Engine Workshop Manual Z5-DOHC

7/94 1424-10-94G

mazda

WARNING

Servicing a vehicle can be dangerous. If you have not received service-related training, the risks of injury and property damage increase. The recommended servicing procedures for the vehicle in this workshop manual were developed with Mazda-trained technicians in mind. This manual may be useful to non-Mazda trained technicians, but a technician with our service-related training and experience will be at less risk when performing servicing operations. However, all users of this manual are expected to know general safety procedures.

This manual contains "Warnings" and "Cautions" applicable to risks not normally encountered in a general technician's experience. They should be followed to reduce the risk of injury and the risk that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that the "Warnings" and "Cautions" are not exhaustive. It is impossible to warn of all the hazardous consequences that might result from failure to follow the procedures.

The procedures recommended and described in this manual are effective methods of performing service and repair. Some require tools specifically designed for a specific purpose. Nonrecommended procedures and tools should include consideration for safety of the technician and continued safe operation of the vehicle.

Parts should be replaced with genuine Mazda replacement parts, not parts of lesser quality. Use of a nonrecommended replacement part should include consideration for safety of the technician and continued safe operation of the vehicle.

Mazda Engine Workshop Manual Z5–DOHC

CONTENTS

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 June, 1994. 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.

Mazda Motor Corporation
HIROSHIMA, JAPAN

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GENERAL INFORMATION

SAFETY INFORMATION

LUBRICANTS

Avoid prolonged and repeated contact with petroleum-based oils. Used oil may irritate the skin, and can cause skin cancer and other skin disorders.

Wash thoroughly after working with oil. We recommend water soluble hand cleaners. Do not use kerosene, gasoline, or any other solvent, to remove oil from your skin.

If repeated or prolonged contact with oil is necessary, wear protective clothing. Soiled clothing, particularly those soiled with used oils and greases containing lead, should be cleaned at regular intervals.

HOW TO USE THIS MANUAL

ADVISORY MESSAGES

You'll find several **Warnings**, **Cautions**, and **Notes** in this manual.

Warning

- **A Warning indicates a situation in which serious injury or death could result if the warning is ignored.**

Caution

- **A Caution indicates a situation in which damage to the vehicle could result if the caution is ignored.**

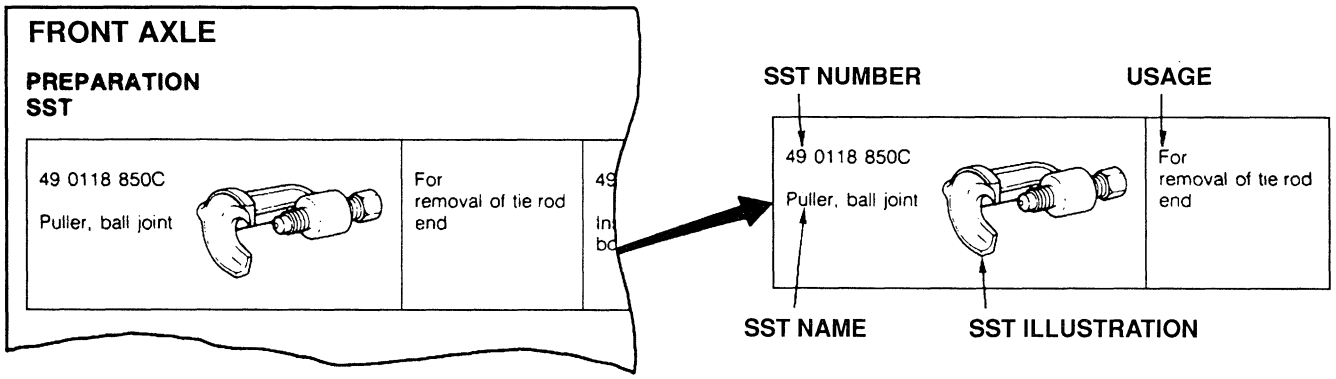
Note

- A **Note** provides added information that will help you to complete a particular procedure.

PREPARATION

This points out the needed **SSTs** for the service operation. It is best to gather all necessary **SSTs** before beginning work.

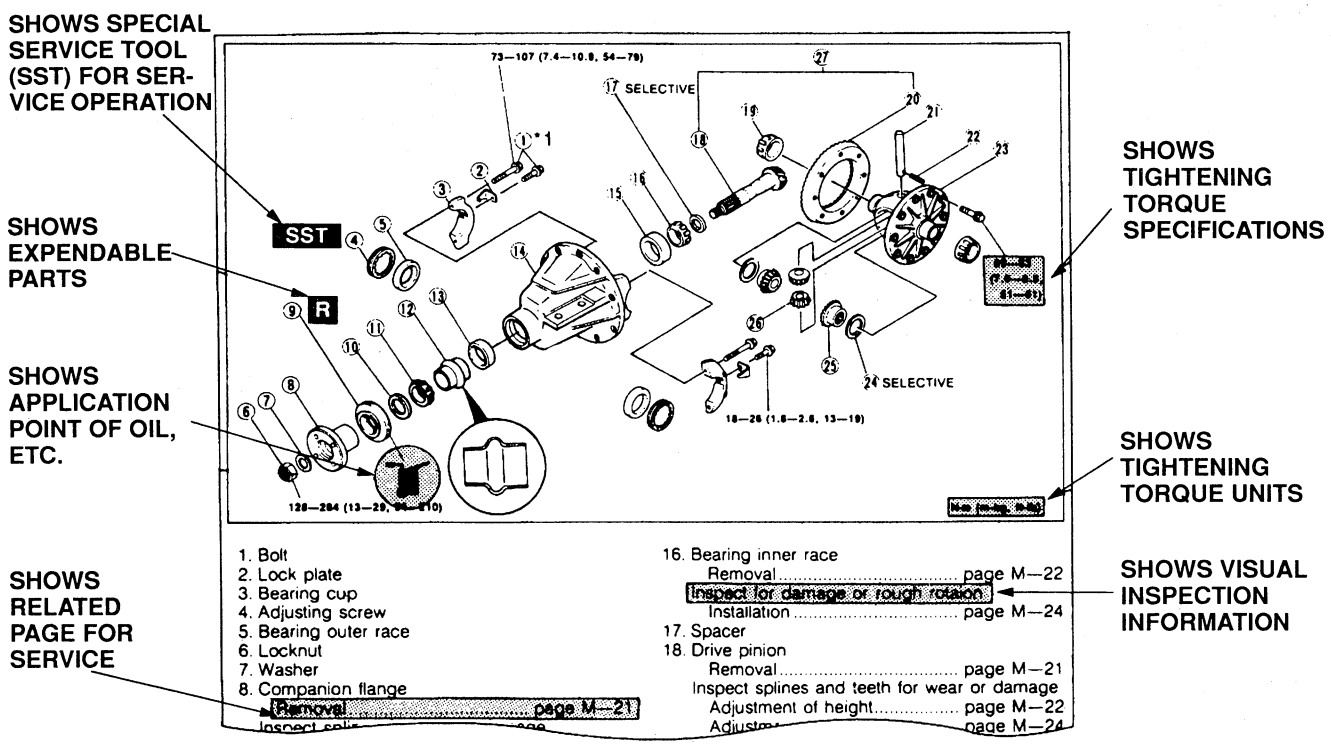
Example:



REPAIR PROCEDURE

1. Most repair operations begin with an overview illustration. It identifies the components, shows how the parts fit together, and describes visual part inspection. If a damaged or worn part is found, repair or replace it as necessary.
2. Expendable parts, tightening torques, and symbols for oil, grease, and sealant are shown in the overview illustration.
3. Pages related to service procedures are shown under the illustration. Refer to this information when servicing the related part.

Example:

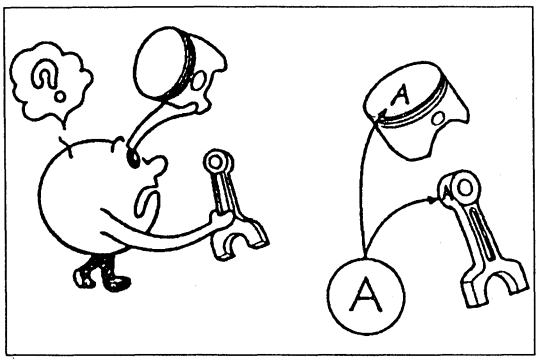


*1: The numbers (①, etc.) refer to part identification and servicing procedures.

SYMBOLS

There are seven symbols indicating oil, grease, and sealant. These symbols show the points of applying such materials during service.

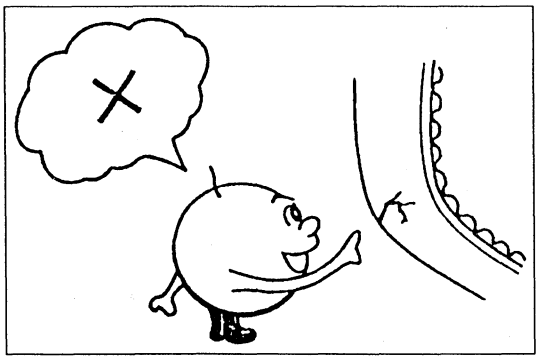
Symbol	Meaning	Kind
OIL	Apply oil (except ATF and brake fluid)	New engine oil as appropriate
GREASE	Apply grease	Appropriate grease
SEALANT	Apply sealant	Appropriate sealant
P	Apply petroleum jelly	Appropriate petroleum jelly
R	Replace part	O-ring, gasket, etc.



FUNDAMENTAL PROCEDURES

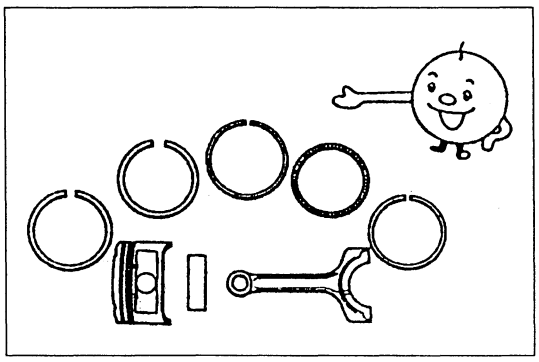
DISASSEMBLY

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.



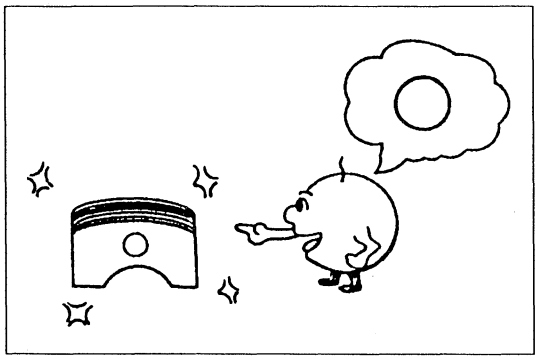
1. Inspection of parts

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

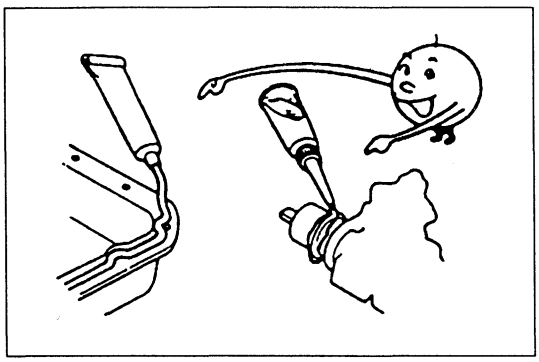
- **Using compressed air can cause dirt and other particles to fly out, causing injury to the eyes. Wear protective eye wear whenever using compressed air.**

REASSEMBLY

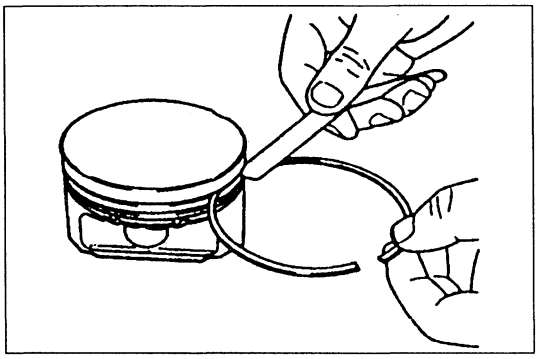
Standard values, such as tightening torques and adjustment values must be strictly observed in the reassembly of all parts.

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

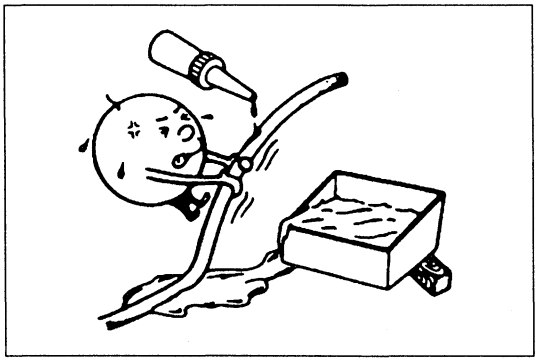


Depending on location:
1. Sealant gasket, or both should be applied to the specified location. When sealant is applied, parts should be installed before sealant hardens. Hardened sealant causes leaks.
2. Oil should be applied to the sliding surfaces of moving parts.
3. Specified oil or grease should be applied at the prescribed locations (such as oil seals) before reassembly.



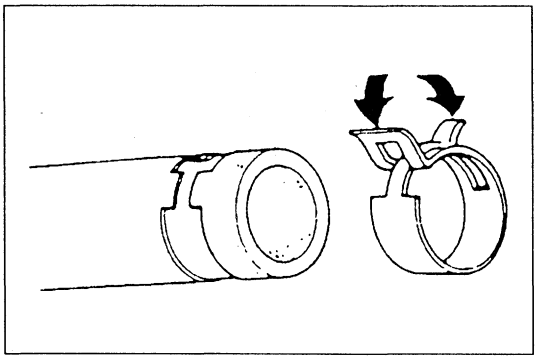
ADJUSTMENTS

Use gauges and/or tester 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.

UNITS

Electrical current	A (ampere)
Electric potential	V (volt)
Electric power	W (watt)
Length	mm (millimeter) in (inch)
Negative pressure	kPa (kilo Pascal) mmHg (millimeters of mercury) inHg (inches of mercury)
Positive pressure	kPa (kilo Pascal) kgf/cm^2 (kilogram force per square centimeter) psi (pounds per square inch)
Resistance	Ω (ohm)
Torque	N·m (Newton meter) kgf·m (kilogram force per meter) kgf·cm (kilogram force per centimeter) ft·lbf (foot pound) in·lbf (inch pound)
Volume	L (liter) US qt (U.S. quart) Imp qt (Imperial quart) ml (milliliter) cc (cubic centimeter) cu in (cubic inch) fl oz (fluid ounce)
Weight	g (gram) oz (ounce)

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 are 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/cm^2 in the following specifications:

- 210—260 kPa { 2.1—2.7 kgf/cm^2 , 30—38 psi }
- 270—310 kPa { 2.7—3.2 kgf/cm^2 , 39—45 psi }

The actual converted values for 2.7 kgf/cm^2 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.

ABBREVIATIONS

ATX	Automatic transaxle
BDC	Bottom dead center
EX	Exhaust
HLA	Hydraulic lash adjuster
IN	Intake
LH	Left hand
MAX	Maximum
MBSP	Main bearing support plate
MIN	Minimum
MTX	Manual transaxle
O.S	Over size
P/S	Power steering
RH	Right hand
SST	Special service tool
STD	Standard
TDC	Top dead center
U.S	Under size
VRAS	Vibration reducing aluminum stiffener

SAE STANDARDS

In accordance with new regulations, SAE (Society of Automotive Engineers) standard names and abbreviations are now used in this manual. The table below lists the names and abbreviations that have been used in Mazda manuals up to now and their SAE equivalents.

Previous Standard		SAE Standard		
Abbreviation	**Name**	**Abbreviation**	**Name**	**Remark**
—	Accelerator Pedal	AP	Accelerator Pedal	
—	Air Cleaner	ACL	Air Cleaner	
—	Air Conditioning	A/C	Air Conditioning	
—	Airflow Meter	VAF	Volume Air Flow Sensor	
—	Airflow Sensor	MAF	Mass Air Flow Sensor	
—	Alternator	GEN	Generator	
—	ATF Thermosensor	—	Transmission (Transaxle) Fluid Temperature Sensor	
—	Atmospheric Pressure	BARO	Barometric Pressure	
V_B	Battery Voltage	B+	Battery Positive Voltage	
—	Catalytic Converter	OC	Oxidation Catalytic Converter	
		TWC	Three Way Catalytic Converter	
		WU-TWC	Warm Up Three Way Catalytic Converter	#1
—	Circuit Opening Relay	FPR	Fuel Pump Relay	#2
—	Clutch Position	CPP	Clutch Pedal Position	
—	Crank Angle Sensor	CMP	Camshaft Position Sensor	
—	Crank Angle Sensor 2	CKP	Crankshaft Position Sensor	
—	Diagnosis Connector	DLC	Data Link Connector	
—	Diagnosis/Self-Diagnosis	OBD	On-Board Diagnostic	
—	Direct Ignition	DLI	Distributorless Ignition	
—	EC-AT Control Unit	TCM	Transmission (Transaxle) Control Module	
EGI	Electronic Gasoline Injection System	CIS	Continuous Fuel Injection System	
—	Electronic Spark Ignition	EI	Electronic Ignition	#3
ECU	Engine Control Unit	PCM	Powertrain Control Module	#4
		ECM	Engine Control Module	
—	Engine Modification	EM	Engine Modification	
—	Engine RPM Signal	—	Engine Speed Input Signal	
—	Engine Speed	RPM	Engine Speed	
—	Evaporative Emission	EVAP	Evaporative Emission	
—	Exhaust Gas Recirculation	EGR	Exhaust Gas Recirculation	
—	Fan Control	FC	Fan Control	
—	Feedback System	CLS	Closed Loop System	
—	Flexible Fuel	FF	Flexible Fuel	
—	Fuel Pump	FP	Fuel Pump	
—	Fully Closed	CTP	Closed Throttle Position	
—	Fully Open	WOT	Wide Open Throttle	
—	Ground/Earth	GND	Ground	

#1: Directly connected to exhaust manifold
#2: In some models, there is a fuel pump relay that controls pump speed. That relay is now called the fuel pump relay (speed).
#3: Controlled by the ECM (PCM)
#4: Device that controls engine and powertrain

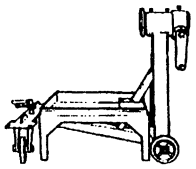
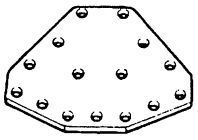
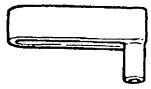
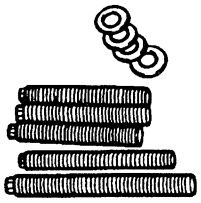
Previous Standard		SAE Standard		
Abbreviation	Name	Abbreviation	Name	Remark
—	IC Regulator	VR	Voltage Regulator	
—	Idle Speed Control	IAC	Idle Air Control	
—	Idle Switch	—	Closed Throttle Position Switch	
—	Igniter	ICM	Ignition Control Module	
—	Inhibitor Position	TR	Transmission (Transaxle) Range	
—	Intake Air Pressure	MAP	Manifold Absolute Pressure	
—	Intake Air Thermo	IAT	Intake Air Temperature	
—	Intercooler	CAC	Charge Air Cooler	
—	Knock Sensor	KS	Knock Sensor	
—	Line Pressure Solenoid Valve	—	Pressure Control Solenoid	
—	Lock-up Position	TCC	Torque Converter Clutch	
—	Malfunction Indicator Light	MIL	Malfunction Indicator Lamp	
—	Multiport Fuel Injection	MFI	Multiport Fuel Injection	
—	Open Loop	OL	Open Loop	
—	Overdrive	4GR	Fourth Gear	
—	Oxygen Sensor	HO2S	Heated Oxygen Sensor	With heater
		O2S	Oxygen Sensor	
—	Park/Neutral Range	PNP	Park/Neutral Position	
—	Power Steering Pressure	PSP	Power Steering Pressure	
—	Pulse Generator	—	Input/Turbine Speed Sensor	
—	Reed Valve	SAPV	Secondary Air Pulse Valve	
—	Secondary Air Injection System	PAIR	Pulsed Secondary Air Injection	Pulsed injection
		AIR	Secondary Air Injection	Inject with compressor
—	Sequential Fuel Injection	SFI	Sequential Multipoint Fuel Injection	
—	Service Code(s)	DTC	Diagnostic Trouble Code(s)	
—	Spark Ignition	DI	Distributor Ignition	
—	Stoplight Switch	—	Brake Switch	
—	Test Mode	DTM	Diagnostic Test Mode	#5
—	Throttle Body	TB	Throttle Body	
—	Throttle Sensor	TP	Throttle Position Sensor	
—	Turbocharger	TC	Turbocharger	
—	Vehicle Speed Sensor	VSS	Vehicle Speed Sensor	
—	Vehicle Speed Sensor 1	—	Output Speed Sensor	
—	Water Thermo	ECT	Engine Coolant Temperature	
—	1–2 Shift Solenoid Valve	—	Shift Solenoid A	
—	2–3 Shift Solenoid Valve	—	Shift Solenoid B	
—	3–4 Shift Solenoid Valve	—	Shift Solenoid C	
—	3rd Gear	3GR	Third Gear	
—	—	—	Incorrect Gear Ratio	

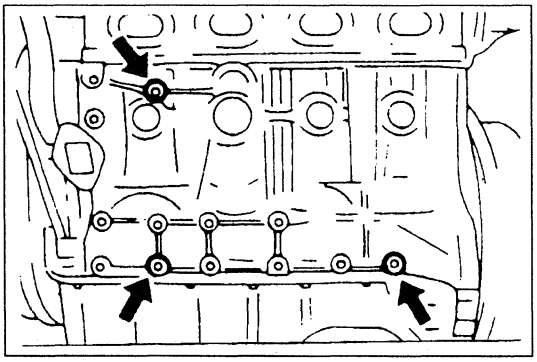
#5: Diagnostic trouble codes depend on the diagnostic test mode

ENGINE OVERHAUL

ENGINE STAND MOUNTING/DISMOUNTING

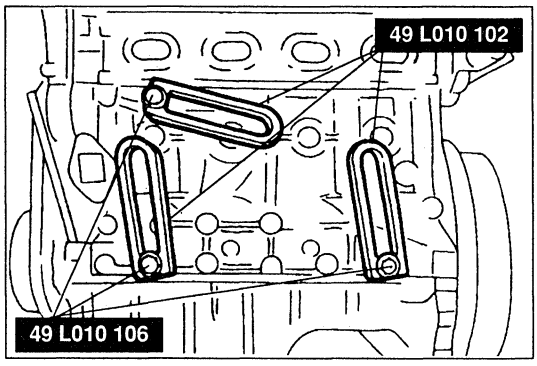
PREPARATION
SST

49 0107 680A Engine stand 	For disassembly and assembly of engine	49 L010 1A0 Hanger set, engine stand 	For disassembly and assembly of engine
49 L010 101 Plate (Part of 49 L010 1A0) 	For disassembly and assembly of engine	49 L010 102 Arms (Part of 49 L010 1A0) 	For disassembly and assembly of engine
49 L010 103 Hooks (Part of 49 L010 1A0) 	For disassembly and assembly of engine	49 L010 104 Nuts (Part of 49 L010 1A0) 	For disassembly and assembly of engine
49 L010 105 Bolts (Part of 49 L010 1A0) 	For disassembly and assembly of engine	49 L010 106 Bolts (Part of 49 L010 1A0) 	For disassembly and assembly of engine

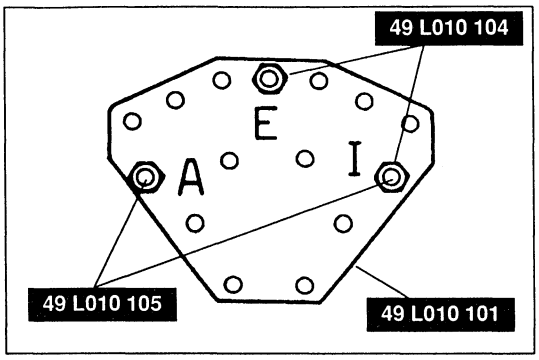


MOUNTING

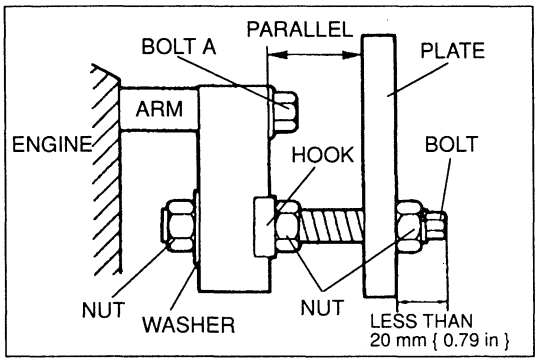
1. Use the holes shown in the figure.



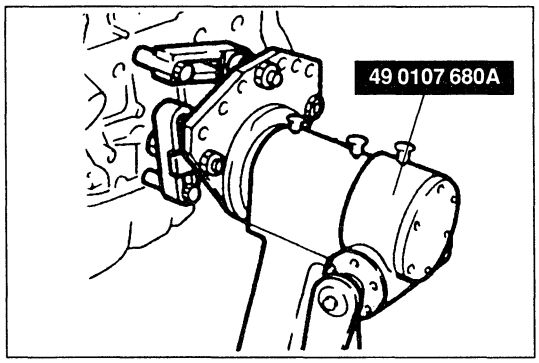
2. Install the **SST** (arms) to the holes as shown in the figure, and hand tighten the **SST** (bolts).



3. Assemble the **SST** (bolts, nuts, and plate) in the specified positions marked A, E, and I.



4. Install the **SST** assembled in step 3 to the respective arms.
5. Adjust the **SST** (bolts) so that less than **20 mm { 0.79 in }** of thread is exposed.
6. Make the **SST** (plate and arms) parallel by adjusting the **SST** (bolts and nuts).
7. Tighten the **SST** (bolts and nuts) to affix the **SST** firmly.



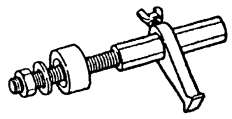
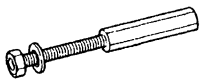
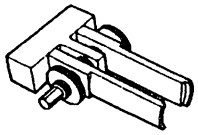
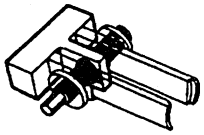
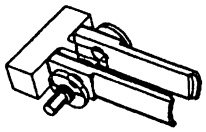
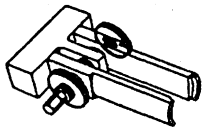
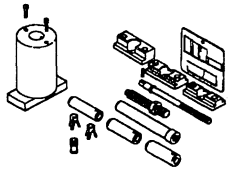
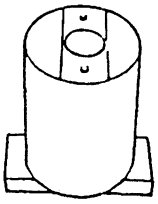
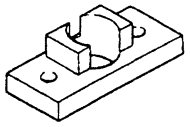
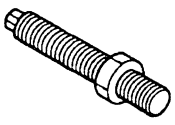
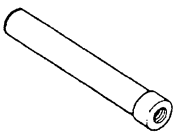
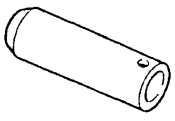
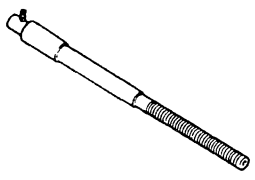
8. Mount the engine on the **SST** (engine stand).

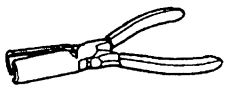
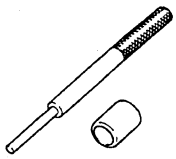
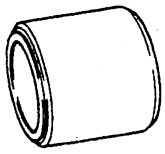
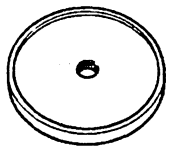
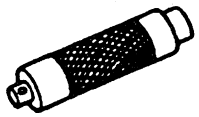
DISMOUNTING

Dismount in the reverse order of mounting.

DISASSEMBLY / ASSEMBLY

PREPARATION
SST

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 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 0636 100B Arm, valve spring lifter 	For removal / installation of valves	49 L011 0A0B Setting tool set, piston pin 	For removal / installation of piston pins
49 L011 001 Support block body (Part of 49 L011 0A0B) 	For removal / installation of piston pins	49 D011 002B Support block head (Part of 49 L011 0A0B) 	For removal / installation of piston pins
49 L011 005 Stopper bolt (Part of 49 L011 0A0B) 	For removal / installation of piston pins	49 L011 006 Puller & installer (Part of 49 L011 0A0B) 	For removal / installation of piston pins
49 L011 007 Guide (Part of 49 L011 0A0B) 	For removal / installation of piston pins	49 E011 002 Screw 	For removal / installation of piston pins

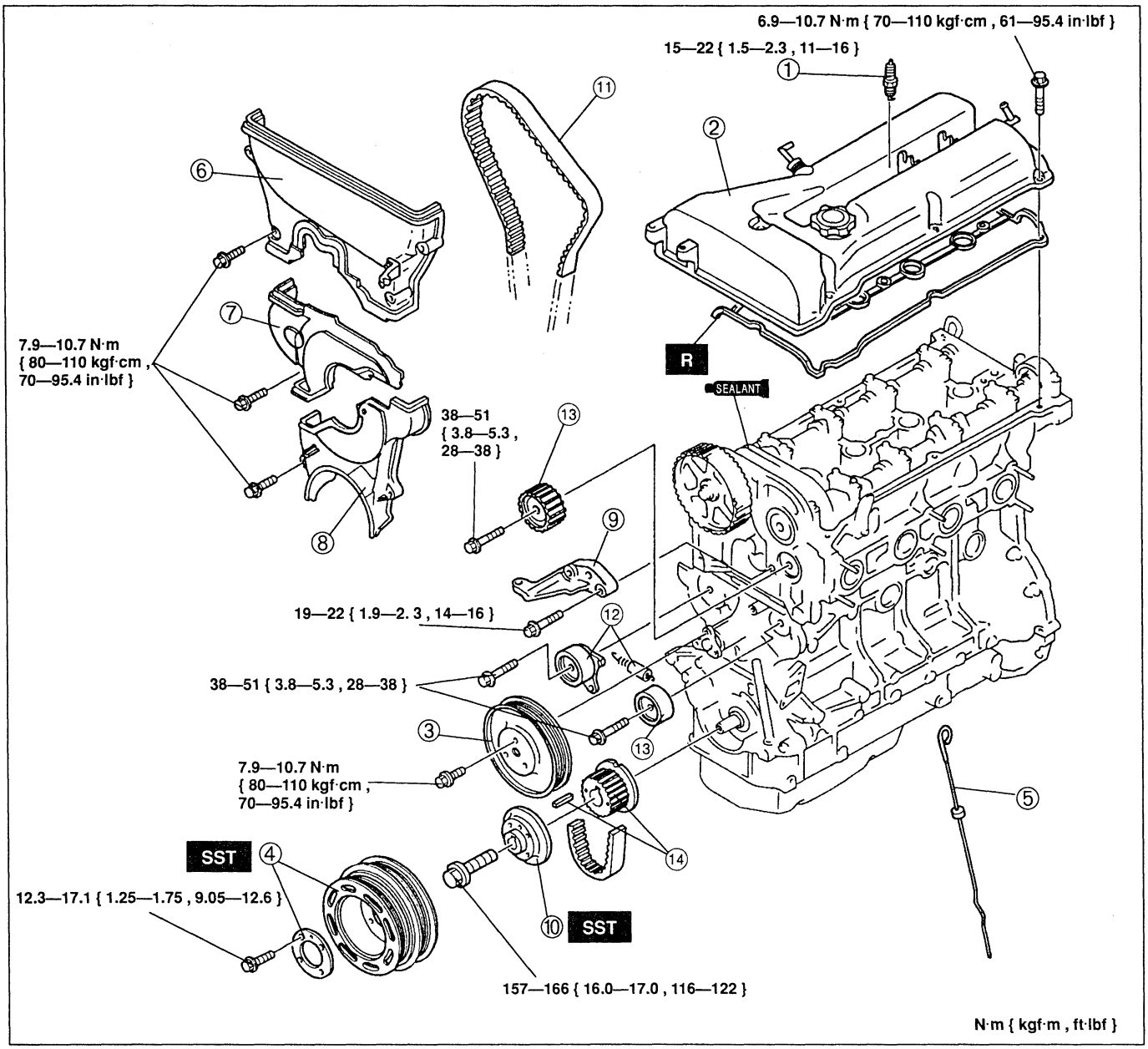
49 S120 170 Remover, valve seal 	For removal of valve seals	49 B012 0A3 Installer, valve seal & valve guide 	For installation of valve seals
49 B012 015 Installer (Part of 49 B012 0A3) 	For installation of valve seals	49 B012 016 Attachment (Part of 49 B012 0A3) 	For installation of valve seals
49 B014 001 Installer, oil seal 	For installation of front oil seal	49 W033 105 Installer, oil seal 	For installation of rear oil seal
49 G030 795 Installer, oil seal 	For installation of rear oil seal	49 G030 797 Handle (Part of 49 G030 795) 	For installation of rear oil seal

Warning

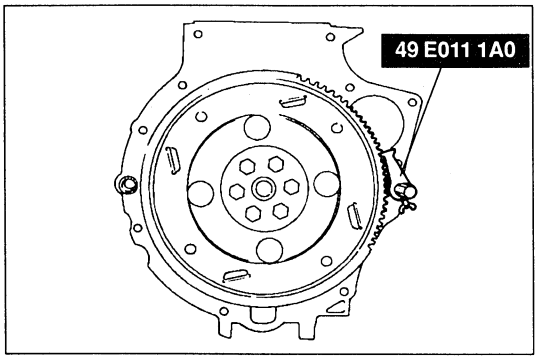
- **Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.**

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**.

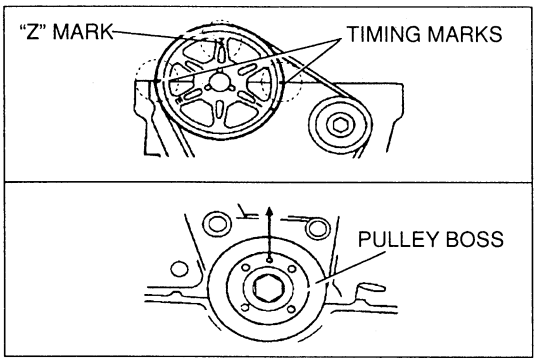


1. Spark plug
2. Cylinder head cover
   Assembly Note ..... page B–10
3. Water pump pulley
4. Crankshaft pulley and plate
   Disassembly Note ..... page B– 7
   Assembly Note ..... page B– 9
5. Dipstick
6. Timing belt cover, upper
7. Timing belt cover, middle
8. Timing belt cover, lower
9. No.3 engine mount bracket
10. Pulley boss
    Disassembly Note ..... page B– 7
    Assembly Note ..... page B– 8
11. Timing belt
    Disassembly Note ..... page B– 7
    Assembly Note ..... page B– 8
12. Tensioner and tensioner spring
    Assembly Note ..... page B– 8
13. Idler
14. Timing belt pulley and key
    Assembly Note ..... page B– 8



Disassembly Note
Crankshaft pulley and plate

1. Hold the flywheel (MTX) or drive plate (ATX) by using the **SST**.
2. Remove the crankshaft pulley and plate.

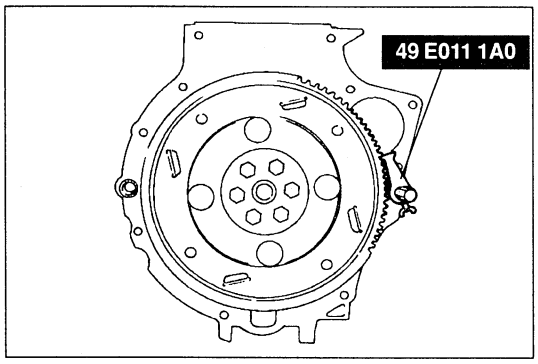


Pulley boss

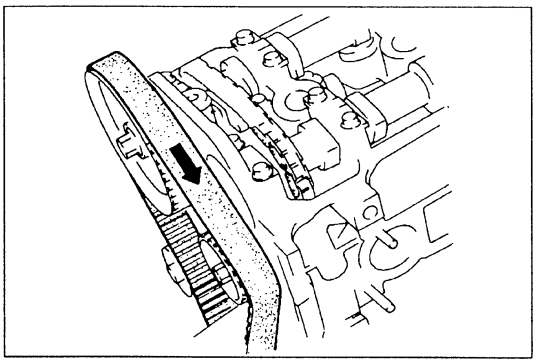
1. Turn the crankshaft clockwise and align the timing marks of the pulleys.

Note

- Face the locating pin on the pulley boss and "Z" mark on the camshaft pulley straight up, and align the timing marks with the cylinder head upper surface.



2. Hold the flywheel (MTX) or drive plate (ATX) by using the **SST**.
3. Remove the pulley boss.

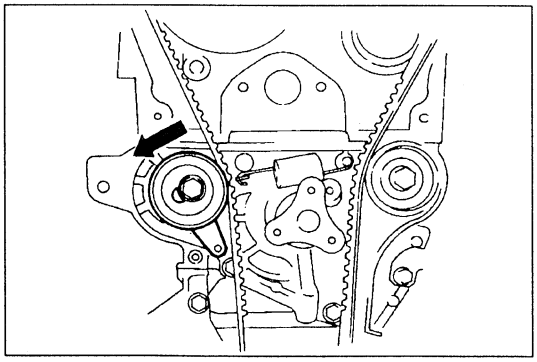


Timing belt

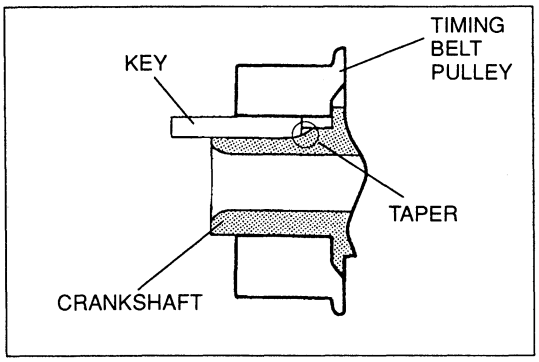
Caution

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

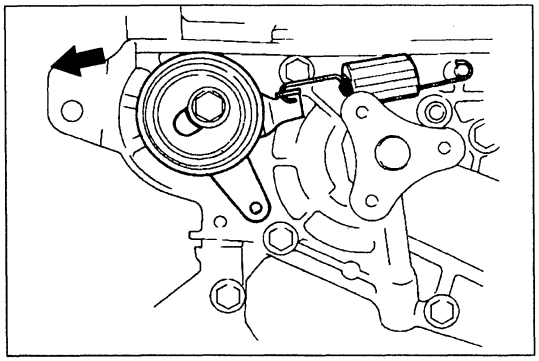
1. Mark the timing belt rotation on the belt for proper reinstallation.



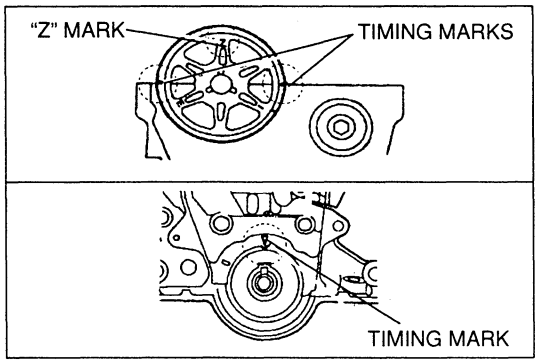
2. Loosen the tensioner lock bolt.
3. Push the tensioner in the direction of the arrow and hand tighten the lock bolt.
4. Remove the timing belt.



Assembly Note
Timing belt pulley and key
Insert the key into the timing belt pulley, facing the tapered side downward. Push the key until it stops.

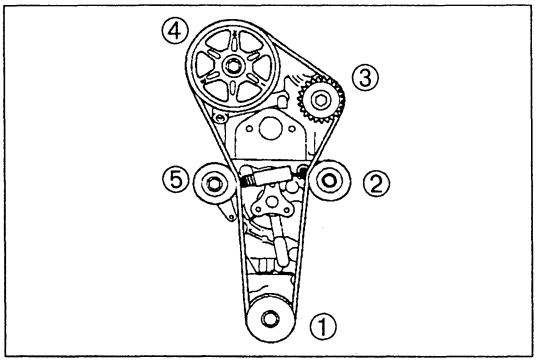


Tensioner and tensioner spring
1. Install the tensioner spring as shown.
2. Push the tensioner in the direction of the arrow and hand tighten the lock bolt.

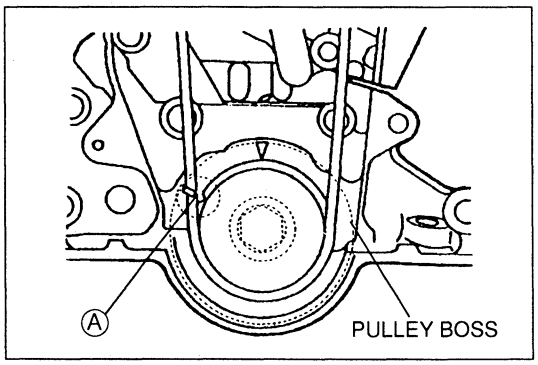


Timing belt
1. Verify that all timing marks are correctly aligned.

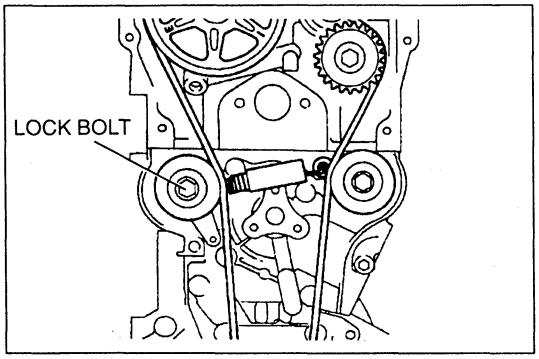
Note
- Face "Z" mark on the camshaft pulley straight up and align the timing marks with the cylinder head upper surface.



2. Install the timing belt on the pulleys in the order shown below.
   ① Timing belt pulley
   ② No.2 idler pulley
   ③ No.1 idler pulley
   ④ Camshaft pulley
   ⑤ Tensioner

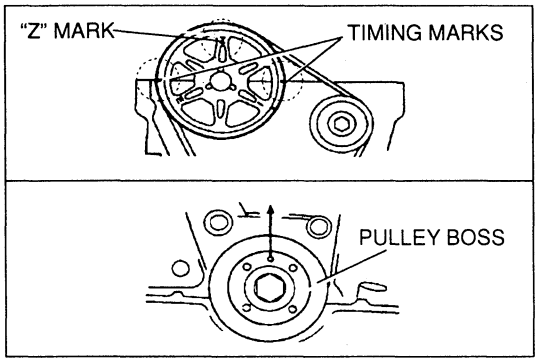


Pulley boss
1. Install the pulley boss and pulley lock bolt. Turn the crankshaft clockwise 1 and 5/6 times, and verify that the timing mark and the tensioner set mark Ⓐ are aligned.



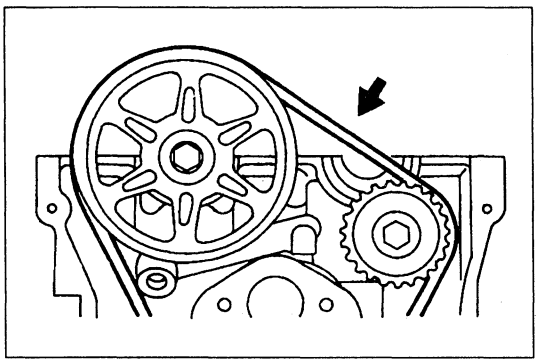
2. Loosen the tensioner lock bolt to apply tension to the timing belt. Do not apply tension other than that of the tensioner spring.
3. Tighten the tensioner lock bolt.

Tightening torque:
38—51 N·m { 3.8—5.3 kgf·m , 28—38 ft·lbf }



4. Turn the crankshaft clockwise 2 and 1/6 times, and verify that all timing marks are correctly aligned.

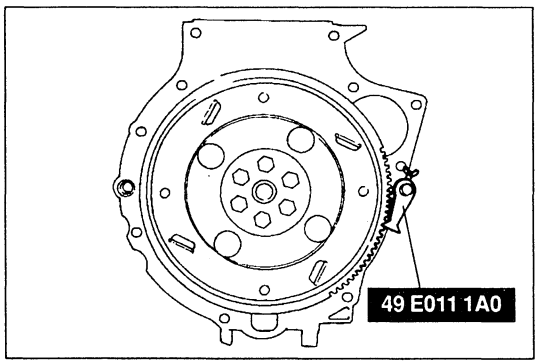
Note
- Timing is correct when the locating pin on the pulley boss and "Z" mark on the camshaft pulley are facing straight up, and the timing marks are aligned with the cylinder head upper surface.



5. Check the belt deflection at the point indicated by applying moderate pressure **98 N { 10 kgf , 22 lbf }**.

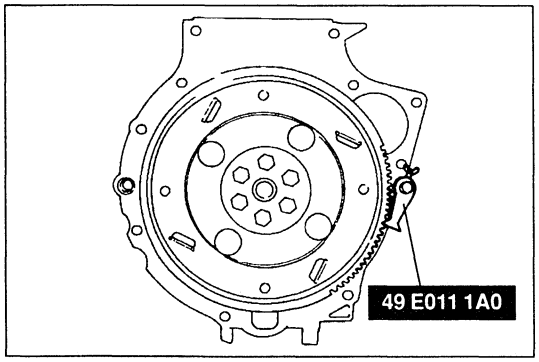
Deflection: 7—9 mm { 0.28—0.35 in }

6. If the timing belt deflection is not correct, remove the timing belt and repeat from timing belt assembly note step 1.



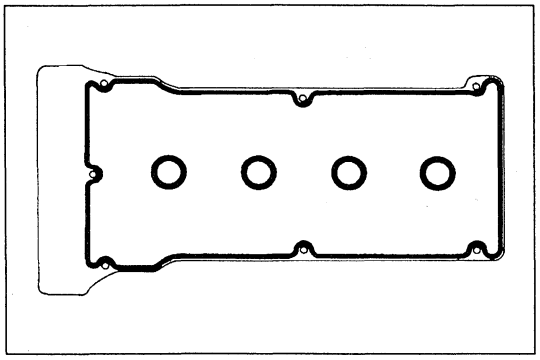
7. Hold the drive plate (ATX) or flywheel (MTX) by using the **SST**.
8. Tighten the pulley lock bolt.

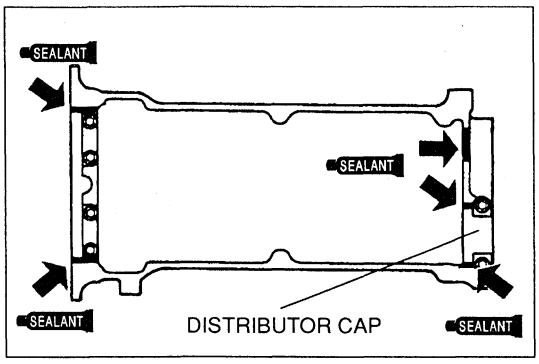
Tightening torque: 157—166 N·m
{ 16.0—17.0 kgf·m , 116—122 ft·lbf }

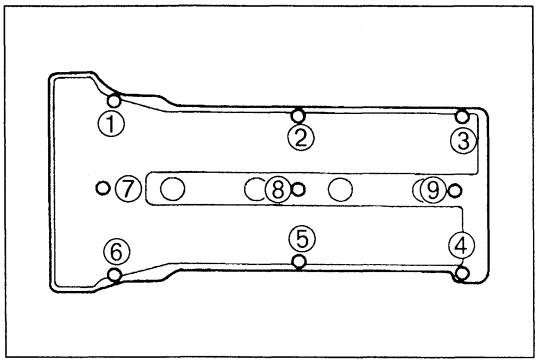


Crankshaft pulley and plate
1. Hold the drive plate (ATX) or flywheel (MTX) by using the **SST**.
2. Install the crankshaft pulley and plate.

Tightening torque: 12.3—17.1 N·m
{ 1.25—1.75 kgf·m , 9.05—12.6 ft·lbf }







Cylinder head cover

1. Before installing the cylinder head cover, measure the valve clearances. (Refer to page B–39.)

   Caution
   - **Silicone sealant hardens and causes oil leakage when it is left for an extended period.**

2. Verify that the grooves on the cylinder head cover are free of oil, water and other foreign material.
3. Install the new cylinder head cover gasket into the cylinder head cover.
4. Apply silicone sealant to the shaded areas shown.

   Thickness: ϕ 3—4 mm { 0.12—0.15 in }

5. Install the cylinder head cover.

6. Tighten the cylinder head cover bolts in five or six steps in the order shown.

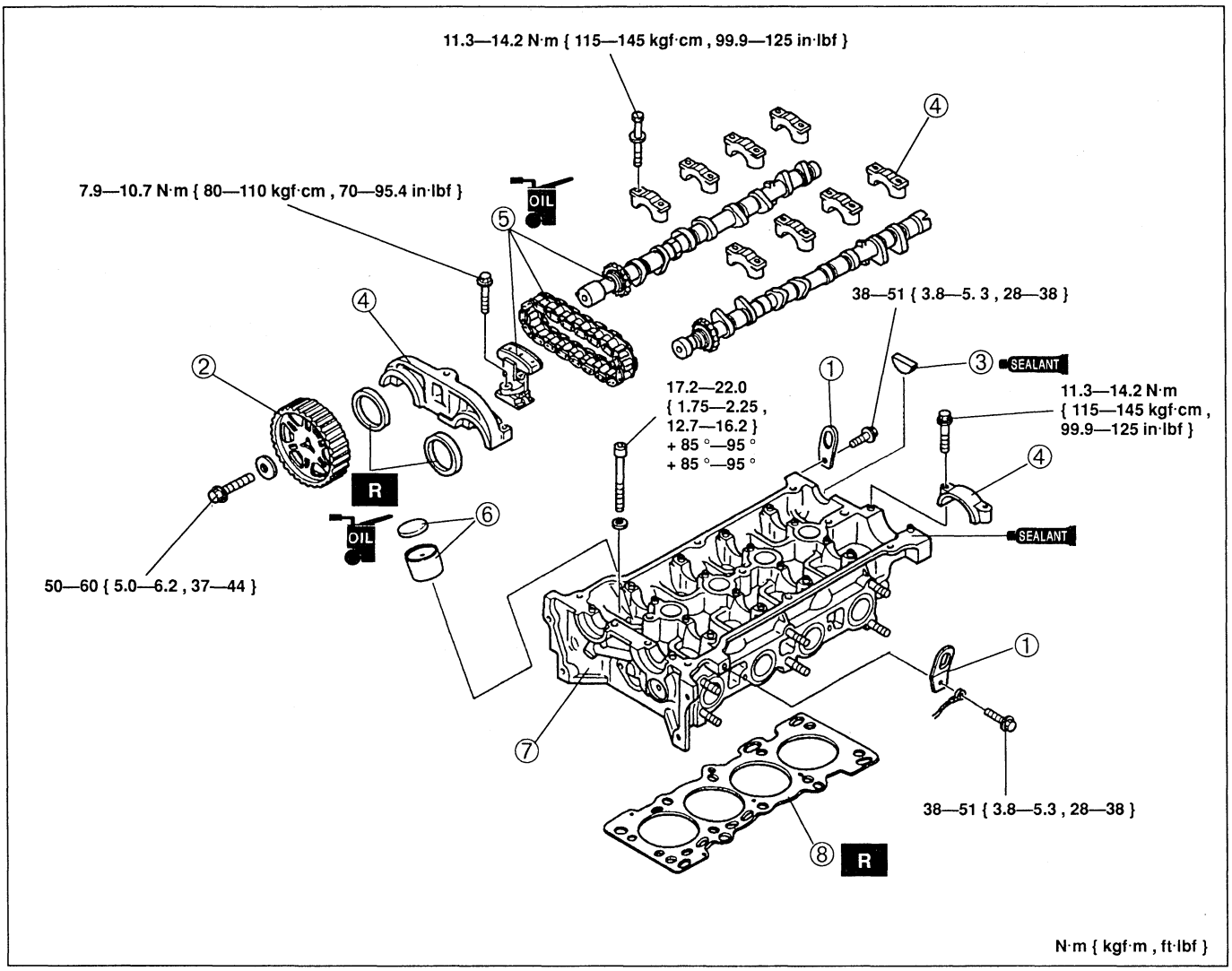
   Tightening torque:
   6.9—10.7 N·m { 70—110 kgf·cm , 61—95.4 in·lbf }

7. Retighten the bolts in the order shown.

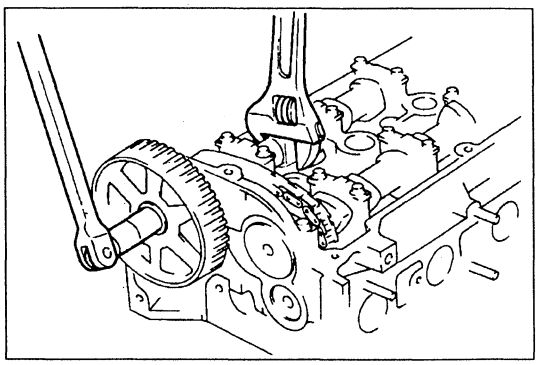
   Tightening torque:
   6.9—10.7 N·m { 70—110 kgf·cm , 61—95.4 in·lbf }

CYLINDER HEAD (I)

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**.

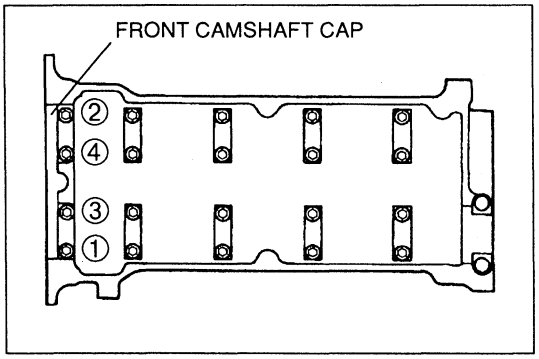


1. Engine hanger
2. Camshaft pulley
   Disassembly Note ..... below
   Assembly Note ..... page B–14
3. Seal cap
   Assembly Note ..... page B–14
4. Camshaft cap
   Disassembly Note ..... page B–12
   Assembly Note ..... page B–13
5. Camshaft, timing chain, and chain adjuster
   Disassembly Note ..... page B–12
   Assembly Note ..... page B–13
6. Tappet and adjustment shim
7. Cylinder head
   Disassembly Note ..... page B–12
   Assembly Note ..... page B–12
8. Cylinder head gasket



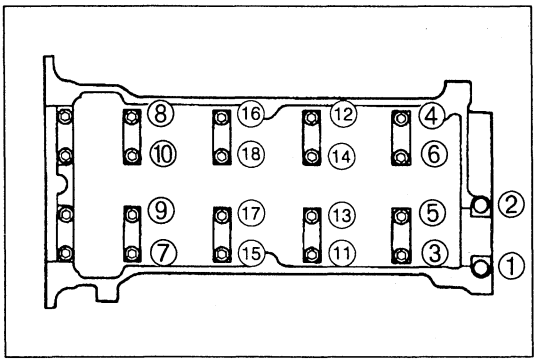
Disassembly Note
Camshaft pulley

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



Camshaft cap

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

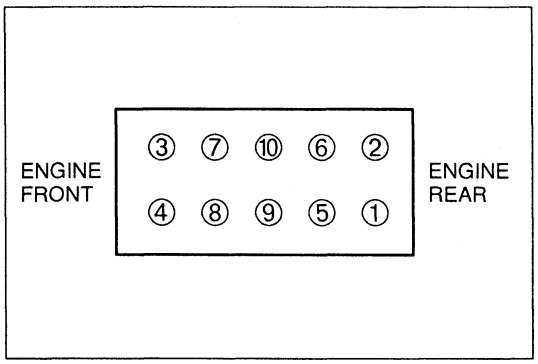


3. Loosen the camshaft cap bolts in five or six steps in the order shown.
4. Remove the camshaft cap bolts and camshaft caps.

Camshaft, timing chain, and chain adjuster

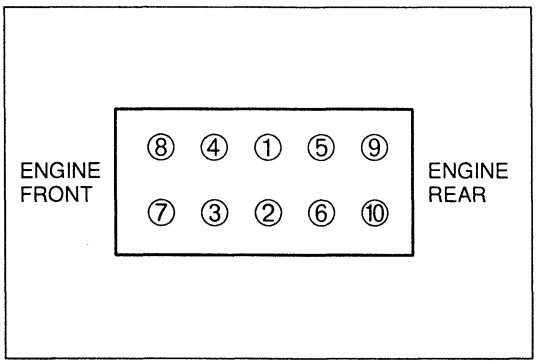
Before removing the camshaft, timing chain, and chain adjuster, inspect the following.

(1) Camshaft end play (Refer to page B–32.)
(2) Camshaft journal oil clearance (Refer to page B–32.)



Cylinder head

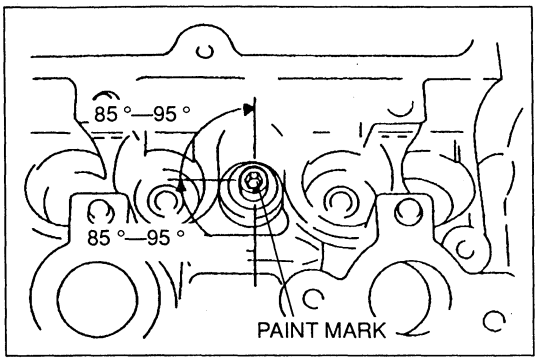
1. Loosen the cylinder head bolts in two or three steps in the order shown.
2. Remove the cylinder head.



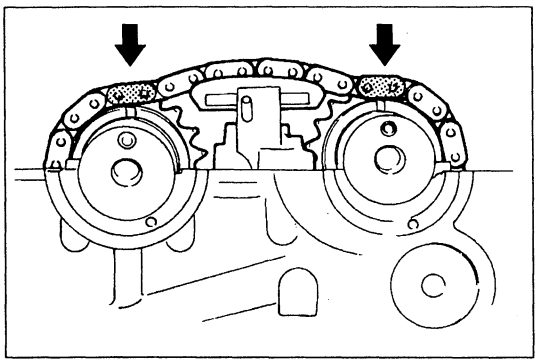
Assembly Note
Cylinder head

1. Before installation, measure the length of each bolt. Replace any that exceed the maximum length. (Refer to page B–38.)
2. Install the bolts and tighten them in two or three steps in the order shown.

Tightening torque: 17.2—22.0 N·m
{ 1.75—2.25 kgf·m , 12.7—16.2 ft·lbf }

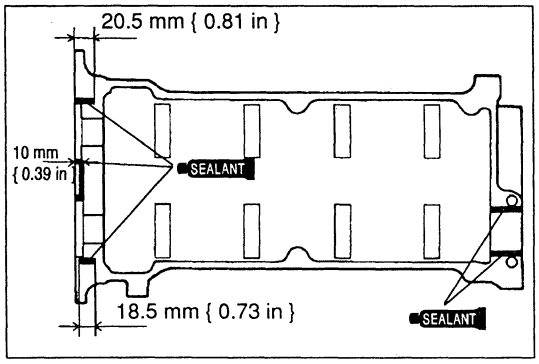


3. Put a paint mark on each bolt head.
4. Using the marks as a reference, tighten the bolts by turning each **85 °—95 °** in the sequence shown.
5. Further tighten each bolt by turning another **85 °—95 °**.



Camshaft, timing chain, and chain adjuster

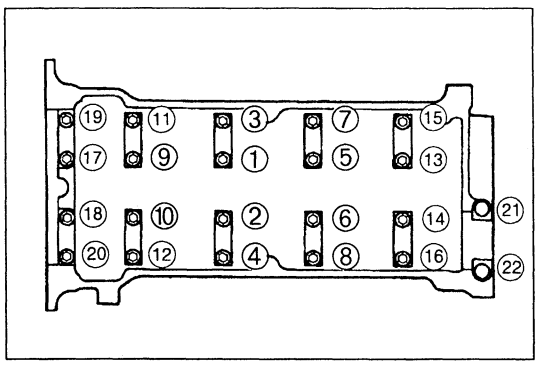
1. Apply clean engine oil to the camshaft journals, camshaft lobes, and camshaft gears.
2. Install the camshafts onto the cylinder head, aligning marks on the camshaft gear and the timing chain.



Camshaft cap

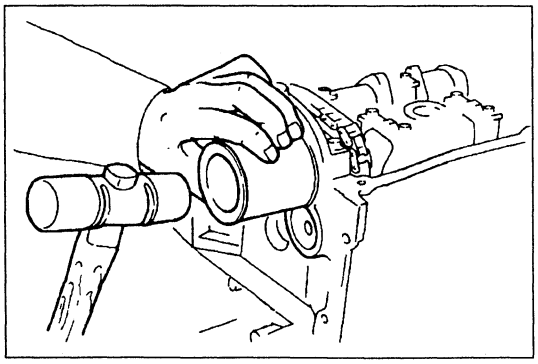
1. Apply silicone sealant to the shaded areas shown in the figure.

   Thickness: ϕ 1 mm { 0.04 in }



2. Install the camshaft caps to the positions from which they were removed.
3. Hand tighten the camshaft cap bolts marked ⑤, ⑦, ②, and ④.
4. Tighten the camshaft cap bolts in five or six steps in the order shown.

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

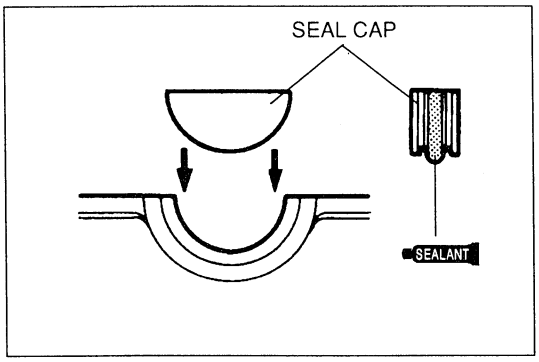


5. Apply clean engine oil to the lip of the new camshaft oil seal.
6. Push the oil seal slightly in by hand.
7. Tap the camshaft oil seal in evenly by using a pipe.

   Protrusion IN: 0—0.4 mm { 0—0.01 in }
   EX: 1.0—1.4 mm { 0.04—0.05 in }

Note

- Oil seal outer diameter: 48.0 mm { 1.89 in }
- Oil seal inner diameter: 34.2 mm { 1.35 in }

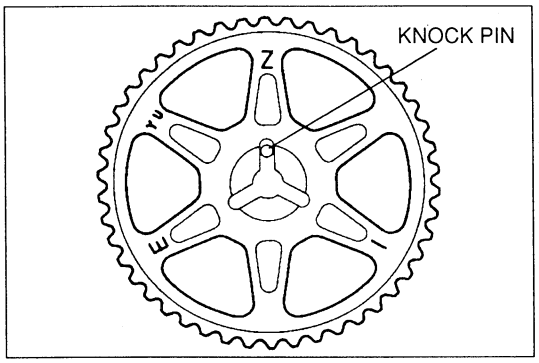


Seal cap

1. Apply silicone sealant to the seal cap as shown.

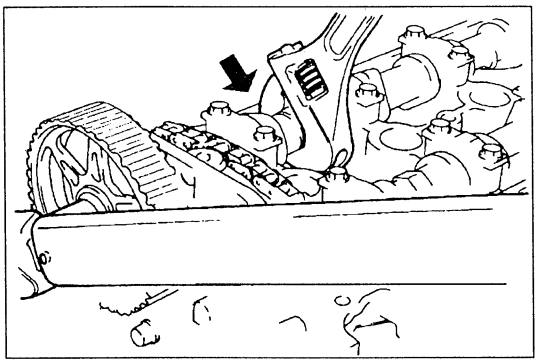
   Thickness: ϕ 3—4 mm { 0.12—0.15 in }

2. Install the seal cap.



Camshaft pulley

1. Install the camshaft pulley so that the "Z" mark aligns with the knock pin.

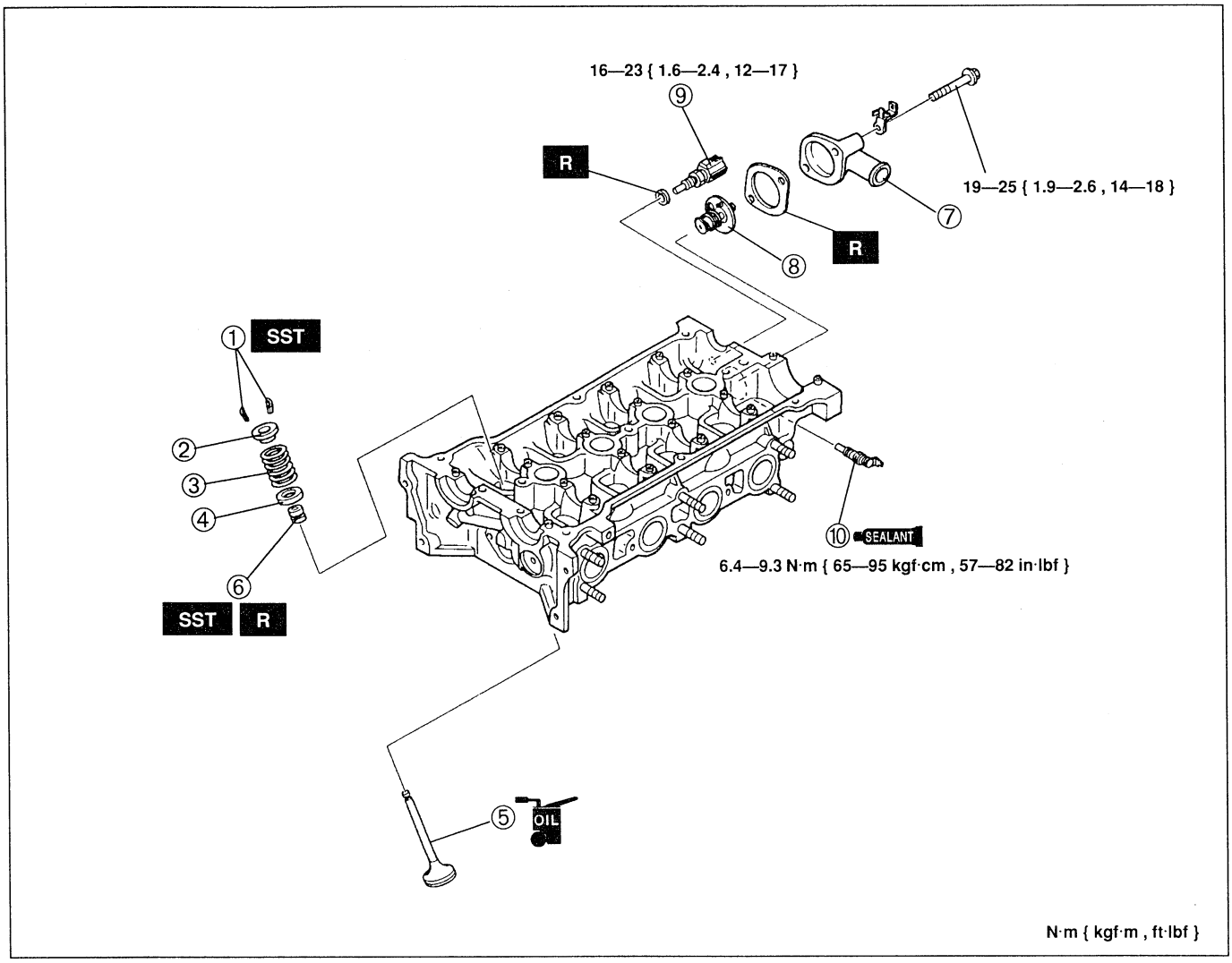


2. Hold the camshaft by using a wrench on the cast hexagon, and tighten the lock bolt.

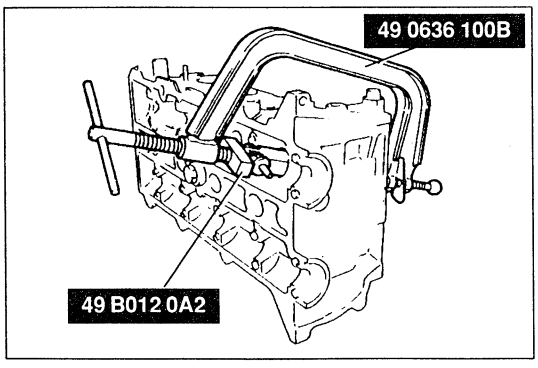
   Tightening torque:
   50—60 N·m { 5.0—6.2 kgf·m , 37—44 ft·lbf }

CYLINDER HEAD (II)

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**.

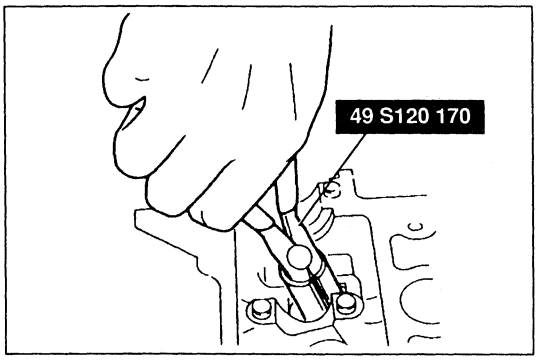


1. Valve keeper
   Disassembly Note ..... below
   Assembly Note ..... page B–17
2. Valve spring seat, upper
3. Valve spring
   Assembly Note ..... page B–17
4. Valve spring seat, lower
5. Valve
6. Valve seal
   Disassembly Note ..... page B–16
   Assembly Note ..... page B–16
7. Thermostat cover
8. Thermostat
   Assembly Note ..... page B–16
9. Engine coolant temperature sensor
10. Water temperature sender unit
    Assembly Note ..... page B–16

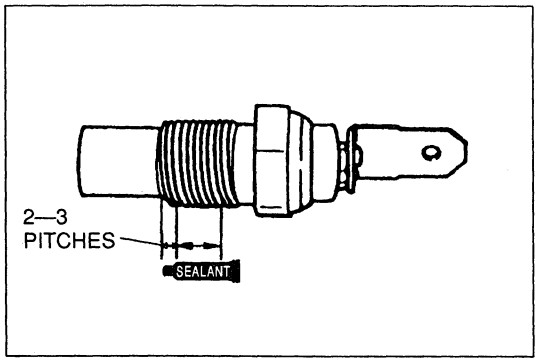


Disassembly Note
Valve keeper

1. Set the **SST** against the upper valve spring seat as shown.
2. Remove the valve keepers.

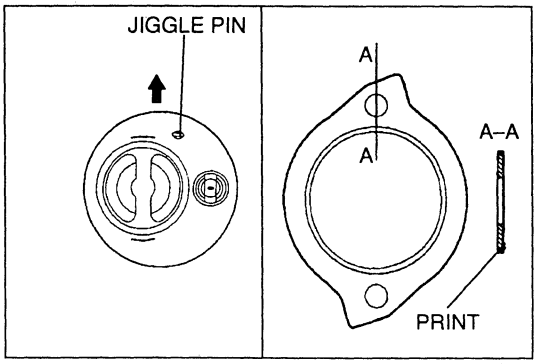


Valve seal
Remove the valve seal by using the **SST**.

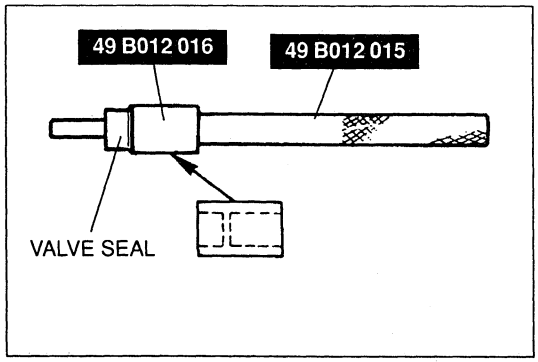


Assembly Note
Water temperature sender unit
1. Apply silicone sealant to the thread of the water temperature sender unit as shown.
2. Install the water temperature sender unit.

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



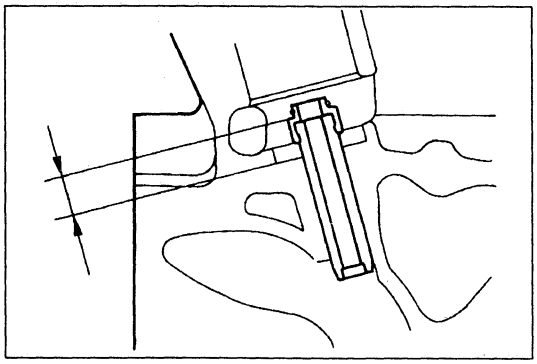
Thermostat
1. Install the thermostat with the jiggle pin facing upward.
2. Install the new gasket with the printed side facing the cylinder head.



Valve seal
The intake and exhaust valve seals are colored for identification.

IN: gray
EX: green

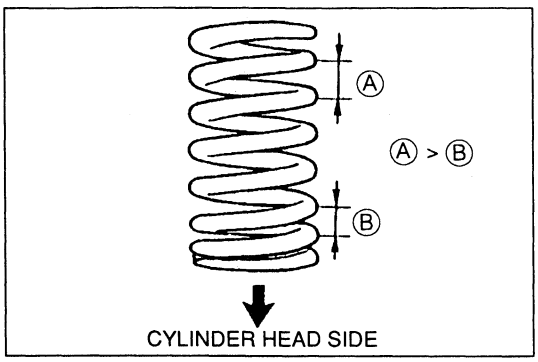
1. Assemble the **SSTs** as shown.



Caution
- **Using a hammer will damage the valve seal.**

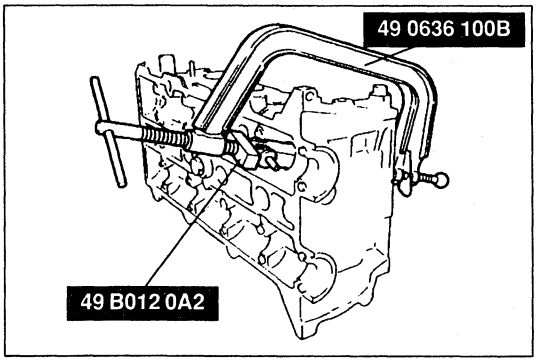
2. Using the **SST**, press the valve seal on by hand.
3. Measure the valve seal setting height.

Valve seal setting height: 10.82 mm { 0.426 in }



Valve spring

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

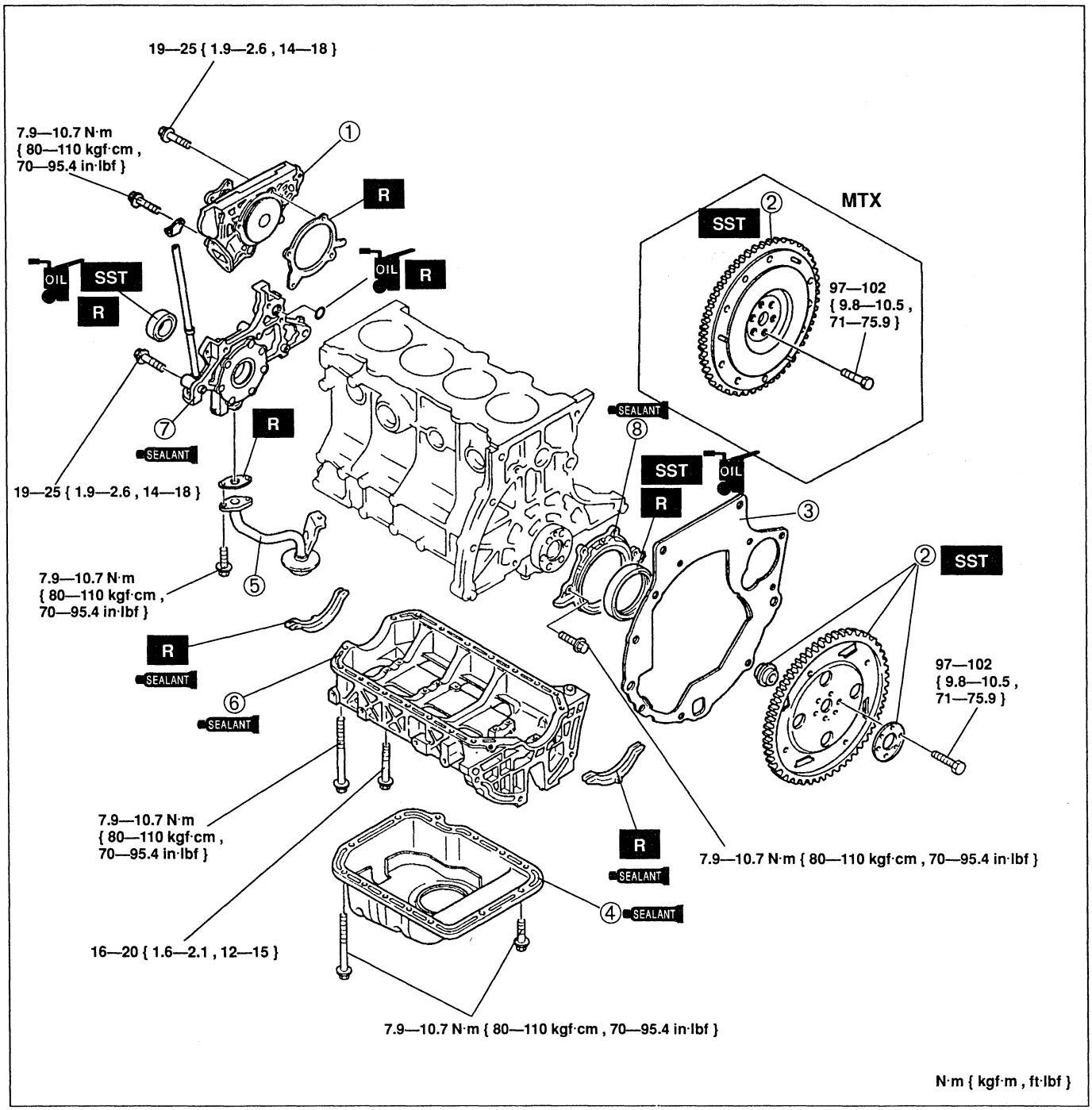


Valve keeper

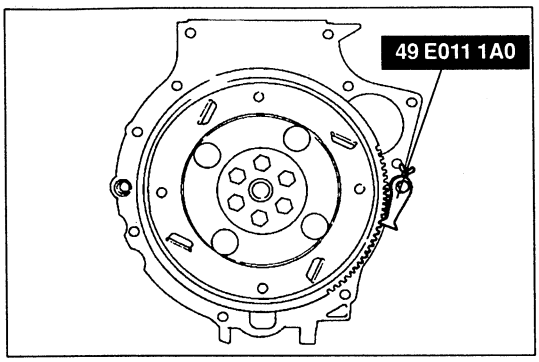
Compress the valve spring by using the **SST**, and install the valve keepers.

CYLINDER BLOCK (EXTERNAL 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**.

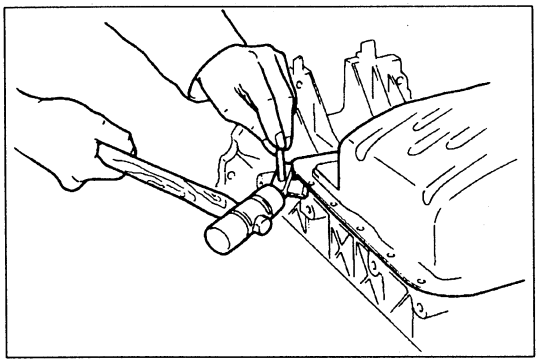


1. Water pump
   Assembly Note ..... page B–21
2. Backing plate, drive plate, adapter (ATX), flywheel (MTX)
   Disassembly Note ..... page B–19
   Assembly Note ..... page B–21
3. End plate
4. Oil pan
   Disassembly Note ..... page B–19
   Assembly Note ..... page B–21
5. Oil strainer
6. VRAS
   Disassembly Note ..... page B–19
   Assembly Note ..... page B–20
7. Oil pump
   Disassembly Note ..... page B–19
   Assembly Note ..... page B–20
   Disassembly / Inspection / Assembly ..... section D
8. Rear cover
   Disassembly Note ..... page B–19
   Assembly Note ..... page B–20



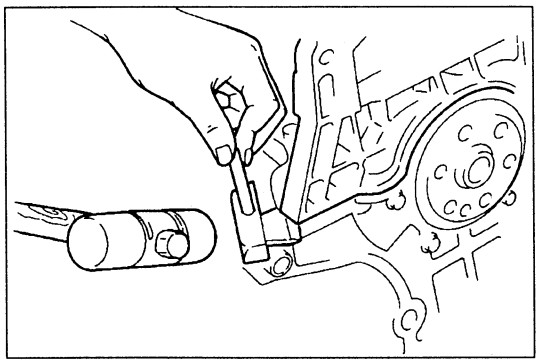
Disassembly Note
Backing plate, drive plate, adapter (ATX), flywheel (MTX)

1. Hold the drive plate (ATX) or flywheel (MTX) by using the **SST**.
2. Remove the drive plate lock bolts and remove the backing plate and adapter. (ATX)
3. Remove the flywheel lock bolts and remove the flywheel. (MTX)



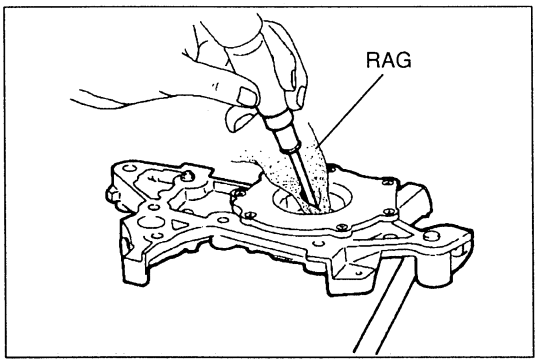
Oil pan

Separate the oil pan from the VRAS by using a scraper or a separator tool.



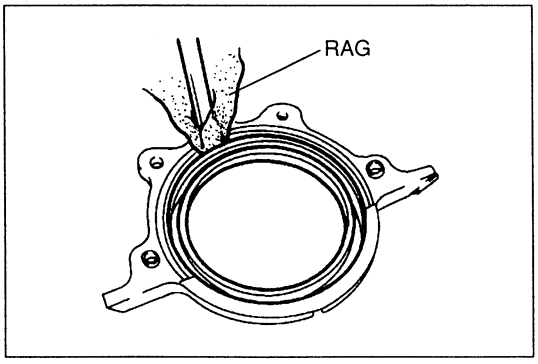
VRAS

Separate the VRAS from the cylinder block by using a scraper or a separator tool.



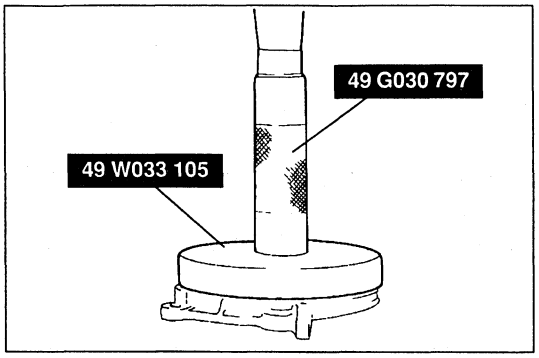
Oil pump

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



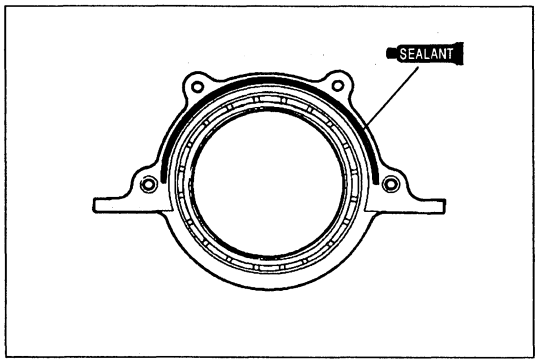
Rear cover

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



Assembly Note
Rear cover
1. Apply clean engine oil to the new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly by using the **SST**.

Protrusion: 0—0.5 mm { 0—0.019 in }

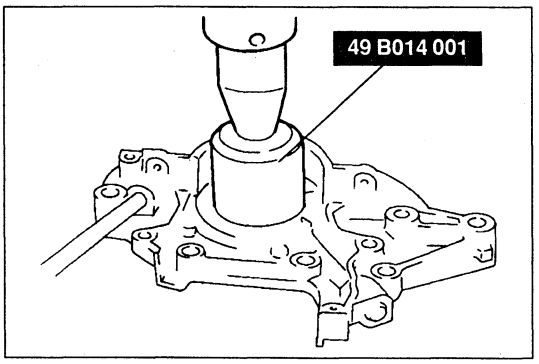


4. Apply silicone sealant to the rear cover as shown.

Thickness: ϕ 2 mm { 0.079 in }

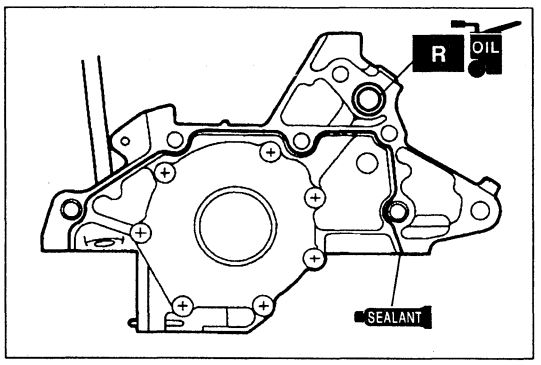
5. Install the rear cover.

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



Oil pump
1. Apply clean engine oil to the new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly by using the **SST**.

Protrusion: 0.5—1.0 mm { 0.020—0.039 in }

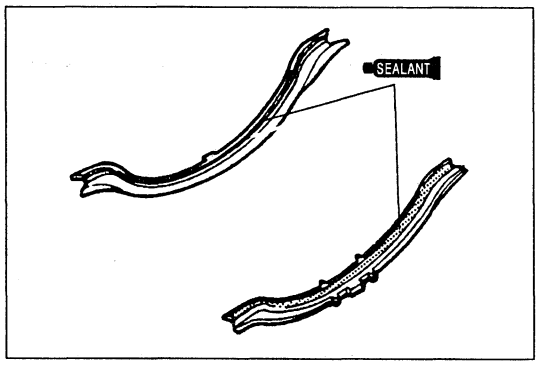


4. Install the new O-ring.
5. Apply silicone sealant to the oil pump body as shown.

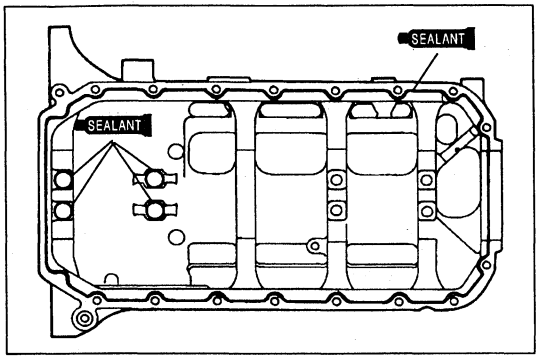
Thickness: ϕ 1—2 mm { 0.040—0.078 in }

6. Install the oil pump.

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



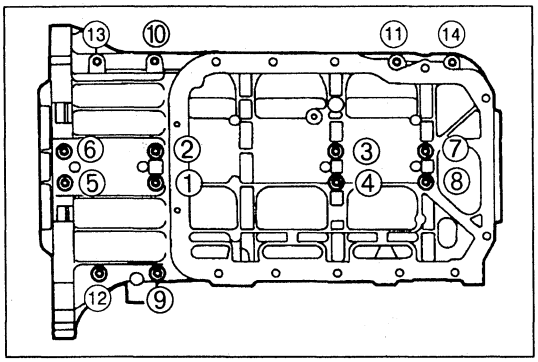
VRAS
1. Apply silicone sealant to the oil pump and rear cover mounting surfaces of the new oil pan gaskets, and install them.



2. Apply silicone sealant to the VRAS as shown.

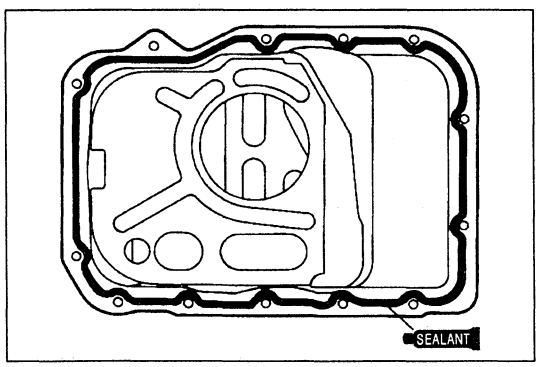
   Thickness: ϕ 2—3 mm { 0.079—0.118 in }

3. Install the VRAS.



4. Tighten the bolts in the order shown.

   Tightening torque
   ①—⑧:
   16—20 N·m { 1.6—2.1 kgf·m , 12—15 ft·lbf }
   ⑨—⑭:
   7.9—10.7 N·m { 80—110 kgf·cm , 70—95.4 in·lbf }



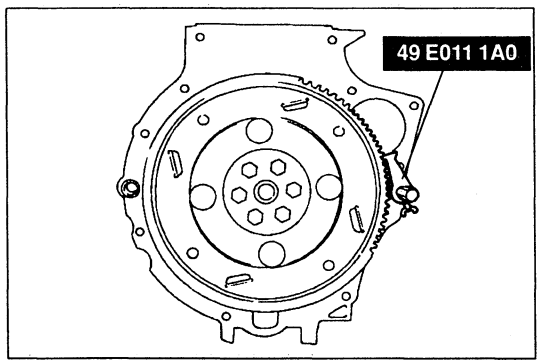
Oil pan

1. Apply silicone sealant to the oil pan as shown.

   Thickness: ϕ 2—3 mm { 0.079—0.118 in }

2. Install the oil pan.

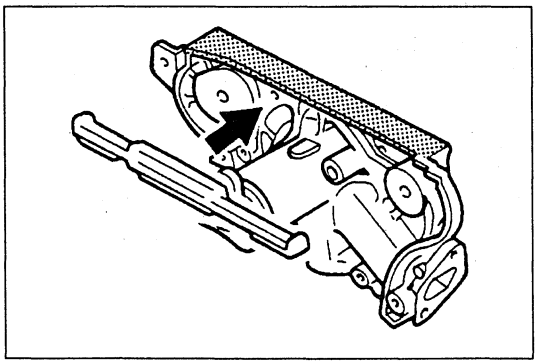
   Tightening torque:
   7.9—10.7 N·m { 80—110 kgf·cm , 70—95.4 in·lbf }



Backing plate, drive plate, adapter (ATX), flywheel (MTX)

1. Hold the drive plate (ATX) or flywheel (MTX) by using the **SST**.
2. Install the drive plate. (ATX)
3. Install the flywheel. (MTX)

   Tightening torque:
   97—102 N·m { 9.8—10.5 kgf·m , 71—75.9 ft·lbf }



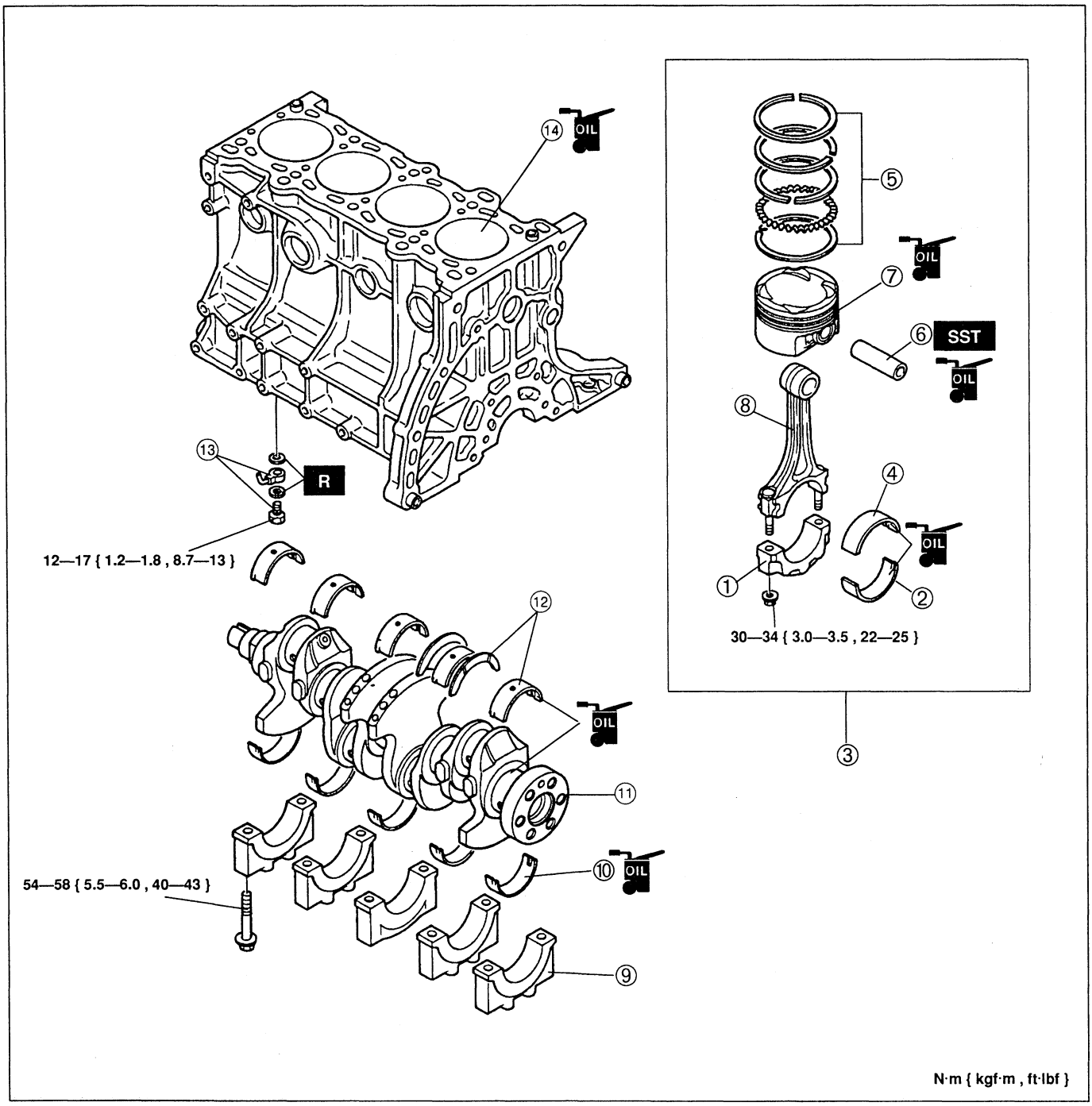
Water pump

1. Verify that the rubber seal is securely fixed onto the water pump.
2. If not, remove the rubber seal and reinstall it with the bonding agent.
3. Install the water pump.

   Tightening torque:
   19—25 N·m { 1.9—2.6 kgf·m , 14—18 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
2. Connecting rod bearing, lower
3. Piston and connecting rod assembly
   - Disassembly Note ..... page B–23
   - Assembly Note ..... page B–25
4. Connecting rod bearing, upper
5. Piston ring
6. Piston pin
   - Disassembly Note ..... page B–23
   - Assembly Note ..... page B–24
7. Piston
8. Connecting rod
9. Main bearing cap
   - Disassembly Note ..... page B–24
   - Assembly Note ..... page B–24
10. Main bearing, lower
11. Crankshaft
    - Disassembly Note ..... page B–24
12. Main bearing, upper and thrust bearing
13. Oil jet valve and nozzle
14. Cylinder block

Disassembly Note
Piston and connecting rod assembly

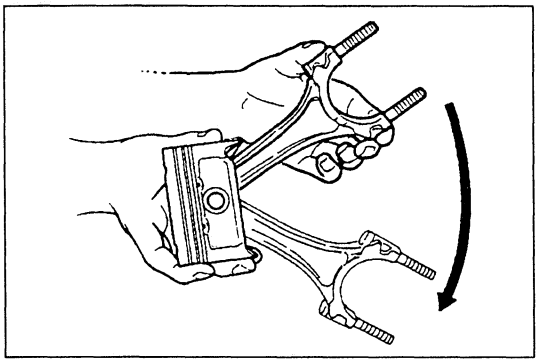
Before removing the piston and connecting rod assembly, inspect the following.

(1) Connecting rod large end side clearance
(Refer to page B–35.)
(2) Connecting rod bearing oil clearance
(Refer to page B–35.)

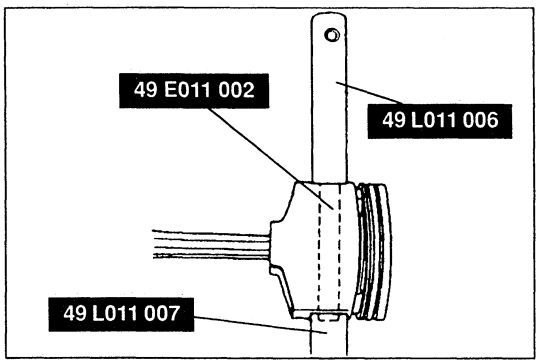
Piston pin

Caution
- **The connecting rods must be reinstalled in the same positions from which they were removed. If they are not, it can cause premature and uneven wear.**

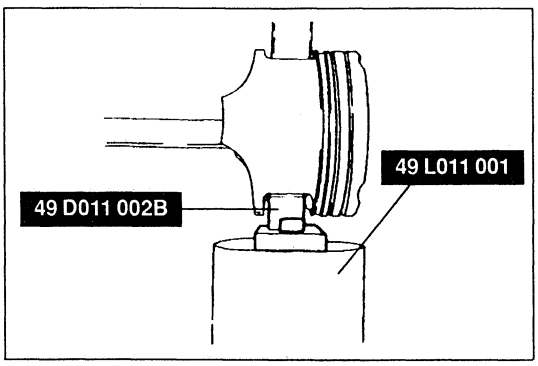
Note
- Mark the connecting rods to show their original positions.



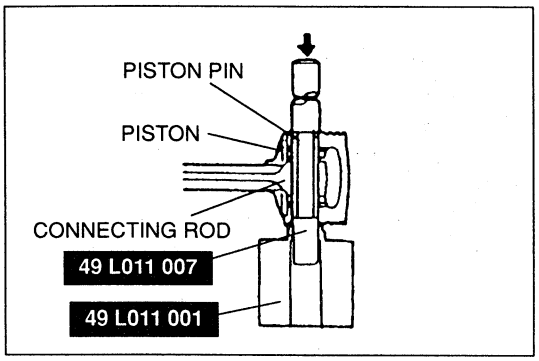
1. Before disassembling the piston and connecting rod, check the oscillation torque as shown. If the large end does not drop by its own weight, replace the piston or the piston pin.



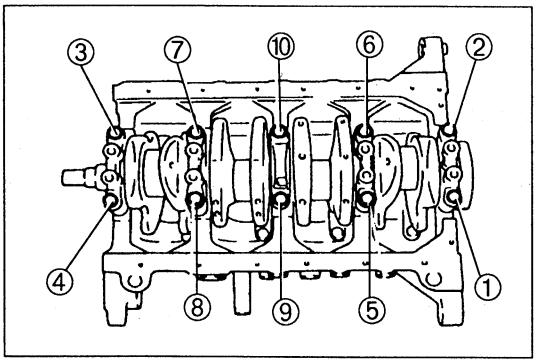
2. Insert the **SST** into the piston pin as shown.



3. Mount the piston and connecting rod in the **SST** as shown.



4. Press out the piston pin.

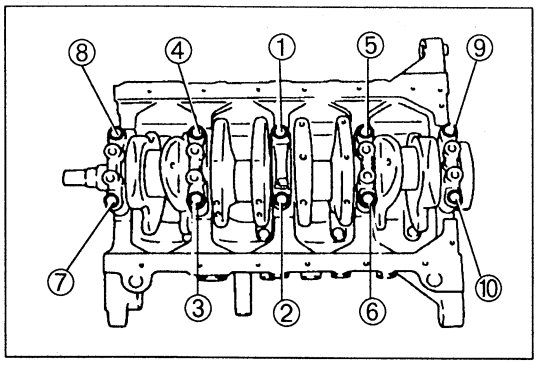


Main bearing cap

1. Before removing the main bearing caps, measure the crankshaft end play. (Refer to page B–36.)
2. Loosen the main bearing cap bolts in two or three steps in the order shown in the figure.
3. Remove the main bearing caps.

Crankshaft

Before removing the crankshaft, measure the main bearing oil clearances. (Refer to page B–37.)

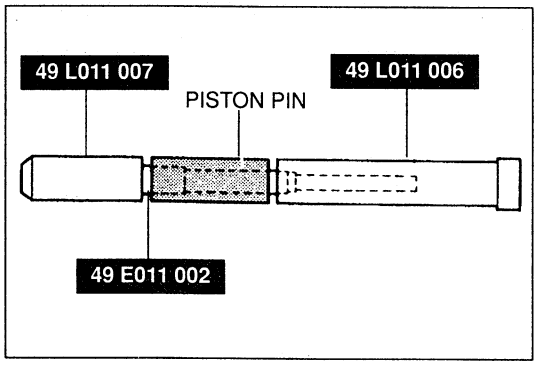


Assembly Note

Main bearing cap

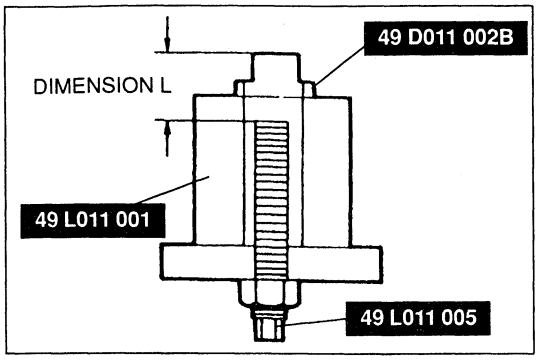
Tighten the main bearing cap bolts in two or three steps in the order shown.

Tightening torque:
54—58 N·m { 5.5—6.0 kgf·m , 40—43 ft·lbf }



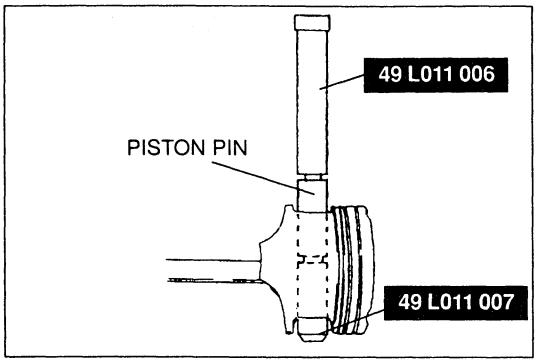
Piston pin

1. Set the piston pin on the **SST** as shown.

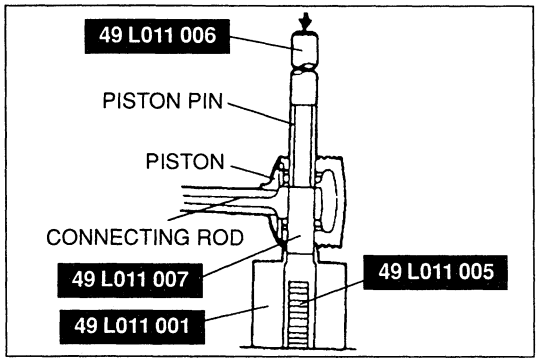


2. Apply clean engine oil to the piston pin.
3. Set the stopper bolt so that dimension **L** is as specified.

   Dimension L: 61.4 mm { 2.42 in }



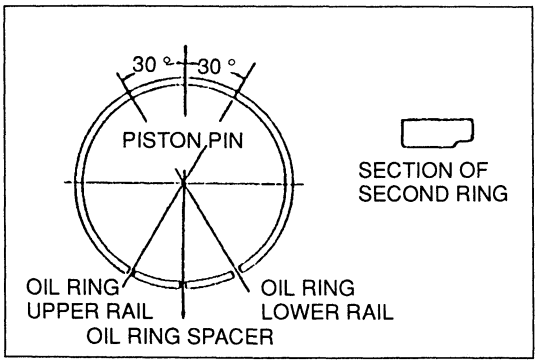
4. Insert the piston pin and **SST** assembled in step 1 into the piston and connecting rod assembly.



5. Press the piston pin into the piston and connecting rod until the **SST** (guide) contacts the **SST** (stopper bolt).
6. While inserting the piston pin, check the pressure force. If it is less than specification, replace the piston pin or the connecting rod.

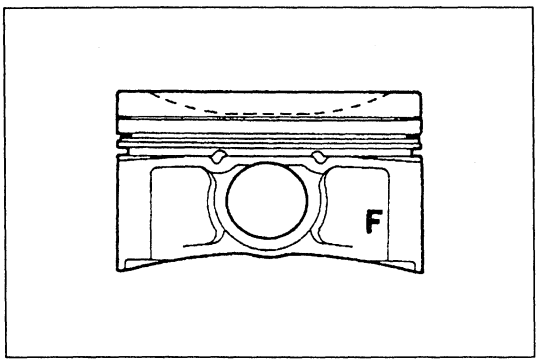
   Pressure force: 4.91—14.70 kN
   { 500—1,500 kgf , 1,100—3,300 lbf }

7. Check the oscillation torque of the connecting rod. (Refer to page B–23.)

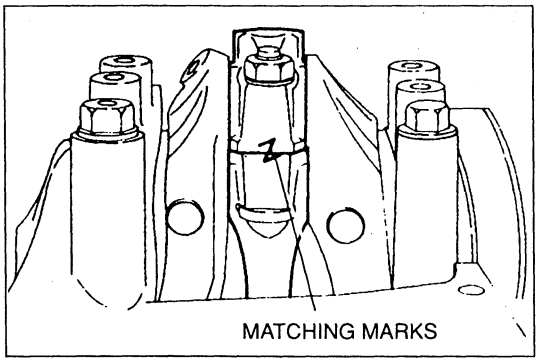


Piston and connecting rod assembly

1. Verify that the second ring is installed with the scraper face downward.
2. Position the end gap of each ring as shown.



3. Insert the piston and connecting rod assembly into the cylinder with the F mark facing the front of the engine.

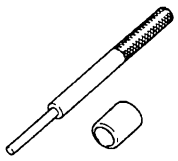
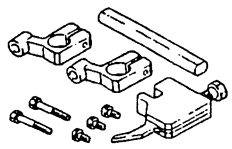
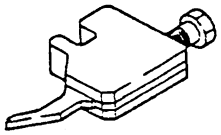
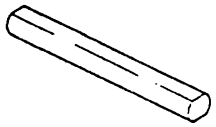
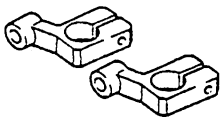
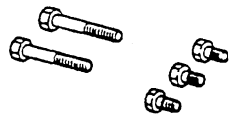

MATCHING MARKS

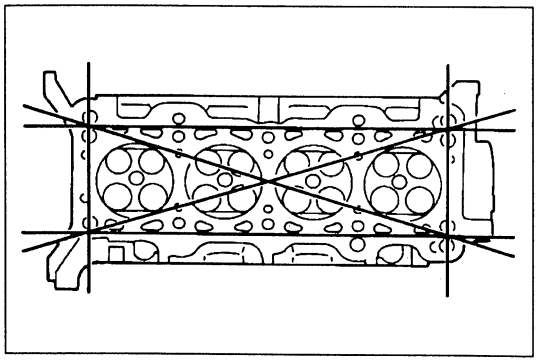
4. Align the matching marks on the connecting rod and the connecting rod cap, install the connecting rod cap.

Tightening torque:
30—34 N·m { 3.0—3.5 kgf·m , 22—25 ft·lbf }

INSPECTION / REPAIR

PREPARATION
SST

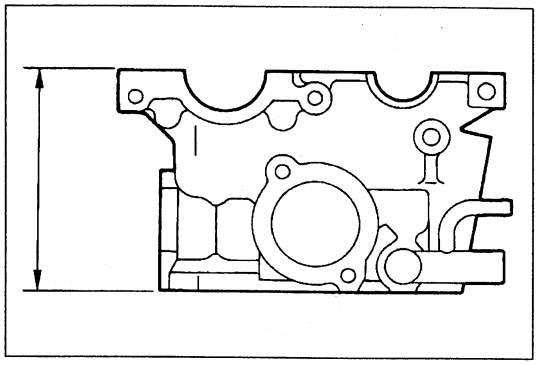
49 B012 0A3 Installer, valve seal & valve guide 	For replacement of valve guides	49 B012 015 Installer (Part of 49 B012 0A3) 	For replacement of valve guides
49 B012 016 Attachment (Part of 49 B012 0A3) 	For replacement of valve guides	49 T012 0A0 Holder, tappet 	For replacement of adjustment shims
49 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
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



CYLINDER HEAD

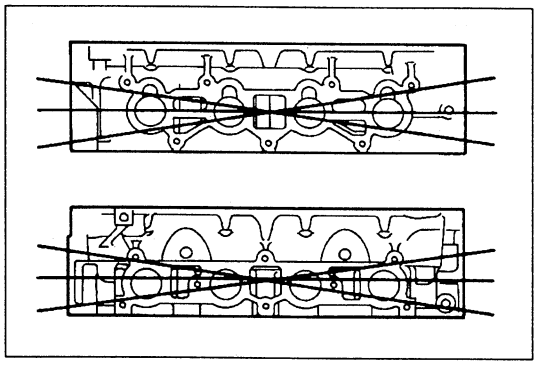
1. Carry out coloring flaw detection on the cylinder head surface. Replace the cylinder head if necessary.
2. Measure the cylinder head for distortion in the six directions as shown.

Distortion: 0.15 mm { 0.006 in } max.



3. Inspect for the following and repair or replace.
   (1) Sunken valve seats
   (2) Damaged intake and exhaust manifold contact surfaces
   (3) Excessive camshaft oil clearance and end play
4. If the cylinder head distortion exceeds the maximum, repair by grinding or replace the cylinder head. If the cylinder head height is not within the specification, replace it.

Grinding: 0.20 mm { 0.008 in } max.
Height: 120.23—120.43 mm { 4.734—4.741 in }

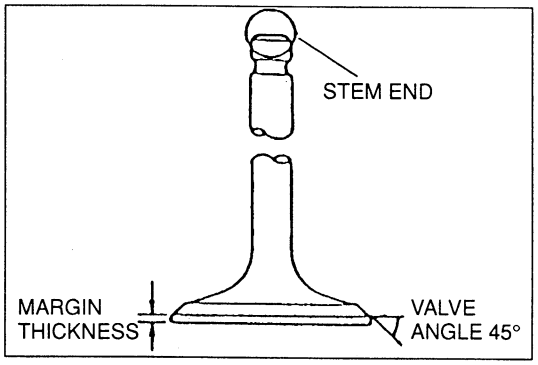


5. Measure the exhaust manifold and intake manifold contact surface distortions as shown.

Distortion: 0.15 mm { 0.006 in } max.

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

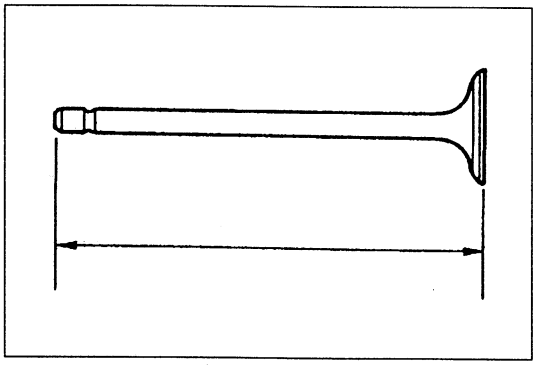
Grinding: 0.20 mm { 0.008 in } max.



VALVE, VALVE GUIDE

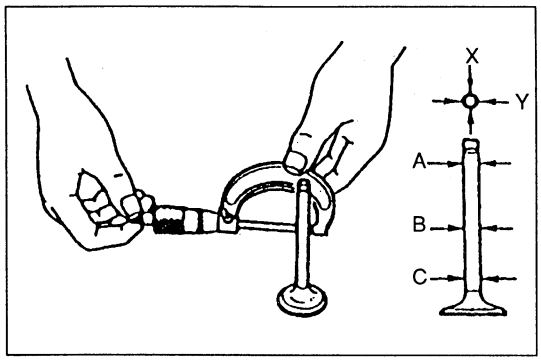
1. Measure the valve head margin thickness of each valve. Replace the valve if necessary.

Margin thickness
IN: 1.1 mm { 0.043 in } min.
EX: 1.2 mm { 0.047 in } min.



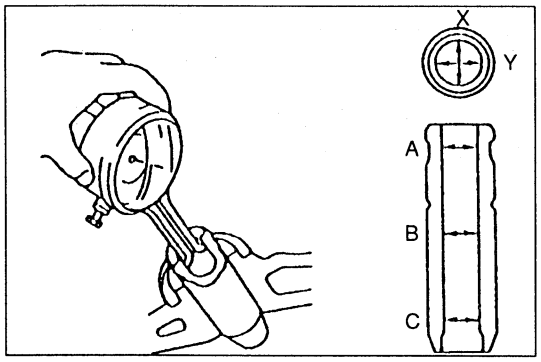
2. Measure the length of each valve. Replace the valve if necessary.

Length
IN
Standard: 91.99—92.59 mm { 3.622—3.645 in }
Minimum: 91.79 mm { 3.614 in }
EX
Standard: 92.41—93.01 mm { 3.639—3.661 in }
Minimum: 92.21 mm { 3.630 in }



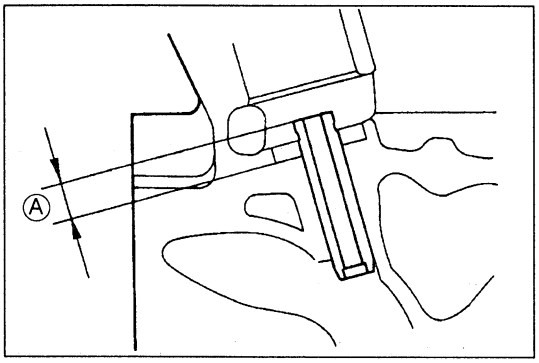
3. Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) shown. Replace the valve if necessary.

Diameter
IN
Standard: 5.470—5.485 mm { 0.2154—0.2159 in }
Minimum: 5.420 mm { 0.2134 in }
EX
Standard: 5.465—5.480 mm { 0.2152—0.2157 in }
Minimum: 5.415 mm { 0.2132 in }



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

Inner diameter:
5.51—5.53 mm { 0.2170—0.2177 in }
5.52—5.54 mm { 0.2174—0.2181 in }
(Service parts)

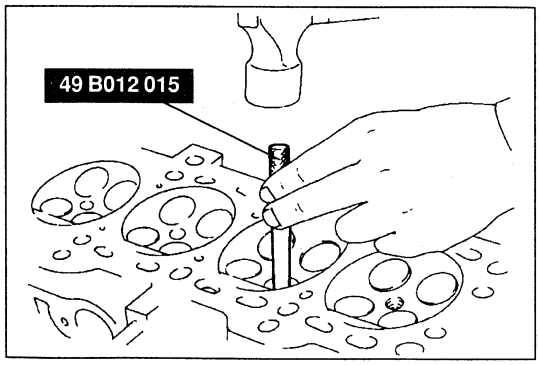


5. Calculate the valve stem-to-valve guide clearance. Subtract the outer diameter of the valve stem from the inner diameter of the corresponding valve guide.

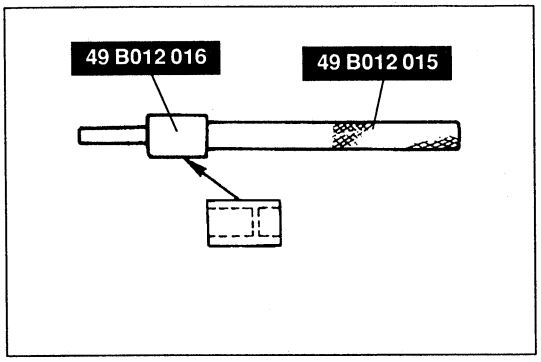
Clearance
IN: 0.025—0.060 mm { 0.0010—0.0023 in }
0.035—0.070 mm { 0.0014—0.0027 in }
(Service parts)
EX: 0.030—0.065 mm { 0.0012—0.0025 in }
0.040—0.075 mm { 0.0016—0.0029 in }
(Service parts)
Maximum: 0.2 mm { 0.008 in }

6. If the clearance exceeds the specification, replace the valve and/or valve guide.
7. Measure the protrusion height (dimension Ⓐ) of each valve guide without valve spring seat, low. Replace the valve guide if necessary.

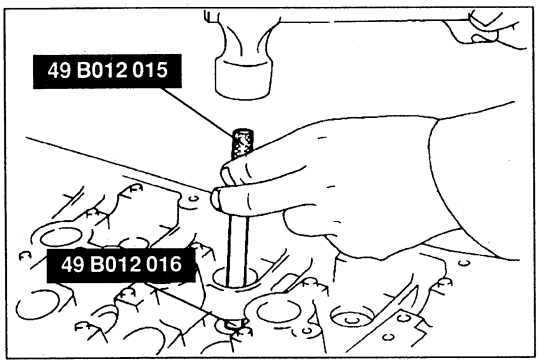
Height: 9.22—9.82 mm { 0.363—0.386 in }



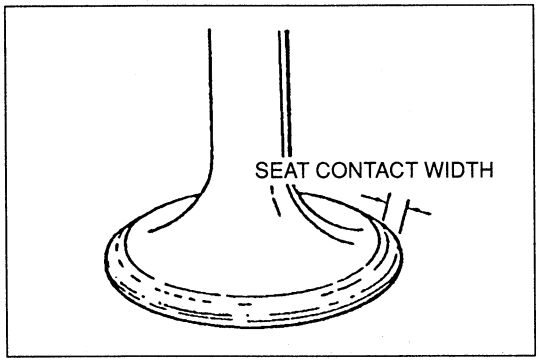
Replacement of valve guide
Removal
Using the **SST**, remove the valve guide from the combustion chamber side.



Installation
1. Assemble the **SSTs** as shown.
2. Fit the clip onto the valve guide.

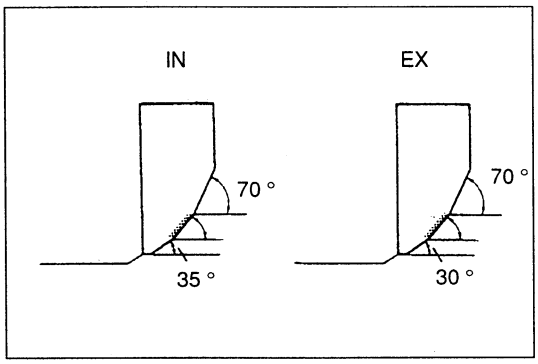


3. Using the **SST**, tap the valve guide in from the side opposite the combustion chamber until the **SST** contacts the cylinder head.
4. Verify that the valve guide protrusion height is within the specification. (Refer to page B–29.)



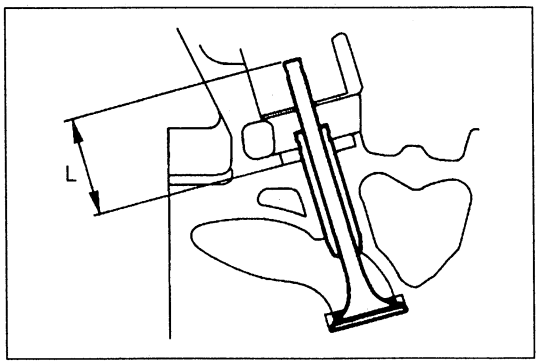
VALVE SEAT
1. If necessary, resurface the valve seat by using a **45** ° valve seat cutter and/or resurface the valve face.
2. Apply a thin coat of prussian blue to the valve face.
3. Check the valve seating by pressing the valve against the seat.
   If blue does not appear 360 ° around the valve seat,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

   Width: 0.8—1.4 mm { 0.032—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** ° cutter, and a **45** ° cutter.
   (2) If the seating position is too low, correct the valve seat using a **35** ° **(IN)** or **30** ° **(EX)** cutter, and a **45** ° cutter.
6. Seat the valve to the valve seat using lapping compound.
7. Check the sinking of the valve seat.
   (1) Measure the protruding length (dimension L) of the valve stem.

   Dimension L: 33.6 mm { 1.323 in }

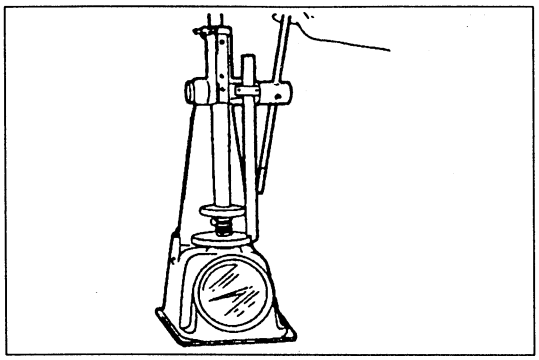


   (2) If **L** is as below, it can be used as it is.

   33.6—34.1 mm { 1.323—1.342 in }

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

   34.2 mm { 1.346 in }

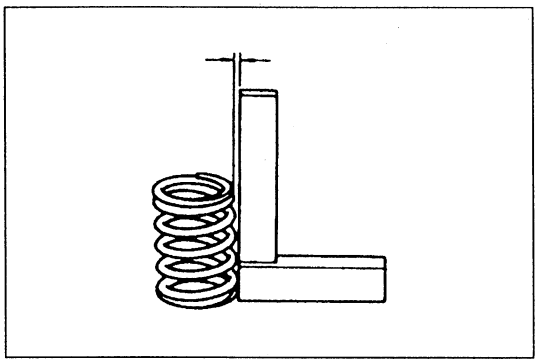


VALVE SPRING

1. Apply pressing force of **126.7—143.3 N { 12.92—14.62 kgf , 29—32 lbf }** to the valve spring and check the spring height.

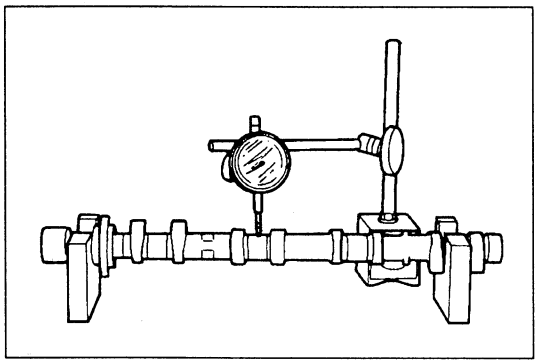
   Height: 31.5 mm { 1.24 in }

2. Replace the valve spring if necessary.



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

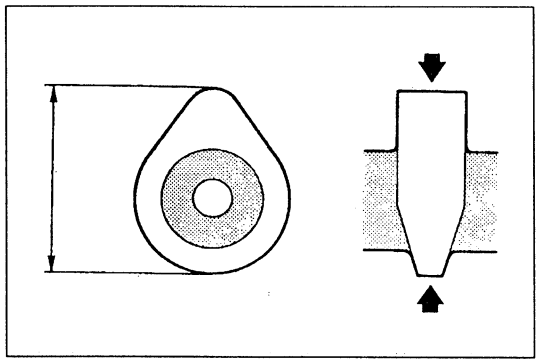
   Out-of-square: 1.33 mm { 0.052 in } max.



CAMSHAFT

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

   Runout: 0.03 mm { 0.0012 in } max.

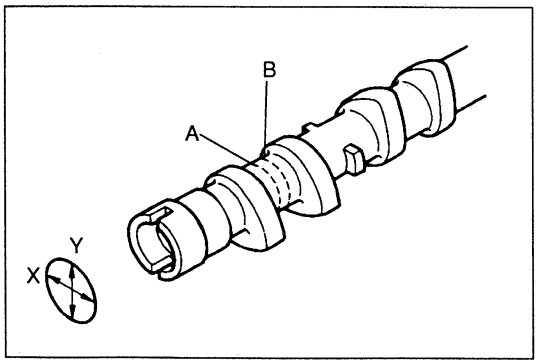


3. Measure the cam lobe heights at the point as shown.

Height

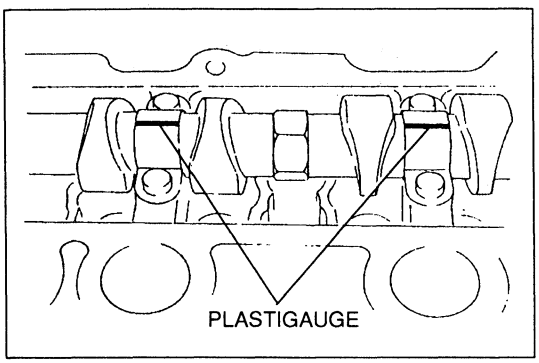
mm { in }

IN	Standard	40.900 { 1.6102 }
	Minimum	40.700 { 1.6024 }
EX	Standard	40.900 { 1.6102 }
	Minimum	40.700 { 1.6024 }

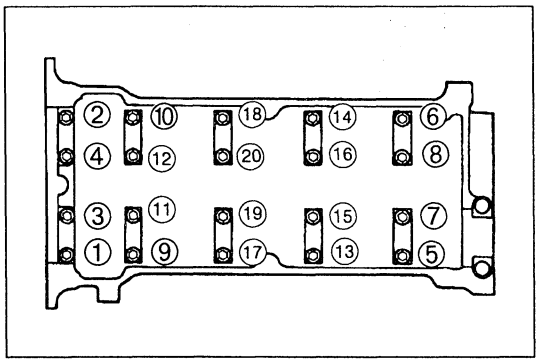


4. Measure the journal diameters in X and Y directions at the two points (A and B) shown. Replace the camshaft if necessary.

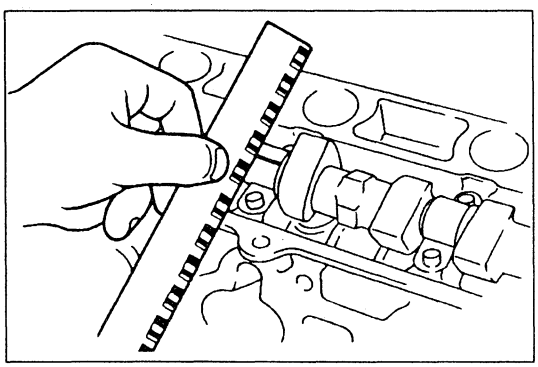
   Diameter
   Standard:
   25.940—25.965 mm { 1.0213—1.0222 in }
   Minimum: 25.910 mm { 1.0201 in }



5. With the tappets and shims removed, measure the camshaft journal oil clearances as follows.
   (1) Position Plastigauge atop the journals in the axial direction.



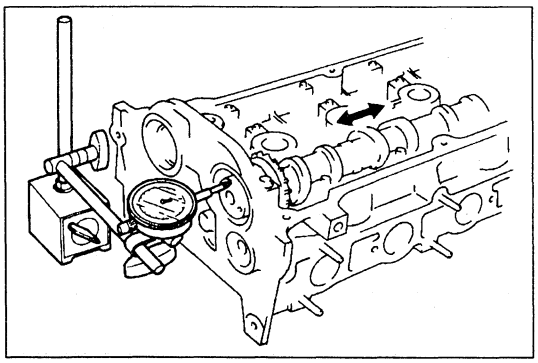
   (2) Do not rotate the camshaft when measuring the oil clearances.
   (3) Install the camshaft caps and tighten the camshaft cap bolts. (Refer to page B–13.)
   (4) Loosen the camshaft cap bolts in five or six steps in the order shown in the figure, and remove the bolts.
   (5) Remove the camshaft caps.



   (6) Measure the oil clearance.

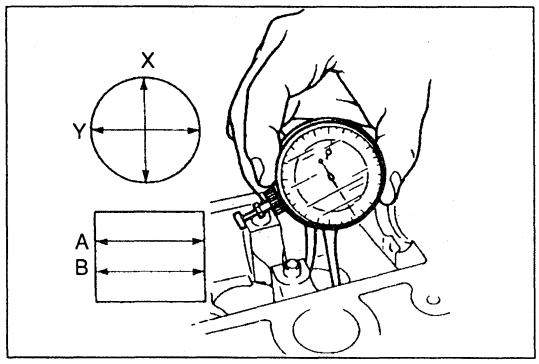
   Oil clearance:
   0.035—0.085 mm { 0.0014—0.0033 in }

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



6. Install the front camshaft cap.
7. Measure the camshaft end play. If it exceeds the maximum, replace the cylinder head or camshaft.

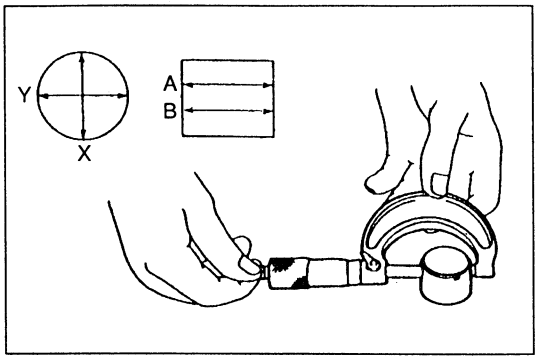
   End play
   Standard: 0.07—0.19 mm { 0.0028—0.0074 in }
   Maximum: 0.20 mm { 0.0079 in }



TAPPET

1. Measure the tappet hole inner diameter in X and Y directions at the two points (A and B) shown.

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



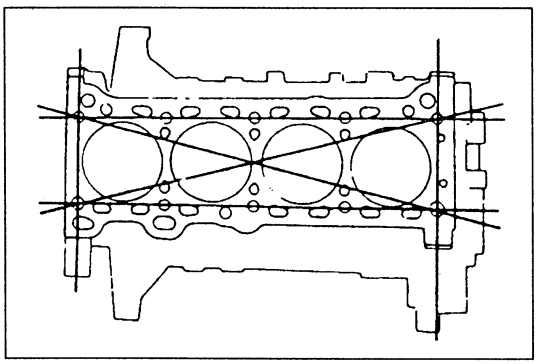
2. Measure the tappet body outer diameters in X and Y directions at the two points (A and B) shown.

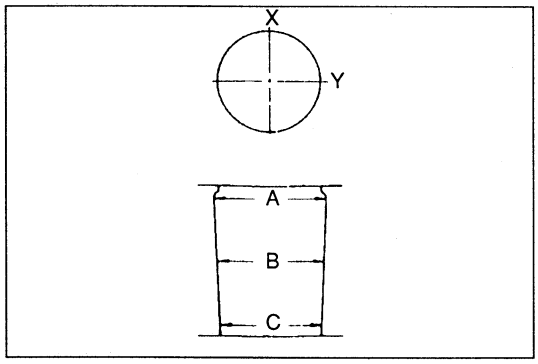
   Outer diameter:
   29.959—29.975 mm { 1.1795—1.1801 in }

3. Subtract the tappet body outer diameter from the tappet hole inner diameter.

   Clearance
   Standard: 0.025—0.066 mm { 0.0010—0.025 in }
   Maximum: 0.180 mm { 0.0071 in }

4. If the clearance exceeds the maximum, replace the tappet or cylinder head.





CYLINDER BLOCK

1. Measure the distortion of the cylinder block top surface in the six directions shown in the figure.

   Distortion: 0.15 mm { 0.006 in } max.

2. If the distortion exceeds the maximum, repair by grinding or replace the cylinder block. If the cylinder block height is not within specification, replace it.

   Grinding: 0.20 mm { 0.008 in } max.
   Height: 221.5 mm { 8.72 in }

3. Measure the cylinder bores in X and Y directions at the three points (A, B, and C) in each cylinder as shown. If the difference between measurements A and C or measurements X and Y exceeds the wear limit, replace the cylinder block or rebore the cylinder to oversize.

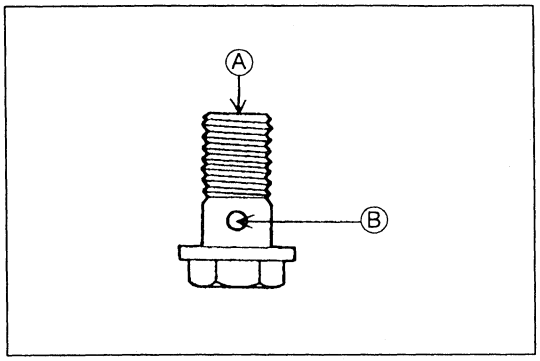
   Note
   - The boring size should be based on the same size as an oversize piston and the same for all cylinders.

Cylinder bore

mm { in }

Standard	75.300—75.319 { 2.9646—2.9653 }
0.25 { 0.01 } oversize	75.550—75.569 { 2.9745—2.9751 }
0.50 { 0.02 } oversize	75.800—75.819 { 2.9843—2.9849 }

Wear limit: 0.15 mm { 0.006 in }

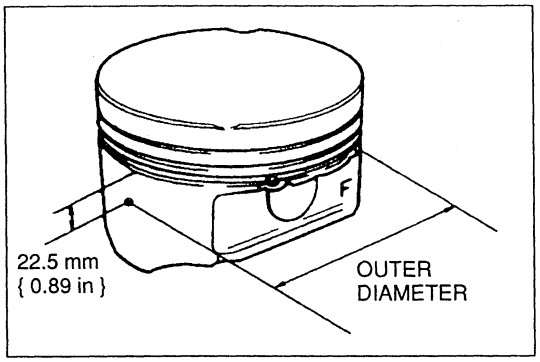


OIL JET

1. Apply compressed air to oil jet valve Ⓐ and verify that air passes through oil ject valve Ⓑ. If not, replace the oil jet valve.

   Air pressure:
   167—225 kPa { 1.7—2.3 kgf/cm^2 , 25—32 psi }

2. Check the oil jet nozzle for clogs. Replace the nozzle if necessary.



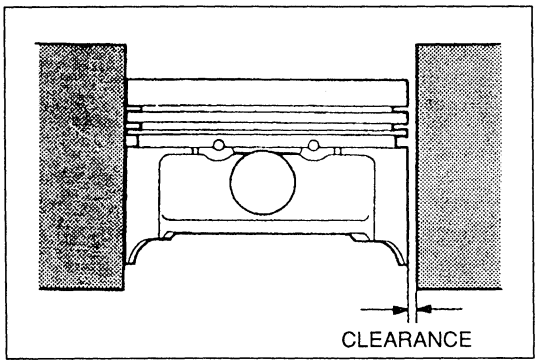
PISTON, PISTON RING, AND PISTON PIN

1. Measure the outer diameter of each piston at a right angle (90°) to the piston pin, **22.5 mm { 0.89 in }** below the oil ring land lower edge.

Piston diameter

mm { in }

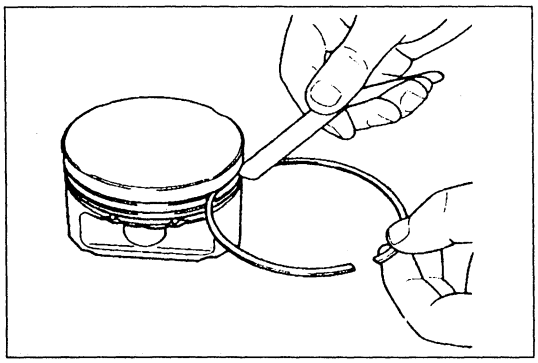
Standard	75.263—75.283 { 2.9632—2.9638 }
0.25 { 0.01 } oversize	75.513—75.533 { 2.9730—2.9737 }
0.50 { 0.02 } oversize	75.763—75.783 { 2.9828—2.9835 }



2. Calculate the piston-to-cylinder clearance. Subtract the piston diameter from the cylinder bore of the corresponding cylinder.

   Clearance: 0.030—0.043 mm { 0.0012—0.0016 in }
   Maximum: 0.10 mm { 0.0039 in }

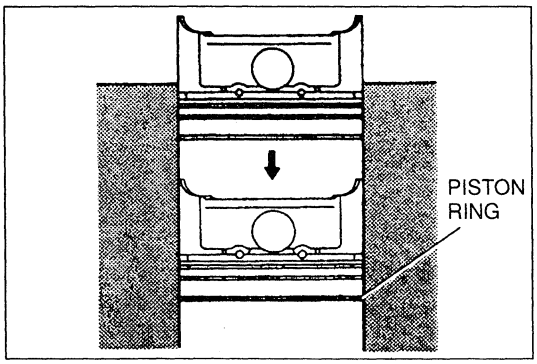
3. If the clearance exceeds the maximum, replace the piston or rebore the cylinders to fit oversize pistons.
4. If the piston is replaced, the piston rings must also be replaced.



5. Measure the piston ring-to-ring land clearance around the entire circumference using a new piston ring.

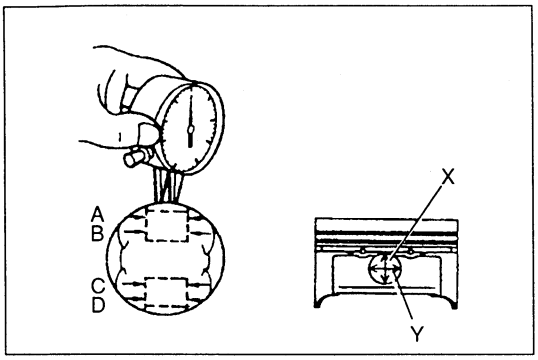
   Clearance
   Top: 0.035—0.065 mm { 0.0014—0.0025 in }
   Second: 0.030—0.065 mm { 0.0012—0.0025 in }
   Oil: 0.07—0.16 mm { 0.003—0.006 in }
   Maximum: 0.15 mm { 0.006 in }

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



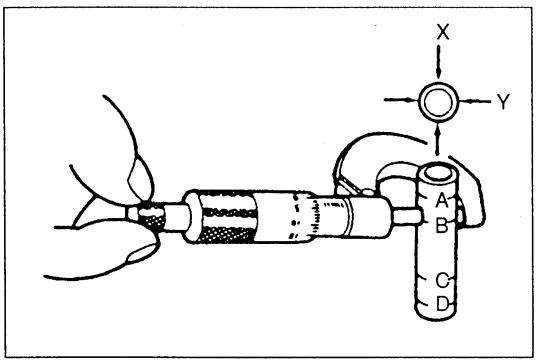
7. Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
8. Measure each piston ring end gap with a feeler gauge. Replace the piston ring if necessary.

   End gap
   Top: 0.15—0.30 mm { 0.006—0.011 in }
   Second: 0.25—0.40 mm { 0.010—0.015 in }
   Oil rail: 0.20—0.70 mm { 0.008—0.027 in }
   Maximum: 1.0 mm { 0.039 in }



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

Diameter: 19.988—20.000 mm { 0.7870—0.7874 in }



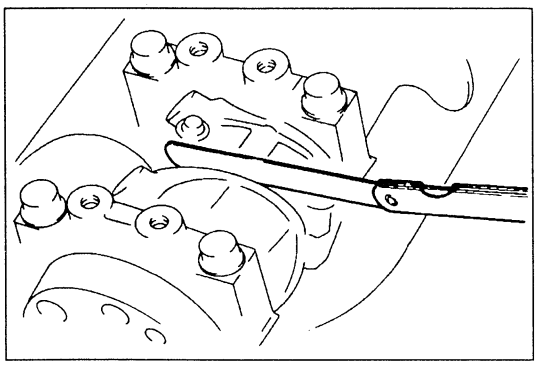
10. Measure each piston pin diameter in X and Y directions at the four points (A, B, C, and D) as shown.

Diameter: 19.974—19.980 mm { 0.7864—0.7866 in }

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

Clearance: 0.008—0.026 mm { 0.0004—0.0010 in }

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

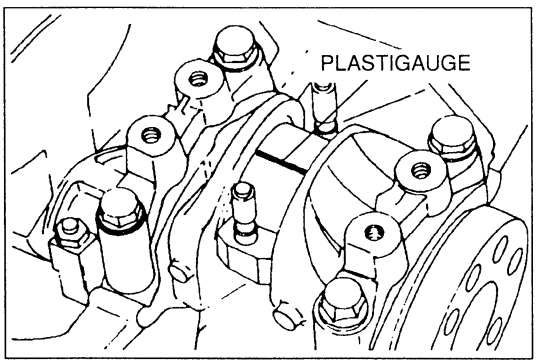


CONNECTING ROD

1. Measure the connecting rod large end side clearance.

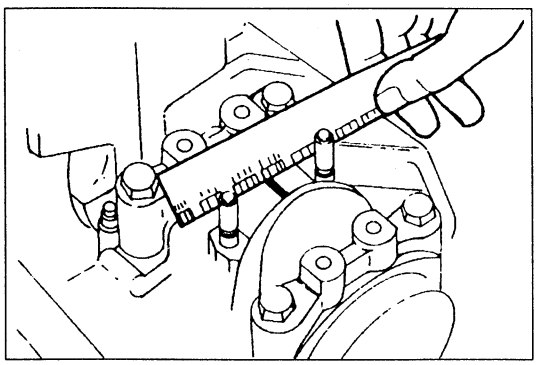
Clearance: 0.110—0.262 mm { 0.0044—0.0103 in }
Maximum: 0.3 mm { 0.0118 in }

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



3. Measure the connecting rod large end oil clearances as follows.
   (1) Position plastigauge atop the crankshaft in the axial direction.
   (2) Install the connecting rod caps and tighten the connecting rod cap nuts. (Refer to page B–26.)
   (3) Remove the connecting rod cap nuts and connecting rod cap.
   (4) Measure the plastigauge at each crank pin.

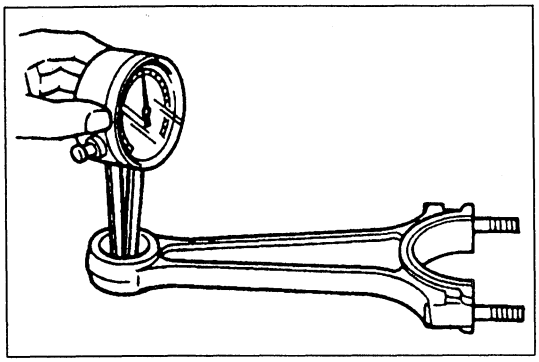
Oil clearance:
0.028—0.048 mm { 0.0012—0.0018 in }
Maximum: 0.10 mm { 0.0039 in }



   (5) If the oil clearance exceeds the maximum replace the connecting rod bearing or grind the crank pin and use undersize bearings.

mm { in }

Bearing	Crank pin
Standard	39.940—39.956 { 1.5725—1.5730 }
0.25 { 0.01 } undersize	39.690—39.706 { 1.5626—1.5632 }
0.50 { 0.02 } undersize	39.440—39.456 { 1.5528—1.5533 }
0.75 { 0.03 } undersize	39.190—39.206 { 1.5430—1.5435 }

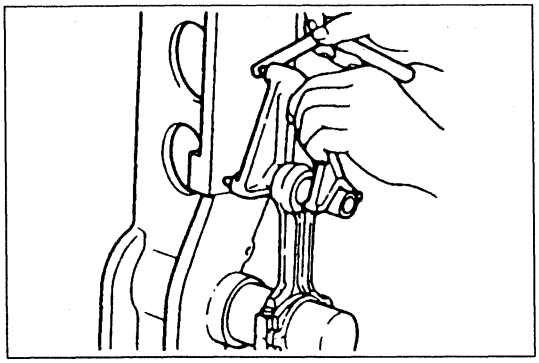


4. Measure each connecting rod bushing inner diameter.

   Diameter: 19.943—19.961 mm { 0.7852—0.7858 in }

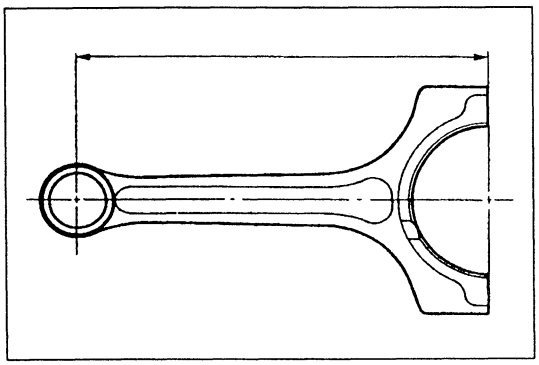
5. Calculate the connecting rod bushing-to-piston pin clearance. If the clearance is not as specified, replace the connecting rod or piston pin.

   Clearance:
   –0.037— –0.013 mm { –0.0014— –0.0006 in }

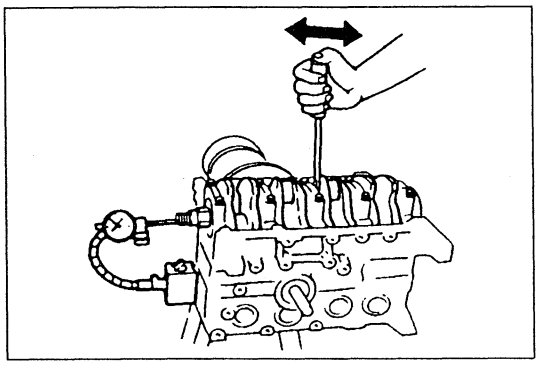


6. Measure each connecting rod for bending. Repair or replace the connecting rod if necessary.

   Bending:
   0.075 mm { 0.0030 in } max./50 mm { 1.97 in }
   Distortion:
   0.180 mm { 0.0071 in } max./50 mm { 1.97 in }
   Center-to-center distance:
   135.95—136.05 mm { 5.353—5.356 in }



7. If the connecting rod is replaced, the connecting rod cap must also be replaced because they are machined together.



CRANKSHAFT

1. Measure the crankshaft end play.

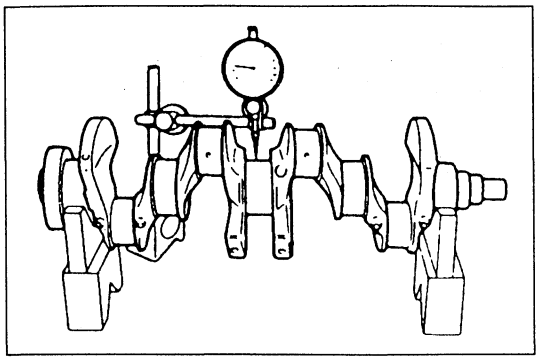
   End play: 0.080—0.282 mm { 0.0032—0.0111 in }
   Maximum: 0.3 mm { 0.01 in }

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

Journal width

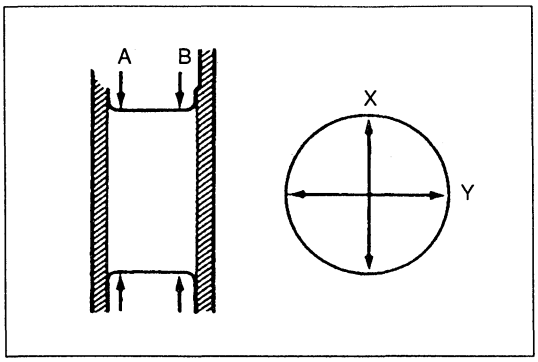
mm { in }

Bearing	No.4 journal width
Standard	24.07—24.12 { 0.948—0.949 }
0.25 { 0.01 } oversize	24.32—24.37 { 0.958—0.959 }
0.50 { 0.02 } oversize	24.57—24.62 { 0.968—0.969 }
0.75 { 0.03 } oversize	24.82—24.87 { 0.978—0.979 }



3. Set the crankshaft No.1 and No.5 main journals on V-blocks.
4. Measure the crankshaft runout at the No.3 main journals. Replace the crankshaft if necessary.

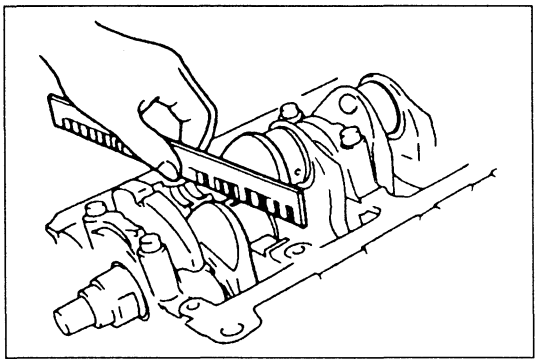
Runout: 0.04 mm { 0.0016 in } max.



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

Main journal
Diameter:
49.938—49.956 mm { 1.9661—1.9667 in }
Minimum: 49.904 mm { 1.9647 in }
Out-of-round: 0.05 mm { 0.0020 in } max.

Crank pin journal
Diameter:
39.940—39.956 mm { 1.5725—1.5730 in }
Minimum: 39.908 mm { 1.5712 in }
Out-of-round: 0.05 mm { 0.0020 in } max.



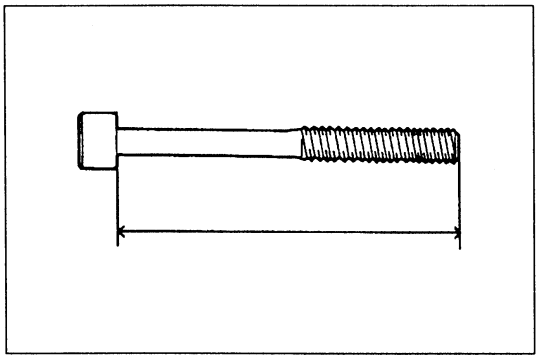
6. If the diameter exceeds the maximum, grind the journal and install the undersize bearing.
7. Measure the main journal oil clearances as follows.
   (1) Position plastigauge atop the crankshaft in the axial direction.
   (2) Install the main bearing cap and tighten the main bearing cap bolts. (Refer to page B–24.)
   (3) Remove the main bearing cap bolts and main bearing caps. (Refer to page B–24.)
   (4) Measure the plastigauge at each journal.

Oil clearance:
0.018—0.036 mm { 0.0008—0.0014 in }
Maximum: 0.1 mm { 0.004 in }

   (5) If the oil clearance exceeds the maximum, replace the connecting rod bearing or grind the main journal and use undersize bearings.

mm { in }

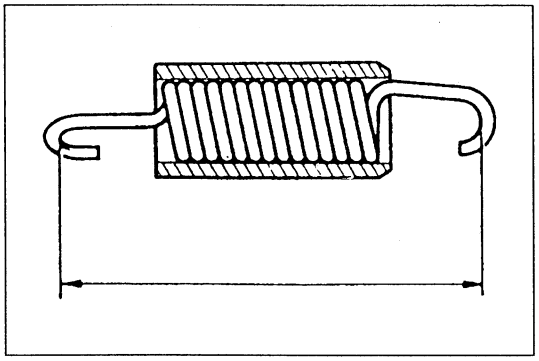
Bearing	Main journal
Standard	49.938—49.956 { 1.9661—1.9667 }
0.25 { 0.01 } undersize	49.688—49.706 { 1.9563—1.9569 }
0.50 { 0.02 } undersize	49.438—49.456 { 1.9464—1.9470 }
0.75 { 0.03 } undersize	49.188—49.206 { 1.9366—1.9372 }



BOLT

Measure the length of each cylinder head bolt. Replace any that exceed the maximum length.

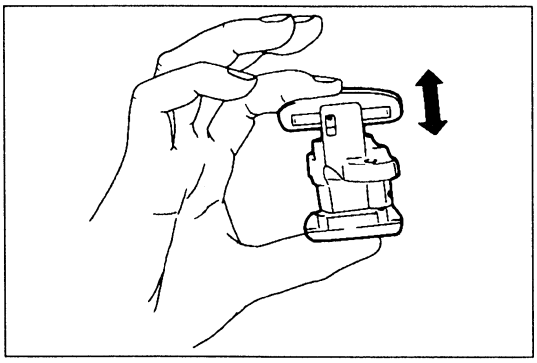
Length: 99.2—99.8 mm { 3.91—3.92 in }
Maximum: 100.5 mm { 3.957 in }



TENSIONER SPRING

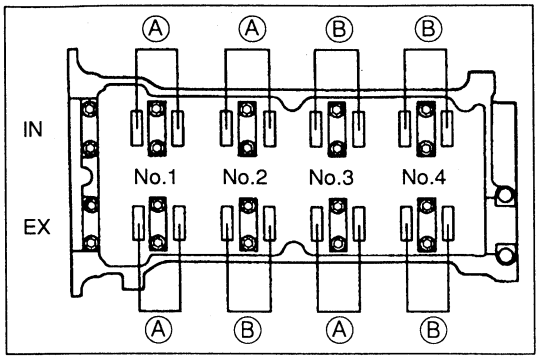
Measure the free length of the tensioner spring. Replace the tensioner spring if necessary.

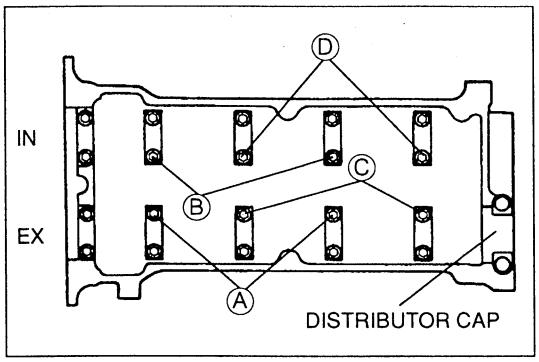
Free length: 71.0 mm { 2.80 in }



CHAIN ADJUSTER

Check the chain adjuster for smooth operation. Replace the chain adjuster if necessary.





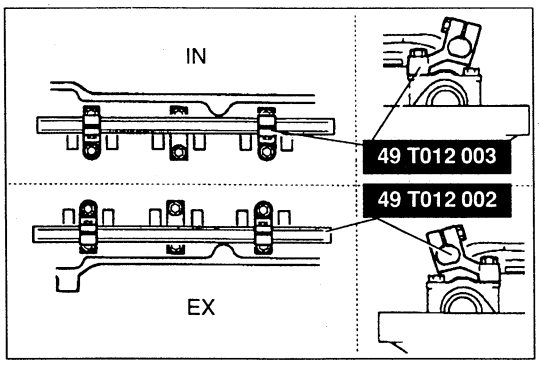
VALVE CLEARANCE

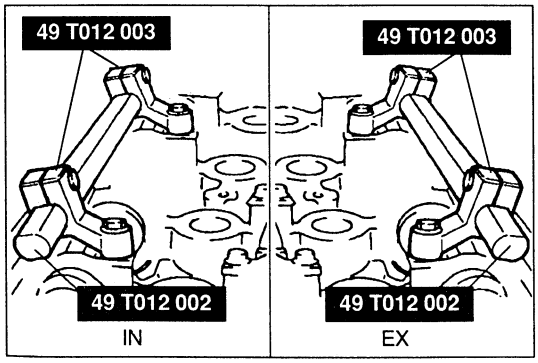
1. Measure the valve clearance as follows.
   (1) Turn the crankshaft clockwise so that the No.1 piston is at TDC of the compression stroke.
   (2) Measure the valve clearance at Ⓐ in the figure.
   (3) Turn the crankshaft 360° clockwise so that the No.4 piston is at TDC of the compression stroke.
   (4) Measure the valve clearance at Ⓑ in the figure.

   Standard (Engine cold)
   IN: 0.25—0.31 mm { 0.010—0.012 in }
   EX: 0.25—0.31 mm { 0.010—0.012 in }

2. If the valve clearance exceeds the standard, replace the adjustment shim
3. Turn the crankshaft clockwise so that the cam on the camshaft requiring adjustment shim replacement are positioned straight up.
4. Remove the camshaft cap bolts as necessary.
   Ⓐ: For EX side No.1, 2, 3 cylinder adjustment shim removal
   Ⓑ: For IN side No.1, 2, 3 cylinder adjustment shim removal
   Ⓒ: For EX side No.2, 3, 4 cylinder adjustment shim removal
   Ⓓ: For IN side No.2, 3, 4 cylinder adjustment shim removal

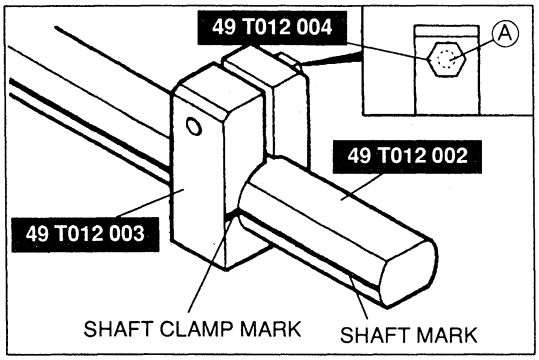
   Note
   - To replace the shim of the EX side No.2 and/or No.3 cylinder, removal the bolts marked either Ⓐ or Ⓒ.
   - To replace the shim of the IN side No.2 and/or No.3 cylinder, removal the bolts marked either Ⓑ or Ⓓ.



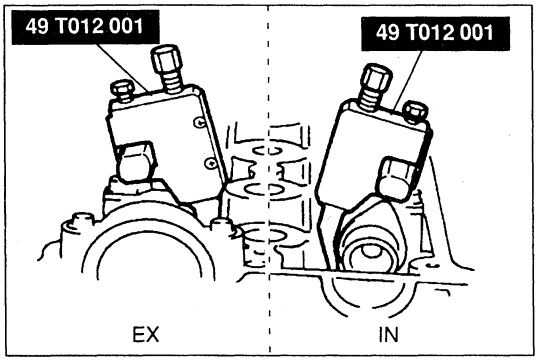


5. Install the **SSTs** as shown, using the camshaft cap bolt holes.

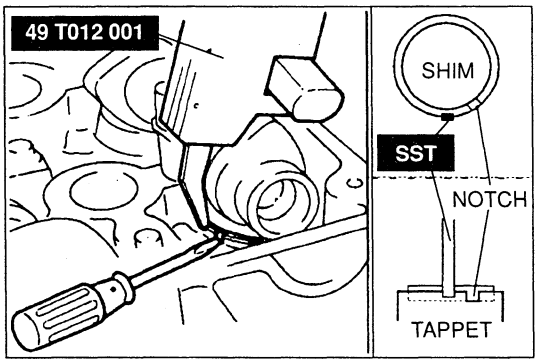
   Tightening torque: 11.3—14.2 N·m
   { 115—145 kgf·cm , 99.9—125 in·lbf }



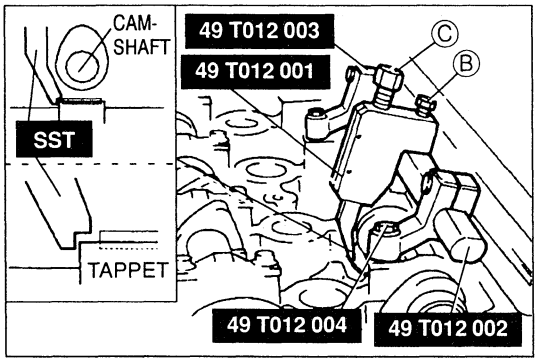
6. Align the marks on the **SSTs** (shaft and shaft clamp).
7. Tighten bolts Ⓐ to secure the **SST** (shaft).



8. Face the **SST** (body) toward the center of the cylinder head, and mount it on the **SST** (shaft) at the position of the adjustment shim to be replaced.



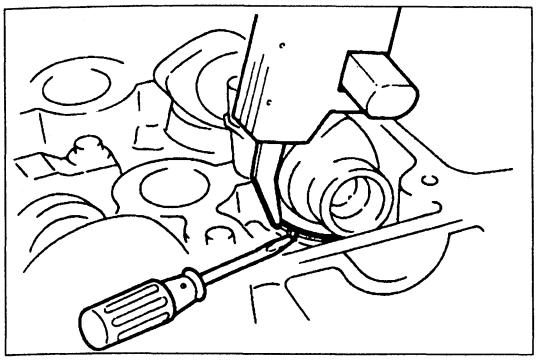
9. Face the notch of the tappet so that a fine screwdriver can be inserted.



10. Set the **SST** on the tappet by its notch.
11. Tighten bolt Ⓑ to secure the **SST** (body) onto the **SST** (shaft).

Caution
- **The cylinder head can be damaged by the tip of the SST (body) while pressing down the tappet.**

12. Tighten bolt Ⓒ 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 Clarence (0.28 mm { 0.011 in })

15. Push the selected shim into the tappet.
16. Loosen bolt Ⓒ to allow the tappet to move up.
17. Loosen bolt Ⓑ 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. Repeat steps 3—18 for all adjustment shims that require replacement.
20. Check the valve clearance. (Refer to page B–39.)

LUBRICATION SYSTEM

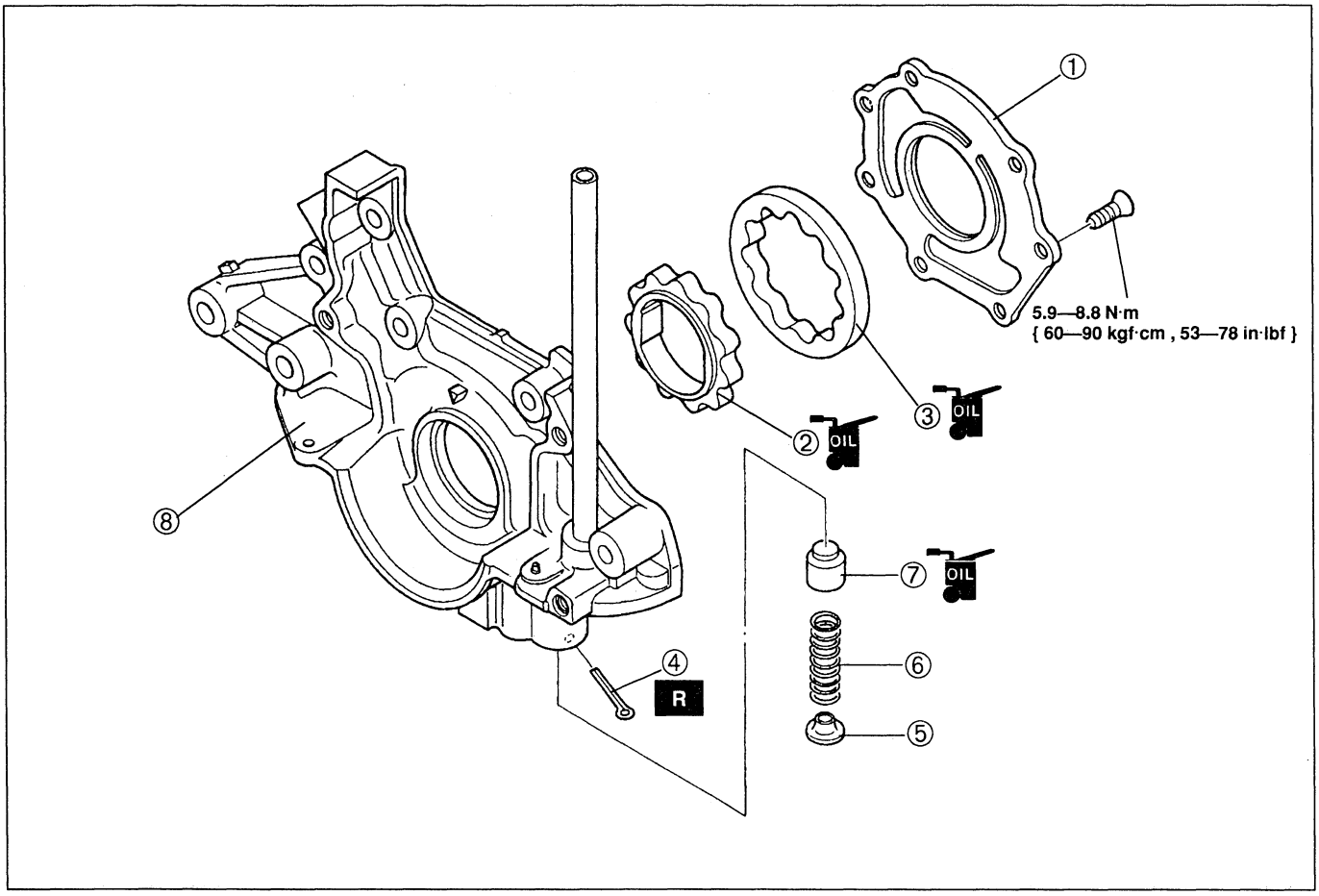
OIL PUMP

DISASSEMBLY / INSPECTION / ASSEMBLY

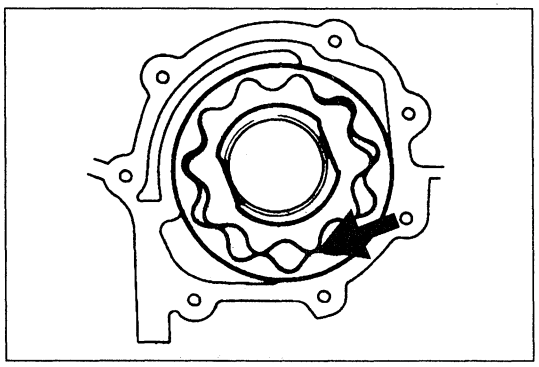
Warning

- **Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing whit 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
2. Inner rotor
   Inspection ..... below
3. Outer rotor
   Inspection ..... below
4. Cotter pin
   Assembly Note ..... page D–3
5. Spring seat
6. Pressure spring
   Inspection ..... page D–3
7. Control plunger
8. Oil pump body
   Inspection ..... below

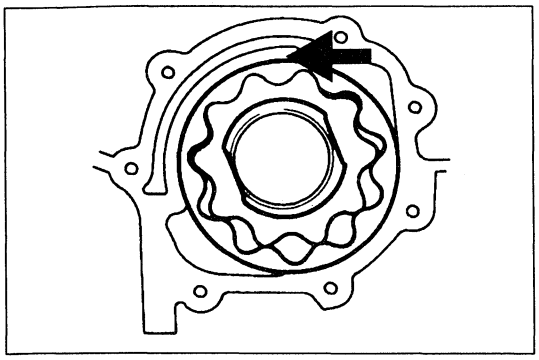


Inspection

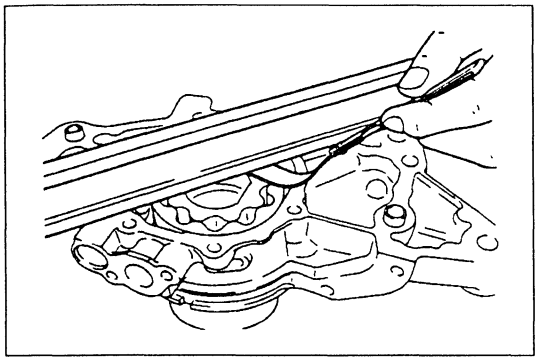
Inner rotor, outer rotor, and oil pump body

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

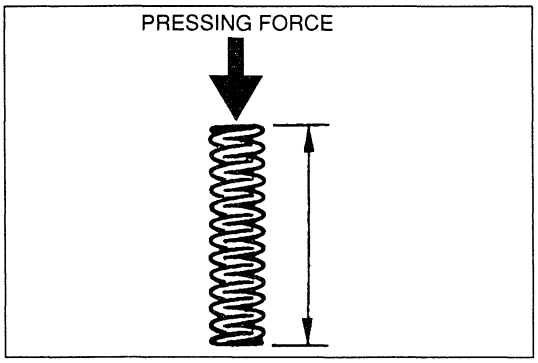
Tooth tip clearance:
0.02—0.16 mm { 0.0008—0.0062 in }
Maximum: 0.20 mm { 0.0079 in }



Outer rotor-to-oil pump body clearance:
0.090—0.180 mm { 0.0036—0.0070 in }
Maximum: 0.22 mm { 0.0087 in }



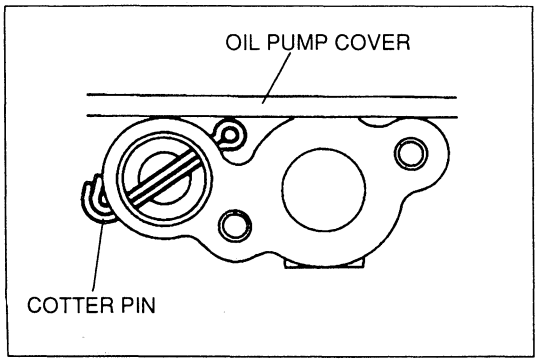
Side clearance: 0.03—0.11 mm { 0.0012—0.0043 in }
Maximum: 0.14 mm { 0.0055 in }



Pressure spring

Apply pressing force to the pressure spring and check the spring height.

Pressing force:
62.8—68.6 N { 6.4—7.7 kgf , 14.1—15.4 lbf }
Height: 35.42 mm { 1.394 in }



Assembly Note
Cotter pin

Bend the cotter pin so that its tip does not project from the oil pump cover mounting surface.

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