

SQR477F ENGINE MECHANICAL

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GENERAL INFORMATION

Description

SQR477F engine has the following features:

- Vertical and water-cooled type
- In-line SOHC with 4 cylinders
- Four valves per cylinder
- Aluminum cylinder head
- Cast iron cylinder block

Operation

SQR477F engine adopts vertical, in-line 4-cylinder, water-cooled, 4-stroke, four valves per cylinder, SOHC and electronic controlled sequential multiport fuel injection, etc. The engine adopts electronic controlled coil double ignition system.

The engine uses cast iron cylinder block. The aluminum oil pan is fixed on the bottom of cylinder block with bolts. The aluminum cylinder head is fixed on the cylinder block with bolts.

The camshafts are installed in the cylinder head. The power output from the crankshaft drives the camshaft to rotate by the crankshaft pulley and timing belt to make the camshaft interact with the valve lifter to open and close the valve. The piston assembly is an aluminum piston with cast iron connecting rod. This engine has reliable structure and good performance.

Specifications

SQR477F Engine Specifications

Item	Specification
Engine Type	Vertical, in-line 4-cylinder, water-cooled, 4-stroke, SOHC
Engine Model	SQR477F
Valve Number Per Cylinder	4
Cylinder Diameter (mm)	77.40
Piston Stroke (mm)	79.52
Displacement (ml)	1497
Compression Ratio	10.5:1
Combustion Chamber Type	Pentroof type
Fuel Supply Type	Electronic controlled sequential multiport fuel injection
Ignition Type	Electrical control
Ignition Sequence	1 - 3 - 4 - 2
Idle Speed (r/min)	650 ± 50
Rated Power (kW)	80
Max. Torque (N·m)	140
Max. Torque Speed (r/min)	4500
Max. Permissible Speed (r/min)	6000
Min. Fuel Consumption Rate (g/kW·h)	260

Item	Specification	
Oil and Fuel Consumption Percentage	≤ 0.15	
Max. Intake Valve Lift (mm)	8.56	
Max. Exhaust Valve Lift (mm)	8	
Intake Valve Opening Angle (1 mm)	372°	
Exhaust Valve Closing Angle (1 mm)	354°	
Intake Valve Closing Angle (1 mm)	573°	
Exhaust Valve Opening Angle (1 mm)	178°	
Fuel Octane Number (Not Less Than)	Unleaded gasoline, octane number 93	
Oil Octane Number	In summer	SAE 10W-40 (grade SL or higher)
	In winter	SAE 5W-40 (grade SL or higher)
Oil Capacity (L)	3.9 ± 0.5	
Crankshaft Rotation Direction	Counterclockwise (viewed from cross section of engine flywheel)	
Starting Type	Electrical starting	
Cooling Type	Forced circulation type antifreeze cooling	
Lubrication Type	Compound type (pressure, splash lubrication)	
Net Weight (kg)	110	
Cylinder Compression Pressure (bar) (180 - 250) r/min	10 - 13.5	
Oil Pressure (bar)	Idle Speed (650 ± 50 r/min)	Higher than 1.5
	High Speed (4000 ± 50 r/min)	Higher than 3.5
Boundary Dimension (Length × Width × Height) (mm)	$615 \times 580 \times 695$	
Starting Performance	With atmospheric temperature at -30°C , engine can start smoothly within 8 seconds without taking special measures. Starting test shows that starting can be performed 3 times consecutively. If it fails to start once, perform starting again after 2 minutes.	

Engine Mechanical Specifications

Item			Specification
Rocker Arm Shaft	Rocker Arm Shaft Hole Diameter for Intake Left Rocker Arm Assembly (mm)		$\phi 19^{+0.035}_{+0.017}$
	Rocker Arm Shaft Hole Diameter for Intake Right Rocker Arm Assembly (mm)		$\phi 19^{+0.035}_{+0.017}$
	Intake Rocker Arm Shaft Diameter (mm)		$\phi 19^{-0.002}_{-0.015}$
	Rocker Arm Shaft Hole Diameter for Exhaust Rocker Arm Assembly (mm)		$\phi 19^{+0.035}_{+0.017}$
	Exhaust Rocker Arm Shaft Diameter (mm)		$\phi 19^{-0.002}_{-0.015}$
Camshaft	Intake Camshaft Lift (mm)		5.09
	Exhaust Camshaft Lift (mm)		5.34
	Camshaft Journal Diameter (mm)		$\phi 26^{-0.02}_{-0.033}$
	Camshaft Thrust Clearance (mm)		0.095 - 0.153
Cylinder Head	Lower Surface Flatness (mm)		0.055
	Overall Height (mm)		97
Valve	Valve Lifter Diameter (mm)	Intake Valve	$\phi 5.972 - \phi 5.988$
		Exhaust Valve	$\phi 5.952 - \phi 5.968$
	Valve Head Margin Thickness (mm)	Intake Valve	0.012 - 0.043
		Exhaust Valve	0.032 - 0.063
	Clearance Between Valve Lifter and Guide (mm)	Intake Valve	0.012 - 0.043
		Exhaust Valve	0.032 - 0.063
	Valve Height (mm)	Intake Valve	107.998
		Exhaust Valve	117.410
Valve Spring	Free Height (mm)		47.7
	Preload (N)		249 - 271
Piston	Piston Diameter (mm)		$\phi 77.325 - \phi 77.365$
Piston Ring	Piston Ring Side Clearance (mm)	First Ring	0.04 - 0.08
		Second Ring	0.03 - 0.07
		Oil Ring	0.03 - 0.16
	Piston Ring End Gap (mm)	First Ring	0.2 - 0.35
		Second Ring	0.4 - 0.55
		Oil Ring	0.2 - 0.6

Item			Specification
Crankshaft	Crankshaft Main Journal	Diameter (mm)	$\phi 48.99 \pm 0.01$
		Main Bearing Shell Thickness (mm)	$2.131^{+0.007}_0$
		Radial Clearance (mm)	0.011 - 0.058
		Thrust Clearance (mm)	0.093 - 0.303
		Runout (mm)	0.05
		Cylindricity (mm)	0.008
		Roundness (mm)	0.005
	Crankshaft Connecting Rod Journal (mm)	Diameter (mm)	$\phi 44.90 \pm 0.01$
Cylinder Block	Cylinder Bore Roundness (mm)		0.008
	Upper Surface Flatness (mm)		0.05
	Cylinder Diameter (mm)		$\phi 77.36 - \phi 77.40$
Connecting Rod	Big End Thrust Clearance (mm)		0.333 - 0.387
	Connecting Rod Bearing Shell Radial Clearance (mm)		0.006 - 0.06
	Connecting Rod Bearing Shell Thickness (mm)		$1.48^{+0.007}_0$

Engine Torque Specifications

Description	Torque (N·m)
Inner Torx Fixing Bolt for Power Steering Pump	25 ± 3
Locking Nut for Power Steering Pump Tension Bolt	30 ± 3
Coupling Bolt Between Steering Pump Fixing Bracket and Power Steering Pump	25 ± 3
Coupling Bolt Between Idler Pulley and Generator	20 ± 5
Inner Torx Round Fixing Bolt for Idler Pulley	20 ± 5
Torx Flange Fixing Bolt for Idler Pulley	40 ± 5
Inner Torx Round Fixing Bolt for Tensioner	20 ± 5
Timing Belt Upper Cover Fixing Bolt	8 - 11
Crankshaft Pulley Fixing Bolt	105 - 115
Timing Belt Lower Cover Fixing Bolt	8 - 11
Timing Belt Tensioner Fixing Bolt	16 - 20
Camshaft Timing Pulley Fixing Bolt	100 ± 10
Worm Clamp	2.5 ± 0.5
Camshaft Position Sensor Fixing Bolt	10 ± 2
Rear Right Bracket Fixing Bolt	7 ± 1
Coolant Pipe Assembly Fixing Bolt	7 ± 1
Cylinder Head Cover Fixing Bolt	1st step: Pretighten to 3 - 5 2nd step: Tighten to 8 - 11
Rocker Arm Shaft Fixing Bolt	1st step: 15 ± 1.5 2nd step: 30 ± 1.5
First Bearing Cap Fixing Bolt	9.5 ± 1
Coupling Bolt Between Small Circulation Coolant Pipe and Cylinder Head	8 ± 1
Cylinder Head Fixing Bolt	1st step: 20 - 25 2nd step: 40 - 45 3rd step: Rotate 90° clockwise 4th step: Rotate 90° clockwise
Flywheel Fixing Bolt	1st step: 50 - 60 2nd step: 105 - 115
Coupling Bolt Between Rear Mounting Bracket and Left Side of Transmission Case	55 ± 5.5
Coupling Bolt Between Rear Mounting Bracket and Right Side of Transmission Case	55 ± 5.5
Locking Nut for Through Bolt Between Rear Mounting Bracket and Rear Mounting Cushion Assembly	85 ± 8.5
Coupling Bolt Between Rear Mounting Cushion Assembly and Front Sub Frame Welding Assembly	85 ± 8.5

Description	Torque (N·m)
Bracket I Fixing Bolt	8 ± 1
Locking Nut for Through Bolt Between Left Mounting Cushion Assembly and Left Mounting Bracket	80 ± 8
Coupling Bolt Between Left Mounting Cushion Assembly and Body	60 ± 6
Coupling Bolt Between Left Mounting Bracket and Transmission Case	55 ± 5.5
Coupling Bolt Between Right Mounting Bracket and Right Mounting Cushion Assembly	60 ± 6
Fixing Nut Between Right Mounting Bracket and Right Mounting Cushion Assembly	60 ± 6
Coupling Bolt Between Right Mounting Bracket and Engine Block	60 ± 6
Expansion Tank Fixing Bolt	7 ± 1.5
Right Mounting Cushion Assembly Fixing Bolt	60 ± 6
Coupling Nut Between Main Catalytic Converter Assembly and Precatalytic Converter Assembly	45 ± 5
Clutch Release Cylinder Pipe Coupling Plug	18 ± 2
Positive Wire Harness Fixing Nut	7 ± 1
Battery Negative Wire Harness Fixing Bolt	20 ± 3
Ground Fixing Bolt of Engine Wire Harness on ECM Side	7 ± 1
Fixing Bolt for Power Steering Pump Fixing Bracket	55 ± 5
A/C Compressor Bracket Fixing Bolt	55 ± 5
Knock Sensor Fixing Bolt	$17 - 23$
Oil Pressure Switch	20 ± 2
Exhaust Manifold Fixing Bolt	45 ± 5
Coupling Bolt Between Small Circulation Coolant Pipe and Cylinder Block	40 ± 4
Rear Right Bracket Fixing Bolt	7 ± 1
Crankshaft Rear Oil Seal Bracket Fixing Bolt	$8 - 11$
Connecting Rod Bearing Cap Fixing Bolt	$20 + 5$
Crankshaft Main Bearing Cap Fixing Bolt	$90 - 100$
Crankshaft Main Bearing Cap Fixing Nut	$90 - 100$
Piston Cooling Nozzle Fixing Bolt	$20 - 25$

Lubrication Areas during Engine Assembly

Lubrication Area	Note
Piston Pin	SL10W-40
Piston Ring	SL10W-40
Piston	SL10W-40
Cylinder Bore	SL10W-40
Main Bearing Shell and Crankshaft Main Journal	SL10W-40
Crankshaft Thrust Washer (Oil Groove Side)	SL10W-40
Connecting Rod Bearing Cap Bolt Head and Thread Part	SL10W-40
Connecting Rod Bearing Shell and Crankshaft Connecting Rod Journal	SL10W-40
Main Bearing Cap Bolt Head	SL10W-40
Crankshaft Front Oil Seal Lip and Crankshaft Oil Seal Journal	SL10W-40
Crankshaft Rear Oil Seal Lip and Crankshaft Oil Seal Journal	SL10W-40
Valve Guide Hole	SL10W-40
Valve Lifter	SL10W-40
Camshaft Cam and Journal	SL10W-40
Valve Rocker Arm Head	SL10W-40
Valve Small End, Valve Rocker Arm Head	SL10W-40
Valve Retainer Hole (Cylinder Head Assembly)	SL10W-40
Valve Guide or Guide Bottom Hole (Cylinder Head)	SL10W-40
Camshaft Oil Seal Lip and Camshaft Journal	SL10W-40
Oil Filter Gasket Surface	SL10W-40

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All engine lubricants should be 5W-40 (for winter)/10W-40 (for summer) SL grade or higher.

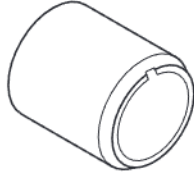
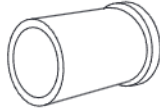
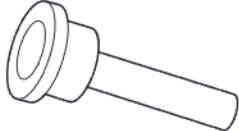
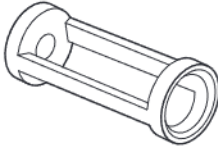


Areas with Seal Gum Applied during Engine Assembly

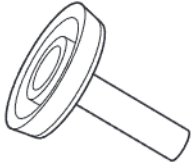
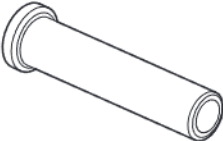
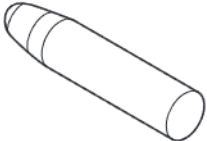
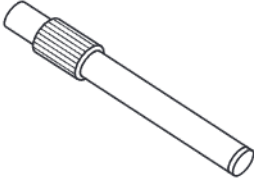
Area with Seal Gum Applied	Seal Gum Type
Cylinder Block Bowl Plug	Loctite 648
Semi-circle Joint Surface Between Oil Pan Gasket and Oil Pump	Loctite 5910
Semi-circle Joint Surface Between Oil Pan Gasket and Rear Oil Seal Bracket	Loctite 5910
Joint Surface Between Oil Pump Bottom and Cylinder Block Bottom	Loctite 5910
Joint Surface Between Rear Oil Seal Bracket Bottom and Cylinder Block Bottom	Loctite 5910
Semi-circle Joint Surface Between Oil Pan Gasket and Oil Pan	Loctite 5910
Cylinder Head Bowl Plug	Loctite 648
First Camshaft Bearing Cap	Loctite 574
Spark Plug Socket	Loctite 243
Coolant Temperature Sensor	Loctite 243
Oil Pressure Switch	Loctite 243
Intake/Exhaust Manifold Stub	Loctite 271
Flywheel Bolt	Precoated Seal Gum
Cylinder Head Cover Gasket and Bolt	Loctite 5910
Cylinder Block - Sleeve - Oil Dipstick Tube	Loctite 648

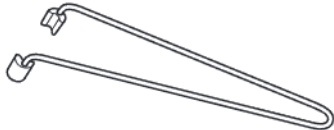
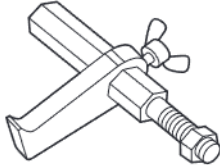
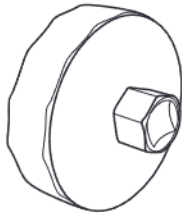
Tools

Special Tools

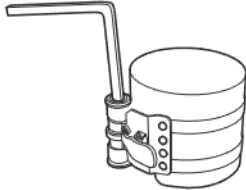
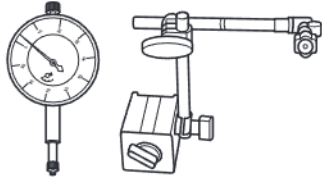
Crankshaft Front Oil Seal Guide Tool	 RCH0000049
Crankshaft Front Oil Seal Installer	 RCH0000067
Camshaft Oil Seal Installer	 RCH0000017
Valve Spring Compression Adapter	 RCH0000050
Valve Spring Compressor	 RCH0000028

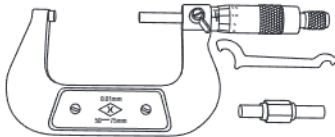
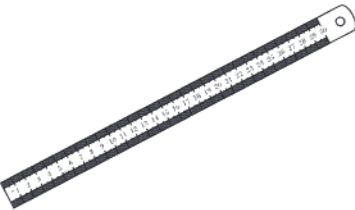
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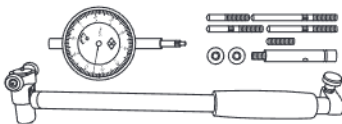
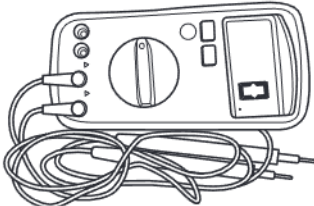
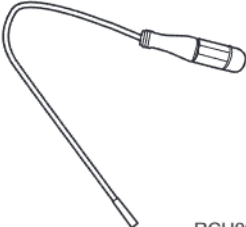
Crankshaft Rear Oil Seal Installer	 RCH0000031
Valve Oil Seal Installer	 RCH0000034
Valve Oil Seal Guide Sleeve	 RCH0000035
Driven Disc Assembly & Clutch Cover Assembly Guide Special Tool	 RCH0000018
Valve Oil Seal Remover	 RCH0000037

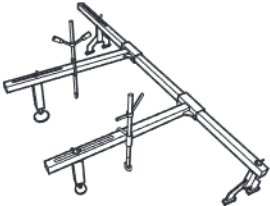
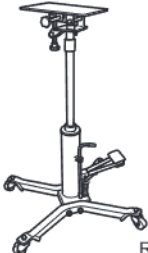
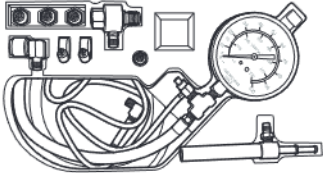
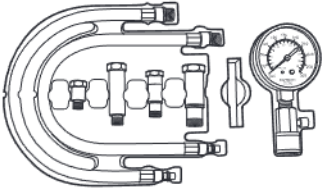
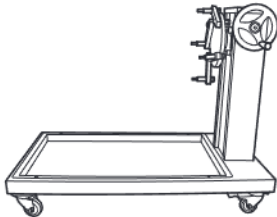
Valve Cotter Installer	 RCH0000029
Flywheel Holding Tool	 RCH0000040
Oil Filter Remover	 RCH0000054

General Tools

Piston Installer	 RCH0000039
Dial Indicator and Magnetic Holder	 RCH0000023

Outer Diameter Micrometer	 RCH0000064
Vernier Caliper	 RCH0000019
Inner Diameter Micrometer	 RCH0000068
Precision Straightedge	 RCH0000063
Feeler Gauge	 RCH0000060

Cylinder Gauge	 RCH0000065
Piston Ring Remover	 RCH0000066
Digital Multimeter	 RCH0000002
Flexional Magnetic Rod	 RCH0000042
Engine Hoist	 RCH0000043

Engine Equalizer	 RCH0000026
Transmission Carrier	 RCH0000005
Fuel System Pressure Tester	 RCH0000048
Cylinder Pressure Gauge	 RCH0000044
Engine Service Platform	 RCH0000057

DIAGNOSIS & TESTING

Problem Symptoms Table

HINT:

Use the table below to help determine the cause of problem symptoms. Check each suspected area in sequence. Repair or replace the faulty components, or adjust them as necessary.

Symptom	Suspected Area	See page
Valve mechanism noise	Engine oil (oil level high or low, oil lean or rich)	13-9
	Cam	07-40
	Valve spring seat (excessive runout)	07-47
	Valve (excessive clearance between valve and guide)	07-47
Connecting rod noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-11
	Connecting rod bearing cap (loose fixing nut)	07-67
	Connecting rod (misaligned)	07-67
	Connecting rod bearing shell (excessive radial clearance)	07-67
	Connecting rod journal (out-of roundness)	07-67
Main bearing noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-11
	Main bearing shell (excessive clearance)	07-67
	Crankshaft thrust clearance (excessive)	07-67
	Crankshaft journal (out-of roundness or worn)	07-67
	Flywheel or clutch (loose)	07-55
Oil loss or spark plug blockage	Piston ring (worn, scratched or damaged)	07-67
	Piston ring groove (fouled)	07-67
	Valve oil seal (worn or damaged)	07-47
	Valve (excessive clearance between valve and guide)	07-47

Symptom	Suspected Area	See page
Engine power loss	Spark plug (dirt, burns or incorrect gap)	14-12
	Electric fuel pump assembly	08-15
	Ignition coil	14-10
	Valve timing (incorrect)	-
	Cylinder head (leaked)	07-18
	Valve (burns, deformation or excess clearance)	07-47
	Low cylinder pressure	-
	Fuel system (dirty)	-
	Exhaust system (blocked)	-

07 Inspection

1. Check the coolant (See page 12-13).
2. Check the engine oil (See page 13-9).
3. Check the battery (See page 16-7).
4. Check the air filter.
 - a. Remove the air filter element (See page 10-9).
 - b. Visually check that there is no dirt, blockage or damage in the air filter element.

HINT:

- If there is any dirt or blockage in the air filter element, clean it with compressed air.
 - If any dirt or blockage remains even after cleaning the air filter element with compressed air, replace it.
5. Check the spark plugs (See page 14-12).
 6. Test the cylinder compression pressure.
 - Cylinder pressure is the main index to judge the engine operation and also can be used to judge definitely whether some system of engine operates well or not. Therefore, it is necessary to perform the measurement of cylinder pressure when servicing the engine.
 - Ensure that the battery is fully charged and the engine starter is in good operating condition. Otherwise, the indicated compression pressure used for diagnosis may be invalid.

CAUTION

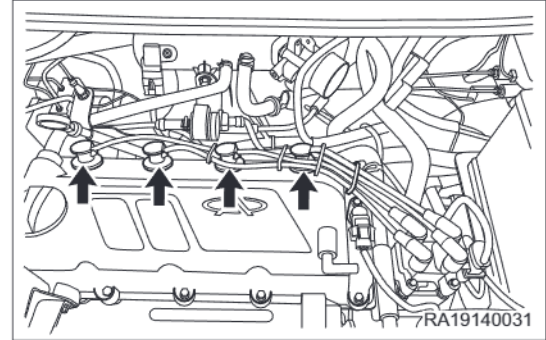
- The recommended compression pressure is only used as a guide for diagnosing engine malfunction.
- Never determine the causes of low pressure by disassembling the engine unless there are some malfunctions.

Measurement procedures

CAUTION

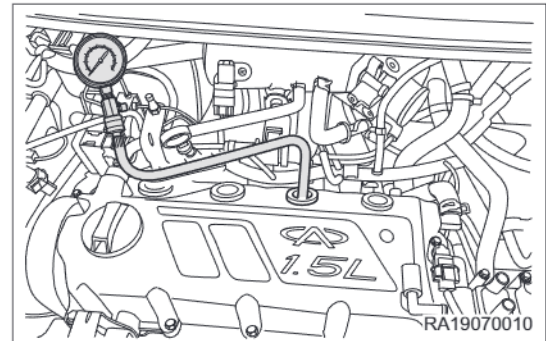
- Select the cylinder pressure gauge with accurate reading and reset it to zero. Otherwise, it will affect the accuracy of reading.

- Turn off all the electrical equipment and ignition switch.
- Unplug all the high-voltage cables (arrow) from the spark plugs side.



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- Disconnect all the injector connectors.
- Remove the spark plugs (See page 14-12).
- Slowly screw the cylinder pressure gauge joint vertically into the spark plug hole. Do not tighten it excessively to prevent difficult removal.



CAUTION

- DO NOT screw the cylinder pressure gauge excessively to prevent difficult removal.

- With the transmission in neutral position, release the accelerator pedal fully, then start the engine and keep it racing for 3 to 5 seconds to measure and record the pressure value.
- Press the bleeder button of cylinder pressure gauge to reset it to zero. Measure three times in the same way and take the average.

Standard value for cylinder pressure: 10 - 13.5 bar

CAUTION

- During measurement, do not turn the ignition switch to "START" for more than 10 seconds. Otherwise, the engine may be damaged.
- Ensure that the battery is fully charged when cranking the engine. The correct cylinder pressure can be measured only when the engine is running at 200 - 300 r/min.
- Use the same method to measure the pressure of other cylinders.

Cylinder Pressure Value Judgment

- Correct cylinder pressure

Standard cylinder pressure value is between 10 and 13.5 bar and will drop slightly with the using of engine. But the lowest value cannot be below 9 bar and the pressure difference between each cylinder should not be above 3 bar.

- If the cylinder pressure of engine is lower than the standard value, it indicates that the cylinder pressure is insufficient. Add a small amount of engine oil through the spark plug hole and perform measurement again.

If the pressure increases after adding oil, the piston ring or cylinder bore may be worn or damaged.

If the pressure remains low, the valve may be stuck or not properly installed or there is air leakage from the cylinder head gasket.

- h. Install the spark plugs ([See page 14-13](#)).
- i. Connect all the injector connectors ([See page 08-25](#)).
- j. Install the high-voltage cables.

7. Test the cylinder head gasket.

The cylinder head gasket leakage may be present between adjacent cylinders, between cylinder and adjacent water jacket or from an oil passage to the external of engine.

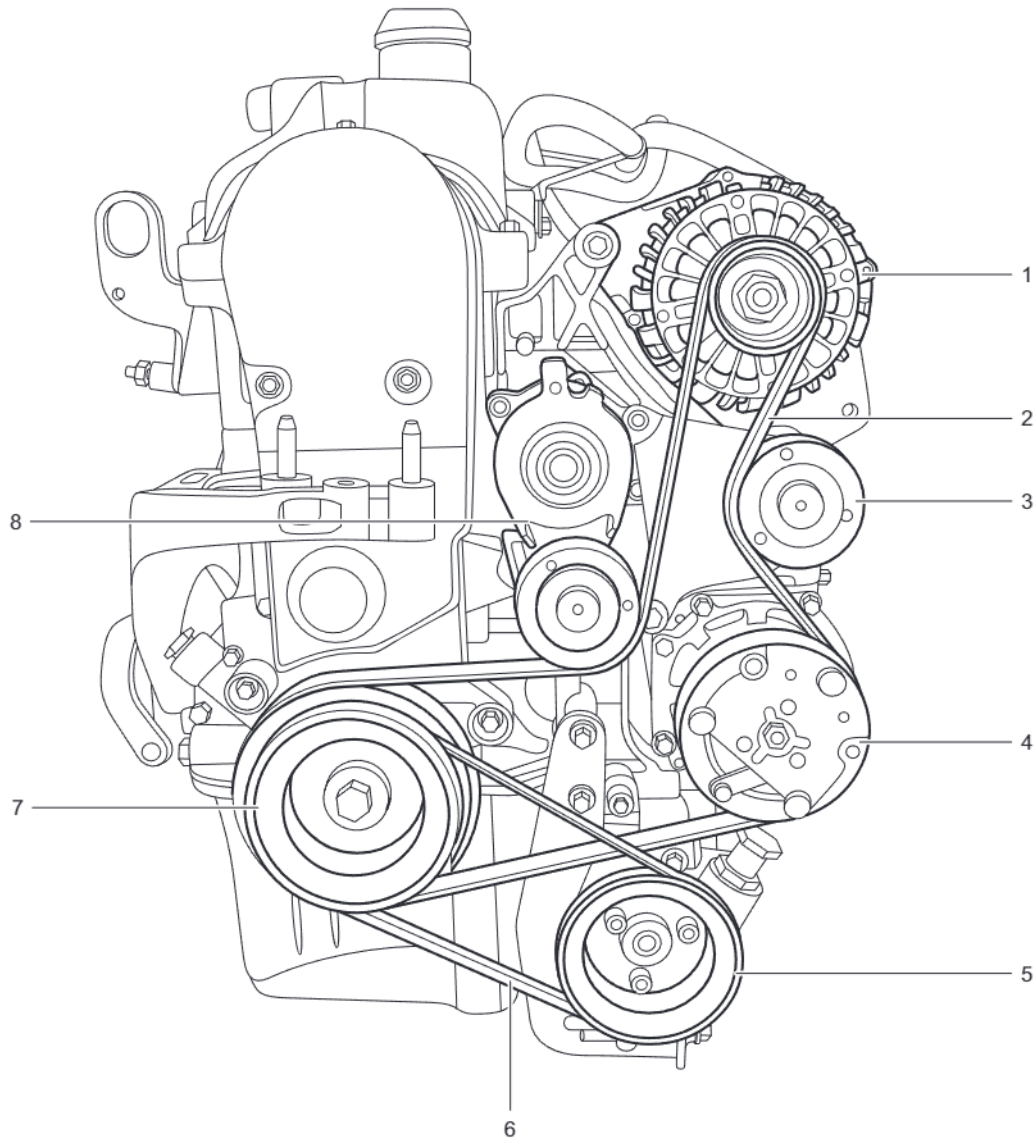
- Possible indications of cylinder head gasket leakage between adjacent cylinders are as follows:
 - Engine power loss
 - Engine stall
 - Low fuel economy
- Possible indications of cylinder head gasket leakage between cylinder and adjacent water jacket are as follows:
 - Engine overheat
 - Coolant loss
 - Excessive steam (white smoke) emitted from the exhaust system
 - Coolant foaming

ON-VEHICLE SERVICE

Drive Belt

Description

07

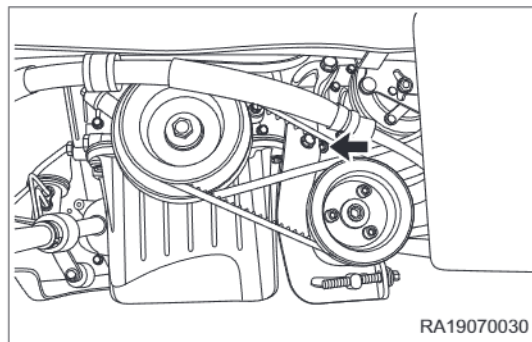


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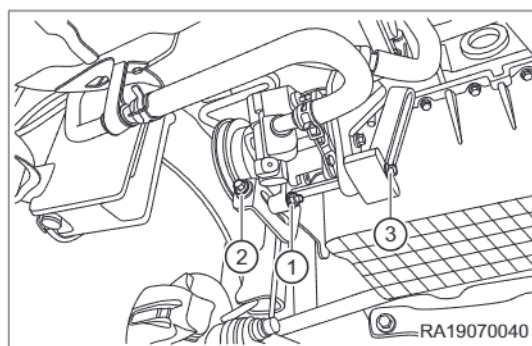
1 - Generator	2 - V-ribbed Belt
3 - Idler Pulley	4 - A/C Compressor
5 - Power Steering Pump Pulley	6 - Power Steering Pump Belt
7 - Crankshaft Pulley	8 - V-ribbed Belt Tensioner

Removal

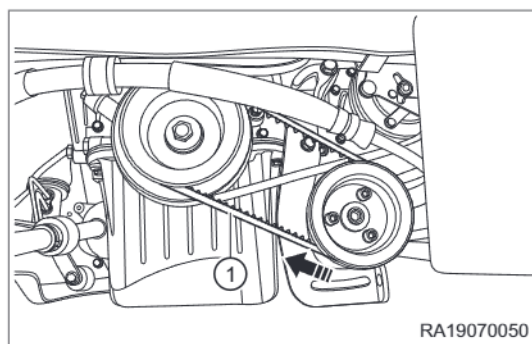
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the lower right deflector (See page 46-20).
5. Remove the power steering pump belt.
 - a. Loosen the inner Torx fixing bolt (arrow) for power steering pump.
(Tightening torque: 25 ± 3 N·m)



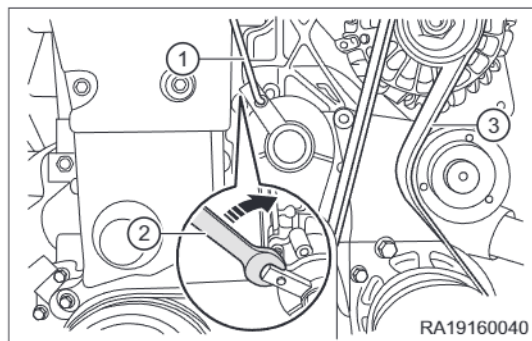
- b. Remove the locking nut (1) from the tension bolt.
(Tightening torque: 30 ± 3 N·m)
 - c. Remove the adjustment bolt (2) and tension bolt.
 - d. Remove the coupling bolt (3) between power steering pump fixing bracket and power steering pump.
(Tightening torque: 25 ± 3 N·m)



- e. Push the power steering pump in the direction of arrow as shown in the illustration, and remove the power steering pump belt (1).



6. Remove the V-ribbed belt.
 - a. Turn the V-ribbed belt tensioner in the direction of arrow as shown in the illustration with a wrench (2), and insert the lock pin (1) while aligning the lock hole of tensioner with the lock hole of bracket to lock the tensioner.
 - b. Remove the V-ribbed belt (3).

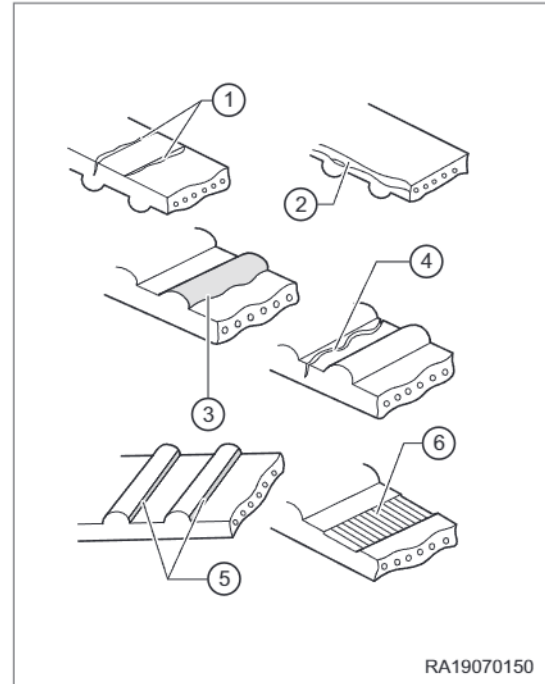


Inspection

1. Check the power steering pump drive belt.

Replace the power steering pump drive belt if the following occurs.

- There are cracks on the back of belt: as shown in the illustration (1).
- There are cracks at the bottom of cord fabric layer of belt: as shown in the illustration (2), (3), (5) and (6).
- Belt worn: as shown in the illustration (5).
- Belt teeth missing and damaged: as shown in the illustration (4) and (6).

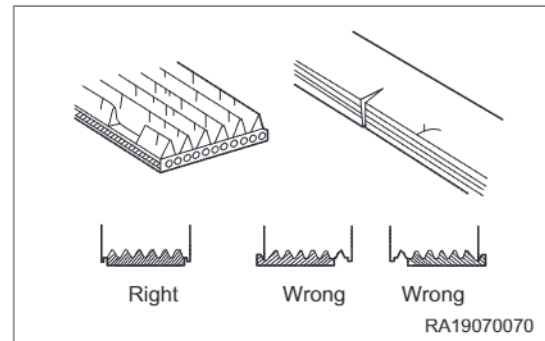


2. Check the V-ribbed belt.

Visually check the V-ribbed belt for excessive wear, frayed cords, etc. If any of the defects is found, replace the V-ribbed belt.

HINT:

- Cracks on the rib side of a V-ribbed belt are considered acceptable. If the V-ribbed belt has chunks missing from the ribs, it should be replaced.
- After installing the V-ribbed belt, check that it fits properly in the ribbed grooves. Confirm that the belt has not slipped out of bottom slot of the crank pulley by hand.



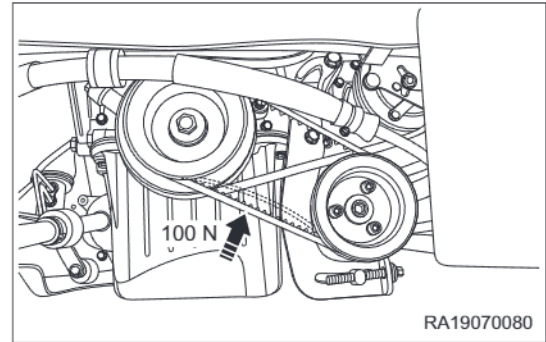
Installation

Installation is in the reverse order of removal.

Adjustment

1. Adjust the tension of power steering pump drive belt.

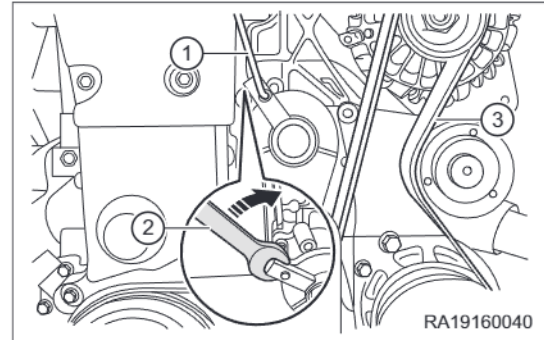
Apply 100 N of force to center part of the belt between crankshaft pulley and power steering pump pulley with your thumb as shown in the illustration. The belt compression amount should not more than 10 mm.



Idler Pulley

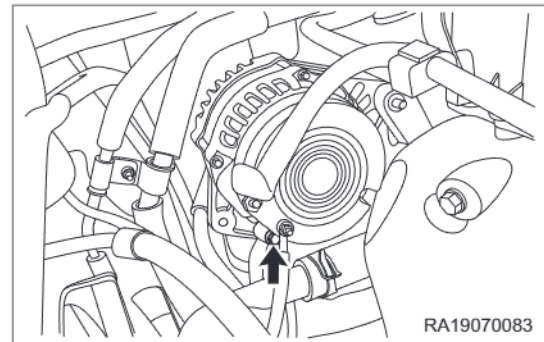
Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Loosen the V-ribbed belt.
 - a. Turn the V-ribbed belt tensioner in the direction of arrow as shown in the illustration with a wrench (2), and insert the lock pin (1) while aligning the lock hole of tensioner with the lock hole of bracket to lock the tensioner.
 - b. Move away the V-ribbed belt (3).

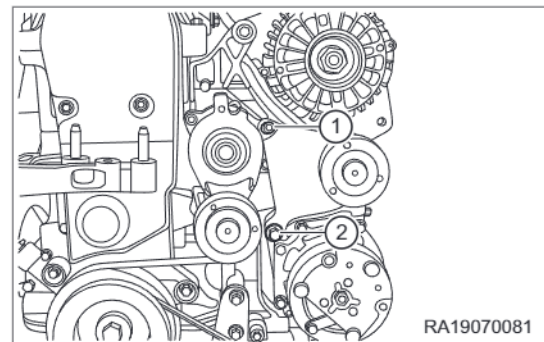


07

4. Remove the idler pulley.
 - a. Remove the coupling bolt (arrow) between idler pulley and generator.
(Tightening torque: $20 \pm 5 \text{ N}\cdot\text{m}$)



- b. Remove the inner Torx round fixing bolt (1) and the Torx flange fixing bolt (2) from the idler pulley.
(Tightening torque for inner Torx round fixing bolt: $20 \pm 5 \text{ N}\cdot\text{m}$)
(Tightening torque for Torx flange bolt: $40 \pm 5 \text{ N}\cdot\text{m}$)



- c. Remove the idler pulley.

Inspection

1. Rotate the idler pulley by hands and check if the rotation is smooth and if abnormal noise occurs.
2. Wiggle the idler pulley in the axial and radial direction to check the bearing for looseness.
3. Check if there is damage on the idler pulley operating surface.

Installation

Installation is in the reverse order of removal.

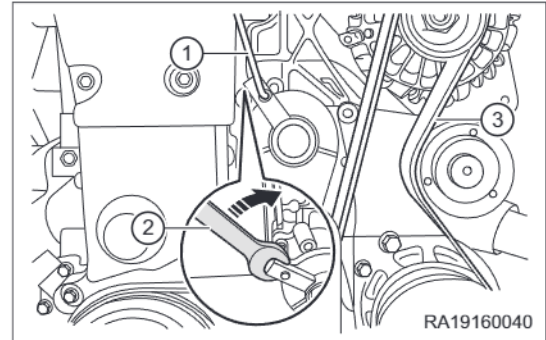
CAUTION

- After installation, turn the crankshaft with a wrench to run the V-ribbed belt several circles, and check if the crankshaft turns smoothly and the belt runs well. If it does not turn smoothly, reinstall the V-ribbed belt.
- Make sure to install the V-ribbed belt in place, and it does not interfere with other components.

Tensioner

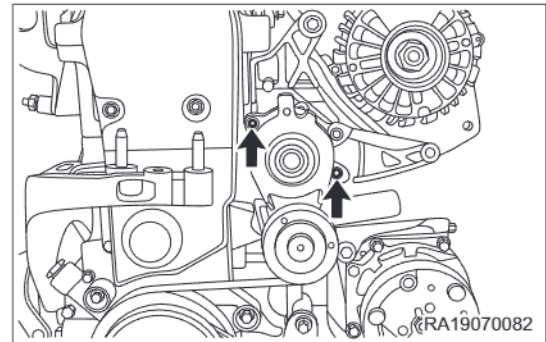
Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Loosen the V-ribbed belt.
 - a. Turn the V-ribbed belt tensioner in the direction of arrow as shown in the illustration with a wrench (2), and insert the lock pin (1) while aligning the lock hole of tensioner with the lock hole of bracket to lock the tensioner.
 - b. Move away the V-ribbed belt (3).



07

4. Remove the idler pulley (See page 07-25).
5. Remove the tensioner.
 - a. Remove 2 inner Torx round fixing bolts (arrow) from the tensioner.
(Tightening torque for inner Torx round fixing bolt: $20 \pm 5 \text{ N}\cdot\text{m}$)



- b. Remove the tensioner.

Inspection

1. Rotate the tensioner by hands and check if the rotation is smooth and if abnormal noise occurs.
2. Wiggle the tensioner in the axial and radial direction to check the bearing for looseness.
3. Check if there is damage on the tensioner operating surface.

Installation

Installation is in the reverse order of removal.

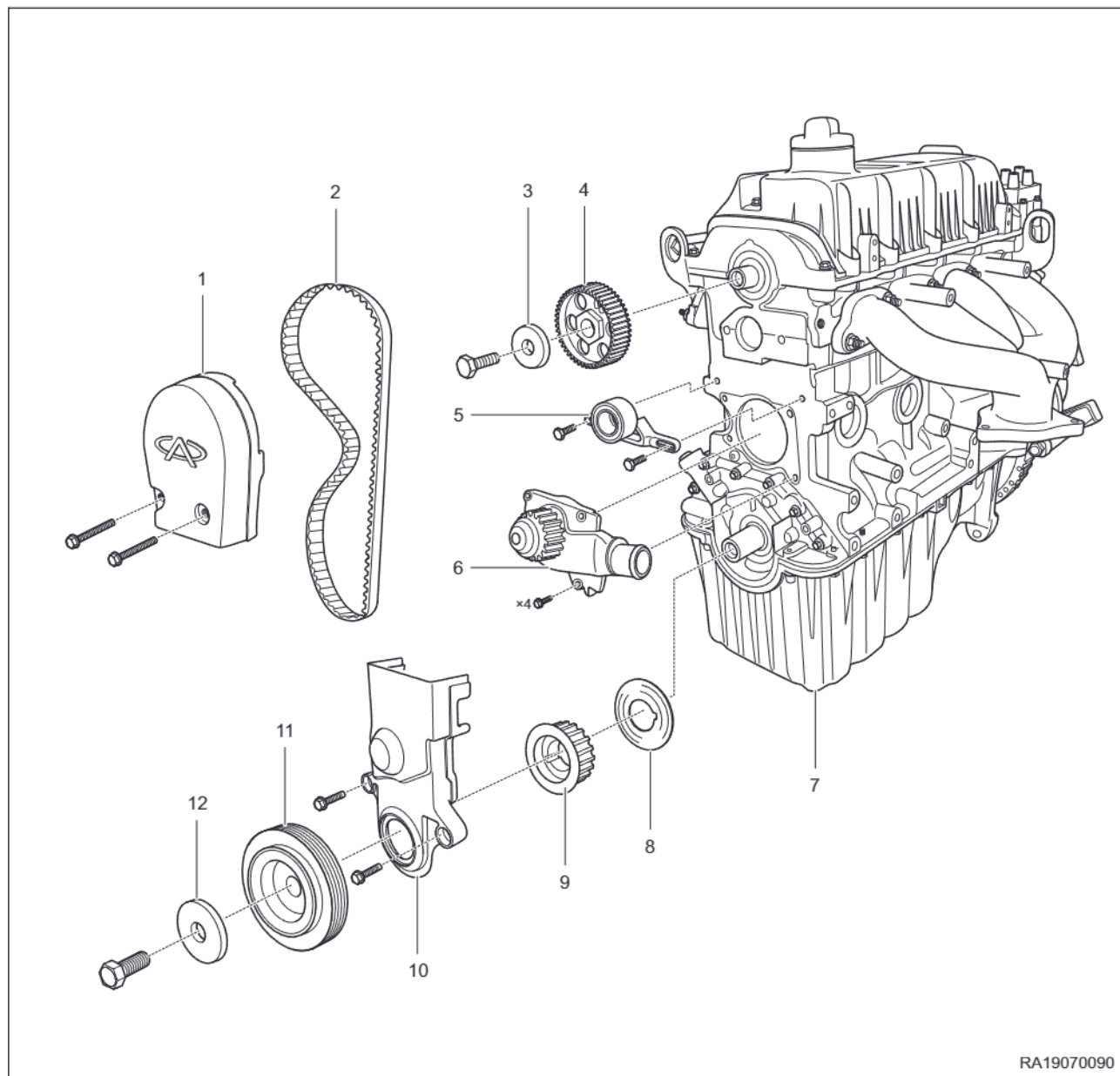
CAUTION

- After installation, turn the crankshaft with a wrench to run the V-ribbed belt several circles, and check if the crankshaft turns smoothly and the belt runs well. If it does not turn smoothly, reinstall the V-ribbed belt.
- Make sure to install the V-ribbed belt in place, and it does not interfere with other components.

Engine Timing Belt

Description

07

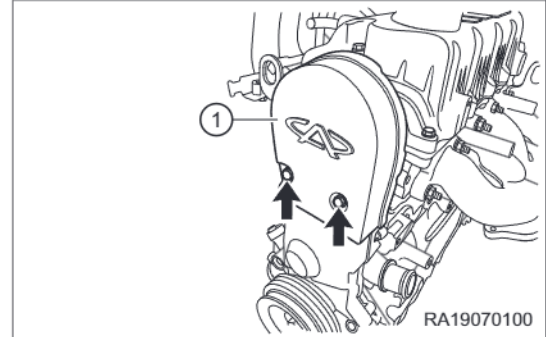


RA19070090

1 - Timing Belt Upper Cover	2 - Timing Belt
3 - Camshaft Timing Pulley Fixing Bolt Washer	4 - Camshaft Timing Pulley
5 - Timing Belt Tensioner	6 - Water Pump Assembly
7 - Engine Assembly	8 - Crankshaft Timing Pulley Washer
9 - Crankshaft Timing Pulley	10 - Timing Belt lower Cover
11 - Crankshaft Pulley	12 - Crankshaft Pulley Fixing Bolt Washer

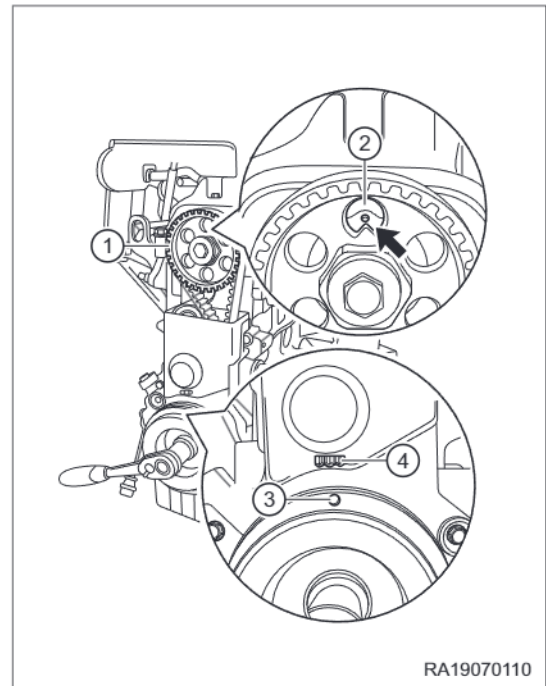
Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the lower right deflector ([See page 46-20](#)).
4. Remove the drive belt ([See page 07-21](#)).
5. Remove the timing belt cover.
 - a. Loosen and remove 2 fixing bolts (arrow) from the timing belt upper cover, and then remove the timing belt upper cover (1).
(Tightening torque: 8 - 11 N·m)



07

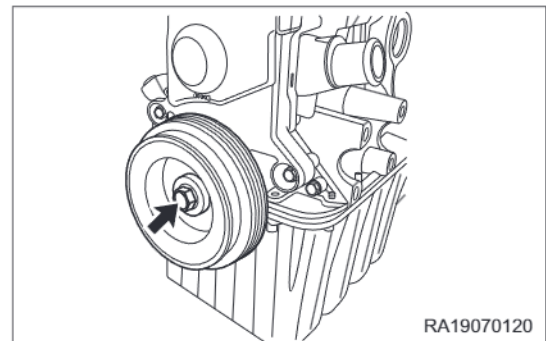
- b. Rotate the crankshaft pulley to align the mark (arrow) on the camshaft timing pulley (1) with the mark (2) on the cylinder head as shown in the illustration. Also, align the mark (3) on the crankshaft pulley with the fifth protrusion mark (4) on the timing belt lower cover (4).



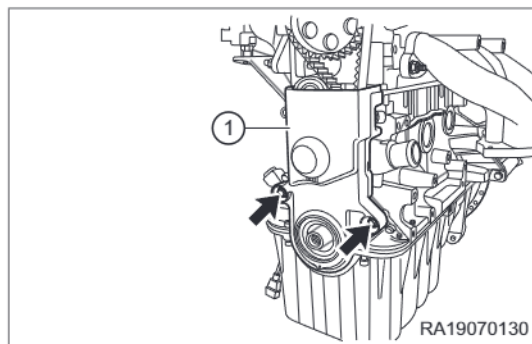
- c. Loosen and remove the crankshaft pulley fixing bolt (arrow), and then remove the crankshaft pulley.
(Tightening torque: 105 - 115 N·m)

HINT:

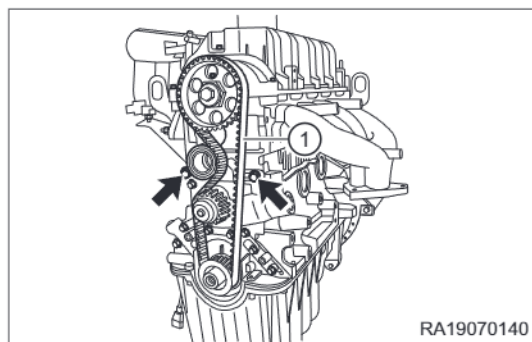
Shift the transmission into 5th gear when loosening the crankshaft pulley fixing bolt to engage the crankshaft and propeller shaft. The other technician depresses the brake pedal, which can lock the crankshaft by the mechanical gear train.



- d. Loosen and remove 2 fixing bolts (arrow) from the timing belt lower cover, and then remove the timing belt lower cover (1).
(Tightening torque: 8 - 11 N·m)



6. Remove the timing belt.
 - a. Remove 2 fixing bolts (arrow) from the timing belt tensioner, and then remove the timing belt tensioner.
 - b. Remove the timing belt (1).



07

Inspection

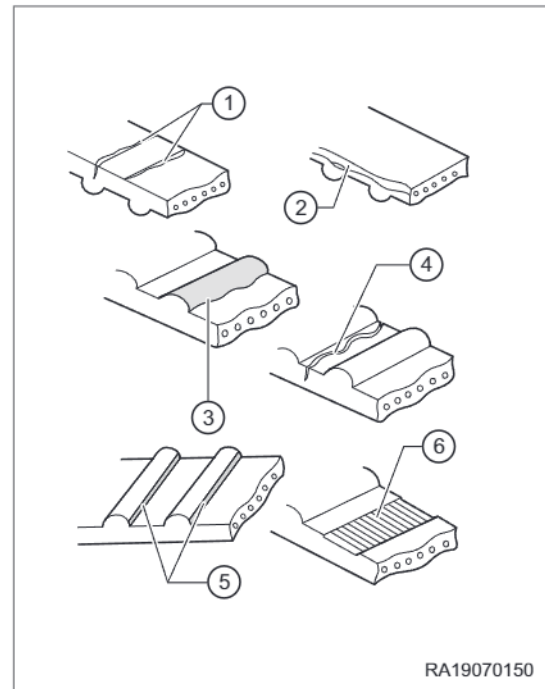
1. Check the timing belt.

CAUTION

- Check the timing belt carefully before installation, and replace it to prevent any of the following symptoms.

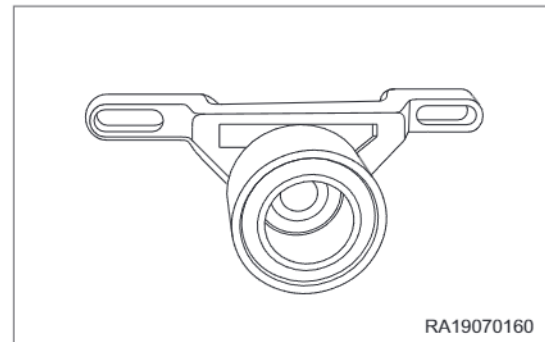
If the timing belt has the following conditions, replace it.

- a. There are cracks on the back of belt: as shown in the illustration (1).
- b. There are cracks at the bottom of cord fabric layer of belt: as shown in the illustration (2), (3) and (5).
- c. Belt worn: as shown in the illustration (6).
- d. Belt teeth missing and damaged: as shown in the illustration (4) and (6).



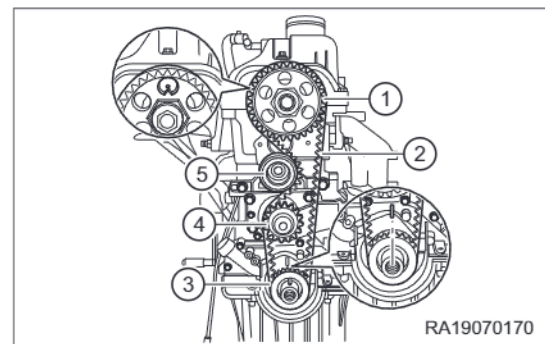
07

2. Check the timing belt tensioner.
 - a. Rotate the timing belt tensioner by hands and check if the rotation is smooth and if abnormal noise occurs.
 - b. Wiggle the timing belt tensioner in the axial and radial direction to check if there is slackness.
 - c. Check if there is damage on the timing belt tensioner surface.

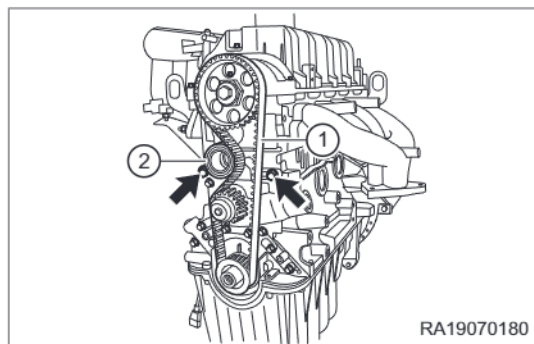


Installation

1. Install the timing belt (2) and be sure to align the arrow mark on the camshaft pulley hole with the upper mark on the cylinder (upper left partial view). Also, align the protrusion mark on the crankshaft timing pulley with the mark on the oil pump housing (lower right partial view).
2. Check if the timing belt is installed to the camshaft timing pulley (1), timing belt tensioner (5), water pump pulley (4) and crankshaft timing pulley (3) correctly.



3. Using an auxiliary fixture, apply 300 ± 50 N of load to the timing belt tensioner (2) in the horizontal direction so that the timing belt (1) can bear the proper tension (the timing belt tension should be 250 - 350 N when the camshaft has no load and the engine does not crank), then tighten the 2 timing belt tensioner fixing bolts (arrow).
(Tightening torque: 16 - 20 N·m)



CAUTION

- Lock the crankshaft and camshaft when assembling the timing belt.

07

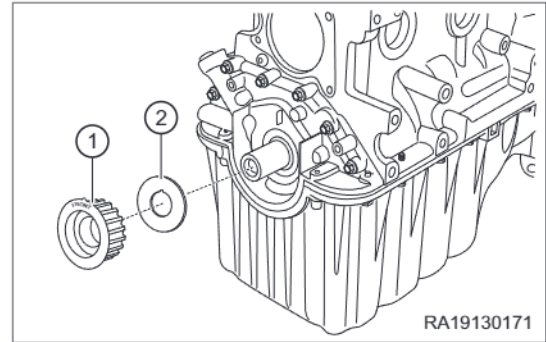
4. Rotate the crankshaft one turn to check the timing mark for offset. If necessary, remove the belt and reinstall it.

Other installation procedures are in the reverse order of removal.

Crankshaft Front Oil Seal

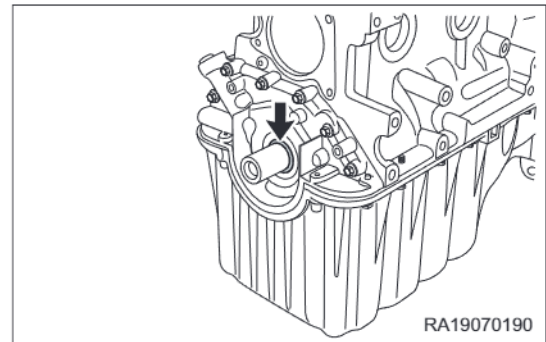
Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the lower right deflector (See page 46-20).
4. Remove the drive belt (See page 07-21).
5. Remove the engine timing belt (See page 07-28).
6. Remove the crankshaft timing pulley (1) and crankshaft timing pulley washer (2) from the crankshaft.



07

7. Remove the crankshaft front oil seal.
 - a. Using a flat tip screwdriver with the tip wrapped with tape, pry out the crankshaft front oil seal (arrow).

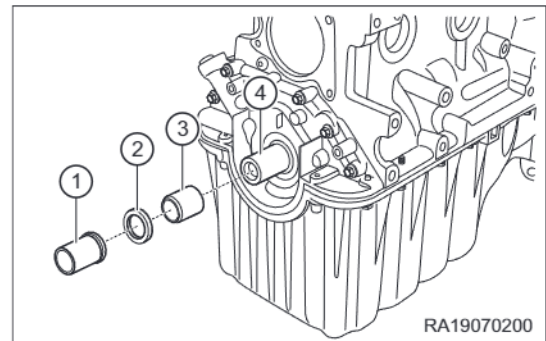


CAUTION

- Be careful not to damage the oil seal retainer and surface of crankshaft when removing the crankshaft front oil seal.

Installation

1. Install the crankshaft front oil seal guide tool (3) to the crankshaft (4).
2. Install the new oil seal (2) to the crankshaft front oil seal guide tool, then install the new oil seal fully into the oil seal retainer with the crankshaft front oil seal installer (1).



 CAUTION

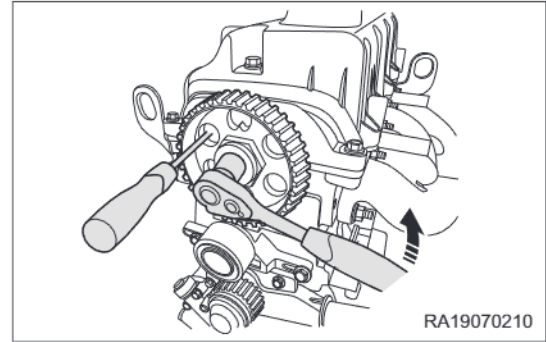
- Apply a coat of engine oil to the crankshaft front oil seal guide tool before installing the new oil seal.
- Remove the dirt on the oil seal retainer and apply a coat of engine oil to the oil seal retainer and oil seal lip before installation.
- Be sure to prevent the lip of crankshaft front oil seal from being scratched during installation. If it is damaged, replace it immediately.

Other installation procedures are in the reverse order of removal.

Camshaft Oil Seal

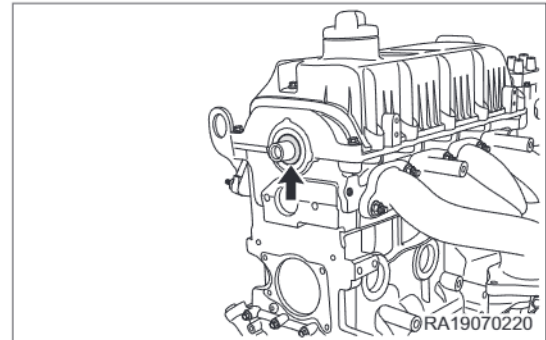
Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the lower right deflector (See page 46-20).
4. Remove the drive belt (See page 07-21).
5. Remove the engine timing belt (See page 07-28).
6. Remove the camshaft timing pulley.
 - a. Hold the camshaft timing pulley with a tool, then turn the wrench in the direction of arrow as shown in the illustration to remove the camshaft timing pulley fixing bolt.
(Tightening torque: $100 \pm 10 \text{ N}\cdot\text{m}$)



07

- b. Remove the camshaft timing pulley.
7. Remove the camshaft oil seal.
 - a. Using a flat tip screwdriver with the tip wrapped with tape, pry out the camshaft oil seal (arrow).

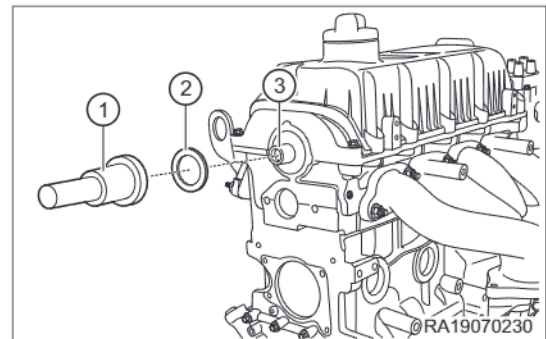


CAUTION

- Be careful not to damage the oil seal retainer and surface of camshaft when removing the camshaft oil seal.

Installation

1. Using a special tool (camshaft oil seal installer) (1), install the new oil seal (2) to the camshaft (3).



 CAUTION

- Remove the dirt on the oil seal retainer and apply a coat of engine oil to the oil seal retainer and oil seal lip before installation.
- Be sure to prevent the lip of camshaft oil seal from being scratched during installation. If it is damaged, replace it immediately.

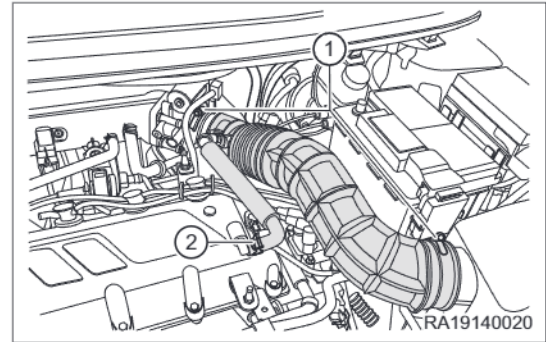
Other installation procedures are in the reverse order of removal.

Cylinder Head Cover

Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Blow the dirt and debris away from the upper surface of cylinder head cover with compressed air.
5. Remove the intake hose with crankcase ventilation hose assembly.

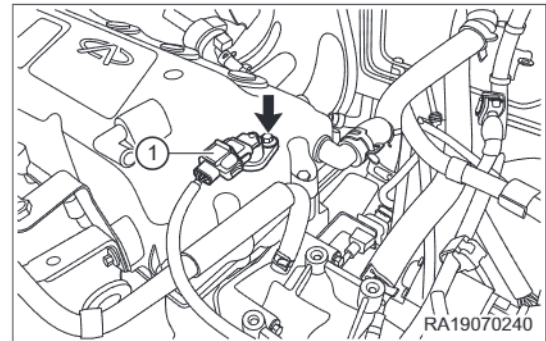
- a. Loosen the worm clamps (1) on both ends of the intake hose and disconnect the intake hose.
(Tightening torque: $2.5 \pm 0.5 \text{ N}\cdot\text{m}$)
- b. Loosen the elastic clamp (2) and disconnect the crankcase ventilation hose from the cylinder head cover.



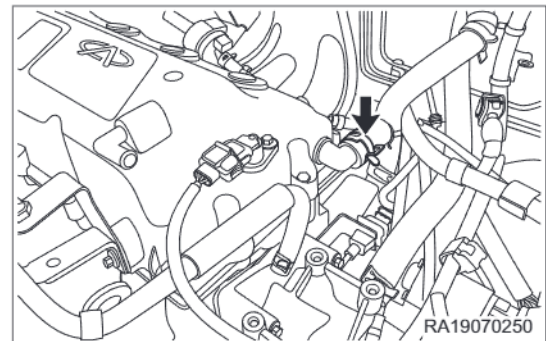
07

- c. Remove the intake hose with crankcase ventilation hose assembly.
6. Remove the high-voltage cables (See page 14-8).
7. Remove the PCV valve (See page 09-10).
8. Remove the camshaft position sensor.

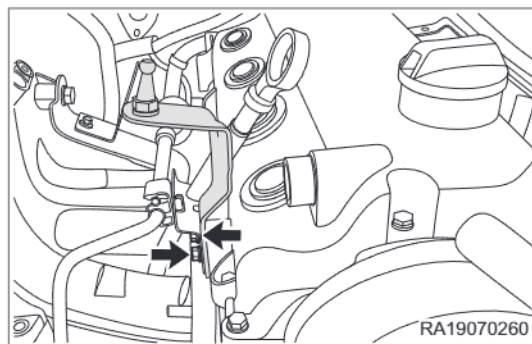
- a. Disconnect the camshaft position sensor connector (1).
- b. Remove the fixing bolt (arrow) from the camshaft position sensor.
(Tightening torque: $10 \pm 2 \text{ N}\cdot\text{m}$)



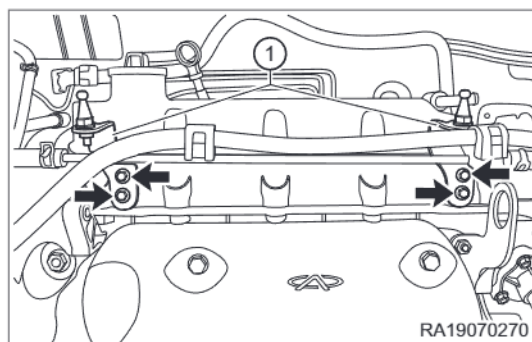
- c. Remove the camshaft position sensor from the cylinder head cover.
9. Remove the cylinder head cover.
- a. Loosen the elastic clamp (arrow) and disconnect the hose from the cylinder head cover.



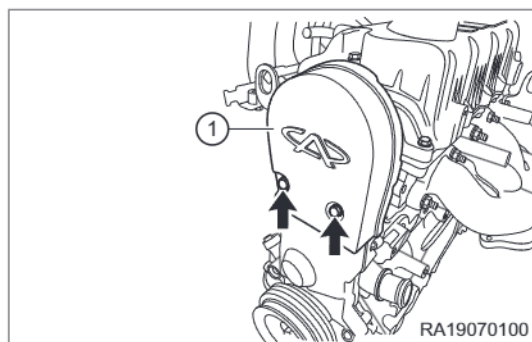
- b. Remove 2 fixing bolts (arrow) from the rear right bracket, and then remove the rear right bracket.
(Tightening torque: 7 ± 1 N·m)



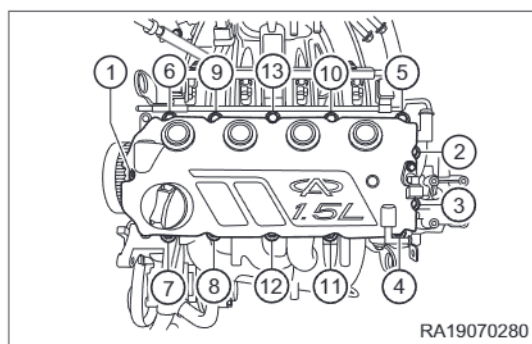
- c. Remove 4 fixing bolts (arrow) from the coolant pipe assembly, and then remove the 2 front bracket assemblies (1).
(Tightening torque: 7 ± 1 N·m)



- d. Loosen 2 fixing bolts (arrow) on the timing belt upper cover, and then move away the timing belt upper cover (1).
(Tightening torque: 8 - 11 N·m)



- e. Remove the cylinder head cover fixing bolts in the order shown in the illustration.
(Tightening torque: step 1: Tighten to 3 - 5 N·m; step 2: Tighten to 8 - 11 N·m)



- f. Remove the cylinder head cover from the cylinder head.

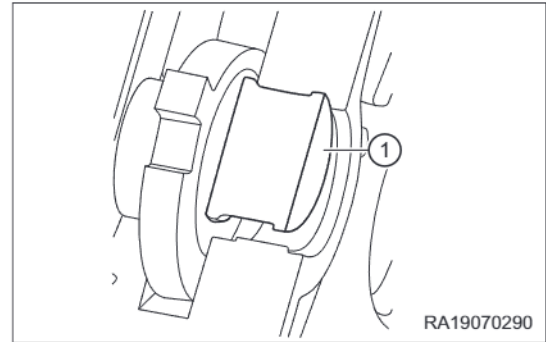
CAUTION

- Remove the oil and seal gum on the cylinder head cover with a special tool.

10. Remove the cylinder head cover gasket and semi-circle tight plug.

Installation

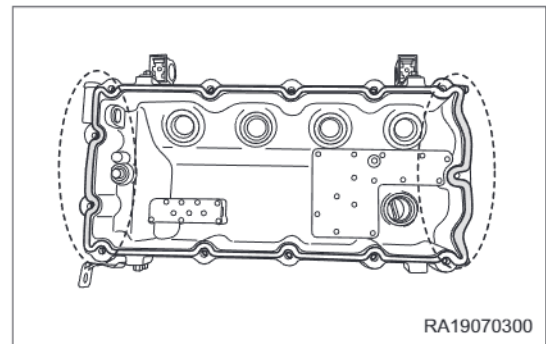
1. Replace the cylinder head cover gasket, semi-circle tight plug and spark plug guide washer.
2. Apply seal gum to the contact surface between semi-circle tight plug (1) and cylinder head, and install the semi-circle tight plug to the cylinder head. Align the semi-circle tight plug limit groove with the upper opening during installation, then press it down.



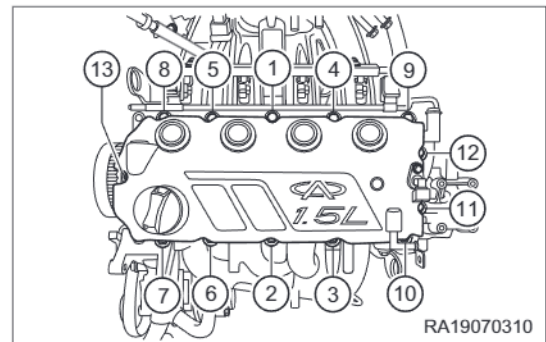
CAUTION

- During installation, align the corner side of semi-circle tight plug with the inside of cylinder head.

3. Install the cylinder head cover gasket into the groove of cylinder head, and then apply seal gum to the cylinder head cover gasket in the oval areas as shown in the illustration.

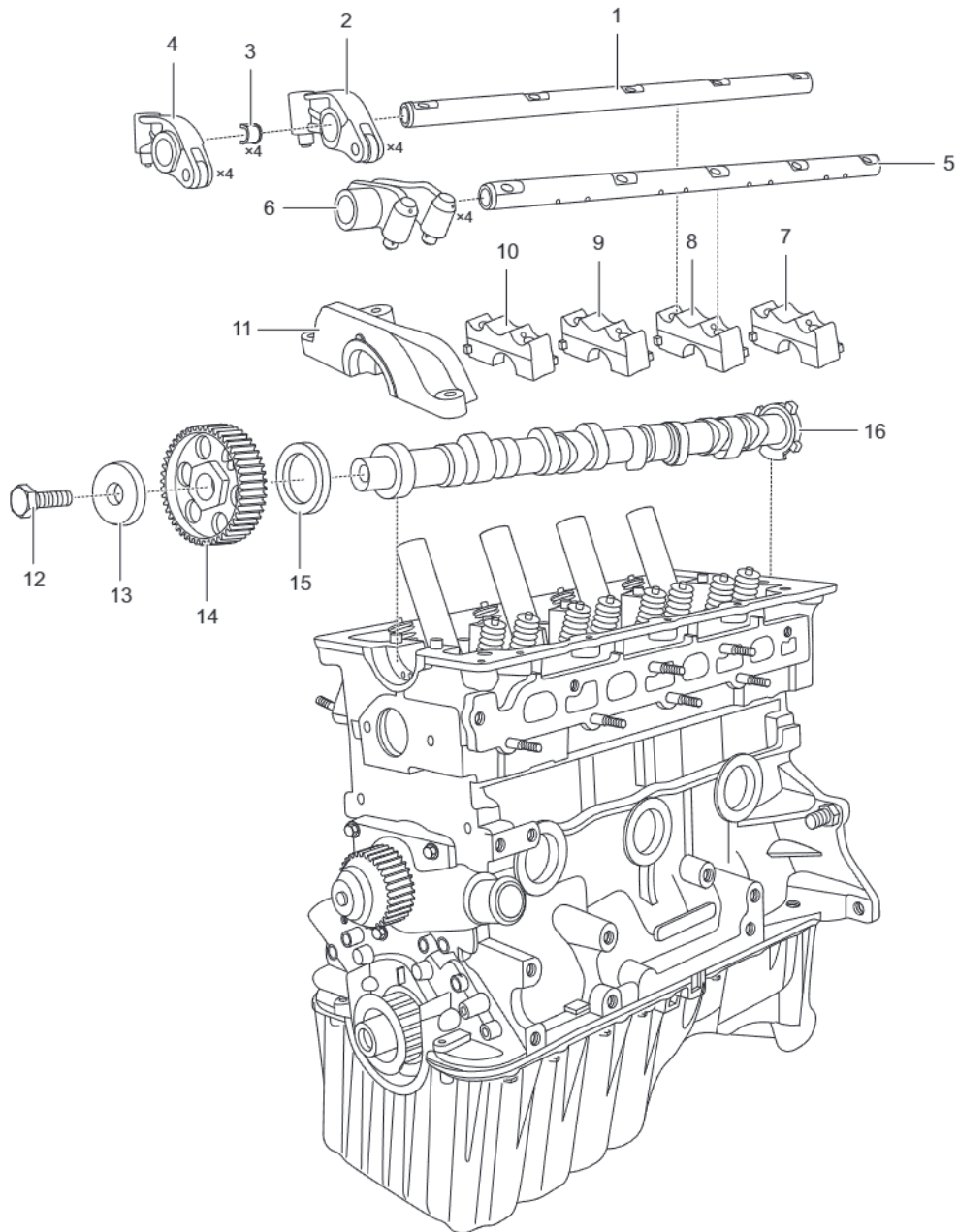


4. Hold the cylinder head cover by hands, make the spark plug protection pipe pass through the seal ring and press it down firmly, which can match the head cover with the bolt hole of the cylinder head. Then install it to the cylinder head after alignment. During assembly, take it carefully to prevent the gasket from falling off the head cover and the assembly should be completed in one time to prevent the seal gum offset.
5. Install the head cover bolts to the cylinder head cover in the sequence shown in the illustration by following the operation procedures:
 - a. Install the bolts in place by hand;
 - b. Tighten them to 3 - 5 N·m in order;
 - c. Retighten them to 8 - 11 N·m in order.



Camshaft & Rocker Arm Shaft

Description

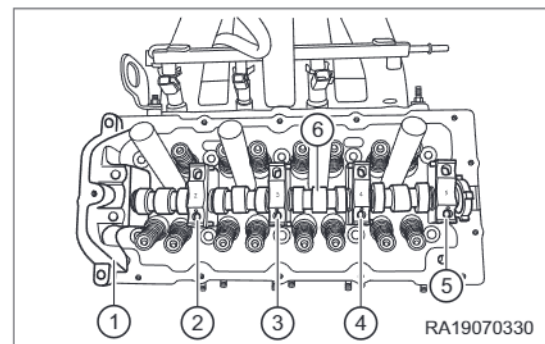
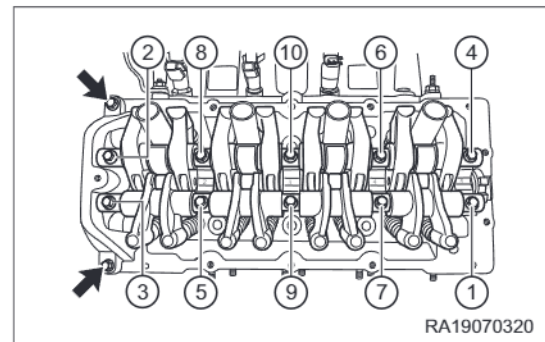


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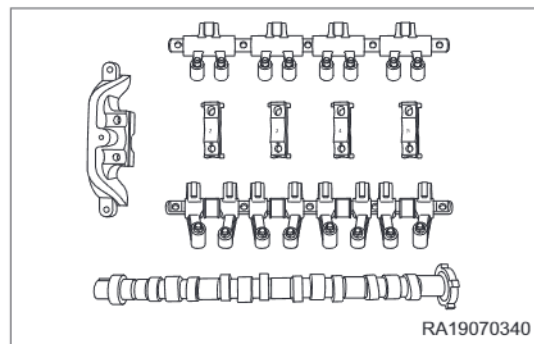
1 - Intake Rocker Arm Shaft	2 - Intake Right Rocker Arm Assembly
3 - Intake Rocker Arm Retaining Sleeve	4 - Intake Left Rocker Arm Assembly
5 - Exhaust Rocker Arm Shaft	6 - Exhaust Rocker Arm Assembly
7 - 5th Bearing Cap	8 - 4th Bearing Cap
9 - 3rd Bearing Cap	10 - 2nd Bearing Cap
11 - 11th Bearing Cap	12 - Camshaft Timing Pulley Fixing Bolt
13 - Camshaft Timing Pulley Fixing Bolt Washer	14 - Camshaft Timing Pulley
15 - Camshaft Oil Seal	16 - Camshaft

Removal

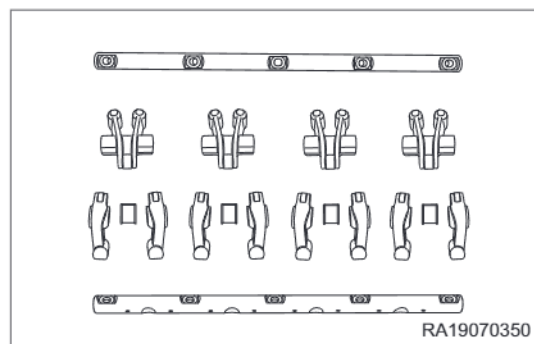
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the high-voltage cables ([See page 14-8](#)).
5. Remove the drive belt ([See page 07-21](#)).
6. Remove the engine timing belt ([See page 07-28](#)).
7. Remove the camshaft oil seal ([See page 07-35](#)).
8. Remove the cylinder head cover assembly ([See page 07-37](#)).
9. Remove the rocker arm shaft and camshaft.
 - a. Remove the rocker arm shaft fixing bolts in the sequence shown in the illustration and remove the 1st bearing cap fixing bolts (arrow). Remove the rocker arm shafts with rocker arms and place them aside carefully.
 - b. Remove the camshaft bearing caps from (1) to (5), and then remove the camshaft (6).



- c. Arrange the removed parts orderly on the workbench.



- d. Arrange the disassembled intake and exhaust rocker arms and rocker arm shafts in the assembly order on the workbench.



07

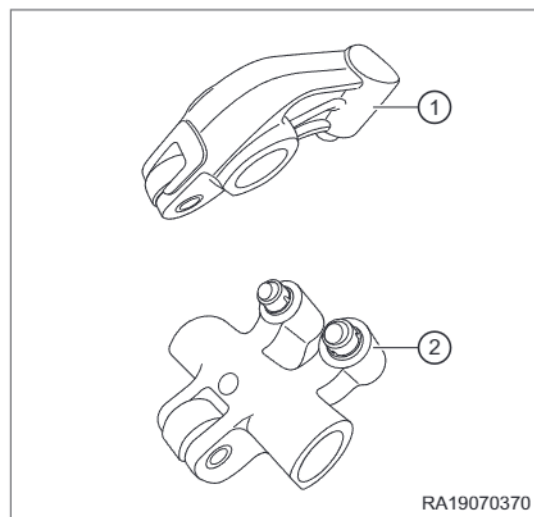
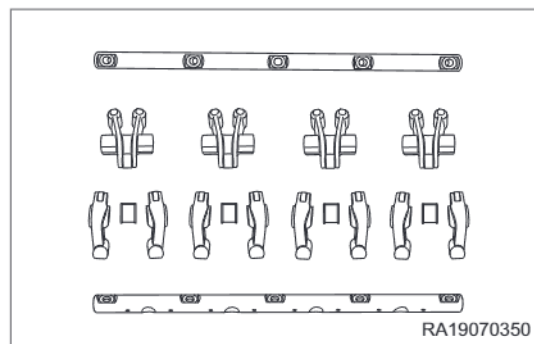
Inspection

1. Check the rocker arm shaft.
 - a. Check the rocker arm shaft diameter.
Measure the intake/exhaust rocker arm shaft diameter with the outer diameter micrometer.

Measurement Item	Specification (mm)
Intake Rocker Arm Shaft Diameter	$\phi 19^{+0.035}_{+0.017}$
Exhaust Rocker Arm Shaft Diameter	$\phi 19^{+0.035}_{+0.017}$

If the intake/exhaust rocker arm shaft diameter is not within the specified range, replace the intake/exhaust rocker arm shaft.

2. Check the valve rocker arm assembly.
 - a. Check if the rocker arm retainer is damaged or if the rocker arm tappet ball is damaged or falls out. If this occurs, replace the intake rocker arm assembly (1) or exhaust rocker arm assembly (2).
 - b. Check if the rocker arm tappet ball rotates freely. If it cannot rotate freely or is loose excessively, replace the intake rocker arm assembly (1) or exhaust rocker arm assembly (2).
 - c. Check the valve rocker arm hole. If it is damaged or tightened excessively, replace the intake rocker arm assembly (1) or exhaust rocker arm assembly (2).



- d. Check the hole diameter of rocker arm shaft for intake rocker arm assembly.

Measure the hole diameter of rocker arm shaft for intake left/right rocker arm assembly with the inner diameter micrometer.

Measurement Item	Specification (mm)
Hole Diameter of Rocker Arm Shaft for Intake Left Rocker Arm Assembly	$\phi 19^{+0.035}_{+0.017}$
Hole Diameter of Rocker Arm Shaft for Intake Right Rocker Arm Assembly	$\phi 19^{+0.035}_{+0.017}$

If the hole diameter of rocker arm shaft for intake left/right rocker arm assembly is not within the specified range, replace the intake left/right rocker arm assembly.

- e. Check the hole diameter of rocker arm shaft for exhaust rocker arm assembly.

Measure the hole diameter of rocker arm shaft for exhaust rocker arm assembly with the inner diameter micrometer.

Measurement Item	Specification (mm)
Hole Diameter of Rocker Arm Shaft for Exhaust Rocker Arm Assembly	$\phi 19^{+0.035}_{+0.017}$

If the hole diameter of rocker arm shaft for exhaust rocker arm assembly is not within the specified range, replace the exhaust rocker arm assembly.

3. Check the camshaft.

- a. Check the appearance.

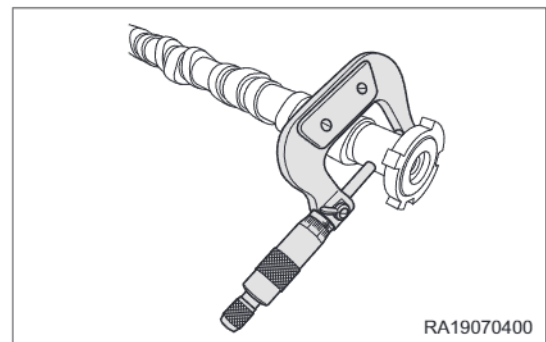
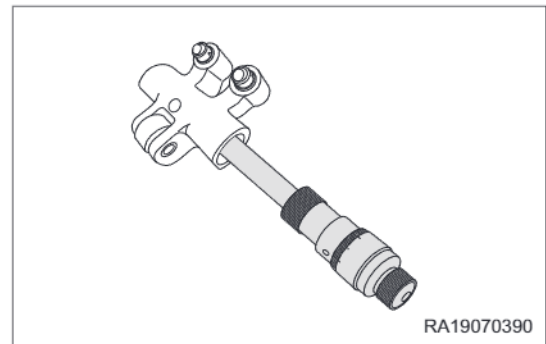
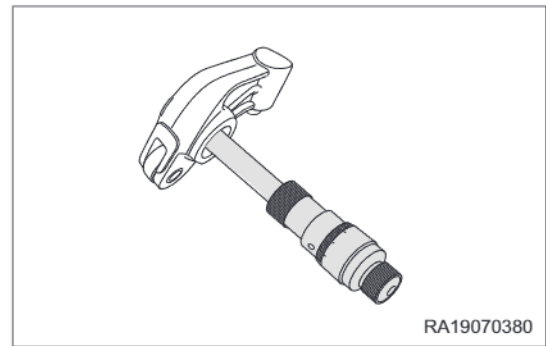
- Check if there are scratches on the camshaft bearing and cam surface. If there are scratches, repair or replace the camshaft.
- Check if there are leaking holes and cracks on the camshaft bearing cap. If there are leaking holes or cracks, replace the camshaft.

- b. Check the camshaft journal diameter.

Measure the camshaft journal diameter with the outer diameter micrometer.

Measurement Item	Specification (mm)
Camshaft Journal Diameter	$\phi 26^{-0.02}_{-0.033}$

If the camshaft journal diameter is not within the specified range, replace the camshaft.



c. Check the cam lift.

Measure the cam lift with the outer diameter micrometer as shown in the illustration.

- Camshaft lift height:
Measurement value A - Measurement value B

Measurement Item	Specification (mm)
Intake Cam Lift	5.09
Exhaust Cam Lift	5.34

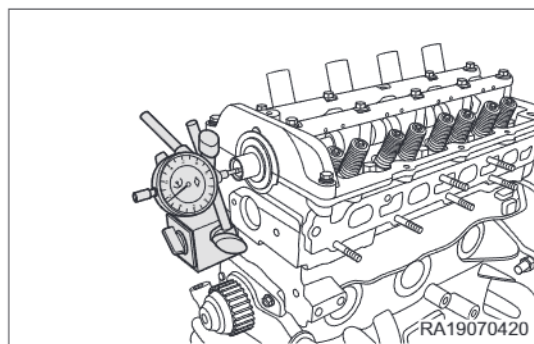
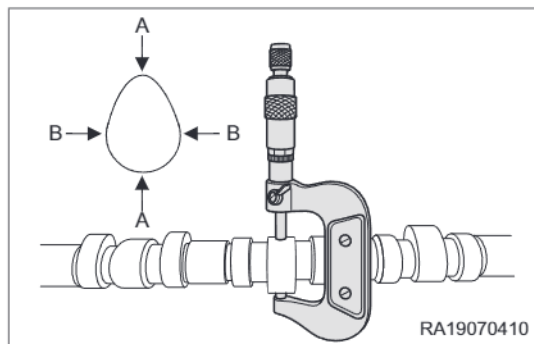
If the camshaft cam lift is not within the specified range, replace the camshaft.

d. Check the camshaft thrust clearance.

- Reinstall the camshaft.
- Remove the rocker arm and reinstall the rocker arm shaft and rocker arm shaft bolts, then tighten the bolts in two steps. 1st step: tighten them to $15 \pm 1.5 \text{ N}\cdot\text{m}$; 2nd step: retighten them to $30 \pm 1.5 \text{ N}\cdot\text{m}$. After the rocker arm shaft bolts are pre-tightened, tighten the bolts on both sides of 1st bearing cap.
(Tightening torque: $9.5 \pm 1 \text{ N}\cdot\text{m}$)
- Keep the measuring rod of dial indicator contacting with the front end of camshaft. Push the camshaft forward and backward gently (do not rotate the camshaft) and read the value from the dial indicator.

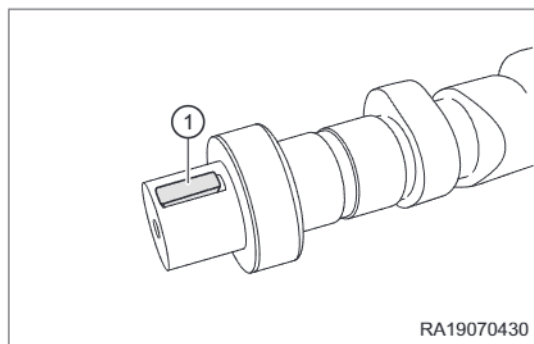
Measurement Item	Specification (mm)
Camshaft Thrust Clearance	0.095 - 0.153

If the camshaft thrust clearance is not within the specified range, replace the camshaft.



Installation

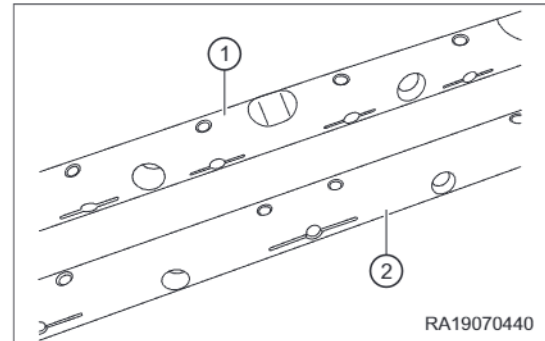
- Clean the intake and exhaust rocker arm shafts, camshaft and camshaft bearing caps.
- Install the camshaft semi-circle key (1).



CAUTION

- The camshaft semi-circle key (1) and the camshaft key slot is matched in transition fit along the width direction. The matching clearance is $-0.051 - 0.004$ mm.
- Check the protrusion height of semi-circle key after installing the key. The protrusion height of semi-circle key should be $1.64 - 2.11$ mm.

3. Check if there are residues and foreign matter in the rocker arm shaft oil hole.

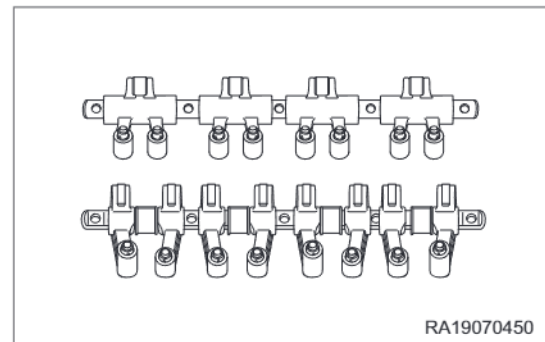


07

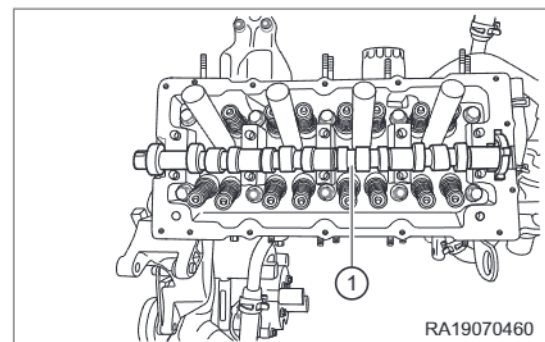
CAUTION

- Distinguish the intake and exhaust rocker arm shafts. There are four grooves on the intake rocker arm shaft (1) (to avoid the spark plug socket). There is no groove on the exhaust rocker arm shaft (2). During assembly, check that there are no burrs, fins and chips in the chamfer at both ends of each rocker arm shaft oil groove and oil hole. The surface of rocker arm shaft should be clean without any residues and foreign matter.

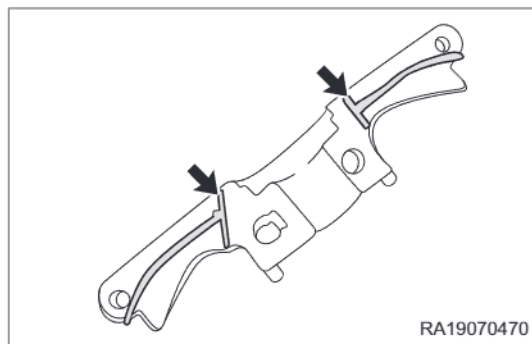
4. Check if the intake/exhaust rocker arm ball and intake rocker arm retaining sleeve are normal. Apply engine oil to the rocker arm shaft and install the rocker arm to the rocker arm shaft.



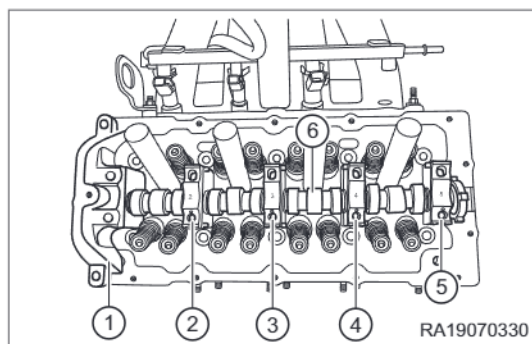
5. Apply engine oil to the contact surface of camshaft (1) and install the camshaft.



6. Clean the camshaft bearing cap. Apply seal gum to the seal areas (arrow) of 1st camshaft bearing cap as shown in the illustration.



7. Apply engine oil to the cam and camshaft journal and install the camshaft bearing caps in the order from (1) to (5).

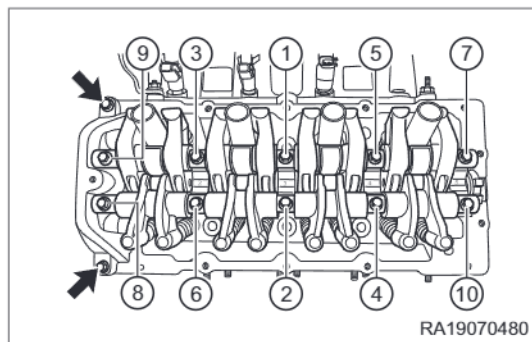


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CAUTION

- The dowel pin of camshaft bearing cap is matched with the clearance of cylinder head. When installing the camshaft bearing cap, put it in right position by hands and tap it lightly in place with a rubber hammer. Rotate the camshaft (6) by hands until some resistance can be felt.

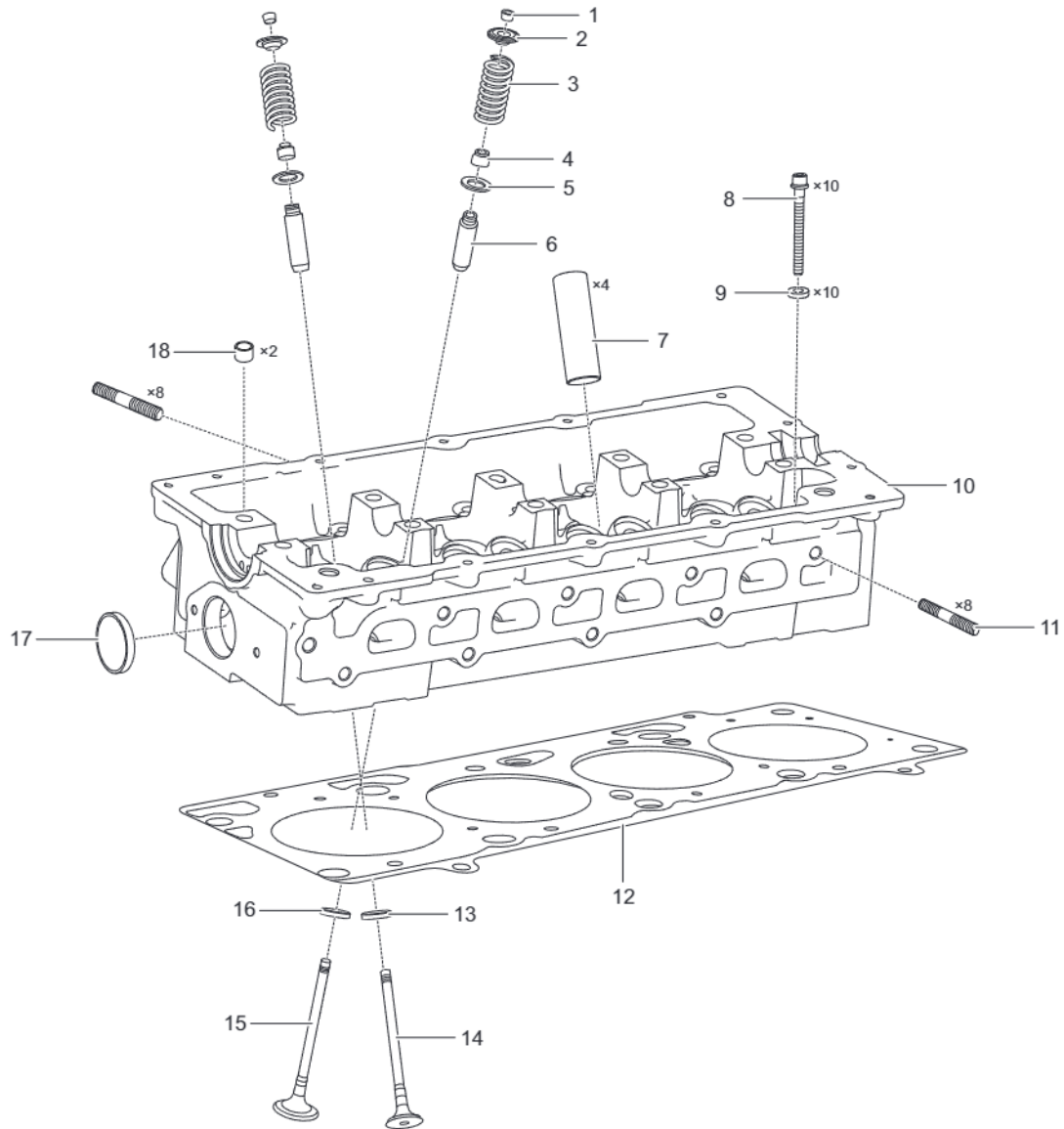
8. Install the intake rocker arm shaft assembly (the largest groove end faces toward 1st camshaft bearing cap and it should not be reversed) and adjust the rocker arm position, so that the rocker arm shaft contacts the bearing seat bracket.
9. Install the exhaust rocker arm shaft assembly (the large angle end surface faces toward 1st camshaft bearing cap and it should not be reversed) and with the camshaft not rotated, adjust the rocker arm position, and ensure that the exhaust rocker arm does not interfere with the bearing retainer and intake rocker arm.
10. Install the rocker arm shaft bolts. As shown in the illustration, tighten the rocker arm shaft fixing bolts from (1) to (10).
(Tightening torque: 1st step: tighten them to $15 \pm 1.5 \text{ N}\cdot\text{m}$;
2nd step: retighten them to $30 \pm 1.5 \text{ N}\cdot\text{m}$)
11. After the rocker arm shaft bolts are pre-tightened, tighten the bolts (arrow) on both sides of 1st bearing cap.
(Tightening torque: $9.5 \pm 1 \text{ N}\cdot\text{m}$)



12. After the rocker arm shaft bolts are tightened, apply an appropriate amount of engine oil to the tappet ball of rocker arm and ensure that there are an appropriate amount of engine oil at the contacting position between tappet ball and camshaft.

Cylinder Head

Description



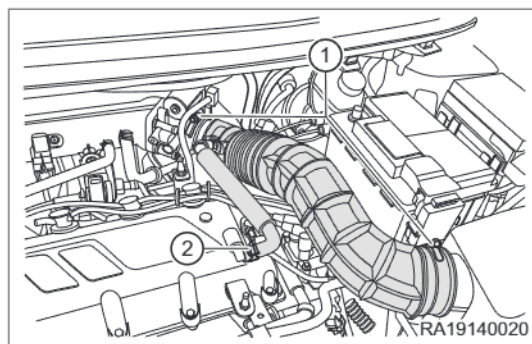
RA19070490

1 - Valve Cotter	2 - Valve Spring Upper Seat
3 - Valve Spring	4 - Valve Oil Seal
5 - Valve Spring Lower Seat	6 - Valve Guide
7 - Spark Plug Socket	8 - Cylinder Head Fixing Bolt
9 - Cylinder Head Fixing Bolt Washer	10 - Cylinder Head
11 - Stud	12 - Cylinder Head Gasket
13 - Intake Valve Retainer	14 - Intake Valve
15 - Exhaust Valve	16 - Exhaust Valve Retainer
17 - Bowl Plug	18 - Bush

Removal

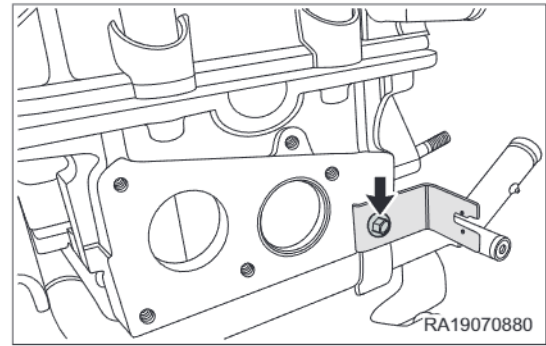
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1. Release the fuel system pressure ([See page 08-11](#)).
2. Turn off all the electrical equipment and ignition switch.
3. Disconnect the negative battery cable.
4. Drain the coolant ([See page 12-14](#)).
5. Remove the intake hose with crankcase ventilation hose assembly.
 - a. Loosen the worm clamps (1) on both ends of the intake hose and disconnect the intake hose.
(Tightening torque: 2.5 ± 0.5 N·m)
 - b. Loosen the elastic clamp (2) and disconnect the crankcase ventilation hose from the cylinder head cover.

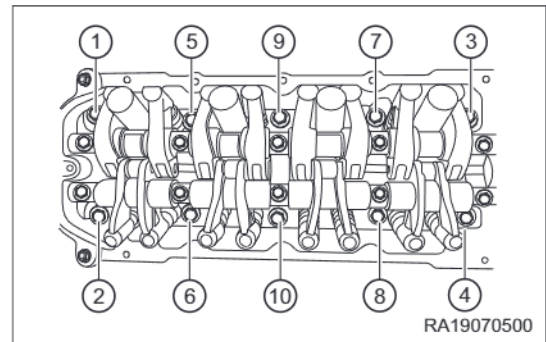


- c. Remove the intake hose with crankcase ventilation hose assembly.
6. Remove the high-voltage cables ([See page 14-8](#)).
7. Remove the spark plugs ([See page 14-12](#)).
8. Remove the ignition coil ([See page 14-10](#)).
9. Remove the thermostat ([See page 12-18](#)).
10. Remove the thermostat seat ([See page 12-21](#)).
11. Remove the fuel rail injector assembly ([See page 08-25](#)).
12. Remove the electronic throttle assembly ([See page 10-12](#)).
13. Remove the intake manifold assembly ([See page 10-15](#)).
14. Remove the exhaust manifold assembly ([See page 11-7](#)).
15. Remove the generator and generator bracket ([See page 16-9](#)).
16. Remove the engine timing belt ([See page 07-28](#)).
17. Remove the camshaft oil seal ([See page 07-35](#)).

18. Remove the coupling bolt (arrow) between small circulation coolant pipe and cylinder head, and then remove the speed sensor bracket.
(Tightening torque: $8 \pm 1 \text{ N}\cdot\text{m}$)



19. Remove the cylinder head cover (See page 07-37).
20. Remove the camshaft and rocker arm shaft (See page 07-40).
21. Remove the cylinder head fixing bolts in the sequence from (1) to (10) shown in the illustration.



07

CAUTION

- Failure to follow the sequence to remove the cylinder head bolts will cause cylinder head deformation.

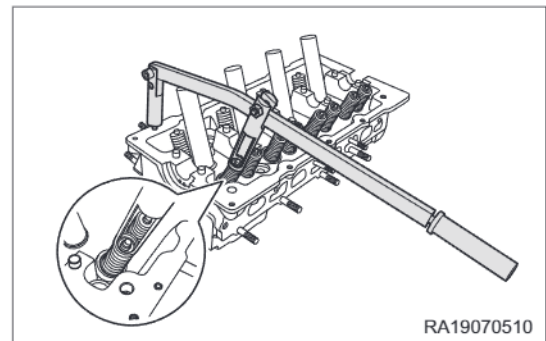
22. Remove the cylinder head and cylinder head gasket.

CAUTION

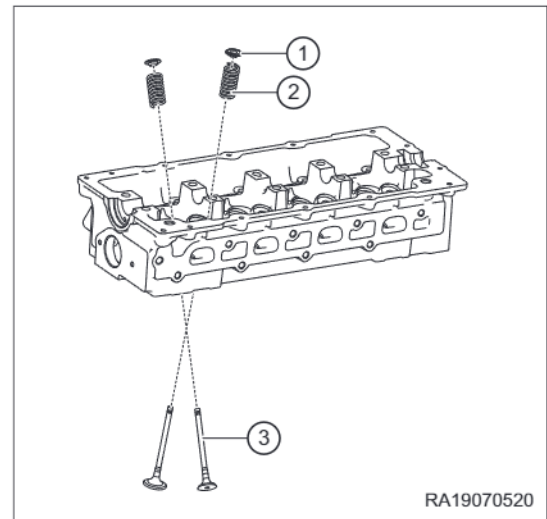
- Replace the used gasket with a new one.

Disassembly

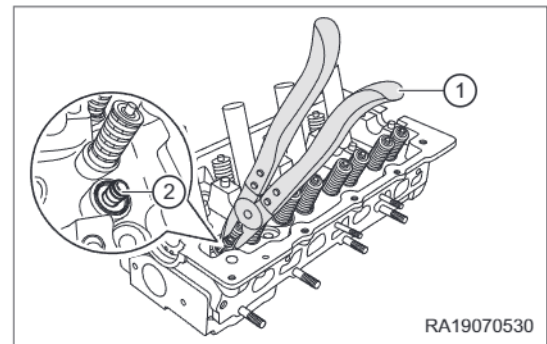
1. Using a special tool (valve spring compressor), compress the valve spring and remove the valve cotter with a flexional magnetic rod.



2. Remove the valve spring upper seat (1), valve spring (2) and valve (3) from the cylinder head.



- 07 3. Using a valve oil seal remover (1), remove the valve oil seal (2).



4. Using a flexional magnetic rod, remove the valve spring lower seat.

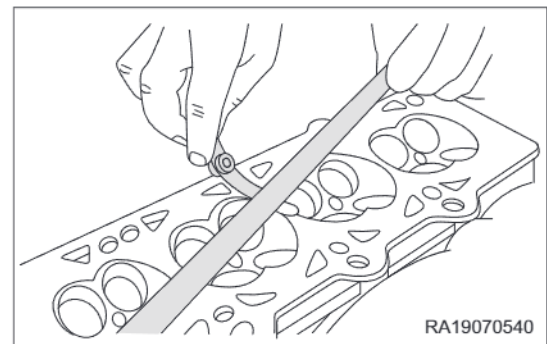
Inspection

1. Check the cylinder head.
 - a. Check the appearance.
 - Check if there are scratches on the camshaft bearing journal.
 - Remove the carbon deposits and varnish inside the valve guide with the valve guide cleaner.
 - Make sure that the valve cotter can move and rotate in the cylinder bore freely.
 - b. Check the cylinder head flatness.

Using a precision straightedge and feeler gauge, check the cylinder head flatness. The cylinder head flatness must be within 0.04 mm.

Measurement Item	Specification (mm)
Cylinder Head Flatness	0.04

If the cylinder head flatness is not within the specified range, repair or replace the cylinder head.

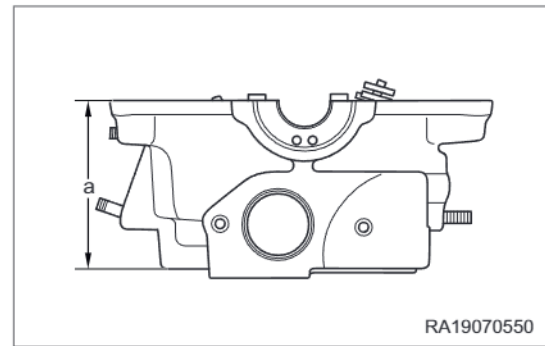


c. Check the cylinder head height.

Using a precision straightedge, measure the cylinder head height.

Measurement Item	Specification (mm)
Cylinder Head Height	97

If the cylinder head height is not within the specified range, replace the cylinder head.



CAUTION

- During replacement, the cylinder head should be fully equipped with valves, oil seals, springs, retainers, cotters, hydraulic tappets and crankshafts.

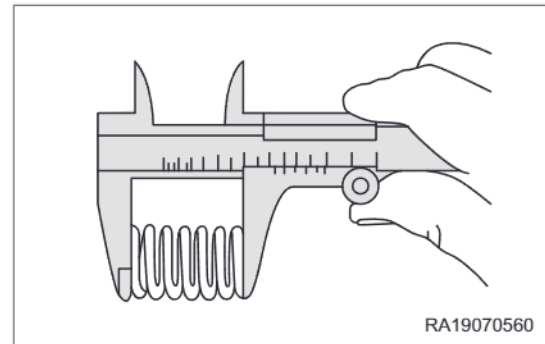
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2. Check the valve spring.

Using a vernier caliper, measure the free length of valve spring and the length of valve spring with the pre-pressure between 249 N and 271 N.

Measurement Item	Specification (mm)
Valve Spring Free Length	47.70
Valve Spring Length under Pre-pressure	32

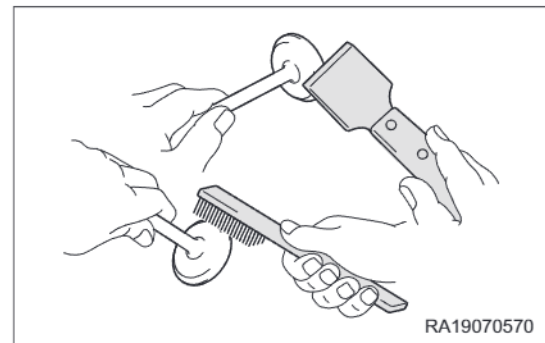
If the valve spring length is not within the specified range, replace the valve spring.



3. Check the valve.

a. Clean the valve.

- Using a scraper, remove the carbon deposited on the valve head.
- Using a wire brush, clean the valve thoroughly.

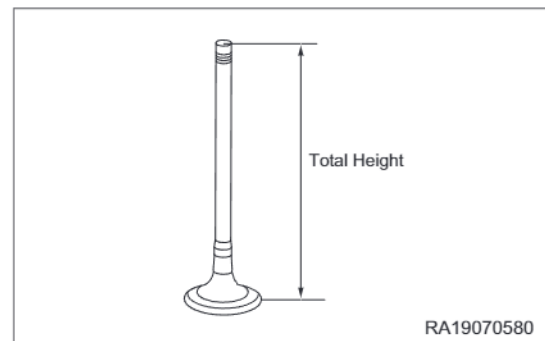


b. Check the valve height.

Using a micrometer, measure the valve height.

Measurement Item	Specification (mm)
Intake Valve Height	107.998
Exhaust Valve Height	117.410

If the height is less than the specified value, replace the valve.



c. Check the valve head.

Using a vernier caliper, measure the valve head.

Measurement Item	Specification (mm)
Intake Valve Head Thickness	0.6
Exhaust Valve Head Thickness	0.4
Grommet Width a of Intake Valve	2.83
Grommet Width b of Exhaust Valve	2.26

If it is not within the specified range, replace the valve.

d. Check the valve lifter diameter.

Using a micrometer, measure the valve lifter diameter.

Measurement Item	Specification (mm)
Intake Valve Lifter Diameter	$\phi 5.972 - \phi 5.988$
Exhaust Valve Lifter Diameter	$\phi 5.952 - \phi 5.968$

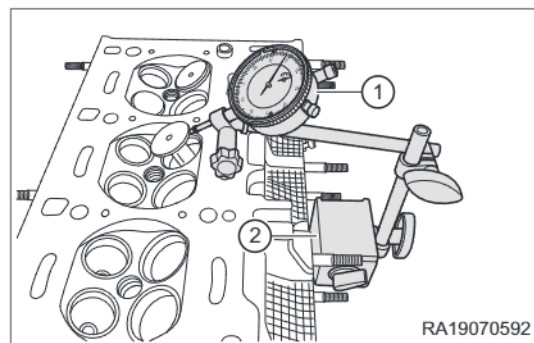
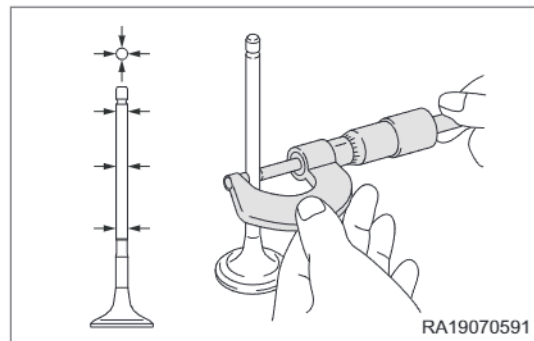
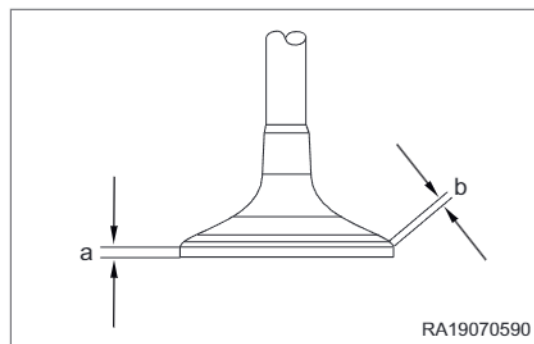
If the valve lifter diameter is not within the specified range, check the clearance between valve lifter and valve guide.

e. Check the clearance between valve lifter and valve guide.

- Install the dial indicator (1) to the holder (2). Install the intake valve or exhaust valve to the guide to be checked.
- Using the dial indicator, check the clearance between valve lifter and valve guide. Pull the valve to be checked out of the valve guide approximately 10 mm, and shake the valve gently to measure the clearance between valve and guide.

Measurement Item	Specification (mm)
Clearance Between Intake Valve and Guide	0.012 - 0.043
Clearance Between Exhaust Valve and Guide	0.032 - 0.063

If the clearance is not within the specified range, replace the valve or valve guide.



Assembly

HINT:

Clean all the components to be assembled thoroughly before assembly.

1. Install the valve (1) into the cylinder head.

HINT:

- Distinguish the intake valves and exhaust valves during installation.
- Apply a light coat of engine oil to the valve lifter end when assembling the valve.

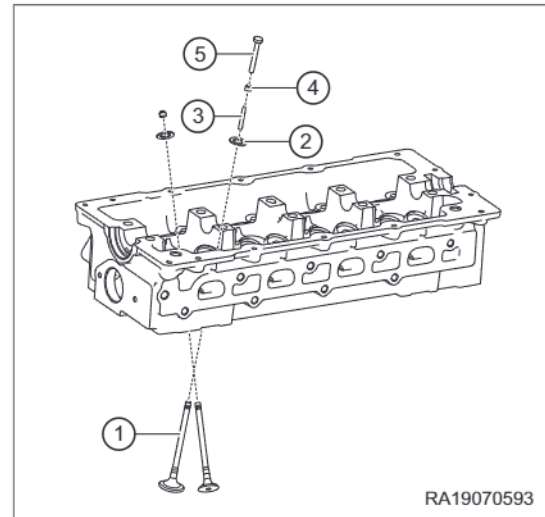
2. Install the new valve spring lower seat (2) if necessary.
3. Install the valve oil seal.

HINT:

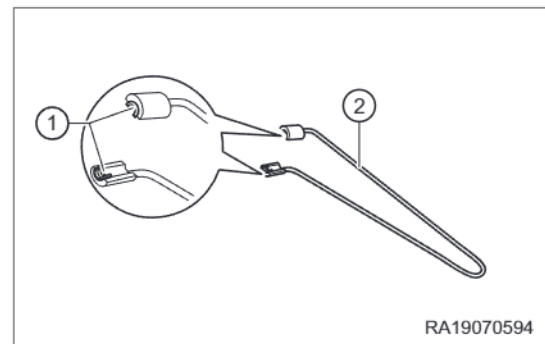
Apply a light coat of engine oil to the installation surface of valve oil seal end when assembling the valve oil seal.

- a. Install the valve oil seal guide sleeve (3) to the valve lifter.
- b. Install the valve oil seal (4) to the valve oil seal guide sleeve.
- c. Tap the valve oil seal installer (5) lightly with a rubber hammer to install the valve oil seal in place.

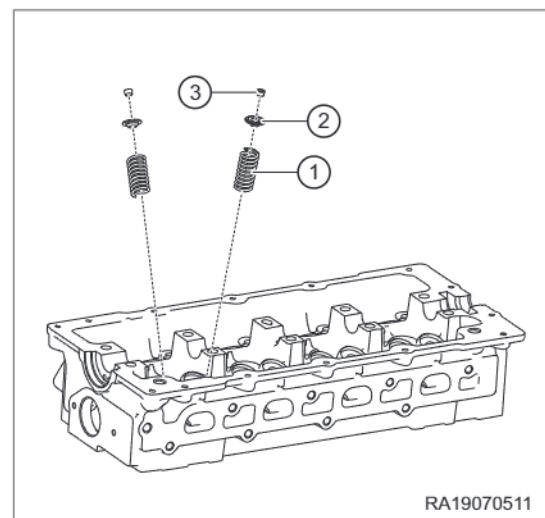
4. Install the valve cotter (1) to the valve cotter installer (2).



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5. Install the valve spring (1) and valve spring upper seat (2).
6. Using a valve spring compressor, compress the valve spring and install the valve cotter (3) in place.



7. Tap the valve cotter lightly with a rubber hammer to make sure the cotter is installed in place after assembly.

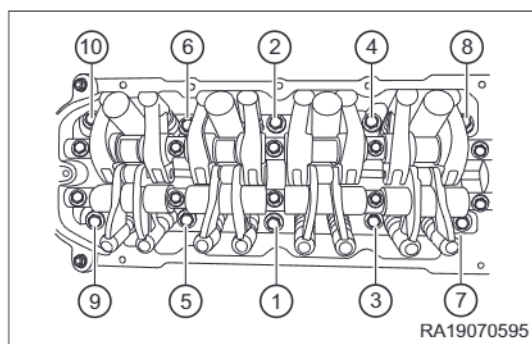
Installation

CAUTION

- Remove the residual seal gum and oil on the cylinder head and cylinder block.
- Replace the O-ring and cylinder head gasket.
- Check that the cylinder head gasket is neat and clean without any chips and scratches. The side stamped with part number of cylinder gasket should face upward.
- Install the cylinder gasket to the flat surface of cylinder block with a dowel pin.
- Clean the joint surface between cylinder head and combustion chamber, together with the flat surface of cylinder block top and thread hole. There should be no accumulated oil at the bottom of cylinder block thread hole.
- During installation, the piston should not be located at the top dead center, in order to prevent it from being impacted by the opening valve when installing the rocker arm.
- Install the cylinder head bolt washer with the chamfering surface facing upward and the flat side facing cylinder head.

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1. Make sure to tighten the cylinder head fixing bolts in the sequence from (1) to (10) shown in the illustration:
 - a. Apply a small amount of oil to the bolt head and root.
 - b. Install the bolts and tighten them in place by hands.
 - c. Tighten the cylinder head fixing bolts in the following procedures:
 - 1st step: Tighten the bolts to 20 - 25 N·m in the sequence from (1) to (10) shown in the illustration.
 - 2nd step: Tighten the bolts to 40 - 45 N·m in the sequence from (1) to (10) shown in the illustration.
 - 3rd step: Rotate the bolts by 90° in tightening sequence.
 - 4th step: Rotate the bolts by 90° again in tightening sequence.



CAUTION

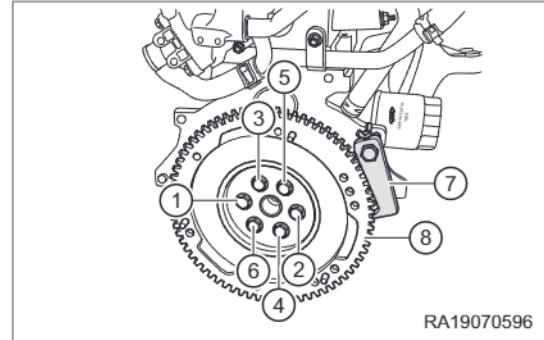
- Check the cylinder head fixing bolts before installation. If they are damaged, replace them immediately.
- Be sure to tighten the cylinder head bolts by following the operating procedures above strictly to achieve the technology standard for vehicle usage.

Other installation procedures are in the reverse order of removal.

Flywheel

Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-21).
4. Remove the clutch assembly (See page 18-16).
5. Using the special tool (flywheel holding tool) (7), lock the flywheel and remove the flywheel fixing bolts in the sequence from (1) to (6) shown in the illustration, then remove the flywheel (8).



07

⚠ WARNING

- Pay attention to personal safety when operating.
- DO NOT remove all the fixing bolts without any assist measure.

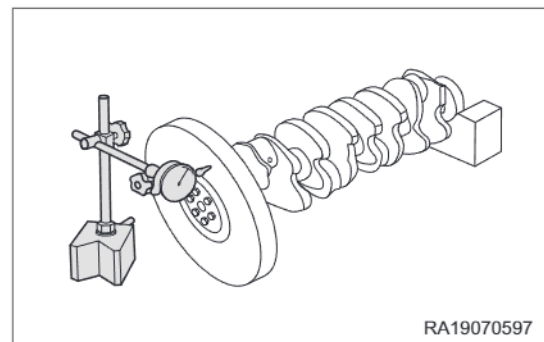
👁 CAUTION

- The flywheel fixing bolts must be disposed after removal. Never reuse them.

Inspection

1. Check if the crankshaft position signal gear is distorted or deformed. If damaged, replace the flywheel. Clean the signal gear before installation.
2. Check if the starter drive gear ring is worn. If excessively worn, replace the flywheel.
3. Check the contact surface of clutch lining. If the contact surface is damaged or excessively worn, replace the flywheel.
4. Measure the flywheel end surface runout with the dial indicator. If the measured value exceeds the limit, replace the flywheel with a new one.

Limit value for the end surface runout: 0.1 mm



Installation

WARNING

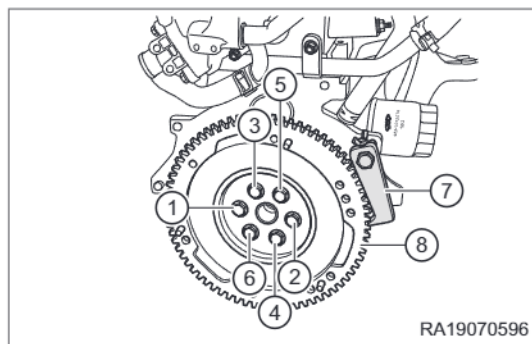
- Never reuse the flywheel fixing bolts after removal.
- Make sure to use the new flywheel fixing bolt with seal gum before installation.

CAUTION

- The six bolt holes on the flywheel have asymmetrical positions. There are matchmark holes on the flywheel. The mark hole is located right above when 1st cylinder of engine is at the top dead center and flywheel fixing bolts are aligned with the bolt holes of crankshaft.

07 The installation procedures are in the reverse order of removal, and pay attention to the followings:

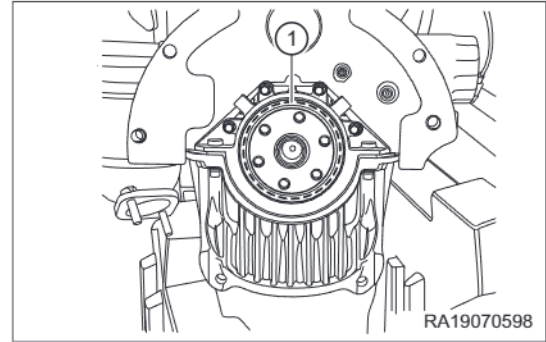
1. Align the flywheel installation hole with the crankshaft positioning journal and then push lightly during assembly. DO NOT tap the flywheel with a hammer.
2. Replace the flywheel fixing bolts with precoated seal gum with new ones.
3. Install the flywheel (8) and bolts, and then lock the flywheel with the flywheel lock tool (7). Tighten the flywheel fixing bolts in two steps in the sequence from (1) to (6).
 - 1st step: 50 - 60 N·m
 - 2nd step: 105 - 115 N·m



Crankshaft Rear Oil Seal

Removal

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-21).
4. Remove the clutch assembly (See page 18-16).
5. Remove the flywheel (See page 07-55).
6. Remove the crankshaft rear oil seal.
 - a. Using a screwdriver with the tip wrapped with tape, remove the crankshaft rear oil seal (1).



07

CAUTION

- Be careful not to damage the surrounding parts and oil seal retainer when removing the oil seal.
- Be careful not to damage the oil pan gasket when removing the rear oil seal bracket.

Installation

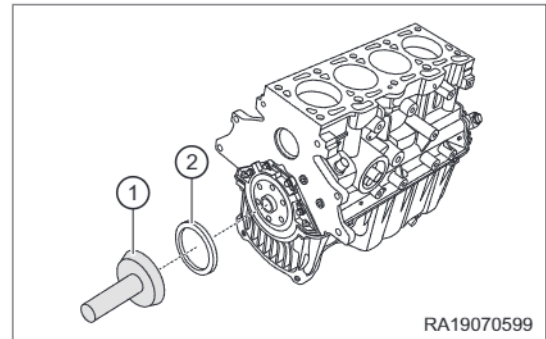
CAUTION

- Be sure to clean the dirt around the oil seal retainer and on the inside wall before installation.
- Check the oil seal for damage before installation. If there is any damage, replace it.
- Be sure to prevent the lip of crankshaft rear oil seal from being scratched during installation.
- Be careful not to damage the oil seal retainer during installation.

1. Install the new gasket and rear oil seal bracket.
2. Using the crankshaft rear oil seal installer (1), install the oil seal (2) with the part number side facing outward.

HINT:

Apply a coat of engine oil to the rear oil seal lip or crankshaft rear oil seal journal.

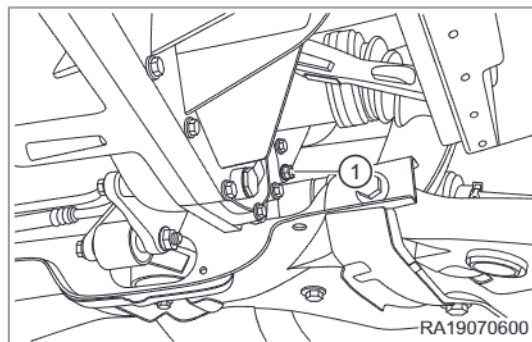


Other installation procedures are in the reverse order of removal.

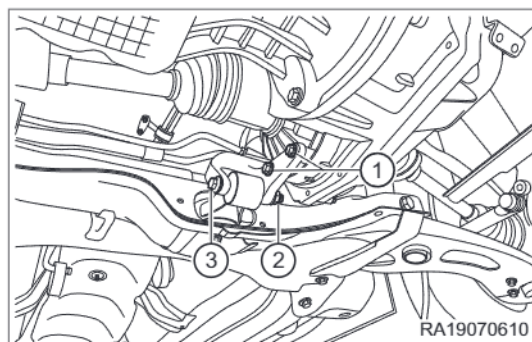
Engine Mounting Assembly

Removal & Installation - Rear Mounting Assembly

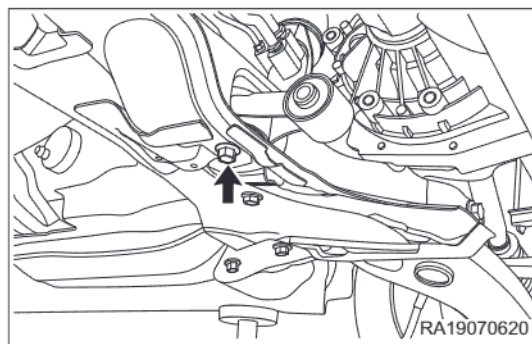
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Support the transmission with a transmission carrier.
4. Remove the engine rear mounting bracket.
 - a. Remove the coupling bolt (1) between rear mounting bracket and left side of transmission case. (Tightening torque: 55 ± 5.5 N·m)



- b. Remove 2 coupling bolts (1) between rear mounting bracket and right side of transmission case. (Tightening torque: 55 ± 5.5 N·m)
 - c. Remove the locking nut (2) for through bolt between rear mounting bracket and rear mounting cushion assembly, and then remove the through bolt (3). (Tightening torque: 85 ± 8.5 N·m)



- d. Remove the rear mounting bracket.
5. Remove the engine rear mounting cushion assembly.
 - a. Remove the coupling bolt (arrow) between rear mounting cushion assembly and front sub frame welding assembly. (Tightening torque: 85 ± 8.5 N·m)



- b. Remove the engine rear mounting cushion assembly from the front sub frame welding assembly.

Other installation procedures are in the reverse order of removal.

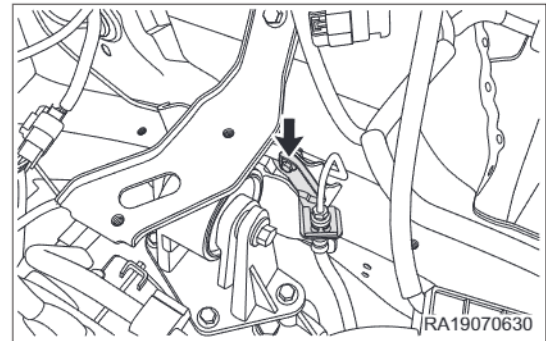
Removal & Installation - Left Mounting Assembly

1. Turn off all the electrical equipment and ignition switch.

CAUTION

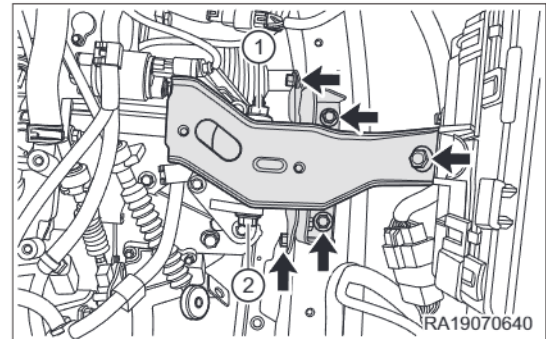
- Install the protector to prevent the body from being scratched.

2. Disconnect the negative battery cable.
3. Use an engine equalizer to hang the engine.
4. Remove the battery (See page 16-7).
5. Remove the battery tray (See page 16-8).
6. Remove the engine left mounting cushion assembly.
 - a. Remove the fixing bolt (arrow) from the bracket I, and then move away the bracket I from the left mounting cushion assembly.
(Tightening torque: $8 \pm 1 \text{ N}\cdot\text{m}$)

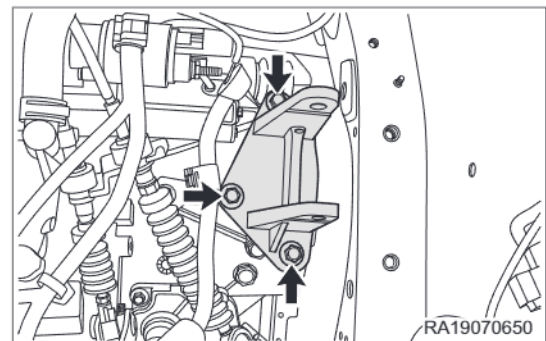


07

- b. Remove the locking nut (1) for through bolt between left mounting cushion assembly and left mounting bracket, and then remove the through bolt (2).
(Tightening torque: $80 \pm 8 \text{ N}\cdot\text{m}$)
- c. Remove 5 coupling bolts (arrow) between left mounting cushion assembly and body.
(Tightening torque: $60 \pm 6 \text{ N}\cdot\text{m}$)



- d. Remove the left mounting cushion assembly.
7. Remove the left mounting bracket.
 - a. Remove 3 coupling bolts (arrow) between left mounting bracket and transmission case.
(Tightening torque: $55 \pm 5.5 \text{ N}\cdot\text{m}$)



- b. Remove the left mounting bracket.

Other installation procedures are in the reverse order of removal.

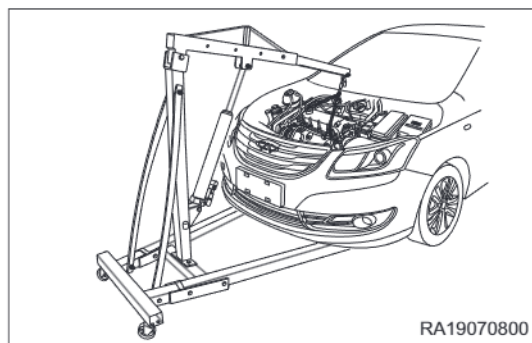
Removal & Installation - Right Mounting Assembly

1. Turn off all the electrical equipment and ignition switch.

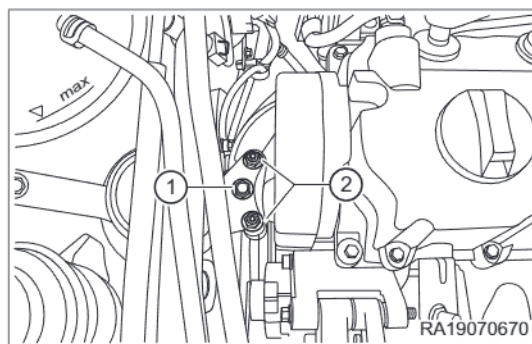
CAUTION

- Install the protector to prevent the body from being scratched.

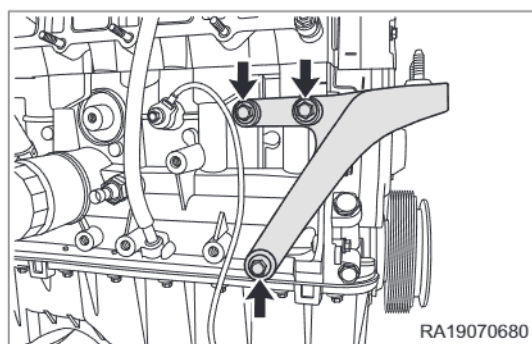
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Use an engine equalizer to hang the lifting eyes on both sides of the engine.



5. Remove the engine right mounting bracket.
 - a. Remove 1 coupling bolt (1) and 2 fixing nuts (2) between right mounting bracket and right mounting cushion assembly.
(Tightening torque: $60 \pm 6 \text{ N}\cdot\text{m}$)

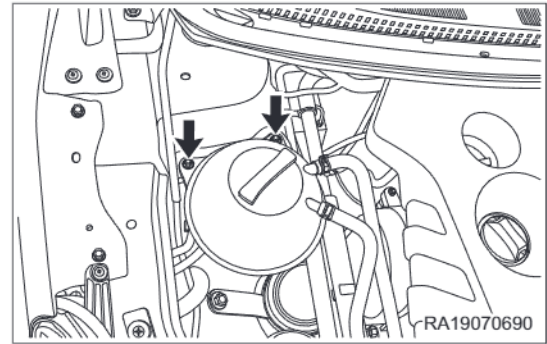


- b. Remove 3 coupling bolts (arrow) between right mounting bracket and engine block.
(Tightening torque: $60 \pm 6 \text{ N}\cdot\text{m}$)

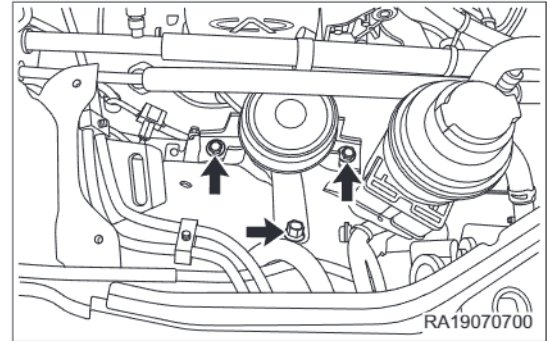


- c. Remove the engine right mounting bracket.

6. Remove the engine right mounting cushion assembly.
- a. Remove 2 fixing bolts (arrow) from the expansion tank and move the expansion tank to one side.
(Tightening torque: $7 \pm 1.5 \text{ N}\cdot\text{m}$)



- b. Remove 3 fixing bolts (arrow) from the right mounting cushion assembly.
(Tightening torque: $60 \pm 6 \text{ N}\cdot\text{m}$)



07

- c. Remove the engine right mounting cushion assembly.

Other installation procedures are in the reverse order of removal.

ENGINE UNIT REPAIR

Engine Assembly

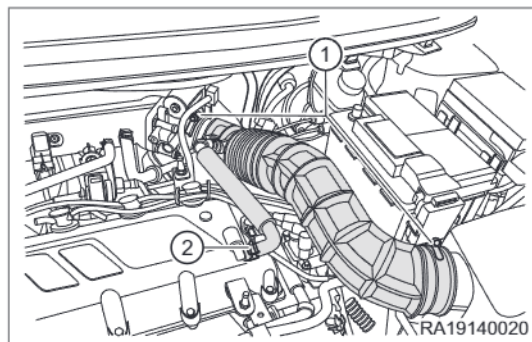
Removal

CAUTION

- Remove the engine and transmission as an assembly.
- Install the protector to prevent the body from being scratched.
- Block the inlet of intake pipe after removing the air filter and engine trim cover to prevent the foreign matter from entering. Otherwise, the foreign matter will block the intake passage when starting, which may cause serious damage to the engine.

07

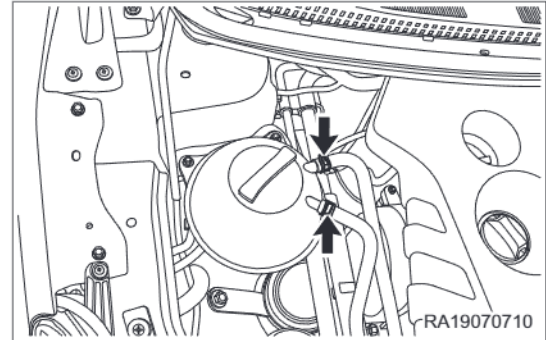
1. Remove the engine trim cover.
2. Release the fuel system pressure ([See page 08-11](#)).
3. Turn off all the electrical equipment and ignition switch.
4. Disconnect the negative battery cable.
5. Drain the engine oil ([See page 13-11](#)).
6. Drain the transmission oil ([See page 17-12](#)).
7. Drain the brake fluid ([See page 25-13](#)).
8. Drain the coolant ([See page 12-14](#)).
9. Drain the steering fluid ([See page 28-9](#)).
10. Recover the refrigerant ([See page 29-20](#)).
11. Remove the engine hood assembly ([See page 45-9](#)).
12. Remove the intake hose with crankcase ventilation hose assembly.
 - a. Loosen the worm clamps (1) on both ends of the intake hose and disconnect the intake hose.
(Tightening torque: $2.5 \pm 0.5 \text{ N}\cdot\text{m}$)
 - b. Loosen the elastic clamp (2) and disconnect the crankcase ventilation hose from the cylinder head cover.
- c. Remove the intake hose with crankcase ventilation hose assembly.
13. Remove the air filter ([See page 10-10](#)).
14. Remove the battery ([See page 16-7](#)).
15. Remove the battery tray ([See page 16-8](#)).
16. Remove the fuel rail injector assembly ([See page 08-25](#)).
17. Remove the electronic throttle assembly ([See page 10-12](#)).
18. Remove the intake manifold assembly ([See page 10-15](#)).
19. Install the engine right lifting eye.



HINT:

When installing 2 fixing nuts of the engine right lifting eye, install a thick washer between the nut and the lifting eye to make sure that the engine right lifting eye is securely fitted with nuts.

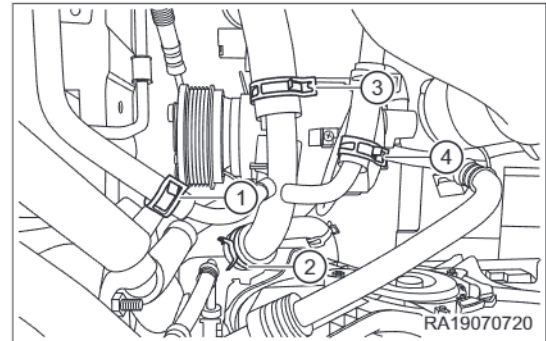
20. Remove the front wheel (See page 23-10).
21. Remove the drive shaft assembly (See page 19-5).
22. Disconnect the joint that connects the expansion tank and the coupling hose.
 - a. Loosen the elastic clamps (arrow) and disconnect the connection between expansion tank and outlet hose.



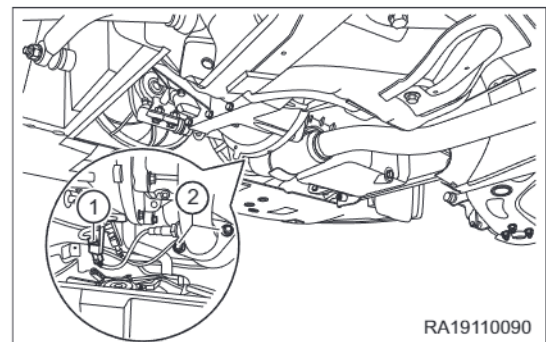
07

23. Remove the drive belt (See page 07-21).
24. Remove the generator assembly (See page 16-9).
25. Remove the idler pulley (See page 07-25).
26. Remove the tensioner (See page 07-27).
27. Remove the generator bracket (See page 16-9).
28. Remove the compressor assembly (See page 29-54).
29. Remove the power steering pump assembly (See page 28-17).
30. Remove the coolant pipe (4-way).

- a. Loosen the elastic clamp (1) and disconnect the connection between coolant pipe (4-way) and expansion tank outlet hose.
- b. Loosen the elastic clamp (2) and disconnect the connection between coolant pipe (4-way) and engine inlet pipe.
- c. Loosen the elastic clamp (3) and disconnect the connection between coolant pipe (4-way) and water pump assembly inlet coupling hose.
- d. Loosen the elastic clamp (4) and disconnect the connection between coolant pipe (4-way) and small circulation coolant pipe coupling hose.

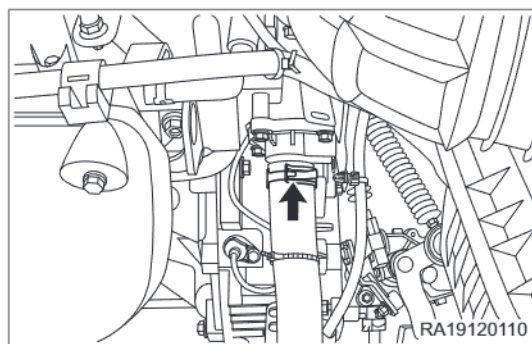


31. Disconnect the exhaust pipe connection.
 - a. Disconnect the downstream oxygen sensor connector (1) and remove it from the bracket.
 - b. Remove 2 coupling nuts (2), disconnect the main catalytic converter assembly and precatalytic converter assembly, and then remove the gasket in the connection.
(Tightening torque: $45 \pm 5 \text{ N}\cdot\text{m}$)



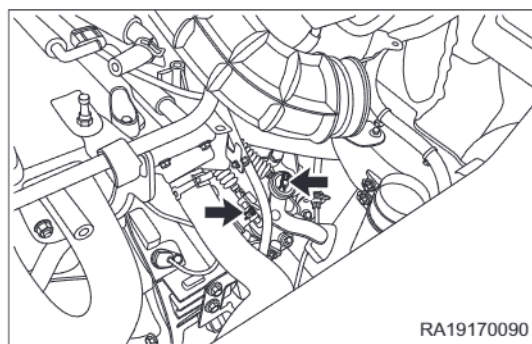
32. Disconnect the joint that connects thermostat housing and hose.

- a. Loosen the engine outlet hose elastic clamp (arrow), and disconnect the connection between engine inlet hose and thermostat housing.

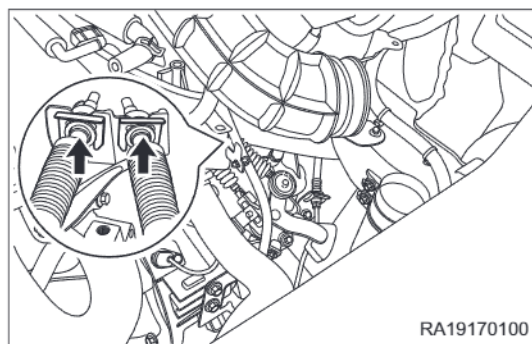


33. Move away the gear select and shift cable.

- a. Remove the cotter pins (arrow) that connect the gear select and shift cable and the transmission gear shift mechanism.



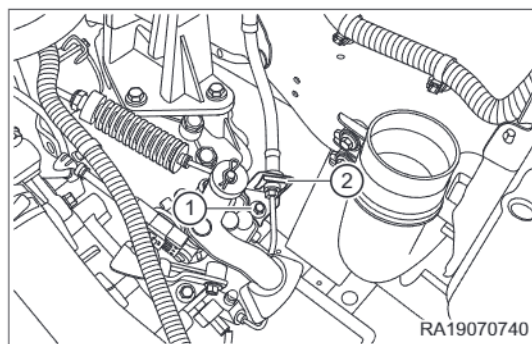
- b. Remove the flexible shaft clamps (arrow) from the gear select and shift cable.



- c. Move away the gear select and shift cable from the flexible shaft bracket.

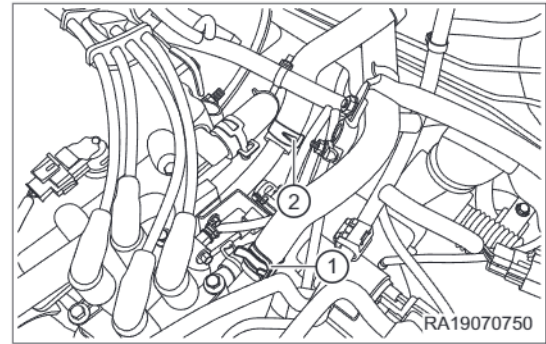
34. Disconnect the clutch hydraulic line connection.

- a. Loosen the coupling plug (1) and disconnect the connection between clutch release cylinder pipe assembly II and hose assembly. (Tightening torque: 18 ± 2 N·m)
- b. Remove the hose assembly clamp (2) and move away the hose assembly from the bracket.



35. Disconnect the heater water pipe.

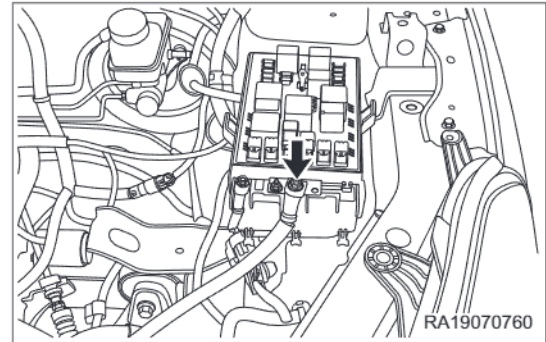
- a. Loosen the elastic clamp (1) and disconnect the connection between heater inlet pipe and the thermostat seat.
- b. Loosen the elastic clamp (2) and disconnect the connection between heater outlet pipe and coolant pipe assembly.



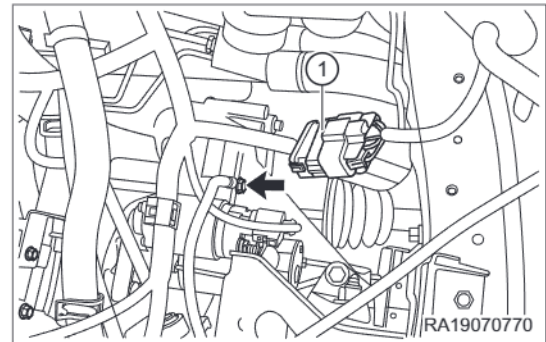
36. Move away the canister solenoid valve and its coupling hose from the bracket.

37. Disconnect the engine wire harness.

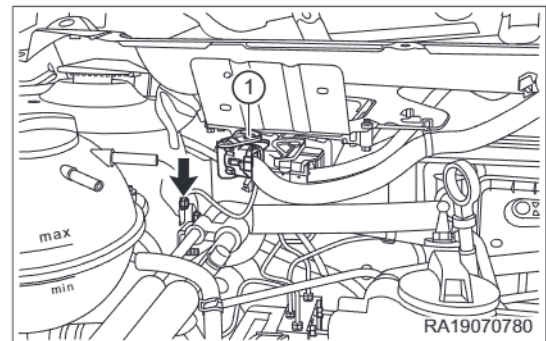
- a. Open the fuse and relay block cover and remove the positive wire harness fixing nut (arrow), then disconnect the connection between positive wire harness and fuse and relay block. (Tightening torque: 7 ± 1 N·m)



- b. Disconnect the connector (1) that connects the engine wire harness and the body floor wire harness.
- c. Remove the fixing bolt (arrow) and disconnect the negative battery cable from the transmission. (Tightening torque: 20 ± 3 N·m)



- d. Remove the fixing bolt (arrow) to disconnect the engine wire harness on ECM side. (Tightening torque: 7 ± 1 N·m)
- e. Disconnect the ECM wire harness connector (1).

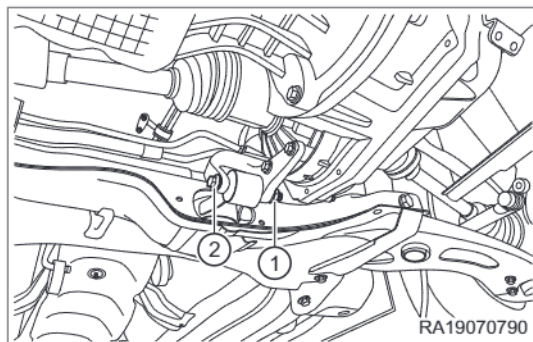


- f. Disconnect the fixing clip between engine wire harness and drain channel front end panel assembly.

38. Use an engine equalizer to hang the engine.

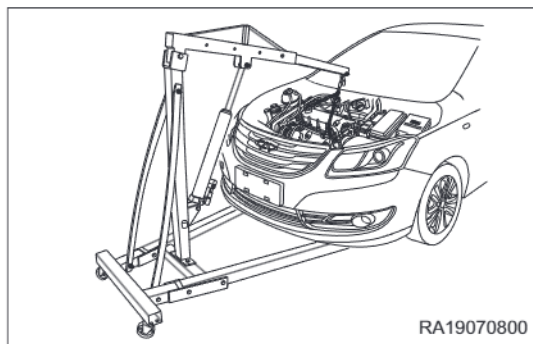
39. Remove the engine rear mounting through bolt.

- a. Remove the locking nut (1) for through bolt between rear mounting bracket and rear mounting cushion assembly, and then remove the through bolt (2).
(Tightening torque: $85 \pm 8.5 \text{ N}\cdot\text{m}$)



- b. Disconnect the connection between rear mounting bracket and rear mounting cushion assembly.

40. Remove the engine equalizer, and use an engine hoist to hang the lifting eyes on both sides of the engine.



41. Remove the engine left mounting cushion assembly ([See page 07-59](#)).

42. Remove the engine right mounting cushion assembly ([See page 07-60](#)).

43. Confirm that all the components are disconnected from the engine.

44. Remove the engine with transmission from the engine compartment.

45. Remove the engine wire harness and positive battery cable from the engine.

46. Separate the engine and the transmission.

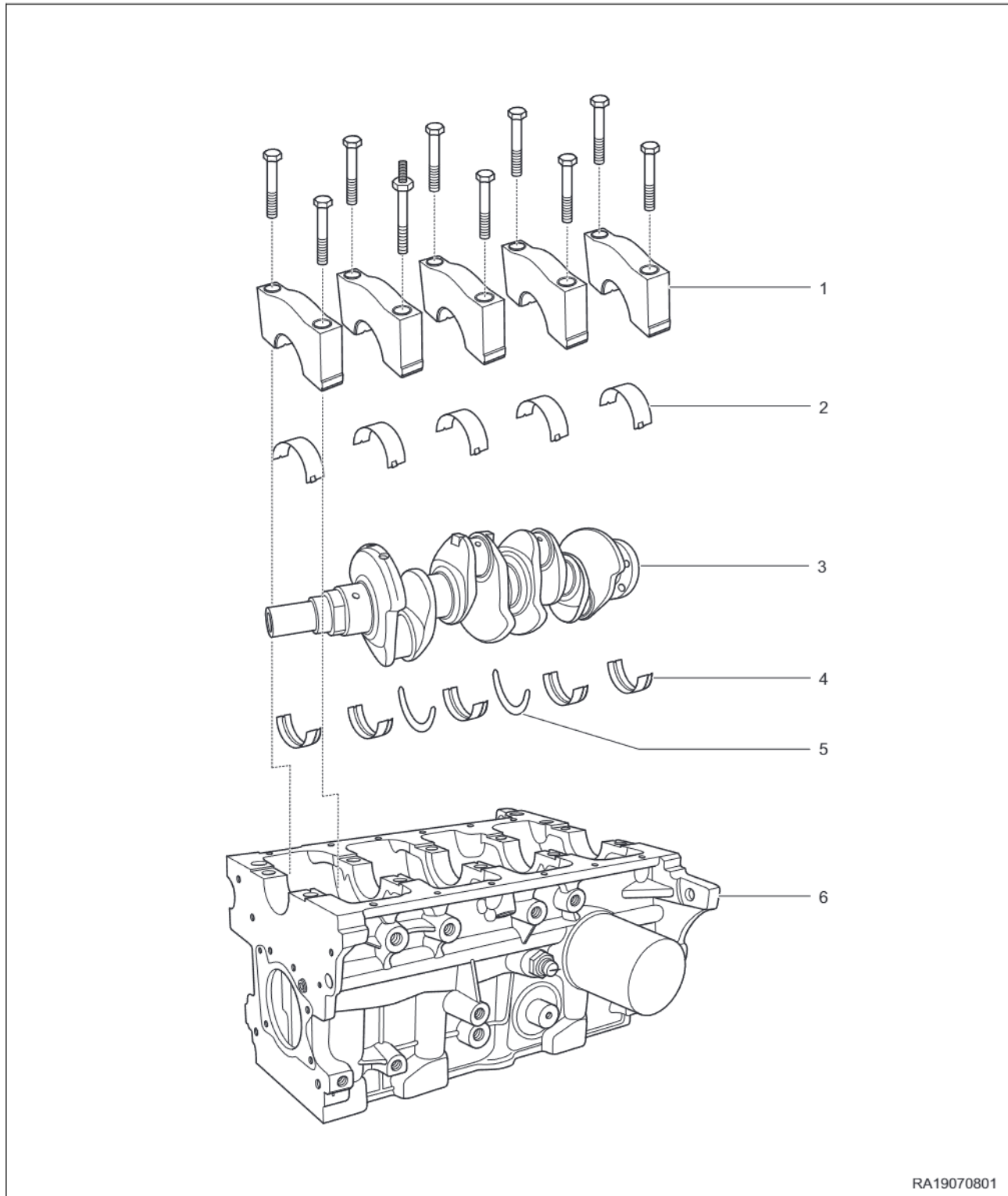
47. Install the engine on the engine service platform.

Installation

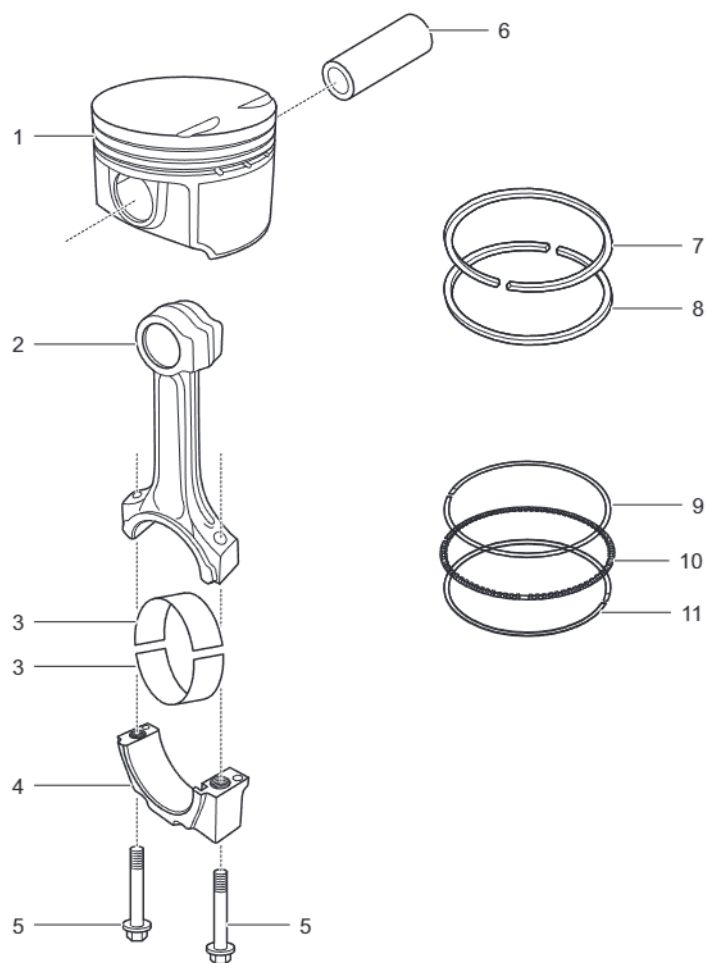
Installation is in the reverse order of removal.

Engine Block

Description



1 - Crankshaft Main Bearing Cap	2 - Crankshaft Main Bearing Upper Shell
3 - Crankshaft	4 - Crankshaft Main Bearing Lower Shell
5 - Crankshaft Thrust Washer	6 - Cylinder Block



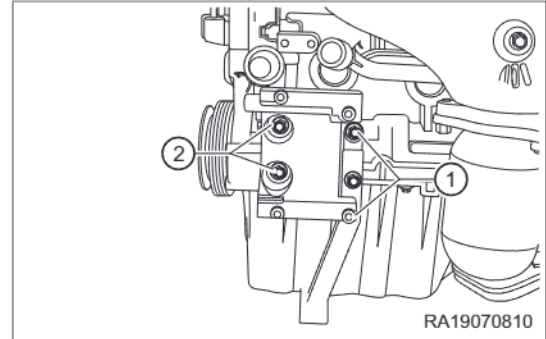
RA19070802

1 - Piston	2 - Connecting Rod
3 - Connecting Rod Bearing Shell	4 - Connecting Rod Bearing Cap
5 - Connecting Rod Fixing Bolt	6 - Piston Pin (Semi-floating)
7 - First Compression Ring	8 - Second Compression Ring
9 - Upper Rail	10 - Bushing Ring
11 - Lower Rail	

Disassembly

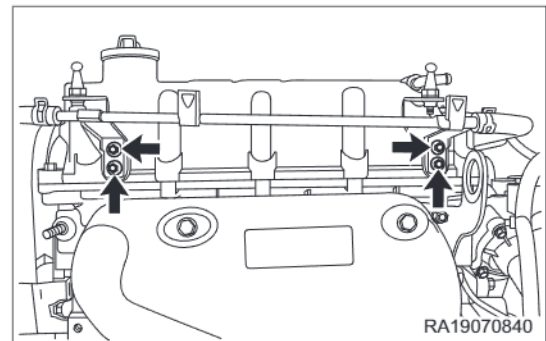
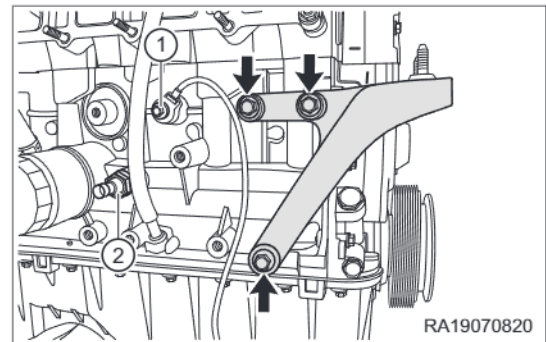
1. Remove the engine assembly and install the engine on the engine service platform (See page 07-62).
2. Remove the high-voltage cable (See page 14-8).
3. Remove the ignition coil (See page 14-10).
4. Remove the spark plugs (See page 14-12).
5. Remove the thermostat seat (See page 12-21).
6. Remove the engine accessory bracket.

- a. Remove 2 fixing bolts (1) from the power steering pump fixing bracket, and then remove the power steering pump fixing bracket.
(Tightening torque: 55 ± 5 N·m)
- b. Remove 2 fixing bolts (2) from the A/C compressor bracket, and then remove the A/C compressor bracket.
(Tightening torque: 55 ± 5 N·m)



07

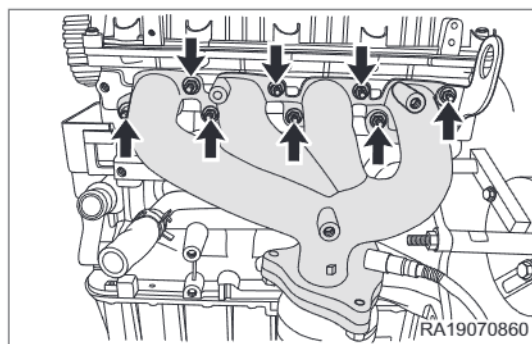
7. Remove the engine right mounting bracket.
 - a. Remove 3 fixing bolts (arrow) from the engine right mounting bracket, and then remove the engine right mounting bracket.
(Tightening torque: 60 ± 6 N·m)
8. Remove the knock sensor.
 - a. Remove the knock sensor fixing bolt (1), and then remove the knock sensor.
(Tightening torque: 17 - 23 N·m)
9. Remove the oil pressure switch.
 - a. Remove the oil pressure switch (2) from the engine block.
(Tightening torque: 20 ± 2 N·m)
10. Remove the oil filter (See page 13-13).
11. Remove the coolant pipe and the front bracket assembly.
 - a. Remove 4 fixing bolts (arrow) from the coolant pipe, and then remove the coolant pipe assembly.
(Tightening torque: 7 ± 1 N·m)



- b. Remove 2 front bracket assemblies.
12. Remove the exhaust manifold heat insulator (See page 11-7).

13. Remove the exhaust manifold with precatalytic converter assembly.

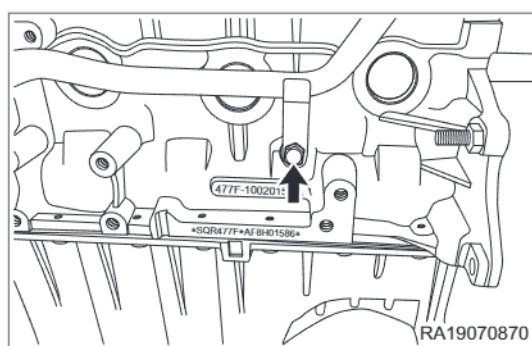
- a. Remove 8 fixing nuts (arrow) and 6 nut washers from the exhaust manifold.
(Tightening torque: $45 \pm 5 \text{ N}\cdot\text{m}$)



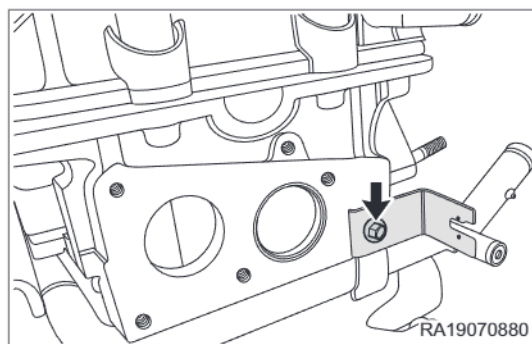
- b. Remove the engine left lifting eye and exhaust manifold with precatalytic converter assembly.
- c. Remove the exhaust manifold gasket.

14. Remove the small circulation coolant pipe.

- a. Remove the coupling bolt (arrow) between small circulation coolant pipe and cylinder block.
(Tightening torque: $40 \pm 4 \text{ N}\cdot\text{m}$)



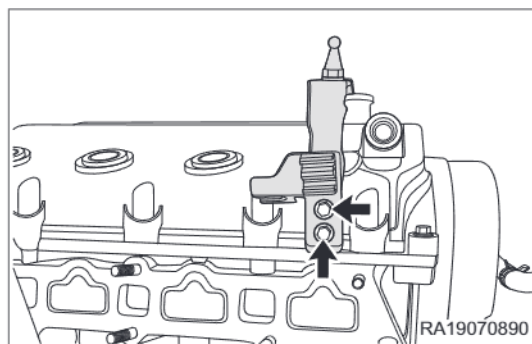
- b. Remove the coupling bolt (arrow) between engine speed sensor bracket and cylinder head, and then remove the engine speed sensor bracket.
(Tightening torque: $8 \pm 1 \text{ N}\cdot\text{m}$)



- c. Remove the small circulation coolant pipe.

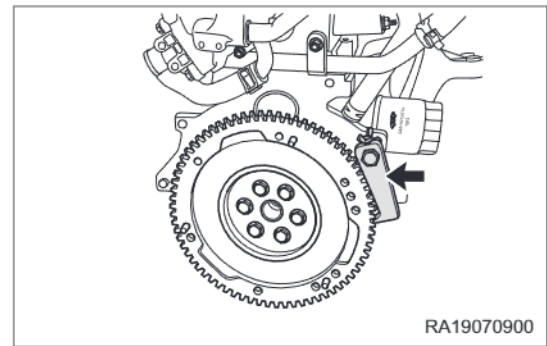
15. Remove the rear right bracket.

- a. Remove 2 fixing bolts (arrow) from the rear right bracket.
(Tightening torque: $7 \pm 1 \text{ N}\cdot\text{m}$)

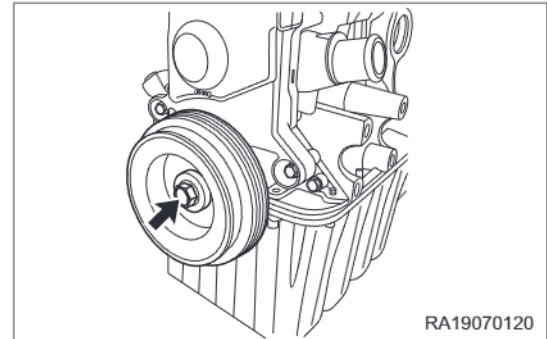


- b. Remove the rear right bracket.

16. Fix the flywheel with a flywheel holding tool (arrow).

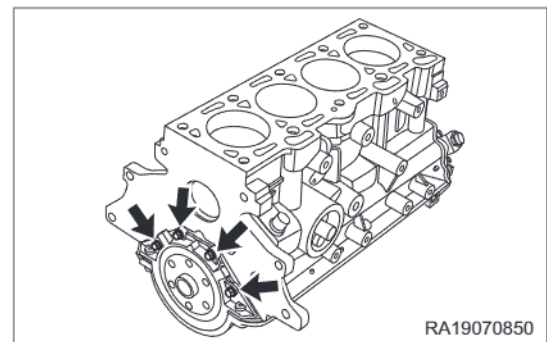


17. Remove the crankshaft pulley bolt (arrow), and then remove the crankshaft pulley.
(Tightening torque: 105 - 115 N·m)



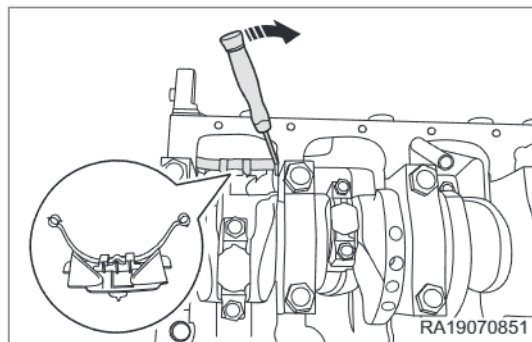
07

18. Remove the clutch assembly (See page 18-16).
19. Remove the flywheel assembly (See page 07-55).
20. Remove the timing belt (See page 07-28).
21. Remove the water pump (See page 12-28).
22. Remove the cylinder head cover (See page 07-37).
23. Remove the camshaft and rocker arm shaft (See page 07-40).
24. Remove the cylinder head (See page 07-47).
25. Loosen the elastic clamp to remove the crankcase ventilation hose from the cylinder block.
26. Remove the oil pan (See page 13-17).
27. Remove the oil strainer (See page 13-20).
28. Remove the oil pump assembly (See page 13-21).
29. Remove 4 fixing bolts (arrow) from the crankshaft rear oil seal bracket, and then remove the crankshaft rear oil seal bracket with rear oil seal assembly and grommet.
(Tightening torque: 8 - 11 N·m)



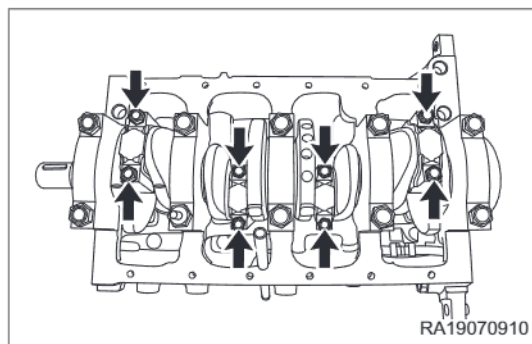
30. Remove the oil deflector assembly inside the cylinder block.

- a. Remove the oil deflector assembly with a screwdriver as shown in the illustration.



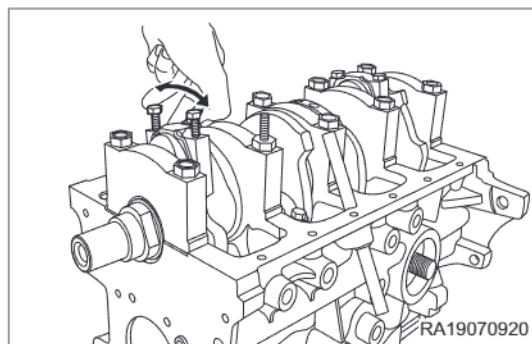
31. Remove the piston connecting rod assembly.

- a. Using a ridge reamer or equivalent, remove all the carbon from the top of the cylinder.
- b. Remove the connecting rod bearing cap fixing bolts (arrow), and then remove the connecting rod bearing caps.
(Tightening torque: 1st step: tighten them to 20 ± 3 N·m;
2nd step: retighten them to 33 ± 3 N·m)

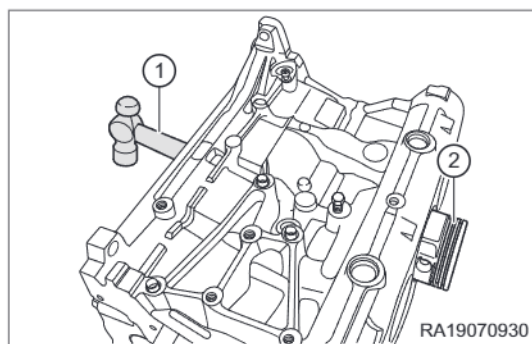


HINT:

Using the 2 removed connecting rod bearing cap bolts, remove the connecting rod bearing cap with connecting rod bearing lower shell assembly by wiggling the connecting rod bearing cap right and left as shown in the illustration.



- c. Using a hammer handle (1), push the piston connecting rod assembly (2) out of the top of the cylinder.

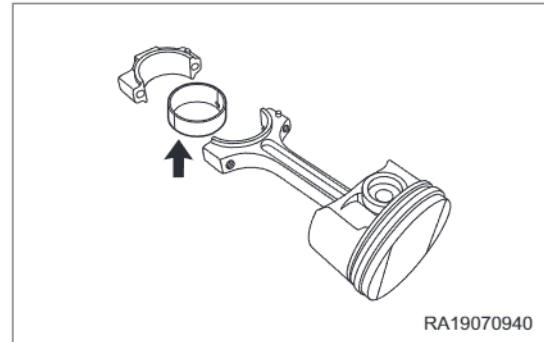


32. Remove the connecting rod bearing.

- a. Remove the connecting rod bearing (arrow).

HINT:

Arrange the removed parts in the correct order.

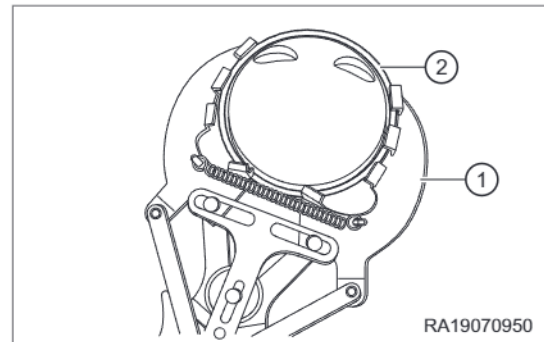
**CAUTION**

- Be careful not to scratch the cylinder wall during operation.
- Attach a label with the corresponding number to each piston connecting rod assembly to prevent incorrect installation.

07

33. Remove the piston ring.

- a. Using a piston ring remover (1), remove 2 compression rings (2).

**CAUTION**

- Before removing the piston ring, check the piston ring side clearance. If it is necessary to be reused, be sure to mark the piston ring position.

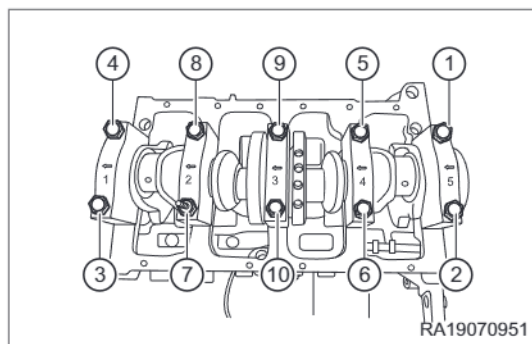
- b. Remove the oil ring rail and bushing ring by hands.

34. Remove the piston.

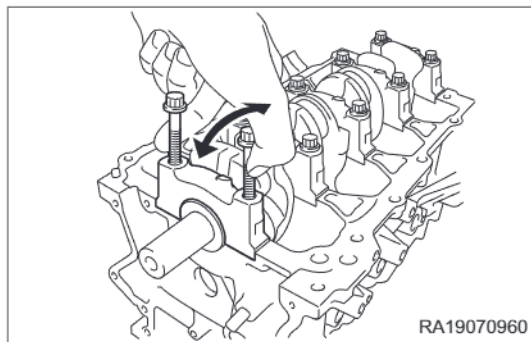
The piston pin is semi-floating and cannot be assembled by general process after removal, so it is not allowable to be removed in service. If there are abnormal noises caused by improper piston pin clearance, replace the piston connecting rod assembly.

35. Remove the crankshaft.

- a. Evenly loosen and remove 9 crankshaft main bearing cap fixing bolts and a fixing nut in the order shown in the illustration.
(Tightening torque: 90 - 100 N·m)



- b. Using 2 removed main bearing cap bolts, remove 5 main bearing caps.

**HINT:**

- Store the bearing lower shell and main bearing cap as a set.
- Arrange the main bearing caps in the correct order.

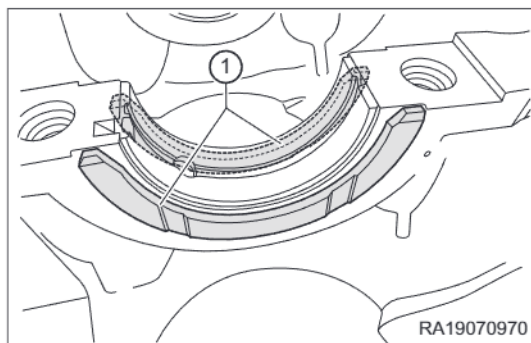
CAUTION

- Insert the bolts into the bearing caps in turn. Pull the bearing cap out by gently pulling up and applying force toward the front and back sides of cylinder block as shown in the illustration. Be careful not to damage the contact surfaces of bearing cap and cylinder block.

- c. Remove the crankshaft.

36. Remove the crankshaft thrust washer.

- a. Remove the crankshaft thrust washers (1) from the cylinder block.

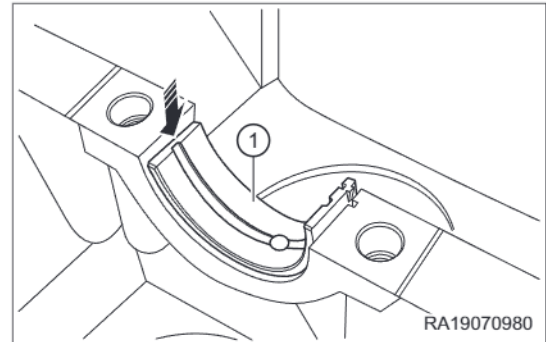


37. Remove the crankshaft main bearing lower shell.

- a. Slightly push the crankshaft main bearing lower shell (1) in the direction of arrow and remove it carefully.

HINT:

Remove other crankshaft main bearing lower shells in the same way.

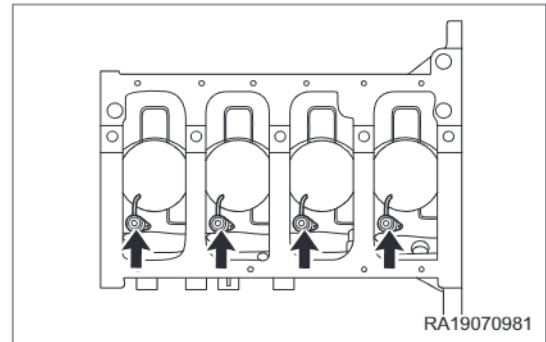
**CAUTION**

- Pay attention to the clearance position. Push out the bearing carefully as shown in the illustration. It is difficult to push out the bearing and the parts may be damaged if pushing in the opposite direction.

07

38. Remove the piston cooling nozzle.

- a. Remove the piston cooling nozzle fixing bolts (arrow), and then remove the piston cooling nozzle from the cylinder block.
(Tightening torque: 20 - 25 N·m)

**Inspection**

1. Check the cylinder block.

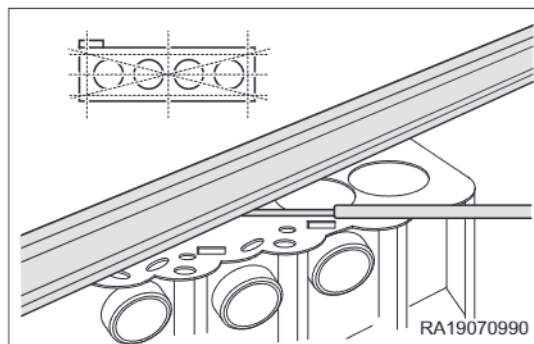
- Clean the engine block thoroughly and check all the hole passages for leakage.
- Check the engine block and cylinder bore for cracks.
- Check the bottom surface of engine block for cracks.

CAUTION

- DO NOT wash the cylinder at high temperature; otherwise, the cylinder liner will stick out beyond the engine block.

2. Check the flatness of engine block upper surface.
 - a. Clean the engine block upper surface.
 - b. Using a precision straightedge and feeler gauge, measure the flatness of engine block upper surface.

Measurement Item	Specification (mm)
Engine Block Upper Surface Flatness	0.05

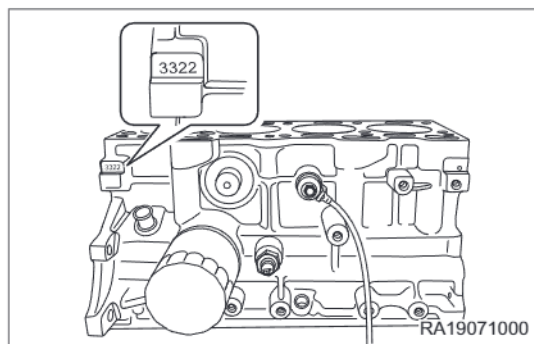


If the flatness of engine block upper surface is not as specified, adjust it. If it exceeds the limit, replace the engine block.

- The maximum allowable wear thickness of engine block is 0.15 mm.
- The maximum allowable wear thickness of engine block and cylinder head is 0.20 mm.

3. Check the cylinder.
 - a. Standard cylinder bore diameter and service size.

- Generally, divide the cylinder bores into four groups by 0.04 mm of tolerance.
- The cylinder bore group marks are printed on the small plane at the rear end of cylinder block intake manifold side (shown in illustration). The printed mark consists of numbers. Mark the cylinder bore groups in the order of "4 - 3 - 2 - 1" from left to right.



- Under the special conditions, enlarge the cylinder bore for service. The tolerance for cylinder bore is 0.03 mm and the bores are divided into three groups when servicing. When one cylinder bore is serviced to the service size, the diameter for the remaining three cylinder bores should also be processed to the service size.

Production	Group No.	Cylinder Bore Diameter (mm)
Normal Production	1	$\phi 77.36 - \phi 77.37$
	2	$\phi 77.37 - \phi 77.38$
	3	$\phi 77.38 - \phi 77.39$
	4	$\phi 77.39 - \phi 77.40$
Production Service	A	$\phi 77.63 - \phi 77.64$
	B	$\phi 77.64 - \phi 77.65$
	C	$\phi 77.65 - \phi 77.66$

b. Check the cylindricity of cylinder.

Using a cylinder gauge, measure the cylinder bore at positions A, B and C in the thrust and axial directions.

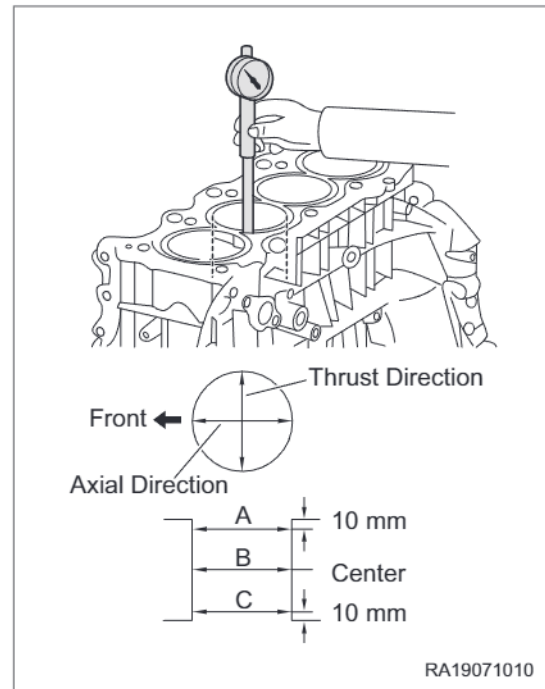
Measurement Item	Specification (mm)
Cylindricity	0.008

Cylindricity calculation method (for general measurement):

Measure the cylinder bore at A, B and C and obtain 6 values. The cylindricity is half of the difference between maximum and minimum values among 6 values.

$\text{Cylindricity} = (\text{maximum diameter} - \text{minimum diameter})/2$

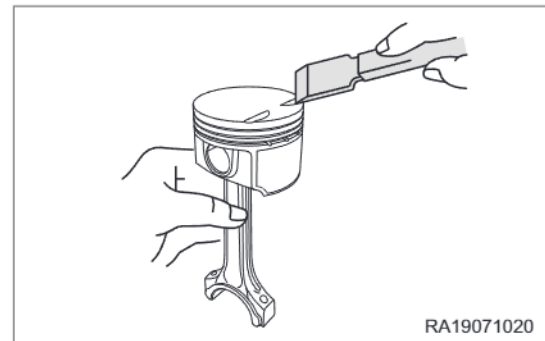
If the average bore diameter value measured at positions A, B and C exceeds the specified cylinder bore diameter or the cylindricity exceeds the specified value, replace the engine block.



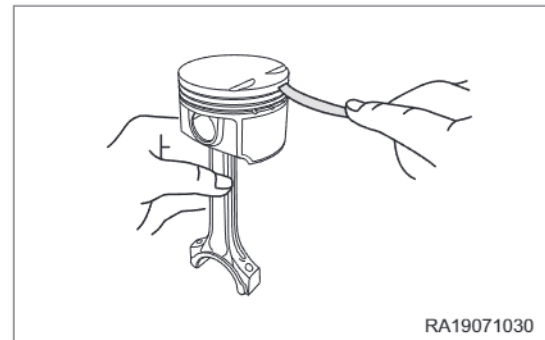
07

4. Check the piston.

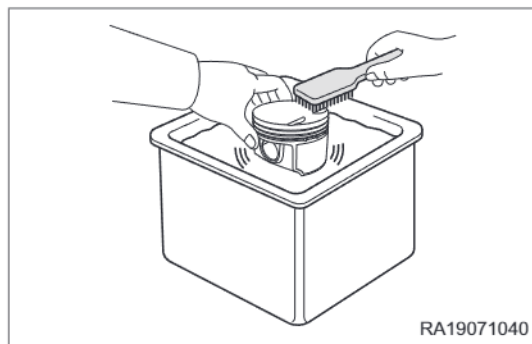
a. Using a scraper, remove the carbon deposits on the top of piston.



b. Using a piston ring, remove the carbon deposits in the piston ring groove.



- c. Using a brush and solvent, thoroughly clean the piston.



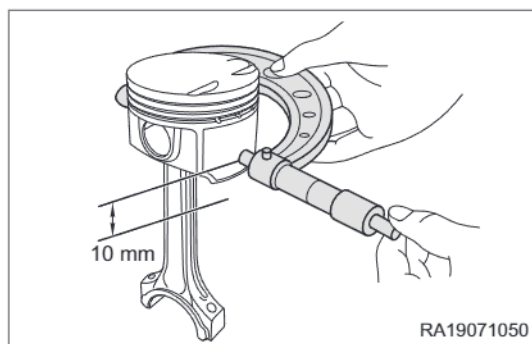
RA19071040

CAUTION

- DO NOT use a wire brush to clean.

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- d. Measure the piston diameter with a micrometer at the position that is approximately 10 mm under the piston skirt portion in the vertical direction of the piston pin.



RA19071050

Group No.	Piston Diameter (mm)	Corresponding Cylinder Bore Diameter (mm)
1	$\phi 77.325 - \phi 77.335$	$\phi 77.36 - \phi 77.37$
2	$\phi 77.335 - \phi 77.345$	$\phi 77.37 - \phi 77.38$
3	$\phi 77.345 - \phi 77.355$	$\phi 77.38 - \phi 77.39$
4	$\phi 77.355 - \phi 77.365$	$\phi 77.39 - \phi 77.40$

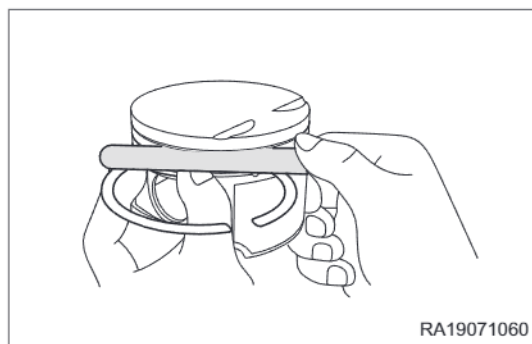
If the piston diameter is not within the specified range, replace the piston connecting rod assembly.

5. Check the clearance between piston ring and ring groove side.

Using a feeler gauge, measure the clearance between the new piston ring and the ring groove side.

Measurement Item		Specification (mm)
Piston Ring Side Clearance	First Ring	0.04 - 0.08
	Second Ring	0.03 - 0.07
	Oil Ring	0.03 - 0.16

If the piston ring side clearance is not within the specified range, replace the piston connecting rod assembly.



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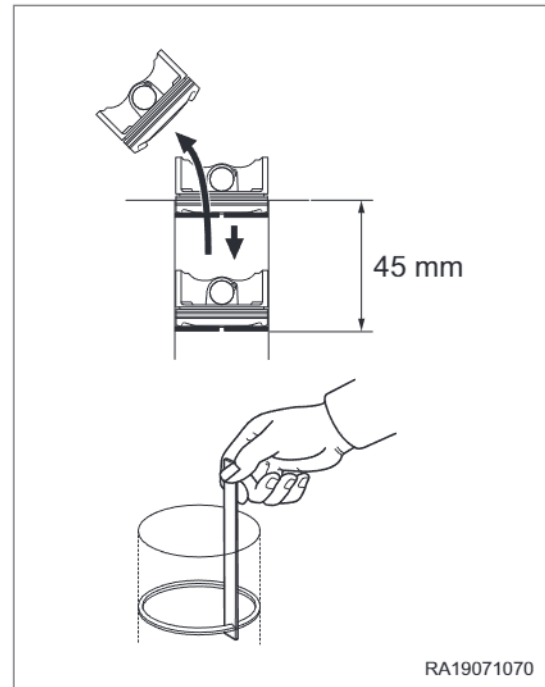
6. Check the piston ring end gap.

- Using a piston, push the piston ring from the top of cylinder to a place that is 45 mm from the top of the cylinder bore.
- Using a feeler gauge, measure the end gap.

Measurement Item		Specification (mm)
Piston Ring End Gap	First Ring	0.2 - 0.35
	Second Ring	0.4 - 0.55
	Oil Ring	0.2 - 0.6

If the piston ring end gap is not within the specified range, replace the piston ring with a new one.

If the end gap is still not within the specified range after replacement, replace the engine block.



7. Check the diameter of crankshaft main journal.

- Measure the main journal diameter with the outer diameter micrometer, and measure again after rotating the crankshaft 90°.

Measurement Item	Specification (mm)
Crankshaft Main Journal Diameter	$\phi 48.99 \pm 0.01$

If the crankshaft main journal diameter is not within the specified range, replace the main bearing shells with new ones, and check the radial clearance of crankshaft ([See page 07-80](#)).

If the radial clearance of the main bearing shell is still not within the specified range after replacement, replace the crankshaft.

- Calculate the roundness and cylindricity by the measured values (measured area is shown in the illustration).

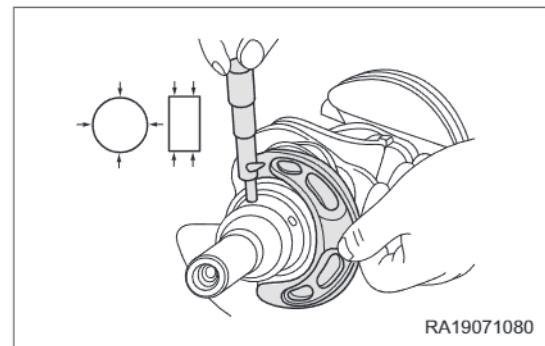
Roundness and cylindricity calculation method (for general measurement):

- Measure the diameter twice on the same cross section, and the roundness is half of the difference between maximum and minimum values.

$$\text{Roundness} = (\text{maximum diameter} - \text{minimum diameter})/2$$

- As shown in the illustration, measure the diameter twice in different directions on two cross sections separately to obtain four values. The cylindricity is the half of the difference between the maximum and minimum values among the four values.

$$\text{Cylindricity} = (\text{maximum diameter} - \text{minimum diameter})/2$$

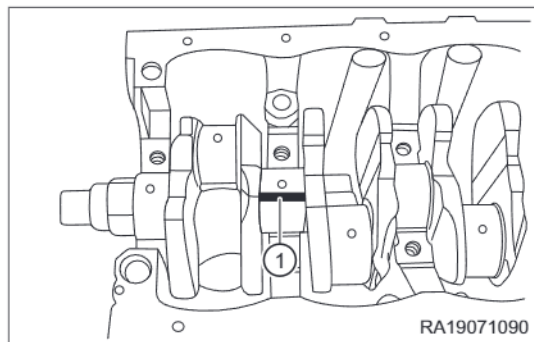


Measurement Item		Specification (mm)
Crankshaft Main Journal	Cylindricity	0.008
	Roundness	0.005

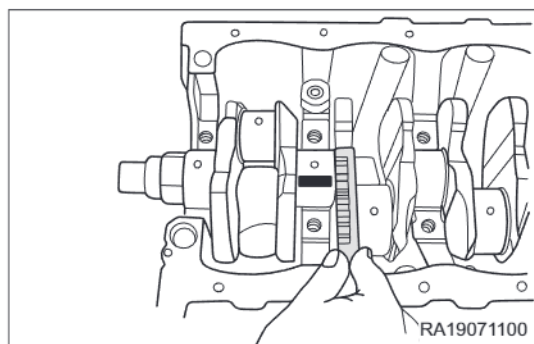
If the roundness or cylindricity of crankshaft main journal exceeds the specified value, replace the crankshaft.

8. Check the crankshaft radial clearance.

- a. Clean the crankshaft main journals and main bearing shells.
- b. Install the crankshaft. Place the plastic feeler gauge (1) on the crankshaft main journal, and make it parallel to the crankshaft center axis and cover the installation width range of main bearing cap completely.



- c. Install all the main bearing caps and tighten the cap fixing bolts to 90 - 100 N·m in the specified sequence.
- d. Remove the main bearing caps. Using the feeler gauge, measure the widest part of compressed feeler gauge. The measured value is the crankshaft radial clearance.



If the crankshaft radial clearance is not within the specified range, install the new main bearing shell. Replace the crankshaft if necessary.

CAUTION

- Replace the bearing shells in pairs.

For selection of main bearing shell, refer to [07-83](#).

9. Check the crankshaft thrust clearance.

- a. Clean the crankshaft main journals and main bearing shells.
- b. Install all the main bearing caps and tighten the cap fixing bolts to 90 - 100 N·m in the specified sequence.

- c. Push the crankshaft forward and backward and read the value from the dial indicator.

Measurement Item	Specification (mm)
Crankshaft Thrust Clearance	0.093 - 0.303

If the crankshaft thrust clearance is not within the specified range, replace the thrust washer as a set.

10. Check the crankshaft runout.

- Install the crankshaft onto the tester and keep it level as shown in the illustration.
- Rotate the crankshaft slowly and read the max. change value from the dial indicator. (Reading from the dial indicator)/2 is the coaxiality of crankshaft.

Measurement Item	Specification (mm)
Crankshaft Runout	0.05

If the crankshaft main journal runout is not within the specified range, replace the crankshaft.

11. Check the diameter of crankshaft connecting rod journal.

Using an outer diameter micrometer, measure the diameter of crankshaft connecting rod journal.

Measurement Item	Specification (mm)
Crankshaft Connecting Rod Journal Diameter (mm)	$\phi 44.90 \pm \phi 0.01$

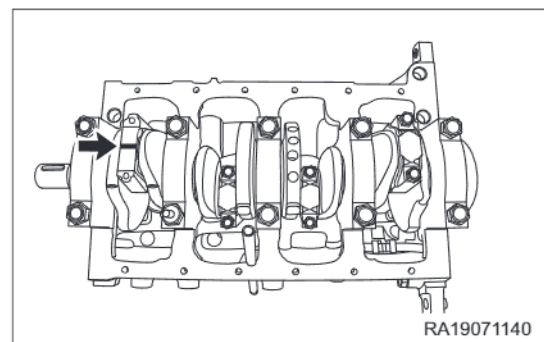
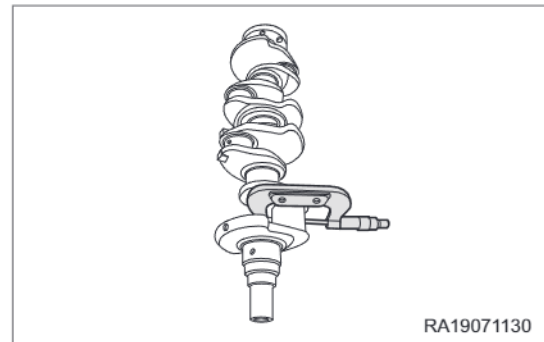
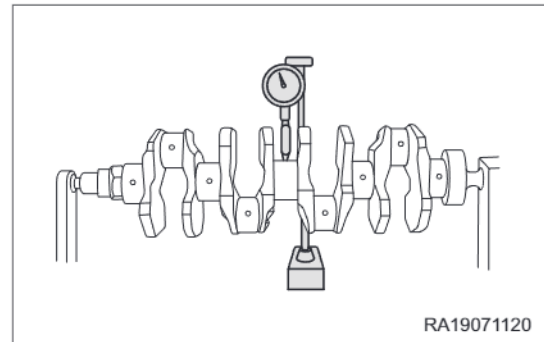
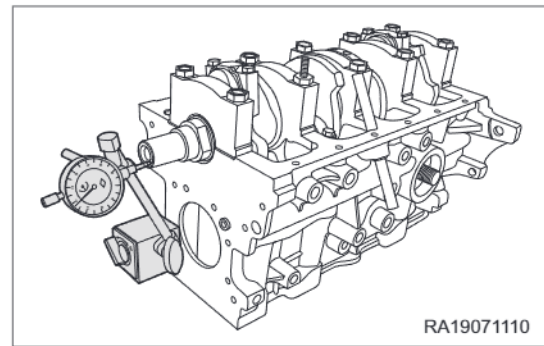
If the connecting rod journal diameter is not within the specified range, replace the connecting rod bearing shells with new ones, and check the radial clearance of connecting rod bearing shell.

If the radial clearance of connecting rod bearing shell is still not within the specified range after replacement, replace the crankshaft.

For selection of connecting rod bearing shell, refer to [07-83](#).

12. Check the radial clearance of crankshaft connecting rod bearing shell.

- Clean the connecting rod journals and the connecting rod bearing shells.
- Place a feeler gauge (arrow) on the connecting rod journal as shown in the illustration.



- c. Install the connecting rod bearing caps, and tighten the connecting rod bearing cap fixing bolts to $20 + 5 \text{ N}\cdot\text{m}$.

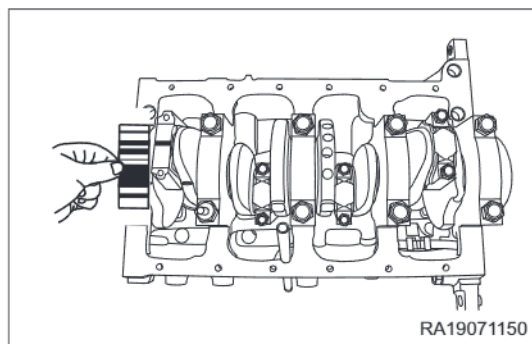
CAUTION

- DO NOT turn the crankshaft during installation.

- d. Remove the connecting rod bearing caps (See page 07-67).
- e. Using the gauge scale of feeler gauge, measure the widest part of the compressed feeler gauge to obtain the radial clearance of connecting rod bearing shell as shown in the illustration.

Measurement Item	Specification (mm)
Connecting Rod Bearing Shell Radial Clearance	0.006 - 0.06

If the radial clearance of connecting rod bearing shell is not within the specified range, replace the connecting rod bearing shell. Replace the crankshaft if necessary.

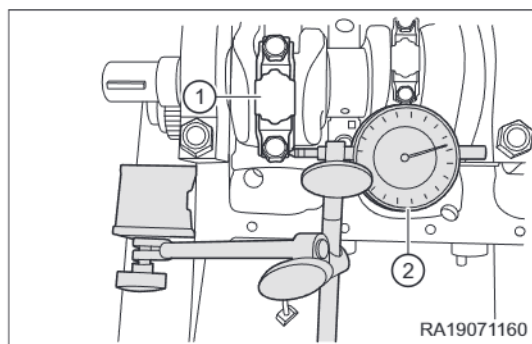


13. Check the connecting rod big end thrust clearance.

- a. Install the connecting rod bearing caps, and tighten the connecting rod bearing cap fixing bolts to $20 + 5 \text{ N}\cdot\text{m}$.
- b. Install a dial indicator (2) with its measuring rod contacting the side of connecting rod cap (1).
- c. Turn the dial of dial indicator to reset it to zero.
- d. Push the connecting rod forward and backward (do not move the crankshaft forward and backward) and read the value on the dial indicator.

Measurement Item	Specification (mm)
Connecting Rod Big End Thrust Clearance	0.333 - 0.387

If the thrust clearance of connecting rod big end is not within the specified range, replace the piston connecting rod assembly.



Selection of Bearing Shell

SQR477F engine adopts the "standard type" main bearing shell and connecting rod bearing shell without any color marks, only the "STD" mark is printed on the back side of bearing shell.

There are three types of main bearing shell and two types of connecting rod bearing shell for service.

Selection of main bearing shell

Production	Symptom	Shell Description
Production Service	Engine block main bearing hole enlarges 0.4 mm.	"0.4" mark is printed on the back side of bearing shell and a black mark is on bearing shell.
	Crankshaft journal is worn by 0.25 mm.	A mark is printed on the back side of bearing shell and a green mark is on bearing shell.
	Noise from bearing shell is too loud.	A "0.02" mark is printed on the back side of the main bearing shell that is used for gap correction and a yellow mark is on the shell.

07

Selection of connecting rod bearing shell

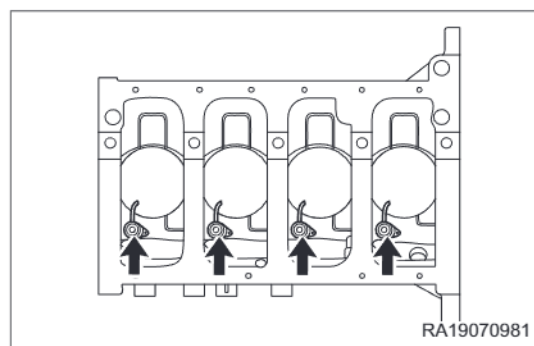
Production	Symptom	Shell Description
Production Service	Crankshaft journal is worn by 0.25 mm.	A "0.25" mark is printed on the back side of bearing shell and a green mark is on bearing shell.
	Noise from bearing shell is too loud.	A "0.025" mark is printed on the back side of the main bearing shell that is used for gap correction and a yellow mark is on the shell.

Precautions for bearing shell assembly:

- There is shell groove and oil hole on the main bearing upper shell, and the oil hole should be aligned with that the engine block, but the main bearing lower shell has no oil hole.
- The connecting rod upper and lower bearing shells without oil grooves are universal, but one of the connecting rod bearing shells has oil hole.
- It is necessary to use a set of connecting rod bearing shell and main bearing shell that are provided by the same manufacturer on the same engine.
- Apply a coat of engine oil to the inner surface of connecting rod bearing shell and main bearing shell before installation. The back side and inner surface of the bearing shell should be clean without any oil or foreign matter during assembly.

Assembly

1. Install the piston cooling nozzle.
 - a. Install the piston cooling nozzle to the engine block, and tighten the piston cooling nozzle fixing bolts (arrow).
(Tightening torque: 20 - 25 N·m)

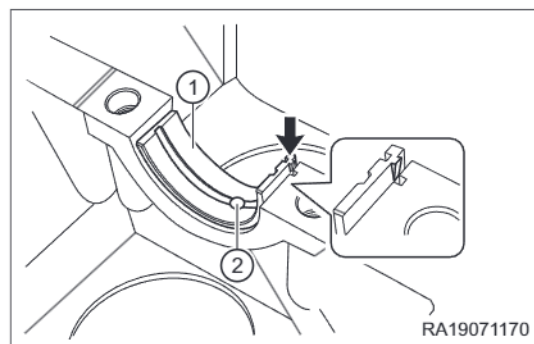


2. Install the crankshaft main bearing shell.

CAUTION

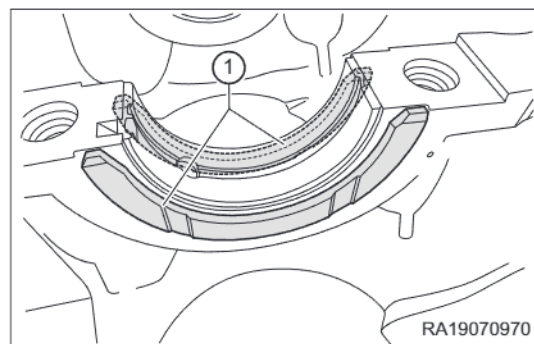
- Apply a coat of engine oil to the inner surface of main bearing shell before installation.

- a. Carefully install the crankshaft bearing (1) in the direction of arrow, and the notch of each main bearing should be aligned with the cylinder block. The oil passage hole on crankshaft main bearing (2) should be aligned with the passage hole on cylinder block after installation.



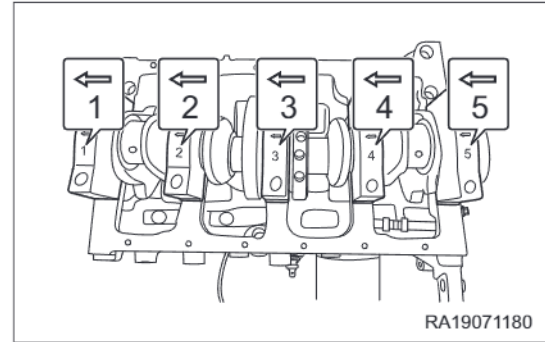
3. Install the crankshaft thrust washer.

- a. Clean the crankshaft thrust washers and cylinder block inner wall before installation.
- b. Apply a coat of engine oil to the crankshaft thrust washers.
- c. There are 2 crankshaft thrust washers on the cylinder, which are installed on the front and rear sides of thrust surface (both sides of 3rd bearing) respectively.
- d. As shown in the illustration, the two grooves on one side of crankshaft thrust washers (1) face outward while the other side without groove is jointed with the cylinder block inside wall.

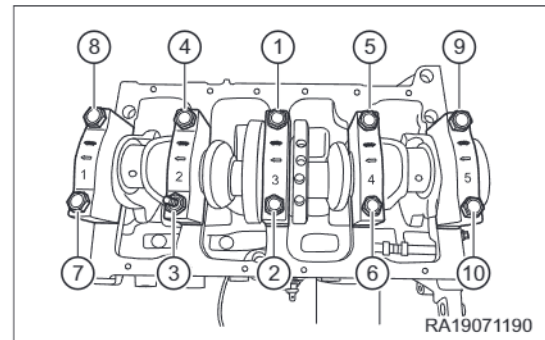


4. Install the crankshaft.

- a. Place the crankshaft on the cylinder block carefully.
- b. There are "1 - 2 - 3 - 4 - 5" and "arrow" stamped on the crankshaft main bearing cap. Install the crankshaft main bearing caps from the timing belt side and make sure that the "arrow" points to the timing belt side.

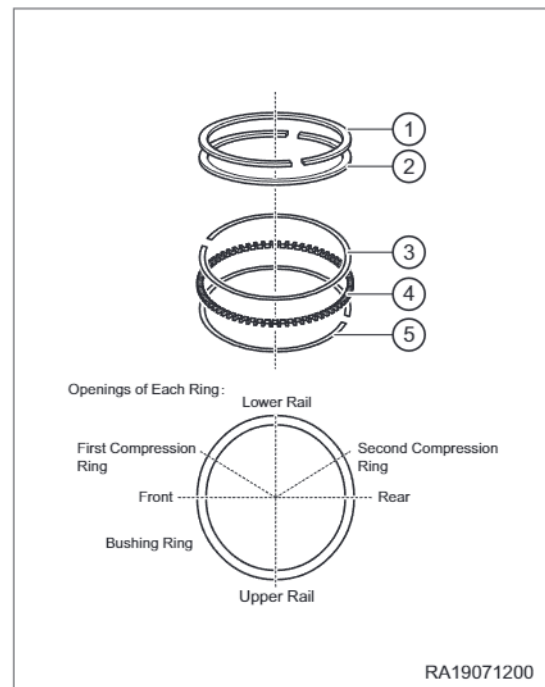


- c. Install the crankshaft main bearing cap fixing bolts in place by hands, and then tighten the crankshaft main bearing cap fixing bolts in the sequence shown in the illustration.
(Tightening torque: 90 - 100 N·m)



5. Install the piston ring.

- a. The first compression ring is rectangular ring (1), the second compression ring is conical ring (2), and the oil ring is steel band combination ring. Apply a small amount of engine lubricant to the piston ring groove and piston. Note that the side with words for first compression ring should face upward and the outer cutting of second compression ring should face downward.
- b. The oil ring is steel band combination oil ring and composed of upper rail (3), lower rail (5) and bushing ring (4). When installing the oil ring, first install the bushing ring into the oil groove, then install the two rails with the two rails opening of steel band combination oil ring staggered by 90° from the bushing ring closed gap, and the upper and lower rails 180°. Then install the second compression ring, and install the first compression ring finally with the two compression rings staggered by 120° from the upper rail opening. The piston ring should rotate in the ring groove freely without any stuck condition.



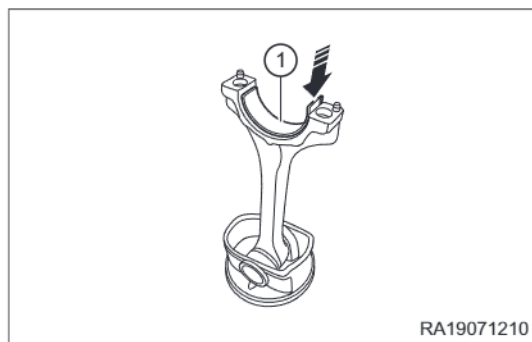
- c. Rotate the piston ring several turns after applying engine oil to the piston ring groove, and note that the position of ring notch should be the same with that described above; clean the crankshaft connecting rod journal and cylinder bore with a non-woven fabric cloth.

6. Install the connecting rod bearing shell.

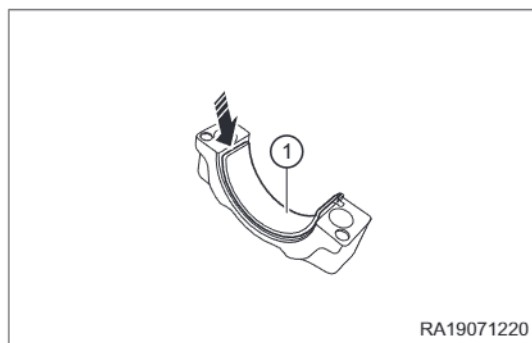
CAUTION

- Apply a coat of engine oil to the inner surface of connecting rod bearing shell before installation.
- The back side of connecting rod bearing shell should be clean without any oil or foreign matter during assembly.

- a. Carefully install the connecting rod bearing upper shell (1) in the direction of arrow, and keep the groove opening of each connecting rod bearing upper shell face the piston and connecting rod assembly.

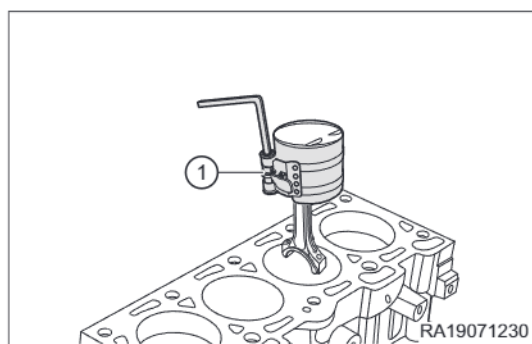


- b. Carefully install the connecting rod bearing lower shell (1) in the direction of arrow, and keep the groove opening of each connecting rod bearing lower shell face the connecting rod bearing cap.

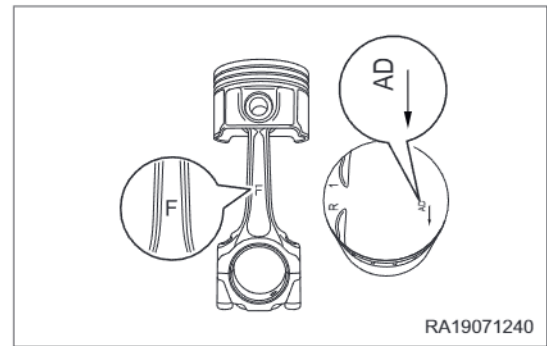


7. Install the piston connecting rod assembly.

- Rotate the crankshaft to the top dead center of 1st and 4th cylinder.
- Apply a coat of engine oil to the piston surface and cylinder inside wall.
- As shown in the illustration, install the piston connecting rod assembly to the cylinder with the piston installer (1).

**CAUTION**

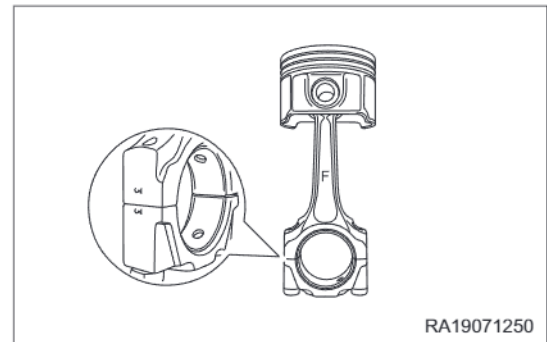
- Pay attention to the front marks of piston and connecting rod during assembly without being reversed. Install them with the side stamped with letter "F" on the connecting rod and piston top arrow facing toward pulley side as shown in the illustration.



8. Install the connecting rod bearing cap.

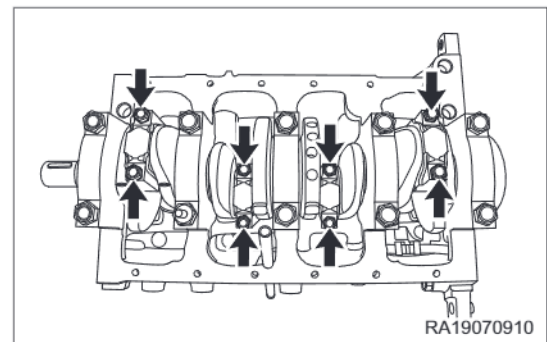
HINT:

The direction of the number on one side of connecting rod is the same as that of the number on the connecting rod bearing cap. These numbers are cylinder numbers indicating at which cylinder are located. For example, number 3 indicates that the mounting position is at No.3 cylinder.



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- a. Install the connecting rod bearing caps in place, and screw the connecting rod bearing cap fixing bolts (arrow) by hands, then tighten the connecting rod bearing cap fixing bolts to $20 + 5 \text{ N}\cdot\text{m}$ with a torque wrench.



CAUTION

- Apply a small amount of engine lubricant to the connecting rod, connecting rod bearing cap and thread joint surface.

Other assembly is in the reverse order of disassembly.

