

SQRE4G16 ENGINE MECHANICAL

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GENERAL INFORMATION

Description

1.6 L SQRE4G16 engine has the following features:

- Water cooled vertical
- In-line DOHC with 4 cylinders
- Four valves per cylinder
- Dual Variable Valve Timing (DVVT)
- Variable Intake System (VIS)
- Aluminum cylinder head
- Cast iron cylinder block
- Aluminum crankshaft frame

Operation

1.6 L SQRE4G16 engine has 4 cylinders, DOHC and 4 valves per cylinder. 1.6 L SQRE4G16 engine uses individual coil ignition system and a cast iron cylinder block. Bearing shells are integrated with crankshaft frame. Aluminum oil pan is fixed to the bottom of crankshaft frame with bolts. Camshafts are installed in the cylinder head and interact with hydraulic lifters to open and close valves. Camshafts are driven by a timing chain, which is driven by sprockets on the crankshaft. Piston assembly is an aluminum piston with cast iron connecting rod.

Aluminum cylinder head has DOHC with 4 valves per cylinder. Valves are 2 banks in-line. Cylinder head includes valve guides and valve seats. Cylinder head is held on cylinder block with multilayer steel cylinder head gasket and fixing bolts.

Specifications

SQRE4G16 Engine Specifications

Item	Specifications
Engine Type	Vertical, in-line 4-cylinder, 16 valves, water-cooled, 4-stroke, DOHC, electronic controlled sequential multiport fuel injection, Variable Valve Timing (VVT), Variable Intake System (VIS)
Engine Model	SQRE4G16
Valve Number Per Cylinder	4
Cylinder Diameter (mm)	77
Piston Stroke (mm)	85.8
Displacement (L)	1.598
Compression Ratio	11:1
Fuel Supply Type	Electronic controlled sequential multiport fuel injection
Ignition Type	Electrical control
Ignition Sequence	1 - 3 - 4 - 2
Rated Power (kW)	93
Rated Power Speed (r/min)	6150
Max. Torque (N·m)	160
Max. Torque Speed (r/min)	3900



Item	Specifications	
Min. Fuel Consumption Rate (g/kW·h)	234	
Fuel Octane Number (Not Less Than)	Unleaded gasoline, octane number 93	
Oil Octane Number	In summer	SAE 10W-40 (SM grade or higher)
	In winter	SAE 5W-40 (SM grade or higher)
Oil Capacity (L)	4 ± 0.5	
Crankshaft Rotation Direction	Counterclockwise (viewed from end surface of engine flywheel)	
Starting Type	Electrical starting	
Cooling Type	Forced circulation type antifreeze cooling	
Lubrication Type	Compound type (pressure, splash lubrication)	
Fuel Pressure (bar)	4	
Cylinder Compression Pressure (bar) (180 - 250) r/min	9 - 13.5	
Oil Pressure (bar)	Low Idling Speed (700 ± 50 r/min)	1.0
	High Idling Speed (2000 r/min)	1.8
	High Speed (4000 r/min)	3.0
Thermostat Operation Temperature (°C)	Open Temperature	82
	Full Open Temperature	97
Starting Performance	With atmospheric temperature at -25°C, engine can start smoothly within 30 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			Specifications
Camshaft	Cam Height (mm)	Intake Cam	37.18
		Exhaust Cam	37.05
	Camshaft Journal Diameter (mm)	Intake Cam	$\phi 24_{-0.053}^{-0.040}$
		Exhaust Cam	$\phi 24_{-0.053}^{-0.040}$
	Camshaft Axial Clearance (mm)	Intake Cam	0.15 - 0.20
		Exhaust Cam	0.15 - 0.20
Cylinder Head	Lower Surface Flatness (mm)		0.04
	Overall Height (mm)		139.4 ± 0.41
	Surface Grinding Limit (mm)		0.15
	Total Grinding Amount of Cylinder Block and Cylinder Head (mm)		0.20
Valve	Valve Head Margin Thickness (mm)	Intake Valve	0.3 ± 0.15
		Exhaust Valve	0.3 ± 0.15
	Valve Stem Diameter (mm)	Intake Valve	$\phi 5.98 \pm 0.008$
		Exhaust Valve	$\phi 5.96 \pm 0.008$
	Grommet Width (mm)	Intake Valve	1.158
		Exhaust Valve	1.306
	Clearance Between Valve Stem and Guide (mm)	Intake Valve	0.02
		Exhaust Valve	0.04
	Inclination Angle (°)	Intake Valve	65
		Exhaust Valve	68
	Height (mm)	Intake Valve	107.998
		Exhaust Valve	106.318
Valve Spring	Free Height (mm)		47.7
	Operating Preload/Operating Height		$585 \pm 25 \text{ N}/32 \text{ mm}$
Valve Guide	Valve Guide Length (mm)		38 ± 0.25
	Inner Diameter (mm)		$\phi 6.0 + 0.015$
	Outer Diameter (mm)		$\phi 11_{+0.040}^{+0.051}$
	Depression Depth (mm)		16 ± 0.3
	Valve Stem Protrusion Amount (mm)		47.5
Piston	Piston Skirt Diameter (mm)		$\phi 76.950 \pm 0.009$

07



Item			Specifications
Piston Ring	Side Clearance (mm)	First Ring	0.035 - 0.080
		Second Ring	0.030 - 0.075
	End Gap (mm)	First Ring	0.2 - 0.4
		Second Ring	0.4 - 0.6
	Height (mm)	First Ring	1 ^{-0.01} _{-0.03}
		Second Ring	1.2 ^{-0.006} _{-0.050}
		Oil Ring	1.5 ^{-0.02} _{-0.13}
Piston Ring Groove	Height (mm)	First Ring	1.2 ^{+0.06} _{+0.05}
		Second Ring	1.5 ^{+0.04} _{+0.02}
		Oil Ring	1.5 ^{+0.03} _{+0.01}
Piston Pin	Diameter (mm)		$\phi 18$ ⁰ _{-0.005}
	Length (mm)		45 ⁰ _{-0.3}
	Piston Pin Hole Diameter (mm)		$\phi 18$ ^{+0.010} _{+0.004}
Crankshaft	Axial Clearance (mm)		0.070 - 0.265
	Radial Clearance (mm)		0.021 - 0.060
	Crankshaft Main Journal	Diameter (mm)	$\phi 54$ ⁰ _{-0.016}
		Coaxially (mm)	0.04
		Cylindricity (mm)	0.007
		Roundness (mm)	0.004
	Connecting Rod Journal	Diameter (mm)	$\phi 46$ ⁰ _{-0.016}
		Parallelism to Main Journal (mm)	0.008
Cylinder Block	Overall Height (mm)		274 ^{+0.1} ₀
	Bore Roundness (mm)		0.008
	Cylindricity (mm)		0.01
	Upper Surface Flatness (mm)		0.04
	Surface Grinding Limit (mm)		0.15
	Total Grinding Amount of Cylinder Block and Cylinder Head (mm)		0.20
Connecting Rod	Big End Hole Radial Clearance (mm)		0.016 - 0.061
	Big End Axial Clearance (mm)		0.15 - 0.40

Engine Torque Specifications

Description	Torque (N·m)
Ignition Coil Fixing Bolt	8 + 2
Accessory Drive Belt Tensioner Assembly Fixing Bolt	40 + 5
Idler Pulley Assembly Fixing Bolt	40 + 5
Cylinder Head Cover Fixing Bolt	1st step: 3 - 5 2nd step: 8 - 10
Crankshaft Pulley Fixing Bolt	1st step: 90 - 110 2nd step: 120° ± 10°
Clutch Pressure Plate Fixing Bolt	25 ± 2
Flywheel Fixing Bolt	1st step: 25 ± 5 2nd step: 30° ± 5°
Water Pump Pulley Fixing Bolt	20 + 5
Camshaft Timing Tool Installation Hole Bolt	40 + 5
Hydraulic Tensioner Fixing Bolt	9 - 12
Engine Timing Chain Fixing Guide Rail Fixing Bolt	9 - 12
Engine Timing Chain Movable Guide Rail Fixing Bolt	9 - 12
Timing Chain Upper Guide Rail Fixing Bolt	9 - 12
Exhaust Camshaft Phaser Assembly Fixing Bolt	105 + 5
Intake Camshaft Phaser Assembly Fixing Bolt	105 + 5
Engine Timing Chain Cover Fixing Bolt	Inner Hexagon Bolt: 20 - 25 Hexagon Flange Bolt: 40 - 45
Coupling Bolt Between Engine Timing Chain Cover and Oil Pan	20 + 5
Camshaft Bearing Cap Fixing Bolt	9 ± 1.5
Engine Wire Harness Ground Wire Fixing Bolt	7 ± 1
Intake Camshaft Variable Timing Control Valve Fixing Bolt	8 ± 2
Exhaust Camshaft Variable Timing Control Valve Fixing Bolt	8 ± 2
Intake Camshaft Position Sensor	8 ± 1
Exhaust Camshaft Position Sensor	8 ± 1
Cylinder Head Fixing Bolt	1st step: 40 ± 5 2nd step: 90° ± 5° 3rd step: 90° ± 5°
Locking Nut Between Rear Mounting Upper Body Assembly and Rear Mounting Lower Body Assembly	80 ± 5
Rear Mounting Upper Body Assembly Fixing Bolt (for MT Model)	45 ± 5
Rear Mounting Upper Body Assembly Fixing Bolt (for CVT Model)	45 ± 5



Description	Torque (N·m)
Coupling Bolt Between Rear Mounting Lower Body Assembly and Front Sub Frame Welding Assembly	105 ± 5
Coupling Nut Between Left Mounting Cushion Assembly and Left Mounting Bracket	60 ± 5
Coupling Bolt Between Left Mounting Cushion Assembly and Body	60 ± 5
Coupling Nut Between Left Mounting Bracket and Transmission Case (for MT Model)	80 ± 5
Coupling Nut Between Left Mounting Arm and Transmission Case (for CVT Model)	80 ± 5
Coupling Bolt Between Left Mounting Cushion Assembly and Body (for CVT Model)	60 ± 5
Expansion Tank Fixing Bolt	7 ± 1
Coupling Bolt Between Line Bracket and Engine Right Mounting	7 ± 1
Coupling Nut Between Engine Right Mounting Assembly and Engine Timing Chain Cover	70 ± 5
Coupling Bolt Between Engine Right Mounting Assembly and Body	60 ± 5
Coupling Nut Between Shift Cable and Shift Arm (for CVT Model)	16 - 20
High Pressure Fluid Pipe Hollow Bolt (Equipped with Hydraulic Assist System)	45 ± 5
Transmission Ground Wire Fixing Bolt	15 ± 2
Coupling Nut Between Battery Wire Harness and Engine Compartment Fuse and Relay Box	7 ± 1
Engine Wire Harness Ground Wire Fixing Nut	15 ± 2
A/C High/Low Pressure Line Fixing Bolt	25 ± 4
Engine Trim Cover Bracket	8 ± 1
Intake Manifold Fixing Nut	20 + 5
Oil Dipstick Tube Fixing Bolt	7 ± 1
Knock Sensor Fixing Bolt	20 ± 5
Engine Discharge Pipe Fixing Bolt	7 ± 1
Coolant Pipe Assembly I Fixing Bolt	20 + 5
Oil Filter Module Fixing Bolt	40 + 5
Oil Pump Chain Movable Guide Rail Fixing Bolt	9 - 12
Oil Deflector Assembly	8 + 3
Crankshaft Main Bearing Cap Fixing Bolt	1st step: 45 ± 5 2nd step: 180° ± 10°
Crankshaft Frame Fixing Bolt	20 + 3
Connecting Rod Bearing Cap Fixing Bolt	1st step: 15 ± 3 2nd step: 60° ± 5°

Lubrication Areas during Engine Assembly

Lubrication Area	Note
Piston Pin	SM10W-40
Piston Ring	SM10W-40
Piston	SM10W-40
Cylinder Bore	SM10W-40
Main Bearing Shell and Crankshaft Main Journal	SM10W-40
Crankshaft Thrust Washer (Oil Groove Side)	SM10W-40
Connecting Rod Bearing Cap Bolt Head and Thread	SM10W-40
Connecting Rod Bearing Shell and Crankshaft Connecting Rod Journal	SM10W-40
Main Bearing Cap Bolt Head	SM10W-40
Crankshaft Front Oil Seal Lip and Crankshaft Oil Seal Journal	SM10W-40
Crankshaft Rear Oil Seal Lip and Crankshaft Oil Seal Journal	SM10W-40
Valve Guide Hole	SM10W-40
Valve Stem	SM10W-40
Camshaft Cam and Journal	SM10W-40
Hydraulic Lifter	SM10W-40
Hydraulic Lifter Hole and Valve Rocker Arm Head	SM10W-40
Valve Seat Hole (Cylinder Head Assembly)	SM10W-40
Valve Guide or Guide Bottom Hole (Cylinder Head)	SM10W-40
Oil Filter Module Gasket Surface	SM10W-40

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

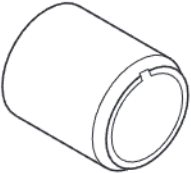
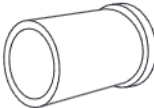
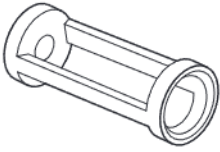
Areas with Seal Gum Applied during Engine Assembly

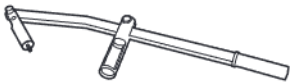
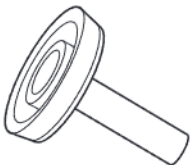
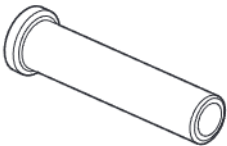
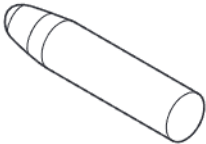
Area with Seal Gum Applied	Seal Gum Type
Cylinder Block Bowl Plug	Loctite 747
Cylinder Block Main Oil Passage Plug	Loctite 5910
Contact Surface Between Crankshaft Frame and Cylinder Block	Loctite 518
Crankshaft Frame and Oil Pan	Loctite 5910
Cylinder Head Bowl Plug	Loctite 11747
Cylinder Head Oil Passage Plug	Loctite 577
Coolant Temperature Sensor	Loctite 243
Oil Pressure Sensor	Loctite 577
Oil Deflector Bolt	Loctite 243
Engine Timing Chain Cover	Loctite 5910

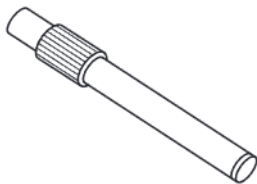
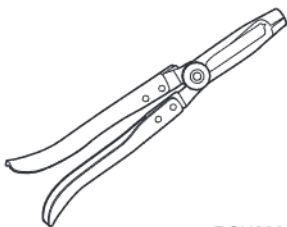
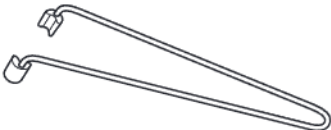
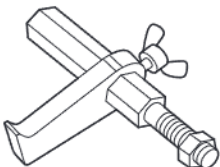
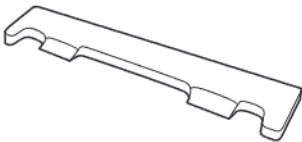
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Tools

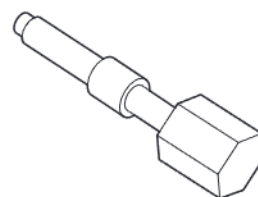
Special Tools

Crankshaft Front Oil Seal Guide Tool	 RCH0000049
Crankshaft Front Oil Seal Installer	 RCH0000067
Valve Spring Compression Adapter	 RCH0000050

Valve Spring Compressor	 RCH0000028
Crankshaft Rear Oil Seal Guide Tool	 RCH0000031
Crankshaft Rear Oil Seal Installer	 RCH0000070
Valve Oil Seal Installer	 RCH0000034
Valve Oil Seal Guide Sleeve	 RCH0000035

Clutch Pressure Plate Installer	 RCH0000018
Valve Oil Seal Remover	 RCH0000037
Valve Cotter Installer	 RCH0000029
Flywheel Holding Tool	 RCH0000040
Camshaft Timing Tool	 RCH0000033

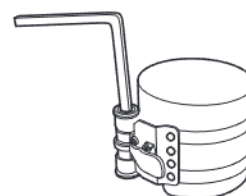
Crankshaft Timing Tool



RCH0000027

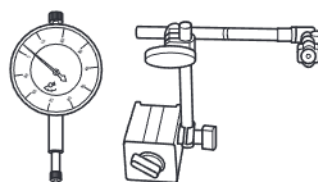
General Tools

Piston Installer



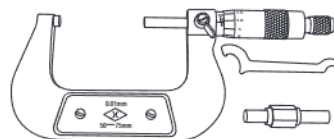
RCH0000039

Dial Indicator and Magnetic Holder



RCH0000023

Outer Diameter Micrometer



RCH0000064

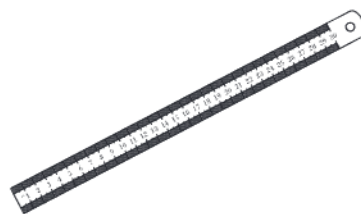
Vernier Caliper



RCH0000019

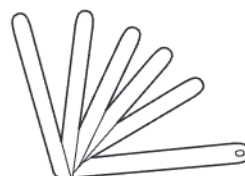
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Precision Straightedge



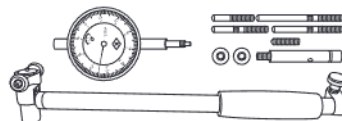
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Feeler Gauge



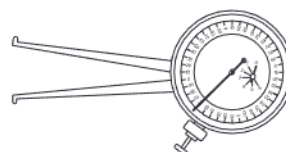
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Cylinder Gauge



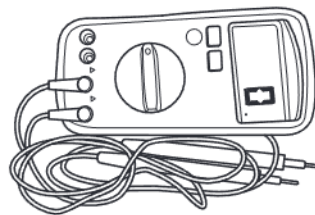
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Caliper Gauge

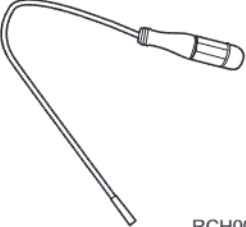
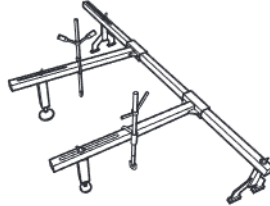
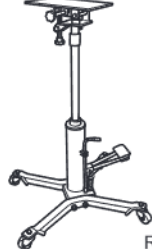
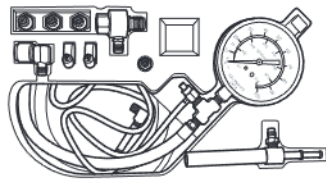


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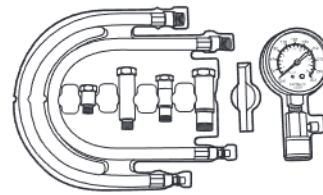
Digital Multimeter



RCH0000002

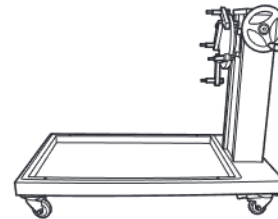
Flexional Magnetic Rod	 RCH0000042
Engine Hoist	 RCH0000043
Engine Equalizer	 RCH0000026
Transmission Carrier	 RCH0000005
Fuel System Pressure Tester	 RCH0000048

Cylinder Pressure Gauge



RCH0000044

Engine Service Platform



RCH0000057

DIAGNOSIS & TESTING

Engine Performance Diagnosis

HINT:

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

Symptom	Suspected Area	See page
Valve mechanism noise	Engine oil (oil level high or low, oil lean or rich)	13-12
	Cam	07-46
	Valve spring seat (excessive runout)	07-54
	Valve (excessive clearance between valve and guide)	07-56
Connecting rod noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-12
	Connecting rod bearing cap (loose fixing bolt)	07-98
	Connecting rod (misaligned)	07-98
	Connecting rod bearing shell (excessive radial clearance)	07-90
	Connecting rod journal (out-of roundness)	07-90
Main bearing noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-12
	Main bearing shell (excessive clearance)	07-88
	Crankshaft axial clearance (excessive)	07-89
	Crankshaft journal (out-of roundness or worn)	07-88
	Flywheel or clutch (loose)	07-34
Oil loss or spark plug blockage	Piston ring (worn, scratched or damaged)	07-81
	Piston ring groove (carbon deposited)	07-85
	Valve oil seal (worn or damaged)	07-54
	Valve (excessive clearance between valve and guide)	07-56

Inspection

1. Check the coolant (See page 12-12).
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.
 - 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 air filter element, clean it with compressed air.
 - If any dirt or blockage remains, even after cleaning air filter element with compressed air, replace it.
5. Check the spark plugs (See page 14-11).
 6. Test the cylinder compression pressure.
 - Cylinder pressure is the main index to judge 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 cylinder pressure measurement when servicing the engine.
 - Ensure battery is fully charged and engine starter is in good operating condition. Otherwise, indicated compression pressure used for diagnosis may be invalid.

CAUTION

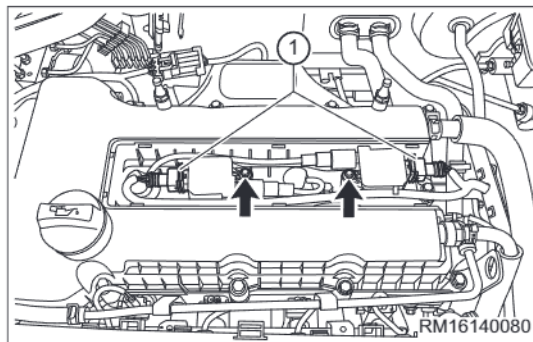
- Recommended compression pressure is only used as a guide for diagnosing engine malfunction.
- Never determine cause of low pressure by disassembling engine unless there are some malfunctions.

Measurement Procedures

CAUTION

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

- a. Turn off all electrical equipment and the ignition switch.
- b. Remove the engine trim cover.
- c. Remove the ignition coil with high-voltage cable assembly.
 - Disconnect the ignition coil connectors (1) and move away the wire harness from ignition coils.
 - Loosen and remove 2 fixing bolts (arrow) from ignition coils.
(Tightening torque: 8 + 2 N·m)

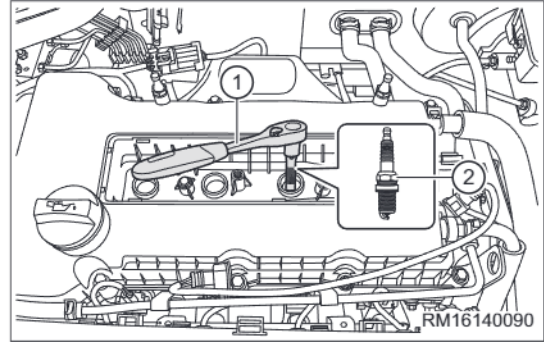


- Remove the ignition coil with high-voltage cable assembly.

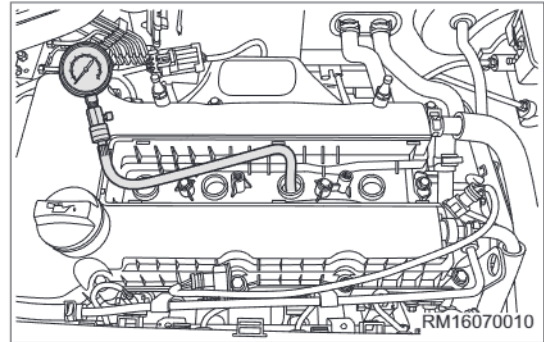
CAUTION

- Be careful not to damage high-voltage cables when pulling them upward.

- d. Disconnect all injector connectors.
- e. Remove the spark plug.
 - Using a special spark plug socket wrench (1), loosen the spark plug.
 - Remove the spark plug (2).



- f. Slowly screw the cylinder pressure gauge connector 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.

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

Standard value for cylinder pressure: 9 - 13.5 bar

CAUTION

- During measurement, do not turn ignition switch to "START" for more than 10 seconds. Otherwise, engine may be damaged.
- Ensure battery is fully charged when cranking engine. Correct cylinder pressure can be measured only when engine is running at 180 - 250 r/min.
- Use same method to measure pressure of other cylinders.

Cylinder Pressure Value Judgment

- Correct cylinder pressure

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

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

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

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

- i. Install the spark plug.
- j. Reconnect all injector connectors.
- k. Install the ignition coil with high-voltage cable assembly.

7. Test cylinder head gasket.

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.

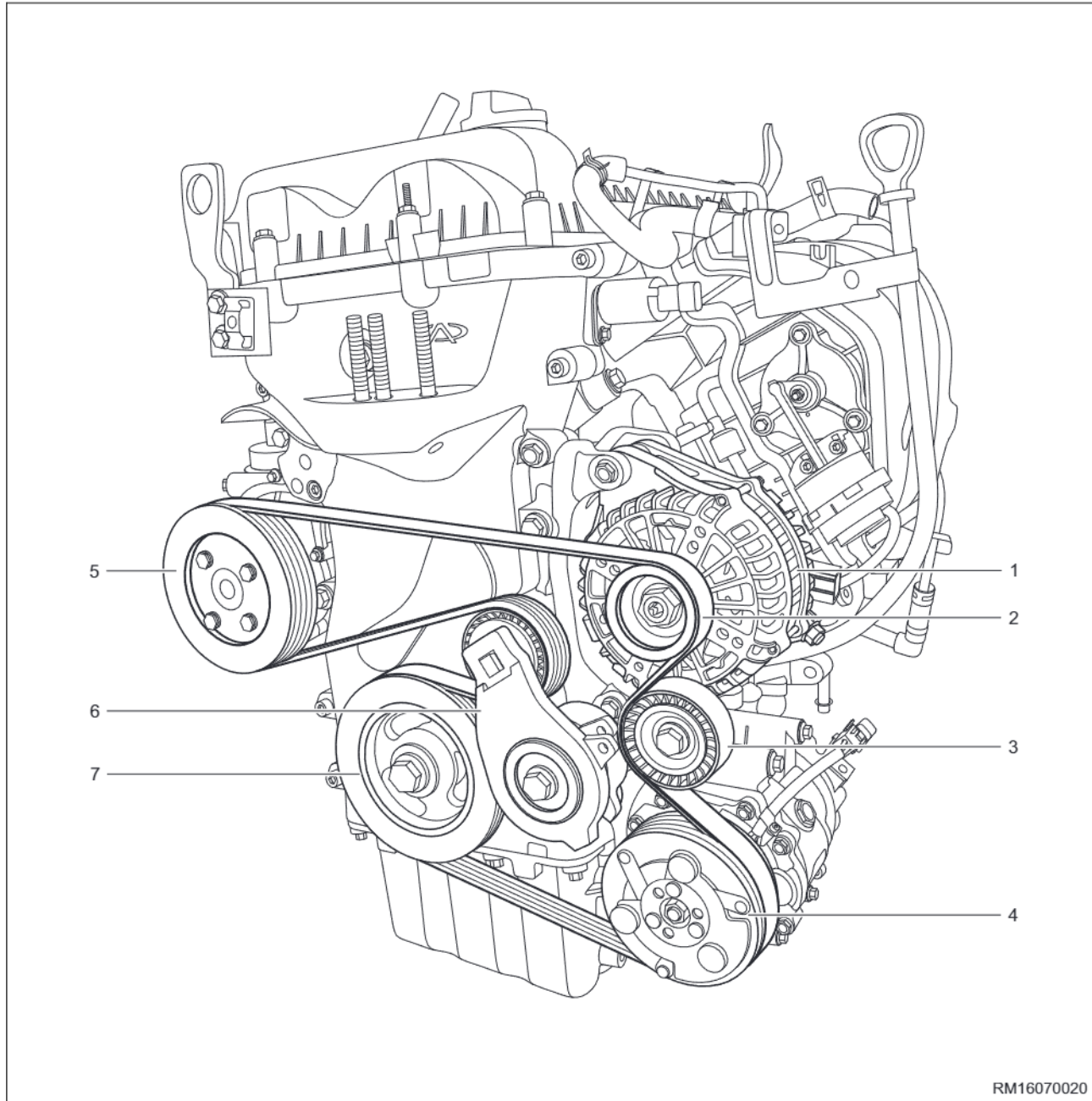
- Possible indications of cylinder head gasket leakage between adjacent cylinders are as follows:
 - Engine power loss
 - Engine stall
 - Low fuel economy
- Possible indications of cylinder head gasket leakage between cylinder and adjacent water jacket are as follows:
 - Engine overheating
 - Coolant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

ON-VEHICLE SERVICE

Accessory Drive Belt

Description

Model Equipped with Electronic Power Steering



07

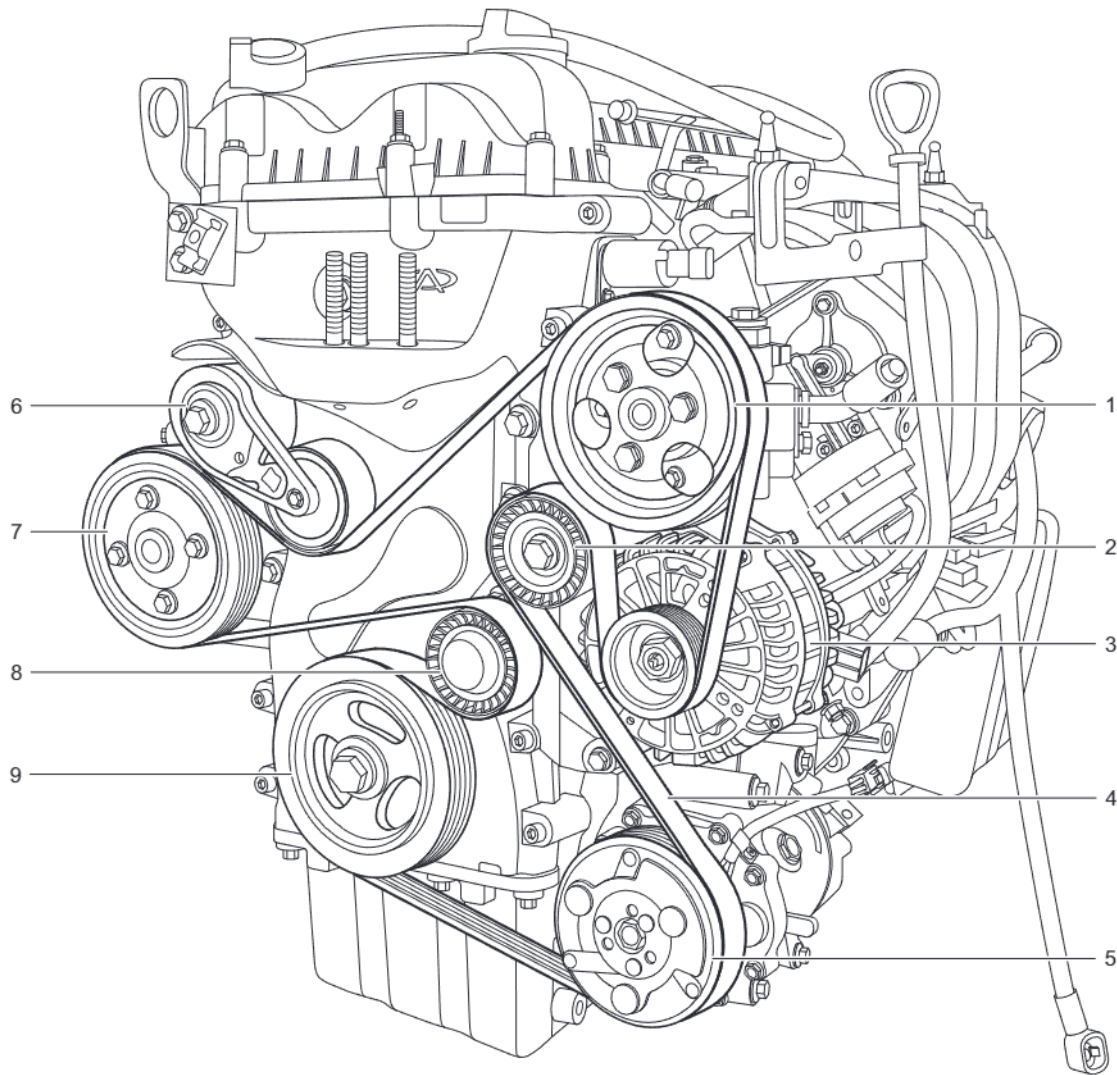
RM16070020

1 - Alternator	2 - Accessory Drive Belt
3 - Idler Pulley	4 - A/C Compressor Pulley
5 - Water Pump Pulley	6 - Belt Tensioner Assembly
7 - Crankshaft Pulley	



Model Equipped with Hydraulic Assist Steering

07



RM16070030

1 - Power Steering Pump Pulley	2 - Upper Idler Pulley
3 - Alternator	4 - Accessory Drive Belt
5 - A/C Compressor Pulley	6 - Belt Tensioner Assembly
7 - Water Pump Pulley	8 - Lower Idler Pulley
9 - Crankshaft Pulley	

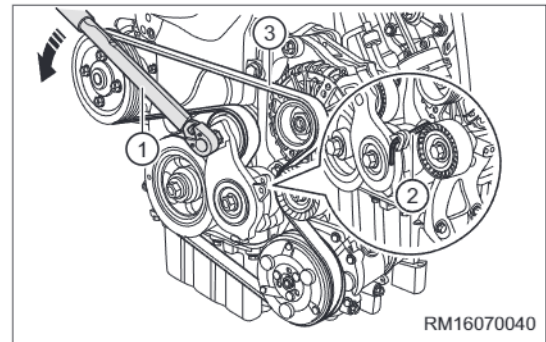
Removal

CAUTION

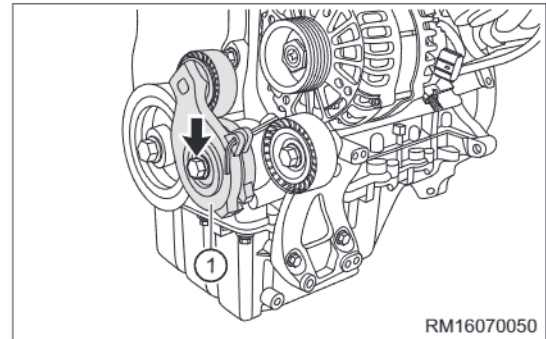
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (w/ electronic power steering).

- a. Insert the head of an appropriate wrench (1) into the tensioner pin hole, and rotate the accessory drive belt tensioner assembly in direction of arrow as shown in illustration, while aligning the lock hole of tensioner assembly with the lock hole of bracket, and insert the lock pin (2) at the same time to lock the tensioner assembly.
- b. Move away the accessory driver belt (3).

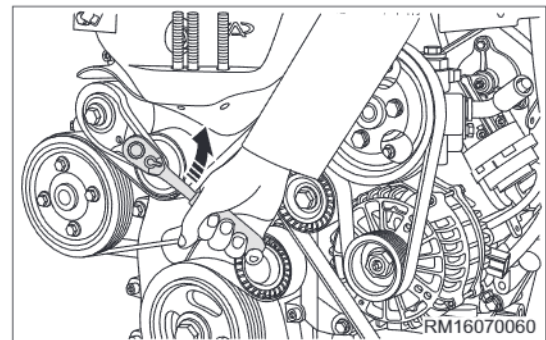


- c. Remove the accessory drive belt tensioner assembly fixing bolt (arrow) and remove the accessory drive belt tensioner assembly (1).
(Tightening torque: $40 + 5 \text{ N}\cdot\text{m}$)



- d. Remove the accessory drive belt.
5. Remove the accessory drive belt (w/ hydraulic assist steering).

- a. Insert the head of an appropriate wrench into the tensioner pin hole, and push in direction of arrow as shown in illustration, so that the tensioner assembly moves upward.



⚠ WARNING

- Prevent hand from contacting belt tensioner assembly when moving it upward.

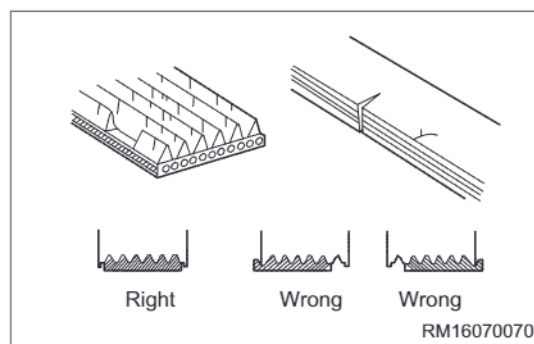
- Take out the accessory drive belt from idler pulley assembly and loosen the wrench to remove the accessory drive belt.

Inspection

- Check belt surface for pilling, oiliness and deterioration, etc. If any of these defects is found, replace the accessory drive belt.
- Check internal face and edge of belt for damage, wear, foreign matter and cracks, etc. If any of these defects is found, replace the accessory drive belt.

HINT:

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

**Installation**

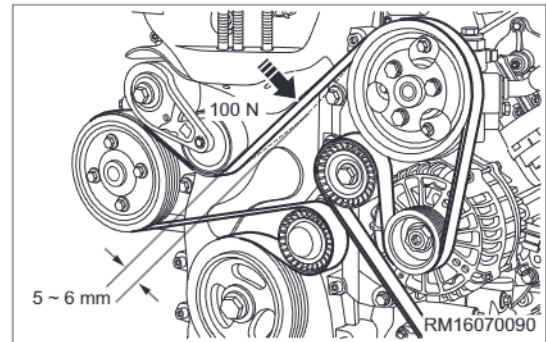
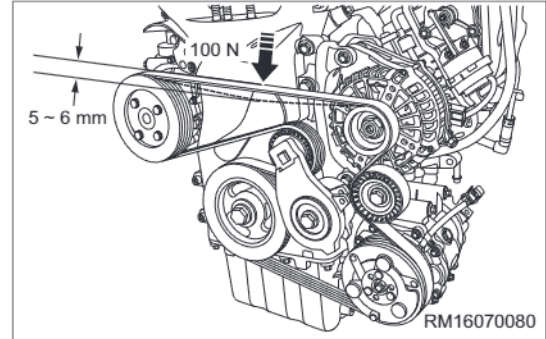
Installation is in the reverse order of removal.

👁 CAUTION

- Before installation, remove oil and foreign matter from accessory drive belt.
- For vehicle models equipped with electronic power steering, set the belt on tensioner before installing accessory belt tensioner assembly, when installing accessory drive belt.
- Rotate crankshaft for 2 turns after installation of accessory drive belt, making sure accessory drive belt is installed in place and does not contact with other objects.

Adjustment

1. Check the tension of accessory drive belt.
 - a. Rotate crankshaft for 2 turns, making sure belt tension between each pulley is even.
 - b. For vehicle models equipped with electronic power steering, apply 100 N of force to center part of the belt between alternator pulley and water pump pulley with your thumb. Check that displacement of belt is within 5 - 6 mm. If displacement is too large or too small, adjust, check or repair.
 - c. For vehicle models equipped with hydraulic assist steering, apply 100 N of force to center part of the belt between power steering pulley and tensioner pulley with your thumb. Check that displacement of belt is within 5 - 6 mm. If displacement is too large or too small, adjust, check or repair.



07

Idler Pulley Assembly

Removal

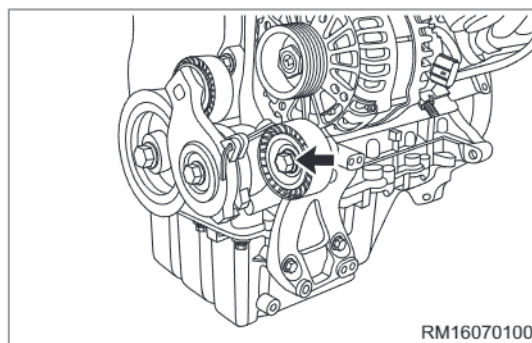
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (See page 07-21).
5. Remove the idler pulley assembly (w/ electronic power steering).

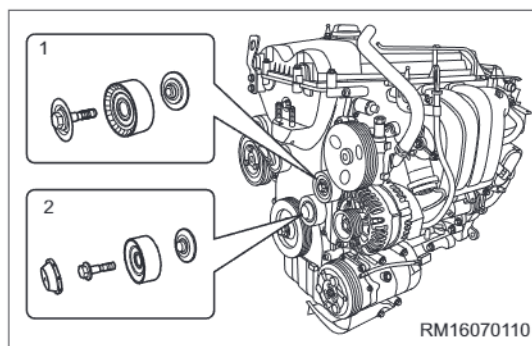
07

- a. Remove the fixing bolt (arrow) from idler pulley assembly, and remove the idler pulley assembly.
(Tightening torque: $40 + 5 \text{ N}\cdot\text{m}$)



6. Remove the idler pulley assembly (w/ hydraulic assist steering).

- a. Remove the fixing bolt from upper idler pulley assembly (1) and remove the upper idler pulley and washer.
(Tightening torque: $40 + 5 \text{ N}\cdot\text{m}$)
- b. Remove the protector from lower idler pulley assembly (2).
- c. Remove the fixing bolt from lower idler pulley assembly and remove the lower idler pulley and washer.



Inspection

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

Installation

Installation is in the reverse order of removal.

CAUTION

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

Belt Tensioner Assembly

Removal

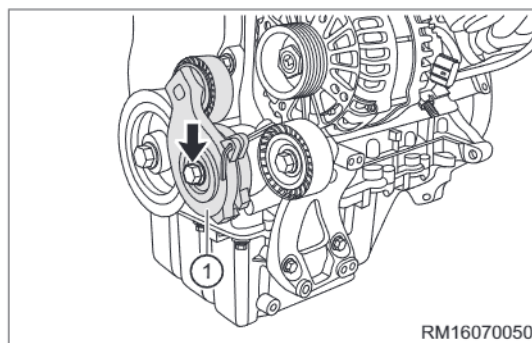
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the accessory drive belt (See page 07-21).
5. Remove the belt tensioner assembly (w/ electronic power steering).

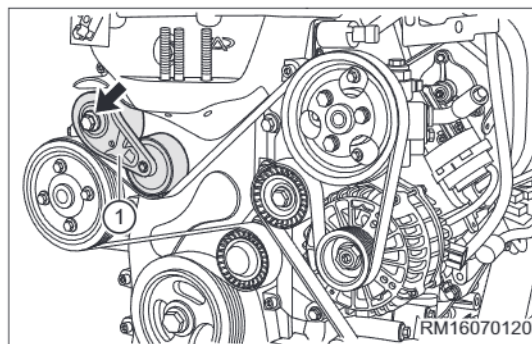
07

- a. Remove the belt tensioner assembly fixing bolt (arrow) and remove the belt tensioner assembly (1).
(Tightening torque: $40 + 5 \text{ N}\cdot\text{m}$)



6. Remove the belt tensioner assembly (w/ hydraulic assist steering).

- a. Remove the belt tensioner assembly fixing bolt (arrow) and remove the belt tensioner assembly (1).
(Tightening torque: $40 + 5 \text{ N}\cdot\text{m}$)



Inspection

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

Installation

Installation is in the reverse order of removal.

CAUTION

- After installation, turn crankshaft with a wrench to run accessory drive belt several circles, and check if crankshaft turns smoothly and belt runs well. If it does not turn smoothly, reinstall accessory drive belt.
- For vehicle models equipped with electronic power steering, set accessory drive belt on tensioner before installing belt tensioner assembly, when installing drive belt.
- Make sure to correctly install accessory drive belt, and it does not interfere with other components.

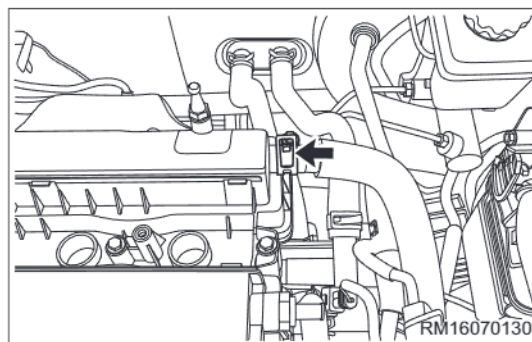
Cylinder Head Cover

Removal

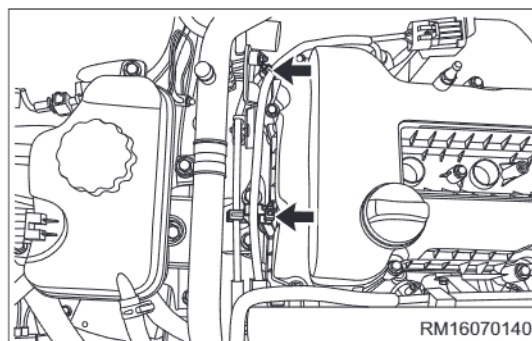
CAUTION

- Blow dirt and debris away from upper surface of cylinder head cover with compressed air.
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

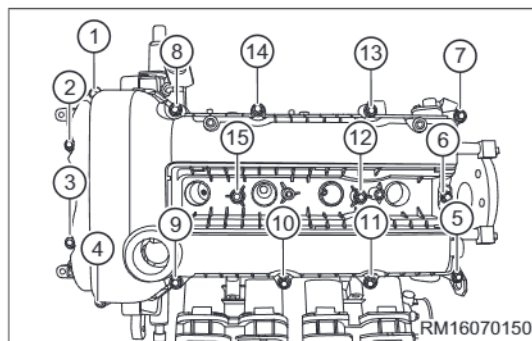
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coils and high-voltage cables ([See page 14-8](#)).
5. Remove the cylinder head cover.
 - a. Remove the PCV valve ([See page 09-11](#)).
 - b. Loosen the elastic clamp (arrow) and disconnect the crankcase ventilation hose from cylinder head cover.



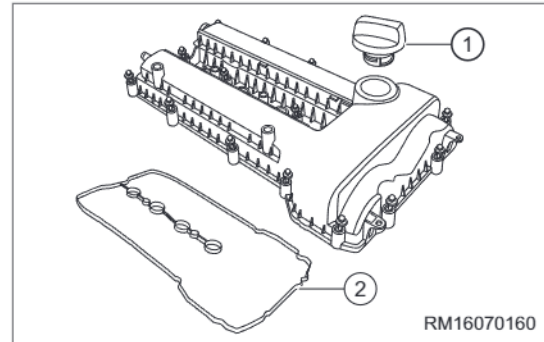
- c. Remove the engine wire harness fixing clips (arrow).



- d. Remove 15 fixing bolts from cylinder head cover in order shown in illustration.

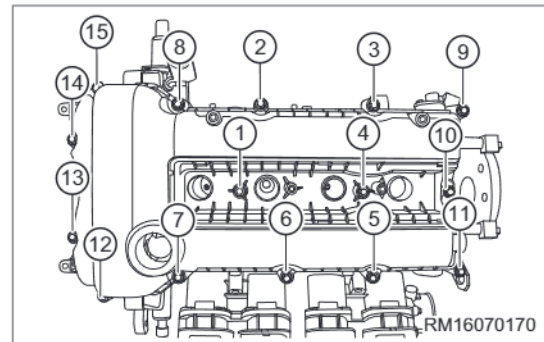


- e. Remove the cylinder head cover from cylinder head.
6. Remove the oil filler cap (1) and cylinder head cover gasket (2) from cylinder head cover.



Installation

1. Install 15 fixing bolts onto cylinder head cover in order shown in illustration.
(Tightening torque: 1st step: tighten to 3 - 5 N·m; 2nd step: retighten to 8 - 10 N·m)



07

2. Other installation procedures are in the reverse order of removal.

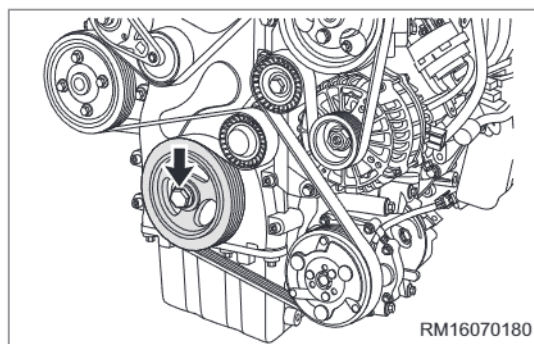
Crankshaft Front Oil Seal

Removal

CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

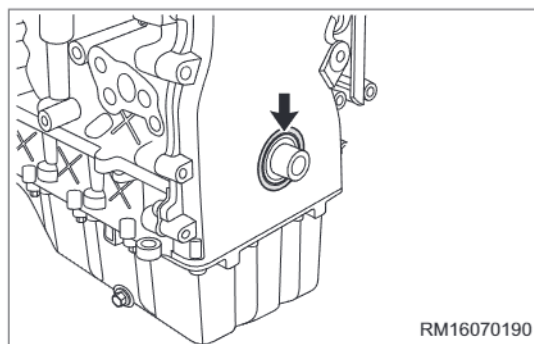
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the engine lower protector assembly (See page 49-22).
5. Remove the accessory drive belt (See page 07-21).
6. Remove the crankshaft front oil seal.
 - a. Loosen the crankshaft pulley fixing bolt (arrow).



HINT:

Shift transmission into 5th gear (for MT model) or D (for CVT model) when loosening crankshaft timing gear fixing bolt to engage crankshaft and propeller shaft. Another technician depresses brake pedal, which can lock the crankshaft by mechanical gear train.

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



CAUTION

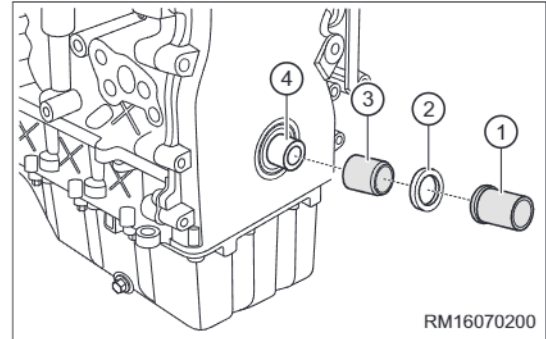
- Be careful not to damage oil seal retainer and surface of crankshaft, when removing crankshaft front oil seal.

Installation

CAUTION

- Apply a coat of engine oil to the crankshaft front oil seal guide tool before installing a new oil seal.
- Remove dirt on oil seal retainer and apply a coat of engine oil to 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 immediately.

1. Remove the dirt around the crankshaft front oil seal retainer and on its inner wall.
2. Install the crankshaft front oil seal guide tool (3) to the crankshaft (4).
3. Install the new oil seal (2) to the crankshaft front oil seal guide tool, then install the new oil seal fully into oil seal retainer with a crankshaft front oil seal installer (1).

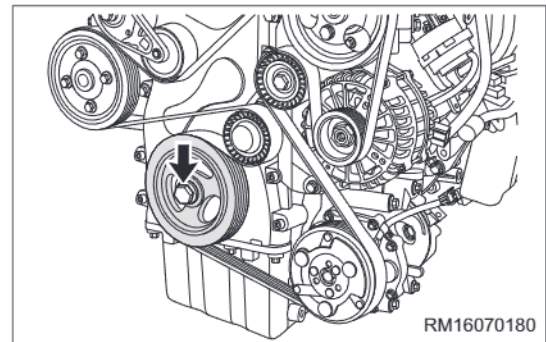


07

CAUTION

- Press oil seal in place by pressing the installation tool around oil seal, making sure oil seal surface is 0 to 1.0 mm lower than front cover.

4. Tighten the crankshaft pulley fixing bolt (arrow).
(Tightening torque: 1st step: tighten to $100 \pm 10 \text{ N}\cdot\text{m}$; 2nd step: retighten by $120^\circ \pm 10^\circ$)



5. Other installation procedures are in the reverse order of removal.

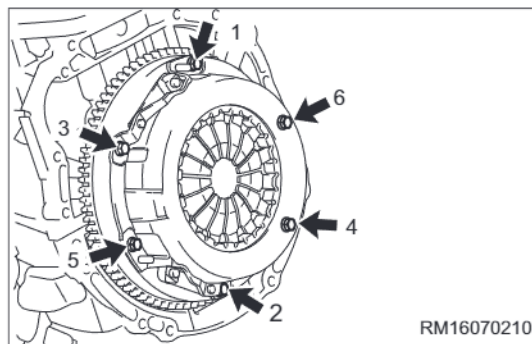
Flywheel

Removal

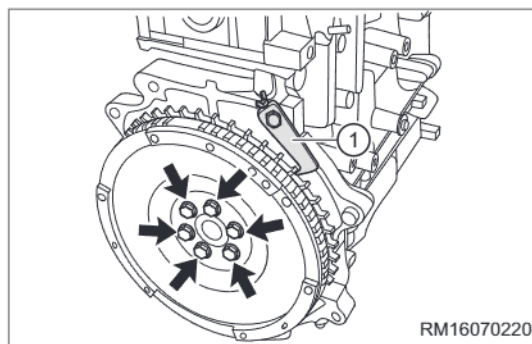
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-20 for MT model, See page 18-120 for CVT model).
4. Remove the clutch assembly.
 - a. Remove 6 fixing bolts from clutch pressure plate, and remove the clutch pressure plate. (Tightening torque: 25 ± 2 N·m)



5. Remove the flywheel.
 - a. As shown in the illustration, install the flywheel holding tool (1) to hold the flywheel securely.
 - b. Remove 6 fixing bolts (arrow) from flywheel, and remove the flywheel.



WARNING

- Pay special attention to safety during operation, do not remove all flywheel fixing bolts without any auxiliary measures.
- If necessary, other operators will be required to assist.

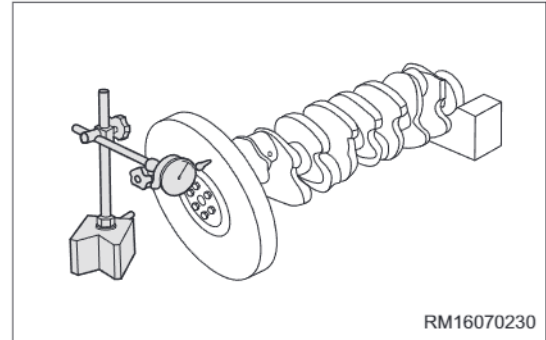
CAUTION

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

Inspection

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

Limit for end surface runout: 0.2 mm



RM16070230

07

Installation

⚠ WARNING

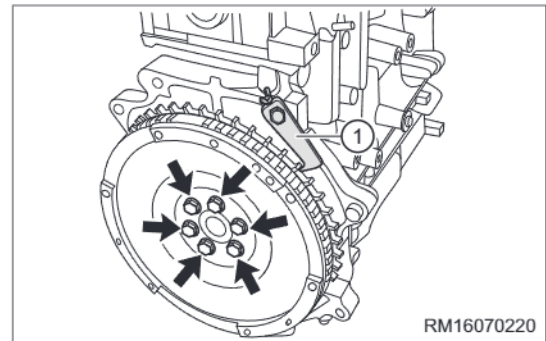
- Never reuse flywheel fixing bolts after removal.
- Make sure to apply seal gum to flywheel fixing bolts, before bolting on flywheel.

👁 CAUTION

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

Installation procedures are in the reverse order of removal, and pay attention to the following:

1. Align flywheel installation hole with crankshaft positioning journal and then lightly push flywheel onto the journal. DO NOT tap flywheel with a hammer.
2. Replace the flywheel fixing bolts with new ones and apply seal gum to the bolt threads.
3. Install the flywheel fixing bolts (arrow), and then hold the flywheel securely with flywheel holding tool (1). Tighten the flywheel fixing bolts.
(Tightening torque: 1st step: tighten to 25 ± 5 N·m; 2nd step: retighten by $30^\circ \pm 5^\circ$)



RM16070220

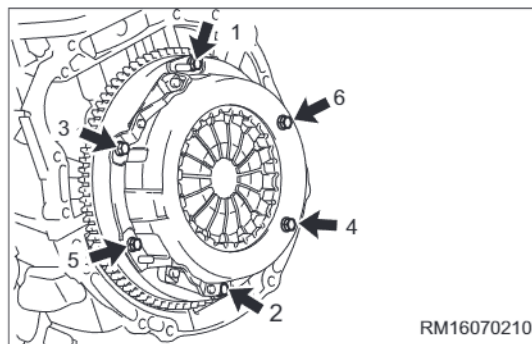
Crankshaft Rear Oil Seal

Removal

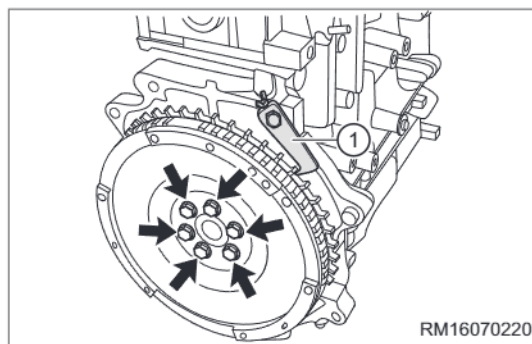
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

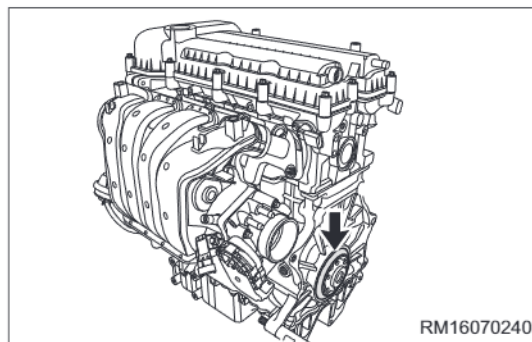
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-20 for MT model, See page 18-120 for CVT model).
4. Remove the clutch assembly.
 - a. Remove 6 fixing bolts from clutch pressure plate, and remove the clutch pressure plate.
(Tightening torque: 25 ± 2 N·m)



5. Remove the flywheel.
 - a. As shown in the illustration, install the flywheel holding tool (1) to hold the flywheel securely.
 - b. Remove 6 fixing bolts (arrow) from flywheel and remove the flywheel.
(Tightening torque: 1st step: tighten to 25 ± 5 N·m; 2nd step: retighten by $30^\circ \pm 5^\circ$)



6. Remove the crankshaft rear oil seal.
 - a. Using a screwdriver with the tip wrapped with tape, remove the crankshaft rear oil seal (arrow).



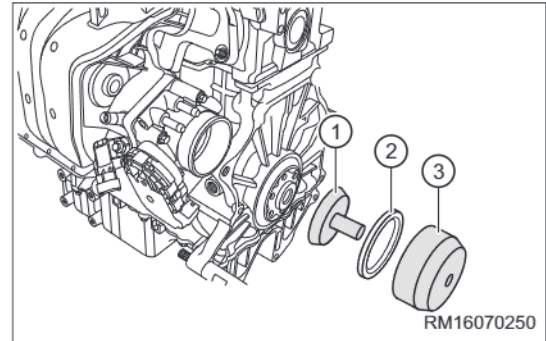
CAUTION

- Be careful not to damage surrounding parts and oil seal retainer, when removing oil seal.

Installation**CAUTION**

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

1. Apply a coat of engine oil to the crankshaft oil seal journal and crankshaft rear oil seal lip.
2. Install the crankshaft rear oil seal guide tool (1) to the crankshaft.
3. Install the new rear oil seal (2) to the crankshaft rear oil seal guide tool, then install the new oil seal fully into oil seal retainer with a crankshaft rear oil seal installer (3).

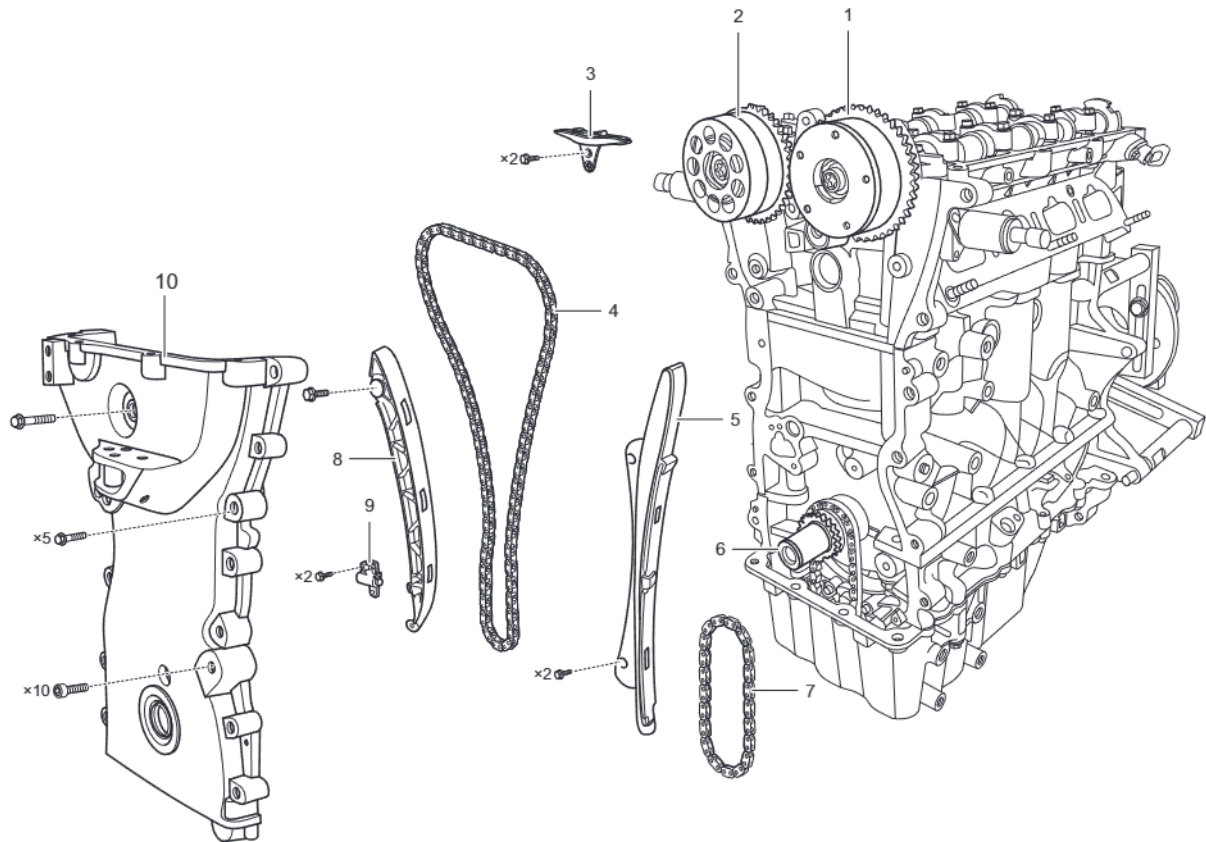
**CAUTION**

- Makes sure to install crankshaft rear oil seal in place. Otherwise it will lead to engine oil leakage.

4. Other installation procedures are in the reverse order of removal.

Engine Timing Chain

Description



RM16070260

1 - Intake Camshaft Phaser Assembly	2 - Exhaust Camshaft Phaser Assembly
3 - Timing Chain Upper Guide Rail Assembly	4 - Engine Timing Chain
5 - Fixing Guide Rail Assembly	6 - Crankshaft
7 - Oil Pump Chain	8 - Movable Guide Rail Assembly
9 - Hydraulic Tensioner	10 - Engine Timing Chain Cover

Removal

CAUTION

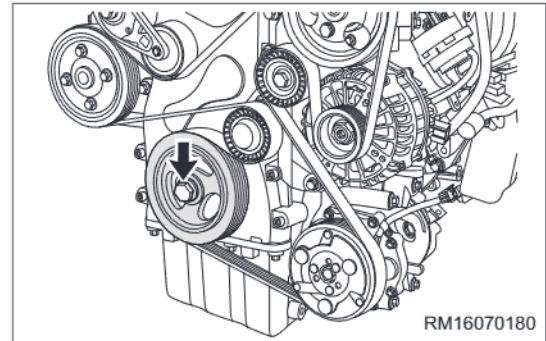
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.
- Blow dirt and debris away from upper surface of cylinder head cover with compressed air.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coils and high-voltage cables (See page 14-8).
5. Remove the cylinder head cover (See page 07-30).
6. Remove the engine lower protector assembly (See page 49-22).
7. Remove the accessory drive belt (See page 07-21).
8. Remove the accessory drive belt tensioner assembly (See page 07-23).
9. Remove the idler pulley assembly (See page 07-26).
10. Remove alternator and alternator bracket (w/ electronic power steering) (See page 16-12).
11. Remove the crankshaft pulley.

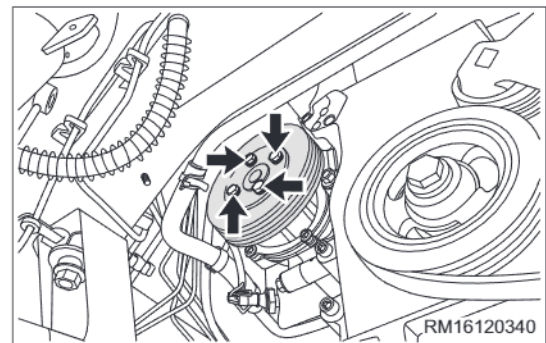
- a. Loosen the crankshaft pulley fixing bolt (arrow).
(Tightening torque: 1st step: tighten to $100 \pm 10 \text{ N}\cdot\text{m}$;
2nd step: retighten by $120^\circ \pm 10^\circ$)

HINT:

Shift transmission into 5th gear (for MT model) or D (for CVT model) when loosening crankshaft timing gear fixing bolt to engage crankshaft and propeller shaft. Another technician depresses brake pedal, which can lock the crankshaft by mechanical gear train.



12. Remove 4 fixing bolts (arrow) from water pump pulley and remove the water pulley.
(Tightening torque: $20 \pm 5 \text{ N}\cdot\text{m}$)



13. Use an engine equalizer to hang the engine left lifting eye.

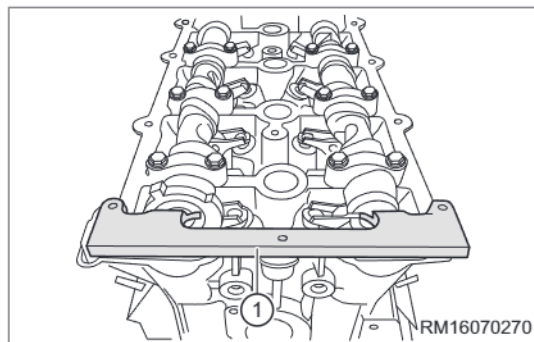
HINT:

Use an engine equalizer to hang the engine left lifting eye while supporting engine oil pan with a jack. Avoid engine from leaning to right side, so as to remove the engine right mounting assembly.

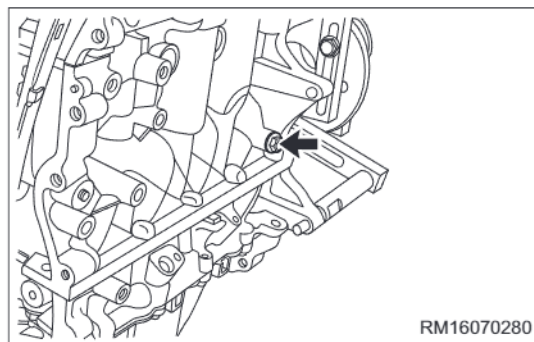
14. Remove the engine right mounting assembly (See page 07-66).

15. Install the timing tool.

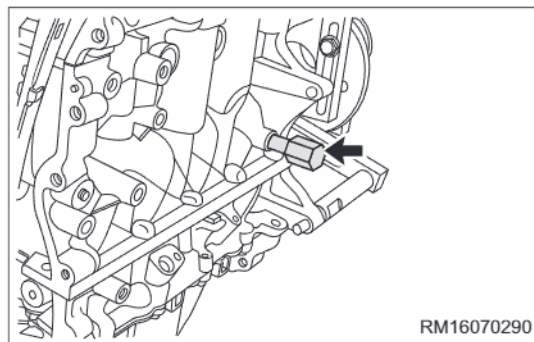
- a. Turn the camshaft, install the camshaft timing tool (1), and lock the exhaust camshaft and intake camshaft.



- b. Remove the starter (See page 15-71).
- c. Remove the plug (arrow) for installing crankshaft timing tool from the bottom of engine block. (Tightening torque: $40 \pm 5 \text{ N}\cdot\text{m}$)



- d. Carefully screw in the crankshaft timing tool (arrow) until the crankshaft is stuck completely.

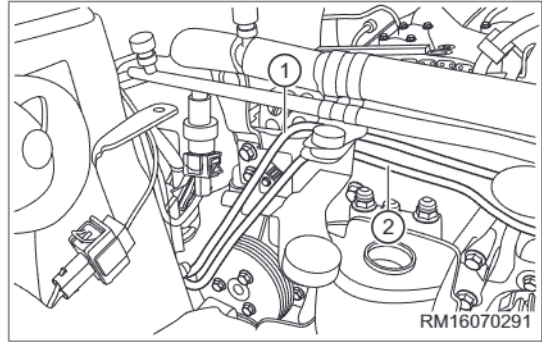


CAUTION

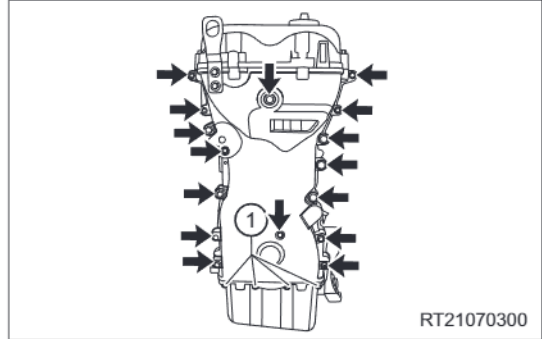
- This operation needs patience, and perform with extreme care not to damage the crankshaft.
- When crankshaft is stuck completely, pistons in 4 cylinders of engine are at the same level.

16. Remove the engine timing chain cover.

- a. Move away the inlet pipe (1) and fuel vapor pipe (2) from line bracket.



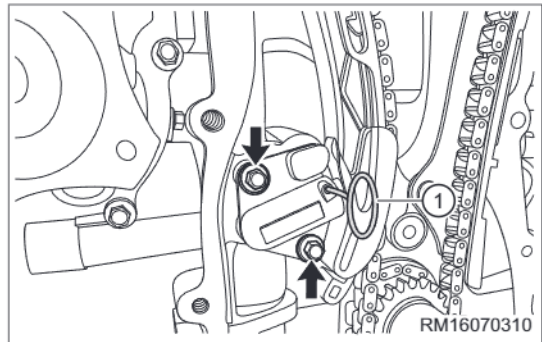
- b. Remove 4 coupling bolts (1) between engine timing chain cover and oil pan.
- c. Remove the engine timing chain cover fixing bolts (arrow).



- d. Remove the engine timing chain cover.

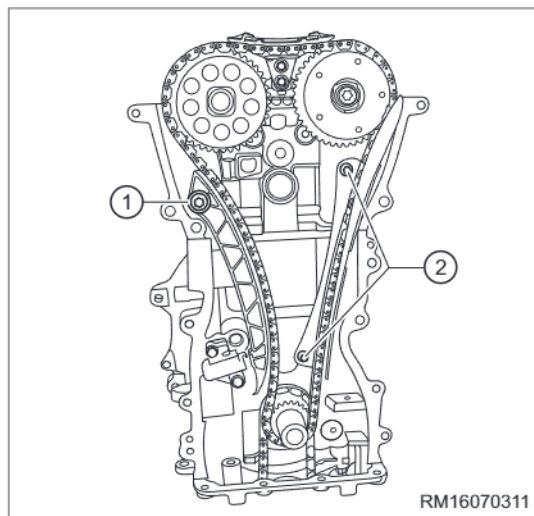
17. Remove the engine timing chain.

- a. Compress the movable guide rail, push the hydraulic tensioner plunger to maximum compressing position, and hold the hydraulic tensioner plunger with a snap pin (1).
- b. Remove 2 fixing bolts (arrow) from hydraulic tensioner, and remove the hydraulic tensioner. (Tightening torque: 9 - 12 N·m)


 CAUTION

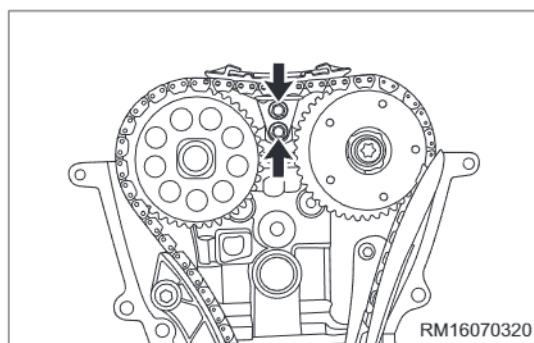
- There is a spring with large tensile force in hydraulic tensioner. Never remove hydraulic tensioner mounting bolts directly to prevent plunger from popping out suddenly.

- c. Remove the movable guide rail fixing bolt (1), and remove the movable guide rail.
- d. Remove the fixing guide rail fixing bolts (2), and remove the fixing guide rail.



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- e. Remove 2 fixing bolts (arrow) from engine timing chain upper guide rail, and remove the engine timing chain upper guide rail.



CAUTION

- Two sides of silent chain are worn differently due to direction of chain movement. It is necessary to remove and install the chain in the same direction.

- f. Remove the engine timing chain cover.

CAUTION

- After removal, always mark the front and back sides of chain with marking pen to keep it installed in same direction when assembling.

Inspection

1. Check the engine timing chain.

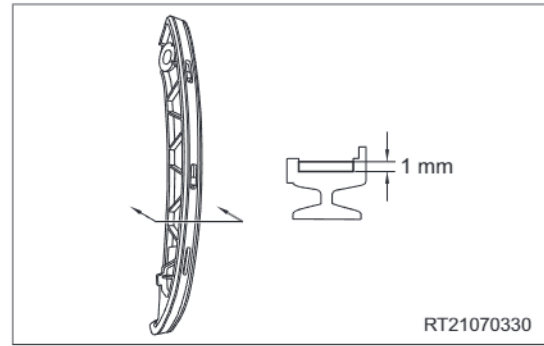
Carefully inspect the timing chain. Timing chain has same service life with engine. It can be reused if there is no serious wear or cracks on the tooth face.

2. If timing chain is to be replaced, the sprocket, chain and guide rail should be replaced as a set.

3. Check the engine timing chain movable guide rail.

Measure depth of engine timing chain movable rail with a vernier caliper.

Grinding limit is 1 mm.

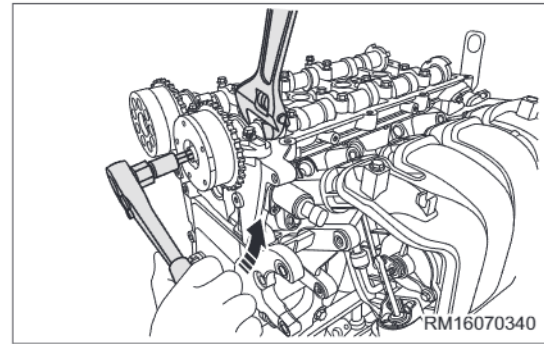


Installation

CAUTION

- Perform engine timing adjustment before installation.
- Apply seal gum along the inside edge of engine timing chain cover. Pay attention to apply seal gum to inside of timing chain cover mounting bolt holes.

1. While holding the hexagon surface on intake camshaft with an appropriate wrench, loosen the fixing bolt of intake camshaft phaser assembly in direction of arrow as shown in illustration.



2. Loosen the exhaust camshaft phaser assembly fixing bolt in the same way as the intake camshaft phaser assembly fixing bolt.
3. Install the engine timing chain upper guide rail.

CAUTION

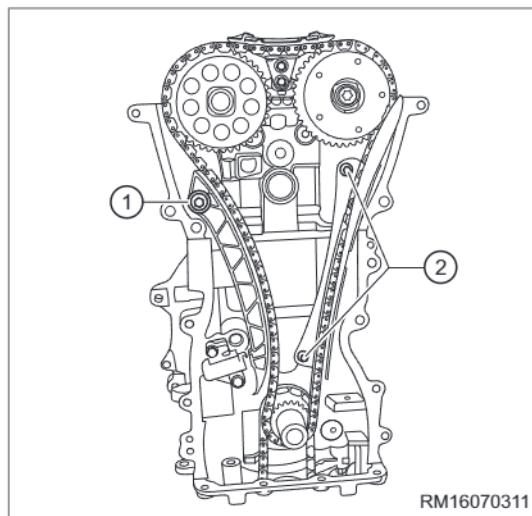
- Install the engine timing chain upper guide rail fixing bolts to camshaft 1st bearing cap without fully tightening the bolts.

4. Install the engine timing chain.

CAUTION

- Install engine timing chain according to marks on it, making sure it is installed correctly.
- Hang engine timing chain on intake phaser assembly, exhaust phaser assembly and crankshaft sprocket. Make sure the chain is fixed to lower face of upper guide rail and the upper guide rail surface is level.

5. Install the engine timing chain fixing guide rail and tighten 2 fixing bolts (2).
(Tightening torque: 9 - 12 N·m)
6. Install the engine timing chain movable guide rail and tighten the fixing bolt (1).
(Tightening torque: 9 - 12 N·m)

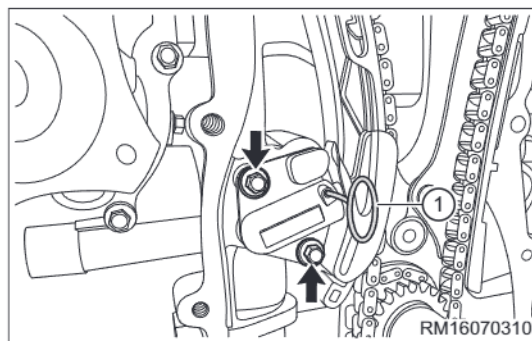


07

CAUTION

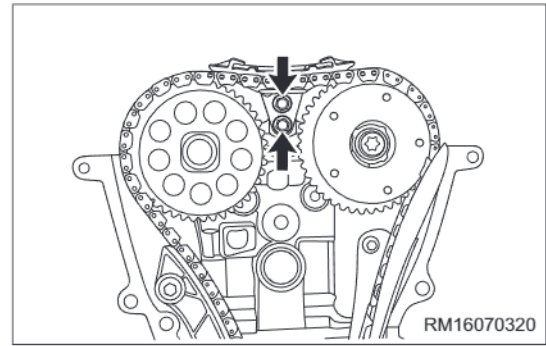
- After tightening, movable guide rail should rotate around the bolt flexibly. Otherwise remove and check the bolt and movable guide rail.

7. Install the hydraulic tensioner.
 - a. Install the hydraulic tensioner and tighten 2 hydraulic tensioner fixing bolts (arrow).
(Tightening torque: 9 - 12 N·m)
 - b. Pull the movable guide rail, press the hydraulic tensioner plunger firmly and pull out the tensioner snap pin (1) to tense the chain.


CAUTION

- During installation, make sure the orifice of hydraulic tensioner is clean. Otherwise poor lubrication will result in abnormal noises and damage of timing chain and guide rail.
- After chain is tensed, rotate the intake and exhaust phaser assemblies successively, ensuring that chain is tensed on fixing guide rail side. Check that chain is pressed in the fixing guide rail and movable guide rail, and engages normally with crankshaft sprocket, intake and exhaust camshaft phaser assemblies.
- Always make sure that engaging points from intake camshaft phaser assembly to crankshaft sprocket and the chain between intake and exhaust camshaft phaser assemblies (chain that contacts with upper guide rail) are not loose and keep upper guide rail level.

8. Tighten 2 upper guide rail fixing bolts (arrow).
(Tightening torque: 9 - 12 N·m)



9. Tighten the exhaust camshaft phaser assembly fixing bolt.
(Tightening torque: 105 + 5 N·m)
10. Tighten the intake camshaft phaser assembly fixing bolt.
(Tightening torque: 105 + 5 N·m)
11. Remove the crankshaft and camshaft timing positioning special tools, and rotate the crankshaft 2 turns clockwise to check if timing system operates normally.

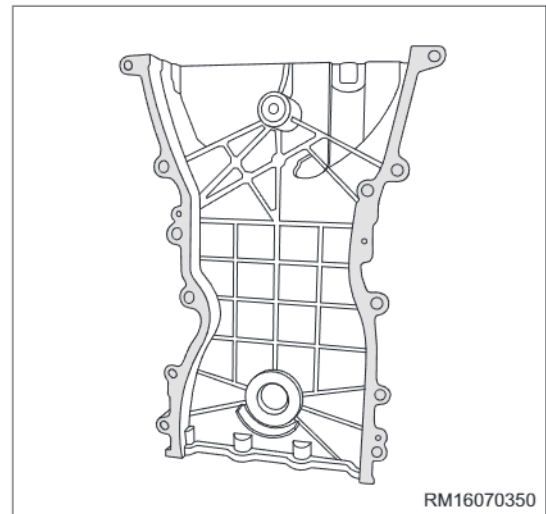
07

CAUTION

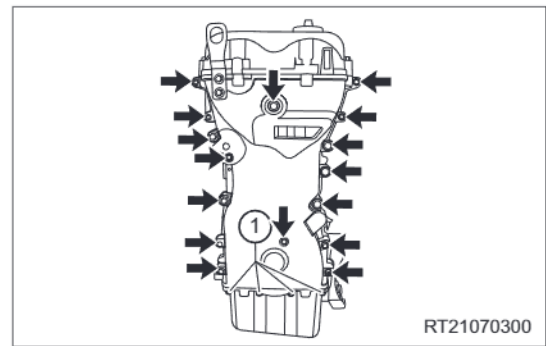
- It is prohibited to rotate crankshaft counterclockwise.

12. Install the engine timing chain cover.

- a. Apply seal gum along the inside edge of engine timing chain cover. Pay attention to apply seal gum to inside of timing chain cover mounting bolt holes.



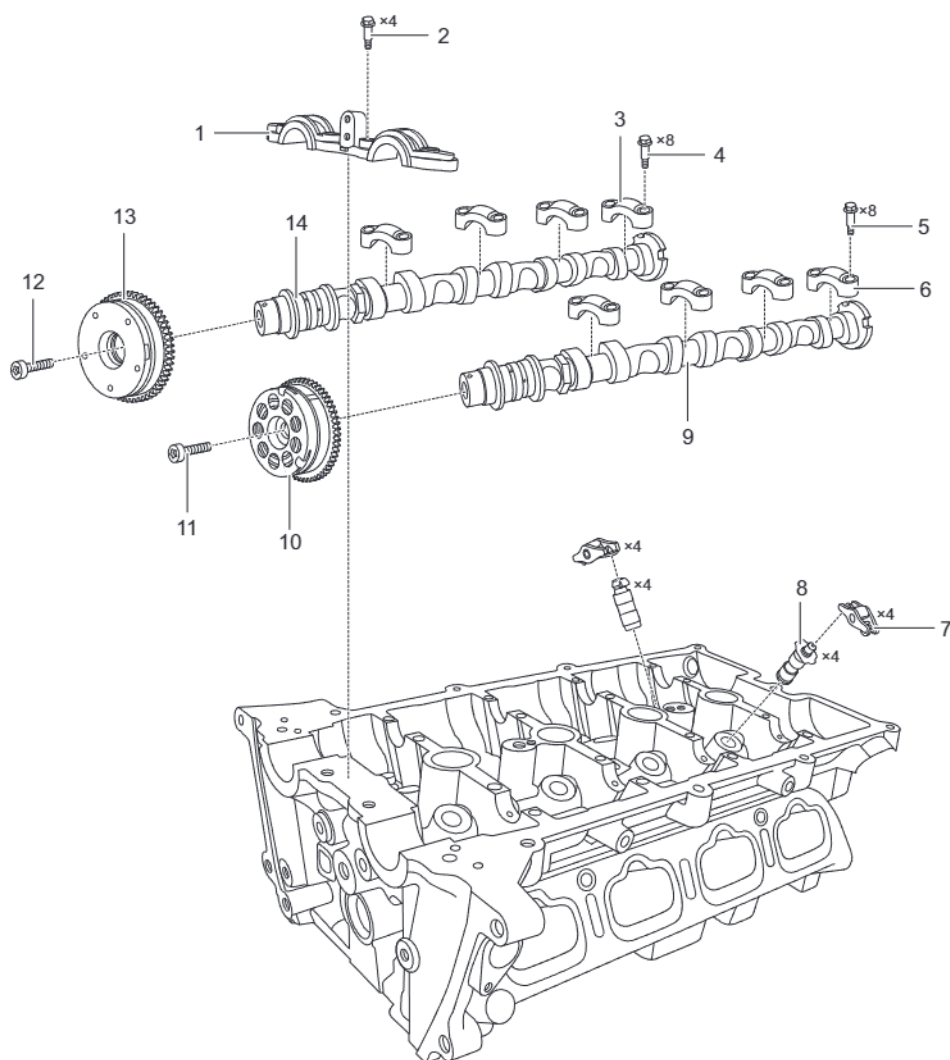
- b. Install and tighten the engine timing chain cover fixing bolts (arrow).
(Tightening torque for inner hexagon bolts: 20 - 25 N·m;
Tightening torque for hexagon flange bolt: 40 - 45 N·m)
- c. Install and tighten 4 coupling bolts (1) between engine timing chain cover and oil pan.
(Tightening torque: 20 + 5 N·m)



13. Other installation procedures are in the reverse order of removal.

Camshaft & Rocker Arm

Description



RM16070360

1 - Camshaft 1st Bearing Cap	2 - Camshaft 1st Bearing Cap Fixing Bolt
3 - Exhaust Camshaft Bearing Cap	4 - Exhaust Camshaft Bearing Cap Fixing Bolt
5 - Intake Camshaft Bearing Cap Fixing Bolt	6 - Intake Camshaft Bearing Cap
7 - Rocker Arm	8 - Hydraulic Lifter
9 - Exhaust Camshaft	10 - Intake Camshaft Phaser Assembly
11 - Intake Camshaft Phaser assembly Fixing Bolt	12 - Exhaust Camshaft Phaser assembly Fixing Bolt
13 - Exhaust Camshaft Phaser Assembly	14 - Exhaust Camshaft

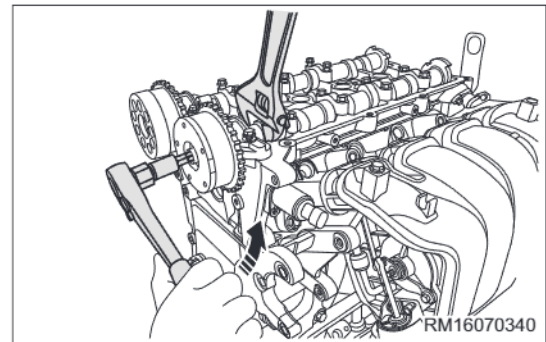
Removal

CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.
- Blow dirt and debris away from upper surface of cylinder head cover with compressed air.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Remove the ignition coils and high-voltage cables (See page 14-8).
5. Remove the cylinder head cover.
6. Remove the engine lower protector assembly (See page 49-22).
7. Remove the accessory drive belt (See page 07-21).
8. Remove the accessory drive belt tensioner assembly (See page 07-23).
9. Remove the idler pulley assembly (See page 07-26).
10. Remove alternator and alternator bracket (w/ electronic power steering) (See page 16-12).
11. Remove the engine timing chain (See page 07-38).
12. Remove the camshaft phaser assembly.

- a. While holding the hexagon surface on intake camshaft with an appropriate wrench, loosen the fixing bolt of intake camshaft phaser assembly in direction of arrow as shown in illustration, and remove the intake camshaft phaser assembly.
(Tightening torque: $105 + 5 \text{ N}\cdot\text{m}$)



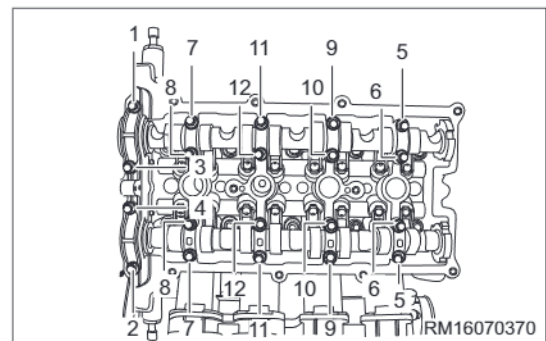
- b. Remove the exhaust camshaft phaser assembly in the same way as the intake camshaft phaser assembly.
(Tightening torque: $105 + 5 \text{ N}\cdot\text{m}$)

13. Remove the camshaft.

- a. Remove the intake/exhaust camshaft bearing cap fixing bolts in order shown in illustration.

HINT:

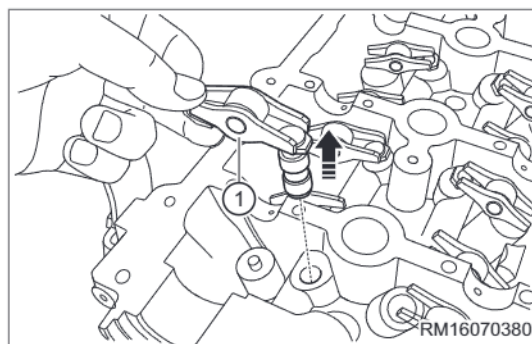
During removal, loosen fixing bolts in steps in order shown in illustration.



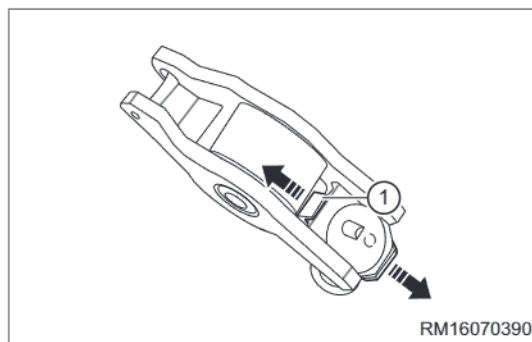
- b. Place the removed camshaft bearing caps in order.
- c. Remove the intake camshaft and exhaust camshaft.

14. Remove the rocker arm and hydraulic lifter.

- a. Remove the rocker arm with hydraulic lifter assembly (1) in direction of arrow as shown in illustration.



- b. Remove the snap spring (1) in direction of arrow as shown in illustration, and separate the rocker arm and hydraulic lifter.



07

Inspection

1. Check the camshaft.

- a. Check the appearance.

- Check if there are scratches on camshaft bearings and cam surfaces. If there are scratches, repair or replace the camshaft.
- Check if there are leaking holes and cracks in camshaft bearing caps. If there are leaking holes or cracks, replace the camshaft.

- b. Check the camshaft journal diameter.

Measure camshaft journal diameter with an outer diameter micrometer.

Measurement Item	Specification (mm)
Intake Camshaft Journal	$\phi 24_{-0.053}^{-0.040}$
Exhaust Camshaft Journal	$\phi 24_{-0.053}^{-0.040}$

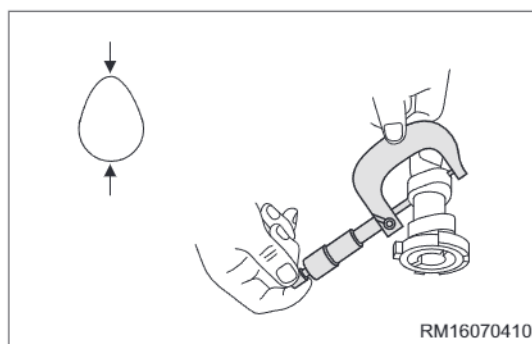
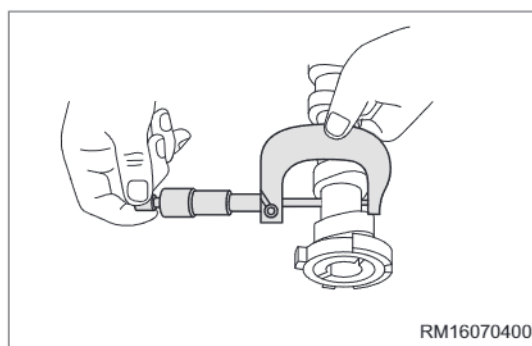
If camshaft journal diameter is not within specified range, replace the camshaft.

- c. Check the cam height.

Measure cam height with an outer diameter micrometer as shown in illustration.

Measurement Item	Specification (mm)
Intake Cam Height	37.18
Exhaust Cam Height	37.05

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

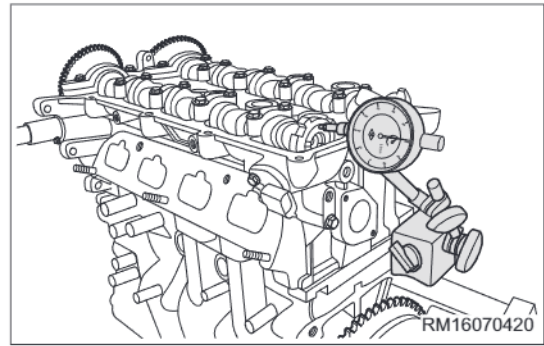


d. Check the camshaft axial clearance.

Reinstall the camshaft.

Keep plunger of dial indicator in contact with front end of camshaft. Turn dial of dial indicator to reset it to zero.

Push camshaft forward and backward gently (do not rotate camshaft) and read value from dial indicator.



Measurement Item	Specification (mm)
Intake Camshaft Axial Clearance	0.15 - 0.20
Exhaust Camshaft Axial Clearance	0.15 - 0.20

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

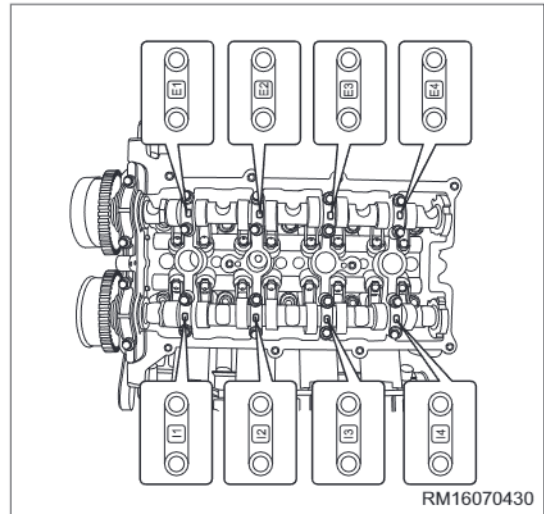
Installation

07

CAUTION

- Adjust 4 pistons to same level and adjust timing before installing camshaft.
- Install exhaust camshaft phaser assembly to exhaust camshaft, screw in bolts by hand, and check if exhaust camshaft phaser assembly can rotate smoothly around the bolt. Otherwise, remove and check exhaust camshaft phaser assembly and bolt. Install intake camshaft phaser assembly in the same way. Tighten bolts on intake side, then tighten bolts on exhaust side.

- Clean the intake, exhaust camshafts and camshaft bearing caps.
- Apply engine oil to the outer surface of camshaft cam and journal. Also add engine oil into cylinder head camshaft bearing holes.
- Install the intake camshaft, exhaust camshaft, and intake and exhaust camshaft bearing caps.



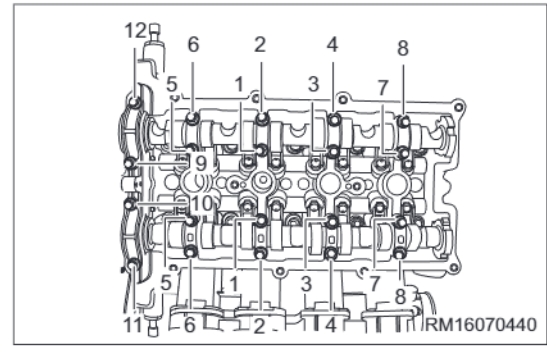
CAUTION

- Install camshaft bearing caps according to the marks on them.

- First screw the camshaft bearing cap fixing bolts by hand without tightening.



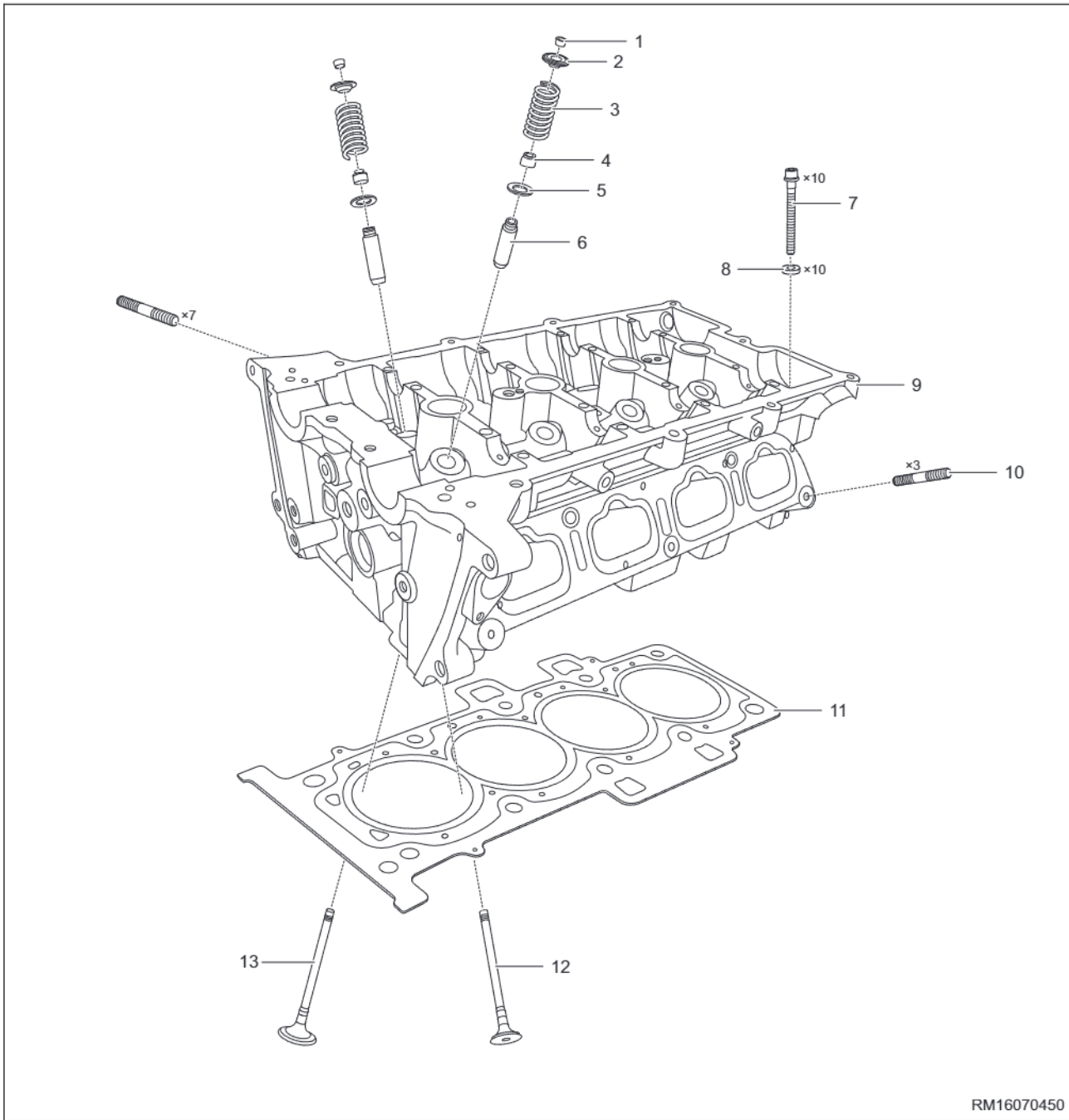
5. Tighten the camshaft bearing cap fixing bolts in order shown in illustration.
(Tightening torque: 9 ± 1.5 N·m)



6. Other installation procedures are in the reverse order of removal.

Cylinder Head

Description



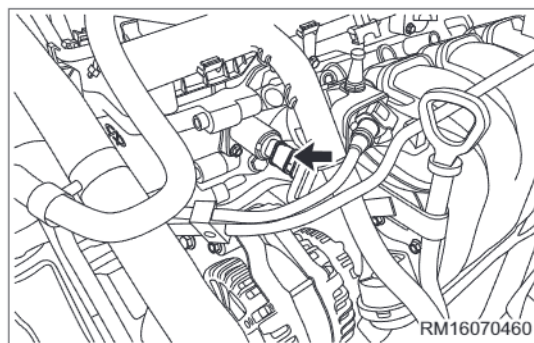
07

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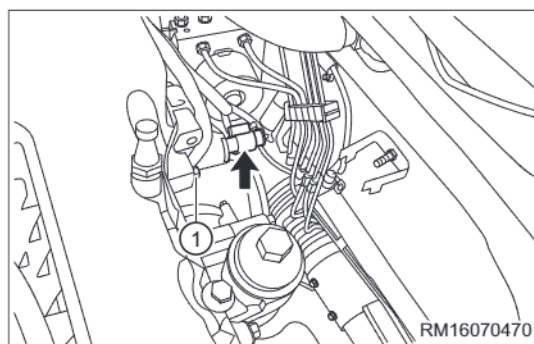
1 - Valve Cotter	2 - Valve Spring Upper Seat
3 - Valve Spring	4 - Valve Oil Seal
5 - Valve Spring Lower Seat	6 - Valve Guide
7 - Cylinder Head Fixing Bolt	8 - Cylinder Head Fixing Bolt Washer
9 - Cylinder Head	10 - Stud
11 - Cylinder Gasket	12 - Exhaust Valve
13 - Intake Valve	

Removal

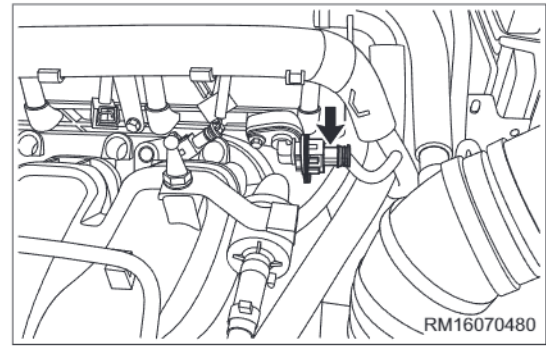
1. Release the fuel system pressure ([See page 08-10](#)).
2. Turn off all electrical equipment and the ignition switch.
3. Disconnect the negative battery cable.
4. Drain the engine oil ([See page 13-12](#)).
5. Drain the coolant ([See page 12-13](#)).
6. Remove the air filter assembly ([See page 10-12](#)).
7. Remove the battery ([See page 16-7](#)).
8. Remove the battery tray ([See page 16-9](#)).
9. Remove the ignition coils and high-voltage cables ([See page 14-8](#)).
10. Remove the spark plugs ([See page 14-11](#)).
11. Remove the fuel rail injector assembly ([See page 08-26](#)).
12. Remove the electronic throttle assembly ([See page 10-14](#)).
13. Remove the intake manifold assembly ([See page 10-20](#)).
14. Remove the thermostat ([See page 12-20](#)).
15. Remove the thermostat seat ([See page 12-22](#)).
16. Remove the exhaust manifold assembly ([See page 11-6](#)).
17. Remove the accessory drive belt ([See page 07-21](#)).
18. Remove the alternator and alternator bracket ([See page 16-12](#)).
19. Disconnect the wire harness connector.
 - a. Disconnect the intake camshaft variable timing control valve connector (arrow).



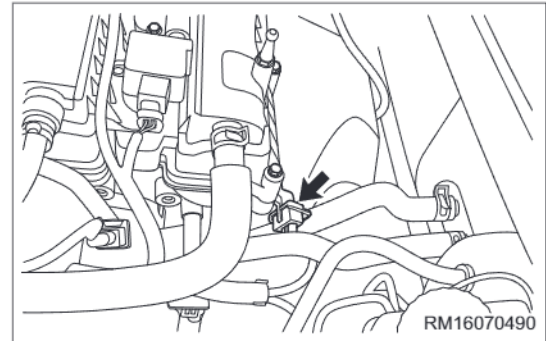
- b. Disconnect the exhaust camshaft variable timing control valve connector (arrow).
- c. Remove the engine wire harness ground wire fixing bolt (1) and move away the engine wire harness ground wire.
(Tightening torque: $7 \pm 1 \text{ N}\cdot\text{m}$)



- d. Disconnect the intake camshaft position sensor connector (arrow).



- e. Disconnect the exhaust camshaft position sensor connector (arrow).



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20. Remove the cylinder head cover (See page 07-30).

21. Use an engine equalizer to hang the engine.

HINT:

Use an engine equalizer to hang the engine while supporting engine oil pan with a transmission carrier. Avoid engine from leaning to right side.

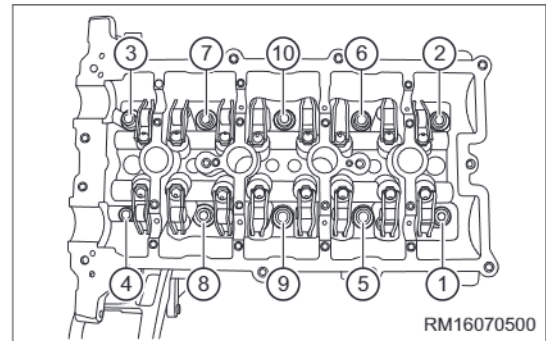
22. Remove the engine timing chain (See page 07-38).

23. Remove the camshaft and rocker arm (See page 07-46).

24. Remove the engine equalizer.

25. Remove the cylinder head.

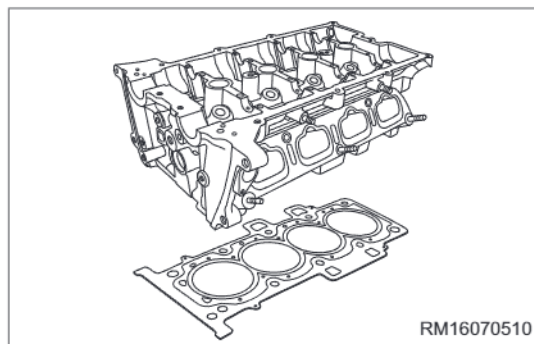
- a. Remove 10 cylinder head fixing bolts in order shown in illustration.



CAUTION

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

- b. Remove the cylinder head and cylinder head gasket.



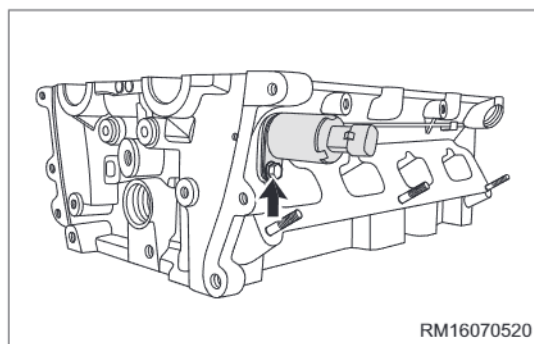
CAUTION

- Removed cylinder gasket cannot be reused. Replace it with a new one.

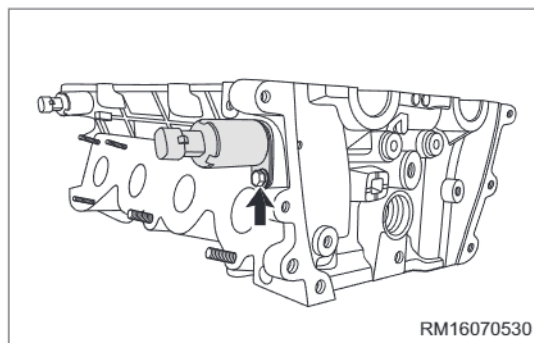
07

Disassembly

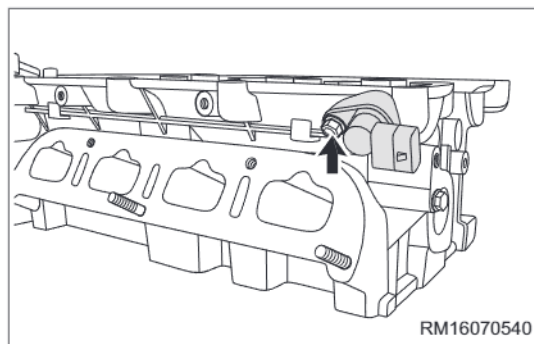
1. Remove the intake camshaft variable timing control valve fixing bolt (arrow), and remove the intake camshaft variable timing control valve.
(Tightening torque: 8 ± 2 N·m)



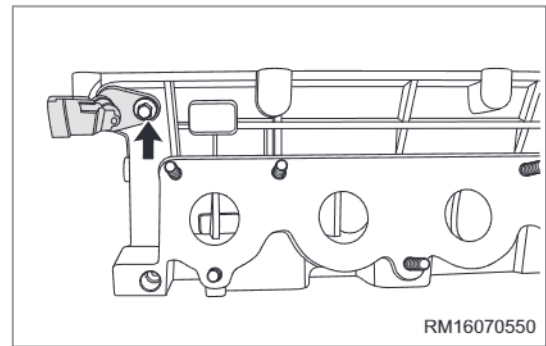
2. Remove the exhaust camshaft variable timing control valve fixing bolt (arrow), and remove the exhaust camshaft variable timing control valve.
(Tightening torque: 8 ± 2 N·m)



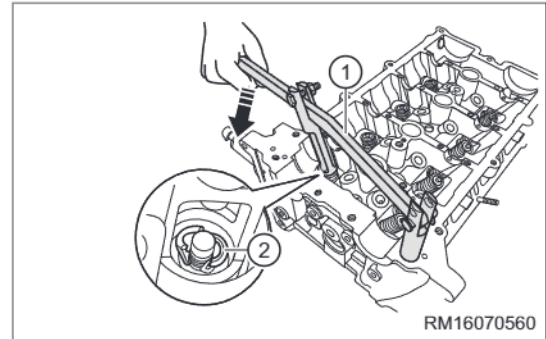
3. Remove the intake camshaft position sensor fixing bolt (arrow), and remove the intake camshaft position sensor.
(Tightening torque: 8 ± 1 N·m)



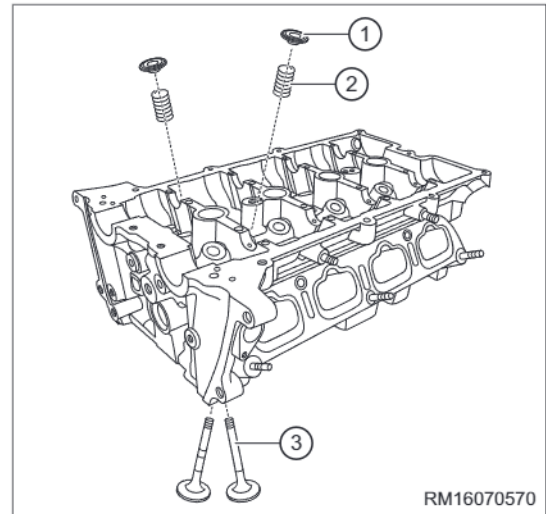
4. Remove the exhaust camshaft position sensor fixing bolt (arrow), and remove the exhaust camshaft position sensor.
(Tightening torque: $8 \pm 1 \text{ N}\cdot\text{m}$)



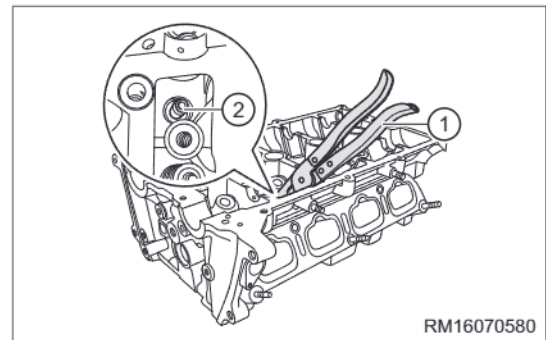
5. Using a special tool (valve spring compressor) (1), compress the valve spring and remove the valve cotter (2) with a flexional magnetic rod.



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



7. Using a valve oil seal remover (1), remove the valve oil seal (2).



8. 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 camshaft bearing journals.
- Remove carbon deposits and varnish inside valve guides with valve guide cleaner.
- Make sure valve cotteners can move and rotate freely.

b. Check the cylinder head flatness.

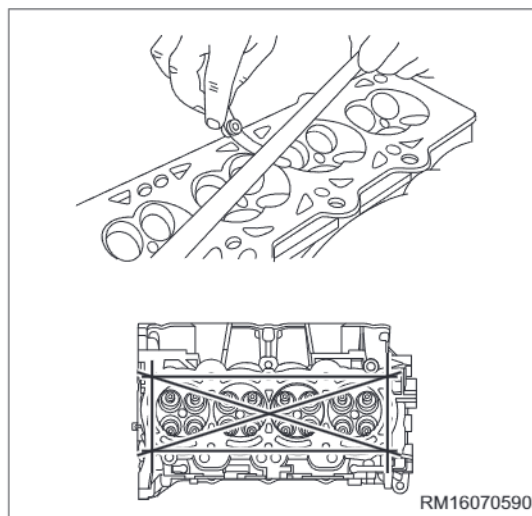
Using a precision straightedge and feeler gauge, check cylinder head flatness. Cylinder head flatness must be within 0.04 mm.

Measurement Item	Specification (mm)
Cylinder Head Flatness	0.04

If cylinder head flatness exceeds standard value, adjust it. If cylinder head flatness exceeds the limit, replace the cylinder head.

Maximum allowable wear thickness of engine head is 0.15 mm.

Maximum allowable wear thickness of engine block and cylinder head is 0.20 mm.



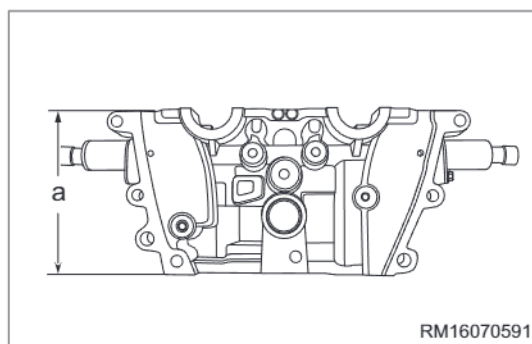
RM16070590

c. Check the cylinder head height.

Using a precision straightedge, measure cylinder head height.

Measurement Item	Specification (mm)
Cylinder Head Height	139.40 ± 0.41

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



RM16070591

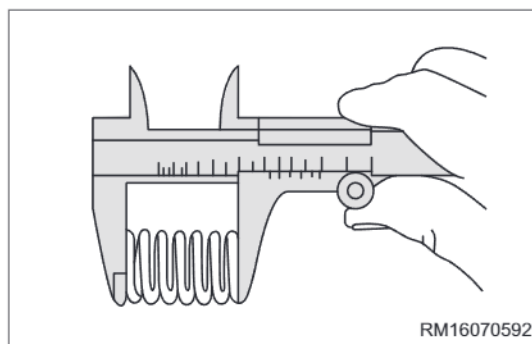
CAUTION

- During replacement, cylinder head should be fully equipped with valves, oil seals, springs, seats, cotteners, hydraulic lifters and crankshaft.

2. Check the valve spring.

- #### a. Using a vernier caliper, measure free length of valve spring and length of valve spring under the operation pre-pressure of 585 ± 25 N.

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



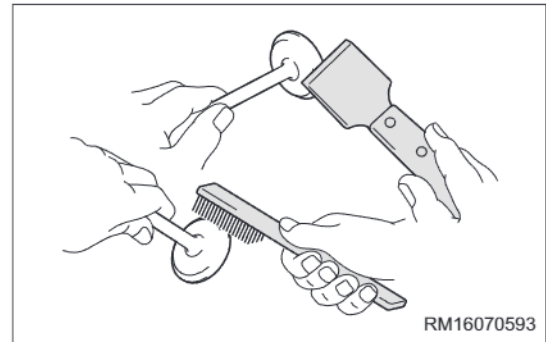
RM16070592

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

3. Check the valve.

a. Clean the valve.

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

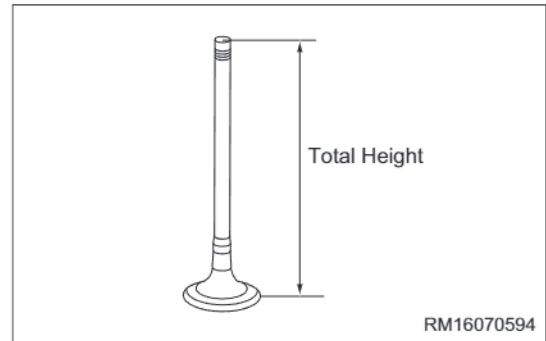


b. Check the valve height.

Using a vernier caliper, measure the valve height.

Measurement Item	Specification (mm)
Intake Valve Height	107.998
Exhaust Valve Height	106.318

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



c. Check the valve head.

- Measure valve head thickness "a" and record.
- Check if contacting area of valve face is even and if valve face is located at the center of valve inclined plane, and measure valve face width "b".

Measurement Item	Specification (mm)
Intake Valve Head Thickness	0.3 ± 0.15
Exhaust Valve Head Thickness	0.3 ± 0.15
Intake Valve Valve Face Width	1.158
Exhaust Valve Valve Face Width	1.306

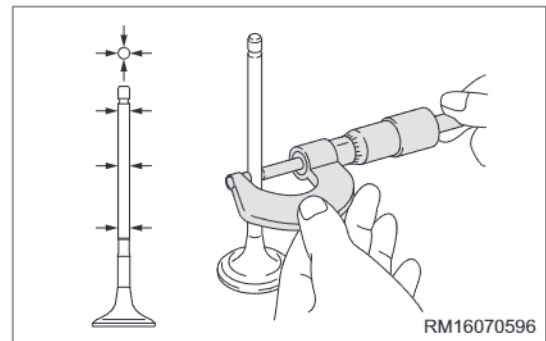
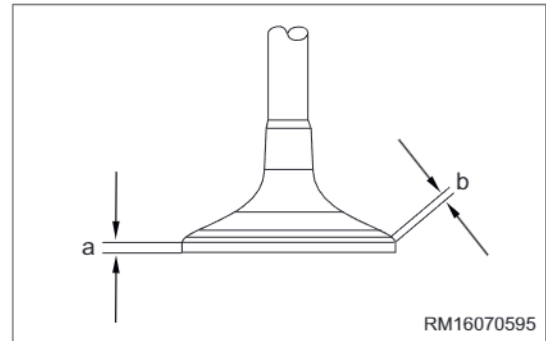
If not within specified range, replace the valve.

d. Check the valve stem diameter.

Using a micrometer, measure the valve stem diameter.

Measurement Item	Specification (mm)
Intake Valve Stem Diameter	$\phi 5.98 \pm 0.008$
Exhaust Valve Stem Diameter	$\phi 5.96 \pm 0.008$

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



- e. Check clearance between valve and valve guide.

Using a caliper gauge, measure inner diameter of valve guide.

Measurement Item	Specification (mm)
Valve Guide Inner Diameter	$\phi 6.0 + 0.015$

Clearance between valve and valve guide = Valve guide inner diameter - Valve stem diameter

Measurement Item	Specification (mm)
Clearance Between Intake Valve and Guide	0.02
Clearance Between Exhaust Valve and Guide	0.04

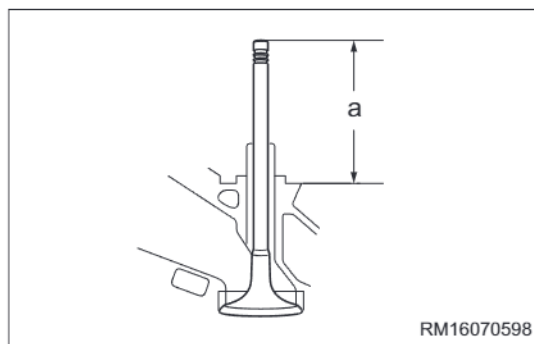
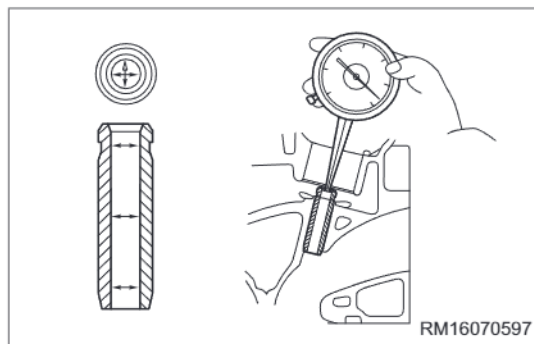
If clearance is not within specified range, replace valve or valve guide.

4. Check valve stem protrusion amount.

- a. Using a vernier caliper, measure distance "a" (valve stem protrusion amount) between valve stem end surface and valve spring seat end surface.

Measurement Item	Specification (mm)
Intake Valve Stem Protrusion	47.5
Exhaust Valve Stem Protrusion	47.5

If valve stem protrusion is not within specified range, replace the valve.



Assembly

CAUTION

- Soak new valve oil seal in oil for several minutes before installation.
- Check if valve spring lower seat is installed properly before installing valve spring.
- Variable pitch valve spring is used, which must be installed with the painted side facing the valve spring lower seat.

HINT:

Clean all components to be assembled thoroughly before assembly.

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

HINT:

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

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

HINT:

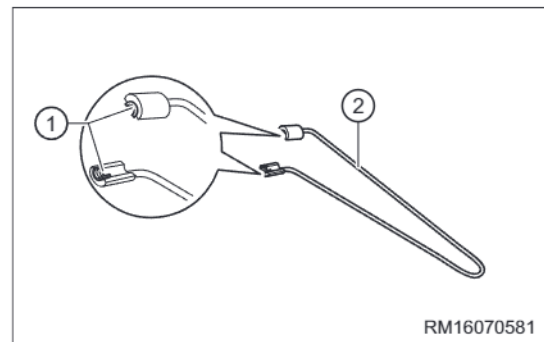
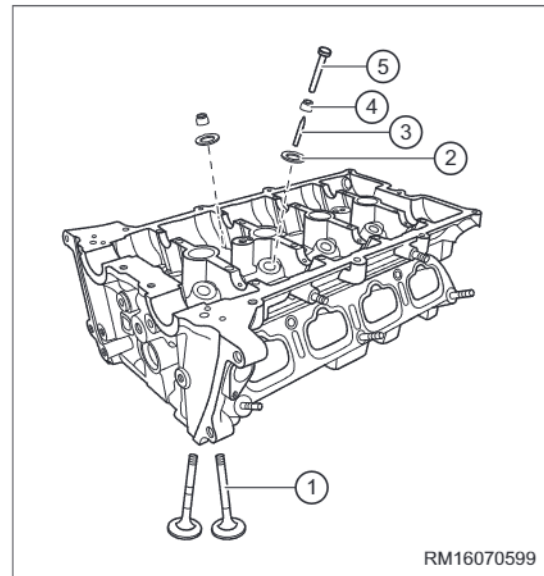
Bottom of valve spring lower seat should face cylinder head.

3. Install the valve oil seal.

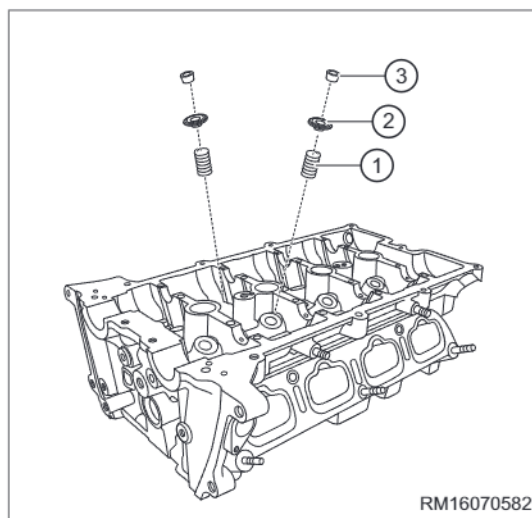
HINT:

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

- a. Install the valve oil seal guide sleeve (3) to the valve stem.
 - 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).



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.



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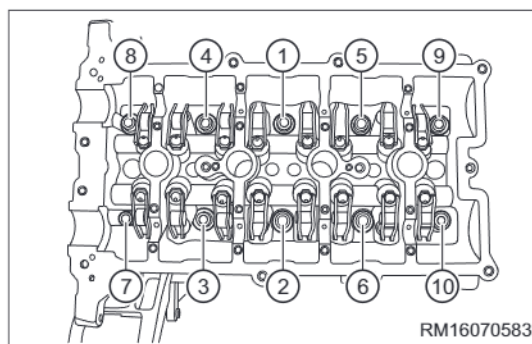
7. Tap the valve cotter lightly with a rubber hammer to make sure the cotter is installed in place after assembly.

Installation

CAUTION

- Remove residual seal gum and oil on cylinder head and cylinder block.
- Replace cylinder head gasket.
- Check that 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 cylinder gasket to flat surface of cylinder block with a dowel pin.
- Clean joint surfaces between cylinder head and combustion chamber, together with 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, piston should not be located at the top dead center, in order to prevent it from being impacted by opening valve, when installing the rocker arm.
- Install the cylinder head bolt washer with chamfering surface facing upward and flat side facing cylinder head.

1. Make sure to tighten the cylinder head fixing bolts in sequence from (1) to (10) shown in 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 bolts to 40 ± 5 N·m in sequence from (1) to (10) shown in illustration.
 - 2nd step: Rotate bolts clockwise by $90^\circ \pm 5^\circ$ in tightening sequence.
 - 3rd step: Rotate bolts by $90^\circ \pm 5^\circ$ in tightening sequence.



 CAUTION

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

2. Other installation procedures are in the reverse order of removal.

Engine Mounting Assembly

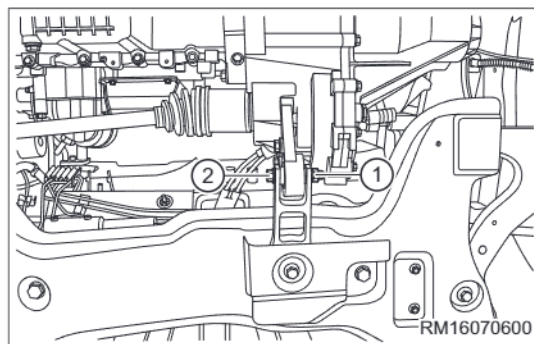
Removal & Installation - Rear Mounting Assembly

CAUTION

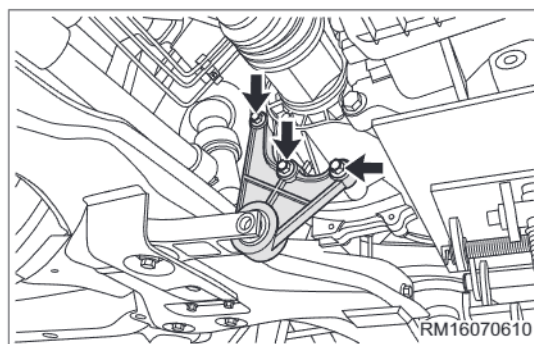
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Support the transmission with a transmission carrier.
4. Remove the engine rear mounting assembly.

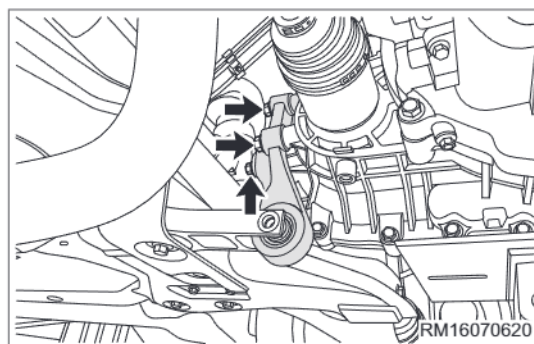
- a. Remove the locking nut (1) between rear mounting upper body assembly and rear mounting lower body assembly, and then remove the through bolt (2).
(Tightening torque: 80 ± 5 N·m)



- b. Remove 3 rear mounting upper body assembly fixing bolts (arrow) from transmission case (for MT model).
(Tightening torque: 45 ± 5 N·m)

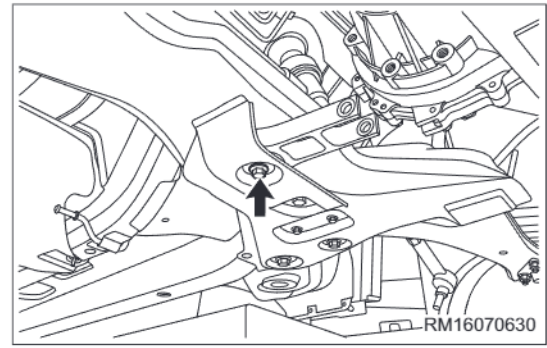


- c. Remove 3 rear mounting upper body assembly fixing bolts (arrow) from transmission case (for CVT model).
(Tightening torque: 45 ± 5 N·m)



- d. Remove the engine rear mounting upper body assembly.

- e. Remove the coupling bolt (arrow) between rear mounting lower body assembly and front sub frame welding assembly.
(Tightening torque: $105 \pm 1.5 \text{ N}\cdot\text{m}$)



- f. Remove the engine rear mounting lower body assembly from front sub frame welding assembly.
5. Installation is in the reverse order of removal.

Removal & Installation - Left Mounting Assembly

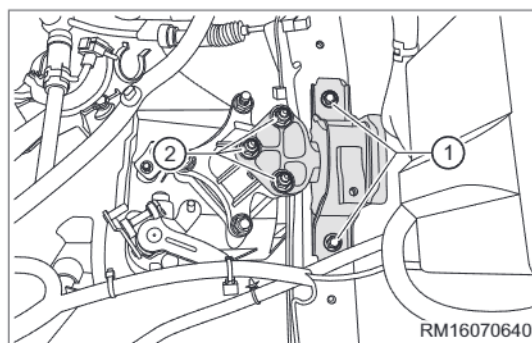
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

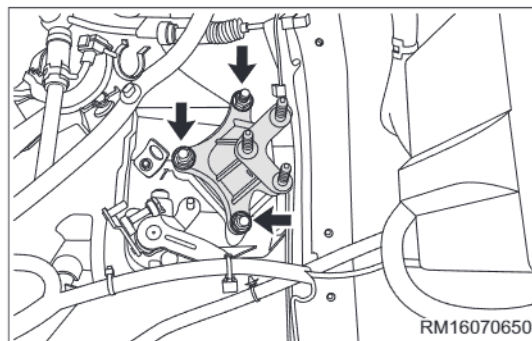
1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Use an engine equalizer to hang the engine.
4. Remove the air filter assembly (See page 10-12).
5. Remove the battery (See page 16-7).
6. Remove the battery tray (See page 16-9).
7. Remove the engine left mounting cushion assembly (for MT model).

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- a. Remove 3 coupling nuts (2) between left mounting cushion assembly and left mounting bracket.
(Tightening torque: $60 \pm 5 \text{ N}\cdot\text{m}$)
- b. Remove 2 coupling bolts (1) between left mounting cushion assembly and body.
(Tightening torque: $60 \pm 5 \text{ N}\cdot\text{m}$)



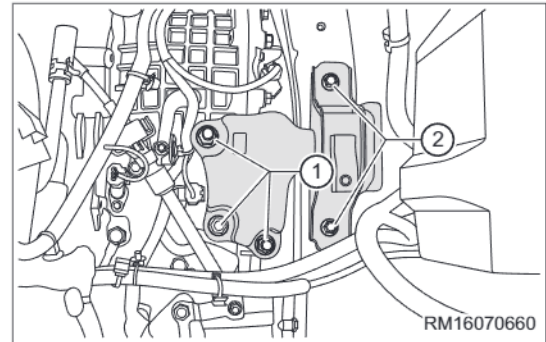
- c. Remove the left mounting cushion assembly.
8. Remove the engine left mounting bracket (for MT model).
 - a. Remove 3 coupling nuts (arrow) between left mounting bracket and transmission case.
(Tightening torque: $80 \pm 5 \text{ N}\cdot\text{m}$)



- b. Remove the left mounting bracket.

9. Remove the engine left mounting assembly (for CVT model).

- a. Remove 3 coupling nuts (1) between left mounting arm and transmission case.
(Tightening torque: 80 ± 5 N·m)
- b. Remove 2 coupling bolts (2) between left mounting cushion assembly and body.
(Tightening torque: 60 ± 5 N·m)



- c. Remove the engine left mounting assembly.

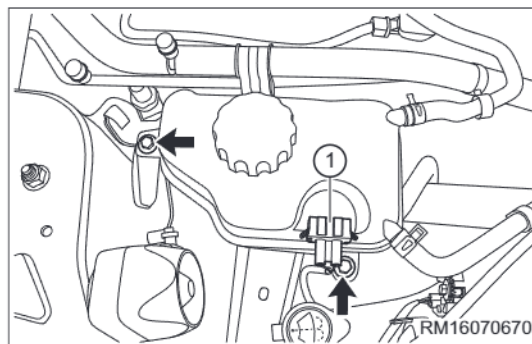
10. Installation is in the reverse order of removal.

Removal & Installation - Right Mounting Assembly

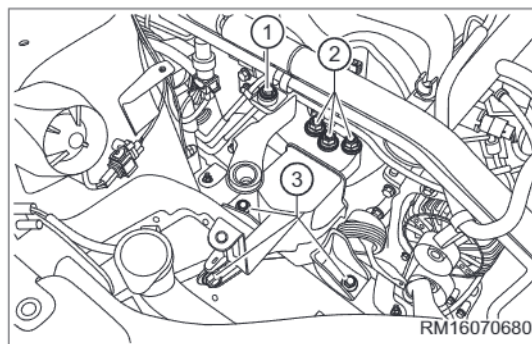
CAUTION

- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all electrical equipment and the ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover.
4. Use an engine equalizer to hang the engine.
5. Remove the engine right mounting assembly.
 - a. Disconnect the coolant level sensor connector (1).
 - b. Remove 2 fixing bolts (arrow) from expansion tank and move the expansion tank to one side.
(Tightening torque: $7 \pm 1 \text{ N}\cdot\text{m}$)



- c. Move the coolant level sensor wire harness away from engine right mounting assembly.
- d. Remove the coupling bolt (1) between line bracket and engine right mounting assembly.
(Tightening torque: $7 \pm 1 \text{ N}\cdot\text{m}$)
- e. Remove 3 coupling nuts (2) between engine right mounting assembly and engine timing chain cover.
(Tightening torque: $70 \pm 5 \text{ N}\cdot\text{m}$)
- f. Remove 3 coupling bolts (3) between engine right mounting assembly and body.
(Tightening torque: $60 \pm 5 \text{ N}\cdot\text{m}$)



- g. Remove the engine right mounting assembly.
6. Installation is in the reverse order of removal.

ENGINE UNIT REPAIR

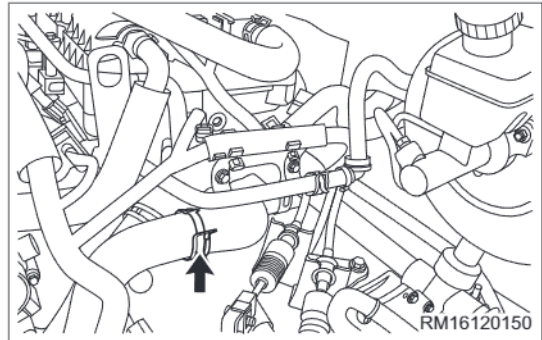
Engine Assembly

Removal

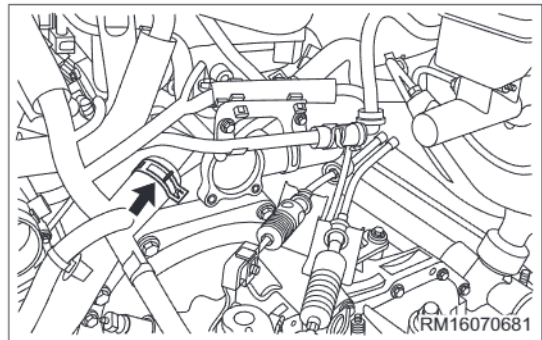
CAUTION

- Remove engine and transmission as an assembly.
- Install protector to prevent body from being scratched.

1. Remove the engine trim cover.
2. Release the fuel system pressure ([See page 08-10](#)).
3. Turn off all electrical equipment and the ignition switch.
4. Disconnect the negative battery cable.
5. Drain the engine oil ([See page 13-12](#)).
6. Drain the transmission oil ([See page 17-20](#) for MT model, [See page 18-120](#) for CVT model).
7. Drain the coolant ([See page 12-13](#)).
8. Drain the steering fluid (w/ hydraulic assist steering) ([See page 29-7](#)).
9. Recover the refrigerant ([See page 31-77](#)).
10. Remove the engine lower protector assembly ([See page 49-22](#)).
11. Remove the air filter assembly ([See page 10-12](#)).
12. Remove the battery ([See page 16-7](#)).
13. Remove the battery tray ([See page 16-9](#)).
14. Move away the engine inlet hose and outlet hose.
 - a. Loosen the elastic clamp (arrow) and disconnect the connection between engine inlet hose and thermostat cover.

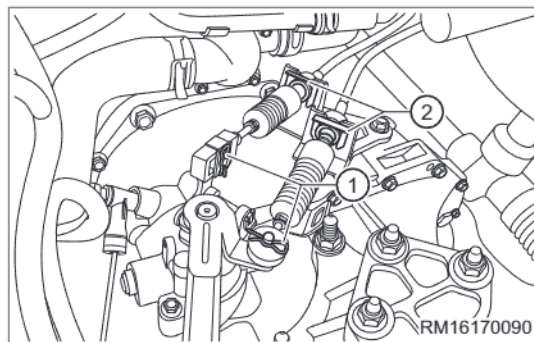


- b. Loosen the elastic clamp (arrow) and disconnect the connection between engine inlet hose and thermostat seat.



15. Move away the gear select and shift cable (for MT model).

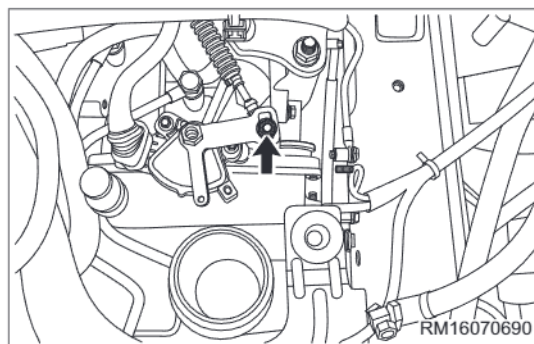
- a. Remove the cotter pins (1) connecting gear select and shift cable and the transmission gear shift mechanism.
- b. Remove the flexible shaft clamps (2) from gear select and shift cable.



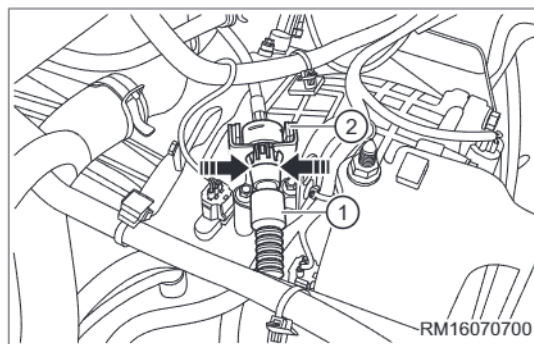
- c. Move away the gear select and shift cable from flexible shaft bracket.

16. Move away the gear shift cable (for CVT model).

- a. Remove the coupling nut (arrow) between gear shift cable and gear shift arm, and disconnect the gear shift cable from gear shift arm.
(Tightening torque: 16 - 20 N·m)

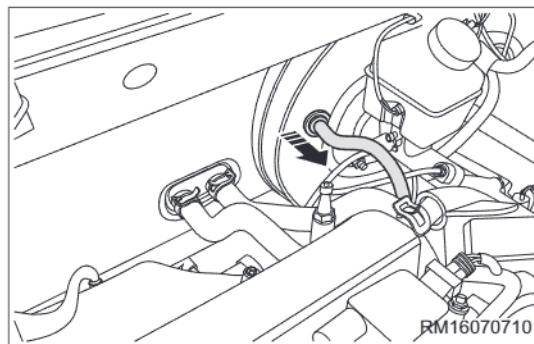


- b. Push 2 positioning claws on gear shift cable (1) in direction of arrow as shown in illustration, and detach the gear shift cable from transmission gear shift cable bracket (2).



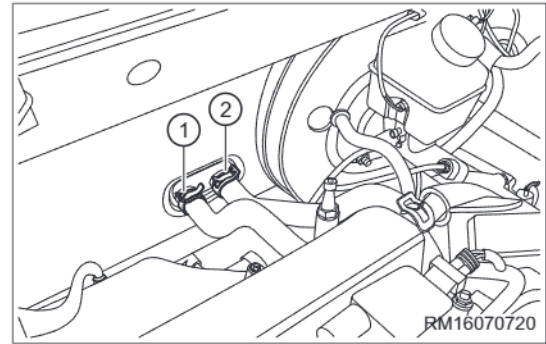
17. Disconnect the connection between vacuum pipe and vacuum booster.

- a. Move the vacuum pipe away from vacuum booster in direction of arrow as shown in illustration.



18. Disconnect the connection between hose and heater core.

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

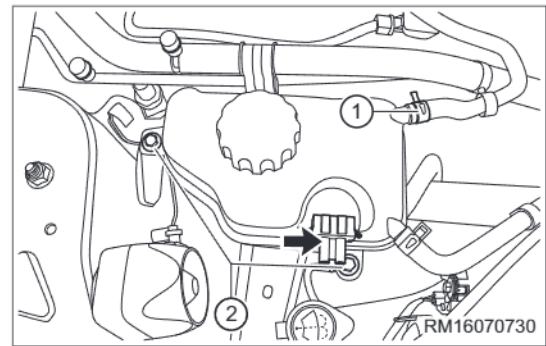


19. Remove the main catalytic converter assembly (See page 11-9).

20. Remove the exhaust manifold assembly (See page 11-6).

21. Remove the expansion tank.

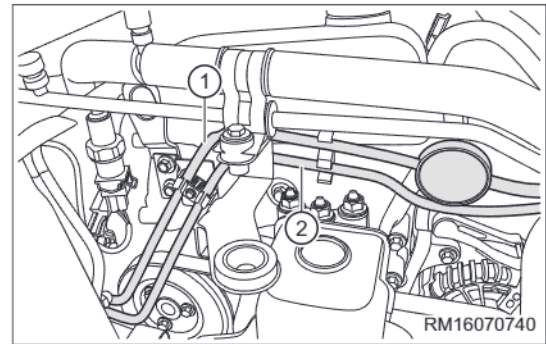
- a. Disconnect the expansion tank level sensor (arrow).
- b. Loosen the elastic clamp (1) and disconnect the connection between engine gas hose and expansion tank.
- c. Remove 2 fixing bolts (2) from expansion tank.
(Tightening torque: $7 \pm 1 \text{ N}\cdot\text{m}$)



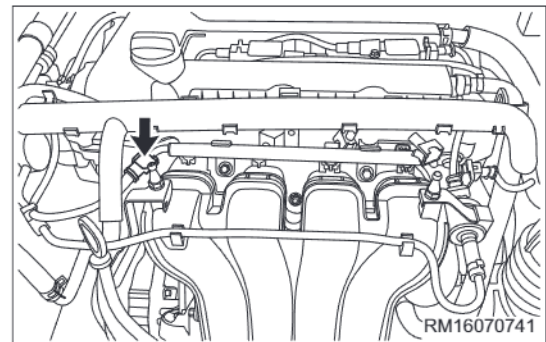
07

- d. Move the expansion tank to one side.

22. Move away the inlet pipe III (1) and canister solenoid valve inlet hose (2) from line bracket.

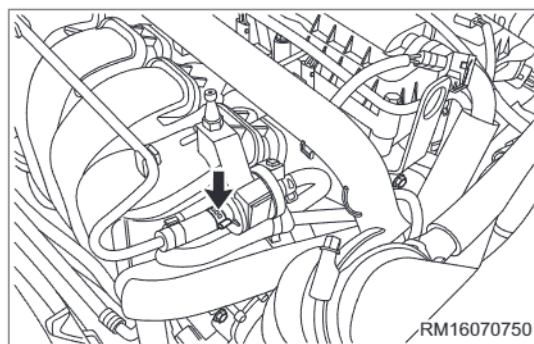


23. Disconnect the coupling joint (arrow) between inlet pipe III and fuel rail injector assembly.



24. Move away the canister solenoid valve inlet hose.

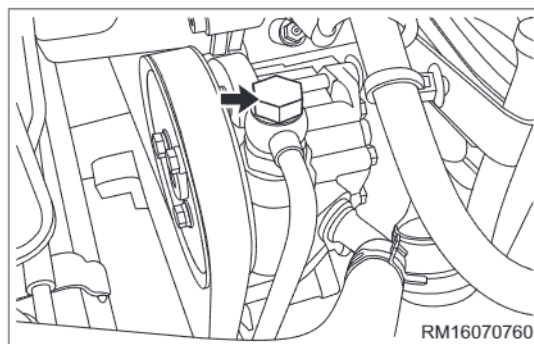
- a. Remove the clamp (arrow) from canister solenoid valve intake hose, and disconnect the connection between hose and canister solenoid valve.



- b. Move away the canister solenoid valve intake hose from intake manifold.

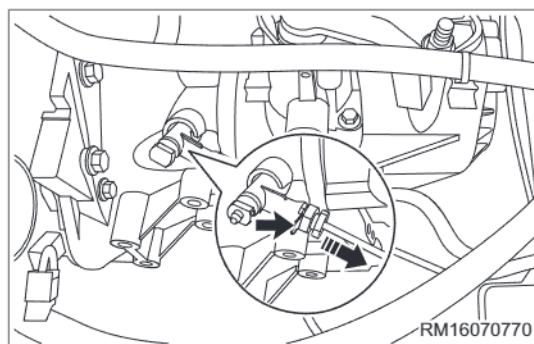
25. Disconnect the steering pump line (w/ hydraulic assist steering).

- a. Remove the high pressure fluid pipe hollow bolt (arrow), and move away the steering pump line from steering pump.
(Tightening torque: 45 ± 5 N·m)



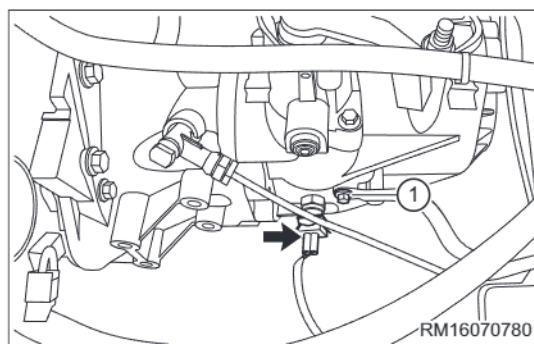
26. Disconnect the clutch pipe.

- a. Disconnect the clutch pipe clip (arrow), and move away the clutch pipe in direction of arrow as shown in illustration.

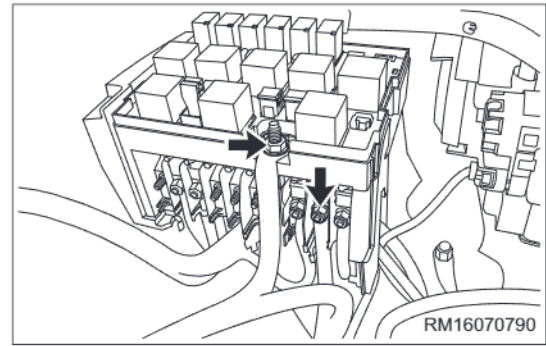


27. Disconnect the following wire harness connectors.

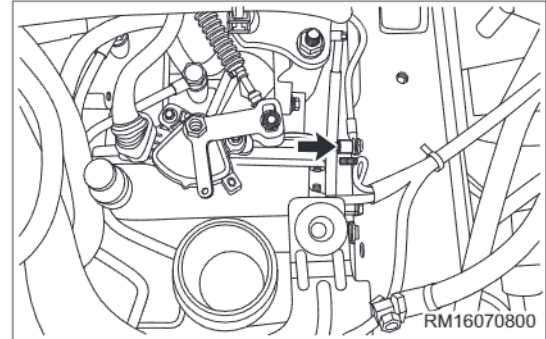
- a. Disconnect the back-up light switch connector (arrow) (for MT model).
- b. Remove the transmission ground wire fixing bolt (1) and move away the transmission ground wire (for MT model).
(Tightening torque: 15 ± 2 N·m)



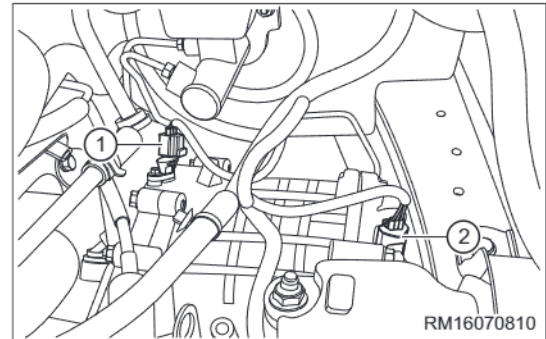
- c. Open the fuse and relay box cover and remove the battery wire harness fixing nut (arrow), then disconnect the connection between battery wire harness and engine compartment fuse and relay box. (Tightening torque: 7 ± 1 N·m)



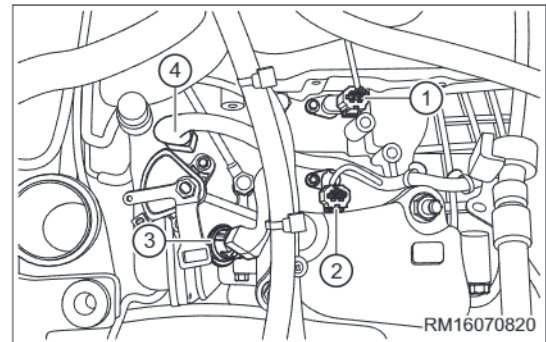
- d. Remove the engine wire harness ground wire fixing nut (arrow) and move away the engine ground wire. (Tightening torque: 15 ± 2 N·m)



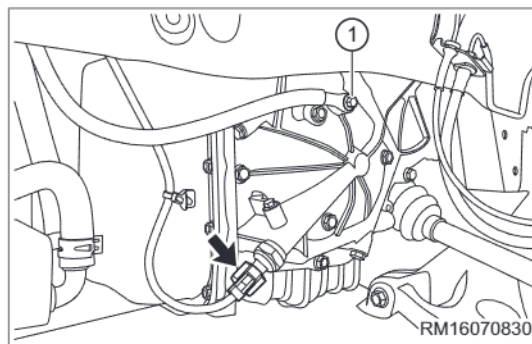
- e. Remove the engine compartment fuse and relay box, and disconnect the engine wire harness connector from engine compartment fuse and relay box.
- f. Disconnect the second shaft speed sensor connector (1) (for CVT model).
- g. Disconnect the second shaft pressure sensor connector (2) (for CVT model).



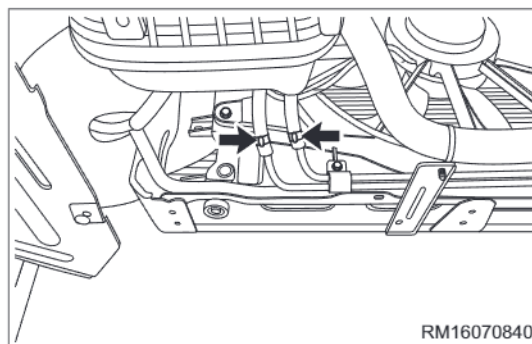
- h. Disconnect the turbo speed sensor connector (1) (for CVT model).
- i. Disconnect the primary shaft speed sensor connector (2) (for CVT model).
- j. Disconnect the transmission connector (3) (for CVT model).
- k. Disconnect the gear switch connector (4) (for CVT model).



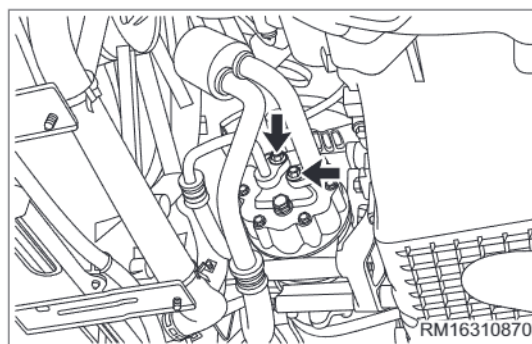
- l. Disconnect the primary shaft pressure sensor connector (arrow) (for CVT model).
- m. Remove the transmission ground wire fixing bolt (1) and move away the transmission ground wire (for CVT model).
(Tightening torque: 15 ± 2 N·m)



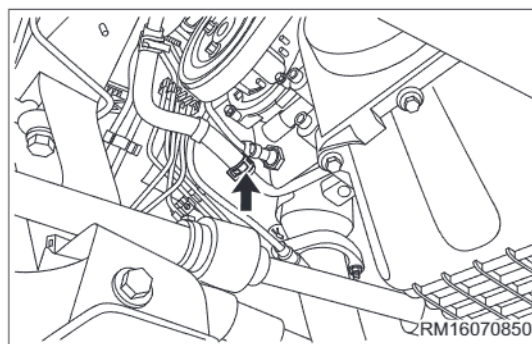
28. Remove the front wheels (See page 24-9).
29. Remove the drive shafts (See page 20-5).
30. Disconnect the transmission oil cooling pipe (for CVT model).
 - a. Remove the tightening clamps (arrow) and disconnect transmission oil cooling pipe.



31. Disconnect the A/C line.
 - a. Remove 2 fixing bolts (arrow) between A/C high/low pressure line and compressor assembly, and disengage the A/C high/low pressure line from compressor assembly.
(Tightening torque: 25 ± 4 N·m)



32. Loosen the elastic clamp (arrow) and disconnect the connection between expansion tank outlet pipe and coolant pipe assembly I.



33. Use an engine equalizer to hang the engine.
34. Remove the engine rear mounting assembly (See page 07-62).
35. Remove the engine equalizer, and use an engine hoist to hang the lifting eyes on both sides of engine.

- 36.Remove the engine left mounting assembly ([See page 07-64](#)).
- 37.Remove the engine right mounting assembly ([See page 07-66](#)).
- 38.Confirm that all engine components are disconnected from engine.
- 39.Hang out the engine with transmission from engine compartment.
- 40.Remove the engine wire harness and battery wire harness from engine.
- 41.Separate the engine and transmission.
- 42.Remove the clutch from engine assembly ([See page 19-13](#)).
- 43.Install the engine on the engine service platform.

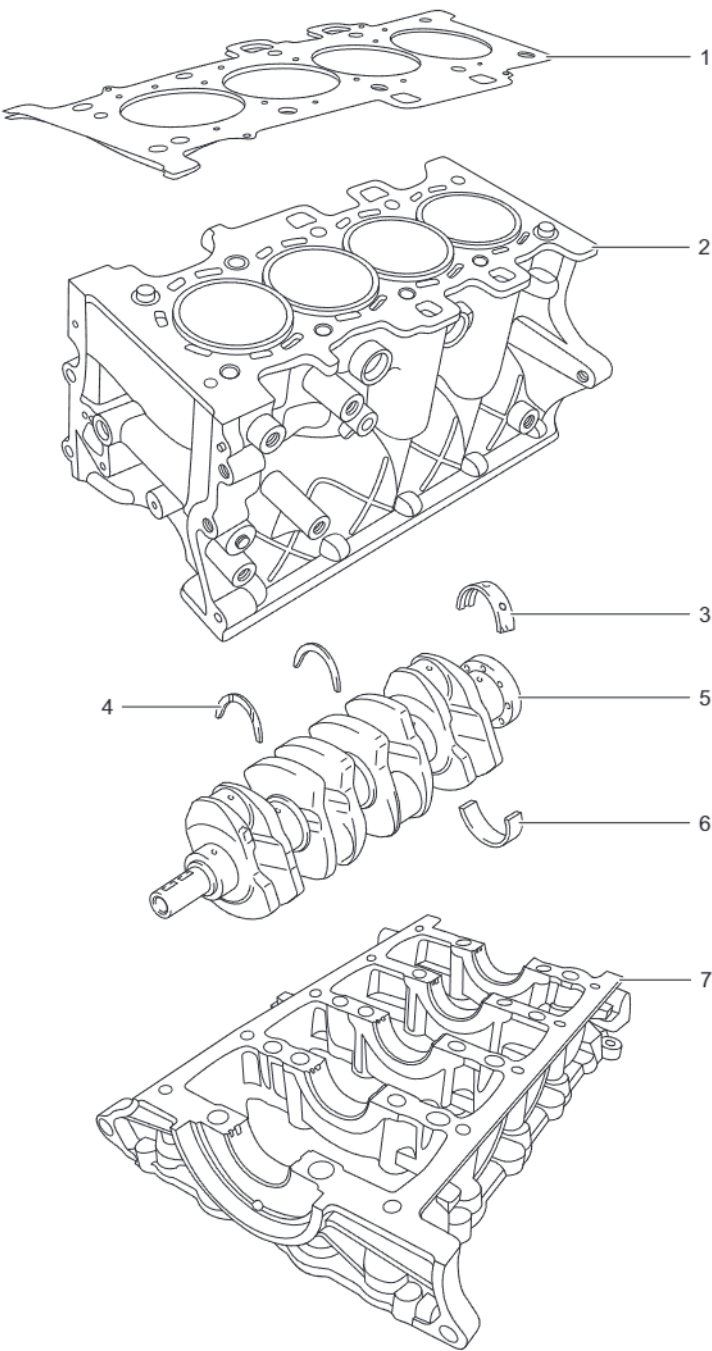
Installation

Installation is in the reverse order of removal.

Engine Block

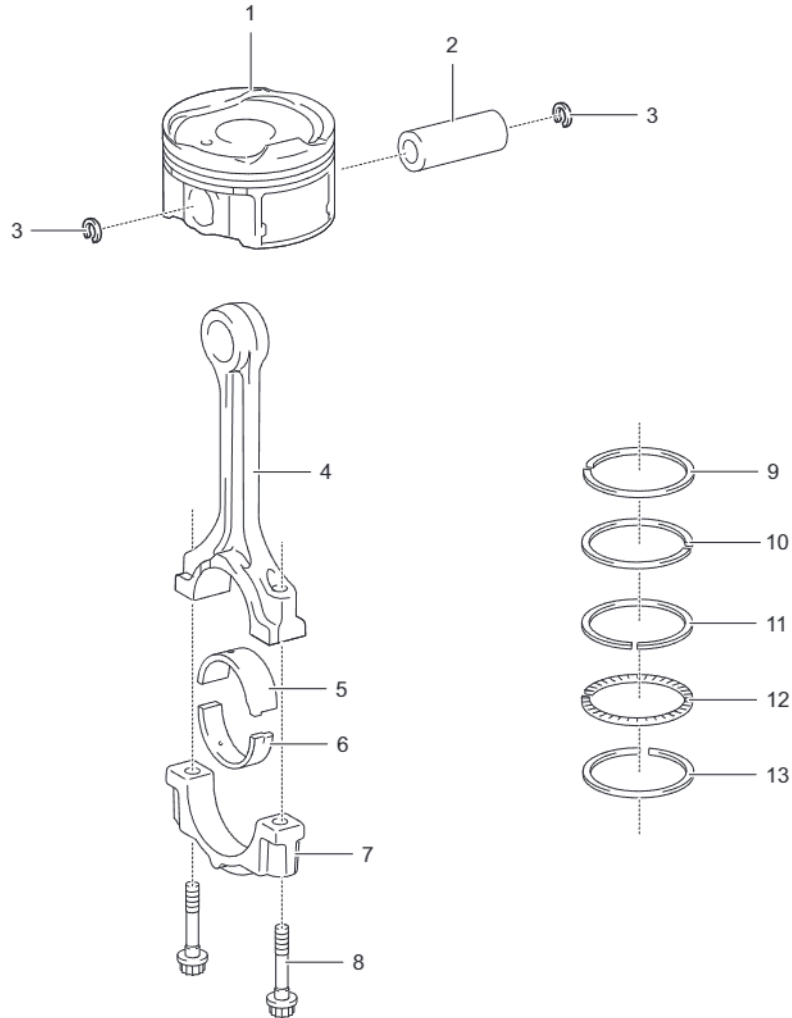
Description

07



RM16070860

1 - Cylinder Head Gasket	2 - Cylinder Block
3 - Crankshaft Main Bearing Upper Shell	4 - Thrust Washer
5 - Crankshaft	6 - Crankshaft Main Bearing Lower Shell
7 - Crankshaft Frame	

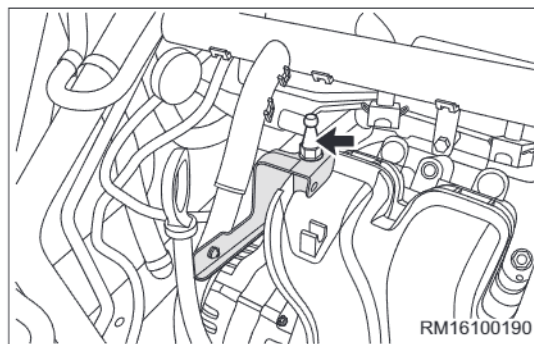


RM16070870

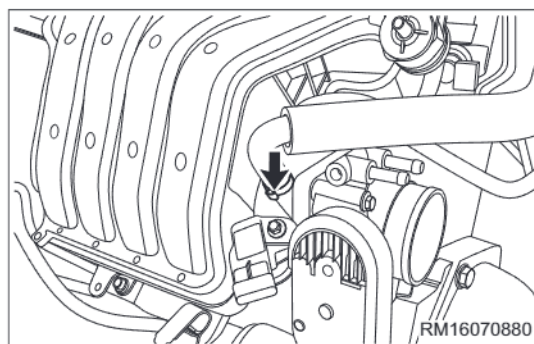
1 - Piston	2 - Piston Pin (Semi-floating)
3 - Piston Pin Snap Ring	4 - Connecting Rod
5 - Connecting Rod Bearing Upper Shell	6 - Connecting Rod Bearing Lower Shell
7 - Connecting Rod Bearing Cap	8 - Connecting Rod Bearing Cap Fixing Bolt
9 - First Compression Ring	10 - Second Compression Ring
11 - Upper Rail	12 - Expander
13 - Lower Rail	

Disassembly

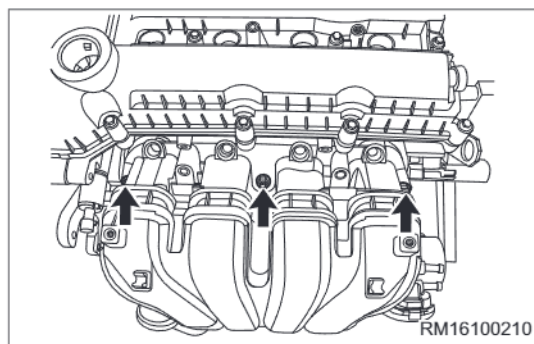
1. Remove the engine assembly and install the engine on the engine service platform (See page 07-67).
2. Remove the accessory drive belt (See page 07-21).
3. Remove the idler pulley assembly (See page 07-26).
4. Remove the accessory drive belt tensioner assembly (See page 07-23).
5. Remove the fuel rail injector assembly (See page 08-26).
6. Remove the thermostat (See page 12-20).
7. Remove the thermostat seat (See page 12-22).
8. Remove the intake manifold assembly (w/ electronic throttle assembly and canister solenoid valve).
 - a. Remove the engine trim cover bracket (arrow) that fixes oil dipstick tube.
(Tightening torque: $8 \pm 1 \text{ N}\cdot\text{m}$)



- b. Remove the fixing clamp (arrow) and disconnect the connection between positive crankcase ventilation valve and intake manifold.



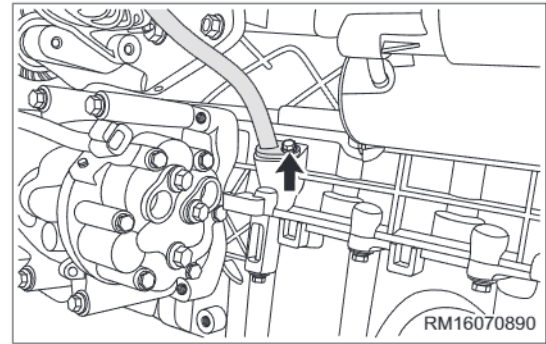
- c. Remove 3 fixing nuts (arrow) from intake manifold assembly.
(Tightening torque: $20 + 5 \text{ N}\cdot\text{m}$)



- d. Remove the intake manifold assembly (w/ electronic throttle assembly and canister solenoid valve).

9. Remove the oil dipstick tube with oil dipstick assembly.

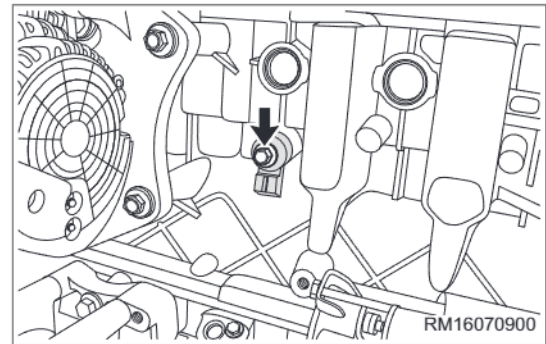
- a. Remove the oil dipstick tube fixing bolt (arrow).
(Tightening torque: 7 ± 1 N·m)



- b. Pull out the oil dipstick tube with oil dipstick assembly from engine.

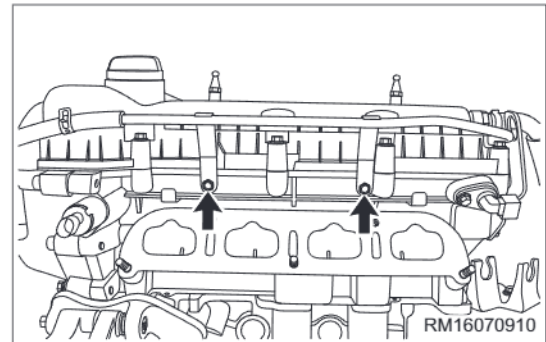
10. Remove the knock sensor.

- a. Remove the knock sensor fixing bolt (arrow) and remove the knock sensor.
(Tightening torque: 20 ± 5 N·m)

11. Remove the power steering pump (w/ power steering pump) ([See page 29-15](#)).12. Remove the alternator and alternator bracket ([See page 16-12](#)).13. Remove the A/C compressor assembly and bracket ([See page 31-114](#)).

14. Remove the engine discharge pipe.

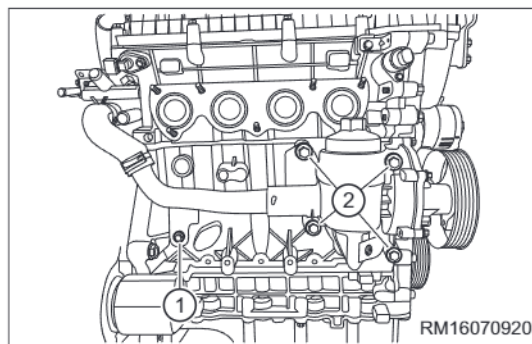
- a. Remove 2 fixing bolts (arrow) from engine discharge pipe.
(Tightening torque: 7 ± 1 N·m)



15. Remove the ignition coils and high-voltage cables (See page 14-8).

16. Remove the oil filter module with water pump assembly.

- a. Remove the coolant pipe assembly I fixing bolt (1).
(Tightening torque: $20 \pm 5 \text{ N}\cdot\text{m}$)
- b. Remove 4 fixing bolts (2) from oil filter module.
(Tightening torque: $40 \pm 5 \text{ N}\cdot\text{m}$)



CAUTION

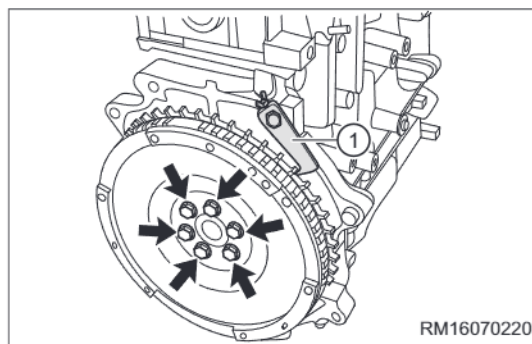
- There will be coolant residue in the engine. If coolant gets on your skin, wash off with water immediately.
- There will be oil residue in the engine. Prolonged and repeated contact with engine oil will be harmful to your skin. If engine oil spills on your skin, wash it off immediately with water. In addition, used engine oil contains potentially harmful contaminants, which may cause skin cancer. Therefore, always take proper skin protection measures when performing vehicle service.

ENVIRONMENTAL PROTECTION

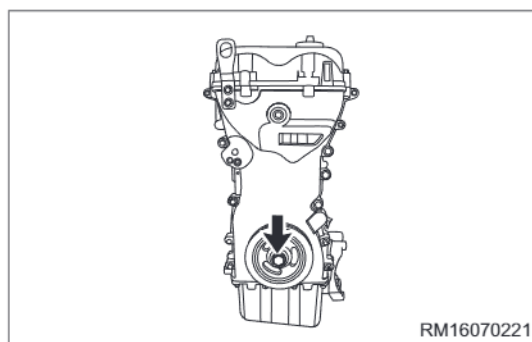
- There will be coolant residue in the engine. Wasted coolant should be handled according to local environmental regulations.

17. Remove the crankshaft pulley.

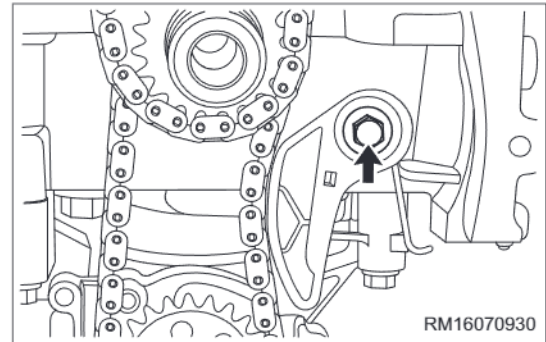
- a. As shown in the illustration, install the flywheel holding tool (1) to hold the flywheel securely.



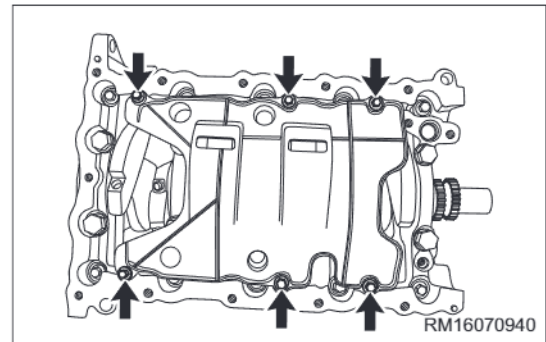
- b. Loosen the crankshaft pulley fixing bolt (arrow).
(Tightening torque: 1st step: tighten to $100 \pm 10 \text{ N}\cdot\text{m}$;
2nd step: retighten by $120^\circ \pm 10^\circ$)



- c. Remove the crankshaft pulley.
- 18. Remove the crankshaft front oil seal (See page 07-32).
- 19. Remove the flywheel assembly (See page 07-34).
- 20. Remove the crankshaft rear oil seal (See page 07-36).
- 21. Remove the cylinder head cover (See page 07-30).
- 22. Remove the oil pan (See page 13-20).
- 23. Remove the engine timing chain (See page 07-38).
- 24. Remove the camshafts (See page 07-46).
- 25. Remove the cylinder head (See page 07-51).
- 26. Remove the oil strainer (See page 13-23).
- 27. Remove the oil pump assembly (See page 13-24).
- 28. Remove the oil pump chain.
 - a. Remove the oil pump chain movable guide rail fixing bolt (arrow), and remove the oil pump chain movable guide rail.
(Tightening torque: $20 + 5 \text{ N}\cdot\text{m}$)



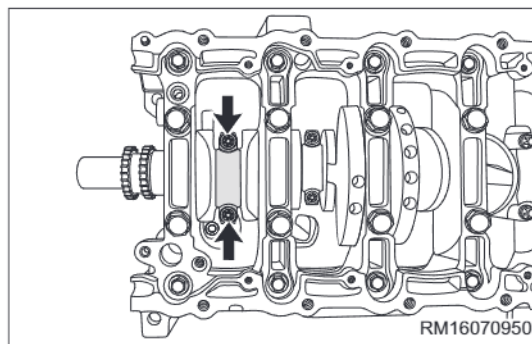
- b. Remove the oil pump chain.
- 29. Remove the oil deflector assembly.
 - a. Remove 6 fixing bolts (arrow) from oil deflector assembly.
(Tightening torque: $8 + 3 \text{ N}\cdot\text{m}$)



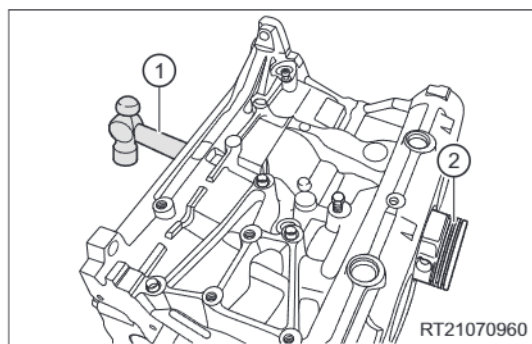
- b. Remove the oil deflector assembly.

30. Remove the piston connecting rod assembly.

- a. Using a ridge reamer or equivalent, remove all the carbon deposit from top of the cylinder.
- b. Remove the connecting rod bearing cap fixing bolts (arrow), and then remove the connecting rod bearing cap.



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



07

CAUTION

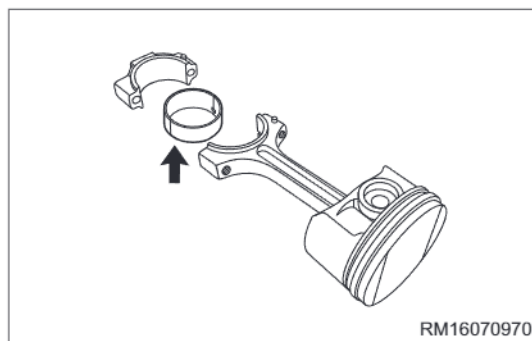
- Operate careful during removal, avoid damage cylinder liner.

31. Remove the connecting rod bearing.

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

HINT:

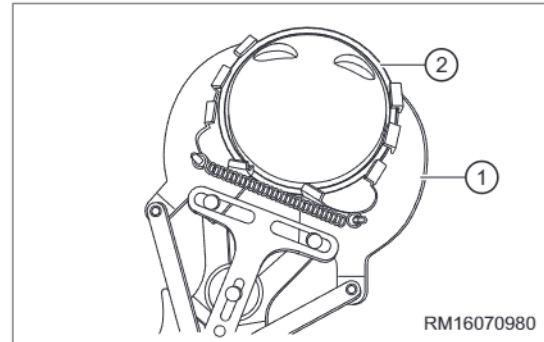
Arrange removed parts in correct order.

**CAUTION**

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

32. Remove the piston rings.

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


CAUTION

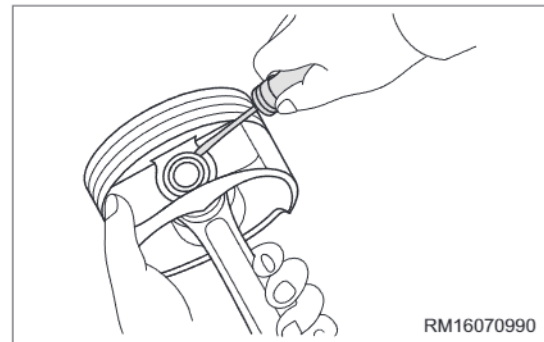
- Before removing piston ring, check piston ring side clearance. If it is necessary to be reused, be sure to mark the piston ring position.

07

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

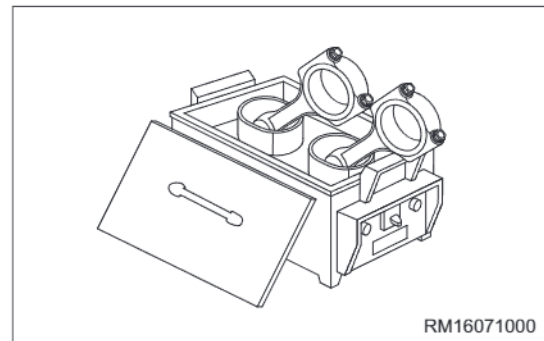
33. Separate the piston and piston connecting rod.

- a. Using a flat tip screwdriver, pull out the piston pin snap rings from two ends of piston.

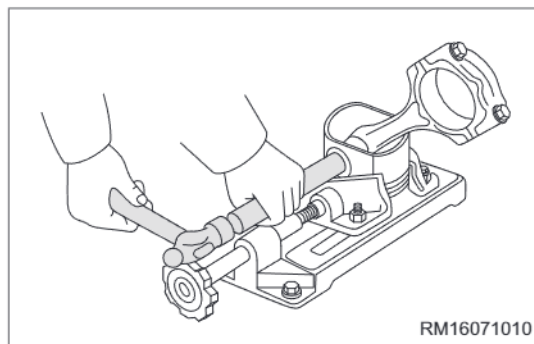

CAUTION

- Piston pin snap ring has a large tensile force. Make sure to take it out carefully during removal to prevent personal injury.

- b. Gradually heat the pistons to 80 - 90°C.

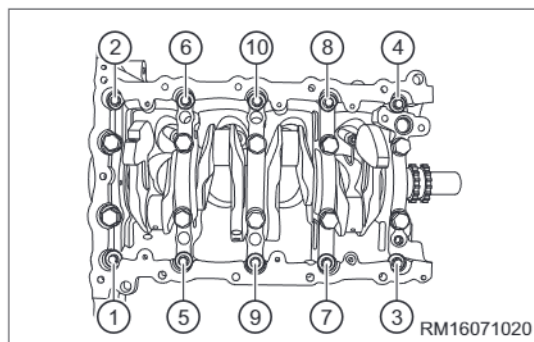


- c. Gently tap out the piston pin and remove the connecting rod with a rubber hammer and a brass bar.

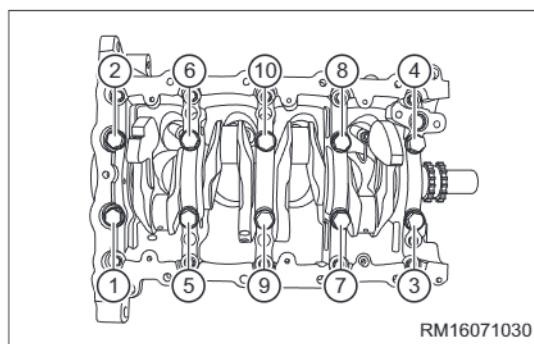


34. Remove the crankshaft.

- a. Evenly loosen and remove 10 crankshaft frame fixing bolts in order shown in illustration.



- b. Evenly loosen and remove 10 main bearing cap fixing bolts in order shown in illustration.



- c. Remove the crankshaft frame.

HINT:

If it is difficult to remove the crankshaft frame due to seal gum, tap it gently with a rubber hammer to make it loose. Be sure not to damage surrounding components.

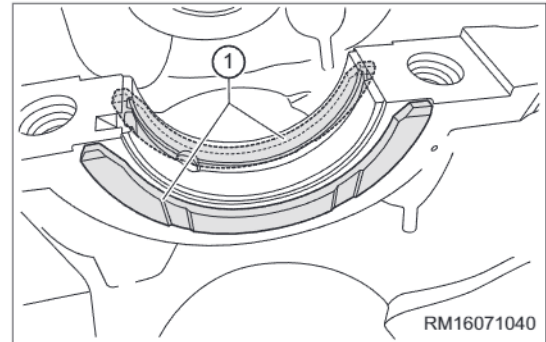
- d. Take out the crankshaft.

CAUTION

- Take care when removing crankshaft, as it is heavy. If necessary, ask other operators to assist.
- Take particular care when removing crankshaft. Avoid scratching contact surfaces of crankshaft and bearing shell.

35. Remove the crankshaft thrust washers.

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

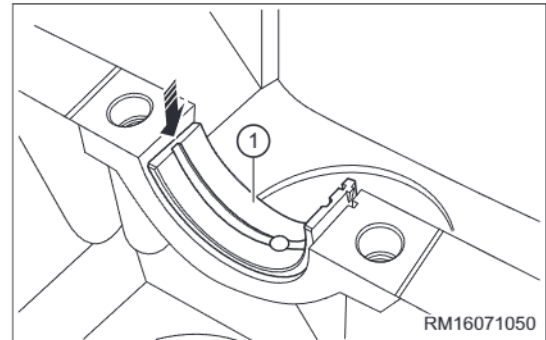


36. Remove the crankshaft main bearing shell.

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

HINT:

- Remove other crankshaft main bearing upper shells from cylinder block in the same way.
- Pay attention to the notch position. Push out bearing shell carefully as shown illustration. It is difficult to push out bearing shell and parts may be damaged if pushing in the opposite direction.

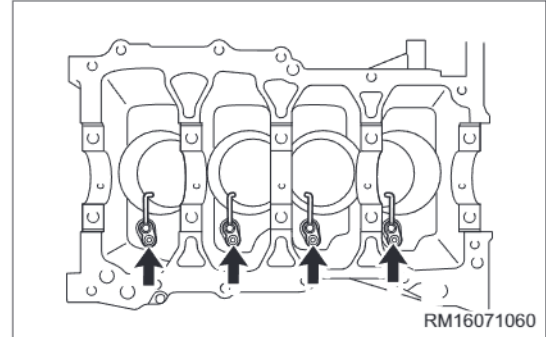


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- b. Remove the crankshaft main bearing lower shell from crankshaft frame in the same way.

37. Remove the piston cooling nozzles.

- a. Remove the piston cooling nozzle fixing bolts (arrow), and remove the piston cooling nozzles.



Inspection

1. Check the cylinder block.

Clean engine block thoroughly and check all hole passages for leakage.

Check engine block and cylinder bore for cracks.

Check bottom surface of engine block for cracks.

CAUTION

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

2. Check the flatness of engine block upper surface.

a. Clean engine block upper surface.

b. Using a precision straightedge and feeler gauge, measure flatness of engine block upper surface.

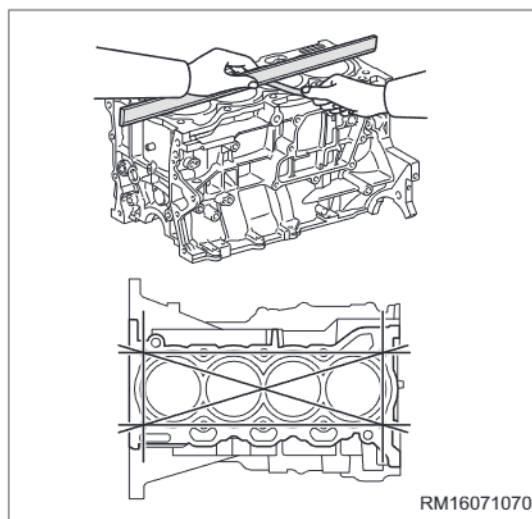
07

Measurement Item	Specification (mm)
Engine Block Upper Surface Flatness	0.04

If cylinder head flatness exceeds standard value, adjust it. If cylinder head flatness exceeds the limit, replace the cylinder head.

Maximum allowable wear thickness of engine block is 0.15 mm.

Maximum allowable wear thickness of engine block and cylinder head is 0.20 mm.



3. Check the cylinder.

a. Roundness and cylindricity calculation method (for general measurement):

Thrust direction - perpendicular to axis of crankshaft; Axial direction: parallel with axis of crankshaft

Cylindricity calculation method

Cylindricity is half of diameter difference measured in the same direction.

Cylindricity in thrust direction = (maximum bore diameter measured at A, B and C in thrust direction - minimum bore diameter measured at A, B and C in thrust direction)/2

Cylindricity in axial direction = (maximum bore diameter measured at A, B and C in axial direction - minimum bore diameter measured at A, B and C in axial direction)/2

Compare maximum value measured at 2 directions with standard cylinder cylindricity.

Roundness calculation method

Roundness error is half of diameter difference measured at the same section.

Roundness of section A = (maximum bore diameter measured in thrust direction and axial direction at point A - minimum bore diameter measured in thrust direction and axial direction at point A)/2

Roundness of section B = (maximum bore diameter measured in thrust direction and axial direction at point B - minimum bore diameter measured in thrust direction and axial direction at point B)/2

Roundness of section C = (maximum bore diameter measured in thrust direction and axial direction at point C - minimum bore diameter measured in thrust direction and axial direction at point C)/2

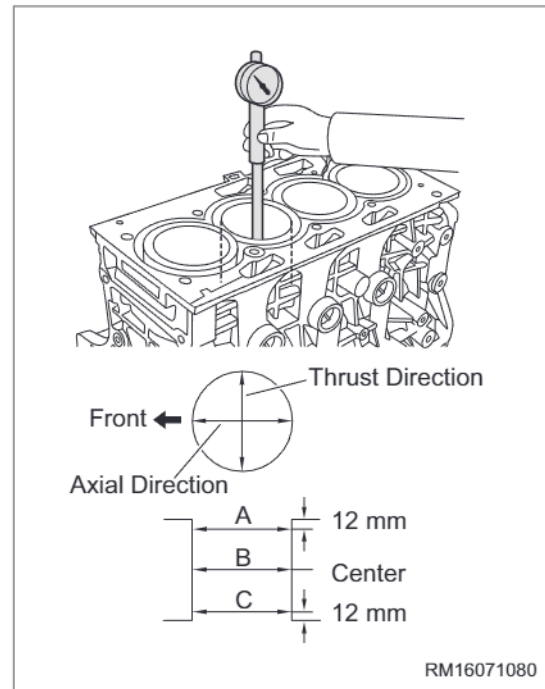
Compare maximum value measured at A, B and C with standard cylinder roundness.

b. Check the cylindricity of cylinder.

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

Measurement Item	Specification (mm)
Cylindricity	0.01
Cylinder Roundness	0.008

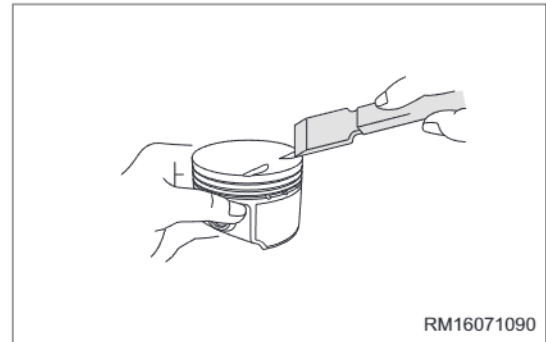
If cylindricity or roundness value measured at positions A, B and C exceeds specified value, replace the engine block.



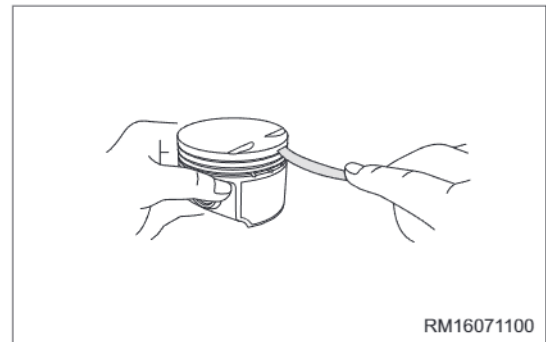
07

4. Check the piston.

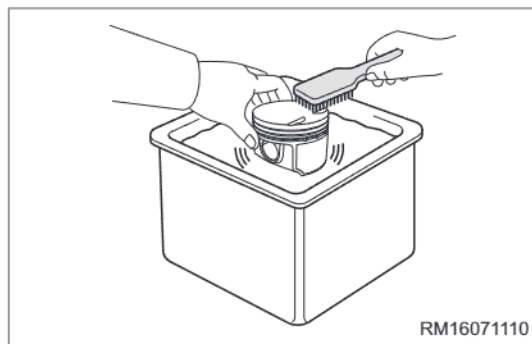
a. Using a scraper, remove carbon deposits on piston top.



b. Using a piston ring, remove carbon deposits from piston ring grooves.



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



RM16071110

CAUTION

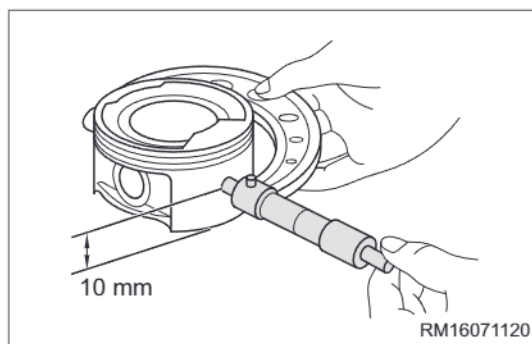
- DO NOT use a wire brush to clean.

07

- d. Measure piston diameter with a micrometer at position, that is approximately 10 mm above piston skirt in vertical direction of piston pin hole.

Measurement Item	Specification (mm)
Piston Diameter	$\phi 76.950 \pm 0.009$

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



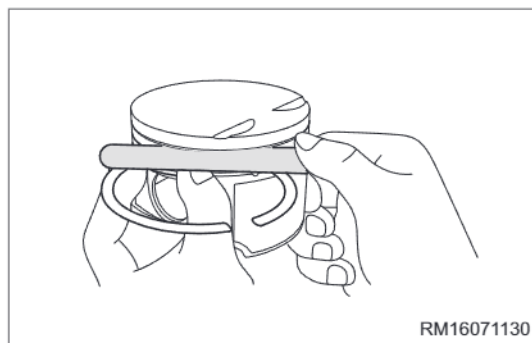
RM16071120

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

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

Measurement Item		Specification (mm)
Piston Ring Side Clearance	First Ring	0.035 - 0.080
	Second Ring	0.030 - 0.075

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



RM16071130

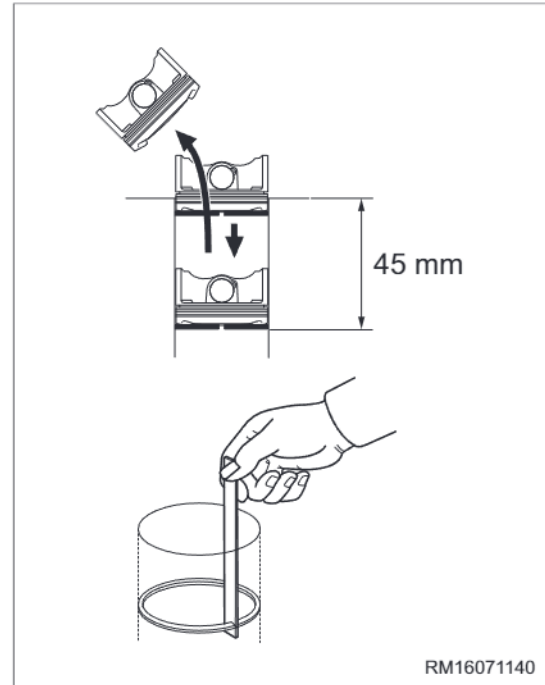
6. Check the piston ring end gap.

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

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

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

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

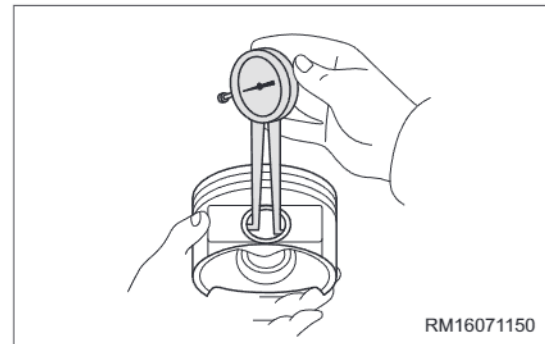


7. Check the piston pin.

- Using a feeler gauge, measure diameter of piston pin hole.

Measurement Item	Specification (mm)
Piston Pin Hole Diameter	$\phi 18^{+0.010}_{+0.004}$

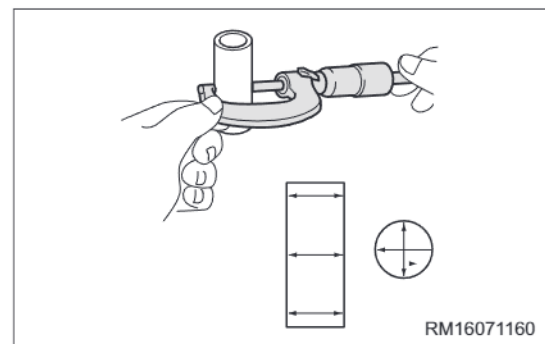
If piston pin hole diameter is not within specified range, replace the piston with a new one.



- Using an outer diameter micrometer, measure diameter of piston pin.

Measurement Item	Specification (mm)
Piston Pin Diameter	$\phi 18^0_{-0.005}$

If piston pin diameter is not within specified range, replace piston with a new one.



8. Check the diameter of crankshaft main journal.

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

Measurement Item	Specification (mm)
Crankshaft Main Journal Diameter	$\phi 54 \begin{smallmatrix} 0 \\ -0.016 \end{smallmatrix}$

If crankshaft main journal diameter is not within specified range, replace main bearing shells with new ones and check radial clearance of crankshaft (See page 07-88).

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

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

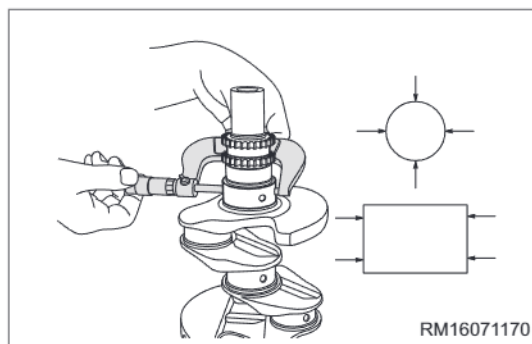
Roundness and cylindricity calculation method (for general measurement):

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

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

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

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



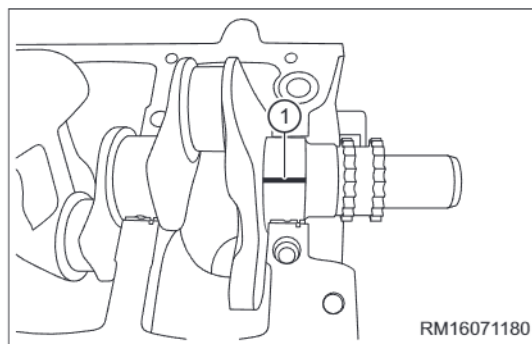
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Measurement Item		Specification (mm)
Crankshaft Main Journal	Cylindricity	0.007
	Roundness	0.04

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

9. Check the crankshaft radial clearance.

- a. Clean crankshaft main journals and main bearing shells.
- b. Install the crankshaft.
- c. Place the plastic feeler gauge (1) on crankshaft main journal, parallel to crankshaft center axis and as wide as distance covered by bearing cap.

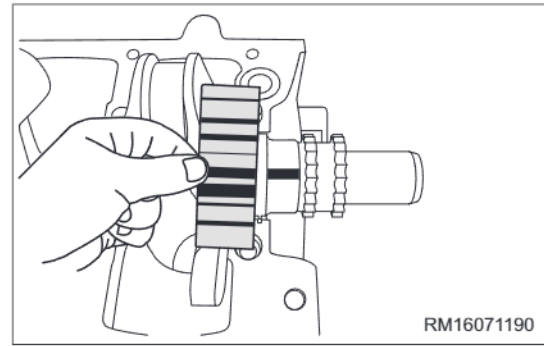


- d. Install the crankshaft frame and tighten the main bearing cap fixing bolts to specified torque in order.

- e. Remove the main bearing caps. Using a feeler gauge, measure widest part of compressed feeler gauge. Measured value is the crankshaft radial clearance.

Measurement Item	Specification (mm)
Crankshaft Radial Clearance	0.021 - 0.060

If crankshaft radial clearance exceeds specified range, install new main bearing shells. Replace the crankshaft if necessary.



CAUTION

- Replace bearing shells in pairs.

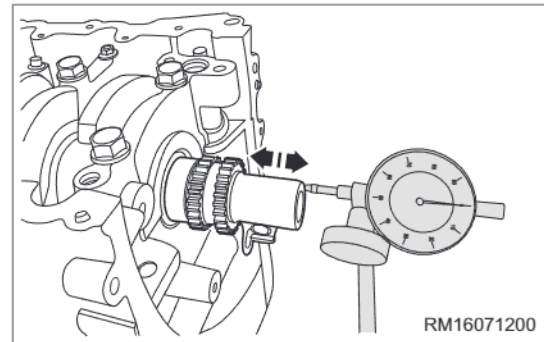
For selection of main bearing shell, refer to 07-92.

10. Check the crankshaft axial clearance.

- Clean crankshaft main journals and main bearing shells.
- Intall the crankshaft frame and tighten the main bearing cap fixing bolts to specified torque in order.
- Push crankshaft forward and backward and read value from dial indicator.

Measurement Item	Specification (mm)
Crankshaft Axial Clearance	0.070 - 0.265

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

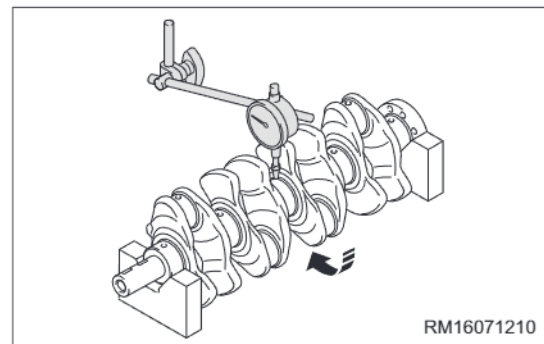


11. Check the crankshaft coaxiality.

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

Measurement Item	Specification (mm)
Coaxiality of Crankshaft	0.04

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



12. Check diameter of crankshaft connecting rod journal.

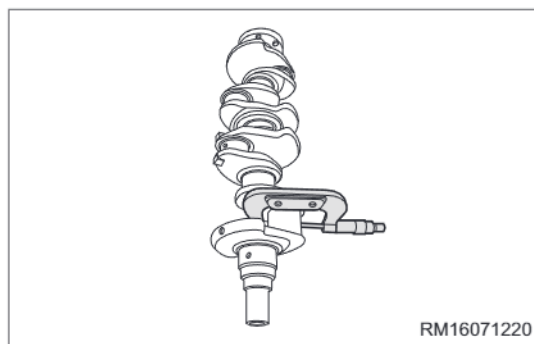
- c. Using an outer diameter micrometer, measure diameter of crankshaft connecting rod journal.

Measurement Item	Specification (mm)
Crankshaft Connecting Rod Journal Diameter	$\phi 47.9^{+0}_{-0.016}$

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

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

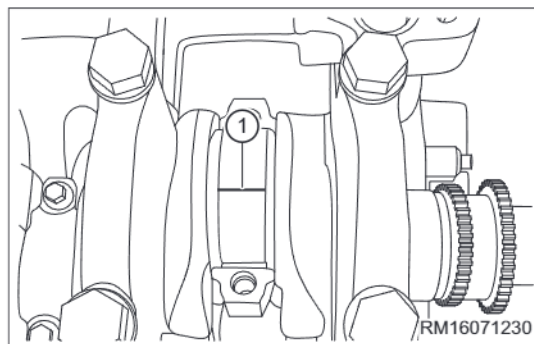
For selection of connecting rod bearing shell, refer to [07-93](#).



07

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

- a. Clean connecting rod journals and connecting rod bearing shells.
- b. Place a feeler gauge (1) on the connecting rod journal as shown in illustration.



- c. Install the connecting rod bearing caps, and tighten the connecting rod bearing cap fixing bolts to specified torque.

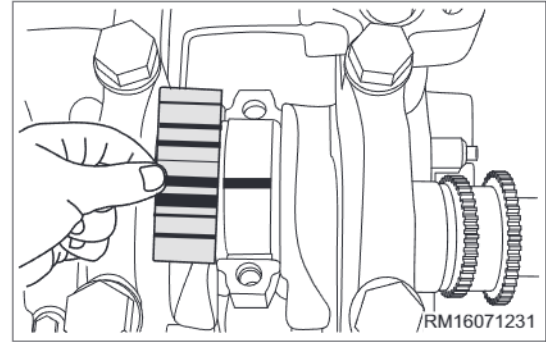
 CAUTION

- DO NOT turn crankshaft during installation.

- d. Remove the connecting rod bearing caps (See page 07-80).
- e. Using gauge scale of feeler gauge, measure widest part of compressed feeler gauge to obtain radial clearance of connecting rod bearing shell as shown in illustration.

Measurement Item	Specification (mm)
Connecting Rod Bearing Shell Radial Clearance	0.016 - 0.061

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

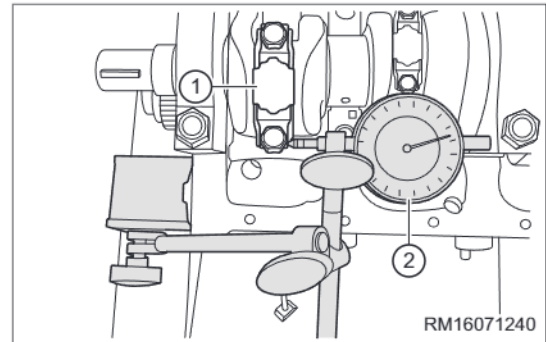


14. Check connecting rod big end axial clearance.

- a. Install the connecting rod bearing caps, and tighten the connecting rod bearing cap fixing bolts to specified torque.
- b. Install a dial indicator (2) with its plunger 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 value on the dial indicator.

Measurement Item	Specification (mm)
Connecting Rod Big End Axial Clearance	0.15 - 0.40

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

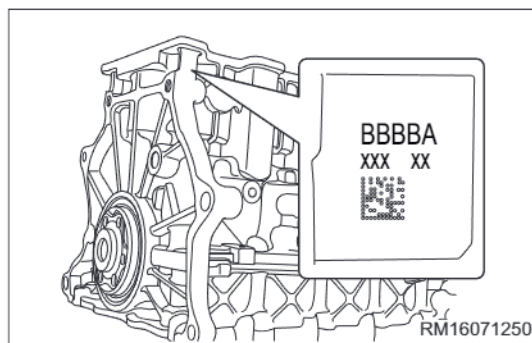


Selection of Bearing Shell

Selection of main bearing shell

1. Selection of crankshaft main bearing upper shell.
 - a. Related letter marks are available on cylinder block (consisting of "A" and "B"). Such as "BBBBA" in the illustration, each letter from left to right is for one type of crankshaft bearing upper shell. First letter "B" is for the upper shell type of crankshaft main bearing first journal, and so on; fifth letter "A" is for the upper shell type of crankshaft main bearing fifth journal.

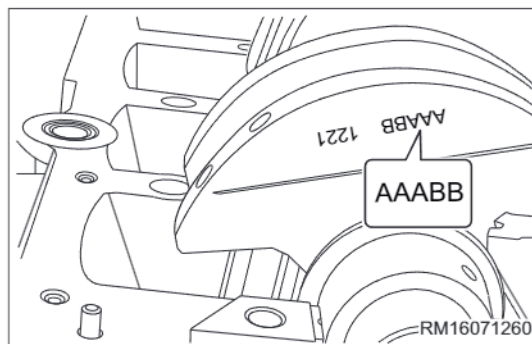
Name	Color	Cylinder Block Mark
Main Bearing Upper Shell	Red	A
	Blue	B



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2. Selection of crankshaft main bearing lower shell.
 - a. Related marks are available on the first balancer at the front end of crankshaft (consisting of "A" and "B"). Such as "AAABB" on the first crankshaft front end balancer shown in the illustration, first letter "A" is for the lower shell type of crankshaft main bearing first journal, and so on; fifth letter "B" is for the lower shell type of crankshaft main bearing fifth journal.

Name	Color	Cylinder Block Mark
Main Bearing Lower Shell	Red	A
	Blue	B

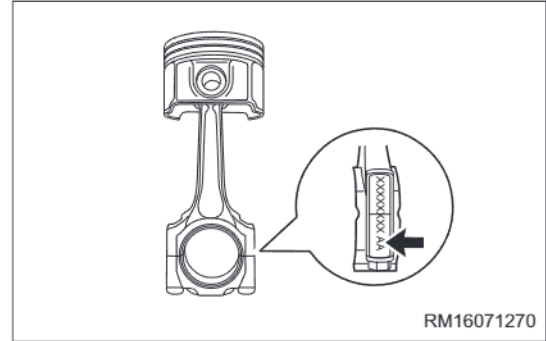


3. Precautions for crankshaft main bearing shell assembly:
 - a. There is a shell groove and oil hole on the main bearing upper shell, and oil hole should be aligned with that on the engine block, but the main bearing lower shell has no oil hole.
 - b. Apply a coat of engine oil to inner surface of main bearing shell before installation. Back side of bearing shell should be clean without any oil or foreign matter during assembly.

Selection of Connecting Rod Bearing Shell

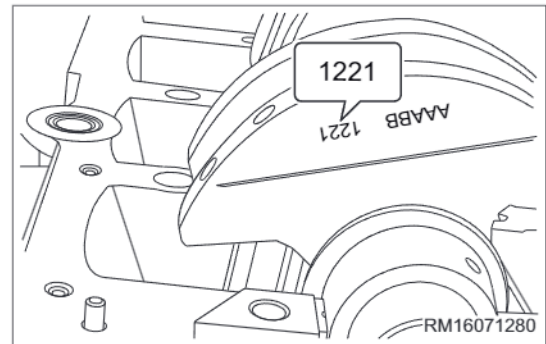
1. Selection of connecting rod bearing upper shell.
 - a. Connecting rod bearing upper shells are divided into red shells and blue shells. Related marks are available on the connecting rod. Select related connecting rod bearing shell according to the marks.
 - b. As shown in the illustration, among the mark "130523 A" on the connecting rod, "A" indicates red shell.

Name	Color	Cylinder Block Mark
Connecting Rod Bearing Upper Shell	Red	A
	Blue	B



2. Selection of connecting rod bearing lower shell.
 - a. Related digital marks are available on the first balancer at the front end of crankshaft (consisting of "1" and "2"). Such as "1221" on the first crankshaft front end balancer shown in the illustration, first digit "1" is for the lower shell type of 1st cylinder piston connecting rod, and so on; fourth digit "1" is for the lower shell type of fourth cylinder piston connecting rod.

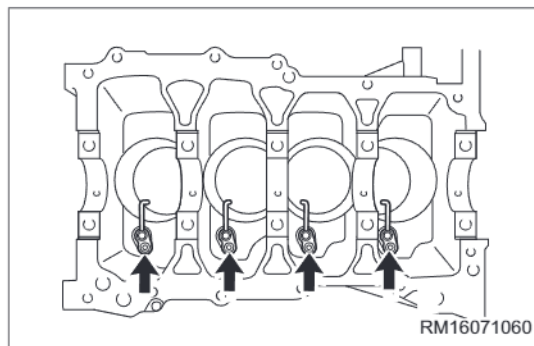
Name	Color	Cylinder Block Mark
Connecting Rod Bearing Lower Shell	Red	1
	Blue	2



3. Precautions for connecting rod bearing shell assembly:
 - a. Connecting rod upper and lower bearing shells without oil grooves are universal, but one of the connecting rod bearing shells has an oil hole.
 - b. It is necessary to use a set of connecting rod bearing shells that are provided by the same manufacturer on the same engine.
 - c. Apply a coat of engine oil to inner surface of the connecting rod bearing shell before installation. Back side of bearing shell should be clean without any oil or foreign matter during assembly.

Assembly

1. Install the piston cooling nozzles.
 - a. Install the piston cooling nozzles and tighten the piston cooling nozzle fixing bolts.



2. Install the crankshaft main bearing shells.

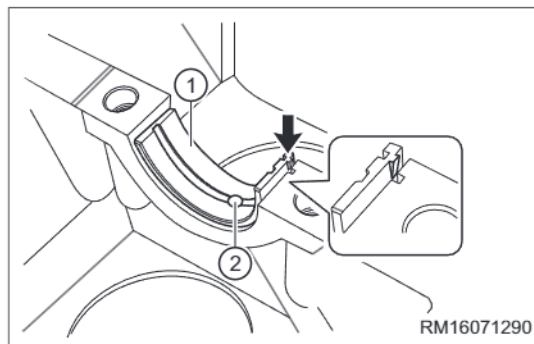
CAUTION

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

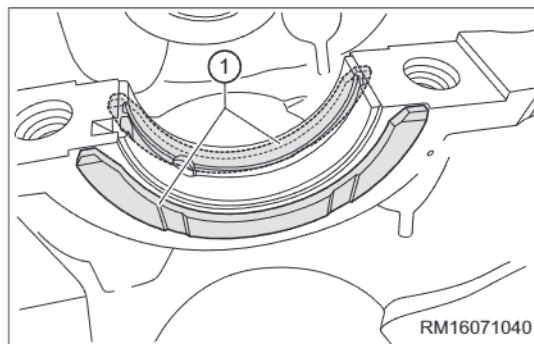
- a. Carefully install the crankshaft main bearing upper shell (1) in direction of arrow, and the notch of each main bearing upper shell should be aligned with the cylinder block. Oil passage hole (2) on crankshaft main bearing upper shell should be aligned with the passage hole on cylinder block after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

HINT:

Install the crankshaft main bearing lower shell to crankshaft frame in the same way.

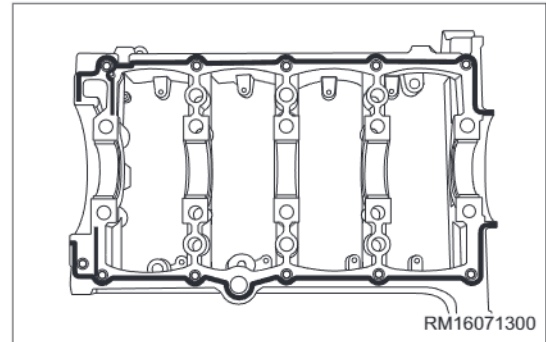


3. Install the crankshaft thrust washers.
 - a. Clean crankshaft thrust washers and cylinder block inner wall before installation.
 - b. Apply a coat of engine oil to crankshaft thrust washers.
 - c. There are 2 crankshaft thrust washers on the cylinder, which are installed on the front and rear sides 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.

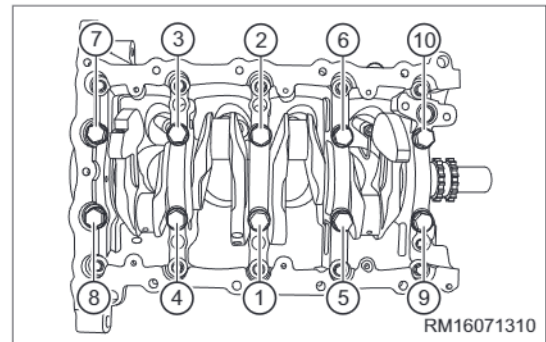
- a. Apply seal gum to the installation surface of frame before installation.


CAUTION

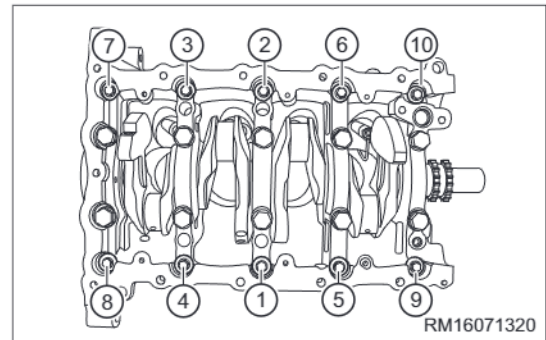
- DO NOT apply seal gum into bearing shell installation area when applying seal gum.
- Seal gum should not be applied too thick. Avoid seal gum entering bearing shell installation area due to compressing.

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- b. Place the crankshaft on the cylinder block carefully.
- c. Install the crankshaft main bearing cap fixing bolts in place by hands, and then tighten 10 crankshaft main bearing cap fixing bolts in sequence shown in illustration.
(Tightening torque: 1st step: tighten to $45 \pm 5 \text{ N}\cdot\text{m}$;
2nd step: retighten by $180^\circ \pm 10^\circ$)



- d. Evenly tighten 10 crankshaft frame fixing bolts in order shown in illustration.
(Tightening torque: $20 + 3 \text{ N}\cdot\text{m}$)



5. Assembly the piston and piston connecting rod.

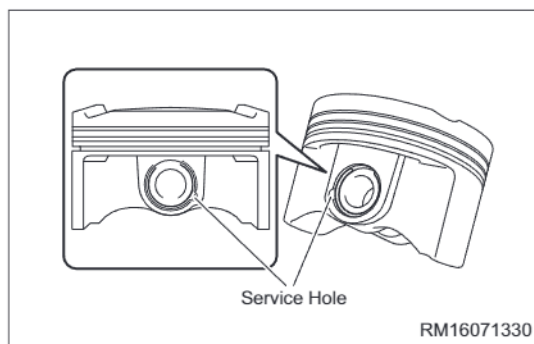
CAUTION

- Apply a coat of clean engine oil to piston pin outer surface and piston hole inner surface.

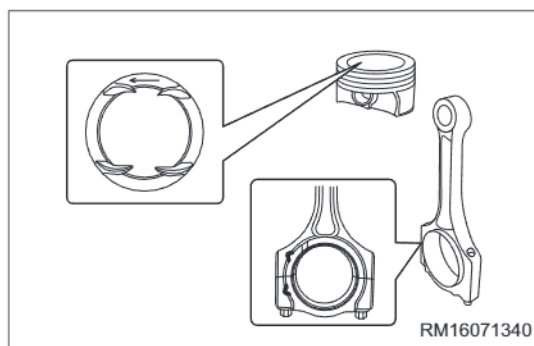
- Using a small screwdriver, install the new piston pin snap ring to one end of piston service hole.

HINT:

Make sure to stagger piston pin snap ring end gap and piston pin service hole.



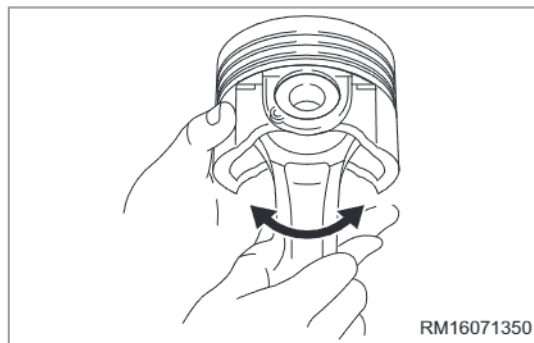
- Gradually heat the pistons to about 80 - 90°C.
- Align the front marks on piston and piston connecting rod and push the piston pin in with your thumb, until the piston pin contacts the snap ring pin hole.



- Install the piston pin snap ring to the other end of piston pin service hole, and check if piston pin rotates smoothly.

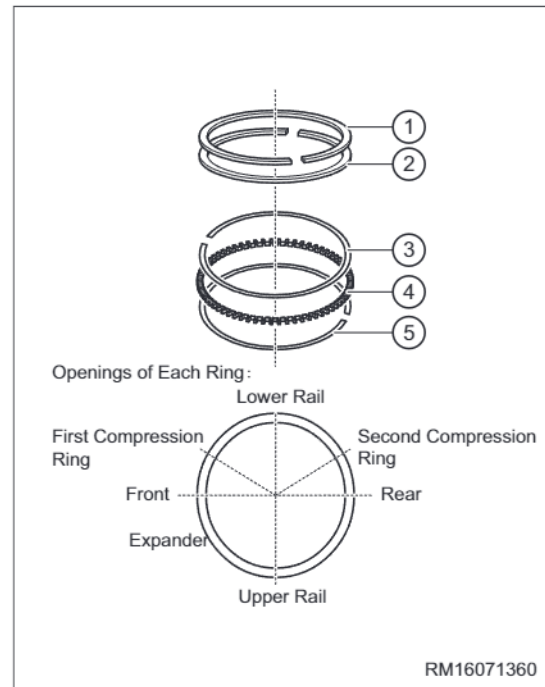
HINT:

Make sure to stagger piston pin snap ring end gap and piston pin service hole.



6. Install the piston rings.

- a. Apply a small amount of engine lubricant to the piston ring grooves and piston. Note that the side with words for first and second compression rings should face upward to piston top.
- b. Oil ring is steel band combination oil ring and composed of upper rail (3), lower rail (5) and expander (4). When installing the oil ring, first install the expander into oil groove, then install two rails with two rails opening of steel band combination oil ring staggered by 90° from the expander closed gap, and the upper and lower rails 180° . Then install the second compression ring, and install the first compression ring finally with 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.

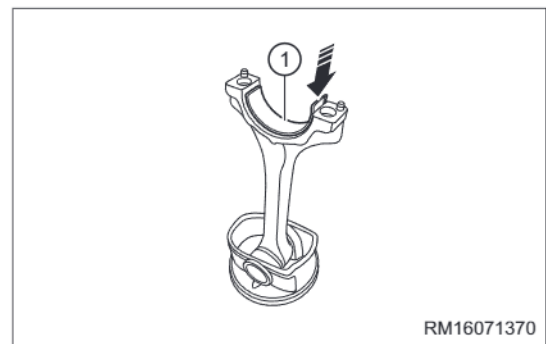


- c. Rotate the piston ring several turns after applying engine oil to piston ring groove, and note that the position of ring notch should be the same with that described above; clean the crankshaft connecting rod journal and cylinder bore with a non-woven fabric cloth.
7. Install the connecting rod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

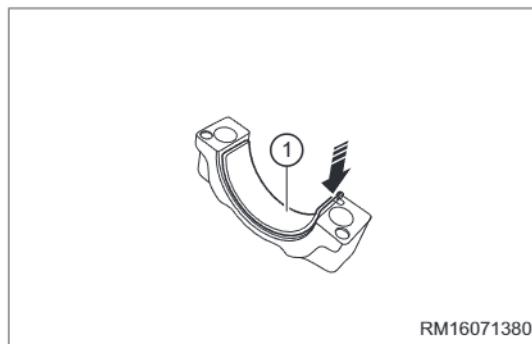
CAUTION

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

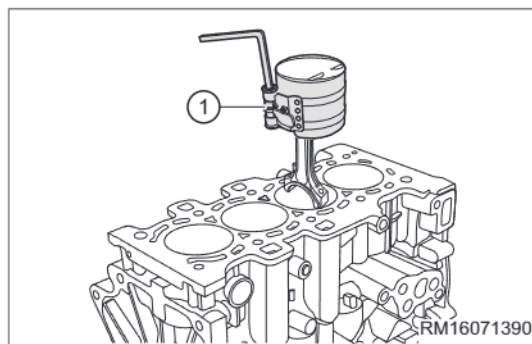
- a. Carefully install the connecting rod bearing upper shell (1) in direction of arrow, and keep the groove opening of each connecting rod bearing upper shell face the piston and connecting rod assembly.



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

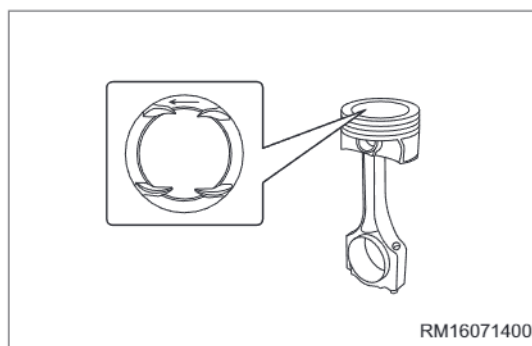


8. Install the piston connecting rod assembly.
- Rotate the crankshaft to the top dead center of No.1 and 4 cylinders.
 - Apply a coat of engine oil to the piston surface and cylinder inside wall.
 - As shown in the illustration, install the piston connecting rod assembly to the cylinder with the piston installer (1).



CAUTION

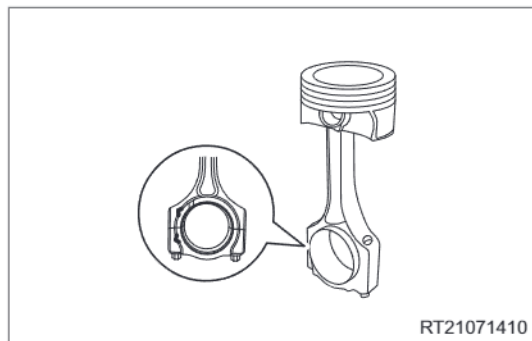
- Pay attention to face front marks on piston to timing chain side during assembly, without being reversed.



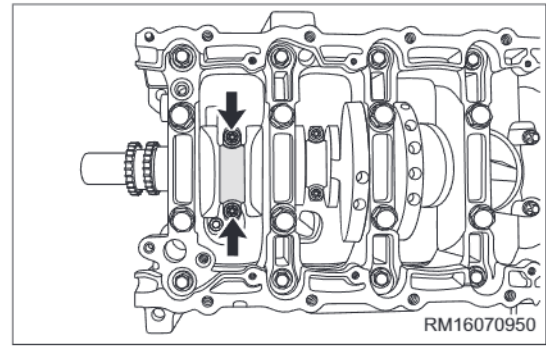
9. Install the connecting rod bearing cap.

HINT:

Salient points on on connecting rod and connecting rod bearing cap should be in the same side.



- a. Correctly install the connecting rod bearing caps, and screw the connecting rod bearing cap fixing bolts (arrow) by hands, then tighten the connecting rod bearing cap fixing bolts in 2 steps with a torque wrench.
(Tightening torque: 1st step: tighten to 15 ± 3 N·m;
2nd step: retighten by $60^\circ \pm 5^\circ$)

**CAUTION**

- Apply a small amount of engine lubricant to connecting rods, connecting rod bearing caps and thread joint surfaces.

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10. Other assembly is in the reverse order of disassembly.

