SQR484F ENGINE MECHANICAL

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GENERAL INFORMATION

Description

SQR484F engine has the following features:

- Vertical and water-cooled type
- In-line DOHC with 4 cylinders
- Four valves per cylinder
- DVVT
- Aluminum cylinder head
- Aluminum cylinder block
- Aluminum crankshaft frame

Operation

SQR484F engine adopts vertical, in-line 4-cylinder, water-cooled, 4-stroke, four valves per cylinder, DOHC, DVVT, electronic controlled sequential multiport fuel injection and natural aspiration. The engine is made of whole aluminum and adopts electronic controlled coil double ignition system.

Aluminum oil pan is fixed to the bottom of crankshaft frame with bolts. Aluminum cylinder head is fixed on the cylinder block with bolts. Camshafts are installed in the cylinder head. Power output from the crankshaft drives the camshaft to rotate by crankshaft timing pulley and timing belt to make the camshaft interact with valve hydraulic lifter to open and close. Piston assembly is an aluminum piston with cast iron connecting rod. This engine has reliable structure and good performance.

Specifications

SQR484F Engine Specifications

Item	Specification
Engine Type	Vertical, in-line 4-cylinder, water-cooled, 4-stroke, DOHC, electronic controlled sequential multiport fuel injection, Variable Valve Timing (VVT)
Engine Model	SQR484F
Valve Number Per Cylinder	4
Cylinder Diameter (mm)	83.5
Piston Stroke (mm)	90
Displacement (L)	1.971
Compression Ratio	10:1
Combustion Chamber Type	Pentroof type
Fuel Supply Type	Electronic controlled sequential multiport fuel injection
Ignition Type	Electrical control
Ignition Sequence	1 - 3 - 4 - 2
Idle Speed (r/min)	750 ± 50
Rated Power (kW)	102
Rated Power Speed (r/min)	5750
Max. Torque (N·m)	182
Max. Torque Speed (r/min)	4300 - 4500

Item	Specification	
Max. Permissible Speed (r/min)	5800	
Min. Fuel Consumption Rate (g/kW·h)	250	
Oil and Fuel Consumption Percentage	≤ 0.15	
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)	3.9 ± 0.5	
Crankshaft Rotation Direction	Counterclockwise (viewed from cross section of engine flywheel)	
Starting Type	Electrical starting	
Cooling Type	Forced circulation type antifreeze cooling	
Lubrication Type	Compound type (pressure, splash lubrication)	
Fuel Pressure (bar)	4	
Cylinder Compression Pressure (bar) (180 ~ 250) r/min	10 - 13.5	
Oil Pressure (kPa)	Low Idling Speed (700 ± 50 r/min)	Higher than 150 kPa (when oil temperature is 90°C)
	High Idle Speed (2000 r/min)	Higher than 360 kPa (when oil temperature is 90°C)
	High Speed (4000 r/min)	Higher than 470 kPa (when oil temperature is 90°C)
Thermostat Operation Temperature (°C)	Open Temperature	87 ± 2
	Full Open Temperature	102
Net Weight (kg)	148	
Boundary Dimension (Length × Width × Height) (mm)	641 × 613 × 644	
Starting Performance	With atmospheric temperature at -25°C, engine can start smoothly within 30 seconds without taking special measures. Starting test shows that staring can be performed 3 times consecutively. If it fails to start once, perform starting again after 2 minutes.	

Engine Mechanical Specifications

Item			Specification
Camshaft	Cam Height (mm)	Intake Cam	37.65
		Exhaust Cam	37.06
	Camshaft Journal Diameter (mm)	Intake	ϕ23.947 - ϕ23.960
		Exhaust	ϕ23.947 - ϕ23.960
	Camshaft Axial Clearance (mm)	Intake	0.15 - 0.20
		Exhaust	0.15 - 0.20
Cylinder Head	Lower Surface Flatness (mm)		0.04
	Overall Height (mm)		139.83 ± 0.335
	Surface Grinding Limit		Grinding is not permitted
Valve	Valve Head Margin Thickness (mm)	Intake Valve	0.9
		Exhaust Valve	0.7
	Valve Stem Diameter (mm)	Intake Valve	ϕ5.98 ± 0.008
		Exhaust Valve	ϕ5.96 ± 0.008
	Grommet Width (mm)	Intake Valve	2.263
		Exhaust Valve	2.828
	Clearance Between Valve Stem and Guide (mm)	Intake Valve	0.012 - 0.043
		Exhaust Valve	0.032 - 0.063
	Grommet Cone Angle (°)	Intake Valve	90 - 90.5
		Exhaust Valve	90 - 90.5
	Height (mm)	Intake Valve	107.998
		Exhaust Valve	106.318
Valve Spring	Free Height (mm)		47.7
	Operating Preload/Operating Height		260 ± 11 N/41 mm
Valve Guide	Valve Guide Length (mm)		38 ± 0.25
	Inner Diameter (mm)		ϕ6 - ϕ6.015
	Outer Diameter (mm)		ϕ11.040 - ϕ11.051
	Depression Depth (mm)		16 ± 0.3
	Valve Stem Protrusion Amount (mm)		31.497 - 31.515
Piston	Piston Skirt Diameter (mm)		ϕ83.455 ± 0.009
Piston Ring	Side Clearance (mm)	First Ring	0.04 - 0.08
		Second Ring	0.025 - 0.070
	End Gap (mm)	First Ring	0.2 - 0.4
		Second Ring	0.4 - 0.6
	Height (mm)	First Ring	$1.2^{-0.01}_{-0.05}$
		Second Ring	$1.5^{-0.006}_{-0.050}$
		Oil Ring	2.5

Item			Specification
Piston Ring Groove	Height (mm)	First Ring	$1.2^{+0.06}_{+0.05}$
		Second Ring	$1.5^{+0.04}_{+0.02}$
		Oil Ring	$25^{+0.05}_{+0.01}$
Piston Pin	Diameter (mm)		$\phi 21^{0}_{-0.006}$
	Length (mm)		$60^{0}_{-0.5}$
	Piston Pin Hole Diameter (mm)		$\phi 21^{+0.010}_{+0.006}$
Crankshaft	Axial Clearance (mm)		0.070 - 0.265
	Radial Clearance (mm)		0.021 - 0.059
	Crankshaft Main Journal	Diameter (mm)	$\phi 54^{0}_{-0.019}$
		Coaxially (mm)	0.04
		Cylindricity (mm)	0.007
		Roundness (mm)	0.004
	Connecting Rod Journal	Diameter (mm)	$\phi 47.9^{0}_{-0.016}$
		Parallelism to Main Journal	0.008
Cylinder Block	Overall Height (mm)		293
	Bore Roundness (mm)		0.008
	Cylindricity (mm)		0.01
	Upper Surface Flatness (mm)		0.04
	Surface Grinding Limit		Grinding is not permitted
Connecting Rod	Connecting Rod Big End Radial Clearance (mm)		0.021 - 0.056
	Big End Axial Clearance (mm)		0.15 - 0.40

Engine Torque Specifications

Description	Torque (N·m)
Accessory Drive Belt Upper Idler Pulley Assembly Fixing Bolt	40 + 5
Accessory Drive Belt Lower Idler Pulley Assembly Fixing Bolt	40 + 5
Accessory Drive Belt Tensioner Assembly Fixing Bolt	40 + 5
Timing Belt Front Cover Upper Body Fixing Bolt	7
Crankshaft Pulley Fixing Bolt	1st step: 25 ± 5 2nd step: 30° ± 5°
Timing Belt Front Cover Lower Body Fixing Bolt	7
Plug for Installing Crankshaft Timing Tool on Bottom of Engine Block	40 + 5
Timing Belt Tensioner Fixing Bolt	20 + 5
Exhaust Phaser Cover	30
Exhaust Camshaft Phaser Assembly Fixing Bolt	120 ± 5
Intake Phaser Cover	30
Intake Camshaft Phaser Assembly Fixing Bolt	120 ± 5
Crankshaft Timing Pulley Fixing Bolt	1st step: 130 ± 10 2nd step: 65° ± 5°
Flywheel Fixing Bolt	1st step: 35 ± 5 2nd step: 45° ± 5°
Engine Wire Harness Assembly Fixing Bolt	7 ± 1
Intake Camshaft Position Sensor Fixing Bolt	8 ± 0.5
Exhaust Camshaft Position Sensor Fixing Bolt	8 ± 0.5
Cylinder Head Cover Fixing Bolt	8 + 3
Timing Belt Idler Pulley Fixing Bolt	40 + 5
Timing Belt Rear Cover Fixing Screw	5 + 2
Camshaft First Bearing Cap Fixing Bolt	8 + 3
Camshaft Bearing Cap Fixing Bolt	8 + 3
Cylinder Head Fixing Bolt	1st step: 45 ± 5 2nd step: 180° ± 10°
Coupling Bolt Between Rear Mounting Cushion Assembly and Front Sub Frame Welding Assembly (for MT Model)	70 ± 5
Rear Mounting Cushion Assembly Fixing Nut (for MT Model)	70 ± 5
Locking Nut for Through Bolt Between Rear Mounting Bracket and Rear Mounting Cushion Assembly (for MT Model)	70 ± 5
Coupling Bolt Between Rear Mounting Bracket and Transmission Case (for MT Model)	55 ± 5

Description	Torque (N·m)
Coupling Bolt Between Rear Mounting Cushion Assembly and Front Sub Frame Welding Assembly (for CVT Model)	70 ± 5
Locking Nut for Through Bolt Between Rear Mounting Bracket and Rear Mounting Cushion Assembly (for CVT Model)	70 ± 5
Coupling Bolt Between Rear Mounting Bracket and Transmission Case (for CVT Model)	80 ± 6
Coupling Bolt Between Front Mounting Cushion Assembly and Side Rail Welding Assembly	70 ± 5
Locking Nut for Through Bolt Between Front Mounting Cushion Assembly and Front Mounting Bracket	70 ± 5
Coupling Bolt Between Front Mounting Bracket and Transmission Case	55 ± 5
Locking Nut for Through Bolt Between Left Mounting Cushion Assembly and Left Mounting Bracket (for MT Model)	105 ± 10
Coupling Bolt Between Left Mounting Cushion Assembly and Body (for MT Model)	90 ± 5
Fixing Nut Between Left Mounting Bracket and Transmission Case (for MT Model)	80 ± 6
Left Mounting Cushion Assembly Locking Nut (for CVT Model)	80 ± 6
Coupling Bolt Between Left Mounting Cushion Assembly and Body (for CVT Model)	70 ± 5
Fixing Nut Between Left Mounting Bracket and Transmission Case (for CVT Model)	80 ± 6
Coupling Bolt Between Left Mounting Bracket and Transmission Case (for CVT Model)	80 ± 6
Expansion Tank Fixing Bolt	7 ± 1
Coupling Bolt and Nut Between Right Mounting Cushion Assembly and Right Mounting Bracket	80 ± 6
Coupling Bolt Between Right Mounting Cushion Assembly and Body	70 ± 5
Right Mounting Cushion Assembly Fixing Bolt	55 ± 5
Left Coupling Bolt Between Precatalytic Converter Assembly Bracket and Engine Block	23 ± 2
Right Coupling Bolt Between Precatalytic Converter Assembly Bracket and Engine Block	50 ± 5
Coupling Nut Between Shift Cable and Shift Arm (for CVT Model)	18 ± 2
Coupling Plug Between Pipe II Assembly and Clutch Release Cylinder	16 ± 2
Bracket II Fixing Bolt	15 ± 2

Description	Torque (N·m)
Bracket I Fixing Bolt	15 ± 2
Transmission Ground Wire Fixing Bolt	15 ± 2
High Pressure Pipe Hollow Bolt	45 ± 5
Fixing Bolt Between A/C High/Low Pressure Line and Compressor Assembly	25 ± 2.5
Battery Wire Harness Fixing Nut	7 ± 1
Knock Sensor Inner Torx Fixing Bolt	20 ± 5
Small Circulation Metal Tube Fixing Bolt	20 ± 5
Engine Accessory Bracket Fixing Bolt	40 + 5
Power Steering Pump Bracket Fixing Bolt	30 + 5
Oil Cooler Bracket Fixing Bolt	40 + 5
Trim Cover Rear Right Bracket Fixing Bolt	7 ± 1
Oil Deflector Assembly Fixing Bolt	8 ± 3
Connecting Rod Bearing Cap Fixing Bolt	1st step: 25 ± 3 2nd step: 90° ± 5°
Crankshaft Frame Fixing Bolt	20 + 3
Main Bearing Cap Fixing Bolt	1st step: 45 ± 5 2nd step: 180° ± 10°

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 Part	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, Valve Rocker Arm	SM10W-40
Valve Small End, Valve Rocker Arm Head	SM10W-40
Valve Retainer Hole (Cylinder Head Assembly)	SM10W-40
Valve Guide or Guide Bottom Hole (Cylinder Head)	SM10W-40
Camshaft Oil Seal Lip and Camshaft Journal	SM10W-40
Oil Filter Gasket Surface	SM10W-40

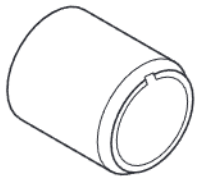
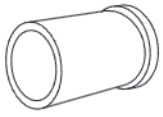
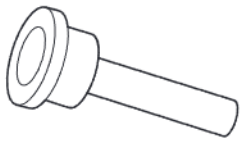
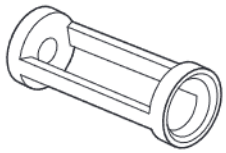
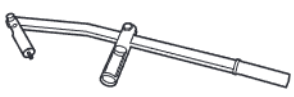
All engine lubricants should be 5W-40 (for winter)/10W-40 (for summer) SM grade or higher.

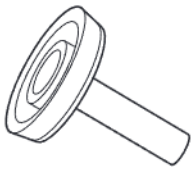
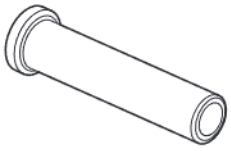
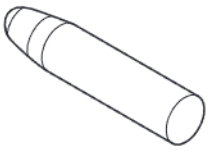
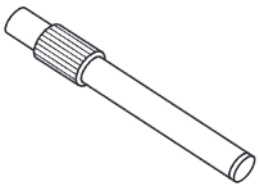
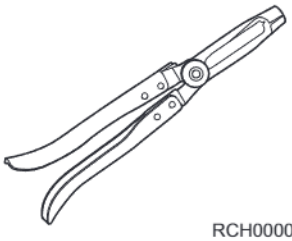
Areas with Seal Gum Applied during Engine Assembly

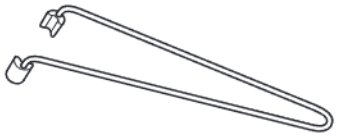
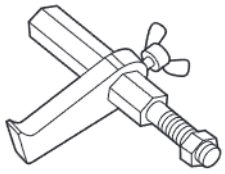
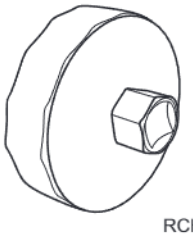
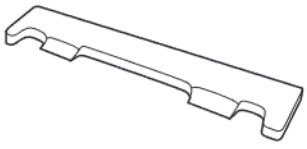
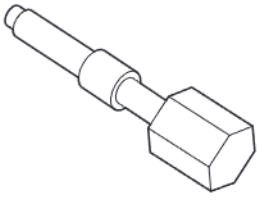
Area with Seal Gum Applied	Seal Gum Type
Cylinder Block Bowl Plug	Loctite 747
Cylinder Block Main Oil Passage Plug	Loctite 5910
Joint Surface Between Crankshaft Frame and Cylinder Block	Loctite 518
Crankshaft Frame and Oil Pan	Loctite 5910
Cylinder Head Bowl Plug	Loctite 11747
Cylinder Head Oil Passage Plug	Loctite 577
First Bearing Cap Bottom Plate	Loctite 574
Coolant Temperature Sensor	Loctite 243
Oil Pressure Sensor	Loctite 577
Camshaft Variable Valve Timing Control Valve	Loctite 243
Oil Deflector Bolt	Loctite 243
Oil Pump Mounting Bolt	Loctite 5910
Timing Gear Rear Cover Fixing Screw	Loctite 243

Tools

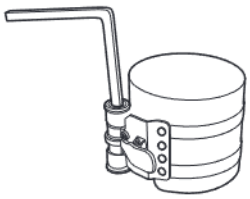
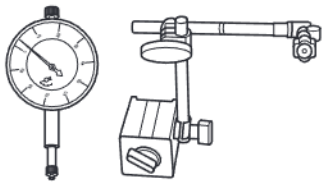
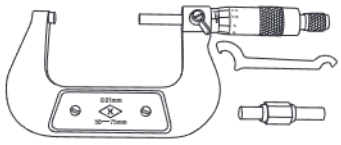
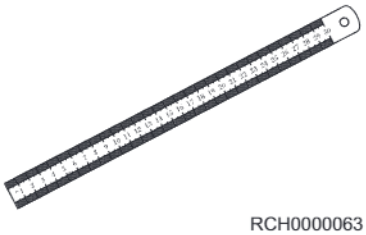
Special Tools

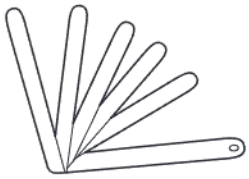
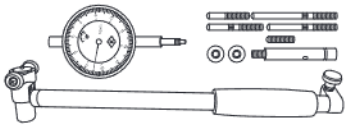
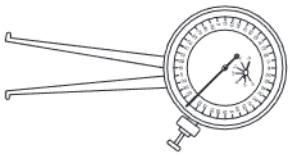
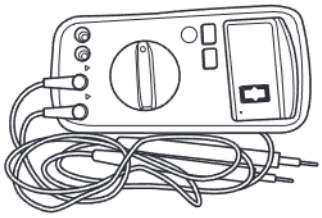
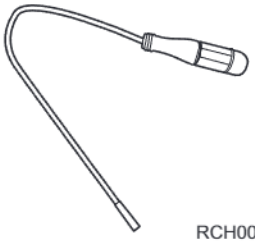
Crankshaft Front Oil Seal Guide Tool	 RCH0000049
Crankshaft Front Oil Seal Installer	 RCH0000067
Camshaft Oil Seal Installer	 RCH0000017
Valve Spring Compression Adapter	 RCH0000050
Valve Spring Compressor	 RCH0000028

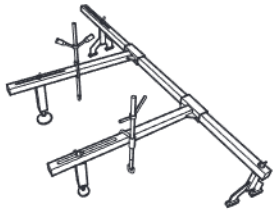
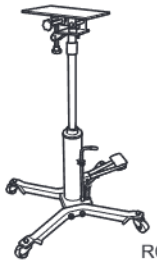
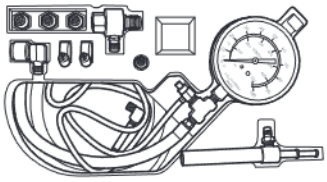
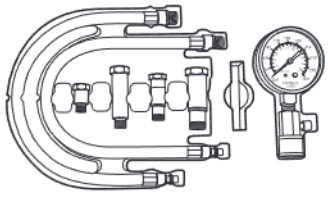
Crankshaft Rear Oil Seal Installer	 RCH0000031
Valve Oil Seal Installer	 RCH0000034
Valve Oil Seal Guide Sleeve	 RCH0000035
Clutch Pressure Plate Installer	 RCH0000018
Valve Oil Seal Remover	 RCH0000037

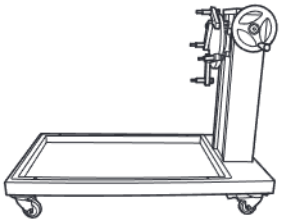
Valve Cotter Installer	 RCH0000029
Flywheel Holding Tool	 RCH0000040
Oil Filter Remover	 RCH0000054
Camshaft Timing Tool	 RCH0000033
Crankshaft Timing Tool	 RCH0000027

General Tools

Piston Installer	 RCH0000039
Dial Indicator and Magnetic Holder	 RCH0000023
Outer Diameter Micrometer	 RCH0000064
Vernier Caliper	 RCH0000019
Precision Ruler	 RCH0000063

Feeler Gauge	 RCH0000060
Cylinder Gauge	 RCH0000065
Caliper Gauge	 RCH0000069
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 the table below to help determine the cause of the problem. Check each suspected area in sequence.
- Repair or replace the faulty components, or adjust as necessary.

Symptom	Suspected Area	See page
Valve mechanism noise	Engine oil (oil level high or low, oil lean or rich)	13-11
	Cam	07-49
	Valve spring seat (excessive runout)	07-57
	Valve (excessive clearance between valve and guide)	07-60
Connecting rod noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-11
	Connecting rod bearing cap (loose fixing nut)	07-98
	Connecting rod (misaligned)	07-97
	Connecting rod bearing shell (excessive radial clearance)	07-91
	Connecting rod journal (out-of roundness)	07-91
Main bearing noise	Engine oil (low pressure)	13-10
	Engine oil (lean)	13-11
	Main bearing shell (excessive clearance)	07-90
	Crankshaft axial clearance (excessive)	07-90
	Crankshaft journal (out-of roundness or worn)	07-89
	Flywheel or clutch (loose)	07-42
Oil loss or spark plug blockage	Piston ring (worn, scratched or damaged)	07-84
	Piston ring groove (fouled)	07-87
	Valve oil seal (worn or damaged)	07-57
	Valve (excessive clearance between valve and guide)	07-60

Inspection

1. Check coolant (See page 12-12).
2. Check engine oil (See page 13-9).
3. Check battery (See page 16-7).
4. Check 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 the air filter element, clean it with compressed air.
   - If any dirt or blockage remains even after cleaning the air filter element with compressed air, replace it.
5. Check spark plugs (See page 14-12).
6. Test 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 the measurement of cylinder pressure when servicing the engine.
   - Ensure that battery is fully charged and the engine starter is in good operating condition. Otherwise the indicated compression pressure used for diagnosis may be invalid.

CAUTION

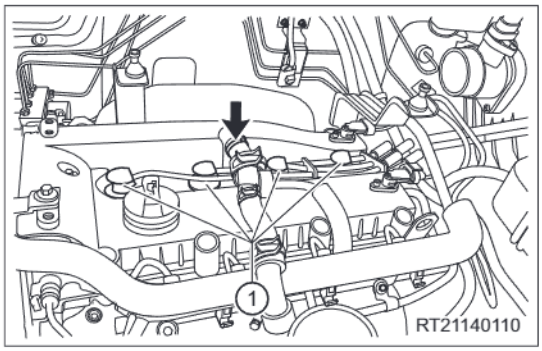
- Recommended compression pressure is only used as a guide for diagnosing engine malfunction.
- Never determine causes of low pressure by disassembling engine unless there are some malfunctions.

Measurement Procedures

CAUTION

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

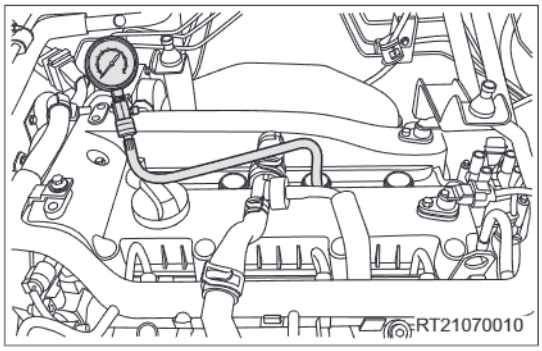
a. Turn off all the electrical equipment and ignition switch.
b. Remove the engine trim cover assembly (See page 10-10).
c. Move away the high-voltage cables for each cylinder.
   - Remove the clamp (arrow) from crankcase ventilation hose, and disconnect the connection between crankcase ventilation hose and cylinder head cover.
   - Move away the crankcase ventilation hose.
   - Loosen the high-voltage cables (1) in order, pull them upward from spark plug holes, and move them to one side.



CAUTION

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

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



CAUTION

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

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

   Standard value for cylinder pressure: 10 - 13.5 bar

CAUTION

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

Cylinder Pressure Value Judgement

- Correct cylinder pressure

  Standard cylinder pressure value is between 10 and 13.5 bar and will drop slightly with the using of engine. But the lowest value cannot be below 9 bar and the pressure difference between each cylinder should not be above 3 bar.
- If cylinder pressure of engine is lower than the 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, the piston ring or cylinder bore may be worn or damaged.

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

i. Install the spark plug (See page 14-12).
j. Connect all fuel injector connectors (See page 08-26).
k. Install the high-voltage cables.

7. Test cylinder head gasket.

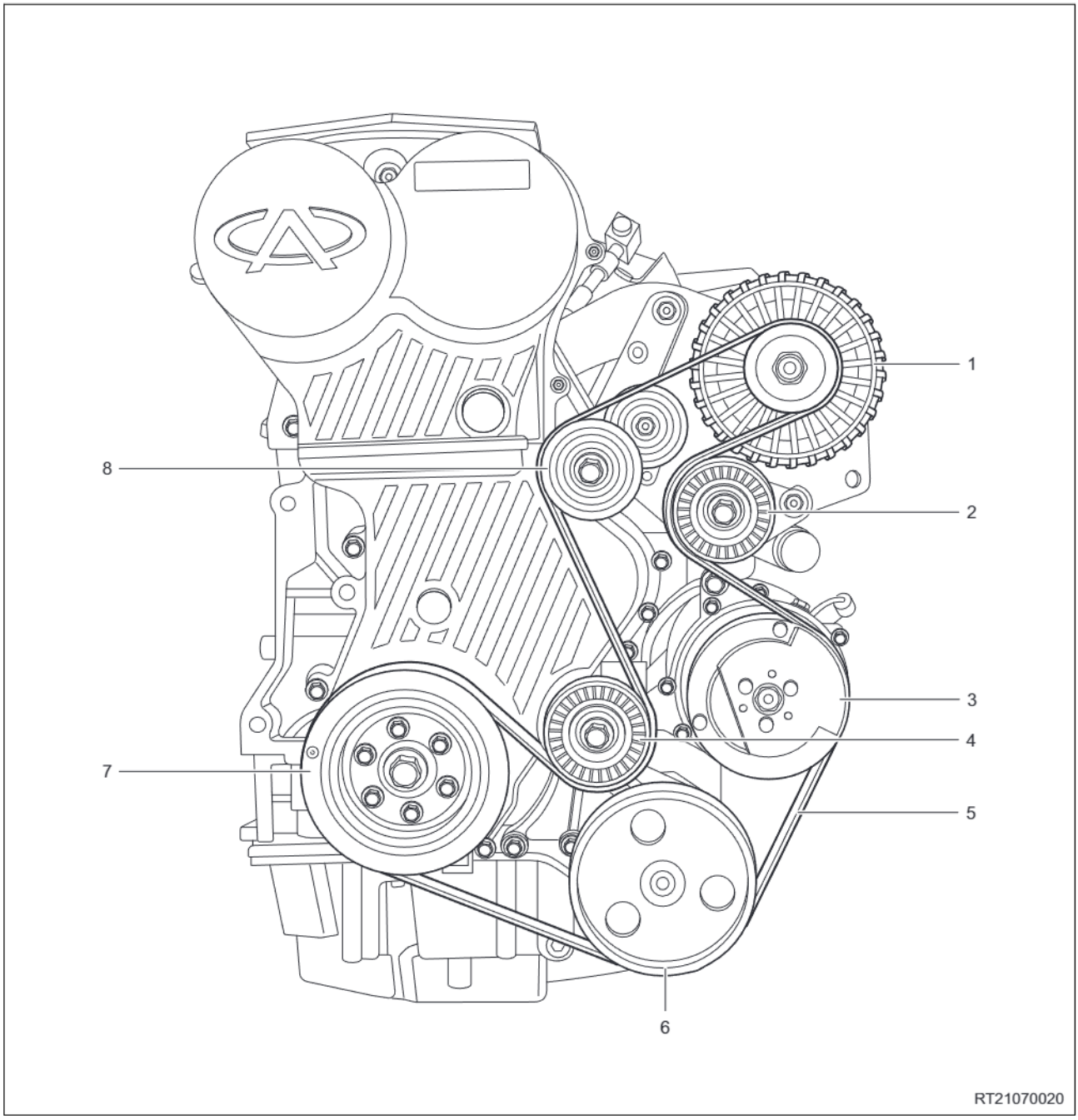
   Cylinder head gasket leakage may be present between adjacent cylinders, between cylinder and adjacent water jacket or from an oil passage to the external of engine.

   - 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 overheat
     - Coolant loss
     - Excessive steam (white smoke) emitted from exhaust system
     - Coolant foaming

ON-VEHICLE SERVICE

Accessory Drive Belt

Description



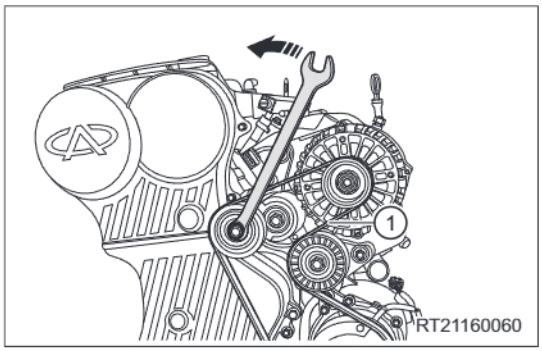
1 - Alternator	2 - Upper Idler Pulley
3 - A/C Compressor	4 - Lower Idler Pulley
5 - Accessory Drive Belt	6 - Power Steering Pump Pulley
7 - Crankshaft Pulley	8 - Accessory Drive Belt Tensioner

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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Remove the accessory drive belt.
   a. Put the 15# open wrench (or socket) through area between engine and right side rail, and clamp the tensioner pulley bolt.
   b. Rotate the open wrench counterclockwise firmly in the direction of arrow as show in the illustration. Loosen the accessory drive belt (1) after it is loosened.



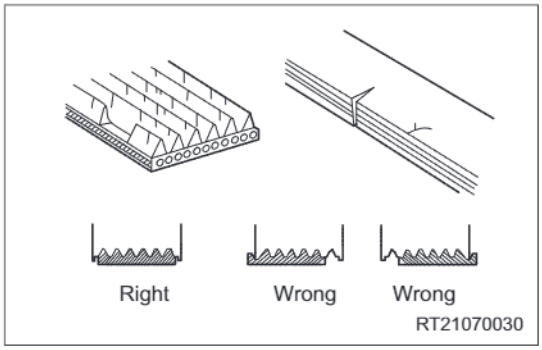
   c. Carefully remove the accessory drive belt.

Inspection

1. Check belt surface for pilling, oiliness and deterioration, etc. If any of the defects is found, replace the accessory drive belt.
2. Check the Internal and edge of belt for damage, wear, foreign matter and cracks, etc. If any of the defects is found, replace the accessory drive belt.

HINT:

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



Installation

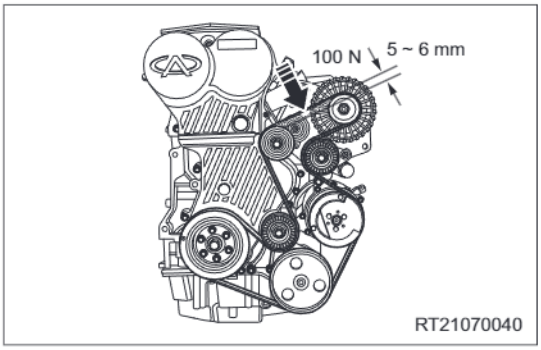
Installation is in the reverse order of removal.

CAUTION

- Before installation, Remove oil and foreign matter from accessory drive belt.
- After installing accessory drive belt, turn crankshaft 2 turns with a wrench to make sure to install accessory drive belt in place, and not interfere with other components.

Adjustment

1. Check the tension of accessory drive belt.
   a. Turn the crankshaft pulley 2 turns. Distribute the belt tension between each pulley evenly.
   b. Apply 100 N of force to center part of the belt between alternator pulley and tensioner with your thumb. Check that the displacement of belt should be within 5 - 6 mm. If the displacement is too large or too small, adjust or repair.



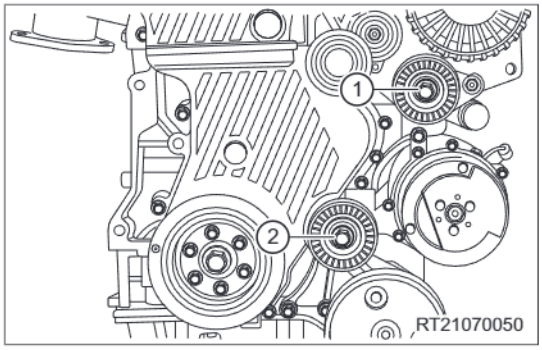
Idler Pulley Assembly

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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Remove the accessory drive belt (See page 07-24).
6. Remove the idler pulley assembly.
   a. Remove the fixing bolt (1) from upper idler pulley assembly, and remove the upper idler pulley assembly.
   (Tightening torque: 40 + 5 N·m)
   b. Remove the fixing bolt (2) from lower idler pulley assembly, and remove the lower idler pulley assembly.
   (Tightening torque: 40 + 5 N·m)



Inspection

1. Rotate idler pulley assembly by hands and check if the rotation is smooth and if abnormal noise occurs.
2. Wiggle idler pulley assembly in the axial and radial direction to check the 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 the accessory drive belt.
- Make sure to install accessory drive belt in place, and not interfere with other components.

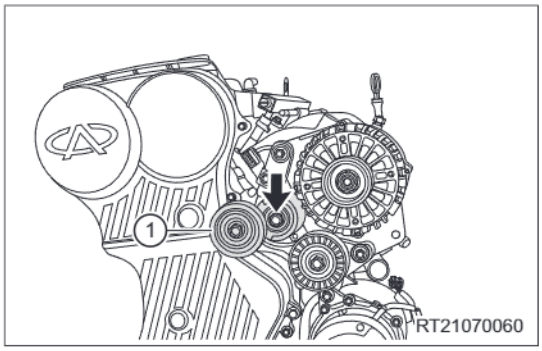
Belt Tensioner Assembly

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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the accessory drive belt (See page 07-24).
5. Remove the belt tensioner assembly.
   a. Remove the fixing bolt from belt tensioner assembly, and remove the belt tensioner assembly (1). (Tightening torque: 40 + 5 N·m)



Inspection

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

Installation

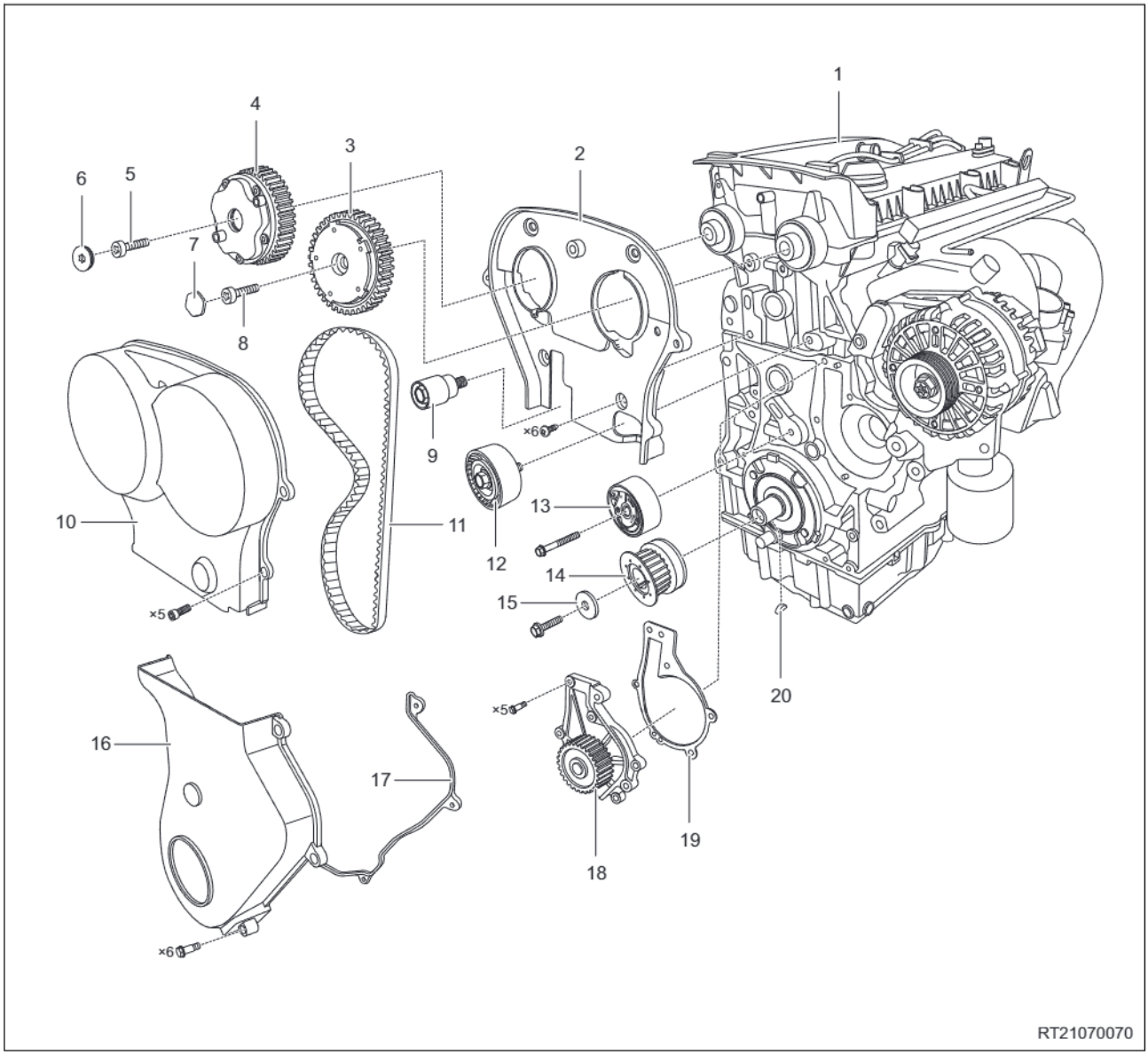
Installation is in the reverse order of removal.

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 the accessory drive belt.
- Make sure to install accessory drive belt in place, and not interfere with other components.

Engine Timing Belt

Description



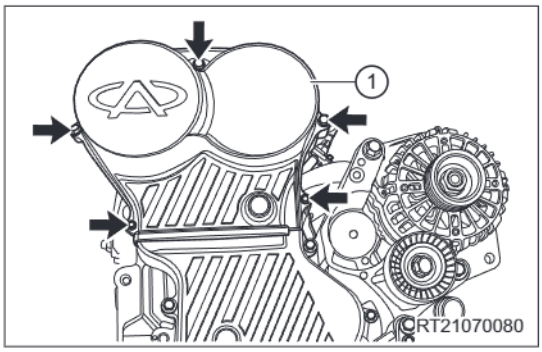
1 - Engine Assembly	2 - Timing Belt Rear Cover
3 - Intake Camshaft Phaser Assembly	4 - Exhaust Camshaft Phaser Assembly
5 - Exhaust Camshaft Phaser Assembly Fixing Bolt	6 - Exhaust Phaser Cover
7 - Intake Phaser Cover	8 - Intake Camshaft Phaser Assembly Fixing Bolt
9 - Contacting Idler Pulley	10 - Timing Belt Front Cover Upper Body
11 - Timing Belt	12 - Timing Belt Idler Pulley
13 - Timing Belt Tensioner	14 - Crankshaft Timing Pulley
15 - Camshaft Timing Pulley Fixing Bolt Washer	16 - Timing Belt Front Cover Lower Body
17 - Timing Belt Front Cover Lower Body Gasket	18 - Water Pump Assembly
19 - Water Pump Assembly Gasket	20 - Semi-circle Key

Removal

CAUTION

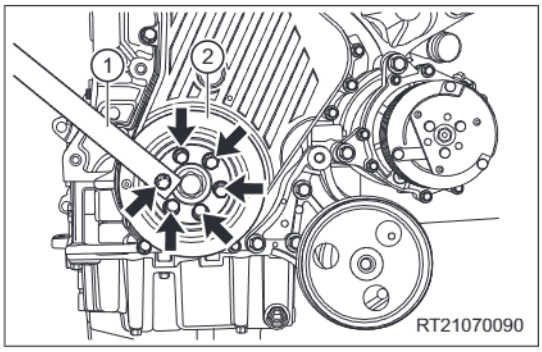
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Remove the accessory drive belt (See page 07-24).
6. Remove the belt tensioner assembly (See page 07-27).
7. Use an engine equalizer to hang the engine right lifting eye.
8. Remove the engine right mounting (See page 07-68).
9. Remove the timing belt front cover.
   a. Loosen and remove 5 fixing bolts (arrow) from timing belt front cover upper body, and remove the timing belt front cover upper body (1).
   (Tightening torque: 7 N·m)

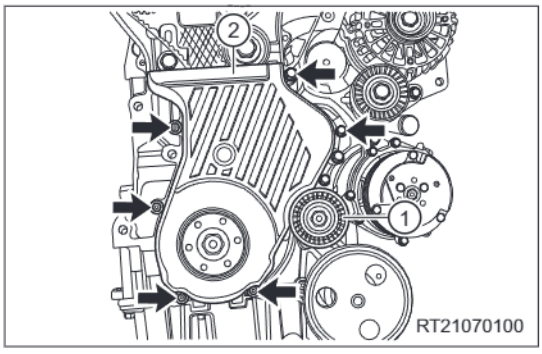


   b. Loosen and remove 6 fixing bolts (arrow) from crankshaft pulley, and remove the crankshaft pulley (1).
   (Tightening torque: 1st step: tighten to 25 ± 5 N·m; 2nd step: retighten by 30° ± 5°)

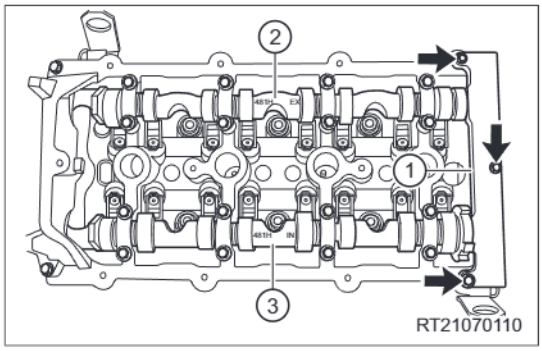
   HINT:
   Shift the transmission into 5th gear (for MT model) or D position (for CVT model) when loosening the crankshaft timing gear fixing bolt to engage the crankshaft and propeller shaft. Another technician depresses the brake pedal, which can lock the crankshaft by mechanical gear train.



   c. Loosen and remove the fixing bolt from accessory drive belt lower idler pulley assembly, and remove the accessory drive belt lower idler pulley assembly (1).
   (Tightening torque: 40 + 5 N·m)
   d. Loosen and remove 6 fixing bolts (arrow) from timing belt front cover lower body, and remove the timing belt front cover lower body (2).
   (Tightening torque: 7 N·m)



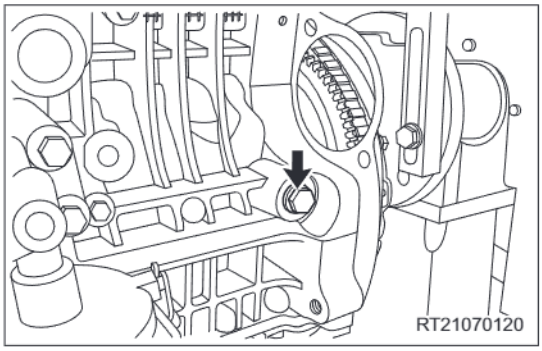
10. Remove the timing belt.
    a. Remove the cylinder head cover (See page 07-46).
    b. Turn the camshaft, install the camshaft timing tool (1), tighten the fixing bolts (arrow), and lock the exhaust camshaft (2) and intake camshaft (3).



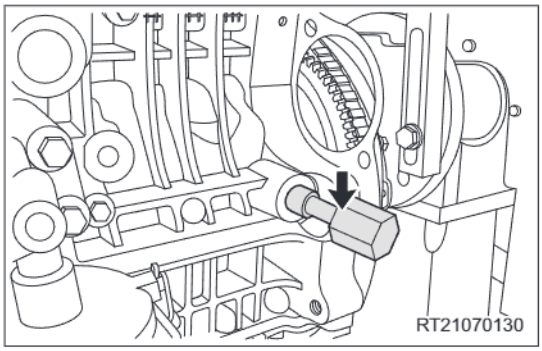
CAUTION

- After installing camshaft locking special tool, the crankshaft will be in the timing position, the camshaft timing tool can be installed at this time.

    c. Remove the plug (arrow) for installing crankshaft timing tool from the bottom of engine block. (Tightening torque: 40 + 5 N·m)



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

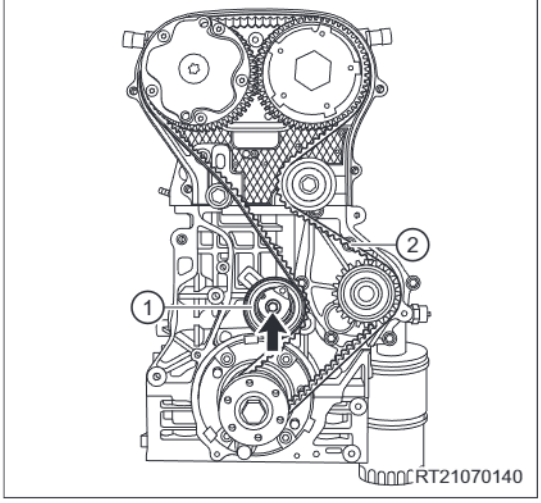


CAUTION

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

e. Remove the fixing bolt (arrow) from timing belt tensioner, and remove the timing belt tensioner assembly (1).
(Tightening torque: 20 + 5 N·m)

f. Remove the timing belt (2).



Inspection

1. Check timing belt.

CAUTION

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

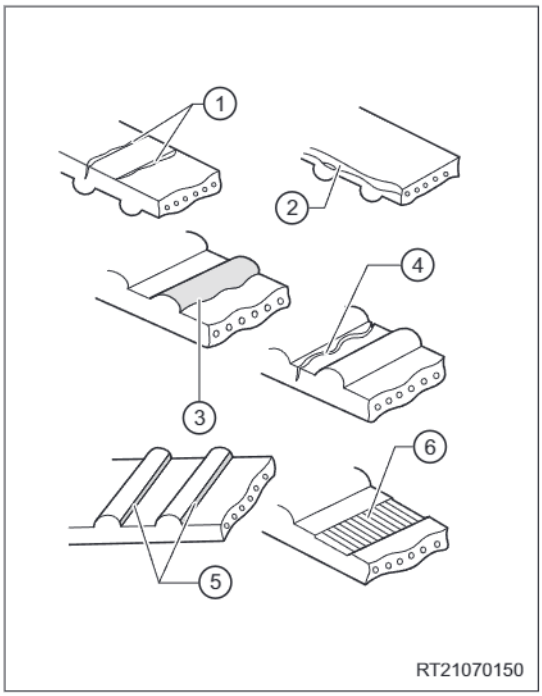
If the timing belt has the following conditions, replace it.

a. There are cracks on the back of belt: as shown in the illustration (1).

b. There are cracks at the bottom or cord fabric layer of belt: as shown in the illustration (2), (3) and (5).

c. Belt worn: as shown in the illustration (6).

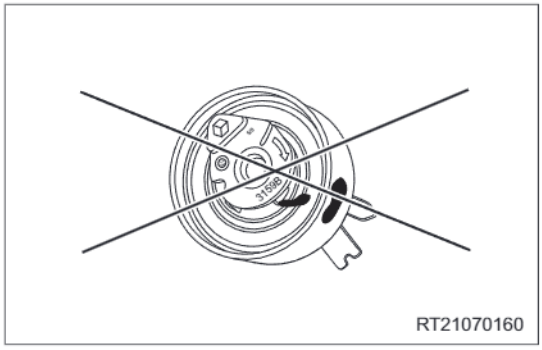
d. Belt teeth missing and damaged: as shown in the illustration (4) and (6).



CAUTION

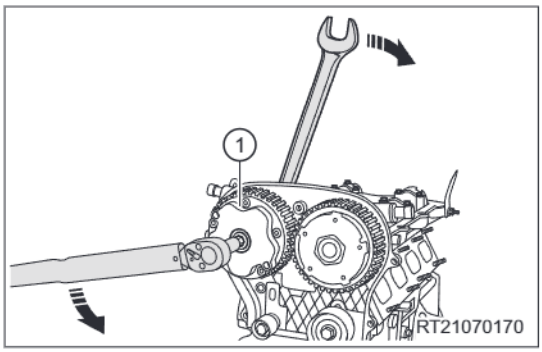
- Check timing belt carefully before installation. If any of above conditions occurs, replace the timing belt.

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


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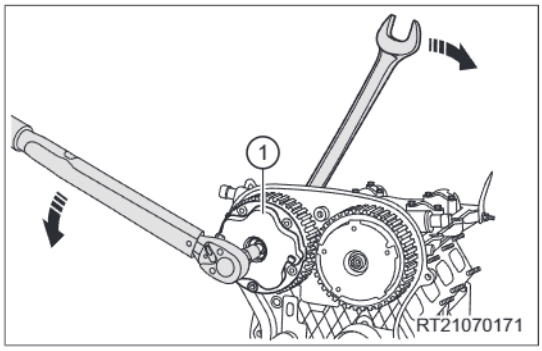
Installation

1. Loosen the exhaust camshaft phaser assembly.
   a. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the exhaust phaser cover (1) with a torque wrench in the direction of arrow as shown in the illustration.
   (Tightening torque: 30 N·m)
   b. Remove the exhaust phaser cover.



RT21070170

   c. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the fixing bolt of exhaust camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration.
   (Tightening torque: 120 ± 5 N·m)

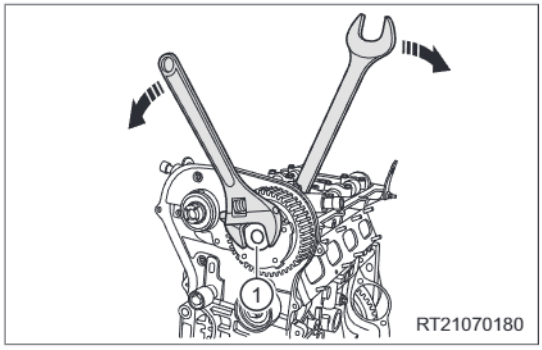


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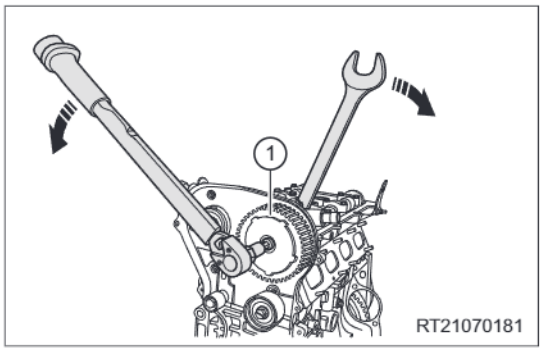
CAUTION

- Loosen exhaust camshaft phaser assembly without removing it.

2. Loosen the intake camshaft phaser assembly.
   a. While holding the hexagon surface on intake camshaft with an open wrench, loosen the intake phaser cover (1) with the monkey wrench in the direction of arrow as shown in the illustration.
   (Tightening torque: 30 N·m)
   b. Remove the intake phaser cover.



   c. While holding the hexagon surface on intake camshaft with an open wrench, loosen the fixing bolt of intake camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration.
   (Tightening torque: 120 ± 5 N·m)

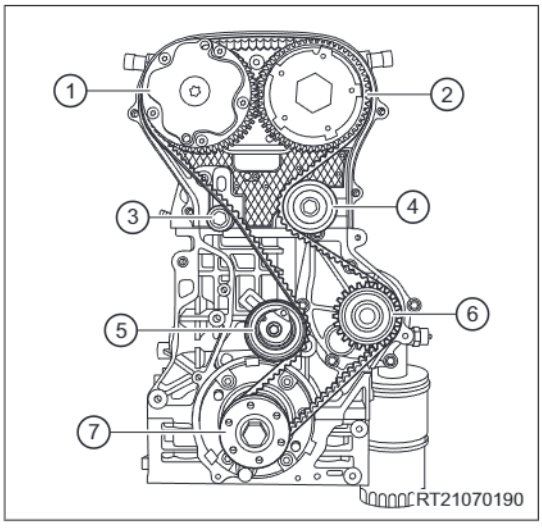


CAUTION

- Loosen intake camshaft phaser assembly without removing it.

3. Install the timing belt.

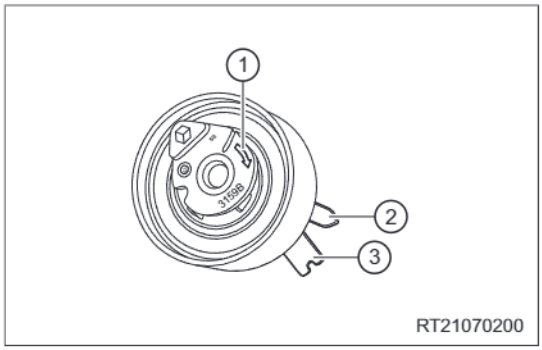
   HINT:
   Install the timing belt and be sure that the exhaust camshaft phaser assembly (1), intake camshaft phaser assembly (2), crankshaft timing belt pulley (7) and coolant pump pulley (6) are at inside of timing belt tooth. Also, the timing belt tensioner (5), contacting idler pulley (3) and timing belt idler pulley (4) are at outside of tooth.



4. Install the timing belt tensioner.
   a. Install the fixing bolt to timing belt tensioner by hand, and do not tighten the fixing bolt of timing belt tensioner.

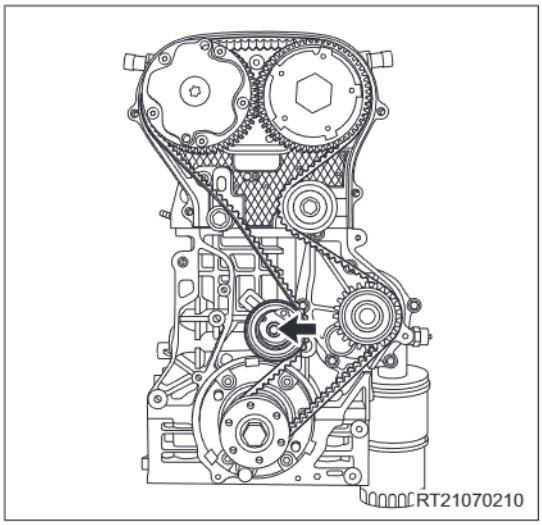
b. Using a suitable inner hexagon wrench, adjust the tensioner adjuster in the adjustment direction (1) of timing belt tensioner, and also tighten the fixing bolt with a wrench until the timing belt tensioner needle (2) and timing notch mark (3) of base are aligned.

HINT:
After marks of tensioner are aligned, return to an angle after rotating by 5° - 10°, then align the marks again.

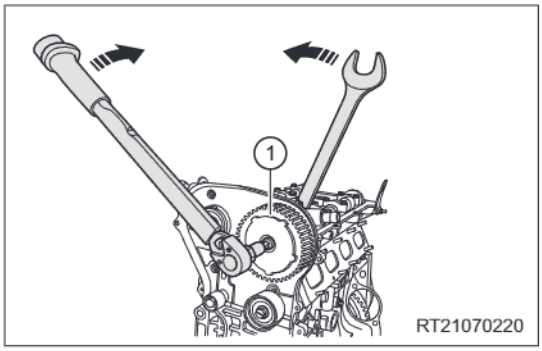


RT21070200

5. Tighten the timing belt tensioner fixing bolt (arrow).
(Tightening torque: 20 + 5 N·m)

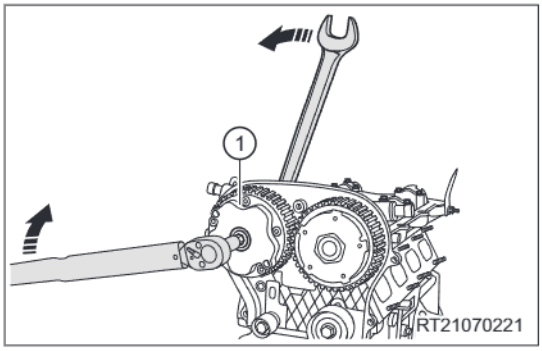

RT21070210

6. Tighten the intake camshaft phaser assembly (1) fixing bolt.
(Tightening torque: 120 ± 5 N·m)



RT21070220

7. Tighten the exhaust camshaft phaser assembly (1) fixing bolt.
(Tightening torque: 120 ± 5 N·m)



RT21070221

8. Remove the camshaft locking special tool.
9. Remove the crankshaft timing tool, and install the plug.
(Tightening torque: 40 + 5 N·m)

CAUTION

- Rotate the crankshaft 2 turns, and check the tension of timing belt tensioner. The tension of timing belt is 375 - 483 N. If alignment marks of timing belt tensioner are not aligned, loosen the tensioner fixing bolt, and adjust the tensioner again.
- In order to ensure the usage life of timing belt, it is necessary to perform timing belt self-adjustment operation.

10. Perform timing belt self-adjustment.
    a. Turn the crankshaft to run timing belt several circles smoothly.
    b. Install the camshaft locking special tool.
    c. Install the crankshaft timing tool.
    d. Loosen the fixing bolts of exhaust/intake camshaft phaser assembly, so that the timing belt returns to natural state.
    e. Tighten the exhaust/intake camshaft phaser assembly fixing bolt.
    f. Remove the camshaft locking special tool.
    g. Remove the crankshaft timing tool.
11. Tighten the intake/exhaust phaser covers.
    (Tightening torque: 30 N·m)
12. Other installation procedures are in the reverse order of removal.

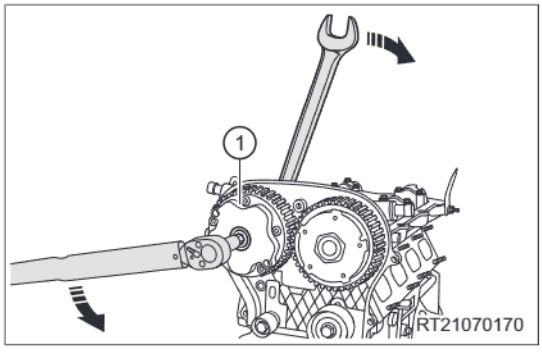
Camshaft Oil Seal

Removal

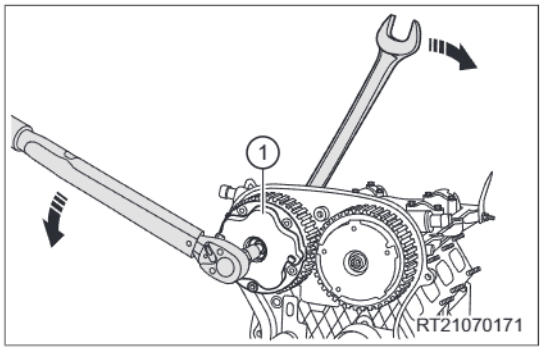
CAUTION

- 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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Remove the accessory drive belt (See page 07-24).
6. Remove the belt tensioner assembly (See page 07-27).
7. Use an engine equalizer to hang the engine right lifting eye.
8. Remove the engine right mounting (See page 07-68).
9. Remove the engine timing belt (See page 07-28).
10. Remove the exhaust camshaft phaser assembly.
    a. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the exhaust phaser cover (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the exhaust phaser cover.
    (Tightening torque: 30 N·m)

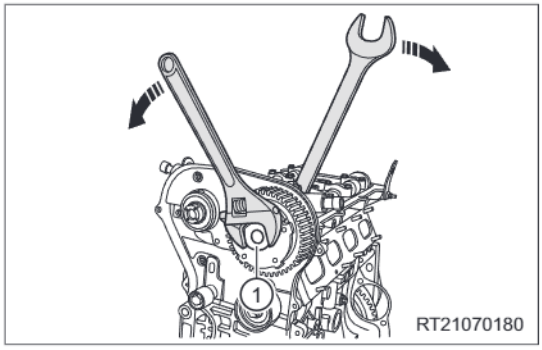


    b. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the fixing bolt of exhaust camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the exhaust camshaft phaser assembly.
    (Tightening torque: 120 ± 5 N·m)

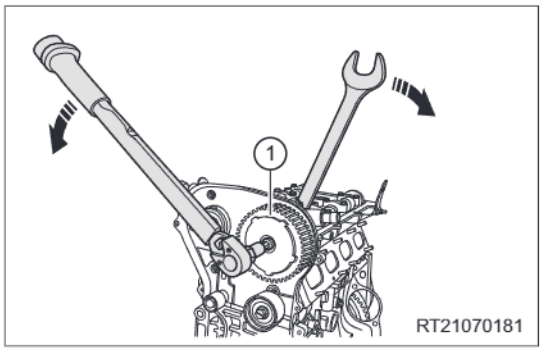


11. Remove the intake camshaft phaser assembly.

a. While holding the hexagon surface on intake camshaft with an open wrench, loosen the intake phaser cover (1) with the monkey wrench in the direction of arrow as shown in the illustration, and remove the intake phaser cover.
(Tightening torque: 30 N·m)

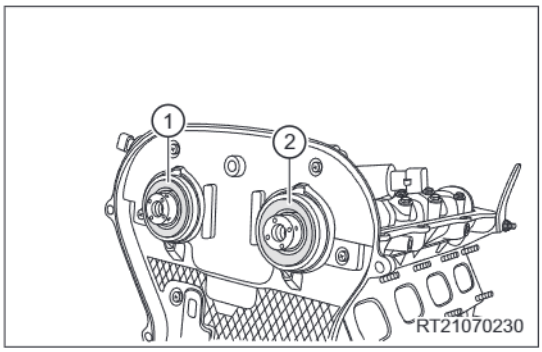


b. While holding the hexagon surface on intake camshaft with an open wrench, loosen the fixing bolt of intake camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the intake camshaft phaser assembly.
(Tightening torque: 120 ± 5 N·m)



12. Remove the camshaft oil seal.

a. Using a flat tip screwdriver wrapped with tape, pry out the exhaust camshaft oil seal (1) and intake camshaft oil seal (2) carefully.



CAUTION

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

Installation

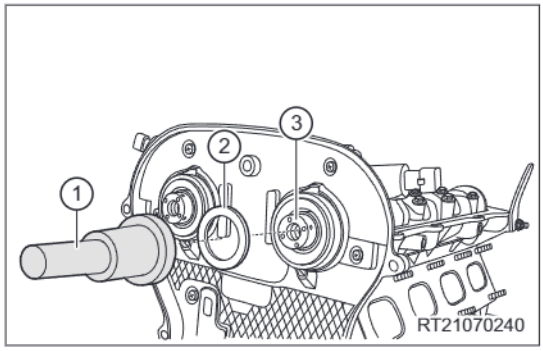
CAUTION

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

1. Install the camshaft oil seal.

   HINT:
   - Use the same installation procedures for the exhaust camshaft oil seal and intake camshaft oil seal.
   - Procedures listed below are for intake camshaft oil seal.

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



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

Crankshaft Front Oil Seal

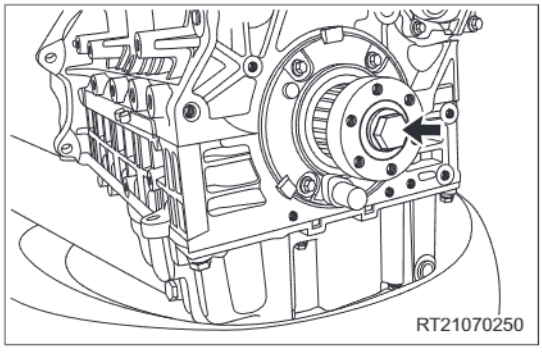
Removal

CAUTION

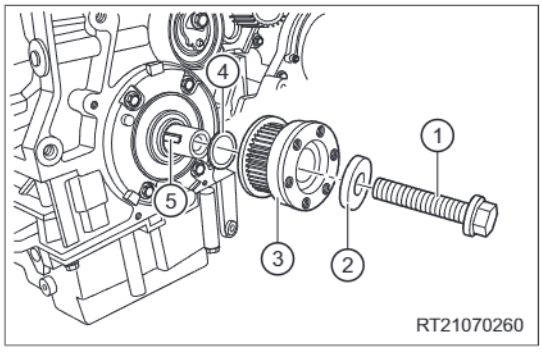
- Be sure to wear necessary safety equipment to prevent accidents when repairing.
- Try to prevent body paint surface from being scratched during removal and installation.

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Remove the accessory drive belt (See page 07-24).
6. Remove the belt tensioner assembly (See page 07-27).
7. Use an engine equalizer to hang the engine right lifting eye.
8. Remove the engine right mounting (See page 07-68).
9. Remove the engine timing belt (See page 07-28).
10. Remove the crankshaft timing pulley.
    a. Loosen the crankshaft timing pulley fixing bolt (arrow). (Tightening torque: 1st step: tighten to 130 ± 10 N·m; 2nd step: retighten by 65° ± 5°)

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



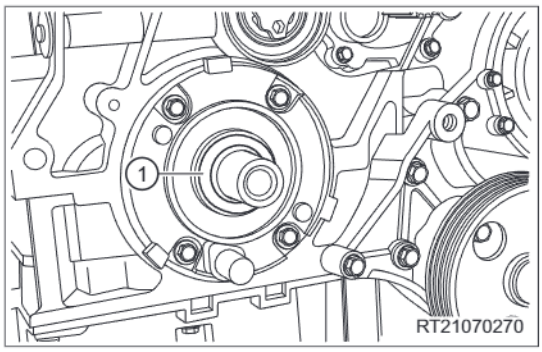
    b. Remove the timing pulley fixing bolt (1), washer (2), crankshaft timing pulley (3), lining (4) and semi-circle key (5) in order.



CAUTION

- Semi-circle key is small, so it is easy to be ignored. During installation, pay thorough attention not to forget to install.

11. Remove the crankshaft front oil seal.
    a. Using a flat tip screwdriver wrapped with tape, pry out the crankshaft front oil seal (1) carefully.



CAUTION

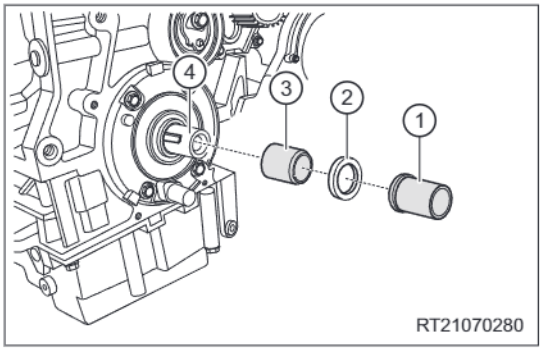
- Be careful not to damage the oil seal retainer and surface of crankshaft when removing crankshaft front oil seal.

Installation

CAUTION

- Apply a coat of engine oil to crankshaft front oil seal guide tool before installing the new oil seal.
- Remove the 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.

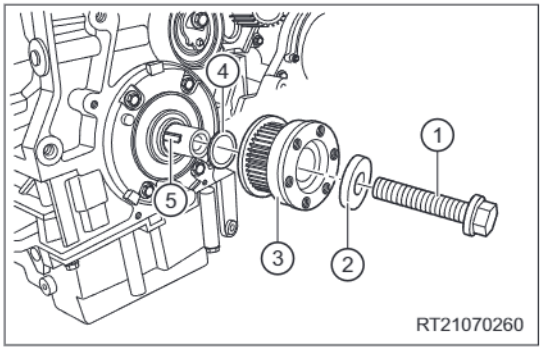
1. Remove the dirt around the crankshaft front oil seal retainer and on its inner wall.
2. Install the crankshaft front oil seal guide tool (3) to the crankshaft (4).
3. Install the new oil seal (2) to the crankshaft front oil seal guide tool, and install the new oil seal to the oil seal retainer completely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



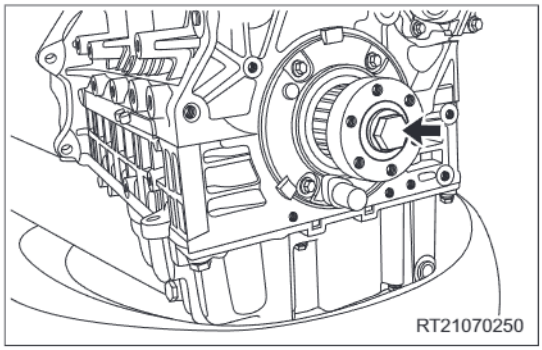
4. Install the lining (4).
5. Using a brass bar, install the semi-circle key (5) in place.

   HINT:
   Protrusion height of semi-circle key should be 2.2 - 2.3 mm.

6. Install the crankshaft timing pulley (3), washer (2) and bolt (1) in order.



7. Tighten the crankshaft timing pulley fixing bolt (arrow). (Tightening torque: 1st step: tighten to 130 ± 10 N·m; 2nd step: retighten by 65° ± 5°)



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

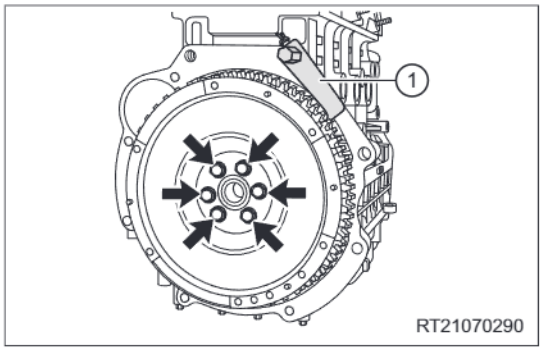
Flywheel

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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-21 for MT model, See page 18-130 for CVT model).
4. Remove the clutch assembly (See page 19-14).
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 35 ± 5 N·m; 2nd step: retighten by 45° ± 5°)



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.

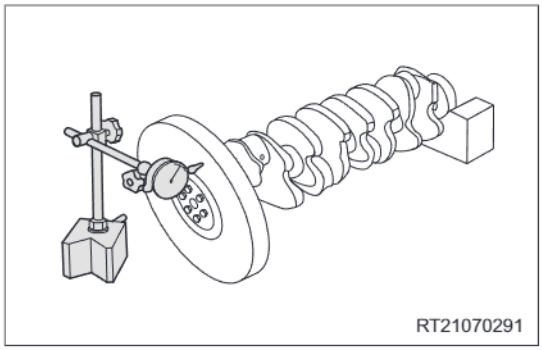
CAUTION

- 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 the signal gear before installation.
2. Check if starter drive gear ring is worn. If excessively worn, replace the flywheel.
3. Check contact surface of clutch lining. If the contact surface is damaged or excessively worn, replace the flywheel with a new one.

4. Measure flywheel end surface runout with the dial indicator. If measured value exceeds the limit, replace the flywheel with a new one.
   Limit for end surface runout: 0.2 mm


RT21070291

Installation

⚠ WARNING

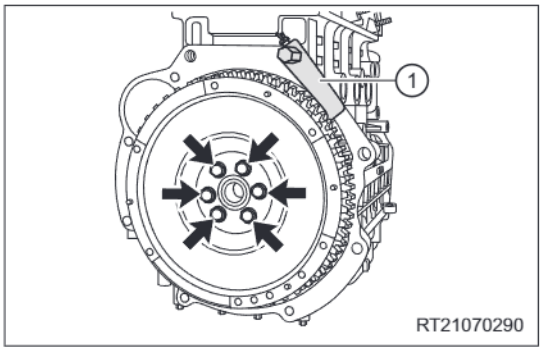
- Never reuse flywheel fixing bolts after removal.
- Make sure to use new flywheel fixing bolts with seal gum before installation.

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 the 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 followings:

1. Align the flywheel installation hole with the crankshaft positioning journal and then push lightly during assembly. Do not tap the flywheel with a hammer.
2. Replace the flywheel fixing bolts with precoated seal gum with new ones.
3. Install the flywheel fixing bolts (arrow), and then hold the flywheel securely with the flywheel holding tool (1). Tighten the flywheel fixing bolts.
   (Tightening torque: 1st step: tighten to 35 ± 5 N·m; 2nd step: retighten by 45° ± 5°)



RT21070290

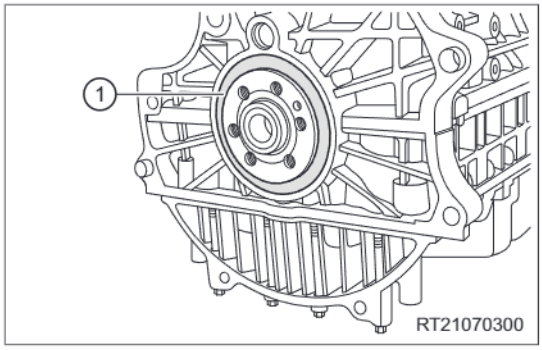
Crankshaft Rear Oil Seal

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 the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the transmission assembly (See page 17-21 for MT model, See page 18-130 for CVT model).
4. Remove the clutch assembly (See page 19-14).
5. Remove the flywheel (See page 07-42).
6. Remove the crankshaft rear oil seal.
   a. Using a screwdriver with the tip wrapped with tape, remove the crankshaft rear oil seal (1).



CAUTION

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

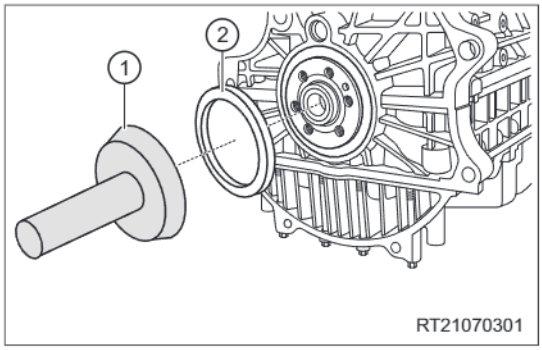
Installation

CAUTION

- Be sure to clean the dirt around oil seal retainer and on the inner 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. Replace the new crankshaft rear oil seal.
2. Using the crankshaft rear oil seal installer (1), install the oil seal (2) with the part number side facing outward.

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



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

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 when repairing to prevent accidents.
- Try to prevent body paint surface from being scratched during removal and installation.

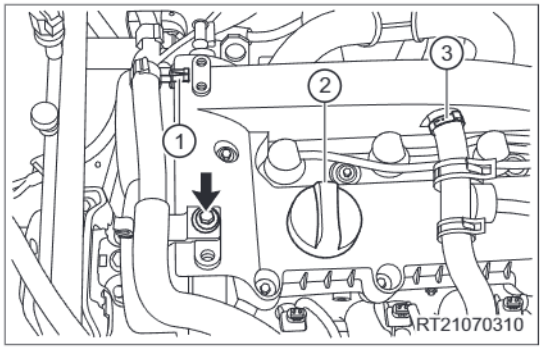
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the cylinder head cover.

a. Remove the engine wire harness assembly fixing bolt (arrow). (Tightening torque: 7 ± 1 N·m)

b. Remove the connecting clip (1) between engine wire harness assembly and cylinder head cover.

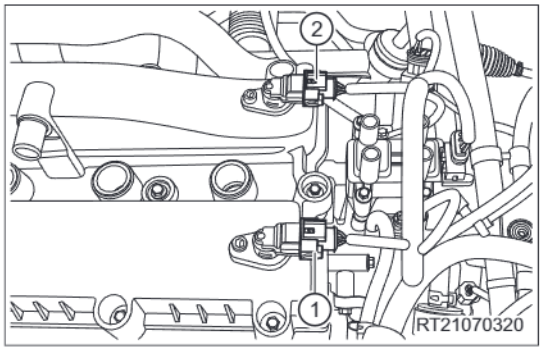
c. Rotate the fuel tank cap (2) counterclockwise to remove it.

d. Remove the clamp (3) and disconnect the connection between crankcase ventilation hose and cylinder head cover.



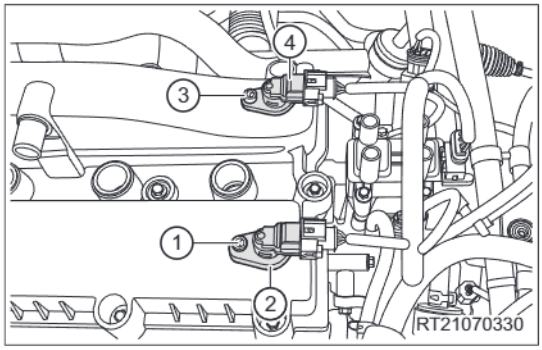
e. Remove the high-voltage cables (See page 14-8).

f. Disconnect the intake camshaft position sensor connector (1) and exhaust camshaft position sensor connector (2).

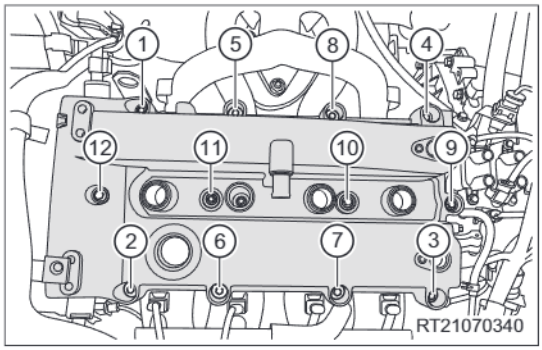


g. Remove the fixing bolt (1) from intake camshaft position sensor and remove the intake camshaft position sensor (2) from cylinder head cover. (Tightening torque: 8 ± 0.5 N·m)

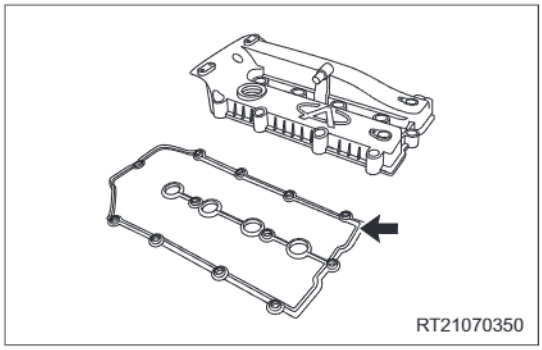
h. Remove the fixing bolt (3) from exhaust camshaft position sensor and remove the exhaust camshaft position sensor (4) from cylinder head cover. (Tightening torque: 8 ± 0.5 N·m)



i. Remove 12 fixing bolts from cylinder head cover in the order shown in the illustration.
(Tightening torque: 8 + 3 N·m)



j. Remove the cylinder head cover gasket (arrow) from cylinder head cover.

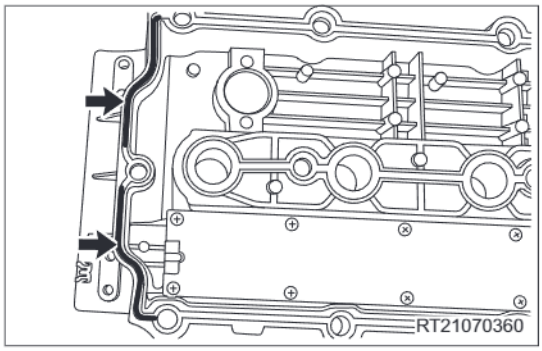


5. Remove the trim cover rear right bracket and rear left bracket from cylinder head cover.

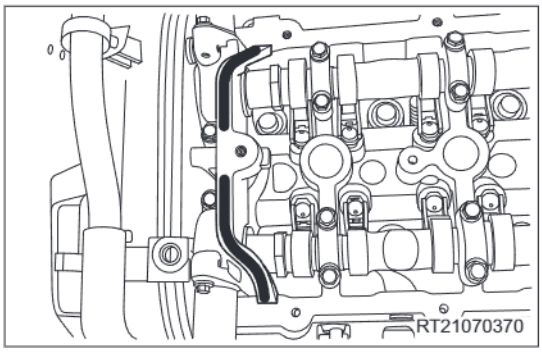
Installation

1. Remove the residue of seal gum on camshaft 1st bearing cap and cylinder head cover with a scraper.
2. Replace the cylinder head cover gasket.
3. Install the cylinder head cover gasket into the groove of cylinder head cover.

   HINT:
   Before installing cylinder head cover gasket, apply seal gum to the cylinder head cover groove in the areas as shown in the illustration. Avoid gasket falling out from groove during installation.

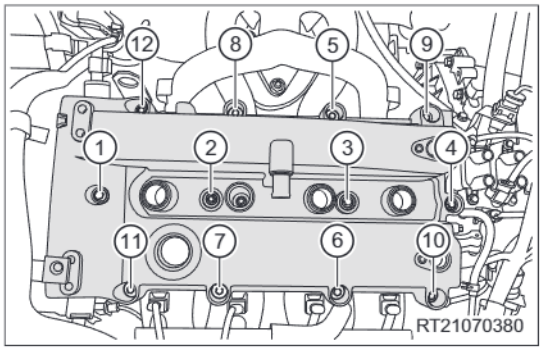


4. Apply seal gum to connecting part of camshaft 1st bearing cap and cylinder head cover in the oval areas as shown in the illustration.



5. Install the cylinder head cover, and tighten the cylinder head cover fixing bolts to the specified torque in sequence shown in the illustration.

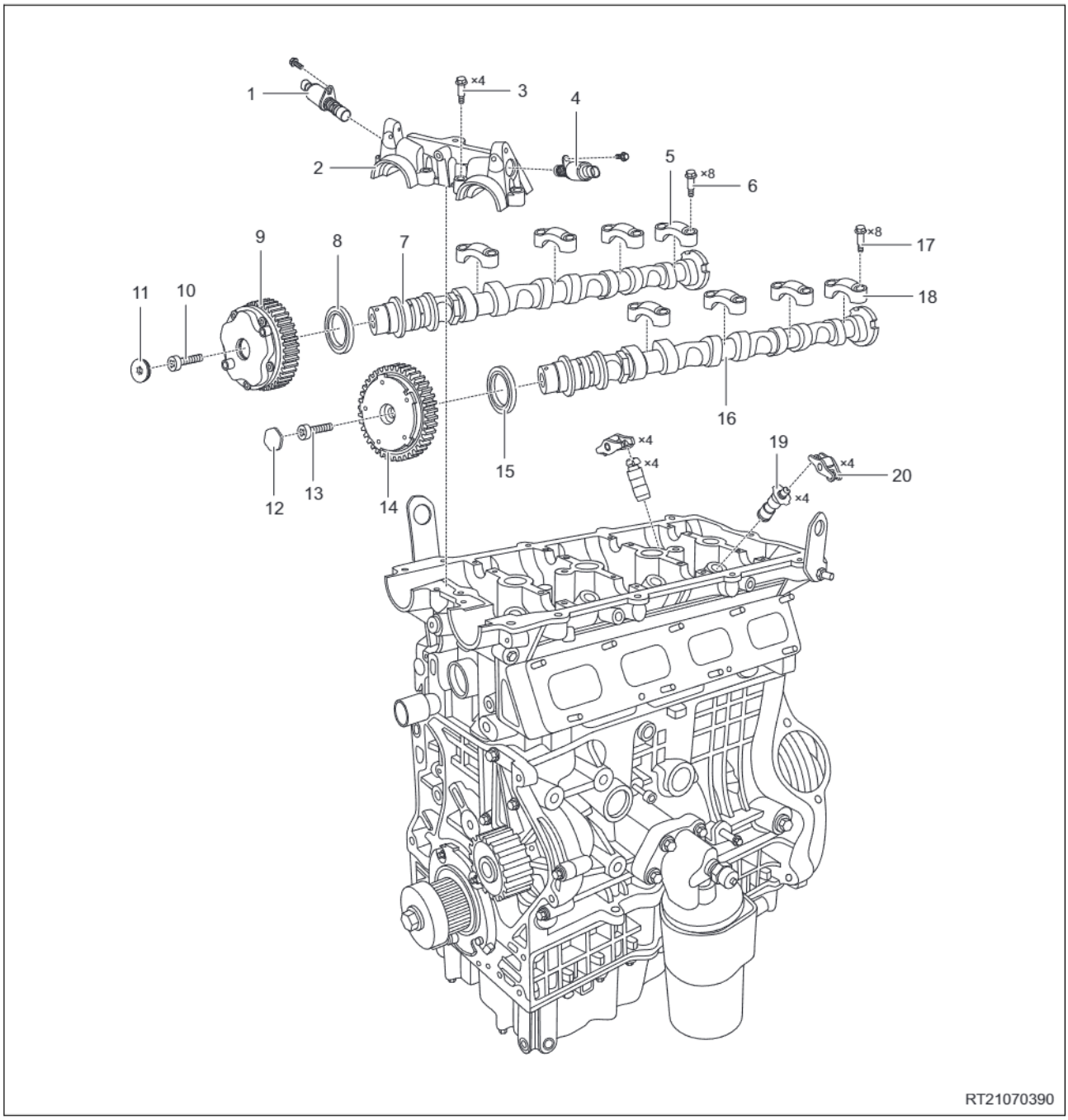
   HINT:
   First screw the bolts in order until they press against the cylinder head and fit closely with cylinder head, then tighten them again to the specified torque in order.



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

Camshaft

Description



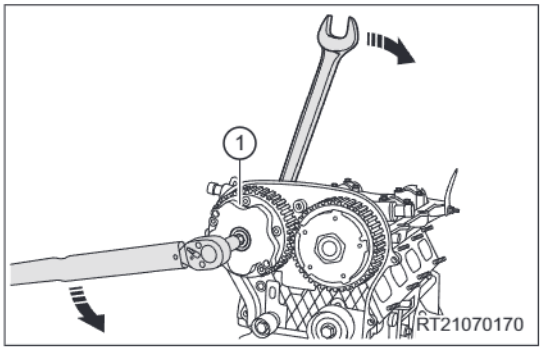
1 - Exhaust VVT Control Valve	2 - Camshaft 1st Bearing Cap
3 - Camshaft 1st Bearing Cap Fixing Bolt	4 - Intake VVT Control Valve
5 - Exhaust Camshaft Bearing Cap	6 - Exhaust Camshaft Bearing Cap Fixing Bolt
7 - Exhaust Camshaft	8 - Exhaust Camshaft Oil Seal
9 - Exhaust Camshaft Phaser Assembly	10 - Exhaust Camshaft Phaser Assembly Fixing Bolt
11 - Exhaust Phaser Cover	12 - Intake Phaser Cover
13 - Intake Camshaft Phaser Assembly Fixing Bolt	14 - Intake Camshaft Phaser Assembly
15 - Intake Camshaft Oil Seal	16 - Intake Camshaft
17 - Intake Camshaft Bearing Cap Fixing Bolt	18 - Intake Camshaft Bearing Cap
19 - Hydraulic Lifter	20 - Rocker Arm

Removal

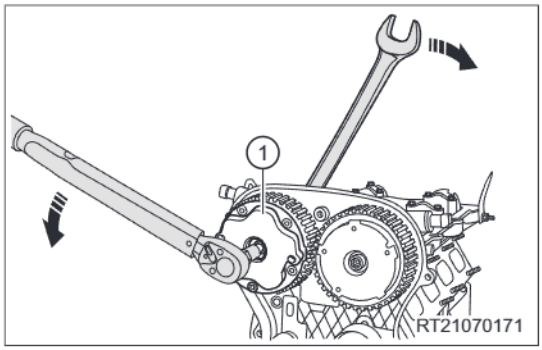
CAUTION

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

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the high-voltage cables (See page 14-8).
5. Remove the accessory drive belt (See page 07-24).
6. Remove the cylinder head cover assembly (See page 07-46).
7. Remove the intake/exhaust VVT control valve (See page 06-242).
8. Remove the engine timing belt (See page 07-28).
9. Remove the exhaust camshaft phaser assembly.
   a. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the exhaust phaser cover (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the exhaust phaser cover.
   (Tightening torque: 30 N·m)

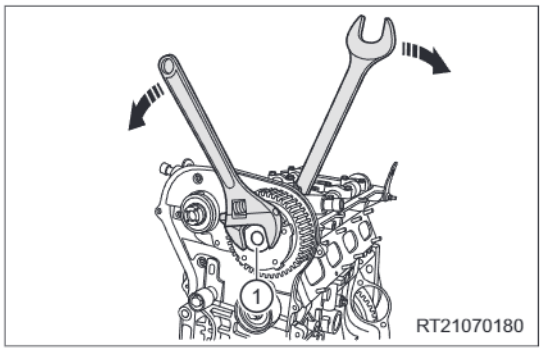


b. While holding the hexagon surface on exhaust camshaft with an open wrench, loosen the fixing bolt of exhaust camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the exhaust camshaft phaser assembly.
(Tightening torque: 120 ± 5 N·m)

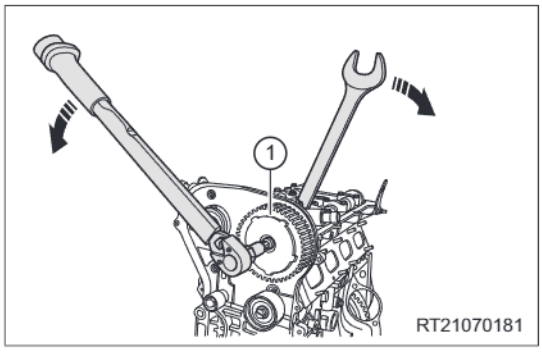


10. Remove the intake camshaft phaser assembly.

a. While holding the hexagon surface on intake camshaft with an monkey wrench, loosen the intake phaser cover (1) with the open wrench in the direction of arrow as shown in the illustration, and remove the intake phaser cover.
(Tightening torque: 30 N·m)

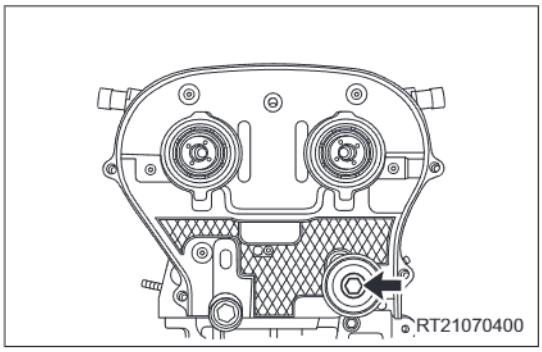


b. While holding the hexagon surface on intake camshaft with an open wrench, loosen the fixing bolt of intake camshaft phaser assembly (1) with a torque wrench in the direction of arrow as shown in the illustration, and remove the intake camshaft phaser assembly.
(Tightening torque: 120 ± 5 N·m)

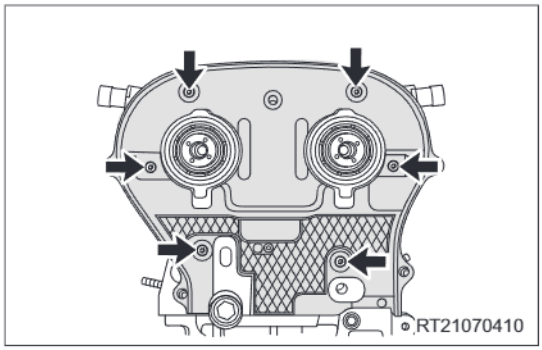


11. Remove the timing belt rear cover.

a. Remove the timing belt idler pulley fixing bolt (arrow) and remove the timing belt idler pulley.
(Tightening torque: 40 + 5 N·m)

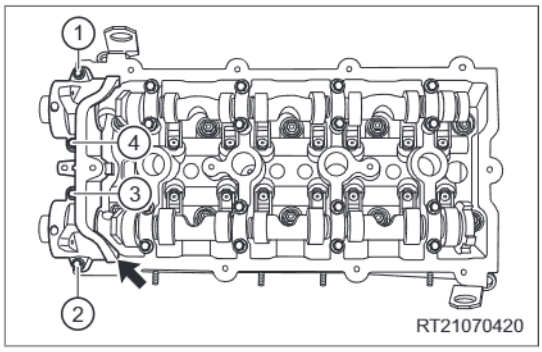


b. Remove 6 timing belt rear cover fixing screws (arrow) and remove the timing belt rear cover.
(Tightening torque: 5 + 2 N·m)



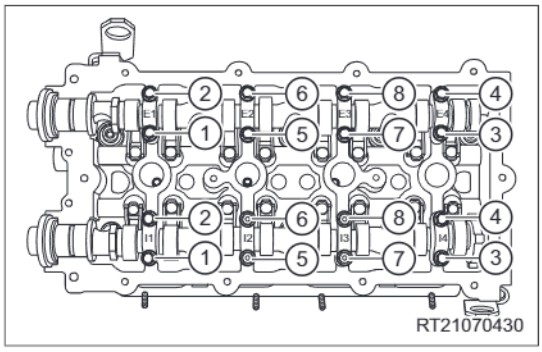
12. Remove the camshaft.

a. Remove 4 camshaft 1st bearing cap fixing bolts in the order shown in the illustration and remove the camshaft 1st bearing cap (arrow).
(Tightening torque: 8 + 3 N·m)



b. Remove the intake/exhaust camshaft bearing cap fixing bolts separately in the order shown in the illustration, and place the romoved camshaft bearing caps in order.
(Tightening torque: 8 + 3 N·m)

HINT:
During removal, tighten the fixing bolts in steps in the order shown in the illustration.

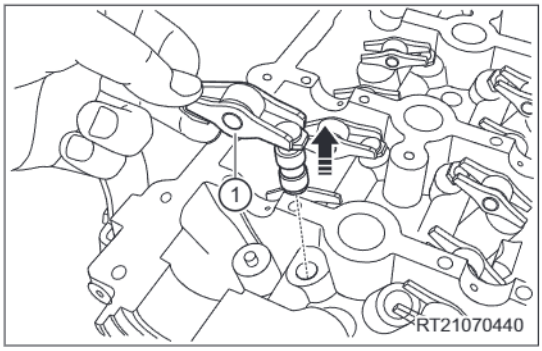


c. Remove the intake camshaft and exhaust camshaft.

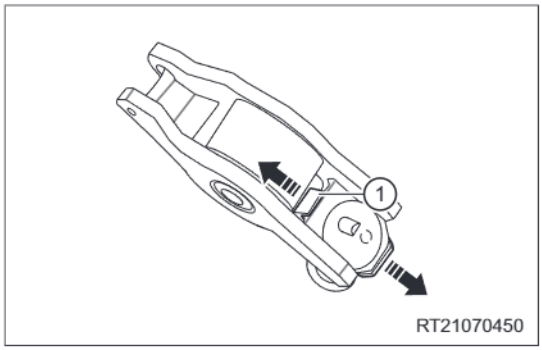
d. Remove the intake camshaft oil seal and exhaust camshaft oil seal separately.

13. Remove the rocker arm and hydraulic lifter.

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



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

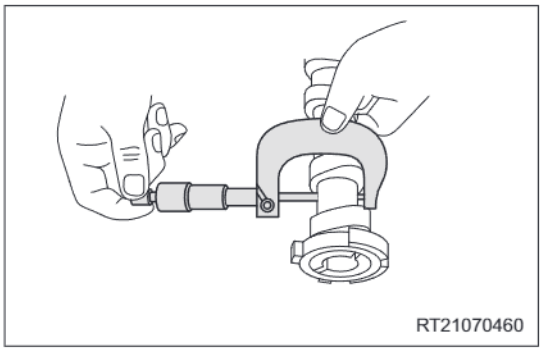


Inspection

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

   b. Check camshaft journal diameter.

      Measure camshaft journal diameter with the outer diameter micrometer.

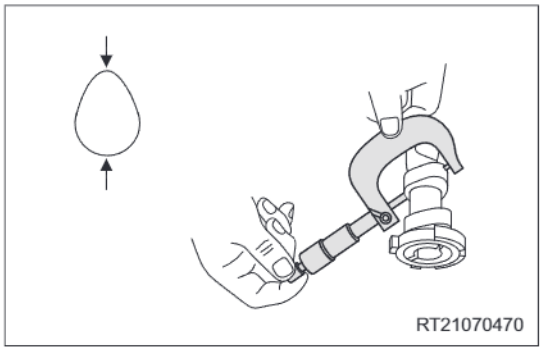


Measurement Item	Specification (mm)
Intake Camshaft Journal	ϕ23.947 - ϕ23.960
Exhaust Camshaft Journal	ϕ23.947 - ϕ23.960

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

   c. Check cam lift.

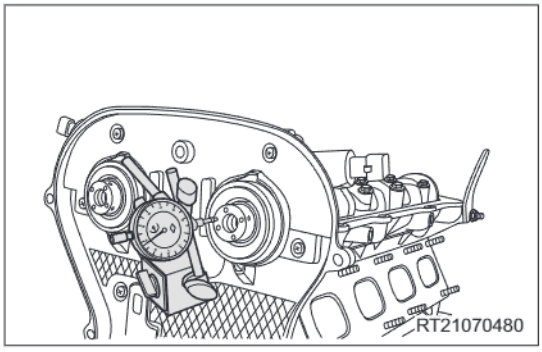
      Measure cam lift with the outer diameter micrometer as shown in the illustration.



Measurement Item	Specification (mm)
Intake Camshaft Journal	37.65
Exhaust Camshaft Journal	37.06

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

   d. Check camshaft axial clearance.
      - Reinstall the camshaft.
      - Keep measuring rod of dial indicator contacting with front end of camshaft. Turn the dial of dial indicator to reset it to zero.
      - Push camshaft forward and backward gently (do not rotate camshaft) and read the 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 the specified range, replace camshaft.

Installation

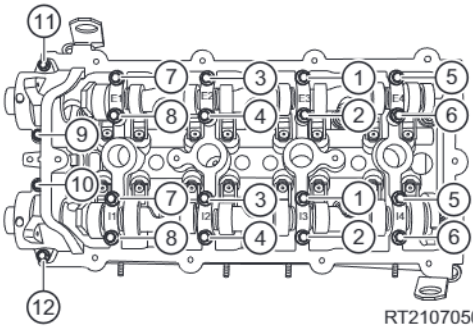
1. Clean the intake camshaft, exhaust camshaft, and camshaft bearing caps.
2. Apply seal gum to the bottom of camshaft 1st bearing cap evenly as shown in the illustration.


RT21070490

CAUTION

- Pay attention not to apply seal gum into the oil hole.

3. First screw the camshaft bearing cap fixing bolts by hand without tightening.
4. Tighten the camshaft bearing cap fixing bolts in the order shown in the illustration.

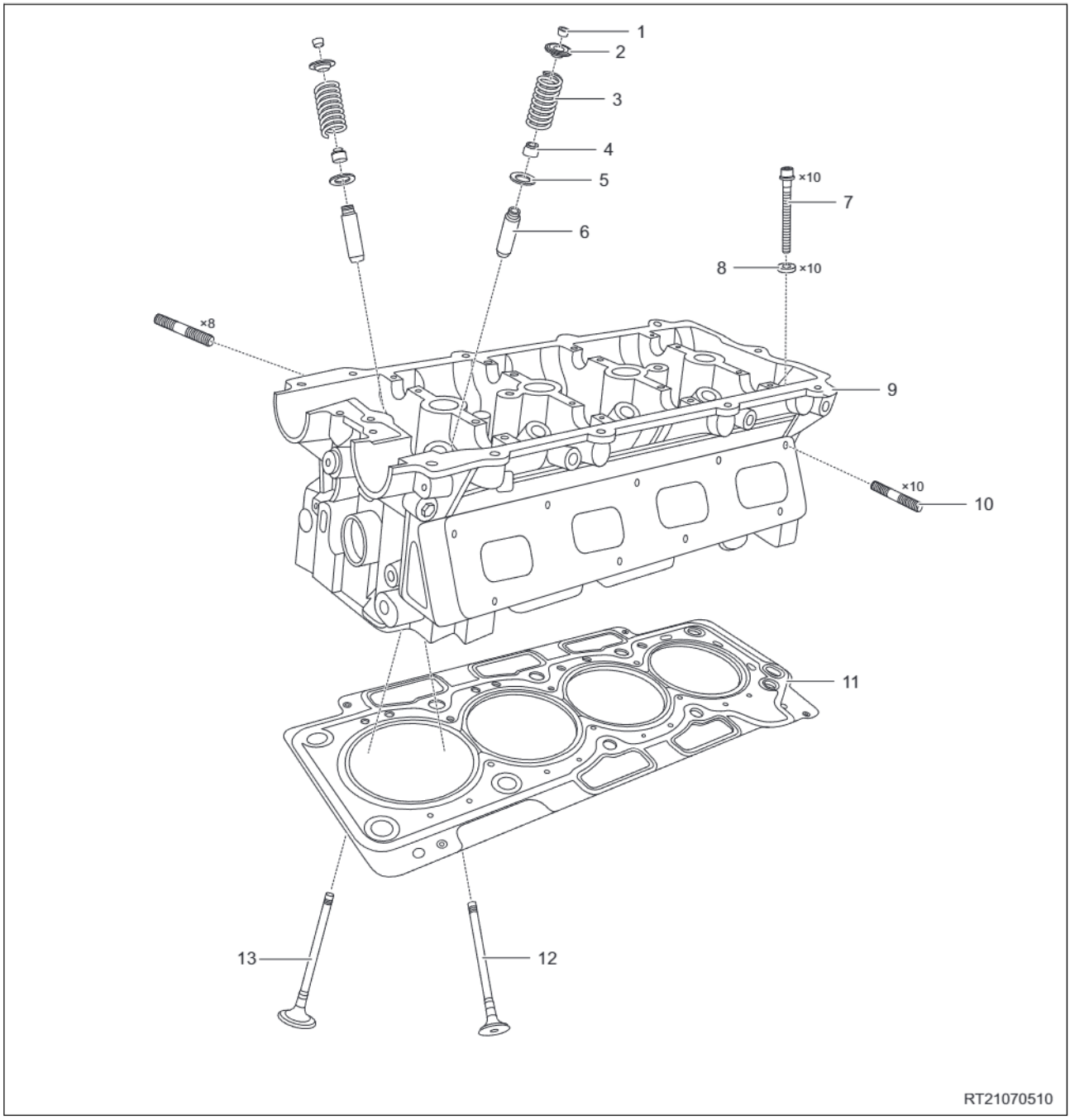


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5. Install the camshaft oil seals (See page 07-38).
6. Other installation procedures are in the reverse order of removal.

Cylinder Head

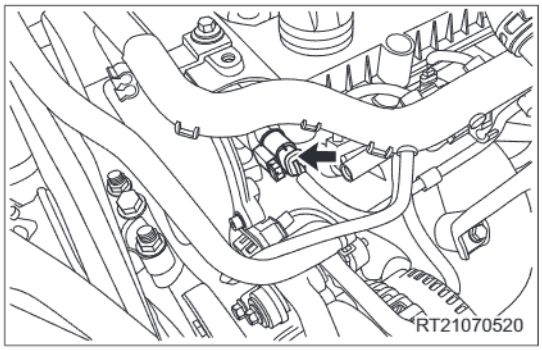
Description



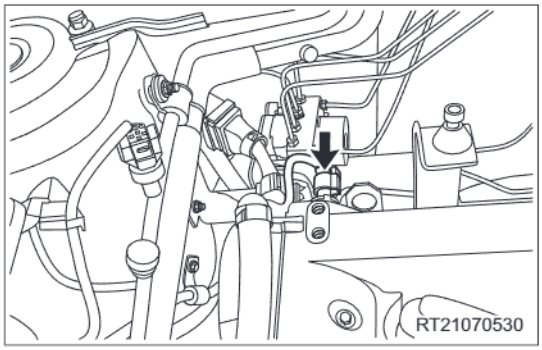
1 - Valve Cotter	2 - Valve Spring Upper Seat
3 - Valve Spring	4 - Valve Oil Seal
5 - Valve Spring Lower Seat	6 - Valve Guide
7 - Cylinder Head Fixing Bolt	8 - Cylinder Head Fixing Bolt Washer
9 - Cylinder Head	10 - Stud
11 - Cylinder Gasket	12 - Exhaust Valve
13 - Intake Valve	

Removal

1. Release fuel system pressure (See page 08-10).
2. Turn off all the electrical equipment and ignition switch.
3. Disconnect the negative battery cable.
4. Drain the coolant (See page 12-13).
5. Remove the high-voltage cables (See page 14-8).
6. Remove the spark plugs (See page 14-12).
7. Remove the ignition coil (See page 14-10).
8. Remove the thermostat (See page 12-19).
9. Remove the thermostat seat (See page 12-22).
10. Remove the fuel rail injector assembly (See page 08-26).
11. Remove the exhaust manifold assembly (See page 11-7).
12. Disconnect the intake VVT control vavle connector (arrow).

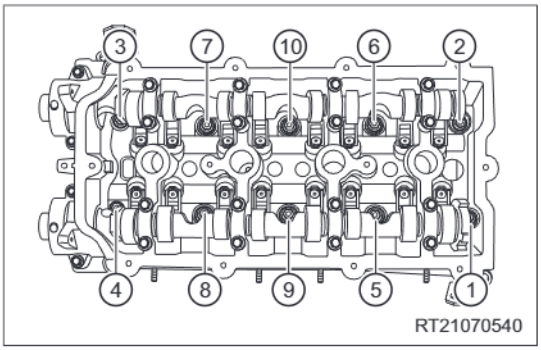


13. Disconnect the exhaust VVT control vavle connector (arrow).



14. Remove the electronic throttle assembly (See page 10-20).
15. Remove the intake manifold assembly (See page 10-24).
16. Remove the accessory drive belt (See page 07-23).
17. Use an engine equalizer to hang the engine.
18. Remove the engine timing belt (See page 07-28).
19. Remove the cylinder head cover (See page 07-46).
20. Remove the exhaust camshaft phaser assembly (See page 07-50).
21. Remove the intake camshaft phaser assembly (See page 07-51).
22. Remove the timing belt rear cover (See page 07-51).

23. Rotate intake/exhaust camshafts to a proper position with an appropriate wrench, and remove the cylinder head fixing bolts in the sequence from (1) to (10) shown in the illustration.



CAUTION

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

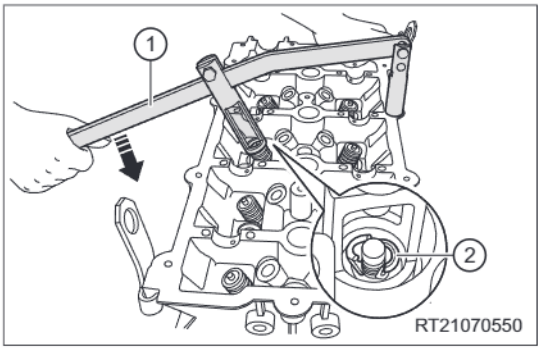
24. Remove the cylinder head and cylinder head gasket.

CAUTION

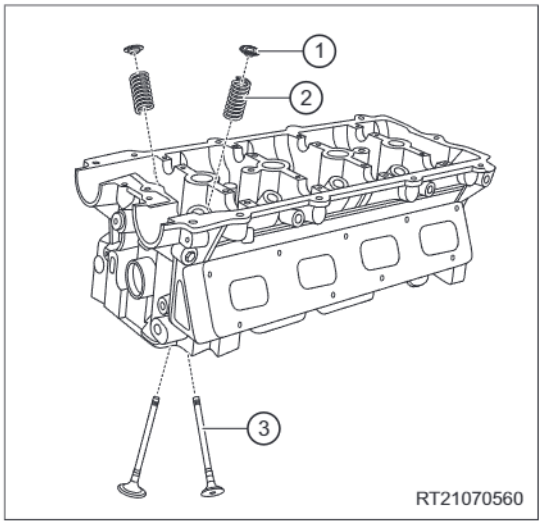
- Replace the used gasket with a new one.

Disassembly

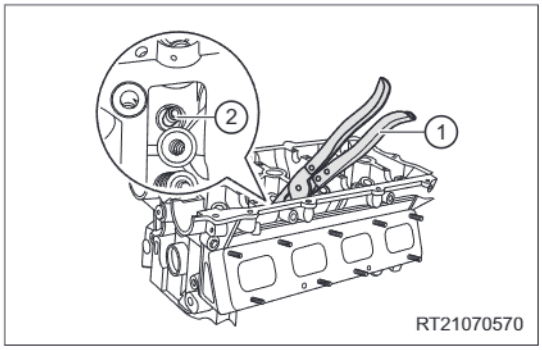
1. Remove the camshaft (See page 07-52).
2. Remove the rocker arm and hydraulic lifter (See page 07-52).
3. Using a special tool (valve spring compressor) (1), compress the valve spring and remove the valve cotter (2) with a flexional magnetic rod.



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



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

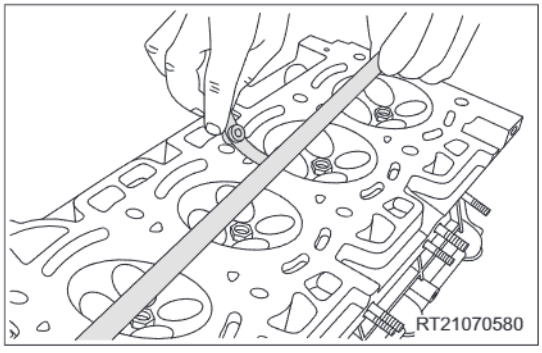


6. Using a flexional magnetic rod, remove the valve spring lower seat.

Inspection

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

      Using a precision ruler 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

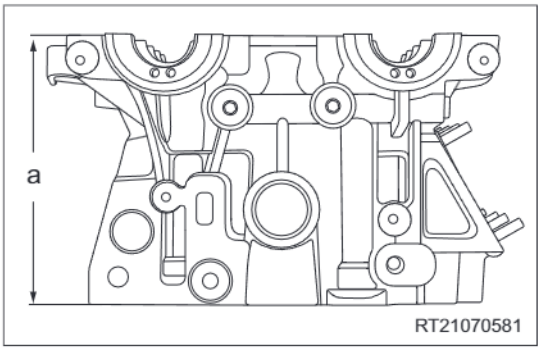
      If cylinder head flatness is not within the specified range, repair or replace cylinder head.

c. Check cylinder head height.

Using a precision ruler, measure cylinder head height.

Measurement Item	Specification (mm)
Cylinder Head Height	97

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



CAUTION

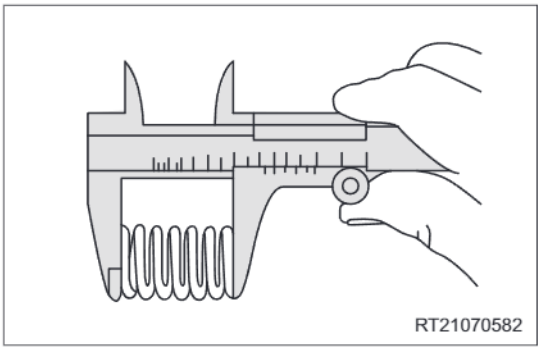
- During replacement, cylinder head should be fully equipped with valves, oil seals, springs, spring seats, cotters, hydraulic lifters and camshafts.

2. Check valve spring.

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

Measurement Item	Specification (mm)
Valve Spring Free Length	47.70
Valve Spring Length under Pre-pressure	41

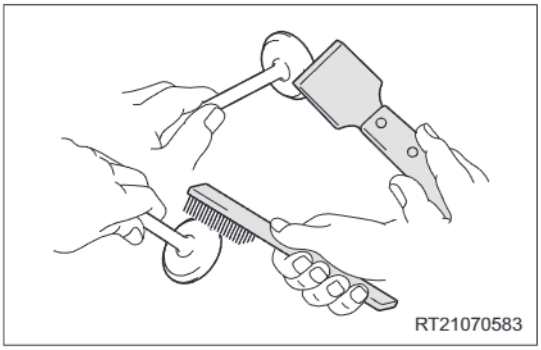
If valve spring length is not within the specified range, replace valve spring.



3. Check valve.

a. Clean valve.

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

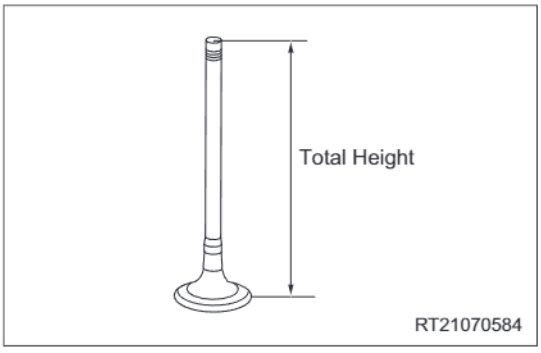


b. Check valve height.

Using a micrometer, measure valve height.

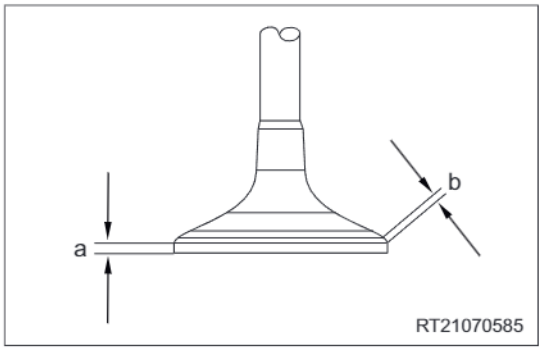
Measurement Item	Specification (mm)
Intake Valve Height	107.998
Exhaust Valve Height	106.318

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



c. Check valve head.

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

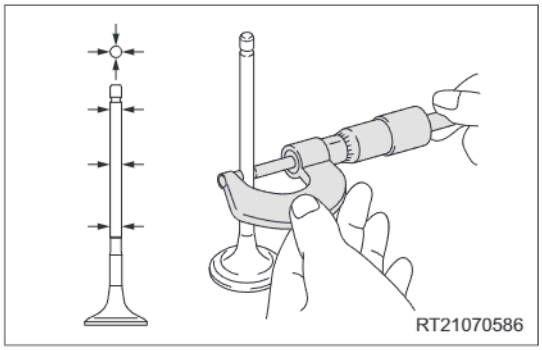


Measurement Item	Specification (mm)
Intake Valve Head Thickness	0.9
Exhaust Valve Head Thickness	0.7
Intake Valve Grommet Width	2.263
Exhaust Valve Grommet Width	2.828

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

d. Check valve stem diameter.

Using a micrometer, measure valve stem diameter.

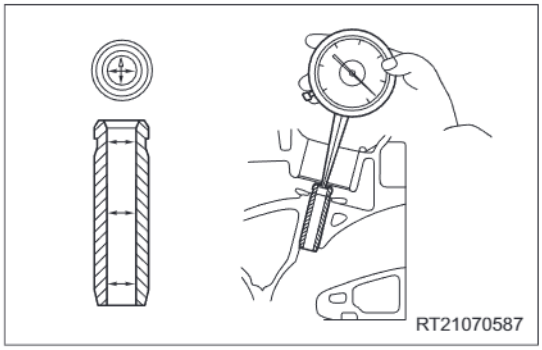


Measurement Item	Specification (mm)
Intake Valve Stem Diameter	ϕ5.98 ± 0.008
Exhaust Valve Stem Diameter	ϕ5.96 ± 0.008

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

e. Check clearance between valve and valve guide.

Using a caliper gauge, measure the inside diameter of valve guide.



Measurement Item	Specification (mm)
Valve Guide Inner Diameter	ϕ6 - ϕ6.015

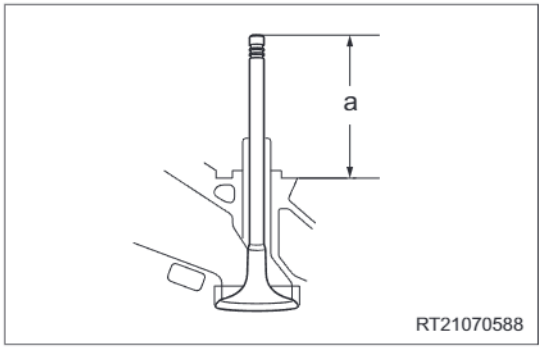
Clearance between valve and valve guide = Valve guide inner diameter - Valve stem diameter

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

If clearance is not within the 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	31.497 - 31.515
Exhaust Valve Stem Protrusion	31.497 - 31.515

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

07

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 the valve stem end when assembling the valve.

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

   HINT:
   Bottom of valve spring lower seat should face the cylinder head.

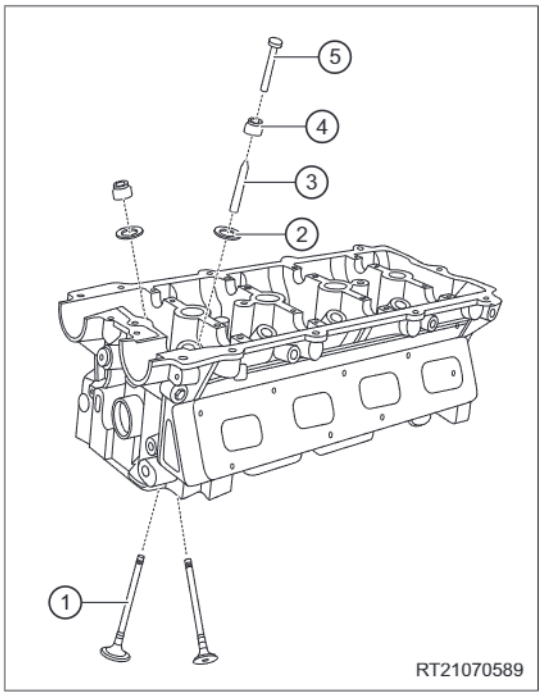
3. Install the valve oil seal.

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

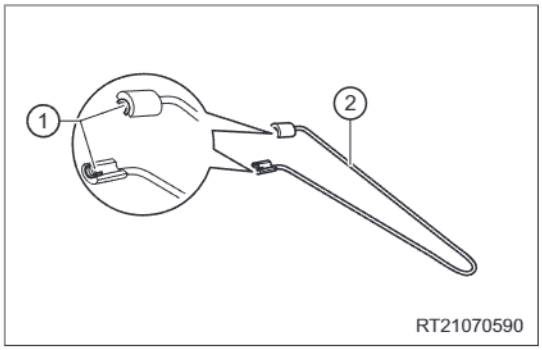
   a. Install the valve oil seal guide sleeve (3) to the valve stem.

   b. Install the valve oil seal (4) to the valve oil seal guide sleeve.

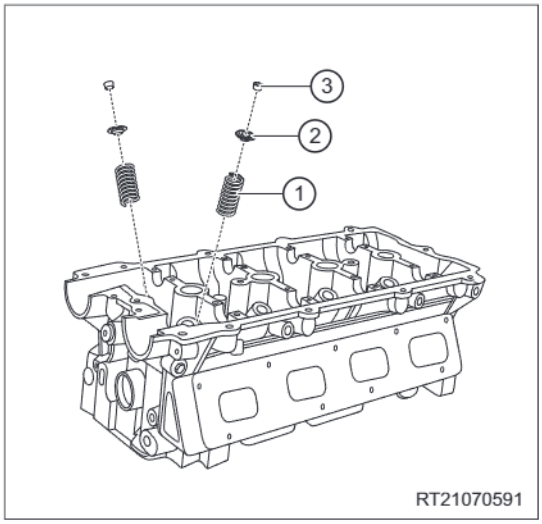
   c. Tap the valve oil seal installer lightly with a rubber hammer to install the valve oil seal in place.



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.



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

Installation

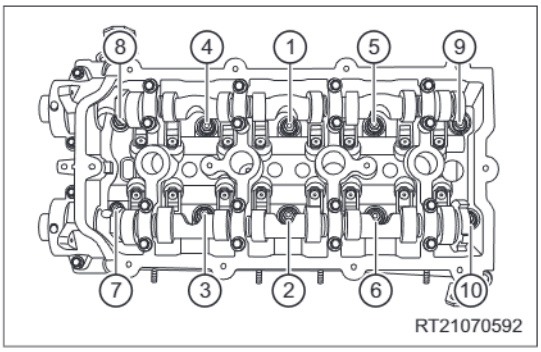
CAUTION

- 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 the joint surface between cylinder head and combustion chamber, together with the flat surface of cylinder block top and thread hole. There should be no accumulated oil at the bottom of cylinder block thread hole.
- During installation, piston should not be located at the top dead center, in order to prevent it from being impacted by the opening valve when installing rocker arm.
- Install cylinder head bolt washer with the chamfering surface facing upward and the flat side facing cylinder head.

1. Make sure to tighten the cylinder head fixing bolts in the sequence from (1) to (10) shown in the illustration:
   a. Apply a small amount of oil to the bolt head and root.
   b. Install the bolts and tighten them in place by hands.
   c. Tighten the cylinder head fixing bolts in the following procedures:

      1st step: Tighten the bolts to 45 ± 5 N·m in the sequence from (1) to (10) shown in the illustration.

      2nd step: Rotate the bolts clockwise by 180° ± 10° in tightening sequence.



CAUTION

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

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

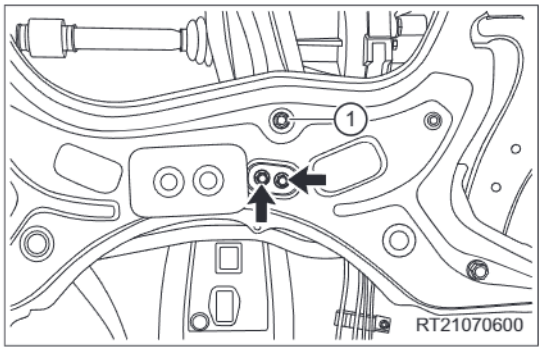
Engine Mounting Assembly

Removal & Installation - Rear Mounting Assembly

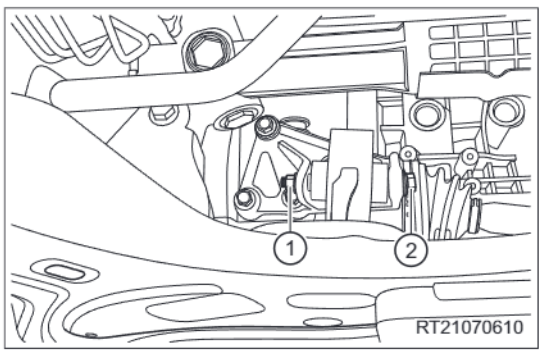
CAUTION

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

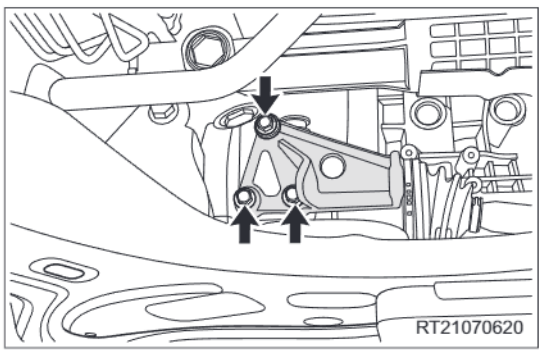
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Support the transmission with a transmission carrier.
4. Remove the engine rear mounting cushion assembly (for MT model).
   a. Remove 2 coupling bolt (arrow) between rear mounting cushion assembly and front sub frame welding assembly.
   (Tightening torque: 70 ± 5 N·m)
   b. Remove the fixing nut (1) from rear mounting cushion assembly.
   (Tightening torque: 70 ± 5 N·m)



   c. Remove the locking nut (1) for through bolt between rear mounting bracket and rear mounting cushion assembly, and remove the through bolt (2).
   (Tightening torque: 70 ± 5 N·m)

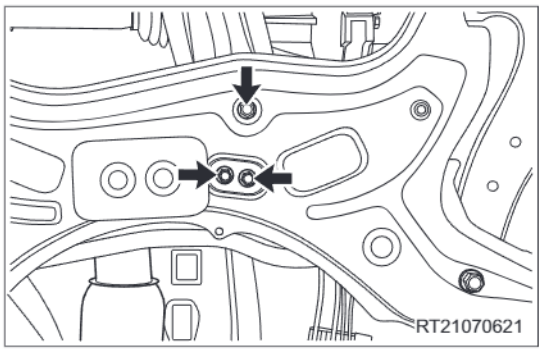


   d. Remove the engine rear mounting cushion assembly.
5. Remove the engine rear mounting bracket (for MT model).
   a. Remove 3 coupling bolts (arrow) between rear mounting bracket and transmission case.
   (Tightening torque: 55 ± 5 N·m)

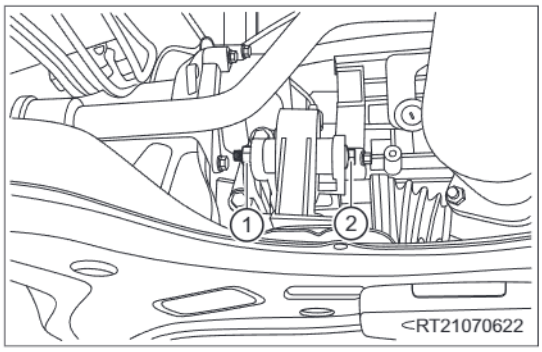


   b. Remove the engine rear mounting bracket from transmission case.

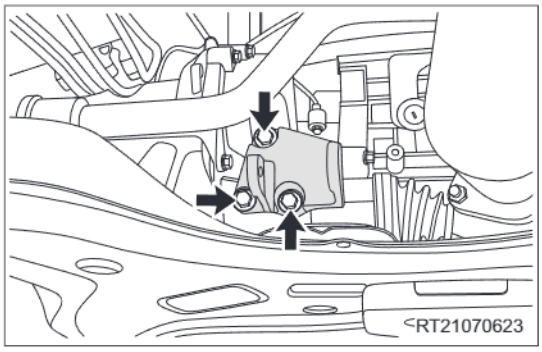
6. Remove the engine rear mounting cushion assembly (for CVT model).
   a. Remove 3 coupling bolts (arrow) between rear mounting cushion assembly and front sub frame welding assembly.
   (Tightening torque: 70 ± 5 N·m)



   b. Remove the locking nut (1) for through bolt between rear mounting bracket and rear mounting cushion assembly, and remove the through bolt (2).
   (Tightening torque: 70 ± 5 N·m)



   c. Remove the engine rear mounting cushion assembly.
7. Remove the engine rear mounting bracket (for CVT model).
   a. Remove 3 coupling bolts (arrow) between rear mounting bracket and transmission case.
   (Tightening torque: 80 ± 6 N·m)



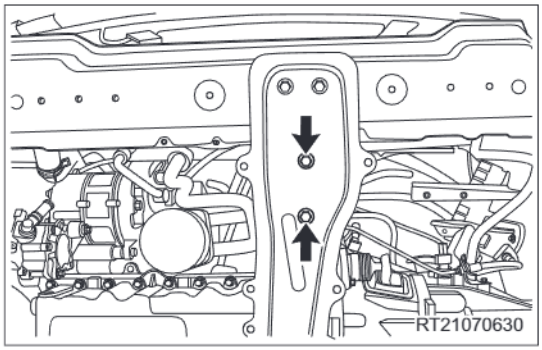
   b. Remove the engine rear mounting bracket from transmission case.
8. Installation is in the reverse order of removal.

Removal & Installation - Front Mounting Assembly

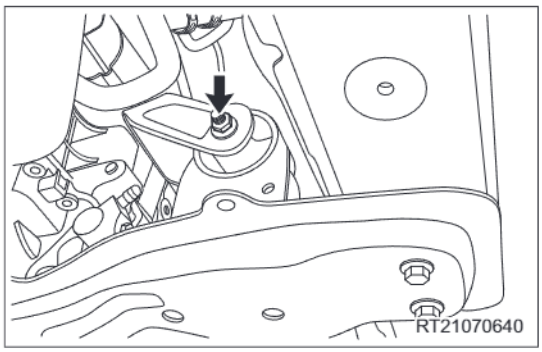
CAUTION

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

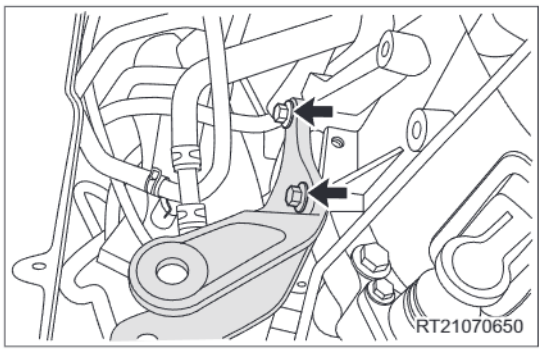
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine lower protector assembly (See page 48-29).
4. Support the transmission with a transmission carrier.
5. Remove the engine front mounting cushion assembly.
   a. Remove 2 coupling bolts (arrow) between front mounting cushion assembly and side rail welding assembly.
   (Tightening torque: 70 ± 5 N·m)



   b. Remove the locking nut (arrow) for through bolt between front mounting cushion assembly and front mounting bracket, and remove the through bolt.
   (Tightening torque: 70 ± 5 N·m)



   c. Remove the engine front mounting cushion assembly.
6. Remove the engine front mounting bracket.
   a. Remove 2 coupling bolts (arrow) between front mounting bracket and transmission case.
   (Tightening torque: 55 ± 5 N·m)



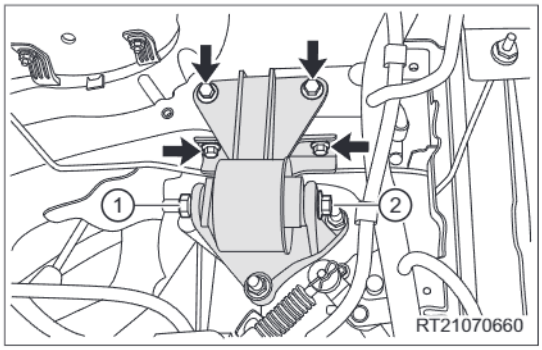
   b. Remove the engine front mounting bracket from transmission case.
7. Installation is in the reverse order of removal.

Removal & Installation - Left Mounting Assembly

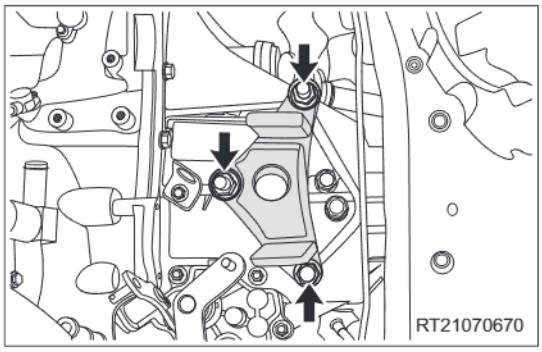
CAUTION

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

1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Use an engine equalizer to hang the engine.
4. Remove the air filter assembly and its bracket (See page 10-17).
5. Remove the battery (See page 16-7).
6. Remove the battery tray and tray bracket (See page 16-9).
7. Remove the engine left mounting cushion assembly (for MT model).
   a. Remove the locking nut (1) for through bolt between left mounting cushion assembly and left mounting bracket, and remove the through bolt (2).
   (Tightening torque: 105 ± 10 N·m)
   b. Remove 4 coupling bolts (arrow) between left mounting cushion assembly and body.
   (Tightening torque: 70 ± 5 N·m)

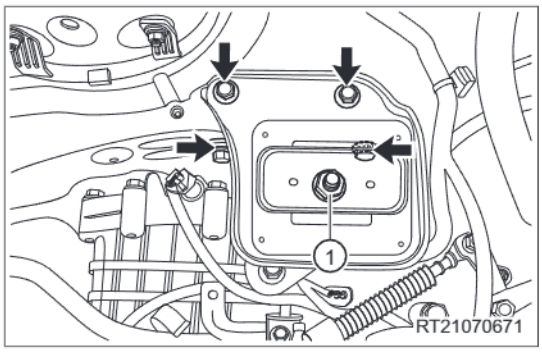


   c. Remove the left mounting cushion assembly.
8. Remove the engine left mounting bracket (for MT model).
   a. Remove 3 fixing nuts (arrow) between left mounting bracket and transmission case.
   (Tightening torque: 80 ± 6 N·m)

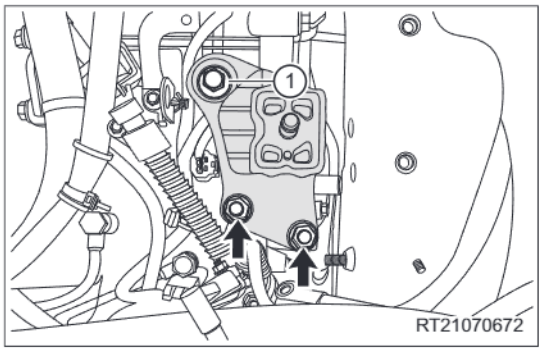


   b. Remove the left mounting bracket.

9. Remove the engine left mounting cushion assembly (for CVT model).
   a. Remove the locking nut (1) from left mounting cushion assembly.
      (Tightening torque: 80 ± 6 N·m)
   b. Remove 4 coupling bolts (arrow) between left mounting cushion assembly and body.
      (Tightening torque: 70 ± 5 N·m)



   c. Remove the left mounting cushion assembly.
10. Remove the engine left mounting bracket (for CVT model).
   a. Remove 2 fixing nuts (arrow) between left mounting bracket and transmission case.
      (Tightening torque: 80 ± 6 N·m)
   b. Remove the coupling bolt (1) between left mounting bracket and transmission case.
      (Tightening torque: 80 ± 6 N·m)



   c. Remove the left mounting bracket.
11. Installation is in the reverse order of removal.

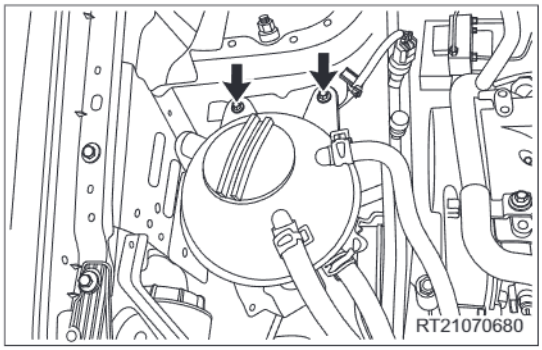
Removal & Installation - Right Mounting Assembly

CAUTION

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

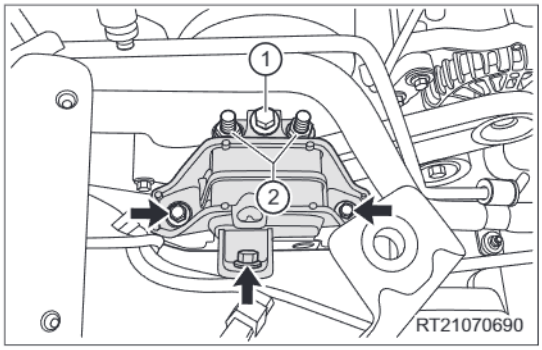
1. Turn off all the electrical equipment and ignition switch.
2. Disconnect the negative battery cable.
3. Remove the engine trim cover assembly (See page 10-10).
4. Remove the engine lower right protector assembly (See page 48-29).
5. Use an engine equalizer to hang the engine.
6. Remove the engine right mounting cushion assembly.

a. Remove 2 fixing bolts (arrow) from expansion tank and move the expansion tank to one side.



b. Remove the coupling bolt (1) and 2 coupling nuts (2) between right mounting cushion assembly and right mounting bracket.
(Tightening torque: 80 ± 6 N·m)

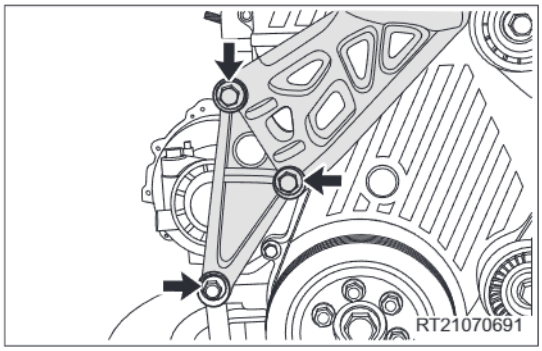
c. Remove 3 coupling bolts (arrow) between right mounting cushion assembly and body.
(Tightening torque: 70 ± 5 N·m)



d. Remove the engine right mounting bracket.

7. Remove the engine right mounting bracket.

a. Remove 3 fixing bolts (arrow) from right mounting cushion assembly.
(Tightening torque: 55 ± 5 N·m)



b. Remove the engine right mounting bracket assembly.

8. Installation is in the reverse order of removal.

ENGINE UNIT REPAIR

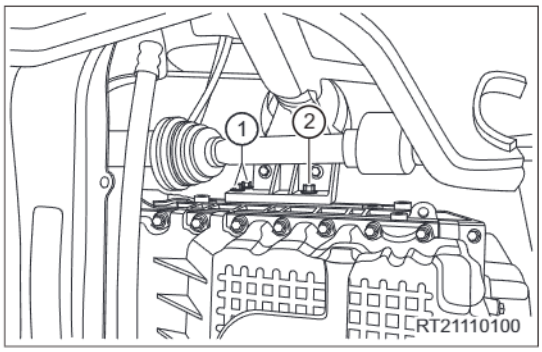
Engine Assembly

Removal

CAUTION

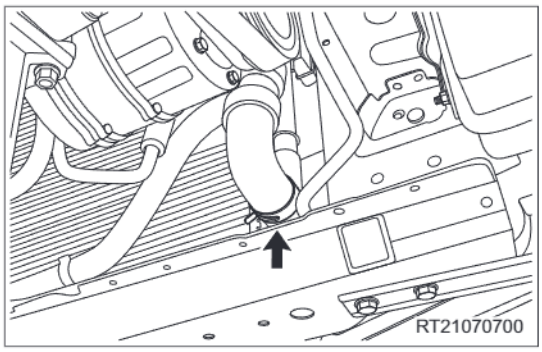
- Remove engine and transmission as an assembly.
- Install protector to prevent the body from being scratched.
- Block inlet of intake pipe after removing air filter and engine trim cover to prevent foreign matter from entering. Otherwise the foreign matter will block intake passage when starting, which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

1. Remove the engine trim cover assembly (See page 10-10).
2. Remove the trim cover rear left bracket (See page 10-12).
3. Release fuel system pressure (See page 08-10).
4. Turn off all the electrical equipment and ignition switch.
5. Disconnect the negative battery cable.
6. Drain the engine oil (See page 13-11).
7. Drain the transmission oil (See page 17-14 for MT model, See page 18-110 for CVT model).
8. Drain the brake fluid (See page 26-13).
9. Drain the coolant (See page 12-13).
10. Drain the steering fluid (w/ hydraulic assist steering) (See page 29-7).
11. Recover the refrigerant (See page 31-66).
12. Remove the hood assembly (See page 47-11).
13. Remove the battery (See page 16-7).
14. Remove the battery tray and tray bracket (See page 16-9).
15. Remove the air induction pipe assembly (See page 10-16).
16. Remove the air filter assembly and its bracket (See page 10-17).
17. Remove the exhaust manifold assembly (See page 11-7).
18. Remove the brake fluid reservoir (See page 26-14).
19. Remove the front wheel (See page 24-9).
20. Remove the engine lower protector assembly (See page 48-29).
21. Remove the drive shaft (See page 20-5).
22. Disconnect the connection between precatalytic converter assembly and cylinder block.
    a. Remove 2 coupling bolts (1) on left side and the coupling bolt (2) on right side between precatalytic converter assembly bracket and cylinder block (Tightening torque for coupling bolt on left side: 23 ± 2 N·m; Tightening torque for coupling bolt on right side: 50 ± 5 N·m).



23. Disconnect the engine inlet hose.

a. Loosen the elastic clamp (arrow) and disconnect the connection between engine inlet hose and radiator assembly.

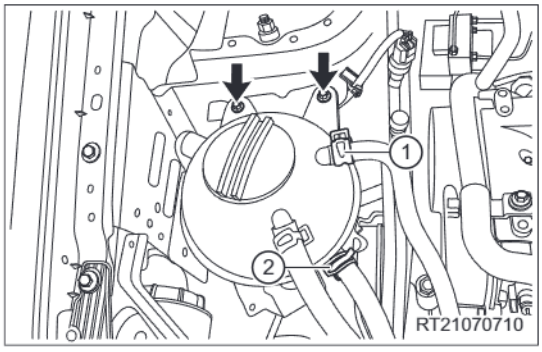


24. Move away the expansion tank.

a. Loosen the elastic clamp (1) and disconnect the connection between expansion tank and engine discharge hose I.

b. Loosen the elastic clamp (2) and disconnect the connection between expansion tank and expansion tank outlet hose.

c. Remove 2 fixing bolts (arrow) from expansion tank. (Tightening torque: 7 ± 1 N·m)

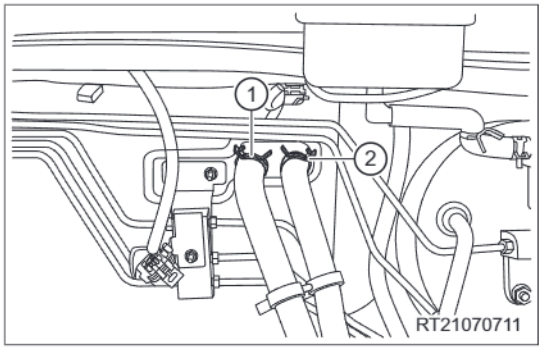


d. Take out the expansion tank from expansion tank bracket, and move the expansion tank to one side.

25. Disconnect the connection between hose and heater core.

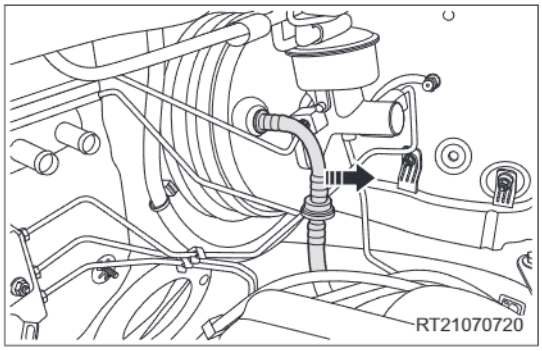
a. Loosen the elastic clamp (1) and disconnect the connection between heater inlet hose and heater core.

b. Loosen the elastic clamp (2) and disconnect the connection between heater outlet hose and heater core.

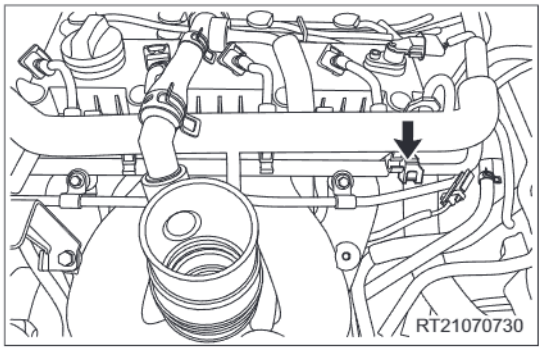


26. Disconnect the connection between vacuum pipe and vacuum booster.

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

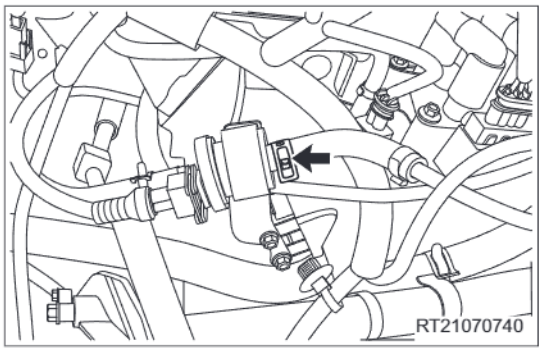


27. Disconnect the coupling joint (arrow) between delivery pipe and fuel rail.



28. Move away the fuel vapor hose III assembly.

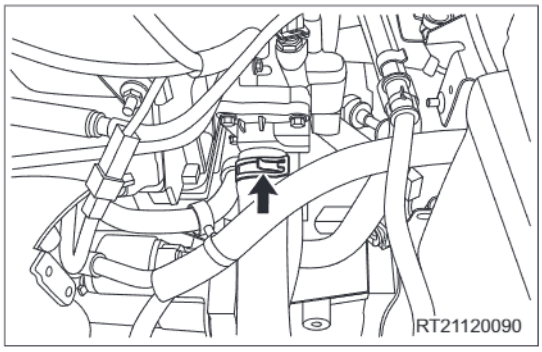
a. Disengage the elastic clamp (arrow) and disconnect the connection between fuel vapor hose III assembly and charcoal canister.



b. Move the fuel vapor hose III assembly to one side.

29. Move away the engine outlet hose.

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

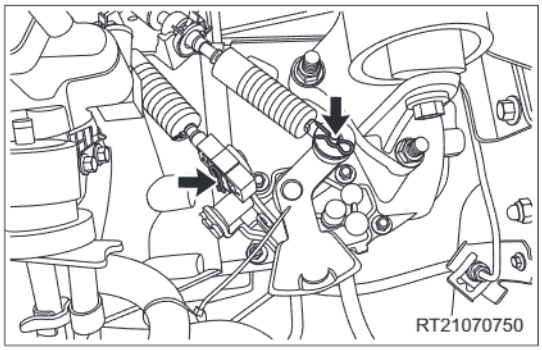


b. Move the engine outlet hose to one side.

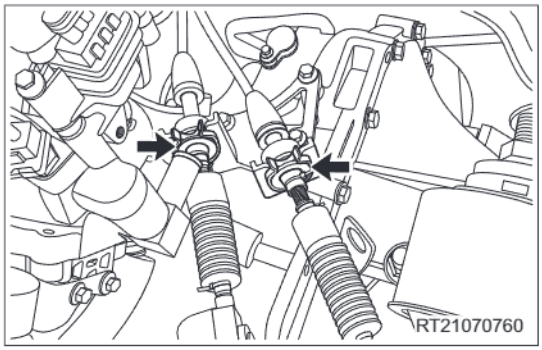
HINT:
As for MT model, it is necessary to move away the back-up light switch wire harness clamp before moving away the engine outlet hose.

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

a. Remove the cotter pins (arrow) connecting gear select and shift cable and transmission gear shift control mechanism.



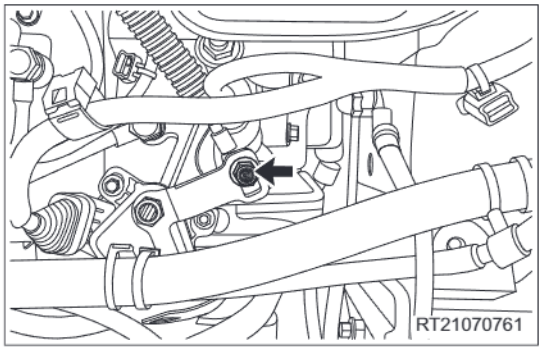
b. Remove the flexible shaft clamps (arrow) from gear select and shift cable.



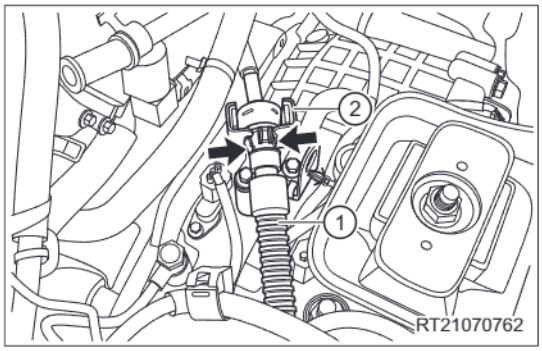
c. Move away the gear select and shift cable from flexible shaft bracket.

31. 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: 18 ± 2 N·m)

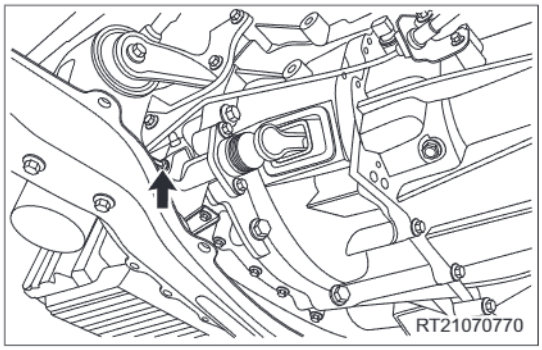


b. Push 2 locating claws on gear shift cable (1) in the direction of arrow as shown in the illustration, and disengage the gear shift cable from transmission gear shift cable bracket (2).

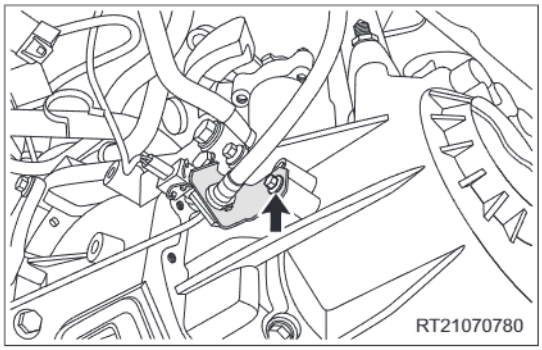


32. Disconnect the connection of clutch hydraulic line (for MT model).

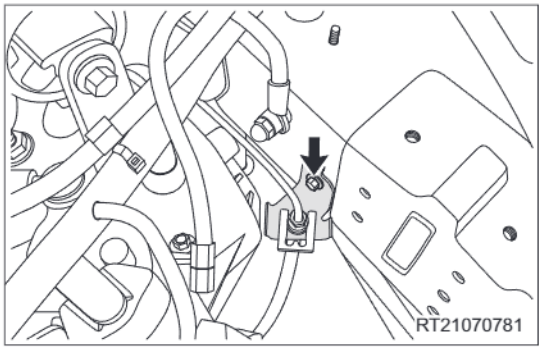
a. Loosen the coupling plug (arrow) and disconnect the connection between clutch release cylinder pipe II assembly and clutch release cylinder.
(Tightening torque: 16 ± 2 N·m)



b. Remove the fixing bolt (arrow) and move away the bracket II from transmission.
(Tightening torque: 15 ± 2 N·m)

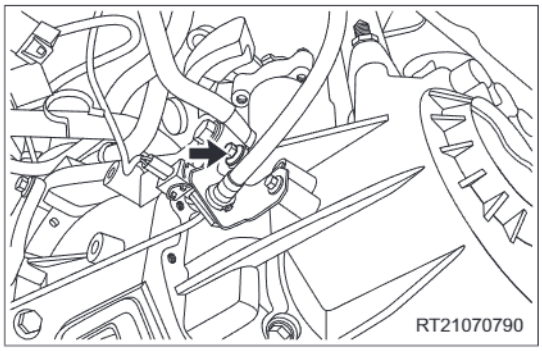


c. Remove the fixing bolt (arrow) and move away the bracket I from transmission.
(Tightening torque: 15 ± 2 N·m)

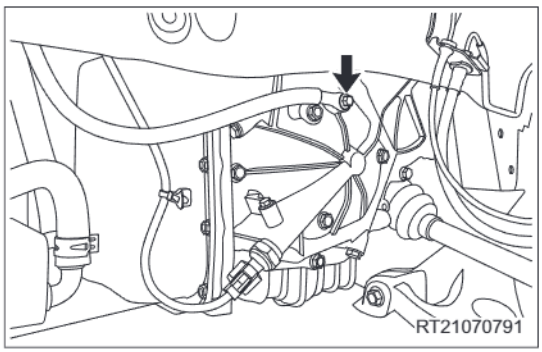


33.Move away the transmission ground wire.

a. Remove the transmission ground wire fixing bolt (arrow) and move away the transmission ground wire (for MT model).
(Tightening torque: 15 ± 2 N·m)

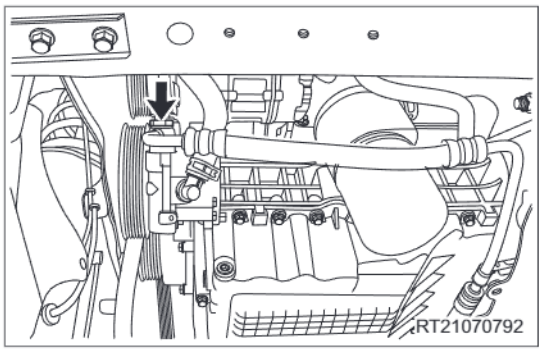


b. Remove the transmission ground wire fixing bolt (arrow) and move away the transmission ground wire (for CVT model).
(Tightening torque: 15 ± 2 N·m)



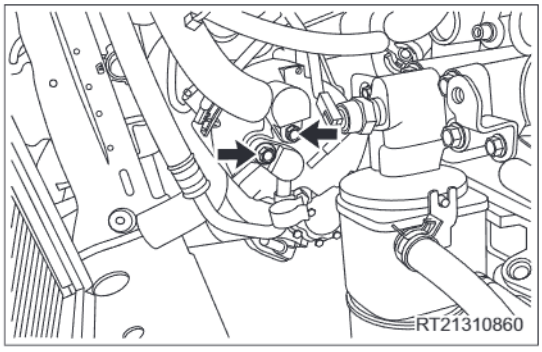
34. Disconnect the steering pump line (w/ hydraulic assist steering).

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



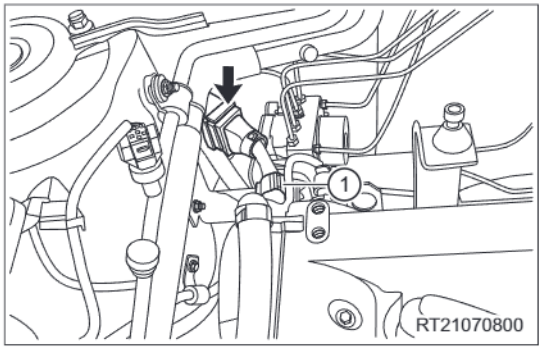
35. Disconnect the A/C line.

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 ± 2.5 N·m)

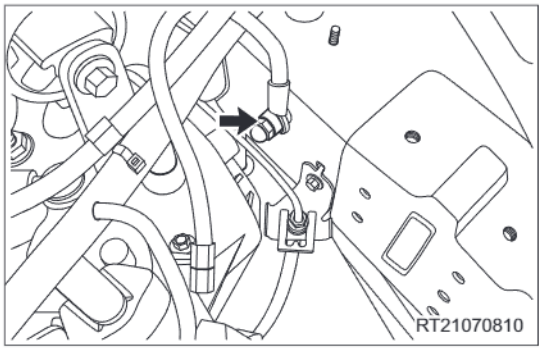


36. Disconnect the engine wire harness.

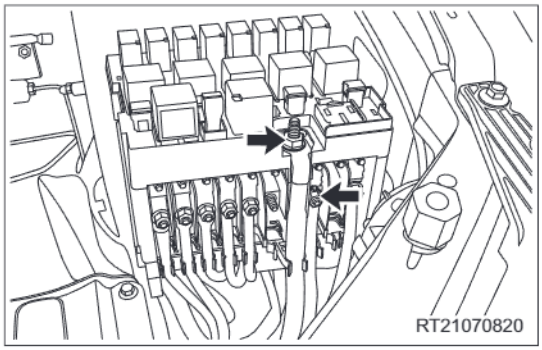
a. Disconnect the engine wire harness connector (arrow) and move the engine wire harness away from the wire harness clip (1).



b. Remove the battery wire harness ground wire fixing bolt (arrow) and move away the battery wire harness ground wire.



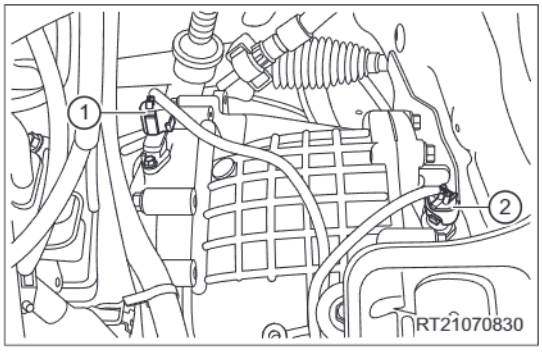
c. Open the fuse and relay box cover, remove the battery wire harness fixing nut (arrow), and disconnect the connection between battery wire harness and fuse and relay box.
(Tightening torque: 7 ± 1 N·m)



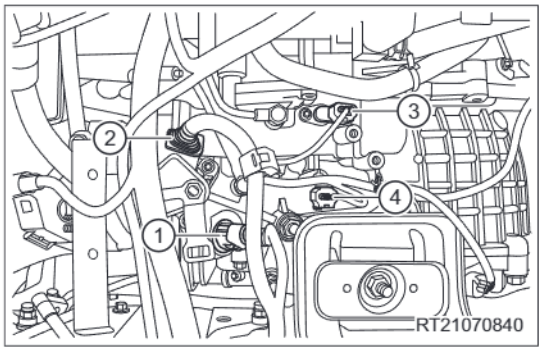
d. Remove the fuse and relay box and disconnect 2 engine wire harness connectors.

37. Disconnect the CVT connector (for CVT model).

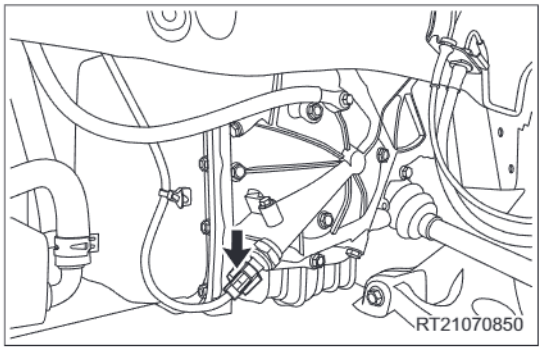
a. Disconnect the second shaft pressure sensor (1).
b. Disconnect the second shaft speed sensor (2).



c. Disconnect the connector B (1).
d. Disconnect the connector A (2).
e. Disconnect the clutch speed sensor (3).
f. Disconnect the primary shaft speed sensor (4).



g. Disconnect the primary shaft pressure sensor (arrow).



38. Use an engine equalizer to hang the engine.
39. Remove the engine rear mounting assembly (See page 07-64).
40. Remove the engine front mounting assembly (See page 07-66).
41. Remove the engine equalizer and use an engine hoist to hang the lifting eyes on both sides of the engine.
42. Remove the engine left mounting cushion assembly (See page 07-67).

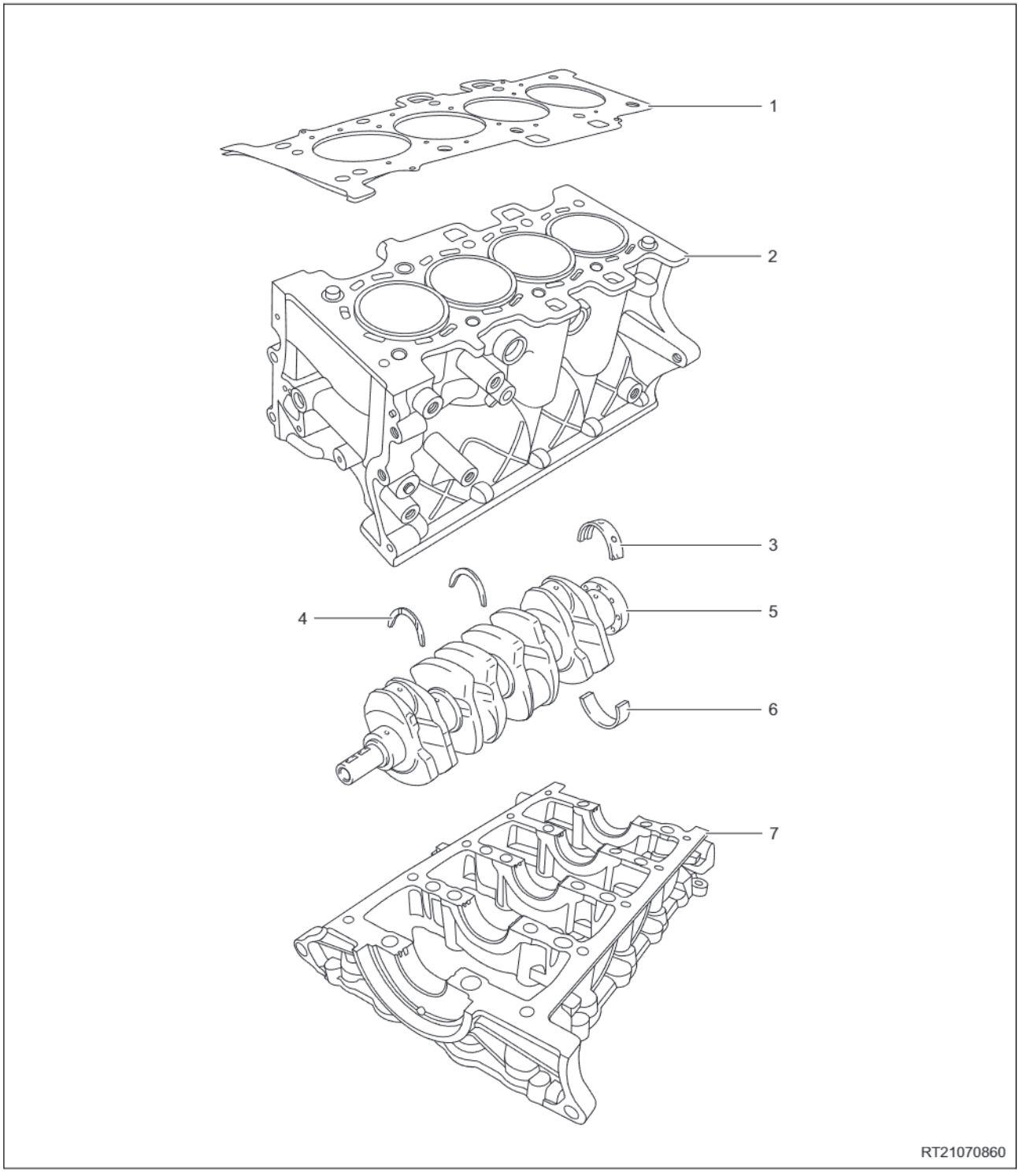
43. Remove the engine right mounting cushion assembly (See page 07-68).
44. Confirm that all the components are disconnected from engine.
45. Hang the engine with transmission out of engine compartment.
46. Remove the engine wire harness and battery wire harness from engine.
47. Separate the engine and the transmission.
48. Install the engine on the engine service platform.

Installation

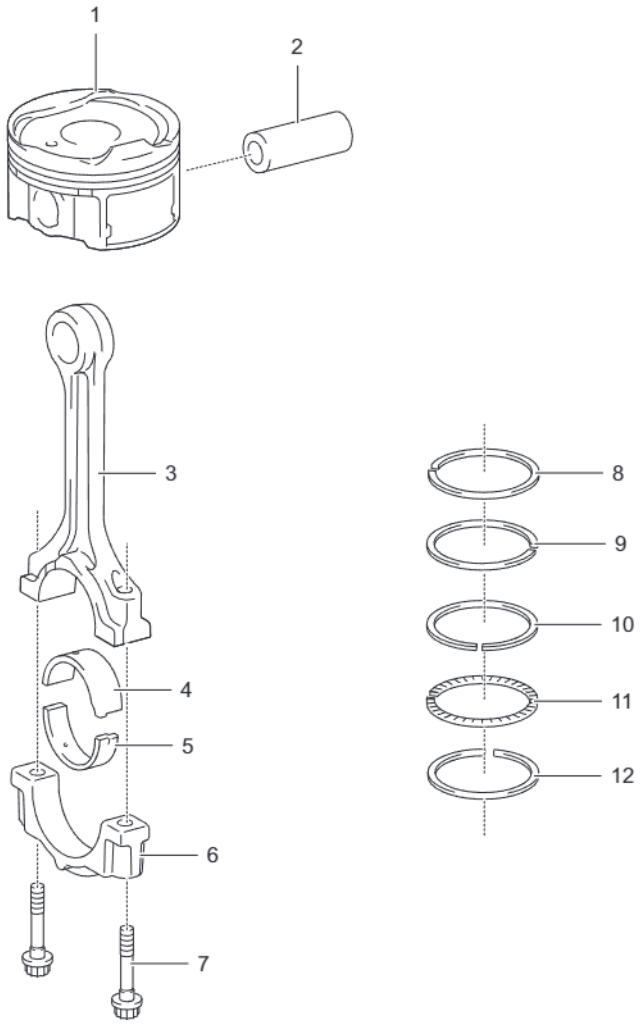
Installation is in the reverse order of removal.

Engine Block

Description



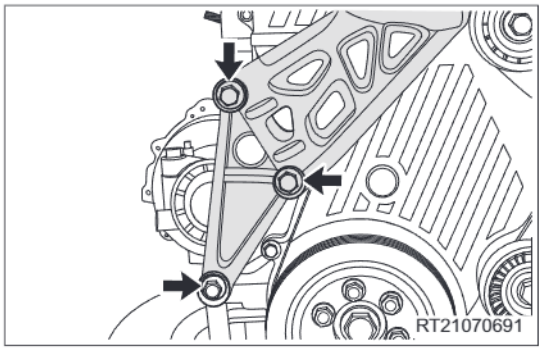
1 - Cylinder Head Gasket	2 - Cylinder Block
3 - Crankshaft Main Bearing Upper Shell	4 - Thrust Washer
5 - Crankshaft	6 - Crankshaft Main Bearing Lower Shell
7 - Crankshaft Frame	



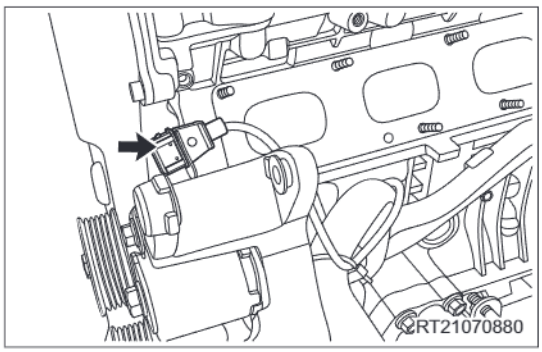
1 - Piston	2 - Piston Pin (Semi-floating)
3 - Connecting Rod	4 - Connecting Rod Bearing Upper Shell
5 - Connecting Rod Bearing Lower Shell	6 - Connecting Rod Bearing Cap
7 - Connecting Rod Fixing Bolt	8 - First Compression Ring
9 - Second Compression Ring	10 - Upper Rail
11 - Oil Ring Expander	12 - Lower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

Disassembly

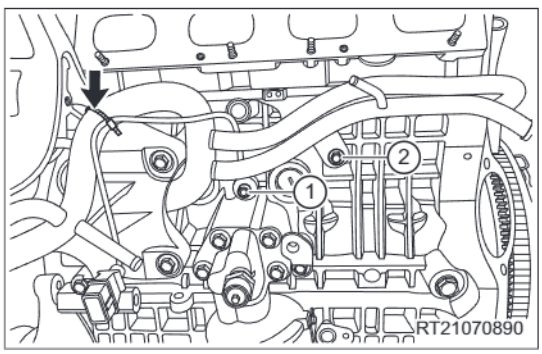
1. Remove the engine assembly and install the engine on engine service platform (See page 07-70).
2. Remove the high-voltage cables (See page 14-8).
3. Remove the ignition coil (See page 14-10).
4. Remove the thermostat (See page 12-19).
5. Remove the thermostat seat (See page 12-22).
6. Remove the oil dipstick (See page 13-15).
7. Remove the intake manifold (See page 10-24).
8. Remove the alternator (See page 16-10).
9. Remove the accessory drive belt lower idler pulley (See page 07-26).
10. Remove the compressor assembly (See page 31-99).
11. Remove the engine right mounting bracket.
    a. Remove 3 fixing bolts (arrow) from right mounting bracket.
    (Tightening torque: 55 ± 5 N·m)



    b. Remove the engine right mounting bracket.
12. Move away the knock sensor connector (arrow) from knock sensor bracket.



13. Remove the knock sensor.
    a. Remove the knock senor inner hexagon bolt (1).
    (Tightening torque: 20 ± 5 N·m)
    b. Remove the knock sensor cable fixing band (arrow) from small circulation metal tube, and remove the knock sensor.
14. Remove the small circulation metal tube.
    a. Remove the small circulation metal tube fixing bolt (2).
    (Tightening torque: 20 ± 5 N·m)
    b. Remove the small circulation metal tube from engine.



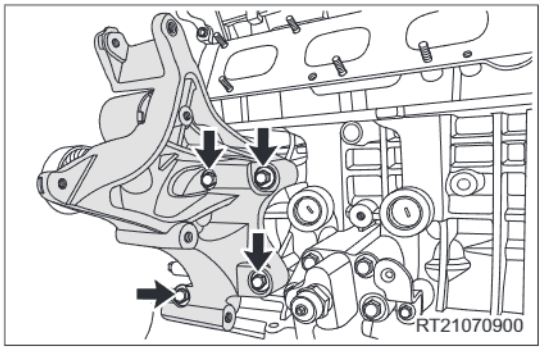
CAUTION

- There will be residue of coolant in the engine. If coolant gets on your skin, wash off with water immediately.

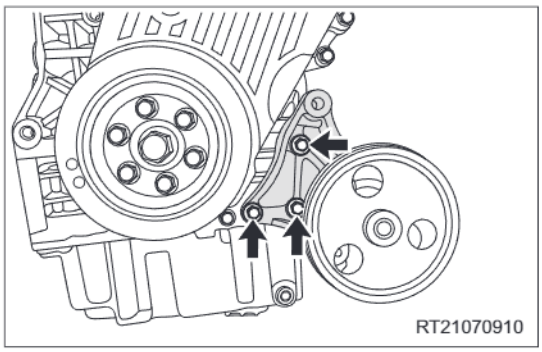
ENVIRONMENTAL PROTECTION

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

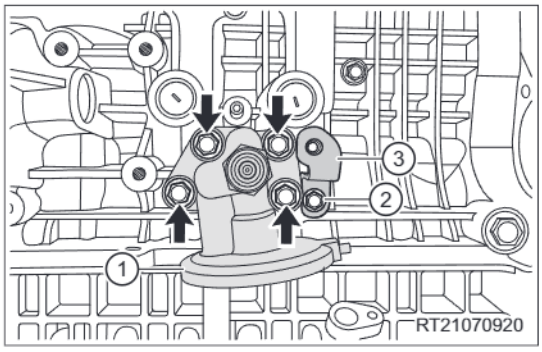
15. Remove the engine accessory bracket.
    a. Remove 4 fixing bolts from engine accessory bracket. (Tightening torque: 40 + 5 N·m)
    b. Remove the engine accessory bracket.



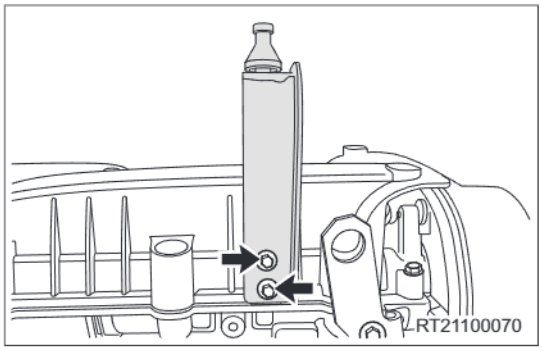
16. Remove the power steering pump with bracket assembly.
    a. Remove 3 fixing bolts (arrow) from power steering pump, and remove the steering pump with bracket assembly.
    (Tightening torque: 30 + 5 N·m)



17. Remove the oil filter (See page 13-13).
18. Remove the oil cooler bracket with oil pressure switch assembly and intake manifold lower bracket.
    a. Remove 4 fixing bolts (arrow) from oil cooler bracket. (Tightening torque: 40 + 5 N·m)
    b. Remove the oil cooler bracket with oil pressure switch assembly (1).
    c. Remove the intake manifold lower bracket fixing bolt (2) and remove the intake manifold lower bracket (3).

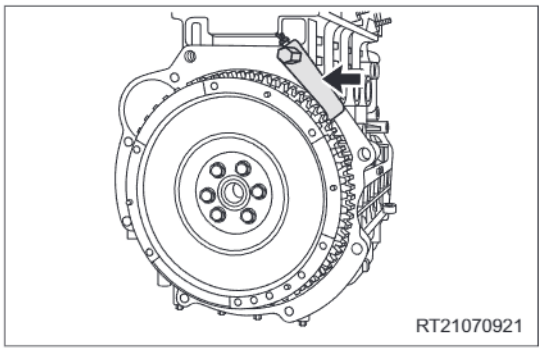


19. Remove the trim cover rear right bracket.
    a. Remove 2 fixing bolts (arrow) from trim cover rear right bracket.
    (Tightening torque: 7 ± 1 N·m)

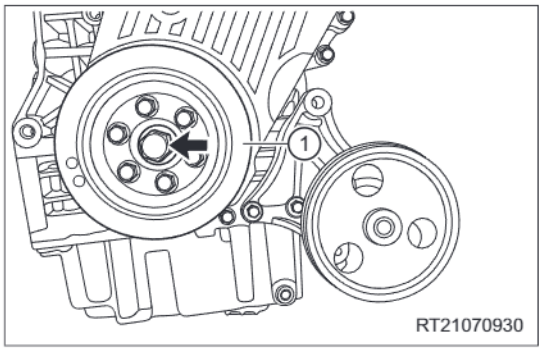


    b. Remove the trim cover rear right bracket.

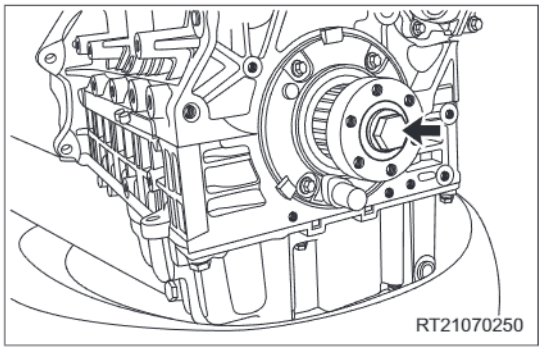
20. Fix the flywheel with a flywheel holding tool (arrow).



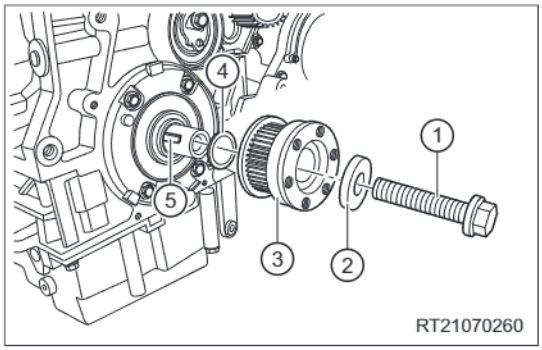
21. Remove the crankshaft pulley bolt (arrow), and remove the crankshaft pulley (1).
    (Tightening torque: 1st step: tighten to 25 ± 5 N·m; 2nd step: rotate for 30° ± 5°)



22. Remove the cylinder head cover (See page 07-46).
23. Remove the timing belt (See page 07-28).
24. Remove the water pump (See page 12-31).
25. Remove the crankshaft timing pulley.
    a. Loosen the crankshaft timing pulley fixing bolt (arrow).
    (Tightening torque: 1st step: tighten to 130 ± 10 N·m; 2nd step: retighten for 30° ± 5°)



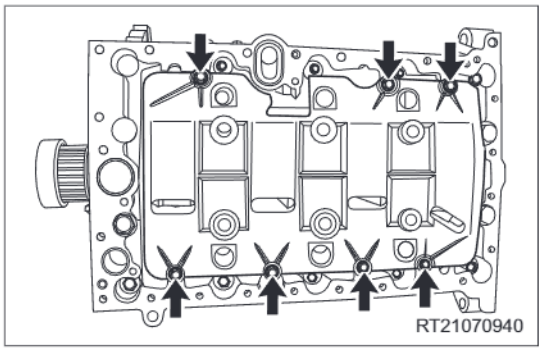
b. Take out timing pulley fixing bolt (1), washer (2), crankshaft timing pulley (3), lining (4) and semi-circle key (5).



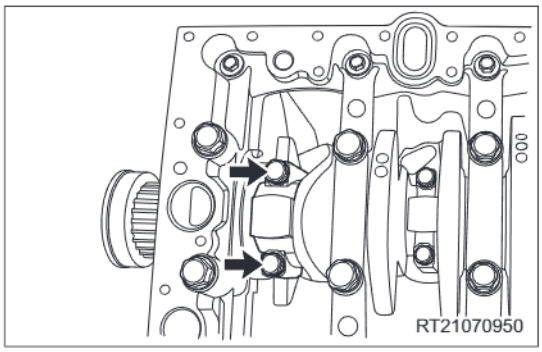
CAUTION

- Semi-circle key is small, so it is easy to be ignored. During installation, pay thorough attention not to forget to install.

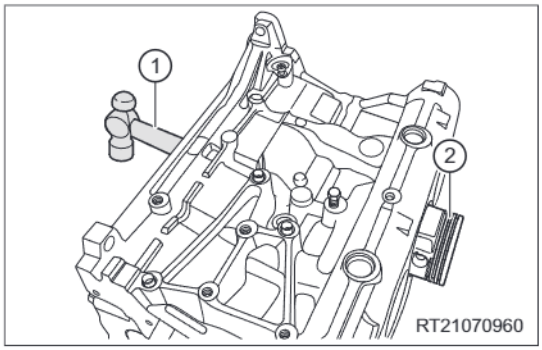
26. Remove the clutch assembly (See page 19-14).
27. Remove the flywheel assembly (See page 07-42).
28. Remove the cylinder head (See page 07-55).
29. Remove the oil pan (See page 13-20).
30. Remove the oil strainer (See page 13-23).
31. Remove the oil pump assembly (See page 13-24).
32. Remove the crankshaft rear oil seal (See page 07-44).
33. Remove the oil deflector assembly.
    a. Remove 7 fixing bolts (arrow) from oil deflector assembly.
    (Tightening torque: 8 ± 3 N·m)



    b. Remove the oil deflector assembly.
34. Remove the piston connecting rod assembly.
    a. Using a ridge reamer or equivalent, remove all carbon from the top of cylinder.
    b. Remove the connecting rod bearing cap fixing bolts (arrow), and remove the connecting rod bearing cap.
    (Tightening torque: 1st step: tighten to 25 ± 3 N·m; 2nd step: retighten for 90° ± 5°)



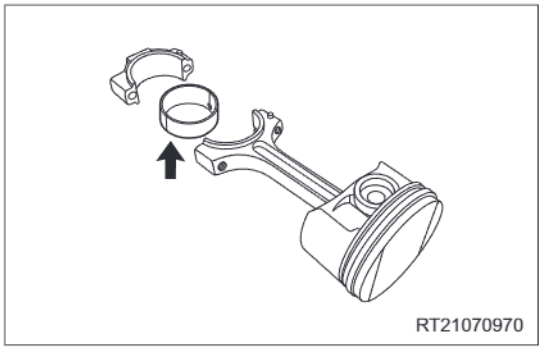
c. Using a hammer handle (1), push the piston connecting rod assembly (2) out of the top of cylinder.



35. Remove the connecting rod bearing.

a. Remove the connecting rod bearing (arrow).

HINT:
Arrange the removed parts in the correct order.



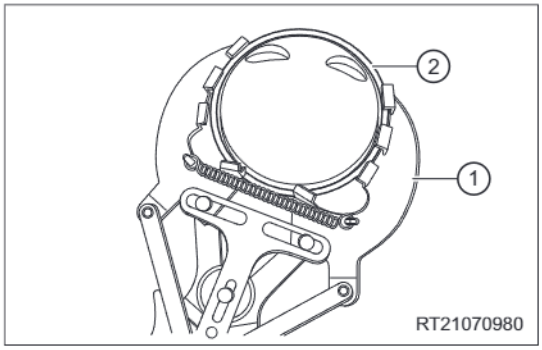
07

CAUTION

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

36. Remove the piston ring.

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



CAUTION

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

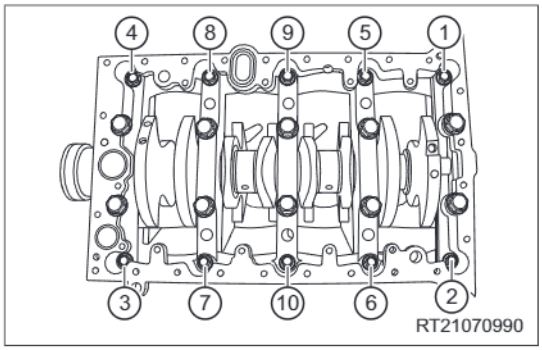
b. Remove the oil ring rail and expander by hands.

37. Remove the piston.

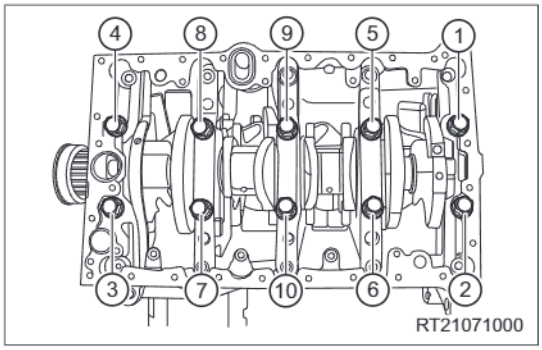
Piston pin is semi-floating and cannot be assembled by general process after removal, so it is not allowable to be removed in service. If there are abnormal noises caused by improper piston pin clearance, replace the piston connecting rod assembly.

38. Remove the crankshaft.

a. Evenly loosen and remove 10 crankshaft frame fixing bolts in the order shown in the illustration.
(Tightening torque: 20 + 3 N·m)



b. Evenly loosen and remove 10 crankshaft main bearing cap fixing bolts in the order shown in the illustration.
(Tightening torque: 1st step: tighten to 45 ± 5 N·m; 2nd step: retighten for 180° ± 10°)



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.

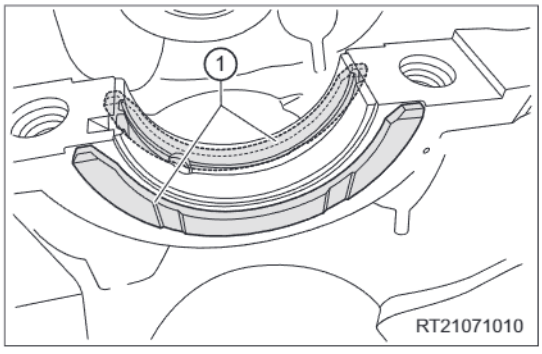
d. Take out the crankshaft.

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 the contact surface of crankshaft and bearing shell.

39. Remove the crankshaft thrust washer.

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

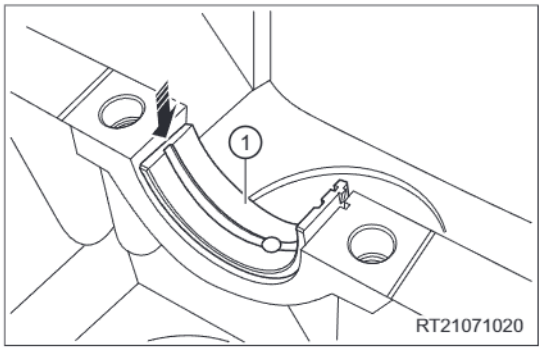


40. Remove the crankshaft main bearing shell.

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

HINT:

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



Inspection

1. Check 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 the cylinder at high temperature. Otherwise the cylinder liner will stick out beyond the engine block.

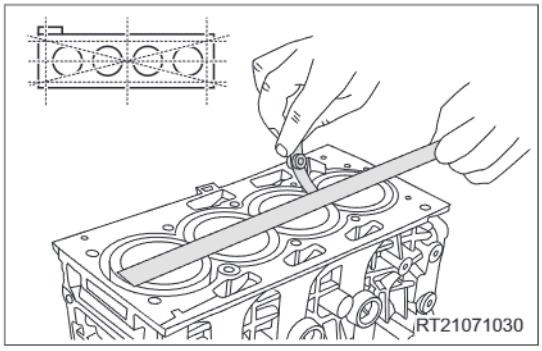
2. Check flatness of engine block upper surface.

a. Clean the engine block upper surface.

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

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

It is not allowed to grind the block upper surface. If the flatness of engine block upper surface exceeds the limit, replace the engine block.



3. Check cylinder.

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

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

Cylindricity calculation method

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

Cylindricity in thrust direction = (maximum diameter measured at A, B and C in thrust direction - minimum 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 the maximum value measured at the 2 directions with the standard cylinder cylindricity.

Roundness calculation method

Roundness error is half of the 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 B)/2

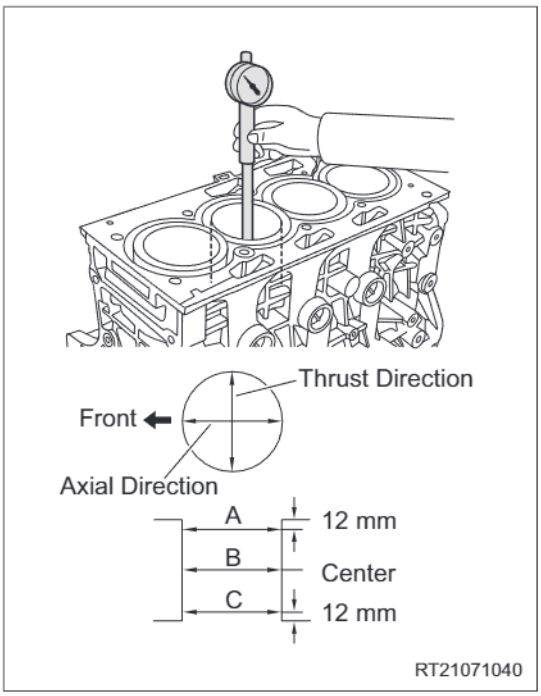
Compare maximum value roundness measured at A, B and C with the standard cylinder roundness.

b. Check cylindricity of cylinder.

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

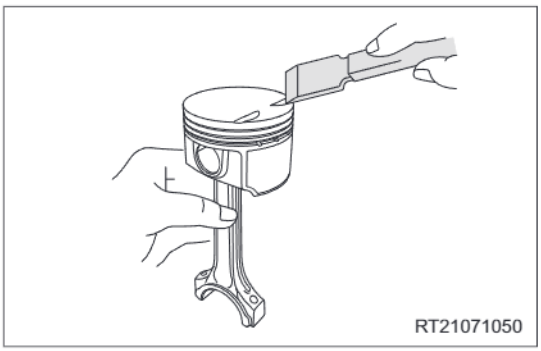
Measurement Item	Specification (mm)
Cylinder Cylindricity	0.01
Cylinder Roundness	0.008

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

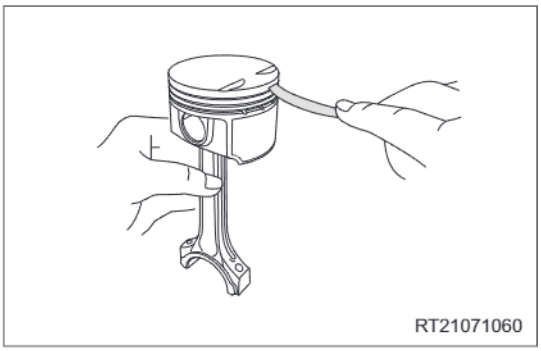


4. Check piston.

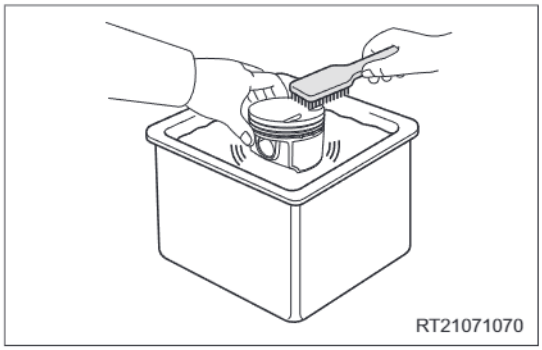
a. Using a scraper, remove the carbon deposits on the top of piston.



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



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


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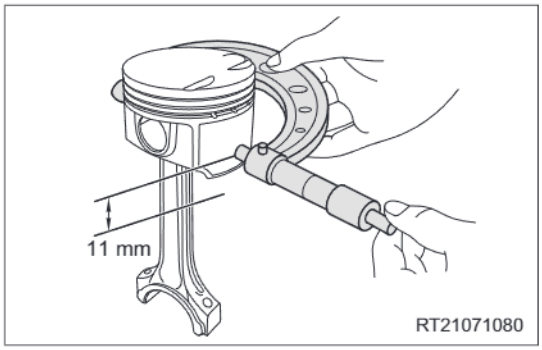
CAUTION

- DO NOT use a wire brush to clean.

d. Measure the piston diameter with a micrometer at the position that is approximately 11 mm under the piston skirt in the vertical direction of piston pin.

Measurement Item	Specification (mm)
Piston Diameter	ϕ83.455 ± 0.009

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



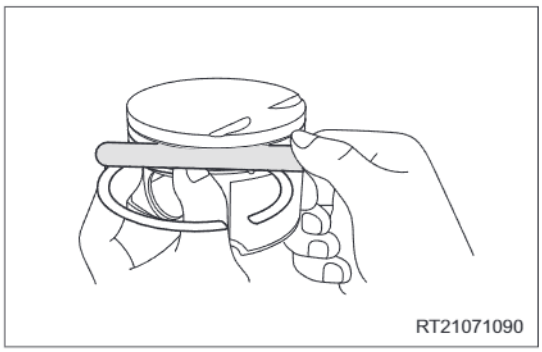
RT21071080

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

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

Measurement Item		Specification (mm)
Piston Ring Side Clearance	First Ring	0.04 - 0.08
	Second Ring	0.025 - 0.070

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

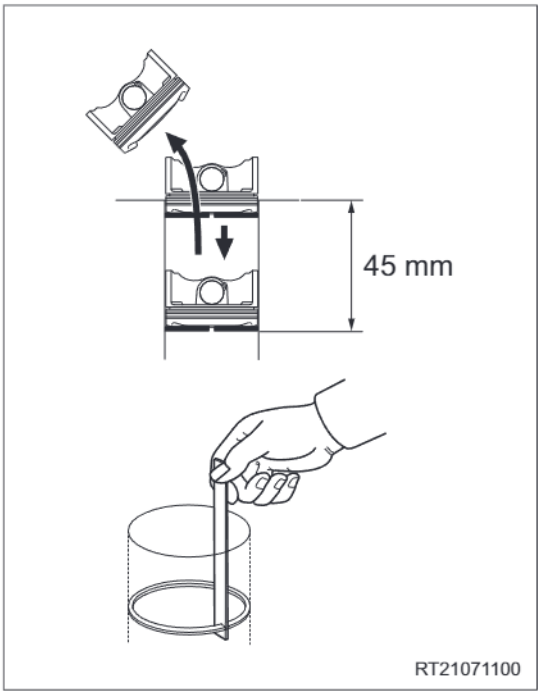

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6. Check piston ring end gap.
   a. Using a piston, push the piston ring from the top of cylinder to a place that is 45 mm from the top of cylinder bore.
   b. Using a feeler gauge, measure the end gap.

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 the specified range, replace the piston ring with a new one.

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

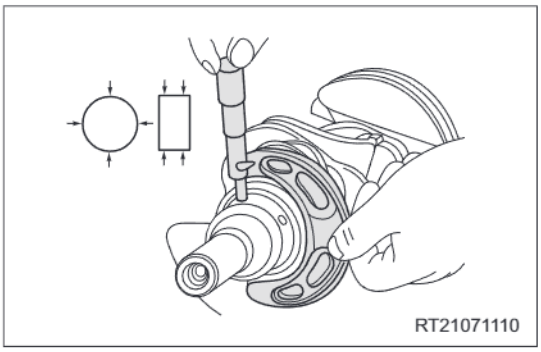


7. Check diameter of crankshaft main journal.
   a. Using a micrometer, measure the main journal diameter. Measure again after rotating the crankshaft for 90°.

Measurement Item	Specification (mm)
Crankshaft Main Journal Diameter	$\phi 54\ ^{0}_{-0.019}$

If crankshaft main journal diameter is not within the specified range, replace the main bearing shells with new ones, and check radial clearance of crankshaft (See page 07-90).

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



   b. Calculate the crankshaft cylindricity by measured values (measured area is shown in the illustration).

Roundness calculation method (for general measurement):

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

Roundness = (maximum diameter - minimum diameter)/2

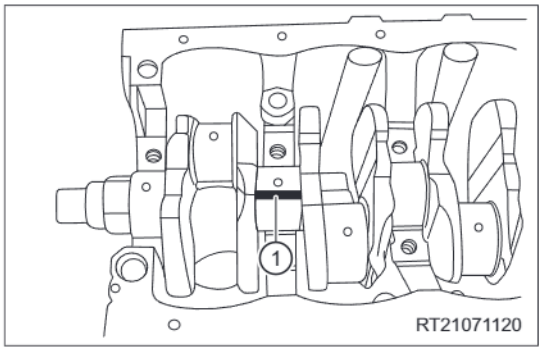
As shown in the illustration, measure the diameter twice in different directions on two cross sections separately to obtain four values. The cylindricity is the half of the difference between maximum and minimum values among the four values.

Cylindricity = (maximum diameter - minimum diameter)/2

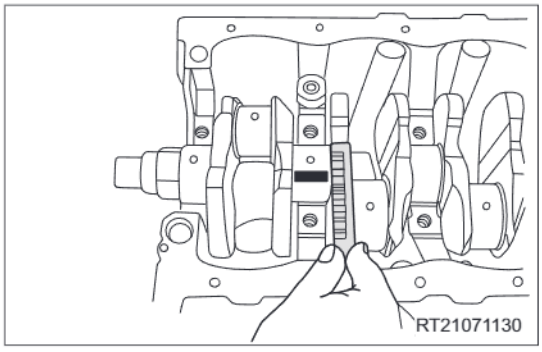
Measurement Item		Specification (mm)
Crankshaft Main Journal	Cylindricity	0.007
	Roundness	0.04

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

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



   c. Install the crankshaft frame and tighten the main bearing cap fixing bolts to the specified torque in order.
   d. Remove the crankshaft frame. Using the feeler gauge, measure the widest part of compressed feeler gauge. The measured value is the crankshaft radial clearance.



Measurement Item	Specification (mm)
Crankshaft Radial Clearance	0.021 - 0.059

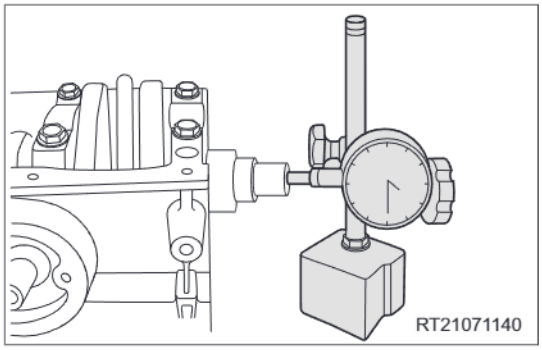
If crankshaft radial clearance is not within the specified range, install new main bearing shell. Replace the crankshaft if necessary.

CAUTION

- Replace bearing shells in pairs.

For selection of main bearing shell (See page 07-93).

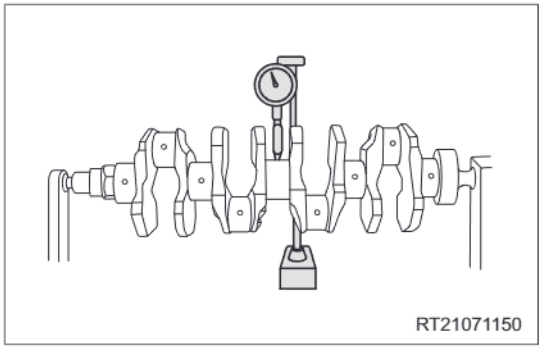
9. Check the crankshaft axial clearance.
   a. Clean the crankshaft main journals and main bearing shells.
   b. Install the crankshaft frame and tighten the main bearing cap fixing bolts to the specified torque in order.
   c. Push the crankshaft forward and backward and read the value from the dial indicator.



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

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

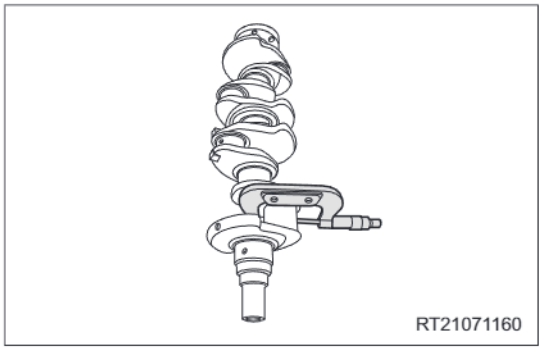
10. Check the crankshaft coaxiality.
    a. Install the crankshaft onto the inspection table and keep it level.
    b. Rotate the crankshaft slowly and read the maximum change value from the dial indicator.
    (Reading from the dial indicator)/2 is the coaxiality of the crankshaft.


RT21071150

Measurement Item	Specification (mm)
Coaxiality of Crankshaft	0.04

If radial runout is not at the specified range, replace the crankshaft.

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


RT21071160

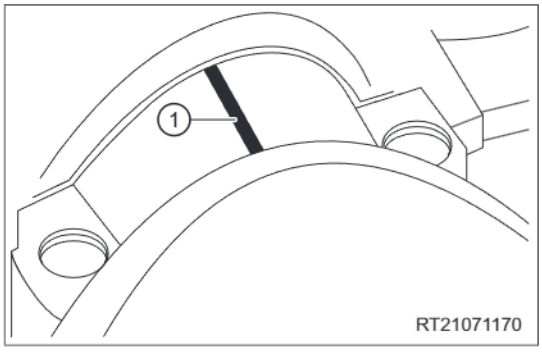
Measurement Item	Specification (mm)
Crankshaft Connecting Rod Journal Diameter	$\phi 47.9\ ^{0}_{-0.016}$

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

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

For selection of connecting rod bearing shell (See page 07-93).

12. Check radial clearance of crankshaft connecting rod bearing shell.
    a. Clean connecting rod journals and connecting rod bearing shells.
    b. Place a feeler gauge (arrow) on the connecting rod journal as shown in the illustration.



RT21071170

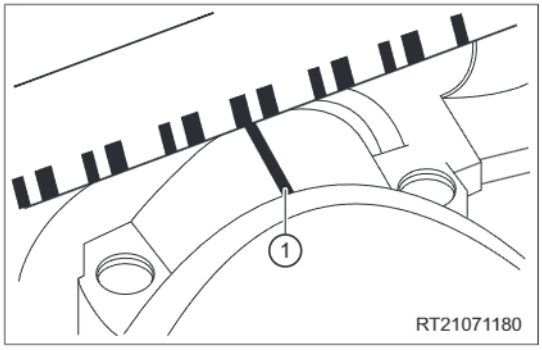
    c. Install the connecting rod bearing caps, and tighten the connecting rod bearing cap fixing bolts to 20 + 5 N·m.

CAUTION

- DO NOT turn the crankshaft during installation.

d. Remove the connecting rod bearing caps.

e. Using the gauge scale of feeler gauge, measure the widest part of the compressed feeler gauge to obtain the radial clearance of connecting rod bearing shell as shown in the illustration.



Measurement Item	Specification (mm)
Connecting Rod Bearing Shell Radial Clearance	0.021 - 0.056

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

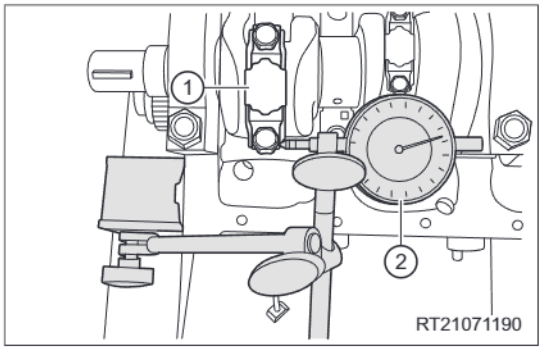
13. Check connecting rod big end axial clearance.

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

b. Install a dial indicator (2) with its measuring rod contacting the side of connecting rod cap (1).

c. Turn the dial of dial indicator to reset it to zero.

d. Push the connecting rod forward and backward (do not move the crankshaft forward and backward) and read the value on the dial indicator.



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

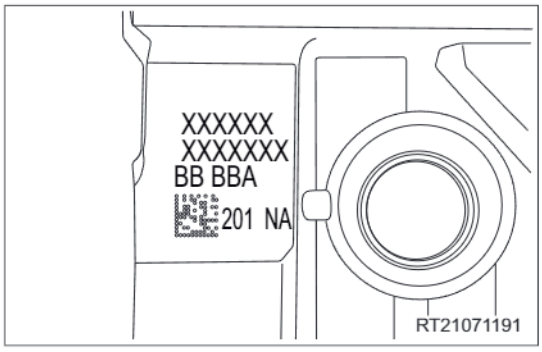
If the axial clearance of connecting rod big end is not within the specified range, replace the piston connecting rod assembly.

Selection of Bearing Shell

Selection of main bearing shell

1. Selection of crankshaft main bearing upper shell.

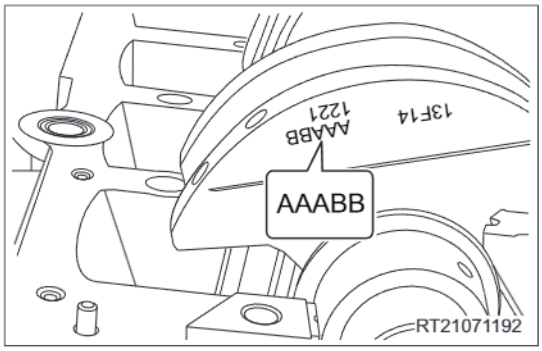
   Related letter marks are available on the cylinder block (consisting of "A" and "B"). Such as "BBBBA" in the illustration, each letter from left to right is for one type of crankshaft bearing upper shell. The first letter "B" is for the upper shell type of crankshaft main bearing first journal, and so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

2. Selection of crankshaft main bearing lower shell.

   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, the first letter "A" is for the lower shell type of crankshaft main bearing first journal, and so on; the 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

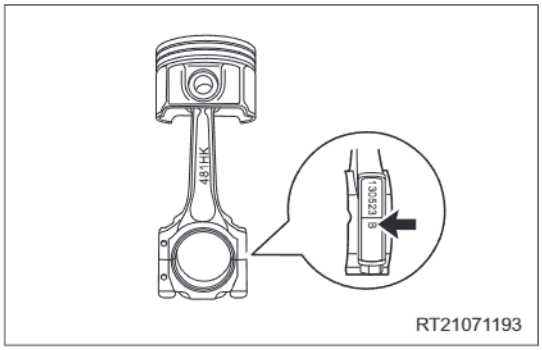
3. Precautions for crankshaft main bearing shell assembly:
   a. There is shell groove and oil hole on the main bearing upper shell, and the oil hole should be aligned with that on the engine block, but the main bearing lower shell has no oil hole.
   b. Apply a coat of engine oil to the inner surface of main bearing shell before installation. The 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.

   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.

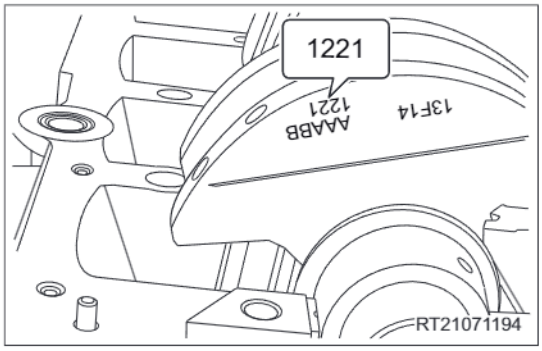
   As shown in the illustration, among the mark "130523 B" on the connecting rod, "B" indicates blue shell.



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

2. Selection of connecting rod bearing lower shell.

   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, the first digit "1" is for the lower shell type of the 1st cylinder piston connecting rod, and so on; the fourth digit "1" is for the lower shell type of the fourth cylinder piston connecting rod.



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

3. Precautions for connecting rod bearing shell assembly:
   a. The connecting rod upper and lower bearing shells without oil grooves are universal, but one of the connecting rod bearing shells has 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 the inner surface of the connecting rod bearing shell before installation. The back side of bearing shell should be clean without any oil or foreign matter during assembly.

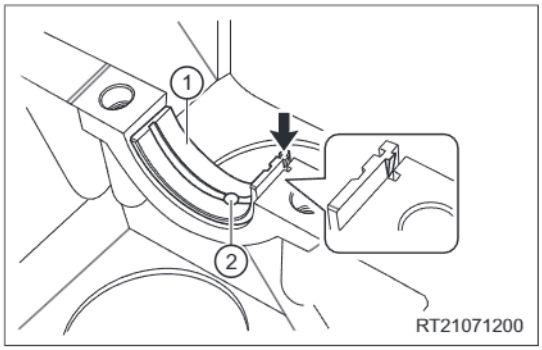
Assembly

1. Install the crankshaft main bearing shell.

CAUTION

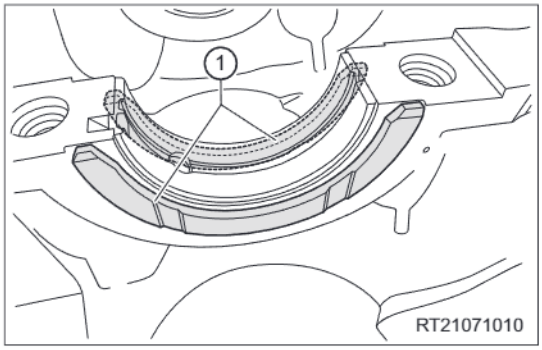
- Apply a coat of engine oil to the inner surface of main bearing shell before installation.

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

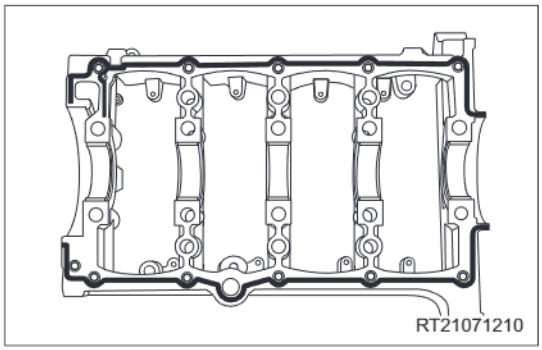


HINT:
Install the crankshaft main bearing lower shells to the crankshaft frame in the same way,and the notch of each main bearing lower shell should be aligned with the crankshaft frame.

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



3. Install the crankshaft.
   a. Apply seal gum to the installation surface of frame before installation.

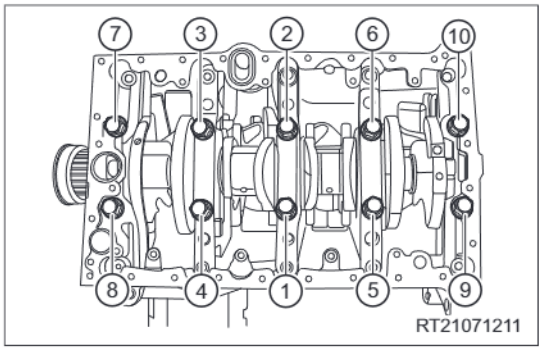


CAUTION

- DO NOT apply seal gum into the 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.

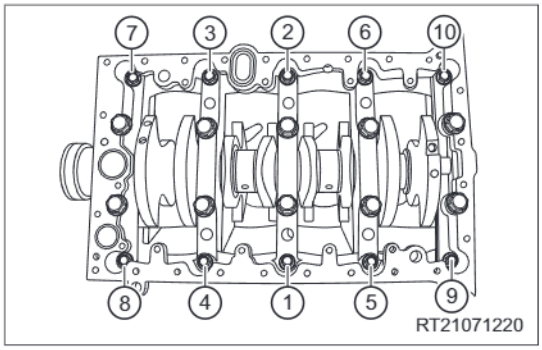
b. Place the crankshaft on the cylinder block carefully.

c. Install the crankshaft main bearing cap fixing bolts in place by hand, and tighten 10 crankshaft main bearing cap fixing bolts in the order shown in the illustration.
(Tightening torque: 1st step: tighten to 45 ± 5 N·m; 2nd step: retighten for 180° ± 10°)



07

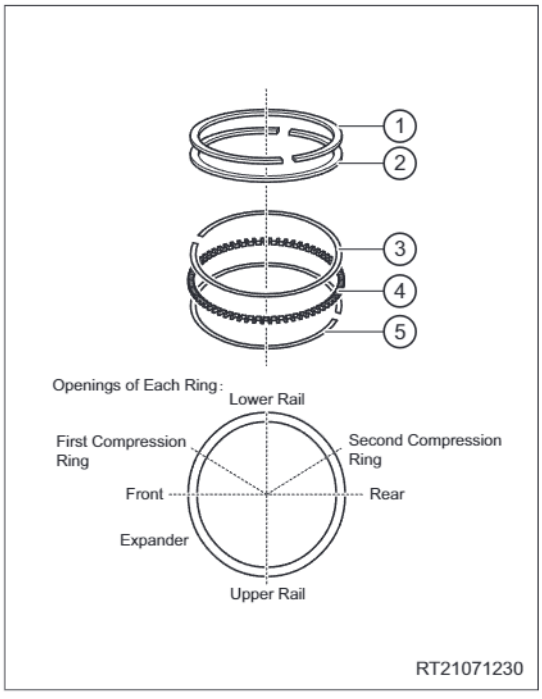
d. Evenly tighten 10 crankshaft frame fixing bolts in the order shown in the illustration.
(Tightening torque: 20 + 3 N·m)



4. Install the piston ring.

a. The first compression ring is rectangular ring (1), the second compression ring is conical ring (2), and the oil ring is steel band combination ring. Apply a small amount of engine lubricant to the piston ring groove and piston. Note that the side with words for first compression ring should face upward and the outer cutting of second compression ring should face downward.

b. The oil ring is steel band combination oil ring and composed of upper rail (3), lower rail (5) and expander (4). When installing the oil ring, first install the expander into the oil groove, then install the two rails with the two rails opening of steel band combination oil ring staggered by 90° from the expander closed gap, and the upper and lower rails 180°. Then install the second compression ring, and install the first compression ring finally with the two compression rings staggered by 120° from the upper rail opening. The piston ring should rotate in the ring groove freely without any stuck condition.



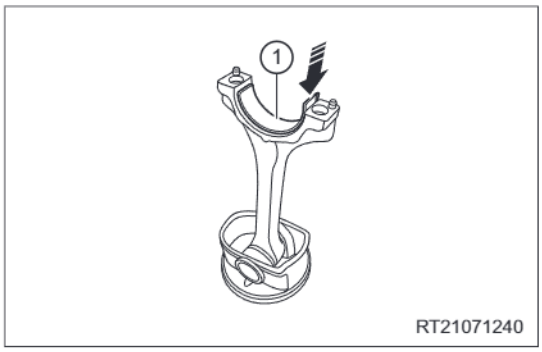
c. Rotate the piston ring several turns after applying engine oil to the piston ring groove, and note that the position of ring notch should be the same with that described above; clean the crankshaft connecting rod journal and cylinder bore with a non-woven fabric cloth.

5. Install the connecting rod bearing shell.

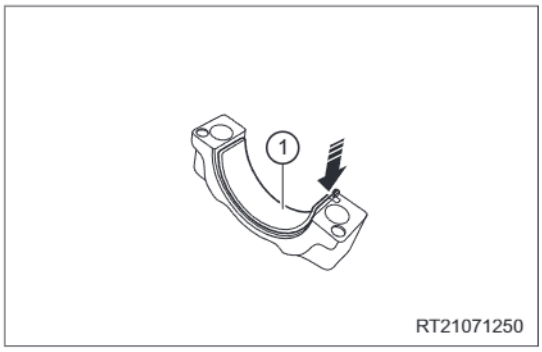
CAUTION

- Apply a coat of engine oil to the 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.

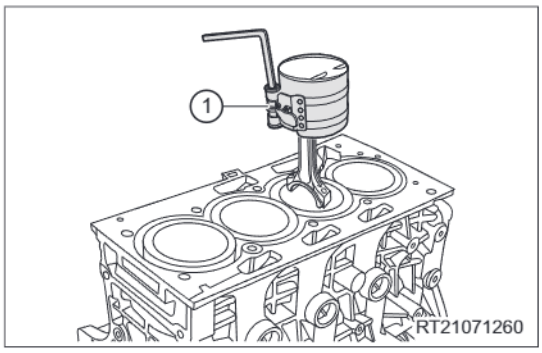
a. Carefully install the connecting rod bearing upper shell (1) in the direction of arrow, and keep the groove opening of each connecting rod bearing upper shell face the piston and connecting rod assembly.



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

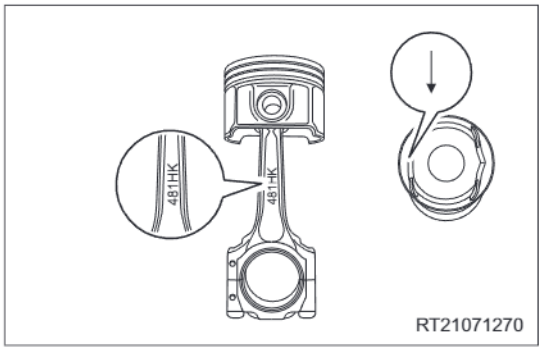


6. Install the piston connecting rod assembly.
   a. Rotate the crankshaft to the top dead center of 1st and 4th cylinder.
   b. Apply a coat of engine oil to the piston surface and cylinder inside wall.
   c. As shown in the illustration, install the piston connecting rod assembly to the cylinder with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



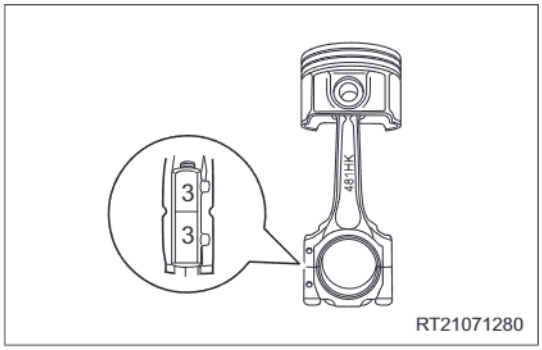
CAUTION

- Pay attention to the front marks of piston and connecting rod during assembly without being reversed. Install them with the side stamped with letter "481HK" on the connecting rod and piston top arrow facing toward timing belt side as shown in the illustration.

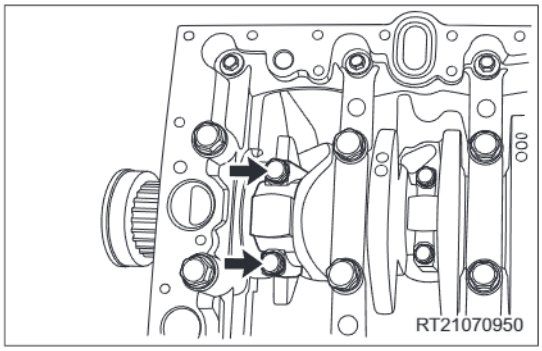


7. Install the connecting rod bearing cap.

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



   a. Install the connecting rod bearing cap in place, and screw the connecting rod bearing cap fixing bolts (arrow) by hands, then tighten the connecting rod bearing cap fixing bolts in two steps.
   (Tightening torque: 1st step: tighten to 25 ± 3 N·m; 2nd step: retighten for 90° ± 5°)



CAUTION

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

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