SECTION EM
ENGINE MECHANICAL

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PRECAUTION

PRECAUTIONS

Precaution for Supplemental Restraint System (SRS) "AIR BAG" and "SEAT BELT PRE-TENSIONER"

INFOID:0000000014727286

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. Information necessary to service the system safely is included in the SR and SB section of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, it is recommended that all maintenance and repair be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper repair, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SR section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

PRECAUTIONS WHEN USING POWER TOOLS (AIR OR ELECTRIC) AND HAMMERS

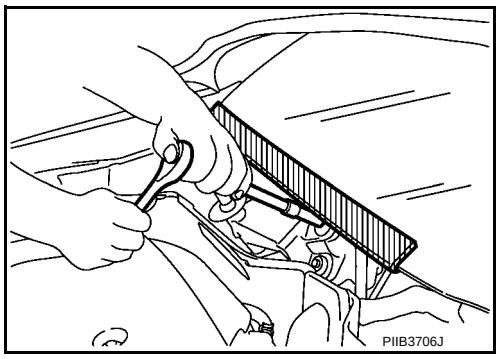
WARNING:

- **When working near the Air Bag Diagnosis Sensor Unit or other Air Bag System sensors with the Ignition ON or engine running, DO NOT use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the Ignition OFF, disconnect the battery or batteries, and wait at least three minutes before performing any service.**

Precaution for Procedure without Cowl Top Cover

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When performing the procedure after removing cowl top cover, cover the lower end of windshield with urethane, etc to prevent damage to windshield.



High Voltage Precautions

INFOID:0000000014727289

DANGER:

Since hybrid vehicles and electric vehicles contain a high voltage battery, there is the risk of electric shock, electric leakage, or similar accidents resulting in death or severe injury, if high voltage components and vehicle are mishandled. When performing an inspection or maintenance, be sure to comply with the instructions below to perform correct work procedures.

WARNING:

- **Be sure to remove the service plug in order to disconnect the high voltage circuits before performing inspection or maintenance of high voltage system harnesses and parts.**
- **The removed service plug must always be carried in a pocket of the responsible worker or placed in the tool box during the procedure to prevent the plug from being connected by mistake.**
- **Be sure to wear insulated protective equipment before beginning work on the high voltage system.**

- **Never allow workers other than the responsible person to touch the vehicle containing high voltage parts. To keep others from touching the high voltage parts, these parts must be covered with an insulating sheet except when using them.**

CAUTION:

- **Be sure to install the high voltage harness clips to the original positions to prevent damage to high voltage harness. If the clips are damaged, replace them with new ones before installing the high voltage harness.**
- **To prevent damage to parts, never allow coolant to splash on the high voltage harness connector. If coolant splashes on the high voltage harness connector, immediately remove moisture from the high voltage harness connector by using an air blow gun.**
- **Never bring the vehicle into the READY status with the service plug removed unless otherwise instructed in the Service Manual. A malfunction may occur if this is not observed.**

HIGH VOLTAGE HARNESS AND EQUIPMENT IDENTIFICATION

All the high voltage harnesses and connectors are orange. The Li-ion battery and other high voltage devices include an orange high voltage label. Never touch these harnesses and high voltage parts.

HANDLING OF HIGH VOLTAGE HARNESS AND TERMINALS

Immediately insulate disconnected high voltage connectors and terminals with insulating tape.

GUIDELINES ON WORKERS WITH MEDICAL ELECTRONICS

WARNING:

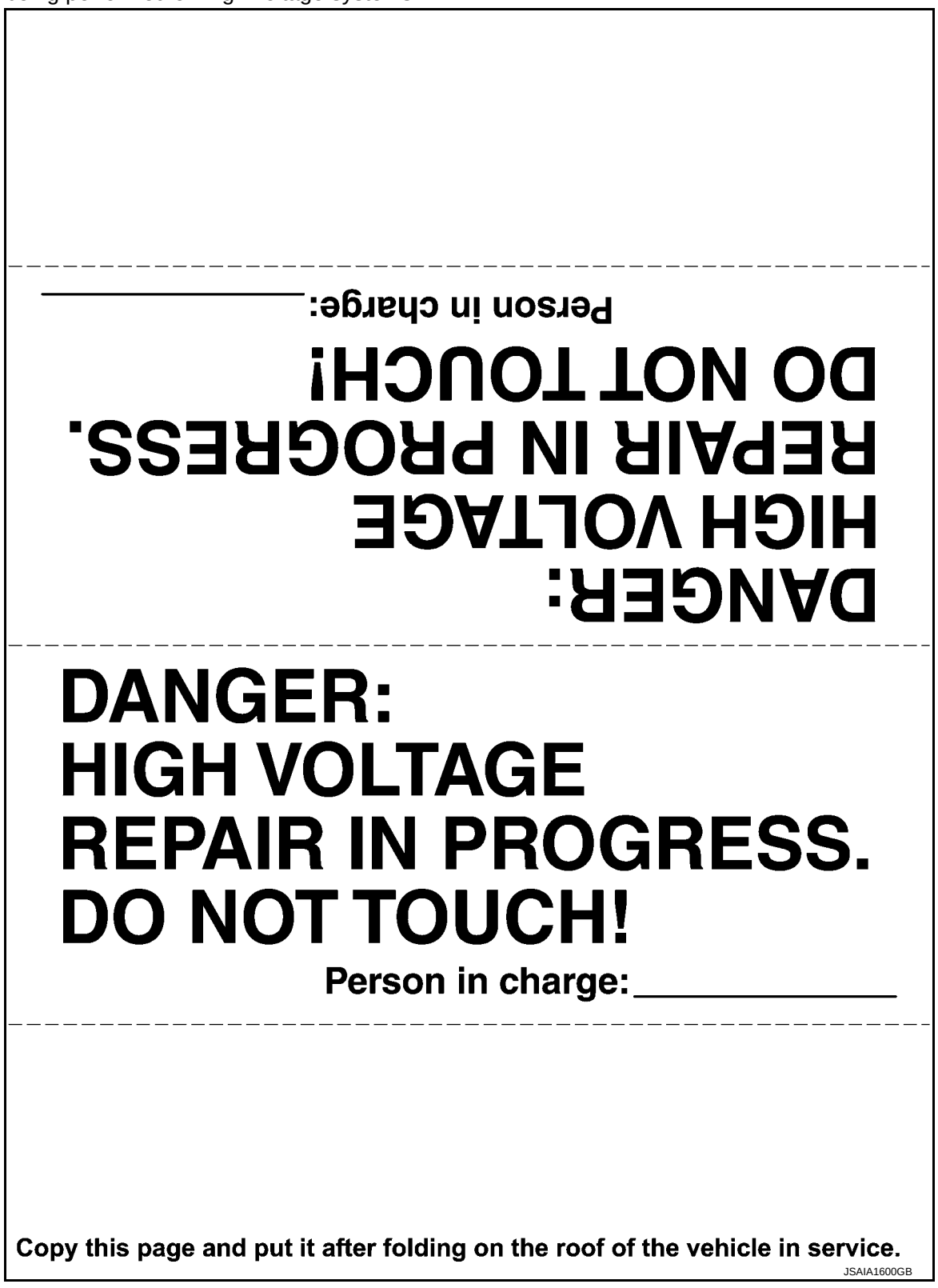
The vehicle contains parts that contain powerful magnets. If a person who is wearing a heart pacemaker or other medical device is close to these parts, the medical device may be affected by the magnets. Such persons must not perform work on the vehicle.

PROHIBITED ITEMS TO CARRY DURING THE WORK

Hybrid vehicles and electric vehicles contain parts with high voltage and intense magnetic force. Never carry metal products and magnetic recording media (e.g. credit card, debit card) to repair/inspect high voltage parts. If this is not observed, the metal products may create a risk of short circuit and the magnetic recording media may lose their magnetic recording.

POST A SIGN OF “DANGER! HIGH VOLTAGE AREA. KEEP OUT”

Call the attention of other workers and indicate "High voltage work in progress." Do not touch vehicles where work is being performed on high voltage systems.



Precaution for Handling High Pressure Fuel System

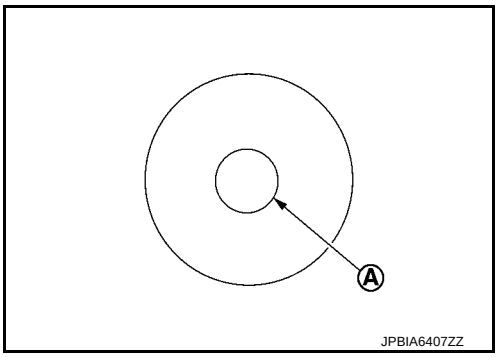
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- High pressure fuel system components are between high pressure fuel pump and fuel injector.
- Always release fuel pressure and never start the engine when performing removal and installation.
- When removing or installing parts without releasing fuel pressure, fuel may be splashed and, if fuel contacts skin or eyes, it may cause inflammation.

Special Cautions to Ensure the Safe Disposal of Sodium-filled Valves

INFOID:0000000014727292

Handling and disposal of sodium-filled valves requires special care and consideration. Under conditions such as breakage with subsequent contact with water, metal sodium which lines the inner portion of valve will react violently, forming sodium hydroxide and hydrogen which may result in an explosion. Sodium-filled valve is identified on the top of its stem as shown in illustration.



Identification mark of sodium-filled valve (A)

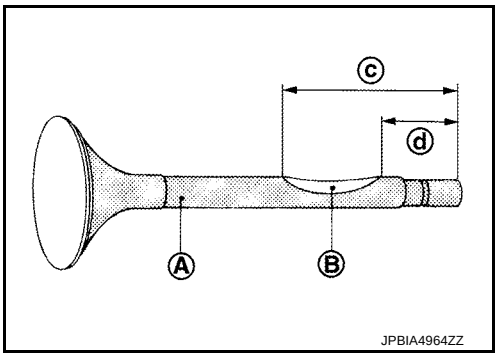
Intake	: Not applicable
Exhaust	: BBA

DEALER DISPOSAL INSTRUCTIONS

CAUTION:

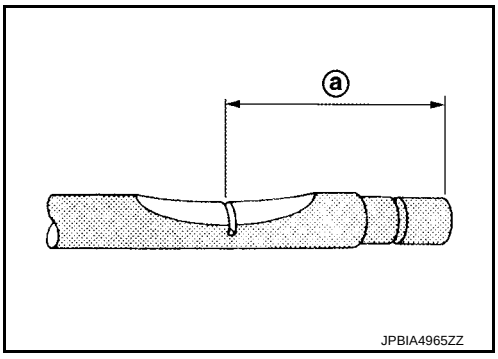
- **Use approved shatter-resistant eye protection when performing this procedure.**
- **Perform this and all subsequent disposal work procedures in an open room, away from flammable liquids. Keep a fire extinguisher, rated at least 10 ABC, in close proximity to the work area.**
- **Be sure to wear rubber gloves when performing the following operations.**
- **Make sure the resultant (high alkalinity) waste water does not contact your skin. If the waste water does contact you, wash the contacted area immediately with large quantities of water.**
- **Dealers should check their respective state and local regulations concerning any chemical treatment or waste water discharge permits which may be required to dispose of the resultant (high alkalinity) waste water.**

1. Clamp valve stem in a vice.
2. The valve has a specially-hardened surface. To cut through it, first remove a half-round section, approximately 30 mm (1.18 in) long using air-powered grinder until black color is removed and silver color appears.



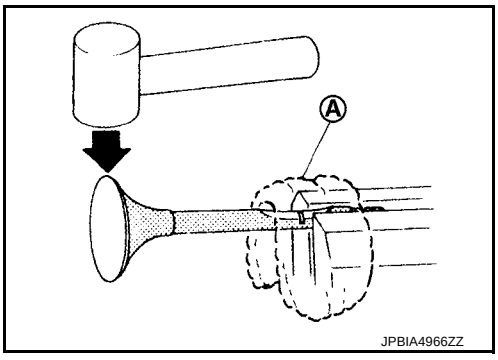
(A) : Black color
(B) : Silver color
(c) : 47 mm (1.85 in)
(d) : 17 mm (0.67 in)

3. Use hacksaw to cut through approximately half the diameter of valve stem. Make the serration at a point ⓐ from the end of valve stem.

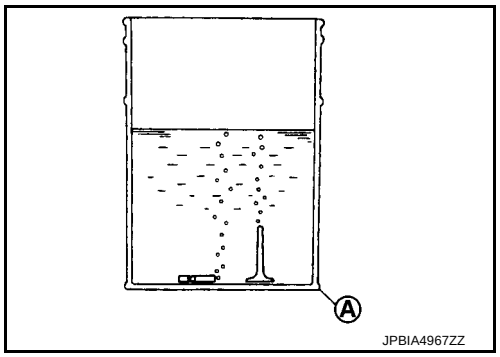


(a) : 32 mm (1.26 in)

4. Cover the serrated end of the valve with a large shop towel (A). Strike the valve face end with a hammer, separating it into two pieces.
5. Fill a bucket, such as a 20 ℓ (5-1/4 US gal, 4-3/8 Imp gal) oil can with at least 10 ℓ (2-5/8 US gal, 2-1/4 Imp gal) of water. Carefully place the already cut (serrated) valves into the water one-at-a-time using a set of large tweezers and quickly move away at least 2.7 m (9 ft).



6. The valves should be placed in a standing position as shown in the illustration to allow complete reaction. After the bubbling action has subsided, additional valves can be placed into the bucket allowing each subsequent chemical reaction to subside. However, no more than 8 valves should be placed in the same 10 ℓ (2-5/8 US gal, 2-1/4 lmp gal) amount of water. The complete chemical reaction may take as long as 4 to 5 hours. Remove the valves using a set of large tweezers after the chemical reaction has stopped. Afterwards, valves can be disposed as ordinary scrap.



(A) : Bucket [Such as 20 ℓ (5-1/4 US gal, 4-3/8 Imp gal) oil can]

Precautions For Engine Service

INFOID:0000000014727293

DISCONNECTING FUEL PIPING

- Before starting work, check no fire or spark producing items are in the work area.
- Release fuel pressure before disconnecting and disassembly.
- After disconnecting pipes, plug openings to stop fuel leakage.

DRAINING ENGINE COOLANT

Drain engine coolant and engine oil when the engine is cooled.

INSPECTION, REPAIR AND REPLACEMENT

Before repairing or replacing, thoroughly inspect parts. Inspect new replacement parts in the same way, and replace if necessary.

REMOVAL AND DISASSEMBLY

- When instructed to use SST, use specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Dowel pins are used for several parts alignment. When replacing and reassembling parts with dowel pins, check that dowel pins are installed in the original position.
- Must cover openings of engine system with a tape or equivalent, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and reassembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified. Power tools may be used in the step.

ASSEMBLY AND INSTALLATION

- Use torque wrench to tighten bolts or nuts to specification.
- When tightening nuts and bolts, as a basic rule, equally tighten in several different steps starting with the ones in center, then ones on inside and outside diagonally in this order. If the order of tightening is specified, do exactly as specified.
- Replace with new gasket, packing, oil seal or O-ring.
- Thoroughly wash, clean, and air-blow each part. Carefully check engine oil or engine coolant passages for any restriction and blockage.
- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- After disassembling, or exposing any internal engine parts, change engine oil and replace oil filter with a new one.
- Release air within route when refilling after draining engine coolant.
- After repairing, start the engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust gases for leakage.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-113, "Description".

Parts Requiring Angle Tightening

INFOID:0000000014727294

- Use the Tool for the final tightening of the following engine parts:

Tool number : KV10112100 (BT-8653-A)

- Camshaft sprocket (INT) bolt
- Cylinder head bolts
- Main bearing cap bolts
- Connecting rod cap bolts
- Crankshaft pulley bolt (No the angle wrench is required as bolt flange is provided with notches for angle tightening)

- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Liquid Gasket

INFOID:0000000014727295

REMOVAL OF LIQUID GASKET SEALING

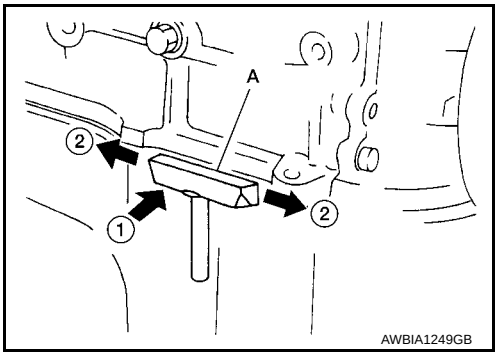
- After removing the bolts and nuts, separate the mating surface and remove the liquid gasket using Tool (A).

Tool Number : KV10111100 (J-37228)

CAUTION:
Be careful not to damage the mating surfaces.

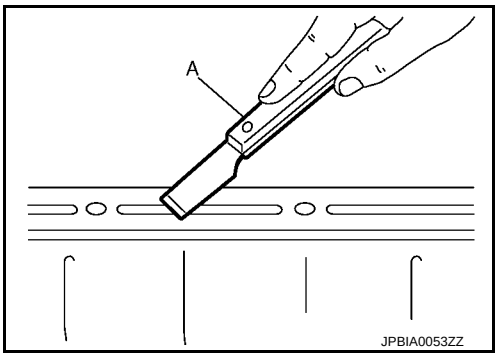
- In areas where the cutter is difficult to use, use a plastic hammer to lightly tap (1) the cutter where the liquid gasket is applied. Use a plastic hammer to slide (2) the cutter by tapping on the side.

CAUTION:
Do not damage the mating surfaces.

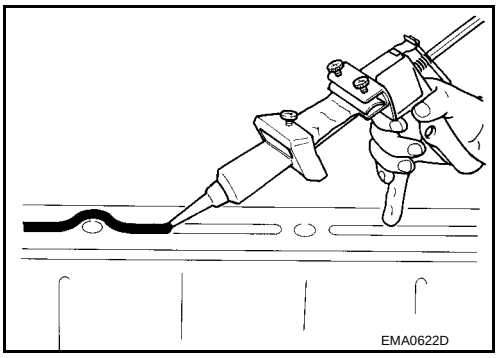


LIQUID GASKET APPLICATION PROCEDURE

1. Using suitable tool (A), remove old liquid gasket adhering to the liquid gasket application surface and the mating surface.
   - Remove liquid gasket completely from the groove of the liquid gasket application surface, mounting bolts, and bolt holes.
2. Thoroughly clean the mating surfaces and remove adhering moisture, grease and foreign materials.

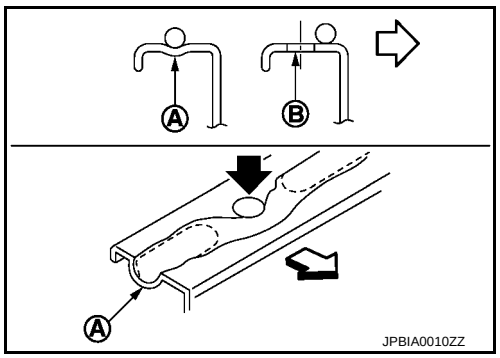


3. Attach liquid gasket tube to the suitable tool.
   Use Genuine Silicone RTV Sealant, or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
   - If there is a groove for liquid gasket application, apply liquid gasket to the groove.



- As for bolt holes (B), normally apply liquid gasket inside the holes. Occasionally, it should be applied outside the holes. Check to read the text of this manual.

(A) : Groove
⇦ : Inside



- Within five minutes of liquid gasket application, install the mating component.
- If liquid gasket protrudes, wipe it off immediately.
- Do not retighten bolts or nuts after the installation.
- After 30 minutes or more have passed from the installation, fill engine oil and engine coolant. Refer to LU-12, "Refilling" and CO-11, "Refilling".

CAUTION:
If there are more specific instructions in the procedures contained in this manual concerning liquid gasket application, observe them.

Precautions Concerning On-board Servicing of Hybrid Systems

INFOID:0000000014727296

CAUTION:
Be sure to turn the ignition switch OFF before performing inspection and servicing inside the engine compartment or underneath the vehicle. If the ignition switch is ON (vehicle READY state), even if the engine is stopped, the conditions of the vehicle may cause the engine to start automatically.
If it is necessary to continually operate the engine during inspection or servicing, use the designated inspection mode. HBC-113, "Description".
NOTE:
The engine starts when hood is opened with the vehicle in READY state.

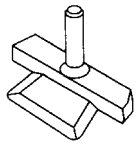
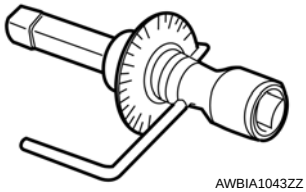
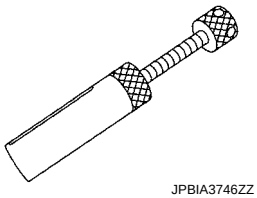
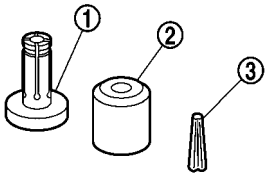
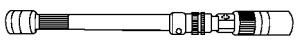
PREPARATION

PREPARATION

Special Service Tools

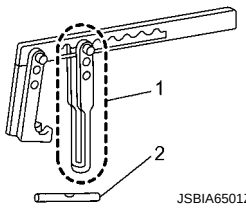
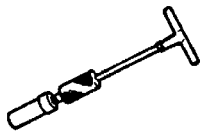
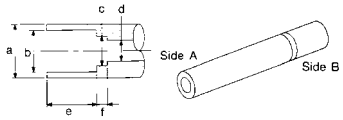
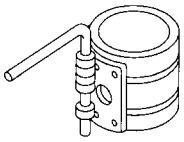
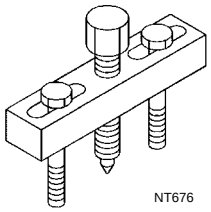
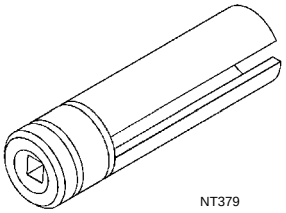
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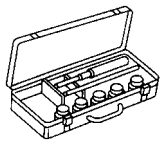
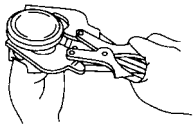
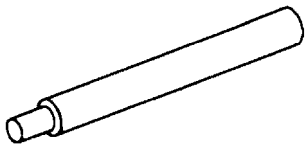
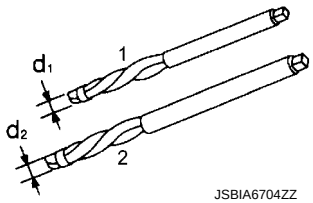
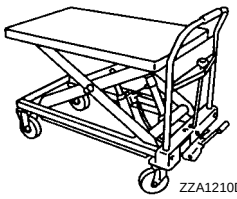
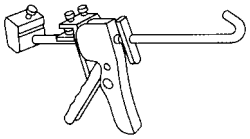
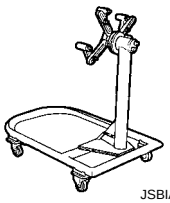
The actual shapes of TechMate tools may differ from those of special service tools illustrated here.

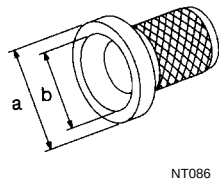
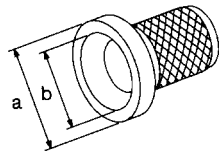
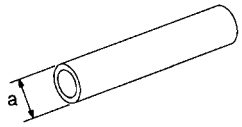
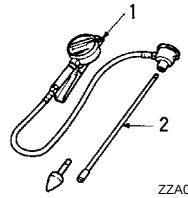
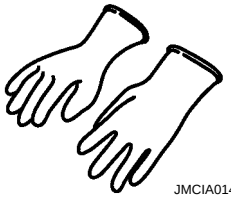
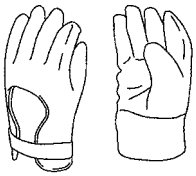
Tool number (TechMate No.) Tool name	Description
KV10111100 (J-37228) Seal cutter  S-NT046	Removing oil pan (upper and lower) etc.
KV10112100 (BT-8653-A) Angle wrench  AWBIA1043ZZ	Tightening bolts for main bearing cap, cylinder head, etc.
KV10119600 (J-50366) Injector remover  JPBIA3746ZZ	Removing and installing direct injection fuel injector
KV101197S0 (J-50364) Injector seal drift set 1. KV10119730 (—) Seal installer 2. KV10119710 (—) Drift 3. KV10119720 (—) Seal guide  JPBIA5653ZZ	Installing fuel injector seal
— (J-48891) Spark plug wrench  ALBIA3191ZZ	Removing and installing spark plug

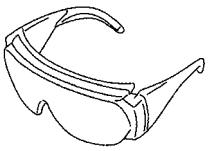
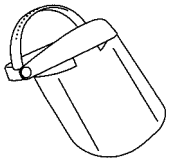
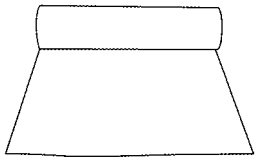
Commercial Service Tools

INFOID:0000000014727298

(TechMate No.) Tool name	Description
(—) Pulley holder  ZZA1010D	Crankshaft pulley removing and installing
(—) Valve spring compressor Attachment Adapter  JSBIA6501ZZ	Disassembling and assembling valve mechanism Part (1) is a component of KV10116200, but Part (2) is not so.
(—) Valve oil seal puller  ZZA0015D	Removing valve oil seal
(—) Valve oil seal drift  S-NT603	Installing valve oil seal **Use side A.** **a: 20 (0.79) dia.** **d: 8 (0.31) dia.** **b: 13 (0.51) dia.** **e: 10.7 (0.421)** **c: 10.3 (0.406) dia.** **f: 5 (0.20)** Unit: mm (in)
(—) Piston ring compressor  S-NT044	Installing piston assembly into cylinder bore
(—) Pulley puller  NT676	Removing crankshaft pulley
(—) Heated oxygen sensor wrench  NT379	Loosening or tightening heated oxygen sensor 1 **For 22 mm (0.87 in) width hexagon nut**

(TechMate No.) Tool name	Description
(—) Valve seat cutter set  S-NT048	Finishing valve seat dimensions
(—) Piston ring expander  S-NT030	Removing and installing piston ring
(—) Valve guide drift  PBIC4012E	Removing and installing valve guide
(—) Valve guide reamer  JSBIA6704ZZ	1: Reaming valve guide inner hole 2: Reaming hole for oversize valve guide **d1: 6.0 mm (0.236 in) dia.** **d2: 10.2 mm (0.402 in) dia.**
(—) Manual lift table caddy  ZZA1210D	Removing and installing engine
(—) Tube presser  S-NT052	Pressing the tube of liquid gasket
(—) Engine stand  JSBIA4606ZZ	Engine overhaul

(TechMate No.) Tool name	Description
(—) Drift  NT086	Installing front oil seal **a: ϕ57.0 mm (2.244 in).** **b: ϕ45.0 mm (1.772 in).**
(—) Drift  NT086	Installing rear oil seal **a: ϕ115.0 mm (4.528 in).** **b: ϕ90.0 mm (3.543 in).**
(—) Stick  NT083	Installing rear oil seal **a: ϕ18.0 mm (0.709 in).**
(—) Compression gauge set  ZZA0008D	Compression pressure 1: Compression gauge 2: Adapter
(—) Insulated Gloves  JMCIA0149ZZ	• Removing and installing high voltage components • [Guaranteed insulation performance for 1000V/300A]
(—) Leather Gloves  JPCIA0066ZZ	• Removing and installing high voltage components • Protect insulated gloves [Use leather gloves that can fasten the wrist tight]
(—) Insulated Safety Shoes  JPCIA0011ZZ	Removing and installing high voltage components

(TechMate No.) Tool name	Description
(—) Safety Glasses  JPCIA0012ZZ	• Removing and installing high voltage components • To protect eye from the spatter on the work to electric line • [ANSI Z87.1]
(—) Face Shield Protection  JPCIA0167ZZ	• Removing and installing high voltage components • To protect eyes and face from the spatter on the work to electric line
(—) Insulated Rubber Sheet  JPCIA0019ZZ	Removing and installing high voltage components

BASIC INSPECTION

CAMSHAFT VALVE CLEARANCE

Inspection and Adjustment

INFOID:0000000014727301

INSPECTION

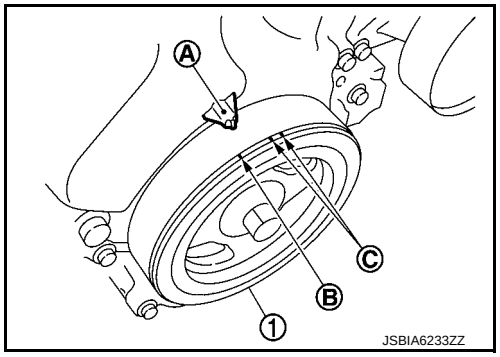
Perform inspection as follows after removal, installation or replacement of camshaft or valve-related parts, or if there is unusual engine conditions regarding valve clearance.

1. Remove rocker cover. Refer to EM-63, "Removal and Installation".
2. Measure the valve clearance with the following procedure:

a. Set No. 1 cylinder at TDC of its compression stroke.

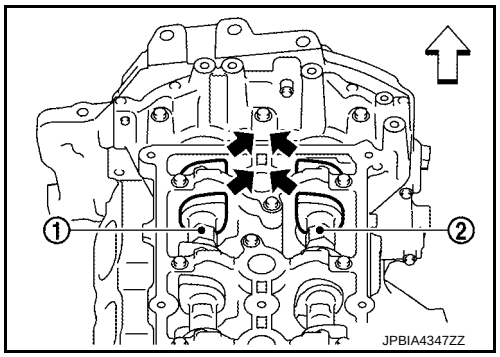
- Rotate crankshaft pulley (1) clockwise and align TDC mark [no paint (B)] to timing indicator (A) on front cover.

(C) : White paint mark (Not use for service)



- At the same time, check that both intake and exhaust cam noses of No. 1 cylinder face inside (⬅) as shown in the figure.

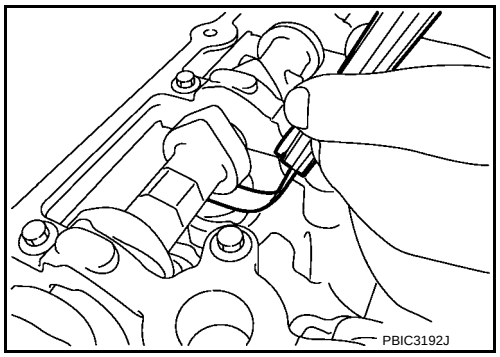
(1) : Camshaft (INT)
(2) : Camshaft (EXT)
⇦ : Engine front



- If they do not face inside, rotate crankshaft pulley once more (360 degrees) and align as shown in the figure.

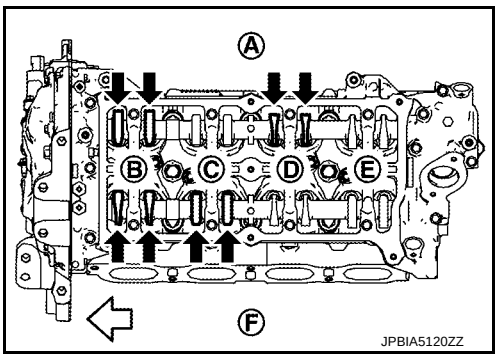
b. Using a suitable tool, measure the clearance between valve lifter and camshaft.

Valve clearance : Refer to EM-142, "Camshaft".



- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below [locations indicated with black arrow (⬅)] with a suitable tool.

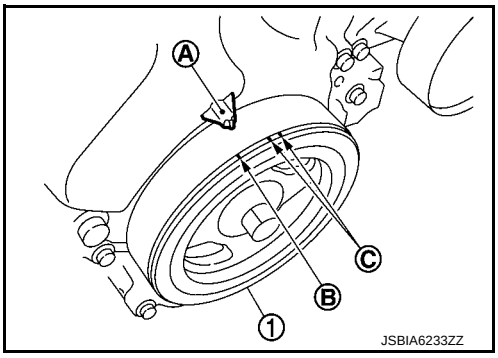
(A) : Exhaust side
(B) : No. 1 cylinder
(C) : No. 2 cylinder
(D) : No. 3 cylinder
(E) : No. 4 cylinder
(F) : Intake side
⇦ : Engine front



Measuring position		No. 1 CYL.	No. 2 CYL.	No. 3 CYL.	No. 4 CYL.
No. 1 cylinder at compression TDC	EXH	×		×	
	INT	×	×		

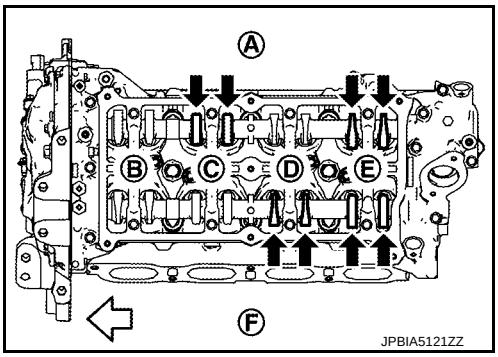
c. Set No. 4 cylinder at TDC of its compression stroke.
- Rotate crankshaft pulley (1) one revolution (360 degrees) and align TDC mark [no paint (B)] to timing indicator (A) on front cover.

(C) : White paint mark (Not use for service)



- By referring to the figure, measure the valve clearance at locations marked "×" as shown in the table below [locations indicated with black arrow (⬅)] with a suitable tool.

(A) : Exhaust side
(B) : No. 1 cylinder
(C) : No. 2 cylinder
(D) : No. 3 cylinder
(E) : No. 4 cylinder
(F) : Intake side
⇦ : Engine front



Measuring position		No. 1 CYL.	No. 2 CYL.	No. 3 CYL.	No. 4 CYL.
No. 4 cylinder at compression TDC	EXH		×		×
	INT			×	×

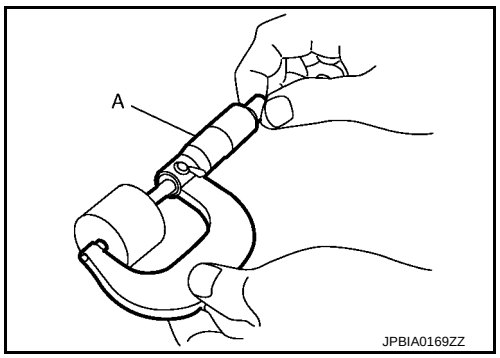
3. If out of standard, perform adjustment. Refer to "ADJUSTMENT".

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.

1. Remove camshaft. Refer to EM-77, "Removal and Installation".
2. Remove valve lifters at the locations that are out of the standard.

3. Measure the center thickness of the removed valve lifters with a suitable tool (A).



4. Use the equation below to calculate valve lifter thickness for replacement.

Valve lifter thickness calculation: $t = t_1 + (C_1 - C_2)$

t = Valve lifter thickness to be replaced

t_1 = Removed valve lifter thickness

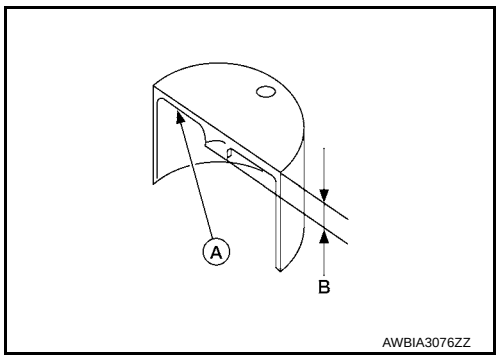
C_1 = Measured valve clearance

C_2 = Standard valve clearance:

Intake : 0.28 mm (0.011 in)

Exhaust : 0.30 mm (0.012 in)

- Thickness of new valve lifter (B) can be identified by stamp mark (A) on the reverse side (inside the cylinder).
- Stamp mark “302” indicates 3.02 mm (0.1189 in) in thickness.



NOTE:
Available thickness of valve lifter: 26 sizes range 3.00 to 3.50 mm (0.1181 to 0.1378 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to EM-142, "Camshaft".

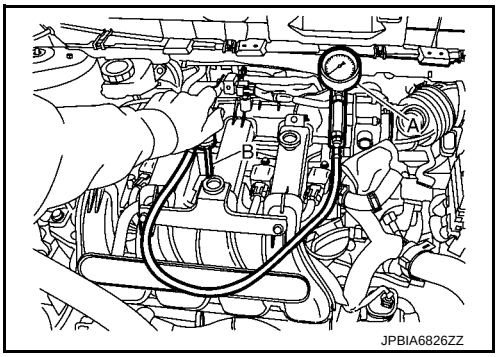
5. Install the selected valve lifter.
6. Install camshaft. Refer to EM-77, "Removal and Installation".
7. Install timing chain and related parts. Refer to EM-66, "Removal and Installation".
8. Manually rotate crankshaft pulley a few rotations.
9. Check that the valve clearances is within the standard. Refer to “INSPECTION”.
10. Installation of the remaining parts is in the reverse order of removal.
11. Warm up the engine, and check for unusual noise and vibration.

COMPRESSION PRESSURE

Inspection

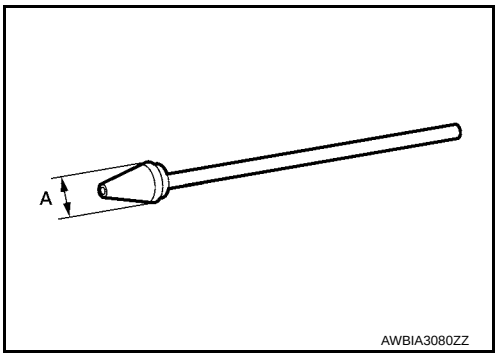
INFOID:0000000014727302

1. Warm up engine thoroughly. Then, stop it.
2. Release the fuel pressure. Refer to EC-162, "Work Procedure".
3. Remove the fuel pump fuse from IPDM E/R to avoid fuel injection during measurement.
4. Remove ignition coil and spark plug from each cylinder. Refer to EM-63, "Removal and Installation".
5. Connect engine tachometer (not required in use of CONSULT).
6. Install suitable tool (A) with suitable tool (B) onto spark plug hole.



- Use the adapter whose picking up end inserted to spark plug hole is smaller than 20 mm (0.79 in) in diameter. Otherwise, it may be caught by cylinder head during removal.

(A) : 20 mm (0.79 in)



7. Connect CONSULT and select “ACTIVE TEST” mode in “EV/HEV” to perform “INSPECTION MODE 7”. Refer to HBC-115, "Work Procedure (Inspection Mode 7)".
8. With accelerator pedal fully depressed, turn ignition switch to “START” for cranking. When the gauge pointer stabilizes, read the compression pressure and the engine rpm. Perform these steps to check each cylinder.

Compression pressure : Refer to EM-141, "General Specification".

CAUTION:
Always use a fully charged battery to obtain the specified engine speed.
- If the engine speed is out of the specified range, check battery liquid for proper gravity. Check the engine speed again with normal battery gravity.
- If compression pressure is below minimum value, check valve clearances, and parts associated with combustion chamber (valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After the checking, measure compression pressure again.
- If some cylinder has low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to recheck it for compression.
  - If the added engine oil improves the compression, piston rings may be worn out or damaged. Check piston rings and replace if necessary.
  - If the compression pressure remains at low level despite the addition of engine oil, valves may be malfunctioning. Check valves for damage. Replace valve or valve seat accordingly.
- If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, cylinder head gaskets are leaking. In such a case, replace cylinder head gaskets.

9. After inspection is completed, installation is in the reverse order of removal.

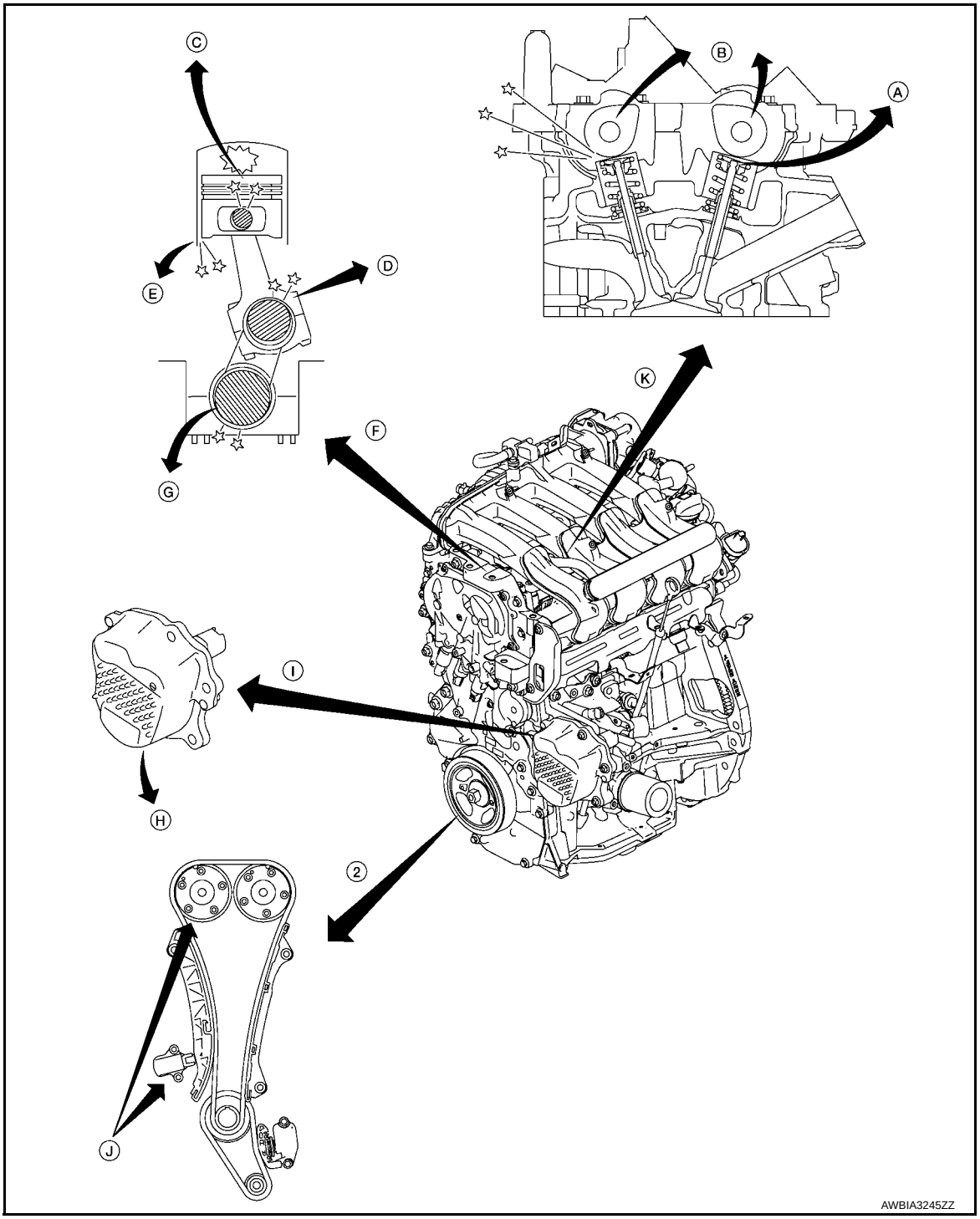
10. Start the engine, and check that the engine runs smoothly.
NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".
11. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-170, "Description".

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH troubleshooting Chart

INFOID:0000000014727303



1. Water pump
2. Timing chain
A. Tappet noise
B. Camshaft bearing noise
C. Piston pin noise
D. Connecting rod bearing noise
E. Piston slap noise
F. Rotation mechanism
G. Main bearing noise
H. Water pump noise
J. Timing chain and chain tensioner noise
K. Valve mechanism

1. Locate the area where noise occurs.

2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Refer-ence page
		Before warm-up	After warm-up	When start-ing	When idling	When racing	While driving			
Top of en-gine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-15
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal oil clearance Camshaft runout	EM-142
Crank-shaft pul-ley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin oil clearance Connecting rod bushing oil clearance	EM-147
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clear-ance Piston ring end gap Connecting rod bend and torsion	EM-147
	Knock	C	A	—	B	A	B	Connect-ing rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-147 EM-150
	Knock	C	A	—	B	A	B	Main bear-ing noise	Main bearing oil clear-ance Crankshaft runout	EM-151 EM-147
Front of engine Front cov-er	Tapping or ticking	A	A	A	B	A	B	Timing chain and chain ten-sioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-76 EM-65
Front of engine	Squall Creak	—	A	—	A	C	C	Engine cooling electric water pump noise	Engine cooling electric water pump operation	Replace engine cooling electric water pump*

A: Closely related B: Related C: Sometimes related —: Not related

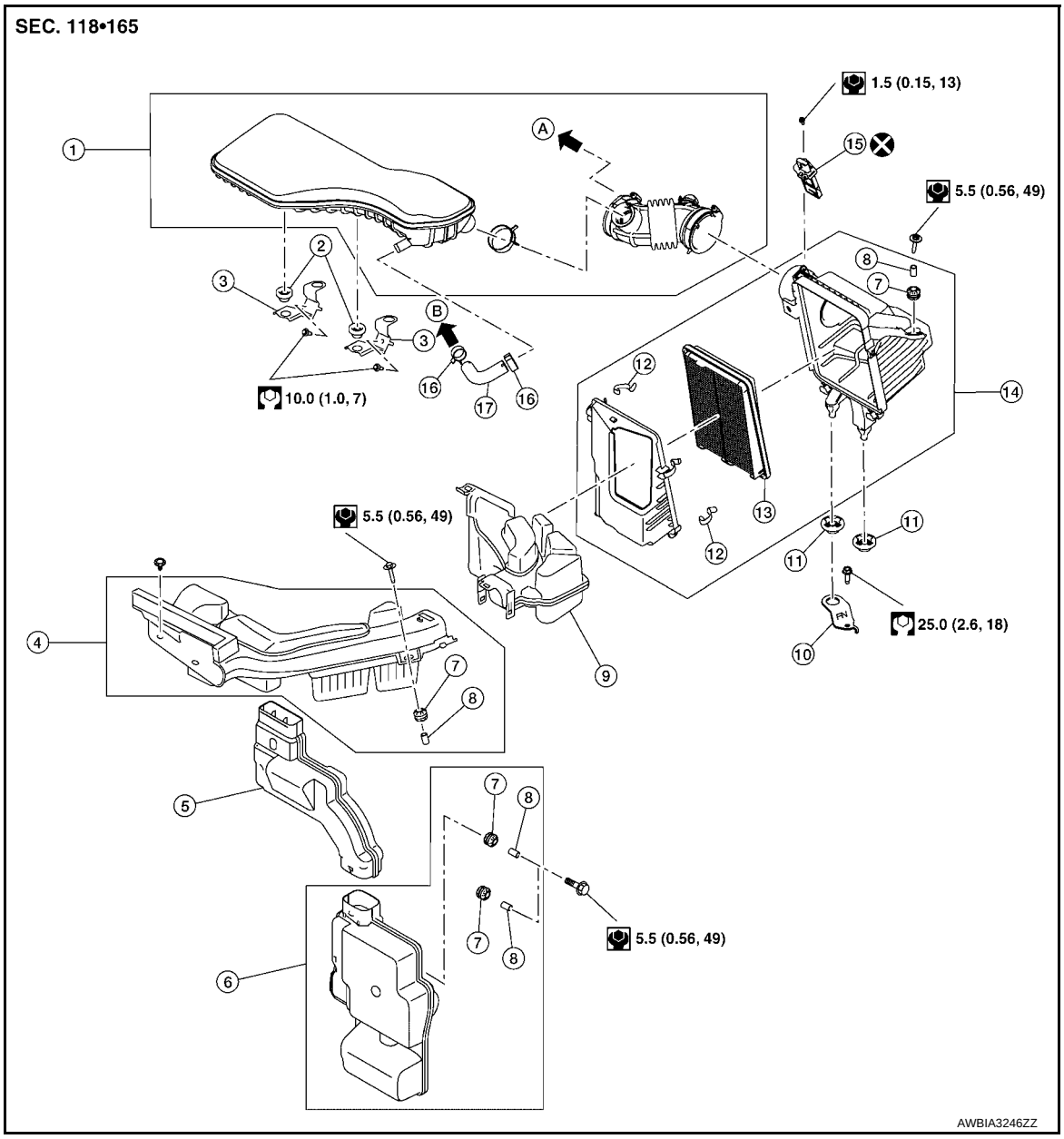
*After replacing engine cooling electric water pump, check DTC of ECM and perform DTC confirmation procedure. Refer to EC-109, "DTC Index".

PERIODIC MAINTENANCE

AIR CLEANER FILTER

Exploded View

INFOID:0000000014727304



1. Air duct and resonator assembly
2. Mounting rubber
3. Resonator bracket
4. Air duct 1
5. Resonator duct
6. Resonator
7. Grommet
8. Retainer
9. Air duct 2
10. Air cleaner bracket
11. Mounting rubber
12. Clip
13. Air cleaner filter
14. Air cleaner assembly
15. Mass air flow sensor
16. Clamp
17. PCV hose
A. To electric throttle control actuator
B. To rocker cover

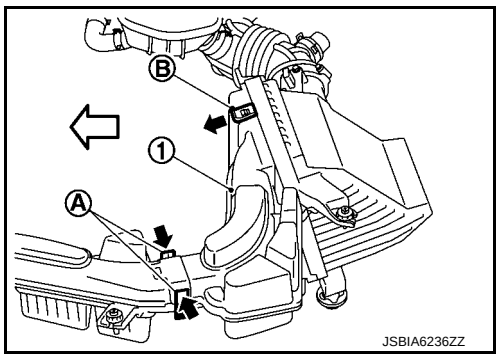
Removal and Installation

INFOID:0000000014727305

REMOVAL

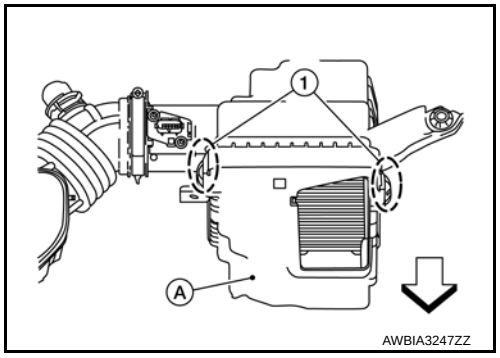
1. To remove air duct 2 (1), pinch pawl (A) to unlock, move pawl (B) frontward and remove air duct 2 upward.

⇦ : Vehicle front



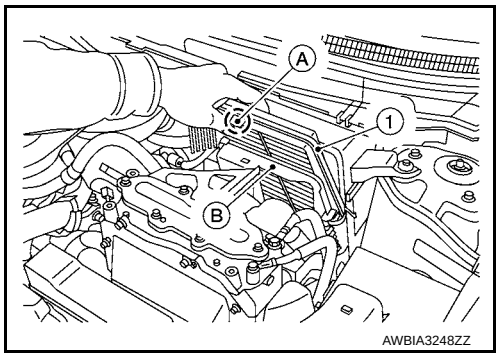
2. Remove the clips (1) of air cleaner case [upper (A)].

⇦ : Vehicle front



3. Reposition the air cleaner case [upper (B)] to the front of the vehicle and remove the air cleaner filter (1).

(A) : Projection

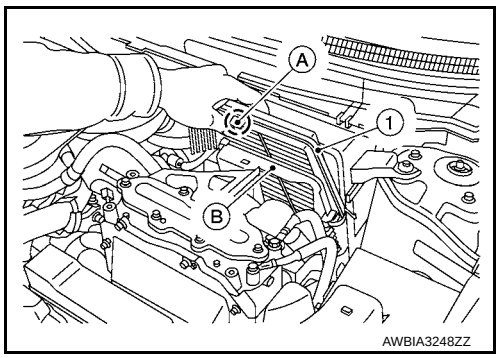


INSTALLATION

Install in the reverse order of removal.

1. Insert air cleaner filter (1), placing protrusion (A) in the position (vehicle front upper side) as shown.

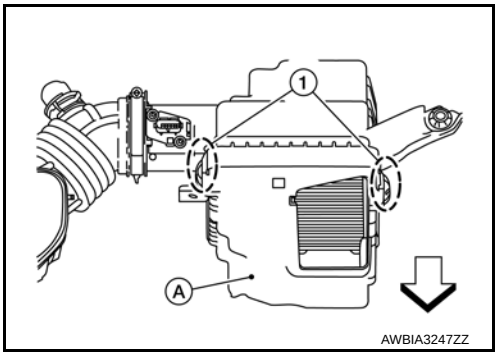
(B) : Air cleaner cover



2. Install clips (1) of air cleaner case [upper (A)].

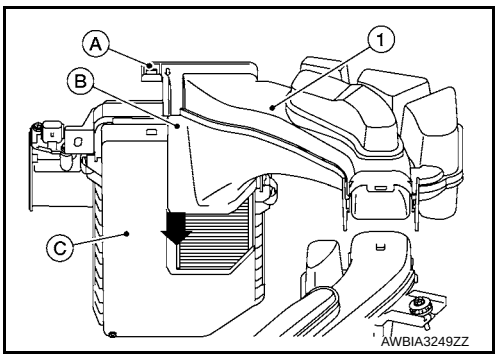
⇦ : Vehicle front

- Check that air cleaner cover is securely fit with no backlash.



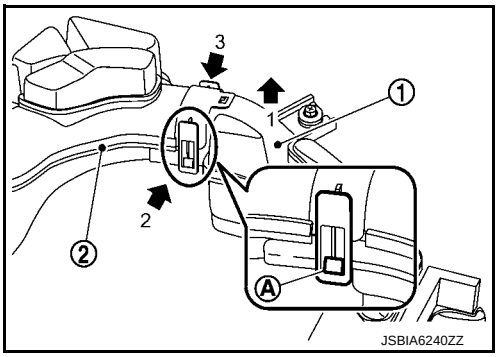
3. Fit air cleaner case [upper (C)] into the grooves (B) of air duct 2 (1) (⬅).

CAUTION:
Do not allow pawl (A) of air duct 2 to be engaged.



4. While lifting air duct 1 [1 (⬅1)], engage air duct 2 (2) with pawl (A) of air duct 1 in the order of inside (⬅2), outside (⬅3).

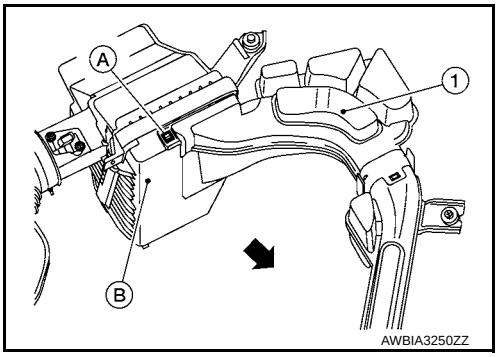
CAUTION:
After checking that the inside pawl is engaged, engage the outside pawl.



5. Engage pawl (A) of air duct 2 (1).

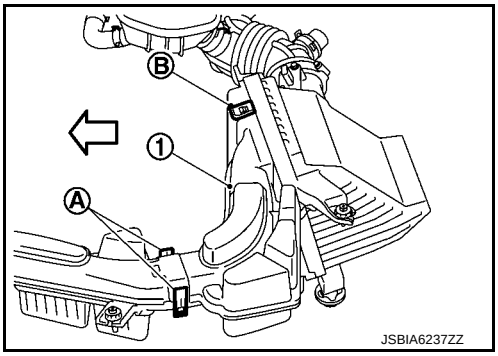
(B) : Air cleaner case (upper)

⇦ : Vehicle front



6. Check that pawls (A/B) of air duct 2 (1) are engaged.

⇦ : Vehicle front



Inspection (Viscous Paper Type)

INFOID:0000000014727307

INSPECTION AFTER REMOVAL

Examine with eyes that there is no stain, clogging, or damage on air cleaner filter.

- Remove dusts (such as dead leafs) on air cleaner filter surface and inside cleaner case.
- If clogging or damage is observed, replace the air cleaner filter.

CAUTION:

Do not clean the viscous paper type air cleaner filter by blowing as there is a risk of deterioration of its performance

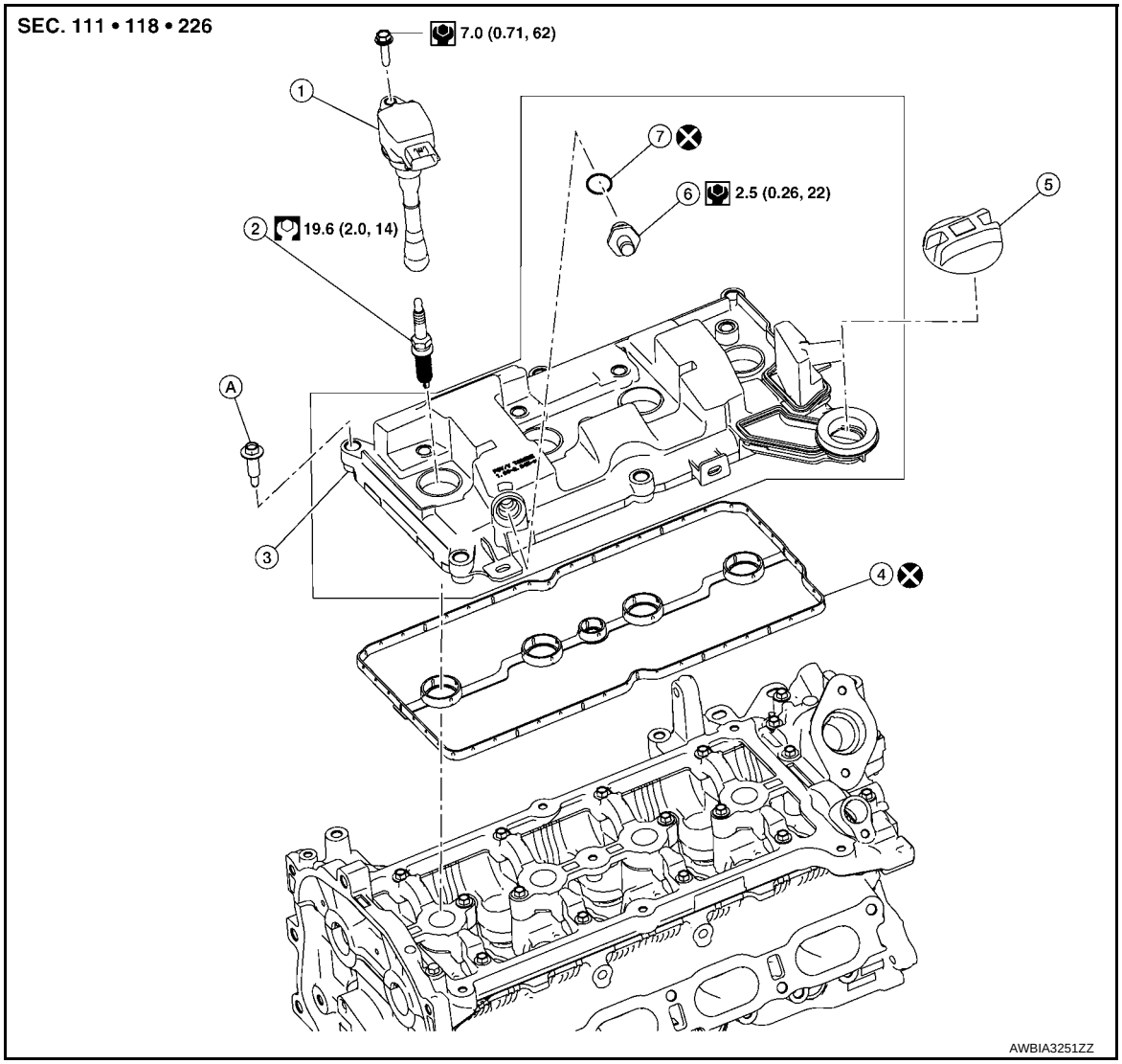
MAINTENANCE INTERVAL

Refer to MA-7, "Introduction of Periodic Maintenance".

SPARK PLUG

Exploded View

INFOID:0000000014727308



1. Ignition coil
2. Spark plug
3. Rocker cover assembly
4. Rocker cover gasket
5. Oil filler cap
6. PCV valve
7. O-ring
A. Refer to EM-63, "Removal and Installation".

Removal and Installation

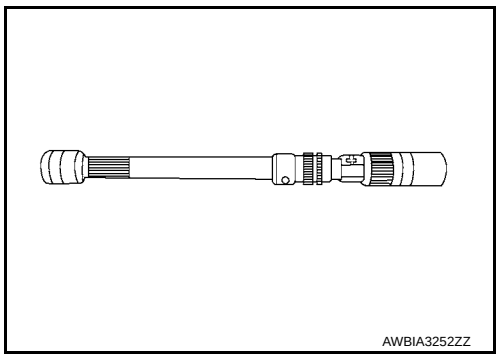
INFOID:0000000014727309

REMOVAL

1. Remove ignition coil. Refer to EM-63, "Removal and Installation".

2. Remove spark plug with Tool.
CAUTION:
Do not drop or shock spark plug.

Tool number : — (J-48891)


AWBIA3252ZZ

3. After removal, inspect the spark plug. Refer to INSPECTION AFTER REMOVAL.

INSTALLATION

Installation is in the reverse order of removal.

Make	NGK
Standard type*	DILKAR7D11H
Gap (nominal)	1.1 mm (0.043in)

*: Always check with the Parts Department for the latest parts information.

Inspection

INFOID:0000000014727310

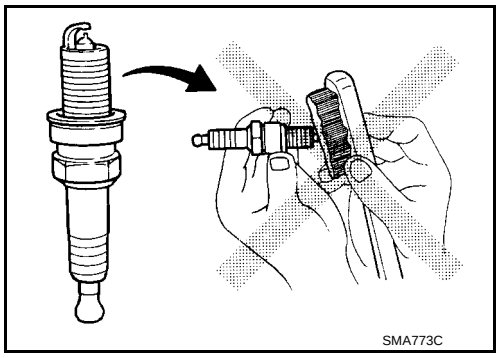
INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

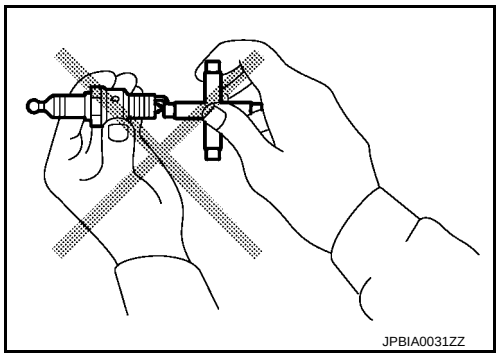
Spark plug (Standard type) : Refer to EM-142, "Spark Plug".

CAUTION:
- **Do not drop or shock spark plug.**
- **Do not use a wire brush for cleaning.**
- **If spark plug tip is covered with carbon, spark plug cleaner may be used.**

Cleaner air pressure : Less than 588 kPa (6 kg/cm^2, 85 psi)
Cleaning time : Less than 20 seconds


SMA773C

- **Checking and adjusting spark plug gap is not required between replacement intervals.**
- **Measure spark plug gap. when it exceeds the limit, replace spark plug even if it is with in the specified replacement mileage. Refer to EM-142, "Spark Plug".**

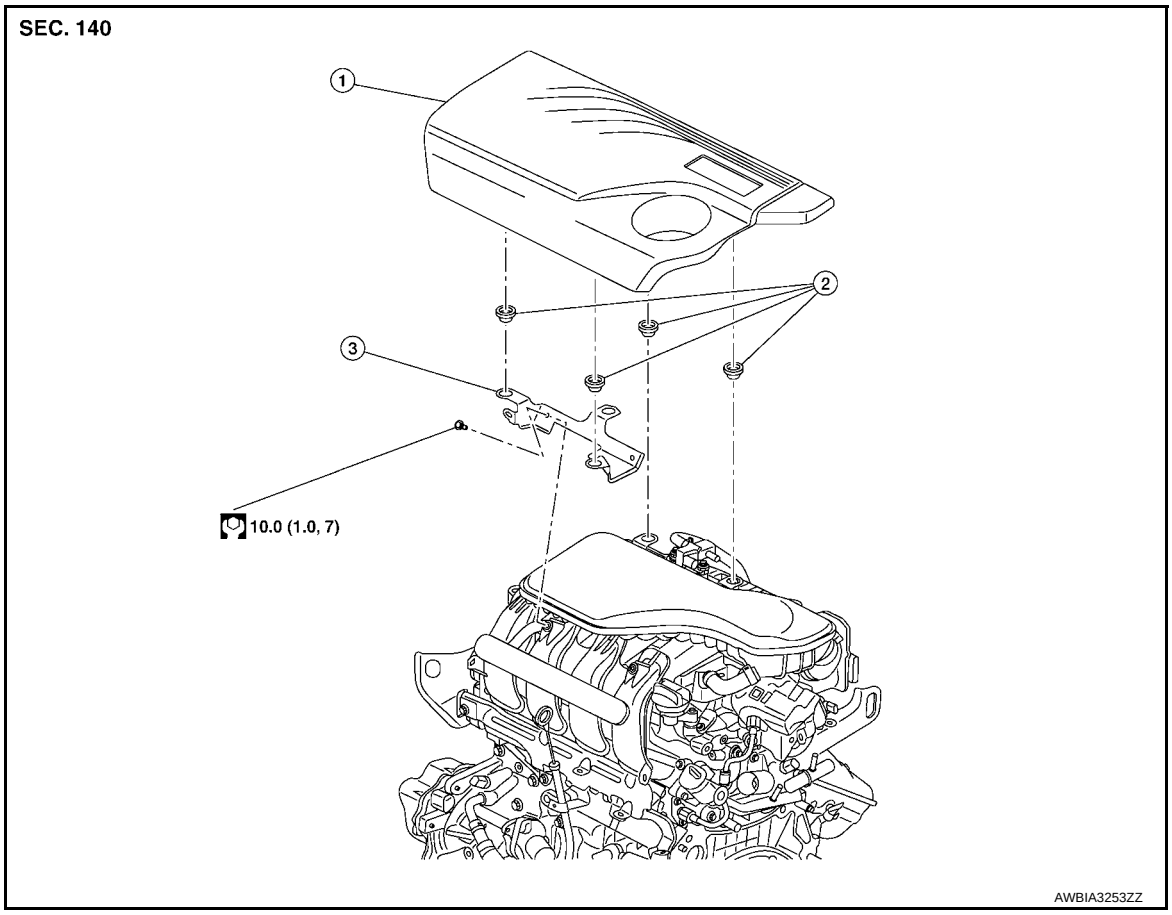

JPBIA0031ZZ

REMOVAL AND INSTALLATION

ENGINE COVER

Exploded View

INFOID:0000000014727311



1. Engine cover
2. Mounting rubber
3. Mounting rubber bracket

Removal and Installation

INFOID:0000000014727312

REMOVAL

1. Disengage the engine cover from the mounting rubbers and remove the engine cover.
   CAUTION:
   Do not damage or scratch the engine cover when removing or installing.
2. Remove mounting rubber bracket (if necessary).

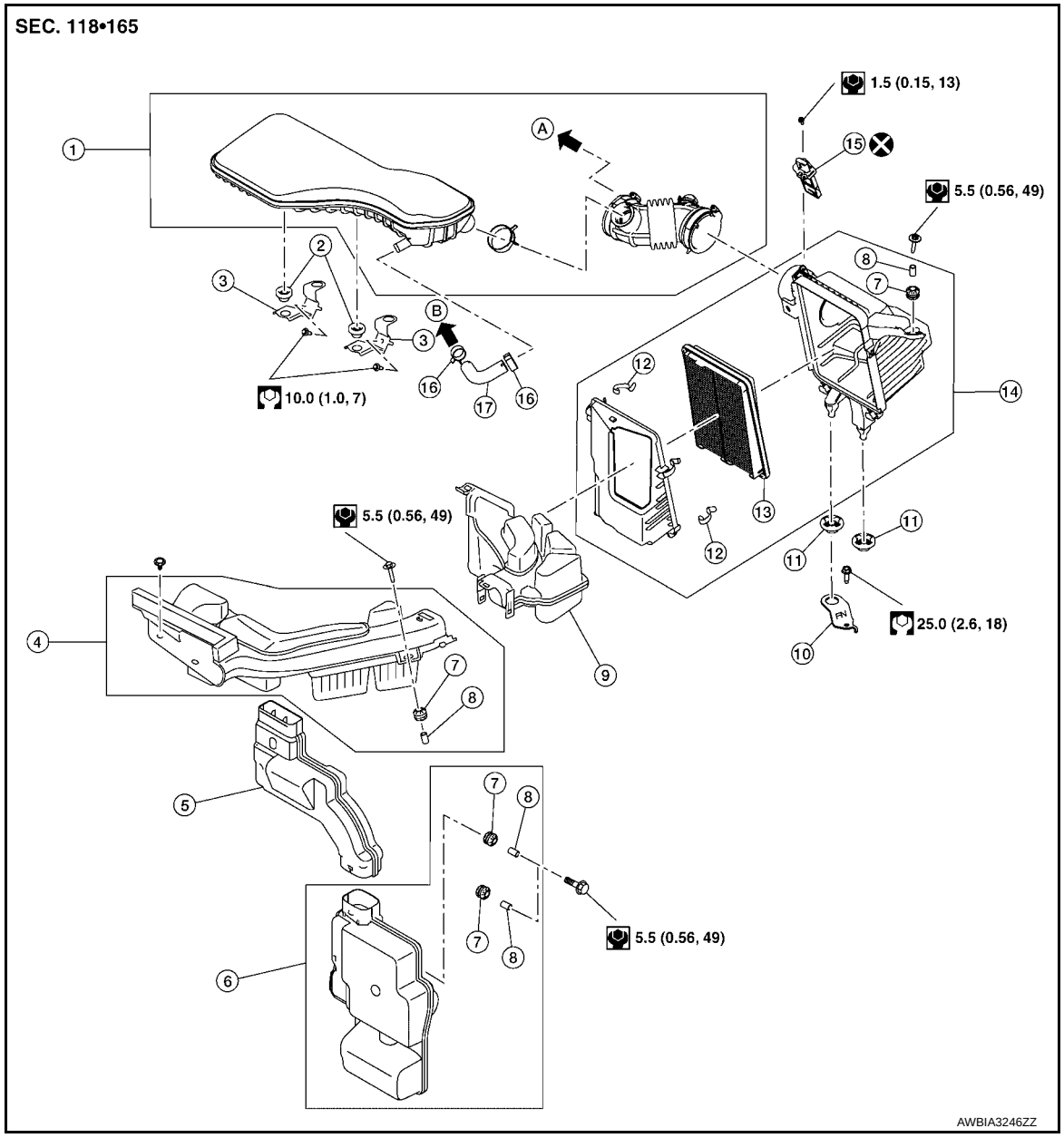
INSTALLATION

Installation is in the reverse order of removal.

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:0000000014727313



1. Air duct and resonator assembly
2. Mounting rubber
3. Resonator bracket
4. Air duct 1
5. Resonator duct
6. Resonator
7. Grommet
8. Retainer
9. Air duct 2
10. Air cleaner bracket
11. Mounting rubber
12. Clip
13. Air cleaner filter
14. Air cleaner assembly
15. Mass air flow sensor
16. Clamp
17. PCV hose
A. To electric throttle control actuator
B. To rocker cover

Removal and Installation

INFOID:0000000014727314

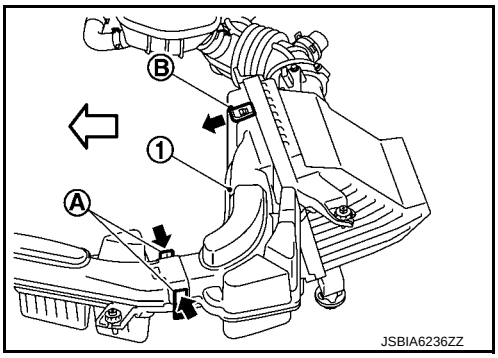
REMOVAL

NOTE:

Mass air flow sensor is removable under the car-mounted condition.

1. Remove engine cover. Refer to EM-28, "Removal and Installation".
2. Remove air duct 1 and air duct 2.
   - To remove air duct 2 (1), pinch (⬅) pawl (A) to unlock, move pawl (B) frontward (⬅), and remove air duct 2 upward.

   ⇦ : Vehicle front



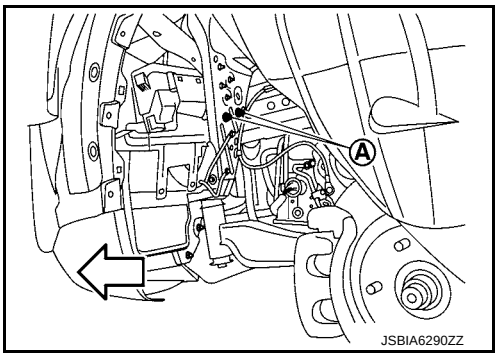
3. Remove cowl top extension. Refer to EXT-37, "Removal and Installation".
4. Disconnect the harness connector from the mass air flow sensor.
5. Loosen clamp connecting air duct and resonator assembly to air cleaner assembly.
   - Add mating marks if necessary for easier installation.
6. Remove air cleaner assembly.
7. Remove mass air flow sensor from air cleaner assembly (if necessary).
   CAUTION:
   - **Do not shock the mass air flow sensor.**
   - **Do not disassemble the mass air flow sensor.**
   - **Do not touch the sensor of the mass air flow sensor.**
8. Disconnect PCV hose from the air duct and resonator assembly.
9. Loosen clamp and remove air duct and resonator assembly.
10. Remove resonator bracket (if necessary).

Resonator and Resonator Duct

1. Remove front fender protector (LH). Refer to EXT-40, "FENDER PROTECTOR : Removal and Installation".
2. Remove fuse block (junction box) bracket nuts (A).

   ⇦ : Vehicle front

3. Reposition the fuse box and remove the resonator and resonator duct.



INSTALLATION

Installation is in the reverse order of removal.

Mass air flow sensor

After replacing mass air flow sensor, perform MIXTURE RATIO SELF-LEARNING VALUE CLEAR. Refer to EC-158, "Work Procedure".

Air Cleaner Assembly

CAUTION:

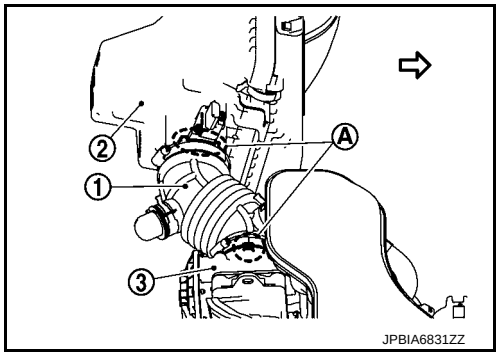
Check that mounting rubber is positioned in the mounting location and be careful not to allow it to be dislocated when installing air cleaner body.

Air Duct Assembly

- To install air duct and resonator assembly (1), align the matching marks (A) on both ends with the others.

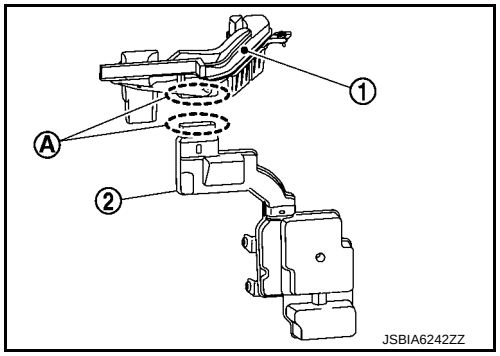
CAUTION:
Do not allow foreign materials to adhere to the mounting part of air duct assembly and each mating part.

(2) : Air cleaner assembly
(3) : Electric throttle control actuator
⇦ : Vehicle front



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Air Duct 1
To install air duct 1 (1), hold resonator duct (2) and securely engage the joint (A).



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Air Duct 2
Securely engage the joint of air cleaner case (upper) and air duct 1.

Inspection

INFOID:0000000014727315

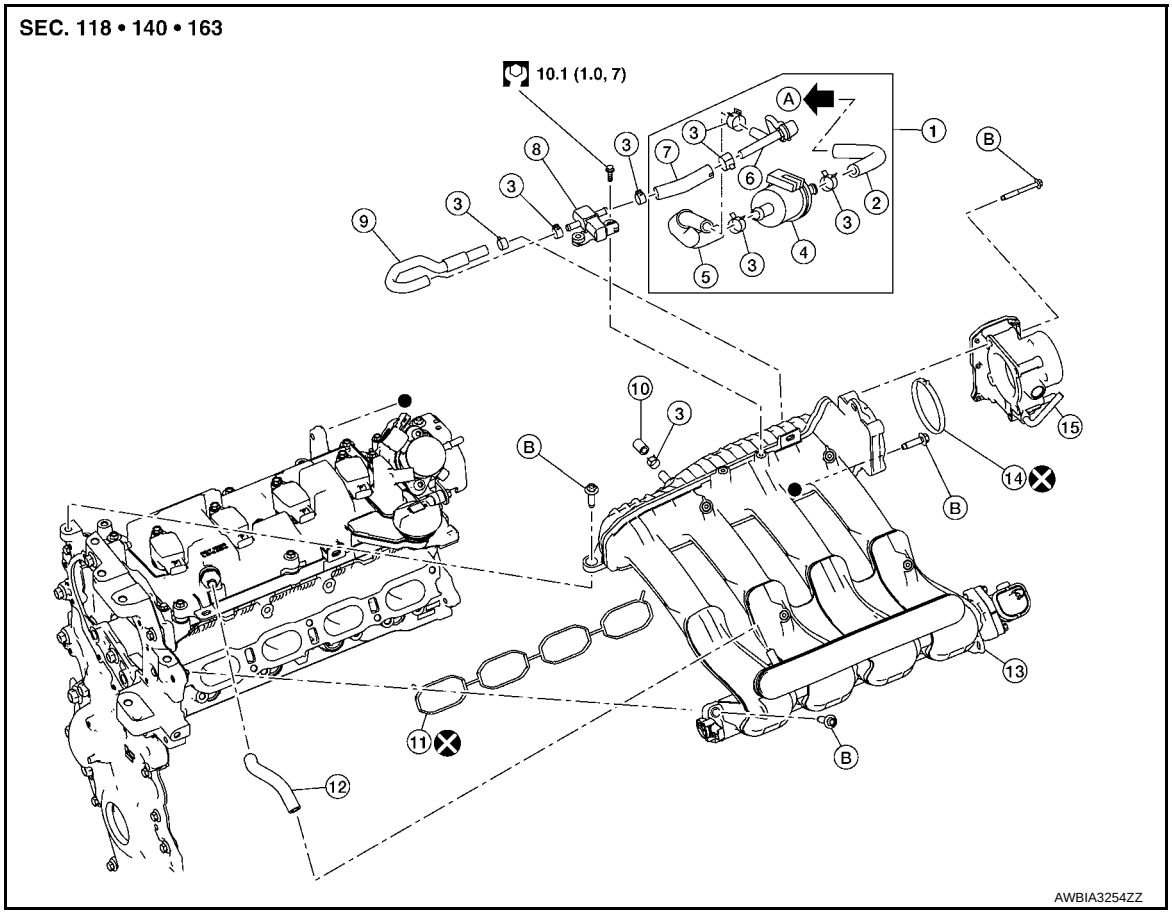
INSPECTION AFTER REMOVAL

Inspect air duct assembly for crack or tear.
- If anything found, replace air duct assembly.

INTAKE MANIFOLD

Exploded View

INFOID:0000000014727316



1.	EVAP hose assembly	2.	EVAP hose A	3.	Clamp
4.	Vacuum delay hose valve connector	5.	EVAP hose B	6.	EVAP service port
7.	EVAP hose C	8.	EVAP canister purge volume control solenoid valve	9.	EVAP hose D
10.	Blind hose	11.	Intake manifold gasket	12.	Blowby hose
13.	Intake manifold	14.	Electric throttle control actuator gasket	15.	Electric throttle control actuator
A.	To EVAP canister	B.	Refer to INSTALLATION		

● : Indicates that the part is connected at points with same symbol in actual vehicle.

Removal and Installation

INFOID:0000000014727317

REMOVAL

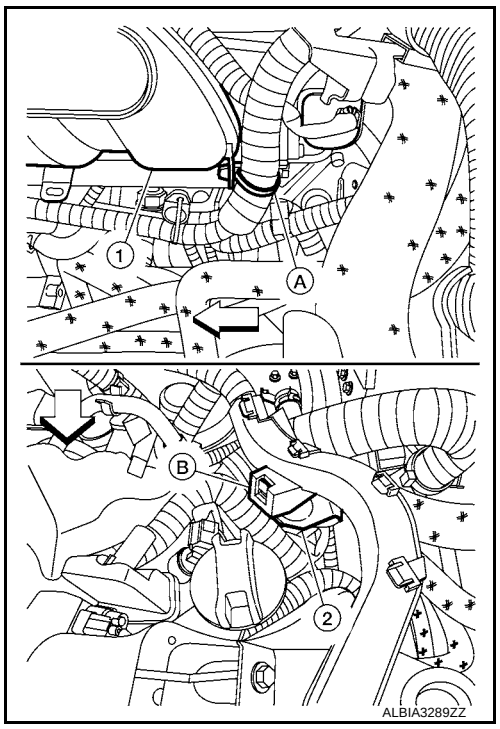
1. Remove the engine cover. Refer to EM-28, "Removal and Installation".
2. Remove the air cleaner assembly and air duct and resonator assembly. Refer to EM-29, "Removal and Installation".

3. Disengage engine harness retainer (A) from the intake manifold (1).

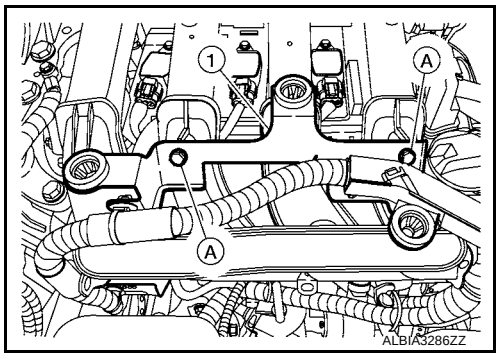
⇦ : Engine front

4. Disconnect the high voltage harness protector (B) from the bracket (2).

⇦ : Engine front



5. Remove bolts (A) and reposition mounting rubber bracket (1) and high voltage harness.



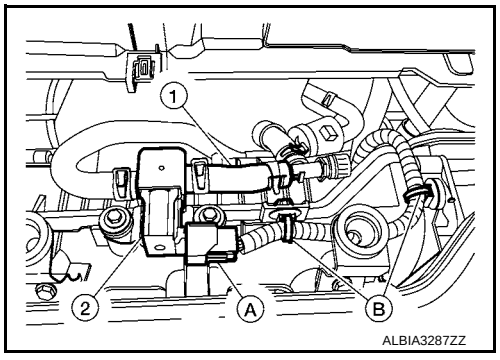
6. Disconnect the harness connector from the electric throttle control actuator.
7. Remove electric throttle control actuator bolts and reposition.

CAUTION:
- **Handle carefully to avoid any shock to electric throttle control actuator.**
- **Do not disassemble electric throttle control actuator.**
- **Do not reuse electric throttle control actuator gasket.**

8. Disconnect the harness connector (A) from the EVAP canister purge volume control solenoid valve (2).

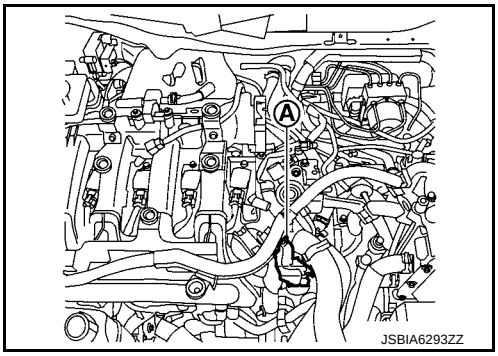
CAUTION:
Handle carefully to avoid any shock to EVAP canister purge volume control solenoid valve.

9. Disconnect the harness retainers (B) from the intake manifold.
10. Disconnect the EVAP hose (1) from the EVAP canister purge volume control solenoid valve.



11. Disconnect blowby hose from intake manifold and rocker cover.

12. Remove harness bracket (A).



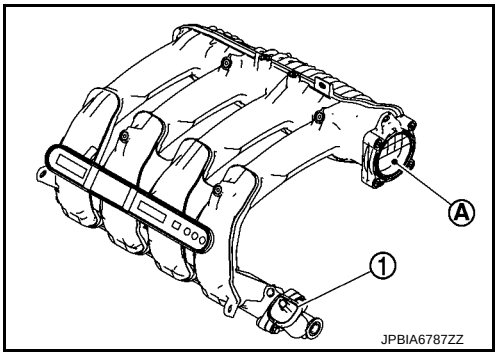
13. Unbolt the reservoir tank and reposition. Refer to CO-15, "Exploded View".
14. Remove intake manifold with the following procedure:

a. Disconnect the harness connector from the intake manifold runner control valve.

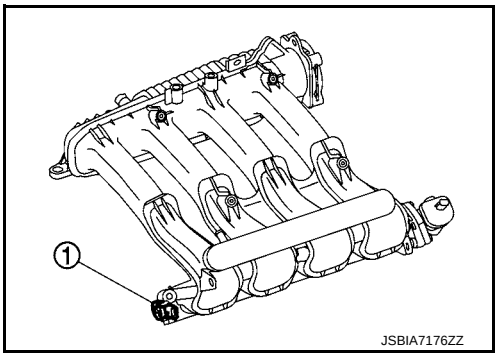
CAUTION:

- **Handle carefully to avoid any shock to intake manifold runner control valve (1).**
- **Do not remove intake manifold runner control valve.**
- **Cover engine openings to avoid entry of foreign materials.**

(A) : Electric throttle control actuator side



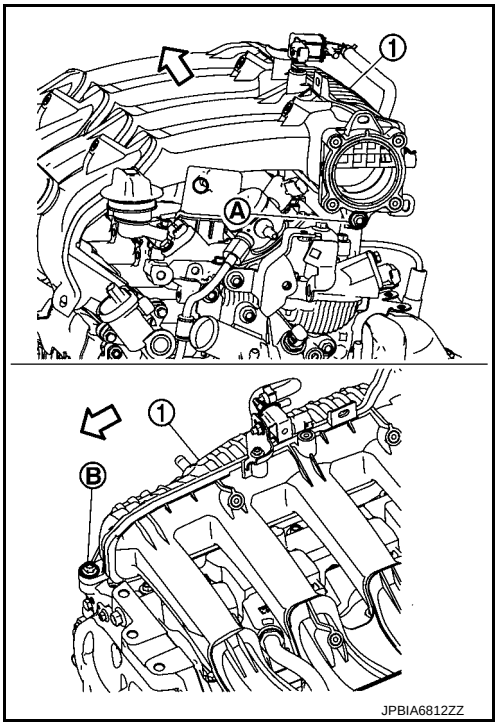
b. Disconnect harness connector from the intake manifold runner control valve position sensor (1).



c. Loosen and remove intake manifold bolts (A/B).

(1) : Intake manifold

⇦ : Engine front



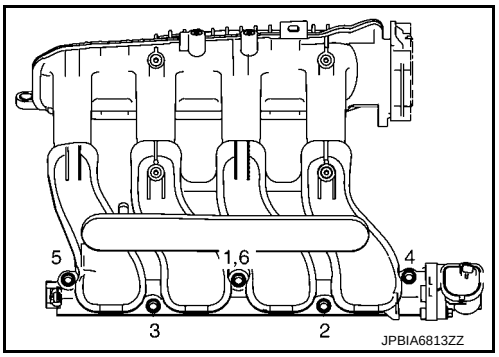
d. Loosen intake manifold bolts in reverse of the order shown.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

NOTE:

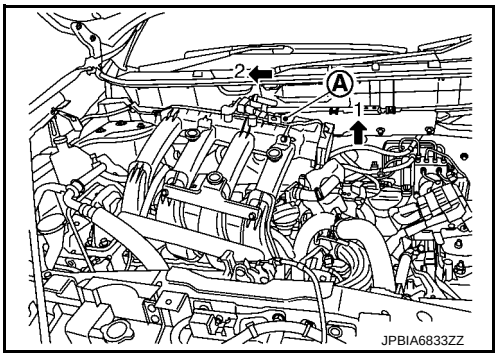
Disregard No. 6 when loosening.



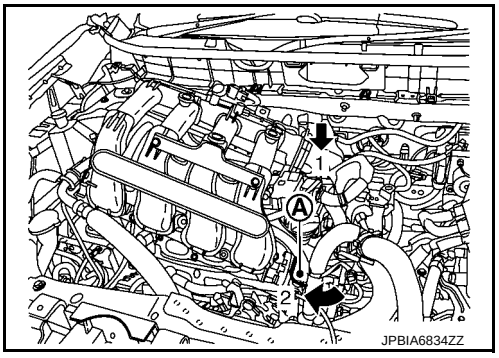
e. Lift the surge tank side (A) of intake manifold to move it in the direction of engine front.

NOTE:

Keep off the brake reservoir tank and A/C low pressure pipe.



f. Lower the surge tank side to pull out intake manifold runner control valve (A) from between harness and cylinder head.



15. Remove brackets from intake manifold (if necessary).
16. Disconnect the EVAP hose from the intake manifold and remove EVAP canister purge volume control solenoid valve from intake manifold (if necessary).

INSTALLATION

Installation is in the reverse order of removal.

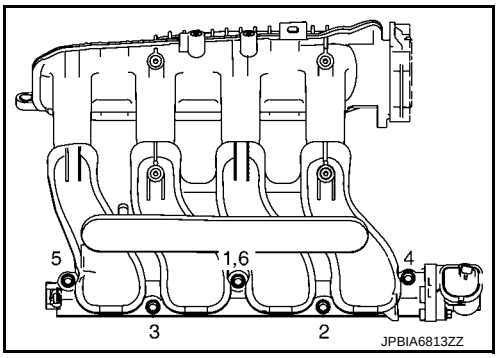
Intake Manifold

1. Install the intake manifold gasket into the groove of intake manifold.
   CAUTION:
   Do not reuse intake manifold gasket.
2. Install the intake manifold using the following procedure:

a. Hand tighten bolts 4 and 5 as shown.

b. Tighten the intake manifold bolts to the specified torque in the sequence shown.

Intake manifold bolts : 27.0 N·m (2.8 kg-m, 20 ft-lb)

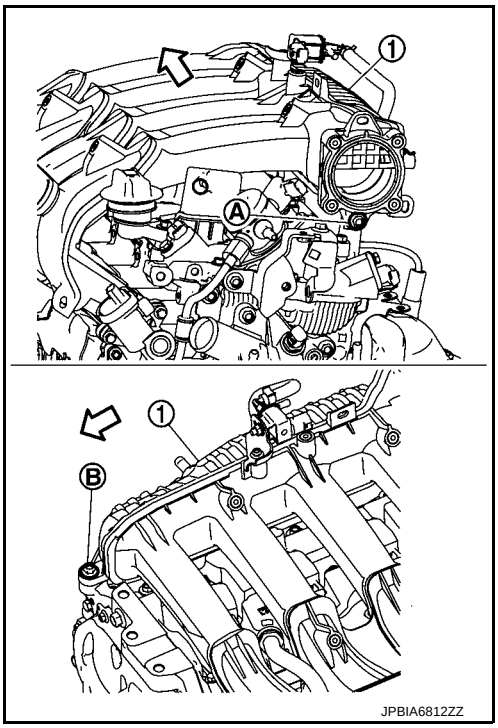


c. Tighten intake manifold bolt (A) and then tighten intake manifold bolt (B) to the specified torque.

Intake manifold bolts : 19.6 N·m (2.0 kg-m, 14 ft-lb)

(1) : Intake manifold

⇦ : Engine front



Electric Throttle Control Actuator

- Tighten bolts of electric throttle control actuator equally and diagonally in several steps.

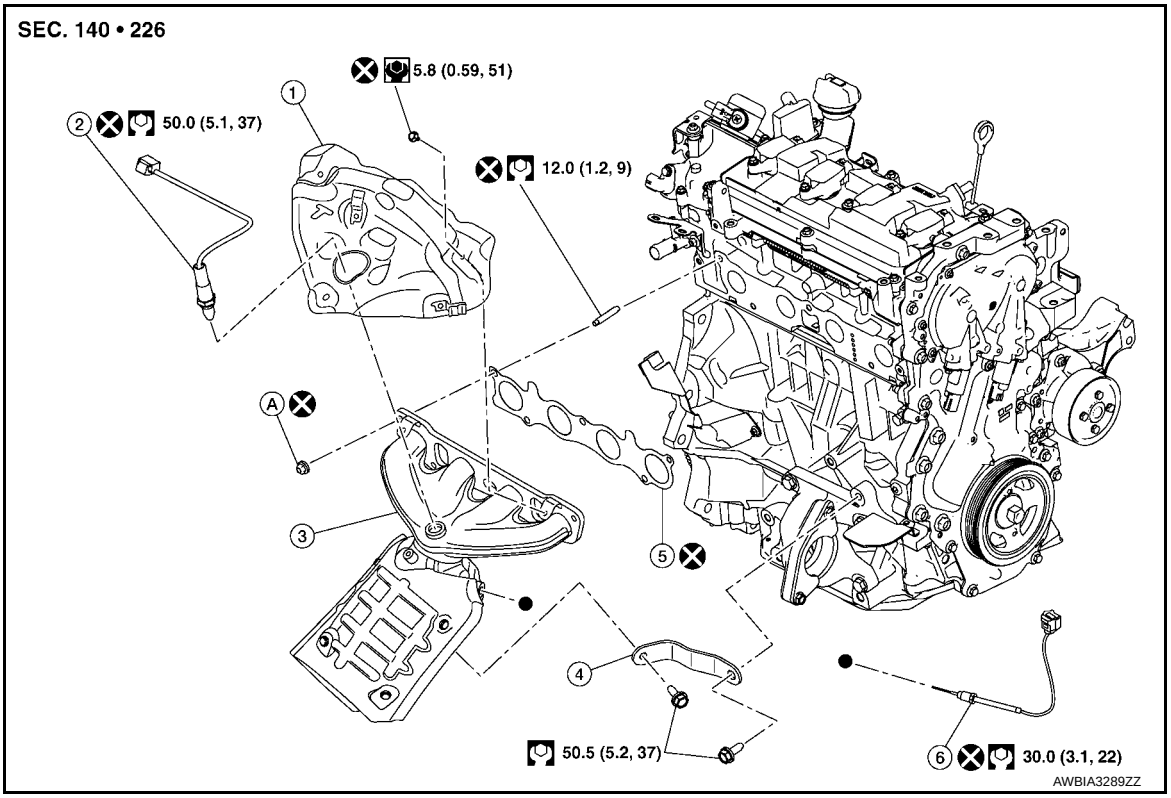
Electric throttle control actuator bolts : 10.0 N·m (1.0 kg-m, 7 ft-lb)

- Perform “Throttle Valve Closed Position Learning” after repair when removing harness connector of the electric throttle control actuator. Refer to EC-155, "Work Procedure".

EXHAUST MANIFOLD

Exploded View

INFOID:0000000014727318



1. Exhaust manifold cover
2. Air fuel ratio sensor 1
3. Exhaust manifold
4. Exhaust manifold stay
5. Exhaust manifold gasket
6. Exhaust gas temperature sensor
A. Refer to INSTALLLATION

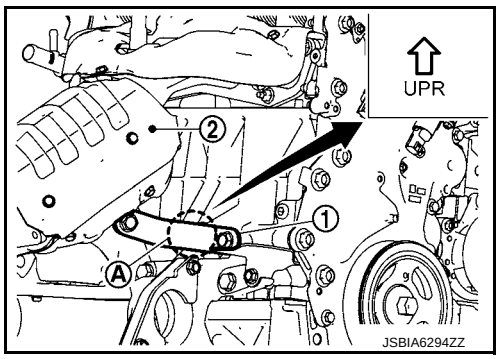
Removal and Installation

INFOID:0000000014727319

REMOVAL

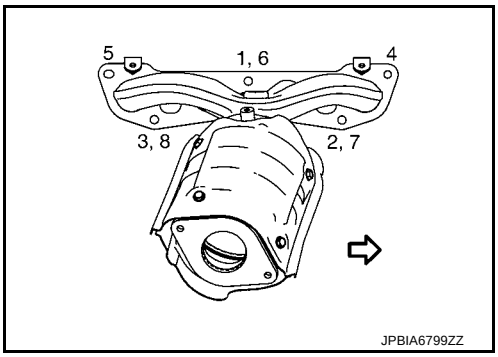
1. Remove intake manifold. Refer to EM-32, "Removal and Installation".
2. Remove cowl top extension. Refer to EXT-37, "Removal and Installation".
3. Disconnect the harness connector from the air fuel ratio sensor 1.
4. Disengage the air fuel ratio sensor 1 and exhaust gas temperature sensor harnesses from the harness retainers on the exhaust manifold cover.
5. Remove exhaust manifold cover.
6. Disconnect the harness connector from the exhaust gas temperature sensor.
7. Remove exhaust front tube. Refer to EX-7, "Exploded View".
8. Remove exhaust manifold stay (1).

(2) : Exhaust manifold
(A) : Upper mark



9. Loosen exhaust manifold nuts in reverse of the sequence shown and remove exhaust manifold.
CAUTION:
Do not reuse exhaust manifold nuts.
NOTE:
Disregard No. 6 to 8 when loosening.

⇦ : Engine front



10. Remove exhaust manifold gasket.
CAUTION:
- **Cover engine openings to avoid entry of foreign materials.**
- **Do not reuse exhaust manifold gasket.**

11. Remove the air fuel ratio sensor 1 using Tool (if necessary).

Tool number : KV991J0050 (J-44626)

CAUTION:
Handle air fuel ratio sensor 1 carefully and avoid impacts.

12. Remove the exhaust gas temperature sensor (if necessary).
CAUTION:
Handle exhaust gas temperature sensor carefully and avoid impacts.

13. Remove exhaust manifold stud from cylinder head (if necessary).
CAUTION:
Do not reuse exhaust manifold stud.

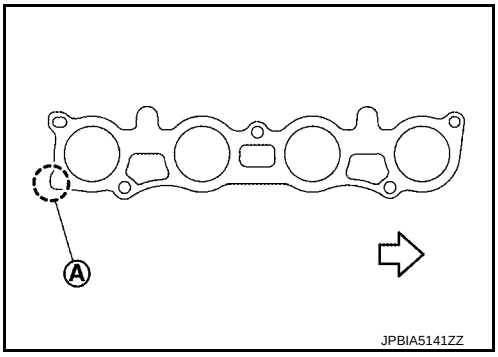
INSTALLATION

1. Install exhaust manifold stud (if necessary).
CAUTION:
Do not reuse exhaust manifold stud.

2. Install exhaust manifold gasket to cylinder head as shown.
CAUTION:
Do not reuse exhaust manifold gasket.

(A) : Identification

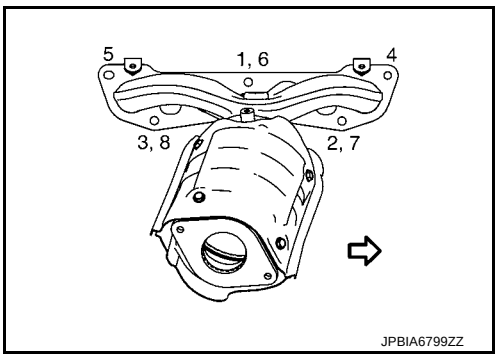
⇦ : Engine front



3. Install exhaust manifold and tighten exhaust manifold nuts to the specified torque in the sequence shown.

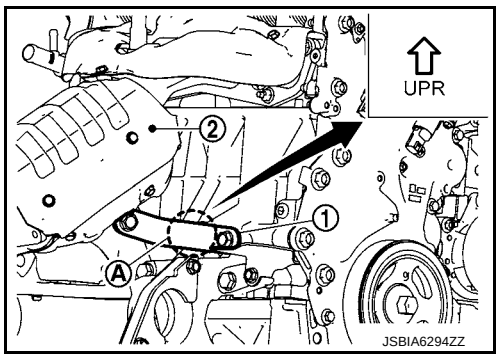
Exhaust manifold nuts : 33.4 N·m (3.4 kg-m, 25 ft-lb)

⇦ : Engine front



4. Install exhaust manifold stay (1) in the direction as shown.

(2) : Exhaust manifold
(A) : Upper mark



5. Installation of the remaining parts in the reverse order of removal.

CAUTION:

- **Before installing the air fuel ratio sensor 1, clean the exhaust manifold threads using oxygen sensor thread cleaner tool and apply anti-seize lubricant or equivalent.**

Oxygen sensor thread cleaner : — (J-43897-18)

- **Do not over-tighten the air fuel ratio sensor 1. Doing so may cause damage, resulting in a malfunction and the MIL coming on.**

Tool number : KV991J0050 (J-44626)

Inspection

INFOID:0000000014727320

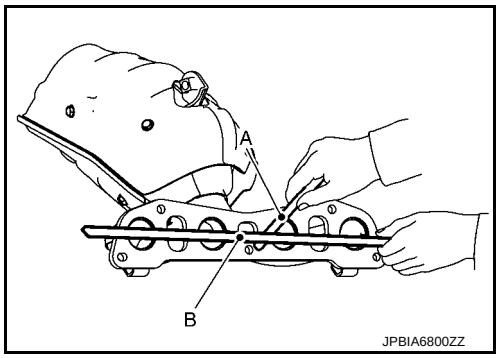
INSPECTION AFTER REMOVAL

Surface Distortion

- Using suitable tool (A) and suitable tool (B), check the surface distortion of exhaust manifold mating surface in each exhaust port and entire part.

Limit : Refer to EM-142, "Exhaust Manifold".

- If it exceeds the limit, replace exhaust manifold.



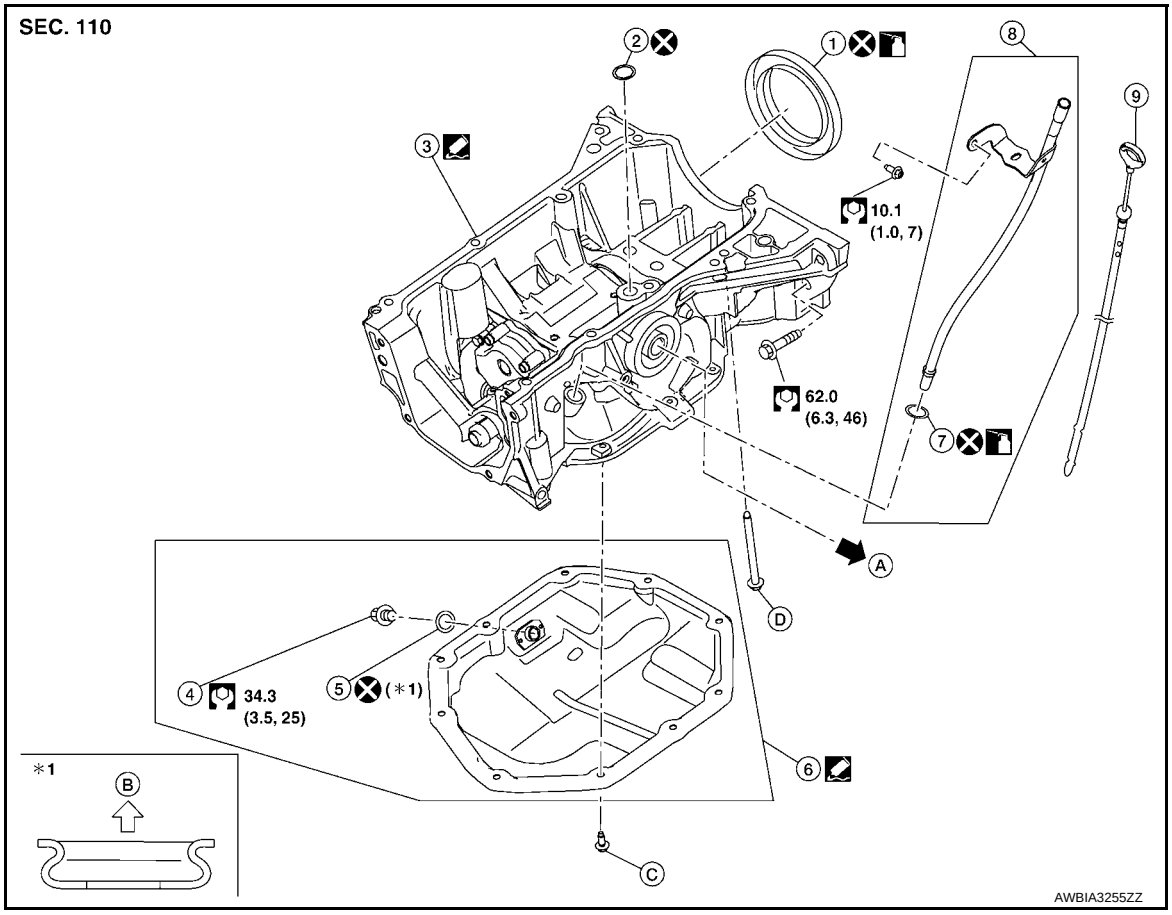
INSPECTION AFTER INSTALLATION

Check the joint of parts with the engine in running state. Check that there is no leaks of exhaust gas and abnormal sound.

OIL PAN (LOWER)

Exploded View

INFOID:0000000014727321



1. Rear oil seal
2. O-ring
3. Oil pan (upper)
4. Drain plug
5. Drain plug washer
6. Oil pan (lower)
7. O-ring
8. Oil level gauge guide
9. Oil level gauge
A. To oil cooler
B. Oil pan (lower) side
C. Refer to INSTALLATION
D. Refer to EM-43, "Removal and Installation".

Removal and Installation

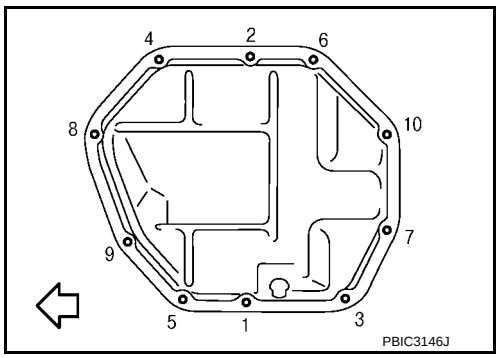
INFOID:0000000014727322

REMOVAL

1. Remove engine under cover. Refer to EXT-49, "ENGINE UNDER COVER : Removal and Installation".
2. Drain engine oil. Refer to LU-11, "Draining".
3. Remove oil pan (lower) using the following procedure:

a. Loosen oil pan (lower) bolts in reverse of the sequence shown.

⇦ : Engine front

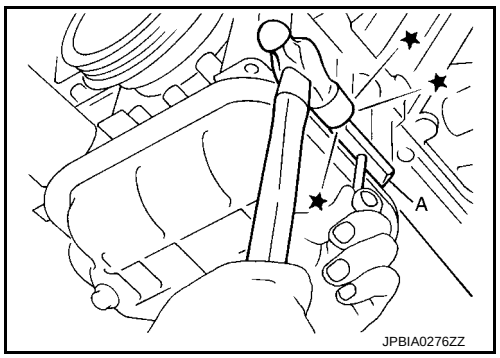


b. Insert Tool (A) between oil pan (upper) and oil pan (lower).

CAUTION:

- **Be careful not to damage the mating surface.**
- **Since factory default liquid gasket has better adhesion than conventional one, do not pick the area forcibly with a screw driver.**

Tool number : KV10111100 (J-37228)



INSTALLATION

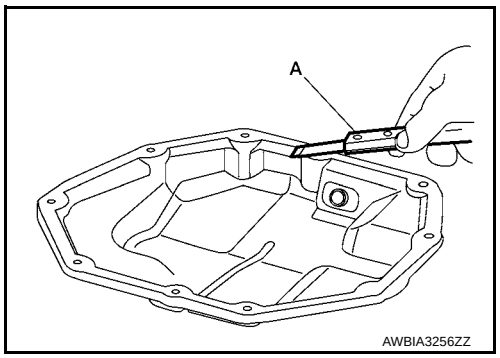
1. Install oil pan (lower) using the following procedure:

a. Use a suitable tool (A) to remove old liquid gasket from mating surfaces.

- Also remove old liquid gasket from mating surface of oil pan (upper).
- Remove old liquid gasket from the bolt holes and threads.

CAUTION:

Do not scratch or damage the mating surface when cleaning off old liquid gasket.



b. Apply a continuous bead of liquid gasket (A) with a suitable tool as shown.

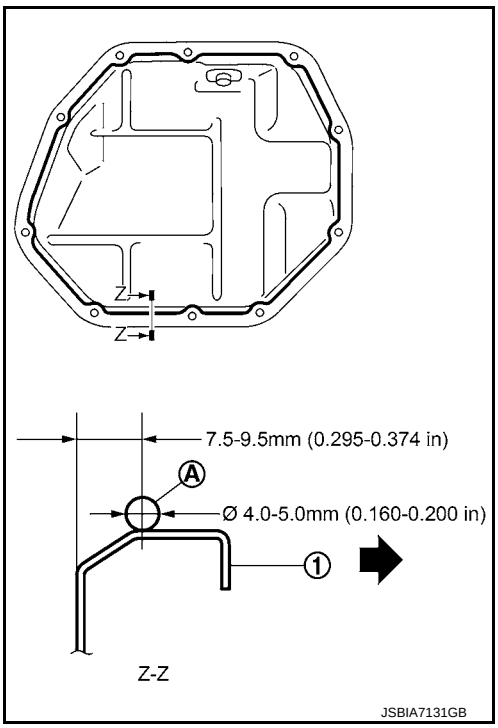
(1) : Oil pan (lower)

⬅ : Engine outside

Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

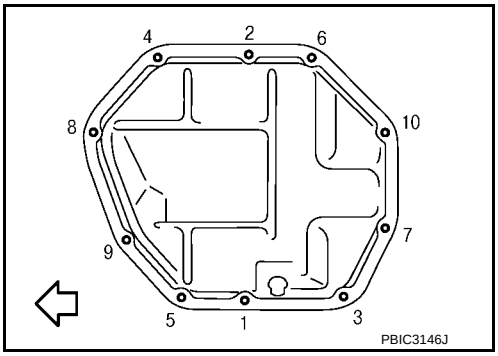
CAUTION:

- **The components must be installed within 5 minutes of the liquid gasket application.**
- **Do not confirm torque after 5 minutes have elapsed.**
- **Then allow 30 minutes for the liquid gasket to set before adding oil to the engine.**



c. Tighten oil pan (lower) bolts to the specified torque in the sequence shown.

Oil pan (lower) bolts : 10.1 N·m (1.0 kg-m, 7 ft-lb)



2. Install drain plug.
   CAUTION:
   Do not reuse drain plug washer.
3. Installation of the remaining components is in the reverse order of removal.
   - Refill engine oil, refer to LU-12, "Refilling".

   NOTE:
   Wait at least 30 minutes after oil pan (lower) is installed before refilling engine oil.

Inspection

INFOID:0000000014727323

INSPECTION AFTER REMOVAL

Clean oil strainer portion [part of the oil pan (upper)] if any object attached.

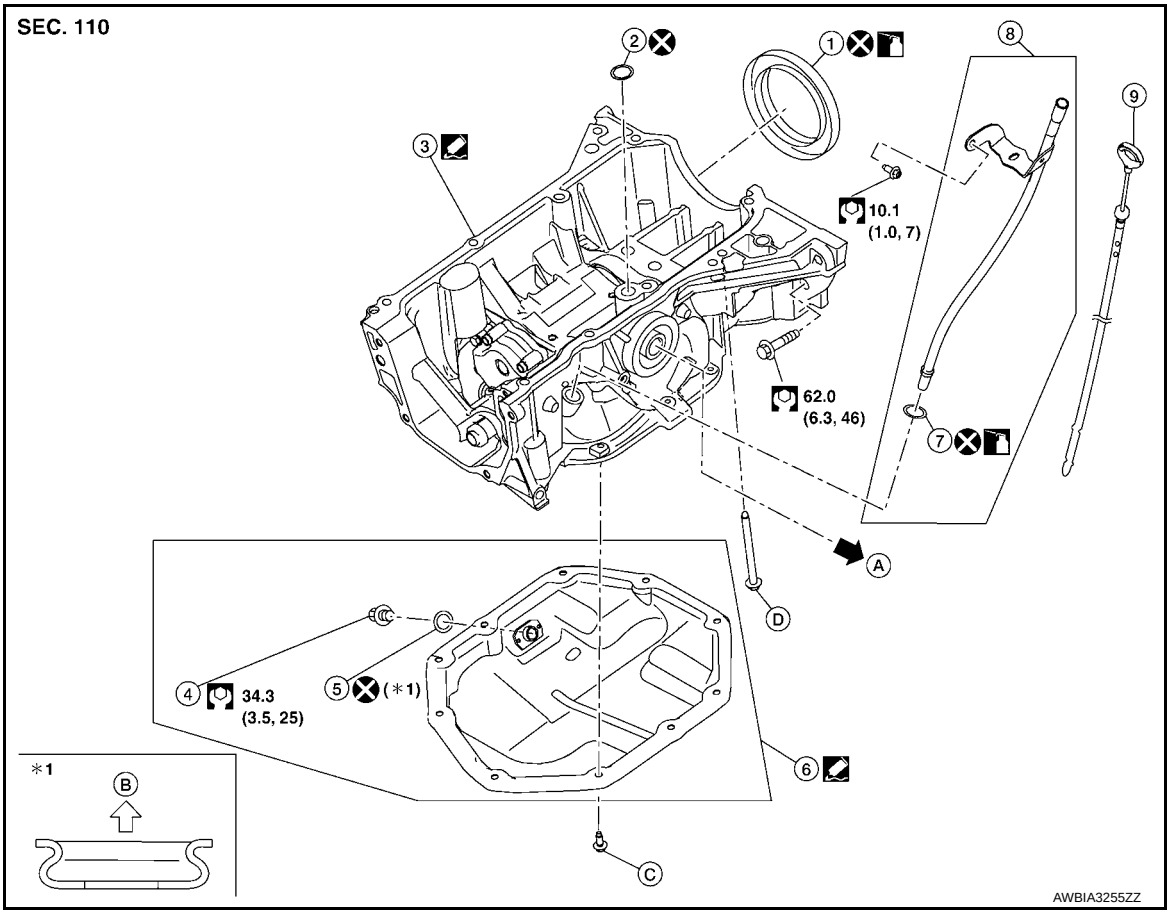
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-10, "Inspection".
2. Start engine, and check there are no engine oil leaks.
   NOTE:
   Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-10, "Inspection".

OIL PAN (UPPER)

Exploded View

INFOID:0000000014727352



1. Rear oil seal	2. O-ring	3. Oil pan (upper)
4. Drain plug	5. Drain plug washer	6. Oil pan (lower)
7. O-ring	8. Oil level gauge guide	9. Oil level gauge
A. To oil cooler	B. Oil pan (lower) side	C. Refer to EM-40, "Removal and Installation".
D. Refer to INSTALLATION		

Removal and Installation

INFOID:0000000014727353

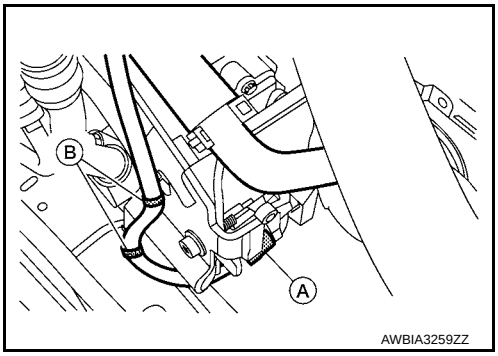
REMOVAL

CAUTION:

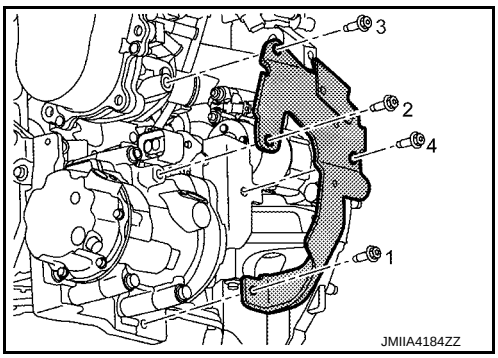
Oil pan (upper) is integral with oil pump balancer unit. Do not disassemble them.

1. Mount engine assembly to engine stand. Refer to EM-106, "Removal and Installation".
2. Remove oil pan (lower). Refer to EM-40, "Removal and Installation".
3. Remove the oil cooler. Refer to LU-14, "Removal and Installation".
4. Remove oil level gauge and oil level gauge guide.
   CAUTION:
   Do not reuse O-ring.
5. Remove the fuel rail protector. Refer to EM-54, "Exploded View".
6. Remove bolt securing intake manifold to front cover. Refer to EM-32, "Exploded View".

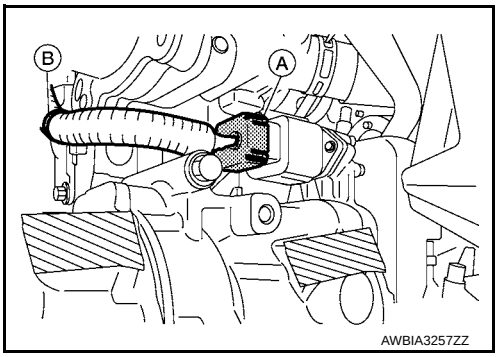
7. Disconnect low voltage harness connector (A) from the electric compressor.
8. Disengage low voltage harness retainers (B) from compressor stay 1.



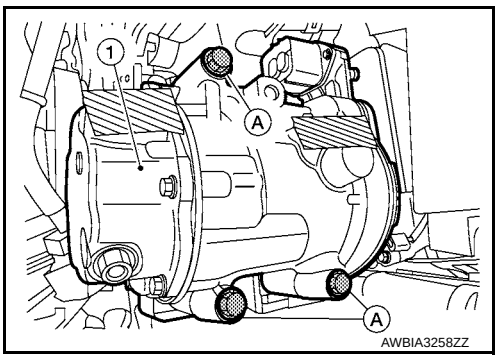
9. Remove compressor stay 1 bolts (A) in reverse of the sequence shown and then remove compressor stay 1.



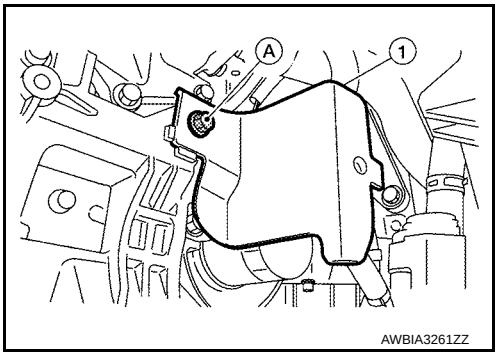
10. Disconnect the high voltage harness connector (A) from the electric compressor.
11. Disengage high voltage harness retainer (B) from the front cover.



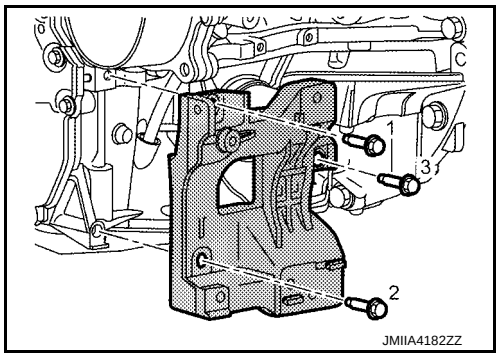
12. Remove the electric compressor bolts (A) and remove the electric compressor (1).



13. Remove bolt (A) and then remove compressor stay 2 (1).



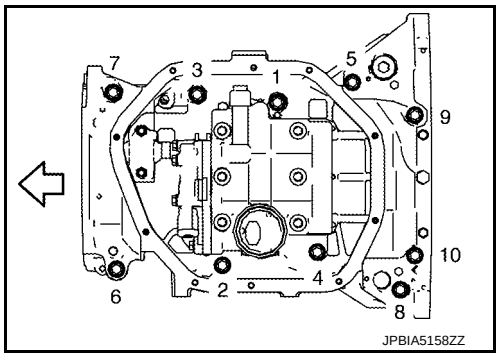
14. Remove compressor bracket bolts in reverse of the order shown and remove compressor bracket.



15. Remove front cover, timing chain, balancer unit timing chain, and other related parts. Refer to EM-66, "Removal and Installation".
16. Remove oil pan (upper) using the following procedure:

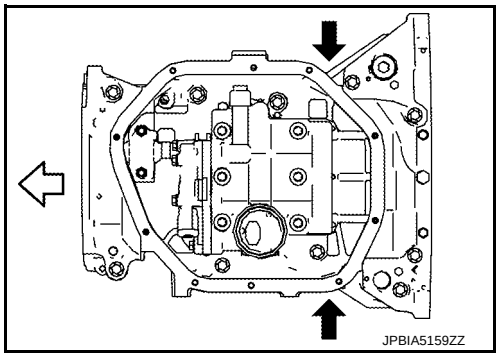
a. Loosen oil pan (upper) bolts in reverse of the sequence shown.

⇦ : Engine front



b. Insert a suitable tool into the location shown by the arrow (⬅) and open up a crack between oil pan (upper) and cylinder block.
CAUTION:
- **Do not damage the mating surface.**
- **The liquid gasket used at the factory is very strong. Pry only in the areas shown.**

⇦ : Engine front



c. Insert Tool between oil pan (upper) and cylinder block, and slide it by tapping on the side of the Tool with a hammer.
CAUTION:
Be careful not to damage the mating surface.

Tool number : KV10111100 (J-37228)

17. Remove O-ring between cylinder block and oil pan (upper).
CAUTION:
Do not reuse O-ring.
18. Remove rear oil seal. Refer to EM-102, "REAR OIL SEAL : Removal and Installation".

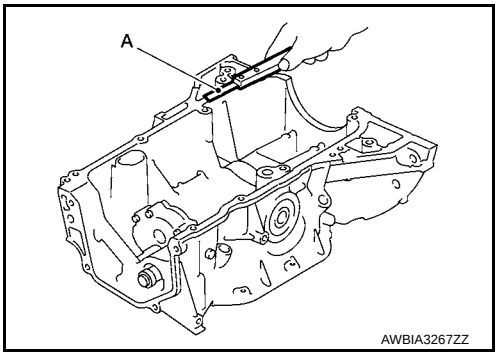
INSTALLATION

CAUTION:
Do not reuse O-rings.

1. Install oil pan (upper) using the following procedure:

a. Use a suitable tool (A) to remove old liquid gasket from mating surfaces.
- Remove the old liquid gasket from mating surface of cylinder block.
- Remove old liquid gasket from the bolt holes and threads.

CAUTION:
Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.

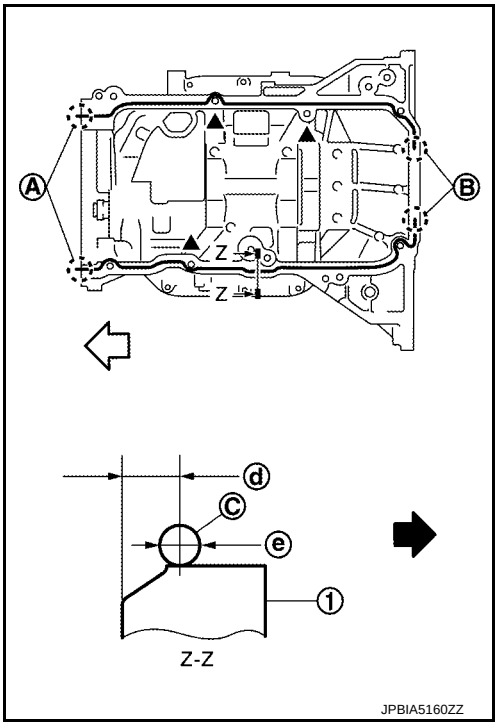


b. Apply a continuous bead of liquid gasket (C) with a suitable tool as shown.

(1) : Oil pan (upper)
(A) : 2 mm (0.08 in) protruded to outside
(B) : 2 mm (0.08 in) protruded to rear oil seal mounting side
(d) : 6.5 mm (0.26 in)
(e) : ϕ4.0 - 5.0 (0.157 - 0.197 in)
⇦ : Engine front
⬅ : Engine outside

Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

CAUTION:
- **Apply liquid gasket to outside of bolt hole for the positions shown by ▲ marks.**
- **Attaching should be done within 5 minutes after liquid gasket application.**
- **Do not confirm torque after the 5 minutes have elapsed.**
- **Then allow 30 minutes for the liquid gasket to set before adding oil to the engine.**



c. Install new O-ring at cylinder block side.

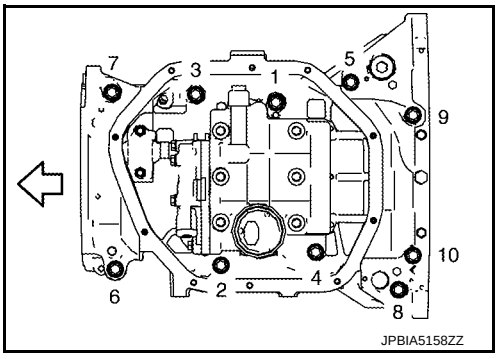
CAUTION:
- **Install avoiding misalignment of O-ring.**
- **Do not reuse O-ring.**

d. Tighten oil pan (upper) bolts to the specified torque in the sequence shown.

CAUTION:
Remove any liquid gasket that protrudes onto the front cover or rear oil seal sealing surface.

Oil pan (upper) bolts : 25.1 N·m (2.6 kg-m, 19 ft-lb)

⇦ : Engine front



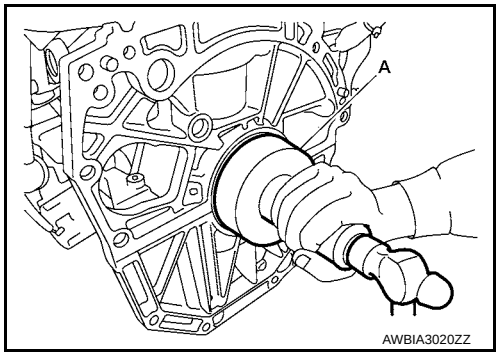
2. Install rear oil seal with the following procedure.

CAUTION:
- **The installation of rear oil seal should be completed within 5 minutes after installing oil pan (upper).**
- **Do not reuse rear oil seal.**
- **Do not touch oil seal lip.**

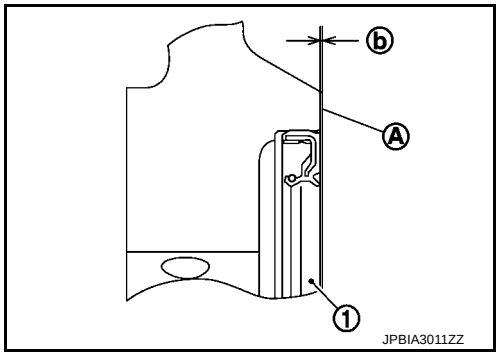
a. Wipe off liquid gasket protruding to the rear oil seal mounting part of oil pan (upper) and cylinder block using a suitable tool.

b. Apply clean engine oil to entire outside area of rear oil seal.

c. Press-fit the rear oil seal using a suitable drift (A) with outer diameter 115 mm (4.53 in) and inner diameter 90 mm (3.54 in).



- Press-fit the rear oil seal to the specified dimensions as shown.



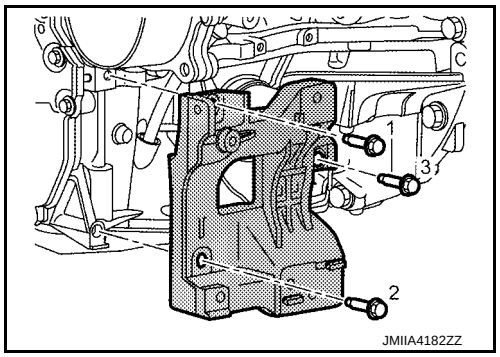
(1) : Rear oil seal
(A) : Rear end surface of cylinder block
(B) : 0.0 - 0.5 mm (0.0 - 0.020 in)

CAUTION:
- **Do not touch the grease applied to the oil seal lip.**
- **Be careful not to damage the rear oil seal mounting part of oil pan (upper) and cylinder block or the crankshaft.**
- **Press-fit straight, checking that rear oil seal does not curl or tilt.**

NOTE:
The standard surface of the dimension is the rear end surface of cylinder block.

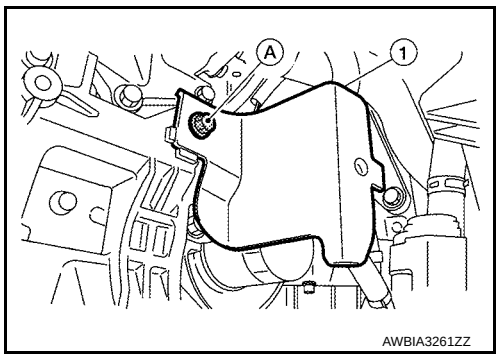
3. Install compressor bracket and tighten bolts to the specified torque in the sequence shown.

Compressor bracket bolts : 25.0 Nm (2.6 kg-m, 18 ft-lb)



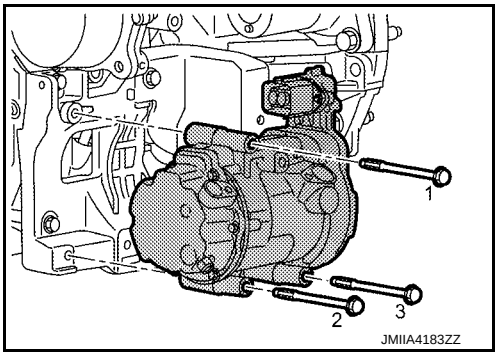
4. Install compressor stay 2 and tighten bolt to the specified torque.

Compressor stay 2 bolts : 25.0 Nm (2.6 kg-m, 18 ft-lb)



5. Install electric compressor and tighten bolts to the specified torque in the sequence shown.

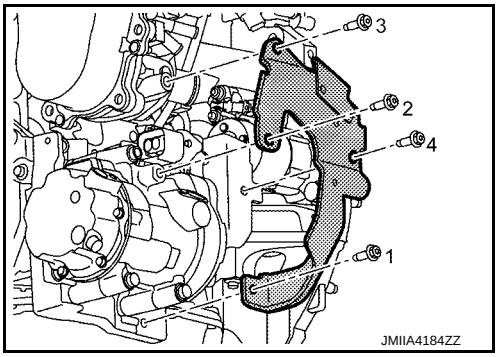
Electric compressor bolts : 25.0 Nm (2.6 kg-m, 18 ft-lb)



6. Connect the high voltage harness connector to the electric compressor.
7. Install compressor stay 1 and tighten bolts to the specified torque in the sequence shown.

CAUTION:
Be sure to reinstall high voltage harness and low voltage harness fixing clips in their original position. If a clip is damaged, replace it with a new clip before installing.

Compressor stay 1 bolts : 25.0 Nm (2.6 kg-m, 18 ft-lb)



8. Installation of the remaining components is in the reverse order of removal.

CAUTION:
- **In order to prevent conventional PAG oil from becoming mixed in, do not reuse recovered compressor oil and instead always use new oil. The use of oil including the conventional PAG oil may degrade the performance of insulation.**
- **To prevent performance degradation, do not use a fluorescent agent in order to detect refrigerant leakage. Also take care that a fluorescent agent does not enter the oil.**
- **To prevent degradation in insulation performance, use special electric compressor oil as the compressor oil.**
- **Before installing the new electric compressor, adjust the compressor oil level. Refer to HA-29, "Oil Adjusting Procedure for Compressor Replacement".**
- **To prevent refrigerant leak, replace the O-ring with a new one. Apply a coat of compressor oil to the O-ring prior to installation.**
- **Use a refrigerant collecting equipment (for HFC-134a) to charge the refrigerant. Refer to HA-27, "Charge Refrigerant".**
- **Perform a check for refrigerant leaks when charging with refrigerant. Refer to HA-25, "Leak Test".**
- **Set the vehicle to READY and operate the air-conditioner for at least 1 minute with the vehicle parked to perform a break-in.**

Inspection

INFOID:0000000014727354

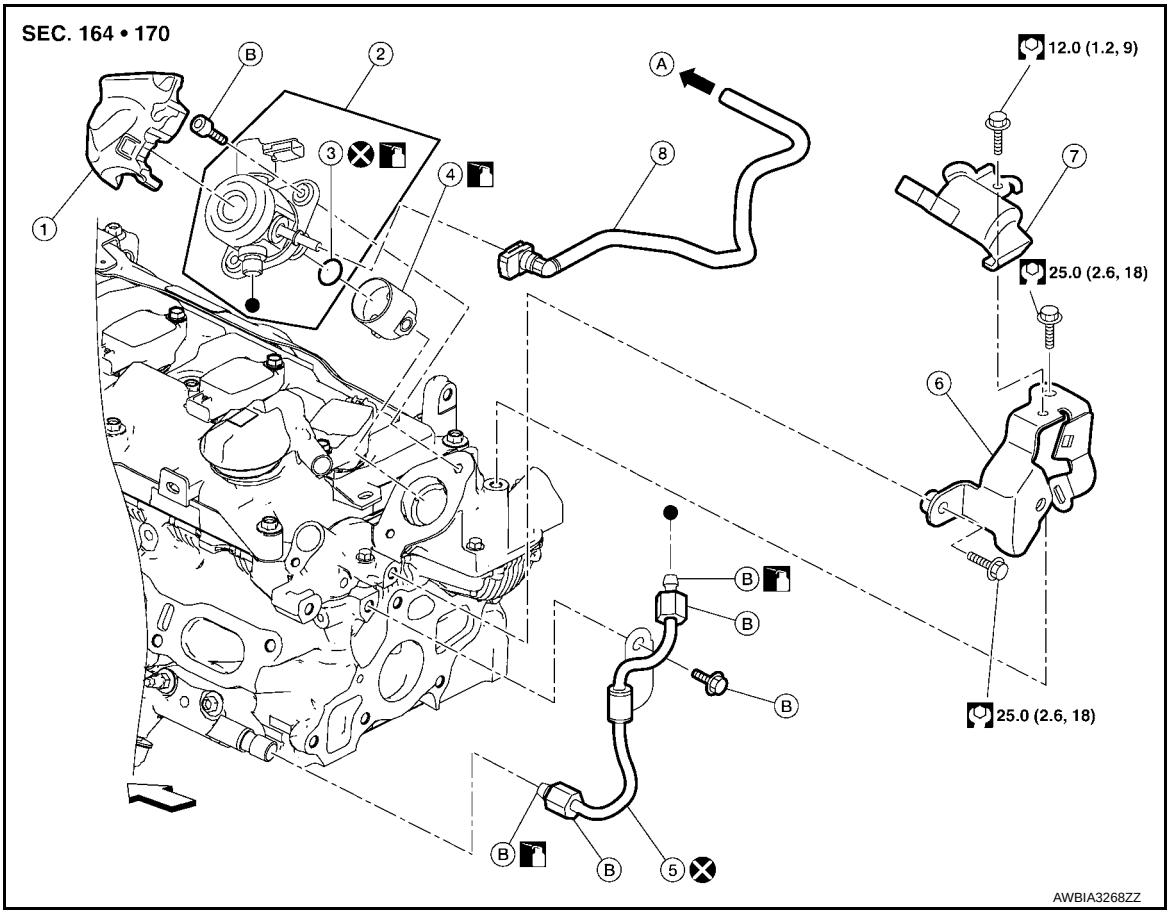
INSPECTION AFTER REMOVAL

Clean oil strainer portion (part of the oil pump) if any object attached.

HIGH PRESSURE FUEL PUMP AND FUEL HOSE

Exploded View

INFOID:0000000014727324



1.	High pressure fuel pump insulator	2.	High pressure fuel pump	3.	O-ring
4.	High pressure fuel pump lifter	5.	High pressure fuel tube	6.	Bracket
7.	Fuel pump connector protector	8.	Fuel feed hose	A.	To centralized under-floor piping
B.	Refer to INSTALLATION	⇦	Engine front		

CAUTION:
Do not remove or disassemble parts unless instructed as shown.

Removal and Installation

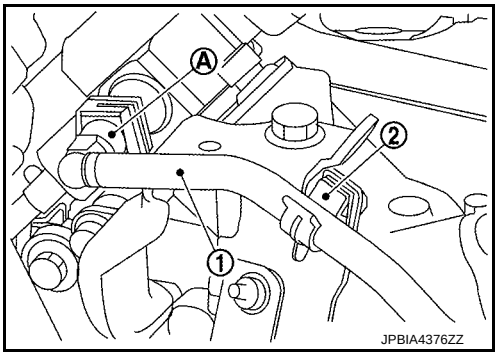
INFOID:0000000014727325

REMOVAL

WARNING:
- **Be sure to read EM-5, "Precaution for Handling High Pressure Fuel System" when working on the high pressure fuel system.**
- **Put a “CAUTION: FLAMMABLE” sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 fire extinguisher.**
- **Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.**
- **To avoid the danger of being scalded, do not drain engine coolant when engine is hot.**

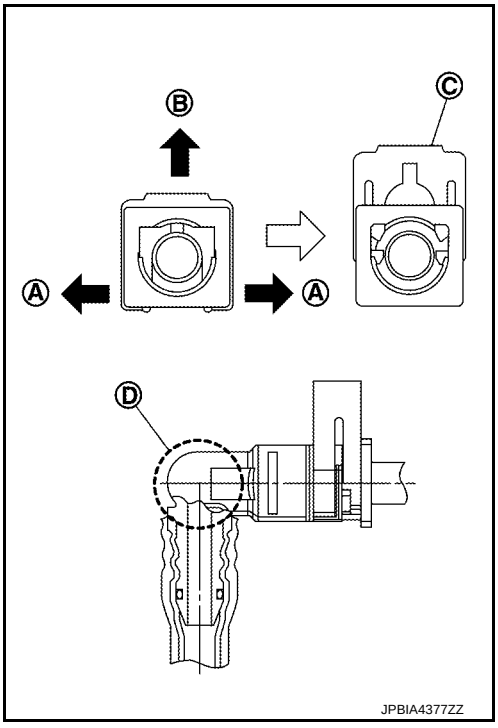
1. Release fuel pressure. Refer to EC-162, "Work Procedure".
2. Disconnect the battery. Refer to PG-128, "Battery Disconnect".
3. Remove intake manifold. Refer to EM-32, "Removal and Installation".
4. Remove fuel pump connector protector and remove high pressure fuel pump insulator.
5. Disconnect quick connector (A) using the following procedure:

a. Disconnect fuel feed hose (1) from bracket hose clamp (2).

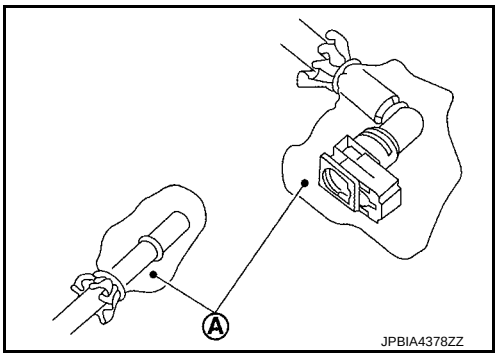


b. Disengage (A) and pull up (B) the pawl of the fuel feed hose connector retainer (C) to disconnect the fuel feed hose from high pressure fuel pump.
NOTE:
If the fuel feed hose is stuck, hold the fuel pipe by hand and disconnect it by pushing and pulling.
CAUTION:
- **Keep parts away from heat source. Especially, be careful when welding is performed around them.**
- **Do not expose parts to battery electrolyte or other acids.**
- **Do not bent or twist connection between quick connector and fuel feed hose during installation/removal.**
- **Pull quick connector while holding at location (D).**
- **Do not remove the retainer.**
- **Prepare a tray and waste beforehand as fuel leaks out.**
- **Do not pull with lateral force applied. O-ring inside quick connector may be damaged.**

Retainer color : Red



- **To prevent damage to each joint and protect it from the entry of foreign matter, cover the joint with plastic bag (A) or an equivalent.**



6. Remove high pressure fuel tube.
CAUTION:
Do not reuse high pressure fuel tube.
7. Disconnect the harness connector from the high pressure fuel pump.

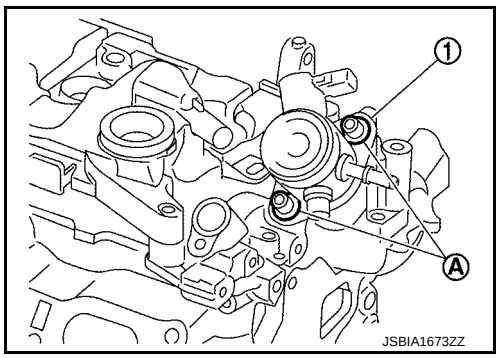
8. Remove high pressure fuel pump (1) and lifter.

CAUTION:

- **To prevent damage to high pressure fuel pump and camshaft bracket, loosen bolts (A) by alternating sides one turn at a time until the reaction force applied on the high pressure fuel pump disappears.**
- **Do not reuse O-ring.**

NOTE:

Remove O-ring from high pressure fuel pump.



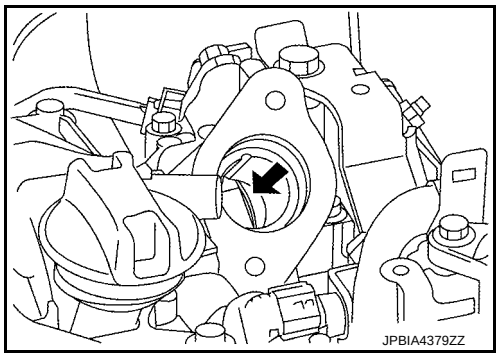
INSTALLATION

CAUTION:

- **Do not reuse O-rings.**
- **To prevent damage to parts due to generated abnormal stress and eccentric load, always observe the installation procedure.**

1. Install high pressure fuel pump using the following procedure:

a. Check the orientation of pump cam from the mounting area of high pressure fuel pump.

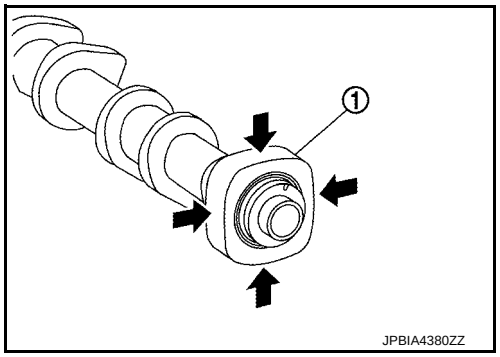


b. Aim pump cam at the BDC area as shown.

NOTE:

For BDC area, anywhere within the area indicated by ⬅ can be accepted.

(1) : Camshaft (EXH)

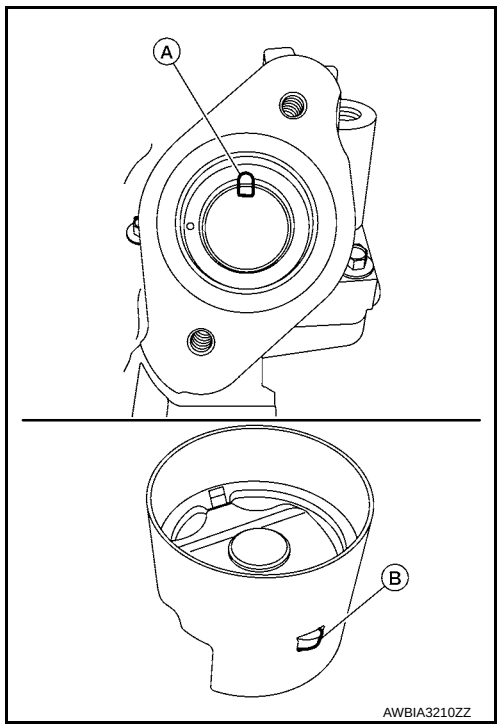


c. Install O-ring to high pressure fuel pump.

CAUTION:

- **Do not reuse O-ring.**
- **Handle O-ring with bare hands. Do not wear gloves.**
- **Lubricate O-ring with new engine oil.**
- **Do not clean O-ring with solvent.**
- **Check that O-ring and its mating part are free of foreign material.**
- **Do not damage O-ring with tools and fingernails during the installation. In addition, twisting or stretching O-ring is not allowed. If O-ring is stretched during the installation to high pressure fuel pump, do not install high pressure fuel pump immediately.**

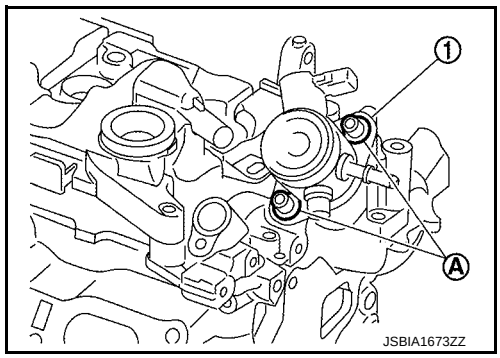
d. Install high pressure fuel pump lifter.
NOTE:
- Lubricate the high pressure fuel pump lifter and bore of camshaft bracket.
- When installing the high pressure fuel pump lifter, note the orientation of the protrusion (B) and cutout (A) in the camshaft bracket, they should be aligned.



e. Apply clean engine oil to the fitting area of high pressure fuel pump O-ring and camshaft bracket side to install high pressure fuel pump.

f. Install high pressure fuel pump (1) and tighten bolts (A) by alternating sides one turn at a time until high pressure fuel pump is seated to camshaft bracket. Tighten high pressure fuel pump bolts to the specified torque.

High pressure fuel pump bolts : 10.0 N·m (1.0 kg-m, 7 ft-lb)



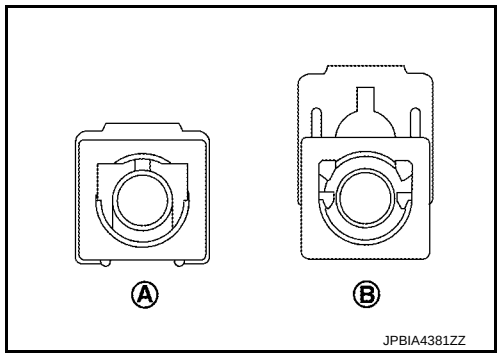
2. Install the fuel feed hose using the following procedure:

a. Check no foreign substances are deposited in and around matching pipe and quick connector, and no damage on them.

b. Quick connector shall be inserted gradually, aligning with the axis of the matching pipe.

c. Insert the retainer until it clicks and check the retainer is locked. After insertion, pull the connector and check that the connector is locked.
CAUTION:
If retainer cannot be installed smoothly, quick connector may be have not been installed correctly. Check connection again.

(A) : Lock position
(B) : Unlock position

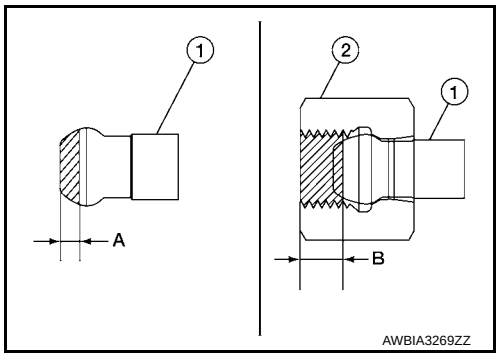


d. After attaching the quick connector and fix the hose to the clamp.

3. Install the high pressure fuel tube with the following procedure.
CAUTION:
- **Do not reuse high pressure fuel tube.**
- **Do not use high pressure fuel tube if its terminal tip is damaged.**

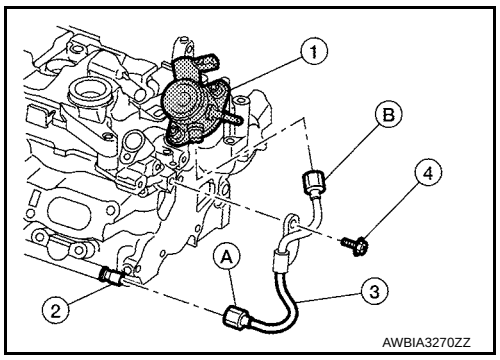
- **Observe the tightening sequence and the tightening torque.**

a. Apply clean engine oil to area (A) [5 mm from the tip of the nipple located at either end of high pressure fuel tube (1)] and area (B) [approximately 5 threads long from the tip of the inner screw thread of flare nut (2)].
CAUTION:
Check for damage and adhesion of foreign matter.



b. Temporarily tighten flare nut (A/B) of high pressure fuel tube (3) until seated
CAUTION:
To tighten flare nut temporarily, insert by fitting the center of pipe.

(1) : High pressure fuel pump
(2) : Fuel rail



c. Tighten high pressure fuel tube bracket bolt (4) to the specified torque.

High pressure fuel tube bracket bolt	**: 25.0 N·m (2.6 kg-m, 18 ft-lb)**

d. Tighten flare nuts in the order of (A) and then (B).
CAUTION:
Securely install the tool to flare nut before tightening.

Flare nut	**: 36.0 N·m (3.7 kg-m, 27 ft-lb)**

e. Tighten mounting bolt.
f. Tighten flare nuts in the order of (A) and then (B) again.
4. Installation of the remaining components is in the reverse order of removal.

Inspection

INFOID:0000000014727326

INSPECTION AFTER INSTALLATION

Check for Fuel Leaks

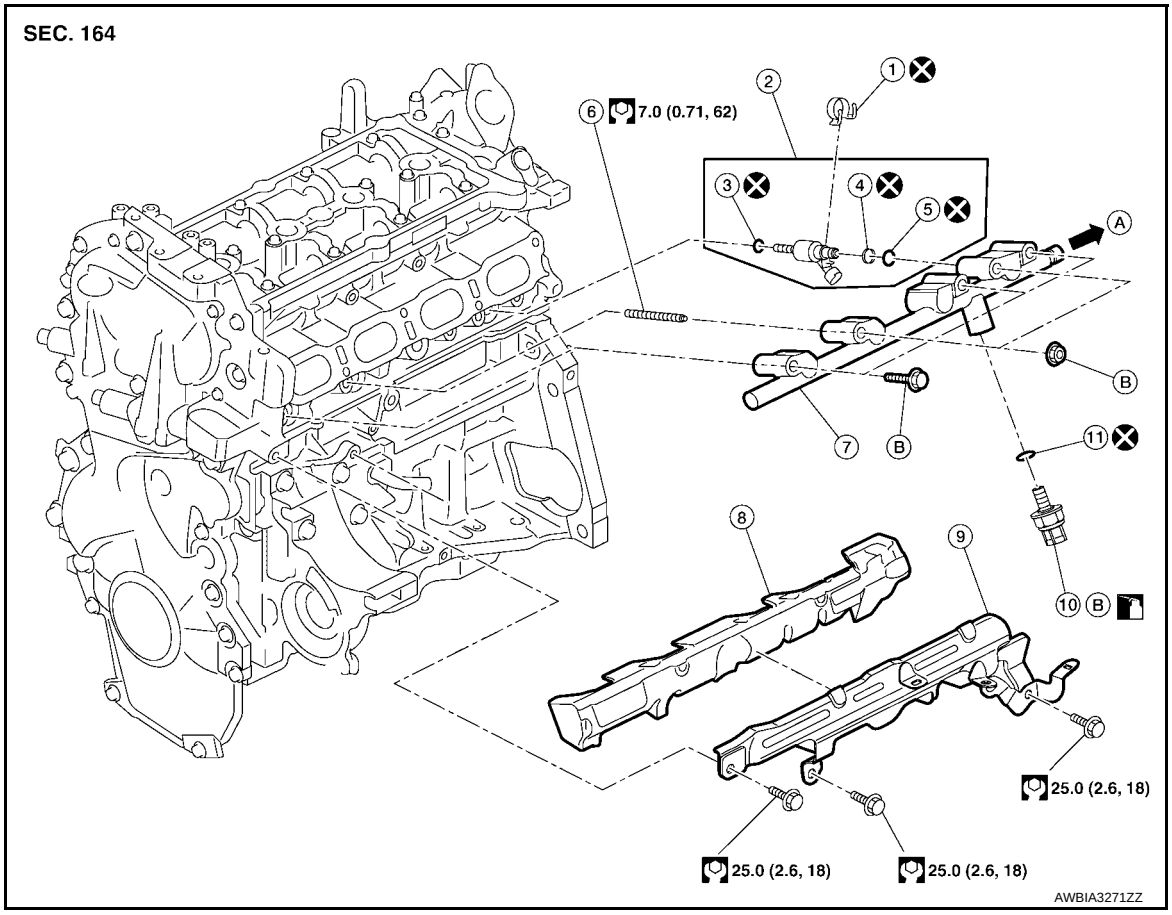
1. Turn ignition switch “ON” (with the engine stopped). With fuel pressure applied to fuel piping, check that there are no fuel leaks at connection points.
NOTE:
Use mirrors for checking at points out of clear sight.
2. Start the engine. With engine speed increased, check again that there are no fuel leaks at connection points.
CAUTION:
- **Do not touch the engine immediately after it is stopped because the engine is extremely hot.**
- **After checking for fuel leaks, maintain idling condition for 10 minutes to discharge air included in the fuel piping.**

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".

FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:0000000014727327



1. Injector holder
2. Fuel injector assembly
3. Seal ring (white)
4. Backup ring
5. O-ring (blue)
6. Stud bolt
7. Fuel rail
8. Fuel rail insulator
9. Fuel rail cover
10. Fuel rail pressure sensor
11. Fuel rail pressure sensor gasket
A. To high pressure fuel tube
B. Refer to INSTALLATION

CAUTION:
- **Do not remove or disassemble parts unless instructed as shown.**

Removal and Installation

INFOID:0000000014727328

WARNING:
- **Be sure to read EM-5, "Precaution for Handling High Pressure Fuel System" when working on the high pressure fuel system.**
- **Put a “CAUTION: FLAMMABLE” sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 fire extinguisher.**
- **Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.**
- **To avoid the danger of being scalded, do not drain engine coolant when engine is hot.**

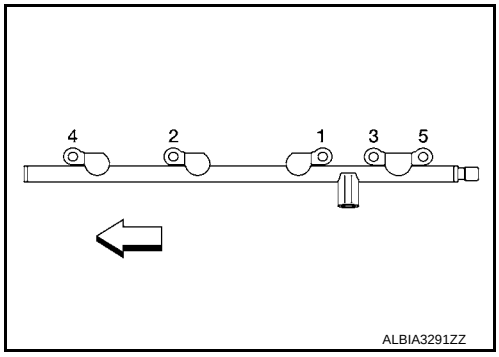
REMOVAL

1. Release the fuel pressure. Refer to EC-162, "Work Procedure".
2. Disconnect the battery. Refer to PG-128, "Battery Disconnect".
3. Unbolt the reservoir tank (high voltage cooling system) and reposition. Refer to HCO-12, "Exploded View".
4. Remove oil level gauge guide. Refer to EM-43, "Exploded View".

5. Remove fuel rail cover, and then remove fuel rail insulator.
6. Remove high pressure fuel tube. Refer to EM-49, "Exploded View".
7. Disconnect the harness connector from the fuel rail pressure sensor.
8. Disconnect the harness connector from the fuel injector.
9. Loosen fuel rail nuts and bolts in reverse of the sequence shown and remove the fuel rail.

CAUTION:
- **When removing, be careful to avoid any interference with fuel injector.**
- **Use a shop cloth to absorb any fuel that leaks from fuel rail.**

⇦ : Engine front



10. Remove fuel rail pressure sensor (if necessary).

CAUTION:
Do not reuse fuel rail pressure sensor gasket.

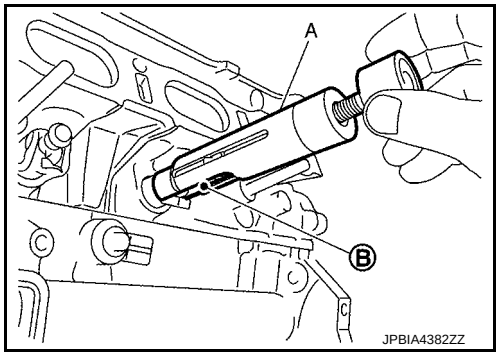
11. Remove fuel injector from cylinder head using the following procedure:

CAUTION:
- **Be careful with remaining fuel that may go out from fuel rail.**
- **Be careful not to damage injector nozzles during removal.**
- **Do not bump or drop fuel injector.**
- **Do not disassemble fuel injector.**

a. Remove injector holder.

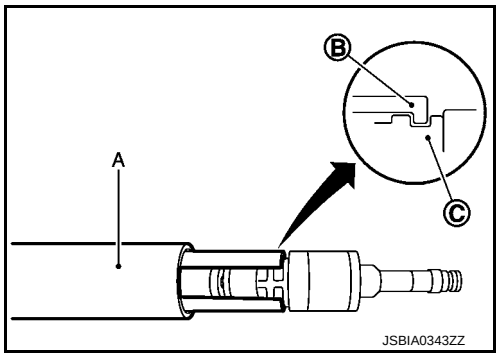
b. Install Tool (A) to the injector connector side so that cutout (B) of injector remover faces the fuel injector connector side.

Tool number : KV10119600 (J-50366)



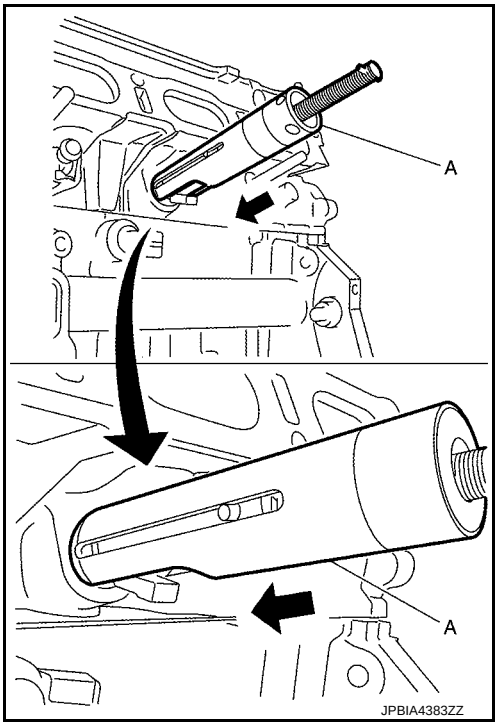
- Hook pawl portion (B) of Tool (A) to groove portion (C) of injector

Tool number : KV10119600 (J-50366)



c. Press down body portion of Tool (A) until it contacts cylinder head.

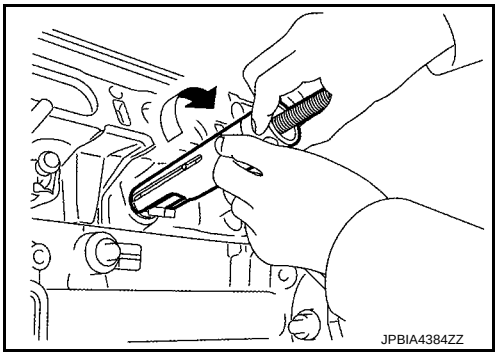
Tool number : KV10119600 (J-50366)



d. Tighten Tool clockwise and remove injector from cylinder head.

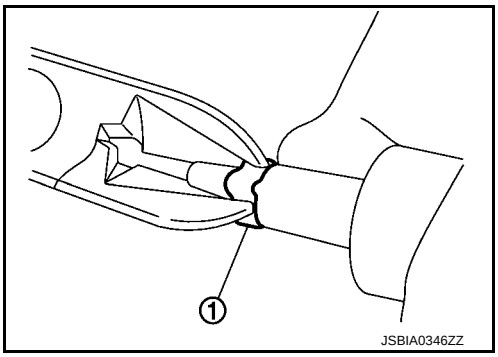
CAUTION:
Do not reuse O-ring (blue) or backup ring.

Tool number : KV10119600 (J-50366)



e. Cut seal ring (1) while pinching it.

CAUTION:
- **Do not scratch fuel injector when removing seal ring (white).**
- **Do not reuse seal ring (white).**



12. Remove stud bolt (if necessary).

INSTALLATION

CAUTION:
Do not reuse O-ring (blue), backup ring, seal ring (white) or injector holder.

1. Install stud bolt to cylinder head (if necessary).
2. Install the fuel rail pressure sensor using the following procedure (if necessary):

a. Secure fuel rail using a suitable tool.

CAUTION:
Do not scratch or crack fuel rail when installing fuel rail pressure sensor.

b. Apply engine oil to the entire perimeter of the fuel pressure sensor screw.

CAUTION:

Check that fuel rail and fuel pressure sensor screw have no damage, foreign matter, or stains.

c. Install the fuel rail pressure sensor gasket to fuel rail pressure sensor.

CAUTION:

Do not reuse the fuel rail pressure sensor gasket.

d. Tighten fuel rail pressure sensor to the specified torque.

CAUTION:

- **Before tightening fuel rail pressure sensor, securely install a hexagon tool.**
- **Do not use fuel rail pressure sensor that has been dropped.**

Fuel rail pressure sensor : 10.0 N·m (1.0 kg-m, 7 ft-lb)

e. Tighten fuel rail pressure sensor to the specified angle using Tool.

CAUTION:

- **To check tightening angle, use Tool. Do not judge the angle by visual inspection.**
- **The torque value for the angle tightening must be 90 N·m (9.2 kg-m, 66 ft-lb) or less.**
- **If torque value reaches 90 N·m (9.2 kg-m, 66 ft-lb), then replace the fuel rail pressure sensor with a new one.**

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 45° [(–0°) - (+5°)]

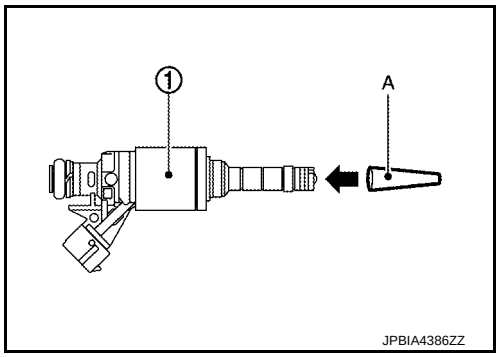
3. Install seal ring (white) to fuel injector using the following procedure:

CAUTION:

- **Handle seal ring (white) with bare hands. Do not wear gloves.**
- **Do not apply engine oil to seal ring (white).**
- **Do not clean seal ring (white) with solvent.**

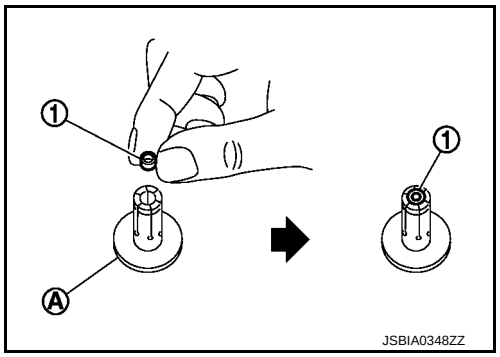
a. Install Tool (A) to fuel injector (1).

Tool number : KV10119720 (J-50364)



b. Set seal ring [white (1)] into Tool (A)

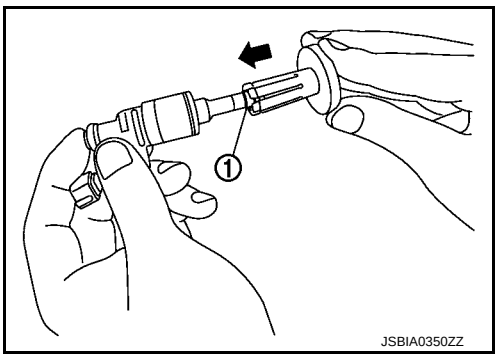
Tool number : KV10119720 (J-50364)



c. Straightly insert seal ring [white (1)], which is set in step 2, to fuel injector as shown and install onto fuel injector.

CAUTION:

Be careful that seal ring does not exceed the groove portion of fuel injector.

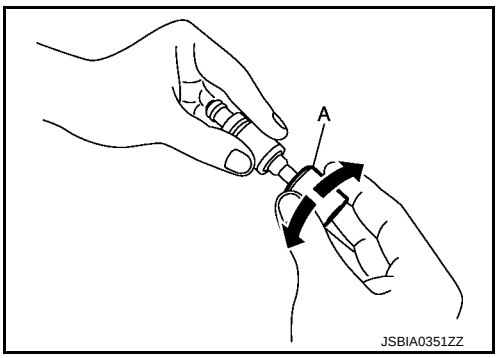


d. Insert Tool (A) to fuel injector and rotate clockwise and counter-clockwise by 90° while pressing seal ring (white) to fit it.

NOTE:

For correcting any elongation of the seal ring (white) caused by installation and for preventing sticking when inserting fuel injector into cylinder head.

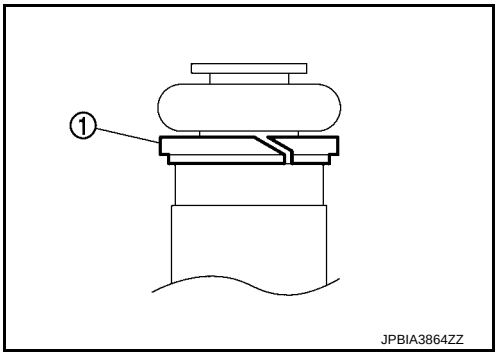
Tool number : KV10119720 (J-50364)



4. Install O-ring (blue) and backup ring to fuel injector.

CAUTION:

- **Do not reuse O-ring (blue).**
- **Handle O-ring (blue) with bare hands. Do not wear gloves.**
- **Lubricate O-ring (blue) with new engine oil.**
- **Do not clean O-ring (blue) with solvent.**
- **Check that O-ring (blue) and its mating part are free of foreign material.**
- **When installing O-ring (blue), be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring (blue). If O-ring (blue) was stretched while it was being attached, do not insert it quickly into fuel tube.**
- **Insert new O-ring (blue) straight into fuel rail. Do not decenter or twist it.**
- **Always install the back up ring (1) in the right direction as instructed.**



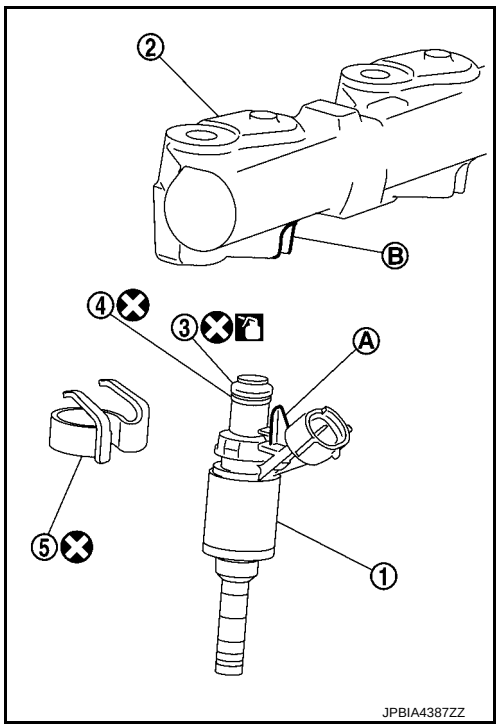
5. Install fuel injector (1) to fuel rail (2) using the following procedure:

(3) : O-ring (blue)
(4) : Backup ring

a. Install injector holder (5) to fuel injector.
CAUTION:
- **Do not reuse injector holder.**
- **Be careful to keep fuel injector holder from interfering with O-ring (blue). If interference occurs, replace O-ring (blue).**

b. Insert fuel injector into fuel rail with injector holder attached.
- Insert it while matching it to the axial center.
- Insert so that protrusion (A) of fuel injector is aligned to cutout (B).

c. Check that installation is complete by checking that fuel injector does not rotate or come off.
- Check that protrusions of fuel injectors and fuel rail are aligned with cutouts of clips after installation.

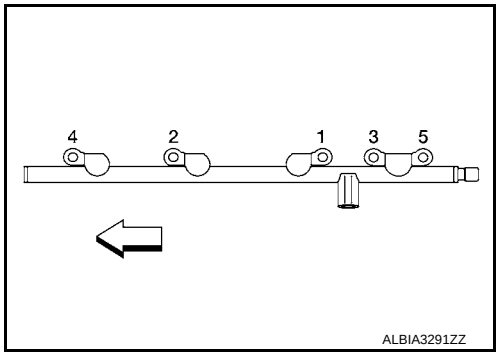


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6. Install fuel rail and fuel injector assembly to cylinder head and tighten nuts and bolts to the specified torque in the sequence shown.

Step 1 : 10.0 N·m (1.0 kg-m, 7 ft-lb)
Step 2 : 20.5 N·m (2.1 kg-m, 15 ft-lb)

⇦ : Engine front



ALBIA3291ZZ

7. Connect the harness connector to the fuel rail pressure sensor.
8. Connect the harness connector to the fuel injectors.
9. Install the fuel rail insulator.
CAUTION:
- **As covering part of fuel tube connector at the back end of common rail can easily move because of its shape, do not remove it before installation.**
- **Install the insulator so that it is placed under lower side of intake manifold flange.**
10. Installation of the remaining components is in the reverse order of removal.
NOTE:
After replacing fuel injector, erase air fuel ratio learning value. Refer to EC-158, "Work Procedure".

Inspection

INFOID:0000000014727329

INSPECTION AFTER INSTALLATION

Check on Fuel Leaks

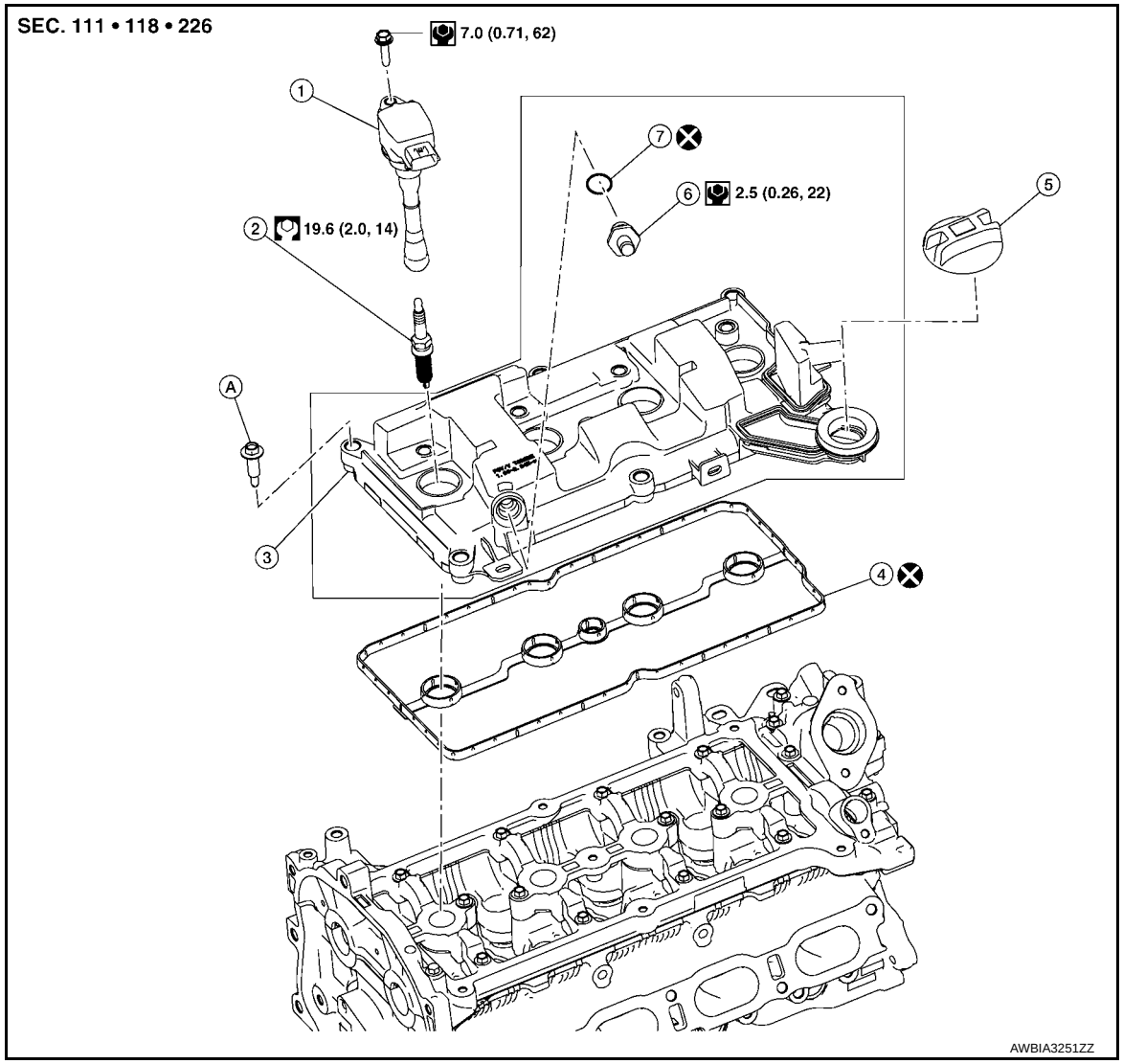
1. Turn ignition switch “ON” (with the engine stopped). With fuel pressure applied to fuel piping, check there are no fuel leaks at connection points.
NOTE:
Use mirrors for checking at points out of clear sight.
2. Start the engine. With engine speed increased, check again that there are no fuel leaks at connection points.
CAUTION:
Do not touch the engine immediately after stopped, as the engine becomes extremely hot.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".

IGNITION COIL

Exploded View

INFOID:0000000014746420



1. Ignition coil
2. Spark plug
3. Rocker cover assembly
4. Rocker cover gasket
5. Oil filler cap
6. PCV valve
7. O-ring
A. Refer to EM-63, "Removal and Installation".

Removal and Installation

INFOID:0000000014746419

REMOVAL

1. Remove the engine cover. Refer to EM-28, "Exploded View".
2. Disconnect the blowby hose from the air duct and resonator assembly. Refer to EM-29, "Exploded View".
3. Remove the air duct and resonator assembly. Refer to EM-29, "Exploded View".
4. Disconnect the harness connector from the ignition coil.
5. Remove the ignition coil.
   CAUTION:
   - **Do not drop or shock ignition coil.**
   - **Do not disassemble ignition coil.**

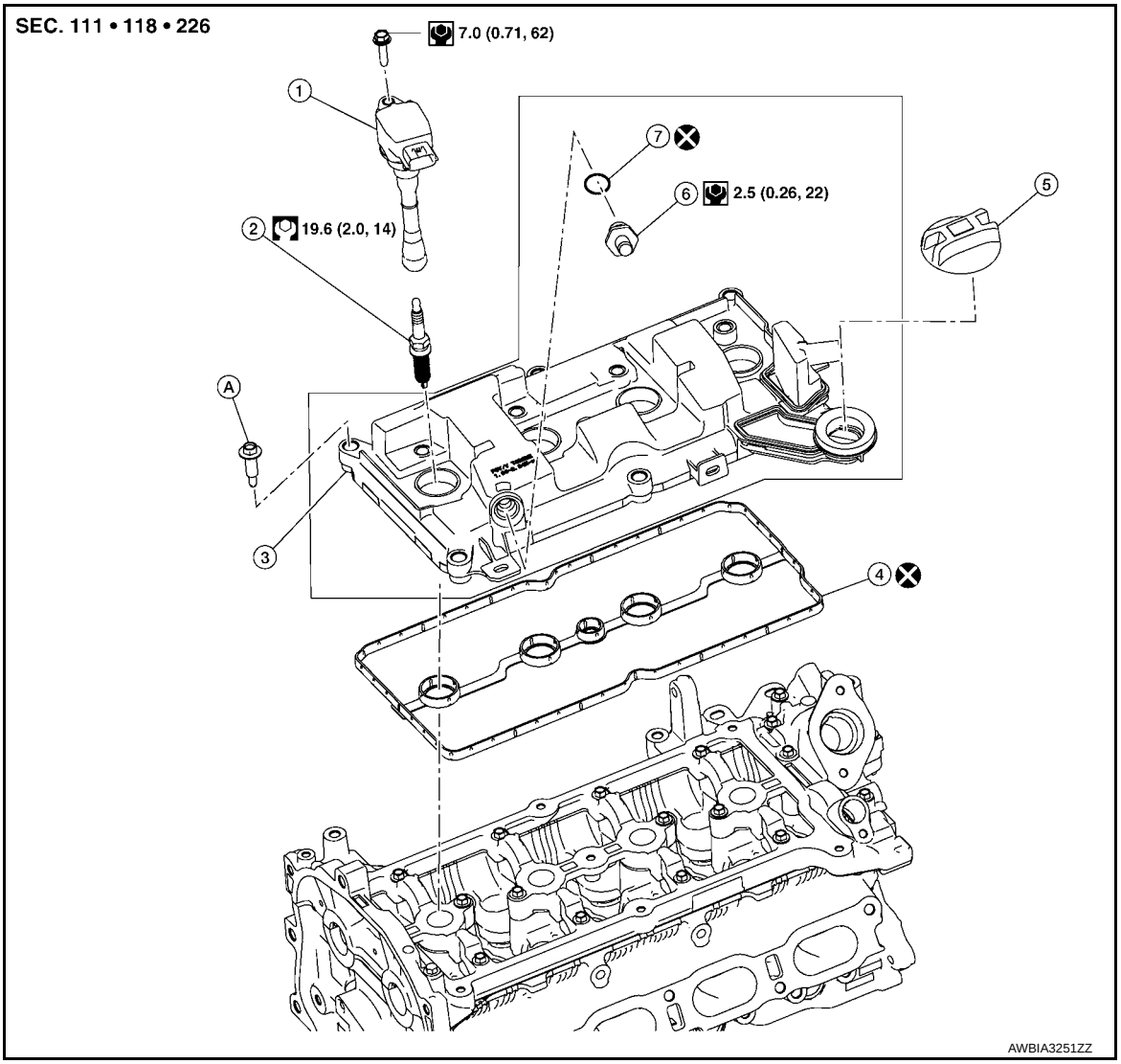
INSTALLATION

Installation is in the reverse order of removal.

ROCKER COVER

Exploded View

INFOID:0000000014727330



1. Ignition coil
2. Spark plug
3. Rocker cover assembly
4. Rocker cover gasket
5. Oil filler cap
6. PCV valve
7. O-ring
A. Refer to INSTALLATION

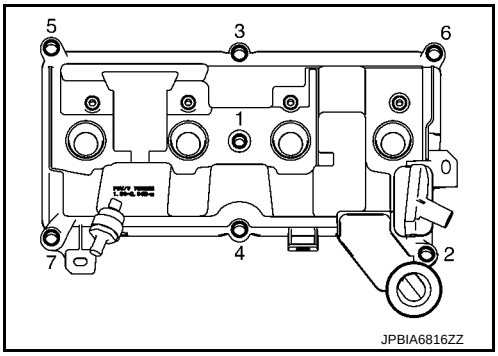
Removal and Installation

INFOID:0000000014727331

REMOVAL

1. Remove the intake manifold. Refer to EM-32, "Removal and Installation".
2. Remove the ignition coils.
   CAUTION:
   - **Do not drop or shock ignition coil.**
   - **Do not disassemble ignition coil.**
3. Remove rocker cover.

- Loosen bolts in the order from 7 to 1 shown in the figure.



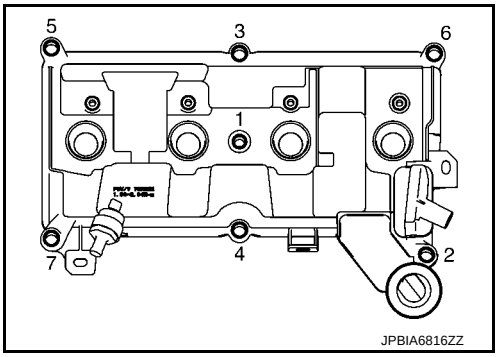
4. Remove rocker cover gasket from rocker cover.
   CAUTION:
   Do not reuse rocker cover gasket.
5. Remove the following from the rocker cover (if necessary):
   - PCV hose
   - PCV valve
     CAUTION:
     Do not reuse O-ring.
   - Oil filler cap
6. Use suitable tool to remove all traces of liquid gasket from camshaft bracket.
   CAUTION:
   Do not scratch or damage the mating surface when cleaning off old liquid gasket.

INSTALLATION

CAUTION:
Do not reuse O-ring.

1. Install the rocker cover gasket to rocker cover.
   CAUTION:
   Do not reuse rocker cover gasket.
   NOTE:
   Make sure rocker cover gasket is installed into groove in rocker cover.
2. Install the rocker cover and tighten the bolts to the specified torque in the sequence shown.

   Step 1 : 1.96 N·m (0.20 kg-m, 17 in-lb)
   Step 2 : 8.33 N·m (0.85 kg-m, 74 in-lb)

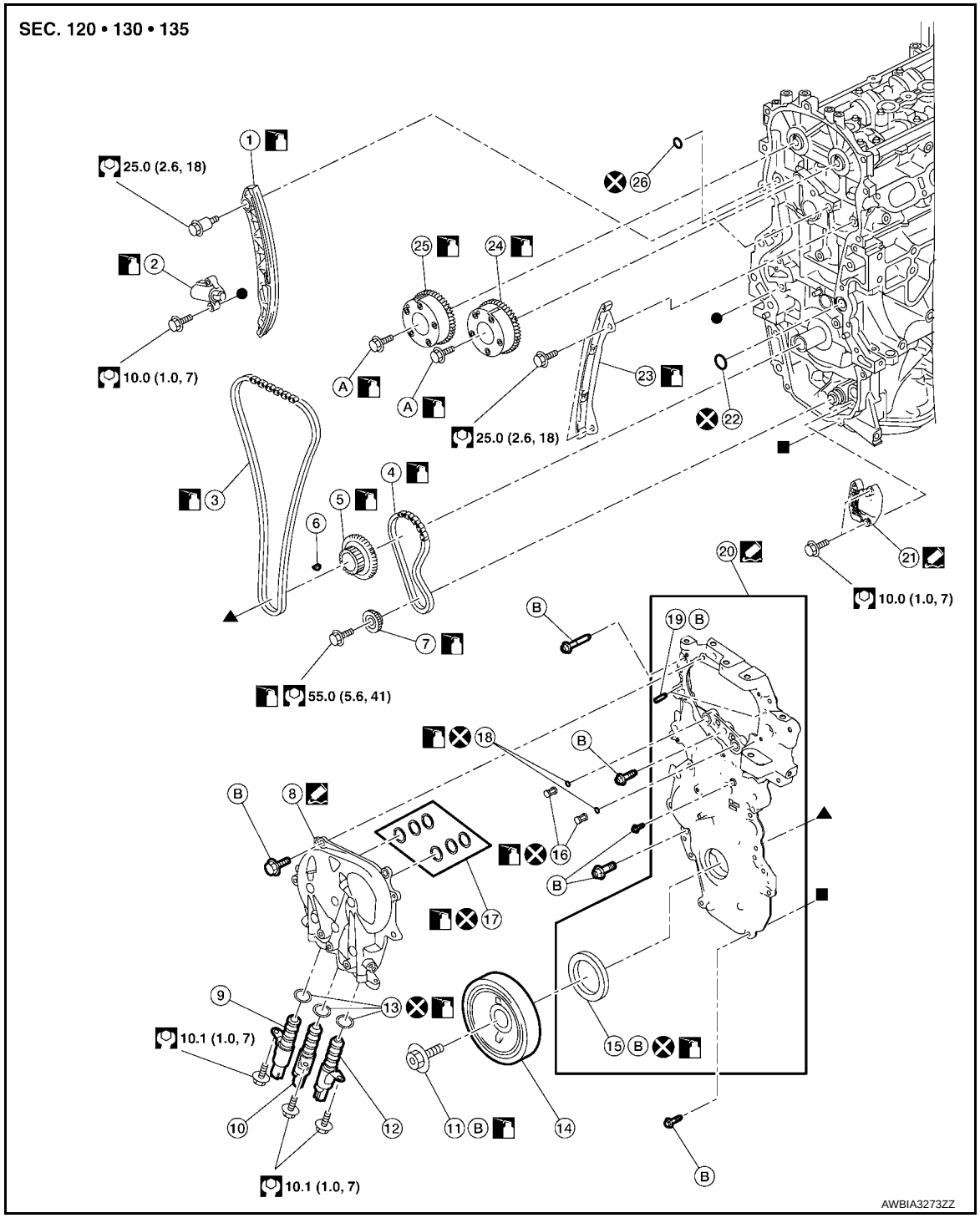


3. Installation of the remaining components is in the reverse order of removal.

TIMING CHAIN

Exploded View

INFOID:0000000014727339



1. Slack guide
2. Timing chain tensioner
3. Timing chain
4. Balancer unit timing chain
5. Crankshaft sprocket
6. Crankshaft key
7. Balancer unit sprocket
8. VTC cover
9. Exhaust valve timing control solenoid valve
10. Intake valve timing intermediate lock control solenoid valve
11. Crankshaft pulley bolt
12. Intake valve timing control solenoid valve
13. O-ring
14. Crankshaft pulley
15. Front oil seal

16. Filter
17. O-ring
18. O-ring
19. Dowel
20. Front cover
21. Balancer unit timing chain tensioner
22. O-ring
23. Timing chain tension guide
24. Camshaft sprocket (INT)
25. Camshaft sprocket (EXH)
26. O-ring
A. Refer to EM-77, "Removal and Installation".
B. Refer to INSTALLATION

Removal and Installation

INFOID:0000000014727340

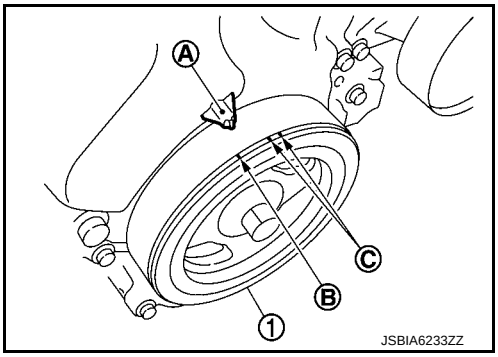
REMOVAL

CAUTION:
The rotating direction in the text indicates all directions seen from the engine front.

1. Mount the engine assembly to stand. Refer to EM-115, "Setting".
2. Drain engine oil. Refer to LU-11, "Draining".
   CAUTION:
   Perform this step when engine is cold.
3. Remove rocker cover. Refer to EM-63, "Removal and Installation".
4. Set No. 1 cylinder at TDC on its compression stroke using the following procedure:

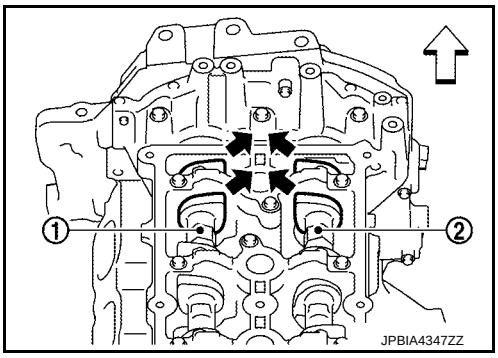
a. Rotate crankshaft pulley (1) clockwise and align TDC mark [no paint (B)] to timing indicator (A) on front cover.

(C) : White paint (Not use for service)



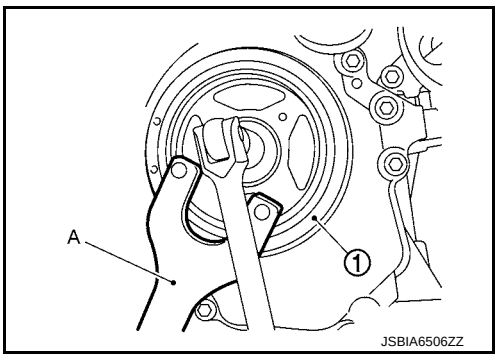
b. At the same time, check that the cam noses of the No. 1 cylinder are orientated (⬅) as shown.
   • If not, rotate crankshaft pulley one revolution (360 degrees) and align as shown.

(1) : Camshaft (INT)
(2) : Camshaft (EXH)
⇦ : Engine front

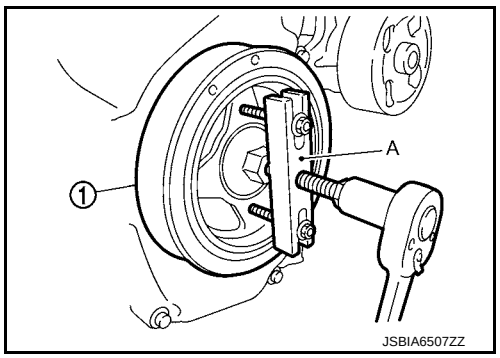


5. Remove crankshaft pulley using the following procedure:

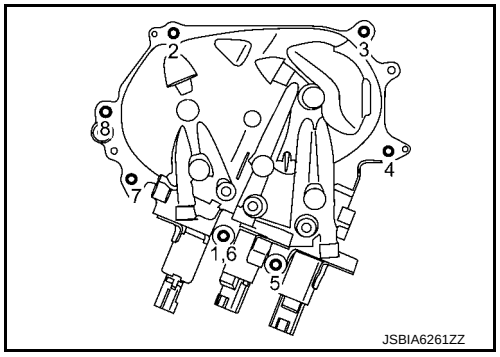
a. Secure crankshaft pulley (1) with a suitable tool (A) and loosen crankshaft pulley bolt.
   CAUTION:
   Do not remove the crankshaft pulley bolt as it is used as a supporting point for a suitable puller.



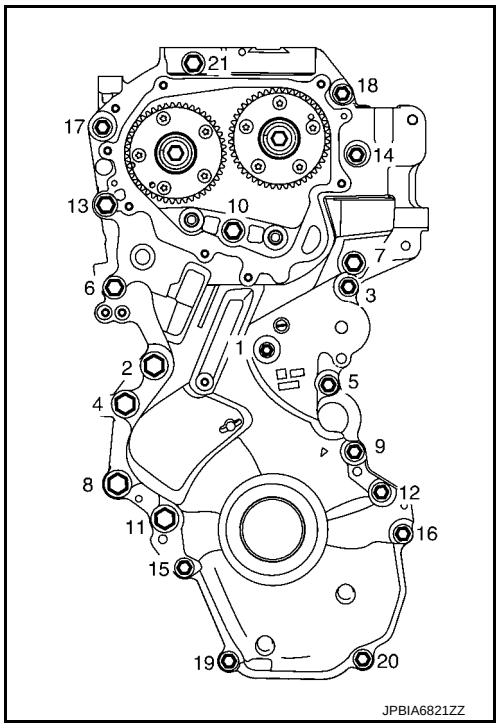
b. Attach a suitable puller (A) in the threaded hole on crankshaft pulley (1) and remove crankshaft pulley.



6. Remove oil pan (lower). Refer to EM-40, "Removal and Installation".
NOTE:
If crankshaft sprocket, balancer unit sprocket and the balancer unit timing chain are not being removed, this step is unnecessary.
7. Disconnect the harness connectors from the intake valve timing control solenoid valve, intake valve timing intermediate lock control solenoid valve and exhaust valve timing control solenoid valve.
8. Remove intake valve timing control solenoid valve, intake valve timing intermediate lock control solenoid valve and exhaust valve timing control solenoid valve (if necessary).
9. Loosen the VTC cover bolts in reverse of the sequence shown and remove the VTC cover.
NOTE:
Disregard No. 6 when loosening.

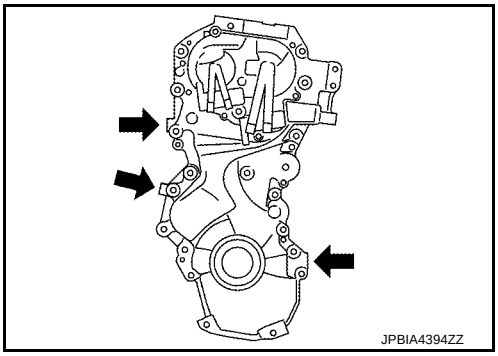


10. Remove front cover using the following procedure:
a. Loosen front cover bolts in reverse of the sequence shown.



b. Cut liquid gasket by prying the position (⬅) shown and then remove the front cover.

CAUTION:
- **Do not damage the mating surface.**
- **The liquid gasket used at the factory is very strong. Pry only in the areas shown.**



11. Remove front oil seal from front cover.

CAUTION:
- **Be careful not to damage front cover.**
- **Do not reuse front oil seal.**

12. Remove timing chain tensioner using the following procedure:

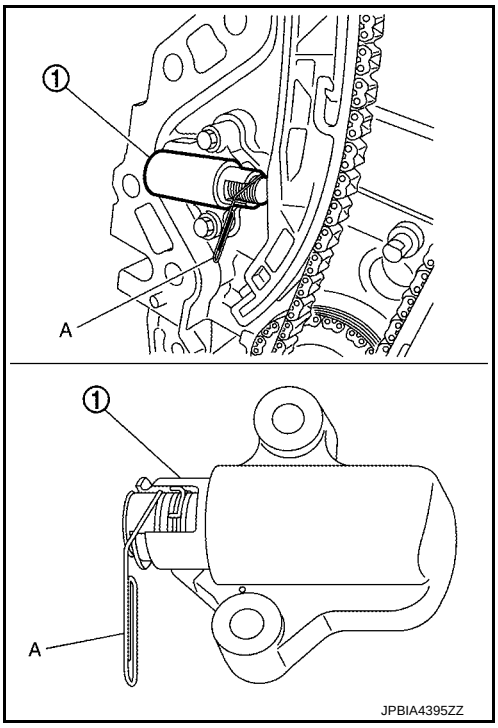
a. Push in timing chain tensioner plunger.

b. Insert a suitable tool (A) into the body hole, and then fix it with the plunger pushed in.

(1) : Timing chain tensioner

c. Remove the timing chain tensioner.

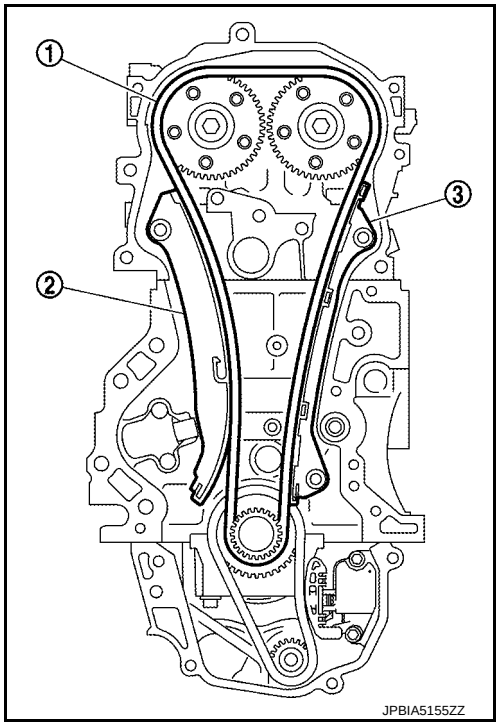
CAUTION:
Do not remove suitable tool (A) from timing chain tensioner when removed from vehicle. If timing chain tensioner plunger becomes fully extended, replace timing chain tensioner.



13. Remove slack guide (2), timing chain tension guide (3) and timing chain (1).

CAUTION:

Do not rotate the crankshaft and camshafts individually while timing chain is removed. It causes interference between valve and piston.

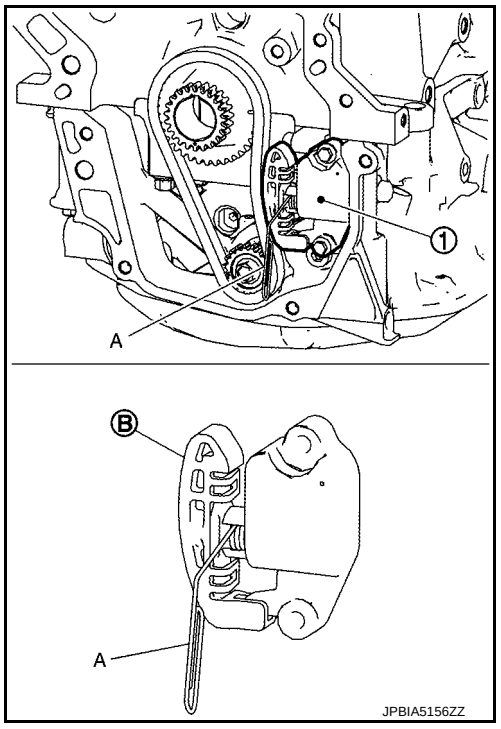


14. Remove crankshaft sprocket and balancer unit drive component using the following procedure:

a. Press the balancer unit timing chain slack guide (B) toward balancer unit timing chain tensioner (1).

b. Insert a suitable tool (A) into tensioner body slit to secure the balancer unit timing chain slack guide.

c. Remove balancer unit timing chain tensioner.
   - When the holes on lever and tensioner body cannot be aligned, align these holes by slightly moving the balancer unit timing chain slack guide.



d. Hold the WAF part of balancer shaft [WAF: 19 mm (0.75 in)] (A), and then loosen the balancer unit sprocket bolt.

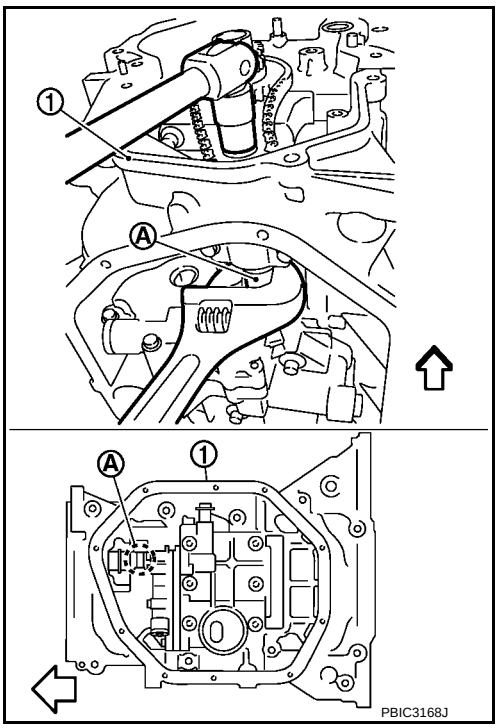
CAUTION:

- **Secure the balancer unit shaft with the WAF part.**
- **Do not loosen the balancer unit sprocket bolt by tightening the balancer unit timing chain.**

(1) : Oil pan (upper)

⇦ : Engine front

e. Remove crankshaft sprocket, balancer unit sprocket and balancer unit timing chain as a set.



INSTALLATION

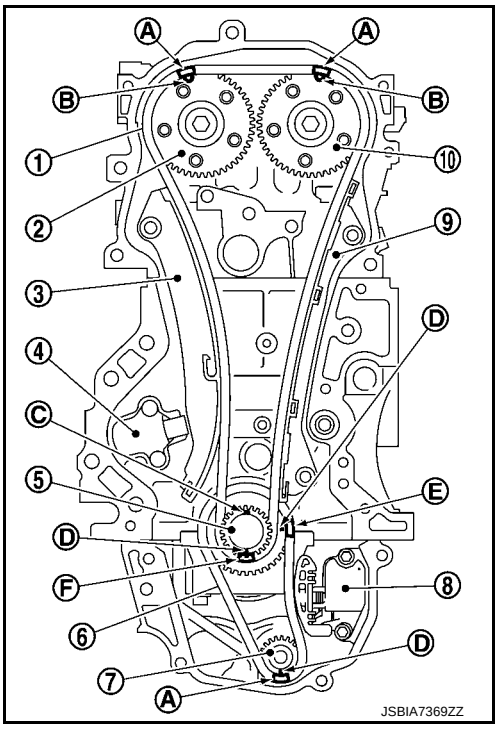
CAUTION:

Do not reuse O-rings.

NOTE:

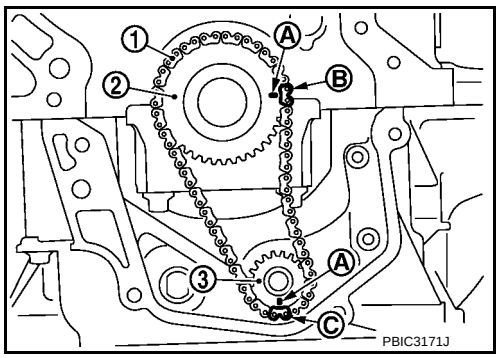
- The illustration shows the relationship between the matching mark on each timing chain and that on the corresponding sprocket, with the components installed.
- There are two outer grooves in the camshaft sprocket (INT). The wider one is a matching mark.

(1) : Timing chain
(2) : Camshaft sprocket (EXH)
(3) : Slack guide
(4) : Timing chain tensioner
(5) : Crankshaft sprocket
(6) : Balancer unit timing chain
(7) : Balancer unit sprocket
(8) : Balancer unit timing chain tensioner
(9) : Timing chain tension guide
(10) : Camshaft sprocket (INT)
(A) : Matching mark (dark blue link)
(B) : Matching mark (stamping)
(C) : Crankshaft key position (straight up)
(D) : Matching mark (stamping)
(E) : Matching mark (white link)
(F) : Matching mark (yellow link)



1. Check that crankshaft key points straight up.

2. Install crankshaft sprocket (2), balancer unit sprocket (3) and balancer unit timing chain (1).



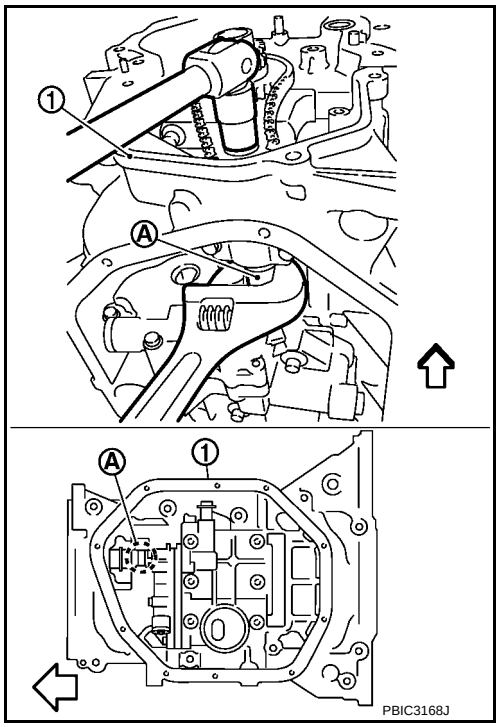
(A) : Matching mark (stamping)
(B) : Matching mark (white link)
(C) : Matching mark (dark blue link)

- Install it by aligning matching marks on each sprocket and balancer unit timing chain.
- If these matching marks are not aligned, rotate the balancer shaft slightly to correct the position.

CAUTION:
Check matching mark position of each sprocket after installing the balancer unit timing chain.

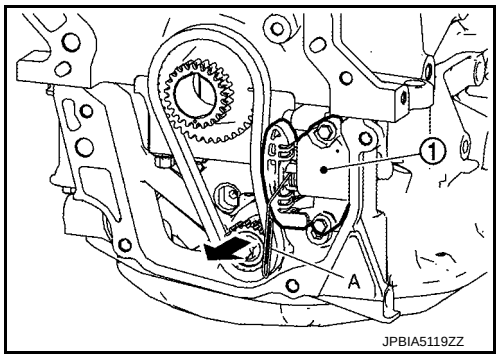
3. Hold the WAF part of balancer unit shaft [WAF: 19 mm (0.75 in)] (A) and then tighten the balancer shaft sprocket bolt.

CAUTION:
- **Secure the balancer unit shaft with the WAF part.**
- **Do not loosen the balancer shaft sprocket bolt by tightening the balancer unit timing chain.**



(1) : Oil pan (upper)
⇦ : Engine front

4. Install balancer unit timing chain tensioner (1).
- Fix the plunger at the most compressed position using a suitable tool (A) and then install it.
- Securely pull out (⬅) the suitable tool after installing the balancer unit timing chain tensioner.
- Check matching mark position of balancer unit timing chain and each sprocket again.

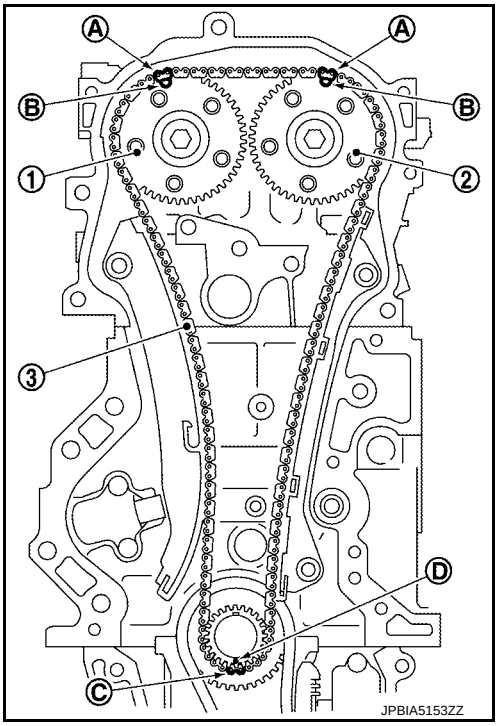


5. Align the matching marks of each sprocket with the matching marks of timing chain.
NOTE:
There are two outer grooves in the camshaft sprocket (INT). The wider one is a matching mark.

(1) : Timing chain
(2) : Camshaft sprocket (EXH)
(3) : Slack guide
(A) : Matching mark (dark blue link)
(B) : Matching mark (stamping)
(C) : Crankshaft key position (straight up)
(D) : Matching mark (stamping)

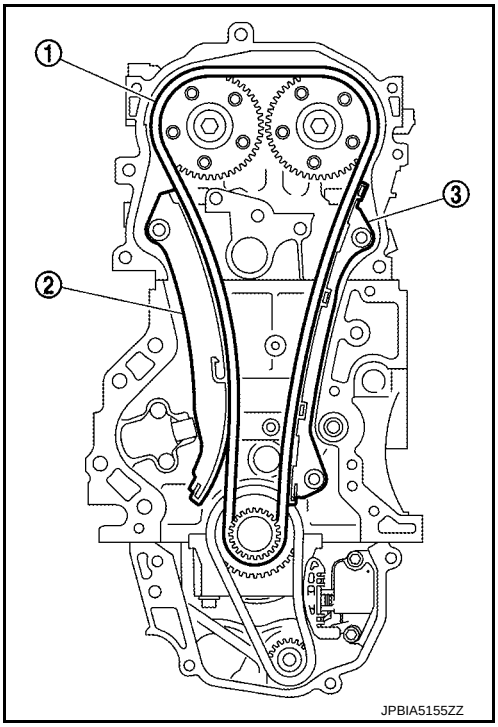
- If these matching marks are not aligned, rotate the camshaft slightly by holding the hexagonal portion to correct the position.

CAUTION:
Check matching mark position of each sprocket and timing chain again after installing the timing chain.



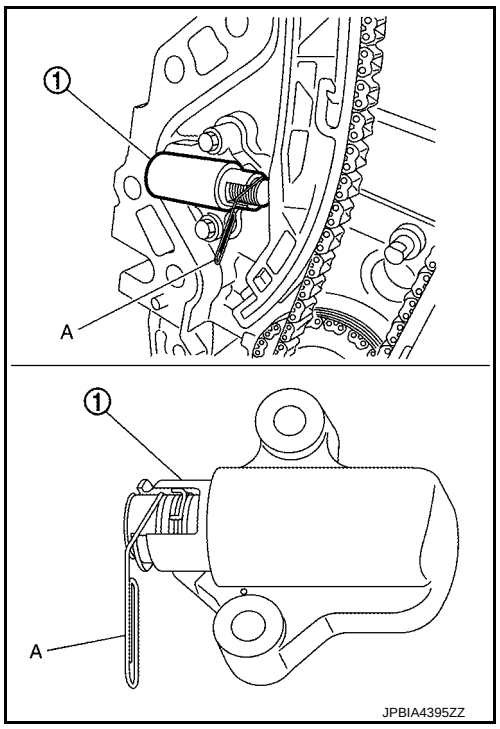
6. Install the timing chain tension guide (3) and the slack guide (2).

(1) : Timing chain



7. Install the timing chain tensioner (1).
   - Securely pull out the suitable tool after installing the timing chain tensioner.

   CAUTION:
   Do not remove suitable tool (A) from timing chain tensioner when removed from vehicle. If timing chain tensioner plunger becomes fully extended, replace timing chain tensioner.



8. Check matching mark position of timing chain and each sprocket again.
9. Install front oil seal. Refer to EM-100, "FRONT OIL SEAL : Removal and Installation".
10. Install front cover with the following procedure:

a. Install new O-ring to cylinder block.

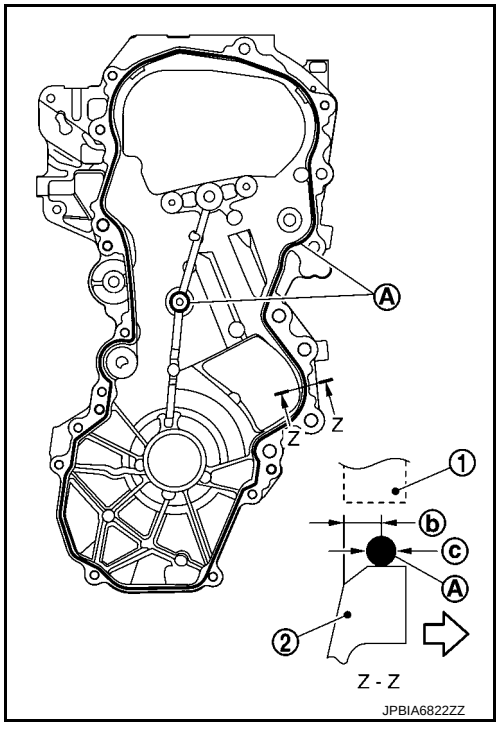
   CAUTION:
   - **Do not reuse O-ring.**
   - **Make sure O-ring is not misaligned.**

b. Apply a continuous bead of liquid gasket (A) with a suitable tool to front cover (2) as shown.

   (1) : Cylinder block, oil pan (lower)
   (b) : 4.0 - 5.6 mm (0.157 - 0.220 in)
   (c) : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)
   ⇦ : Engine outside

   Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

   CAUTION:
   - **The components must be installed within 5 minutes of the liquid gasket application.**
   - **Do not confirm torque after the 5 minutes have elapsed.**
   - **Then allow 30 minutes for the liquid gasket to set before adding oil to the engine.**



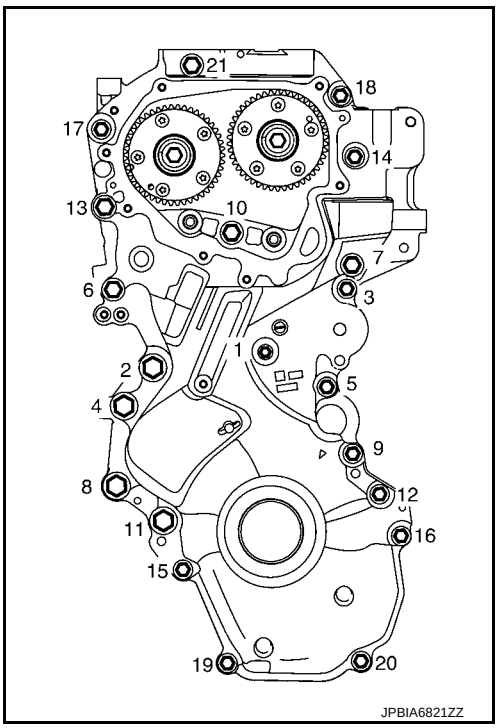
c. Check that matching marks of timing chain and each sprocket are still aligned. Then install front cover.

   CAUTION:
   - **Check O-ring on cylinder block is correctly installed.**
   - **Be careful not to damage front oil seal by interference with front end of crankshaft.**

d. Install the front cover and tighten bolts to the specified torque in the sequence shown.
- Refer to the following for the installation position of bolts.

M6	**: No. 1**	**: 6.6 N·m (0.67 kg-m, 58 in-lb)**
M10	**: No. 6, 7, 10, 13, 21**	**: 55.0 N·m (5.6 kg-m, 41 ft-lb)**
M12	**: No. 2, 4, 8, 11**	**: 75.0 N·m (7.7 kg-m, 55 ft-lb)**
M8	**: Except the above**	**: 25.5 N·m (2.6 kg-m, 19 ft-lb)**

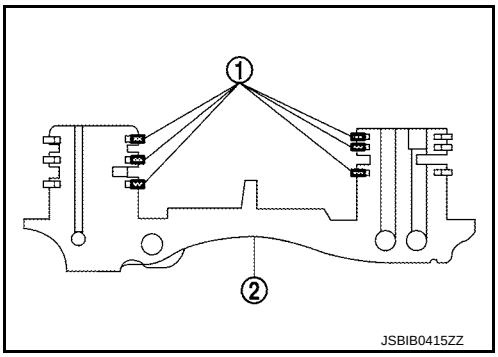
CAUTION:
- **The components must be installed within 5 minutes of the liquid gasket application.**
- **Be sure to wipe off any excessive liquid gasket.**



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11. Install VTC cover using o the following instructions:

a. Install new O-rings (1) to the groove of VTC cover (2) (if necessary).



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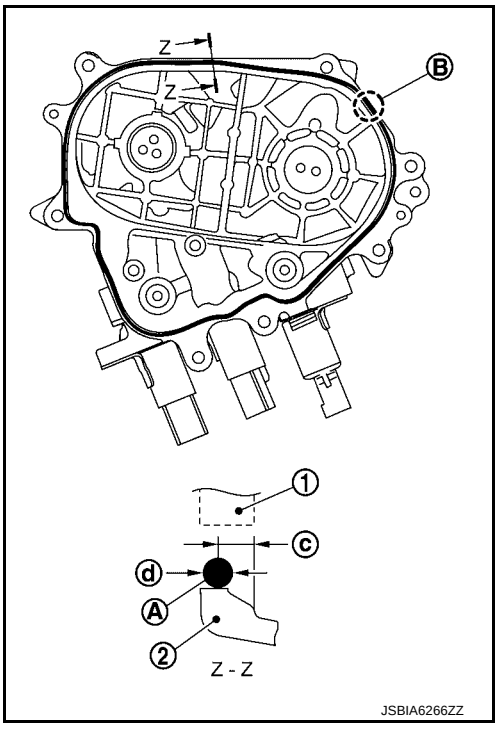
b. Apply a continuous bead of liquid gasket (B) with a suitable tool to the VTC cover as shown.

(1) : Front cover
(2) : VTC cover
(B) : Start/End of liquid gasket application
(c) : 4.0 - 5.6 mm (0.157 - 0.220 in)
(d) : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

CAUTION:
- **The components must be installed within 5 minutes of the liquid gasket application.**
- **Do not confirm torque after the 5 minutes have elapsed.**
- **Then allow 30 minutes for the liquid gasket to set before adding oil to the engine.**

NOTE:
Overlap the start and end of liquid gasket application positions at least 5 mm (0.20 in).

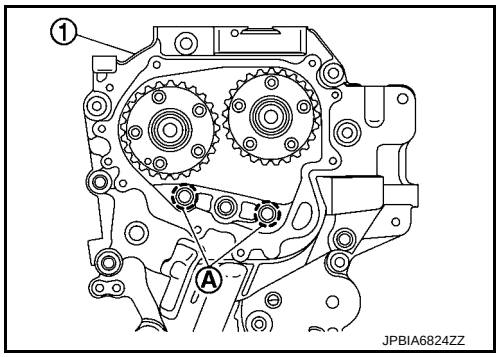


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c. Install filter (if necessary) and O-ring to the groove of front cover (1).

CAUTION:
- **Do not reuse O-rings.**
- **Do not reuse filter (if necessary).**
- **Filter must be inserted to the end of O-ring installation part.**

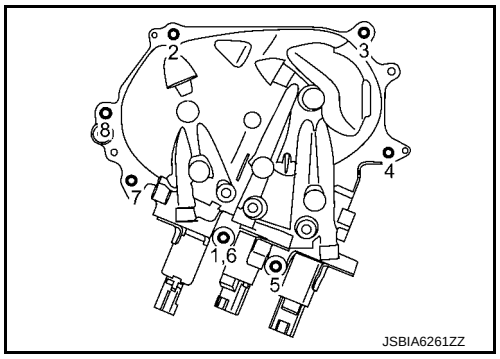
(A) : O-ring installation position



d. Tighten the VTC cover bolts to the specified torque in the sequence shown.

CAUTION:
Be sure to wipe off any excess liquid gasket.

VTC cover bolts : 10.0 Nm (1.0 kg-m, 7 ft-lb)



12. Install crankshaft pulley using the following procedure:

a. When inserting crankshaft pulley with a suitable tool, tap on its center portion (not circumference).

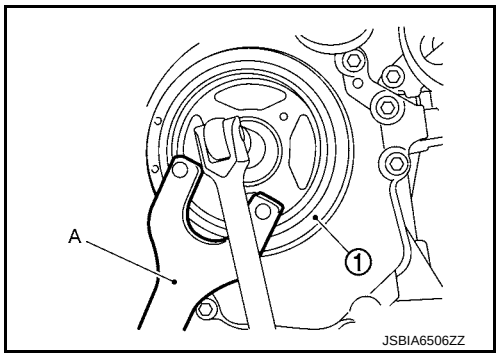
CAUTION:
Do not damage front oil seal lip portion.

b. Secure crankshaft pulley (1) with a suitable tool (A).

c. Apply new engine oil to thread and seat surfaces of crankshaft pulley bolt.

d. Tighten crankshaft pulley bolt to the specified torque.

Crankshaft pulley bolt : 29.4 N·m (3.0 kg-m, 22 ft-lb)



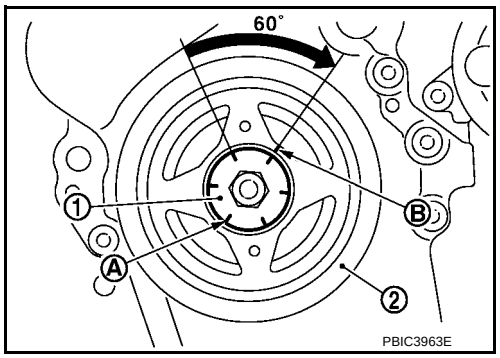
e. Put a paint mark (B) on crankshaft pulley (2), matching with any one of six easy to recognize angle marks (A) on crankshaft pulley bolt (1) flange.

f. Tighten crankshaft pulley bolt to the specified angle using Tool.
- Check the tightening angle with movement of one angle mark.

CAUTION:
Check and confirm the tightening angle using Tool. Avoid judgement by visual inspection without Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 60°



g. Check that crankshaft rotates clockwise smoothly.

13. Installation of the remaining components is in the reverse order of removal.

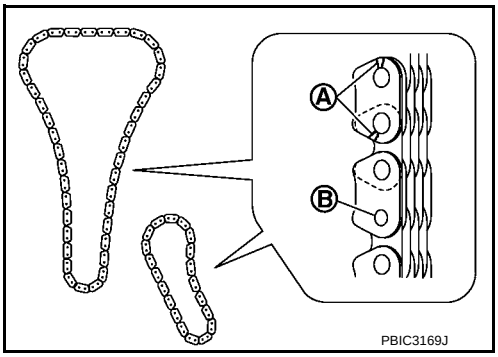
Inspection

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INSPECTION AFTER REMOVAL

Timing Chain

Check for cracks (A) and any excessive wear (B) at link plates and roller links of timing chain. Replace timing chain if necessary.



INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates leakage, and exhaust gases leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-11, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

  NOTE:

  Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".
- Run engine to check for unusual noise and vibration.

  NOTE:

  If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in guide may generate a pounding noise during and just after the engine start. However, this does not indicate an unusualness. Noise will stop after hydraulic pressure rises.
- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

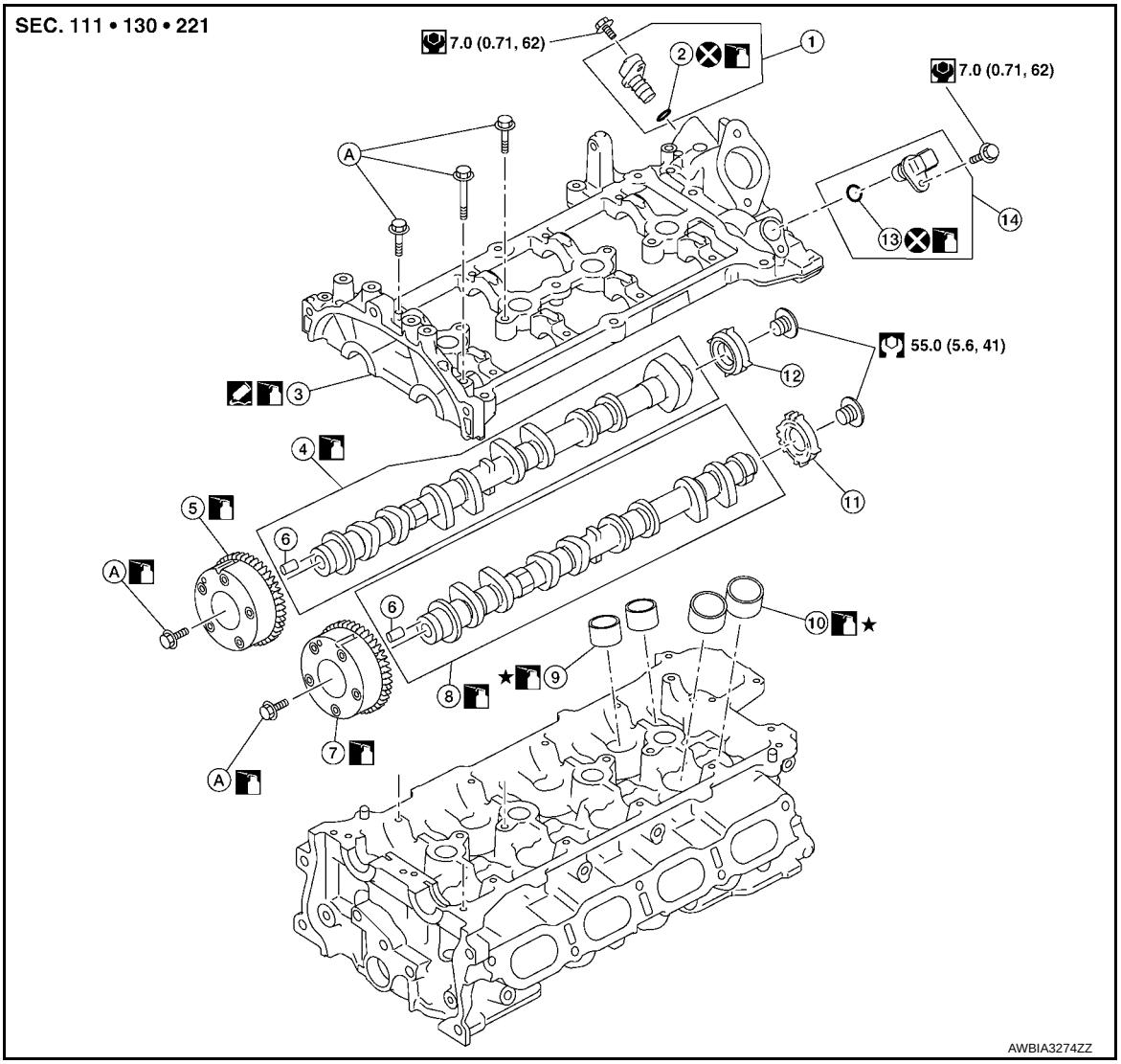
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage	Level
Fuel		Leakage	Leakage	Leakage
Exhaust gases		—	Leakage	—

*: Power steering fluid, brake fluid, etc.

CAMSHAFT

Exploded View

INFOID:0000000014727342



1. Exhaust valve timing control position sensor	2. O-ring	3. Camshaft bracket
4. Camshaft (EXH)	5. Camshaft sprocket (EXH)	6. Dowel
7. Camshaft sprocket (INT)	8. Camshaft (INT)	9. Valve lifter (EXH)
10. Valve lifter (INT)	11. Signal plate (INT)	12. Signal plate (EXH)
13. O-ring	14. Camshaft position sensor	A. Refer to INSTALLATION

Removal and Installation

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CAUTION:
The rotating direction in the text indicates all directions seen from the engine front.

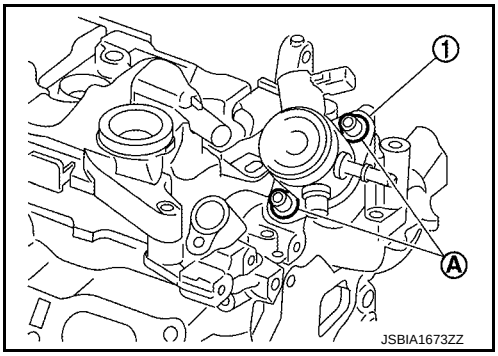
REMOVAL

1. Remove the front cover and timing chain. Refer to EM-66, "Removal and Installation".
   NOTE:
   Removal of oil pump drive related part is not necessary.
2. Disconnect the harness connectors from the camshaft position sensor and exhaust valve timing control position sensor.

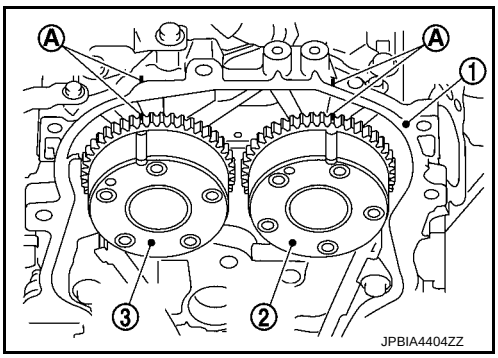
3. Remove camshaft position sensor and exhaust valve timing control position sensor from camshaft bracket.
CAUTION:
- **Handle camshaft position sensor and exhaust valve timing control position sensor carefully and avoid impacts.**
- **Do not disassemble camshaft position sensor and exhaust valve timing control position sensor.**
- **Do not place sensor where it is exposed to magnetism.**

4. Remove the high pressure fuel tube. Refer to EM-49, "Exploded View".
5. Disconnect the harness connector from the high pressure fuel pump.
6. Remove high pressure fuel pump (1) and lifter.
CAUTION:
- **To prevent damage to high pressure fuel pump and camshaft bracket, loosen bolts (A) by alternating sides one turn at a time until the reaction force applied on the high pressure fuel pump disappears.**
- **Do not reuse O-ring.**

NOTE:
Remove O-ring from the high pressure fuel pump.

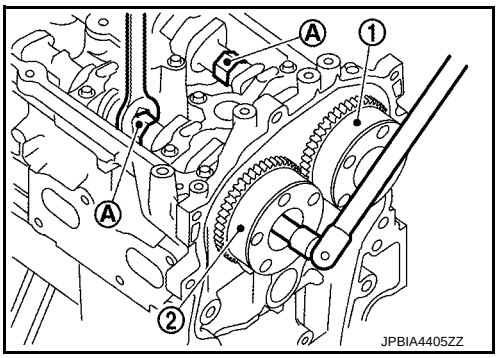


7. Put the matching mark (A) on the camshaft sprocket [INT (2)], camshaft sprocket [EXH (3)] and the camshaft bracket (1) as show.
NOTE:
It prevents the dowel of the camshaft (INT) from engaging with the incorrect pin hole when installing the camshaft sprocket (INT).



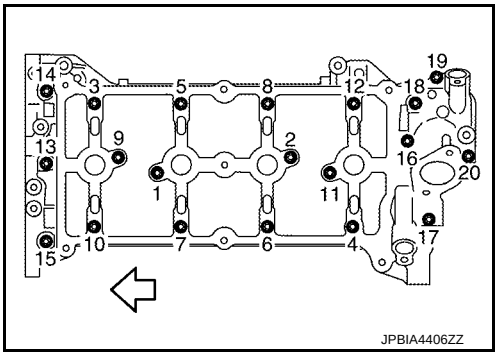
8. Secure the hexagonal part (A) of the camshaft and remove the bolts and camshaft sprockets (INT and EXH).
CAUTION:
- **Do not rotate crankshaft or camshaft while timing chain is removed. It causes interference between valve and piston.**
- **Do not loosen the bolts with securing anything other than the camshaft hexagonal part or with tensioning the timing chain.**

(1) : Camshaft sprocket (INT)
(2) : Camshaft sprocket (EXH)



9. Remove camshaft bracket using the following procedure:
a. Loosen camshaft bracket bolts in reverse of the sequence shown.

⇦ : Engine front

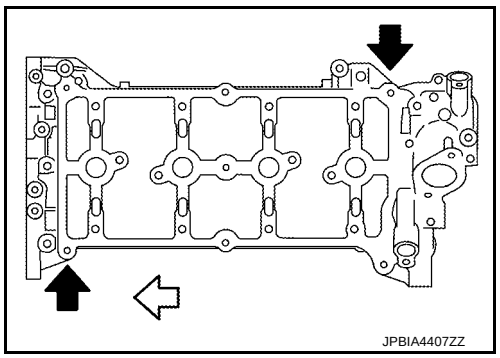


b. Cut liquid gasket by prying the position (⬅) shown in the figure, and then remove the camshaft bracket.

CAUTION:

- **Do not damage the mating surface.**
- **The liquid gasket used at the factory is very strong. Pry only in the areas shown.**

⇦ : Engine front



10. Remove camshafts.
11. Remove valve lifters (if necessary).
    - Identify installation positions, and store them without mixing them up.
12. Remove signal plate from camshaft (if necessary).

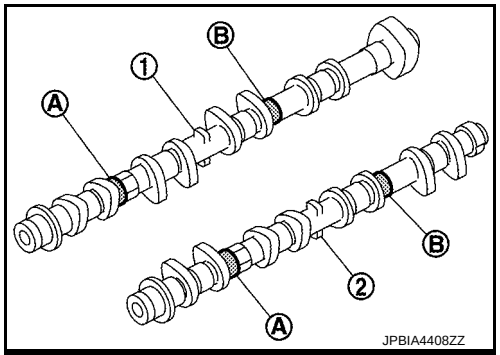
INSTALLATION

CAUTION:

Do not reuse O-rings.

1. Install valve lifters (if necessary).
   - Install them in the original positions.
2. Install camshafts.
   - Clean camshaft journal to remove any foreign material.
   - Distinguish between the camshaft [INT (2)] and the camshaft [EXH (1)] by looking at the different shapes of the front and rear ends of the camshaft or using the identification colors (A/B).

Identification color	(A)	(B)
Camshaft (EXH)	—	Brown
Camshaft (INT)	Brown	—

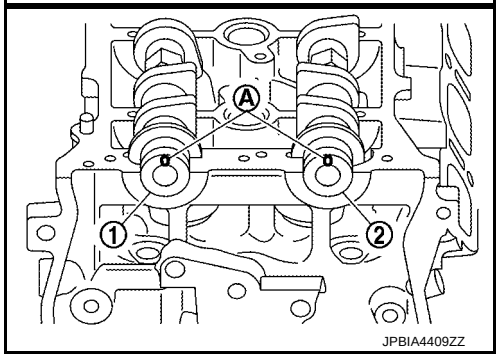


- Install camshafts so that camshaft dowel pins (A) on the front side are positioned as shown.

NOTE:

Though camshaft does not stop at the positions as shown, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction of the figure.

(1) : Camshaft (EXH)
(2) : Camshaft (INT)



3. Install camshaft bracket using the following procedure:

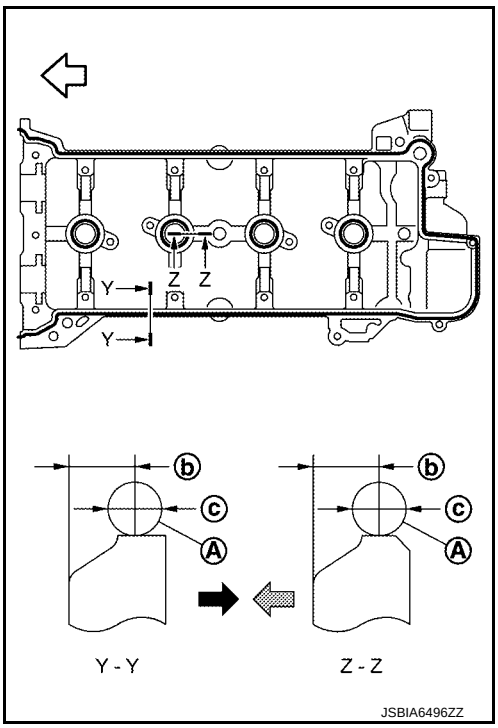
a. Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.

b. Apply a continuous bead of liquid gasket (B) with a suitable tool to the camshaft bracket as shown.

(b) : 4.0 - 5.6 mm (0.157 - 0.220 in)
(c) : ϕ 3.4 - 4.4 mm (0.134 - 0.173 in)
⇦ : Engine front
⇦ : Plug hole inner wall
⬅ : Engine outside

Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

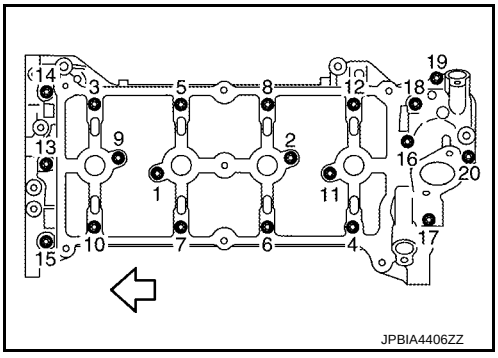
CAUTION:
- **the components must be installed within 5 minutes of the liquid gasket application.**
- **Do not confirm torque after the 5 minutes have elapsed.**
- **Then allow 30 minutes for the liquid gasket to set before adding oil to the engine.**



c. Tighten the camshaft bracket bolts to the specified torque in the sequence shown.

NOTE:
There are two types of mounting bolts. Refer to the following for locating bolts.

M6 bolts [thread length: 57.5 mm (2.264 in)]
: 13, 14, and 15
M6 bolts [thread length: 35.0 mm (1.378 in)]
: Except the above



⇦ : Engine front

i. Tighten camshaft bracket bolts to the specified torque in the sequence shown.

Camshaft bracket bolts : 1.96 N·m (0.20 kg-m, 17 in-lb)

ii. Tighten camshaft bracket bolts to the specified torque in the sequence shown.

Camshaft bracket bolts : 5.88 N·m (0.60 kg-m, 52 in-lb)

iii. Tighten camshaft bracket bolts to the specified torque in the sequence shown.

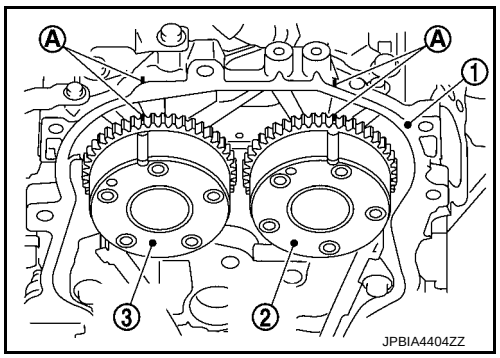
Camshaft bracket bolts : 9.5 N·m (0.97 kg-m, 84 in-lb)

CAUTION:
After tightening camshaft bracket bolts, be sure to wipe off excessive liquid gasket from the mating surface of cylinder head.

4. Install the camshaft sprocket to the camshaft using the following procedure.

a. When the camshaft sprocket [INT (2)] and camshaft sprocket [EXH (3)] is removed, refer to the paint mark (A) put according to step “3”. Securely align the dowel and the pin hole and then install them.

(1) : Camshaft bracket



b. Tighten camshaft sprocket bolts using the following steps.
- Secure the hexagonal part of camshaft using a suitable tool to tighten camshaft sprocket bolt.

i. Tighten camshaft sprocket bolt to the specified torque.

Camshaft sprocket bolt : 35.0 N·m (3.6 kg-m, 26 ft-lb)

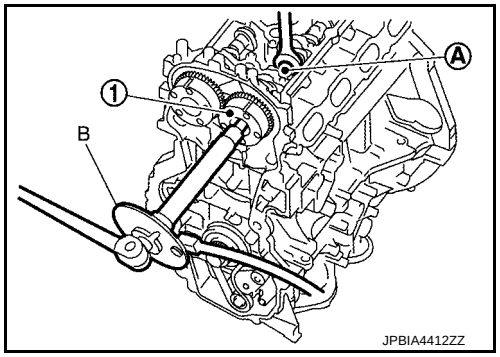
ii. Tighten camshaft sprocket bolt by the specified angle.

CAUTION:
Check the tightening angle by using Tool (B). Do not judge by visual inspection without Tool.

Tool number : KV10112100 (BT-8653-A)

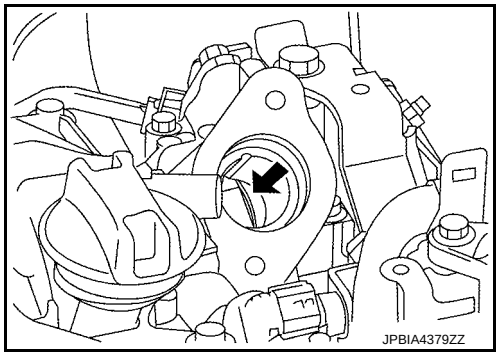
Tightening angle : 28° - 33°

(1) : Camshaft sprocket
(A) : Camshaft hexagonal part



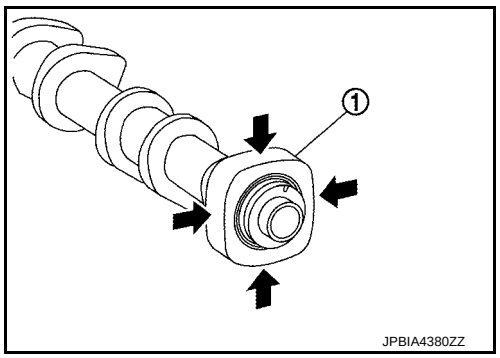
5. Install timing chain and related parts. Refer to EM-66, "Removal and Installation".
6. Install high pressure fuel pump using the following procedure:

a. Check the orientation of pump cam from the mounting area of high pressure fuel pump.



b. Aim pump cam at the BDC area as shown.
NOTE:
For BDC area, anywhere within the area indicated by ⬅ can be accepted.

(1) : Camshaft (EXH)

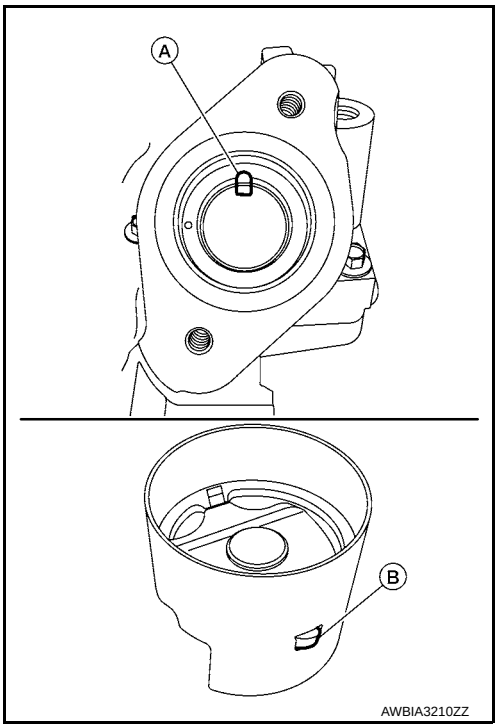


c. Install O-ring to high pressure fuel pump.

CAUTION:
- **Do not reuse O-ring.**
- **Handle O-ring with bare hands. Do not wear gloves.**
- **Lubricate O-ring with new engine oil.**
- **Do not clean O-ring with solvent.**
- **Check that O-ring and its mating part are free of foreign material.**
- **Do not damage O-ring with tools and fingernails during the installation. In addition, twisting or stretching O-ring is not allowed. If O-ring is stretched during the installation to high pressure fuel pump, do not install high pressure fuel pump immediately.**

d. Install high pressure fuel pump lifter.

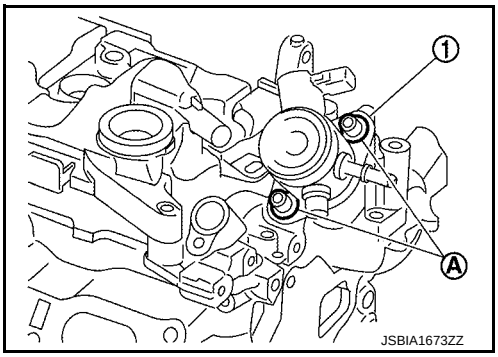
NOTE:
- Lubricate the high pressure fuel pump lifter and bore of camshaft bracket.
- When installing the high pressure fuel pump lifter, note the orientation of the protrusion (B) and cutout (A) in the camshaft bracket, they should be aligned.



e. Apply clean engine oil to the fitting area of high pressure fuel pump O-ring and camshaft bracket side to install high pressure fuel pump.

f. Install high pressure fuel pump (1) and tighten bolts (A) by alternating sides one turn at a time until high pressure fuel pump is seated to camshaft bracket. Tighten high pressure fuel pump bolts to the specified torque.

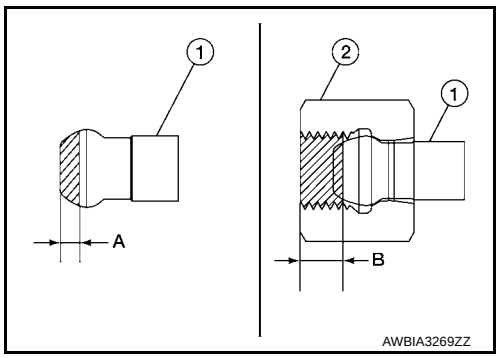
High pressure fuel pump bolts : 10.0 N·m (1.0 kg-m, 7 ft-lb)



7. Install the high pressure fuel tube with the following procedure.

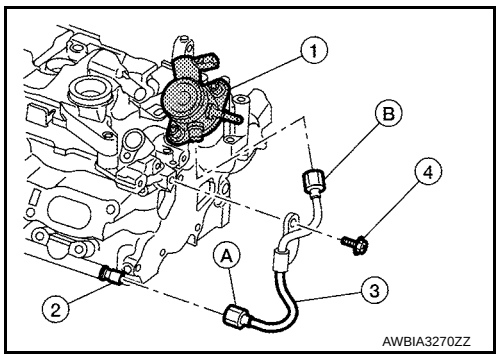
CAUTION:
- **Do not reuse high pressure fuel tube.**
- **Do not use high pressure fuel tube if its terminal tip is damaged.**
- **Observe the tightening sequence and the tightening torque.**

a. Apply clean engine oil to area (A) [5 mm from the tip of the nipple located at either end of high pressure fuel tube (1)] and area (B) [approximately 5 threads long from the tip of the inner screw thread of flare nut (2)].
CAUTION:
Check for damage and adhesion of foreign matter.



b. Temporarily tighten flare nut (A) and (B) of high pressure fuel tube (3) until seated
CAUTION:
To tighten flare nut temporarily, insert by fitting the center of pipe.

(1) : High pressure fuel pump
(2) : Fuel rail



c. Tighten high pressure fuel tube bracket bolt (4) to the specified torque.

High pressure fuel tube bracket bolt : 25.0 N·m (2.6 kg-m, 18 ft-lb)

d. Tighten flare nuts in the order of (A) and then (B).
CAUTION:
Securely install the tool to flare nut before tightening.

Flare nut : 36.0 N·m (3.7 kg-m, 27 ft-lb)

e. Tighten mounting bolt.
f. Tighten flare nuts in the order of (A) and then (B) again.
8. Inspect and adjust valve clearance. Refer to EM-15, "Inspection and Adjustment".
9. Installation of the remaining components is in the reverse order of removal.

Inspection

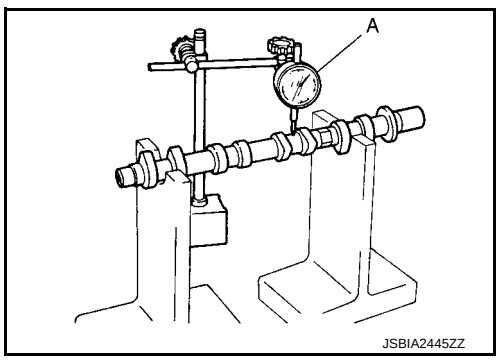
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INSPECTION AFTER REMOVAL

Camshaft Runout

1. Put V-block on a precise flat table, and support No. 2 and 5 journal of camshaft.
CAUTION:
Never support No. 1 journal (on the side of camshaft sprocket) because it has a different diameter from the other four locations.
2. Set suitable tool (A) vertically to No. 3 journal.
3. Turn camshaft to one direction with hands, and measure the camshaft runout on suitable tool. (Total indicator reading)

Standard and Limit : Refer to EM-142, "Camshaft".

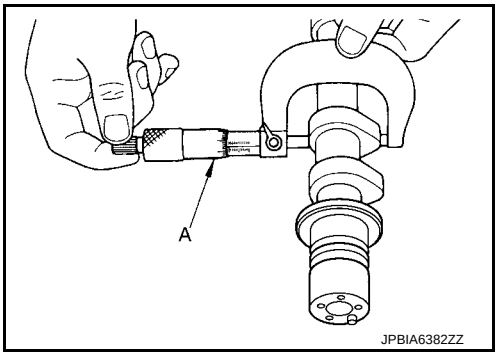


4. If it exceeds the limit, replace camshaft.

Camshaft Cam Height

1. Measure the camshaft cam height with a suitable tool (A).

Standard and Limit : Refer to EM-142, "Camshaft".



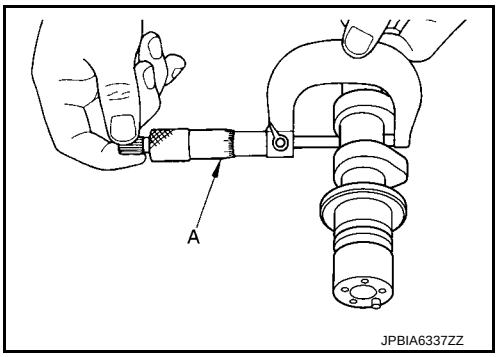
2. If it exceeds the limit, replace camshaft.

Camshaft Journal Oil Clearance

CAMSHAFT JOURNAL OUTER DIAMETER

Measure the outer diameter of camshaft journal with a suitable tool (A).

Standard : Refer to EM-142, "Camshaft".

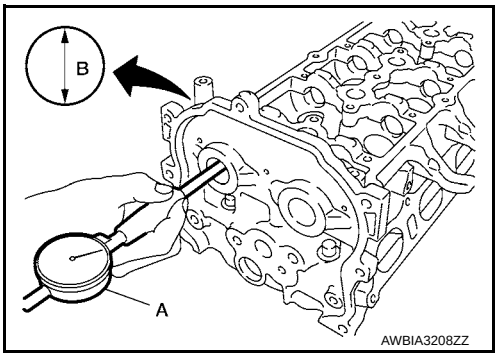


CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolts with specified torque. Refer to EM-77, "Removal and Installation".
- Measure the inner diameter of camshaft bracket with a suitable tool (A).

Standard : Refer to EM-142, "Camshaft".

(B) : Measuring direction of inner diameter



CAMSHAFT JOURNAL OIL CLEARANCE

- (Oil clearance) = (Camshaft bracket inner diameter) – (Camshaft journal diameter)

Standard and Limit : Refer to EM-142, "Camshaft".

- If it exceeds the limit, replace camshaft or cylinder head, or both.

NOTE:

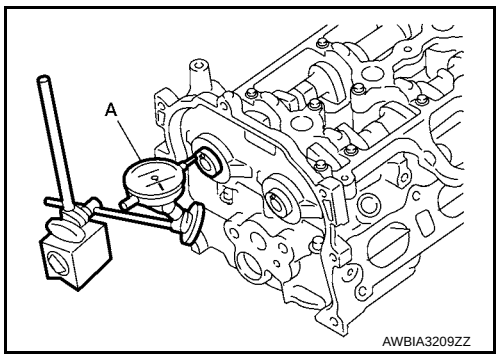
Camshaft bracket cannot be replaced as a single part, because it is machined together with cylinder head. Replace whole cylinder head assembly.

Camshaft End Play

1. Install camshaft in cylinder head. Refer to EM-77, "Removal and Installation".

2. Install suitable tool in thrust direction on front end of camshaft. Read the end play of suitable tool (A) when camshaft is moved forward/backward (in direction to axis).

Standard and Limit : Refer to EM-142, "Camshaft".



- Measure the following parts if out of the standard.

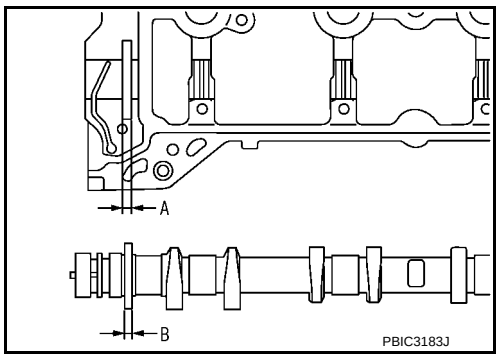
- Dimension (A) for groove of cylinder head No. 1 journal

Standard : 4.000 - 4.030 mm (0.1575 - 0.1587 in)

- Dimension (B) for camshaft flange

Standard : 3.877 - 3.925 mm (0.1526 - 0.1545 in)

- Refer to the standards above, and then replace camshaft and/or cylinder head.



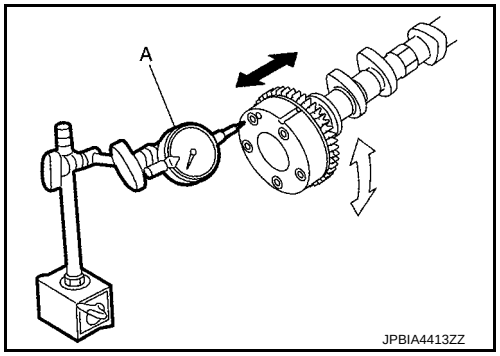
Camshaft Sprocket Runout

1. Put V-block on precise flat table, and support No. 2 and 5 journals of camshaft.
CAUTION:
Do not support No. 1 journal (on the side of camshaft sprocket) because it has a different diameter from the other four locations.

2. Measure the camshaft sprocket runout with a suitable tool (A). (Total indicator reading)

Limit : Refer to EM-142, "Camshaft".

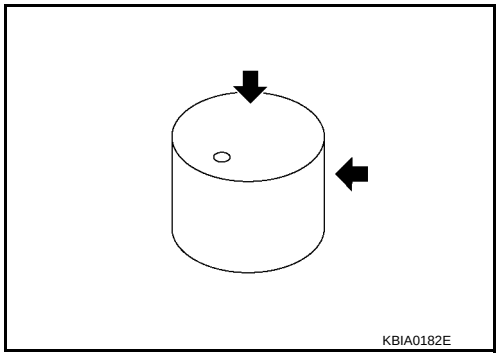
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

Check if surface of valve lifter has any wear or cracks.

- If anything above is found, replace valve lifter. Refer to EM-142, "Camshaft".

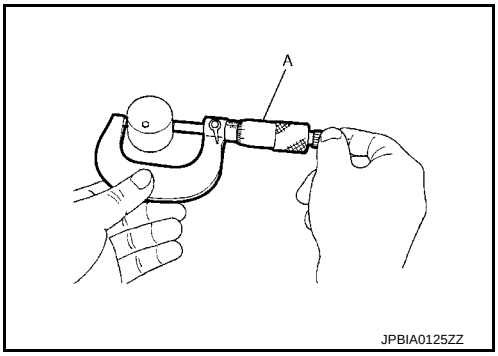


Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

- Measure the outer diameter of valve lifter with a suitable tool (A).

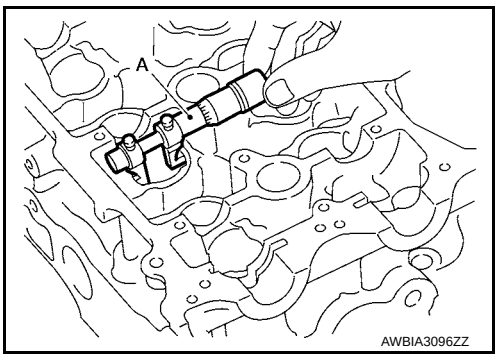
Standard : Refer to EM-142, "Camshaft".



VALVE LIFTER HOLE DIAMETER

Measure the inner diameter of valve lifter hole of cylinder head with a suitable tool (A).

Standard : Refer to EM-142, "Camshaft".



VALVE LIFTER CLEARANCE

- (Valve lifter clearance) = (Valve lifter hole diameter) – (Valve lifter outer diameter)

Standard : Refer to EM-142, "Camshaft".

- If out of the standard, referring to the each standard of valve lifter outer diameter and valve lifter hole diameter, replace either or both valve lifter and cylinder head.

INSPECTION AFTER INSTALLATION

Inspection of Camshaft Sprocket (INT), (EXH) Oil Groove

CAUTION:

- **Perform this inspection only when DTC P0011 or P0014 is detected in self-diagnostic results of CONSULT and it is directed according to inspection procedure of EC section. Refer to EC-200, "Diagnosis Procedure" (P0011) or EC-203, "Diagnosis Procedure" (P0014).**
- **Check when engine is cold so as to prevent burns by the splashing engine oil.**

1. Check engine oil level. Refer to LU-10, "Inspection".
2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.

a. Release the fuel pressure. Refer to EC-162, "Work Procedure".
b. Remove intake manifold. Refer to EM-32, "Removal and Installation".
c. Disconnect the harness connectors from the ignition coils and fuel injector.
d. Support the bottom surface of engine using a transmission jack, and then remove the engine mounting bracket (RH) and engine mounting insulator (RH). Refer to EM-106, "Removal and Installation".

3. Remove intake or exhaust valve timing control solenoid valve. Refer to EM-65, "Exploded View".
   - Lift the front side of the engine with a jack base to remove intake or exhaust valve timing control solenoid valve.
4. Clean the mounting area of intake or exhaust valve timing control solenoid valve, and then insert a clean waste with no oil adhesion into the oil hole of the cylinder head.
5. Install engine mounting insulator (RH) and engine mounting bracket (RH). (After the removal of intake or exhaust valve timing control solenoid valve and insertion of a waste into the oil hole.)
6. Perform cranking to check that engine oil comes out from the oil hole (mounting hole of intake or exhaust valve timing control solenoid valve) of cylinder head.
   - Regarding the engine oil check, judge it by the amount of oil adhered to the wasted inserted into the oil hole.

   WARNING:
   - **Do not insert fingers into the oil hole.**
   - **Do not touch rotating parts (crankshaft pulley, etc.).**

   CAUTION:

- **Do not perform cranking without installing the engine mounting insulator (RH) and engine mounting bracket (RH).**
- **Prevent splashing by using a shop cloth so as to prevent the worker from injury from engine oil and so as to prevent engine oil contamination.**
- **Prevent splashing by using a shop cloth so as to prevent engine oil from being splashed to engine and vehicle. Especially, be careful not to apply engine oil to rubber parts of engine mounting insulator, etc. Wipe engine oil off immediately if it is splashed.**

7. Perform the following inspection if engine oil does not come out from intake or exhaust valve timing control solenoid valve oil hole of the cylinder head.
   - Clean oil groove between oil strainer and intake valve timing control solenoid valve. Refer to LU-7, "Engine Lubrication System" and LU-8, "Engine Lubrication System Schematic".
8. Remove components between intake or exhaust valve timing control solenoid valve and camshaft sprocket (INT) or (EXH), and then check each oil groove for clogging.
   - Clean oil groove if necessary. Refer to LU-7, "Engine Lubrication System" and LU-8, "Engine Lubrication System Schematic".
9. After inspection, installation is in the reverse order removal.

INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates leakage, and exhaust gases leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-11, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.

- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".

- Run engine to check for unusual noise and vibration.

NOTE:
If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in guide may generate a pounding noise during and just after the engine start. However, this does not indicate an unusualness. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage	Level
Fuel		Leakage	Leakage	Leakage
Exhaust gases		—	Leakage	—

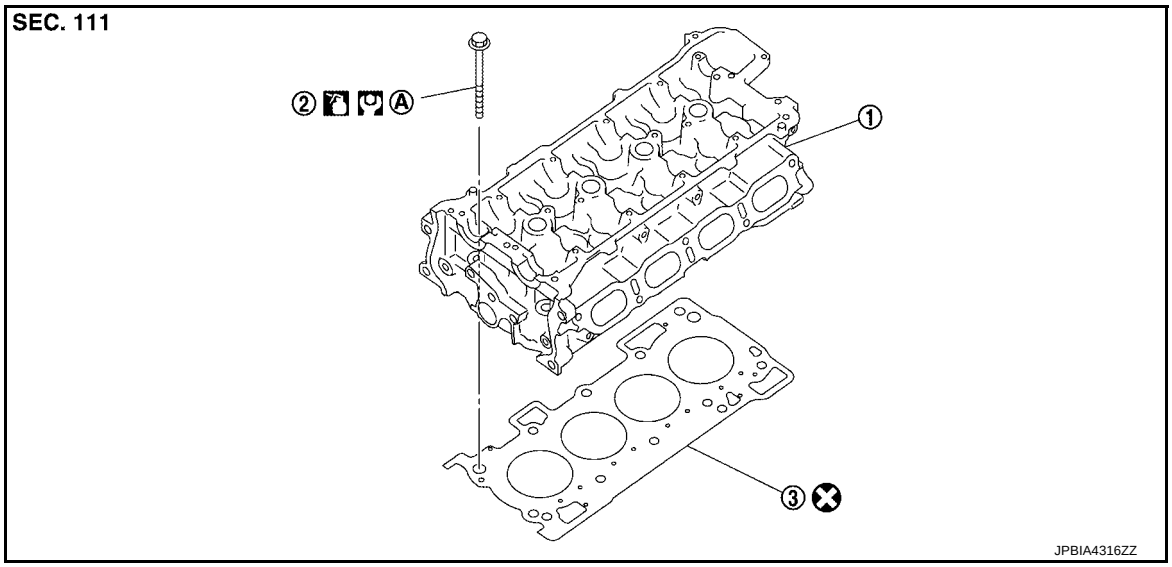
*: Power steering fluid, brake fluid, etc.

CYLINDER HEAD

Exploded View

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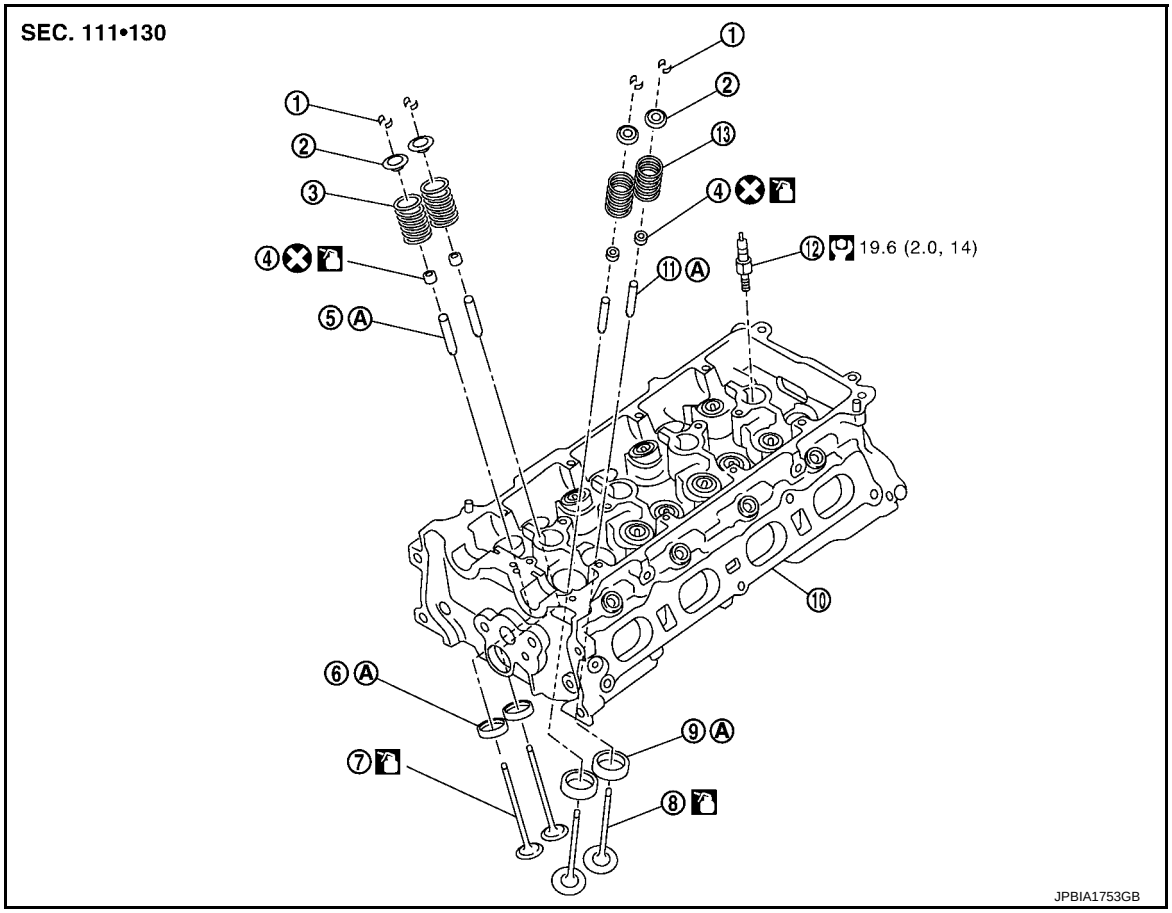
REMOVAL



1. Cylinder head assembly
2. Cylinder head bolt
3. Cylinder head gasket

A. Refer to INSTALLATION

DISASSEMBLY



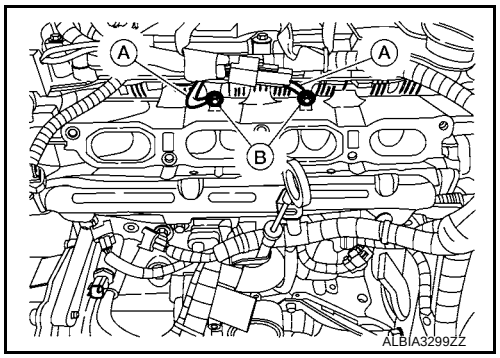
1. Valve collet
2. Valve spring retainer
3. Valve spring (EXH)
4. Valve oil seal
5. Valve guide (EXH)
6. Valve seat (EXH)
7. Valve (EXH)
8. Valve (INT)
9. Valve seat (INT)
10. Cylinder head
11. Valve guide (INT)
12. Spark plug
13. Valve spring (INT)
A. Refer to ASSEMBLY

Removal and Installation

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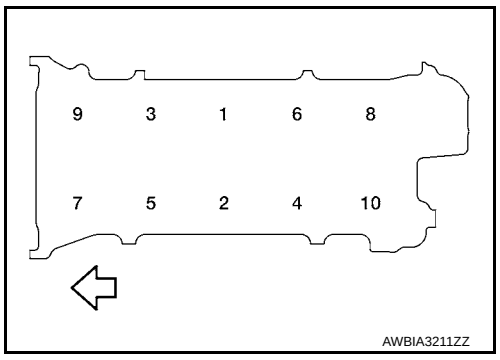
REMOVAL

1. Drain engine oil. Refer to LU-11, "Draining".
2. Remove the camshafts. Refer to EM-77, "Removal and Installation".
3. Remove the exhaust manifold. Refer to EM-37, "Exploded View".
4. Remove the fuel tube and fuel injectors. Refer to EM-54, "Removal and Installation".
5. Disconnect the harness connector from the engine coolant temperature sensor 1. Refer to CO-27, "Exploded View".
6. Remove the bolts (B) and disconnect the ground cables (A) the cylinder head.



7. Remove the water outlet (if necessary). Refer to CO-27, "Exploded View".
8. Loosen cylinder head bolts in reverse of the sequence shown and remove the cylinder head.

⇦ : Engine front



9. Remove cylinder head gasket.
CAUTION:
Do not reuse cylinder head gasket.

INSTALLATION

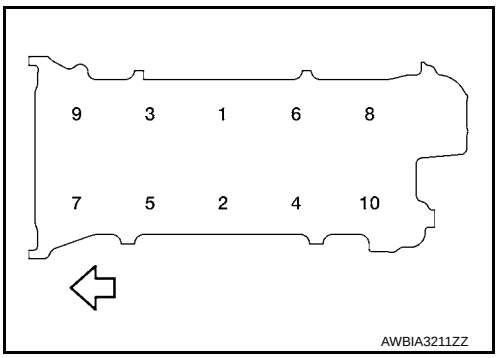
1. Install cylinder head gasket.
CAUTION:
Do not reuse cylinder head gasket.
2. Install cylinder head and tighten cylinder head bolts using the following procedure:
CAUTION:
If cylinder head bolts are reused, check their outer diameters before installation. Refer to EM-95, "Inspection".

a. Apply new engine oil to threads and seating surface of cylinder head bolts.

b. Tighten all cylinder head bolts to the specified torque in the sequence shown.

Cylinder head bolts : 40.0 N·m (4.1 kg-m, 30 ft-lb)

⇦ : Engine front

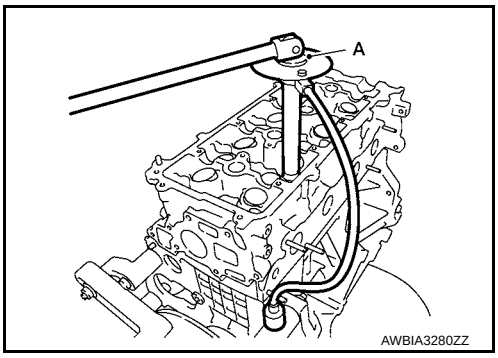


c. Tighten cylinder head bolts to the specified angle in the sequence shown.

CAUTION:
Check and confirm the tightening angle by using a Tool (A) or protractor. Do not judge by visual inspection without the Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 100°

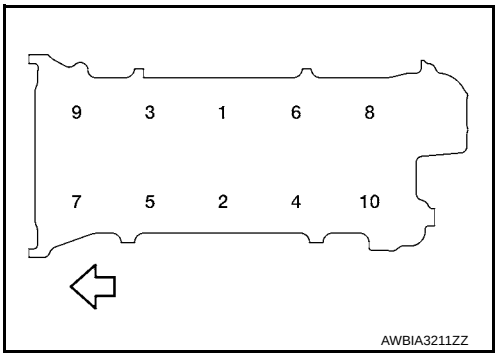


d. Completely loosen cylinder head bolts in reverse of the sequence shown.

CAUTION:
In this step, loosen cylinder head bolts in reverse of the sequence shown.

Cylinder head bolts : 0 N·m (0 kg-m, 0 ft-lb)

⇦ : Engine front



e. Tighten cylinder head bolts to the specified torque in the sequence shown.

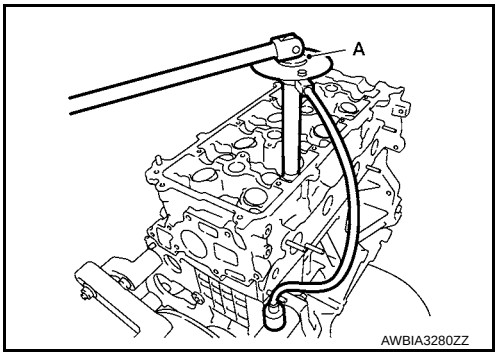
Cylinder head bolts : 40.0 N·m (4.1 kg-m, 30 ft-lb)

f. Tighten cylinder head bolts to the specified angle in the sequence shown.

CAUTION:
Check and confirm the tightening angle by using a Tool (A) or protractor. Do not judge by visual inspection without the Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 100°



g. Tighten cylinder head bolts to the specified angle in the sequence shown.

CAUTION:
Check and confirm the tightening angle by using a Tool or protractor. Do not judge by visual inspection without the Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 100°

3. Installation of the remaining components is in the reverse order of removal.

Disassembly and Assembly

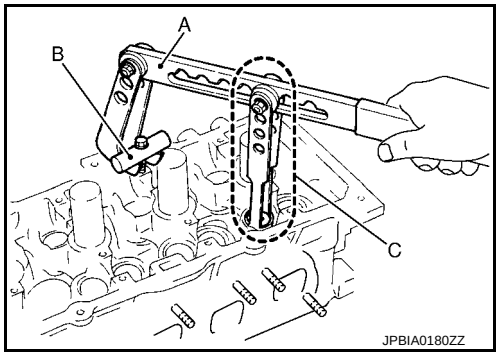
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DISASSEMBLY

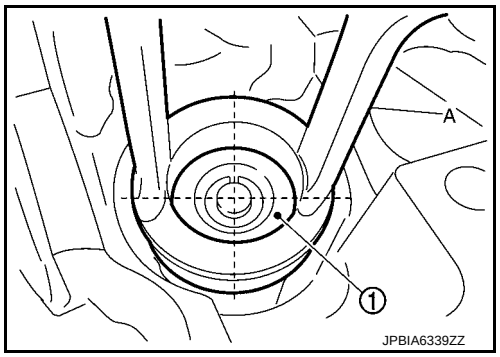
1. Remove spark plug with Tool.

Tool number : — (J-48891)

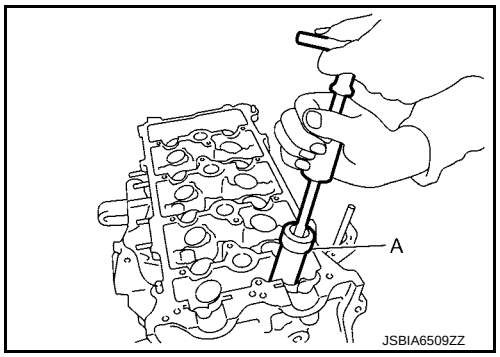
2. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.
3. Compress the valve spring with suitable tool (A/B/C) and remove the valve collet with a suitable magnetic tool.



CAUTION:
- **Be careful not to damage valve lifter holes.**
- **The center of the suitable tool (A) and valve spring retainer (1) must be aligned.**



4. Remove valve spring retainer and valve spring (with valve spring seat).
   CAUTION:
   Do not remove valve spring seat from valve spring.
5. Push valve into combustion chamber side and remove valve.
   - Identify installation positions, and store them without mixing them up.
6. Remove valve oil seal with suitable tool (A).



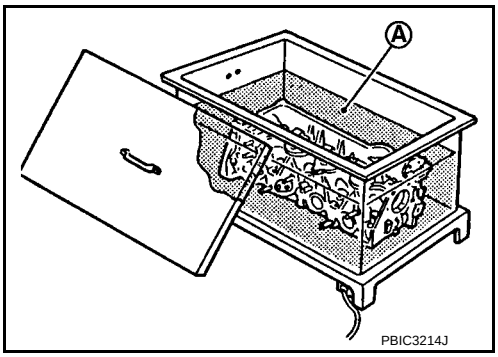
7. When valve seat must be replaced.

- Bore out old valve seat until it collapses. Boring should not continue beyond the bottom face of the valve seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to EM-144, "Cylinder Head".

CAUTION:
Never bore excessively to prevent cylinder head from scratching.

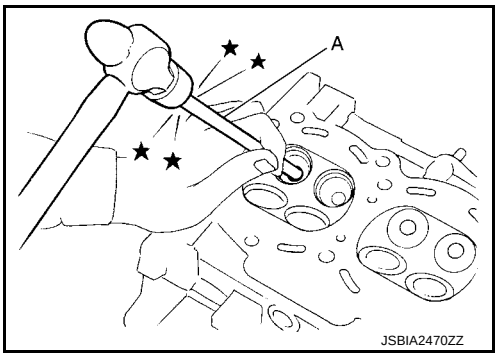
8. When valve guide must be replaced.

a. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



b. Drive out valve guide with a hammer and suitable tool (A).

CAUTION:
Cylinder head contains heat, wear protective equipment to avoid getting burned.



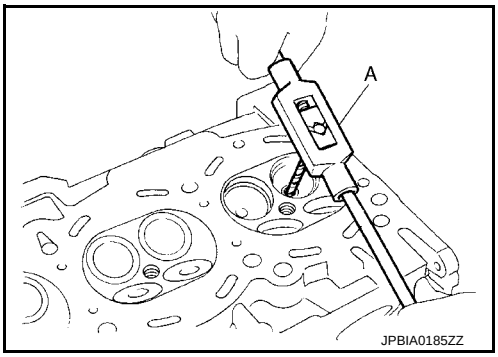
ASSEMBLY

1. When valve guide is removed, install it.

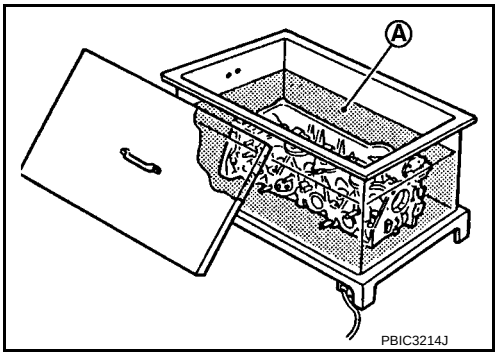
CAUTION:
Replace with oversize [0.2 mm (0.008 in)] valve guide.

a. Ream cylinder head valve guide hole with a suitable tool (A).

For service parts: Oversize [0.2 mm (0.008 in)]
Refer to EM-144, "Cylinder Head".



b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).

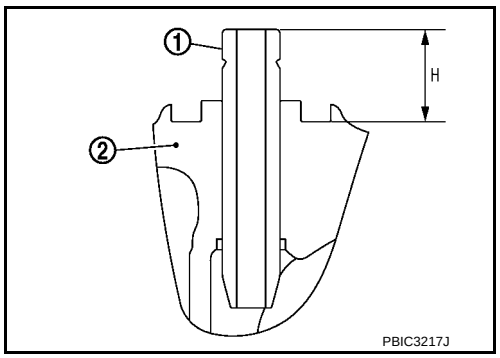


c. Press valve guide (1) from camshaft side to dimensions as shown.

CAUTION:
Cylinder head contains heat, wear protective equipment to avoid getting burned.

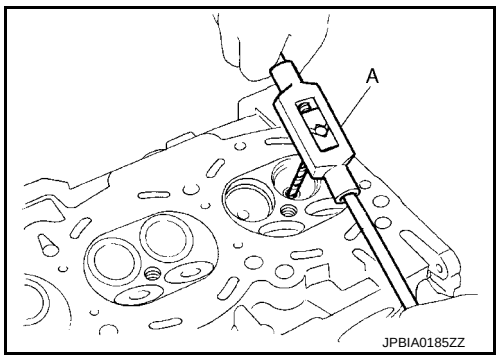
Projection (H) : Refer to EM-144, "Cylinder Head".

(2) : Cylinder head



d. Apply reamer finish to valve guide with a suitable tool (A).

Standard : Refer to EM-144, "Cylinder Head".



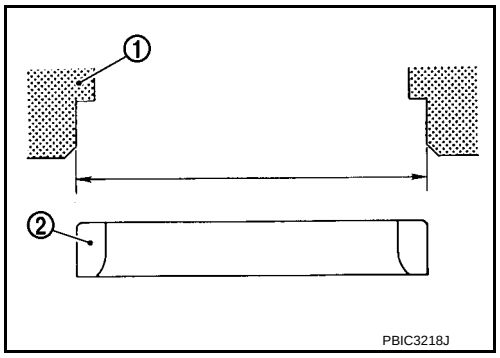
2. When valve seat is removed, install it.

CAUTION:
Replace with oversize [0.5 mm (0.020 in)] valve seat.

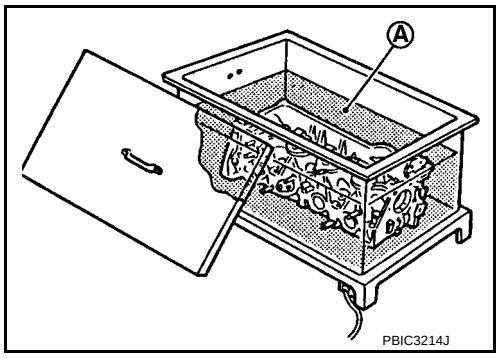
a. Ream cylinder head (1) recess diameter for service valve seat (2).

For service parts: Oversize [0.5 mm (0.020 in)]
Refer to EM-144, "Cylinder Head".

- Be sure to ream in circles concentric to the valve guide center. This will enable valve seat to fit correctly.



b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



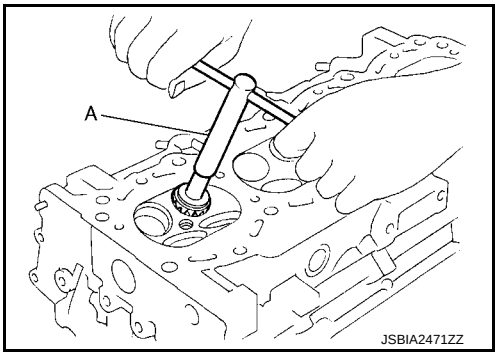
c. Provide valve seats cooled well with dry ice. Press-fit valve seat into cylinder head.

CAUTION:
- **Never touch cold valve seats directly.**
- **Cylinder head contains heat, wear protective equipment to avoid getting burned.**

d. Using suitable tool (A), finish valve seat to the specified dimensions. For dimensions, refer to EM-144, "Cylinder Head".

CAUTION:

When using suitable tool, firmly grip the suitable tool handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on with the cutter or cutting many different times may result in stage valve seat.



e. Using compound, grind to adjust valve fitting.

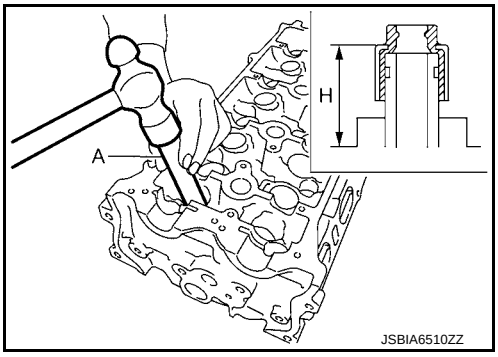
f. Check again for normal contact. Refer to EM-95, "Inspection".

3. Install valve oil seal using suitable tool (A) to the specified height (H).

NOTE:

Dimension is height that measured before installing valve spring (with valve spring seat).

Height (H) : 15.1 - 15.7 mm (0.594 - 0.618 in)



4. Install valve.
   - Install larger diameter to intake side.

5. Install valve spring (with valve spring seat).
   - Install smaller pitch (valve spring seat side) to cylinder head side (B).

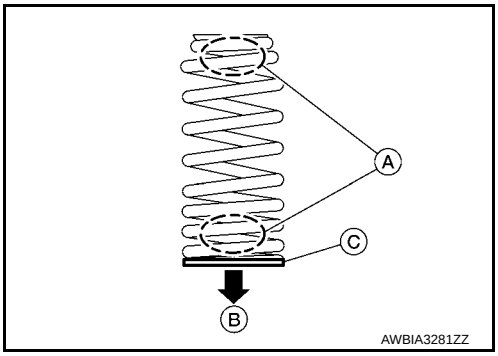
CAUTION:

Do not remove valve spring seat (C) from valve spring.

   - Confirm identification color (A) of valve spring.

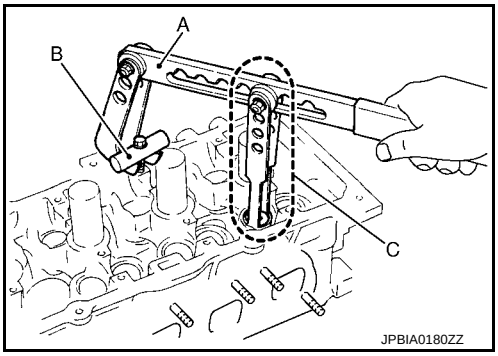
Intake : Yellow

Exhaust : None



6. Install valve spring retainer.

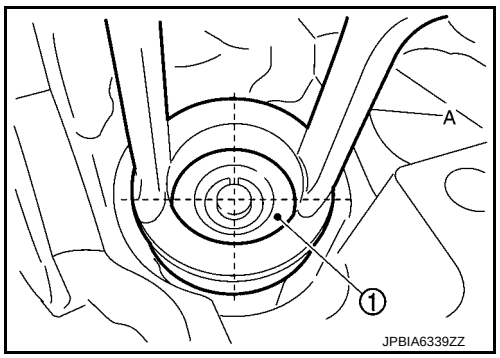
7. Install valve collet.
   - Compress the valve spring with suitable tool (A/B/C) and install the valve collet with a suitable magnetic tool.



CAUTION:

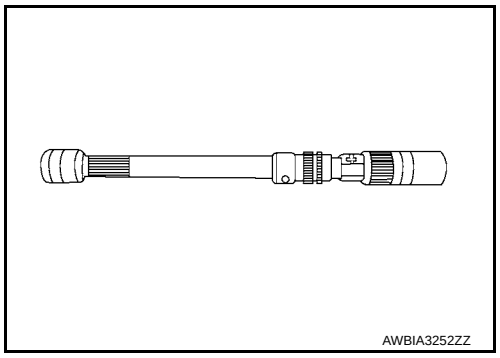
- **Be careful not to damage valve lifter holes.**

- **The center of the suitable tool (A) and valve spring retainer (1) must be aligned.**
- Tap valve stem edge lightly with a plastic hammer after installation to check its installed condition.



8. Install valve lifter.
   - Install it in the original position.
9. Install spark plug with Tool.

Tool number : — (J-48891)



Inspection

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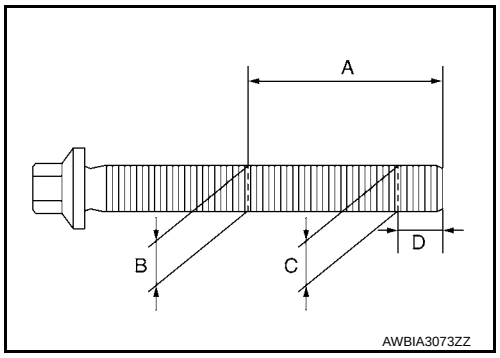
INSPECTION AFTER REMOVAL

Cylinder Head Bolts Outer Diameter

- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between (C) and (B) exceeds the limit, replace them with a new one.

Limit [(C) – (B)] : 0.15 mm (0.0059 in)
Dimension (A) : 45 mm (1.7717 in)
Dimension (D) : 11 mm (0.4331 in)

- If reduction of outer diameter appears in a position other than (B), use it as (B) point.

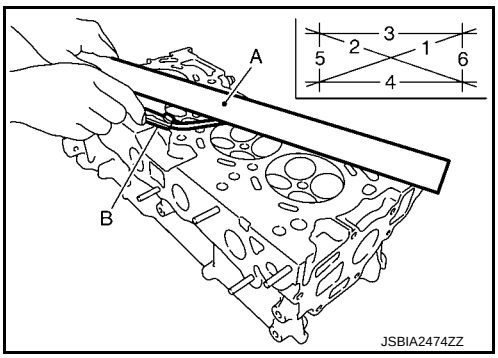


Cylinder Head Distortion

NOTE:
When performing this inspection, cylinder block distortion should be also checked. Refer to EM-125, "Inspection".

1. Wipe off engine oil and remove water scale (like deposit), gasket, sealant, carbon, etc. with a suitable tool.
   CAUTION:
   Never allow gasket debris to enter passages for engine oil or water.

2. At each of several locations on bottom surface of cylinder head, measure the distortion in six directions using suitable tool (A) and suitable tool (B).



Limit **: Refer to EM-144, "Cylinder Head".**

- If it exceeds the limit, replace cylinder head.

INSPECTION AFTER DISASSEMBLY

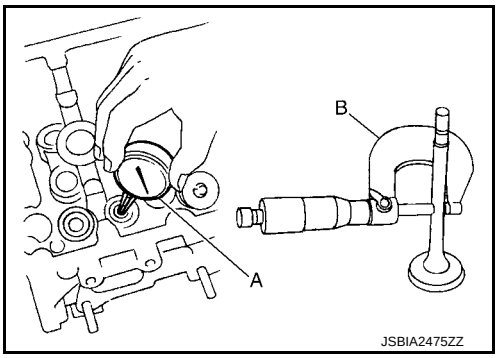
VALVE DIMENSIONS

- Check the dimensions of each valve. For the dimensions, refer to EM-144, "Cylinder Head".
- If dimensions are out of the standard, replace valve and check valve seat contact. Refer to "VALVE SEAT CONTACT".

VALVE GUIDE CLEARANCE

Valve Stem Diameter

- Measure the diameter of valve stem with a suitable tool (B).



Standard **: Refer to EM-144, "Cylinder Head".**

Valve Guide Inner Diameter

- Measure the inner diameter of valve guide with a suitable tool (A).

Standard **: Refer to EM-144, "Cylinder Head".**

Valve Guide Clearance

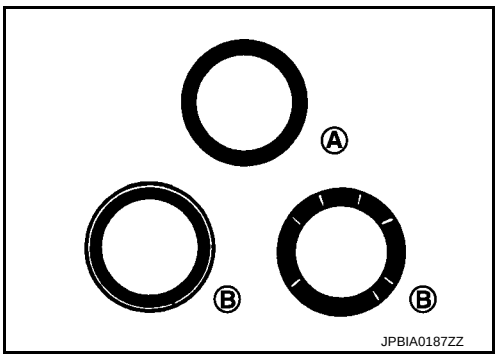
- (Valve guide clearance) = (Valve guide inner diameter) – (Valve stem diameter)

Standard and Limit **: Refer to EM-144, "Cylinder Head".**

- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced. Refer to EM-91, "Disassembly and Assembly".

VALVE SEAT CONTACT

- After confirming that the dimensions of valve guides and valves are within the specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.



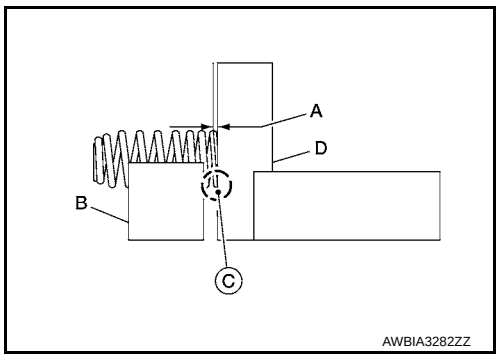
(A) : OK

- If not, grind to adjust valve fitting and check again. If the contacting surface still has “NG” conditions (B) even after the recheck, replace valve seat. Refer to EM-91, "Disassembly and Assembly".

VALVE SPRING SQUARENESS

- Set a suitable tool (D) along the side of valve spring and rotate spring. Measure the maximum clearance (A) between the top of spring and suitable tool.

(B) : Suitable tool
(C) : Contact area



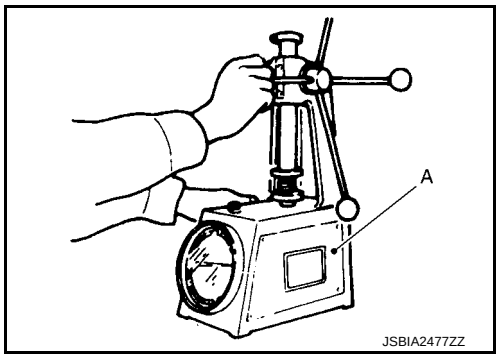
Limit : **Refer to EM-144, "Cylinder Head".**

- If it exceeds the limit, replace valve spring.

VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring pressure (A) with valve spring seat installed at the specified spring height.

CAUTION:
Do not remove valve spring seat from valve spring.
NOTE:
Before measuring valve spring pressure, compress each spring to specified solid height for intake and exhaust valve springs.



Valve spring (EXH) : **28.40 mm (1.1181 in)**
Valve spring (INT) : **26.77 mm (1.0539 in)**

Standard : **Refer to EM-144, "Cylinder Head".**

- If the installation load or load with valve open is out of the standard, replace valve spring (with valve spring seat).

INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates leakage, and exhaust gases leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-11, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".

- Run engine to check for unusual noise and vibration.

NOTE:
If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in guide may generate a pounding noise during and just after the engine start. However, this does not indicate an unusualness. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage

Other oils and fluids*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*: Power steering fluid, brake fluid, etc.

OIL SEAL

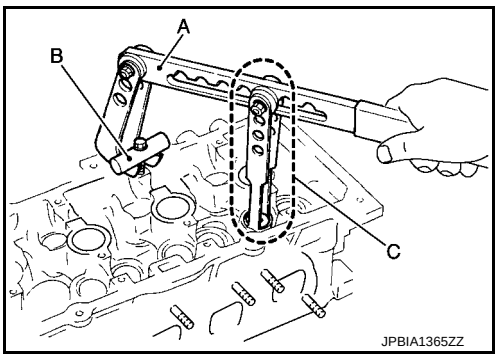
VALVE OIL SEAL

VALVE OIL SEAL : Removal and Installation

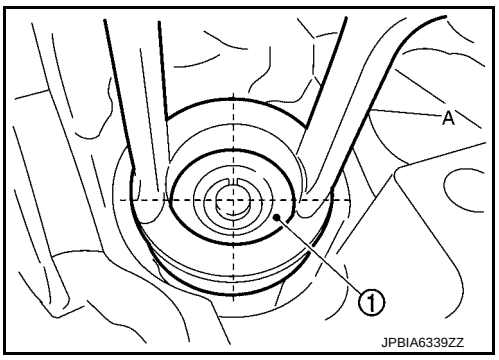
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REMOVAL

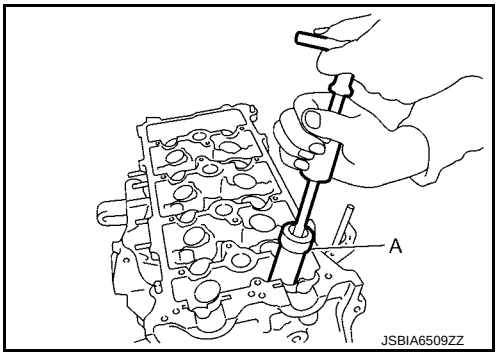
1. Remove camshafts. Refer to EM-77, "Removal and Installation".
2. Remove valve lifters. Refer to EM-77, "Exploded View".
3. Rotate crankshaft and set piston whose valve oil seal is to be removed to TDC. This will prevent valve from dropping into cylinder.
   CAUTION:
   When rotating crankshaft, be careful to avoid scarring front cover with timing chain.
4. Compress the valve spring with suitable tool (A/B/C) and remove the valve collet with a suitable magnetic tool.



CAUTION:
- **Do not damage valve lifter holes.**
- **The center of suitable tool (A) and valve spring retainer (1) must be aligned.**



5. Remove valve spring retainer and valve spring (with valve spring seat).
   CAUTION:
   Do not remove valve spring seat from valve spring.
6. Remove valve oil seal with suitable tool (A).

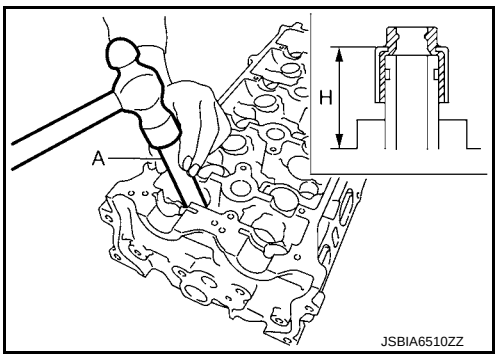


INSTALLATION

1. Apply new engine oil to valve oil seal joint surface and seal lip.

2. Press in valve oil seal using suitable tool (A) to the specified height (H).

Height (H) : 15.1 - 15.7 mm (0.594 - 0.618 in)



3. Installation of the remaining components is in the reverse order of removal.

FRONT OIL SEAL

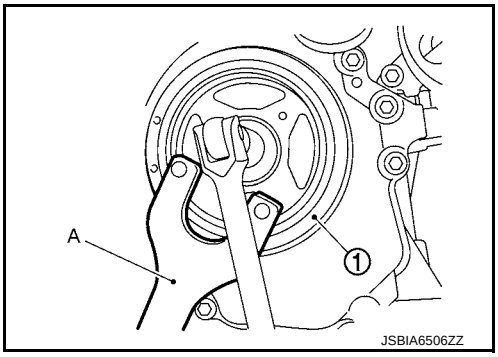
FRONT OIL SEAL : Removal and Installation

INFOID:0000000014727346

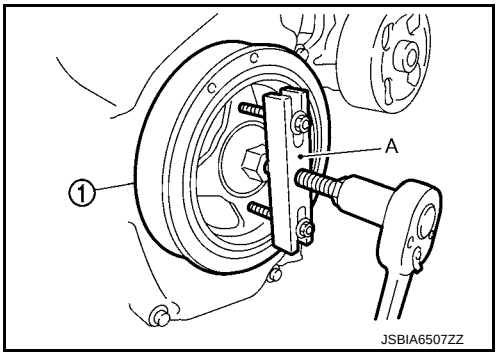
REMOVAL

1. Remove the front fender protector (RH). Refer to EXT-40, "FENDER PROTECTOR : Removal and Installation".
2. Remove crankshaft pulley using the following procedure:

a. Secure crankshaft pulley (1) with a suitable tool (A) and loosen crankshaft pulley bolt.
CAUTION:
Do not remove the crankshaft pulley bolt as it is used as a supporting point for a suitable puller.



b. Attach a suitable puller (A) in the threaded hole on crankshaft pulley (1) and remove crankshaft pulley.



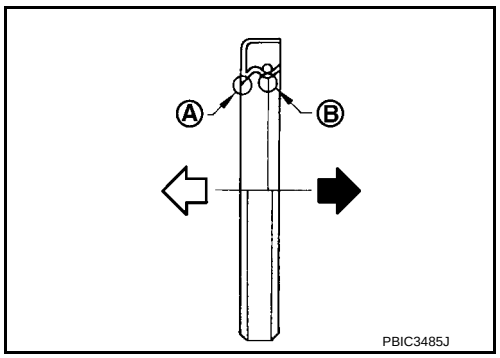
3. Remove front oil seal with a suitable tool.
CAUTION:
- **Do not damage front cover and crankshaft.**
- **Do not reuse front oil seal.**

INSTALLATION

1. Apply new engine oil to new front oil seal joint surface and seal lip.

2. Install front oil seal so that each seal lip is oriented as shown.

(A) : Dust seal lip
(B) : Oil seal lip
⇦ : Engine outside
⬅ : Engine inside



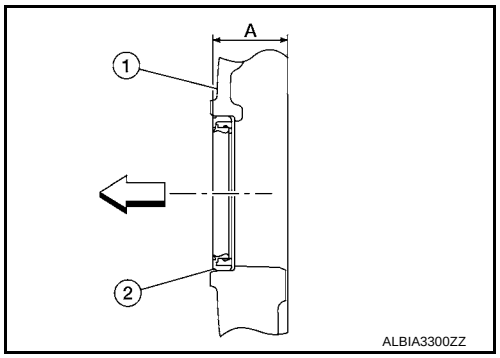
- Press-fit front oil seal using a suitable drift with outer diameter 57 mm (2.24 in) and inner diameter 45 mm (1.77 in).

CAUTION:
- **Do not damage front cover or crankshaft.**
- **Press-fit front oil seal straight to avoid causing burrs or tilting.**

NOTE:
Front oil seal (2) should be installed to the specified depth (A).

Dimension (A) : 27.5 - 28.3 mm (1.0827 - 1.1142 in)

(1) : Front cover
⇦ : Engine front



3. Install crankshaft pulley using the following procedure:

a. When inserting crankshaft pulley with a suitable tool, tap on its center portion (not circumference).

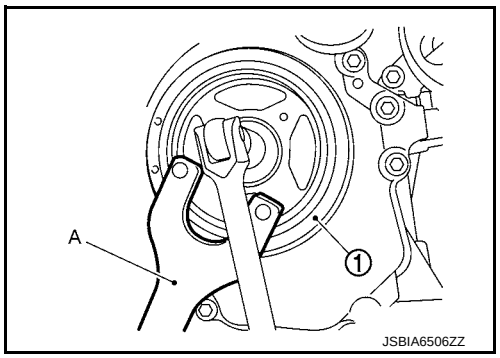
CAUTION:
Do not damage front oil seal lip portion.

b. Secure crankshaft pulley (1) with a suitable tool (A).

c. Apply new engine oil to thread and seat surfaces of crankshaft pulley bolt.

d. Tighten crankshaft pulley bolt to the specified torque.

Crankshaft pulley bolt : 29.4 N·m (3.0 kg-m, 22 ft-lb)

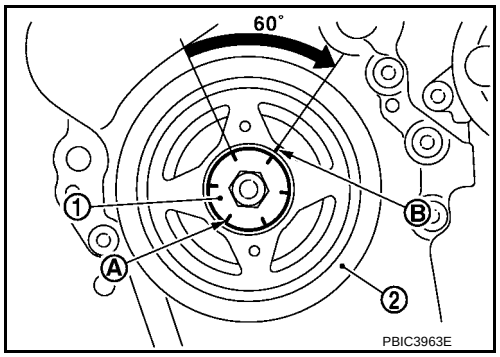


e. Put a paint mark (B) on crankshaft pulley (2), matching with any one of six easy to recognize angle marks (A) on crankshaft pulley bolt (1) flange.

f. Tighten crankshaft pulley bolt to the specified angle using Tool.
- Check the tightening angle with movement of one angle mark.

CAUTION:
Check and confirm the tightening angle using Tool. Avoid judgement by visual inspection without Tool.

Tool number : KV10112100 (BT-8653-A)



Tightening angle : 60°

g. Check that crankshaft rotates clockwise smoothly.

4. Installation of the remaining components is in the reverse order of removal.

REAR OIL SEAL

REAR OIL SEAL : Removal and Installation

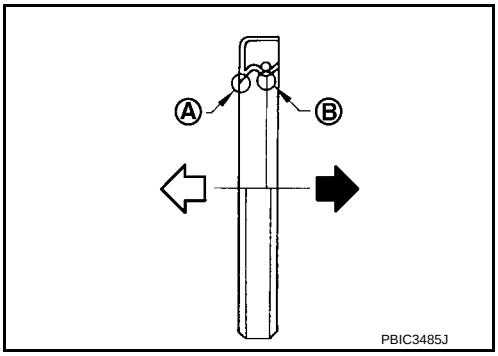
INFOID:0000000014727347

REMOVAL

1. Remove torsion damper. Refer to EM-103, "Removal and Installation".
2. Remove rear oil seal with a suitable tool.
   CAUTION:
   - **Do not damage crankshaft or cylinder block.**
   - **Do not reuse rear oil seal.**

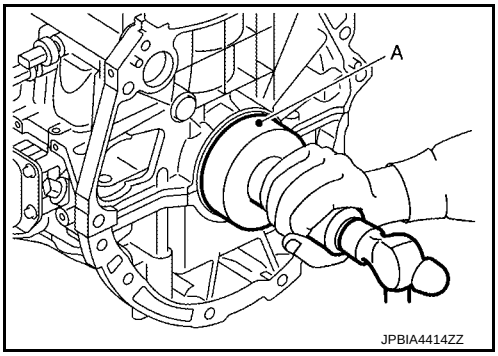
INSTALLATION

1. Install rear oil seal so that each seal lip is oriented as shown.



(A) : Dust seal lip
(B) : Oil seal lip
⇦ : Engine outside
⬅ : Engine inside

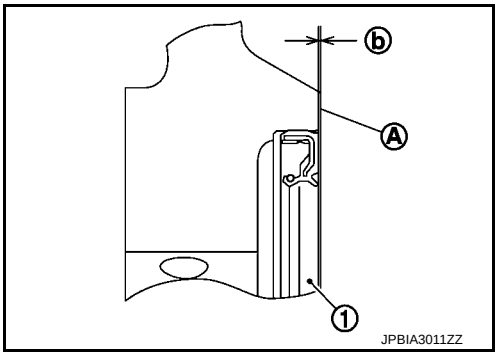
- Press-fit rear oil seal with a suitable drift (A) outer diameter 115 mm (4.53 in) and inner diameter 90 mm (3.54 in).
  CAUTION:
  - **Do not damage crankshaft or cylinder block.**
  - **Press-fit rear oil seal straight to avoid causing burrs or tilting.**
  - **Do not touch grease applied onto oil seal lip.**



- Press in rear oil seal (1) to the position as shown.

Dimension (b) : 0.0 - 0.05 mm (0.000 in - 0.020 in)

(A) : Rear end surface of cylinder block

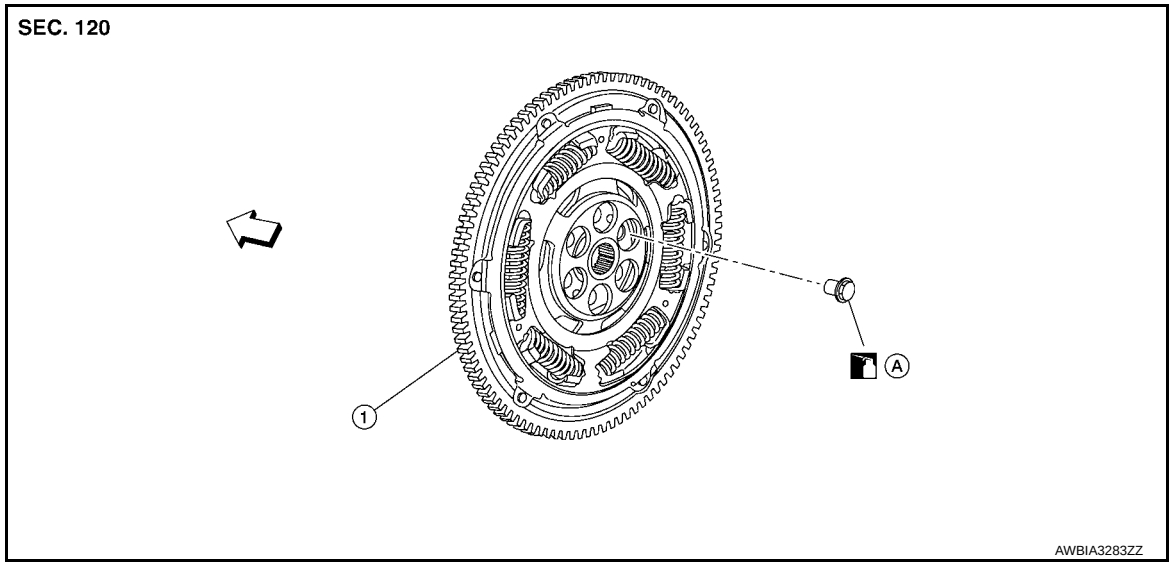


2. Installation of the remaining components is in the reverse order of removal.

TORSION DAMPER

Exploded View

INFOID:0000000014727336



1. Torsion damper
A. Refer to INSTALLATION
⇦ : Crankshaft side

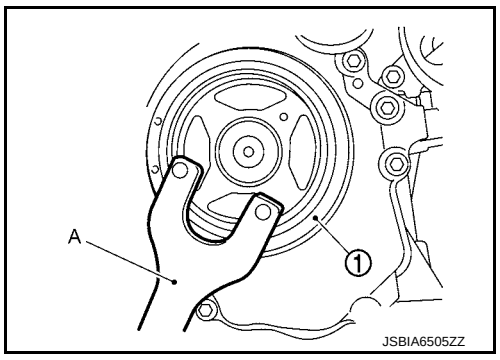
Removal and Installation

INFOID:0000000014727337

REMOVAL

1. Remove the engine and the transaxle assembly from the vehicle, and separate the transaxle from the engine. Refer to EM-106, "Removal and Installation".
2. Remove the torsion damper using the following procedure:

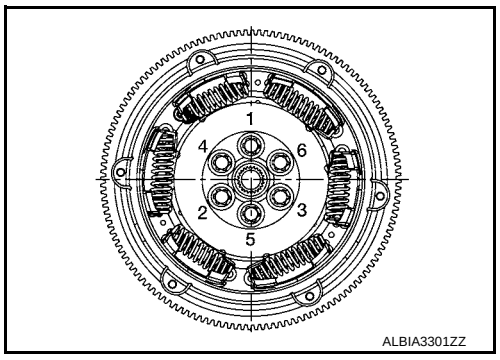
a. Secure crankshaft pulley (1) with a suitable tool (A).



b. Loosen torsion damper bolts in reverse of the sequence shown and remove torsion damper.

CAUTION:

- **Do not disassemble torsion damper.**
- **Do not place torsion damper with signal plate facing down.**
- **When handling signal plate, take care not to damage or scratch torsion damper.**
- **Handle signal plate in a manner that prevents them from becoming magnetized.**

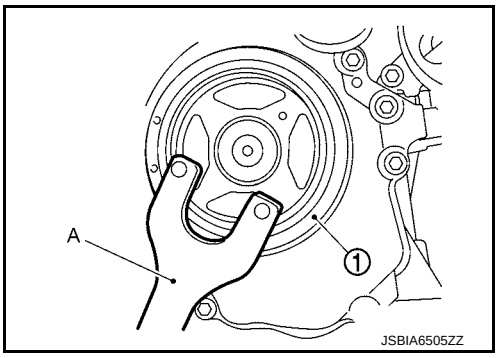


INSTALLATION

1. Install torsion damper using the following procedure:

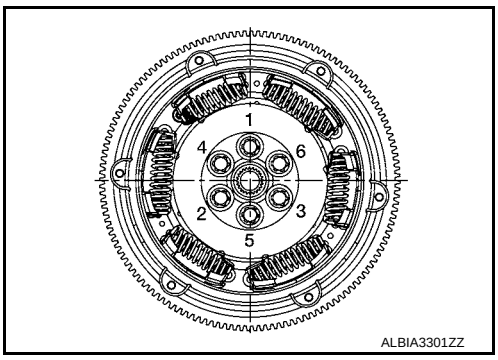
a. Install torsion damper and hand tighten bolts.

b. Secure crankshaft pulley (1) with a suitable tool (A).



c. Tighten torsion damper bolts to the specified torque in the sequence shown.

Torsion damper bolts : 108.0 Nm (11 kg-m, 80 ft-lb)



d. Installation of the remaining components is in the reverse order of removal.

Inspection

INFOID:0000000014727338

DRIVE PLATE DEFLECTION

Appearance of ring gear

Check for dents and scratches. If they exist, replace torsion damper.

Appearance of torsion damper

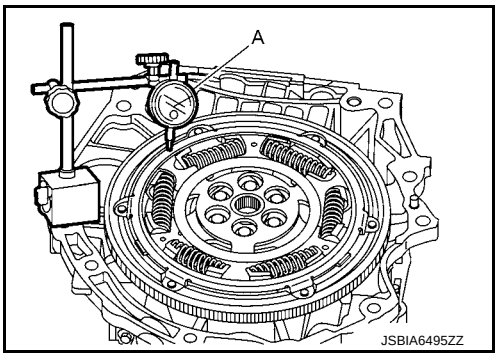
Check for dents and scratches. If they exist, replace torsion damper.

Torsion damper lateral run-out

- Install torsion damper to crank shaft and measure lateral run-out with suitable tool (A).
- Measuring range is within ϕ280 mm (11.02 in) from the center.

Standard : 0.50 mm (0.02 in) or less. (Measure it under horizontal conditions.)

- If the measurement value is outside the reference value, replace torsion damper.

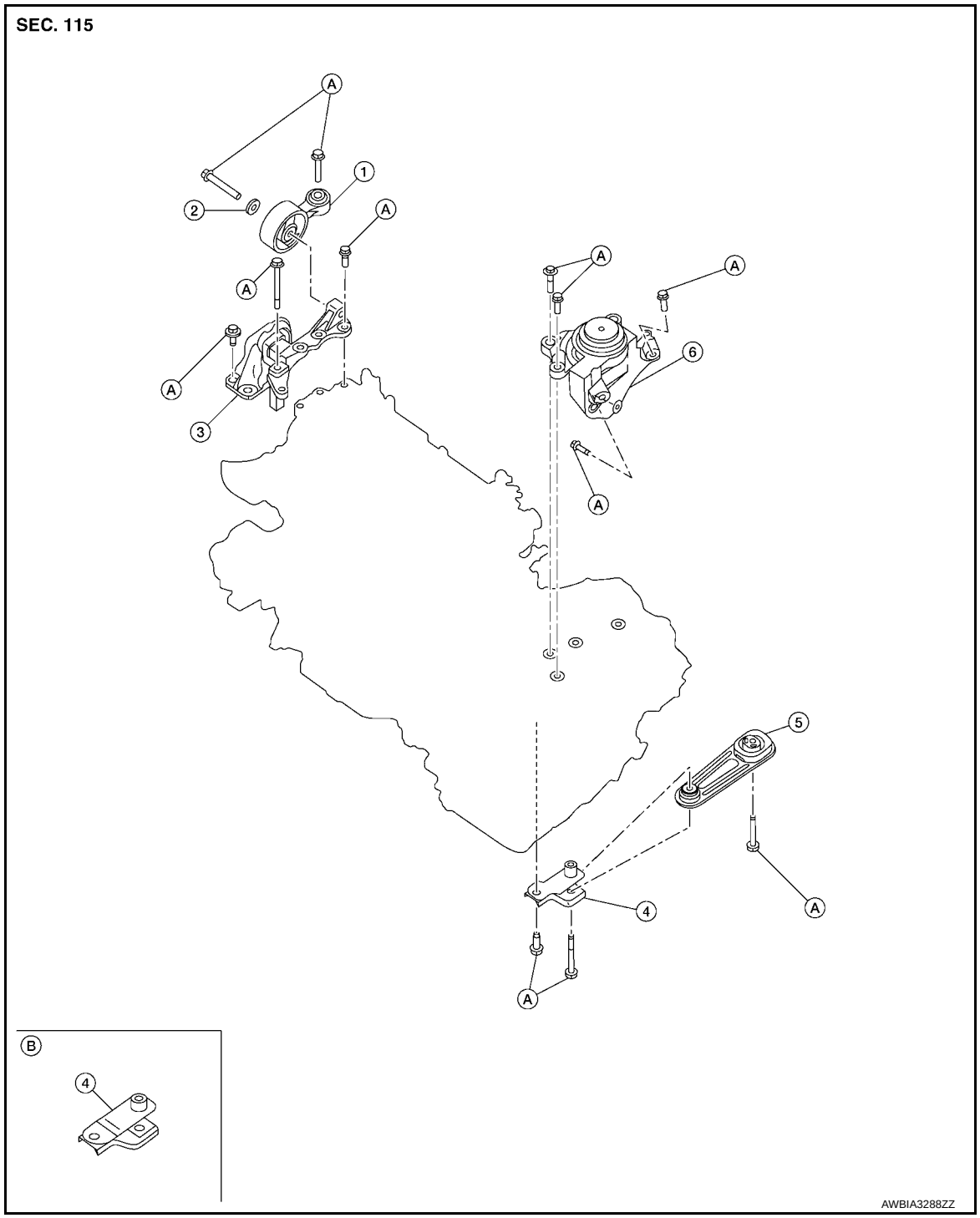


UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Exploded View

INFOID:0000000014727332



1. Torque rod (RH)
2. Washer
3. Engine mounting insulator (RH)
4. Rear torque rod bracket
5. Rear torque rod
6. Engine mounting insulator (LH)

A. Refer to INSTALLATION
B. 4WD models

Removal and Installation

INFOID:0000000014727333

DANGER:

Since hybrid vehicles and electric vehicles contain a high voltage battery, there is the risk of electric shock, electric leakage, or similar accidents if the high voltage component and vehicle are handled incorrectly. Be sure to follow the correct work procedures when performing inspection and maintenance.

WARNING:

- **Be sure to remove the service plug in order to disconnect the high voltage circuits before performing inspection or maintenance of high voltage system harnesses and parts.**
- **The removed service plug must always be carried in a pocket of the responsible worker or placed in the tool box during the procedure to prevent the plug from being connected by mistake.**
- **Be sure to wear insulating protective equipment before beginning work on the high voltage system.**
- **Do not allow workers other than the responsible person to touch the vehicle containing high voltage parts. To keep others from touching the high voltage parts, these parts must be covered with an insulating sheet except when using them.**
- **Refer to EM-3, "High Voltage Precautions".**
- **Situate the vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Attach proper slingers and bolts described in PARTS CATALOG if engine slingers are not equipped.**

CAUTION:

- **Do not bring the vehicle into the READY status with the service plug removed unless otherwise instructed in the Service Manual. A malfunction may occur if this is not observed.**
- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and coolant are cool enough.**
- **If items or work required are not covered by the engine section, refer to the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with a transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-39, "Garage Jack and Safety Stand and 2-Pole Lift".**

NOTE:

When removing components such as hoses, tubes/lines, etc., cap or plug openings to prevent fluid from spilling.

REMOVAL

1. Release the fuel pressure. Refer to EC-162, "Work Procedure".
2. Disconnect the high voltage circuit.

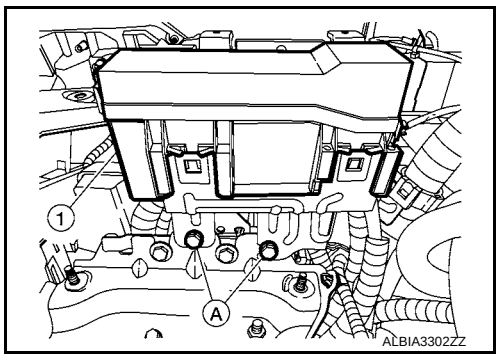
   WARNING:

   - **Disconnect high voltage circuit. Refer to GI-29, "How to Disconnect High Voltage".**
   - **Check voltage in high voltage circuit. Refer to GI-31, "Check Voltage in High Voltage Circuit".**
3. Disconnect the battery or batteries. Refer to PG-128, "Battery Disconnect".
4. Drain the engine coolant from radiator. Refer to CO-10, "Draining".

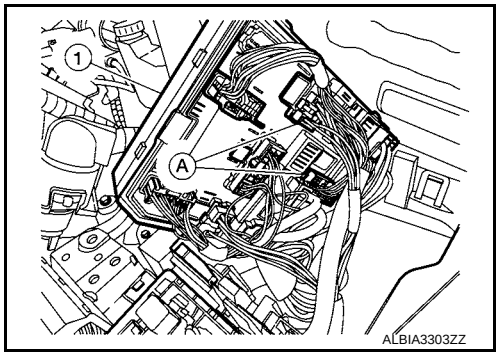
   CAUTION:

   Perform this step when the engine is cold.
5. Remove the traction motor inverter. Refer to TMS-132, "Removal and Installation".
6. Remove the air duct 1, air duct 2, air cleaner assembly and air duct and resonator assembly. Refer to EM-29, "Exploded View".
7. Disconnect the EVAP hose from the EVAP canister purge volume control solenoid valve. Refer to EM-32, "Exploded View".

8. Remove the bolts (A) and reposition the relay box (1).

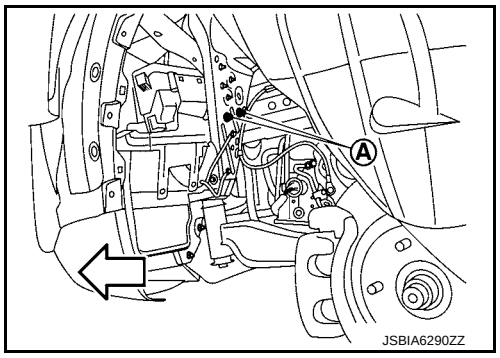


9. Remove the traction motor inverter bracket. Refer to TMS-132, "Exploded View".
10. Remove the ECM, TCM and TCM bracket as an assembly. Refer to EC-595, "Removal and Installation".
11. Remove the IPDM E/R cover and disconnect the harness connectors (A) from the IPDM E/R (1).

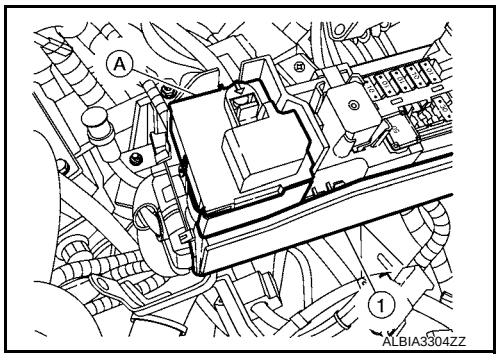


12. Remove IPDM E/R harness cover B and reposition harness. Refer to PCS-46, "Exploded View".
13. Remove the fender protector (RH/LH). Refer to EXT-40, "FENDER PROTECTOR : Removal and Installation".
14. Remove fuse block (junction box) bracket nuts (A) and ground cable bolts and feed fuse block (junction box) through opening between strut housing and front side member into engine bay.

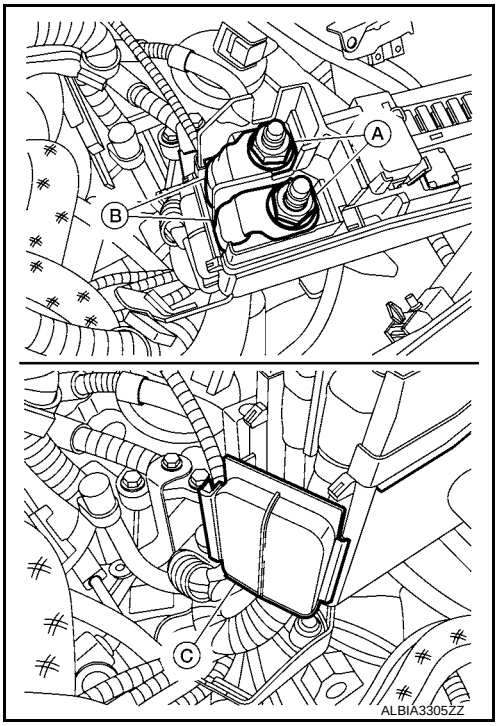
⇦ : Vehicle front



15. Remove the cover from the relay box 1 (1) and remove cover (A).

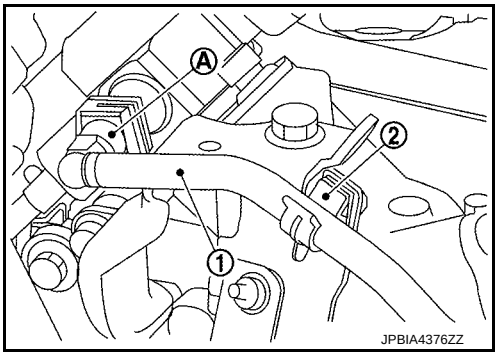


16. Remove nuts (A) and cover (C) and remove harness connectors (B) from relay box 1.



17. Reposition engine harness.
18. Disconnect water hose from fuel pump connector protector and remove fuel pump connector protector and high pressure fuel pump insulator. Refer to EM-49, "Exploded View".
19. Disconnect quick connector (A) using the following procedure:

a. Disconnect fuel feed hose (1) from hose clamp (2).

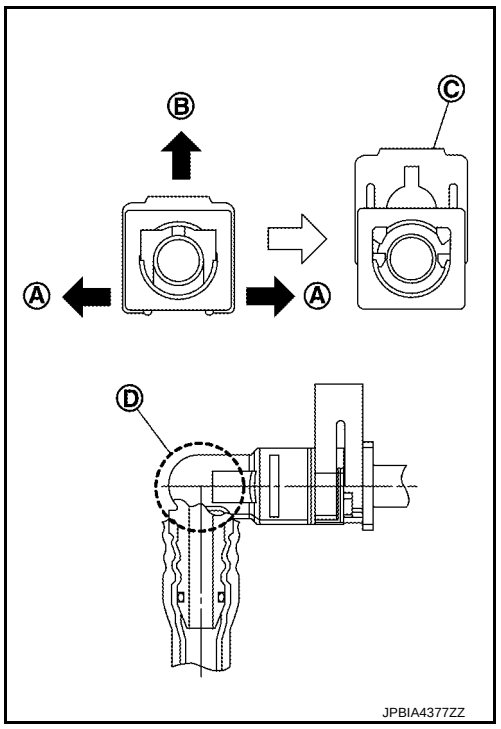


b. Disengage (A) and pull up (B) the pawl of the fuel feed hose connector retainer (C) to disconnect the fuel feed hose from high pressure fuel pump.

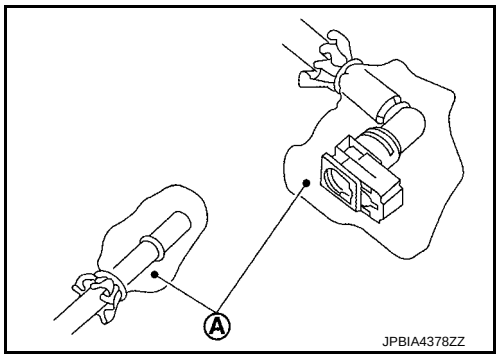
NOTE:
If the fuel feed hose is stuck, hold the fuel feed hose by hand and disconnect it by pushing and pulling.

CAUTION:
- **Keep parts away from heat source. Especially, be careful when welding is performed around them.**
- **Do not expose parts to battery electrolyte or other acids.**
- **Do not bend or twist connection between quick connector and fuel feed hose during installation/removal.**
- **Pull quick connector while holding at location (D).**
- **Do not remove the retainer.**
- **Prepare a tray beforehand to catch fuel that leaks out.**
- **Do not pull with lateral force applied. O-ring inside quick connector may be damaged.**

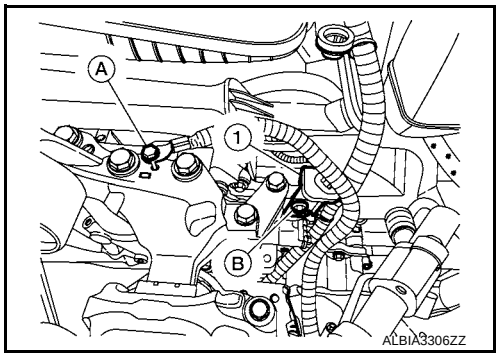
Retainer color : Red



- **To prevent damage to each joint and protect it from the entry of foreign matter, cover the joint with plastic bag (A) or an equivalent.**

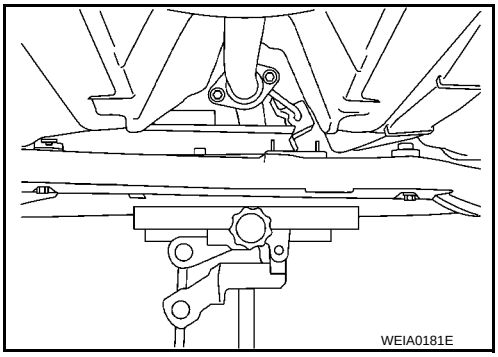


20. Disconnect the radiator hose (upper) and radiator hose (lower) from the engine assembly. Refer to CO-15, "Exploded View".
21. Disconnect the control cable from the transmission assembly. Refer to TM-210, "Removal and Installation".
22. Disconnect the heater hoses from the water outlet. Refer to CO-27, "Exploded View".
23. Remove bolts (A/B) and reposition ground cable and bracket (1).

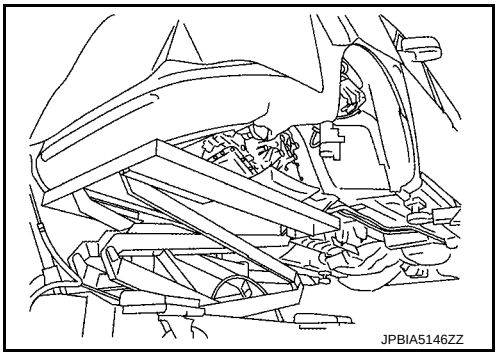


24. Disconnect water hose 5 and water hose 4 from the reservoir tank and remove the reservoir tank. Refer to HCO-12, "Exploded View".
25. Disconnect the harness connectors from the cooling fan control module 1, cooling fan control module 2 and electric water pump assembly sub-harness.
26. Disconnect CVT water hose A from the CVT oil warmer. Refer to TM-230, "Exploded View".

27. Remove the drive shaft assembly (RH/LH). Refer to FAX-19, "Removal and Installation (LH)" and FAX-22, "Removal and Installation (RH)" (FOR 2WD) or FAX-56, "Removal and Installation (LH)" and FAX-59, "Removal and Installation (RH)" (FOR 4WD).
28. Remove the front exhaust tube. Refer to EX-7, "Exploded View".
29. Remove the rear propeller shaft. Refer to DLN-106, "Removal and Installation" (FOR 4WD).
30. Remove the rear torque rod and rear torque rod bracket.
31. Remove the bolts for the electric water pump assembly and reposition. Refer to HCO-18, "Exploded View".
32. Set suitable jack under front suspension member.
33. Remove bolts and remove front suspension member stay from vehicle. Refer to FSU-21, "Exploded View".
34. Remove bolts and nuts from front suspension member.
35. Gradually lower jack to remove front suspension member from vehicle.
    CAUTION:
    Secure front suspension member to suitable jack while removing it.

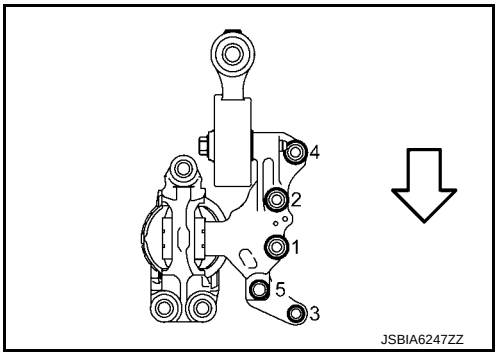


36. Discharge the refrigerant. Refer to HA-26, "Recycle Refrigerant".
37. Disconnect the low pressure flexible hose and high pressure flexible hose from the electric compressor. Refer to HA-37, "Exploded View".
38. Remove the pinch bolt and separate the steering column joint from the steering gear pinion shaft. Refer to ST-29, "Exploded View".
39. Disconnect the ground cable from the transaxle assembly.
40. Use a suitable tool to securely support bottom of the engine and the transaxle assembly.
    CAUTION:
    Put a piece of wood or something similar under the supporting surface to secure a completely stable condition.



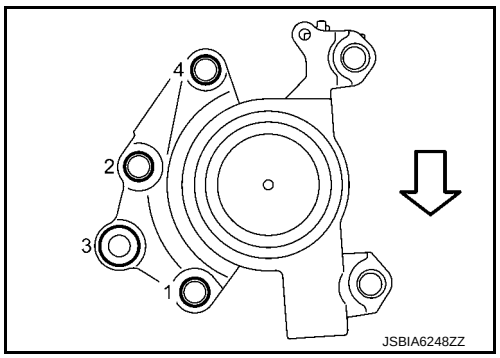
41. Remove engine mounting insulator (RH) bolts in reverse of the sequence shown.

⇦ : Vehicle front



42. Remove engine mounting insulator (LH) bolts in reverse of the sequence shown.

⇦ : Vehicle front

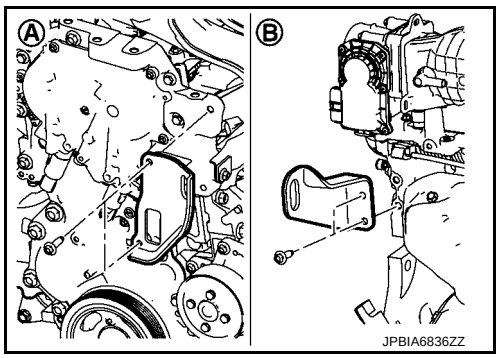


43. Carefully lower suitable jack or raise lift to remove the engine and the transaxle assembly.
CAUTION:
- **Check that no part interferes with the vehicle side.**
- **Before and during this lifting, always check if any harnesses are left connected.**
- **During the removal, always be careful to prevent the vehicle from falling off the lift due to changes in the center of gravity.**
- **If necessary, support the vehicle by setting jack or suitable tool at the rear.**

44. Separate the engine and transmission assembly using the following procedure (if necessary):

a. Install engine slinger to front cover front left side (A) and cylinder head rear right side (B).

Slinger bolts : 32.9 N·m (3.4 kg-m, 24 ft-lb)



b. Remove starter motor. Refer to STR-23, "Exploded View".

c. Lift with a hoist and separate the engine from the transaxle assembly. Refer to TM-244, "Removal and Installation".

INSTALLATION

Installation is in the reverse order of removal.

CAUTION:
- **Do not allow engine oil to get on engine mounting insulator. Be careful not to damage engine mounting insulator.**
- **Check that each engine mounting insulator is seated properly, and tighten nuts and bolts.**

1. Install engine mounting insulator and engine assembly using the following procedure:

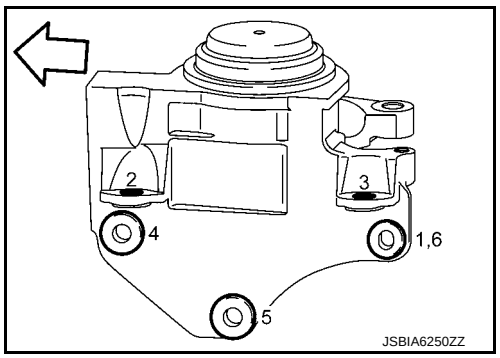
a. Hand tighten the engine mounting insulator (RH) to the body.

b. Hand tighten engine mounting insulator (LH) bolt No. 1.

⇦ : Vehicle front

c. Tighten the engine mounting insulator (LH) bolts to the specified torque in the sequence shown.

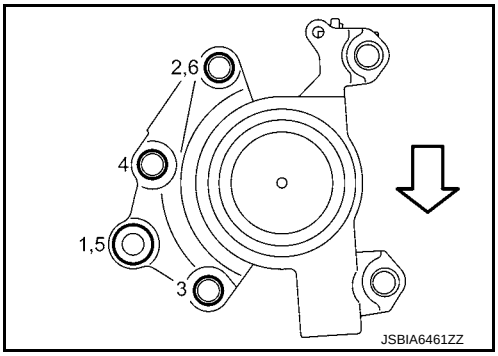
Engine mounting insulator (LH) bolts : 80 N·m (8.2 kg-m, 59 ft-lb)



d. Carefully lift engine and transaxle assembly into the position using a suitable tool.

e. Hand tighten engine mounting insulator (LH) bolts, No. 1 and 2 as shown.

⇦ : Vehicle front

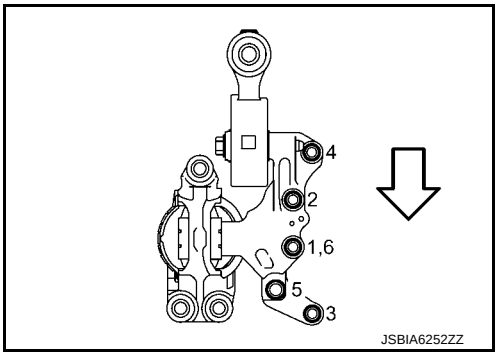


f. Tighten engine mounting insulator (LH) bolts to the specified torque in the sequence shown.

Engine mounting insulator (LH) bolts : 50 N·m (5.1 kg-m, 37 ft-lb)

g. Hand tighten engine mounting insulator (RH) bolt No. 1 as shown.

⇦ : Vehicle front



h. Tighten engine mounting insulator (RH) bolts No. 2 through 6 to the specified torque in the sequence shown.

Engine mounting insulator (RH) bolts : 55 N·m (5.6 kg-m, 41 ft-lb)

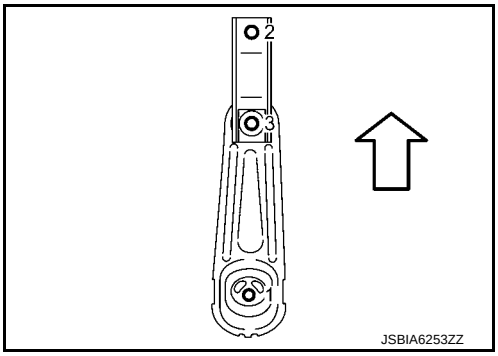
i. Carefully remove suitable tool supporting engine and transaxle assembly.
CAUTION:
Check that each engine mounting insulator has no abnormal twists.

j. Tighten the engine mounting insulator (RH) bolts to the specified torque.

Engine mounting insulator (RH) bolts : 65 N·m (6.6 kg-m, 48 ft-lb)

k. Hand tighten rear torque rod and rear torque rod bracket bolts in the sequence shown.
CAUTION:
Check that rear torque rod has no abnormal twists.

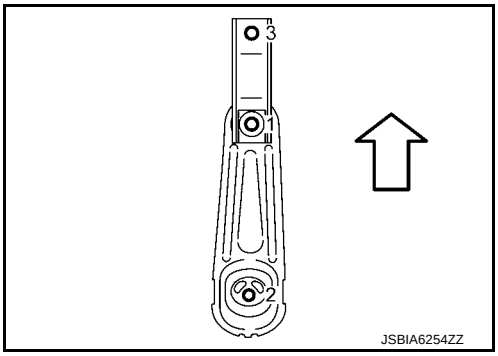
⇦ : Vehicle front



l. Tighten the rear torque rod and rear torque rod bracket bolts to the specified torque in the sequence shown.

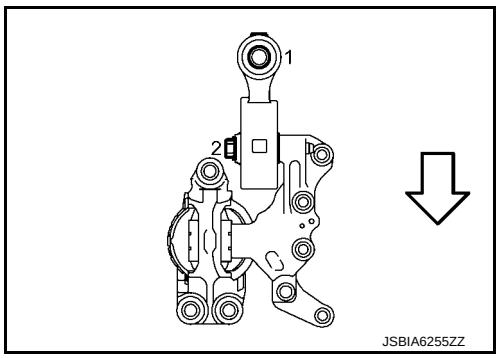
Rear torque rod and rear torque rod bracket bolts : 125 N·m (13 kg-m, 92 ft-lb)

⇦ : Vehicle front



m. Hand tighten the torque rod (RH) in the sequence shown.

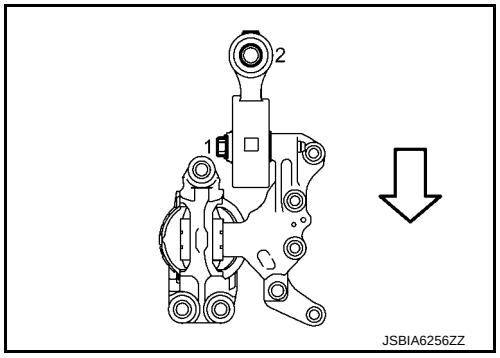
⇦ : Vehicle front



n. Tighten the torque rod (RH) bolts to the specified torque in the sequence shown.

Bolt 1 : 85 N·m (8.7 kg-m, 63 ft-lb)
Bolt 2 : 120 N·m (12 kg-m, 89 ft-lb)

⇦ : Vehicle front



Inspection

INFOID:0000000014727334

INSPECTION AFTER INSTALLATION

- Check wheel alignment. Refer to FSU-7, "Inspection".
- Adjust the neutral position of the steering angle sensor. Refer to BRC-77, "Description".

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates leakage, and exhaust gases leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-11, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.

- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-115, "Work Procedure (Inspection Mode 5)".

- Run engine to check for unusual noise and vibration.

NOTE:
If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in guide may generate a pounding noise during and just after the engine start. However, this does not indicate an unusualness. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage	Level

Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

*: Power steering fluid, brake fluid, etc.

UNIT DISASSEMBLY AND ASSEMBLY

ENGINE STAND SETTING

Setting

INFOID:0000000014727335

NOTE:
Explained here is how to disassemble with engine stand supporting transaxle surface. Some steps may be different if using a different type of engine stand.

1. Remove the engine and the transaxle assembly from the vehicle, and separate the transaxle from the engine. Refer to EM-106, "Removal and Installation".
2. Install engine to engine stand using the following procedure:

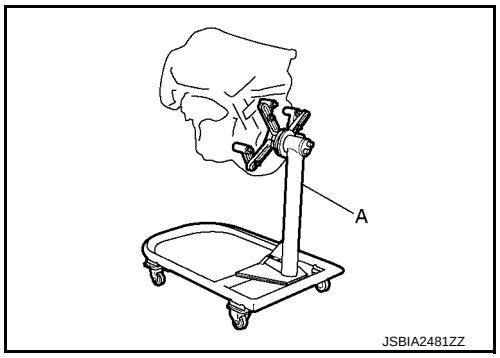
a. Remove torsion damper. Refer to EM-103, "Removal and Installation".

b. Lift the engine with a hoist to install it onto widely use engine stand.

CAUTION:
- **Use the engine stand that has a load capacity [approximately 135 kg (298 lb) or more] large enough for supporting the engine weight.**
- If the load capacity of stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning stand.
- Intake manifold: Refer to EM-32, "Removal and Installation".
- Exhaust manifold: Refer to EM-37, "Removal and Installation".

NOTE:
Shown is an example of widely used engine stand (A) that can support mating surface of transaxle with the torsion damper removed.

CAUTION:
Before removing the hanging chains, check the engine stand is stable and there is no risk of overturning.



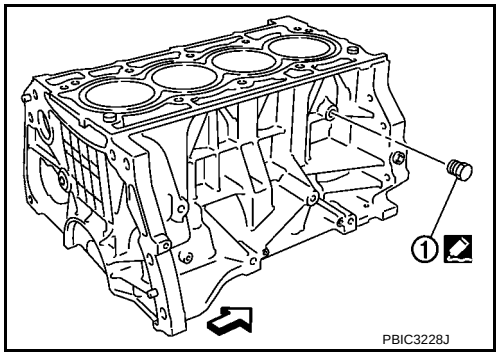
3. Drain engine oil. Refer to LU-11, "Draining".

CAUTION:
Be sure to clean drain plug and install with new drain plug washer.

4. Drain engine coolant from cylinder block by removing water drain plug (1) from the side of the engine.
Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

Tightening torque : Refer to EM-117, "Disassembly and Assembly".

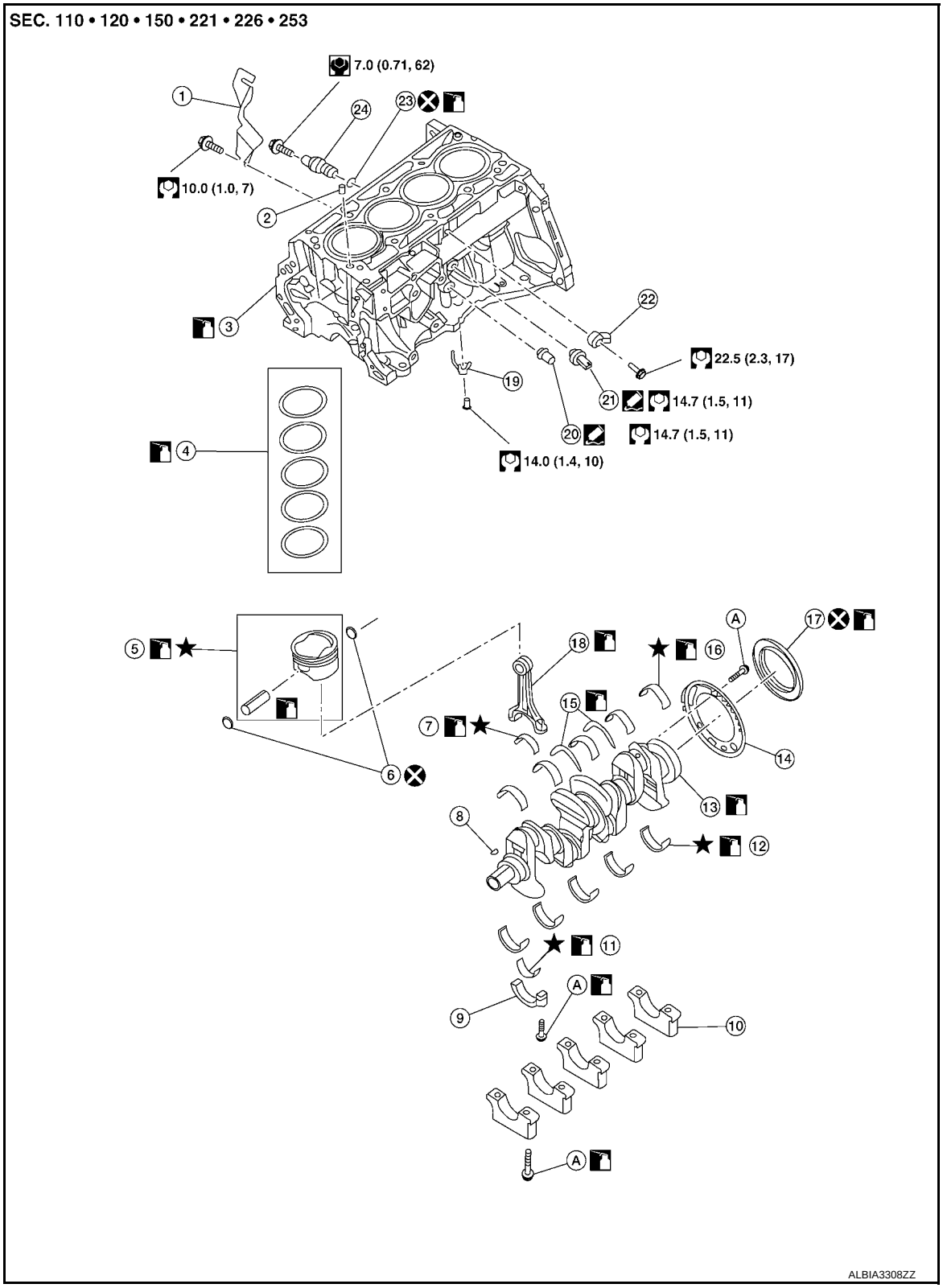
⇦ : Engine front



CYLINDER BLOCK

Exploded View

INFOID:0000000014727355



1. Crankshaft position sensor cover
2. Dowel pin
3. Cylinder block
4. Piston rings
5. Piston
6. Snap ring
7. Connecting rod bearing (upper)
8. Crankshaft key
9. Connecting rod cap

10. Main bearing cap	11. Connecting rod bearing (lower)	12. Main bearing (lower)
13. Crankshaft	14. Signal plate	15. Thrust bearing
16. Main bearing (upper)	17. Rear oil seal	18. Connecting rod
19. Oil jet	20. Engine oil temperature sensor	21. Engine oil pressure sensor
22. Knock sensor	23. O-ring	24. Crankshaft position sensor
A. Refer to INSTALLATION	★ : Select with proper thickness.	

CAUTION:
- **Main bearing cap cannot be replaced individually, it is machined with the cylinder block and must be serviced as an assembly.**
- **Connecting rod cap cannot be replaced individually, it is machined with the connecting rod and must be serviced as an assembly.**
- **Main bearing (upper) and main bearing (lower) are serviced together.**
- **Connecting rod bearing (upper) and connecting rod bearing (lower) are serviced together.**

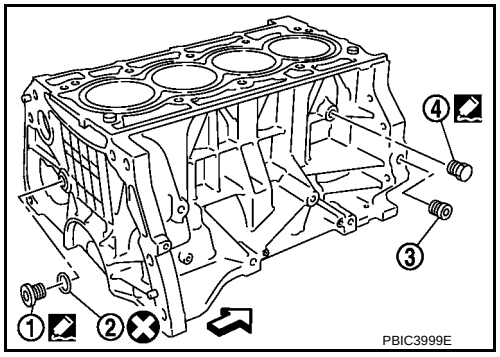
Disassembly and Assembly

INFOID:0000000014727356

DISASSEMBLY

1. Remove the cylinder head. Refer to EM-89, "Removal and Installation".
2. Remove the oil pan (upper). Refer to EM-43, "Removal and Installation".
3. Remove the water pump housing. Refer to CO-24, "Removal and Installation".
4. Remove the engine oil pressure sensor and engine oil temperature sensor.
5. Remove the knock sensor.
   CAUTION:
   Handle it carefully and avoid impacts.
6. Remove crankshaft position sensor cover and crankshaft position sensor.
   CAUTION:
   - **Handle crankshaft position sensor carefully and avoid impacts.**
   - **Do not disassemble.**
   - **Do not place crankshaft position sensor in a location where it is exposed to magnetism.**
7. Remove the water drain plug (4) and threaded plugs (1/4) from the cylinder block.
   CAUTION:
   Do not reuse washer (2).

   ⇦ : Engine front



8. Remove piston and connecting rod assembly using the following procedure:
   - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to EM-125, "Inspection".

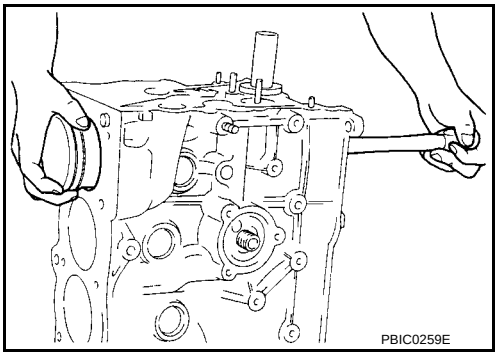
a. Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.

b. Remove connecting rod cap.
   CAUTION:
   Identify the original positions for installation and store the connecting rod caps without mixing them up.

c. Using a suitable tool, push piston and connecting rod assembly out through the cylinder head side.

CAUTION:

- **Be careful not to damage matching surface with connecting rod cap.**
- **Be careful not to damage the cylinder wall or crankshaft pin, resulting from an interference of the connecting rod big end.**



9. Remove connecting rod bearings.

CAUTION:

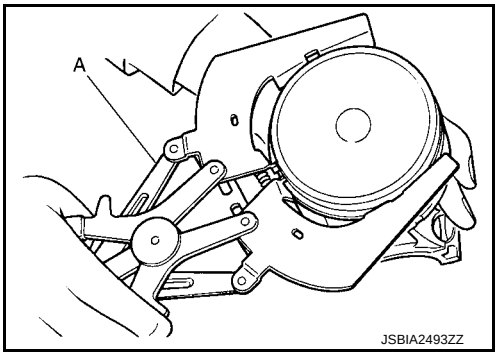
Identify the original positions for installation and store the connecting rod bearings without mixing them up.

10. Remove piston rings form piston.

- Before removing piston rings, check the piston ring side clearance. Refer to EM-125, "Inspection".
- Use suitable tool (A) to remove piston rings as shown.

CAUTION:

- **When removing piston rings, be careful not to damage the piston.**
- **Be careful not to damage piston rings by expanding them excessively.**

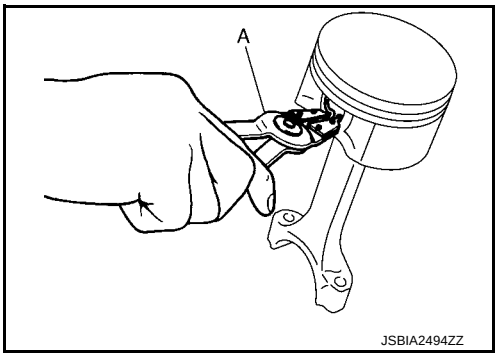


11. Remove piston from connecting rod using the following procedure:

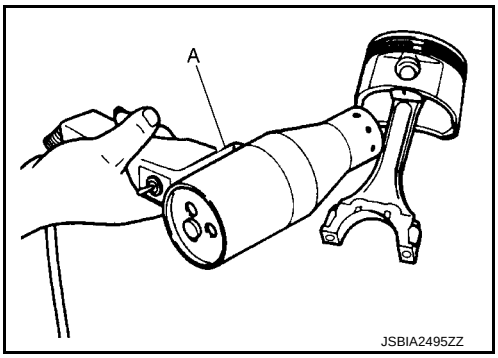
a. Using suitable tool (A), remove snap rings.

CAUTION:

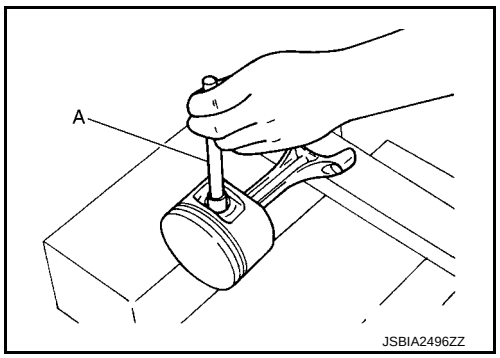
Do not reuse snap rings.



b. Heat piston to 60 to 70°C (140 to 158°F) with a suitable tool (A).

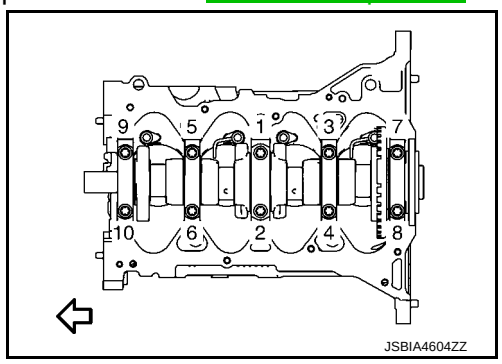


c. Push out piston pin with a suitable tool (A) with an outer diameter approximately 18 mm (0.71 in).



12. Remove main bearing cap bolts.
    - Measure crankshaft end play before loosening main bearing cap bolts. Refer to EM-125, "Inspection".
    - Loosen and remove main bearing cap bolts in reverse of the sequence shown.

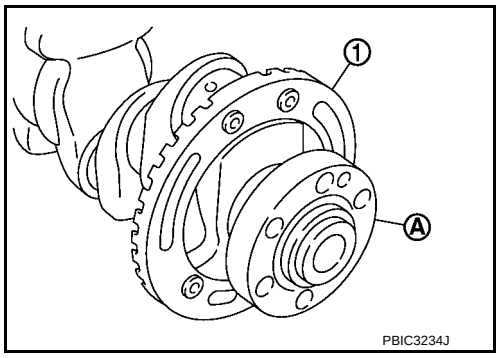
⇦ : Engine front



13. Remove main bearing caps.
    - Tap main bearing caps lightly with a plastic hammer for removal.

    CAUTION:
    Be careful not to damage the mounting surface.
14. Remove crankshaft.

    CAUTION:
    - **Be careful not to damage or deform signal plate (1) mounted on rear end of crankshaft (A).**
    - **When setting crankshaft on a flat floor surface, use a block of wood to avoid interference between signal plate and the floor surface.**
    - **Do not remove signal plate unless it is necessary to do so.**
15. Remove the signal plate from the crankshaft (if necessary).



16. Pull rear oil seal out from rear end of crankshaft.
17. Remove main bearings and thrust bearings from cylinder block and main bearing caps.

    CAUTION:
    Identify original installation positions and store main bearings and thrust bearings without mixing them up.
18. Remove the oil jets.
19. Inspect dowel pins, welch plugs and threaded plugs and remove if necessary.

ASSEMBLY

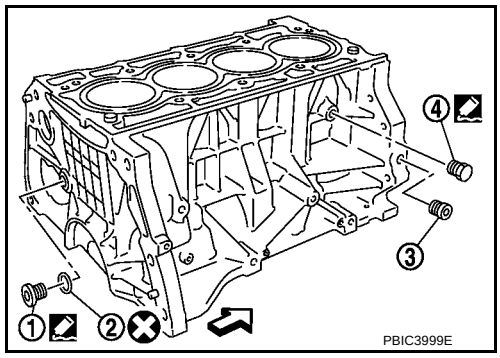
CAUTION:
Do not reuse O-rings or washers.

1. Fully air-blow engine coolant and engine oil passages in cylinder block, cylinder bore and crankcase to remove any foreign material.

   CAUTION:

Use a goggles to protect your eye.

2. Install each plug to cylinder block as shown and tighten to the specified torque.



CAUTION:
Do not reuse washer (2).

⇦ : Engine front

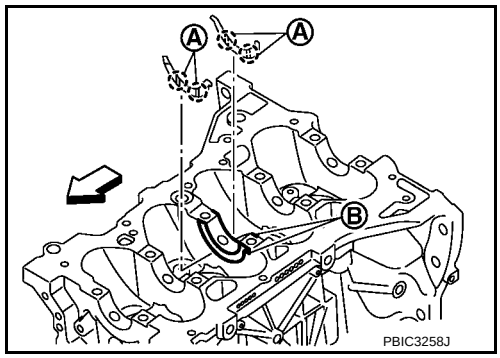
NOTE:
- Apply liquid gasket to thread of water drain plug (4).
  Use Genuine Silicone RTV Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".
- Apply sealant to thread of plug (1).
  Use Genuine High Temperature, High Strength Thread Locking Sealant (Red) or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".
- Do not apply liquid gasket or high strength thread locking sealant to the plug (3).

Part	Washer	Tightening torque
Threaded plug (1)	Yes	: 54.0 N·m (5.5 kg-m, 40 ft-lb)
Threaded plug (3)	No	: 19.6 N·m (2.0 kg-m, 14 ft-lb)
Water drain plug (4)	No	: 9.8 N·m (1.0 kg-m, 87 in-lb)

3. Install main bearings and thrust bearings using the following procedure:

a. Remove dust, dirt, and engine oil on the bearing mating surfaces of cylinder block and main bearing cap.

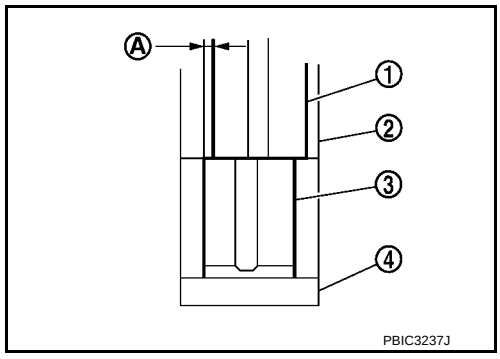
b. Install thrust bearings to the both sides of the No. 3 journal housing (B) on cylinder block.



⇦ : Engine front

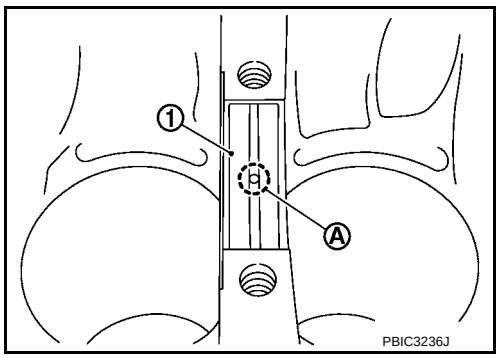
- Install thrust bearings with the oil groove (A) facing crankshaft arm (outside).

c. Install the main bearings paying attention to the direction.
- Before installing main bearings, apply new engine oil to the bearing surface (inside). Do not apply new engine oil to the back surface, but thoroughly clean it.
- When installing, align main bearing to the center position of cylinder block and main bearing cap.
- The difference (A) between main bearing [upper (1)] and main bearing [lower (3)] should be 0.85 mm (0.0335 in) or less when installing.



(2) : Cylinder block
(4) : Main bearing cap

- Ensure the oil holes on cylinder block and oil holes (A) on the main bearings (1) are aligned.



4. Install signal plate to crankshaft if removed.

a. Set the signal plate with the flange facing toward the counter weight side (engine front side) to the crankshaft rear surface.

b. Apply new engine oil to threads and seat surfaces of bolts.

c. Install dowel pin (service part) into hole on crankshaft.

d. Position crankshaft and signal plate using a dowel pin (service part) and tighten bolts to the specified torque.

NOTE:
Dowel pin of crankshaft and signal plate is provided as a set for each.

Signal plate bolts : 20.0 N·m (2.0 kg-m, 15 ft-lb)

e. Remove dowel pin.

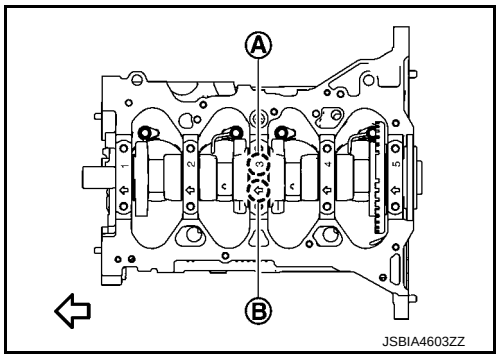
CAUTION:
Be sure to remove dowel pin.

5. Install crankshaft to cylinder block.
   - While turning crankshaft by hand, check that it turns smoothly.
6. Install main bearing caps using the following procedure:

a. Install main bearing caps referring to the journal No. stamp (A) and front mark (B) as shown.

NOTE:
Main bearing cap cannot be replaced as a single part because it is machined together with cylinder block.

⇦ : Engine front



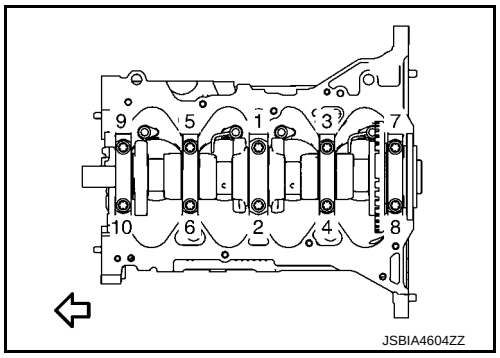
b. Tighten main bearing cap bolts using the following procedure:

i. Apply new engine oil to threads and seat surfaces of bolts.

ii. Tighten main bearing cap bolts to the specified torque in the sequence shown.

Main bearing cap bolts : 34.3 N·m (3.5 kg-m, 25 ft-lb)

⇦ : Engine front

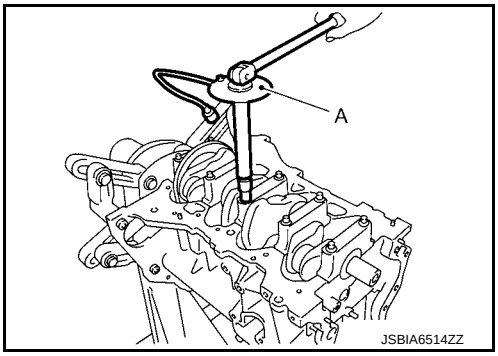


iii. Tighten main bearing cap bolts to the specified angle in the sequence shown.

CAUTION:
Confirm the tightening angle by using Tool (A). Do not judge by visual inspection without the Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 60°



- After installing bolts, check that crankshaft can be rotated smoothly by hand.
- Check crankshaft end play. Refer to EM-125, "Inspection".

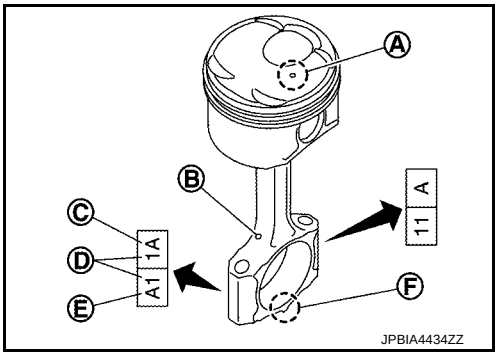
7. Install piston to connecting rod with the following procedure:

a. Using suitable tool, install new snap ring to the groove of the piston rear side.
- Insert it fully into groove to install.

CAUTION:
Do not reuse snap rings.

b. Assemble piston to connecting rod.
- Using a suitable tool, heat the piston until the piston pin can be pushed in by hand without excess force [approximately 60 to 70°C (140 to 158°F)]. From the front to the rear, insert piston pin into piston and connecting rod.
- Assemble so that the front mark (A) on the piston head and the oil hole (B) and the cylinder number (D) on connecting rod are positioned as shown.

(C) : Management code
(E) : Big end diameter grade
(F) : Front mark (connecting rod cap)

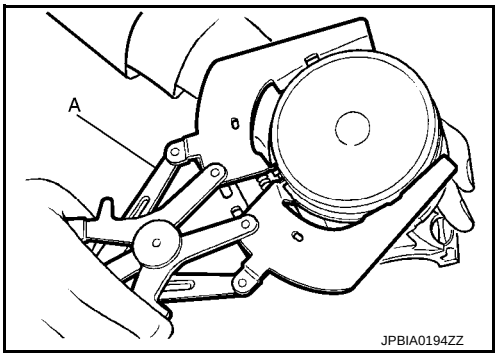


c. Install new snap ring to the groove of the piston front side.
- Insert it fully into groove to install.

CAUTION:
Do not reuse snap rings.
- After installing, check that connecting rod moves smoothly.

8. Using a suitable tool (A), install piston rings.

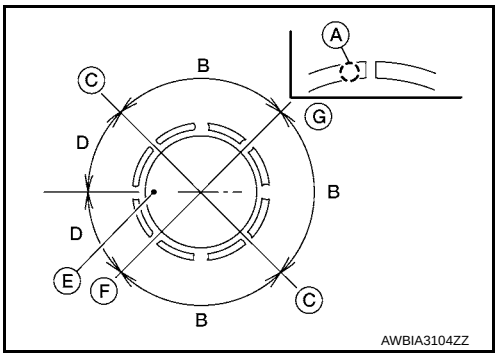
CAUTION:
- **Be careful not to damage piston.**
- **Be careful not to damage piston rings by expanding them excessively.**



- Position end gaps of each piston ring as shown when referring to the piston front mark (E).

CAUTION:
Do not allow the rail end gap under the oil ring to contact the oil drain cast groove of piston.

(B) : 90°
(C) : Oil ring upper or lower rail gap
(D) : 45°



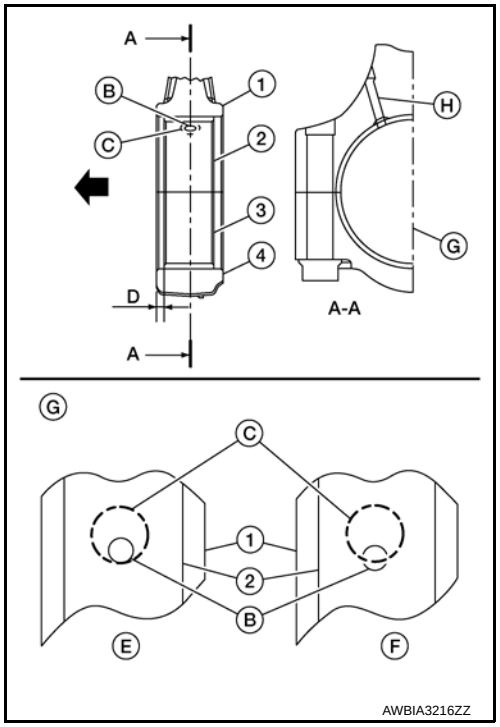
(F) : Second ring gap
(G) : Top ring gap

- Install second ring and top ring with the stamped mark (A) facing upward.

Stamped mark:
Top ring : 1N
Second ring : 2N

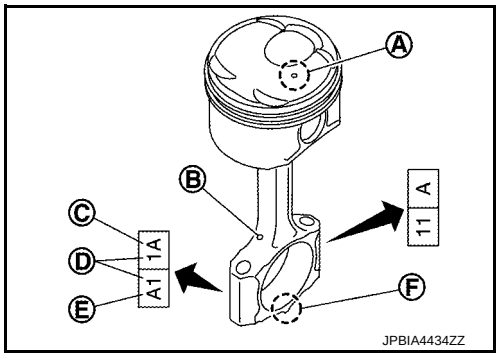
9. Install connecting rod bearing [upper (2)] and connecting rod bearing [lower (3)] to connecting rod (1) and connecting rod cap (4).

(D) : 2.05 - 2.45 mm (0.0807 - 0.0965 in)
(E) : OK
(F) : NG
(G) : View G
(H) : Oil hole
⇦ : Engine front



- Install the connecting rod in the dimension shown.
- Check that connecting rod bearing oil hole (B) is completely in the inside of connecting rod oil hole chamfered area (C).
- When installing connecting rod bearings, apply new engine oil to the bearing surface (inside). Do not apply new engine oil to the back surface, but thoroughly clean it.
  NOTE:
  - There is no positioning tab.
  - Install the connecting rod bearings in the center of connecting rod and connecting rod cap as shown. For service operation, the center position can be checked, visually.

10. Install piston and connecting rod assembly to crankshaft.
- Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
- Apply new engine oil sufficiently to the cylinder bore, piston and crankshaft pin.
- Match the cylinder position with the cylinder number (D) on connecting rod to install.

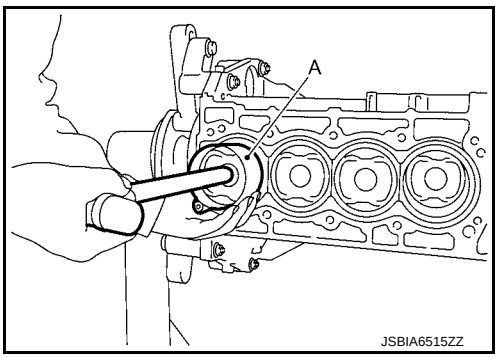


(B) : Oil hole
(C) : Management code
(E) : Big end diameter grade
(F) : Front mark (connecting rod cap)

- Install so that front mark (A) on the piston head faces the front of engine.

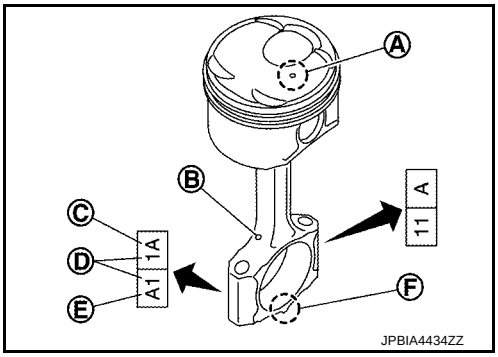
- Using a suitable tool (A), install piston and connecting rod assembly with the front mark on the piston head facing the front of the engine.

CAUTION:
Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.



11. Install connecting rod cap.
- Match the stamped cylinder number marks (D) on connecting rod with those on connecting rod cap to install.

(A) : Front mark (piston)
(B) : Oil hole
(C) : Management code
(E) : Big end diameter grade
(F) : Front mark (connecting rod cap)



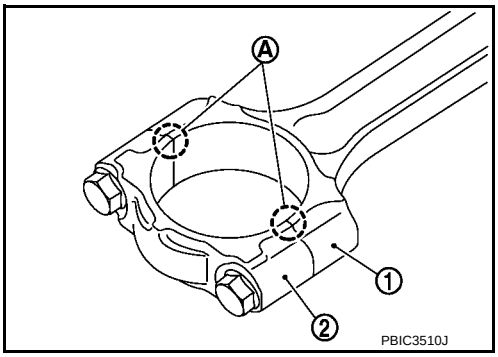
12. Tighten connecting rod cap bolt using the following procedure:

CAUTION:
- **Check that there is no gap in the thrust surface (A) of the joint between connecting rod (1) and connecting rod cap (2) and that these parts are in the correct position. And then, tighten the connecting rod cap bolts.**
- **If the connecting rod cap bolts are reused, measure the outer diameter. Refer to EM-125, "Inspection".**

a. Apply new engine oil to the threads and seats of connecting rod cap bolts.

b. Tighten connecting rod cap bolts to the specified torque.

Connecting rod cap bolts : 33.0 N·m (3.4 kg-m, 24 ft-lb)



c. Completely loosen connecting rod cap bolts.

Connecting rod cap bolts : 0 N·m (0 kg-m, 0 ft-lb)

d. Tighten connecting rod cap bolts to the specified torque.

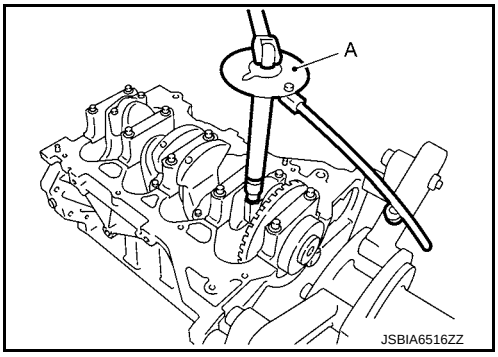
Connecting rod cap bolts : 19.6 N·m (2.0 kg-m, 14 ft-lb)

e. Then tighten connecting rod cap bolts to the specified angle using Tool (A).

CAUTION:
Check and confirm the tightening angle by using a Tool. Do not judge by visual inspection without the Tool.

Tool number : KV10112100 (BT-8653-A)

Tightening angle : 60° - 65°

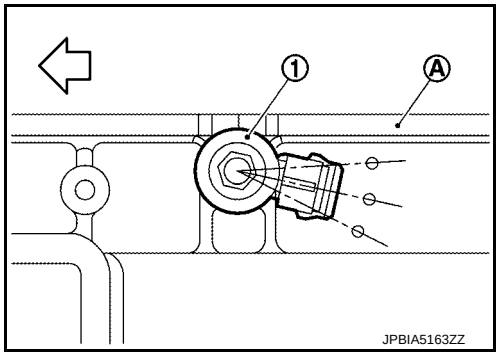


- After tightening connecting rod cap bolt, check that crankshaft rotates smoothly.

- Check the connecting rod side clearance. Refer to EM-125, "Inspection".

13. Install oil pan (upper). Refer to EM-43, "Removal and Installation".
    NOTE:
    Install the rear oil seal after installing the oil pan (upper).
14. Install rear oil seal. Refer to EM-102, "REAR OIL SEAL : Removal and Installation".
15. Install drive plate. Refer to EM-103, "Removal and Installation"
16. Install knock sensor (1) with harness connector facing toward the rear of engine.
    CAUTION:
    - **Do not tighten bolt while holding the harness connector.**
    - **If any impact by dropping is applied to knock sensor, replace it with a new one.**

    NOTE:
    - Check that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
    - Check that knock sensor does not interfere with other parts.



(A) : Cylinder block left side

⇦ : Engine front

17. Install crankshaft position sensor and crankshaft position sensor cover.
    CAUTION:
    - **Handle crankshaft position sensor carefully and avoid impacts.**
    - **Do not disassemble.**
    - **Do not place crankshaft position sensor in a location where it is exposed to magnetism.**
18. Assembly of the remaining components is in the reverse order of disassembly.

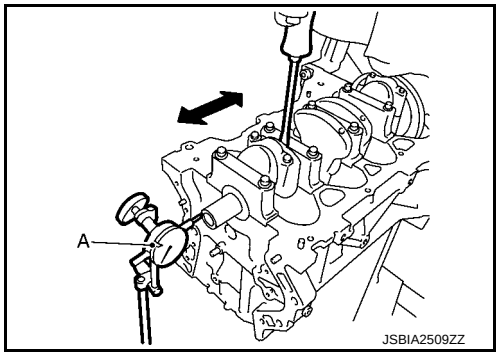
Inspection

INFOID:0000000014727357

CRANKSHAFT END PLAY

- Measure the clearance between thrust bearings and crankshaft arm when crankshaft is moved fully forward or backward with a suitable tool (A).

Standard and Limit : Refer to EM-147, "Cylinder Block".

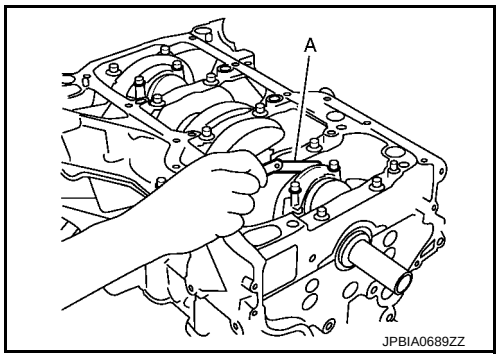


- If the measured value exceeds the limit, replace thrust bearings, and measure again. If it still exceeds the limit, replace crankshaft also.

CONNECTING ROD SIDE CLEARANCE

- Measure the side clearance between connecting rod and crankshaft arm with a suitable tool (A).

Standard and Limit : Refer to EM-147, "Cylinder Block".



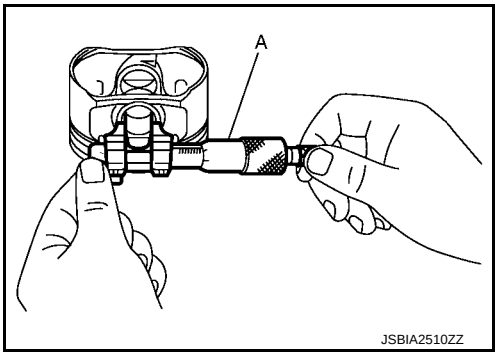
- If the measured value exceeds the limit, replace connecting rod, and measure again. If it still exceeds the limit, replace crankshaft also.

PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

Measure the inner diameter of piston pin hole with a suitable tool (A).

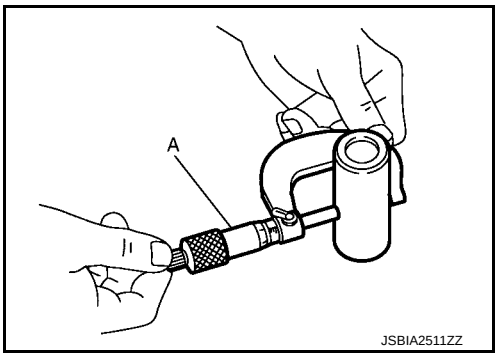
Standard : Refer to EM-147, "Cylinder Block".



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a suitable tool (A).

Standard : Refer to EM-147, "Cylinder Block".



Piston to Piston Pin Oil Clearance

(Piston to piston pin oil clearance) = (Piston pin hole diameter) – (Piston pin outer diameter)

Standard : Refer to EM-147, "Cylinder Block".

- If oil clearance is out of the standard, replace piston and piston pin assembly.
- When replacing piston and piston pin assembly. Refer to EM-134, "Description".

NOTE:

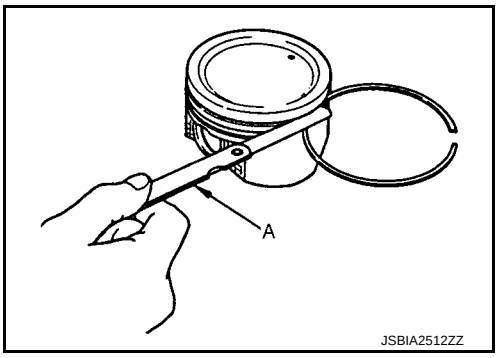
- Piston is available together with piston pin as assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only grade “0” is available.)

PISTON RING SIDE CLEARANCE

- Measure the side clearance of piston ring and piston ring groove with a suitable tool (A).

Standard and Limit : Refer to EM-147, "Cylinder Block".

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, replace piston also.



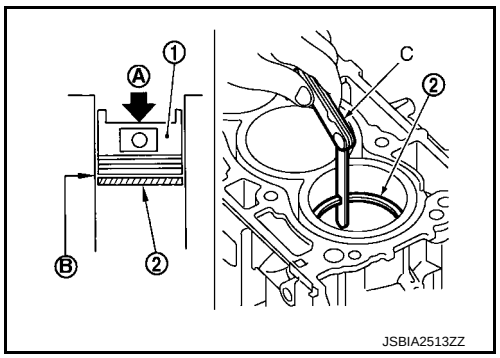
PISTON RING END GAP

- Check that cylinder bore inner diameter is within specification. Refer to “PISTON TO CYLINDER BORE CLEARANCE”.

- Lubricate with new engine oil to piston (1) and piston ring (2), and then insert (A) piston ring until middle of cylinder (B) with piston, and measure piston ring end gap with a suitable tool (C).

Standard and Limit : Refer to EM-147, "Cylinder Block".

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, rebore cylinder and use oversized piston and piston rings.



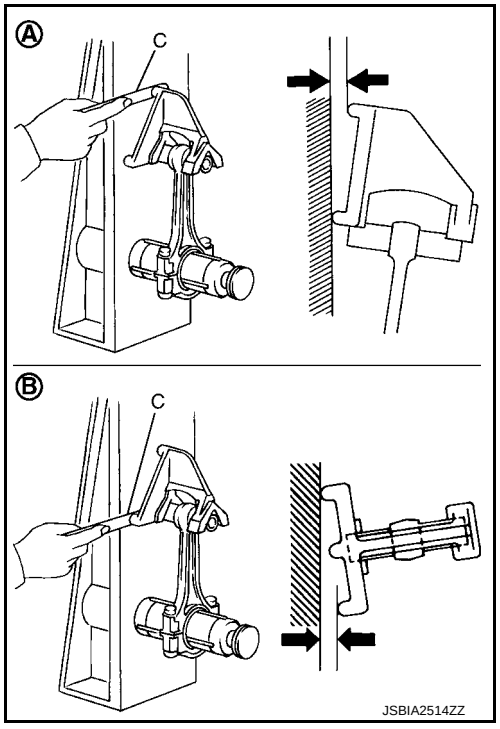
CONNECTING ROD BEND AND TORSION

- Check with a suitable tool (C).

(A) : Bend
(B) : Torsion

Limit : Refer to EM-147, "Cylinder Block".

- If it exceeds the limit, replace connecting rod assembly.



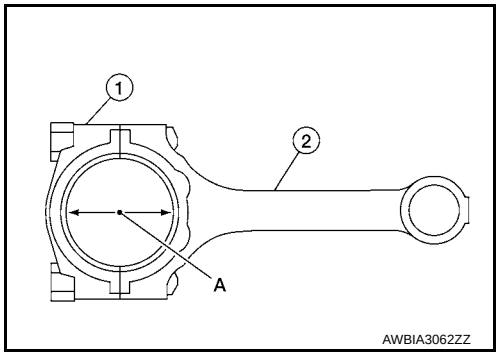
CONNECTING ROD BIG END DIAMETER

- Install connecting rod cap (1) without connecting rod bearing installed, and tightening connecting rod cap bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".
- Measure the inner diameter of connecting rod big end with an inside micrometer.

Standard : Refer to EM-147, "Cylinder Block".

(2) : Connecting rod

- If out of the standard, replace connecting rod assembly.

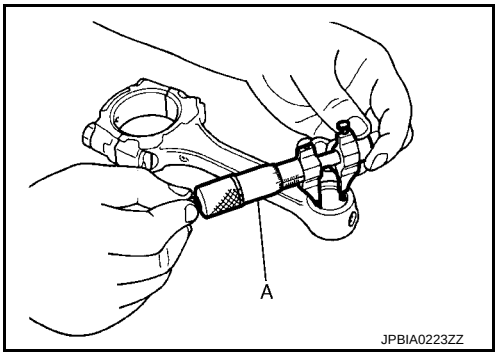


CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

Measure the inner diameter of connecting rod bushing with a suitable tool (A).

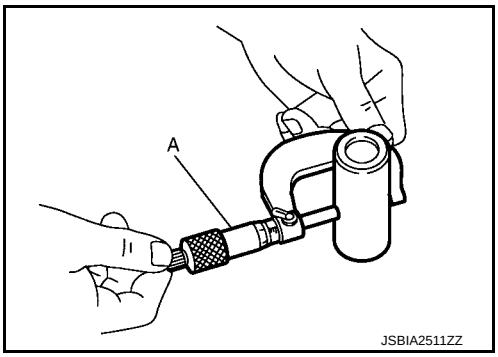
Standard : Refer to EM-147, "Cylinder Block".



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a suitable tool (A).

Standard : Refer to EM-147, "Cylinder Block".



Connecting Rod Bushing Oil Clearance

(Connecting rod bushing oil clearance) = (Connecting rod bushing inner diameter) – (Piston pin outer diameter)

Standard and Limit : Refer to EM-147, "Cylinder Block".

- If the measured value is out of the standard, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly. Refer to EM-134, "Piston".
- If replacing connecting rod assembly. Refer to EM-135, "Connecting Rod Bearing".

CYLINDER BLOCK TOP SURFACE DISTORTION

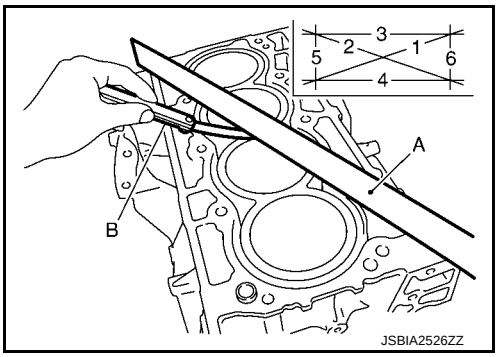
- Using a suitable tool, remove gasket on the cylinder block surface, and also remove engine oil, scale, carbon, or other contamination.

  CAUTION:

  Be careful not to allow gasket particles to enter engine oil or engine coolant passages.
- Measure the distortion on the cylinder block upper face at different points in six different directions with a suitable tool (A) and suitable tool (B).

Limit : Refer to EM-147, "Cylinder Block".

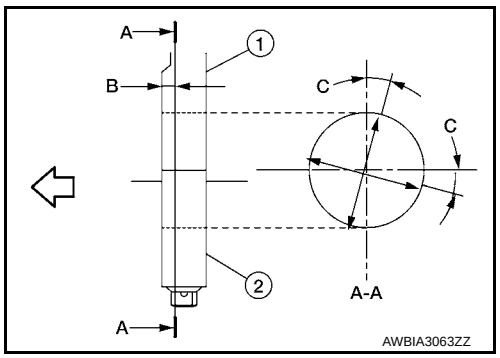
- If it exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

- Install main bearing cap without main bearings installed, and tighten main bearing cap mounting bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".
- Measure the inner diameter of main bearing housing with a suitable tool.

- Measure the position shown backward from main bearing housing front side in the 2 directions as shown. The smaller one is the measured value.



Standard : Refer to EM-147, "Cylinder Block".

(1) : Cylinder block
(2) : Main bearing cap
(B) : 5 mm (0.20 in)
(C) : 15°
⇦ : Engine front

- If out of the standard, replace cylinder block and main bearing caps assembly.

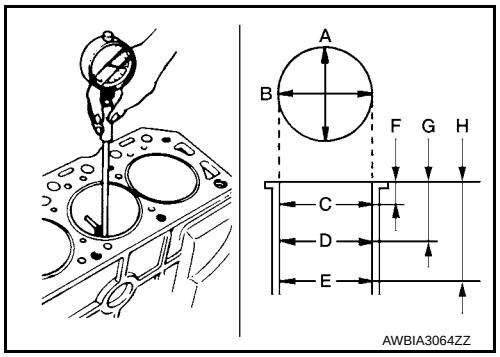
NOTE:
Main bearing caps cannot be replaced as a single, because it is machined together with cylinder block.

PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

- Using a cylinder gauge, measure the cylinder bore for wear, out-of-round and taper at six different points on each cylinder. [(A) and (B) directions at (C), (D), and (E)] [(A) is in longitudinal direction of engine]

NOTE:
When determining cylinder bore grade, measure the cylinder bore (B) direction at (D) position.



(F) : 10 mm (0.39 in)
(G) : 60 mm (2.36 in)
(H) : 130 mm (5.12 in)

Standard:

Cylinder bore inner diameter

: Refer to EM-147, "Cylinder Block".

Limit:

Out-of-round [Difference between (A) and (B)]

Taper [Difference between (C) and (D)]

: Refer to EM-147, "Cylinder Block".

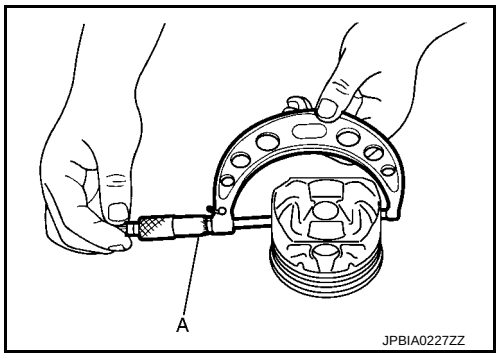
- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, replace cylinder block.

NOTE:
Oversize piston is not provided.

Piston Skirt Diameter

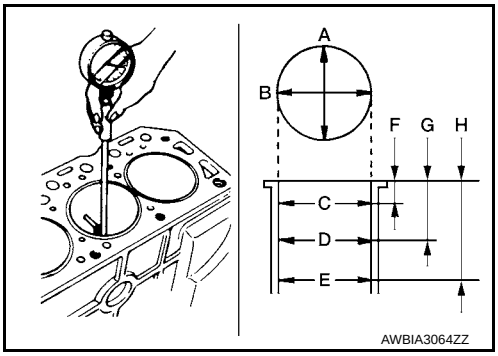
Measure the outer diameter of piston skirt with a suitable tool (A).

Standard : Refer to EM-147, "Cylinder Block".



Piston to Cylinder Bore Clearance

Calculate by piston skirt diameter and cylinder bore inner diameter [direction (B), position (D)].



(A) : Direction A
(C) : Position C
(E) : Position E
(F) : 10 mm (0.39 in)
(G) : 60 mm (2.36 in)
(H) : 130 mm (5.12 in)

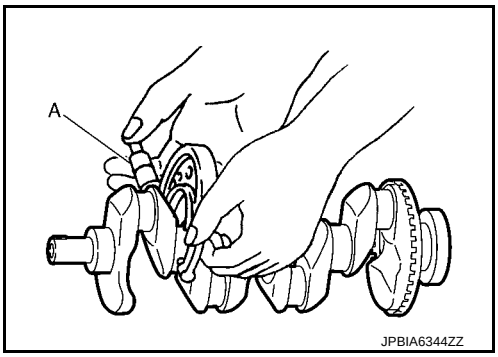
(Clearance) = (Cylinder bore inner diameter) – (Piston skirt diameter)

Standard and Limit : Refer to EM-147, "Cylinder Block".

- If it exceeds the limit, replace piston and piston pin assembly and/or cylinder block. Refer to EM-134, "Piston".

CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft main journals with a suitable tool (A).



Standard : Refer to EM-147, "Cylinder Block".

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to EM-151, "Main Bearing".

CRANKSHAFT PIN JOURNAL DIAMETER

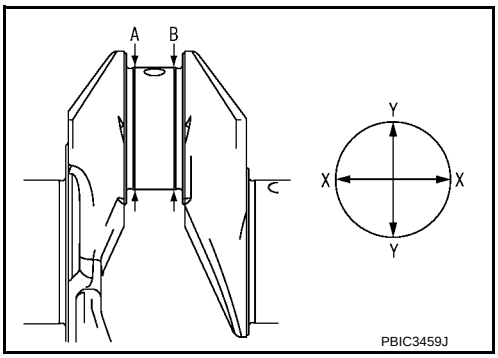
- Measure the outer diameter of crankshaft pin journal with a suitable tool.

Standard : Refer to EM-147, "Cylinder Block".

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to EM-135, "Connecting Rod Bearing".

OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Measure the dimensions at four different points as shown on each main journal and pin journal with a suitable tool.
- Out-of-round is indicated by the difference in dimensions between (X) and (Y) at (A) and (B).
- Taper is indicated by the difference in dimension between (A) and (B) at (X) and (Y).



Limit:

Out-of-round [Difference between (X) and (Y)]

Taper [Difference between (A) and (B)]

: Refer to EM-147, "Cylinder Block".

- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure main bearing oil clearance of the corrected main journal and/or pin journal. Then select main bearing and/or connecting rod bearing. Refer to EM-135, "Connecting Rod Bearing" and/or EM-137, "Main Bearing".

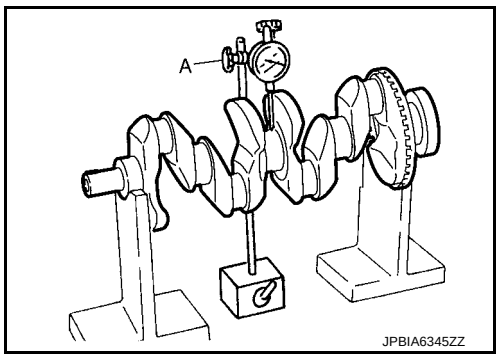
CRANKSHAFT RUNOUT

- Place a V-block on a precise flat table to support the journals on the both end of the crankshaft.

- Place a suitable tool (A) straight up on the No. 3 journal.
- While rotating crankshaft, read the movement of the pointer on the suitable tool. (Total indicator reading)

Standard and Limit : Refer to EM-147, "Cylinder Block".

- If it exceeds the limit, replace crankshaft.



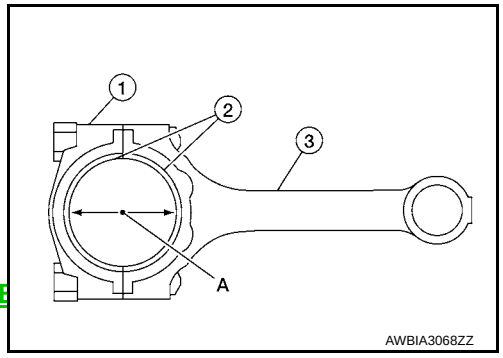
CONNECTING ROD BEARING OIL CLEARANCE

Method by Calculation

- Install connecting rod bearings (2) to connecting rod (3) and connecting rod bearing cap (1) and tighten connecting rod cap bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".
- Measure the inner diameter (A) of connecting rod bearing with a suitable tool.
  (Bearing oil clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin journal diameter)

Standard and Limit : Refer to EM-150, "Connecting Rod E

- If clearance exceeds the limit, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin journal diameter to obtain specified bearing oil clearance. Refer to EM-135, "Connecting Rod Bearing".



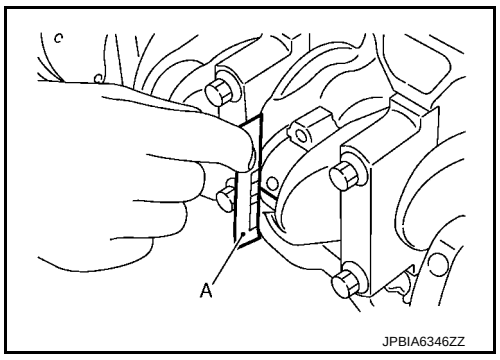
Method of Using Plastigage

- Remove engine oil and dust on crankshaft pin and the surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install connecting rod bearings to connecting rod and connecting rod cap, and tighten connecting rod cap bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".

CAUTION:
Do not rotate crankshaft.

- Remove connecting rod cap and connecting rod bearing, and using the scale (A) on the plastigage bag, measure the plastigage width.

NOTE:
The procedure when the measured value exceeds the limit is same as that described in the “Method by Calculation”.

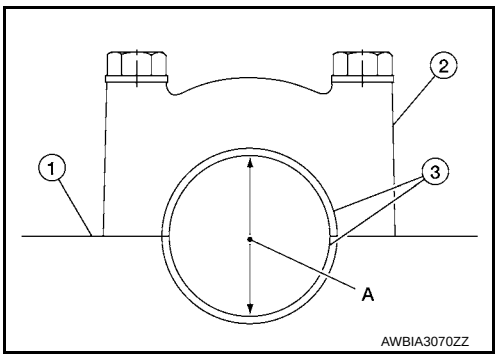


MAIN BEARING OIL CLEARANCE

Method by Calculation

- Install main bearings (3) to cylinder block (1) and main bearing cap (2) and tighten main bearing cap bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".
- Measure the inner diameter (A) of main bearing with a suitable tool.

(Bearing oil clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)



Standard and Limit : Refer to EM-151, "Main Bearing".

- If clearance exceeds the limit, select proper main bearing according to main bearing inner diameter and crankshaft main journal diameter to obtain specified bearing oil clearance. Refer to EM-137, "Main Bearing".

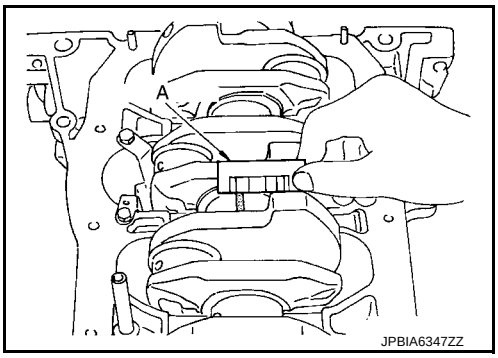
Method of Using Plastigage

- Remove engine oil and dust on crankshaft main journal and the surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install main bearings to cylinder block and main bearing cap, and tighten main bearing cap bolts to the specified torque. Refer to EM-117, "Disassembly and Assembly".

CAUTION:
Never rotate crankshaft.

- Remove main bearing cap and main bearings, and using the scale (A) on the plastigage bag, measure the plastigage width.

NOTE:
The procedure when the measured value exceeds the limit is same as that described in the “Method by Calculation”.

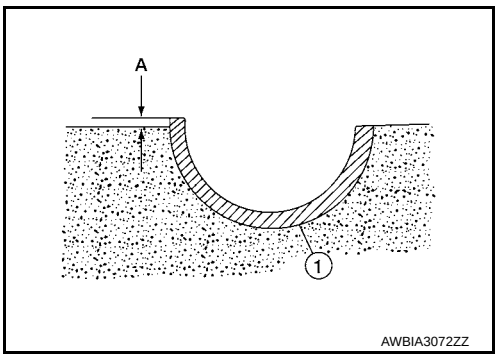


MAIN BEARING CRUSH HEIGHT

- When main bearing cap is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of main bearing must protrude (B). Refer to EM-117, "Disassembly and Assembly".

Standard : There must be crush height.

- If the standard is not met, replace main bearings.

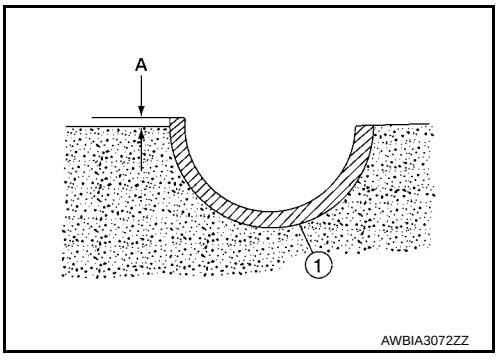


CONNECTING ROD BEARING CRUSH HEIGHT

- When connecting rod cap is removed after being tightened to the specified torque with connecting rod bearings (1) installed, the tip end of connecting rod bearing must protrude (A). Refer to EM-117, "Disassembly and Assembly".

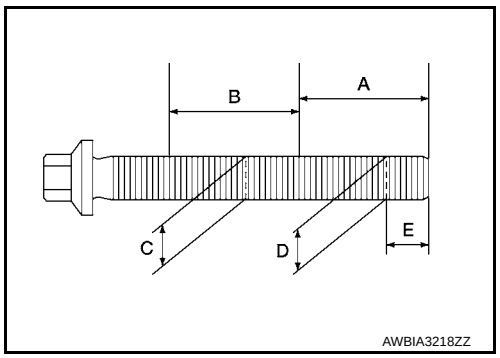
Standard : There must be crush height.

- If the standard is not met, replace connecting rod bearings.



MAIN BEARING CAP BOLT OUTER DIAMETER

- Measure the outer diameters (C) and (D) at two positions as shown.



(A) : 30 mm (1.18 in)
(B) : Diameter (C) measurement range 30 mm (1.18 in)
(E) : 10 mm (0.39 in)

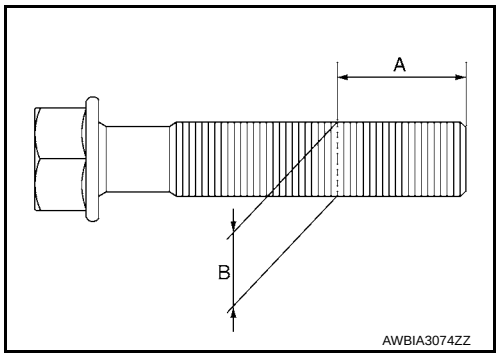
- If reduction appears in places other than (B) range, regard it as (C).

Limit [(D) – (C)]: 0.15 mm (0.0059 in)

- If it exceeds the limit, replace main bearing cap bolt with a new one.

CONNECTING ROD CAP BOLT OUTER DIAMETER

- Measure the outer diameter (B) at position as shown.
- If reduction appears in a position other than (B), regard it as (B).



Limit: 7.75 mm (0.3051 in)

(A) : 17 mm (0.67 in)

- When (B) exceeds the limit, replace connecting rod cap bolt with a new one.

HOW TO SELECT PISTON AND BEARING

Description

INFOID:0000000014727358

Selection points	Selection parts	Selection items	Selection methods
Between cylinder block and crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft and connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod big end diameter and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block and piston	Piston and piston pin assembly (piston is available together with piston pin as an assembly.)	Piston grade (piston outer diameter)	Piston grade = cylinder bore grade (inner diameter of bore)

- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, refer to the text.

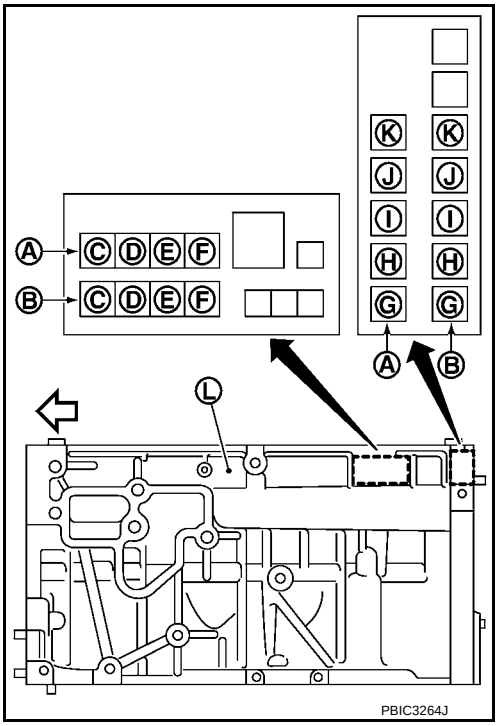
Piston

INFOID:0000000014727359

WHEN NEW CYLINDER BLOCK IS USED

- Check the cylinder bore grade on rear left side of cylinder block (L), and select piston of the same grade.

(A) : Corrected stamping position
(B) : Standard stamping position
(C) : Cylinder No. 1 bore grade
(D) : Cylinder No. 2 bore grade
(E) : Cylinder No. 3 bore grade
(F) : Cylinder No. 4 bore grade
(G) : No. 1 main bearing housing grade
(H) : No. 2 main bearing housing grade
(I) : No. 3 main bearing housing grade
(J) : No. 4 main bearing housing grade
(K) : No. 5 main bearing housing grade
⇦ : Engine front



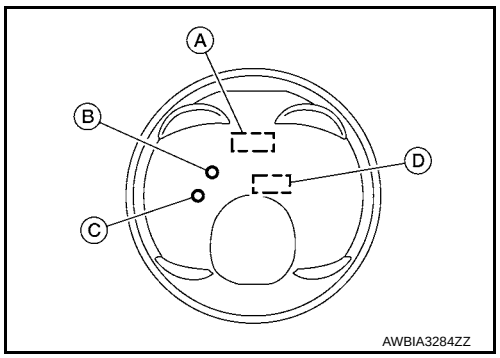
- If there is a correction stamp mark on the cylinder block, use it as a correct reference.

WHEN CYLINDER BLOCK IS REUSED

1. Measure the cylinder bore inner diameter. Refer to EM-147, "Cylinder Block".
2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the “Piston Selection Table”.

3. Select piston of the same grade.

(A) : Identification code
(B) : Identification mark
(C) : Front mark
(D) : Piston type stamping



PISTON SELECTION TABLE

Unit: mm (in)

Grade number (Mark)	1	2
Cylinder bore Inner diameter	84.000 - 84.010 (3.3071 - 3.3075)	84.010 - 84.020 (3.3075 - 3.3079)
Piston skirt diameter	83.970 - 83.980 (3.3059 - 3.3063)	83.980 - 83.990 (3.3063 - 3.3067)

NOTE:
Piston is available together with piston pin as an assembly.

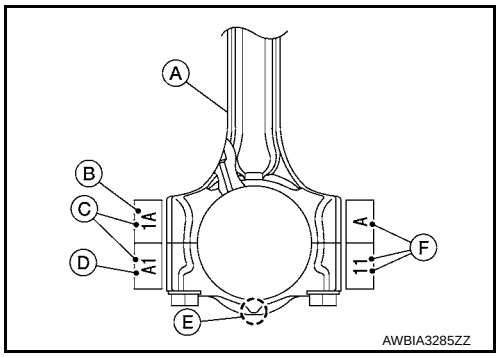
Connecting Rod Bearing

INFOID:0000000014727360

WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

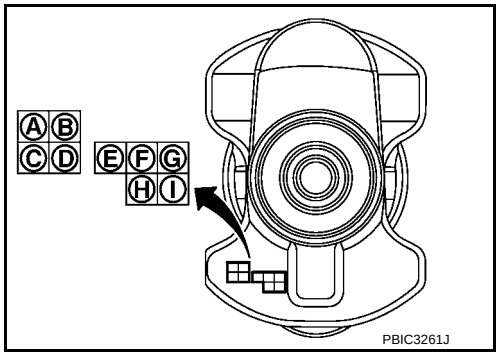
1. Apply connecting rod big end diameter grade stamped on connecting rod side face to the row in the “Connecting Rod Bearing Selection Table”.

(A) : Oil hole
(B) : Engine type
(C) : Cylinder number
(D) : Big end diameter grade
(E) : Front mark
(F) : Production control mark



2. Apply crankshaft pin journal diameter grade stamped on crankshaft front side to the column in the “Connecting Rod Bearing Selection Table”.

(A) : No. 1 pin journal diameter grade
(B) : No. 2 pin journal diameter grade
(C) : No. 3 pin journal diameter grade
(D) : No. 4 pin journal diameter grade
(E) : No. 1 main journal diameter grade
(F) : No. 2 main journal diameter grade
(G) : No. 3 main journal diameter grade
(H) : No. 4 main journal diameter grade
(I) : No. 5 main journal diameter grade



3. Read the symbol at the cross point of selected row and column in the “Connecting Rod Bearing Selection Table”.
4. Apply the symbol obtained to the “Connecting Rod Bearing Grade Table” to select connecting rod bearing.

WHEN CONNECTING ROD AND CRANKSHAFT ARE REUSED

1. Measure the dimensions of the connecting rod big end diameter and crankshaft pin journal diameter individually. Refer to EM-125, "Inspection".
2. Apply the measured dimension to the “Connecting Rod Bearing Selection Table”.
3. Read the symbol at the cross point of selected row and column in the “Connecting Rod Bearing Selection Table”.
4. Apply the symbol obtained to the “Connecting Rod Bearing Grade Table” to select connecting rod bearing.

CONNECTING ROD BEARING SELECTION TABLE

Crankshaft pin journal diameter Unit: mm (in) / Connecting rod big end diameter Unit: mm (in)		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N
Mark	Axle diameter	Hole diameter	47.000 - 47.001 (1.8504 - 1.8504)	47.001 - 47.002 (1.8504 - 1.8505)	47.002 - 47.003 (1.8505 - 1.8505)	47.003 - 47.004 (1.8505 - 1.8505)	47.004 - 47.005 (1.8505 - 1.8506)	47.005 - 47.006 (1.8506 - 1.8506)	47.006 - 47.007 (1.8506 - 1.8507)	47.007 - 47.008 (1.8507 - 1.8507)	47.008 - 47.009 (1.8507 - 1.8507)	47.009 - 47.010 (1.8507 - 1.8508)	47.010 - 47.011 (1.8508 - 1.8508)	47.011 - 47.012 (1.8508 - 1.8509)	47.012 - 47.013 (1.8509 - 1.8509)
A	43.970 - 43.971 (1.7311 - 1.7311)		0	0	0	0	0	01	01	01	1	1	1	12	12
B	43.969 - 43.970 (1.7311 - 1.7311)		0	0	0	0	01	01	01	1	1	1	12	12	12
C	43.968 - 43.969 (1.7310 - 1.7311)		0	0	0	01	01	01	1	1	1	12	12	12	2
D	43.967 - 43.968 (1.7310 - 1.7310)		0	0	01	01	01	1	1	1	12	12	12	2	2
E	43.966 - 43.967 (1.7309 - 1.7310)		0	01	01	01	1	1	1	12	12	12	2	2	2
F	43.965 - 43.966 (1.7309 - 1.7309)		01	01	01	1	1	1	12	12	12	2	2	2	23
G	43.964 - 43.965 (1.7309 - 1.7309)		01	01	1	1	1	12	12	12	2	2	2	23	23
H	43.963 - 43.964 (1.7308 - 1.7309)		01	1	1	1	12	12	12	2	2	2	23	23	23
J	43.962 - 43.963 (1.7308 - 1.7308)		1	1	1	12	12	12	2	2	2	23	23	23	3
K	43.961 - 43.962 (1.7307 - 1.7308)		1	1	12	12	12	2	2	2	23	23	23	3	3
L	43.960 - 43.961 (1.7307 - 1.7307)		1	12	12	12	2	2	2	23	23	23	3	3	3
M	43.959 - 43.960 (1.7307 - 1.7307)		12	12	12	2	2	2	23	23	23	3	3	3	34
N	43.958 - 43.959 (1.7306 - 1.7307)		12	12	2	2	2	23	23	23	3	3	3	34	34
P	43.957 - 43.958 (1.7306 - 1.7306)		12	2	2	2	23	23	23	3	3	3	34	34	34
R	43.956 - 43.957 (1.7305 - 1.7306)		2	2	2	23	23	23	3	3	3	34	34	34	4
S	43.955 - 43.956 (1.7305 - 1.7305)		2	2	23	23	23	3	3	3	34	34	34	4	4
T	43.954 - 43.955 (1.7305 - 1.7305)		2	23	23	23	3	3	3	34	34	34	4	4	4
U	43.953 - 43.954 (1.7304 - 1.7305)		23	23	23	3	3	3	34	34	34	4	4	4	4

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CONNECTING ROD BEARING GRADE TABLE

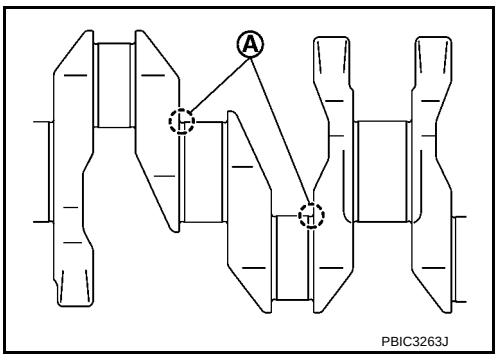
Connecting rod bearing grade table : Refer to EM-150, "Connecting Rod Bearing".

UNDERSIZE BEARINGS USAGE GUIDE

- When the specified connecting rod bearing oil clearance is not obtained with standard size connecting rod bearings, use undersize (US) bearings.
- When using undersize (US) bearing, measure the connecting rod bearing inner diameter with bearing installed, and grind the crankshaft pin so that the connecting rod bearing oil clearance satisfies the standard.

CAUTION:

In grinding crankshaft pin to use undersize bearings, keep the fillet R [1.5 - 1.7 mm (0.059 - 0.067 in)] (A).



Bearing undersize table

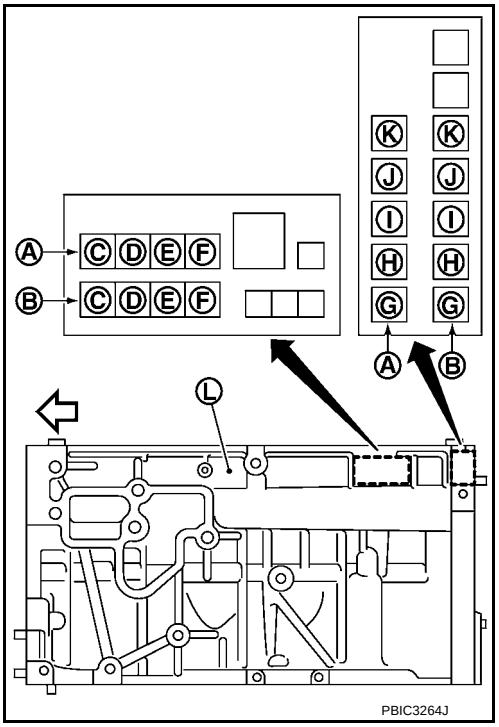
: Refer to EM-150, "Connecting Rod Bearing".

Main Bearing

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WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

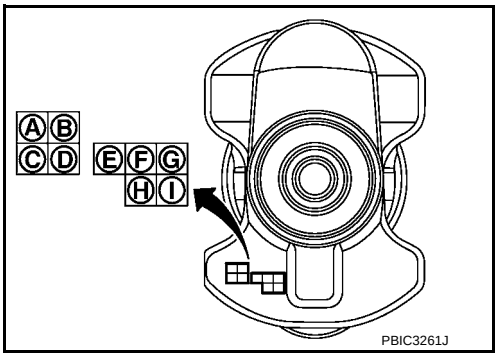
1. "Main Bearing Selection Table" rows correspond to main bearing housing grade on rear left side of cylinder block (L).



(A) : Corrected stamping mark
(B) : Standard stamping mark
(C) : Cylinder No. 1 bore grade
(D) : Cylinder No. 2 bore grade
(E) : Cylinder No. 3 bore grade
(F) : Cylinder No. 4 bore grade
(G) : No. 1 main bearing housing grade
(H) : No. 2 main bearing housing grade
(I) : No. 3 main bearing housing grade
(J) : No. 4 main bearing housing grade
(K) : No. 5 main bearing housing grade
⇦ : Engine front

- If there is a correction stamp mark on cylinder block, use it as a correct reference.

2. Apply main journal diameter grade stamped on crankshaft front side to column in the "Main Bearing Selection Table".



(A) : No. 1 pin journal diameter grade
(B) : No. 2 pin journal diameter grade
(C) : No. 3 pin journal diameter grade
(D) : No. 4 pin journal diameter grade
(E) : No. 1 main journal diameter grade
(F) : No. 2 main journal diameter grade
(G) : No. 3 main journal diameter grade
(H) : No. 4 main journal diameter grade
(I) : No. 5 main journal diameter grade

3. Read the symbol at the cross point of selected row and column in the "Main Bearing Selection Table".
CAUTION:
There are two main bearing selection tables. One is for No. 1 and 4 journals and the other is for No. 2, 3 and 5 journals. Make certain to use the appropriate table. This is due to differences in the specified clearances.

4. Apply the symbol obtained to the “Main Bearing Grade Table” to select main bearing.
NOTE:
Service part is available as a set of both upper and lower.

WHEN CYLINDER BLOCK AND CRANKSHAFT ARE REUSED

1. Measure the dimensions of the cylinder block main bearing housing inner diameter and crankshaft main journal diameter individually. Refer to EM-125, "Inspection".
2. Apply the measured dimension to the “Main Bearing Selection Table”.
3. Read the symbol at the cross point of selected row and column in the “Main Bearing Selection Table”.
CAUTION:
There are two main bearing selection tables. One is for No. 1 and 4 journals and the other is for No. 2, 3 and 5 journals. Make certain to use the appropriate table. This is due to differences in the specified clearances.
4. Apply the symbol obtained to the “Main Bearing Grade Table” to select main bearing.
NOTE:
Service part is available as a set of both upper and lower.

MAIN BEARING SELECTION TABLE (No. 1 AND 4 JOURNAL)

Crankshaft main journal diameter Unit: mm (in) / Cylinder block main bearing housing inner diameter Unit: mm (in)		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W
		Hole diameter	55.997 - 55.998 (2.2046 - 2.2046)	55.998 - 55.999 (2.2046 - 2.2047)	55.999 - 56.000 (2.2047 - 2.2047)	56.000 - 56.001 (2.2047 - 2.2048)	56.001 - 56.002 (2.2048 - 2.2048)	56.002 - 56.003 (2.2048 - 2.2048)	56.003 - 56.004 (2.2048 - 2.2049)	56.004 - 56.005 (2.2049 - 2.2049)	56.005 - 56.006 (2.2049 - 2.2050)	56.006 - 56.007 (2.2050 - 2.2050)	56.007 - 56.008 (2.2050 - 2.2050)	56.008 - 56.009 (2.2050 - 2.2051)	56.009 - 56.010 (2.2051 - 2.2051)	56.010 - 56.011 (2.2051 - 2.2052)	56.011 - 56.012 (2.2052 - 2.2052)	56.012 - 56.013 (2.2052 - 2.2052)	56.013 - 56.014 (2.2052 - 2.2053)	56.014 - 56.015 (2.2053 - 2.2053)	56.015 - 56.016 (2.2053 - 2.2053)	56.016 - 56.017 (2.2053 - 2.2054)
Mark	Axle diameter																					
A	51.978 - 51.979 (2.0464 - 2.0464)		0	0	0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23
B	51.977 - 51.978 (2.0463 - 2.0464)		0	0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23
C	51.976 - 51.977 (2.0463 - 2.0463)		0	0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23
D	51.975 - 51.976 (2.0463 - 2.0463)		0	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3
E	51.974 - 51.975 (2.0462 - 2.0463)		0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3
F	51.973 - 51.974 (2.0462 - 2.0462)		0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3
G	51.972 - 51.973 (2.0461 - 2.0462)		0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34
H	51.971 - 51.972 (2.0461 - 2.0461)		01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34
J	51.970 - 51.971 (2.0461 - 2.0461)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34
K	51.969 - 51.970 (2.0460 - 2.0461)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
L	51.968 - 51.969 (2.0460 - 2.0460)		1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
M	51.967 - 51.968 (2.0459 - 2.0460)		1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
N	51.966 - 51.967 (2.0459 - 2.0459)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
P	51.965 - 51.966 (2.0459 - 2.0459)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
R	51.964 - 51.965 (2.0458 - 2.0459)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
S	51.963 - 51.964 (2.0458 - 2.0458)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
T	51.962 - 51.963 (2.0457 - 2.0458)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
U	51.961 - 51.962 (2.0457 - 2.0457)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
V	51.960 - 51.961 (2.0457 - 2.0457)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5
W	51.959 - 51.960 (2.0456 - 2.0457)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5

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MAIN BEARING SELECTION TABLE (No. 2, 3 AND 5 JOURNAL)

Crankshaft main journal diameter Unit: mm (in) / Cylinder block main bearing housing inner diameter Unit: mm (in)		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W
Mark	Axle diameter	Hole diameter	55.997 - 55.998 (2.2046 - 2.2046)	55.998 - 55.999 (2.2046 - 2.2047)	55.999 - 56.000 (2.2047 - 2.2047)	56.000 - 56.001 (2.2047 - 2.2048)	56.001 - 56.002 (2.2048 - 2.2048)	56.002 - 56.003 (2.2048 - 2.2048)	56.003 - 56.004 (2.2048 - 2.2049)	56.004 - 56.005 (2.2049 - 2.2049)	56.005 - 56.006 (2.2049 - 2.2050)	56.006 - 56.007 (2.2050 - 2.2050)	56.007 - 56.008 (2.2050 - 2.2050)	56.008 - 56.009 (2.2050 - 2.2051)	56.009 - 56.010 (2.2051 - 2.2051)	56.010 - 56.011 (2.2051 - 2.2052)	56.011 - 56.012 (2.2052 - 2.2052)	56.012 - 56.013 (2.2052 - 2.2052)	56.013 - 56.014 (2.2052 - 2.2053)	56.014 - 56.015 (2.2053 - 2.2053)	56.015 - 56.016 (2.2053 - 2.2053)	56.016 - 56.017 (2.2053 - 2.2054)
A	51.978 - 51.979 (2.0464 - 2.0464)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
B	51.977 - 51.978 (2.0463 - 2.0464)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
C	51.976 - 51.977 (2.0463 - 2.0463)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
D	51.975 - 51.976 (2.0463 - 2.0463)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
E	51.974 - 51.975 (2.0462 - 2.0463)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
F	51.973 - 51.974 (2.0462 - 2.0462)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
G	51.972 - 51.973 (2.0461 - 2.0462)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
H	51.971 - 51.972 (2.0461 - 2.0461)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
J	51.970 - 51.971 (2.0461 - 2.0461)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
K	51.969 - 51.970 (2.0460 - 2.0461)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
L	51.968 - 51.969 (2.0460 - 2.0460)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
M	51.967 - 51.968 (2.0459 - 2.0460)		3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
N	51.966 - 51.967 (2.0459 - 2.0459)		3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
P	51.965 - 51.966 (2.0459 - 2.0459)		34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
R	51.964 - 51.965 (2.0458 - 2.0459)		34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
S	51.963 - 51.964 (2.0458 - 2.0458)		34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
T	51.962 - 51.963 (2.0457 - 2.0458)		4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
U	51.961 - 51.962 (2.0457 - 2.0457)		4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
V	51.960 - 51.961 (2.0457 - 2.0457)		4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7
W	51.959 - 51.960 (2.0456 - 2.0457)		45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	7	7

PBIC4079E

MAIN BEARING GRADE TABLE (ALL JOURNALS)

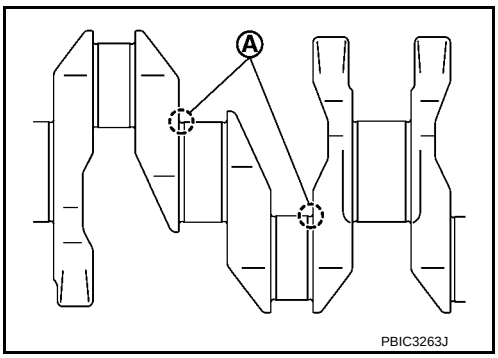
Main bearing grade table (All journals) : Refer to EM-151, "Main Bearing".

UNDERSIZE BEARING USAGE GUIDE

- When the specified main bearing oil clearance is not obtained with standard size main bearings, use undersize (US) bearing.
- When using undersize (US) bearing, measure the main bearing inner diameter with bearing installed, and grind main journal so that the main bearing oil clearance satisfies the standard.

CAUTION:

In grinding crankshaft main journal to use undersize bearings, keep the fillet R [1.5 - 1.7 mm (0.059 - 0.067 in)] (A).



Bearing undersize table:

Refer to EM-151, "Main Bearing".

SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000014727362

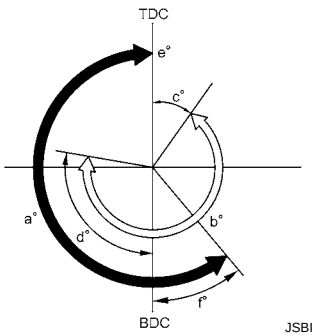
GENERAL SPECIFICATIONS

Engine type		MR20DD
Cylinder arrangement		In-line 4
Displacement cm^3 (cu in)		1,997 (121.86)
Bore and stroke mm (in)		84.0×90.1 (3.307×3.547)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Compression ratio		11.2
Compression pressure kPa (bar, kg/cm^2, psi)/250 rpm	Standard	1,530 (15.3, 15.6, 222)
	Minimum	1,280 (12.8, 13.1, 186)
	Differential limit between cylinders	100 (1.0, 1.0, 15)

Unit: degree

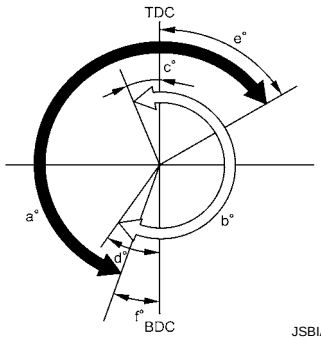
Valve timing
⇦: Intake valve
⬅: Exhaust valve

VTC Minimum phasing (Mechanical)



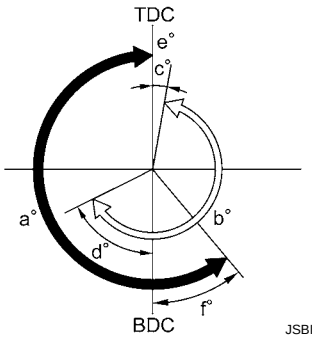
JSBIA6490GB

VTC Maximum phasing (Mechanical)



JSBIA6491GB

Engine start (Mechanical)



JSBIA6492GB

a	b	c	d	e	f
EXH valve opening angle	INT valve opening angle	INT open	INT close	EXH close	EXH open

VTC Minimum phasing (Mechanical) *1	220	240	43 ATDC	103 ABDC	0 TDC	40 BBDC
VTC Maximum phasing (Mechanical) *2			22 BTDC	38 ABDC	60 ATDC	20 ABDC
Intermediate lock phasing (Mechanical) *3			8 ATDC	68 ABDC	0 TDC	40 BBDC

*1: When running at idle with engine coolant temperature more than 60°C (140°F).

*2: When the intake or exhaust valve opening angle is at the maximum.

*3: When starting the engine with engine coolant temperature 60°C (140°F) or less.

Spark Plug

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SPARK PLUG

Unit: mm (in)

Make		NGK
Standard type		DILKAR7D11H
Gap (Nominal)	Standard	1.1 (0.043)
	Limit	1.3 (0.051)

Exhaust Manifold

INFOID:0000000014727364

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Each exhaust port	0.3 (0.012)
	Entire part	0.7 (0.028)

Camshaft

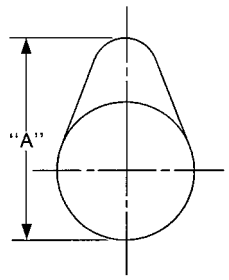
INFOID:0000000014727365

CAMSHAFT

Unit: mm (in)

Items		Standard	Limit
Camshaft journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
	No. 2, 3, 4, 5	0.030 - 0.071 (0.0012 - 0.0028)	
Camshaft bracket inner diameter	No. 1	28.000 - 28.021 (1.1024 - 1.1032)	—
	No. 2, 3, 4, 5	25.000 - 25.021 (0.9843 - 0.9851)	—
Camshaft journal diameter	No. 1	27.935 - 27.955 (1.0998 - 1.1006)	—
	No. 2, 3, 4, 5	24.950 - 24.970 (0.9823 - 0.9831)	—
Camshaft end play		0.075 - 0.153 (0.0030 - 0.0060)	0.24 (0.0094)
Camshaft cam height “A”	Intake	45.265 - 45.455 (1.7821 - 1.7896)	45.085 (1.7750)
	Exhaust	43.775 - 43.965 (1.7234 - 1.7309)	43.575 (1.7155)
Camshaft runout [TIR*]		Less than 0.014 (0.0006)	0.05 (0.0020)

Camshaft sprocket runout [TIR*]	—	0.15 (0.0059)



SEM671

*: Total indicator reading

VALVE LIFTER

Unit: mm (in)

Items		Standard
Valve lifter outer diameter	Intake	33.977 - 33.987 (1.3377 - 1.3381)
	Exhaust	29.977 - 29.987 (1.1802 - 1.1806)
Valve lifter hole diameter	Intake	34.000 - 34.021 (1.3386 - 1.3394)
	Exhaust	30.000 - 30.021 (1.1811 - 1.1819)
Valve lifter clearance		0.013 - 0.044 (0.0005 - 0.0017)

VALVE CLEARANCE

Unit: mm (in)

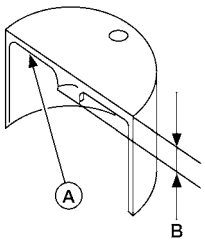
Items	Cold	Hot* (reference data)
Intake	0.24 - 0.32 (0.009 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.26 - 0.34 (0.010 - 0.013)	0.308 - 0.432 (0.012 - 0.017)

*: Approximately 80°C (176°F)

AVAILABLE VALVE LIFTER

Unit: mm (in)

Identification mark (A)	Thickness (B)



AWBIA3076ZZ

300	3.00 (0.1181)
302	3.02 (0.1189)
304	3.04 (0.1197)
306	3.06 (0.1205)
308	3.08 (0.1213)
310	3.10 (0.1220)
312	3.12 (0.1228)

Identification mark (A)	Thickness (B)
314	3.14 (0.1236)
316	3.16 (0.1244)
318	3.18 (0.1252)
320	3.20 (0.1260)
322	3.22 (0.1268)
324	3.24 (0.1276)
326	3.26 (0.1283)
328	3.28 (0.1291)
330	3.30 (0.1299)
332	3.32 (0.1307)
334	3.34 (0.1315)
336	3.36 (0.1323)
338	3.38 (0.1331)
340	3.40 (0.1339)
342	3.42 (0.1346)
344	3.44 (0.1354)
346	3.46 (0.1362)
348	3.48 (0.1370)
350	3.50 (0.1378)

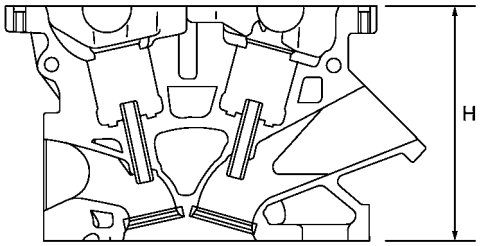
Cylinder Head

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CYLINDER HEAD

Unit: mm (in)

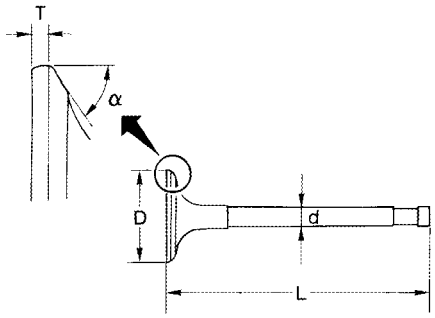
Items	Standard	Limit
Head surface distortion	—	0.1 (0.004)
Normal cylinder head height “H”	130.9 (5.15)	—



PBIC0924E

VALVE DIMENSIONS

Unit: mm (in)

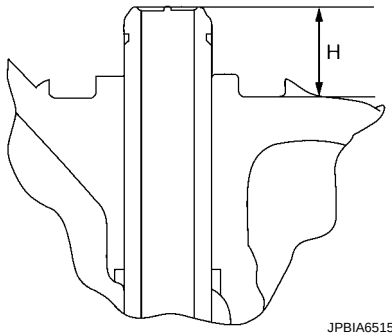


JSBIA1166ZZ

Valve head diameter “D”	Intake	33.8 - 34.1 (1.331 - 1.343)
	Exhaust	27.6 - 27.9 (1.087 - 1.098)
Valve length “L”	Intake	106.42 (4.19)
	Exhaust	105.41 (4.15)
Valve stem diameter “d”	Intake	5.465 - 5.480 (0.2152 - 0.2157)
	Exhaust	5.455 - 5.470 (0.2148 - 0.2154)
Valve seat angle “α”		45°15′ - 45°45′
Valve margin “T”	Intake	1.3 - 1.6 (0.051 - 0.063)
	Exhaust	1.45 - 1.75 (0.057 - 0.069)

VALVE GUIDE

Unit: mm (in)



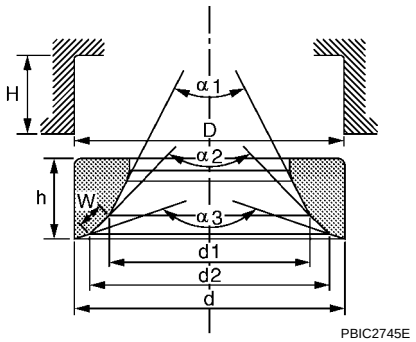
JPBIA6515ZZ

Items		Standard	Oversize (service) [0.2 (0.008)]
Valve guide	Outer diameter	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)
	Inner diameter (Finished size)	5.500 - 5.518 (0.2165 - 0.2172)	
Cylinder head valve guide hole diameter		9.475 - 9.496 (0.3730 - 0.3739)	9.675 - 9.696 (0.3809 - 0.3817)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	

Items		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	
Projection length “H”		13.35 - 13.65 (0.5256 - 0.5374)	

VALVE SEAT

Unit: mm (in)



Items		Standard	Oversize (service) [0.5 (0.02)]
Cylinder head seat recess diameter “D”	Intake	34.700 - 34.727 (1.3661 - 1.3672)	35.200 - 35.227 (1.3858 - 1.3869)
	Exhaust	28.700 - 28.727 (1.1299 - 1.1310)	29.200 - 29.227 (1.1496 - 1.1507)
Valve seat outer diameter “d”	Intake	34.808 - 34.824 (1.3704 - 1.3710)	35.297 - 35.313 (1.3896 - 1.3903)
	Exhaust	28.808 - 28.824 (1.1342 - 1.1348)	29.308 - 29.324 (1.1539 - 1.1545)
Valve seat interference fit		0.081 - 0.124 (0.0032 - 0.0049)	
Diameter “d1”*1	Intake	31.8 (1.252)	
	Exhaust	25.3 (0.996)	
Diameter “d2”*2	Intake	33.1 - 33.6 (1.303 - 1.323)	
	Exhaust	26.9 - 27.4 (1.059 - 1.079)	
Angle “α1”	Intake	70°	
	Exhaust	45°	
Angle “α2”		88°45′ - 90°15′	
Angle “α3”		120°	
Contacting width “W”*3	Intake	1.0 - 1.4 (0.039 - 0.055)	
	Exhaust	1.2 - 1.6 (0.047 - 0.063)	
Height “h”	Intake	5.9 - 6.0 (0.232 - 0.236)	5.03 - 5.13 (0.1980 - 0.2020)
	Exhaust		4.95 - 5.05 (0.1949 - 0.1988)
Depth “H”	Intake	6.04 (0.2378)	
	Exhaust	6.05 (0.2382)	

*1: Diameter made by intersection point of conic angles “α1” and “α2”

*2: Diameter made by intersection point of conic angles “α2” and “α3”

*3: Machining data

VALVE SPRING

Items	Standard	
	Intake	Exhaust
Free height	48.5 mm (1.909 in)	52.0 mm (2.047 in)
Installation height	37.46 mm (1.475 in)	37.46 mm (1.475 in)
Installation load	155 - 177 N (15.8 - 18.1 kg, 34.8 - 39.8 lb)	140 - 156 N (14.3 - 15.9 kg, 31.5 - 35.1 lb)
Height during valve open	27.86 mm (1.0968 in)	29.4 mm (1.1575 in)
Load with valve open	351 - 385 N (35.8 - 39.3 kg, 78.9 - 86.5 lb)	280 - 306 N (28.6 - 31.2 kg, 62.9 - 68.8 lb)
Identification color	Yellow	—

Unit: mm (in)

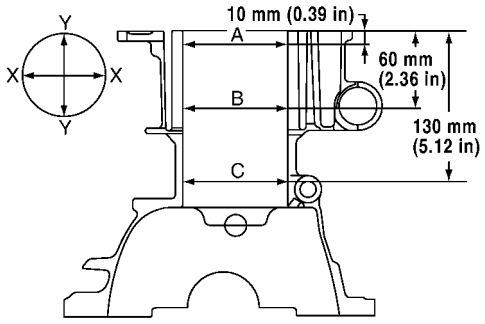
Items	Limit
Valve spring squareness	1.0 (0.039)

Cylinder Block

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CYLINDER BLOCK

Unit: mm (in)

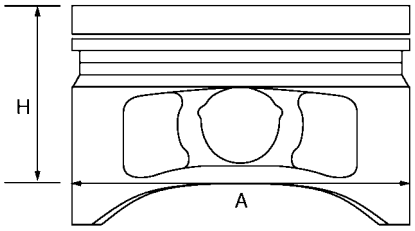


PBIC4017E

Cylinder block top surface distortion	Limit		0.03 (0.001)
Cylinder bore inner diameter	Standard	Grade No. 1	84.000 - 84.010 (3.3071 - 3.3075)
		Grade No. 2	84.010 - 84.020 (3.3075 - 3.3079)
Out-of-round	Limit		0.015 (0.0006)
Taper			0.010 (0.0004)
Main bearing housing inner diameter grade		Grade No. A	55.997 - 55.998 (2.2046 - 2.2046)
		Grade No. B	55.998 - 55.999 (2.2046 - 2.2047)
		Grade No. C	55.999 - 56.000 (2.2047 - 2.2047)
		Grade No. D	56.000 - 56.001 (2.2047 - 2.2048)
		Grade No. E	56.001 - 56.002 (2.2048 - 2.2048)
		Grade No. F	56.002 - 56.003 (2.2048 - 2.2048)
		Grade No. G	56.003 - 56.004 (2.2048 - 2.2049)
		Grade No. H	56.004 - 56.005 (2.2049 - 2.2049)
		Grade No. J	56.005 - 56.006 (2.2049 - 2.2050)
		Grade No. K	56.006 - 56.007 (2.2050 - 2.2050)
		Grade No. L	56.007 - 56.008 (2.2050 - 2.2050)
		Grade No. M	56.008 - 56.009 (2.2050 - 2.2051)
		Grade No. N	56.009 - 56.010 (2.2051 - 2.2051)
		Grade No. P	56.010 - 56.011 (2.2051 - 2.2052)
		Grade No. R	56.011 - 56.012 (2.2052 - 2.2052)
		Grade No. S	56.012 - 56.013 (2.2052 - 2.2052)
		Grade No. T	56.013 - 56.014 (2.2052 - 2.2053)
		Grade No. U	56.014 - 56.015 (2.2053 - 2.2053)
		Grade No. V	56.015 - 56.016 (2.2053 - 2.2053)
		Grade No. W	56.016 - 56.017 (2.2053 - 2.2054)

AVAILABLE PISTON

Unit: mm (in)



PBIC0188E

Piston skirt diameter “A”	Standard	Grade No. 1	83.970 - 83.980 (3.3059 - 3.3063)
		Grade No. 2	83.980 - 83.990 (3.3063 - 3.3067)
Measure point “H”			39.2 (1.543)
Piston pin hole diameter			19.993 - 19.999 (0.7871 - 0.7874)
Piston to cylinder bore clearance		Standard	0.020 - 0.040 (0.0008 - 0.0016)
		Limit	0.08 (0.0031)

PISTON RING

Unit: mm (in)

Items		Standard	Limit
Piston ring side clearance	Top ring	0.04 - 0.08 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd ring	0.03 - 0.07 (0.0012 - 0.0028)	0.10 (0.0039)
	Oil ring	0.055 - 0.155 (0.0022 - 0.0061)	—
Piston ring end gap	Top ring	0.20 - 0.30 (0.0079 - 0.0118)	0.49 (0.0193)
	2nd ring	0.50 - 0.65 (0.0197 - 0.0256)	0.81 (0.0319)
	Oil (rail ring)	0.15 - 0.45 (0.0059 - 0.0177)	0.76 (0.0299)

PISTON PIN

Unit: mm (in)

Items	Standard	Limit
Piston pin outer diameter	19.989 - 19.995 (0.7870 - 0.7872)	—
Piston to piston pin oil clearance	0.002 - 0.006 (0.0001 - 0.0002)	—

CONNECTING ROD

Unit: mm (in)

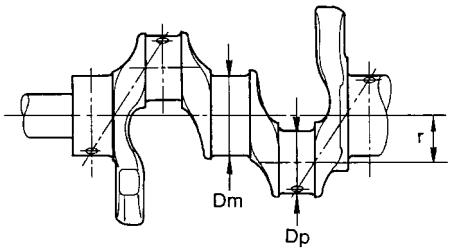
Center distance		138.97 - 139.07 (5.47 - 5.48)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod bushing inner diameter*	Standard	20.000 - 20.012 (0.7874 - 0.7879)
Connecting rod bushing oil clearance	Standard	0.005 - 0.023 (0.0002 - 0.0009)
	Limit	0.03 (0.0012)

Connecting rod side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.4 (0.016)
Connecting rod big end diameter grade	Grade No. A	47.000 - 47.001 (1.8504 - 1.8504)
	Grade No. B	47.001 - 47.002 (1.8504 - 1.8505)
	Grade No. C	47.002 - 47.003 (1.8505 - 1.8505)
	Grade No. D	47.003 - 47.004 (1.8505 - 1.8505)
	Grade No. E	47.004 - 47.005 (1.8505 - 1.8506)
	Grade No. F	47.005 - 47.006 (1.8506 - 1.8506)
	Grade No. G	47.006 - 47.007 (1.8506 - 1.8507)
	Grade No. H	47.007 - 47.008 (1.8507 - 1.8507)
	Grade No. J	47.008 - 47.009 (1.8507 - 1.8507)
	Grade No. K	47.009 - 47.010 (1.8507 - 1.8508)
	Grade No. L	47.010 - 47.011 (1.8508 - 1.8508)
	Grade No. M	47.011 - 47.012 (1.8508 - 1.8509)
	Grade No. N	47.012 - 47.013 (1.8509 - 1.8509)

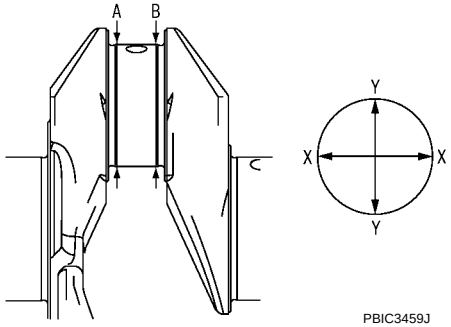
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



PBIC3459J

Center distance “r”		44.89 - 44.97 (1.7673 - 1.7705)
Out-of-round	Limit	0.0035 (0.0001)
Taper	Limit	
Runout [TIR*]	Standard	0.05 (0.0020)
	Limit	0.1 (0.004)
Crankshaft end play	Standard	0.10 - 0.26 (0.0039 - 0.0102)
	Limit	0.3 (0.012)

Crankshaft pin journal diameter “Dp” grade.	Grade No. A	43.970 - 43.971 (1.7311 - 1.7311)
	Grade No. B	43.969 - 43.970 (1.7311 - 1.7311)
	Grade No. C	43.968 - 43.969 (1.7310 - 1.7311)
	Grade No. D	43.967 - 43.968 (1.7310 - 1.7310)
	Grade No. E	43.966 - 43.967 (1.7309 - 1.7310)
	Grade No. F	43.965 - 43.966 (1.7309 - 1.7309)
	Grade No. G	43.964 - 43.965 (1.7309 - 1.7309)
	Grade No. H	43.963 - 43.964 (1.7308 - 1.7309)
	Grade No. J	43.962 - 43.963 (1.7308 - 1.7308)
	Grade No. K	43.961 - 43.962 (1.7307 - 1.7308)
	Grade No. L	43.960 - 43.961 (1.7307 - 1.7307)
	Grade No. M	43.959 - 43.960 (1.7307 - 1.7307)
	Grade No. N	43.958 - 43.959 (1.7306 - 1.7307)
	Grade No. P	43.957 - 43.958 (1.7306 - 1.7306)
	Grade No. R	43.956 - 43.957 (1.7305 - 1.7306)
	Grade No. S	43.955 - 43.956 (1.7305 - 1.7305)
	Grade No. T	43.954 - 43.955 (1.7305 - 1.7305)
	Grade No. U	43.953 - 43.954 (1.7304 - 1.7305)
Crankshaft main journal diameter “Dm” grade.	Grade No. A	51.978 - 51.979 (2.0464 - 2.0464)
	Grade No. B	51.977 - 51.978 (2.0463 - 2.0464)
	Grade No. C	51.976 - 51.977 (2.0463 - 2.0463)
	Grade No. D	51.975 - 51.976 (2.0463 - 2.0463)
	Grade No. E	51.974 - 51.975 (2.0462 - 2.0463)
	Grade No. F	51.973 - 51.974 (2.0462 - 2.0462)
	Grade No. G	51.972 - 51.973 (2.0461 - 2.0462)
	Grade No. H	51.971 - 51.972 (2.0461 - 2.0461)
	Grade No. J	51.970 - 51.971 (2.0461 - 2.0461)
	Grade No. K	51.969 - 51.970 (2.0460 - 2.0461)
	Grade No. L	51.968 - 51.969 (2.0460 - 2.0460)
	Grade No. M	51.967 - 51.968 (2.0459 - 2.0460)
	Grade No. N	51.966 - 51.967 (2.0459 - 2.0459)
	Grade No. P	51.965 - 51.966 (2.0459 - 2.0459)
	Grade No. R	51.964 - 51.965 (2.0458 - 2.0459)
	Grade No. S	51.963 - 51.964 (2.0458 - 2.0458)
	Grade No. T	51.962 - 51.963 (2.0457 - 2.0458)
	Grade No. U	51.961 - 51.962 (2.0457 - 2.0457)
	Grade No. V	51.960 - 51.961 (2.0457 - 2.0457)
	Grade No. W	51.959 - 51.960 (2.0456 - 2.0457)

*: Total indicator reading

Connecting Rod Bearing

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CONNECTING ROD BEARING GRADE TABLE

Unit: mm (in)

Grade number		Thickness	Identification color	Remarks
0		1.494 - 1.497 (0.0588 - 0.0589)	Black - Black	Grade and color are the same for upper and lower bearings.
1		1.497 - 1.500 (0.0589 - 0.0591)	Brown - Brown	
2		1.500 - 1.503 (0.0591 - 0.0592)	Green - Green	
3		1.503 - 1.506 (0.0592 - 0.0593)	Yellow - Yellow	
4		1.506 - 1.509 (0.0593 - 0.0594)	Blue - Blue	
01	UPR	1.494 - 1.497 (0.0588 - 0.0589)	Black - Black	Grade and color are different between upper and lower bearings.
	LWR	1.497 - 1.500 (0.0589 - 0.0591)	Brown - Brown	
12	UPR	1.497 - 1.500 (0.0589 - 0.0591)	Brown - Brown	
	LWR	1.500 - 1.503 (0.0591 - 0.0592)	Green - Green	
23	UPR	1.500 - 1.503 (0.0591 - 0.0592)	Green - Green	
	LWR	1.503 - 1.506 (0.0592 - 0.0593)	Yellow - Yellow	
34	UPR	1.503 - 1.506 (0.0592 - 0.0593)	Yellow - Yellow	
	LWR	1.506 - 1.509 (0.0593 - 0.0594)	Blue - Blue	

UNDERSIZE TABLE

Unit: mm (in)

Items	Thickness	Crank pin journal diameter
US 0.25 (0.0098)	1.623 - 1.631 (0.0639 - 0.0642)	Grind so that bearing clearance is the specified value.

CONNECTING ROD BEARING OIL CLEARANCE

Unit: mm (in)

Connecting rod bearing oil clearance	Standard	0.037 - 0.047 (0.0015 - 0.0019)
	Limit	0.07 (0.0028)

Main Bearing

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MAIN BEARING GRADE TABLE (ALL JOURNALS)

Unit: mm (in)

Grade number		Thickness	Identification color	Remarks
0		1.996 - 1.999 (0.0786 - 0.0787)	Black - Black	Grade and color are the same for upper and lower bearings.
1		1.999 - 2.002 (0.0787 - 0.0788)	Brown - Brown	
2		2.002 - 2.005 (0.0788 - 0.0789)	Green - Green	
3		2.005 - 2.008 (0.0789 - 0.0791)	Yellow - Yellow	
4		2.008 - 2.011 (0.0791 - 0.0792)	Blue - Blue	
5		2.011 - 2.014 (0.0792 - 0.0793)	Pink - Pink	
6		2.014 - 2.017 (0.0793 - 0.0794)	Purple - Purple	
7		2.017 - 2.020 (0.0794 - 0.0795)	White - White	
01	UPR	1.996 - 1.999 (0.0786 - 0.0787)	Black - Black	Grade and color are different between upper and lower bearings.
	LWR	1.999 - 2.002 (0.0787 - 0.0788)	Brown - Brown	
12	UPR	1.999 - 2.002 (0.0787 - 0.0788)	Brown - Brown	
	LWR	2.002 - 2.005 (0.0788 - 0.0789)	Green - Green	
23	UPR	2.002 - 2.005 (0.0788 - 0.0789)	Green - Green	
	LWR	2.005 - 2.008 (0.0789 - 0.0791)	Yellow - Yellow	
34	UPR	2.005 - 2.008 (0.0789 - 0.0791)	Yellow - Yellow	
	LWR	2.008 - 2.011 (0.0791 - 0.0792)	Blue - Blue	
45	UPR	2.008 - 2.011 (0.0791 - 0.0792)	Blue - Blue	
	LWR	2.011 - 2.014 (0.0792 - 0.0793)	Pink - Pink	
56	UPR	2.011 - 2.014 (0.0792 - 0.0793)	Pink - Pink	
	LWR	2.014 - 2.017 (0.0793 - 0.0794)	Purple - Purple	
67	UPR	2.014 - 2.017 (0.0793 - 0.0794)	Purple - Purple	
	LWR	2.017 - 2.020 (0.0794 - 0.0795)	White - White	

UNDERSIZE TABLE

Unit: mm (in)

Items	Thickness	Main journal diameter
US 0.25 (0.0098)	2.126 - 2.134 (0.0837 - 0.0840)	Grind so that bearing clearance is the specified value.

MAIN BEARING OIL CLEARANCE

Unit: mm (in)

Main bearing oil clearance	Standard	No. 1 and 4	0.024 - 0.034 (0.0009 - 0.0013)
		No. 2, 3 and 5	0.012 - 0.022 (0.0005 - 0.0009)
	Limit		0.065 (0.0026)