ENGINE

CONTENTS

GENERAL INFORMATION 2

SPECIFICATIONS 3

- Service Specifications 3
- Torque Specifications 5
- New Tightening Method by Use of Bolts to Be Tightened in Plastic Area 9
- Sealants 9
- Form-In-Place Gasket 10

SPECIAL TOOLS 11

ALTERNATOR AND IGNITION SYSTEM .. 14

TIMING BELT 15

FUEL AND EMISSION CONTROL PARTS 27

SECONDARY AIR SYSTEM AND INTAKE MANIFOLD 29

EXHAUST MANIFOLD 31

WATER PUMP AND WATER HOSE 34

ROCKER ARMS AND CAMSHAFT 37

CYLINDER HEAD AND VALVES 43

FRONT CASE, COUNTERBALANCE SHAFT AND OIL PAN 51

PISTON AND CONNECTING ROD 59

CRANKSHAFT AND FLYWHEEL 67

THROTTLE BODY 73

TURBOCHARGER 75

ALTERNATOR 79

STARTER MOTOR 83

GENERAL INFORMATION

Descriptions			Specifications
Type			In-line OHV, SOHC
Number of cylinders			4
Combustion chamber			Pentroof + curved top piston type
Total displacement dm^3			1,997
Cylinder bore mm			85.0
Piston stroke mm			88.0
Compression ratio			8.8
Valve timing	Intake valve	Opens (BTDC)	21°
		Closes (ABDC)	59°
	Exhaust valve	Opens (BBDC)	58°
		Closes (ATDC)	18°
Lubrication system			Pressure feed, full-flow filtration
Oil pump type			Involute gear type

SPECIFICATIONS

SERVICE SPECIFICATIONS

Items		Standard value	Limit
Timing belt			
Auto-tensioner rod projection length mm		12	–
Auto-tensioner rod pushed-in amount [when pushed with a force of 98 – 196 N] mm		1.0 or less	–
Rocker arms and camshaft			
Camshaft cam height mm	Intake	35.79	35.29
	Exhaust	35.49	34.99
Camshaft journal outer diameter mm		26	–
Cylinder head and valves			
Cylinder head flatness of gasket surface mm		Less than 0.05	0.2
Cylinder head grinding limit of gasket surface mm Total resurfacing depth of both cylinder head and cylinder block		–	0.2
Cylinder head overall height mm		131.9 – 132.1	–
Cylinder head bolt shank length mm		–	Maximum 99.4
Valve thickness of valve head (margin) mm	Intake	1.0	0.5
	Exhaust	1.5	1.0
Overall valve length mm	Intake	109.5	109.0
	Exhaust	109.7	109.2
Valve thickness to valve guide clearance mm	Intake	0.02 – 0.05	0.10
	Exhaust	0.05 – 0.09	0.15
Valve face angle		45° – 45.5°	–
Valve spring free length mm		48.3	47.3
Valve spring load/installed height N/mm		294/40.0	–
Valve spring out-of-squareness		1.5° or less	Maximum 4°
Valve seat contact width mm		0.9 – 1.3	–
Valve guide inner diameter mm		6.6	–
Valve guide projection from cylinder head upper surface mm		20.5	–
Valve stem projection mm	Intake	49.20	49.70
	Exhaust	48.40	48.90
Oversize rework dimensions of valve guide hole mm	0.05 O.S.	12.05 – 12.07	–
	0.25 O.S.	12.25 – 11.27	–
	0.50 O.S.	12.50 – 12.52	–

Items		Standard value	Limit
Intake oversize rework dimensions of valve guide hole mm	0.3 O.S.	35.30 – 35.33	–
	0.6 O.S.	35.60 – 35.63	–
Exhaust oversize rework dimensions of valve guide hole mm	0.3 O.S.	33.30 – 33.33	–
	0.6 O.S.	33.60 – 33.63	–
Front case and oil pan			
Oil pump side clearance mm	Drive gear	0.08 – 0.14	–
	Driven gear	0.06 – 0.12	–
Oil pressure at curb idle speed kPa [Oil temperature is 75 to 90°C]		78 or more	–
Piston and connecting rod			
Piston outer diameter mm		85.0	–
Piston ring side clearance mm	No. 1 ring	0.04 – 0.075	–
	No. 2 ring	0.02 – 0.06	–
Piston ring end gap mm	No. 1 ring	0.25 – 0.35	0.8
	No. 2 ring	0.40 – 0.55	0.8
	Oil ring	0.10 – 0.40	1.0
Piston pin outer diameter mm		21.0	–
Piston pin press-in load N (Room temperature)		7,350 – 17,200	–
Crankshaft pin oil clearance mm		0.02 – 0.05	0.1
Connecting rod big end side clearance mm		0.10 – 0.25	0.4
Crankshaft and flywheel			
Crankshaft end play mm		0.05 – 0.25	0.40
Crankshaft journal outer diameter mm		57.0	–
Crankshaft pin outer diameter mm		44.0	–
Crankshaft journal oil clearance mm		0.02 – 0.04	0.1
Bearing cap bolt shank length mm		–	Maximum 71.1
Piston to cylinder clearance mm		0.02 – 0.04	–
Cylinder block grinding limit of gasket surface mm Total resurfacing depth of both cylinder head and cylinder block		–	0.2
Cylinder block overall height mm		284	–
Cylinder block inner diameter mm		85.0	–
Cylinder block cylinder mm		0.01	–
Turbocharger			
Waste gate actuator operation check kPa		100	113.3

Items	Standard value	Limit
Alternator		
Rotor coil resistance Ω	Approx. 3 – 5	–
Protrusion length of brush mm	–	2
Starter motor		
Commutator runout mm	0.05	0.1
Commutator outer diameter mm	32.0	31.4
Commutator undercut mm	0.5	–

TORQUE SPECIFICATIONS

Items	Nm
Alternator and ignition system	
Oil level gauge guide	13
Water pump pulley	9
Alternator brace (Alternator side)	21
Alternator brace (Tightened with water pump)	23
Alternator pivot bolt	44
Crankshaft pulley	25
Center cover	3
Spark plug	25
Ignition coil	10
Timing belt	
Timing belt cover (Flange bolt)	11
Timing belt cover (Washer bolt)	9
Power steering pump bracket	49
Tensioner pulley	49
Tensioner arm	24
Auto tensioner	24
Idler pulley	48
Crank angle sensor	9
Oil pump sprocket	54
Camshaft bolt	118
Tensioner "B"	19
Counterbalance shaft sprocket	45

Items	Nm
Rocker cover	3.5
Engine support bracket	49
Camshaft sprocket bolt	88
Timing belt rear right cover	11
Timing belt rear left upper cover	11
Fuel and emission control parts	
Throttle body	18
Fuel pressure regulator	9
Delivery pipe	11
Vacuum tank bracket	9
Solenoid valve bracket	9
Solenoid valve	9
Vacuum hose and vacuum pipe	11
Secondary air intake manifold	
Heat protector	13
Vacuum hose and vacuum pipe	11
Air pipe (Heat protector side)	13
Air pipe (Cam position sensor side)	11
Air pipe (Eye bolt)	49
Air pipe (Control valve side)	24
Air control valve	21
Air control valve bracket	24
Intake manifold stay	30
Intake manifold (M8)	19
Intake manifold (M10)	35
Exhaust manifold	
Engine hanger	12
Heat protector (Turbocharger side)	14
Oxygen sensor	54
Exhaust fitting bolt	59
Exhaust fitting nut	59
Air outlet fitting	19

Items	Nm
Oil return pipe (Turbocharger side)	9
Oil return pipe (Oil pan side – Head mark 7)	9
Oil return pipe (Oil pan side – Head mark 10)	13
Oil pipe	11
Oil pipe eye bolt (Cylinder head side)	16
Oil pipe eye bolt (Turbocharger side)	30
Water pipe	11
Water pipe eye bolt	41
Exhaust manifold (M8)	29
Exhaust manifold (M10)	49
Exhaust manifold (Turbocharger side)	59
Water pump and water hose	
Water temperature sensor	29
Water temperature gauge unit	11
Water inlet fitting	24
Water outlet fitting (M6)	10
Water outlet fitting (M8)	13
Thermostat housing	24
Thermostat housing (Clamp)	11
Water inlet pipe (Cylinder block)	13
Water inlet pipe (Outlet fitting)	10
Water pump	14
Knock sensor	22
Rocker arms and camshaft	
Camshaft position sensor	9
Camshaft position sensor cover	10
Camshaft position sensing cylinder	21
Camshaft position sensing support	13
Camshaft bearing cap	20
Oil delivery body	11
Cylinder head and valves	
Cylinder head bolt [Tighten to 78 Nm and then completely before tightening to final torque specification]	20 → 90° + 90°

Items	Nm
Front case and oil pan	
Drain plug	39
Oil pan	7
Oil screen	19
Buffle plate	22
Oil pressure switch	10
Oil cooler by-pass valve	54
Relief plug	44
Plug	24
Front case	24
Oil pump cover (Screw)	10
Oil pump cover (Bolt)	16
Piston and connecting rods	
Connecting rod nut	20 + 90° to 94°
Crankshaft and flywheel	
Flywheel bolt	132
Rear plate	11
Bell housing cover	9
Oil seal case	11
Beam bearing cap bolt	25 + 90°
Check valve	32
Throttle body	
Throttle position sensor	3.5
Idle speed control body assembly	3.5
Turbocharger	
Waste gate actuator	11

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 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.

SEALANTS

Item	Specified sealant	Quantity
Engine support bracket bolt	3M™ AAD Part No. 8672 or equivalent	As required
Semi-circular packing	3M™ AAD Part No. 8672 or equivalent	As required
Rocker cover	3M™ AAD Part No. 8672 or equivalent	As required
Oil return pipe gasket	3M™ AAD Part No. 8731 or equivalent	As required
Thermostat housing	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Water outlet fitting	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Engine coolant temperature gauge unit	3M™ AAD Part No. 8672 or equivalent	As required
Engine coolant temperature sensor	3M™ AAD Part No. 8731 or equivalent	As required
Cam position sensor support	Mitsubishi Genuine Part No. MD970389 or equivalent	As required
Oil pressure switch	3M™ AAD Part No. 8672 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

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 vulcanisation (RTV) type and is supplied in a 100-gram tube (Part No. MD970389). 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. MD997110 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.

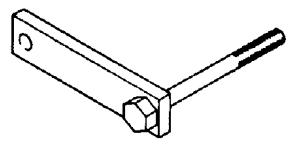
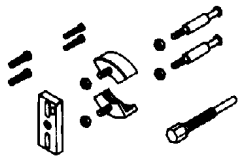
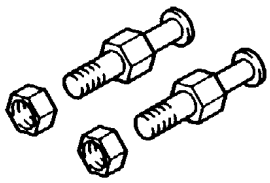
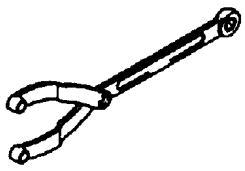
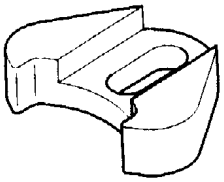
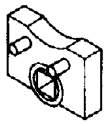
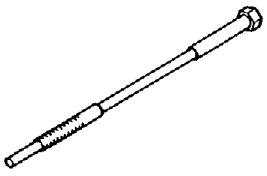
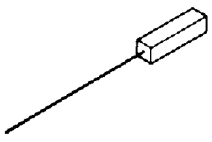
Surface Preparation

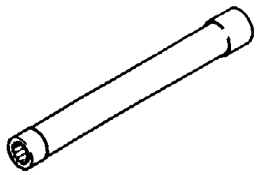
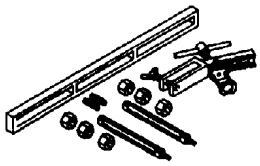
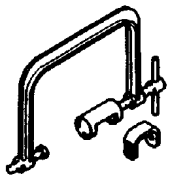
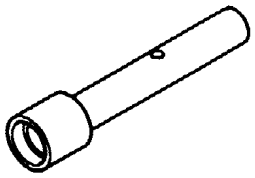
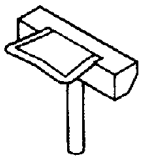
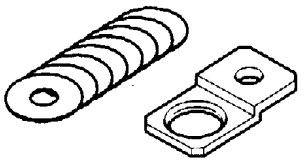
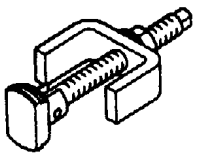
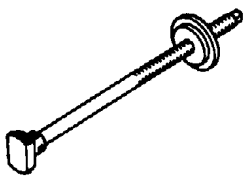
Thoroughly remove all substances deposited on the gasket application surfaces, using a gasket scraper or wire brush. Check to ensure that the surfaces to which the FIPG is to be applied is flat. Make sure that there are no oils, greases and foreign substances deposited on the application surfaces. Do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

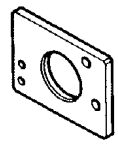
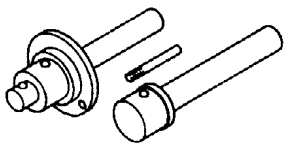
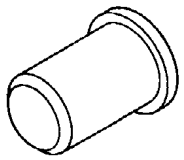
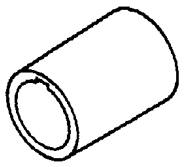
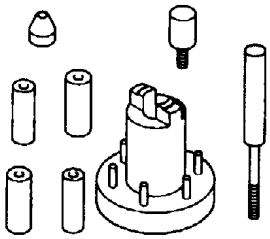
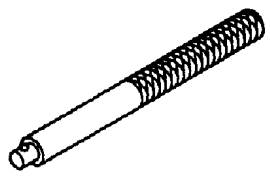
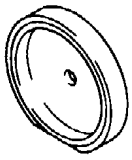
Form-in-Place Gasket Application

When assembling parts with the FIPG, you must observe some precautions, but the procedures 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.

SPECIAL TOOLS

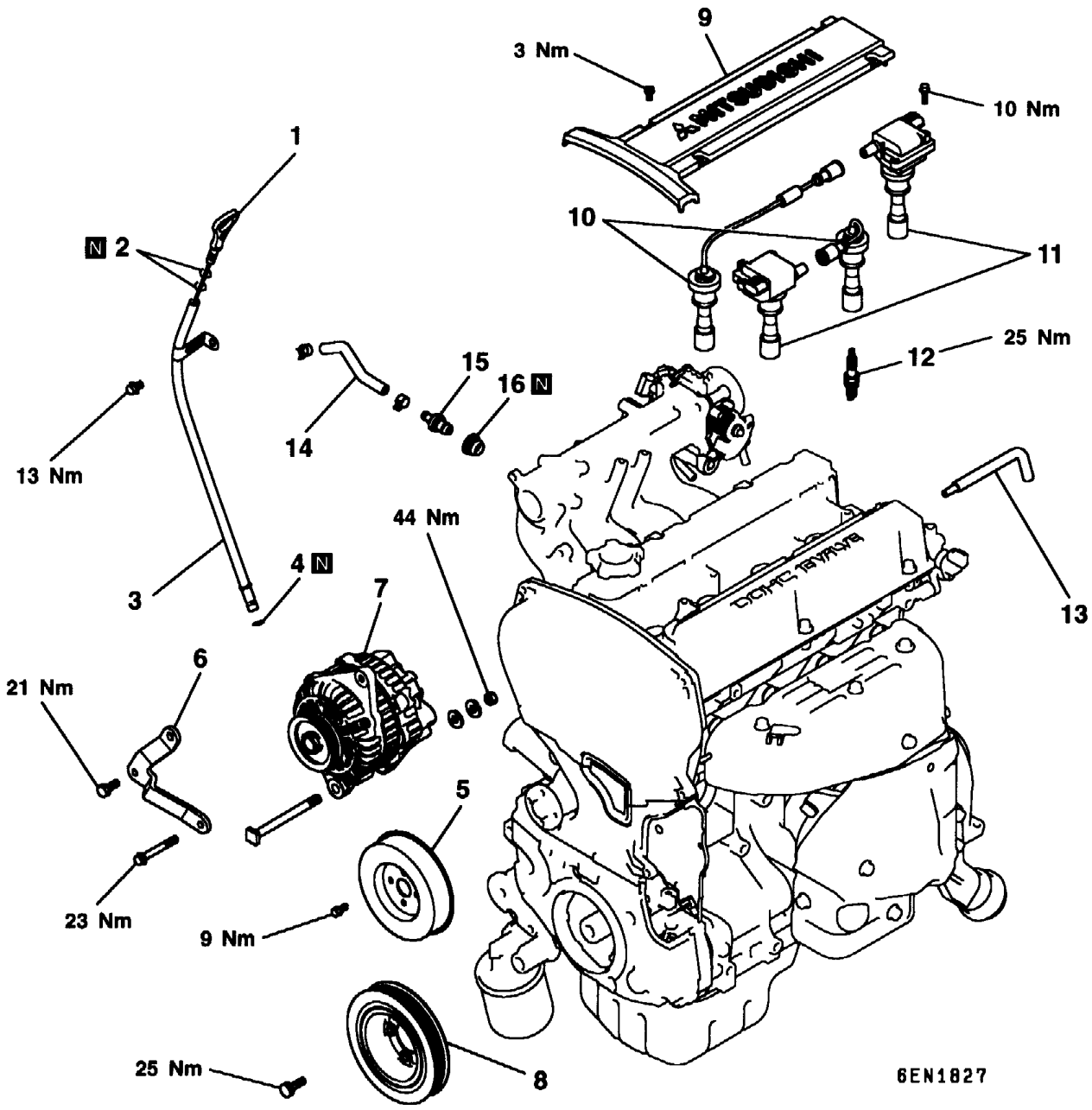
Tool	Number	Name	Use
	MD998781	Flywheel stopper	Holding of flywheel and drive plate
	MD998778	Crankshaft sprocket puller	Removal of crankshaft sprocket
	MD998719	Pulley holder pin	Holding camshaft sprocket
	MB990767	Crankshaft pulley holder	
	MD998785	Sprocket stopper	Holding silent shaft sprocket
	MD998767	Tensioner puller socket wrench	Adjustment of timing belt tension
	MD998738	Set screw	
	MD998713	Camshaft oil seal installer	Installation of camshaft oil seal
	MD998442	Lash adjuster wire	Air bleeding of lash adjuster

Tool	Number	Name	Use
	MB991654	Cylinder head bolt wrench (12)	Removal and installation of cylinder head bolt
	MD998772	Valve spring compressor	Removal and installation of valve and related parts
	MD998735	Valve spring compressor	
	MD998737	Valve stem seal installer	Installation of valve stem seal
	MD998727	Oil pan remover	Removal of oil pan
	MD998162	Plug wrench	Removal and installation of front case cap plug Use with MD998783.
	MD998783	Plug wrench retainer	Removal and installation of front case cap plug
	MD998371	Silent shaft bearing puller	Removal of counterbalance shaft front bearing
	MD998372	Silent shaft bearing puller	Removal of counterbalance shaft rear bearing

Tool	Number	Name	Use
	MB991603	Silent shaft bearing puller stopper	Guide stopper for removal and installation of counterbalance shaft rear bearing Use with MD998372.
	MD998705	Silent shaft bearing installer	Installation of counterbalance shaft front and rear bearing
	MD998375	Crankshaft front seal installer	Installation of crankshaft front oil seal
	MD998285	Crankshaft front oil seal guide	Guide for installation of crankshaft front oil seal Use with MD998375.
	MD998780	Piston setting tool	Removal and installation of piston pin
	MB990938	Handle	Installation of crankshaft rear oil seal
	MD998776	Crankshaft rear oil seal installer	

ALTERNATOR AND IGNITION SYSTEM

REMOVAL AND INSTALLATION

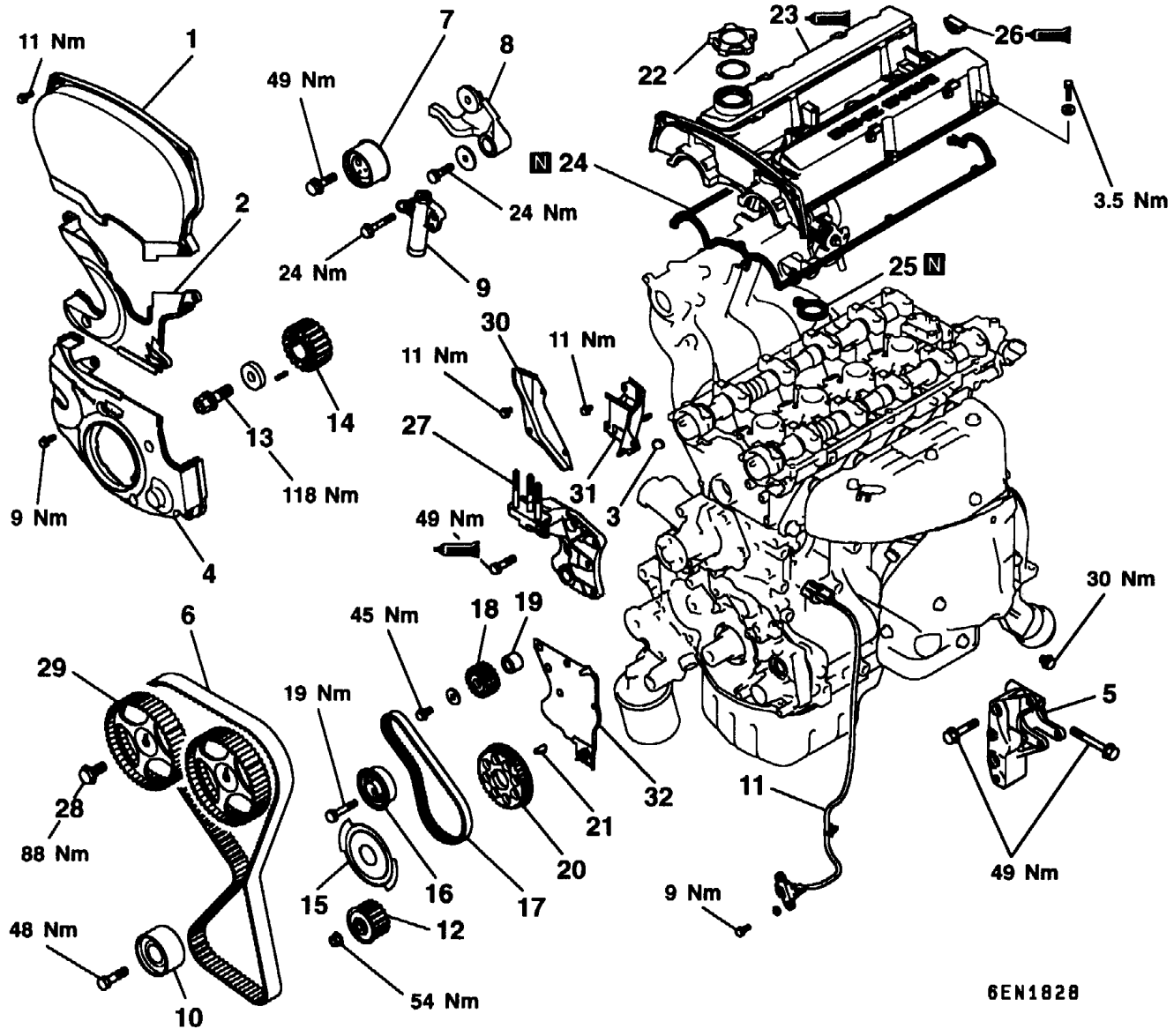


Removal steps

1. Oil level gauge
2. O-ring
3. Oil level gauge guide
4. O-ring
5. Water pump pulley
6. Alternator brace
7. Alternator
8. Crankshaft pulley
9. Center cover
10. Spark plug cable
11. Ignition coil
12. Spark plug
13. Breather hose
14. PCV hose
15. PCV valve
16. PCV valve gasket

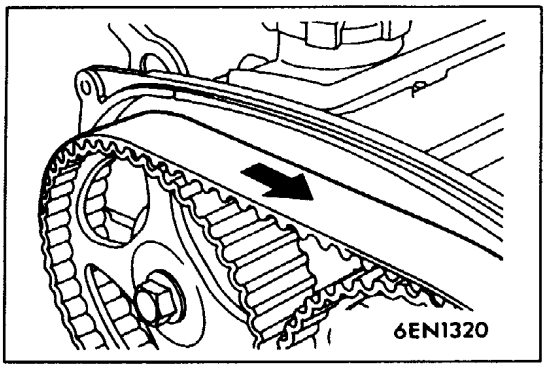
TIMING BELT

REMOVAL AND INSTALLATION



Removal steps

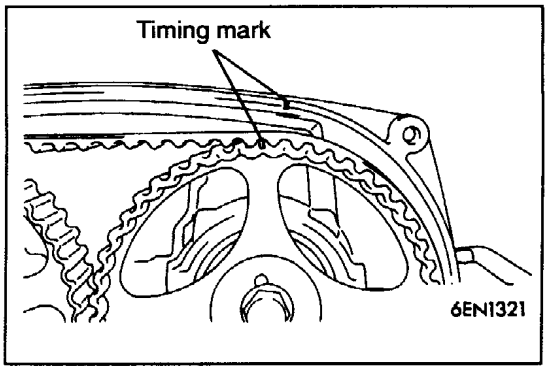
1. Timing belt front upper cover
2. Timing belt front center cover
3. Rubber plug
4. Timing belt front lower cover
5. Power steering pump bracket
6. Timing belt
7. Tensioner pulley
8. Tensioner arm
9. Auto tensioner
10. Idler pulley
11. Crank angle sensor
12. Oil pump sprocket
13. Crankshaft sprocket bolt
14. Crankshaft sprocket
15. Crankshaft sensing blade
16. Tensioner B
17. Timing belt B
18. Counterbalance shaft sprocket
19. Crankshaft spacer
20. Crankshaft sprocket B
21. Crankshaft key
22. Oil filler cap
23. Rocker cover
24. Rocker cover gasket A
25. Rocker cover gasket B
26. Semi-circular packing
27. Engine support bracket
28. Camshaft sprocket bolt
29. Camshaft sprocket
30. Timing belt rear right cover
31. Timing belt rear left upper cover
32. Timing belt rear left lower cover



REMOVAL SERVICE POINTS

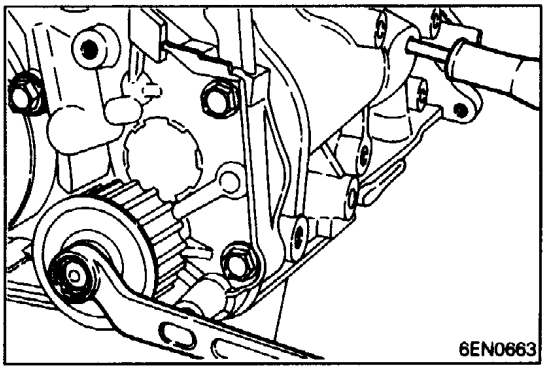
◀A▶ TIMING BELT REMOVAL

(1) If the timing belt is to be reused, chalk an arrow mark on the back surface of the belt so that the belt can be reinstalled in the same direction.
(2) Place the exhaust camshaft sprocket in a position where the timing mark for No. 1 cylinder is positioned about one tooth before the top dead center of the compression stroke.



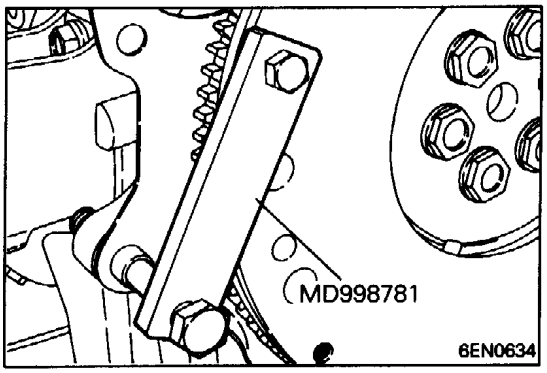
Caution
The camshaft sprocket on the exhaust side can turn very easily because of the valve spring tension. Use care not to allow your fingers to get caught by the sprocket.

(3) Loosen the lock nut of the tensioner pulley, then remove the timing belt.



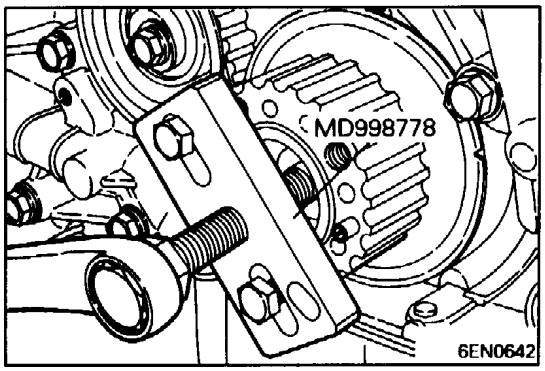
◀B▶ OIL PUMP SPROCKET REMOVAL

(1) Remove the plug on the left side of cylinder block.
(2) Insert a screwdriver (shank diameter 8 mm) to block the counterbalance shaft.
(3) Remove the nut.
(4) Remove the oil pump sprocket.



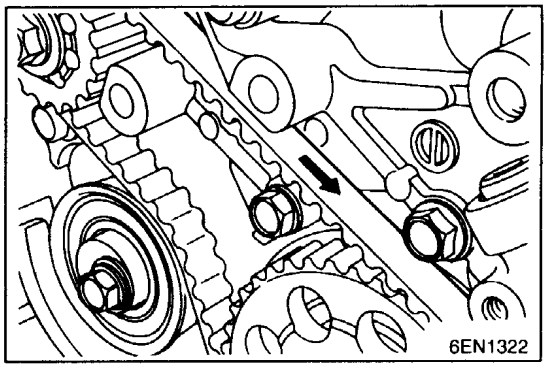
◀C▶ CRANKSHAFT BOLT LOOSENING

(1) Hold the drive plate with the special tool as shown.
(2) Remove the crankshaft bolt.



◀D▶ CRANKSHAFT SPROCKET REMOVAL

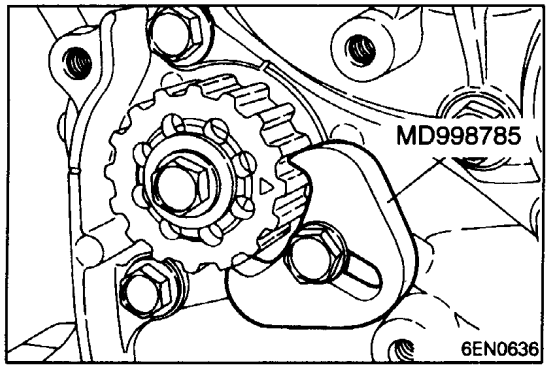
If it is difficult to remove the sprocket, use the special tool.



◀E▶ TIMING BELT "B" REMOVAL

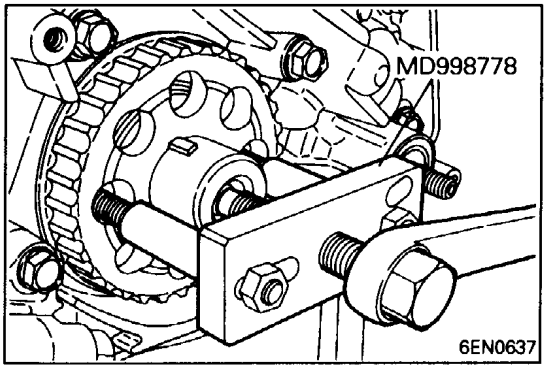
Make a mark on the back of the timing belt indicating the direction of rotation so it may be reassembled in the same direction if it is to be reused.

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



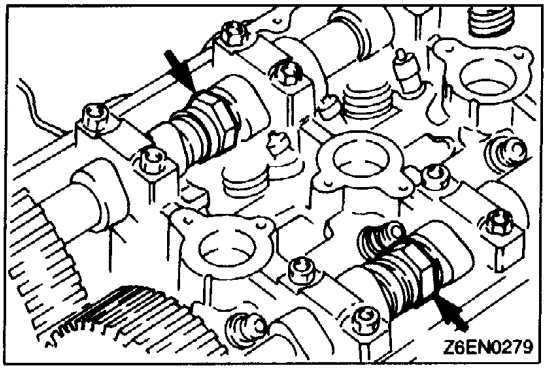
◀F▶ COUNTERBALANCE SHAFT SPROCKET REMOVAL

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



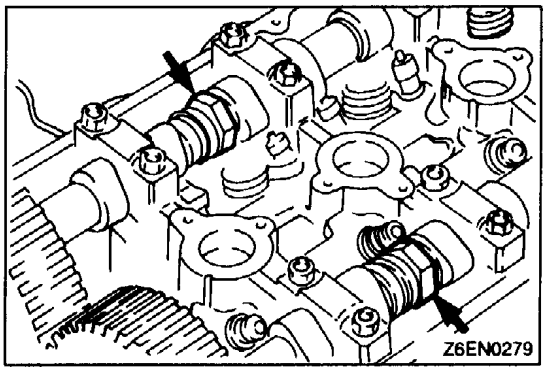
◀G▶ CRANKSHAFT SPROCKET "B" REMOVAL

If it is difficult to remove the sprocket, use the special tool.



◀H▶ CAMSHAFT SPROCKET BOLT LOOSENING

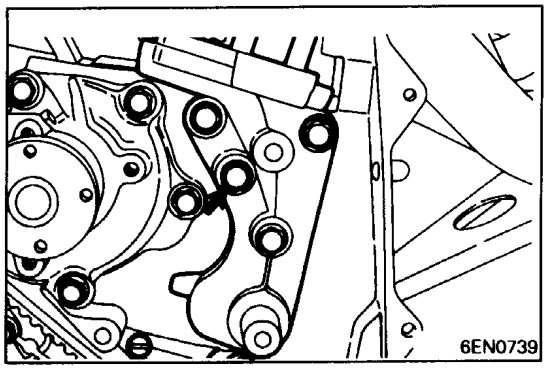
Use a wrench to hold the hexagonal part of the camshaft, and then remove the camshaft sprocket mounting bolt.



INSTALLATION SERVICE POINTS

▶A◀ CAMSHAFT SPROCKET BOLT TIGHTENING

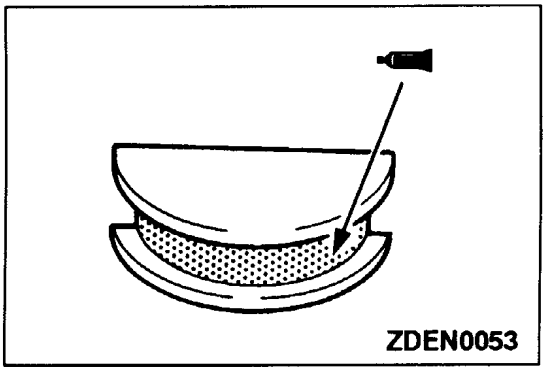
Using a wrench, hold the camshaft at its hexagon and tighten the bolt to the specification.



▶B◀ ENGINE SUPPORT BRACKET INSTALLATION

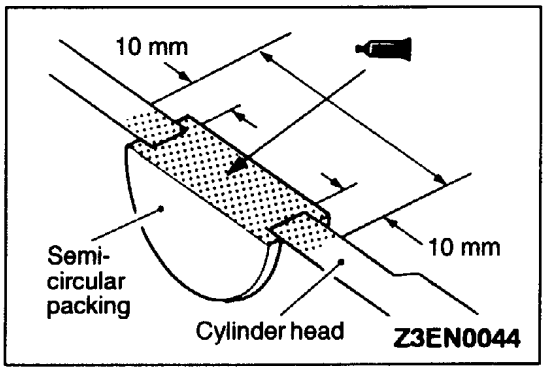
Coat the bolts illustrated with sealant before tightening.

Specified sealant: 3M™ AAD Part No. 8672 or equivalent



▶C◀ SEALANT APPLICATION TO SEMI-CIRCULAR PACKING

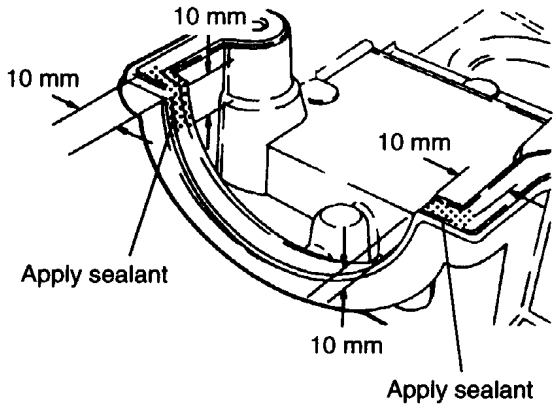
Specified sealant: 3M™ AAD Part No. 8672 or equivalent

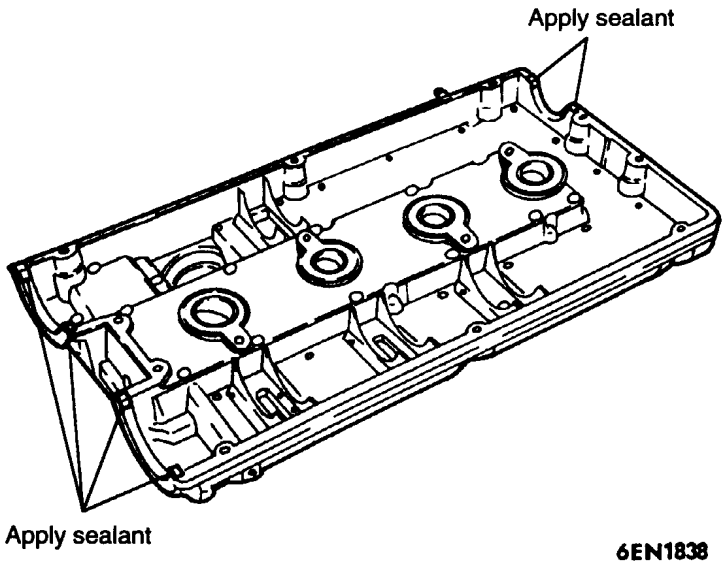


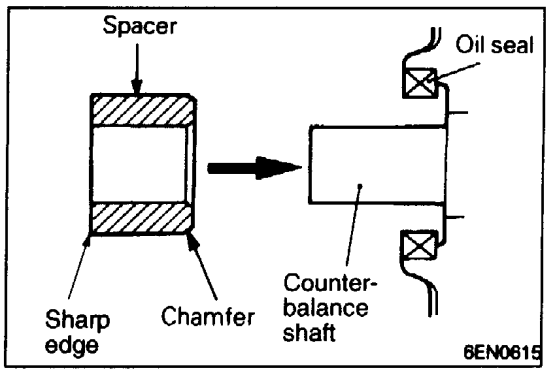
▶D◀ SEALANT APPLICATION TO ROCKER COVER

Apply sealant to the areas indicated in the illustration.

Specified sealant: 3M™ AAD Part No. 8672 or equivalent

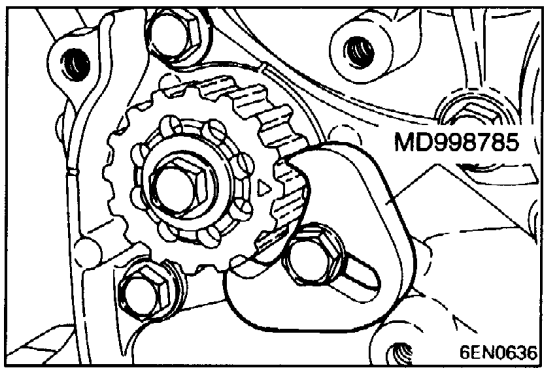






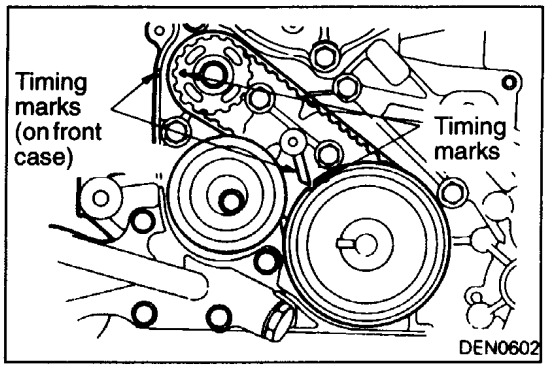
▶E◀ SPACER INSTALLATION

Install the spacer with the chamfered end toward the oil seal.



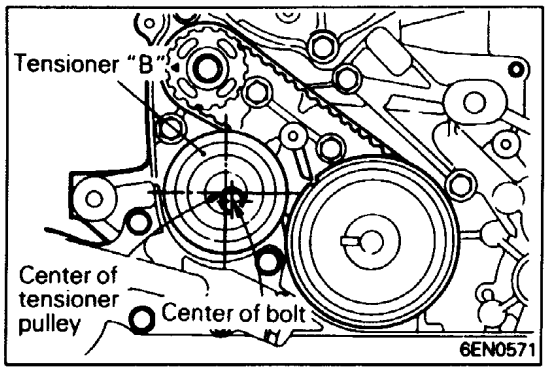
▶F◀ COUNTERBALANCE SHAFT SPROCKET INSTALLATION

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

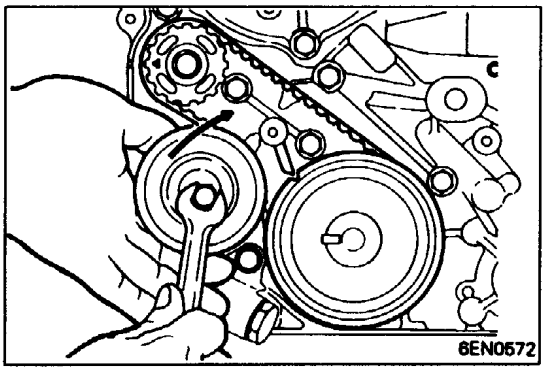


▶G◀TIMING BELT "B" INSTALLATION

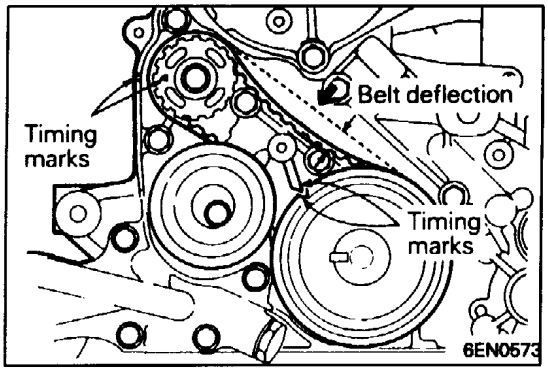
(1) Align timing marks on the crankshaft sprocket "B" and counterbalance shaft sprocket with the marks on the front case respectively.
(2) Install the timing belt "B" on the crankshaft sprocket "B" and counterbalance shaft sprocket. There should be no slack on the tension side.



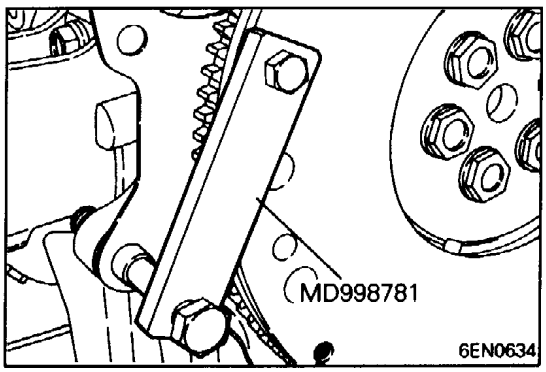
(3) Make sure that the relationship between the tensioner pulley center and the bolt center is as shown in the illustration.



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

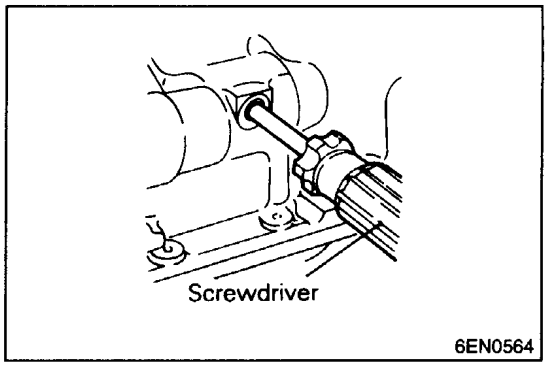


(5) Check to ensure that timing marks on sprockets and front case are in alignment.
(6) Press with index finger the center of span on the tension side of timing belt "B". The bolt must deflect 5 – 7 mm.



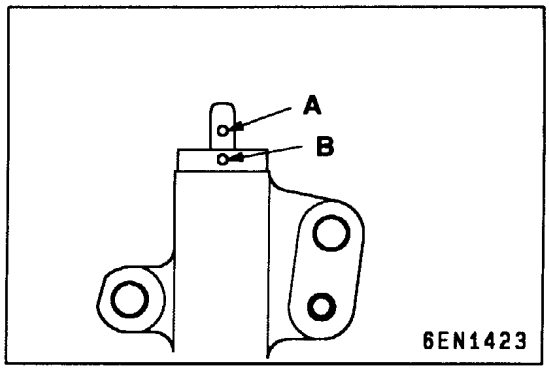
▶H◀CRANKSHAFT BOLT TIGHTENING

(1) Using the special tool, hold the flywheel or drive plate.
(2) Install the crankshaft pulley in position.



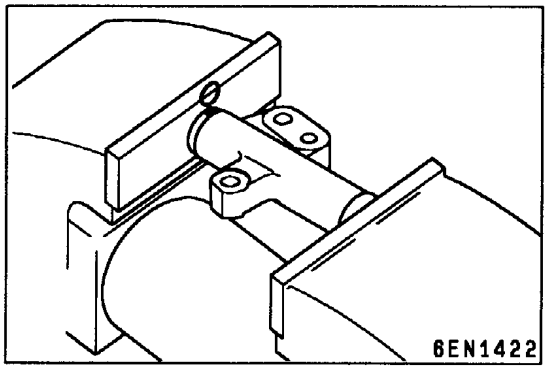
▶I◀ OIL PUMP SPROCKET INSTALLATION

(1) Insert a Phillips screwdriver (shank diameter 8 mm shaft) through the plug hole on the left side of the cylinder block to block the left counterbalance shaft.
(2) Install the oil pump sprocket.
(3) Apply a proper amount of engine oil to the bearing surfaces of the nuts.
(4) Tighten the nuts to the specified torque.

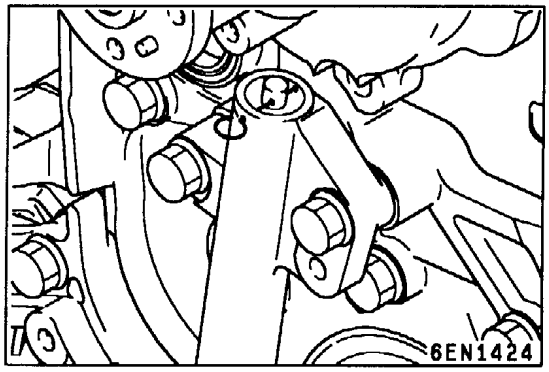


▶J◀ AUTO TENSIONER INSTALLATION

(1) If the auto tensioner rod is in its fully extended position, reset it as follows.
(2) Clamp the auto-tensioner in the vise with soft jaws.
(3) Push in the rod little by little with the vise until the set hole A in the rod is aligned with the hole B in the cylinder.

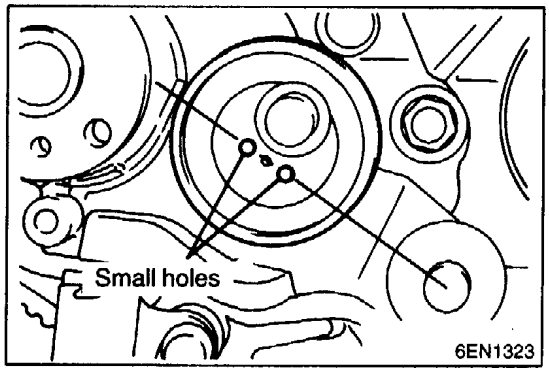


(4) Insert a wire (1.4 mm in diameter) into the set holes.
(5) Unclamp the auto tensioner from the vise.



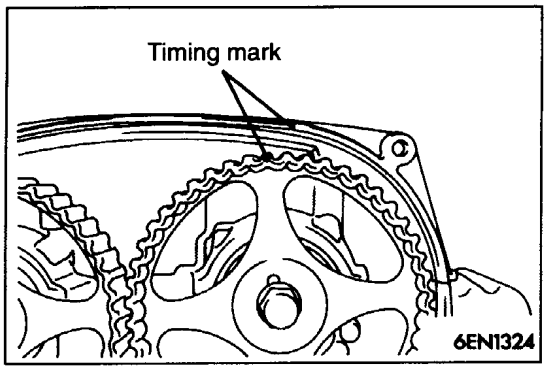
(6) Install the auto tensioner to front case and tighten to the specified torque.

Caution
Leave the wire installed in the auto tensioner.



▶K◀ TENSIONER PULLEY INSTALLATION

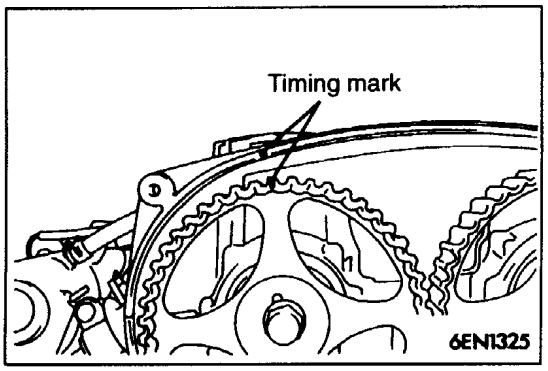
Install the tensioner pulley in such direction that its two small holes are arranged vertically.



▶L◀ TIMING BELT INSTALLATION

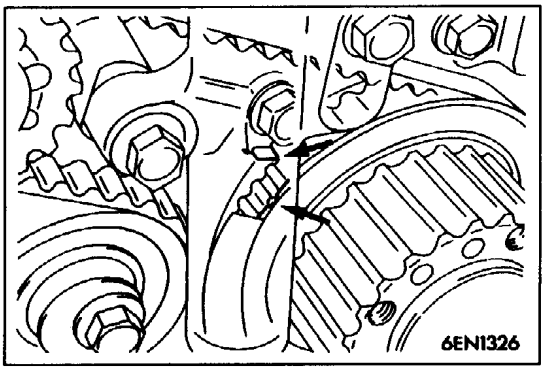
(1) Place the exhaust side camshaft sprocket in a position where its timing mark is one tooth offset from the timing mark on the rocker cover in the counterclockwise direction.

NOTE
Even if the timing marks on the sprocket and the rocker cover are brought into alignment, the exhaust camshaft is forced back by the valve spring tension. It is stabilized at a position one tooth before the timing mark.

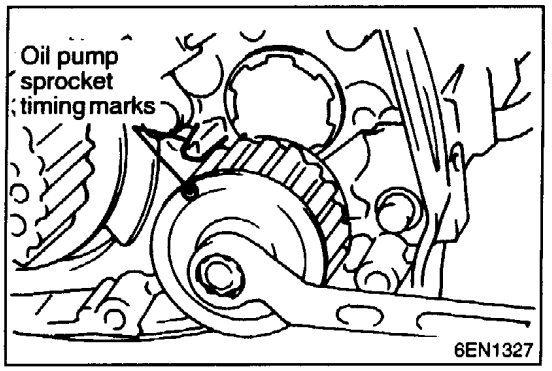


(2) Align the timing mark on the intake side camshaft sprocket with that on the rocker cover.

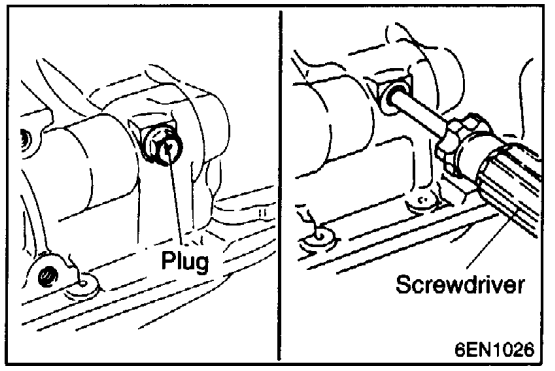
NOTE
Even if the timing marks on the sprocket and the cover are brought into alignment, the intake camshaft is forced to turn one tooth in the clockwise direction by the valve spring tension and stabilized there.



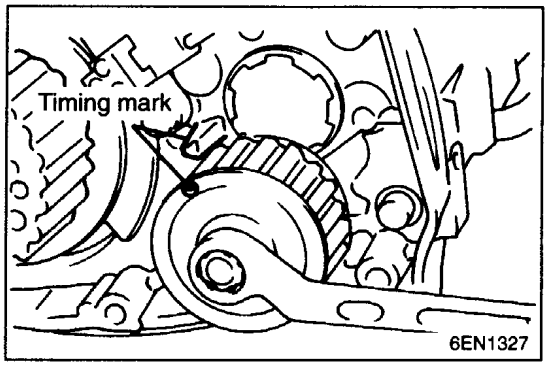
(3) Place the timing mark on the crankshaft sprocket one tooth this side from the mated timing mark as in the case of the camshaft sprocket.



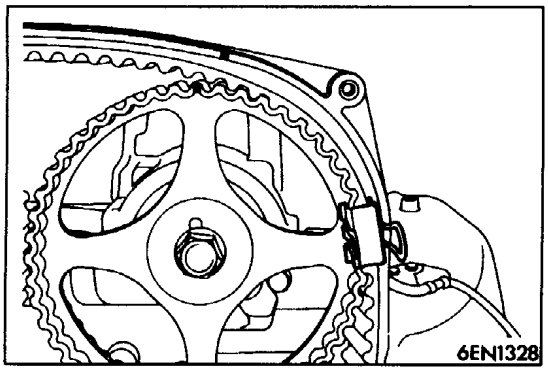
(4) Align the timing mark on oil pump sprocket with its mating mark.



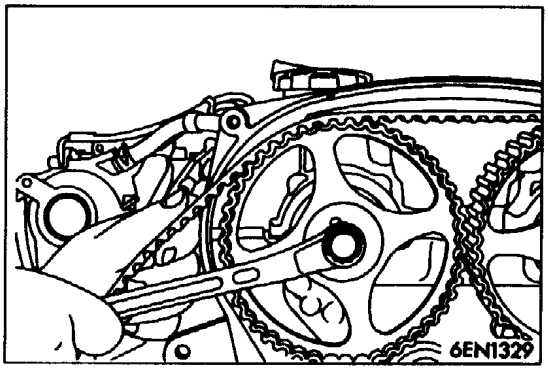
(5) Remove the plug on cylinder block and insert a Phillips screwdriver (shank diameter 8 mm) through the hole (Engine with counterbalance shafts).
If it can be inserted as deep as 60 mm or more, the timing marks are correctly aligned. If the inserted depth is only 20 – 25 mm, turn the oil pump sprocket one turn and realign timing marks. Then check to ensure that the screwdriver can be inserted 60 mm or more. Keep the screwdriver inserted until installation of timing belt is finished.



(6) Remove the Phillips screwdriver. Place the oil pump sprocket in a position where its timing mark is one tooth offset from the mated timing mark in the counterclockwise direction.

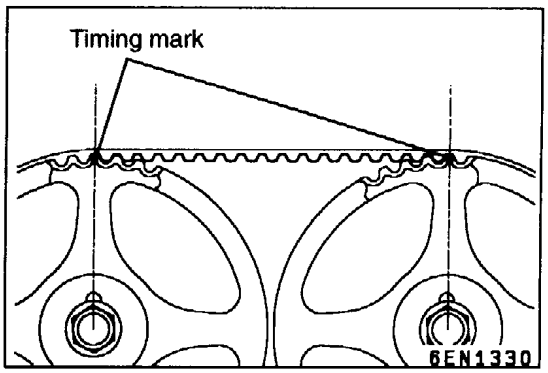


(7) Fit the timing belt over the exhaust side camshaft sprocket, and secure it at the illustrated position using a paper clip.



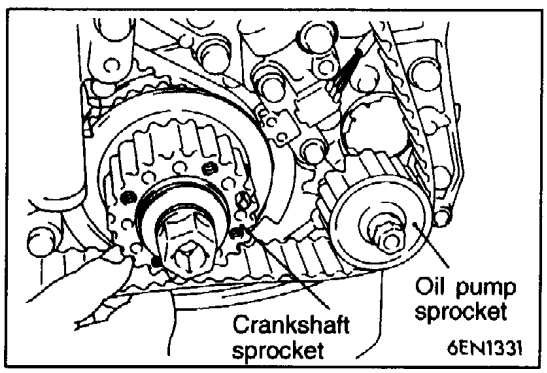
(8) Turn the intake side camshaft sprocket as shown to a position where its timing mark is one tooth offset from the mated timing mark in the counterclockwise direction. Then, fit the timing belt over the sprocket and secure it with a paper clip.

NOTE
The intake camshaft will be turned a little clockwise by the valve spring tension and stabilized in position even if the belt is clipped at one tooth offset position.



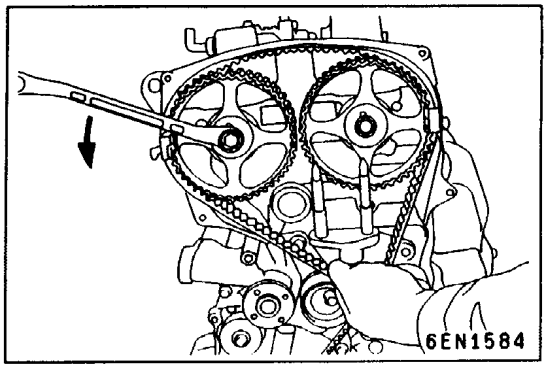
(9) Check to ensure that the timing marks on the intake camshaft sprocket side are in alignment when the exhaust camshaft sprocket is turned clockwise to align the timing marks.

NOTE
The timing belt span between the intake and exhaust sprockets will have 17 cogs.



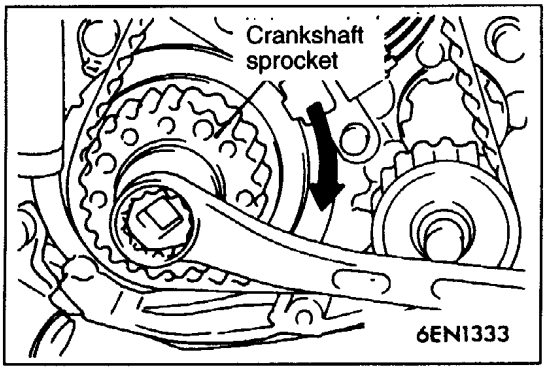
(10) Fit the timing belt over the idler pulley, oil pump sprocket and crankshaft sprocket in this order.

NOTE
Be careful that the belt does not become slack.



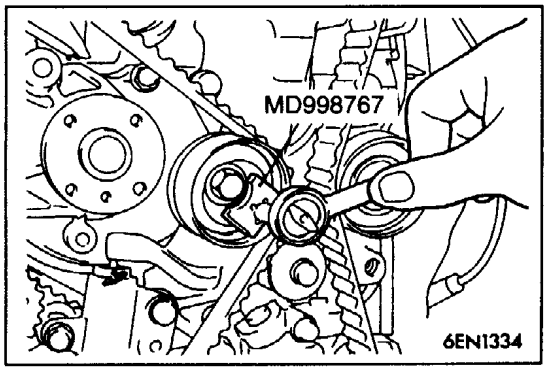
(11) Fit the timing belt over the tensioner pulley.

NOTE
When fitting the timing belt over the tensioner pulley, turn the intake side camshaft sprocket a little counterclockwise, as this will facilitate the work.



(12) Turn the crankshaft pulley a little in the illustrated direction to pull up the timing belt at the idler pulley side.

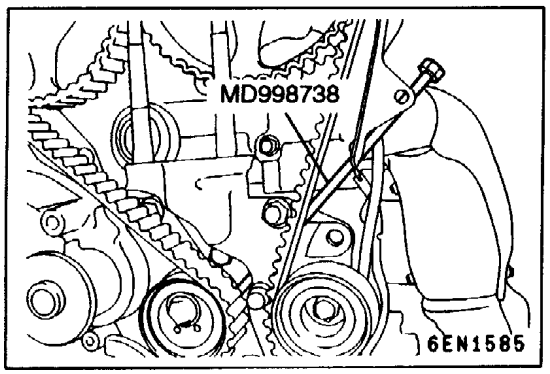
(13) Check to ensure that the timing marks on the crankshaft sprocket, oil pump sprocket and exhaust camshaft sprocket are all offset one tooth from the corresponding timing marks in the counterclockwise direction.



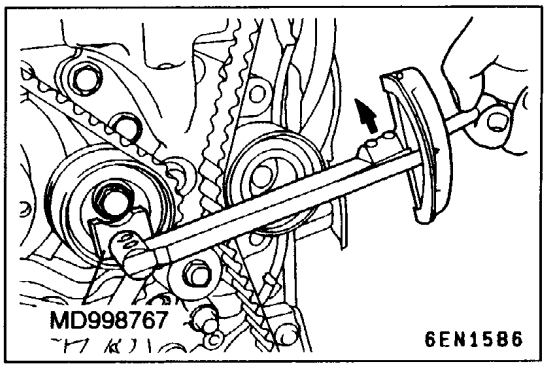
(14) Using the special tool, turn the tensioner pulley in the illustrated direction to strain the timing belt. Then, secure the tensioner temporarily by tightening the retaining bolt lightly.

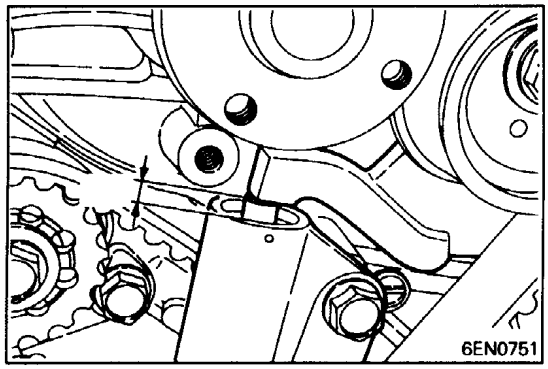
NOTE
There must be no slack in the timing belt between the intake and exhaust camshafts.

(15) Turn the crankshaft to align the timing mark with the mark for No. 1 cylinder top dead center in the compression stroke.



(16) Set the special tool as shown and screw it in up to the position where the wire inserted in the auto-tensioner when installing it can be moved lightly.





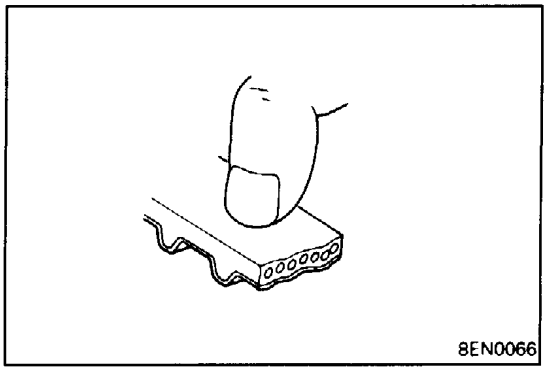
(17)Loosen the retaining bolt of the tensioner pulley.

Caution
Loosening the retaining bolt can cause the intake and exhaust camshafts to turn, resulting in slackened timing belt. Use care that the timing belt does not come off the sprockets at this time.

(18)Pull up the slack of the timing belt by turning the tensioner in illustrated direction using the special tool and a torque wrench (0 – 5 Nm).
(19)From this position, turn back the tensioner until the torque wrench reading becomes 3.5 Nm, then secure it by tightening the retaining bolt.
(20)Remove the special tool attached in step (16).
(21)Rotate the crankshaft clockwise 2 turns. Then, leave it intact 15 minutes.
(22)Check to see that the wire inserted when installing the auto-tensioner can be pulled out lightly. If it can be pulled out lightly, the timing belt is being tensioned properly. If so, remove the wire. In addition, check that the rod protrusion from the auto-tensioner meets the standard value, which is also an indication of properly tensioned timing belt.

Standard value: 3.8 – 4.5 mm

(23)If the wire cannot be removed with a light force, repeat steps (16) through (21) until the proper belt tensioner is obtained.

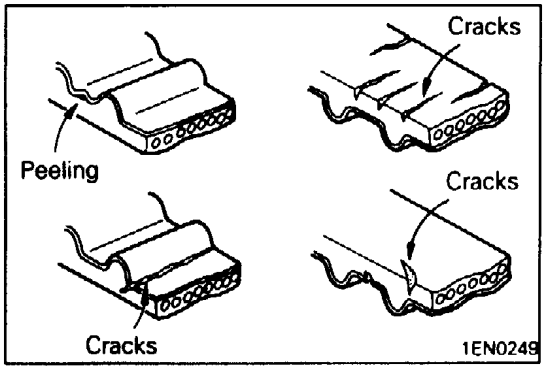


INSPECTION

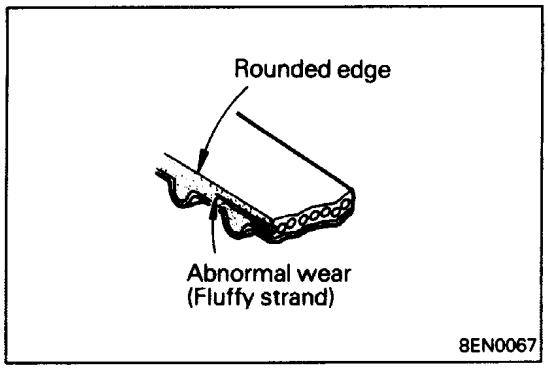
TIMING BELT

Replace belt if any of the following conditions exist.

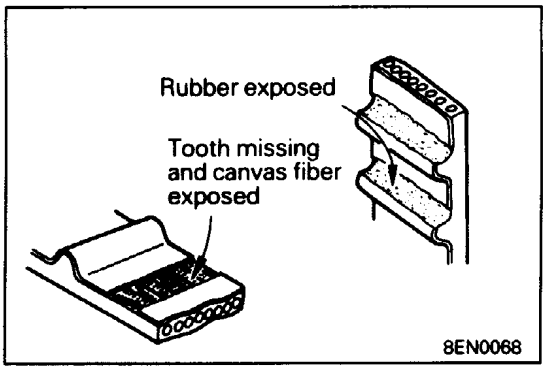
(1) Hardening of back rubber.
Back side is glossy without resilience and leaves no indent when pressed with fingernail.



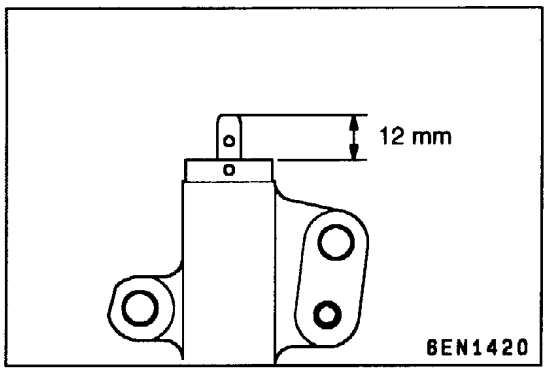
(2) Cracks on rubber back.
(3) Cracks or peeling of canvas.
(4) Cracks on rib root.
(5) Cracks on belt sides.



(6) Abnormal wear of belt sides. The sides are normal if they are sharp as if cut by a knife.



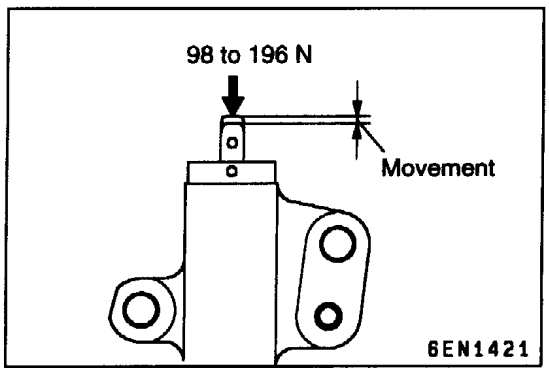
(7) Abnormal wear on teeth.
(8) Missing tooth.



AUTO TENSIONER

(1) Check the auto tensioner for possible leaks and replace as necessary.
(2) Check the rod end for wear or damage and replace as necessary.
(3) Measure the rod protrusion. If it is out of specification, replace the auto tensioner.

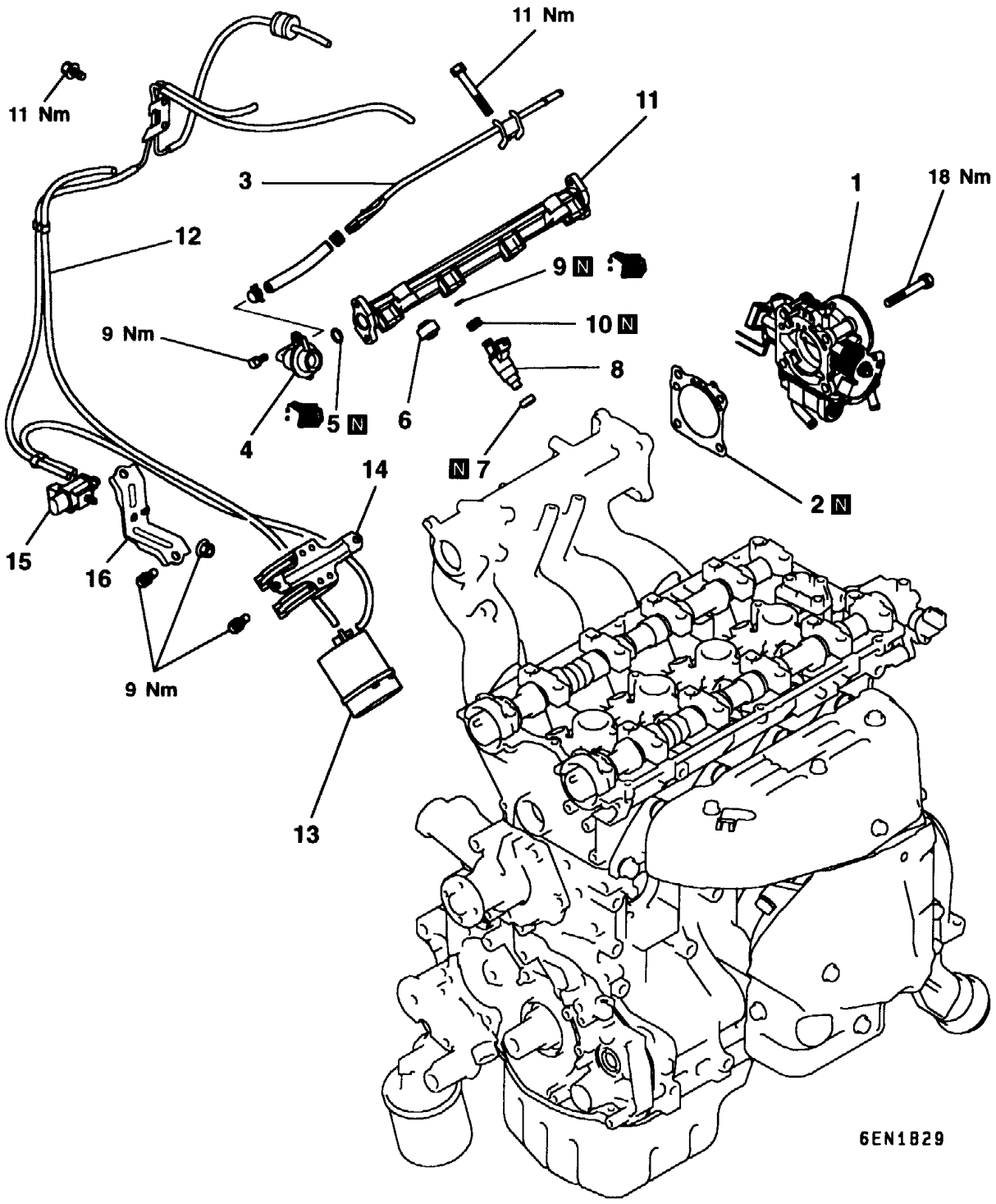
Standard value: 12 mm



(4) Press the rod with a force of 98 to 196 N and measure its protrusion.
(5) If the measured value is 1 mm or more shorter than the value obtained in step (3), replace the auto tensioner.

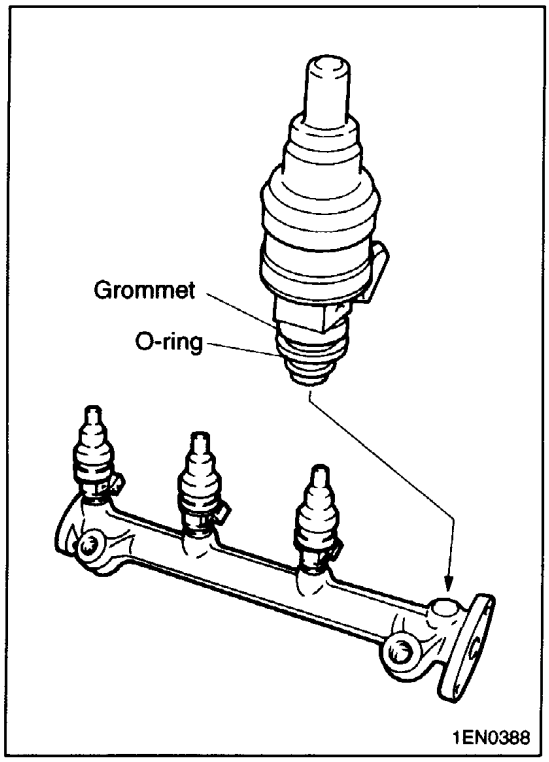
FUEL AND EMISSION CONTROL PARTS

REMOVAL AND INSTALLATION



Removal steps

1. Throttle body
▶C◀ 2. Throttle body gasket
3. Fuel return pipe
▶B◀ 4. Fuel pressure regulator
5. O-ring
6. Insulator
7. Insulator
▶A◀ 8. Injector
9. O-ring
10. Grommet
11. Delivery pipe
12. Vacuum hose and vacuum pipe
13. Vacuum tank
14. Vacuum tank bracket
15. Solenoid valve
16. Solenoid valve bracket



INSTALLATION SERVICE POINTS

▶A◀ INJECTORS INSTALLATION

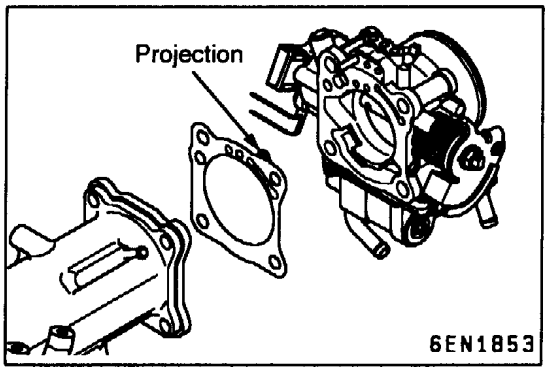
(1) Before installing an injector, the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.
(2) Install injector top end. Be careful not to damage O-ring during installation.

▶B◀ FUEL PRESSURE REGULATOR INSTALLATION

(1) Apply a small amount of new engine oil to the O-ring. Insert the fuel pressure regulator into the delivery pipe being careful not to damage the O-ring.

Caution
Be sure not to let engine oil get into the delivery pipe.

(2) Check that the fuel pressure regulator turns smoothly. If it does not turn smoothly, the O-ring may be trapped. Remove the fuel pressure regulator and check the O-ring for damage, and then re-insert it into the delivery pipe and check once again.

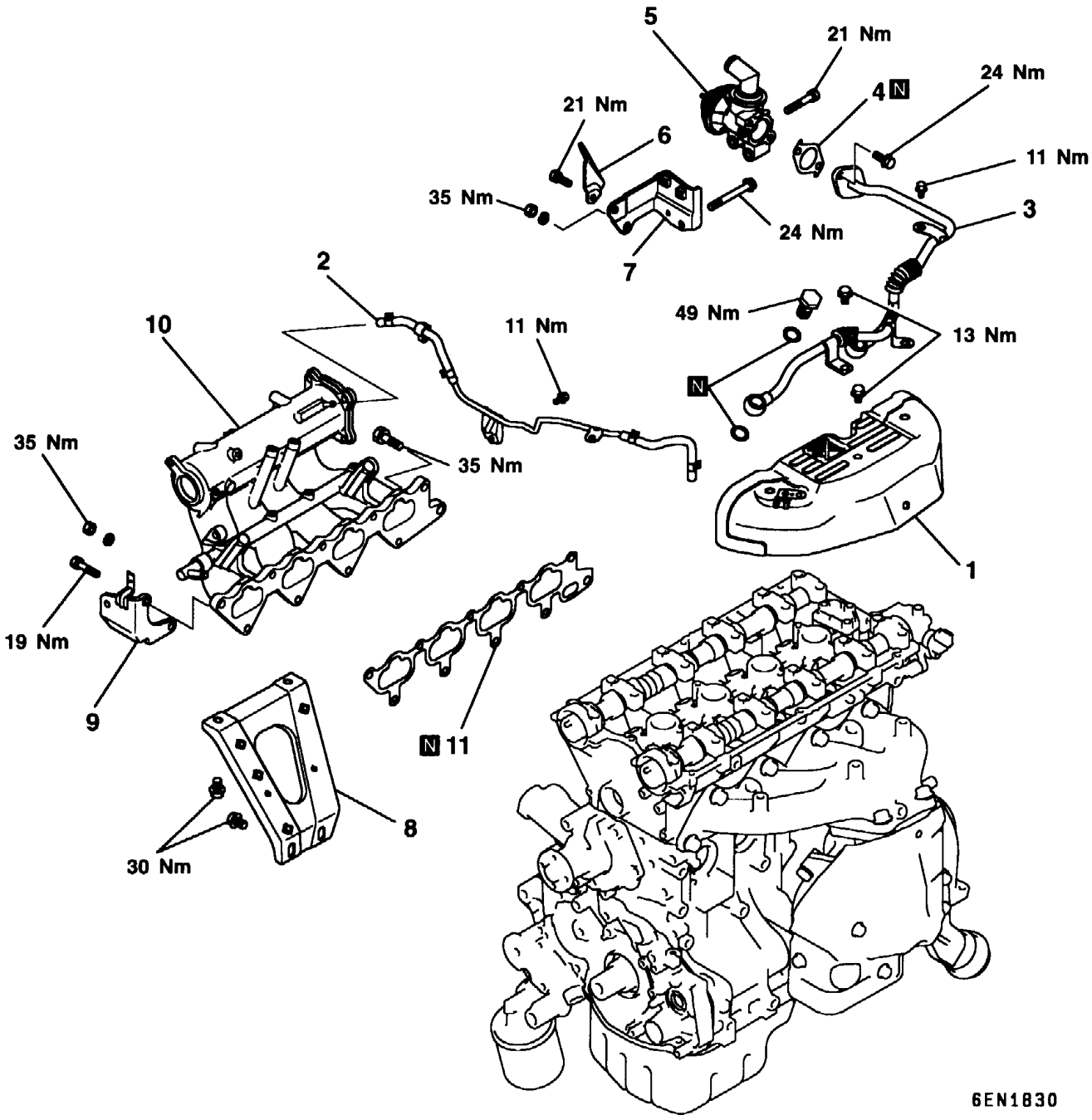


▶C◀ GASKET INSTALLATION

Position the projection as shown in the illustration.

SECONDARY AIR SYSTEM AND INTAKE MANIFOLD

REMOVAL AND INSTALLATION



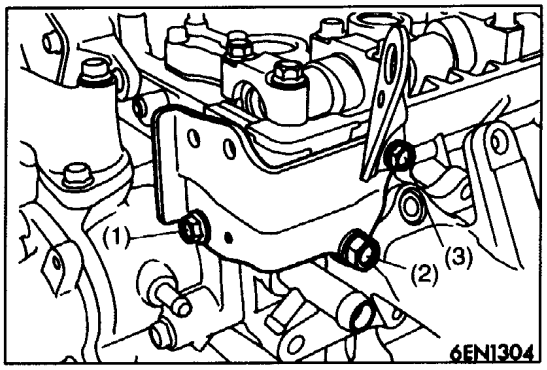
Removal steps

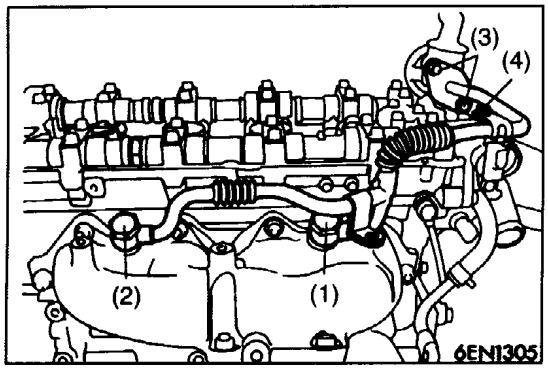
1. Exhaust manifold heat protector
2. Vacuum hose and vacuum pipe

▶B◀ 3. Air pipe assembly

4. Air control valve gasket
5. Air control valve assembly
6. Engine hanger

▶A◀ 7. Air control valve bracket
8. Intake manifold stay
9. Alternator brace stay
10. Intake manifold
11. Intake manifold gasket





INSTALLATION SERVICE POINTS

▶A◀ AIR CONTROL VALVE BRACKET INSTALLATION

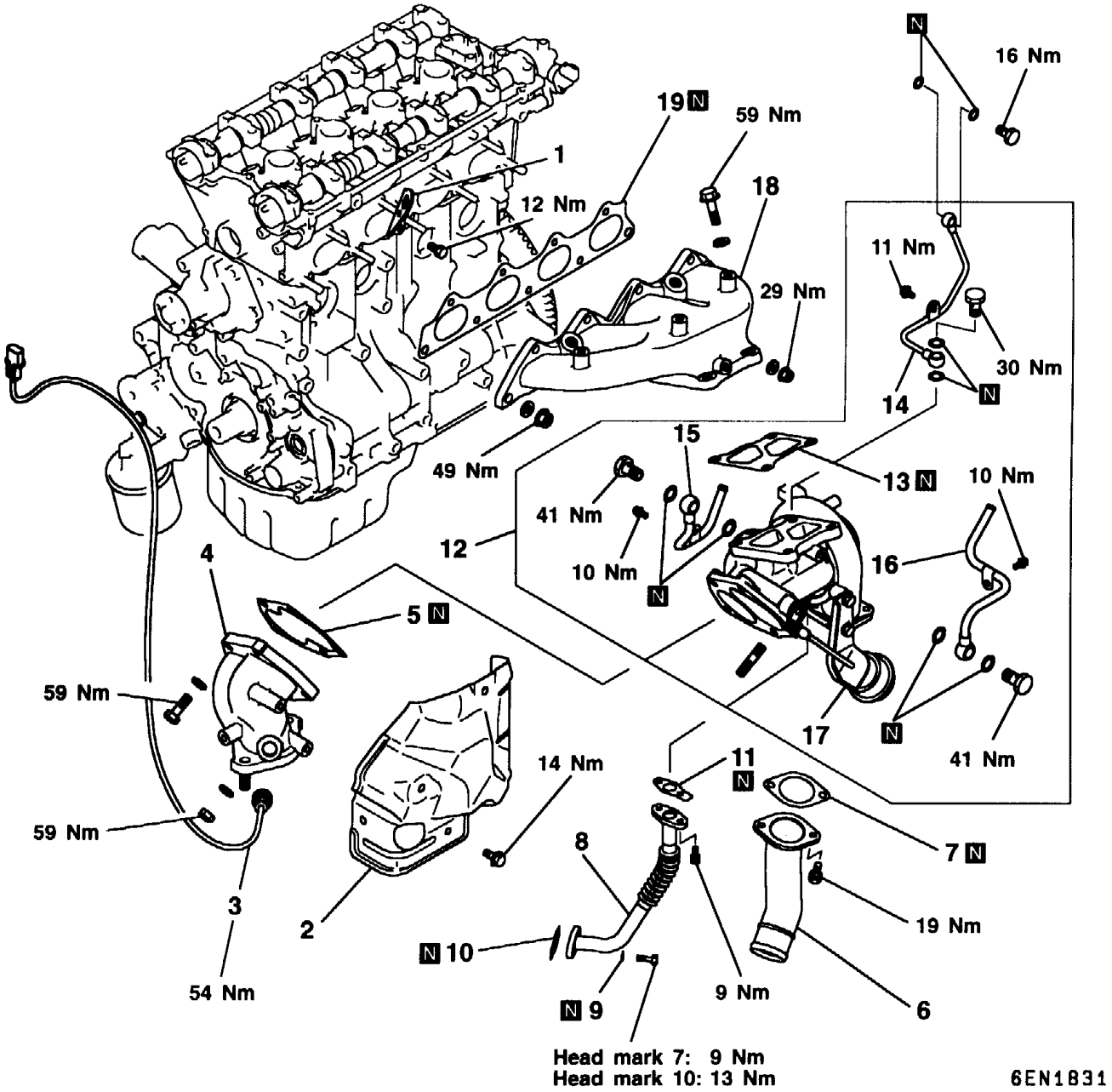
(1) Attach the air control valve bracket and the engine hanger to the intake manifold using bolts and nuts with which the intake manifold is also installed to the engine.
(2) Tighten the bolts and nuts to the specified torque in the sequence given in the illustration.

▶B◀ AIR PIPE ASSEMBLY INSTALLATION

(1) Install the air pipe assembly to the exhaust manifold and to the air control valve and secure it provisionally by tightening the fasteners handtight.
(2) Tighten the fasteners to the specified torque in the sequence given in the illustration.

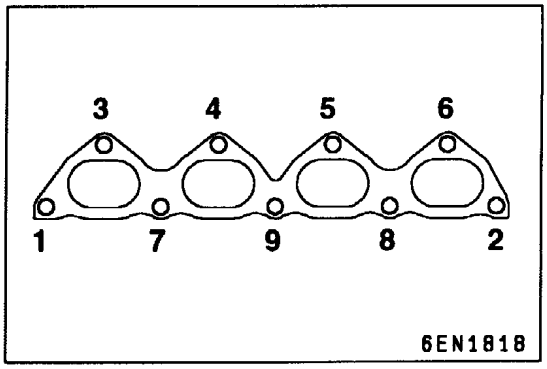
EXHAUST MANIFOLD

REMOVAL AND INSTALLATION



Removal steps

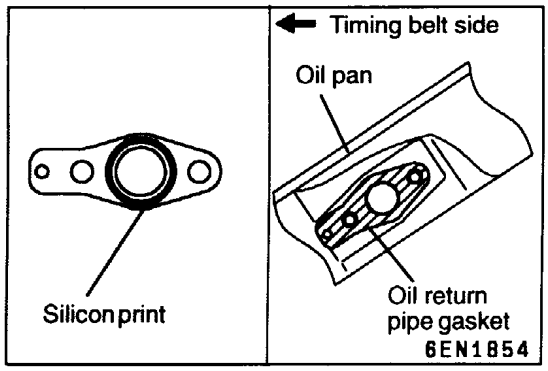
1. Engine hanger
2. Turbocharger heat protector
3. Oxygen sensor
4. Exhaust fitting
5. Exhaust fitting gasket
6. Air outlet fitting
- ▶C◀ 7. Air outlet fitting gasket
8. Oil return pipe
- ▶B◀ 9. Gasket
- ▶B◀ 10. Oil return pipe gasket (Oil pan side)
11. Oil return pipe gasket (Turbocharger side)
12. Turbocharger assembly
13. Turbocharger gasket
14. Oil pipe
15. Water pipe
16. Water pipe
17. Turbocharger
- ▶A◀ 18. Exhaust manifold
19. Exhaust manifold gasket



INSTALLATION SERVICE POINTS

▶A◀ EXHAUST MANIFOLD INSTALLATION

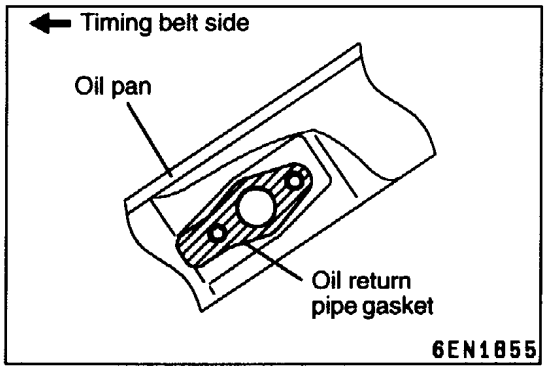
Tighten the exhaust manifold mounting nuts to the specified torque in the sequence given in the illustration.



▶B◀ GASKET / OIL RETURN GASKET INSTALLATION

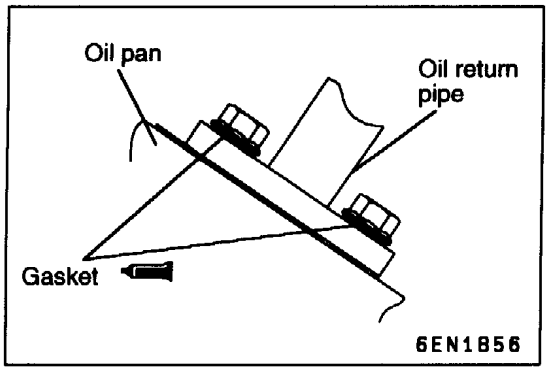
EVOLUTION IV AND V

Install the gasket with the silicon-printed side toward the oil pan and with the tabbed end directed as shown.



EVOLUTION VI

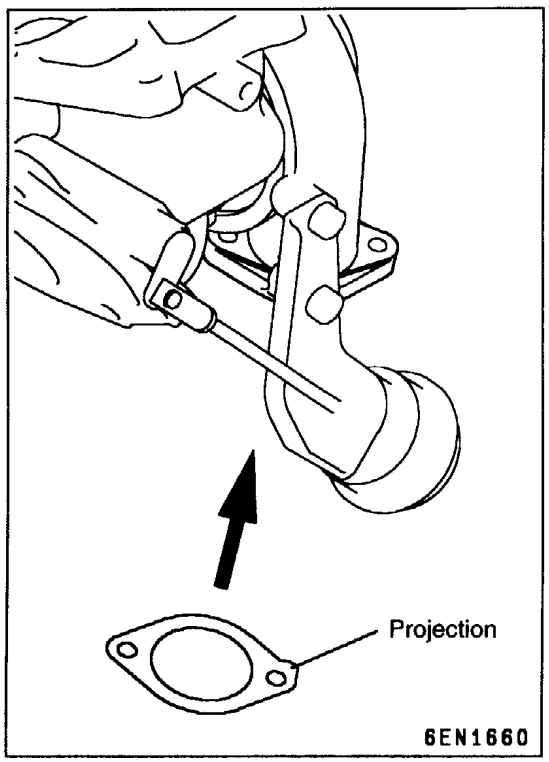
(1) Install the gasket with the tabbed end directed as shown.



(2) Apply sealant to both sides of the oil return pipe gasket and leave it for 20 minutes to dry before installing. Tighten the mounting bolts to the specified torque.

Specified sealant:
3M™ AAD Part No. 8731 or equivalent

NOTE
If mounting bolts with head mark 7 have been used, be sure to replace them with bolts having head mark 10.

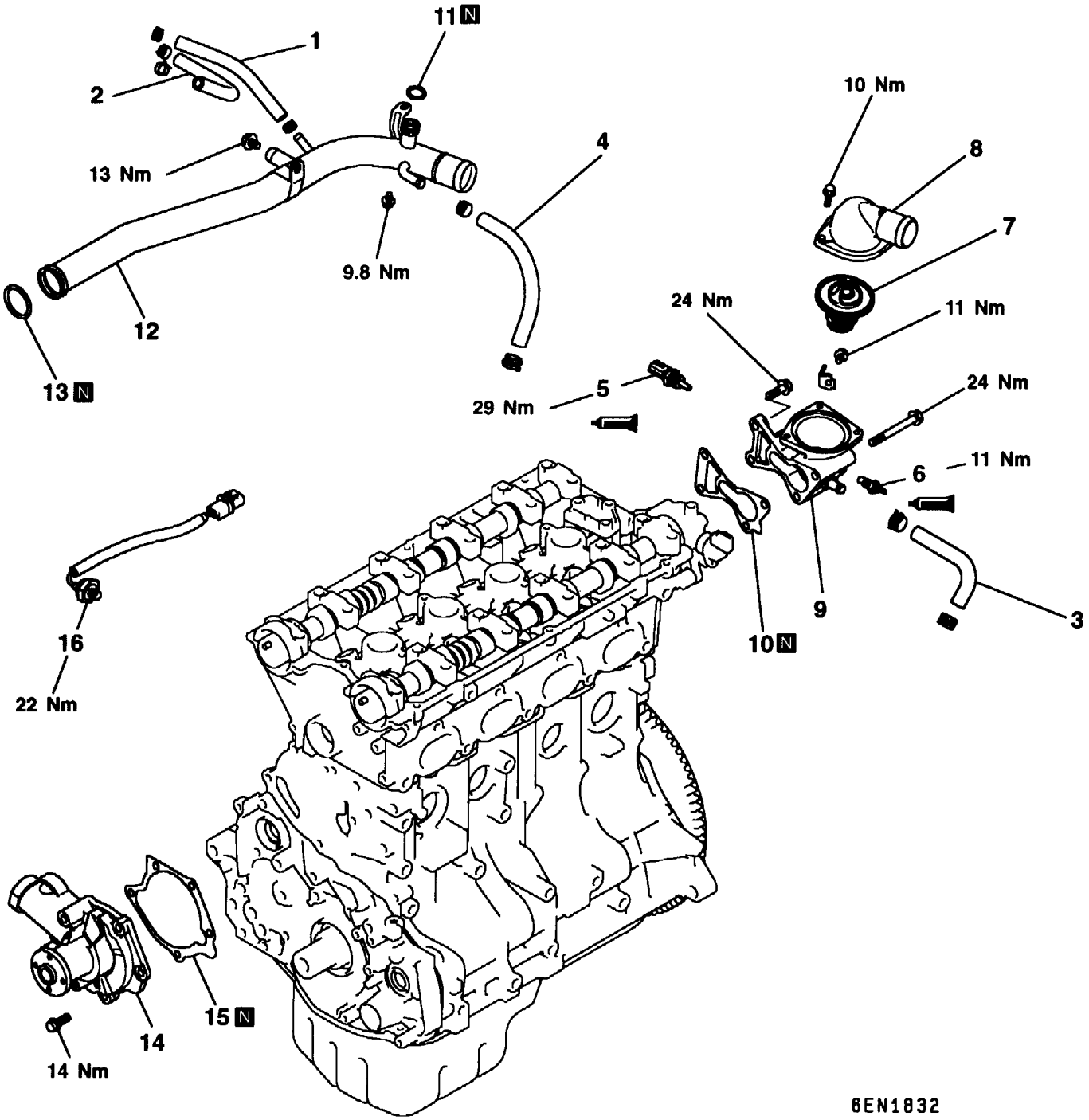


▶C◀ GASKET INSTALLATION

Position the projection as shown in the illustration.

WATER PUMP AND WATER HOSE

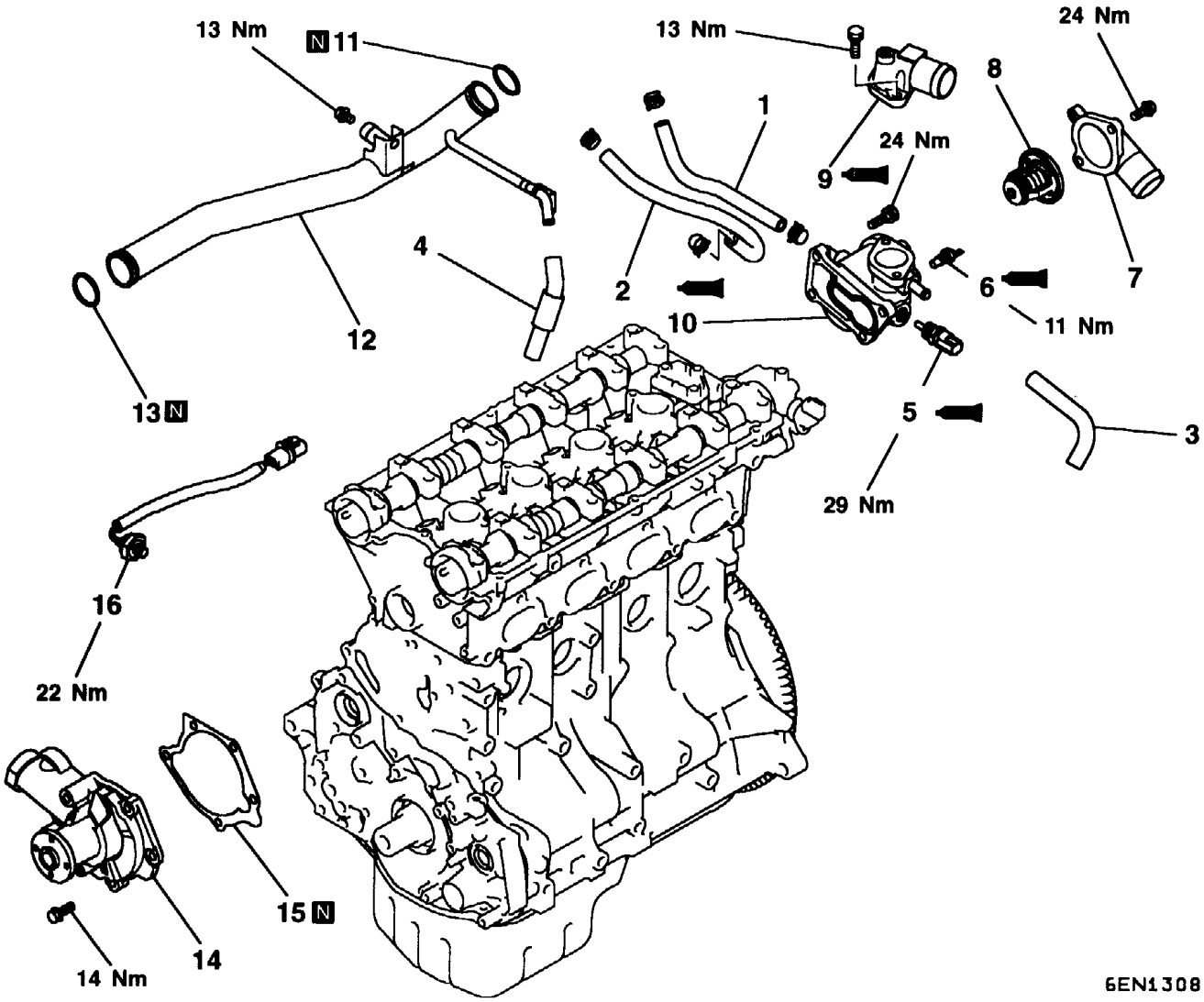
REMOVAL AND INSTALLATION <EVOLUTION VI>



Removal steps

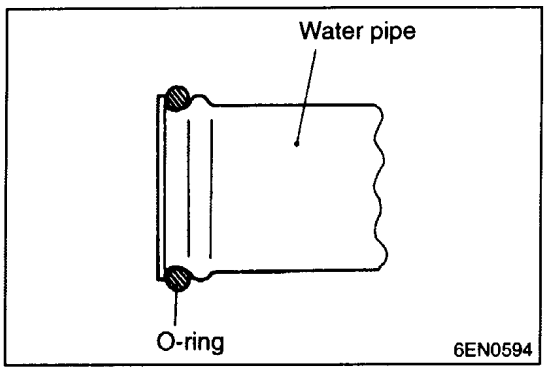
1. Water hose
2. Water hose
3. Water hose
4. Water hose
▶E◀ 5. Water temperature sensor
▶D◀ 6. Water temperature gauge unit
7. Thermostat
8. Water outlet fitting
9. Thermostat housing
10. Thermostat housing gasket
▶A◀ 11. O-ring
▶A◀ 12. Water inlet pipe
▶A◀ 13. O-ring
14. Water pump
15. Water pump gasket
16. Knock sensor

REMOVAL AND INSTALLATION <EVOLUTION IV or V>



Removal steps

1. Water hose
2. Water hose
3. Water hose
4. Water hose
▶E◀ 5. Water temperature sensor
▶D◀ 6. Water temperature gauge unit
7. Water inlet fitting
8. Thermostat
▶C◀ 9. Water outlet fitting
▶B◀ 10. Thermostat housing
▶A◀ 11. O-ring
▶A◀ 12. Water inlet pipe
▶A◀ 13. O-ring
14. Water pump
15. Water pump gasket
16. Knock sensor

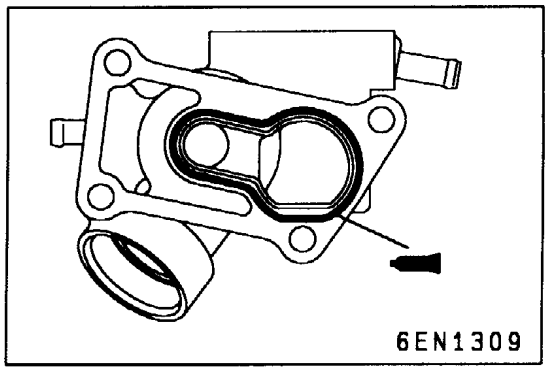


INSTALLATION SERVICE POINTS

▶A◀ WATER PIPE / O-RING INSTALLATION

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

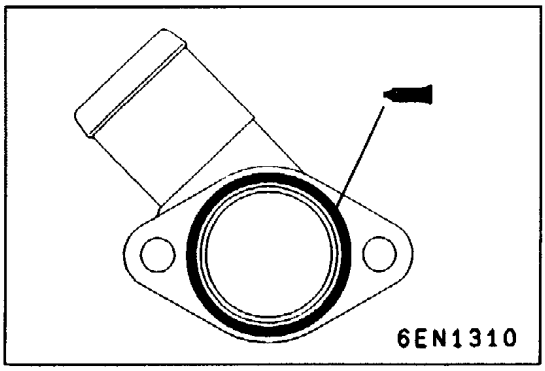
Caution
Keep the O-ring free of oil or grease.



▶B◀ THERMOSTAT HOUSING INSTALLATION

Apply 3 mm diameter of form-in-place gasket (FIPG) to the location shown in the illustration.

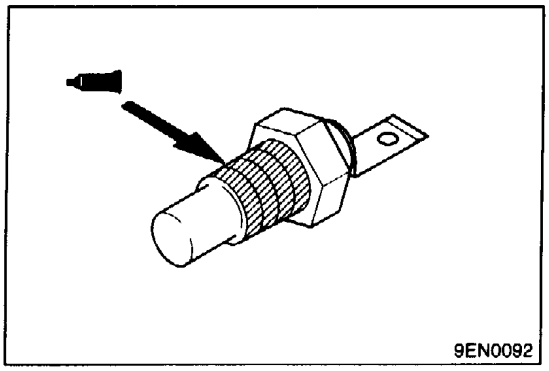
Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent



▶C◀ WATER OUTLET FITTING INSTALLATION

Apply 3 mm diameter of form-in-place gasket (FIPG) to the location shown in the illustration.

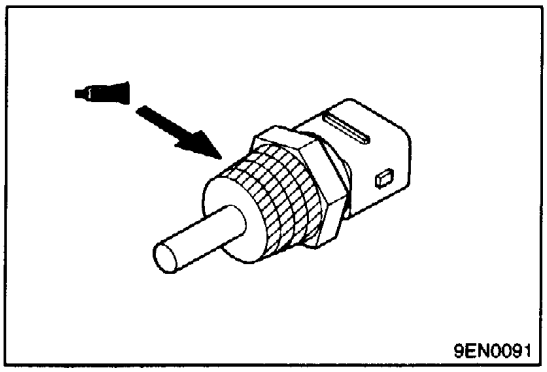
Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent



▶D◀ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE GAUGE UNIT

(1) When reusing the gauge unit, clean its thread.
(2) Apply the specified sealant to the thread.

Specified sealant:
3M™ AAD Part No. 8672 or equivalent



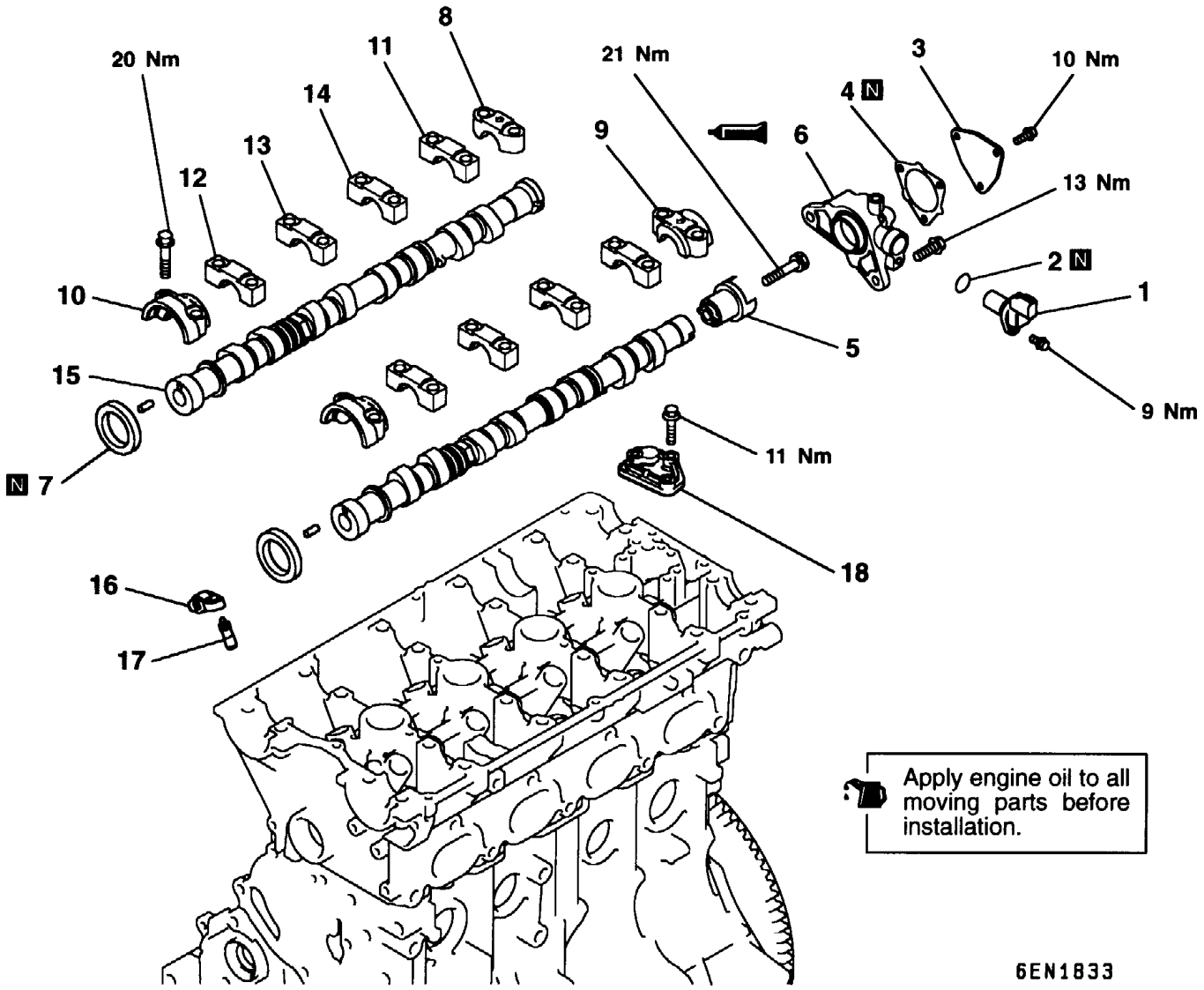
▶E◀ SEALANT APPLICATION TO ENGINE COOLANT TEMPERATURE SENSOR

(1) When reusing the sensor, clean its thread.
(2) Apply the specified sealant to the thread.

Specified sealant:
3M™ AAD Part No. 8731 or equivalent

ROCKER ARMS AND CAMSHAFT

REMOVAL AND INSTALLATION



Removal steps

1. Cam position sensor
2. O-ring
3. Cam position sensor support cover
4. Cam position sensor support gasket

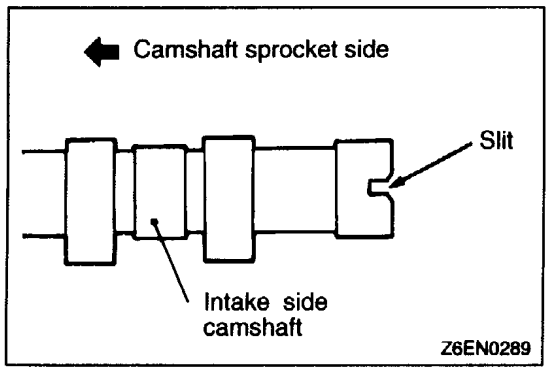
▶F◀ 5. Cam position sensing cylinder
▶E◀ 6. Cam position sensor support
▶D◀ 7. Camshaft oil seal
▶C◀ 8. Camshaft bearing cap rear right
▶C◀ 9. Camshaft bearing cap rear left
▶C◀ 10. Camshaft bearing cap front
▶C◀ 11. Camshaft bearing cap No. 5
▶C◀ 12. Camshaft bearing cap No. 2
▶C◀ 13. Camshaft bearing cap No. 3
▶C◀ 14. Camshaft bearing cap No. 4
▶B◀ 15. Camshaft
16. Rocker arm
▶A◀ 17. Lash adjuster
18. Oil delivery body

INSTALLATION SERVICE POINTS

▶A◀ LASH ADJUSTER INSTALLATION

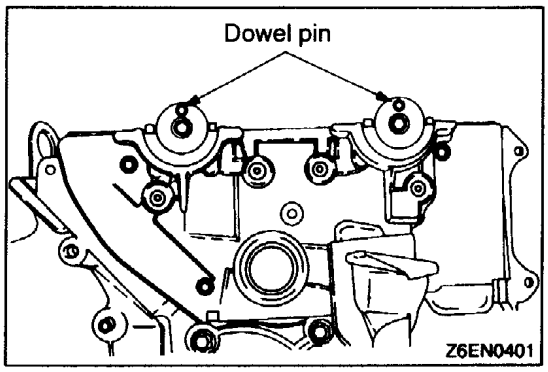
Caution
If the lash adjuster is re-used, clean the lash adjuster.

Fit the lash adjuster onto rocker arm without allowing diesel fuel to spill out.

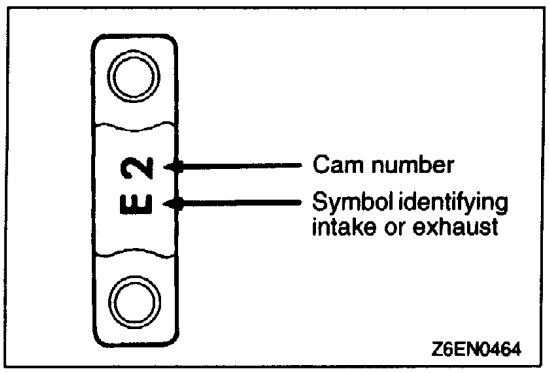


▶B◀ CAMSHAFT INSTALLATION

(1) Apply engine oil to the journals and cams of the camshafts. Install the camshafts on the cylinder head.
Use care not to confuse the intake camshaft with the exhaust one. The intake camshaft has a slit on its rear end for driving the crankshaft position sensor.

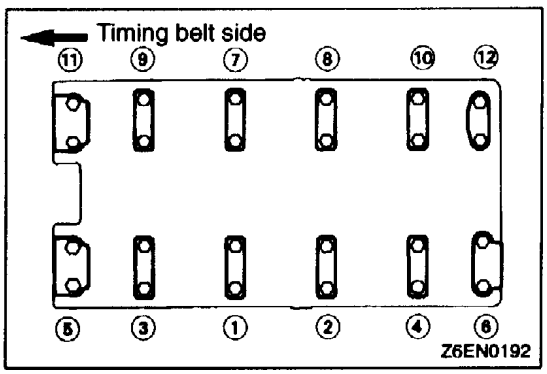


(2) Install the crankshaft sprocket B or spacer and flange to one end of the crankshaft, and turn the crankshaft until the timing marks are lined up, setting No. 1 cylinder to the TDC.
(3) Set the camshafts so that their dowel pins are positioned at top.

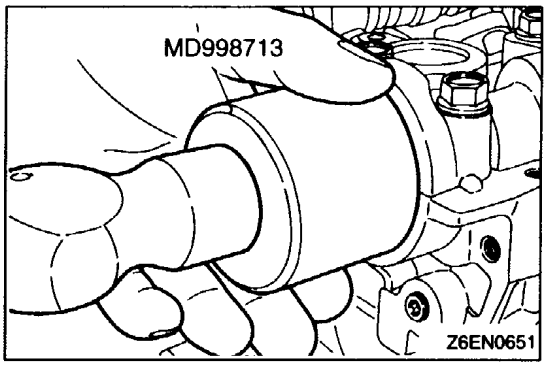


▶C◀ BEARING CAP INSTALLATION

(1) According to the identification mark stamped on the top of each bearing cap, install the caps to the cylinder head.
Only "L" or "R" is stamped on front bearing cap. Cap No. is stamped on No. 2 to No. 5 bearing caps. Rear bearing cap has no stamping.
I: For intake camshaft side
E: For exhaust camshaft side

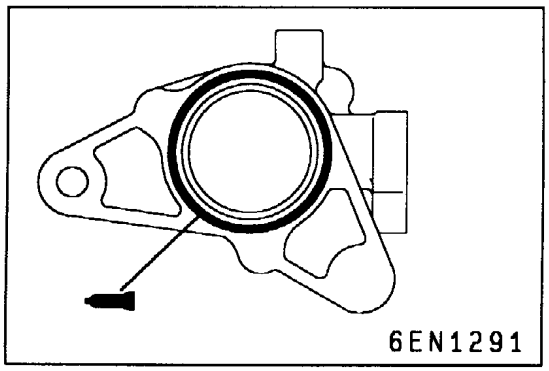


(2) Tighten the bearing caps in the order shown two to three times by torquing progressively.
Tighten to the specification in the final sequence.
(3) Check to ensure that the rocker arm is positioned correctly on the lash adjuster and valve stem end.



▶D◀ CAMSHAFT OIL SEAL INSTALLATION

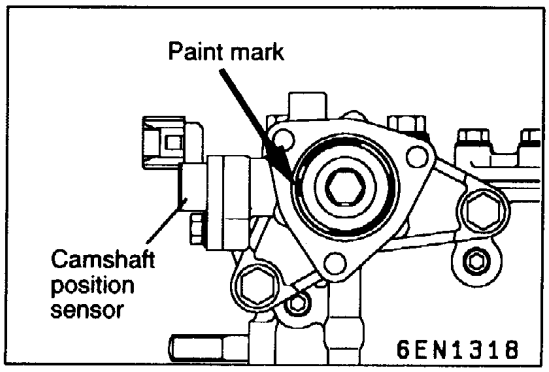
(1) Apply engine oil to lib area of the oil seal and the front end outside diameter of the camshaft.
(2) Using special tool install the camshaft oil seals.



▶E◀ CAMSHAFT POSITION SENSOR SUPPORT INSTALLATION

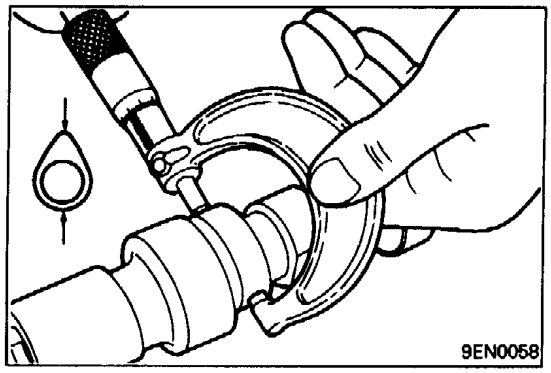
Apply 3 mm diameter of form-in-place gasket (FIPG) to the location shown in the illustration.

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent



▶F◀ CAMSHAFT POSITION SENSING CYLINDER INSTALLATION

(1) Set the No. 1 cylinder to the compression top dead center position (so that dowel pin of the exhaust camshaft is at the top).
(2) Install the camshaft position sensing cylinder so that the white paint mark is facing in the direction shown in the illustration.

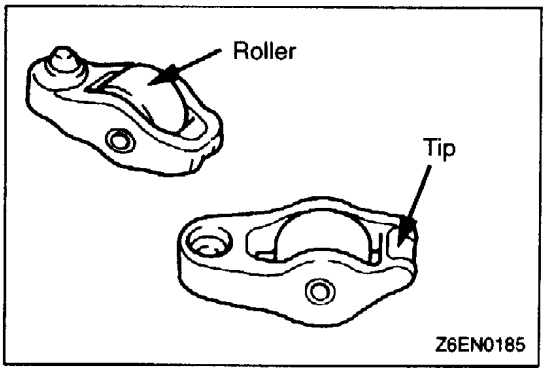


INSPECTION

CAMSHAFT

Measure the cam height.

Item	Standard value mm	Limit mm
Intake	35.79	35.29
Exhaust	35.49	34.99

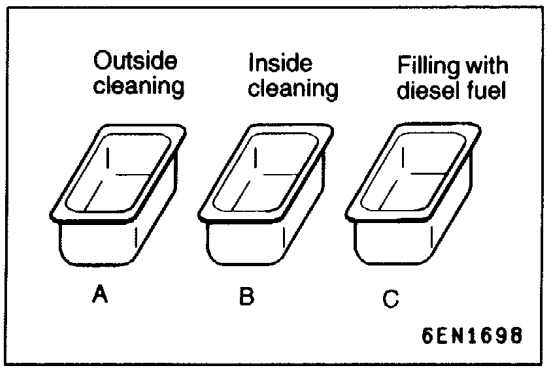


ROCKER ARM

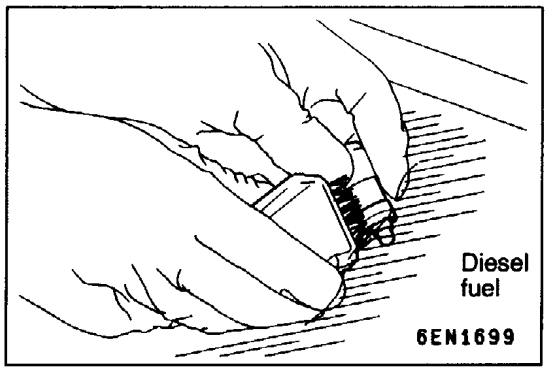
(1) Check the roller surface. If any dents, damage or seizure is evident, replace the rocker arm.
(2) Check rotation of the roller. If it does not rotate smoothly or if looseness is evident, replace the rocker arm.
(3) Check the inside diameter. If damage or seizure is evident, replace the rocker arm.

LASH ADJUSTER

Caution
(1) The lash adjusters are precision-engineered mechanisms. Do not allow them to become contaminated by dirt or other foreign substances.
(2) Do not attempt to disassemble the lash adjusters.
(3) Use only fresh diesel fuel to clean the lash adjusters.

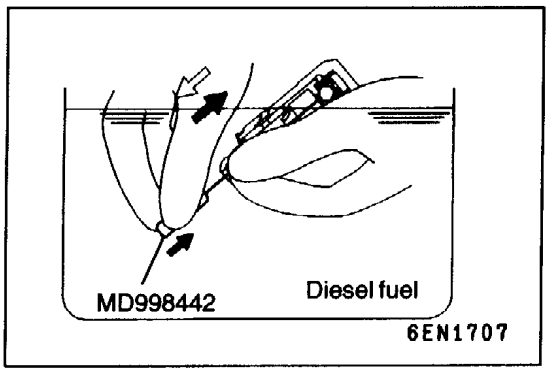


(1) Prepare three containers and approximately five liters of diesel fuel. Into each container, pour enough diesel fuel to completely cover a lash adjuster when it is standing upright. Then, perform the following steps with each lash adjuster.



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

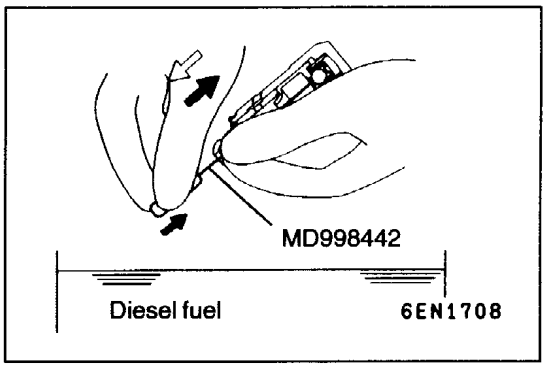
NOTE
Use a nylon brush if deposits are hard to remove.



(3) While gently pushing down the internal steel ball using wire (0.5 mm in diameter) or special tool MD998442, move the plunger through 5 to 10 strokes until it slides smoothly. In addition to eliminating stiffness in the plunger, this operation will remove dirty oil.

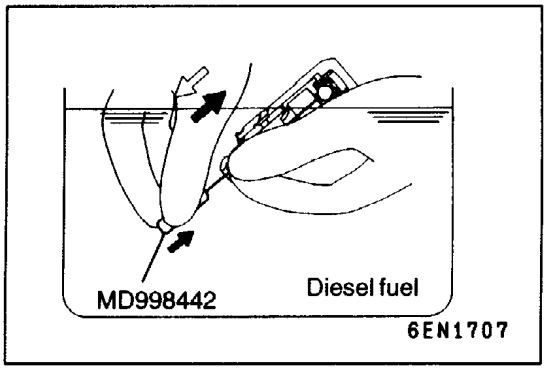
Caution
The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.

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



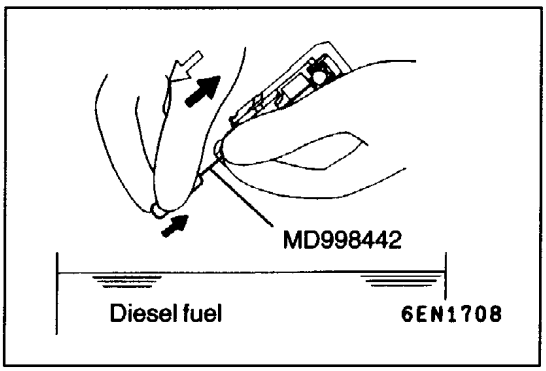
(4) Removal the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

Caution
Make sure the oil hole in the side of the body is pointing toward container A. Do not point the oil hole at yourself or other people.



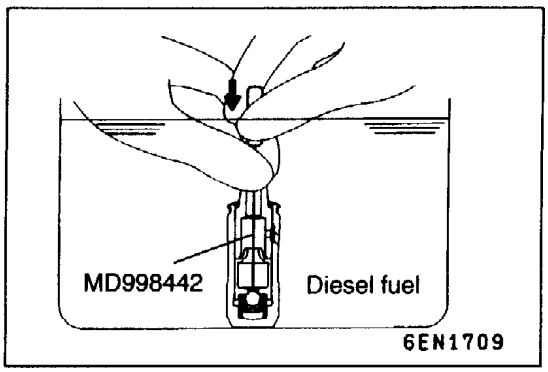
(5) Place the lash adjuster in container B. Then, gently push down the internal steel ball using wire (0.5 mm in diameter) or special tool MD998442 and move the plunger through 5 to 10 strokes until it slides smoothly. This operation will clean the lash adjuster's pressure chamber.

Caution
The steel ball spring is extremely weak, so the lash adjuster's functionality may be lost if the air bleed wire is pushed in hard.



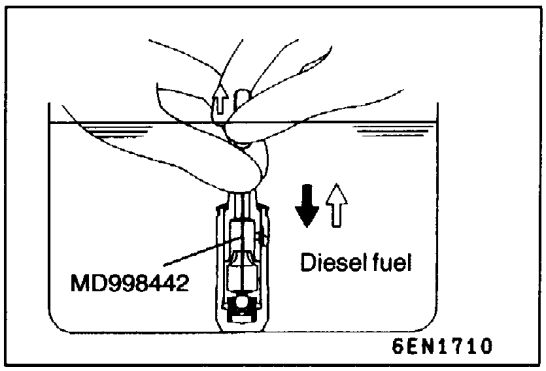
(6) Remove the lash adjuster from the container. Then, push down the steel ball gently and push the plunger to eliminate diesel fuel from the pressure chamber.

Caution
Make sure the oil hole in the side of the body is pointing toward container A. Do not point the oil hole at yourself or other people.

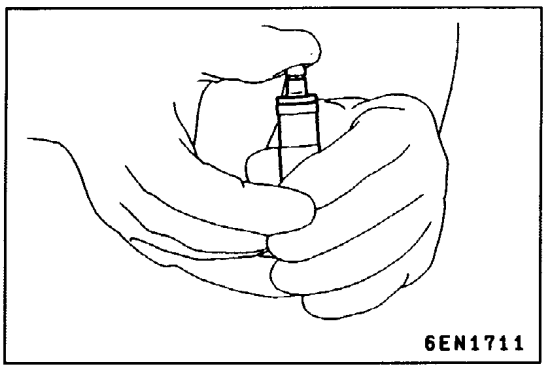


(7) Place the lash adjuster in container C. Then, gently push down the internal steel ball using wire (0.5 mm in diameter) or special tool MD998442.

Caution
Do not use container C for cleaning. If cleaning is performed in container C, foreign matter could enter the pressure chamber when chamber is filled with diesel fuel.



(8) Stand the lash adjuster with its plunger at the top, then push the plunger downward firmly until it moves through its greatest possible stroke. Return the plunger slowly, then release the steel ball and allow the pressure chamber to fill with diesel fuel.



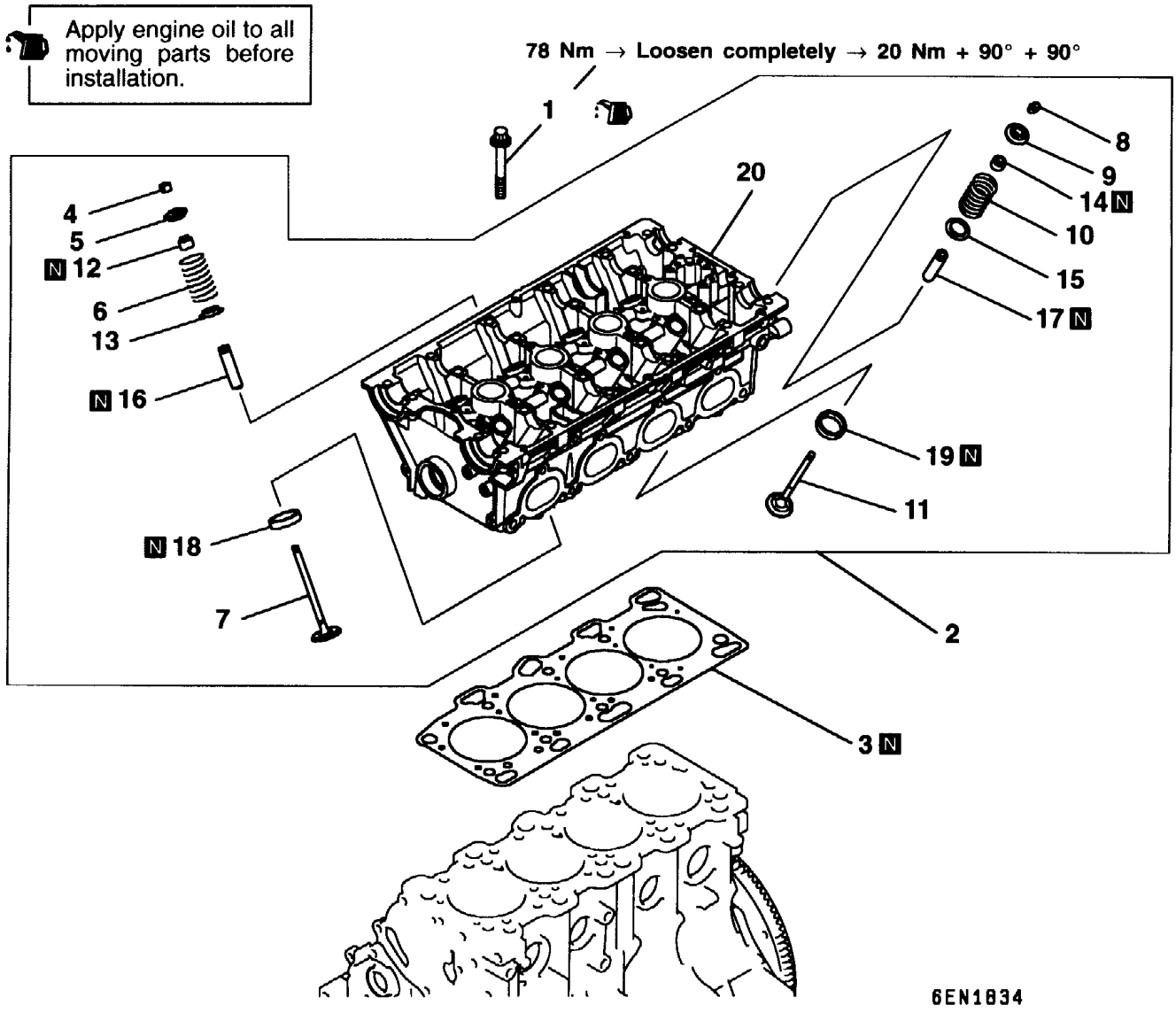
(9) Remove the lash adjuster from the container, then stand the lash adjuster with its plunger at the top. Push the plunger firmly and check that it does not move. Also, check that the lash adjuster's height matches that of a new lash adjuster.

NOTE
If lash adjuster contracts, perform the operations (7) through (9) again to fill it with diesel fuel completely. Replace the lash adjuster if it still contracts after performing these steps.

(10) Stand the lash adjuster upright to prevent diesel fuel from spilling out. Do not allow the lash adjuster to become contaminated by dirt or other foreign matter. Fit the lash adjuster onto the engine as soon as possible.

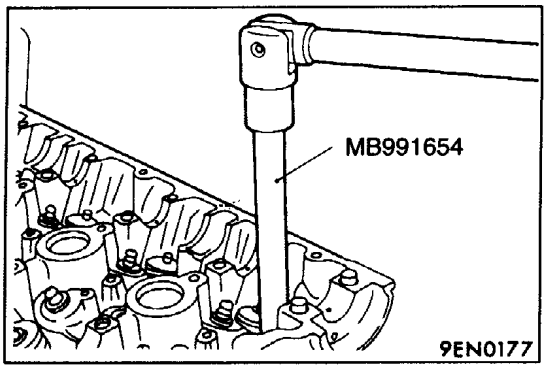
CYLINDER HEAD AND VALVES

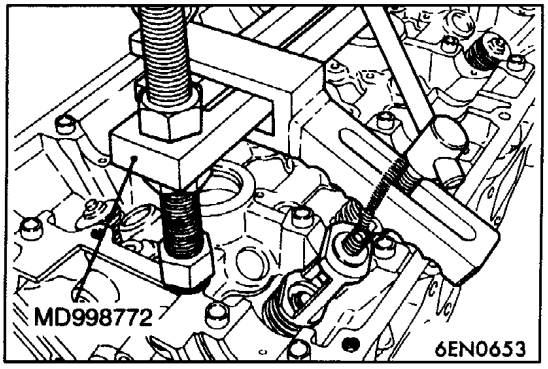
REMOVAL AND INSTALLATION

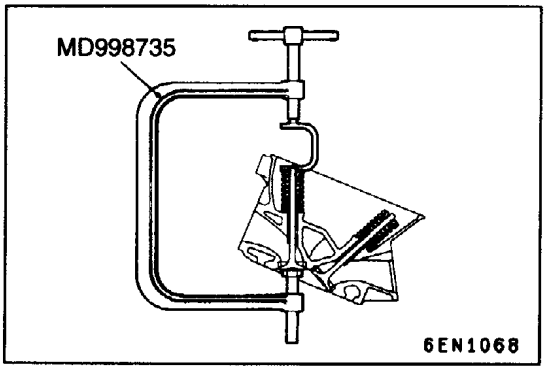


Removal steps

◀A▶ ▶D◀ 1. Cylinder head bolt
2. Cylinder head assembly
3. Cylinder head gasket
◀B▶ ▶C◀ 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
◀C▶ 11. Exhaust valve
▶A◀ 12. Valve stem seal
13. Valve spring seat
▶A◀ 14. Valve stem seal
15. Valve spring seat
16. Intake valve guide
17. Exhaust valve guide
18. Intake valve seat
19. Exhaust valve seat
20. Cylinder head







REMOVAL SERVICE POINTS

PRECAUTION FOR REMOVED PARTS

Keep removed parts in order according to the cylinder number and intake/exhaust.

◀A▶ CYLINDER HEAD BOLTS REMOVAL

Using the special tool, loosen the cylinder head bolts. Loosen evenly, little by little.

◀B▶ RETAINER LOCK REMOVAL

Store removed valves, springs and other parts, tagged to indicate their cylinder No. and location for reassembly.

◀C▶ VALVE HANDLING PRECAUTIONS

(1) Sodium reacts violently with water or moisture generation heat and liberating hydrogen. It must be handled with utmost care because otherwise the following dangerous conditions may result:
Loss of eyesight if sodium gets in eyes.
Burns if soduim contact skin.
Fire hazard.

(2) Handling of Soduim-filled Exhaust Valves
Soduim-filled exhaust valves are not dangerous and may be handled in the same way as ordinary valves unless they are broken.
Never try to break the valves and expose soduim to the air. When worn exhaust valves are to be discarded, have them disposed of by a salvage company equipped with special disposal system, notifying them that the valves contain soduim.
Should the exhaust valves be broken, neutralize soduim using the method described below, and discard the valves in the same way as ordinary valves.

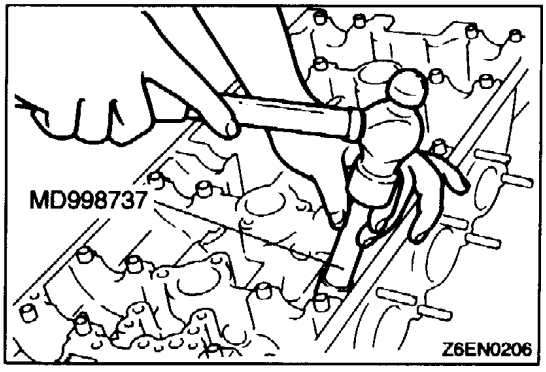
(3) How to Neutralize Sodium
Place a container filled with more than 10 liters of water in a well ventilated large space.
Wear rubber gloves and goggles, and carefully take out broken valves from the cylinder head.
Put a broken valve in the water-filled container and quickly get away from the container at least 2 or 3 m.

Caution
1. **Valves must be neutralized one at a time.**
2. **Put a valve in the container only after soduim in the preceding one has completely reacted with water.**

Keep fire away from the container during the neutralization. The resulting hydrogen gas is highly explosive.
When the reaction has finished (there is no more generation of hydrogen gas), take the valves out of the container with large tweezers or the like.

NOTE
The reaction occurs when water enters the cavity in the valve. Hydrogen gas may be trapped inside the valve, temporarily blocking the water passage. In such a case, wait until hydrogen gas in released and remaining soduim reacts with water.
After the neutralization of soduim, water in the container contains soduim hydroxide and is highly alkaline. The water solution should be disposed of according to local regulations.

Caution
1. **Do not let the solution contact the eyes or the skin.**
2. **Should it get in the eyes, immediately flush them with clean water thoroughly, and receive medical attention. When it contacts the skin, wash with ample amounts of clean water.**

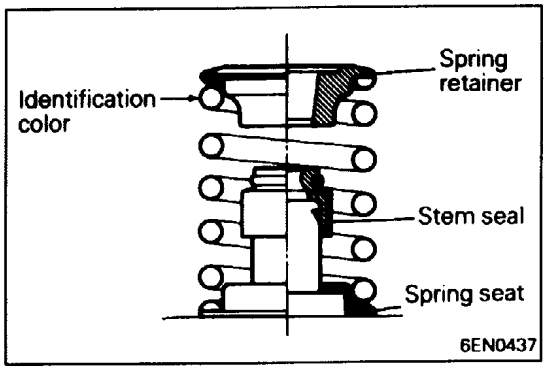


INSTALLATION SERVICE POINTS

▶A◀ VALVE STEM SEAL INSTALLATION

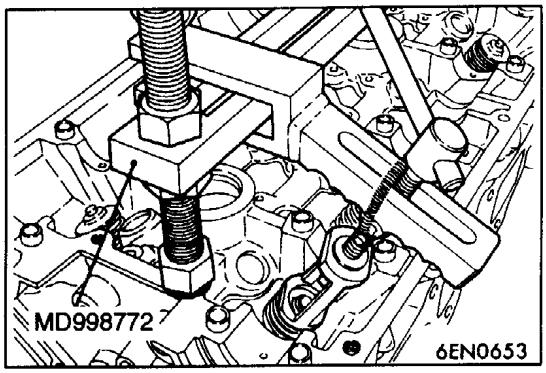
(1) Install the valve spring seat.
(2) The special tool must be used to install the valve stem seal. Improper installation could result in oil leaks past the valve guide.

Caution
Do not reuse removed valve stem seals.



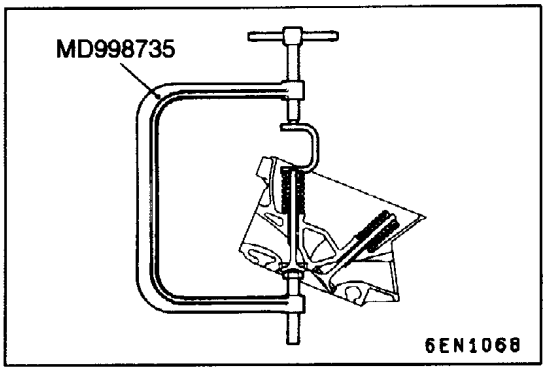
▶B◀ VALVE SPRING INSTALLATION

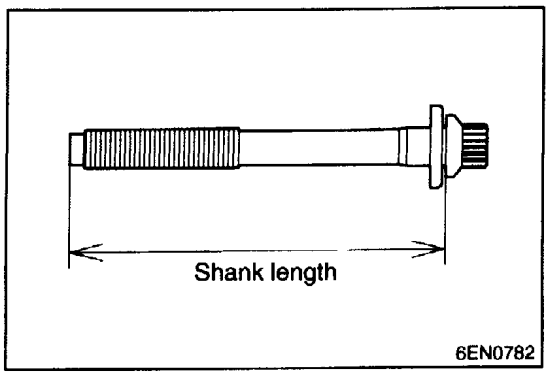
Direct the valve spring end with identification color toward the spring retainer.



▶C◀ RETAINER LOCK INSTALLATION

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



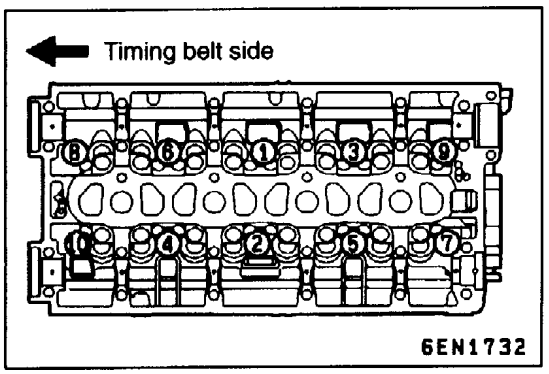


▶D◀ CYLINDER HEAD BOLT INSTALLATION

(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 bolt.

Limit: Max. 99.4 mm

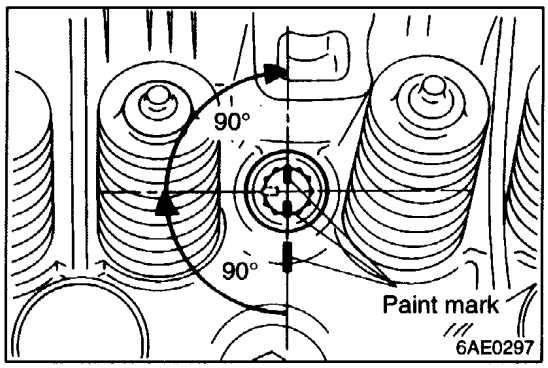
(2) Apply engine oil to the bolt threads and to the washers.



(3) Using the special tool (MB991654) and according to the tightening sequence, tighten the bolts to the specified torque.

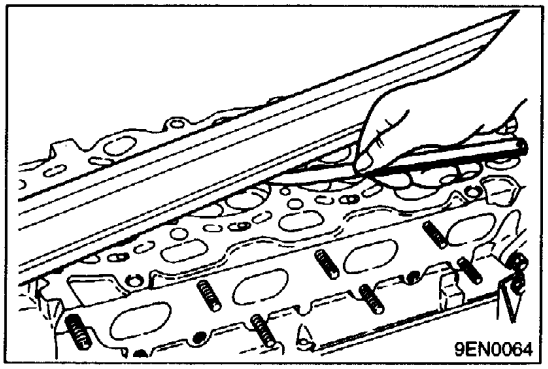
Tightening torque: 78 Nm

(4) Loosen all bolts fully.
(5) Retighten the loosened bolts to a torque of 20 Nm in the specified tightening sequence.



(6) Make paint marks on the cylinder head bolt heads and cylinder head.
(7) Give a 90° turn to the cylinder head bolts in the specified tightening sequence.
(8) Give another 90° turn to the cylinder head bolts and make sure that the paint mark on the head of each cylinder head bolt and that on the cylinder head are on the same straight line.

Caution
1. **If the bolt is turned less than 90°, proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.**
2. **If the bolt is overtightened, loosen the bolt completely and then retighten it by repeating the tightening procedure from step (1).**



INSPECTION

CYLINDER HEAD

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

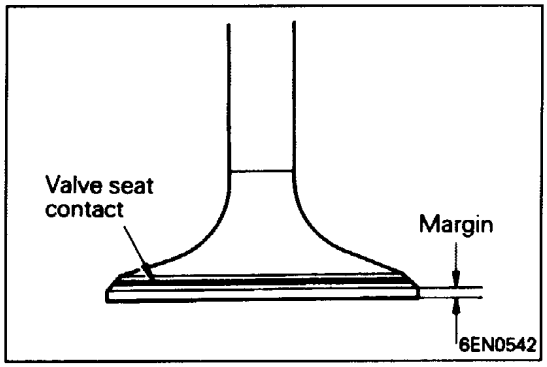
Standard value: 0.05 mm
Limit: 0.2 mm

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

Grinding limit: *0.2 mm

* Includes combined with cylinder block grinding.

Cylinder head height (Specification when new): 131.9 – 132.1 mm



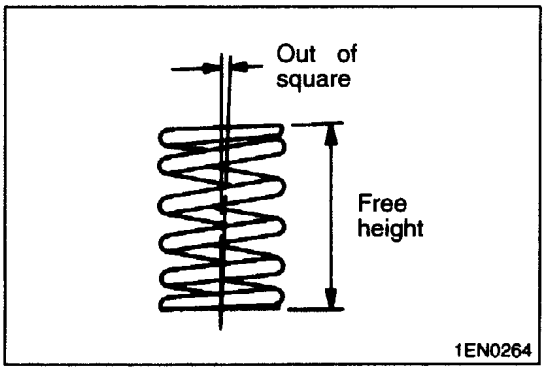
VALVE

(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 exceeds the service limit, replace the valve.

Item	Standard value mm	Limit mm
Intake	1.0	0.5
Exhaust	1.5	1.0

(3) Measure valve's total length. If measurement is less than specified, replace the valve.

Item	Standard value mm	Limit mm
Intake	109.5	109.0
Exhaust	109.7	109.2



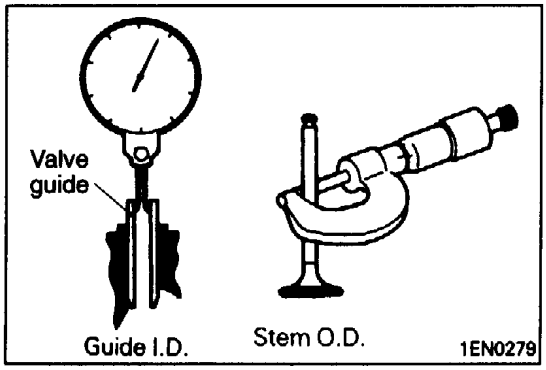
VALVE SPRING

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

Standard value mm	Limit mm
48.3	47.3

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

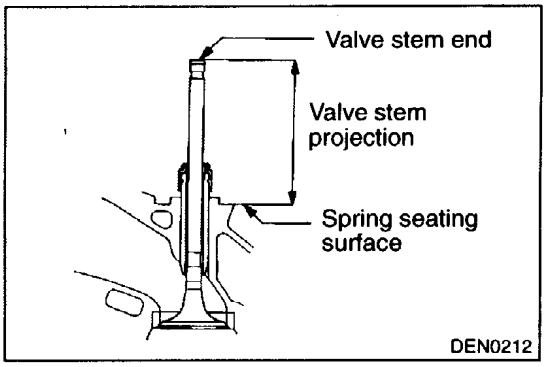
Standard value	Limit
1.5°	4°



VALVE GUIDE

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

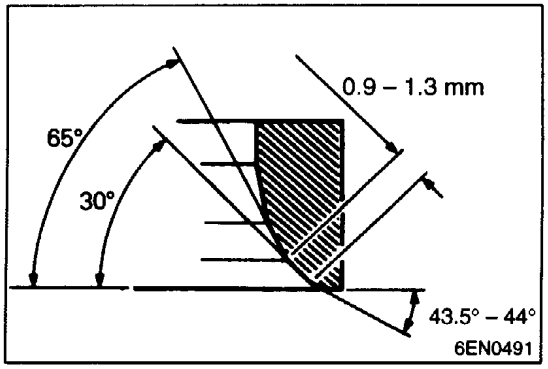
Item	Standard value mm	Limit mm
Intake	0.02 – 0.05	0.10
Exhaust	0.05 – 0.09	0.15



VALVE SEAT

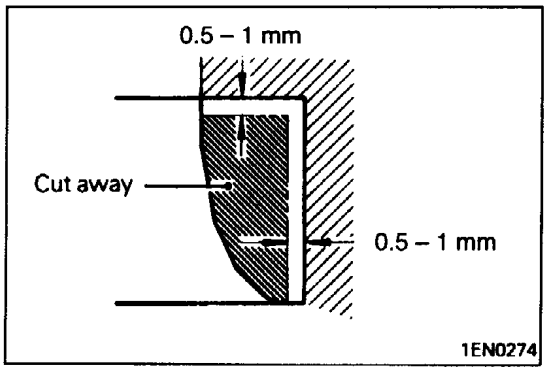
Assemble the valve, then measure the valve stem projection between the end of the valve stem and the spring seating surface. If the measurement exceeds the specified limit, replace the valve seat.

Item	Standard value mm	Limit mm
Intake	49.20	49.70
Exhaust	48.40	48.90



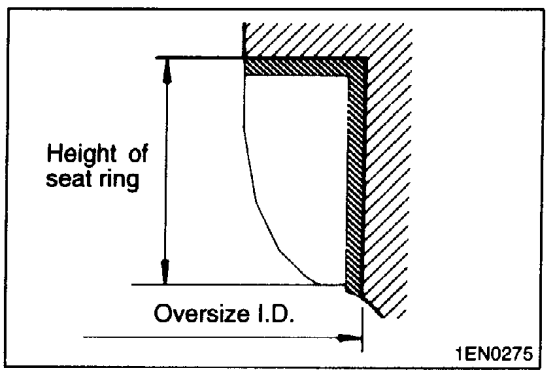
VALVE SEAT RECONDITIONING PROCEDURE

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



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.

Valve seat ring hole diameter

Item		Standard value mm
Intake	0.30 O.S.	35.30 – 35.33
	0.60 O.S.	35.60 – 35.63
Exhaust	0.30 O.S.	33.30 – 33.33
	0.60 O.S.	33.60 – 33.63

(3) Before fitting the valve seat, either heat the cylinder head up to approximately 250°C 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".

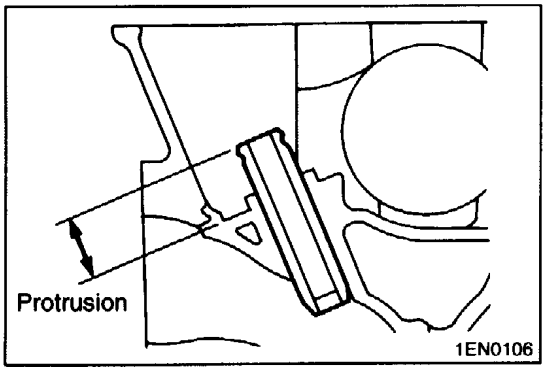
VALVE GUIDE REPLACEMENT PROCEDURE

(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 the valve guide of the same size as the removed one.

Valve gauge hole diameters in cylinder head

Item	Standard value mm
0.05 O.S.	12.05 – 12.07
0.25 O.S.	12.25 – 12.27
0.50 O.S.	12.50 – 12.52



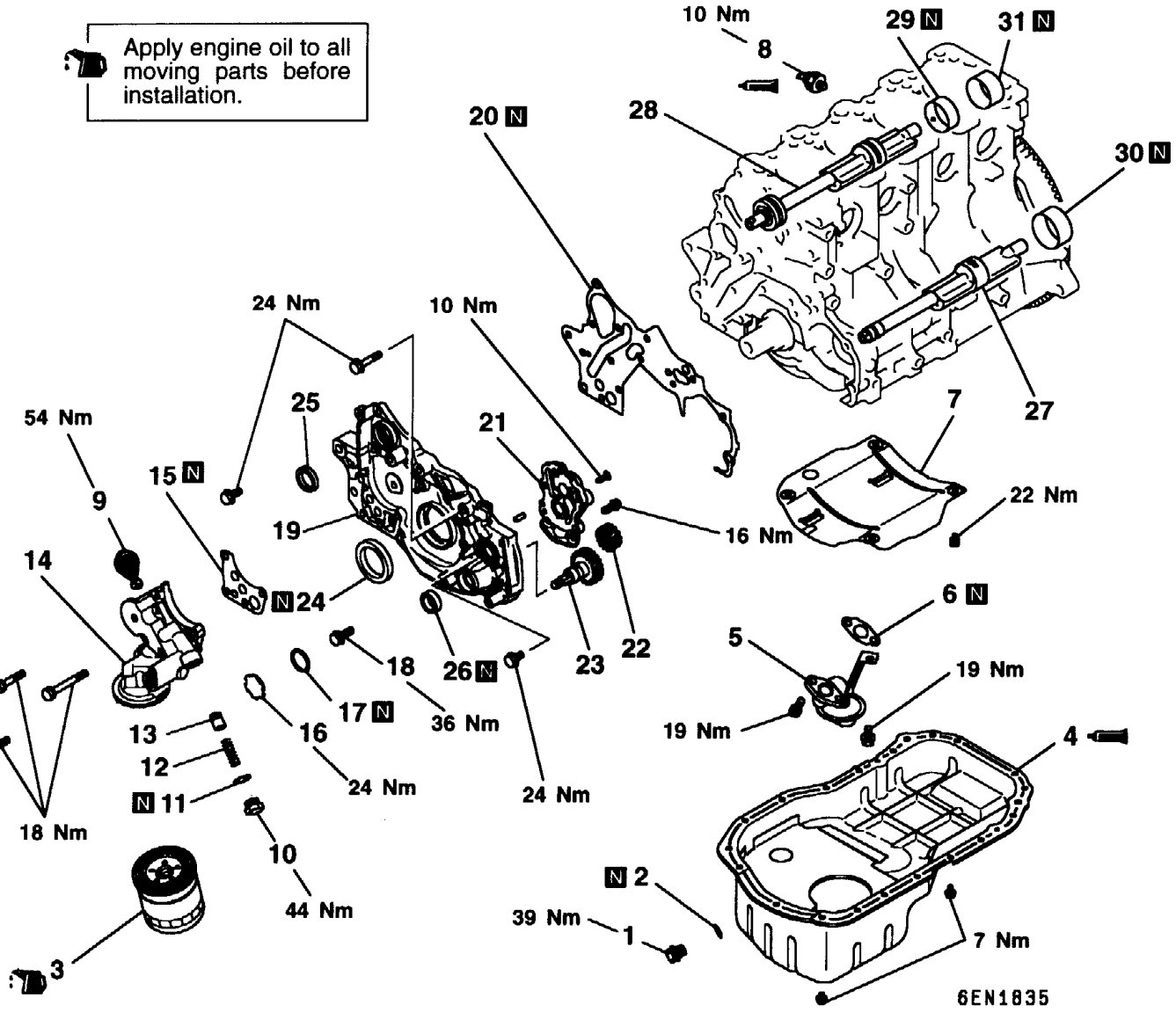
(3) Press-fit the valve guide until it protrude specified value 19.5 mm as shown in the illustration.

Caution
1. **Press the valve guide from the cylinder head top surface.**
2. **Valve guide for intake valve and that for exhaust valve are different in length. (45.5 mm for intake valve; 50.5 mm for exhaust valve)**

(4) After the valve guide has been installed, insert a new valve to check for smooth sliding motion.

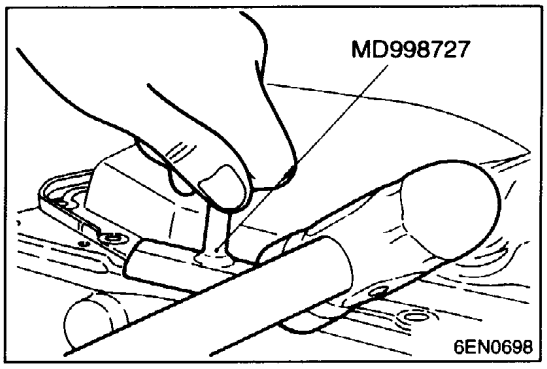
FRONT CASE, COUNTERBALANCE SHAFT AND OIL PAN

REMOVAL AND INSTALLATION



Removal steps

1. Drain plug
▶N◀ 2. Drain plug gasket
▶M◀ 3. Oil filter
◀A▶ ▶L◀ 4. Oil pan
5. Oil screen
6. Oil screen gasket
7. Buffle plate
▶I◀ 8. Oil pressure switch
9. Oil cooler by-pass valve
10. Relief plug
11. Relief plug gasket
12. Relief spring
13. Relief plunger
14. Oil filter bracket
15. Oil filter bracket gasket
◀B▶ ▶K◀ 16. Plug
17. O-ring
◀C▶ ▶J◀ 18. Flange bolt
▶H◀ 19. Front case
20. Front case gasket
21. Oil pump cover
▶G◀ 22. Oil pump driven gear
▶G◀ 23. Oil pump drive gear
▶F◀ 24. Crankshaft oil seal
▶E◀ 25. Oil pump oil seal
▶D◀ 26. Counterbalance shaft oil seal
27. Counterbalance shaft left
28. Counterbalance shaft right
◀D▶ ▶C◀ 29. Counterbalance shaft front bearing
◀E▶ ▶B◀ 30. Counterbalance shaft rear bearing left
◀E▶ ▶A◀ 31. Counterbalance shaft rear bearing right

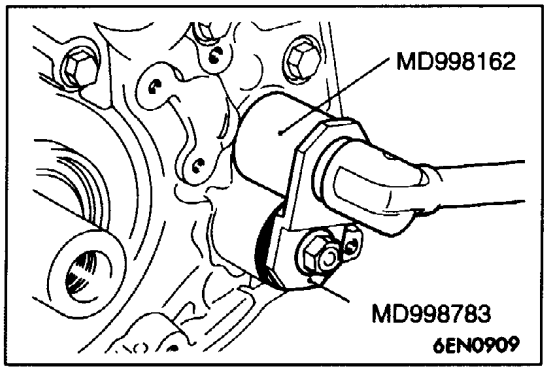


REMOVAL SERVICE POINTS

◀A▶ OIL PAN REMOVAL

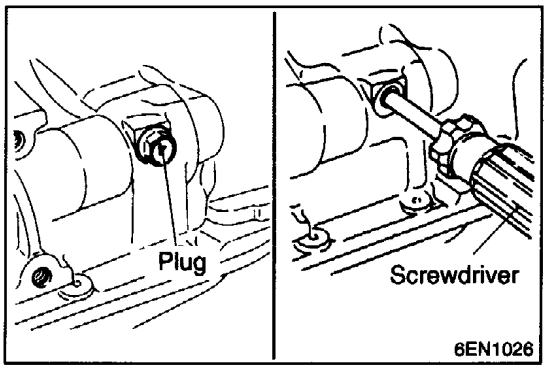
(1) Remove all oil pan bolts.
(2) Drive in the special tool between the cylinder block and oil pan.

NOTE
Never use a screwdriver or chisel, instead of the service tool, as a deformed oil pan flange will result in oil leakage.



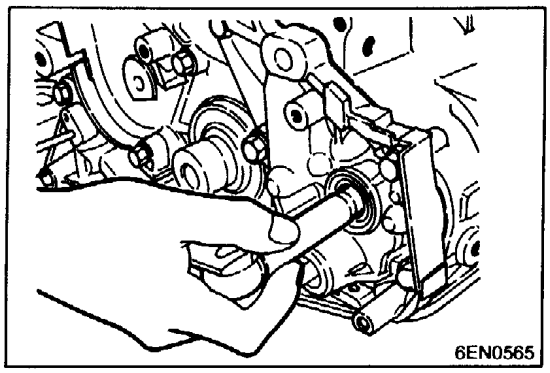
◀B▶ PLUG REMOVAL

(1) Fit special tool MD998162 on the plug, and then hold it in position with special tool MD998783.
(2) Loosen the plug.
(3) Remove the special tools MD998783 and MD998162 and then the plug.

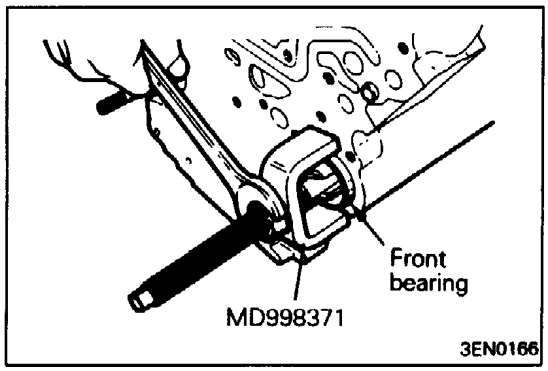


◀C▶ FLANGE BOLT REMOVAL

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



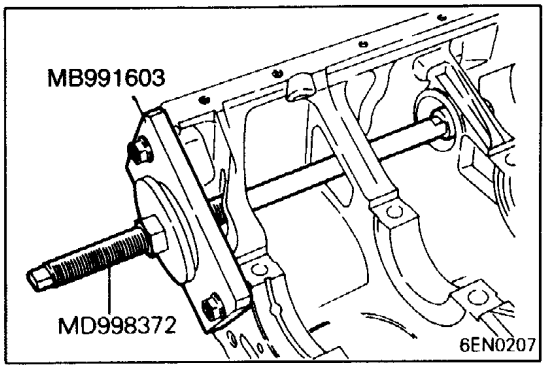
(3) Loosen the flange bolt.



◀D▶ COUNTERBALANCE SHAFT FRONT BEARING REMOVAL

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

NOTE
Be sure to remove the front bearing first.
If it has not been removed, the Rear Bearing Puller cannot be used.

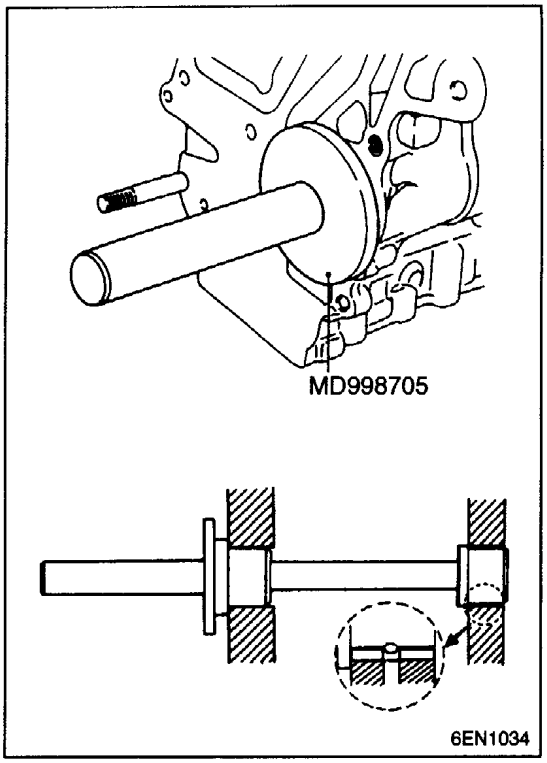


◀E▶ COUNTERBALANCE SHAFT REAR BEARING REMOVAL

Using the special tool, remove the left counterbalance shaft rear bearing from the cylinder block.

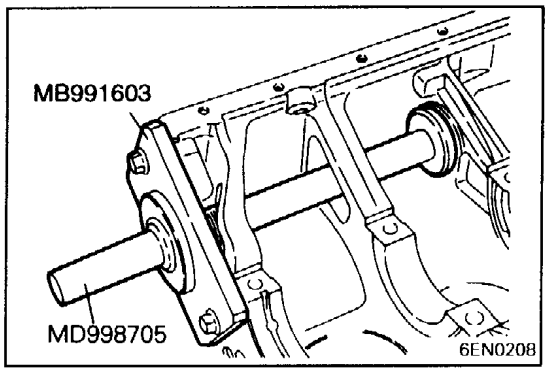
NOTE
When removing the left counterbalance shaft rear bearing, install the special tool (MB991603) in front of the cylinder block.

INSTALLATION SERVICE POINTS



▶A◀ RIGHT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION

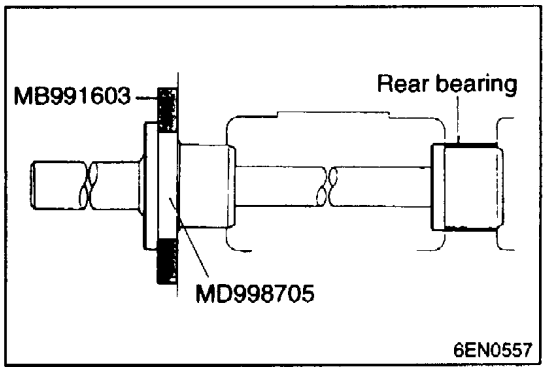
(1) Apply engine oil to the outer surface of bearing.
(2) Using special tools, install right rear bearing. Make sure that oil hole of bearing is aligned with oil hole of cylinder block.

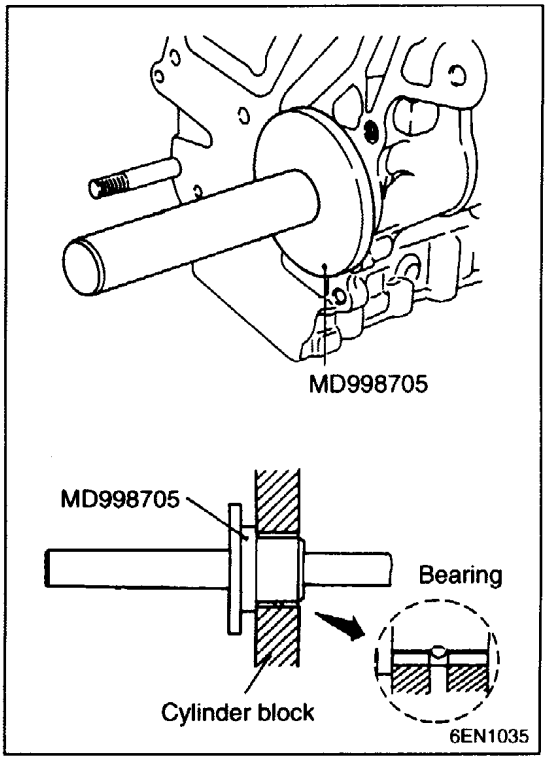


▶B◀ LEFT COUNTERBALANCE SHAFT REAR BEARING INSTALLATION

(1) Install the special tool (Guide Plate) to the cylinder block.
(2) Apply engine oil to the rear bearing outer circumference and bearing hole in the cylinder block.
(3) Using the special tool, install the rear bearing.

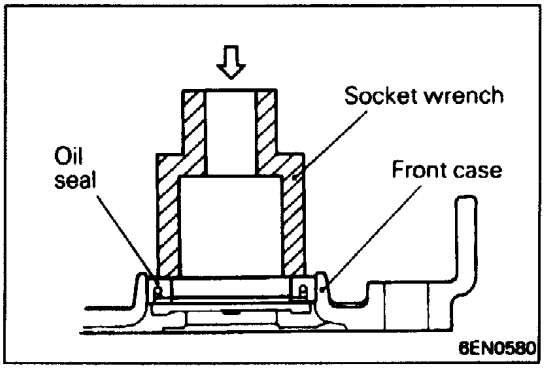
NOTE
The left rear bearing has no oil holes.





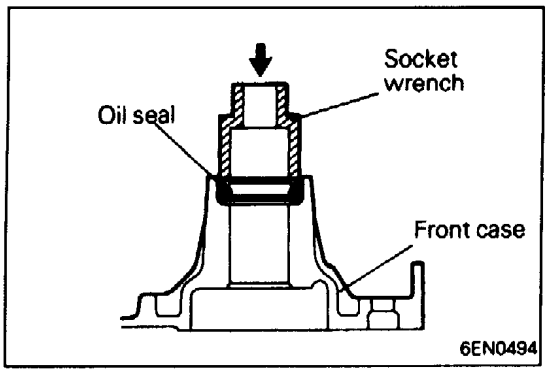
▶C◀ COUNTERBALANCE SHAFT FRONT BEARING INSTALLATION

Using special tools, install front bearing.



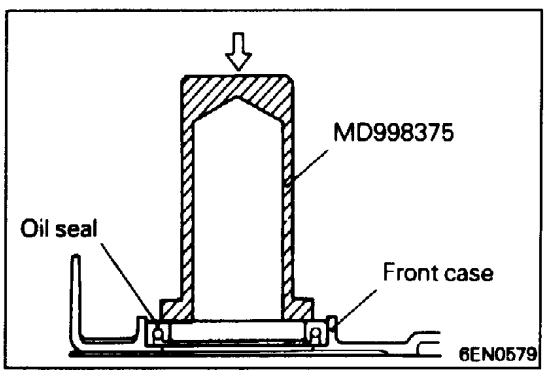
▶D◀ COUNTERBALANCE SHAFT OIL SEAL INSTALLATION

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



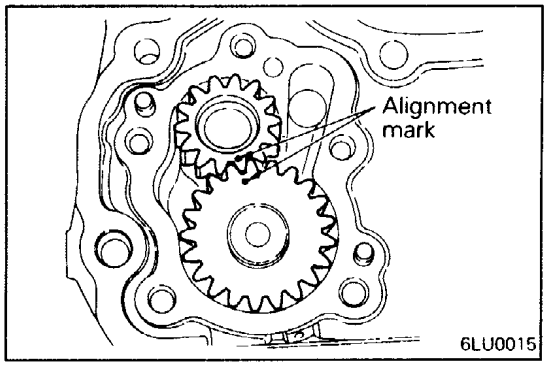
▶E◀ OIL PUMP OIL SEAL INSTALLATION

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



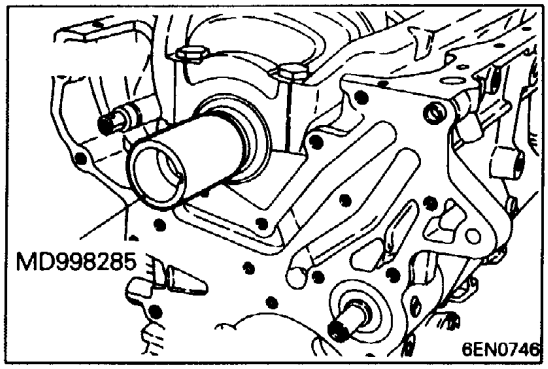
▶F◀ CRANKSHAFT FRONT OIL SEAL INSTALLATION

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



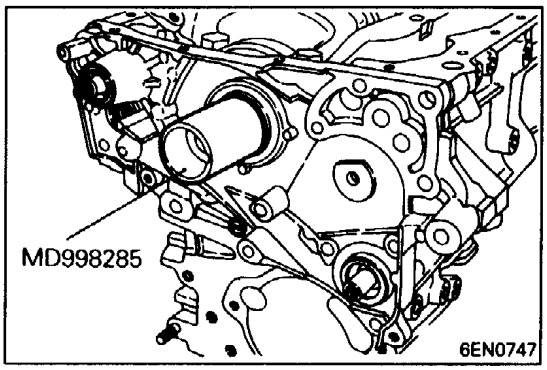
▶G◀ OIL PUMP DRIVEN GEAR / OIL PUMP DRIVE GEAR INSTALLATION

Apply engine oil amply to the gears and line up the alignment marks.

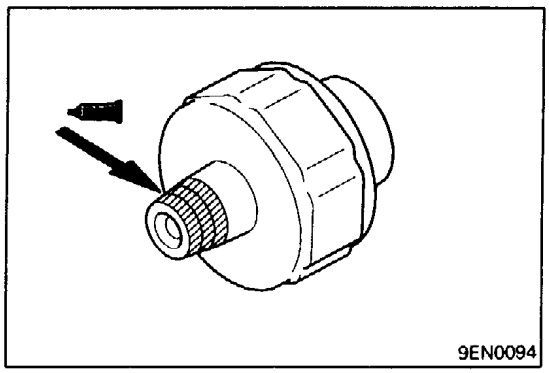


▶H◀ FRONT CASE ASSEMBLY INSTALLATION

(1) Set the special tool on the front end of crankshaft and apply a thin coat of engine oil to the outer circumference of the special tool to install the front case.



(2) Install the front case assembly through a new front case gasket and temporarily tighten the flange bolts (other than those for tightening the filter bracket).

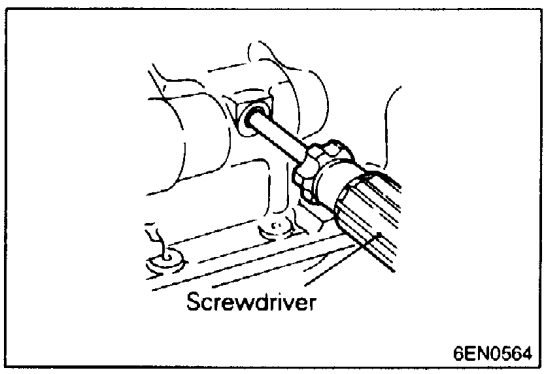


▶I◀ SEALANT APPLICATION TO OIL PRESSURE SWITCH

Coat the threads of switch with sealant and install the switch using the special tool.

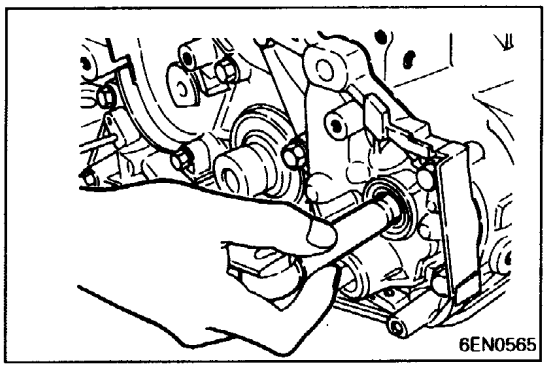
Specified sealant: 3M™ AAD Part No. 8672 or equivalent

Caution
(1) Keep the end of the thread portion clear or sealant.
(2) Avoid an overtightening.

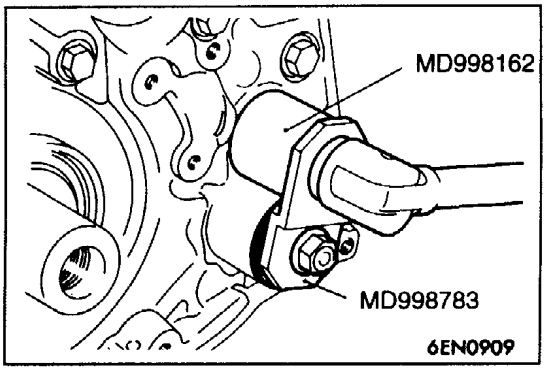


▶J◀ FLANGE BOLT INSTALLATION

(1) Insert a Phillips screwdriver into a hole in the left side of the cylinder block to lock the silent shaft.

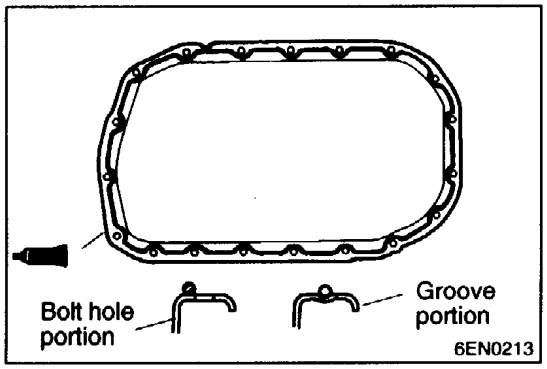


(2) Secure the oil pump driven gear onto the left counterbalance shaft by tightening the flange bolt to specified torque.



▶K◀ PLUG INSTALLATION

(1) Install a new O-ring to the groove of the front case.
(2) Install the plug to the front case.
(3) Fit the special tool MD998162 on the plug, and then hold it in position with special tool MD998783.
(4) Tighten the plug to the specified torque.
(5) Remove the special tools MD998783 and MD998162.

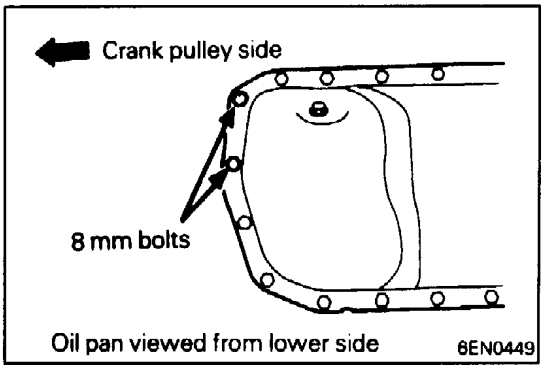


▶L◀ OIL PAN INSTALLATION

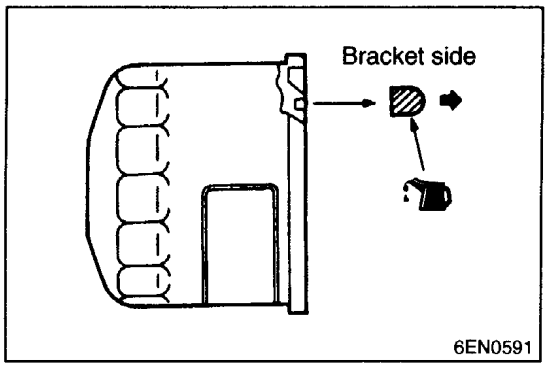
(1) Clean both mating surfaces of oil pan and cylinder block.
(2) Apply a 4 mm wide bead of sealant to the entire circumference of the oil pan flange.

Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

NOTE
1. Be sure to install the oil pan quickly while the sealant is wet (within 15 minutes).
2. After installation, keep the sealed area away from the oil and coolant for approx. one hour.

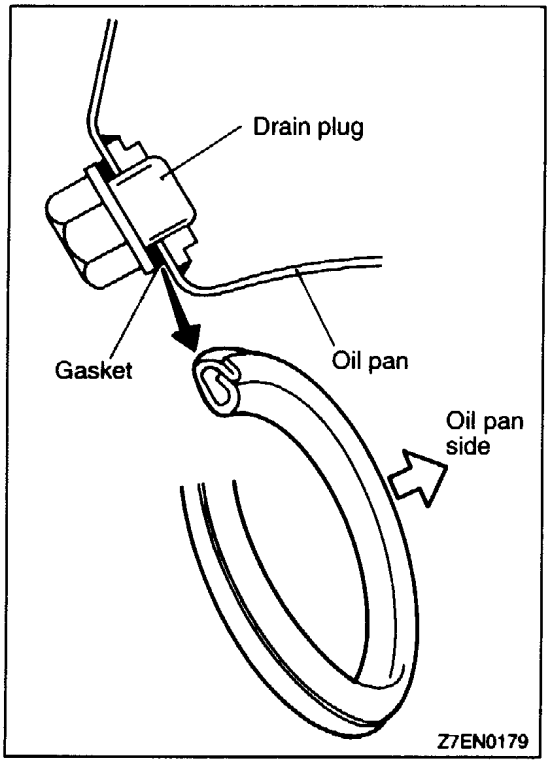


(3) Note the difference in bolt lengths at the location shown.



▶M◀OIL FILTER INSTALLATION

(1) Clean the installation surfaces of the filter bracket.
(2) Apply engine oil to the O-ring of the oil filter.
(3) Screw the oil filter in until the O-ring contacts the bracket. Then tighten 3/4 turn (tightening torque: 16 Nm).



▶N◀DRAIN PLUG GASKET INSTALLATION

Caution
Fitting the gasket in a wrong way will result in oil leakage.

Install the drain plug gasket in the direction shown.

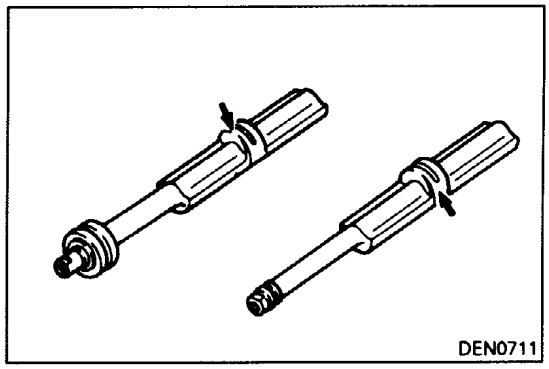
INSPECTION

FRONT CASE

(1) Check oil holes for clogging and clean if necessary.
(2) Check the left counterbalance shaft front bearing section for wear, damage and seizure. If there is anything wrong with the section, replace the front case.
(3) Check the front case for cracks and other damage. Replace cracked or damaged front case.

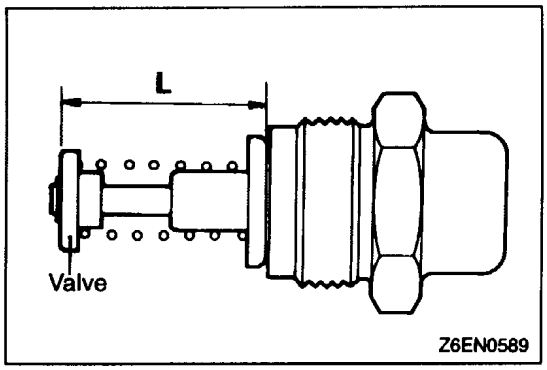
OIL SEAL

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


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COUNTERBALANCE SHAFT

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



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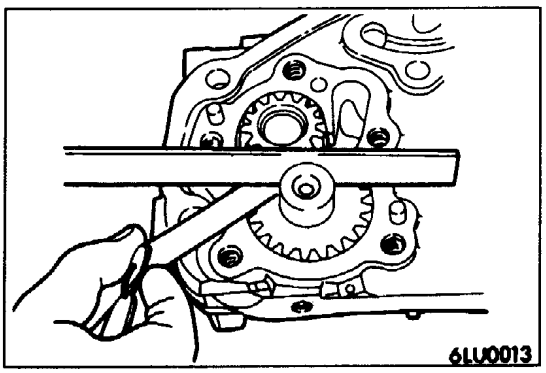
OIL COOLER BY-PASS VALVE (ENGINE WITH AIR COOLING TYPE OIL COOLER)

(1) Make sure that the valve moves smoothly.
(2) Ensure that the dimension (L) measures the standard valve under normal temperature and humidity.

Standard value (L): 34.5 mm

(3) The dimension must be the standard value when measured after the valve has been dipped in 100°C oil.

Standard value (L): 40 mm or more


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OIL PUMP

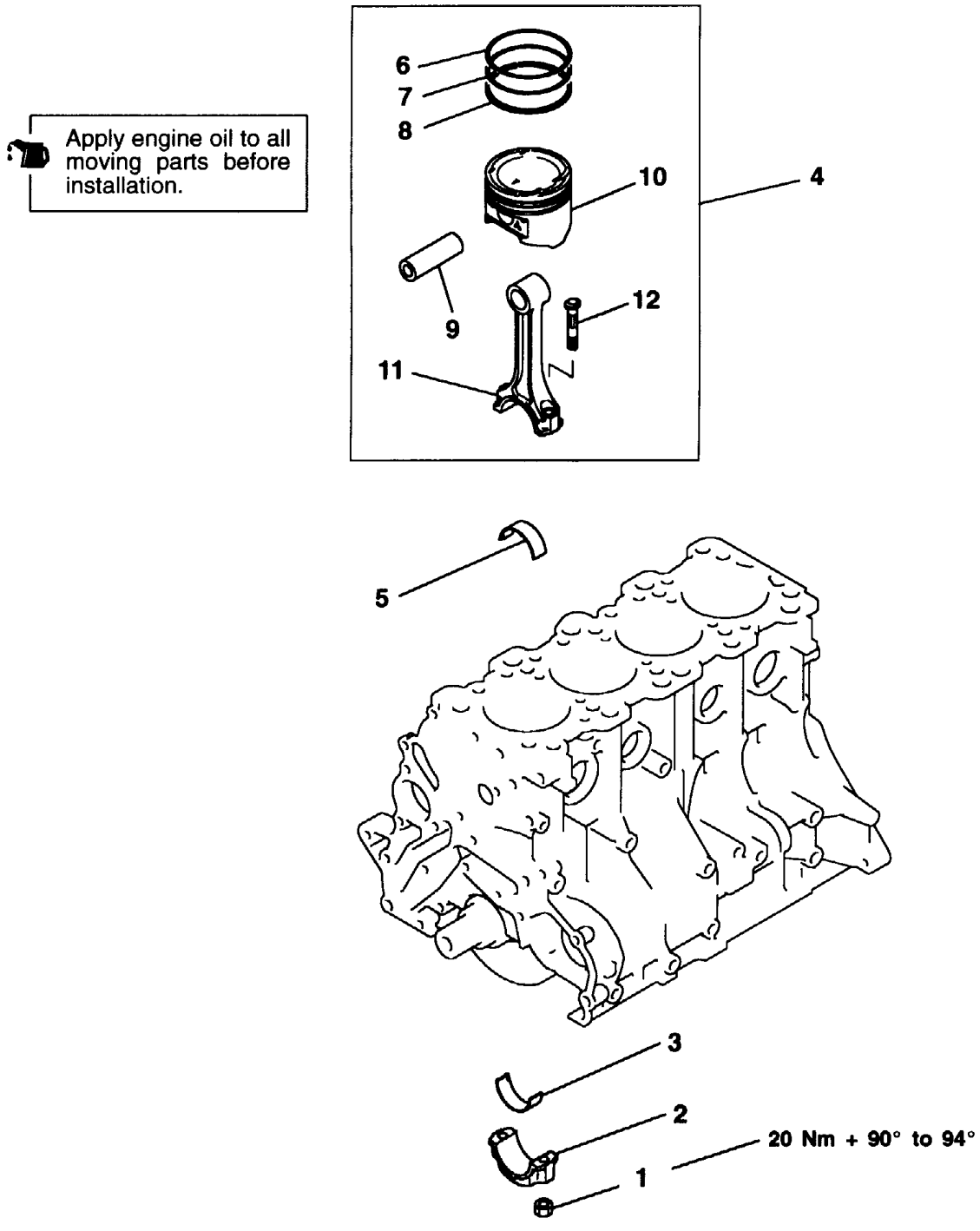
(1) Assemble the oil pump gear to the front case and rotate it to ensure smooth rotation with no looseness.
(2) Ensure that there is no ridge wear on the contact surface between the front case and the gear surface of the oil pump cover.
(3) Check the side clearance.

Standard value:

Drive gear	**0.08 – 0.14 mm**
Driven gear	**0.06 – 0.12 mm**

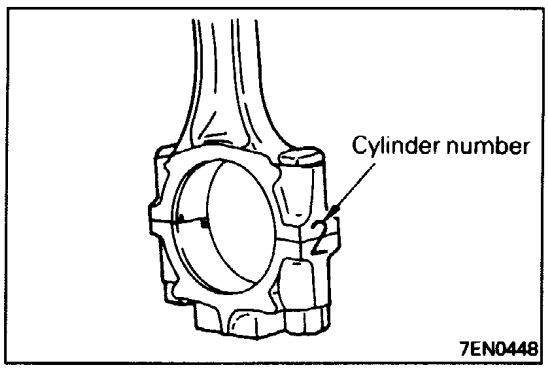
PISTON AND CONNECTING ROD

REMOVAL AND INSTALLATION



Removal steps

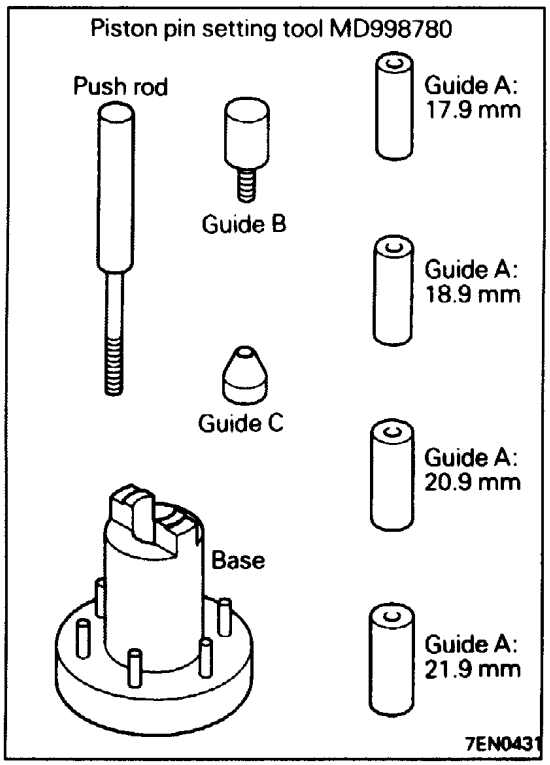
- ▶G◀ 1. Connecting rod nut
- ◀A▶ ▶F◀ 2. Connecting rod cap
- ▶E◀ 3. Connecting rod bearing
- ▶D◀ 4. Piston and connecting rod assembly
- 5. Connecting rod bearing
- ▶C◀ 6. Piston ring No. 1
- ▶C◀ 7. Piston ring No. 2
- ▶B◀ 8. Oil ring
- ◀B▶ ▶A◀ 9. Piston pin
- 10. Piston
- 11. Connecting rod
- 12. Bolt



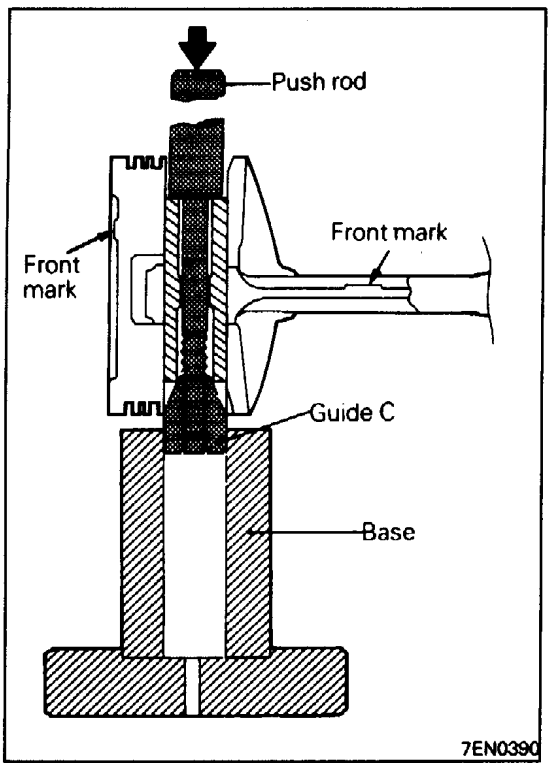
REMOVAL SERVICE POINTS

◀A▶ CONNECTING ROD CAP REMOVAL

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

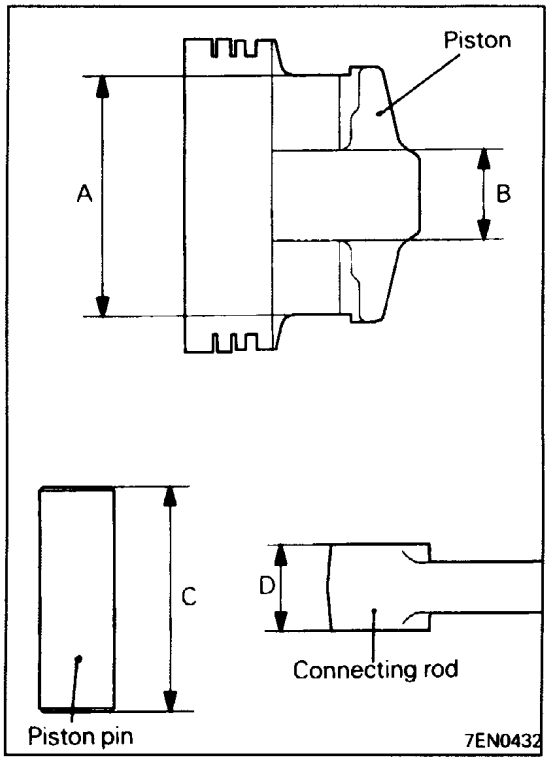


◀B▶ PISTON PIN REMOVAL



(1) Insert the special tool, Push Rod, 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 special tool, Piston Pin Setting Base, 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.



INSTALLATION SERVICE POINTS

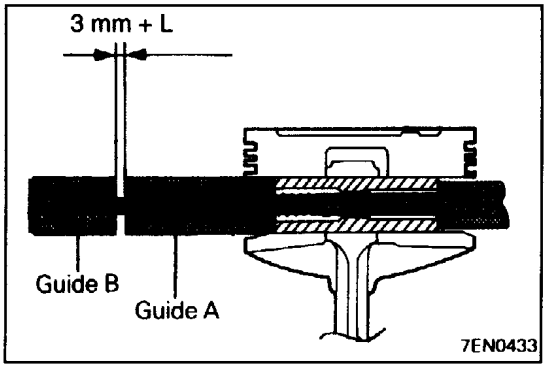
▶A◀ PISTON PIN INSTALLATION

(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

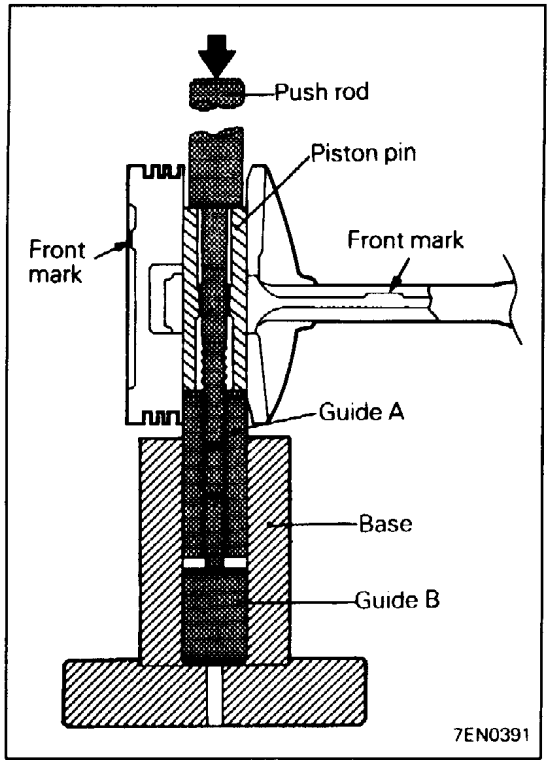
(2) Obtain dimension L (to be used later) from the above measurements by using by following formula.

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

(3) Insert the special tool, Push Rod, 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.

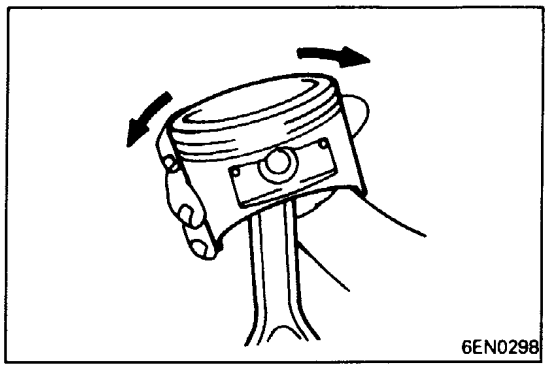


(7) Screw the guide B into the guide A until the gap between both guides amounts to the value L obtained in step (2) plus 3 mm.

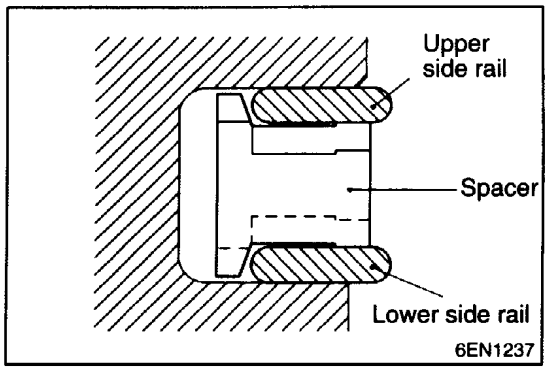


(8) Place the piston and connecting rod assembly onto the piston setting base with the front marks directed upward.
(9) Press-fit the piston pin using a press.
If the press-fitting force required is less than the standard value, replace the piston and piston pin set or/and the connecting rod.

Standard value: 7,350 – 17,200 N



(10)Check that the piston moves smoothly

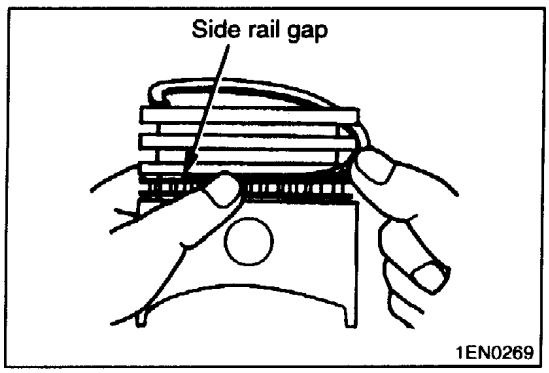


▶B◀ OIL RING INSTALLATION

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

NOTE
1. The side rails and spacer may be installed in either direction.
2. New spacers and side rails are colored for identification of their sizes.

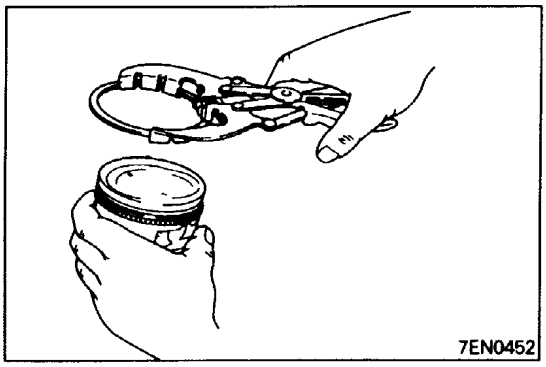
Size	Identification color
Standard	None
0.50 mm oversize	Red
1.00 mm oversize	Yellow

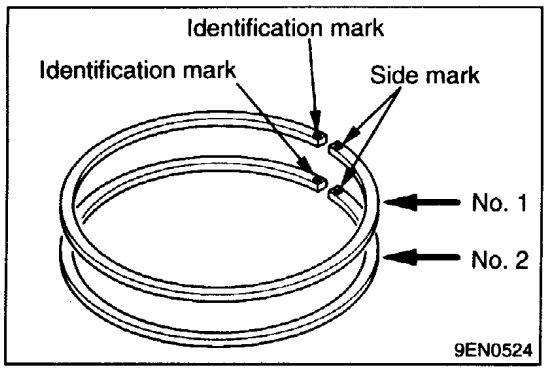


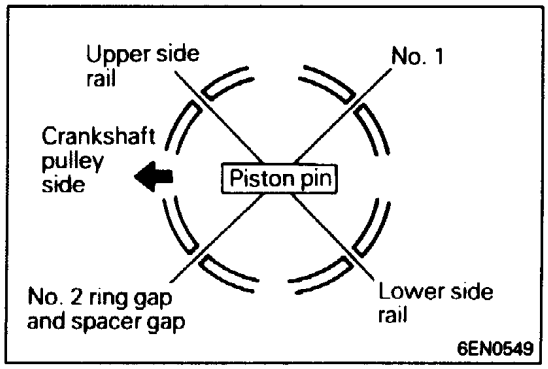
(2) Install the upper side rail.
To install the side rail, first fit one end of the rail into the piston groove, then press the remaining portion into position by finger. See illustration.
Use of ring expander to expand the side rail end gap can break the side rail, unlike other piston rings.

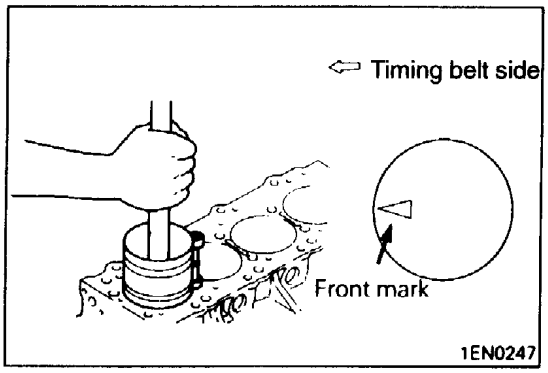
Caution
Do not use piston ring expander when installing side rail.

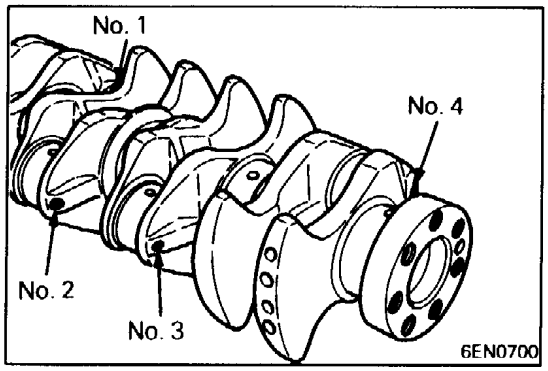
(3) Install the lower side rail in the same procedure as described in step (2).
(4) Make sure that the side rails move smoothly in either direction.











▶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. The ring end is provided with identification mark.

Item	Identification mark
No. 1 ring	1R
No. 2 ring	2R

2. Install piston rings with identification mark facing up, to the piston crown side.
3. Size marks on position rings are as follows.

Size	Size mark
Standard	None
0.50 mm oversize	50
1.00 mm oversize	100

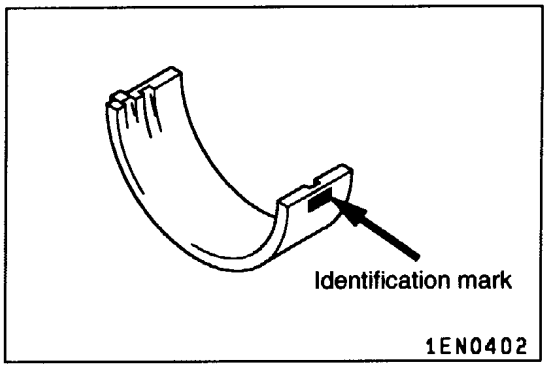
▶D◀ PISTON AND CONNECTING ROD ASSEMBLY INSTALLATION

(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 the crankshaft so that crank pin is on the center of cylinder bore.

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

▶E◀ CONNECTING ROD BEARINGS INSTALLATION

When the bearing needs replacing, select and install a proper bearing by the following procedure.
(1) Measure the crankshaft pin diameter and confirm its classification from the following table. In the case of a crankshaft supplied as a service part, identification colors of its pins are painted at the positions shown in the illustration.



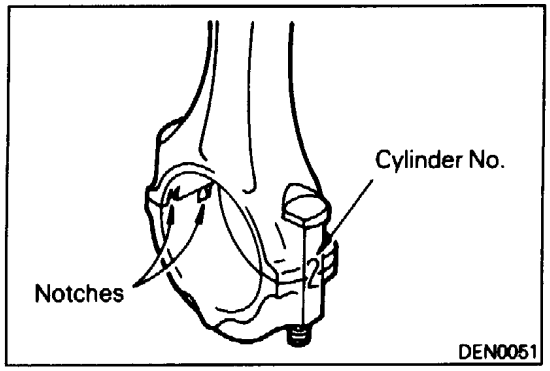
(2) The connecting rod bearing identification mark is stamped at the position shown in the illustration.

Crankshaft pin				Connecting rod bearing	
Classification	Identification mark	Identification color	O. D. mm	Identification mark	Thickness mm
	Production part	Service part			
1	None	Yellow	44.995 – 45.000	0	1.483 – 1.487
2	None	None	44.985 – 44.995	1	1.487 – 1.491
3	None	White	44.980 – 44.985	2	1.491 – 1.495

Connecting rod I.D.: 48.000 – 48.015 mm

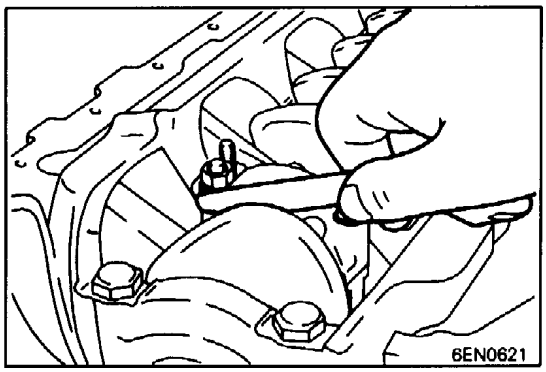
(3) Select a proper bearing from the above table on the basic of the identification data confirmed under items (1) and (2).

[Example]
If the measured value of a crankshaft pin outer diameter is 44.996 mm, the pin is classified as "1" in the table. In case the crankshaft is also replaced by a spare part, check the identification colors of the pins painted on the new crankshaft. If the color is yellow, for example, the pin is classified as "1". In the above cases, select the connection rod bearing having identification mark "0".



▶F◀ CONNECTING ROD CAP INSTALLATION

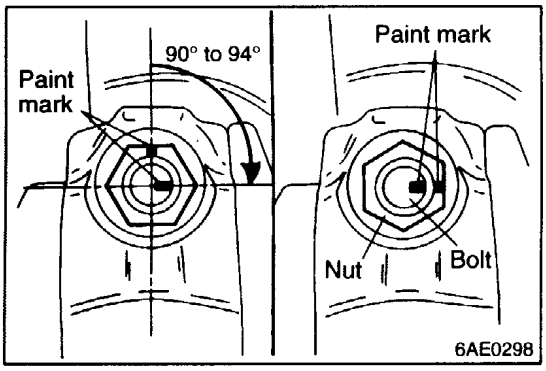
(1) Verifying the mark made during disassembly, install the bearing cap to the connecting rod. If the connecting rod is new with no index mark, make sure that the bearing locking notches come on the same side as shown.



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

Standard value: 0.10 – 0.25 mm

Limit: 0.4 mm

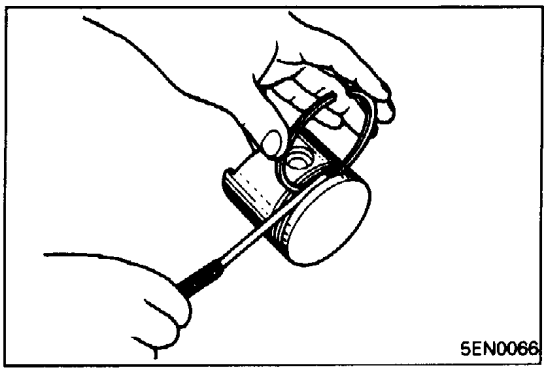


▶G◀CONNECTING ROD CAP NUT INSTALLATION

Caution
If the cylinder head has been installed before installing the connecting rod cap nut, be sure to remove the spark plugs.

(1) Since the connecting rod cap bolts and nuts are torqued using the plastic area tightening method, the bolts should be examined BEFORE reuse. If the bolt threads are "necked down", the bolt should be replaced.
Necking can be checked by running a nut with fingers to the full length of the bolt threads. If the nut does not run down smoothly, the bolt should be replaced.
(2) Before installation of each nut, apply engine oil to the thread portion and bearing surface of the nut.
(3) Install each nut to the bolt and tighten it with fingers. Then tighten the nuts alternately to install the cap properly.
(4) Tighten the nuts to a torque of 20 Nm.
(5) Make a paint mark on the head of each nut.
(6) Make a paint mark on the bolt end at the position 90° to 94° from the paint mark made on the nut in the direction of tightening the nut.
(7) Give a 90° to 94° turn to the nut and make sure that the paint mark on the nut and that on the bolt are in alignment.

Caution
1. **If the nut is turned less than 90°, proper fastening performance may not be expected. When tightening the nut, therefore, be careful to give a sufficient turn to it.**
2. **If the nut is overtightened (exceeding 94°), loosen the nut completely and then retighten it by repeating the tightening procedure from step (1).**



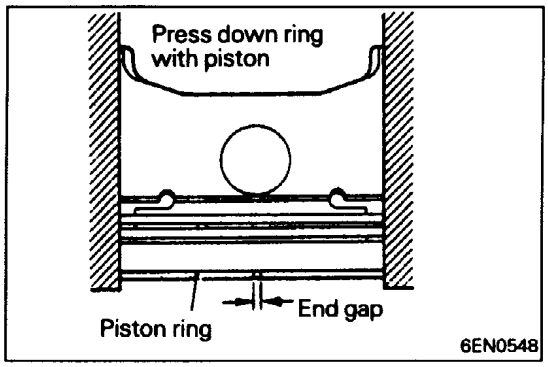
INSPECTION

PISTON RING

(1) Check the piston ring for damage, excessive wear, and breakage and replace if defects are evident. If the piston has been replaced with a new one, the piston rings must also be replaced with new ones.
(2) Check for the clearance between the piston ring and ring groove. If the limit is exceeded, replace the ring or piston, or both.

Standard value:
No. 1 ring 0.04 – 0.075 mm
No. 2 ring 0.02 – 0.06 mm

Limit: 0.1 mm



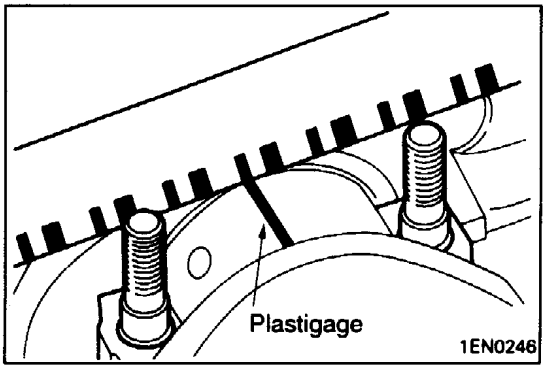
(3) Install the piston ring into the cylinder bore. Force it down with a piston, its crown being in contact with the ring, to correctly position it at right angles to the cylinder wall. Then, measure the end gap with a feeler gauge. If the ring gap is excessive, replace the piston ring.

Standard value:

No. 1 ring	**0.25 – 0.35 mm**
No. 2 ring	**0.40 – 0.55 mm**
Oil ring	**0.10 – 0.40 mm**

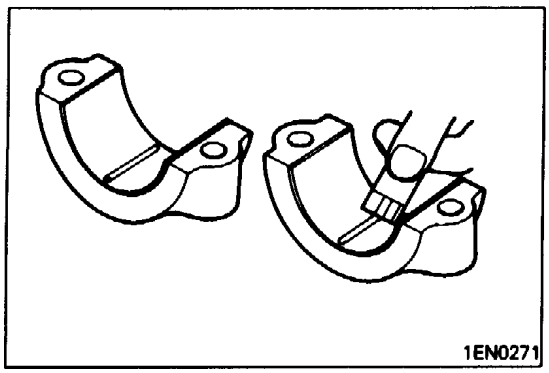
Limit:

No. 1, No. 2 ring 0.8 mm
Oil ring 1.0 mm



CRANKSHAFT PIN OIL CLEARANCE (PLASTIC GAUGE METHOD)

(1) Remove oil from the crankshaft pin and connecting rod bearing.
(2) Cut the Plastigage to the same length as the width of the bearing and place it on the crankshaft pin in parallel with its axis.



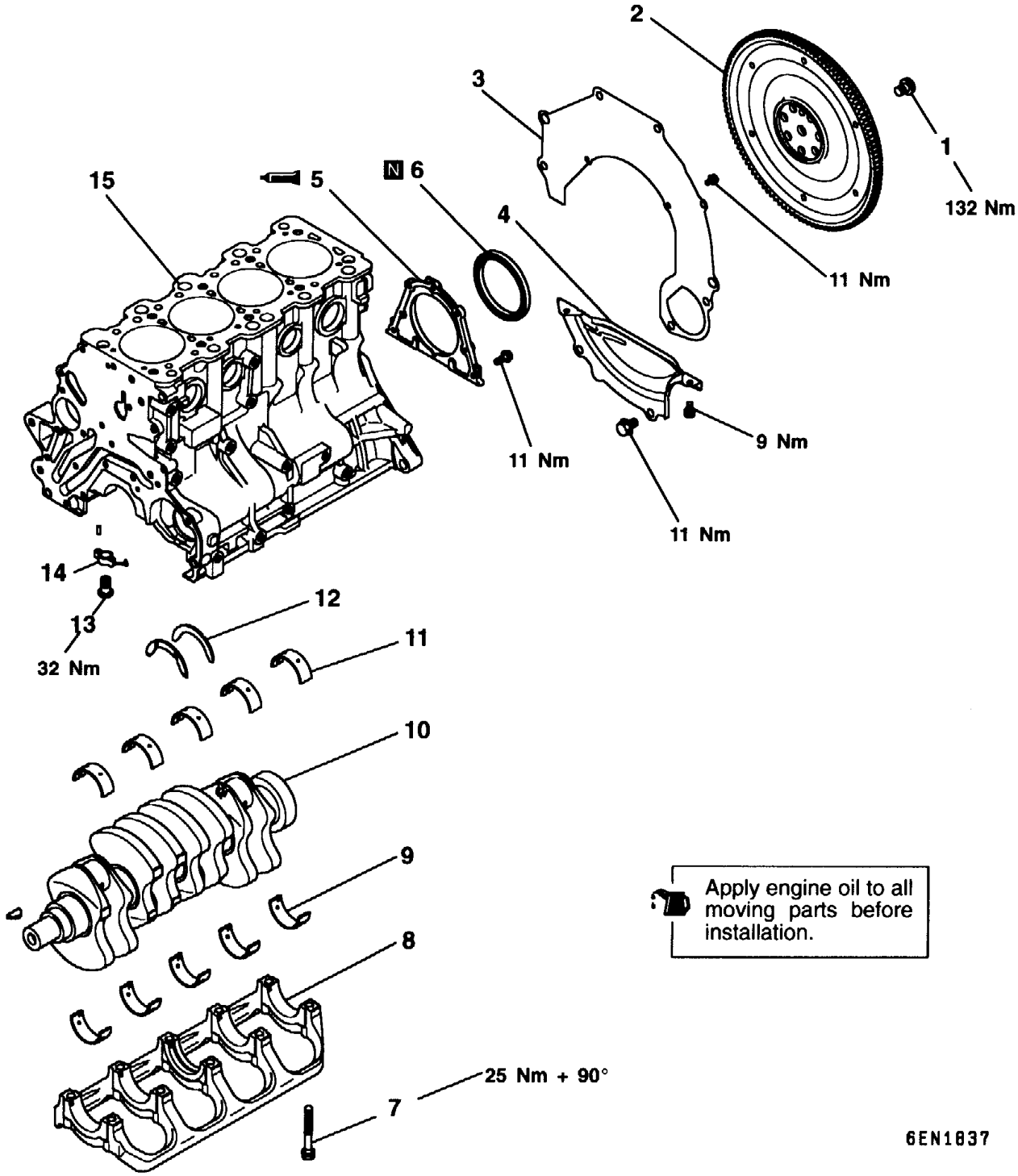
(3) Install the connecting rod cap carefully and tighten the nuts to specified torque.
(4) Carefully remove the connecting rod cap.
(5) Measure the width of the Plastigage at its widest part by using a scale printed on the Plastigage package.

Standard value: 0.03 – 0.05 mm

Limit: 0.1 mm

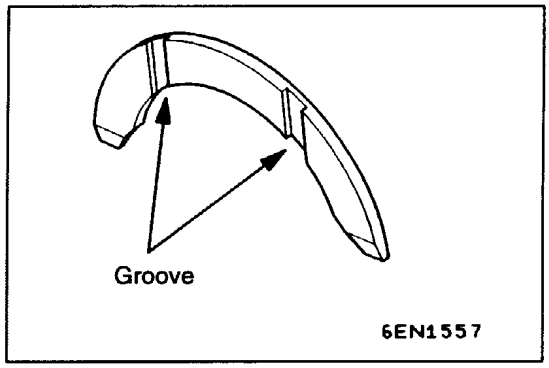
CRANKSHAFT AND FLYWHEEL

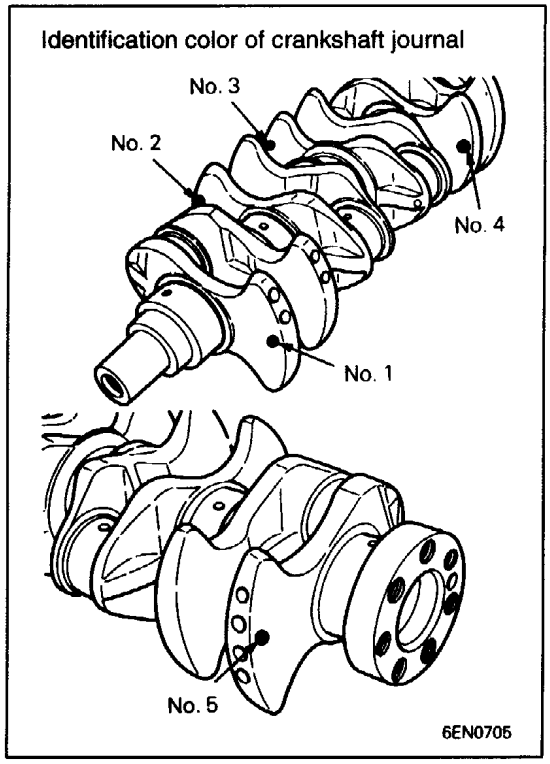
REMOVAL AND INSTALLATION

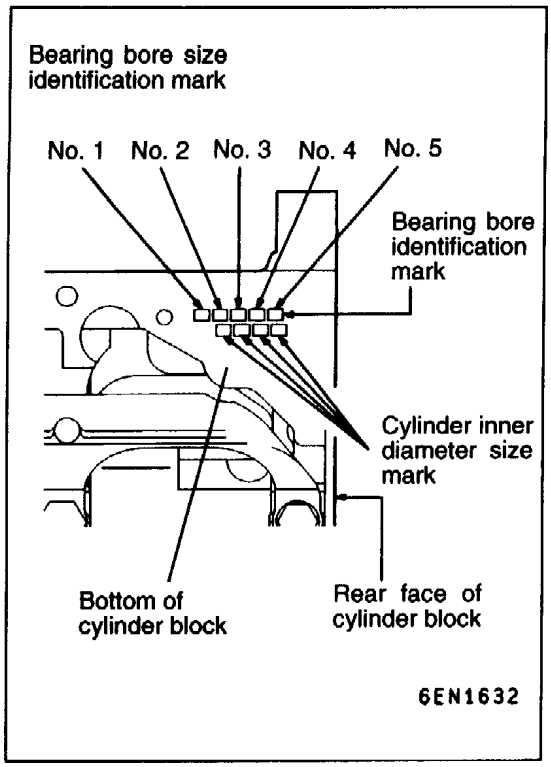


Removal steps

1. Flywheel bolt
2. Flywheel
3. Rear plate
4. Bell housing cover
- ▶E◀ 5. Oil seal case
- ▶D◀ 6. Oil seal
- ▶C◀ 7. Beam bearing cap bolt
- ▶C◀ 8. Beam bearing cap
- ▶B◀ 9. Crankshaft bearing lower
10. Crankshaft
- ▶B◀ 11. Crankshaft bearing upper
- ▶A◀ 12. Crankshaft thrust bearing
13. Check valve
14. Oil jet
15. Cylinder block







INSTALLATION SERVICE POINTS

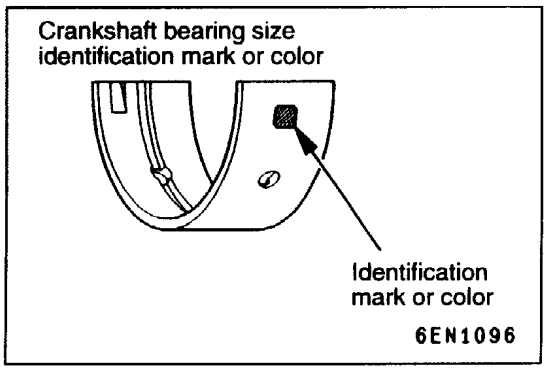
▶A◀ CRANKSHAFT THRUST BEARING INSTALLATION

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

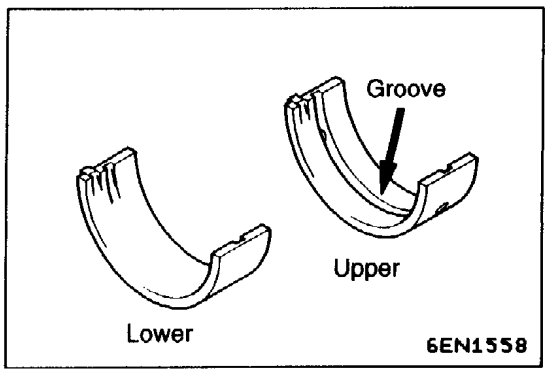
▶B◀ CRANKSHAFT BEARING INSTALLATION

(1) From the following table, select a bearing whose size is appropriate for the crankshaft journal outside diameter.

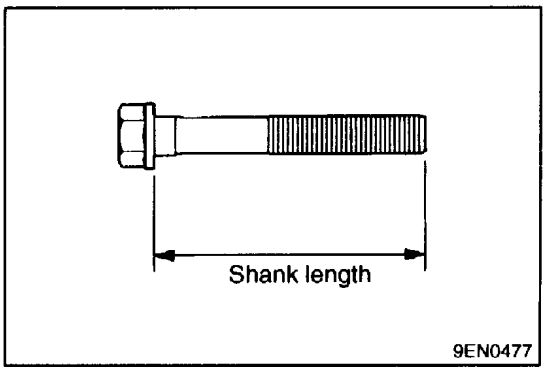
Crankshaft journal outside diameter		Cylinder block bearing bore	Crankshaft bearing
Identification color	Size mm	Identification mark	Identification mark or color
Yellow	56.994 – 57.000	0	0 or Black
		1	1 or Green
		2	2 or Yellow
None	56.988 – 56.994	0	1 or Green
		1	2 or Yellow
		2	3 or None
White	56.982 – 56.988	0	2 or Yellow
		1	3 or None
		2	4 or Blue



For example, if the crankshaft journal outside diameter ID color is "yellow" and cylinder block bearing bore ID mark is "1", select a bearing whose ID mark is "1".
If there is no ID color paint on the crankshaft, measure the journal outside diameter and select a bearing appropriate for the measured value.



(2) Install the bearings having an oil groove to the cylinder block.
(3) Install the bearings having no oil groove to the bearing cap.

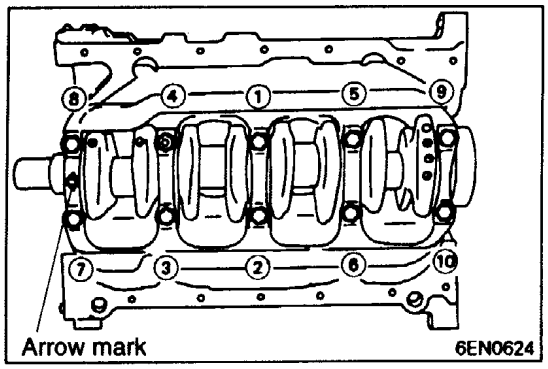


▶C◀ BEARING CAP / BEARING CAP BOLT INSTALLATION

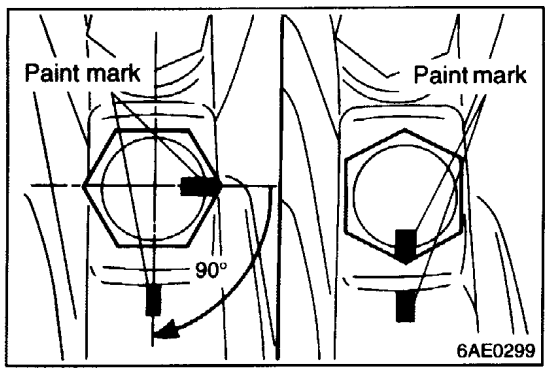
(1) Install the bearing caps so the arrow points to the timing belt side.
(2) Before installing the bearing cap bolts, check that the shank length of each bolt meets the limit. If the limit is exceeded, replace the bolt.

Limit: Max. 71.1 mm

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

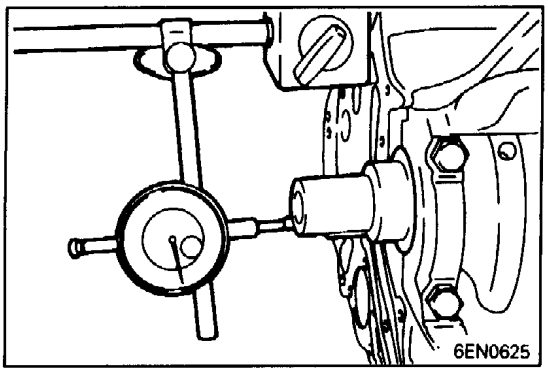


(4) Tighten the bolts to 25 Nm in the specified tightening sequence.



(5) Make a paint mark on the head of each bolt.
(6) Make a paint mark on the bearing cap at the position 90° from the paint mark made on the bolt in the direction of tightening the bolt.
(7) According to the specified tightening sequence, give a 90° turn to each bolt and make sure that the paint mark on the bolt and that on the cap are in alignment.

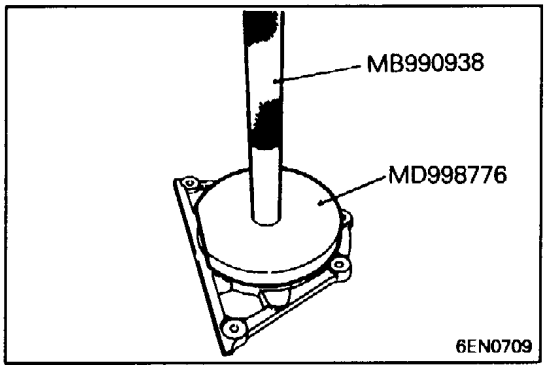
Caution
If the bolt is turned less than 90°, proper fastening performance may not be expected. When tightening the bolt, therefore, be careful to give a sufficient turn to it.



(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 No. 3 crankshaft bearings.

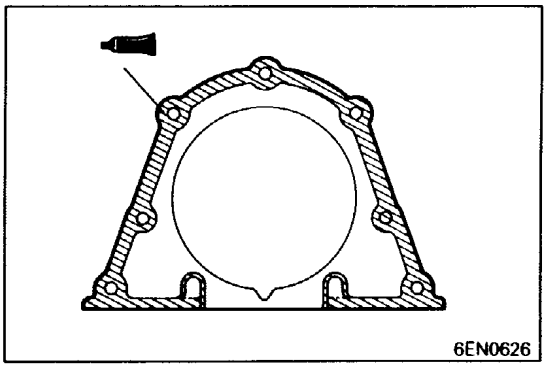
Standard value: 0.05 – 0.25 mm

Limit: 0.4 mm



▶D◀ OIL SEAL INSTALLATION

Using the special tool, knock the oil seal into the oil seal case.



▶E◀ SEALANT APPLICATION TO OIL SEAL CASE

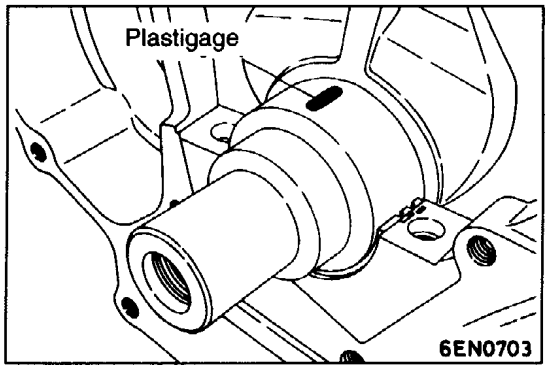
Specified sealant:
Mitsubishi Genuine Part No. MD970389 or equivalent

NOTE
(1) Be sure to install the case quickly while the sealant is wet (within 15 minutes).
(2) After installation, keep the sealed area away from the oil and coolant for approx. one hour.

INSPECTION

CRANKSHAFT OIL CLEARANCE (PLASTIGAGE METHOD)

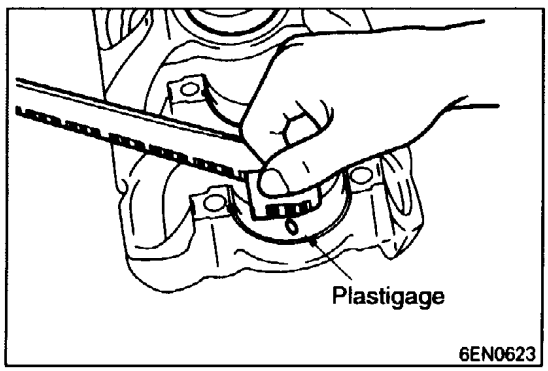
(1) Remove oil from the crankshaft journal and the crankshaft bearing.
(2) Install the crankshaft.
(3) Cut the Plastigage to the same length as the width of the bearing and place it on the journal in parallel with its axis.



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

Standard value: 0.02 – 0.04 mm

Limit: 0.1 mm

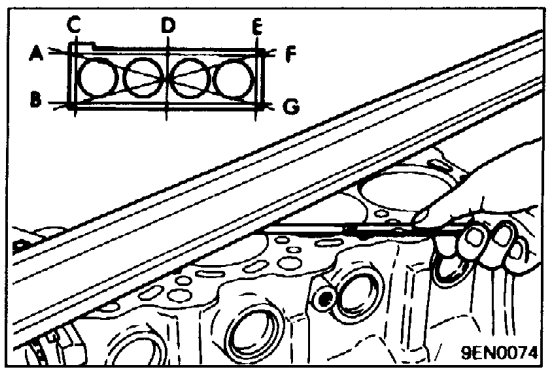


CYLINDER BLOCK

(1) Visually check for scratches, rust, and corrosion. Use also a flaw detecting agent for the check. If defects are evident, correct, or replace.
(2) Using a straightedge and feeler gauge, check the block top surface for warpage. Make sure that the surface is free from gasket chips and other foreign matter.

Standard value: 0.05 mm

Limit: 0.1 mm

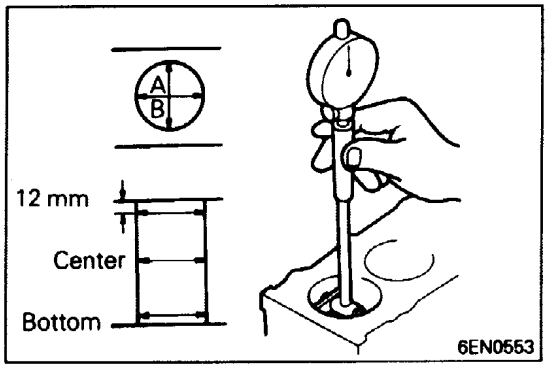


(3) If the distortion is excessive, correct within the allowable limit or replace.

Grinding limit: 0.2 mm
Includes/combined with cylinder head grinding

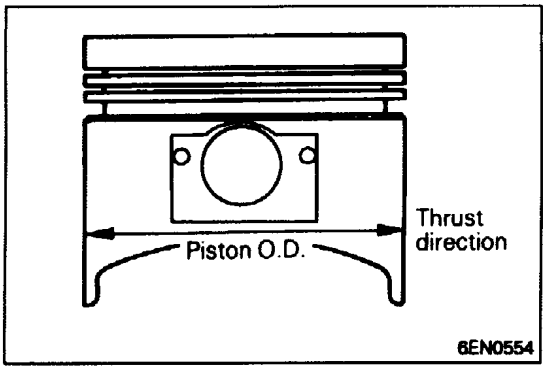
Cylinder block height (when new): 284 mm

(4) Check cylinder walls for scratches and seizure. If defects are evident, correct (bored to oversize) or replace.



(5) 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. 85.00 – 85.03 mm
Cylindricity 0.01 mm or less



BORING CYLINDER

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

Piston size identification

Size	Identification mark
0.50 O.S.	50
1.00 O.S.	100

NOTE
Size mark is stamped on the piston top.

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

(3) Based on the measured piston O.D. calculate boring finish dimension.

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

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

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

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

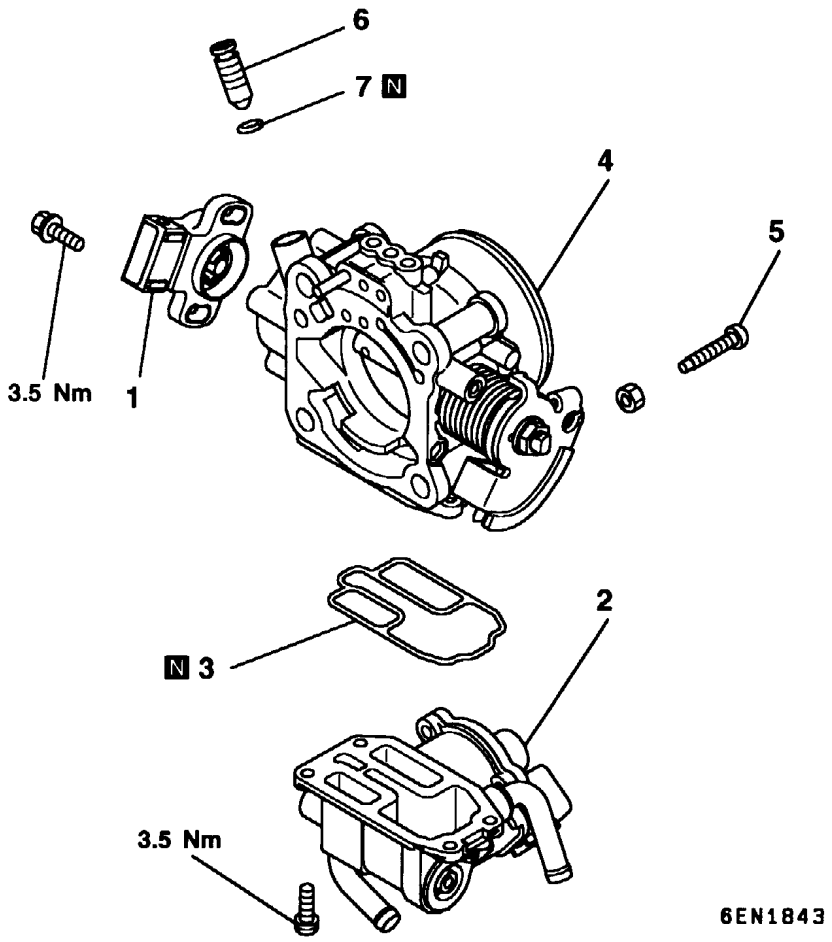
(6) Check clearance between piston and cylinder.

Clearance between piston and cylinder:
0.02 – 0.04 mm

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

THROTTLE BODY

DISASSEMBLY AND REASSEMBLY



Disassembly steps

◀A▶ ▶A◀ 1. Throttle position sensor (with built-in closed throttle position switch)
2. Idle speed control body assembly
3. O-ring
◀B▶ 4. Throttle body
5. Fixed SAS
6. Speed adjusting screw
8. O-ring

NOTE
1. The fixed SAS and the speed adjusting screw are correctly adjusted at the factory and should not be removed.
2. If the fixed SAS should happen to have been removed, carry out fixed SAS adjustment.
3. If the speed adjusting screw should happen to have been removed, carry out speed adjusting screw adjustment.

DISASSEMBLY SERVICE POINTS

◀A▶ THROTTLE POSITION SENSOR AND IDLE AIR CONTROL MOTOR REMOVAL

(1) Do not disassemble the sensor and motor.
(2) Do not immerse solvent to clean the sensor and motor. Clean then with shop towel.

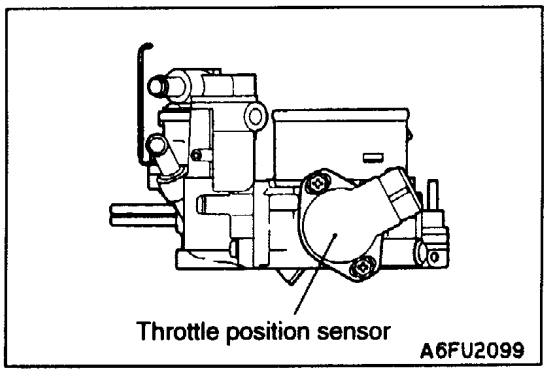
◀B▶ THROTTLE BODY REMOVAL

(1) Do not remove the throttle body.
(2) Check if the vacuum port or passage is clogged. Use compressed air to clean the vacuum passage.

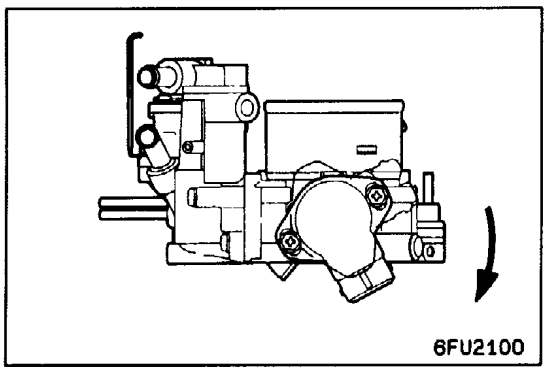
REASSEMBLY SERVICE POINT

▶A◀ THROTTLE POSITION SENSOR INSTALLATION

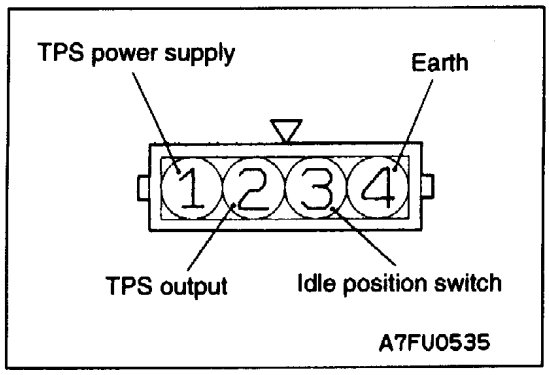
(1) Install the throttle position sensor to the throttle body as shown in the diagram.



(2) Turn throttle position sensor 90° clockwise to set it, and tighten screws.



(3) Check the continuity between terminal No. 3 (Idle throttle position switch) and No. 4 (Earth).

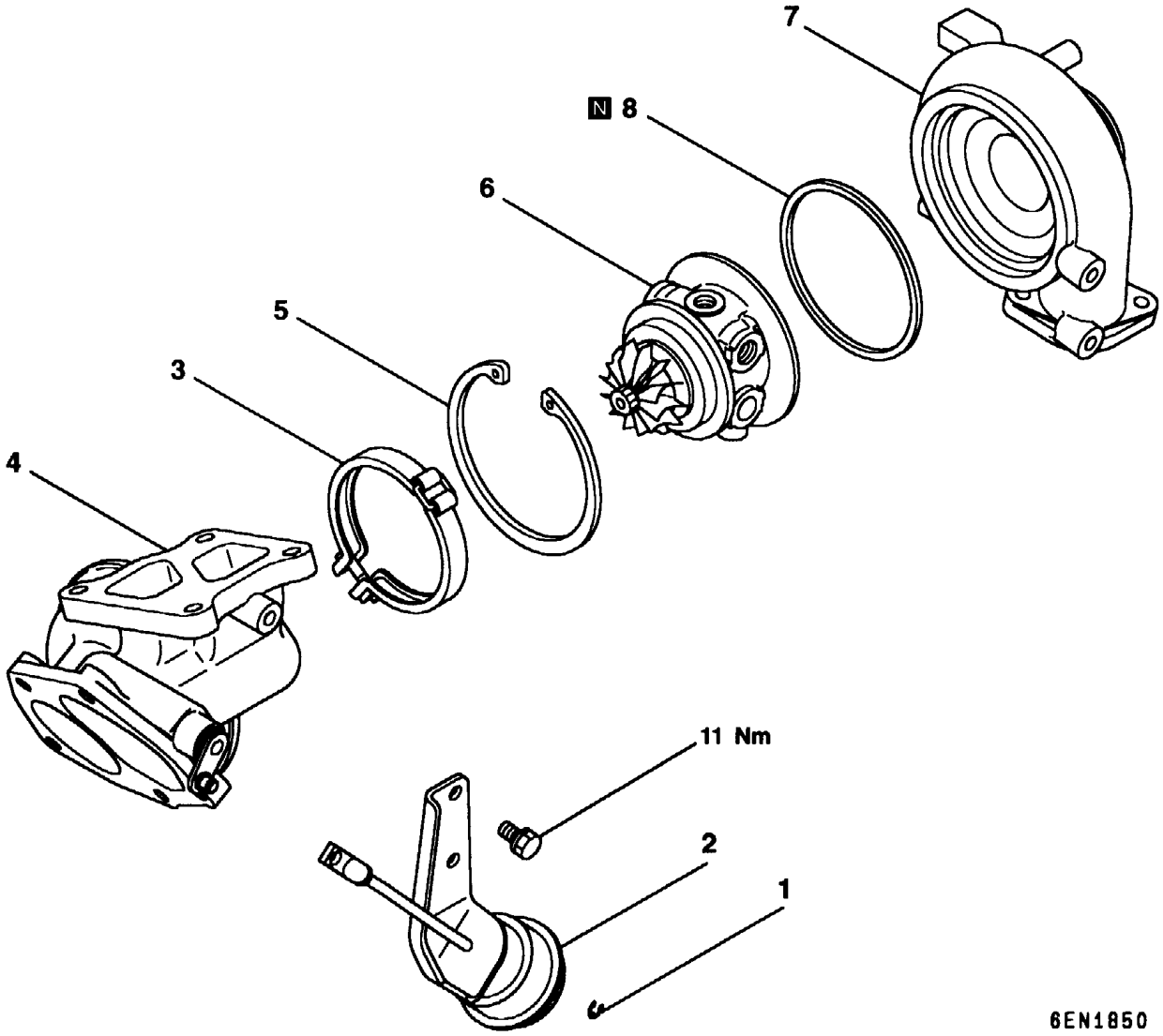


Throttle valve condition	Continuity
Fully closed	Conductive
Fully open	No conductive

If there is no continuity with the throttle valve fully closed, turn the throttle position sensor counterclockwise, and then check again.

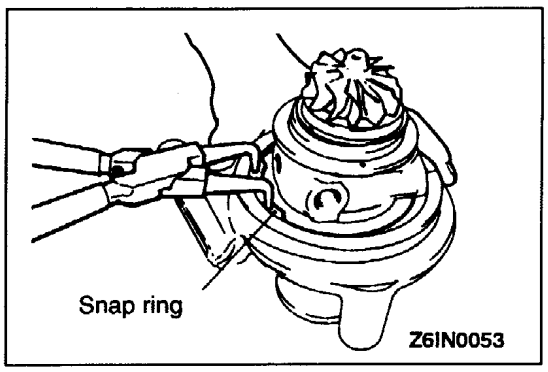
TURBOCHARGER

DISASSEMBLY AND REASSEMBLY



Disassembly steps

▶F◀ • Inspection of turbocharger waste gate actuator operation
1. Snap pin
2. Waste gate actuator
▶E◀ 3. Coupling
▶D◀ 4. Turbine housing
◀A▶ ▶C◀ 5. Snap ring
◀B▶ ▶B◀ 6. Turbine wheel assembly
7. Compressor cover
▶A◀ 8. O-ring

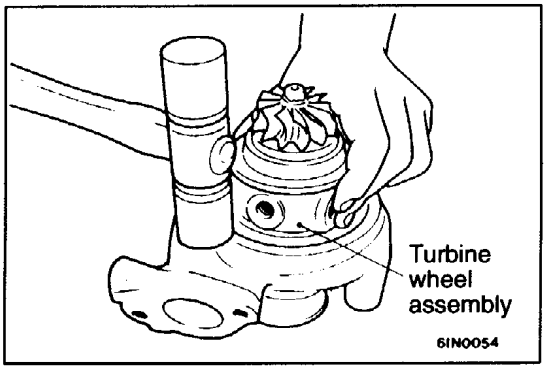


DISASSEMBLY SERVICE POINTS

◀A▶ SNAP RING REMOVAL

Lay the unit with the compressor cover side facing down and using snap ring pliers, remove the compressor cover attaching snap ring.

Caution
When removing the snap ring, hold it with fingers to prevent it from springing away.

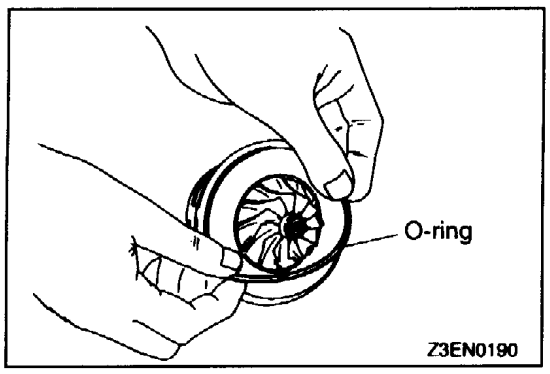


◀B▶ TURBINE WHEEL ASSEMBLY REMOVAL

Remove the turbine wheel assembly, striking the circumference of the compressor cover with a plastic hammer. The turbine wheel assembly may be a little hard to remove due to an O-ring put on the outer circumference.

CLEANING

(1) Use a clean cleaning oil commercially available. Do not use corrosive cleaning oils as they could damage to some parts.
(2) Use a plastic scraper or hard brush to clean aluminum parts.

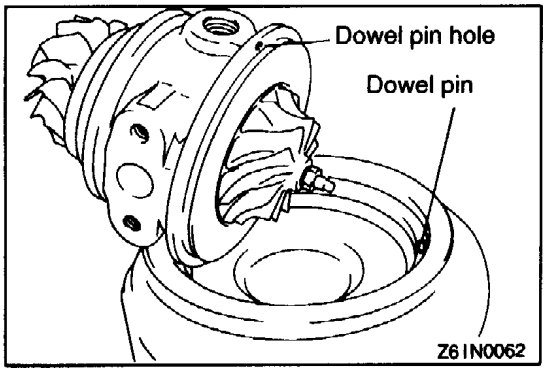


REASSEMBLY SERVICE POINTS

▶A◀ O-RING INSTALLATION

Apply a light coat of engine oil to a new O-ring and fit in the turbine wheel assembly groove.

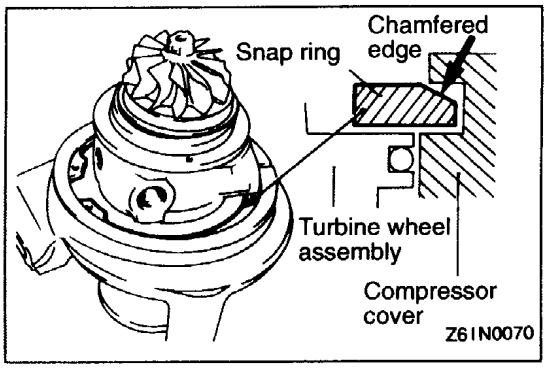
Caution
When installing the O-ring, use care not to damage it. A damaged O-ring causes oil leaks.



▶B◀ TURBINE WHEEL ASSEMBLY

(1) Apply a light coat of engine oil to the periphery of the O-ring.
(2) Install the turbine wheel assembly to the compressor cover in relation to the dowel pin.

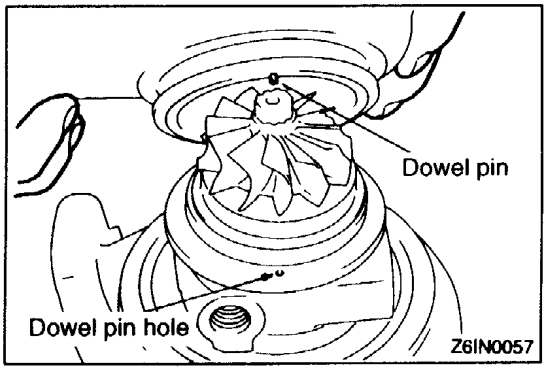
Caution
Use care not to damage the blades of turbine wheel and compressor wheel.



▶C◀ SNAP RING INSTALLATION

Lay the assembly with the compressor cover facing down and fit the snap ring.

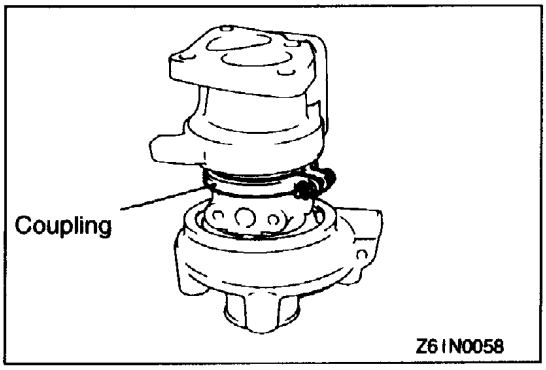
Caution
Fit the snap ring with its chamfered side facing up.



▶D◀ TURBINE HOUSING INSTALLATION

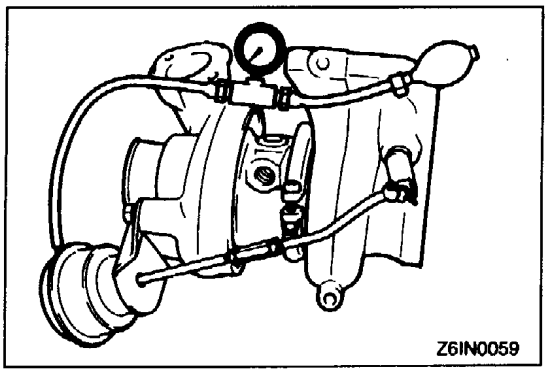
Install the turbine housing in relation to the dowel pin.

Caution
Use care not to damage the blades of turbine wheel.



▶E◀ COUPLING INSTALLATION

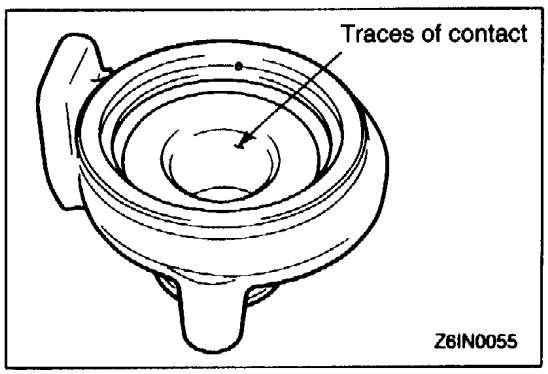
Install the coupling and tighten to the specified torque.



▶F◀ WASTE GATE ACTUATOR OPERATION CHECK

Using a tester, apply a pressure of approx. 100.0 kPa to the actuator and make sure that the rod moves.

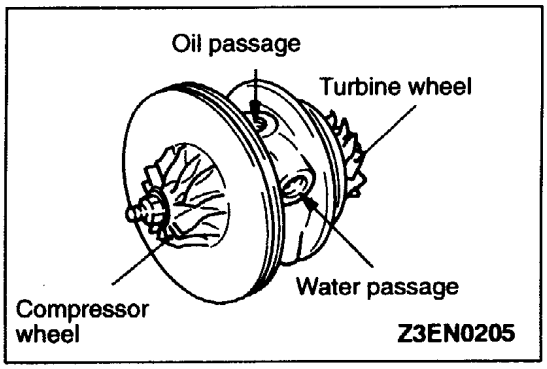
Caution
Do not apply a pressure of more than 113.3 kPa to the actuator. Otherwise, diaphragm may be damaged. Never attempt to adjust the waste gate valve.



INSPECTION

TURBINE HOUSING

(1) Check the housing for traces of contact with the turbine wheel, cracks due to overheating, pitching, deformation and other damage. Replace with a new turbine housing if cracked.
(2) Operate the waste gate valve lever manually to check that the gate can be operated and closed smoothly.



COMPRESSOR COVER

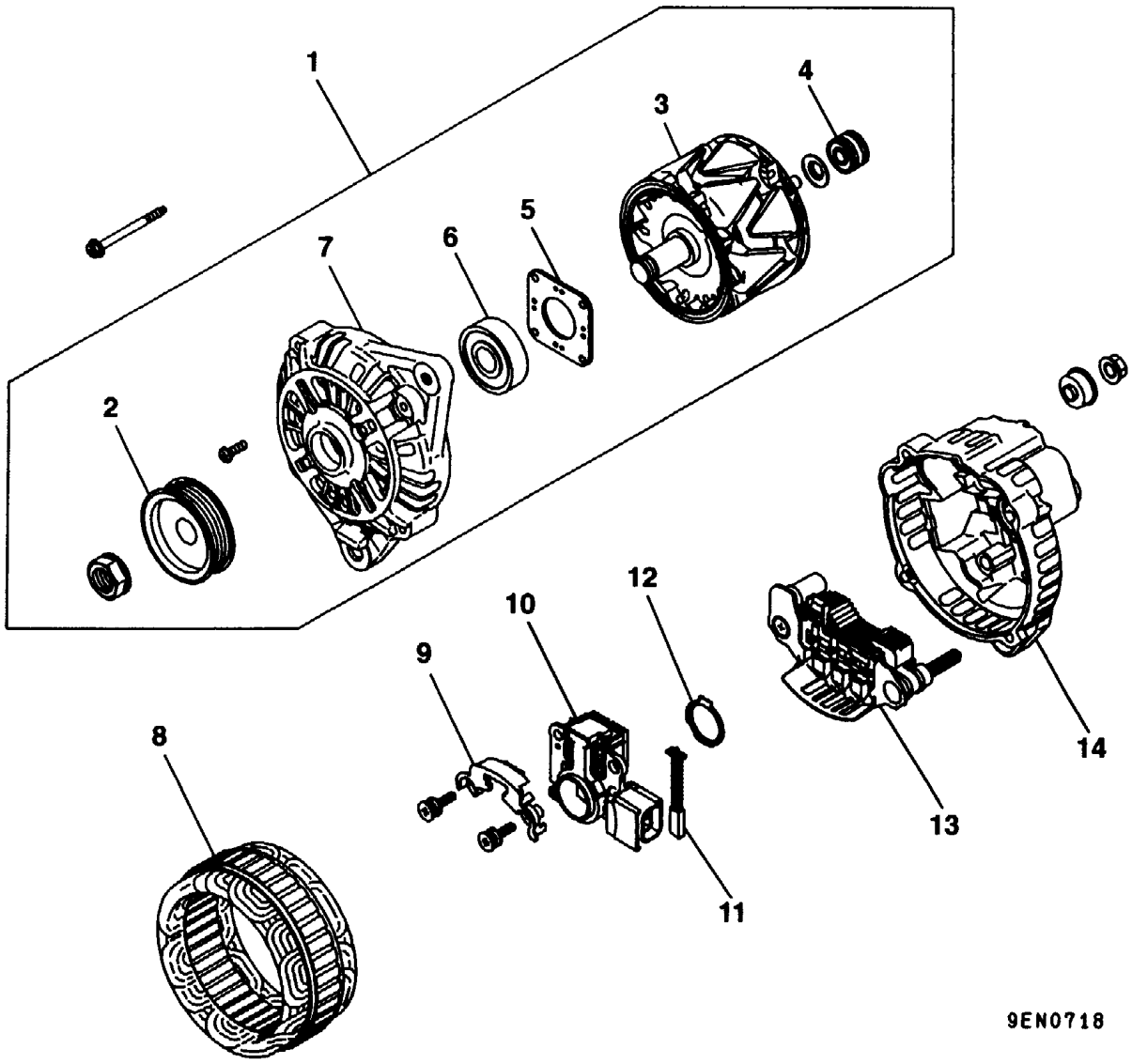
Check the compressor cover for traces of contact with the compressor wheel and other damage.

TURBINE WHEEL ASSEMBLY

(1) Check the turbine and compressor wheel blades for bend, burr, damage, corrosion and traces of contact on the back side and replace if defective.
(2) Check the oil passage of the turbine wheel assembly for deposit and clogging.
(3) In the case of water cooled type, check also the water passage for deposit and clogging.
(4) Check the turbine wheel and compressor wheel for light and smooth turning.

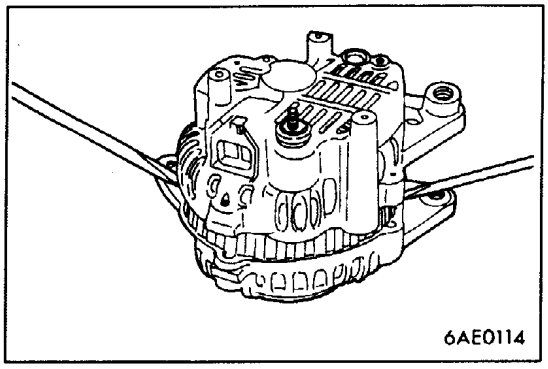
ALTERNATOR

DISASSEMBLY AND REASSEMBLY



Disassembly steps

◀A▶ ◀B▶ 1. Front bracket assembly
2. Alternator pulley
▶B◀ 3. Rotor
4. Rear bearing
5. Bearing retainer
6. Front bearing
7. Front bracket
◀C▶ 8. Stator
9. Plate
◀C▶ ▶A◀ 10. Regulator assembly
11. Brush
12. Slinger
13. Rectifier
14. Rear bracket

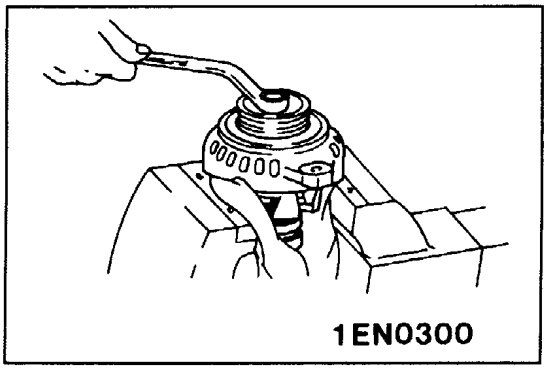


DISASSEMBLY SERVICE POINTS

◀A▶ FRONT BRACKET ASSEMBLY REMOVAL

Insert a flat tip screwdrivers or the like in the clearance between the front bracket assembly and stator core, to pry open and separate the stator and front bracket.

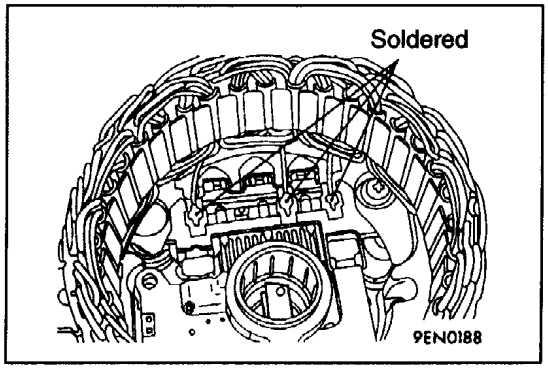
Caution
Do not insert the screwdriver too far, or the stator coil gets damaged.



◀B▶ ALTERNATOR PULLEY REMOVAL

Face pulley side upward, fix the rotor with a work bench and remove the pulley.

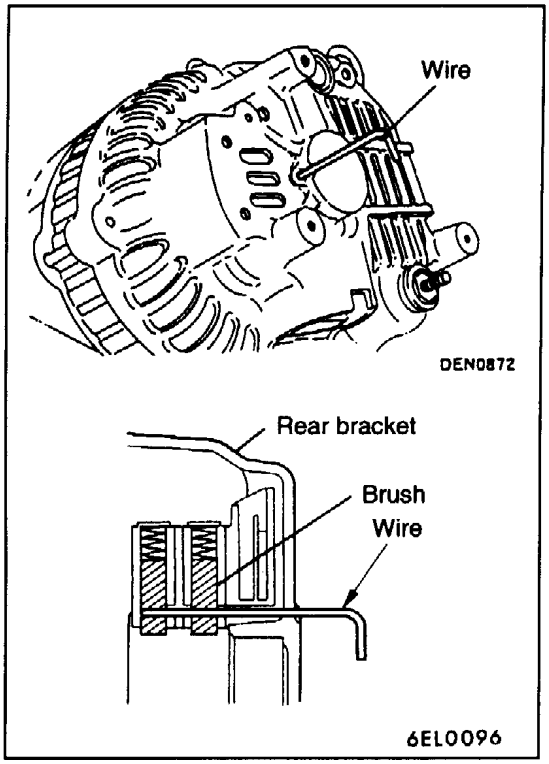
Caution
Use care not to damage the rotor.



◀C▶ STATOR / REGULATOR ASSEMBLY REMOVAL

(1) Unsolder the stator with a soldering iron (180 to 250 W). Complete this work within four seconds not to transfer heat to the diode.
(2) When removing rectifier from the regulator assembly, remove the soldered sections to rectifier.

Caution
1. **Use care to make sure that the heat of the soldering iron is not transmitted to the diodes for a long period.**
2. **Use care that no undue force is exerted to the lead wires of the diodes.**

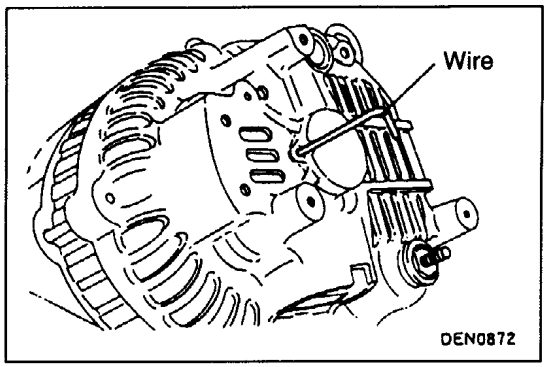


REASSEMBLY SERVICE POINTS

▶A◀ REGULATOR ASSEMBLY INSTALLATION

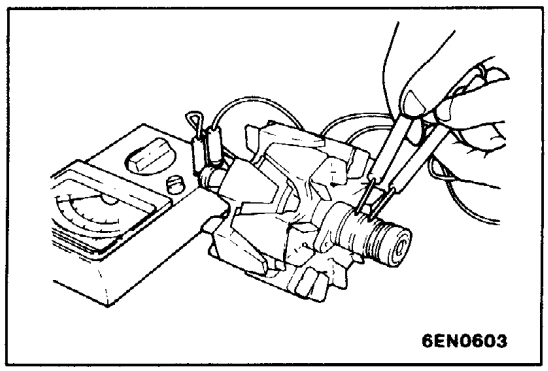
After installing the regulator assembly, insert a wire into the hole provided on the rear bracket while pressing in the brush to fix the brush.

NOTE
The brush is fixed when a wire is inserted, making rotor installation easier.



▶B◀ ROTOR INSTALLATION

After installing the rotor, remove the wire used to fix the brush.

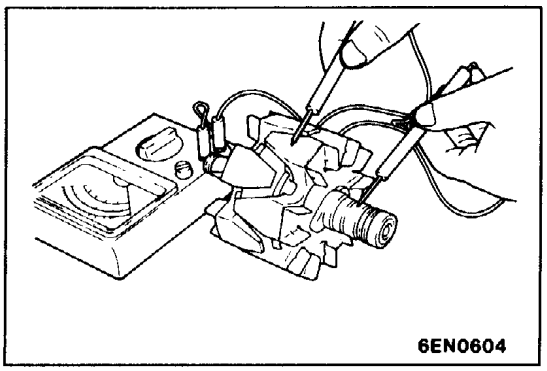


INSPECTION

ROTOR CHECK

(1) Check the continuity between the rotor coil slip rings, and replace the rotor if the resistance value is not at the standard value.

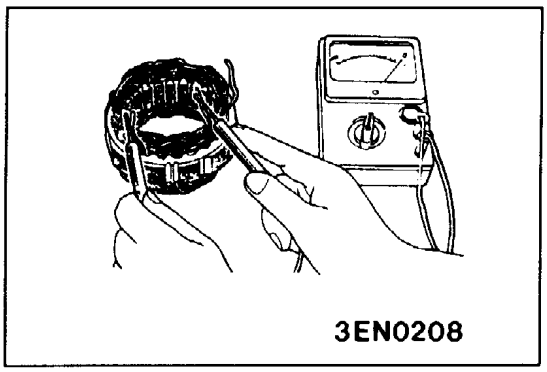
Standard value: 3 – 5 Ω



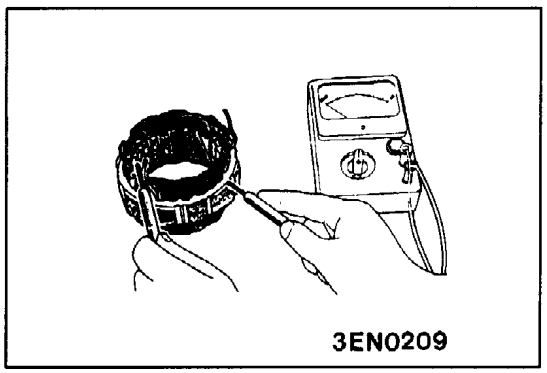
(2) Check the continuity between the slip ring and core, and if there is continuity, replace the rotor.

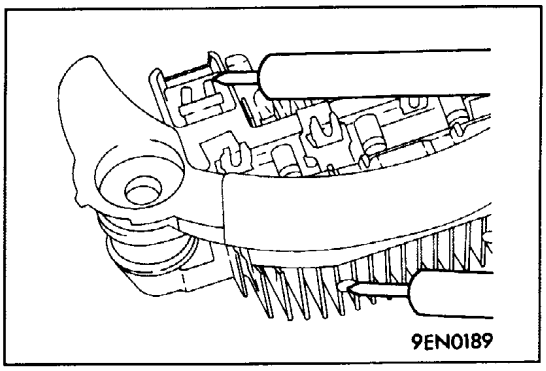
STATOR CHECK

(1) Check the continuity between the coil leads, and if there is continuity, replace the stator.



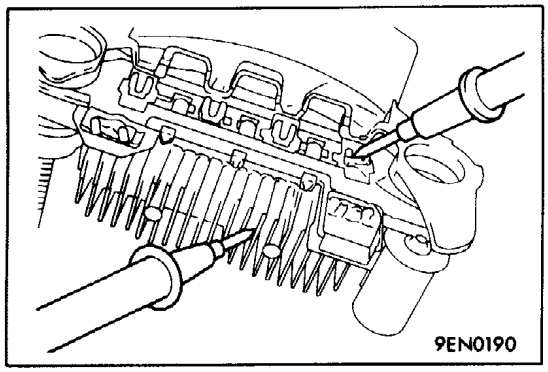
(2) Check the continuity between the coil and core, and if there is continuity, replace the stator.



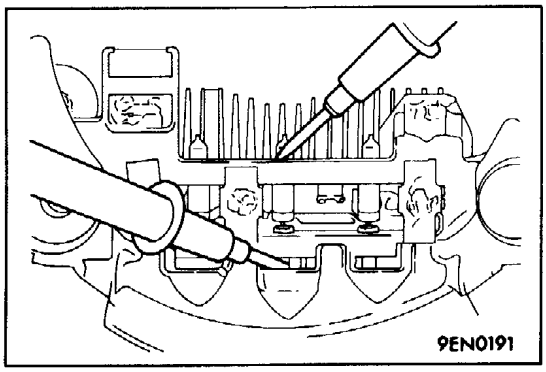


RECTIFIERS CHECK

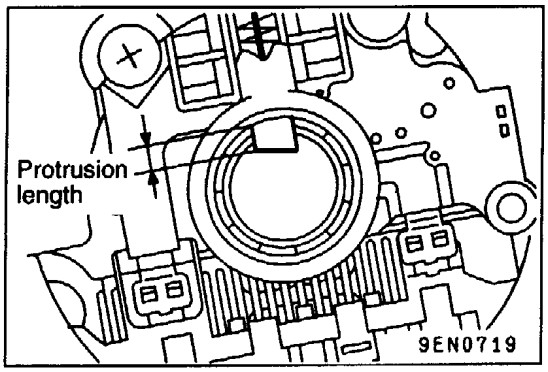
(1) Inspect the (+) heat sink by checking the continuity between the (+) heat sink and stator coil lead wire connection terminal using a tester probe.
If there is a continuity at both, the diode is short circuited, so replace the rectifier.



(2) Inspect the (–) heat sink by checking the continuity between the (–) heat sink and stator coil lead wire connection terminal using a tester probe.
If there is a continuity at both, the diode is short circuited, so replace the rectifier.



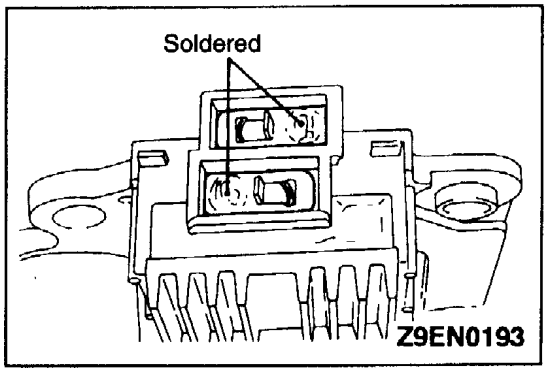
(3) Check the diode trio by connecting an ohmmeter to both ends of each diode and check the continuity of the three diodes.
If there is a continuity at both ends, or if there is no continuity, the diode is damaged so replace the recitifier.



BRUSH CHECK

(1) Measure the length of the brush protrusion shown in the illustration, and replace the brush if the measured value is below the limit value.

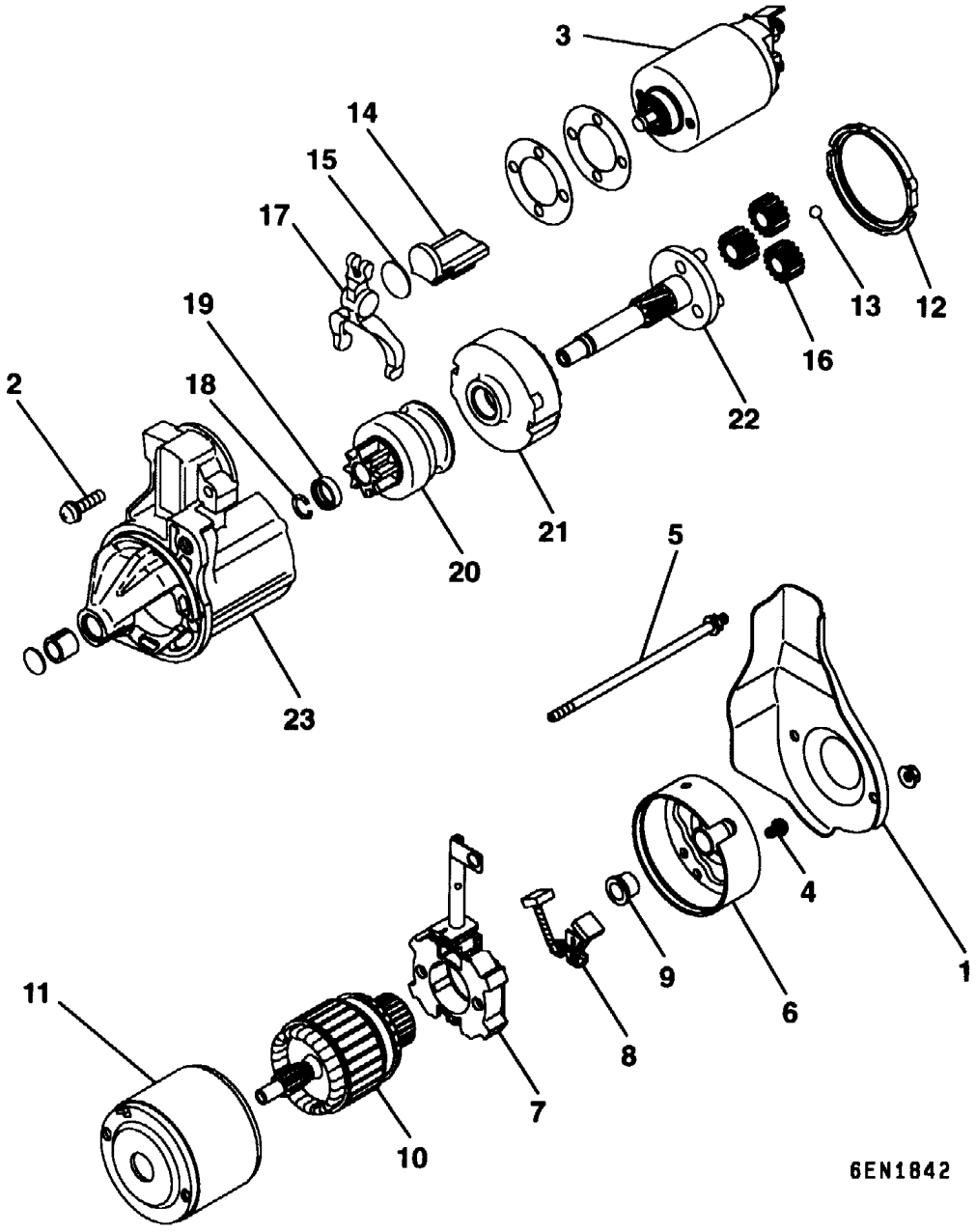
Limit: 2 mm or less



(2) The brush can be removed if the solder of the brush lead wire is removed.
(3) When installing a new brush, insert the brush into the holder as shown in the illustration, and then solder the lead wires.

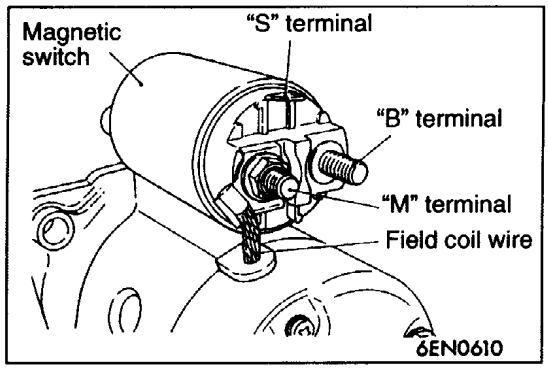
STARTER MOTOR

DISASSEMBLY AND REASSEMBLY



Disassembly steps

1. Cover
2. Screw
◀A▶ 3. Magnetic switch
4. Screw
5. Through
6. Rear bracket
7. Brush holder
8. Brush
9. Rear bearing
◀B▶ 10. Armature
11. Yoke assembly
◀B▶ 12. Ball
13. Packing A
14. Packing B
15. Plate
16. Planetary gear
17. Lever
◀C▶ ▶A◀ 18. Snap ring
◀C▶ ▶A◀ 19. Stop ring
20. Overrunning clutch
21. Internal gear
22. Planetary gear holder
23. Front bracket



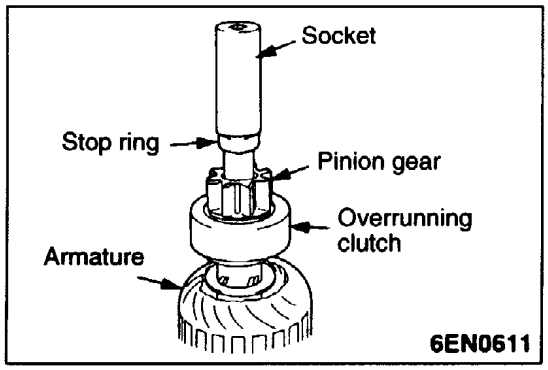
DISASSEMBLY SERVICE POINTS

◀A▶ MAGNETIC SWITCH REMOVAL

Disconnect field coil wire from "M" terminal of magnetic switch.

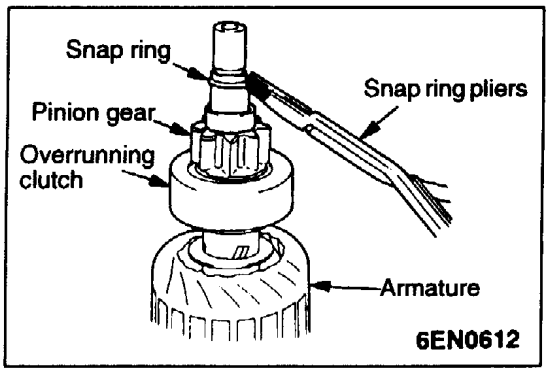
◀B▶ ARMATURE / BALL REMOVAL

Caution
When removing the armature, take care not to lose the ball (which is used as a bearing) in the armature end.



◀C▶ SNAP RING / STOP RING REMOVAL

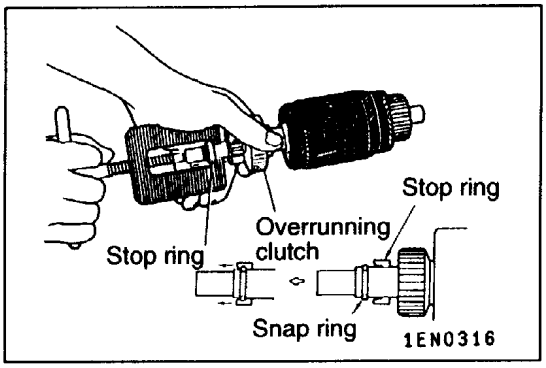
(1) Press stop ring off snap ring with a suitable socket.



(2) Remove snap ring with snap ring pliers and then remove stop ring and overrunning clutch.

STARTER MOTOR PARTS CLEANING

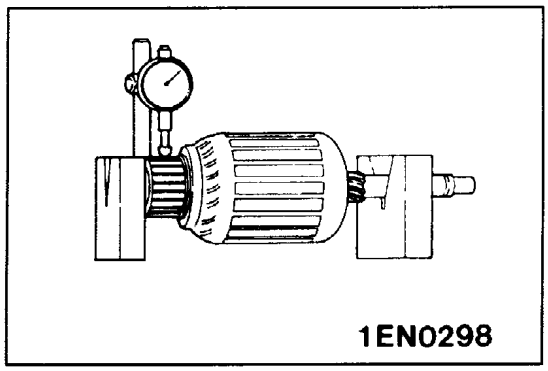
(1) Do not immerse parts in cleaning solvent. Immersing the yoke and field coil assembly and/or armature will damage insulation. Wipe motor assembly with a cloth only.
(2) Do not immerse drive unit in cleaning solvent. Overrunning clutch is pre-lubricated at the factory and solvent will wash lubrication from clutch.
(3) The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.



REASSEMBLY SERVICE POINTS

▶A◀ STOP RING / SNAP RING INSTALLATION

Using a suitable pulling tool, pull overrunnig clutch stop ring over snap ring.



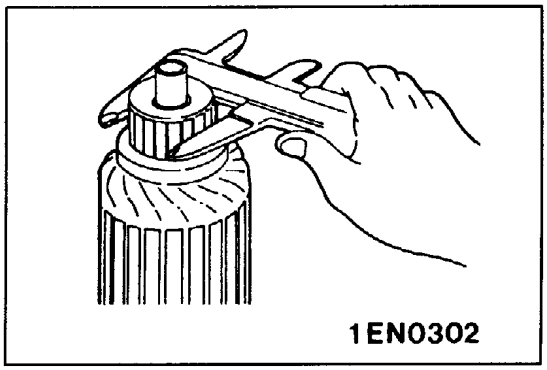
INSPECTION

COMMUTATOR CHECK

(1) Place the armature in a pair of "V" blocks and check the runout with a dial indicator.

Standard value: 0.05 mm

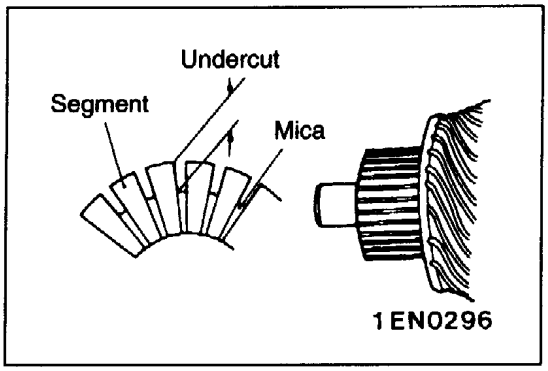
Limit: 0.1 mm



(2) Measure the commutator outer diameter.

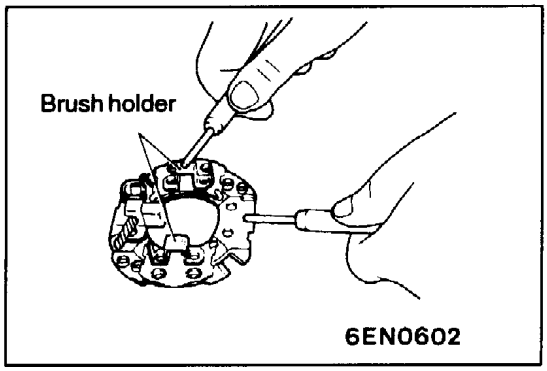
Standard value: 32.0 mm

Limit: 31.4 mm



(3) Check the undercut depth between segments.

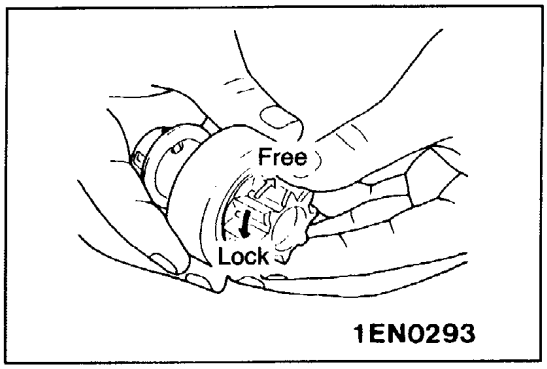
Standard value: 0.5 mm



BRUSH HOLDER CHECK

Check the continuity between brush holder plate and brush holder.

If there is no continuity, the brush holder is in order.

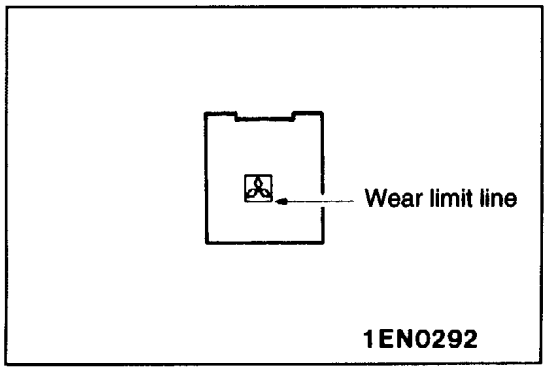


OVERRUNING CLUTCH CHECK

(1) While holding clutch housing, rotate the pinion. Drive pinion should rotate smoothly in one direction, but should not rotate in opposite direction. If clutch does not function properly, replace overrunnig clutch assembly.
(2) Inspect pinion for wear or burrs. If pinion is worn or burred, replace overrunning clutch assembly. If pinion is damaged, also inspect ring gear for wear or burrs.

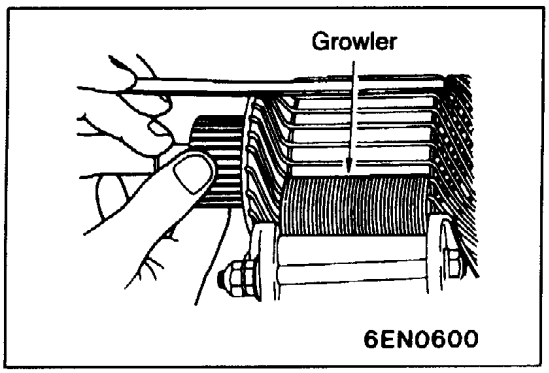
FRONT AND REAR BRACKET BUSHING CHECK

Inspect bushing for wear or burrs. If bushing is worn or burred, replace front bracket assembly or rear bracket assembly.



BRUSH AND SPRING REPLACEMENT

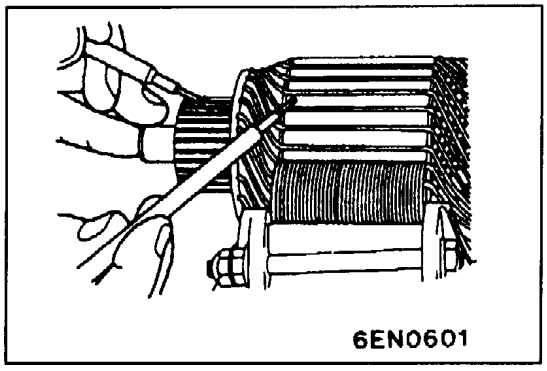
(1) Brushes that are worn beyond wear limit line, or oil-soaked, should be replaced.
(2) When replacing ground brush, slide the brush from brush holder by prying retaining spring back.



ARMATURE TEST

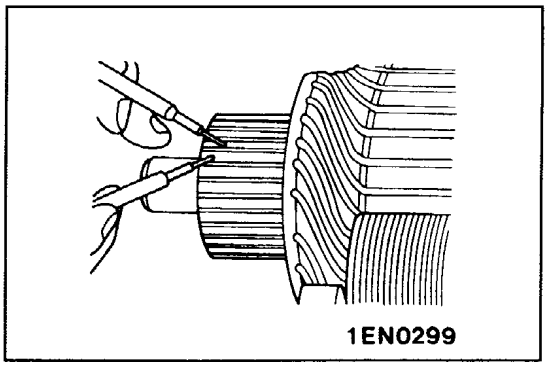
ARMATURE COIL SHORT-CIRCUIT TEST

(1) Place armature in a growler.
(2) Hold a thin steel blade parallel and just above while rotating armature slowly in growler. A shorted armature will cause blade to vibrate and be attracted to the core. Replace shorted armature.



ARMATURE COIL EARTH TEST

Check the insulation between each commutator segment and armature coil core.
If there is no continuity, the insulation is in order.



ARMATURE COIL OPEN-CIRCUIT INSPECTION

Check the continuity between segments. If there is continuity, the coil is in order.