

Engine Workshop Manual KJ

12/93 1409-10-93L

mazda

USA, CANADA

Mazda Engine Workshop Manual KJ

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FOREWORD

This manual explains the disassembly, inspection, repair, and reassembly procedures for the above-indicated engine. In order to do these procedures safely, quickly, and correctly, you must first read this manual and any other relevant service materials carefully.

The information in this manual is current up to Nov., 1993. Any changes that occur after that time will not be reflected in this particular manual. Therefore, the contents of this manual may not exactly match the mechanism that you are currently servicing.

For vehicles with vehicle identification numbers more recent, if there are any changes in the engine type indicated above or in similar engine type, these changes will be noted in that particular vehicle's workshop manual. Please refer to those materials together with this manual when servicing its respective engine.

**Mazda Motor Corporation
HIROSHIMA, JAPAN**

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1409-10-93L**

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HOW TO USE THIS MANUAL

This manual is intended for use by service technicians of authorized Mazda dealers. This manual details the Mazda engine structure and explains its service procedure.

PREPARATION

Preparation points out the needed Special Service Tool (SST) for the service operation that it proceeds. Gather all necessary SST before beginning work.

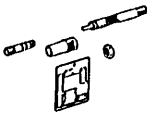
Ex.)

INSPECTION / REPAIR

B

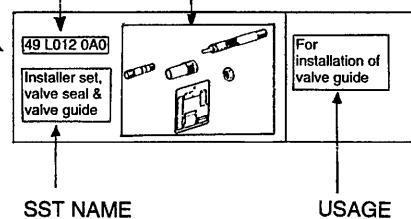
INSPECTION / REPAIR

PREPARATION SST

49 B012 005 Remover & installer, valve guide 	For removal/ installation of valve guide	49 L012 0A0 Installer set, valve seal & valve guide 	For installation of valve guide
49 L012 002 Body (Part of 49 L012 0A0) 	For installation of valve guide	49 L012 003 Installer (Part of 49 L012 0A0) 	For installation of valve guide
49 L012 004 Nut (Part of 49 L012 0A0) 	For installation of valve guide		

SST NUMBER

SST ILLUSTRATION



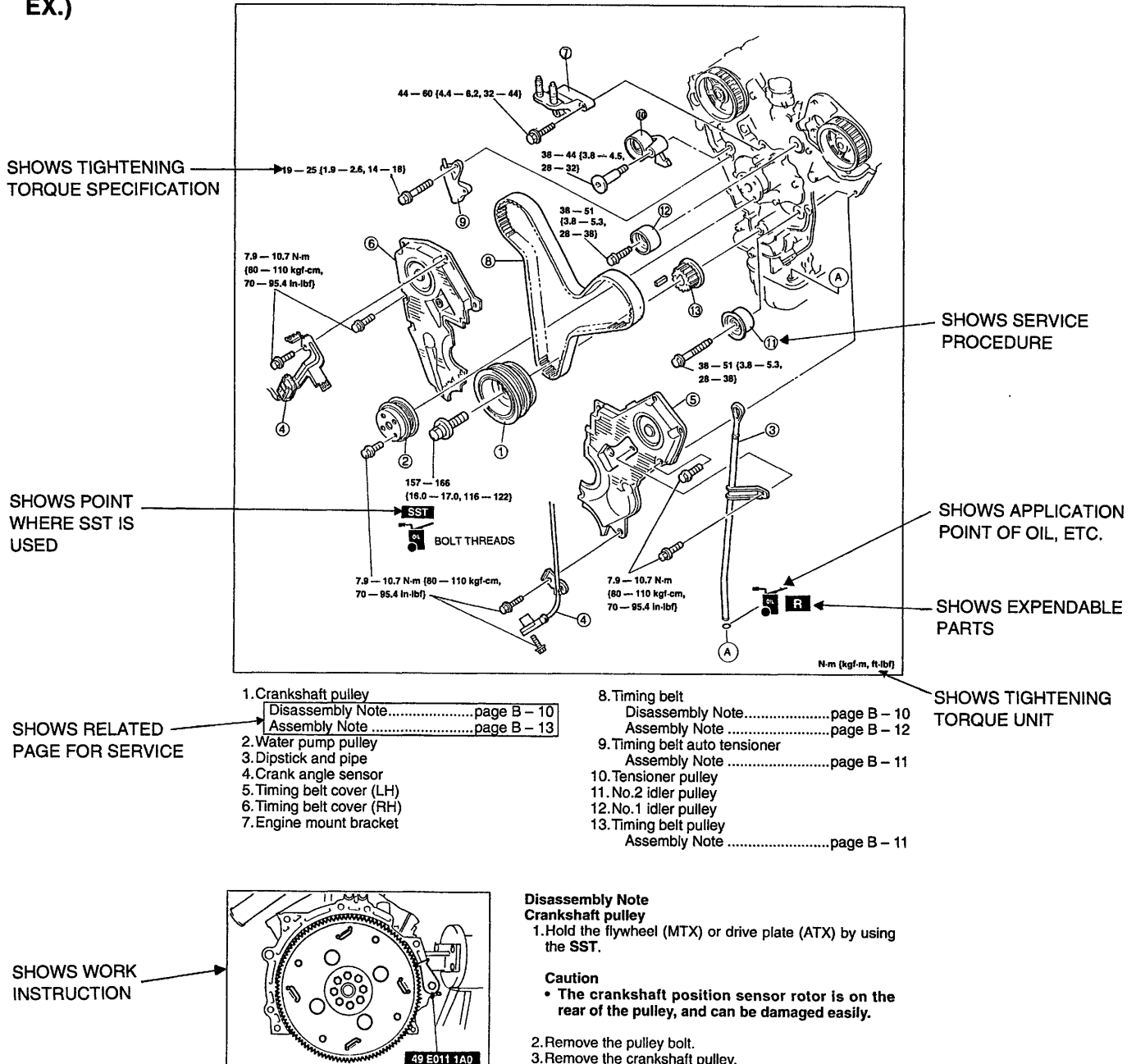
SST NAME

USAGE

REPAIR PROCEDURE

1. A structural view is shown at the beginning of each service operation to indicate name and configuration of each part, and how these parts are fit together.
2. The structural view shows all necessary information for service operation, such as procedure, oil and grease application points, where the Special Service Tool (SST) is used, expendable parts, and tightening torques.
3. Pages related to service procedures are shown under the structural view.
4. The numbers in the structural view indicate the service procedure. Proceed with service operation, referring to the instructions in the reference pages when provided.

EX.)



Note

- Vehicle data that are registered at the Ministry of Transport are shown in their original units.
- Tightening torque are shown in N-m {kgf-cm} when less than 1.5 kgf-m.

EX.)

4.0 - 4.9 N-m {40 - 50 kgf-cm}
 20 - 29 N-m {2.0 - 3.0 kgf-m}

SYMBOLS

Following symbols indicating oil, grease, and sealant are used in the structural view. These symbols show the points of applying such materials during service.

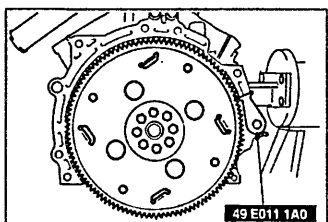
Symbol	Meaning	Description
	Apply oil (except ATF and brake fluid)	Engine oil, transaxle gear oil, etc.
	Apply grease	Genuine multi-purpose grease, genuine clutch grease, etc.
	Apply sealant	Liquid gasket, etc.
	Replace part	O-ring, gasket, etc.

Note

- When special oil or grease is needed, it is indicated in the illustration.

SST SYMBOLS

When a **SST** is required in a specific procedure, "**SST**" is written in the instruction and its **SST** No. is indicated in the corresponding illustration.



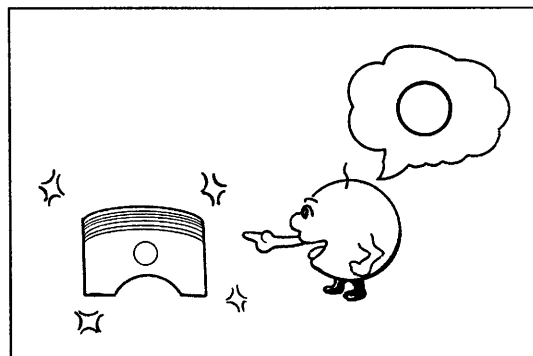
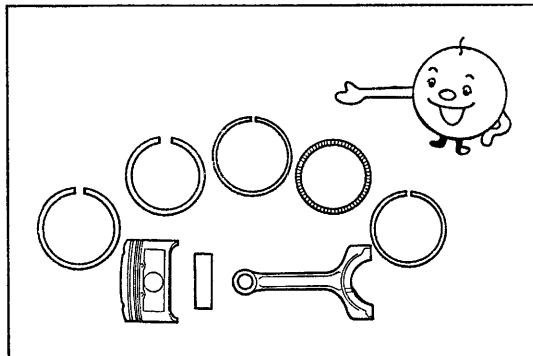
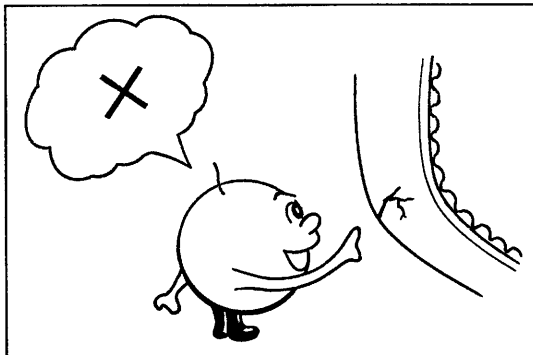
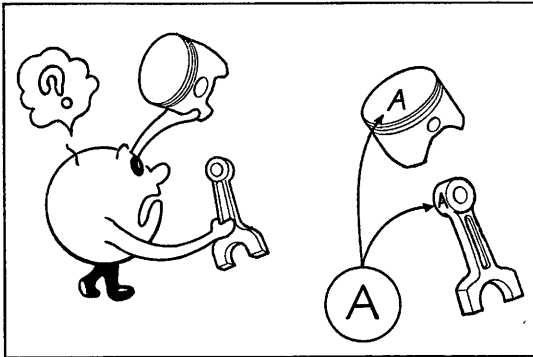
Disassembly Note
Crankshaft pulley
 1. Hold the flywheel (MTX) or drive plate (ATX) by using the **SST**.

Caution
 • The crankshaft position sensor rotor is on the rear of the pulley, and can be damaged easily.

2. Remove the pulley bolt.
 3. Remove the crankshaft pulley.

WORD DEFINITION

- Note** : An additional information that will help you to complete a particular procedure.
- Caution** : Important information for a particular procedure. Equipment damage could result when ignored.
- Warning** : Prohibition for a particular procedure. Death or injury could result when ignored.
- Standard** : Acceptable value range for inspection/adjustment.
- Limit** : Maximum or minimum value for inspection/adjustment.



FUNDAMENTAL PROCEDURES

DISASSEMBLY

If the disassembly procedure is complex, requiring many parts to be disassembled, all parts should be identified in a way that will not affect their performance or appearance for easy reassembly.

GI

1. Inspection of parts

When removed, each part should be carefully inspected for malfunctioning, deformation, damage, and other problems.

2. Arrangement of parts

All disassembled parts should be carefully arranged for reassembly. Be sure to separate or otherwise identify the parts to be replaced from those that will be reused.

3. Cleaning parts for reuse

All parts to be reused should be carefully and thoroughly cleaned in the appropriate method.

Warning

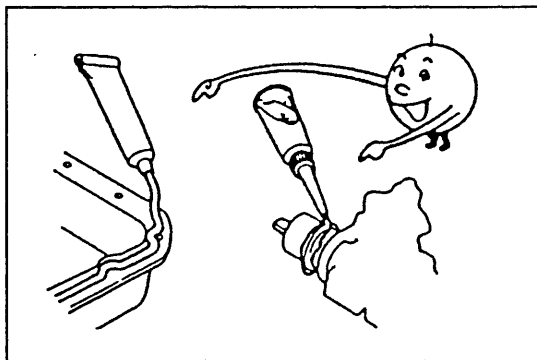
- Using compressed air can cause dirt and other particles to fly out, causing injury to the eyes. Wear protective eyewear whenever using compressed air.

REASSEMBLY

Standard values, such as tightening torques and adjustment values must be strictly observed in the reassembly of all parts.

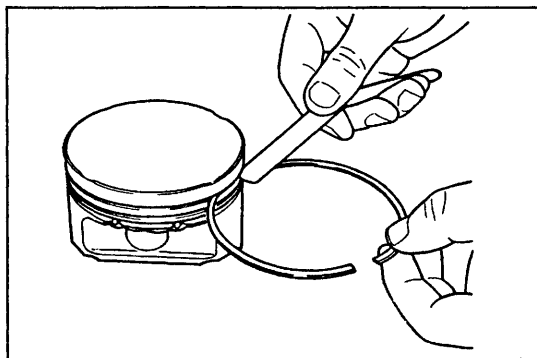
If removed, these parts should be replaced with new ones:

- | | |
|----------------|-----------------|
| 1. Oil seals | 2. Gaskets |
| 3. O-rings | 4. Lock washers |
| 5. Cotter pins | 6. Nylon nuts |



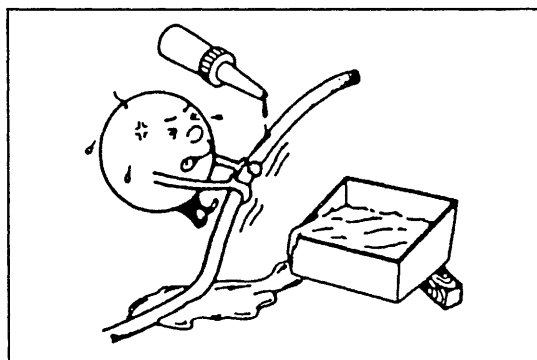
Depending on location:

1. Sealant should be applied to gaskets.
2. Oil should be applied to the sliding surfaces of moving parts.
3. Specified oil or grease should be applied at the prescribed locations (such as oil seals) before reassembly.



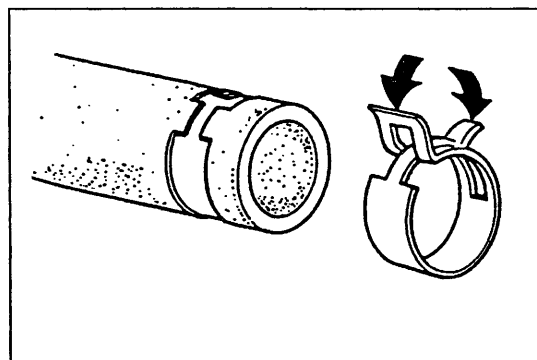
ADJUSTMENTS

Use gauges and/or testers when making adjustments.



RUBBER PARTS AND TUBING

Prevent gasoline or oil from getting on rubber parts or tubing.



HOSE CLAMPS

When reinstalling, position the hose clamp in the original location on the hose, and squeeze the clamp lightly with large pliers to ensure a good fit.

ABBREVIATIONS

A/CAir conditioner
 ATX.....Automatic transaxle
 BDC.....Bottom dead center
 EX.....Exhaust
 IN.....Intake
 LH.....Left hand
 MAX.....Maximum
 MIN.....Minimum
 MTX.....Manual transaxle
 O.SOver size
 P/S.....Power steering
 RHRight hand
 SSTSpecial service tool
 STDStandard
 U.SUnder size

SAE STANDARDS

Previous Standard	SAE Standard	
Name	Abbreviation	Name
Alternator	GEN	Generator
Catalytic Converter	WU-TWC	Warm Up Three Way Catalytic Converter #1
Crank Angle (Sensor)	CMP	Camshaft Position (Sensor)
Crank Angle (Sensor2)	CKP	Crankshaft Position (Sensor)
Intercooler	CAC	Charge Air Cooler

#1: Directy connected to exhaust manifold

GI

UNITS

N·m {kgf·m or kgf·cm,
 ft lbf or in·lbf}Torque
 °Angle
 mmLength
 N {kgf}Load

Conversion to SI Units (Système International d'Unités)

All numerical values in this manual are based on SI units. Numbers shown in conventional units are converted from these values.

Rounding off

Converted values are rounded off to the same number of places as the SI unit value. For example, if the SI unit value is 17.2 and the value after conversion is 37.84, the converted value will be rounded off to 37.8.

Upper and lower limits

When the data indicates upper and lower limits, the converted values are rounded down if the SI unit value is an upper limit and rounded up if the SI unit value is a lower limit.

Therefore, converted values for the same SI unit value may differ after conversion. For example, consider 2.7 kgf/cm² in the following specifications:

- * 210 — 260 kPa {2.1 — 2.7 kgf/cm², 30 — 38 psi}
- * 270 — 310 kPa {2.7 — 3.2 kgf/cm², 39 — 45 psi}

The actual converted values for 2.7 kgf/cm² are 264 kPa and 38.4 psi. In the top specification, 2.7 is used as an upper limit, so its converted values are rounded down to 260 and 38. In the bottom specification, 2.7 is used as a lower limit, so its converted values are rounded up to 270 and 39.

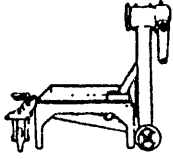
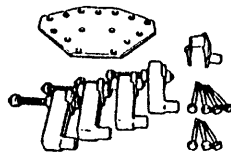
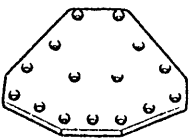
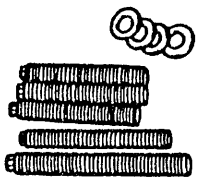
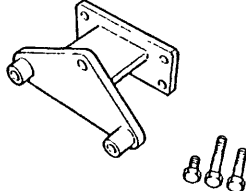
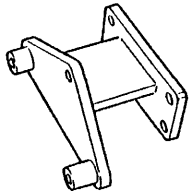
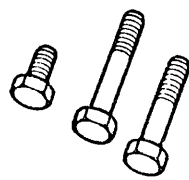
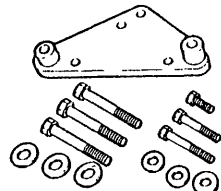
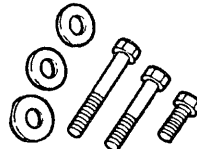
ENGINE OVERHAUL

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ENGINE STAND MOUNTING

PREPARATION

SST

49 0107 680A Engine stand 	For disassembly / assembly of engine	49 L010 1A0 Engine stand hanger set 	For disassembly / assembly of engine
49 L010 101 Plate (Part of 49 L010 1A0) 	For disassembly / assembly of engine	49 L010 102 Arm (Part of 49 L010 1A0) 	For disassembly / assembly of engine
49 L010 103 Hook (Part of 49 L010 1A0) 	For disassembly / assembly of engine	49 L010 104 Nut (Part of 49 L010 1A0) 	For disassembly / assembly of engine
49 L010 105 Bolt (Part of 49 L010 1A0) 	For disassembly / assembly of engine	49 L010 106 Bolt (Part of 49 L010 1A0) 	For disassembly / assembly of engine
49 E010 1A0 Engine stand hanger set 	For disassembly / assembly of engine	49 E010 101 Body (Part of 49 E010 1A0) 	For disassembly / assembly of engine
49 E010 102 Bolt (Part of 49 E010 1A0) 	For disassembly / assembly of engine	49 E010 1A1 Engine stand hanger set 	For disassembly / assembly of engine
49 E010 103 Hanger (Part of 49 E010 1A1) 	For disassembly / assembly of engine	49 E010 102 Bolt (Part of 49 E010 1A1) 	For disassembly / assembly of engine

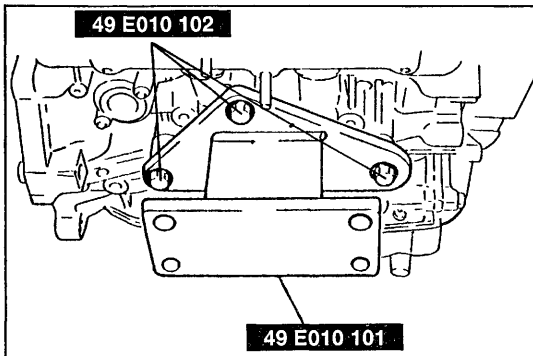
PROCEDURE

When using SST (49 E010 1A0)

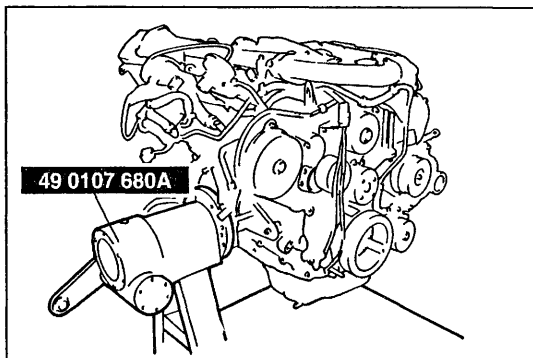
1. Remove the heated oxygen sensor (Front RH).
2. Remove the EGR pipe.
3. Remove the insulator (RH).
4. Remove the warm up three way catalytic converter (RH) and gasket.

B

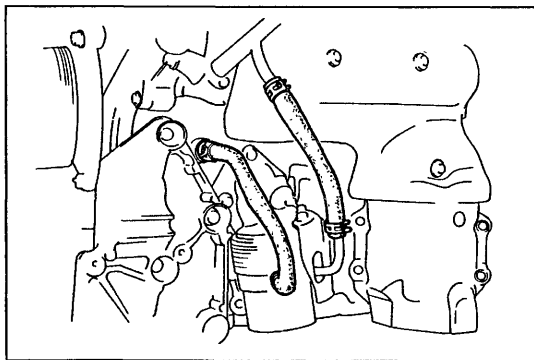
5. Instal the **SST** at the positions as shown.



6. Mount the engine on the **SST**.



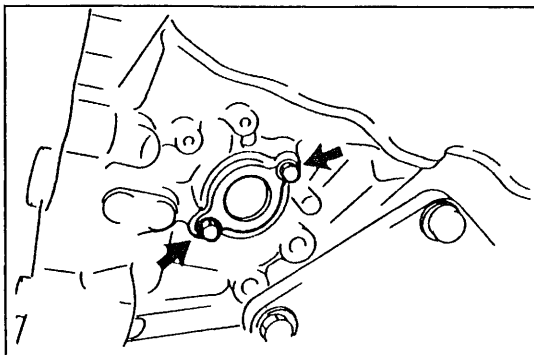
7. After installing the engine to the **SST** (engine stand), disconnect the oil cooler hoses as shown to drain the coolant.

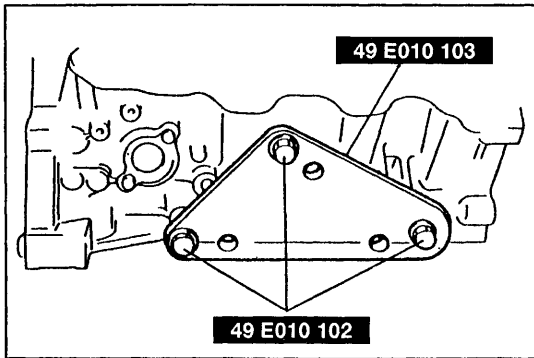


8. Remove the blind cover and drain the coolant.
9. After draining the coolant, install a new O-ring and install the blind cover.

Tightening torque:

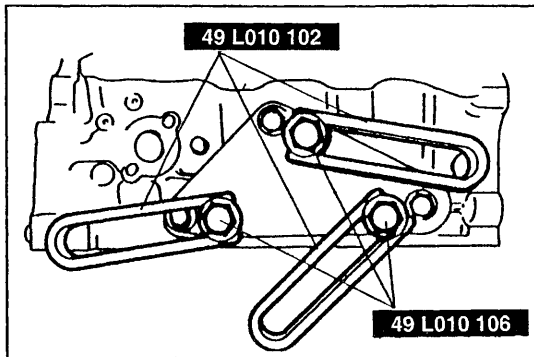
19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}



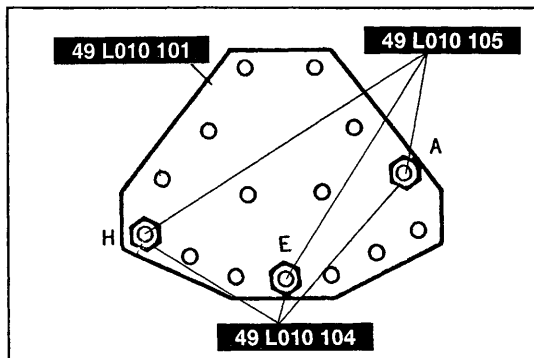


When using SST (49 E010 1A1 and 49 L010 1A0)

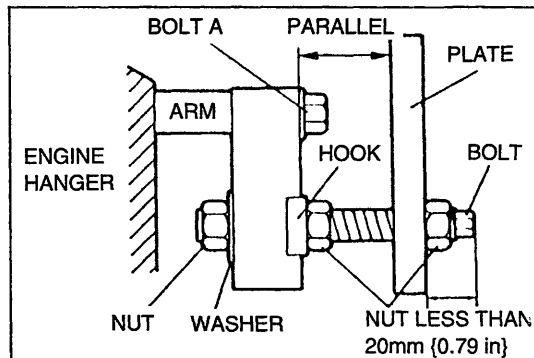
1. Remove the heated oxygen sensor (Front RH).
(Refer to page B – 3.)
2. Remove the EGR pipe. (Refer to page B – 3.)
3. Remove the insulator (RH). (Refer to page B – 3.)
4. Remove the warm up three way catalytic converter (RH) and gasket (RH).
(Refer to page B – 3.)
5. Install the **SST** at the positions as shown.



6. Install the **SST** (arms) to the holes as shown, and hand tighten the **SST** (bolts).



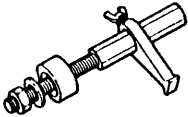
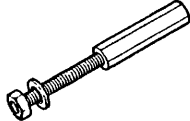
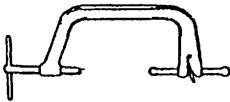
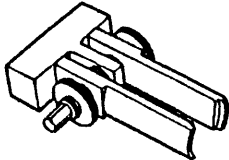
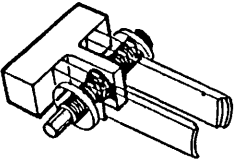
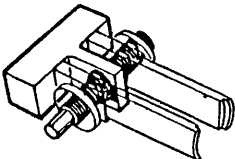
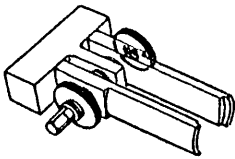
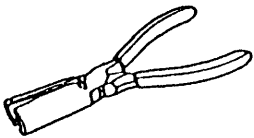
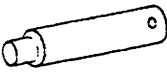
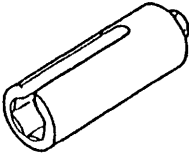
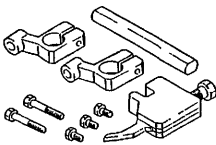
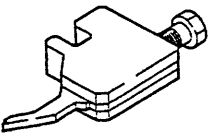
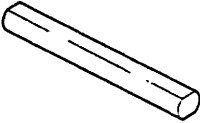
7. Assemble the **SST** (bolts, nuts and plate) as shown.



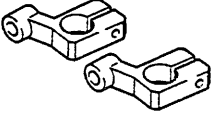
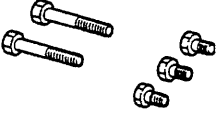
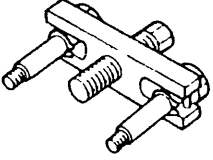
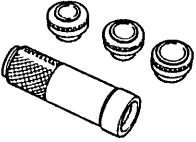
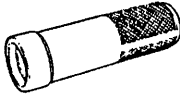
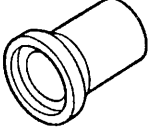
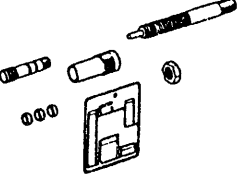
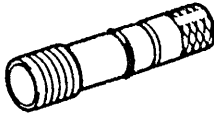
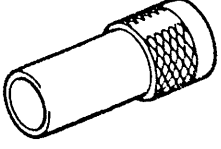
8. Install the **SST** assembled in step 7 to the **SST** installed in step 6.
9. Adjust the **SST** (bolts) so that less than **20 mm {0.79 in}** of thread is exposed.
10. Make the **SST** (plate and arms) parallel by adjusting the length of the bolts.
11. Tighten the **SST** (bolts and nuts) to affix the **SST** firmly.
12. Mount the engine on the **SST** (engine stand).
13. After installing the engine to the **SST** (engine stand), disconnect the oil cooler hoses to drain the coolant.
(Refer to page B – 3.)

DISASSEMBLY / ASSEMBLY

PREPARATION
SST

49 G014 001 Wrench, oil filter		For removal / installation of oil filter	49 E011 1A0 Brake set, ring gear		For prevention of crankshaft rotation
49 E011 103 Shaft (Part of 49 E011 1A0)		For prevention of crankshaft rotation	49 E011 104 Collar (Part of 49 E011 1A0)		For prevention of crankshaft rotation
49 E011 105 Stopper (Part of 49 E011 1A0)		For prevention of crankshaft rotation	49 0636 100B Lifter arm, valve spring		For removal / installation of valves
49 B012 0A2 Pivot		For removal / installation of valves	49 B012 012 Body (Part of 49 B012 0A2)		For removal / installation of valves
49 B012 013 Foot (Part of 49 B012 0A2)		For removal / installation of valves	49 B012 014 Locknut (Part of 49 B012 0A2)		For removal / installation of valves
49 S120 170 Remover, valve seal		For removal of valve seals	49 T011 001 Installer, piston pin		For removal / installation of piston pins
49 H018 001 Wrench, knock sensor		For removal / installation of knock sensor	49 T012 0A0 Holder, tappet		For replacement of adjustment shims
49 T012 001 Body (Part of 49 T012 0A0)		For replacement of adjustment shims	49 T012 002 Shaft (Part of 49 T012 0A0)		For replacement of adjustment shims

B

49 T012 003 Clamp, shaft (Part of 49 T012 0A0) 	For replacement of adjustment shims	49 T012 004 Bolt (Part of 49 T012 0A0) 	For replacement of adjustment shims
49 S120 215A Puller, pulley 	For removal of timing belt pulley	49 F401 330B Installer set, bearing 	For installation of camshaft oil seals
49 F401 337A Attachment C (Part of 49 F401 330B) 	For installation of camshaft oil seals	49 F401 331 Body (Part of 49 F401 330B) 	For installation of camshaft oil seals
49 G019 017 Installer, oil seal 	For installation of rear oil seal	49 H010 401 Installer, oil seal 	For installation of front oil seal
49 L012 0A0 Installer set, valve seal & valve guide 	For installation of valve seals	49 L012 001 Installer (Part of 49 L012 0A0) 	For installation of valve seals
49 L012 005 Spacer (Part of 49 L012 0A0) 	For installation of valve seals	49 L012 002 Body (Part of 49 L012 0A0) 	For installation of valves seals

1. Code or arrange all identical parts (such as pistons, piston rings, connecting rods, and valve springs.) so that they can be reinstalled in the cylinder from which they were removed.
2. Clean the parts by using a steam cleaner. Blow dry with compressed air.
3. Clean all parts before reinstallation.
4. Apply clean engine oil to all sliding and rotating parts.
5. Replace plain bearings if they are peeled, burned, or otherwise damaged.
6. Tighten all bolts and nuts to the specified torque.

warning

- Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

AUXILIARY PARTS (I)

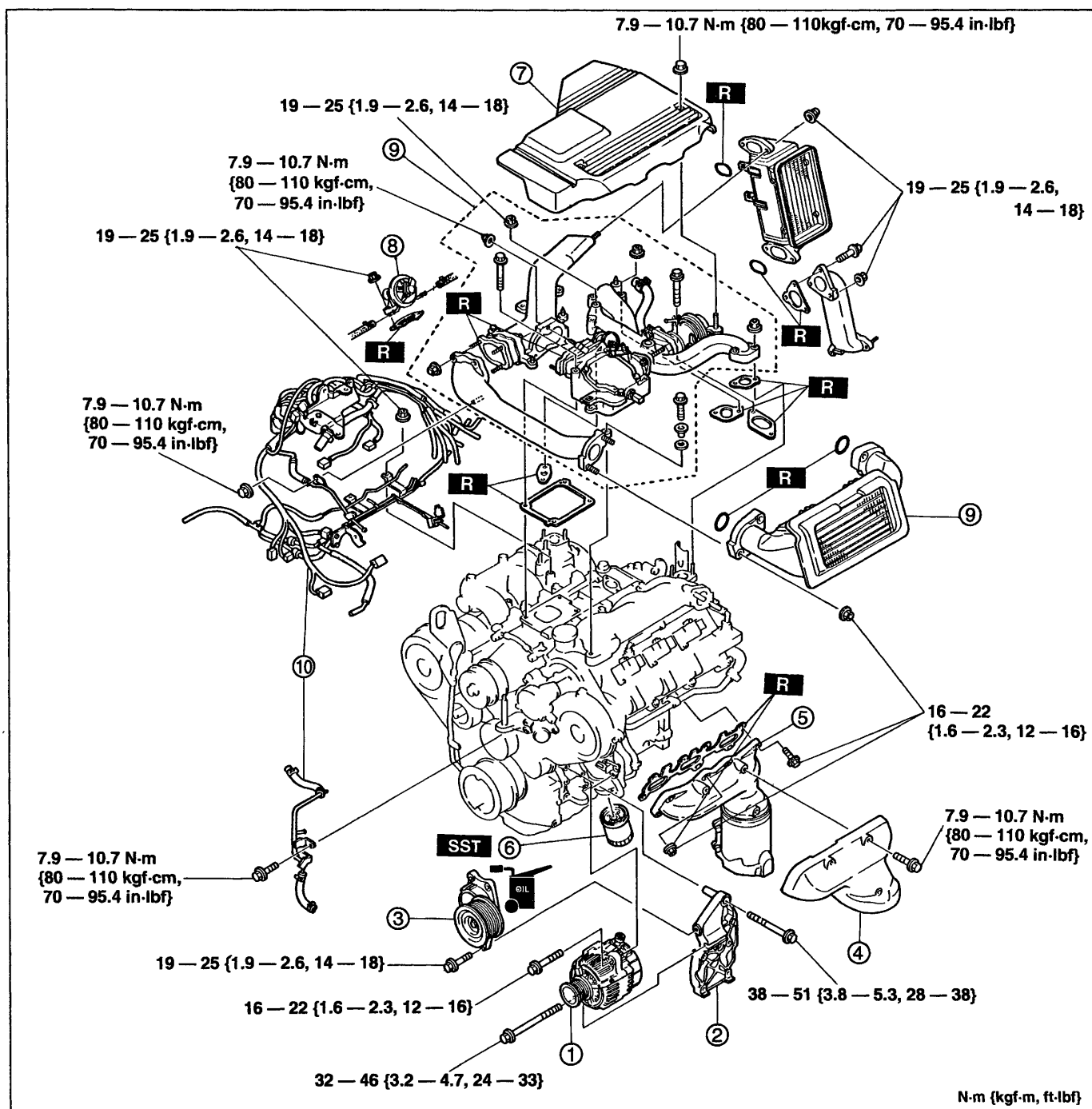
1. Remove the oil drain plug and drain the engine oil. After draining the engine oil, install the oil drain plug.

Tightening torque: 30 — 41 N·m {3.0 — 4.2 kgf·m, 22 — 30 ft·lbf}

2. Disassemble in the order shown in the figure, referring to **Disassembly Note**.

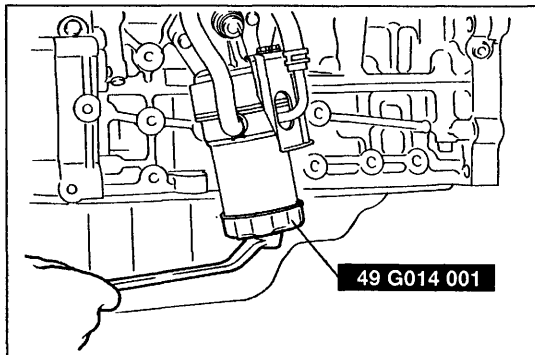
3. Assemble in the reverse order of disassembly, referring to **Assembly Note**.

B

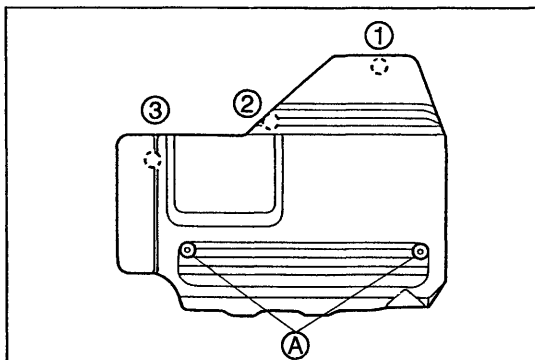


1. Generator
2. A/C compressor bracket
3. Auto tensioner (generator)
4. Insulator (LH)
5. Warm up three way catalytic converter (LH)
Assembly Notepage B — 9
6. Oil filter
Disassembly Note.....page B — 8
Assembly Notepage B — 9

7. Dynamic chamber cover
Disassembly Note.....page B — 8
8. EGR control valve
9. Charge air cooler, air intake pipe assembly
Assembly Notepage B — 8
10. Harness and hose assembly

**Disassembly Note****Oil filter**

Remove the oil filter by using the **SST**.

**Dynamic chamber cover**

1. Remove nuts (A).

2. Remove the dynamic chamber cover in the order shown.

Assembly Note**Charge air cooler, air intake pipe assembly**

1. Hand tighten the nuts and bolts in the order shown until the air intake pipe No.3 contacts the intake manifold.

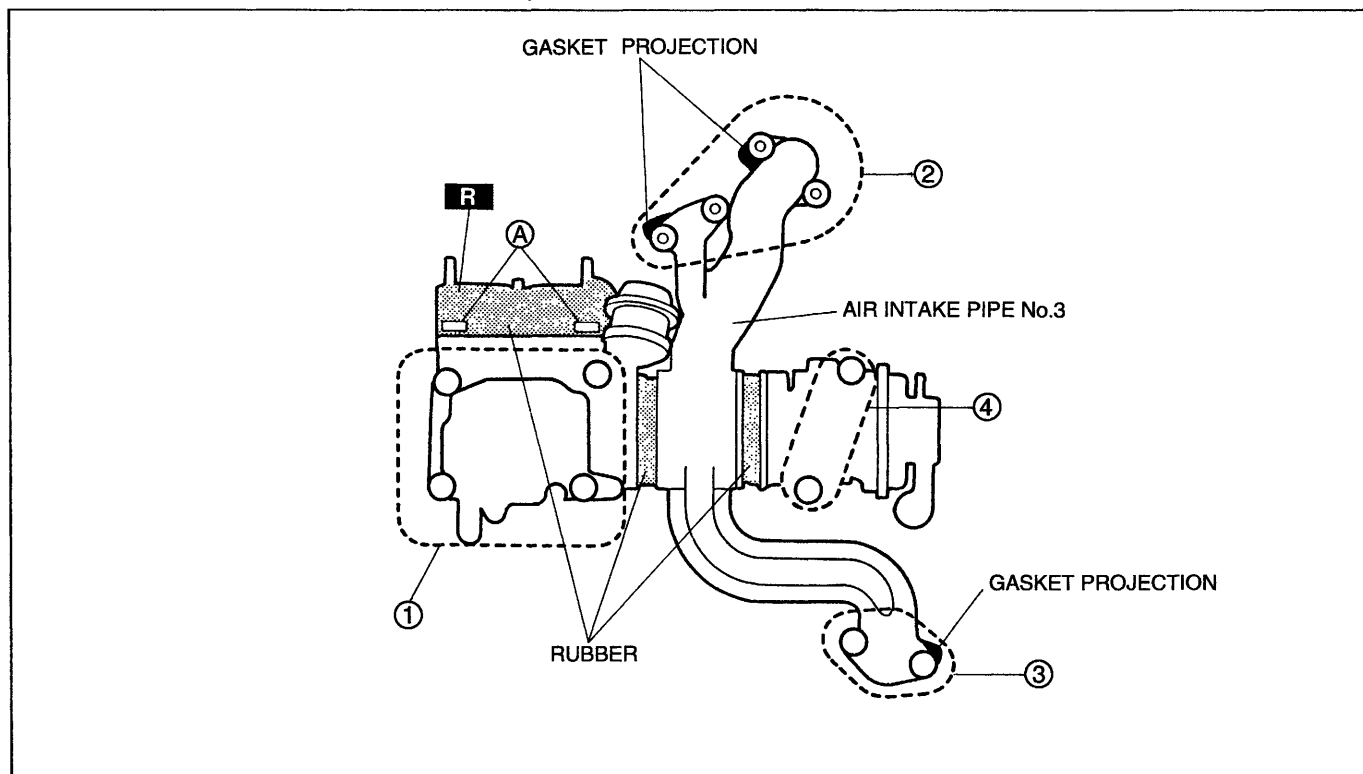
2. Verify that the rubbers are not twisted or distorted.

3. Tighten the nuts and bolts to the specified torque in the order shown.

Tightening torque

(A): 7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}

Others: 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

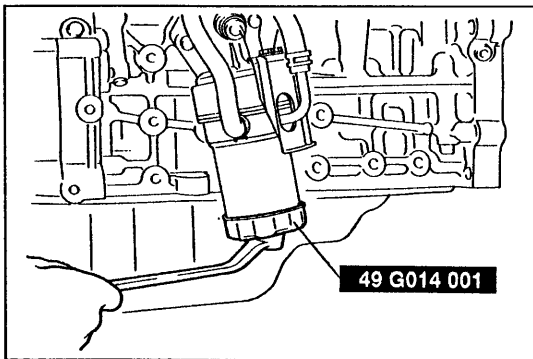
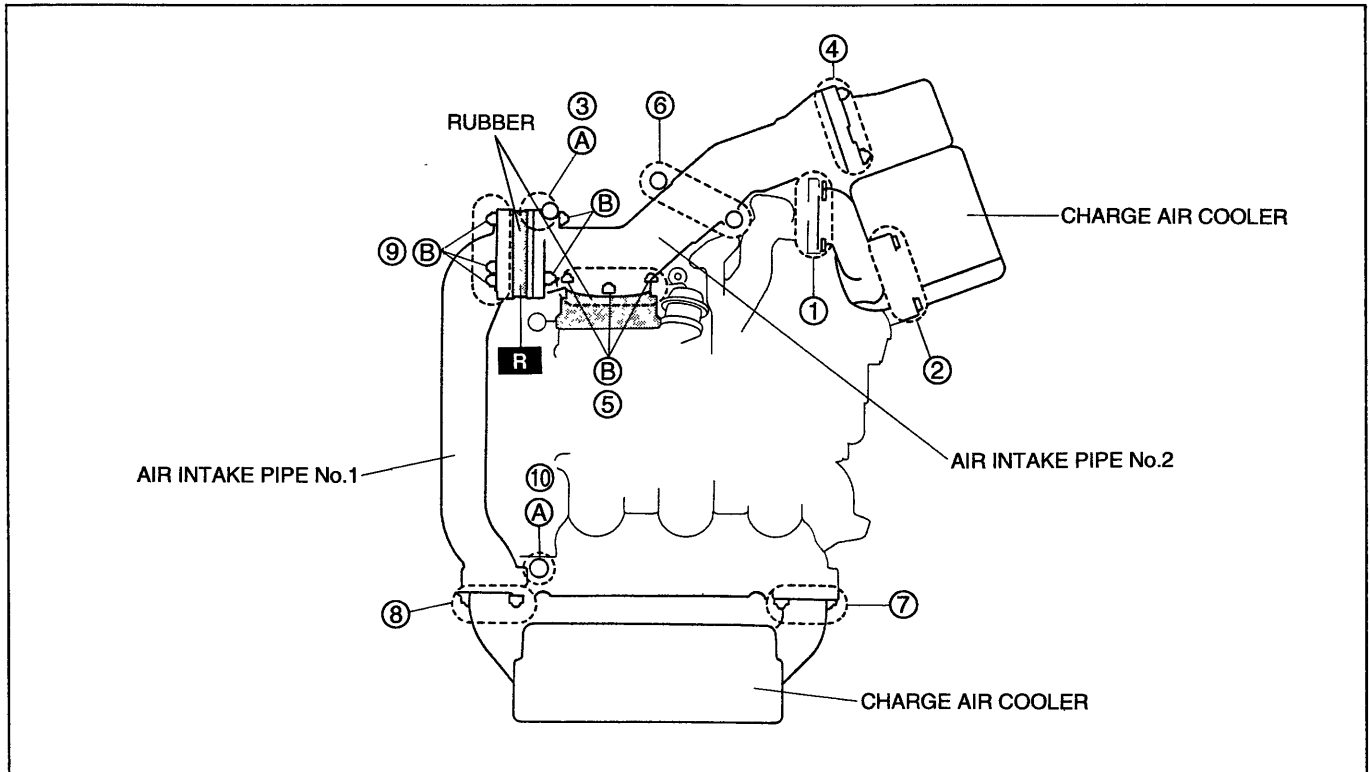


4. Hand tighten the nuts and bolts in the order shown until the charge air coolers and the air intake pipes No.1 and No.2 contact the intake manifold.
5. Verify that the rubbers are not twisted or distorted.
6. Tighten the nuts and bolts to the specified torque in the order shown.

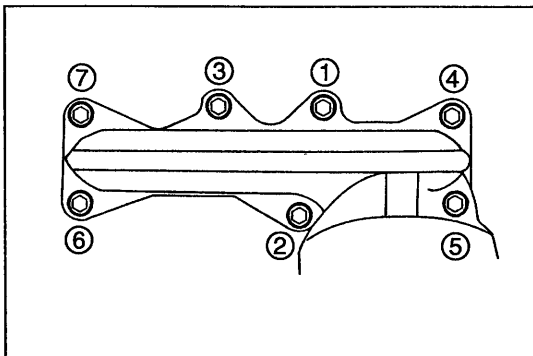
Tightening torque

- Ⓐ: 5.8 — 8.8 N·m {50 — 90 kgf·cm, 44 — 78 in·lbf}
 Ⓑ: 7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}
 Others: 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

B

**Oil filter**

1. Apply clean engine oil to the rubber seal of the oil filter.
2. Install the oil filter and tighten it by hand until the rubber seal contacts the oil cooler.
3. Tighten the oil filter 1 — 1/6 turns by using the SST.

**Warm up three way catalytic converter (LH)**

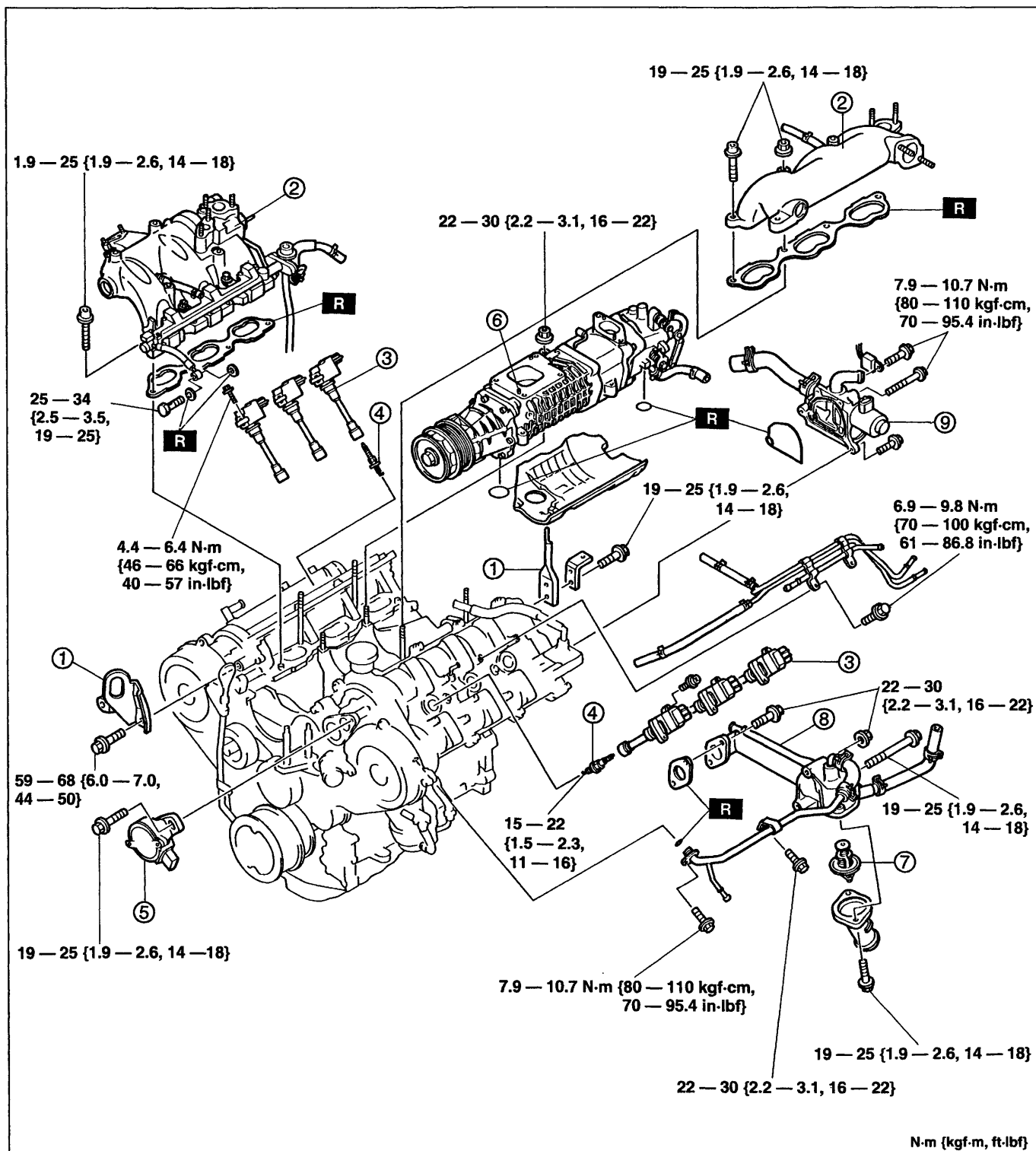
1. Install a new gasket and the warm up three way catalytic converter (LH).
2. Tighten the bolts and new nuts in the order shown.

Tightening torque:

- 16 — 22 N·m {1.6 — 2.3 kgf·m, 12 — 16 ft·lbf}

AUXILIARY PARTS (II)

1. Disassemble in the order shown in the figure.

2. Assemble in the reverse order of disassembly, referring to **Assembly Note**.

1. Engine hanger

2. Intake manifold assembly

Assembly Notepage B — 11

3. Ignition coil

4. Spark plug

5. Camshaft position sensor

6. Lysholm compressor

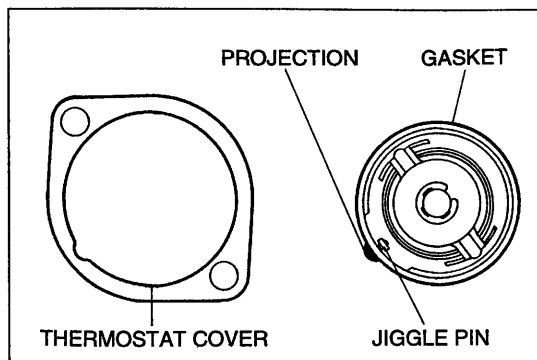
Assembly Notepage B — 11

7. Thermostat

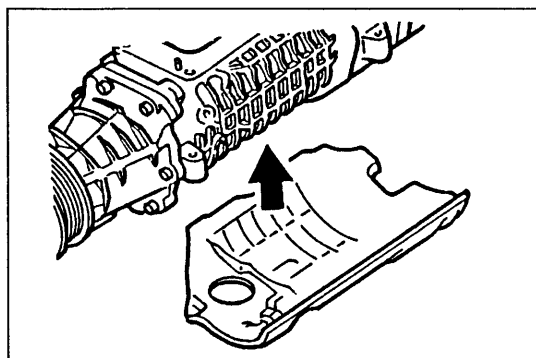
Assembly Notepage B — 11

8. Water pipe and thermostat case

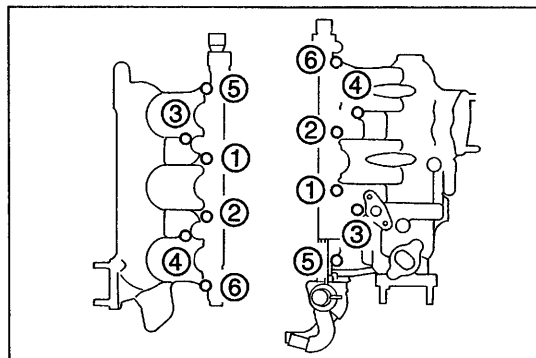
9. BAC valve

**Assembly Note****Thermostat**

1. Verify that the jiggle pin is aligned with the projection of thermostat gasket as shown.
2. Install the thermostat and gasket into the thermostat cover, aligning the projection to the cover as shown.

**Lysholm compressor**

Before installation, temporarily fix the rubber onto the Lysholm compressor with two-side adhesive tape.

**Intake manifold assembly**

1. Install the intake manifold assembly with the new gaskets.
2. Tighten the bolts and nuts in the order shown.

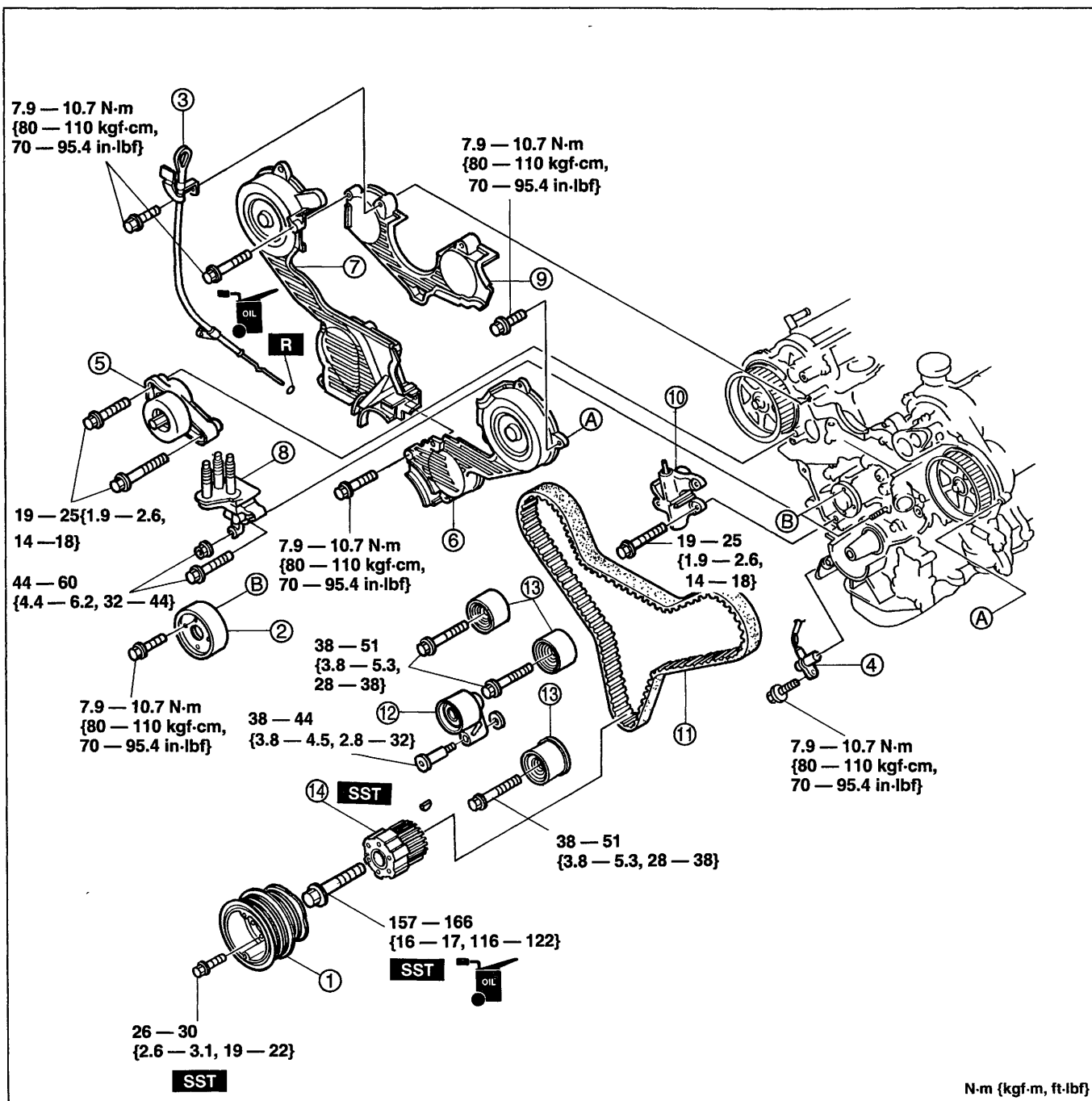
Tightening torque:

19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

TIMING BELT

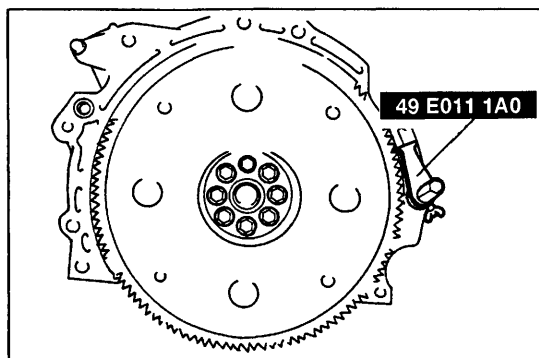
1. Disassemble in the order shown in the figure, referring to **Disassembly Note**.

2. Assemble in the reverse order of disassembly, referring to **Assembly Note**.

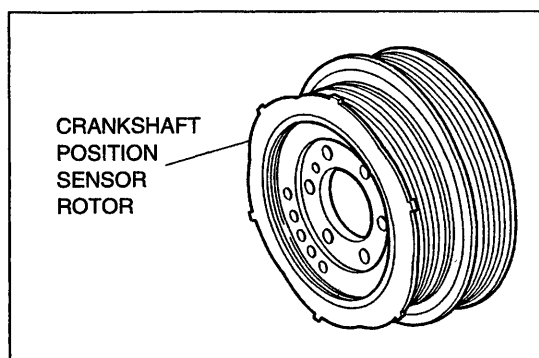


1. Crankshaft pulley
Disassembly Note.....page B — 13
Assembly Notepage B — 16
2. Water pump pulley
3. Dipstick and pipe
4. Crankshaft position sensor
5. Auto tensioner (P/S oil pump)
6. Timing belt cover (LH)
Assembly Notepage B — 15
7. Timing belt cover (RH)
Assembly Notepage B — 15
8. No.3 engine mount bracket

9. Timing belt cover (Upper)
Assembly Notepage B — 15
10. Timing belt auto tensioner
Disassembly Note.....page B — 13
Assembly Notepage B — 15
11. Timing belt
Disassembly Note.....page B — 13
Assembly Notepage B — 14
12. Tensioner pulley
13. No.1, No.2 idler pulley
14. Timing belt pulley
Disassembly Note.....page B — 14
Assembly Notepage B — 14

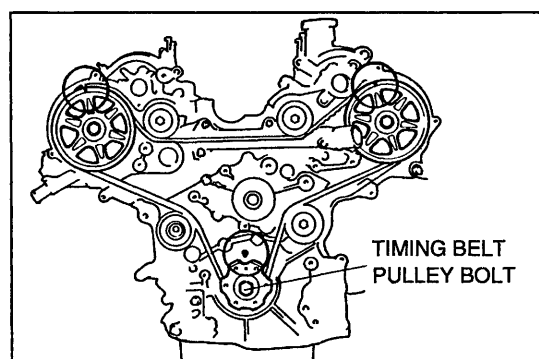
**Disassembly Note****Crankshaft pulley**

1. Hold the drive plate by using the **SST**.
2. Remove the crankshaft pulley bolts.

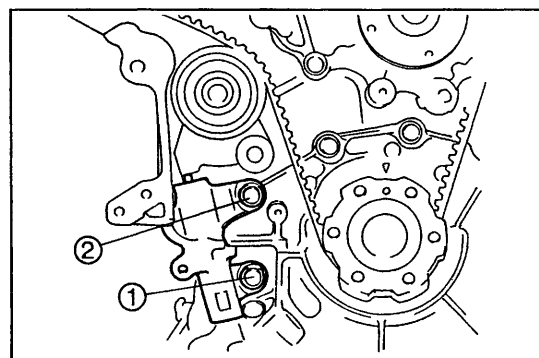
**Caution**

- The crankshaft position sensor rotor is on the rear of the pulley, and can be damaged easily.

3. Remove the crankshaft pulley.

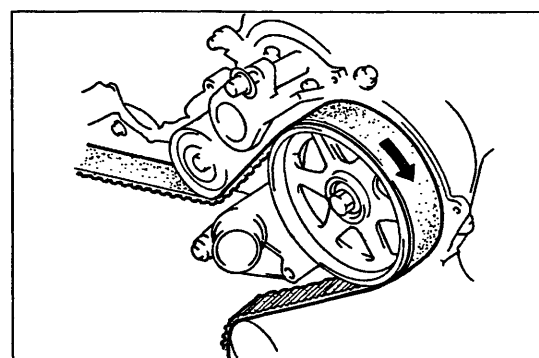
**Timing belt auto tensioner**

1. Before removing the auto tensioner, temporarily install the timing belt pulley bolt.
2. Turn the crankshaft clockwise to align the timing marks of the pulleys.

**Caution**

- When removing the bolt, hold the tensioner so that the bolt holes are aligned, otherwise the threads can be damaged.

3. Remove the auto tensioner bolts in five or six steps in the order shown.
4. Remove the auto tensioner.

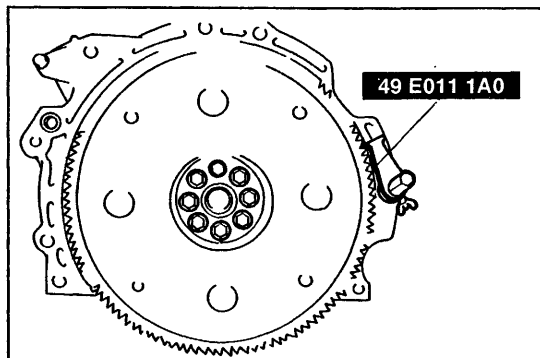
**Timing belt**

1. Mark the timing belt rotation for proper reinstallation.

Caution

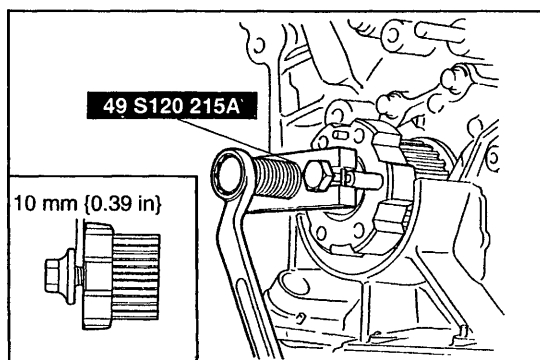
- The following will damage the belt and shorten its life; forcefully twisting it, turning it inside out, bending it, or allowing oil or grease on it.

2. Remove the timing belt.



Timing belt pulley

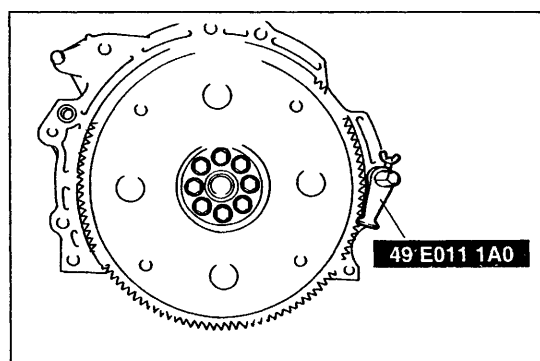
1. Hold the drive plate by using the **SST**.



2. Loosen the timing belt pulley lock bolt 10 mm {0.39 in}.

3. Remove the timing belt pulley by using the **SST**.

4. Remove the crankshaft key.



Assembly Note

Timing belt pulley

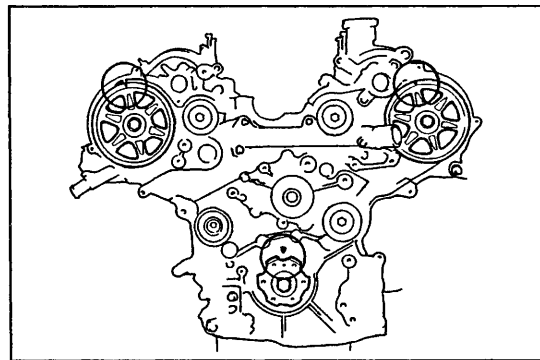
1. Hold the drive plate by using the **SST**.

2. Apply clean engine oil to the timing belt pulley bolt threads.

3. Tighten the timing belt pulley bolt.

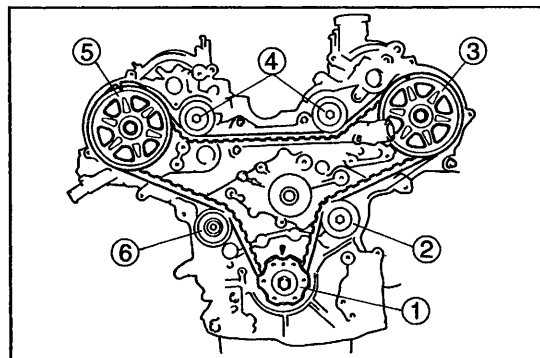
Tightening torque:

157 — 166 N·m {16 — 17 kgf·m, 116 — 122 ft·lbf}



Timing belt

1. Align the timing marks of the pulleys.



2. Install the timing belt on the pulleys in the order described below.

① Timing belt pulley

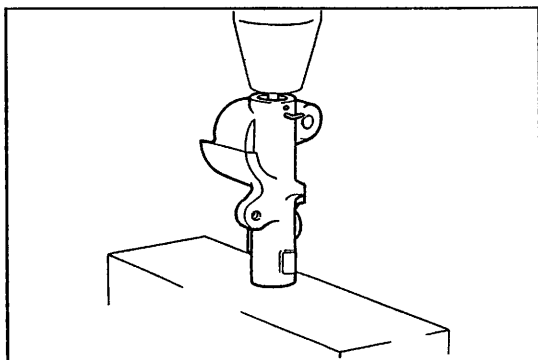
② No.2 idler pulley

③ Camshaft pulley (LH)

④ No.1 idler pulleys

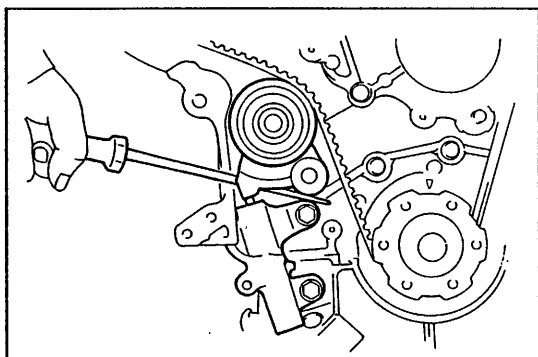
⑤ Camshaft pulley (RH)

⑥ Tensioner pulley

**Timing belt auto tensioner****Caution**

- Applying pressure of more than 9807 N {1000 kgf, 2200 lbf} can damage the tensioner.

1. Press in the tensioner rod slowly, using a press.
2. Insert a pin (ϕ 1.6 mm {0.06 in}) into the second hole in the body to hold the tensioner rod.

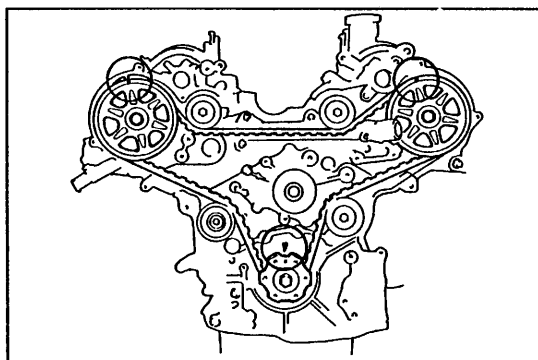


3. Install the auto tensioner and hand tighten the auto tensioner bolts.
4. Push up the auto tensioner by using a screwdriver and tighten the auto tensioner bolts.

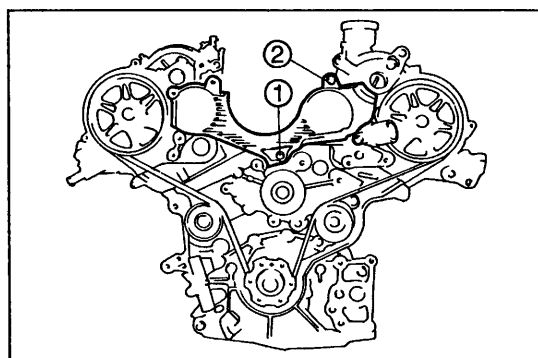
Tightening torque:

19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

5. Remove the pin from the auto tensioner, and apply tension to the belt.



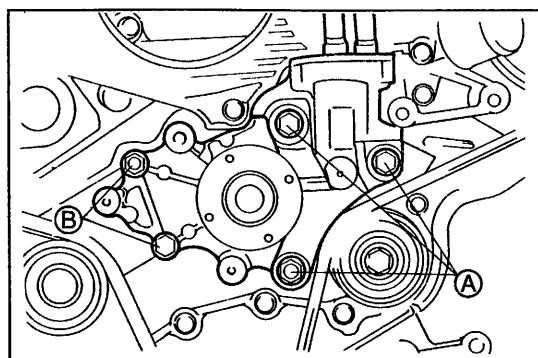
6. Turn the crankshaft clockwise two turns, and align the timing marks.
 7. Verify that all timing marks are correctly aligned. If not aligned, remove the timing belt and repeat the procedure from Timing belt.
- (Refer to page B – 14.)

**Timing belt cover**

1. Install the timing belt cover (Upper) and tighten the bolts in the order shown.

Tightening torque:

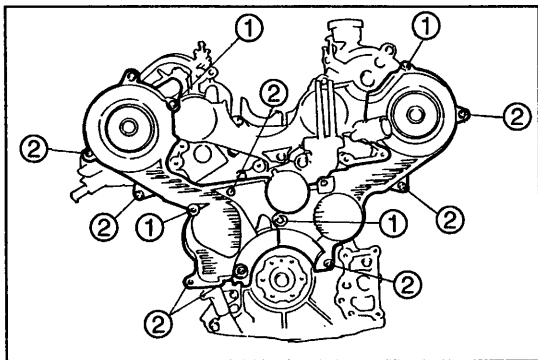
7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}



2. Install the No.3 engine mount bracket.

Tightening torque

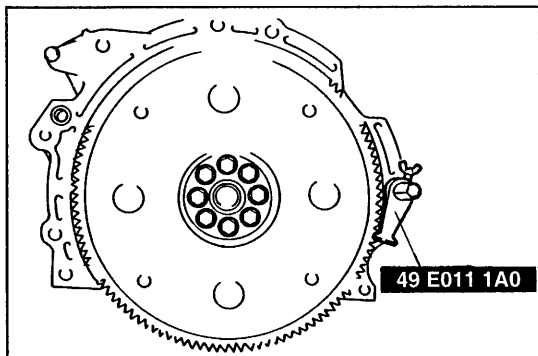
- Ⓐ: 44 — 60 N·m {4.4 — 6.2 kgf·m, 32 — 44 ft·lbf}
 Ⓑ: 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}



3. Install the timing belt covers (RH, LH) and tighten the bolts in the order shown.

Tightening torque:

7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}

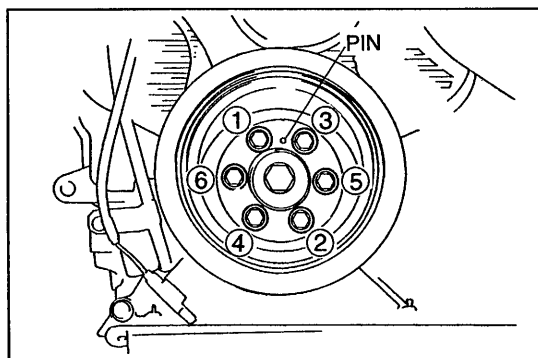


Crankshaft pulley

1. Hold the drive plate by using the SST.

Caution

- Install the crankshaft pulley carefully. The crankshaft position sensor rotor is on the rear of the pulley, and can be damaged easily.



2. Install the crankshaft pulley.

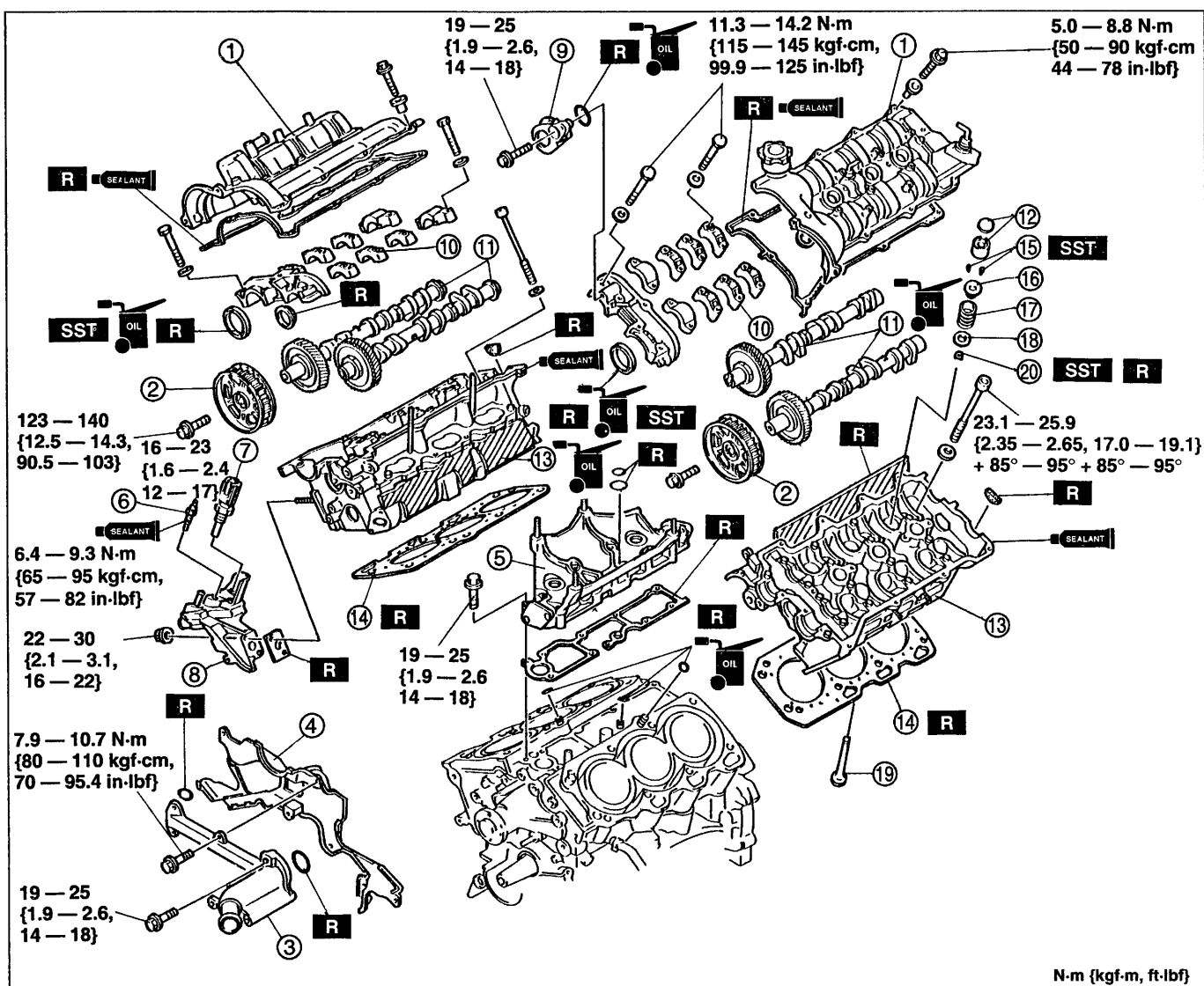
3. Hand tighten the crankshaft pulley bolts and tighten the bolts in the order shown.

Tightening torque:

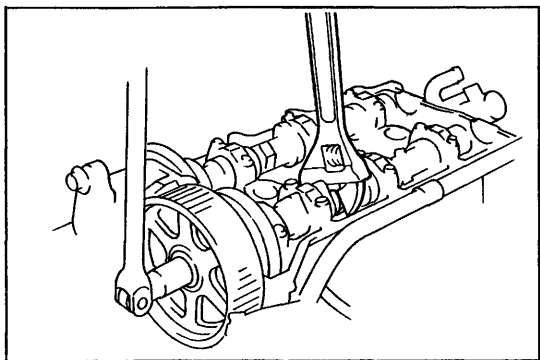
26 — 30 N·m {2.6 — 3.1 kgf·m, 19 — 22 ft·lbf}

CYLINDER HEAD

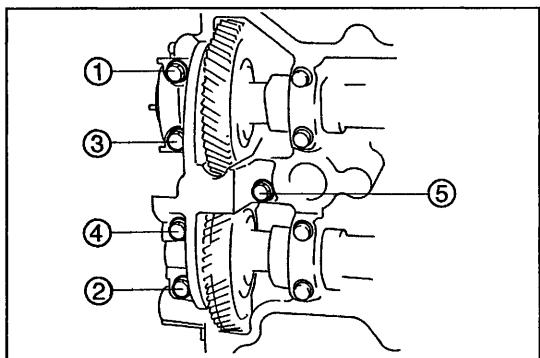
1. Disassemble in the order shown in the figure, referring to **Disassembly Note**.
2. Assemble in the reverse order of disassembly, referring to **Assembly Note**.



- | | |
|--|---|
| 1. Cylinder head cover
Assembly Notepage B — 26 | 11. Camshaft
Disassembly Note.....page B — 18
Assembly Notepage B — 22 |
| 2. Camshaft pulley
Disassembly Note.....page B — 18
Assembly Notepage B — 24 | 12. Tappet and adjustment shim |
| 3. Water outlet pipe
Assembly Notepage B — 23 | 13. Cylinder head
Disassembly Note.....page B — 19
Assembly Notepage B — 21 |
| 4. Seal plate | 14. Cylinder head gasket
Assembly Notepage B — 20 |
| 5. Lysholm compressor bracket
Assembly Notepage B — 23 | 15. Valve keeper
Disassembly Note.....page B — 19
Assembly Notepage B — 20 |
| 6. Water temperature sender unit
Assembly Notepage B — 23 | 16. Upper valve spring seat |
| 7. Engine coolant temperature sensor | 17. Valve spring
Assembly Notepage B — 20 |
| 8. Front housing | 18. Lower valve spring seat |
| 9. Spacer | 19. Valve
Disassembly Note.....page B — 19
Assembly Notepage B — 19 |
| 10. Camshaft cap
Disassembly Note.....page B — 18
Assembly Notepage B — 22 | 20. Valve seal
Disassembly Note.....page B — 19
Assembly Notepage B — 19 |

**Disassembly Note****Camshaft pulley**

1. Hold the camshaft by using a wrench on the cast hexagon as shown, and loosen the camshaft pulley lock bolts.
2. Remove the camshaft pulley lock bolts.
3. Remove the camshaft pulleys.

**Camshaft cap**

1. Loosen the front camshaft cap bolts in five or six steps in the order shown.
2. Remove the front camshaft caps.

Note

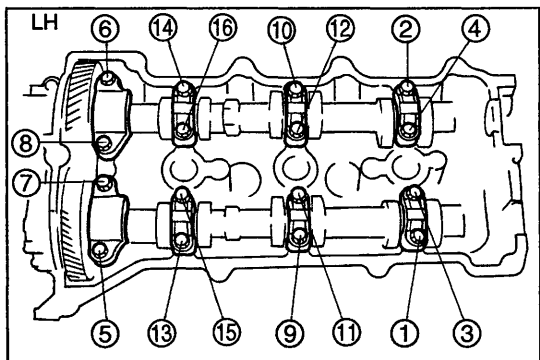
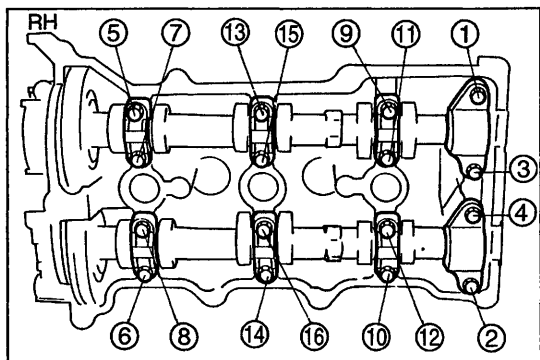
- Bolt ⑤ fits only the right cylinder head.

3. Loosen the camshaft cap bolts in five or six steps in the order shown.

Caution

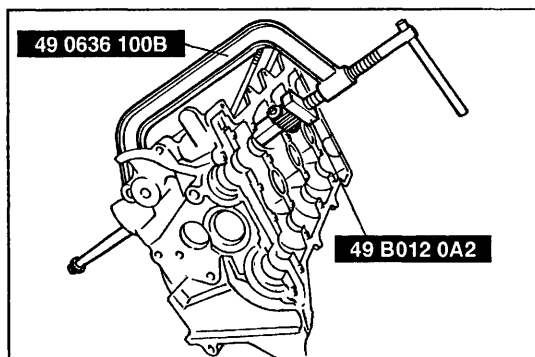
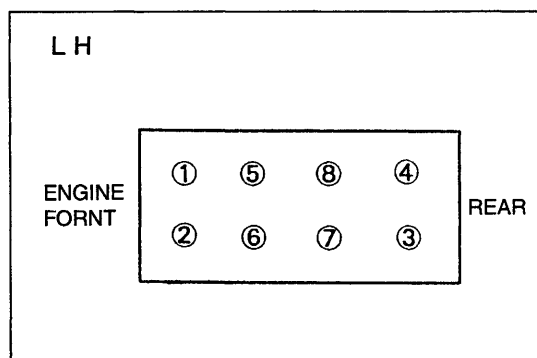
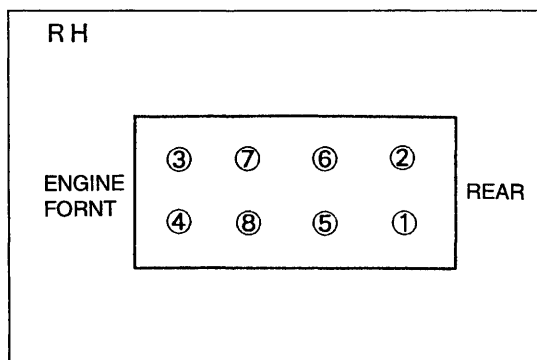
- Remove the thrust caps only after removing all camshaft caps. Otherwise, the thrust caps can be damaged.

4. Remove the camshaft caps.

**Camshaft**

Inspect the following when removing the camshafts.

- (1) Camshaft end play (Refer to page B – 43.)
- (2) Camshaft journal oil clearance (Refer to page – 42.)

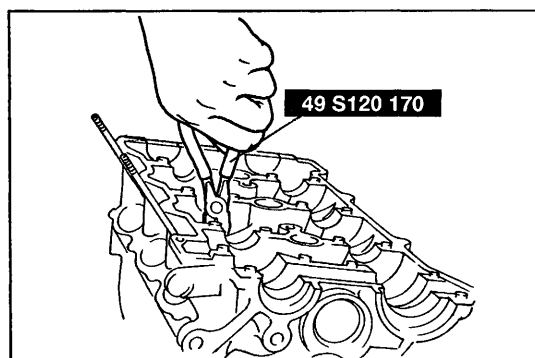
**Cylinder head**

1. Loosen the cylinder head bolts in two or three steps in the order shown.
2. Remove the cylinder head bolts.

Caution

- Removing the LH cylinder head with the rubber insulator still installed can damage the knock sensor harness.

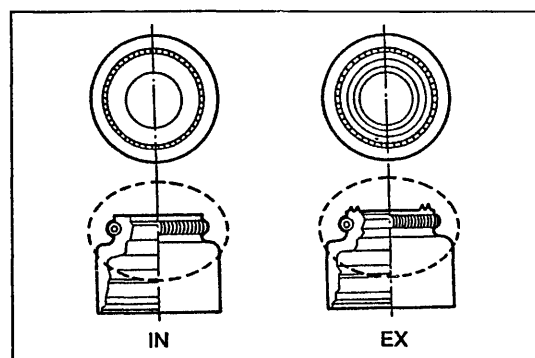
3. Remove the cylinder heads.

**Valve keeper**

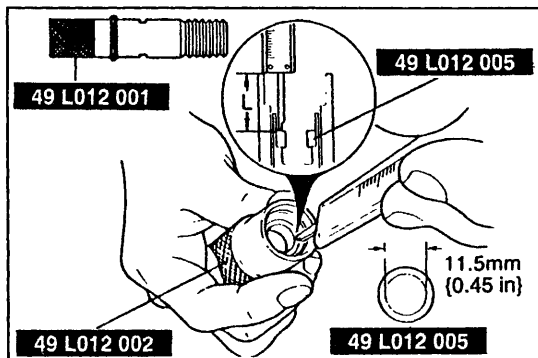
1. Set the **SST** against the upper valve spring seat as shown.
2. Compress the valve spring and remove the valve keepers.

Valve seal

Remove the valve seal by using the **SST**.

**Assembly Note****Valve seal****Caution**

- The intake and exhaust valve seals are different as shown. The exhaust valve seal has ridges on the top for identification.



1. Assemble the **SST** so that depth L is as specified.

Depth L

IN : 15.0 mm {0.591 in}

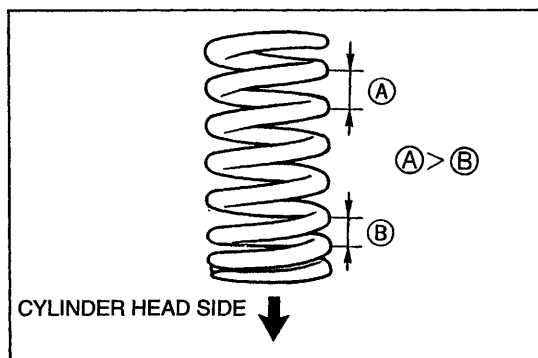
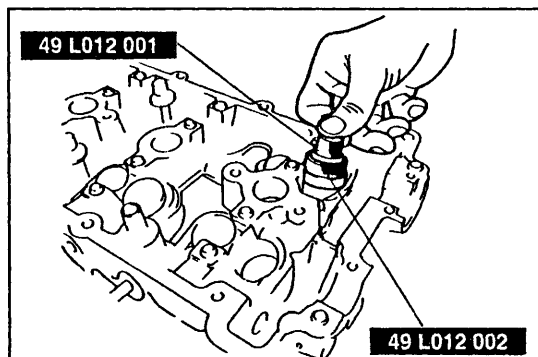
EX : 13.5 mm {0.531 in}

2. Slide the valve seal onto the valve guide with the **SST**.
3. Set the **SST** against the valve seal.

Caution

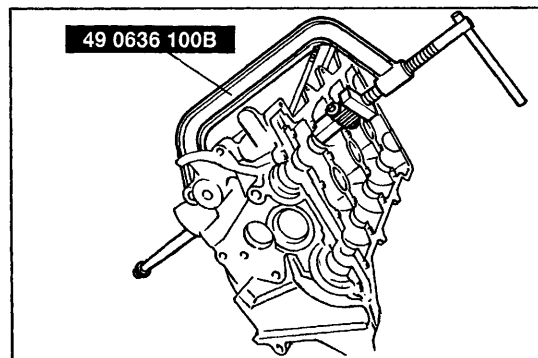
- Using a hammer will damage the valve seal.

4. Using the **SST**, press the valve seal on by hand until the **SST** touches the cylinder head.



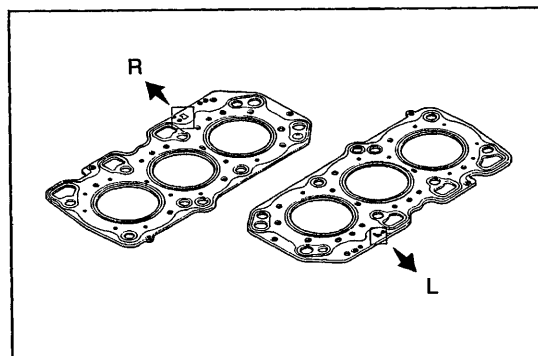
Valve spring

Install the valve spring with the closer pitch toward the cylinder head.



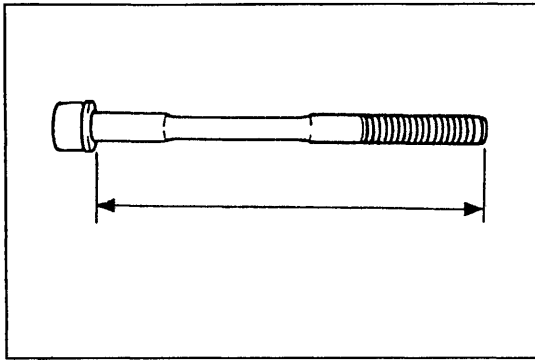
Valve keeper

1. Compress the valve spring with the **SST**, and install the valve keepers.
2. Remove the **SST**.
3. Tap the end of the valve stem lightly two or three times with a plastic hammer to verify that the keepers are fully seated.



Cylinder head gasket

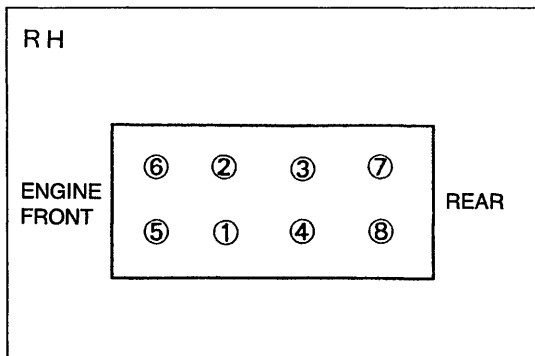
1. Apply clean engine oil to new O-rings and install them to the oil control plugs.
2. Turn the crankshaft clockwise and apply clean engine oil to the cylinder walls.
3. Place a new cylinder head gasket on the left bank with the L mark.
4. Place a new cylinder head gasket on the right bank with the R mark.

**Cylinder head**

1. Install the cylinder heads to the cylinder block.
2. Tighten the cylinder head bolts as described below.
 - (1) Before installation, measure the length of each bolt. Replace any that exceed the maximum length.

Length: 133.7 — 134.3 mm {5.264 — 5.287 in}

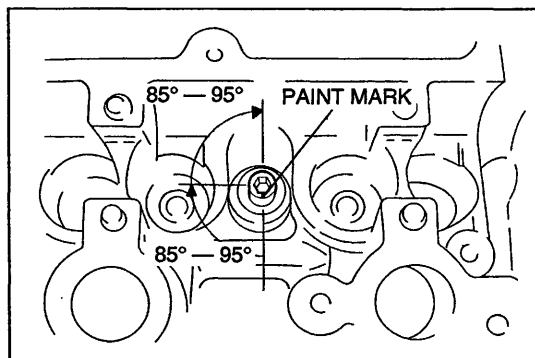
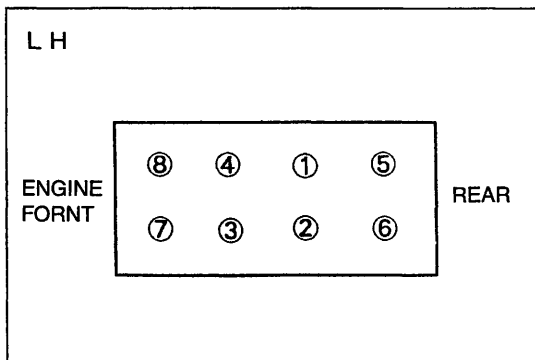
Maximum : 135.0 mm {5.315 in}



- (2) Apply clean engine oil to the threads and the seat face of each bolt and install them.
- (3) Tighten the bolts in two or three steps in the order shown.

Tightening torque:

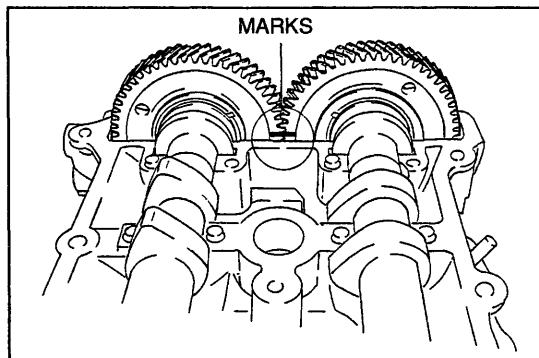
23.1 — 25.9 N·m {2.35 — 2.65 kgf·m, 17.0 — 19.1 ft·lbf}



- (4) Put a paint mark on each bolt head.
- (5) Using the marks as a reference, tighten the bolts by turning each **85° — 95°** in the sequence shown.
- (6) Further tighten each bolt by turning another **85° — 95°**.

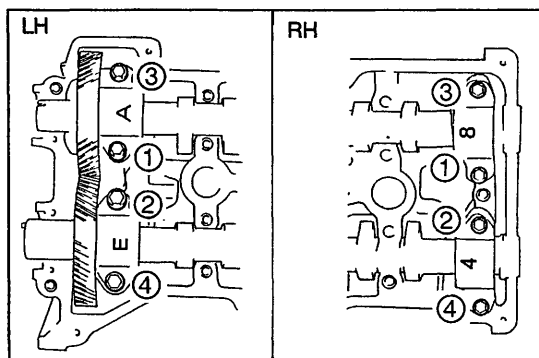


- (7) Fit the knock sensor harness into drill hole (A) on the cylinder block.
- (8) Pass the harness under the new rubber insulator on the LH cylinder head.



Camshaft

1. Apply clean engine oil to the camshaft journals and the supports.
2. Install the camshafts so that intake camshaft gear mark and exhaust camshaft gear mark align.



Camshaft cap

Caution

- Camshaft caps must be assembled in the following procedure. Otherwise, camshaft can be broken or damaged because there is little camshaft thrust clearance.
- Install the thrust caps first. (Caps marked "4" and "8" for RH, and caps marked "A" and "E" for LH) Otherwise, camshaft can be broken or damaged.

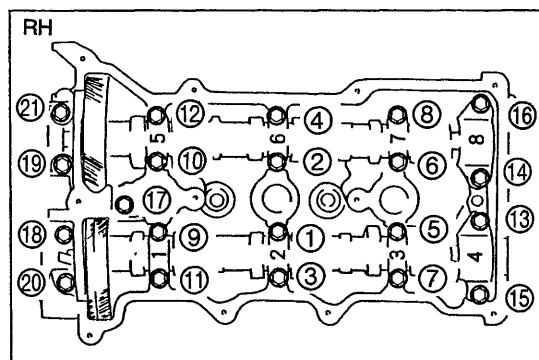
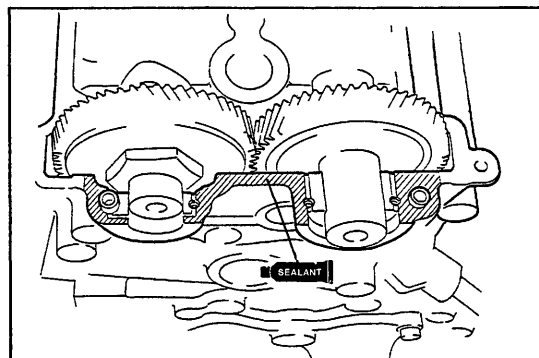
1. Install the thrust caps onto the cylinder heads. Hand tighten the bolts in five or six steps in the order shown, until the thrust caps are fully seated on the cylinder heads.

Caution

- Excessive silicone sealant will get into the cylinder head and cause the piston seizure.

2. Apply silicone sealant to the shaded areas as shown.

Thickness: ϕ 1.5 — 2.5 mm {0.06 — 0.09 in}

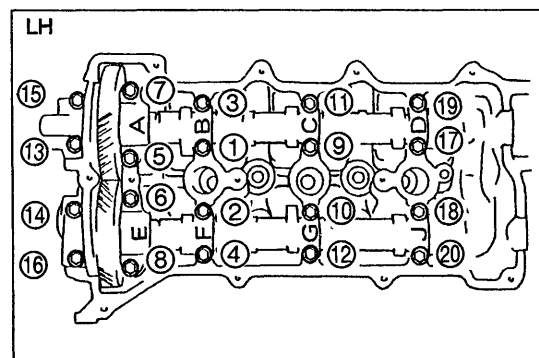


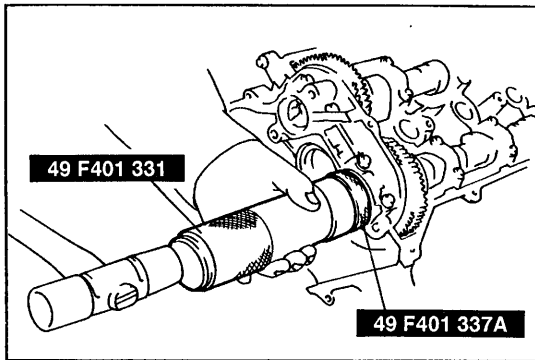
3. Install the camshaft caps onto the cylinder heads. Hand tighten the bolts in five or six steps in the order shown, until the camshaft caps are fully seated on the cylinder heads.
4. Tighten the bolts in the order shown.

Tightening torque : 11.3 — 14.2 N·m
{115 — 145 kgf·cm, 99.9 — 125 in·lbf}

5. Retighten the bolts in the order shown.

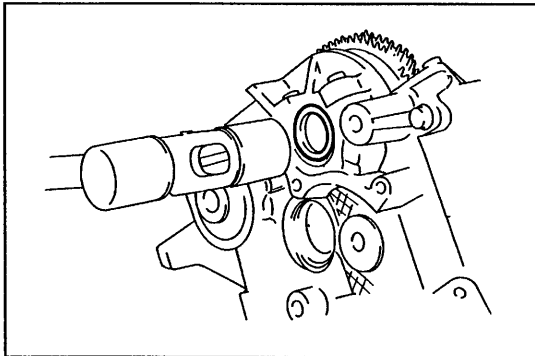
Tightening torque : 11.3 — 14.2 N·m
{115 — 145 kgf·cm, 99.9 — 125 in·lbf}



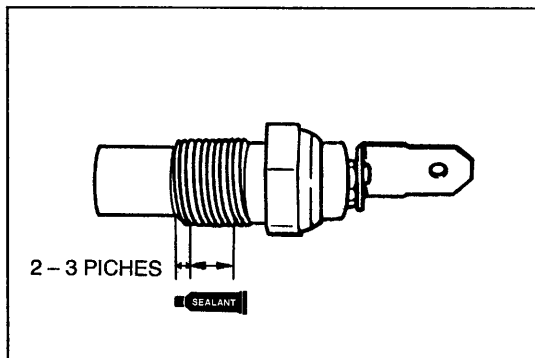


6. Apply clean engine oil to the new oil seal.
7. Push the oil seal slightly in by hand.
8. Tap the oil seal into the cylinder head by using a SST and hammer.

Protrusion: 0 — 0.5 mm {0 — 0.02 in}



9. Tap in the new blind cap by using a plastic hammer.

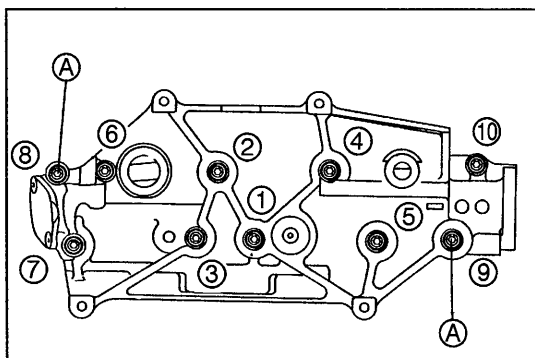


Water temperature sender unit

1. Apply silicone sealant to the top two-thirds of the threads.
2. Install the water temperature sender unit.

Tightening torque:

6.4 — 9.3 N·m {65 — 95 kgf·cm, 57 — 82 in·lbf}

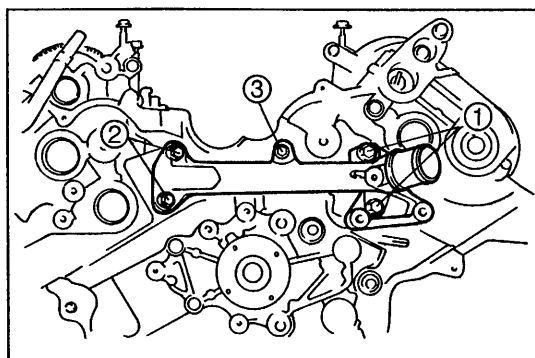


Lysholm compressor bracket

1. Install the Lysholm compressor bracket and hand tighten bolts A until the Lysholm compressor bracket seats fully to the cylinder block
2. Tighten the bolts in the order shown.

Tightening torque:

19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

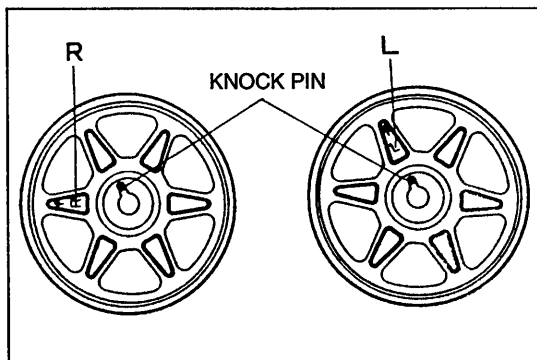


Water outlet pipe

1. Install the water outlet pipe and hand tighten the bolts in the order shown.
2. Tighten the bolts in the order shown.

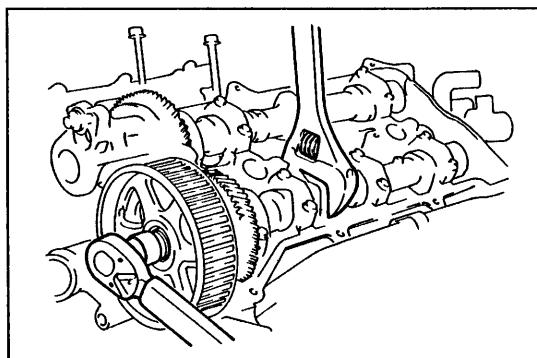
Tightening torque

①, ②: 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}
③: 7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}



Camshaft pulley

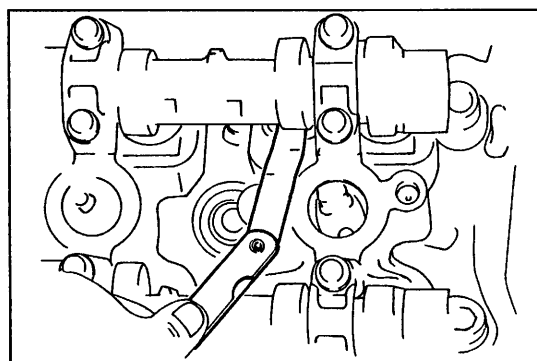
1. Install the camshaft pulley so that the "R" mark (RH) can be seen and the groove aligns with the camshaft knock pin.
2. Install the camshaft pulley so that the "L" mark (LH) can be seen and the groove aligns with the camshaft knock pin.



3. Apply clean engine oil to the camshaft pulley lock bolt threads.
4. Hold the camshaft by using a wrench on the cast hexagon as shown, and tighten the camshaft pulley lock bolt.

Tightening torque:

123 — 140 N·m {12.5 — 14.3 kgf·m, 90.5 — 103 ft·lbf}

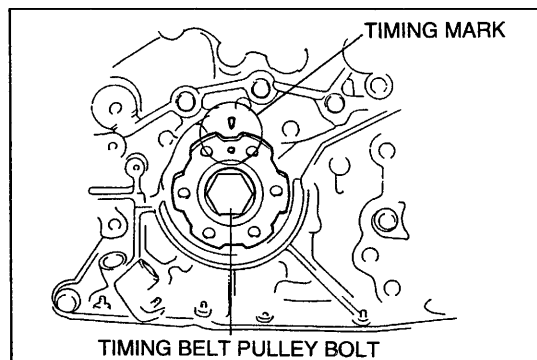


5. Verify that the engine is in cold condition.
6. Verify that the pistons are not at TDC.
7. Turn the camshaft to set the cam lobe right over. Measure the valve clearance.

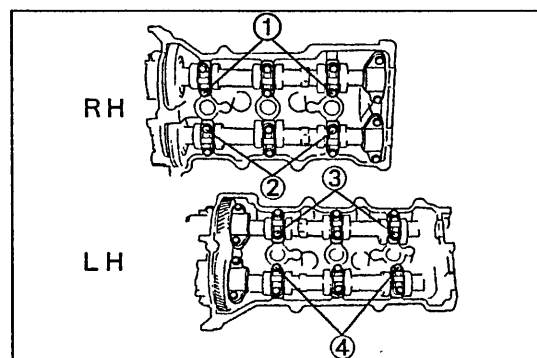
Valve clearance (Engine cold)

Standard IN : 0.27 — 0.33 mm {0.011 — 0.012 in}

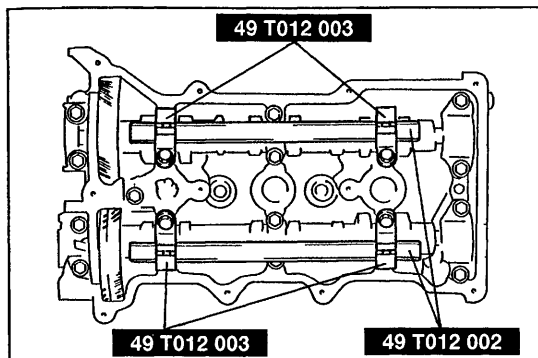
EX: 0.27 — 0.33 mm {0.011 — 0.012 in}



8. If the valve clearance exceed the standard, replace the adjustment shim in the order shown below.
 - (1) Install the timing belt pulley and bolt.
 - (2) Turn the crankshaft clockwise so that the No.1 piston is at TDC.



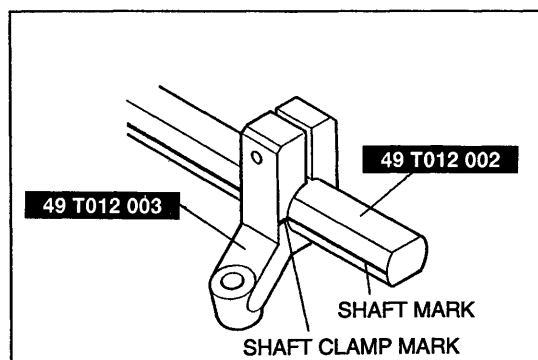
- (3) Turn the crankshaft approx. 180° clockwise.
- (4) Remove the camshaft cap bolts as necessary.
 - ① : For RH exhaust side adjustment shim removal
 - ② : For RH intake side adjustment shim removal
 - ③ : For LH intake side adjustment shim removal
 - ④ : For LH exhaust side adjustment shim removal



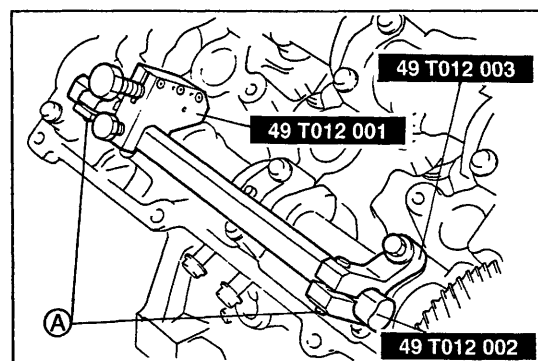
(5) Install the **SST** as shown.

Tightening torque:

11.3 — 14.2 N·m {115 — 145 kgf·m, 99.9 — 125 in·lbf}

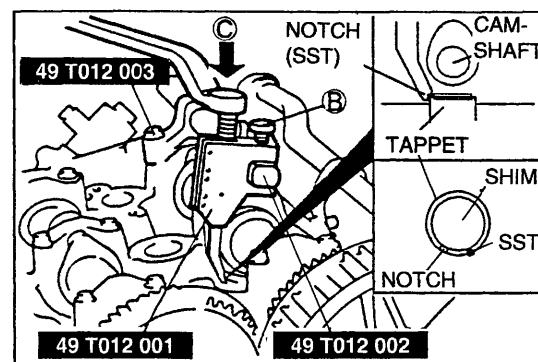


(6) Align the marks on the **SSTs** (shaft and shaft clamp).



(7) Face the **SST** (body) toward the center of the cylinder head, and mount it on the camshaft using the camshaft cap bolt holes.

(8) Tighten bolts **A** to secure the **SST** (shaft).

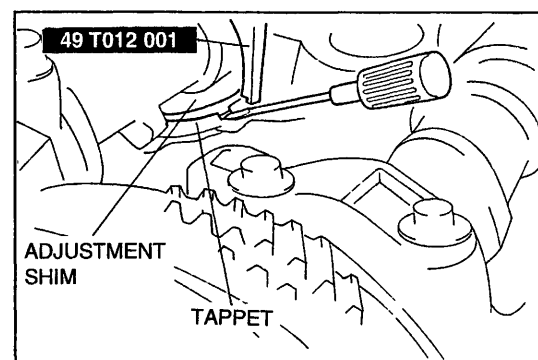


(9) Face the notch of the tappet so that a fine screwdriver can be inserted.

(10) Set the **SST** on the tappet by its notch.

(11) Tighten bolt **B** to secure the **SST** (body).

(12) Tighten bolt **C** and press down the tappet.

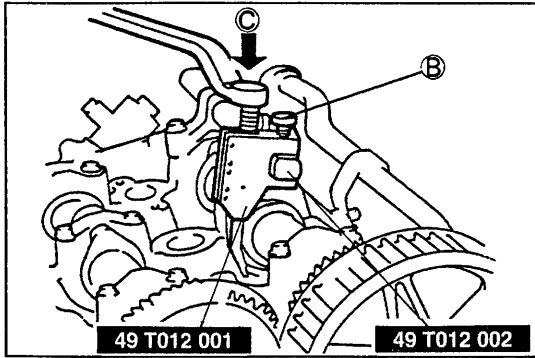


(13) Using a fine screwdriver, pry up the adjustment shim through the notch on the tappet. Remove the shim by using a magnet.

(14) Select proper adjustment shim.

New adjustment shim

= Removed shim thickness + Measured valve clearance
– Standard valve clearance (0.3 mm {0.012 in})

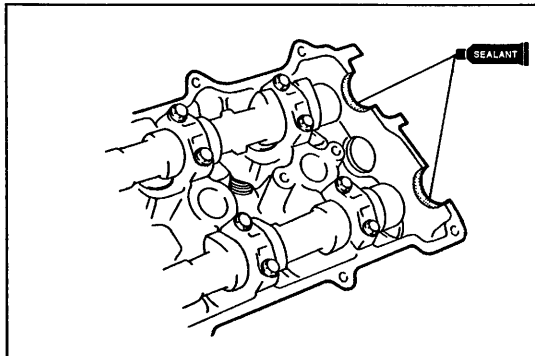


- (15) Push the selected shim into the tappet.
- (16) Loosen bolt © to allow the tappet to move up.
- (17) Loosen bolt ⑥ and remove the **SST** (body).
- (18) Remove the **SSTs** and tighten the camshaft cap bolts.

Tightening torque:

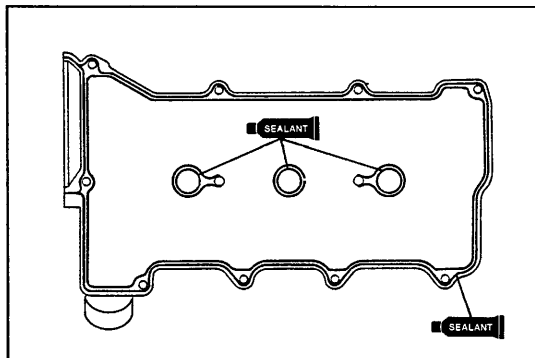
11.3 — 14.2 N·m {115 — 145 kgf·cm, 99.9 — 125 in·lbf}

- (19) Check the valve clearance. (Refer to page B – 24)



Cylinder head cover

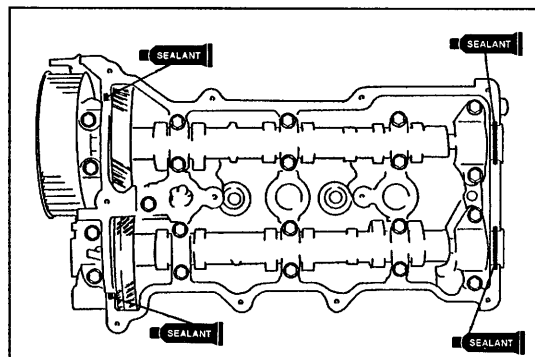
- 1. Apply silicone sealant to the shaded area as shown.



- 2. Apply silicone sealant to the cylinder head cover as shown.

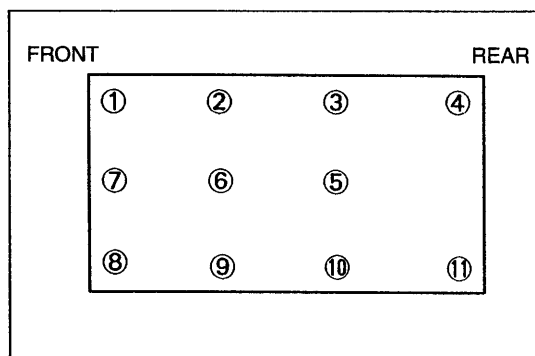
Thickness: ϕ 1.0 — 2.0 mm {0.04 — 0.07 in}

- 3. Install the new cylinder head cover gasket into the cylinder head cover.



- 4. Apply silicone sealant to the shaded area as shown.

Thickness: ϕ 1.5 — 2.5 mm {0.06 — 0.09 in}



- 5. Install the cylinder head cover and tighten the bolts in five or six steps in the order shown.

Tightening torque:

5.0 — 8.8 N·m {50 — 90 kgf·cm, 44 — 78 in·lbf}

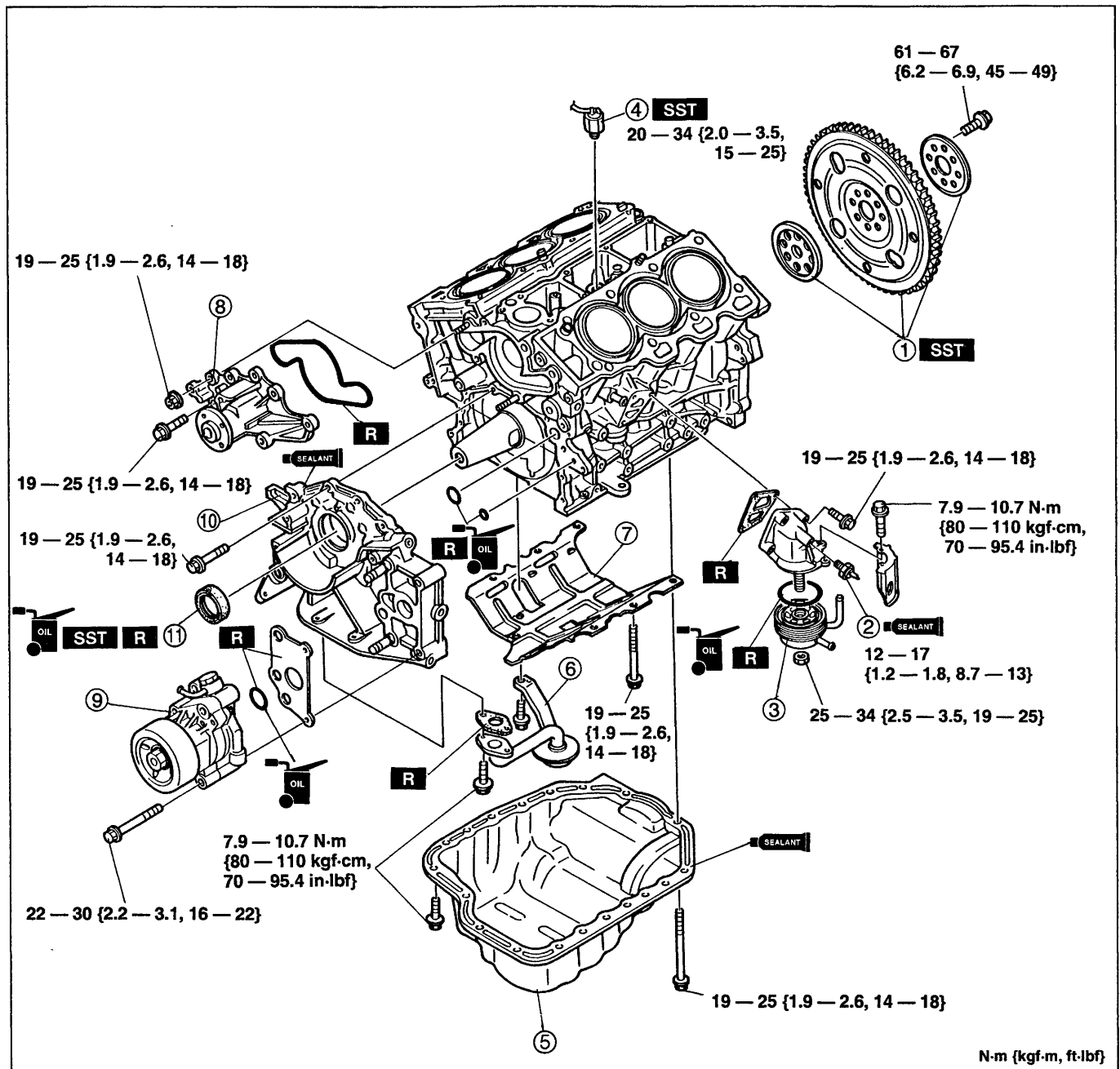
- 6. Retighten RH ⑤, ⑥ and LH ⑤, ⑥ cylinder head cover bolts.

Tightening torque:

5.0 — 8.8 N·m {50 — 90 kgf·cm, 44 — 78 in·lbf}

CYLINDER BLOCK (EXTERNAL PARTS)

1. Disassemble in the order shown in the figure, referring to **Disassembly Note**.
2. Assemble in the reverse order of assembly, referring to **Assembly Note**.

**1. Backing plate, drive plate, adapter**

Disassembly Notepage B — 28

Assembly Notepage B — 31

2. Oil pressure switch

Assembly Notepage B — 30

3. Oil cooler**4. Knock sensor**

Disassembly Notepage B — 28

Assembly Notepage B — 30

5. Oil pan

Disassembly Notepage B — 28

Assembly Notepage B — 30

6. Oil strainer

Assembly Notepage B — 30

7. Oil baffle

Assembly Notepage B — 29

8. Water pump

Assembly Notepage B — 29

9. Vacuum pump

Assembly Notepage B — 29

10. Oil pump

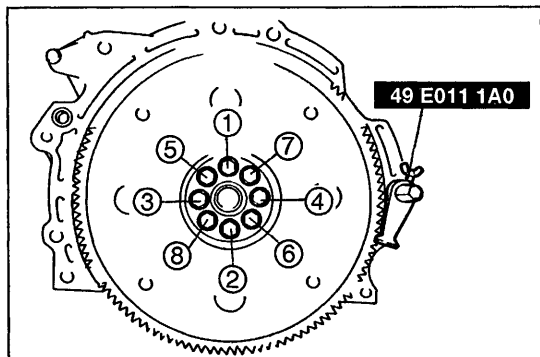
Disassembly / Inspection / Assembly

..... section D

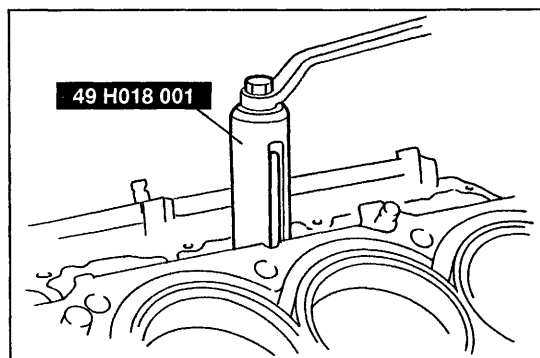
11. Front oil seal

Disassembly Notepage B — 28

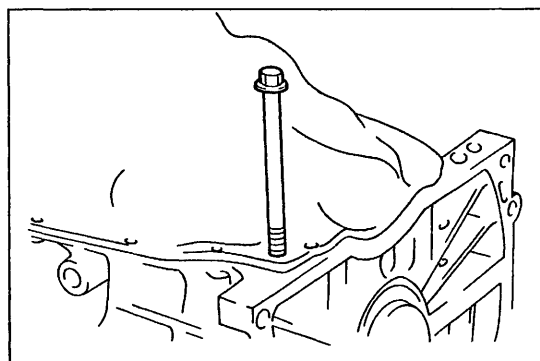
Assembly Notepage B — 29

**Disassembly Note****Backing plate, drive plate, adapter**

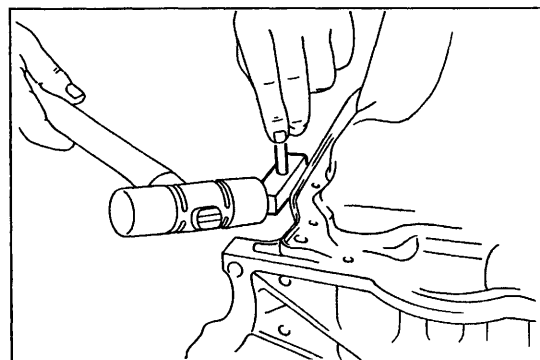
1. Hold the drive plate by using the **SST**
2. Remove the drive plate bolts in two or three steps in the order shown.
3. Remove the backing plate, drive plate, and adapter.

**Knock sensor**

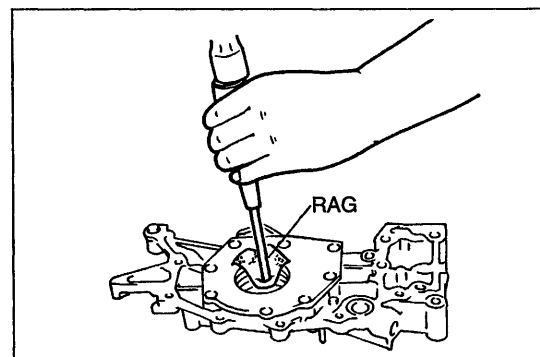
Remove the knock sensor by using the **SST**.

**Oil pan**

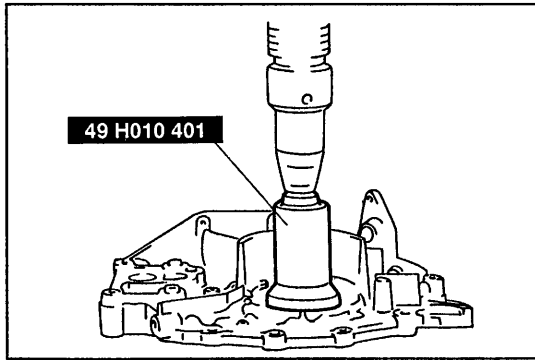
1. Remove the oil pan bolts.
2. Turn a bolt into the special bolt hole as shown to make a small gap between the oil pan and the lower cylinder block.



3. Insert a screwdriver or seal cutter between the cylinder block and the oil pan to separate them.
4. Remove the oil pan.

**Front oil seal**

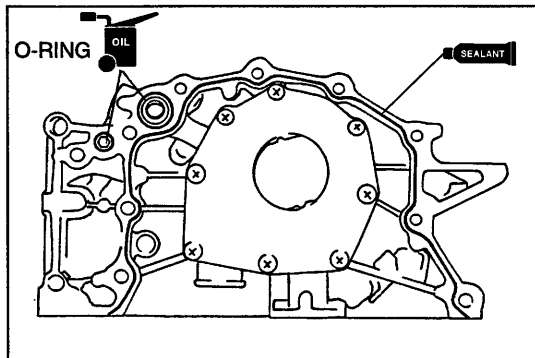
Remove the oil seal by using a screwdriver protected with a rag.

**Assembly Note****Front oil seal**

1. Apply clean engine oil to the new oil seal.
2. Install the oil seal into the oil pump body by hand.
3. Press the oil seal into the oil pump body by using a SST.

Protrusion: 0 — 0.7 mm {0 — 0.03 in}

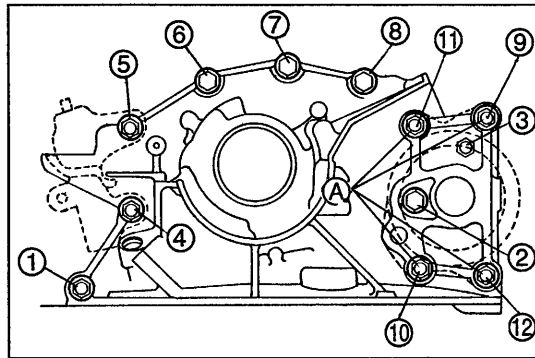
Slope: 0.4 mm {0.016 in} max.

**Oil pump**

1. Apply silicone sealant to the contact surface of the oil pump.

Thickness: ϕ 1.0 — 2.0 mm {0.04 — 0.07 in}

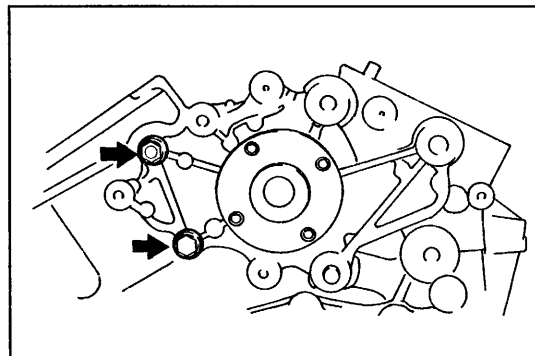
2. Apply clean engine oil to the new O-ring and install it into the oil pump body.
3. Apply clean engine oil to the oil seal lip.
4. Install the oil pump and tighten the bolts in two or three steps in the order shown.

**Note**

- Install the auto tensioner and vacuum pump at the same time that you install the oil pump.
- The auto tensioner will have to be removed temporarily when the timing belt is installed, but tighten it to the specified torque anyway.

Tightening torque:

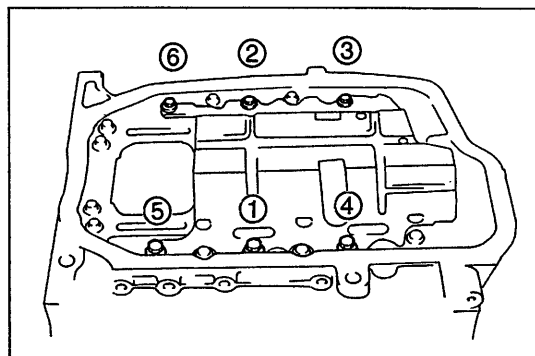
- Ⓐ 22 — 30 N·m {2.2 — 3.1 kgf·m, 16 — 22 ft·lbf}
 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

**Water pump**

Install a new rubber seal and the water pump.

Note

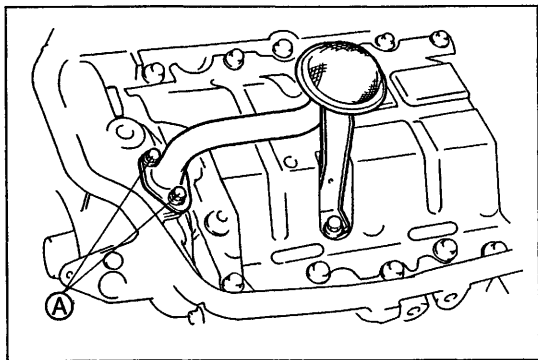
- When installing the No.3 engine mount bracket, tighten it to the specified torque.

**Oil baffle**

Install the oil baffle and tighten the bolts in two or three steps in the order shown.

Tightening torque:

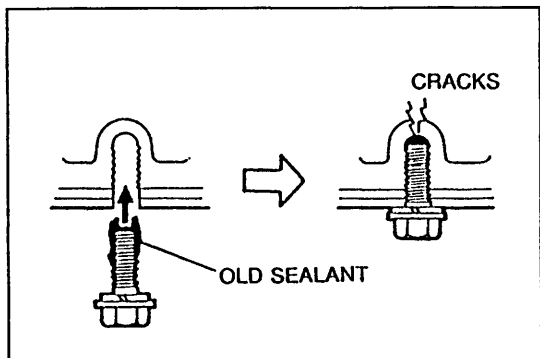
- 19 — 25 N·m {1.9 — 2.6 Kgf·m, 14 — 18 ft·lbf}

**Oil strainer**

1. Install a new gasket and the oil strainer onto the oil pump body.
2. Tighten bolts ① first.

Tightening torque:

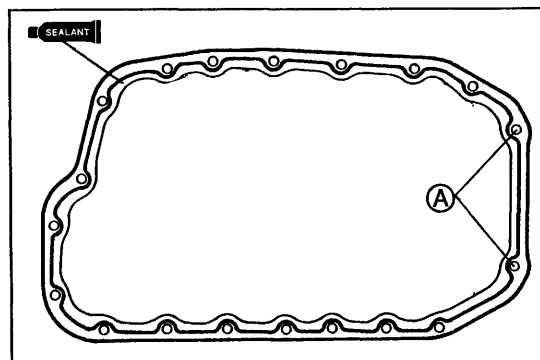
7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}

**Oil pan**

1. Remove the old sealant from the oil pan bolts and bolt holes in the lower cylinder block.

Caution

- If the bolts are reused, remove the old sealant from the bolt threads. Tightening a bolt that has old sealant on it can cause thread damage.

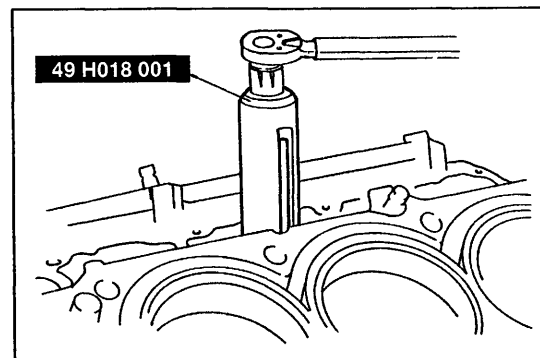


2. Apply silicone sealant to the oil pan along the inside of the bolt holes, and overlap the ends.
3. Install the oil pan within five minutes of applying the sealant.

Tightening torque

①: 19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}

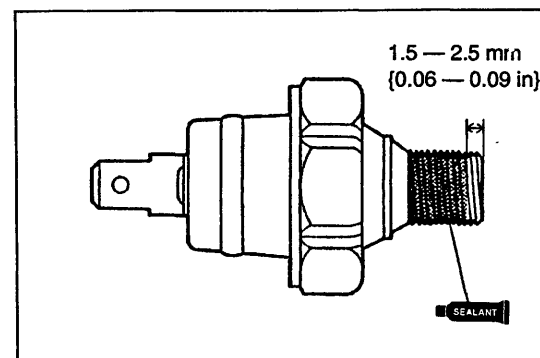
7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in·lbf}

**Knock sensor**

Install the knock sensor by using the SST.

Tightening torque:

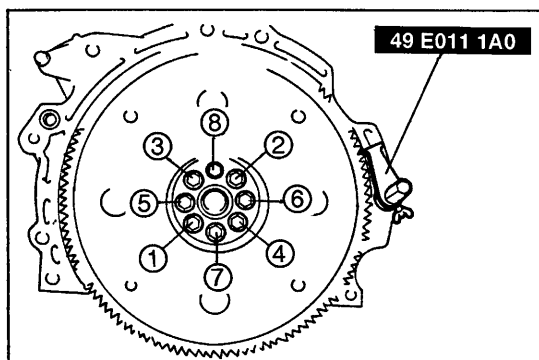
20 — 34 N·m {2.0 — 3.5 kgf·m, 15 — 25 ft·lbf}

**Oil pressure switch**

1. Apply sealant to the oil pressure switch threads as shown.
2. Install the oil pressure switch.

Tightening torque:

12 — 17 N·m {1.2 — 1.8 kgf·m, 8.7 — 13 ft·lbf}

**Backing plate, drive plate, adapter****Caution**

- **Verify that the adapter and the backing plate are mounted in the specified directions. Incorrect mounting can damage the engine and transaxle.**

1. Install the following parts to the crankshaft.

- (1) Adapter
- (2) Drive plate
- (3) Backing plate

2. Hand tighten the drive plate bolts.

3. Hold the drive plate by using the **SST**.

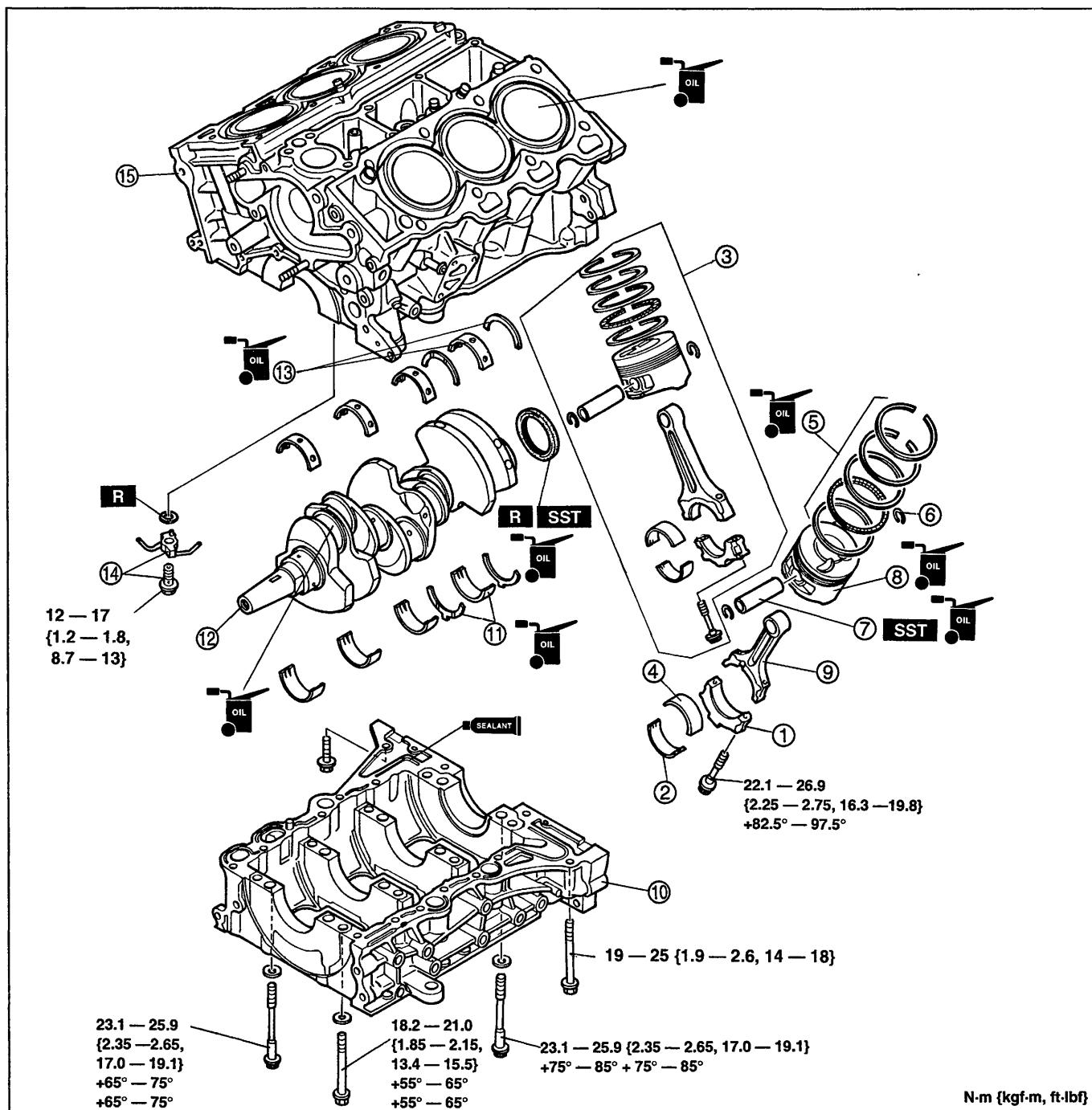
4. Tighten the bolts in two or three steps in the order shown.

Tightening torque:

61 — 67 N·m {6.2 — 6.9 Kgf·m, 45 — 49 ft·lbf}

CYLINDER BLOCK (INTERNAL PARTS)

1. Disassemble in the order shown in the figure, referring to **Disassembly Note**.
2. Assemble in the reverse order of disassembly, referring to **Assembly Note**.



- | | |
|---------------------------------------|---|
| 1. Connecting rod cap | 8. Piston |
| 2. Lower connecting rod bearing | 9. Connecting rod |
| 3. Piston and connecting rod assembly | 10. Lower cylinder block |
| Disassembly Note.....page B - 33 | Disassembly Note.....page B - 33 |
| Assembly Notepage B - 36 | Assembly Notepage B - 33 |
| 4. Upper connecting rod bearing | 11. Lower main bearing and lower thrust bearing |
| 5. Piston ring | 12. Crankshaft |
| 6. Piston pin clip | 13. Upper main bearing and upper thrust bearing |
| 7. Piston pin | 14. Oil jet |
| Disassembly Note.....page B - 33 | 15. Cylinder block |
| Assembly Notepage B - 35 | |

Disassembly Note**Piston and Connecting rod assembly**

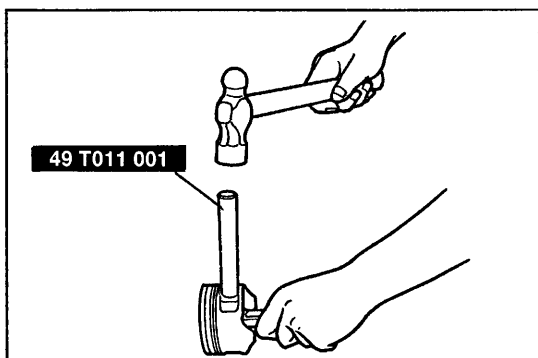
Before removing the piston and connecting rod assembly, measure the connecting rod side clearance and connecting rod bearing oil clearance.

(1) Measure the connecting rod side clearance.

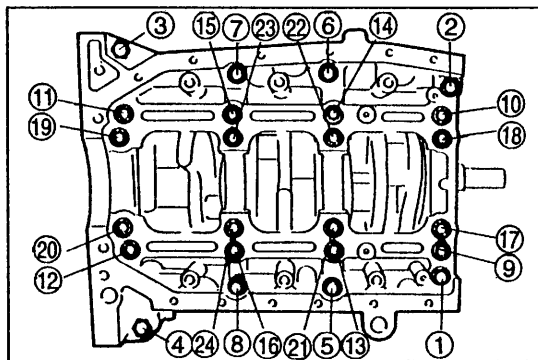
(Refer to page B – 46.)

(2) Measure the connecting rod bearing oil clearance.

(Refer to page B – 46.)

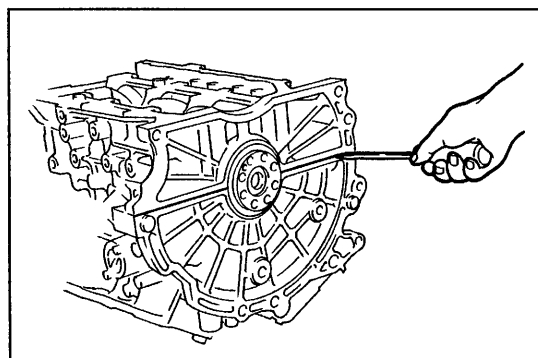
**Piston pin**

Remove the piston pin by using the SST.

**Lower cylinder block**

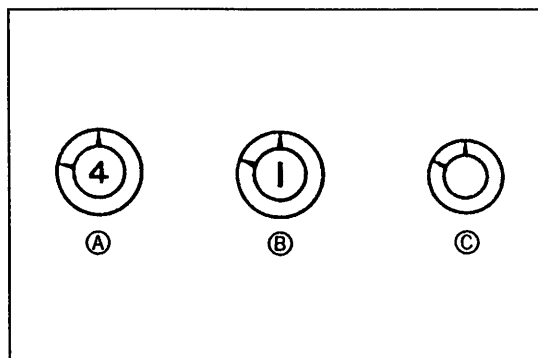
1. Before removing the lower cylinder block, measure the crankshaft end play. (Refer to page B – 47.)

2. Loosen the lower cylinder block bolts in two or three steps in order shown.

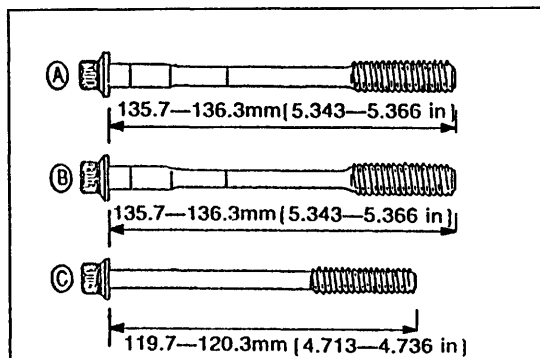


3. Insert a screwdriver only at the points as shown.

4. Remove the lower cylinder block.

**Assembly Note****Lower cylinder block****Note**

- Lower cylinder block bolts (A) are marked “4” on the head.
- Lower cylinder block bolts (B) are marked “I” on the head.
- Lower cylinder block bolts (C) have no mark on the head.



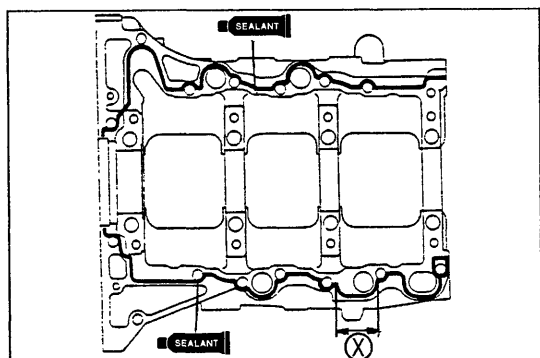
1. Measure the length of lower cylinder block bolts. Replace any that exceed the maximum length.

Bolt A and B

Length : 135.7 — 136.3 mm {5.343 — 5.366 in}
Maximum : 138.5 mm {5.453 in}

Bolt C

Length : 119.7 — 120.3 mm {4.713 — 4.736 in}
Maximum : 121.0 mm {4.764 in}

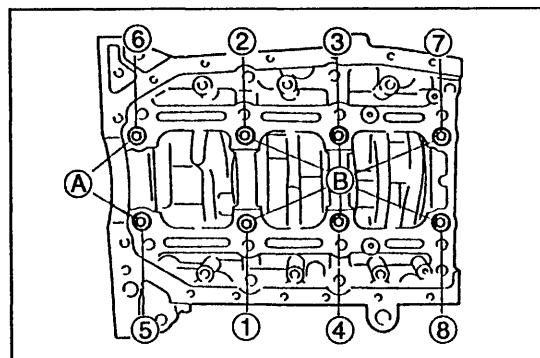


2. Install the lower cylinder block as follows:

- (1) Install the upper thrust bearings in the upper cylinder block.
- (2) Apply clean engine oil to the main bearings, thrust bearings, and main journals.
- (3) Install the crankshaft in the cylinder block.
- (4) Apply silicone sealant to the contact surface as shown.

Thickness

Groove: ϕ 2.5 — 3.5 mm {0.10 — 0.13 in}
Others: ϕ 0.5 — 1.5 mm {0.02 — 0.05 in}



- (5) Install the lower cylinder block, lower main bearings, and lower thrust bearings within five minutes of applying the sealant. Wipe off excessive seal from matching surface of the upper and lower cylinder blocks (area X).
- (6) Apply clean engine oil to the threads and seat faces of the lower cylinder block bolts.
- (7) Tighten bolts A and B in two or three steps in the order shown.

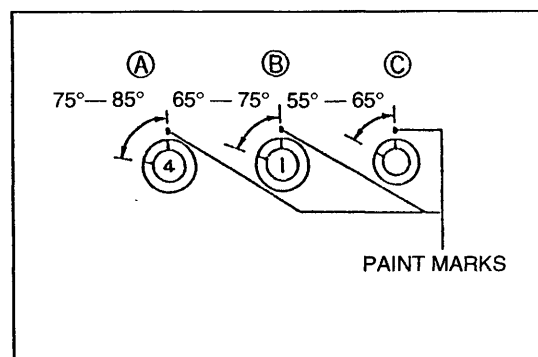
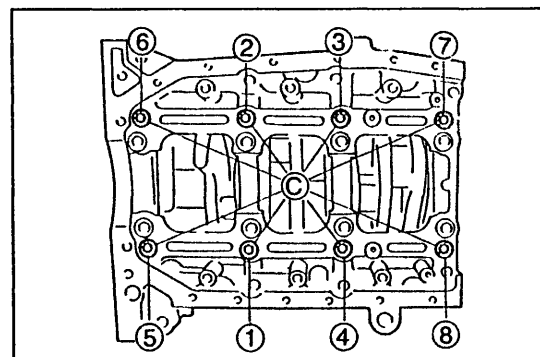
Tightening torque:

23.1 — 25.9 N·m {2.35 — 2.65 kgf·m, 17.0 — 19.1 ft·lb}

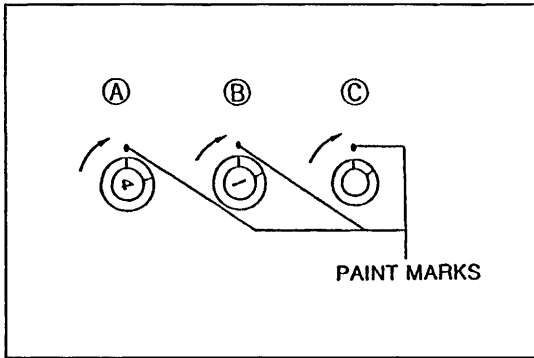
- (8) Tighten bolts C in two or three steps in the order shown.

Tightening torque:

18.2 — 21.0 N·m {1.85 — 2.15 kgf·m, 13.4 — 15.5 ft·lb}

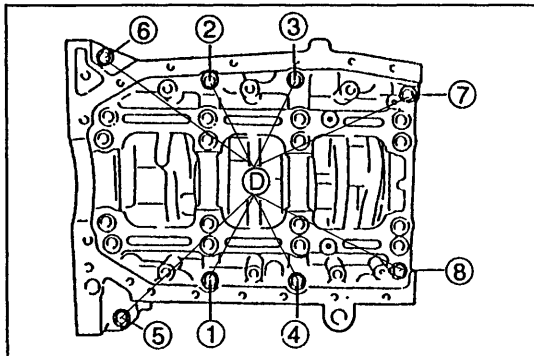


- (9) Put a paint mark on the lower cylinder block next to the bolt flange marks as shown.
- (10) Using the marks as a reference, further tighten the bolts in the order shown.



(11) Tighten the bolts till the mark on each bolt flange aligns with the corresponding paint mark.

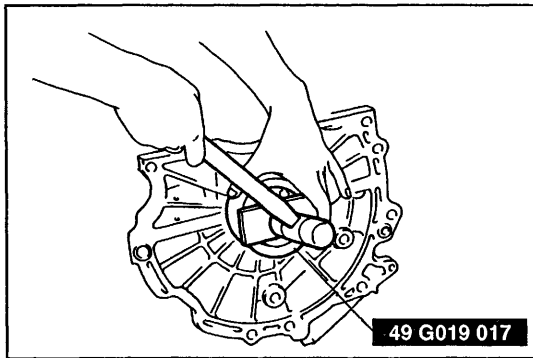
(12) Further tighten each bolt by performing step (9), (10).



(13) Tighten lower cylinder block bolts ① in the order shown.

Tightening torque:

19 — 25 N·m {1.9 — 2.6 kgf·m, 14 — 18 ft·lbf}



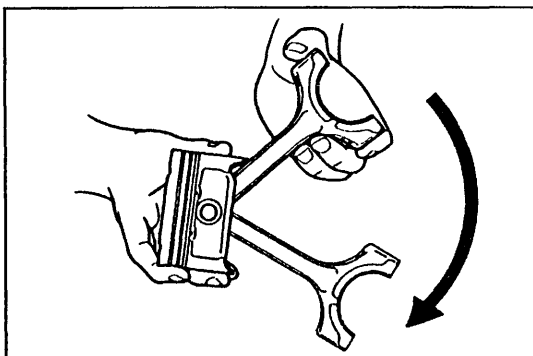
3. Apply clean engine oil to the new rear oil seal lip.

4. Push the rear oil seal slightly in by hand.

5. Tap the oil seal in evenly by using a **SST** and a hammer.

Protrusion: 0 — 0.7 mm {0 — 0.03 in}

Slope: 0.4 mm {0.016 in} max.



Piston pin

1. Install the piston pin clip into the clip groove in the piston.

2. Assemble the piston and the connecting rod in the direction from which they were disassembled.

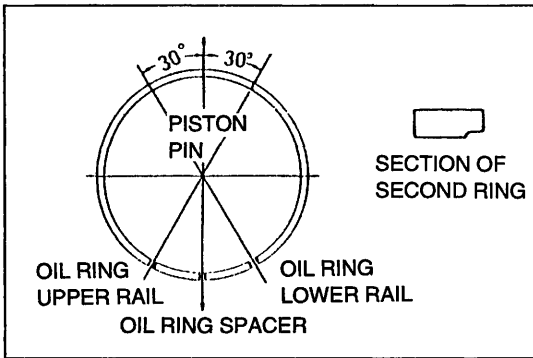
3. Apply clean engine oil to the piston pin.

4. Install the piston pin from the side opposite the clip.

5. Install the piston pin until the pin contacts the clip. If the pin cannot be installed easily, heat the piston.

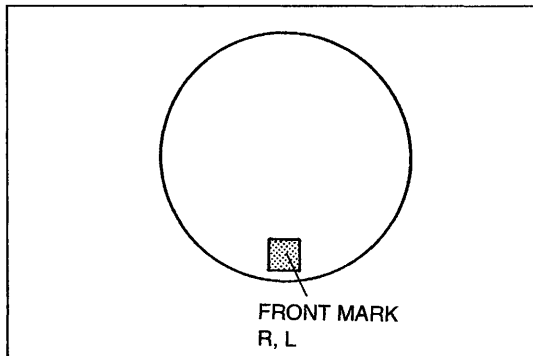
6. Install the second clip into the clip groove in the piston.

7. Check the connecting rod oscillation torque as shown. If the large end does not drop by its own weight, replace the piston or the piston pin.

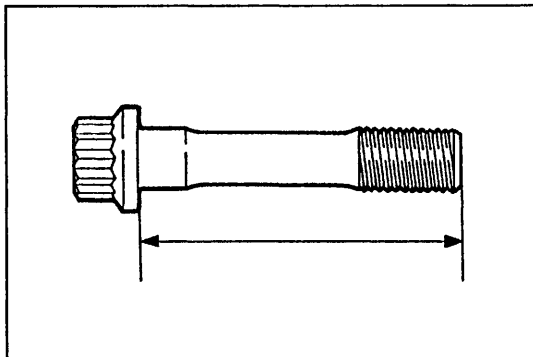


Piston and connecting rod assembly

1. Install the three-piece oil rings on the pistons.
Face the scraper side of the second ring downward.
2. Position the end gap of each ring as shown.



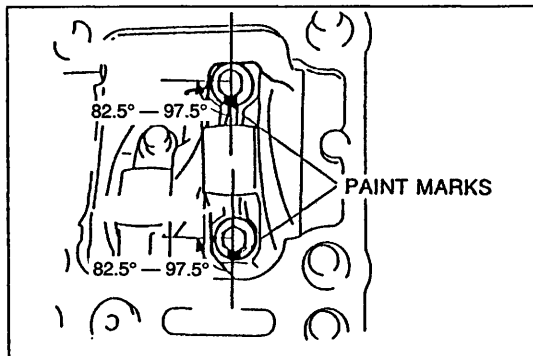
3. Insert the piston assemblies into the cylinder block with the R mark (RH) and the L mark (LH) facing the front of the engine. Use a piston ring compressor to install.



4. Measure the length of connecting rod cap bolt. Replace it if the length exceeds the maximum.

Length: 46.7 — 47.3 mm {1.84 — 1.86 in}

Maximum: 48.0 mm {1.89 in}



5. Install the connecting rod cap as follows:

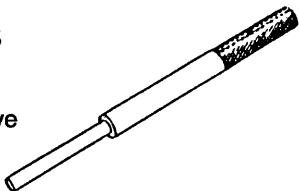
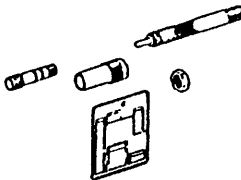
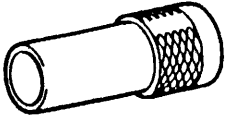
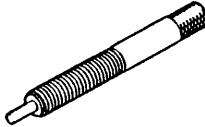
- (1) Apply clean engine oil to the connecting rod cap bolt threads.
- (2) Tighten the connecting rod cap bolts.

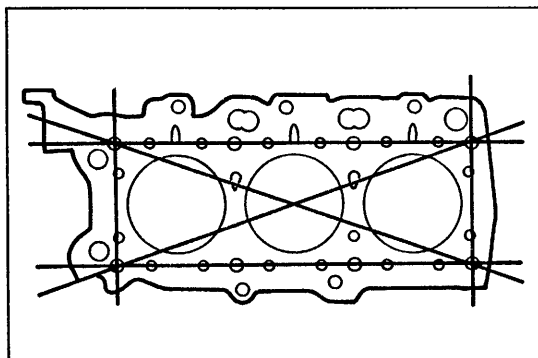
**Tightening torque: 22.1 — 26.9 N·m
{2.25 — 2.75 kgf·m, 16.3 — 19.8 ft·lbf}**

- (3) Put a paint mark on each bolt head.
- (4) Using this mark as a reference, tighten the bolts **82.5° — 97.5°**

INSPECTION / REPAIR

PREPARATION
SST

49 B012 005 Remover & installer, valve guide 	For removal/ installation of valve guides	49 L012 0A0 Installer set, valve seal & valve guide 	For installation of valve guides
49 L012 002 Body (Part of 49 L012 0A0) 	For installation of valve guides	49 L012 003 Installer (Part of 49 L012 0A0) 	For installation of valve guides
49 L012 004 Nut (Part of 49 L012 0A0) 	For installation of valve guides		



CYLINDER HEAD

1. Measure the cylinder head for distortion in the six directions as shown.

Distortion: 0.10 mm {0.004 in} max.

2. Inspect for the following and repair or replace as necessary.

- (1) Sunken of valve seals
- (2) Damaged warm up three way catalytic converter contact surfaces
- (3) Excessive camshaft oil clearance and end play

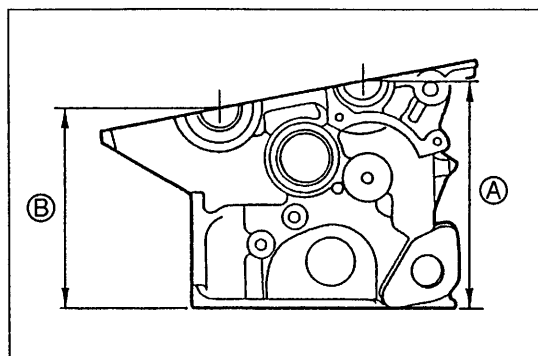
3. If the cylinder head distortion exceeds specification, grind the cylinder head surface.

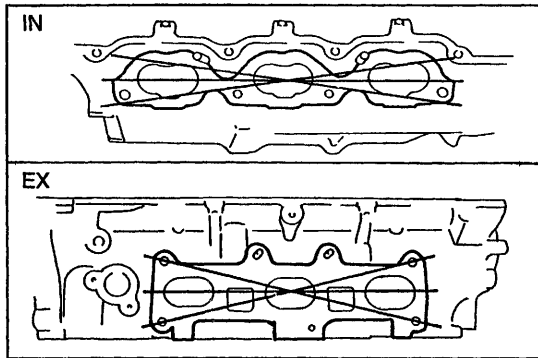
Grinding: 0.15 mm {0.006 in} max.

4. If the cylinder head height is not within specification, replace it.

Height (A): 145.89 — 145.99 mm {5.7437 — 5.7476 in}

(B): 127.81 — 127.91 mm {5.0319 — 5.0358 in}



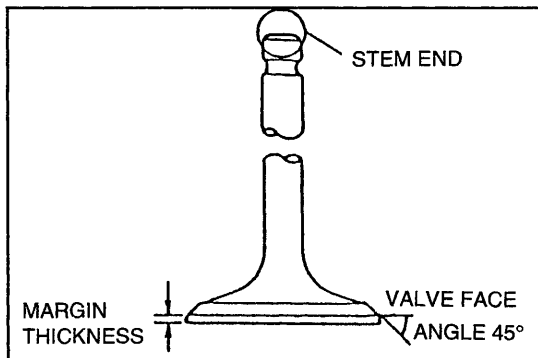


3. Measure the intake manifold and warm up three way catalytic converter contact surfaces for distortion in the six directions as shown.

Distortion: 0.10 mm {0.004 in} max.

4. If distortion exceeds specification, grind the surface or replace the cylinder head.

Grinding: 0.15 mm {0.006 in} max.



VALVE MECHANISM

Valve and Valve Guide

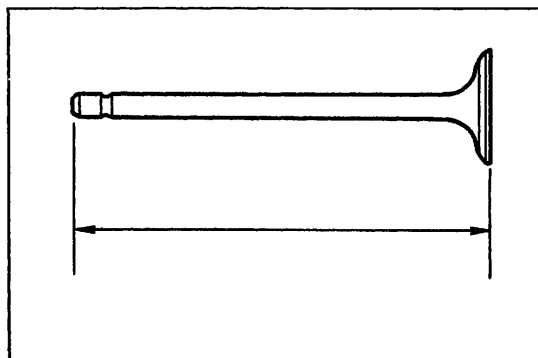
1. Measure the valve head margin thickness. Replace the valve if necessary.

Margin thickness

Standard

IN : 0.775 — 1.325 mm {0.306 — 0.052 in} min.

EX : 1.355 — 1.905 mm {0.054 — 0.074 in} min.



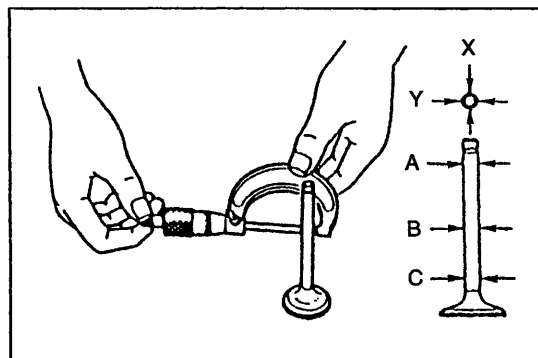
2. Measure the valve length. Replace the valve if necessary.

Length

Standard

IN : 107.66 — 108.46 mm {4.2386 — 4.2700 in}

EX : 107.71 — 108.51 mm {4.2406 — 4.2720 in}



3. Measure the valve stem diameter in X and Y directions at three points (A, B and C) as shown. Replace the valve if necessary.

Diameter

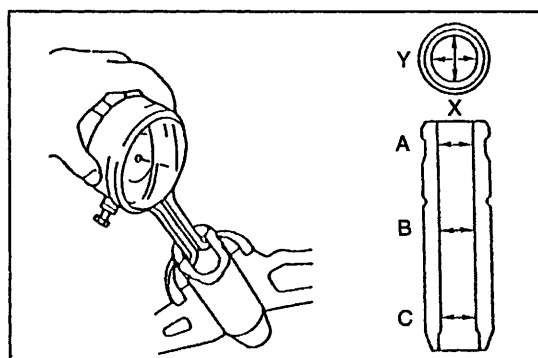
IN : 5.970 — 5.985 mm {0.2351 — 0.2356 in}

EX : 5.965 — 5.980 mm {0.2349 — 0.2354 in}

Minimum

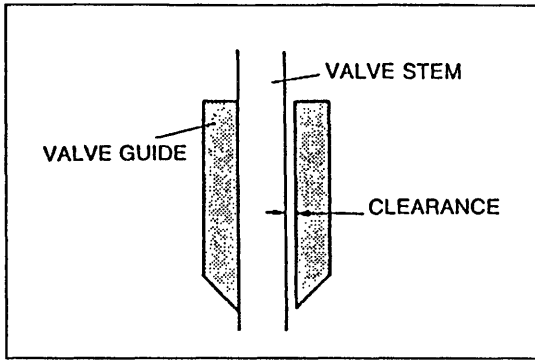
IN : 5.920 mm {0.2331 in}

EX : 5.915 mm {0.2329 in}



4. Measure the valve guide inner diameter in X and Y directions at three points (A, B and C) as shown. Replace the guide if necessary.

Inner diameter: 6.01 — 6.03 mm {0.2367 — 0.2374 in}



5. Calculate the valve stem-to-valve guide clearance. Subtract the outer diameter of the valve stem from the inner diameter of the corresponding valve guide.

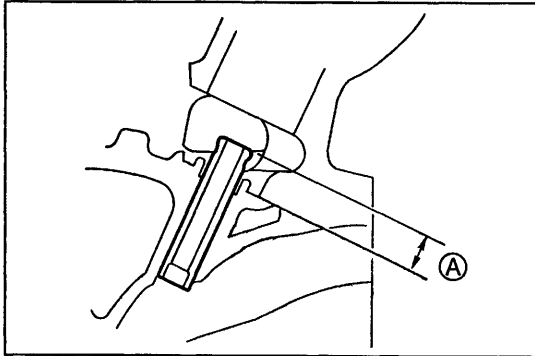
Clearance

IN : 0.025 — 0.060 mm {0.0010 — 0.0023 in}

EX : 0.030 — 0.065 mm {0.0012 — 0.0025 in}

Maximum: 0.20 mm {0.008 in}

6. If the clearance exceeds the maximum, replace the valve and / or valve guide.



7. Measure the valve guide projection height (dimension A). Replace the valve guide if necessary.

Height A

IN : 13.4 — 14.0 mm {0.528 — 0.551 in}

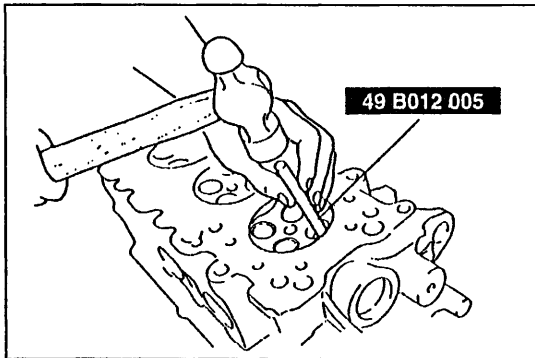
EX : 11.9 — 12.5 mm {0.469 — 0.492 in}

Replacement of valve guide

Note

- The intake and exhaust valve guides are different.

1. Remove the valve guide from the combustion chamber side by using the SST.

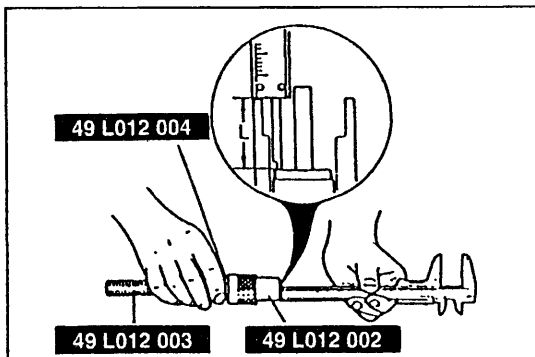


2. Assemble the SST so that depth L is as specified.

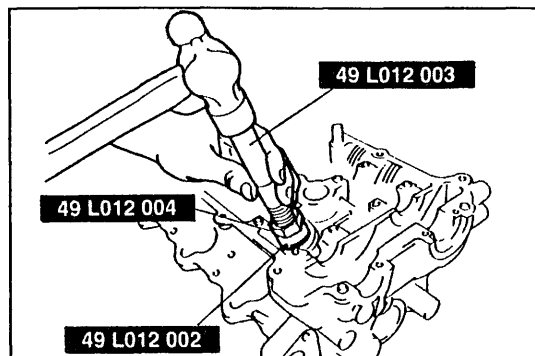
Depth L

IN : 13.4 — 14.0 mm {0.528 — 0.551 in}

EX : 11.9 — 12.5 mm {0.469 — 0.492 in}



3. Tighten the nut.



4. Tap the valve guide in from the side opposite the combustion chamber until the SST contacts the cylinder head.

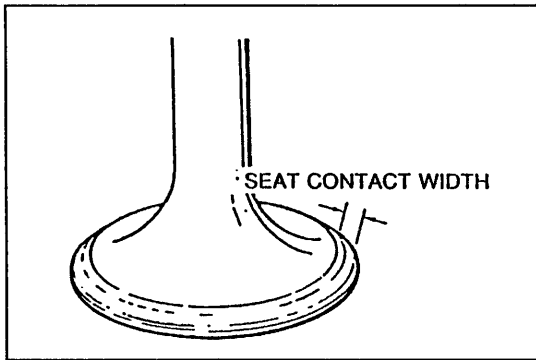
5. Verify that the valve guide projection height (dimension) is within specification.

Height (dimension)

IN : 13.4 — 14.0 mm {0.528 — 0.551 in}

EX : 11.9 — 12.5 mm {0.469 — 0.492 in}

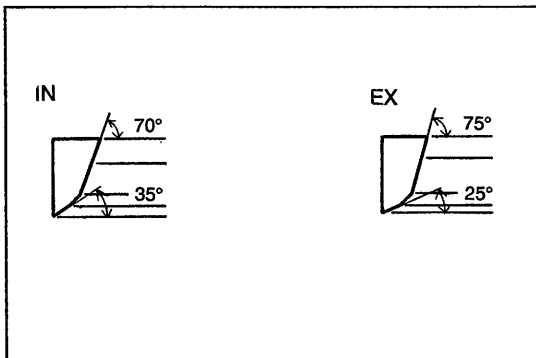
6. If not, repeat steps 1 — 4.



Valve Seat

1. If necessary, resurface the valve seat by using a 45° valve seat cutter and / or resurface the valve face.
2. Apply a thin coat of Prussian blue to the valve face.
3. Check the valve seating by pressing the valve against the seat.
 - (1) If blue does not appear 360° around the valve face, replace the valve.
 - (2) If blue does not appear 360° around the valve seat, resurface the seat.
4. Measure the seat contact width.

Width: 0.8 — 1.4 mm {0.031 — 0.055 in}



5. Verify that the valve seating position is at the center of the valve face.

- (1) If the seating position is too high, correct the valve seat using a 70° (IN) or 75° (EX) cutter, and a 45° cutter.
- (2) If the seating position is too low, correct the valve seat using a 35° (IN) or 25° (EX) cutter, and a 45° cutter.
6. Seat the valve to the valve seat by using lapping compound.
7. Check the sinking of the valve seat.

- (1) Measure the protruding length (dimension L) of the valve stem.

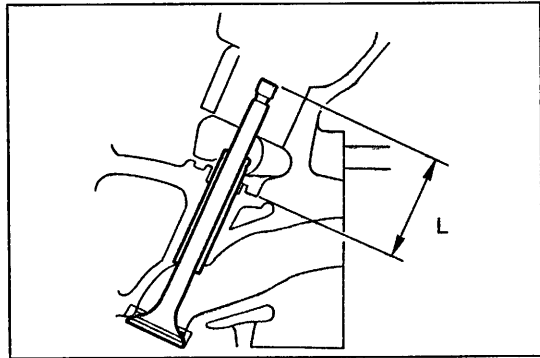
Dimension L: 43.4 mm {1.709 in}

- (2) If L is as below, it can be used as it is.

43.4 — 43.9 mm {1.709 — 1.728}

- (3) If L is more than below, replace the cylinder head.

44.0 mm {1.732 in}

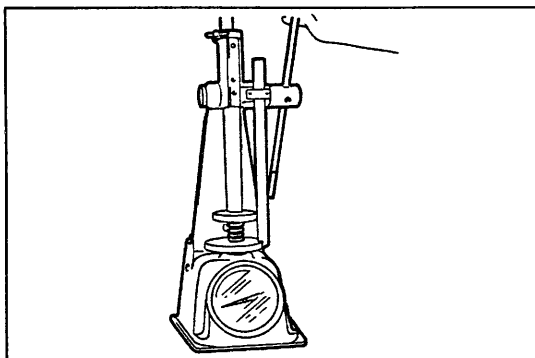


Valve Spring

1. Check the following pressure. Replace the valve spring if necessary.

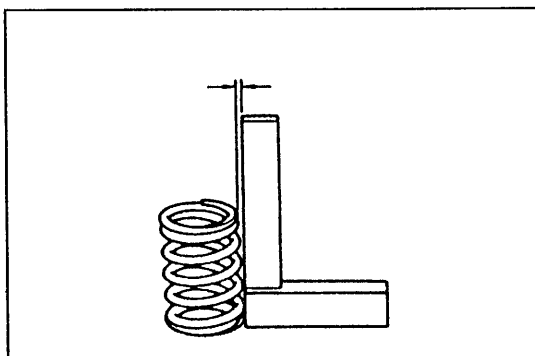
Standard:

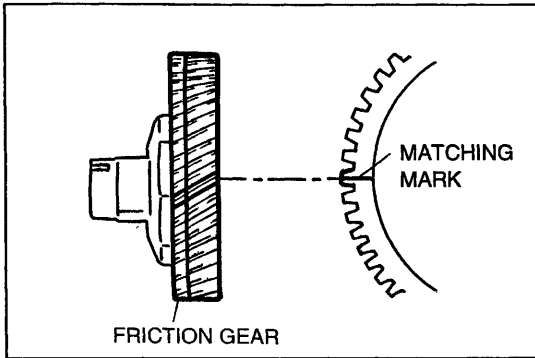
**35.9 mm {1.413 in} with a set load of 187 — 205 N
{19 — 21 kgf, 42 — 46 lbf}**



2. Measure the out-of-square of the spring. Replace the valve spring if necessary.

Out-of-square: 1.57 mm {0.062 in} max.

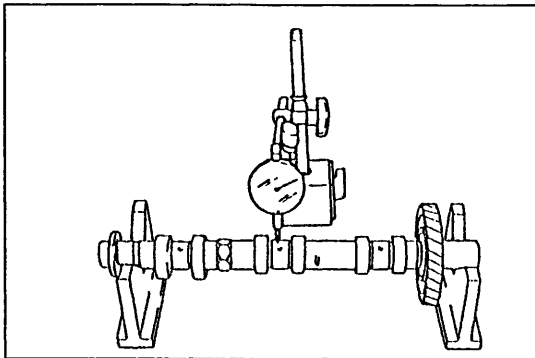
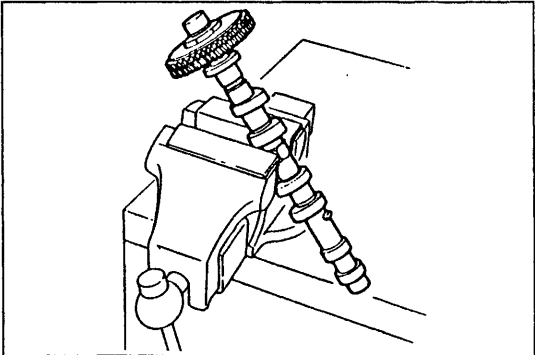


**CAMSHAFT**

1. Visually inspect the helical gears and the friction gear.
2. If a problem is found with the helical gear, replace the camshaft assembly.
3. If a problem is found with the friction gear, replace the friction gear as follows.
 - (1) Secure the camshaft cast hexagon in a vise protected with aluminum plates.
 - (2) Loosen the locknut and remove the friction gear.
 - (3) Align the matching marks and assemble the new friction gear.

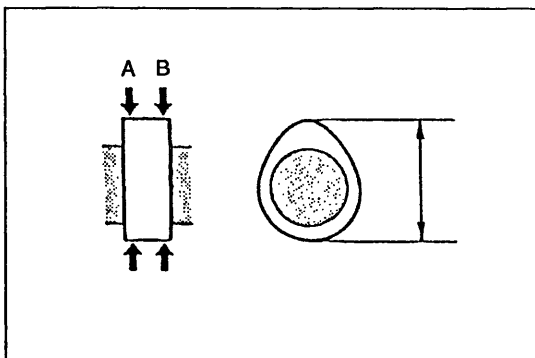
Tightening torque:

69 — 78 N·m {7.0 — 8.0 kgf·m, 51 — 57 ft·lbf}



4. Set the No.1 and No.5 journals on V-blocks. Measure the camshaft runout at the No.2 — No.4 journals. Replace the camshaft if necessary.

Runout: 0.02 mm {0.0008 in} max.

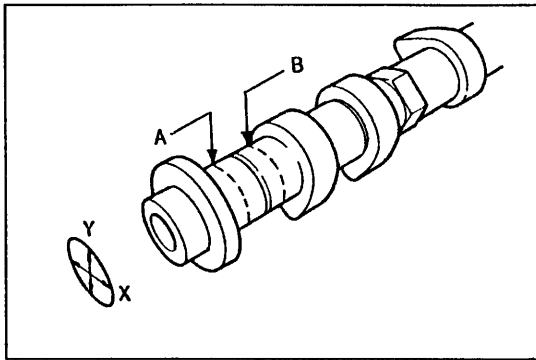


5. Measure the cam lobe height at two points (A and B) as shown. Replace the camshaft if necessary.

Height**Standard**

IN : 43.635 mm {1.7179 in}

EX : 42.847 mm {1.6869 in}



6. Measure the journal diameters in X and Y directions at two points (A and B) as shown. Replace the camshaft if necessary.

Journal diameter

Standard

No.1 25.940 — 25.960 mm {1.0213 — 1.0220 in} (IN)
29.975 — 29.995 mm {1.1802 — 1.1809 in} (EX)

No.2, 3, 4

25.910 — 25.930 mm {1.0201 — 1.0208 in}

No.5 25.940 — 25.960 mm {1.0213 — 1.0220 in}

Minimum

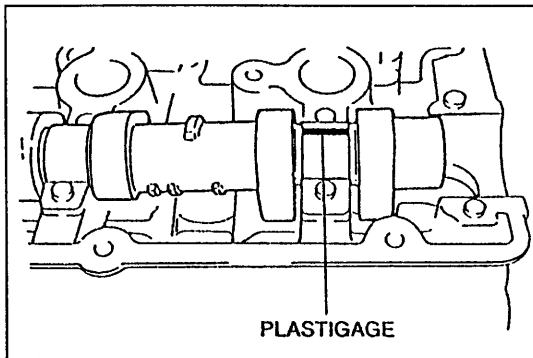
No.1 25.890 mm {1.0193 in} (IN)

29.925 mm {1.1781 in} (EX)

No.2, 3, 4

25.860 mm {1.0181 in}

No.5 25.890 mm {1.0193 in}



7. Measure the camshaft oil clearance with the tappet and shim removed.

- (1) Install the camshafts so that the intake camshaft gear mark and exhaust camshaft gear mark align.
- (2) Position Plastigage atop each journal in the journal axial direction.
- (3) Do not rotate the camshaft when measuring the oil clearance.

(4) Install the thrust caps. (Refer to page B – 22)

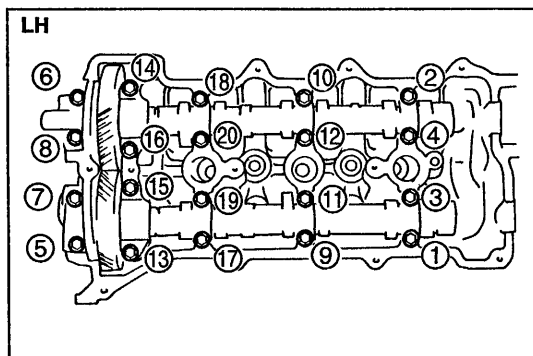
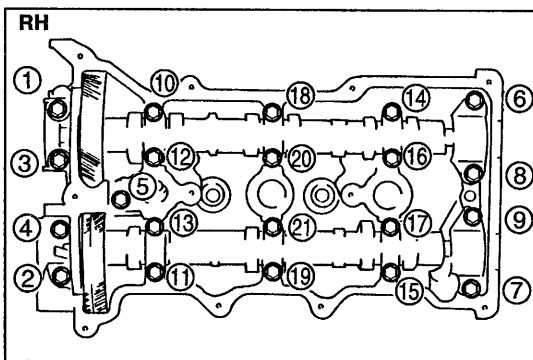
(5) Install the camshaft caps. (Refer to page B – 22)

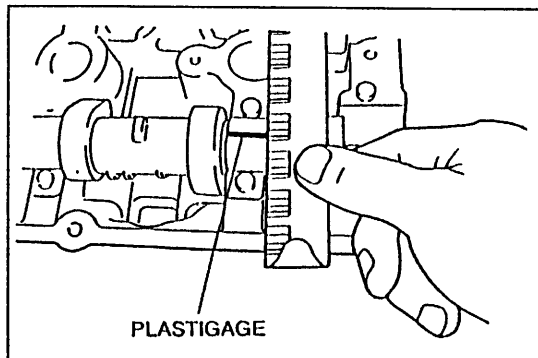
Caution

- Remove the thrust caps only after removing all camshaft caps. Otherwise, the thrust caps can be damaged.

(6) Loosen the camshaft cap bolts in five or six steps in the order shown.

(7) Remove the camshaft caps.





(8) Measure the oil clearance.

Oil clearance

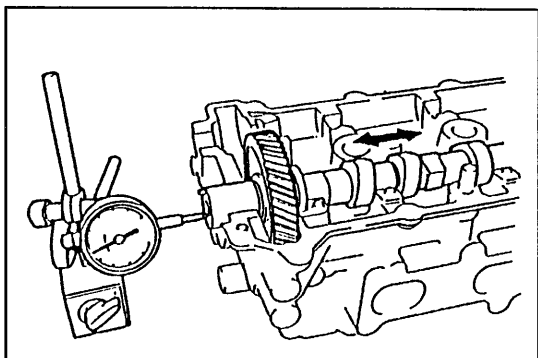
No.1, No.5:

0.040 — 0.081 mm {0.0016 — 0.0031 in}

No.2 — No.4:

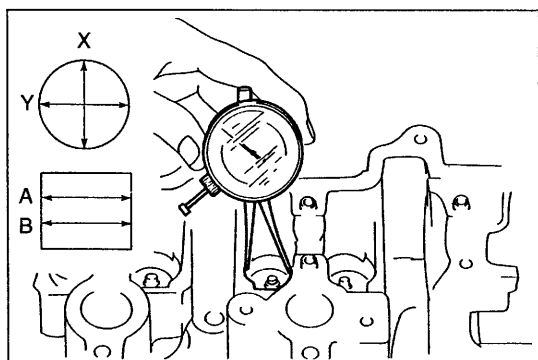
0.070 — 0.111 mm {0.0028 — 0.0043 in}

(9) If the oil clearance exceeds the specification, replace the camshaft or the cylinder head.



8. Measure the camshaft end play. If it exceeds the specification, replace the camshaft or the cylinder head.

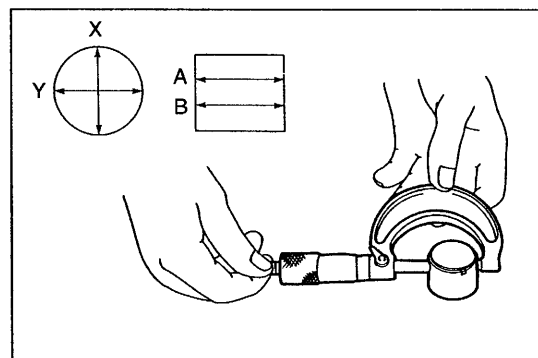
End play: 0.05 — 0.10 mm {0.0020 — 0.0039 in}



TAPPET

1. Measure the tappet bore in X and Y directions at two points (A and B) as shown.

Diameter: 30.000 — 30.025 mm {1.1811 — 1.1820 in}



2. Measure the tappet diameter in X and Y directions at two points (A and B) as shown.

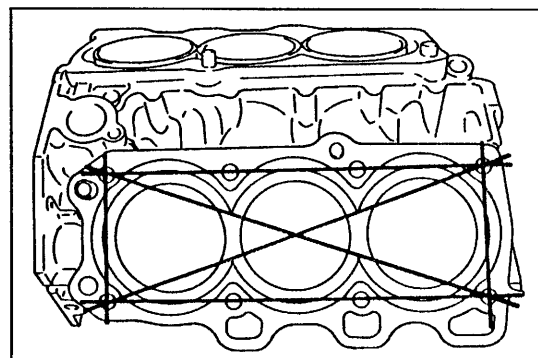
Diameter: 29.959 — 29.975 mm {1.1795 — 1.1801 in}

3. Calculate the clearance between the tappet diameter and the related tappet bore.

Clearance:

0.025 — 0.066 mm {0.00099 — 0.00259 in}

4. If the clearance exceeds the specification, replace the tappet and / or cylinder head.

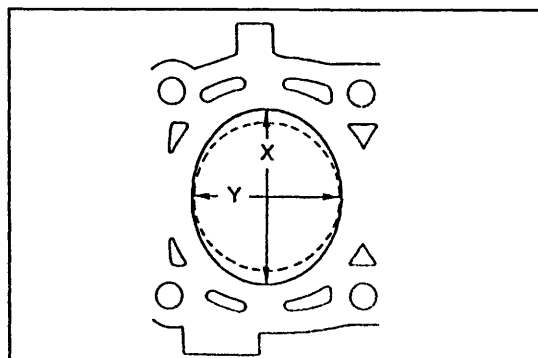
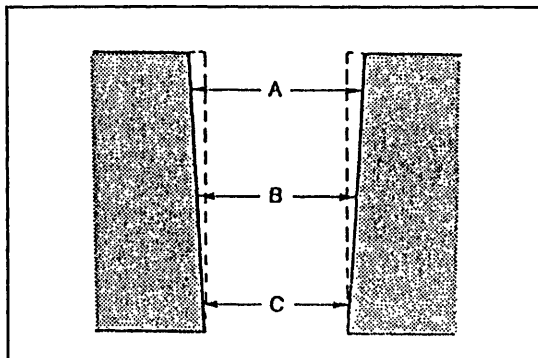


CYLINDER BLOCK

1. Using a straightedge, measure the cylinder block decks for distortion in six directions as shown.

Distortion: 0.15 mm {0.0059 in} max.

2. If distortion exceeds the maximum, replace the cylinder block.



3. Measure the cylinder bore in X and Y directions at three points (A, B and C) as shown.

Cylinder bore

Base the boring diameter on the diameter of an oversize piston. All cylinders must be the same diameter.

mm {in}

Standard	80.300 — 80.322 {3.1615 — 3.1622}
0.25 {0.01} O.S	80.550 — 80.572 {3.1713 — 3.1721}
0.50 {0.02} O.S	80.800 — 80.822 {3.1811 — 3.1819}

Maximum: 0.15 mm {0.0059 in}

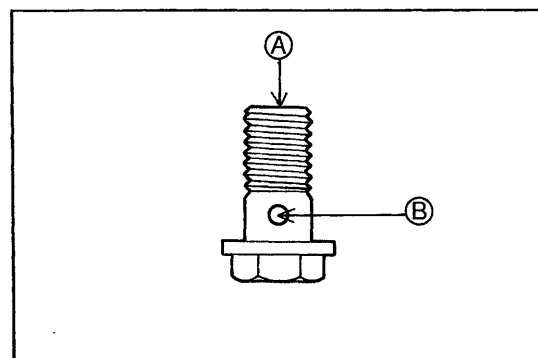
- (1) If the cylinder bore exceeds the maximum, replace the cylinder block or rebore the cylinder to oversize.
- (2) If the difference between measurements A and C exceeds the maximum taper, replace the cylinder block or rebore the cylinder to oversize.

Taper: 0.022 mm {0.0009 in} max.

- (3) If the difference between measurements X and Y exceeds the maximum out-of-round, rebore the cylinder to oversize.

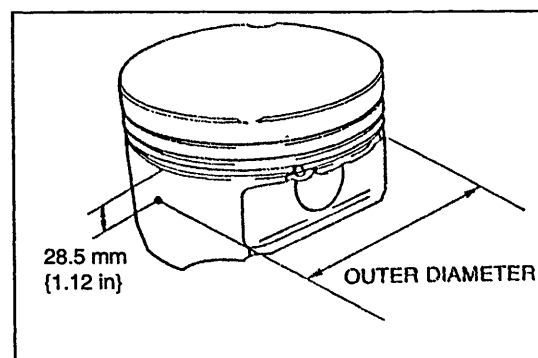
Out-of-round: 0.020 mm {0.0008 in} max.

4. If the upper part of a cylinder wall shows uneven wear, remove the ridge with a ridge reamer.



OIL JET

1. Apply compressed air of **206 — 245 kPa {2.1 — 2.5 kgf/cm², 30 — 35 psi}** to oil jet valve (A) and verify that air passes through oil jet valve (B). If not, replace the oil jet.
2. Check the oil jet nozzles for clogs. Replace the nozzle if necessary.



PISTON, PISTON RING, AND PISTON PIN

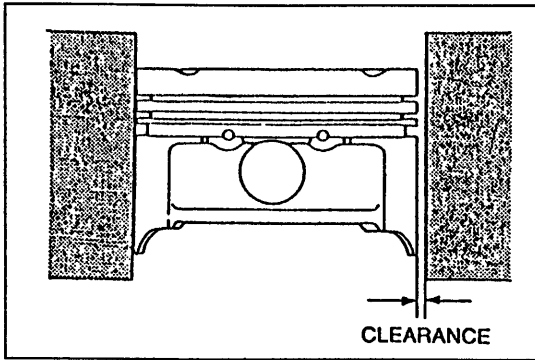
Piston

1. Measure the diameter of each piston at a right angle 90° to the piston pin, **28.5 mm {1.12 in}** below the oil ring groove lower edge.

Piston diameter

mm {in}

Standard	80.271 — 80.303 {3.1603 — 3.1615}
0.25 {0.01} O.S	80.521 — 80.553 {3.1702 — 3.1713}
0.50 {0.02} O.S	80.771 — 80.803 {3.1800 — 3.1812}



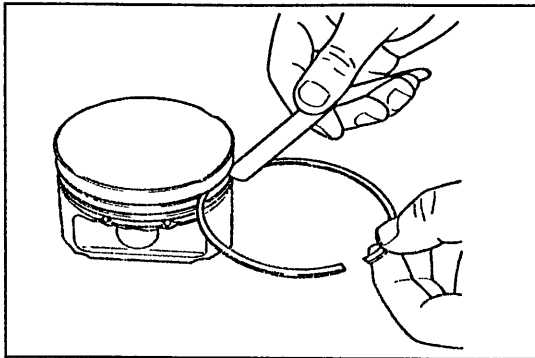
2. Measure the piston-to-cylinder clearance.

Clearance: 0.010 — 0.038 mm {0.0004 — 0.0014 in}

Maximum: 0.112 mm {0.0044 in}

3. If the clearance exceeds the maximum, replace the piston or rebores the cylinders to fit oversize pistons.

4. If the piston is replaced, the piston rings must also be replaced.



Piston and Piston Ring

1. Measure the piston groove clearance around the entire circumference by using a new piston ring.

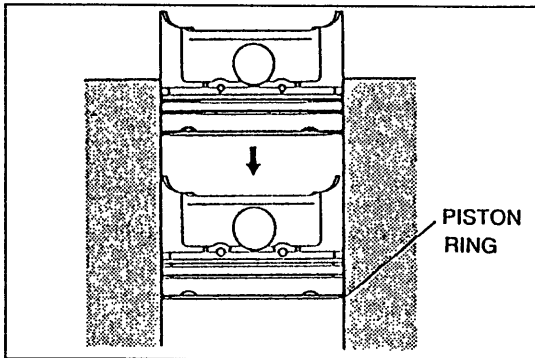
Clearance

Top: 0.035 — 0.065 mm {0.0014 — 0.0025 in}

Second: 0.030 — 0.065 mm {0.0012 — 0.0025 in}

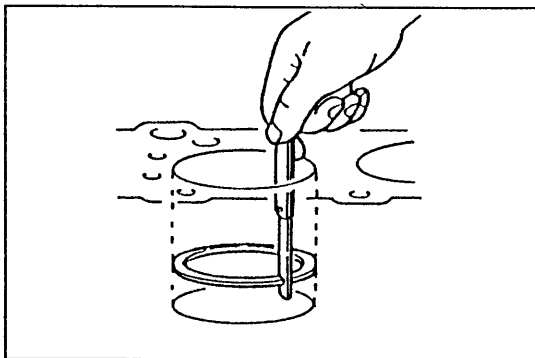
Oil: 0.07 — 0.16 mm {0.0028 — 0.0062 in}

Maximum: 0.15 mm {0.0059 in}



2. If the clearance exceeds the maximum, replace the piston and piston ring.

3. Insert the piston ring into the cylinder by hand and use the piston pin to push it to the bottom of the ring travel.



4. Measure each piston ring end gap by using a feeler gauge.

End gap

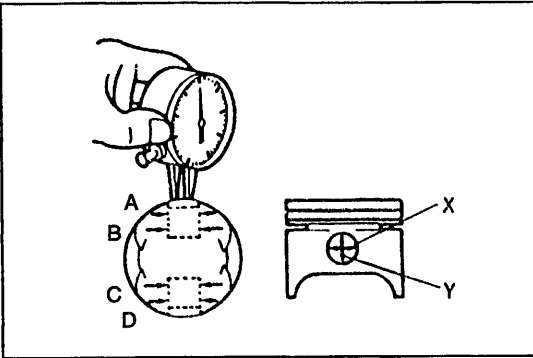
Top: 0.15 — 0.25 mm {0.0060 — 0.0098 in}

Second: 0.25 — 0.35 mm {0.0099 — 0.0137 in}

Oil: 0.20 — 0.70 mm {0.0079 — 0.0275 in}

Maximum: 1.0 mm {0.0394}

5. If the clearance exceeds the maximum, replace the piston ring.



Piston and Piston pin

1. Measure the piston pin bore in X and Y directions at four points (A,B,C and D) as shown.

Diameter:

20.988 — 21.000 mm {0.8263 — 0.8267 in}

2. Measure the piston pin diameter in X and Y directions at four points (A,B,C and D) as shown.

Diameter:

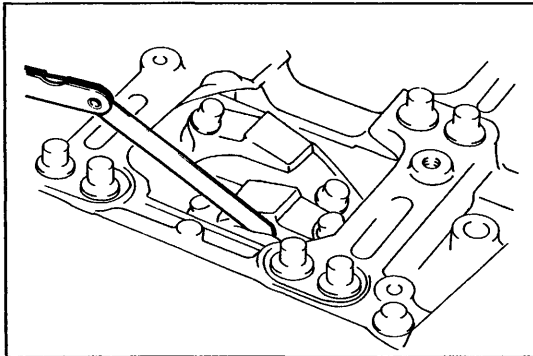
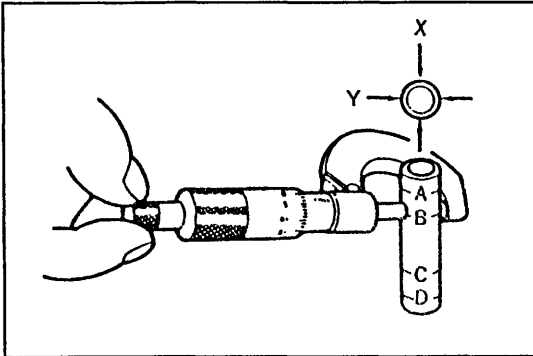
20.987 — 20.993 mm {0.8263 — 0.8264 in}

3. Calculate the piston pin bore-to-piston pin clearance.

Clearance:

-0.005 — 0.013 mm {-0.0002 — 0.0005 in}

4. If the clearance exceeds specification, replace the piston and / or piston pin.



CONNECTING ROD

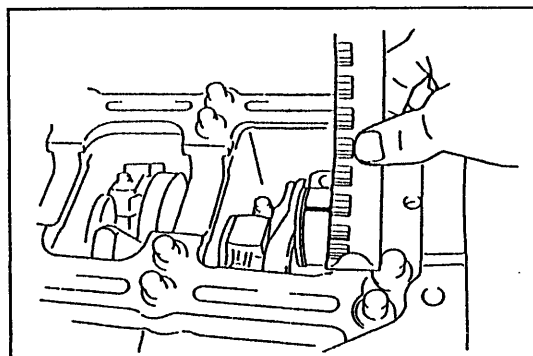
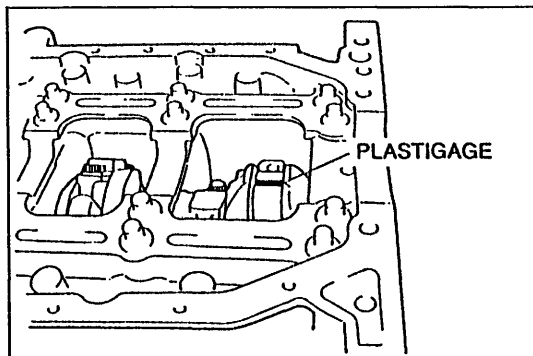
1. Measure the connecting rod side clearance.

Side clearance:

0.178 — 0.330 mm {0.0071 — 0.129 in}

Maximum: 0.40 mm {0.0157 in}

If the clearance exceeds the maximum, replace the connecting rod and cap assembly.

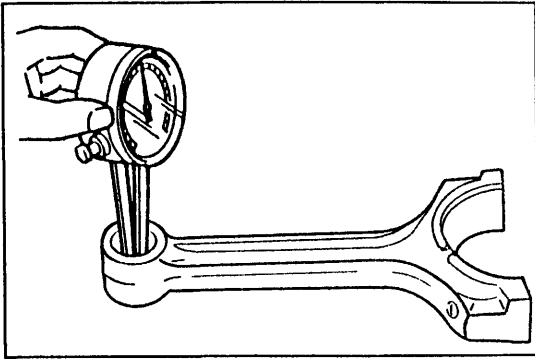


2. Measure the connecting rod bearing oil clearances as follows.

- (1) Measure the oil clearance with the connecting rod in BDC position.
- (2) Do not rotate the crankshaft when measuring the oil clearances.
- (3) Position Plastigage atop the journals in the axial direction.
- (4) Remove any foreign material and oil from the lower connecting rod bearing and connecting rod cap.
- (5) Install the connecting rod bearing in the cap.
- (6) Apply clean engine oil to the threads and seat faces of the connecting rod cap bolts.
- (7) Install the connecting rod cap.
- (8) Tighten the connecting rod cap bolts. (Refer to page B - 36.)
- (9) Remove the connecting rod cap.
- (10) Measure the Plastigage at each journal at the widest point for the smallest clearance, and the narrowest point for the largest clearance.

Oil clearance: 0.023 — 0.043 mm {0.0010 — 0.0016 in}

Maximum: 0.08 mm {0.0031 in}

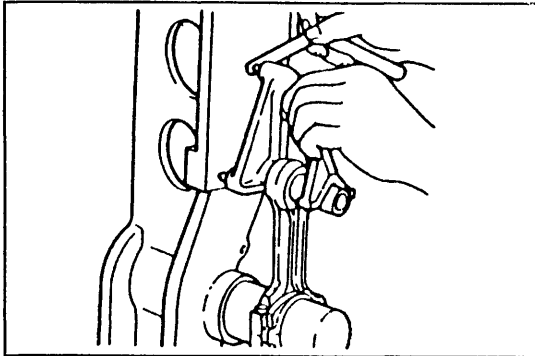


- (11) If the clearance exceeds the maximum, grind the crankshaft and install undersize bearings.

Crank pin journal diameter undersize

mm {in}

Bearing size	Journal diameter
0.25 {0.01} U.S	52.690 — 52.705 {2.0745 — 2.0749}



3. Measure the connecting rod small end bore.

Diameter:

21.003 — 21.014 mm {0.8269 — 0.8273 in}

4. Calculate the small end bore to piston pin. Replace the connecting rod if necessary.

Clearance: 0.010 — 0.027 mm {0.0004 — 0.0010 in}

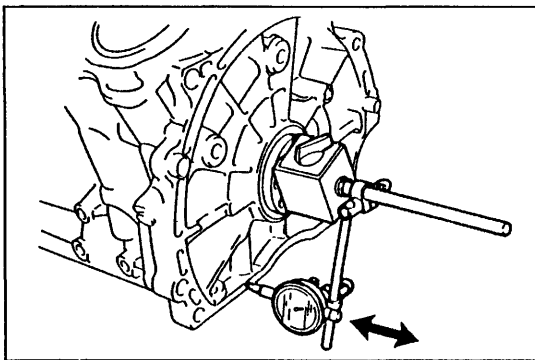
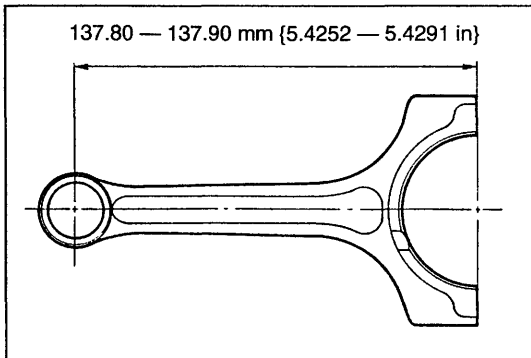
If the connecting rod is replaced, the connecting rod cap and bolts must also be replaced because they are a matched set.

5. Measure the connecting rod bending. Replace the connecting rod if necessary.

Bend: 0.05 mm {0.002 in} / 50 mm {1.9685 in} max.

Length (Center to center):

137.80 — 137.90 mm {5.4252 — 5.4291 in}



CRANKSHAFT

1. Measure the crankshaft end play.

End play: 0.080 — 0.282 mm {0.0032 — 0.0111 in}

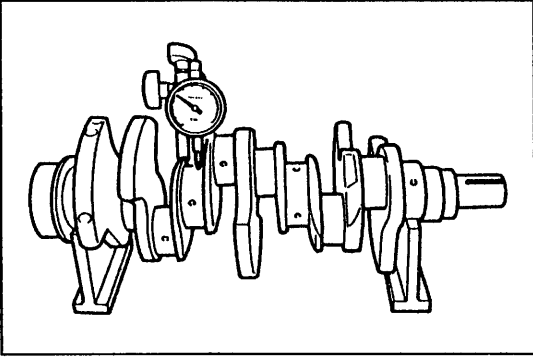
Maximum: 0.32 mm {0.0126 in}

2. If the end play exceeds the maximum, grind the crankshaft and install oversize thrust bearings or replace the crankshaft and thrust bearing.

Journal width

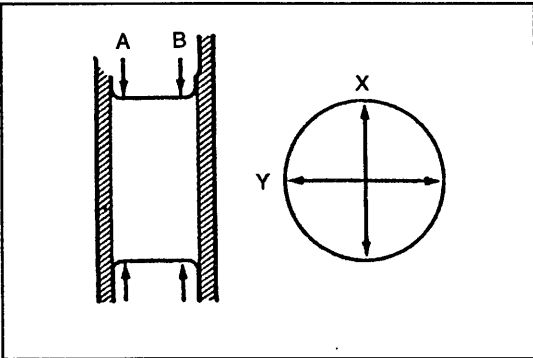
mm {in}

Bearing size	No.4 journal width
0.25 mm {0.01 in} O.S	30.82 — 30.87 {1.214 — 1.215}
0.50 mm {0.02 in} O.S	31.07 — 31.12 {1.224 — 1.225}



3. Set the crankshaft No.1 and No.4 main journals on V-blocks.
4. Measure the crankshaft runout at the No.2 and No.3 main journals. Replace the crankshaft if necessary.

Runout: 0.015 mm {0.0006 in} max.



5. Measure journal diameter in X and Y directions at two points (A and B) as shown.

Main journal

Diameter:

61.938 — 61.955 mm {2.4385 — 2.4391 in}

Out-of-round: 0.04 mm {0.0016 in} max.

Crank pin journal

Diameter:

52.940 — 52.955 mm {2.0843 — 2.0848 in}

Out-of-round: 0.03 mm {0.0012 in} max.

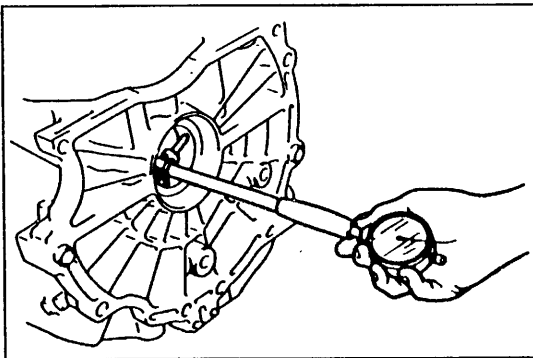
6. If the diameter is less than the specification, replace the crankshaft or grind the journals to match undersize bearings. (Refer to pages B – 47, 48.)
7. Measure the main bearing oil clearances as described below.

Oil clearance inspection

- (1) Install the upper main bearings and upper thrust bearings.

Note

- No.4 bearing is wider than other bearings.



- (2) Install the lower cylinder block along with the lower main bearings and thrust bearings.
- (3) Apply clean engine oil to the bolt threads and seat faces of the lower cylinder block bolts.
- (4) Tighten the bolts. (Refer to page B – 34)
- (5) After tightening, measure the cylinder block No.1 — No.4 journal bore diameter.
- (6) Subtract the main journal diameter from the bore diameter.
- (7) If the oil clearance exceeds the maximum, replace the bearing or grind the crankshaft and install undersize main bearings.

Oil clearance: 0.037 — 0.057 mm {0.0015 — 0.0022 in}

Maximum: 0.064 mm {0.0025 in}

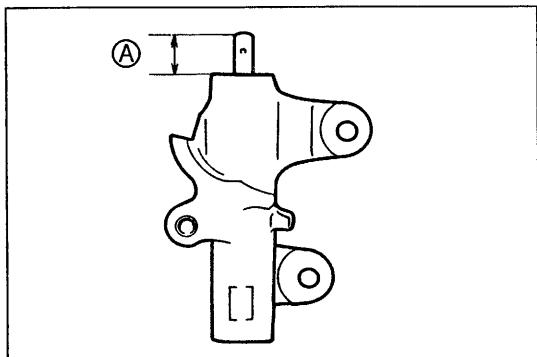
Main journal diameter

Standard:

61.938 — 61.955 mm {2.4385 — 2.4391 in}

0.25 mm {0.01 in} U.S:

61.688 — 61.705 mm {2.4287 — 2.4293 in}

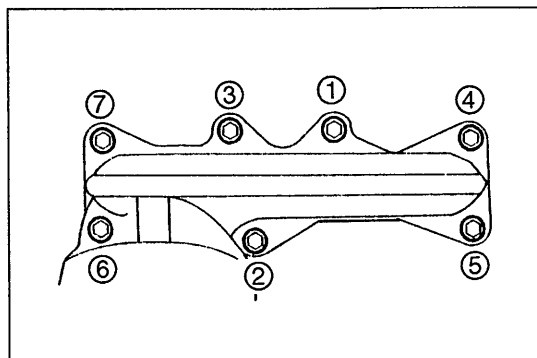
**TIMING BELT AUTO TENSIONER**

1. Measure the auto tensioner rod projection (A). Replace the auto tensioner if necessary.

Projection (A) (Free length)

14 — 16 mm {0.56 — 0.62 in}

2. Check the auto tensioner for oil leakage. Replace the auto tensioner if necessary.

**ENGINE STAND DISMOUNTING****PROCEDURE**

1. Remove the engine from the **SST** (engine stand).
2. Remove the **SST** from the engine in the reverse order of installation. (Refer to page B - 3.)
3. Install the new gasket and the warm up three way catalytic converter (RH). Tighten the new nuts and bolts in the order shown.

Tightening torque:

16 — 22 N·m {1.6 — 2.3 kgf·m, 12 — 16 ft·lbf}

4. Install the insulator (RH).

Tightening torque:

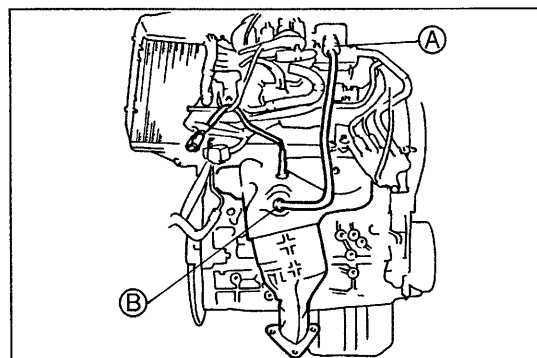
7.9 — 10.7 N·m {80 — 110 kgf·cm, 70 — 95.4 in lbf}

5. Install the EGR pipe.

Tightening torque:

(A) 44 — 58 N·m {4.4 — 6.0 kgf·m, 32 — 43 ft·lbf}

(B) 32 — 47 N·m {3.2 — 4.8 kgf·m, 24 — 34 ft·lbf}



6. Install the heated oxygen sensor (Front RH).

Tightening torque:

30 — 49 N·m {3.0 — 5.0 kgf·m, 22 — 36 ft·lbf}

LUBRICATION SYSTEM



OIL PUMP..... D – 2
DISASSEMBLY / INSPECTION
/ ASSEMBLY..... D – 2

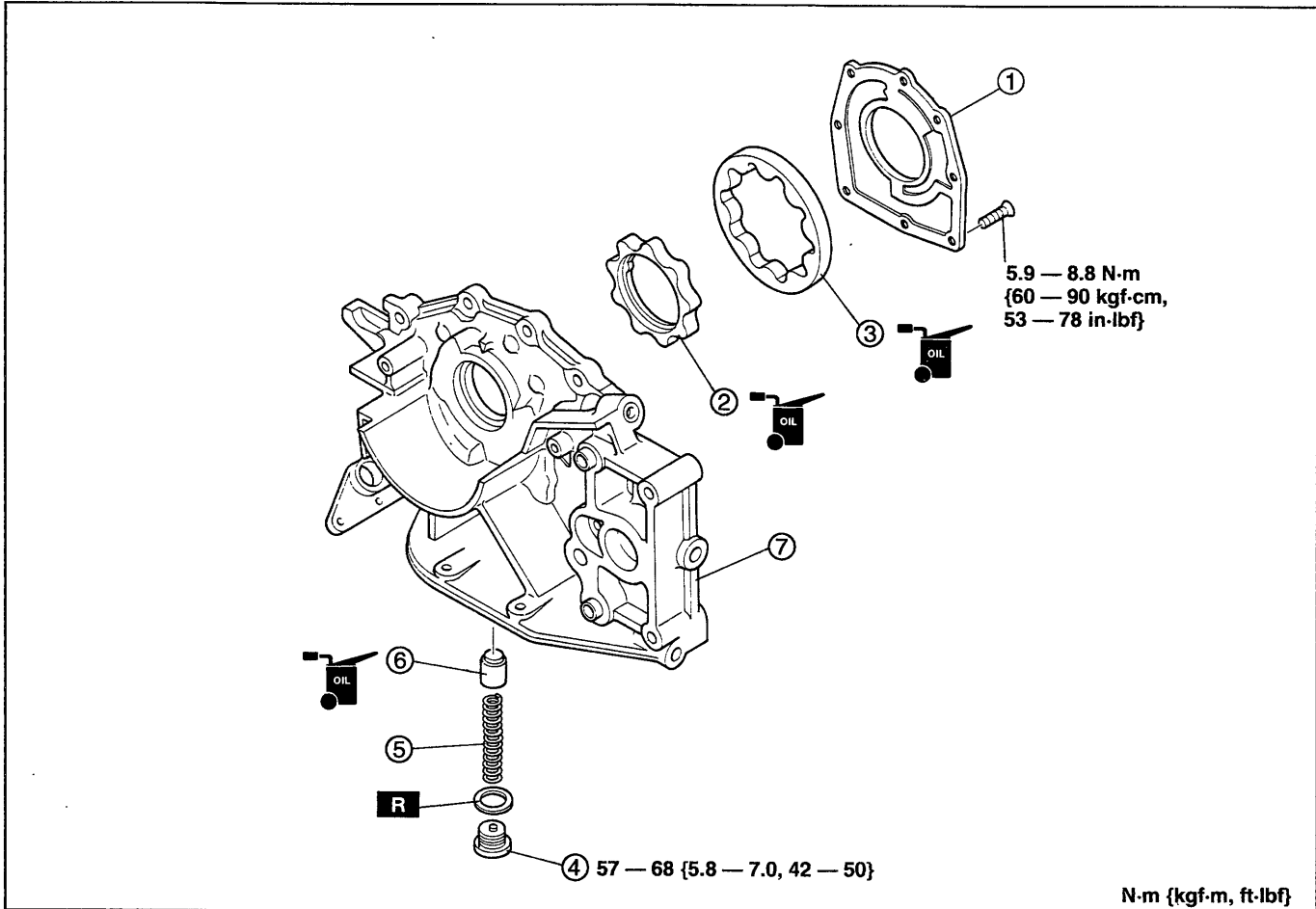
OIL PUMP

DISASSEMBLY / INSPECTION / ASSEMBLY

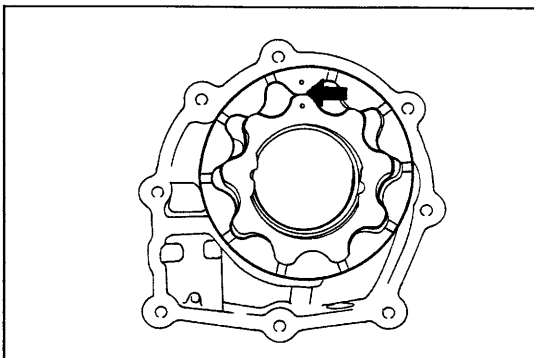
Warning

- Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

1. Disassemble in the order shown in the figure.
2. Assemble in the reverse order of disassembly, referring to **Assembly Note**.



- | | |
|-------------------------------|-----------------------------|
| 1. Oil pump cover | 4. Blind plug |
| Assembly Note..... page D — 3 | 5. Pressure spring |
| 2. Inner rotor | Inspection page D — 3 |
| Inspectionbelow | 6. Control plunger |
| Assembly Note..... page D — 3 | 7. Oil pump body |
| 3. Outer rotor | Inspectionbelow |
| Inspectionbelow | |
| Assembly Note..... page D — 3 | |



INSPECTION

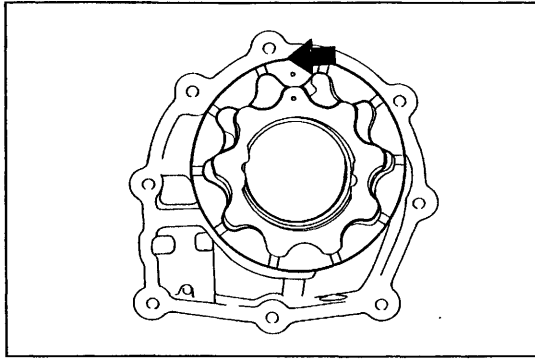
Inner rotor, Outer rotor, and Oil pump body

Measure the following clearances. Replace the rotor or oil pump body if necessary.

Tooth tip clearance:

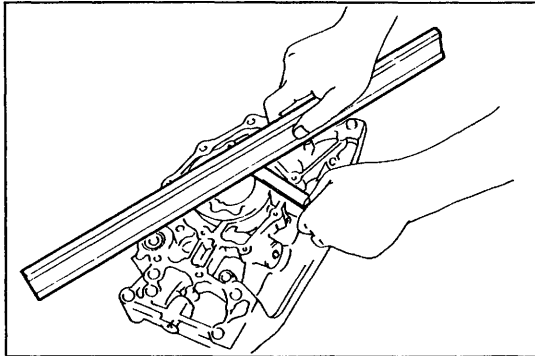
0.02 — 0.18 mm {0.0008 — 0.0070 in}

Maximum: 0.20 {0.0079 in}

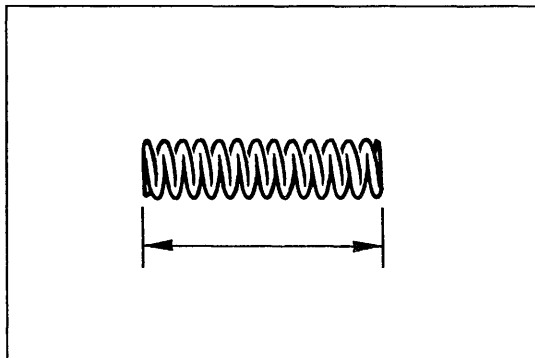


Outer rotor – to – oil pump body clearance:
 0.113 — 0.186 mm {0.00445 — 0.00732 in}
 Maximum: 0.22 mm {0.0087 in}

D



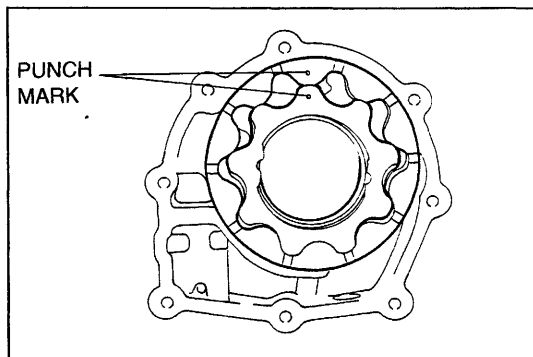
Side clearance:
 0.03 — 0.09 mm {0.00119 — 0.00354 in}
 Maximum: 0.13 mm {0.00512 in}



Pressure spring

Measure the free length. Replace the spring if necessary.

Free length: 46.79 mm {1.842 in}

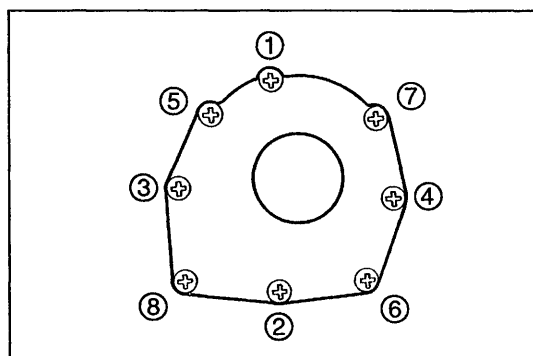


PUNCH
MARK

Assembly Note

Inner rotor and outer rotor

Install the inner rotor and outer rotor into the oil pump body with the marks aligned as shown.



Oil pump cover

Install the oil pump cover and tighten the bolts in the order shown.

Tightening torque:

5.9 — 8.8 N·m {60 — 90 kgf·cm, 53 — 78 in·lbf}

