RODEO

ENGINE

CONTENTS

ENGINE MECHANICAL (6VD1 3.2L)

CONTENTS

Service Precaution

WARNING: THIS VEHICLE HAS A SUPPLEMENTAL RESTRAINT SYSTEM (SRS). REFER TO THE SRS COMPONENT AND WIRING LOCATION VIEW IN ORDER TO DETERMINE WHETHER YOU ARE PERFORMING SERVICE ON OR NEAR THE SRS COMPONENTS OR THE SRS WIRING. WHEN YOU ARE PERFORMING SERVICE ON OR NEAR THE SRS COMPONENTS OR THE SRS WIRING, REFER TO THE SRS SERVICE INFORMATION. FAILURE TO FOLLOW WARNINGS COULD RESULT IN POSSIBLE AIR BAG DEPLOYMENT, PERSONAL INJURY, OR OTHERWISE UNNEEDED SRS SYSTEM REPAIRS.

CAUTION: Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.

General Description

Engine Cleanliness And Care

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the thousandths of a millimeter (ten thousandths of an inch). Accordingly, when any internal engine parts are serviced, care and cleanliness are important. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

- A liberal coating of engine oil should be applied to all friction areas during assembly to protect and lubricate the surfaces on initial operation.
- Whenever valve train components, pistons, piston rings, connecting rods, rod bearings, and crankshaft journal bearings are removed for service, they should be retained in order.
- At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.
- Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.
- The six cylinders of this engine are identified by numbers; Right side cylinders 1, 3 and 5, Left side cylinders 2, 4 and 6, as counted from crankshaft pulley side to flywheel side.

General Information on Engine Service

The following information on engine service should be noted carefully, as it is important in preventing damage and contributing to reliable engine performance.

- When raising or supporting the engine for any reason, do not use a jack under the oil pan. Due to the small clearance between the oil pan and the oil pump strainer, jacking against the oil pan may cause damage to the oil pick–up unit.
- The 12–volt electrical system is capable of damaging circuits. When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected at the battery.
- Any time the intake air duct or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material into the cylinder which could cause extensive damage when the engine is started.

Cylinder Block

The cylinder block is made of aluminum die–cast casting for 75˚V–type six cylinders. It has a rear plate integrated structure and employs a deep skirt. The cylinder liner is cast and the liner inner diameter and crankshaft journal diameter are classified into grades. The crankshaft is supported by four bearings of which width is different between No.2, No.3 and No.1, No.4; the width of No.3 bearing on the body side is different in order to support the thrust bearing. The bearing cap is made of nodular cast iron and each bearing cap uses four bolts and two side bolts.

Cylinder Head

The cylinder head, made of aluminum alloy casting employs a pent–roof type combustion chamber with a spark plug in the center. The intake and exhaust valves are placed in V–type design. The ports are cross–flow type.

Valve Train

Intake and exhaust camshaft on the both side of banks are driven through an camshaft drive gear by timing belt. The valves are operated by the camshaft and the valve clearance is adjusted to select suitable thickness shim.

Intake Manifold

The intake manifold system is composed of the aluminum cast common chamber and intake manifold attached with six fuel injectors.

Exhaust Manifold

The exhaust manifold is made of nodular cast iron.

Pistons and Connecting Rods

Aluminum pistons are used after selecting the grade that meets the cylinder bore diameter. Each piston has two compression rings and one oil ring. The piston pin made of chromium steel is offset 1mm toward the thrust side, and the thrust pressure of piston to the cylinder wall varies gradually as the piston travels. The connecting rods are made of forged steel. The connecting rod bearings are graded for correct size selection.

Crankshaft and Bearings

The crankshaft is made of Ductile cast–iron. Pins and journals are graded for correct size selection for their bearing.

Engine Diagnosis

Hard Starting

1. Starting Motor Does Not Turn Over

Troubleshooting Procedure

Turn on headlights and starter switch.

Condition	Possible cause	Correction
Headlights go out or dim considerably	Battery run down or under charged	Recharge or replace battery
	Terminals poorly connected	Clean battery posts and terminals and connect properly
	Starting motor coil circuit shorted	Overhaul or replace
	Starting motor defective	Overhaul or replace

2. Ignition Trouble — Starting Motor Turns Over But Engine Does Not Start

Spark Test

Disconnect an ignition coil from any spark plug. Connect the spark plug tester J–26792 (ST–125), start the engine, and check if a spark is generated in the spark plug tester.

Before starting the engine, make sure that the spark plug tester is properly grounded. To avoid electrical shock, do not touch the part where insulation of the ignition coil is broken while the engine is running.

Condition	Possible cause	Correction
Spark jumps across gap	Spark plug defective	Clean, adjust spark gap or replace
	Ignition timing incorrect	Refer to Ignition System
	Fuel not reaching fuel injector(s) or engine	Refer to item 3 (Trouble in fuel system)
	Valve timing incorrect	Adjust
	Engine lacks compression	Refer to item 4 (Engine lacks compression)
No sparking takes place	Ignition coil disconnected or broken	Connect properly or replace
	Electronic Ignition System with module	Replace
	Poor connections in engine harness	Correct
	Powertrain Control Module cable disconnected or defective	Correct or replace

3. Trouble In Fuel System

Condition	Possible cause	Correction
Starting motor turns over and spark occurs but engine does not start.	Fuel tank empty	Fill
	Water in fuel system	Clean
	Fuel filter clogged	Replace filter
	Fuel pipe clogged	Clean or replace
	Fuel pump defective	Replace
	Fuel pump circuit open	Correct or replace
	Evaporative Emission Control System circuit clogged	Correct or replace
	Multiport Fuel Injection System faulty	Refer to “Electronic Fuel Injection” section

4. Engine Lacks Compression

Condition	Possible cause	Correction
Engine lacks compression	Spark plug loosely fitted or spark plug gasket defective	Tighten to specified torque or replace gasket
	Valve timing incorrect	Adjust
	Cylinder head gasket defective	Replace gasket
	Valve incorrectly seated	Lap valve
	Valve stem seized	Replace valve and valve guide
	Valve spring weakened or broken	Replace
	Cylinder or piston rings worn	Overhaul engine
	Piston ring seized	Overhaul engine.

Engine Compression Test Procedure

1. Start and run the engine until the engine reaches normal operating temperature.
2. Turn the engine off.
3. Remove all the spark plugs.
4. Remove ignition coil fuse (15A) and disable the ignition system.
5. Remove the fuel pump relay from the relay and fuse box.
6. Engage the starter and check that the cranking speed is approximately 300 rpm.
7. Install cylinder compression gauge into spark plug hole.
8. With the throttle valve opened fully, keep the starter engaged until the compression gage needle reaches the maximum level. Note the reading.
9. Repeat the test with each cylinder.
   If the compression pressure obtained falls below the limit, engine overhaul is necessary.

   Limit; 1000 kPa (145 psi)

Rough Engine Idling or Engine Stalling

Condition	Possible cause	Correction
Trouble in fuel injection system	Idle air control valve defective	Replace
	Throttle shutting off incomplete	Correct or replace
	Throttle position sensor circuit open or shorted	Correct or replace
	Fuel injector circuits open or shorted	Correct or replace
	Fuel injectors damaged	Replace
	Fuel pump relay defective	Replace
	Mass Airflow Sensor circuit open or poor connections	Correct or replace
	Mass Airflow Sensor defective	Replace
	Manifold Absolute Pressure Sensor circuit open or poor connections	Correct or replace
	Manifold Absolute Pressure Sensor defective	Replace
	Engine Coolant Temperature Sensor circuit open or poor connections	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
	Intake Air Temperature sensor circuit open or poor connections	Correct or replace
	Intake Air Temperature sensor defective	Replace
	Knock Sensor (KS) cable broken or poor connections	Correct or replace
	KS defective	Replace
	KS Module circuits open or ground	Correct or replace
	KS Module defective	Replace
	Vehicle Speed Sensor circuit open or shorted	Correct or replace
	Vehicle Speed Sensor defective	Replace
Trouble in emission control system	Powertrain Control Module defective	Replace
	Exhaust Gas Recirculation Valve circuit open or poor connections	Correct or replace
	Exhaust Gas Recirculation Valve faulty	Replace
	Canister purge valve circuit open or poor connections	Correct or replace
	Canister purge valve defective	Replace
	Evaporative Emission Canister Purge control valve defective	Replace
	Trouble in ignition system	Refer to “Hard Start”

Condition	Possible cause	Correction
Others	Engine lacks compression	Refer to “Hard Start”
	Valve incorrectly seated	Lap valve
	Air Cleaner Filter clogged	Replace filter element
	Valve timing incorrect	Readjust
	Idle air control valve broken	Replace
	Fast idle solenoid defective	Replace
	Positive Crankcase Ventilation valve defective or clogged	Replace

Rough Engine Running

Condition	Possible cause	Correction
Engine misfires periodically	Ignition coil layer shorted	Replace
	Spark plugs fouling	Clean or install hotter type plug
	Spark plug(s) insulator nose leaking	Replace
	Fuel injector(s) defective	Replace
	Powertrain control module faulty	Replace
Engine knocks periodically	Spark plugs running too hot	Install colder type spark plugs
	Powertrain control module faulty	Replace
Engine lacks power	Spark plugs fouled	Clean
	Fuel injectors defective	Replace
	Mass Airflow Sensor or Intake Airflow Sensor circuit defective	Correct or replace
	Manifold Absolute Pressure (MAP) Sensor or Manifold Absolute Pressure Sensor circuit defective	Correct or replace
	Engine Coolant Temperature Sensor or Engine Coolant Temperature Sensor circuit defective	Correct or replace
	Powertrain Control Module faulty	Replace
	Intake Air Temperature Sensor or Intake Air Temperature Sensor circuit defective	Correct or replace
	Throttle Position Sensor or Throttle Position Sensor circuit defective	Correct or replace
	Knock Sensor or Knock Sensor circuits defective	Correct or replace
	Knock Sensor Module or Knock Sensor Module circuits defective	Correct or replace

Hesitation

Condition	Possible cause	Correction
Hesitation on acceleration	Throttle Position Sensor adjustment incorrect	Replace throttle valve assembly
	Throttle Position Sensor circuit open or shorted	Correct or replace
	Excessive play in accelerator linkage	Adjust or replace
	Mass Airflow Sensor circuit open or poor connections	Correct or replace
	Mass Airflow Sensor defective	Replace
	Manifold Absolute Pressure (MAP) Sensor circuit open or shorted	Correct or replace
	MAP Sensor defective	Replace
	Intake Air Temperature (IAT) Sensor circuit open or poor connections	Correct or replace
	Knock Sensor (KS) circuit open or poor connections	Correct or replace
	KS defective	Replace
	KS Module circuits open or shorted	Correct or replace
	KS Module defective	Replace
	IAT Sensor defective	Replace
Hesitation at high speeds (Fuel pressure too low)	Fuel tank strainer clogged	Clean or replace
	Fuel pipe clogged	Clean or replace
	Fuel filter clogged	Replace
	Defective fuel pump system	Check and replace
	Fuel Pressure Control Valve leaking	Replace
Hesitation at high speeds (Fuel injector not working normally)	Power supply or ground circuit for Multiport Fuel Injection System shorted or open	Check and correct or replace
	Fuel Injector defective	Replace
	Cable of Multiport Fuel Injection System circuit open or poor connections	Correct or replace

Condition	Possible cause	Correction
Hesitation at high speeds	Powertrain Control Module defective	Replace
	Throttle Position Sensor cable broken or poor connections	Correct or replace
	Throttle Position Sensor defective	Replace
	Engine Coolant Temperature Sensor circuit open or shorted	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
	Mass Airflow Sensor circuit open or poor connections	Correct or replace
	Mass Airflow Sensor defective	Replace
	MAP Sensor cable broken or poor connections	Correct or replace
	MAP Sensor defective	Replace
	IAT Sensor circuit open or poor connections	Correct or replace
	IAT Sensor defective	Replace
	KS circuit open or poor connections	Correct or replace
	KS defective	Replace
	KS Module circuit open or shorted	Correct or replace
	KS Module defective	Replace
	Throttle valve not fully opened	Check and correct or replace
	Air Cleaner Filter clogged	Replace filter element
	Power supply voltage too low	Check and correct or replace

Engine Lacks Power

Condition	Possible cause	Correction
Trouble in fuel system	Fuel Pressure Control Valve not working normally	Replace
	Fuel injector clogged	Clean or replace
	Fuel pipe clogged	Clean
	Fuel filter clogged or fouled	Replace
	Fuel pump drive circuit not working normally	Correct or replace
	Fuel tank not sufficiently breathing due to clogged Evaporative Emission Control System circuit	Clean or replace
	Water in fuel system	Clean
	Inferior quality fuel in fuel system	Use fuel of specified octane rating
	Powertrain Control Module supplied poor voltage	Correct circuit
	Throttle Position Sensor cable broken or poor connections	Correct or replace
	Throttle Position Sensor defective	Replace
	Mass Airflow Sensor not working normally	Replace
	Manifold Absolute Pressure Sensor not working normally	Replace
	Intake Air Temperature Sensor not working normally	Replace
	Engine Coolant Temperature Sensor circuit open or shorted	Correct or replace
	Engine Coolant Temperature Sensor defective	Replace
	Powertrain Control Module defective	Replace
Trouble in intake or exhaust system	Air Cleaner Filter clogged	Replace filter element
	Air duct kinked or flattened	Correct or replace
Ignition failure	———	Refer to Hard Start Troubleshooting Guide
	Heat range of spark plug inadequate	Install spark plugs of adequate heat range
	Ignition coil defective	Replace

Condition	Possible cause	Correction
Engine overheating	Level of Engine Coolant too low	Replenish
	Fan clutch defective	Replace
	Incorrect fan installed	Replace
	Thermostat defective	Replace
	Engine Coolant pump defective	Correct or replace
	Radiator clogged	Clean or replace
	Radiator filler cap defective	Replace
	Level of oil in engine crankcase too low or wrong engine oil	Change or replenish
	Resistance in exhaust system increased	Clean exhaust system or replace defective parts
	Throttle Position Sensor adjustment incorrect	Replace with Throttle Valve ASM
	Throttle Position Sensor circuit open or shorted	Correct or replace
	Cylinder head gasket damaged	Replace
Engine overcooling	Thermostat defective	Replace (Use a thermostat set to open at 82˚C (180˚F))
Engine lacks compression	————	Refer to Hard Start
Others	Tire inflation pressure abnormal	Adjust to recommended pressures
	Brake drag	Adjust
	Clutch slipping	Adjust or replace
	Level of oil in engine crankcase too high	Correct level of engine oil
	Exhaust Gas Recirculation Valve defective	Replace

Engine Noisy

Abnormal engine noise often consists of various noises originating in rotating parts, sliding parts and other moving parts of the engine. It is, therefore, advisable to locate the source of noise systematically.

Condition	Possible cause	Correction
Noise from crank journals or from crank bearings (Faulty crank journals and crank bearings usually make dull noise that becomes more evident when accelerating)	Oil clearance increased due to worn crank journals or crank bearings	Replace crank bearings and crankshaft or regrind crankshaft and install the undersize bearing
	Crankshaft out of round	Replace crank bearings and crankshaft or regrind crankshaft and install the undersize bearing
	Crank bearing seized	Crank bearing seized Replace crank bearings and crankshaft or regrind crankshaft and install the undersize bearing

Troubleshooting Procedure

Short out each spark plug in sequence using insulated spark plug wire removers. Locate cylinder with defective bearing by listening for abnormal noise that stops when spark plug is shorted out.

Condition	Possible cause	Correction
Noise from connecting rods or from connecting rod bearings (Faulty connecting rods or connecting rod bearings usually make an abnormal noise slightly higher than the crank bearing noise, which becomes more evident when engine is accelerated)	Bearing or crankshaft pin worn	Replace connecting rod bearings and crankshaft or regrind crankshaft pin and install the undersize bearing
	Crankpin out of round	Replace connecting rod bearings and crankshaft or regrind crankshaft pin and install the undersize bearing
	Connecting rod bent	Correct or replace
	Connecting rod bearing seized	Replace connecting rod bearings and crankshaft or regrind crankshaft pin and install the undersize bearing

Troubleshooting Procedure

Abnormal noise stops when the spark plug on the cylinder with defective part is shorted out.

Condition	Possible cause	Correction
Piston and cylinder noise (Faulty piston or cylinder usually makes a combined mechanical thumping noise which increases when engine is suddenly accelerated but diminishes gradually as the engine warms up)	Piston clearance increased due to cylinder wear	Replace piston and cylinder body
	Piston seized	Replace piston and cylinder body
	Piston ring broken	Replace piston and cylinder body
	Piston defective	Replace pistons and others

Troubleshooting Procedure

Short out each spark plug and listen for change in engine noise.

Condition	Possible cause	Correction
Piston pin noise (Piston makes noise each time it goes up and down)	Piston pin or piston pin hole worn	Replace piston, piston pin and connecting rod assy

Troubleshooting Procedure

The slapping sound stops when spark plug on bad cylinder is shorted out.

Condition	Possible cause	Correction
Timing belt noise	Timing belt tension is incorrect	Replace pusher or adjust the tension pulley or replace timing belt
	Tensioner bearing defective	Replace
	Timing belt defective	Replace
	Timing pulley defective	Replace
	Timing belt comes in contact with timing cover	Replace timing belt and timing cover
Valve noise	Valve clearance incorrect	Replace adjusting shim
	Valve and valve guide seized	Replace valve and valve guide
	Valve spring broken or weakened	Replace
	Valve seat off–positioned	Correct
	Camshaft worn out	Replace
Crankshaft noise	Crankshaft end play excessive (noise occurs when clutch is engaged)	Replace thrust bearing
Engine knocking	Preignition due to use of spark plugs of inadequate heat range	Install Spark Plugs of adequate heat range
	Carbon deposits in combustion chambers	Clean
	Fuel too low in octane rating	Replace fuel
	Wide Open Throttle enrichment system failure	Refer to Section 6E
	Selection of transmission gear incorrect	Caution operator of incorrect gear selection
	Engine overheating	Refer to “Engine Lacks Power”
Others	Water pump defective	Replace
	Drive belt slipping	Replace auto tentioner or drive belt

Abnormal Combustion

Condition	Possible cause	Correction
Trouble in fuel system	Fuel pressure control valve defective	Replace
	Fuel filter clogged	Replace
	Fuel pump clogged	Clean or replace
	Fuel tank or fuel pipe clogged	Clean or replace
	Fuel injector clogged	Clean or replace
	Fuel pump relay defective	Replace
	Power supply cable for fuel pump broken or poor connections	Reconnect, correct or replace
	Mass Airflow (MAF) Sensor circuit open or defective	Correct or replace
	MAF Sensor defective	Replace
	Manifold Absolute Pressure Sensor circuit open or shorted	Correct or replace
	Manifold Absolute Pressure Sensor defective	Replace
	Engine Coolant Temperature (ECT) Sensor circuit open or shorted	Correct or replace
	ECT Sensor defective	Replace
	Throttle Position Sensor adjustment incorrect	Readjust
	Throttle Position Sensor defective	Replace
	Throttle Position Sensor connector poor connections	Reconnect
	Vehicle Speed Sensor cable poor connections or defective	Correct or replace
	Vehicle Speed Sensor loosely fixed	Fix tightly
	Vehicle Speed Sensor in wrong contact or defective	Replace
	Powertrain Control Module cable poor connections or defective	Correct or replace
Trouble in emission control system	Heated Oxygen Sensor circuit open	Correct or replace
	Heated Oxygen Sensor defective	Replace
	Signal vacuum hose loosely fitted or defective	Correct or replace
	EGR Valve circuit open or shorted	Correct or replace
	Exhaust Gas Recirculation Valve defective	Replace
	ECT Sensor circuit open or shorted	Correct or replace
	Canister Purge Valve circuit open or shorted	Correct or replace
	Canister Purge Valve defective	Replace
	ECT Sensor defective	Replace
	Positive Crankcase Ventilation (PCV) valve and hose clogged	Correct or replace
	Evaporator system	Refer to Section 6E
Trouble in ignition system	————	Refer to “Engine Lacks Power”

Condition	Possible cause	Correction
Trouble in cylinder head parts	Carbon deposits in combustion chamber	Remove carbon
	Carbon deposit on valve, valve seat and valve guide	Remove carbon

Engine Oil Consumption Excessive

Condition	Possible cause	Correction
Oil leaking	Oil pan drain plug loose	Retighten or replace gasket
	Crankcase fixing bolts loosened	Retighten
	Oil pan setting bolts loosened	Retighten
	Oil pan gasket broken	Replace gasket
	Front cover retaining bolts loose or gasket broken	Retighten or replace gasket
	Head cover fixing bolts loose or gasket broken	Retighten or replace gasket
	Oil cooler adapter cracked	Replace
	Oil cooler center bolt loose	Retighten
	Oil cooler O–ring broken	Replace
	Oil cooler piping loose or broken	Retighten or replace
	Oil filter adapter cracked	Replace
	Oil filter attachings bolt loose or rubber gasket broken	Retighten or replace oil filter
	Oil cooler broken	Replace
	Crankshaft front or rear oil seal defective	Replace oil seal
	Oil pressure unit loose or broken	Retighten or replace
	Blow–by gas hose broken	Replace hose
	Positive Crankcase Ventilation Valve clogged	Clean
	Engine/Transmission coupling failed	Replace oil seal
Oil leaking into combustion chambers due to poor seal in valve system	Valve stem oil seal defective	Replace
	Valve stem or valve guide worn	Replace valve and valve guide
Oil leaking into combustion chambers due to poor seal in cylinder parts	Cylinders and pistons worn excessively	Replace cylinder body assembly and pistons
	Piston ring gaps incorrectly positioned	Correct
	Piston rings set with wrong side up	Correct
	Piston ring sticking	Replace cylinder body assembly and pistons
	Piston ring and ring groove worn	Replace pistons and others
	Return ports in oil rings clogged	Clean piston and replace rings
Positive Crankcase Ventilation System malfunctioning	Positive Crankcase Ventilation Valve clogged	Clean
Others	Improper oil viscosity	Use oil of recommended S.A.E. viscosity
	Continuous high speed driving and/or severe usage such as trailer towing	Continuous high speed operation and/or severe usage will normally cause increased oil consumption

Fuel Consumption Excessive

Condition	Possible cause	Correction
Trouble in fuel system	Mixture too rich or too lean due to trouble in fuel injection system	Refer to “Abnormal Combustion”
	Fuel cut function does not work	Refer to “Abnormal Combustion”
Trouble in ignition system	Misfiring or abnormal combustion due to trouble in ignition system	Refer to “Hard Start” or “Abnormal Combustion”
Others	Engine idle speed too high	Reset Idle Air Control Valve
	Returning of accelerator control sluggish	Correct
	Fuel system leakage	Correct or replace
	Clutch slipping	Correct
	Brake drag	Correct
	Selection of transmission gear incorrect	Caution operator of incorrect gear selection
	Excessive Exhaust Gas Recirculation flow due to trouble in Exhaust Gas Recirculation system	Refer to “Abnormal Combustion”

Lubrication Problems

Condition	Possible cause	Correction
Oil pressure too low	Wrong oil in use	Replace with correct engine oil
	Relief valve sticking	Replace
	Oil pump not operating properly	Correct or replace
	Oil pump strainer clogged	Clean or replace strainer
	Oil pump worn	Replace
	Oil pressure gauge defective	Correct or replace
	Crankshaft bearing or connecting rod bearing worn	Replace
Oil contamination	Wrong oil in use	Replace with correct engine oil
	Oil filter clogged	Replace oil filter
	Cylinder head gasket damage	Replace gasket
	Burned gases leaking	Replace piston and piston rings or cylinder body assembly
Oil not reaching valve system	Oil passage in cylinder head or cylinder body clogged	Clean or correct

Engine Oil Pressure Check

1. Check for dirt, gasoline or water in the engine oil.
   a. Check the viscosity of the oil.
   b. Check the viscosity of the oil.
   c. Change the oil if the viscosity is outside the specified standard.
   d. Refer to the “Maintenance and Lubrication” section of this manual.
2. Check the engine oil level.
   The level should fall somewhere between the “ADD” and the “FULL” marks on the oil level dipstick.
   If the oil level does not reach the “ADD” mark on the oil level dipstick, engine oil must be added.
3. Remove the oil pressure unit.
4. Install an oil pressure gauge.
5. Start the engine and allow the engine to reach normal operating temperature (About 80˚C).
6. Measure the oil pressure.
   Oil pressure should be:
   392–550 kPa (56.9–80.4 psi) at 3000 rpm.
7. Stop the engine.
8. Remove the oil pressure gauge.
9. Install the oil pressure unit.
10. Start the engine and check for leaks.

Malfunction Indicator Lamp

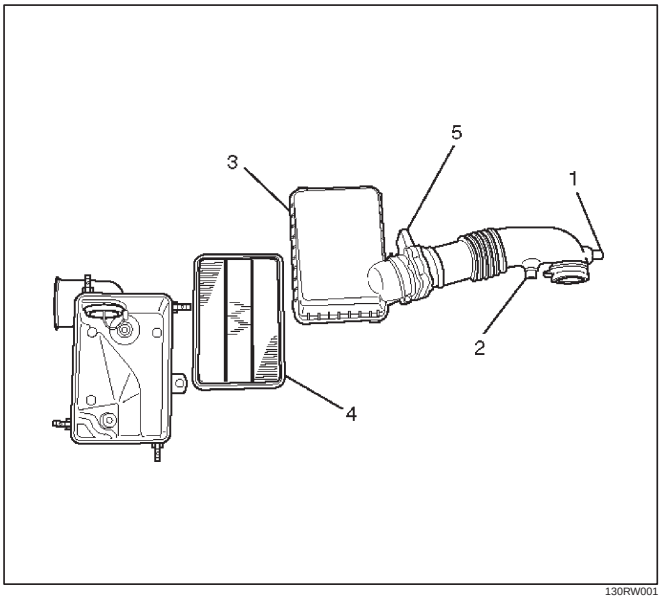
The instrument panel “CHECK ENGINE” Malfunction Indicator Lamp (MIL) illuminates by self diagnostic system when the system checks the starting of engine, or senses malfunctions.

Condition	Possible cause	Correction
“CHECK ENGINE” MIL does not illuminate at the starting of engine	Bulb defective	Replace
	MIL circuit open	Correct or replace
	Command signal circuit to operate self diagnostic system shorted	Correct or replace
	Powertrain Control Module (PCM) cable loosely connected, disconnected or defective	Correct or replace
	PCM defective	Replace
“CHECK ENGINE” MIL illuminates, and stays on	Deterioration of heated oxygen sensor internal element	Replace
	Heated oxygen sensor connector terminal improper contact	Reconnect properly
	Heated oxygen sensor lead wire shorted	Correct
	Heated oxygen sensor circuit open	Correct or replace
	Deterioration of engine coolant temperature sensor internal element	Replace
	Engine coolant temperature sensor connector terminal improper contact	Reconnect properly
	Engine coolant temperature sensor lead wire shorted	Correct
	Engine coolant temperature sensor circuit open	Correct or replace
	Throttle position sensor open or shorted circuits	Correct or replace
	Deterioration of crankshaft position sensor	Replace
	Crankshaft position sensor circuit open or shorted	Correct or replace
	Vehicle speed sensor circuit open	Correct or replace
	Manifold absolute pressure sensor circuit open or shorted	Correct or replace
	Intake air temperature sensor circuit open or shorted	Correct or replace
	Fuel injector circuit open or shorted	Correct or replace
	PCM driver transistor defective	Replace PCM
	Malfunctioning of PCM RAM (Random Access Memory) or ROM (Read Only Memory)	Replace PCM

Cylinder Head Cover LH

Removal

1. Disconnect battery ground cable.
2. Remove air cleaner duct assembly.



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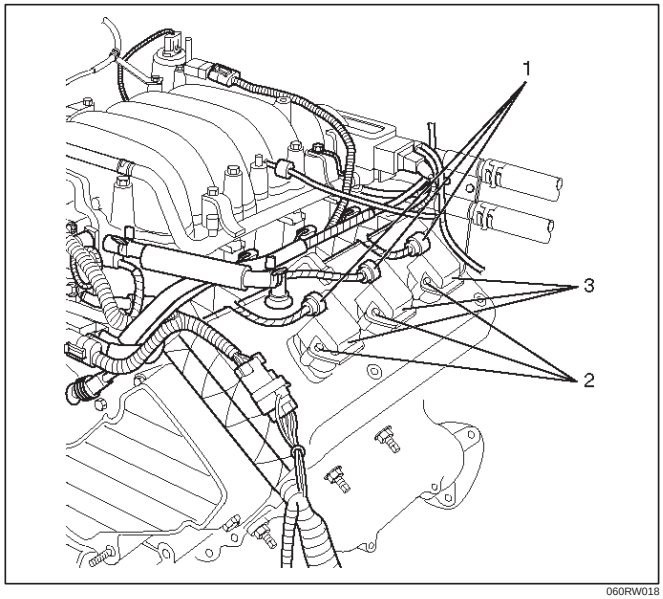
Legend

(1) Positive Crankcase Ventilation Hose Connector
(2) Intake Air Temperature Sensor
(3) Air Cleaner Duct Assembly
(4) Air Cleaner Element
(5) Mass Air Flow Sensor

3. Disconnect positive crankcase ventilation hose.
4. Remove camshaft angle sensor connector.
5. Remove ground cable fixing bolt on cylinder head cover.
6. Ignition coil connector and ignition coil.
   - Disconnect the three connectors from the ignition coils.
   - Remove harness bracket bolt on cylinder head cover.
   - Remove fixing bolts on ignition coils.



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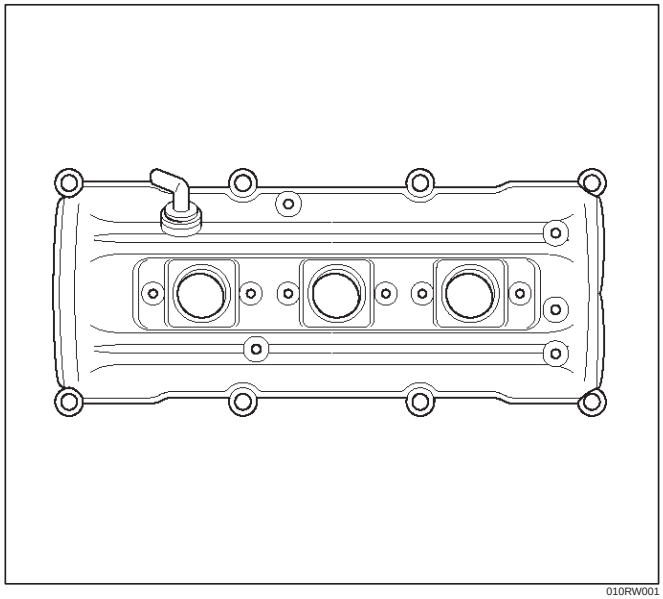
Legend

(1) Ignition Coil Connector
(2) Bolt
(3) Ignition Coil Assemblies

7. Remove fixing bolt for fuel injector harness bracket.
8. Remove eight fixing bolts, then the cylinder head cover.



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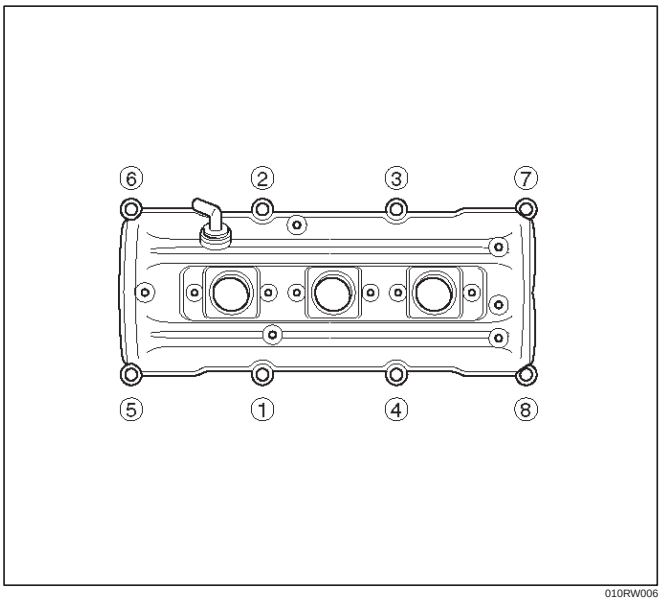
Installation

1. Install cylinder head cover.
   - Clean the sealing surface of cylinder head and cylinder head cover to remove oil and sealing materials completely.
   - Apply sealant (TB-1207B or equivalent) of bead diameter 2-3 mm at eight place of arched area of camshaft bracket on front and rear sides.
   - The cylinder head cover must be installed with in 5 minutes after sealant application to prevent hardning of sealant.
   - Tighten bolts to the specified torque.

   Torque : 9 N·m (80 lb in)



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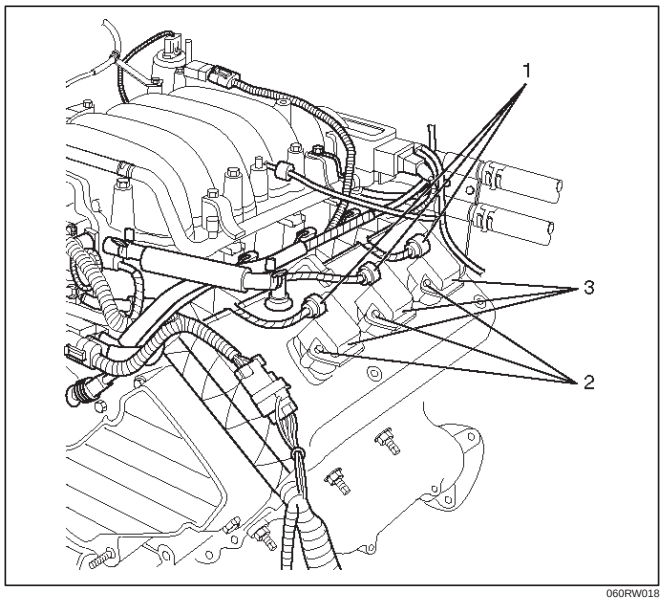
2. Install fuel injection harness bracket and tighten bolt to the specified torque.

   Torque : 9 N·m (80 lb in)

3. Connect ignition coil connector and ignition coil, then tighten bolt to the specified torque.

   Torque : 4 N·m (35 lb in)



060RW018

Legend

(1) Ignition Coil Connector
(2) Bolt
(3) Ignition Coil Assembly

4. Connect ground cable and tighten bolts to the specified torque.

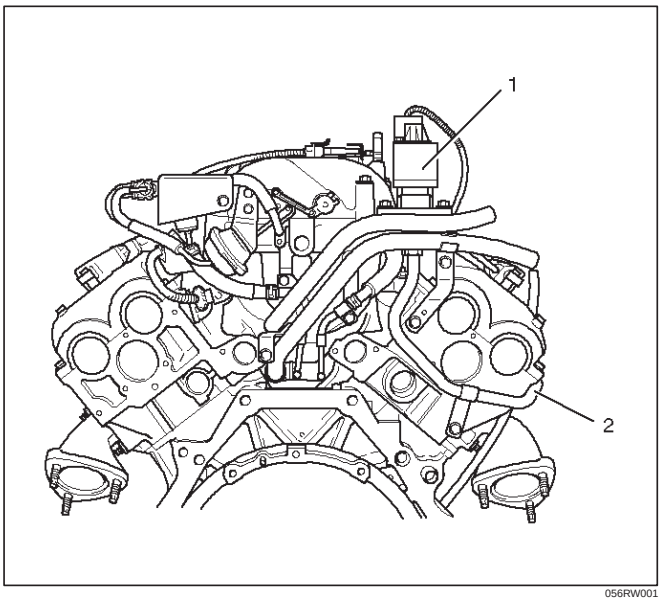
   Torque : 9 N·m (80 lb in)

5. Connect camshaft angle sensor connector.
6. Install positive crankcase ventilation hose.
7. Install air cleaner duct assembly.

Cylinder Head Cover RH

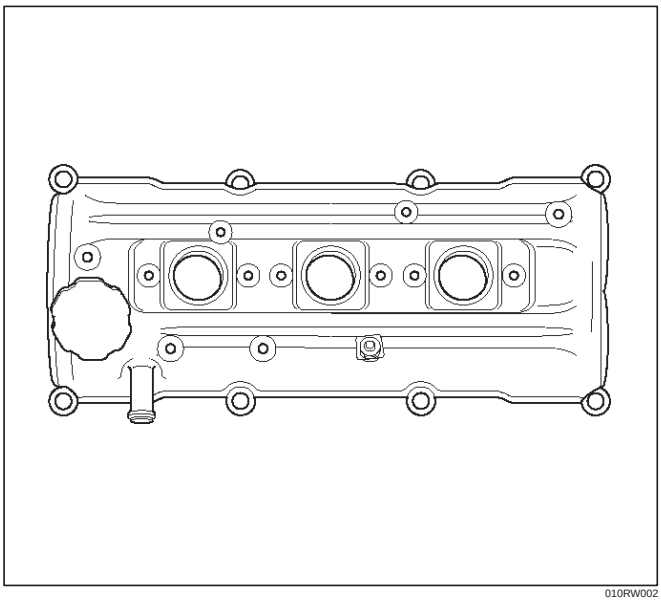
Removal

1. Disconnect battery ground cable.
2. Disconnect ventilation hose from cylinder head cover.
3. Disconnect three ignition coil connectors from ignition coils and remove harness bracket bolts on cylinder head cover then remove ignition coil fixing bolts on ignition coils and remove ignition coils.
4. Remove heater pipe fixing bolts from the bracket.
5. Disconnect fuel injector harness connector then remove fuel injector harness bracket bolt.
6. Remove exhaust gas recirculation (EGR) pipe.
   - Remove flare nut from EGR valve.
   - Remove fixing bolt of EGR pipe bracket on rear end cylinder head.
   - Remove two fixing bolt and nut on exhaust manifold.



056RW001

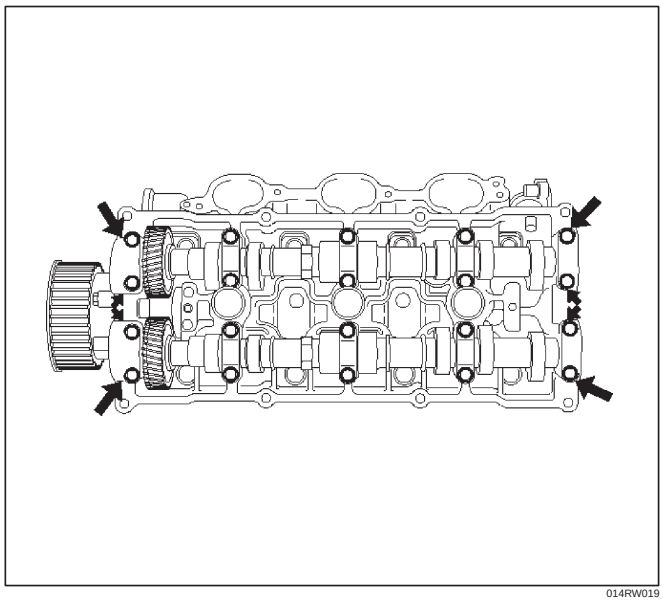
7. Remove eight fixing bolts then the cylinder head cover.


010RW002

Installation

1. Install cylinder head cover.
   - Clean the sealing surface of cylinder head and cylinder head cover to remove oil and sealing materials completely.
     Apply sealant (TB-1207B or equivalent) of bead diameter 2-3 mm at eight place of arched area of camshaft bracket on front and rear sides.
   - The cylinder head cover must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.
   - Tighten bolts to the specified torque.

   Torque : 9 N·m (80 lb in)


014RW019

2. Install exhaust gas recirculation pipe and tighten to specified torque.

   Torque:

   Exhaust manifold side: 28 N·m (21 lb ft)

   Flare nut: 44 N·m (33 lb ft)

   Cylinder head side: 25 N·m (18 lb ft)
3. Tighten fuel injector harness bracket bolts to specified torque then reconnect fuel injector harness connector.

   Torque : 7.8 N·m (5.7 lb ft)
4. Install heater pipe bolt to the specified torque.

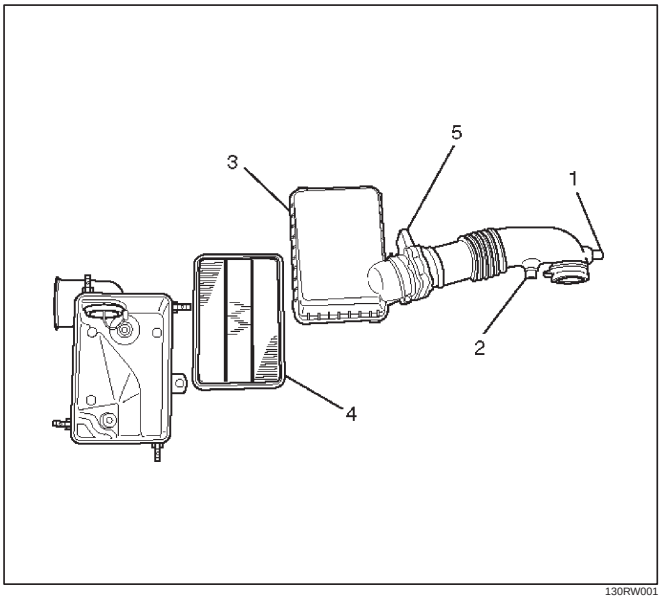
   Torque : 21 N·m (15 lb ft)
5. Connect ignition coil connector and tighten ignition coil fixing bolts to specified torque.

   Torque : 4 N·m (35 lb in)
6. Connect ventilation hose to cylinder head.

Common Chamber

Removal

1. Disconnect battery ground cable.
2. Remove air cleaner duct assembly.

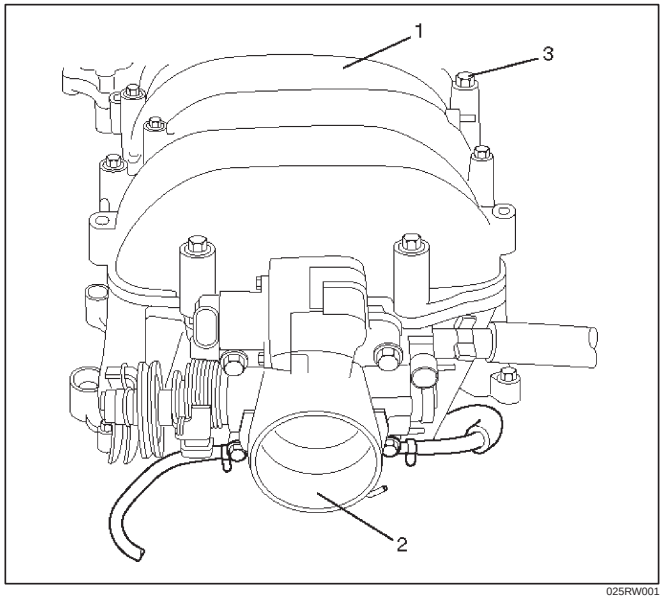


130RW001

Legend

(1) Positive Crankcase Ventilation Hose Connector
(2) Intake Air Temperature Sensor
(3) Air Cleaner Duct Assembly
(4) Air Cleaner Element
(5) Air Flow Sensor

3. Disconnect accelerator pedal cable from throttle body and cable bracket.
4. Disconnect vacuum booster hose from common chamber.
5. Disconnect connector from manifold absolute pressure sensor, idle air control valve, throttle position sensor, solenoid valve, electric vacuum sensing valve, and EGR valve.
6. Disconnect vacuum hose on canister VSV and positive crankcase ventilation hose, fuel rail assembly with pressure control valve bracket.
7. Remove ventilation hose from throttle valve and intake duct and remove water hose.
8. Remove the four throttle body fixing bolts.
9. Remove exhaust gas recirculation valve assembly fixing bolt and nut on common chamber and remove EGR valve assembly.
10. Remove two bolts from common chamber rear side for remove fuel hose bracket.
11. Remove common chamber four bolts and four nuts then remove the common chamber.



025RW001

Legend

(1) Common Chamber
(2) Throttle Valve Assembly
(3) Bolt

Installation

1. Install common chamber and tighten bolts and nuts to the specified torque.

   Torque :

   Bolt : 25 N·m (18 lb ft)

   Nut : 25 N·m (18 lb ft)
2. Install fuel hose bracket and tighten bolts to specified torque.

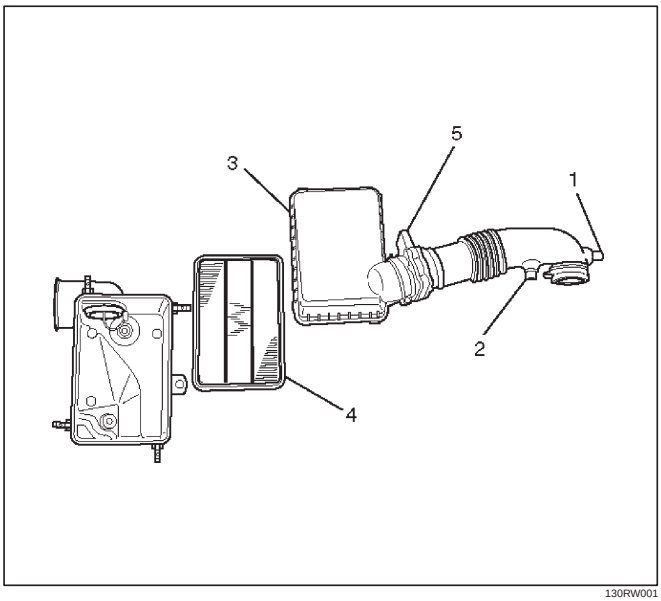
   Torque : 10 N·m (89 lb in)
3. Install exhaust gas recirculation valve assembly and tighten bolt and nut to the specified torque.

   Torque : 25 N·m (18 lb ft)
4. Install throttle body and tighten bolts to the specified torque.

   Torque : 25 N·m (18 lb ft)
5. Install ventilating hose to throttle valve and intake duct.
6. Connect vacuum hoses on canister VSV and positive crankcase ventilation hose. Tighten bolts for fuel rail assembly with pressure control valve bracket.

   Torque : 25 N·m (18 lb ft)
7. Connect each connector without fail.
8. Connect vacuum booster hose.
9. Connect accelerator pedal cable.

10. Install air cleaner duct assembly.



130RW001

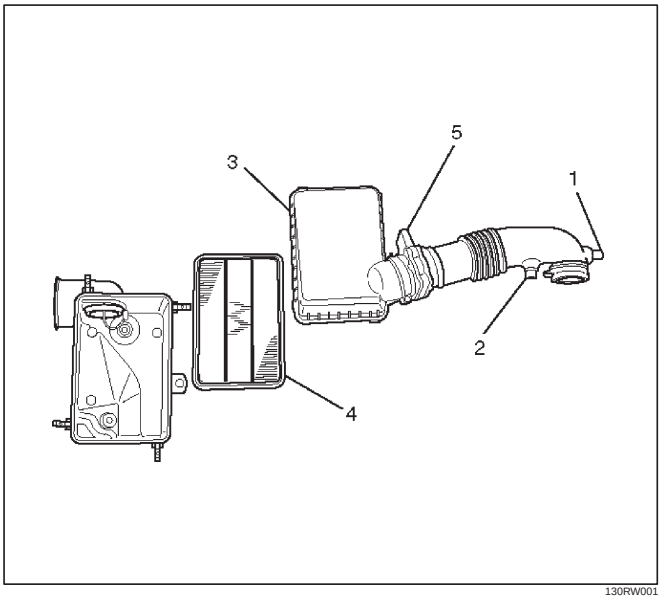
Legend

(1) Positive Crankcase Ventilation Hose Connector
(2) Intake Air Temperature Sensor
(3) Air Cleaner Duct Assembly
(4) Air Cleaner Element.
(5) Air Flow Sensor

Exhaust Manifold LH

Removal

1. Disconnect battery ground cable.
2. Remove air cleaner duct assembly.

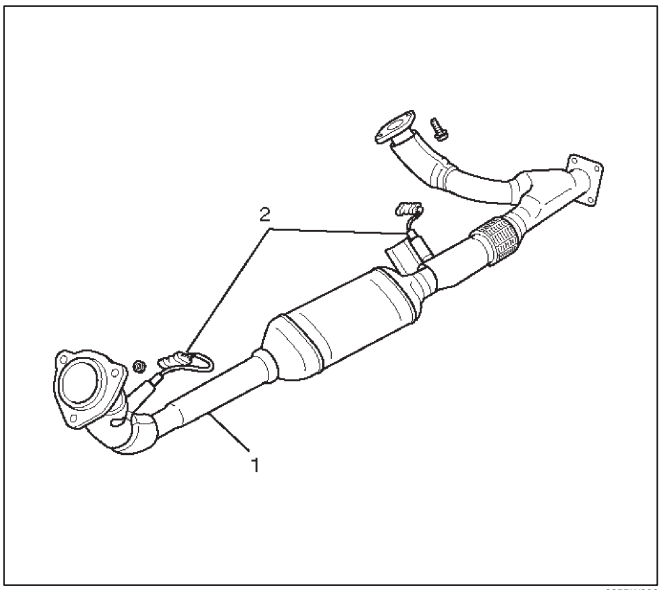


130RW001

Legend

(1) Positive Crankcase Ventilation Hose Connector
(2) Intake Air Temperature Sensor
(3) Air Cleaner Duct Assembly
(4) Air Cleaner Element
(5) Air Flow Sensor

3. Disconnect O_2 sensor connector.
4. Remove exhaust front pipe three stud nuts from exhaust side and two nuts from rear end of exhaust front pipe.



035RW006

Legend

(1) Exhaust Front Pipe LH
(2) O_2 Sensor

5. Remove heat protector two fixing bolts then the heat protector.
6. Remove a bolt on engine LH side for air conditioner (A/C) compressor bracket and loosen two bolts for A/C compressor then move A/C compressor to front side.
7. Remove exhaust manifold eight fixing nuts and remove exhaust manifold from the engine.

Installation

1. Install exhaust manifold and tighten exhaust manifold fixing nuts to the specified torque with new nuts.

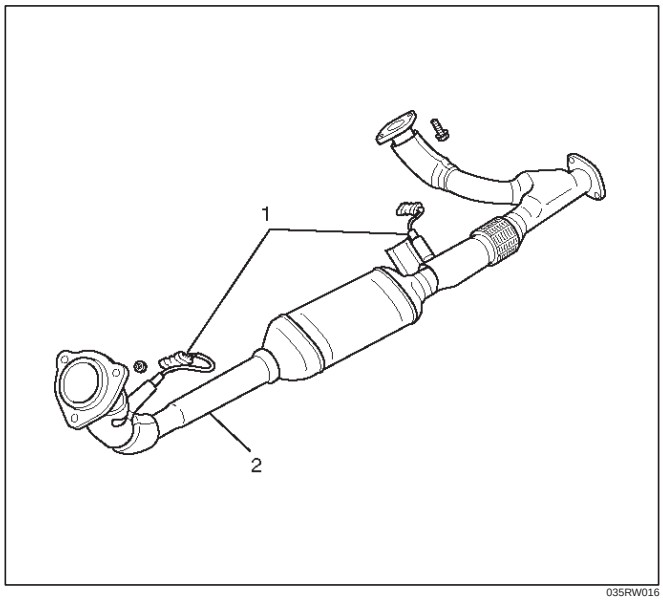
   Torque: 57 N·m (42 lb ft)

2. Install heat protector.
3. Install exhaust front pipe and tighten three stud nuts and two nuts to the specified torque.

   Torque :

   Stud nuts: 67 N·m (49 lb ft)

   Nuts: 43 N·m (32 lb ft)



035RW016

Legend

(1) O_2 Sensor
(2) Exhaust Front Pipe LH

4. Set A/C compressor to normal position and tighten two bolts and a bolt to the specified torque.

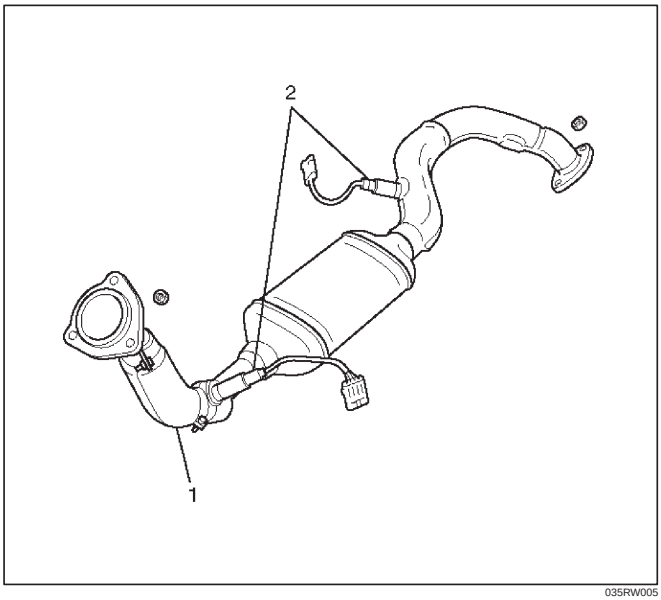
   Torque : 40 N·m (30 lb ft)

5. Reconnect O_2 sensor connector.
6. Install air cleaner duct assembly.

Exhaust Manifold RH

Removal

1. Disconnect battery ground cable.
2. Remove torsion bar. Refer to removal procedure in Front Suspension section.
3. Remove exhaust front pipe three stud nuts and two nuts then disconnect exhaust front pipe.

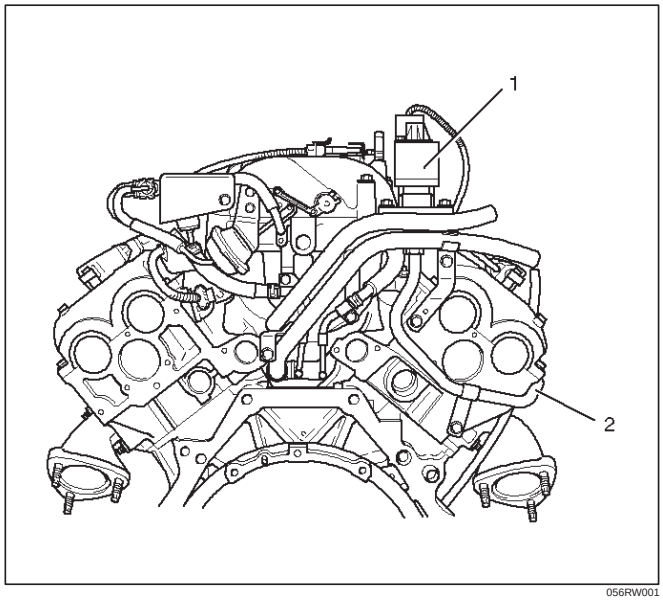


035RW005

Legend

(1) Exhaust Front Pipe RH
(2) O_2 Sensor

4. Remove heat protector two fixing bolts then the heat protector.
5. Remove exhaust gas recirculation (EGR) pipe fixing bolt and nut from exhaust manifold, remove a nut from EGR valve and a bolt from rear side of cylinder head for bracket of EGR pipe then remove the EGR pipe.



056RW001

Legend

(1) Exhaust Gas Recirculation (EGR) Valve
(2) EGR Pipe

6. Remove exhaust manifold eight fixing nuts then the exhaust manifold.

Installation

1. Install exhaust manifold and tighten bolts to the specified torque.

   Torque : 57 N·m (42 lb ft)

2. Install the EGR pipe, tighten bolt and nut on exhaust manifold to specified torque.

   Torque : 28 N·m (21 lb ft)

   Tighten nut to EGR valve to the specified torque.

   Torque : 44 N·m (33 lb ft)

   Tighten the bolt for EGR pipe bracket to specified torque.

   Torque : 25 N·m (18 lb ft)

3. Install heat protector
4. Install exhaust front pipe and tighten three stud nuts and two nuts to the specified torque.

   Torque:

   Stud nuts: 67 N·m (49 lb ft)

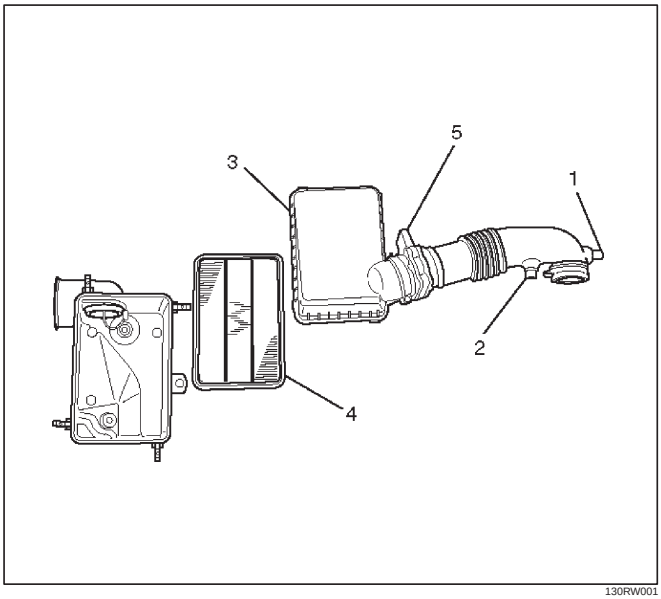
   Nuts: 43 N·m (32 lb ft)

5. Install the torsion bar and readjust the vehicle height. Refer to installation and vehicle height adjustment procedure for front suspension.

Crankshaft Pulley

Removal

1. Disconnect battery ground cable.
2. Remove air cleaner assembly.

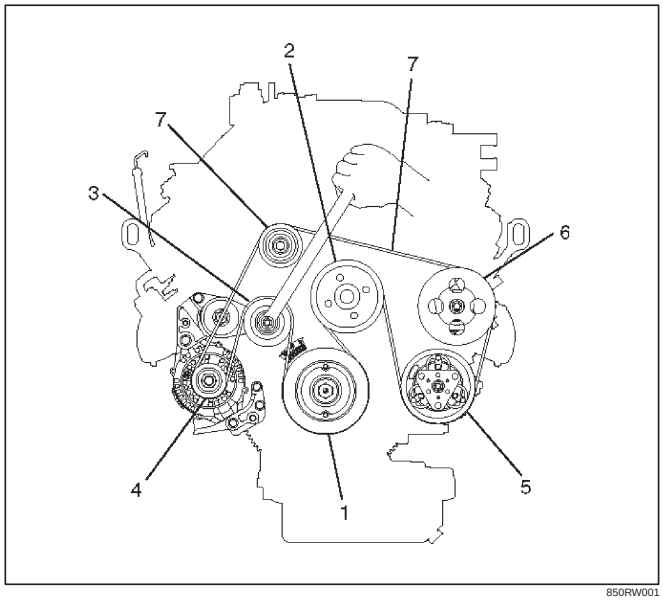


130RW001

Legend

(1) Positive Crankcase Ventilation Hose Connector
(2) Intake Air Temperature Sensor
(3) Air Cleaner Duct Assembly
(4) Air Cleaner Element
(5) Air Flow Sensor

3. Remove radiator upper fan shroud from radiator.
4. Move serpentine belt tensioner to loose side using wrench then remove serpentine belt.



850RW001

Legend

(1) Crankshaft Pulley
(2) Cooling Fan Pulley
(3) Tensioner
(4) Generator
(5) Air Conditioner Compressor
(6) Power Steering Oil Pump
(7) Serpentine Belt

5. Remove cooling fan assembly four fixing nuts, then the cooling fan assembly.
6. Remove crankshaft pulley assembly using J-8614-01 crankshaft holder, hold crankshaft pulley then remove center bolt and pulley.

Installation

1. Install crankshaft pulley using J-8614-01 crankshaft holder, hold the crankshaft pulley and tighten center bolt to the specified torque.

   Torque : 167 N·m (123 lb ft)

2. Install cooling fan assembly and tighten bolts/nuts to the specified torque.

   Torque : 22 N·m (16 lb ft) for fan pulley and fan bracket.

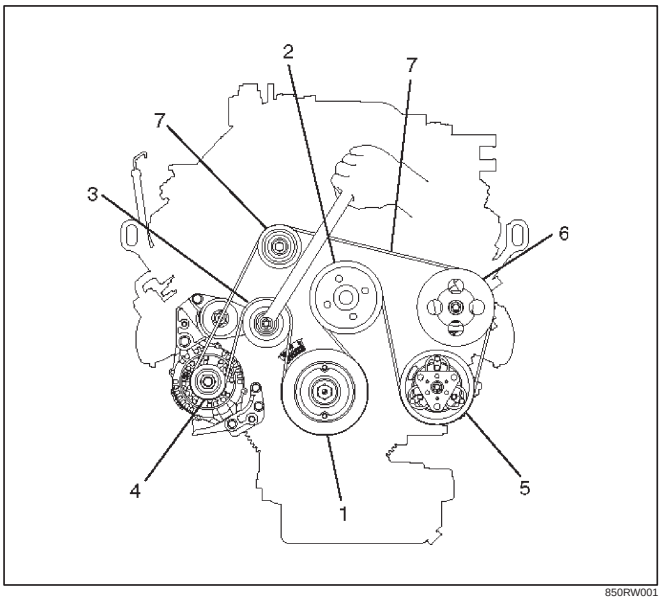
   Torque : 7.5 N·m (66.4 lb in) for fan and clutch assembly.

3. Move serpentine belt tensioner to loose side using wrench, then install serpentine belt to normal position.
4. Install radiator upper fan shroud.
5. Install air cleaner assembly.

Timing Belt

Removal

1. Disconnect battery ground cable.
2. Remove air cleaner assembly.
3. Remove radiator upper fan shroud from radiator.
4. Move drive belt tensioner to loose side using wrench then remove drive belt.



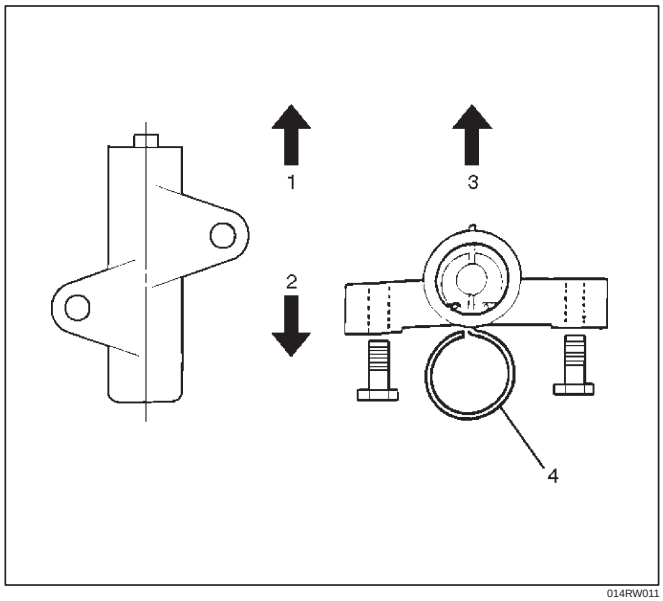
850RW001

Legend

(1) Crankshaft Pulley
(2) Cooling Fan Pulley
(3) Tensioner
(4) Generator
(5) Air Conditioner Compressor
(6) Power Steering Oil Pump
(7) Drive Belt

5. Remove cooling fan assembly four nuts, then the cooling fan assembly.
6. Remove cooling fan drive pulley assembly.
7. Remove idle pulley assembly.
8. Remove serpentine belt tensioner assembly.
9. Remove power steering pump assembly.
10. Remove crankshaft pulley assembly using J-8614-01 crankshaft holder, hold crankshaft pulley remove center bolt, then the pulley.
11. Remove right side timing belt cover then left side timing belt cover.
12. Remove lower timing belt cover
13. Remove pusher.

CAUTION: The pusher prevents air from entering the oil chamber. Its rod must always be facing upward.



014RW011

Legend

(1) Up Side
(2) Down Side
(3) Direction For Installation
(4) Locking Pin

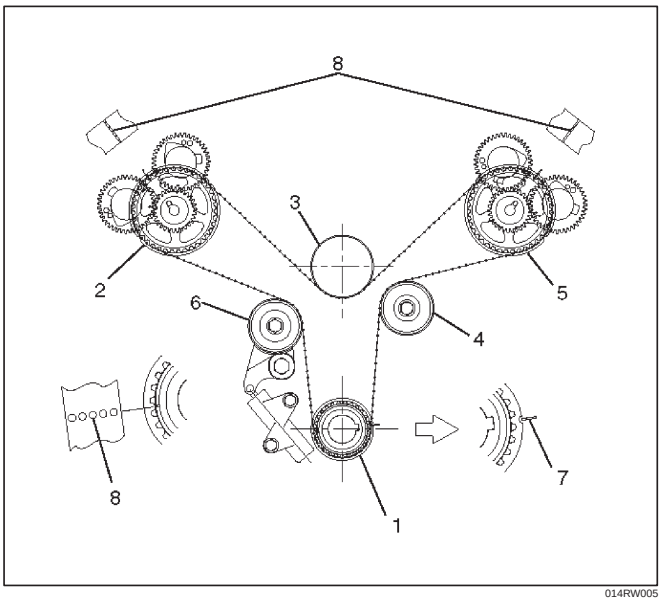
14. Remove timing belt.

CAUTION:

1. **Do not bend or twist the belt, otherwise its core could be damaged. The belt should not be bent at a radius less than 30 mm.**
2. **Do not allow oil or other chemical substances to come in contact with the belt. They will shorten the life.**
3. **Do not attempt to pry or stretch the belt with a screw driver or any other tool during installation.**
4. **Store timing belt in a cool and dark place. Never expose the belt direct sunlight or heat.**

Installation

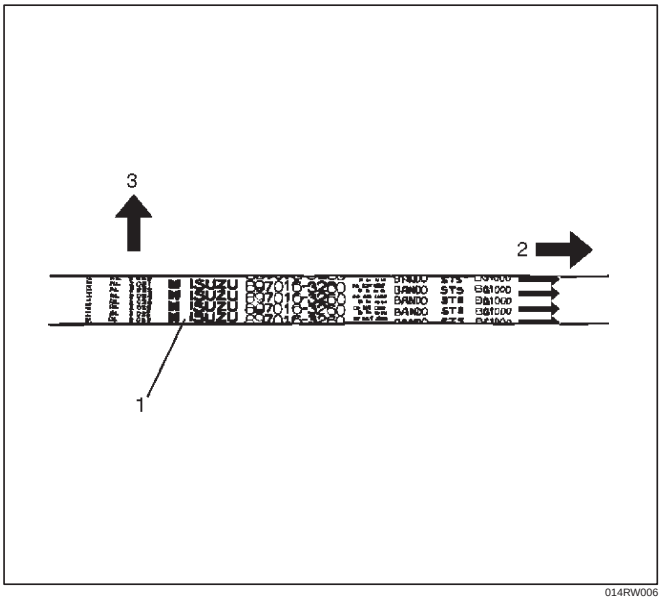
NOTE: For correct belt installation, the letter on the belt must be able to be read as viewed from the front of the vehicle.



014RW005

Legend

(1) Crankshaft Timing Pulley
(2) RH Bank Camshaft Drive Gear Pulley
(3) Water Pump Pulley
(4) Idle Pulley
(5) LH Bank Camshaft Drive Gear Pulley
(6) Tension Pulley
(7) Alignment Mark on Oil Pump.
(8) Alignment Mark on Timing Belt



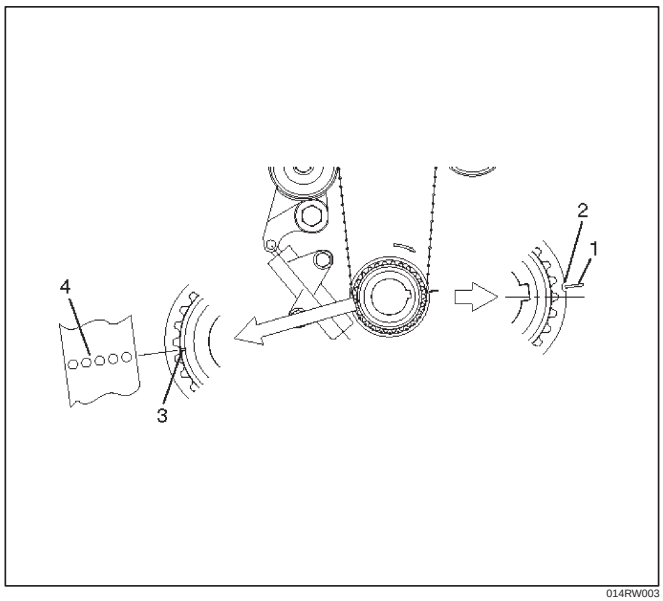
014RW006

Legend

(1) Timing Belt
(2) Engine Rotation Direction
(3) Cylinder Head Side

1. Install timing belt.
   1. Align groove of crankshaft timing pulley with mark on oil pump.
      Align the mark on the crankshaft timing pulley with alignment mark (white dots line) on the timing belt.
      Secure the belt with a double clip.

NOTE: When timing marks are aligned, No.2 piston will be on Top Dead Center.

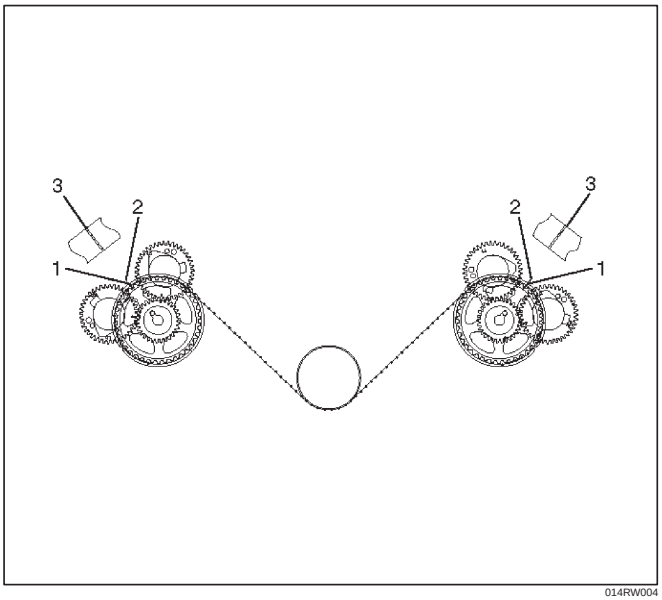


014RW003

Legend

(1) Alignment Mark on Oil Pump
(2) Groove on Crankshaft Timing Pulley
(3) Alignment Mark on Crankshaft Timing Pulley
(4) Alignment Mark on Timing Belt

2. Align the marks on the camshaft drive gear pulleys with the corresponding alignment marks on the cylinder head covers.



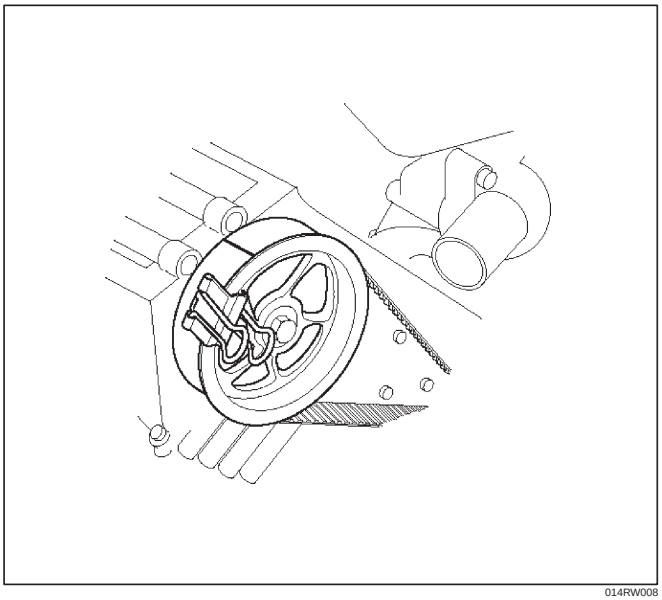
014RW004

Legend

(1) Alignment Mark on Camshaft Drive Gear Pulley
(2) Alignment Mark on Cylinder Head Cover.
(3) Alignment Mark on Timing Belt (White Line)

3. Align the alignment mark (white line) on the timing belt with alignment mark on the RH bank camshaft drive gear pulley (on the left side as viewed from the front of the vehicle).

   Secure the belt with a double clip.

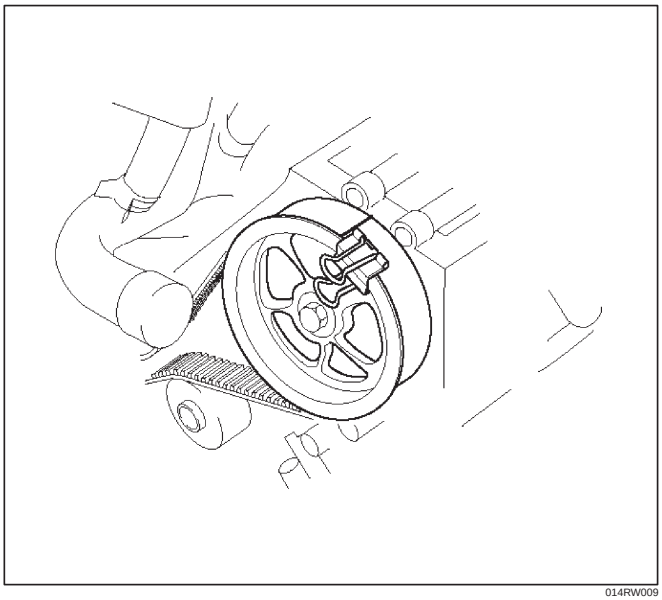


014RW008

4. Align the alignment mark (white line) on the timing belt with the alignment mark on the LH bank camshaft drive gear pulley.

   When aligning the timing marks, use a wrench to turn the camshaft drive gear pulley, then set the timing mark between timing belt and camshaft drive gear pulley.
   Secure the belt with a double clip.

NOTE: It is recommended for easy installation that the belt be secured with a double clip after it is installed to each pulley.



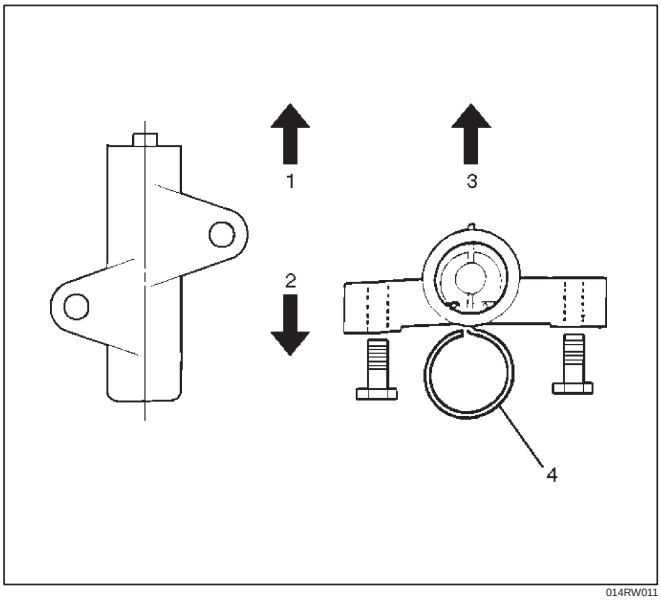
014RW009

5. Install crankshaft pulley temporarily and tighten center bolt by hand (do not use a wrench).

   Turn the crankshaft pulley clockwise to give some belt slack between the crankshaft timing pulley and the RH bank camshaft drive gear pulley.

2. Install pusher and tighten bolt to the specified torque.
   1. Install the pusher while pushing the tension pulley to the belt.
   2. Pull out pin from the pusher.

NOTE: When reusing the pusher, press the pusher with approximately 100Kg to retract the rod, and insert a pin (1.4 mm piano wire).



014RW011

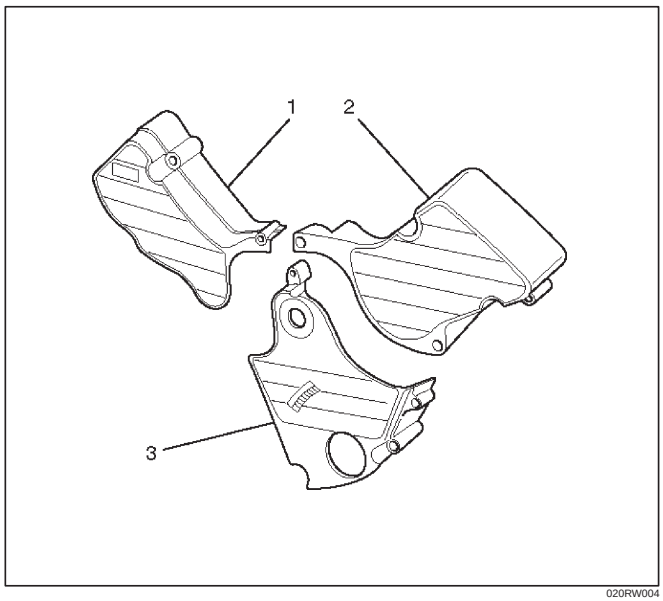
Legend
(1) Up Side
(2) Down Side
(3) Direction for Installation
(4) Locking Pin

3. Remove double clips from timing belt pulleys.
   Turn the crankshaft pulley clockwise by two turns.

Torque : 25 N·m (18 lb ft)

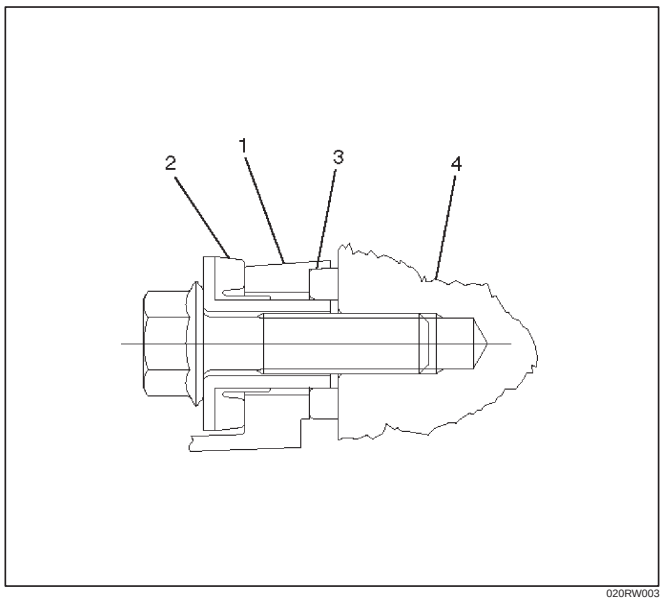
3. Install timing belt cover.
   Remove crankshaft pulley that was installed in step 1 item 5.
   Tighten bolts to the specified torque.

Torque: 19 N·m (14 lb ft)



020RW004

Legend
(1) Timing Belt Cover RH
(2) Timing Belt Cover LH
(3) Timing Belt Cover Lower



020RW003

Legend
(1) Timing Belt Cover
(2) Rubber Bushing
(3) Sealing Rubber
(4) Cylinder Body

4. Install crankshaft pulley using J-8614-01, hold the crankshaft pulley and tighten center bolt to the specified torque.

Torque : 167 N·m (123 lb ft)

5. Install fan pulley bracket and tighten fixing bolts to the specified torque.

   Torque : 22 N·m (16 lb ft)

6. Install power steering pump assembly and tighten to the specified torque.

   Torque :

   M8 bolt : 22 N·m (16 lb ft)

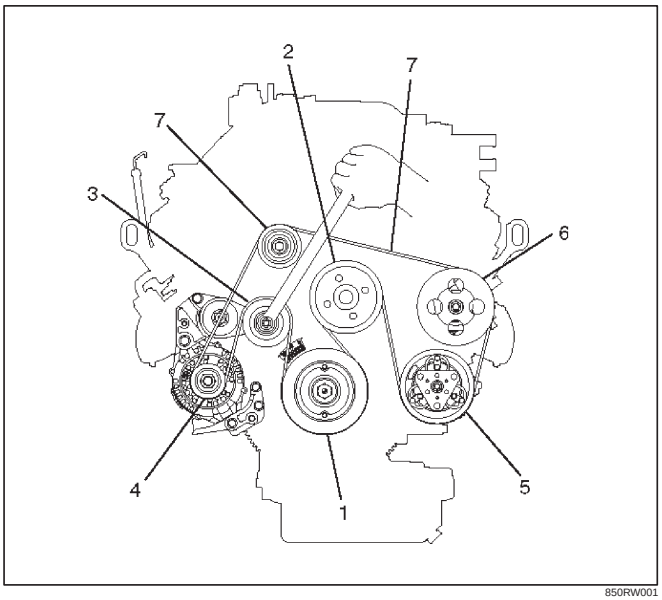
   M10 bolt : 46 N·m (34 lb ft)

7. Install cooling fan assembly and tighten bolts/nuts to the specified torque.

   Torque : 22 N·m (16 lb ft) for fan pulley and fan bracket.

   Torque : 7.5 N·m (66.4 lb in) for fan and clutch assembly.

8. Move drive belt tensioner to loose side using wrench, then install drive belt to normal position.



850RW001

Legend

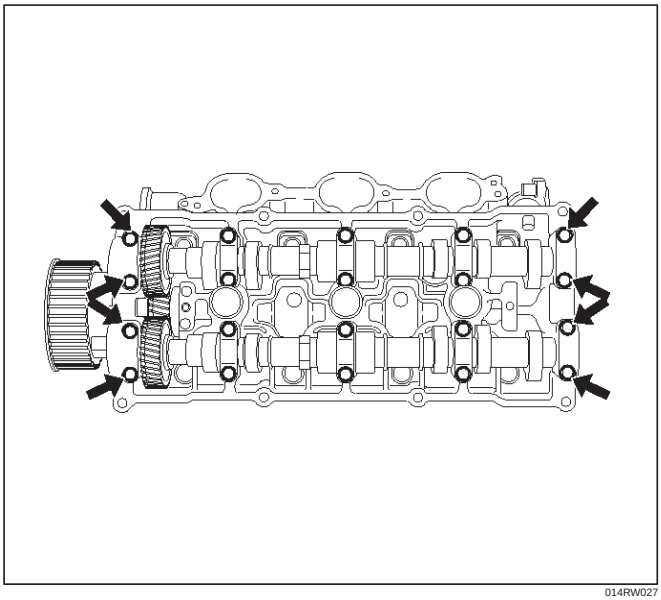
(1) Crankshaft Pulley
(2) Cooling Fan Pulley
(3) Tensioner
(4) Generator
(5) Air Conditioner Compressor
(6) Power Steering Oil Pump
(7) Drive Belt

9. Install radiator upper fan shroud.
10. Install air cleaner assembly.

Camshaft

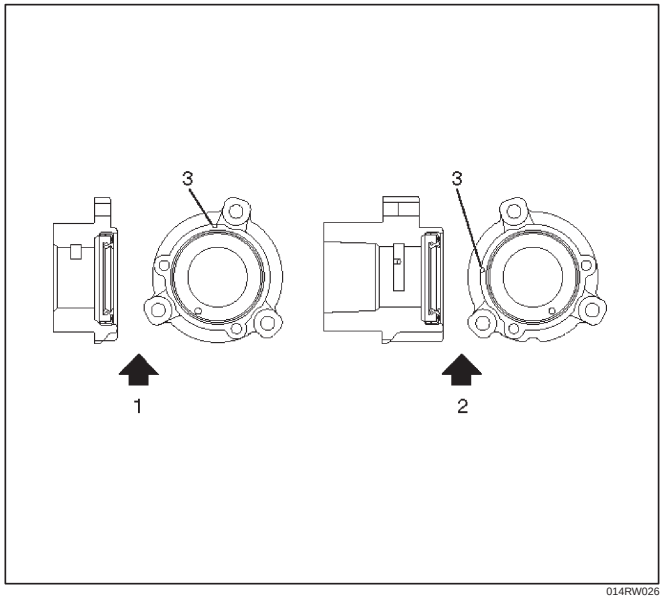
Removal

1. Disconnect battery ground cable.
2. Remove crankshaft pulley.
   - Refer to removal procedure for Crankshaft Pulley in this manual.
3. Remove timing belt.
   - Refer to removal procedure for Timing Belt in this manual.
4. Remove cylinder head cover LH.
   - Refer to removal procedure for Cylinder Head Cover LH in this manual.
5. Remove cylinder head cover RH.
   - Refer to removal procedure for Cylinder Head Cover RH in this manual.
6. Remove twenty fixing bolts from inlet and exhaust camshaft bracket on one side bank, then camshaft brackets.



014RW027

7. Remove camshaft assembly.
8. Remove fixing bolt for camshaft drive gear pulley.
9. Remove three fixing bolts from camshaft drive gear retainer, then camshaft drive gear assembly.



014RW026

Legend

(1) Right Bank
(2) Left Bank
(3) Timing Mark on Retainer

Installation

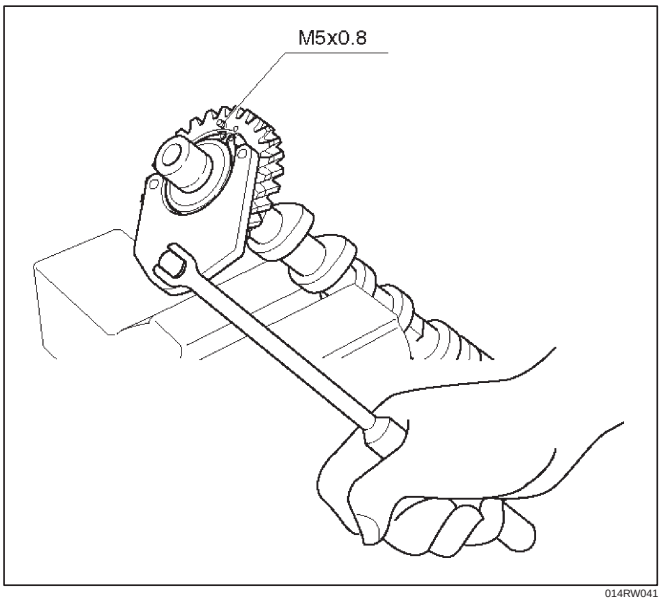
1. Install camshaft drive gear assembly and tighten three bolts to the specified torque.

   Torque : 10 N·m (89 lb in)

2. Tighten bolt for camshaft drive gear assembly pulley to the specified torque.

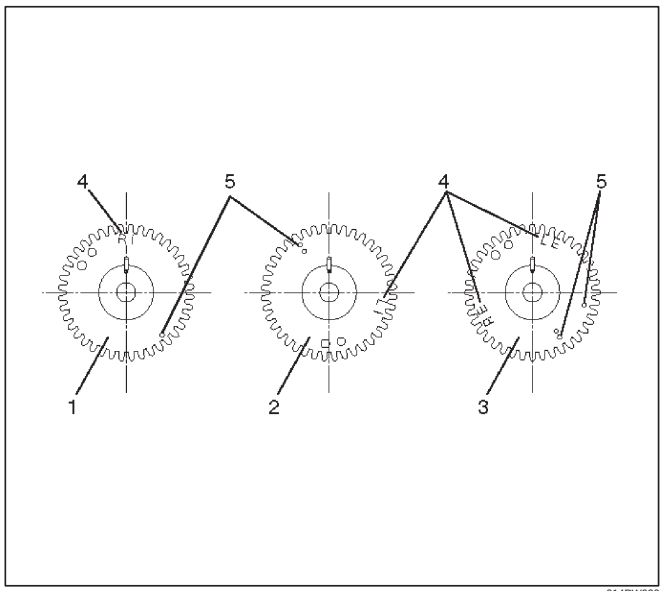
   Torque : 98 N·m (72 lb ft)

3. Tighten sub gear setting bolt.
   1. Use J-42686 to turn sub gear to right direction until it aligns with the M5 bolt hole between camshaft driven gear and sub gear.
   2. Tighten the M5 bolt to a suitable torque to prevent the sub gear from moving.



014RW041

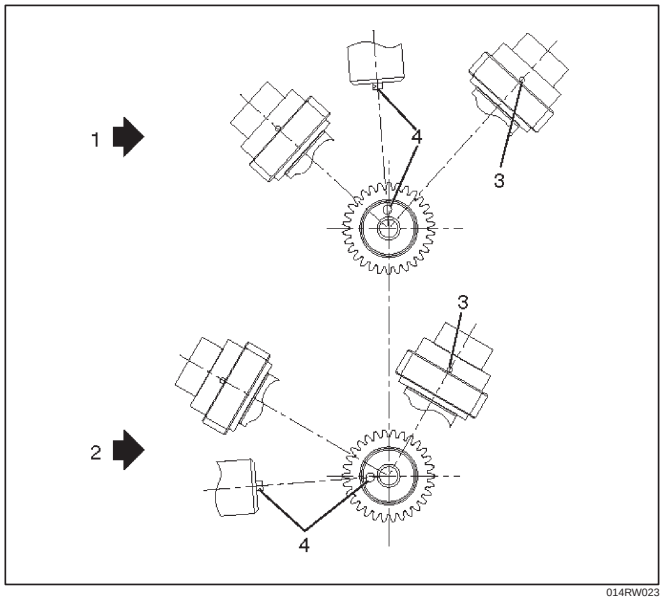
4. Install camshaft assembly and camshaft brackets, tighten twenty bolts on one side bank to the specified torque.
   1. Apply engine oil to camshaft journal and bearing surface of camshaft bracket.
   2. Align timing mark on intake camshaft (one dot for right bank, two dot for left bank) and exhaust camshaft (one dot for right bank, two dots for left bank) to timing mark on camshaft drive gear (one dot).



014RW020

Legend

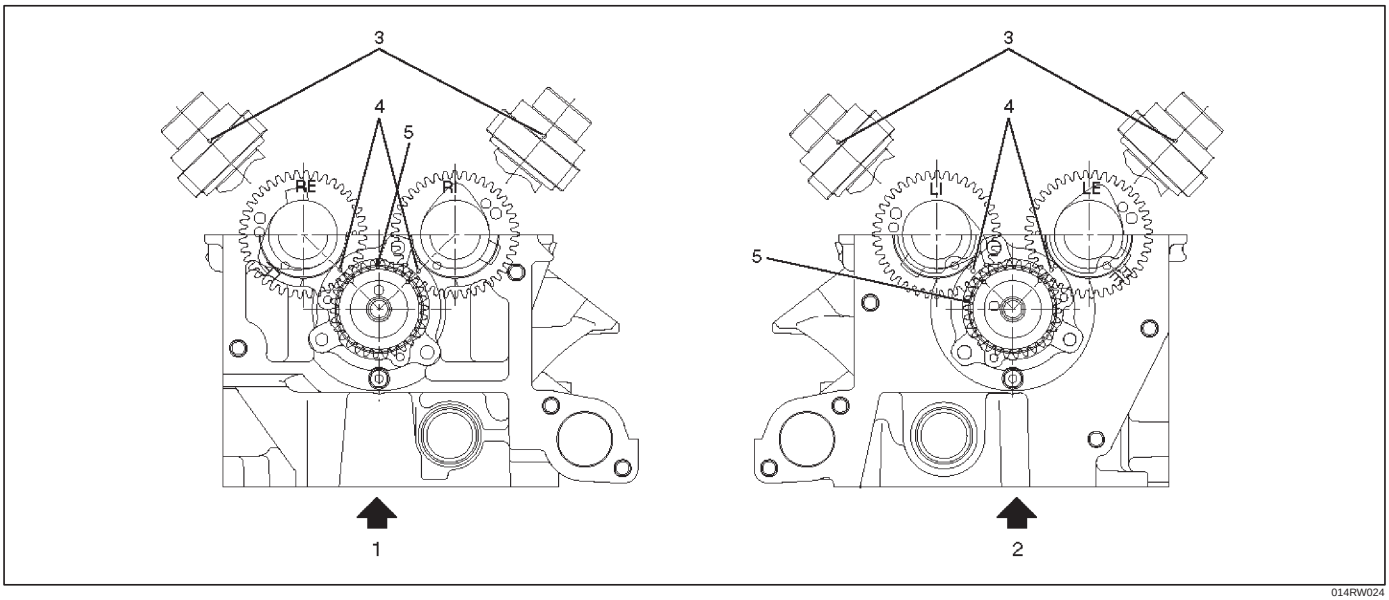
(1) Intake Camshaft Timing Gear for Right Bank
(2) Intake Camshaft Timing Gear for Left Bank
(3) Exhaust Camshaft Timing Gear
(4) Discrimination Mark
(LI: Left bank intake, RI: Right bank intake)
(LE: Left bank exhaust, RE: Right bank exhaust)



014RW023

Legend

(1) Right Bank Camshaft Drive Gear
(2) Left Bank Camshaft Drive Gear
(3) Timing Mark on Drive Gear
(4) Dowel Pin



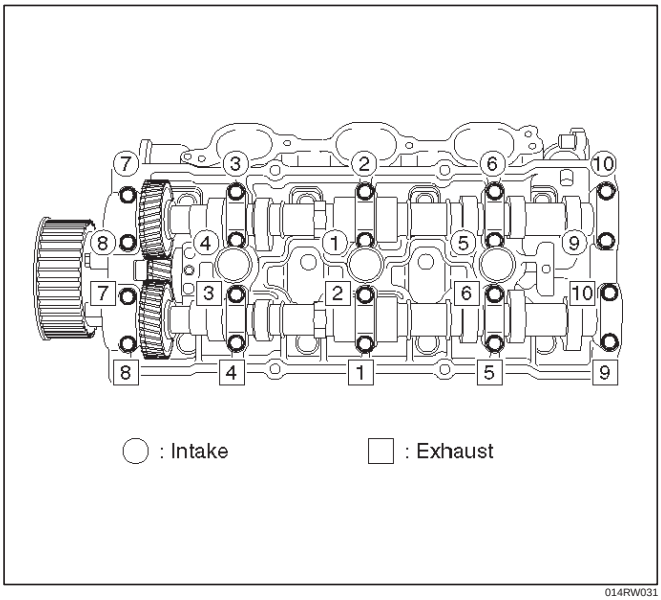
014RW024

Legend

(1) Right Bank
(2) Left Bank
(3) Alignment Mark on Camshaft Drive Gear
(4) Alignment Mark on Camshaft
(5) Alignment Mark on Retainer

3. Tighten twenty bolts on numerical order an one side bank as shown in the illustration.

Torque : 10 N·m (89 lb in)



014RW031

5. Install cylinder head cover RH.
   - Refer to installation procedure for CYLINDER HEAD COVER RH in this manual.
6. Install cylinder head cover LH.
   - Refer to installation procedure for CYLINDER HEAD COVER LH in this manual.
7. Install timing belt.
   - Refer to installation procedure for TIMING BELT in this manual.
8. Install crankshaft pulley.
   - Refer to installation procedure for CRANKSHAFT PULLEY in this manual.
9. Install Accelerator pedal cable.

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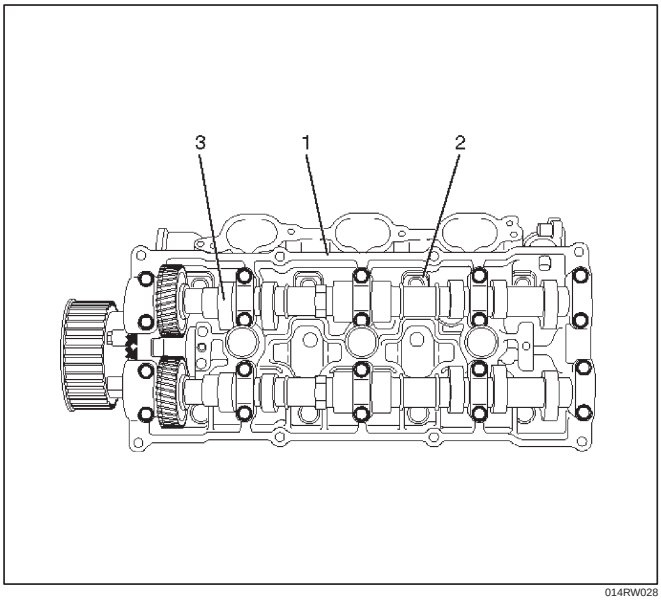
Cylinder Head

Removal

1. Remove engine hood.
2. Disconnect battery ground cable.
3. Drain radiator coolant.
4. Drain engine oil.
5. Remove crankshaft pulley.
   - Refer to removal procedure for Crankshaft Pulley in this manual.
6. Remove timing belt.
   - Refer to removal procedure for Timing Belt in this manual.
7. Remove cylinder head cover LH.
   - Refer to removal procedure for Cylinder Head Cover LH in this manual.
8. Remove cylinder head cover RH.
   - Refer to removal procedure for Cylinder Head Cover RH in this manual.
9. Remove common chamber.
   - Refer to removal procedure for Common Chamber in this manual.
10. Remove cylinder head assembly.
    1. Loosen eights bolts for tight cylinder head.
    2. Remove cylinder head assembly.



014RW028

Legend

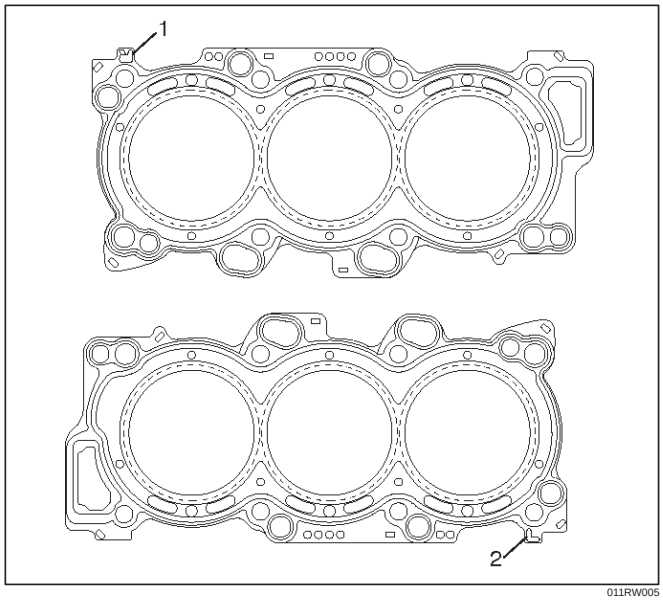
(1) Cylinder Head
(2) Cylinder Head Bolt
(3) Camshaft

Installation

1. Install cylinder head assembly to cylinder block.
   1. Put cylinder head gasket on the cylinder block.

NOTE: There is discrimination mark “R” for right bank and “L” for left bank on the cylinder head gasket as shown in the illustration.

Do not reuse cylinder head gasket.



011RW005

   2. Align dowel pin hole to dowel pin on the cylinder block.
   3. Tighten two bolts temporarily by hand to prevent the cylinder head assembly from moving.
   4. Using J-24239-01 cylinder head bolt wrench, tighten bolts in numerical order as shown in the illustration to the specified torque.

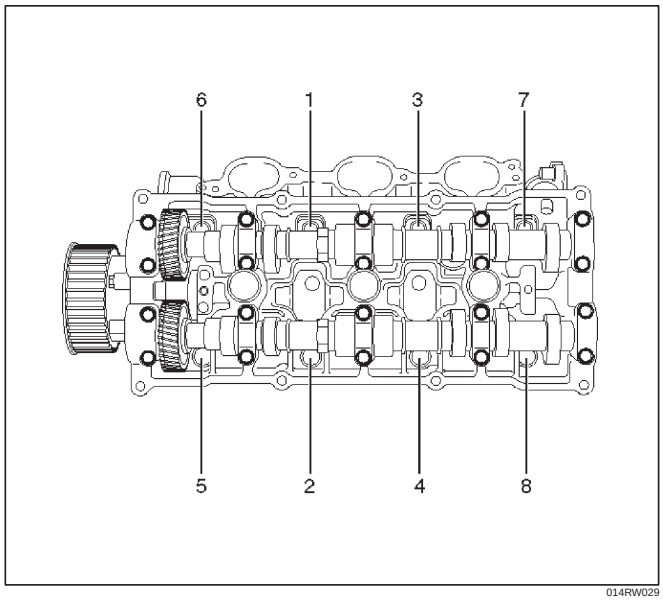
NOTE: Do not reuse cylinder head bolts.

Do not apply any lubricant to the cylinder head bolts.

Torque :

Temporary : 29 N·m (21 lb ft)

Final : 64 N·m (47 lb ft)



014RW029

2. Install common chamber.
   - Refer to installation procedure for Common Chamber in this manual.
3. Install cylinder head cover RH.
   - Refer to installation procedure for Cylinder Head Cover RH in this manual.
4. Install cylinder head cover LH.
   - Refer to installation procedure for Cylinder Head Cover LH in this manual.
5. Install timing belt.
   - Refer to installation procedure for Timing Belt in this manual.
6. Install crankshaft pulley.
   - Refer to installation procedure for Crankshaft Pulley in this manual.
7. Install Accelerator pedal cable.

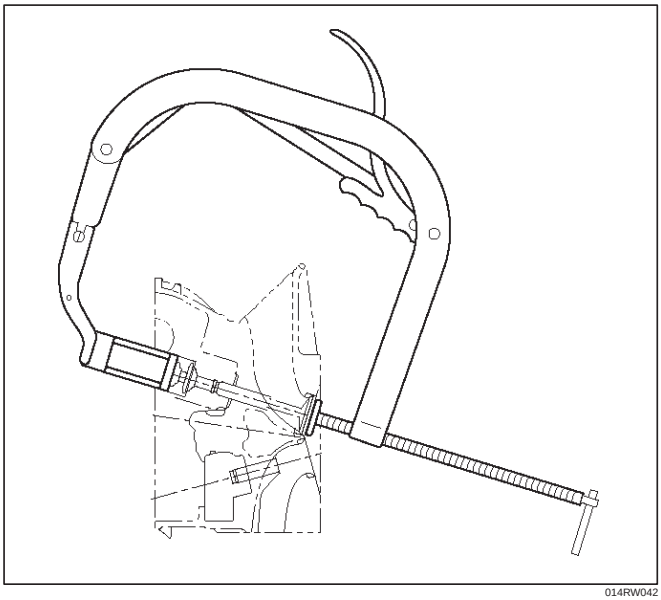
Valve Stem Oil Controller , Valve Spring and Valve Guide

Removal

1. Disconnect battery ground cable.
2. Drain engine oil.
   - Drain engine coolant.
3. Remove cylinder head assembly.
   - Refer to removal procedure for Cylinder Head in this manual.
4. Remove camshaft.
   - Refer to removal procedure for Camshaft in this manual.
5. Remove tappets with shim.

NOTE: Do not damage shim surface.

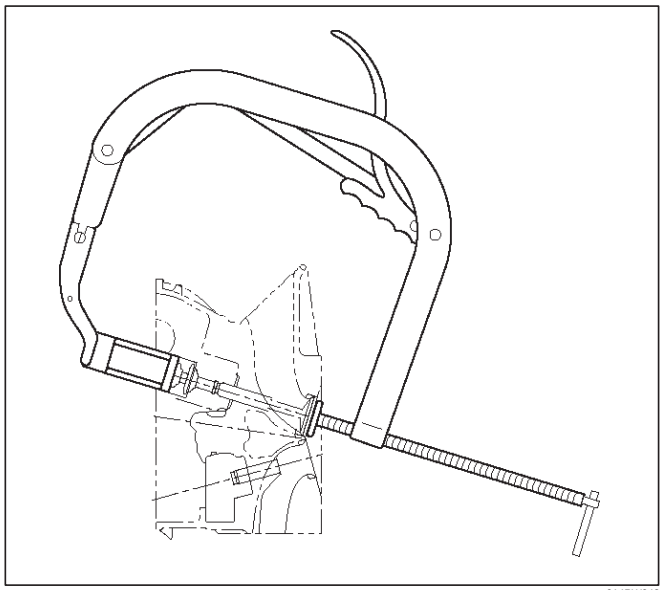
6. Remove valve springs using J-8062 valve spring compressor and J-42898 valve spring compressor adapter then remove upper valve spring seat and lower seat.



7. Remove oil controller using J-37281 oil controller remover, remove each valve stem oil controller.
8. Remove valve guide using J-37985 valve guide replacer.

Installation

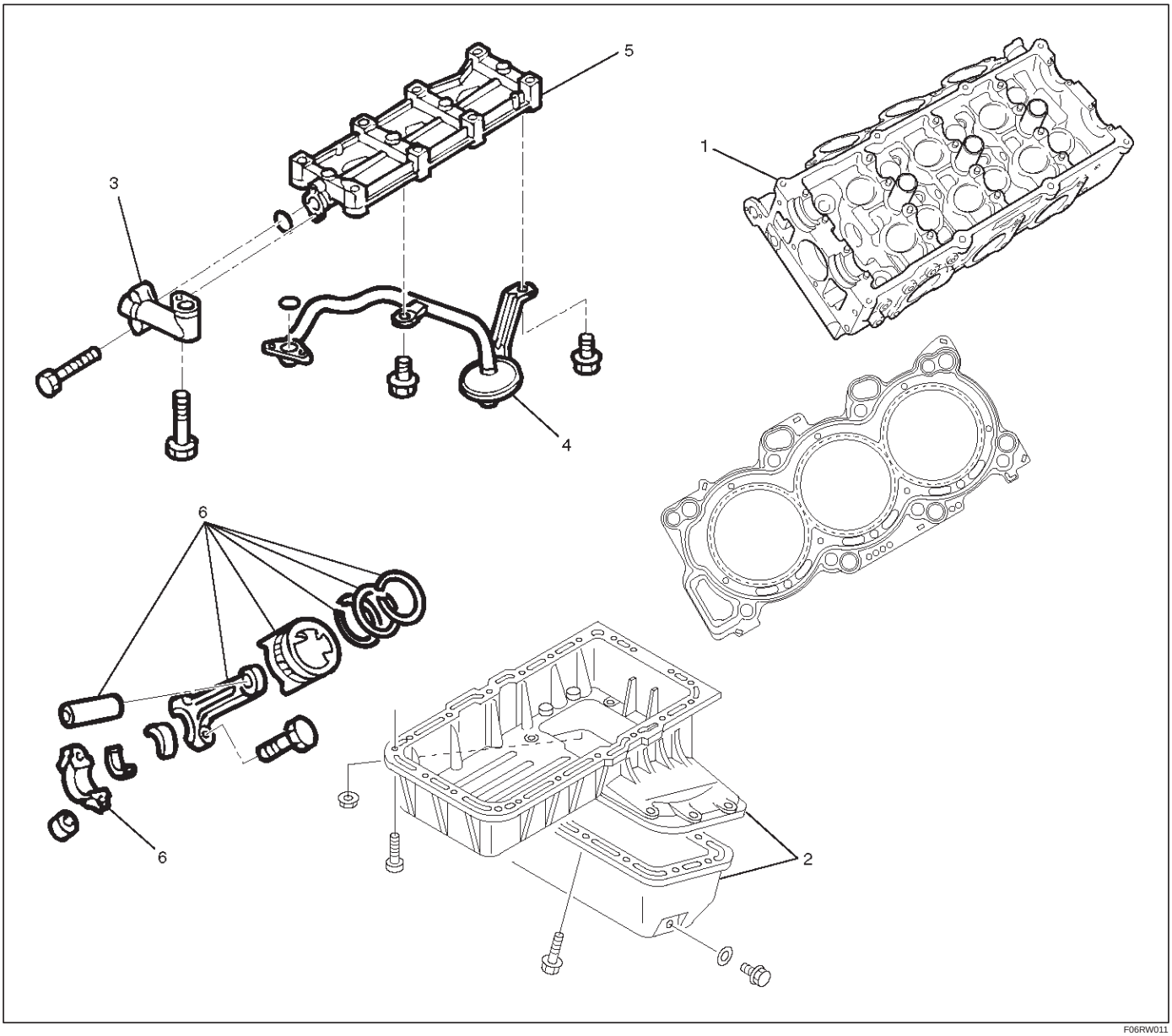
1. Install valve guide using J-42899 valve guide installer.
2. Install oil controller using J-38537 oil controller installer.
3. Install lower valve spring seat, valve spring and upper valve spring seat then put split collars on the upper spring seat, using J-8062 valve spring compressor and J-42898 valve spring compressor adapter to install the split collars.



4. Install tappet with shim.
5. Install camshaft assembly.
   - Refer to installation procedure for Camshaft in this manual.
6. Install cylinder head assembly.
   - Refer to installation procedure for Cylinder Head in this manual.
7. Fill engine oil until full level.
8. Fill engine coolant.

Piston, Piston Ring and Connecting Rod

Removal



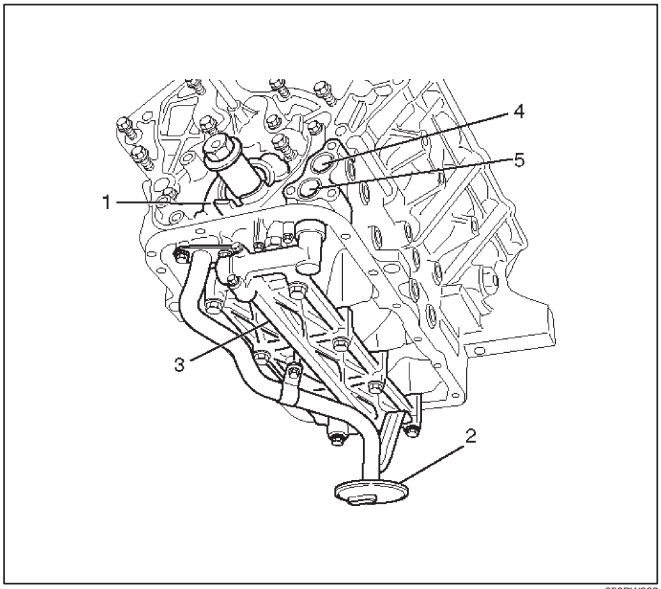
F06RW011

Legend

(1) Cylinder Head
(2) Crankcase with Oil Pan
(3) Oil Pipe
(4) Oil Strainer
(5) Oil Gallery
(6) Piston with Connecting Rod Assembly

1. Remove cylinder head assembly.
   - Refer to removal procedure for Cylinder Head in this manual.
2. Remove crankcase with oil pan.
   - Refer to removal procedure for Oil Pan and Crankcase in this manual.

3. Remove oil strainer fixing bolts, remove oil strainer assembly with O-ring.



050RW002

Legend

(1) Oil Pump
(2) Oil Strainer
(3) Oil Gallery
(4) From Oil Filter
(5) To Oil Filter

4. Remove three fixing bolts, oil pipe with O-ring.
5. Remove eight fixing bolts, oil gallery.
6. Remove piston with connecting rod assembly, before removing the bearing cap, remove carbon on the top of cylinder bore and push piston with connecting rod out from the top of cylinder bore.

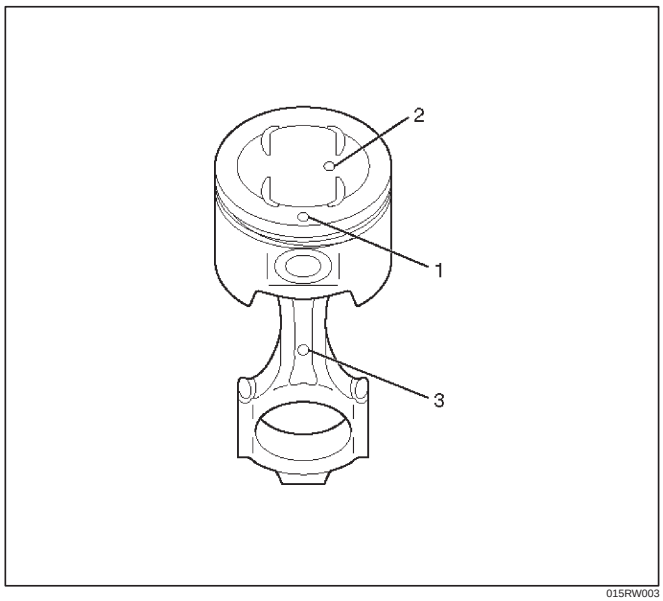
Installation

1. Install piston with connecting rod assembly.
   - Apply engine oil to cylinder bore, connecting rod bearing and crank pin.
     When installing the piston, its front mark must face the engine front side.
   - The bearing cap number must be the same as connecting rod number.
   - Apply engine oil to the thread and seating surface of each nut.
   - Tighten nuts to the specified torque.

   Torque : 54 N·m (40 lb ft)

   - After tightening the nuts, make sure that the crankshaft rotates smoothly.

NOTE: Do not apply engine oil to the bearing back faces and connecting rod bearing fitting surfaces.



015RW003

Legend

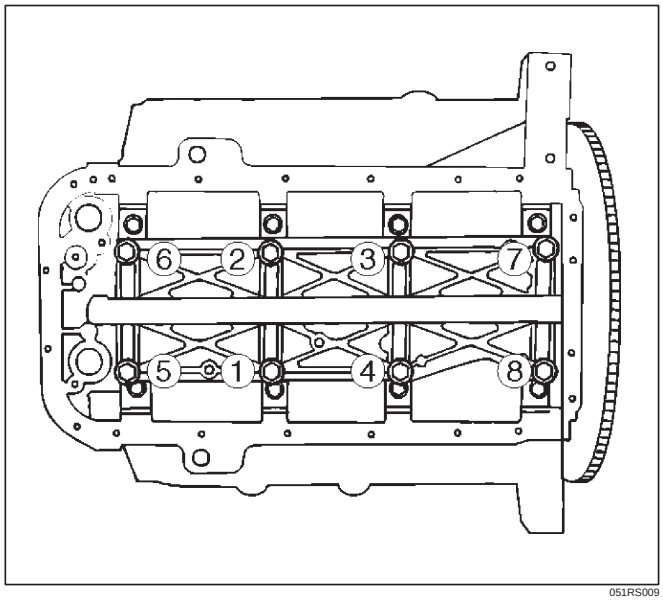
(1) Piston Front Mark
(2) Piston Grade
(3) Connecting Rod Front Mark

2. Install oil gallery and tighten the bolts in two steps, in the order shown in illustration.

   Torque :

   1st step : 29 N·m (21 lb ft)

   2nd step : 55˚–65˚



051RS009

3. Install oil pipe with O-ring.

   Torque : 10 N·m (89 lb in)

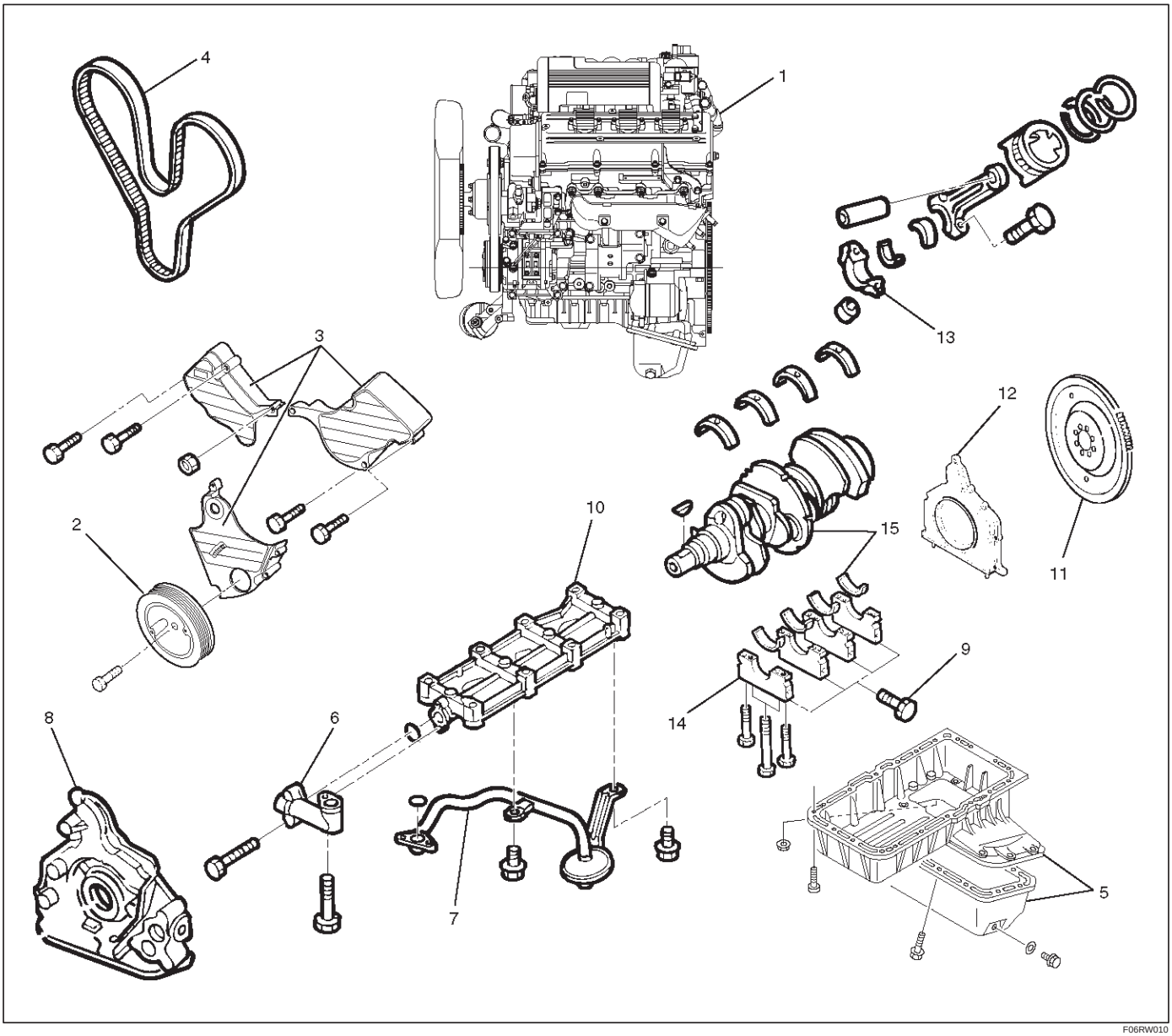
4. Install oil strainer assembly with O-ring.

   Torque : 25 N·m (18 lb ft)

5. Install crankcase with oil pan.
   - Refer to installation procedure for Oil Pan and Crankcase in this manual.
6. Install cylinder head assembly.
   - Refer to installation procedure for Cylinder Head in this manual.

Crankshaft and Main Bearings

Removal



F06RW010

Legend

(1) Engine Assembly
(2) Crankshaft Pulley
(3) Timing Belt Cover
(4) Timing Belt
(5) Crankcase with Oil Pan
(6) Oil Pipe
(7) Oil Strainer
(8) Oil Pump Assembly
(9) Cylinder Body Side Bolt
(10) Oil Gallery
(11) Flywheel
(12) Rear Oil Seal Retainer
(13) Connecting Rod Cap
(14) Crankshaft Main Bearing Cap
(15) Crankshaft and Main Bearing

1. Remove engine assembly.
   - Refer to removal procedure for Engine Assembly in this manual.
2. Remove timing belt.
   - Refer to removal procedure for Timing Belt in this manual.
3. Remove oil pan and crankcase.
   - Refer to removal procedure for Oil Pan and Crankcase in this manual.
4. Remove oil pipe with O-ring.
5. Remove oil strainer assembly with O-ring.

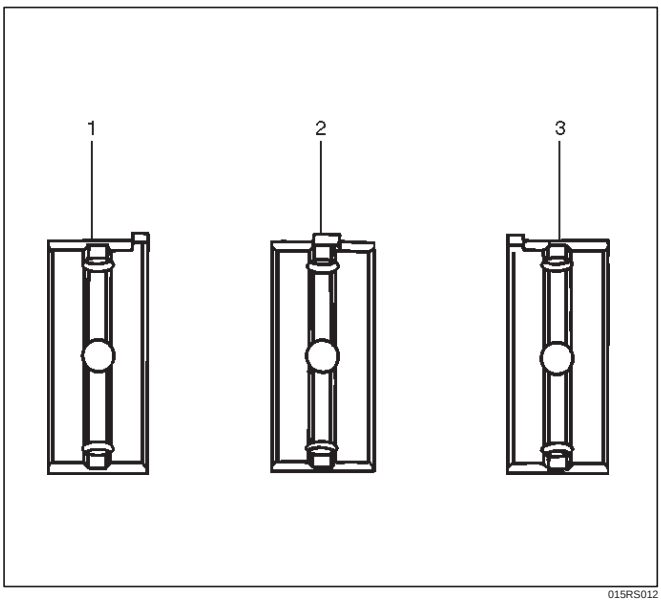
6. Remove oil pump assembly.
   - Refer to removal procedure for Oil Pump in this manual.
7. Remove cylinder body side bolts.
8. Remove oil gallery.
9. Remove flywheel.
10. Remove rear oil seal retainer.
    - Refer to removal procedure for Rear Oil Seal in this manual.
11. Remove connecting rod caps.
12. Remove crankshaft main bearing caps.
13. Remove crankshaft and main bearings.

Installation

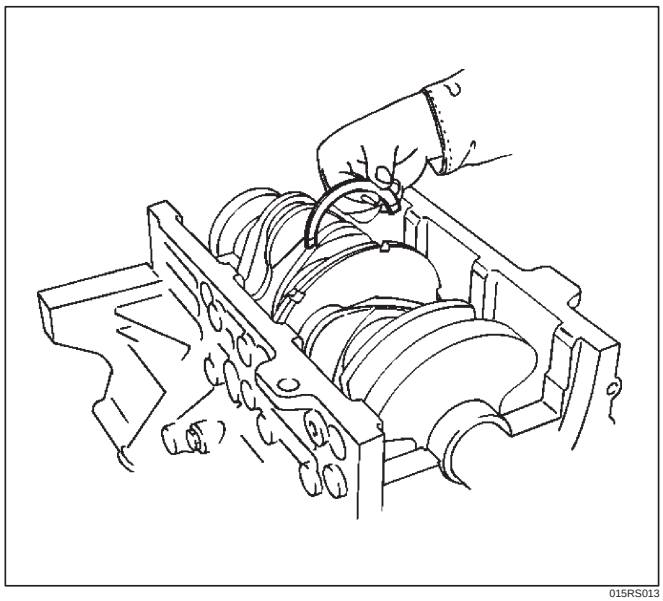
1. Install crankshaft and main bearings.
   - Install main bearing in the cylinder block and main bearing cap respectively.
     Apply new engine oil to upper and lower main bearings.

NOTE:

- Do not apply engine oil to the bearing back faces.
- Make sure that main bearings are in correct position.
- Install crankshaft with care.
- Apply engine oil to the thrust washer.
- Install thrust washer on No.3 journal.
- Oil grooves in thrust washer must face the crankshaft.



015RS012


015RS013

2. Install crankshaft main bearing caps.
   - Apply engine oil to the thread and seating surface of each bearing cap fixing bolt.

NOTE:

- Do not apply engine oil to the bearing back faces.
- Install bearing caps in the order of numbers, starting with cylinder block front side.
- Tighten main bearing fixing bolts to the specified torque.

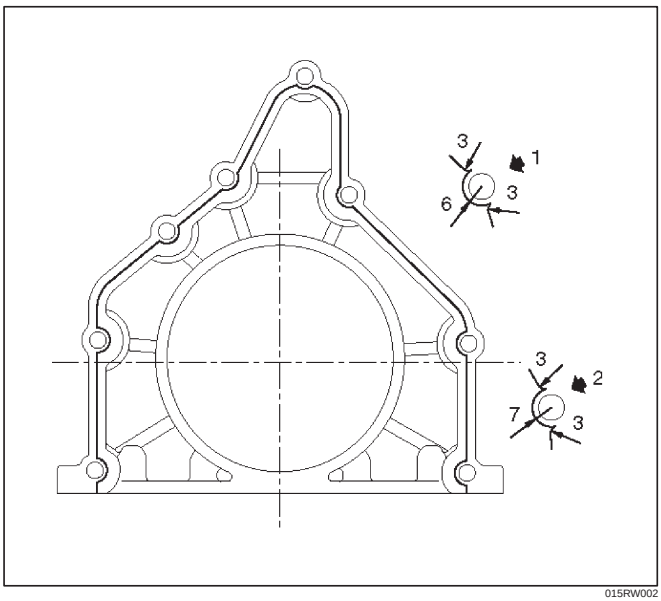
  Torque : 39 N·m (29 lb ft)

- After tightening the bolts, make sure that the crankshaft rotates smoothly.

3. Install connecting rod caps.
   - The cap number must be same as connecting rod number.
   - Apply engine oil to the thread and seating surface of each nut.
   - Tighten nuts to the specified torque.

   Torque : 54 N·m (40 lb ft)

   - After tightening the nuts, make sure that the crankshaft rotates smoothly.
4. Install rear oil seal retainer.
   - Remove oil on cylinder block and retainer fitting surface.
   - Apply sealant (TB1207B or equivalent) to retainer fitting surface as shown in illustration.
   - The oil seal retainer must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.

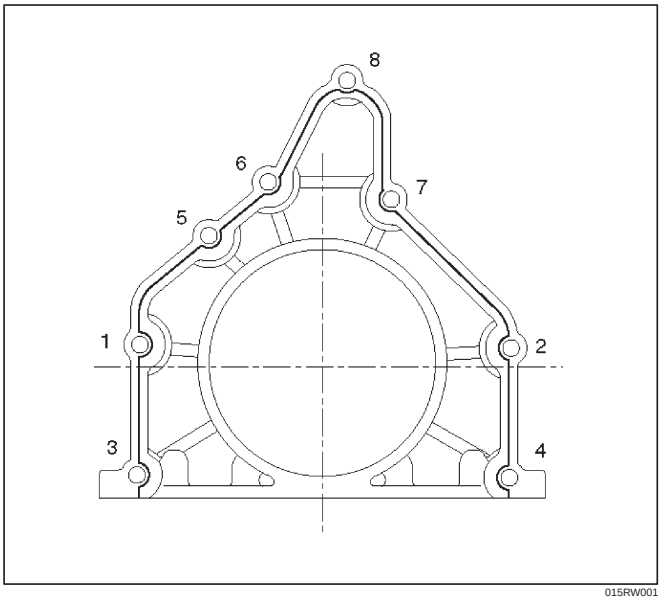


015RW002

Legend
(1) Around Bolt Holes
(2) Around Dowel Pin

- Apply engine oil to oil seal lip and align a dowel pin hole in the cylinder block with that in the retainer.
- Tighten retainer fixing bolts to the specified torque.

Torque : 18 N·m (13 lb ft)

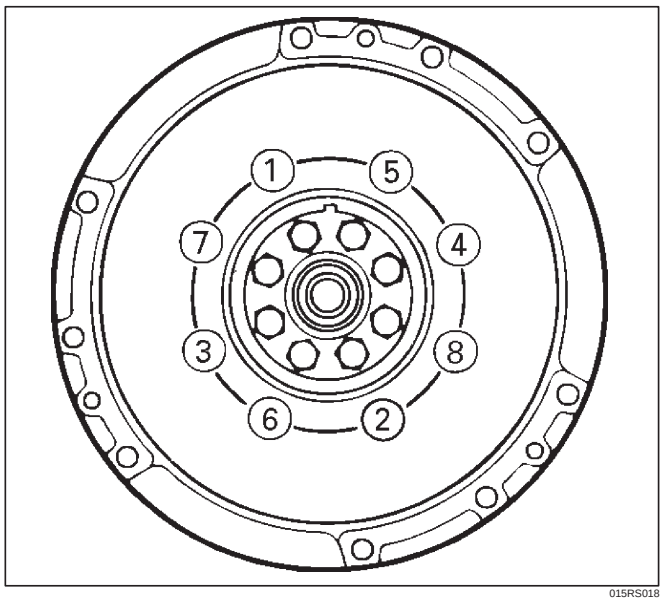


015RW001

5. Install flywheel.
   - Clean tapped holes in the crankshaft.
   - Remove oil on crankshaft and flywheel fitting surface.

NOTE:
- Do not reuse the bolts.
- Do not apply oil or thread lock to the bolts.
- Tighten fixing bolts to the specified torque.

Torque : 54 N·m (40 lb ft)



015RS018

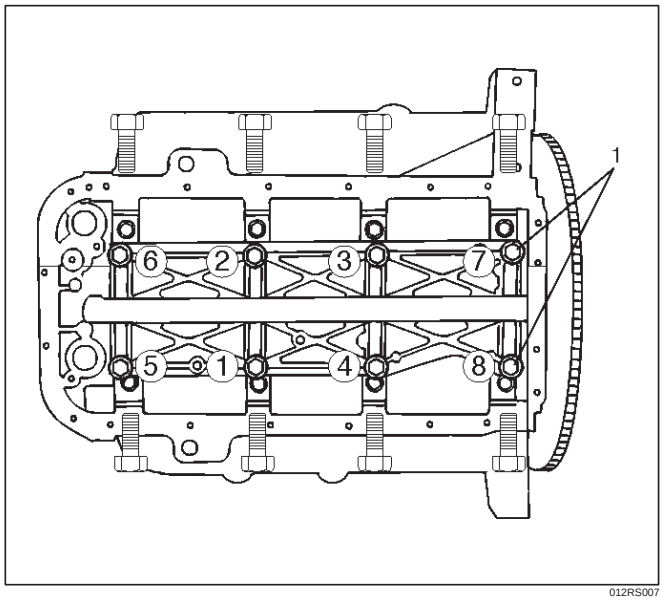
6. Install oil gallery.
   - Clean contact surface of oil gallery and main bearing cap.
     Apply engine oil to oil gallery fixing bolts and tighten the bolts in two steps, in the order shown.

Torque :
1st step : 29 N·m (21 lb ft)
2nd step : 55˚–65˚

7. Install cylinder body side bolts and tighten bolts in order to the specified torque.

Torque : 39 N·m (29 lb ft)

NOTE: Do not apply the oil to the bolts.

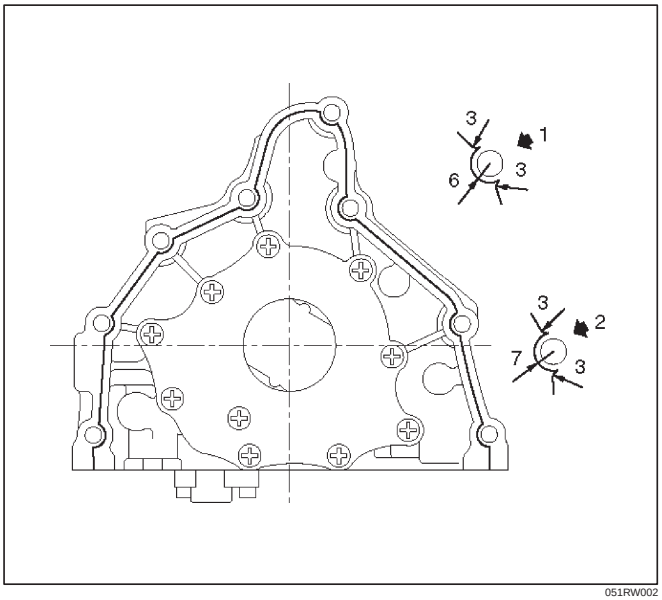


012RS007

8. Install oil pump assembly.
   - Remove oil on cylinder block and oil pump mounting surface.
   - Apply sealant (TB1207B or equivalent) to the oil pump mounting surface.
   - The oil pump assembly must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.

- Apply engine oil to oil seal lip.
- Install oil pump in the cylinder block and tighten fixing bolts to the specified torque.

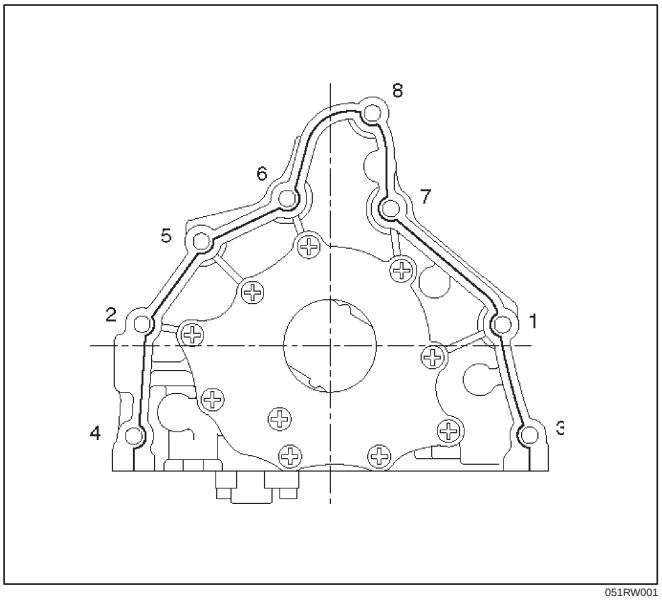
Torque : 25 N·m (18 lb ft)



051RW002

Legend

(1) Around Bolt Holes
(2) Around Dowel Pin



051RW001

9. Install oil strainer with O-ring, tighten to the specified torque.

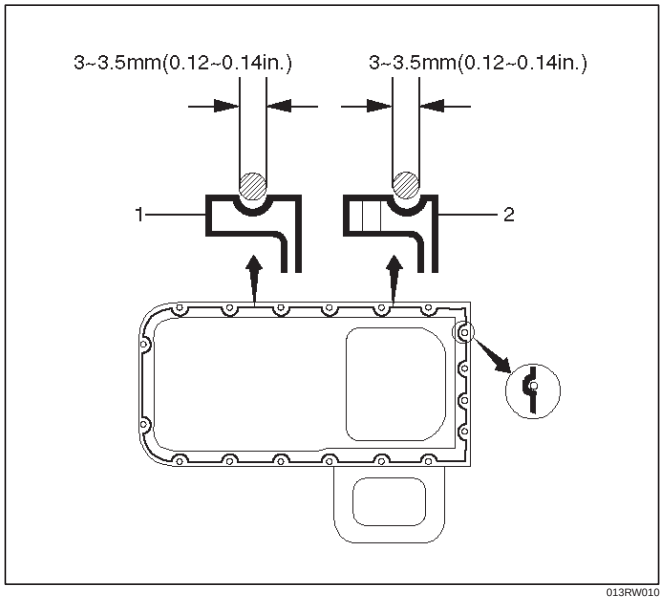
Torque : 25 N·m (18 lb ft)

10. Install oil pipe with O-ring, tighten fixing bolts to the specified torque.

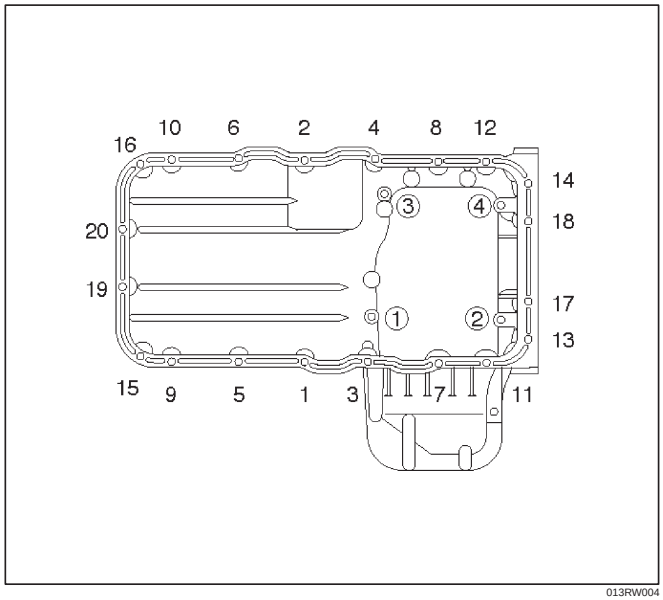
Torque : 25 N·m (18 lb ft)

11. Install crankcase.
    - Remove oil on crankcase mounting surface and dry the surface.
    - Properly apply a 4.5 mm (0.7 in) wide bead of sealant (TB1207C or equivalent) to the crankcase mounting surface. The bead must be continuous.
    - The crankcase must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.
    - Tighten fixing bolts to the specified torque.

Torque : 10 N·m (89 lb in)



013RW010

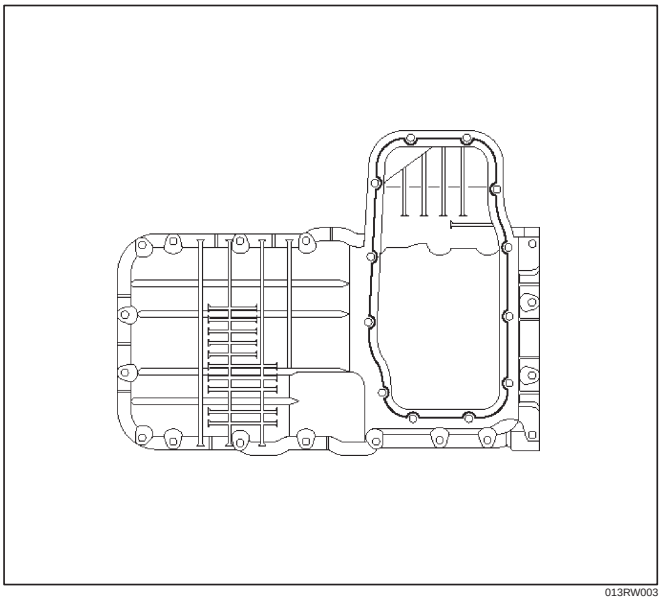


013RW004

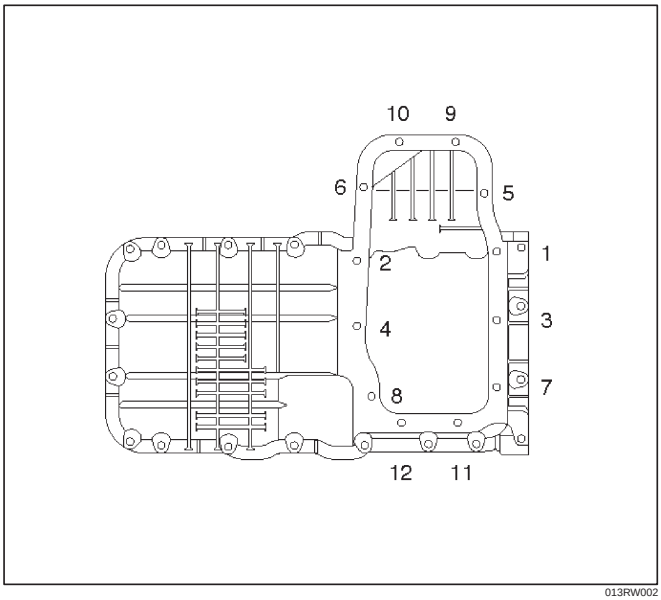
12. Install oil pan
    - Remove oil on oil pan mounting surface and dry the surface.
    - Properly apply a 4.5 mm (0.7 in) wide bead of sealant (TB1207C or equivalent) to the oil pan mounting surface. The bead must be continuous.
    - The oil pan must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.

- Tighten fixing bolts to the specified torque.

Torque : 25 N·m (18 lb ft)



013RW003



013RW002

13. Install timing belt.
    - Refer to installation procedure for Timing Belt in this manual.
14. Install engine assembly.
    - Refer to installation procedure for Engine Assembly in this manual.

Rear Oil Seal

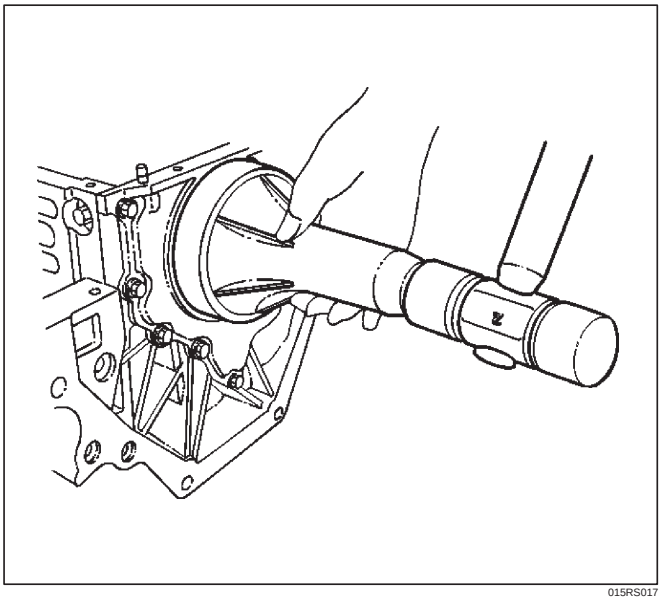
Removal

1. Remove transmission assembly.
   - See Transmission section in this manual.
2. Remove flywheel.
3. Remove rear oil seal using a seal remover.

NOTE: Take care not to damage the crankshaft or oil seal retainer when removing oil seal.

Installation

1. Apply engine oil to oil seal lip and install oil seal using J-39201.

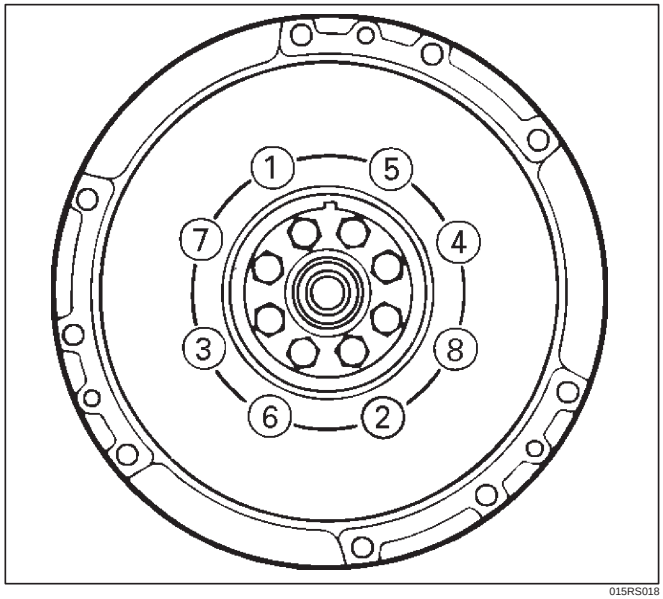


015RS017

2. Install flywheel.
   - Clean tapped holes in the crankshaft.
   - Remove oil on the crankshaft and flywheel mounting surface.
   - Tighten fixing bolts to the specified torque.

NOTE: Do not reuse the bolts and do not apply oil or thread lock to the bolts.

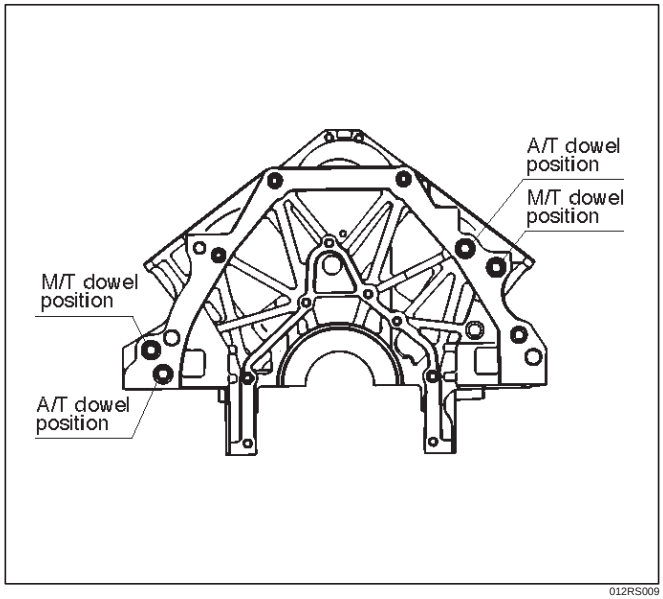
Torque : 54 N·m (40 lb ft)



015RS018

3. Install transmission.
   - See Transmission section in this manual.

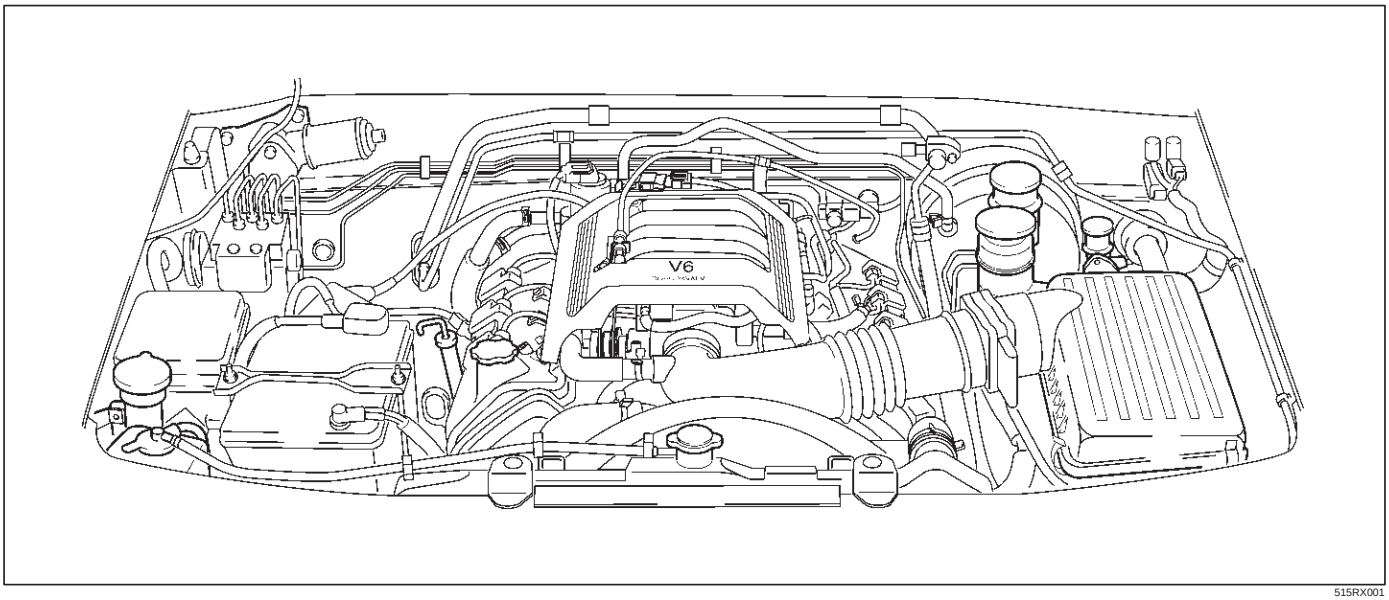
CAUTION: When assembling the engine and transmission, confirm that dowels have been mounted in the specified positions at the engine side. Take care that dowel positions are different between the manual transmission and the automatic transmission.
Otherwise, the transmission may be damaged.



012RS009

Engine Assembly

Removal



515RX001

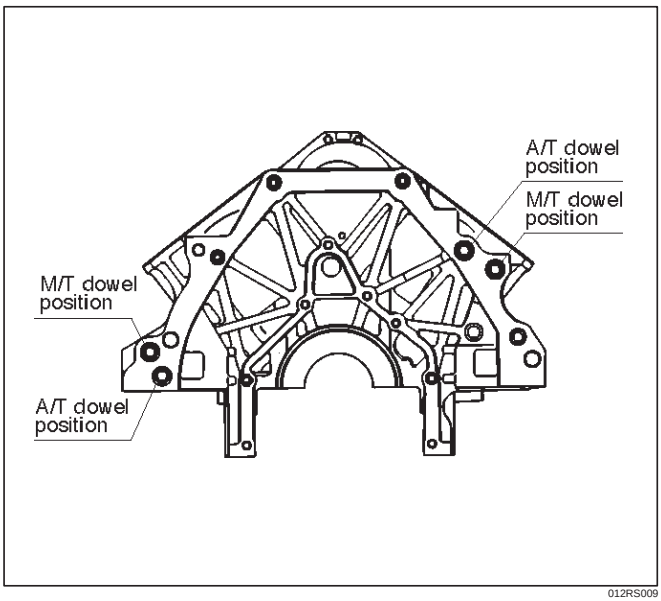
1. Disconnect battery ground and positive cable.
2. Remove battery.
3. Make alignment mark on the engine hood and hinges before removal in order to return the hood to original position exactly.
4. Remove engine hood.
5. Drain radiator coolant.
6. Disconnect accelerator cable and automatic cruise control cable from throttle valve on common chamber.
7. Disconnect air duct with air cleaner cover.
8. Remove air cleaner assembly.
9. Disconnect canister vacuum hose.
10. Disconnect vacuum booster hose.
11. Disconnect three engine harness connectors.
12. Disconnect harness connector to transmission (left front side of engine compartment), disconnect shift on the fly harness connector from front side of front axle and remove transmission harness bracket from engine left side.
13. Disconnect ground cable between engine and frame.
14. Disconnect bonding cable connector on the back of right dash panel.
15. Disconnect bonding cable terminal on the left bank.
16. Disconnect starter harness connector from starter.
17. Disconnect generator harness connector from generator.
18. Disconnect coolant reserve tank hose from radiator.
19. Remove radiator upper and lower hoses.
20. Remove upper fan shroud.
21. Remove cooling fan assembly four fixing nuts, then the cooling fan assembly.
22. Move drive belt tensioner to loose side using wrench then remove drive belt.
23. Remove power steering pump fixing bolts, then power steering pump. Place the power steering pump along with piping on the body side.
24. Remove air conditioning compressor fixing bolts from bracket and place the compressor along with piping on the body side.
25. Remove four O_2 sensor harness connectors (two each bank) from exhaust front pipe.
26. Remove three exhaust pipe fixing nuts from each bank.
27. Remove two exhaust pipe fixing nuts from each exhaust pipe, then move exhaust pipe to rear side of vehicle.
28. Remove flywheel dust covers.
29. Disconnect two heater hoses from engine.
30. Disconnect fuel hose from right side of transmission.

CAUTION: Plug fuel pipe on engine side and fuel hose from fuel tank.

31. Remove transmission assembly. Refer to Transmission section in this manual.
32. Support the engine by engine hoist.
33. Remove two left side engine mount fixing bolts from engine mount on chassis side.
34. Remove two right side engine mount fixing bolts from engine mount on chassis side.
35. Remove engine assembly.

Installation

CAUTION: When assembling the engine and transmission, confirm that dowels have been mounted in the specified positions at the engine side. Also take care that dowel positions are different between the manual transmission and the automatic transmission.
Otherweise, the transmission may be damaged.



012RS009

1. Install engine assembly. Tighten engine mount fixing bolts to frame to the specified torque.

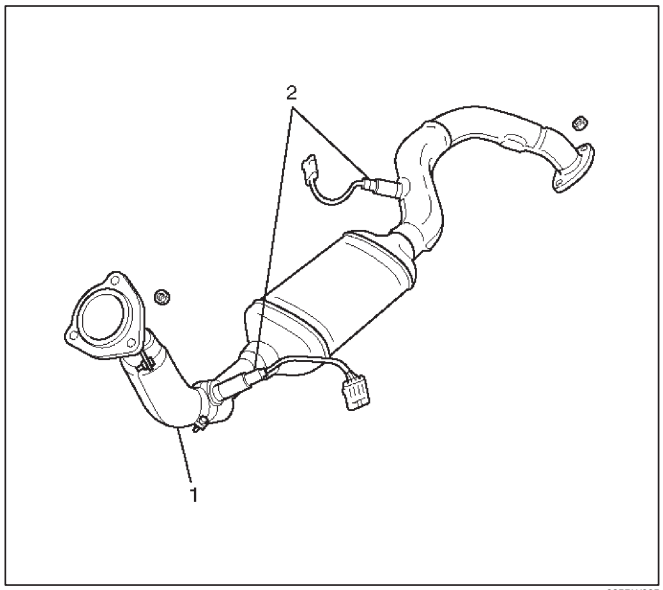
   Torque: 41 N·m (30 lb ft)

2. Reconnect fuel hose to fuel pipe on engine.
3. Install transmission assembly. Refer to Transmission section in this manual.
4. Reconnect two heater hoses to engine.
5. Install flywheel dust covers.
6. Install exhaust pipe and temporally tighten two (each bank) rear exhaust flange nuts then tighten three stud nuts (each bank) between exhaust manifold and exhaust pipe, finally tighten rear side nuts to the specified torque.

   Torque:

   Nuts: 43 N·m (32 lb ft)

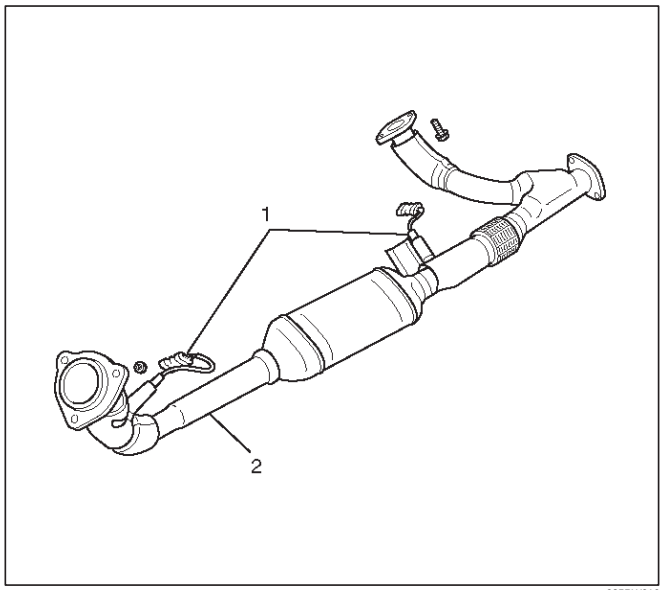
   Stud nuts: 67 N·m (49 lb ft)



035RW005

Legend

(1) Exhaust Front Pipe RH
(2) O_2 Sensor



035RW016

Legend

(1) O_2 Sensor
(2) Exhaust Front Pipe LH

7. Reconnect O_2 sensor connector.
8. Install cooling fan assembly and tighten bolts/nuts to the specified torque.

   Torque : 22 N·m (16 lb ft) for fan pulley and fan bracket.

   Torque : 7.5 N·m (66.4 lb in) for fan and clutch assembly.

9. Install air conditioner compressor to engine and tighten to the specified torque.

   6VD1

   Torque : 43 N·m (32 lb ft)

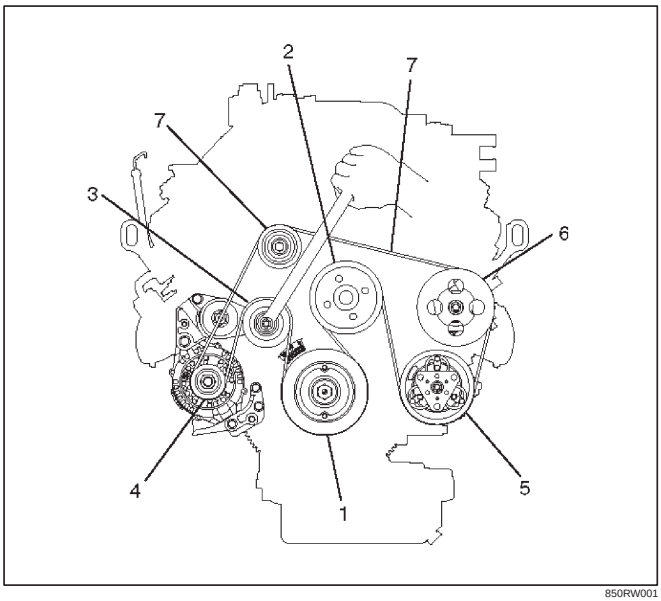
10. Install power steering pump, tighten fixing bolt to the specified torque.

    Torque :

    M8 bolts : 22N·m (16 lb ft)

    M10 bolts : 46 N·m (34 lb ft)

11. Move drive belt tensioner to loose side using wrench, then install drive belt to normal position.

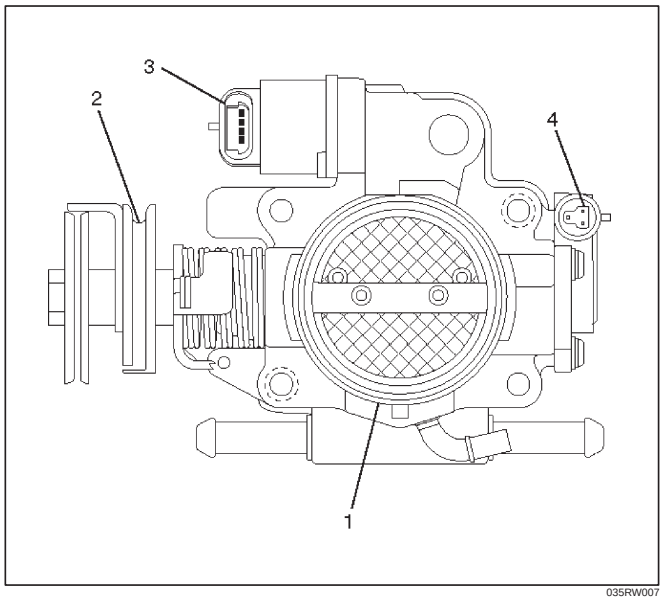


850RW001

Legend

(1) Crankshaft Pulley
(2) Cooling Fan Pulley
(3) Tensioner
(4) Generator
(5) Air Conditioner Compressor
(6) Power Steering Oil Pump
(7) Drive Belt

12. Install upper fan shroud.
13. Reconnect radiator upper and lower hoses.
14. Reconnect coolant reserve tank hose to radiator.
15. Reconnect generator harness connector.
16. Reconnect starter harness connector.
17. Reconnect bonding cable terminal on left bank
18. Reconnect bonding cable terminal on the back of right dash panel.
19. Reconnect ground cable between engine and chassis.
20. Reconnect harness connector to transmission and install transmission harness bracket on engine left side.
21. Reconnect three engine harness connectors.
22. Reconnect vacuum booster hose.
23. Reconnect canister vacuum hose.
24. Install air cleaner assembly.
25. Reconnect air duct.
26. Reconnect accelerator cable and automatic cruise control cable to throttle valve on common chamber.



035RW007

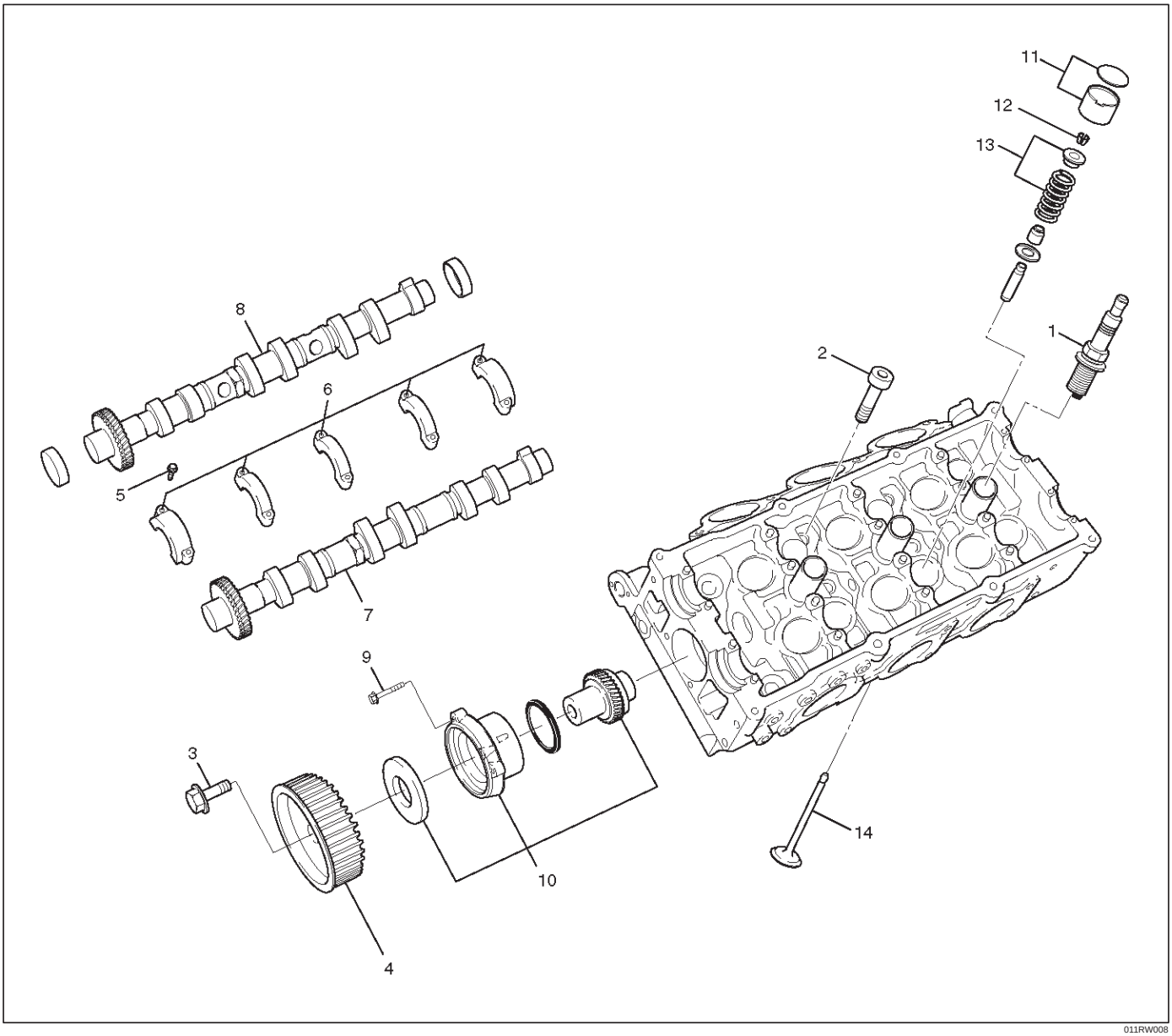
Legend

(1) Throttle Valve Assembly
(2) Throttle Lever
(3) Idle Air Control Valve
(4) Throttle Position Sensor

27. Install engine hood to the original position.
    - Refer to installation procedure for Body section in this manual.
28. Install Accelerator pedal cable.

Cylinder Head

Cylinder Head and Associated Parts



011RW008

Legend

(1) Spark Plug
(2) Cylinder Head Bolt
(3) Camshaft Drive Gear Pulley Fixing Bolt
(4) Camshaft Drive Gear Pulley
(5) Camshaft Bracket Fixing Bolt
(6) Camshaft Bracket
(7) Camshaft Exhaust
(8) Camshaft Intake
(9) Retainer Fixing Bolt
(10) Retainer Assembly
(11) Tappet with Shim
(12) Split Collar
(13) Valve Spring and Spring Upper Seat
(14) Valve

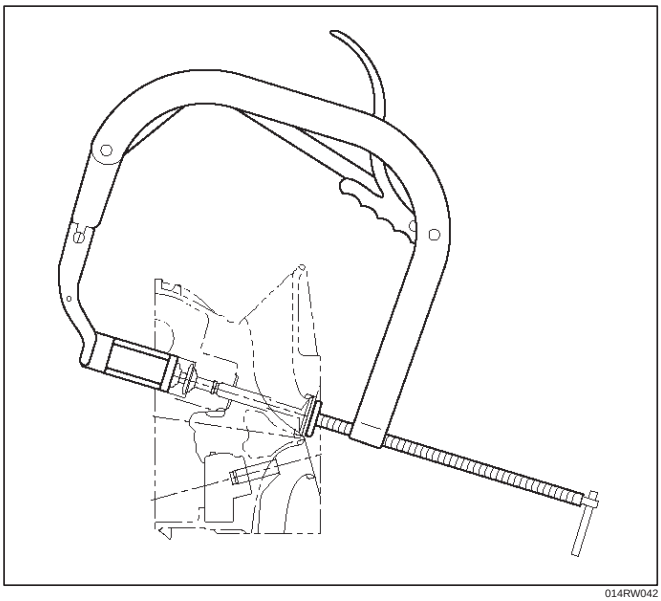
Disassembly

NOTE:

- During disassembly, be sure that the valve train components are kept together and identified so that they can be reinstalled in their original locations.
- Before removing the cylinder head from the engine and before disassembling the valve mechanism, perform a compression test and note the results.

1. Remove camshaft drive gear pulley fixing bolt (3), then pulley (4).

2. Remove camshaft bracket fixing bolt (5), camshaft bracket (6), then camshaft exhaust (7), and intake side (8).
3. Remove tappet with shim (11).
4. Use the J–8062 valve spring compressor and J–42898 valve spring compressor adapter to remove the split collar (12), valve spring with upper seat (13) and valve (14).


014RW042

5. Remove spark plug (1).

CAUTION: Do not remove the spark plugs when the head and plugs are hot. Clean dirt and debris from spark plug recess areas before removal.

Clean

Cylinder head

Carefully remove all varnish, soot and carbon from the bare metal. Do not use a motorized wire brush on any gasket sealing surface.

Inspection and Repair

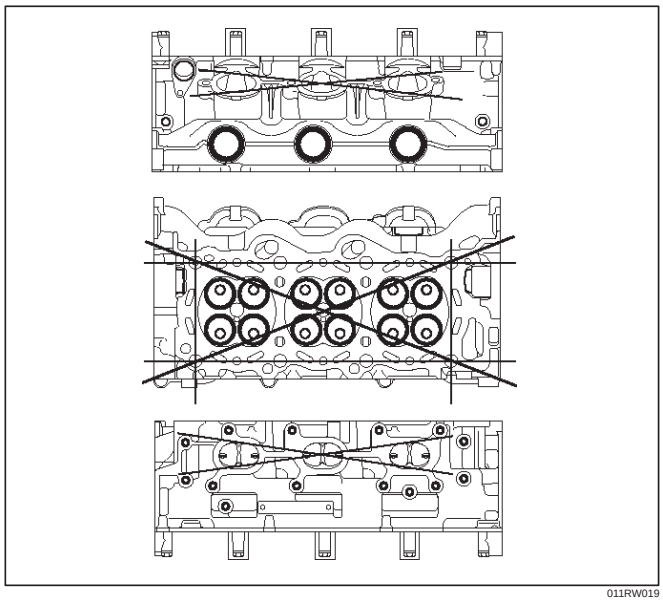
1. Cylinder head gasket and mating surfaces for leaks, corrosion and blow–by. If the gasket has failed, determine the cause.
   – Insufficient torque on head bolts
   – Improper installation
   – Loose or warped cylinder head
   – Missing dowel pins
   – Warped case surface
2. Cylinder head for cracks, especially between valve seats and in the exhaust ports.
3. Cylinder head deck for corrosion, sand particles in head and porosity.

CAUTION:

- **Do not attempt to weld the cylinder head. Replace it.**
- **Do not reuse cylinder head bolts.**

4. Cylinder head deck, common chamber and exhaust manifold mating surfaces for flatness. These surfaces may be reconditioned by milling. If the surfaces are “out of flat” by more than specification, the surface should be ground to within specifications. Replace the head if it requires machining beyound the repairable limit.

Head surface and manifold surface
Standard: 0.05 mm (0.002 in) or less
Warpage limit: 0.2 mm (0.0079 in)
Maximum Repairable limit: 0.2 mm (0.0079 in)
Head height
Standard height : 133.2 mm (5.2441 in)
Warpage limit : 0.2 mm (0.0079 in)
Maximum Repairable limit : 133.0 mm (5.2362 in)


011RW019

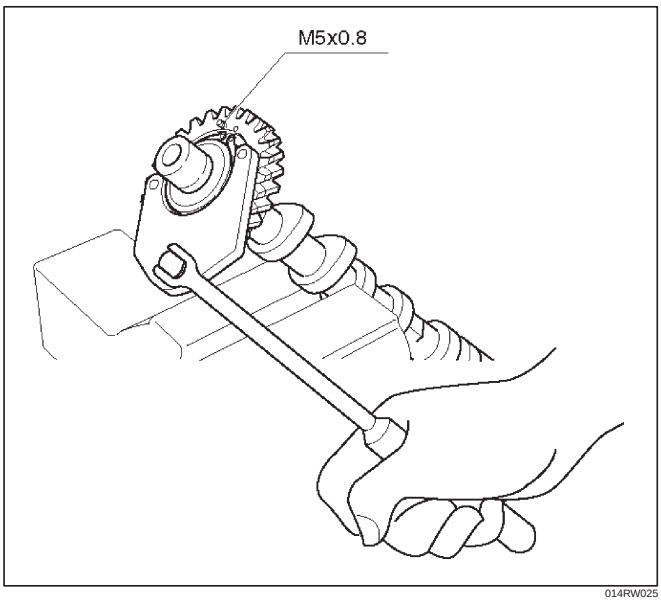
5. Water jacket sealing plugs seating surfaces.

Reassembly

1. Install Spark plug and tighten all the spark plugs to specified torque.

   Torque: 18 N·m (13 lb ft)

2. Tighten sub gear setting bolt.
   1. Use J–42686 gear spring lever to turn sub gear to right direction until the M5 bolt aligns with the hole between camshaft driven gear and sub gear.
   2. Tighten the M5 bolt to a suitable torque to prevent the sub gear from moving.

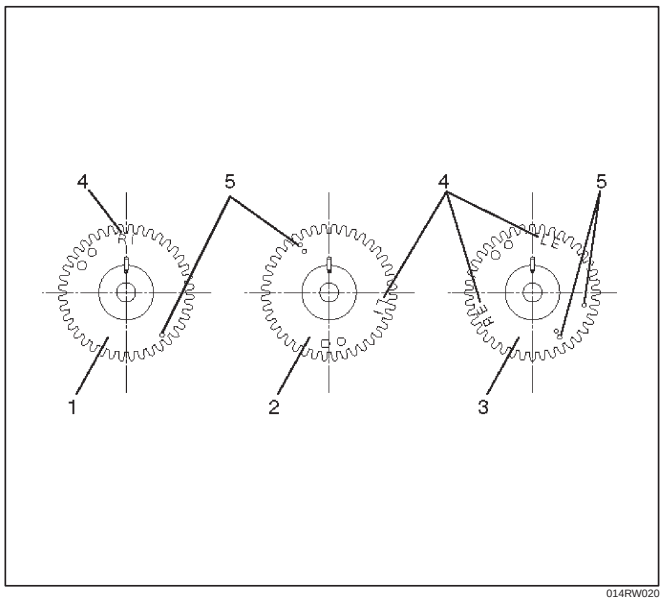


014RW025

3. Install camshaft drive gear assembly and tighten three bolts to the specified torque.

   Torque: 10 N·m (89 lb in)

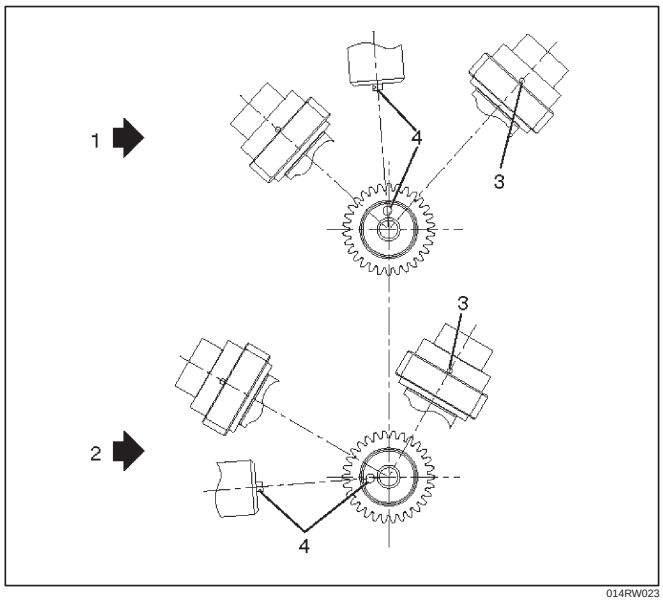
4. Install camshaft assembly and camshaft brackets, tighten twenty bolts on one side bank to the specified torque.
   1. Apply engine oil to camshaft journal and bearing surface of camshaft bracket.
   2. Align timing mark on intake camshaft (one dot for right bank, two dots for left bank) and exhaust camshaft (one dot for right bank, two dots for left bank) to timing mark on camshaft drive gear (one dot).



014RW020

Legend

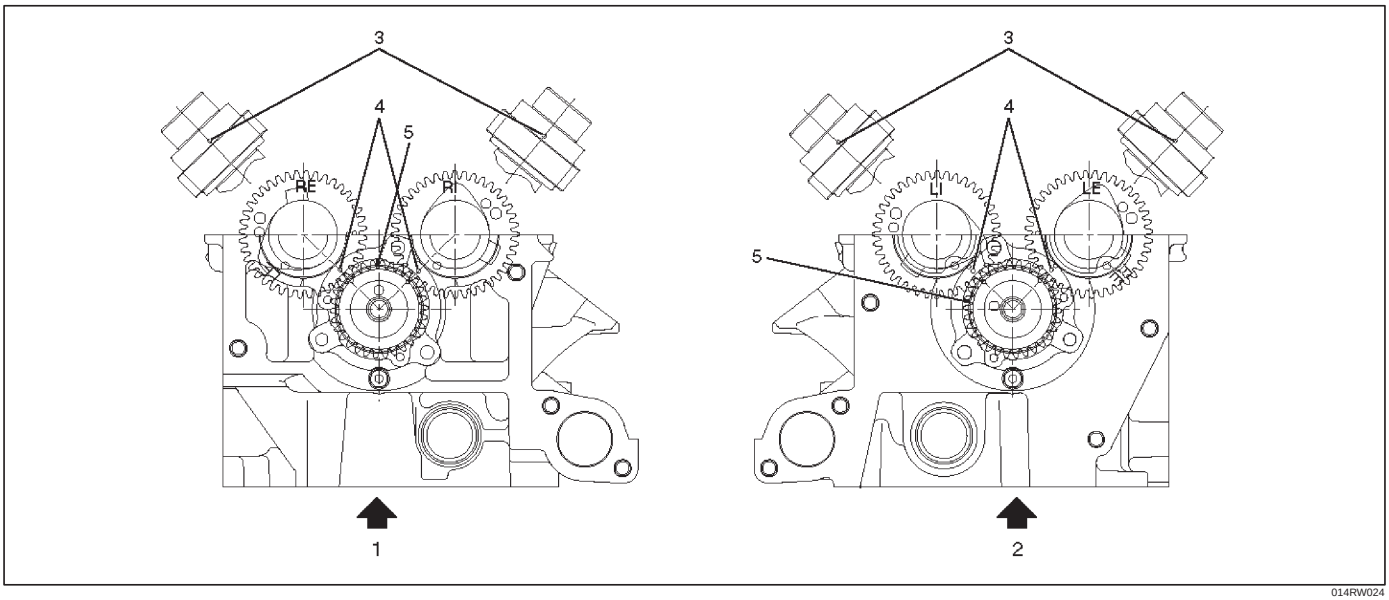
(1) Intake Camshaft Timing Gear for Right Bank
(2) Intake Camshaft Timing Gear for Left Bank
(3) Exhaust Camshaft Timing Gear
(4) Discrimination Mark
LI: Left Bank Intake
RI: Right Bank Intake
LE: Left Bank Exhaust
RE: Right Bank Exhaust



014RW023

Legend

(1) Right Bank Camshaft Drive Gear
(2) Left Bank Camshaft Drive Gear
(3) Timing Mark on Drive Gear
(4) Dowel Pin



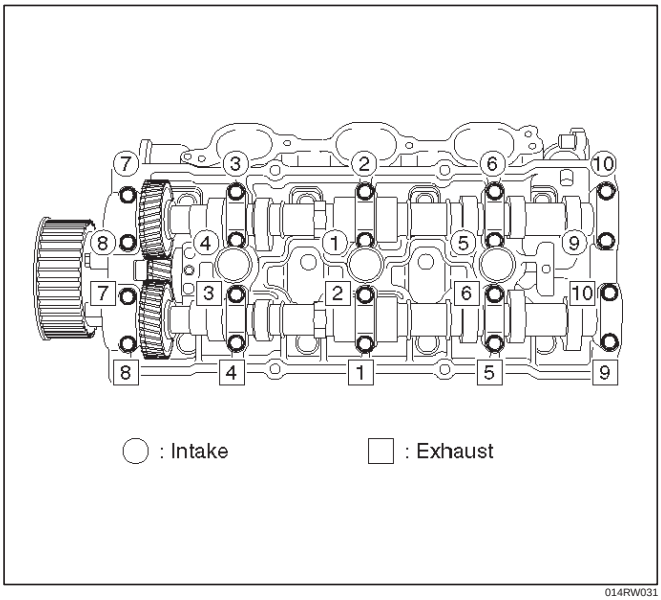
014RW024

Legend

(1) Right Bank
(2) Left Bank
(3) Alignment Mark on Camshaft Drive Gear
(4) Alignment Mark on Camshaft
(5) Alignment Mark on Retainer

3. Tighten twenty bolts in numerical order on each bank as shown in the illustration.

Torque: 10 N·m (89 lb in)



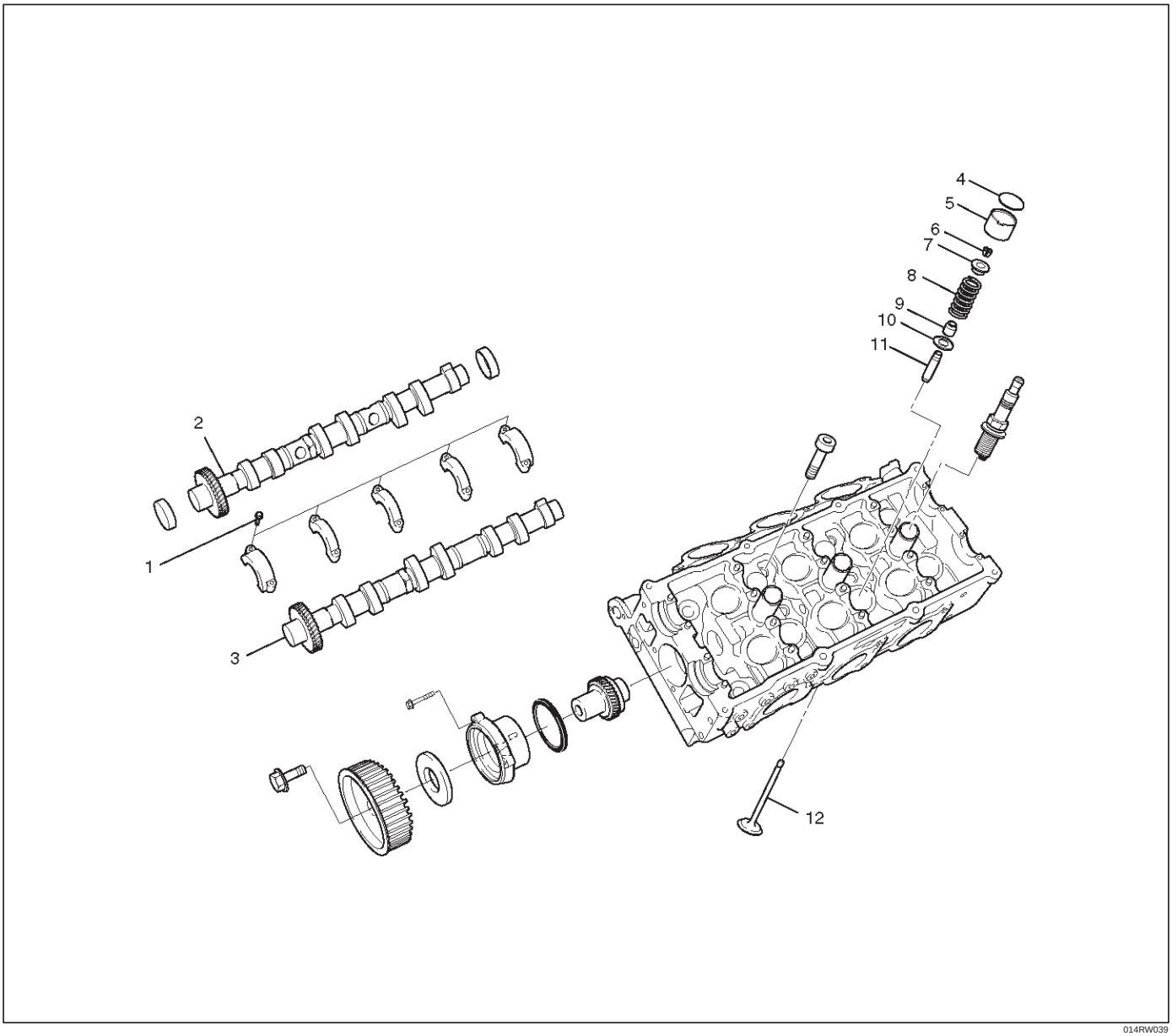
014RW031

5. Tighten bolt for camshaft drive gear assembly pulley to the specified torque.

Torque: 98 N·m (72 lb ft)

Valve Spring, Oil Controller, Valve, Valve Guide

Valve Spring, Oil Controller, Valve, Valve Guide and Associated Parts



014RW039

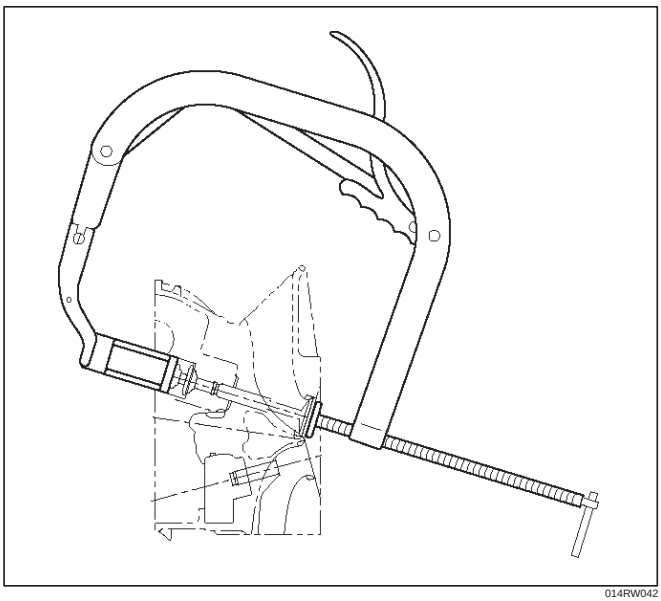
Legend

(1) Camshaft Bracket Fixing Bolts
(2) Camshaft Assembly Inlet
(3) Camshaft Assembly Exhaust
(4) Shim
(5) Tappet
(6) Split Collar
(7) Spring Upper Seat
(8) Valve Spring
(9) Oil Controller
(10) Spring Lower Seat
(11) Valve Guide
(12) Valve

Disassembly

1. Remove camshaft bracket fixing bolts (1).
2. Remove camshaft assembly (intake).
3. Remove camshaft assembly (Exhaust side).
4. Remove shim (4) and tappet (5).

5. Use the J–8062 valve spring compressor and J–42898 valve spring compressor adapter to remove split collar.


014RW042

6. Remove valve spring.
7. Remove valve.
8. Remove oil controller and spring lower seat.
9. Remove the valve guide using the J–42899 valve guide replacer.

Inspection and Repair

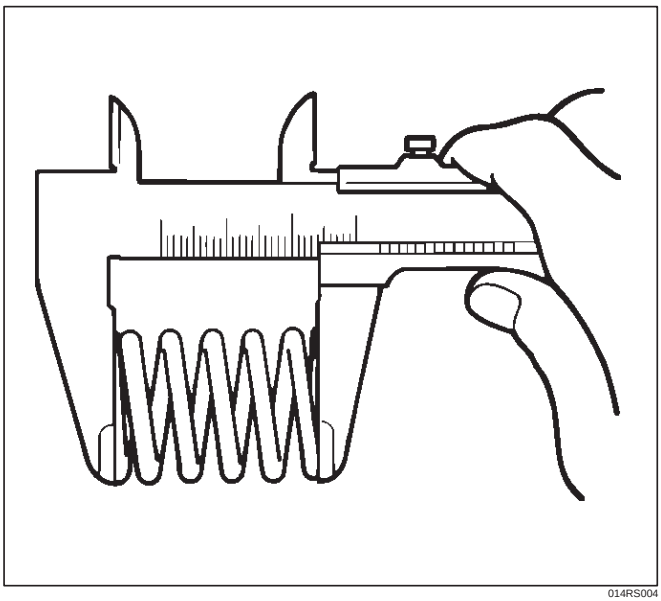
Valve Spring

CAUTION: Visually inspect the valve springs and replace them if damage or abnormal wear is evident.

1. Measure the free height of the springs. The springs must be replaced if the free height is below the specified limit.

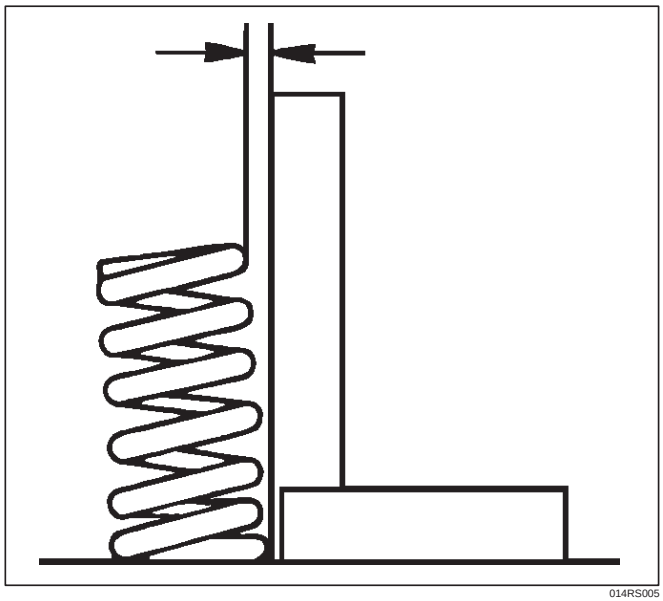
Standard : 44.6 mm (1.756 in)

Limit : 43.6 mm (1.717 in)


014RS004

2. Measure the valve spring squareness with a steel square and replace the valve springs if the measured value exceeds the specified limit.

Limit : 2 mm (0.079 in)

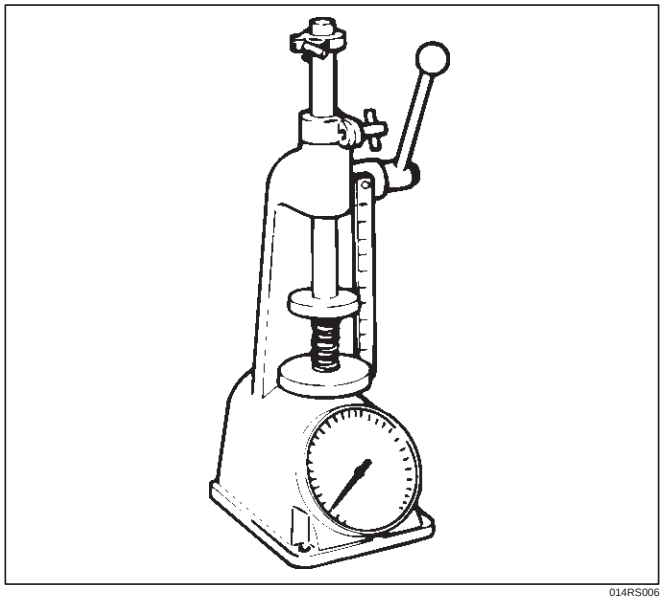

014RS005

3. Using a spring tester to compress the springs to the installed height, measure the compressed spring tension, and replace the springs if the measured tension is below the specified limit.

At installed height: 35.0 mm (1.38 in)

Standard: 196 N (44 lb)

Limit: Less than 181 N (41 lb)


014RS006

Valve Guide

CAUTION: Take care not to damage the valve seat contact surface, when removing carbon adhering to the valve head. Carefully inspect the valve stem for scratchs or abnormal wear. If these conditions are present, the valve and the valve guide must be replaced as a set.

1. Measure the valve stem diameter with a micrometer. If the valve stem diameter is less than the specified limit, the valve and the valve guide must be replaced as a set.

Diameter of Valve Stem

Intake

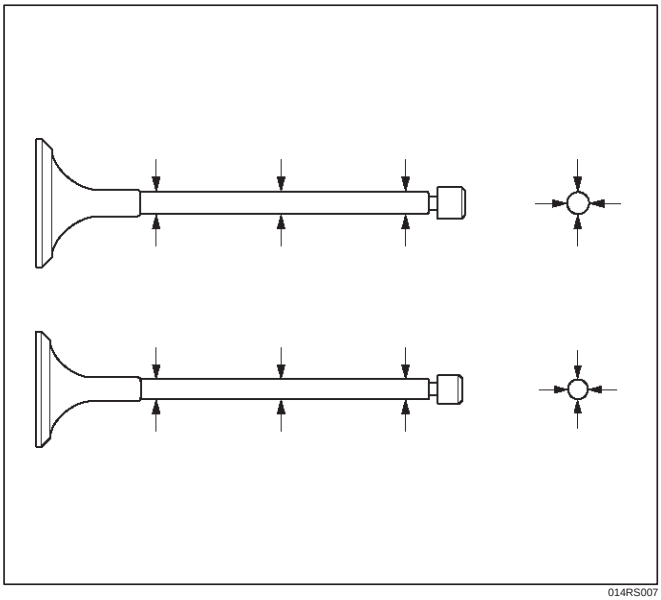
Standard : 5.977 mm–5.959 mm (0.2353 in–0.2346 in)

Limit : 5.90 mm (0.2323 in)

Exhaust

Standard : 5.952 mm–5.970 mm (0.2343 in–0.2350 in)

Limit : 5.90 mm (0.2323 in)



014RS007

2. Measure the inside diameter of the valve guide with a micrometer. Subtract the measured outer diameter of the valve stem from the measured inner diameter of the valve guide. If the value exceeds the specified limit, the valve and the valve guide must be replaced as a set.

Inside Diameter of the Vale Guide

Inlet clearance

Standard : 0.023 mm–0.056 mm (0.0009 in–0.0002 in)

Limit : 0.20 mm (0.00787 in)

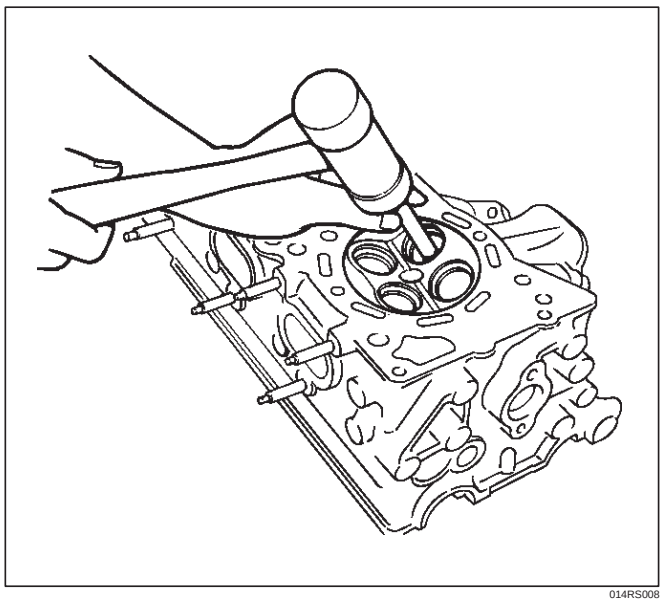
Exhaust clearance

Standard : 0.030 mm–0.063 mm (0.0012 in–0.0025 in)

Limit : 0.20 mm (0.00787 in)

Valve Guide Replacement

1. Using Valve guide replacer: J–42899, drive out the valve guide from the combustion chamber side.

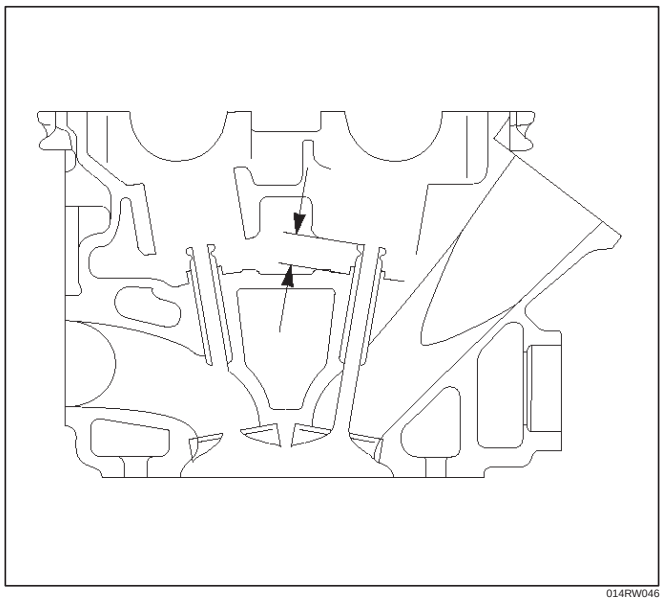


014RS008

2. Apply engine oil to the outside of the valve guide. Using valve guide replacer J–42899, drive in a new valve guide from the camshaft side, and check the valve guide height.

Valve guide upper end height: 13.0 mm (0.5118 in)

(Measured from the cylinder head upper face)



014RW046

3. Check the clearance. If the clearance is less than the specified value, ream the inside diameter of valve guide. Using a sharp 6 mm reamer, ream the valve guide to obtain the specified clearance.

Valve Seat

1. Measure the protrusion of the valve stem when a new valve is installed in the cylinder head. If the protrusion of the valve stem exceeds the limit, replace the valve seat insert or the cylinder head assembly.

Protrusion of valve stem

Intake

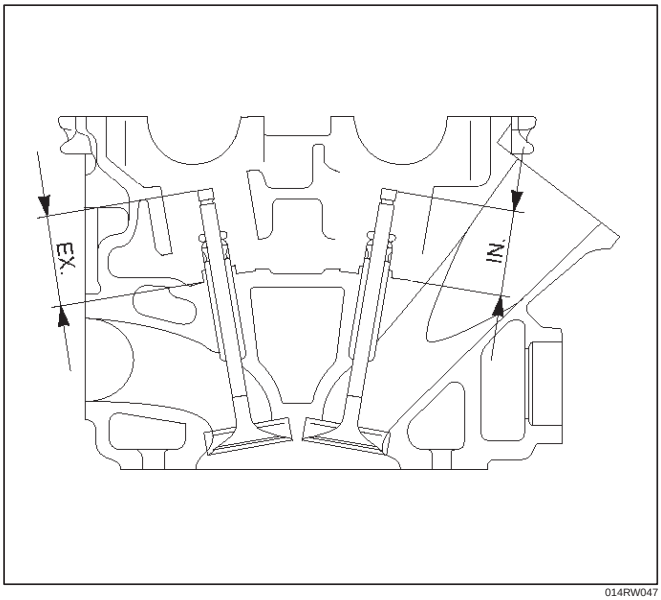
Standard: 39.32 mm (1.5480 in)

Limit: 39.47 mm (1.5539 in)

Exhaust

Standard: 39.3 mm (1.5472 in)

Limit: 39.45 mm (1.5531 in)



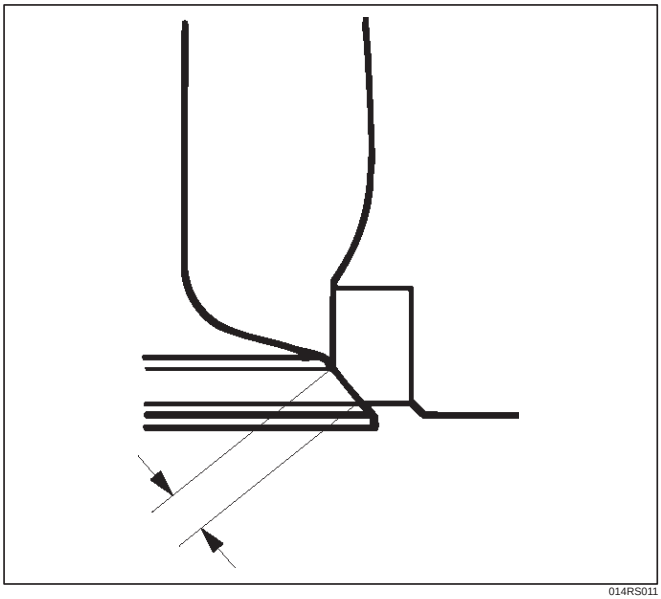
014RW047

2. Measure the valve seat contact width. Make the necessary corrections if the seat contact surface is damaged or rough or if the contact width wear exceeds the limit.

Valve seat contact width

Standard: 1.1 mm (0.0433 in)

Limit: 1.7 mm (0.0669 in)

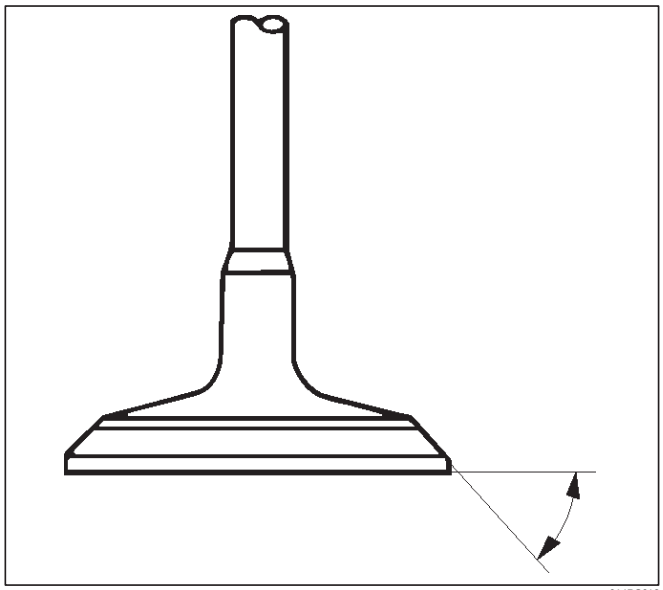


014RS011

Contact Surface Angle on Valve Seat on Valve

1. Measure contact surface angle on valve seat.
2. If the measured value exceeds the limit, replace valve, valve guide and valve seat as a set.

Valve contact surface angle: 45˚

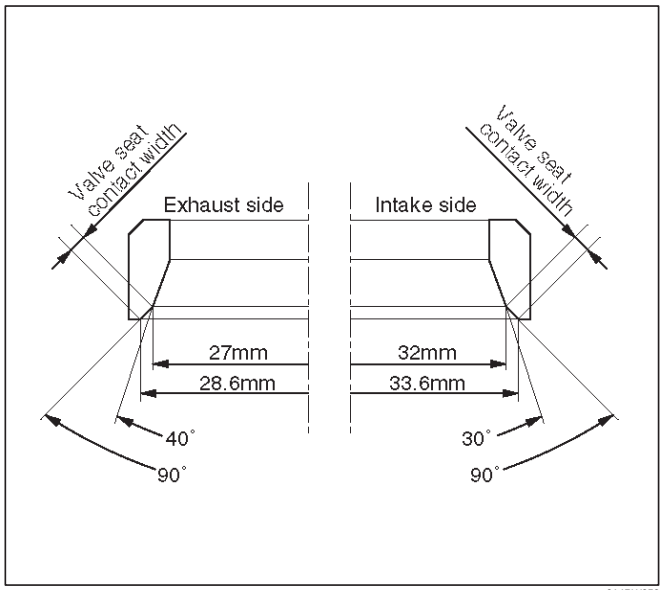


014RS012

Valve Seat Insert Correction

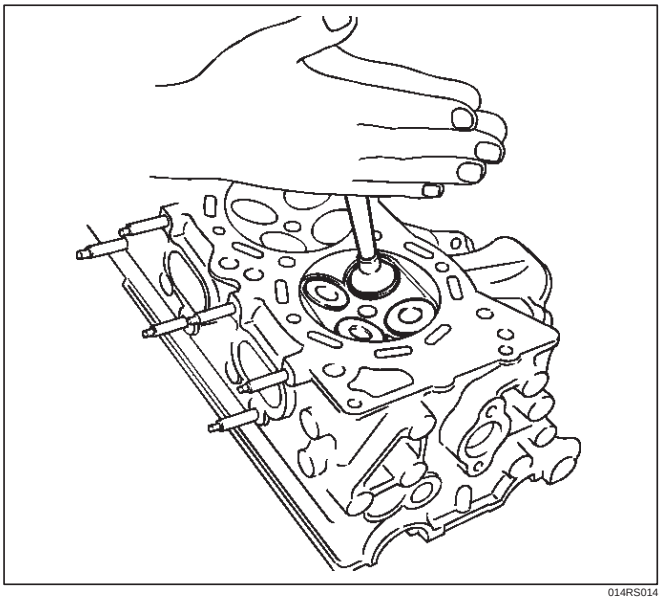
1. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter to minimize scratches and other rough areas. This will bring the contact width back to the standard value. Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surface.

Valve seat angle degree: 90˚



014RW059

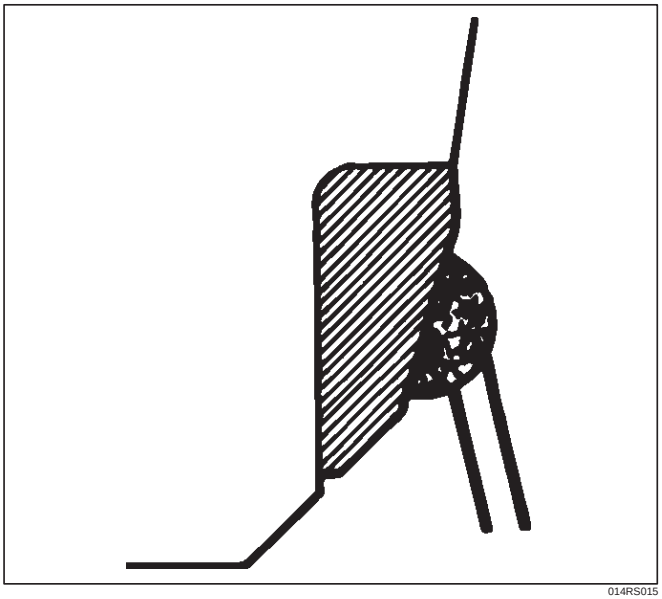
3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Turn the valve while lapping it to fit the valve seat insert.
6. Check that the valve contact width is correct.
7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.



014RS014

Valve Seat Insert Replacement

1. Arc weld the rod at several points. Be careful not to damage the aluminum section.
2. Allow the rod to cool for a few minutes. This will cause the valve seat to shrink.
3. Strike the rod and pull it out.



014RS015

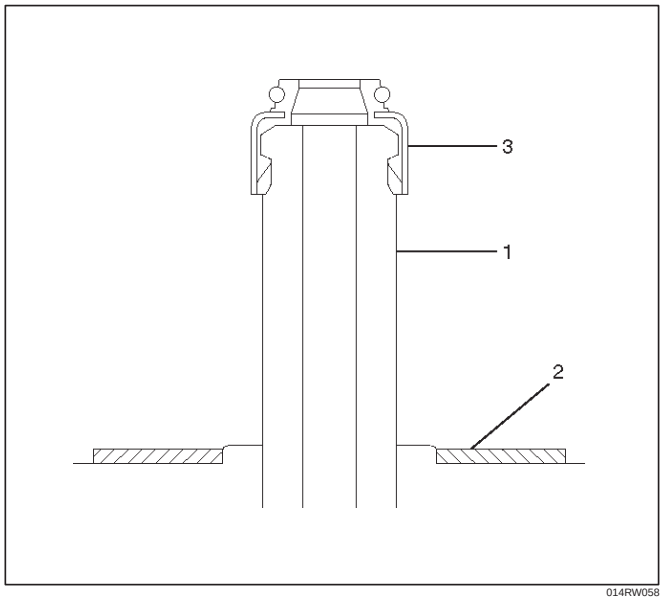
4. Carefully clean the valve seat press–fit section on the cylinder head side.
5. Heat the press–fit section with steam or some other means to cause expansion. Cool the valve seat with dry ice or some other means.
6. Insert the press–fit section into the valve seat horizontally.

Standard fitting interference: 0.14 mm–0.09 mm (0.0055 in–0.0035 in)

7. After insertion, use a seat grinder to grind finish the seating face. Carefully note the seating angle, the contact width, and the depression.
8. Lap the valve and the seat.

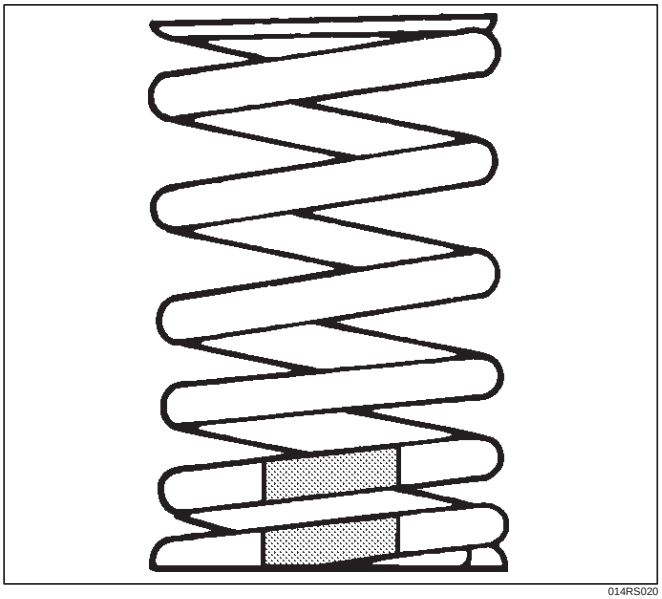
Reassembly

1. Install valve guide (1) to cylinder head. Apply engine oil to the outside of the valve guide. Using valve guide replacer J–42899, drive in a new valve guide from the camshaft side.
2. Install oil controller (3) and spring lower seat (2). Using oil controller replacer J–37281, drive in a new oil controller.

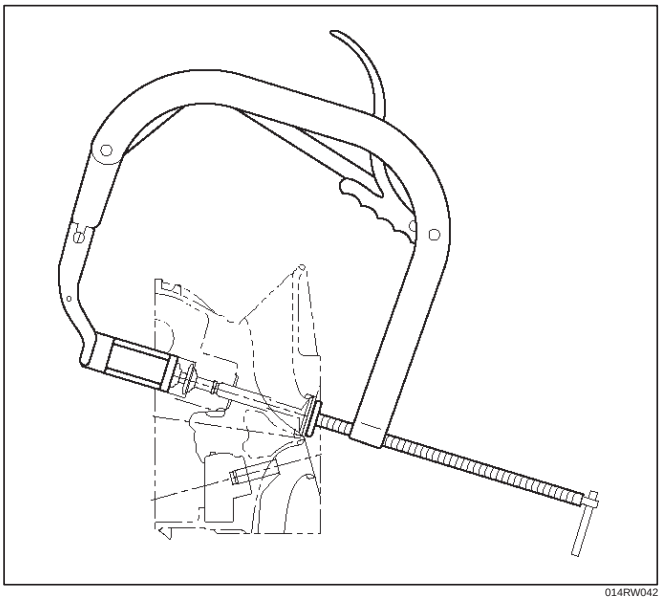


014RW058

3. Install valve to valve guide. Before install valve guide apply engine oil to the outside of the valve stem.
4. Install valve spring to cylinder head. Attach the valve spring to the lower spring seat. The painted area of the valve spring should be facing downward.


014RS020

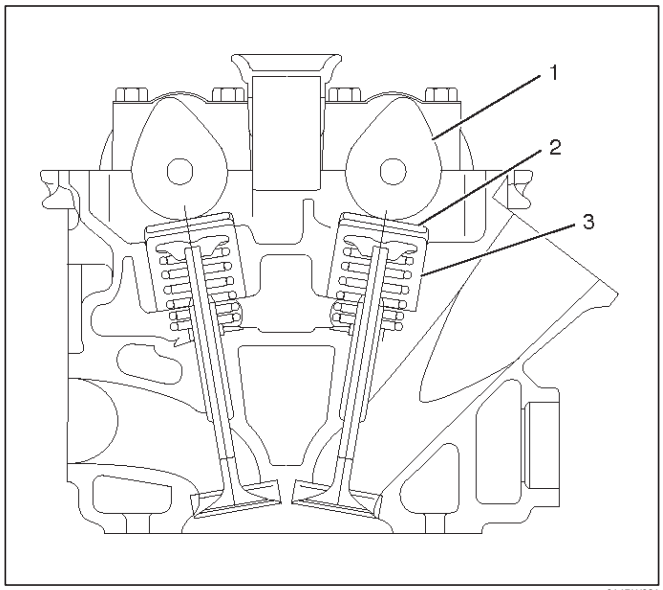
5. Install lower valve spring seat, valve spring and upper valve spring seat then put split collars on the upper spring seat, using the J–8062 valve spring compresor and J–42898 valve spring compressor adapter to install the split collars.


014RW042

6. Install tappet with shim.
7. Install camshaft assembly.
   - Refer to installation procedure for Camshaft in this manual.

Valve Clearance Adjustments

NOTE: To adjust valve clearance, apply engine oil to the cam as well as to the adjusting shim (2) with the cylinder head built on the cylinder block, give a few turns to the camshaft by means of timing pulley tightening bolt, and measure valve clearance when the nose of cam is just opposite to maximum cam lift (1) as shown in illustration below.



014RW081

Legend
(1) Cam
(2) Shim
(3) Tappet

Valve Clearance Standard Value (cold)

Intake: 0.23 mm–0.33 mm (0.0091 in–0.0130 in)

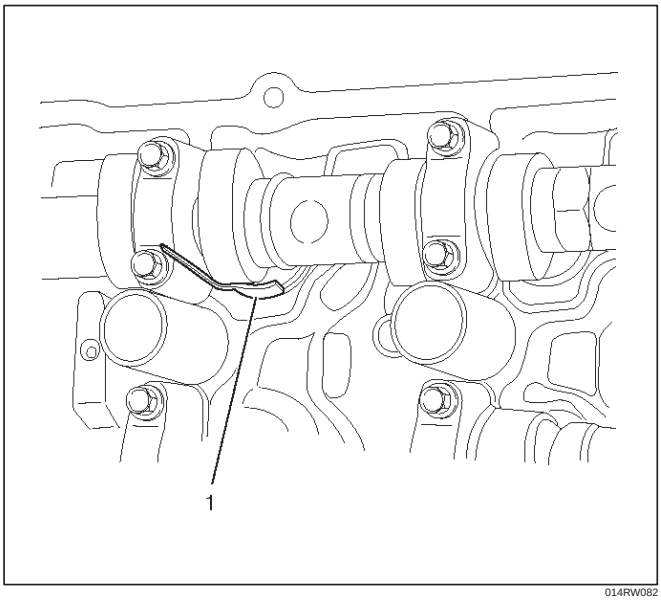
Exhaust: 0.25 mm–0.35 mm (0.0098 in–0.0138 in)

Selection of Adjusting Shim

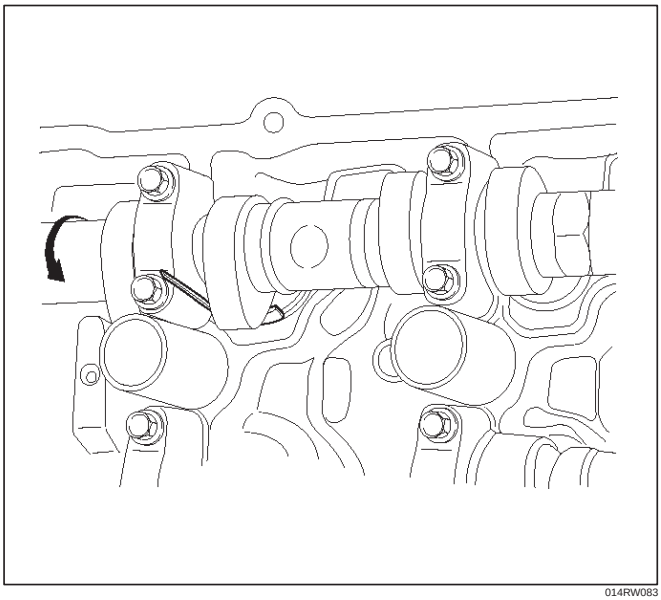
Shim to be selected = (Thickness of removed shim) + (Valve clearance measurement – Standard valu)
Based on the above formula, the best suited shim should be selected from 41 sorts of shim (differently thick at 0.02mm (0.0008 in) intervals from 2.40mm (0.0945 in) through 3.2mm (0.1260 in) thick). Install the shim and check valve clearance.

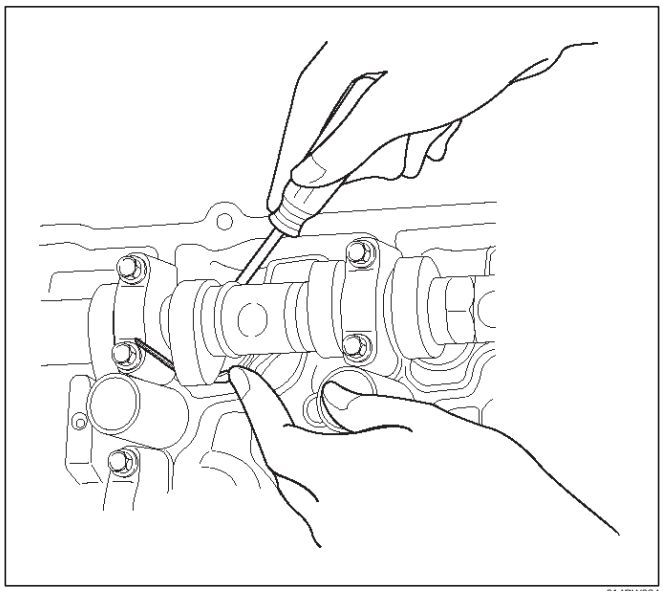
Replacement of Shim

Let the cam push down the edge of tappet by using J–42689 valve clearance adjusting tool and push out the shim with a flat blade screw driver as shown in illustrations below.



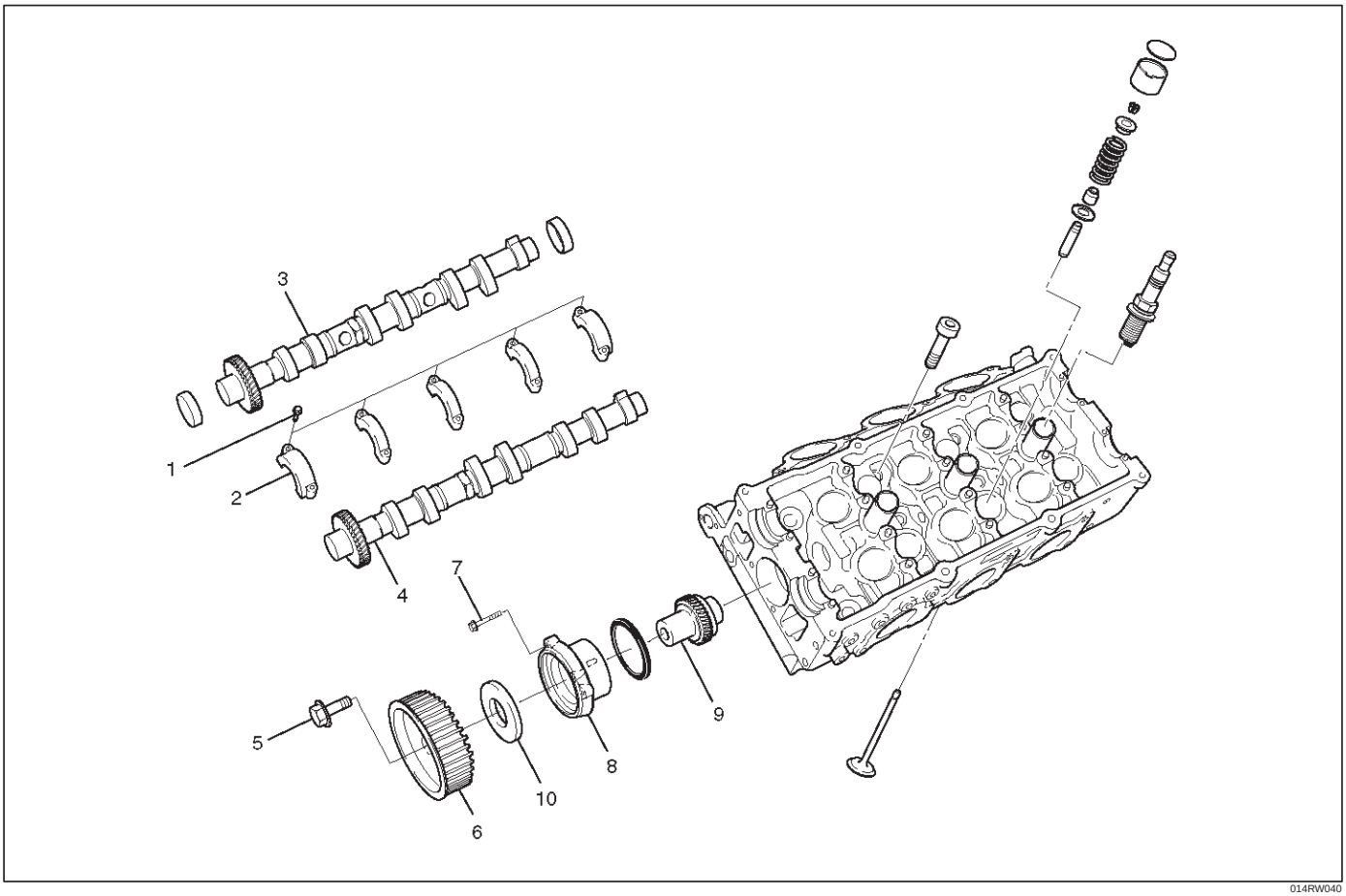
014RW082


014RW083


014RW084

Camshaft

Camshaft and Associated Parts



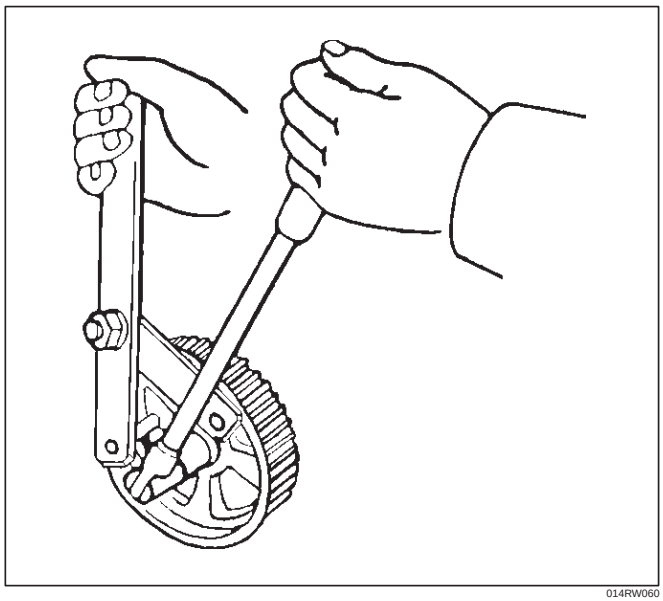
014RW040

Legend

(1) Camshaft Bracket Fixing Bolt
(2) Camshaft Bracket
(3) Camshaft Assembly Intake
(4) Camshaft Assembly Exhaust
(5) Pulley Fixing Bolt
(6) Camshaft Drive Gear Pulley
(7) Retainer Fixing Bolt
(8) Retainer
(9) Camshaft Drive Gear
(10) Oil Seal

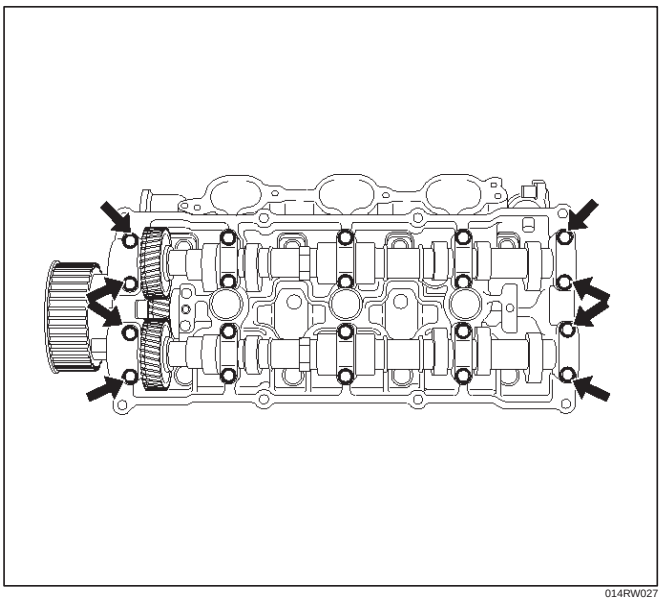
Disassembly

1. Remove fixing bolt (5) for camshaft drive gear pulley using J–43041 universal holder.



014RW060

2. Remove twenty fixing bolts from inlet and exhaust camshaft bracket on one side bank, then camshaft brackets (2).



014RW027

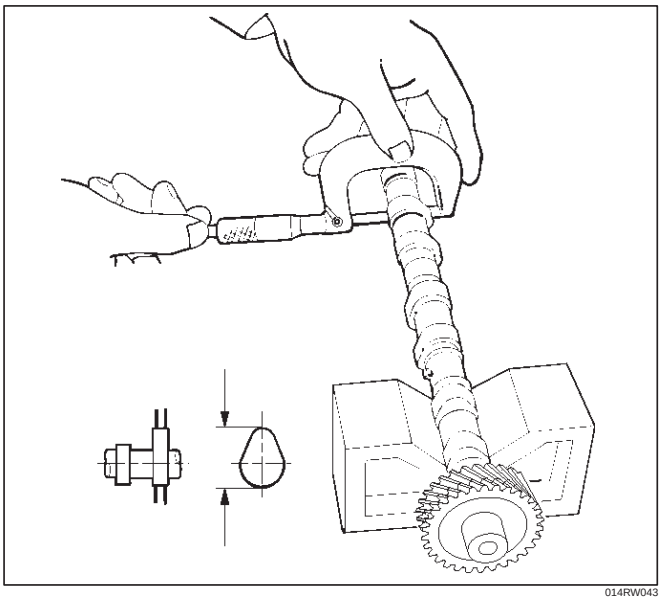
3. Remove camshaft assembly (3), (4).
4. Remove three fixing bolts (7) from camshaft drive gear retainer (8), then camshaft drive gear assembly.

Inspection and Repair

1. Use a micrometer to measure the cam lobe height and uneven wear. Replace the camshaft if either the lobe height or the uneven wear exceeds the specified limit.

Lobe height : 44.709 mm (1.7602 in)

Uneven wear : 0.05 mm (0.0020 in)



014RW043

2. Use a micrometer to measure the diameter and the uneven wear of the camshaft journals.

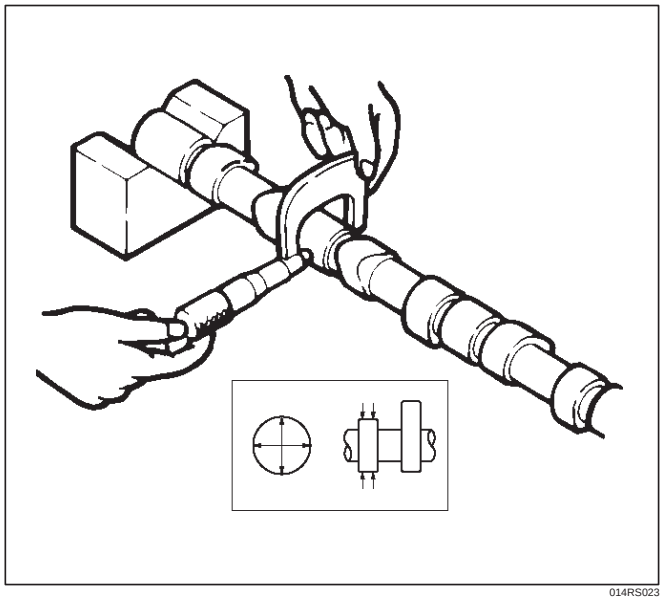
Replace the camshaft if the diameter or the uneven wear exceeds the specified limit.

Journal Diameter

Standard : 25.972 mm–25.993 mm (1.0225 in–1.0233 in)

Limit : 25.8 mm (1.0157 in)

Uneven wear : 0.05 mm (0.0020 in)



014RS023

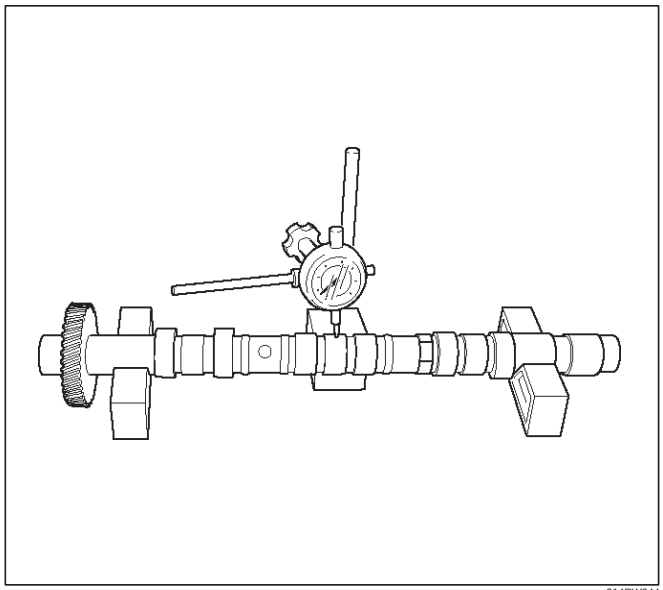
3. Place the camshaft on V–blocks.

Slowly rotate the camshaft and measure the runout with a dial indicator.

Replace the camshaft if the runout exceeds the specified limit.

Run out

Limit : 0.1 mm (0.0039 in)

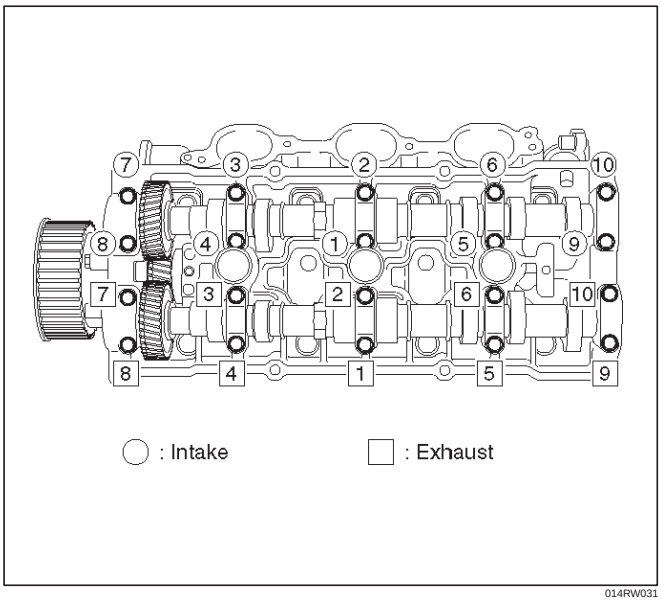


014RW044

4. Measure the camshaft journal oil clearance.
   1. Measure the camshaft bracket housing inside diameter.

NOTE: Tighten camshaft bracket (2) to specified torque before measuring the camshaft bracket inside diameter.

Torque : 10 N·m (89 lb in)



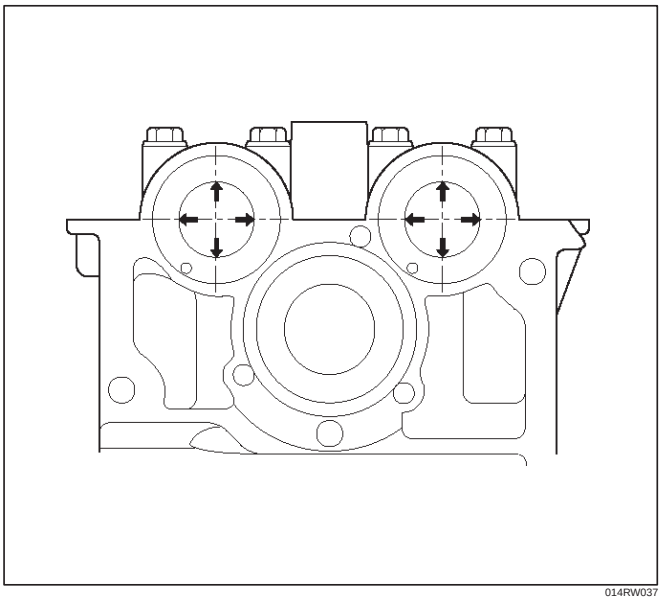
014RW031

   2. Subtract the camshaft outside diameter from the camshaft bracket housing inside diameter.

Oil Clearance

Standard : 0.027 mm–0.078 mm (0.0011 in–0.0031 in)

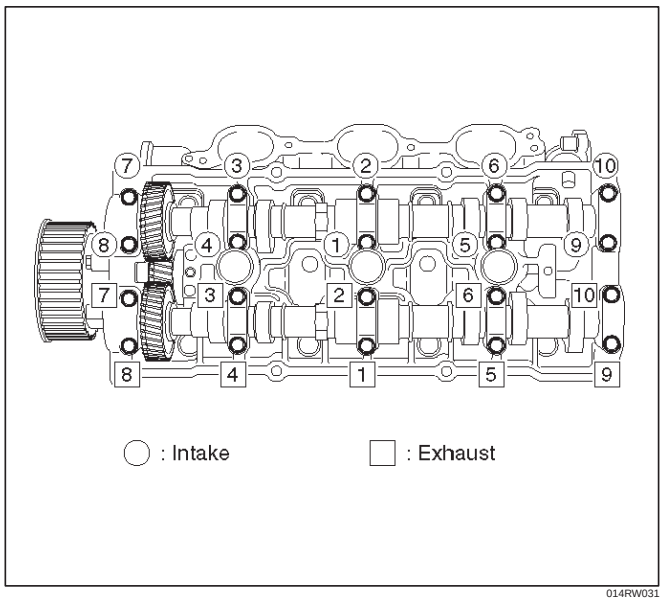
Limit : 0.11 mm (0.0043 in)



014RW037

5. Replace the cylinder head and/or camshaft if the measured oil clearance exceeds the specified limit.
   1. Carefully clean the camshaft journal, the camshaft bracket, and the cylinder head.
   2. Install camshaft assembly and camshaft brackets (2), tighten twenty bolts (1) on one side bank to the specified torque.

Torque: 10 N·m (89 lb in)



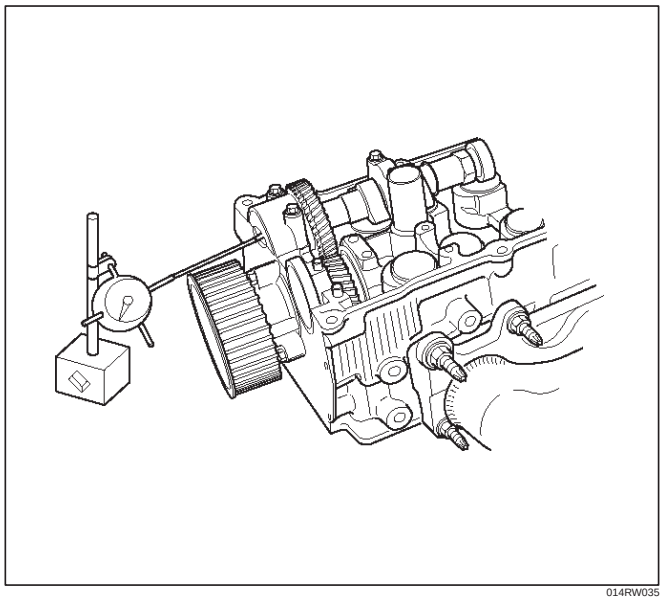
014RW031

   3. Measure the camshaft thrust clearance with a dial indicator. Replace the camshaft and/or the cylinder head if the camshaft thrust clearance exceeds the specified limit.

Camshaft thrust Clearance

Standard : 0.03 mm–0.08 mm (0.0012 in.–0.0031 in.)

Limit : 0.12 mm (0.0047 mm)



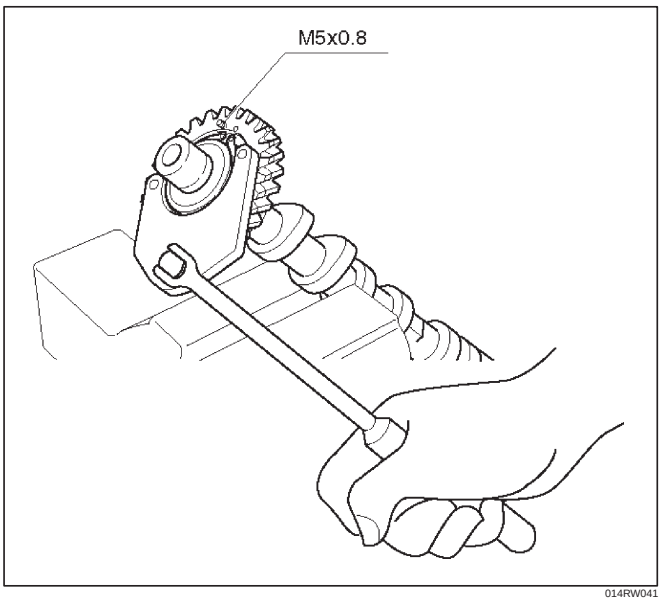
014RW035

Reassembly

1. Install camshaft drive gear assembly and tighten three bolts to specified torque.

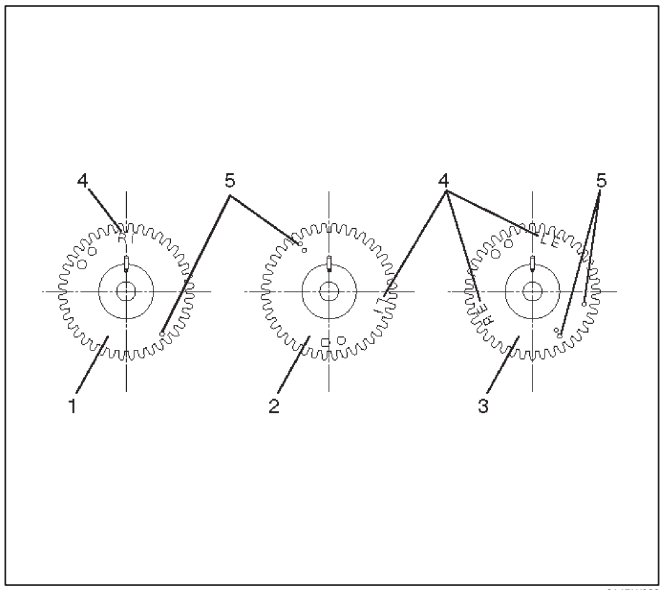
   Torque: 10 N·m (89 lb in)

2. Tighten sub gear setting bolt.
   1. Use J–42686 to turn sub gear to right direction until the M5 bolt hole aligns between camshaft driven gear and sub gear.
   2. Tighten M5 bolt suitable torque for prevent moving the sub gear.



014RW041

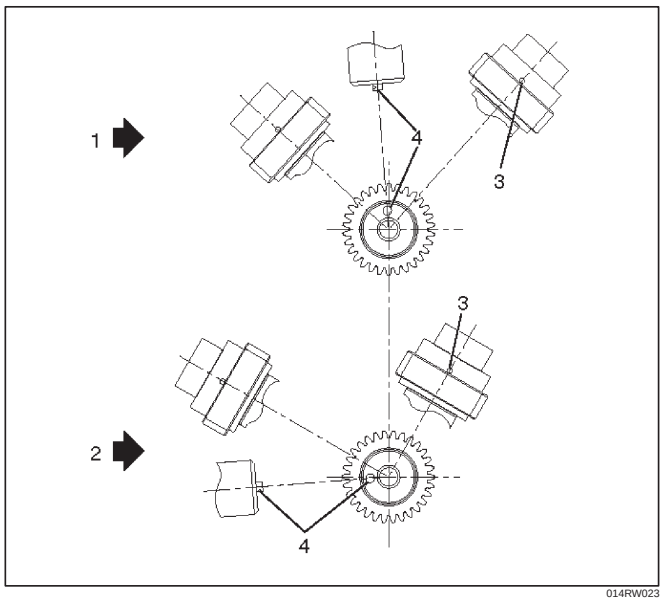
3. Install camshaft assembly and camshaft brackets, tighten twenty bolts on one side bank to the specified torque.
   1. Apply engine oil to camshaft journal and bearing surface of camshaft bracket.
   2. Align timing mark on intake camshaft (one dot for right bank, two dots for left bank) and exhaust camshaft (one dot for right bank, two dots for left bank) to timing mark on camshaft drive gear (one dot).



014RW020

Legend

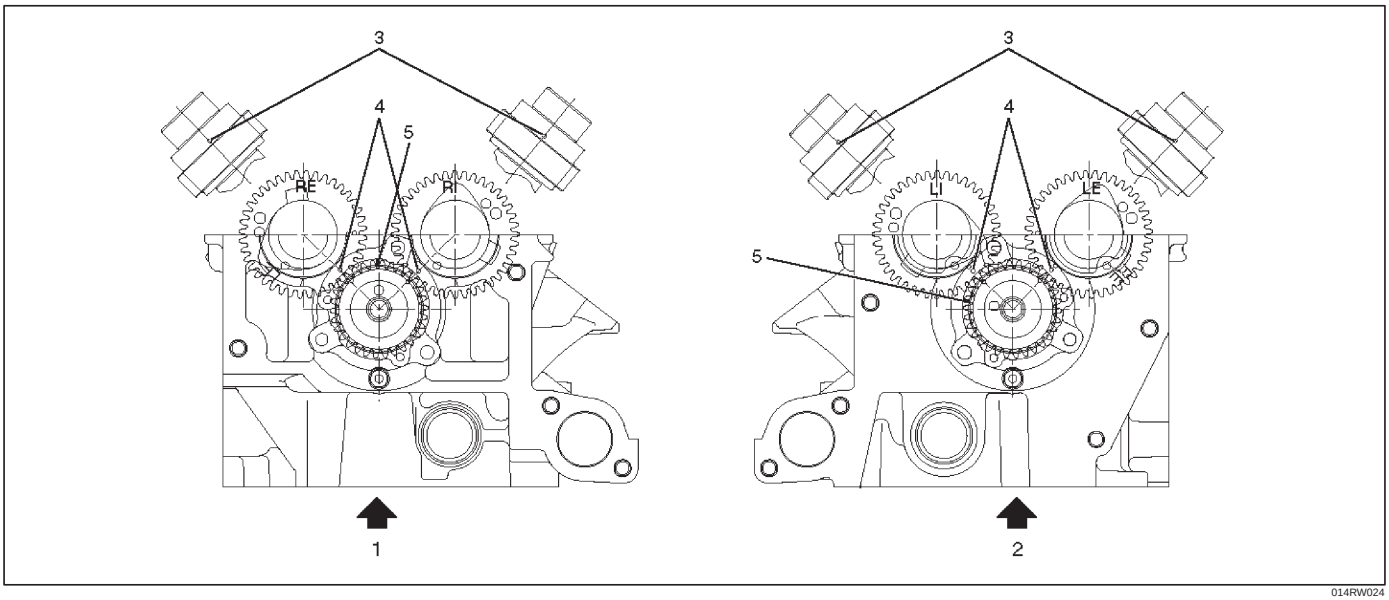
(1) Intake Camshaft Timing Gear for Right Bank
(2) Intake Camshaft Timing Gear for Left Bank
(3) Exhaust Camshaft Timing Gear
(4) Discerning Mark
LI: Left Bank Intake
RI: Right Bank Intake
LE: Left Bank Exhaust
RE: Right Bank Exhaust



014RW023

Legend

(1) Right Bank Camshaft Drive Gear
(2) Left Bank Camshaft Drive Gear
(3) Timing Mark on Drive Gear
(4) Dowel Pin



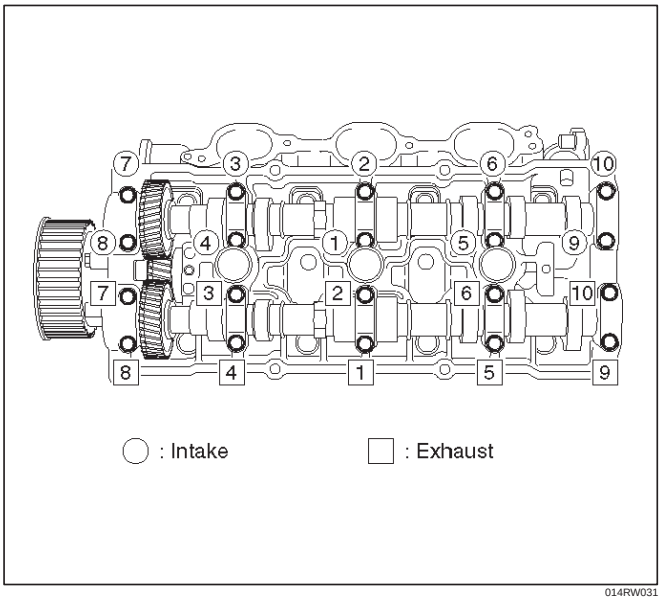
014RW024

Legend

(1) Right Bank
(2) Left Bank
(3) Alignment Mark on Camshaft Drive Gear
(4) Alignment Mark on Camshaft
(5) Alignment Mark on Retainer

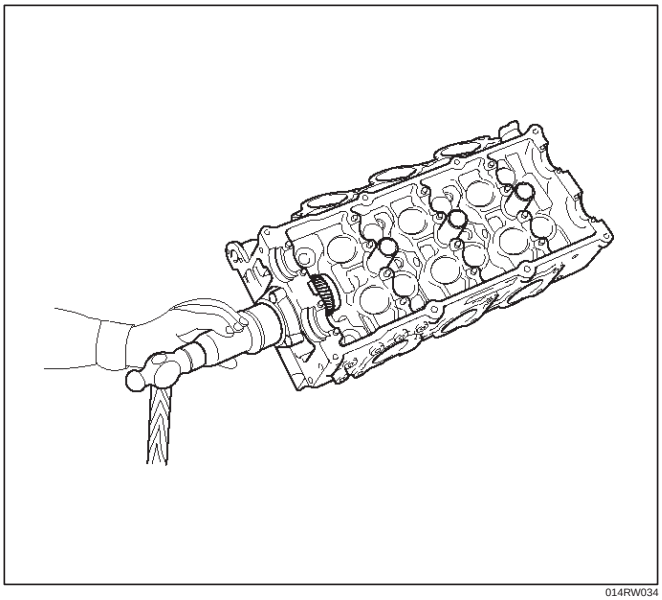
3. Tighten twenty bolts in numerical order on one side bank as shown in the illustration.

Torque: 10 N·m (89 lb in)



014RW031

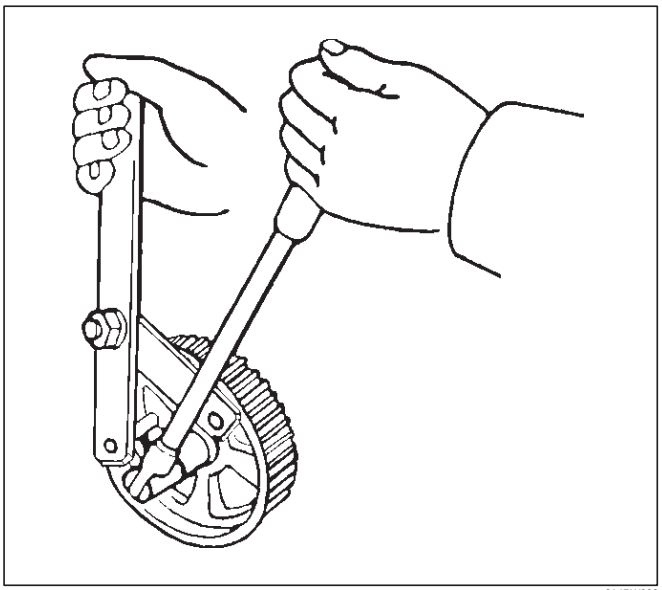
4. If the oil seal requires replacement, use the J–42985 to install the oil seal.



014RW034

5. Tighten bolt for camshaft drive gear assembly pulley to the specified torque using the J–43041 universal holder.

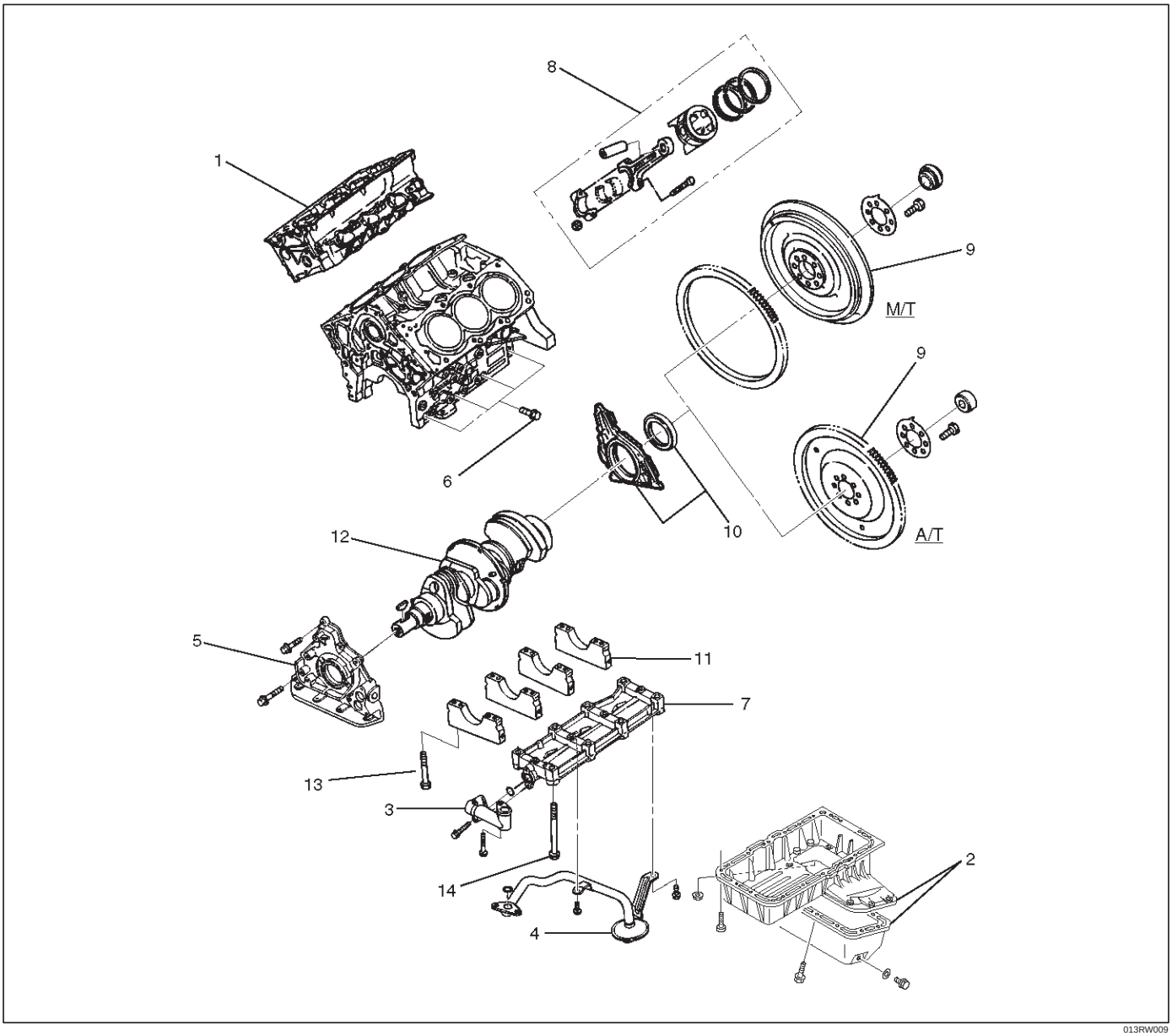
Torque: 98 N·m (72 lb ft)



014RW060

Crankshaft

Crankshaft and Associated Parts



013RW009

Legend

(1) Cylinder Head Assembly
(2) Crankcase with Oil Pan
(3) Oil Pipe and O-ring
(4) Oil Strainer and O-ring
(5) Oil Pump Assembly
(6) Cylinder Block Side Bolts
(7) Oil Gallery
(8) Piston and Connecting Rod Assembly
(9) Flywheel
(10) Rear Oil Seal Retainer and Oil Seal
(11) Main Bearing Cap
(12) Crankshaft
(13) Main Bearing Cap Fixing Bolts
(14) Oil Gallery Fixing Bolts

Disassembly

1. Remove cylinder head assembly (1). Refer to “Cylinder Head” in this manual.
2. Remove crankcase with oil pan (2). Refer to “Oil Pan and Crankcase” in this manual.

CAUTION: Take care not to damage or deform the sealing flange surface of crankcase.

3. Remove oil pipe and O-ring (3).
4. Remove oil strainer and O-ring (4).
5. Remove oil pump assembly (5).
6. Remove crankcase side bolts (6).

7. Remove oil gallery (7).
8. Remove piston and connecting rod assembly (8). Refer to “Piston, Piston Ring and Connecting Rod” in this manual.
9. Remove flywheel (9).
10. Remove rear oil seal retainer (10).
11. Remove main bearing cap (11).
12. Remove crankshaft (12).

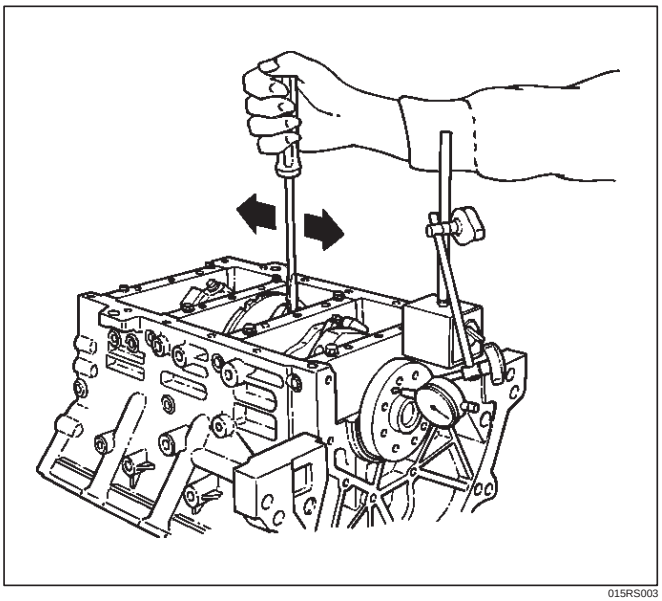
Inspection and Repair

1. Crankshaft
   Set the dial indicator as shown in the illustration and measure the crankshaft thrust clearance. If the thrust clearance exceeds the specified limit, replace the thrust bearings as a set.

   Thrust Clearance

   Standard : 0.06 mm–0.24 mm (0.0024 in–0.0094 in)

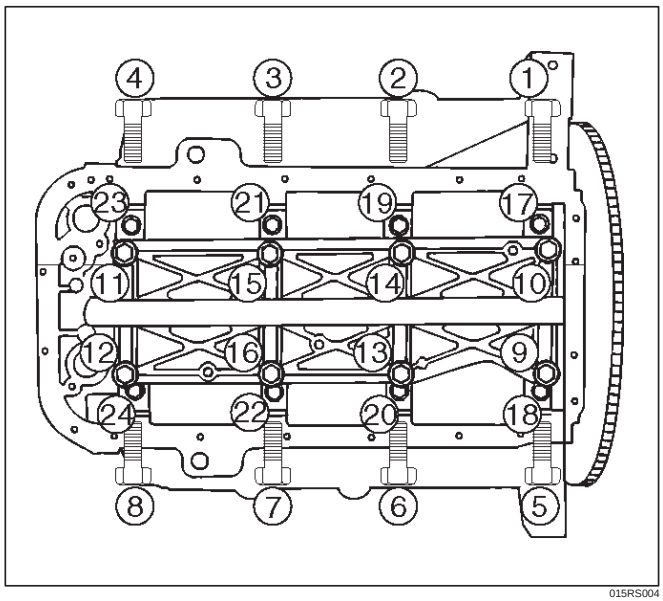
   Limit : 0.30 mm (0.0118 in)



015RS003

Main Bearing Clearance

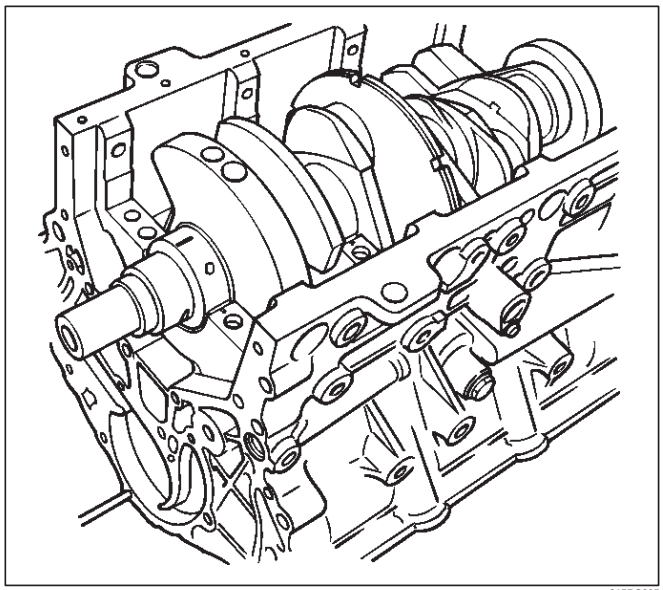
1. Remove the bearing caps and measure the oil clearance.
2. Remove the main bearing cap fixing bolts in the sequence shown in the illustration.
   Arrange the removed main bearing caps in the cylinder number order.
   Remove the main bearings.



015RS004

3. Remove the crankshaft.
   Remove the main bearings.
4. Clean the upper and lower bearings as well as the crankshaft main journal.
5. Check the bearings for damage or excessive wear.
   The bearings must be replaced as a set if damage or excessive wear is discovered during inspection.
6. Set the upper bearings and the thrust washers to their original positions.
   Carefully install the crankshaft.
7. Set the lower bearings to the bearing cap original position.
8. Apply plastigage to the crankshaft journal unit as shown in the illustration.

NOTE: Do not set the plastigage on the oil hole.



015RS005

9. Install main bearing caps, oil gallery and crank case bolts in the order shown, and tighten each bolt to the specified torque.

NOTE: Do not apply engine oil to the crank case side bolts.

Main bearing cap bolts.

Torque: 39 N·m (29lb ft)

Oil gallery fixing bolts.

Torque:

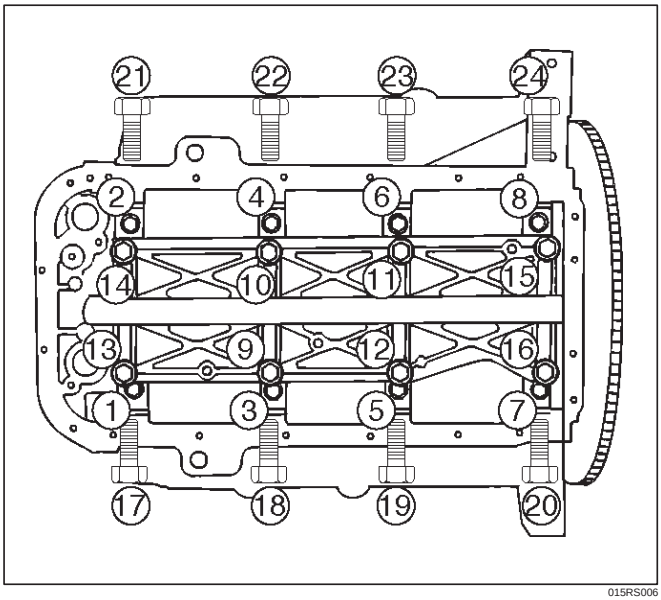
1st step: 29 N·m (21 lb ft)

2nd step 55˚~ 65˚

Crank case side bolts

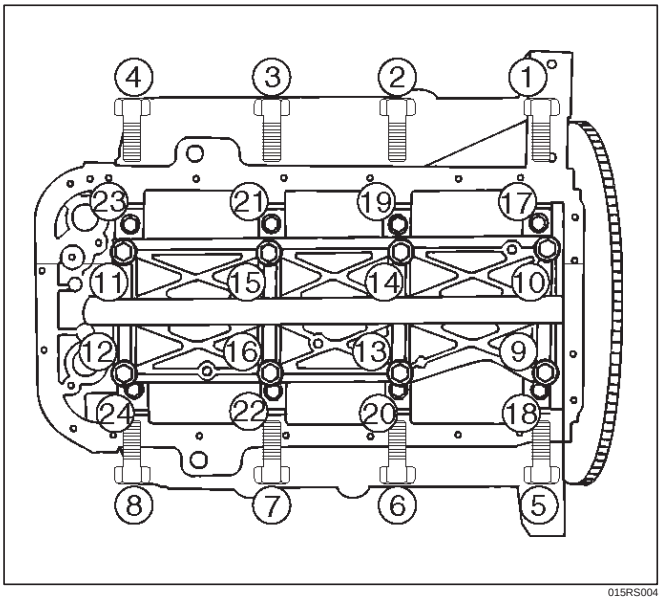
Torque : 39 N·m (29lb ft)

NOTE: Do not allow the crankshaft to rotate.



015RS006

10. Remove the main bearing caps in the sequence shown in the illustration.

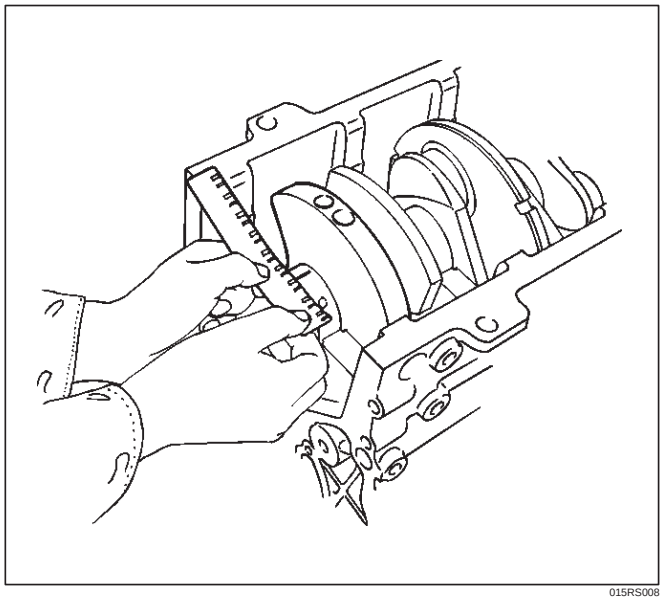


015RS004

11. Measure the plastigage width and determine the oil clearance. If the oil clearance exceeds the specified limit, replace the main bearings as a set and/or replace the crankshaft.

Standard : 0.019 mm–0.043 mm (0.0007 in–0.0017 in)

Limit : 0.08 mm (0.0031 in)


015RS008

12. Clean the plastigage from the bearings and the crankshaft.

Remove the crankshaft and the bearings.

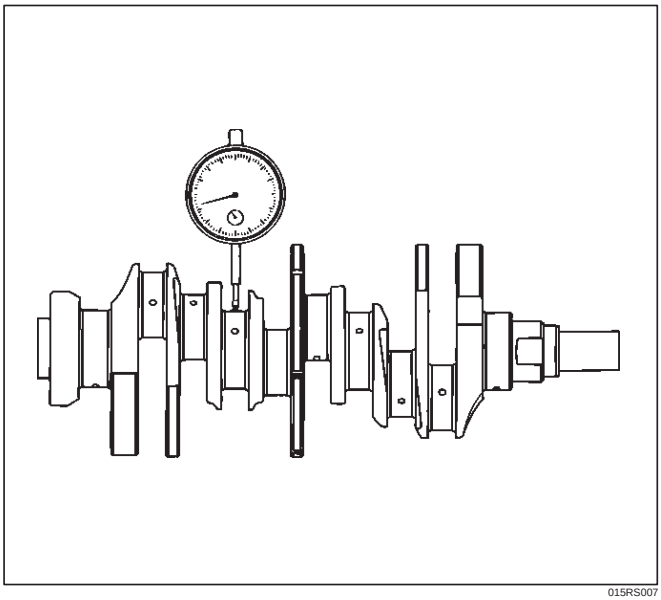
Crankshaft (12) Inspection

Inspect the surface of the crankshaft journal and crank pins for excessive wear and damage. Inspect the oil seal fitting surfaces for excessive wear and damage. Inspect the oil ports for obstructions.

Inspection and Repair

1. Carefully set the crankshaft on the V–blocks. Slowly rotate the crankshaft and measure the runout. If the crankshaft runout exceeds the specified limit, the crankshaft must be replaced.

Runout : 0.04 mm (0.0016 in)

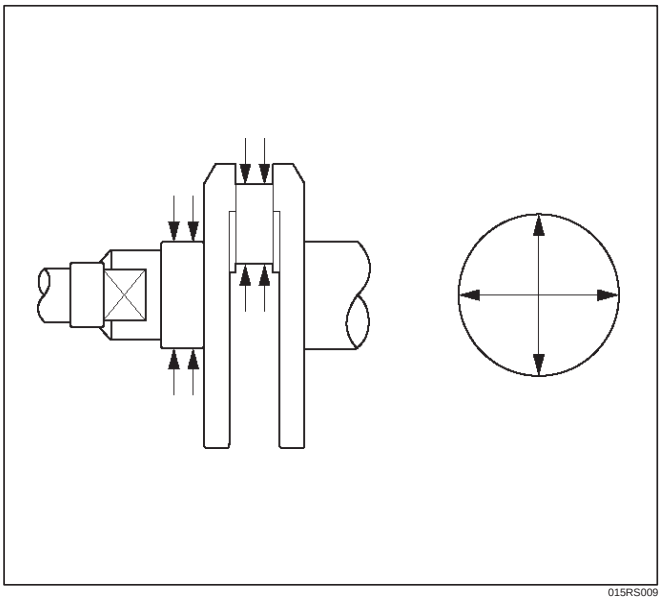


2. Measure the diameter and the uneven wear of main journal and crank pin. If the crankshaft wear exceeds the specified limit, crankshaft must be replaced.

Main journal diameter : 63.918 mm–63.933 mm (2.5165 in–2.5170 in)

Crank pin diameter : 53.922 mm–53.937 mm (2.1229 in.–2.1235 in.)

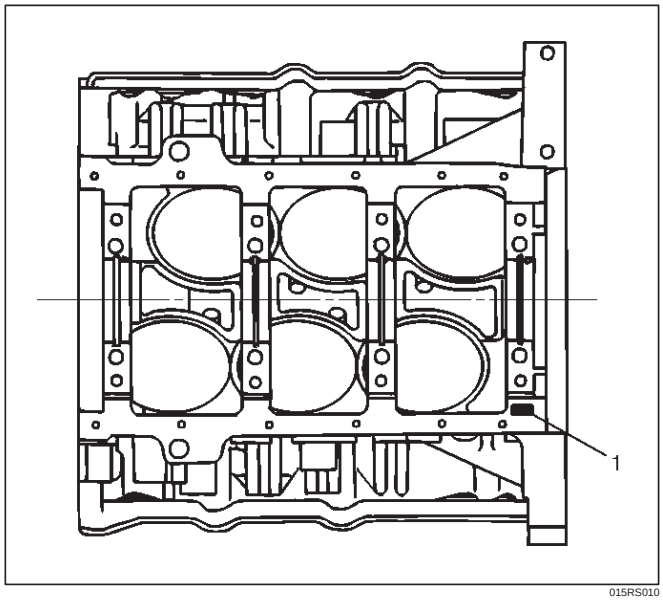
Uneven wear limit : 0.005 mm (0.0002 in)



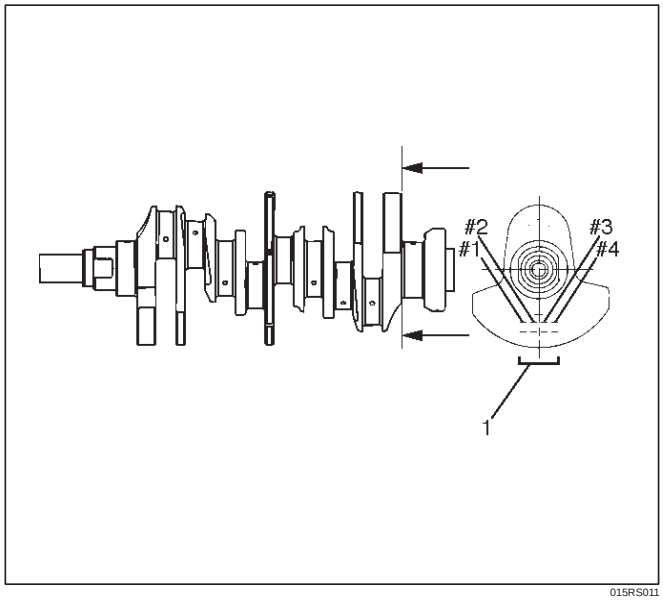
Crankshaft Bearing Selection

When installing new crankshaft bearings or replacing bearings, refer to the selection table below. Select and install the new crankshaft bearings, paying close attention to the cylinder block journal hole.

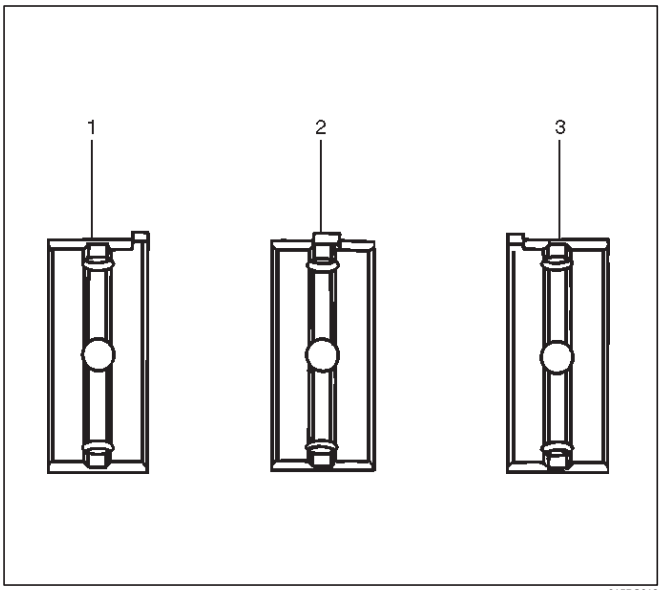
1. Diameter size mark (1) and the crankshaft journal.



2. Diameter size mark (1).
   The diameter size marks are stamped on the No.1 crankshaft balancer as shown in the illustration.



NOTE: Take care to ensure the bearings are positioned correctly.



Legend

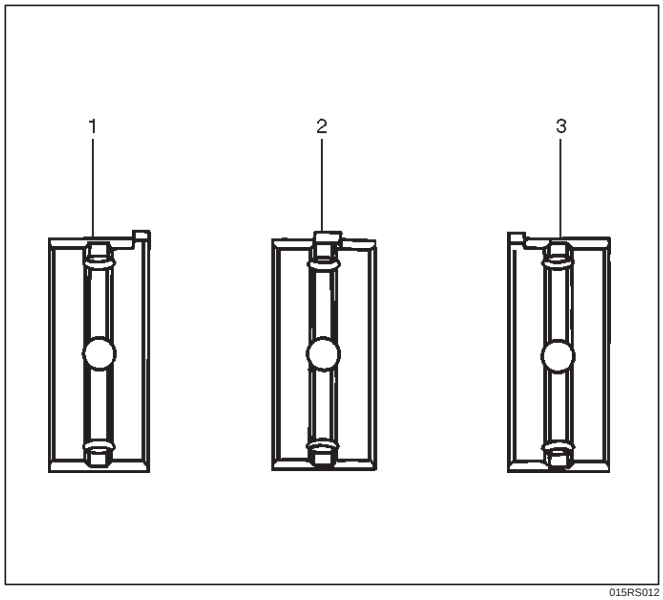
(1) Number 1 and 4 main bearing upper and lower
(2) Number 2 and 3 main bearing upper
(3) Number 2 and 3 main bearing lower

1 Size Mark	Main Bearing Bore Diameter	Crank Shaft Main Journal Diameter	2 Size Mark	Crank Shaft Bearing Size Mark (Upper Side)	Crank Shaft Bearing Size Mark (Lower Side)	Oil Clearance (Reference)
1	68.994-69.000 (2.7163-2.7165)	63.918-63.925 (2.5165-2.5167)	2	Blue	Blue	0.030-0.049 (0.0012-0.0019)
		63.926-63.933 (2.5168-2.5170)	1	Brown	Brown	0.028-0.047 (0.0011-0.0019)
2	68.987-68.993 (2.7160-2.7163)	63.918-63.925 (2.5165-2.5167)	2			0.029-0.048 (0.0011-0.0019)
		63.926-63.933 (2.5168-2.5170)	1	Green	Green	0.027-0.046 (0.0011-0.0018)
3	68.980-68.986 (2.7157-2.7160)	63.918-63.925 (2.5165-2.5167)	2			0.028-0.047 (0.0011-0.0019)
		63.926-63.933 (2.5168-2.5170)	1	Yellow	Yellow	0.026-0.045 (0.0010-0.0018)

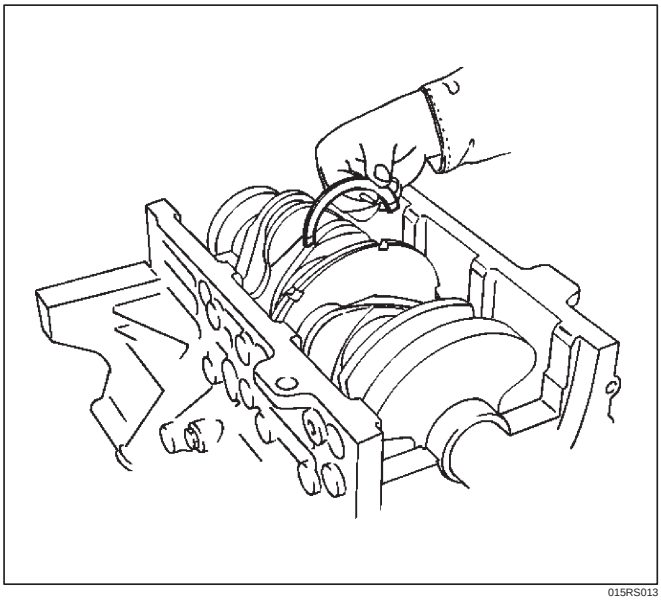
Reassembly

1. Crankshaft (12)
   - Install the main bearings to the cylinder block and the main bearing caps.
   - Be sure that they are positioned correctly.
   - Apply new engine oil to the upper and lower main bearing faces.

NOTE: Do not apply engine oil to the main bearing back faces.



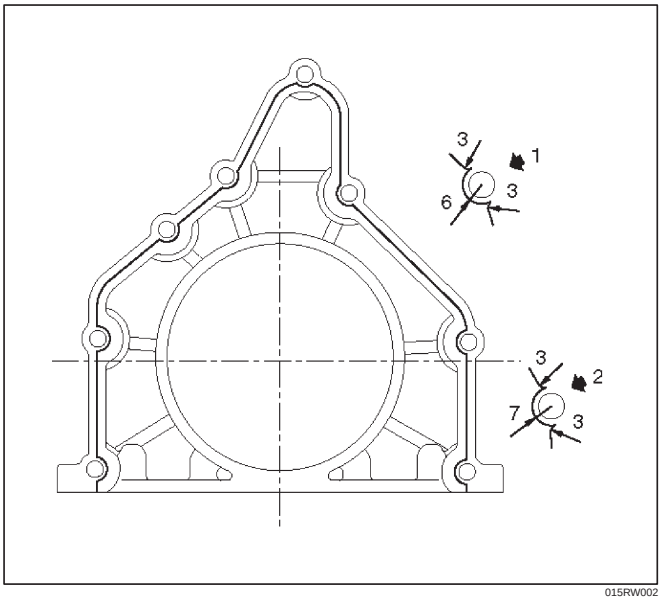
- Carefully mount the crankshaft.
- Apply engine oil to the thrust washer.
- Assemble the thrust washer to the No.3 bearing journal. The oil grooves must face the crankshaft.



015RS013

2. Rear oil seal (10)
   - Remove the oil from the cylinder block and the retainer mounting surface.
   - Apply sealant (TB–1207B or equivalent) to the retainer mounting surface, following the pattern shown in the illustration.

     The retainer must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.



015RW002

Legend

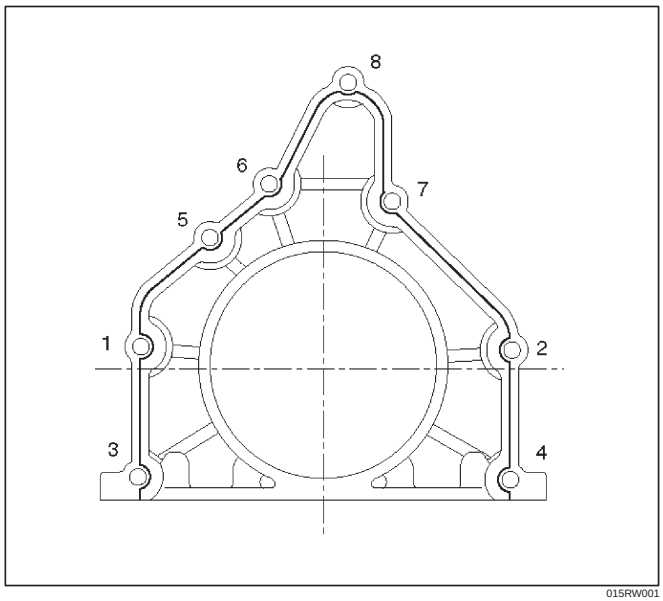
(1) Around Bolt Holes
(2) Around Dowel Pin

- Apply engine oil to the oil seal lip.
- Align the cylinder block dowel pin holes with the rear retainer dowel pins.
- Tighten the rear retainer fixing bolts. New bolts should be used when installing rear retainer.

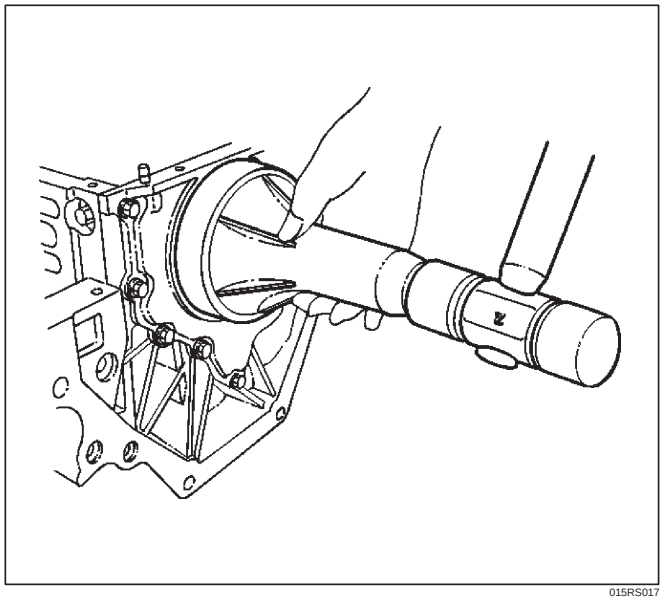
Torque: 18 N·m (13 lb ft)

NOTE: Be very careful not to disengage the oil seal garter spring during installation of the rear retainer.

If the seal was removed from retainer for replacement, apply engine oil to the oil seal lip and install the oil seal using J–39201 oil seal installer.



015RW001



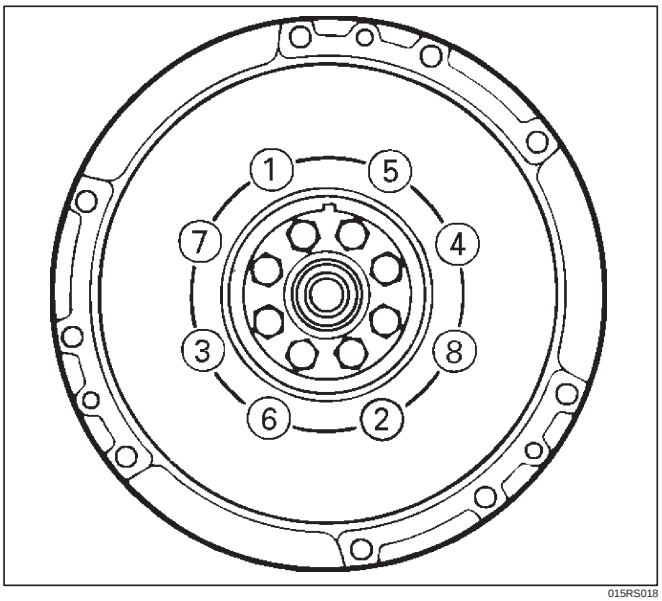
015RS017

3. Flywheel (9)
   1. Thoroughly clean and remove the oil from the threads of crankshaft.
   2. Remove the oil from the crankshaft and flywheel mounting faces.
   3. Mount the flywheel on the crankshaft and then install the washer.

4. Hold the crankshaft to prevent from rotating then install the bolts in the order shown to the specified torque.

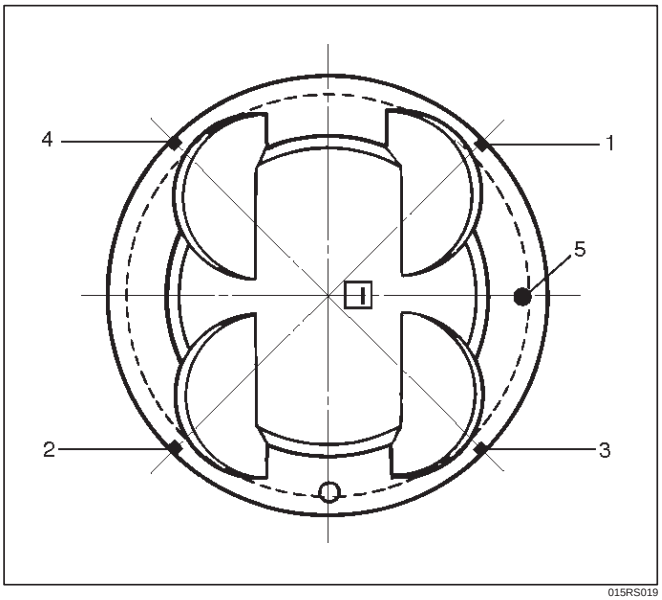
Torque: 54 N·m (40 lb ft)

NOTE: Do not reuse the bolt and do not apply oil or thread lock to the bolt.



015RS018

4. Piston and connecting rod assembly (8)
   - Apply engine oil to the cylinder bores, the connecting rod bearings and the crankshaft pins. Check to see that the piston ring end gaps are correctly positioned.



015RS019

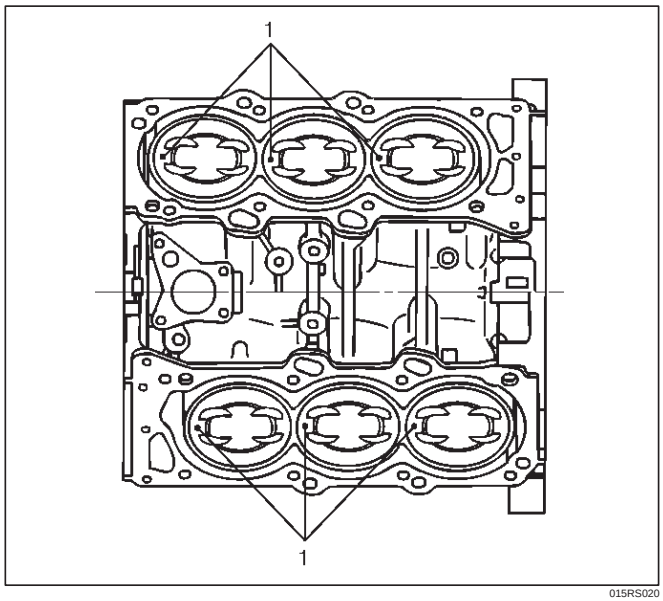
Legend
(1) No.1 Compression Ring
(2) No.2 Compression Ring
(3) Oil Ring Side Rail Upper
(4) Oil Ring Side Rail Lower
(5) Piston Front Mark

   - Insert the piston/connecting rod assemblies into each cylinder with the piston ring compressor. The front marks must be facing the front of the engine.
   - Match the numbered caps with the numbers on the connecting rods. Align the punched marks on the connecting rods and caps.
   - Apply engine oil to the threads and seating faces of the nuts.
   - Tighten the nuts.

Torque: 54 N·m (40 lb ft)

After tightening the cap nuts, check to see that the crankshaft rotates smoothly.

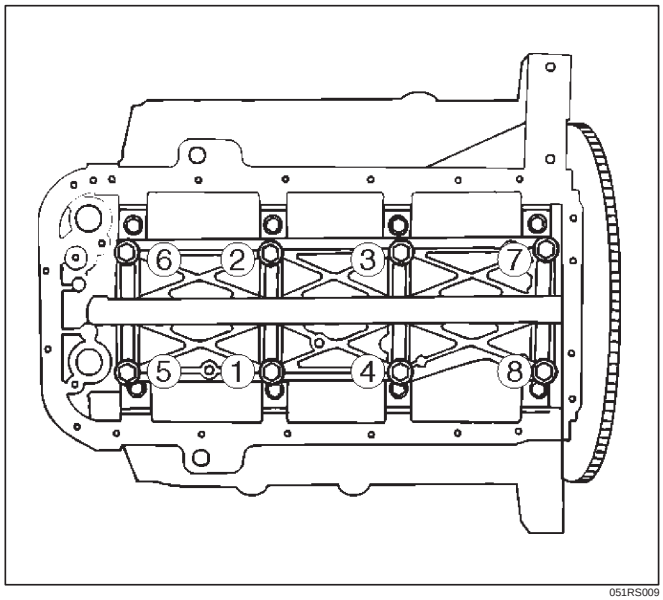
NOTE: Do not apply engine oil to the bearing back faces.



015RS020

5. Install oil gallery (7) and tighten the bolts in 2 steps, in the order shown.

1st step: 29 N·m (22 lb ft)
2nd step: 55°~65°

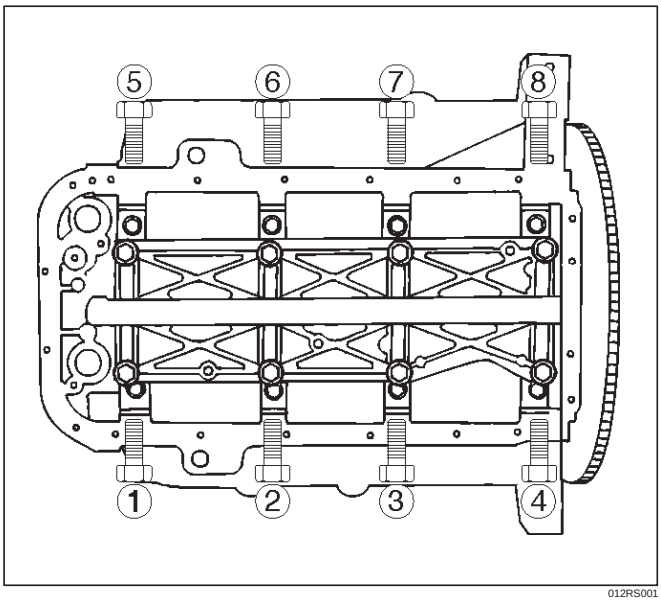


051RS009

6. Cylinder block side bolts (6)
   - Tighten all the bolts to the specified torque in the order shown.

NOTE: Do not apply engine oil to the crank case side bolts.

Torque: 39 N·m (29 lb ft)



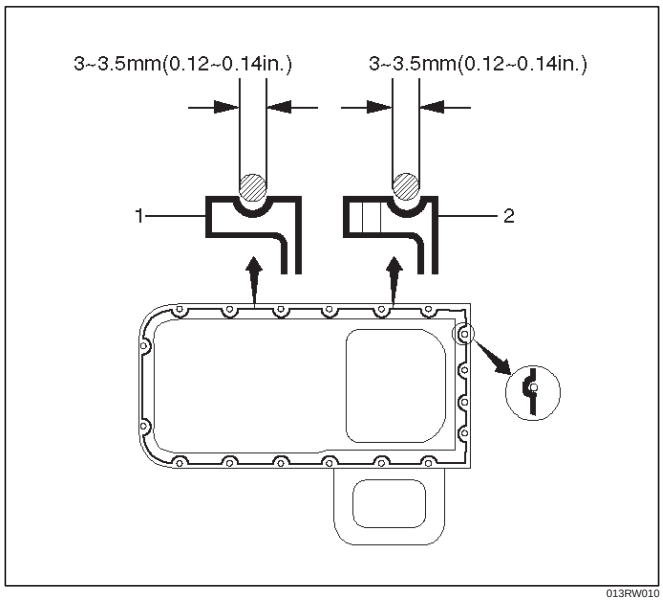
012RS001

7. Install oil pump assembly (5), refer to “Oil pump” in this manual.
8. Install oil strainer and O-ring (4).
9. Install oil pipe and O-ring (3) and tighten the bolts.

Torque: 25 N·m (18 lb ft)

10. Install crankcase with oil pan (2).
    1. Completely remove all residual sealant, lubricant and moisture from the sealing surfaces. The surfaces must be perfectly dry.
    2. Apply a correct width bead of sealant (TB—1207C or its equivalent) to the contact surfaces of the oil pan. There must be no gaps in the bead.
    3. The crankcase assembly must be installed within 5 minutes after sealant application.
    4. Tighten the bolts and nuts to the specified torque.

Torque : 10 N·m (89 lb in)



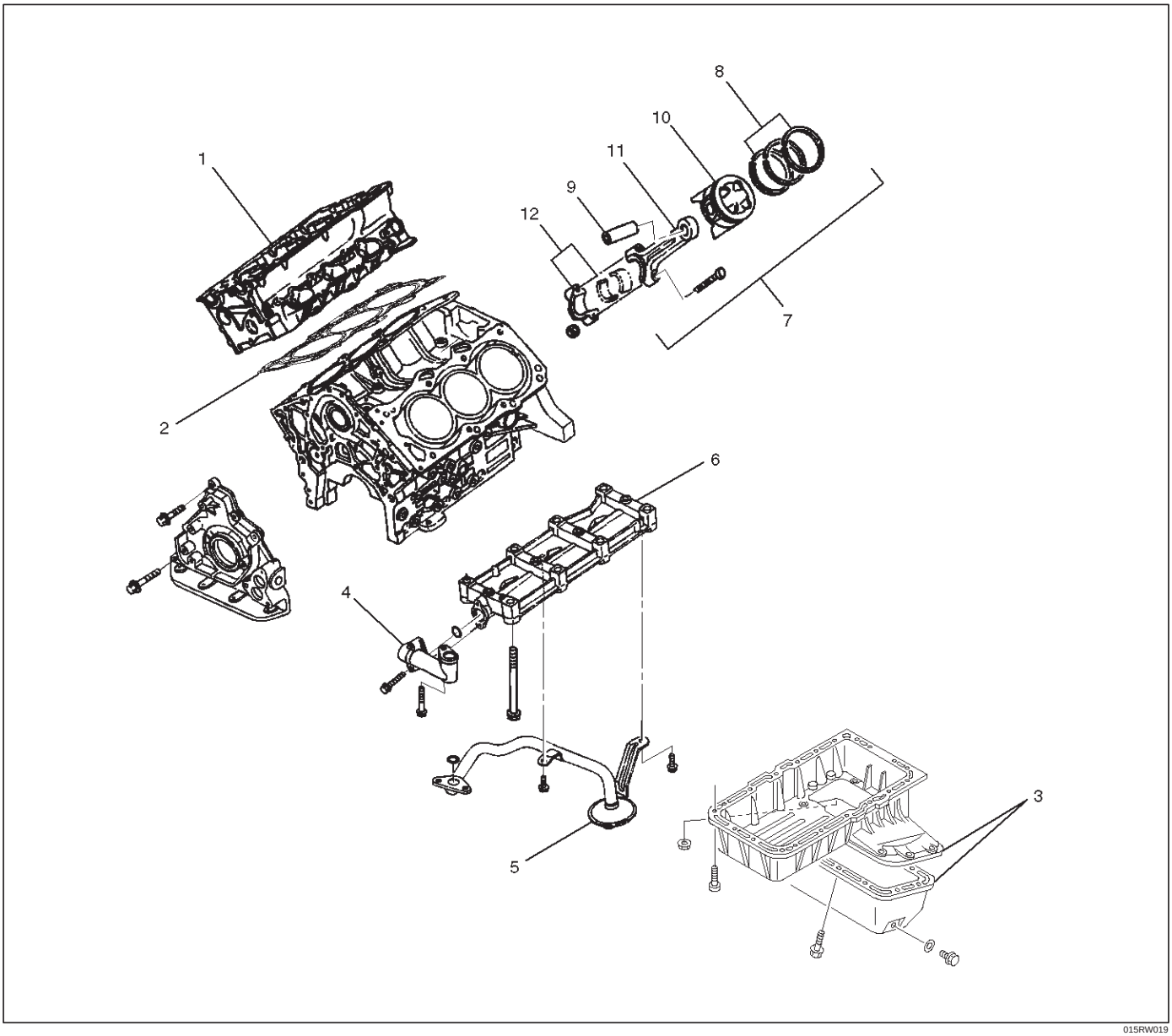
013RW010

Legend
(1) Portion Between Bolt Holes
(2) Bolt Hole Portion

11. Install cylinder head assembly, refer to “Cylinder head” in this manual.

Piston and Connecting Rod

Piston, Connecting Rod and Associate Parts



015RW019

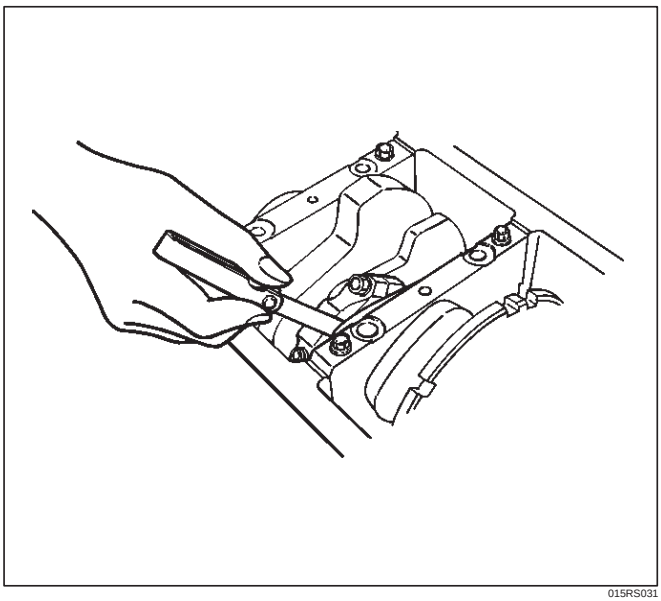
Legend

(1) Cylinder Head Assembly
(2) Cylinder Head Gasket
(3) Crankcase with Oil Pan
(4) Oil Pipe and O-ring
(5) Oil Strainer and O-ring
(6) Oil Gallery
(7) Piston and Connecting Rod Assembly
(8) Piston Ring
(9) Piston Pin
(10) Piston
(11) Connecting Rod
(12) Connecting Rod Cap

Disassembly

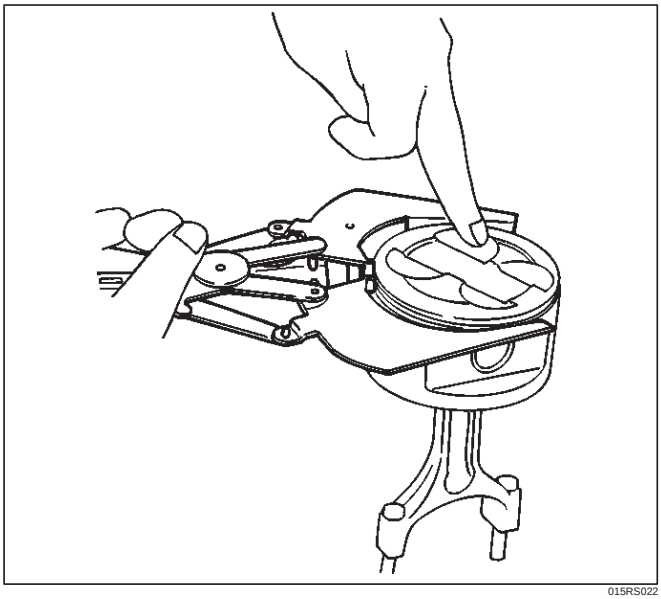
1. Remove cylinder head assembly (1). Refer to “Cylinder Head Removal” in this manual.
2. Remove cylinder head gasket (2).
3. Remove crankcase with oil pan (3). Refer to“Oil Pan and Crankcase” in this manual.
4. Remove oil pipe and O-ring (4).
5. Remove oil strainer and O-ring (5).
6. Remove oil gallery (6).
7. Remove connecting rod cap with connecting rod lower bearing (12).
8. Remove piston and connecting rod assembly (7).

NOTE: Before removing piston and connecting rod assembly, measure thrust clearance.


015RS031

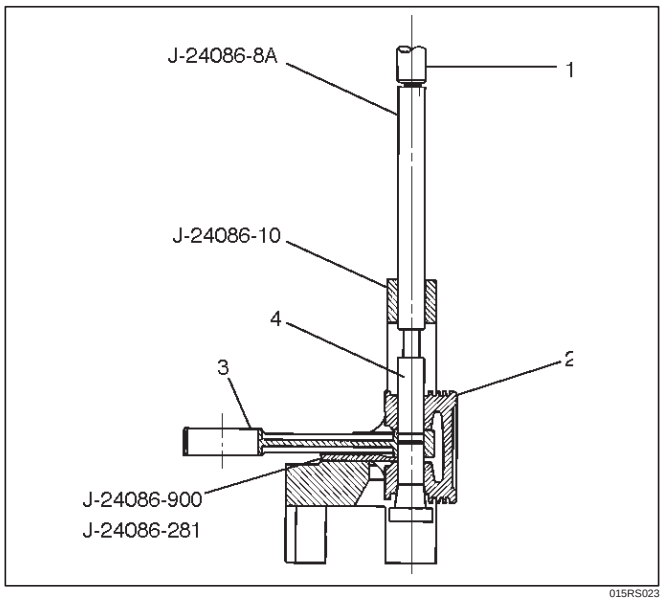
- Remove any ridge or carbon build up from the top end of the cylinder.

9. Remove the piston rings (8) with a piston ring expander. Arrange the removed piston rings in the cylinder number order.


015RS022

10. Remove the piston pin (9) using J–24086–C piston pin service set and piston support with a press.

NOTE: Keep the parts removed from each cylinder separate. All parts must be reinstalled in their original positions. Heating the connecting rod will permit easy removal of the piston pin.



015RS023

Legend

(1) Press Ram
(2) Piston
(3) Connecting Rod
(4) Piston Pin

11. Piston (10)
12. Connecting rod (11)

Inspection and Repair

Pistons (10)

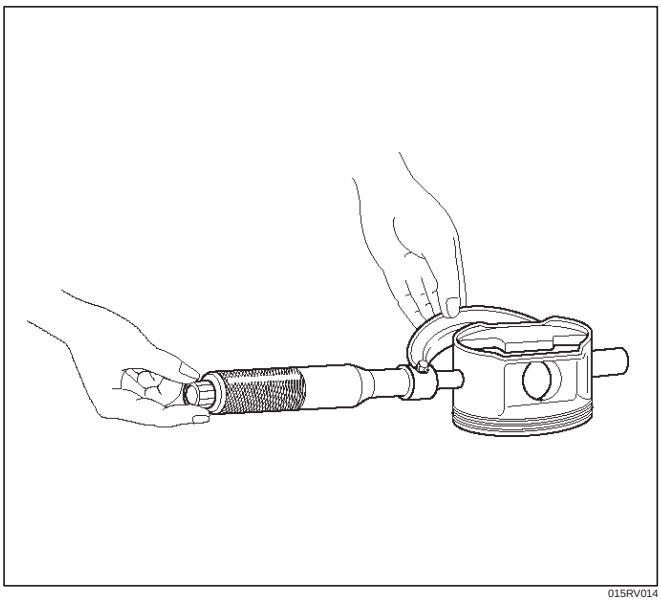
Carefully clean away all the carbon adhering to the piston head and the piston ring grooves.

NOTE: Never use a wire brush to clean the pistons. Damage will result. Visually check each piston for cracking, scoring, and other signs of excessive wear. If any of the above conditions are found, the piston must be replaced.

Piston Diameter

1. Measure the piston outside diameter with micrometer at the piston grading position and a right angle to the piston pin.
   Piston grading position (from piston head)

   Piston grading position : 43.0 mm (1.6929 in)


015RV014

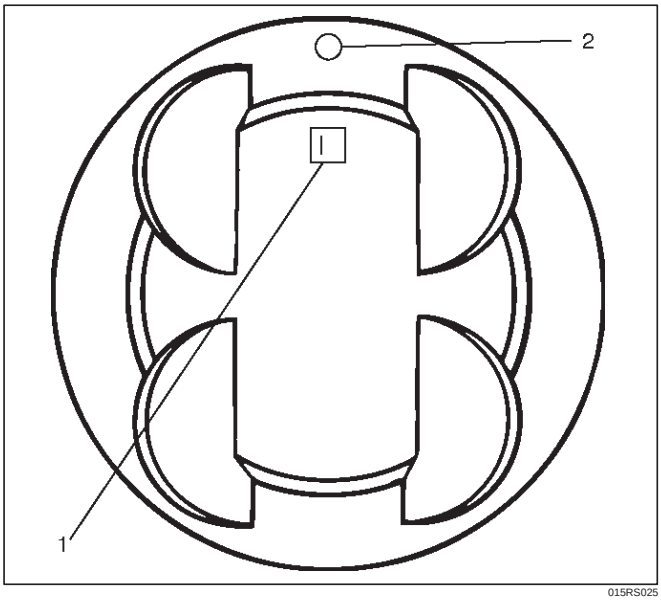
The size mark (1) for piston outside diameter is represented as shown in Figure.

Outside Diameter

Size Mark A : 93.360 mm–93.370 mm (3.6756 in–3.6760 in)

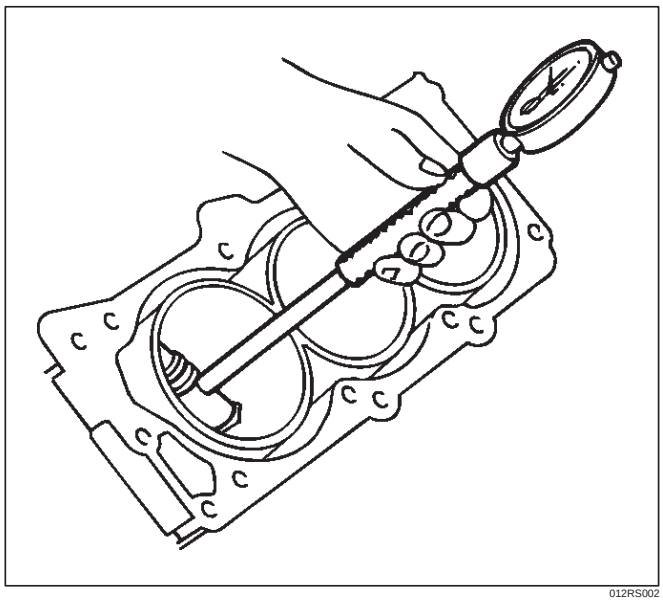
Size Mark B : 93.371 mm–93.380 mm (3.6760 in–3.6764 in)

Size Mark C : 93.381 mm–93.390 mm (3.6764 in–3.6768 in)



015RS025

Measure the cylinder bore inside diameter (refer to “Cylinder Block” in this manual).


012RS002

Piston Rings (8)

Any worn or damaged part discovered during engine overhaul must be replaced with a new one.

1. Ring end gap measurement
   - Insert the piston ring into the bore.
   - Push the ring by the piston, at a right angle to the wall, into the point at which the cylinder bore diameter is the smallest.
   - Measure the ring end gap.

Compression Ring

1st ring

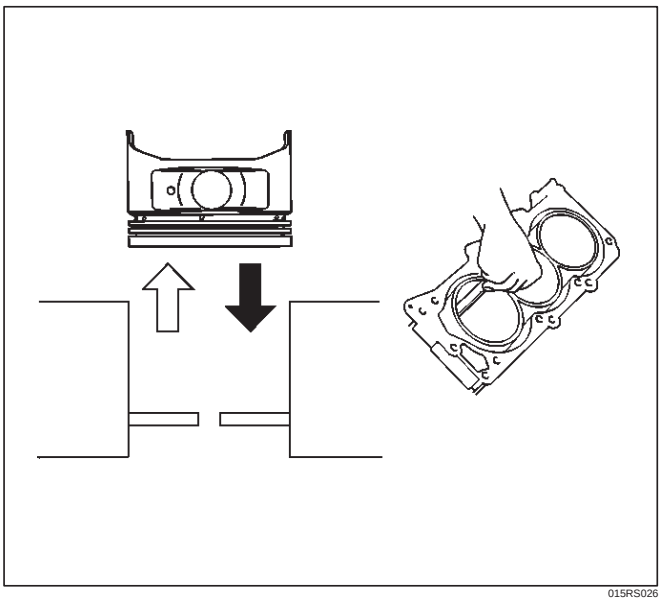
Standard:	**0.300 mm–0.400 mm (0.0118 in–0.0157 in)**
Limit:	**1.0 mm (0.0394 in)**

2nd ring

Standard:	**0.450 mm–0.600 mm (0.0177 in–0.0236 in)**
Limit:	**1.2 mm (0.0472 in)**

Oil ring

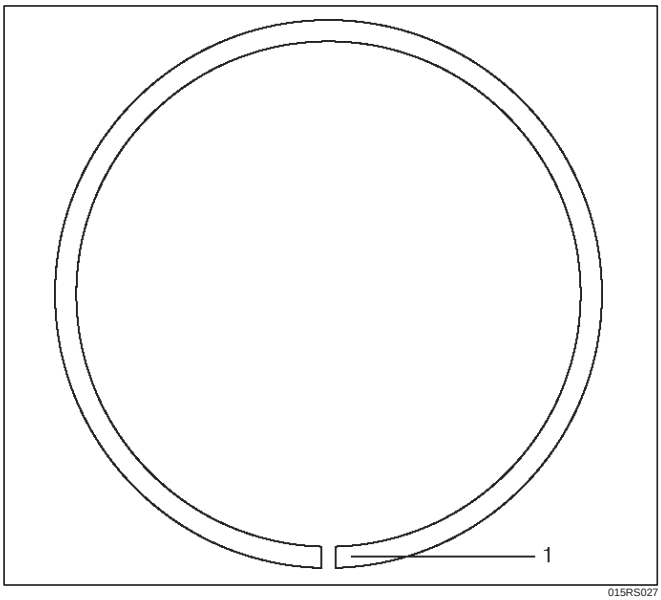
Standard:	**0.150 mm–0.450 mm (0.0059 in–0.0177 in)**
Limit:	**1.05 mm (0.0413 in)**


015RS026

- Positioning mark (1) is painted as shown in the illustration.

Marked T : No.1 Compression ring

Marked T2 : No.2 Compression ring



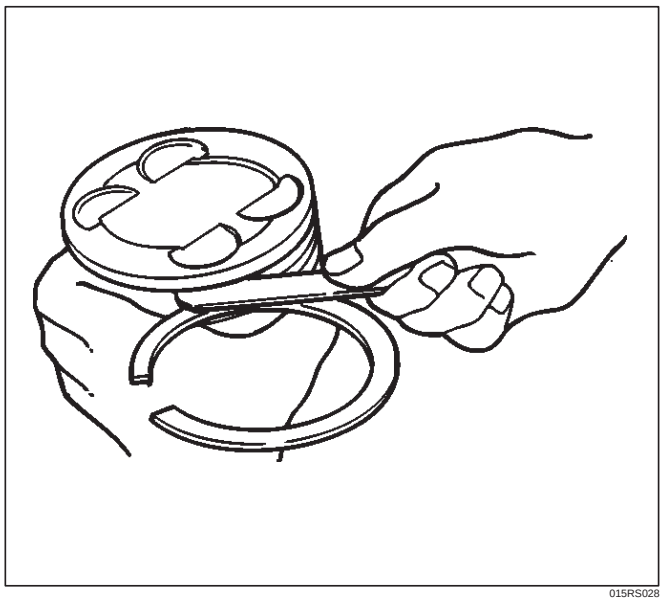
015RS027

2. Measure the clearance between the piston ring groove and the piston ring with a feeler gauge. If the piston ring groove / piston ring clearance exceeds the specified limit, the piston must be replaced.

Compression Ring Clearance

Standard : 0.025 mm–0.065 mm (0.0006 in.–0.0015 in)

Limit : 0.1mm (0.0059 in)

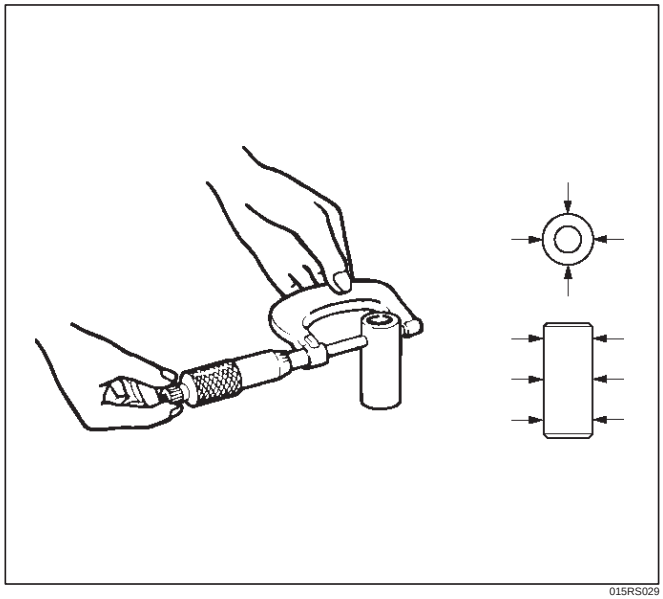

015RS028

Piston Pin (9)

NOTE: Do not reuse the old piston pin.

1. Use a micrometer to measure the new piston pin outside diameter in both directions at three different positions.
2. Measure the inside diameter of the connecting rod small end. If the fitting interference between the small end and pin does not conform to the specified value, the connecting rod must be replaced.

Standard : 0.023 mm–0.038 mm (0.0009 in–0.0015 in)


015RS029

3. Insert the new pin into the piston and rotate it. If the pin rotates smoothly with no backlash, the clearance is normal. If there is backlash or roughness, measure the clearance. If the clearance exceeds the specified limit, the piston must be replaced.

Clearance

Standard : 0.010 mm–0.017 mm (0.0004 in.–0.0007 in)

Limit : 0.040 mm (0.0016 in)

Connecting Rods (11)

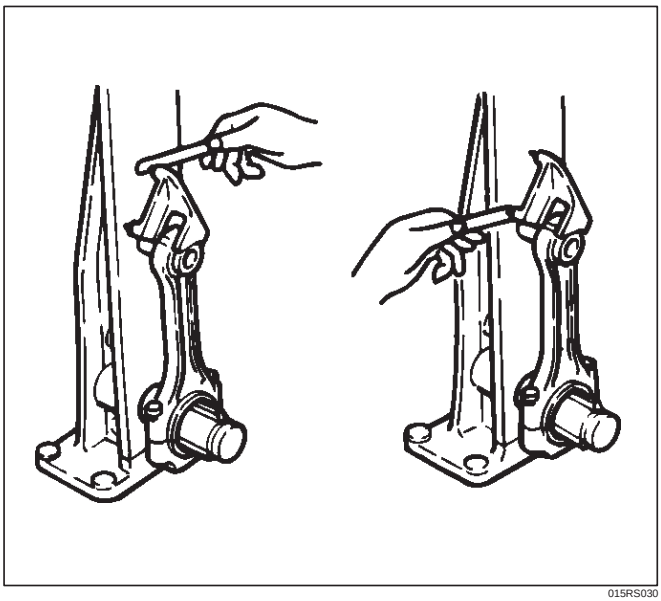
1. Check the connecting rod alignment If either the bend or the twist exceeds the specified limit, the connecting rod must be replaced.

Bend per 100 mm (3.937 in)

Limit: 0.15 (0.0059)

Twist per 100 mm (3.937 in)

Limit: 0.20 (0.0078)

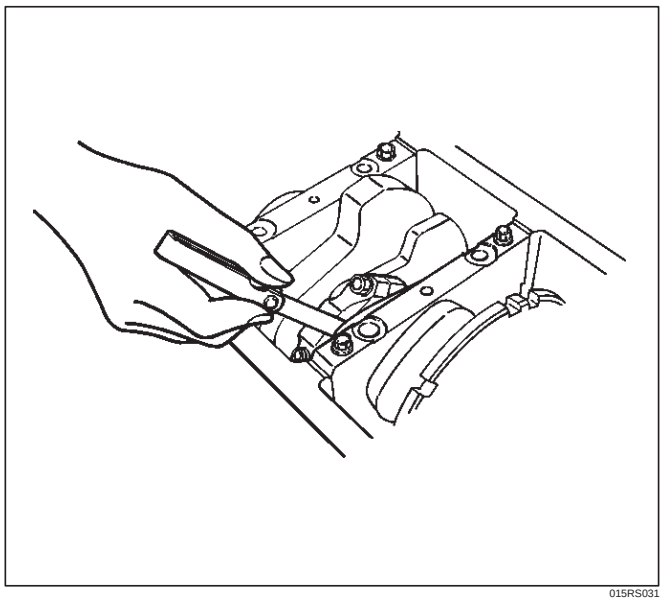


015RS030

2. Measure the connecting rod thrust clearance. Use a feeler gauge to measure the thrust clearance at the large end of the connecting rod If the clearance exceeds the specified limit, the connecting rod must be replaced.

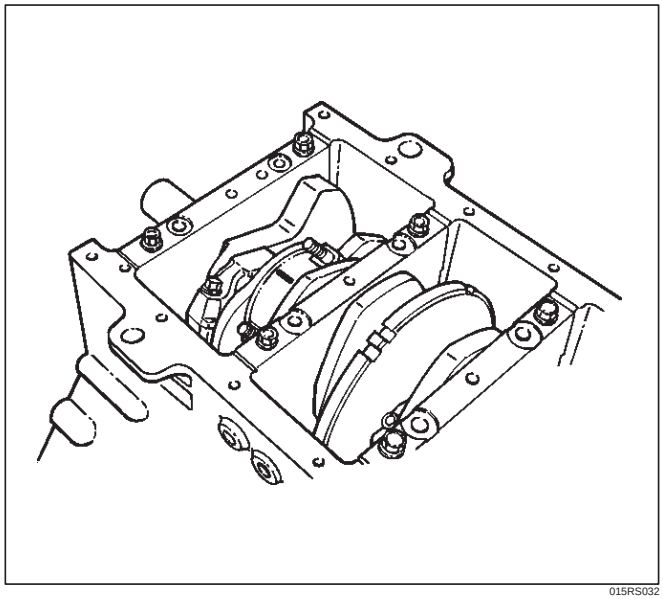
Standard : 0.16 mm–0.35 mm (0.0063 in.–0.0138 in)

Limit : 0.40 mm (0.0157 in)



015RS031

3. Measure the oil clearance between the connecting rod and the crankshaft.
   1. Remove the connecting rod cap nuts and the rod caps (12).
      Arrange the removed rod caps in the cylinder number order.
   2. Clean the rod bearings and the crankshaft pins.
   3. Carefully check the rod bearings. If even one bearing is found to be damaged or badly worn, the entire bearing assembly must be replaced as a set. Reinstall the bearings in their original positions. Apply plastigage to the crank pin.



015RS032

   4. Reinstall the rod caps (12) to their original positions.
      Tighten the rod cap nuts.

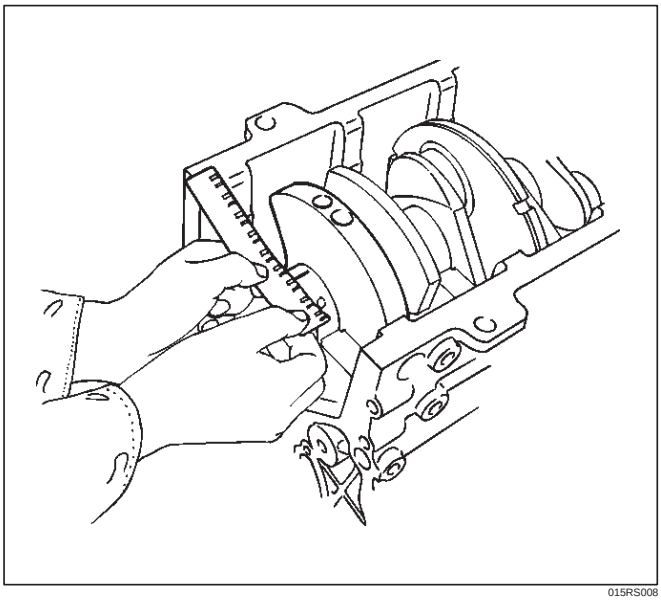
Torque: 54 N·m (40 lb ft)

NOTE: Do not allow the crankshaft to rotate.

5. Remove the rod caps.
6. Measure the width of the plastigage and determine the oil clearance. If the oil clearance exceeds the limit, replace the rod bearing as a set.

Standard : 0.019 mm–0.043 mm (0.0007 in–0.0017 in)

Limit : 0.08 mm (0.0031 in)

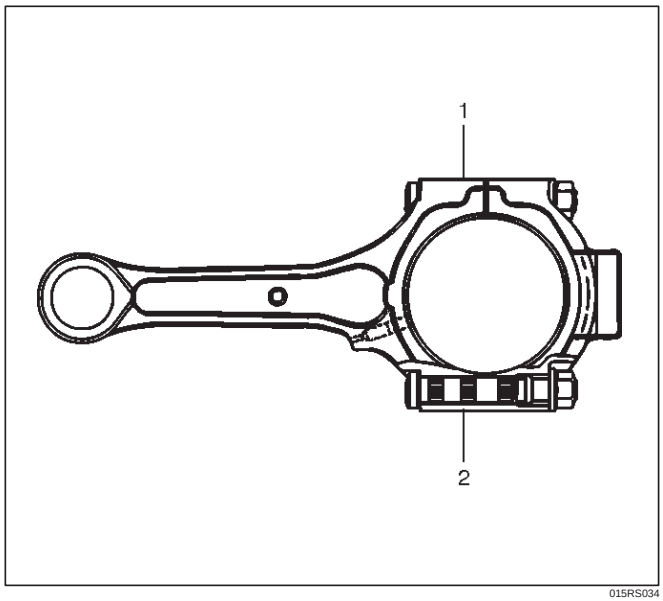

015RS008

7. Clean the plastigage from the bearings and the crankshaft pins.

Con–rod Bearing Selection

Select and install the new connecting rod bearings, paying close attention to the connecting rod big end diameter size mark (1).

NOTE: Take care not to confuse the alignment mark (2) and the size mark (1) during the installation procedure.



015RS034

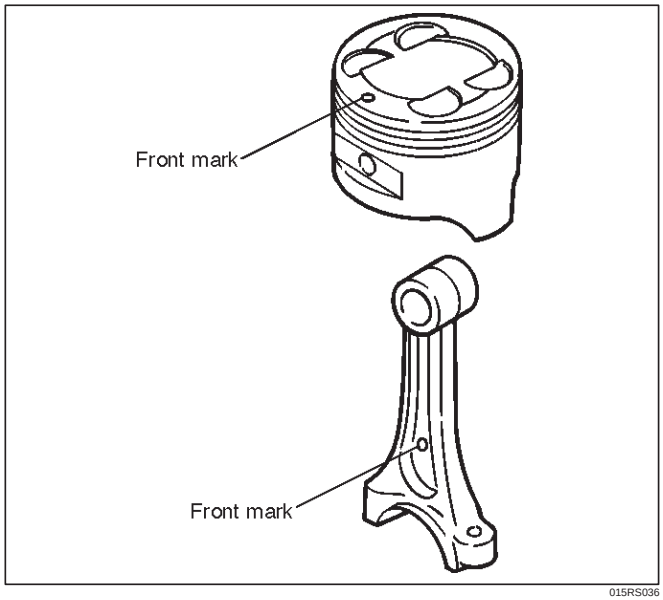
1 Size Mark	Big end Bore Diameter	Crankshaft Pin Diameter	Connecting Rod Bearing Thickness (Reference)	Color of Size Mark	Oil Clearance (Reference)
A	56.994-57.000 (2.2439-2.2441)	53.922-53.937 (2.1229-2.1235)	1.512-1.516 (0.0595-0.0597)	Yellow	0.025-0.054 (0.0010-0.0021)
B	56.988-56.994 (2.2436-2.2439)		1.508-1.512 (0.0594-0.0595)	Green	0.027-0.056 (0.0011-0.0022)
C	56.982-56.988 (2.2434-2.2436)		1.504-1.508 (0.0592-0.0594)	Pink	0.029-0.058 (0.0011-0.0023)

Reassembly

1. Install connecting rod
2. Install piston
3. Install piston pin
   - Apply a thin coat of engine oil to the piston pin. Try to insert the piston pin into the piston pin hole with normal finger pressure.

NOTE: When changing piston / connecting rod combinations, do not change the piston / piston pin combination and do not reuse the old piston pin.

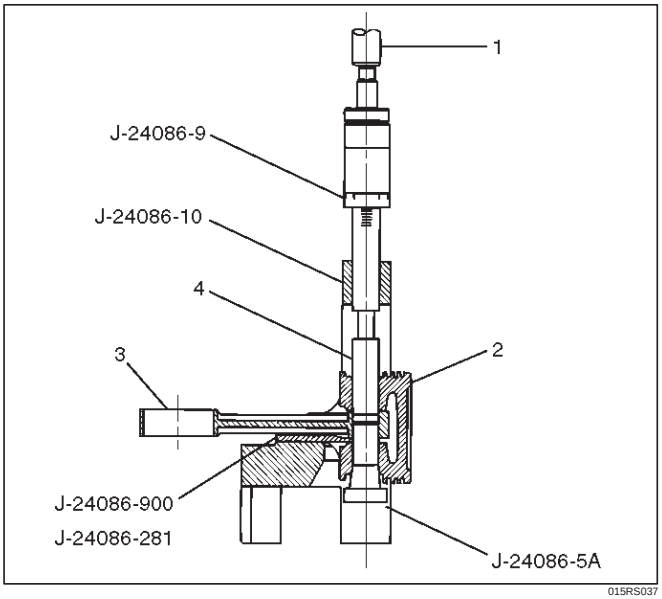
- Attach the piston to the connecting rod with the piston front mark and the connecting rod front mark on the same side.



015RS036

- With J–24086–C Piston pin service set and a press, press fit the piston pin.

NOTE: Heat the connecting rod small end to a suitable temperature to ensure smooth installation.



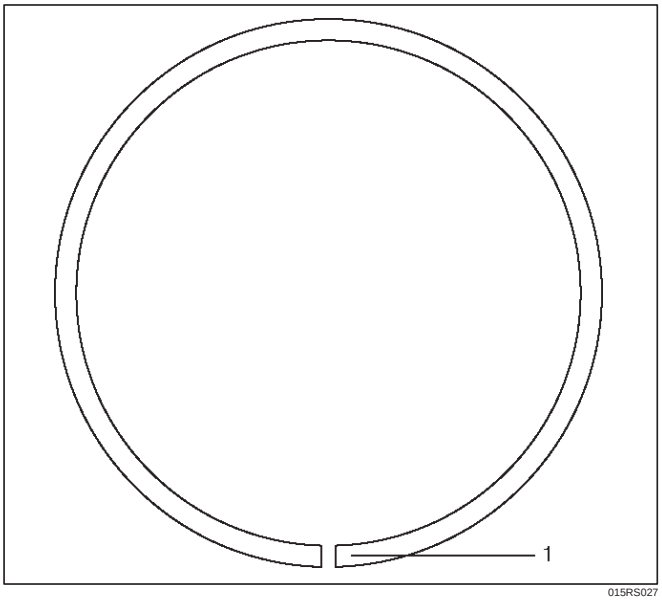
Legend

(1) Press Ram
(2) Piston
(3) Connecting Rod
(4) Piston Pin

4. Install piston ring with the piston ring expander.
   The compression ring must be set with the T mark (1) facing up.

Marked T : No.1 Compression ring

Marked T2 : No.2 Compression ring



- Install piston rings in the following sequence.

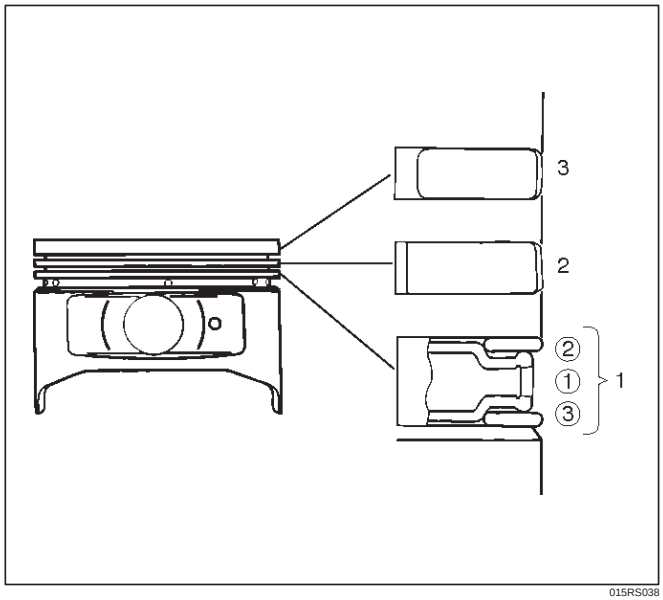
1. Oil ring
   1. Expander ring
   2. Upper side rail
   3. Lower side rail
2. 2nd compression ring
3. 1st compression ring

- The compression rings must be set with the T or T2 mark facing up.

Marked T : No.1 Compression ring

Marked T2 : No.2 Compression ring

- After installation, apply engine oil to the entire circumference of the piston rings. Check to see that all the rings rotate smoothly.



5. Install piston and connecting rod assembly.
   - Insert the bearings into the connecting rods and caps. Apply new engine oil to the bearing faces and nuts.
   - Tighten the connecting rod cap nuts

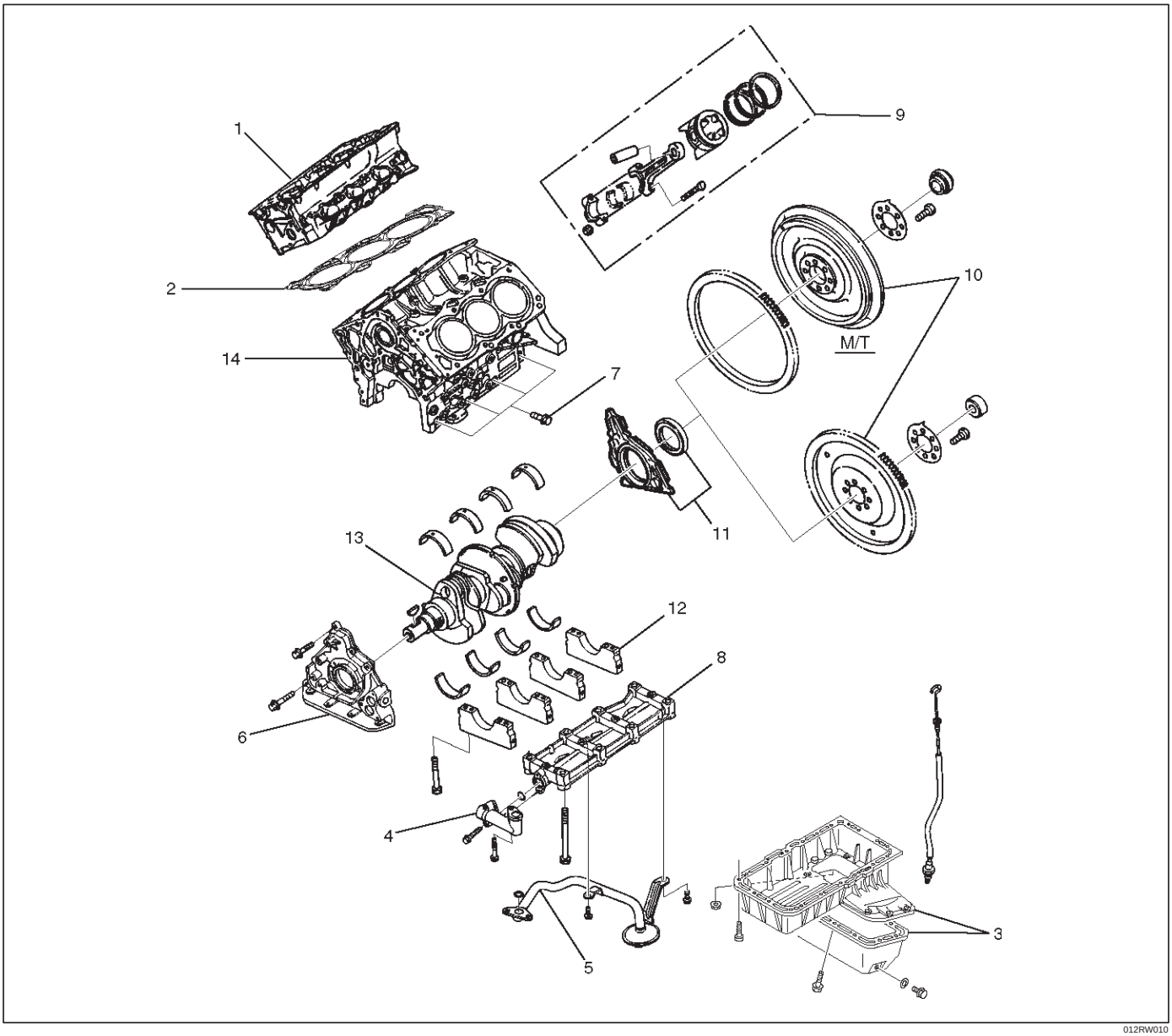
Torque : 54 N·m (40 lb ft)

NOTE: Do not apply engine oil to the bearing back faces.

6. Oil gallery, refer to “Crankshaft and main bearing” in this manual.
7. Oil strainer and O-ring.
8. Oil pipe and O-ring.
9. Install crankcase with oil pan, refer to “Oil pan and Crankcase” in this manual.
10. Install cylinder head gasket.
11. Install Cylinder head assembly.
    - Refer to “Cylinder head” in this manual.

Cylinder Block

Cylinder Block and Associated Parts



012RW010

Legend

(1) Cylinder Head Assembly
(2) Cylinder Head Gasket
(3) Crankcase with Oil Pan
(4) Oil Pipe and O-ring
(5) Oil Strainer and O-ring
(6) Oil Pump Assembly
(7) Cylinder Block Side Bolts
(8) Oil Gallery
(9) Piston and Connecting Rod Assembly
(10) Flywheel
(11) Rear Oil Seal Retainer Assembly
(12) Main Bearing Cap
(13) Crankshaft
(14) Cylinder Block

Disassembly

1. Remove cylinder head assembly.
2. Remove cylinder head gasket.
3. Remove crankcase with oil pan.
4. Remove oil pipe and O-ring.
5. Remove oil strainer and O-ring.
6. Remove oil pump assembly.
7. Remove crankcase side bolts.
8. Remove oil gallery.
9. Remove piston and connecting rod assembly.
10. Remove flywheel.

11. Remove rear oil seal retainer assembly.
12. Remove main bearing cap.
13. Remove crankshaft.
14. Remove cylinder block.

Inspection and Repair

1. Remove the cylinder head gasket and any other material adhering to the upper surface of the cylinder block. Be very careful not to allow any material to accidentally drop into the cylinder block. Be very careful not to scratch the cylinder block.
2. Carefully remove the oil pump, rear oil seal retainer, and crankcase assembly installation surface seal.
3. Wipe the cylinder block clean.
4. Visually inspect the cylinder block. If necessary, use a flaw detector to perform a dye penetrate and hydraulic (or air pressure) test. If cracking or other damage is discovered, the cylinder block must either be repaired or replaced.

Flatness

1. Using a straight–edge and feeler gauge, check that the upper surface of the cylinder block is not warped.

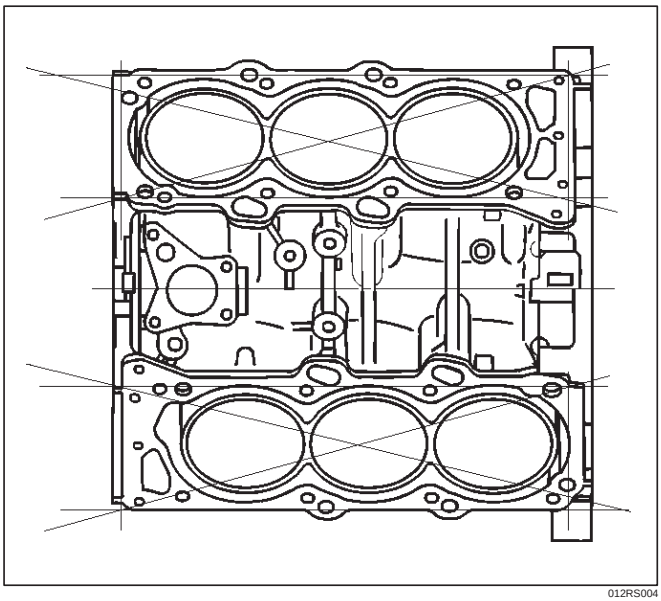
CAUTION: Be very careful not to allow any material to accidentally drop into the upper surface of the cylinder block. Be very careful not to scratch the upper surface of the cylinder block.

2. The cylinder block must be reground or replaced if the warpage exceeds the limit.

Warpage

Limit : 0.15 mm (0.0059 in)

Maximum repairable limit: 0.15 mm (0.0059 in)



012RS004

Cylinder Bore

Use a cylinder gauge to measure the cylinder bore diameter in both the axial and thrust directions. Each measurement should be made at six points.

CAUTION: Be very careful not to allow any material to accidentally drop into the upper surface of the cylinder block. Be very careful not to scratch the upper surface of the cylinder block.

Cylinder Bore Inside Diameter

Limit : 93.530 (3.6823)

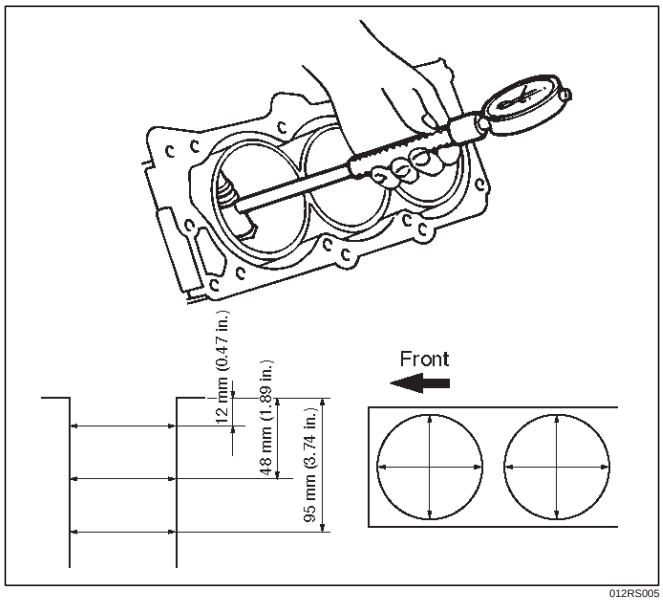
If the measurement exceed the specified limit, the cylinder block must be replaced.

Diameter

Grade A : 93.400 mm–93.410 mm (3.6772 in–3.6776 in)

Grade B : 93.411 mm–93.420 mm (3.6776 in–3.6779 in)

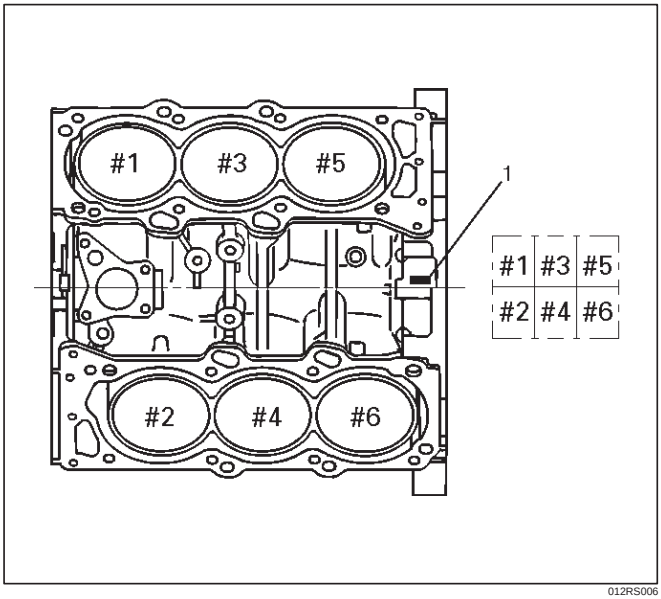
Grade C : 93.421 mm–93.430 mm (3.6780 in–3.6783 in)



012RS005

NOTE: For information on piston diameter, please refer to the section ”Inspection of the Piston and Connecting Rod Assembly” in this manual.

- The ”Grade” mark (1) is stamped at the position illustrated.

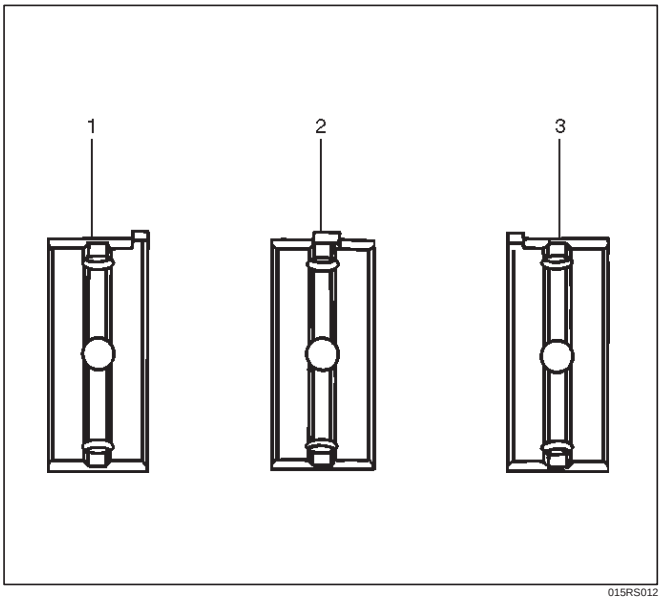


012RS006

Reassembly

1. Install cylinder block.
2. Install crankshaft.
   - Install the main bearings to the cylinder block and the main bearing caps.
   - Be sure that they are positioned correctly.
   - Apply new engine oil to the upper and lower main bearing faces.

NOTE: Do not apply engine oil to the bearing back faces.

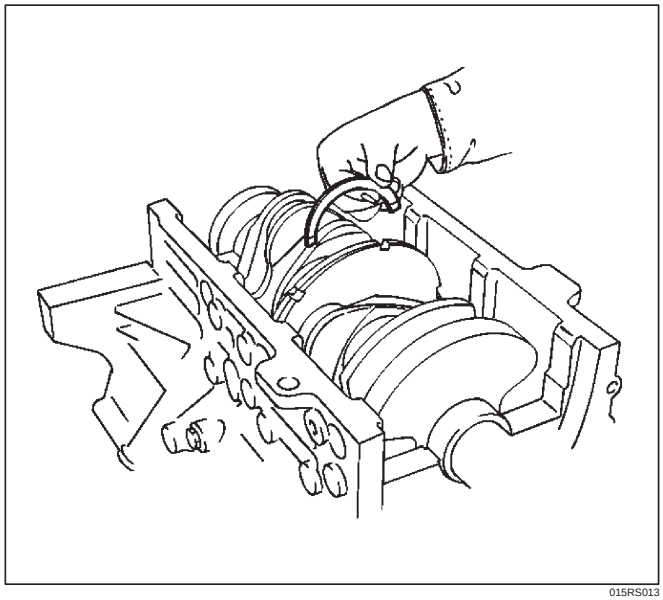


015RS012

Legend

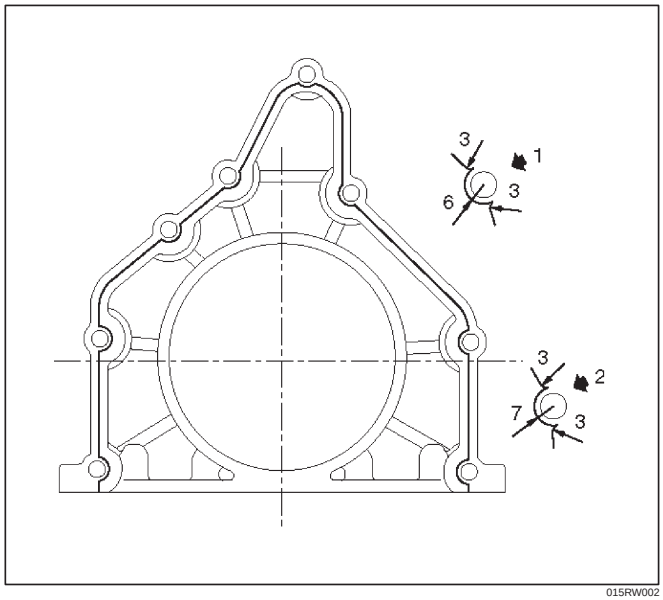
(1) Number 1 and 4 main bearing upper and lower.
(2) Number 2 and 3 main bearing upper.
(3) Number 2 and 3 main bearing lower.

- Carefully mount the crankshaft.
- Apply engine oil to the thrust washer.
- Assemble the thrust washer to the No. 3 bearing journal. The oil grooves must face the crankshaft.



015RS013

3. Install rear oil seal retainer.
   - Remove oil on cylinder block and retainer fitting surface.
   - Apply sealant (TB1207B or equivalent) to retainer fitting surface as shown in illustration.
   - The oil seal retainer must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.



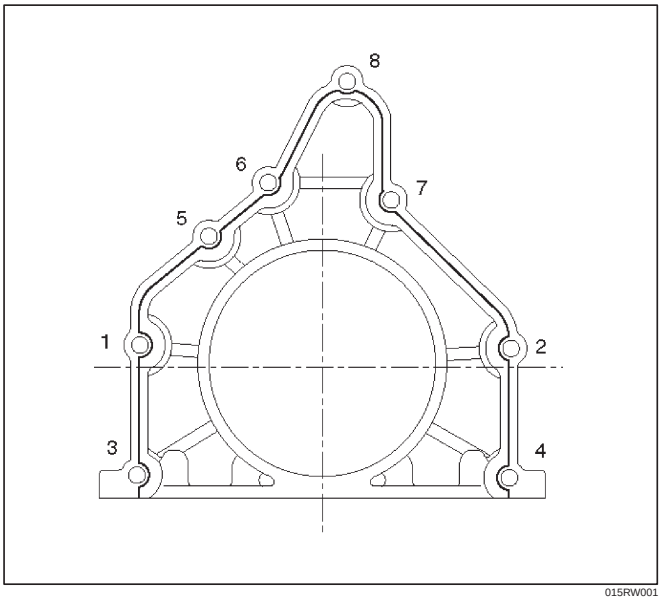
015RW002

Legend

(1) Around Bolt Holes
(2) Around Dowel Pin

- Apply engine oil to oil seal lip and align a dowel pin hole in the cylinder block with that in the retainer.
- Tighten retainer fixing bolts to the specified torque.

Torque: 25 N·m (18.4 lb ft)

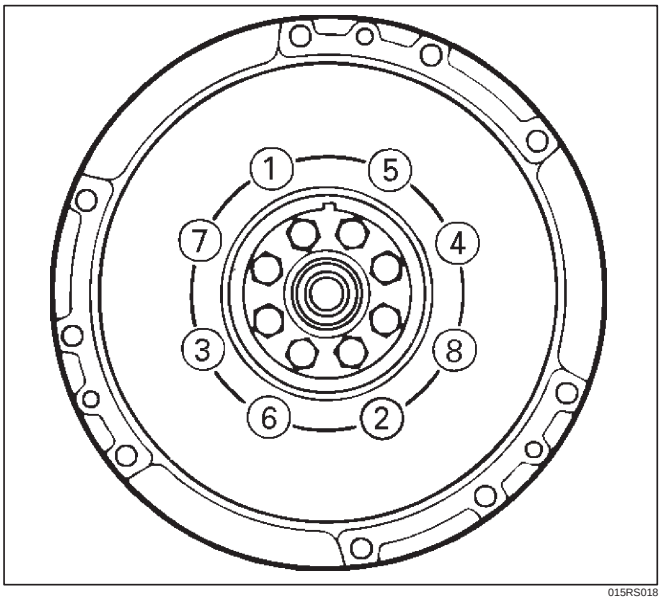


015RW001

4. Install flywheel
   1. Thoroughly clean and remove the oil from the threads of crankshaft.
   2. Remove the oil from the crankshaft and flywheel mounting faces.
   3. Mount the flywheel on the crankshaft and then install the washer.
   4. Holding the crankshaft stationary, tighten the flywheel bolts in the order shown.

Torque: 54 N·m (40 lb ft)

NOTE: Do not reuse the bolts and do not apply oil or thread lock to the bolts.

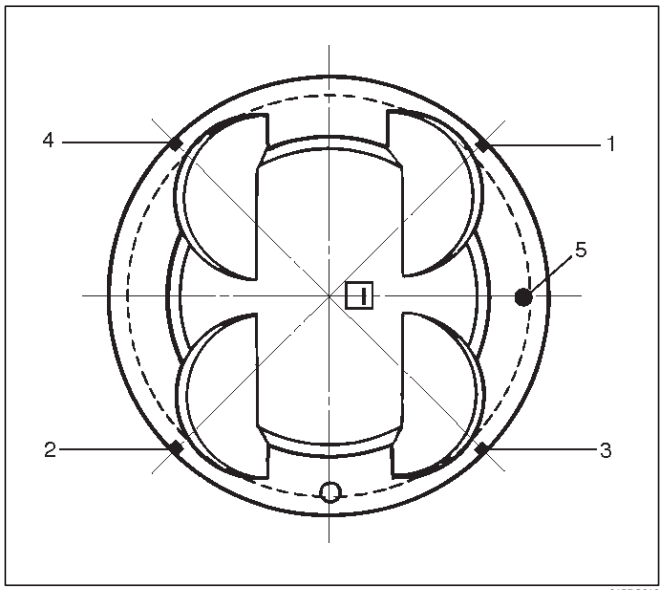


015RS018

5. Install piston and connecting rod assembly.
   - Apply engine oil to the cylinder bores, the connecting rod bearings and the crankshaft pins.

NOTE: Do not apply engine oil to the bearing back faces.

- Check to see that the piston ring end gaps are correctly positioned.

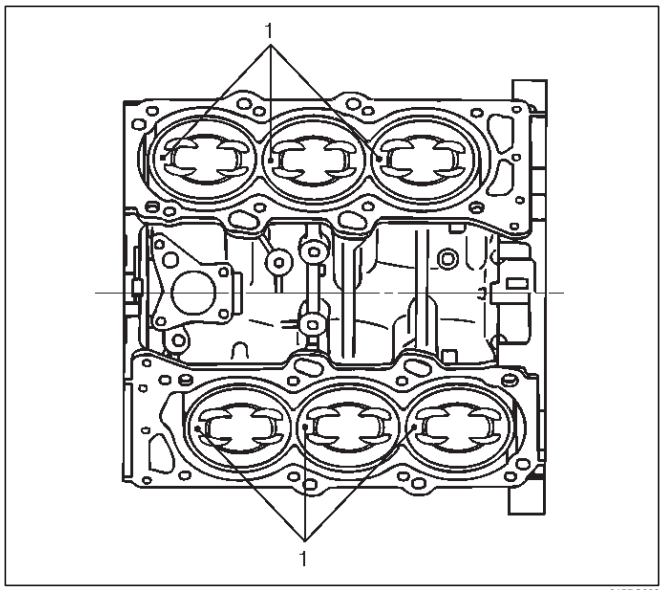


015RS019

Legend

(1) No.1 Compression Ring
(2) No.2 Compression Ring
(3) Oil Ring Side Rail Upper
(4) Oil Ring Side Rail Lower
(5) Piston Front Mark

- Insert the piston/connecting rod assemblies into each cylinder with the piston ring compressor.
- The front marks (1) must be facing the front of the engine.

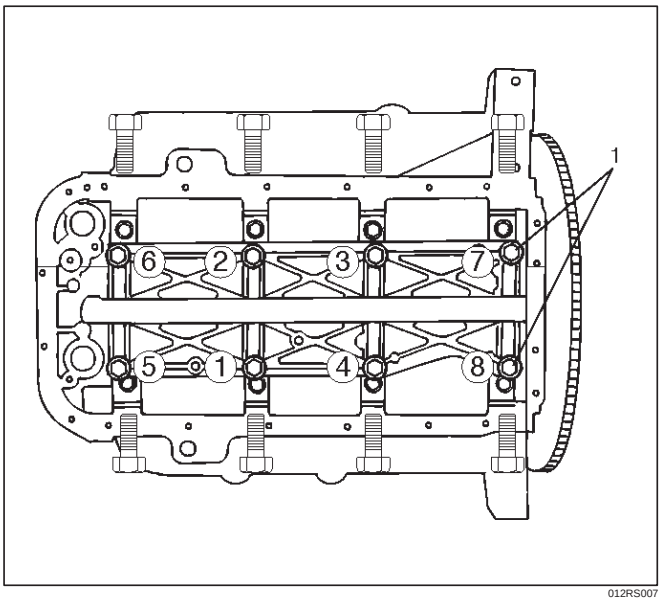


015RS020

6. Install oil gallery and tighten the bolts in 2 steps in the order shown.

1st step : 29 N·m (22 lb ft)

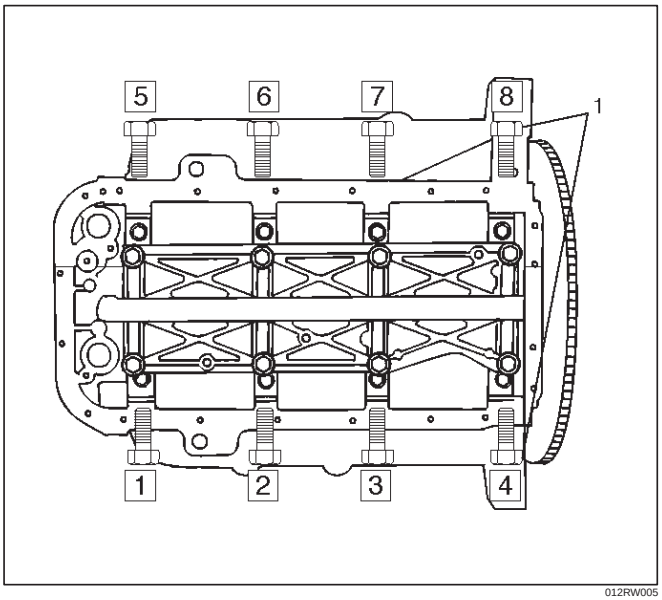
2nd step : 55˚~ 65˚



012RS007

7. Install cylinder block side bolts (1) and tighten crankcase bolts in sequence shown in the illustration.

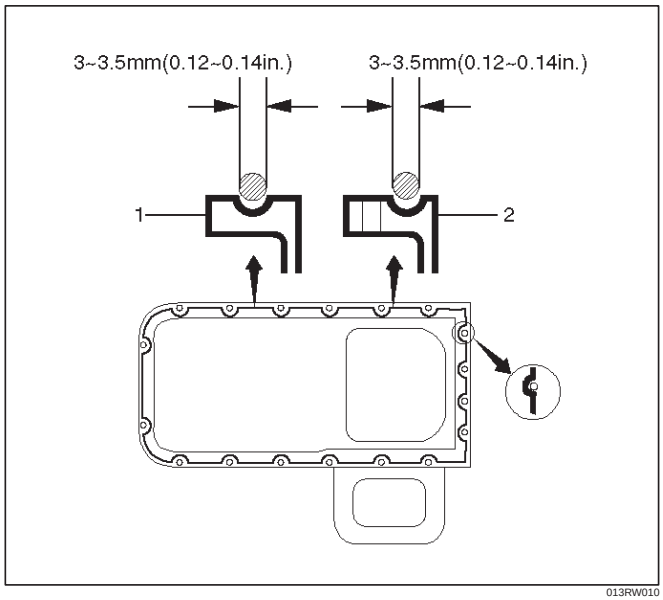
Torque : 39 N·m (29 lb ft)



012RW005

8. Install oil pump assembly. Refer to “Oil Pump” in this manual.
9. Install oil strainer and O-ring.
10. Install oil pipe and O-ring.
11. Install crankcase with oil pan.
    1. Completely remove all residual sealant, lubricant and moisture from the sealing surfaces. The surfaces must be perfectly dry.
    2. Apply a correct width bead of sealant (TB– 1207C or its equivalent) to the contact surfaces of the crankcase. There must be no gaps in the bead.
    3. The oil pan must be installed within 5 minutes after sealant application to prevent premature hardening of sealant.
    4. Tighten the bolts and nuts to the specified torque.

Torque : 10 N·m (89 lb in)



013RW010

Legend

(1) Portion Between Both Holes
(2) Bolt Hole Portions

12. Install cylinder head gasket.
13. Install cylinder head assembly. Refer to “Cylinder Head” in this manual.

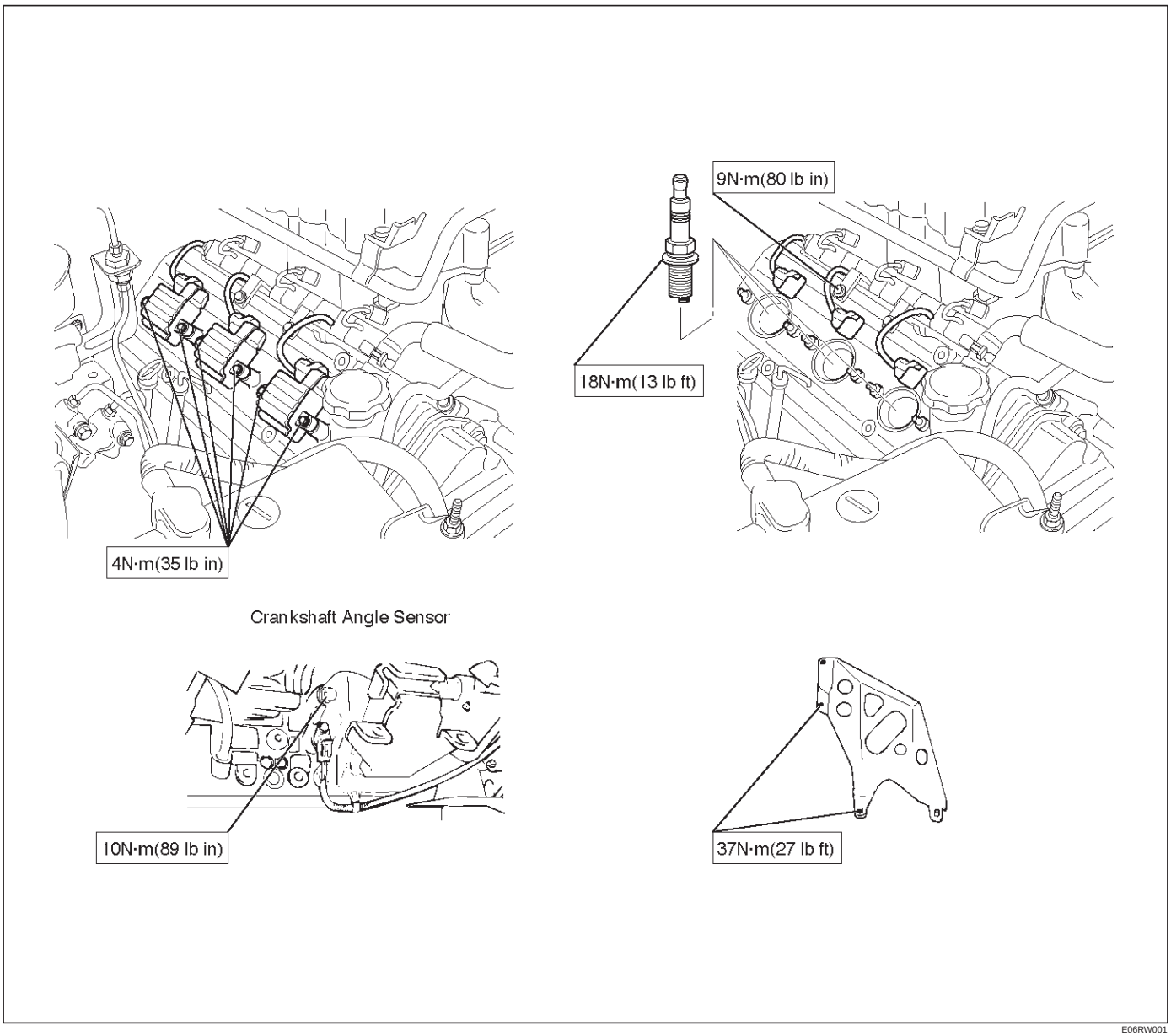
Main Data and Specification

General Specification

Item	Specifications
	6VD1
Engine type, number of cylinders and arrangement	Water cooled, four cycle V6
Form of combustion chamber	Pent-roof type
Valve mechanism	4-Cams, 4-Valves, DOHC Gear & Belt Drive
Cylinder liner type	Casted in cylinder drive
Total piston displacement	3165 cc
Cylinder bore x stroke	93.4mm x 77mm (3.677 in x 3.031 in)
Compression ratio	9.1
Compression pressure at 300rpm	1.37 MPa (14.0 Kg/cm^2)
Engine idling speed rpm	Non adjustable (750)
Valve clearance	Intake: 0.28 mm (0.11 in)
	Exhaust: 0.30mm (0.12in)
Oil capacity	5.3 liters
Ignition timing	Non adjustable (16˚ BTDC at idle rpm)
Spark plug	PK16PR11, RC10PYP4, K16PR-P11
Plug gap	1.0 mm–1.1 mm(0.0394 in – 0.0433 in)

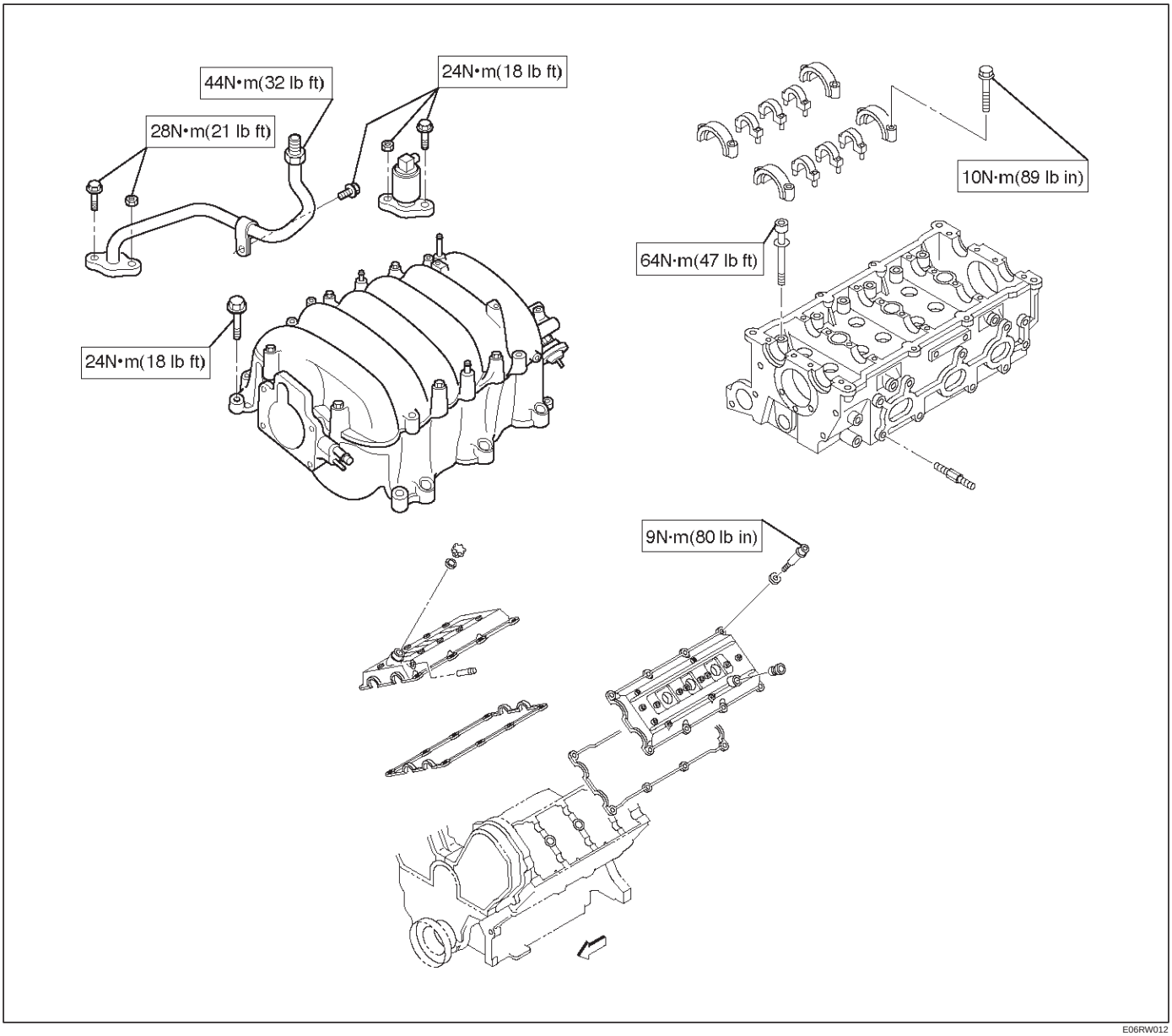
Torque Specifications

Ignition coil, Spark plug, Crankshaft angle sensor and Under cover



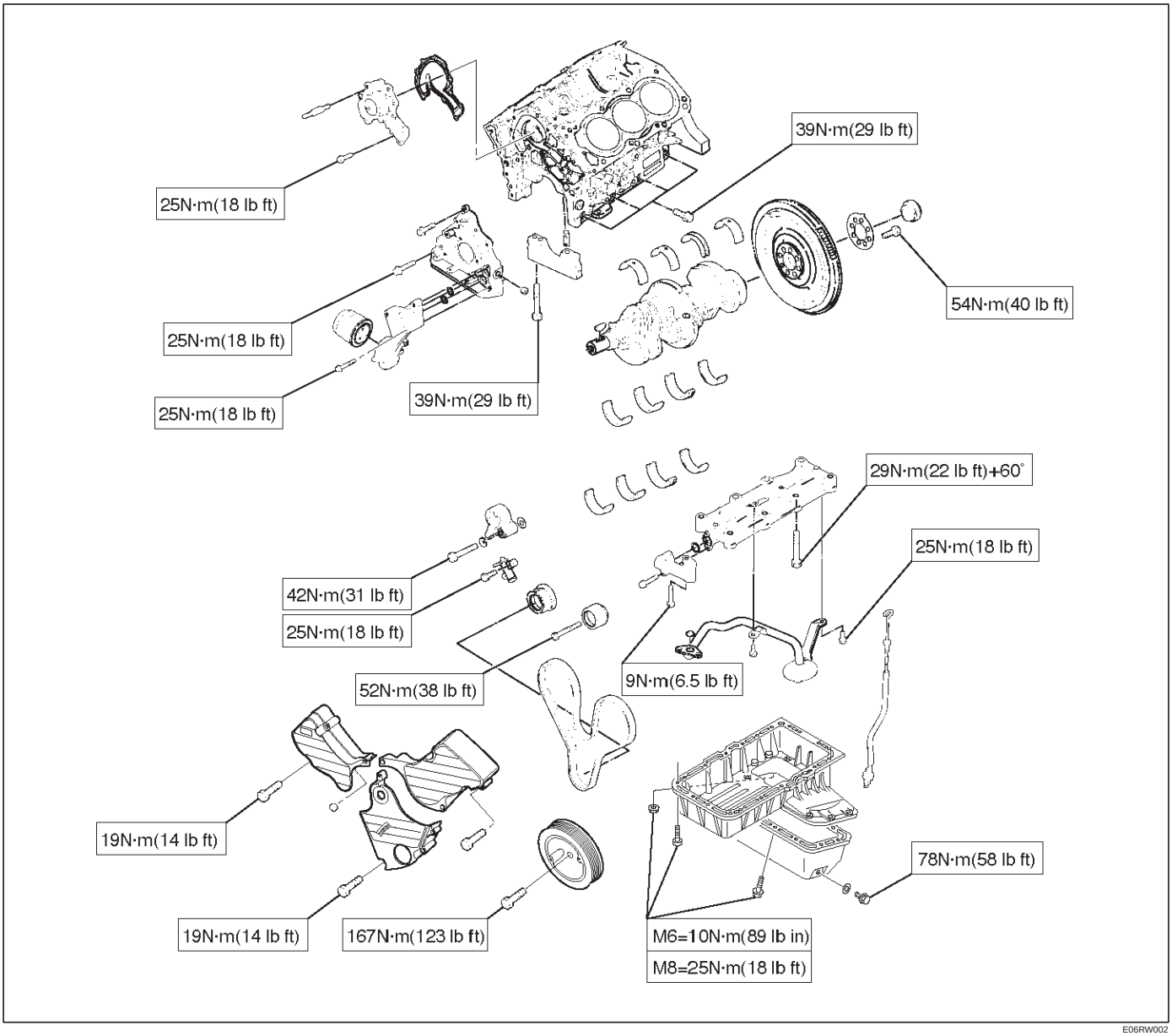
E06RW001

Cylinder head cover, Cylinder head, Camshaft bracket, Common chamber, EGR valve and EGR pipe



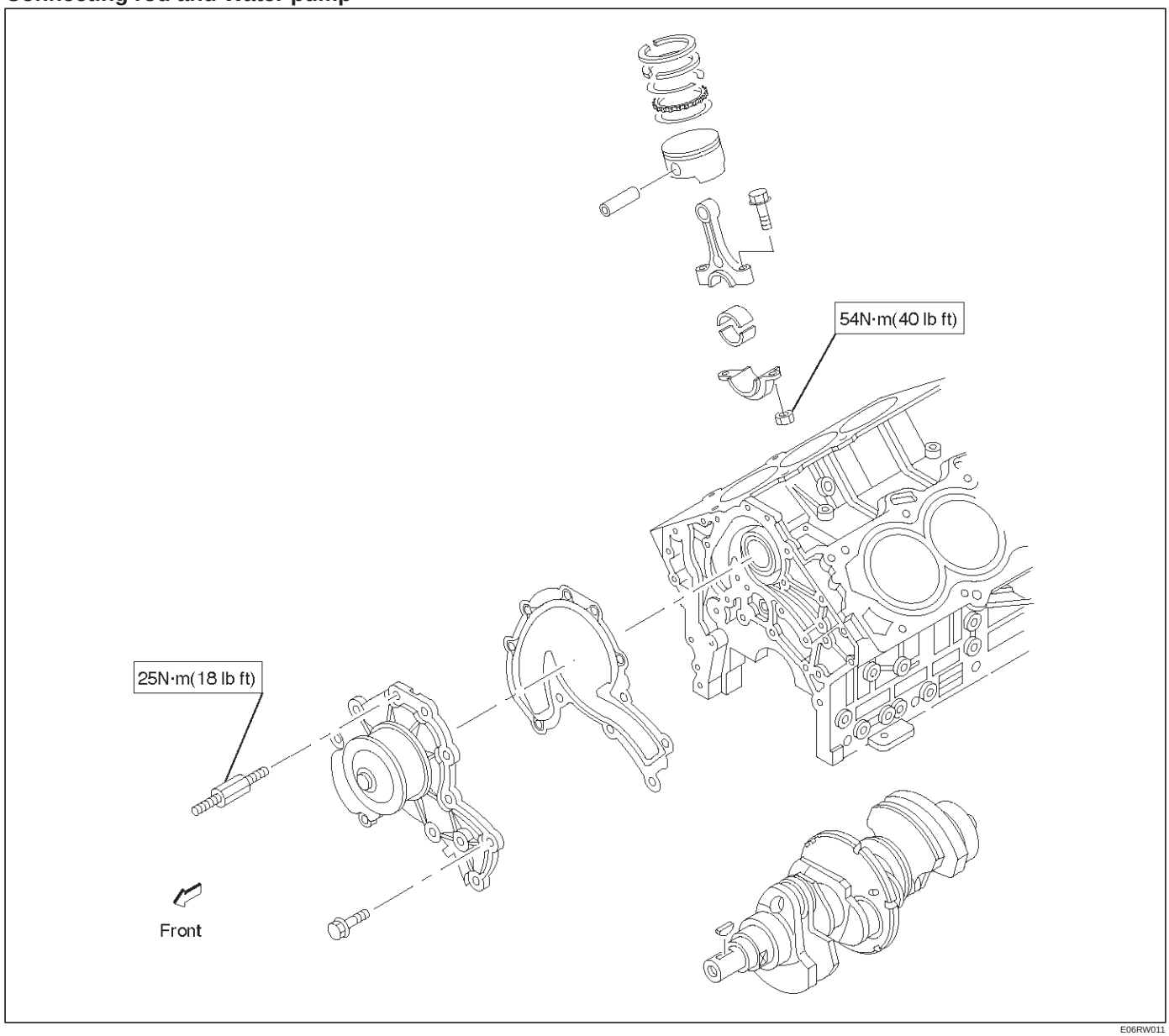
E06RW012

Crankshaft main bearing, Flywheel, Crankcase, Oil pan, Timing belt tensioner, Timing pulley, timing belt cover, Oil pump, Oil gallery, Oil strainer and water pump



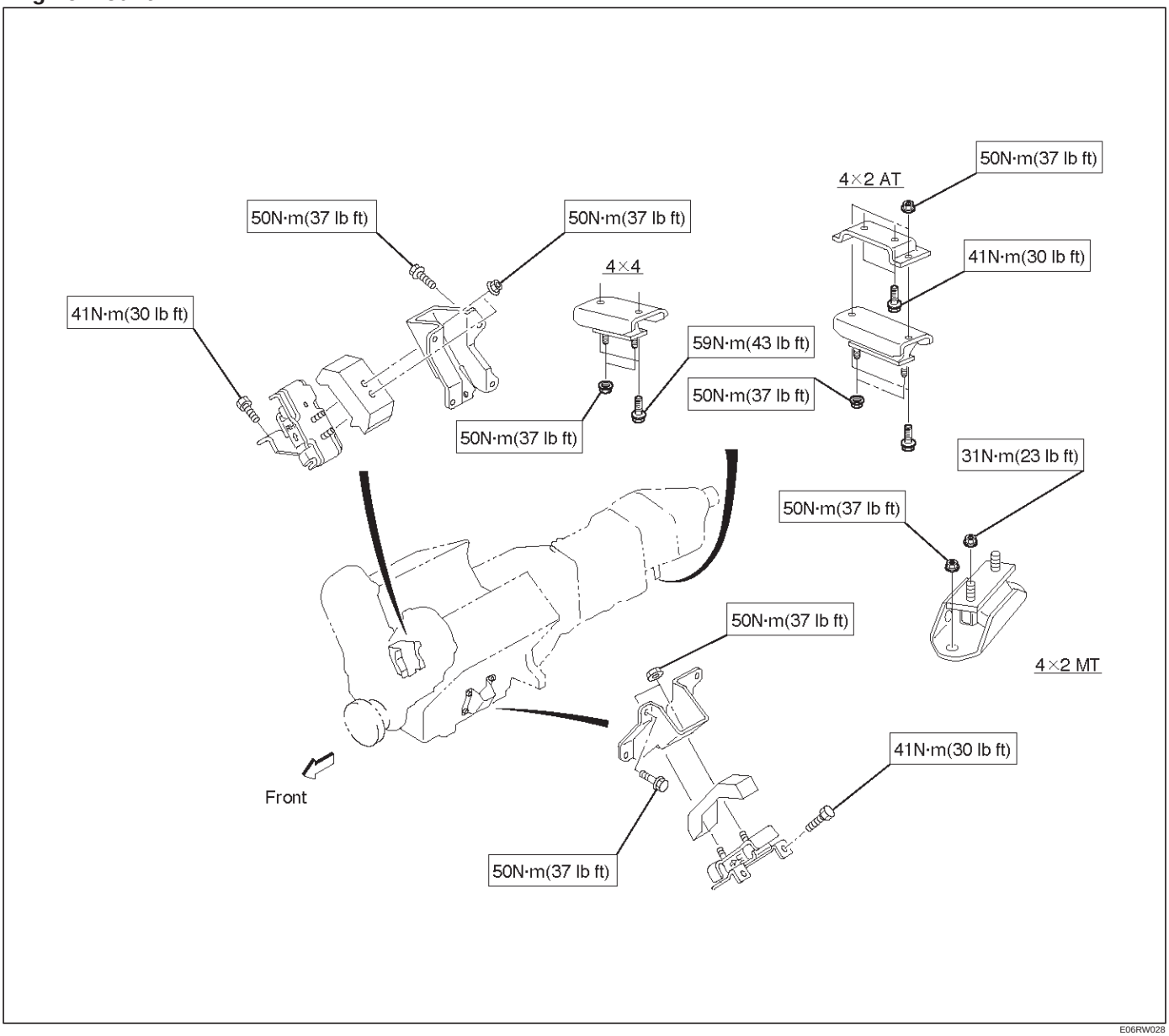
E06RW002

Connecting rod and Water pump



E06RW011

Engine mount



E06RW028

Special Tool

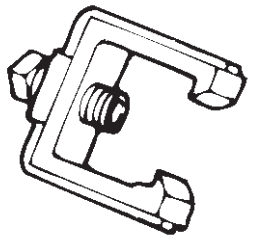
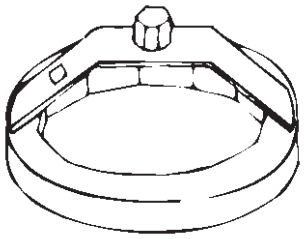
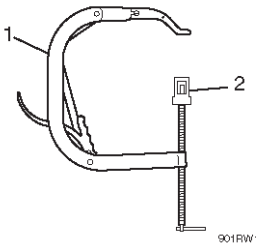
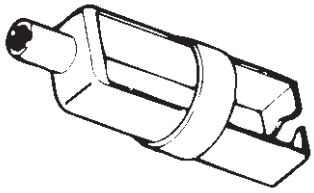
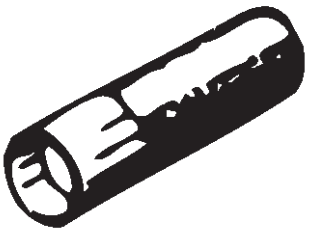
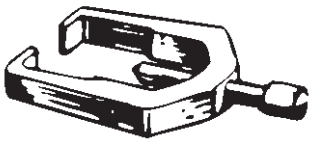
ILLUSTRATION	TOOL NO. TOOL NAME
 901RT033	**J–21687–02** Remover; tie rod end
 901RT034	**J–36390** Wrench; Oil filter
 901RW108	**J–8062** Compressor; Valve spring (1) **J–42898** Adapter; Compressor, Valve spring (2)
 901RT036	**J–37281** Remover; Oil controller
 901RT037	**J–38537** Installer; Oil controller
 901RT038	**J–29107** Universal pitman arm puller

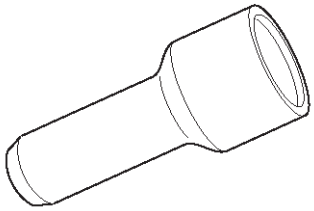
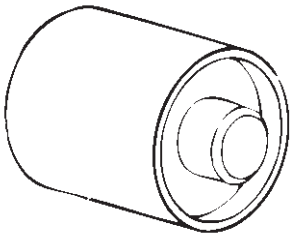
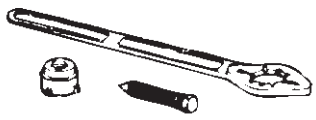
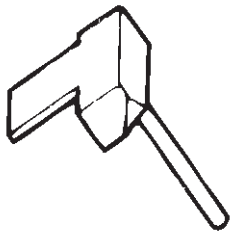
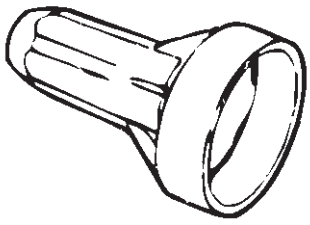
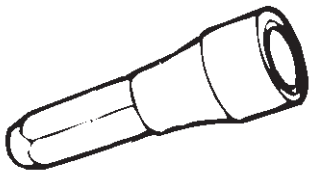
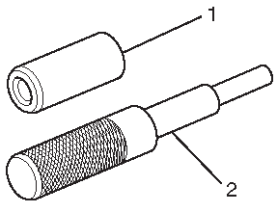
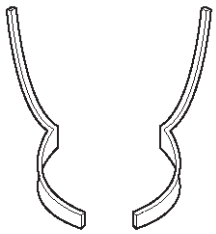
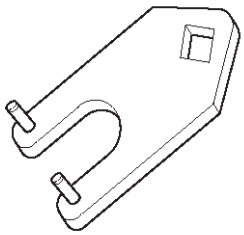
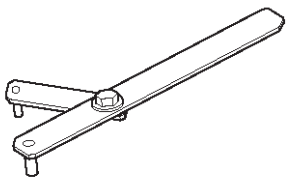
ILLUSTRATION	TOOL NO. TOOL NAME
 901RW171	**J–42985** Installer; Camshaft oil seal
 901RT040	**J–39206** Installer; Pilot bearing
 901RT041	**J–8614–01** Holder; Crankshaft
 901RT042	**J–37228** Seal cutter
 901RT043	**J–39201** Installer; Real oil seal
 901RT044	**J–39202** Installer; Oil pump oil seal

ILLUSTRATION	**TOOL NO.** TOOL NAME
 901RT046	**J–24239–1** Cylinder head bolt wrench
 901RW182	**J–42899** Replacer; Valve guide (1,2) **J–42687** Installer; Valve guide (1) **J–37985–1** Remover; Valve guide (2)
 901RW109	**J–42689** Adjusting Tool; Valve clearance
 901RW110	**J–42686** Lever; Gear spring
 901RW115	**J–43041** Holder; Universal