SECTION 6A

ENGINE MECHANICAL (4JK1/4JJ1)

TABLE OF CONTENTS

ISUZU DIESEL ENGINE (4JK1/4JJ1) 6A-3
Service Precautions 6A-3
Trouble Shooting 6A-8
Main Data and Specifications 6A-13
Special Tools 6A-14
Engine Assembly 6A-15
Removal 6A-15
Installation 6A-17
Special Tools 6A-19
Engine Mount 6A-20
Components 6A-20
Removal 6A-21
Installation 6A-21
Torque Specifications 6A-22
Special Tools 6A-22
Cylinder Head Cover 6A-23
Components 6A-23
Removal 6A-24
Installation 6A-25
Intake Manifold 6A-27
Components (Standard Output) 6A-27
Components (High Output) 6A-28
Removal 6A-29
Installation 6A-31
Torque Specifications 6A-32
Turbocharger and Exhaust Manifold (Standard Output) 6A-33
Components 6A-33
Removal 6A-34
Inspection 6A-36
Installation 6A-37
Torque Specifications 6A-40
Turbocharger (High Output) 6A-41
Components 6A-41
Removal 6A-42
Inspection 6A-43
Installation 6A-44
Torque Specifications 6A-45
Exhaust Manifold (High Output) 6A-46
Components 6A-46
Removal 6A-47
Inspection 6A-47
Installation 6A-47
Torque Specifications 6A-49
Timing Gear Train 6A-50
Components 6A-50
Removal 6A-51
Disassembly 6A-53
Reassembly 6A-53
Inspection 6A-54
Installation 6A-55
Torque Specifications 6A-58
Camshaft Assembly 6A-59
Components 6A-59
Removal 6A-60
Disassembly 6A-61
Reassembly 6A-63
Installation 6A-64
Torque Specifications 6A-66
Special Tools 6A-66
Valve Stem Seal and Valve Spring 6A-67
Components 6A-67
Removal 6A-68
Inspection 6A-69
Installation 6A-70
Special Tools 6A-71
Cylinder Head 6A-72
Components 6A-72
Removal 6A-72
Disassembly 6A-81
Inspection 6A-83
Reassembly 6A-87
Installation 6A-89
Torque Specifications 6A-100
Special Tools 6A-100
Piston and Connecting Rod 6A-101
Components 6A-101
Removal 6A-101
Disassembly 6A-102
Reassembly 6A-107
Installation 6A-108
Torque Specifications 6A-110

Special Tools....6A-110
Flywheel....6A-111
Components....6A-111
Removal....6A-111
Inspection....6A-113
Installation....6A-113
Torque Specifications....6A-115
Special Tools....6A-115
Gear Case Assembly....6A-116
Components....6A-116
Removal....6A-117
Installation....6A-118
Torque Specifications....6A-119
Crankshaft Front Oil Seal....6A-120
Components....6A-120
Removal....6A-120
Installation....6A-121
Torque Specifications....6A-122
Special Tools....6A-122
Crankshaft Rear Oil Seal....6A-123
Components....6A-123
Removal....6A-124
Installation....6A-124
Special Tools....6A-125
Crankshaft....6A-126
Components....6A-126
Removal....6A-127
Disassembly....6A-127
Reassembly....6A-128
Inspection....6A-128
Installation....6A-132
Torque Specifications....6A-135
Cylinder Block....6A-136
Components....6A-136
Removal....6A-136
Inspection....6A-137
Installation....6A-139
Lubrication System....6A-140
Service Precautions....6A-140
Functional Check....6A-141
Oil Filter Cartridge....6A-143
Components....6A-143
Removal....6A-143
Installation....6A-143
Special Tools....6A-144
Oil Filter Assembly and Oil Cooler....6A-145
Components....6A-145
Removal....6A-145
Disassembly....6A-146
Reassembly....6A-147
Installation....6A-147
Crank Case and Oil Pan....6A-150
Components....6A-150
Removal....6A-151
Disassembly....6A-152
Reassembly....6A-152
Installation....6A-153
Torque Specifications....6A-155
Oil Pump....6A-156
Components....6A-156
Removal....6A-156
Disassembly....6A-157
Reassembly....6A-158
Inspection....6A-158
Installation....6A-159
Oil Pressure SW....6A-161
Components....6A-161
Removal....6A-162
Inspection....6A-162
Installation....6A-162
Circuit check....6A-162
Air Cleaner Element....6A-163
Removal....6A-163
Cleaning....6A-163
Installation....6A-163

ISUZU DIESEL ENGINE (4JK1/4JJ1)

Service Precautions

Matters that require attention in terms of maintenance

To prevent damage to the engine and ensure reliability of its performance, pay attention to the following in maintaining the engine:

- When lifting up or supporting the engine, do not apply a jack on the oil pan.
  When taking down the engine on the ground, do not make the bearing surface of the oil pan touch the ground directly. Use a wooden frame, for example, to support the engine with the engine foot and the flywheel housing.
  Because there is only a small clearance between the oil pan and the oil pump strainer, it can damage the oil pan and the oil strainer.
- When the air duct or air cleaner is removed, cover the air intake opening to prevent foreign matter from getting into the cylinder. If it gets contaminated, it can considerably damage the cylinder and others while the engine is operating.
- When maintaining the engine, never fail to remove the battery earth cable. If not, it may damage the wire harness or electrical parts. If you need electricity on for the purpose of inspection, for instance, watch out for short circuits and others.
- Apply engine oil to the sliding contact surfaces of the engine before reassembling it. This ensures adequate lubrication when the engine is first started.
- When valve train parts, pistons, piston rings, connecting rods, connecting rod bearings or crankshaft journal bearings are removed, put them in order and keep them.
- When installing them, put them back in the same location they were removed from.
- Gaskets, oil seals, O-rings, etc. must be replaced with new ones when the engine is reassembled.
- As for parts where a liquid gasket is used, remove an old liquid gasket completely and clean it up thoroughly so that no oil, water or dust is clinging to them. Then, apply the designated liquid gasket to each place anew before assembly.
- Surfaces covered with liquid gasket must be assembled within 5 minutes of gasket application. If more than 5 minutes has elapsed, remove the existing liquid gasket and apply a new liquid gasket.
- When assembling or installing parts, fasten them with the prescribed tightening torque so that they are installed properly.

Matters that require attention in specifically dealing with this engine.

Holes or clearances in the fuel system, which serve as a passage of fuel, including the inside of the injector, are made with extreme precision. For this reason, they are highly sensitive to foreign matter and, if it gets in, it can lead to an accident on the road, for instance; thus, make sure that foreign matter is prevented from getting in.

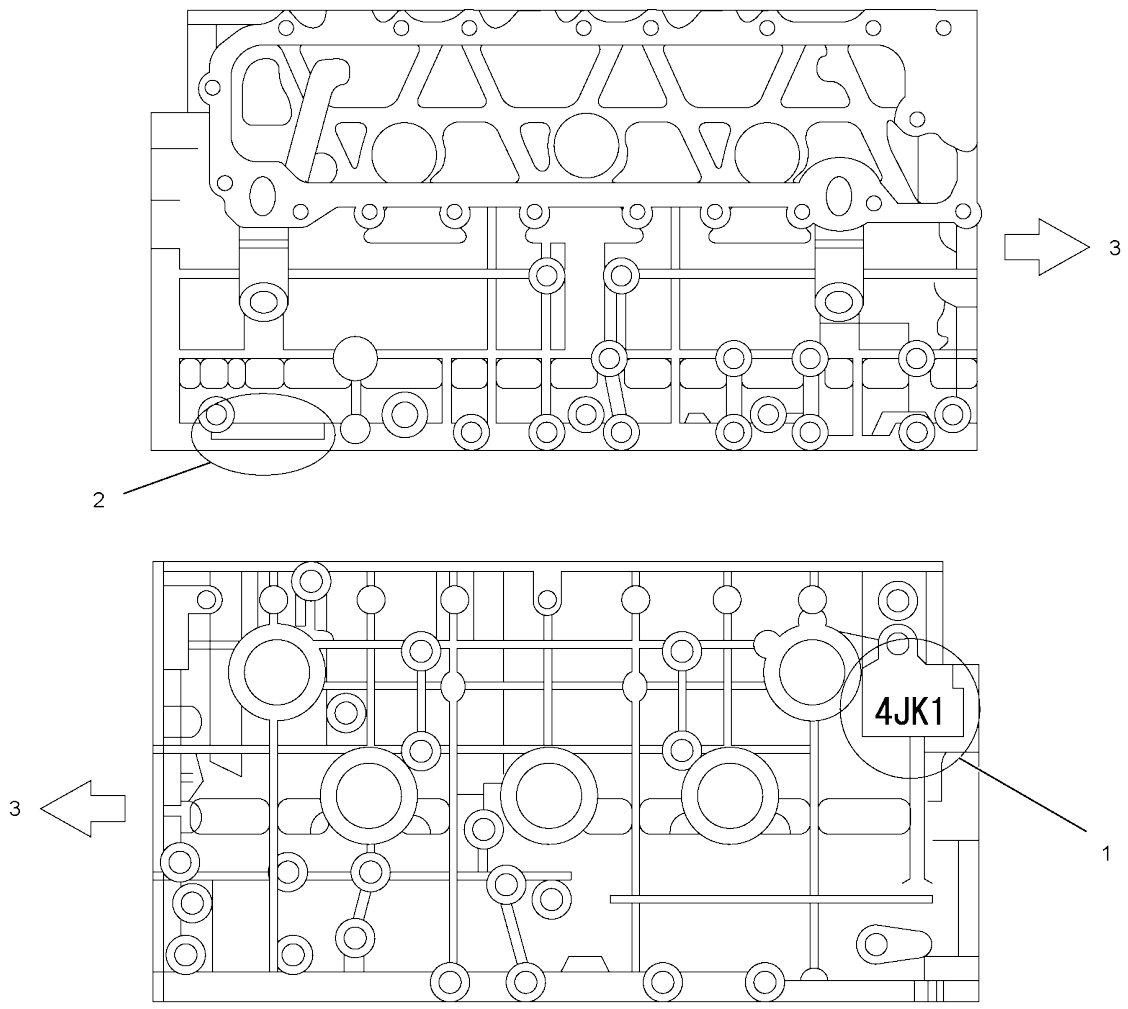
When servicing the fuel system, every precaution must be taken to prevent the entry of foreign material into the system.

- Before beginning the service procedure, wash the fuel line and the surrounding area.
- Perform the service procedures with clean hands. Do not wear work gloves.
- Immediately after removing the fuel hose and/or fuel pipe, carefully tape vinyl bags over the exposed ends of the hose or pipe.
- If parts are to be replaced (fuel hose, fuel pipe, etc.) do not open the new part packaging until installation.

Work procedure

- The fuel opening must be quickly sealed when removing the fuel pipe, injection pipe, fuel injector, fuel supply pump, and fuel rail.
- The eyebolts and gasket must be stored in a clean parts box with a lid to prevent adhesion of foreign matter.
- Fuel leakage could cause fires. Therefore, after finishing the work, wipe off the fuel that has leaked out and make sure there is no fuel leakage after starting the engine.

How to read the model (This illustration is 4JK1 engine)



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Legend

1. Engine Model (Stamped)
2. Engine Number (Stamped)
3. Front

Explanation of functions and operations

Electronic engine control

With the control unit, the range from injection to air intake/exhaust, including fuel injection quantity, injection timing, intake air restriction, EGR, and idling rpm, is controlled.

Piston

The piston is aluminum-alloy and a thermal flow piston with a strut cast, while the combustion chamber is a round reentrant type.

Cylinder head

The cylinder head is aluminum-alloy and there are 4 valves per cylinder. The angular tightening method of the cylinder head bolt further increases reliability and durability.

EGR system

Based upon data, including water temperature, engine speeds or engine loads, it is controlled via Engine Control Module (ECM) to purify exhaust by recycling part of it.

Its main components include an EGR valve, an EGR cooler and various sensors.

Connecting rod cap bolt

The angular tightening method of the connecting rod cap bolt further increases reliability and durability.

Fuel rail-type electronic control injection system

The fuel rail-type electronic control injection system is composed of a fuel supply pump that sets the target pressure of high-pressure fuel and supply it, a fuel rail that measures such high-pressure fuel and a fuel injector that turns it into a fine spray and injects it. Each is controlled via ECM based upon various signals, while injection timing or fuel injection quantity is controlled under every possible driving condition.

Fuel injector

The fuel injector is a 6-hole nozzle that adjusts fuel injection quantity or injection timing by opening or closing an electromagnetic valve on the head of the fuel injector.

ECM corrects the dispersion of fuel injection quantity between fuel injector according to ID code data in memory. At the replacement of fuel injector, ID code data should be stored in ECM.

Fuel filter with sedimenter

It is a fuel filter with sedimenter that gets rid of water by making use of the difference in specific gravity between light oil and water, which comes with an indicator that notifies you that it is filled with water.

Preheating system

The preheating system consists of the ECM, the glow relay, glow plugs and the glow indicator lamp. The preheating system is operated when the engine coolant temperature is low, and makes the engine easy to start.

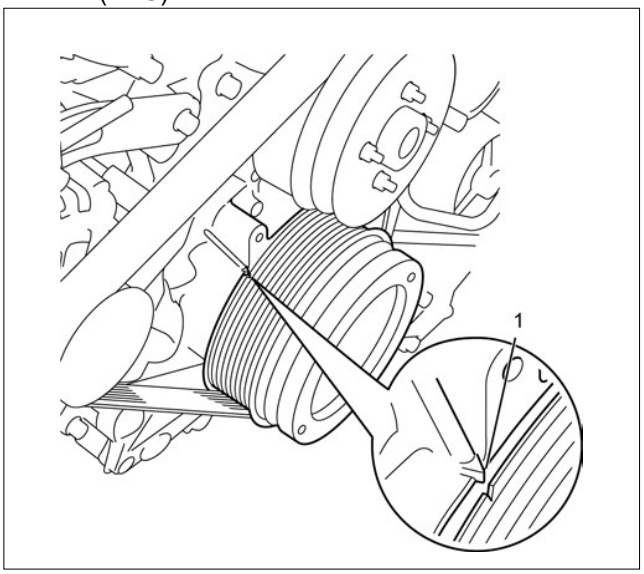
Lubrication system

It is an oil filter with full-flow bypass, which uses a water-cool oil cooler and oil jet to cool the piston.

Functional inspection

Inspection/adjustment of valve clearance

1. Inspection of valve clearance
   - Remove the fuel injector harness assembly.
   - Remove the leak off hose.
   - Remove the cylinder head cover.
   - Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



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Legend

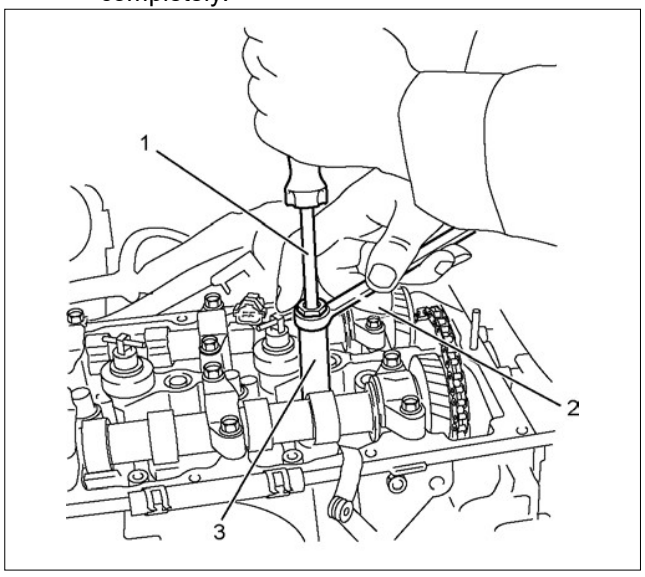
1. TDC

- Insert a 0.15 mm (0.006 in) thickness gauge between the roller of the rocker arm and the camshaft to tighten up the adjusting screw of the rocker arm. When the movement of the thickness gauge becomes tight, fasten the adjusting screw nut of the rocker arm.

Valve clearance	mm (in)
Intake valve	0.15 (0.006)
Exhaust valve	0.15 (0.006)

Note:
Adjust while cold.

2. Adjustment of valve clearance
   - Loosen each adjusting screw of the rocker arm completely.



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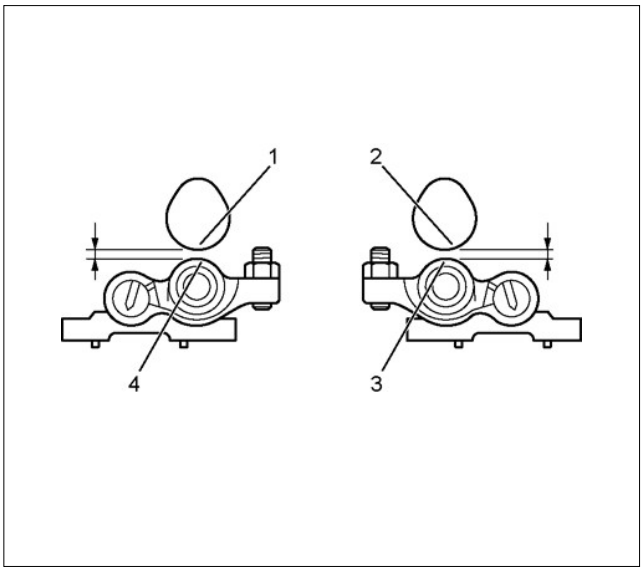
Legend

1. Screwdriver
2. Ring Spanner
3. Valve Clearance Adjust Nut Wrench

Special tool
Valve clearance adjust nut wrench: 5-8840-2822-0

- Insert a 0.15 mm (0.006 in) thickness gauge between the roller of the rocker arm and the camshaft to tighten up the adjusting screw of the rocker arm. When the movement of the thickness gauge becomes tight, fasten the adjusting screw nut of the rocker arm.



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Legend

1. Cam; Exhaust
2. Cam; Intake
3. Roller; Intake
4. Roller; Exhaust

Tightening torque:

Rocker arm adjustment screw nut
18 N·m (1.8 kg·m/ 13 lb ft)

Adjustment table

Cylinder No.	1		2		3		4	
Valve arrangement	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder Compression TDC	○	○	○			○		
No. 4 cylinder Compression TDC				×	×		×	×

- If the No.1 cylinder is the compression TDC, adjust a valve clearance with ○ mark given on the table and if the No. 4 cylinder is the compression TDC, adjust that with × mark.
- Install the cylinder head cover.
  Refer to "Cylinder Head Cover."
- Install the leak off hose.
- Install the fuel injector harness assembly.

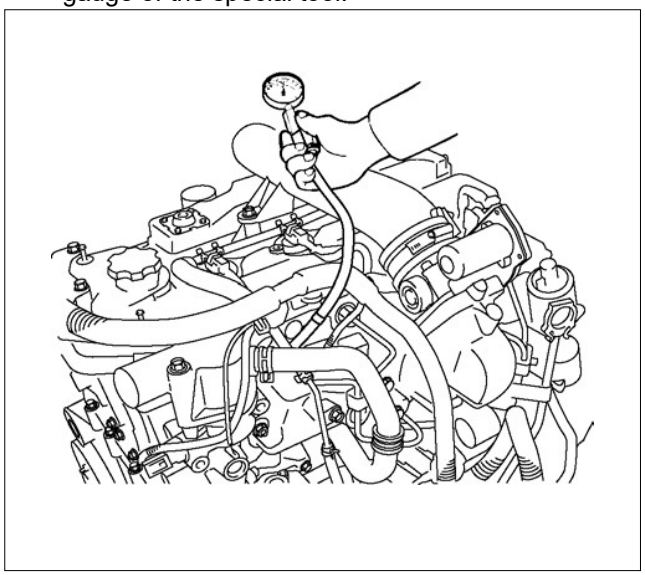
Compression pressure inspection

- Warm up the engine.
- Disconnect the negative battery cable.

- Remove the all glow plugs.

Note:
When the harness connector is removed, ECM judges that it broke down and DTC is recorded. Upon completion of measurement, never fail to clear the memory of the ECM.
(For how to clear the memory of the ECM, refer to “ENGINE CONTROL SYSTEM” Section)

- Connect the negative battery cable.
- Turn on the starter to emit foreign matter within the cylinders.
- Install an adapter and a gauge of a compression gauge of the special tool.



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Compression gauge: 5-8840-2675-0
Gauge adapter: 5-8840-2815-0

- Turn on the starter to inspect compression pressure.

Compression pressure	MPa(psi)/200rpm
Standard	2.84 – 3.24 (412 – 469)
Limit	1.96 (284)
Differences among the cylinders	294 kPa (43)

- Measure each cylinder one by one.

Note:
To keep engine speed at 200 rpm or more, use fully charged batteries.

- Remove a compression gauge of the special tool.
- Disconnect the negative battery cable.
- Install the glow plugs.
- Connect the negative battery cable.

A list of defective phenomena

- Engine does not turn over.
- Engine turns over but does not start.
- Excessive black exhaust smoke.
- Excessive white exhaust smoke.
- Engine knocking.
- Abnormal engine rotation.
- Abnormal battery charging.
- Turbocharger trouble shooting.

Trouble Shooting

Engine does not turn over

Condition	Possible Cause	Correction
Starter motor does not rotate	Dead or weak battery	Charge battery Replace battery
	Incomplete circuit	Connect Repair
	Starter motor brushes stuck, worn, or broken	Replace brushes
	Starter motor internal damage	Repair motor
Starter motor not meshed with flywheel	Ring gear abrasion	Replace ring gear
	Magnetic switch (starter motor) not properly adjusted	Adjust
Starter motor pinion meshed with ring gear but does not rotate	Dead or weak battery	Charge battery Replace battery
	Insufficient contact pressure between starter motor brushes and commutator	Adjust pressure
	Armature (starter motor) stuck	Repair armature
	Engine internal damage (Seizure)	Repair engine

Engine turns over but does not start

Condition	Possible Cause	Correction
Fuel is not delivered to fuel supply pump	Air in fuel system	Bleed air from fuel system
	Air entering fuel pipe	Replace pipe and bleed air from fuel system
	Empty fuel tank	Replenish fuel
	Clogged strainer (fuel suction)	Clean or replace strainer
	Clogged fuel pipe	Clean or replace pipe
	Feed pump malfunction	Replace pump
	Use of wrong fuel for prevailing temperatures	Drain existing fuel and replace with appropriate fuel
	Clogged fuel filter	Replace filter
Fuel is delivered to fuel supply pump	Loose injection pipe connections	Tighten connections
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Bad rotational sensor	Replace sensor
	Engine control system malfunction	System diagnosis
Insufficient or unstable fuel delivery volume	Air in fuel system	Bleed air from fuel system
	Feed pump malfunction	Repair pump
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Clogged fuel filter	Replace filter
	Engine control system malfunction	System diagnosis

Excessive black exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Bad fuel injector condition	Carbon deposit at nozzle tip	Clean fuel injector assembly
	Sticking nozzle	Replace fuel injector assembly
	Engine control system malfunction	System diagnosis
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
	Poor fuel quality	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged intake pipes	Clean or replace pipes
	Clogged air cleaner element	Clean or replace element
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Engine control system malfunction	System diagnosis
EGR valve and/or intake throttle valve malfunction	Intake throttle valve sticking	Repair or replace valve
	EGR valve sticking	Repair or replace valve
	Engine control system malfunction	System diagnosis
Turbocharger malfunction	Damaged turbocharger blade	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Oil leakage from oil seal	Replace turbocharger
	Broken actuator	Replace turbocharger

Excessive white exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Control unit malfunction	Replace unit
	Engine control system malfunction	System diagnosis
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
Excessive oil consumption	Worn or damaged piston ring(s)	Replace ring(s)
	Defective valve stem oil seal	Replace oil seal
	Defective turbocharger oil seal	Replace turbocharger
	Clogged turbocharger oil return pipe	Repair pipe

Engine knocking

Condition	Possible Cause	Correction
Bad timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Control unit malfunction	Replace unit
	Engine control system malfunction	System diagnosis
Fuel condition	Poor quality fuel	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged air cleaner element	Clean or replace element
	Clogged intake pipes	Clean or replace pipes
	Engine control system malfunction	System diagnosis
Engine break-down	Foreign material in cylinders	Engine overhaul
	Scored pistons and/or bearings	Replace pistons and/or bearings

Abnormal engine rotation

Condition	Possible Cause	Correction
Engine speed cannot be increased	Defective control unit	Replace unit
	Engine control system malfunction	System diagnosis
Engine speed unstable	Defective control unit	Replace unit
	Engine control system malfunction	System diagnosis
	Clogged fuel filter element	Replace element
	Defective fuel injector(s)	Replace fuel injector assembly
	Water in fuel	Drain existing fuel and replace with new fuel
	Air in fuel system	Bleed air from fuel system
Turbocharger malfunction	Damaged turbocharger fan	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Broken actuator	Replace turbocharger

Abnormal battery charging

Condition	Possible Cause	Correction
No charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Defective battery	Replace battery
Insufficient charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Loose generator drive belt	Adjust belt tension or replace belt
	Defective battery	Replace battery
Excessive charging	Shorted wiring	Repair or replace wiring
	Defective generator	Repair or replace generator
	Defective battery	Replace battery

Turbocharger Troubleshooting

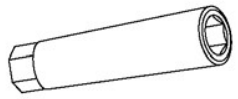
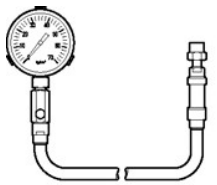
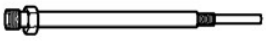
Condition	Possible Cause	Correction
Engine has less than normal power	Air leakage from intake pipe rubber hose	Repair
	Air leakage from intake cover	Repair
	Clogged intercooler cooling section	Clean
	Clogged air cleaner element	Clean or replace
	Intake throttle valve stuck	Repair or replace
	Turbine and housing contact (Interference)	Replace
	Excessive carbon deposit near turbine exhaust port that interferes with turbine	Clean or repair
	Rough turbine shaft rotation	Repair or replace
	Damaged turbine blade	Repair or replace
Blue exhaust smoke	Oil leakage from turbocharger oil seal	Repair or replace
	Clogged turbocharger oil return pipe	Repair
	Clogged center housing oil passages	Repair or replace
	Engine oil deterioration	Change engine oil
Noisy turbocharger operation	Gas leakage from intake or exhaust system	Repair
	Turbine and housing contact (Interference)	Repair or replace
	Damaged turbine blade	Replace
	Turbine shaft bearing abrasion or scoring	Repair or replace
Excessive rotating part wear	Engine oil deterioration	Change engine oil
	Clogged turbocharger oil feed pipe	Repair
	Low engine oil pressure	Repair

Main Data and specifications

Item			Engine model 4JK1	Engine model 4JJ1
Type			Diesel/4-cycle/water cooling-type in-line DOHC	
Combustion chamber type			Direct injection type	
Cylinder liner type			Liner less	
Number of cylinders -cylinder bore × strokes		mm (in)	4-95.4 (3.76) × 87.4 (3.44)	4-95.4(3.76) × 104.9(4.13)
Displacement		cc (cu.in)	2499 (152)	2999 (183)
Compression ratio			18.3	17.5
Compression pressure		MPa (psi)/rpm	3 (435)/200	
Idling speed		rpm	700 ± 25	
Valve clearance	Intake		0.15 (0.006) (cold)	
mm (in)	Exhaust		0.15 (0.006) (cold)	
Ignition type			Compressed ignition	
Injection order			1 - 3 - 4 - 2	
Lubricating system				
Lubricating type			Pressure delivery type	
Oil pump type			Gear type	
Volume of lubricating oil		L (qts)	8.0 (8.5)	
Oil filter type			Full flow filter (cartridge type)	
Oil cooling type			Built-in-type, water cooling	
Cooling system				
Cooling type			Water cooling type	
Radiator type			Corrugated fin (pressure type)	
Water pump type			Centrifugal, belt drive type	
Thermostat type			Wax-type units	
Thermostat valve-opening temperature		°C (°F)	85 (185)	
Volume of coolant		L (qts)	M/T8.7 (9.2) A/T 8.6 (9.1) (incl. radiator)	
Fuel system				
Injection pump type			Fuel supply pump fuel rail type	
Fuel injector type			Electronic control injector 6-hole	
Fuel pump type			Into the fuel tank type	
Charging system				
Generator type			AC type	
Power output		V-A	12 - 90	

Item		Engine model 4JK1	Engine model 4JJ1
Regulator type		IC	
Starting system		Engage magnet type	
Starter type		Reduction type	
Power output	V-kW	12 – 2.3	
Preheat system type		Glow plug	
Glow plug standard voltage/electric current	V-A	12 - 3.5	

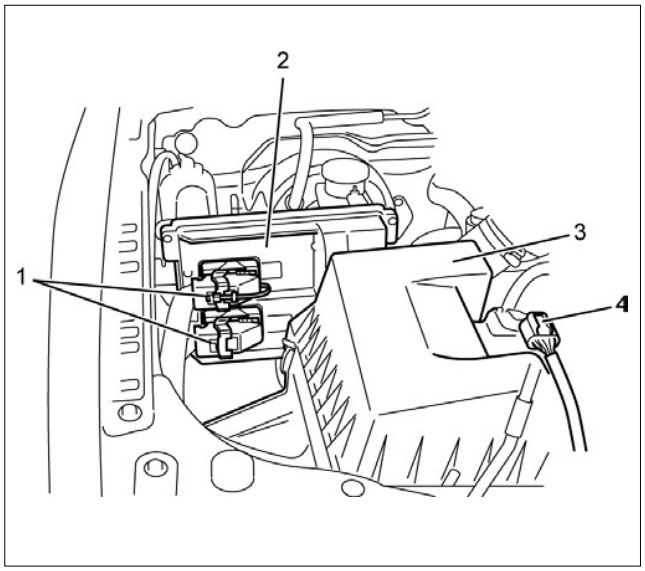
Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028220	**5-8840-2822-0** Valve clearance adjust nut wrench
 5884026750	**5-8840-2675-0** Compression gauge
 5884028150	**5-8840-2815-0** Compression gauge adapter

Engine Assembly

Removal

1. Disconnect the negative battery cable.
2. Remove the engine hood.
3. Drain the coolant.
4. Remove the starter motor.
5. Remove the transmission assembly.
   Refer to removal procedure for “TRANSMISSION” in this manual.
6. Disconnect the ECM harness connector.
7. Remove the ECM.
8. Remove the air cleaner.
   - Disconnect the MAF sensor harness connector.
   - Remove the intake pipe with the lid of air cleaner box.
   - Remove the air cleaner box.



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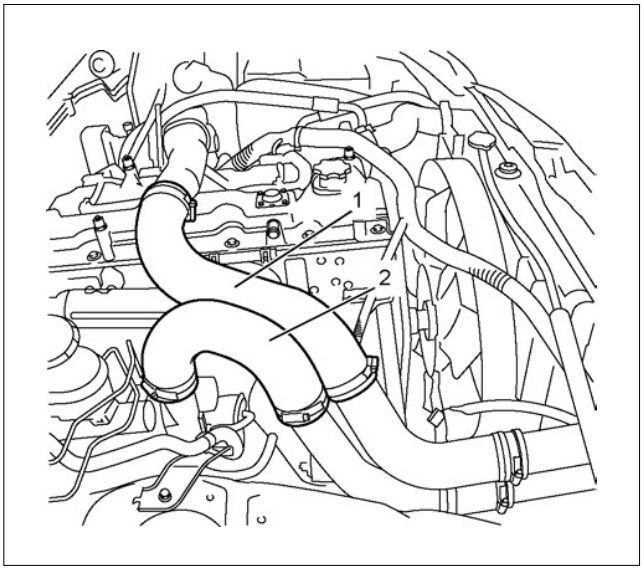
Legend

1. ECM Harness Connector
2. ECM
3. Air Cleaner Box
4. MAF Sensor Harness Connector

9. Remove the intake hose (intercooler - intake throttle) (Standard output).
10. Remove the intake hose (turbocharger - intercooler) (Standard output).
    Remove the harness connector.



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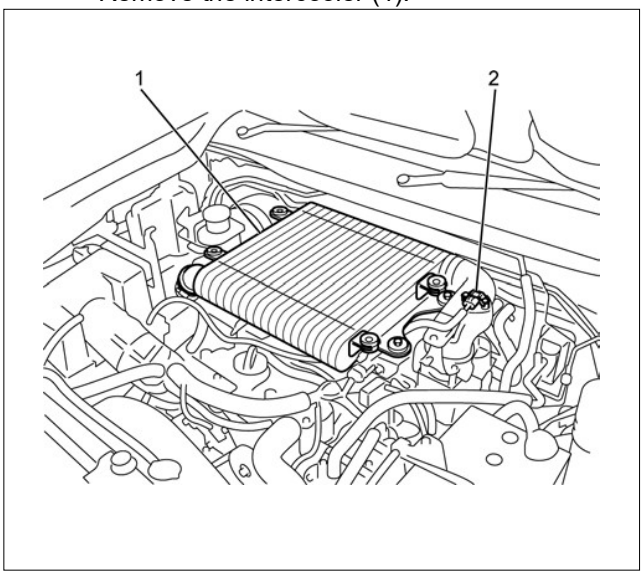
Legend

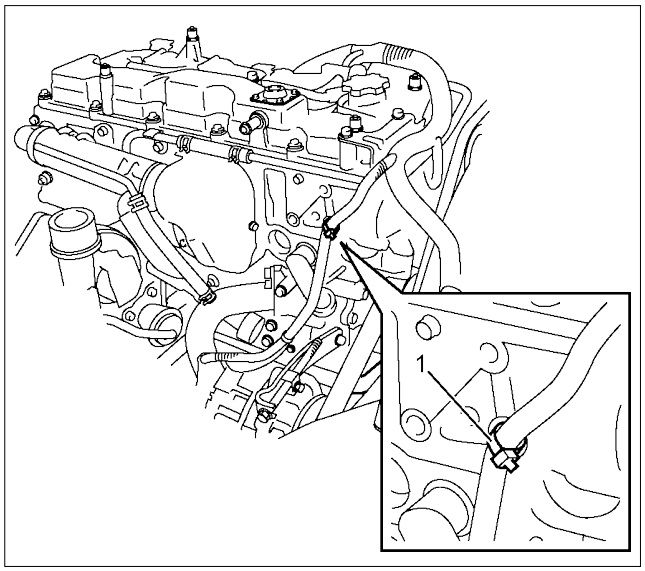
1. Intake Hose (intercooler - intake throttle)
2. Intake Hose (turbocharger - intercooler)

11. Remove the intercooler (High output).
    - Disconnect the BARO sensor harness connector (2).
    - Remove the two intake hoses.
    - Remove the intercooler (1).



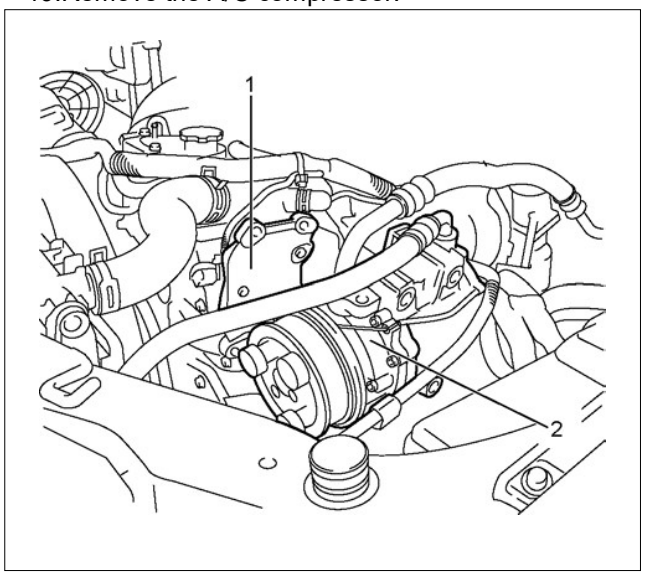
RTW76ASH000501

12. Remove the radiator upper hose.
13. Remove the engine harness clip (1).



RTW76ASH001401

14. Remove the breather hose and lower hose of the radiator.
15. Remove the fan guide.
16. Remove the drive belt.
17. Remove the fan assembly.
18. Remove the radiator.
19. Remove the A/C compressor.



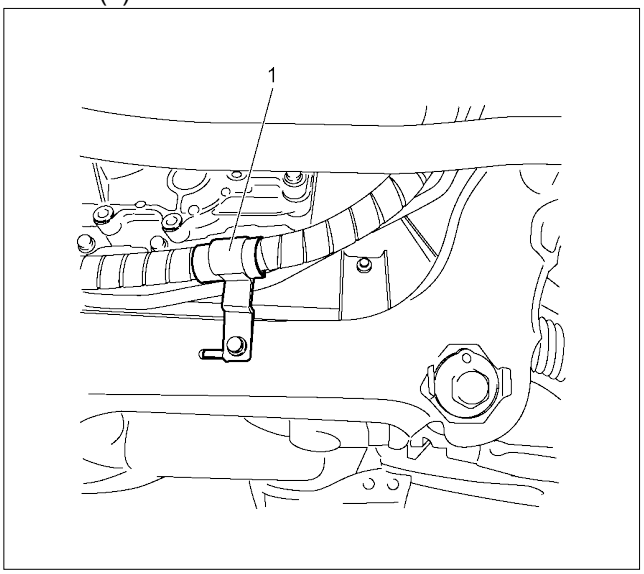
RTW76ASH000701

Legend

1. A/C Compressor Bracket
2. A/C Compressor

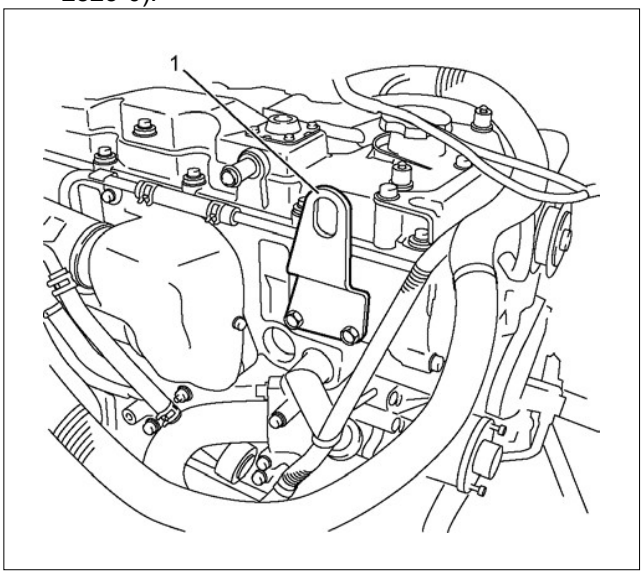
- Disconnect the connector.
- Disconnect the A/C generator harness.
- Disconnect the terminal B cable and harness connector from the generator.

20. Remove the power steering pump.
    - Remove the bracket of power steering oil hose (1).



LTW56ASH000101

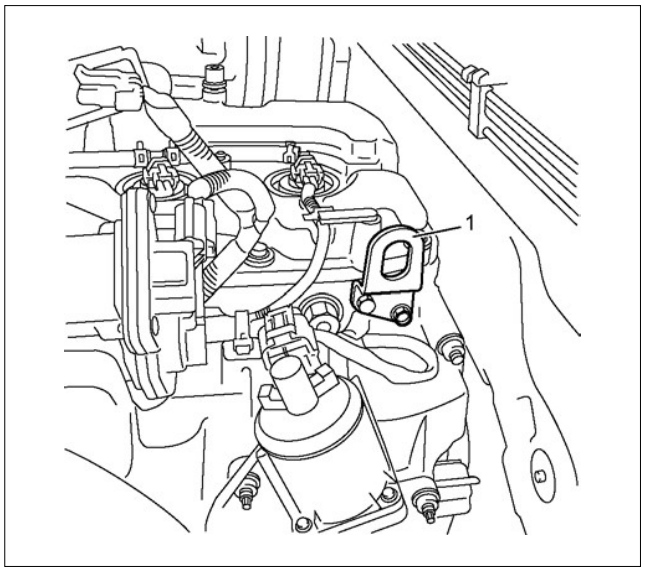
21. Remove the harness of engine, battery and earth from the body side.
22. Remove the connector of the shift on the fly (4×4).
23. Remove the vacuum hose of brake master-vac.
24. Remove the front exhaust pipe.
25. Disconnect the fuel hose on the feed and return sides.
26. Install the engine hanger (special tool 5-8840-2823-0).



RTW56ASH004301

Legend

1. Engine Hanger (Front Side)



RTW56ASH004401

Legend

1. Engine Hanger (Rear Side)

27. Hang wire on the engine hanger and hoist to lift up the engine slightly.
28. Remove the engine mount.
- Remove the fastening bolts for the engine mount on the engine side.

29. Remove the engine assembly.
- Hoist the engine slightly to provide space to remove the catalytic converter.

Installation

Notice:
Be absolutely sure that each harness is reconnected to its original position.

1. Install the engine assembly.
- Hang wire on the engine hanger and hoist to lift up the engine.
- Operate a hoist slowly to move the engine to the place where it is to be installed.
- Make the transmission side lower and operate a hoist slowly, pulling it backward to the engine.

2. Install the engine mount.

Tightening torque: 48 N·m (4.9kg·m / 35 lb ft)

3. Remove the engine hanger.
4. Install the catalytic converter.

Tightening torque: 27 N·m (2.8kg·m /20 lb ft)

5. Install the front exhaust pipe.

Tightening torque: 67 N·m (6.8kg·m / 49 lb ft)

6. Install the fuel hose on the feed and return sides.
7. Install the vacuum hose of brake master-vac.
8. Install the connector of the shift on the fly (4×4).
9. Install the harness of engine, battery and earth to the body side.
10. Install the power steering pump.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

- Install the bracket of power steering oil hose.

11. Install the A/C compressor.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

- Install the connector.

12. Install the A/C generator harness.
- Install the terminal B cable and the harness connector to the generator.

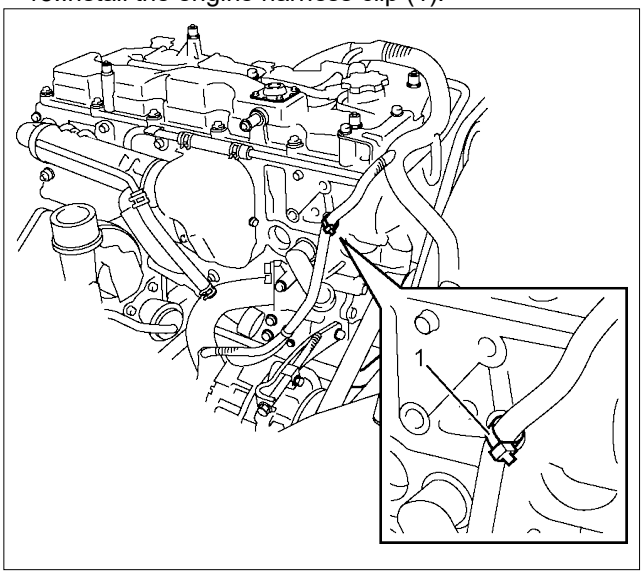
13. Install the radiator.

Tightening torque: 25 N·m (2.5kg·m / 18 lb ft)

14. Install the fan assembly.

Tightening torque: 8 N·m (0.8kg·m / 69 lb in)

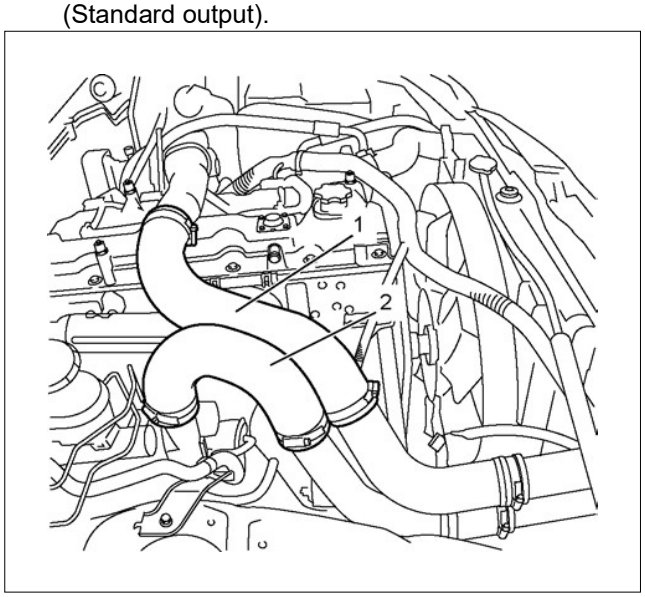
15. Install the drive belt.
Refer to removal procedure for drive belt in this manual.
16. Install the fan guide.
17. Install the breather hose and lower hose of the radiator.
18. Install the engine harness clip (1).



RTW76ASH001401

19. Install the radiator upper hose.
20. Install the intake hose (turbocharger -intercooler) (Standard output).
- Install the harness connector.

21.Install the intake hose (intercooler - intake throttle) (Standard output).



RTW56ASH004001

22.Install the intercooler (High output).
- Install the intercooler.
- Install the two intake hoses.
- Connect the BARO sensor harness connector.

23.Install the air cleaner.
- Install the intake pipe with the lid of air cleaner box.
- Install the air cleaner box.
- Connect the MAF sensor harness connector.

24.Install the ECM.

25.Connect the ECM harness connector.

26.Install the transmission assembly.
Refer to installation procedure for “TRANSMISSION”.

27.Install the starter motor.

Tightening torque: 94 N·m (9.6kg·m / 69 lb ft)

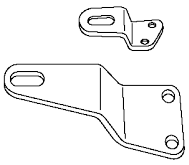
28.Replenish the coolant.

29.Install the engine hood.

Tightening torque: 10 N·m (1.0kg·m / 87 lb in)

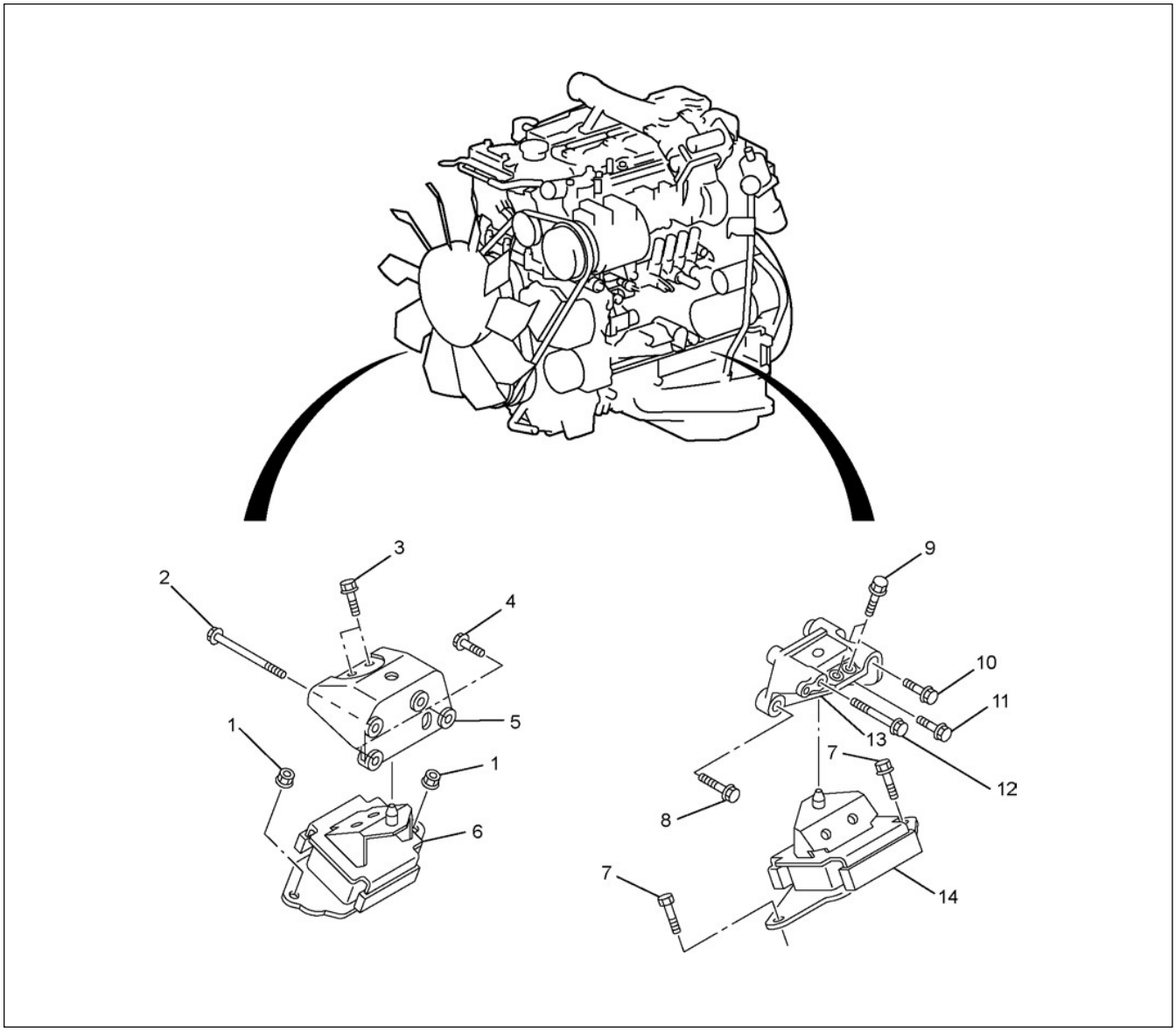
30.Connect the negative battery cable.

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028230	**5-8840-2823-0** Engine hanger

Engine Mount

Components



RTW56ALF001801

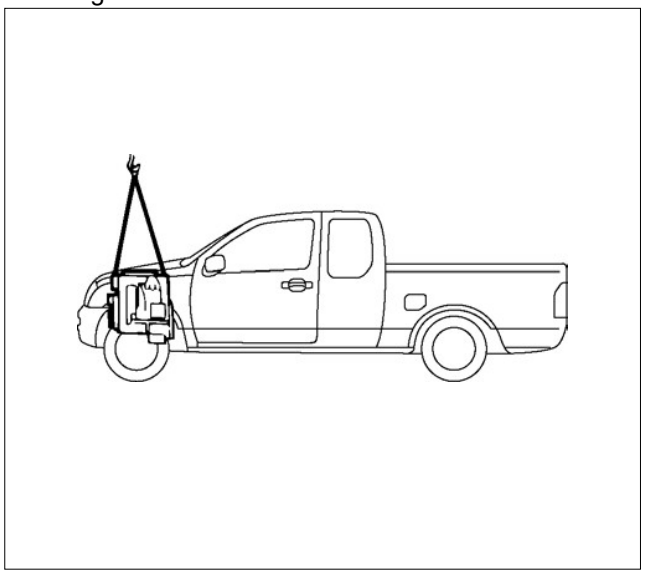
Legend

1. Nut
2. Bolt (L = 80 mm / 3.15 in)
3. Bolt (L = 30 mm / 1.18 in)
4. Bolt (L = 30 mm / 1.18 in)
5. Engine Foot RH
6. Engine Mount RH
7. Bolt (L = 25 mm / 0.98 in)
8. Bolt (L = 45 mm / 1.77 in)
9. Bolt (L = 30 mm / 1.18 in)
10. Bolt (L = 40 mm / 1.57 in)
11. Bolt (L = 20 mm / 0.78 in)
12. Bolt (L = 100 mm / 3.94 in)
13. Engine Foot LH
14. Engine Mount LH

Removal

1. Remove the engine hood.
2. Remove the engine cover.
3. Set the hoist and the engine hanger of the special tool (special tool 5-8840-2823-0).
4. Remove the engine mount.

- Before removing the engine mount, hang the engine with a hoist.
- Remove the bolts of the engine mount.
- Hoist the engine assembly slightly to remove the engine mount.



RTW56ASH004501

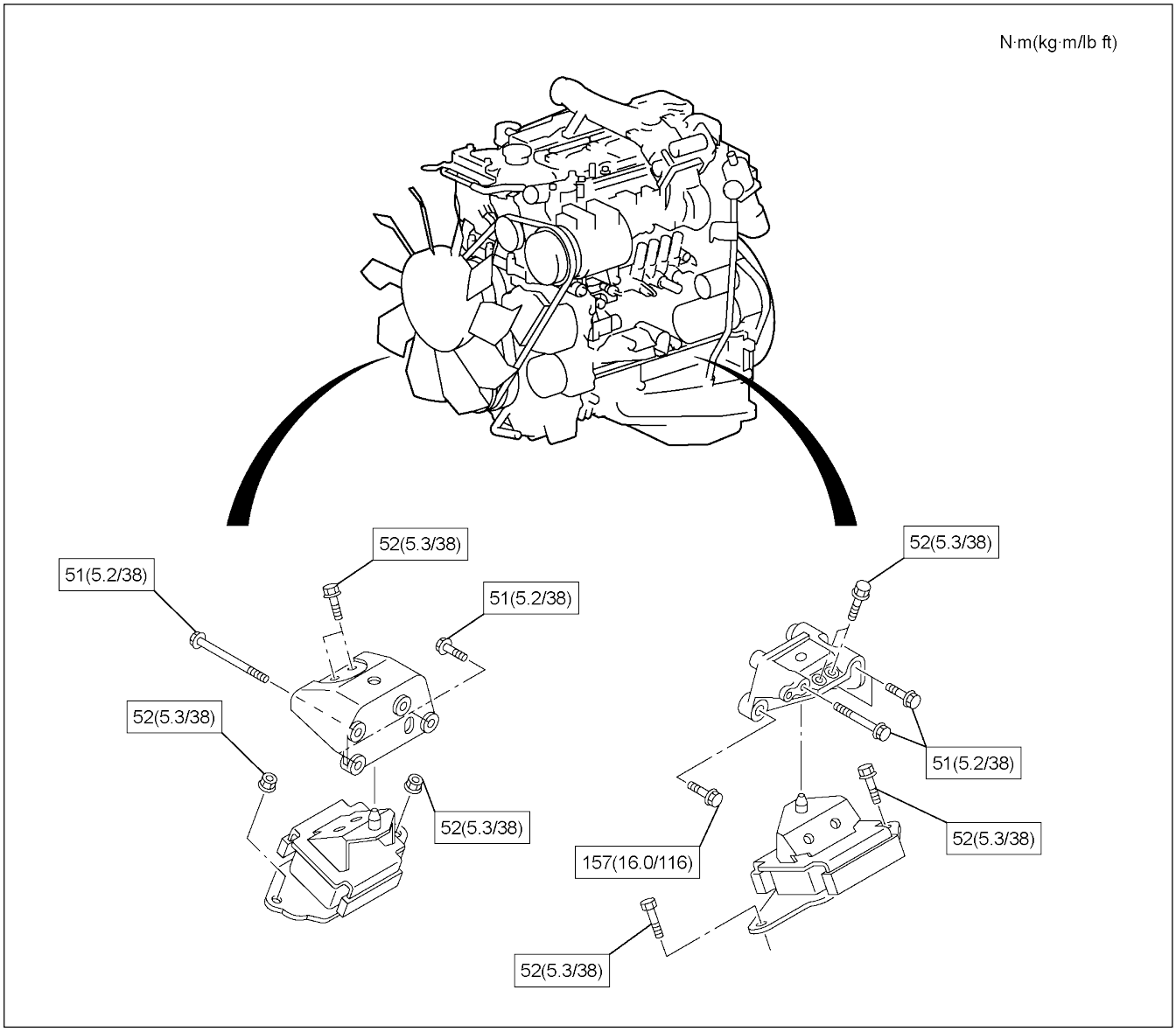
Installation

1. Install the engine mount and tighten up with the specified torque.

Tightening torque: 52 N·m (5.3 kg·m / 38 lb ft)

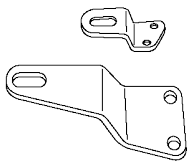
2. Install the engine cover.
3. Install the engine hood.
   - Check if nothing is wrong with the engine mount by starting the engine.

Torque Specifications



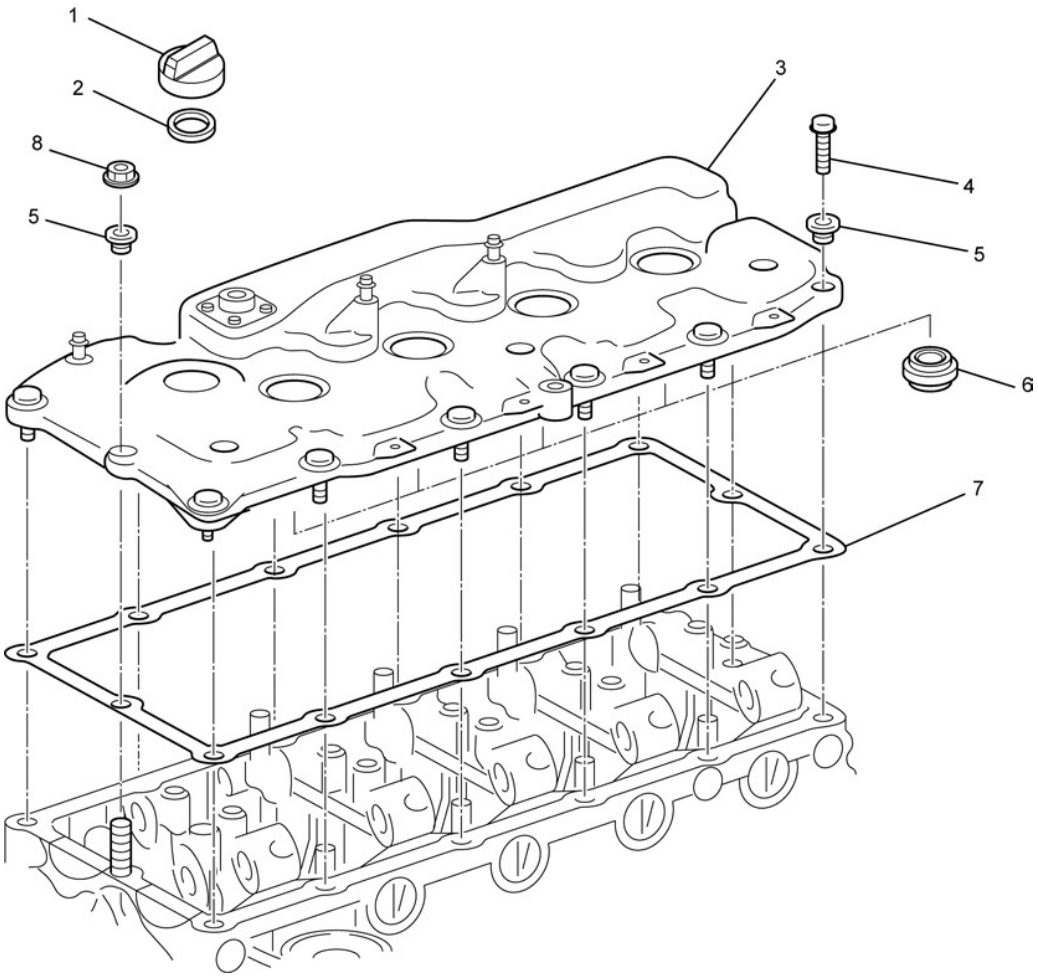
RTW56ALF003801

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028230	**5-8840-2823-0** Engine hanger

Cylinder Head Cover

Components



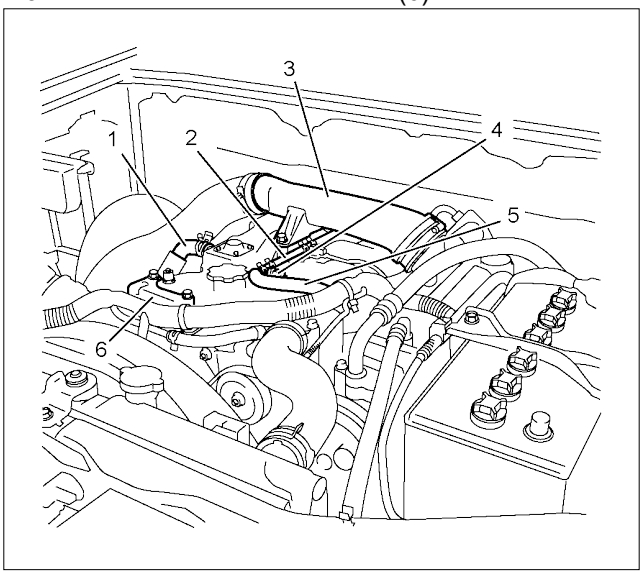
RTW76ALF000101

Legend

1. Oil Filler Cap
2. Oil Filler Cap Gasket
3. Cylinder Head Cover
4. Bolt
5. Head Cover Mounting Rubber
6. Nozzle Seal Cover
7. Head Cover Gasket
8. Nut

Removal

1. Remove the engine cover.
2. Remove the intake air duct (3) (Standard output).
3. Remove the harness bracket (6).

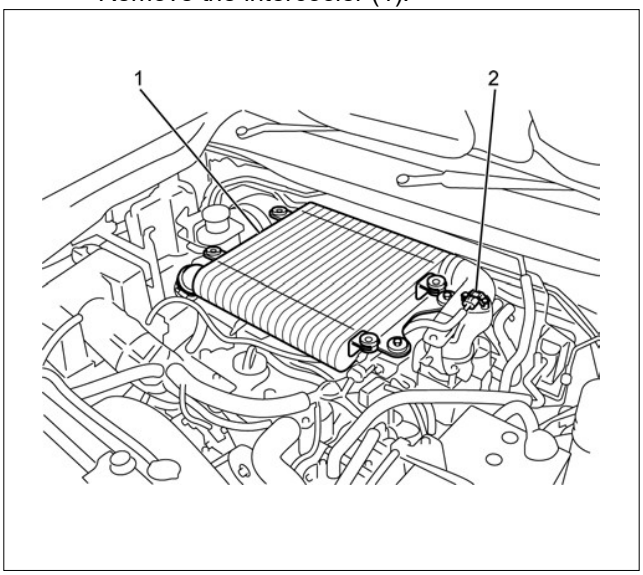


RTW56ASH025001

Legend

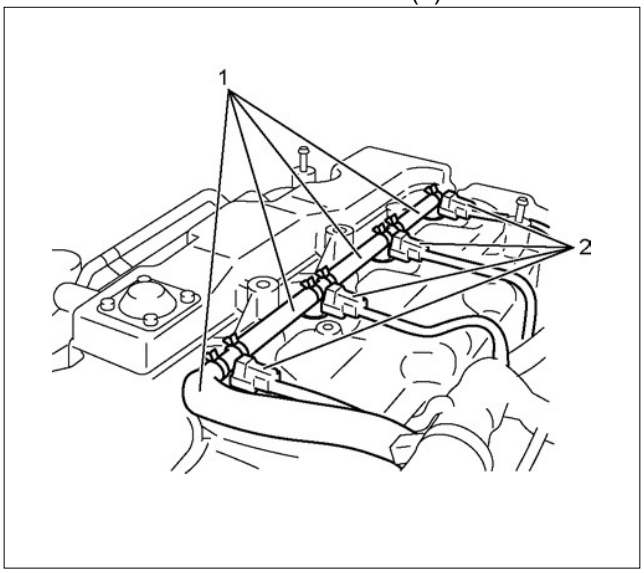
1. Blow-by Hose
2. Leak-off Hose
3. Intake Air Duct
4. Fuel Injector Connector
5. Leak-off Hose
6. Harness Bracket

4. Remove the intercooler (High output).
   - Disconnect the BARO sensor harness connector (2).
   - Remove the two intake hoses.
   - Remove the intercooler (1).



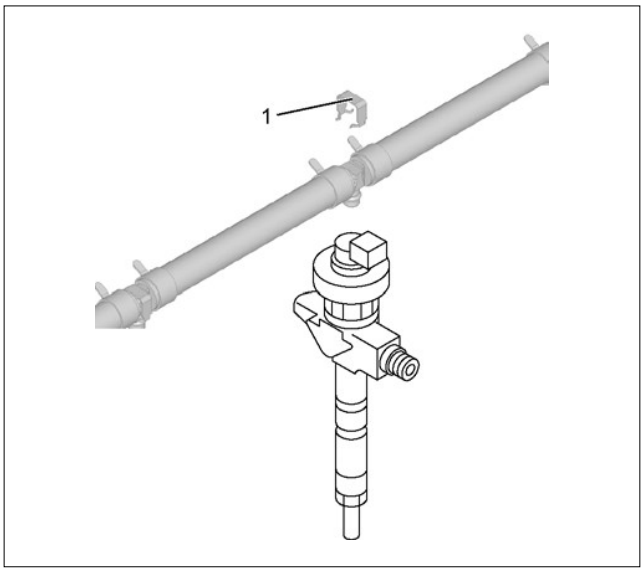
RTW76ASH000501

5. Disconnect the fuel injector connector (2).
6. Remove the fuel leak off hose (1).



RTW76ASH000101

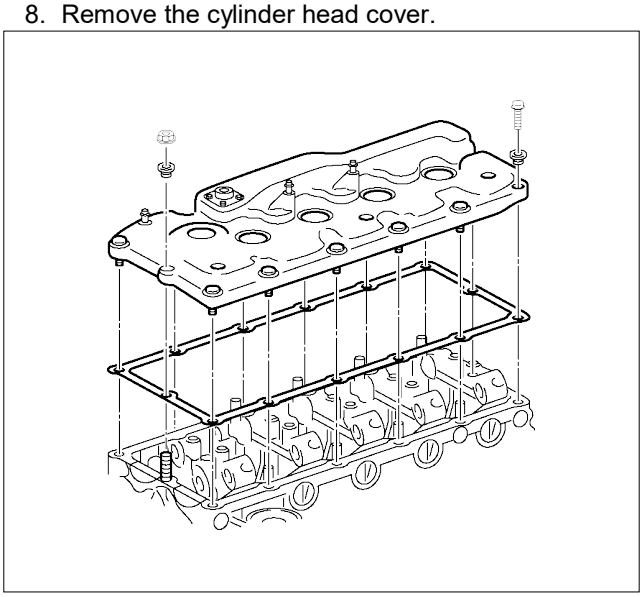
Note: Do not reuse the clips (1).



LNW76ASH002101

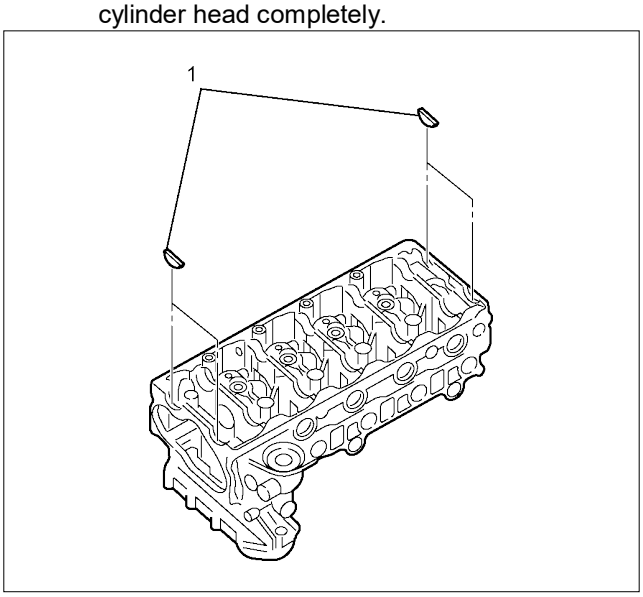
7. Disconnect the blow-by hose.

8. Remove the cylinder head cover.



LNW71BSH000401

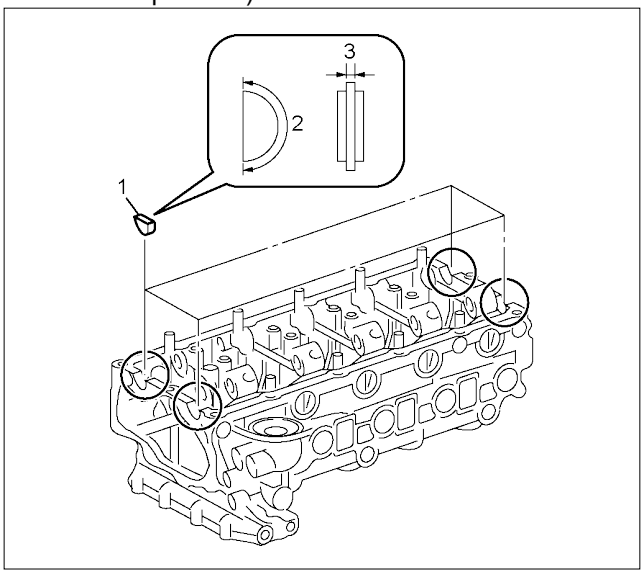
9. Remove the nozzle seal cover from the cylinder head cover.
   - Remove from the lower side of cylinder head cover.
10. Remove the cam end gasket (1).
   - Remove the liquid gasket that has adhered to cylinder head completely.



RTW56ASH020501

Installation

1. Install the nozzle seal cover.
   - Insert from the lower side of cylinder head cover.
   - Apply soapy water or engine oil to the surface of cylinder head cover side.
   - Insert the nozzle seal cover as far as it will go.
2. Install the cam end gasket.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent) and mount.

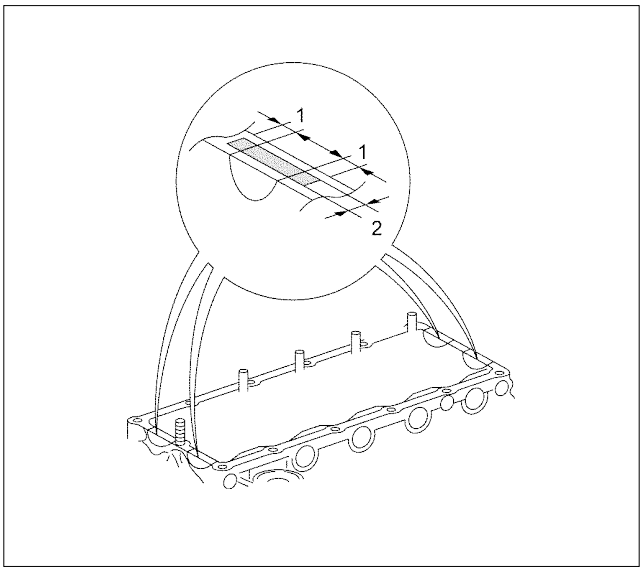


RTW56ASH020601

Legend

1. Cam End Gasket
2. Apply The Liquid Gasket
3. 2.0 - 3.0 mm (0.079 - 0.118 in)

   - Apply attaching cam end gasket.
     Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



RTW56ASH022701

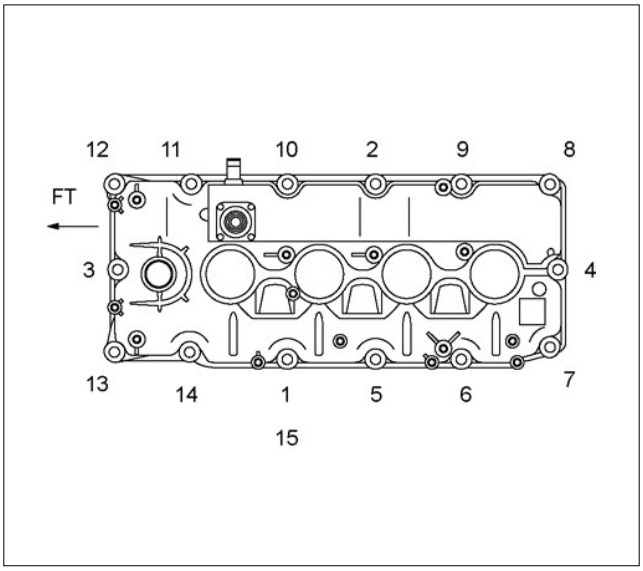
Legend

1. 3.0 - 5.0 mm (0.118 - 0.197 in)
2. 3.0 - 5.0 mm (0.118 - 0.197 in)

3. Install the cylinder head cover.

   Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

   - Tighten the nut and bolts in order shown in the illustration.



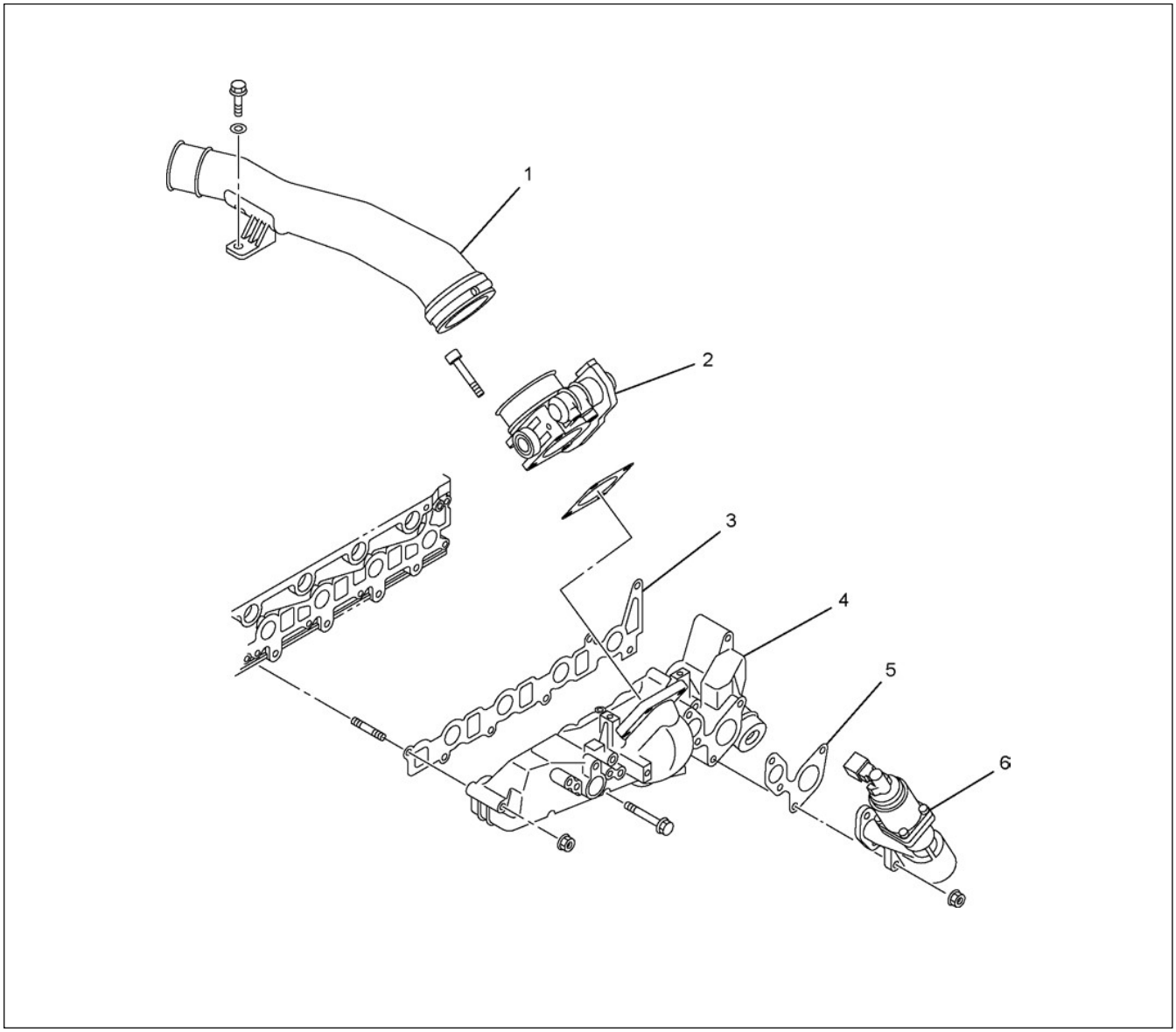
RTW56ASH004801

4. Install the blow-by hose.
5. Install the leak-off hose and the fuel injector connector.
6. Install the harness bracket to the cylinder head cover.
7. Install the intercooler (High output).
   - Install the intercooler.
   - Install the two intake hoses.
   - Connect the BARO sensor harness connector.
8. Install the intake air duct.

   Tightening torque: 25 N·m (2.5 kg·m / 18 lb in)
9. Install the engine cover.

Intake Manifold

Components (Standard Output)

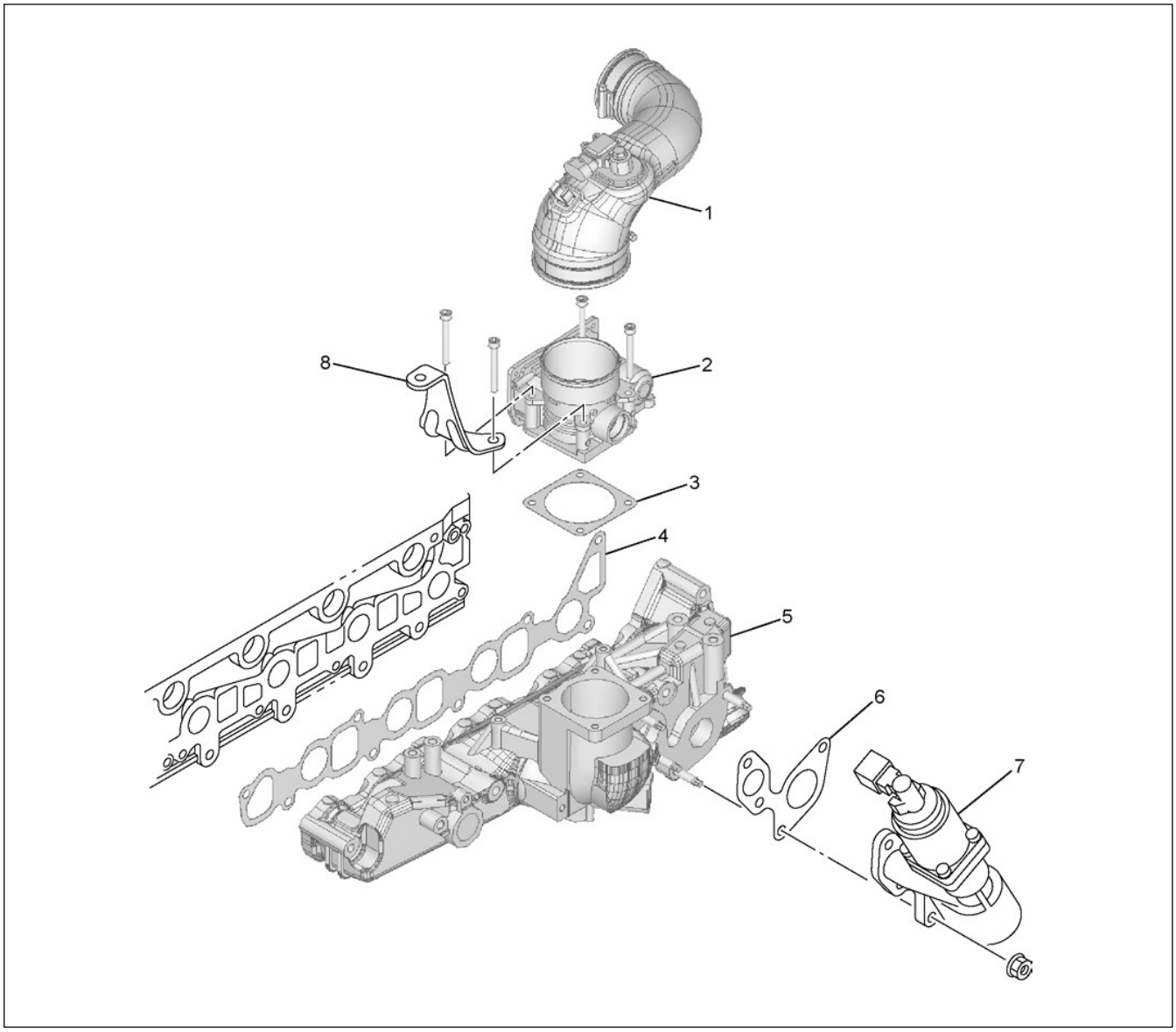


RTW76ALF000201

Legend

1. Intake Duct
2. Throttle Assembly
3. Intake Manifold Gasket
4. Intake Manifold
5. EGR Valve Assembly Gasket
6. EGR Valve Assembly

Components (High Output)



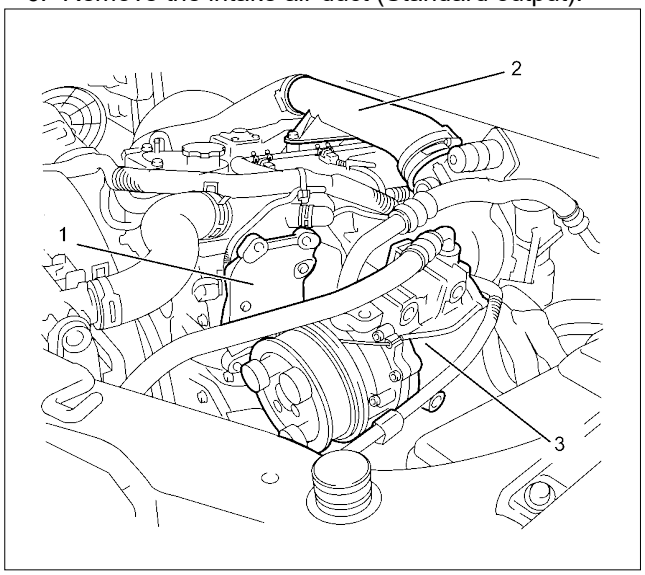
RTW76ALF000301

Legend

1. Intake Duct
2. Intake Throttle
3. Intake Throttle Gasket
4. Intake Manifold Gasket
5. Intake Manifold
6. EGR Valve Assembly Gasket
7. EGR Valve Assembly
8. Bracket

Removal

1. Remove the engine cover.
2. Disconnect the connectors.
   - Fuel Injector
   - Throttle Assembly
   - EGR Valve
   - Glow Plug
   - Barometric Sensor
   - A/C Compressor Connector
3. Remove the A/C belt
4. Remove the A/C compressor.
5. Remove the A/C compressor bracket.
6. Remove the intake air duct (Standard output).

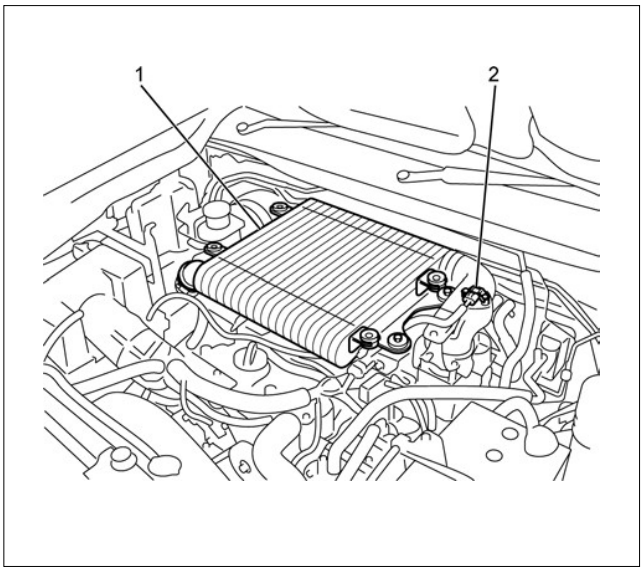


RTW56ASH024801

Legend

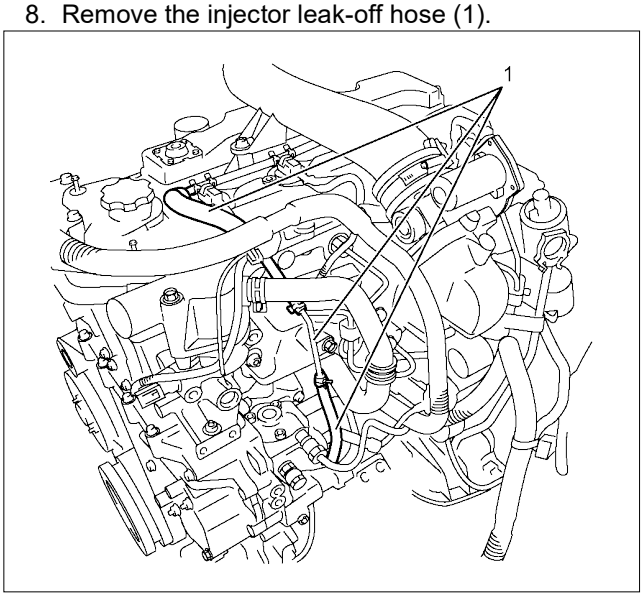
1. A/C Compressor Bracket
2. Intake Air Duct
3. A/C Compressor

7. Remove the intercooler (High output).
   - Disconnect the BARO sensor harness connector (2).
   - Remove the two intake hoses.
   - Remove the intercooler (1).



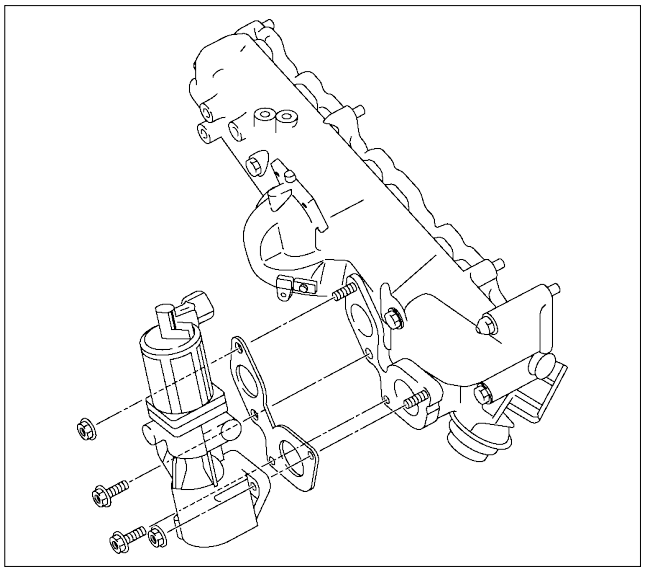
RTW76ASH000501

8. Remove the injector leak-off hose (1).



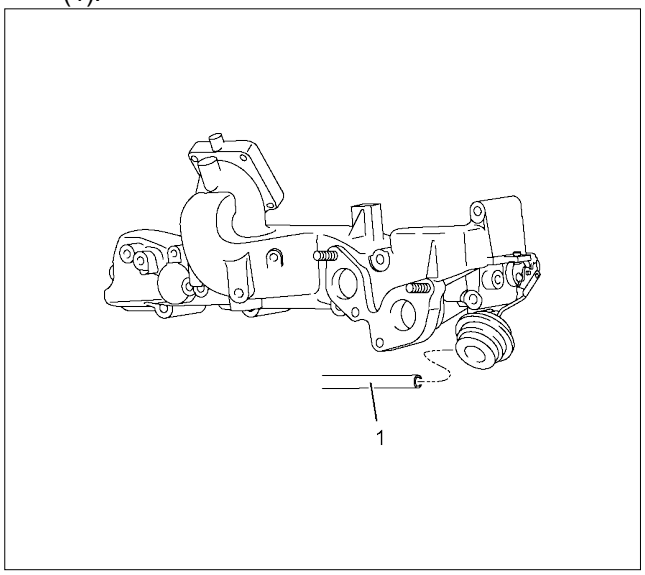
RTW56ASH024301

9. Remove the engine oil level gauge guide tube.
10. Remove the EGR valve.



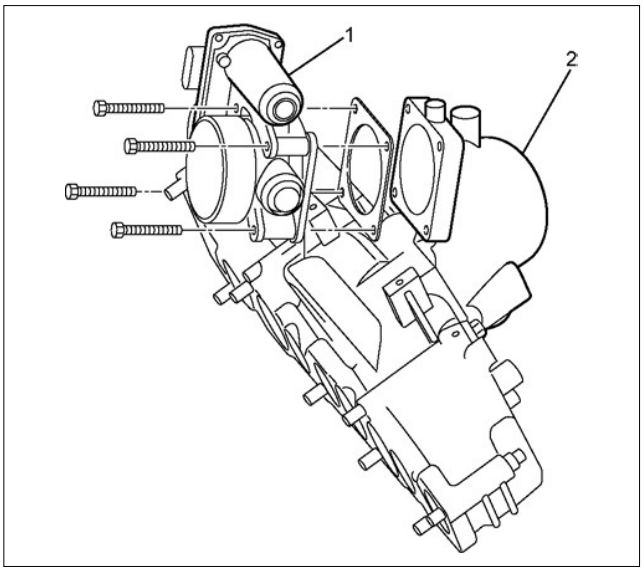
RTW66ASH003001

11. Remove the injection pipes.
    - Remove sequentially from No.1 cylinder.
12. Disconnect the vacuum hose of swirl control valve (1).



RTW66ASH003101

13. Remove the throttle assembly and gasket.

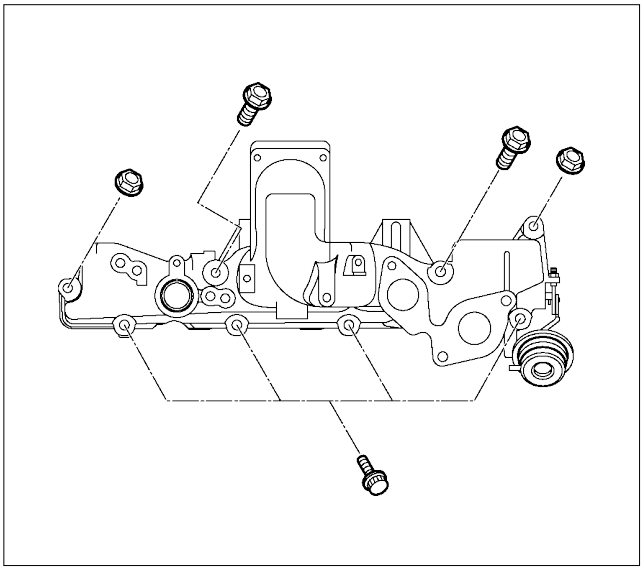


RTW56ASH005201

Legend

1. Throttle Assembly
2. Intake Manifold

14. Remove the intake manifold.



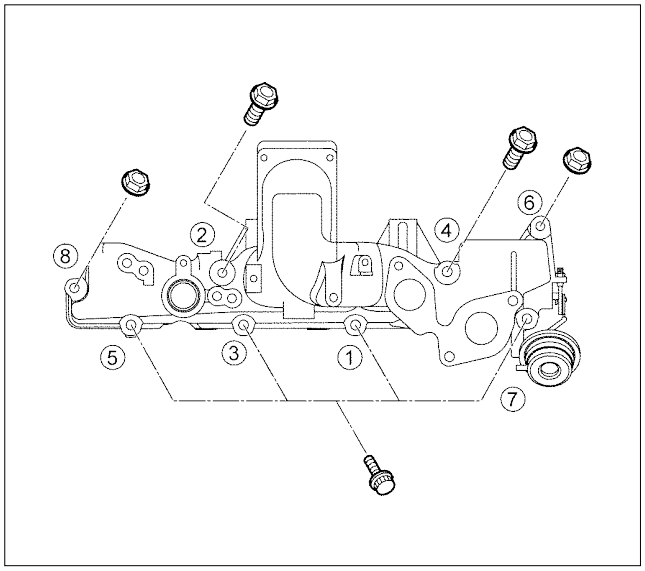
RTW56ASH018001

15. Remove the intake manifold gasket.

Installation

1. Install the intake manifold gasket.
2. Install the intake manifold.
   - Tighten the nuts and bolts in the order described in the drawing.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH018001

3. Install the throttle assembly and gasket.
   - Tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

4. Install the vacuum hose of swirl control valve.
5. Install the injection pipe (fuel rail - fuel injector).
   - It installs sequentially from No. 4 cylinder.

Tightening torque: 29 N·m (3.0 kg·m / 22 lb ft)

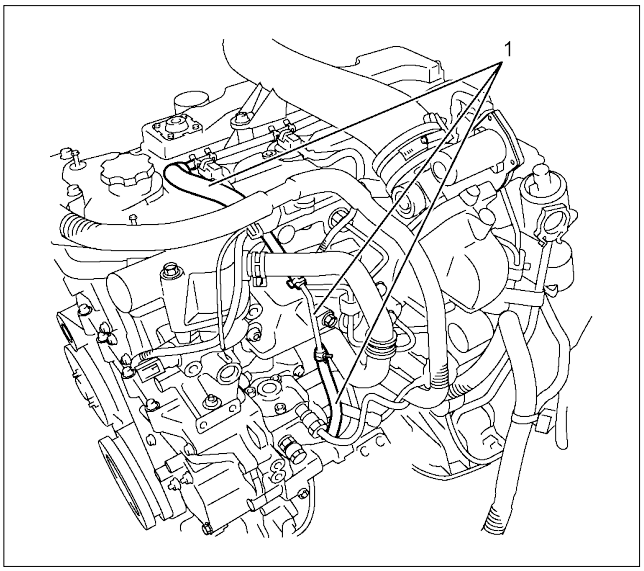
6. Install the EGR valve.
   - Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

7. Install the engine oil level guide tube.
   Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

8. Install the intercooler (High output).
9. Connect the connector of other parts.
   - Fuel Injector
   - Throttle Assembly
   - EGR Valve
   - Glow Plug
   - Barometric Sensor
   - A/C Compressor Connector
10. Install the leak-off hose.



RTW56ASH024301

Legend

1. Injector Leek-off Hose

11. Install the intake air duct.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

12. Install the A/C compressor bracket.

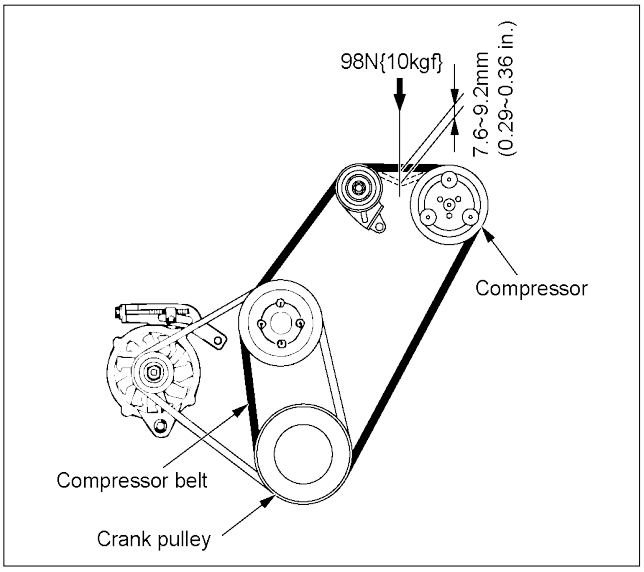
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

13. Install the A/C compressor and A/C compressor connector.

Tightening torque: 44 N·m (4.5 kg·m / 33 lb ft)

14. Install the A/C belt.
    Check the A/C belt tension.
    Depress the A/C belt mid-portion with 98 N (10 kg / 22 lb) force.

Standard deflection: 7.6 - 9.2 mm (0.29 - 0.36 in)



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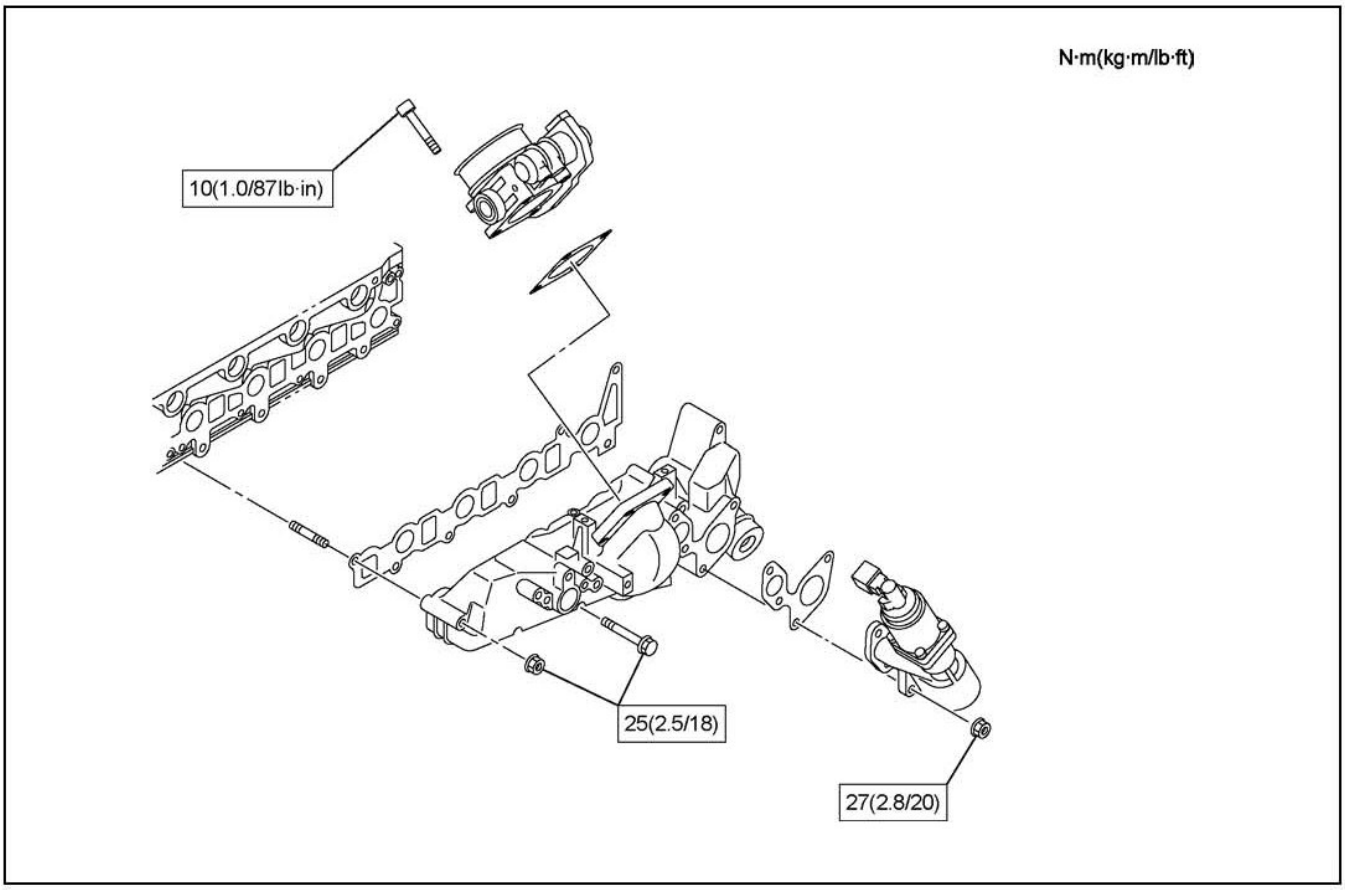
15. Install the engine cover.

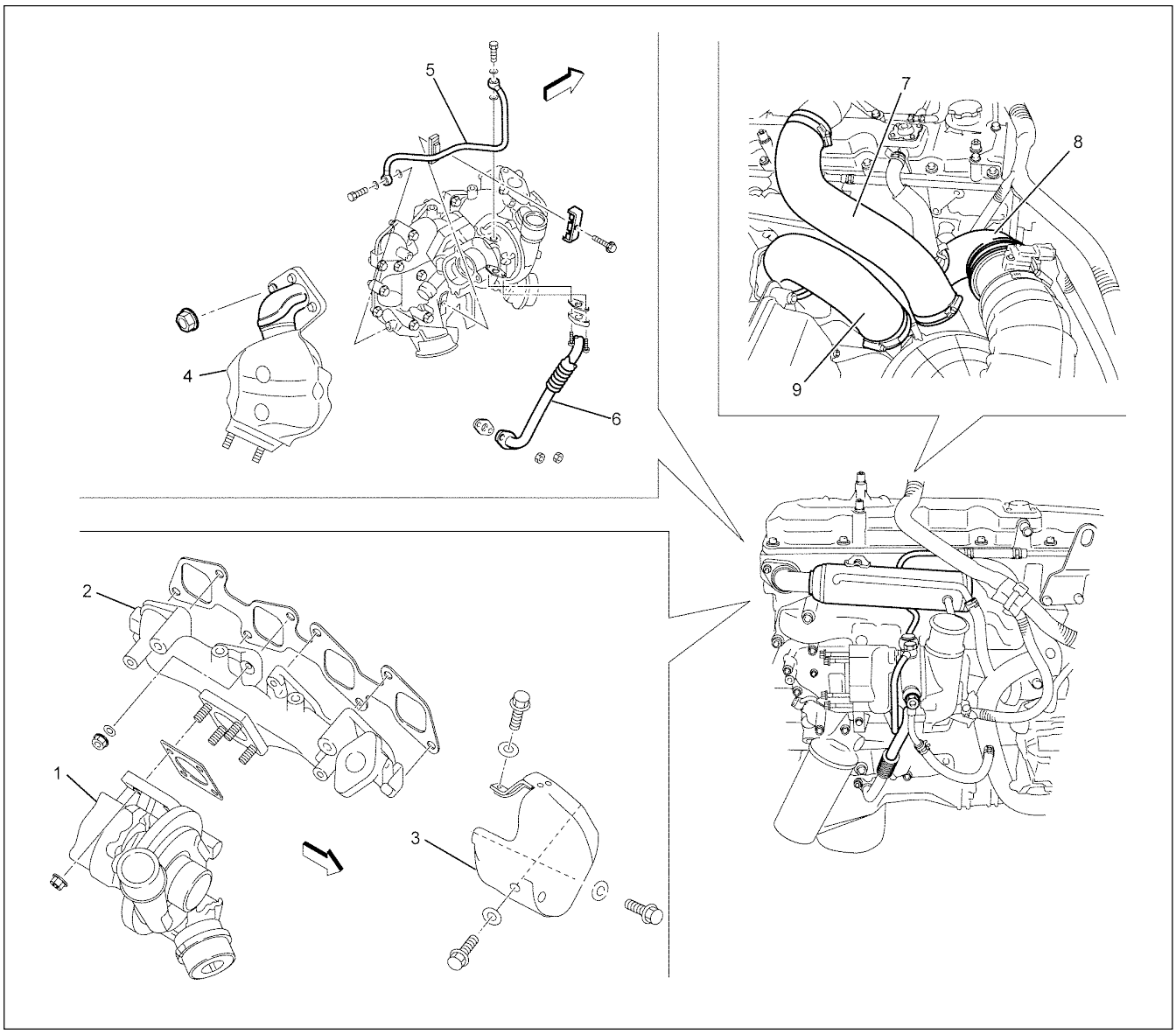
Torque Specifications



RTW76AMF000101

Turbocharger and Exhaust Manifold (Standard Output)

Components



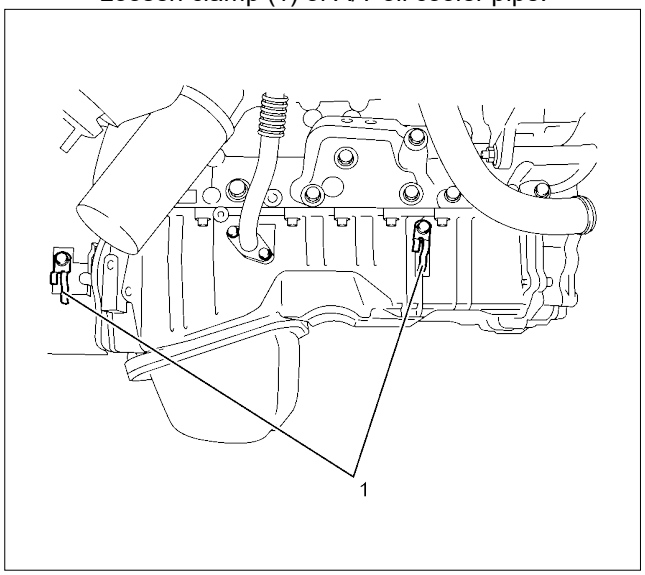
RTW56ALF002101

Legend

1. Turbocharger Assembly
2. Exhaust Manifold
3. Heat Protector
4. Catalyst Converter
5. Oil Feed Pipe
6. Oil Return Pipe
7. Intake Hose for Intercooler and Intake Throttle
8. Intake Duct for Turbocharger and Air Cleaner
9. Intake Hose for Turbocharger and Intercooler

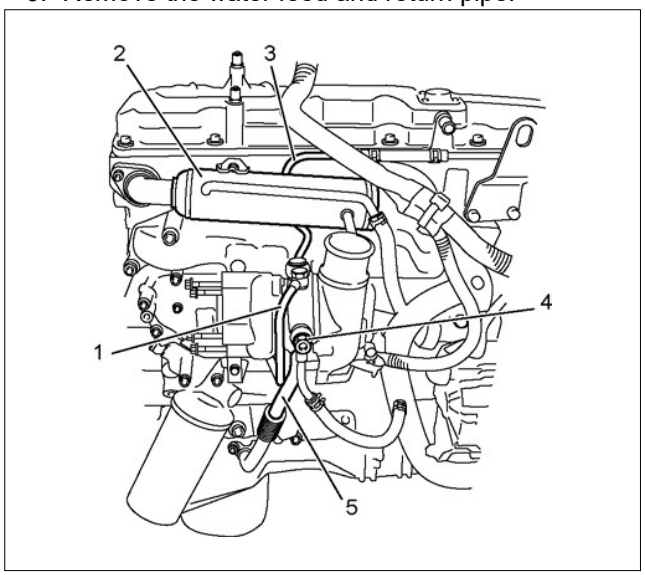
Removal

1. Loosen the radiator drain plug to drain coolant.
2. Remove the engine cover.
3. Remove the intake hose from the intercooler and intake throttle.
4. Remove the intake hose from the turbocharger and the intercooler.
5. Remove the air intake duct from the turbocharger and the air cleaner.
6. Remove the EGR cooler.
   Refer to “EGR Cooler” in EXHAUST SYSTEM Section.
7. Remove the oil feed pipe.
8. Remove the oil return pipe.
   - Loosen clamp (1) of A/T oil cooler pipe.



RTW56ASH025101

9. Remove the water feed and return pipe.

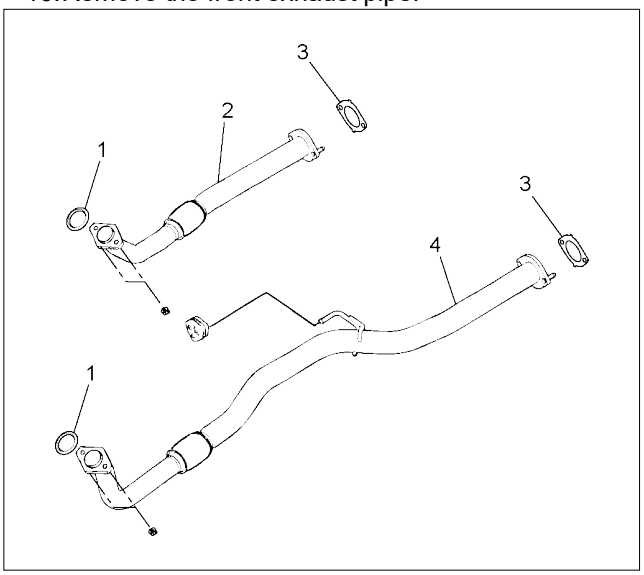


RTW56ASH005401

Legend

1. Oil Feed Pipe
2. EGR Cooler
3. Water Feed Pipe
4. Water Return Pipe
5. Oil Return Pipe

10. Remove the front exhaust pipe.

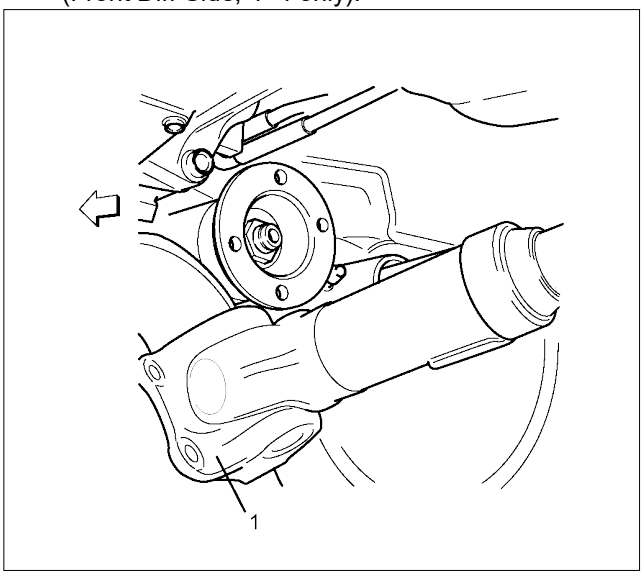


RTW56ASH018301

Legend

1. Gasket
2. Front Exhaust Pipe (4×2 High Ride Suspention, 4×4)
3. Gasket
4. Front Exhaust Pipe (4×2 Except High Ride Suspention)

11. Disconnect the front propeller shaft flange (1) (Front Diff Side, 4×4 only).



RTW76ASH002301

12. Remove the catalyst converter.

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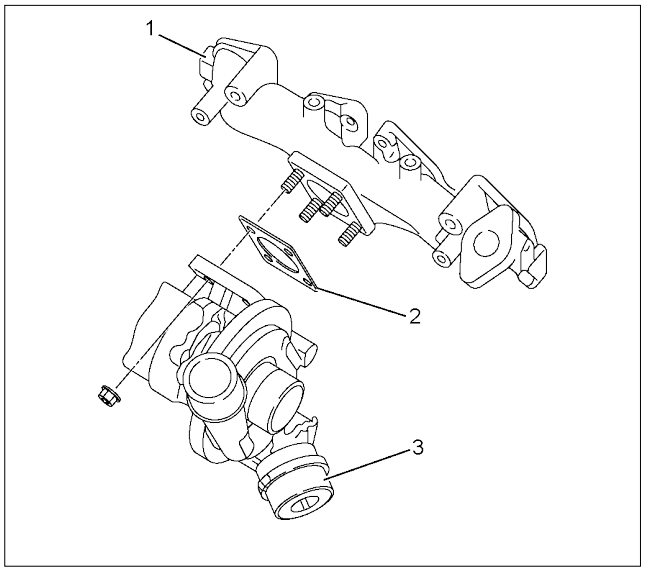
13. Remove the turbocharger from the exhaust manifold.

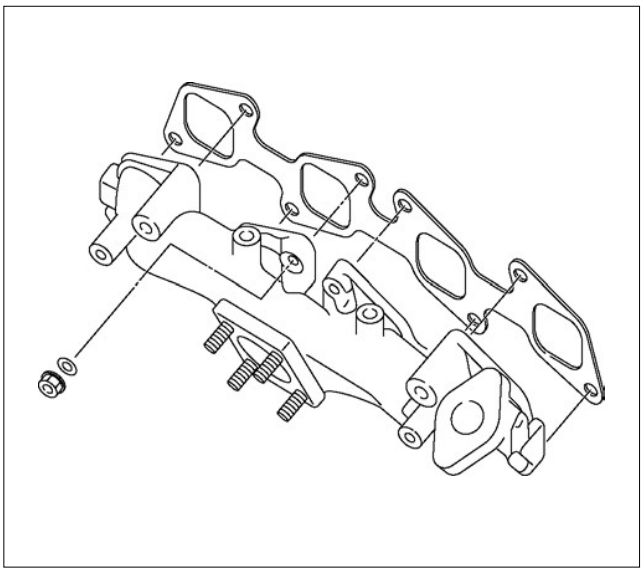


RTW56ASH005501

Legend

1. Exhaust Manifold
2. Gasket
3. Turbocharger

14. Remove the exhaust manifold.
    - Remove the 8 nuts from the exhaust manifold.



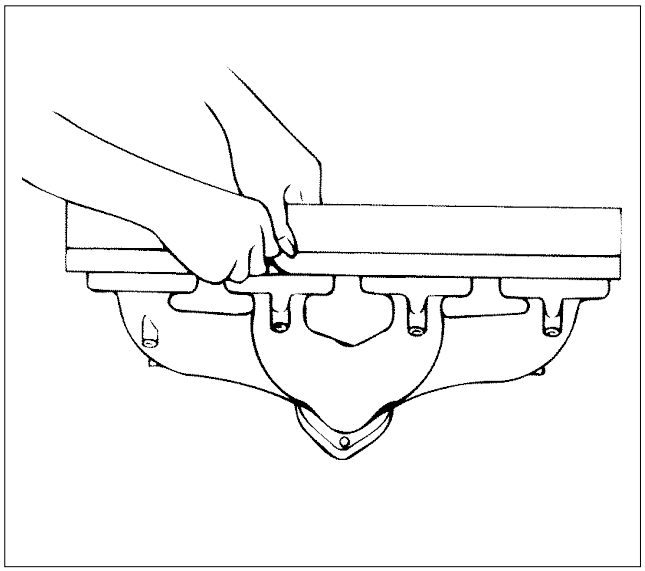
RTW56ASH005601

Inspection

- Inspection of the exhaust manifold. Inspect the plane surface of the plane on which the manifold and the cylinder head are to be installed.

Manifold installation plane surface	mm (in)
Standard	0.3 (0.01) or lower
Limit	0.5 (0.02)

Note:
If the plane surface exceeds the limit, replace it.



LNW21BSH022301

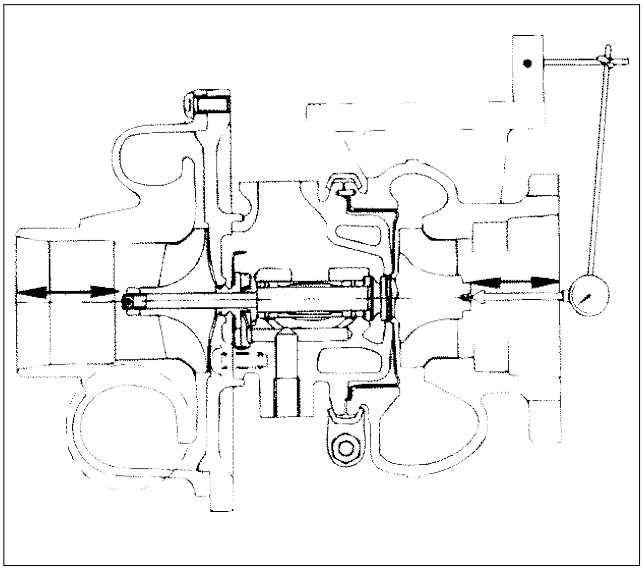
- Check a crack in the exhaust manifold visually.

Carefully inspect the turbocharger for abrasion and/or excessive wear. Make any necessary adjustments, repairs, and/or part replacements.

Wheel shaft axial play

Use a dial gauge to measure the wheel axle shaft play when a force of 12 N (1.2 kg / 2.6 lb) is alternately applied to both sides of the compressor wheel.

Axial play	mm (in)
Standard	0.03 – 0.06 (0.0012 – 0.0024)
Limit	0.09 (0.0035)

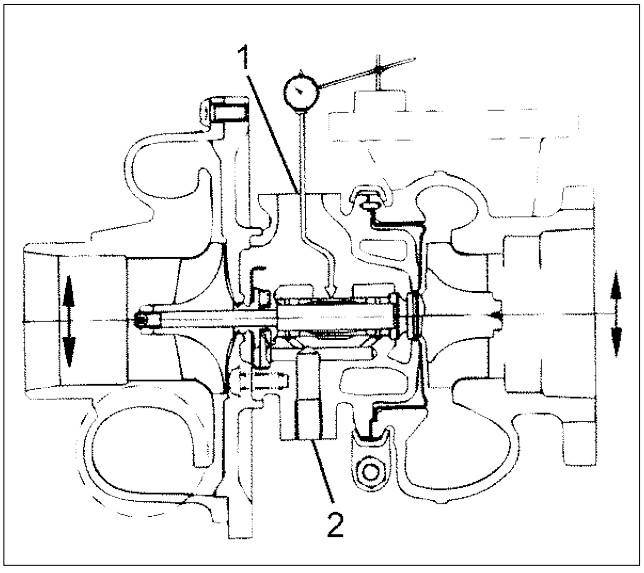


LNW21BSH022201

Wheel shaft and bearing clearance

Use a dial gauge to measure the clearance between the wheel shaft and the bearing.

Clearance	mm (in)
Standard	0.056 – 0.127 (0.0022 – 0.0050)
Limit	0.14 (0.0055)



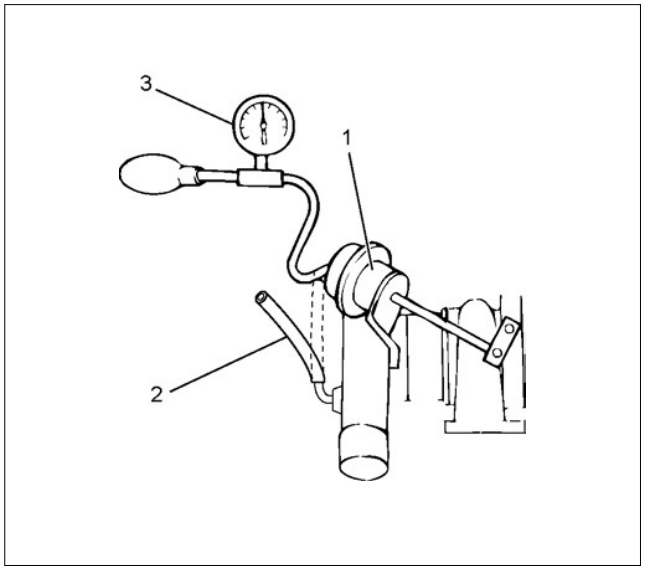
LNW21BSH022301

Legend

1. Oil Outlet
2. Oil Intake

Waste gate operation

1. Remove the hose from the waste gate actuator.
2. Install the pressure gauge (general tool). Refer to the illustration.



RTW56ASH005701

Legend

1. Waste Gate Actuator
2. Waste Gate Hose
3. Pressure Gauge (General Tool)

3. Use the pressure gauge pump to apply pressure (load) to the waste gate actuator (the engine must be off).
4. Note the pressure at which the control rod moves 2 mm (0.078 in). This pressure must be within the specified limit.

Control rod pressure range:	kPa (mmHg / psi)
109 – 118 (818 – 885 / 16 – 17)	

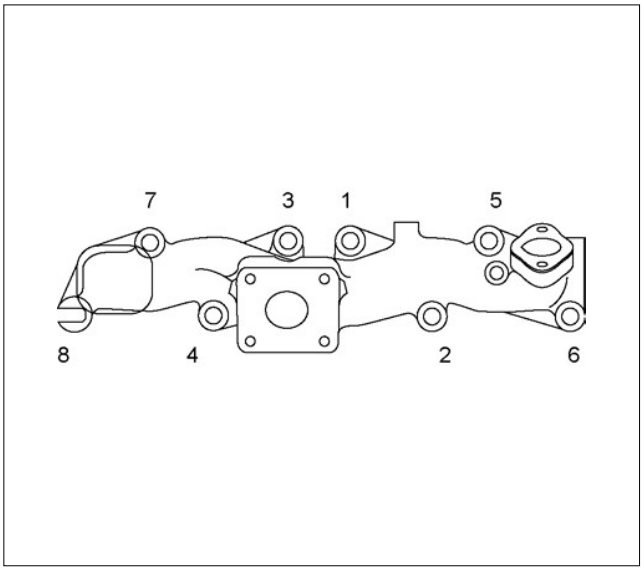
5. Inspect the hose for cracks and other damage. Replace the hose if necessary.
6. Do not apply a pressure of more than 120 kPa (900 mmHg) to the waste gate actuator.

Installation

1. Put the gasket in to install the exhaust manifold.
   - Tighten up with the 8 nuts according to the order given in the figure.

Tightening torque: 52 N·m (5.3 kg·m / 38 lb ft)

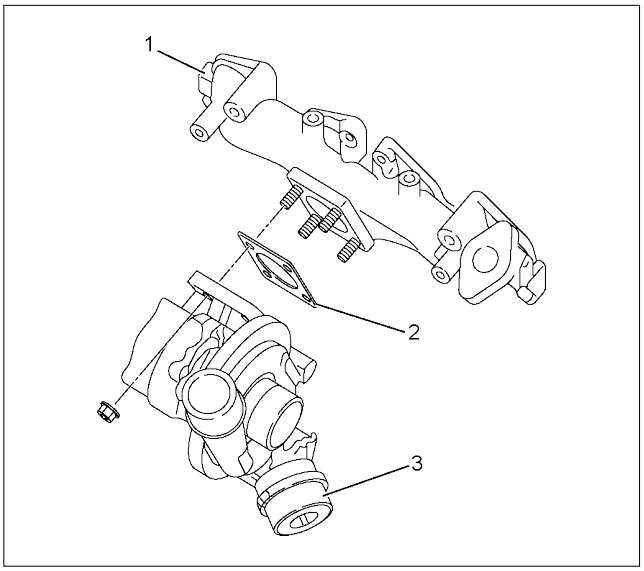
Note:
Do not tighten up too much because it hampers expansion and contraction due to the heat from the manifold.



RTW56ASH005801

2. Install the gasket and turbocharger to the exhaust manifold. Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)



RTW56ASH005501

Legend

1. Exhaust Manifold
2. Gasket
3. Turbocharger

3. Install the catalyst converter.
   Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

4. Connect the front propeller shaft flange (Front Diff Side, 4×4 only).
5. Install the front exhaust pipe.
   Tighten the nuts to the specified torque.

Tightening torque

Exhaust Manifold Side: 67 N·m (6.8 kg·m / 49 lb ft)

Exhaust Pipe Side: 43 N·m (4.4 kg·m / 32lb ft)

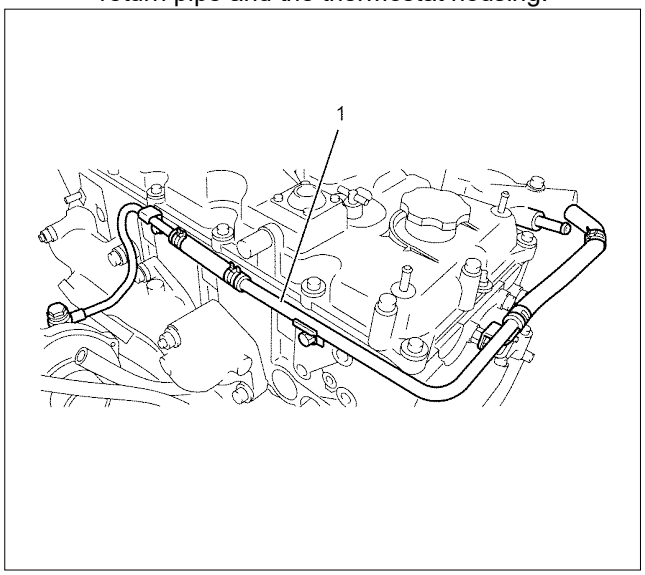
6. Install the water feed pipe to the turbocharger (1).
   - Tighten the joint bolts to the specified torque.

Tightening torque: 54 N·m (5.5 kg·m / 40 lb ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

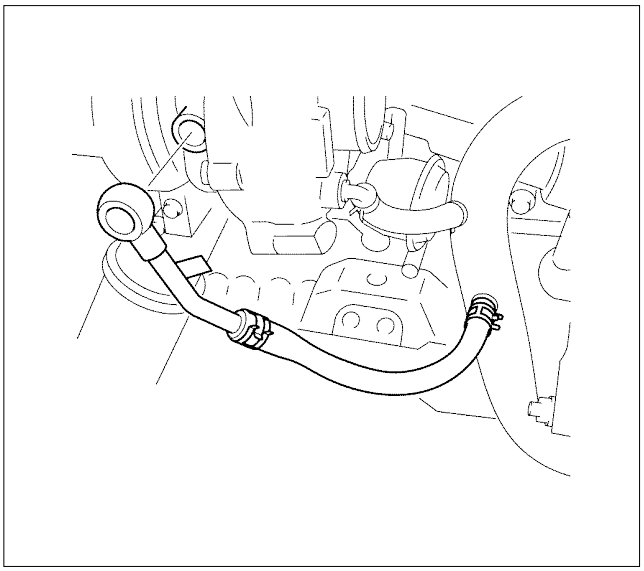
   - Install the rubber hose between the water return pipe and the thermostat housing.



RTW56ASH019101

7. Install the water return pipe. Tighten the joint bolt to the specified torque.

Tightening torque: 54 N·m (5.5 kg·m / 40 lb ft)



RTW56ASH019001

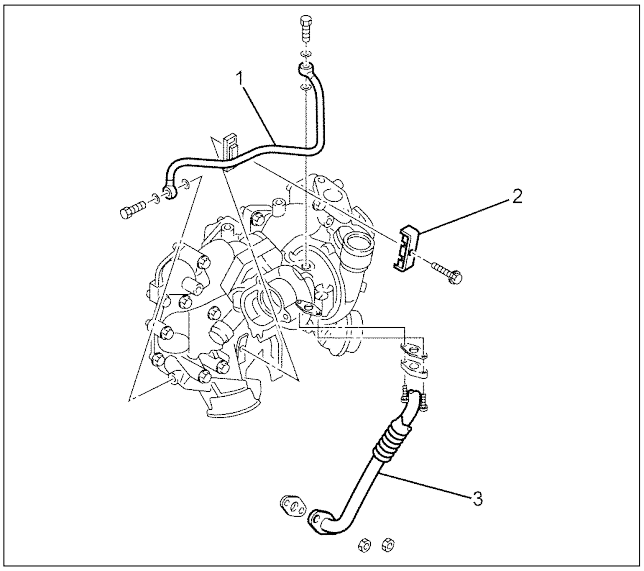
8. Install the turbocharger oil feed pipe to the top of the turbocharger. Tighten the joint bolts to the specified torque.

Tightening torque (Turbo charger side):
23 N·m (2.3 kg·m / 17 lb ft)

Tightening torque (Oil cooler side):
23 N·m (2.3 kg·m / 17 lb ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tightening torque: (Clip)
10 N·m (1.0 kg·m / 87 lb in)



RTW56ASH00610

Legend

1. Oil Feed Pipe
2. Clip
3. Oil Return Pipe

9. Tighten the oil return pipe bolts and nuts to the specified torque.

Tightening torque (Turbocharger side):
10 N·m (1.0 kg·m / 87 lb in)

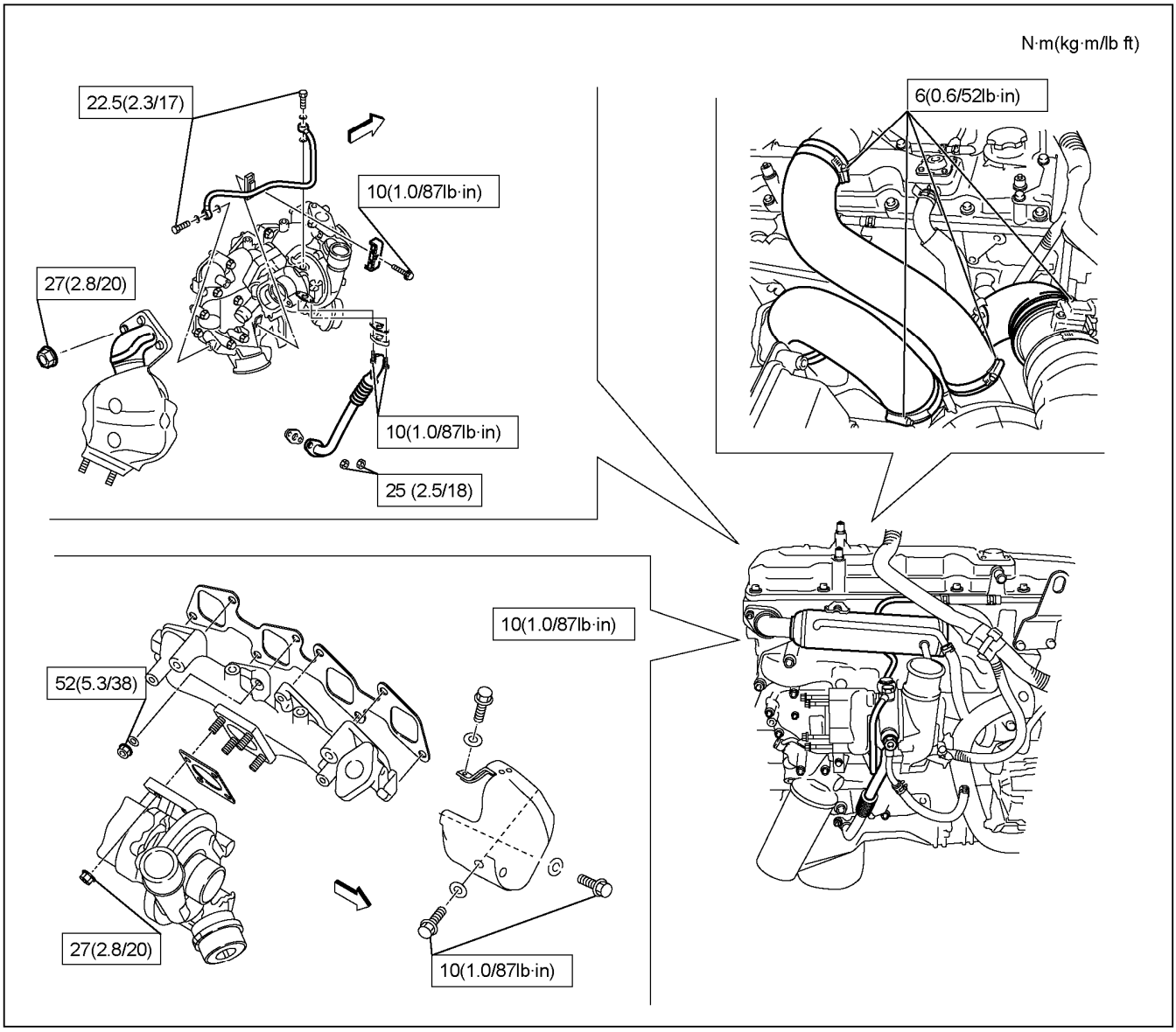
Tightening torque (Crank case side):
25 N·m (2.5 kg·m / 18 lb ft)

10. Install the EGR cooler.
    - Refer to “EGR Cooler” in EXHAUST SYSTEM section.
11. Install the heat protector.
    - Refer to “EGR Cooler” in EXHAUST SYSTEM section.
12. Install the intake hose between the intercooler and the intake throttle (7).
13. Install the intake hose between the turbocharger and the intercooler (9).
14. Install the intake duct between the turbocharger and the air cleaner (8).

Tightening torque: 6 N·m (0.6 kg·m / 52 lb in)

15. Replenish the coolant.

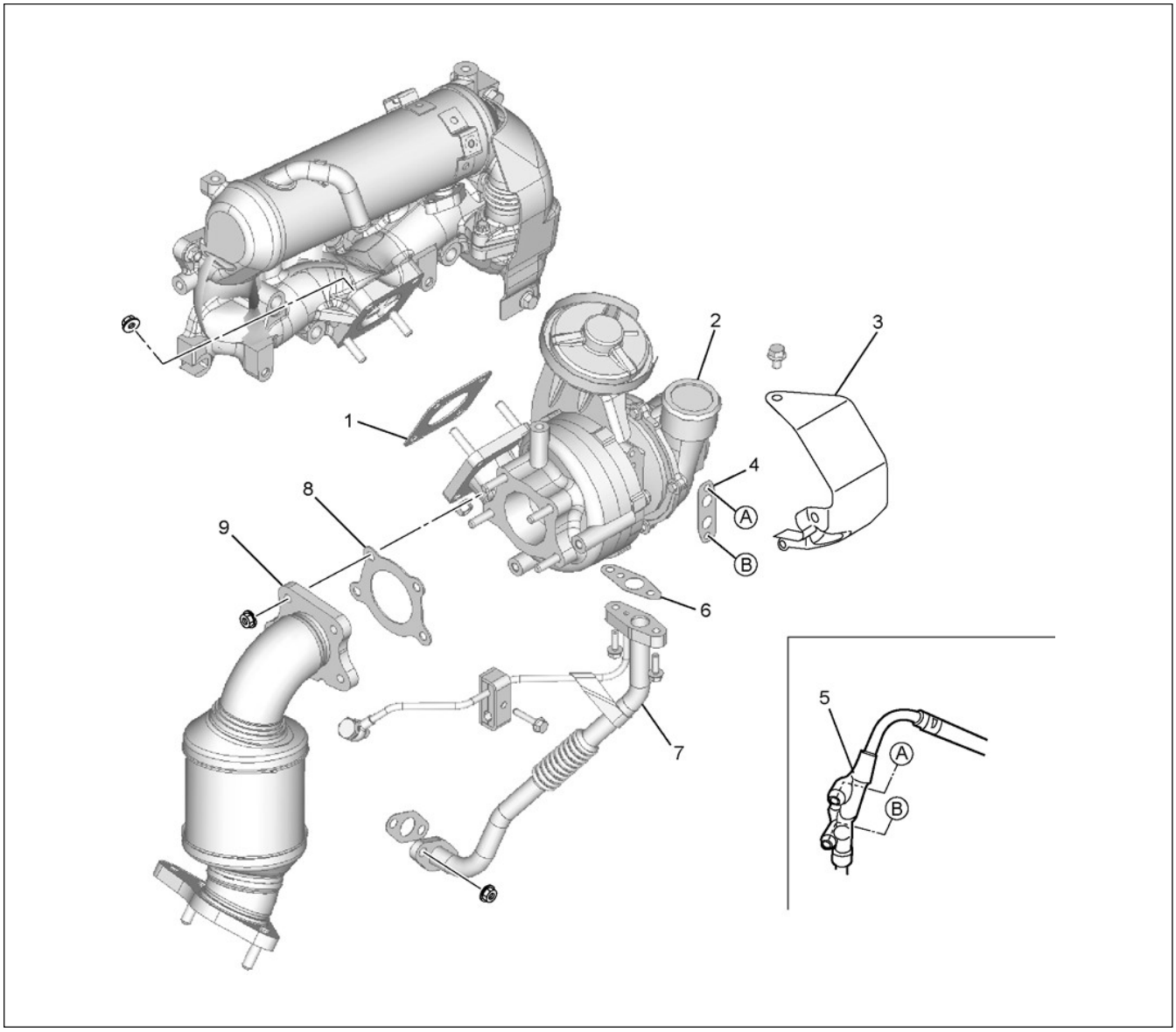
Torque Specifications



RTW76ALF000901

Turbocharger (High Output)

Components



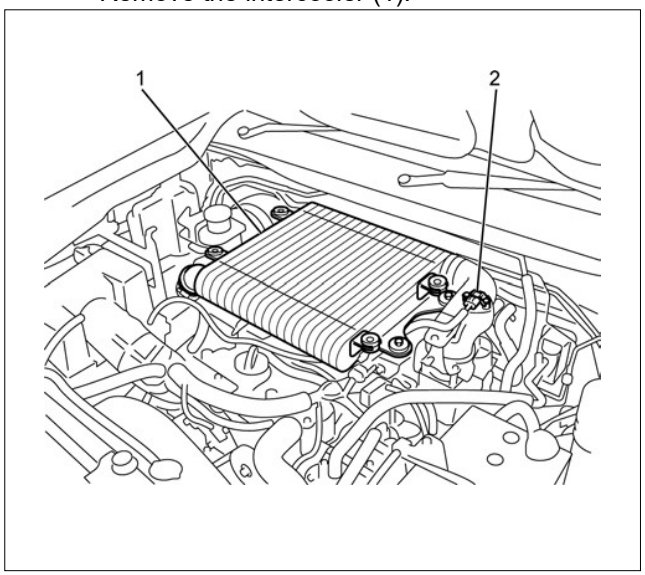
RTW76ALF000401

Legend

1. Turbocharger Assembly Gasket
2. Turbocharger Assembly
3. Turbocharger Heat Protecter
4. Water Feed and Return Pipe Gasket
5. Water Feed and Return Pipe
6. Oil Feed and Return Pipe Gasket
7. Oil Feed and Return Pipe
8. Catalyst Converter Gasket
9. Catalyst Converter

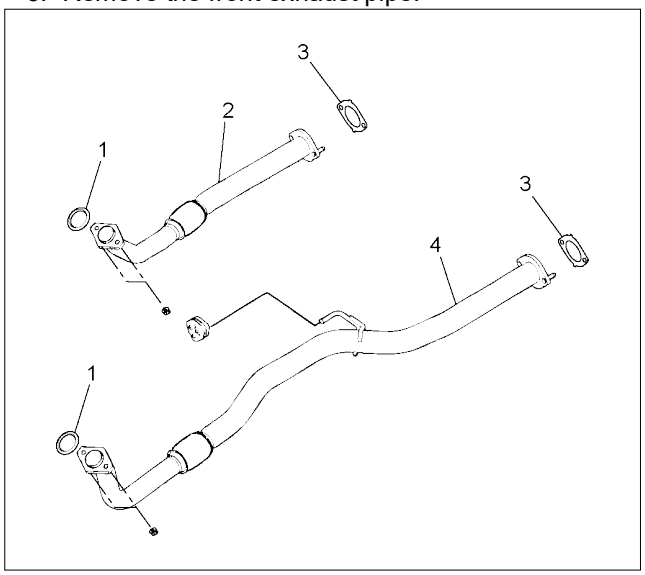
Removal

1. Drain the engine coolant.
2. Remove the engine cover.
3. Remove the intercooler.
   - Disconnect the BARO sensor harness connector (2).
   - Remove the two intake hoses.
   - Remove the intercooler (1).



RTW76ASH000501

4. Disconnect the vacuum hose from the turbocharger actuator.
5. Remove the air intake duct from the turbocharger and the air cleaner.
6. Remove the front exhaust pipe.

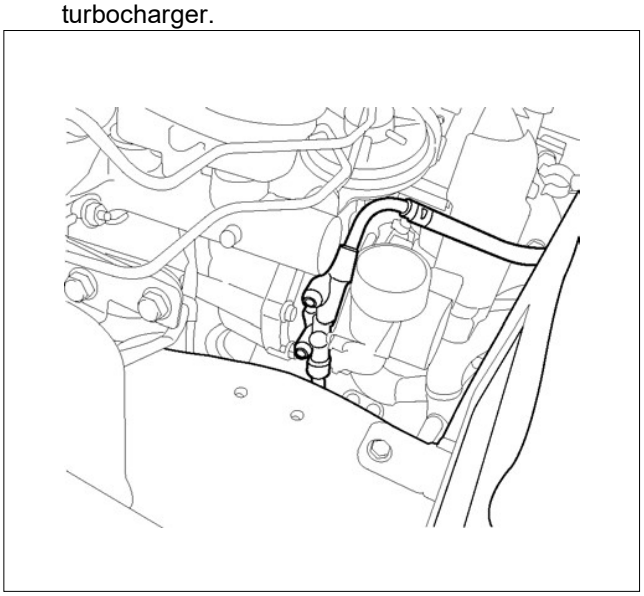


RTW56ASH018301

Legend

1. Gasket
2. Front Exhaust Pipe (4×2 High Ride Suspention, 4×4)
3. Gasket
4. Front Exhaust Pipe (4×2 Except High Ride Suspention)

7. Remove the heat protector of the turbocharger.
   - Remove the mud cover of front RH fender skirt (4×4 only).
   - Loosen the bolt of Turbocharger bracket.
8. Remove the catalyst converter.
9. Remove the turbocharger bracket.
10. Remove the oil feed and return pipe.
11. Remove the water feed and return pipe from the turbocharger.



RTW76ASH001001

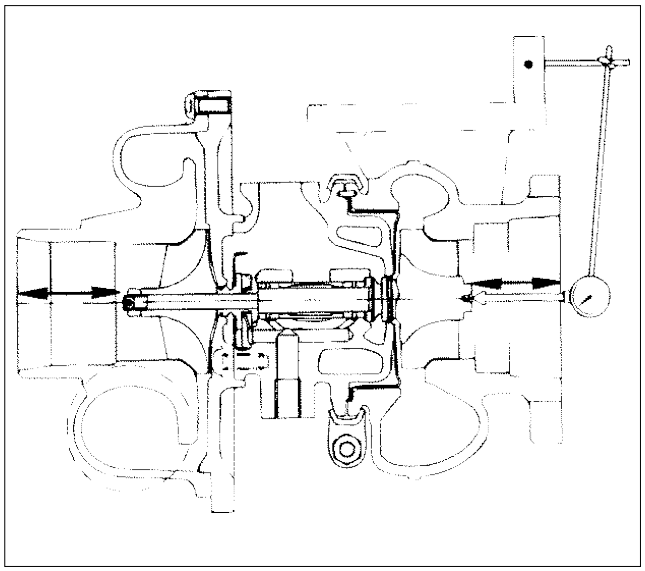
12. Remove the turbocharger from the exhaust manifold.

Inspection

Wheel shaft axial play

Use a dial gauge to measure the wheel axle shaft play when a force of 12 N (1.2kg / 2.6 lb) is alternately applied to both sides of the compressor wheel.

Axial play	mm (in)
Standard	0.03 – 0.06 (0.0012 – 0.0024)
Limit	0.09 (0.0035)

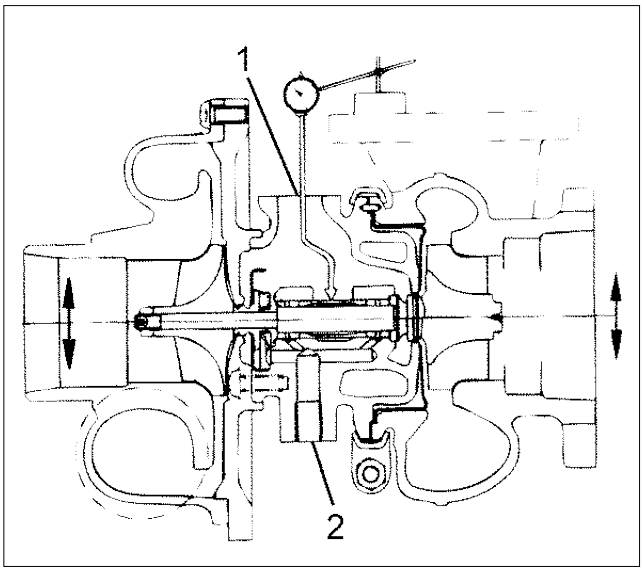


LNW21BSH022201

Wheel shaft and bearing clearance

Use a dial gauge to measure the clearance between the wheel shaft and the bearing.

Clearance	mm (in)
Standard	0.056 – 0.127 (0.0022 – 0.0050)
Limit	0.14 (0.0055)



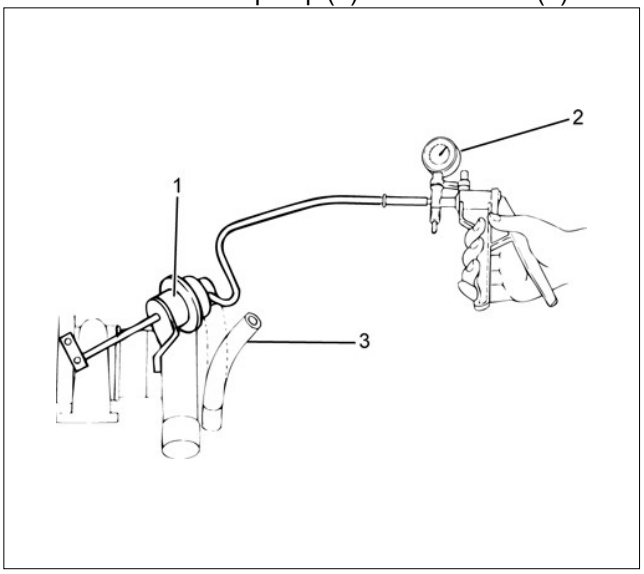
LNW21BSH022301

Legend

1. Oil Outlet
2. Oil Intake

Actuator operation

1. Install a vacuum pump (2) to the actuator (1).



LNW71JSH000201

2. Operate the vacuum pump and apply vacuum pressure to the actuator.

Working vacuum pressure	kPa (mmHg / psi)
52.8 (396 / 7.66)	

3. Place a vernier caliper on the end of the control rod of actuator. Release the vacuum pressure and check the control rod moves. Measure the length of the control rod moving.

Standard length	mm (in)
12 (0.48)	

Installation

1. Install the gasket and the turbocharger to the exhaust manifold. Temporarily tighten nuts.
2. Install the oil feed and return pipe and temporarily tighten.
3. Tighten the turbocharger nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

4. Tighten the oil feed and return pipe bolts and nuts to the specified torque.

Tightening torque (Turbocharger side):
10 N·m (1.0 kg·m / 87 lb in)

Tightening torque (Crank case side):
25 N·m (2.5 kg·m / 18 lb ft)

5. Install the water feed and return pipe to the turbocharger.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

6. Install the heat protector to the turbocharger.

Tightening torque: 10 N·m (1.0 kg·m / 18 lb ft)

7. Install the turbocharger bracket.
8. Install the catalyst converter.
   Tighten the nuts to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)

9. Install the mud cover of front RH fender skirt (4×4 only).
10. Install the front exhaust pipe.
    Tighten the nuts to the specified torque.

Tightening torque

Exhaust Manifold Side: 67 N·m (6.8 kg·m / 49 lb ft)

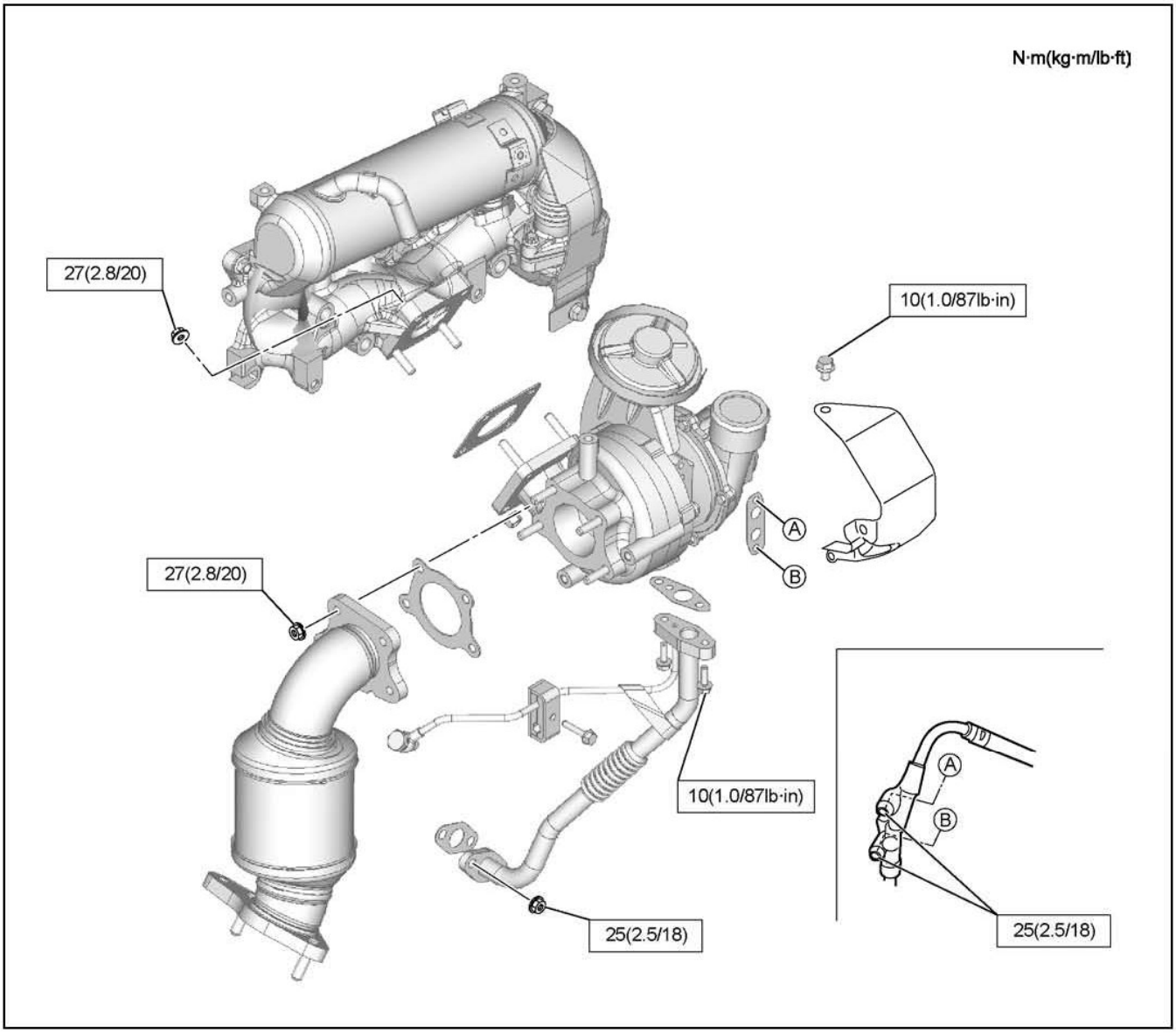
Exhaust Pipe Side: 43 N·m (4.4 kg·m / 32lb ft)

11. Install the intercooler.
    - Install the intercooler.
    - Install the two intake hoses.
    - Connect the BARO sensor harness connector.
12. Install the intake duct between the turbocharger and the air cleaner.

Tightening torque: 6 N·m (0.6 kg·m / 52 lb in)

13. Replenish the coolant.

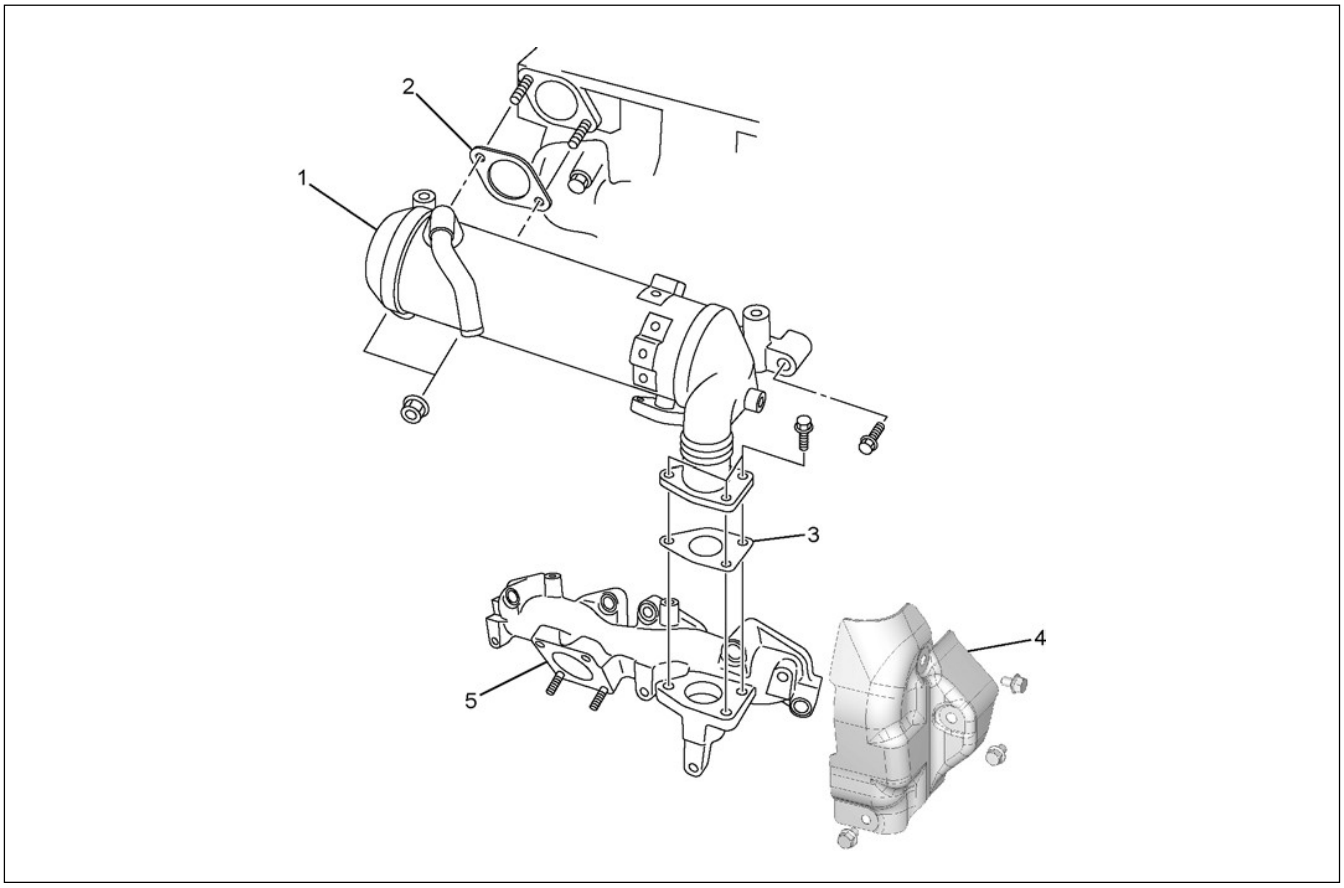
Torque Specifications



RTW76ALF000501

Exhaust Manifold (High Output)

Components



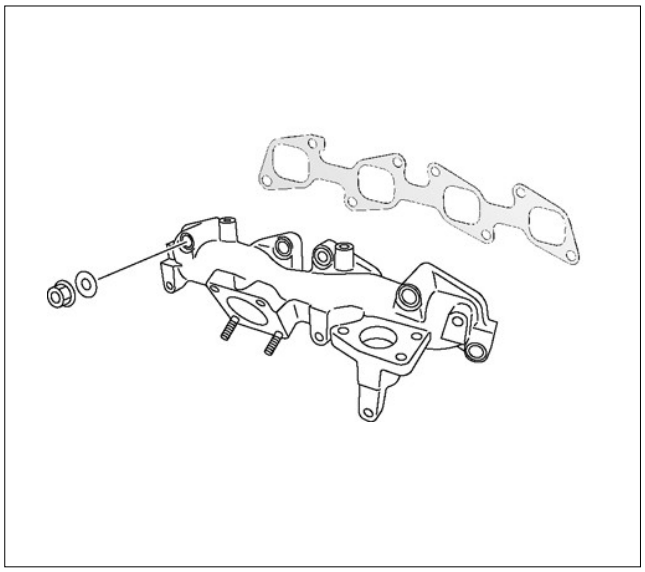
RTW76FMF000101

Legend

1. EGR Cooler
2. EGR Cooler Gasket
3. EGR Cooler Gasket
5. Heat Protector
6. Exhaust Manifold

Removal

1. Drain the engine coolant.
2. Remove the turbocharger.
   - Refer to “Turbocharger”.
3. Remove the EGR cooler heat protector.
4. Disconnect the water hoses from the EGR cooler water pipes.
5. Remove the EGR cooler.
6. Remove the exhaust manifold.



RTW76ASH002101

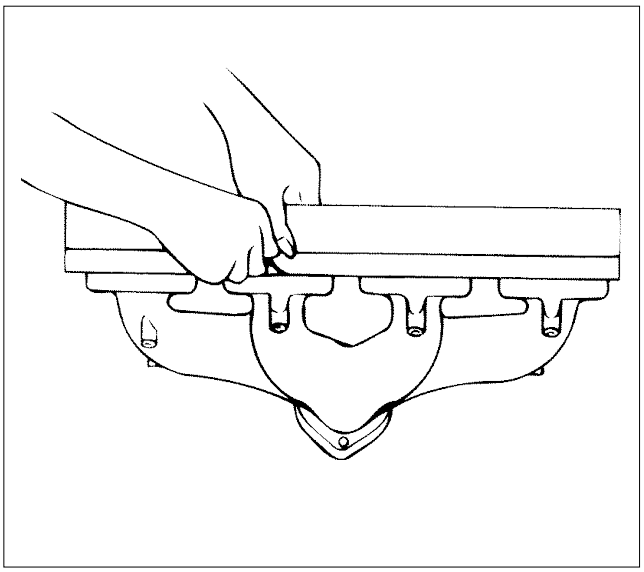
Inspection

- Inspection of the exhaust manifold. Inspect the plane surface of the plane on which the manifold and the cylinder head are to be installed.

Manifold installation plane surface	mm (in)
Standard	0.3 (0.01) or lower
Limit	0.5 (0.02)

Caution:

If the plane surface exceeds the limit, replace it.



LNW21BSH022301

- Check a crack in the exhaust manifold visually.

Carefully inspect the turbocharger for abrasion and/or excessive wear. Make any necessary adjustments, repairs, and/or part replacements.

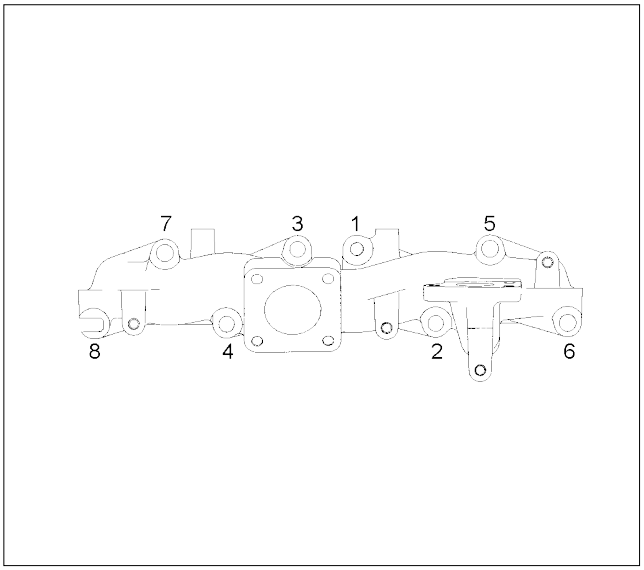
Installation

1. Put the gasket in to install the exhaust manifold.
   - Tighten up with the 8 nuts according to the order given in the illustration.

Tightening torque: 52 N·m (5.3 kg·m / 38 lb ft)

Caution:

Do not tighten up too much because it hampers expansion and contraction due to the heat from the manifold.



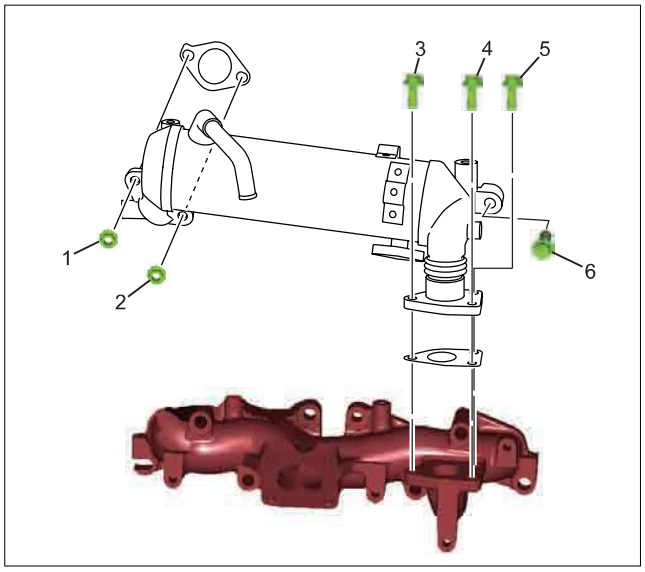
RTW76ASH002201

2. Install the EGR cooler.
   - Install the gaskets.
   - Install the EGR cooler.
   - Temporary tightening order.
     1→2→3→4→5→6
   - Fully tightening order.
     3→4→5→1→2→6

   Tighten the nut and bolts to the specified torque.

Tightening torque:

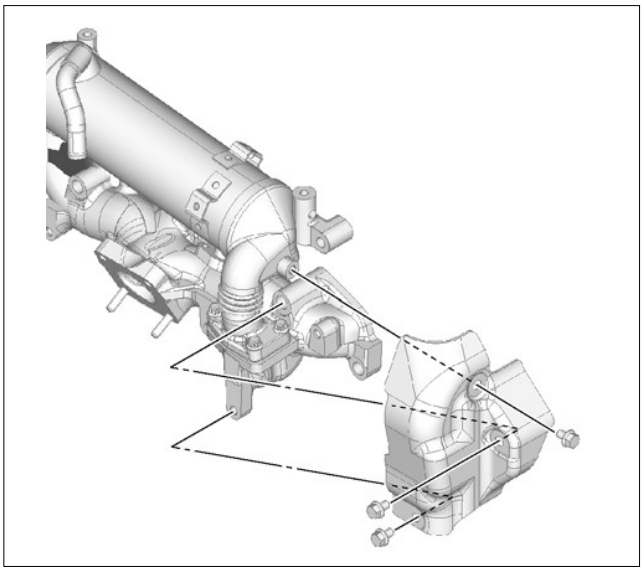
Nuts and bots 1-5: 27 N·m (2.8 kg·m / 20 lb ft)
Bolt 6: 52 N·m (5.3 kg·m / 38 lb ft)



RTW76FSH000201

3. Install the water hoses to the EGR cooler water pipes.
4. Heat protector.
   Tighten the bolts to the specified torque.

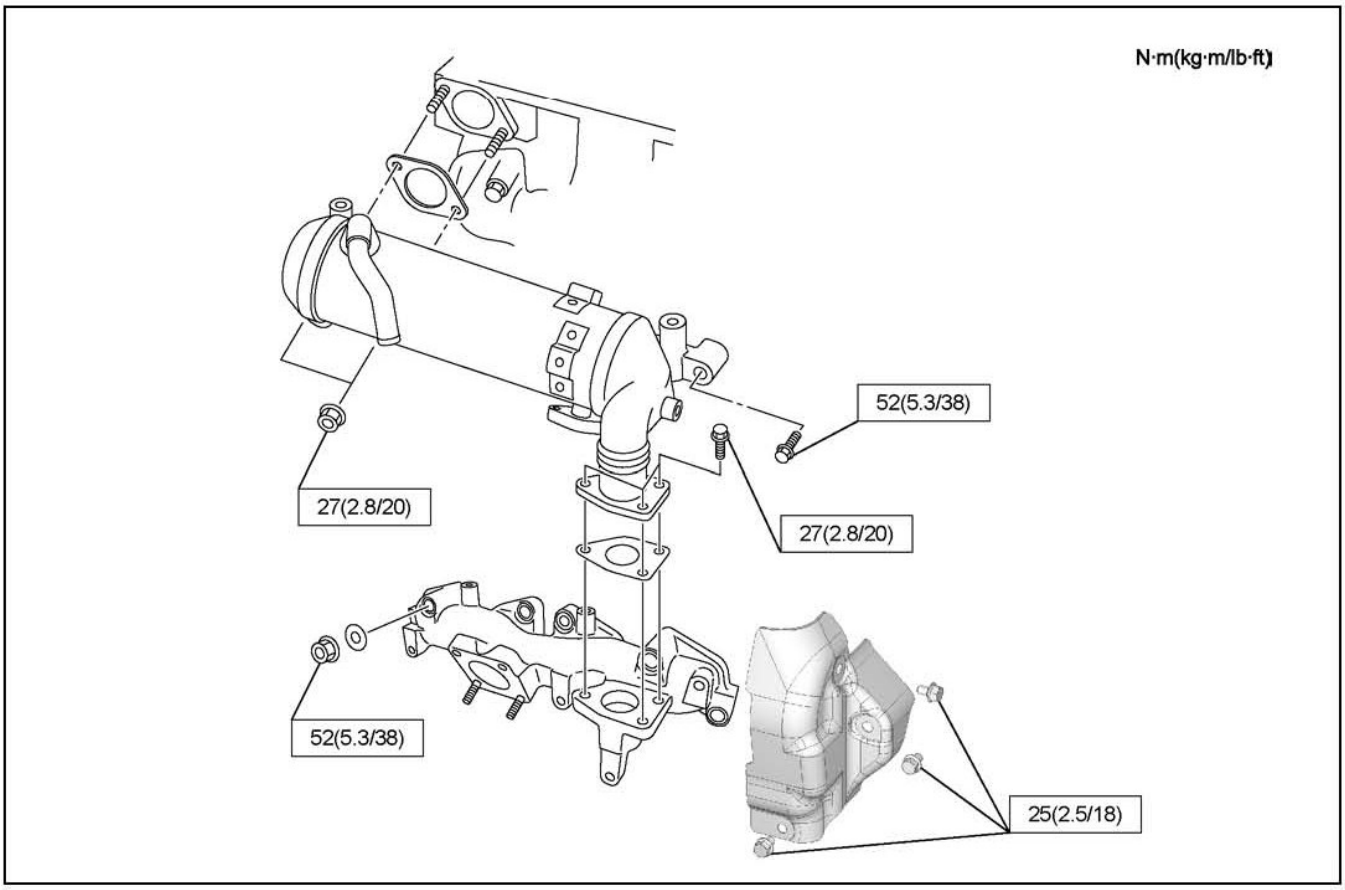
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76FSH000101

5. Install the turbocharger.
   - Refer to “Turbocharger”.
6. Replenish the engine coolant.

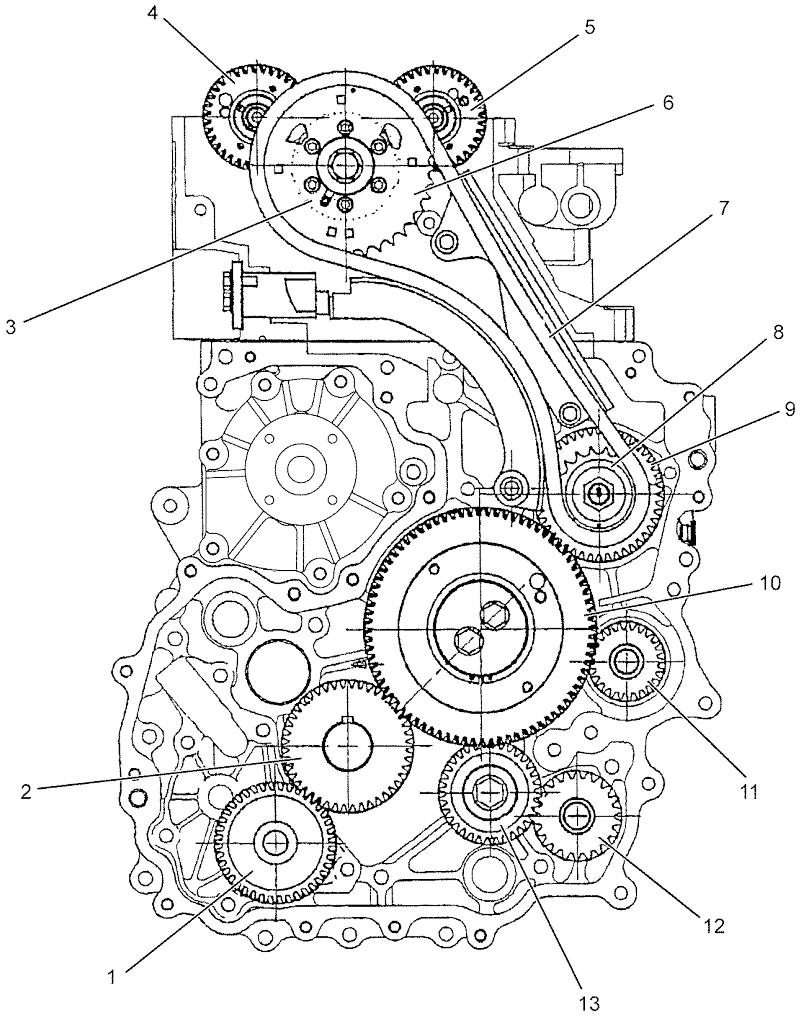
Torque Specifications



RTW76AMF000701

Timing Gear Train

Components



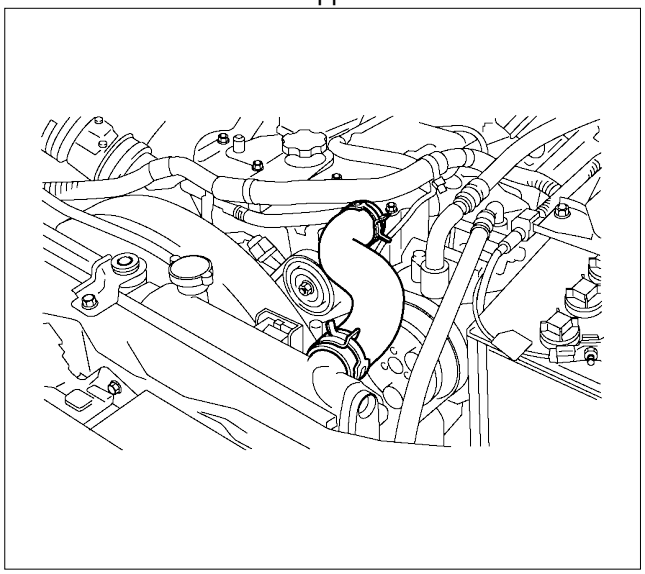
RTW56ALF001101

Legend

1. Oil Pump Gear
2. Crankshaft Gear
3. Idle Gear D
4. Exhaust Camshaft Gear
5. Intake Camshaft Gear
6. Idle Gear D Sprocket
7. Timing Chain
8. Injection Pump Sprocket
9. Injection Pump Gear
10. Idle Gear A
11. Vacuum Pump Gear
12. Power Steering Oil Pump Gear
13. Idle Gear C

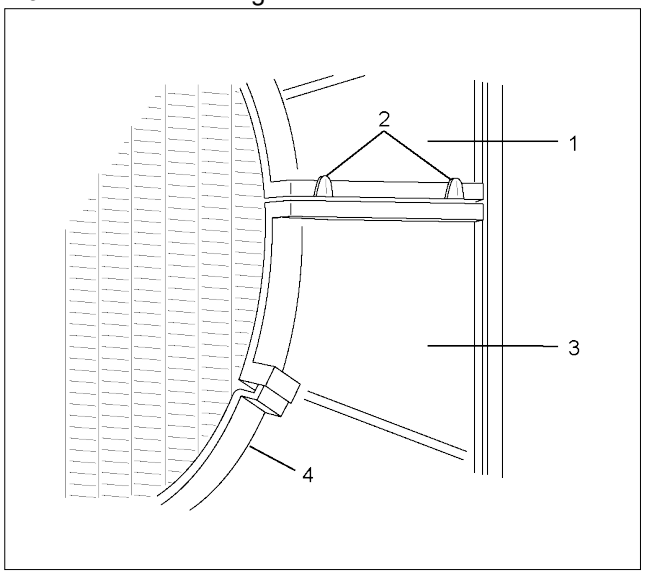
Removal

1. Partially drain the engine coolant.
2. Remove the radiator upper hose.



RTW56FSH000101

3. Remove the fan guide.

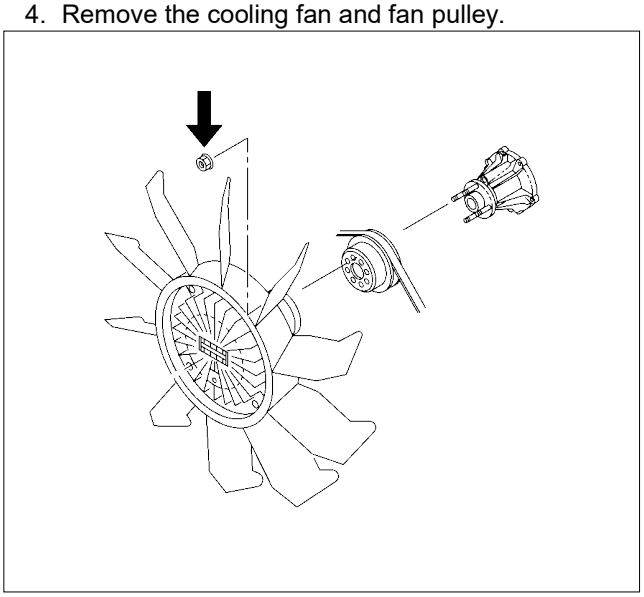


RTW46BSH000101

Legend

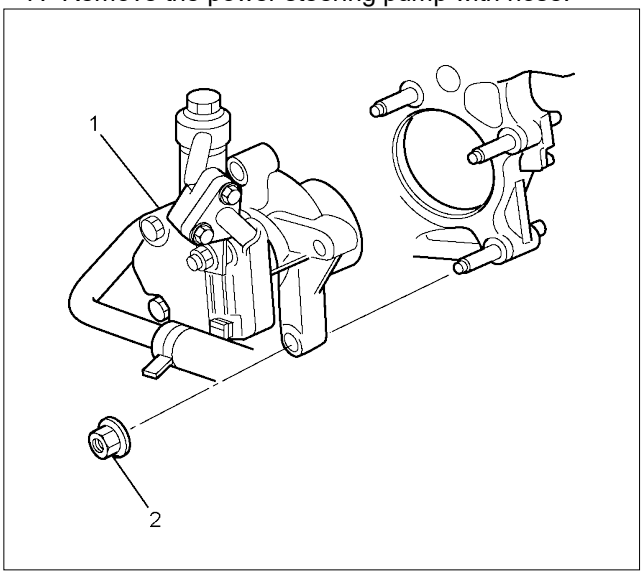
1. Fan Guide
2. Clips
3. Lower Fan Guide
4. Fan Shroud

4. Remove the cooling fan and fan pulley.



RTW56ASH025401

5. Remove the A/C compressor drive belt and fan belt.
6. Remove the crank pulley.
7. Remove the power steering pump with hose.

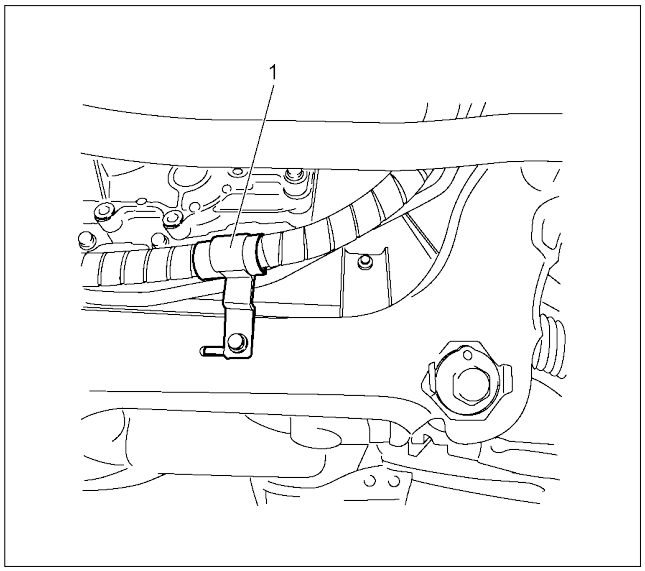


RTW56ASH021101

Legend

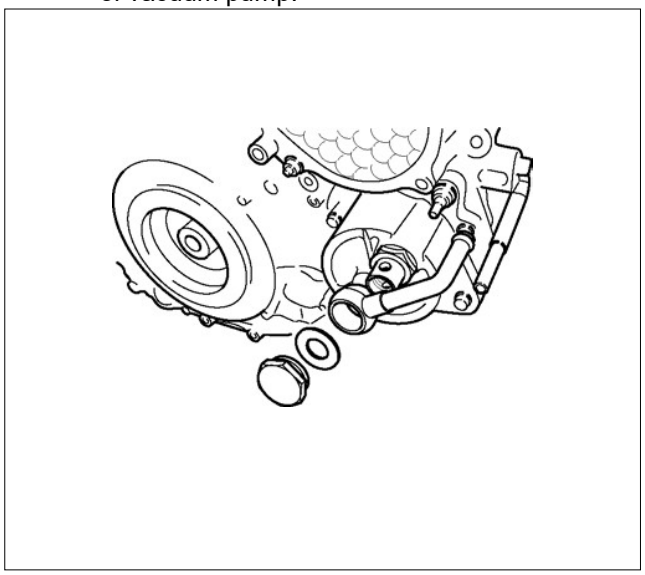
1. Power Steering Pump
2. Nut

- Disconnect the bracket (1) of power steering oil hose.



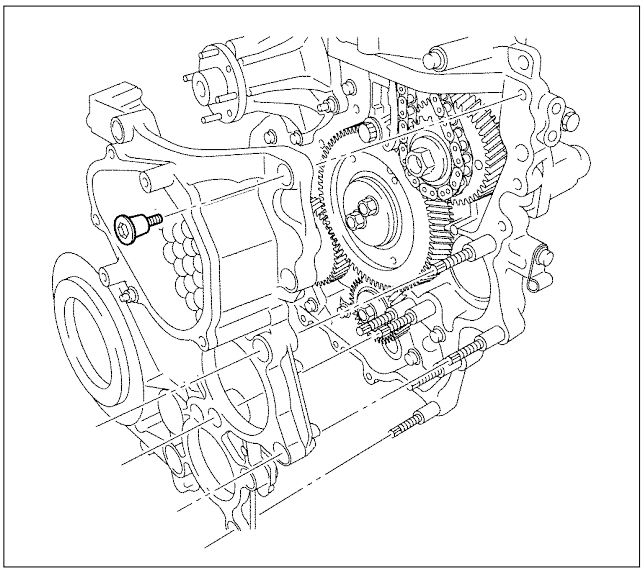
LTW56ASH000101

8. Remove the vacuum pump.
   - Remove the vacuum pipe bracket and vacuum pipe.
   - Remove the oil pipe (feed side and return side) of vacuum pump.



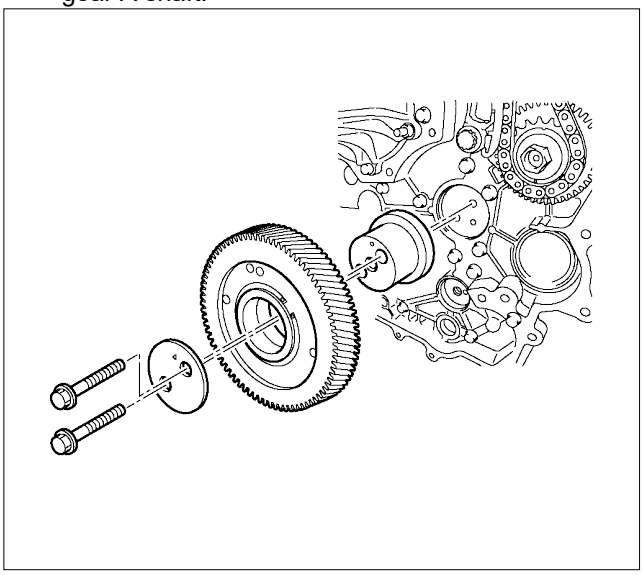
RTW76ASH000201

9. Remove the front cover.



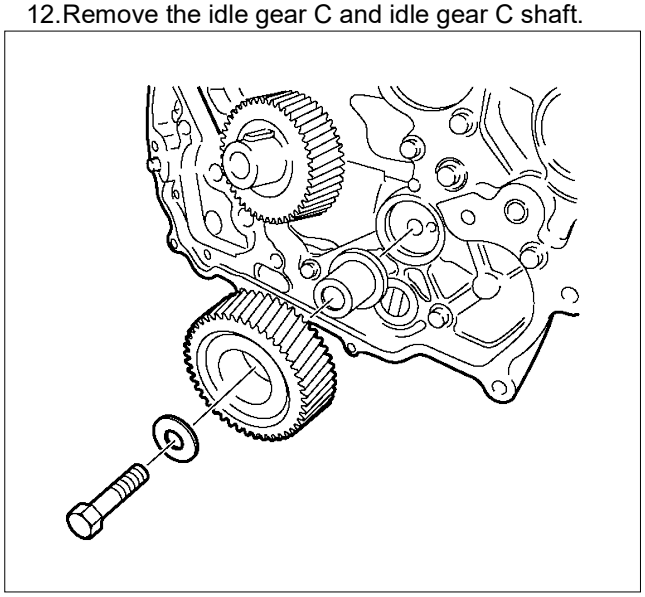
RTW56ASH019701

10. Install the M6 bolt to the idle gear A.
11. Remove the idle gear A and idle gear A flange, idle gear A shaft.



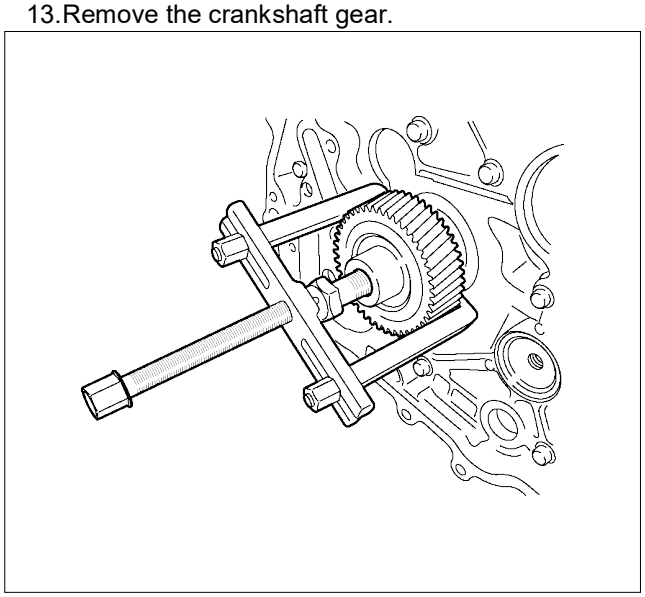
RTW56ASH011301

12.Remove the idle gear C and idle gear C shaft.



RTW56ASH011401

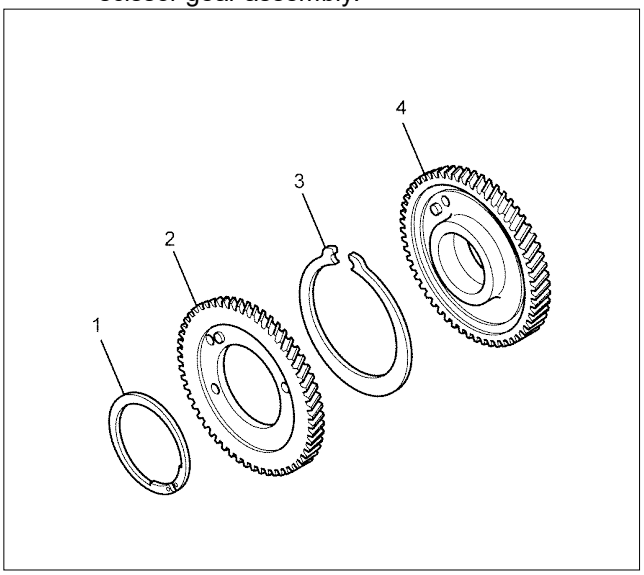
13.Remove the crankshaft gear.



RTW56ASH021501

Disassembly

1. Remove the scissor gear assembly.
   - Clamp the vise. Insert soft metal protectors (aluminum) between the vise and component. Use a pair of snap ring pliers to remove the scissor gear assembly.



RTW56ASH022001

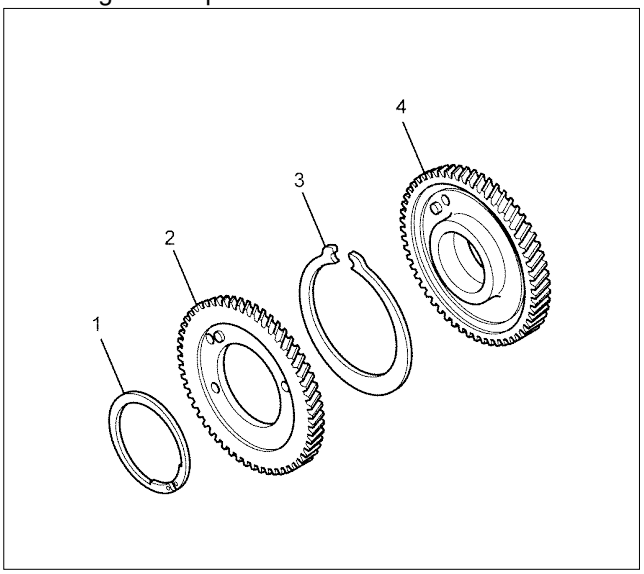
Legend

1. Snap Ring
2. Sub-gear
3. Spring
4. Idle Gear A

Reassembly

1. Install the scissor gear assembly.
   - Clamp the vise. Insert soft metal protectors (aluminum) between the vise and component. Press against the pin on the left side of the idle gear A spring to make a gap on the right side of the spring. Push the spring into place.

- Align the sub gear pin with the hole in the right side of the idle gear A spring. Press the sub-gear into place.



RTW56ASH022001

Legend

1. Snap Ring
2. Sub-gear
3. Spring
4. Idle Gear A

- Use a pair of snap ring pliers to snuggly install the snap ring.

Inspection

1. Measurement of idle gear backlash
   - Apply a dial gauge on the teeth of the idle gear to be measured and move the gear to right and left lightly to read how much the dial gauge shook (never fail to fix the gear).
   - If the measurement exceeds the limit, replace the idle gear.

Backlash of the idle gear	mm (in)
Standard	0.10 – 0.17 (0.004 – 0.006)
Limit	0.30 (0.01)

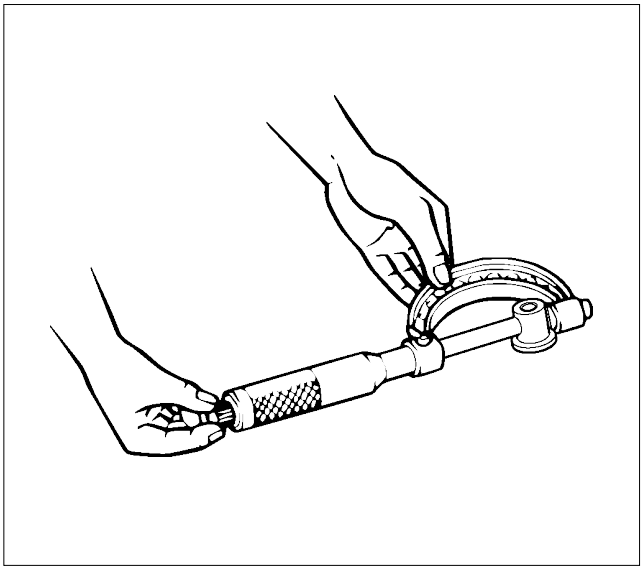
   - Measure backlash of the idle gear before removing the idle gear A.
2. Measurement of end clearance of the idle gear.
   - Insert a thickness gauge between the idle gear and the thrust collar to measure a clearance.
   - If the measurement exceeds the limit, replace either the idle gear or the thrust collar.

End clearance of the idle gear	mm (in)
Standard	0.080 – 0.155 (0.003 – 0.006)
Limit	0.20 (0.008)

   - Measure an end clearance of the idle gear before removing the idle gear B.
3. External diameter of the idle gear shaft.
   - Use a micrometer to measure an external diameter of each idle gear shaft.
   - If the measurement exceeds the limit, replace the shaft.

External diameter of the idle gear A shaft	mm (in)
Standard	44.950 – 44.957 (1.7697 – 1.7700)
Limit	44.80 (1.764)

External diameter of the idle gear C shaft	mm (in)
Standard	24.959 – 24.980 (0.9826 – 0.9835)
Limit	24.80 (0.976)



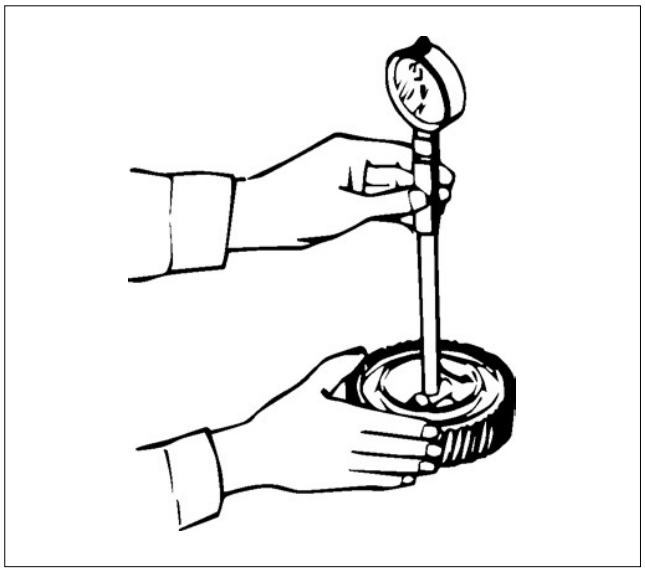
RTW56ASH021601

4. Clearance between the idle gear and the idle gear shaft
   - Measure an inside diameter of the idle gear bush to calculate a clearance between the idle gear and the idle gear shaft.

- If the measurement exceeds the limit, replace either the idle gear or the shaft.

Clearance between the idle gear A and the shaft mm (in)	
Standard	0.020 – 0.062 (0.0007 – 0.0024)
Limit	0.200 (0.0079)

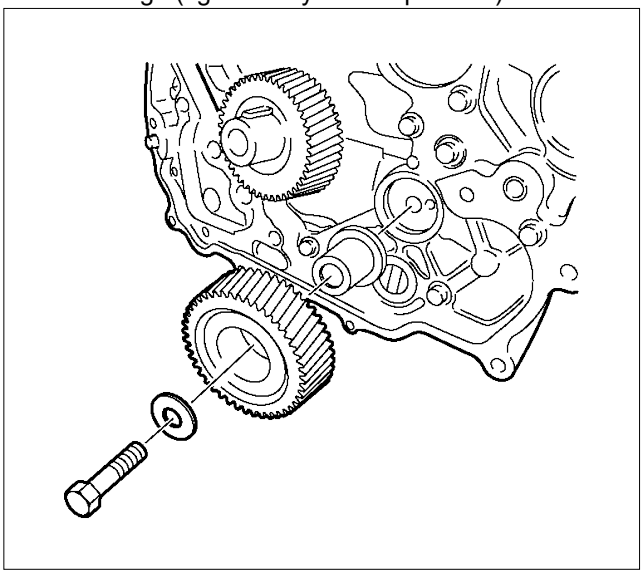
Clearance between the idle gear C and the shaft mm (in)	
Standard	0.025 – 0.075 (0.0010 – 0.0030)
Limit	0.200 (0.0079)



LNW21BSH003601

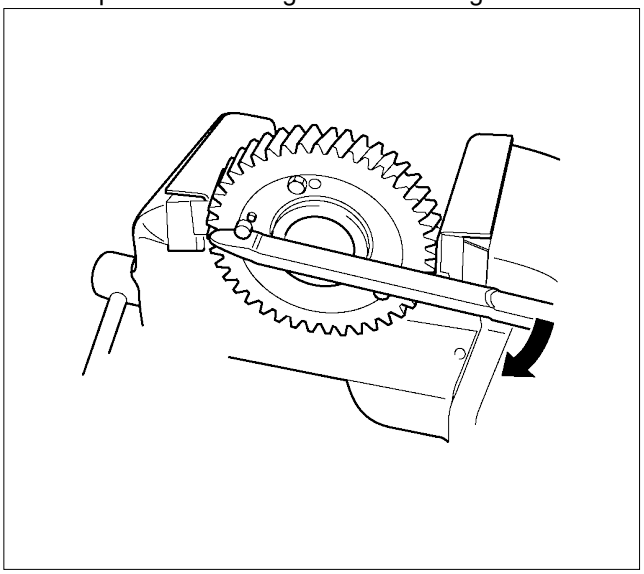
Installation

1. Install the crankshaft gear.
2. Install the idle gear C.
   - Apply engine oil over the part where the gear of the idle gear shaft is to be put together.
   - Apply engine oil to the bolt screw thread and seat, and temporarily tighten together with the flange (tighten fully in later process).



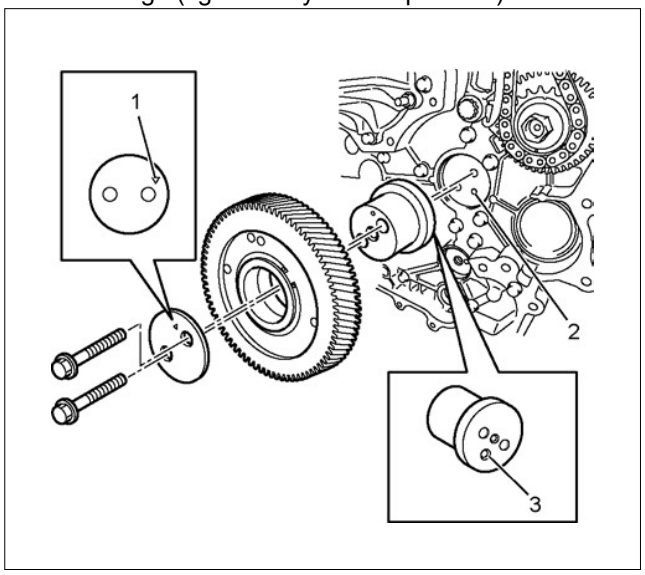
RTW56ASH011401

3. Install the idle gear A.
4. Tighten sub gear setting bolt.
   - Use the M6 bolts and lever to turn sub gear to right direction until it aligns with the M6 bolt hole between idle gear A and sub gear.
   - Tighten the M6 bolt to a suitable torque to prevent the sub gear from moving.



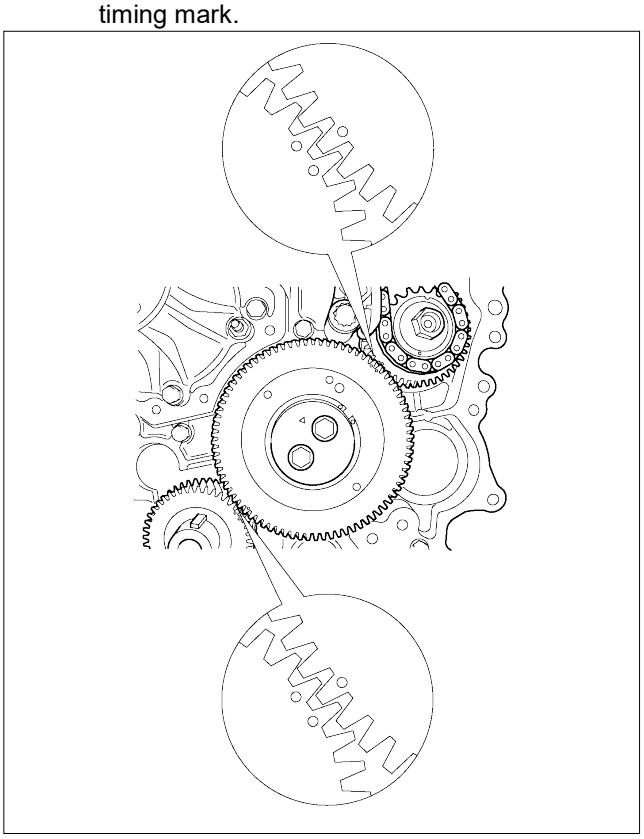
RTW56ASH011501

- Align the oil hole of the cylinder body (2) with the oil hole of the idle gear A shaft (3).
- Install the flange so that the front mark (1) face toward the front.
- Install the idle gear A and idle gear A flange, idle gear A shaft at the position shown in the figure.
- Apply engine oil over the part where the gear of the idle gear shaft is to be put together.
- Apply engine oil to the bolt screw thread and seat, and temporarily tighten together with the flange (tighten fully in later process).



LNW71BSH000501

- Attach, aligning with the gear crank: idle A and timing mark.

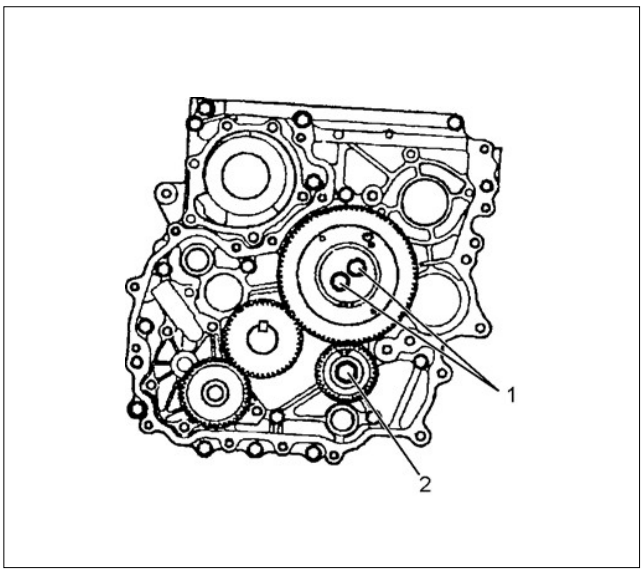


RTW56ALH000301

5. Tighten the bolts of idle gear A and idle gear C to the specified torque.

Tightening torque:

idle gear A 32 N·m (3.3 kg·m / 24 lb ft)
idle gear C 59 N·m (6.0 kg·m / 43 lb ft)

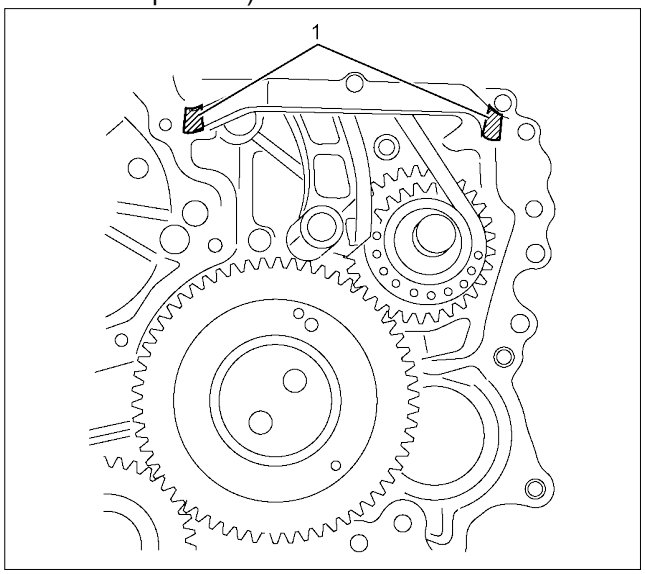


RTW56ASH011701

Legend

1. Idle Gear A Bolt
2. Idle Gear C Bolt

6. Remove the M6 bolt from the idle gear A.
7. Install the gear case cover.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



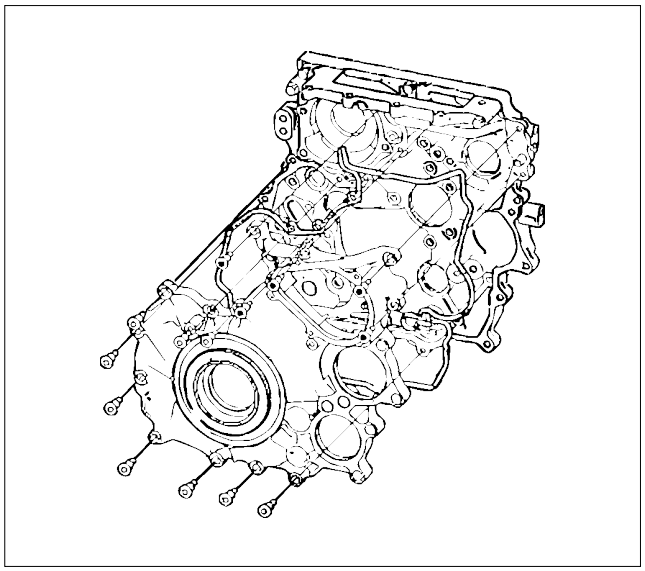
RTW56ASH020101

Legend

1. Apply the liquid gasket

   - Install the gasket in slot of the gear case cover.
   - Tighten the bolts to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)



RTW56ASH012101

8. Install the vacuum pump.

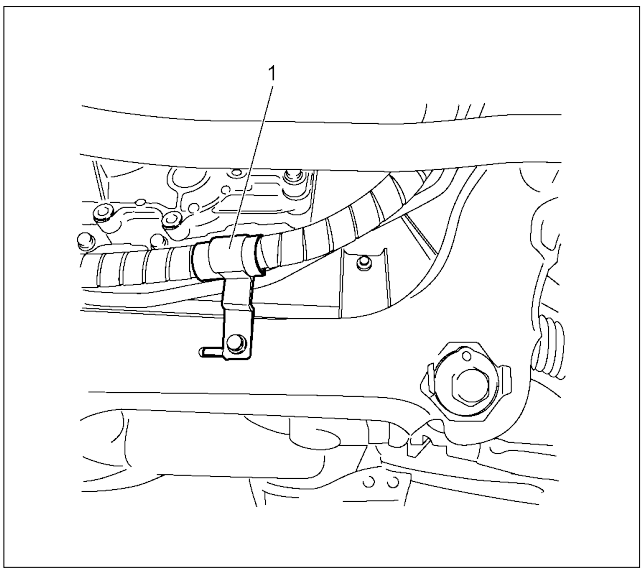
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Install the oil pipe (feed side and return side) of vacuum pump.
   - Install the vacuum pipe bracket and vacuum pipe.

9. Install the power steering pump.
   - Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Connect the bracket (1) of power steering oil hose.



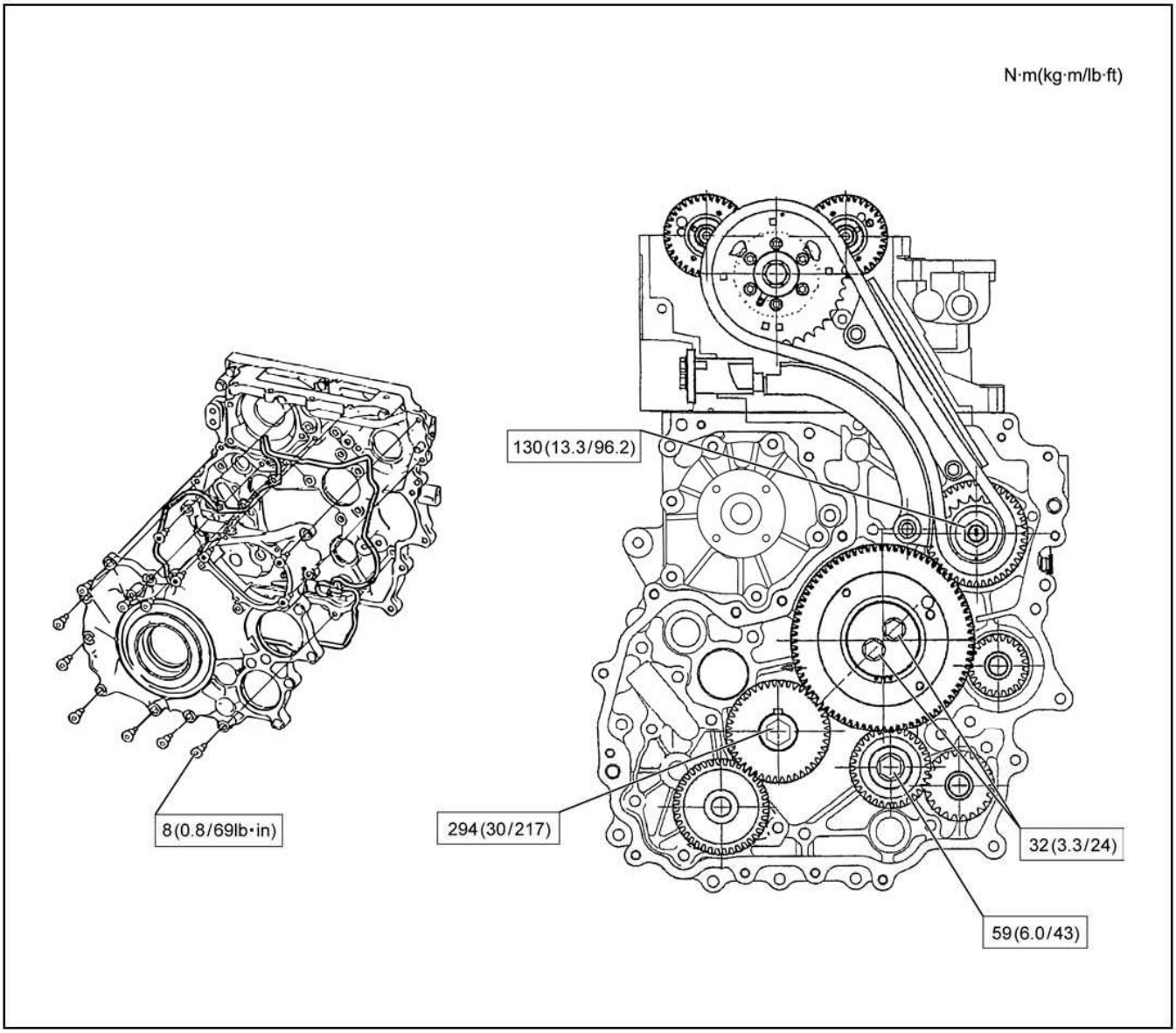
LTW56ASH000101

10. Install the crank pulley.

Tightening torque: 294 N·m (30.0 kg·m / 217 lb ft)

11. Install the A/C compressor drive belt and fan belt. Refer to drive belt tension check procedure for Heating and air conditioning and Engine cooling in this manual.
12. Install the cooling fan.
13. Install the fan guide.
14. Install the radiator upper hose.
15. Replenish the engine coolant.

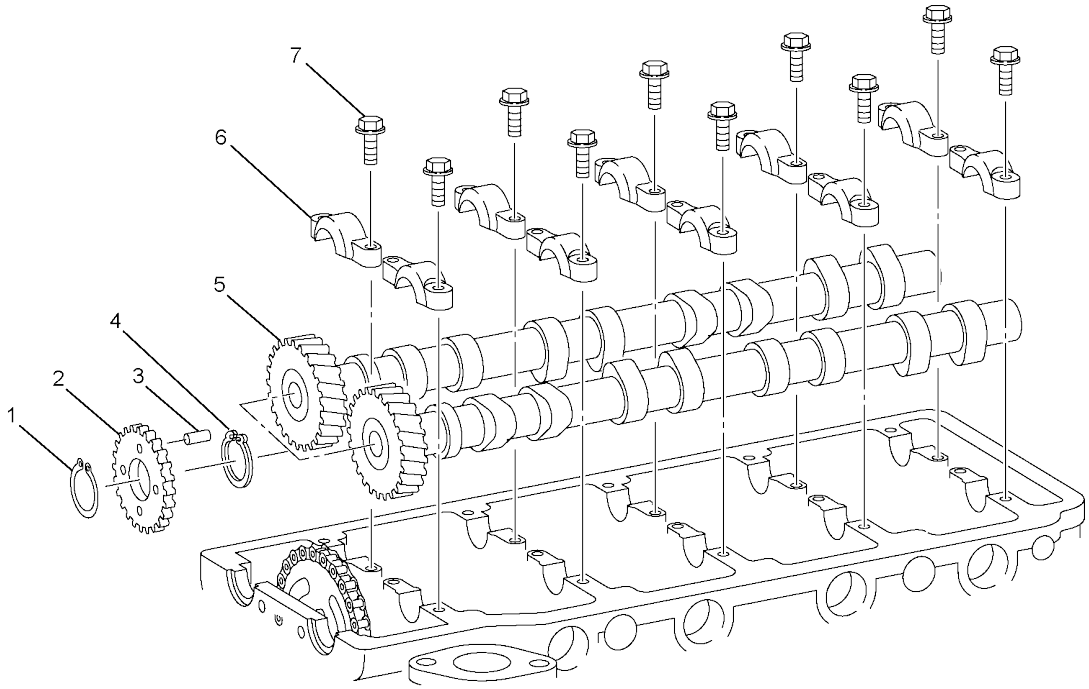
Torque Specifications



LNW76ALF000601

Camshaft Assembly

Components



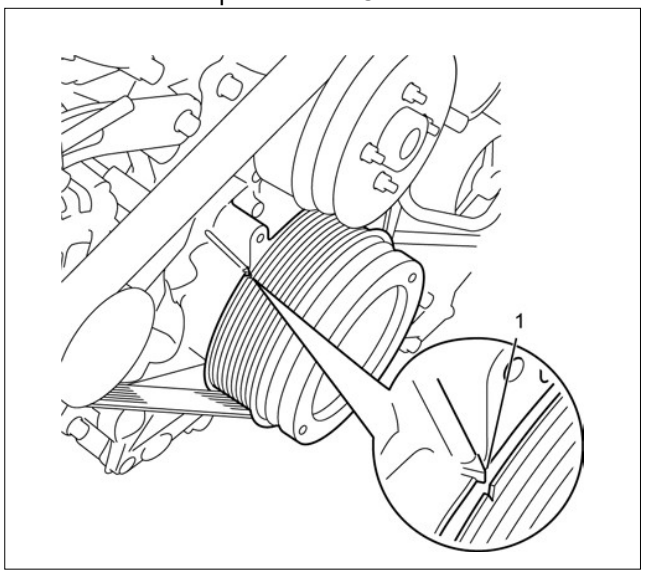
RTW56ALF000901

Legend

1. Snap Ring
2. Sub Gear
3. Knock Pin
4. Damper Spring
5. Camshaft Gear and Camshaft
6. Camshaft Bearing Cap
7. Bolt

Removal

1. Rotate the crankshaft to make the No. 1 cylinder meet the compression TDC.

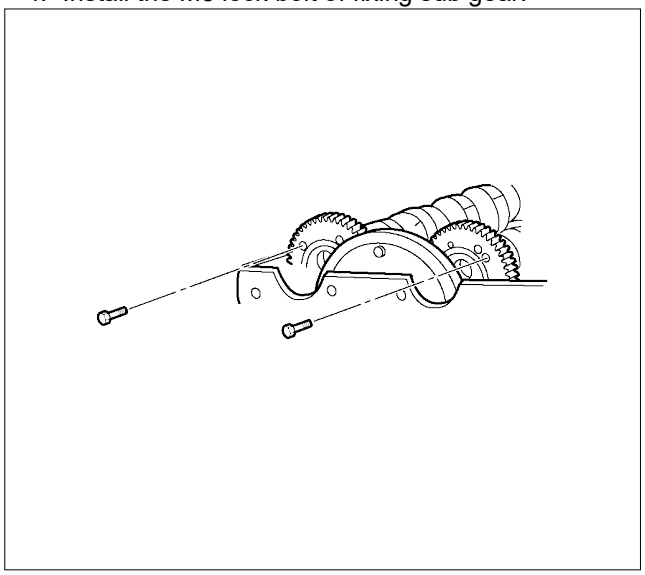


RTW76ASH001301

Legend

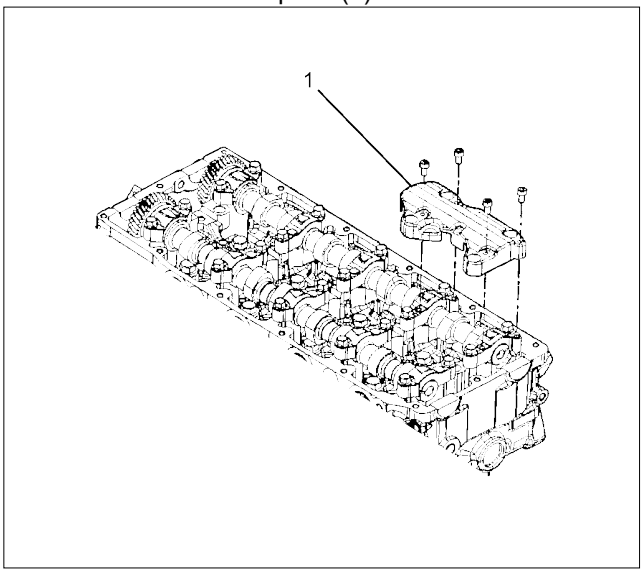
1. TDC

2. Remove the engine cover.
3. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
4. Install the M5 lock bolt of fixing sub gear.



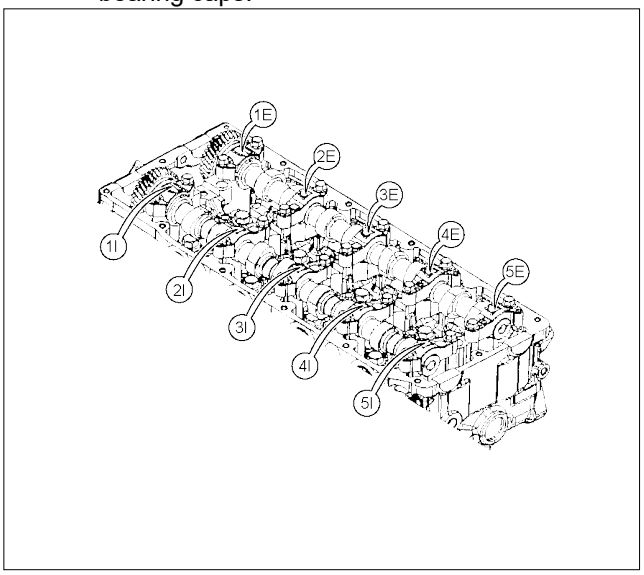
RTW56ASH007101

5. Remove the baffle plate (1).

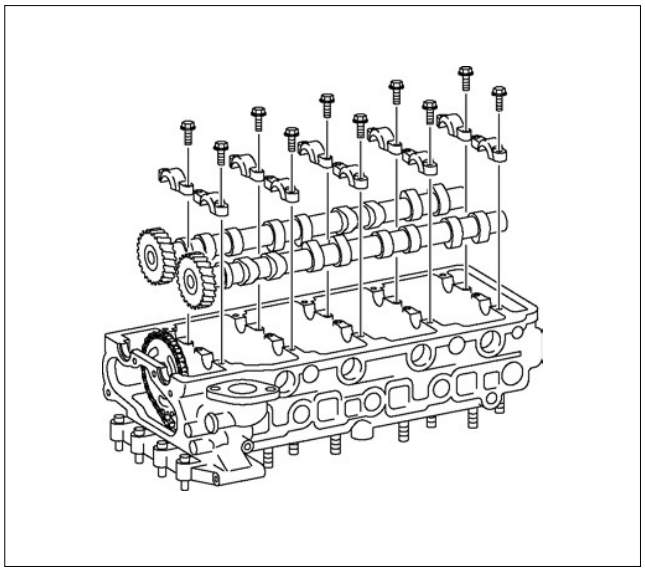


RTW56ASH006301

6. Remove the camshaft bearing cap and camshaft.
   - Check the engraved making on the camshaft bearing caps.



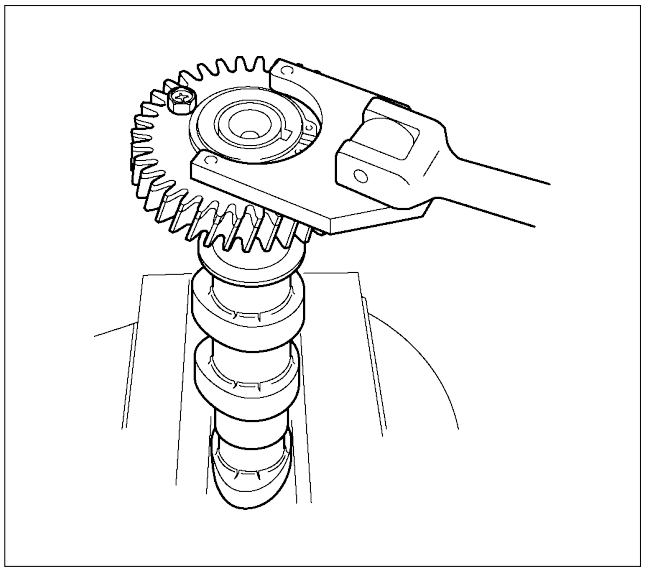
RTW56ASH018401



RTW56ASH013801

Disassembly

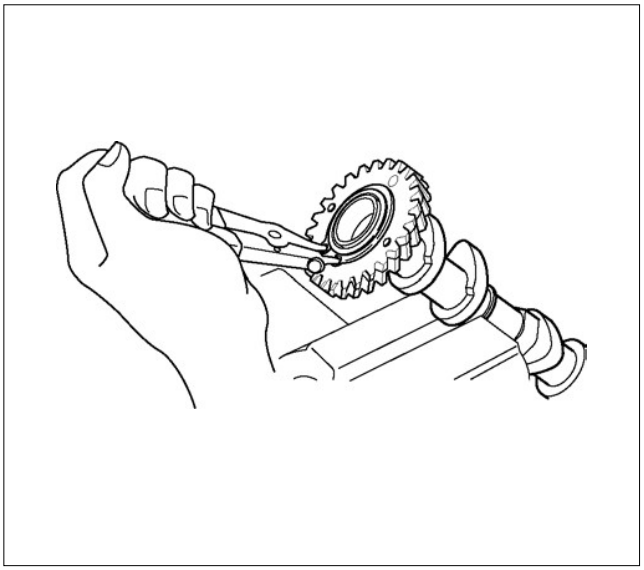
1. Remove the sub gear assembly.
   - Clamp the camshaft in a vise. Insert soft metal protectors (aluminum) between the vise surfaces and the camshaft.
   - Use 5-8840-2591-0 to turn sub gear to right direction to remove the M5 bolt.



RTW56ASH006801

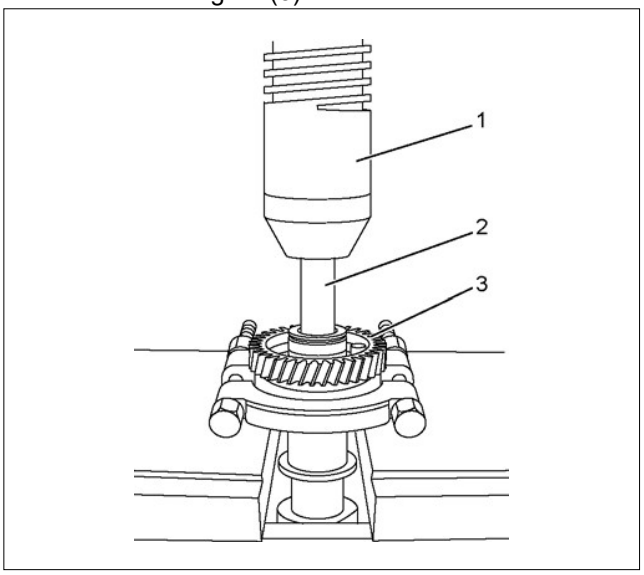
   - Use a pair of snap ring pliers to remove the scissor gear assembly.

Note:
Take care not to damage the camshaft cams and journals.



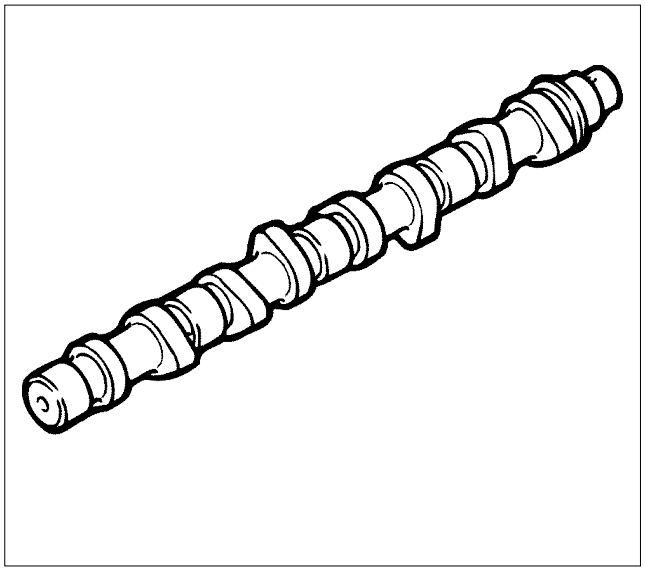
RTW56ASH006401

2. Remove the camshaft gear.
   - Use a press (1) and socket (2) to remove the camshaft gear (3).



RTW56ASH006501

3. Remove the dowel pin.
4. Inspect the camshaft visually.
   - Check if the journal and cam parts of the camshaft are worn or damaged, if so, replace it.

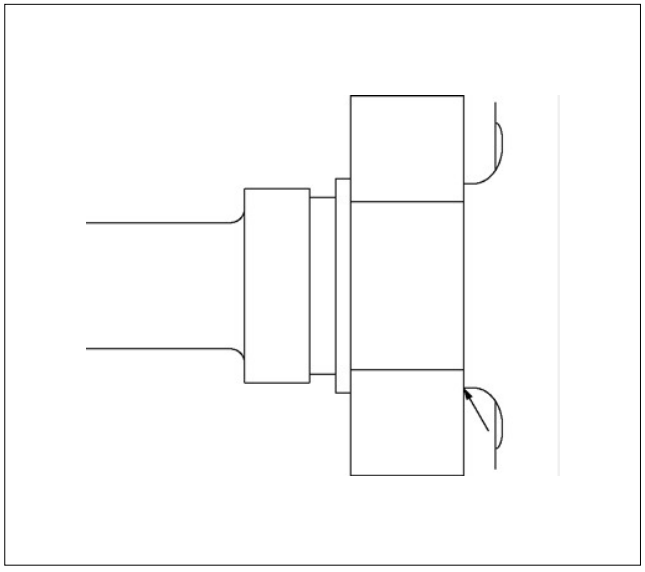


LNW21BSH020201

5. Inspect an end clearance of the camshaft.
   - Use a thickness gauge to measure an end clearance of the camshaft gear and the camshaft bracket.
   - If the measurement exceeds the limit, replace the camshaft gear or the camshaft.

End clearance of the camshaft	mm (in)
Standard	0.085 – 0.205 (0.003 – 0.008)
Limit	0.25 (0.010)

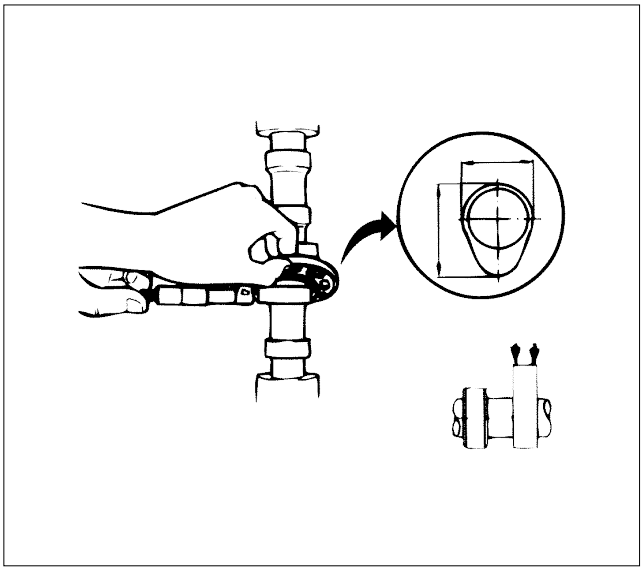
Note:
Measure an end clearance of the camshaft before disassembling.



RTW56ASH013901

6. Check if the cam lobe is worn.
   - Use a micrometer to measure the height of the cam lobe.
   - If the height of the cam lobe is at the limit or less, replace the camshaft.

Height of the cam lobe		mm (in)
	Inlet	Exhaust
Standard	40.6 (1.60)	40.6 (1.60)
Limit	39.6 (1.56)	39.6 (1.56)

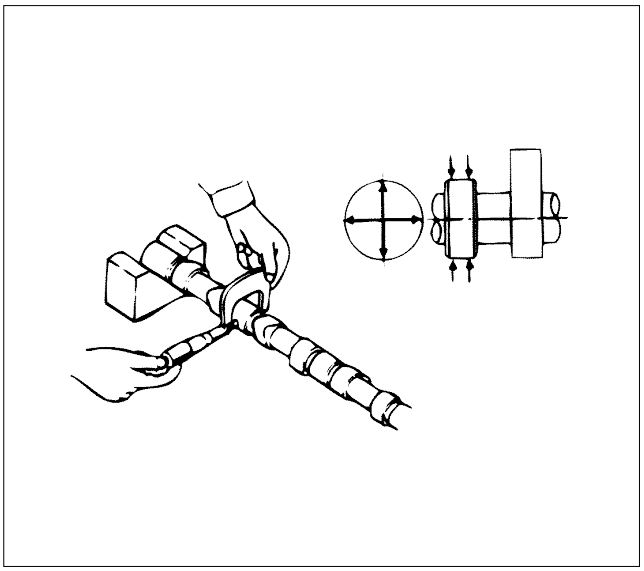


LNW21BSH020401

7. Check if the camshaft journal is worn.
   - Use a micrometer to measure wear which is not even with a diameter of the camshaft journal.
   - If the measured uneven wear exceeds the limit, replace the camshaft.

External diameter of the camshaft journal part mm (in)	
Standard	29.909 – 29.930 (1.1775 – 1.1783)
Limit	29.809 (1.1736)

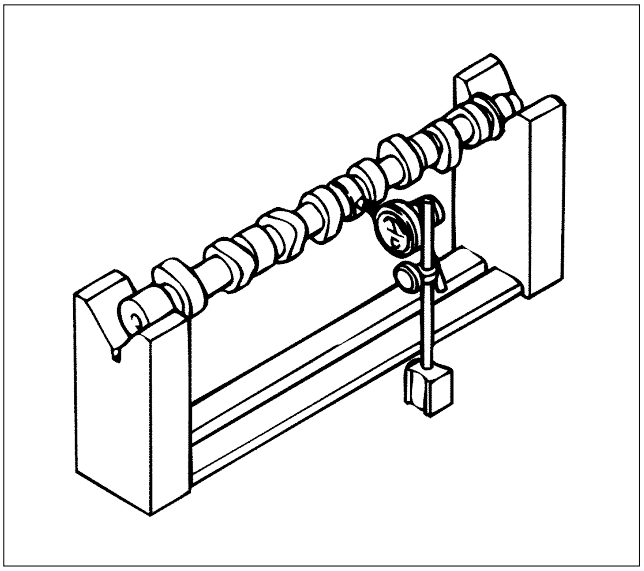
Partial wear of the camshaft journal part	mm (in)
Limit	0.05 (0.0020)



LNW21BSH020501

8. Check if the camshaft is runout.
   - Place the camshaft on a V block to measure a runout with a dial gauge.
   - Rotate the camshaft slowly to measure how much the dial indicator shook. If it exceeds the limit, replace the camshaft.

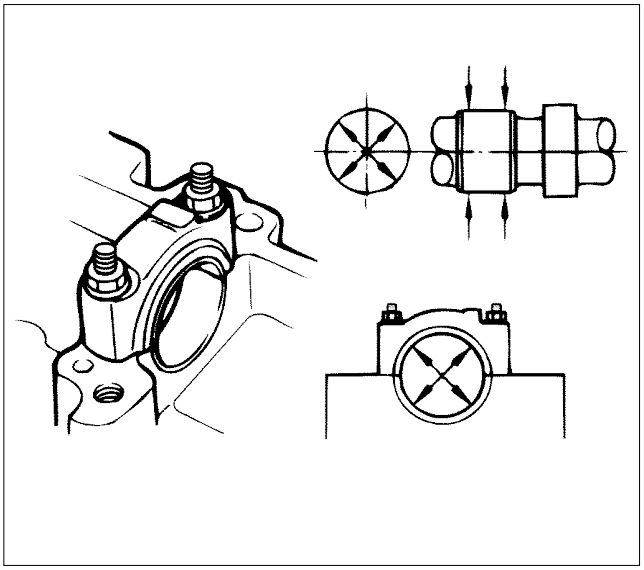
Runout of the camshaft	mm (in)
Limit	0.05 (0.0020)



LNW21BSH020601

9. Measure a camshaft journal oil clearance.
   a. Measure an inside diameter of the camshaft bearing with a dial gauge.
   b. Read the difference between the inside diameter of the camshaft bearing and the diameter of the camshaft journal.
   If the measured oil clearance exceeds the limit, replace the camshaft bearing.

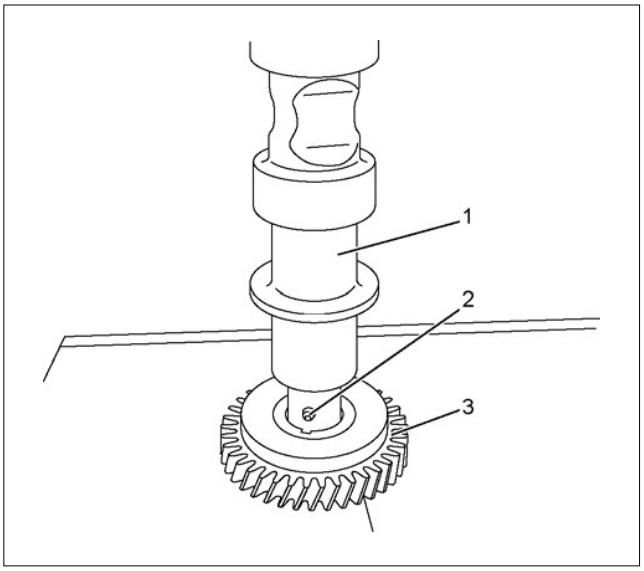
Clearance of the journal part	mm (in)
Standard	0.025 – 0.087 (0.0010 – 0.0034)
Limit	0.15 (0.0059)



LNW21BSH054601

Reassembly

1. Install the dowel pin.
2. Install the camshaft gear.
   - Align the knock pin with the slot in the camshaft gear. Use a press to install the camshaft gear to the camshaft.

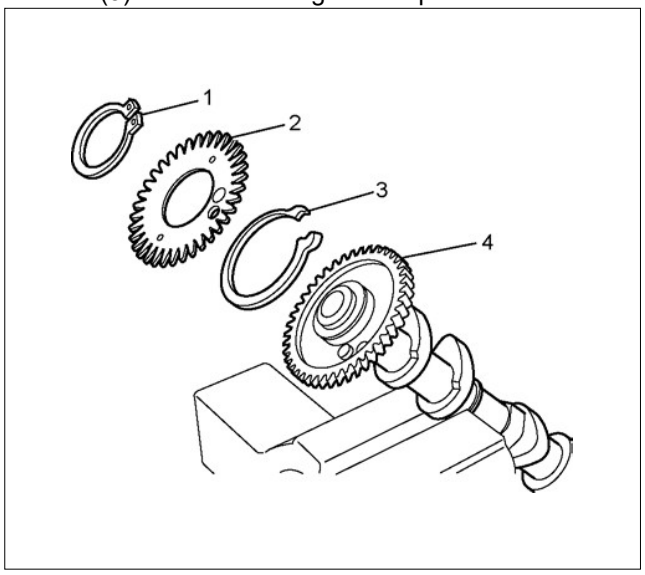


RTW56ASH006601

Legend

1. Camshaft
2. Dowel Pin
3. Camshaft Gear

3. Install the sub gear assembly.
   - Clamp the camshaft in a vise. Insert soft metal protectors (aluminum) between the vise surfaces and the camshaft. Press against the pin on the left side of the camshaft gear spring (3) to make a gap on the right side of the spring. Push the spring into place.
   - Align the sub gear pin (2) with the hole in the right side of the camshaft gear damper spring (3). Press the sub-gear into place.



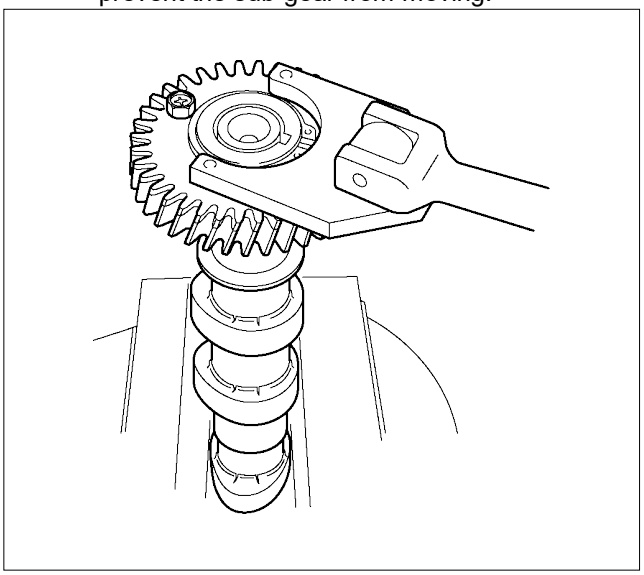
RTW56ASH006701

Legend

1. Snap Ring
2. Sub-gear
3. Damper Spring
4. Camshaft Gear

   - Use a pair of snap ring pliers to snuggly install the snap ring.

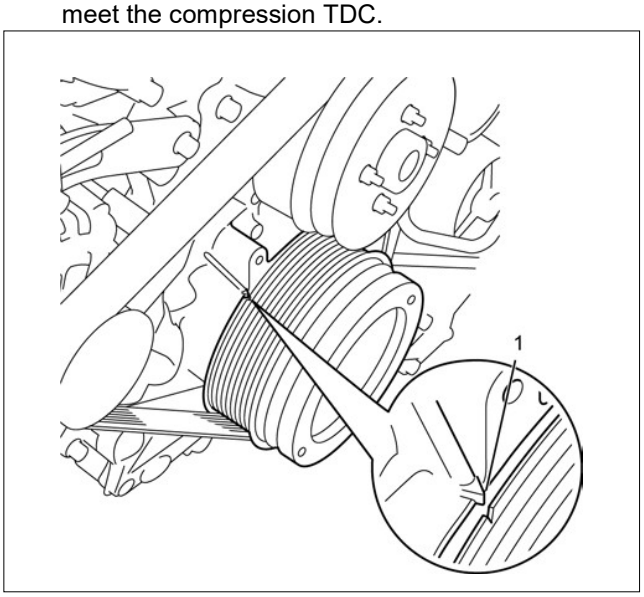
4. Tighten sub gear setting bolt.
   - Use 5-8840-2591-0 to turn sub gear to right direction until it aligns with the M5 bolt hole between camshaft driven gear and sub gear.
   - Tighten the M5 bolt to a suitable torque to prevent the sub-gear from moving.



RTW56ASH006801

Installation

1. Check the crankshaft to make the No. 1 cylinder meet the compression TDC.



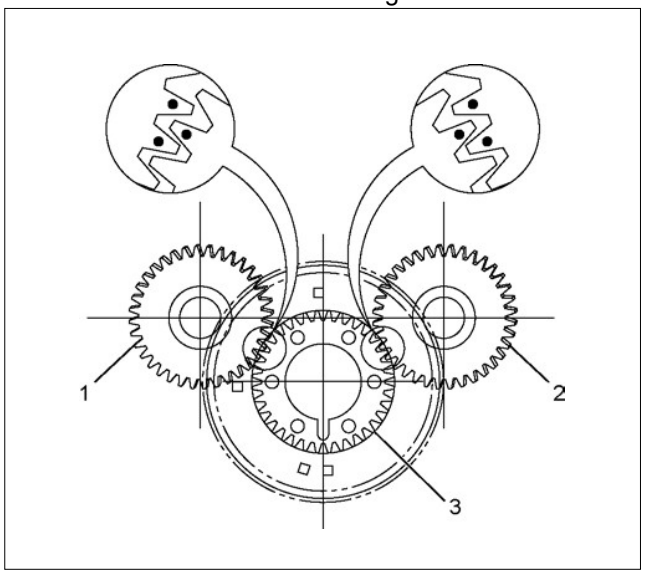
RTW76ASH001301

Legend

1. TDC

---

2. Install the camshaft assembly.
   - Align timing mark on intake camshaft and exhaust camshaft to idle gear D.

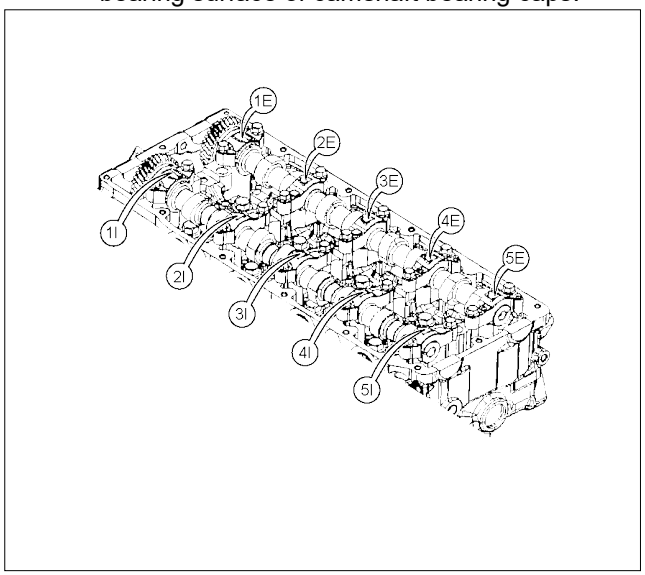


RTW56ASH007001

Legend

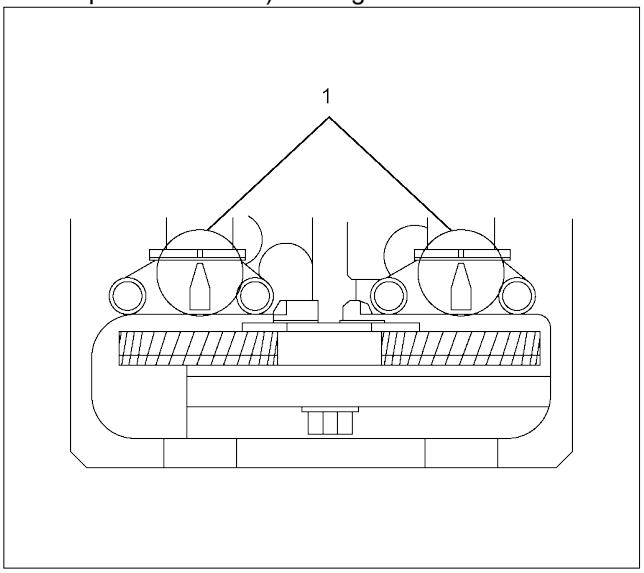
1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

3. Camshaft bearing caps, tighten ten bolts on one side bank to the specified torque.
   - Apply engine oil to camshaft journal and bearing surface of camshaft bearing caps.



RTW56ASH018401

4. Check that the alignment marks (camshaft bearing cap and camshaft) are aligned.



RTW56ASH006901

Legend

1. Align mark on intake camshaft and exhaust camshaft to mark of bearing cap

   - Apply engine oil over the screw part and tighten up the bearing cap with the prescribed torque.

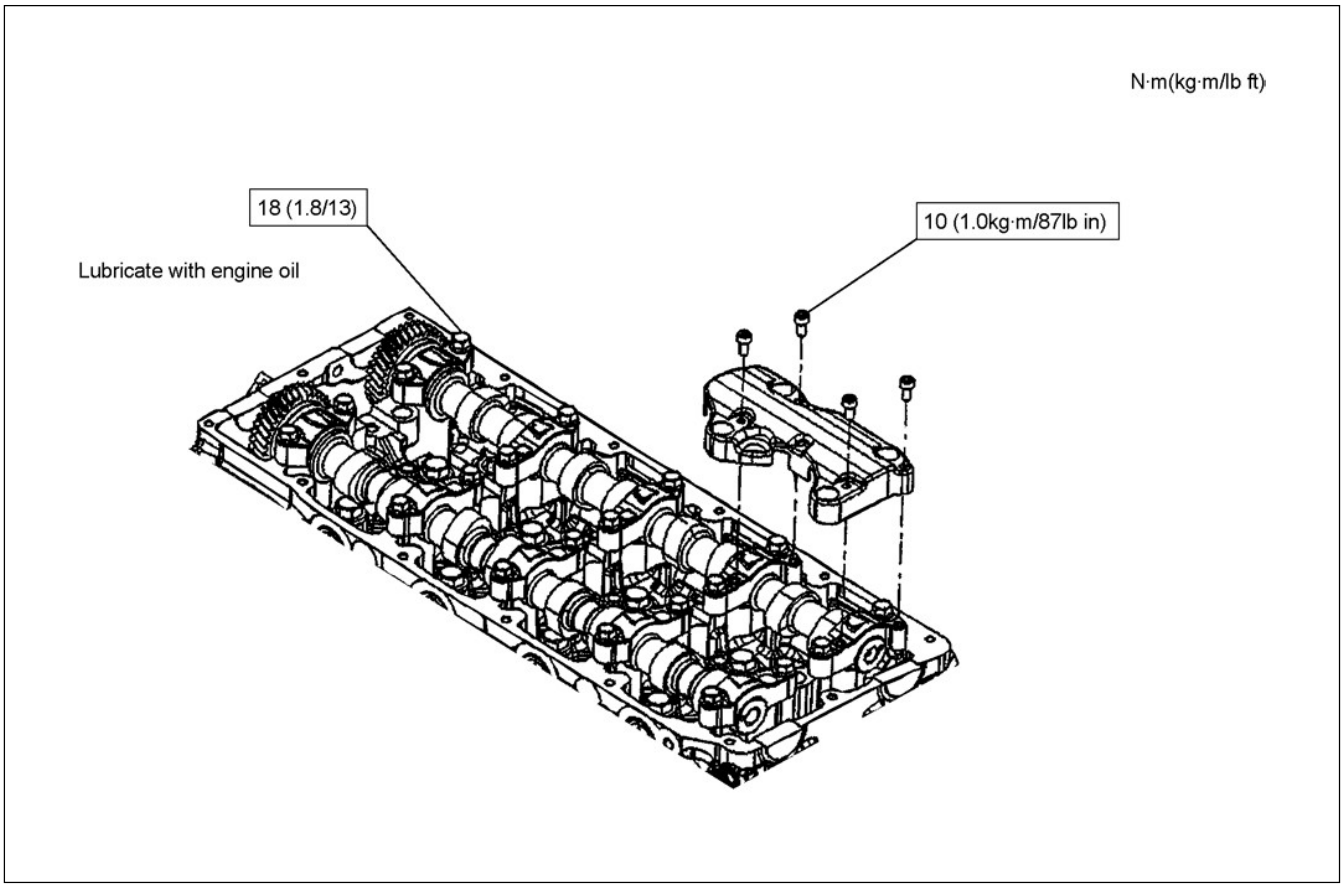
   Tightening torque: 18 N·m (1.8kg·m / 13 lb ft)

5. Remove the M5 lock bolt of fixing sub gear.
6. Adjustment of valve clearance.
   - Refer to installation procedure for inspection / adjustment of valve clearance in this manual.
7. Install the baffle plate. Tighten the bolts to the specified torque.

   Tightening torque: 10 N·m (1.0 kg·m/87 lb in)

8. Install the cylinder head cover.
   Refer to "Cylinder Head Cover".
9. Install the engine cover.

Torque Specifications



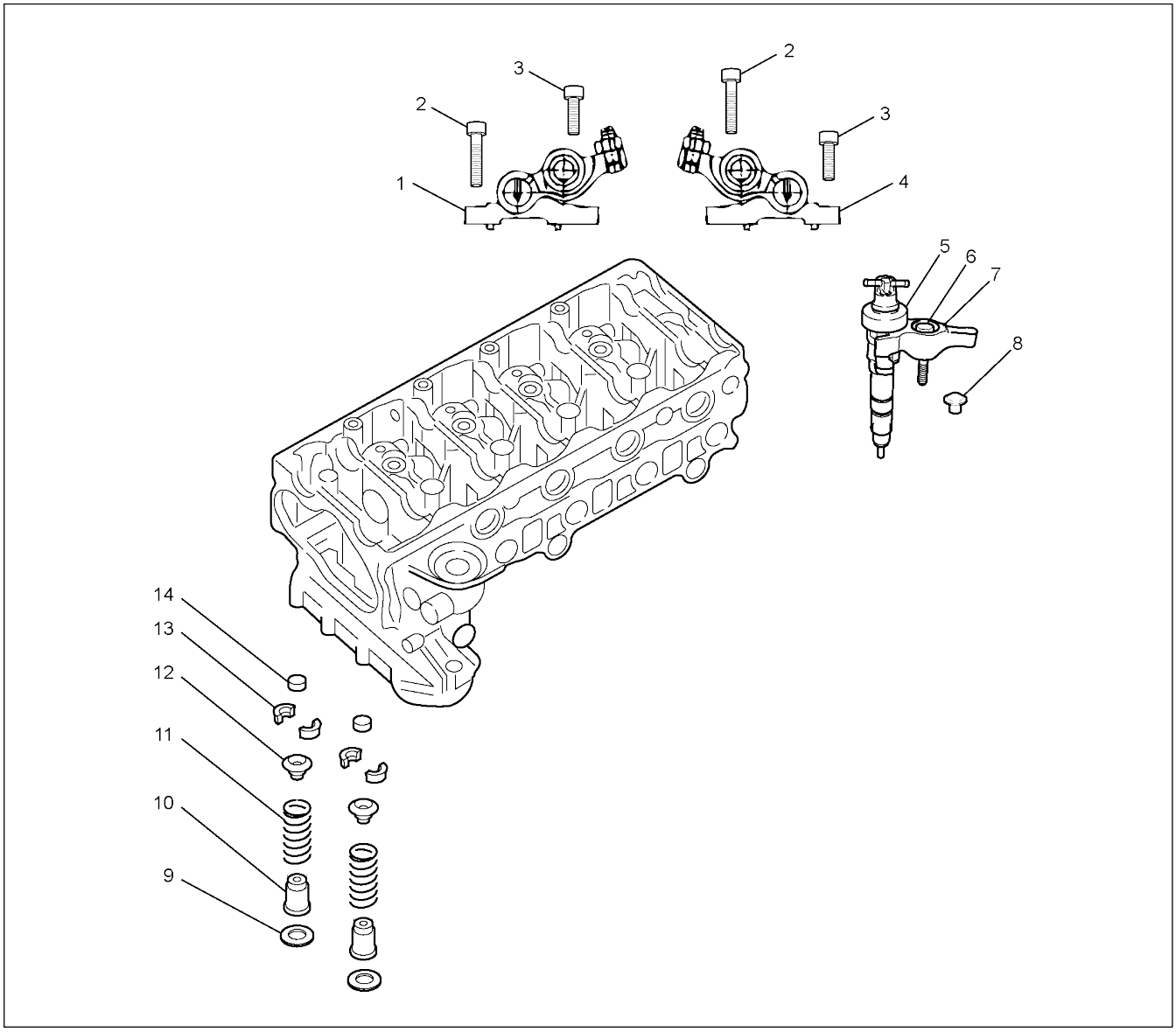
RTW56AMF001701

Special Tools

ILLUSTRATION	PART NO. PART NAME
	5-8840-2591-0 Camshaft gear tool

Valve Stem Seal and Valve Spring

Components



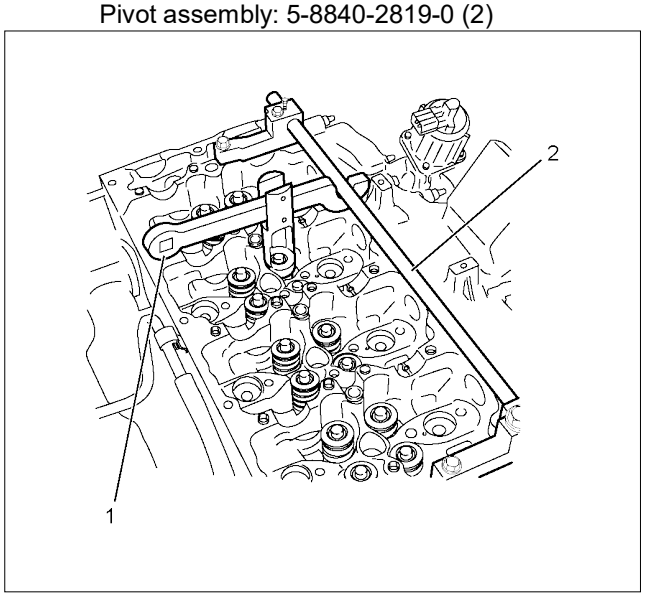
RTW56ALF001301

Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Fuel Injector Assembly
6. Bolt
7. Fuel Injector Clamp
8. Pin
9. Spring Lower Seat
10. Valve Stem Oil Seal
11. Valve Spring
12. Spring Upper Seat
13. Split Collar
14. Valve Stem End Cap

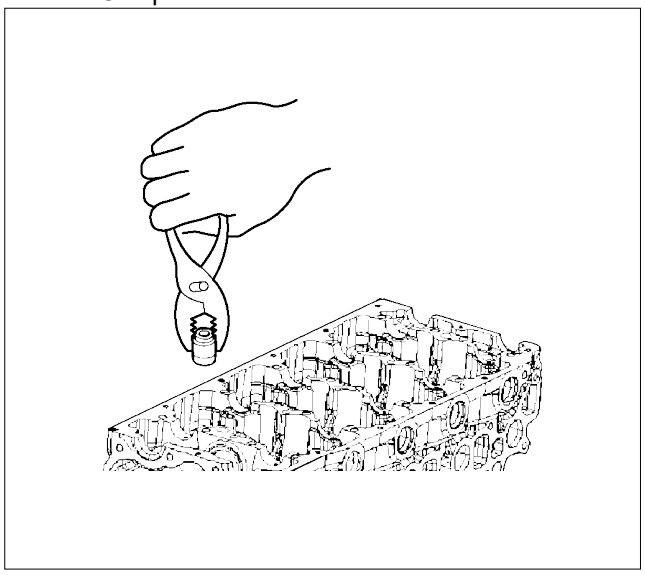
Removal

1. Remove the cylinder head.
   Refer to “Cylinder Head”.
2. Remove the split collar.
   - Use a replacer to compress the valve spring to remove the split collar.
     Special tool
     Valve spring replacer: 5-8840-2818-0 (1)
     Pivot assembly: 5-8840-2819-0 (2)



RTW56ASH012301

3. Remove the spring upper seat.
   - Remove the special tool to remove the upper seat.
4. Remove the valve spring.
   Put the removed valve springs in order by cylinder number.
5. Remove the valve stem oil seal.
   - Use pliers to remove the oil seal.



RTW56ASH012401

Note:
Do not use the removed oil seal again.

6. Remove the spring lower seat.

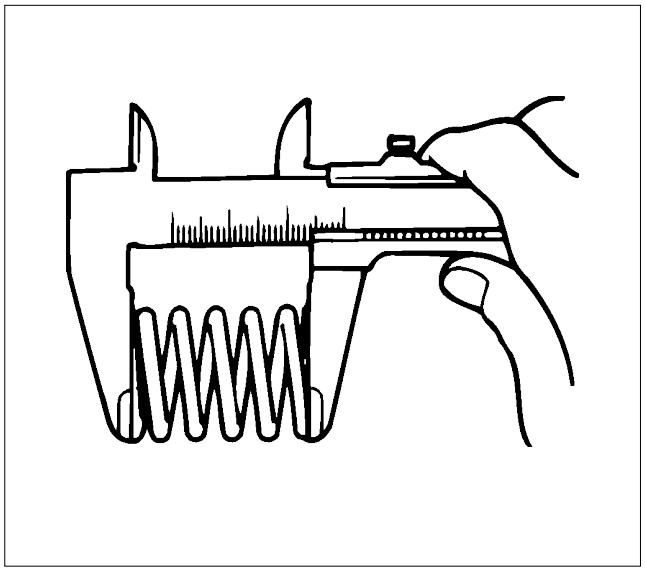
Inspection

Inspect the valve spring

Note:
Check the valve spring visually and if there is clear damage or wear, replace it.

1. Free length
   - Measure free length of the spring and if it is shorter than the prescribed limit, replace the spring.

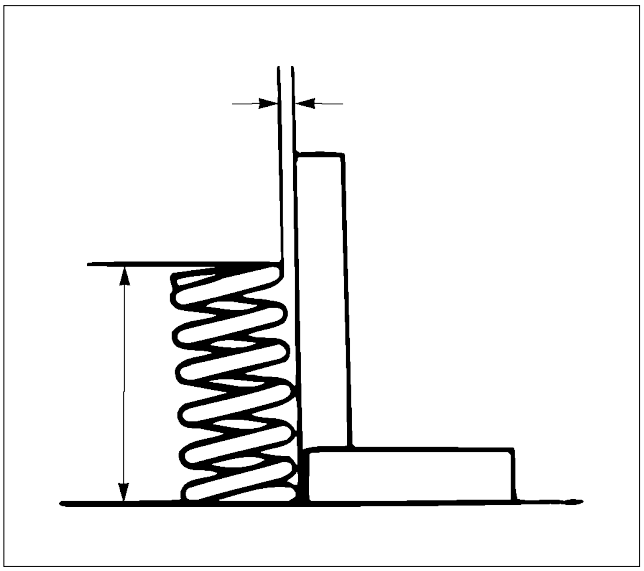
Free length of the valve spring	mm (in)
	Inlet / Exhaust
Standard	49.04 (1.93)
Limit	48.15 (1.89)



LNW21BSH017001

2. Valve spring squareness.
   - Use a surface plate and a square to measure the valve spring squareness.
     If the measured value exceeds the specified limit, the valve spring must be replaced.

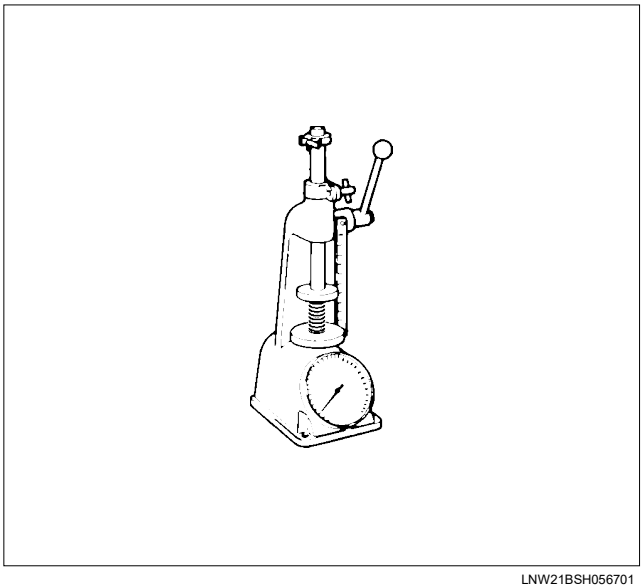
Valve spring squareness	mm (in)
Limit	2.1 (0.083)



LNW21BSH017101

3. Tension
   - Use a spring tester to compress the spring to the installation height. Measure tension of the compressed spring. If the measurement is lower than the limit, replace the spring.

Tension of the valve spring	N (kg / lb)
	Inlet / Exhaust
Installation length mm (in)	37.80 (1.488)
Standard	213 (21.7 / 47.8)
Limit	188 (19.2 / 42.3)



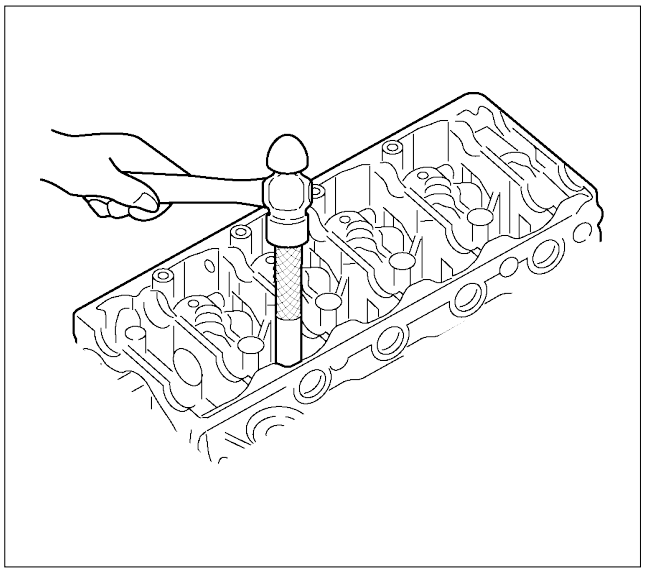
LNW21BSH056701

Installation

1. Install the spring lower seat.
2. Install the valve stem oil seal.
   - Apply engine oil over the peripheral part of the valve guide and install the oil seal by using a valve stem seal installer.

Note:
After installing the valve stem oil seal, check if it is inserted nice and deep and the oil seal is not tilted or the garter spring has not come off.

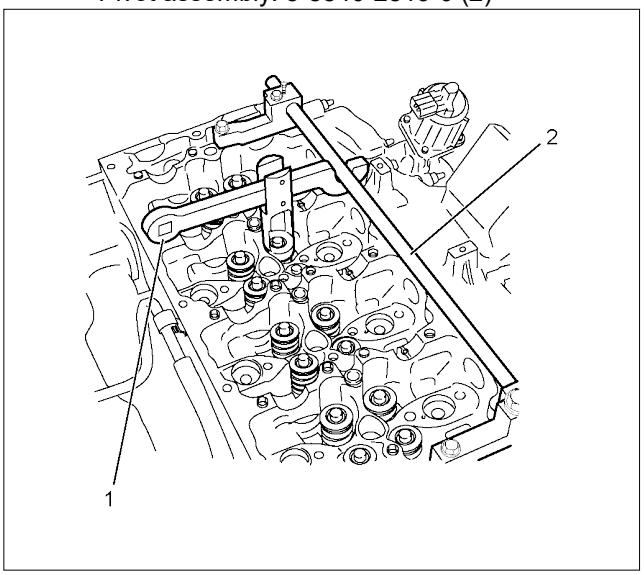
Special tool
Valve stem seal installer: 5-8840-2817-0



RTW56ASH013701

3. Install the valve spring.
4. Install the spring upper seat.
5. Install the split collar.
   - Use a replacer to compress the valve spring and install the split collar.

   Special tool
   Valve spring replacer: 5-8840-2818-0 (1)
   Pivot assembly: 5-8840-2819-0 (2)

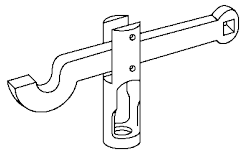
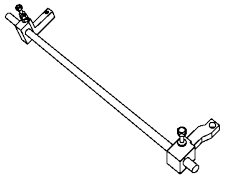
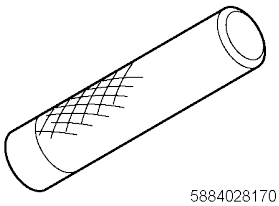


RTW56ASH012301

Note:
Move it up and down to check if it moves smoothly.

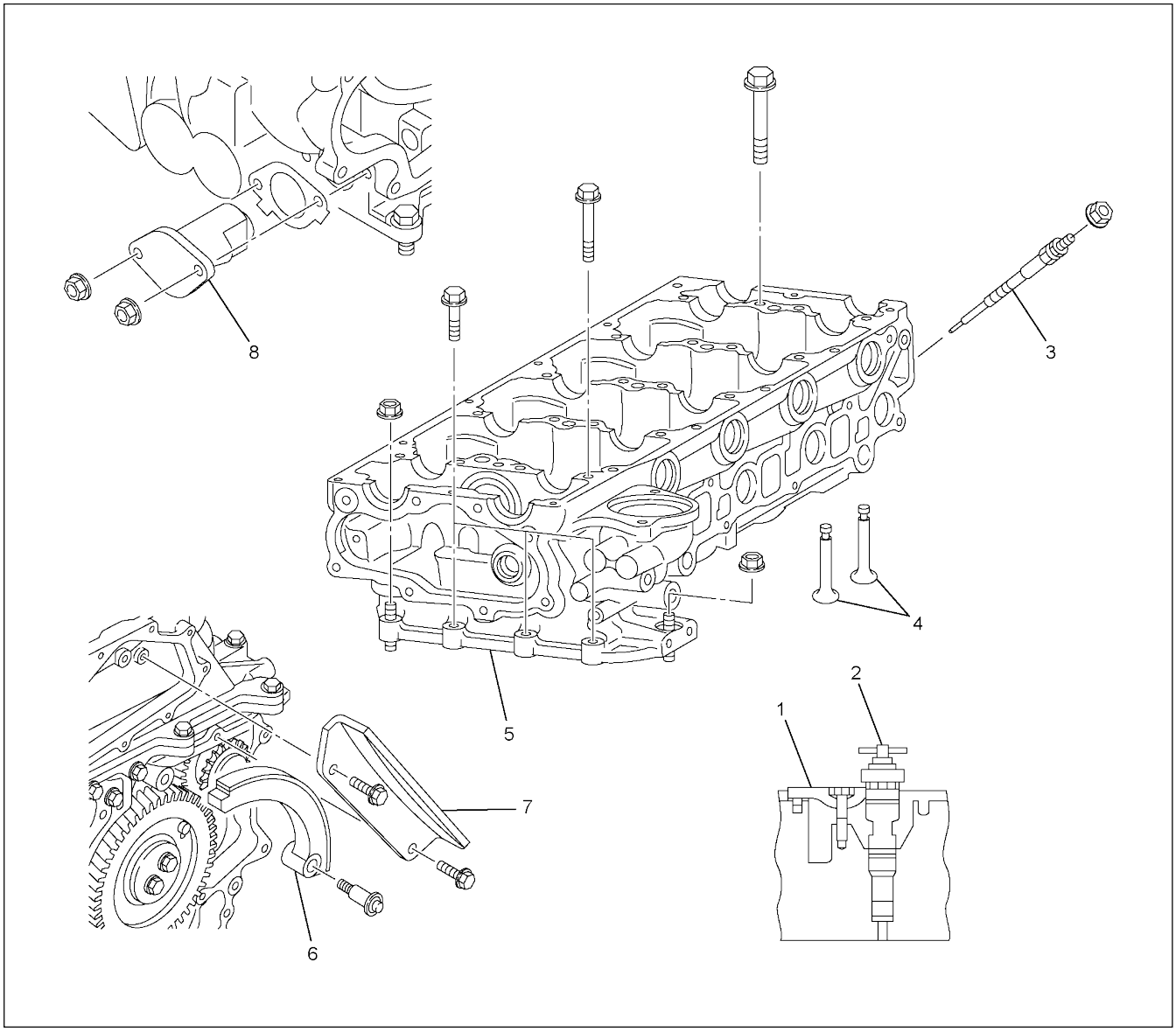
6. Install the cylinder head.
   Refer to “Cylinder Head”.

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028180	**5-8840-2818-0** Valve spring replacer
 5884028190	**5-8840-2819-0** Pivot assembly
 5884028170	**5-8840-2817-0** Valve stem seal installer

Cylinder Head

Components



RTW56ALF001001

Legend

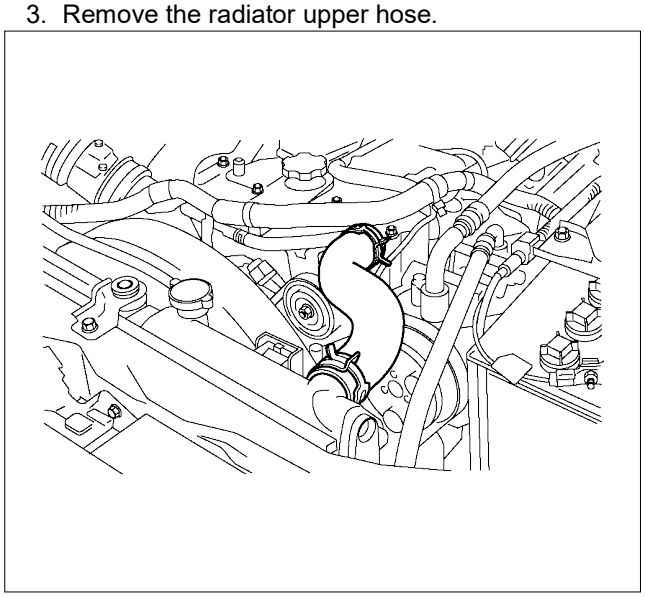
1. Fuel Injector Clamp
2. Fuel Injector Assembly
3. Glow Plug
4. Intake and Exhaust Valves
5. Cylinder Head
6. Timing Chain Tension Lever
7. Timing Chain Guide
8. Timing Chain Tensioner

Note:
To avoid electric shock;
Set the switch to the 'OFF' position and disconnect the negative battery cable before checking or repairing the fuel injector, wiring or/and connectors.

Removal

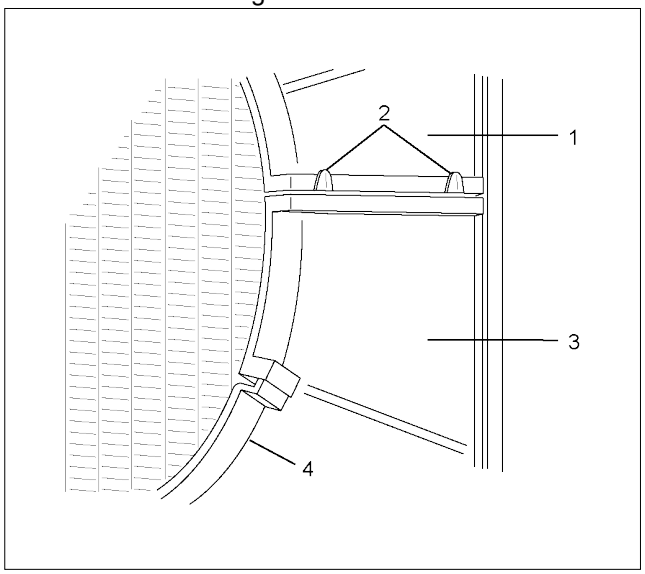
1. Remove the engine head cover.
2. Drain the engine coolant.

3. Remove the radiator upper hose.



RTW56FSH000101

4. Remove the fan guide.

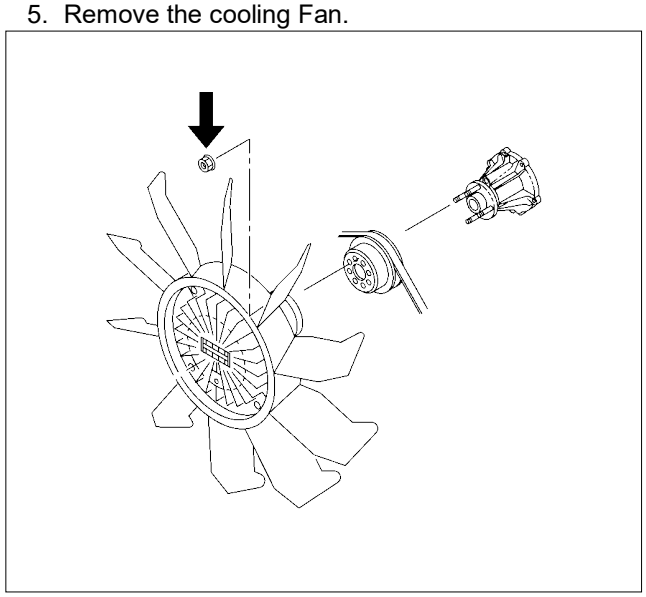


RTW46BSH000101

Legend

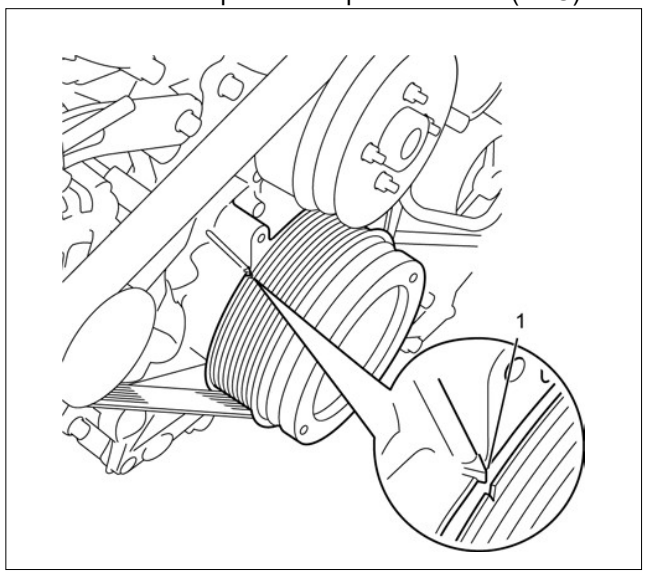
1. Fan Guide
2. Clips
3. Lower Fan guide
4. Fan Shroud

5. Remove the cooling Fan.



RTW56ASH025401

6. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



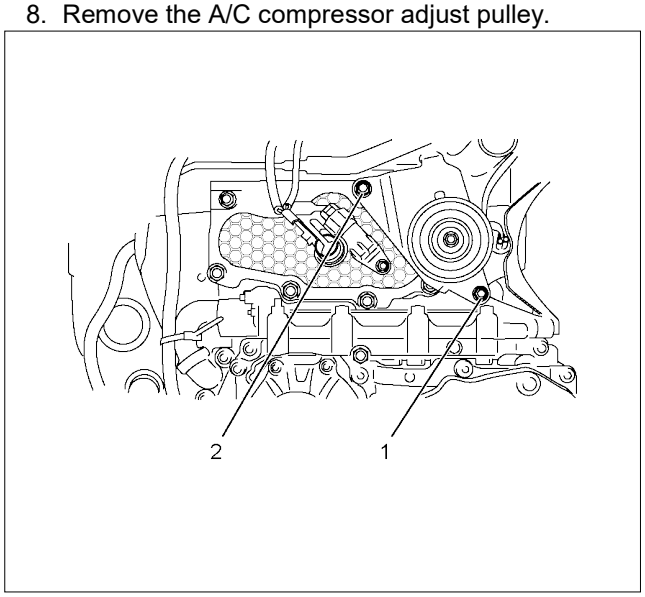
RTW76ASH001301

Legend

1. TDC

7. Remove the A/C compressor drive belt.

8. Remove the A/C compressor adjust pulley.

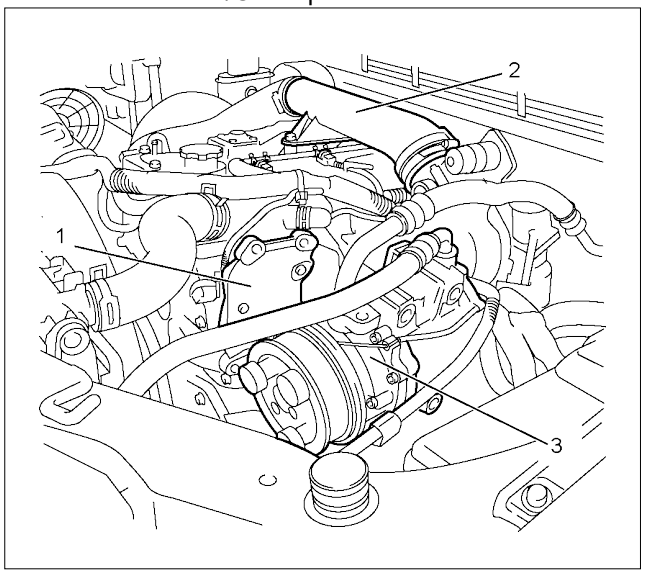


RTW56ASH010601

Legend

1. Bolt
2. Nut

9. Remove the battery.
10. Disconnect the A/C compressor connector and A/C compressor with hose.
11. Remove the A/C compressor bracket.

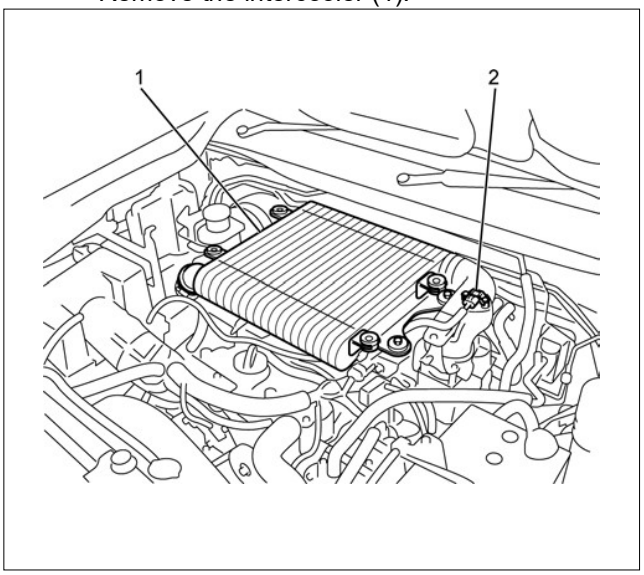


RTW56ASH024201

Legend

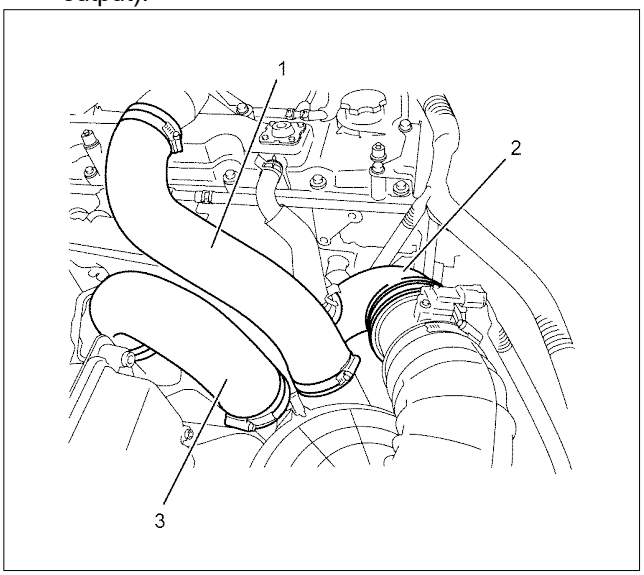
1. A/C Compressor Bracket
2. Intake Duct
3. A/C Compressor

12. Remove the intercooler (High output).
    - Disconnect the BARO sensor harness connector (2).
    - Remove the two intake hoses.
    - Remove the intercooler (1).



RTW76ASH000501

13. Remove the intake hose and duct (Standard output).

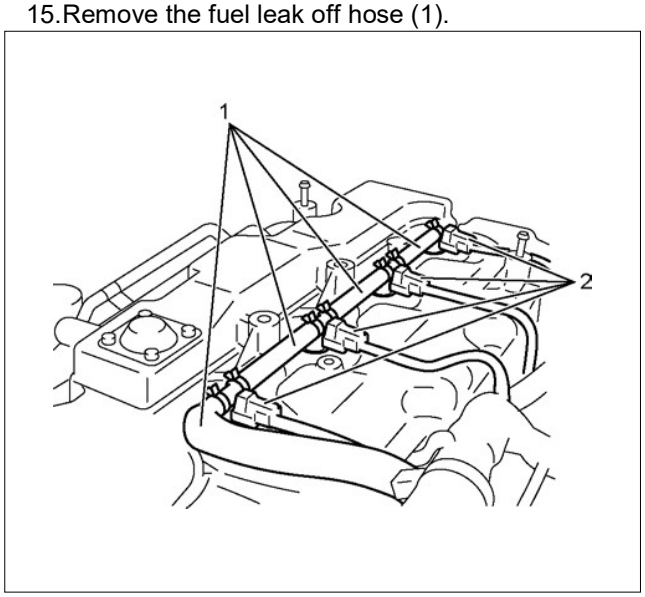


RTW56ASH022501

Legend

1. Intake Hose for Intercooler and Intake Throttle
2. Intake Duct for Turbocharger and Air Cleaner
3. Intake Hose for Turbocharger and Intercooler

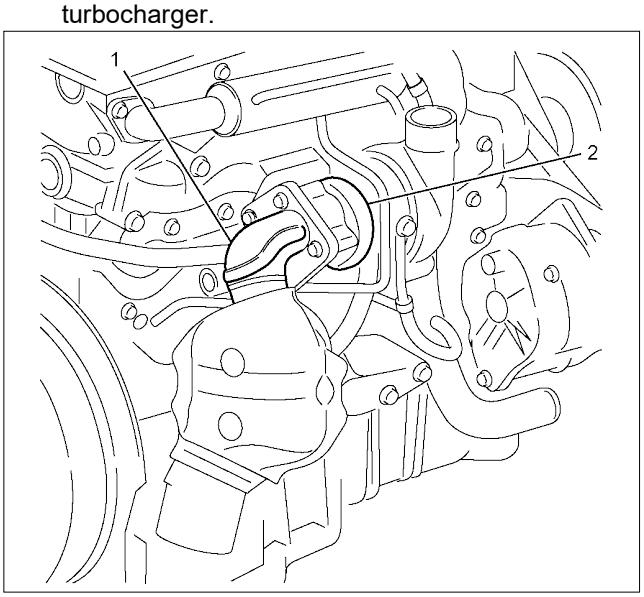
14. Disconnect the fuel injector connector (2).
15. Remove the fuel leak off hose (1).



RTW76ASH000101

Note:
Do not reuse the fuel leak off hose clips.

16. Disconnect each connector.
    - Glow Plug
    - EGR Valve
    - Throttle Assembly
    - Barometric Sensor
    - Water temperature sensor
    - Camshaft Position sensor
17. Remove the harness bracket.
18. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover”.
19. Remove the EGR cooler heat protector.
20. Remove the EGR cooler water pipe.
21. Remove the EGR cooler.
22. Loosen the nuts of catalyst converter and turbocharger.

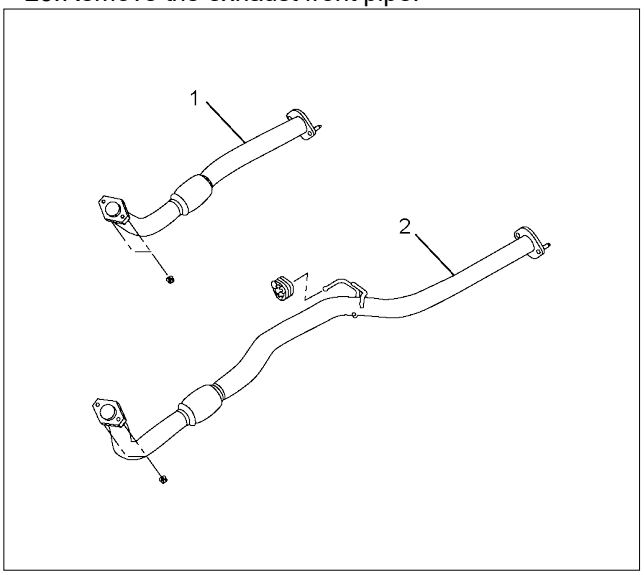


RTW56ASH006201

Legend

1. Catalyst Converter
2. Turbocharger

23. Remove the exhaust front pipe.

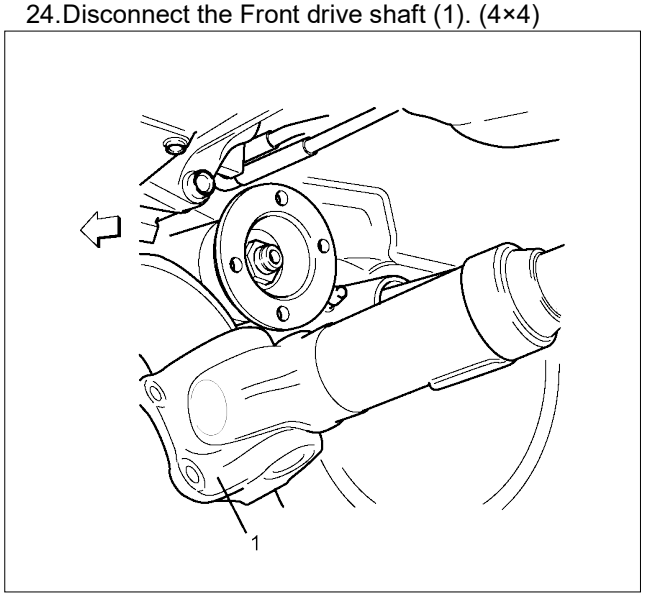


RTW56ASH007701

Legend

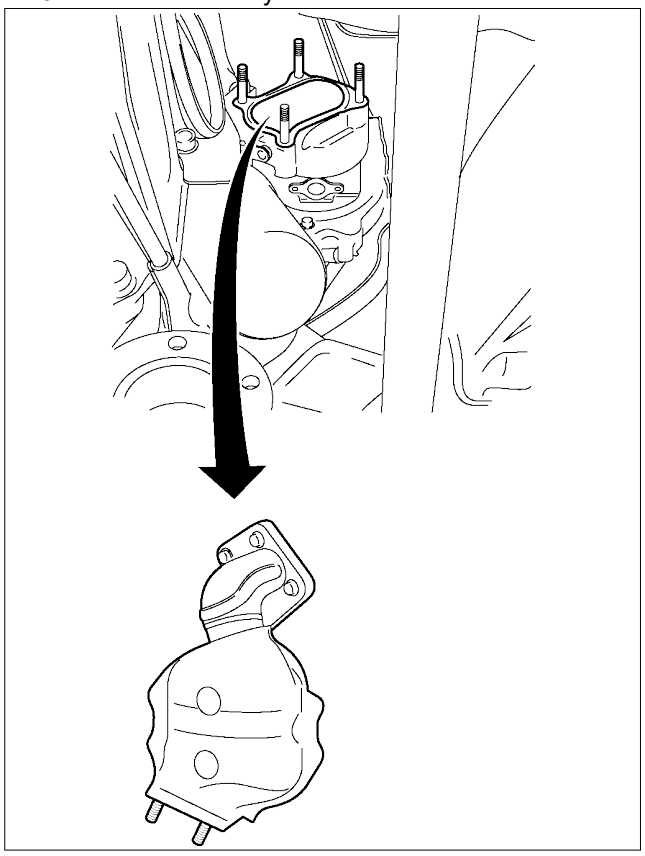
1. Exhaust Front Pipe (4×2 High Ride Suspension, 4×4)
2. Exhaust Front Pipe (4×2 Except High Ride Suspension)

24.Disconnect the Front drive shaft (1). (4×4)



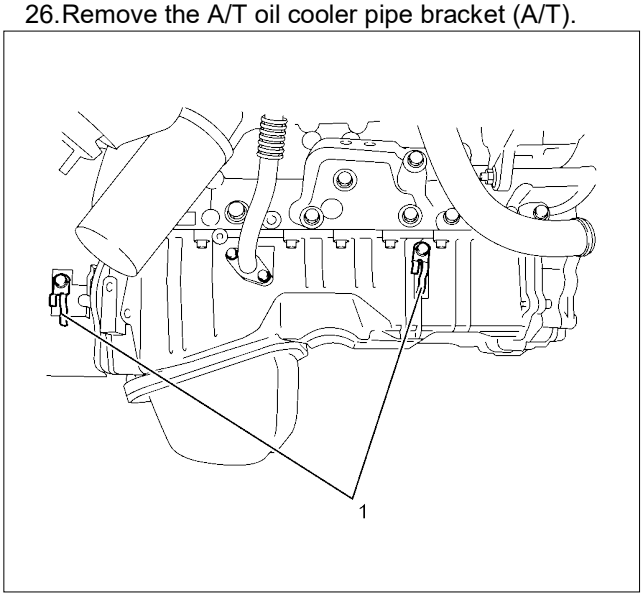
RTW76ASH002301

25.Remove the catalyst converter.



RTW56ALH000201

26.Remove the A/T oil cooler pipe bracket (A/T).

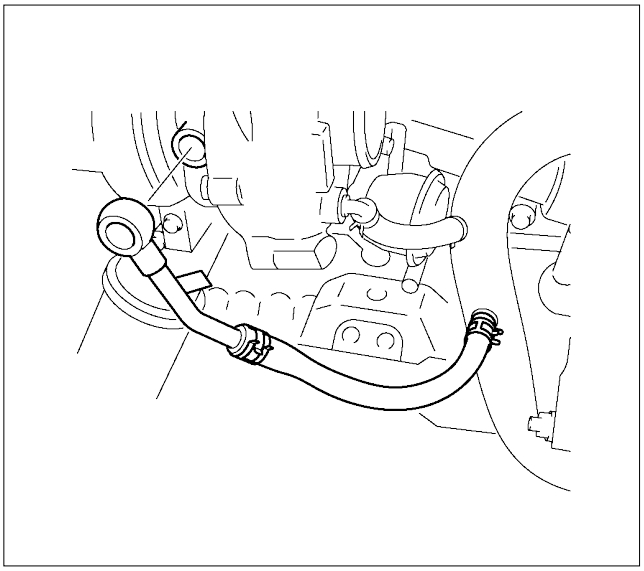


RTW56ASH025101

Legend

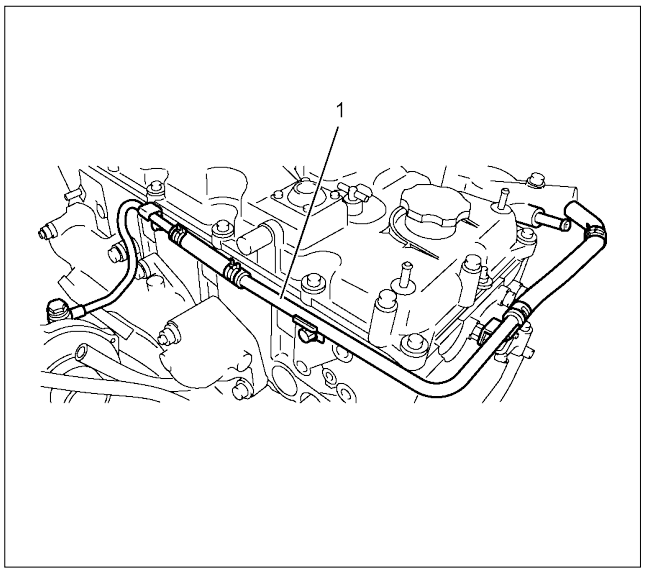
1. A/T Oil Cooler Pipe Bracket

27.Remove the turbocharger water return pipe and hose.



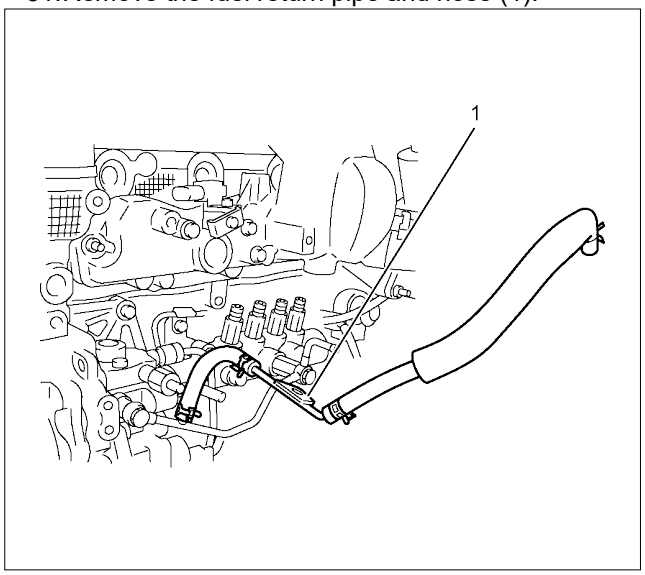
RTW56ASH019001

28. Remove the turbocharger water feed pipe (1) and hose.



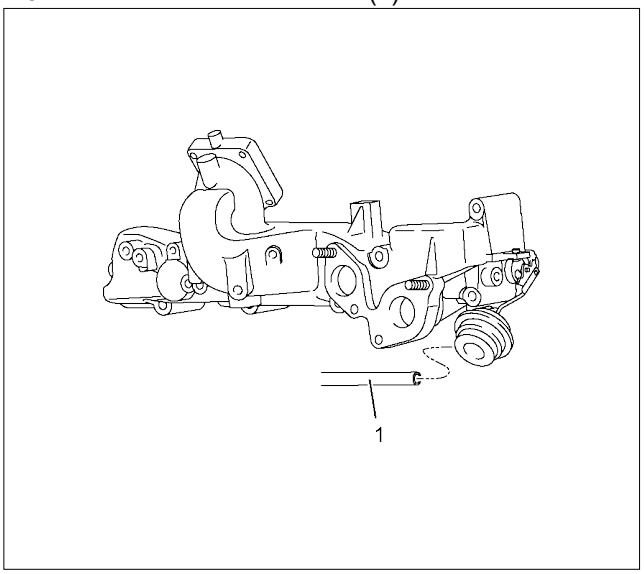
RTW56ASH019101

29. Remove the turbocharger engine oil feed pipe.
30. Remove the engine oil level gauge guide tube.
31. Remove the fuel return pipe and hose (1).



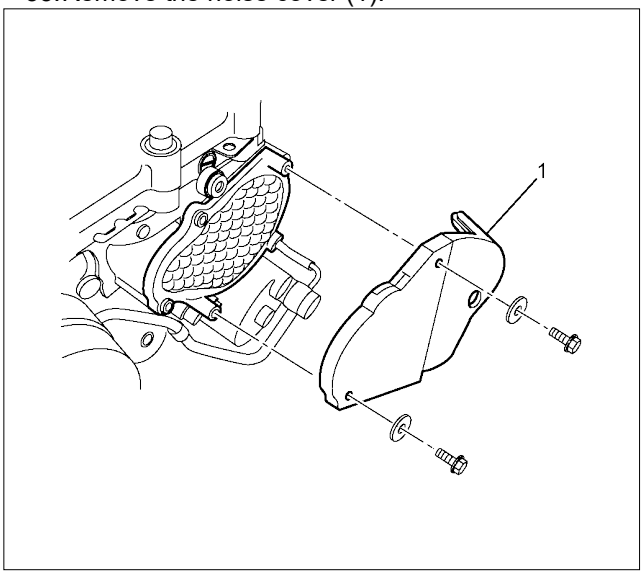
RTW56ASH019201

32. Remove the fuel injection pipe clip.
33. Remove the fuel injection pipe.
34. Remove the vacuum hose (1).



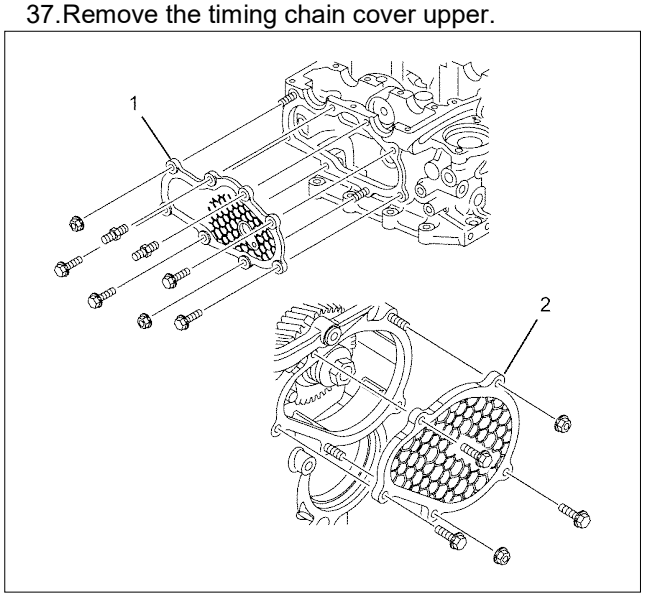
RTW66ASH003101

35. Remove the noise cover (1).



RTW56CSH001401

36. Remove the timing chain cover lower.
37. Remove the timing chain cover upper.

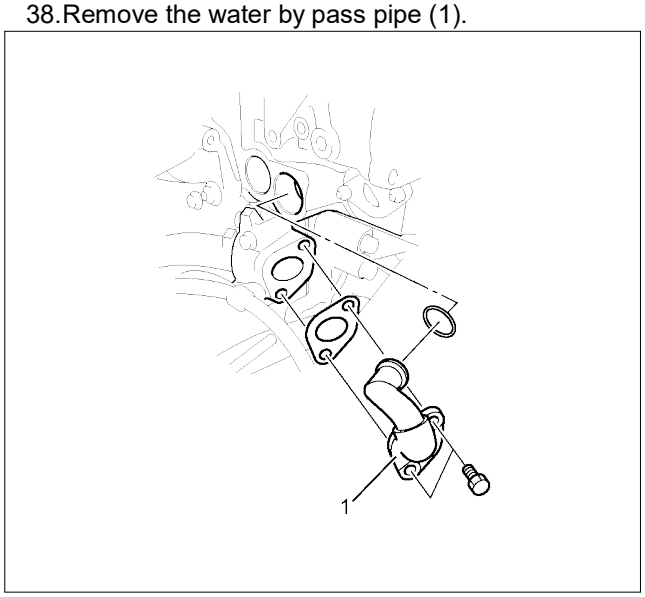


RTW56CSH001501

Legend

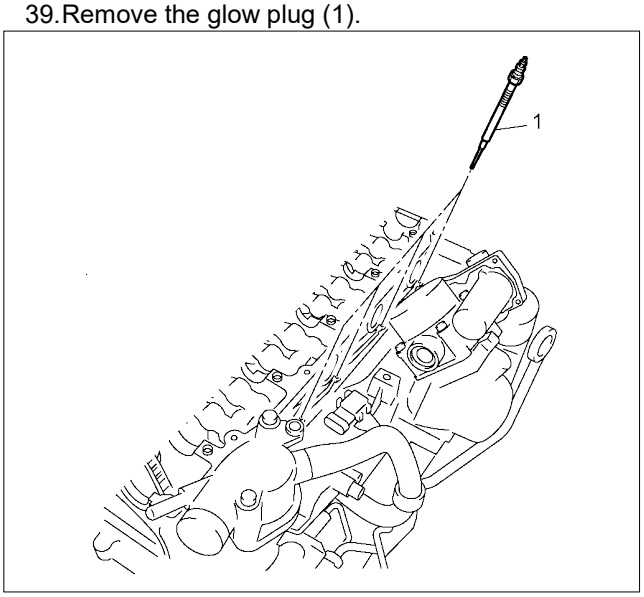
1. Timing Chain Cover Upper
2. Timing Chain Cover Lower

38. Remove the water by pass pipe (1).



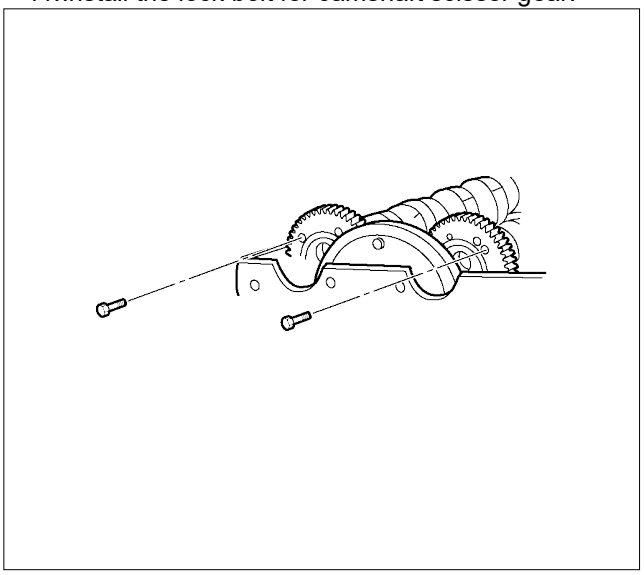
RTW56ASH008401

39. Remove the glow plug (1).



RTW56ASH019301

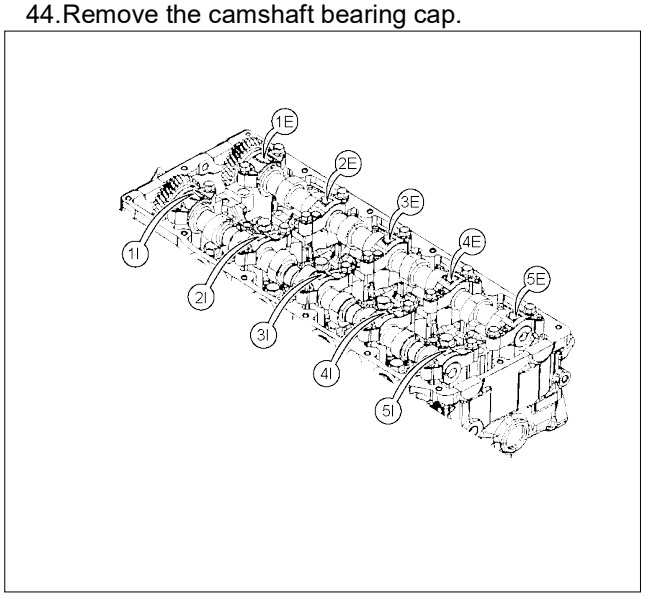
40. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover”.
41. Install the lock bolt for camshaft scissor gear.



RTW56ASH007101

42. Remove the fuel injector assembly.
43. Remove the baffle plate.

44.Remove the camshaft bearing cap.

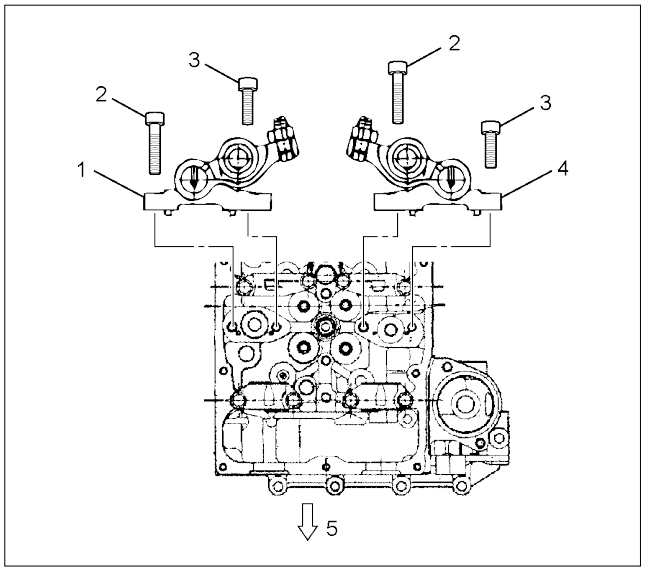


RTW56ASH018401

45.Remove the camshaft.

46.Remove the rocker arm shaft assembly.

Note:
Keep the removed rocker arm shaft assembly properly so that they may be put back to the original place.



RTW56ASH012201

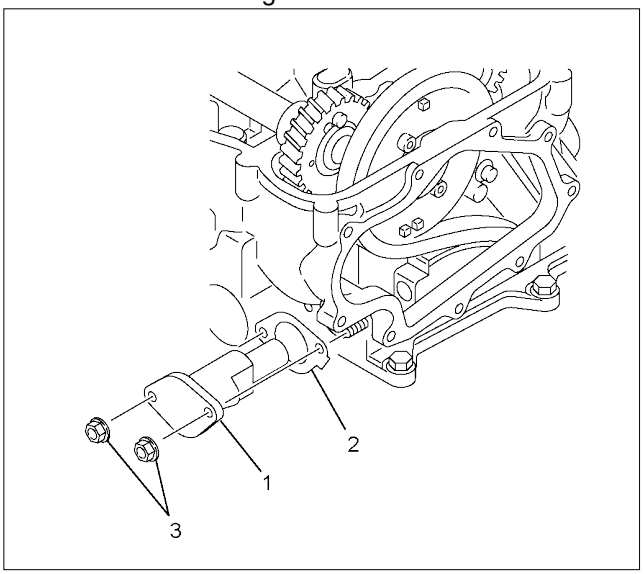
Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Front

Note:
Pay full attention so as not to drop the parts in the gear case of the front part of the cylinder head or a hole into which oil pours back in the front.

Note:
Remember the original position.

47.Remove the timing chain tensioner.



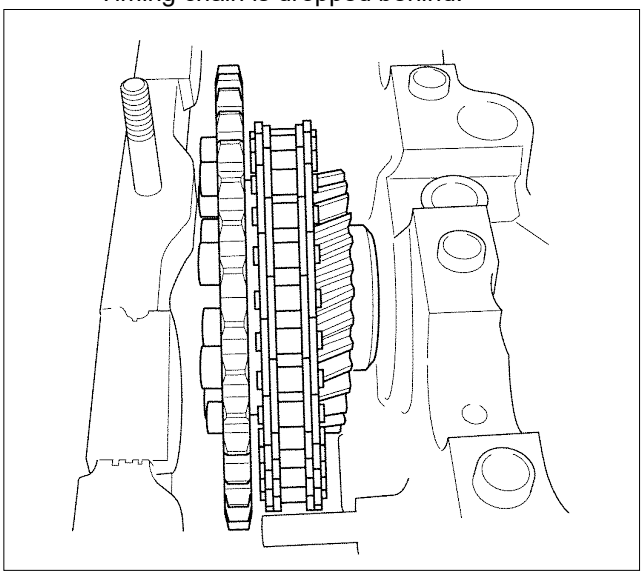
RTW56CSH003701

Legend

1. Timing Chain Tensioner
2. Gasket
3. Nut

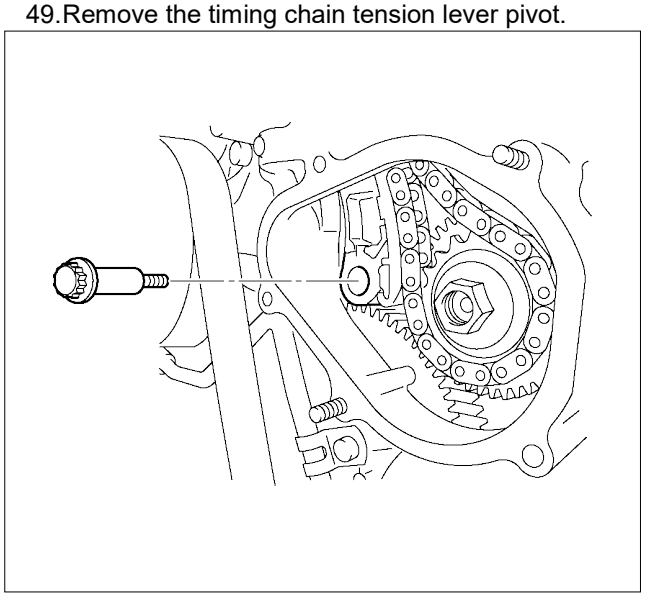
48.Remove the idle gear D.

- Timing chain is dropped behind.



RTW56ASH022101

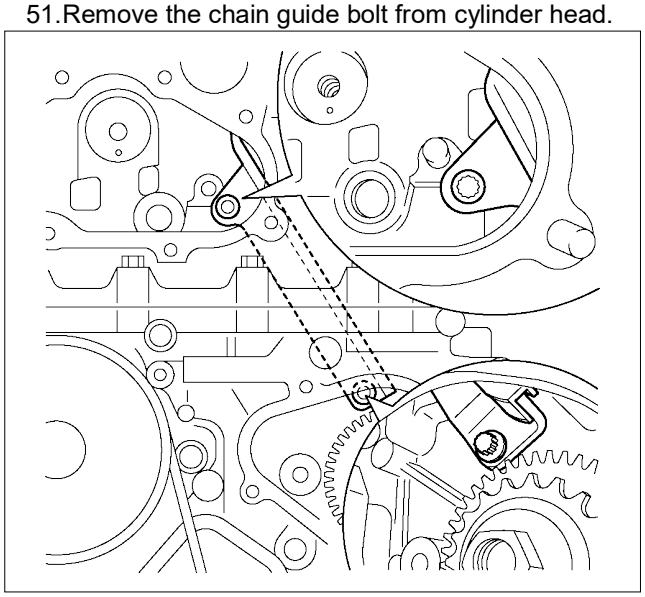
49.Remove the timing chain tension lever pivot.



RTW56ASH019401

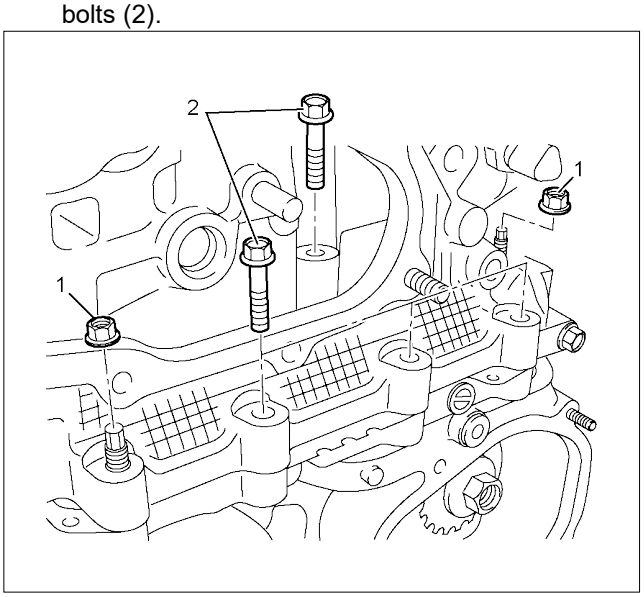
50.Remove the timing chain from supply pump sprocket.

51.Remove the chain guide bolt from cylinder head.



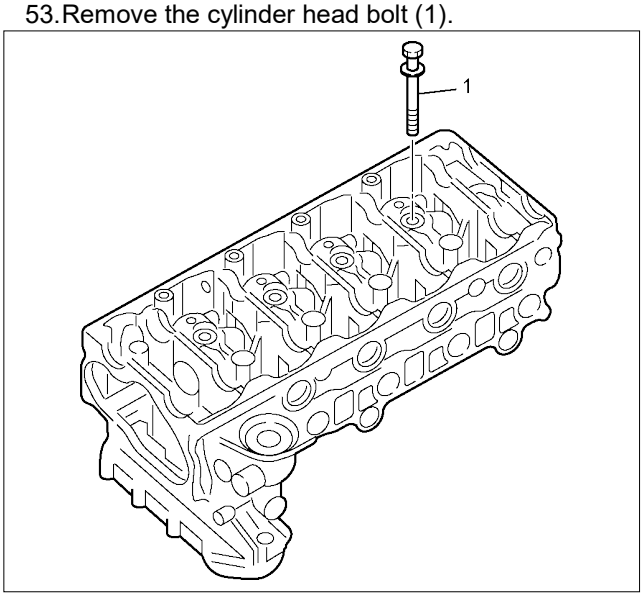
RTW56ASH019501

52.Remove the cylinder head gear case nuts (1) and bolts (2).



RTW56ASH020801

53.Remove the cylinder head bolt (1).

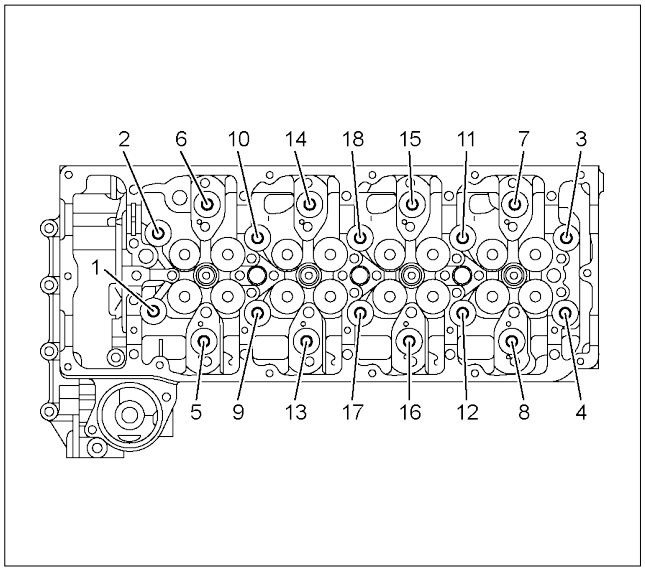


RTW56ASH008501

Note:
Do not reuse the cylinder head bolt.

54. Remove the cylinder head assembly.
    - Loosen the cylinder head bolts in the order described in the drawing.
    - Remove the cylinder head gasket.

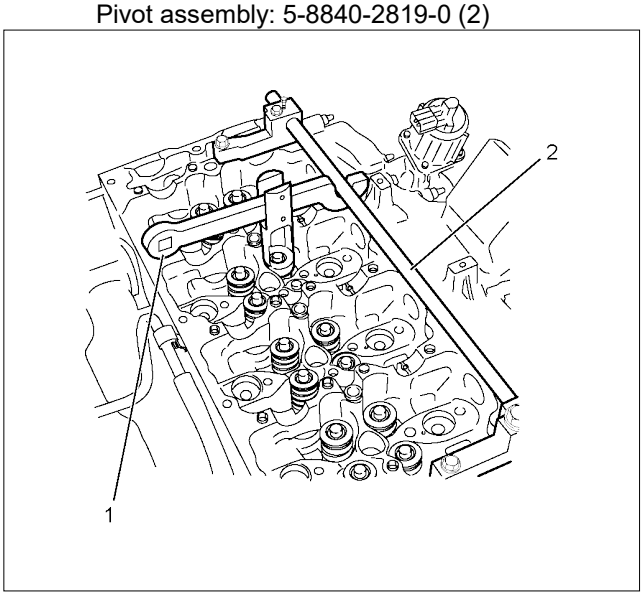
Note:
Replace the head gasket with a new one once it is removed.



RTW56ASH008601

Disassembly

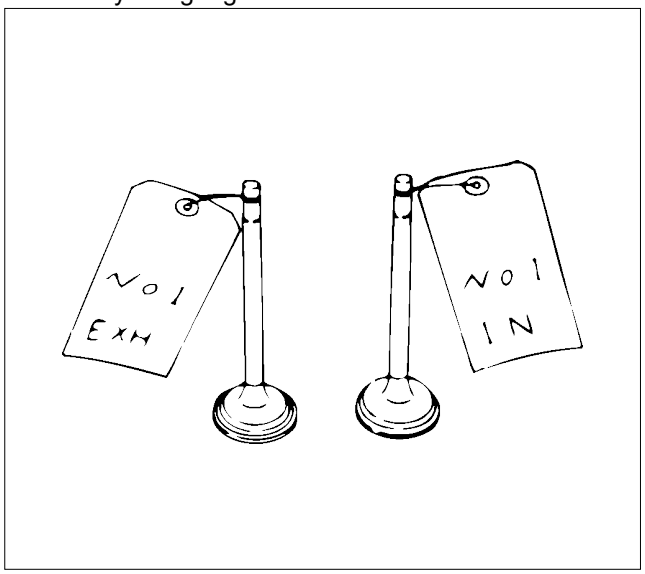
1. Remove the throttle assembly.
    - Refer to procedure for Intake Manifold in this manual.
2. Remove the intake manifold assembly.
    - Refer to procedure for Intake Manifold in this manual.
3. Remove the turbocharger.
    - Refer to “Turbocharger and Exhaust Manifold”.
4. Remove the exhaust manifold assembly.
    - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
5. Remove the water outlet pipe.
6. Remove the valve stem cap.
   Refer to procedure for valve stem and valve in this manual.
7. Remove the split collar.
    - Use a replacer to compress the valve spring to remove the split collar.
      Special tool
      Valve spring replacer: 5-8840-2818-0 (1)
      Pivot assembly: 5-8840-2819-0 (2)



RTW56ASH012301

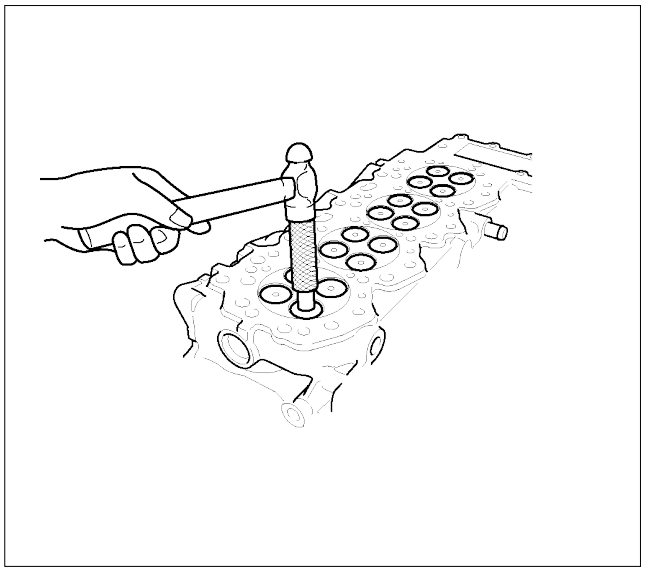
8. Remove the spring upper seat.
    - Remove the special tool to remove the upper seat.
9. Remove the valve spring.
    - Put the removed valve springs in order by cylinder number.

10. Remove the intake and exhaust valve.
    - Sort the removed valves according to cylinders by using tags others.



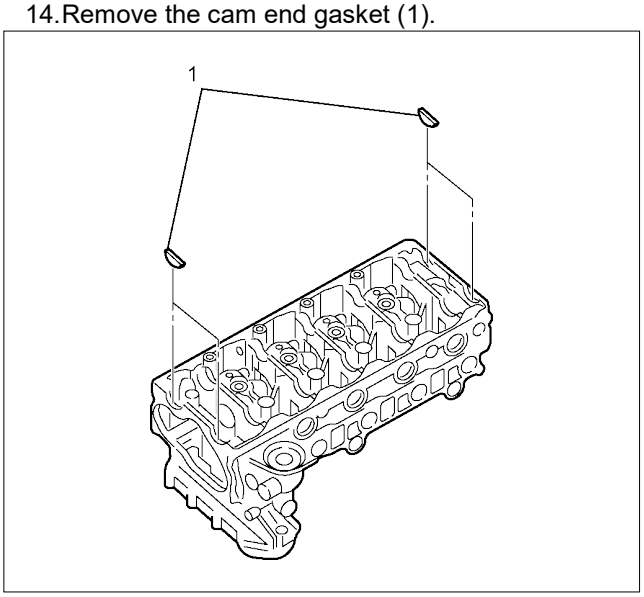
LNW21BSH016801

11. Remove the valve stem oil seal.
    - Refer to procedure for valve stem and valve in this manual.
12. Remove the spring lower seat.
13. Remove the valve guide.
    - Use the valve guide replacer to press out the valve guides from the bottom side of the cylinder head.
      Special tool
      Valve guide remover and installer:
      5-8840-2816-0



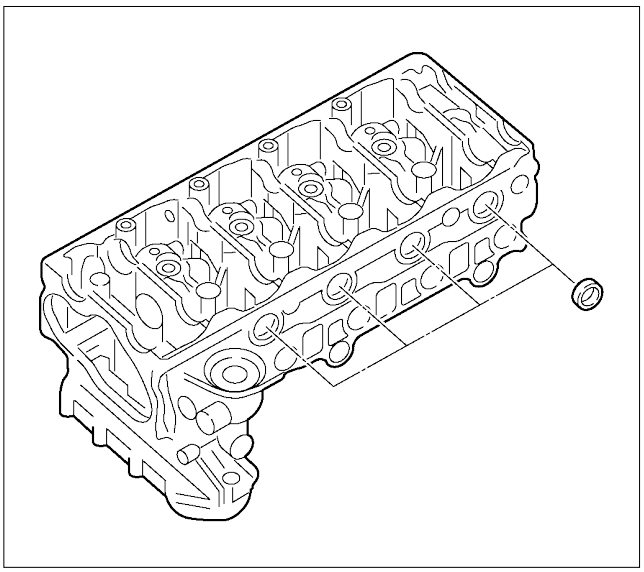
RTW56ASH008701

14. Remove the cam end gasket (1).



RTW56ASH020501

15. Remove the oil seal.



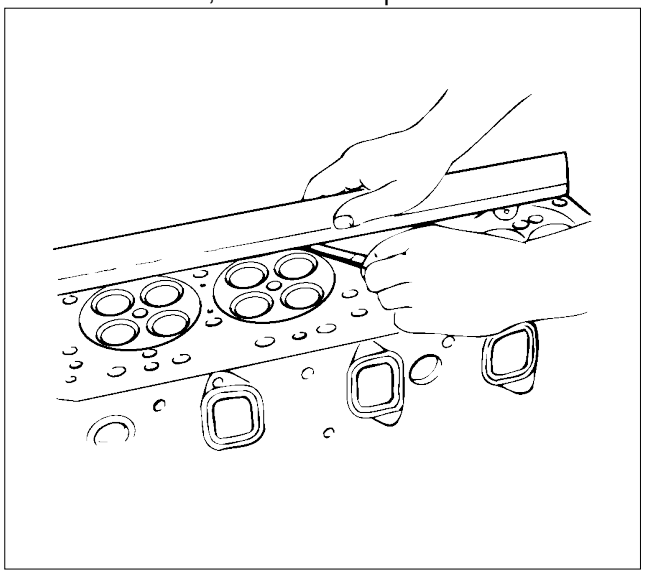
RTW56ASH008801

Inspection

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Cylinder Head Lower Face Warpage

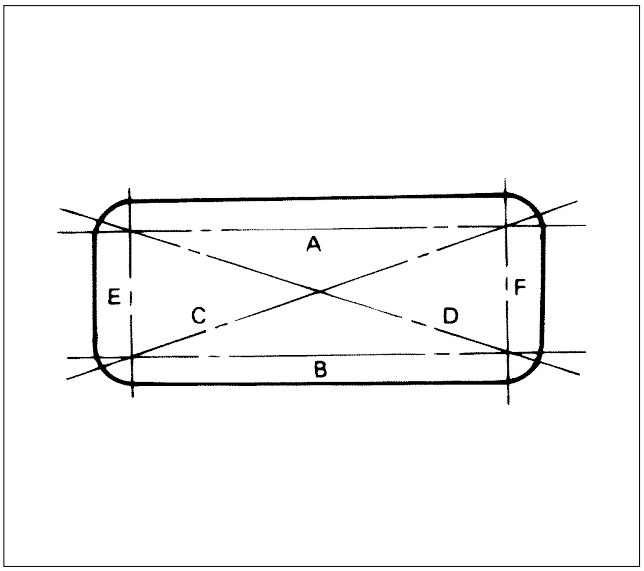
1. Use a straight edge and a thickness gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. The cylinder head lower surface warpage is more than the limit, it should be replaced.



RTW56ASH008901

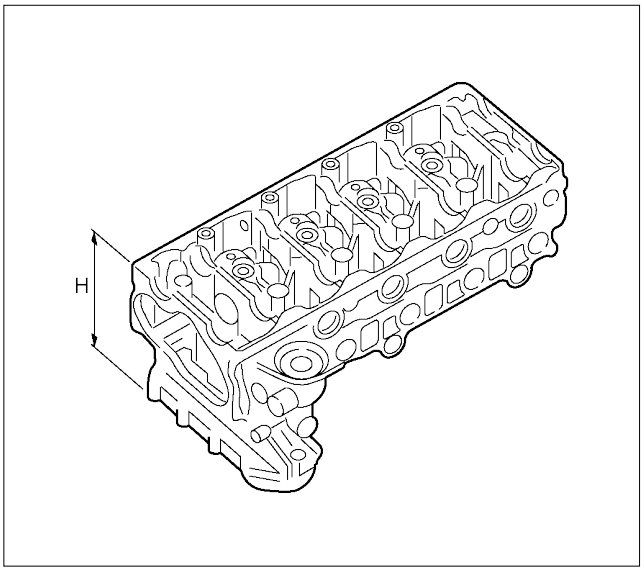
Cylinder Head Lower Face Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.0079)

NOTE:
The cylinder head lower face cannot be regrind.



011RY00013

Cylinder Head Height (H) (Reference)	mm (in)
Standard	143.4 (5.646)



RTW56ASH017401

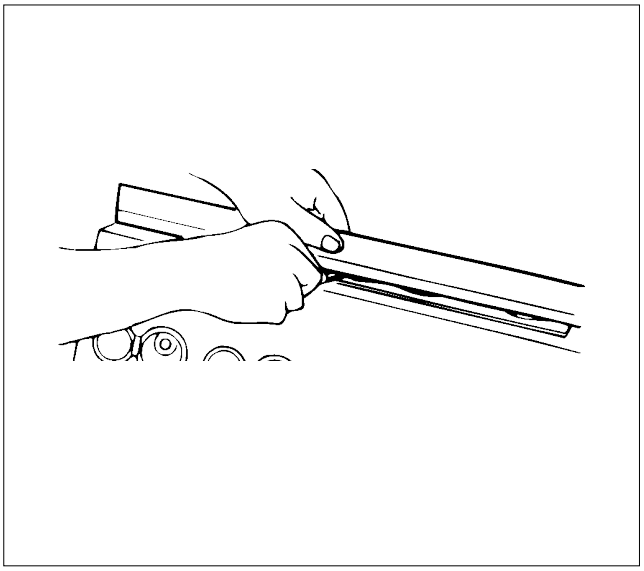
Manifold Fitting Face Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.

Regrind the manifold cylinder head fitting surfaces if the measured values are greater than the specified limit but less than the maximum grinding allowance.

If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Manifold Fitting Face Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.008)
Maximum Grinding Allowance	0.40 (0.016)



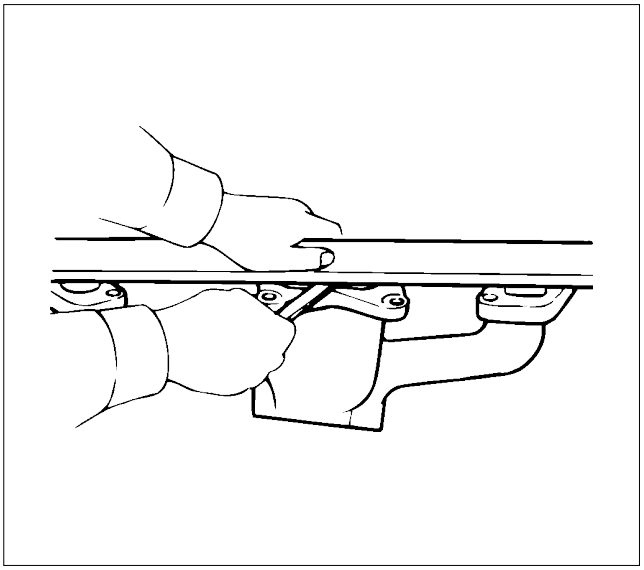
RTW56ASH017501

Exhaust Manifold Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.

If the measured values exceed the specified limit, the manifold must be replaced.

Exhasut Manifold Warpage	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.008)



027RY00002

Valve Stem Cap

Make the necessary part replacements.

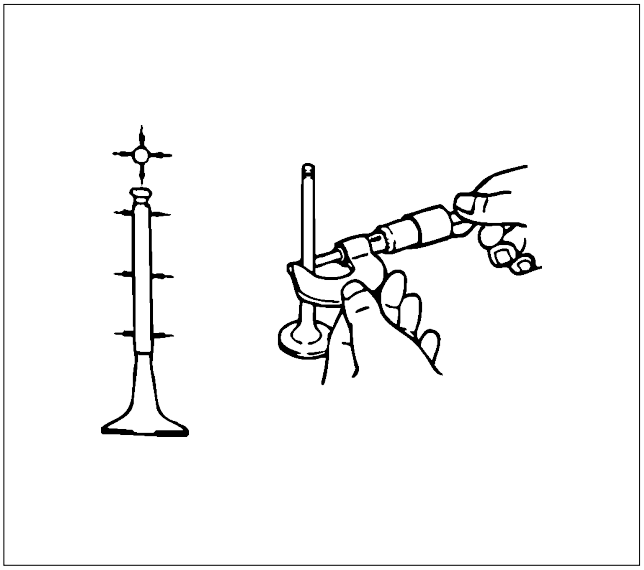
If excessive wear or damage is discovered during inspection.

Valve Stem Outside Diameter

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Outside Diameter		mm (in)
	Intake Valve	Exhaust Valve
Standard	6.955 – 6.970 (0.2738 – 0.2744)	6.939 – 6.949 (0.2732 – 0.2736)
Limit	6.935 (0.2730)	6.920 (0.2724)

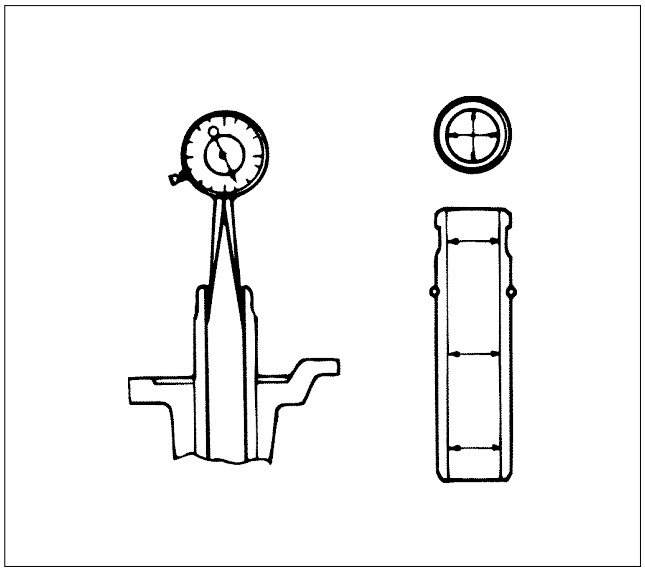


011LX027

Valve Stem and Valve Guide Clearance

1. Measure the valve stem outside diameter.
   Refer to the item “Valve Stem Outside Diameter”.
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.
   If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

Valve Stem Clearance		mm (in)
	Intake Valve	Exhaust Valve
Standard	0.039 – 0.071 (0.0015 – 0.0028)	0.064 – 0.096 (0.0025 – 0.0038)
Limit	0.200 (0.008)	0.250 (0.0098)



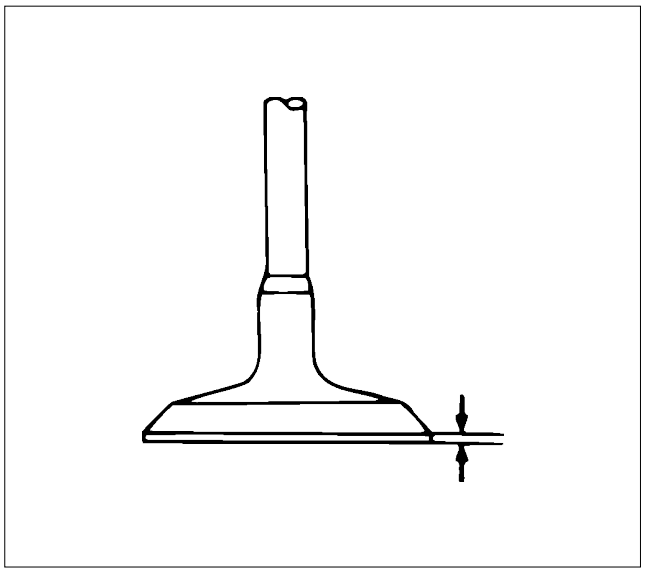
011RY00023

Valve Thickness

Measure the valve thickness.

If the measured value is less than the specified limit, the valve and the valve guide must be replaced as a set.

Intake and Exhasut Valve Thickness	mm (in)
Standard	1.32 (0.052)
Limit	1.1 (0.043)

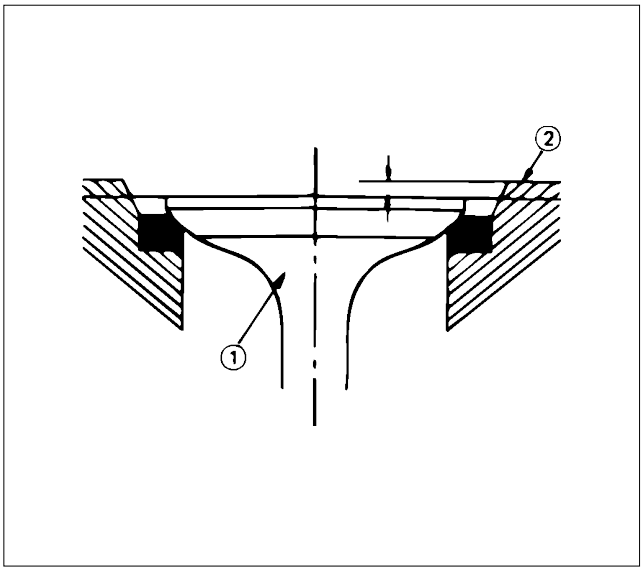


014RY00020

Valve Depression

1. Install the valve (1) to the cylinder head (2).
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Depression	mm (in)
Standard	1.8 (0.07)
Limit	2.5 (0.098)

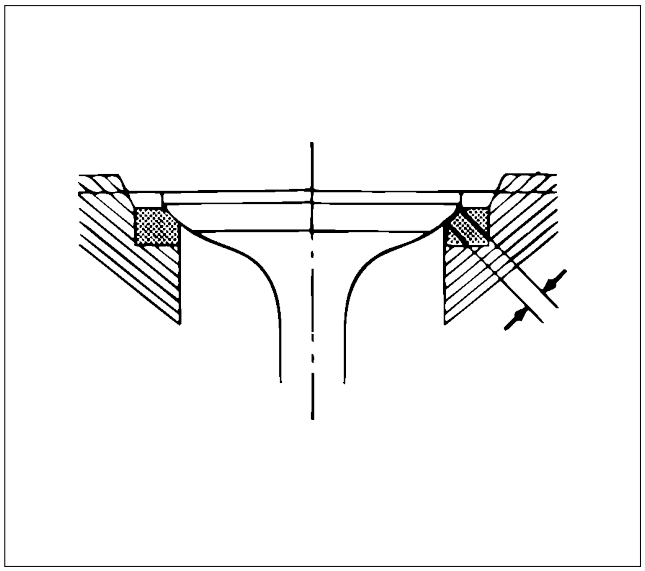


014RY00021

Valve Contact Width

1. Check the valve contact faces for roughness and unevenness. Make smooth the valve contact surfaces.
2. Measure the valve contact width.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

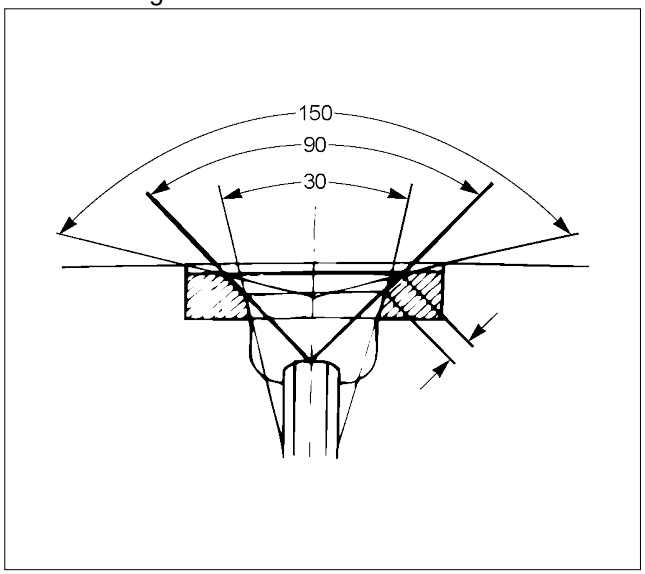
Valve Contact Width		mm (in)
	Intake	Exhaust
Standard	1.7 (0.067)	2.0 (0.079)
Limit	2.2 (0.087)	2.5 (0.098)



014RY00027

Repair of the seat surface

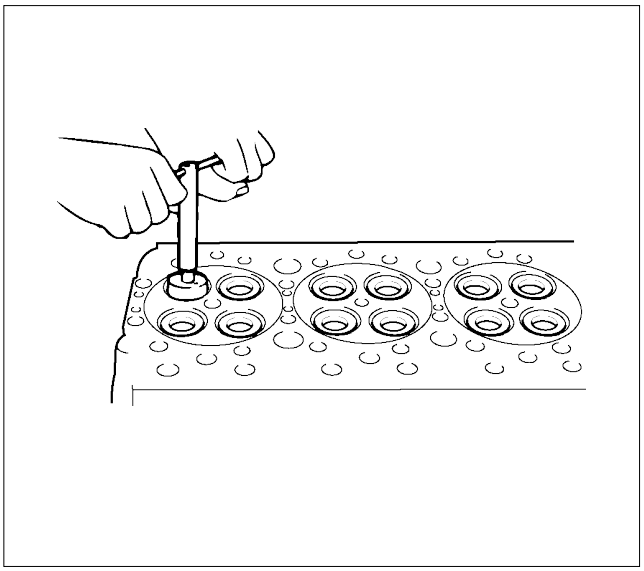
- Remove carbon from the surface of the valve insert seat.
- Use a seat cutter to minimize the scratch and other roughness (15/45/75 degree-blade), thereby returning the contact width to the standard value.



LNW21BSH018201

Note:
Remove only scratches and roughness, and do not cut the surface too much.
Use the free adjustment valve cutter pilot.
Do not let the valve cutter pilot waver inside the valve guide.

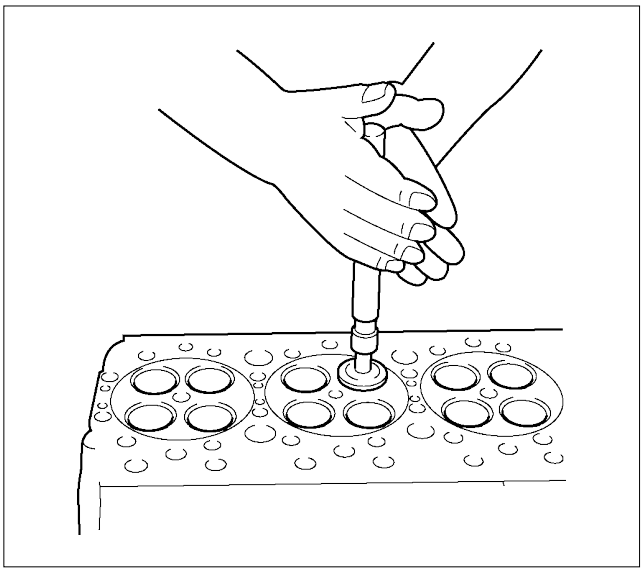
Valve Seat Angle	Degree
45	



LNW21BSH056101

- Attach compound in the valve insert seat.
- Insert the valve into the valve guide.
- Attach compound on the valve seat surface, rotate the valve and hit it lightly to grind it, and confirm that it has even contact all round.

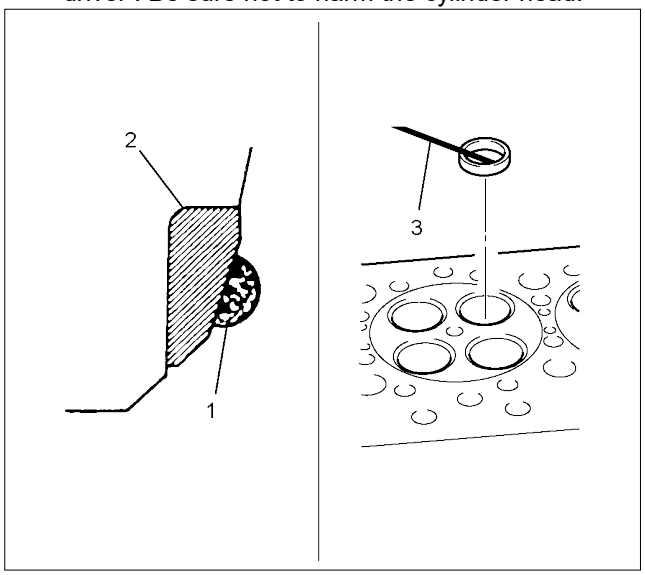
Note:
Remove compound completely after grinding.



LNW21BSH031801

Remove the valve seat insert

- Arc-weld the entire inner diameter of the valve seat insert.
- Cool the valve seat insert for two to three minutes. Contraction due to cooling makes it easier to remove the valve seat insert.
- Remove the valve seat insert, using a screw driver . Be sure not to harm the cylinder head.



LNW21BSH056001

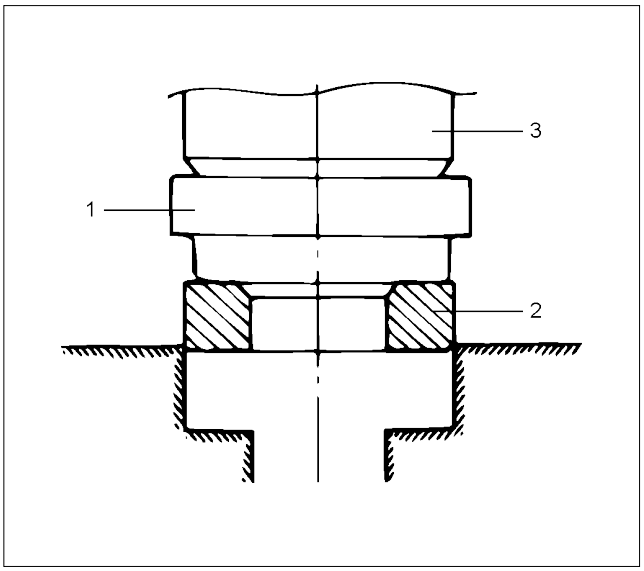
Legend

1. Arc-Weld
2. Valve Seat Insert
3. Screw Driver

Install the valve seat insert

- Carefully place a washer (the outer diameter is smaller than the valve seat insert) on the valve seat insert.
- Use the press to apply pressure gradually on the washer, thereby pushing the valve seat insert.

Note:
Do not apply too much pressure with the press. Attach compound on the valve seat surface, rotate the valve and hit it lightly to grind it, and confirm that it has even contact all round.



LNW21BSH018601

Legend

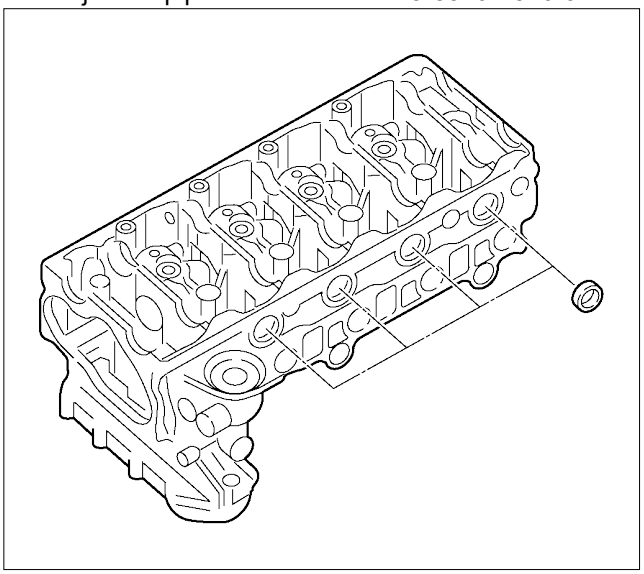
1. Attach Compound
2. Valve Seat
3. Press

Reassembly

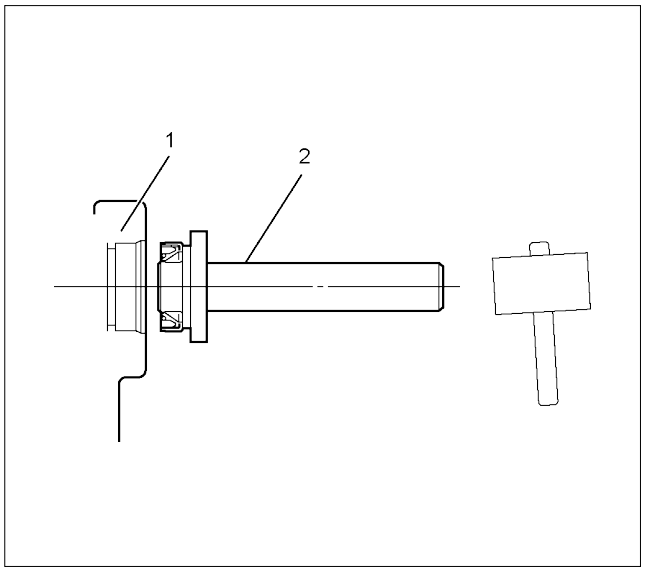
1. Install the oil seal.
   - Install on the surface of the injection pipe insert.
   - Hammer it in so that the seal does not incline.

Note:
Be sure not to harm the lip.

Special tool
Injection pipe oil seal installer: 5-8840-2820-0



RTW56ASH008801



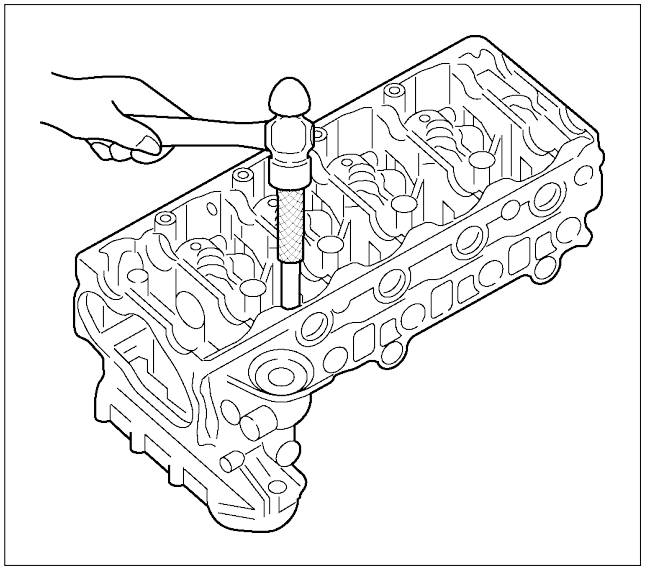
RTW56ASH009101

Legend

1. Cylinder Head
2. Oil Seal Installer

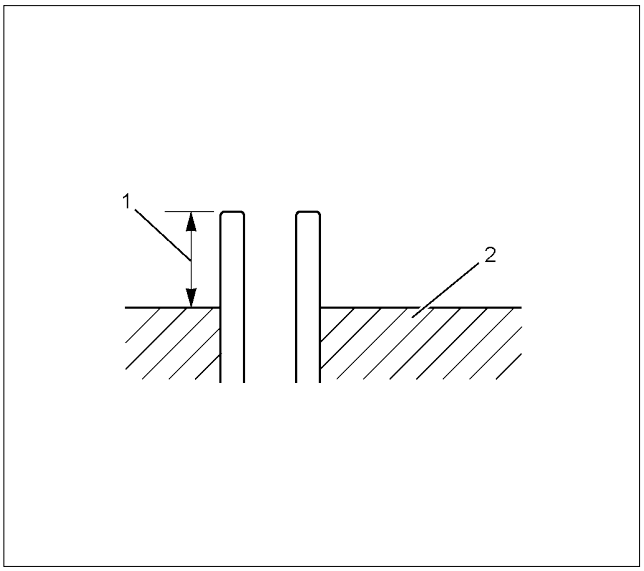
2. Install the valve guide.
   - Hammer in the valve guide from the upper surface of the cylinder head, using the valve guide installer.
     Special tool
     Valve guide remover and installer:
     5-8840-2816-0

Note:
When replacing the valve guide, it must be replaced together with the valve.



RTW56ASH009001

- Height from the upper surface of the cylinder head to the edge surface of the valve guide



RTW56ASH023001

Legend

1. 12.6 ± 0.1 mm (0.50 ± 0.0039 in)
2. Cylinder Head

3. Install the valve spring lower seat.
4. Install the valve stem oil seal.
   - Refer to procedure for valve stem and valve in this manual.
5. Install the intake and exhaust valve.
   - Apply engine oil on the valve stem part and install the valve.
6. Install the valve spring, the valve spring upper seat and the split collar.
   - Refer to procedure for valve stem and valve in this manual.
7. Install the rocker arm and shaft assembly.
   - Refer to procedure for valve stem and valve in this manual.
8. Install the exhaust manifold assembly.
   - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
9. Install the turbocharger.
   - Refer to procedure for Turbocharger and Exhaust Manifold in this manual.
10. Install the intake manifold assembly.
    - Refer to procedure for Intake Manifold in this manual.
11. Install the throttle assembly.
    - Refer to procedure for Intake Manifold in this manual.

Installation

1. Select the cylinder head gasket.

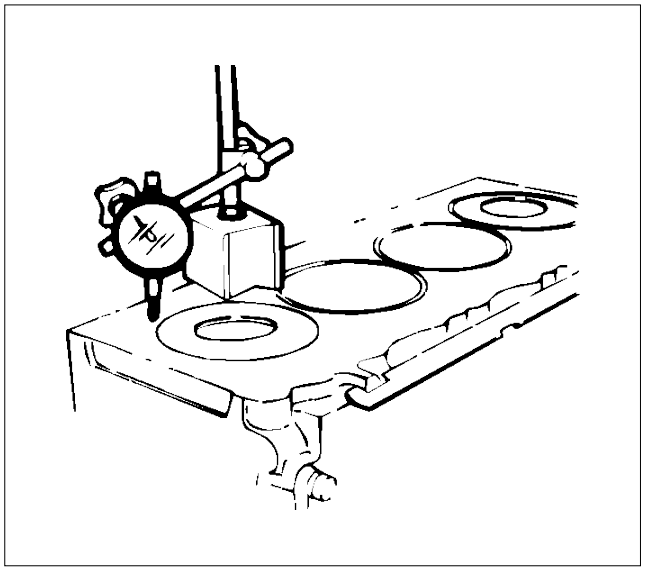
Cylinder Head Gasket Selection

Cylinder head gasket is determined by the piston head projection from the cylinder body upper surface, in order to improve engine performance.

Three types of gasket are provided with difference of thickness. Select the appropriate one out of three grades of

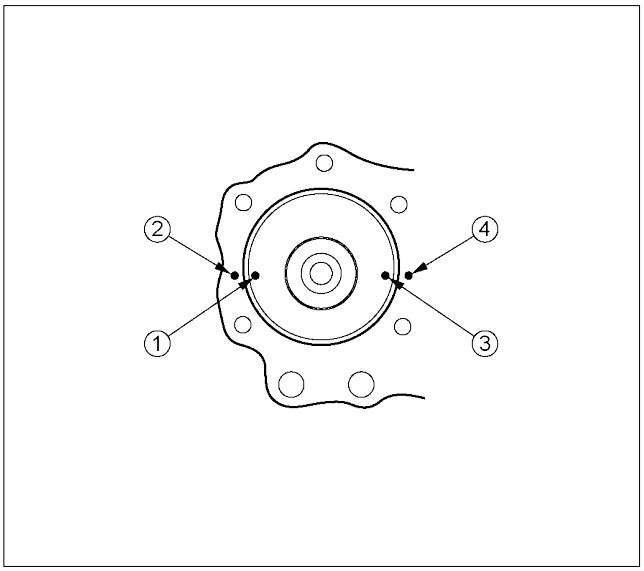
gasket, according to the following procedure.

Before measurement, clear off carbon from the piston head and cylinder body surface and also clean the place where the gasket was installed.



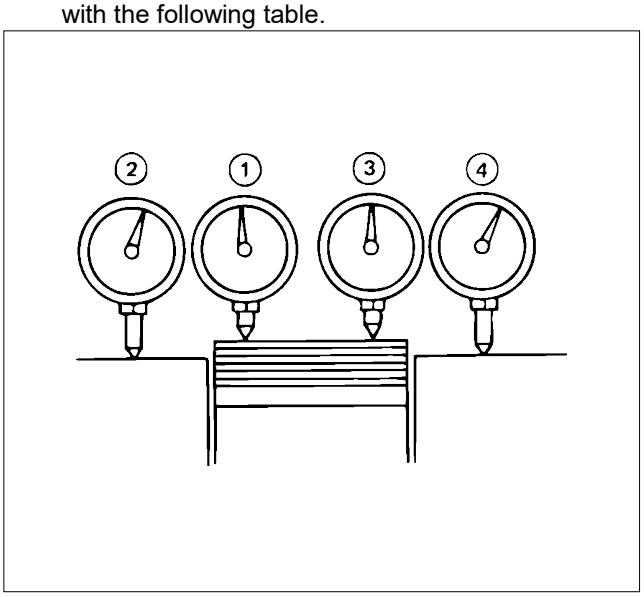
011LX011

1. Use a dial indicator to measure the piston projection amount.
2. Refer to the illustration for the piston head projection measuring positions. All measuring positions should be as close as possible to the cylinder block.



RTW36ASH001701

3. Measure the points 1, 2, 3, 4 and obtain two differences 1-2 and 3-4 on each cylinder. Calculate the average value of the piston head projection on each cylinder.
4. Obtain the maximum value in the four cylinders.
5. Determine the gasket grade required to the maximum value described above in accordance with the following table.

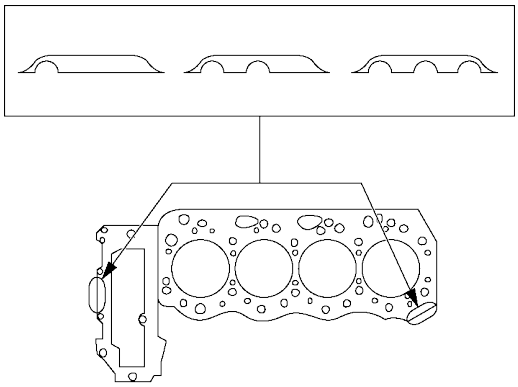


011RY00027

Cylinder Head Gasket Combination mm (in)

Gasket Grade Mark	Piston Projection	Gasket Thickness
A	0.067-0.117 (0.0026-0.0046)	0.95 (0.0374)
B	0.117-0.167 (0.0046-0.0066)	1.00 (0.0394)
C	0.167-0.217 (0.0066-0.0085)	1.05 (0.0413)

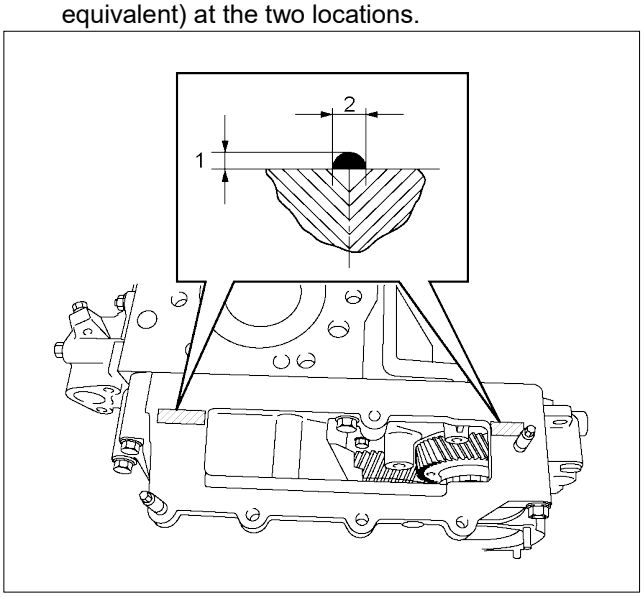
RTW76ASH000301



RTW56ASH009501

Note:
Difference of each piston projection must be equal or within 0.05 mm (0.002 in).

7. Select the gear case gasket.
   - This should be of the same grade as the cylinder gasket.
8. Apply liquid gasket (ThreeBond 1207B or equivalent) at the two locations.



RTW56ASH020901

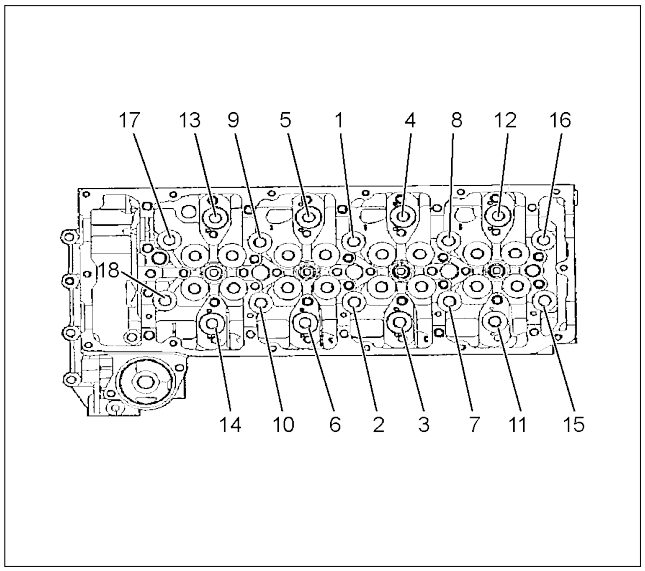
Legend

1. 2 - 3 mm (0.079 - 0.118 in)
2. 3 - 4 mm (0.118 - 0.157 in)

9. Install the cylinder head within 5 minutes application of the liquid gasket.
10. Install the cylinder head.
    - Wipe the cylinder head lower face.
    - Install the cylinder head, adjusting the dowel of the cylinder block.
11. Install the cylinder head bolt.
    - Please use new cylinder head bolt.
    - Use a torque wrench and angle gauge to tighten the head bolts in the order described in the drawing.

Tightening torque:

1st step = 70 N·m (7.1 kg·m / 51 lb ft)
2nd step = 70 N·m (7.1 kg·m / 51 lb ft)
3rd step = 60° (degrees)
4th step = 60° (degrees)

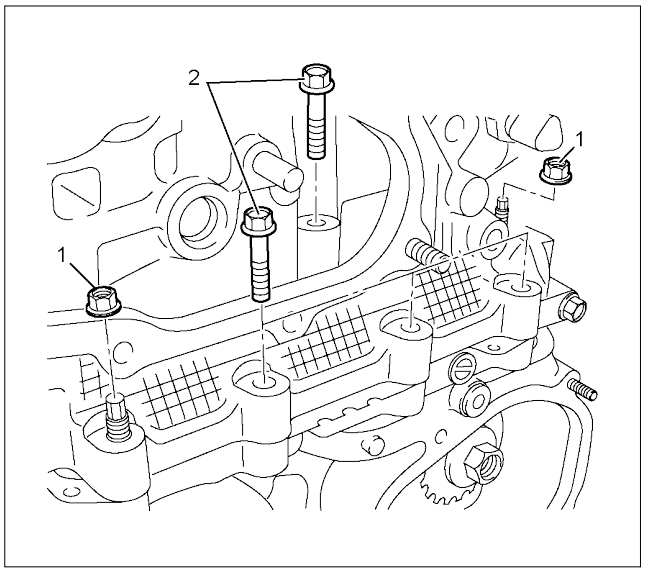


RTW56ASH009701

Special tool
Angle gauge: 5-8840-0266-0

12. Install the cylinder head gear case bolt and nut.
    - Tighten the nuts (1) and bolts (2) to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

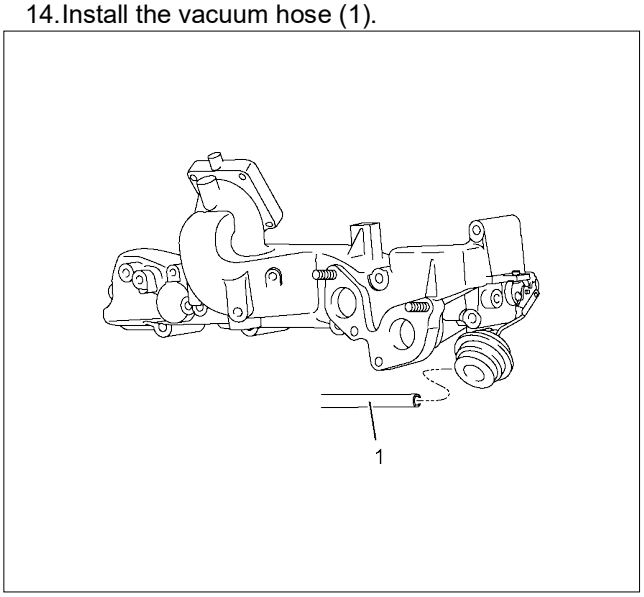


RTW56ASH020801

13. Install the water by pass pipe.
    Apply soapy water to the O-ring.
    Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

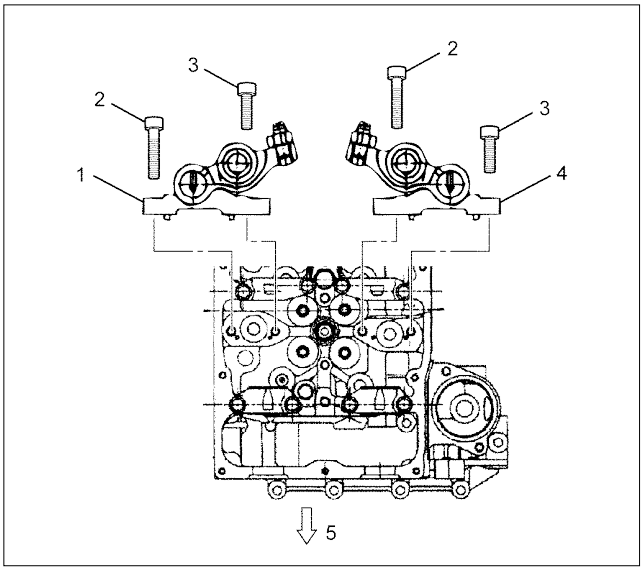
14. Install the vacuum hose (1).



RTW66ASH003101

15. Install the rocker arm shaft assembly.
    - Apply the engine oil.
    - Attach the rocker arm shaft assembly in sequence from No.1 to No.4.

Tightening torque: 21 N·m (2.1 kg·m / 15 lb ft)



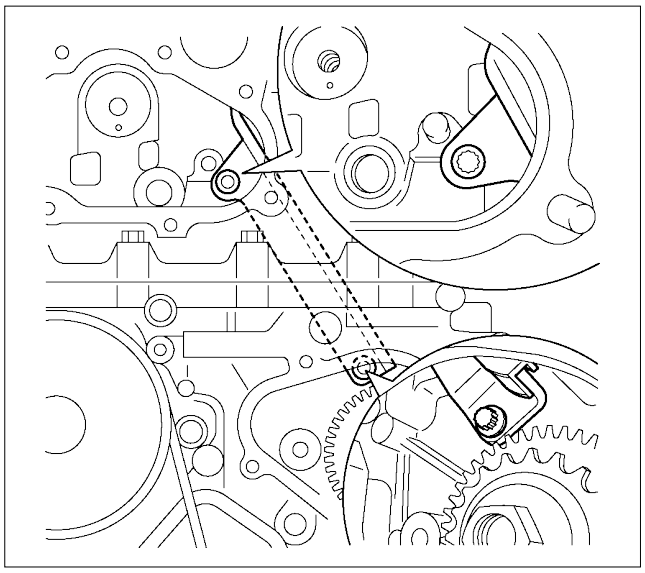
RTW56ASH012201

Legend

1. Exhaust Rocker Arm Shaft Assembly
2. Bolt (Long)
3. Bolt (Short)
4. Intake Rocker Arm Shaft Assembly
5. Front

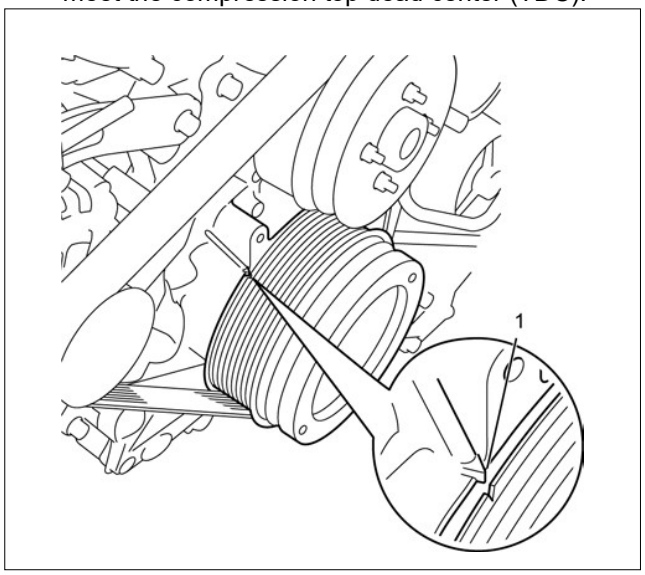
16. Install the chain guide bolt from cylinder head. Tighten the bolt to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m/18 lb ft)



RTW56ASH019501

17. Install the tension lever.
18. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).



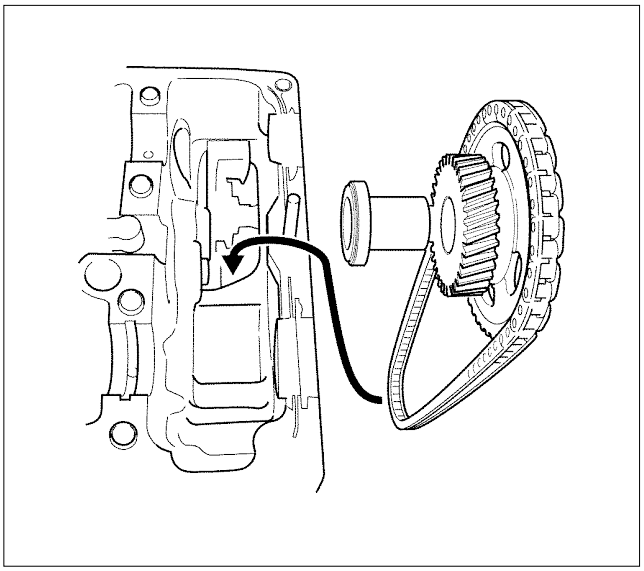
RTW76ASH001301

Legend

1. TDC

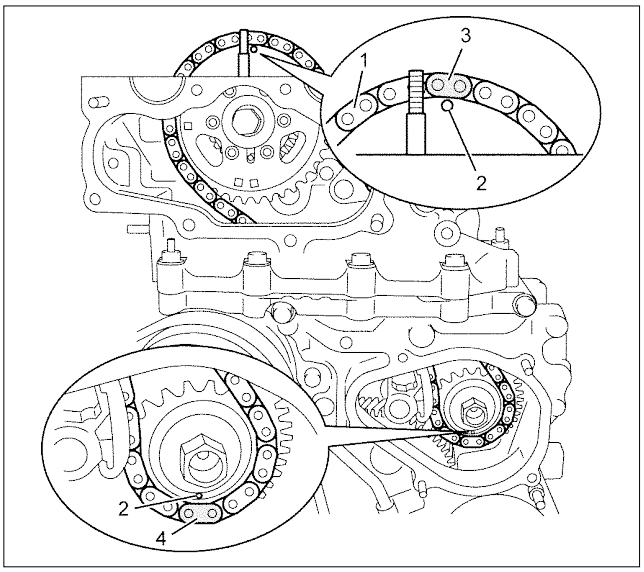
19. Install the timing chain with idle gear D.
    - Apply the engine oil bolt thread and seat.

Tightening torque : 59 N·m (6.0 kg·m/43 lb ft)



RTW56ASH021801

- Align the timing marks at two locations as shown.



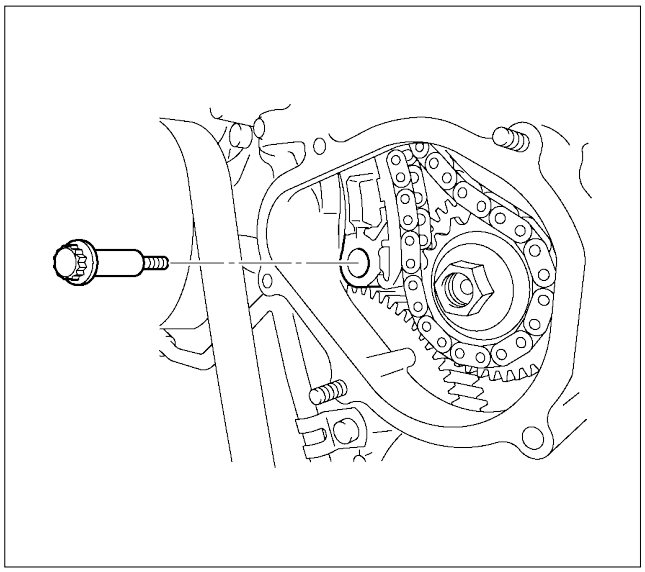
RTW56ASH020301

Legend

1. Timing Chain
2. Timing Mark
3. Blue Link
4. Yellow Link

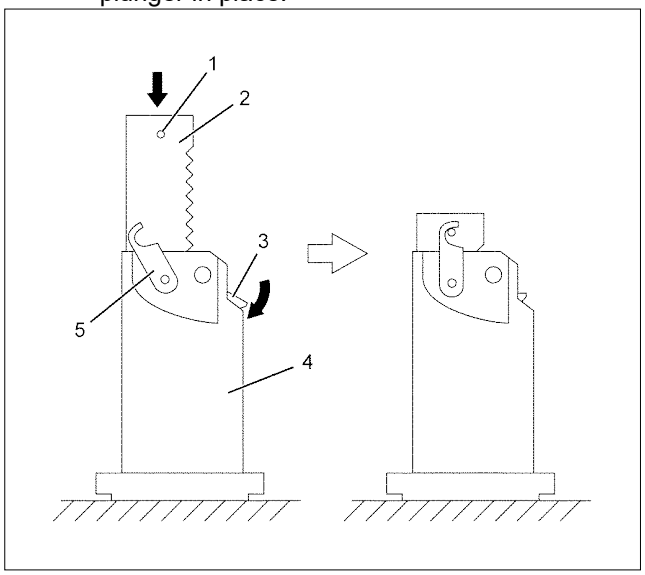
20. Install the timing chain tension lever pivot.
    Tighten the bolt to the specified torque.

Tightening torque: 27 N·m (2.8 kg·m / 20 lb ft)



RTW56ASH019401

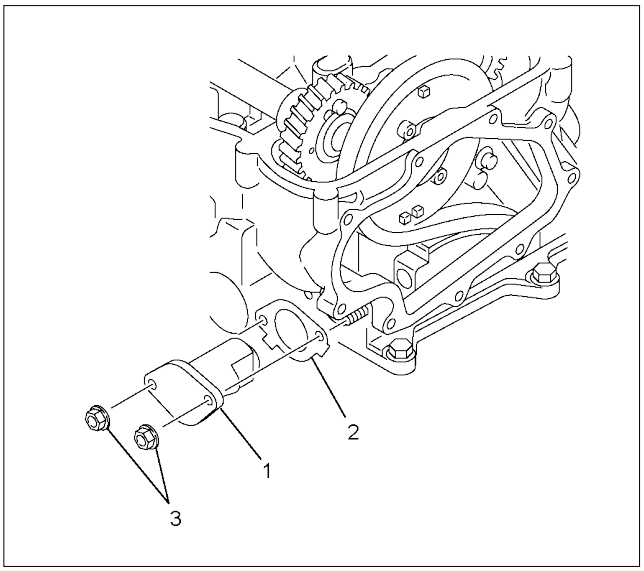
21. Attach the hook of the timing chain tensioner.
    - Hold the latch (3) depressed. Insert the plunger (2). Attach the hook (5) to the pin (1) to hold the plunger in place.



RTW56CSH004401

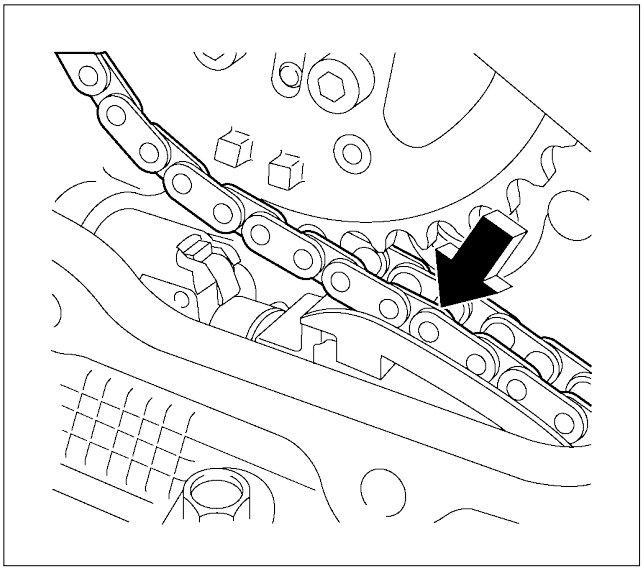
22. Install the timing chain tensioner (1) and the gasket (2).
    Tighten the nuts (3) to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)



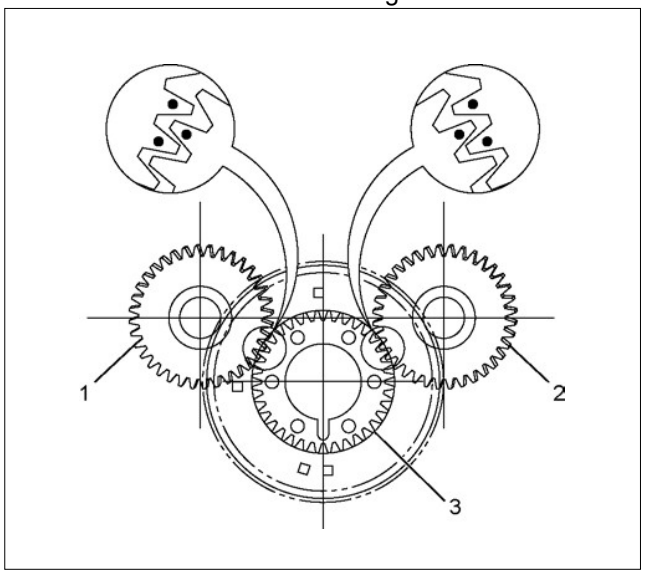
RTW56CSH001701

23. Unlock the tensioner hook.
    - Press the place of the arrow in the figure.
    - The hook is opened. The plunger pushes the tension lever.



RTW56ASH020401

24. Install the camshaft assembly.
    - Align timing mark on intake camshaft and exhaust camshaft to idle gear D.

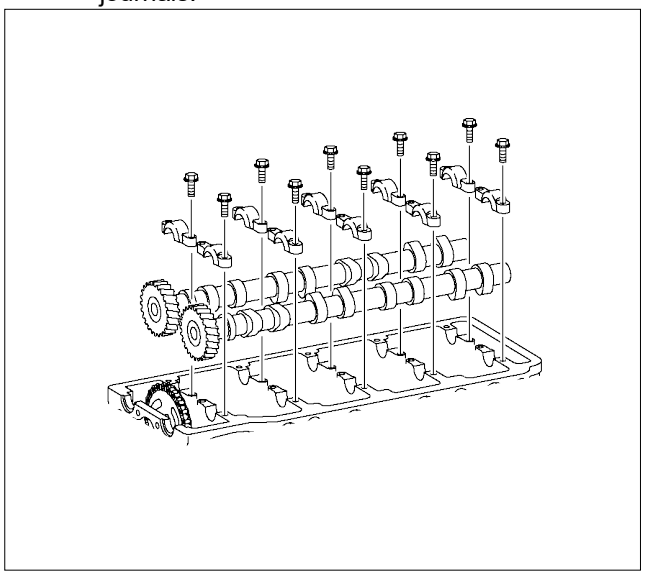


RTW56ASH007001

Legend

1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

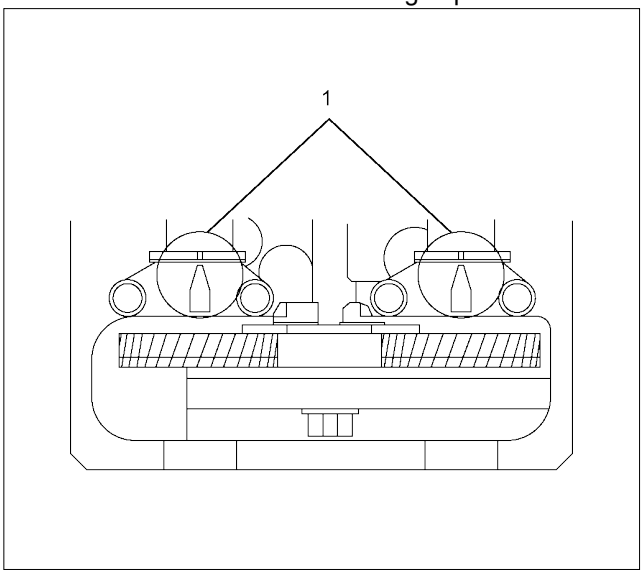
25. Install the camshaft bearing cap.
    - Apply engine oil to all of the cylinder head journals.



RTW56ASH013801

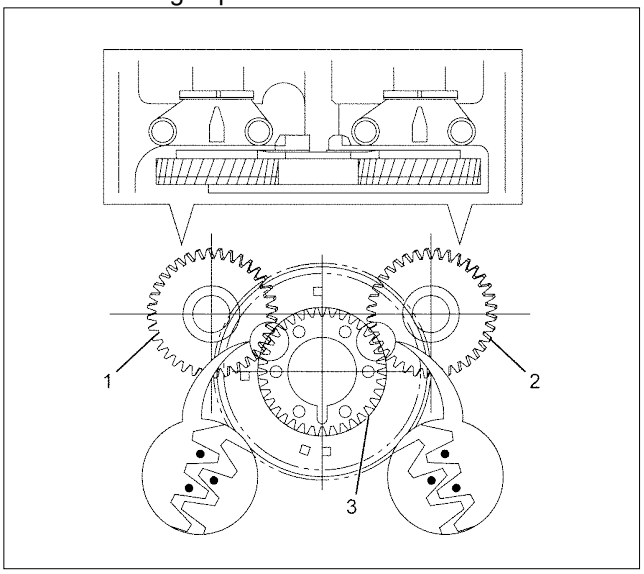
Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)

26. Align mark on camshaft to mark on camshaft bearing cap.
    - Align mark (1) on intake camshaft and exhaust camshaft to mark of bearing cap.



RTW56ASH006901

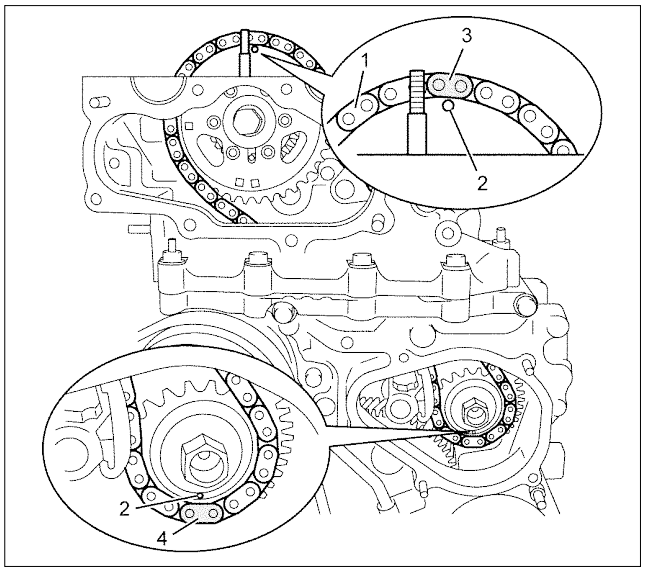
27. Remove the lock bolt from the camshaft gear.
28. Turn the crank pulley two rotation (720°CA).
    - Align mark on camshaft to mark on camshaft bearing cap.



RTW56ASH020701

Legend

1. Exhaust Camshaft Gear
2. Intake Camshaft Gear
3. Idle Gear D

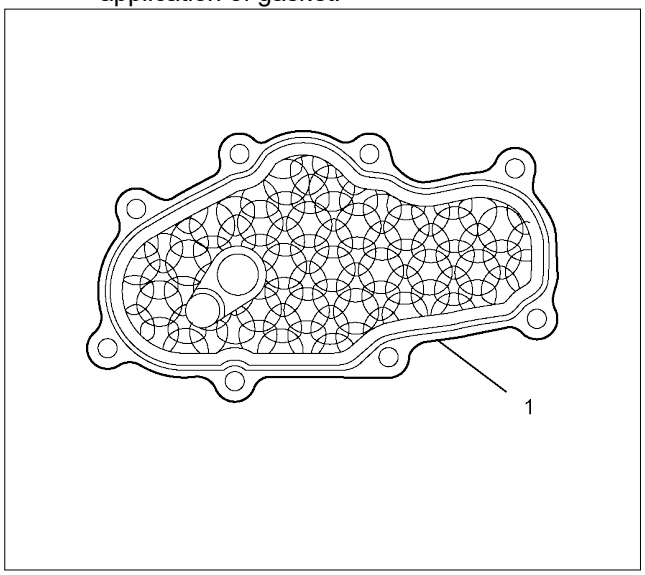


RTW56ASH020301

Legend

1. Timing Chain
2. Timing Mark
3. Blue Link
4. Yellow Link

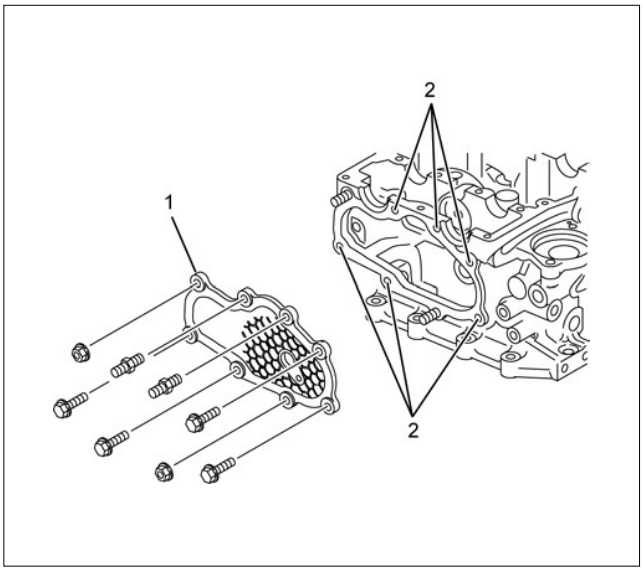
29. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to timing chain cover upper (1).
    - Attach cover within 5minutes after the application of gasket.



RTW56CSH002101

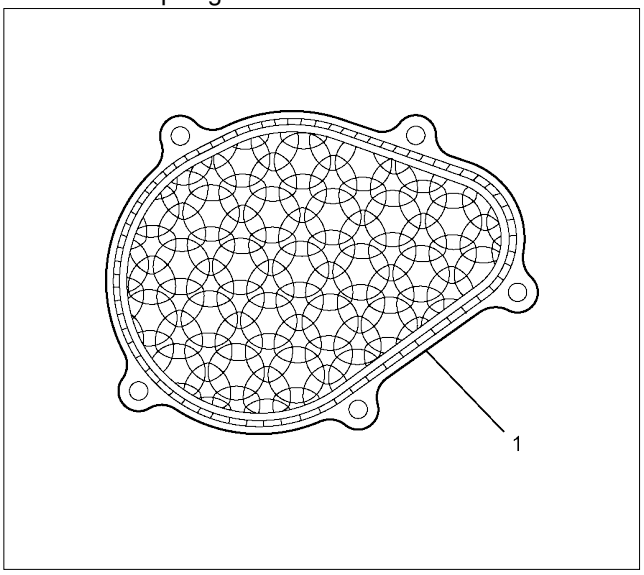
30. Install the timing chain cover upper (1).
    Tighten the bolt to the specified torque.
    - Apply loctite #262 or equivalent to the bolt and stud threads of cylinder side head side (2).

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76CSH001201

31. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to the timing chain cover lower (1).
    - Attach the cover within 5 minutes of applying the liquid gasket.



RTW56CSH002301

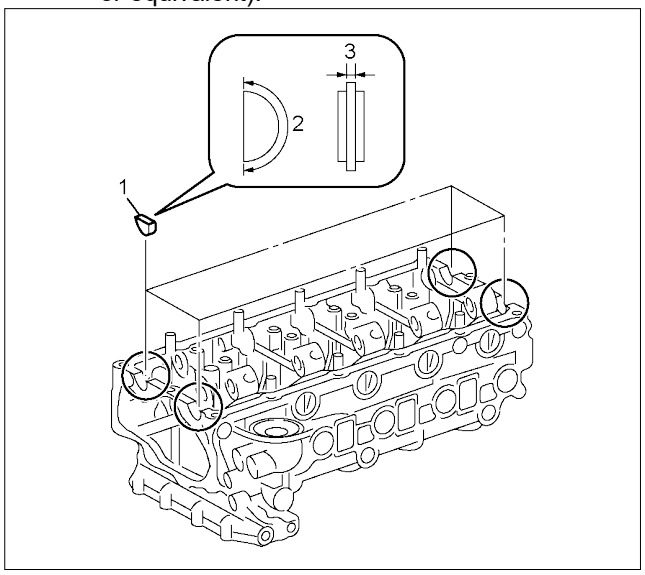
32. Install the timing chain cover lower.
    Tighten the bolts and nuts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

33. Install the noise cover to the timing chain cover lower.
    Tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

34. Inspection / adjustment of valve clearance.
    - Refer to procedure for Service Precautions in this manual.
35. Install the fuel injector.
    - Refer to procedure for Fuel System in this manual.
36. Install the baffle cover.
    - Refer to procedure for Camshaft Assembly in this manual.
37. Install the cam end gasket.
    - Apply the liquid gasket (ThreeBond TB-1207B or equivalent).



RTW56ASH020601

Legend

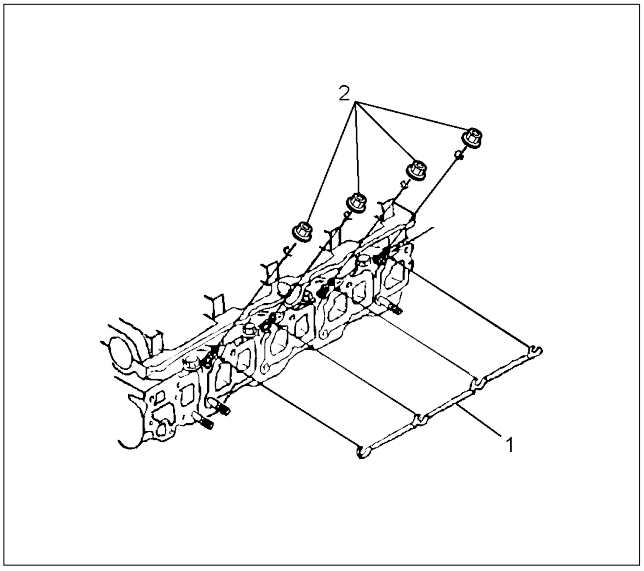
1. Cam End Gasket
2. 2.0 - 3.0 mm (0.078 - 0.118 in)

38. Install the cylinder head cover.
    Refer to procedure for Cylinder Head Cover in this manual.
39. Install the glow plug .
    Tighten the glow plug to the specified torque.

Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)

40. Install the glow plug connector.
    Tighten the nut to the specified torque.

Tightening torque: 2 N·m (0.2 kg·m / 17 lb in)



RTW56ASH010201

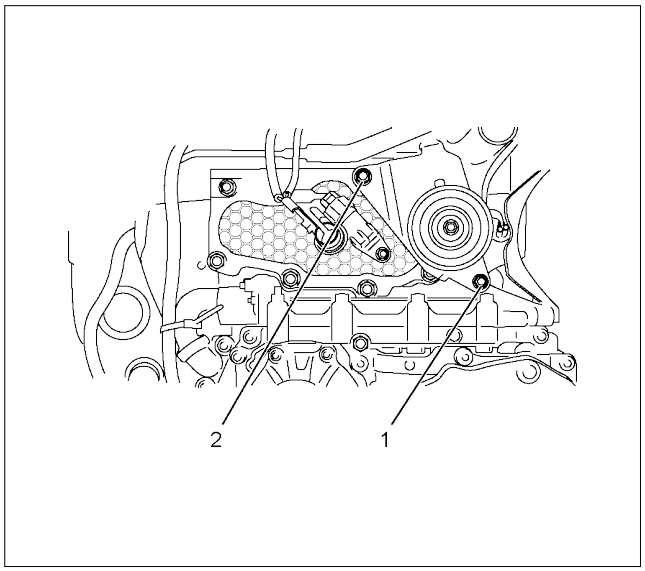
Legend

1. Glow Plug Connector
2. Nut

47. Install the A/C compressor adjust pulley.
    Tighten the bolt and nut to the specified torque.

Tightening torque: bolt 25 N·m (2.6 kg·m/19 lb ft)

Tightening torque: nut 25 N·m (2.6 kg·m/19 lb ft)



RTW56ASH010601

Legend

1. Bolt
2. Nut

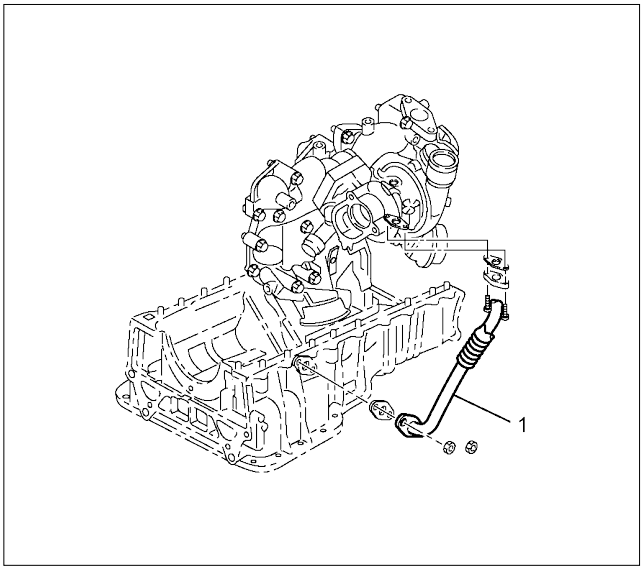
48. Install the A/C compressor and connector.
    Tighten the bolt to the specified torque.

Tightening torque: 44 N·m (4.5 kg·m / 33 lb ft)

49. Connect each connector.
    - Barometric Sensor
    - EGR Valve
    - Glow plug
    - Water temperature sensor
    - Camshaft Position sensor
    - Throttle Assembly

50. Install the turbocharger engine oil return pipe (1).
    Tighten the bolt and nut to the specified torque.

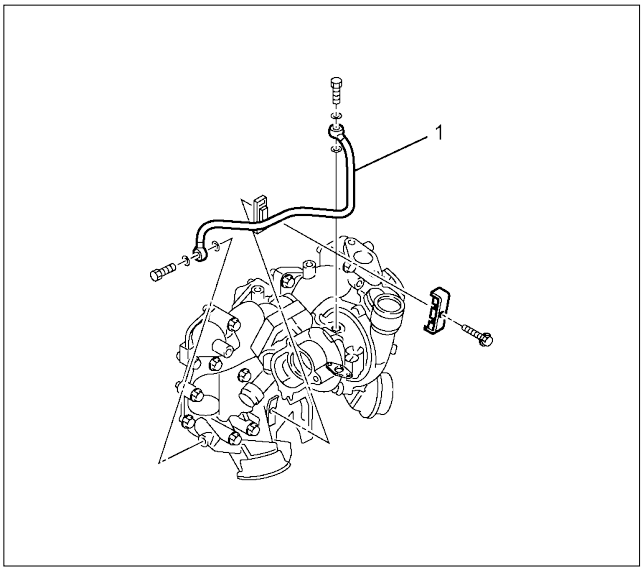
Tightening torque:
nut: 25 N·m (2.6 kg·m/19 lb ft)
bolt: 10 N·m (1.0 kg·m/87 lb in)



RTW56ASH010701

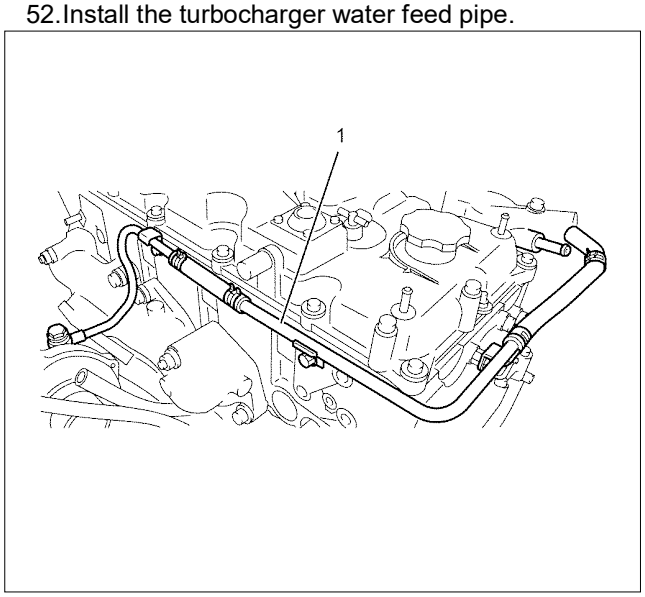
51. Install the turbocharger engine oil feed pipe (1).
    Tighten the bolt to the specified torque.

Tightening torque: bolt 23 N·m (2.3 kg·m/17 lb ft)



RTW56ASH010801

52. Install the turbocharger water feed pipe.

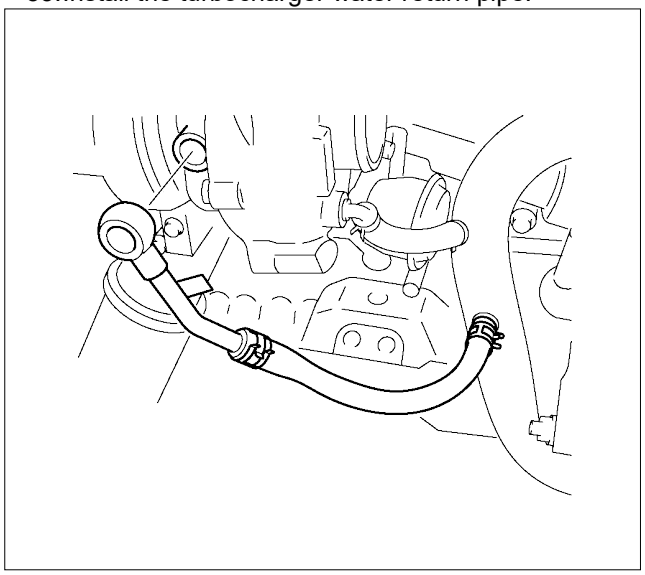


RTW56ASH019101

Legend

1. Turbocharger Water Feed Pipe

53. Install the turbocharger water return pipe.



RTW56ASH019001

Legend

1. Turbocharger Water Return Pipe

54 Install the A/T oil cooler pipe bracket.
Refer to procedure for automatic transmission in this manual.

55. Install the catalyst converter.
Refer to procedure for Turbocharger and Exhaust Manifold in this manual.

56. Connect the front drive shaft. (4×4)
Refer to procedure for front propeller shaft in this manual.

57. Install the exhaust front pipe.
- Refer to procedure for “Exhaust System” in this manual.

58. Install the EGR cooler.
- Refer to procedure for “Exhaust System” in this manual.

59. Install the EGR cooler water pipe.
- Refer to procedure for “Exhaust System” in this manual.

60. Install the EGR cooler heat protector.
- Refer to procedure for “Exhaust System” in this manual.

61. Install the cooling fan.
- Refer to procedure for “Engine Cooling” in this manual.

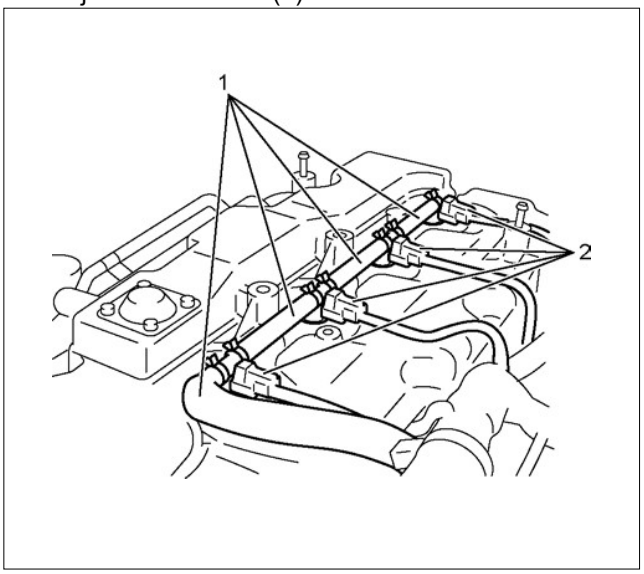
62. Install the A/C drive belt.
- Refer to procedure for “Intake Manifold” in this manual.

63. Install the radiator fan shroud. Upper and lower.

64. Install the radiator upper hose.
- Refer to procedure for engine cooling in this manual.

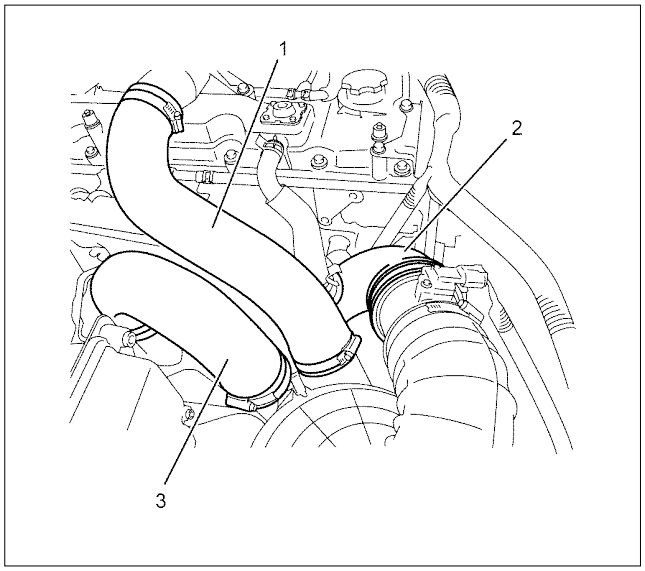
65. Install the harness bracket.

66. Install the fuel leak off hose (1), and the fuel injector connector (2).



RTW76ASH000101

67. Install the intercooler (High output).
    - Install the intercooler.
    - Install the two intake hoses.
    - Connect the BARO sensor harness connector.
68. Install the intake hose.



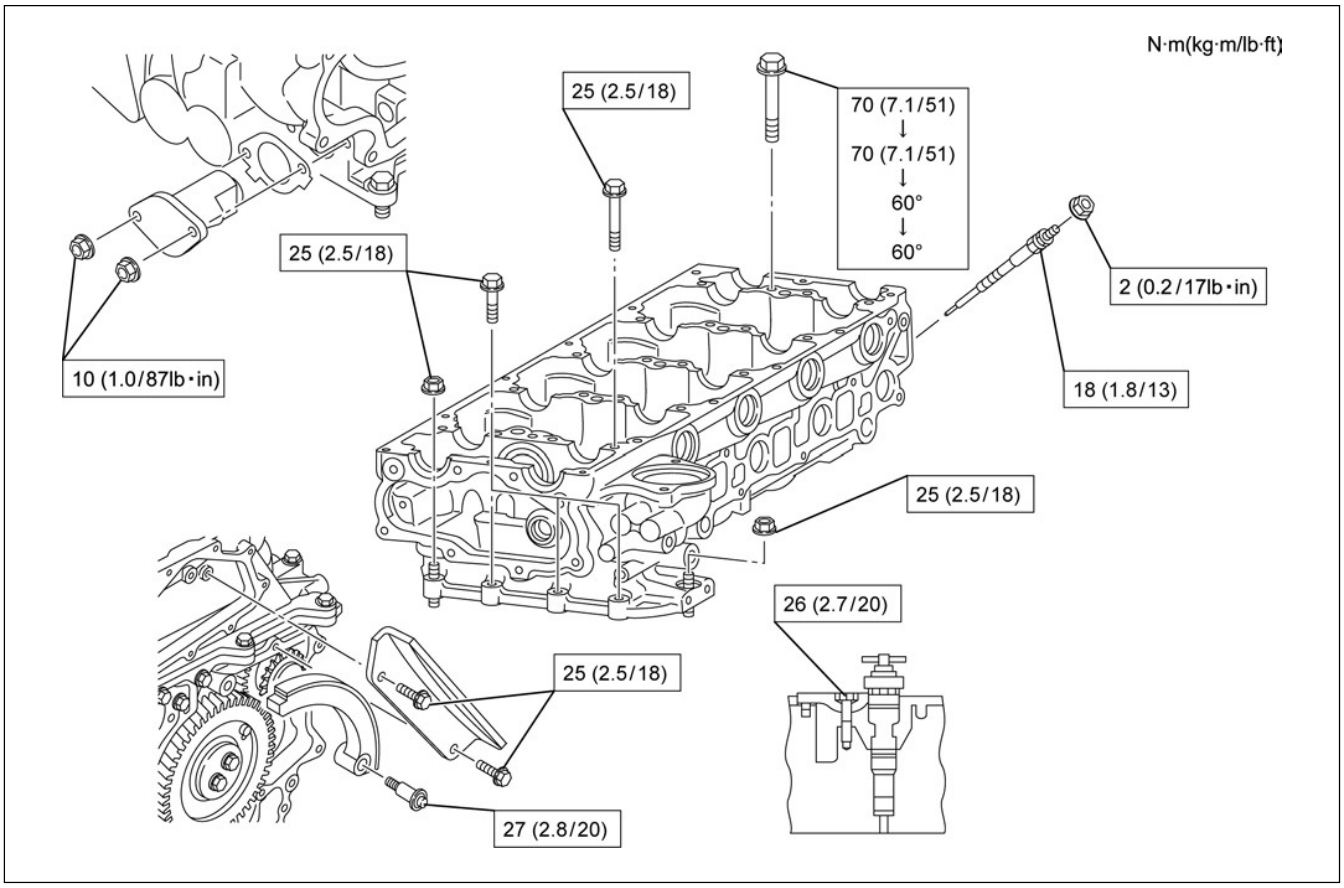
RTW56ASH022501

Legend

1. Intake Hose for Intercooler and Intake Throttle
2. Intake Duct for Turbocharger and Air Cleaner
3. Intake Hose for Turbocharger and Intercooler

69. Install the engine head cover.
70. Replenish the coolant.

Torque Specifications



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Special Tools

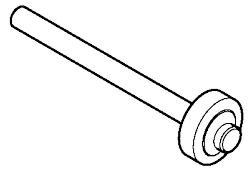
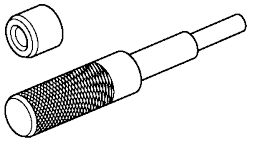
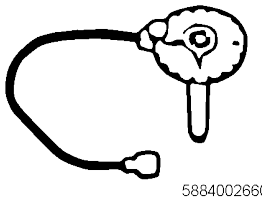
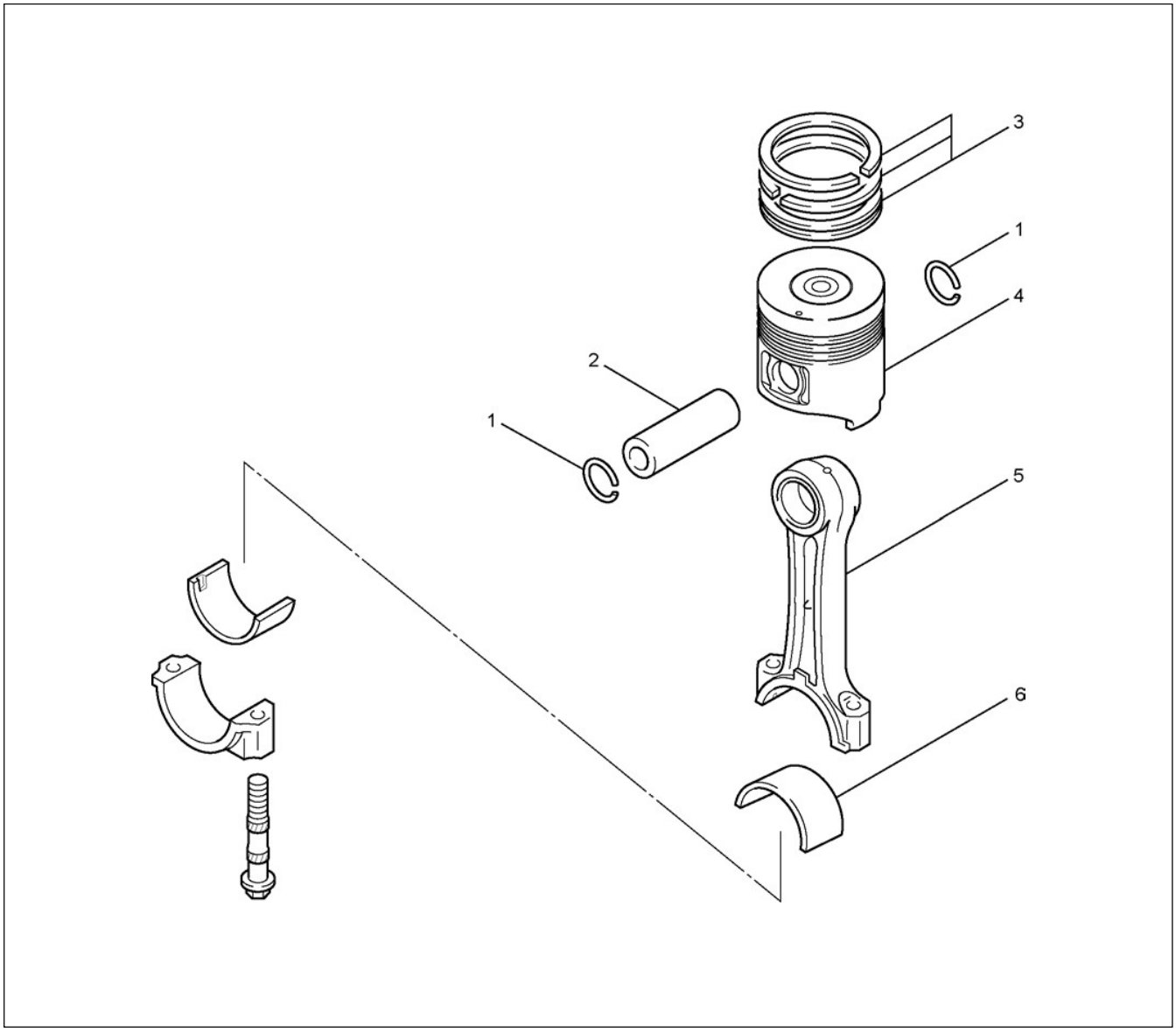
ILLUSTRATION	PART NO. PART NAME
 5884028200	**5-8840-2820-0** Injection pipe oil seal installer
 5884028160	**5-8840-2816-0** Valve guide remover and installer

ILLUSTRATION	PART NO. PART NAME
 5884002660	**5-8840-0266-0** Angle gauge

Piston and Connecting Rod

Components



RTWA56ALF001601

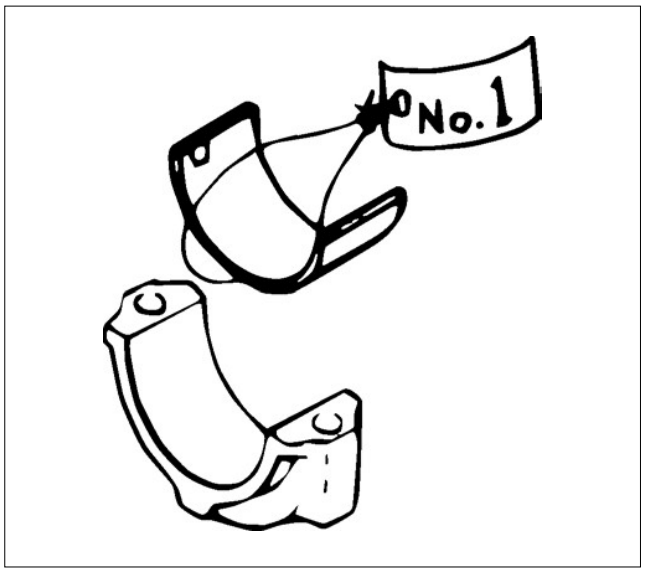
Legend

1. Piston Pin Snap Ring
2. Piston Pin
3. Piston Ring
4. Piston
5. Connecting Rod
6. Bearing

Removal

1. Demount the engine assembly.
   Refer to “Engine Assembly”.
2. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
3. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
4. Remove the cylinder head.
   Refer to “Cylinder Head”.
5. Remove the gear case assembly.
   Refer to “Gear Case Assembly”.
6. Remove the oil pan.
   Refer to “Oil Pan” .
7. Remove the connecting rod cap.

Note:
Sort the removed bearings according to cylinders by using tags.



LNW21BSH004901

8. Remove the piston and connecting rod.
   - Remove carbon on the upper side of the cylinder block with a scraper.
   - Pull out the piston and connecting rod towards the cylinder head.

Note:
Be sure not to damage the oil jet and cylinder block when pushing out the connecting rod.

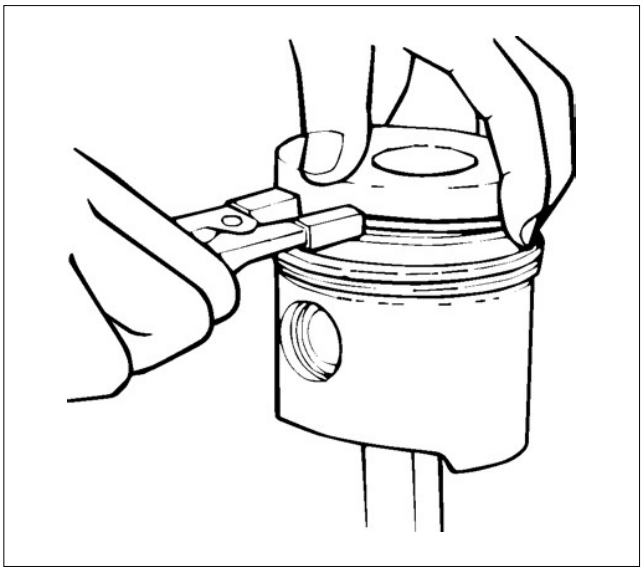
9. Remove the connecting rod bearing.

Note:
Sort the bearings in the order of cylinders when reusing them so that they are not confused with the bearings of other cylinders.

Disassembly

1. Remove the piston ring.
   - Use ring pliers to remove the piston ring.

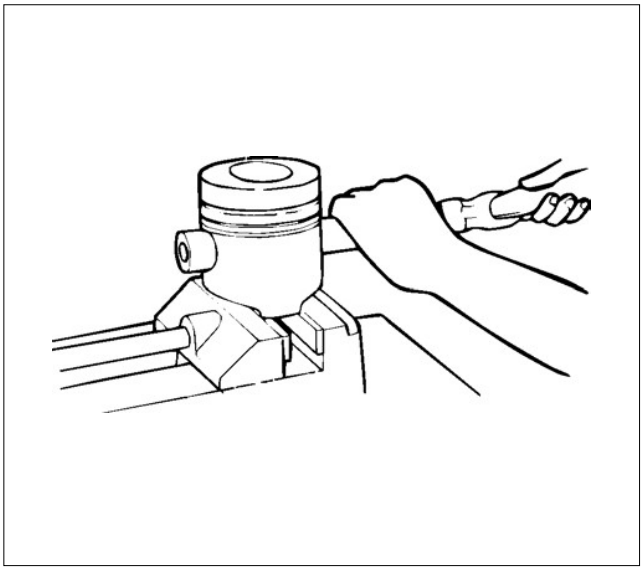
Note:
Sort the piston rings in the same order as the cylinders when reusing them so that they are not confused with the pistons and piston rings of other cylinders.



LNW21BSH005101

2. Remove the snap ring.
3. Remove the piston pin.

Note:
Sort the disassembled piston pins, pistons and connecting rods together in the same order as the cylinders.



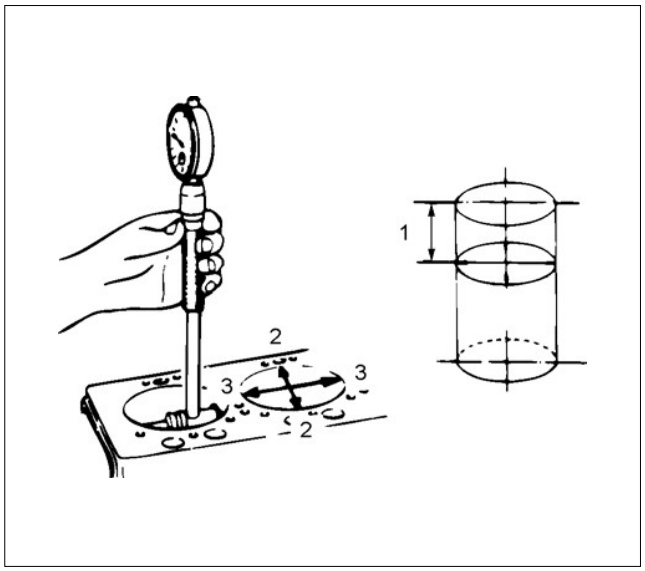
LNW21BSH005201

4. Remove the connecting rods from the piston.
5. Clean the piston.
   - Carefully clean carbon that is adhered to the head of the piston and the groove of the piston ring.

Note:
Do not use a wire brush to clean the piston because it scratches the piston.
Visually inspect the piston for cracks, burns and other excessive wear, and replace it if there is any abnormality.

6. Measure the gap between the piston and the inner diameter of the cylinder block.
   Inner diameter of the cylinder block.
   - Use a cylinder bore dial indicator to measure the cylinder block inner diameter both in the thrust and radial directions in the designated position.
   - Measurement position (from the upper surface of the cylinder block) 20 mm (0.79 in)
   - Measure the cylinder block inner diameter based on the average value of the actual measurement values on 6 positions.

Cylinder block inner diameter	mm (in)
95.421 – 95.450 (3.75673 – 3.75787)	



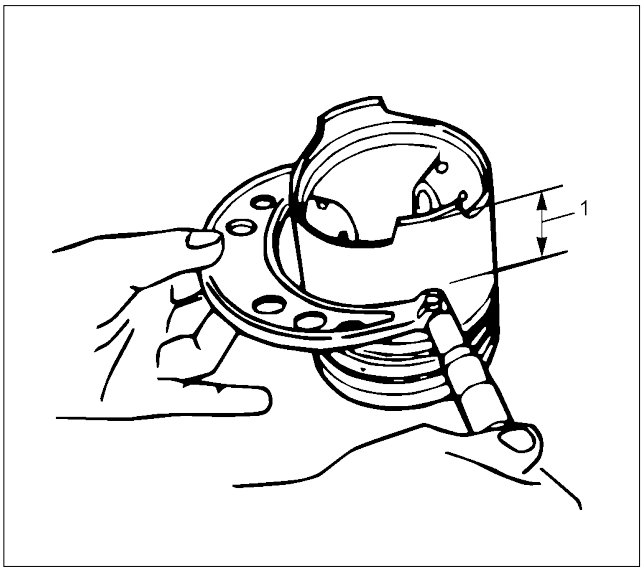
LNW61ASH006401

Legend

1. 20 mm (0.79 in)
2. Radial
3. Thrust

Piston outside diameter

- Use a micrometer to measure the outside diameter of the piston in the right angle to the piston pin in the designated position.
- Measurement position (from the bottom surface of the piston) 11.00 mm (0.43 in).



RTW56ASH023101

Legend

1. 11 mm (0.43 in)

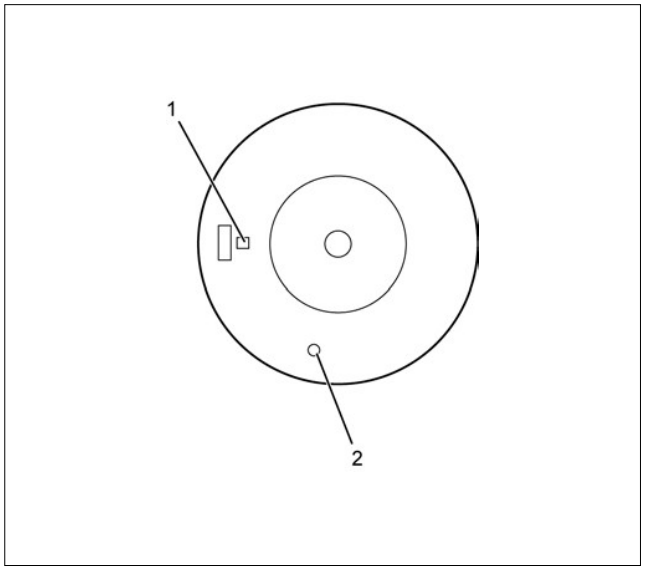
Gap between the piston and the inner diameter of the cylinder block	mm (in)
Standard	0.082 – 0.100 (0.0032 – 0.0039)

NOTE:
If the gap exceeds the standard value, replace the piston or rebore the cylinder block.

7. Piston replacement
   - The head of piston has a marking of grade A, B or C.
   - Refer to “Cylinder Block” if over size piston is installed.

Piston Grade (Service Part)	mm (in)
A	95.330 – 95.339 (3.75314 – 3.75350)
B	95.340 – 95.349 (3.75354 – 3.75389)
C	95.350 – 95.359 (3.75393 – 3.75428)

4JK1

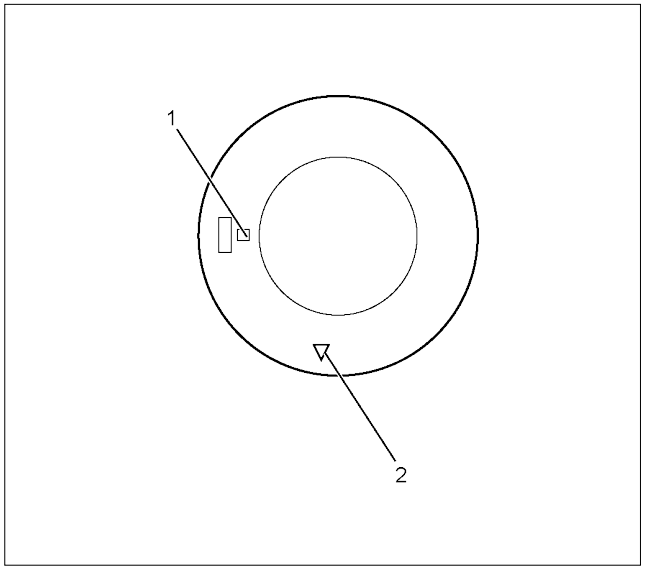


RTW56ASH025701

Legend

1. Grade
2. Front Mark Cut

4JJ1

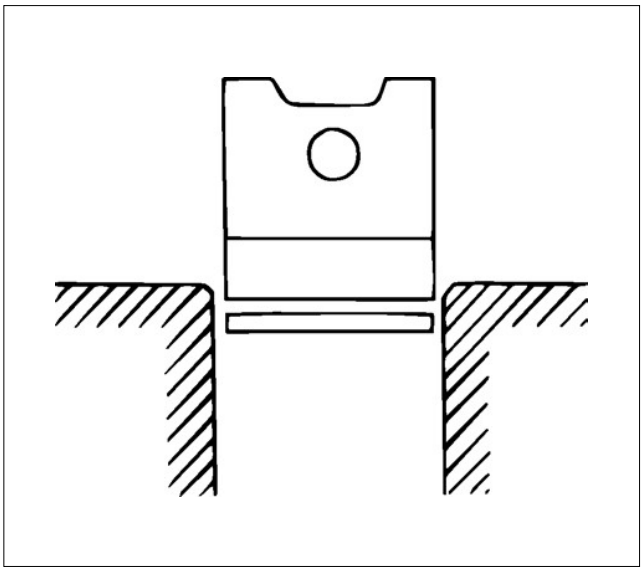


LNW76ASH001401

Legend

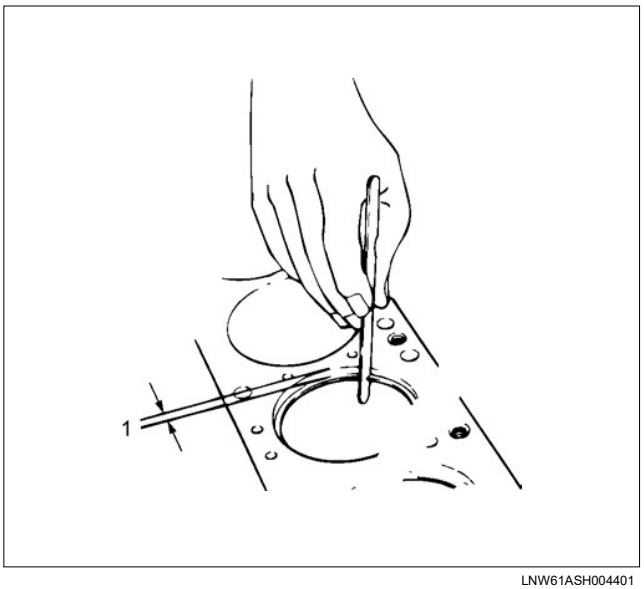
1. Grade
2. Front Mark Cut

8. Inspect the piston ring.
   - Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder block.



LNW21BSH009301

- Push the piston ring into the cylinder bore until it reaches the measuring point 1 or 2 where the cylinder block bore is the smallest.
  Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.
  Measuring Point 1 10 mm (0.4 in)
  or
  Measuring Point 2 120 mm (4.7 in).



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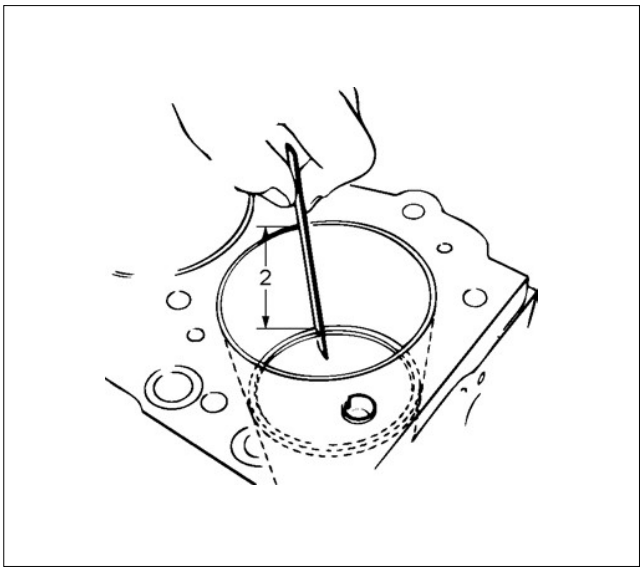


LNW61ASH004501

- Use a thickness gauge to measure the piston ring gap.
  If the measured value exceeds the specified limit, the piston ring must be replaced.

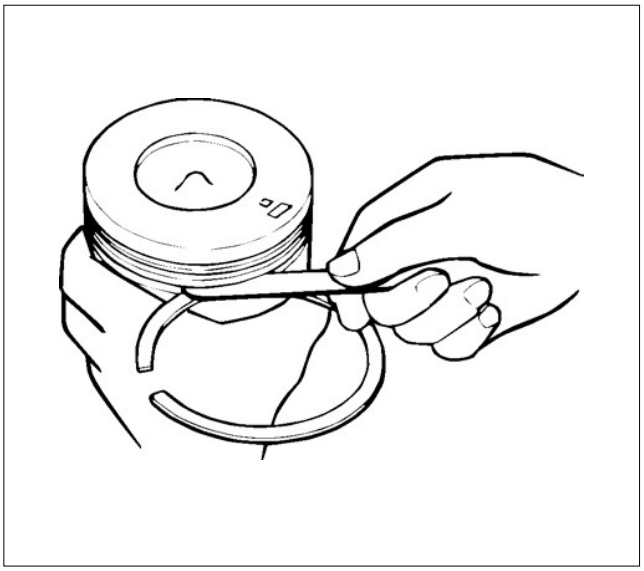
Piston ring gap		mm (in)
	Standard	Limit
1st compression ring	0.3 - 0.5 (0.0118 - 0.0197)	1.50 (0.059)
2nd compression ring	0.3 - 0.5 (0.0118 - 0.0197)	1.50 (0.059)
Oil ring	0.25 - 0.45 (0.0098- 0.0177)	1.50 (0.059)

Measure the clearance between the piston ring groove and the piston.

- Remove carbon in the piston ring groove.
- Put the piston ring in the piston ring groove, use a thickness gauge to measure the gap between them.
- If the clearance between the piston ring groove and the piston exceeds the limit, replace the piston and the piston ring.

Piston ring and piston ring groove clearance		mm (in)
	Standard	Limit
1st compression ring	— *	— *
2nd compression ring	0.05 - 0.09 (0.0020 - 0.0035)	1.50 (0.059)
Oil ring	0.03 - 0.07 (0.0012- 0.0028)	1.50 (0.059)

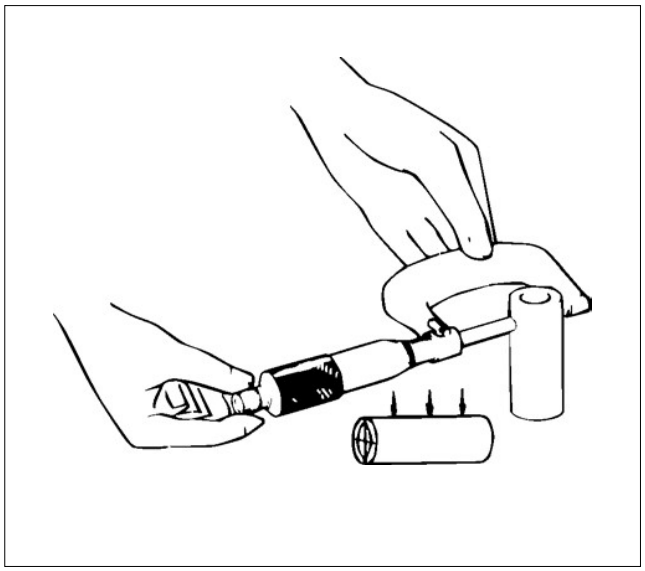
* Measurement is impossible



LNW21BSH009501

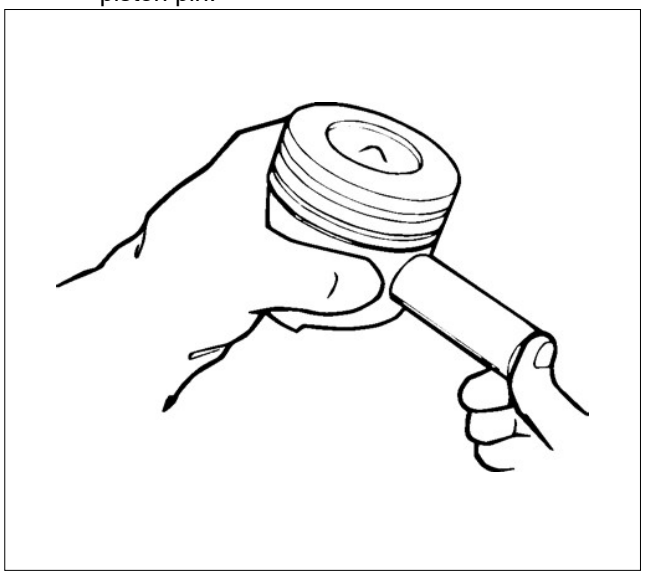
9. Inspect the piston pin.
   - Visually inspect the piston pin for cracks, scratches and other damage, and replace it if necessary.
   - Use a micrometer to measure the outer diameter of the piston pin. If the measured value exceeds the limit, replace the piston pin.

Piston pin outer diameter	mm (in)
Standard	33.995 – 34.000 (1.33838 – 1.33858)
Limit	33.970 (1.33740)



LNW21BSH009601

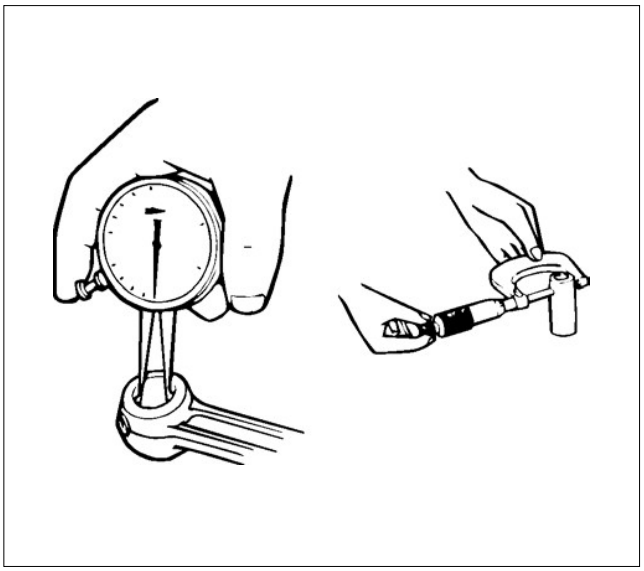
- Inspect to make sure that there is a resistance to the extent which the piston can push the piston pin lightly in normal temperatures.
- If it feels a large looseness or instability in normal temperatures, replace the piston or piston pin.



LNW21BSH009701

- Measure the bush of the small edge of the connecting rod. If the clearance of the bush inner diameter and the pin diameter exceeds the limit, replace the bush or connecting rod assembly, and the pin.

Piston pin and connecting rod small end bushing clearance	mm (in)
Standard	0.008 - 0.020 (0.0003 - 0.0008)
Limit	0.05 (0.0020)



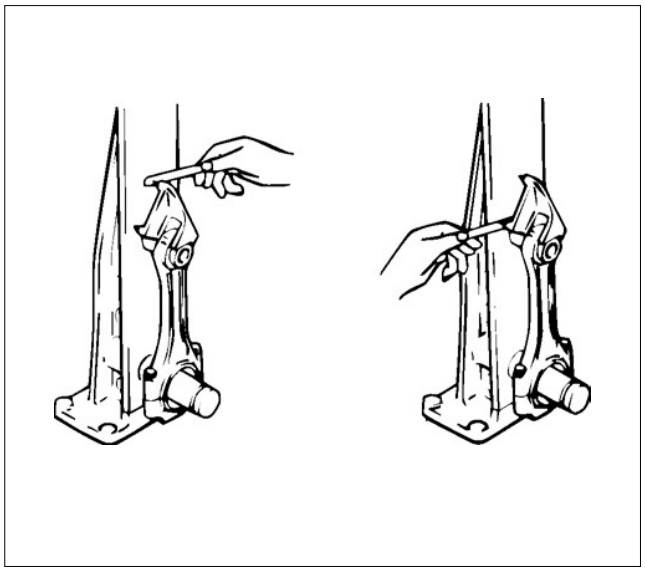
LNW21BSH009801

10. Measure the clearance between the piston and the piston pin.
    - Apply engine oil on the piston pin. Use your finger to push it in the piston hole and rotate it. If the pin smoothly rotates without instability, the clearance is normal. If there is instability, measure the clearance. If the clearance exceeds the limit, replace the piston and the piston pin.

Piston pin and piston pin hole clearance	mm (in)
Standard	0.004 - 0.017 (0.0002 - 0.0007)
Limit	0.04 (0.0016)

11. Measure the connecting rod alignment.
    - Use a connecting rod aligner to measure the torsion and parallel level of the big end hole and the small end hole. If the measured value exceeds the limit, replace it.

Connecting rod alignment (par length of 100 mm (3.94 in))		mm (in)
	Standard	Limit
Distortion	0.08 (0.003) or less	0.20 (0.008)
Parallelism	0.05 (0.002) or less	1.50 (0.060)



LNW21BSH010401

12. Measure the bearing oil clearance.
    - Install the bearing to the connecting rod big end.
    - Tighten the bearing cap to the two step of angular tightening method.
    - Use an inside dial indicator to measure the connecting rod bearing inside diameter.

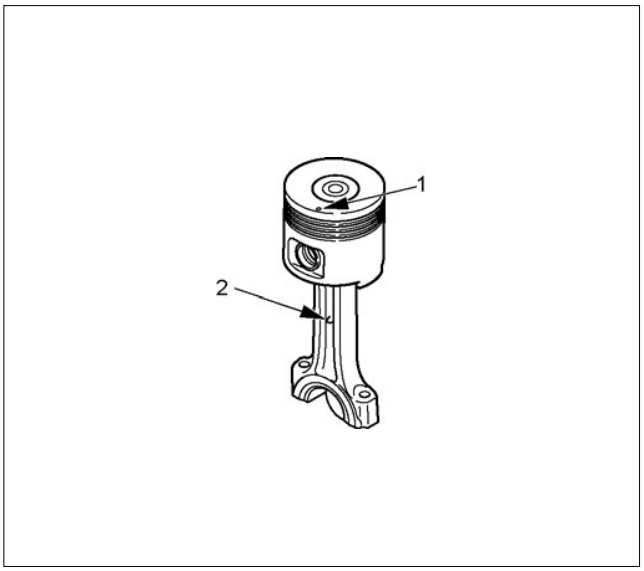
Connecting rod bearing cap bolt torque: N·m (kg·m / lb ft)	
1st step	29.4 (3.0 / 22)
2nd step	45 deg

If the clearance between the measured bearing inside diameter and the crankpin exceeds the specified limit, the bearing and/or the crankshaft must be replaced.

Crankpin and bearing clearance	mm (in)
Standard	0.029 - 0.083 (0.0011 - 0.0033)
Limit	0.10 (0.0039)

Reassembly

1. Install the piston.
2. Install the connecting rod.
    - Install it so that the front mark of the head of the piston, and the connecting rod forging mark (projecting) on the connecting rod, both face in the same direction.
    - Install the snap ring of one side.



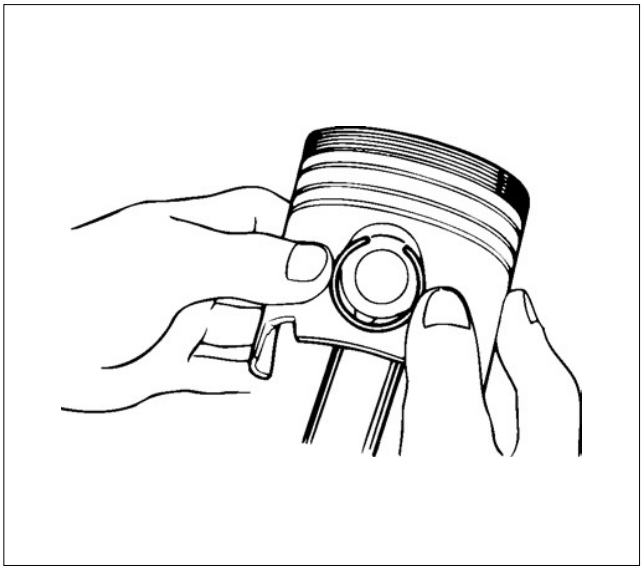
LNW46ASH004601

Legend

1. Front Mark
2. Forging Mark (Projecting)

4. Apply enough engine oil on the piston pin, push it in the piston and the connecting rod small edge.
5. Use snap ring pliers to install the snap ring.

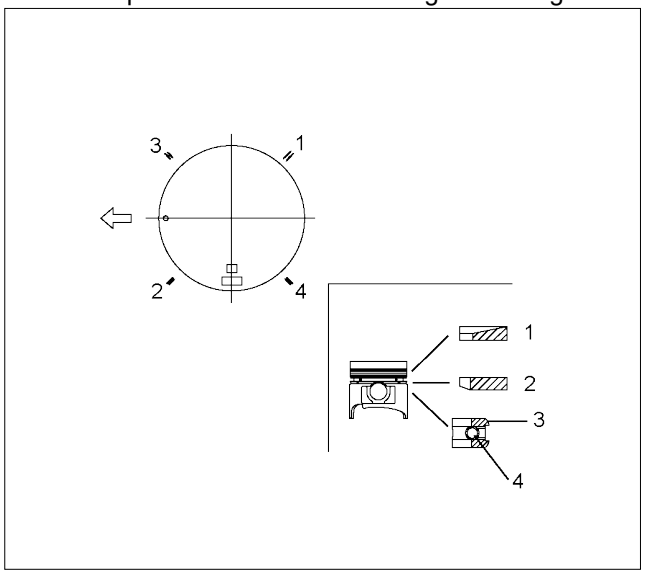
Note:
Make sure that the snap ring is installed in the ring groove properly. Make sure that the connecting rod moves smoothly.



015R100001

6. Use ring pliers to install the piston ring.
    - Install the piston rings in the order shown in the illustration.
    - Install 2nd and 1st compression rings in this order so that the marks “2N” and “N” face upward.

- Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.



RTW56ASH023201

Legend

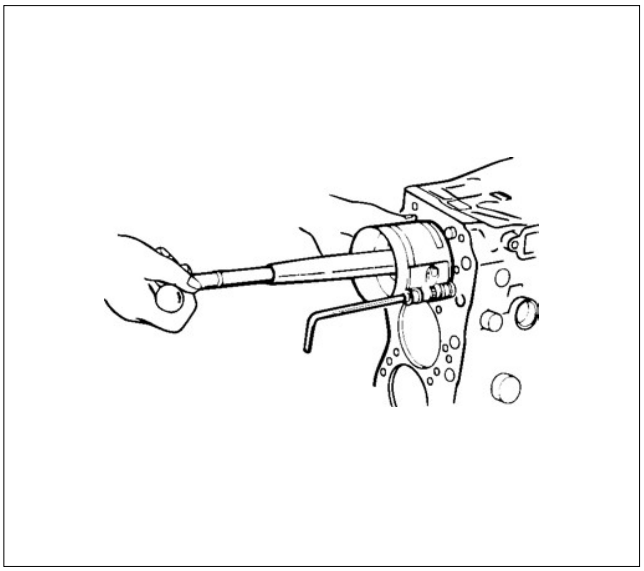
1. Compression Ring 1st
2. Compression Ring 2nd
3. Oil Ring
4. Expander

Installation

1. Install the connecting rod bearing.
   - Install the bearing on the connecting rod, and apply engine oil on the bearing.
2. Install the piston and connecting rod assembly.
   - Apply enough engine oil on the piston ring, ring groove and piston side surface.
   - With the piston front mark cut facing forward, use the piston ring compressor to insert the piston in the cylinder block.

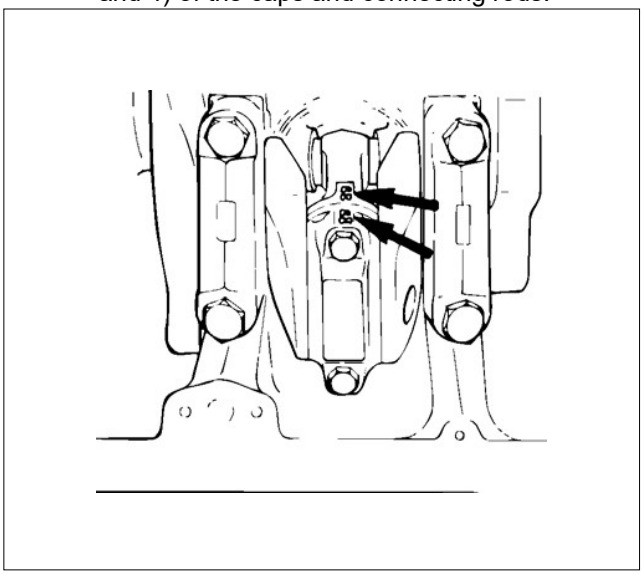
Note:

- Be sure not to make the connecting rod touch the oil jet when pushing in the piston.
- Be sure not to harm the inside of the cylinder block when pushing in the piston.
  Special tool
  Piston ring compressor: 5-8840-9018-0



015LX096

3. Install the connecting rod cap.
   - Install the bearing on the connecting rod cap and apply engine oil.
   - Install the cap, matching the numbers (1, 2, 3, and 4) of the caps and connecting rods.



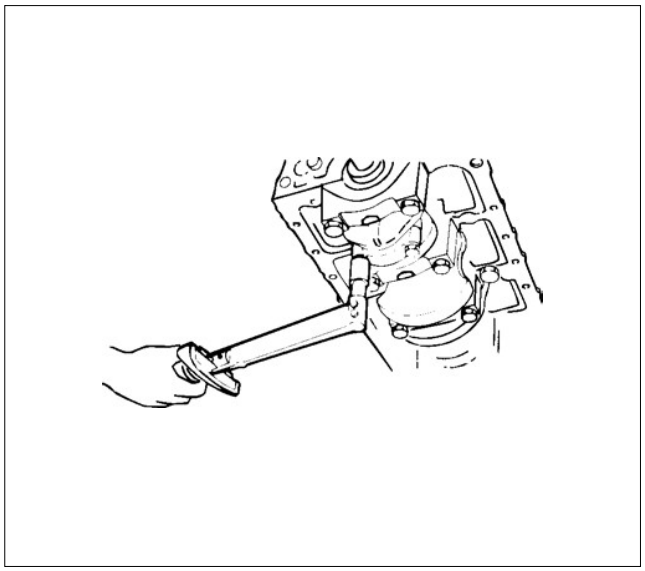
015R100007

- Apply engine oil disulfide on the screw part and the setting face of the tightening bolt and tighten it with the designated torque.

Tightening torque:
1st step = 29 N·m (3.0 kg·m / 22 lb ft)
2nd step = 45° (degrees)

Special tool
Angle gauge: 5-8840-0266-0

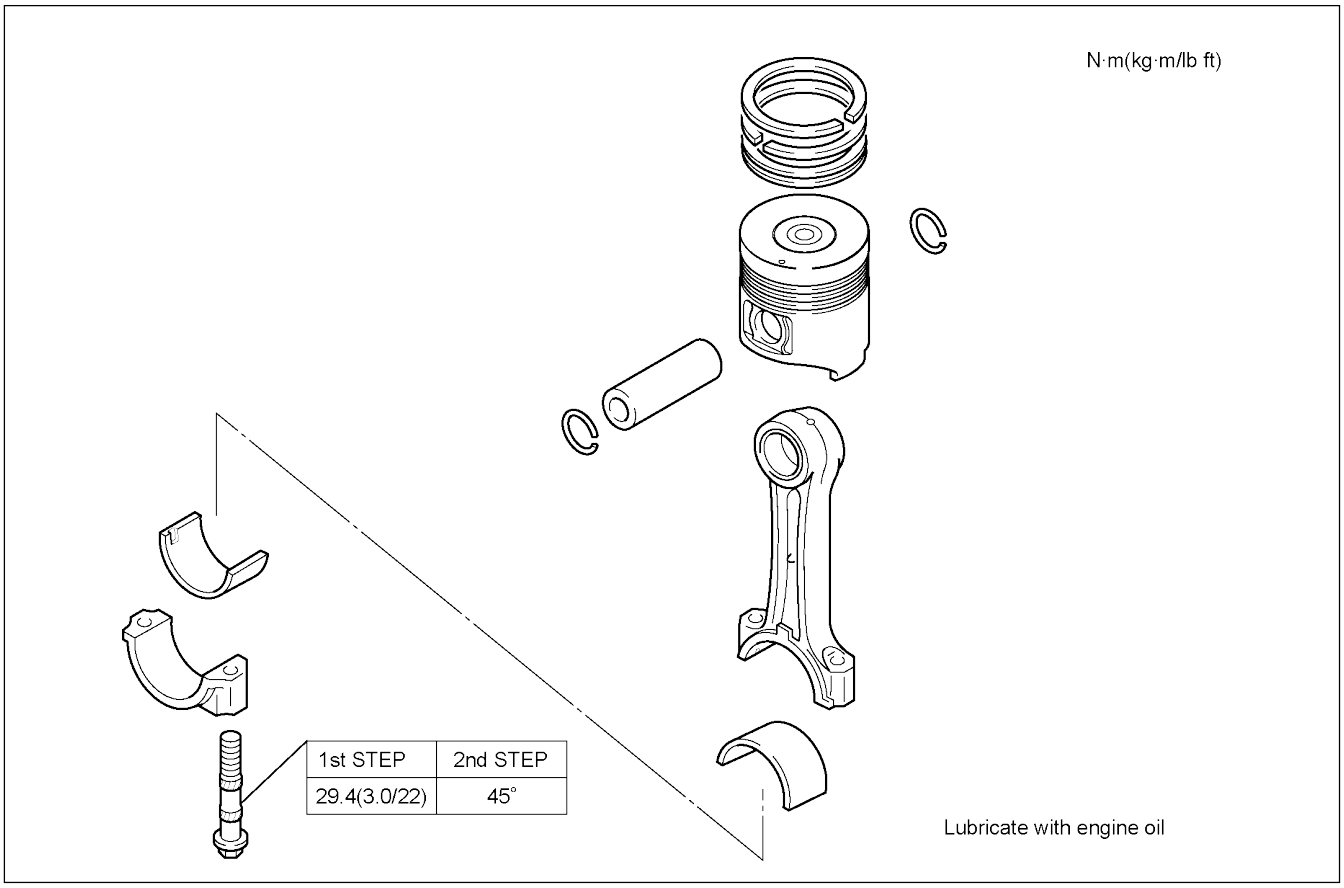
Note:
Make sure that the crankshaft smoothly rotates.



015LX130

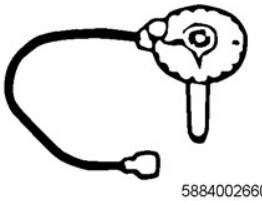
4. Install the oil pan.
   Refer to “Oil Pan”.
5. Install the gear case assembly.
   Refer to “Gear Case Assembly”.
6. Install the cylinder head.
   Refer to “Cylinder Head”.
7. Install the camshaft assembly.
   Refer to “Camshaft Assembly”.
8. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.

Torque Specifications



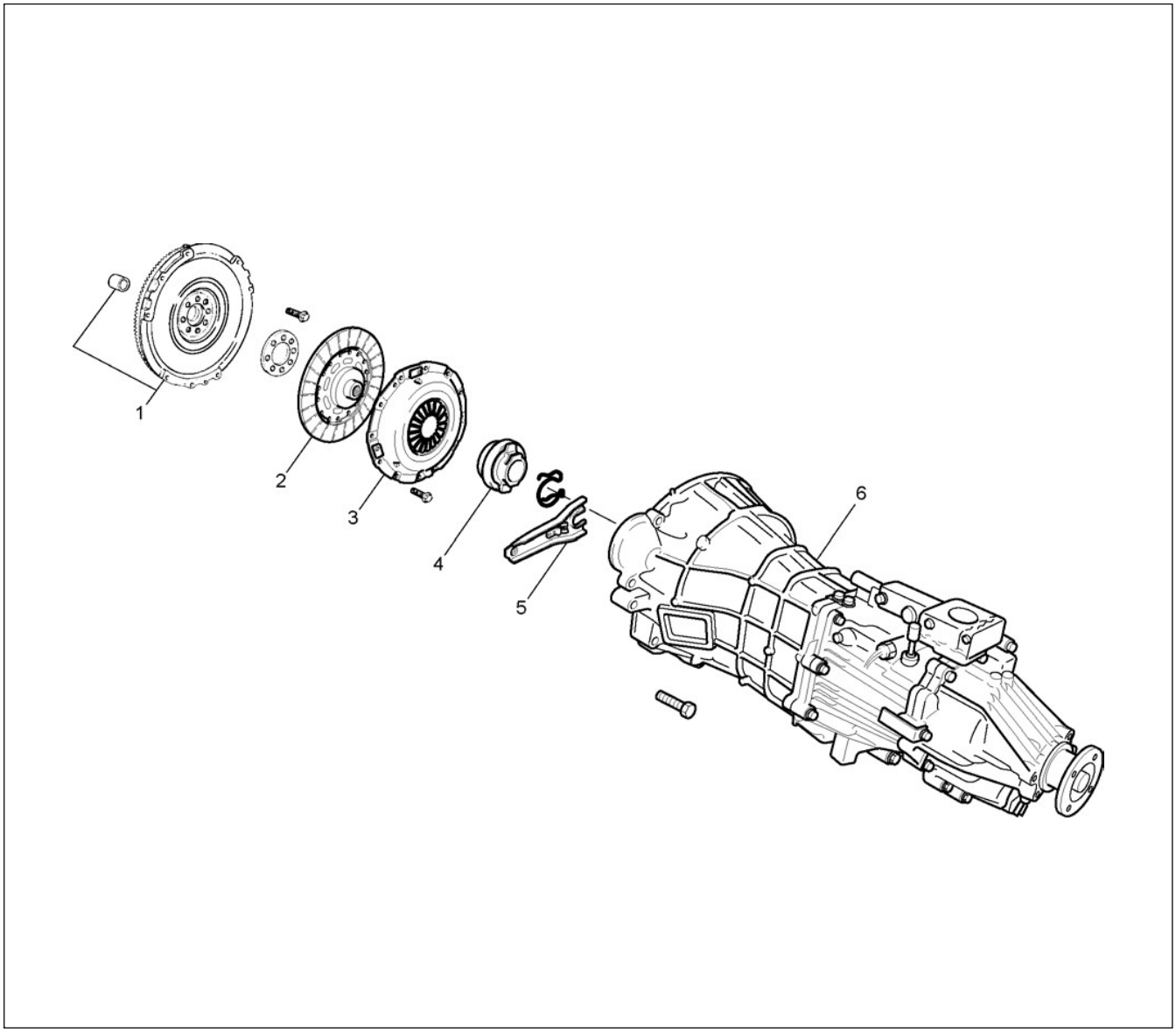
RTW56AMF001801

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884090180	**5-8840-9018-0** Piston ring compressor
 5884002660	**5-8840-0266-0** Angle gauge

Flywheel

Components



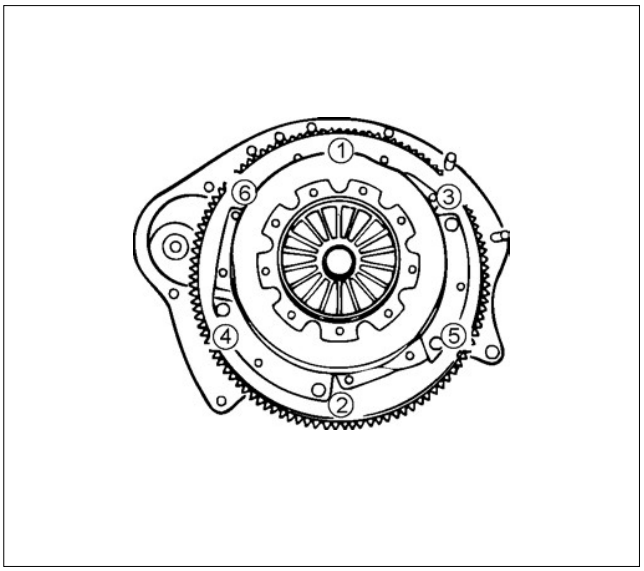
RTW56ALF001701

Legend

1. Flywheel Assembly and Pilot Bearing
2. Driven Plate
3. Pressure Plate Assembly
4. Release Bearing
5. Shift Fork
6. Transmission Assembly

Removal

1. Remove the transmission assembly.
   Refer to "transmission assembly removal and installation".
2. Remove the clutch pressure plate.
   - Remove the pressure plate installation bolts in the order shown in the drawing.
   - Remove the pressure plate from the flywheel.



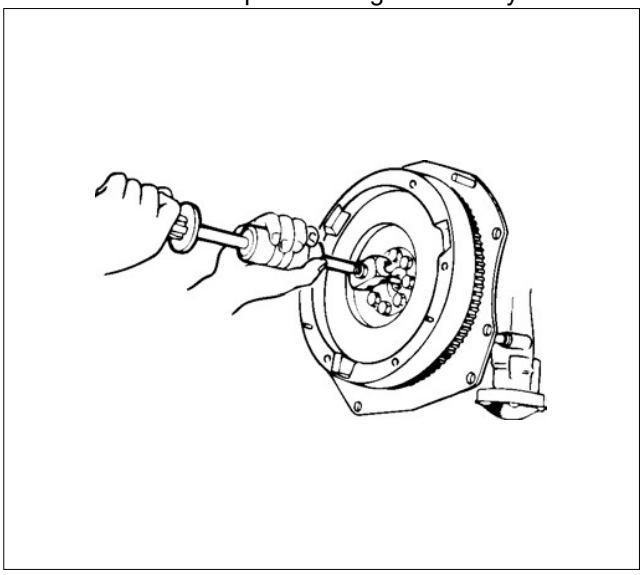
RTW56ASH014201

3. Remove the driven plate.
   - Remove the driven plate from the flywheel along with the clutch aligner.
   - Install the crankshaft stopper in the starter installation part of the rear plate.

Note:
Make sure that the stopper is applied with the ring gear and installed properly.

Special tool
Crankshaft stopper: 5-8840-0214-0

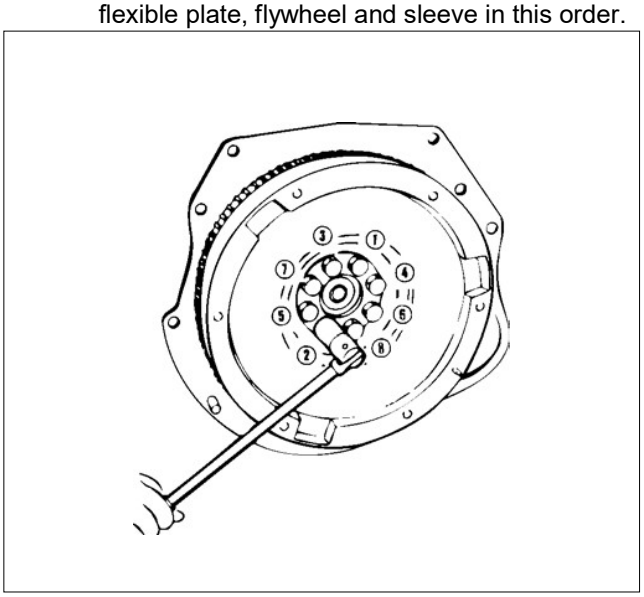
4. Remove the pilot bearing.
   - Remove the pilot bearing from the flywheel.



015RY00018

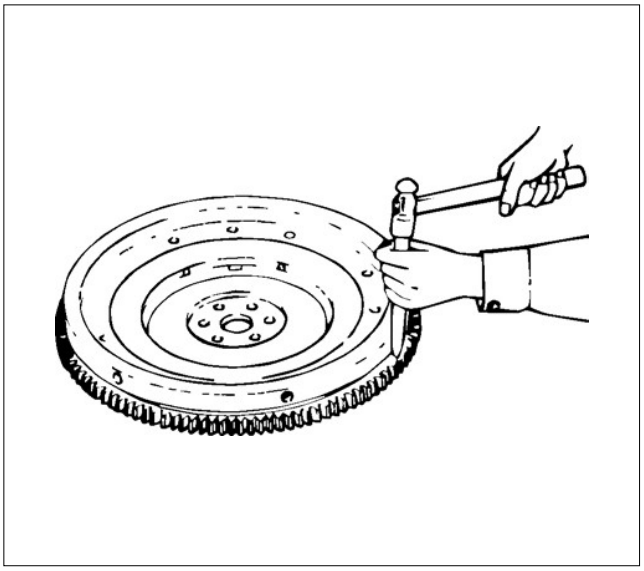
Special tool
Pilot Bearing Remover: 5-8840-2000-0
Sliding Hammer: 5-8840-0019-0

5. Remove the flywheel.
   - Gradually loosen the flywheel installation bolts in the order shown in the drawing so that the flywheel does not rotate.
   - After loosening the bolts, remove the stopper and remove the flywheel.
   - In the case of A/T car, after loosening the flywheel installation bolts, remove the washer, flexible plate, flywheel and sleeve in this order.



015RY00001

6. Remove the ring gear.
   - Put a bar on the ring gear and hit it with a hammer to remove it.



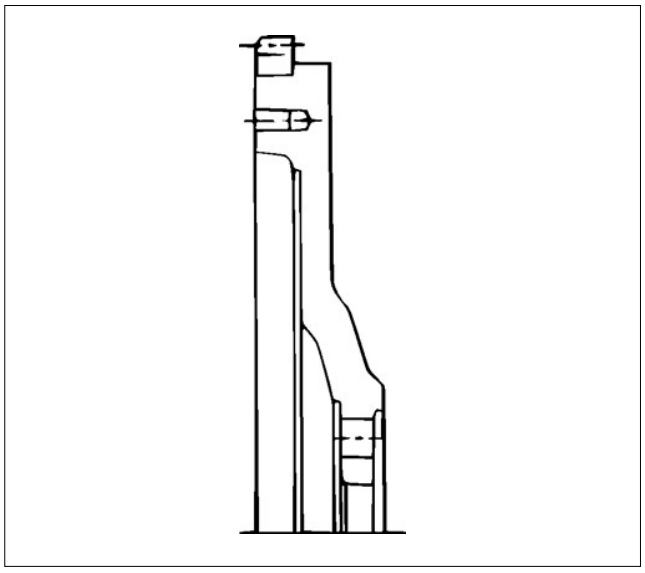
LNW21BSH012001

Inspection

1. Visual inspection
   - Inspect the flywheel friction surface for cracks and damages, and replace it if it has abnormality.
   - Inspect the tooth part of the ring gear, replace the ring gear if it has damage or serious wear.
2. Measurement of the friction surface
   - Measure the depth of the friction surface of the flywheel.
   - Adjust it if the measured value is within the standard value and the limit.
   - If the measured value exceeds the limit, replace the flywheel.

Depth of the friction surface of the flywheel mm (in)	
Standard	18 (0.7087)
Limit	19 (0.7480)

Depth = From the pressure installation surface to the friction surface.



LNW21BSH011901

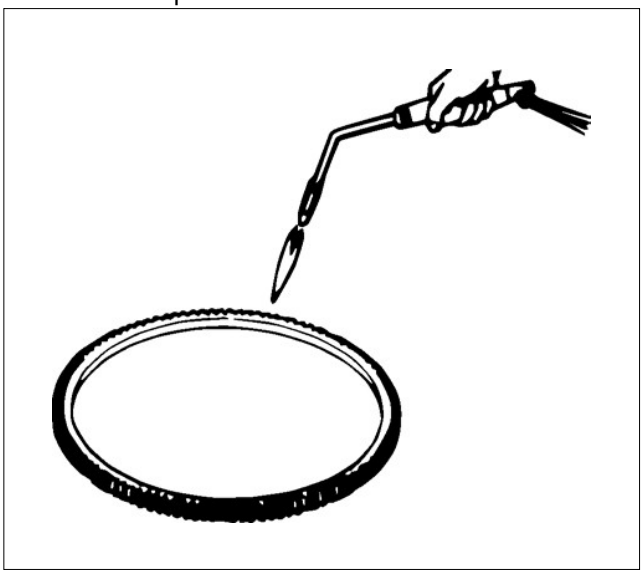
3. Flywheel installation bolts.
   - There is no damage in appearance.
   - Exchange for a new part if damage is extensive.

Installation

1. Install the ring gear.
   - Heat the ring gear evenly with a gas burner to invite thermal expansion. Do not allow the temperature of the gas burner to exceed 200°C (392°F).
   - Install the ring gear when it is sufficiently heated. The ring gear must be installed with the chamfer facing the clutch.

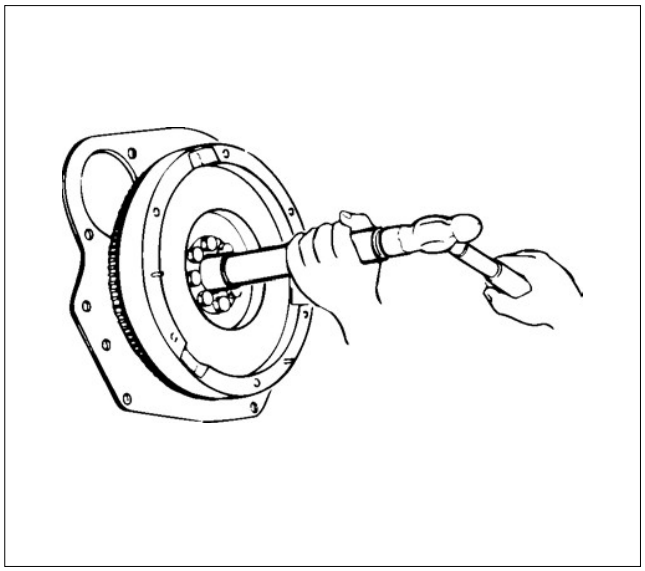
Note:

- Install the ring gear so that the side with a pattern faces forward.
- Shrink fit the ring gear to the flywheel.
  Make sure that flywheel and ring gear adhesion is complete.



LNW21BSH01201

2. Install the pilot bearing.
   - Place the crankshaft pilot bearing right angle across the crankshaft bearing installation hole.
   - Tap around the edges of the crankshaft pilot bearing outer races with a brass hammer to drive the bearing into the crankshaft bearing installation hole.
     Special tool
     Pilot Bearing Installer: 5-8522-0024-0

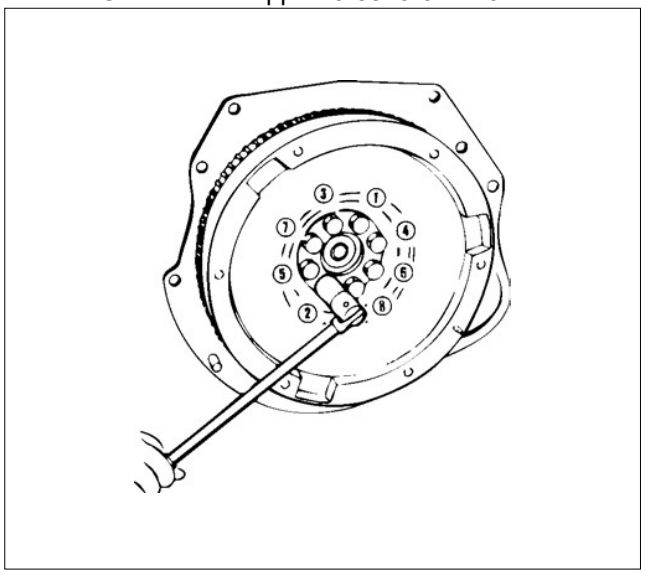


015RY00010

3. Install the flywheel.
   - Install the flywheel of the crankshaft, tighten them in the order shown in the illustration.
   - Apply molybdenum disulfide on the screw part and setting face of the bolt.
   - Install the crankshaft stopper on the starter installation part of the rear plate.

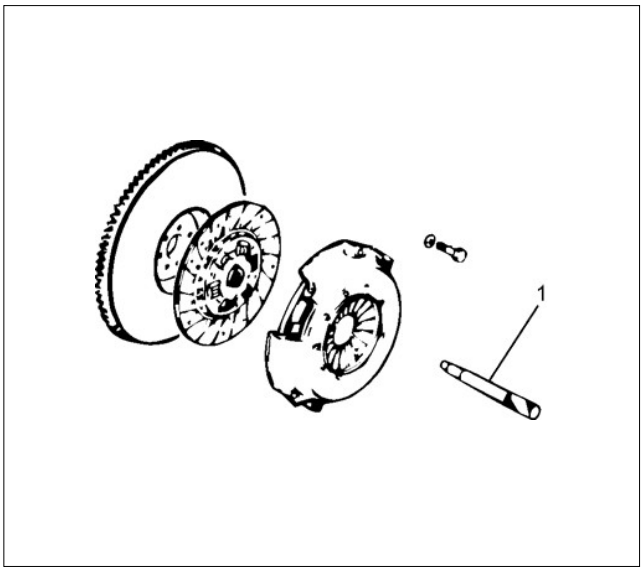
Tightening torque:
1st step = 59 N·m (6.0 kg·m / 43 lb ft)
2nd step = 60° - 90° (degrees)

Special tool
Crankshaft stopper: 5-8840-0214-0



015RY00001

4. Install the driven plate.
   - Use a clutch aligner to install the driven plate on the flywheel.



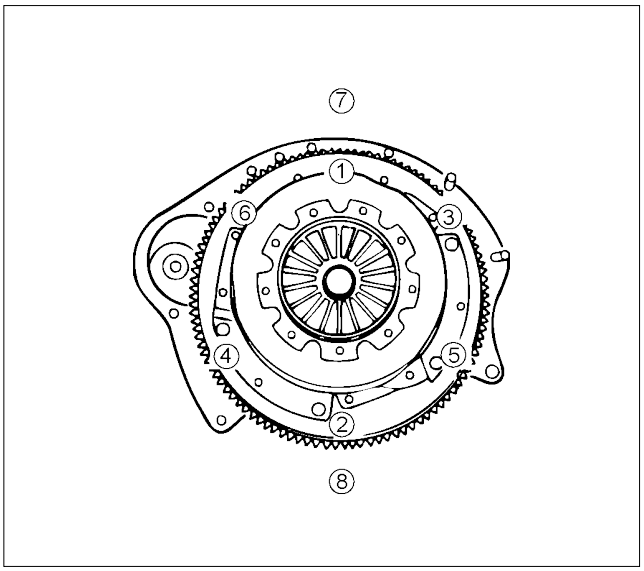
LNW21BSH002601

Legend

1. Clutch Aligner

5. Install the clutch pressure plate.
   - Install the pressure plate on the flywheel so that the installation hole of the pressure plate matches with the dowel pins of the flywheel.
   - Tighten the pressure plate in the order shown in the illustration.

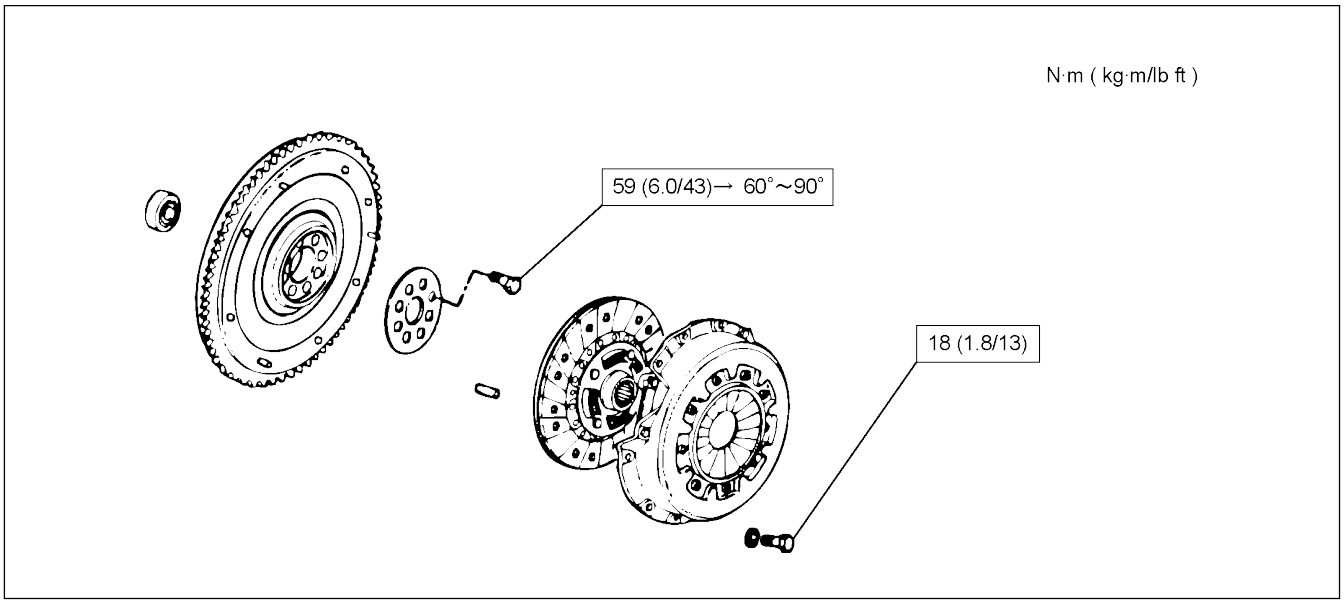
Tightening torque: 18 N·m (1.8 kg·m / 13 lb ft)



RTW56ASH023301

6. Install the transmission assembly.
   Refer to removal procedure for “TRANSMISSION”.

Torque Specifications



Special Tools

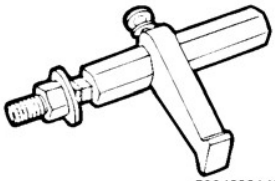
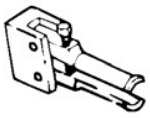
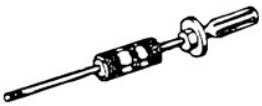
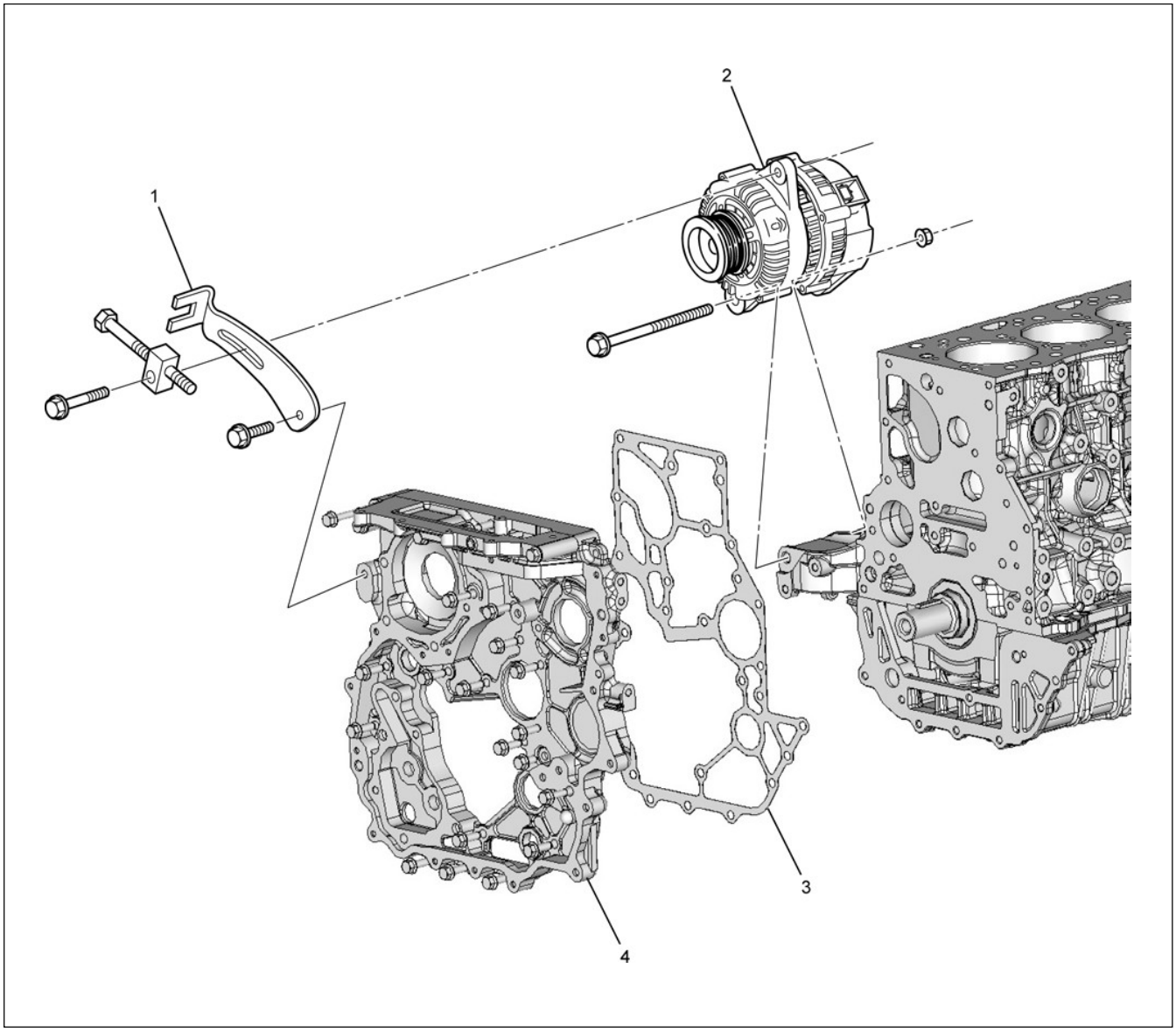
ILLUSTRATION	PART NO. PART NAME
 5884002140	**5-8840-0214-0** Crankshaft stopper
 5884020000	**5-8840-2000-0** Pilot Bearing Remover
 5884000190	**5-8840-0019-0** Sliding Hammer

ILLUSTRATION	PART NO. PART NAME
 5852200240	**5-8522-0024-0** Pilot Bearing Installer

Gear Case Assembly

Components



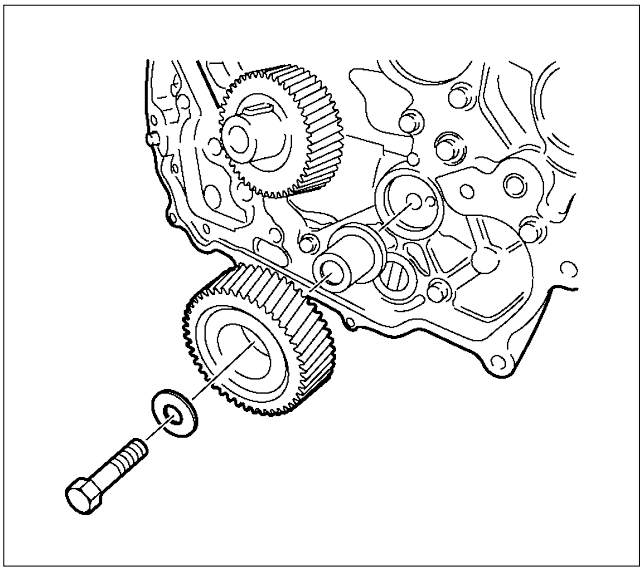
RTW76ALF000601

Legend

1. Adjust Plate
2. Generator
3. Gasket
4. Gear Case Assembly

Removal

1. Remove the engine assembly.
   Refer to removal procedure for “Engine Assembly” in this manual.
2. Remove the cylinder head.
   Refer to removal procedure for “Cylinder Head” in this manual.
3. Remove the adjustment bracket of generator.
4. Remove the vacuum pump and pipe.
   Refer to removal procedure for “Brake” in this manual.
5. Remove the power steering pump.
   Refer to removal procedure for “Power Steering” in this manual.
6. Remove the water pump.
   Refer to removal procedure for “Water Pump” in this manual.
7. Remove the fuel supply pump.
   Refer to removal procedure for “Fuel Supply Pump” in this manual.
8. Remove the crankshaft pulley.
   Refer to removal procedure for “Crankshaft Front Oil Seal” in this manual.
9. Remove the gear case cover.
   Refer to removal procedure for “Gear Case Cover” in this manual.
10. Remove the idle gear A and idle gear A shaft, idle gear C and idle gear C shaft.
    Refer to removal procedure for “Timing Gear Train” in this manual.



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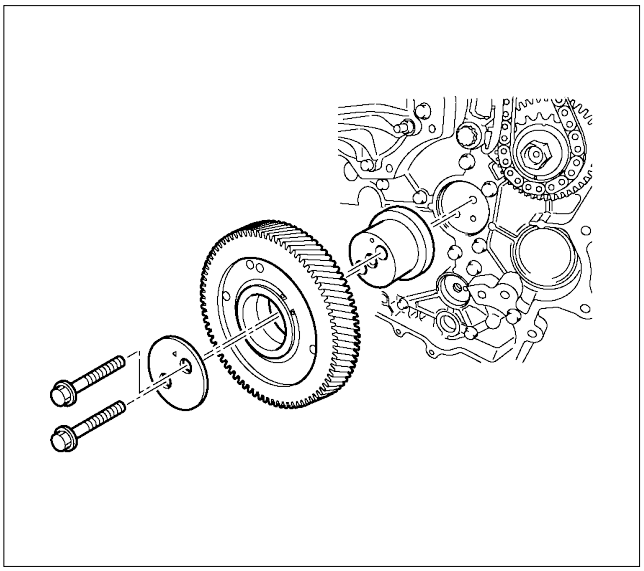
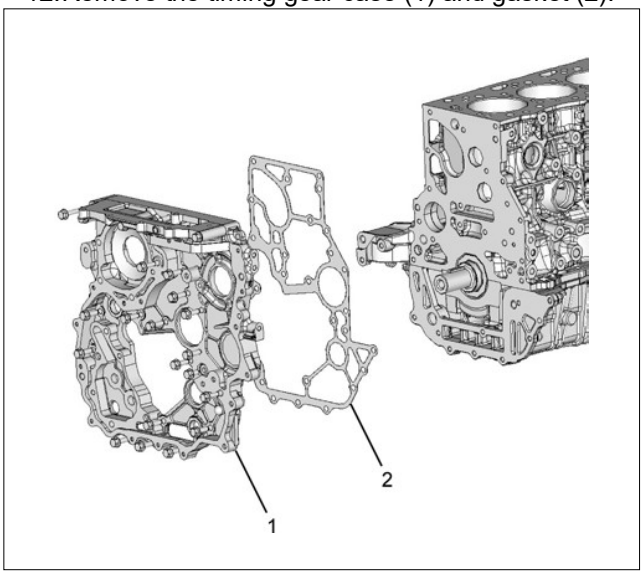


RTW56ASH011301

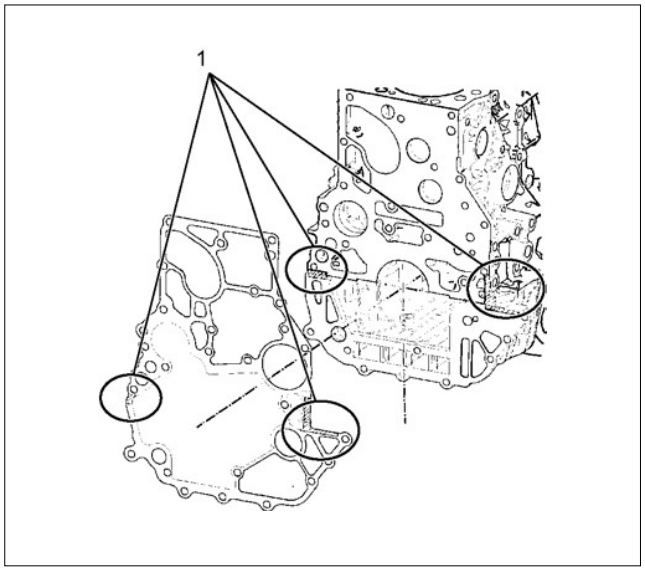
11. Remove the oil pump.
    Refer to removal procedure for “Oil Pump” in this manual.
12. Remove the timing gear case (1) and gasket (2).



RTW76ASH001201

Installation

1. Install the packing of the timing gear case.
   - Apply liquid gasket (ThreeBond 1207B or equivalent) on the joint (1) of the cylinder block and the crank case.



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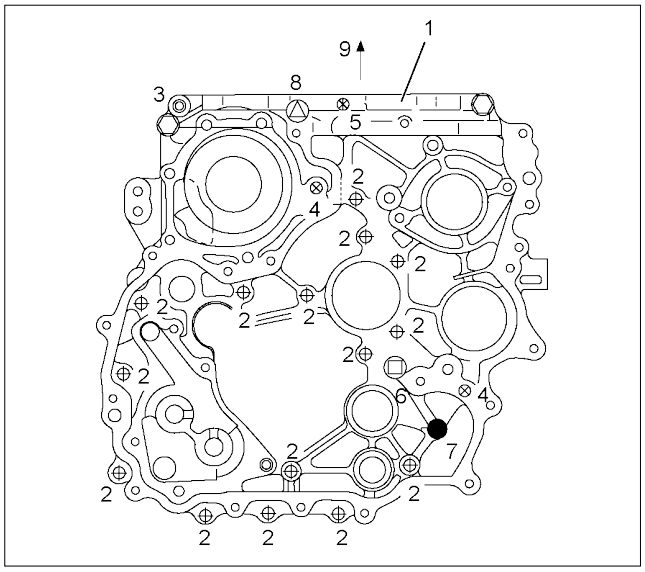
2. Install the timing gear case.
   - Install the timing gear case to match with the dowel pins, install bolts in the order shown in the illustration.



RTW56ASH022601

Legend

1. Gear Case Assembly
2. Bolt L = 25 mm (0.98 in)
3. Bolt L = 60 mm (2.36 in)
4. Bolt L = 45 mm (1.77 in)
5. Bolt L = 35 mm (1.38 in)
6. Bolt L = 16 mm (0.63 in)
7. Bolt L = 20 mm (0.79 in)
8. Bolt L = 50 mm (1.97 in)
9. UP

   - Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

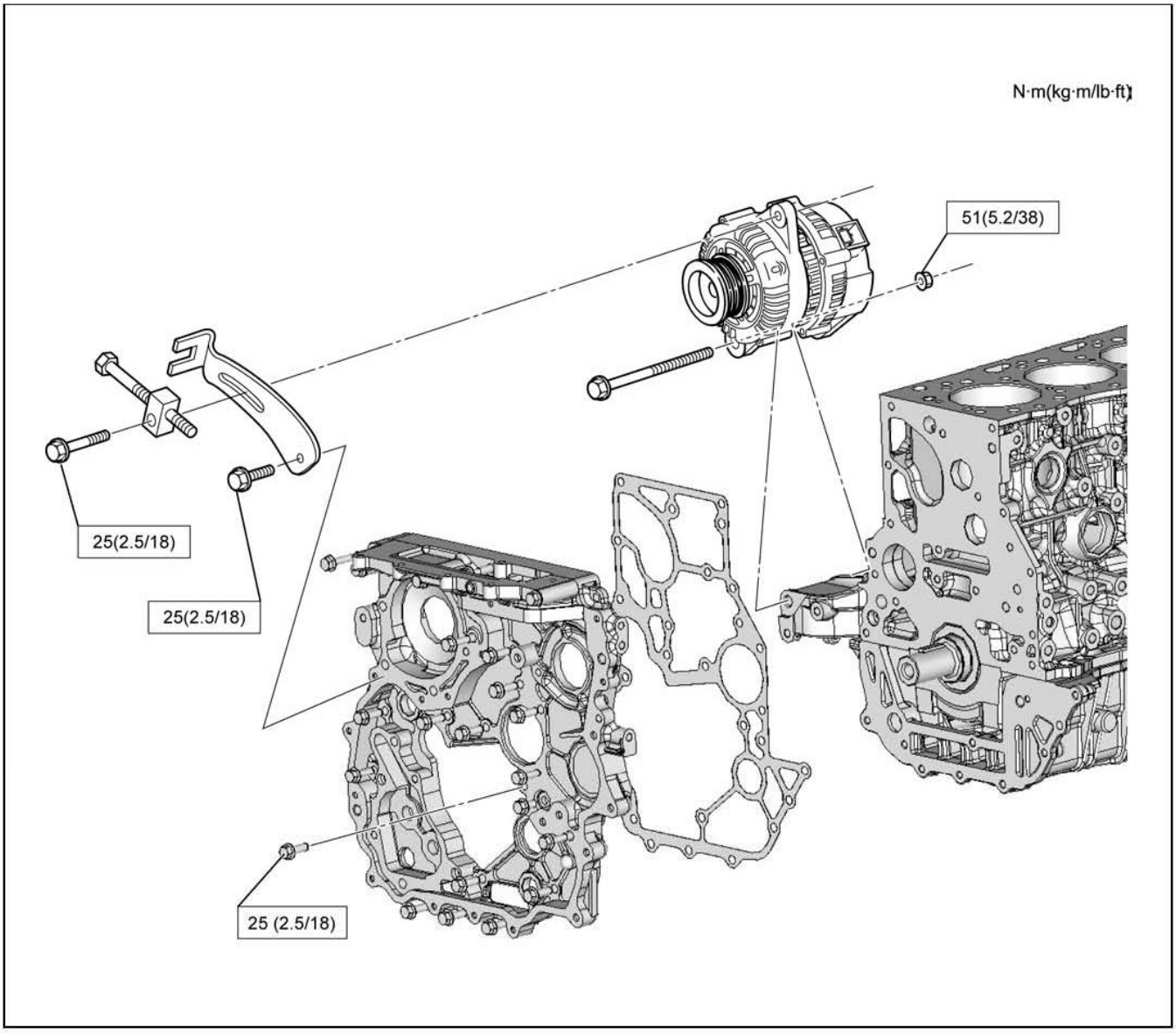
   - Tighten them in the order shown in the illustration.

3. Install the oil pump.
   Refer to installation procedure for “Oil Pump” in this manual.
4. Install the idle gear C shaft and idle gear C, idle gear A shaft and idle gear A.
   Refer to installation procedure for “Timing Gear Train” in this manual.
5. Install the gear case cover.
   Refer to removal procedure for “Gear Case Cover” in this manual.
6. Install the crankshaft pulley.
   Refer to removal procedure for “Crankshaft Front Oil Seal” in this manual.
7. Install the fuel supply pump.
   Refer to installation procedure for “Fuel Supply Pump” in this manual.
8. Install the water pump.
   Refer to installation procedure for “Water Pump” in this manual.
9. Install the power steering pump.
   Refer to removal procedure for “Power Steering” in this manual.
10. Install the vacuum pump and pipe.
    Refer to removal procedure for “Brake” in this manual.
11. Install the adjustment bracket of generator.
    Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

12. Install the cylinder head.
    Refer to installation procedure for “Cylinder Head” in this manual.
13. Install the engine assembly.
    Refer to installation procedure for “Engine Assembly” in this manual.

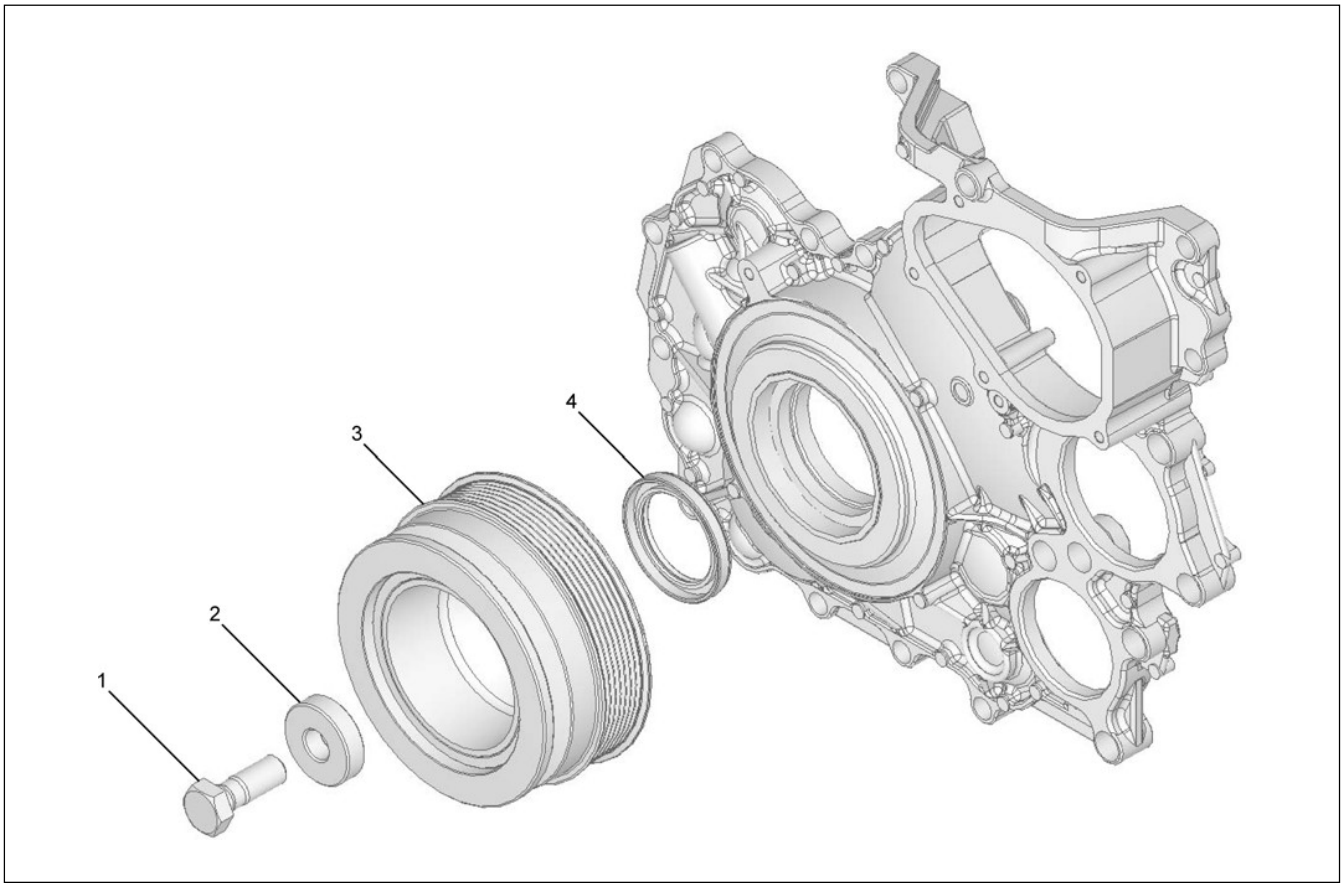
Torque Specifications



RTW76ALF000701

Crankshaft Front Oil Seal

Components



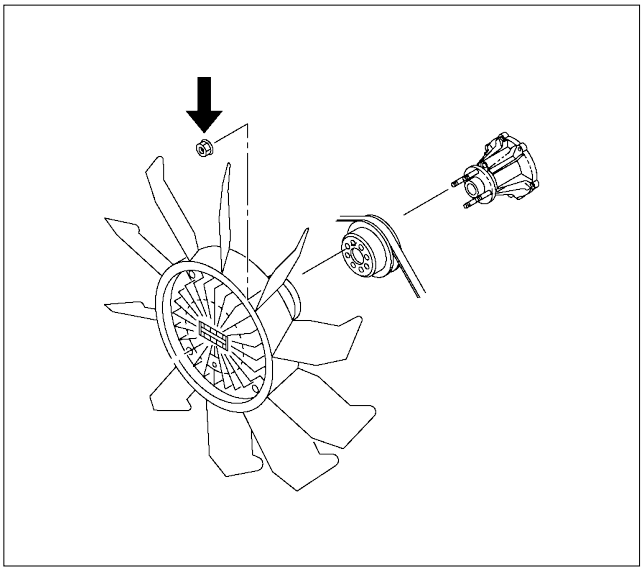
RTW76AMF000501

Legend

1. Bolt
2. Washer
3. Crankshaft Damper Pulley
4. Crankshaft Front Oil Seal

Removal

1. Remove the fan assembly.
   - Remove the fan assembly unscrewing four mounting nuts.

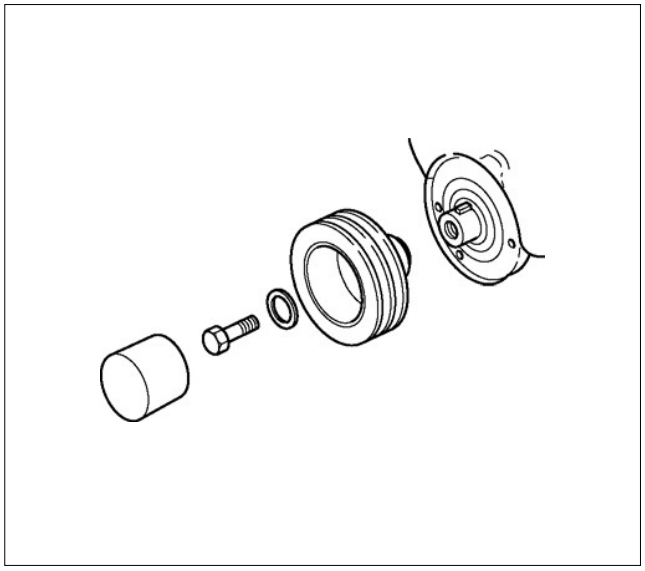


RTW56ASH025401

2. Remove the fan belt.

3. Remove the crankshaft pulley.

Note:
Do not reuse the bolt and the washer.

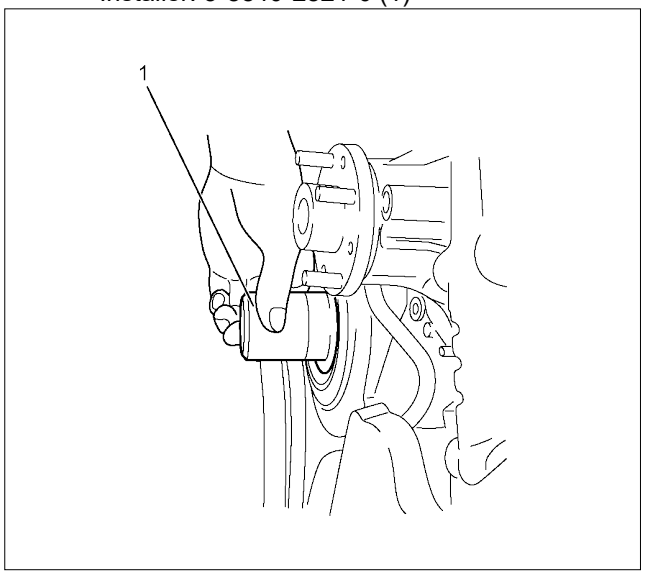


LNW61ASH005301

4. Remove the crankshaft front oil seal.
   - Remove only the oil seal with a screwdriver or the like, avoiding damage to the oil seal contact surface on the front cover and the shaft.

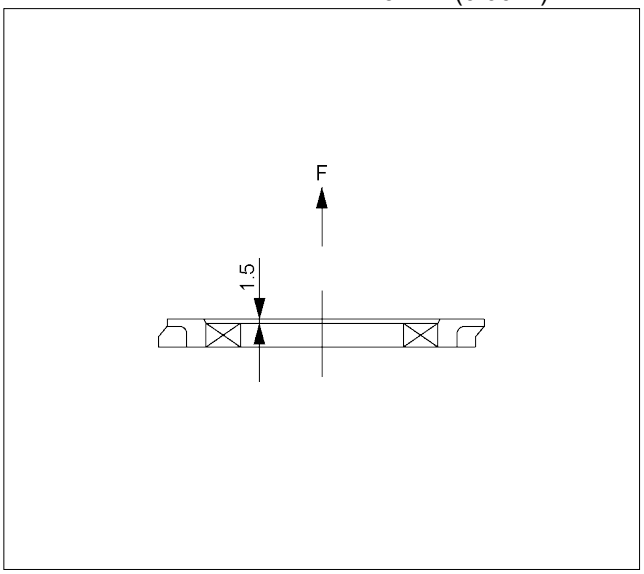
Installation

1. Install the crankshaft front oil seal.
   - Use the special tool to install the front oil seal.
     Front Oil Seal
     Installer: 5-8840-2821-0 (1)



RTW56ASH016501

   - Apply engine oil to the lip of the oil seal.
   - With the seal pressed in check the dimension of the oil seal section.
     Standard Dimension = 1.5 mm (0.06 in)

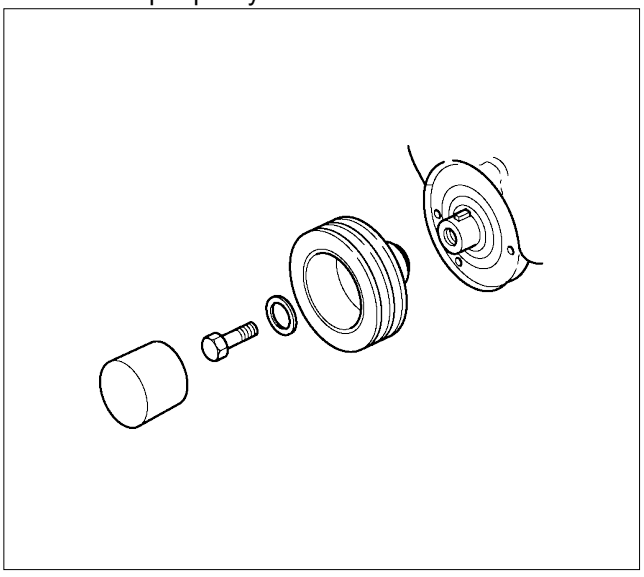


RTW56ASH016601

2. Install the crankshaft damper pulley.
   - Install the crankshaft pulley aligning with the key on the crankshaft.
   - Hold the flywheel ring gear stationary to prevent the crankshaft from turning when tightening the damper pulley bolt.

Tightening torque: 294 N·m (30 kg·m/217 lb ft)

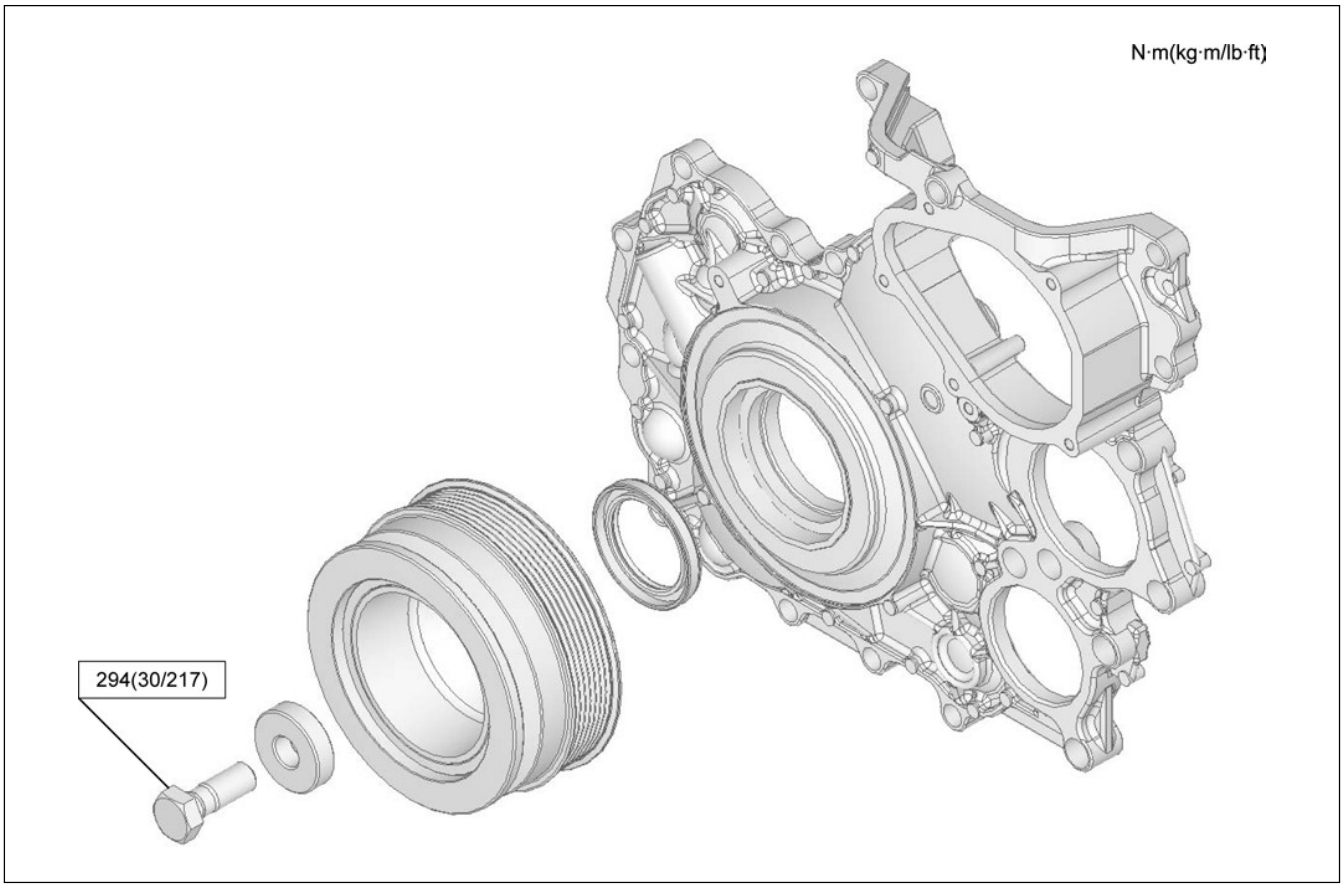
   - Take care not to damage the crankshaft damper pulley boss.



014R100014

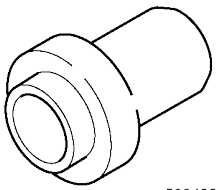
3. Install the fan belt.
   - Refer to “Engine Cooling”

Torque Specifications



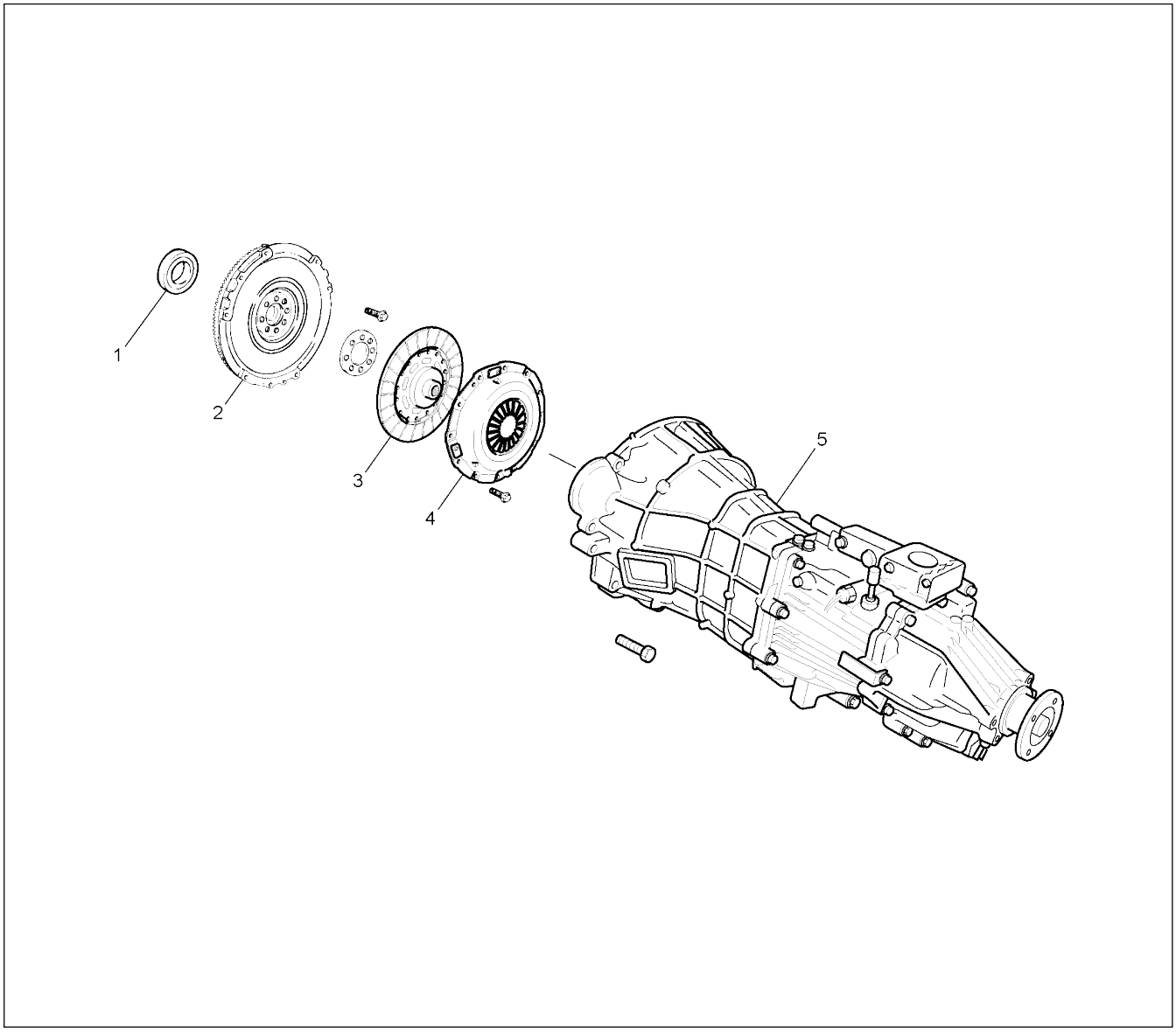
RTW76AMF000601

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884028210	**5-8840-2821-0** Oil seal installer

Crankshaft Rear Oil Seal

Components



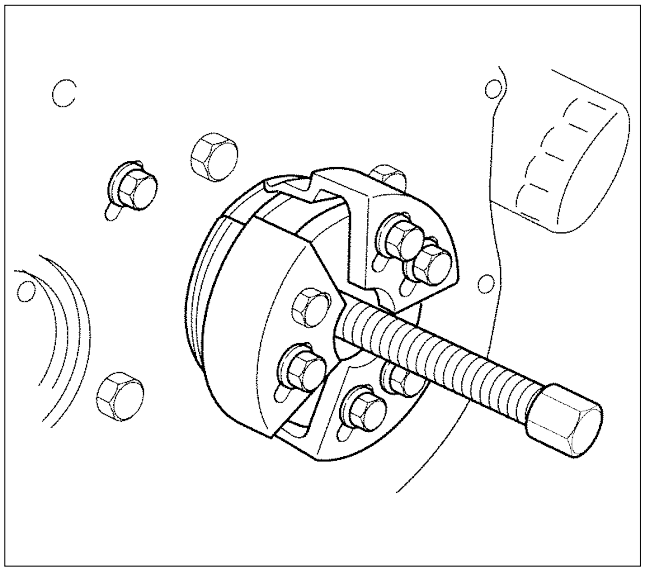
RTW56ALF002501

Legend

1. Crankshaft Rear Oil Seal
2. Flywheel
3. Driven Plate
4. Clutch Pressure Plate
5. Transmission Assembly

Removal

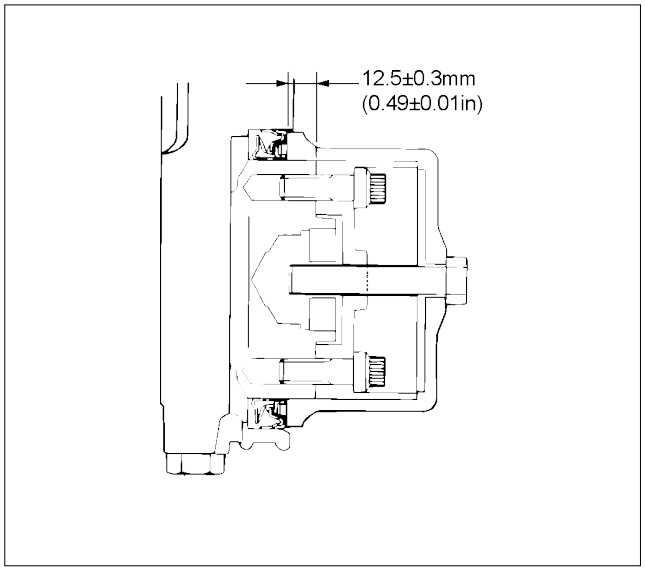
1. Remove the flywheel.
   Refer to "Flywheel".
   - With the oil seal pushed in deep, install the special tool as shown in the illustration and remove the oil seal.
     Oil Seal Remover: 5-8840-2360-0



015LV002

Installation

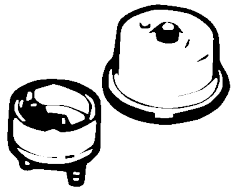
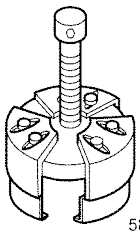
1. Install the crankshaft rear oil seal.
   - Use an oil seal install to install the crankshaft rear oil seal.
     Oil Seal Installer: 5-8840-2359-0



RTW56ASH022901

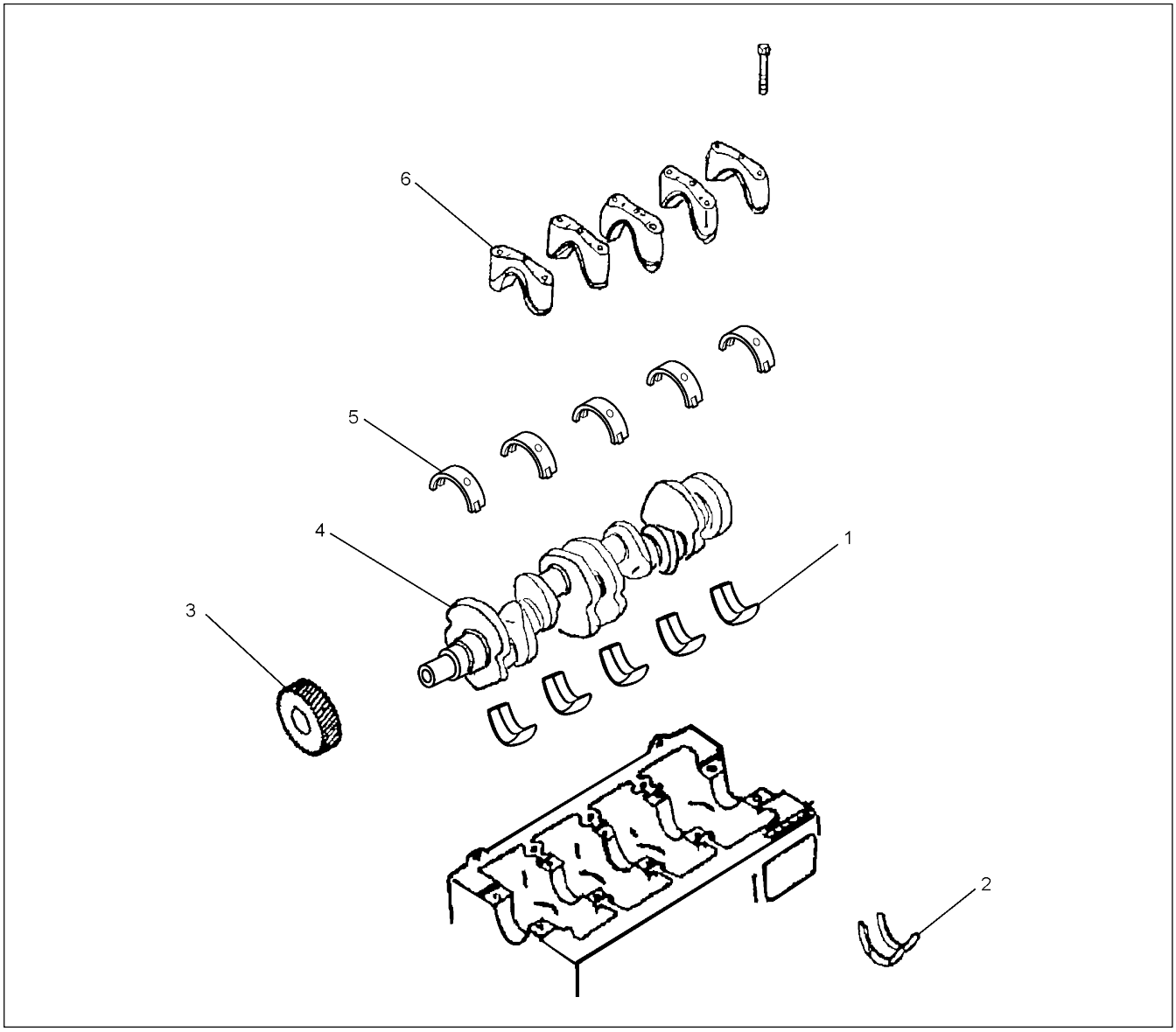
2. Install the flywheel.
   Refer to "Flywheel".

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884023590	**5-8840-2359-0** Oil seal installer
 5884023600	**5-8840-2360-0** Oil seal remover

Crankshaft

Components



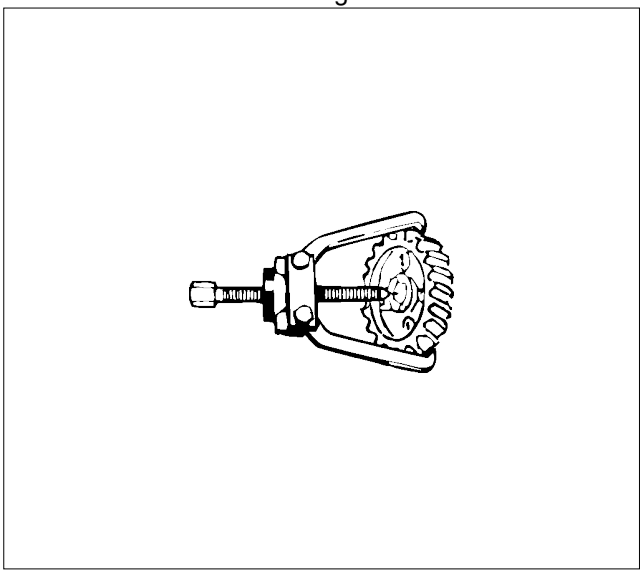
RTW56ALF002601

Legend

1. Upper Bearing
2. Thrust Bearing
3. Gear
4. Crankshaft
5. Lower Bearing
6. Bearing Cap

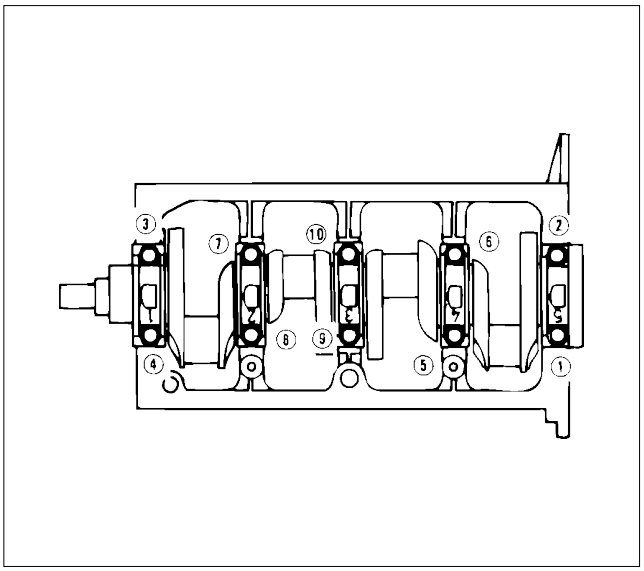
Removal

1. Demount the engine assembly.
   Refer to "Engine Assembly".
2. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
3. Remove the camshaft.
   Refer to "Camshaft Assembly".
4. Remove the cylinder head.
   Refer to "Cylinder Head".
5. Remove the fuel supply pump and fuel rail.
   Refer to "Fuel Supply Pump" and "Fuel Rail" in the fuel system section.
6. Remove the front cover.
   Refer to "Front Cover".
7. Remove the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
8. Remove the water pump.
   Refer to "Water Pump" in Cooling System Section.
9. Remove the timing gear train.
   Refer to "Timing Gear Train".
10. Remove the oil pump.
    Refer to "Oil Pump".
11. Remove the gear case assembly.
    Refer to “Gear Case Assembly”.
12. Remove the crankshaft gear.



901R100008

13. Remove the crank case.
    Refer to "Crank Case and Oil Pan".
14. Remove pistons and connecting rods.
    Refer to "Piston and Connecting Rod".
15. Remove the bearing cap.
    - Loosen the crankshaft bearing cap bolts in numerical order a little at a time.

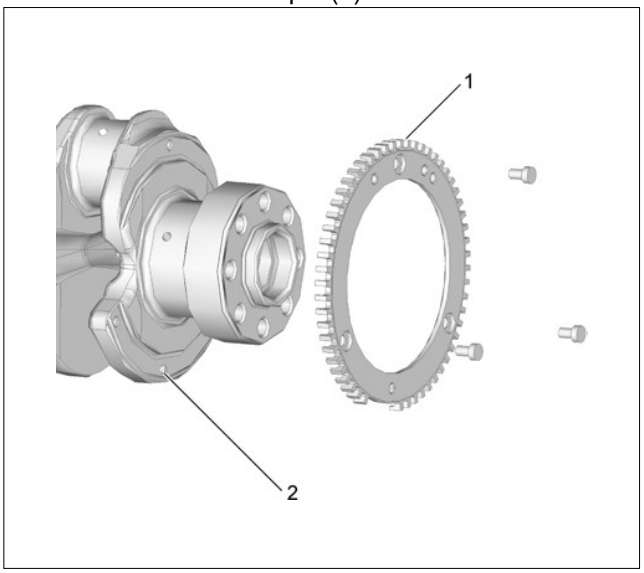


015RY00003

16. Remove the lower crankshaft bearings.
17. Remove the crankshaft assembly.
18. Remove the thrust bearing.
19. Remove the upper crankshaft bearings.

Disassembly

1. Remove the crank angle sensor rotor (1).
   - Confirm that the pin (2) is not removed.

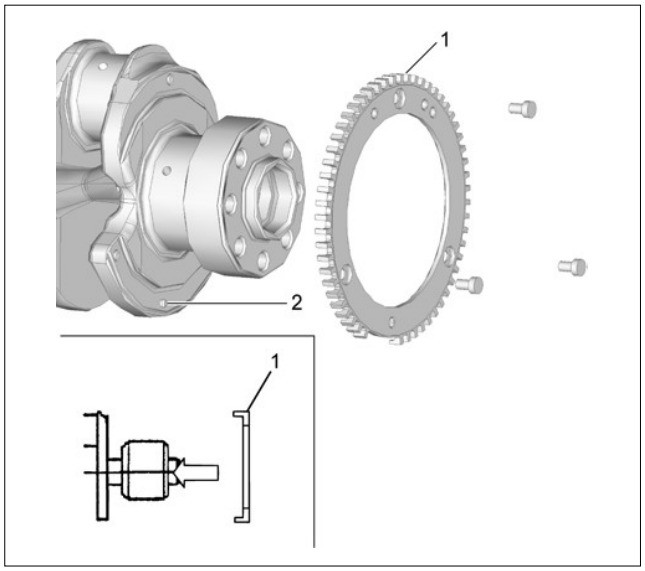


RTW76ASH001501

Reassembly

1. Install the crank angle sensor rotor.
   - Attach by making a rotor tooth's running out side into a front side.
   - Apply Loctite #262 or the equivalent to the bolt threads (if a new bolt is used, Loctite application is not required).

Tightening torque: 12 N·m (1.2 kg·m / 104 lb in)



RTW76ASH001601

Legend

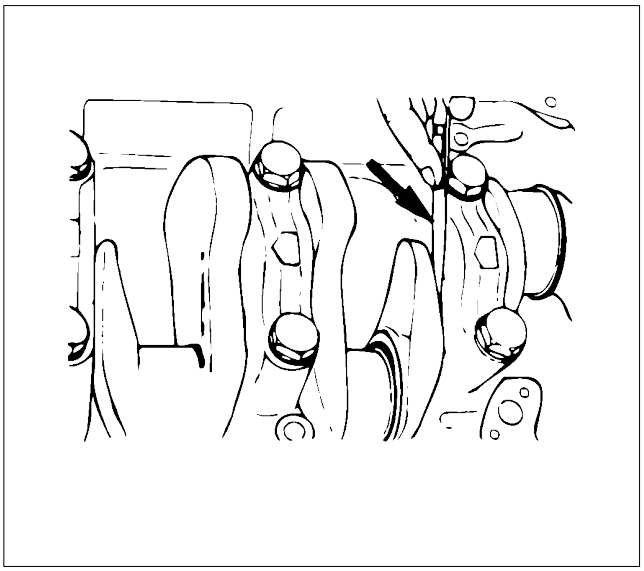
1. Crank Angle Sensor Rotor
2. Pin

Inspection

1. Thrust clearance
   - Measure the crankshaft end play at the center journal of the crankshaft.
   - Do this before removing the crankshaft bearing caps. If the measured value exceeds the specified limit, the crankshaft thrust bearing must be replaced.

Axial play of the crankshaft	mm (in)
Standard	0.10 (0.004)
Limit	0.30 (0.012)

Note:
Measure the thrust clearance before dismounting.



015RY00002

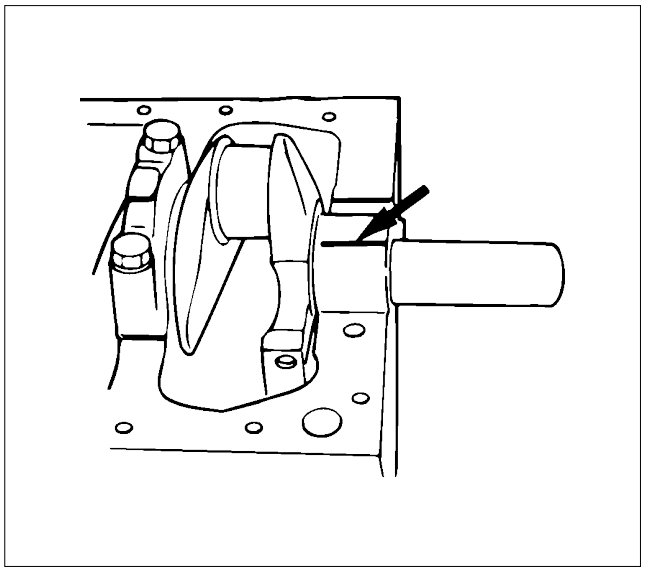
2. Main bearing clearance
   - Remove the crank case.
     Set out disassembled main bearings in the order of the numbers.
   - Remove the crankshaft. Remove the main bearings.
   - Clean the crankshaft journal and upper and lower bearings.
   - Check the bearings for damage or excessive wear.

     If you find damage or excessive wear, replace the bearings in pairs.

   - Place the upper bearings and the crankshaft on the cylinder block. Install the crankshaft so that it is horizontal.

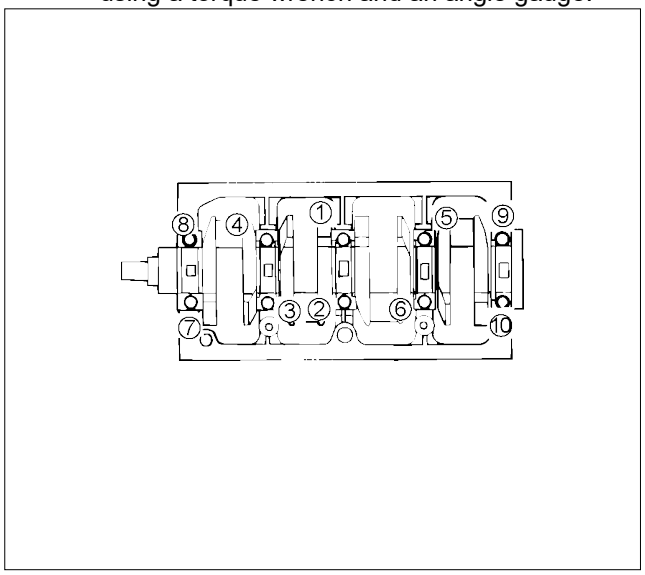
Note:
Turn the crankshaft about 30 degrees to allow the bearings to settle in.

   - Place plastigage on the crankshaft journal as shown.
   - Place the lower bearings at original positions on the bearing cap.



015RY00012

- Install the bearing cap and tighten bolts to the specified tightening torque.
- Tighten the bearing cap in the sequence shown using a torque wrench and an angle gauge.



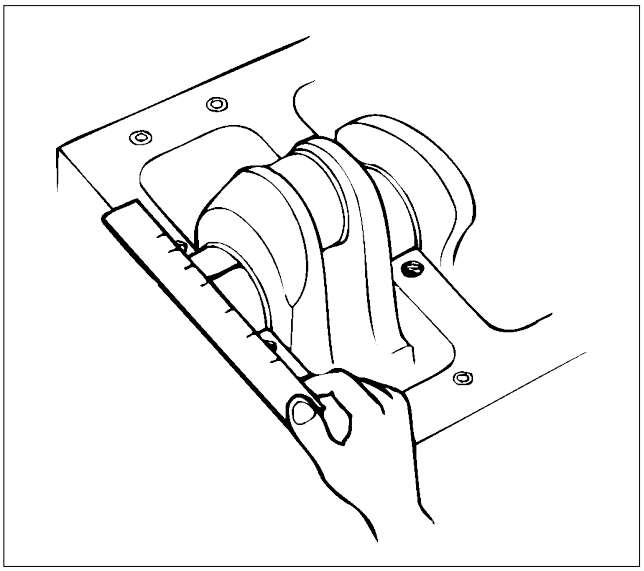
015LX129

Tightening torque: 166 N·m (16.9 kg·m / 122 lb ft)

Note:
Do not turn the crankshaft after you have tightened the bearing cap.

- Loosen the bolts and gently remove the bearing cap.
- Measure the widest part of the Plastigage flattened by tightening the bearing cap to determine the clearance.

Journal oil clearance	mm (in)
Standard	0.032 - 0.077 (0.0013 - 0.0030)
Limit	0.11 (0.0043)



LNW21BSH024401

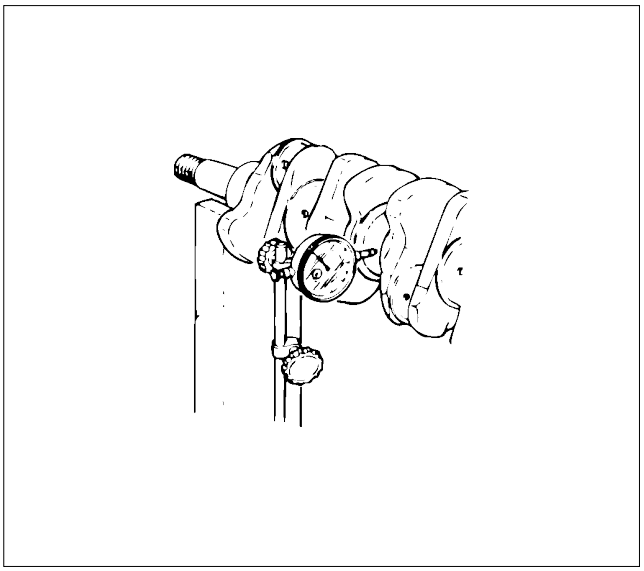
- If the journal oil clearance exceeds the limit, replace the main bearings altogether or the crankshaft.
- Remove the Plastigage from the bearings and the crankshaft.

Inspection of the crankshaft

- Check the crankshaft journal and crank pin surfaces for wear and damage. Check the oil seal contact surface for excessive wear and damage.
- Check the oil port for clogging.

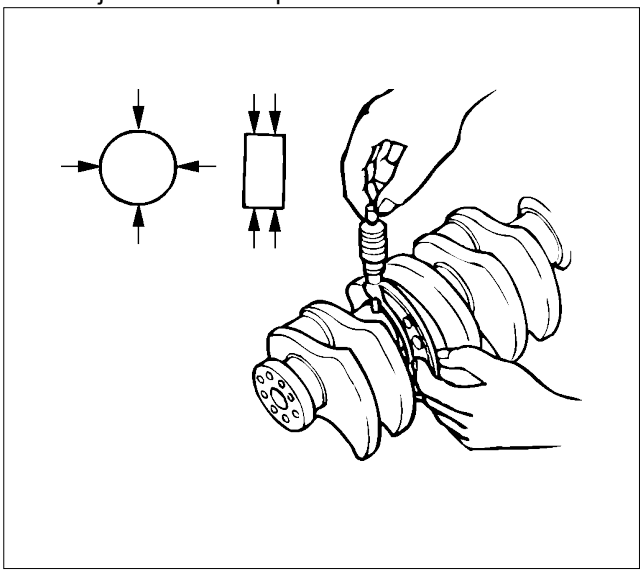
3. Crankshaft run-out
   Carefully set the crankshaft on the V block. Slowly turn the crankshaft to measure the run-out. If the crankshaft run-out exceeds the limit, replace the crankshaft.

Crankshaft run-out	mm (in)
Standard	0.05 or less (0.0020 or less)
Limit	0.08 (0.003)



015LX061

4. Measure the journal and the crankpin diameters and uneven wear.
   - Measure outer diameters of the journal and the pin and calculate differences between the maximum and the minimum values. Take measurements at four positions for both the journal and the pin.



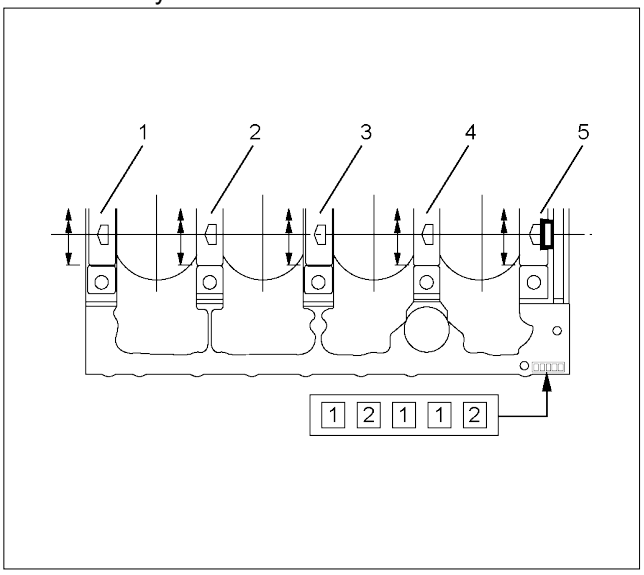
LNW21BSH024601

Crankshaft outside diameter		mm (in)
	Standard	Limit
Journal	69.917 – 69.932 (2.7526 – 2.7532)	69.91 (2.7524)
Pin	52.915 – 52.930 (2.0833 – 2.0839)	52.9 (2.083)

Note:
Tufftriding (soft nitriding treatment) is applied to enhance strength of the crankshaft. Therefore, you should not polish the surface of the crankshaft.

Crankshaft bearing selection

- Crankshaft bearing selection is based on the measured diameters of the crankshaft journals and the bearing inserts.
- Match the crankshaft bearing housing grade marks and the crankshaft journal grade marks in the table below to determine the correct crankshaft bearing size.
- Crankshaft bearing housing grade marks 1, 2 or 3 are stamped on the rear right hand side of the cylinder block.



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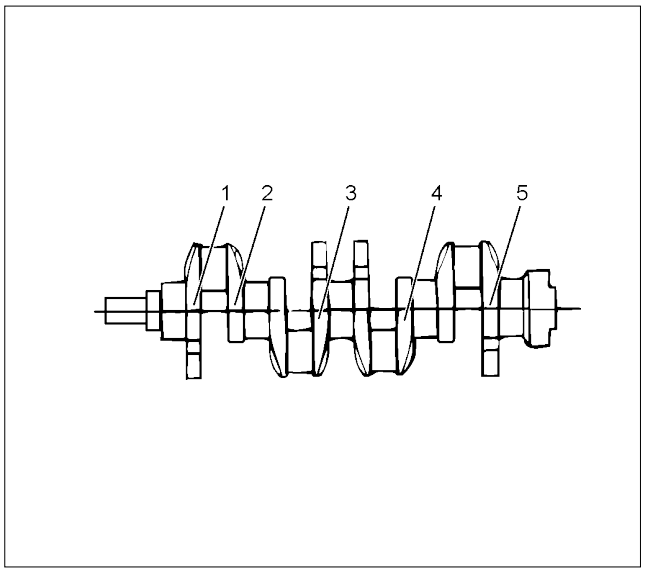
Legend

1. No.1
2. No.2
3. No.3
4. No.4
5. No.5

- The crankshaft journal grade marks (1 or -, 2 or --, 3 or ---) are stamped on each crankshaft journal web.
  The crankshaft journal and bearing clearance must be the same for each position after installation of the crankshaft and the crankshaft bearings.

4JK1



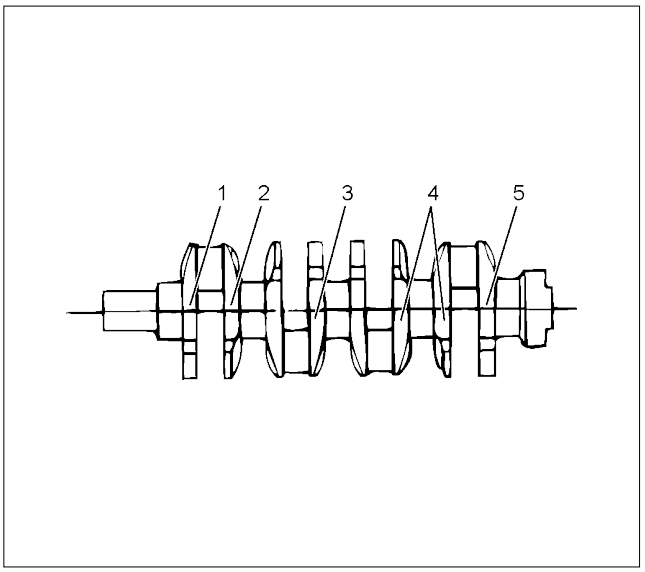
RTW56ASH023901

Legend

1. No.1
2. No.2
3. No.3
4. No.4
5. No.5

NOTE:
The crankshaft journal mark No. 4 is stamped on crankshaft No. 4 journal web front side or rear side.

4JJ1

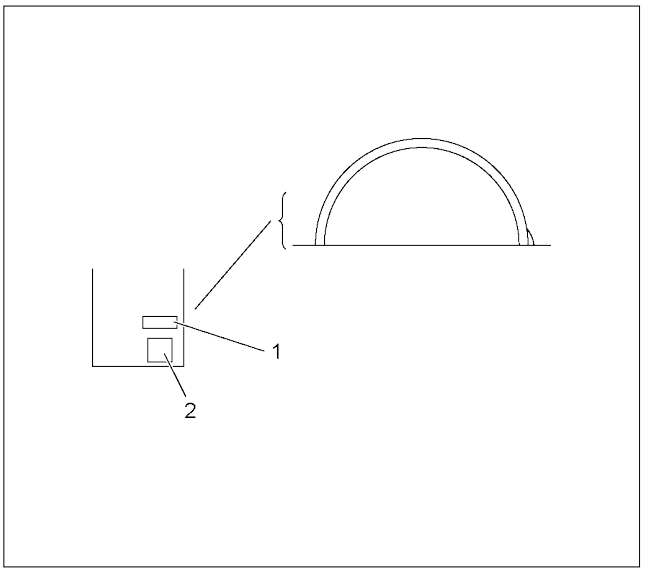


RTW56ASH017201

Legend

1. No.1
2. No.2
3. No.3
4. No.4
5. No.5

Note:
Be careful about difference in the shape of the bearings when installing them.



RTW56ASH017301

Legend

1. Lot No.
2. Size Code

Bearing Selection Table

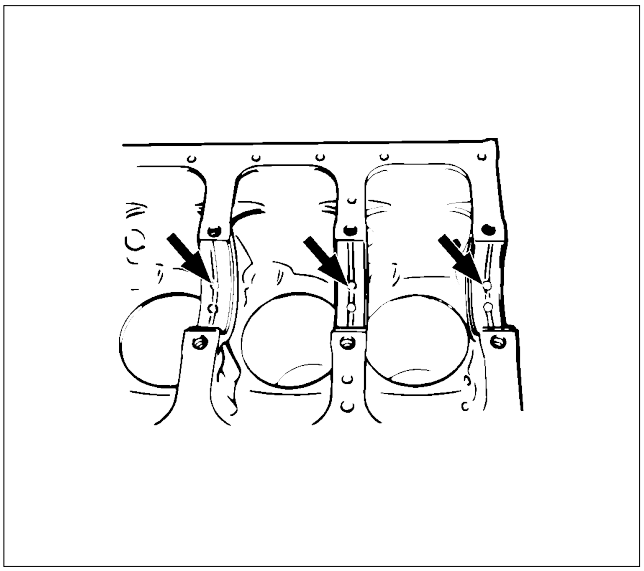
mm (in)

Crankshaft Bearing Housing		Crankshaft Journal		Crankshaft Bearing Size Code
Grade Mark	Diamaeter	Grade Mark	Diamaeter	
1	73.992-74.000 (2.9131-2.9134)	1 or -	69.927-69.932 (2.7530-2.7532)	4
		2 or - -	69.922-69.927 (2.7528-2.7530)	
		3 or - - -	69.917-69.922 (2.7526-2.7528)	5
2	73.983-73.991 (2.9127-2.9130)	1 or -	69.927-69.932 (2.7530-2.7532)	2
		2 or - -	69.922-69.927 (2.7528-2.7530)	3
		3 or - - -	69.917-69.922 (2.7526-2.7528)	4
3	73.975-73.982 (2.9124-2.9127)	1 or -	69.927-69.932 (2.7530-2.7532)	1
		2 or - -	69.922-69.927 (2.7528-2.7530)	2
		3 or - - -	69.917-69.922 (2.7526-2.7528)	

Installation

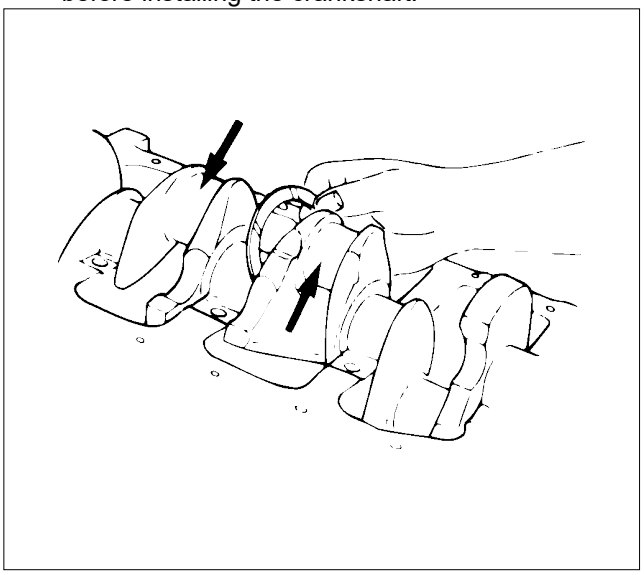
1. Install the crankshaft upper bearing.
   - The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings do not.
   - Carefully wipe any foreign material from the upper bearing.
   - Locate the position mark applied at disassembly if the removed upper bearings are to be reused.

Note:
Do not apply engine oil to the bearing back faces and the cylinder block bearing fitting surfaces.



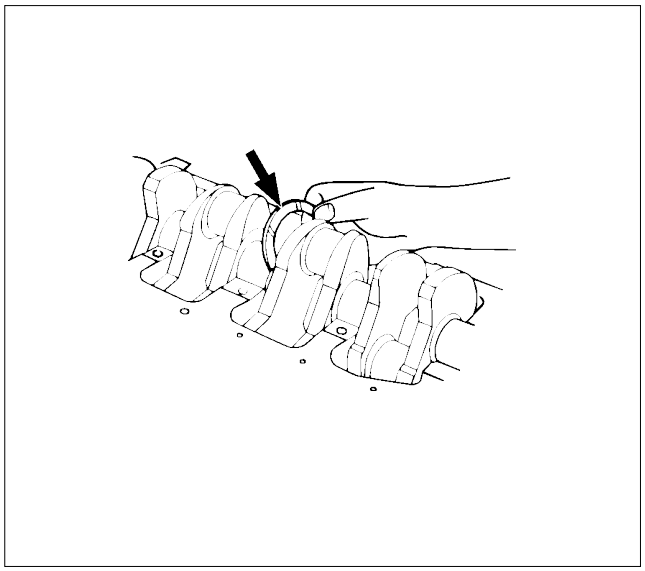
015LX125

2. Install the crankshaft assembly.
   Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft.



015R100004

3. Install the thrust bearing.
   - Apply an ample coat of engine oil to the thrust bearings before installation. Install the thrust bearings to the crankshaft center journal.
   - The thrust bearing oil grooves must be facing the sliding faces.

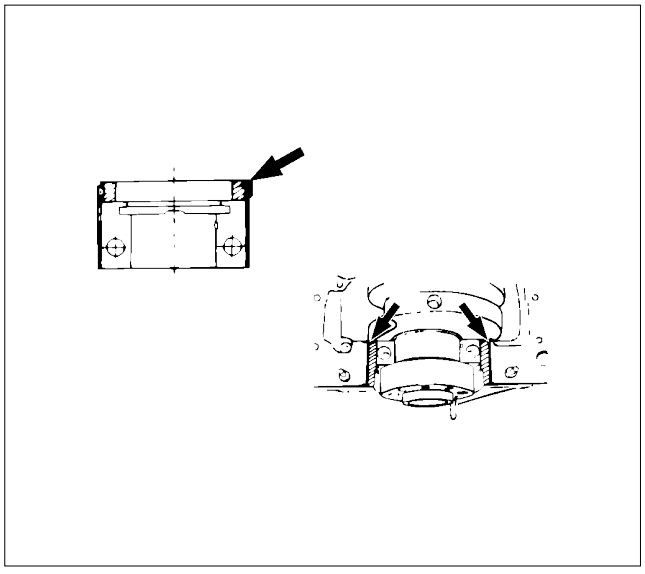


015LX115

4. Install the lower crankshaft bearing.
   - Before the crankshaft bearing installation, select the appropriate bearings in accordance with the description in CRANK BEARING SELECTION of INSPECTION AND REPAIR.
   - Apply the recommended liquid gasket or its equivalent to the No. 5 crankshaft bearing cap cylinder body fitting surfaces at the points shown in the illustration.

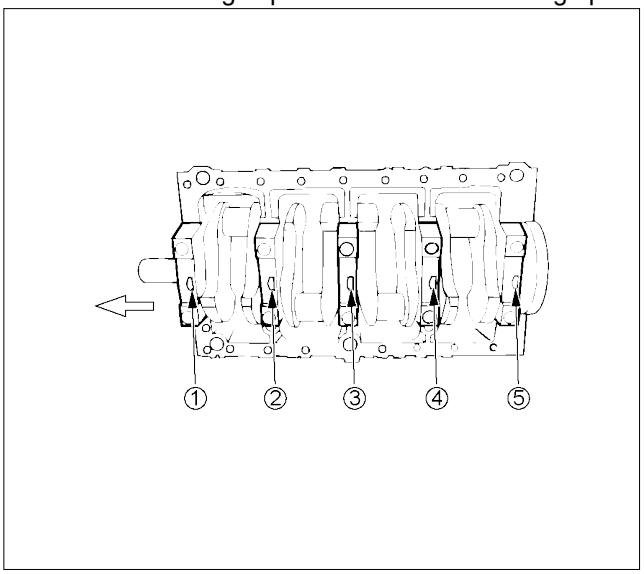
Note:
Be sure that the bearing cap fitting surface is completely free of oil before applying the liquid gasket. ThreeBond 1207B Do not allow the liquid gasket to obstruct the cylinder thread holes and bearings.

ThreeBond 1207B is a fast-drying liquid gasket. Tighten the bearing caps immediately after applying the gasket.



015LX127

5. Install the bearing cap.
   - Install the bearing caps with the bearing cap head arrow mark facing the front of the engine. The bearing cap numbers must be facing up.



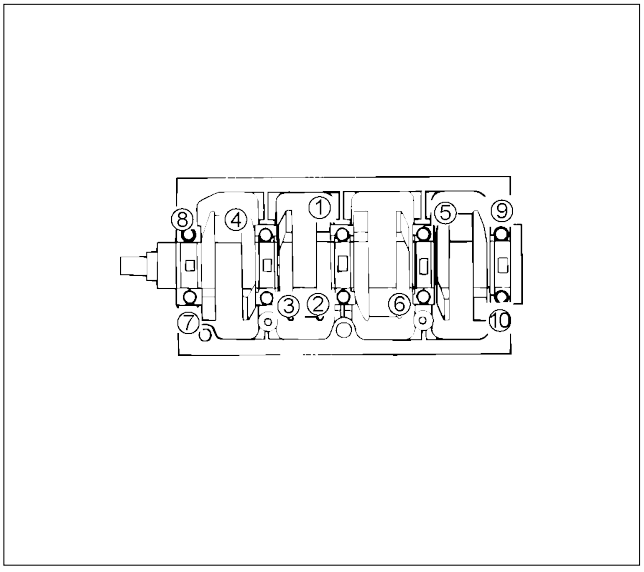
015LX128

   - Tighten the crankshaft bearing cap bolts to the specified torque a little at time in the sequence shown in the illustration.

Crankshaft Bearing Cap Torque	N·m (kg·m / lb ft)
166 (16.9 / 122)	

   Check to see the crankshaft turns smoothly by rotating it manually.

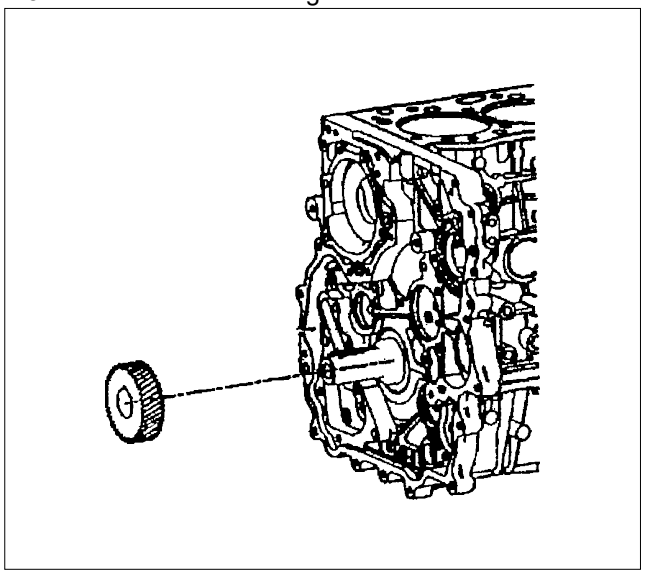
Note:
Confirm that the crankshaft turns smoothly.



015LX129

6. Install pistons and connecting rods.
   Refer to "Piston and Connecting Rod".

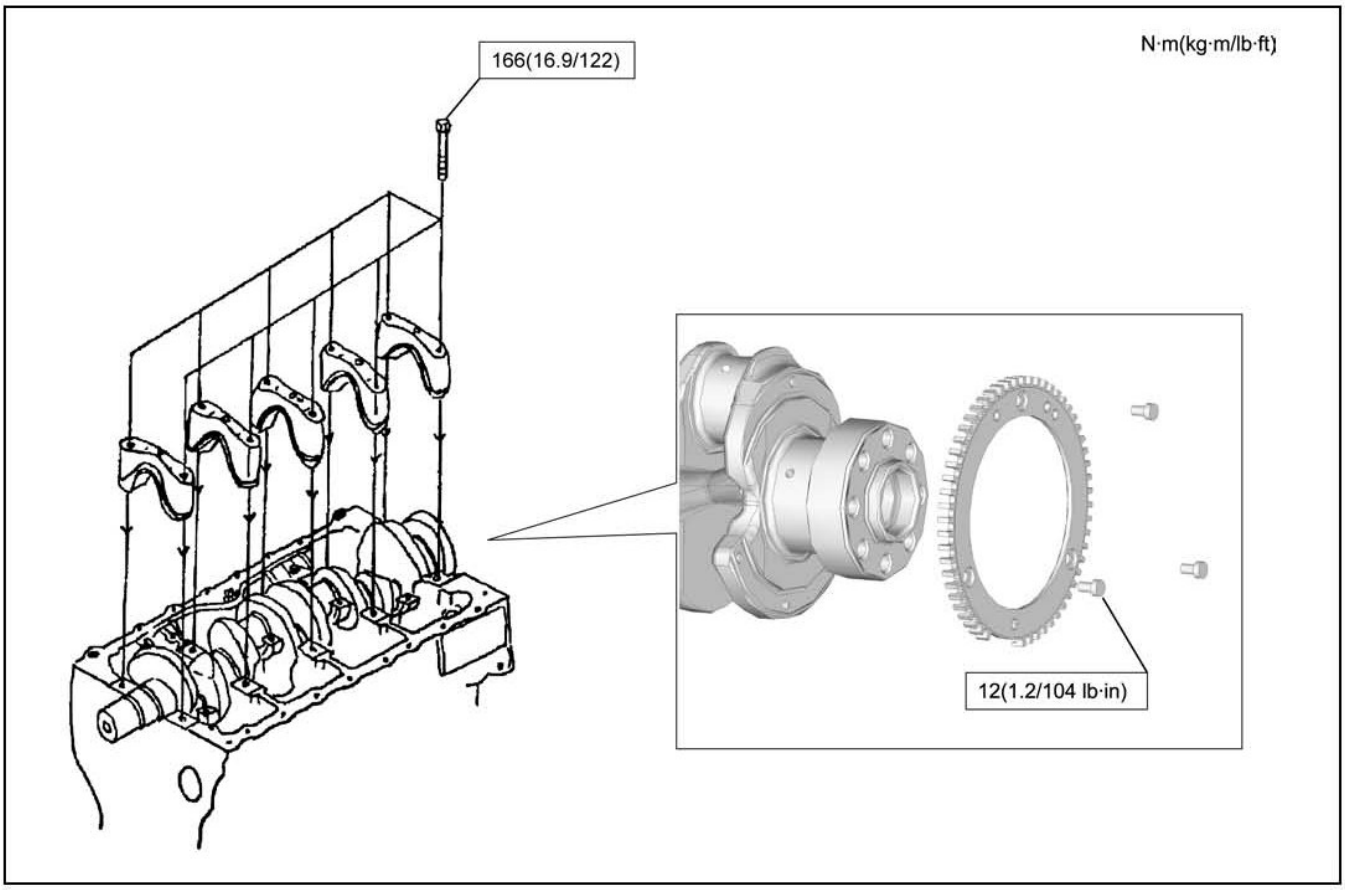
7. Install the crank case.
   Refer to "Crank Case and Oil Pan".
8. Install the crankshaft gear.



RTW56ASH017001

9. Install the gear case assembly.
   Refer to "Gear Case Assembly".
10. Install the oil pump.
    Refer to "Oil Pump".
11. Install the timing gear train.
    Refer to "Timing Gear Train".
12. Install the water pump.
    Refer to "Water Pump" in Cooling System Section.
13. Install the front cover.
    Refer to "Timing Gear Train".
14. Install the crankshaft rear oil seal.
    Refer to "Crankshaft Rear Oil Seal".
15. Install the fuel supply pump and fuel rail.
    Refer to "Fuel Supply Pump" and "Fuel Rail".
16. Install the cylinder head.
    Refer to "Cylinder Head".
17. Install the camshaft assembly.
    Refer to "Camshaft Assembly".
18. Install the cylinder head cover.
    Refer to "Cylinder Head Cover".
19. Mount the engine assembly on the chassis.
    Refer to "Engine Assembly".

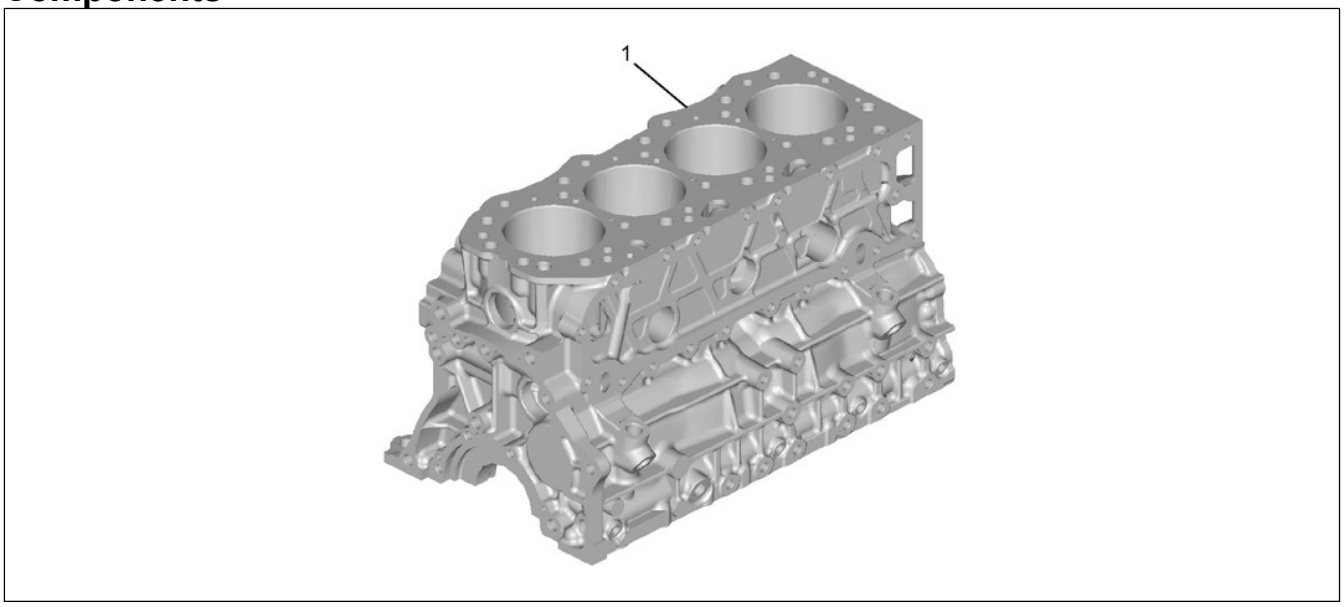
Torque Specifications



RTW76AMF000301

Cylinder Block

Components



RTW76ASF000101

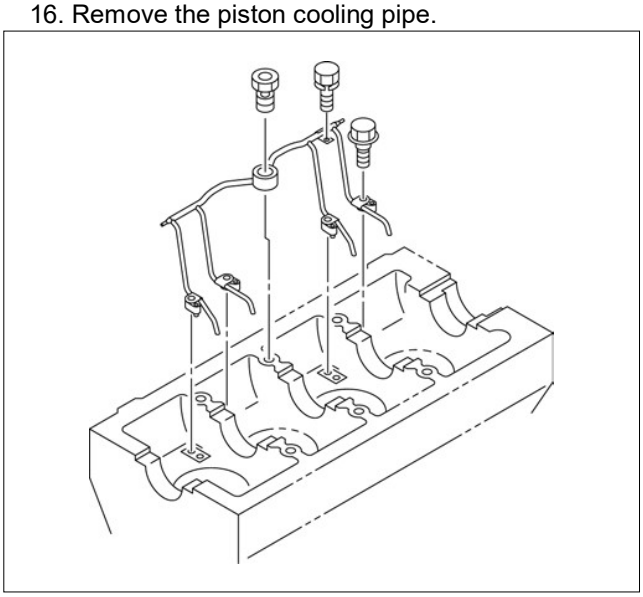
Legend

1. Cylinder Block

Removal

1. Demount the engine assembly.
   Refer to "Engine Assembly".
2. Remove the cylinder head cover.
   Refer to "Cylinder Head Cover".
3. Remove the camshaft assembly.
   Refer to "Camshaft Assembly".
4. Remove the cylinder head.
   Refer to "Cylinder Head".
5. Remove the fuel supply pump and fuel rail assembly.
   Refer to "Fuel Supply Pump" and "Fuel Rail Assembly" in FUEL SYSTEM Section.
6. Remove the oil filter assembly and oil cooler.
   Refer to “Oil Filter Assembly and Oil Cooler”.
7. Remove the crankshaft front oil seal.
   Refer to "Crankshaft Front Oil Seal".
8. Remove the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
9. Remove the oil pan.
   Refer to "Oil Pan".
10. Remove the water pump.
    Refer to "Water Pump" in Cooling System Section.
11. Remove the front cover.
    Refer to "Front Cover".
12. Remove the timing gear train.
    Refer to "Timing Gear Train".
13. Remove the oil pump.
    Refer to "Oil Pump".
14. Remove pistons and connecting rods.
    Refer to "Piston and Connecting Rod".
15. Remove the crankshaft.
    Refer to "Crankshaft".

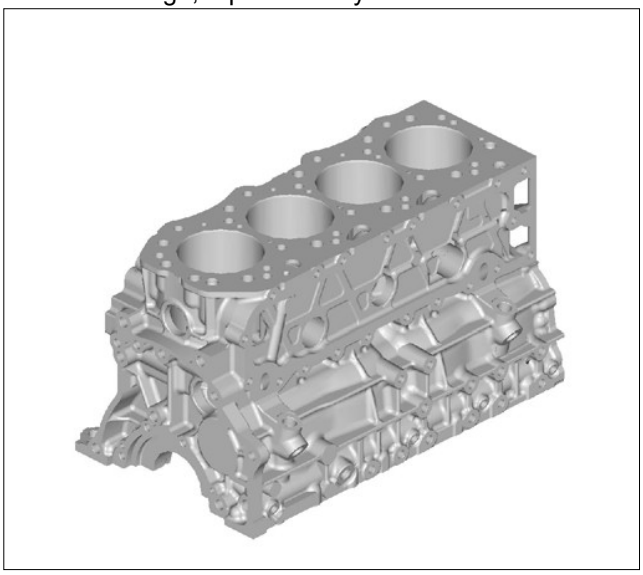
16. Remove the piston cooling pipe.



RTW76ASH001101

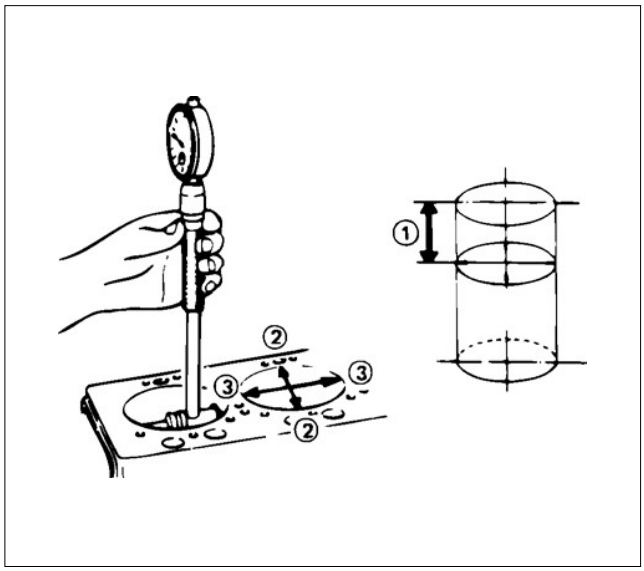
Inspection

1. Carefully remove water stains or other foreign matters on the surface of the cylinder block.
   - Be careful not to damage the cylinder block.
2. Carefully remove the liquid gasket on the crankcase mounting surface.
3. Clean up the cylinder block.
4. Visually inspect the cylinder block.
   - Conduct color check and hydraulic (or pneumatic) test and if you find a crack or other damage, replace the cylinder block.



RTW76ASH000801

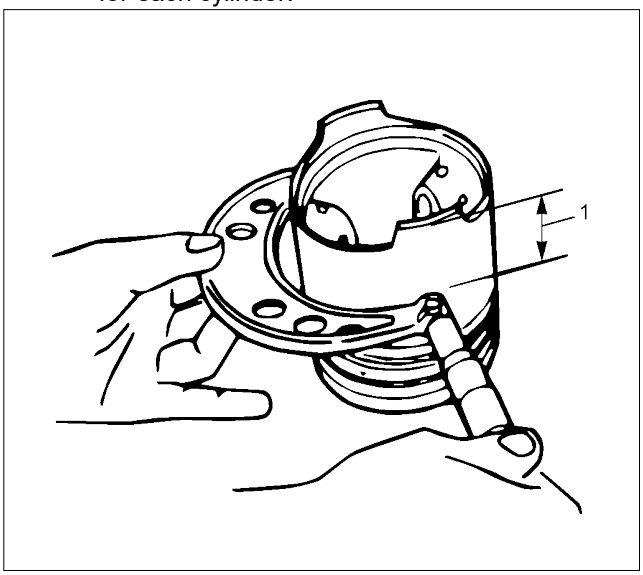
5. Cylinder block wear measurement.
   - Use a cylinder indicator to measure the cylinder bore at measuring point (1) in the thrust (2-2) and axial (3-3) directions of the crankshaft.
   - Measuring Point (1): 20 mm (0.79 in)
     If the measured value exceeds the specified limit, the cylinder block must be replaced or rebored.



012RY00010

Cylinder block bore diameter	mm (in)
Standard	95.421 – 95.450 (3.7567 – 3.7579)
Limit	95.48 (3.7590)

6. Cylinder Reboring.
   - Select oversize pistons to fit the largest cylinder bore (previously measured).
   - At a point 11 mm (0.43 in) above the lower edge of the piston skirt, measure the piston diameter at a right angle to the piston pin. Calculate the additional cylinder boring required for each cylinder.



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Legend

1. 11mm (0.43in)

- Formula
  Boring inside diameter = D + C - H ± E
  D = Piston outside diameter
  (Measured Oversize Piston)
  C = Piston and cylinder bore clearance
  0.082 - 0.100 mm (0.0032 - 0.0039 in)
  H = Honing allowance
  0.03 mm (0.0012 in) or less
  E = Boring machine error

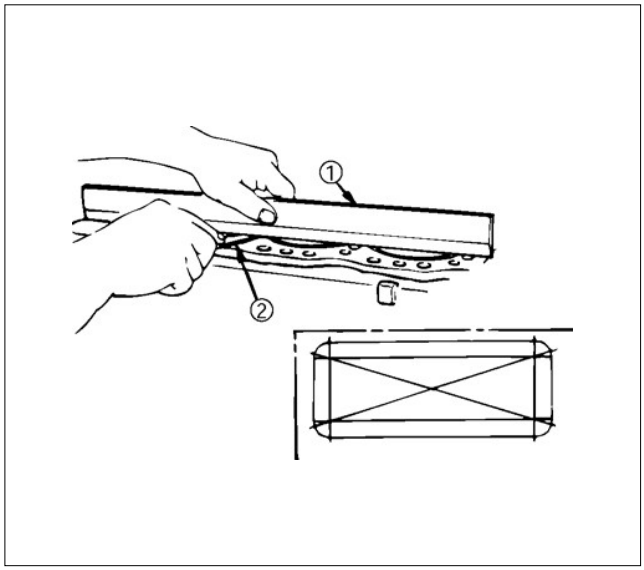
Piston size		mm (in)
Standard		95.330 - 95.359 (3.7531 - 3.7543)
Oversize	(0.25)	95.580 - 95.609 (3.7629 - 3.7641)
	(0.50)	95.830 - 95.859 (3.7728 - 3.7739)
	(0.75)	96.080 - 96.109 (3.7826 - 3.7838)

   - Bore and hone the individual cylinders as required.
   - Once again, measure the individual cylinder bores.

Each cylinder bore remainder	mm (in)
0.02 (0.0008) or less.	

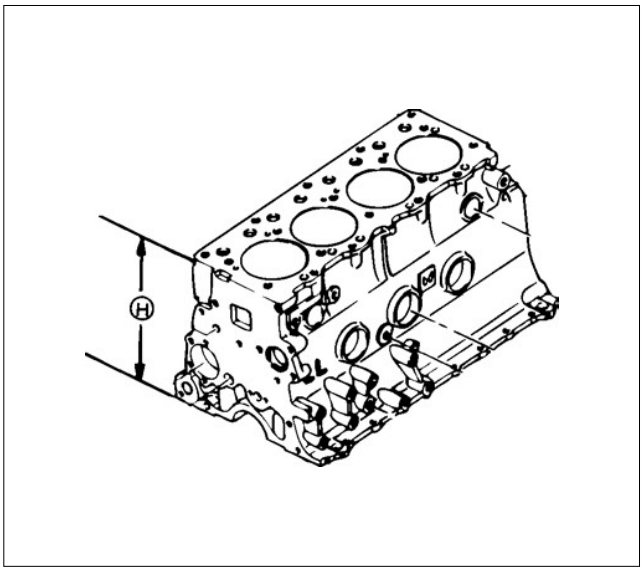
7. Cylinder block upper face warpage.
   - Use a straight edge (1) and a thickness gauge (2) to measure the four sides and the two diagonals of the cylinder block upper face.
   - If the measured values exceeds the limit, the cylinder block must be replaced.

Cylinder block upper face warpage		mm (in)
Standard	0.05 or less (0.002 or less)	
Limit	0.20 (0.0080)	



012R100001

Cylinder block height (H) (Reference)	mm (in)
Standard	259.945 – 260.055 (10.2340 – 10.2384)



012R100009

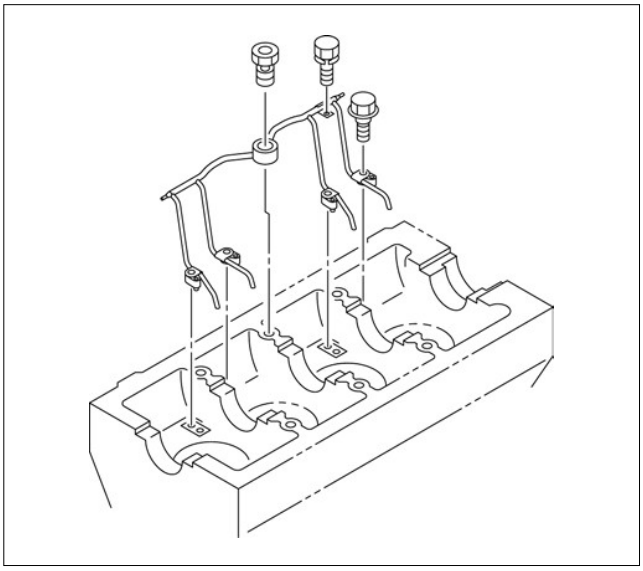
Installation

1. Install the piston cooling pipe.
   - Align the dowel pin of the piston cooling pipe with the pin hole on the cylinder block and tighten with the relief valve.

Tightening torque:

Relief valve	**30 N·m (3.1 kg·m / 22 lb ft)**
bolts M8	**25 N·m (2.5 kg·m / 18 lb ft)**
bolts M6	**8 N·m (0.8 kg·m / 69 lb in)**

Note:
Be careful not to deform or damage the piston cooling pipe nozzle.



RTW76ASH001101

2. Install the crankshaft.
   Refer to "Crankshaft".
3. Install pistons and connecting rods.
   Refer to "Piston and Connecting Rod".
4. Install the oil pump.
   Refer to "Oil Pump".
5. Install the timing gear train.
   Refer to "Timing Gear Train".
6. Install the front cover.
   Refer to "Front Cover".
7. Install the water pump.
   Refer to "Water Pump" in Cooling System Section.
8. Install the oil pan.
   Refer to "Oil Pan".
9. Install the crankshaft rear oil seal.
   Refer to "Crankshaft Rear Oil Seal".
10. Install the crankshaft front oil seal.
    Refer to "Crankshaft Front Oil Seal".
11. Install the oil filter assembly and oil cooler.
    Refer to "Oil Filter Assembly and Oil Cooler".
12. Install the fuel supply pump and fuel rail assembly.
    Refer to "Fuel Supply Pump" and "Fuel Rail Assembly " in Fuel System Section.
13. Install the cylinder head.
    Refer to "Cylinder Head".
14. Install the camshaft assembly.
    Refer to "Camshaft Assembly".
15. Install the cylinder head cover.
    Refer to "Cylinder Head Cover".
16. Mount the engine assembly on the chassis.
    Refer to "Engine Assembly".

Lubrication System

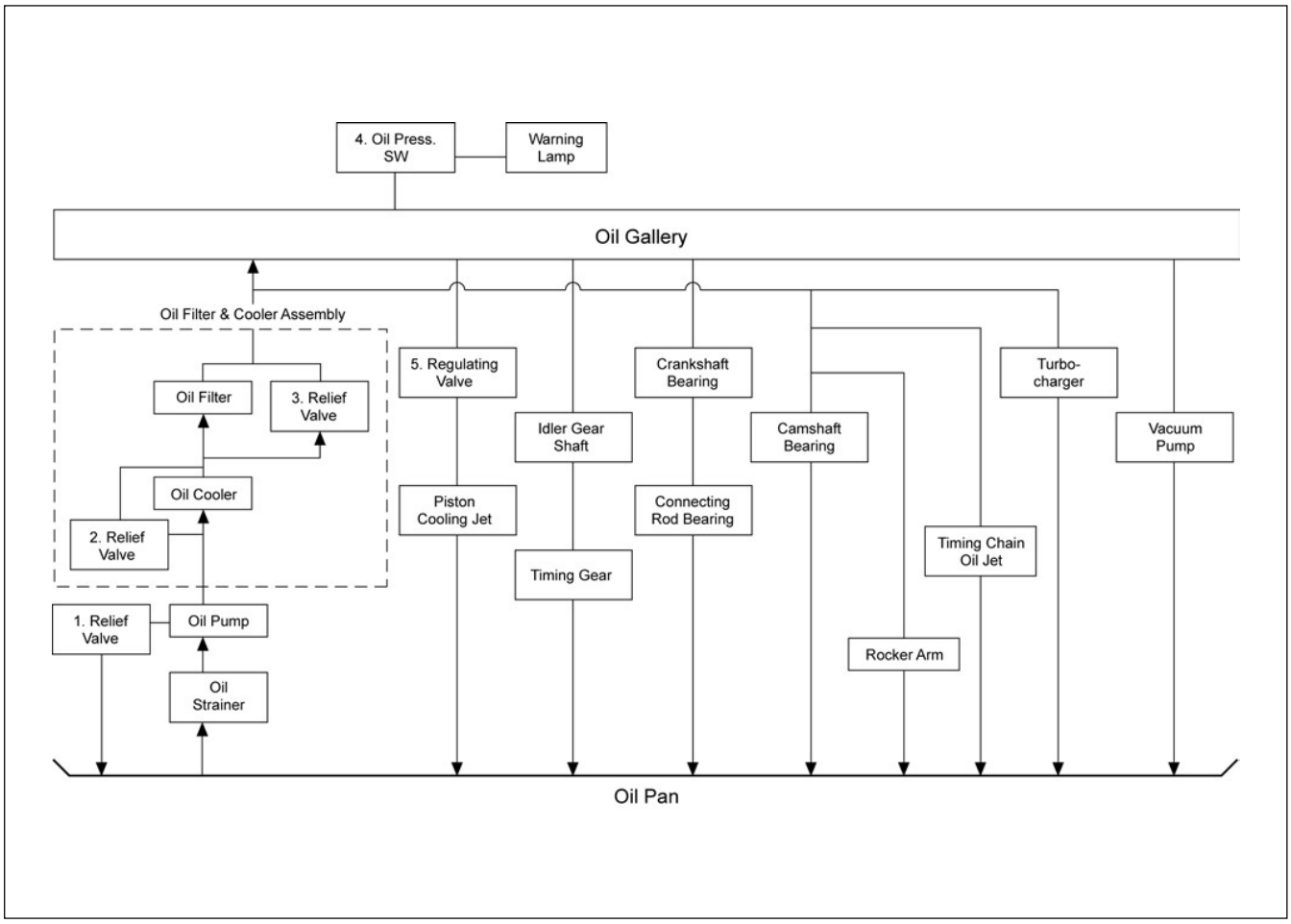
Service Precautions

- During each disassembly, remove the old gasket adhering to each part and mating part completely using a scraper at the location, where the fluid gasket is to be used, clean the traces of oil, moisture, and dirt completely using waste cotton and apply the specified new fluid gasket at each location.
- Avoid excessive or insufficient coating volume. Note that seizure may occur in case of excessive coating due to clogging of the oil gallery and oil jet, and oil and water leakage may occur if the coating is insufficient.
- Always, the start and end of the application should be overlapped.

Explanations on functions and operation

The lubrication system uses the filter element combined with a full flow bypass, water-cooled oil cooler, and oil jet for piston cooling.

Lubricating system diagram



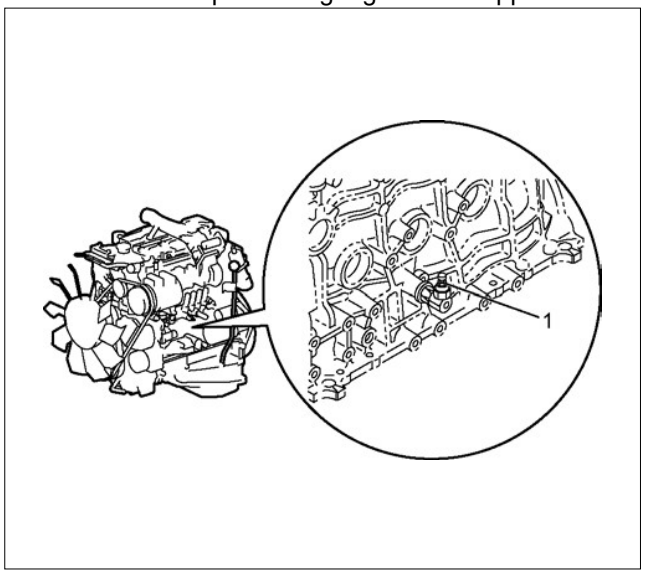
LNW76ALF000201

1. Oil Pump Relief Valve Operating Pressure: 490 – 686 kPa (5.0 – 7.0 kg/cm^2 / 71 – 100 psi)
2. Oil Cooler Relief Valve Opening Pressure: 176 – 216 kPa (1.8 – 2.2 kg/cm^2 / 26 – 31 psi)
3. Oil Filter Relief Valve Opening Pressure: 80 – 120 kPa (0.8 – 1.2 kg/cm^2 / 11 – 17 psi)
4. Oil Pressure Switch Operating Pressure: 29.4 – 49.0 kPa (0.3 – 0.5 kg/cm^2 / 4.3 – 7.1 psi)
5. Regulating Valve: 176 – 216 kPa (1.8 – 2.2 kg/cm^2 / 26 – 31 psi)

Functional Check

Oil pressure check

1. Check whether the engine oil is contaminated with dirt, light oil, or water. If contaminated with dirt, light oil, or water (after examining the cause and taking the appropriate measures for light oil or water contamination), replace the oil.
2. Check the engine oil level. The oil level should be between the two holes of the level gauge. If the oil level is insufficient, replenish it.
3. Remove the oil pressure switch on the nipple.
4. Install the oil pressure gauge on the nipple.



RTW56ASH015501

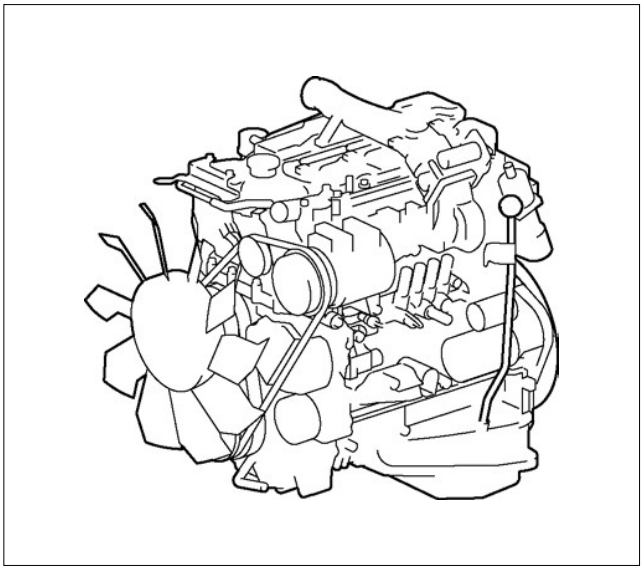
Legend

1. Oil Pressure Switch

5. Warm the engine.
6. Measure the oil pressure, to check whether it is more than 400 kPa (4 kg/cm^2 / 58 psi) at 3600 rpm.
7. Stop the engine.
8. Remove the oil pressure gauge.
9. Install the oil pressure switch.
10. Start the engine and check for oil leakage.

Engine oil

- Ensure the car is on level ground. Before starting the engine or when 30 minutes or more have elapsed after stopping the engine, check the engine oil volume using the level gauge. The volume is appropriate if the engine oil is between the upper and lower limits of the level gauge. Replenish the engine oil, if level is below the lower limit. Also, check for contamination of the engine oil.



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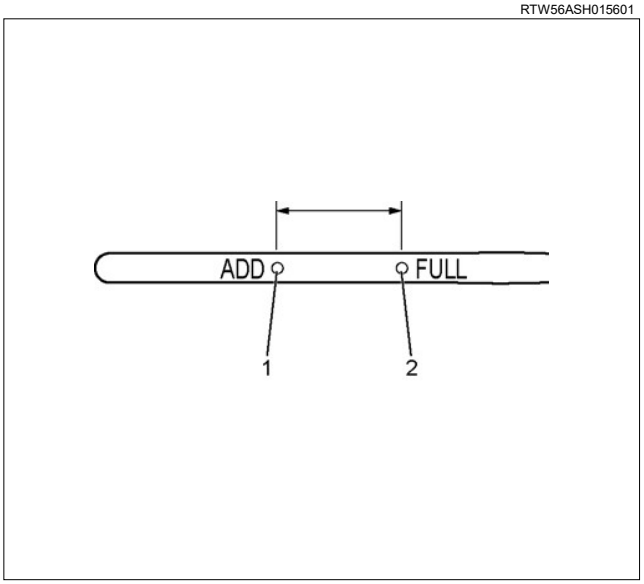


RTW56ASH015701

Legend

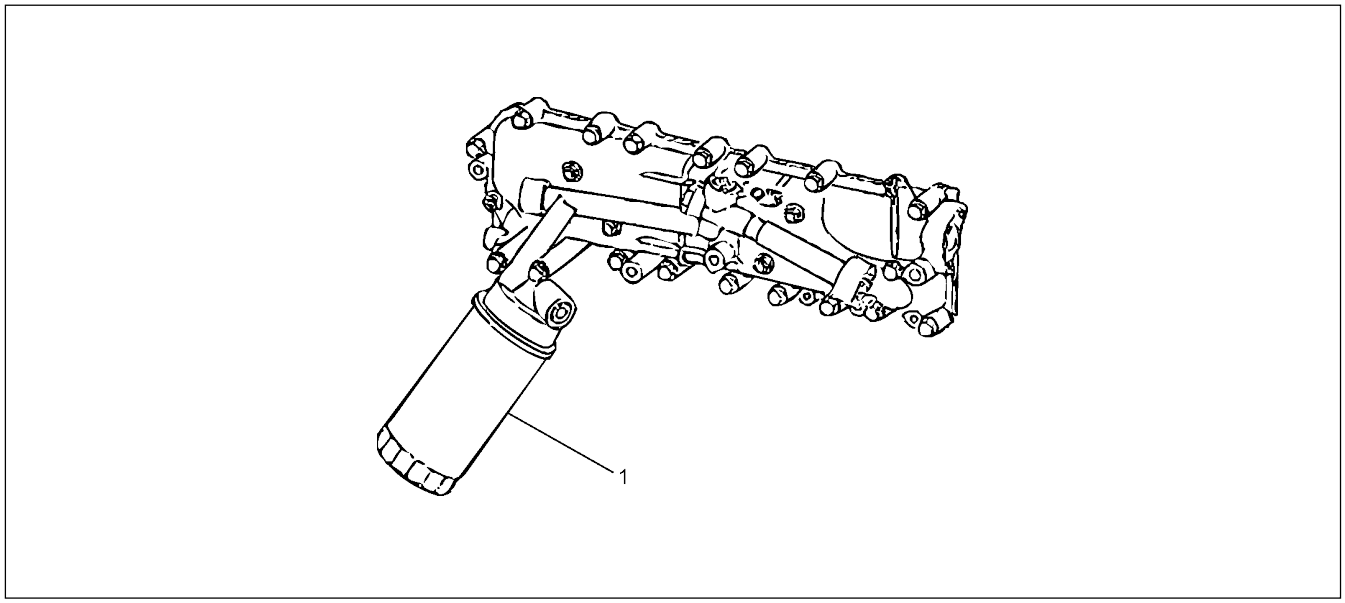
1. Lower Limit
2. Upper Limit

Engine oil leakage

- In the lift up condition, confirm that there are no leaks from the cylinder head cover and oil pan.

Oil Filter Cartridge

Components



RTW56ASF000101

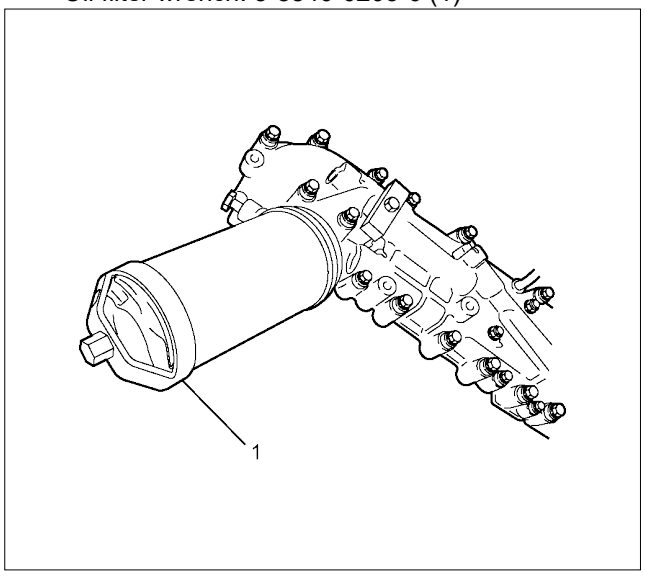
Legend

1. Oil Filter Cartridge

Removal

1. Place a tray under the oil filter cartridge.
2. Remove the oil filter cartridge using the oil filter wrench.

   Special tool
   Oil filter wrench: 5-8840-0203-0 (1)



RTW56ASH012501

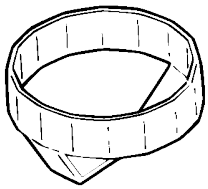
Installation

1. Install the oil filter cartridge.
   - Apply grease or engine oil to the seal in the cartridge and install it using the oil filter wrench.
   - Tighten the cartridge using the specified torque.

   Tightening torque: 20 N·m (2.0 kg·m / 14 lb ft)
   Or
   After it comes in contact with the oil seal, tighten it through an additional turn of 1 and 1/4.

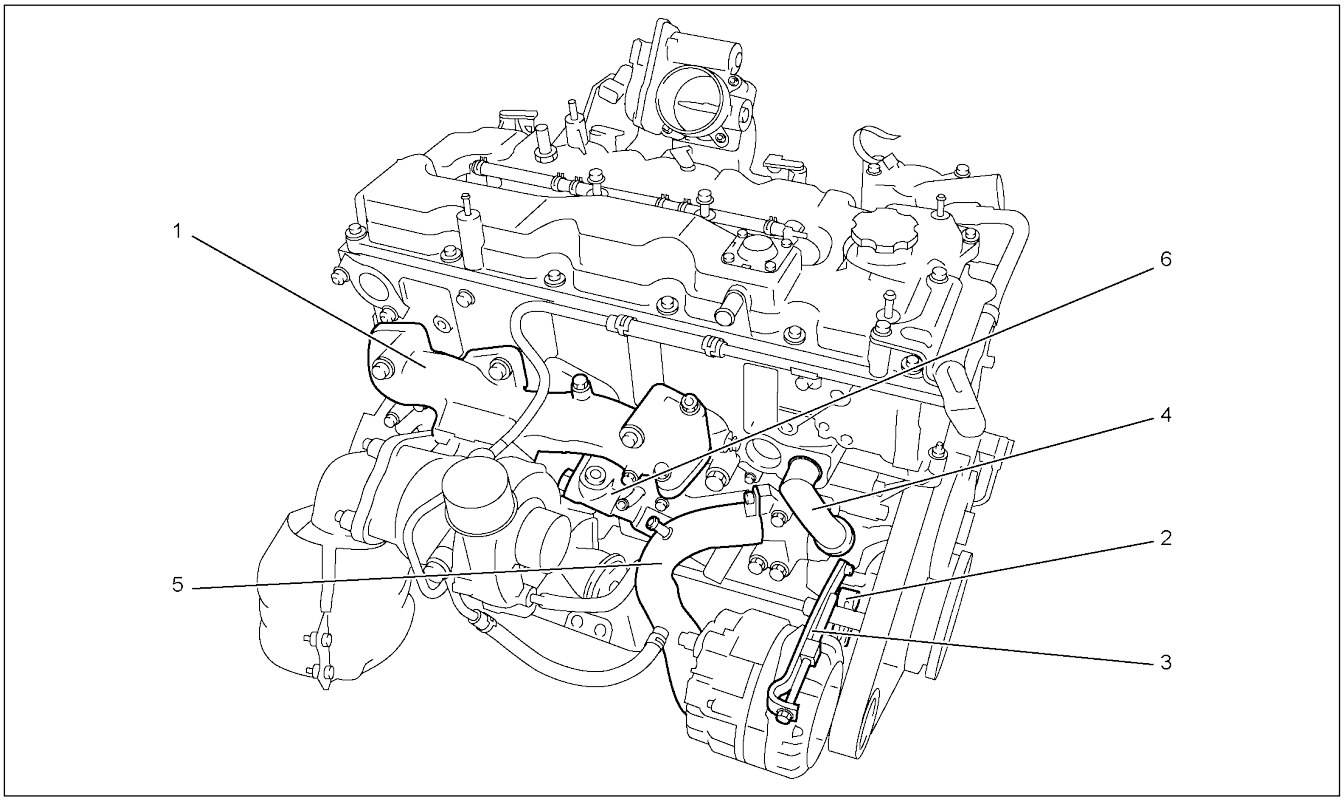
   Special tool
   Oil filter wrench: 5-8840-0203-0

Special Tools

ILLUSTRATION	PART NO. PART NAME
 5884002030	**5-8840-0203-0** Oil filter wrench

Oil Filter Assembly and Oil Cooler

Components



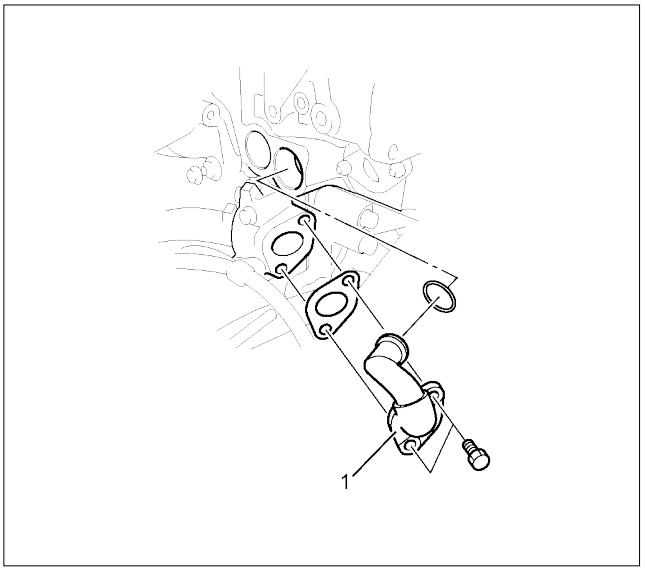
RTW56AMF000401

Legend

1. Exhaust Manifold
2. Generator Bracket
3. Generator Adjustment Bracket
4. Water Bypass Pipe
5. Water Intake Pipe
6. Oil Filter Assembly and Oil Cooler

Removal

1. Remove the exhaust manifold.
   Refer to removal procedure for "Turbocharger and Exhaust Manifold" in this manual.
2. Remove the generator.
   Refer to removal procedure for generator in this manual.
3. Remove the adjustment bracket of generator.
4. Remove the bracket of generator.
5. Remove the water bypass pipe (1).



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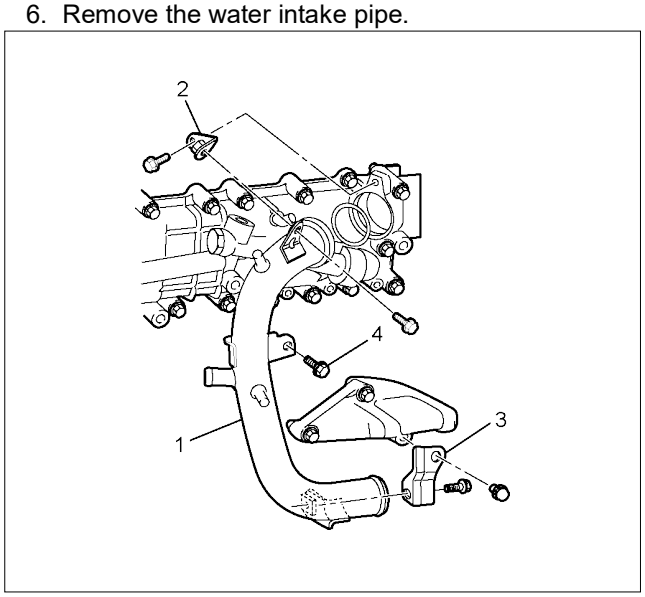
6. Remove the water intake pipe.

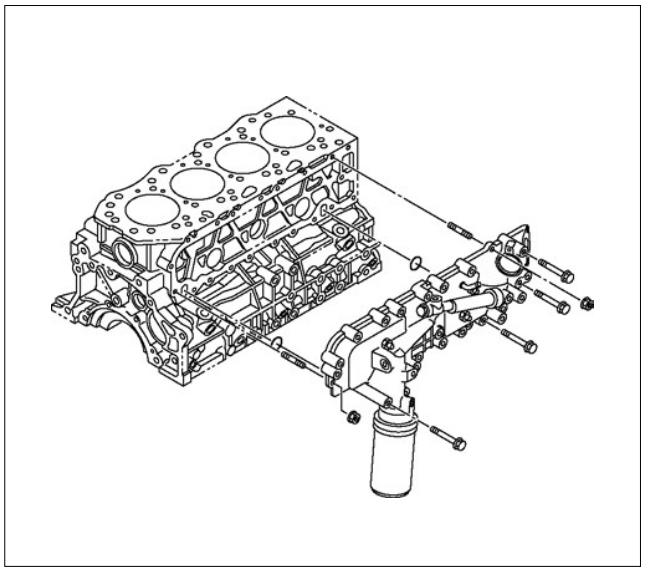


RTW56ASH012601

Legend

1. Water Intake Pipe
2. Bracket
3. Bracket
4. Bolt

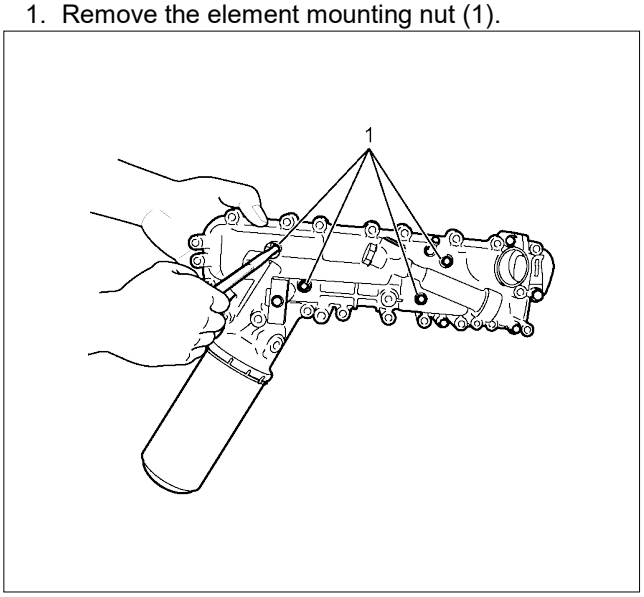
7. Remove the oil cooler.



RTW66ASH009101

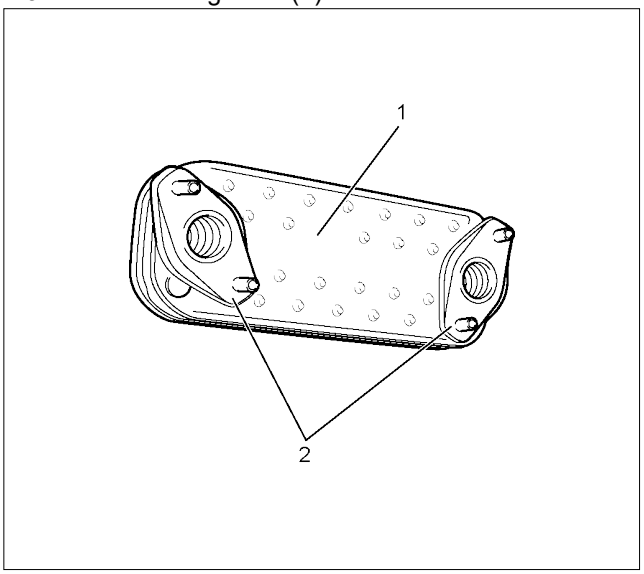
Disassembly

1. Remove the element mounting nut (1).



RTW56ASH012901

2. Remove the element (1).
3. Remove the gasket (2).



RTW56ASH013001

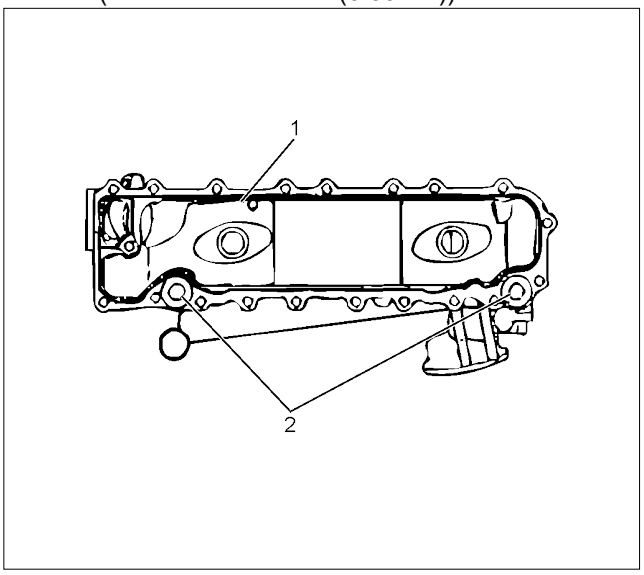
Reassembly

1. Install the gasket on the element.
2. Install the element.
3. Tighten the element fixing nut using the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

Installation

1. Install the oil filter and cooler.
   - Install the O-ring on the oil filter and cooler, apply grease.
   - Apply the liquid gasket and mount within 5 minutes. Apply liquid gasket (ThreeBond TB-1207C or equivalent) to the flange surface groove (cylinder block). Bead diameter must be between 2 and 3 mm (0.079 and 0.118 in). Refer to the illustration for the offset position (no more than 1 mm (0.004 in)).

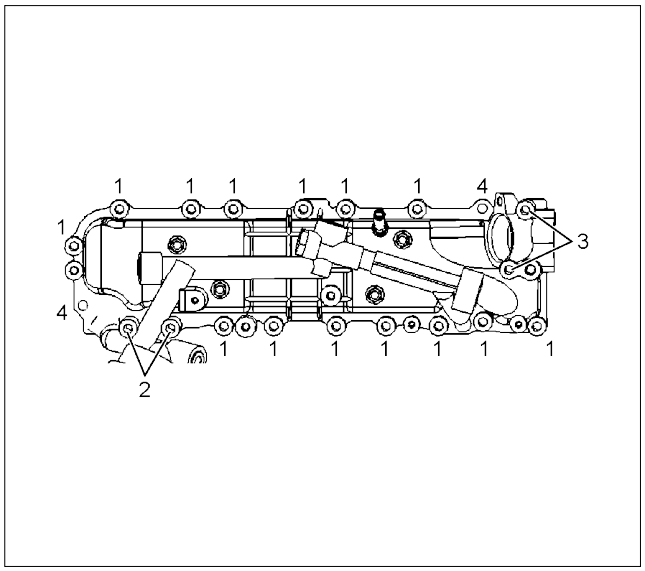


RTW56ASH013101

Legend

1. Liquid Gasket
2. O-ring

   - Align the oil filter and cooler holes with the cylinder block studs. Install the oil cooler to the cylinder clock.



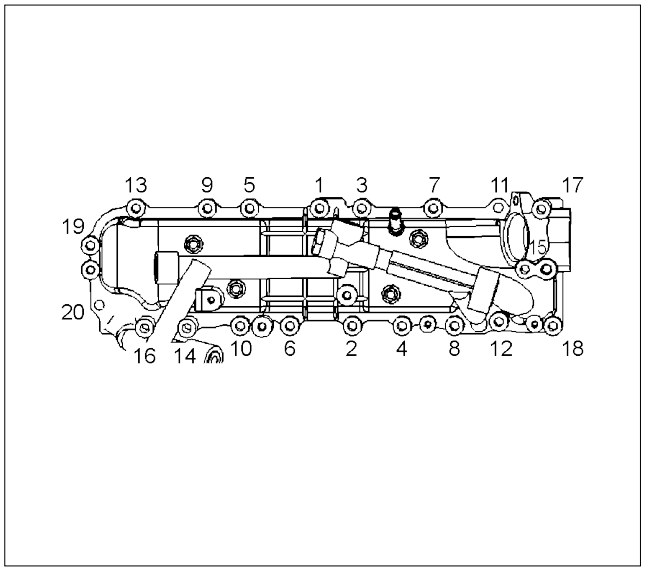
RTW56ASH013201

Legend

1. Bolt 45 mm (1.77 in)
2. Bolt 110 mm (4.33 in)
3. Bolt 70 mm (2.76 in)
4. Nut

- Tighten the bolts to the specified torque in the order shown in the illustration.

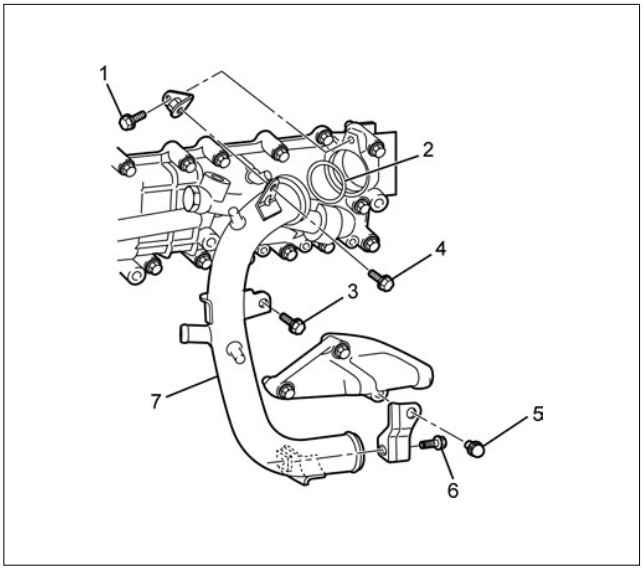
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH013301

2. Install the water intake pipe.
   a. Temporarily tighten the bolt (6).
   b. Install the O-ring (2) to the water intake pipe (7).
   c. Apply soapy water to the O-ring (2) and install the water intake pipe (7).
      - Take care not to twist the O-ring.
   d. Temporarily tighten the bolts.
      Temporary tightening order: 1→3→4→5
   e. Tighten the bolts to the specified torque.
      Fully tightening order: 3→4→1→5→6

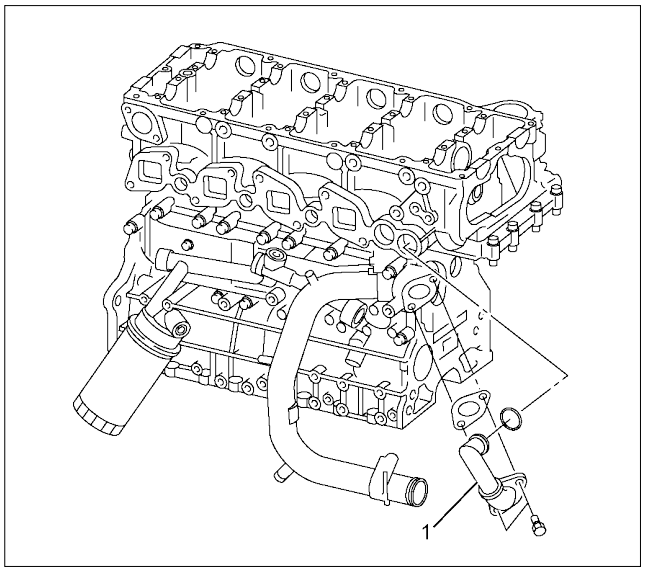
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW76ASH001701

3. Install the water bypass pipe (1).
   - After applying soapy water to O-ring, set it on bypass pipe and insert into the cylinder head. Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH008401

4. Install the bracket of generator.
   Tighten the bolts to the specified torque.

Tightening torque: 51 N·m (5.2 kg·m / 38 lb ft)

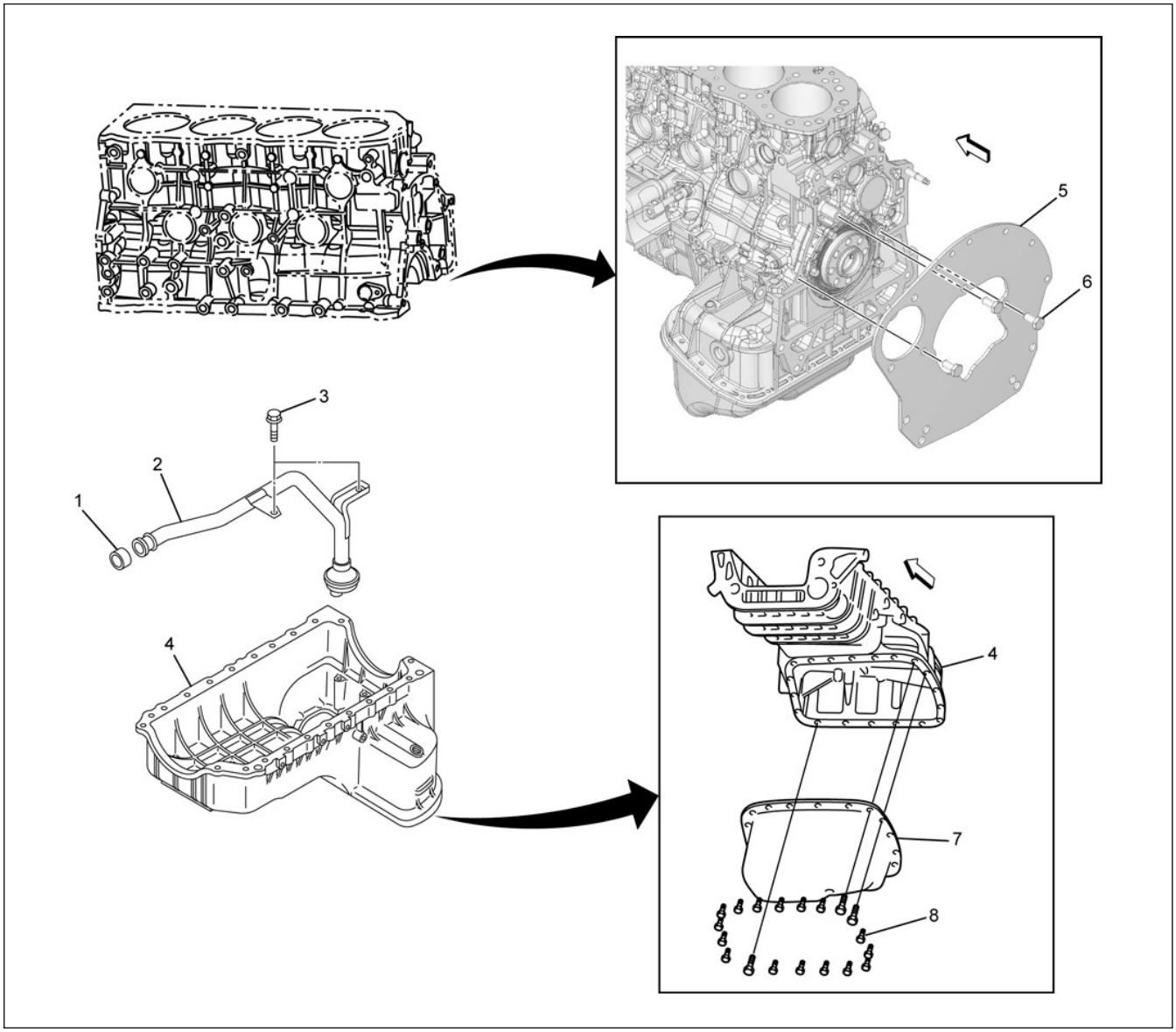
5. Install the adjustment bracket of generator.
   Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

6. Install the generator.
   Refer to Installation procedure for generator in this manual.
7. Install the exhaust manifold.
   Refer to Installation procedure for turbocharger and exhaust manifold in this manual.

Crank Case and Oil Pan

Components



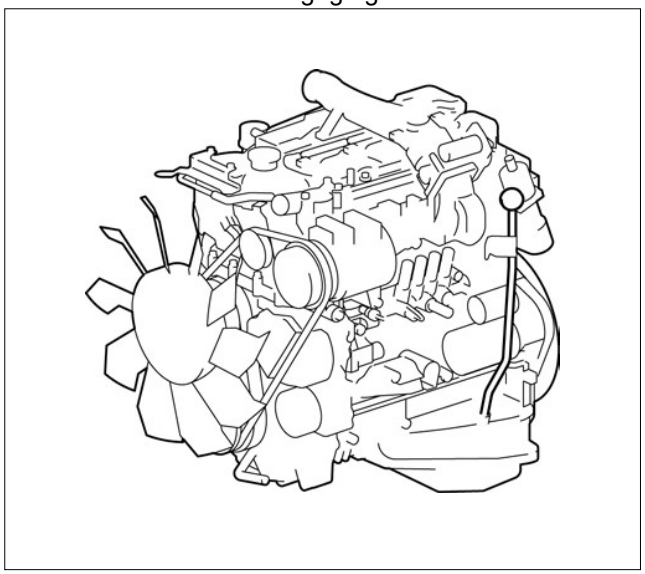
RTW76ALF000801

Legend

1. Gasket
2. Oil Strainer
3. Bolt
4. Crank Case
5. Rear Plate
6. Bolt
7. Oil Pan
8. Bolt

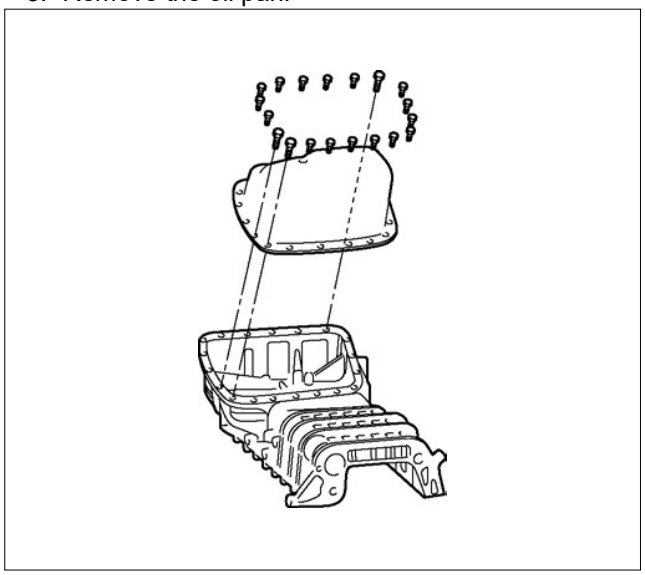
Removal

1. Remove the engine assembly.
   Refer to “Engine Assembly”.
2. Remove the oil level gage guide tube.



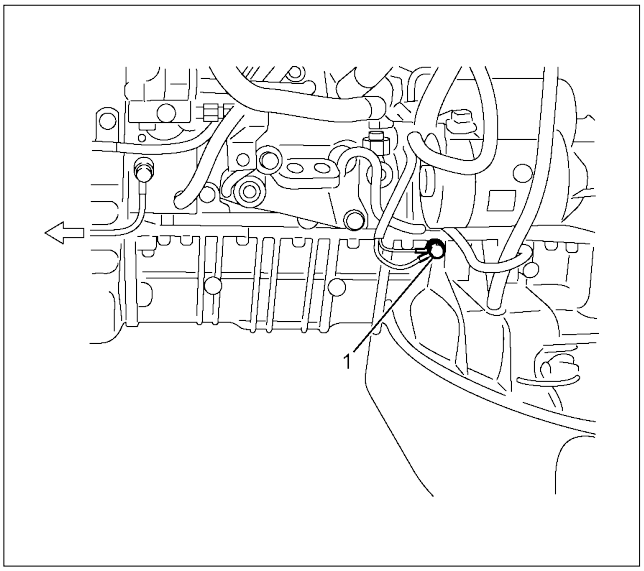
RTW56ASH015601

3. Remove the oil pan.



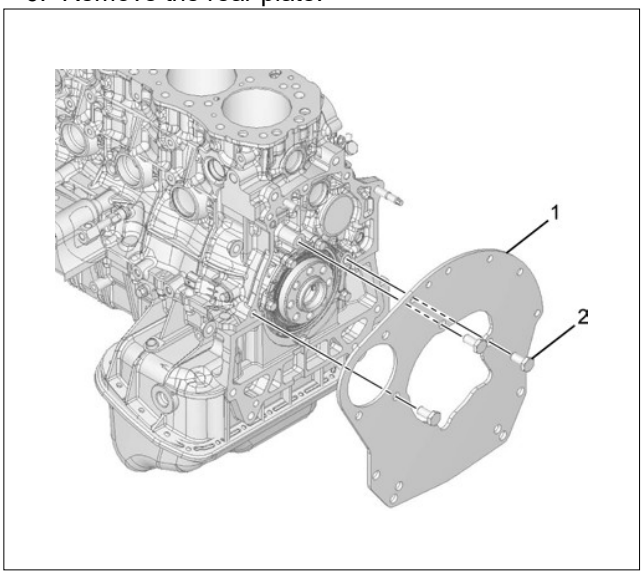
RTW56ASH015001

4. Disconnect the earth terminal (1) of crank case side.



RTW76ASH001801

5. Remove the flywheel.
   Refer to “Flywheel”.
6. Remove the rear plate.

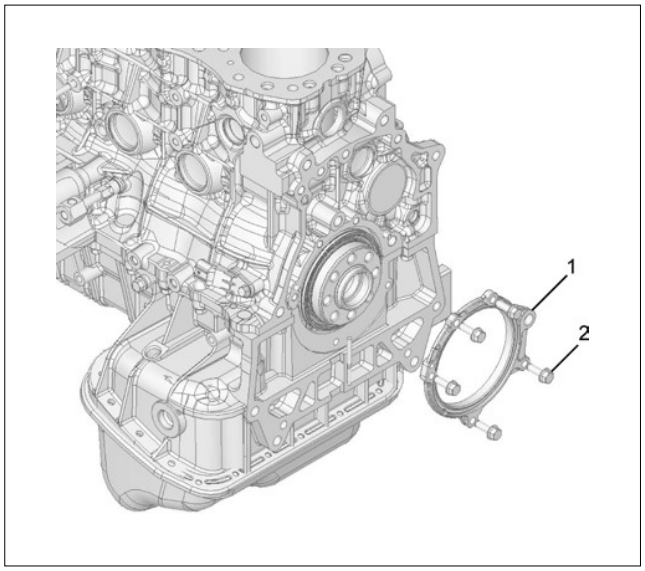


RTW76ASH001901

Legend

1. Rear Plate
2. Bolt

7. Remove the cylinder head.
   Refer to “Cylinder Head”.
8. Remove the timing gear case.
   Refer to “Timing Gear Case”.
9. Remove the retainer.

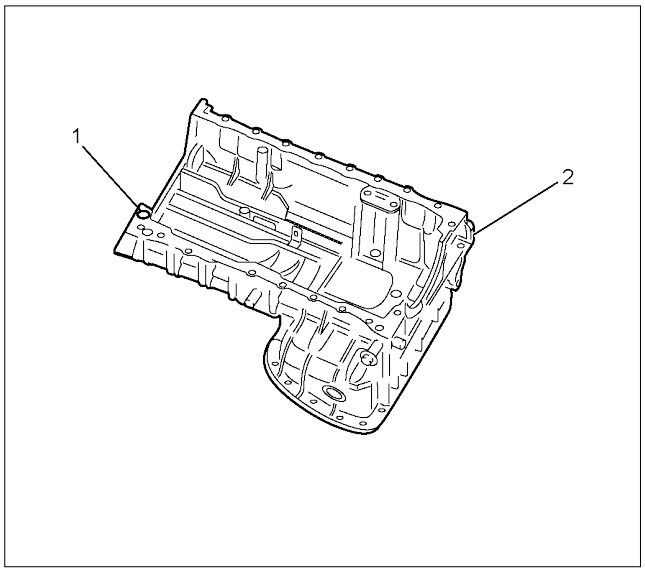


RTW76ASH002001

Legend

1. Retainer
2. Bolt

10. Remove the crank case.



RTW56ASH021901

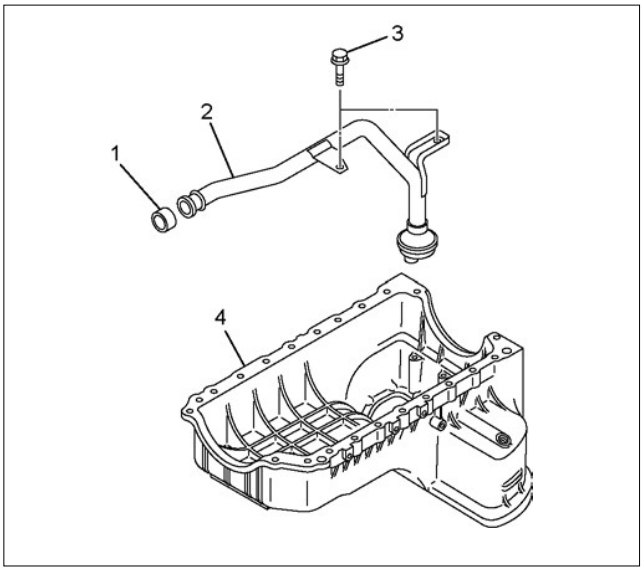
Legend

1. O-ring
2. Crank Case

Note:
Take care not to damage the O-ring.

Disassembly

1. Remove the oil strainer.



RTW66ASH009201

Legend

1. Gasket
2. Oil Strainer
3. Bolt
4. Crank Case

Reassembly

Install the oil strainer.

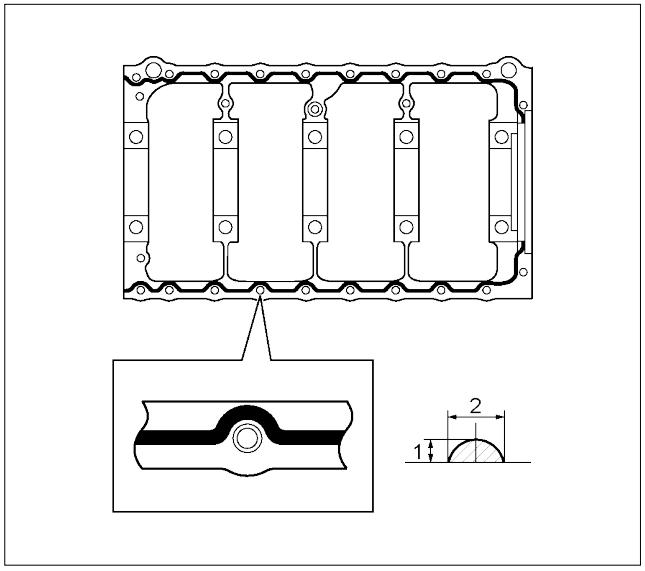
- Install the gasket on the strainer.
- Tighten the bolts to the specified torque.

Tightening torque: 22 N·m (2.2 kg·m / 16 lb ft)

Installation

1. Install the crank case.
   - Apply the liquid gasket (ThreeBond TB-1207C or equivalent) and mount within 5 minutes.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



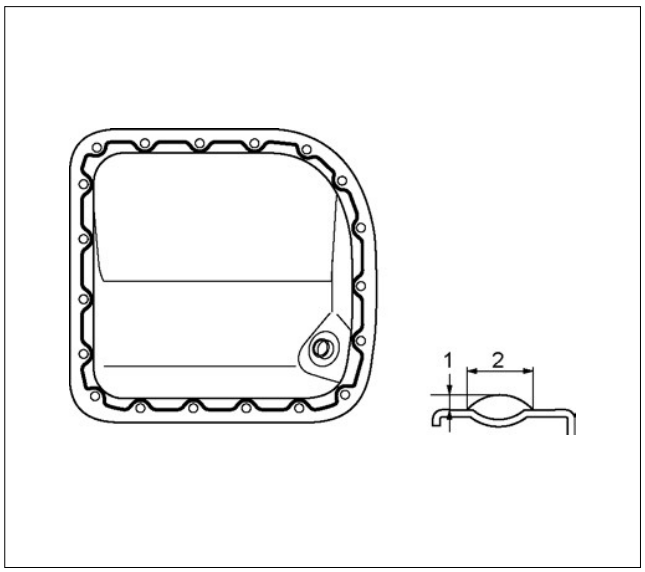
RTW56ASH015301

Legend

1. 2.0 - 3.0 mm (0.079 - 0.118 in)
2. 4.0 - 5.0 mm (0.157 - 0.197 in)

2. Install the oil pan.
   - Apply the liquid gasket (ThreeBond TB-1207B or equivalent)and mount within 5 minutes.

Tightening torque: 22 N·m (2.2 kg·m / 16 lb ft)



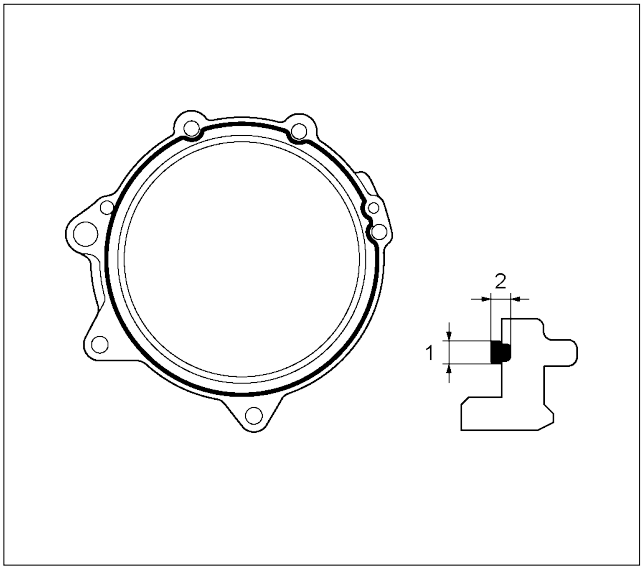
RTW56ASH015201

Legend

1. 2.0 mm (0.079 in)
2. 3.0 mm (0.118 in)

3. Install the retainer.
   - Apply the liquid gasket (ThreeBond TB-1207C or equivalent) and mount within 5 minutes.

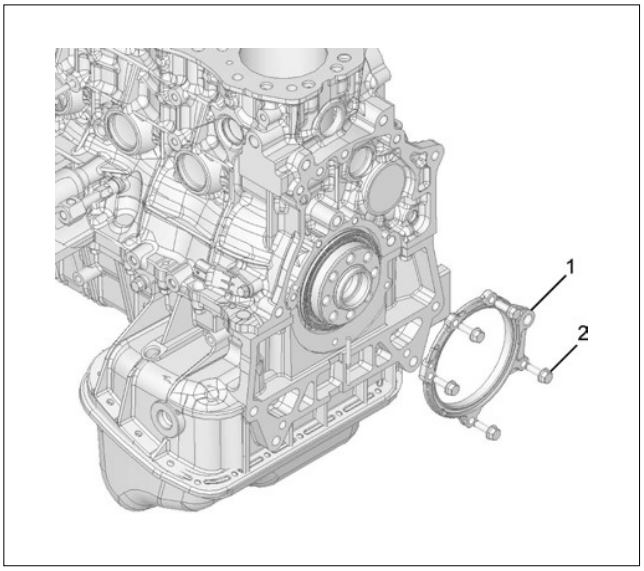
Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)



RTW56ASH017701

Legend

1. 2 - 2.5 mm (0.079 - 0.098 in)
2. 2 - 2.5 mm (0.079 - 0.098 in)



RTW76ASH002001

Legend

1. Retainer
2. Bolt

4. Install the timing gear case.
   Refer to “Gear Case Assembly”.
5. Install the cylinder head.
   Refer to “Cylinder Head”.

6. Install the rear plate.
   - Tighten the bolts to the specified torque.

Tightening torque: 82 N·m (8.4 kg·m / 61 lb ft)

7. Install the flywheel.
   Refer to “Flywheel”.
8. Connect the earth terminal of crank case side.

Note:
Do not allow the caulked portion of the terminal to interfere with nearby parts.

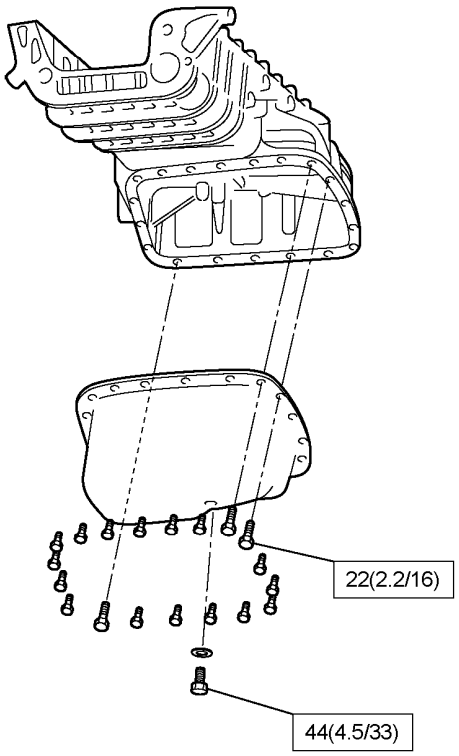
9. Install the oil level gage guide tube.
   - Apply the engine oil to the O-ring.
   - Tighten the bolts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

10. Install the engine assembly.
    Refer to “Engine Assembly”.

Torque Specifications

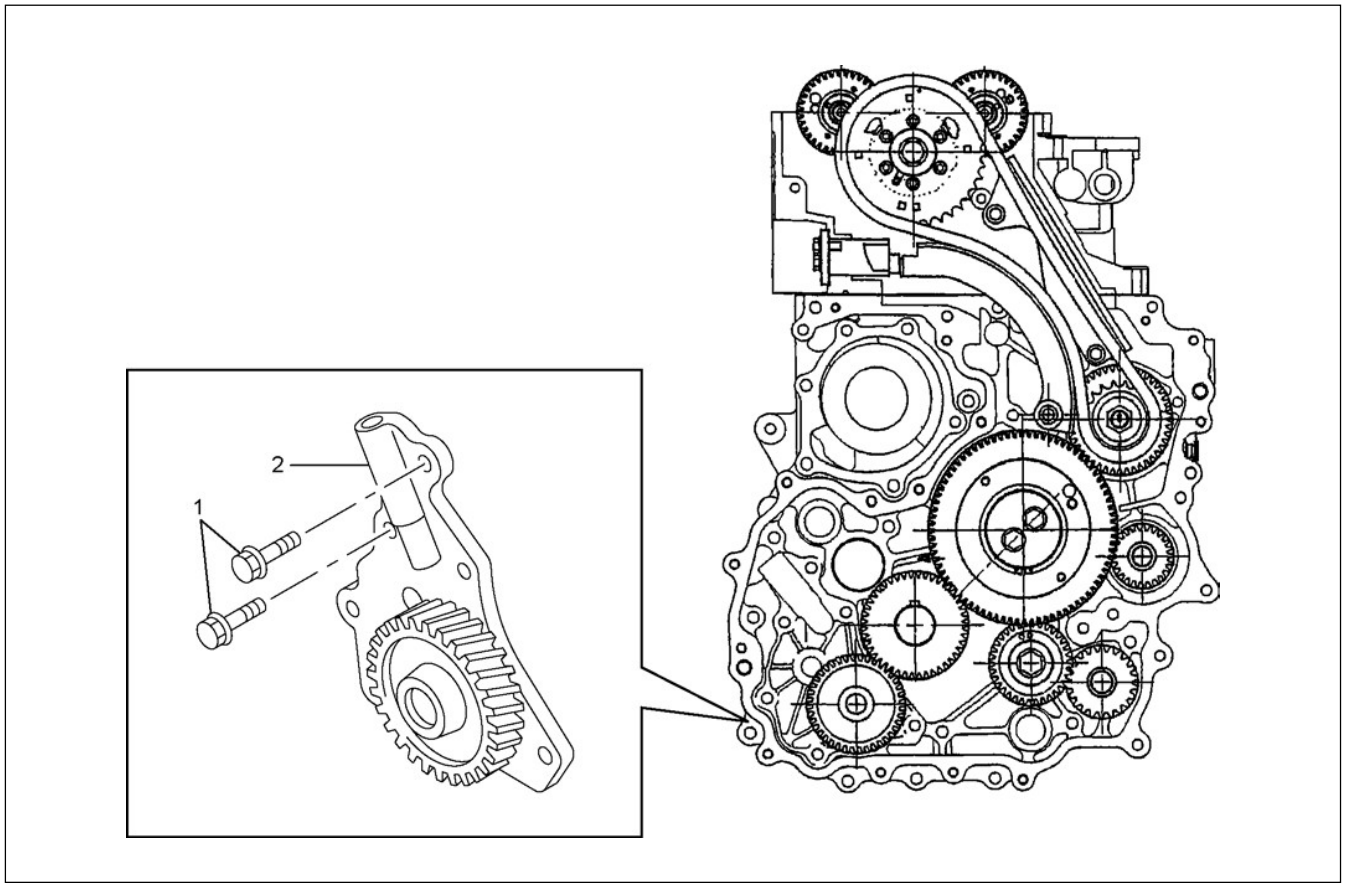
N·m(kg·m/lb ft)



RTW56AMF001901

Oil Pump

Components



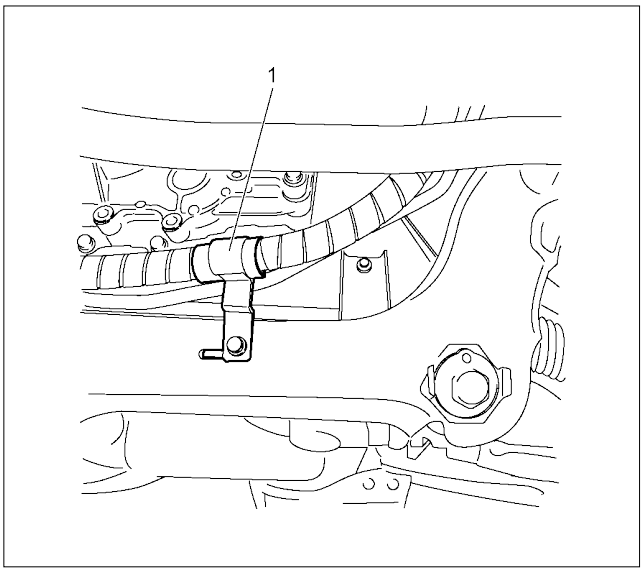
RTW66AMF000701

Legend

1. Bolt
2. Oil Pump Assembly

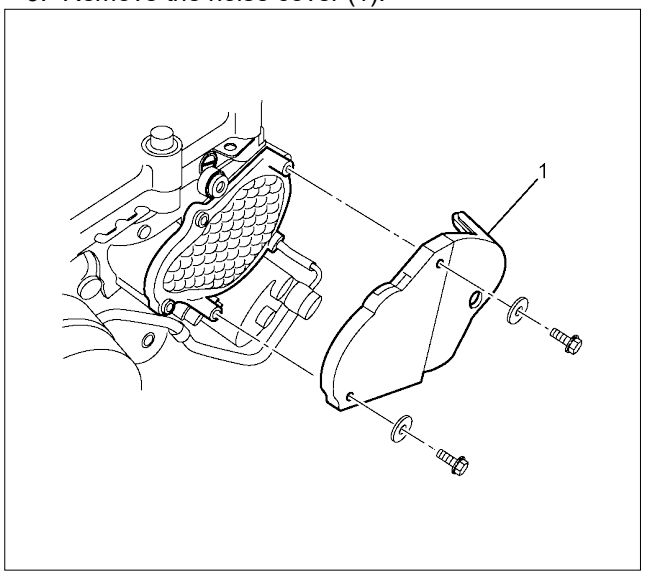
Removal

1. Drain the engine coolant.
2. Remove the radiator upper hose.
3. Remove the upper fan shroud.
4. Remove the fan and fan clutch.
   - Loosen the fan clutch nuts.
   - Remove the fan together with the fan clutch. Take care not to damage the radiator core.
5. Remove the fan drive belt and pulley.
   - Loosen the tension adjust bolt on the generator and A/C.
   - Remove the fan drive belt with the fan pulley.
6. Remove the lower fan shroud.
7. Disconnect the power steering pump.
   - Disconnect the bracket of the power steering oil hose clip (1).



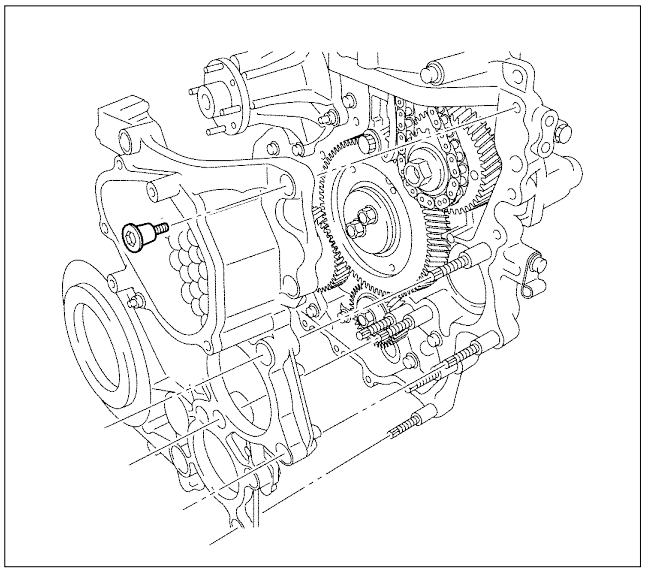
LTW56ASH000101

8. Remove the vacuum pump.
   - Remove the vacuum pipe bracket and vacuum pipe.
   - Remove the oil pipe (feed side and return side) of vacuum pump.
9. Remove the noise cover (1).



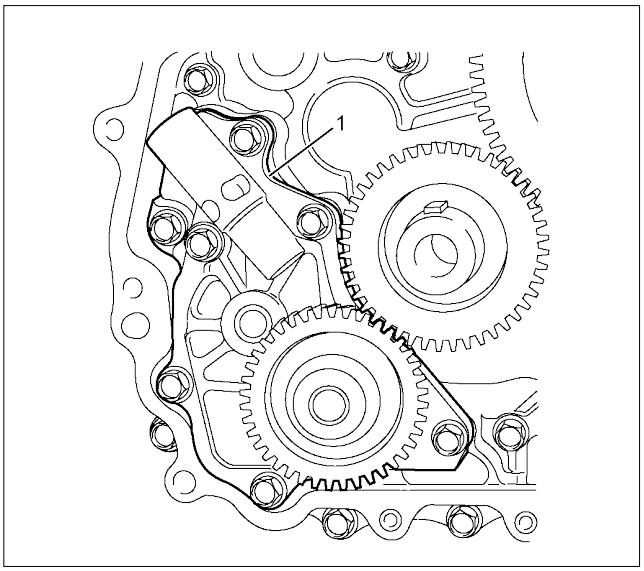
RTW56CSH001401

10. Remove the crank pulley.
11. Remove the front cover.



RTW56ASH019701

12. Remove the oil pump (1).



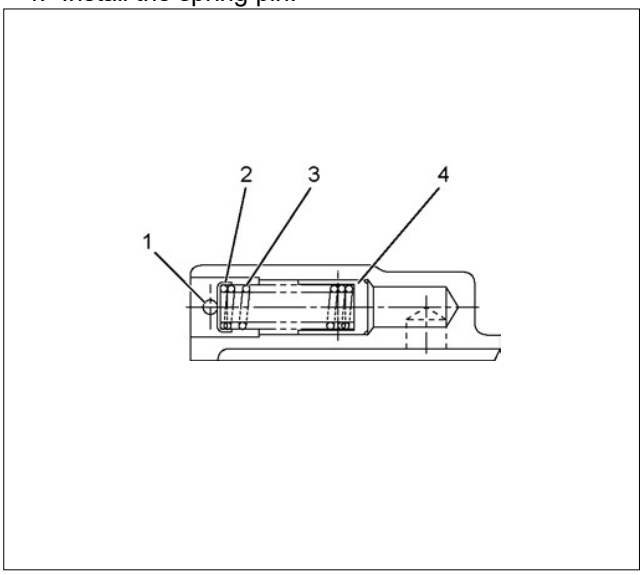
RTW56ASH020001

Disassembly

1. Remove the spring pin.
2. Remove the spring seat.
3. Remove the spring.
4. Remove the valve.

Reassembly

1. Install the valve.
2. Install the spring.
3. Install the spring seat.
4. Install the spring pin.



RTW56ASH015901

Legend

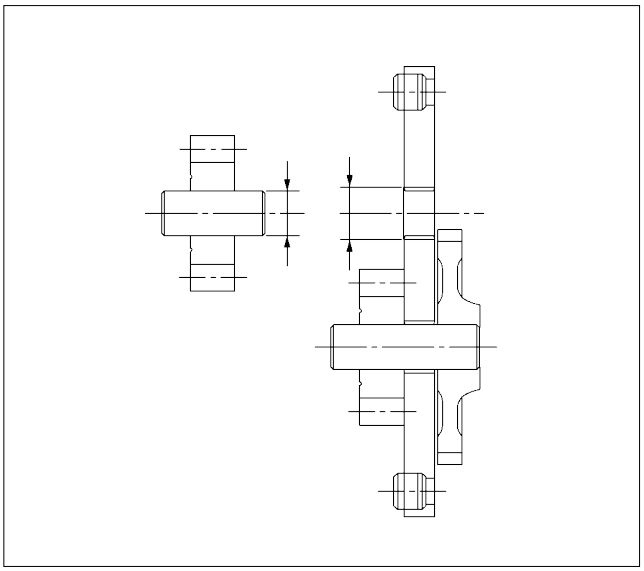
1. Spring Pin
2. Spring Seat
3. Spring
4. Valve

Inspection

NOTE:
Think to match direction of ditch of gear when assembling it.

1. Measure the clearance between the driven gear/drive gear shaft and the bush.
   - Measure the outside diameter of the driven gear shaft using a micrometer.

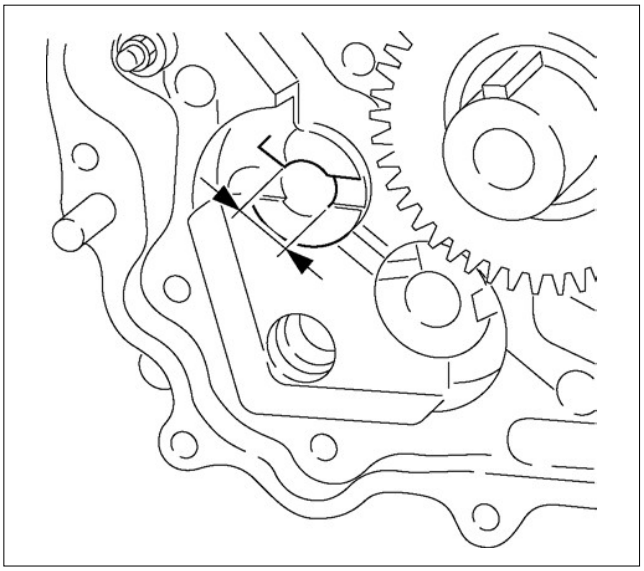
Outside diameter of the driven gear shaft/drive gear shaft	mm (in)
Standard	15.989 - 16.000 (0.62949 - 0.62992)
Limit	15.900 (0.62598)



RTW56ASH025601

   - Measure the inside diameter of the bushes of the cylinder block using the dial gauge.
   - If the clearance between the driven gear shaft/drive gear shaft and bush exceeds the limit, replace the oil pump assembly.

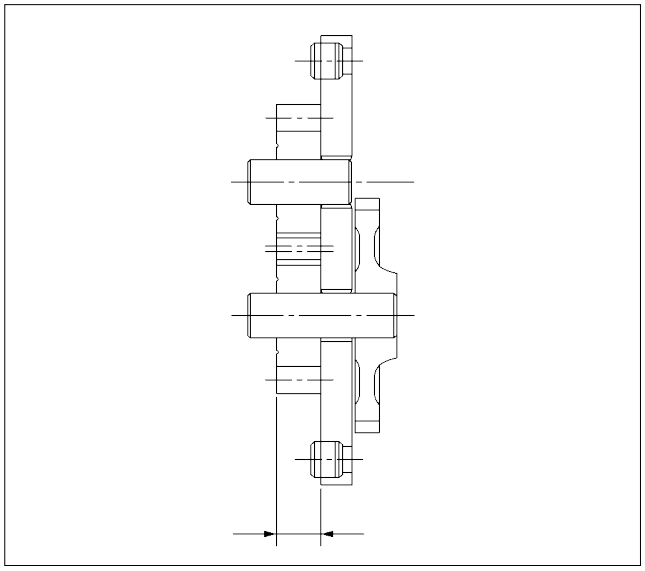
Clearance between the driven gear shaft/drive gear shaft and bush	mm (in)
Standard	0.04 - 0.07 (0.0016 - 0.0028)
Limit	0.20 (0.0079)



RTW56ASH014701

2. Measure the clearance between the gear side surface and the gear side surface of the oil pump housing.
   - Measure the width size the driven gear/drive gear.

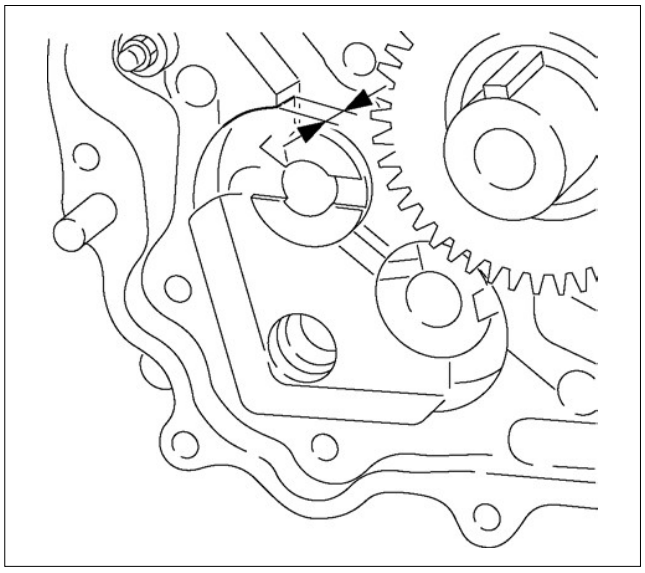
Width size the driven gear/drive gear	mm (in)
Standard	14.5 (0.5709)



RTW56ASH025501

- Measure the Depth size of the gear case housing surface and the oil pump housing gear case side.

Depth size the gear case housing surface and the oil pump housing gear case side mm (in)	
Standard	14.500 - 14.527 (0.5709 - 0.5719)



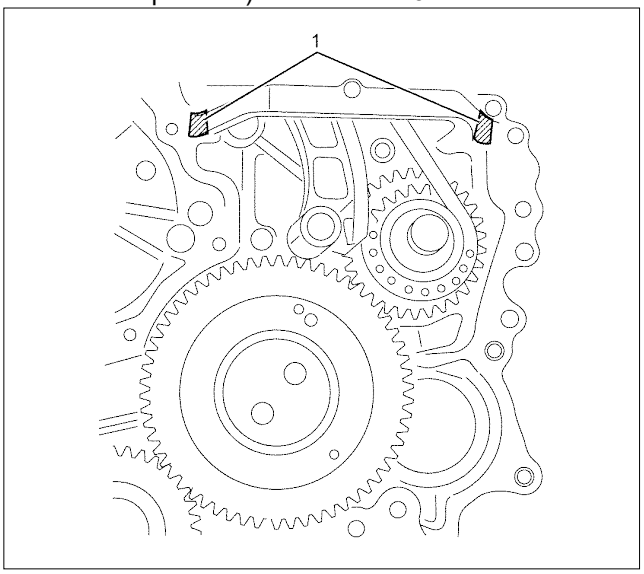
RTW56ASH014801

Clearance between the gear side surface and the gear side surface of the oil pump housing mm (in)	
Standard	0.063 - 0.027 (0.0025 - 0.0011)
Limit	0.20 (0.0079)

Installation

1. Install the oil pump.
   - Apply engine oil to the oil pump attachment gearbox.
   - Tighten the bolts to the specified torque.

   Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)
   - Installed pump gear should be smooth to rotate.
2. Install the gear case cover.
   - Apply the liquid gasket (Threebond TB-1207B or equivalent) mount within 5 minutes.



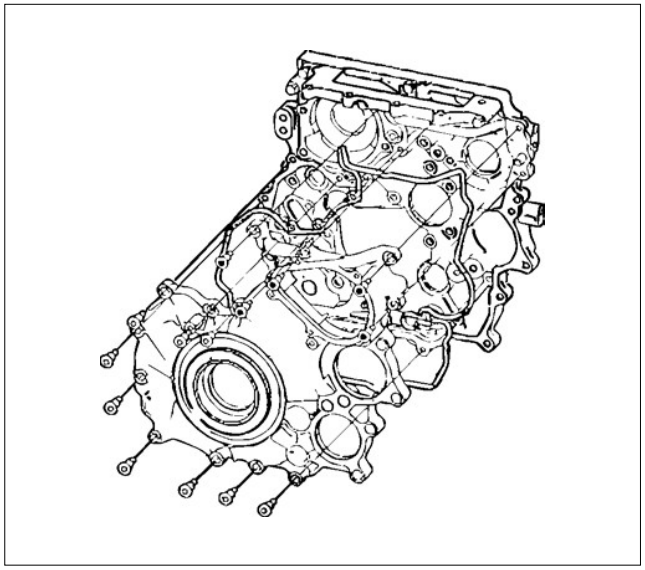
RTW56ASH020101

Legend

1. Apply the liquid gasket in area

- Install the gasket in the slot of the gear case cover.
- Tighten the bolts to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)



RTW56ASH012101

3. Install the crank pulley.
   - Tighten the bolts to the specified torque.

Tightening torque: 294 N·m (30.0 kg·m / 217 lb ft)

4. Install the noise cover to the timing chain cover lower.
   - Tighten the bolts to the specified torque.

Tightening torque: 10 N·m (1.0 kg·m / 87 lb in)

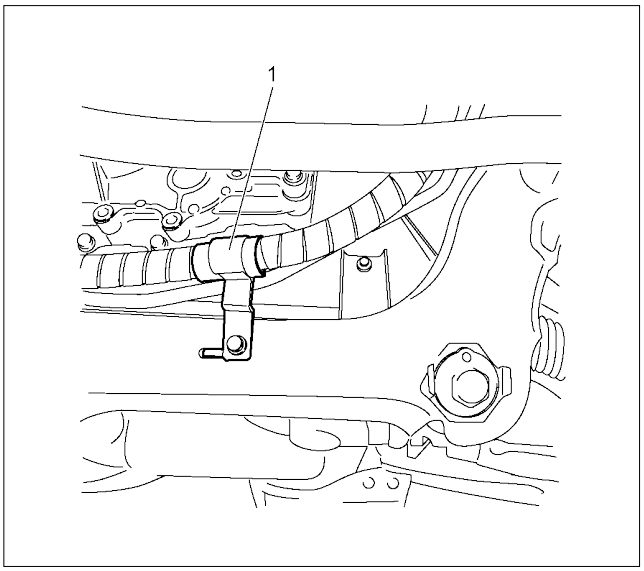
5. Install the vacuum pump.
   - Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Install the oil pipe (feed side and return side) of vacuum pump.
   - Install the vacuum pipe bracket and vacuum pipe.
6. Install the power steering pump.
   - Tighten the nuts to the specified torque.

Tightening torque: 25 N·m (2.5 kg·m / 18 lb ft)

   - Install the bracket of power steering oil hose clip (1).



LTW56ASH000101

7. Install the lower fan shroud.
8. Install the fan drive belt and pulley.
   - Install the fan drive belt with the fan pulley.
9. Install the fan and fan clutch.
   - Tighten the bolts to the specified torque.

Tightening torque: 8 N·m (0.8 kg·m / 69 lb in)

10. Adjust the drive belt of generator and A/C compressor.
    - Apply tension to the fan drive belt by moving the generator.
    - Apply a force of 98 N (10 kg / 22 lb) to the drive belt mid portion to check the drive belt deflection.

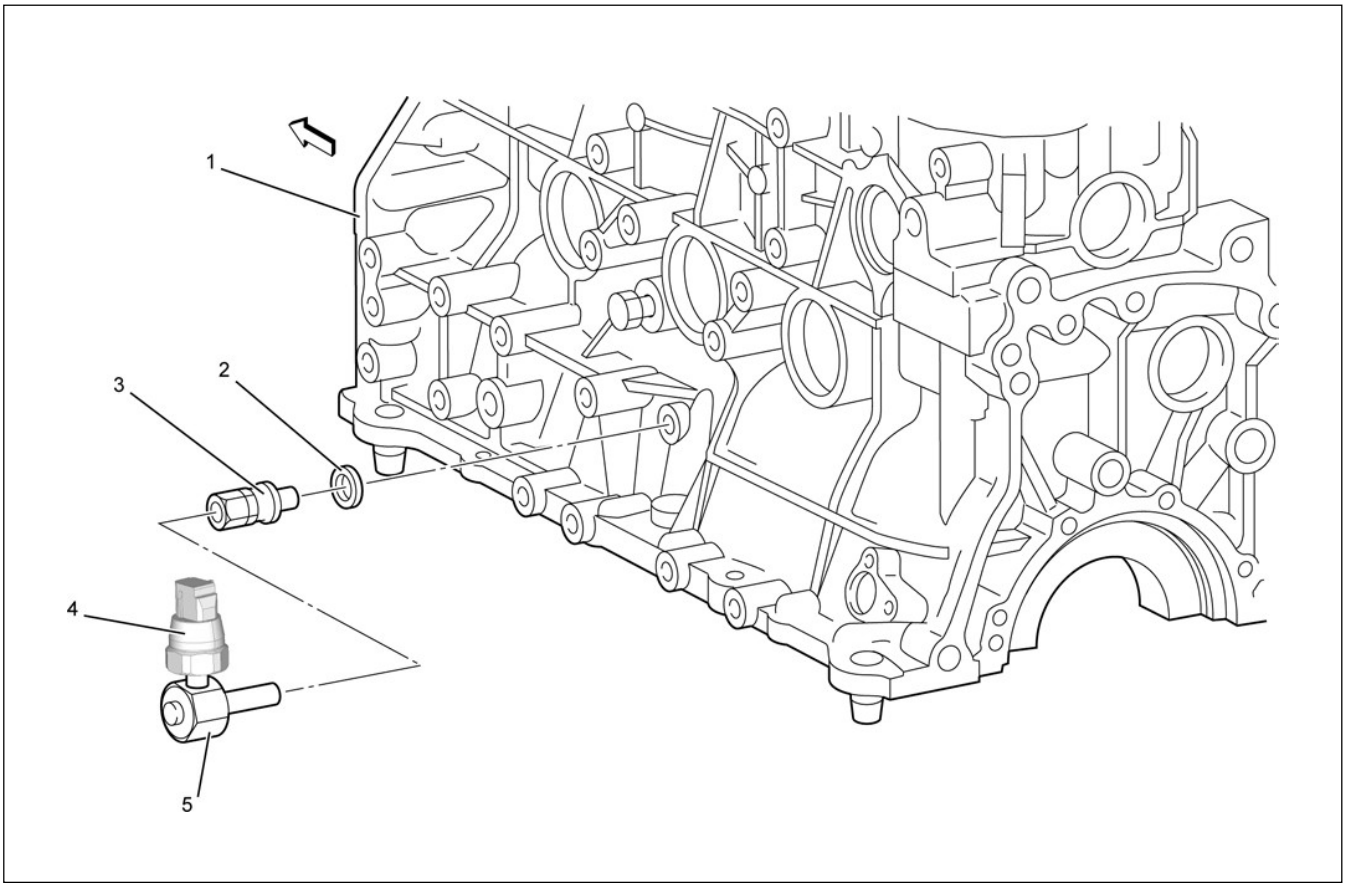
Generator drive belt deflection	mm (in)
New belt	5 - 6 (0.20 – 0.24)
Reuse belt	7 - 8 (0.28 – 0.31)

A/C compressor drive belt deflection	mm (in)
New belt	6 - 7 (0.24 – 0.28)
Reuse belt	8 - 9 (0.31 – 0.35)

11. Install the upper fan shroud.
12. Install the radiator upper hose.
13. Replenish the engine coolant.

Oil Pressure SW

Components



RTW76AMF000401

Legend

1. Cylinder Block
2. Gasket
3. Nipple; Oil Pressure Warning SW
4. Oil Pressure SW
5. Nipple; Oil Gallery

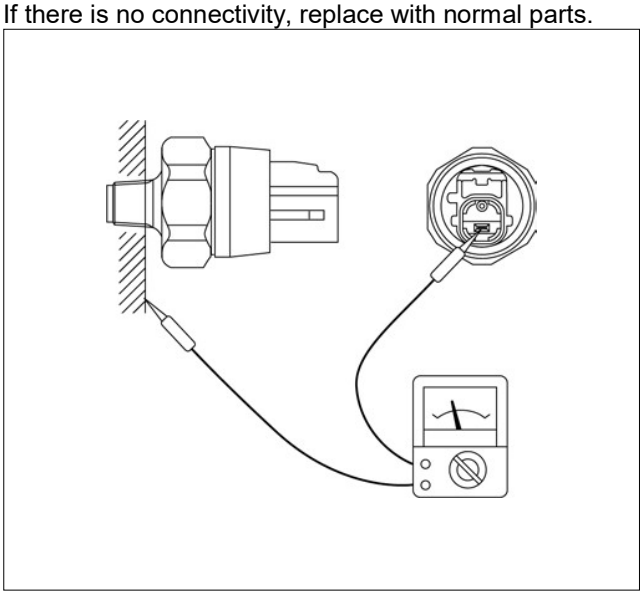
Removal

1. Remove the oil pressure SW.
2. Remove the nipple; oil gallery.
3. Remove the nipple; oil pressure warning SW and gasket.

Inspection

Check the continuity between the switch terminal and the body grounding in a no-load condition.

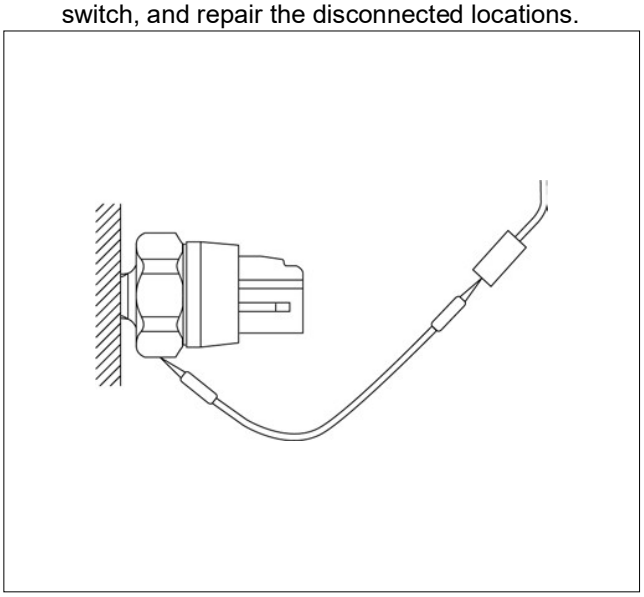
If there is no connectivity, replace with normal parts.



LNW21HSH003301

Circuit check

1. Turn the starter switch to ON.
2. Disconnect the oil pressure switch connector, and confirm that the oil pressure-warning lamp lights when the connector on the harness side is grounded.
   If the warning lamp does not light up, check the circuit between the meter and the oil pressure switch, and repair the disconnected locations.



LNW21HSH003401

Installation

1. Install the nipple; oil gallery, oil pressure warning SW and gasket.

   Tightening torque: 25 N·m (2.5 kg·m/18 lb ft)

2. Install the Nipple.

   Tightening torque: 15 N·m (1.5 kg·m/11 lb ft)

3. Install the oil pressure SW.

   Tightening torque: 15 N·m (1.5 kg·m/11 lb ft)

Air Cleaner Element

Removal

1. Remove the air cleaner cover fixing clip.
2. Remove the air cleaner element assembly.

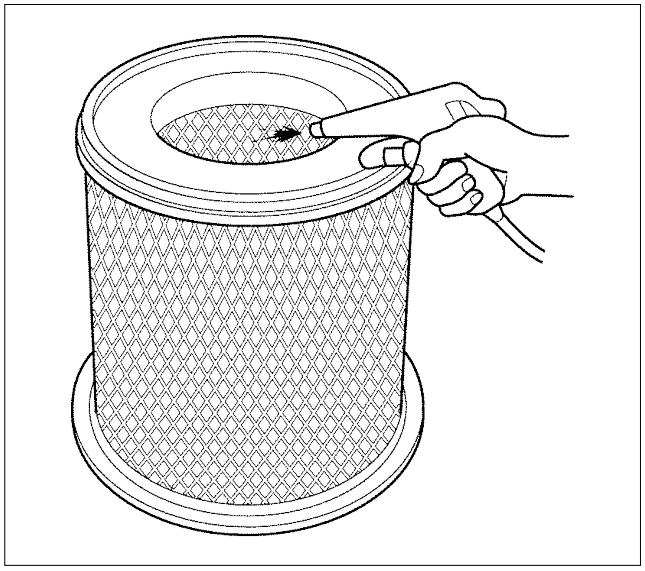
Cleaning

Dry type element

- Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

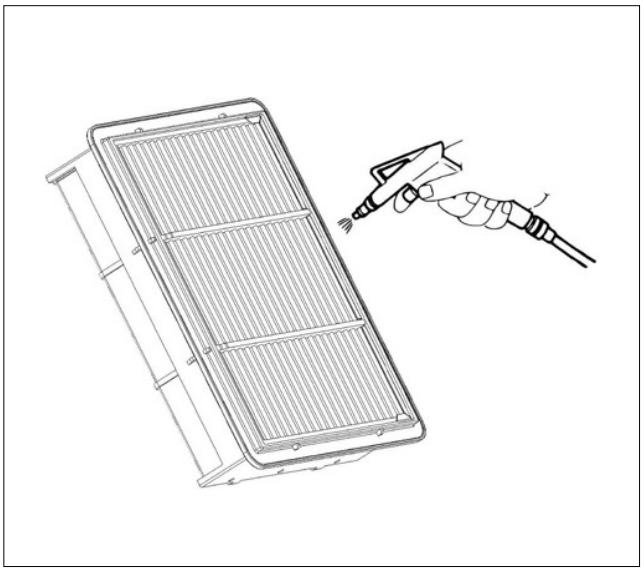
Compressed air pressure	kPa (kg/cm^2 /psi)
392 – 490 (4 – 5/57 – 71)	

Standard Output



LNW46ASH003201

High Output



LNW71BSH000201

Installation

1. Install the air cleaner element assembly.
2. Install the air cleaner cover.