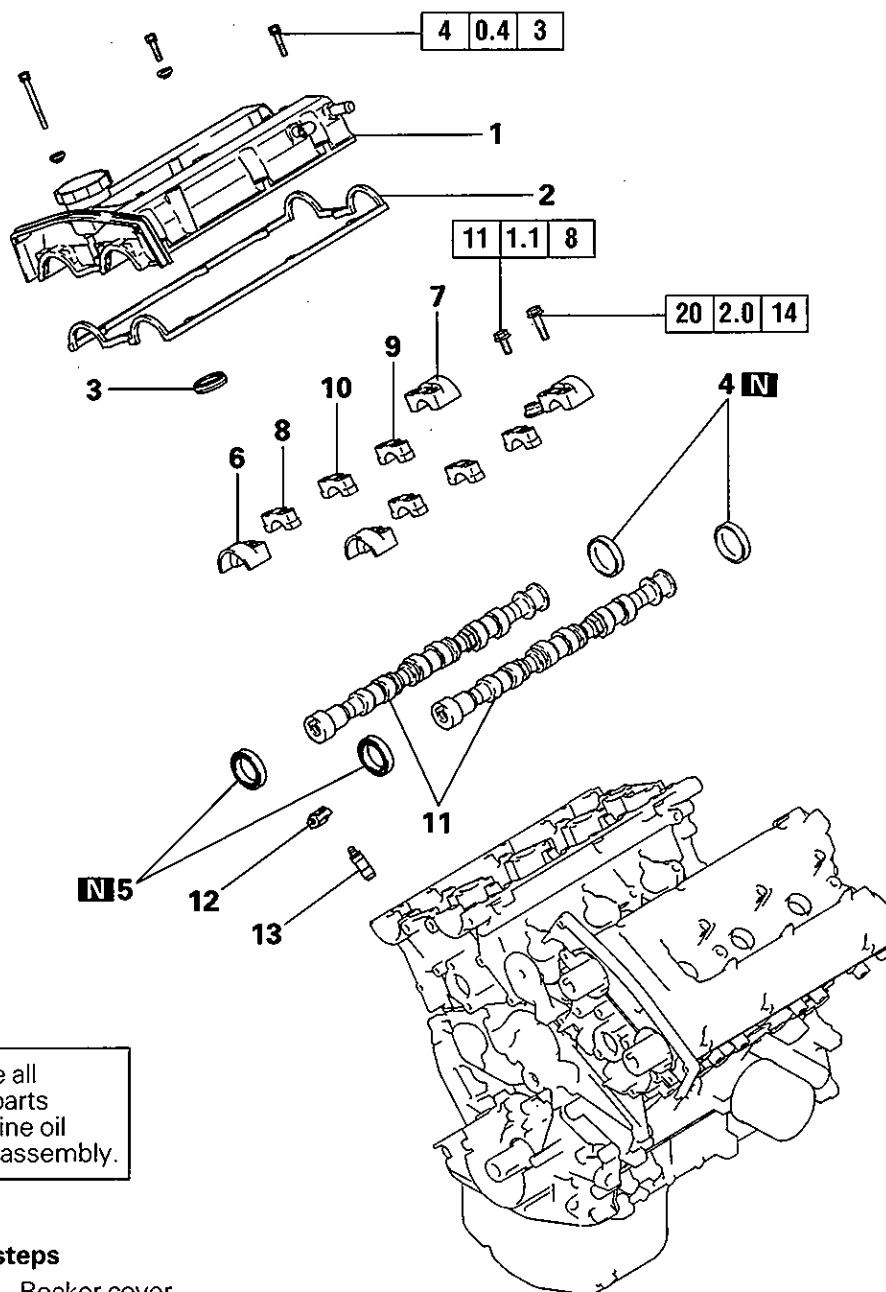
1. Intake manifold
2. Gasket
3. Heat protector, right
4. Exhaust manifold, right
5. Gasket
6. Heat protector, left
7. Exhaust manifold, left
8. Gasket


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## NOTES

## 9. ROCKER ARM AND CAMSHAFT

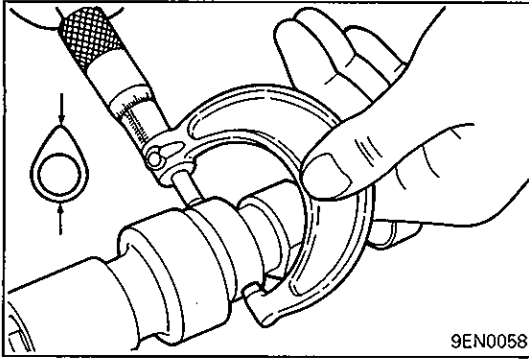
### REMOVAL AND INSTALLATION



 Lubricate all internal parts with engine oil during reassembly.

#### Removal steps

- ♦F♦ 1. Rocker cover
- 2. Gasket A
- 3. Gasket B
- ♦E♦ 4. Circular packing
- ♦D♦ 5. Oil seal
- ♦C♦ 6. Bearing cap, front
- ♦C♦ 7. Bearing cap, rear
- ♦C♦ 8. Bearing cap No. 2
- ♦C♦ 9. Bearing cap No. 4
- ♦C♦ 10. Bearing cap No. 3
- ♦A♦ 11. Camshaft
- 12. Rocker arm
- ♦B♦ 13. Lash adjuster



## INSPECTION

### CAMSHAFT

- (1) Measure the cam height (lobe diameter) and, if the limit is exceeded, replace the camshaft.

#### Standard value:

35.20 mm (1.3858 in.) ..... Intake side

34.91 mm (1.3744 in.) ..... Exhaust side

#### Limit:

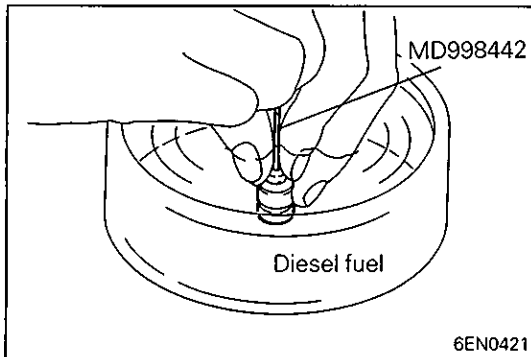
34.70 mm (1.3661 in.) ..... Intake side

34.41 mm (1.3547 in.) ..... Exhaust side

## LASH ADJUSTER LEAK DOWN TEST

### Caution

- The lash adjuster is a precision part. Keep it free from dust and other foreign matters.
- Do not disassemble lash adjuster.
- When cleaning lash adjuster, use clean diesel fuel only.



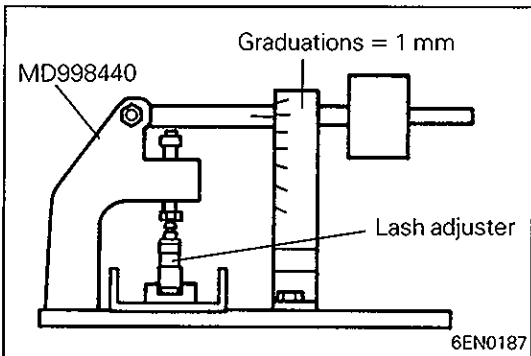
- (1) Immerse the lash adjuster in clean diesel fuel.
- (2) While lightly pushing down inner steel ball using the special tool (Air bleed wire MD998442), move the plunger up and down four or five times to bleed air. Use of the special tool (Retainer MD998441) helps facilitate the air bleeding of the rocker arm mounted type lash adjuster.
- (3) Remove the special tool (Air bleed wire MD998442) and press the plunger. If the plunger is hard to be pushed in, the lash adjuster is normal. If the plunger can be pushed in all the way readily, bleed the lash adjuster again and test again. If the plunger is still loose, replace the lash adjuster.

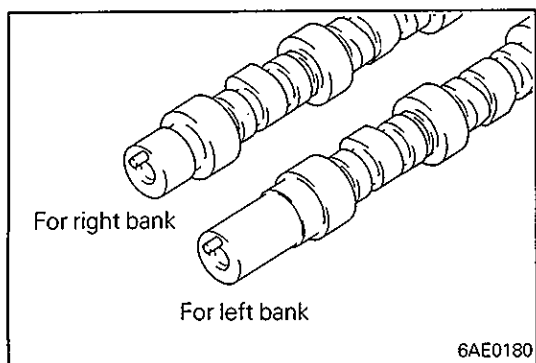
### Caution

- Upon completion of air bleeding, hold lash adjuster upright to prevent inside diesel fuel from spilling.

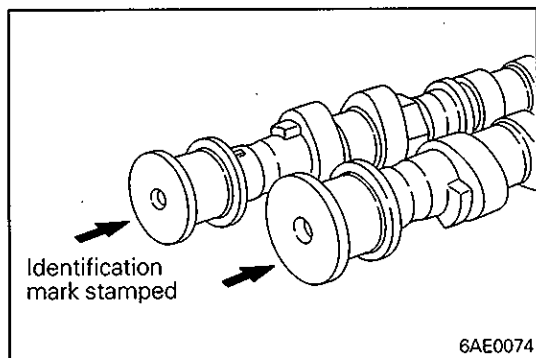
- (4) After air bleeding, set lash adjuster on the special tool (Leak down tester MD998440).
- (5) After plunger has gone down somewhat [0.2 – 0.5 mm (0.0015 – 0.0020 in.)], measure time taken for it to go down 1 mm (0.04 in.). Replace if measured time is out of specification.

**Standard value: 4 – 20 seconds/1 mm (0.04 in.)**  
**[Diesel fuel at 15 – 20°C (59 – 68°F)]**



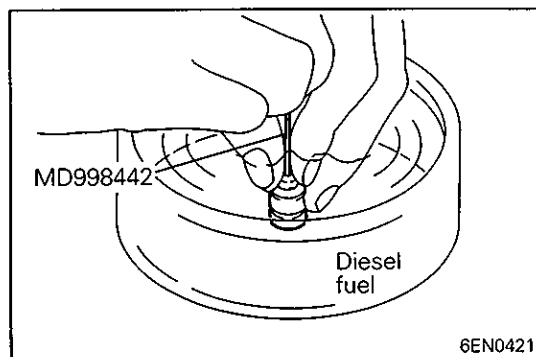
**REMOVAL SERVICE POINTS****◆A◆ CAMSHAFT INSTALLATION**

- (1) Apply engine oil to journals and cams of the camshaft before installation.  
Be sure to install the correct camshafts on the correct bank.  
Do not confuse the intake camshaft with the exhaust one.

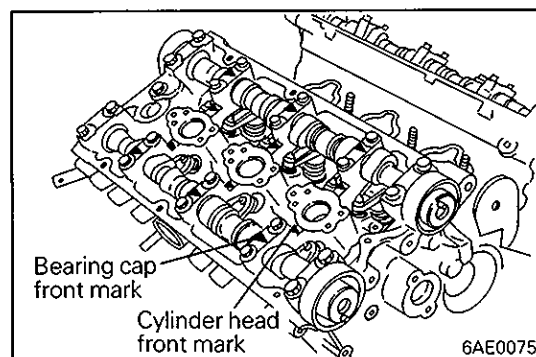


## Identification symbol

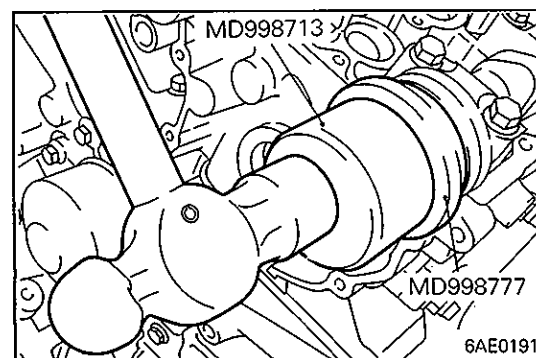
Right bank	Intake	P1
	Exhaust	P2
Left bank	Intake	2
	Exhaust	B

**◆B◆ LASH ADJUSTER INSTALLATION**

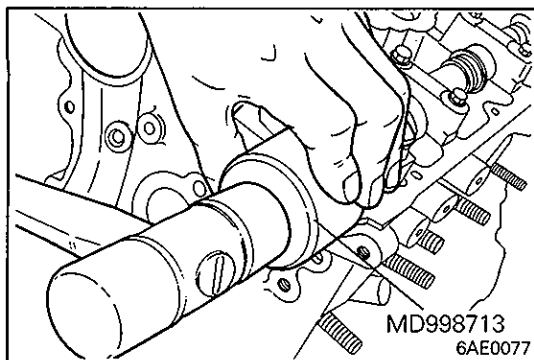
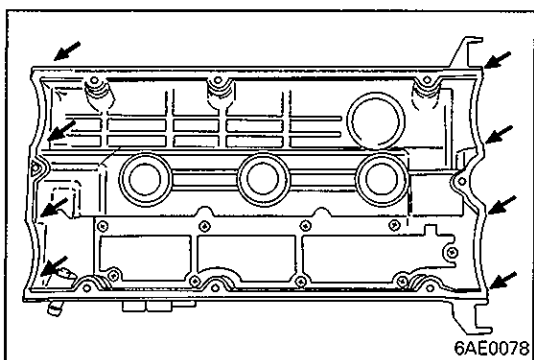
- (1) Immerse the lash adjuster in clean diesel fuel.
- (2) Using the special tool (air bleed wire), move the plunger up and down 4 or 5 times while pushing down lightly on the check ball in order to bleed out the air.

**◆C◆ BEARING CAP INSTALLATION**

- (1) Before installing each bearing cap, check for its identification mark and number. The Nos. 2, 3, and 4 bearing caps have a front mark which should point to the same direction as a one on the cylinder head.

**◆D◆ CAMSHAFT OIL SEAL INSTALLATION**

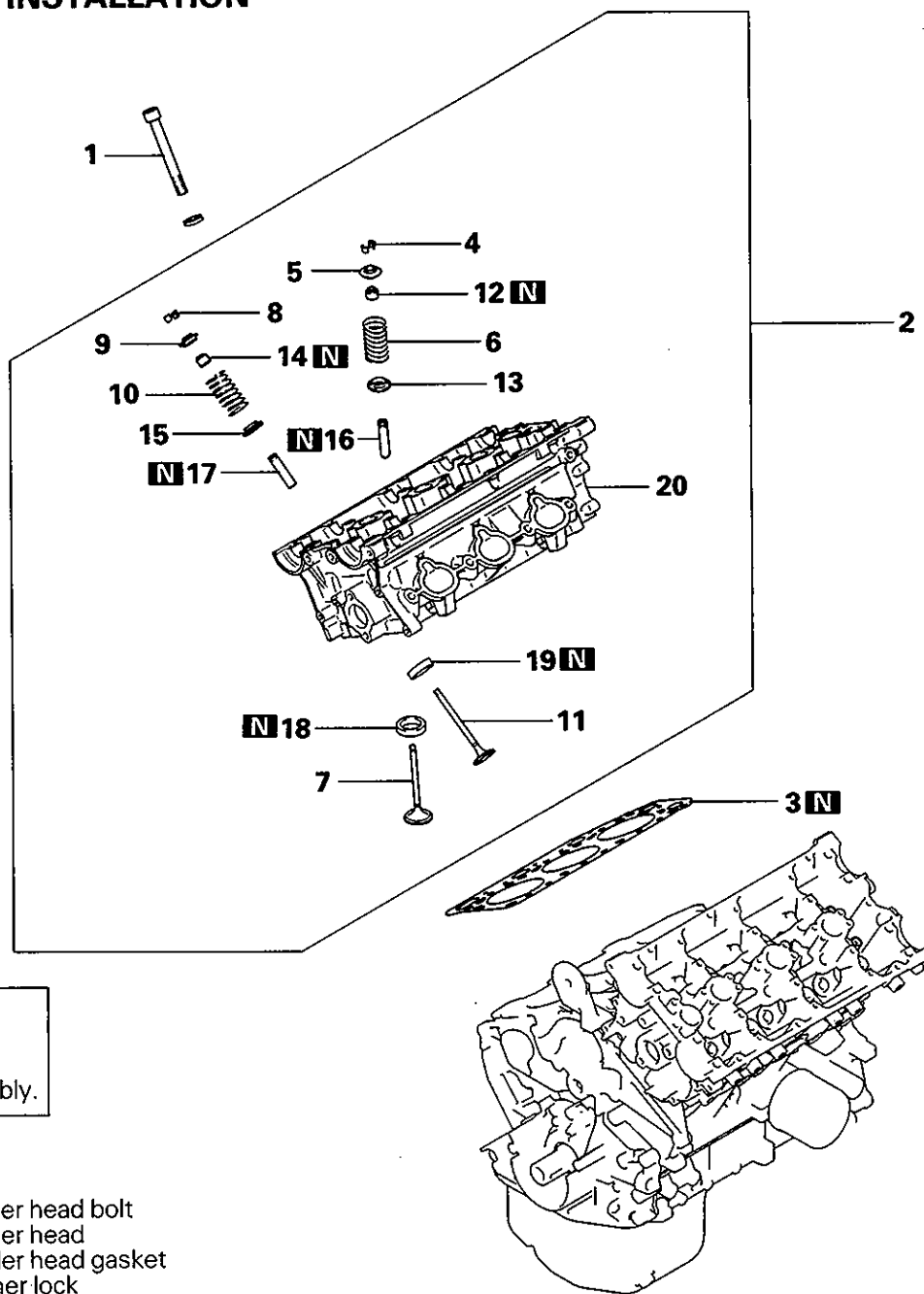
- (1) Apply engine oil to the oil seal lip.


**⇨E⇩ CIRCULAR PACKING INSTALLATION****⇨F⇩ ROCKER COVER INSTALLATION**

Specified sealant:  
3M ATD Part No. 8660 or equivalent

## 10. CYLINDER HEAD AND VALVES

## REMOVAL AND INSTALLATION

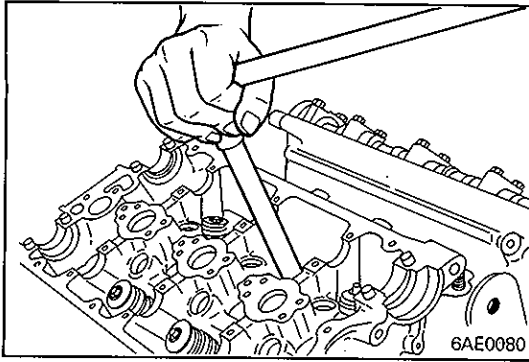


 Lubricate all internal parts with engine oil during reassembly.

**Removal steps**

- ◊A◊ ◊D◊ 1. Cylinder head bolt
- 2. Cylinder head
- ◊B◊ ◊C◊ 3. Cylinder head gasket
- 4. Retainer lock
- 5. Valve spring retainer
- ◊B◊ 6. Valve spring
- 7. Intake valve
- ◊B◊ ◊C◊ 8. Retainer lock
- 9. Valve spring retainer
- ◊B◊ 10. Valve spring
- 11. Exhaust valve
- ◊C◊ ◊A◊ 12. Valve stem seal
- 13. Valve spring seat
- ◊C◊ ◊A◊ 14. Valve stem seal
- 15. Valve spring seat
- 16. Intake valve guide
- 17. Exhaust valve guide
- 18. Intake valve seat
- 19. Exhaust valve seat
- 20. Cylinder head



**REMOVAL SERVICE POINTS****PRECAUTION FOR REMOVED PARTS**

- (1) Keep removed parts in order according to the cylinder number and intake/exhaust side.

**◊A◊ CYLINDER HEAD BOLT REMOVAL**

- (1) Using a 10 mm – 12 points, socket wrench, loosen the cylinder head bolts.  
Loosen evenly, little by little.

**◊B◊ RETAINER LOCK REMOVAL**

- (1) Store removed valves, springs and other parts, tagged to indicate their cylinder Nos. and location for reassembly.

**◊C◊ VALVE STEM SEAL REMOVAL**

- (1) Do not reuse removed valve stem seals.

**INSPECTION****CYLINDER HEAD**

- (1) Check the cylinder head gasket surface for flatness by using a straightedge and thickness gauge.

**Standard value: 0.05 mm (0.0020 in.)**

**Limit: 0.2 mm (0.008 in.)**

**VALVE**

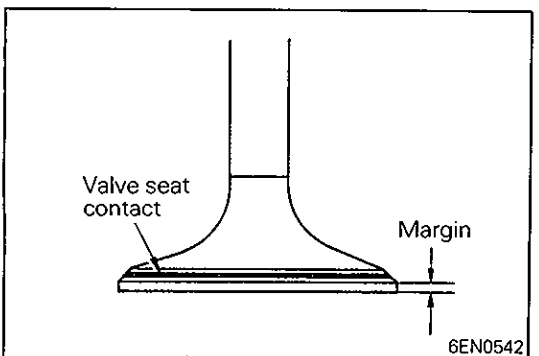
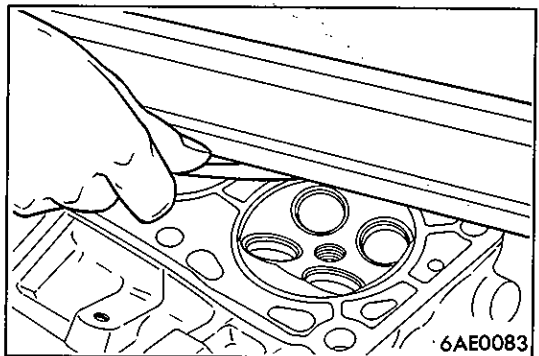
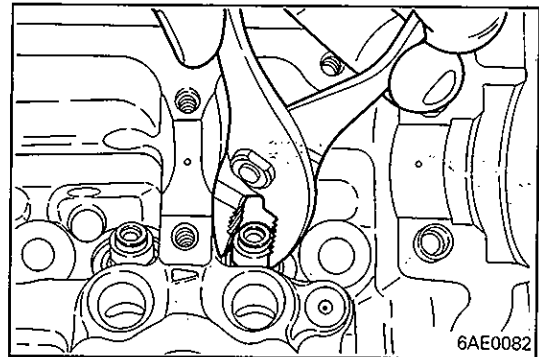
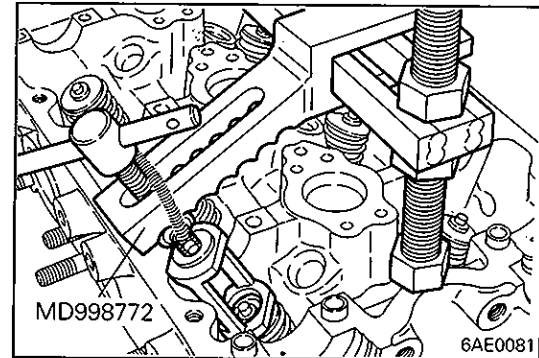
- (1) Check the valve face for correct contact. If incorrect, reface using a valve refacer. Valve seat contact should be maintained uniform at the center of valve face.
- (2) If the margin is smaller than the service limit, replace the valve.

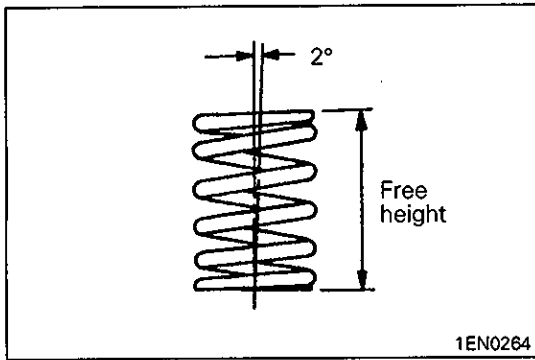
**Standard value: 1.0 mm (0.039 in.)**

**1.3 mm (0.051 in.)**

**Limit: 0.5 mm (0.020 in.)**

**0.8 mm (0.031 in.)**



**VALVE SPRING**

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

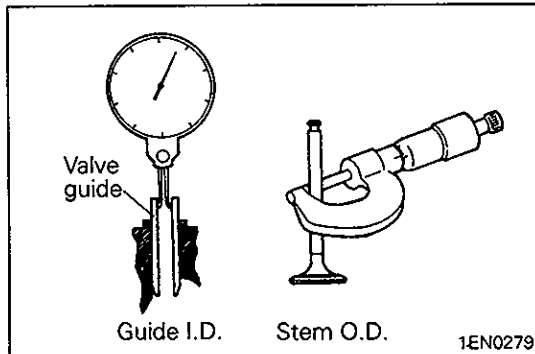
**Standard value: 47.3 mm (1.862 in.)**

**Limit: 46.3 mm (1.823 in.)**

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

**Standard value: 2° or less**

**Limit: max. 4°**

**VALVE GUIDE**

- (1) Measure the clearance between the valve guide and the valve stem and, if the limit is exceeded, replace either the valve guide or valve, or both.

**Standard value:**

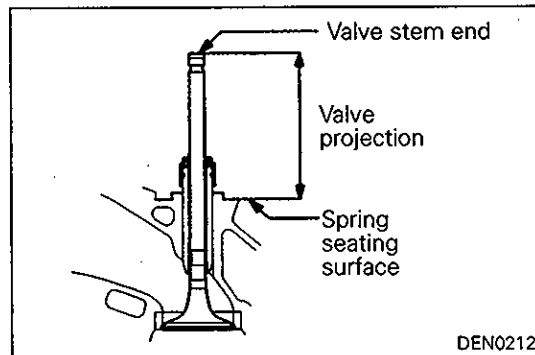
**IN ..... 0.02 – 0.04 mm (0.0008 – 0.0016 in.)**

**EX ..... 0.03 – 0.06 mm (0.0012 – 0.0023 in.)**

**Limit:**

**IN ..... 0.10 mm (0.004 in.)**

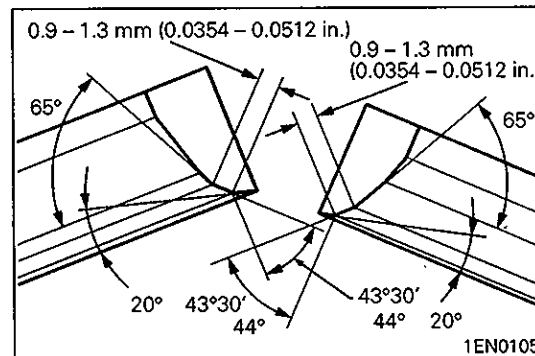
**EX ..... 0.15 mm (0.006 in.)**

**VALVE SEATS**

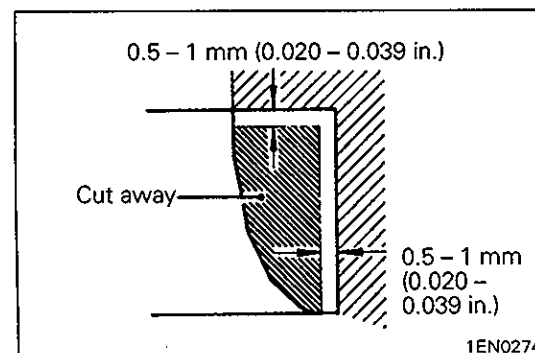
- (1) Assemble the valve, then measure the valve stem projection between the end of the valve stem and the spring seating surface while seating the valve against the valve seat. If the measurement exceeds the specified limit, replace the valve seat.

**Standard value: 48.40 mm (1.9055 in.)**

**Limit: 48.90 mm (1.9252 in.)**

**VALVE SEAT RECONDITIONING PROCEDURE**

- (1) Before correcting the valve seat, check for clearance between the valve guide and valve and, if necessary, replace the valve guide.
- (2) Using the special tool or seat grinder, correct to obtain the specified seat width and angle.
- (3) After correction, valve and valve seat should be lapped with a lapping compound.

**VALVE SEAT REPLACEMENT PROCEDURE**

- (1) Cut the valve seat to be replaced from the inside to thin the wall thickness. Then, remove the valve seat.
- (2) Rebore the valve seat hole in the cylinder head to a selected oversize valve seat diameter.

**Intake valve seat hole diameter**

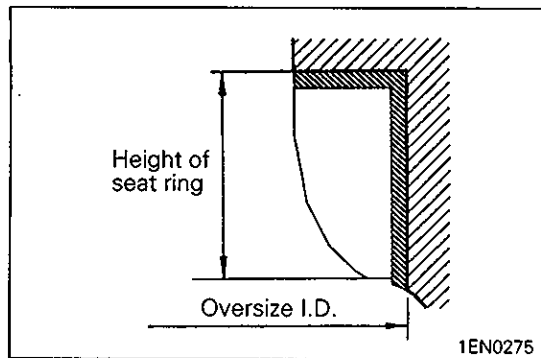
**0.3 O.S. .... 32.30 – 32.32 mm (1.2717 – 1.2724 in.)**

**0.6 O.S. .... 32.60 – 32.62 mm (1.2835 – 1.2842 in.)**

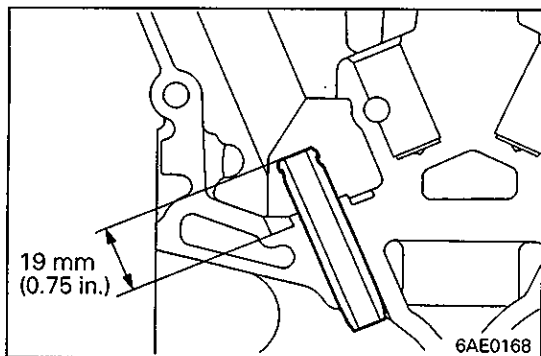
**Exhaust valve seat hole diameter**

**0.3 O.S. .... 29.80 – 29.82 mm (1.1732 – 1.1740 in.)**

**0.6 O.S. .... 30.10 – 30.12 mm (1.1850 – 1.1858 in.)**



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



### VALVE GUIDE REPLACEMENT

- (1) Force the valve guide out toward the cylinder block using a press.
- (2) Machine the valve guide hole in the cylinder head to the size of the oversize valve guide to be installed.

#### Caution

- Do not use a valve guide of the same size as the removed one.

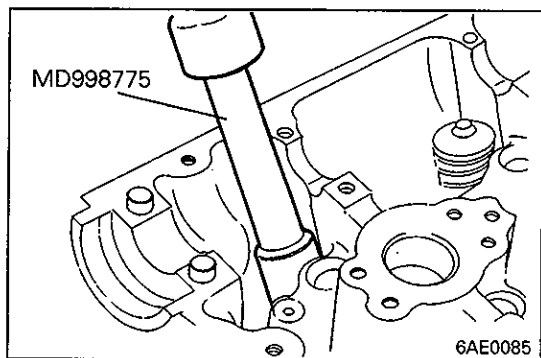
#### Valve guide hole diameters in cylinder head

0.05 O.S. .... 11.05 – 11.07 mm (0.4350 – 0.4358 in.)

0.25 O.S. .... 11.25 – 11.27 mm (0.4429 – 0.4437 in.)

0.50 O.S. .... 11.50 – 11.52 mm (0.4528 – 0.4535 in.)

- (3) Press-fit the valve guide until the protrusion measures 19 mm (0.75 in.) as shown. Press the valve guide from the cylinder head top surface side.
- (4) After the valve guide has been installed, insert a new valve to check for smooth sliding motion.



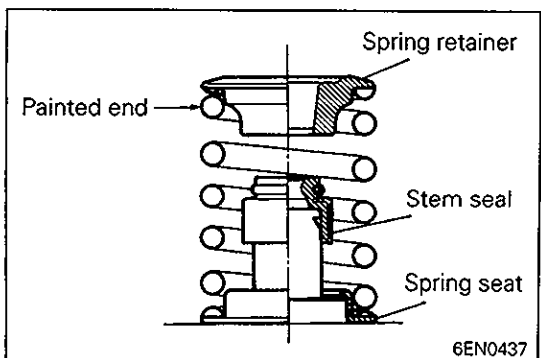
### INSTALLATION SERVICE POINTS

#### ◆A◆ VALVE STEM SEAL INSTALLATION

- (1) Install the valve spring seat.
- (2) The special tool must be used to install the valve stem seal. Improper installation could result in oil leaking past the valve guide.

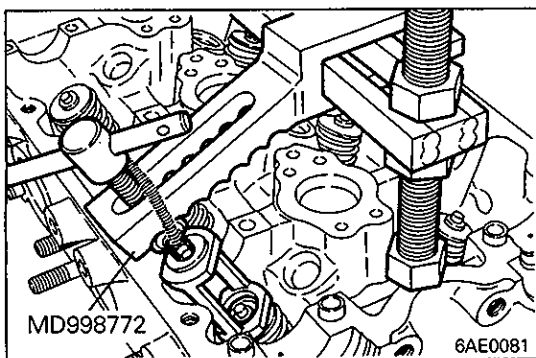
#### Caution

- Do not reuse valve stem seal.



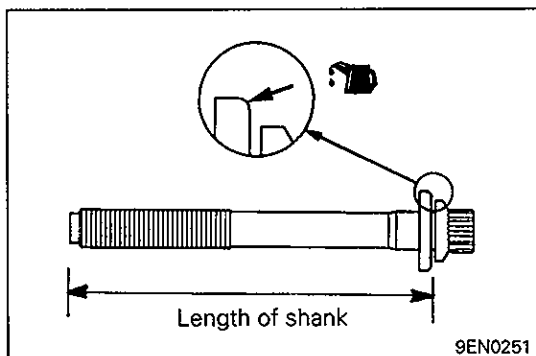
#### ◆B◆ VALVE SPRING INSTALLATION

- (1) Install the valve spring with the painted end on the rocker arm side.



### RETAINER LOCK INSTALLATION

- (1) The valve spring, if excessively compressed, causes the bottom end of retainer to be in contact with, and damage, the stem seal.

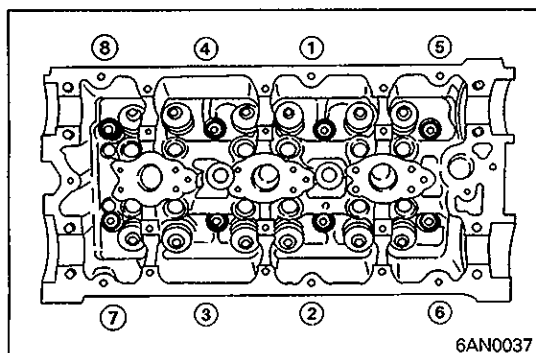


### CYLINDER HEAD BOLT INSTALLATION

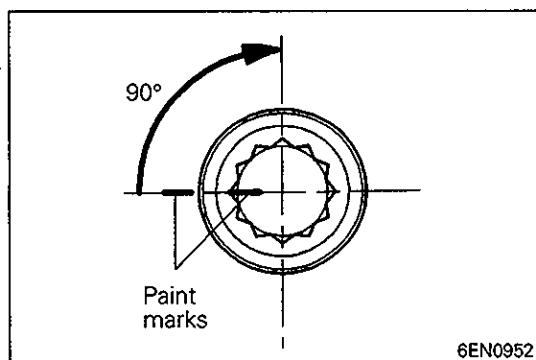
- (1) When installing the cylinder head bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolts.

**Limit: max. 96.4 mm (3.79 in.)**

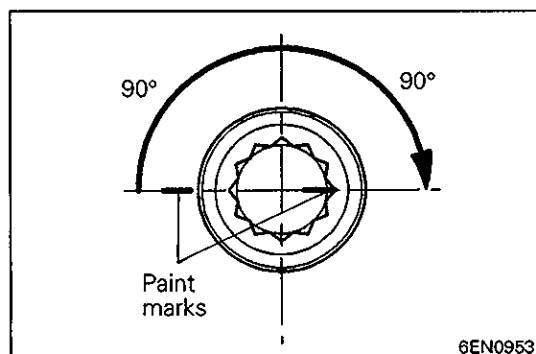
- (2) Install the washers as illustrated.
- (3) Apply engine oil to the bolt threads and washers.



- (4) According to the tightening sequence, tighten the bolts to the specified torque 74 Nm (7.5 kgm, 54 ft.lbs.).
- (5) Loosen all bolts fully.
- (6) Retighten the loosened bolts to a torque of 20 Nm (2.0 kgm, 14.5 ft.lbs.) in the specified tightening sequence.



- (7) Make paint marks on the cylinder head bolts and cylinder head.
- (8) Give a 90° turn to the bolts in the specified tightening sequence.



- (9) Give another 90° turn to the cylinder head bolts and make sure that the paint mark on each cylinder head bolt and that on the cylinder head are on the same straight line.

### Caution

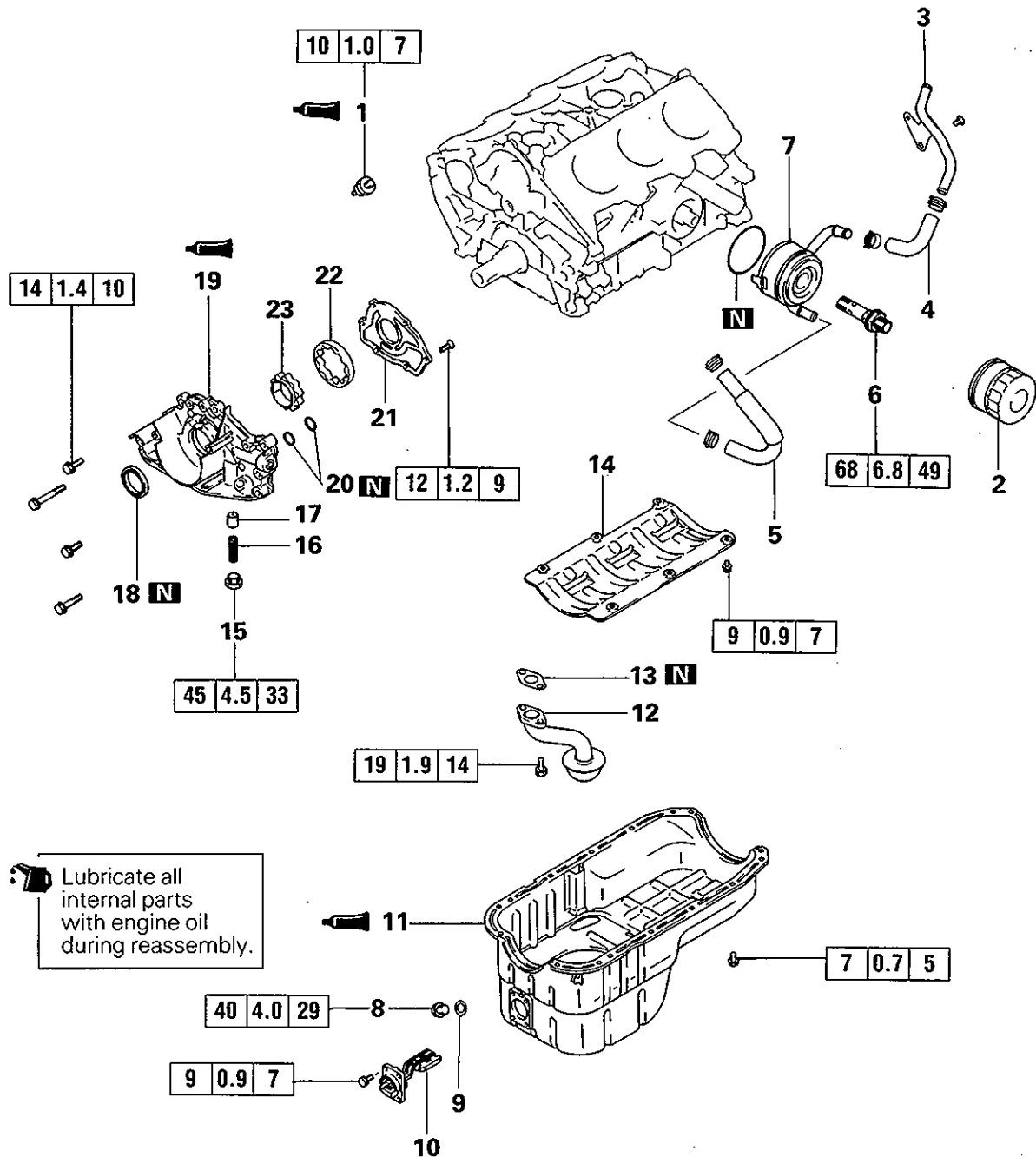
- If the bolts are tightened by an angle of less than 90°, they may not hold the cylinder head with sufficient strength.
- If a bolt is overtightened, completely remove all the bolts and carry out the installation procedure again from step (1).

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## NOTES

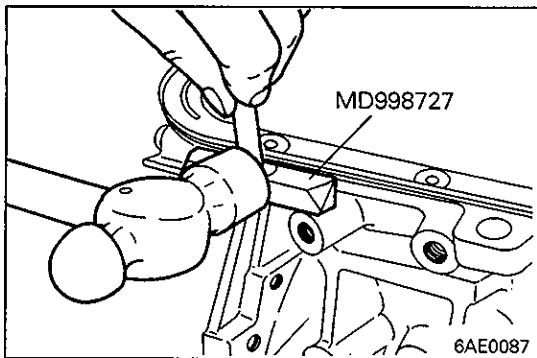
## 11. OIL PUMP CASE AND OIL PAN

## REMOVAL AND INSTALLATION



## Removal steps

- |         |                        |                                    |
|---------|------------------------|------------------------------------|
| ◆G◆     | 1. Oil pressure switch | 13. Gasket                         |
| ◆F◆     | 2. Oil filter          | 14. Baffle plate (From 1994 model) |
|         | 3. Water hose          | 15. Relief plug                    |
|         | 4. Water pipe          | 16. Relief spring                  |
|         | 5. Water pipe          | 17. Relief plunger                 |
|         | 6. Bolt                | ◆C◆                                |
| ◆E◆     | 7. Oil cooler          | 18. Oil seal                       |
|         | 8. Drain plug          | ◆B◆                                |
|         | 9. Gasket              | 19. Oil pump case                  |
| ◆A◆ ◆D◆ | 10. Oil level sensor   | 20. O-ring                         |
|         | 11. Oil pan            | 21. Oil pump case cover            |
|         | 12. Oil screen         | ◆A◆                                |
|         |                        | 22. Outer rotor                    |
|         |                        | ◆A◆                                |
|         |                        | 23. Inner rotor                    |



## REMOVAL SERVICE POINTS

### ◊A◊ OIL PAN REMOVAL

- (1) Knock the special tool deeply between the oil pan and the cylinder block.
- (2) Hitting the side of the special tool, slide the special tool along the oil pan to remove it.

## INSPECTION

### OIL PUMP

- (1) Check the tip clearance.

**Standard value: 0.06 – 0.18 mm (0.0024 – 0.007 in.)**

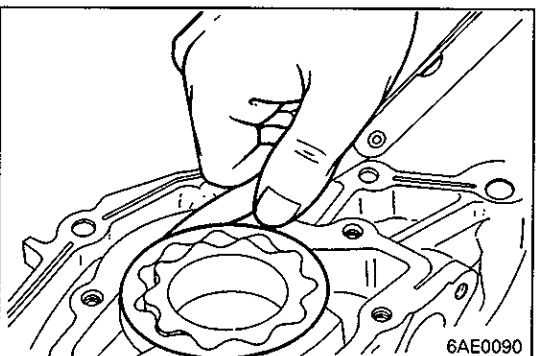
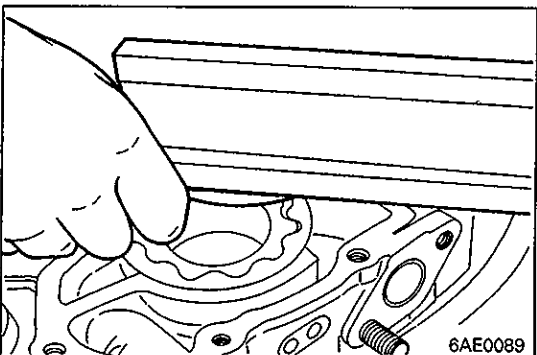
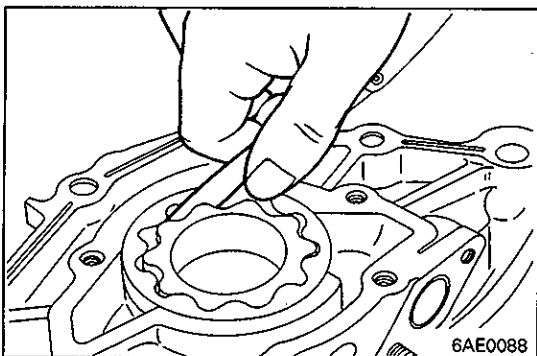
- (2) Check the side clearance.

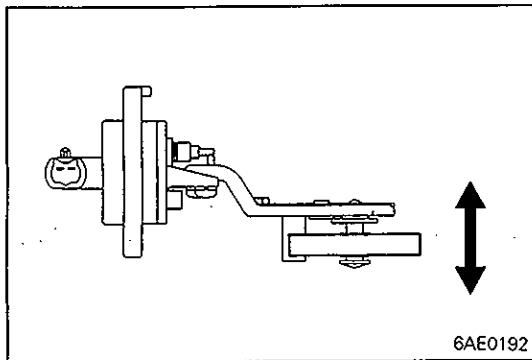
**Standard value: 0.04 – 0.10 mm (0.0016 – 0.0039 in.)**

- (3) Check the body clearance.

**Standard value: 0.10 – 0.18 mm (0.0039 – 0.0071 in.)**

**Limit: 0.35 mm (0.0138 in.)**



**OIL LEVEL SENSOR (FOR EUROPE, GCC)**

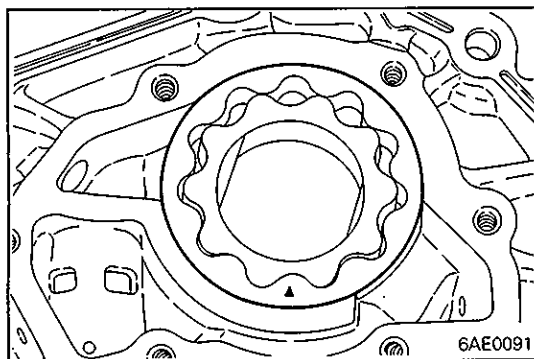
- (1) Put the oil level sensor in the oil, then move the float up and down with the oil at a temperature either lower than 40°C (104°F) or higher than 80°C (176°F), and check for continuity.

40°C (104°F)

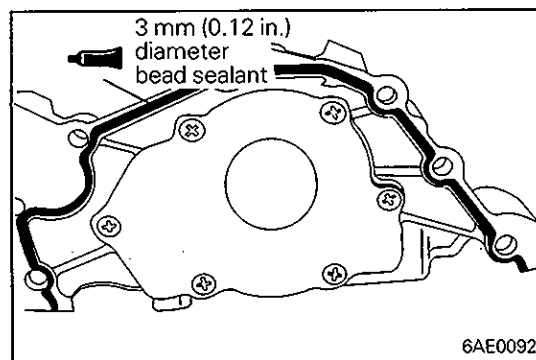
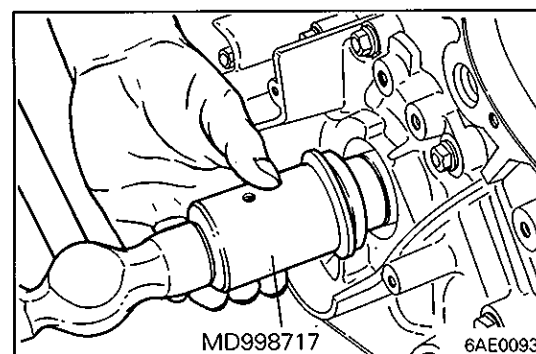
Float position	Switch ON/OFF
Condition when down	ON (continuity)
Condition when up	ON (continuity)

80°C (176°F)

Float position	Switch ON/OFF
Condition when down	OFF (no continuity)
Condition when up	ON (continuity)

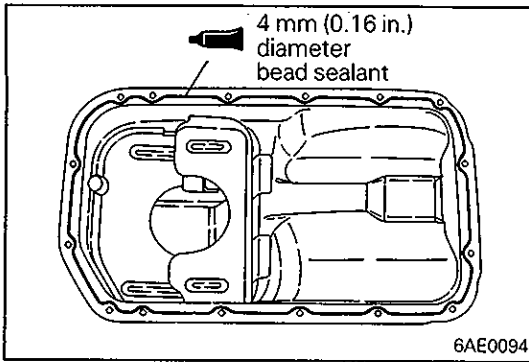
**INSTALLATION SERVICE POINTS****◆A◆ INNER ROTOR/OUTER ROTOR INSTALLATION**

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

**◆B◆ SEALANT APPLICATION TO OIL PUMP CASE****Specified sealant:****Mitsubishi Genuine Part No. MD970389 or equivalent****◆C◆ OIL SEAL INSTALLATION**

- (1) Apply engine oil to the oil seal lip.  
Using the special tool, knock the oil seal into the oil pump case.



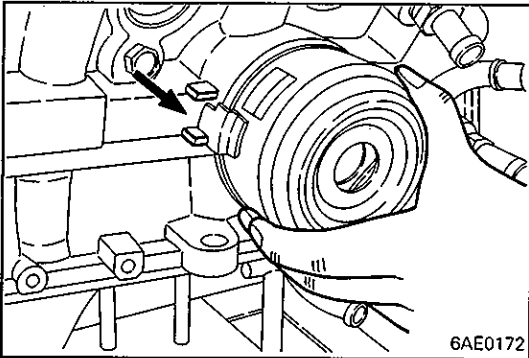


### ◆D◆ OIL PAN INSTALLATION

- (1) Clean the cylinder block and oil pan gasket application surfaces.
- (2) Install the oil pan within 15 minutes after FIPG has been applied to the entire flange surfaces of the oil pan.

#### Specified sealant:

**Mitsubishi Genuine Part No. MD970389 or equivalent**

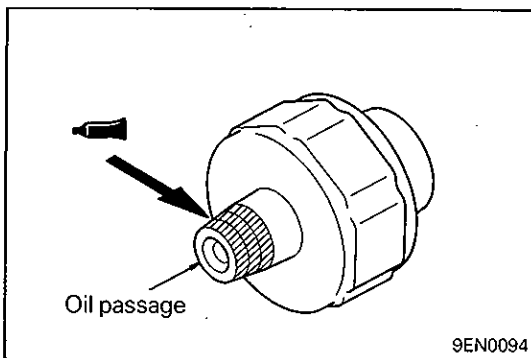


### ◆E◆ OIL COOLER INSTALLATION

- (1) Install the oil cooler, with the oil cooler's positioning projection positioned against the rib on cylinder block.

### ◆F◆ OIL FILTER INSTALLATION

- (1) Clean the surfaces of the cylinder block on which the oil filter is to be mounted.
- (2) Apply engine oil to the O-ring of the oil filter.
- (3) Turn down the oil filter until the O-ring contacts the cylinder block surface, and then give the oil filter one more turn 14 Nm (1.4 kgm, 10 ft.lbs.).



### ◆G◆ SEALANT APPLICATION TO SEALANT TO OIL PRESSURE SWITCH

- (1) Apply sealant to the threads of the switch.

#### Specified sealant:

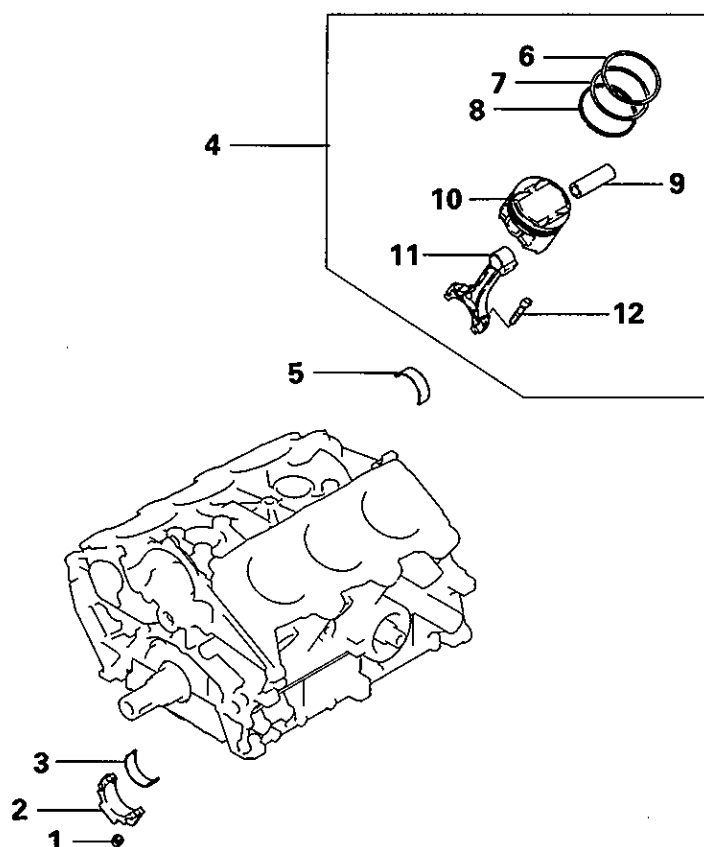
**3M ATD Part No. 8660 or equivalent**


#### Caution

- Use care not to allow the sealant to plug the oil passage.

## 12. PISTON AND CONNECTING ROD

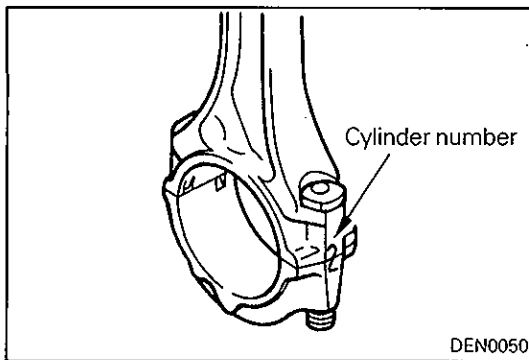
### REMOVAL AND INSTALLATION



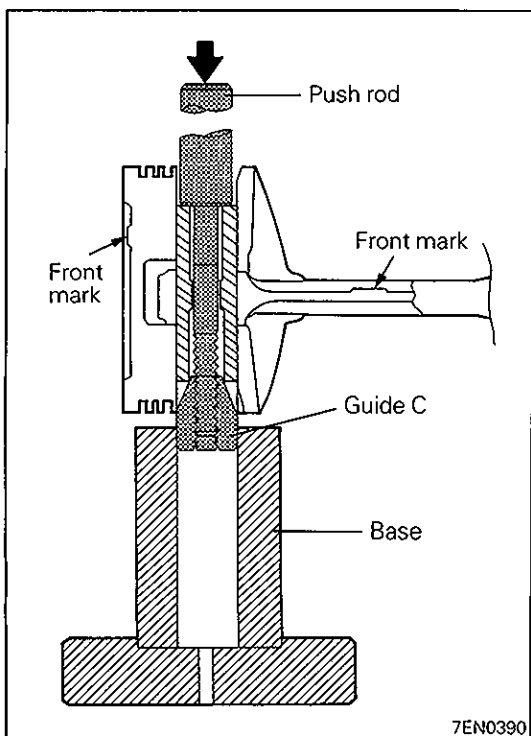
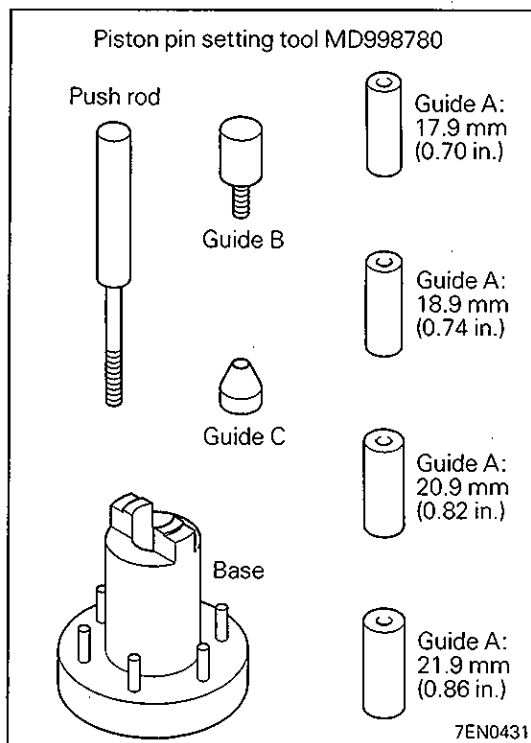
 Lubricate all internal parts with engine oil during reassembly.

#### Removal steps

- ◆G◆ 1. Nut
- ◆A◆ ◆F◆ 2. Connecting rod cap
- ◆E◆ 3. Connecting rod bearing
- ◆D◆ 4. Piston and connecting rod
- ◆E◆ 5. Connecting rod bearing
- ◆C◆ 6. Piston ring No.1
- ◆C◆ 7. Piston ring No.2
- ◆B◆ 8. Oil ring
- ◆B◆ ◆A◆ 9. Piston pin
- 10. Piston
- 11. Connecting rod
- 12. Bolt

**REMOVAL SERVICE POINTS****◁A▷ CONNECTING ROD CAP REMOVAL**

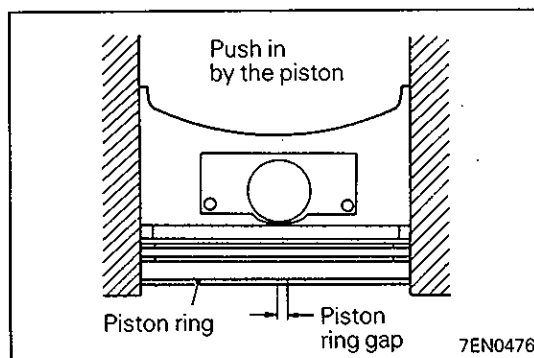
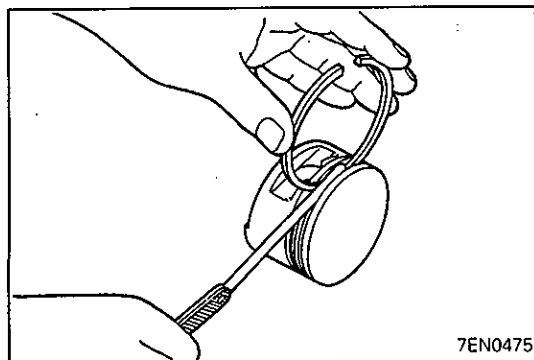
- (1) Mark the large end of the connecting rod with the cylinder number for use during reassembly.

**◁B▷ PISTON PIN REMOVAL**

- (1) Insert the Push Rod (special tool) into the piston from the side on which the front mark is stamped in the piston head, and attach the guide C to the push rod end.
- (2) Place the piston and connecting rod assembly on the Piston Pin Setting Base (special tool) with the front mark facing upward.
- (3) Using a press, remove the piston pin.

**NOTE**

Keep the disassembled pistons, piston pins and connecting rods in order according to the cylinder number.

**INSPECTION****PISTON RING**

- (1) Check the side clearance between the piston ring and ring groove. If the limit is exceeded, replace the ring or piston, or both.

**Standard value:**

No. 1	0.03 – 0.07 mm (0.0012 – 0.0028 in.)
No. 2	0.02 – 0.06 mm (0.0008 – 0.0024 in.)

**Limit:**

No. 1	0.1 mm (0.004 in.)
No. 2	0.1 mm (0.004 in.)

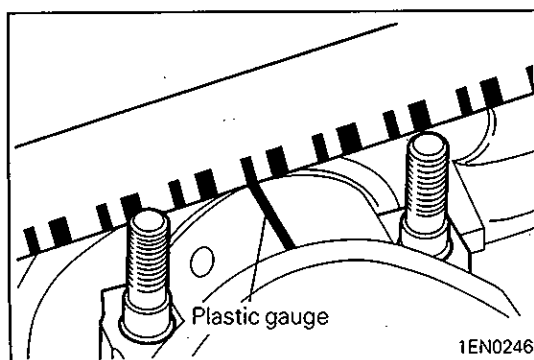
Install the piston ring into the cylinder bore. Force it down with a piston, its crown being in contact with the ring, to correctly position it at right angles to the cylinder wall. Then, measure the end gap with a feeler gauge. If the ring gap is excessive, replace piston ring.

**Standard value:**

No. 1	0.25 – 0.40 mm (0.0098 – 0.0157 in.)
No. 2	0.40 – 0.55 mm (0.0157 – 0.0217 in.)
Oil	0.10 – 0.35 mm (0.0039 – 0.0138 in.)

**Limit:**

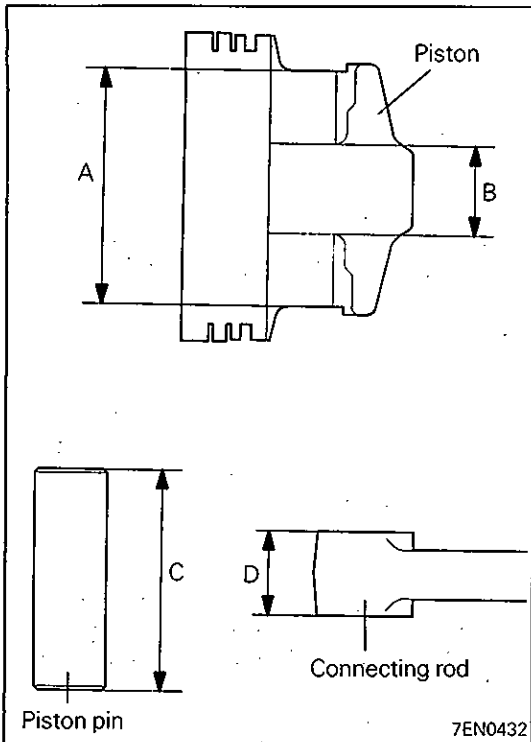
No. 1, No. 2	0.8 mm (0.031 in.)
Oil	1.0 mm (0.039 in.)

**CRANKSHAFT PIN OIL CLEARANCE (PLASTIC GAUGE METHOD)**

- (1) Remove oil from crankshaft pin and connecting rod bearing.
- (2) Cut the plastic gauge to the same length as the width of bearing and place it on crankshaft pin in parallel with its axis.
- (3) Install the connecting rod cap carefully and tighten the bolts to specified torque.
- (4) Carefully remove the connecting rod cap.
- (5) Measure the width of the plastic gauge at its widest part by using a scale printed on the plastic gauge package.

**Standard value:** 0.02 – 0.05 mm (0.0008 – 0.0020 in.)

**Limit:** 0.1 mm (0.004 in.)



## INSTALLATION SERVICE POINTS

### ▶▶ PISTON PIN INSTALLATION

- (1) Measure the following dimensions of the piston, piston pin and connecting rod.

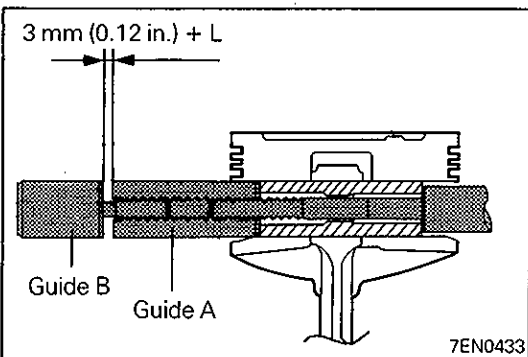
A: Piston pin insertion hole length  
 B: Distance between piston bosses  
 C: Piston pin length  
 D: Connecting rod small end width

- (2) Calculate the following formula by substituting the measured values.

$$L = \frac{(A - C) - (B - D)}{2}$$

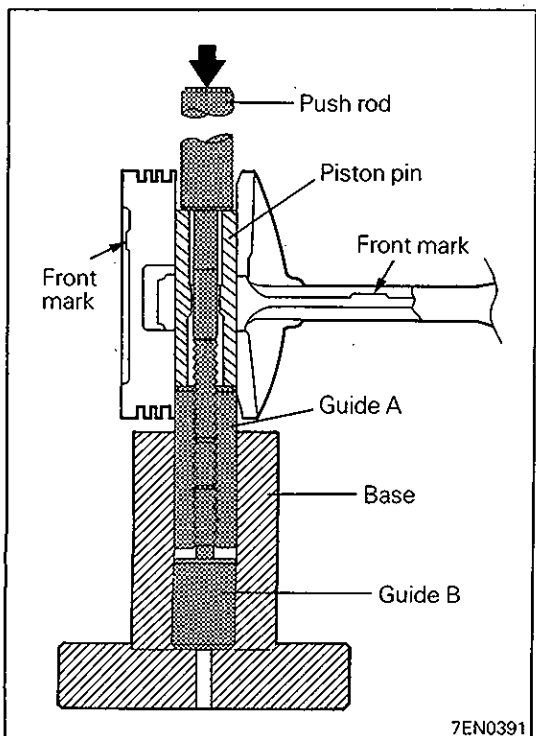
- (3) Insert the Push Rod (special tool) into the piston pin and attach the guide A to the push rod end.
- (4) Assemble the connecting rod in the piston with their front marks facing the same direction.
- (5) Apply engine oil to the entire periphery of the piston pin.
- (6) Insert the piston pin, push rod and guide A assembly having assembled in step (3) from the guide A side into the piston pin hole on the front marked side.

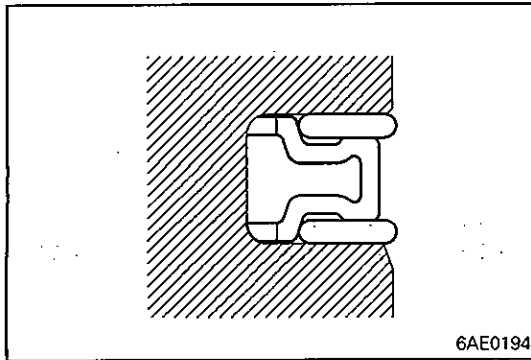
- (7) Screw the guide B into the guide A until the gap between both guides amounts to the value L obtained in step (2) plus 3 mm (0.12 in.).



- (8) Place the piston and connecting rod assembly onto the piston setting base with the front marks directed upward.
- (9) Press-fit the piston pin using a press.  
 If the press-fitting force required is less than the standard value, replace the piston and piston pin set or/and the connecting rod.

**Standard value: 5,000 – 15,000 N (500 – 1,500 kg, 1,102 – 3,307 lbs.)**





### ◆B◆ OIL RING INSTALLATION

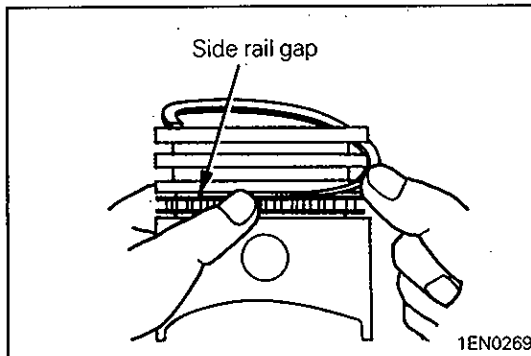
- (1) Fit the oil ring spacer into the piston ring groove.

#### NOTE

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

- (2) Install the upper side rail.

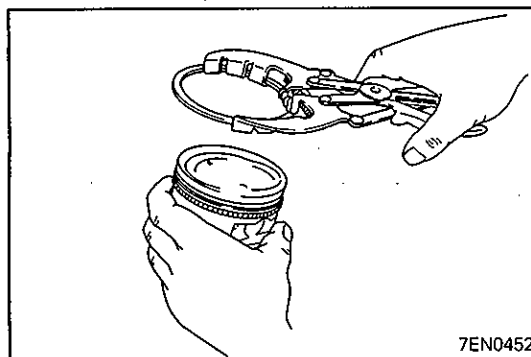
To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into position by finger. See illustration.



#### NOTE

Do not use piston ring expander when installing side rail. Use of ring expander to expand the side rail end gap can break the side rail, unlike other piston rings.

- (3) Install the lower side rail in the same procedure as described in step (2).
- (4) Make sure that the side rails move smoothly in either direction.

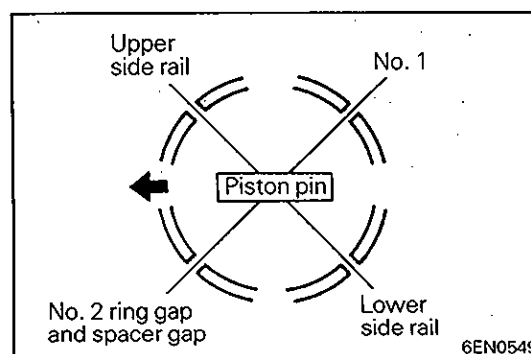
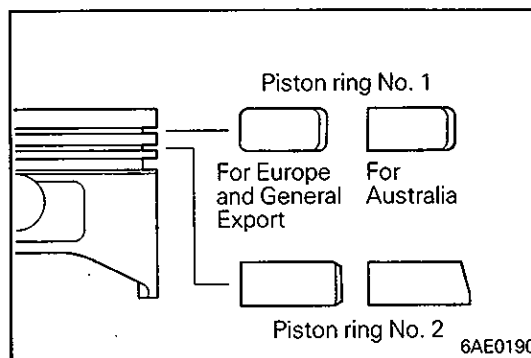


### ◆C◆ PISTON RING NO. 2 / PISTON RING NO. 1 INSTALLATION

- (1) Using piston ring expander, fit No. 2 and then No. 1 piston ring into position.

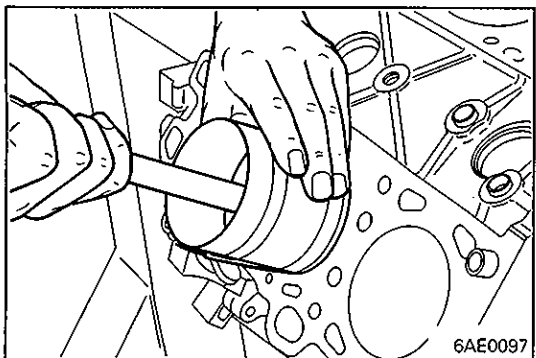
#### NOTE

- (1) Note the difference in shape between No. 1 and No. 2 piston rings.
- (2) Install piston rings No. 1 and No. 2 with their side having marks facing up (on the piston crown side).



### ◆D◆ PISTON AND CONNECTING ROD INSTALLATION

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



- (4) Use suitable thread protectors on connecting rod bolts before inserting piston and connecting rod assembly into cylinder block. Care must be taken not to nick crank pin.
- (5) Using a suitable piston ring compressor tool, install piston and connecting rod assembly into the cylinder block.

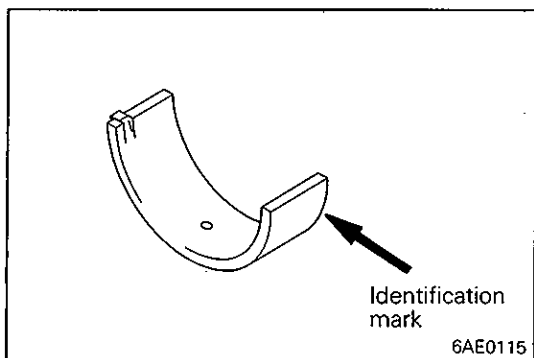
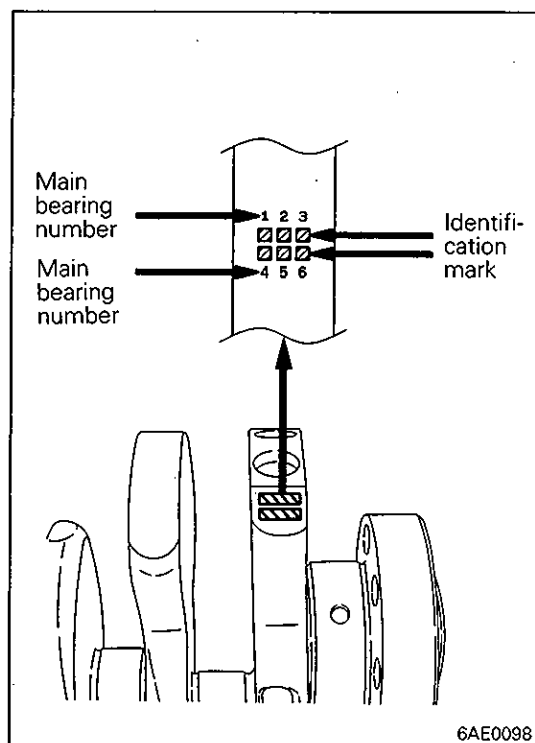
#### Caution

- Insert the front mark (arrow) on the top of the piston so it faces the engine front (timing belt side).

### ◆E◆ CONNECTING ROD BEARINGS INSTALLATION

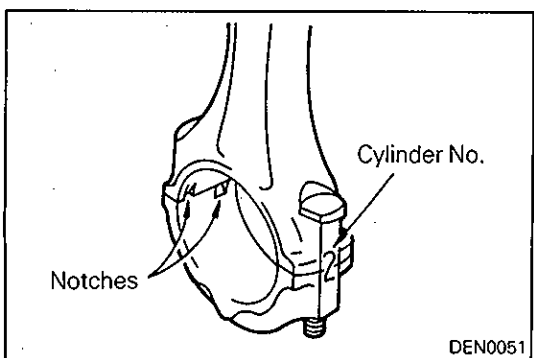
- (1) When the bearings are to be replaced, select correct ones and install them in the correct positions according to the identification marks stamped on the crankshaft.

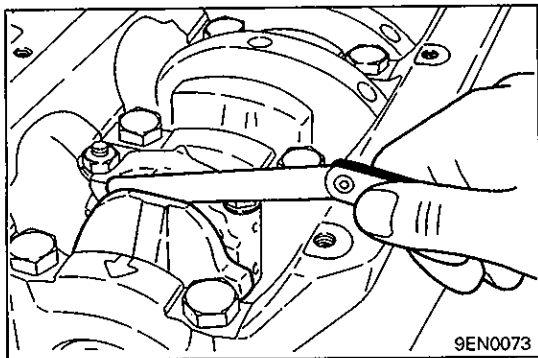
Crankshaft		Connecting rod bearing	
Pin O.D. identification mark	Pin O.D. mm (in.)	Identification mark	Thickness mm (in.)
1	42.995 – 43.000 (1.6927 – 1.6929)	S1	1.487 – 1.491 (0.0585 – 0.0587)
2	42.985 – 42.995 (1.6923 – 1.6927)	S2	1.491 – 1.495 (0.0587 – 0.0589)
3	42.980 – 42.985 (1.6921 – 1.6923)	S3	1.495 – 1.499 (0.0589 – 0.0590)



### ◆F◆ CONNECTING ROD CAP INSTALLATION

- (1) Mate the correct bearing cap with the correct connecting rod by checking with the alignment marks marked during disassembly. If a new connecting rod is used which has no alignment mark, position the notches for locking the bearing on the same side.





- (2) Check if the thrust clearance in the connecting rod big end is correct.

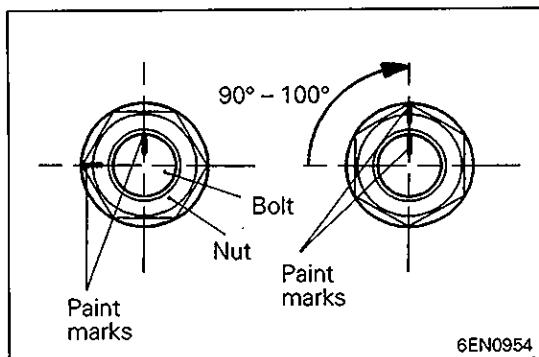
**Standard value: 0.10 – 0.25 mm (0.0039 – 0.0098 in.)**

**Limit: 0.4 mm (0.016 in.)**

### ◆G◆ CONNECTING ROD CAP NUT INSTALLATION

- (1) Since the connecting rod bolts and nuts are torqued using a new procedure they should be examined BEFORE reuse. If the bolt threads are "necked down" the bolts should be replaced.

Necking can be checked by running a nut with fingers to the full length of the bolt's thread. If the nut does not run down smoothly, the bolt should be replaced.



- (2) Before installation of each nut, apply engine oil to the threaded portion and bearing surface of the nut.
- (3) Install each nut to the bolt and tighten it finger tight. Then tighten the nuts alternately to install the cap properly.
- (4) Tighten the nuts to a torque of 18 Nm (1.8 kgm, 13 ft.lbs.).
- (5) Make a paint mark on the head of each nut.
- (6) Make a paint mark on the bolt at the position 90° to 100° from the paint mark made on the nut in the direction of tightening the nut.
- (7) Give a 90° to 100° turn to the nut and make sure that the paint mark on the nut and that on the bolt are in alignment.

#### Caution

- If the nuts are tightened by an angle of less than 90°, they may not hold the caps with sufficient strength.
- If a nut is tightened by an angle exceeding 100°, completely remove all the nuts and carry out the installation procedure again from step (1).

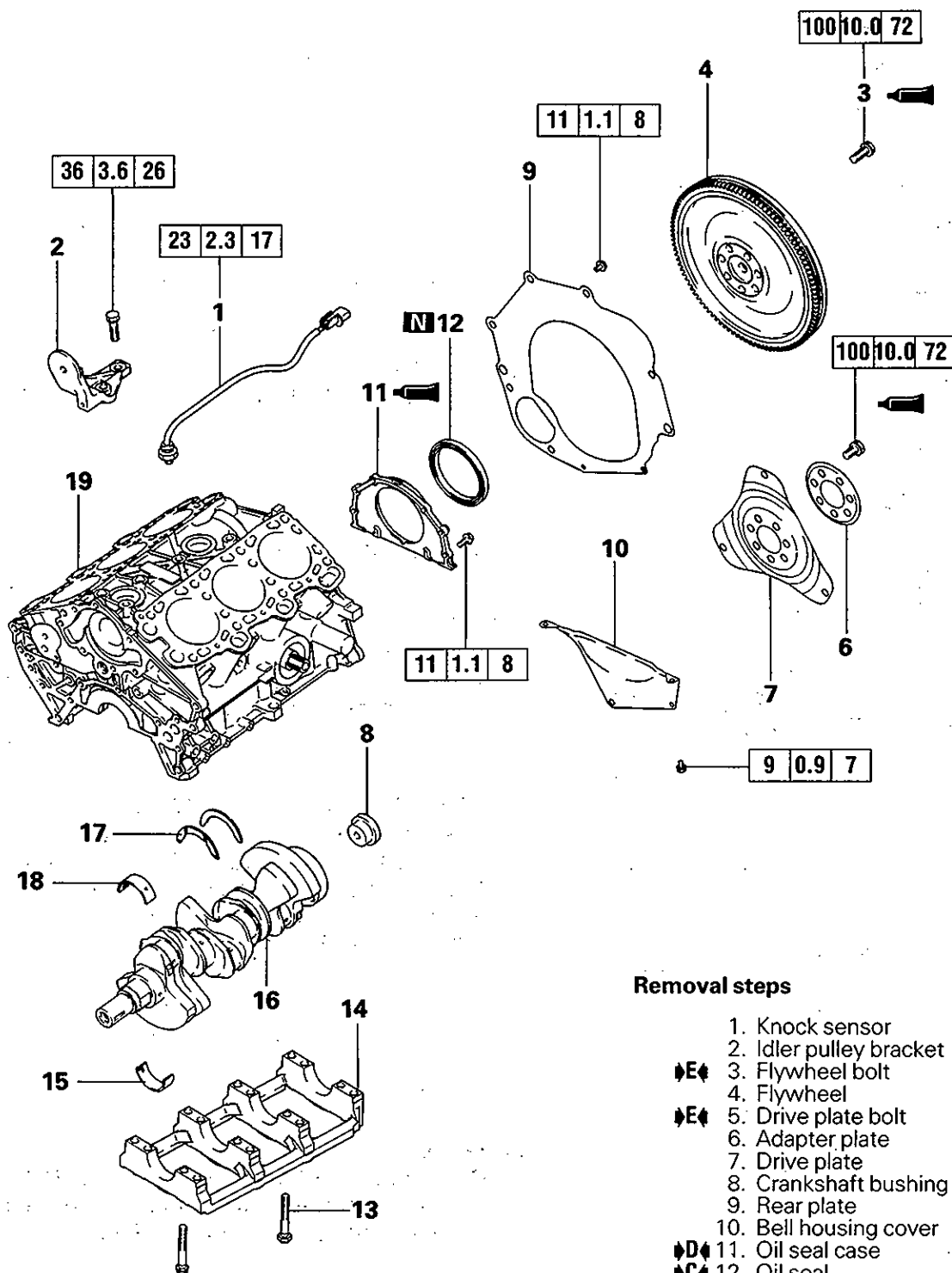



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**NOTES**

# 13. CRANKSHAFT, CYLINDER BLOCK, FLYWHEEL AND DRIVE PLATE

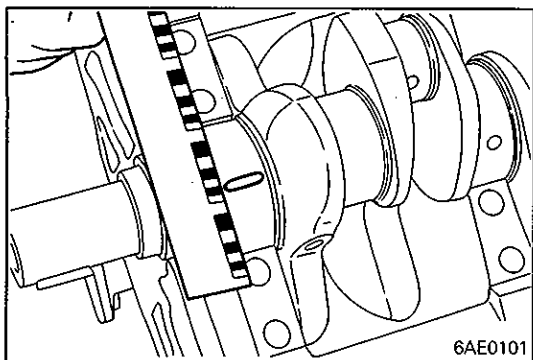
## REMOVAL AND INSTALLATION



 Lubricate all internal parts with engine oil during reassembly.

### Removal steps

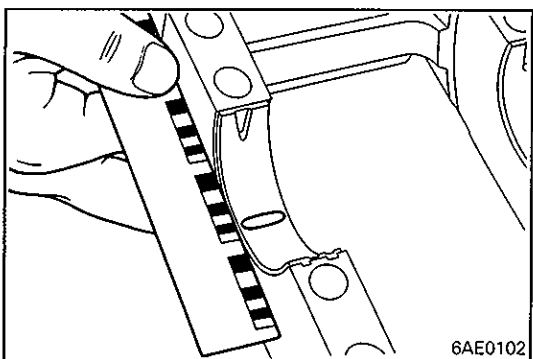
1. Knock sensor
2. Idler pulley bracket
3. Flywheel bolt
4. Flywheel
5. Drive plate bolt
6. Adapter plate
7. Drive plate
8. Crankshaft bushing
9. Rear plate
10. Bell housing cover
11. Oil seal case
12. Oil seal
13. Bearing cap bolt
14. Bearing cap
15. Crankshaft bearing, lower
16. Crankshaft
17. Thrust bearing
18. Crankshaft bearing, upper
19. Cylinder block



## INSPECTION

### CRANKSHAFT OIL CLEARANCE (PLASTIC GAUGE METHOD)

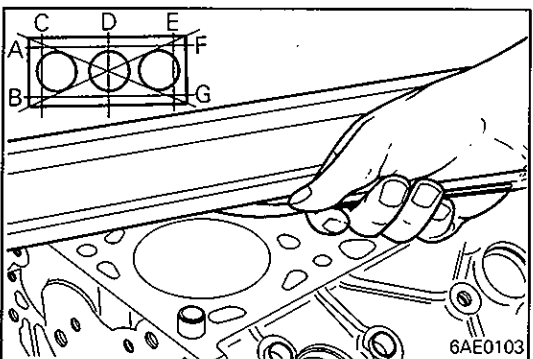
- (1) Remove oil from crankshaft journal and crankshaft bearing.
- (2) Install the crankshaft.
- (3) Cut the plastic gauge to the same length as the width of bearing and place it on journal in parallel with its axis.



- (4) Install the crankshaft bearing cap carefully and tighten the bolts to specified torque.
- (5) Carefully remove the crankshaft bearing cap.
- (6) Measure the width of the plastic gauge at its widest part by using a scale printed on the plastic gauge package.

**Standard value: 0.02 – 0.04 mm (0.0008 – 0.0016 in.)**

**Limit: 0.1 mm (0.0040 in.)**



### CYLINDER BLOCK

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

**Standard value: 0.05 mm (0.0020 in.) or less**

**Limit: 0.1 mm (0.0040 in.)**

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

**Grinding limit: 0.2 mm (0.008 in.)**

**The total thickness of the stock allowed to be removed from cylinder block and mating cylinder head is 0.2 mm (0.008 in.) at maximum.**

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

**190 mm (7.48 in.)**

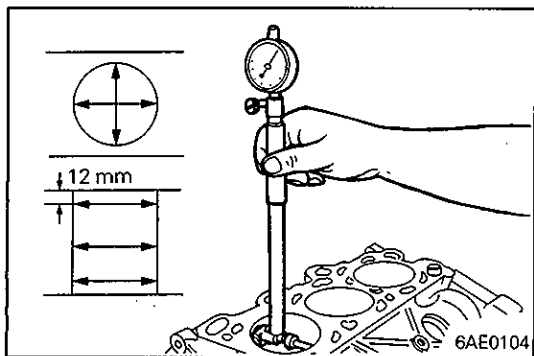
- (3) Check cylinder walls for scratches and seizure. If defects are evident, correct (bored to oversize) or replace.
- (4) Using cylinder gauge, measure the cylinder bore and cylindricity. If worn badly, correct cylinder to an oversize and replace piston and piston rings. Measure at the points shown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

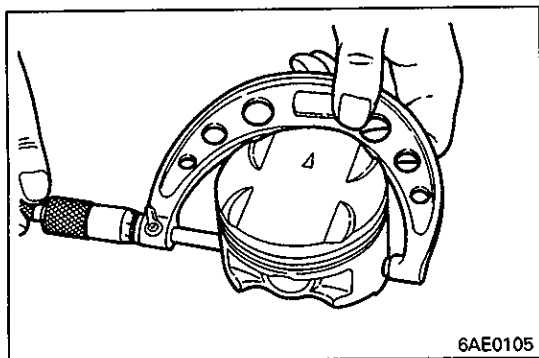
**Standard value:**

**Cylinder I.D.: 78.40 – 78.43 mm (3.0867 – 3.0878 in.)**

**Out-of-roundness and taper of cylinder bore:**

**0.01 mm (0.0004 in.) or less**



**BORING CYLINDER**

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

**Piston size identification****Up to 1993 models**

Size	Identification mark
0.25 mm (0.01 in.) O.S.	0.25
0.50 mm (0.02 in.) O.S.	0.50
0.75 mm (0.03 in.) O.S.	0.75
1.00 mm (0.04 in.) O.S.	1.00

**From 1994 models**

Size	Identification mark
0.50 mm (0.02 in.) O.S.	0.50
1.00 mm (0.04 in.) O.S.	1.00

**NOTE**

Size mark is stamped on piston top.

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

**Boring finish dimension = Piston O.D. + (Clearance between piston O.D. and cylinder) – 0.02 mm (0.0008 in.) (honing margin)**

- (4) Bore all cylinders to calculated boring finish dimension.

**Caution**

- To prevent distortion that may result from temperature rise during honing, bore cylinders, working from No. 2 to No. 4 to No. 1 to No. 3.

- (5) Hone to final finish dimension (piston O.D. + clearance between piston O.D. and cylinder.)
- (6) Check clearance between piston and cylinder.

**Clearance between piston and cylinder:**

**0.02 – 0.04 mm (0.0008 – 0.0016 in.)**

**NOTE**

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

## INSTALLATION SERVICE POINTS

### ◆A◆ CRANKSHAFT BEARING INSTALLATION

- (1) When replacing bearing, select a one of proper size according to the identification marks stamped on both crankshaft and cylinder block.

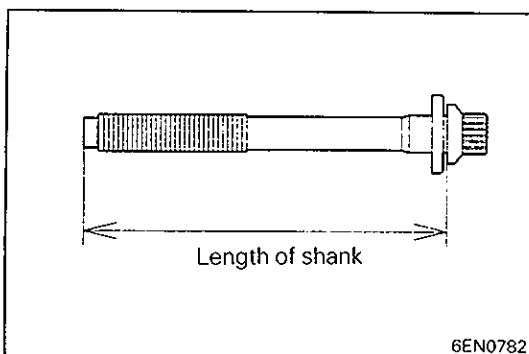
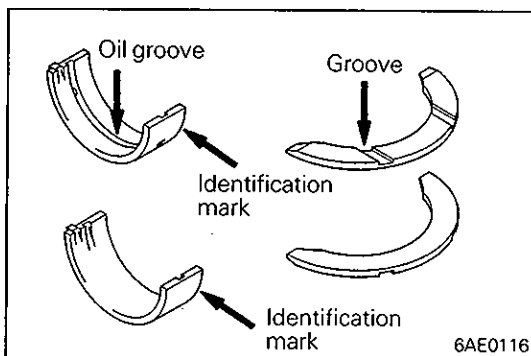
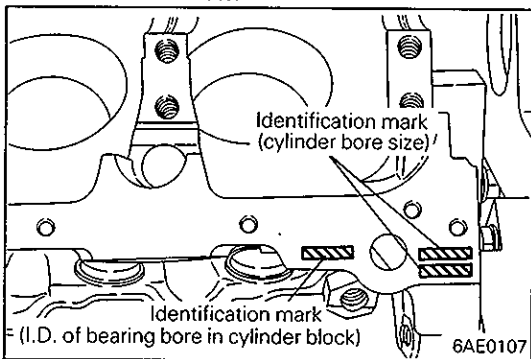
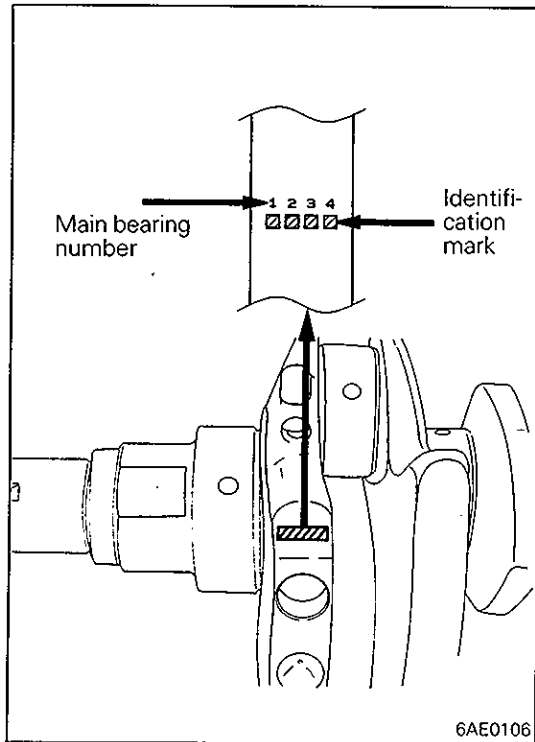
Crankshaft journal		Cylinder block bearing bore		Crankshaft bearing	
Identification mark	O.D. mm (in.)	Identification mark	I.D. mm (in.)	Identification mark	Thickness mm (in.)
1	52.994 – 53.000 (2.0864 – 2.0866)	0	57.000 – 57.006 (2.2441 – 2.2443)	1	1.991 – 1.994 (0.0784 – 0.0785)
		1	57.006 – 57.012 (2.2443 – 2.2446)	2	1.994 – 1.997 (0.0785 – 0.0786)
		2	57.012 – 57.018 (2.2446 – 2.2448)	3	1.997 – 2.000 (0.0786 – 0.0787)
2	52.988 – 52.994 (2.0861 – 2.0864)	0	57.000 – 57.006 (2.2441 – 2.2443)	2	1.994 – 1.997 (0.0785 – 0.0786)
		1	57.006 – 57.012 (2.2443 – 2.2446)	3	1.997 – 2.000 (0.0786 – 0.0787)
3	52.982 – 52.988 (2.0859 – 2.0861)	2	57.012 – 57.018 (2.2446 – 2.2448)	4	2.000 – 2.003 (0.0787 – 0.0789)
		0	57.000 – 57.006 (2.2441 – 2.2443)	3	1.997 – 2.000 (0.0786 – 0.0787)
		1	57.006 – 57.012 (2.2443 – 2.2446)	4	2.000 – 2.003 (0.0787 – 0.0789)
		2	57.012 – 57.018 (2.2446 – 2.2448)	5	2.003 – 2.006 (0.0789 – 0.0790)

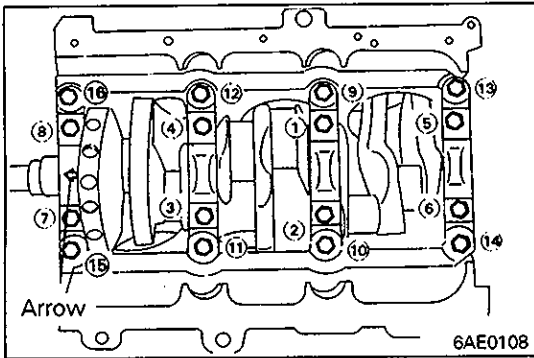
- (2) Install the bearings having an oil groove to the cylinder block.  
 (3) Install the bearings having no oil groove to the bearing caps.  
 (4) Install the thrust bearings at the No. 3 upper bearing with the grooved side toward the crank web.

### ◆B◆ BEARING CAP / BEARING CAP BOLT INSTALLATION

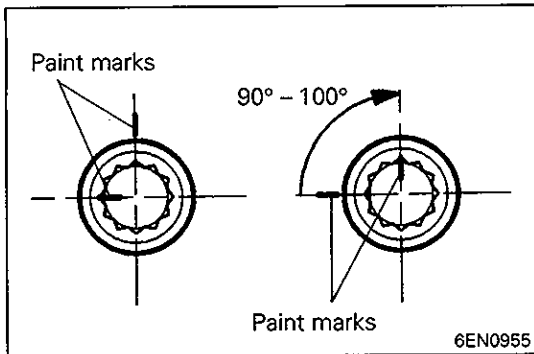
- (1) Install the bearing caps so that their arrows are positioned on the timing belt side.  
 (2) When installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.

**Limit: max. 71.1 mm (2.79 in.)**





- (3) Apply engine oil to the threaded portion and bearing surface of the bolt.
- (4) Tighten the bearing cap bolts to 25 Nm (2.5 kgm, 18 ft.lbs.) torque in the tightening sequence.



- (5) Make a paint mark on the head of each nut.
- (6) Make a paint mark on the area around the bolt bearing surface at location 90° to 100° in the direction of tightening the bolt.
- (7) Give a 90° to 100° turn to the bolts in the tightening sequence. Make sure that the paint mark on the bolt and that on the area around the bolt bearing surface are in alignment.

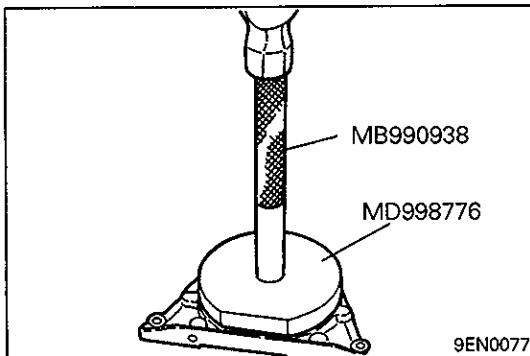
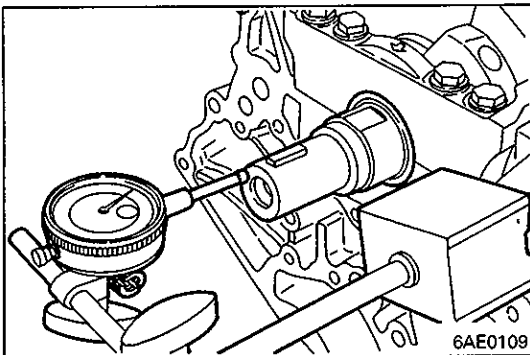
#### Caution

- If the bolts are tightened by an angle of less than 90°, they may not hold the cap with sufficient strength.
- If a bolt is tightened by an angle exceeding 100°, completely remove all the bolts and carry out the installation procedure again from step (1).

- (8) After installing the bearing caps, make sure that the crankshaft turns smoothly and the end play is correct. If the end play exceeds the limit, replace crankshaft bearings.

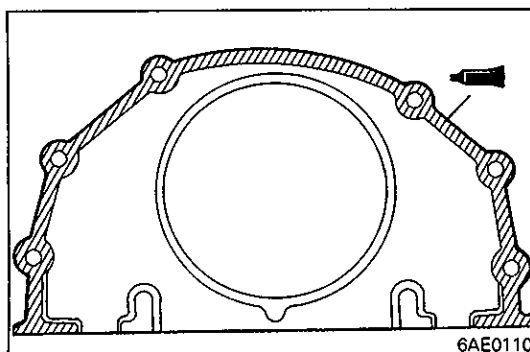
**Standard value: 0.05 – 0.25 mm (0.0020 – 0.0098 in.)**

**Limit: 0.4 mm (0.016 in.)**



#### ❖C❖ OIL SEAL INSTALLATION

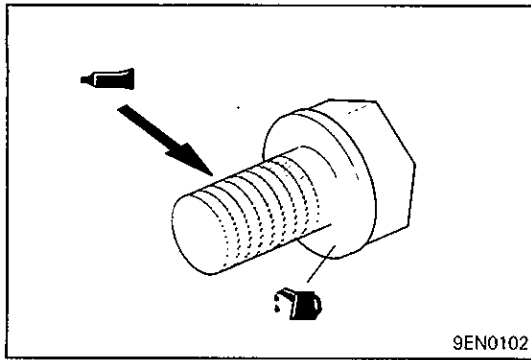
- (1) Apply engine oil to oil seal lip.



#### ❖D❖ APPLICATION OF OIL SEAL CASE

**Specified sealant:**

**Mitsubishi Genuine Part No. MD970389 or equivalent**



### ◆E◆ DRIVE PLATE BOLT / FLYWHEEL BOLT INSTALLATION

- (1) Remove all the remaining sealant from bolts and thread holes of crankshaft.
- (2) Apply engine oil to the flange of bolt.
- (3) Apply engine oil into the thread holes of crankshaft.
- (4) Apply specified sealant to the thread of bolts.

#### **Specified sealant:**

**3M Nut Locking Part No. 4171 or equivalent**

- (5) Tighten the bolts to specified torque.